The Third

Announcement of Opportunity

VLBI Space Observatory Programme

Prepared by the

VSOP Science Operations Group

Institute of Space and Astronautical Science

1 September 1999

Proposals Due: Friday, 1 October 1999

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1 Introduction

This Announcement of Opportunity (AO) invites proposals for the third phase of scientific programs to be carried out by the VLBI Space Observatory Programme (VSOP) mission, a Japanese-led international scientific project involving joint observations by the orbiting radio telescope HALCA and several ground-based observatories and networks. The international scientific community is invited to participate in the scientific program of the mission by submitting proposals for General Observing Time (GOT), which will be reviewed by an independent international Scientific Review Committee (SRC). This AO outlines the procedures for submitting proposals, which cover the use of both HALCA and ground radio telescopes in the GOT observations, and for participating in the VSOP Survey Program. Proposers are strongly advised to refer to the VSOP Proposer's Guide for further details of the VSOP mission. This AO solicits proposals to be scheduled from January 2000. Proposers wishing to continue, or complete, programs started during the first or second AO periods must submit a proposal in response to this Announcement of Opportunity. Proposals must arrive at the Institute of Space and Astronautical Science (ISAS) by 1 October 1999. Proposals received after that date will not be accepted.

The current schedule for VSOP-related events is as follows:

- Release of the third AO (AO3) .... 1 September 1999
- **Proposals to be received at ISAS .... by 24:00 UT, 1 October 1999**
- SRC review of proposals complete .... November 1999
- Notification to Principal Investigators .... December 1999
- First AO3 observations may be scheduled .... January 2000
- AO4 proposal deadline .... 1 February 2000

1.1 Changes from AO1 and AO2

The main changes for AO3 from AO2 are briefly summarised in this section. Starting with AO3, VSOP Announcements of Opportunity will occur three times per year, coordinated with the calls for proposals by the ground VLBI networks. HALCA's orbital elements precess with periods of the order of a year, so AO3 proposals are particularly encouraged for sources in those regions of sky allowing good (u,v) coverage during the first half of 2000. All-sky (u,v) coverages are available from the the VSOP World Wide Web site; as a result proposers no longer have the option of including one page of (u,v) coverages per source with their proposals (see §4.3). HALCA will experience a series of long eclipses during apogee passes between 13 April and 7 May 2000 and little, if any, observing will be possible during this time. Proposals will be scheduled for up to a year after they are accepted. If an observation is not scheduled within this time a new proposal will need to be submitted in response to a later Announcement of Opportunity.

From AO3, proposers will be expected to take responsibility for preparing the schedule files for the ground radio telescopes assigned by the VSOP Science Operations Group for their observation. Proposers with little experience in preparing these schedule files may request assistance or consultation from the VSOP Science Operations Group on the proposal cover sheets. Finally, starting with AO3, the scientific justification may be submitted either by e-mail in postscript form or by surface mail (see §4.3.2).

2 Mission Overview

Very Long Baseline Interferometry (VLBI) enables high angular resolution images to be made at radio wavelengths. The angular resolution of ground-based VLBI at a given wavelength is limited by the Earth's diameter. Space VLBI is a natural extension of ground-based VLBI, with one additional telescope in Earth orbit added to the ground radio telescope array. The high data rate necessary for high sensitivity requires the down-linking of data from the satellite in real time. This in turn requires a world-wide network of telemetry stations to receive and record this data and, just as importantly, to up-link the reference frequency to the satellite.

The VLBI Space Observatory Programme (VSOP) is a project of Japan's Institute of Space and Astronautical Science (ISAS) in close collaboration with the National Astronomical Observatory (NAO). In addition, the National Aeronautics and Space Administration (NASA) in the USA and a number of organizations around the world are providing facilities which are essential components of the science mission. The mission elements are described briefly below, and also in Hirabayashi et al. (Science, **281**, 1825 and erratum **282**, 1995). A more detailed description is available in the VSOP Proposer's Guide (see §5.1 for more details of the Proposer's Guide).

2.1 The HALCA Satellite

During its development the VSOP satellite was referred to as MUSES-B, as it was the second in the series of ISAS's Mu Space Engineering Satellites. After launch on 12 February 1997, the satellite was renamed HALCA – the 'Highly Advanced Laboratory for Communications and Astronomy'. The launch was followed by an intensive In-Orbit Checkout period, during which the end-to-end VSOP elements – HALCA, tracking stations, orbit determination, data recorders, correlators and reduction software – were checked and debugged to form a fully integrated network. The mission is made available to the astronomical community on a best-efforts basis.

The expected lifetime of the satellite is 3–5 years.

HALCA was launched from the Kagoshima Space Center into Earth orbit on the first flight of ISAS's M-V rocket. The orbital parameters are given in Table 1. Over the life of the mission the precession of the satellite's orbit will allow good (u,v) coverage over the whole sky. The (u,v) coverage each month for the year 2000 for HALCA and an illustrative ground array is available from the VSOP web site: the simulation software packages described in §5.2 can be used to examine in more detail the (u,v) coverage for sources of interest. The apogee height allows baselines three times longer than on the Earth, while the perigee height is low enough to fill in the intermediate baselines and to aid with calibration of data obtained on ground–space baselines by comparison with data from ground-only baselines. Typically, a General Observing Time observation of a source will last 7–14 hours, although various constraints result in the loss of ground–space baselines for some part of each observation. A full description of observing constraints is given in §4 of the VSOP Proposer's Guide.

Table 1: Orbital Parameters

Element	Value
Period	6.3 hours
Inclination	31 degrees
Apogee altitude	21,400 km
Perigee altitude	560 km

HALCA's parabolic main reflector is composed of a thin flexible mesh that was deployed in orbit and fixed in position by a set of cables attached to a support structure. The aperture has a physical area of 50 m^2, equivalent to an 8 m diameter reflector. A concentric feed is located at the Cassegrain focus, followed by left-hand circular polarizers and receivers at 1.6, 5, and 22 GHz. The observing bands include standard VLBI continuum frequencies and the frequencies of OH and H_2O masers. However early in HALCA's In-Orbit Checkout it was discovered that the performance at 22 GHz was severely impaired. Proposals for observations at 22 GHz will not be accepted in response to this Announcement of Opportunity. A summary of observing parameters and sensitivities at 1.6 and 5 GHz is given in Table 2.

HALCA observations are subject to a number of constraints, which are described in detail in §4 of the Proposer's Guide. The position of the Sun relative to the source imposes a major constraint. The sun angle, defined as the angle between the Sun and the source being observed, must be greater than 70° as otherwise the main antenna shadows the solar panels. The sun angle ranges have been further limited because of excessive angular momentum build-up at other angles, however it is anticipated that the range 80°–180° will be available for AO3 observations.

HALCA is also unable to observe when sunlight falling on the solar panels is eclipsed by the Earth or moon. Furthermore, after each eclipse an amount of time approximately equal to the eclipse duration is required to fully recharge the batteries. A series of long eclipses is predicted

Table 2: Observing Bands and Sensitivities

Band	1.6 GHz	5 GHz
Frequency	1.60–1.73 GHz	4.7–5.0 GHz
Polarization	LCP only	LCP only
$T_{\rm sys}$	75 K	95 K
Aperture Efficiency	24%	34%
System gain	4.3 mK Jy^{-1}	6.2 mK Jy^{-1}
$T_{\rm sys}$ (Equivalent Flux Density)	17,400 Jy	15,300 Jy
Typical Coherence Time (τ_c)	600 s	400 s
7σ Sensitivity to VLBA Antenna:		
Continuum source (1)	131 mJy	147 mJy
Line source (2)	4.2 Jy/ch	4.7 Jy/ch

(1). For a 16 MHz bandwidth, with an integration time of τ_c, typical for observations within two hours of apogee. See §9 of the VSOP Proposer's Guide for details of these calculations.
(2). As for (1), with 1024 channel correlation. See §9.11 and §12 of the VSOP Proposer's Guide for details of the spectral line capabilities of correlators.

to take place when HALCA is near apogee between 13 April 2000 and 7 May 2000, and the observing efficiency during this time will be extremely limited.

Three combinations of bandwidth, sampling and channelization are available, under the constraint of a total bit rate of 128 Mbps. The mode with two channels of 16 MHz bandwidth and 2-bit sampling is the standard mode for scientific observations, and is the only mode compatible with VLBA, Mk IV and S2 recording systems. (The VSOP-T recording system can handle two other modes of recording – see §3 of the VSOP Proposer's Guide for more details.) The default observing mode has the two observing channels side by side; however the channels can be separated within the allowed observing band. The channels can be selected on HALCA so that one channel is in the 1.6 GHz range and the other is in the 5 GHz range. Such a mode is not supported at most ground radio telescopes, but frequency-agile telescopes can switch frequencies regularly so that observations with one 16 MHz channel are interleaved at the two frequencies (see §3.2.1 for more details).

2.2 Ground Facilities

HALCA is commanded via 2.1 GHz (S-band) telemetry from ISAS's Kagoshima Space Center. ISAS is also providing a 15 GHz (Ku-band) tracking and data link station at Usuda (Japan). Four similar tracking and data link stations are being provided by NASA: three Deep Space Network sites, at Goldstone (USA), Robledo (Spain), and Tidbinbilla (Australia), and one at the National Radio Astronomy Observatory (NRAO) site at Green Bank (USA). (See §6 of the VSOP Proposer's Guide for more details.) Orbit determination teams at ISAS and JPL use data from the tracking stations to derive precise reconstructed orbits for data correlation, and to provide predicted orbits for future tracking passes.

A number of ground radio telescopes (GRTs) will be committing time for simultaneous observations with space VLBI observatories; these are listed in Table 3. Participating VLBI networks include the Very Long Baseline Array (VLBA), operated by the NRAO, and the European VLBI Network (EVN). Other individual telescopes are also providing time (see §7 of the VSOP Proposer's Guide for more details). Participation of ground-based observatories and allocations of ground telescope time are arranged under the auspices of the Global VLBI Working Group (GVWG), currently chaired by R. Schilizzi (JIVE).

The VSOP Science Operations Group (VSOG) will allocate GRTs for VSOP observations (see §6.3), and any special requirement of particular GRTs must be clearly justified in the proposal. As for most ground VLBI observations, preparation of observing files for all ground telescopes will, from AO3, normally be done by the Principal Investigator (PI), although assistance from the VSOG may be requested on the Cover Sheets. Scientific observations with HALCA will depend strongly on the availability of GRT time, so all proposers should carefully consider their demands on these resources. Policies of the individual ground observatories will be respected in the VSOP scheduling process.

There are three different tape formats used for VSOP observations: VSOP-T, VLBA/MkIV, and S2. Most GRTs can record in only one format. Experiments involving two or more formats will thus require conversion of some tapes before correlation. Data will be correlated at the VSOP correlator in Mitaka (Japan), the S2 correlator in Penticton (Canada) and at the VLBA correlator in Socorro (USA). Although proposers may nominate a preferred correlator, the correlator used for a certain observation will normally be determined during the scheduling process by the VSOG. Correlation facilities are described in more detail in §12 of the VSOP Proposer's Guide.

The NRAO AIPS software package has been upgraded to Space VLBI capability for all aspects of data reduction, and the Caltech DIFMAP program is also space-VLBI capable for imaging, model-fitting, and self-calibration. Further details of these software packages and additional sources of information related to data reduction are available from http://www.vsop.isas.ac.jp/obs/Reduction.html.

User-support facilities to assist investigators in analysis of their VSOP observations are operated on a regional basis by ISAS (for Japan), by NRAO (for the USA), and by JIVE (for Europe).

2.3 Mission Organization

The VSOP mission is led by the Project Manager, H. Hirosawa, and the Project Scientist, H. Hirabayashi. The mission is overseen by the VSOP International Science Council (VISC), a sixteen member group consisting of representatives of the participating organizations and several 'at large' representatives. The VISC is currently co-chaired by H. Hirabayashi (ISAS) and D. Jauncey (ATNF). The day-to-day operation of the mission is undertaken by the VSOP Science Operations Group (VSOG), comprising members from ISAS and NAO, with support from visiting staff at ISAS and other institutions.

Table 3: Participating Ground Radio Telescopes and VLBI Networks

GRT/Array	Location	System Equivalent Flux Density (Jy) 1.6 GHz	5 GHz
Arecibo	Puerto Rico	2.5	3.5
ATCA (Narrabri)	Australia	60	80
Ceduna	Australia	—	380
EVN:			
Cambridge	UK	212	136
Effelsberg	Germany	19	20
Jodrell (Lovell)	UK	44	—
Jodrell (Mk II)	UK	—	320
Medicina	Italy	582	296
Noto	Italy	784	260
Onsala	Sweden	390	600
Shanghai	China	1088	520
Torun	Poland	200	220
Westerbork	Netherlands	280	700
Goldstone	USA	49	—
Hartebeesthoek	South Africa	370	680
Hobart	Australia	1400	1200
Mopra	Australia	350	450
Robledo	Spain	49	—
Tidbinbilla	Australia	49	—
Usuda	Japan	69	69
VLA-27	USA	14	14
VLBA (10 sites)	USA	300	290

The system equivalent flux density (SEFD) is given for frequency bands that will be supported during the AO3 period (see §7 of the VSOP Proposer's Guide for more details.) The SEFD, also known as the system temperature in jansky, is the ratio of the system temperature in K to the antenna sensitivity in K Jy^{-1}.

3 Observing Opportunities

Typically 25–30 target pointings are being made per month with HALCA. This section describes the nature of the observing opportunities open to the astronomical community and provides some details on the types of observations that are possible.

3.1 Nature of Observing Opportunities

There are three categories of VSOP scientific observations: (1) General Observing Time, (2) the VSOP Survey Program, and (3) Target of Opportunity Observations. The astronomical community is invited to participate in these observational categories by submitting proposals in response to this Announcement of Opportunity for General Observing Time, or contacting the Project Scientist regarding participation in the VSOP Survey Program or Target of Opportunity observations, as described below.

As an ISAS engineering mission, VSOP has no dedicated technical support in Japan, and hence the local radio astronomical community is responsible for all elements of HALCA operations and operating the VSOP correlator. However, since the project is being run as an international endeavour, on a best-efforts basis, all investigators are strongly encouraged to consider contributing some of their time to working on details of the mission operation in return for their scientific rewards. Anyone interested in assisting with VSOP operations should contact the VSOP Project Scientist (e-mail: vsop_ps@vsop.isas.ac.jp).

3.1.1 General Observing Time

General Observing Time is open to the astronomical community through peer-reviewed proposals. This will be the most common means for astronomers to take part in the VSOP mission. The GRT time used to support General Observing Time observations will be drawn from the pool of telescope time that has been contributed to the mission from ground arrays and telescopes (the General Observing Time pool). A typical General Observing Time observation is likely to use a large array of ground telescopes (e.g., the VLBA or the EVN, or both) and last 7–14 hours.

All proposals for General Observing Time will be reviewed by the Scientific Review Committee (SRC). If similar investigations are contained in two or more proposals, the SRC may choose only the best rated experiment, recommend a merging of the proposal teams or, if the scientific goals are sufficiently different, recommend that the data is shared between the teams (see §6.2). Potential proposers of similar investigations are encouraged to form teams before submitting a proposal. A list of the observations scheduled over the AO1 and AO2 periods (showing source and observation band) is available from the VSOP WWW site; proposers may wish to refer to this list while planning their proposal. Further details of the scheduled observations are also available from the VSOP WWW site.

A limited number of the best scientific experiments may be recommended by the SRC to form Key Science Programs, to ensure that important scientific goals of the mission are realized. Inclusion in KSPs will take place only with the concurrence of the VISC and the proposers. Each KSP observation will be led by its original PI (unless there are proposal mergers as discussed above), with the VSOG paying closer attention to the planning, scheduling, and calibration of the observation. In return, the mission may request that one or two VSOG members be added as co-investigators to the KSP observation.

3.1.2 The VSOP Survey Program

The VSOP Survey Program is led by the VSOP mission through the Survey Working Group (SWG). Surveys of active galactic nuclei and maser sources are being conducted as part of the Survey Program. These surveys increase the scientific output of the mission by increasing the percentage of time during which scientific observations occur over that possible with General Observing Time, since they will utilize GRT time devoted directly to the surveys, as arranged by the mission. The survey results are essential for planning future VLBI observations (including those with VSOP) and for designing future space VLBI missions. A survey observation will typically last 4–7 hours and be made with no more than 3–4 ground telescopes, thus providing significantly less data than normal imaging observations. Details of the Survey Program, including the source lists, are available from the VSOP World Wide Web site (http://www.vsop.isas.ac.jp).

The SWG encourages contributions of telescope time, other resources or coordinated observing programs. Interested scientists should contact the VSOP Project Scientist (e-mail: vsop_ps@vsop.isas.ac.jp).

The survey data on individual sources will be made available concurrently for scientific use to other investigators who have successfully proposed more detailed observations of those sources at the survey frequency. If General Observing Time observations of Survey Program sources are made before the survey observations are scheduled, the Principal Investigators may be asked for permission to share a portion of their data – for a limited period from a limited number of ground radio telescopes – with the Survey Working Group in order to increase the overall efficiency of scheduling the survey sources.

3.1.3 Target of Opportunity Observations

A Target of Opportunity (ToO) is an astrophysical phenomenon which cannot be predicted and for which observations cannot be proposed in the normal manner. Target of Opportunity proposals may be submitted at any time, in the same format as normal proposals, to the VSOP Project Scientist. Before submitting a ToO proposal, proposers should use the simulation software packages to ensure the source is in a region of sky which HALCA can observe. Proposals should also indicate the timescale for which ToO observations are requested. A minimum time period of four days should be assumed from receipt of a ToO proposal to the earliest possible observation being made. ToO proposals requiring a rapid (i.e. less than 2 week) change of HALCA and ground radio telescope schedules will be permitted only in exceptional circumstances. ToO observations will require the approval of the VSOP Project Scientist and his VISC co-chair.

Given the time-critical nature of these observations, Target of Opportunity proposals may be submitted in their entirety by e-mail and/or fax (see Appendix B for contact details).

3.2 Types of General Observing Time Proposals

General Observing time proposals may fall into one of the following categories:

3.2.1 Single Observations

A proposal contains one or more *experiments*, each of which contains one or more *observations*. Each observation will last typically 7–14 hours. Many of the VSOP programs will be single observations made in order to produce high-resolution images. Source changes with HALCA will typically take several hours, so programs requiring rapid switching among sources will not be possible. Limited frequency changes *within* a band are possible during single observations (see §4.8 of the VSOP Proposer's Guide). A change *between* frequency bands in either of HALCA's channels marks a separate observation.

HALCA can observe with one 16 MHz channel at 1.6 GHz and the other at 5 GHz. Frequency-agile ground radio telescopes can then alternate between 1.6 GHz and 5 GHz to enable images at both frequencies to be made. This observing mode can be selected on the proposal Cover Sheets, however proposers should note that these observations will be made with GRTs recording only one 16 MHz channel: polarization mode observations may not be combined with this mode.

3.2.2 Monitoring Observations

Experiments proposed for multi-epoch observations are referred to as monitoring observations. As HALCA's orbit precesses rapidly, the (u,v) coverage for any given source changes substantially from month to month. In addition, the 80° sun angle constraint implies that there will be periods of up to 5 months when observations of some sources will be impossible. Because of these complications, monitoring programs are significantly more complex than those traditionally carried out in ground-based VLBI. Proposals for monitoring observations should include suggested observing dates which are consistent with the HALCA constraints and the goals of the experiment. Beginning with AO3, Announcements of Opportunity will be released every four months and proposals will be scheduled for up to a year after they are accepted. Monitoring programs may be extended beyond the one-year life of a proposal in the scheduling queue by proposing again in response to a later Announcement of Opportunity.

3.2.3 Polarization Observations

HALCA receives only left circular polarization (LCP). However, the use of dual-polarization radio telescopes on the ground may enable images of the polarized intensity to be made. The VISC established a Polarization Study Team to investigate the feasibility of polarization imaging with HALCA. The Study Team determined that the polarization impurity of HALCA's feed is sufficiently small that useful polarization observations are possible. Proposers are reminded that, unlike most ground-based telescopes used for VLBI polarimetry, HALCA does not rotate about the source direction and cannot slew to calibrators, and this significantly complicates calibration of the polarization impurity. When combined with HALCA's small aperture and limited polarized (u,v) coverage (only LCP) it is clear that VSOP polarization imaging proposals should be considered with great care. Further details are available from http://www.vsop.isas.ac.jp/obs/Pol.html.

The default observing mode for polarization experiments is for ground radio telescopes to record one, 2-bit sampled, 16 MHz channel each in both LCP and RCP, however 'double-rate' recording (i.e. two, 2-bit sampled, 16 MHz channels each in both LCP and RCP) is possible with VLBA/MkIV systems and will be considered if a significantly strong scientific case is made.

3.2.4 Time-Critical Observations

Scheduling constraints limit the ability to make time-critical observations such as coordinated observations with other satellites or ground telescopes. Proposers wishing to make coordinated observations should provide as much detail as possible about the acceptable scheduling dates. Information on acceptable scheduling dates that becomes available after the VSOP AO3 proposal has been submitted should be e-mailed to vsog@vsop.isas.ac.jp, quoting the assigned VSOP proposal code.

Some proposed VSOP experiments may be scientifically enhanced by additional ground-only VLBI observations at another frequency. For example VSOP observations at 5 GHz and global VLBI observations at 15 GHz will have about the same resolution and accurate spectral properties of the source can be obtained. The amount of the ground-only observations and the closeness in time to the VSOP observations will depend on the source properties and goals of the experiment.

The VSOP and ground-VLBI proposals must be proposed independently, although each proposal should acknowledge the other as part of the general scientific justification. For AO3 observations (which may be as early as mid-January, 2000 – see §4.1), proposals for the ground-VLBI observations may have to be submitted before the October 1999 ground-array deadlines.

During most VSOP observations, there are periods of time when no HALCA signal can be received by any of the tracking stations. During these periods the ground array will observe calibrator sources or continue observing the source at the same frequency. If the VSOP observations are scheduled to use frequency-agile arrays (such as the VLBA), one option for obtaining the ground-only observations at a different frequency is to submit a proposal to the appropriate ground-based network for the use these gaps in the VSOP observations (typically $\sim$20% of an observation). Please indicate in your ground-array proposal if this relatively small amount of data taken during the 'gaps' in the VSOP observation is sufficient to meet the goals of the ground observations.

3.2.5 Spectral Line Observations

Although observation of water vapor masers at 22 GHz are not possible, VSOP observations of OH maser and molecular absorption spectral lines are able to be made. The spectral line frequency should be offset by 1–2 MHz from the center of the observing band to avoid contamination from spurious signals at the band center which are known to exist for HALCA and some GRTs.

All proposals, including proposals for spectral line observations, must contain information about the correlated flux density of the source(s) on long Earth baselines. Spectral line proposers are encouraged to nominate a preferred correlator for each experiment after considering the spectral resolution required to meet their scientific goals (see §9.11 of the Proposer's Guide for more details). The choice of correlator will largely determine which telescopes can be selected for the observation, as the amount of translating able to be accommodated between recording formats is limited.

4 Proposal Preparation and Submission

This section describes the preparation and submission process for proposals for General Observing Time. The process for participation in the VSOP Survey Program is described in §3.1.2.

4.1 Period Covered by Announcement of Opportunity

Beginning with AO3, VSOP Announcements of Opportunity will be made three times per year, coordinated with the calls for proposals by the ground VLBI networks. This is a departure from the two previous VSOP AOs, which have had durations of a year or longer. Proposals will be scheduled for up to a year after they are accepted, depending on the proposal ranking and the (u,v) coverage available. After one year the proposal will be dropped and a new proposal will be required.

Accepted AO3 proposals may be scheduled as early as mid-January, 2000. A number of outstanding AO1 and AO2 observations that were postponed while HALCA ceased observing in late 1998 have already been scheduled in the year 2000, but there are gaps in the schedule left to be filled by sources from successful AO3 proposals. HALCA's orbital elements precess with periods of the order of a year, so AO3 proposals are particularly encouraged for sources in those regions of sky allowing good (u,v) coverage during the first half of the year 2000 (see below). Proposers are reminded that between 13 April and 7 May 2000 little or no VSOP observing will be possible – see §2.1. The next deadline for VSOP proposals will be 1 February, 2000.

Details of observations that have been, or will be, scheduled from highly ranked AO1 and AO2 proposals are available from the VSOP web site. Proposers wishing to continue, or complete, programs started during the AO1 and AO2 periods must submit a proposal in response to this Announcement of Opportunity. Related AO1 and/or AO2 proposal code(s) should be listed in item (8) of the AO2 Cover Sheets.

4.2 Who May Propose?

Proposals for VSOP observations may be submitted by scientists of any affiliation and from any country. Proposals will be evaluated solely on the basis of their scientific merits and technical feasibility. No letter of intent is required in order to submit a proposal. Each proposal should identify a single individual who will act as Principal Investigator, and may also list any co-Investigators. The PI will be responsible for the scientific and administrative conduct of the proposed project, and would normally be the formal contact for all communications with the VSOG unless a co-investigator is designated as the contact person.

4.3 Proposal Format and Content

All proposals must be submitted in the standard format described below. The proposal consists of the Cover Sheets and the scientific and technical justification. (For AO1 and AO2, proposers also had the option of submitting additional (u,v) coverage plots to support their applications. As all-sky (u,v) coverage plots for each month are available from the VSOP web site, this option is no longer available.) Proposers wishing to refer to a specific (u,v) coverage in their proposal should include the plot as part of their scientific and technical justification. The Cover Sheets (i.e. completed LaTeX template) must be submitted by e-mail. The scientific and technical justification may also be submitted electronically as a postscript document — alternatively two paper copies of the complete proposal (including the Cover Sheets) should be submitted to ISAS and received by 1 October 1999. Proposals must be written in English and, if the scientific and technical justification is not submitted electronically, printed on A4 or $8\frac{1}{2}\times 11$ inch paper: in such cases it is essential that the electronic and paper versions of the Cover Sheets are identical. Submission a few days before the deadline is recommended for postscript files to ensure there are no problems with the printing of the proposal.

Each proposal must be completed according to the instructions provided below. Key information from the Cover Sheets will be entered into an electronic database and will be used to track proposals and schedule observations. It is therefore essential that proposers follow the instructions when filling out the Cover Sheets. Failure to follow these instructions may result in the rejection of the proposal.

4.3.1 Cover Sheets

The Cover Sheets have a fixed format. The LaTeX template should be obtained electronically (see §5.4). Detailed instructions on completing the Cover Sheets are included in the template. Note that although many observing parameters may be specified on the Cover Sheets, the final observing configuration of ground radio telescopes and HALCA will be determined by the VSOG (see §6.2). Standard options are available for a number of observing parameters. A request for any non-standard observing configuration should be clearly explained in the scientific and technical justification (see below). Information from the Cover Sheets will be made available to the general astronomical community from the VSOP WWW site after an observation is scheduled.

4.3.2 Scientific and Technical Justification

The justification can be submitted in free-form. The font size must be 10 pt or larger, and each page of text should be contained within a width of 16 cm and height of 23 cm. The justification must not exceed two pages of text, including the list of references. Up to two pages of figures and tables may optionally be included in addition to the text. Figures and tables should not be embedded in the text, but should follow the text on separate pages. Colour figures may be submitted but all figures are photocopied in black and white before distribution to the Scientific Review Committee. A LaTeX template file is available from the VSOP ftp and WWW sites for the justification section of a proposal.

The scientific and technical justification may be submitted electronically, however proposers should not submit by e-mail if this is at the expense of including essential diagrams and other material. Electronic submission should be made a few days before the proposal deadline so that proposers can be notified if there are problems printing the file. The PI's name and a short title should be used as the subject line for proposal identification. Grey-scale plots, which can create very lengthy files, should be avoided. If a paper size is specified for printing, the size A4 should be used.

4.4 Proposal Submission

The deadline for receipt of proposals at ISAS is 24:00 UT, Friday, 1 October 1999. It is the responsibility of proposers to send their proposals early enough to ensure arrival by the deadline. Proposals received after the deadline, or proposals that are incomplete, cannot be accepted, and their PIs will be so notified. An acknowledgment of the receipt of complete proposals will be sent to the PI or contact person designated on the Cover Sheets after the complete proposal has been received.

If the scientific and technical justification is not being submitted electronically, two paper copies of the complete proposal, i.e. the Cover Sheets and the scientific and technical justification, should be sent — unfolded and unstapled — to the following address:

VSOP Observing Proposals
VSOP Science Operations Group
Institute of Space and Astronautical Science
3-1-1 Yoshinodai, Sagamihara
Kanagawa 229–8510
JAPAN

The completed LaTeX (i.e. <filename>`.tex`) Cover Sheets file should also be e-mailed to

submit@vsop.isas.ac.jp

with the PI's family name and several identifying words from the proposal title as the subject. If the scientific and technical justification is being electronically submitted, it should be e-mailed (separately from the Cover Sheets) to the same address.

5 Assistance for Proposers

5.1 VSOP Proposer's Guide

Proposers are strongly advised to read the VSOP Proposer's Guide, which provides the technical information necessary to plan and write a proposal. The revised Proposer's Guide will be available from from the WWW and ftp sites described in §5.4. The VSOP Proposer's Guide provides technical details on many mission components and activities, including HALCA and its capabilities, and the ground radio telescopes, tracking stations and correlators that support VSOP observations.

5.2 Simulation Software

Software for simulating VSOP observations is available, and is highly recommended to those wishing to write a competitive proposal. Software packages have been developed at three different institutions, and detailed comparisons have been made to ensure they are all correct and consistent. Software is available for Unix and PC platforms. Revised versions of the packages for AO3 proposal preparation will be available. The three different packages, including details on how to obtain them, are described in §11 of the VSOP Proposer's Guide.

The software provides the ability to simulate observations and (u,v) coverage at different times of the year, in different parts of the sky, for different combinations of ground radio telescopes. The software packages account for all observing constraints with an accuracy sufficient for proposal preparation.

5.3 E-mail Help Desk

Questions relating to the AO, proposal submission, technical aspects of the mission, or simulation software that are not answered elsewhere in this document or the VSOP Proposer's Guide, may be addressed via e-mail to vsop_help@vsop.isas.ac.jp . Such questions will also be compiled to create a 'Frequently Asked Questions' file, which can be accessed on the VSOP WWW site (http://www.vsop.isas.ac.jp). Questions directed to the help desk will be responded to in a timely manner. As the resources for proposal support are limited, however, questions should be asked as early in the proposal period as possible, to avoid any possible congestion during the last weeks before the deadline.

5.4 Access to Documentation

Documentation, software, and information related to the mission status and data analysis may be obtained from the VSOP World Wide Web site (http://www.vsop.isas.ac.jp/AO.html).

The following AO3 documents are also available via anonymous-ftp from ftp.vsop.isas.ac.jp (133.74.2.131):

in the directory *pub*:	Guide to the VSOP ftp site (README)
in the directory *pub/docs* :	VSOP Announcement of Opportunity
	VSOP Proposer's Guide
	Cover Sheets template
	Examples of completed Cover Sheets

Printed copies of the documents will be mailed upon request (see Appendix B for contact information).

5.5 VSOP newsletters

Mission updates and information of interest to proposers is published regularly in a short newsletter that is distributed by e-mail. Proposers can join the distribution list by sending an e-mail with the subject 'VSOP news SUBSCRIBE' to vsog@vsop.isas.ac.jp .

5.6 Financial Assistance

No funding for proposers will be available from the VSOP mission.

5.7 Proposal Checklist

- ☐ Obtain VSOP Proposer's Guide (see §§5.1, 5.4)
- ☐ Obtain Cover Sheets template (see §5.4)
- ☐ Obtain simulation software (see §§5.2, 5.4)
- ☐ Examine (u,v) coverages on VSOP web site
- ☐ Simulate proposed observations
- ☐ Determine all observing parameters
- ☐ Prepare Cover Sheets (see §4.3.1)
- ☐ Write scientific and technical justification (see §4.3.2)
- ☐ **EITHER** mail two copies of proposal, including Cover Sheets, to ISAS (see §4.4)
  OR e-mail postscript file of the scientific and technical justification to ISAS
- ☐ E-mail LaTeX Cover Sheets file to ISAS (see §4.4)
- ☐ Meet proposal deadline **at ISAS** of 24:00 UT Friday, 1 October 1999

6 Proposal Review and Scheduling

6.1 Technical Review of Proposals

The VSOG will review all proposals for technical feasibility. This review will include the simulation of the proposed observations, including all HALCA constraints, and an analysis of the general capability of the satellite to make the proposed observations. A brief technical evaluation of each proposal will be given to SRC members to aid in their deliberations.

6.2 Scientific Review of Proposals

The VISC has appointed an independent international Scientific Review Committee (SRC) to evaluate and rank proposals for General Observing Time based on their scientific merit and technical feasibility. The VSOG's technical evaluations may affect the ranking. The SRC may propose that similar proposals be merged or that the data be shared between different proposers. Proposal merging will occur only with the approval of the VISC and the affected proposers. The SRC may grade experiments within a proposal separately; proposals requesting many observations may be only partially accepted. Approximately three months after the proposal deadline, PIs will be notified of the ratings of their proposals and the likelihood that they will be scheduled.

Ground radio telescopes and networks participating in the mission will have the right to evaluate the complete set of observing proposals for General Observing Time if they desire. The purpose of this review is to allow the ground observatories to determine their commitments to the General Observing Time pool.

Every effort will be made in the entire review process to ensure the confidentiality of proposals. Proposers are reminded that information from the Cover Sheets of proposals from which an observation is scheduled will be made available from the VSOP World Wide Web site.

6.3 Scheduling of Observations

Based on the scientific and technical ratings, the VSOG will allocate the mission elements for each observation. These allocations will depend on the correctness of the information submitted on the proposal Cover Sheets. Since the orbit changes with time, and the GRT resources are limited, scheduling will be a complicated process that attempts to optimize the total science return from the mission. Therefore, the scheduling group in the VSOG will allocate the GRT facilities as they consider necessary to maximize the total science return. Accepted proposals will not always be scheduled with the exact dates nor with the GRTs that were suggested in the proposals. Therefore, it is important that all required parameters be defined clearly on the proposal Cover Sheets.

The PI (or designated contact person) will be notified a month before the observation of the

HALCA tracking allocation and the observing frequencies and will be expected (unless the "VSOG assistance required" option is selected at item (10) on the cover sheets) to generate and distribute the GRT schedule files in a timely manner. Information to aid in the preparation and distribution of schedule files will be available from the VSOP web site. The NRAO SCHED software should be used to prepare the GRT schedules: details of this package are available from http://www.nrao.edu/~cwalker/sched/sched/sched.html .

A problem at a mission element during an observation may mean the science goals of the observation cannot be met. Some problems (e.g. with HALCA) are apparent immediately, but many are recognized only after initial attempts at the calibration of the data. For this reason, investigators are requested to analyze their VSOP data as quickly as possible. The sooner the mission knows about an unsuccessful observation, the more likely it can be rescheduled. Requests for the re-scheduling of observations should be sent by e-mail to the VSOP Project Scientist (e-mail: vsop_ps@vsop.isas.ac.jp).

7 Data Rights

7.1 Engineering and Test Data

The entire mission is being operated to produce the best scientific return overall. The VSOG has the right to analyze any of the scientific observations for their potential to enhance the performance of the mission. The VSOG can also collect data specifically for engineering or test purposes. If engineering observations overlap with successful proposals, analysis for engineering performance evaluation will be done by the VSOG, and the proposers will have exclusive scientific rights to the data.

7.2 Proprietary Data

All data acquired by VSOP will be the exclusive scientific property of the proposers for 18 months following the date when the correlated data are released to the PI. For monitoring and multi-source proposals, the proprietary period will end until 18 months after the date when the last data from a program are released to the PI. Definition of this date will be the responsibility of the VSOG.

7.3 Archive Data

Following the expiration of the period of exclusive data rights, any individual may contact the VSOG requesting the release of some set of VSOP data. The VSOG will direct the appropriate correlator to provide the appropriate correlated data, and notify the PI that the data have been released.

Appendix A: Acronyms and Abbreviations

AO	Announcement of Opportunity
AO1	the first VSOP Announcement of Opportunity
AO2	the second VSOP Announcement of Opportunity
AO3	the third VSOP Announcement of Opportunity
AO4	the fourth VSOP Announcement of Opportunity
ATCA	Australia Telescope Compact Array
ATNF	Australia Telescope National Facility
EVN	European VLBI Network
ftp	file transfer protocol
GOT	General Observing Time
GRT	Ground Radio Telescope
GVWG	Global VLBI Working Group
HALCA	Highly Advanced Laboratory for Communications and Astronomy
ISAS	Institute of Space and Astronautical Science
JIVE	Joint Institute for VLBI in Europe
JPL	Jet Propulsion Laboratory
KSP	Key Science Program
LCP	Left Circular Polarization
NAO	National Astronomical Observatory
NASA	National Aeronautics and Space Administration
NRAO	National Radio Astronomy Observatory
PC	Personal Computer
PI	Principal Investigator
RCP	Right Circular Polarization
SEFD	System Equivalent Flux Density
SRC	Science Review Committee
SWG	Survey Working Group
ToO	Target of Opportunity
VISC	VSOP International Science Council
VLA-27	(the phased, 27 element) Very Large Array
VLBA	Very Long Baseline Array
VLBI	Very Long Baseline Interferometry
VSOG	VSOP Science Operations Group
VSOP	VLBI Space Observatory Programme
WWW	World Wide Web

Appendix B: Important Addresses

World Wide Web site: http://www.vsop.isas.ac.jp

Anonymous-ftp site: ftp.vsop.isas.ac.jp (133.74.2.131)

Documents listed in §5.4 will also be available from other sites: see the VSOP World Wide Web site for details.

E-mail Help Desk: vsop_help@vsop.isas.ac.jp

VSOP Proposal Submission:

E-mail address to submit Cover Sheets: submit@vsop.isas.ac.jp

The scientific and technical justification may be submitted separately as a postscript file to the same address, or alternatively two copies of the full proposal — unfolded and unstapled — should be submitted to

VSOP Observing Proposals
VSOP Science Operations Group
Institute of Space and Astronautical Science
3-1-1 Yoshinodai, Sagamihara
Kanagawa 229-8510
JAPAN

VSOG

E-mail: vsog@vsop.isas.ac.jp
Fax: +81-42-759-8340 or +81-42-769-8949

VSOP Project Scientist — Prof. H. Hirabayashi

E-mail: vsop_ps@vsop.isas.ac.jp
Fax: +81-42-759-8340