Space VLBI Mission "RadioAstron"

Announcement of Opportunity — 1

for the period July 2013 – 30 June 2014

Key Science Program (KSP)

Letters of Intent Due: 17 October 2012, 23:59 UT

RadioAstron KSP Consortia organization meeting: 3-4 December 2012 (Bonn)

Proposals Due: 8 February 2013, 23:59 UT

Contents

1 Summary

The space VLBI Mission "RadioAstron," led by the Astro Space Center (ASC) of Lebedev Physical Institute, provides a range of specific and unique capabilities for detecting and imaging sources of cosmic radio emission at highest angular resolution. The optimal utilisation of these capabilities relies on the construction and execution of a balanced scientific program for the Mission. The scientific program of RadioAstron will consist of three major parts: the Early Science Program (ESP), Key Science Program (KSP), and General Observing Time (GOT) projects. The Early Science Program, currently underway and planned to continue through 2012 until the middle of 2013, explores the main scientific capabilities of RadioAstron observations and paves the way to subsequent engagement in the KSP and GOT programs.

Following the completion of the ESP observations, the RadioAstron KSP will commence in July 2013. The KSP is aimed specifically at bringing the focus on the areas of strongest scientific impact of RadioAstron and ensuring a long-lasting scientific impact of the Mission. KSP observations within the AO-1 period will be carried out between July 2013 and June 2014 inclusive and will have a shared-risk nature since a number of observing modes have not yet been fully tested by the ASC.

Proposals are now invited for the RadioAstron Key Science Program experiments. The KSP application is a two-stage process. An initial Letter of Intent (LoI) should be directed to the Mission by **17 October 2012**. Each team submitting a LoI is expected to participate in the KSP consortia organization meeting that will be held at the Max-Planck-Institute for RadioAstronomy in Bonn on 3-4 December, 2012. Based on the positive feedback from the Mission and discussions with other potential KSP proposers during the December meeting, the resulting KSP consortia are expected to be prepare full KSP proposals to be submitted by **8 February 2013** to the Mission and to the respective ground radio telescopes required for the specific observations.

During the LoI and full proposal preparation, proposers are encouraged to keep contact with the ASC and consult the main operational documents including the "RadioAstron User Handbook[1]."

This document describes the main goals of the RadioAstron KSP, presents the general requirements and criteria for the KSP, and outlines the process of selection and operation of the KSP projects and relations between individual KSP teams and the RadioAstron Mission.

2 RadioAstron Mission Overview

RadioAstron is a space VLBI Mission aimed at achieving the highest angular resolution of radio observations at centimetre wavelengths through ground-space interferometric measurements on baselines of up to $\sim 360,000$ km. The Mission consists of a 10-metre space-borne radio telescope (SRT) operating at wavelengths of 92, 18, 6.2, and 1.2–1.6 cm and supported by a range of ground-based facilities including Satellite Command Stations (SCS) in Bear Lakes and Ussurijsk, a Satellite Tracking Station (STS) in Puschino[2] and ground radio telescopes (GRT) participating in individual RadioAstron observations. Basic parameters of the SRT and RadioAstron observations

[1] `http://www.asc.rssi.ru/radioastron/documents/rauh/en/rauh.pdf`

[2] Construction and operation of two more RadioAstron tracking stations is presently planned at the National Radio Astronomy Observatory site in Green Bank (USA) and at the Hartebeesthoek Radio Astronomy Observatory (South Africa). See for more details 4.1.

are summarised in Table 1

Observations with RadioAstron will provide images of radio sources with ultra-high angular resolution, using ground-space baselines up to 360,000 km in length and reaching a resolution of about 7 microarcseconds at the wavelength of 1.3 cm. These observations will enable accurate measurements of structural properties and evolution on sub-milliarcsecond scales in galactic and extragalactic radio sources. At intermediate baselines, high quality imaging of radio sources with moderate resolution will be obtained for objects located near the orbital plane or observed near perigee passages of the satellite.

Table 1: Basic Parameters of RadioAstron Space Radio Telescope (SRT), for more details see `http://www.asc.rssi.ru/radioastron/documents/rauh/en/rauh.pdf`

Satellite Overview					
Mass	$m_{\rm sat}$ [kg]	3660			
Lifetime	$\tau_{\rm Mission}$ [yr]	5			
Main reflector diameter	$D_{\rm ant}$ [m]	10			
Pointing accuracy	$\sigma_{\rm p}$ [arcsec]	10			
Slew rate	$\Delta_{\rm slew}$ [deg/s]	0.35			
Nominal Orbit					
Perigee height	$H_{\rm p}$ [km]	400 – 65,000			
Apogee height	$H_{\rm a}$ [km]	265,000 – 360,000			
Orbital period	$P_{\rm orb}$ [day]	8.2 – 9.5			
Orbital eccentricity	e	0.59 – 0.96			
Orbital inclination	i [deg]	0 – 75			
Argument of perigee (AOP) precession	$\dot{\omega}$ [deg/yr]	40			
Observing System					
Polarisation		Dual Circular (LCP, RCP)			
Continuum bandwidth	$B_{\rm c}$ [MHz]	32			
Spectral channels per IF	$N_{\rm chan}$	16 000 000			
Observing band	[GHz]	0.3	1.6	5	22 (wide)
System Temperature	$T_{\rm sys}$ [K]	162	38	80	92
SEFD	[Jy]	19000	3400	9500	30000
Bandwidth	B [MHz]	16	2×16	2×16	2×16
Angular resolution[1]	$\theta_{\rm min}$ [μas]	530	100	35	7
Baseline sensitivity[2]	$\sigma_{\rm n}$ [mJy]	16	3	4	13
Image noise[3]	$\sigma_{\rm m}$ [mJy/beam]	0.35	0.06	0.08	0.25

[1] – Fringe spacing for $H_{\rm a} = 350,000$ km.

[2] – Noise on the baseline between RadioAstron and the Green Bank Telescope (GBT) for an integration time of 300 sec and a single polarisation 16 MHz channel.

[3] – Image noise is calculated for a continuum, dual polarisation observation, with a bandwidth of 32 MHz per polarisation and a total integration time of $\tau_{\rm obs} = 1$ hr. Participating ground telescopes: Effelsberg (WSRT, at 90cm), Jodrell Bank, GBT, and the VLBA.

2.1 "Spektr-R" satellite

The space radio telescope is mounted on a "Spektr-R" satellite. The general technical characteristics of the satellite are described in the RadioAstron User Handbook. The scientific payload of the satellite consists of a 10-metre antenna, four feed and receiver/backend systems for operating at 1.2–1.6, 6.2, 18, and 92 centimetre wavelengths, a data formatter, a data transmission module and a hydrogen maser frequency standard. Data are provided in dual-circular polarisation, in continuum and spectral line modes, with a total bandwidth of up to 32 MHz per polarisation (at 92 cm, the maximum bandwidth is 16 MHz per polarisation).

2.2 Ground Facilities

There are a number of different ground facilities participating in operation, tracking, data transfer and observations with the radio antenna on board Spektr-R. These include the Flight Control Center (FCC) at the Lavochkin Association; the Deep Space Network (DSN) antennas in Ussurijsk and Bear Lakes employed for the uplink and telemetry communications with the satellite; the Satellite Tracking Station (STS) in Puschino (and others being planned in the USA and South Africa) used for telemetry and data acquisition from the Spektr-R satellite and radio antenna; the laser ranging stations (LRS) used for orbit determination measurements; and the ground radio telescopes (GRT) taking part in Very Long Baseline Interferometry (VLBI) observations with the Spektr-R antenna (hereafter, RadioAstron observations). VLBI methods are being trialled to determine the space craft state vector for orbit reconstruction.

2.3 Mission Organisation

The RadioAstron Mission is headed by the Astro Space Center (ASC) of the P.N. Lebedev Physical Institute in Moscow, Russia. The Spektr-R satellite operations are supported by the Russian Space Agency (RSA) "Roskosmos" and conducted by the Lavochkin Association (LA) in Chimki, Russia. Orbit determination measurements and analysis are performed by the Ballistics Group at the Institute of Applied Mathematics (IAM) in Moscow. Data from the SRT are received at the Puschino TS operated by the ASC. The data from the SRT are recorded in the RadioAstron Data Format (RDF) specially developed for the Mission operations. Data correlation from RadioAstron observations is conducted at the RadioAstron Correlator Facility designed and operated at the Data Processing Department of the ASC. Enabling RadioAstron data correlation in the DiFX software correlator is presently under active development at the Max Planck Institute for Radio Astronomy, Bonn.

Scientific operations of the RadioAstron Mission are conducted by the ASC and the radio interferometric networks. The RadioAstron International Scientific Council (RISC) comprised of representatives from the ASC, major GRT facilities, and radio astronomical community provides overall policy definitions for the Mission, discusses scientific issues and priorities.

RadioAstron observations are supported in part by the Russian geodetic VLBI Network "KVAZAR" operated by the Institute of Applied Astronomy in Saint Petersburg. Participation of other GRT in RadioAstron observations is presently sought on a proposal basis. Block time commitments to RadioAstron observations are being considered at several GRT facilities.

3 Key Science Program

It is expected that observations with RadioAstron will provide substantial advances in a number of areas of astrophysical research, for both galactic and extragalactic objects.

In order to optimise the scientific output of RadioAstron observations, the ASC and RISC have identified several specific "key science" areas where RadioAstron observations are expected to provide unique and ground breaking results.

3.1 Key science areas

Primary areas of RadioAstron observations will include studies of active galactic nuclei, the vicinity of supermassive black holes, relativistic flows, galactic and extragalactic masers, the physics and dynamics of pulsars, astrometry, the interstellar medium, gravitation and general relativity.

These key science areas may be particularly attractive for engagement within the RadioAstron KSP experiments, although KSP experiments can be proposed for any relevant field of radio astronomical measurement in which observations with RadioAstron may break new scientific ground and bring significant progress in our understanding of cosmic phenomena.

3.2 Scope of the KSP

The Key Science Program of RadioAstron serves four basic goals:

1. The KSP should deliver important science for the Mission through coherent investigations that are unlikely to be carried out as comprehensively through the General Observer program.
2. The KSP should provide a legacy for the Mission by addressing fundamental astrophysical problems and exploiting the areas of astrophysics where RadioAstron offers unique scientific capabilities.
3. The KSP should have a strong visibility within the astrophysical and space science community.
4. The KSP should establish tangible benchmarks and reference points for future space VLBI developments.

3.3 General scientific criteria for KSP

Projects identified as key scientific objectives of RadioAstron should be selected according the following criteria:

1. KSP projects address fundamental and currently unanswered questions in astrophysics or fundamental physics.

2. KSP projects represent science which is either unique to RadioAstron or synergetic with other studies, but in which RadioAstron plays a key role.

3. KSP projects address scientific questions which excite the broader astrophysical and space science communities.

3.4 KSP Experiments and KSP Teams

KSP observations within the AO-1 period will have a shared-risk nature since a number of observing modes have not yet been fully tested by the ASC.

KSP teams generally are expected to include people with knowledge of the Mission prepared to provide tangible contributions to Mission operations.

KSP teams should demonstrate their capability to commit resources necessary for the timely and successful completion of their programs and publication of the results of their KSP observations. The KSP teams should also be committed to operate in close contact with the ASC.

KSP teams should be prepared to be involved in the design of observations and to contribute to the development of data reduction and analysis applications.

KSP teams should assume shared responsibility for the timely processing, publishing, and publicising of scientific results obtained from key science observations.

In some cases and based on evaluation of individual KSP proposals, the ASC or RadioAstron Program Evaluation Committee (RPEC) may suggest the addition of an ASC representative to the proposal team to provide extensive support in order to ensure the timely and successful delivery of science from the KSP observations.

4 Observing Opportunities

KSP observations may be requested for any subject that can be addressed with RadioAstron, not limited to the KSP areas described in section 3.1. All operational and observational modes of RadioAstron will be made available for KSP observations. If necessary, special technical and logistical arrangements for observations can be proposed, based on consultations with the ASC and participating ground facilities. Generic RadioAstron observing modes are summarized below and described in detail in the RadioAstron User Handbook.

4.1 Generic Observational Constraints

A detailed description of the RadioAstron technical capabilities and observational constraints can be found in the RadioAstron User Handbook.

As a specific issue arising for this AO-1 call, it should be noted that RadioAstron observations are presently being made using a single tracking station located in Pushchino. It is anticipated that a second tracking station in Green Bank will become operational before the beginning of the AO-1 time period. Proposers are therefore advised to include also the Green Bank station into planning of KSP experiments for the AO-1 period.

4.2 Main Observing Modes of RadioAstron

RadioAstron can provide several main types of observations, depending on the instrumental setup and the specific configuration of the ground facilities. KSP programs may request any of these observational modes or propose for a specific design and configuration of the observations. The main standard observing modes are summarised below and described in more detail in RadioAstron User Handbook.

4.2.1 Visibility Tracking

Visibility tracking with RadioAstron provides basic measurements of interferometric visibilities within a range of baseline lengths and (typically) a narrow sector of position angle in the visibility plane. This mode is envisaged primarily for survey observations and measurements of size and brightness temperature of compact radio sources. Observations in this mode would be normally made covering different projected spacings and need to be supported by at least three (one large and two medium) ground antennas. The imaging capability of RadioAstron observations will generally be limited in this mode, even with a larger number of ground telescopes employed.

4.2.2 Orbital Plane Imaging

For targets lying close to the plane of the Spektr-R orbit, imaging quality is enhanced by the crossing of the ground-space and ground-ground baseline tracks. For such objects, orbital plane imaging can be employed effectively to provide robust imaging capabilities up to the highest achievable resolution. These observations need to be supported by a large number of ground telescopes, in order to provide better coverage and redundancy of the (u, v)-sampling. The strong evolution of the Spektr-R orbit will enable orbital plane imaging for a substantial fraction of the sky over the lifetime of the mission, but the optimum time periods for such experiments need to be determined in advance in order to successfully plan and prepare the observations.

4.2.3 Perigee Imaging

Perigee imaging will be possible for approximately 20% of the orbital period of Spektr-R and will cover space-ground baselines of up to $\sim 50,000$ km. Perigee imaging requires support from a large number of ground telescopes and will yield good quality images at intermediate resolution. Construction and operation of a RadioAstron STS in the southern hemisphere may be required in order to best optimise the perigee imaging capability. See § 4.1 for discussion regarding availability of tracking stations during the AO-1 period.

4.2.4 Pulsar Observations

Pulsar observations are performed in a standard mode, with the pulse calibration ("P-cal") and noise diode systems turned off, and in some circumstances the automatic gain control disabled. Pulsar mode correlation is supported by the ASC correlator, which can accommodate many baselines, high spectral resolution, and narrow pulse gates. Multiple pulse gates and single-pulse

correlation are available, but require pre-arrangement. The DiFX correlator can also support pulsar phase binning during correlation.

4.2.5 Polarisation Observations

RadioAstron can observe in a dual polarisation mode in the 92, 18 and 1.2–1.6 cm bands: for more details refer to the RadioAstron User Handbook.

At the time of the AO-1 announcement, the ASC had not yet performed polarisation calibration of the space radio telescope (leakage terms and EVPA). This will have to be tested first by KSP team(s) conducting polarization observations. The ASC will support these activities.

4.2.6 Spectral Line Observations

Observations are performed in a standard mode having the pulse calibration system turned off. Correlation by software correlators can be done with up to 16 000 000 channels (1 Hz resolution). KSP teams interested in high spectral resolution should work with the correlator groups to test this mode.

4.2.7 Monitoring Observations

Monitoring observations with RadioAstron will be feasible in principle, however they are expected to be limited in practice by the seasonal variations of the Sun-related orientation constraints and the rapid and strong evolution of the Spektr-R orbit. Engaging in such observations will require careful design and planning, if the desired monitoring period is larger than about 4 months.

4.2.8 Transient Phenomena Observations

KSP observations addressing transient phenomena can be proposed as triggered observations for specific types of target objects. All such proposals must be submitted for the general KSP proposal deadline of 8 February, 2013.

Within given visibility contraints, best efforts will be made to schedule RadioAstron observations of transient phenomena within 48 hours after a trigger is approved by the RadioAstron scheduler together with schedulers of required GRTs.

5 Assistance to Proposers

Proposers of KSP experiments are advised to consult the RadioAstron Mission documents which describe the main characteristics of the satellite, list the main modes and capabilities of RadioAstron observations, and discuss specific constraints arising from inclusion of an orbiting antenna in VLBI observations. Further help and consultation on the issues and areas not covered in these documents can be sought at the ASC, using the contact details provided in Appendix B.

5.1 RadioAstron Mission Website, Documents, and Newsletter

Complete information about the current status, scientific results, and technical developments of the Mission are available from the RadioAstron website at `http://www.asc.rssi.ru/radioastron/`. A description of the RadioAstron observational capabilities, including technical specifications of all available observational modes is given in the "RadioAstron User Handbook[3]". Updates on the Mission status are provided by the RadioAstron Newsletter, distributed by e-mail. A collection of all the Newsletters as well as subscription link can be found at[4].

5.2 Simulation Software

The RadioAstron simulation software `FakeRad` provides a facility for simulating the (u, v)-coverages of RadioAstron observations and determining the optimal ground array support and time periods for specific observations.

The software `FakeRad` is based on the package `FakeSat`, originally developed by David Murphy (JPL). `FakeRad` is currently implemented for the LINUX operating system. The main modification from the original `FakeSat` software is the introduction of the satellite orbit in tabular form. This is required because a Keplerian orbit treatment does not apply for the Moon-perturbed orbit of RadioAstron. Other modifications concern specific operational constraints of the Spektr-R spacecraft. The `FakeRad` package can be obtained at the RadioAstron server[5], together with the `FakeRad` User's Guide[6].

To help proposers to plan RadioAstron observations, the ASC has produced a set of simulated all-sky (u, v)-coverage plots[7].

5.3 Consultation and Contact with the Mission

For specific questions not addressed by the online documentation, consultation can be sought from the ASC. The contact for general consultations is the RadioAstron Science and Technical Operations Group (RSTOG) (see Appendix B). To facilitate the communication between the KSP teams and the ASC, each approved KSP experiment will be assigned a specific contact person within the RSTOG.

6 Proposal Preparation

This document solicits proposals for the first period of the Key Science Program of the RadioAstron Mission. The proposal submission is a two-stage process, with an initial Letter of Intent to be received and evaluated by the RSTOG, and the final proposal to be submitted separately to the Mission and respective ground based facilities required for the observations being proposed. The

[3] `http://www.asc.rssi.ru/radioastron/documents/rauh/en/rauh.pdf`

[4] `http://www.asc.rssi.ru/radioastron/news/news.html`

[5] `http://www.asc.rssi.ru/radioastron/software/fakerad/fakerad.tgz`

[6] `http://www.asc.rssi.ru/radioastron/software/fakerad/fakerad_guide.pdf`

[7] Available from `http://www.asc.rssi.ru/radioastron/ao-1/2013-2014_allsky_uvplots_pu.pdf` and `http://www.asc.rssi.ru/radioastron/ao-1/2013-2014_allsky_uvplots_pu_and_gb.pdf`

proposals will be evaluated separately at all participating telescopes and arrays, and scheduling decision will be made jointly, based on the results of the evaluations. In order to maximize the output of the time- and resource-limited Mission and enhance the scientific productivity of the KSP observations, a KSP consortia organization workshop will be held with the intention of enabling a smaller number of focused KSP proposals to be submitted.

6.1 AO Periods

This Announcement of Opportunity covers the initial shared-risk period of the RadioAstron operation, following the completion of the RadioAstron Early Science Program and extending from July 2013 to June 2014. It is expected that subsequent announcements of opportunity for RadioAstron (both for KSP and general observing time) will be issued once per year with a proposal submission deadline of February each year.

6.2 Eligibility for Proposing

There are no restrictions imposed on the nationality or affiliation of primary investigators and co-investigators of KSP proposals.

6.3 Letters of Intent

Each prospective KSP team is requested to submit a Letter of Intent (LoI) to the Mission. The deadline for LoI submission is **17 October 2012, 23:59 UT**. The LoI should be submitted as a single pdf file as an e-mail attachement to the address: *ra_submit@asc.rssi.ru*, Subject: "LoI". A template for the LoI is provided separately[8].

The letters should adhere to the LoI template, containing a cover page and a description (up to two pages, font size 11 pt or larger) of main scientific merits and critical technical aspects of the intended KSP. The letter should present the scope and goals of the proposal, describe the ground resources required for the observations, outline general approaches and strategies that would be employed for the observations and data reduction, and review the team capabilities enabling a timely completion of the project.

The RSTOG will review the LoI and provide feedback to the proposers, indicating the disposition towards the proposed investigations and providing initial comments about the feasibility of the observational strategy employed.

The feedback will be provided within two weeks of the LoI submission deadline, so as to enable the proposers to take it into account in the their presentations at the KSP consortia organization workshop and for the final submissions of the KSP proposals. In case of two or more LoIs with the same or similar goals and/or observing targets, the Mission may recommend joining the respective KSP teams.

No formal reviewing or pre-selection of the KSP projects will be made on the basis of the LoI, and the RSTOG feedback to the LoI is strictly advisory.

[8] Available from `http://www.asc.rssi.ru/radioastron/ao-1/loi_template.tex` and `http://www.asc.rssi.ru/radioastron/ao-1/loi_template.doc`

6.4 KSP consortia organization workshop on 3-4 December 2012

For the purpose of organizing consortia responsible for KSPs, a meeting will be held at the Max Planck Institute for Radio Astronomy in Bonn on 3-4 December, 2012. It is anticipated that each team submitting a LoI will wish to have one, or more, representatives attend, in order to prepare the most compelling KSP proposal. The ASC and RISC expect KSP collaborations to form at this workshop. Moreover, the RSTOG will provide extended consultations regarding the feasibility of suggested projects to potential KSP proposers. Consequently, taking part in the workshop is expected to provide significant advantages to the teams in preparing their proposals. In the week following the submission of the LoI, each team will receive a formal invitation as well as full information on organizational details of the workshop.

6.5 Full Proposals

Full proposals for RadioAstron KSP experiments are expected to: (a) describe main scientific goals of the project, (b) present a concise scientific justification for investigations proposed, (c) present the methodology for analysis and interpretation of RadioAstron data, (d) demonstrate the availability of resources in the KSP team for the timely analysis of RadioAstron data and publication of results of the observations, (e) provide estimates of required and expected parameters of visibility data and resulting images, and (f) demonstrate the technical feasibility of the observations proposed (addressing, if necessary, all specific technical issues arising in connection to the observations).

RadioAstron KSP proposals must contain a cover sheet section and a scientific justification. The scientific justification submitted to the Mission may not exceed 5 pages, including figures, tables and references. The accompanying cover sheet must be filled out using a form (to be provided later).

Scientific justification(s) and cover sheet(s) submitted separately to the ground segment of the observations proposed should comply with the rules of respective telescopes and interferometric networks.

The KSP proposals should be submitted by e-mail to RadioAstron Mission (e-mail address: *ra_submit@asc.rssi.ru*, subject: "KSP proposal") by **8 February 2013, 23:59 UT**. Submissions to ground facilities requested to participate in KSP projects should be made in compliance with the submission rules and deadlines of the respective facilities.

7 Review and Scheduling of KSP

The RISC has formed a review panel of the Mission — the RadioAstron Program Evaluation Committee (RPEC). Proposals submitted for KSP observations with RadioAstron will be reviewed separately by the RPEC and the requested ground facilities.

7.1 Technical Review

The technical review by the RSTOG will address the technical feasibility of KSP proposals, covering the issues of instrumental and satellite constraints, scheduling restrictions, and logistical limitations of the proposed observations. The RSTOG technical reviews will be made available to the RPEC and the program committees of ground facilities requested for the KSP observations.

7.2 Scientific Review

The scientific review by the RPEC will provide an assessment of scientific novelty, relevance, and merits of the research goals, methodological foundations of analysis and interpretation, and feasibility of achieving the research goals with the observations proposed. The review will further investigate cases of potential conflict and overlap between different KSP proposals. Based on the results of these review actions, recommendations for data sharing may be made.

7.3 Ranking of the KSP Proposals

After completion of the technical and scientific review by the RPEC, the KSP proposals will be ranked according to the combined strength of their scientific merits and technical feasibility. Based on the final ranking of the KSP proposals by the RPEC, scheduling recommendations of the Mission will be determined and communicated to the KSP teams and (if requested) to the ground facilities requested to participate in the KSP observations.

7.4 Scheduling

The final decision on the scheduling of KSP observations will be based on a joint ranking of the respective proposals by the RPEC and the program committees of the ground facilities requested for the KSP observations — similar to the process for "global" VLBI projects. Joint approval by the Mission and the participating ground facilities is a pre-requisite for a positive scheduling decision. In all other cases, scheduling decisions will be made on the basis of negotiations between all parties involved.

The KSP teams will receive the results of the technical and science evaluation as well as the final ranking from the RadioAstron Mission by April 2013.

Scheduling of RadioAstron observations is undertaken on a month-by-month basis, with KSP teams to be notified in advance of their observations being conducted.

8 Data Rights

Any KSP team awarded RadioAstron observing time will have exclusive rights, within a specific proprietary period, to all interferometric data products and SRT scientific data arising from their KSP observations, with the exception of any data to be shared with another KSP team.

8.1 Proprietary Period

A 12 month proprietary period from the release by the correlator of each individual KSP observation will be allocated by the Mission for all data products produced at the ASC correlator from the KSP observations. For RadioAstron data obtained from the KSP observations and correlated at other correlator facilities, the 12 month rule will apply unless other arrangements have been negotiated between the KSP team, the respective correlator facility, and the ASC.

In exceptional circumstances, an extension of the proprietary period may be requested by the KSP teams and will be considered by the Mission.

8.2 Archive Data

After the expiration of the proprietary period, RadioAstron data resulting from KSP observations will be made publicly available and deposited in the RadioAstron archive facility.

A Acronyms and Abbreviations

AO	Announcement of Opportunity
ASC	Astro Space Center
Co-I	Co-Investigator
DSN	Deep Space Network
ESP	Early Science Program
EVPA	Electric Vector Polarization Angle
FCC	Flight Control Center
GBT	Green Bank Telescope
GOT	General Observing Time
GRT	Ground Radio Telescope
IAM	Institute of Applied Mathematics
JPL	Jet Propulsion Laboratory
KSP	Key Science Program
LA	Lavochkin Association
LCP	Left-hand Circular Polarisation
LoI	Letter of Intent
LRS	Laser Ranging Station
PI	Principal Investigator
RCP	Right-hand Circular Polarisation
RDF	RadioAstron Data Format
RISC	RadioAstron International Science Council
RPEC	RadioAstron Program Evaluation Committee
RSA	Russian Space Agency
RSTOG	RadioAstron Science and Technical Operations Group
SCS	Satellite Command Station
SEFD	System Equivalent Flux Density
SRT	Space Radio Telescope
STS	Satellite Tracking Station
ToO	Target of Opportunity
UT	Universal Time
VLBA	Very Long Baseline Array
VLBI	Very Long Baseline Interferometry
WSRT	Westerbork Synthesis Radio Telescope

B Addresses and Contact Information

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