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: PAZ

Satellite Host Organization: HISDESAT

Web Address: www.hisdesat.es

Contact Information:

Primary Technical Contact Information:

Name: Miguel Ángel García Primo

Organization and Position: Hisdesat Operations and Programs Director

Address: Hisdesat. Paseo de la Castellana, 149. 5th floor

Phone No.: +34 91 449 0149

E-mail Address: magarciap@hisdesat.es

Alternate Technical Contact Information:

Name: Miguel Ángel Serrano Ortega

Organization and Position: Hisdesat Head of Spacecraft Operations Department

Address: Hisdesat. Paseo de la Castellana, 149. 5th floor

Phone No.: +34 91 449 0149

E-mail Address: maserrano@hisdesat.es

Primary Science Contact Information:

Name: Carlos González González

Organization and Position: Hisdesat. PAZ Flight Dynamics responsible

Address: Hisdesat. Paseo de la Castellana, 149. 5th floor

Phone No.: +34 91 449 0149

E-mail Address: cgonzalez@hisdesat.es

Alternate Science Contact Information:

Name: __________

Organization and Position: __________

Address: __________

Phone No.: __________

E-mail Address: __________

Mission Specifics:

Scientific or Engineering Objectives of Mission:
(specify)

Main Objective:
* To provide X-Band SAR (Synthetic Aperture Radar) images for a dual use (civil and defense).
Secundary objectives:
* To provide Radio-Occultation data suitable to be ingested in numerical weather prediction models (NWP) in near-real time, to contribute reducing the forecast error.
* To provide a SAR data fusion capability for maritime surveillance from space with AIS (Automatic Identification System) data services

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

Laser ranging will help in the calibration of the on-board microwave Precise Orbit Determination system (IGOR GPS receiver).

Anticipated Launch Date: February 22nd, 2018

Expected Mission Duration: 5.5 years

Required Orbital Accuracy: 20 cm (target < 10 cm) 3D 1σ

Anticipated Orbital Parameters:

Altitude (Min & Max for eccentric orbits): 514 km

Inclination: 97.44 degrees

Eccentricity: 0

Orbital Period: 94.85 minutes

Frequency of Orbital Maneuvers: From 2-3 days (High Solar activity) to more than 1 week

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

Launch + 4 months

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): 5 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: CEIT (Centro Espacial Inta Torrejón)

Prediction Technical Contact Information:

Name: Carlos González González

Organization and Position: Hisdesat. PAZ Flight Dynamics responsible

Address: INTA Torrejón. Carretera de Ajalvir, Km 4. 28850 Madrid

Phone No.: +34 91 449 01 49

E-mail Address: cgonzalez@hisdesat.es

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)

PAZ Backup prediction center is located at CEC (Centro Espacial Canarias of INTA) in the south of Gran Canaria island. In the Canary Islands. PAZ backup prediction center is aimed to provide a safe control of PAZ satellite in case of a complete unavailability the of Main Center. POD activies will not be carried out from CEC.

PAZ is equipped with two GPS receivers for its Nominal Orbit Determination and POD.

MosaicGNSS, a single frequency GPS L1 C/A code receiver. Mosaic PVT solutions are also used by PAZ AOCS and OBT.

IGOR, a dual frequency GPS receiver which provides positioning information by means of two dedicated L-band patch antennas with a dedicated ground plane that enhances the antenna performances. A dual-polarized L-band antenna with electronic tilt captures the occultation data for the scientific community.

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, 1064nn, 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?

⦿ 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/cm^2)? __________)

(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: Dr.-Ing. Sven Bauer

Organization and Position: GFZ. Global Geomonitoring and Gravity Field

Address: Telegrafenberg Building C 4, Room 1.18

14473 Potsdam

Phone No.: +49 331 288-1738

E-mail Address: sven.bauer@gfz-potsdam.de

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:

GFZ German Research Centre for GeoSciences

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

http://ilrs.gsfc.nasa.gov/docs/rra_champ.pdf

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

○ No ⦿ Yes (List the mission(s): CHAMP, GRACE, TerraSAR-X, TanDEM-X and KOMPSAT-5)

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)

Satellite Mechanical Build System (M or Mech). The satellite mechanical build system is centred at the geometrical centre of the "old" separation plane (Dnepr). The XM axis is pointing in the nominal flight direction of the satellite. The ZM axis is pointing along the line of sight of the SAR antenna while the YM axis completes aright hand system. Coordinates of CoM from Mechanical Build System: CoM (BOL) [mm] [2086.6, -17.4, 19.1] CoM (EOL) [mm] [2193.2, -18.5, 19.9] LRA coordinates are provided in this Mechanical Build System

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 body fixed satellite system (B) is the reference system in AOCS. Its origin is at the centre of mass of the spacecraft. XB– Axis: Parallel to XMech; in nominal flight direction; pointing from COM towards the tip of the satellite YB–Axis: Forming a right handed Cartesian system with XB and ZB ZB–Axis: In nominal flight orientation pointing towards nadir (variations around nadir are defined by the total zero Doppler steering and the possibility to command small offset angles). The ZB axis is derived from the ZMech axis by a rotation around XMech of 33.8°

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 (106.6) 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)

Position of the center of the reflectors with respect to the Mechanical Frame.

	Reflector 1 (mm)	Reflector 2 (mm)	Reflector 3 (mm)	Reflector 4 (mm)
XMech	944.263	991.737	991.737	944.263
YMech	-715.212	-715.212	-754.663	-754.663
ZMech	715.028	715.028	688.619	688.619

Orientation of the LOS(Line of Sight) of each reflector with respect to the Mechanical Frame.

Angle definition	Reflector 1 (deg)	Reflector 2 (deg)	Reflector 3 (deg)	Reflector 4 (deg)
LOS - XMech	123.05	56.94	58.21	121.78
LOS - YMech	86.69	86.69	143.83	143.83
LOS - ZMech	33.26	33.26	74.57	74.57

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 (39) mm Height (47.41) mm

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

Quartz

The refractive index of the cube material

= 1.4608 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):

= 1.4855 for wavelength $\lambda = 0.532$ micron

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

Dihedral angle offset(s) and manufacturing tolerance (in arcseconds):
-3.8" (smaller than 90 deg)

Radius of curvature of front surfaces of cubes:

○ Not applied ⦿ Yes (specify: +500 m (convex))

Flatness of cubes' surfaces:

Back-face coating:

○ Uncoated ⦿ Coated (specify the material: aluminum)

Other comments on LRA:

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

http://ilrs.gsfc.nasa.gov/docs/rra_champ.pdf

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 PAZ mission, I hereby request and authorize the ILRS to track the satellite described in this document.

Name (print): MIGUEL ÁNGEL GARCÍA PRIMO

Organization and Position: Hisdesat Operations and Programs Director

Signature: Miguel A. Gª Pri

Date: July 17th, 2018

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)