RADIO SOURCE POSITIONS THROUGH FOUR ANTENNA LONG BASELINE INTERFEROMETRY

by

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Submitted to the Department of Earth and Planetary Sciences in May 1979, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

ABSTRACT

Simultaneous long-baseline interferometric observations have been made of pairs of radio sources. The resulting phase delays measured for each source have been extrapolated unambiguously from observation to observation in order to produce a set of observations that are free from ambiguity except for a single overall constant for each day's observations. The phase delays measured for the two sources of the pair have been differenced in order to produce an observable free from any error due to a difference in the rates of the clocks at the ends of the long baseline. This observable can be used to estimate the relative positions of the radio sources. The errors in this observable may be as low as 20 psec, and relative right ascensions of the source pair 3C 273 - 3C 279 are consistent from day to day to within 0ʺ.003 rms. Six sources have been observed by this technique during experiments in January and October, 1972.

Thesis Supervisor: Irwin I. Shapiro

Title: Professor of Geophysics and Physics

ACKNOWLEDGEMENT

The experiments reported in this thesis were considerably more difficult, in terms of the bulk of data, and the amount of human energy expended, than any other VLBI experiments performed to date. From the beginning, these experiments were an effort of the whole association which is now known as the Haystack-MIT-Goddard Space Flight Center VLBI group. Dr. Thomas A. Clark of GSFC and his associates, particularly Kate Hutton, Gerry Marandino, George Resch, and Nancy Vandenberg, spent months with me in Green Bank, changing tapes while the seasons passed from late Summer to the first snow. At Haystack, Chuck Counselman, Hans Hinteregger, Alan Rogers, and Alan Whitney spent equally long hours in a somewhat less relaxing environment during the periods of data taking, and personally helped in many ways in the following analysis. D.S. Robertson deserves thanks for his contributions to the computer analysis. George Catuna and Norm Donald correlated the more than 7000 pairs of tapes from these experiments - truly a significant contribution to the task!

I would like particularly to thank Prof. Irwin I. Shapiro for personal support at many times during the past twelve years.

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I. Astrometry

1. Introduction

In a time that was already archaic when Aristotle wrote, men believed that the secrets of the universe and of their own lives were revealed to them by the gods, who were the stars in the sky. Aristotle considered that this was an inspired opinion.[1] It has surely survived the test of the ages, since a matured version of the ancients' concern for the state of the heavenly bodies leads us to investigate them today. Before very recent times, the only information available about external objects was that concerning their position and brightness. Hawkins[2] estimates that the builders of Stonehenge in Southwestern England expended a large part of their gross national product over a period of ten years in order to construct a machine to measure the positions of the sun and moon in order to predict eclipses. The accuracy of the measurements required for this purpose is several minutes of arc. Modern telescopic measurements of the stars' positions have improved on this accuracy by a factor of about one thousand. This improvement brought about the discovery of many of the phenomena upon which our modern theories of the motions of the Earth and stars are based. In this thesis we will present the result of an effort to improve positional measurement accuracy by another factor of about one thousand, by employing long-baseline radio interferometers in the simultaneous observation of pairs of radio sources.

2. Optical Astrometry

Optical astrometry is the measurement of angles between stars, or between stars and the local vertical direction. The angles measured are determined by the positions and velocities of the telescopes, and by the true angles as would be measured in an inertial frame. At the time of the first telescopic measurements of the positions of the stars and planets, the only recognized motions of the telescopes were those associated with the orbital and rotational motion of the Earth, and the general precession of the axis of rotation. As telescopic measurement accuracy improved to near its present value, small perturbations of the Earth's motion were revealed. The first of these was the 18.6 year nutation, discovered by James Bradley, the third Astronomer Royal. Bradley, in his pursuit of accuracy, also was the first to notice the annual aberration due to the finite velocity of light, an effect which is at most about 20 seconds of arc. The speed of light itself was first measured by astronomical observations of phenomena in the satellite system of Jupiter, which were delayed when Jupiter was further away from the Earth. Bradley's discovery of nutation and aberration were made in the course of an investigation of a subtler effect - the parallax of nearby stars due to the Earth's orbital motion. The first parallax, of 0.3 seconds of arc, was measured by Bessel in 1838.

All these observations had been made by eye, since photography was not employed much before the twentieth century. Photography opened new vistas to astronomers, who could study much fainter objects, and particularly those objects of lower surface brightness such as the nebulae. Photography improved the results of positional astronomy also, but not by nearly so dramatic an amount. In fact, it is the quantity of observations, and the lessening of the need for an observer of surpassing skill, that have been the major benefits of photography. There is no doubt that there has also been a reduction in the systematic errors. Nevertheless, the present state of the art is such that the smallest measurable parallax is about 0.1 seconds of arc[3], and the r.m.s. differences between positions given the different star catalogues is of about the same order[4].

3. Limitations of Optical Astrometry

The errors in optical astrometry arise from four main sources. First, the photographic images of the objects are about 1" in size, due to the "seeing", or atmospheric scintillations. Second, in photographic astrometry, the plates are subject to deformations unless they are very carefully treated. These deformations would tend to cause systematic errors in the relative star coordinates. Also, there may be deflections in the instruments themselves which affect the focus, or the relation of the instrumental axes to the local vertical. This error is serious in the case of transit observations to determine "absolute" coordinates of stars. To see how easily a second of arc error may be made, consider that one second of arc deflection in an instrument three meters long is only a deflection of about 10^{-3} cm. Finally, star catalogues suffer from a more fundamental defect in that the bright nearby stars which are usually studied generally possess proper motions. That is, the angles between the stars, measured in an inertial frame, change due to the intrinsic relative velocities of the stars. These proper motions may cause the fundamental coordinates determined from the observations to rotate relative to inertial coordinates.

4. Desirable Improvements

These limitations lead to a consideration of what improvements would be desirable. A short list would include the following suggestions:

a) use sources significantly smaller than the typical stellar seeing disk - preferably point sources.
b) avoid the use of photographic plates
c) avoid reliance on strict mechanical tolerances
d) use sources that can in principle define an inertial coordinate system

Radio interferometric observations of extragalactic radio sources conform to these restrictions to an extent that the potential for measurement accuracy is improved by factors of 10 to more than 1000 depending on circumstances. To be sure, the techniques of radio astrometry have their own peculiar limitations, but at present these seem to permit significant improvements in the art of astrometry.

II. Radio Astrometry

1. Introduction

The first attempt to detect extraterrestrial radio radiation was apparently made by Thomas Edison, the remarkable inventor,[1] only a few years after Hertz discovered electromagnetic radiation in 1888.[2*] Edison failed because his equipment was insensitive, and because radiation at the wavelength he chose was totally reflected or absorbed by the ionosphere - a phenomenon which was then unknown. Sir Oliver Lodge proposed in 1897[3] to detect radio waves from the sun using a receiver designed for spark-gap transmissions. He reported his negative result in 1900. Thereafter, the idea remained dormant until Karl Jansky in 1933[4] accidentally discovered a source of radio noise in the direction of the Milky Way, during an investigation of atmospheric radio noise. Even though this aspect of Jansky's work was not encouraged by his employer, The Bell Telephone Laboratories, the publication of his discovery kindled the imagination of Grote Reber, a radio engineer and amateur astronomer who built his own receiving system in his back yard in Wheaton, Illinois. The receiving system with which he finally succeeded in confirming Jansky's results was a thirty foot parabolic reflector and vacuum tube receiver operating at 160 MHz. Reber's original parabolic reflector is still used at the National Radio Astronomy Observatory as an aid in locating radio interference. With this instrument, remarkably advanced for its time, Reber completed the first map of the radio frequency brightness of the northern sky in 1944.[5] He discovered several discrete sources of radiation in directions other than the galactic center, but the angular

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*Reference numbers are restarted at the beginning of each chapter.

resolution of his instrument was insufficient to permit these to be unambiguously identified with objects on optical photographs.

The field of radio astronomy blossomed after the technical developments of the second world war, and the history of positional radio astronomy has since then been the story of a quest for improved sensitivity and angular resolution.

2. Angular Resolution

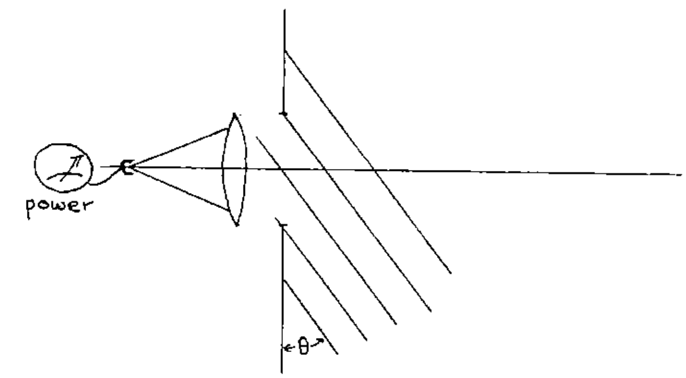


Fig. 2.1

Imagine a lens focusing energy upon a detector. In front of the lens is an aperture, and plane waves are incident upon the aperture from an angle θ with respect to the axis of symmetry of the system. A one-dimensional aperture of this kind is shown in figure 2.1. What will be the power received by the detector? Remember that the lens acts to provide a path of equal phase delay from all points in the plane of the lens to the focal point. In this case, the detector is directly on the optical axis of the system. If we let the phase of the electric field of the plane wave be at Z=0, the upper edge of the aperture, then the phase as a function of Z will be

$$\phi = \frac{\omega z \sin\theta}{c} \cong \frac{\omega z \theta}{c} = \frac{2\pi z \theta}{\lambda} \quad \text{if } \theta \ll 1 \tag{2.2.1}$$

where w is the frequency of the radiation and c is the speed of light.

So the resulting power, summed at the focal point is

$$P = \left[\int_0^L \exp \frac{2\pi i \theta z}{\lambda} \, dz \right]^2 \tag{2.2.2}$$

if the length of the aperture is L, i.e.,

$$P = \left[\frac{\sin \frac{\pi \theta L}{\lambda}}{\frac{\pi \theta L}{\lambda}} \right]^2 \tag{2.2.3}$$

This function is sketched in figure 2.2

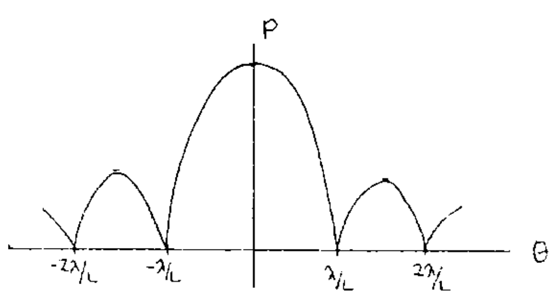


Fig. 2.2

It is seen that the main lobe of the response has a half-width, to the first set of zeros, of λ/L radian. This reflects a more general statement, not proved here,[6] that the angular breadth of the response of an antenna is roughly inversely proportional to the size of the antenna measured in wavelengths.

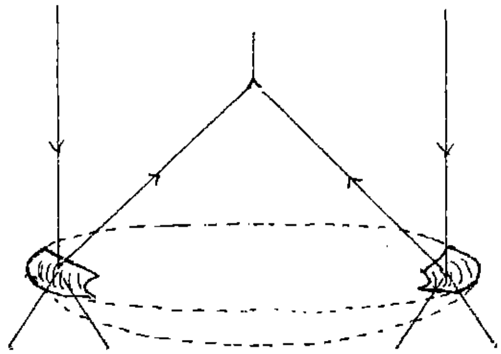
This points the way to improved angular resolution: either lower the wavelength or increase the size of the antenna. There are practical limitations to both approaches. If the wavelength is reduced much below 1 cm, performance is degraded due to the difficulty of constructing large antennas to such tolerances. (The mechanical tolerances tend to be proportional to the wavelength of operation.) Receiver technology is also less well developed for these wavelengths, and the atmosphere begins to lose its transparency due to absorption by water vapor and oxygen.

As for the diameter, L, large structures are awkward, and expensive to construct. These factors have limited the angular resolution of filled-aperture antennas to the present state of the art - about a minute of arc. The first large catalogs of radio source positions were made with large single antennas and resolutions of a few minutes of arc.[7] Further improvement awaited the development of the radio interferometer.

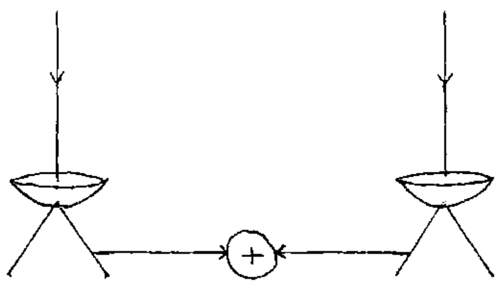
3. The Radio Interferometer

The principle of the radio interferometer is based on the

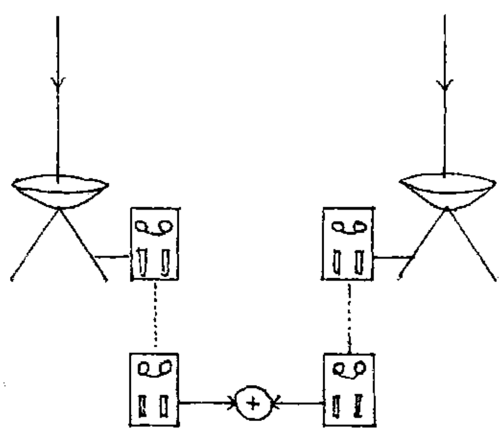
Figure 2.3



a) A large parabolic reflector - but only two pieces of the reflector are in place. The signals are reflected to a common summing point (feed horn)



b) A real-time interferometer. Here the signals are carried by wires to the summing point.



c) A tape-recording interferometer. The separation between antennas is arbitrary since no physical connection is required.

realization that a large filled aperture is not necessary. Imagine a large parabolic antenna of which only two small pieces are actually constructed as in fig. 2.3a.

The signals reflect from the two small pieces of reflector to the feed horn, where the electric fields are summed. What kind of power response pattern, analogous to figure 2.2, does this partial antenna have? The one-dimensional analog is shown in fig. 2.4. It consists of two slits, each of width D,

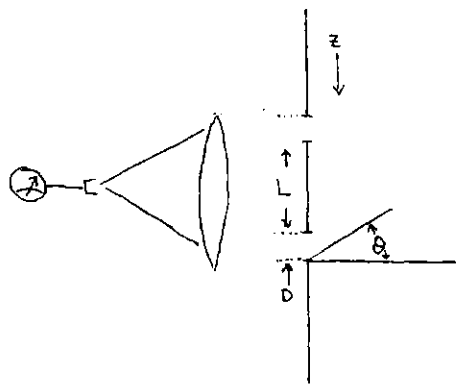


Fig. 2.4

separated by a distance L. The integral corresponding to 2.2.2 is for this case,

$$P = \left[\int_0^D \exp \frac{2\pi i \theta z}{\lambda} \, dz + \int_L^{L+D} \exp \frac{2\pi i \theta z}{\lambda} \, dz \right]^2 \qquad (2.3.1)$$

OR,

$$P = \left[\frac{\sin \frac{\pi \theta D}{\lambda}}{\frac{\pi \theta D}{\lambda}} \cos \frac{\pi \theta L}{\lambda} \right]^2 \qquad (2.3.2)$$

which is illustrated in figure 2.5. The response contains a rapid oscillation at an angular frequency corresponding to the total

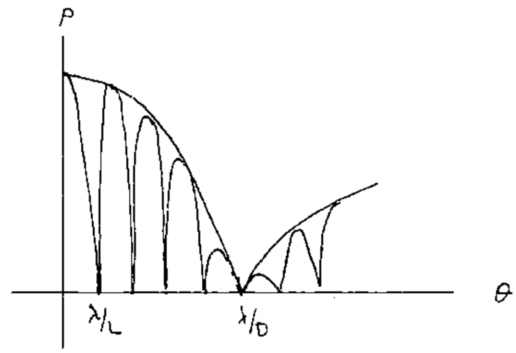


Fig. 2.5

separation L, modulated by a slow variation which is the response function of a single aperture of width D. The rapid variation occurs as the signals from the two slits are first in phase, then out of phase by π at the first minimum, then in phase again at the next maximum, and so on. These correspond to the interference fringes in the Young double-slit experiment, and this name is carried over to radio astronomy. This response does not at first appear very useful for locating radio sources in the sky, since the rapid oscillations are of almost the same amplitude near $\theta=0$, so that there is effectively an ambiguity in the determination of θ if you know P is at a local maximum. The resolution of this difficulty will be presented in the next chapter.

Figures 2.3b and 2.3c indicate more practical arrangements for constructing an interferometer. In fig. 2.3b, the signals are carried to the summing point by means of wires. In 2.3c, the signals are recorded on tape, along with timing signals, and the tapes are later played back into a machine which sums the signals, or performs an analogous function. This arrangement removes the need for a physical connection between the two places where signals are received, and so allows the separation L to be arbitrarily large, limited only by, say, the size of the Earth, although even this limit may be surmounted in principle. This radio interferometer will be analyzed in the next chapter to elucidate the information which may be derived from the response P (θ).

III. Long-baseline Interferometry

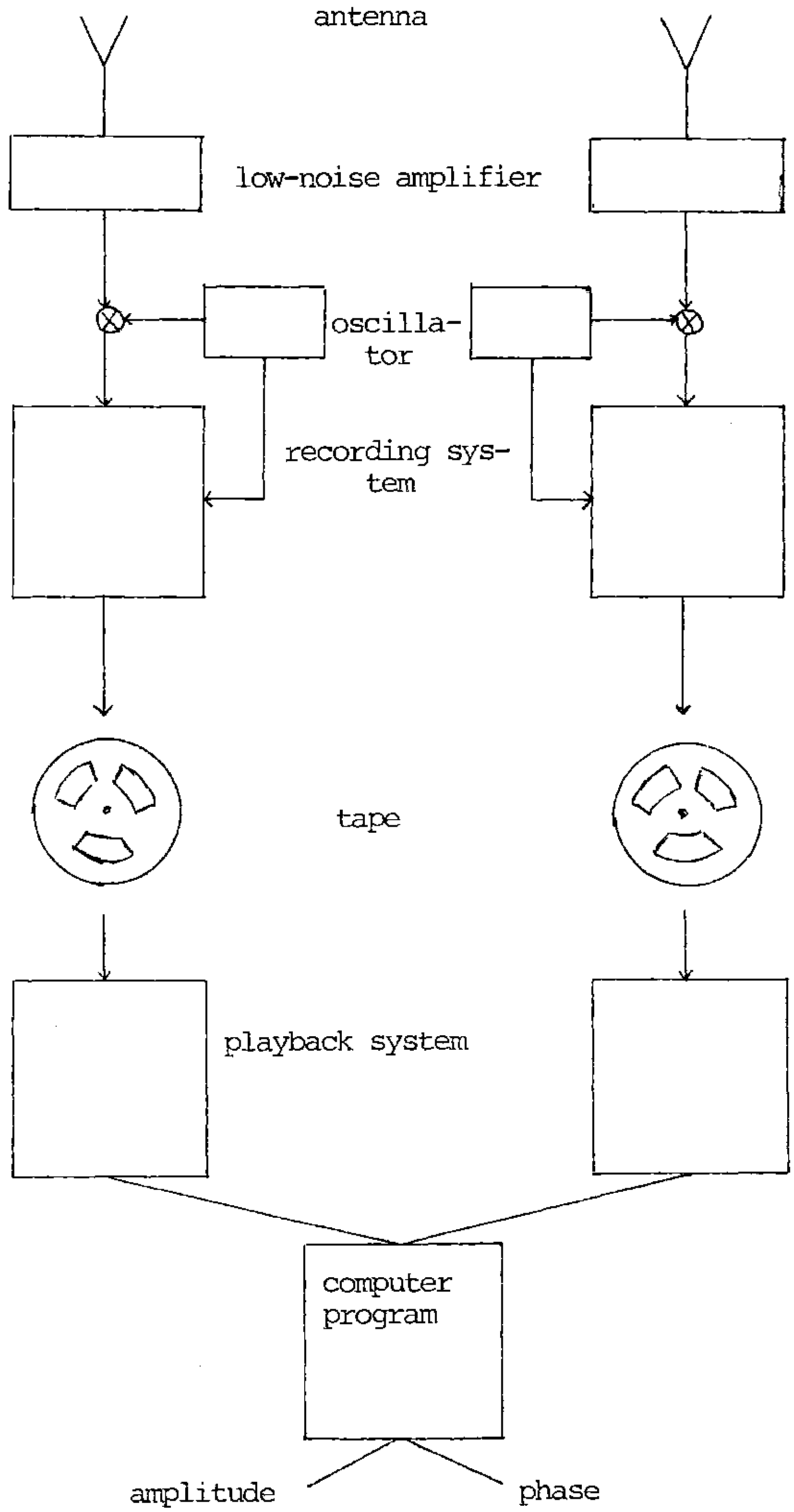
1. Introduction

Here we will derive simplified expressions for the total phase delay measured by a monochromatic interferometer observing a radio source. A more detailed analysis is presented, for instance, in (1) and (2). This analysis will begin by neglecting smaller effects such as reduction to inertial 1950.0 coordinates, differences between time systems, polar motion, and variations in the rotation of the Earth.

2. Response to a Point Source

The interferometer is pictured in figure 3.1. It will be recognized as a variation of the system sketched in figure 2.3c. Suppose that the two stations are located in vacuum at positions $r_i(t)$ $i=1,2$ and the voltage of the narrow-band gaussian random signal received at station i is $v_i(t) = A_i e^{i\omega t}$. The effect of the local oscillator and mixer at each station is to subtract the phase of the oscillator from the phase of the signal. Thus, the signal from the mixer will be $V_i(t) = A_i e^{i[\omega t - \varphi_{Lo}(t)]}$ neglecting noise added in the receiver, where $\varphi_{Lo}(t)$ is the phase of the local oscillator. The time derivative $\frac{d\varphi_{Lo}(t)}{dt}$ is the local oscillator frequency. This signal is processed further in a recording system and finally recorded on tape along with time signals that also originate in the local oscillator.

Figure 3.1


antenna
low-noise amplifier
oscilla-
tor
recording sys-
tem
tape
playback system
computer
program
amplitude
phase

At the same time station 1 is receiving $v_1(t)$, station 2 is receiving a signal $v_2(t)$ which is given by $v_2(t) = v_1(t+\tau)$ by virtue of the assumption that the source of radiation is a distant point source. τ is given implicitly by the expression

$$[\vec{r}_2(t+\tau) - \vec{r}_1(t)] \cdot \hat{e} = \tau \tag{3.2.1}$$

where $\hat{e}$ is a unit vector in the direction of the source of radiation. This expression for τ may be evaluated by successive approximations until the desired accuracy is obtained. For the purposes of this chapter, we will take

$$\tau = [\vec{r}_2(t) - \vec{r}_1(t)] \cdot \hat{e} = \vec{B}(t) \cdot \hat{e} \tag{3.2.2}$$

where $\vec{B}(t)$ is called the baseline vector. This expression neglects the motion of station 2 relative to station 1 during the transit time. The signal recorded at station 2 is therefore

$$V_2(t) = A_2 e^{i\omega[t + \vec{B}(t)\cdot\hat{e}] - \varphi_{lo}(t)} \tag{3.2.3}$$

neglecting noise added by the receiver.

These recordings are read by a computer program for the purpose of determining the phase difference between $V_1(t)$ and $V_2(t)$. The phase difference will be $\Phi(t) = \omega \vec{B}(t)\cdot\hat{e} + \varphi_{lo_2}(t) - \varphi_{lo_1}(t)$. The method used to determine $\Phi(t)$ is to compute an approximation to $\Phi(t)$ based on the best knowledge of the quantities $\vec{B}(t)$ and $\hat{e}$. The local-oscillator phase error $\varphi_{lo_2}(t) - \varphi_{lo_1}(t)$ is in general a random variable and cannot be estimated in advance, unless, for example, the local oscillator frequencies $\frac{d\varphi_{lo_i}}{dt}$ $i=1,2$ are known in advance to differ because of the electronic equipment used to generate the local oscillator signals. Here we assume that the phases φ_{lo_i} $i=1,2$ differ only because of random variations in the atomic frequency standards used to generate them. The best a priori approximation to $\Phi(t)$ may be written

$$\Phi^*(t) = \omega \vec{B}_0(t) \cdot \hat{e}_0 \qquad (3.2.4)$$

where $\vec{B}_0(t)$ and $\hat{e}_0$ are the a priori values of the baseline vector and the source position. The computation of $\vec{B}_0(t)$ is based on the theory of the motion of the stations.

3. Effect of Source Structure

Suppose that the response of a monochromatic interferometer to a point source of radiation is

$$R(t) = e^{i\omega \vec{B}(t)\cdot\hat{e}} \qquad (3.3.1)$$

The magnitude of $R(t)$ in 3.3.1 has been normalized to 1. The phase of $R(t)$ is the quantity of interest for determining the source direction. It is natural to inquire what sort of $R(t)$ would result from a source which is not a point source, but has a brightness distribution $I(\hat{e})$. Such a distributed source is illustrated in figure 3.2.

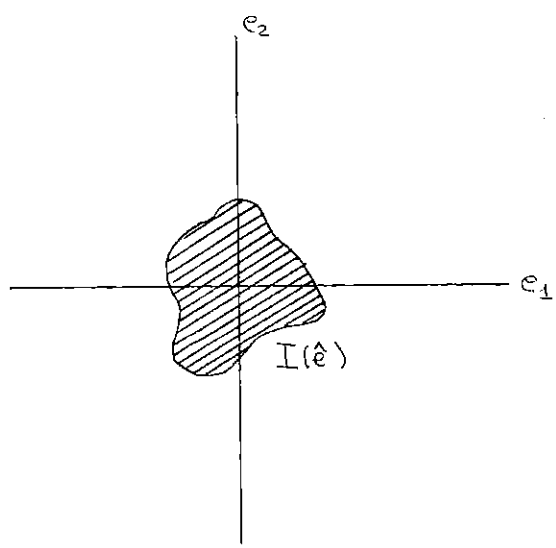


Fig.3.2

In figure 3.2 e_1 and e_2 are two components of the direction e and the origin of coordinates is at a direction $\hat{e}_o$. Assuming that the radiation from each direction is independent, the response to the entire distribution is given by the superposition

$$R(t) = \int d\hat{e} \;\; e^{i[\omega \vec{B}(t)\cdot\hat{e}]} \, I(\hat{e}) \qquad (3.3.2)$$

where the integral extends over the entire distribution. Writing this integral in terms of the conventional coordinates right ascension (α) and declination (δ), and assuming that the extent of the integration is small enough to justify the expansion of $\vec{B}(t)\cdot\hat{e}$ about the center of coordinates $\hat{e}_o = (\alpha_o, \delta_o)$, then we find

$$R(t) = \int d(\Delta\alpha\cos\delta)\, d(\Delta\delta)\, I(\alpha_o+\Delta\alpha, \delta_o+\Delta\delta) \exp i\left[\omega \vec{B}_o(t)\cdot\hat{e}_o + u(t)\Delta\alpha + v(t)\Delta\delta\right] \qquad (3.3.3)$$

where $u(t) = \omega \frac{\partial}{\partial(\alpha\cos\delta)}(\vec{B}(t)\cdot\hat{e}_o)$ and $v(t) = \omega\frac{\partial}{\partial\delta}(\vec{B}_o(t)\cdot\hat{e}_o)$ and the difference in phase between the phase due to $I(\alpha,\delta)$ and that of a point source at (α_o, δ_o) is just the phase of

$$\Delta R(t) = \int d(\Delta\alpha\cos\delta)\, d(\Delta\alpha)\, I(\alpha_o+\Delta\alpha, \delta_o+\Delta\delta) \exp i\left\{u(t)\Delta\alpha + v(t)\Delta\delta\right\} \qquad (3.3.4)$$

This integral is a two-dimensional Fourier transform of $I(\alpha,\delta)$ evaluated at the spatial frequencies u and v in the north-south and east-west directions respectively. The phase of $\Delta R(t)$ is therefore non-zero in general, being zero only if $I(\hat{e})$ is the autocorrelation of some other function $\mathcal{A}(\hat{e})$.

$$I(\hat{e}^*) = \int d\hat{e}\; \mathcal{A}(\hat{e})\, \mathcal{A}(\hat{e}-\hat{e}^*) \qquad (3.3.5)$$

(The Fourier transform of an autocorrelation is always real, of zero phase.) The amount of deviation of the phase of $\Delta R(t)$ from zero depends crucially on the exact nature of $I(\hat{e})$, and, in general, is not known in advance of the interferometer experiment. In addition, many radio sources exhibit time variations in their small-scale structure[3] which practically insure that the phase of $\Delta R(t)$ has long-term variations, also. The only method presently available for the investigation of the phase of $\Delta R(t)$ is the phase-closure method developed by A.E.E. Rogers.[4] The indication here is that the phase due to source structure ranges from zero in the case of simple sources, for instance, to many radians in the case of complex ones such as 3C84. Fortunately, the baseline used in the experiment was short enough so that much of the fine structure of the radio sources remained unresolved, that is, the range of U and V was less than that in the experiments reported in (3) and (4). A confirmation that the sources are not significantly resolved was provided by the observed constancy of the fringe amplitude $|R(t)|$. The fringe amplitude was constant as nearly as could be determined in all cases except that of 3C84, where there was a slow decline in $|R(t)|$ from the beginning to the end of the day.

4. Effect of the Propagation Medium

The receiving antennas are not in vacuum, and in fact there is no vacuum anywhere between the Earth and the distant quasars. The first refracting medium encountered by the photons on their journey is the medium immediately surrounding the source, then the extragalactic medium. The effects of the medium immediately surrounding the source may be complex, but here we will assume that at worst this refraction will appear to affect the perceived brightness distribution . All evidence is that the inhomogeneities in the extragalactic medium of the same scale as the baseline length are not strong enough for any effect to survive the averaging along the $\sim 10^{9}$ parsec line of sight. The effect of the larger scale fluctuations is suppressed by the baseline filter.[5] Refraction in the solar corona is significant, however, due to the higher electron densities and the relative thinness of the refracting medium. The refraction due to the solar corona is only of concern when the line of sight to the distant source passes close to the sun.[6] The most serious problem occurs because of refraction in the medium directly above the antennas: the Earth's atmosphere and ionosphere.

Atmospheric refraction introduces a phase delay in the zenith direction of about 7 nsec: This delay is essentially independent of frequency. Time variations in the zenith refraction due to clouds of water vapor are as large as ten percent of the total and are rapid, with typical times much less than a day. At a wavelength $\lambda \simeq 3.8$ cm, the ionospheric delay in the zenith direction is less than 1 nsec and varies slowly throughout the day. For the four-antenna experiment, to be described below, the two effects were accounted for by adjusting a single "atmosphere" parameter in a model of the atmospheric delay, since the atmospheric and ionospheric effects are highly correlated in a single-frequency experiment. This model has the form

$$\tau_a = \tau_{az} \cdot \frac{1}{A\cos(e) + \frac{B}{C + \sin(e)}} \qquad (3.4.1)$$

where e is the elevation angle, and A, B, C were determined empirically[7] by observations of artificial satellites. τ_{az} is the delay in the zenith direction, which is estimated from the data.

5. Effect of the Clock Error

The conversion from the radio frequency to the frequency actually recorded on tape is controlled directly by the (hydrogen maser) frequency standard. Any errors in the phase rate produced by the standard are reflected in the data recorded on tape. For atomic hydrogen masers in good operating condition, the phase errors correspond to a fractional frequency accuracy of $\frac{\Delta\nu}{\nu} \sim 10^{-14}$ in the long term. Nevertheless, these errors are one of the most significant sources of error in VLBI experiments.

6. Special Features of Four-antenna VLBI

In four-antenna VLBI, the fringe phases from two long baselines are differenced. If the two long baselines share the same clock, the clock error is suppressed in the difference. Furthermore, if the two long baselines are nearly identical, they share to a large extent the same atmospheric and ionospheric errors, so that these are at least partially suppressed in the differencing. These two features are the main advantages of the four-antenna system.

IV. Procedure for Maximum-Likelihood Estimation

1. Introduction

The interferometer fringe phase depends on both the baseline vector $\vec{B}(t)$ and the radio source direction $\hat{e}$. The baseline vector changes in a complicated fashion, however. The receiving sites are fixed to the crust of the Earth. The principal motion of the Earth is its diurnal rotation about its axis. Subtler motions arise from the precession and nutation of the axis of rotation. The rate of the rotation also is not constant. The axis of rotation is also not fixed with respect to the crust, that is, the "North Pole" is not always at the same place. Finally, the motion of the crust may not be rigid, indicated by the possibility of continental drift. Several of these small corrections to the diurnal rotation of the baseline are not known with sufficient accuracy to permit the determination of the radio source coordinates without systematic error, and so they must be estimated simultaneously as the baseline vector components and source directions are estimated. This estimation is done by a maximum-likelihood procedure.

2. Principle

Each measurement of the fringe phase y(t) is assumed to constitute a sample of a function $F(P_1 \ldots P_n, t)$ of many variables called parameters (P_i) and the independent variable time (t). Since the observations are corrupted by noise, the samples are random variables with some probability density. We assume that the noise distribution is gaussian and that the noise correlation between samples is zero. Then the probability density for an observation $y(t_i)$ will be

$$P\{y(t_i)\} = \exp - \frac{[y(t_i) - F(\underset{\sim}{P}, t_i)]^2}{w_i^2} \qquad (4.2.1)$$

where by P we mean all the parameters, and is the variance of the noise at time t_i. The maximum-likelihood principle is the statement that the parameters are determined so as to maximize the joint probability of obtaining the samples $y(t_i)$. This joint probability is written as the "likelihood function" $\mathcal{L}(\underset{\sim}{P})$.

$$\mathcal{L}(\underset{\sim}{P}) = \prod_i \exp - \frac{[y(t_i) - F(\underset{\sim}{P}, t_i)]^2}{w_i^2} \qquad (4.2.2)$$

and the maximization with respect to the parameter values is stated as the conditions

$$\frac{\partial}{\partial P_k} \mathcal{L}(\underset{\sim}{P}) = 0 \qquad (4.2.3)$$

for all k. The evaluation of 4.2.3 is made easier by the observation that maximizing a function is the same as maximizing its logarithm. Taking the logarithm, the conditions become

$$\frac{\partial}{\partial P_k} \sum_j \frac{[y(t_j) - F(\underset{\sim}{P}, t_j)]^2}{w_j^2} = 0 \qquad (4.2.4)$$

for all k, which is the weighted-least-squares principle. The standard method for solving the equations 4.2.4 is by successive linearizations. If $\underset{\sim}{P}^*$ is the set of parameters that satisfies 4.2.4 then the residuals $R(t_j)$ are defined by

$$R(t_j) = y(t_j) - F(\underset{\sim}{P}^*, t_j) \qquad (4.2.5)$$

Note that if the initial assumptions are correct, if the noise distribution is gaussian with standard deviation w_i, if the $y(t_i)$ are in fact samples of $F(\underset{\sim}{P}^*, t)$, and if the noise correlation between samples is zero, then

$R(t_i)/\omega_i$ will be samples of a zero-mean uncorrelated gaussian random variable. If $R(t_i)/\omega_i$ is not of this character, then one or more of the assumptions are invalid, and $\underset{\sim}{P}^*$ will not necessarily correspond to the maximum-likelihood estimates of the parameters.

3. A Priori Constraints

It may occur that more than one sort of information is available to the experimenter. For example, the radio source positions may have all been measured before the present experiment. It is desirable to include whatever a priori information is available about the parameter values, and it is simple to do so. If the i^{th} parameter is known to have a priori value ξ_i with a standard deviation σ_i, then this knowledge may be placed on an equal footing with all the other observations relating to P_i by adding to the sum 4.2.4 the quantity

$$\frac{(\xi_i - P_i)^2}{\sigma_i^2} \qquad (4.3.1)$$

for each a priori value which is known. Any sort of information may be included in the solution by analogous means. An attempt to introduce irrelevant information, e.g., the population of California at time t, will be thwarted, since in this case the partial derivative in 4.2.4 will be zero because $F(\underset{\sim}{P},t)$ does not depend even implicitly, on the value of the population of California.

4. The Computer Program

A computer program for weighted-least-square analysis has been written by D.S. Robertson and others at M.I.T.[2] It is based on, and incorporates portions of the Planetary Ephemeris Program, written mainly by M.E. Ash, then of M.I.T. Lincoln Laboratory.[3] Included in the model function in this computer program are the following variable parameters

a) radio source right ascension and declination with respect to the equinox and equator of 1950.0, corrected for elliptical aberration.

b) receiving site locations, relative to the mean pole of 1900-1905

c) parameters of a simple atmospheric refraction model[1]

d) parameters of polar motion and the difference between Atomic time and UT. 1.

e) instrumental constants

Other parameters are available - these are the ones relevant to the four-antenna VLBI experiment. In addition the program supplies on demand tabulated values of the polar motion and UT. 1 as determined by the Bureau International de l'Heure.

The computer program also takes into account, to the extent of present knowledge, the effects of precession and nutation, solid Earth tides, and the gravitational deflection of light.

V. Instrumentation for the January 1972 Four-Antenna Experiment

1. Introduction

The January 1972 four-antenna experiment was planned because the first phase-difference experiments, made with the Haystack-Goldstone interferometer, appeared to promise substantial improvements in relative source position measurements and we desired to achieve precise position measurements for sources widely separated in the sky. The selection of sites for this experiment was made easy by the fact that only two sites in the world appeared to be obviously compatible with no large expense of time or money. These were the Haystack-Westford interferometer in Tyngsboro and Westford, Mass., and the NRAO interferometer in Green Bank, West Virginia. This pair of sites is ideal in several respects: each has a hydrogen maser, each has well-engineered receivers and automatic antenna pointing equipment (except Westford), and the sites are both convenient to the experimenters. Other sites which might be used, but which would require extensive modification of existing equipment or construction of new equipment, include the Owens Valley Radio Observatory in Big Pine, California, and the NASA Goldstone complex in the Mojave desert of Southern California.

2. The NRAO Interferometer[1]

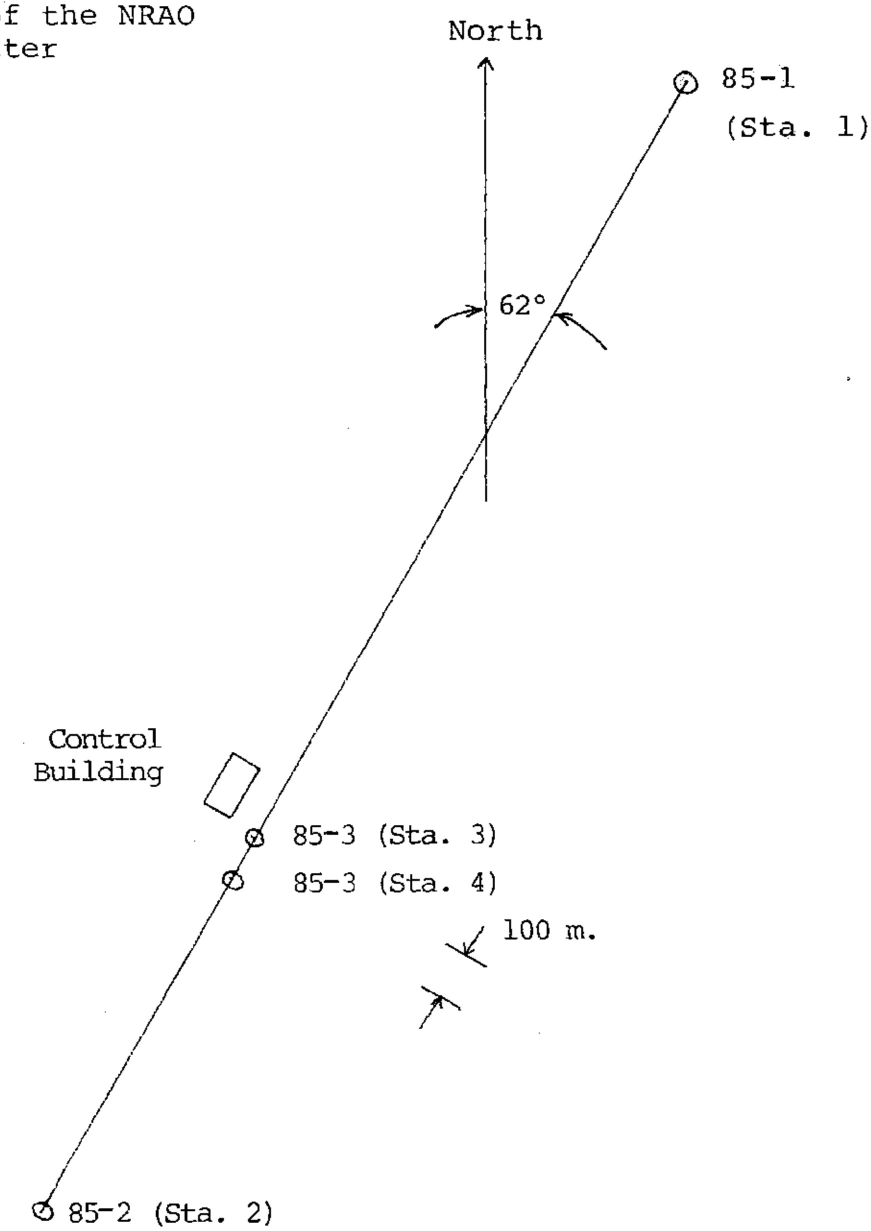
The NRAO interferometer is a dual-frequency (X- and S-band) wideband double-sideband delay-tracking interferometer with three identical

85-foot antennas, which generally operates automatically under computer control. In normal operation, its L.O. frequency is derived from a crystal oscillator. The X-band L.O. frequency is 8085 MHz, and the IF bandwidth is 50 MHz, so that frequencies from 8035 to 8085 MHz are available in the lower sideband, and frequencies from 8085 to 8135 are available in the upper sideband. The sidebands are superimposed in the IF band, and cannot be separated. The single-sideband noise temperature of the receivers is about 200 K.

The most important factor relating to the success or failure of the four-antenna experiment is the relative phase stability between the two antennas at each end of the long baseline. At the NRAO, we relied on the previously existing equipment to provide this stability. The local oscillator signal is distributed along phase-compensated cables. The IF signal returns over cables which are not phase compensated. The lack of compensation in the IF cables has no effect on the normal use of the interferometer, since it is a double-sideband device. It may seem paradoxical that the introduction of an additional delay in one leg of the interferometer before the receiver would affect the interferometer fringe phase, but introducing the same delay after the receiver would not affect the phase. The explanation arises from the fact that the two sidebands are super imposed in the first-stage degenerate parametric amplifier[1]. The receiving system at the other end of the long baseline was single-sideband so that this advantage does not apply to our application of the NRAO interferometer.

Figure 5.1

A portion of the NRAO Interferometer



3. Modifications to the NRAO Interferometer

The local oscillator signal at the NRAO interferometer is usually generated from a crystal oscillator operating nominally at 101.346154 MHz. This signal is multiplied in frequency by 13 in order to obtain the nominal 1317.5 MHz L.O. signal for distribution to the antennas. The phase stability of this crystal oscillator is no doubt poor compared to the stability of an atomic hydrogen maser, which is the more conventional source for the local oscillator signal in a VLBI experiment. In principle, with a "four-antenna" VLBI experiment employing simultaneous recording of the signals from the two antennas at each end of the long baseline, the L.O. stability is not a factor as long as the power spectrum of the local oscillator signal does not extend over more than a few percent of the bandwidth observed. As we did not record the signals simultaneously for both long baselines but switched our recording system between them each $0\overset{s}{.}2$, the requirement on L.O. stability is strengthened to a limit of less than 5 Hz on the width of the power spectrum of the L.O. signal. The crystal oscillator no doubt meets this requirement; nevertheless, we decided that it would be prudent to obtain the L.O. signal from a hydrogen maser, so that if necessary, we could examine the signals received on the two long baselines before taking the difference in fringe phase.

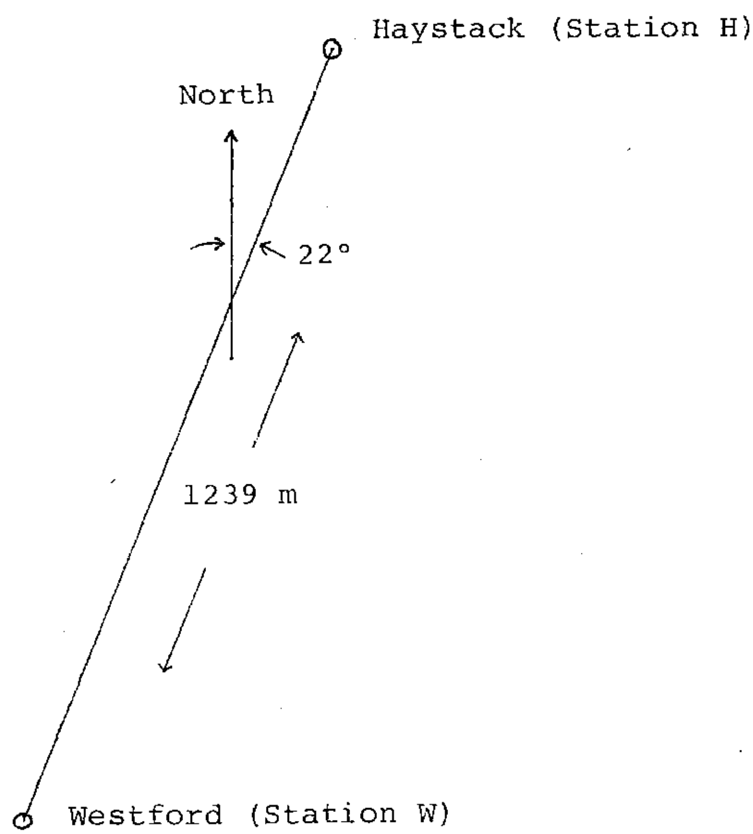
The hydrogen maser at NRAO is located at the 140-foot antenna, and by reason of its weight and delicacy, it is practically speaking, not movable. The solution to this problem was to provide an RG-13 coaxial cable (kindly provided by W.C. Erickson) from the 140-foot antenna to the northernmost antenna of the interferometer triplet, the so-called 85-1 antenna. The 5 MHz signal from the hydrogen maser was sent along this partially buried cable to the 85-1 equipment building, and from there to the interferometer control building along one of the four cables normally used to carry the IF signal. The total length of the cable, which was uncompensated for phase variations, was almost one mile. In order to reduce the effect of pickup of stray signals on this long wire, a 5 MHz crystal oscillator was phase-locked to the signal emerging in the interferometer control building, and all of the equipment was run from this phase-locked crystal oscillator. Even though the phase stability of the maser was no doubt degraded by having its signal passed through a mile of cable, we expect that the results from this method were superior to the only alternative which was the use of a rubidium standard at the interferometer control building.

4. The Haystack-Westford Interferometer

The 120-foot antenna at the Haystack Observatory and the 60-foot antenna at the Westford site were originally operated independently. A system for operating the pair as an interferometer was devised by A.E.E. Rogers to support a lunar radar interferometer experiment. It was this system, appearing in figures 5.2 and 5.3, which was used to provide L.O. phase compensation in the January four-antenna VLBI experiment. This system is similar in principle to the one used at the NRAO interferometer. Several reference signals are multiplexed together at Haystack and are sent to Westford along an airdielectric

Figure 5.3

The Haystack-Westford Interferometer



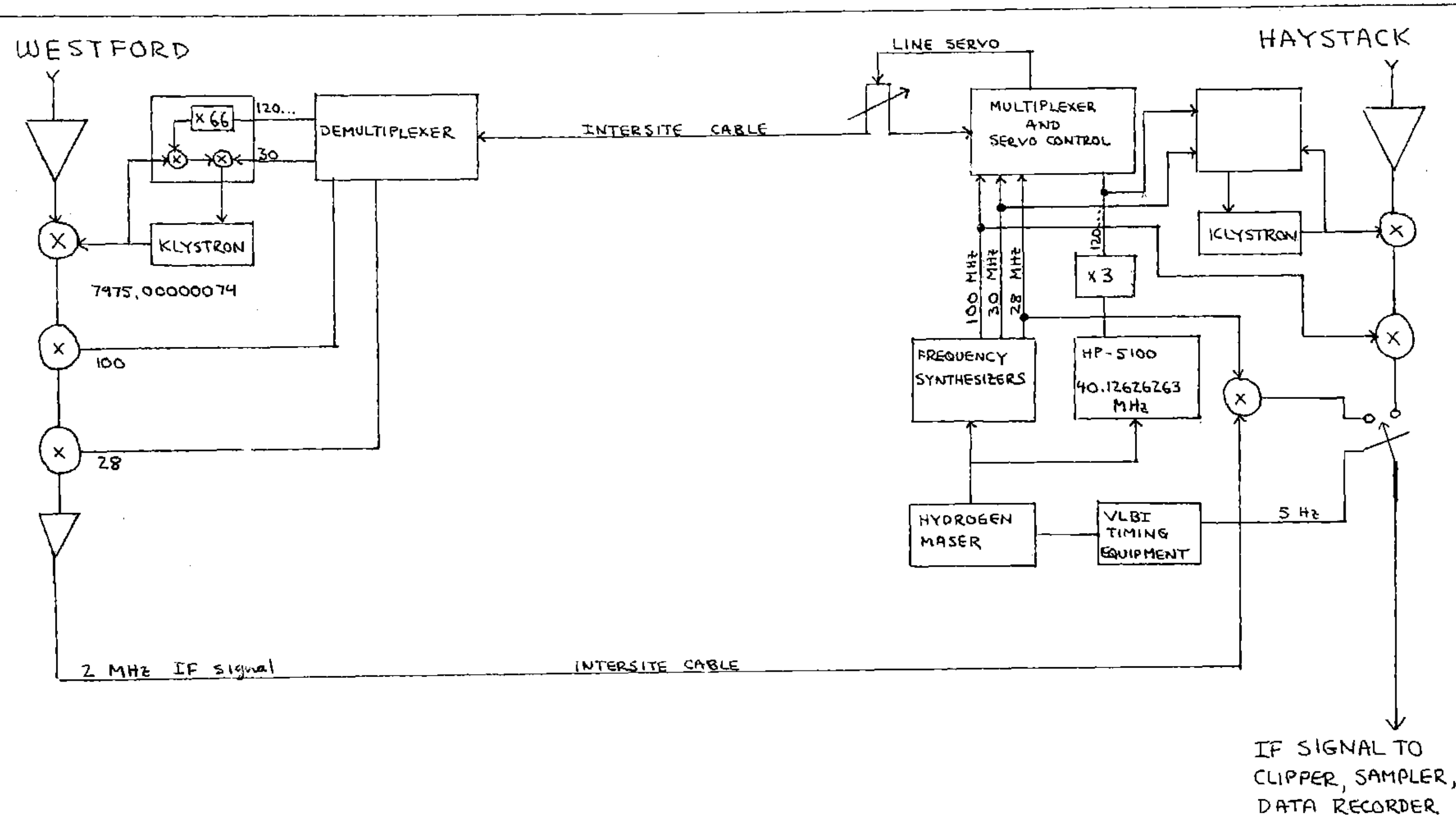

WESTFORD
HAYSTACK
x 66
120...
30
DEMULTIPLEXER
KLYSTRON
7975,00000074
100
28
INTERSITE CABLE
LINE SERVO
MULTIPLEXER AND SERVO CONTROL
KLYSTRON
x 3
120...
100 MHz
30 MHz
28 MHz
FREQUENCY SYNTHESIZERS
HP-5100
40.12626263 MHz
HYDROGEN MASER
VLBI TIMING EQUIPMENT
5 Hz
2 MHz IF signal
INTERSITE CABLE
IF SIGNAL TO CLIPPER, SAMPLER, DATA RECORDER

FIGURE 5.4

coaxial cable. Among these is the 120 MHz reference for the local oscillator multiplier, and a signal at approximately 100 KHz. At the Westford end, the 100 KHz signal is mixed with the 120 MHz signal to generate a signal at 120.1 MHz, which is returned down the same wire to Haystack. At Haystack, the 120.1 MHz signal is combined with the 120 MHz signal to regenerate an 100 KHz signal. This returned signal at 100 KHz suffers a phase shift equal to the one-way phase shift at 100 KHz plus the one-way phase shift at 120.1 MHz plus the one-way phase shift at 120 MHz. The 100 KHz returned signal is phase compared with the original 100 KHz signal, and the phase difference is made to be a constant by the action of the motor-driven "trombones".

5. Data Recording

The Mark-I system was chosen to record the data from this series of experiments. In effect, this amounted to the choice of a proved system, but one requiring much manual labor, over a system (The Mark-II) which would have been easy to use, but whose performance for our purposes was in question. The Mark-I system records one-bit quantized samples of the video signals at a rate of 720000 samples per second on 7-track digital magnetic tape units.[2] A record gap of approximately $0^{s}.005$ is introduced every $0^{s}.2$ to provide compatibility with most digital computers. The first bit recorded each record is synchronized to a multiple of $0^{s}.2$ UTC, to the extent that the recorder controller has been set to UTC by the experimenter. In these experiments, alternate records were recorded with data from the two antennas at each site. The switching was synchronized at the two sites (almost all of the time!) so that the two antennas observing the same source were being recorded simultaneously.

At the Haystack-Westford site, the data recording was performed by the Haystack CDC-3300 computer. The computer has four tape units, providing the redundancy needed for reliability. At the NRAO, we used four Mark-I terminals - two of the original set constructed by C. Bare of the NRAO in 1967, and two new terminals constructed at the Haystack Observatory. Since the schedule of observations for this experiment required nearly continuous recording, at least two tape units were required at each site - one to record while the second is rewinding. At this rate, four recorders provide for a complete duplicate recording system. Even so, the recorders at Green Bank failed sufficiently often that, at one time, only one of them was operative.

VI. Tests of System Performance

1. Introduction

Before the January 1972 four-antenna experiment, we verified that the electronic and mechanical systems were capable of performing adequately to meet the goals of the experiment. The crucial electronic factors are

a) the relative phase stability of the two antennas at each site

b) the system sensitivity (noise temperature)

c) the phase stability of the NRAO site relative to the Haystack site (performance of the hydrogen masers employed)

d) determination of the UTC epoch at the sites

e) measurement of the sense of circular polarization at each site.

The only mechanical question seemed to be the adequacy of the pointing and tracking at the Westford site.

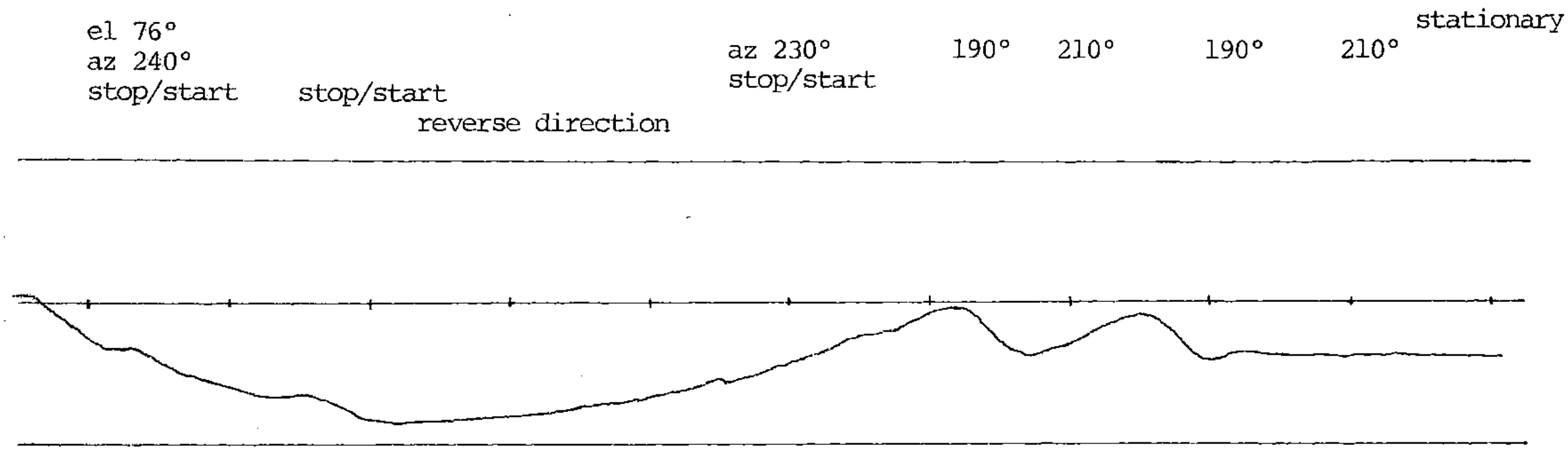
The ultimate system test involved a trial experiment conducted on January 17, 1972.

2. Haystack-Westford phase stability

The two receivers are phase-stabilized by means of a cable whose electrical length is servo-controlled. The terminus of this cable is in the control room at Westford and it originates in the control room at Haystack. Since the line servo was observed to properly compensate for changes in the cable length introduced by means of a manually operated trombone line stretcher, the only unknown factor in the relative phase stability was the possibility of uncompensated phase shifts in the transmission lines between the control room and the receiver at each site. It is known that such phase shifts exist. Figure 6.1 illustrates the results of a test of the Haystack cables performed in the summer of 1969. A signal at 100 MHz was sent from the control room to the Radiometer Box and back along two of the cables usually used for L.O. reference signals. The phase of the returned signal was compared to the phase of the transmitted signal with a Hewlett-Packard vector voltmeter, while the antenna was rotated to exercise the cables. Inspection of Figure 6.1 shows fluctuations of the relative phase that apparently depend in part on the position of the antenna. The excursion in electrical length is about 10^{-11} sec., which is not negligible considering the accuracy of the phase measurement in the four-antenna experiment.

The only experimental evidence involving the whole system was provided through the results of 23 GHz interferometer experiments performed by K-Y. Lo of the Physics Department at M.I.T.[1] Of course, in observing radio sources the effects of instrumental instability are difficult to separate from propagation medium effects, but the combination of effects provides an upper bound for either, since they are uncorrelated. Nevertheless, the overall stability was found to be good, with the exception of infrequent discrete phase jumps of about π radians, several times a day.

The questions of uncompensated cable phase shifts and the origin



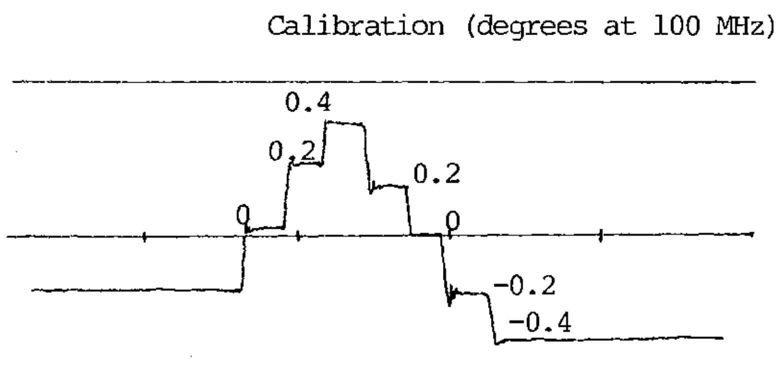


Figure 6.1

Haystack cable stability test

Round-trip phase at 100 MHz <u>vs.</u> azimuth angle of the phase jumps have never been resolved.

3. NRAO Interferometer Phase Stability

The NRAO interferometer stability has been thoroughly investigated by the Observatory staff. One such investigation is reported in reference 2. There is little doubt that the stability of the NRAO interferometer represented the then state of the art. The fluctuations of about 10^{-11} sec. reported in reference 2 are the combination of atmospheric and electronic phase errors.

4. Phase Stability at the IF Frequency

In both the Haystack-Westford interferometer and the NRAO interferometer, the IF signal is returned from the antennas to a central point along cables which are not phase compensated. At Haystack, the IF frequency is only 2 MHz, so that a change in length of 5 m. would be required to produce a phase change of 10 degrees of phase (10 degrees of phase is equivalent to 3 ps. at 8105 MHz). The changes in length of the Haystack-Westford cable are known to be less than 2 meters and are therefore negligible.

At Green Bank, the IF frequency corresponding to an RF frequency of 8105 MHz is 20 MHz. Therefore, only about 0.4 m change in length is required to produce a phase change of 10 degrees. The length L of a copper rod varies with temperature approximately as $L = L_o(1 + \alpha(T-T_o))$ where L_o is the length of the rod at temperature T_o, and T is the temperature. α, the coefficient of linear expansion is about 16.8 x 10^{-6} for copper between 0 and 100 °C. The greatest unbalance in cable lengths at Green Bank occurs between 85-1 and 85-3 at station 3, where the unbalance in length is about 1.8 km. The rate of change of length with temperature is therefore about 3 cm/degree centigrade, or 0°.7 of phase per degree centigrade (at the IF frequency of 20 MHz). Since the day-night temperature variation can be as great as 20 °C, a small but significant phase error may result from the expansion and contraction of the cables in this extreme case. Fortunately, most of the data in the January 1972 experiment were taken between 85-3 at station 3 and 85-2 at station 2, for which the unbalance in cable length is 0.9 km., or half the extreme amount.

It is interesting to note that the changes of cable length are inconsequential to the normal operation of the NRAO interferometer. The reason for this is that the NRAO interferometer correlates both sidebands around the L.O. frequency. An analysis of the double-sideband interferometer is found in reference 3. Since the VLBI system is a single-sideband system, we do not share this benefit.

5. Noise Temperature

The signal-to-noise ratio of an interferometer system depends on the antenna temperatures and receiver system temperatures of its elements as $(S/N) \propto \left[\frac{T_{A_1} T_{A_2}}{T_{S_1} T_{S_2}}\right]^{1/2}$ where the T_A are the antenna temperatures due to the sources at the two sites, and the T_S are the system temperatures at the two sites. The T_A are fixed (although pointing errors may affect

T_A in the case of Westford - see below) and the T_S must be made as small as possible to maximize S/N. T_S at Green Bank is measured to be 200 K single-sideband.[4] T_S at Haystack may be reliably overestimated to be 100 K. The only questionable system was involved in the weakest link - Westford. The Westford receiver used a parametric amplifier constructed at Lincoln Laboratory by W.J. Getsinger.[5] This amplifier was being operated at the edge of its useful frequency range, and so the system temperature was quite dependent on the tuning of the amplifier. With careful tuning it was possible to reduce the noise temperature of the Westford amplifier to the range 200-250 K. A signal-to-noise calculation (see Appendix 6) indicated that this would be marginally satisfactory.

6. Stability of the Hydrogen Masers at the Sites

The stability of the hydrogen masers at the sites can only be measured before the actual experiment by comparison with another hydrogen maser. Since no extra maser was available, the only factor which could be verified in advance was whether or not the stability of the maser was being transferred to the receiver local oscillator properly. The L.O. system at Haystack is routinely tested by sending a test signal through the receiver, and comparing its phase with the phase of a signal generated directly by the maser. At Green Bank, the problem was complicated by the fact that the maser was located almost a mile from the place where its signal was required for this experiment. In fact, it was necessary to install a special cable to carry the 5 MHz maser signal from the 140-foot telescope, where the maser was located, to the nearest point in the interferometer system, the 85-1 control building. From the 85-1 control building the signal was routed along an unused IF cable to the main control building. To insure that no spurious signals were being introduced into the L.O. system from pickup along this long cable, a test signal generator located at the 140-foot antenna was used to send a signal through the 85-1 receiver. The phase of this signal was then compared with the phase of the 5 MHz signal arriving in the interferometer control building. There was no doubt that the phase stability was degraded by the long cable, but the results of this experiment demonstrated enough stability to satisfy the requirements of the four-antenna experiment.

7. Determination of the UTC Epoch at Each Site

While the determination of the UTC epoch to within a few microseconds at each site is simple in principle, it is often troublesome in practice, and careless errors are still frequently made despite the experience of the observers. At Haystack, the staff maintains a UTC clock, and tests its performance regularly. No such service exists at Green Bank, so for the four-antenna experiment we transported a Cesium beam standard and a Rubidium standard, borrowed from NASA Goddard Space Flight Center, from Goddard to NRAO. The Cesium clock was set by direct comparison with the primary standard at the U.S. Naval Observatory. The Rubidium clock was set to agree with the Cesium clock.

8. Measurement of the Sense of Circular Polarization

The antennas at both Haystack and Green Bank were equipped to receive circularly polarized radiation. It is crucial to insure that the sense of the polarization received is the same at both ends of the long baseline, since the LCP radiation is largely uncorrelated with the RCP radiation. (The sources have low intrinsic linear polarization.) We avoided confusion between the IEEE and physicist's definitions by testing each antenna with a test signal radiated from a small helical antenna. With some care, we were able to verify that both Haystack and Green Bank were receiving left-circular polarized (IEEE definition) radiation. An unambiguous way of specifying this polarization is to say that the photons have positive helicity, that is, that their angular momentum vector is in the direction of propagation.

9. Pointing and Tracking at the Westford Site

The VLBI receiving system at all antennas used in the four-antenna experiment was a total-power system, with no attempt made to stabilize the gain other than simple care in the assembly of the receiver. The systems were unstable enough so that most of the sources observed could be detected in the received total power only at Haystack. The Westford system was unstable enough so that no source could reliably be detected in the total power indication. Experience has shown that the automatic pointing capability at Haystack, and at the Green Bank interferometer, was adequate to insure that the antenna could be pointed "blind", that is, with no immediate indication that the pointing was correct. At Westford, the situation was less clear. The only evidence relating directly to the question of the Westford pointing accuracy was provided by experiments conducted by K-Y Lo.[6] Since Lo's conclusion was that the system operation was adequate at 22 GHz, we judged that it was likely to be adequate for blind pointing at 8 GHz.

10. Test Experiment

Time was scheduled on January 17, 1972 for a full system test involving the full four-antenna system. In this experiment all the previously-noted crucial factors were tested in actual operation:

a) the relative phase stability of the antennas at each end of the long baseline was tested by taking data with all four antennas pointed at the same source (3C454.3)
b) the system sensitivity was tested by observing the weakest sources contemplated for use in the actual experiment (3C454.3, 3C345)
c) the phase stability of Haystack vs. NRAO was tested in every observation
d) the determination of the UTC epoch was assured in the analysis of the data
e) the sense of circular polarization was tested by reversing the sense at Green Bank for several observations to verify that the correlation was reduced.
f) the Westford pointing was tested by noting the consistency of the fringe amplitude on the baseline involving Westford.

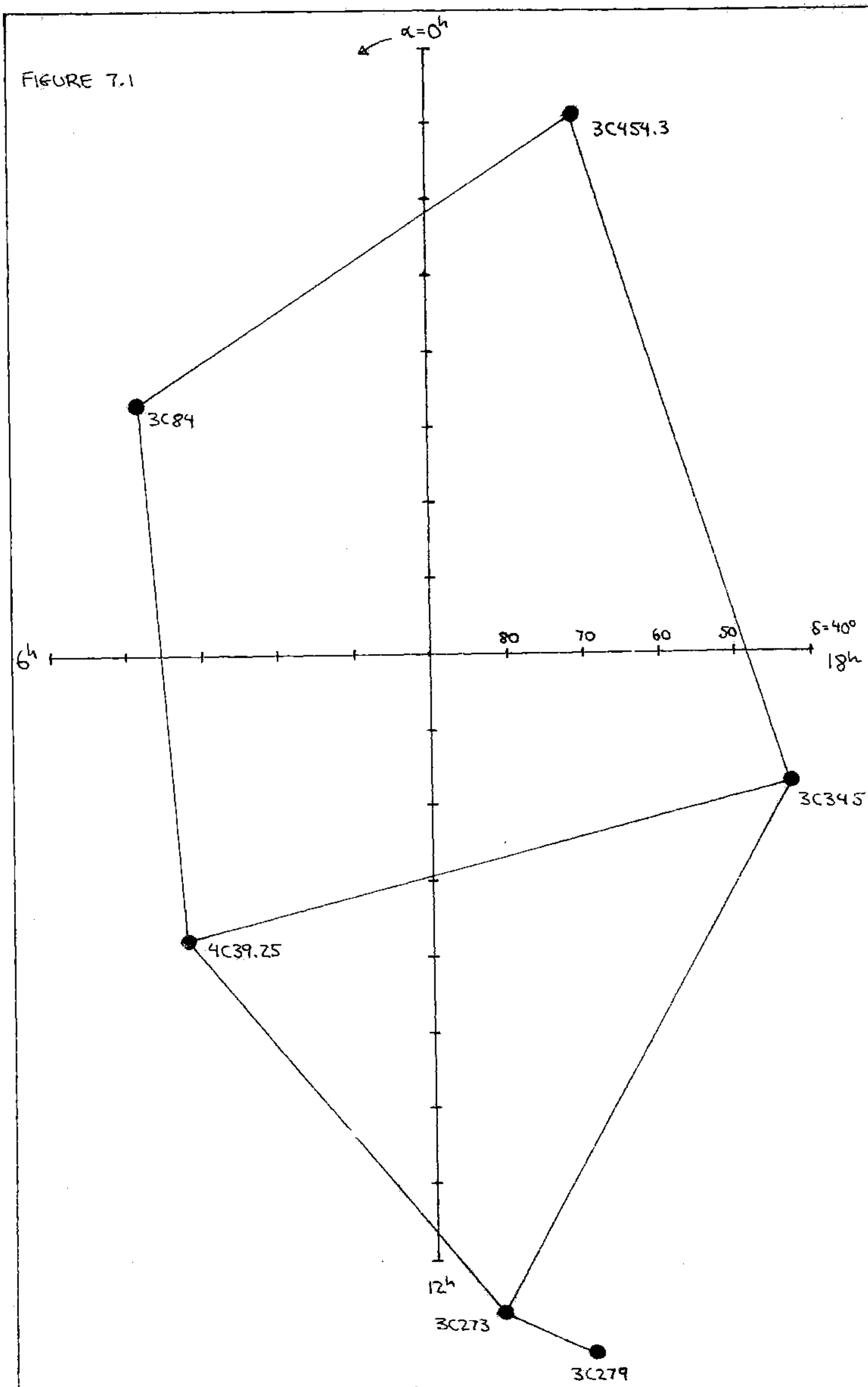
The results of these tests were acceptable in all cases. No alterations in the system were judged to be necessary before the actual experiment.

VII. The January 1972 Experiment

1. Schedule

To determine the relative coordinates of a pair of radio sources, it is desirable to observe them continuously during the time when they are visible from both sites of the interferometer. To establish the consistency of the results, redundancy is required. This redundancy may be achieved by repeatedly observing the same pairs of sources, or by observing all three pairs of a triplet of sources. This latter provides redundancy since there are only two pairs of independent relative coordinates among three radio sources. Since the object of the experiment was, in part, to provide a catalog of radio source positions, another desirable characteristic of the schedule of sources observed is that is should cover the sky as completely as possible. This requires observing many sources. The limitations of available time and the stamina of the observers leads to a minimization of the number of sources observed. These conflicting requirements led after some consideration, to the choice of sources indicated in figure 7.1. Each solid line in figure 7.1 indicates a pair of sources observed together. The figure consisting of 3C84, 3C454.3, 4C39.25 and 3C345 permits a loop around a full 24 hours of right ascension. The pair 3C273-3C279 was added because it was the pair for which the differential fringe phase was first determined, in October 1970 and February 1971.[1]

FIGURE 7.1


α=0h
3C454.3
3C84
6h
80
70
60
50
δ=40°
18h
3C345
4C39.25
12h
3C273
3C279

3C273 was tied to 4C39.25 and 3C345 in order to provide further redundancy. If each solid line in figure 7.1 implies, on average, 8 hours of observations for one determination of the relative coordinates, then the schedule implied by 7.1 requires about 112 hours to complete. In order to insure that the gaps in the data recording would not be so large as to prevent phase-connection, an observation of 3 minutes duration was started each 4 minutes. At this rate, the schedule outlined above would require 3360 magnetic tapes for recording the data. Since this appeared at the time to be already a very ambitious effort, we resisted the urge to include additional sources in the schedule. The final arrangement of the observations is presented in figure 7.2.

2. Procedure

The schedule 7.2 is very taxing of both men and equipment. In order to provide people to change tapes and control the operation of the equipment, every available student was pressed into service. The experiment was performed jointly with Dr. T.A. Clark of the NASA Goddard Space Flight Center, who provided most of the manpower for the Green Bank site. The operators at Haystack were provided mainly by M.I.T., with a significant contribution from the staff of the Haystack Observatory. At Haystack, the CDC-3300 computer, with its four tape units, was used to record the data. To provide redundancy at Green Bank, every available Mark-I recording terminal was transported there. Four recorders were

H = Haystack
W = Westford
1 = 85-1
2 = 85-2 /27
3 = 85-3 /18

Figure 7.2

January 1972 Schedule

1972 Day	Begin UT	End UT	Source / Baseline	Source / Baseline
25	0030	26-0620	3C84 / H2	4C39.25 / W3
26	0744	1228	3C345 / H2	4C39.25 / W3
	1400	1946	3C345 / H2	3C454.3 / W3
27	0420	1224	4C39.25 / H2	3C273 / W3
28	0500	1400	3C279 / H2	3C273 / W3
	1808	29-0120	3C454.3/ H2	3C84 / W3
29	0732	1400	3C345 / H 1	3C273 / W3
	1809	30-0116	3C454.3 / H1	3C84 / W3
30	0400	1208	4C39.25 / H2	3C273 / W3
	1332	1938	3C345 / H2	3C454.3 / W3
31	0008	0600	4C39.25 / H2	3C84 / W3
	0720	1200	3C345 / H3	4C39.25 / W2
	1328	1924	3C345 /H3	3C454.3 / W2
32	0720	1340	3C345 / H3	3C273 / W 1
33	0448	1340	3C279 / H3	3C273 / W2
	1752	34-0104	3C454.3 / H3	3C84 / W2
34	0712	1152	3C345 / H3	4C39.25 / W2
	1316	1912	3C345 / H3	3C454.3 / W2
35	0432	1332	3C279 / H3	3C273 / W2

assembled and connected in parallel so that if one failed, another could be started immediately to insure continuity in the data recording. At least two people (and usually more) were present at both Haystack and Green Bank to change tapes during the observing periods. Each day, the tapes recorded on that day were mailed from the Green Bank, W.Va. post office to Haystack. At Haystack, the tapes were stored until time was available to correlate them.

VIII. The October 1972 Experiment

1. Introduction

The October 1972 experiment was intended to repeat the January experiment, including whatever improvements were considered necessary based on the experience with processing the data from January. A further objective of the October four-antenna experiment was a repetition of the determination of the gravitational bending of light.

2. Difference in Equipment between January and October

Data from the January experiment had been examined only briefly before October. There was no indication at that time that there was any difficulty, so the electronic systems - tape recorders and so on - were identical to January. During the time between January and October, the NRAO had provided a distribution system for the 5 MHz signal from the hydrogen maser so that the cable which was specially installed in January was no longer necessary.

In October, the antennas of the interferometer were positioned at stations 3 and 4 (figure 5.1) so that the spacing between the two movable antennas was only 100 m. This is beneficial from several standpoints: the length of the uncompensated IF cables is minimized, and nearly balanced, and the cancellation of atmospheric errors is improved by the small spacing. The disadvantage is that only one station (station 3) was in common between January and October. This disadvantage is serious only in the comparison between January and October results, since the baseline offsets must be adjusted separately for the two experiments.

3. The October Schedule

The schedule of observation in October was designed to repeat all the observations of January. Additional time was requested for protection against bad weather, and considerably more time was requested for observations of 3C273 and 3C279. The results of the 3C273-3C279 gravitational deflection of light experiment have already been reported, and will only be discussed here as they shed light on the accuracy of the results as a whole. The October 1972 schedule is detailed in figure 8.1. The considerations governing this particular arrangement were

a) to provide a reasonable distribution of 3C273-3C279 observations for performing the gravitational bending experiment

b) to avoid observing 3C273 paired with any source other than 3C279 when 3C273 was close to the sun

c) to limit the total time spanned by the observations, in order to reduce the sensitivity to changes in polar motion and A.T.-UT.1

4. Operational Details

This schedule is much more demanding than that of January in terms

Figure 8.1 October 1972 Schedule

Date	UT Start	UT End	Sources Observed
Sept 23	1400	2100	3C 273 - 3C 279
Oct 1	1400	2200	3C 273 - 3C 279
Oct 2	1400	2200	3C 273 - 3C 279
Oct 3	1245	1700	3C 273 - 3C 279
Oct 4	1645	2130	3C 273 - 3C 279
Oct 5	1400	2100	3C 273 - 3C 279*
Oct 8	0800	1200	3C 84 - 4C 39.25
	1315	1515	3C 274 - 4C 39.25
	1530	1815	3C 345 - 4C 39.25
Oct 10	1300	2100	3C 273 - 3C 279*
Oct 11	1300	2100	3C 273 - 3C 279*
	2200	2400	3C 345 - 3C 454.3
Oct 12	1300	2100	3C 273 - 3C 279*
Oct 13	1300	2100	3C 273 - 3C 279*
Oct 15	1145	1730	4C 39.25 - 3C 273
Oct 16	1145	1730	4C 39.25 - 3C 273
Oct 18	1145	2100	3C 273 - 3C 279
Oct 19	1145	2100	3C 273 - 3C 279
Oct 20	1145	2100	3C 273 - 3C 279
Oct 21	0445	0630	2134+00 - 3C 454.3
	0700	1200	4C 39.25 - 3C 84
	1430	2030	3C 345 - 3C 273
	2130	2330	3C 345 - 2134+00
Oct 22	0200	0730	3C 454.3 - 3C 84
	0800	1200	3C 84 - 3C 84
	1430	2030	3C 345 - 3C 273

---

*During these observations, 3C 273 and/or 3C 279 was near the sun. These observations do not appear in the solutions discussed below. See C. C. Counselman, _et al._, Phys. Rev. Lett. _33_, 1621 (30 Dec 1974) for a discussion of these observations.

of manpower. The Haystack end of the interferometer was manned chiefly by M.I.T. graduate students and members of the Haystack Observatory staff. At Green Bank, most of the manpower was provided by Dr. Thomas A. Clark and his associates and students from NASA Goddard Space Flight Center and the University of Maryland. The schedule often calls for three shifts a day, so up to nine people at a time were in residence at Green Bank.

The recorded tapes were mailed from Green Bank to Haystack, as in January, for processing with the Haystack correlator.

IX. Data Processing

1. Introduction

The January and October experiments together produced approximately 14000 Mark-I recordings, which were processed using the Haystack CDC-3300 computer and its attached high-speed correlator. The data processing proceeded in four steps:

a) correlation of pairs of tapes using the high-speed correlator
b) estimation of phase and phase rate for each observation
c) phase-connection and differencing
d) removal of remaining phase errors (multiples of 2π)

2. Correlation

Let the video signals at the two stations be $x(\xi)$ and $y(\eta)$. ξ and η are time variables which are themselves functions of UTC (t). They are the times kept by the clocks at the two sites. An attempt is made to insure that $\xi(t)\sim t$ and $\eta(t)\sim t$ to within a few microseconds for the duration of the experiment. The signals recorded on the tapes are one-bit samples:

where $X_i = \begin{cases} 1 & \text{if } x(\xi_i)>0 \\ 0 & \text{if } x(\xi_i)<0 \end{cases} \qquad \xi_{i+1}-\xi_i \simeq 1.38\,\mu s.$ (9.2.1)

There is a similar recording Y_i corresponding to the video signal $y(\eta)$. The action of the correlator is to compute the cross-correlation function between X_i and Y_i, given that the two video signals from which X_i and

Y_i were determined are related:

$$y(t_0 + t_\eta(t) + \tau_{atm_1}(t)) = x(t_0 + t_\xi(t) + \tau_{atm_2}(t) + \vec{B}(t)\cdot\hat{e}) \qquad (9.2.2)$$

where t is the time of the start of the recording, τ_{atm_i} (t) is the retardation due to atmospheric refraction, and $\vec{B}(t)\cdot\hat{e}$ is the geometric delay due to the relative distances from the two stations to the source of emission. Here the effects of receiver noise and source structure are neglected. Also, $\eta(t) = t + t_\eta(t)$ and $\xi(t) = t + t_\xi(t)$.

Then, $$y(t) = x(t + t_\xi(t) - t_\eta(t) + \tau_{atm_2}(t) - \tau_{atm_1}(t) + \vec{B}(t)\cdot\hat{e}) \qquad (9.2.3)$$

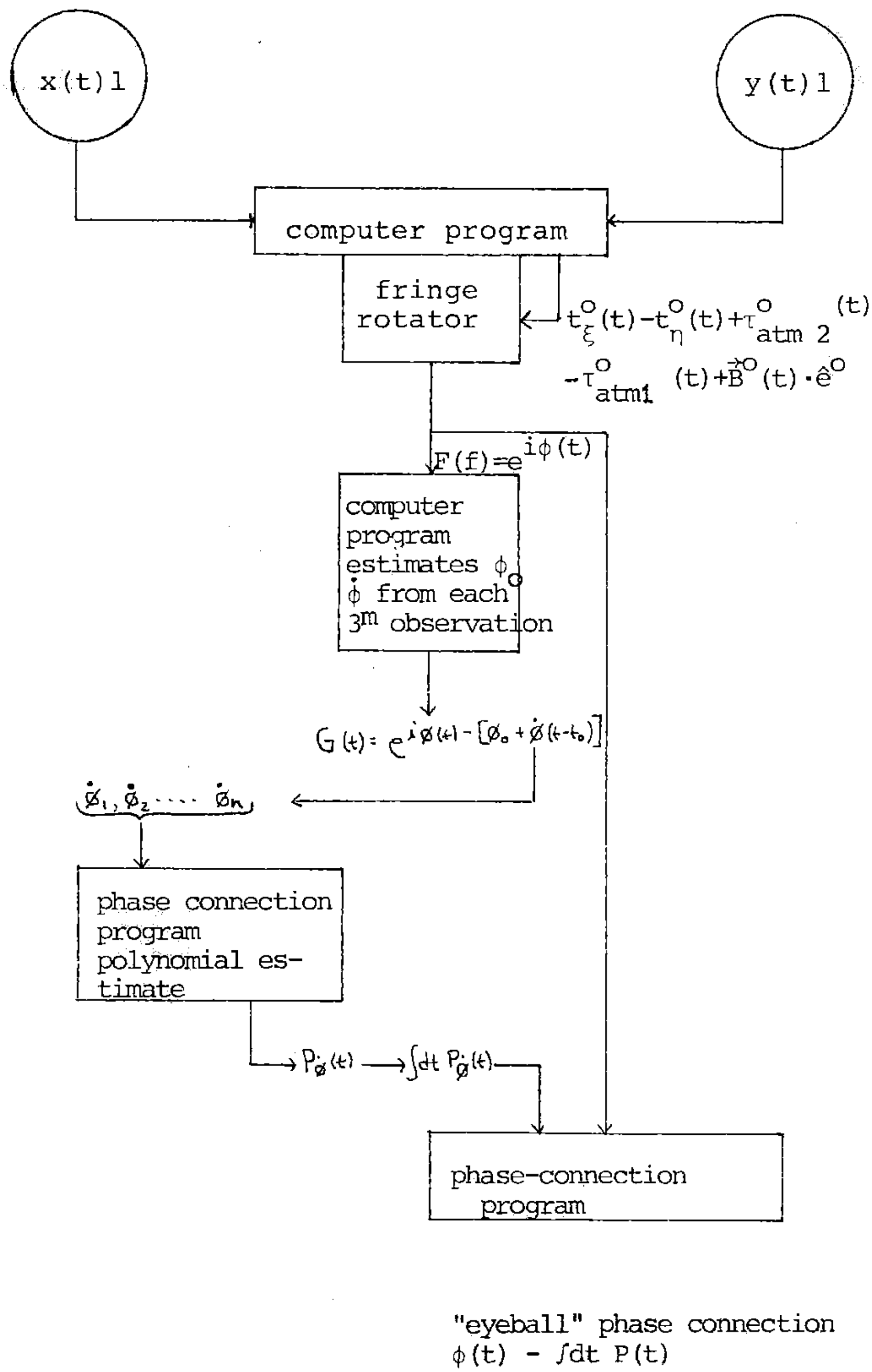
The cross-correlation is performed assuming the a priori values $t^0_\eta(t) - t^0_\xi(t)$, $\tau_{atm_1}(t)$, $\tau_{atm_2}(t)$, $\vec{B}^0(t)$, and $\hat{e}^0$. From the cross-correlation, a cross spectrum is computed, usually at $0^s.2$ intervals. The cross-spectrum will have the form $F(t) = e^{i\phi(t)}$ (neglecting source structure and receiver noise) where $\phi(t)$ is the phase equivalent of the difference between the a priori value $t^0_\xi(t) - t^0_\eta(t) + \tau^0_{atm_2}(t) - \tau_{atm_1}(t) + \vec{B}^0(t)\cdot\hat{e}^0$ and its truevalue. If the a priori values of these quantities do not differ too much from the true values, $\phi(t)$ may be approximated by the form $\phi(t) = \phi(t_0) + \dot{\phi}(t_0)(t - t_0)$. This approximation is usually valid over a 3-minute Mark-I recording.

3. Estimation of Phase and Phase-Rate for Each Recording

The phase $\phi(t_0) + \dot{\phi}(t - t_0)$ is determined from the cross-spectra F(t) by maximizing $|D|$ in the expression

$$D = \sum_t F(t) \exp -i\Omega(t - t_0) \qquad (9.3.1)$$

Figure 9.1 Data Flow



for variations in Ω. If the magnitude of 9.3.1 is maximized for $\Omega = \Omega^*$, then the best values of ϕ and $\dot{\phi}$ are

$$\dot{\phi}(t_0) = \Omega^*$$

$$\phi_0(t_0) = \text{phase of } \sum F(t) \exp - i\Omega^*(t-t_0) \qquad (9.3.2)$$

4. Phase Connection and Removal of 2π Jumps

The total observed fringe phase is the a priori value plus the residual value

$$\Phi(t) = t_\xi^0(t) - t_\eta^0(t) + \tau_{atm_2}^0(t) - \tau_{atm_1}^0(t) + \vec{B}^0(t) \cdot \hat{e}_0 + \phi(t_0) + \dot{\phi}(t_0)(t-t_0) \qquad (9.4.1)$$

Since this quantity varies smoothly with time (if the clocks and atmospheres are stable) it is simple to imagine extrapolating the observed $\Phi(t)$ across a small gap in the data recording to obtain an unambiguous connection between the two segments. The reason that this can be done is that during an observation $\Phi(t)$ is determined five times per second, and during the maximization in 9.3.1 a wide enough range of trial values of Ω is taken to insure that the value Ω^* which maximizes 9.3.1 is the value at the absolute maximum of $|D|$. The function $|D|$ is ambiguous at intervals of 5 Hz due to the sampling interval of $0\overset{s}{.}2$, but the a priori model for the phase is invariably good enough to insure that the correct value of $\dot{\phi}$ is the one which corresponds to the range $-2.5 \text{ Hz} < \dot{\phi}/2\pi < 2.5$ Hz. Hence the phase is determined unambiguously during each observation.

In fact, the algorithm used to effect the extrapolation is more

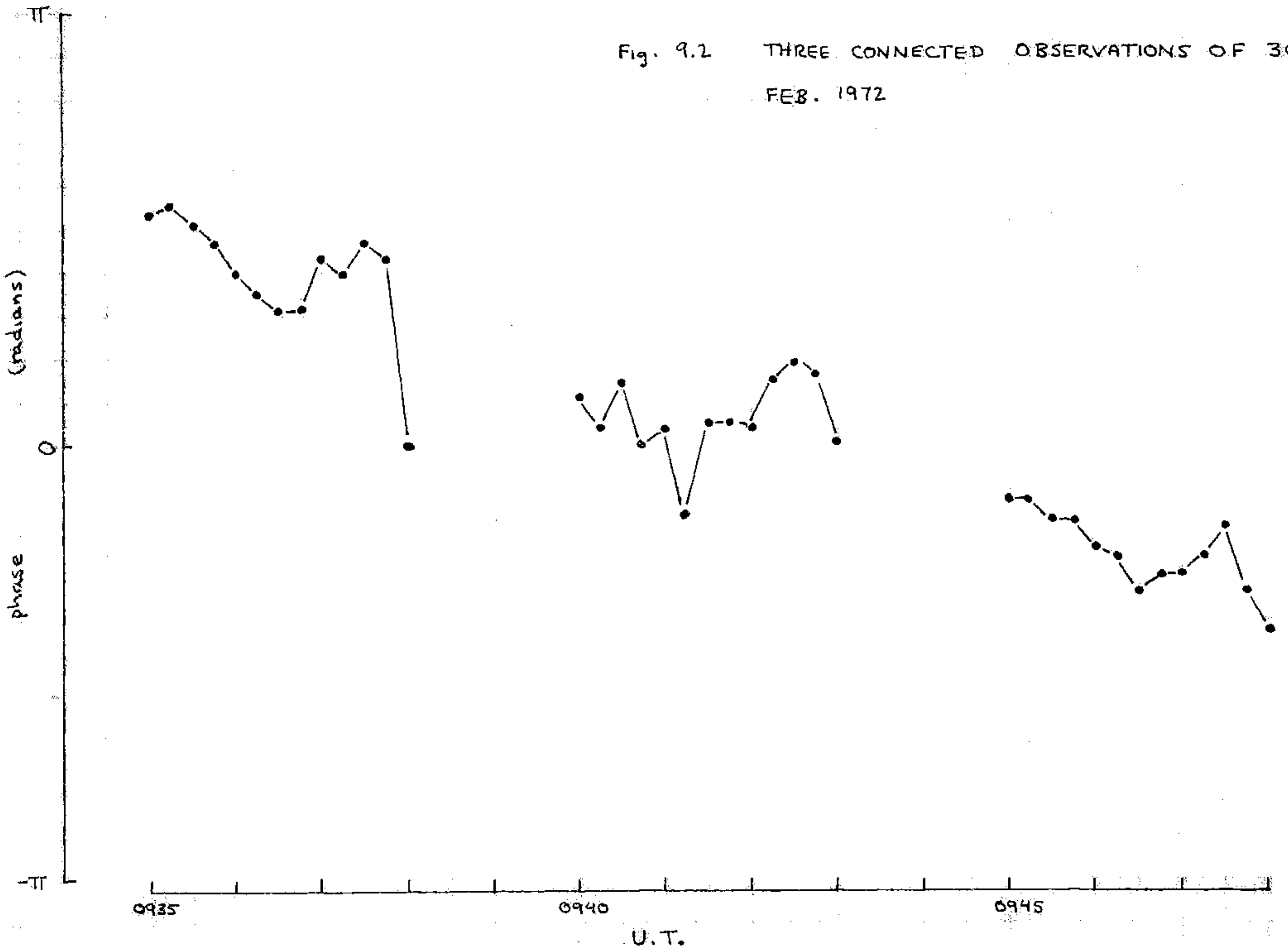


Fig. 9.2 THREE CONNECTED OBSERVATIONS OF 3C273
FEB. 1972

complicated. The complication is introduced to permit the experimenter to visually verify that the extrapolation across gaps in the recording has been done properly. The first stage in the connection algorithm is to make a polynomial approximation to the values of $\dot{\phi}$ corresponding to the n observations of a given source on a given day. A polynomial of low order, say 4, is fit to the values of $\dot{\phi}$ obtained for a source. Typically, $50<n<125$. If the time of the first observation is t_o, the polynomial has the form $P_{\dot{\phi}}(t) = a_0 + a_1(t-t_0) + a_2(t-t_0)^2 + a_3(t-t_0)^3$ and $a_o \rightarrow a_3$ are adjusted to obtain a least-squares fit to the actual . This polynomial is then integrated

$$P_{\phi}(t) = \int dt\, P_{\dot{\phi}}(t) \qquad (9.4.2)$$

and it is used in place of the approximation $\phi_0 + \dot{\phi}(t-t_0)$ to produce the residual phase which is smoothly varying throughout a day, rather than being stepwise discontinuous, and with a stepwise discontinuous slope, with steps at the time of the beginning of each observation. This new residual phase is used to "eyeball" the phase connection, and determine the times when 2π jumps occur. These 2π jumps are then repaired by adding the delay equivalent of 2π phase to the total phase delay for each observatin following the jump. Examples of the output at the final stage in the data processing appear in figure 9.2.

5. Differencing

The procedure above is performed on the data from one source.

After the phase delay has been unambiguously determined for one source and for its companion separately, the difference phase delay is computed to eliminate the $t_{\xi}(t) - t_{\eta}(t)$ part of the phase delay, since it is common to the two sources simultaneously observed. Finally, the differenced delays are used to estimate the radio source positions and station locations and other quantities of interest.

X. Analysis of the Differenced Phase Delays

1. Introduction

The analysis of the differenced phase delays to determine radio source coordinates, station locations, and other quantities of interest proceeds in several steps. First, it is necessary to insure that no errors of 2π in phase have occurred in the phase connecting procedure. Next, preliminary experiments must be done in order to determine if there are any of the data which are obviously inconsistent with the theoretical model. Then, we take advantage of the redundancy in the data to provide an indication of the consistency which might be expected among the source coordinates estimated from the data. Finally, the data are all included in several grand solutions in which small variations are introduced in order to investigate the sensitivity of the solutions to small changes in the data, or in the number of degrees of freedom allowed in the theoretical model.

2. Elimination of Errors of 2π in the Observed Phase Delays.

There may be errors of 2π remaining in the output of the phase-connecting procedure mainly as a result of erroneous judgement, or as a consequence of large gaps in the data. It is our experience that these may almost always be removed, unless extremely numerous, by examining each source-pair on each day separately. From this limited amount of data, the following four parameters are estimated:

a) an overall additive constant
b) an atmospheric zenith delay
c) the right ascension and declination of one of the sources

The resulting residuals (see section 4.2) should be random to the eye. The signal-to-noise ratio in this experiment is high enough so that an error of 2π in the data will be obvious. This situation is illustrated in figure 10.1. The corrective action in this case is to add the appropriate multiple of 2π equivalent of delay (127×10^{-12} sec in this case) to the affected data.

3. Other Obvious Defects in the Data

Figure 10.2 illustrates another appearance of the residuals from this initial test of the data. Here, the residuals alternate between two values approximately one microsecond apart. In fact, the error is by exactly one microsecond, and arises because the computer program which performs the cross-correlation arbitrarily adjusts the 'observed' delay in units of one microsecond until it is within one microsecond of the a priori delay used in the correlation. The corrective action here is to add exactly one microsecond to the appropriate data points.

4. Level of Instrumental Error

In order to judge the level of instrumental error, that is, error due to the electronic systems, we may examine the solution obtained from the data when all four antennas were pointed at the same strong

Figure 10.1

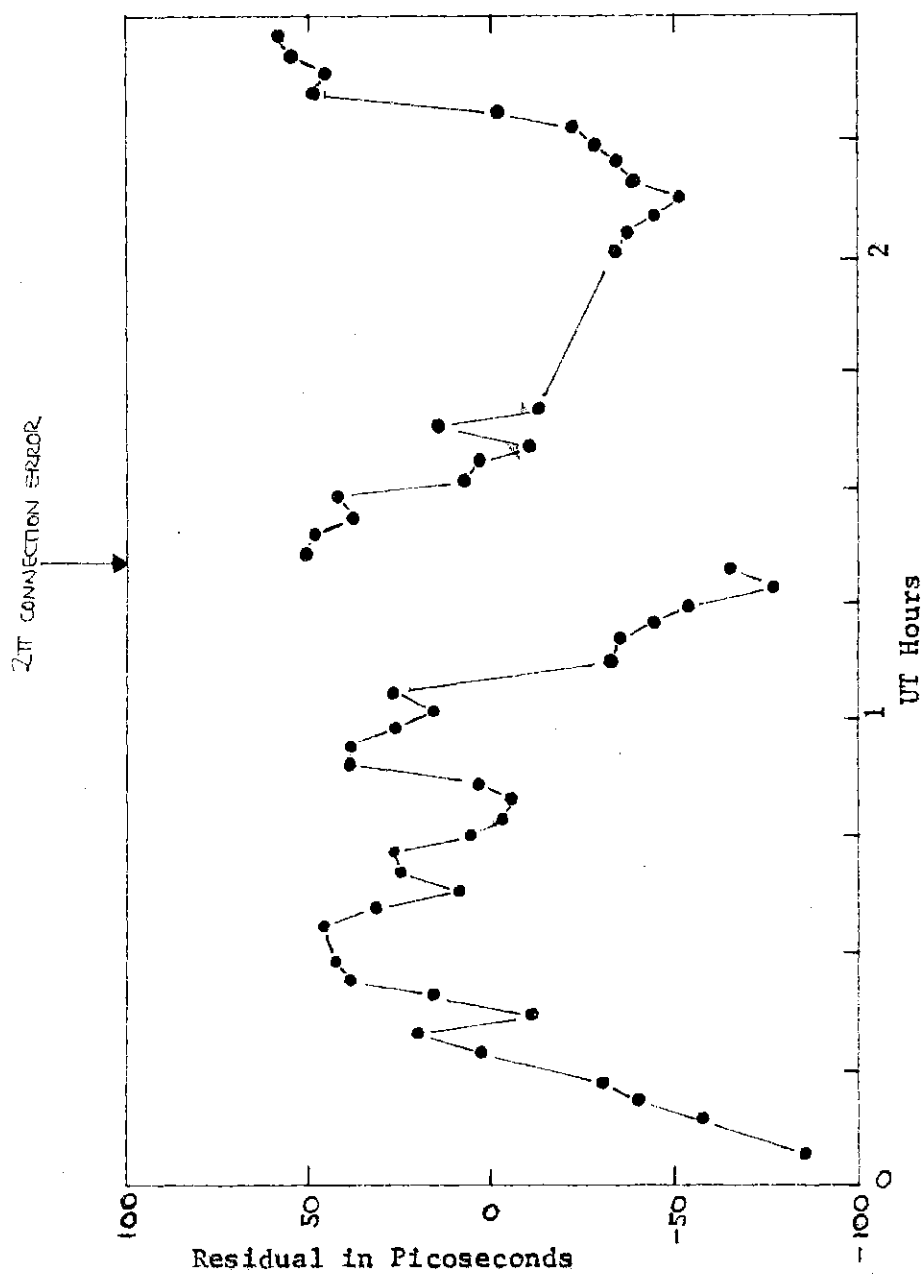
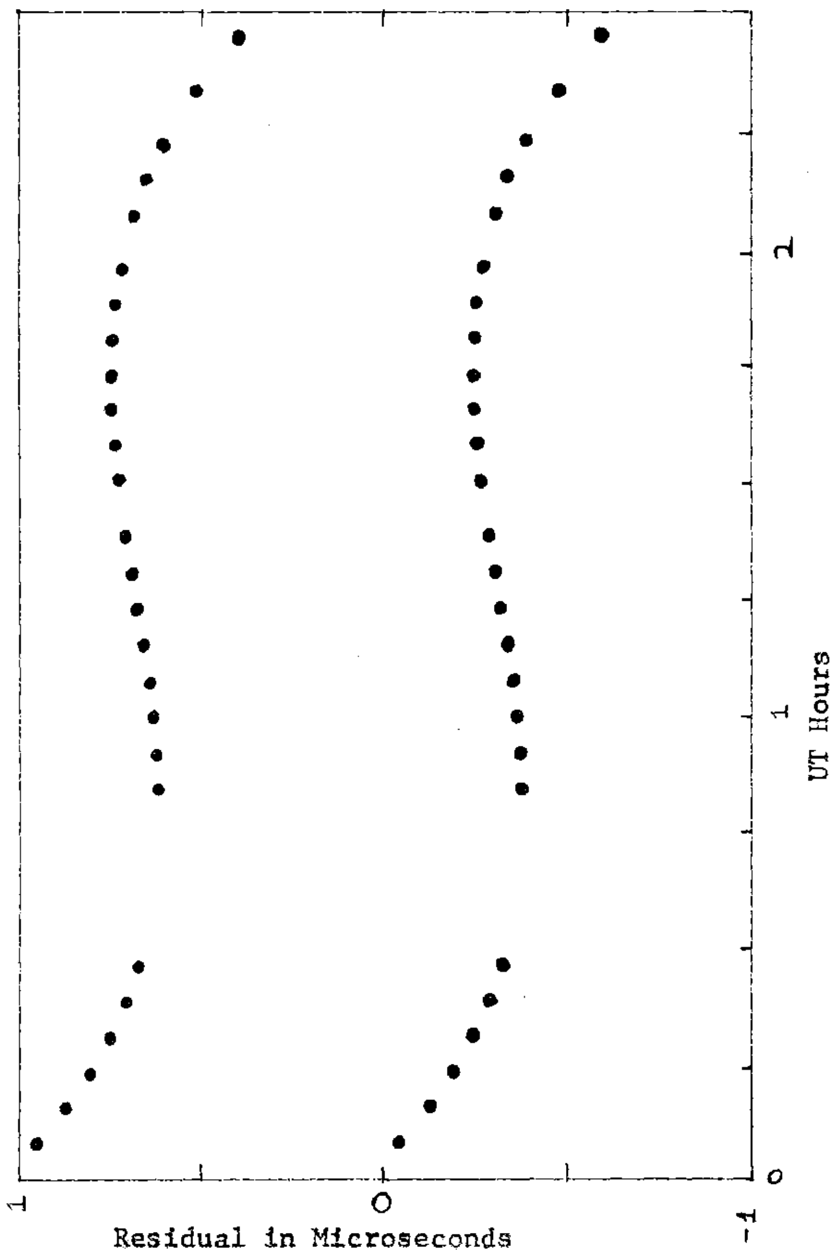

2π CONNECTION ERROR
100
50
0
-50
-100
Residual in Picoseconds
0
1
2
UT Hours

Figure 10,2



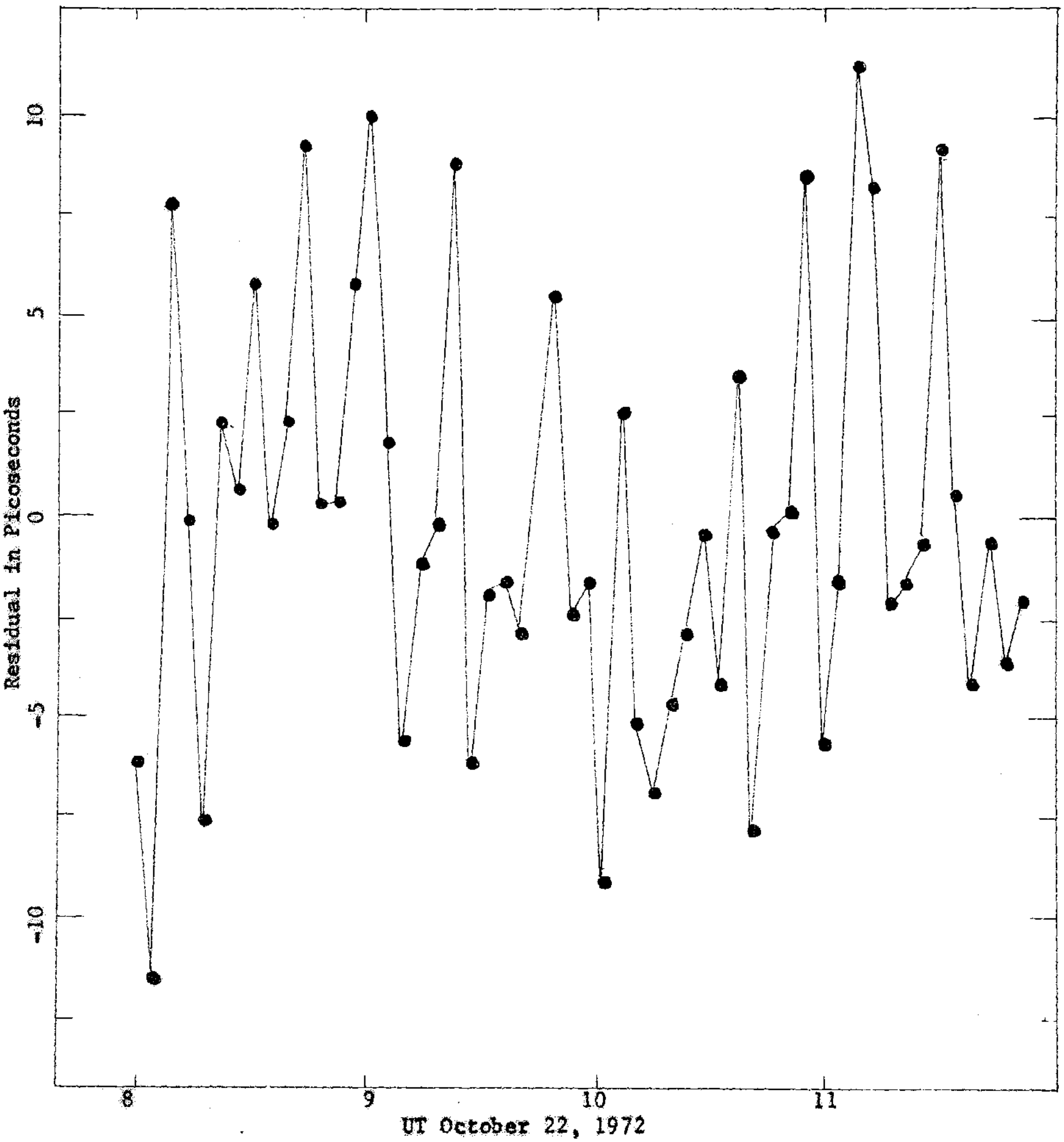
source, 3C84. The residuals are shown in figure 10.3. In this solution, three parameters were adjusted:

a) an additive constant
b) the differences in the equatorial components of the cylindrical coordinates of stations H and W

Since all antennas were pointed toward the same source, the residuals may arise from a limited number of sources:

a) because of the finite signal-to-noise ratio
b) because of phase instability between antennas at the same end of the long baseline
c) because of imperfect cancellation of the atmospheric refraction due to the atmosphere directly above the antennas
d) because of error in the computer programs

The residuals of figure 10.3 have an RMS value of 6.3 ps. and show no obvious systematic behavior. What is the source of these residuals? It cannot be (a), since the signal-to-noise ratio for 3C84 is such that the phase delay error is reduced to 6 ps/sec with only 1 sec. of data, whereas the points in the solution resulted from a 3 minute integration. It is not likely to be (d), although small errors in the computations cannot be absolutely ruled out. The most likely sources of error here are (b) and (c). The independent evidence for this is the fact that phase errors of this magnitude (18° of phase at 8105 MHz) represent the usual behavior of the NRAO interferometer: in routine determinations of the short baselines by NRAO personnel, the RMS residual phase is generally .05 wavelength at 8105 MHz.[1] There is little evidence to



Residual in Picoseconds
10
5
0
-5
-10
8
9
10
11
UT October 22, 1972

distinguish between the two sources of error (b) and (c). This level of error probably represents the best that could be done with then existing interferometer systems.

5. Consistency of the Experimental Results

The consistency of the experimental results can best be determined by comparing many solutions for the same quantity but with different sets of data. This was made possible in the October experiment by the high degree of redundancy in the measurement of the 3C273-3C279 relative position. Table 10.4 displays the results of twenty-four determinations of the right ascension of 3C279 from six independent sets of data. Each set of data was processed four times, progressively limiting the data included in the solution to higher elevation angles. The angle limit refers to the lower limit of the elevation angle of either source at either station. In each solution only three parameters were adjusted: a constant, an atmosphere zenith delay, and the right ascension of 3C279. The consistency of these results is remarkable: the RMS value for the six measurements is only $0\overset{s}{.}00027$ for the 10 degree cutoff, showing that atmospheric phase fluctuations are probably the limiting factor in accuracy at low elevation angles, even though 3C273 and 3C279 are only 10 degrees apart in the sky. The RMS increases rapidly for higher elevation cutoffs. The sources are above 40 degrees elevation at both sites for only about one hour a day.

Table 10.4

Estimated Values of 3C273-3C279 Right Ascension Difference

The seconds of time digits of the 3C279 right ascension are displayed. No a priori constraint was employed in the solutions. The declination of 3C279, the position of 3C273, and the station locations were all fixed to the values given in appendix 5.

Date (1972)	Lower limit of elevation angle of any source			
	10	20	30	40
Sept. 23	35.83485	35.8348	35.8348	35.8315
Oct. 1	.83440	.8343	.8336	.8268
Oct. 2	.83418	.8343	.8343	.8328
Oct. 18	.83487	.8349	.8351	.8404
Oct. 19	.83448	.8345	.8347	.8357
Oct. 20	.83443	.8345	.8348	.8478
Mean	35.83454	35.83455	35.83455	35.83583
RMS	.00027	.00025	.00053	.00740

6. Solutions Involving Large Fractions of the Total Available Data

2499 data points survived the process of correlation, phase connection, and initial screening. These data are found in Apendix 4. Each source-pair was successfully observed at least once in both January and October. From these data, we must determine the values of the radio source coordinates and station locations. There are many choices to be made concerning the exact nature of the solution, i.e., whether or not to adjust, say, the polar motion values, or the Green Bank offset stations positions. The philosophy used here is to adjust as many parameters as possible, placing a priori constraints (in the sense explained in Sec. IV.3) as desired to permit the determination of a unique solution. The constraints are necessary to obtain a solution since each observation of a pair of sources serves to define only two parameters, the amplitude and phase of diurnal sinusoidal dependence of phase delay upon time. These two parameters correspond, say, to the relative right ascension and declination of the sources, so in order to determine the baseline as well, for instance, additional information is required. If as many parameters as possible are adjusted, with reasonable constraints where these are known, the data are permitted to govern the adjustment in those parameters for which they are best suited. As a by product, the formal standard errors of the parameters determined will reflect more nearly the true errors, since the covariance of the estimate of each is taken into account with respect to a wider range of possible influences.

Relatively few of the large range of possible solutions will be presented here. The results presented here will show the consistency of the solutions with respect to changes in the amount of data included, and will compare the results from January and October processed separately.

7. Remark on 3C274 and 2134+00

The data involving sources 3C274 and 2134+00 were taken to fill in small gaps in the schedule, and verify that these sources were visible using the Haystack-NRAO interferometer. The time spanned by the observations is so small that we judge it to be insufficient to determine the source coordinates. Hence, these data were unweighted in the solutions by giving them an error (see section 4.2) of 100 ns.

8. Remark on Station 1 (85-1)

Early in the procedure of trying various solutions we discovered that all of the data involving station 1 (85-1) were defective. This only became obvious when more than one pair of sources was reduced simultaneously. The extent of the problem can be seen in the residuals to the solution presented in figure 10.5. These residuals were computed using the values of the parameters as determined in solution 1 (see below). Comparison of these residuals with a sample of those of solution 1 (figure 10.6) demonstrates that they are orders of magnitude greater than would be expected, and are highly systematic. The only explanation so far advanced for this behavior is that on January 29, 1972, when 85-1 was used because of a failure in the receiver at station 2 (85-2), the phase compensation in the cable was accidentally shut off while the repairs to 85-2 were being made. These data were deleted from all solutions appearing here.

9. Solutions with all Data

What follows is a description of several solutions, which will be given numbers for future reference. The results of the various solutions

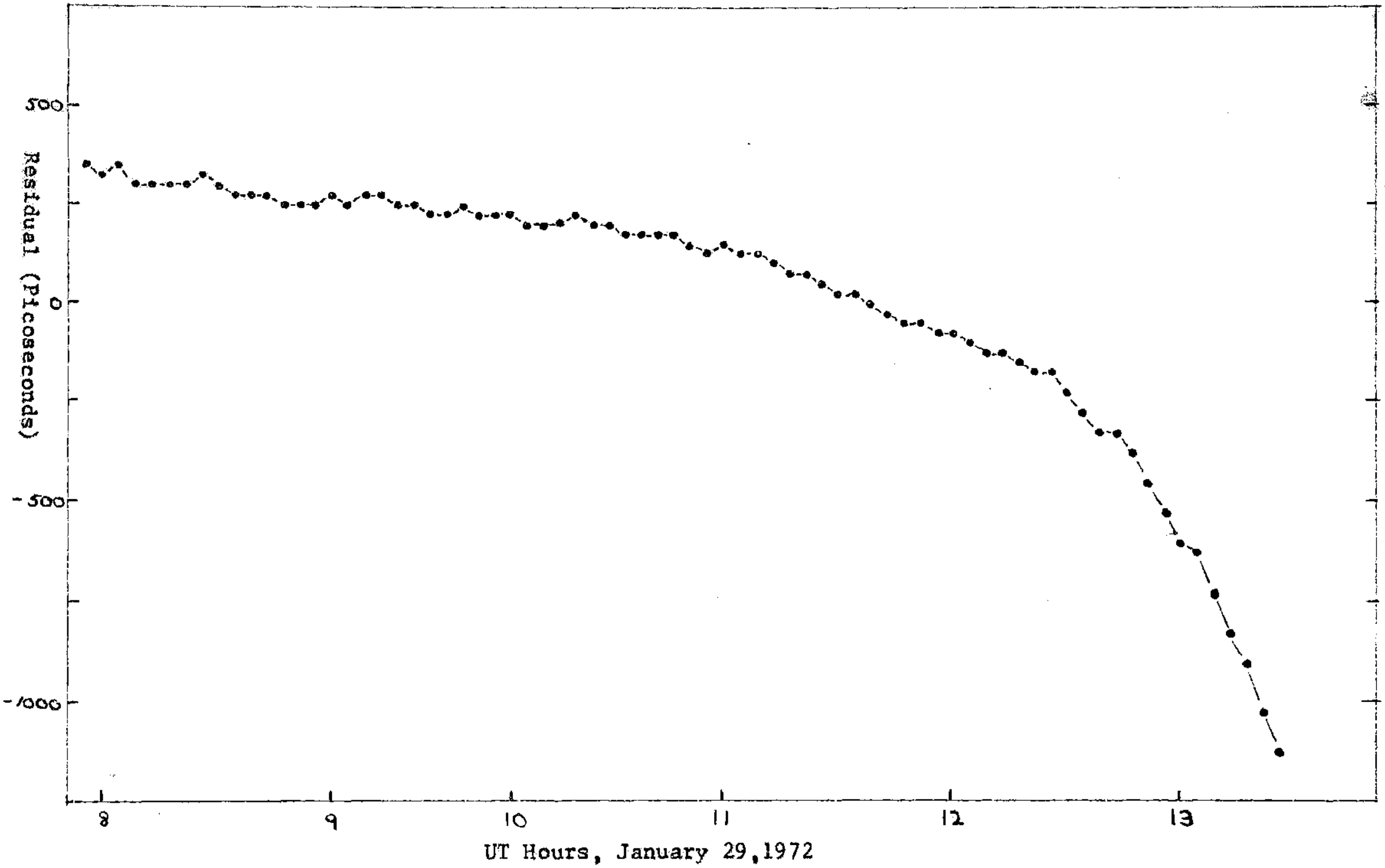

500
0
-500
-1000
Residual (Picoseconds)
8
9
10
11
12
13
UT Hours, January 29,1972

Figure 10.5

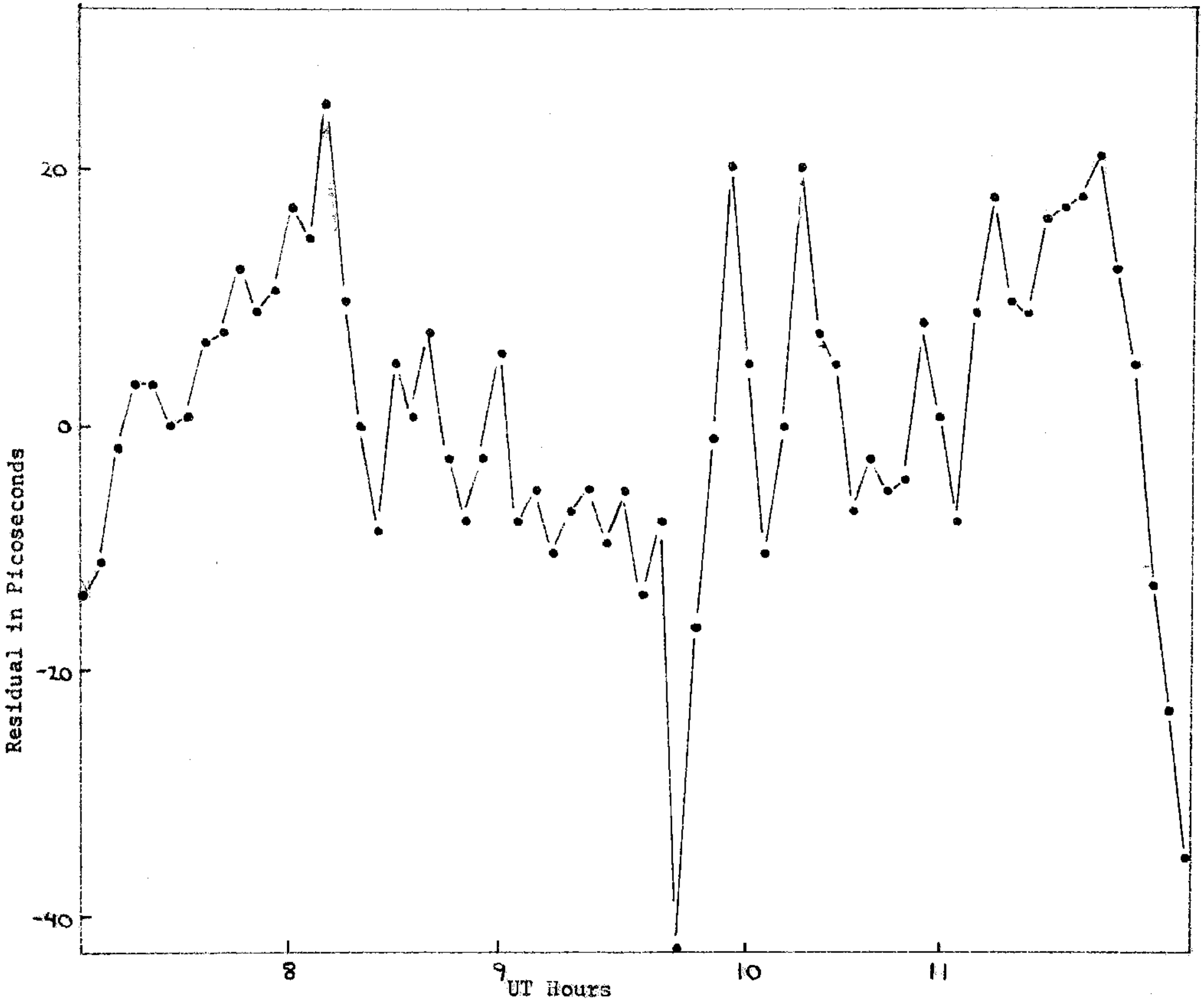


Figure 10.6

are compared in figures 10.7 through 10.13.

In solution 1, January and October data are analyzed together. The position of Westford relative to Haystack is adjusted, but the positions of the antennas at Green Bank are fixed except for an overall adjustment, which appears as an adjustment in the 85-1 cylindrical radius and longitude. For each unbroken series of observations of a source pair an instrumental constant is adjusted, and a zenith atmospheric phase delay is determined. The zenith atmospheric phase delay at Green Bank is adjusted, but it is fixed to 7 ns. at Haystack. This is reasonable since the estimates of the atmosphere parameter at Haystack and Green Bank are highly correlated. The correlation arises because the sources tend to be at approximately the same elevation angle at the two sites at the same time.

The coordinates of all sources are adjusted, except that the right ascension of 3C273 is fixed at $12^h26^m33^s.246$ to provide the origin of right ascension.

In solution 1, the x-component of polar motion and the value of A.T.-UT.1 are allowed a linear dependence on time for the duration of each experiment separately. The values at 0^h on January 26 and September 23, 1972 are separately adjusted. The y-component of polar motion is fixed at the BIH value at the reference epoch in January and October. This is permissible since the sensitivity of the interferometer to changes in the y-component was determined by covariance analysis to be quite low, a factor of five removed from the x-component sensitivity. Also, the time rate of change of the y-component is relatively small at both of these epochs.

In solution 1, Einstein's value for the gravitational bending of light due to the solar gravitation field was used. There was no correction for solid Earth Tides.

A priori constraints were applied to all source coordinates (see Appendix 5). The constraint was $0^{s}.01$ in right ascension and $0''.1$ in declination. The constraint on the 85-1 position was 10m in radius and the equivalent of 10m in longitude. The values of the x-component of polar motion and of A.T.-UT.1 at the reference epoch were constrained to $0''.1$ and $0^{s}.01$ respectively. The slopes were not constrained. The Westford coordinates were not constrained.

All data for which both sources were above 15 elevation at both sites were used. The solution included 2159 data points.

Solution 2 is identical to solution 1 except that the elevation angle cutoff is raised to 30°. The solution included 1572 data points.

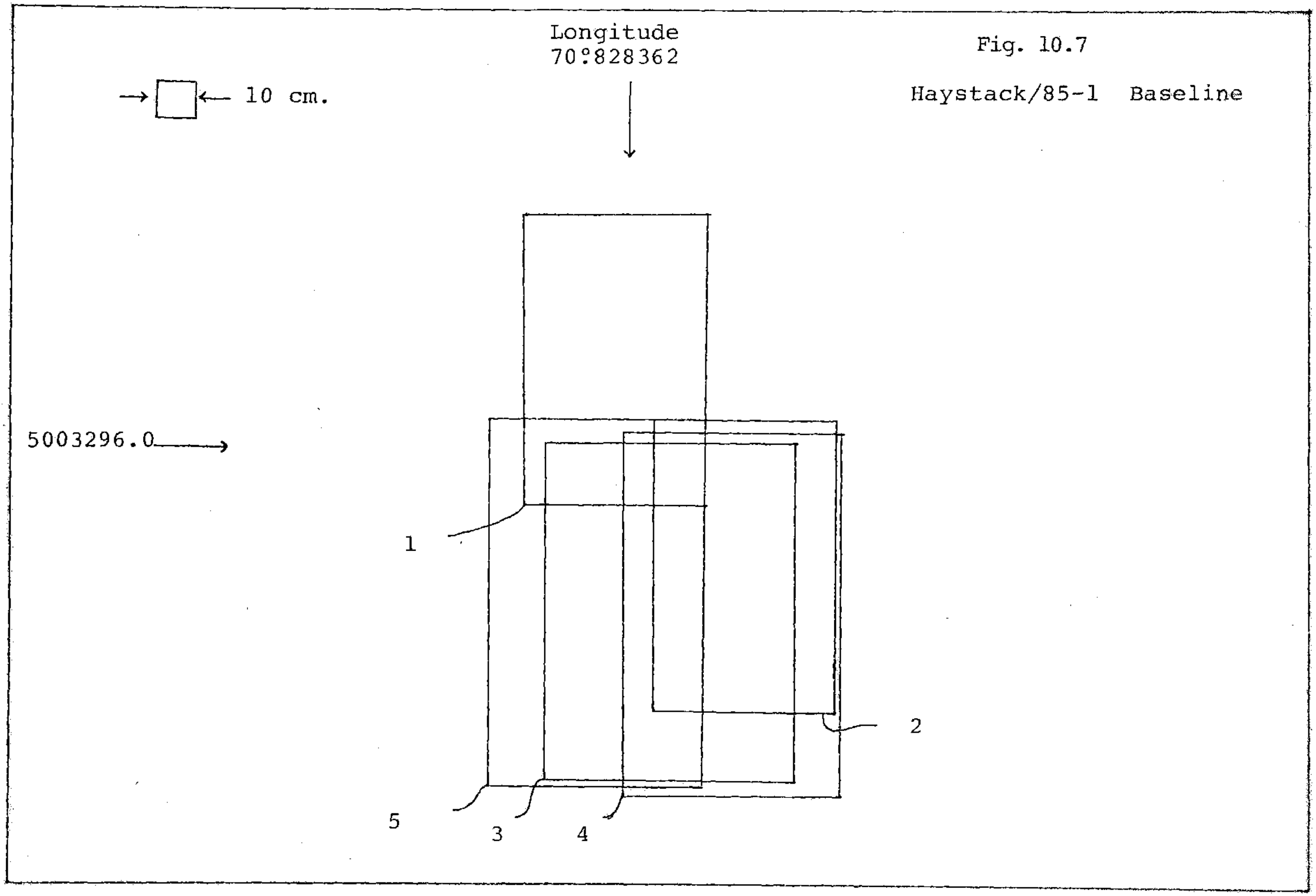
Solution 3 is identical to 1 and 2 except that the elevation angle cutoff is raised to 45°. The solution included 336 data points. The pair 3C273-3C279 was completely excluded by the elevation criterion.

Solution 4 involves only data from January. There are 550 data points. The a priori constraint on the long baseline was 5 meters, with 5 cm. constraint on the baseline offsets. The source coordinates were constrained by the values of the error quoted in ref. 2 except that the constraint for 3C84 was $0^{s}.01$ in right ascension and $0''.1$ in declination.

The baseline offsets in Green Bank were adjusted in this solution, but were constrained as above.

Solution 5 is identical to solution 4, except that only October data were analyzed. There were 1609 data points.

The points labelled "A" in figures 10.7 through 10.13 are at the a priori values for the parameters. These values are listed in appendix 5.


Longitude
70°828362
Fig. 10.7
10 cm.
Haystack/85-1 Baseline
Cylindrical Radius (m)
5003296.0
1
2
5
3
4

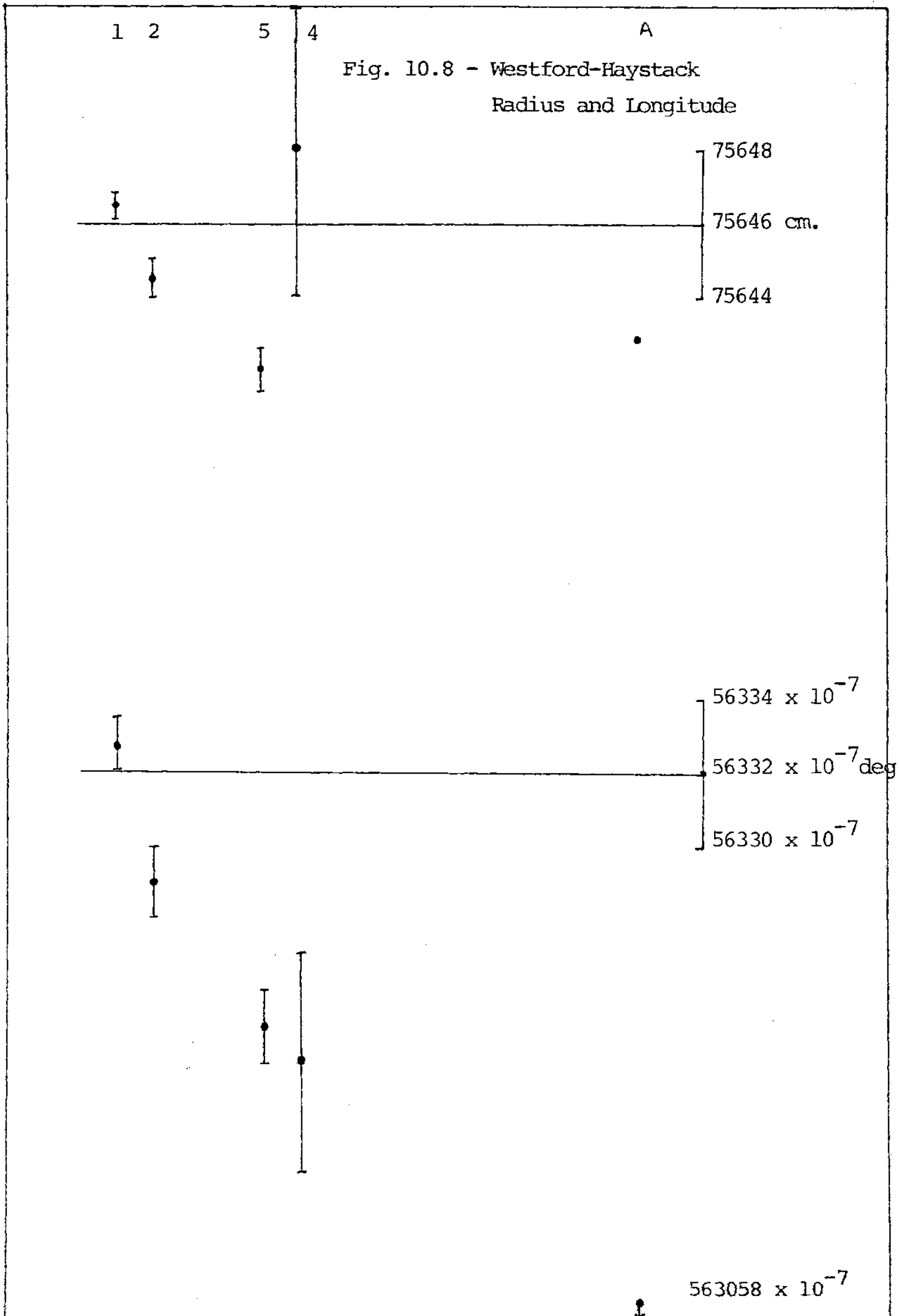
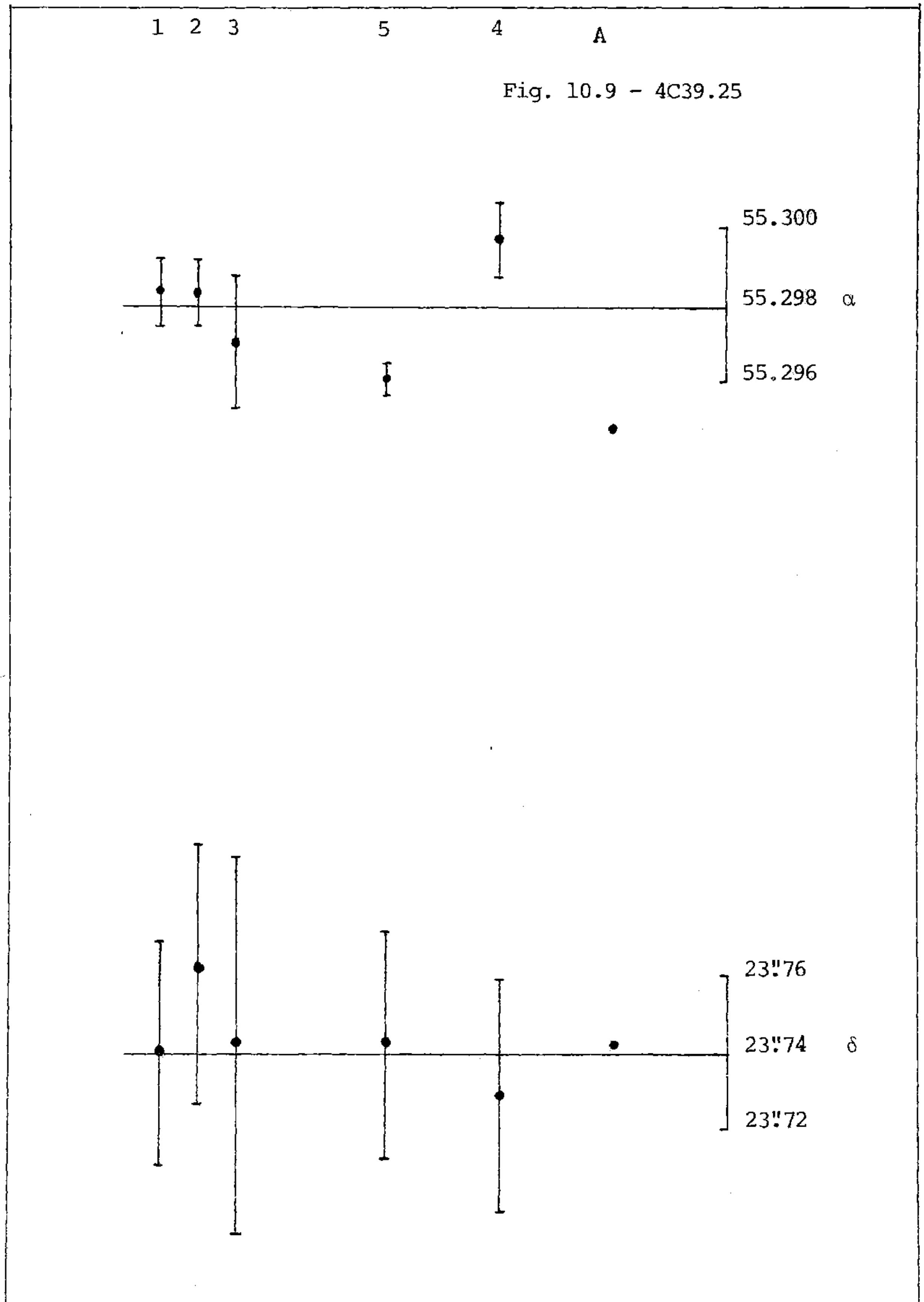


Fig. 10.8 - Westford-Haystack Radius and Longitude



1 2 3 5 4 A
Fig. 10.9 - 4C39.25
55.300
55.298 α
55.296
23.76
23.74 δ
23.72

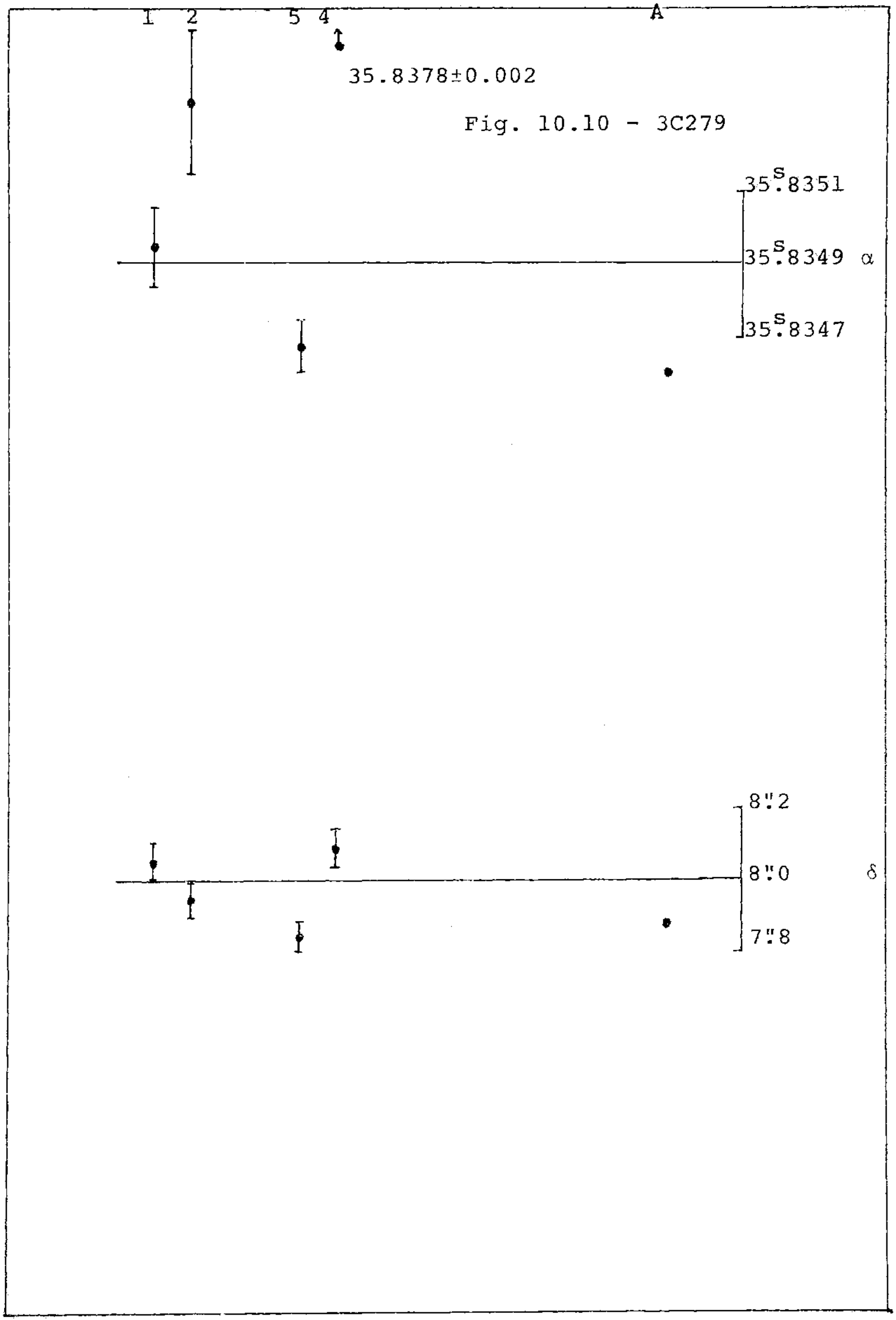
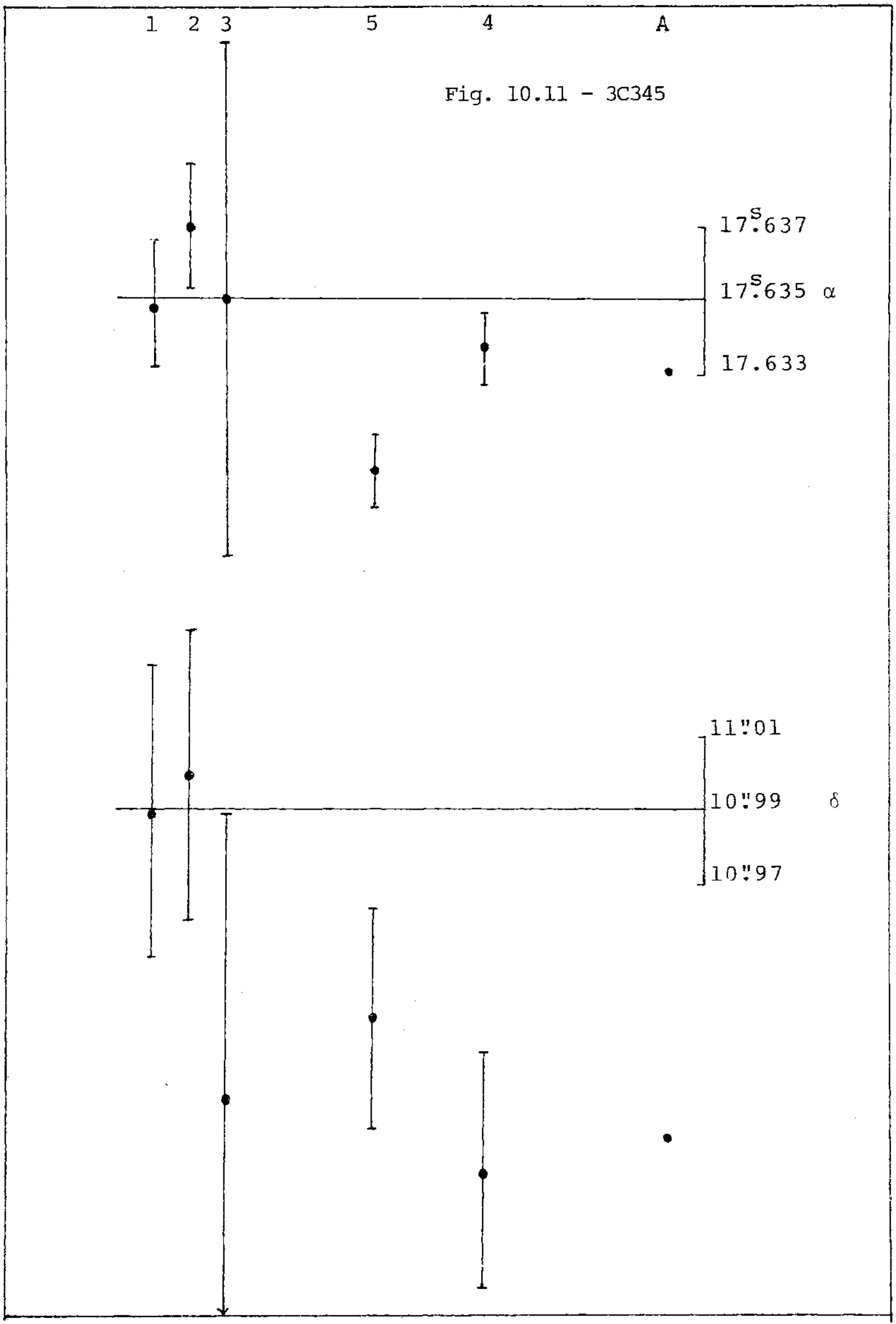
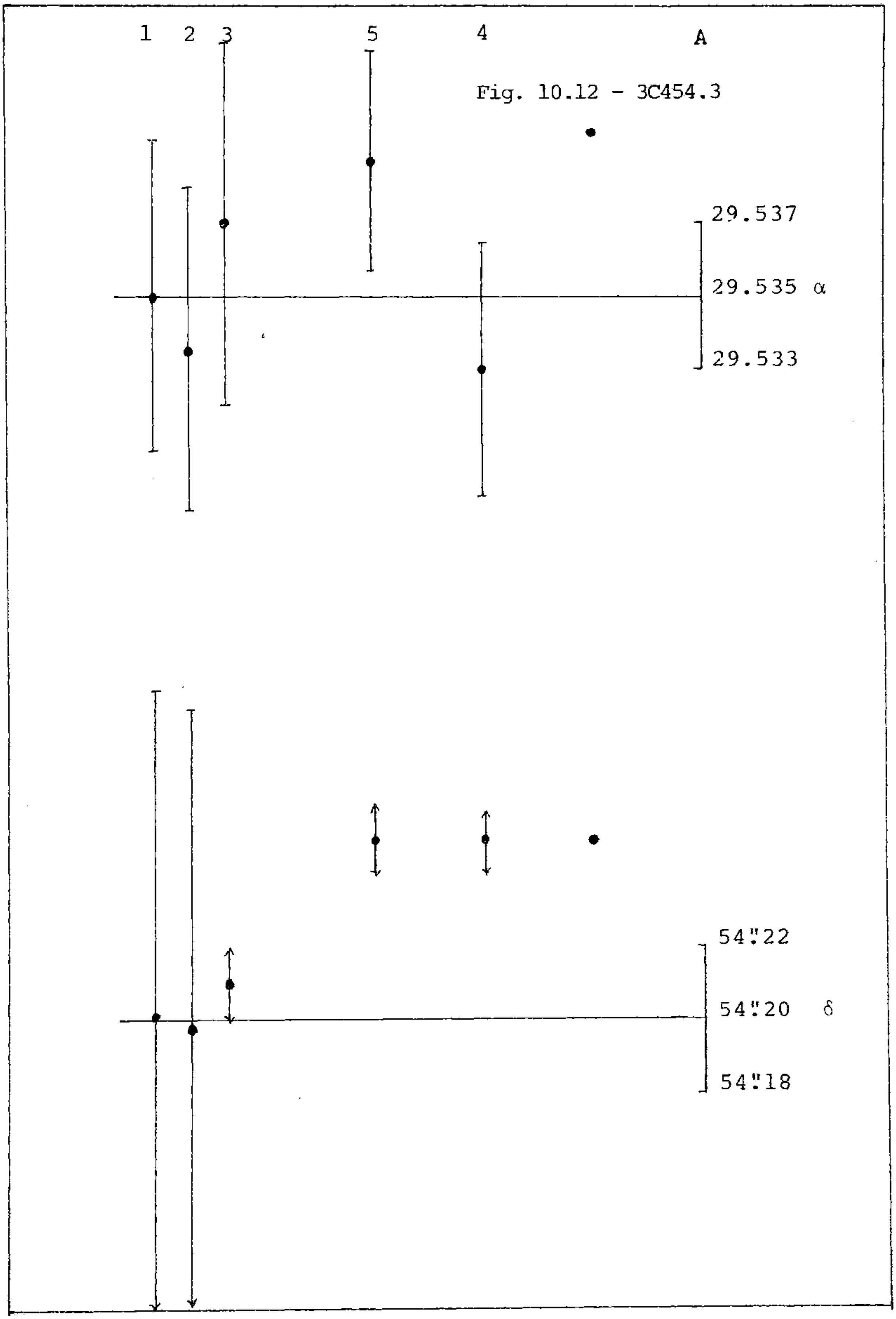


Fig. 10.10 - 3C279


1 2 3 5 4 A
Fig. 10.11 - 3C345
17.637
17.635 α
17.633
11"01
10"99 δ
10"97


1
2
3
5
4
A
Fig. 10.12 - 3C454.3
29.537
29.535 α
29.533
54".22
54".20 δ
54".18

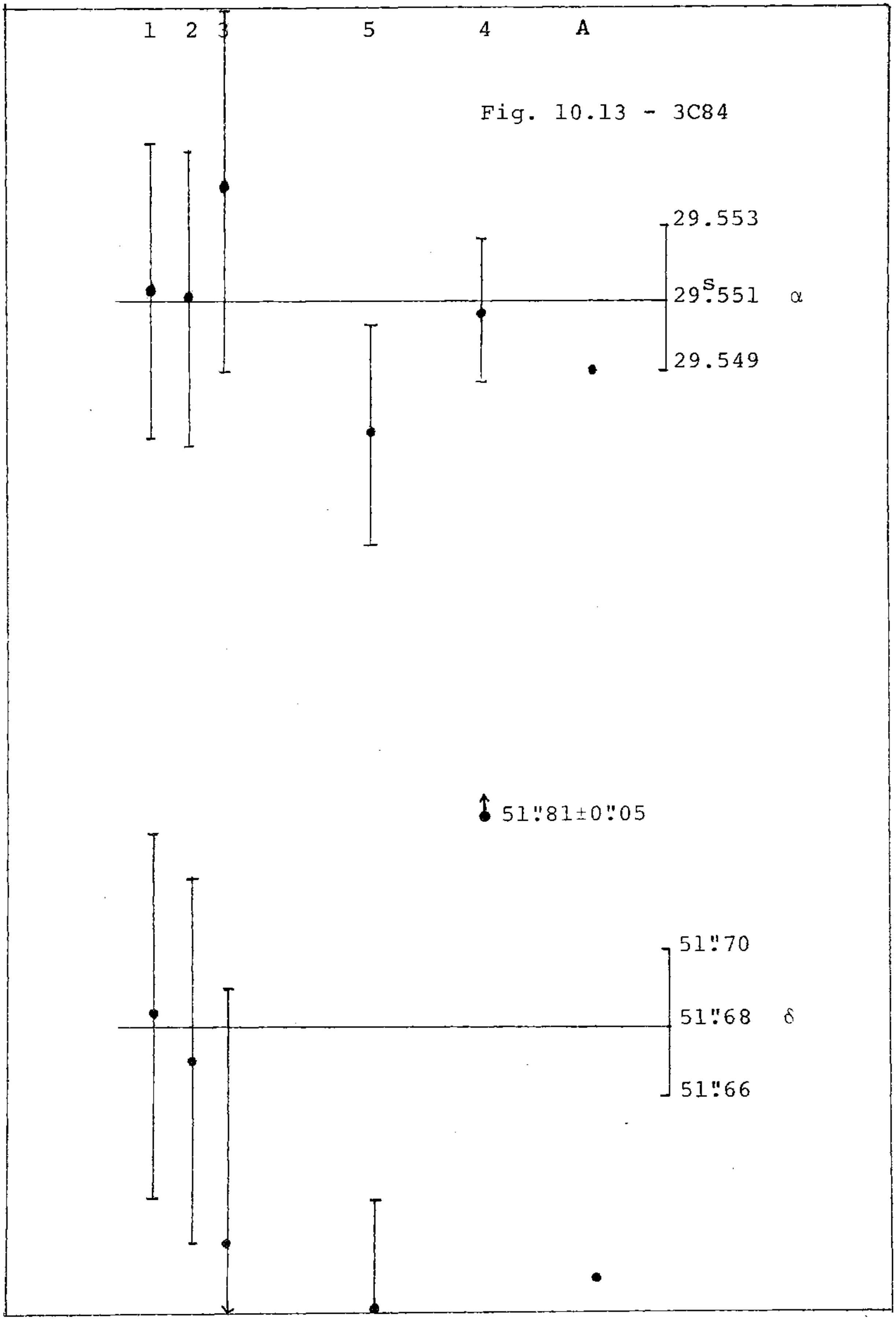


Fig. 10.13 - 3C84

XI. Discussion and Conclusions

1. Examination of the Results

Figures 10.7 through 10.13 reveal that the results for a particular quantity varied among the various solutions by amounts greatly exceeding the formal standard error predicted by the linearized least-squares procedure. A further difficulty is revealed in the residuals (observed minus computed phase delays) to the various solutions. An example of the appearance of the residuals to solution 1 has been given in figure 10.6. This figure makes it clear that the conditions explained in section IV.2 have not been met, that is, the residuals are not independent samples of a gaussian random variable, but are correlated. How can this behavior arise? Unfortunately, all too easily. The phase error resulting from uncompensated changes in the local oscillator cable length from the Haystack control room to the receiver is of the correct magnitude (section IV.2). It is also possible that systematic errors of this magnitude can result from atmospheric refraction if the air mass was changing character (say from polar to tropical or vice versa) at either end of the baseline. Phase changes of this magnitude, but of shorter duration can result from clouds of water vapor in the summer atmosphere.

It is doubtful that errors in the theoretical model for the interferometer delay, such as might arise from inadequate knowledge of the rotation of the Earth, cause the observed differences in the measured source coordinates between the January and October experiments, since the arc distances between the sources as measured in January and October also differ significantly.

These arc distances would tend to be independent of rotations of the coordinate system they are measured in.

Figure 11.1 - Arc Distances Between Sources

Source Pair	Arc Distance (Jan)	Arc Distance (Oct)	Change (Jan-Oct)
3C273-3C345	68°32'22".483	68°32'22".455	-0".028
3C345-3C454.3	81 47 40.380	81 47 40.472	-0.092
3C454.3-3C84	61 51 41.811	61 51 41.692	-0.119
3C84-4C39.25	66 28 50.411	66 28 50.515	-0.104
4C39.25-3C273	55 29 44.935	55 29 44.976	-0.041

Figure 11.1 displays arc distances determined in a solution in which the source coordinates were allowed to be different in January and October, but the baseline was in common for the two experiments.

2. Improvements in the Technique for Future Experiments

Three significant improvements in the state of the art have occurred since 1972. First, reliable means have been developed for calibrating the phase delay through a VLBI receiver system from the antenna feed horn through the tape recorder.[1] Second, systems are being developed to determine the atmospheric refraction along an arbitrary line of sight through a combination of ground level temperature, pressure, and dew point measurements and observations of the opacity of the atmosphere in the 22 GHz water vapor absorption line along the desired line of sight.[2] These two developments would improve the accuracy of the difference phase measurement significantly. On the other hand, the third development - wideband group delay measurement - offers an alternative method with some advantages.

Receivers with bandwidth of up to 500 MHz have been developed for use in the Mark-III VLBI system.[3] Experiments performed with these receivers and the Mark-I recording system have yielded post-fit residuals with RMS of only about 100 picoseconds - about four times the post-fit RMS delay of the October four antenna experiment. With the higher signal to noise ratio available using the wide bandwidth Mark-III recording system, the errors in group delay measurement may well be reduced. Furthermore, the group delay measurements suffer far less from the problem of ambiguities so that observations can be made of more than two sources at a time without losing track of the proper delay ambiguity. Even the differencing method, which removed the clock error almost entirely from the four-antenna observations, can be used to substantially eliminate clock error as a limiting factor in the group delay measurements simply by differencing delays from observations of different radio sources made at nearly the same time. If differencing can be done profitably on observations taken at different times, only one antenna is needed at each end of the baseline.

In conclusion, it seems that while in 1972 there was a significant potential gain in measurement accuracy to be expected from the four-antenna technique, this is no longer true, and I judge that the technique will find application in the future only in cases where truly simultaneous observations of two widely separated objects are required.

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Appendix 1: The Haystack-Westford Land Survey

Early in 1967, a land survey was conducted by Ramond C. Pressey, Inc., Lynn, Massachusetts for the M.I.T. Lincoln Laboratory in order to determine the relative positions of the Haystack and Westford antennas. At the time, these antennas were owned by the Lincoln Laboratory. The survey was carried out in order to determine the baseline of the Haystack-Westford radar interferometer. The following summary is taken from material supplied by Pressey, Inc. in 1967, clarified by personal discussion with Mr. Pressey.

At Westford, the center of rotation about the azimuth axis was determined by fixing a plumb-bob to the superstructure, then rotating the antenna in azimuth while marking the path of the plumb-bob on the concrete floor. Three points were marked, and used to determine the position of the center of rotation. The position reference point at Westford was the point on the azimuth axis which is closest to the center line of elevation rotation. At this point, the perpendicular distance between the centers of the azimuth and elevation axes is 12.50 inches according to the antenna plans. The offset is positive, that is, the elevation axis is displaced in the direction in which the antenna is pointed.

From the concrete support structure, a survey was made with tape and level to a point outside the radome building. From there, the survey was continued in four legs up to the Millstone 1957 benchmark. Each leg consisted of a distance measurement, a vertical angle measurement, and an azimuth measurement. Each distance measurement was made by geodimeter, and is expected to be in error by less than 1 cm. The elevation angle measurements were carried out to the nearest minute of arc and the azimuths to the nearest second. From

Millstone 1957, the survey was extended to the Haystack Outer Control No. 2 by geodimeter, and from there the survey was carried through the radome doors by tape and level to a mark on the concrete floor, and from there to the point of intersection of the center lines of azimuth and elevation rotation.

At each vertex between two surveyed lines, only the relative azimuth was measured. The absolute azimuth with respect to true north, was obtained from an observation of Polaris on January 23, 1964 from Haystack Outer Control No. 2. From this observation of true north, the azimuth of the line Millstone 1957 - Haystack No. 2 was computed to be 204° 40'39", and all other azimuths were computed assuming this value.

The total resulting from the sum of all the individual surveyed lines is, for Westford relative to Haystack,

Distance (l) 4066.16 feet

Azimuth (a) 201° 53'47"

Elevation (e) 1° 22'53"

Pressey estimates that 10 cm. is approximately the tolerance of the relative position.

In November, 1967, the radome was temporarily removed from Westford, affording the opportunity for a direct sight from Millstone to Westford. When the direct sight was made, the distances and angles were corrected by a negligible amount compared to the error of 10 cm. expected in the relative position.

The coordinates, distance (l), azimuth (a), and elevation (e), must be converted to geocentric cylindrical coordinates for use in the computer program VLBI 3. The first step is to define rectangular coordinates x,y,z where z is the direction of the local vertical

x is in the meridian plane at Haystack, pointing north

y is toward the west

then a is measured from the x-z plane, and e is measured from the x-y plane

$$x = l \cos e \cos a$$

$$y = -l \cos e \sin a$$

$$z = l \sin e$$

the second step is to rotate the coordinates about the y-axis until z points to the north celestial pole. This rotation is by an amount $\phi = (\pi/2-b)$ where b is the geodetic latitude of Haystack. ($b=42^\circ 37' 23''.504$ according to 1st Geodetic Survey Squadron Tracking Station Data Sheet No. 28A, 18 Sep 1970)

This rotation produces new coordinates x^1, y^1, z^1 where

$$x^1 = x \cos \phi - z \sin \phi$$

$$y^1 = y$$

$$z^1 = x \sin \phi + z \cos \phi$$

Then, the cylindrical z - offset Δz is equal to z^1, the cylindrical radius offset Δr is equal to $-x^1$, and the cylindrical longitude offset is $\Delta \xi = \tan^{-1}\left(\frac{y'}{r_0 + \Delta r}\right)$ where r_0 is the cylindrical geocentric radius of Haystack, 4700.643324 km. according to the Geodetic Survey Squadron data sheet no. 28A. Performing these calculations yields

$$\Delta z = -0.866153 \text{ km.}$$

$$\Delta \xi = 0^\circ.00563112$$

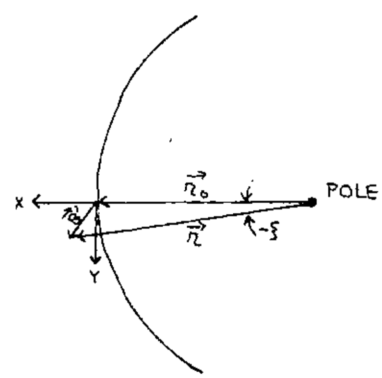
$$\Delta r = 0.756511 \text{ km.}$$

Appendix 2: Green Bank Antenna Offsets

Conventional surveys of the positions of the Green Bank antennas have not been performed with the care which was given to the Haystack-Westford survey (appendix 1). Instead, since the NRAO interferometer is often used for the determination of radio source positions, the data from the interferometer itself have been used to determine the baseline constants - a set of three numbers which characterize the vector separation of each of the movable antennas from the fixed one, 85-1. The method used is somewhat circular. First, a simultaneous determination of radio source positions and baseline parameters is made, thereafter, the positions of the radio sources, now called calibrator sources, are fixed and the baseline is determined from the data. The baselines are determined in a rectangular coordinate system where the z-component is parallel to the Earth's spin axis (of date), the x-axis is in the Equatorial plane (of date), and penetrates the Earth's surface at a longitude of $5^h19^m20^s$ west of Greenwich. The y-axis is in a right-handed sense. Local sidereal time is kept for this longitude by a crystal clock with an uncertainty which may be in excess of 50 millisec known only a posteriori. No reference is made to the standard methods for determining UT.1 from UTC - indeed, the UTC of the observations is not recorded. Fortunately, the baselines involved are very short - 2.7 km at most - so that the error involved in the conversion of the baseline parameters from x,y,z coordinates to cylindrical geocentric coordinates is likely to be small. The order of magnitude of the error is the maximum short-baseline fringe rate (5 Hz) times the sidereal clock error (50 ms.) which is about 0.25 rotation of phase, or about 1 cm.

The figures for the baseline components supplied by E. Fomalont of the NRAO are in Table A2.1. The typical consistency in a baseline component, determined from many determinations of the component, is 0.25 wavelength, or about 1 cm.

These baseline parameters must be converted to cylindrical geocentric position offsets



The diagram above represents the x-y plane. Δz , the cylindrical z-offset, is given directly by B_z. $\vec{B}^1$ in the diagram is a two-component vector made from the equatorial components of $\vec{B}$. ξ is the cylindrical longitude offset, and $|\vec{r}| - |\vec{r}_0|$ is the radius offset, where $|\vec{r}_0|$ is the cylindrical radius of 85-1, given in appendix 3 as 5003.203430 km.

Table A2.1 - NRAO Interferometer Baseline Components

Wavelengths at 8085 MHz w.r.t. the position of 85-1

Station	Bx	By	Bz
3	-13600.20	-42878.11	18250.68
4	-14356.81	-45260.76	19264.61
2	-20436.95	-64319.97	27346.72

Typical error 0.25 wavelength

The vector to 85-1 from the spin axis in the x-y plane has the components $(r_0, 0)$. The vector to the offset site has the components (r_0+B_x, B_y). The magnitude of the vector r^1 is therefore $|r'| \simeq \left[(|\vec{r}_0|+B_x)^2 + B_y^2\right]^{1/2}$ and the radius offset $\Delta r = |\vec{r}'| - |\vec{r}_0| = \left[(|\vec{r}_0|+B_x)^2 + B_y^2\right]^{1/2} - |\vec{r}_0|$. ξ, the longitude offset is given by $-\xi = \tan^{-1} \frac{B_y}{r_0+B_x}$ evaluating these quantities for the baseline parameters of Table A2.1 yields

Station			
3	0.504549	0.018205	-0.676736
4	0.532633	0.019217	-0.714333
2	0.758372	0.027308	-1.014018

Appendix 3: Correction for Relative Rotation of the Interferometer Receiving Antennas

The receiving antennas at the Green Bank site are all equatorially mounted, hence the orientation of the feed horn remains fixed relative to the right ascension-declination coordinate system. At Haystack and Westford, however, the antennas are azimuth-elevation mounted, and the feed horn will appear to rotate about the symmetry axis of the antenna, as viewed by an inertial observer, as a given source is tracked through its daily path in azimuth and elevation. The relative rotation of the feeds at Haystack and Green Bank causes the relative phase of the radiation at Haystack and Green Bank, and therefore the interferometer fringe phase, to be shifted from the values it would have in the absence of the relative rotation.

Imagine a circularly polarized monochromatic plane wave propagating in the positive z-direction Then at constant z, the electric field components are

$$Ex = E_o \cos wt$$

$$Ey = E_o \sin wt$$

This is according to the IEEE definition, a right circularly polarized (positive helicity) wave,

These field components may be expressed relative to a set of axes rotating about the z-direction

$$Ex^1 = Ex \cos \Omega t - Ey \sin \Omega t$$

$$Ex^1 = Ex \sin \Omega t + Ey \cos \Omega t$$

In this transformation the x^1, y^1 axes are rotating in a direction opposite to the direction of rotation of E.

Simplifying the above,

$$Ex^1 = E_o \cos (w+\Omega)t$$

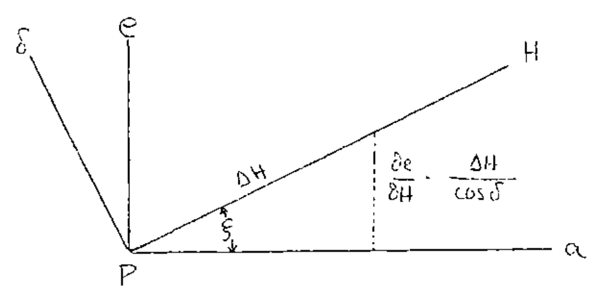
$$Ey^1 = E_o \sin (w+\Omega)t$$

And so the wave observed from x^1, y^1 has had its phase shifted by the amount t, the angle of rotation of x^1, y^1 relative to x, y.

The extra energy transfer to the receiver implied by the higher frequency of the radiation is actually supplied by the rotation of the Earth. The Earth must supply energy to rotate the feed horn against the torque exerted by the incoming radiation.

This energy supplied by the Earth appears as an increased frequency of the radiation as viewed by the receiver.

The proper correction for use with the four-antenna interferometer may be calculated simply by reference to the figure below



where a,e is the azimuth-elevation coordinate system and H, is the hour angle - declination coordinate system, both on the surface of the celestial sphere and assured to be locally rectilinear in the region surrounding the point of interst P. The quantity desired is the angle ξ, the inclination of the H axis relative to the a axis. This is given by $\xi = \sin^{-1}\left(\frac{\partial e}{\partial H}\ \frac{1}{\cos\delta}\right)$

The partial derivative may be evaluated from the relation

$$\sin(e) = \sin(\varphi)\sin(\delta) + \cos(\varphi)\cos(\delta)\cos(H)$$

where δ, H are the declination and hour angle of the source and where φ is the geodetic latitude of the site. The result is

$$\xi = \sin^{-1}\left[\frac{\cos\varphi \sin H}{\cos e}\right]$$

cos e may be evaluated by means of the formula for sin e, since e is always a positive angle less the $\pi/2$.

There are four potentially relevant angles. They will be called ξ_{ij}, for source i at site j. Since the telescopes at Green Bank are equatorially mounted, rotating with the (δ, H) coordinates, only the angles at Haystack need to be considered. Since the radiation received in this experiment was left-circularly polarized (or of negative helicity), and is considered to have its electricfield components defined in the (δ, H) coordinates an increase in the angle implies a decrease in the apparent phase at the site. A phase lag at the Haystack site increases the phase delay measured by the interferometer, since the interferometer computes the phase at site 2 minus the phase at site 1, and site 1 was always taken to be at the Haystack end of the long baseline. Finally, since the difference phase was taken in the sense "source 2 minus source 1", we may express the final correction to the phase:

$$\xi_{total} = \xi_{11} - \xi_{21}$$

which is to be added to the observed fringe phase difference before further analysis.

Appendix 4: Observed Differenced Delays

This appendix contains a tabulation of all observed differenced phase delays. The difference is taken in the same sense (source/baseline 2 - source/baseline 1). The stations are as follows:

H = Haystack

W = Westford

1 = NRAO 85-1

2 = NRAO 85-2, 2700m.

3 = NRAO 85-3, 1800m.

4 = NRAO 85-2, 1900m.

See chapter X for notes on the processing of these data. In particular, note that data taken with station 1 were not included in the source position determinations. The weights are calculated so that the weighted RMS residual (see section IV.2) is approximately 1 for an adjustment of a clock constant, an atmosphere parameter, and the relative right ascension and declination taking each pair of sources separately, one day at a time.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	9/23	14 0	99257872.	19.
H-3	W-4	3C279	3C273	9/23	14 3	101320132.	19.
H-3	W-4	3C279	3C273	9/23	14 6	103338220.	19.
H-3	W-4	3C279	3C273	9/23	14 9	105311785.	19.
H-3	W-4	3C279	3C273	9/23	1412	107240466.	19.
H-3	W-4	3C279	3C273	9/23	1415	109123954.	19.
H-3	W-4	3C279	3C273	9/23	1418	110961908.	19.
H-3	W-4	3C279	3C273	9/23	1421	112754038.	19.
H-3	W-4	3C279	3C273	9/23	1424	114499996.	19.
H-3	W-4	3C279	3C273	9/23	1427	116199493.	19.
H-3	W-4	3C279	3C273	9/23	1430	117852240.	19.
H-3	W-4	3C279	3C273	9/23	1433	119457973.	19.
H-3	W-4	3C279	3C273	9/23	1436	121016405.	19.
H-3	W-4	3C279	3C273	9/23	1439	122527233.	19.
H-3	W-4	3C279	3C273	9/23	1442	123990221.	19.
H-3	W-4	3C279	3C273	9/23	1445	125405111.	19.
H-3	W-4	3C279	3C273	9/23	1448	126771676.	19.
H-3	W-4	3C279	3C273	9/23	1451	128089671.	19.
H-3	W-4	3C279	3C273	9/23	1454	129358853.	19.
H-3	W-4	3C279	3C273	9/23	1457	130579019.	19.
H-3	W-4	3C279	3C273	9/23	15 0	131749953.	19.
H-3	W-4	3C279	3C273	9/23	15 3	132871463.	19.
H-3	W-4	3C279	3C273	9/23	15 6	133943351.	19.
H-3	W-4	3C279	3C273	9/23	15 9	134965400.	19.
H-3	W-4	3C279	3C273	9/23	1512	135937491.	19.
H-3	W-4	3C279	3C273	9/23	1515	136859405.	19.
H-3	W-4	3C279	3C273	9/23	1518	137731023.	19.
H-3	W-4	3C279	3C273	9/23	1521	138552171.	19.
H-3	W-4	3C279	3C273	9/23	1524	139322709.	19.
H-3	W-4	3C279	3C273	9/23	1530	140711456.	19.
H-3	W-4	3C279	3C273	9/23	1533	141329436.	19.
H-3	W-4	3C279	3C273	9/23	1536	141896324.	19.
H-3	W-4	3C279	3C273	9/23	1539	142412033.	19.
H-3	W-4	3C279	3C273	9/23	1542	142876464.	19.
H-3	W-4	3C279	3C273	9/23	1545	143289555.	19.
H-3	W-4	3C279	3C273	9/23	1548	143651214.	19.
H-3	W-4	3C279	3C273	9/23	1551	143961398.	19.
H-3	W-4	3C279	3C273	9/23	1554	144220040.	19.
H-3	W-4	3C279	3C273	9/23	1557	144427107.	19.
H-3	W-4	3C279	3C273	9/23	16 0	144582563.	19.
H-3	W-4	3C279	3C273	9/23	16 3	144686355.	19.
H-3	W-4	3C279	3C273	9/23	16 6	144738494.	19.
H-3	W-4	3C279	3C273	9/23	1612	144687729.	19.
H-3	W-4	3C279	3C273	9/23	1615	144584864.	19.
H-3	W-4	3C279	3C273	9/23	1618	144430357.	19.
H-3	W-4	3C279	3C273	9/23	1621	144224234.	19.
H-3	W-4	3C279	3C273	9/23	1624	143966516.	19.
H-3	W-4	3C279	3C273	9/23	1627	143657259.	19.
H-3	W-4	3C279	3C273	9/23	1630	143296507.	19.
H-3	W-4	3C279	3C273	9/23	1633	142884337.	19.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	9/23	1636	142420813.	19.
H-3	W-4	3C279	3C273	9/23	1639	141906012.	19.
H-3	W-4	3C279	3C273	9/23	1642	141340038.	19.
H-3	W-4	3C279	3C273	9/23	1645	140722989.	19.
H-3	W-4	3C279	3C273	9/23	1648	140054936.	19.
H-3	W-4	3C279	3C273	9/23	1651	139336034.	19.
H-3	W-4	3C279	3C273	9/23	1654	138566385.	19.
H-3	W-4	3C279	3C273	9/23	1657	137746145.	19.
H-3	W-4	3C279	3C273	9/23	17 0	136875431.	19.
H-3	W-4	3C279	3C273	9/23	17 3	135954396.	19.
H-3	W-4	3C279	3C273	9/23	17 9	133962010.	19.
H-3	W-4	3C279	3C273	9/23	1712	132891027.	19.
H-3	W-4	3C279	3C273	9/23	1715	131770380.	19.
H-3	W-4	3C279	3C273	9/23	1718	130600300.	19.
H-3	W-4	3C279	3C273	9/23	1721	129380995.	19.
H-3	W-4	3C279	3C273	9/23	1724	128112646.	19.
H-3	W-4	3C279	3C273	9/23	1727	126795508.	19.
H-3	W-4	3C279	3C273	9/23	1730	125429808.	19.
H-3	W-4	3C279	3C273	9/23	1733	124015730.	19.
H-3	W-4	3C279	3C273	9/23	1736	122553557.	19.
H-3	W-4	3C279	3C273	9/23	1742	119485920.	19.
H-3	W-4	3C279	3C273	9/23	1745	117880970.	19.
H-3	W-4	3C279	3C273	9/23	1748	116228991.	19.
H-3	W-4	3C279	3C273	9/23	1751	114530273.	19.
H-3	W-4	3C279	3C273	9/23	1754	112785085.	19.
H-3	W-4	3C279	3C273	9/23	1757	110993693.	19.
H-3	W-4	3C279	3C273	9/23	18 0	109156464.	19.
H-3	W-4	3C279	3C273	9/23	18 3	107273710.	19.
H-3	W-4	3C279	3C273	9/23	18 6	105345728.	19.
H-3	W-4	3C279	3C273	9/23	18 9	103372856.	19.
H-3	W-4	3C279	3C273	9/23	1812	101355445.	19.
H-3	W-4	3C279	3C273	9/23	1815	99293833.	19.
H-3	W-4	3C279	3C273	9/23	1818	97188396.	19.
H-3	W-4	3C279	3C273	9/23	1821	95039446.	19.
H-3	W-4	3C279	3C273	9/23	1824	92847390.	19.
H-3	W-4	3C279	3C273	9/23	1827	90612614.	19.
H-3	W-4	3C279	3C273	9/23	1830	88335494.	19.
H-3	W-4	3C279	3C273	9/23	1833	86016423.	19.
H-3	W-4	3C279	3C273	9/23	1836	83655797.	19.
H-3	W-4	3C279	3C273	9/23	1839	81254004.	19.
H-3	W-4	3C279	3C273	9/23	1842	78811471.	19.
H-3	W-4	3C279	3C273	9/23	1845	76328633.	19.
H-3	W-4	3C279	3C273	9/23	1848	73805902.	19.
H-3	W-4	3C279	3C273	9/23	1851	71243731.	19.
H-3	W-4	3C279	3C273	9/23	1854	68642560.	19.
H-3	W-4	3C279	3C273	9/23	1857	66002811.	19.
H-3	W-4	3C279	3C273	9/23	19 0	63324963.	19.
H-3	W-4	3C279	3C273	9/23	19 3	60609464.	19.
H-3	W-4	3C279	3C273	9/23	19 6	57856780.	19.
H-3	W-4	3C279	3C273	9/23	19 9	55067403.	19.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	9/23	1912	52241806.	19.
H-3	W-4	3C279	3C273	9/23	1915	49380480.	19.
H-3	W-4	3C279	3C273	9/23	1918	46483893.	19.
H-3	W-4	3C279	3C273	9/23	1921	43552585.	19.
H-3	W-4	3C279	3C273	9/23	1924	40587023.	19.
H-3	W-4	3C279	3C273	9/23	1927	37587728.	19.
H-3	W-4	3C279	3C273	9/23	1930	34555225.	19.
H-3	W-4	3C279	3C273	9/23	1933	31490039.	19.
H-3	W-4	3C279	3C273	9/23	1936	28392662.	19.
H-3	W-4	3C279	3C273	9/23	1939	25263664.	19.
H-3	W-4	3C279	3C273	9/23	1942	22103591.	19.
H-3	W-4	3C279	3C273	9/23	1945	18912956.	19.
H-3	W-4	3C279	3C273	9/23	1948	15692376.	19.
H-3	W-4	3C279	3C273	9/23	1951	12442310.	19.
H-3	W-4	3C279	3C273	9/23	1957	5856151.	19.
H-3	W-4	3C279	3C273	9/23	20 3	-8410[illegible]1.	19.
H-3	W-4	3C279	3C273	9/23	20 9	-7644511.	19.
H-3	W-4	3C279	3C273	9/23	2015	-14549716.	19.
H-3	W-4	3C279	3C273	9/23	2021	-21551800.	19.
H-3	W-4	3C279	3C273	9/23	2027	-28645941.	19.
H-3	W-4	3C279	3C273	9/23	2033	-35827344.	19.
H-3	W-4	3C279	3C273	9/23	2039	-43090980.	19.
H-3	W-4	3C279	3C273	9/23	2045	-50431852.	19.
H-3	W-4	3C279	3C273	9/23	2051	-57844939.	19.
H-3	W-4	3C279	3C273	9/23	2057	-65325091.	19.
H-3	W-4	3C279	3C273	10/ 1	1348	110840420.	19.
H-3	W-4	3C279	3C273	10/ 1	1354	114333705.	19.
H-3	W-4	3C279	3C273	10/ 1	1357	116010627.	19.
H-3	W-4	3C279	3C273	10/ 1	14 0	117640628.	19.
H-3	W-4	3C279	3C273	10/ 1	14 6	120758866.	19.
H-3	W-4	3C279	3C273	10/ 1	14 9	122246550.	19.
H-3	W-4	3C279	3C273	10/ 1	1412	123686278.	19.
H-3	W-4	3C279	3C273	10/ 1	1418	126420834.	19.
H-3	W-4	3C279	3C273	10/ 1	1424	128960673.	19.
H-3	W-4	3C279	3C273	10/ 1	1430	1313[illegible]4073.	19.
H-3	W-4	3C279	3C273	10/ 1	1442	135394956.	19.
H-3	W-4	3C279	3C273	10/ 1	1445	136292588.	19.
H-3	W-4	3C279	3C273	10/ 1	1448	137139755.	19.
H-3	W-4	3C279	3C273	10/ 1	1454	138682390.	19.
H-3	W-4	3C279	3C273	10/ 1	15 0	140021868.	19.
H-3	W-4	3C279	3C273	10/ 1	15 6	141157230.	19.
H-3	W-4	3C279	3C273	10/ 1	1512	142087676.	19.
H-3	W-4	3C279	3C273	10/ 1	1518	142812559.	19.
H-3	W-4	3C279	3C273	10/ 1	1524	143331459.	19.
H-3	W-4	3C279	3C273	10/ 1	1530	143643905.	19.
H-3	W-4	3C279	3C273	10/ 1	1536	143749855.	19.
H-3	W-4	3C279	3C273	10/ 1	1539	143725323.	19.
H-3	W-4	3C279	3C273	10/ 1	1542	143649020.	19.
H-3	W-4	3C279	3C273	10/ 1	1545	143521138.	19.
H-3	W-4	3C279	3C273	10/ 1	1548	143341548.	19.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/ 1	1551	143110461.	19.
H-3	W-4	3C279	3C273	10/ 1	1554	142827828.	19.
H-3	W-4	3C279	3C273	10/ 1	16 0	142108011.	19.
H-3	W-4	3C279	3C273	10/ 1	16 6	141182604.	19.
H-3	W-4	3C279	3C273	10/ 1	1624	137180253.	19.
H-3	W-4	3C279	3C273	10/ 1	1630	135440455.	19.
H-3	W-4	3C279	3C273	10/ 1	1636	133499676.	19.
H-3	W-4	3C279	3C273	10/ 1	1642	131359298.	19.
H-3	W-4	3C279	3C273	10/ 1	1648	129020775.	19.
H-3	W-4	3C279	3C273	10/ 1	1654	126485733.	19.
H-3	W-4	3C279	3C273	10/ 1	17 0	123755896.	19.
H-3	W-4	3C279	3C273	10/ 1	17 6	120833133.	19.
H-3	W-4	3C279	3C273	10/ 1	1712	117719489.	19.
H-3	W-4	3C279	3C273	10/ 1	1718	114417117.	19.
H-3	W-4	3C279	3C273	10/ 1	1724	110928284.	19.
H-3	W-4	3C279	3C273	10/ 1	1730	107255389.	19.
H-3	W-4	3C279	3C273	10/ 1	1736	103400947.	19.
H-3	W-4	3C279	3C273	10/ 1	1742	99367618.	19.
H-3	W-4	3C279	3C273	10/ 1	1748	95158204.	19.
H-3	W-4	3C279	3C273	10/ 1	1754	90775607.	19.
H-3	W-4	3C279	3C273	10/ 1	18 0	86222806.	19.
H-3	W-4	3C279	3C273	10/ 1	18 6	81502963.	19.
H-3	W-4	3C279	3C273	10/ 1	1812	76619344.	19.
H-3	W-4	3C279	3C273	10/ 1	1818	71575294.	19.
H-3	W-4	3C279	3C273	10/ 1	1824	66374276.	19.
H-3	W-4	3C279	3C273	10/ 1	1830	61019944.	19.
H-3	W-4	3C279	3C273	10/ 1	1836	55515914.	19.
H-3	W-4	3C279	3C273	10/ 1	1842	49865992.	19.
H-3	W-4	3C279	3C273	10/ 1	1848	44074096.	19.
H-3	W-4	3C279	3C273	10/ 1	1854	38144217.	19.
H-3	W-4	3C279	3C273	10/ 1	1857	35128790.	19.
H-3	W-4	3C279	3C273	10/ 1	19 3	28999590.	19.
H-3	W-4	3C279	3C273	10/ 1	19 9	22742805.	19.
H-3	W-4	3C279	3C273	10/ 1	1915	16362710.	19.
H-3	W-4	3C279	3C273	10/ 1	1921	9863713.	19.
H-3	W-4	3C279	3C273	10/ 1	1927	3250299.	19.
H-3	W-4	3C279	3C273	10/ 1	1936	-6874388.	19.
H-3	W-4	3C279	3C273	10/ 1	1942	-13753775.	19.
H-3	W-4	3C279	3C273	10/ 1	1948	-20731274.	19.
H-3	W-4	3C279	3C273	10/ 1	1954	-27802104.	19.
H-3	W-4	3C279	3C273	10/ 1	20 0	-34961424.	19.
H-3	W-4	3C279	3C273	10/ 1	20 6	-42204242.	19.
H-3	W-4	3C279	3C273	10/ 1	2012	-49525669.	19.
H-3	W-4	3C279	3C273	10/ 1	2018	-56920513.	19.
H-3	W-4	3C279	3C273	10/ 1	2024	-64383864.	19.
H-3	W-4	3C279	3C273	10/ 1	2030	-71910402.	19.
H-3	W-4	3C279	3C273	10/ 1	2036	-79495042.	19.
H-3	W-4	3C279	3C273	10/ 1	2042	-87132525.	19.
H-3	W-4	3C279	3C273	10/ 1	2048	-94817564.	19.
H-3	W-4	3C279	3C273	10/ 1	2054	-102544895.	19.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/ 1	2057	-106422813.	19.
H-3	W-4	3C279	3C273	10/ 1	21 3	-114203608.	19.
H-3	W-4	3C279	3C273	10/ 1	21 9	-122013363.	19.
H-3	W-4	3C279	3C273	10/ 1	2115	-129846650.	19.
H-3	W-4	3C279	3C273	10/ 1	2121	-137698125.	19.
H-3	W-4	3C279	3C273	10/ 1	2127	-145562338.	19.
H-3	W-4	3C279	3C273	10/ 1	2133	-153433957.	19.
H-3	W-4	3C279	3C273	10/ 1	2139	-161307556.	19.
H-3	W-4	3C279	3C273	10/ 1	2145	-169177594.	19.
H-3	W-4	3C279	3C273	10/ 1	2151	-177038793.	19.
H-3	W-4	3C279	3C273	10/ 1	2157	-184885834.	19.
H-3	W-4	3C279	3C273	10/ 1	22 3	-192713267.	19.
H-3	W-4	3C279	3C273	10/ 2	14 3	121227159.	18.
H-3	W-4	3C279	3C273	10/ 2	1418	128108477.	18.
H-3	W-4	3C279	3C273	10/ 2	1424	130519745.	18.
H-3	W-4	3C279	3C273	10/ 2	1427	131651372.	18.
H-3	W-4	3C279	3C273	10/ 2	1433	133765722.	18.
H-3	W-4	3C279	3C273	10/ 2	1436	134748028.	18.
H-3	W-4	3C279	3C273	10/ 2	1439	135680267.	18.
H-3	W-4	3C279	3C273	10/ 2	1445	137393738.	18.
H-3	W-4	3C279	3C273	10/ 2	1451	138904887.	18.
H-3	W-4	3C279	3C273	10/ 2	15 3	141316304.	18.
H-3	W-4	3C279	3C273	10/ 2	15 9	142214863.	18.
H-3	W-4	3C279	3C273	10/ 2	1515	142907845.	18.
H-3	W-4	3C279	3C273	10/ 2	1521	143394725.	18.
H-3	W-4	3C279	3C273	10/ 2	1527	143675168.	18.
H-3	W-4	3C279	3C273	10/ 2	1533	143748962.	18.
H-3	W-4	3C279	3C273	10/ 2	1539	143616062.	18.
H-3	W-4	3C279	3C273	10/ 2	1545	143275603.	18.
H-3	W-4	3C279	3C273	10/ 2	1548	143029489.	18.
H-3	W-4	3C279	3C273	10/ 2	1551	142730807.	18.
H-3	W-4	3C279	3C273	10/ 2	1557	141979003.	18.
H-3	W-4	3C279	3C273	10/ 2	16 3	141021754.	18.
H-3	W-4	3C279	3C273	10/ 2	16 9	139859708.	18.
H-3	W-4	3C279	3C273	10/ 2	1615	138493626.	18.
H-3	W-4	3C279	3C273	10/ 2	1621	136924581.	18.
H-3	W-4	3C279	3C273	10/ 2	1624	136064155.	18.
H-3	W-4	3C279	3C273	10/ 2	1627	135153447.	18.
H-3	W-4	3C279	3C273	10/ 2	1633	133181593.	18.
H-3	W-4	3C279	3C273	10/ 2	1639	131012346.	18.
H-3	W-4	3C279	3C273	10/ 2	1642	129850406.	18.
H-3	W-4	3C279	3C273	10/ 2	1645	128641210.	18.
H-3	W-4	3C279	3C273	10/ 2	1651	126075784.	18.
H-3	W-4	3C279	3C273	10/ 2	1657	123315870.	18.
H-3	W-4	3C279	3C273	10/ 2	17 3	120363383.	18.
H-3	W-4	3C279	3C273	10/ 2	17 9	117220275.	18.
H-3	W-4	3C279	3C273	10/ 2	1715	113688842.	18.
H-3	W-4	3C279	3C273	10/ 2	1718	112153156.	18.
H-3	W-4	3C279	3C273	10/ 2	1724	108543401.	18.
H-3	W-4	3C279	3C273	10/ 2	1730	104751264.	18.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/ 2	1736	100779290.	18.
H-3	W-4	3C279	3C273	10/ 2	1739	98726754.	18.
H-3	W-4	3C279	3C273	10/ 2	1745	94490223.	18.
H-3	W-4	3C279	3C273	10/ 2	1751	90081003.	18.
H-3	W-4	3C279	3C273	10/ 2	1757	85502039.	18.
H-3	W-4	3C279	3C273	10/ 2	18 3	80756552.	18.
H-3	W-4	3C279	3C273	10/ 2	18 9	75847825.	18.
H-3	W-4	3C279	3C273	10/ 2	1815	70779186.	18.
H-3	W-4	3C279	3C273	10/ 2	1821	65554118.	18.
H-3	W-4	3C279	3C273	10/ 2	1827	60176310.	18.
H-3	W-4	3C279	3C273	10/ 2	1833	54649368.	18.
H-3	W-4	3C279	3C273	10/ 2	1839	48977188.	18.
H-3	W-4	3C279	3C273	10/ 2	1845	43163609.	18.
H-3	W-4	3C279	3C273	10/ 2	1851	37212676.	18.
H-3	W-4	3C279	3C273	10/ 2	1857	31128457.	18.
H-3	W-4	3C279	3C273	10/ 2	19 0	28037675.	18.
H-3	W-4	3C279	3C273	10/ 2	19 3	24915171.	18.
H-3	W-4	3C279	3C273	10/ 2	19 6	21761443.	18.
H-3	W-4	3C279	3C273	10/ 2	19 9	18577075.	18.
H-3	W-4	3C279	3C273	10/ 2	1912	15362627.	18.
H-3	W-4	3C279	3C273	10/ 2	1918	8845556.	18.
H-3	W-4	3C279	3C273	10/ 2	1921	5544104.	18.
H-3	W-4	3C279	3C273	10/ 2	1924	2214789.	18.
H-3	W-4	3C279	3C273	10/ 2	1927	-1141798.	18.
H-3	W-4	3C279	3C273	10/ 2	1930	-4525107.	18.
H-3	W-4	3C279	3C273	10/ 2	1933	-7934565.	18.
H-3	W-4	3C279	3C273	10/ 2	1936	-11369550.	18.
H-3	W-4	3C279	3C273	10/ 2	1939	-14829489.	18.
H-3	W-4	3C279	3C273	10/ 2	1942	-18313678.	18.
H-3	W-4	3C279	3C273	10/ 2	1945	-21821785.	18.
H-3	W-4	3C279	3C273	10/ 2	1948	-25352979.	18.
H-3	W-4	3C279	3C273	10/ 2	1951	-28906704.	18.
H-3	W-4	3C279	3C273	10/ 2	1954	-32482355.	18.
H-3	W-4	3C279	3C273	10/ 2	1957	-36079317.	18.
H-3	W-4	3C279	3C273	10/ 2	20 0	-39696977.	18.
H-3	W-4	3C279	3C273	10/ 2	20 3	-43334676.	18.
H-3	W-4	3C279	3C273	10/ 2	20 6	-46991871.	18.
H-3	W-4	3C279	3C273	10/ 2	20 9	-50667826.	18.
H-3	W-4	3C279	3C273	10/ 2	2012	-54361968.	18.
H-3	W-4	3C279	3C273	10/ 2	2015	-58073662.	18.
H-3	W-4	3C279	3C273	10/ 2	2018	-61802258.	18.
H-3	W-4	3C279	3C273	10/ 2	2 21	-65547097.	18.
H-3	W-4	3C279	3C273	10/ 2	2024	-69307565.	18.
H-3	W-4	3C279	3C273	10/ 2	2027	-73083070.	18.
H-3	W-4	3C279	3C273	10/ 2	2030	-76872784.	18.
H-3	W-4	3C279	3C273	10/ 2	2033	-80676194.	18.
H-3	W-4	3C279	3C273	10/ 2	2036	-84492613.	18.
H-3	W-4	3C279	3C273	10/ 2	2039	-88321402.	18.
H-3	W-4	3C279	3C273	10/ 2	2042	-92161857.	18.
H-3	W-4	3C279	3C273	10/ 2	2045	-96013351.	18.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/ 2	2048	-99875196.	18.
H-3	W-4	3C279	3C273	10/ 2	2051	-103746777.	18.
H-3	W-4	3C279	3C273	10/ 2	2054	-107627343.	18.
H-3	W-4	3C279	3C273	10/ 2	2057	-111516317.	18.
H-3	W-4	3C279	3C273	10/ 2	21 0	-115412996.	18.
H-3	W-4	3C279	3C273	10/ 2	21 3	-119316694.	18.
H-3	W-4	3C279	3C273	10/ 2	21 6	-123226763.	18.
H-3	W-4	3C279	3C273	10/ 2	21 9	-127142506.	18.
H-3	W-4	3C279	3C273	10/ 2	2112	-131063238.	18.
H-3	W-4	3C279	3C273	10/ 2	2115	-134988292.	18.
H-3	W-4	3C279	3C273	10/ 2	2118	-138917040.	18.
H-3	W-4	3C279	3C273	10/ 2	2121	-142848739.	18.
H-3	W-4	3C279	3C273	10/ 2	2124	-146782728.	18.
H-3	W-4	3C279	3C273	10/ 2	2127	-150718399.	18.
H-3	W-4	3C279	3C273	10/ 2	2130	-154655023.	18.
H-3	W-4	3C279	3C273	10/ 2	2133	-158591885.	18.
H-3	W-4	3C279	3C273	10/ 2	2136	-162528336.	18.
H-3	W-4	3C279	3C273	10/ 2	2139	-166463736.	18.
H-3	W-4	3C279	3C273	10/ 2	2142	-170397406.	18.
H-3	W-4	3C279	3C273	10/ 2	2145	-174328589.	18.
H-3	W-4	3C279	3C273	10/ 2	2148	-178256713.	18.
H-3	W-4	3C279	3C273	10/ 2	2151	-182181092.	18.
H-3	W-4	3C279	3C273	10/ 2	2154	-186101051.	18.
H-3	W-4	3C279	3C273	10/ 2	2157	-190015940.	18.
H-3	W-4	3C279	3C273	10/ 2	22 0	-193924989.	18.
H-3	W-4	3C279	3C273	10/ 2	22 3	-197827684.	18.
H-3	W-4	3C279	3C273	10/ 2	22 6	-201723347.	18.
H-3	W-4	3C279	3C273	10/ 2	22 9	-205611327.	18.
H-3	W-4	3C279	3C273	10/ 2	2212	-209490949.	18.
H-3	W-4	3C279	3C273	10/ 3	1242	67877185.	24.
H-3	W-4	3C279	3C273	10/ 3	1245	70474315.	24.
H-3	W-4	3C279	3C273	10/ 3	1248	73032498.	24.
H-3	W-4	3C279	3C273	10/ 3	1251	75551248.	24.
H-3	W-4	3C279	3C273	10/ 3	1254	78030159.	24.
H-3	W-4	3C279	3C273	10/ 3	1257	80468704.	24.
H-3	W-4	3C279	3C273	10/ 3	13 0	82866553.	24.
H-3	W-4	3C279	3C273	10/ 3	13 3	85223264.	24.
H-3	W-4	3C279	3C273	10/ 3	13 6	87538413.	24.
H-3	W-4	3C279	3C273	10/ 3	13 9	89811620.	24.
H-3	W-4	3C279	3C273	10/ 3	1312	92042451.	24.
H-3	W-4	3C279	3C273	10/ 3	1315	94230507.	24.
H-3	W-4	3C279	3C273	10/ 3	1318	96375510.	24.
H-3	W-4	3C279	3C273	10/ 3	1321	98476930.	24.
H-3	W-4	3C279	3C273	10/ 3	1324	100534581.	24.
H-3	W-4	3C279	3C273	10/ 3	1327	102547964.	24.
H-3	W-4	3C279	3C273	10/ 3	1330	104516820.	24.
H-3	W-4	3C279	3C273	10/ 3	1333	106440778.	24.
H-3	W-4	3C279	3C273	10/ 3	1336	108319492.	24.
H-3	W-4	3C279	3C273	10/ 3	1339	110152598.	24.
H-3	W-4	3C279	3C273	10/ 3	1342	111939864.	24.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/ 3	1345	113680929.	24.
H-3	W-4	3C279	3C273	10/ 3	1348	115375476.	24.
H-3	W-4	3C279	3C273	10/ 3	1351	117023306.	24.
H-3	W-4	3C279	3C273	10/ 3	1354	118624043.	24.
H-3	W-4	3C279	3C273	10/ 3	1357	120177436.	24.
H-3	W-4	3C279	3C273	10/ 3	14 0	121683240.	24.
H-3	W-4	3C279	3C273	10/ 3	14 3	123141158.	24.
H-3	W-4	3C279	3C273	10/ 3	14 6	124550945.	24.
H-3	W-4	3C279	3C273	10/ 3	14 9	125912412.	24.
H-3	W-4	3C279	3C273	10/ 3	1412	127225256.	24.
H-3	W-4	3C279	3C273	10/ 3	1415	128489247.	24.
H-3	W-4	3C279	3C273	10/ 3	1418	129704197.	24.
H-3	W-4	3C279	3C273	10/ 3	1421	130869938.	24.
H-3	W-4	3C279	3C273	10/ 3	1424	131986253.	24.
H-3	W-4	3C279	3C273	10/ 3	1427	133052859.	24.
H-3	W-4	3C279	3C273	10/ 3	1430	134069680.	24.
H-3	W-4	3C279	3C273	10/ 3	1433	135036526.	24.
H-3	W-4	3C279	3C273	10/ 3	1436	135953129.	24.
H-3	W-4	3C279	3C273	10/ 3	1439	136819406.	24.
H-3	W-4	3C279	3C273	10/ 3	1442	137635220.	24.
H-3	W-4	3C279	3C273	10/ 3	1445	138400439.	24.
H-3	W-4	3C279	3C273	10/ 3	1448	139114860.	24.
H-3	W-4	3C279	3C273	10/ 3	1451	139778455.	24.
H-3	W-4	3C279	3C273	10/ 3	1454	140391031.	24.
H-3	W-4	3C279	3C273	10/ 3	1457	140952518.	24.
H-3	W-4	3C279	3C273	10/ 3	15 0	141462794.	24.
H-3	W-4	3C279	3C273	10/ 3	15 3	141921812.	24.
H-3	W-4	3C279	3C273	10/ 3	15 6	142329478.	24.
H-3	W-4	3C279	3C273	10/ 3	15 9	142685714.	24.
H-3	W-4	3C279	3C273	10/ 3	1512	142990476.	24.
H-3	W-4	3C279	3C273	10/ 3	1515	143243683.	24.
H-3	W-4	3C279	3C273	10/ 3	1518	143445294.	24.
H-3	W-4	3C279	3C273	10/ 3	1521	143595329.	24.
H-3	W-4	3C279	3C273	10/ 3	1524	143693696.	24.
H-3	W-4	3C279	3C273	10/ 3	1527	143740359.	24.
H-3	W-4	3C279	3C273	10/ 3	1530	143735372.	24.
H-3	W-4	3C279	3C273	10/ 3	1533	143678711.	24.
H-3	W-4	3C279	3C273	10/ 3	1536	143570374.	24.
H-3	W-4	3C279	3C273	10/ 3	1539	143410469.	24.
H-3	W-4	3C279	3C273	10/ 3	1542	143198906.	24.
H-3	W-4	3C279	3C273	10/ 3	1545	142935737.	24.
H-3	W-4	3C279	3C273	10/ 3	1548	142621074.	24.
H-3	W-4	3C279	3C273	10/ 3	1551	142254933.	24.
H-3	W-4	3C279	3C273	10/ 3	1554	141837341.	24.
H-3	W-4	3C279	3C273	10/ 3	1557	141368386.	24.
H-3	W-4	3C279	3C273	10/ 3	16 0	140848239.	24.
H-3	W-4	3C279	3C273	10/ 3	16 3	140276889.	24.
H-3	W-4	3C279	3C273	10/ 3	16 6	139654455.	24.
H-3	W-4	3C279	3C273	10/ 3	16 9	138981041.	24.
H-3	W-4	3C279	3C273	10/ 3	1612	138256827.	24.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/ 3	1615	137481830.	24.
H-3	W-4	3C279	3C273	10/ 3	1618	136656291.	24.
H-3	W-4	3C279	3C273	10/ 3	1621	135780234.	24.
H-3	W-4	3C279	3C273	10/ 3	1624	134853933.	24.
H-3	W-4	3C279	3C273	10/ 3	1627	133877475.	24.
H-3	W-4	3C279	3C273	10/ 3	1630	132851018.	24.
H-3	W-4	3C279	3C273	10/ 3	1633	131774802.	24.
H-3	W-4	3C279	3C273	10/ 3	1636	130648955.	24.
H-3	W-4	3C279	3C273	10/ 3	1639	129473730.	24.
H-3	W-4	3C279	3C273	10/ 3	1642	128249210.	24.
H-3	W-4	3C279	3C273	10/ 3	1648	125653517.	24.
H-3	W-4	3C279	3C273	10/ 3	1651	124282692.	24.
H-3	W-4	3C279	3C273	10/ 3	1654	122863571.	24.
H-3	W-4	3C279	3C273	10/13	1542	135682234.	32.
H-3	W-4	3C279	3C273	10/13	1545	134750622.	32.
H-3	W-4	3C279	3C273	10/13	1548	133768899.	32.
H-3	W-4	3C279	3C273	10/13	1551	132737299.	32.
H-3	W-4	3C279	3C273	10/13	1554	131655808.	32.
H-3	W-4	3C279	3C273	10/13	1557	130524847.	32.
H-3	W-4	3C279	3C273	10/13	16 0	129344418.	32.
H-3	W-4	3C279	3C273	10/13	16 3	128114791.	32.
H-3	W-4	3C279	3C273	10/13	16 6	126836221.	32.
H-3	W-4	3C279	3C273	10/13	16 9	125508864.	32.
H-3	W-4	3C279	3C273	10/13	1612	124132924.	32.
H-3	W-4	3C279	3C273	10/13	1615	122708753.	32.
H-3	W-4	3C279	3C273	10/13	1618	121236579.	32.
H-3	W-4	3C279	3C273	10/13	1621	119716577.	32.
H-3	W-4	3C279	3C273	10/13	1624	118149040.	32.
H-3	W-4	3C279	3C273	10/13	1627	116534211.	32.
H-3	W-4	3C279	3C273	10/13	1630	114872412.	32.
H-3	W-4	3C279	3C273	10/13	1633	113163968.	32.
H-3	W-4	3C279	3C273	10/13	1636	111409352.	32.
H-3	W-4	3C279	3C273	10/13	1639	109608087.	32.
H-3	W-4	3C279	3C273	10/13	1642	107761311.	32.
H-3	W-4	3C279	3C273	10/13	1645	105869043.	32.
H-3	W-4	3C279	3C273	10/13	1648	103931656.	32.
H-3	W-4	3C279	3C273	10/13	1651	101949459.	32.
H-3	W-4	3C279	3C273	10/13	1654	99922776.	32.
H-3	W-4	3C279	3C273	10/13	1657	97851944.	32.
H-3	W-4	3C279	3C273	10/13	17 0	95737367.	32.
H-3	W-4	3C279	3C273	10/13	17 3	93579394.	32.
H-3	W-4	3C279	3C273	10/13	17 6	91378331.	32.
H-3	W-4	3C279	3C273	10/13	17 9	89134760.	32.
H-3	W-4	3C279	3C273	10/13	1712	86848825.	32.
H-3	W-4	3C279	3C273	10/13	1715	84521032.	32.
H-3	W-4	3C279	3C273	10/13	1718	82151751.	32.
H-3	W-4	3C279	3C273	10/13	1721	79741466.	32.
H-3	W-4	3C279	3C273	10/13	1724	77290497.	32.
H-3	W-4	3C279	3C273	10/13	1727	74799282.	32.
H-3	W-4	3C279	3C273	10/13	1730	72268312.	32.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/13	1733	69698001.	32.
H-3	W-4	3C279	3C273	10/13	1736	67088708.	32.
H-3	W-4	3C279	3C273	10/13	1739	64441002.	32.
H-3	W-4	3C279	3C273	10/13	1742	61755247.	32.
H-3	W-4	3C279	3C273	10/13	1745	59031983.	32.
H-3	W-4	3C279	3C273	10/13	1748	56271620.	32.
H-3	W-4	3C279	3C273	10/13	1751	53474684.	32.
H-3	W-4	3C279	3C273	10/13	1754	50641578.	32.
H-3	W-4	3C279	3C273	10/13	1757	47772800.	32.
H-3	W-4	3C279	3C273	10/13	18 0	44869043.	32.
H-3	W-4	3C279	3C273	10/13	18 3	41930606.	32.
H-3	W-4	3C279	3C273	10/13	18 6	38957950.	32.
H-3	W-4	3C279	3C273	10/13	18 9	35951757.	32.
H-3	W-4	3C279	3C273	10/13	1812	32912421.	32.
H-3	W-4	3C279	3C273	10/13	1815	29840525.	32.
H-3	W-4	3C279	3C273	10/13	1818	26736538.	32.
H-3	W-4	3C279	3C273	10/13	1821	23601078.	32.
H-3	W-4	3C279	3C273	10/13	1824	20434634.	32.
H-3	W-4	3C279	3C273	10/13	1827	17237742.	32.
H-3	W-4	3C279	3C273	10/13	1830	14010990.	32.
H-3	W-4	3C279	3C273	10/13	1833	10754916.	32.
H-3	W-4	3C279	3C273	10/13	1836	7470071.	32.
H-3	W-4	3C279	3C273	10/13	1839	4157044.	32.
H-3	W-4	3C279	3C273	10/13	1842	816415.	32.
H-3	W-4	3C279	3C273	10/13	1845	-2551281.	32.
H-3	W-4	3C279	3C273	10/13	1848	-5945450.	32.
H-3	W-4	3C279	3C273	10/13	1851	-9365487.	32.
H-3	W-4	3C279	3C273	10/13	1854	-12810839.	32.
H-3	W-4	3C279	3C273	10/13	1857	-16280870.	32.
H-3	W-4	3C279	3C273	10/13	19 0	-19775067.	32.
H-3	W-4	3C279	3C273	10/13	19 6	-26833211.	32.
H-3	W-4	3C279	3C273	10/13	19 9	-30396041.	32.
H-3	W-4	3C279	3C273	10/13	1912	-33980557.	32.
H-3	W-4	3C279	3C273	10/13	1915	-37586114.	32.
H-3	W-4	3C279	3C273	10/13	1918	-41212085.	32.
H-3	W-4	3C279	3C273	10/13	1921	-44857906.	32.
H-3	W-4	3C279	3C273	10/13	1924	-48522845.	32.
H-3	W-4	3C279	3C273	10/13	1927	-52206329.	32.
H-3	W-4	3C279	3C273	10/13	1930	-55907796.	32.
H-3	W-4	3C279	3C273	10/13	1933	-59626514.	32.
H-3	W-4	3C279	3C273	10/13	1939	-67113164.	32.
H-3	W-4	3C279	3C273	10/13	1942	-70879879.	32.
H-3	W-4	3C279	3C273	10/13	1945	-74661252.	32.
H-3	W-4	3C279	3C273	10/13	1948	-78456629.	32.
H-3	W-4	3C279	3C273	10/13	1951	-82265446.	32.
H-3	W-4	3C279	3C273	10/13	1954	-86086991.	32.
H-3	W-4	3C279	3C273	10/13	1957	-89920637.	32.
H-3	W-4	3C279	3C273	10/13	20 0	-93765648.	32.
H-3	W-4	3C279	3C273	10/13	20 3	-97621444.	32.
H-3	W-4	3C279	3C273	10/13	20 6	-101487330.	32.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/13	20 9	-105362661.	32.
H-3	W-4	3C279	3C273	10/13	2012	-109246765.	32.
H-3	W-4	3C279	3C273	10/13	2015	-113138918.	32.
H-3	W-4	3C279	3C273	10/13	2021	-120944809.	32.
H-3	W-4	3C279	3C273	10/13	2024	-124857204.	32.
H-3	W-4	3C279	3C273	10/13	2027	-128775021.	32.
H-3	W-4	3C279	3C273	10/13	2030	-132697532.	32.
H-3	W-4	3C279	3C273	10/13	2033	-136624081.	32.
H-3	W-4	3C279	3C273	10/13	2036	-140554042.	32.
H-3	W-4	3C279	3C273	10/13	2039	-144486720.	32.
H-3	W-4	3C279	3C273	10/13	2042	-148421384.	32.
H-3	W-4	3C279	3C273	10/13	2045	-152357405.	32.
H-3	W-4	3C279	3C273	10/13	2048	-156294103.	32.
H-3	W-4	3C279	3C273	10/13	2051	-160230818.	32.
H-3	W-4	3C279	3C273	10/13	2054	-164166806.	32.
H-3	W-4	3C279	3C273	10/13	2057	-168101483.	32.
H-3	W-4	3C279	3C273	10/13	21 0	-172034097.	32.
H-3	W-4	3C279	3C273	10/13	21 3	-175963997.	32.
H-3	W-4	3C279	3C273	10/13	21 6	-179890548.	32.
H-3	W-4	3C279	3C273	10/13	21 9	-183813105.	32.
H-3	W-4	3C279	3C273	10/13	2112	-187730964.	32.
H-3	W-4	3C279	3C273	10/13	2115	-191643476.	32.
H-3	W-4	3C279	3C273	10/18	1142	66977566.	28.
H-3	W-4	3C279	3C273	10/18	1145	69587849.	28.
H-3	W-4	3C279	3C273	10/18	1148	72159307.	28.
H-3	W-4	3C279	3C273	10/18	1151	74691542.	28.
H-3	W-4	3C279	3C273	10/18	1154	77184018.	28.
H-3	W-4	3C279	3C273	10/18	1157	79636349.	28.
H-3	W-4	3C279	3C273	10/18	12 0	82048108.	28.
H-3	W-4	3C279	3C273	10/18	12 3	84418875.	28.
H-3	W-4	3C279	3C273	10/18	12 6	86748218.	28.
H-3	W-4	3C279	3C273	10/18	12 9	89035761.	28.
H-3	W-4	3C279	3C273	10/18	1215	93483748.	28.
H-3	W-4	3C279	3C273	10/18	1218	95643422.	28.
H-3	W-4	3C279	3C273	10/18	1221	97759749.	28.
H-3	W-4	3C279	3C273	10/18	1224	99832332.	28.
H-3	W-4	3C279	3C273	10/18	1227	101860861.	28.
H-3	W-4	3C279	3C273	10/18	1230	103844969.	28.
H-3	W-4	3C279	3C273	10/18	1233	105784263.	28.
H-3	W-4	3C279	3C273	10/18	1236	107678428.	28.
H-3	W-4	3C279	3C273	10/18	1239	109527110.	28.
H-3	W-4	3C279	3C273	10/18	1242	111330036.	28.
H-3	W-4	3C279	3C273	10/18	1245	113086898.	28.
H-3	W-4	3C279	3C273	10/18	1248	114797420.	28.
H-3	W-4	3C279	3C273	10/18	1251	116461232.	28.
H-3	W-4	3C279	3C273	10/18	1254	118078101.	28.
H-3	W-4	3C279	3C273	10/18	1257	119647687.	28.
H-3	W-4	3C279	3C273	10/18	13 0	121169705.	28.
H-3	W-4	3C279	3C273	10/18	13 3	122643979.	28.
H-3	W-4	3C279	3C273	10/18	13 6	124070234.	28.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/18	13 9	125448224.	28.
H-3	W-4	3C279	3C273	10/18	1312	126777720.	28.
H-3	W-4	3C279	3C273	10/18	1315	128058476.	28.
H-3	W-4	3C279	3C273	10/18	1318	129290227.	28.
H-3	W-4	3C279	3C273	10/18	1321	130472777.	28.
H-3	W-4	3C279	3C273	10/18	1324	131605955.	28.
H-3	W-4	3C279	3C273	10/18	1327	132689563.	28.
H-3	W-4	3C279	3C273	10/18	1330	133723430.	28.
H-3	W-4	3C279	3C273	10/18	1333	134707365.	28.
H-3	W-4	3C279	3C273	10/18	1336	135641197.	28.
H-3	W-4	3C279	3C273	10/18	1339	136524742.	28.
H-3	W-4	3C279	3C273	10/18	1345	138140350.	28.
H-3	W-4	3C279	3C273	10/18	1348	138872144.	28.
H-3	W-4	3C279	3C273	10/18	1351	139553069.	28.
H-3	W-4	3C279	3C273	10/18	1354	140183107.	28.
H-3	W-4	3C279	3C273	10/18	1357	140762076.	28.
H-3	W-4	3C279	3C273	10/18	14 0	141289932.	28.
H-3	W-4	3C279	3C273	10/18	14 3	141766568.	28.
H-3	W-4	3C279	3C273	10/18	14 6	142191839.	28.
H-3	W-4	3C279	3C273	10/18	14 9	142565691.	28.
H-3	W-4	3C279	3C273	10/18	1412	142888069.	28.
H-3	W-4	3C279	3C273	10/18	1415	143158888.	28.
H-3	W-4	3C279	3C273	10/18	1418	143378151.	28.
H-3	W-4	3C279	3C273	10/18	1421	143545819.	28.
H-3	W-4	3C279	3C273	10/18	1424	143661853.	28.
H-3	W-4	3C279	3C273	10/18	1427	143726237.	28.
H-3	W-4	3C279	3C273	10/18	1430	143739020.	28.
H-3	W-4	3C279	3C273	10/18	1433	143700076.	28.
H-3	W-4	3C279	3C273	10/18	1436	143609453.	28.
H-3	W-4	3C279	3C273	10/18	1439	143467156.	28.
H-3	W-4	3C279	3C273	10/18	1442	143273257.	28.
H-3	W-4	3C279	3C273	10/18	1445	143027756.	28.
H-3	W-4	3C279	3C273	10/18	1448	142730754.	28.
H-3	W-4	3C279	3C273	10/18	1451	142382236.	28.
H-3	W-4	3C279	3C273	10/18	1454	141982281.	28.
H-3	W-4	3C279	3C273	10/18	15 0	141028277.	28.
H-3	W-4	3C279	3C273	10/18	15 3	140474429.	28.
H-3	W-4	3C279	3C273	10/18	15 6	139869480.	28.
H-3	W-4	3C279	3C273	10/18	15 9	139213565.	28.
H-3	W-4	3C279	3C273	10/18	1512	138506762.	28.
H-3	W-4	3C279	3C273	10/18	1515	137749187.	28.
H-3	W-4	3C279	3C273	10/18	1518	136940957.	28.
H-3	W-4	3C279	3C273	10/18	1521	136082212.	28.
H-3	W-4	3C279	3C273	10/18	1524	135173150.	28.
H-3	W-4	3C279	3C273	10/18	1527	134213870.	28.
H-3	W-4	3C279	3C273	10/18	1530	133204527.	28.
H-3	W-4	3C279	3C273	10/18	1533	132145356.	28.
H-3	W-4	3C279	3C273	10/18	1536	131036496.	28.
H-3	W-4	3C279	3C273	10/18	1539	129878202.	28.
H-3	W-4	3C279	3C273	10/18	1542	128670620.	28.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/18	1545	127413962.	28.
H-3	W-4	3C279	3C273	10/18	1548	126108411.	28.
H-3	W-4	3C279	3C273	10/18	1551	124754225.	28.
H-3	W-4	3C279	3C273	10/18	1554	123351643.	28.
H-3	W-4	3C279	3C273	10/18	16 3	118855987.	28.
H-3	W-4	3C279	3C273	10/18	16 6	117262307.	28.
H-3	W-4	3C279	3C273	10/18	1612	113933931.	28.
H-3	W-4	3C279	3C273	10/18	1615	112199795.	28.
H-3	W-4	3C279	3C273	10/18	1618	110419412.	28.
H-3	W-4	3C279	3C273	10/18	1621	108593127.	28.
H-3	W-4	3C279	3C273	10/18	1624	106721169.	28.
H-3	W-4	3C279	3C273	10/18	1627	104803953.	28.
H-3	W-4	3C279	3C273	10/18	1630	102841756.	28.
H-3	W-4	3C279	3C273	10/18	1633	100834916.	28.
H-3	W-4	3C279	3C273	10/18	1636	98783849.	28.
H-3	W-4	3C279	3C273	10/18	1639	96688828.	28.
H-3	W-4	3C279	3C273	10/18	1642	94550244.	28.
H-3	W-4	3C279	3C273	10/18	1645	92368469.	28.
H-3	W-4	3C279	3C273	10/18	1648	90143878.	28.
H-3	W-4	3C279	3C273	10/18	1651	87876843.	28.
H-3	W-4	3C279	3C273	10/18	1654	85567790.	28.
H-3	W-4	3C279	3C273	10/18	1657	83217059.	28.
H-3	W-4	3C279	3C273	10/18	17 0	80825068.	28.
H-3	W-4	3C279	3C273	10/18	17 3	78392281.	28.
H-3	W-4	3C279	3C273	10/18	17 6	75919058.	28.
H-3	W-4	3C279	3C273	10/18	17 9	73405879.	28.
H-3	W-4	3C279	3C273	10/18	1712	70853114.	28.
H-3	W-4	3C279	3C273	10/18	1715	68261244.	28.
H-3	W-4	3C279	3C273	10/18	1718	65630698.	28.
H-3	W-4	3C279	3C273	10/18	1721	62961953.	28.
H-3	W-4	3C279	3C273	10/18	1724	60255452.	28.
H-3	W-4	3C279	3C273	10/18	1727	57511661.	28.
H-3	W-4	3C279	3C273	10/18	1730	54731049.	28.
H-3	W-4	3C279	3C273	10/18	1733	51914084.	28.
H-3	W-4	3C279	3C273	10/18	1736	49061289.	28.
H-3	W-4	3C279	3C273	10/18	1739	46173126.	28.
H-3	W-4	3C279	3C273	10/18	1742	43250093.	28.
H-3	W-4	3C279	3C273	10/18	1745	40292724.	28.
H-3	W-4	3C279	3C273	10/18	1748	37301505.	28.
H-3	W-4	3C279	3C273	10/18	1751	34276938.	28.
H-3	W-4	3C279	3C273	10/18	1754	31219579.	28.
H-3	W-4	3C279	3C273	10/18	1757	28129915.	28.
H-3	W-4	3C279	3C273	10/18	18 0	25008448.	28.
H-3	W-4	3C279	3C273	10/18	18 3	21855877.	28.
H-3	W-4	3C279	3C273	10/18	18 6	18672582.	28.
H-3	W-4	3C279	3C273	10/18	18 9	15459144.	28.
H-3	W-4	3C279	3C273	10/18	1812	12216163.	28.
H-3	W-4	3C279	3C273	10/18	1815	8944138.	28.
H-3	W-4	3C279	3C273	10/18	1818	5643683.	28.
H-3	W-4	3C279	3C273	10/18	1821	2315335.	28.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/18	1824	-1040278.	28.
H-3	W-4	3C279	3C273	10/18	1827	-4422673.	28.
H-3	W-4	3C279	3C273	10/18	1833	-11265213.	28.
H-3	W-4	3C279	3C273	10/18	1836	-14724277.	28.
H-3	W-4	3C279	3C273	10/18	1839	-18207679.	28.
H-3	W-4	3C279	3C273	10/18	1842	-21714882.	28.
H-3	W-4	3C279	3C273	10/18	1845	-25245219.	28.
H-3	W-4	3C279	3C273	10/18	1848	-28798122.	28.
H-3	W-4	3C279	3C273	10/18	1851	-32372970.	28.
H-3	W-4	3C279	3C273	10/18	1857	-39586038.	28.
H-3	W-4	3C279	3C273	10/18	19 0	-43223030.	28.
H-3	W-4	3C279	3C273	10/18	19 3	-46879449.	28.
H-3	W-4	3C279	3C273	10/18	19 6	-50554708.	28.
H-3	W-4	3C279	3C273	10/18	19 9	-54248170.	28.
H-3	W-4	3C279	3C273	10/18	1912	-57959194.	28.
H-3	W-4	3C279	3C273	10/18	1915	-61687159.	28.
H-3	W-4	3C279	3C273	10/18	1918	-65431400.	28.
H-3	W-4	3C279	3C273	10/18	1921	-69191258.	28.
H-3	W-4	3C279	3C273	10/18	1924	-72966103.	28.
H-3	W-4	3C279	3C273	10/18	1927	-76755276.	28.
H-3	W-4	3C279	3C273	10/18	1930	-80558173.	28.
H-3	W-4	3C279	3C273	10/18	1933	-84374074.	28.
H-3	W-4	3C279	3C273	10/18	1936	-88202361.	28.
H-3	W-4	3C279	3C273	10/18	1939	-92042330.	28.
H-3	W-4	3C279	3C273	10/18	1942	-95893389.	28.
H-3	W-4	3C279	3C273	10/18	1945	-99754821.	28.
H-3	W-4	3C279	3C273	10/18	1948	-103625973.	28.
H-3	W-4	3C279	3C273	10/18	1951	-107506182.	28.
H-3	W-4	3C279	3C273	10/18	1954	-111394814.	28.
H-3	W-4	3C279	3C273	10/18	1957	-115291067.	28.
H-3	W-4	3C279	3C273	10/18	20 0	-119194430.	28.
H-3	W-4	3C279	3C273	10/18	20 3	-123104186.	28.
H-3	W-4	3C279	3C273	10/18	20 6	-127019619.	28.
H-3	W-4	3C279	3C273	10/18	20 9	-130940098.	28.
H-3	W-4	3C279	3C273	10/18	2012	-134864924.	28.
H-3	W-4	3C279	3C273	10/18	2015	-138793408.	28.
H-3	W-4	3C279	3C273	10/18	2018	-142724930.	28.
H-3	W-4	3C279	3C273	10/18	2021	-146658750.	28.
H-3	W-4	3C279	3C273	10/18	2024	-150594240.	28.
H-3	W-4	3C279	3C273	10/18	2027	-154530693.	28.
H-3	W-4	3C279	3C273	10/18	2030	-158467439.	28.
H-3	W-4	3C279	3C273	10/18	2033	-162403779.	28.
H-3	W-4	3C279	3C273	10/18	2036	-166339125.	28.
H-3	W-4	3C279	3C273	10/18	2039	-170272723.	28.
H-3	W-4	3C279	3C273	10/18	2042	-174203909.	28.
H-3	W-4	3C279	3C273	10/18	2045	-178132031.	28.
H-3	W-4	3C279	3C273	10/18	2048	-182056406.	28.
H-3	W-4	3C279	3C273	10/18	2051	-185976372.	28.
H-3	W-4	3C279	3C273	10/18	2054	-189891278.	28.
H-3	W-4	3C279	3C273	10/18	2057	-193800460.	28.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/18	21 0	-197703287.	28.
H-3	W-4	3C279	3C273	10/18	21 3	-201599074.	28.
H-3	W-4	3C279	3C273	10/18	21 6	-205487204.	28.
H-3	W-4	3C279	3C273	10/18	21 9	-209367072.	28.
H-3	W-4	3C279	3C273	10/19	1142	70390594.	20.
H-3	W-4	3C279	3C273	10/19	1145	72949944.	20.
H-3	W-4	3C279	3C273	10/19	1148	75469866.	20.
H-3	W-4	3C279	3C273	10/19	1151	77949923.	20.
H-3	W-4	3C279	3C273	10/19	1154	80389711.	20.
H-3	W-4	3C279	3C273	10/19	1157	82788795.	20.
H-3	W-4	3C279	3C273	10/19	12 0	85146743.	20.
H-3	W-4	3C279	3C273	10/19	12 3	87463157.	20.
H-3	W-4	3C279	3C273	10/19	12 6	89737630.	20.
H-3	W-4	3C279	3C273	10/19	12 9	91969715.	20.
H-3	W-4	3C279	3C273	10/19	1212	94159120.	20.
H-3	W-4	3C279	3C273	10/19	1215	96305411.	20.
H-3	W-4	3C279	3C273	10/19	1218	98408215.	20.
H-3	W-4	3C279	3C273	10/19	1221	100467161.	20.
H-3	W-4	3C279	3C273	10/19	1224	102481935.	20.
H-3	W-4	3C279	3C273	10/19	1227	104452149.	20.
H-3	W-4	3C279	3C273	10/19	1230	106377408.	20.
H-3	W-4	3C279	3C273	10/19	1233	108257507.	20.
H-3	W-4	3C279	3C273	10/19	1239	111880672.	20.
H-3	W-4	3C279	3C273	10/19	1242	113623168.	20.
H-3	W-4	3C279	3C273	10/19	1245	115319182.	20.
H-3	W-4	3C279	3C273	10/19	1248	116968438.	20.
H-3	W-4	3C279	3C273	10/19	1251	118570631.	20.
H-3	W-4	3C279	3C273	10/19	1254	120125503.	20.
H-3	W-4	3C279	3C273	10/19	1257	121632768.	20.
H-3	W-4	3C279	3C273	10/19	13 3	124503484.	20.
H-3	W-4	3C279	3C273	10/19	13 6	125866409.	20.
H-3	W-4	3C279	3C273	10/19	13 9	127180761.	20.
H-3	W-4	3C279	3C273	10/19	1312	128446326.	20.
H-3	W-4	3C279	3C273	10/19	1315	129662825.	20.
H-3	W-4	3C279	3C273	10/19	1318	130830104.	20.
H-3	W-4	3C279	3C273	10/19	1321	131947909.	20.
H-3	W-4	3C279	3C273	10/19	1324	133016103.	20.
H-3	W-4	3C279	3C273	10/19	1327	134034474.	20.
H-3	W-4	3C279	3C273	10/19	1330	135002795.	20.
H-3	W-4	3C279	3C273	10/19	1333	135921050.	20.
H-3	W-4	3C279	3C273	10/19	1336	136788934.	20.
H-3	W-4	3C279	3C273	10/19	1339	137606337.	20.
H-3	W-4	3C279	3C273	10/19	1345	139089176.	20.
H-3	W-4	3C279	3C273	10/19	1348	139754364.	20.
H-3	W-4	3C279	3C273	10/19	1351	140368580.	20.
H-3	W-4	3C279	3C273	10/19	1357	141443615.	20.
H-3	W-4	3C279	3C273	10/19	14 0	141904270.	20.
H-3	W-4	3C279	3C273	10/19	14 3	142313568.	20.
H-3	W-4	3C279	3C273	10/19	14 6	142671462.	20.
H-3	W-4	3C279	3C273	10/19	14 9	142977836.	20.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/19	1412	143232644.	20.
H-3	W-4	3C279	3C273	10/19	1424	143735950.	20.
H-3	W-4	3C279	3C273	10/19	1427	143732625.	20.
H-3	W-4	3C279	3C273	10/19	1430	143677628.	20.
H-3	W-4	3C279	3C273	10/19	1433	143570976.	20.
H-3	W-4	3C279	3C273	10/19	1436	143412673.	20.
H-3	W-4	3C279	3C273	10/19	1439	143202760.	20.
H-3	W-4	3C279	3C273	10/19	1442	142941231.	20.
H-3	W-4	3C279	3C273	10/19	1445	142628259.	20.
H-3	W-4	3C279	3C273	10/19	1448	142263741.	20.
H-3	W-4	3C279	3C273	10/19	1451	141847835.	20.
H-3	W-4	3C279	3C273	10/19	1454	141380578.	20.
H-3	W-4	3C279	3C273	10/19	1457	140862055.	20.
H-3	W-4	3C279	3C273	10/19	15 0	140292402.	20.
H-3	W-4	3C279	3C273	10/19	15 3	139671562.	20.
H-3	W-4	3C279	3C273	10/19	15 6	138999826.	20.
H-3	W-4	3C279	3C273	10/19	15 9	138277234.	20.
H-3	W-4	3C279	3C273	10/19	1512	137503901.	20.
H-3	W-4	3C279	3C273	10/19	1515	136679983.	20.
H-3	W-4	3C279	3C273	10/19	1518	135805581.	20.
H-3	W-4	3C279	3C273	10/19	1521	134880904.	20.
H-3	W-4	3C279	3C273	10/19	1524	133906075.	20.
H-3	W-4	3C279	3C273	10/19	1527	132881283.	20.
H-3	W-4	3C279	3C273	10/19	1530	131806675.	20.
H-3	W-4	3C279	3C273	10/19	1533	130682442.	20.
H-3	W-4	3C279	3C273	10/19	1542	127014096.	20.
H-3	W-4	3C279	3C273	10/19	1545	125693444.	20.
H-3	W-4	3C279	3C273	10/19	1548	124324215.	20.
H-3	W-4	3C279	3C273	10/19	1551	122906679.	20.
H-3	W-4	3C279	3C273	10/19	1554	121441047.	20.
H-3	W-4	3C279	3C273	10/19	1557	119927585.	20.
H-3	W-4	3C279	3C273	10/19	16 0	118366546.	20.
H-3	W-4	3C279	3C273	10/19	16 3	116758225.	20.
H-3	W-4	3C279	3C273	10/19	16 6	115102880.	20.
H-3	W-4	3C279	3C273	10/19	16 9	113400804.	20.
H-3	W-4	3C279	3C273	10/19	1612	111652270.	20.
H-3	W-4	3C279	3C273	10/19	1615	109857601.	20.
H-3	W-4	3C279	3C273	10/19	1618	108017086.	20.
H-3	W-4	3C279	3C273	10/19	1621	106131080.	20.
H-3	W-4	3C279	3C273	10/19	1624	104199857.	20.
H-3	W-4	3C279	3C273	10/19	1627	102223786.	20.
H-3	W-4	3C279	3C273	10/19	1633	98138427.	20.
H-3	W-4	3C279	3C273	10/19	1636	96029845.	20.
H-3	W-4	3C279	3C273	10/19	1639	93877837.	20.
H-3	W-4	3C279	3C273	10/19	1642	91682734.	20.
H-3	W-4	3C279	3C273	10/19	1645	89444921.	20.
H-3	W-4	3C279	3C273	10/19	1648	87164802.	20.
H-3	W-4	3C279	3C273	10/19	1651	84842753.	20.
H-3	W-4	3C279	3C273	10/19	1654	82479186.	20.
H-3	W-4	3C279	3C273	10/19	17 0	77629101.	20.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/19	17 3	75143436.	20.
H-3	W-4	3C279	3C273	10/19	17 6	72617918.	20.
H-3	W-4	3C279	3C273	10/19	1712	67449045.	20.
H-3	W-4	3C279	3C273	10/19	1715	64806604.	20.
H-3	W-4	3C279	3C273	10/19	1718	62126076.	20.
H-3	W-4	3C279	3C273	10/19	1721	59407932.	20.
H-3	W-4	3C279	3C273	10/19	1724	56652655.	20.
H-3	W-4	3C279	3C273	10/19	1727	53860725.	20.
H-3	W-4	3C279	3C273	10/19	1730	51032617.	20.
H-3	W-4	3C279	3C273	10/19	1733	48168781.	20.
H-3	W-4	3C279	3C273	10/19	1736	45269744.	20.
H-3	W-4	3C279	3C273	10/19	1739	42336006.	20.
H-3	W-4	3C279	3C273	10/19	1742	39368073.	20.
H-3	W-4	3C279	3C273	10/19	1745	36366437.	20.
H-3	W-4	3C279	3C273	10/19	1751	30264205.	20.
H-3	W-4	3C279	3C273	10/19	1754	27164617.	20.
H-3	W-4	3C279	3C273	10/19	18 0	20871255.	20.
H-3	W-4	3C279	3C273	10/19	18 6	14455889.	20.
H-3	W-4	3C279	3C273	10/19	18 9	11203783.	20.
H-3	W-4	3C279	3C273	10/19	1812	7922922.	20.
H-3	W-4	3C279	3C273	10/19	1815	4613755.	20.
H-3	W-4	3C279	3C273	10/19	1818	1276888.	20.
H-3	W-4	3C279	3C273	10/19	1821	-2087110.	20.
H-3	W-4	3C279	3C273	10/19	1824	-5477625.	20.
H-3	W-4	3C279	3C273	10/19	1827	-8894134.	20.
H-3	W-4	3C279	3C273	10/19	1830	-12336019.	20.
H-3	W-4	3C279	3C273	10/19	1833	-15802678.	20.
H-3	W-4	3C279	3C273	10/19	1836	-19293536.	20.
H-3	W-4	3C279	3C273	10/19	1839	-22807956.	20.
H-3	W-4	3C279	3C273	10/19	1845	-29905140.	20.
H-3	W-4	3C279	3C273	10/19	1848	-33486678.	20.
H-3	W-4	3C279	3C273	10/19	1851	-37089338.	20.
H-3	W-4	3C279	3C273	10/19	1854	-40712526.	20.
H-3	W-4	3C279	3C273	10/19	1857	-44355611.	20.
H-3	W-4	3C279	3C273	10/19	19 0	-48017953.	20.
H-3	W-4	3C279	3C273	10/19	19 3	-51698939.	20.
H-3	W-4	3C279	3C273	10/19	19 6	-55397918.	20.
H-3	W-4	3C279	3C273	10/19	19 9	-59114253.	20.
H-3	W-4	3C279	3C273	10/19	1912	-62847330.	20.
H-3	W-4	3C279	3C273	10/19	1915	-66596491.	20.
H-3	W-4	3C279	3C273	10/19	1918	-70361077.	20.
H-3	W-4	3C279	3C273	10/19	1921	-74140432.	20.
H-3	W-4	3C279	3C273	10/19	1924	-77933968.	20.
H-3	W-4	3C279	3C273	10/19	1927	-81740937.	20.
H-3	W-4	3C279	3C273	10/19	1930	-85560734.	20.
H-3	W-4	3C279	3C273	10/19	1933	-89392699.	20.
H-3	W-4	3C279	3C273	10/19	1936	-93236196.	20.
H-3	W-4	3C279	3C273	10/19	1939	-97090524.	20.
H-3	W-4	3C279	3C273	10/19	1942	-100955042.	20.
H-3	W-4	3C279	3C273	10/19	1945	-104829066.	20.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/19	1948	-108711927.	20.
H-3	W-4	3C279	3C273	10/19	1951	-112603001.	20.
H-3	W-4	3C279	3C273	10/19	1954	-116501578.	20.
H-3	W-4	3C279	3C273	10/19	1957	-120406973.	20.
H-3	W-4	3C279	3C273	10/19	20 3	-128235629.	20.
H-3	W-4	3C279	3C273	10/19	20 6	-132157506.	20.
H-3	W-4	3C279	3C273	10/19	20 9	-136083567.	20.
H-3	W-4	3C279	3C273	10/19	2012	-140013038.	20.
H-3	W-4	3C279	3C273	10/19	2015	-143945326.	20.
H-3	W-4	3C279	3C273	10/19	2021	-151815600.	20.
H-3	W-4	3C279	3C273	10/19	2024	-155752227.	20.
H-3	W-4	3C279	3C273	10/19	2027	-159688926.	20.
H-3	W-4	3C279	3C273	10/19	2030	-163625035.	20.
H-3	W-4	3C279	3C273	10/19	2033	-167559880.	20.
H-3	W-4	3C279	3C273	10/19	2036	-171492787.	20.
H-3	W-4	3C279	3C273	10/19	2039	-175423092.	20.
H-3	W-4	3C279	3C273	10/19	2042	-179350119.	20.
H-3	W-4	3C279	3C273	10/19	2048	-187191635.	20.
H-3	W-4	3C279	3C273	10/19	2051	-191104801.	20.
H-3	W-4	3C279	3C273	10/19	2054	-195012029.	20.
H-3	W-4	3C279	3C273	10/19	2057	-198912709.	20.
H-3	W-4	3C279	3C273	10/19	21 0	-202806142.	20.
H-3	W-4	3C279	3C273	10/20	1139	71189793.	24.
H-3	W-4	3C279	3C273	10/20	1142	73736970.	24.
H-3	W-4	3C279	3C273	10/20	1145	76244620.	24.
H-3	W-4	3C279	3C273	10/20	1148	78712275.	24.
H-3	W-4	3C279	3C273	10/20	1151	81139502.	24.
H-3	W-4	3C279	3C273	10/20	1154	83525883.	24.
H-3	W-4	3C279	3C273	10/20	1157	85870983.	24.
H-3	W-4	3C279	3C273	10/20	12 0	88174405.	24.
H-3	W-4	3C279	3C273	10/20	12 3	90435742.	24.
H-3	W-4	3C279	3C273	10/20	12 9	94830700.	24.
H-3	W-4	3C279	3C273	10/20	1212	96963518.	24.
H-3	W-4	3C279	3C273	10/20	1215	99052736.	24.
H-3	W-4	3C279	3C273	10/20	1218	101098003.	24.
H-3	W-4	3C279	3C273	10/20	1221	103098986.	24.
H-3	W-4	3C279	3C273	10/20	1224	105055314.	24.
H-3	W-4	3C279	3C273	10/20	1227	106966652.	24.
H-3	W-4	3C279	3C273	10/20	1230	108832673.	24.
H-3	W-4	3C279	3C273	10/20	1233	110652944.	24.
H-3	W-4	3C279	3C273	10/20	1236	112427331.	24.
H-3	W-4	3C279	3C273	10/20	1239	114155365.	24.
H-3	W-4	3C279	3C273	10/20	1242	115836918.	24.
H-3	W-4	3C279	3C273	10/20	1245	117471609.	24.
H-3	W-4	3C279	3C273	10/20	1248	119059154.	24.
H-3	W-4	3C279	3C273	10/20	1251	120599273.	24.
H-3	W-4	3C279	3C273	10/20	1254	122091679.	24.
H-3	W-4	3C279	3C273	10/20	1257	123536170.	24.
H-3	W-4	3C279	3C273	10/20	13 0	124932491.	24.
H-3	W-4	3C279	3C273	10/20	13 3	126280388.	24.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/20	13 6	127579632.	24.
H-3	W-4	3C279	3C273	10/20	13 9	128829995.	24.
H-3	W-4	3C279	3C273	10/20	1312	130031257.	24.
H-3	W-4	3C279	3C273	10/20	1315	131183200.	24.
H-3	W-4	3C279	3C273	10/20	1318	132285593.	24.
H-3	W-4	3C279	3C273	10/20	1321	133338320.	24.
H-3	W-4	3C279	3C273	10/20	1324	134341188.	24.
H-3	W-4	3C279	3C273	10/20	1327	135293988.	24.
H-3	W-4	3C279	3C273	10/20	1330	136196585.	24.
H-3	W-4	3C279	3C273	10/20	1333	137048818.	24.
H-3	W-4	3C279	3C273	10/20	1336	137850534.	24.
H-3	W-4	3C279	3C273	10/20	1339	138601578.	24.
H-3	W-4	3C279	3C273	10/20	1342	139301858.	24.
H-3	W-4	3C279	3C273	10/20	1345	139951222.	24.
H-3	W-4	3C279	3C273	10/20	1351	141096829.	24.
H-3	W-4	3C279	3C273	10/20	1354	141592812.	24.
H-3	W-4	3C279	3C273	10/20	1357	142037529.	24.
H-3	W-4	3C279	3C273	10/20	14 0	142430861.	24.
H-3	W-4	3C279	3C273	10/20	14 3	142772760.	24.
H-3	W-4	3C279	3C273	10/20	14 6	143063169.	24.
H-3	W-4	3C279	3C273	10/20	14 9	143302003.	24.
H-3	W-4	3C279	3C273	10/20	1412	143489227.	24.
H-3	W-4	3C279	3C273	10/20	1415	143624826.	24.
H-3	W-4	3C279	3C273	10/20	1418	143708791.	24.
H-3	W-4	3C279	3C273	10/20	1421	143741088.	24.
H-3	W-4	3C279	3C273	10/20	1424	143721722.	24.
H-3	W-4	3C279	3C273	10/20	1427	143650702.	24.
H-3	W-4	3C279	3C273	10/20	1430	143527975.	24.
H-3	W-4	3C279	3C273	10/20	1433	143353722.	24.
H-3	W-4	3C279	3C273	10/20	1436	143127794.	24.
H-3	W-4	3C279	3C273	10/20	1439	142850301.	24.
H-3	W-4	3C279	3C273	10/20	1442	142521248.	24.
H-3	W-4	3C279	3C273	10/20	1445	142140760.	24.
H-3	W-4	3C279	3C273	10/20	1448	141708891.	24.
H-3	W-4	3C279	3C273	10/20	1451	141225736.	24.
H-3	W-4	3C279	3C273	10/20	1454	140691327.	24.
H-3	W-4	3C279	3C273	10/20	1457	140105778.	24.
H-3	W-4	3C279	3C273	10/20	15 0	139469184.	24.
H-3	W-4	3C279	3C273	10/20	15 3	138781618.	24.
H-3	W-4	3C279	3C273	10/20	15 6	138043253.	24.
H-3	W-4	3C279	3C273	10/20	15 9	137254192.	24.
H-3	W-4	3C279	3C273	10/20	1512	136414580.	24.
H-3	W-4	3C279	3C273	10/20	1515	135524567.	24.
H-3	W-4	3C279	3C273	10/20	1518	134584287.	24.
H-3	W-4	3C279	3C273	10/20	1521	133593943.	24.
H-3	W-4	3C279	3C273	10/20	1524	132553674.	24.
H-3	W-4	3C279	3C273	10/20	1530	130324055.	24.
H-3	W-4	3C279	3C273	10/20	1533	129135091.	24.
H-3	W-4	3C279	3C273	10/20	1536	127897008.	24.
H-3	W-4	3C279	3C273	10/20	1539	126609962.	24.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/20	1542	125274202.	24.
H-3	W-4	3C279	3C273	10/20	1545	123889946.	24.
H-3	W-4	3C279	3C273	10/20	1548	122457462.	24.
H-3	W-4	3C279	3C273	10/20	1551	120976907.	24.
H-3	W-4	3C279	3C273	10/20	1554	119448658.	24.
H-3	W-4	3C279	3C273	10/20	1557	117872923.	24.
H-3	W-4	3C279	3C273	10/20	16 0	116249960.	24.
H-3	W-4	3C279	3C273	10/20	16 3	114580098.	24.
H-3	W-4	3C279	3C273	10/20	16 6	112863571.	24.
H-3	W-4	3C279	3C273	10/20	1642	88742202.	24.
H-3	W-4	3C279	3C273	10/20	1645	86449024.	24.
H-3	W-4	3C279	3C273	10/20	1648	84114052.	24.
H-3	W-4	3C279	3C273	10/20	1651	81737653.	24.
H-3	W-4	3C279	3C273	10/20	1654	79320309.	24.
H-3	W-4	3C279	3C273	10/20	1657	76862399.	24.
H-3	W-4	3C279	3C273	10/20	17 0	74364274.	24.
H-3	W-4	3C279	3C273	10/20	17 3	71826472.	24.
H-3	W-4	3C279	3C273	10/20	17 6	69249376.	24.
H-3	W-4	3C279	3C273	10/20	17 9	66633459.	24.
H-3	W-4	3C279	3C273	10/20	1712	63979141.	24.
H-3	W-4	3C279	3C273	10/20	1715	61286885.	24.
H-3	W-4	3C279	3C273	10/20	1718	58557179.	24.
H-3	W-4	3C279	3C273	10/20	1721	55790465.	24.
H-3	W-4	3C279	3C273	10/20	1724	52987245.	24.
H-3	W-4	3C279	3C273	10/20	1727	50147977.	24.
H-3	W-4	3C279	3C273	10/20	1730	47273183.	24.
H-3	W-4	3C279	3C273	10/20	1733	44363339.	24.
H-3	W-4	3C279	3C273	10/20	1736	41418958.	24.
H-3	W-4	3C279	3C273	10/20	1739	38440472.	24.
H-3	W-4	3C279	3C273	10/20	1742	35428496.	24.
H-3	W-4	3C279	3C273	10/20	1745	32383500.	24.
H-3	W-4	3C279	3C273	10/20	1748	29306031.	24.
H-3	W-4	3C279	3C273	10/20	1751	26196618.	24.
H-3	W-4	3C279	3C273	10/20	1754	23055757.	24.
H-3	W-4	3C279	3C273	10/20	1757	19884035.	24.
H-3	W-4	3C279	3C273	10/20	18 0	16681961.	24.
H-3	W-4	3C279	3C273	10/20	18 3	13450124.	24.
H-3	W-4	3C279	3C273	10/20	18 6	10189062.	24.
H-3	W-4	3C279	3C273	10/20	18 9	6899334.	24.
H-3	W-4	3C279	3C273	10/20	1812	3581524.	24.
H-3	W-4	3C279	3C273	10/20	1815	236150.	24.
H-3	W-4	3C279	3C273	10/20	1818	-3136135.	24.
H-3	W-4	3C279	3C273	10/20	1821	-6534793.	24.
H-3	W-4	3C279	3C273	10/20	1824	-9959246.	24.
H-3	W-4	3C279	3C273	10/20	1827	-13408873.	24.
H-3	W-4	3C279	3C273	10/20	1830	-16883087.	24.
H-3	W-4	3C279	3C273	10/20	1833	-20381334.	24.
H-3	W-4	3C279	3C273	10/20	1836	-23902948.	24.
H-3	W-4	3C279	3C273	10/20	1839	-27447339.	24.
H-3	W-4	3C279	3C273	10/20	1842	-31013946.	24.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C279	3C273	10/20	1845	-34602095.	24.
H-3	W-4	3C279	3C273	10/20	1848	-38211215.	24.
H-3	W-4	3C279	3C273	10/20	1851	-41840637.	24.
H-3	W-4	3C279	3C273	10/20	1857	-49157957.	24.
H-3	W-4	3C279	3C273	10/20	19 0	-52844584.	24.
H-3	W-4	3C279	3C273	10/20	19 3	-56549010.	24.
H-3	W-4	3C279	3C273	10/20	19 6	-60270611.	24.
H-3	W-4	3C279	3C273	10/20	19 9	-64008799.	24.
H-3	W-4	3C279	3C273	10/20	1912	-67762736.	24.
H-3	W-4	3C279	3C273	10/20	1915	-71531963.	24.
H-3	W-4	3C279	3C273	10/20	1918	-75315776.	24.
H-3	W-4	3C279	3C273	10/20	1921	-79113544.	24.
H-3	W-4	3C279	3C273	10/20	1924	-82924555.	24.
H-3	W-4	3C279	3C273	10/20	1927	-86748222.	24.
H-3	W-4	3C279	3C273	10/20	1930	-90583842.	24.
H-3	W-4	3C279	3C273	10/20	1933	-94430743.	24.
H-3	W-4	3C279	3C273	10/20	1936	-98288305.	24.
H-3	W-4	3C279	3C273	10/20	1939	-102155833.	24.
H-3	W-4	3C279	3C273	10/20	1942	-106032691.	24.
H-3	W-4	3C279	3C273	10/20	1945	-109918168.	24.
H-3	W-4	3C279	3C273	10/20	1948	-113811635.	24.
H-3	W-4	3C279	3C273	10/20	1951	-117712427.	24.
H-3	W-4	3C279	3C273	10/20	1954	-121619771.	24.
H-3	W-4	3C279	3C273	10/20	1957	-125533146.	24.
H-3	W-4	3C279	3C273	10/20	20 0	-129451777.	24.
H-3	W-4	3C279	3C273	10/20	20 3	-133374995.	24.
H-3	W-4	3C279	3C273	10/20	20 6	-137302151.	24.
H-3	W-4	3C279	3C273	10/20	2012	-145165585.	24.
H-3	W-4	3C279	3C273	10/20	2015	-149100492.	24.
H-3	W-4	3C279	3C273	10/20	2018	-153036649.	24.
H-3	W-4	3C279	3C273	10/20	2021	-156973362.	24.
H-3	W-4	3C279	3C273	10/20	2024	-160909921.	24.
H-3	W-4	3C279	3C273	10/20	2027	-164845730.	24.
H-3	W-4	3C279	3C273	10/20	2030	-168780006.	24.
H-3	W-4	3C279	3C273	10/20	2033	-172712195.	24.
H-3	W-4	3C279	3C273	10/20	2036	-176641533.	24.
H-3	W-4	3C279	3C273	10/20	2039	-180567453.	24.
H-3	W-4	3C279	3C273	10/20	2042	-184489138.	24.
H-3	W-4	3C279	3C273	10/20	2045	-188406016.	24.
H-3	W-4	3C279	3C273	10/20	2048	-192317342.	24.
H-3	W-4	3C279	3C273	10/20	2051	-196222534.	24.
H-3	W-4	3C279	3C273	10/20	2054	-200121012.	24.
H-3	W-4	3C279	3C273	10/20	2057	-204012042.	24.
H-3	W-4	3C279	3C273	10/20	21 0	-207895056.	24.
H-3	W-4	3C279	3C273	10/20	21 3	-211769514.	24.
H-3	W-4	3C84	3C84	10/22	8 0	4761611.	6.
H-3	W-4	3C84	3C84	10/22	8 4	4763991.	6.
H-3	W-4	3C84	3C84	10/22	8 8	4767033.	6.
H-3	W-4	3C84	3C84	10/22	812	4770676.	6.
H-3	W-4	3C84	3C84	10/22	816	4774951.	6.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-4	3C84	3C84	10/22	820	4779876.	6.
H-3	W-4	3C84	3C84	10/22	824	4785416.	6.
H-3	W-4	3C84	3C84	10/22	828	4791591.	6.
H-3	W-4	3C84	3C84	10/22	832	4798378.	6.
H-3	W-4	3C84	3C84	10/22	836	4805797.	6.
H-3	W-4	3C84	3C84	10/22	840	4813843.	6.
H-3	W-4	3C84	3C84	10/22	844	4822488.	6.
H-3	W-4	3C84	3C84	10/22	848	4831759.	6.
H-3	W-4	3C84	3C84	10/22	852	4841649.	6.
H-3	W-4	3C84	3C84	10/22	856	4852147.	6.
H-3	W-4	3C84	3C84	10/22	9 0	4863237.	6.
H-3	W-4	3C84	3C84	10/22	9 4	4874931.	6.
H-3	W-4	3C84	3C84	10/22	9 8	4887238.	6.
H-3	W-4	3C84	3C84	10/22	912	4900137.	6.
H-3	W-4	3C84	3C84	10/22	916	4913636.	6.
H-3	W-4	3C84	3C84	10/22	920	4927696.	6.
H-3	W-4	3C84	3C84	10/22	924	4942361.	6.
H-3	W-4	3C84	3C84	10/22	928	4957600.	6.
H-3	W-4	3C84	3C84	10/22	940	5006740.	6.
H-3	W-4	3C84	3C84	10/22	944	5024263.	6.
H-3	W-4	3C84	3C84	10/22	948	5042314.	6.
H-3	W-4	3C84	3C84	10/22	952	5060912.	6.
H-3	W-4	3C84	3C84	10/22	956	5080062.	6.
H-3	W-4	3C84	3C84	10/22	10 0	5099740.	6.
H-3	W-4	3C84	3C84	10/22	10 4	5119970.	6.
H-3	W-4	3C84	3C84	10/22	10 8	5140702.	6.
H-3	W-4	3C84	3C84	10/22	1012	5161959.	6.
H-3	W-4	3C84	3C84	10/22	1016	5183732.	6.
H-3	W-4	3C84	3C84	10/22	1020	5206009.	6.
H-3	W-4	3C84	3C84	10/22	1024	5228785.	6.
H-3	W-4	3C84	3C84	10/22	1028	5252645.	6.
H-3	W-4	3C84	3C84	10/22	1032	5275802.	6.
H-3	W-4	3C84	3C84	10/22	1040	5324707.	6.
H-3	W-4	3C84	3C84	10/22	1044	5349871.	6.
H-3	W-4	3C84	3C84	10/22	1048	5375481.	6.
H-3	W-4	3C84	3C84	10/22	1052	5401546.	6.
H-3	W-4	3C84	3C84	10/22	1056	5428023.	6.
H-3	W-4	3C84	3C84	10/22	11 0	5454951.	6.
H-3	W-4	3C84	3C84	10/22	11 4	5482311.	6.
H-3	W-4	3C84	3C84	10/22	11 8	5510066.	6.
H-3	W-4	3C84	3C84	10/22	1112	5538217.	6.
H-3	W-4	3C84	3C84	10/22	1116	5566777.	6.
H-3	W-4	3C84	3C84	10/22	1120	5595725.	6.
H-3	W-4	3C84	3C84	10/22	1124	5625062.	6.
H-3	W-4	3C84	3C84	10/22	1128	5654747.	6.
H-3	W-4	3C84	3C84	10/22	1136	5715204.	6.
H-3	W-4	3C84	3C84	10/22	1140	5745957.	6.
H-3	W-4	3C84	3C84	10/22	1144	5777035.	6.
H-3	W-4	3C84	3C84	10/22	1148	5808441.	6.
W-4	H-3	3C84	3C454.3	10/22	2 0	2760391468.	20.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-4	H-3	3C84	3C454.3	10/22	2 4	2773964527.	20.
W-4	H-3	3C84	3C454.3	10/22	2 8	2786825230.	20.
W-4	H-3	3C84	3C454.3	10/22	216	2810394034.	20.
W-4	H-3	3C84	3C454.3	10/22	220	2821094942.	20.
W-4	H-3	3C84	3C454.3	10/22	224	2831069053.	20.
W-4	H-3	3C84	3C454.3	10/22	232	2848824946.	20.
W-4	H-3	3C84	3C454.3	10/22	236	2856601252.	20.
W-4	H-3	3C84	3C454.3	10/22	240	2863639926.	20.
W-4	H-3	3C84	3C454.3	10/22	244	2869938773.	20.
W-4	H-3	3C84	3C454.3	10/22	248	2875495859.	20.
W-4	H-3	3C84	3C454.3	10/22	256	2884378265.	20.
W-4	H-3	3C84	3C454.3	10/22	3 0	2887700821.	20.
W-4	H-3	3C84	3C454.3	10/22	3 4	2890276203.	20.
W-4	H-3	3C84	3C454.3	10/22	3 8	2892103599.	20.
W-4	H-3	3C84	3C454.3	10/22	312	2893182462.	20.
W-4	H-3	3C84	3C454.3	10/22	316	2893512475.	20.
W-4	H-3	3C84	3C454.3	10/22	320	2893093505.	20.
W-4	H-3	3C84	3C454.3	10/22	324	2891925709.	20.
W-4	H-3	3C84	3C454.3	10/22	328	2890009429.	20.
W-4	H-3	3C84	3C454.3	10/22	332	2887345249.	20.
W-4	H-3	3C84	3C454.3	10/22	336	2883934010.	20.
W-4	H-3	3C84	3C454.3	10/22	340	2879776699.	20.
W-4	H-3	3C84	3C454.3	10/22	344	2874874658.	20.
W-4	H-3	3C84	3C454.3	10/22	348	2869229336.	20.
W-4	H-3	3C84	3C454.3	10/22	352	2862842531.	20.
W-4	H-3	3C84	3C454.3	10/22	356	2855716098.	20.
W-4	H-3	3C84	3C454.3	10/22	4 0	2847852324.	20.
W-4	H-3	3C84	3C454.3	10/22	4 4	2839253520.	20.
W-4	H-3	3C84	3C454.3	10/22	4 8	2829922382.	20.
W-4	H-3	3C84	3C454.3	10/22	412	2819861769.	20.
W-4	H-3	3C84	3C454.3	10/22	416	2809074734.	20.
W-4	H-3	3C84	3C454.3	10/22	420	2797564585.	20.
W-4	H-3	3C84	3C454.3	10/22	424	2785334866.	20.
W-4	H-3	3C84	3C454.3	10/22	428	2772389302.	20.
W-4	H-3	3C84	3C454.3	10/22	436	2744366777.	20.
W-4	H-3	3C84	3C454.3	10/22	444	2713531345.	20.
W-4	H-3	3C84	3C454.3	10/22	448	2697070435.	20.
W-4	H-3	3C84	3C454.3	10/22	452	2679920707.	20.
W-4	H-3	3C84	3C454.3	10/22	456	2662087442.	20.
W-4	H-3	3C84	3C454.3	10/22	5 0	2643576123.	20.
W-4	H-3	3C84	3C454.3	10/22	5 4	2624392352.	20.
W-4	H-3	3C84	3C454.3	10/22	5 8	2604542050.	20.
W-4	H-3	3C84	3C454.3	10/22	512	2584031323.	20.
W-4	H-3	3C84	3C454.3	10/22	516	2562866375.	20.
W-4	H-3	3C84	3C454.3	10/22	520	2541053740.	20.
W-4	H-3	3C84	3C454.3	10/22	524	2518600110.	20.
W-4	H-3	3C84	3C454.3	10/22	532	2471797483.	20.
W-4	H-3	3C84	3C454.3	10/22	536	2447462845.	20.
W-4	H-3	3C84	3C454.3	10/22	540	2422515886.	20.
W-4	H-3	3C84	3C454.3	10/22	548	2370815559.	20.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-4	H-3	3C84	3C454.3	10/22	552	2344078149.	20.
W-4	H-3	3C84	3C454.3	10/22	556	2316759983.	20.
W-4	H-3	3C84	3C454.3	10/22	6 0	2288869545.	20.
W-4	H-3	3C84	3C454.3	10/22	6 4	2260415336.	20.
W-4	H-3	3C84	3C454.3	10/22	6 8	2231406080.	20.
W-4	H-3	3C84	3C454.3	10/22	612	2201850651.	20.
W-4	H-3	3C84	3C454.3	10/22	616	2171758136.	20.
W-4	H-3	3C84	3C454.3	10/22	620	2141137713.	20.
W-4	H-3	3C84	3C454.3	10/22	624	2109998792.	20.
W-4	H-3	3C84	3C454.3	10/22	628	2078350801.	20.
W-4	H-3	3C84	3C454.3	10/22	632	2046203651.	20.
W-4	H-3	3C84	3C454.3	10/22	636	2013566977.	20.
W-4	H-3	3C84	3C454.3	10/22	640	1980450899.	20.
W-4	H-3	3C84	3C454.3	10/22	644	1946865521.	20.
W-4	H-3	3C84	3C454.3	10/22	656	1843397256.	20.
W-4	H-3	3C84	3C454.3	10/22	7 0	1808039002.	20.
W-4	H-3	3C84	3C454.3	10/22	7 8	1736084058.	20.
W-4	H-3	3C84	3C454.3	10/22	712	1699509432.	20.
W-4	H-3	3C84	3C454.3	10/22	716	1662551605.	20.
W-4	H-3	3C273	3C345	10/22	1428	-2711320705.	20.
W-4	H-3	3C273	3C345	10/22	1436	-2759117754.	20.
W-4	H-3	3C273	3C345	10/22	1440	-2782081189.	20.
W-4	H-3	3C273	3C345	10/22	1444	-2804411688.	20.
W-4	H-3	3C273	3C345	10/22	1448	-2826102541.	20.
W-4	H-3	3C273	3C345	10/22	1452	-2847147037.	20.
W-4	H-3	3C273	3C345	10/22	15 0	-2887271349.	20.
W-4	H-3	3C273	3C345	10/22	15 4	-2906338918.	20.
W-4	H-3	3C273	3C345	10/22	15 8	-2924735563.	20.
W-4	H-3	3C273	3C345	10/22	1512	-2942455626.	20.
W-4	H-3	3C273	3C345	10/22	1516	-2959493700.	20.
W-4	H-3	3C273	3C345	10/22	1520	-2975844581.	20.
W-4	H-3	3C273	3C345	10/22	1524	-2991503263.	20.
W-4	H-3	3C273	3C345	10/22	1528	-3006464913.	20.
W-4	H-3	3C273	3C345	10/22	1532	-3020724963.	20.
W-4	H-3	3C273	3C345	10/22	1536	-3034279061.	20.
W-4	H-3	3C273	3C345	10/22	1540	-3047123051.	20.
W-4	H-3	3C273	3C345	10/22	1544	-3059252991.	20.
W-4	H-3	3C273	3C345	10/22	1548	-3070665163.	20.
W-4	H-3	3C273	3C345	10/22	1552	-3081356089.	20.
W-4	H-3	3C273	3C345	10/22	1556	-3091322477.	20.
W-4	H-3	3C273	3C345	10/22	16 0	-3100561287.	20.
W-4	H-3	3C273	3C345	10/22	16 4	-3109069671.	20.
W-4	H-3	3C273	3C345	10/22	16 8	-3116845028.	20.
W-4	H-3	3C273	3C345	10/22	1612	-3123884980.	20.
W-4	H-3	3C273	3C345	10/22	1616	-3130187385.	20.
W-4	H-3	3C273	3C345	10/22	1620	-3135750305.	20.
W-4	H-3	3C273	3C345	10/22	1628	-3144651074.	20.
W-4	H-3	3C273	3C345	10/22	1632	-3147986206.	20.
W-4	H-3	3C273	3C345	10/22	1636	-3150576400.	20.
W-4	H-3	3C273	3C345	10/22	1640	-3152420856.	20.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-4	H-3	3C273	3C345	10/22	1644	-3153519022.	20.
W-4	H-3	3C273	3C345	10/22	1648	-3153870564.	20.
W-4	H-3	3C273	3C345	10/22	1652	-3153475344.	20.
W-4	H-3	3C273	3C345	10/22	17 0	-3150445392.	20.
W-4	H-3	3C273	3C345	10/22	17 4	-3147811596.	20.
W-4	H-3	3C273	3C345	10/22	17 8	-3144432886.	20.
W-4	H-3	3C273	3C345	10/22	1712	-3140310352.	20.
W-4	H-3	3C273	3C345	10/22	1720	-3129838987.	20.
W-4	H-3	3C273	3C345	10/22	1724	-3123493386.	20.
W-4	H-3	3C273	3C345	10/22	1728	-3116410350.	20.
W-4	H-3	3C273	3C345	10/22	1732	-3108592033.	20.
W-4	H-3	3C273	3C345	10/22	1736	-3100040828.	20.
W-4	H-3	3C273	3C345	10/22	1740	-3090759366.	20.
W-4	H-3	3C273	3C345	10/22	1744	-3080750514.	20.
W-4	H-3	3C273	3C345	10/22	1748	-3070017310.	20.
W-4	H-3	3C273	3C345	10/22	1752	-3058563054.	20.
W-4	H-3	3C273	3C345	10/22	1756	-3046391227.	20.
W-4	H-3	3C273	3C345	10/22	18 0	-3033505579.	20.
W-4	H-3	3C273	3C345	10/22	18 4	-3019910059.	20.
W-4	H-3	3C273	3C345	10/22	18 8	-3005608846.	20.
W-4	H-3	3C273	3C345	10/22	1812	-2990606276.	20.
W-4	H-3	3C273	3C345	10/22	1816	-2974906986.	20.
W-4	H-3	3C273	3C345	10/22	1820	-2958515761.	20.
W-4	H-3	3C273	3C345	10/22	1824	-2941437617.	20.
W-4	H-3	3C273	3C345	10/22	1828	-2923677816.	20.
W-4	H-3	3C273	3C345	10/22	1832	-2905241785.	20.
W-4	H-3	3C273	3C345	10/22	1844	-2845933800.	20.
W-4	H-3	3C273	3C345	10/22	1848	-2824851343.	20.
W-4	H-3	3C273	3C345	10/22	1852	-2803122920.	20.
W-4	H-3	3C273	3C345	10/22	1856	-2780755201.	20.
W-4	H-3	3C273	3C345	10/22	19 0	-2757755022.	20.
W-4	H-3	3C273	3C345	10/22	19 8	-2709885727.	20.
W-4	H-3	3C273	3C345	10/22	1912	-2685031245.	20.
W-4	H-3	3C273	3C345	10/22	1920	-2633521665.	20.
W-4	H-3	3C273	3C345	10/22	1924	-2606880426.	20.
W-4	H-3	3C273	3C345	10/22	1928	-2579660962.	20.
W-4	H-3	3C273	3C345	10/22	1932	-2551870683.	20.
W-4	H-3	3C273	3C345	10/22	1936	-2523518019.	20.
W-4	H-3	3C273	3C345	10/22	1940	-2494611744.	20.
W-4	H-3	3C273	3C345	10/22	1944	-2465160694.	20.
W-4	H-3	3C273	3C345	10/22	1948	-2435173946.	20.
W-4	H-3	3C273	3C345	10/22	1952	-2404660635.	20.
W-4	H-3	3C273	3C345	10/22	1956	-2373630067.	20.
W-4	H-3	3C273	3C345	10/22	20 0	-2342091827.	20.
W-4	H-3	3C273	3C345	10/22	20 4	-2310055640.	20.
W-4	H-3	3C273	3C345	10/22	20 8	-2277531283.	20.
W-4	H-3	3C273	3C345	10/22	2012	-2244528760.	20.
W-4	H-3	3C84	4C39.25	10/21	7 8	-2736165652.	9.
W-4	H-3	3C84	4C39.25	10/21	712	-2744436680.	9.
W-4	H-3	3C84	4C39.25	10/21	716	-2751858340.	9.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-4	H-3	3C84	4C39.25	10/21	720	-2758428368.	9.
W-4	H-3	3C84	4C39.25	10/21	724	-2764144753.	9.
W-4	H-3	3C84	4C39.25	10/21	732	-2773009837.	9.
W-4	H-3	3C84	4C39.25	10/21	736	-2776155817.	9.
W-4	H-3	3C84	4C39.25	10/21	740	-2778442713.	9.
W-4	H-3	3C84	4C39.25	10/21	744	-2779869832.	9.
W-4	H-3	3C84	4C39.25	10/21	748	-2780436731.	9.
W-4	H-3	3C84	4C39.25	10/21	752	-2780143245.	9.
W-4	H-3	3C84	4C39.25	10/21	756	-2778989452.	9.
W-4	H-3	3C84	4C39.25	10/21	8 0	-2776975705.	9.
W-4	H-3	3C84	4C39.25	10/21	8 4	-2774102634.	9.
W-4	H-3	3C84	4C39.25	10/21	812	-2765782262.	9.
W-4	H-3	3C84	4C39.25	10/21	816	-2760337534.	9.
W-4	H-3	3C84	4C39.25	10/21	820	-2754038564.	9.
W-4	H-3	3C84	4C39.25	10/21	824	-2746887284.	9.
W-4	H-3	3C84	4C39.25	10/21	828	-2738885866.	9.
W-4	H-3	3C84	4C39.25	10/21	836	-2720342763.	9.
W-4	H-3	3C84	4C39.25	10/21	840	-2709806736.	9.
W-4	H-3	3C84	4C39.25	10/21	844	-2698431961.	9.
W-4	H-3	3C84	4C39.25	10/21	852	-2673180303.	9.
W-4	H-3	3C84	4C39.25	10/21	856	-2659311153.	9.
W-4	H-3	3C84	4C39.25	10/21	9 0	-2644618704.	9.
W-4	H-3	3C84	4C39.25	10/21	9 4	-2629107476.	9.
W-4	H-3	3C84	4C39.25	10/21	9 8	-2612782188.	9.
W-4	H-3	3C84	4C39.25	10/21	912	-2595647860.	9.
W-4	H-3	3C84	4C39.25	10/21	916	-2577709726.	9.
W-4	H-3	3C84	4C39.25	10/21	924	-2539444287.	9.
W-4	H-3	3C84	4C39.25	10/21	928	-2519128704.	9.
W-4	H-3	3C84	4C39.25	10/21	932	-2498032751.	9.
W-4	H-3	3C84	4C39.25	10/21	936	-2476162907.	9.
W-4	H-3	3C84	4C39.25	10/21	940	-2453525848.	9.
W-4	H-3	3C84	4C39.25	10/21	944	-2430128553.	9.
W-4	H-3	3C84	4C39.25	10/21	948	-2405978101.	9.
W-4	H-3	3C84	4C39.25	10/21	952	-2381081952.	9.
W-4	H-3	3C84	4C39.25	10/21	956	-2355447714.	9.
W-4	H-3	3C84	4C39.25	10/21	10 0	-2329083278.	9.
W-4	H-3	3C84	4C39.25	10/21	10 8	-2274196218.	9.
W-4	H-3	3C84	4C39.25	10/21	1016	-2216487970.	9.
W-4	H-3	3C84	4C39.25	10/21	1020	-2186597854.	9.
W-4	H-3	3C84	4C39.25	10/21	1028	-2124791483.	9.
W-4	H-3	3C84	4C39.25	10/21	1032	-2092894131.	9.
W-4	H-3	3C84	4C39.25	10/21	1036	-2060346970.	9.
W-4	H-3	3C84	4C39.25	10/21	1040	-2027159947.	9.
W-4	H-3	3C84	4C39.25	10/21	1044	-1993343246.	9.
W-4	H-3	3C84	4C39.25	10/21	1052	-1923862407.	9.
W-4	H-3	3C84	4C39.25	10/21	1056	-1888219541.	9.
W-4	H-3	3C84	4C39.25	10/21	11 0	-1851989564.	9.
W-4	H-3	3C84	4C39.25	10/21	11 4	-1815183554.	9.
W-4	H-3	3C84	4C39.25	10/21	11 8	-1777812763.	9.
W-4	H-3	3C84	4C39.25	10/21	1112	-1739888665.	9.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-4	H-3	3C84	4C39.25	10/21	1116	-1701422883.	9.
W-4	H-3	3C84	4C39.25	10/21	1120	-1662427178.	9.
W-4	H-3	3C84	4C39.25	10/21	1124	-1622913492.	9.
W-4	H-3	3C84	4C39.25	10/21	1128	-1582893941.	9.
W-4	H-3	3C84	4C39.25	10/21	1132	-1542380776.	9.
W-4	H-3	3C84	4C39.25	10/21	1136	-1501386403.	9.
W-4	H-3	3C84	4C39.25	10/21	1140	-1459923391.	9.
W-4	H-3	3C84	4C39.25	10/21	1144	-1418004427.	9.
W-4	H-3	3C84	4C39.25	10/21	1148	-1375642361.	9.
W-4	H-3	3C84	4C39.25	10/21	1152	-1332850151.	9.
W-4	H-3	3C84	4C39.25	10/21	1156	-1289640913.	9.
W-4	H-3	2134+00	3C345	10/21	2132	1767671134.	26.
W-4	H-3	2134+00	3C345	10/21	2136	1747952132.	26.
W-4	H-3	2134+00	3C345	10/21	2144	1706225861.	26.
W-4	H-3	2134+00	3C345	10/21	2148	1684231312.	26.
W-4	H-3	2134+00	3C345	10/21	2152	1661491434.	26.
W-4	H-3	2134+00	3C345	10/21	2156	1638013142.	26.
W-4	H-3	2134+00	3C345	10/21	22 0	1613803666.	26.
W-4	H-3	2134+00	3C345	10/21	22 4	1588870404.	26.
W-4	H-3	2134+00	3C345	10/21	22 8	1563221041.	26.
W-4	H-3	2134+00	3C345	10/21	2216	1509805453.	26.
W-4	H-3	2134+00	3C345	10/21	2220	1482055678.	26.
W-4	H-3	2134+00	3C345	10/21	2224	1453622452.	26.
W-4	H-3	2134+00	3C345	10/21	2228	1424514504.	26.
W-4	H-3	2134+00	3C345	10/21	2232	1394740747.	26.
W-4	H-3	2134+00	3C345	10/21	2236	1364310299.	26.
W-4	H-3	2134+00	3C345	10/21	2240	1333232477.	26.
W-4	H-3	2134+00	3C345	10/21	23 8	1098385330.	26.
W-4	H-3	2134+00	3C345	10/21	2312	1062487327.	26.
W-4	H-3	2134+00	3C345	10/21	2316	1026034345.	26.
W-4	H-3	2134+00	3C345	10/21	2320	989037626.	26.
W-4	H-3	2134+00	3C345	10/21	2324	9515 8458.	26.
W-4	H-3	2134+00	3C345	10/21	2328	913458369.	26.
W-4	H-3	2134+00	3C345	10/21	2332	874898977.	26.
W-4	H-3	2134+00	3C345	10/21	2336	835842156.	26.
W-4	H-3	3C273	3C345	10/21	1424	-2661520409.	20.
W-4	H-3	3C273	3C345	10/21	1428	-2686932870.	20.
W-4	H-3	3C273	3C345	10/21	1432	-2711741592.	20.
W-4	H-3	3C273	3C345	10/21	1436	-2735938974.	20.
W-4	H-3	3C273	3C345	10/21	1440	-2759517597.	20.
W-4	H-3	3C273	3C345	10/21	1444	-2782470298.	20.
W-4	H-3	3C273	3C345	10/21	1448	-2804790016.	20.
W-4	H-3	3C273	3C345	10/21	1452	-2826469884.	20.
W-4	H-3	3C273	3C345	10/21	1456	-2847503341.	20.
W-4	H-3	3C273	3C345	10/21	15 0	-2867883856.	20.
W-4	H-3	3C273	3C345	10/21	15 4	-2887605234.	20.
W-4	H-3	3C273	3C345	10/21	15 8	-2906661441.	20.
W-4	H-3	3C273	3C345	10/21	1516	-2942755122.	20.
W-4	H-3	3C273	3C345	10/21	1520	-2959781536.	20.
W-4	H-3	3C273	3C345	10/21	1524	-2976120669.	20.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-4	H-3	3C273	3C345	10/21	1528	-2991767483.	20.
W-4	H-3	3C273	3C345	10/21	1532	-3006717211.	20.
W-4	H-3	3C273	3C345	10/21	1536	-3020965286.	20.
W-4	H-3	3C273	3C345	10/21	1540	-3034507305.	20.
W-4	H-3	3C273	3C345	10/21	1544	-3047339142.	20.
W-4	H-3	3C273	3C345	10/21	1548	-3059456895.	20.
W-4	H-3	3C273	3C345	10/21	1552	-3070856820.	20.
W-4	H-3	3C273	3C345	10/21	1556	-3081535414.	20.
W-4	H-3	3C273	3C345	10/21	16 4	-3100715760.	20.
W-4	H-3	3C273	3C345	10/21	16 8	-3109211666.	20.
W-4	H-3	3C273	3C345	10/21	1612	-3116974519.	20.
W-4	H-3	3C273	3C345	10/21	1620	-3130291726.	20.
W-4	H-3	3C273	3C345	10/21	1624	-3135842018.	20.
W-4	H-3	3C273	3C345	10/21	1628	-3140651080.	20.
W-4	H-3	3C273	3C345	10/21	1632	-3144717475.	20.
W-4	H-3	3C273	3C345	10/21	1640	-3150617353.	20.
W-4	H-3	3C273	3C345	10/21	1644	-3152449085.	20.
W-4	H-3	3C273	3C345	10/21	1648	-3153534508.	20.
W-4	H-3	3C273	3C345	10/21	1652	-3153873289.	20.
W-4	H-3	3C273	3C345	10/21	1656	-3153465313.	20.
W-4	H-3	3C273	3C345	10/21	17 0	-3152310738.	20.
W-4	H-3	3C273	3C345	10/21	17 4	-3150409888.	20.
W-4	H-3	3C273	3C345	10/21	17 8	-3147763342.	20.
W-4	H-3	3C273	3C345	10/21	1712	-3144371945.	20.
W-4	H-3	3C273	3C345	10/21	1716	-3140236715.	20.
W-4	H-3	3C273	3C345	10/21	1720	-3135358897.	20.
W-4	H-3	3C273	3C345	10/21	1724	-3129740019.	20.
W-4	H-3	3C273	3C345	10/21	1728	-3123381801.	20.
W-4	H-3	3C273	3C345	10/21	1732	-3116286172.	20.
W-4	H-3	3C273	3C345	10/21	1736	-3108455321.	20.
W-4	H-3	3C273	3C345	10/21	1740	-3099891599.	20.
W-4	H-3	3C273	3C345	10/21	1744	-3090597715.	20.
W-4	H-3	3C273	3C345	10/21	1748	-3080576435.	20.
W-4	H-3	3C273	3C345	10/21	1752	-3069830874.	20.
W-4	H-3	3C273	3C345	10/21	1756	-3058364292.	20.
W-4	H-3	3C273	3C345	10/21	18 0	-3046180236.	20.
W-4	H-3	3C273	3C345	10/21	18 4	-3033282404.	20.
W-4	H-3	3C273	3C345	10/21	18 8	-3019674771.	20.
W-4	H-3	3C273	3C345	10/21	1812	-3005361501.	20.
W-4	H-3	3C273	3C345	10/21	1816	-2990346980.	20.
W-4	H-3	3C273	3C345	10/21	1820	-2974635792.	20.
W-4	H-3	3C273	3C345	10/21	1824	-2958232771.	20.
W-4	H-3	3C273	3C345	10/21	1828	-2941142950.	20.
W-4	H-3	3C273	3C345	10/21	1836	-2904923929.	20.
W-4	H-3	3C273	3C345	10/21	1840	-2885805869.	20.
W-4	H-3	3C273	3C345	10/21	1844	-2866023174.	20.
W-4	H-3	3C273	3C345	10/21	1848	-2845581917.	20.
W-4	H-3	3C273	3C345	10/21	1852	-2824488328.	20.
W-4	H-3	3C273	3C345	10/21	1856	-2802748916.	20.
W-4	H-3	3C273	3C345	10/21	19 0	-2780370296.	20.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-4	H-3	3C273	3C345	10/21	19 8	-2733723096.	20.
W-4	H-3	3C273	3C345	10/21	1916	-2684603911.	20.
W-4	H-3	3C273	3C345	10/21	1920	-2659135987.	20.
W-4	H-3	3C273	3C345	10/21	1924	-2633072882.	20.
W-4	H-3	3C273	3C345	10/21	1928	-2606422558.	20.
W-4	H-3	3C273	3C345	10/21	1932	-2579193225.	20.
W-4	H-3	3C273	3C345	10/21	1936	-2551393190.	20.
W-4	H-3	3C273	3C345	10/21	1940	-2523030957.	20.
W-4	H-3	3C273	3C345	10/21	1944	-2494115235.	20.
W-4	H-3	3C273	3C345	10/21	1948	-2464654938.	20.
W-4	H-3	3C273	3C345	10/21	1952	-2434659029.	20.
W-4	H-3	3C273	3C345	10/21	1956	-2404136677.	20.
W-4	H-3	3C273	3C345	10/21	20 0	-2373097320.	20.
W-4	H-3	3C273	3C345	10/21	20 8	-2309505708.	20.
W-4	H-3	3C273	3C345	10/21	2012	-2276972994.	20.
W-4	H-3	3C273	3C345	10/21	2016	-2243962245.	20.
H-3	W-4	2134+00	3C454.3	10/21	444	-627214422.	13.
H-3	W-4	2134+00	3C454.3	10/21	448	-613332906.	13.
H-3	W-4	2134+00	3C454.3	10/21	452	-599357752.	13.
H-3	W-4	2134+00	3C454.3	10/21	456	-585293278.	13.
H-3	W-4	2134+00	3C454.3	10/21	5 0	-571143773.	13.
H-3	W-4	2134+00	3C454.3	10/21	5 4	-556913617.	13.
H-3	W-4	2134+00	3C454.3	10/21	512	-528228788.	13.
H-3	W-4	2134+00	3C454.3	10/21	516	-513782959.	13.
H-3	W-4	2134+00	3C454.3	10/21	520	-499274115.	13.
H-3	W-4	2134+00	3C454.3	10/21	524	-484706729.	13.
H-3	W-4	2134+00	3C454.3	10/21	528	-470085280.	13.
H-3	W-4	2134+00	3C454.3	10/21	532	-455414321.	13.
H-3	W-4	2134+00	3C454.3	10/21	536	-440698380.	13.
H-3	W-4	2134+00	3C454.3	10/21	540	-425942080.	13.
H-3	W-4	2134+00	3C454.3	10/21	544	-411150062.	13.
H-3	W-4	2134+00	3C454.3	10/21	548	-396327006.	13.
H-3	W-4	2134+00	3C454.3	10/21	552	-381477638.	13.
H-3	W-4	2134+00	3C454.3	10/21	556	-366606887.	13.
H-3	W-4	2134+00	3C454.3	10/21	6 0	-351719677.	13.
W-4	H-3	3C273	4C39.25	10/16	1156	1132693024.	30.
W-4	H-3	3C273	4C39.25	10/16	12 4	1126998234.	30.
W-4	H-3	3C273	4C39.25	10/16	12 8	1123308942.	30.
W-4	H-3	3C273	4C39.25	10/16	1216	1114252096.	30.
W-4	H-3	3C273	4C39.25	10/16	1220	1108887397.	30.
W-4	H-3	3C273	4C39.25	10/16	13 8	1001827638.	30.
W-4	H-3	3C273	4C39.25	10/16	1316	976517406.	30.
W-4	H-3	3C273	4C39.25	10/16	1328	934701193.	30.
W-4	H-3	3C273	4C39.25	10/16	1332	919752506.	30.
W-4	H-3	3C273	4C39.25	10/16	1336	904306286.	30.
W-4	H-3	3C273	4C39.25	10/16	1340	888367331.	30.
W-4	H-3	3C273	4C39.25	10/16	1344	871940496.	30.
W-4	H-3	3C273	4C39.25	10/16	1348	855030795.	30.
W-4	H-3	3C273	4C39.25	10/16	1352	837643417.	30.
W-4	H-3	3C273	4C39.25	10/16	1356	819783702.	30.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-4	H-3	3C273	4C39.25	10/16	14 0	801457098.	30.
W-4	H-3	3C273	4C39.25	10/16	14 4	782669268.	30.
W-4	H-3	3C273	4C39.25	10/16	14 8	763425936.	30.
W-4	H-3	3C273	4C39.25	10/16	1412	743732968.	30.
W-4	H-3	3C273	4C39.25	10/16	1416	723596409.	30.
W-4	H-3	3C273	4C39.25	10/16	1420	703022462.	30.
W-4	H-3	3C273	4C39.25	10/16	1424	682017391.	30.
W-4	H-3	3C273	4C39.25	10/16	1428	660587635.	30.
W-4	H-3	3C273	4C39.25	10/16	1432	638739759.	30.
W-4	H-3	3C273	4C39.25	10/16	1436	616480461.	30.
W-4	H-3	3C273	4C39.25	10/16	1440	593816578.	30.
W-4	H-3	3C273	4C39.25	10/16	1444	570755026.	30.
W-4	H-3	3C273	4C39.25	10/16	1448	547302859.	30.
W-4	H-3	3C273	4C39.25	10/16	1452	523467301.	30.
W-4	H-3	3C273	4C39.25	10/16	1456	499255590.	30.
W-4	H-3	3C273	4C39.25	10/16	15 0	474675194.	30.
W-4	H-3	3C273	4C39.25	10/16	15 4	449733628.	30.
W-4	H-3	3C273	4C39.25	10/16	15 8	424438492.	30.
W-4	H-3	3C273	4C39.25	10/16	1512	398797567.	30.
W-4	H-3	3C273	4C39.25	10/16	1516	372818734.	30.
W-4	H-3	3C273	4C39.25	10/16	1520	346509917.	30.
W-4	H-3	3C273	4C39.25	10/16	1524	319879150.	30.
W-4	H-3	3C273	4C39.25	10/16	1528	292934668.	30.
W-4	H-3	3C273	4C39.25	10/16	1532	265684633.	30.
W-4	H-3	3C273	4C39.25	10/16	1536	238137440.	30.
W-4	H-3	3C273	4C39.25	10/16	1540	210301511.	30.
W-4	H-3	3C273	4C39.25	10/16	1544	182185389.	30.
W-4	H-3	3C273	4C39.25	10/16	1548	153797663.	30.
W-4	H-3	3C273	4C39.25	10/16	1552	125147037.	30.
W-4	H-3	3C273	4C39.25	10/16	1556	96242305.	30.
W-4	H-3	3C273	4C39.25	10/16	16 0	67092271.	30.
W-4	H-3	3C273	4C39.25	10/16	16 4	37705932.	30.
W-4	H-3	3C273	4C39.25	10/16	16 8	8092254.	30.
W-4	H-3	3C273	4C39.25	10/16	1612	-21739723.	30.
W-4	H-3	3C273	4C39.25	10/16	1616	-51780818.	30.
W-4	H-3	3C273	4C39.25	10/16	1620	-82021833.	30.
W-4	H-3	3C273	4C39.25	10/16	1624	-112453551.	30.
W-4	H-3	3C273	4C39.25	10/16	1628	-143066577.	30.
W-4	H-3	3C273	4C39.25	10/16	1632	-173851596.	30.
W-4	H-3	3C273	4C39.25	10/16	1636	-204799192.	30.
W-4	H-3	3C273	4C39.25	10/16	1640	-235899787.	30.
W-4	H-3	3C273	4C39.25	10/16	1644	-267143997.	30.
W-4	H-3	3C273	4C39.25	10/16	1648	-298522158.	30.
W-4	H-3	3C273	4C39.25	10/16	1656	-361641880.	30.
W-4	H-3	3C273	4C39.25	10/16	17 0	-393364151.	30.
W-4	H-3	3C273	4C39.25	10/16	17 8	-457084848.	30.
W-4	H-3	3C273	4C39.25	10/16	1712	-489063790.	30.
W-4	H-3	3C273	4C39.25	10/16	1716	-521108699.	30.
W-4	H-3	3C273	4C39.25	10/16	1720	-553209834.	30.
W-4	H-3	3C273	4C39.25	10/16	1724	-585357312.	30.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-4	H-3	3C273	4C39.25	10/16	1728	-617541312.	30.
W-4	H-3	3C273	4C39.25	10/16	1732	-649751959.	30.
W-4	H-3	3C273	4C39.25	10/16	1736	-681979384.	30.
W-4	H-3	3C273	4C39.25	10/16	1740	-714213725.	30.
W-4	H-3	3C273	4C39.25	10/16	1744	-746445119.	30.
W-4	H-3	3C273	4C39.25	10/16	1748	-778663653.	30.
W-4	H-3	3C273	4C39.25	10/16	1752	-810859500.	30.
W-4	H-3	3C273	4C39.25	10/16	18 0	-875143696.	30.
W-4	H-3	3C273	4C39.25	10/16	18 8	-939218944.	30.
W-4	H-3	3C273	4C39.25	10/16	1816	-1003006731.	30.
W-4	H-3	3C273	4C39.25	10/16	1820	-1034768401.	30.
W-4	H-3	3C273	4C39.25	10/16	1824	-1066428917.	30.
W-4	H-3	3C273	4C39.25	10/16	1828	-1097978608.	30.
W-4	H-3	3C273	4C39.25	10/16	1832	-1129407808.	30.
W-4	H-3	3C273	4C39.25	10/16	1836	-1160706903.	30.
W-4	H-3	3C273	4C39.25	10/16	1840	-1191866263.	30.
W-4	H-3	3C273	4C39.25	10/16	1844	-1222876383.	30.
W-4	H-3	3C273	4C39.25	10/16	1848	-1253727736.	30.
W-4	H-3	3C273	4C39.25	10/16	1852	-1284410891.	30.
W-4	H-3	3C273	4C39.25	10/15	1144	1137337951.	18.
W-4	H-3	3C273	4C39.25	10/15	1148	1137015558.	18.
W-4	H-3	3C273	4C39.25	10/15	1152	1136129142.	18.
W-4	H-3	3C273	4C39.25	10/15	1156	1134679044.	18.
W-4	H-3	3C273	4C39.25	10/15	12 4	1130089510.	18.
W-4	H-3	3C273	4C39.25	10/15	12 8	1126951491.	18.
W-4	H-3	3C273	4C39.25	10/15	1212	1123252550.	18.
W-4	H-3	3C273	4C39.25	10/15	1216	1118993808.	18.
W-4	H-3	3C273	4C39.25	10/15	1220	1114176588.	18.
W-4	H-3	3C273	4C39.25	10/15	1224	1108802296.	18.
W-4	H-3	3C273	4C39.25	10/15	1228	1102872676.	18.
W-4	H-3	3C273	4C39.25	10/15	1232	1096389452.	18.
W-4	H-3	3C273	4C39.25	10/15	1236	1089354649.	18.
W-4	H-3	3C273	4C39.25	10/15	1240	1081770468.	18.
W-4	H-3	3C273	4C39.25	10/15	1244	1073639141.	18.
W-4	H-3	3C273	4C39.25	10/15	1256	1045988212.	18.
W-4	H-3	3C273	4C39.25	10/15	13 0	1035695031.	18.
W-4	H-3	3C273	4C39.25	10/15	13 4	1024868838.	18.
W-4	H-3	3C273	4C39.25	10/15	13 8	1013512970.	18.
W-4	H-3	3C273	4C39.25	10/15	1312	1001630878.	18.
W-4	H-3	3C273	4C39.25	10/15	1316	989226255.	18.
W-4	H-3	3C273	4C39.25	10/15	1320	976302851.	18.
W-4	H-3	3C273	4C39.25	10/15	1324	962864661.	18.
W-4	H-3	3C273	4C39.25	10/15	1328	948915718.	18.
W-4	H-3	3C273	4C39.25	10/15	1332	934460418.	18.
W-4	H-3	3C273	4C39.25	10/15	1336	919503107.	18.
W-4	H-3	3C273	4C39.25	10/15	1340	904048371.	18.
W-4	H-3	3C273	4C39.25	10/15	1344	888100922.	18.
W-4	H-3	3C273	4C39.25	10/15	1348	871665734.	18.
W-4	H-3	3C273	4C39.25	10/15	1352	854747777.	18.
W-4	H-3	3C273	4C39.25	10/15	1356	837352199.	18.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-4	H-3	3C273	4C39.25	10/15	14 0	819484449.	18.
W-4	H-3	3C273	4C39.25	10/15	14 4	801149864.	18.
W-4	H-3	3C273	4C39.25	10/15	14 8	782354128.	18.
W-4	H-3	3C273	4C39.25	10/15	1412	763102968.	18.
W-4	H-3	3C273	4C39.25	10/15	1416	743402308.	18.
W-4	H-3	3C273	4C39.25	10/15	1420	723258175.	18.
W-4	H-3	3C273	4C39.25	10/15	1424	702676726.	18.
W-4	H-3	3C273	4C39.25	10/15	1428	681664305.	18.
W-4	H-3	3C273	4C39.25	10/15	1432	660227288.	18.
W-4	H-3	3C273	4C39.25	10/15	1436	638372258.	18.
W-4	H-3	3C273	4C39.25	10/15	1440	616105935.	18.
W-4	H-3	3C273	4C39.25	10/15	1444	593435136.	18.
W-4	H-3	3C273	4C39.25	10/15	1448	570366750.	18.
W-4	H-3	3C273	4C39.25	10/15	1452	546907900.	18.
W-4	H-3	3C273	4C39.25	10/15	1456	523065762.	18.
W-4	H-3	3C273	4C39.25	10/15	15 0	498847601.	18.
W-4	H-3	3C273	4C39.25	10/15	15 4	474260927.	18.
W-4	H-3	3C273	4C39.25	10/15	15 8	449313150.	18.
W-4	H-3	3C273	4C39.25	10/15	1512	424012002.	18.
W-4	H-3	3C273	4C39.25	10/15	1516	398365152.	18.
W-4	H-3	3C273	4C39.25	10/15	1520	372380515.	18.
W-4	H-3	3C273	4C39.25	10/15	1524	346066061.	18.
W-4	H-3	3C273	4C39.25	10/15	1528	319429780.	18.
W-4	H-3	3C273	4C39.25	10/15	1532	292479936.	18.
W-4	H-3	3C273	4C39.25	10/15	1536	2652247[illegible].	18.
W-4	H-3	3C273	4C39.25	10/15	1544	209831569.	18.
W-4	H-3	3C273	4C39.25	10/15	1548	181710666.	18.
W-4	H-3	3C273	4C39.25	10/15	1552	153318338.	18.
W-4	H-3	3C273	4C39.25	10/15	1556	124663218.	18.
W-4	H-3	3C273	4C39.25	10/15	16 0	95754141.	18.
W-4	H-3	3C273	4C39.25	10/15	16 4	66599951.	18.
W-4	H-3	3C273	4C39.25	10/15	16 8	37209586.	18.
W-4	H-3	3C273	4C39.25	10/15	1612	7592030.	18.
W-4	H-3	3C273	4C39.25	10/15	1620	-52288306.	18.
W-4	H-3	3C273	4C39.25	10/15	1624	-82532758.	18.
W-4	H-3	3C273	4C39.25	10/15	1628	-112967702.	18.
W-4	H-3	3C273	4C39.25	10/15	1636	-174371783.	18.
W-4	H-3	3C273	4C39.25	10/15	1640	-205322102.	18.
W-4	H-3	3C273	4C39.25	10/15	1644	-236425356.	18.
W-4	H-3	3C273	4C39.25	10/15	1648	-267671976.	18.
W-4	H-3	3C273	4C39.25	10/15	1652	-299052405.	18.
W-4	H-3	3C273	4C39.25	10/15	1656	-330557021.	18.
W-4	H-3	3C273	4C39.25	10/15	17 0	-362176173.	18.
W-4	H-3	3C273	4C39.25	10/15	17 4	-3939[illegible]2[illegible]8.	18.
W-4	H-3	3C273	4C39.25	10/15	17 8	-425719337.	18.
W-4	H-3	3C273	4C39.25	10/15	1712	-457623909.	18.
W-4	H-3	3C273	4C39.25	10/15	1716	-489604117.	18.
W-4	H-3	3C273	4C39.25	10/15	1720	-521650173.	18.
W-4	H-3	3C273	4C39.25	10/15	1724	-553752231.	18.
W-4	H-3	3C273	4C39.25	10/15	1728	-5859[illegible]467.	18.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-4	H-3	3C273	4C39.25	10/15	1732	-618085055.	18.
W-4	H-3	3C273	4C39.25	10/15	1736	-650296148.	18.
W-4	H-3	3C273	4C39.25	10/15	1740	-682523841.	18.
W-4	H-3	3C273	4C39.25	10/15	1744	-714758237.	18.
W-4	H-3	3C273	4C39.25	10/15	1748	-746989557.	18.
W-4	H-3	3C273	4C39.25	10/15	1752	-779207839.	18.
W-4	H-3	3C273	4C39.25	10/15	1756	-811403292.	18.
W-4	H-3	3C273	4C39.25	10/15	18 0	-843565986.	18.
W-4	H-3	3C273	4C39.25	10/15	18 4	-875686165.	18.
W-4	H-3	3C273	4C39.25	10/15	18 8	-907753846.	18.
W-4	H-3	3C273	4C39.25	10/15	1812	-939759313.	18.
W-4	H-3	3C273	4C39.25	10/15	1816	-971692797.	18.
W-4	H-3	3C273	4C39.25	10/15	1820	-1003544414.	18.
W-4	H-3	3C273	4C39.25	10/15	1824	-1035304470.	18.
W-4	H-3	3C273	4C39.25	10/15	1828	-1066963218.	18.
W-4	H-3	3C273	4C39.25	10/15	1832	-1098510938.	18.
W-4	H-3	3C273	4C39.25	10/15	1836	-1129938024.	18.
W-4	H-3	3C273	4C39.25	10/15	1840	-1161234651.	18.
W-4	H-3	3C273	4C39.25	10/15	1844	-1192391801.	18.
W-4	H-3	3C273	4C39.25	10/15	1848	-1223399309.	18.
W-4	H-3	3C273	4C39.25	10/15	1852	-1254247927.	18.
W-4	H-3	4C39.25	3C84	10/ 8	8 0	2726118260.	20.
W-4	H-3	4C39.25	3C84	10/ 8	8 4	2734243217.	20.
W-4	H-3	4C39.25	3C84	10/ 8	8 8	2741517807.	20.
W-4	H-3	4C39.25	3C84	10/ 8	812	2747939786.	20.
W-4	H-3	4C39.25	3C84	10/ 8	816	2753507196.	20.
W-4	H-3	4C39.25	3C84	10/ 8	820	2758218329.	20.
W-4	H-3	4C39.25	3C84	10/ 8	824	2762071709.	20.
W-4	H-3	4C39.25	3C84	10/ 8	832	2767200792.	20.
W-4	H-3	4C39.25	3C84	10/ 8	836	2768474960.	20.
W-4	H-3	4C39.25	3C84	10/ 8	840	2768888261.	20.
W-4	H-3	4C39.25	3C84	10/ 8	844	2768440544.	20.
W-4	H-3	4C39.25	3C84	10/ 8	848	2767131951.	20.
W-4	H-3	4C39.25	3C84	10/ 8	852	2764962926.	20.
W-4	H-3	4C39.25	3C84	10/ 8	856	2761934104.	20.
W-4	H-3	4C39.25	3C84	10/ 8	9 0	2758046385.	20.
W-4	H-3	4C39.25	3C84	10/ 8	9 4	2753300986.	20.
W-4	H-3	4C39.25	3C84	10/ 8	912	2741243258.	20.
W-4	H-3	4C39.25	3C84	10/ 8	916	2733934614.	20.
W-4	H-3	4C39.25	3C84	10/ 8	920	2725775615.	20.
W-4	H-3	4C39.25	3C84	10/ 8	924	2716768889.	20.
W-4	H-3	4C39.25	3C84	10/ 8	928	2706917079.	20.
W-4	H-3	4C39.25	3C84	10/ 8	932	2696223277.	20.
W-4	H-3	4C39.25	3C84	10/ 8	936	2684690694.	20.
W-4	H-3	4C39.25	3C84	10/ 8	940	2672322940.	20.
W-4	H-3	4C39.25	3C84	10/ 8	944	2659123727.	20.
W-4	H-3	4C39.25	3C84	10/ 8	948	2645097123.	20.
W-4	H-3	4C39.25	3C84	10/ 8	952	2630247452.	20.
W-4	H-3	4C39.25	3C84	10/ 8	956	2614579249.	20.
W-4	H-3	4C39.25	3C84	10/ 8	10 0	2598097290.	20.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-4	H-3	4C39.25	3C84	10/ 8	10 4	2580806670.	20.
W-4	H-3	4C39.25	3C84	10/ 8	10 8	2562712617.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1012	2543820700.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1016	2524136695.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1020	2503666679.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1024	2482416892.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1028	2460393830.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1032	2437604286.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1036	2414055169.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1040	2389753746.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1044	2364707418.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1048	2338923852.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1052	2312411029.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1056	2285176982.	20.
W-4	H-3	4C39.25	3C84	10/ 8	11 0	2257230070.	20.
W-4	H-3	4C39.25	3C84	10/ 8	11 4	2228578877.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1112	2169198907.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1116	2138488361.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1120	2107109849.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1124	2075073034.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1128	2042387670.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1136	1975111786.	20.
W-4	H-3	4C39.25	3C84	10/ 8	1140	1940541782.	20.
W-4	H-3	4C39.25	3C274	10/ 8	1320	-1269114921.	20.
W-4	H-3	4C39.25	3C274	10/ 8	1324	-1260322565.	20.
W-4	H-3	4C39.25	3C274	10/ 8	1328	-1250996657.	20.
W-4	H-3	4C39.25	3C274	10/ 8	1332	-1241139901.	20.
W-4	H-3	4C39.25	3C274	10/ 8	1336	-1230755426.	20.
W-4	H-3	4C39.25	3C274	10/ 8	1340	-1219846313.	20.
W-4	H-3	4C39.25	3C274	10/ 8	1352	-1184005522.	20.
W-4	H-3	4C39.25	3C274	10/ 8	1356	-1171032958.	20.
W-4	H-3	4C39.25	3C274	10/ 8	1452	-938338930.	20.
W-4	H-3	4C39.25	3C274	10/ 8	1456	-918273233.	20.
W-4	H-3	4C39.25	3C274	10/ 8	15 0	-897778616.	20.
W-4	H-3	4C39.25	3C274	10/ 8	15 4	-876861351.	20.
W-4	H-3	4C39.25	3C274	10/ 8	15 8	-855527896.	20.
W-4	H-3	4C39.25	3C345	10/ 8	1524	-3241828777.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1528	-3241633191.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1532	-3240450257.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1536	-3238280237.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1540	-3235123865.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1544	-3230982073.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1548	-3225856112.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1552	-3219747660.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1556	-3212658536.	23.
W-4	H-3	4C39.25	3C345	10/ 8	16 0	-3204595796.	23.
W-4	H-3	4C39.25	3C345	10/ 8	16 4	-3195547070.	23.
W-4	H-3	4C39.25	3C345	10/ 8	16 8	-3185530031.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1612	-3174542791.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1616	-3162588664.	23.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-4	H-3	4C39.25	3C345	10/ 8	1620	-3149671344.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1624	-3135794839.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1632	-3105181350.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1636	-3088453784.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1640	-3070785700.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1644	-3052182571.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1648	-3032650038.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1652	-3012194127.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1656	-2990821103.	23.
W-4	H-3	4C39.25	3C345	10/ 8	17 0	-2968537496.	23.
W-4	H-3	4C39.25	3C345	10/ 8	17 4	-2945350083.	23.
W-4	H-3	4C39.25	3C345	10/ 8	17 8	-2921266060.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1712	-2896292711.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1716	-2870437746.	23.
W-4	H-3	4C39.25	3C345	10/ 8	1720	-2843709086.	23.
W-4	H-3	4C39.25	3C84	10/ 7	8 4	2726270332.	20.
W-4	H-3	4C39.25	3C84	10/ 7	812	2741640734.	20.
W-4	H-3	4C39.25	3C84	10/ 7	816	2748048073.	20.
W-4	H-3	4C39.25	3C84	10/ 7	820	2753600779.	20.
W-4	H-3	4C39.25	3C84	10/ 7	824	2758297190.	20.
W-4	H-3	4C39.25	3C84	10/ 7	828	2762135847.	20.
W-4	H-3	4C39.25	3C84	10/ 7	832	2765115556.	20.
W-4	H-3	4C39.25	3C84	10/ 7	836	2767235444.	20.
W-4	H-3	4C39.25	3C84	10/ 7	840	2768494849.	20.
W-4	H-3	4C39.25	3C84	10/ 7	844	2768893355.	20.
W-4	H-3	4C39.25	3C84	10/ 7	848	2768430883.	20.
W-4	H-3	4C39.25	3C84	10/ 7	852	2767107556.	20.
W-4	H-3	4C39.25	3C84	10/ 7	856	2764923737.	20.
W-4	H-3	4C39.25	3C84	10/ 7	9 0	2761880160.	20.
W-4	H-3	4C39.25	3C84	10/ 7	9 8	2753217631.	20.
W-4	H-3	4C39.25	3C84	10/ 7	912	2747601395.	20.
W-4	H-3	4C39.25	3C84	10/ 7	920	2733807346.	20.
W-4	H-3	4C39.25	3C84	10/ 7	928	2716612545.	20.
W-4	H-3	4C39.25	3C84	10/ 7	932	2706746297.	20.
W-4	H-3	4C39.25	3C84	10/ 7	936	2696038111.	20.
W-4	H-3	4C39.25	3C84	10/ 7	940	2684491169.	20.
W-4	H-3	4C39.25	3C84	10/ 7	944	2672109064.	20.
W-4	H-3	4C39.25	3C84	10/ 7	948	2658895619.	20.
W-4	H-3	4C39.25	3C84	10/ 7	952	2644854912.	20.
W-4	H-3	4C39.25	3C84	10/ 7	956	2629991130.	20.
W-4	H-3	4C39.25	3C84	10/ 7	10 4	2597813070.	20.
W-4	H-3	4C39.25	3C84	10/ 7	10 8	2580508596.	20.
W-4	H-3	4C39.25	3C84	10/ 7	1012	2562400853.	20.
W-4	H-3	4C39.25	3C84	10/ 7	1016	2543495316.	20.
W-4	H-3	4C39.25	3C84	10/ 7	1020	2523797805.	20.
W-4	H-3	4C39.25	3C84	10/ 7	1024	2503314363.	20.
W-4	H-3	4C39.25	3C84	10/ 7	1028	2482051243.	20.
W-4	H-3	4C39.25	3C84	10/ 7	1032	2460015044.	20.
W-4	H-3	4C39.25	3C84	10/ 7	1036	2437212329.	20.
W-4	H-3	4C39.25	3C84	10/ 7	1040	2413650297.	20.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-4	H-3	4C39.25	3C84	10/ 7	1048	2364276999.	20.
H-2	W-3	3C345	4C39.25	1/26	8 8	3251500079.	8.
H-2	W-3	3C345	4C39.25	1/26	812	3252880340.	8.
H-2	W-3	3C345	4C39.25	1/26	816	3253272696.	8.
H-2	W-3	3C345	4C39.25	1/26	820	3252677064.	8.
H-2	W-3	3C345	4C39.25	1/26	824	3251093604.	8.
H-2	W-3	3C345	4C39.25	1/26	832	3244965492.	8.
H-2	W-3	3C345	4C39.25	1/26	840	3234895805.	8.
H-2	W-3	3C345	4C39.25	1/26	844	3228386558.	8.
H-2	W-3	3C345	4C39.25	1/26	848	3220896941.	8.
H-2	W-3	3C345	4C39.25	1/26	852	3212429197.	8.
H-2	W-3	3C345	4C39.25	1/26	856	3202985976.	8.
H-2	W-3	3C345	4C39.25	1/26	9 0	3192570153.	8.
H-2	W-3	3C345	4C39.25	1/26	9 4	3181184905.	8.
H-2	W-3	3C345	4C39.25	1/26	912	3155520418.	8.
H-2	W-3	3C345	4C39.25	1/26	916	3141249016.	8.
H-2	W-3	3C345	4C39.25	1/26	920	3126023917.	8.
H-2	W-3	3C345	4C39.25	1/26	928	3092731576.	8.
H-2	W-3	3C345	4C39.25	1/26	936	3055684178.	8.
H-2	W-3	3C345	4C39.25	1/26	944	3014927090.	8.
H-2	W-3	3C345	4C39.25	1/26	952	2970510240.	8.
H-2	W-3	3C345	4C39.25	1/26	10 0	2922488062.	8.
H-2	W-3	3C345	4C39.25	1/26	10 8	2870919352.	8.
H-2	W-3	3C345	4C39.25	1/26	1016	2815867278.	8.
W-3	H-2	3C454.3	3C345	1/26	1436	2779773818.	20.
W-3	H-2	3C454.3	3C345	1/26	1444	2776469896.	20.
W-3	H-2	3C454.3	3C345	1/26	1448	2773336975.	20.
W-3	H-2	3C454.3	3C345	1/26	1452	2769217948.	20.
W-3	H-2	3C454.3	3C345	1/26	15 0	2758026841.	20.
W-3	H-2	3C454.3	3C345	1/26	15 4	2750958204.	20.
W-3	H-2	3C454.3	3C345	1/26	15 8	2742910296.	20.
W-3	H-2	3C454.3	3C345	1/26	1512	2733885617.	20.
W-3	H-2	3C454.3	3C345	1/26	1520	2712917099.	20.
W-3	H-2	3C454.3	3C345	1/26	1524	2700979734.	20.
W-3	H-2	3C454.3	3C345	1/26	1528	2688078420.	20.
W-3	H-2	3C454.3	3C345	1/26	1544	2626916686.	20.
W-3	H-2	3C454.3	3C345	1/26	1548	2609260581.	20.
W-3	H-2	3C454.3	3C345	1/26	1556	2571146418.	20.
W-3	H-2	3C454.3	3C345	1/26	16 4	2529335643.	20.
W-3	H-2	3C273	4C39.25	1/27	420	1101762447.	14.
W-3	H-2	3C273	4C39.25	1/27	424	1106826040.	14.
W-3	H-2	3C273	4C39.25	1/27	428	1111332002.	14.
W-3	H-2	3C273	4C39.25	1/27	432	1115278959.	14.
W-3	H-2	3C273	4C39.25	1/27	448	1125454485.	14.
W-3	H-2	3C273	4C39.25	1/27	452	1126591335.	14.
W-3	H-2	3C273	4C39.25	1/27	456	1127164449.	14.
W-3	H-2	3C273	4C39.25	1/27	5 0	1127173588.	14.
W-3	H-2	3C273	4C39.25	1/27	5 4	1126618768.	14.
W-3	H-2	3C273	4C39.25	1/27	5 8	1125500160.	14.
W-3	H-2	3C273	4C39.25	1/27	512	1123818091.	14.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-3	H-2	3C273	4C39.25	1/27	516	1121573067.	14.
W-3	H-2	3C273	4C39.25	1/27	520	1118765789.	14.
W-3	H-2	3C273	4C39.25	1/27	524	1115397120.	14.
W-3	H-2	3C273	4C39.25	1/27	528	1111468089.	14.
W-3	H-2	3C273	4C39.25	1/27	532	1106979867.	14.
W-3	H-2	3C273	4C39.25	1/27	536	1101933854.	14.
W-3	H-2	3C273	4C39.25	1/27	540	1096331592.	14.
W-3	H-2	3C273	4C39.25	1/27	548	1083465333.	14.
W-3	H-2	3C273	4C39.25	1/27	552	1076205288.	14.
W-3	H-2	3C273	4C39.25	1/27	556	1068396843.	14.
W-3	H-2	3C273	4C39.25	1/27	6 0	1060042455.	14.
W-3	H-2	3C273	4C39.25	1/27	6 4	1051144598.	14.
W-3	H-2	3C273	4C39.25	1/27	6 8	1041706063.	14.
W-3	H-2	3C273	4C39.25	1/27	612	1031729682.	14.
W-3	H-2	3C273	4C39.25	1/27	616	1021218577.	14.
W-3	H-2	3C273	4C39.25	1/27	620	1010175916.	14.
W-3	H-2	3C273	4C39.25	1/27	628	986509667.	14.
W-3	H-2	3C273	4C39.25	1/27	632	973893360.	14.
W-3	H-2	3C273	4C39.25	1/27	636	960759988.	14.
W-3	H-2	3C273	4C39.25	1/27	640	947113586.	14.
W-3	H-2	3C273	4C39.25	1/27	644	932958338.	14.
W-3	H-2	3C273	4C39.25	1/27	648	918298607.	14.
W-3	H-2	3C273	4C39.25	1/27	652	903138837.	14.
W-3	H-2	3C273	4C39.25	1/27	656	887483689.	14.
W-3	H-2	3C273	4C39.25	1/27	7 0	871337968.	14.
W-3	H-2	3C273	4C39.25	1/27	7 8	837594711.	14.
W-3	H-2	3C273	4C39.25	1/27	712	820007527.	14.
W-3	H-2	3C273	4C39.25	1/27	716	801950397.	14.
W-3	H-2	3C273	4C39.25	1/27	720	783428906.	14.
W-3	H-2	3C273	4C39.25	1/27	724	764448688.	14.
W-3	H-2	3C273	4C39.25	1/27	728	745015585.	14.
W-3	H-2	3C273	4C39.25	1/27	732	725135535.	14.
W-3	H-2	3C273	4C39.25	1/27	740	684059072.	14.
W-3	H-2	3C273	4C39.25	1/27	744	662875250.	14.
W-3	H-2	3C273	4C39.25	1/27	748	641269655.	14.
W-3	H-2	3C273	4C39.25	1/27	752	619248893.	14.
W-3	H-2	3C273	4C39.25	1/27	756	596819652.	14.
W-3	H-2	3C273	4C39.25	1/27	8 4	550763550.	14.
W-3	H-2	3C273	4C39.25	1/27	8 8	527150781.	14.
W-3	H-2	3C273	4C39.25	1/27	812	503157779.	14.
W-3	H-2	3C273	4C39.25	1/27	816	478791913.	14.
W-3	H-2	3C273	4C39.25	1/27	820	454060659.	14.
W-3	H-2	3C273	4C39.25	1/27	824	428971529.	14.
W-3	H-2	3C273	4C39.25	1/27	832	377750582.	14.
W-3	H-2	3C273	4C39.25	1/27	836	351634534.	14.
W-3	H-2	3C273	4C39.25	1/27	840	325191990.	14.
W-3	H-2	3C273	4C39.25	1/27	852	243987042.	14.
W-3	H-2	3C273	4C39.25	1/27	856	216320585.	14.
W-3	H-2	3C273	4C39.25	1/27	920	44639064.	14.
W-3	H-2	3C273	4C39.25	1/27	924	15160141.	14.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-3	H-2	3C273	4C39.25	1/27	932	-44458858.	14.
W-3	H-2	3C273	4C39.25	1/27	936	-74580659.	14.
W-3	H-2	3C273	4C39.25	1/27	940	-104898389.	14.
W-3	H-2	3C273	3C279	1/28	524	-94734839.	18.
W-3	H-2	3C273	3C279	1/28	528	-97811574.	18.
W-3	H-2	3C273	3C279	1/28	532	-100813296.	18.
W-3	H-2	3C273	3C279	1/28	552	-114664461.	18.
W-3	H-2	3C273	3C279	1/28	556	-117197249.	18.
W-3	H-2	3C273	3C279	1/28	6 0	-119649058.	18.
W-3	H-2	3C273	3C279	1/28	6 8	-124306589.	18.
W-3	H-2	3C273	3C279	1/28	612	-126510901.	18.
W-3	H-2	3C273	3C279	1/28	620	-130667236.	18.
W-3	H-2	3C273	3C279	1/28	624	-132617988.	18.
W-3	H-2	3C273	3C279	1/28	628	-134482987.	18.
W-3	H-2	3C273	3C279	1/28	632	-136261673.	18.
W-3	H-2	3C273	3C279	1/28	640	-139557912.	18.
W-3	H-2	3C273	3C279	1/28	644	-141074452.	18.
W-3	H-2	3C273	3C279	1/28	656	-145092266.	18.
W-3	H-2	3C273	3C279	1/28	7 0	-146252916.	18.
W-3	H-2	3C273	3C279	1/28	7 4	-147323626.	18.
W-3	H-2	3C273	3C279	1/28	7 8	-148304067.	18.
W-3	H-2	3C273	3C279	1/28	716	-149993011.	18.
W-3	H-2	3C273	3C279	1/28	720	-150701000.	18.
W-3	H-2	3C273	3C279	1/28	724	-151317667.	18.
W-3	H-2	3C273	3C279	1/28	728	-151842868.	18.
W-3	H-2	3C273	3C279	1/28	732	-152276410.	18.
W-3	H-2	3C273	3C279	1/28	736	-152618172.	18.
W-3	H-2	3C273	3C279	1/28	740	-152868069.	18.
W-3	H-2	3C273	3C279	1/28	744	-153026705.	18.
W-3	H-2	3C273	3C279	1/28	748	-153091906.	18.
W-3	H-2	3C273	3C279	1/28	8 8	-152041637.	18.
W-3	H-2	3C273	3C279	1/28	816	-150978930.	18.
W-3	H-2	3C273	3C279	1/28	824	-149550731.	18.
W-3	H-2	3C273	3C279	1/28	832	-147758730.	18.
W-3	H-2	3C273	3C279	1/28	836	-146727006.	18.
W-3	H-2	3C273	3C279	1/28	840	-145605210.	18.
W-3	H-2	3C273	3C279	1/28	848	-143092759.	18.
W-3	H-2	3C273	3C279	1/28	852	-141702906.	18.
W-3	H-2	3C273	3C279	1/28	856	-140224469.	18.
W-3	H-2	3C273	3C279	1/28	9 4	-137003859.	18.
W-3	H-2	3C273	3C279	1/28	9 8	-135262644.	18.
W-3	H-2	3C273	3C279	1/28	916	-131521053.	18.
W-3	H-2	3C273	3C279	1/28	920	-129521837.	18.
W-3	H-2	3C273	3C279	1/28	924	-127437808.	18.
W-3	H-2	3C273	3C279	1/28	928	-125269608.	18.
W-3	H-2	3C273	3C279	1/28	932	-123017871.	18.
W-3	H-2	3C273	3C279	1/28	936	-120663339.	18.
W-3	H-2	3C273	3C279	1/28	940	-118266733.	18.
W-3	H-2	3C273	3C279	1/28	944	-115768713.	18.
W-3	H-2	3C273	3C279	1/28	952	-110531708.	18.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-3	H-2	3C273	3C279	1/28	956	-107794281.	18.
W-3	H-2	3C273	3C279	1/28	10 0	-104978727.	18.
W-3	H-2	3C273	3C279	1/28	10 4	-102085858.	18.
W-3	H-2	3C273	3C279	1/28	10 8	-99116597.	18.
W-3	H-2	3C273	3C279	1/28	1012	-96071835.	18.
W-3	H-2	3C273	3C279	1/28	1016	-92952528.	18.
W-3	H-2	3C273	3C279	1/28	1020	-89759571.	18.
W-3	H-2	3C273	3C279	1/28	1024	-86494004.	18.
W-3	H-2	3C273	3C279	1/28	1028	-83156799.	18.
W-3	H-2	3C273	3C279	1/28	1032	-79748979.	18.
W-3	H-2	3C273	3C279	1/28	1036	-76271576.	18.
W-3	H-2	3C273	3C279	1/28	1040	-72725712.	18.
W-3	H-2	3C273	3C279	1/28	1044	-69112367.	18.
W-3	H-2	3C273	3C279	1/28	1048	-65432776.	18.
W-3	H-2	3C273	3C279	1/28	1052	-61688008.	18.
W-3	H-2	3C273	3C279	1/28	1056	-57879167.	18.
W-3	H-2	3C273	3C279	1/28	11 4	-50074094.	18.
W-3	H-2	3C273	3C279	1/28	1112	-42027098.	18.
W-3	H-2	3C273	3C279	1/28	1116	-37915976.	18.
W-3	H-2	3C273	3C279	1/28	1120	-33748089.	18.
W-3	H-2	3C273	3C279	1/28	1124	-29524743.	18.
W-3	H-2	3C273	3C279	1/28	1128	-25247193.	18.
W-3	H-2	3C273	3C279	1/28	1136	-16534804.	18.
W-3	H-2	3C273	3C279	1/28	1140	-12102627.	18.
W-3	H-2	3C273	3C279	1/28	1144	-7621600.	18.
W-3	H-2	3C273	3C279	1/28	1148	-3093100.	18.
W-3	H-2	3C273	3C279	1/28	1152	1481489.	18.
W-3	H-2	3C273	3C279	1/28	1156	6100769.	18.
W-3	H-1	3C84	3C454.3	1/29	1816	2379627499.	22.
W-3	H-1	3C84	3C454.3	1/29	1820	2405276884.	22.
W-3	H-1	3C84	3C454.3	1/29	1824	2430323972.	22.
W-3	H-1	3C84	3C454.3	1/29	1828	2454761152.	22.
W-3	H-1	3C84	3C454.3	1/29	1832	2478580904.	22.
W-3	H-1	3C84	3C454.3	1/29	1840	2524339093.	22.
W-3	H-1	3C84	3C454.3	1/29	1844	2546263555.	22.
W-3	H-1	3C84	3C454.3	1/29	1848	2567542540.	22.
W-3	H-1	3C84	3C454.3	1/29	1852	2588169551.	22.
W-3	H-1	3C84	3C454.3	1/29	1856	2608138291.	22.
W-3	H-1	3C84	3C454.3	1/29	19 0	2627442624.	22.
W-3	H-1	3C84	3C454.3	1/29	19 4	2646076635.	22.
W-3	H-1	3C84	3C454.3	1/29	19 8	2664034612.	22.
W-3	H-1	3C84	3C454.3	1/29	1912	2681311054.	22.
W-3	H-1	3C84	3C454.3	1/29	1916	2697900676.	22.
W-3	H-1	3C84	3C454.3	1/29	1920	2713798410.	22.
W-3	H-1	3C84	3C454.3	1/29	1924	2728999368.	22.
W-3	H-1	3C84	3C454.3	1/29	1928	2743498902.	22.
W-3	H-1	3C84	3C454.3	1/29	1932	2757292568.	22.
W-3	H-1	3C84	3C454.3	1/29	1936	2770376151.	22.
W-3	H-1	3C84	3C454.3	1/29	1940	2782745634.	22.
W-3	H-1	3C84	3C454.3	1/29	1944	2794397222.	22.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-3	H-1	3C84	3C454.3	1/29	1948	2805327355.	22.
W-3	H-1	3C84	3C454.3	1/29	1956	2825010077.	22.
W-3	H-1	3C84	3C454.3	1/29	20 0	2833756663.	22.
W-3	H-1	3C84	3C454.3	1/29	20 4	2841769713.	22.
W-3	H-1	3C84	3C454.3	1/29	20 8	2849046817.	22.
W-3	H-1	3C84	3C454.3	1/29	2012	2855585713.	22.
W-3	H-1	3C84	3C454.3	1/29	2016	2861384437.	22.
W-3	H-1	3C84	3C454.3	1/29	2020	2866441158.	22.
W-3	H-1	3C84	3C454.3	1/29	2024	2870754361.	22.
W-3	H-1	3C84	3C454.3	1/29	2028	2874322720.	22.
W-3	H-1	3C84	3C454.3	1/29	2032	2877145137.	22.
W-3	H-1	3C84	3C454.3	1/29	2036	2879220772.	22.
W-3	H-1	3C84	3C454.3	1/29	2040	2880548945.	22.
W-3	H-1	3C84	3C454.3	1/29	2044	2881129294.	22.
W-3	H-1	3C84	3C454.3	1/29	2048	2880961630.	22.
W-3	H-1	3C84	3C454.3	1/29	21 0	2875972157.	22.
W-3	H-1	3C84	3C454.3	1/29	21 4	2872815194.	22.
W-3	H-1	3C84	3C454.3	1/29	2112	2864266053.	22.
W-3	H-1	3C84	3C454.3	1/29	2116	2858876473.	22.
W-3	H-1	3C84	3C454.3	1/29	2120	2852745689.	22.
W-3	H-1	3C84	3C454.3	1/29	2124	2845875595.	22.
W-3	H-1	3C84	3C454.3	1/29	2128	2838268252.	22.
W-3	H-1	3C84	3C454.3	1/29	2132	2829926027.	22.
W-3	H-1	3C84	3C454.3	1/29	2136	2820851466.	22.
W-3	H-1	3C84	3C454.3	1/29	2140	2811047329.	22.
W-3	H-1	3C84	3C454.3	1/29	2148	2789262622.	22.
W-3	H-1	3C84	3C454.3	1/29	2152	2777288733.	22.
W-3	H-1	3C84	3C454.3	1/29	2156	2764598612.	22.
W-3	H-1	3C84	3C454.3	1/29	22 0	2751196150.	22.
W-3	H-1	3C84	3C454.3	1/29	22 4	2737085472.	22.
W-3	H-1	3C84	3C454.3	1/29	22 8	2722270884.	22.
W-3	H-1	3C84	3C454.3	1/29	2212	2706756922.	22.
W-3	H-1	3C84	3C454.3	1/29	2216	2690548363.	22.
W-3	H-1	3C84	3C454.3	1/29	2224	2656067455.	22.
W-3	H-1	3C84	3C454.3	1/29	2228	2637805659.	22.
W-3	H-1	3C84	3C454.3	1/29	2236	2599267399.	22.
W-3	H-1	3C84	3C454.3	1/29	2240	2579002724.	22.
W-3	H-1	3C84	3C454.3	1/29	2244	2558082564.	22.
W-3	H-1	3C84	3C454.3	1/29	2248	2536513327.	22.
W-3	H-1	3C84	3C454.3	1/29	2252	2514301629.	22.
W-3	H-1	3C84	3C454.3	1/29	2256	2491454253.	22.
W-3	H-1	3C84	3C454.3	1/29	23 0	2467978214.	22.
W-3	H-1	3C84	3C454.3	1/29	23 4	2443880701.	22.
W-3	H-1	3C84	3C454.3	1/29	23 8	2419169080.	22.
W-3	H-1	3C84	3C454.3	1/29	2312	2393850931.	22.
W-3	H-1	3C84	3C454.3	1/29	2316	2367934017.	22.
W-3	H-1	3C84	3C454.3	1/29	2320	2341426264.	22.
W-3	H-1	3C84	3C454.3	1/29	2328	2286670878.	22.
W-3	H-1	3C84	3C454.3	1/29	2336	2229651928.	22.
W-3	H-1	3C84	3C454.3	1/29	2344	2170439227.	22.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-3	H-1	3C273	3C345	1/29	752	-2654634168.	17.
W-3	H-1	3C273	3C345	1/29	756	-2680335641.	17.
W-3	H-1	3C273	3C345	1/29	8 0	-2705438018.	17.
W-3	H-1	3C273	3C345	1/29	8 4	-2729933608.	17.
W-3	H-1	3C273	3C345	1/29	8 8	-2753814942.	17.
W-3	H-1	3C273	3C345	1/29	812	-2777074646.	17.
W-3	H-1	3C273	3C345	1/29	816	-2799705629.	17.
W-3	H-1	3C273	3C345	1/29	820	-2821700945.	17.
W-3	H-1	3C273	3C345	1/29	824	-2843053866.	17.
W-3	H-1	3C273	3C345	1/29	828	-2863757876.	17.
W-3	H-1	3C273	3C345	1/29	832	-2883806617.	17.
W-3	H-1	3C273	3C345	1/29	836	-2903193913.	17.
W-3	H-1	3C273	3C345	1/29	844	-2939960724.	17.
W-3	H-1	3C273	3C345	1/29	848	-2957328975.	17.
W-3	H-1	3C273	3C345	1/29	852	-2974013269.	17.
W-3	H-1	3C273	3C345	1/29	856	-2990008527.	17.
W-3	H-1	3C273	3C345	1/29	9 0	-3005309831.	17.
W-3	H-1	3C273	3C345	1/29	9 4	-3019912516.	17.
W-3	H-1	3C273	3C345	1/29	9 8	-3033812079.	17.
W-3	H-1	3C273	3C345	1/29	916	-3059485099.	17.
W-3	H-1	3C273	3C345	1/29	920	-3071253683.	17.
W-3	H-1	3C273	3C345	1/29	924	-3082297446.	17.
W-3	H-1	3C273	3C345	1/29	928	-3092621988.	17.
W-3	H-1	3C273	3C345	1/29	932	-3102221162.	17.
W-3	H-1	3C273	3C345	1/29	936	-3111091990.	17.
W-3	H-1	3C273	3C345	1/29	948	-3133308599.	17.
W-3	H-1	3C273	3C345	1/29	952	-3139241248.	17.
W-3	H-1	3C273	3C345	1/29	10 0	-3148886000.	17.
W-3	H-1	3C273	3C345	1/29	10 4	-3152595169.	17.
W-3	H-1	3C273	3C345	1/29	10 8	-3155560566.	17.
W-3	H-1	3C273	3C345	1/29	1012	-3157781314.	17.
W-3	H-1	3C273	3C345	1/29	1016	-3159256710.	17.
W-3	H-1	3C273	3C345	1/29	1020	-3159986349.	17.
W-3	H-1	3C273	3C345	1/29	1028	-3159207581.	17.
W-3	H-1	3C273	3C345	1/29	1032	-3157699447.	17.
W-3	H-1	3C273	3C345	1/29	1036	-3155445988.	17.
W-3	H-1	3C273	3C345	1/29	1040	-3152447911.	17.
W-3	H-1	3C273	3C345	1/29	1044	-3148706129.	17.
W-3	H-1	3C273	3C345	1/29	1048	-3144221812.	17.
W-3	H-1	3C273	3C345	1/29	1056	-3133031205.	17.
W-3	H-1	3C273	3C345	1/29	11 0	-3126328333.	17.
W-3	H-1	3C273	3C345	1/29	11 4	-3118889798.	17.
W-3	H-1	3C273	3C345	1/29	1112	-3101814937.	17.
W-3	H-1	3C273	3C345	1/29	1116	-3092183870.	17.
W-3	H-1	3C273	3C345	1/29	1120	-3081827561.	17.
W-3	H-1	3C273	3C345	1/29	1124	-3070749172.	17.
W-3	H-1	3C273	3C345	1/29	1128	-3058952107.	17.
W-3	H-1	3C273	3C345	1/29	1132	-3046439985.	17.
W-3	H-1	3C273	3C345	1/29	1136	-3033216618.	17.
W-3	H-1	3C273	3C345	1/29	1140	-3019286083.	17.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-3	H-1	3C273	3C345	1/29	1144	-3004652646.	17.
W-3	H-1	3C273	3C345	1/29	1148	-2989320761.	17.
W-3	H-1	3C273	3C345	1/29	1152	-2973295141.	17.
W-3	H-1	3C273	3C345	1/29	1156	-2956580700.	17.
W-3	H-1	3C273	3C345	1/29	12 0	-2939182529.	17.
W-3	H-1	3C273	3C345	1/29	12 4	-2921106016.	17.
W-3	H-1	3C273	3C345	1/29	12 8	-2902356634.	17.
W-3	H-1	3C273	3C345	1/29	1212	-2882940153.	17.
W-3	H-1	3C273	3C345	1/29	1216	-2862862542.	17.
W-3	H-1	3C273	3C345	1/29	1220	-2842129919.	17.
W-3	H-1	3C273	3C345	1/29	1224	-2820748653.	17.
W-3	H-1	3C273	3C345	1/29	1228	-2798725298.	17.
W-3	H-1	3C273	3C345	1/29	1232	-2776066595.	17.
W-3	H-1	3C273	3C345	1/29	1240	-2728871051.	17.
W-3	H-1	3C273	3C345	1/29	1244	-2704348682.	17.
W-3	H-1	3C273	3C345	1/29	1248	-2679219884.	17.
W-3	H-1	3C273	3C345	1/29	1252	-2653492381.	17.
W-3	H-1	3C273	3C345	1/29	1256	-2627173996.	17.
W-3	H-1	3C273	3C345	1/29	13 0	-2600272830.	17.
W-3	H-1	3C273	3C345	1/29	13 4	-2572797078.	17.
W-3	H-1	3C273	3C345	1/29	13 8	-2544755227.	17.
W-3	H-1	3C273	3C345	1/29	1312	-2516155842.	17.
W-3	H-1	3C273	3C345	1/29	1316	-2487007656.	17.
W-3	H-1	3C273	3C345	1/29	1320	-2457319665.	17.
W-3	H-1	3C273	3C345	1/29	1324	-2427100914.	17.
W-3	H-1	3C273	3C345	1/29	1328	-2396360708.	17.
W-3	H-1	3C273	3C345	1/29	1332	-2365108443.	17.
W-3	H-1	3C273	3C345	1/29	1336	-2333353712.	17.
W-3	H-1	3C273	3C345	1/29	1340	-2301106265.	17.
W-3	H-1	3C273	3C345	1/29	1344	-2268376019.	17.
W-3	H-1	3C273	3C345	1/29	1348	-2235173007.	17.
W-3	H-1	3C273	3C345	1/29	1352	-2201507454.	17.
W-3	H-1	3C273	3C345	1/29	1356	-2167389724.	17.
W-3	H-2	3C84	4C39.25	1/31	016	-2711863209.	20.
W-3	H-2	3C84	4C39.25	1/31	020	-2723049801.	20.
W-3	H-2	3C84	4C39.25	1/31	024	-2733396251.	20.
W-3	H-2	3C84	4C39.25	1/31	028	-2742899398.	20.
W-3	H-2	3C84	4C39.25	1/31	032	-2751556362.	20.
W-3	H-2	3C84	4C39.25	1/31	120	-2788731893.	20.
W-3	H-2	3C84	4C39.25	1/31	128	-2782892747.	20.
W-3	H-2	3C84	4C39.25	1/31	136	-2773620069.	20.
W-3	H-2	3C84	4C39.25	1/31	144	-2760925117.	20.
W-3	H-2	3C84	4C39.25	1/31	148	-2753299029.	20.
W-3	H-2	3C84	4C39.25	1/31	156	-2735501252.	20.
W-3	H-2	3C84	4C39.25	1/31	2 0	-2725334986.	20.
W-3	H-2	3C84	4C39.25	1/31	2 4	-2714327922.	20.
W-3	H-2	3C84	4C39.25	1/31	2 8	-2702483365.	20.
W-3	H-2	3C84	4C39.25	1/31	212	-2689805007.	20.
W-3	H-2	3C84	4C39.25	1/31	216	-2676296692.	20.
W-3	H-2	3C84	4C39.25	1/31	220	-2661962515.	20.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-3	H-2	3C84	4C39.25	1/31	224	-2646806963.	20.
W-3	H-2	3C84	4C39.25	1/31	228	-2630834623.	20.
W-3	H-2	3C84	4C39.25	1/31	232	-2614050365.	20.
W-3	H-2	3C84	4C39.25	1/31	236	-2596459405.	20.
W-3	H-2	3C84	4C39.25	1/31	244	-2558878980.	20.
W-3	H-2	3C84	4C39.25	1/31	248	-2538901950.	20.
W-3	H-2	3C84	4C39.25	1/31	252	-2518139368.	20.
W-3	H-2	3C84	4C39.25	1/31	256	-2496600341.	20.
W-3	H-2	3C84	4C39.25	1/31	300	-2474290518.	20.
W-3	H-2	3C84	4C39.25	1/31	304	-2451216759.	20.
W-3	H-2	3C84	4C39.25	1/31	308	-2427386110.	20.
W-3	H-2	3C84	4C39.25	1/31	312	-2402805893.	20.
W-3	H-2	3C84	4C39.25	1/31	316	-2377483635.	20.
W-3	H-2	3C84	4C39.25	1/31	320	-2351427058.	20.
W-3	H-2	3C84	4C39.25	1/31	324	-2324644192.	20.
W-3	H-2	3C84	4C39.25	1/31	328	-2297143193.	20.
W-3	H-2	3C84	4C39.25	1/31	332	-2268932517.	20.
W-3	H-2	3C84	4C39.25	1/31	352	-2117543661.	20.
W-3	H-2	3C84	4C39.25	1/31	356	-2085263737.	20.
W-3	H-2	3C84	4C39.25	1/31	404	-2018779526.	20.
W-3	H-2	3C84	4C39.25	1/31	420	-1878403028.	20.
W-3	H-2	3C84	4C39.25	1/31	436	-1728727116.	20.
W-3	H-2	3C84	4C39.25	1/31	444	-1650629295.	20.
W-3	H-2	3C84	4C39.25	1/31	452	-1570484963.	20.
W-3	H-2	3C84	4C39.25	1/31	500	-1488392247.	20.
W-3	H-2	3C84	4C39.25	1/31	508	-1404451739.	20.
W-3	H-2	3C84	4C39.25	1/31	516	-1318766277.	20.
W-3	H-2	3C84	4C39.25	1/31	524	-1231440826.	20.
W-3	H-2	3C84	4C39.25	1/31	532	-1142582360.	20.
W-3	H-2	3C84	4C39.25	1/31	540	-1052299721.	20.
W-3	H-2	3C84	4C39.25	1/31	548	-960703515.	20.
W-2	H-3	4C39.25	3C345	2/ 3	732	-3237844750.	25.
W-2	H-3	4C39.25	3C345	2/ 3	736	-3240390438.	25.
W-2	H-3	4C39.25	3C345	2/ 3	740	-3241948903.	25.
W-2	H-3	4C39.25	3C345	2/ 3	748	-3242102454.	25.
W-2	H-3	4C39.25	3C345	2/ 3	752	-3240697563.	25.
W-2	H-3	4C39.25	3C345	2/ 3	756	-3238305281.	25.
W-2	H-3	4C39.25	3C345	2/ 3	800	-3234926430.	25.
W-2	H-3	4C39.25	3C345	2/ 3	808	-3225213323.	25.
W-2	H-3	4C39.25	3C345	2/ 3	812	-3218882125.	25.
W-2	H-3	4C39.25	3C345	2/ 3	816	-3211570195.	25.
W-2	H-3	4C39.25	3C345	2/ 3	820	-3203279855.	25.
W-2	H-3	4C39.25	3C345	2/ 3	828	-3183774451.	25.
W-2	H-3	4C39.25	3C345	2/ 3	832	-3172565333.	25.
W-2	H-3	4C39.25	3C345	2/ 3	836	-3160389696.	25.
W-2	H-3	4C39.25	3C345	2/ 3	840	-3147251333.	25.
W-2	H-3	4C39.25	3C345	2/ 3	844	-3133154258.	25.
W-2	H-3	4C39.25	3C345	2/ 3	848	-3118102769.	25.
W-2	H-3	4C39.25	3C345	2/ 3	852	-3102101513.	25.
W-2	H-3	4C39.25	3C345	2/ 3	856	-3085155386.	25.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-2	H-3	4C39.25	3C345	2/ 3	9 0	-3067269557.	25.
W-2	H-3	4C39.25	3C345	2/ 3	9 8	-3028700982.	25.
W-2	H-3	4C39.25	3C345	2/ 3	912	-3008030051.	25.
W-2	H-3	4C39.25	3C345	2/ 3	916	-2986443052.	25.
W-2	H-3	4C39.25	3C345	2/ 3	920	-2963946580.	25.
W-2	H-3	4C39.25	3C345	2/ 3	924	-2940547528.	25.
W-2	H-3	4C39.25	3C345	2/ 3	932	-2891070658.	25.
W-2	H-3	4C39.25	3C345	2/ 3	936	-2865007977.	25.
W-2	H-3	4C39.25	3C345	2/ 3	940	-2838073018.	25.
W-2	H-3	4C39.25	3C345	2/ 3	948	-2781619578.	25.
W-2	H-3	4C39.25	3C345	2/ 3	952	-2752118329.	25.
W-2	H-3	4C39.25	3C345	2/ 3	956	-2721779430.	25.
W-2	H-3	4C39.25	3C345	2/ 3	10 0	-2690612119.	25.
W-2	H-3	4C39.25	3C345	2/ 3	10 4	-2658625912.	25.
W-2	H-3	4C39.25	3C345	2/ 3	10 8	-2625830677.	25.
W-2	H-3	4C39.25	3C345	2/ 3	1012	-2592236422.	25.
W-2	H-3	4C39.25	3C345	2/ 3	1016	-2557853447.	25.
W-2	H-3	4C39.25	3C345	2/ 3	1020	-2522692242.	25.
W-2	H-3	4C39.25	3C345	2/ 3	1044	-2296002338.	25.
W-2	H-3	4C39.25	3C345	2/ 3	11 4	-2087011716.	25.
W-2	H-3	4C39.25	3C345	2/ 3	11 8	-2044206887.	25.
W-2	H-3	4C39.25	3C345	2/ 3	1112	-1999991187.	25.
W-2	H-3	4C39.25	3C345	2/ 3	1116	-1955168137.	25.
W-2	H-3	4C39.25	3C345	2/ 3	1120	-1909751483.	25.
W-2	H-3	4C39.25	3C345	2/ 3	1124	-1863755147.	25.
W-2	H-3	3C454.3	3C345	2/ 3	1332	2764007757.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1336	2770821653.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1340	2776653309.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1344	2781500933.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1356	2790126123.	20.
W-2	H-3	3C454.3	3C345	2/ 3	14 0	2791025740.	20.
W-2	H-3	3C454.3	3C345	2/ 3	14 4	2790936844.	20.
W-2	H-3	3C454.3	3C345	2/ 3	14 8	2789859517.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1412	2787793952.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1416	2784740904.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1420	2780701251.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1428	2769667453.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1432	2762676652.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1440	2745758022.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1444	2735835333.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1448	2724941008.	20.
W-2	H-3	3C454.3	3C345	2/ 3	15 0	2686463096.	20.
W-2	H-3	3C454.3	3C345	2/ 3	15 4	2671718557.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1512	2639378327.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1516	2621792542.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1520	2603270004.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1524	2583816481.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1528	2563437857.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1536	2519930595.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1540	2496815302.	20.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-2	H-3	3C454.3	3C345	2/ 3	1544	2472801554.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1548	2447896808.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1552	2422108535.	20.
W-2	H-3	3C454.3	3C345	2/ 3	1556	2395444746.	20.
W-3	H-2	3C273	4C39.25	1/30	416	1111077006.	20.
W-3	H-2	3C273	4C39.25	1/30	420	1115083461.	20.
W-3	H-2	3C273	4C39.25	1/30	424	1118498981.	20.
W-3	H-2	3C273	4C39.25	1/30	428	1121353251.	20.
W-3	H-2	3C273	4C39.25	1/30	432	1123645370.	20.
W-3	H-2	3C273	4C39.25	1/30	436	1125374665.	20.
W-3	H-2	3C273	4C39.25	1/30	440	1126540529.	20.
W-3	H-2	3C273	4C39.25	1/30	444	1127142658.	20.
W-3	H-2	3C273	4C39.25	1/30	448	1127180801.	20.
W-3	H-2	3C273	4C39.25	1/30	452	1126654994.	20.
W-3	H-2	3C273	4C39.25	1/30	456	1125565356.	20.
W-3	H-2	3C273	4C39.25	1/30	5 0	1123912264.	20.
W-3	H-2	3C273	4C39.25	1/30	5 4	1121696199.	20.
W-3	H-2	3C273	4C39.25	1/30	5 8	1118917797.	20.
W-3	H-2	3C273	4C39.25	1/30	512	1115577982.	20.
W-3	H-2	3C273	4C39.25	1/30	516	1111677714.	20.
W-3	H-2	3C273	4C39.25	1/30	520	1107218230.	20.
W-3	H-2	3C273	4C39.25	1/30	524	1102200871.	20.
W-3	H-2	3C273	4C39.25	1/30	528	1096627179.	20.
W-3	H-2	3C273	4C39.25	1/30	532	1090498818.	20.
W-3	H-2	3C273	4C39.25	1/30	536	1083817751.	20.
W-3	H-2	3C273	4C39.25	1/30	540	1076585944.	20.
W-3	H-2	3C273	4C39.25	1/30	544	1068805637.	20.
W-3	H-2	3C273	4C39.25	1/30	548	1060479228.	20.
W-3	H-2	3C273	4C39.25	1/30	552	1051609220.	20.
W-3	H-2	3C273	4C39.25	1/30	556	1042198384.	20.
W-3	H-2	3C273	4C39.25	1/30	6 0	1032249584.	20.
W-3	H-2	3C273	4C39.25	1/30	6 4	1021765874.	20.
W-3	H-2	3C273	4C39.25	1/30	6 8	1010750464.	20.
W-3	H-2	3C273	4C39.25	1/30	612	999206715.	20.
W-3	H-2	3C273	4C39.25	1/30	616	987138176.	20.
W-3	H-2	3C273	4C39.25	1/30	620	974548542.	20.
W-3	H-2	3C273	4C39.25	1/30	624	961441626.	20.
W-3	H-2	3C273	4C39.25	1/30	628	947821481.	20.
W-3	H-2	3C273	4C39.25	1/30	632	933692283.	20.
W-3	H-2	3C273	4C39.25	1/30	636	919058352.	20.
W-3	H-2	3C273	4C39.25	1/30	640	903924162.	20.
W-3	H-2	3C273	4C39.25	1/30	644	888294351.	20.
W-3	H-2	3C273	4C39.25	1/30	648	872173703.	20.
W-3	H-2	3C273	4C39.25	1/30	652	855567192.	20.
W-3	H-2	3C273	4C39.25	1/30	656	838479841.	20.
W-3	H-2	3C273	4C39.25	1/30	7 0	820916922.	20.
W-3	H-2	3C273	4C39.25	1/30	7 4	802883807.	20.
W-3	H-2	3C273	4C39.25	1/30	7 8	784386018.	20.
W-3	H-2	3C273	4C39.25	1/30	712	765429221.	20.
W-3	H-2	3C273	4C39.25	1/30	716	746019230.	20.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-3	H-2	3C273	4C39.25	1/30	720	726161978.	20.
W-3	H-2	3C273	4C39.25	1/30	724	705863548.	20.
W-3	H-2	3C273	4C39.25	1/30	728	685130157.	20.
W-3	H-2	3C273	4C39.25	1/30	732	663968179.	20.
W-3	H-2	3C273	4C39.25	1/30	736	642384042.	20.
W-3	H-2	3C273	4C39.25	1/30	740	620384424.	20.
W-3	H-2	3C273	4C39.25	1/30	744	597976024.	20.
W-3	H-2	3C273	4C39.25	1/30	748	575165697.	20.
W-3	H-2	3C273	4C39.25	1/30	752	551963438.	20.
W-3	H-2	3C273	4C39.25	1/30	756	528367370.	20.
W-3	H-2	3C273	4C39.25	1/30	8 0	504393701.	20.
W-3	H-2	3C273	4C39.25	1/30	8 4	480046768.	20.
W-3	H-2	3C273	4C39.25	1/30	8 8	455334039.	20.
W-3	H-2	3C273	4C39.25	1/30	812	430263098.	20.
W-3	H-2	3C273	4C39.25	1/30	816	404841596.	20.
W-3	H-2	3C273	4C39.25	1/30	820	379077338.	20.
W-3	H-2	3C273	4C39.25	1/30	824	352978222.	20.
W-3	H-2	3C273	4C39.25	1/30	828	326552217.	20.
W-3	H-2	3C273	4C39.25	1/30	832	2998 7421.	20.
W-3	H-2	3C273	4C39.25	1/30	836	272752045.	20.
W-3	H-2	3C273	4C39.25	1/30	840	245394360.	20.
W-3	H-2	3C273	4C39.25	1/30	844	217742749.	20.
W-3	H-2	3C273	4C39.25	1/30	848	189805653.	20.
W-3	H-2	3C273	4C39.25	1/30	852	161591702.	20.
W-3	H-2	3C273	4C39.25	1/30	856	133109484.	20.
W-3	H-2	3C273	4C39.25	1/30	9 0	104367690.	20.
W-3	H-2	3C273	4C39.25	1/30	9 4	75375209.	20.
W-3	H-2	3C273	4C39.25	1/30	9 8	46140855.	20.
W-3	H-2	3C273	4C39.25	1/30	912	16673591.	20.
W-3	H-2	3C273	4C39.25	1/30	916	-13017566.	20.
W-3	H-2	3C273	4C39.25	1/30	920	-42923444.	20.
W-3	H-2	3C273	4C39.25	1/30	924	-73034991.	20.
W-3	H-2	3C273	4C39.25	1/30	928	-103342908.	20.
W-3	H-2	3C273	4C39.25	1/30	932	-133837968.	20.
W-3	H-2	3C273	4C39.25	1/3	936	-164510781.	20.
W-3	H-2	3C273	4C39.25	1/30	940	-195351974.	20.
W-3	H-2	3C273	4C39.25	1/30	944	-226352138.	20.
W-3	H-2	3C273	4C39.25	1/30	948	-257501735.	20.
W-3	H-2	3C273	4C39.25	1/30	952	-288791214.	20.
W-3	H-2	3C273	4C39.25	1/30	956	-320211004.	20.
W-3	H-2	3C273	4C39.25	1/30	10 0	-351751503.	20.
W-3	H-2	3C273	4C39.25	1/3	1 8	-415155899.	20.
W-3	H-2	3C273	4C39.25	1/30	1012	-447000377.	20.
W-3	H-2	3C273	4C39.25	1/30	1016	-478926711.	20.
W-3	H-2	3C273	4C39.25	1/30	1 20	-510925136.	20.
W-3	H-2	3C273	4C39.25	1/30	1024	-542985831.	20.
W-3	H-2	3C273	4C39.25	1/30	1028	-575098999.	20.
W-3	H-2	3C273	4C39.25	1/30	1 32	-607254790.	20.
W-3	H-2	3C273	4C39.25	1/30	1 36	-639443363.	20.
W-3	H-2	3C273	4C39.25	1/30	1044	-703879395.	20.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-3	H-2	3C273	4C39.25	1/30	1048	-736107121.	20.
W-3	H-2	3C273	4C39.25	1/30	1052	-768328156.	20.
W-3	H-2	3C273	4C39.25	1/30	1056	-800532648.	20.
W-3	H-2	3C273	4C39.25	1/30	11 0	-832710703.	20.
W-3	H-2	3C273	4C39.25	1/30	11 4	-864852493.	20.
W-3	H-2	3C273	4C39.25	1/30	11 8	-896948165.	20.
W-3	H-2	3C273	4C39.25	1/30	1112	-928987867.	20.
W-3	H-2	3C273	4C39.25	1/30	1116	-960961850.	20.
W-3	H-2	3C273	4C39.25	1/30	1120	-992860242.	20.
W-3	H-2	3C273	4C39.25	1/30	1124	-1024673308.	20.
W-3	H-2	3C273	4C39.25	1/30	1128	-1056391321.	20.
W-3	H-2	3C273	4C39.25	1/30	1132	-1088004565.	20.
W-3	H-2	3C273	4C39.25	1/30	1140	-1150877960.	20.
W-3	H-2	3C273	4C39.25	1/30	1148	-1213216520.	20.
W-3	H-2	3C273	4C39.25	1/30	1156	-1274943869.	20.
W-2	H-3	3C84	3C454.3	2/ 2	18 0	2389586687.	12.
W-2	H-3	3C84	3C454.3	2/ 2	18 4	2415357193.	12.
W-2	H-3	3C84	3C454.3	2/ 2	18 8	2440525412.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1812	2465083664.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1816	2489024409.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1820	2512340324.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1824	2535024254.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1828	2557069258.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1832	2578468641.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1840	2619304280.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1848	2657481226.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1852	2675557908.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1856	2692952644.	12.
W-2	H-3	3C84	3C454.3	2/ 2	19 0	2709660056.	12.
W-2	H-3	3C84	3C454.3	2/ 2	19 4	2725675065.	12.
W-2	H-3	3C84	3C454.3	2/ 2	19 8	2740992762.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1912	2755608459.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1920	2782716129.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1924	2795199795.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1928	2806964864.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1932	2818007706.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1936	2828324942.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1940	2837913439.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1944	2846770237.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1948	2854892619.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1952	2862278122.	12.
W-2	H-3	3C84	3C454.3	2/ 2	1956	2868924446.	12.
W-2	H-3	3C84	3C454.3	2/ 2	20 0	2874829591.	12.
W-2	H-3	3C84	3C454.3	2/ 2	20 4	2879991730.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2012	2888080926.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2016	2891005485.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2020	2893182085.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2024	2894610080.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2028	2895288989.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2032	2895218636.	12.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-2	H-3	3C84	3C454.3	2/ 2	2036	2894390047.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2040	2892830452.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2044	2890513360.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2048	2887448430.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2052	2883636652.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2056	2879079163.	12.
W-2	H-3	3C84	3C454.3	2/ 2	21 4	2867732920.	12.
W-2	H-3	3C84	3C454.3	2/ 2	21 8	2860947638.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2116	2845163090.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2120	2836168680.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2124	2826443114.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2128	2815989362.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2132	2804810630.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2136	2792910346.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2140	2780292138.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2144	2766959902.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2148	2752917681.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2152	2738169807.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2156	2722720760.	12.
W-2	H-3	3C84	3C454.3	2/ 2	22 0	2706575313.	12.
W-2	H-3	3C84	3C454.3	2/ 2	22 4	2689738394.	12.
W-2	H-3	3C84	3C454.3	2/ 2	22 8	2672215184.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2212	2654011040.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2216	2635131502.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2232	2552978348.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2236	2530812779.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2240	2508009567.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2244	2484575713.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2248	2460518406.	12.
W-2	H-3	3C84	3C454.3	2/ 2	2256	2410562968.	12.
H-3	W-2	3C345	4C39.25	1/31	740	3234529399.	15.
H-3	W-2	3C345	4C39.25	1/31	744	3238010857.	15.
H-3	W-2	3C345	4C39.25	1/31	748	3240505817.	15.
H-3	W-2	3C345	4C39.25	1/31	752	3242013489.	15.
H-3	W-2	3C345	4C39.25	1/31	756	3242533463.	15.
H-3	W-2	3C345	4C39.25	1/31	8 0	3242065512.	15.
H-3	W-2	3C345	4C39.25	1/31	8 4	3240609843.	15.
H-3	W-2	3C345	4C39.25	1/31	8 8	3238166849.	15.
H-3	W-2	3C345	4C39.25	1/31	812	3234737309.	15.
H-3	W-2	3C345	4C39.25	1/31	816	3230322281.	15.
H-3	W-2	3C345	4C39.25	1/31	820	3224923079.	15.
H-3	W-2	3C345	4C39.25	1/31	832	3202838640.	15.
H-3	W-2	3C345	4C39.25	1/31	840	3183233236.	15.
H-3	W-2	3C345	4C39.25	1/31	844	3171974393.	15.
H-3	W-2	3C345	4C39.25	1/31	852	3146561540.	15.
H-3	W-2	3C345	4C39.25	1/31	9 0	3117314980.	15.
H-3	W-2	3C345	4C39.25	1/31	9 4	3101265083.	15.
H-3	W-2	3C345	4C39.25	1/31	912	3066336574.	15.
H-3	W-2	3C345	4C39.25	1/31	916	3047468702.	15.
H-3	W-2	3C345	4C39.25	1/31	924	3006954533.	15.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
H-3	W-2	3C345	4C39.25	1/31	932	2962777699.	15.
H-3	W-2	3C345	4C39.25	1/31	940	2914992287.	15.
H-3	W-2	3C345	4C39.25	1/31	948	2863656829.	15.
H-3	W-2	3C345	4C39.25	1/31	956	2808834229.	15.
H-3	W-2	3C345	4C39.25	1/31	10 4	2750591649.	15.
H-3	W-2	3C345	4C39.25	1/31	1012	2689000411.	15.
H-3	W-2	3C345	4C39.25	1/31	1020	2624135977.	15.
H-3	W-2	3C345	4C39.25	1/31	1024	2590501026.	15.
H-3	W-2	3C345	4C39.25	1/31	1028	2556077867.	15.
H-3	W-2	3C345	4C39.25	1/31	1032	2520876997.	15.
H-3	W-2	3C345	4C39.25	1/31	1036	2484909347.	15.
H-3	W-2	3C345	4C39.25	1/31	1040	2448185807.	15.
H-3	W-2	3C345	4C39.25	1/31	1044	2410717670.	15.
H-3	W-2	3C345	4C39.25	1/31	1048	2372516391.	15.
H-3	W-2	3C345	4C39.25	1/31	1052	2333593712.	15.
H-3	W-2	3C345	4C39.25	1/31	1056	2293961494.	15.
H-3	W-2	3C345	4C39.25	1/31	11 0	2253631920.	15.
H-3	W-2	3C345	4C39.25	1/31	11 4	2212617349.	15.
H-3	W-2	3C345	4C39.25	1/31	11 8	2170930321.	15.
H-3	W-2	3C345	4C39.25	1/31	1112	2128583617.	15.
H-3	W-2	3C345	4C39.25	1/31	1124	1997716055.	15.
H-3	W-2	3C345	4C39.25	1/31	1128	1952862228.	15.
H-3	W-2	3C345	4C39.25	1/31	1132	1907415512.	15.
H-3	W-2	3C345	4C39.25	1/31	1136	1861389847.	15.
H-3	W-2	3C345	4C39.25	1/31	1140	1814799315.	15.
H-3	W-2	3C345	4C39.25	1/31	1144	1767658163.	15.
H-3	W-2	3C345	4C39.25	1/31	1148	1719980848.	15.
H-3	W-2	3C345	4C39.25	1/31	1156	1623076262.	15.
W-4	H-3	3C454.3	3C345	10/11	22 4	2755405178.	12.
W-4	H-3	3C454.3	3C345	10/11	22 8	2746779305.	12.
W-4	H-3	3C454.3	3C345	10/11	2212	2737178471.	12.
W-4	H-3	3C454.3	3C345	10/11	2216	2726605563.	12.
W-4	H-3	3C454.3	3C345	10/11	2220	2715063843.	12.
W-4	H-3	3C454.3	3C345	10/11	2224	2702556834.	12.
W-4	H-3	3C454.3	3C345	10/11	2228	2689088378.	12.
W-4	H-3	3C454.3	3C345	10/11	2236	2659283873.	12.
W-4	H-3	3C454.3	3C345	10/11	2240	2642956971.	12.
W-4	H-3	3C454.3	3C345	10/11	2244	2625686870.	12.
W-4	H-3	3C454.3	3C345	10/11	2248	2607478845.	12.
W-4	H-3	3C454.3	3C345	10/11	2252	2588338499.	12.
W-4	H-3	3C454.3	3C345	10/11	2256	2568271680.	12.
W-4	H-3	3C454.3	3C345	10/11	23 0	2547284521.	12.
W-4	H-3	3C454.3	3C345	10/11	23 4	2525383461.	12.
W-4	H-3	3C454.3	3C345	10/11	23 8	2502575230.	12.
W-4	H-3	3C454.3	3C345	10/11	2312	2478866767.	12.
W-4	H-3	3C454.3	3C345	10/11	2316	2454265326.	12.
W-4	H-3	3C454.3	3C345	10/11	2320	2428778534.	12.
W-4	H-3	3C454.3	3C345	10/11	2328	2375180107.	12.
W-4	H-3	3C454.3	3C345	10/11	2332	2347084934.	12.
W-4	H-3	3C454.3	3C345	10/11	2336	2318137199.	12.

SITES 1	SITES 2	SOURCE 1	SOURCE 2	DATE	UT	DELAY (PS)	WEIGHT (PS)
W-4	H-3	3C454.3	3C345	10/11	2340	2288345755.	12.
W-4	H-3	3C454.3	3C345	10/11	2344	2257719681.	12.
W-4	H-3	3C454.3	3C345	10/11	2348	2226268396.	12.
W-4	H-3	3C454.3	3C345	10/11	2352	2194001507.	12.
W-4	H-3	3C454.3	3C345	10/11	2356	2160928929.	12.
W-3	H-2	3C84	4C39.25	1/26	132	-2792056049.	15.
W-3	H-2	3C84	4C39.25	1/26	140	-2789510823.	15.
W-3	H-2	3C84	4C39.25	1/26	144	-2786947647.	15.
W-3	H-2	3C84	4C39.25	1/26	148	-2783525068.	15.
W-3	H-2	3C84	4C39.25	1/26	152	-2779244130.	15.
W-3	H-2	3C84	4C39.25	1/26	156	-2774106180.	15.
W-3	H-2	3C84	4C39.25	1/26	2 0	-2768112696.	15.
W-3	H-2	3C84	4C39.25	1/26	212	-2745019203.	15.
W-3	H-2	3C84	4C39.25	1/26	216	-2735624849.	15.
W-3	H-2	3C84	4C39.25	1/26	220	-2725386792.	15.
W-3	H-2	3C84	4C39.25	1/26	224	-2714308194.	15.
W-3	H-2	3C84	4C39.25	1/26	228	-2702392442.	15.
W-3	H-2	3C84	4C39.25	1/26	232	-2689643169.	15.
W-3	H-2	3C84	4C39.25	1/26	236	-2676064319.	15.
W-3	H-2	3C84	4C39.25	1/26	240	-2661659984.	15.
W-3	H-2	3C84	4C39.25	1/26	244	-2646434641.	15.
W-3	H-2	3C84	4C39.25	1/26	248	-2630392927.	15.
W-3	H-2	3C84	4C39.25	1/26	252	-2613539745.	15.
W-3	H-2	3C84	4C39.25	1/26	3 0	-2577419924.	15.
W-3	H-2	3C84	4C39.25	1/26	3 4	-2558164330.	15.
W-3	H-2	3C84	4C39.25	1/26	3 8	-2538119396.	15.
W-3	H-2	3C84	4C39.25	1/26	312	-2517291281.	15.
W-3	H-2	3C84	4C39.25	1/26	316	-2495686345.	15.
W-3	H-2	3C84	4C39.25	1/26	320	-2473311203.	15.
W-3	H-2	3C84	4C39.25	1/26	328	-2426277978.	15.
W-3	H-2	3C84	4C39.25	1/26	336	-2376249195.	15.
W-3	H-2	3C84	4C39.25	1/26	340	-2350130487.	15.
W-3	H-2	3C84	4C39.25	1/26	344	-2323286176.	15.
W-3	H-2	3C84	4C39.25	1/26	352	-2267453775.	15.
W-3	H-2	3C84	4C39.25	1/26	4 0	-2208820393.	15.
W-3	H-2	3C84	4C39.25	1/26	4 8	-2147457887.	15.
W-3	H-2	3C84	4C39.25	1/26	416	-2083441383.	15.
W-3	H-2	3C84	4C39.25	1/26	424	-2016849336.	15.
W-3	H-2	3C84	4C39.25	1/26	432	-1947763332.	15.
W-3	H-2	3C84	4C39.25	1/26	440	-1876267942.	15.
W-3	H-2	3C84	4C39.25	1/26	448	-1802450806.	15.
W-3	H-2	3C84	4C39.25	1/26	456	-1726402344.	15.
W-3	H-2	3C84	4C39.25	1/26	5 4	-1648215720.	15.
W-3	H-2	3C84	4C39.25	1/26	520	-1485813519.	15.
W-3	H-2	3C84	4C39.25	1/26	528	-1401796933.	15.
W-3	H-2	3C84	4C39.25	1/26	536	-1316039819.	15.
W-3	H-2	3C84	4C39.25	1/26	544	-1228647241.	15.
W-3	H-2	3C84	4C39.25	1/26	552	-1139726284.	15.
W-3	H-2	3C84	4C39.25	1/26	6 0	-1049385834.	15.

Appendix 5: Table of *a priori* Values used in the Solutions

Site Positions - Cylindrical Coordinates

	radius	longitude	z
Haystack	4700.643324 km	71.4886503	4296.696156 km
85-1	5003.296978	79.8284092	3943.987504

Site Offsets

Westford (from Haystack	0.756427	0.0056306	-0.866153
1800 (from 85-1)	0.504549	0.0182057	-0.676737
1900 (from 85-1)	0.532633	0.0192172	-0.714333
2700 (from 85-1)	0.758372	0.0273083	-1.014018

Source Coordinates

3C273	R.A.	$12^h 26^m 33^s.246$	Dec.	2 19'43"2
3C279		12 53 35.831		-5 31 7.9
3C84		3 16 29.539		41 19 51.75
4C39.25		9 23 55.296		39 15 23.78
3C345		16 41 17.633		39 54 11.0
3C454		22 51 29.525		15 52 54.24

Appendix 6: Signal-to-Noise Ratio

If the signal-to-noise ratio R is large, then it is given approximately by

$$R = \left[\frac{T_{A_1} T_{A_2}}{T_{S_1} T_{S_2}} B\tau \right]^{1/2}$$

where Ts_i i=1,2 is the temperature at site i, B is the bandwidth, τ is the coherent integration time, and where T_A i=1,2 is the antenna temperature at site i given by

$$k T_{A_i} B = A_i \cdot S \cdot B$$

k = Boltzmann's constant, 1.4×10^{-23} joule degree^{-1}

s = source flux in watt $m^{-2} Hz^{-1}$

A_i = effective antenna area in m^2

or, for S in flux units ($10^{-26} w\ m^{-2} Hz^{-1}$)

$$T_{A_i} = 7.1 \times 10^{-4} \cdot S \cdot A_i$$

The worst case is Westford-NRAO, where

for Westford: $A \sim 120\ m^2$, $T_S \sim 200\ K$

for NRAO: $A \sim 230\ m^2$, $T_S \sim 200\ K$

in this case, for $B = 360 \times 10^3 Hz$, $\tau = 180$ sec (a Mk-I recording)

$$R \sim 4.7\ S$$

so the correlated fluxes of the sources observed must be greater than $\sim$1 flux unit.