

ILRS SLR MISSION SUPPORT REQUEST FORM (version: January 2018)

SUBMISSION STATUS:

- New Submission (default)
- Incremental Submission (accepted only for a follow-on mission; fill-in new information only)
(provide the reference mission and the date approved by the ILRS: _____)

SECTION I: MISSION INFORMATION:

General Information:

Satellite Name: _____
Satellite Host Organization: _____
Web Address: _____

Contact Information:

Primary Technical Contact Information:

Name: _____
Organization and Position: _____
Address: _____
Phone No.: _____
E-mail Address: _____

Alternate Technical Contact Information:

Name: _____
Organization and Position: _____
Address: _____
Phone No.: _____
E-mail Address: _____

Primary Science Contact Information:

Name: _____
Organization and Position: _____

Address: _____
Phone No.: _____
E-mail Address: _____

Alternate Science Contact Information:

Name: _____
Organization and Position: _____
Address: _____
Phone No.: _____
E-mail Address: _____

Mission Specifics:

Scientific or Engineering Objectives of Mission:
(specify)

Role of Satellite Laser Ranging (SLR) for the Mission:
(specify)

Anticipated Launch Date: _____
Expected Mission Duration: _____
Required Orbital Accuracy: _____

Anticipated Orbital Parameters:

Altitude (Min & Max for eccentric orbits): _____ km

Inclination: _____ degrees
 Eccentricity: _____
 Orbital Period: _____
 Frequency of Orbital Maneuvers: _____

Mission Timeline:
 (example)

Should include when SLR is to start within the mission timeline, such as "on insertion into orbit" or "launch +N" days.

Tracking Requirements:

Tracking Schedule: horizon-to-horizon custom (specify: _____)
 Spatial Coverage: global ILRS network custom (specify: _____)
 Temporal Coverage: full-time custom (specify: _____)
 Normal Point Bin Size (Time Span): _____ seconds

(Choose one from 5, 15, 30, 120 and 300 seconds. Justify if other bin size is required.)

(See the "Bin Size" of other satellites on the ILRS Web site at
http://ilrs.gsfc.nasa.gov/missions/satellite_missions/current_missions/index.html .)

Prediction Center: _____

Prediction Technical Contact Information:

Name: _____

Organization and Position: _____

Address: _____

Phone No.: _____

E-mail Address: _____

Priority of SLR for POD: Primary Secondary Backup

Other Sources of POD:

GNSS DORIS Accelerometer other (specify: _____)

Other comments on mission information:

(specify) (list backup prediction centers and references/links to non-SLR techniques if available)

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. 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.

Are there any science instruments, detectors, or other instruments on the spacecraft that can be damaged or confused by excessive radiation, particularly in any one of these wavelengths (532nm, 1064nm, 846nm, or 432nm)?

No Yes (specify the instrument or
 detector in question, providing
 the wavelength bands and
 modes of sensitivity.)

..

Are there times when the LRA (Laser Retroreflector Array) will not be accessible from the ground?

No Yes (specify: _____)

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

→ Skip the next questions and go directly to SECTION III if you answered "No" to both of the above questions.

Is there a need for an elevation tracking restriction?

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No Yes (What elevation (minimum to maximum in degrees)? _____ degrees)

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

No Yes (Explain the reason(s) _____)

Is there a need for a pass segmentation restriction?

No Yes (Explain the reason(s) _____)

Is there a need for a laser power restriction?

No

Yes (Under what circumstances? _____)

(What is the maximum permitted power level **at** the satellite (nJ/cm²)? _____)

(Is manual control of laser transmit power acceptable? Yes No)

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 provide signature to express agreement to above statement:

Signature: _____

Date: _____

Name (print): _____

Organization and Position: _____

Other comments on tracking restrictions:

(specify)

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: _____

Organization and Position: _____

Address: _____

Phone No.: _____

E-mail Address: _____

Array type:

Single reflector Spherical Hemispherical/Pyramid Planar

other (specify: _____)

Attach a diagram or photograph of the satellite that shows the position of the LRA, at the end of this document.

Attached

Attach a diagram or photograph of the whole LRA at the end of this document.

Attached Same as above, Not attached (acceptable only for a cannonball satellite)

Array manufacturer:

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

Has the LRA design and/or type of cubes been used previously?

No Yes (List the mission(s): _____)

For accurate orbital analysis it is essential that full information is available in order that 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-body-fixed reference frame with respect to the satellite's mass center. In practice this means that the following parameters must be available at 1 mm accuracy or better.

Define the satellite-body-fixed XYZ coordinates (i.e. origin and axes) on the spacecraft:
(specify) (add a diagram in the attachment)

Relate the satellite-body-fixed XYZ coordinates to a Celestial/Terrestrial/Solar Reference Frame including the attitude control policy:
(specify) (add a diagram in the attachment)

The 3-D location of the satellite's mass center in satellite-body-fixed XYZ coordinates is:

Always fixed at (0, 0, 0)

Always fixed at (_____, _____, _____) in mm

Time-varying by approximately (_____) mm during the mission lifetime.

Will a time-variable table of the mass center location be available on the web?

No Yes (URL: _____)

The 3-D location (or time-variable range) of the phase center of the LRA in the satellite-body-fixed XYZ coordinates:

(_____, _____, _____) in mm

The following information on the corner cubes must also be supplied.

The XYZ coordinates referred to in the following are given in:

Satellite-body-fixed system (same as above)

LRA-fixed system (specify below)

(specify the origin and orientation) (add a diagram in the attachment)

List the position (XYZ) of the center of the front face of each corner cube, and the orientation (two angles or normal vector) and the clocking (horizontal rotation) angle of each corner cube. Note that the angles should be clearly defined.

Attached at the end of this document

Listed here (acceptable for small number (10 or fewer) of corner cubes)
(specify) (add a diagram in the attachment)

Is the corner cube recessed in its container (i.e. can the container obscure a part of the corner cube)?

No Yes (specify below)

(specify) (add a diagram)

The size of each corner cube: Diameter (_____) mm Height (_____) mm

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

The refractive index of the cube material

= _____ for wavelength $\lambda = 0.532$ micron

= _____ as a function of wavelength λ (micron):

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

= _____ for wavelength $\lambda = 0.532$ micron

= _____ as a function of wavelength λ (micron):

Dihedral angle offset(s) and manufacturing tolerance (in arcseconds):

Radius of curvature of front surfaces of cubes:

Not applied Yes (specify: _____)

Flatness of cubes' surfaces:

Back-face coating:

Uncoated Coated (specify the material: _____)

Other comments on LRA:

(specify) (add a reference to a study of the optical response simulation/measurement if available) (add a diagram if applicable)

SECTION IV: MISSION CONCURRENCE

The ILRS is a voluntary organization that operates under the auspices of the International Association of Geodesy (IAG). The ILRS adheres to the IAG policy to make all acquired laser ranging data and derived products publicly available. We request that the mission website, as well as mission publications, reference the scientific work derived from ILRS data and derived products, **acknowledge** the role of the ILRS. This acknowledgment is crucial for the continued support from the funding agencies of the ILRS participating organizations.

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

Name (print): _____

Organization and Position: _____

Signature: _____

Date: _____

Send form to: ILRS Central Bureau
c/o Carey Noll
NASA GSFC
Code 61A
Greenbelt, MD 20771
USA
301-614-6542 (Voice)
301-614-6015 (Fax)
Carey.Noll@nasa.gov

SECTION V: ATTACHMENT(S)

Attachments of ILRS SLR Mission Support Request Form for BeiDou3-M1

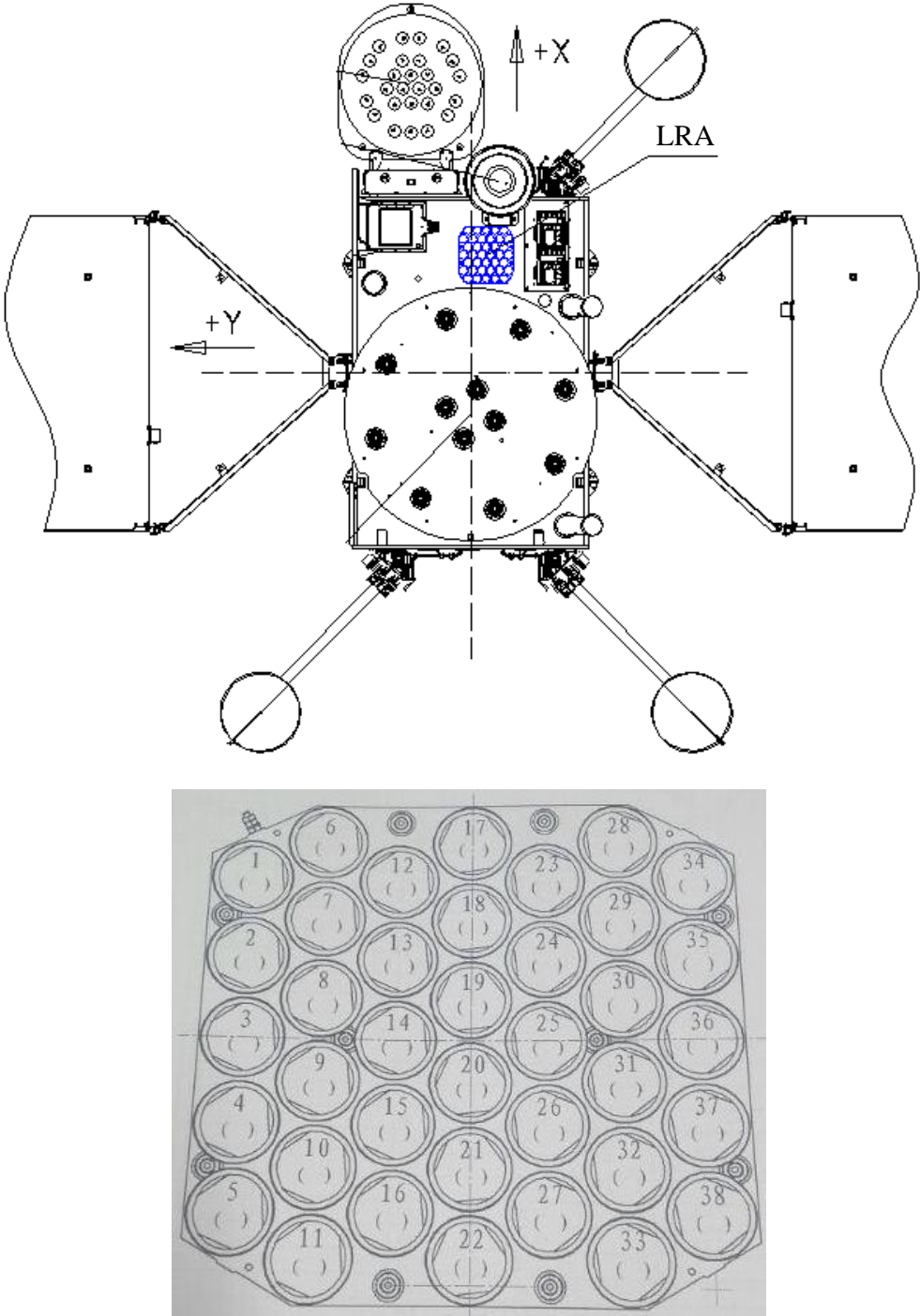


Fig.1 The position of LRA on the BeiDou3-M1 satellite

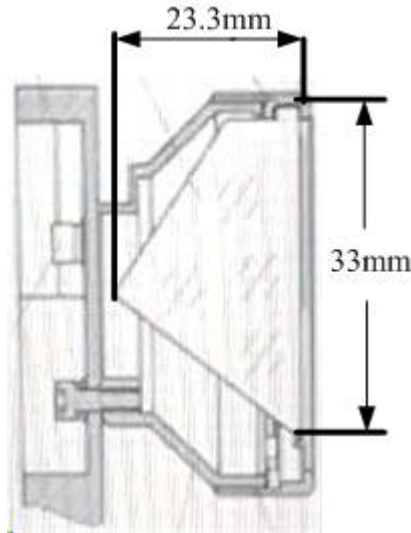


Fig.2 The structure of single CCR on BeiDou3-M1 satellite

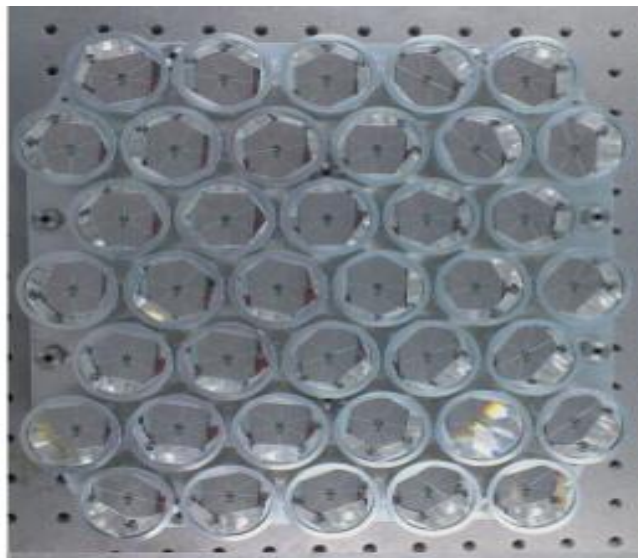


Fig.3 The installation of LRA on BeiDou3-M1 satellite

The planar shape of LRA is applied by the way of the each CCR on the same plane and the normal vector of each CCR points to the earth's center (Z). The distance between the front face of CCR and the phase center of LRA is 8.16mm. So the Z value of the center of the front face of each corner cube is $1137.737\text{mm} + 8.16\text{mm} = 1145.897\text{mm}$. The positions (XYZ) of the center of the front face of each corner cube are following and the orientation (two angles or normal vector) and the clocking (horizontal rotation) angle of each corner cube are random.

Table 1 The position (XYZ) of of the center of the front face of each corner cube

No.	X(mm)	Y(mm)	Z(mm)
1	-115	100.3	1145.897

2	-115	53.5	1145.897
3	-115	6.7	1145.897
4	-115	-40.1	1145.897
5	-115	-86.9	1145.897
6	-73.8	123.7	1145.897
7	-73.8	76.9	1145.897
8	-73.8	30.1	1145.897
9	-73.8	-16.7	1145.897
10	-73.8	-63.5	1145.897
11	-73.8	-110.3	1145.897
12	-32.6	100.3	1145.897
13	-32.6	53.5	1145.897
14	-32.6	6.7	1145.897
15	-32.6	-40.1	1145.897
16	-32.6	-86.9	1145.897
17	8.6	123.7	1145.897
18	8.6	76.9	1145.897
19	8.6	30.1	1145.897
20	8.6	-16.7	1145.897
21	8.6	-63.5	1145.897
22	8.6	123.7	1145.897
23	49.8	100.3	1145.897
24	49.8	53.5	1145.897
25	49.8	6.7	1145.897
26	49.8	-40.1	1145.897
27	49.8	-86.9	1145.897
28	91	123.7	1145.897

29	91	76.9	1145.897
30	91	30.1	1145.897
31	91	-16.7	1145.897
32	91	-63.5	1145.897
33	91	-110.3	1145.897
34	132.2	100.3	1145.897
35	132.2	53.5	1145.897
36	132.2	6.7	1145.897
37	132.2	-40.1	1145.897
38	132.2	-86.9	1145.897

Refractive Index and Dispersion:

Conditions: 22 °C, 760 mm Hg, N ₂				
Wavelength [Vacuum] [nm]	Refractive Index ² n	Thermal Coefficient $\Delta n/\Delta T^3$ [ppm/C]	Polynomial Dispersion Equation Constants ¹ , 22 °C	
1128.950	1.448866	9.6	A ₀	2.104025406E+00
1014.260 n _i	1.450241	9.6	A ₁	-1.456000330E-04
852.344 n _s	1.452463	9.7	A ₂	-9.049135390E-03
706.714 n _r	1.455144	9.9	A ₃	8.801830992E-03
656.454 n _c	1.456364	9.9	A ₄	8.435237228E-05
632.990	1.457016	10.0	A ₅	1.681656789E-06
587.725 n _d	1.458461	10.1	A ₆	-1.675425449E-08
546.227 n _e	1.460076	10.2	A ₇	8.326602461E-10
486.269 n _f	1.463123	10.4	Sellmeier Dispersion Equation Constants ² , 22 °C	
435.957 n _g	1.466691	10.6		
404.770 n _h	1.469615	10.8	A ₁	0.68374049400
365.119 n _i	1.474539	11.2	A ₂	0.42032361300
334.244	1.479764	11.6	A ₃	0.58502748000
312.657	1.484493	12.0		
253.728	1.505522	13.9	B ₁	0.00460352869
228.872	1.521154	15.5	B ₂	0.01339688560
214.506	1.533722	17.0	B ₃	64.49327320000
206.266	1.542665	18.1	An/ΔT Dispersion Equation Constants ³ , 20-25 °C	
194.227	1.558918	20.3		
184.950	1.575017	22.7	C ₀	9.390590
			C ₁	0.235290
			C ₂	-1.318560E-03
			C ₃	3.028870E-04
Other Optical Properties				
nF-nC'			0.006797	
Stress Coefficient			35.0 nm/cm MPa	
Abbe Constants:				
V _e			67.6	
V _d			67.8	

*1 Polynomial Equation: $n^2 = A_0 + A_1 \lambda^4 + A_2 \lambda^2 + A_3 \lambda^{-2} + A_4 \lambda^{-4} + A_5 \lambda^{-6} + A_6 \lambda^{-8} + A_7 \lambda^{-10}$ with λ in μm

*2 Sellmeier Equation: $n^2 - 1 = A_1 \lambda^2 / (\lambda^2 - B_1) + A_2 \lambda^2 / (\lambda^2 - B_2) + A_3 \lambda^2 / (\lambda^2 - B_3)$ with λ in μm

*3 $\Delta n/\Delta T$ Equation: $\Delta n/\Delta T$ [ppm/C] = $C_0 + C_1 \lambda^{-2} + C_2 \lambda^{-4} + C_3 \lambda^{-6}$ with λ in μm

The above dispersion equations for SiO₂ were fit to the refractive indices of 20 wavelengths from 1129 nm to 185 nm.