# ILRS SLR MISSION SUPPORT REQUEST FORM

## SECTION I: MISSION INFORMATION:

**General Information:**

Satellite Name: SPECTER-R

Satellite Host Organization: Lavochkin Association, Russia

Web Address: http://www.laspace.ru

**Contact Information:**

Primary Technical Contact Information:

Name: Alexander Sheikhet

Address: 141400, Himki City, Moscow Region, Russia, Leningradskaya str., 24 , Lavochkin Association

Phone No.: 7-495-575-54-31

Fax No.: 7-495-573-87-10

E-mail Address: sheikhet@laspace.ru

Alternate Technical Contact Information:

Name: Mikhail Artyukhov

Address: 141400, Himki City, Moscow Region, Russia, Leningradskaya str., 24 , Lavochkin Association

Phone No.: 7-495- 573-84-65

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E-mail Address: artyukh@laspace.ru

Primary Science Contact Information:

Name: Roman Bebenin

Address: 117997, Moscow, GSP-7, Russia, Profsoyuznaya str., 84/32 AstroSpace Center

Phone No.: 7-495-333-2423

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E-mail Address: rbeben@asc.rssi.ru

Alternate Science Contact Information:

Name: Yuri Ponomarev

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**Mission Specifics:**

Scientific or Engineering Objectives of Mission: see Appendix: RADIOASTRON Booklet (The Ground – Space Interferometer: "radio telescope much larger than the Earth")

Satellite Laser Ranging (SLR) Role of Mission: SLR Role is very important for this Mission, because Mission is devoted to treat following astrometric problems:

1) Construction of a high precision celestial coordinate frame.
2) Development of a high precision model of the Earth gravitation field, and testing General Relativity by means of the precision redshift measurements.

Anticipated Launch Date: December of 2009

Expected Mission Duration: 5 years

Orbital Accuracy Required: As high as possible

**Anticipated Orbital Parameters:**

Altitude: 500 km – 350000 km

Inclination: 51.4 degrees

Eccentricity: 0.96

Orbital Period: 8.5 – 9.0 days

Frequency of Orbital Maneuvers: One Orbital Maneuver for one or two days

Mission Timeline: To be defined

**Tracking Requirements:**

Tracking Schedule: 30 – 60 minutes per 24 hours at request

Spatial Coverage:

Temporal Coverage:

**Operations Requirements:**

Prediction Center: Ballistic center of Keldysh Institute of Applied Mathematics

Prediction Technical Contact Information:

Name: Viktor Stepanyants

Address: 125047, Moscow, Russia, Miusskaya Sq. 4, Keldysh Institute of Applied Mathematics

Phone No.: 7-495-333-80-67

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E-mail Address: stepan@kiam1.rssi.ru

Priority of SLR for POD: SLR is additional to Other measurings (for astrometric goals)

Other Sources of POD (GPS, Doppler, etc.):

$D, \dot{D}$ will be processed by Control Stations (Bear Lakes & Ussuriysk) and Doppler will be processed by Tracking Stations constantly

Normal Point Time Span (sec): variable

Tracking Network Required (Full/NASA/EUROLAS/WPLTN/Mission Specific):

Stations with ability to perform Lunar Laser Ranging since $H_{apogee}$ ~350000 km

**SECTION II: TRACKING RESTRICTIONS:**

Several types of tracking restrictions have been required during some satellite missions. See *http://ilrs.gsfc.nasa.gov/satellite_missions/restricted.html* for a complete discussion.

1) Elevation restrictions: Certain satellites have a risk of possible damage when ranged near the zenith. Therefore a mission may want to set an elevation (in degrees) above which a station may not range to the satellite.
2) Go/No-go restrictions: There are situations when on-board detectors on certain satellites are vulnerable to damaged by intense laser irradiation. These situations could include safe hold position or maneuvers. A small ascii file is kept on a computer controlled by the satellite's mission which includes various information and the literal “go” or “nogo” to indicate whether it is safe to range to the spacecraft. Stations access this file by ftp every 5-15 minutes (as specified by the mission) and do not range when the flag file is set to “nogo” or when the internet connection prevents reading the file.
3) Segment restrictions: Certain satellites can allow ranging only during certain parts of the pass as seen from the ground. These missions provide station-dependent files with lists of start and stop times for ranging during each pass.
4) Power limits: There are certain missions for which the laser transmit power must always be restricted to prevent detector damage. This requires setting laser power and beam divergence at the ranging station before and after each pass. While the above restrictions are controlled by software, this restriction is often controlled manually.

Many ILRS stations support some or all of these tracking restrictions. See xxx for the current list. You may wish to work through the ILRS with the stations to test their compliance with your restrictions or to encourage additional stations that are critical to your mission to implement them.

The following information gives the ILRS a better idea of the mission's restrictions. Be aware that once predictions are provided to the stations, there is no guarantee that forgotten restrictions can be immediately enforced.

Can detector(s) or other equipment on the spacecraft be damaged or confused by excessive irradiation, particularly in any one of these wavelengths (532nm, 1064nm, 846nm, or 423nm)?

No

Are there times when the LRAs will not be accessible from the ground?

Yes, segmentation files to be developed

(If so, go/nogo or segmentation files might be used to avoid ranging an LRA that is not accessible.)

Is there a need for an altitude tracking restriction? ___No____ What altitude (degrees)? ________

Is there a need for a go/no-go tracking restriction? ___No____

For what reason(s)?

Is there a need for a pass segmentation restriction? Yes__________

For what reason(s)?

Because retroreflector array will be visible from Earth only for 30 – 60 minutes ____________________

Is there a need for a laser power restriction? No __________

Under what circumstances?

______________________________________________________________________

What power level ($mW/cm^2$)? _____________

Is manual control of transmit power acceptable? Yes __________

For ILRS stations to range to satellites with restrictions, the mission sponsor must agree to the following statement:
"The mission sponsor agrees not to make any claims against the station or station contractors or subcontractors, or their respective employees for any damage arising from these ranging activities, whether such damage is caused by negligence or otherwise, except in the case of willful misconduct."

Please initial here to express agreement: __________________________

Other comments on tracking restrictions:

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

## SECTION III: RETROREFLECTOR ARRAY INFORMATION:

A prerequisite for accurate reduction of laser range observations is a complete set of pre-launch parameters that define the characteristics and location of the LRA on the satellite. The set of parameters should include a general description of the array, including references to any ground-tests that may have been carried out, array manufacturer and whether the array type has been used in previous satellite missions. So the following information is requested:

Retroreflector Primary Contact Information:


Name: Vladimir Vasiliev

Address: 53 Aviamotornaya st., Moscow, 111250, Russia, IPIE

Phone No.: +7(495)7071358

Fax No.: +7(495)2349859

E-mail Address: lavaser@kmail.ru


Array type (spherical, hexagonal, planar, etc.), to include a diagram or photograph:

Planar array, see pictures 1-4 of Appendix

Array manufacturer: Single retroreflector assembly (LRR), 100 units - Science Research Institute for Precision Instrument Engineering (IPIE). The retroreflector array consisting of 100 LRR units is made by Lavochkin Research.

Link (URL or reference) to any ground-tests that were carried out on the array:

The LRA design and/or type of cubes was previously used on the following missions:

Cubes of similar design but with different coating (Al) used on GIOVE and GLONASS spacecraft.

For accurate orbital analysis it is essential that full information is available in order that a model of the 3-dimensional position of the satellite center of mass may be referred to the location in space at which the laser range measurements are made. To achieve this, the 3-D location of the LRA phase center must be specified in a satellite fixed reference frame with respect to the satellite's mass center. In practice this means that the following parameters must be available at mm accuracy or better:

The 3-D location (possibly time-dependent) of the satellite's mass center relative to a satellite-based origin:

See Appendix, Table 1

The 3-D location of the phase center of the LRA relative to a satellite-based origin:

See Appendix, Pictures 2-4 and Table 2

However, in order to achieve the above if it is not directly specified (the ideal case) by the satellite manufacturer, and as an independent check, the following information must be supplied prior to launch:

The position and orientation of the LRA reference point (LRA mass-center or marker on LRA assembly) relative to a satellite-based origin:
See Appendix, Picture 2

The position (XYZ) of either the vertex or the center of the front face of each corner cube within the LRA assembly, with respect to the LRA reference point and including information of amount of recession of front faces of cubes:
*N/A*

The orientation of each cube within the LRA assembly (three angles for each cube):

N/A

The shape and size of each corner cube, especially the height:

Each Laser Retroreflector (LRR) unit comprises a cube corner prism retroreflector (CCR) installed in a housing equipped with a 50-mm long cylindric sun shade. The LRR equivalent optical aperture diameter at normal incidence is 28.2 mm; the distance from the prism face center to the prism vertex is 19.1 mm. The height of one LRR unit is (46.5±1.5)g.

The material from which the cubes are manufactured (e.g. quartz):

fused silica (quartz)

The refractive index of the cube material, as a function of wavelength λ (micron):

$n_{0.423mc}$ =1.467856; $n_{0.532mc}$ =1.460694; $n_{0.846mc}$ =1.452340; $n_{1.064mc}$ =1.449666;

Dihedral angle offset(s) and manufacturing tolerance:

90°± 0.5”

Radius of curvature of front surfaces of cubes, if applicable:

N/A

Flatness of cubes’ surfaces (as a fraction of wavelength):

λ/20

Whether or not the cubes are coated and with what material:

Cubes are Ag

coated.

Other Comments:

**SECTION IV: MISSION CONCURRENCE**

As an authorized representative of the _RadioAstron__ mission, I hereby request and authorize the ILRS to track the satellite described in this document.

Name (print): _____Nikolay_Kardashev_________________________________ Date _______________

Signature: ________________________________________________________________________________

Position: _Director of Astro Space Center of Lebedev Physical Institute in Moscow, Russia

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