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DIRECTION CENTRE SPATIAL DE TOULOUSE

SOUS-DIRECTION : PROJETS ORBITAUX

SERVICE : ALTIMÉTRIE

SARAL

AltiKa and ARGOS-3 on SSB

SARAL CHARACTERISTICS FOR DORIS CALIBRATION PLAN AND POD PROCESSING

	Date	Signature
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DOCUMENT CHANGE RECORD

Issue	Rev	Date	Pages	Modifications	Visa
0	0	04/09/2007	all	First issue for TMD4 definition	
0	1	17/09/2008	all	Issue for DIODE Vxx	
0	2	13/10/2008	all	Reference frame precision, Thermo-optic characteristics update, DORIS instruments characteristics added Issue for DIODE Vxx	
0	3	12/03/2009	all	Thermo-optical characteristics updated, DORIS receiver on-board transit time and cable losses characteristics added Issue for DIODE Vxx	
1	0	10/05/2010		Issue for DIODE V4.03, DORIS LV9.0 Satellite Characteristics updates : - Mass and CoM - Surfaces characteristics - Thermo-optical characteristics	
1	1	18/11/2011		Issue for DIODE V4.05 Satellite Characteristics updates (due to SSB size increase, PIM mass increase, update of PIM and SSM surfaces) : - Thermo-optical characteristics - Surfaces characteristics - Mass and CoM	
2	0	14/02/2013		§4.6 Mass and CoG update after S/C MCI measurement §4.7 ARGOS UHF antenna position updated to take into account SSB accommodation modification §4.8.1.5 DORIS resulting total cables loss correction §5.9 LRA characteristics added §5.10 AltiKa antenna reference added	
2	1	30/04/2013		§4.5 and §4.6 : Mass and CoG updated after S/C Orbit Acquisition maneuvers and the 2 first Station Keeping maneuvers	

Issue	Rev	Date	Pages	Modifications	Visa
				§4.7 DORIS antenna mechanical position and LRA mechanical position updated to take insulation washers into account §4.9 LRA characteristics updated, position of the Optical Center and range correction added	
2	2	03/05/2013		§4.8.1.1 - table7 DORIS antenna center of phase in PIM reference plane : updated position in Z PIM (update forgot in the V2.1)	

TERMINOLOGY AND ABREVIATION

Acronym	Definition
AD	Applicable Document
A-DCS	ARGOS Data Collection System
ALK	AltiKa altimeter/radiometer equipment
BDR	Boîtier DORIS Redondant
DORIS	Détermination d’Orbite et Radiopositionnement Intégré par Satellite
DR	Document de Référence
ICU	Interface Control Unit
LRA	Laser Reflector Array
LTX	ARGOS L-band Transmitter
N/A	Not Applicable
PIM	Payload Interface Module
RD	Reference Document
SSB	Small Satellite Bus
TBC	To Be Confirmed
TBD	To Be Defined

APPLICABLE AND REFERENCE DOCUMENTS

APPLICABLE DOCUMENTS

Reference	Title of document	
DOA-RP-D13-EA-15875-SR	AD1	Antennes DORIS reference 522417 rapport d'essai d'acceptation du modèle MV17
200396017H issue 04/a	AD2	SARAL Final flight THERMAL ANALYSIS
001_SARAL_Liv_20110921_3DVI A.exe	AD3	SARAL model
ISAC/SSK/SARAL-2013/pp2	AD4	SARAL S/C Mass properties
AIT-ES-ENV-TAS-PR-11033 issue 01	AD5	Procédures d'intégration - Mesures Masse et Centrage SARAL
REQ-1844-66-114-C	AD6	RAPPORT D'ESSAIS DE QUALIFICATION DE L'ANTENNE PROTOTYPE FLIGHT MODEL – ARGOS3 UHF antenna
4899-000-ID-09-C	AD7	LRA SARAL – Interface Control Document
SRL-LRA-NT-266-CNES	AD8	LOI DE PHASE DU LRA DE LA MISSION ALTIKA
ALK-ALT-NT-483-CNES	AD9	Définition des paramètres pour le fichier de caractérisation sol altimètre AltiKa
200251391F	AD10	Manuel Utilisateur AltiKa
1142776/949	AD11	AltiKa K/KA Antenna data for integration and alignment

REFERENCE DOCUMENTS

Reference	Title of document
	RD1

TBC AND TBD LIST

TBC/TBD	Section	Brief description

TABLE OF CONTENTS

1. PURPOSE

This document describes the SARAL satellite characteristics necessary for:

- Definition of a test orbit as much representative of the flight as possible. This test orbit will be used for DORIS receivers acceptance tests (called TMD4)

- Tuning the DORIS receiver and on-board software, before and during their flight on-board the SARAL satellite. The values of the different parameters provided hereafter are necessary to ensure optimal parameterization of on-board software

- Precise Orbit Determination processing based on DORIS and Laser ranging data, or based on ARGOS-3 measurements.

2. SCOPE

This document is applicable to the SARAL project during development, system test, flight acceptance and operational phases.

3. MISSION ORBIT CHARACTERISTICS

3.1 NOMINAL ORBIT

The main characteristics of the nominal Sun-Synchronous Orbit for the SARAL mission are :

Mean classical orbits elements	
- Repeat period	35 days
- Number of revolution within a cycle	501
- Apogee altitude	814 km
- Perigee altitude	786 km
- Inclination	98.55 deg
- Argument of perigee	90.0 deg
- Local time at ascending node	06:00
- Earth Longitude of equator ascending crossing of pass1	0.1335 deg
- Ground track control band	+/- 1 km
Auxiliary data	
- Semi major axis	7159.496 km
- Eccentricity	$1.165\ 10^{-3}$
- Nodal period	100.59 mn

- Number of orbits per day	14+11/35
- Equatorial cross track separation	75 km
- Inertial nodal rate	0.9856 deg/day
- Mean Orbital speed	7.47 km/s

3.2 ORBIT REFERENCE

Position / Velocity in ITRF reference frame.

Initial bulletin SARAL

TAI Date : 01/06/2010 00h00m40s000ms

TAI-TUC=+34s

SARAL initial bulletin		
X	1009062.02770989	m
Y	2290308.93493495	m
Z	6702925.17577187	m
VX	517.49997391	m/s
VY	-7144.97190880	m/s
VZ	2358.48851492	m/s

3.3 ORBIT CONTROL MANOEUVER

During semi major axis correction orbital maneuvers (increase of semi major axis) the PIM +Y axis is positioned according to the velocity axis (pitch maneuver around the Z axis of 90°, the launcher IF side being at the opposite direction of the velocity), and it remains in this configuration position during at the most 30 minutes (cf. § 4.1 for satellite axis definition).

This maneuver configuration can be repeated every 2 to 4 weeks during the satellite lifetime in orbit in order to keep the ground track within +/- 1 kilometer.

To maintain the ground track under the worst case scenario corresponding to a high Solar activity period, a semi-major axis maneuver will induce an orbit raise of 25m for a weekly based maneuver period (70m every 20 days), i.e. a ΔV of about 6.5 mm/s.

The transitory positioning effects during the satellite axis return would be neglected.

Inclination maneuver would not be necessary.

3.4 ATTITUDE MODE

The satellite pointing law is NADIR (yaw fix).

DIODE is following the nominal attitude law. It will not receive any quaternion or attitude information from the platform.

3.5 SATELLITE SAFE-HOLD MODE

During Satellite SAFEHOLD MODE, DORIS is switched OFF.

3.6 SPECIFIC USE OF THE GEODETIC BULLETINS

DORIS Geodetic bulletins will be used for on board AltiKa altimeter tracking :

- Number of orbits in the cycle : 501
- Longitude of the first ascending node of the cycle : 0.1335 deg

4. SATELLITE DESCRIPTION

4.1 SATELLITE VIEW AND REFERENCE FRAME

The reference frames are defined here after:

- orbital reference frame (G, X, Y, Z)
- satellite reference frame (P, X, Y, Z)
- Payload module reference frame PIM (O, X, Y, Z)

In order to simplify, the orbit will be considered as circular which allows having the axis in the same direction for each reference frame :

- The Yaw axis is parallel to the launcher interface plane and oriented in the NADIR direction.
- The Roll axis is parallel to the launcher interface plane and is parallel to the velocity vector.
- The Pitch axis completes the right-handed orthogonal reference frame (this axis perpendicular to the launcher interface plane and perpendicular to the orbital plane (orientated in the opposite direction to the orbital plane normal direction).

For the three reference frames, the origin is different :

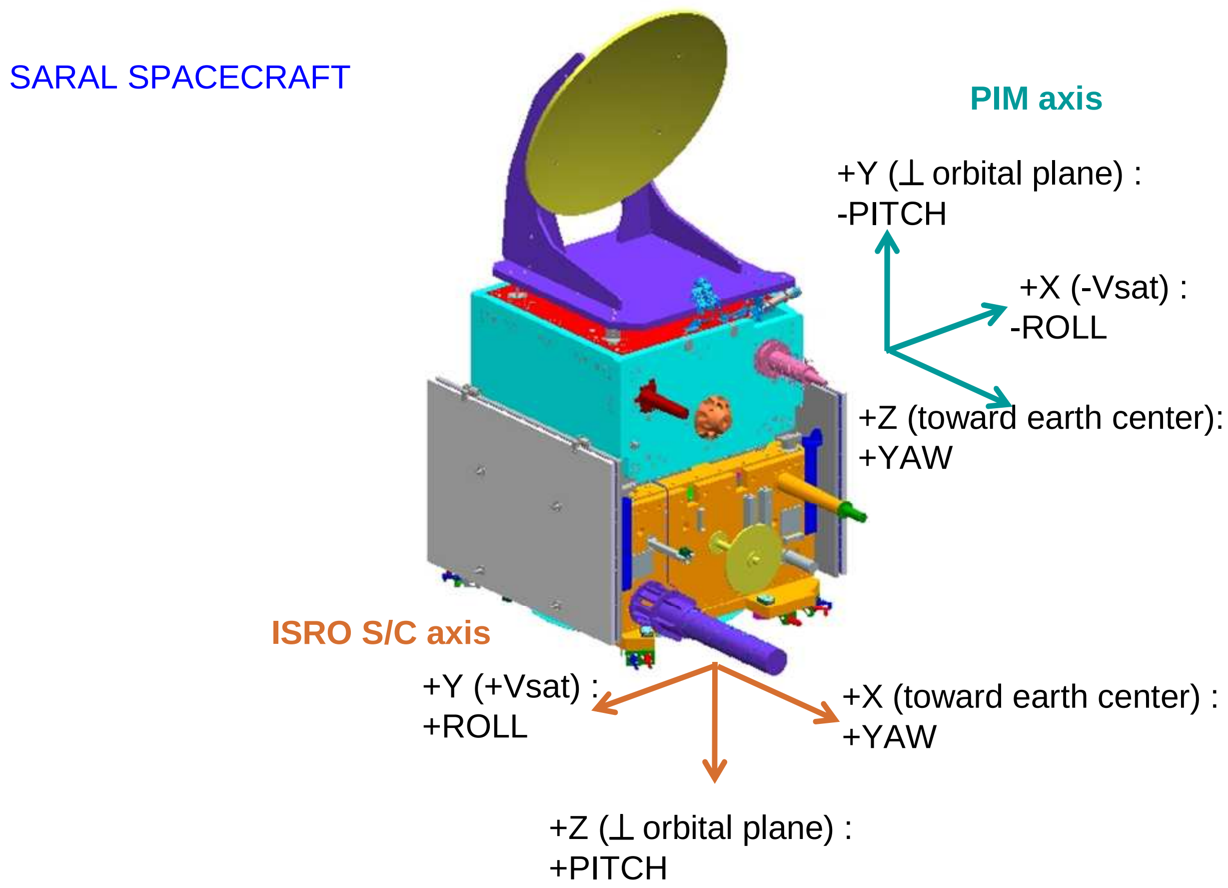
- G is the spacecraft center of mass in operational conditions
- P is located at the center of the launch vehicle interface circle : at the bottom of the SSB interface ring and at the top of the launch vehicle interface ring.
- O is the geometric center of the four upper surfaces of the SSB pods, in the PIM baseplate plane.

The sign conventions for SARAL are as below:

Axis	On S/C	Satellite reference (P, X, Y, Z)	PIM reference (O, X, Y, Z)
Yaw (towards earth center)	Lateral (1)	+X	+Z
Roll (+Vsat)	Lateral (2)	+Y	-X
Pitch (⊥ orbital plane)	Longitudinal	+Z	-Y

Table 1 : SARAL sign conventions

The satellite and PIM reference frames are presented hereafter in Figure 1 : Mechanical reference frame and “earth face” view.



PIM AXIS DEFINITION (to be used for DORIS DIODE ZQS)

Figure 1 : Mechanical reference frame and “earth face” view

4.2 THERMO-OPTICAL PROPERTIES

It may be noticed that the thermo-optical properties of the satellite surfaces evolve along the life of the satellite mainly because of the degradation of materials due to radiation and other space environment. This evolution is not very well known. Nevertheless, the following table gives the optical coefficients for the beginning of life which can be considered with accuracy better than 10%.

4.2.1.1.1 Materials thermo-optical characteristics

The hereafter table gives the thermo optical coefficient values which have been considered for the PIM module coating materials, for the SSB platform module and for the AltiKa antenna ones.

PIM (2)					
	ε	**specularity specular refraction**	**specularity diffuse refraction**	**αmin**	**αmax**
SSM	0,78	0,85	0,00	0,10	0,20
MLI	0,61	0,40	0,225	0,35	0,40

SSB (3)					
	ε	**specularity specular refraction**	**specularity diffuse refraction**	**αmin**	**αmax**
MLI	0,55	0,40	0,26	0,340	0,34
Black paint	0,90	0	0,05	0,950	0,95
OSR	0,78	0,855	0,00	0,080	0,21

AltiKa Antenna (1)					
	ε	**specularity specular refraction**	**specularity diffuse refraction**	**αmin**	**αmax**
MLI	0,60	0,40	0,17	0,36	0,50
KaGe sunshield	0,95	0,25	0,08	0,65	0,69

Table 2 : Materials thermo-optical characteristics

(1) CDR AltiKa antenna values : doc ref 1045643/449 issue 00:- dated Nov 15th, 2007

(2) PDR PIM values

(3) SSB Incremental Review Feb 2010 values

4.2.1.1.2 Thermo-optical coefficients

The following table gives the thermo-optical coefficient values which are deducted for the different SARAL satellite surfaces; based on PIM thermal analysis AD2 and SARAL model AD3.

These values are established as global values for each surface, taking into account the different properties of the different materials, and their respective contributions to the global coefficient.

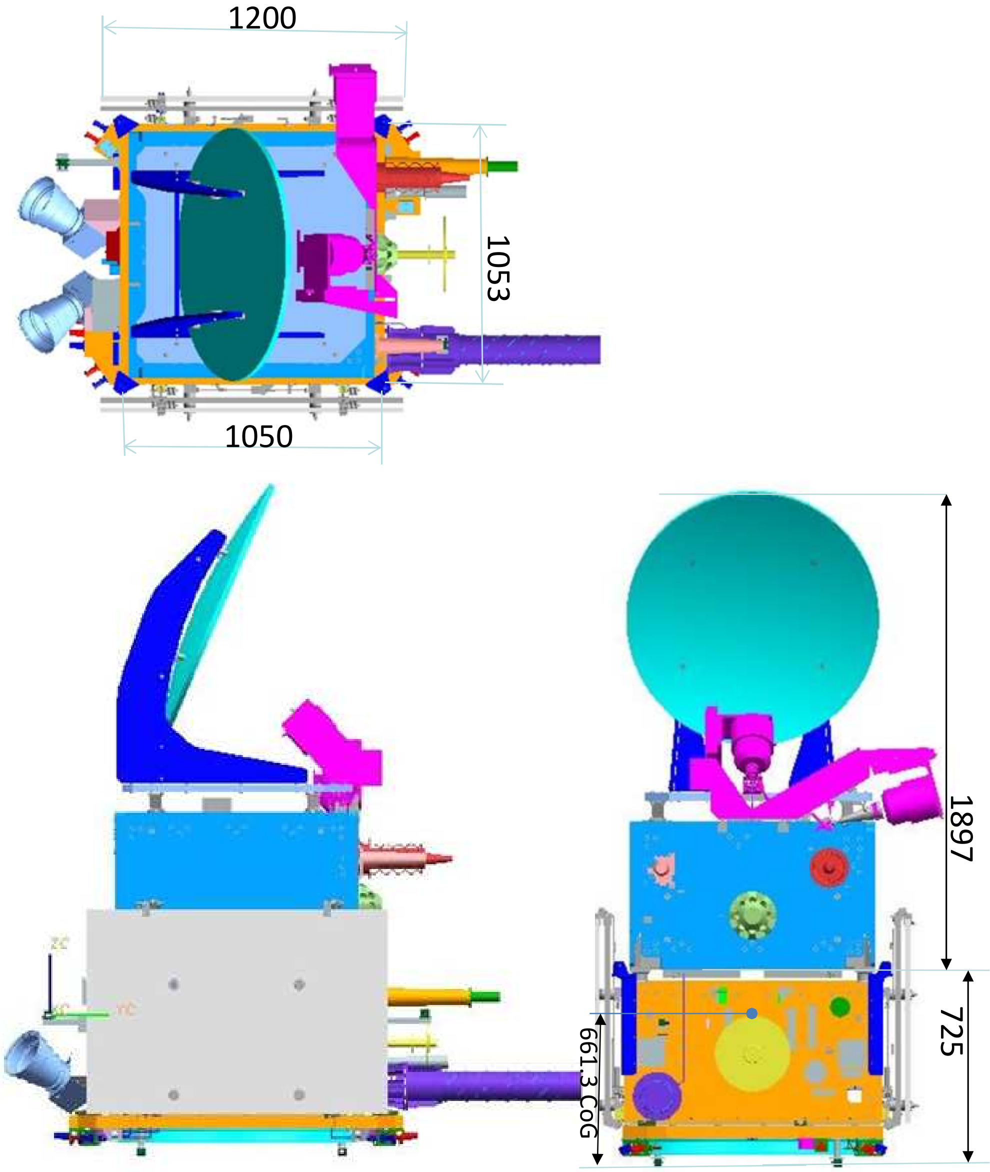
Localization In PIM reference frame	Panel Name	Panel Surface m²	Radiator surface m²	%age of radiators surfaces	Surface characteristics	Ξ emissivity (IR emittance)	Ξ_s specular refraction	Ξ_d diffuse refraction	Ξ absorptivity (solar absorptance) Ξ_{mean}
PIM [+X] panel		0,575000	0,366300	63,7%	64% SSM	0,718	0,687	0,082	0,232
PIM [-X] panel		0,575000	0,351400	61,1%	62% SSM	0,714	0,675	0,087	0,237
PIM [+Y] panel	Top face	0,946729		0,0%	100% MLI	0,610	0,400	0,225	0,375
PIM [-Y] panel	Bottom face	0,946729		N/A	N/A	0,000	0,000	0,000	N/A
PIM [+Z] panel	Earth face	0,574000		0,0%	100% MLI	0,610	0,400	0,225	0,375
PIM [-Z] panel	Anti earth face	0,574000	0,262600	45,7%	46% SSM	0,688	0,606	0,122	0,272
SSB [+X] panel	EP04	1,145000	0,314200	27,4%	27% OSR	0,613	0,525	0,189	0,286
SSB [-X] panel	EP02	1,145000	0,315100	27,5%	23% OSR	0,613	0,524	0,163	0,286
SSB [+Y] panel	Top panel	1,600000		0,0%	NA	0,550	0,400	0,260	0,340
SSB [-Y] panel	Bottom Panel	1,600000		0,0%	100% MLI	0,550	0,400	0,260	0,340
SSB [+Z] panel	EP01 EV	0,787000		0,0%	100% MLI	0,550	0,400	0,260	0,340
SSB [-Z] panel	EP03 AEV	0,787000	0,174100	22,1%	22% OSR	0,601	0,501	0,202	0,297
Solar arrays [front side with solar cells] [-Y]		3,888000			Solar cells	0,820	0,250	0,000	0,740
Solar arrays [rear side] [+Y]		3,888000			Black paint	0,720	0,000	0,040	0,950
AltiKa antenna [+Z]		0,992000			Germanium side	0,950	0,250	0,000	0,670
AltiKa antenna [-Z]		0,992000			100% MLI	0,600	0,300	0,300	0,430
AltiKa antenna [+X]		0,457000			100% MLI	0,600	0,300	0,300	0,430
AltiKa antenna [-X]		0,457000			100% MLI	0,600	0,300	0,300	0,430
AltiKa antenna [+Y]		NA			100% MLI	0,600	0,300	0,300	0,430

Surfaces in PIM ref frame	ε emissivity (IR emittance)	ρ_s specular refraction	ρ_d diffuse refraction	α absorptivity (solar absorptance) α_{mean}
S/C [+X] panel	0,638	0,520	0,184	0,302
S/C [-X] panel	0,637	0,517	0,172	0,304
S/C [+Y] panel	0,698	0,078	0,076	0,837
S/C [-Y] panel	0,741	0,294	0,076	0,623
S/C [+Z] panel	0,733	0,400	0,245	0,355
S/C [-Z] panel	0,622	0,545	0,169	0,286

Table 3 : Thermo-optical characteristics of SARAL satellite surfaces

4.3 SARAL SATELLITE DIMENSIONS

Cf AD4 + update of the CoG position as after the April 13th , 2013 maneuver.



SARAL SPACECRAFT – April 15th, 2013

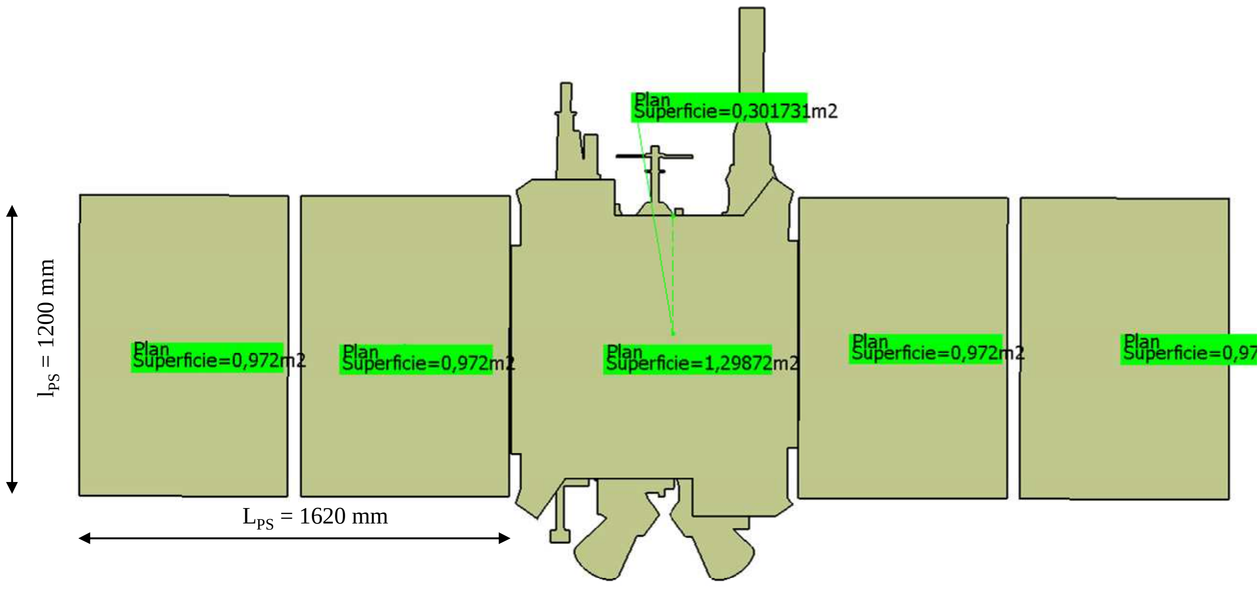


Figure 2 : Satellite dimensions

4.4 SATELLITE SURFACES

For preliminary design calculations, the satellite can be assimilated to a $2m^2$ spherical object. This section dimension is the satellite surface in the (Y_{PIM}, Z_{PIM}) plane perpendicular to the velocity vector.

The projected surfaces are given hereafter :

All the external appendices are taken into account. The fixation pods between the PIM and the SSB are included in the SSB dimensions.

CAO SATELLITE SURFACES

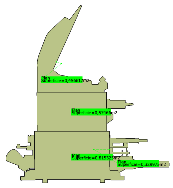
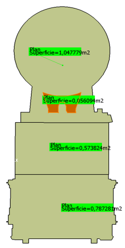
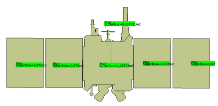
Plane in PIM reference frame		Projected surfaces (m²) with appendices	global surface (m²) with appendices		appendices (m²)
YZ (X projection)	PIM	0,575	2,177		0,33
	SSB	1,145			
	Altika Antenna	0,457			
XY (Z projection)	PIM	0,574	2,353		
	SSB	0,787			
	AltiKa Antenna pod hole	0,056			
	ntenna (pod hole taken into	0,992			
XZ (Y projection)	SSB (including appendices)	1,6	5,488		0,3
	Solar panels	3,888			

Table 4 : Satellite surfaces

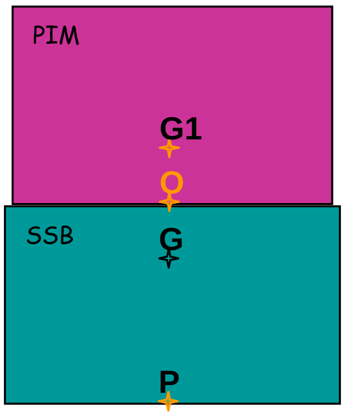
4.5 MASS PROPERTIES

- Total SARAL S/C on-orbit configuration (with propellant and solar panels deployed) = 408.6 kg measured in December 2012 (cf AD4)
  - PIM: 163.8 kg (cf AD5)
  - SSB: 244.8 kg including
    - hydrazine
    - Argos UHF antenna + pedestal : 4.121 kg (2.75 kg (cf AD6) + 1.371kg (CNES spec.))
    - launcher IF ring
- **Satellite total mass** (after Orbit Acquisition maneuvers and the 2 first Station Keeping maneuvers – **April 13th 2013**) = **+404.916 kg**

- Consumption of fuel during the Orbit Acquisition Phase = 3.600 kg
- About 0.88kg of budgeted satellite mass for maintenance phase

4.6 SATELLITE CENTER OF GRAVITY KNOWLEDGE

The projection in the (O,X,Z) plane of the PIM integrated center of mass (including the AltiKa antenna, the Doris antenna and ARGOS-3 L-band antenna, the electrical harnesses and the MLIs) is located in a circle centered on G1 and with a radius inferior to 50mm (goal : 5mm).



Direction	G position (m)
0X	+0.0107
0Y	-0,0637
0Z	-0.0073

Table 5 : Satellite Center of Mass position in <u>PIM Reference frame (O, X, Y, Z)</u>

WARNING : The information given by ISRO SCC in the SAT_CENT_MASS file (and in the SSALTO HISTO_COM file) is in the S/C Reference frame (P, X, Y, Z)

4.7 ANTENNA AND LRA REFERENCE POINTS POSITION IN PIM REFERENCE FRAME

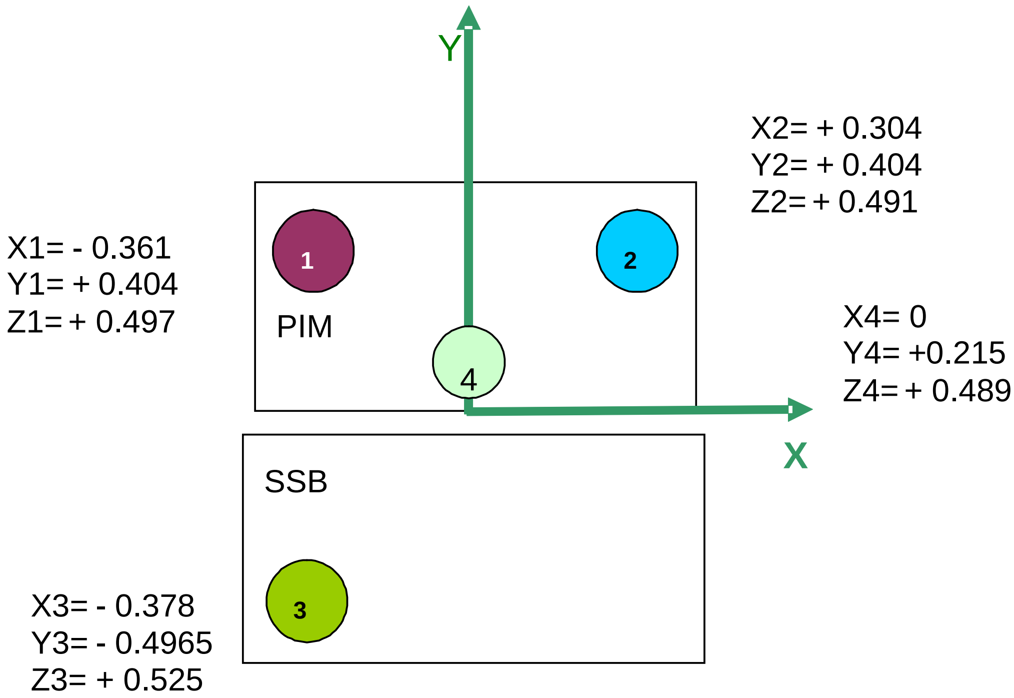


Figure 3 : Antennae mechanical positions in the PIM reference frame (in m)

Antennae mechanical positions are given in the PIM reference frame (in meters) :

position 1: L band antenna

position 2: DORIS antenna

position 3: UHF antenna

position 4 : LRA

The DORIS antenna mechanical reference point is the centre of the antenna mounting plate.

Insulation washers are taken into account.

4.8 DORIS INSTRUMENT CHARACTERISTICS

4.8.1 ON-BOARD ANTENNA

Antenna model : MV 17 (cf. AD1)

4.8.1.1 CENTER OF PHASE (D)

In PIM reference frame, in m	X	Y	Z
400 MHz	0	0	0.156
2GHz	0	0	0.314

Table 6 : DORIS antenna Center of phase positions wrt DORIS antenna mounting plane (Earth panel plane)

In PIM reference frame, in m	X	Y	Z
400 MHz	0.304	0.404	0.647
2GHz	0.304	0.404	0.805

Table 7 : DORIS antenna Center of phase positions in PIM reference plane

In PIM reference frame, in m	X	Y	Z
400 MHz	0.2933	0.4677	0.6543
2GHz	0.2933	0.4677	0.8123

Table 8 : DORIS Center of phase positions wrt Satellite CoG in PIM reference frame (GD vector)

4.8.1.2 PHASE CORRECTION

Phase correction in elevation = 0

4.8.1.3 ANTENNA GAIN

Accuracy = +/- 1dB

Onboard value (angle between the antenna Z-axis and the propagation direction)	Gain in dBi on the 400 MHz channel	Gain in dBi on the 2GHz MHz channel
0°	5	4
10°	4.5	4
20°	4	3.5
30°	3	3
40°	2.5	2.5
50°	1	2
60°	0	1

4.8.1.4 ON-BOARD TRANSIT TIME FOR THE IT3 TIME-TAGGING BIT AND ON-BOARD DOPPLER TRANSIT TIME

Parameter	Measured value	Accuracy
IT3 transit time 400MHz – UT1 to UT7	863 microseconds	+/- 1 microsecond
IT3 transit time 2GHz – UT1 to UT7	324 microseconds	+/- 1 microsecond
Doppler transit time 400MHz – UT1 to UT7	62.5 microseconds	+/- 1 microsecond
Doppler transit time 2GHz – UT1 to UT7	52.4 microseconds	+/- 1 microsecond

Table 9 : On-board transit times

Sensitivity of IT3 transit time to Doppler frequency has been assessed to the following values :

Parameter	Measured value	Accuracy
Alpha IT3 400MHz	0.18 s	0.01s
Alpha IT3 2GHz	0.18 s	0.01s

Table 10 : Sensitivity of IT3 transit time to Doppler frequency

4.8.1.5 CABLES LOSSES

The cables losses measured on the ground have been assessed to be the following:

Parameter	Measured value
400 MHz	0.34 dB
2 GHz	0.67 dB

Table 11 : Internal cable losses

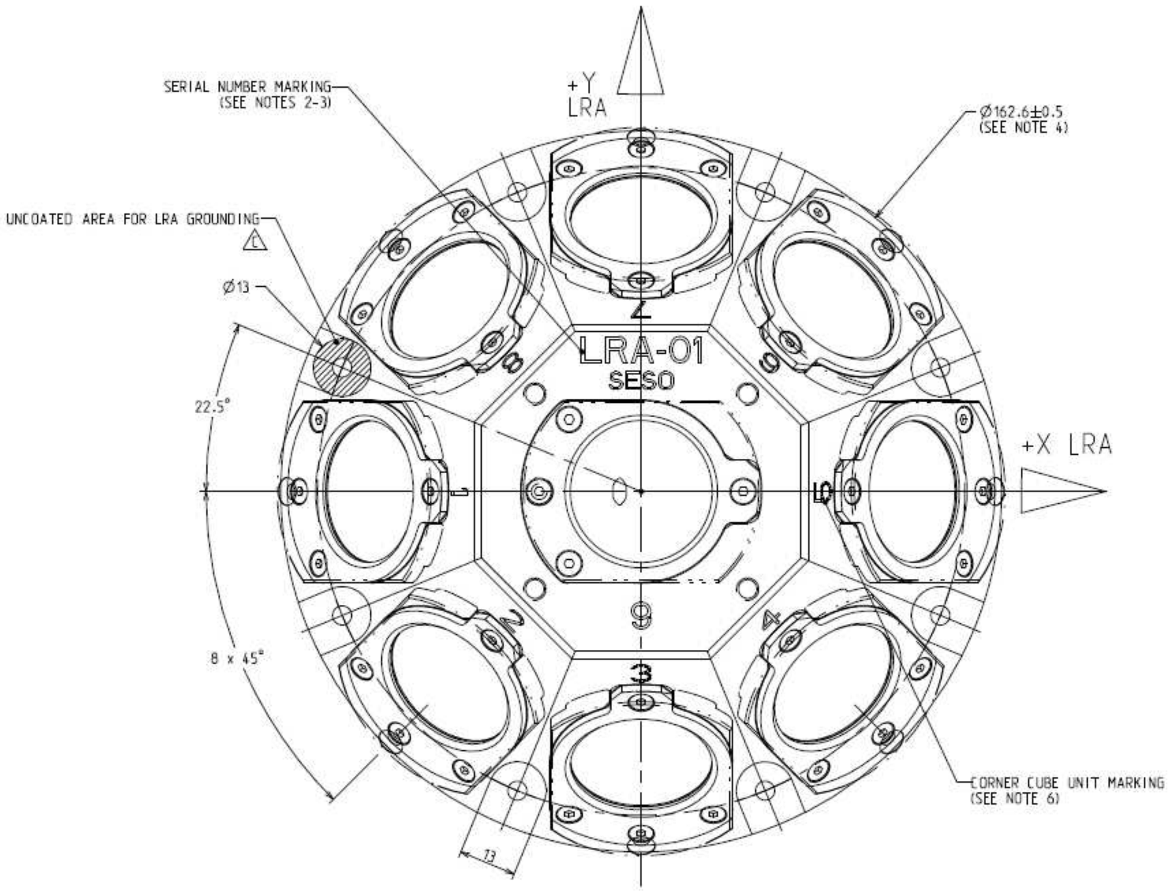
Remark: On UHF-band , a loss of 1 dB due to a specific rejection filter (ARGOS) implemented on-board the DORIS/AltiKa BDR shall be added to the cable losses. The resulting total losses to be taken into account are thus:

Parameter	Measured value
400 MHz	1.34 dB
2 GHz	0.67 dB

Table 12 : Resulting total losses

4.9 LRA CHARACTERISTICS

4.9.1 GEOMETRICAL CHARACTERISTICS



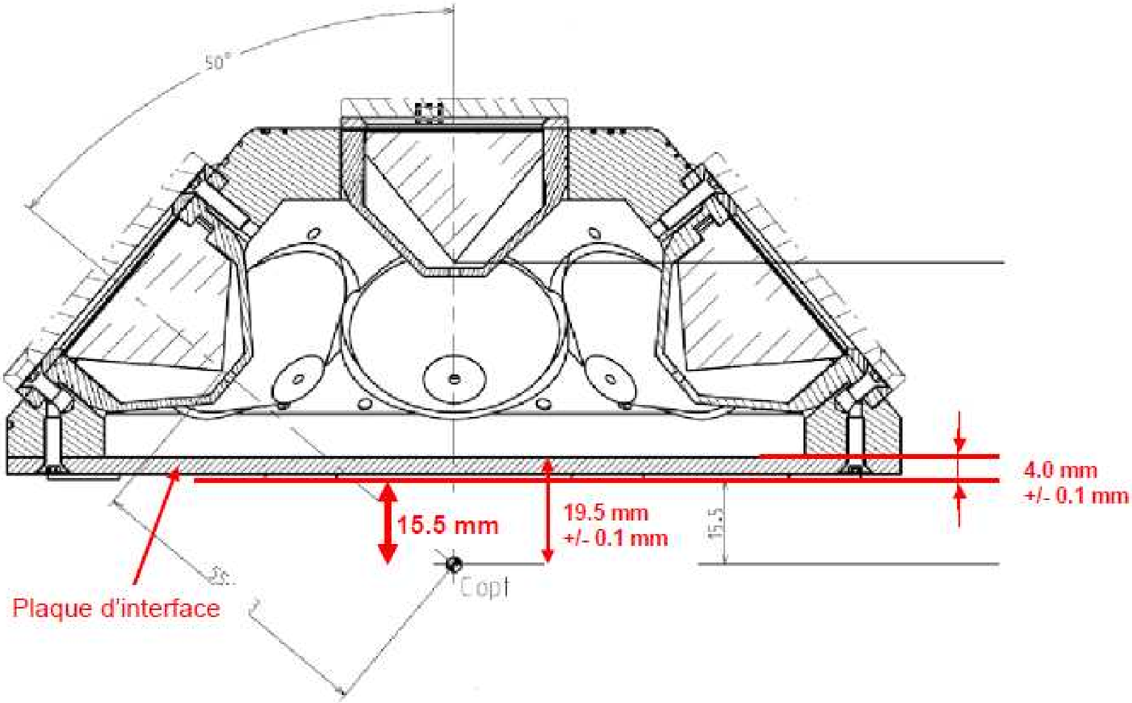
+X LRA = +X PIM

+Y LRA = +Y PIM

LOCALIZATION OF THE COORDINATE SYSTEM X, Y, Z (POINT O)

O	CORRESPONDS TO THE GEOMETRIC CENTER OF THE LRA MOUNTING PLANE (PERMAGLASS SHIMS EXCLUDED)
X LRA	IS IN THE MOUNTING PLANE OF THE LRA (PERMAGLASS SHIMS EXCLUDED)
Y LRA	IS IN THE MOUNTING PLANE OF THE LRA (PERMAGLASS SHIMS EXCLUDED) AND PERPENDICULAR TO THE X AXIS
Z LRA	IS NORMAL TO THE LRA MOUNTING PLANE (PERMAGLASS SHIMS EXCLUDED) AND ORIENTED FROM THE LRA TO THE SPACE

4.9.2 POSITION OF THE C_{OPT} OPTICAL CENTER



In **LRA** reference frame, in m	X	Y	Z
Optical center position	0	0	- 0.0155

Table 13 : Optical Center position in LRA reference frame

In **PIM** reference frame, in m	X	Y	Z
Optical center position	0	0.215	0.4735

Table 14 : Optical Center position in PIM reference frame

4.9.3 RANGE CORRECTION

The range correction depending on the cube corner used and on the incidence angles is given here below

Nota : this correction includes the effect of the range aberration

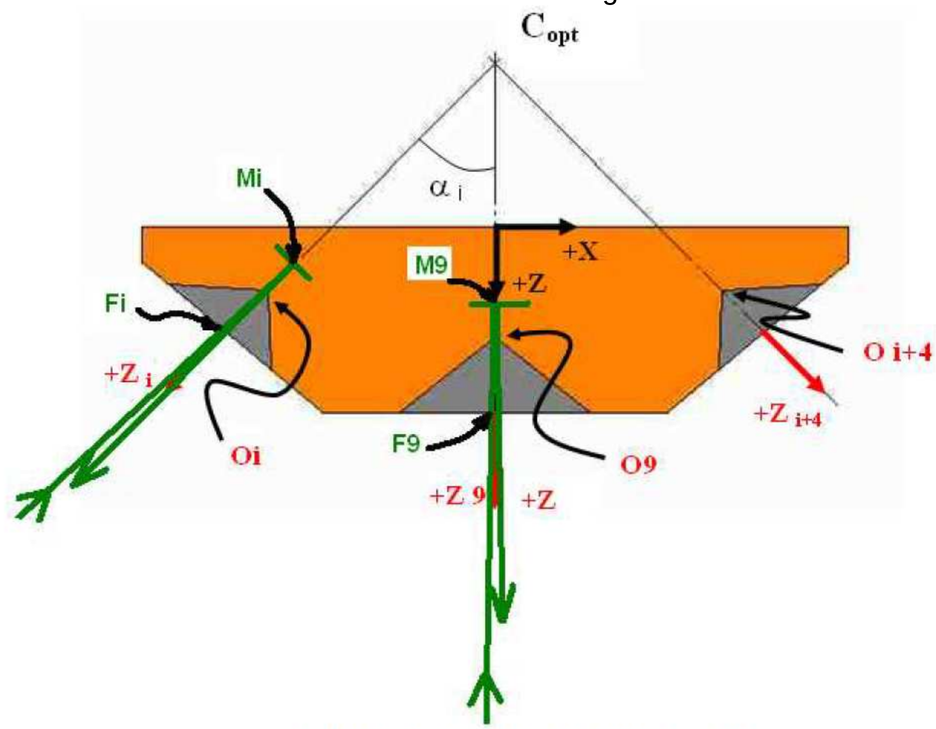
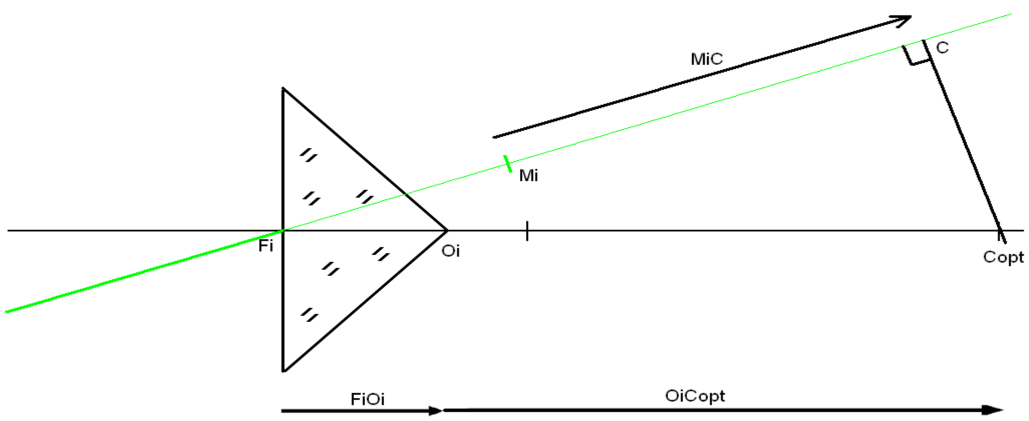


Fig. 2 : Mesure de distance équivalente (point Mi)



C is the projection of the Optical Center Copt on the direction of the incident beam.

θ	ϕ	Barillet concerné	Correction globale MiC en mm	Tolérance associée en mm
180	50	1	43,7	+/- 0,1 mm
225	50	2	43,8	+/- 0,1 mm
270	50	3	43,8	+/- 0,1 mm
315	50	4	43,9	+/- 0,1 mm
0	50	5	43,7	+/- 0,1 mm
45	50	6	43,9	+/- 0,1 mm
90	50	7	43,8	+/- 0,1 mm
135	50	8	43,4	+/- 0,1 mm
0	0	9	43,9	+/- 0,1 mm
0	25	9 et 5	37.9	+/- 0,1 mm
22.5	25	5 et 6	36.3	+/- 0,1 mm
22.5	50	5 et 6	41.0	+/- 0,1 mm

with the following angles definition :

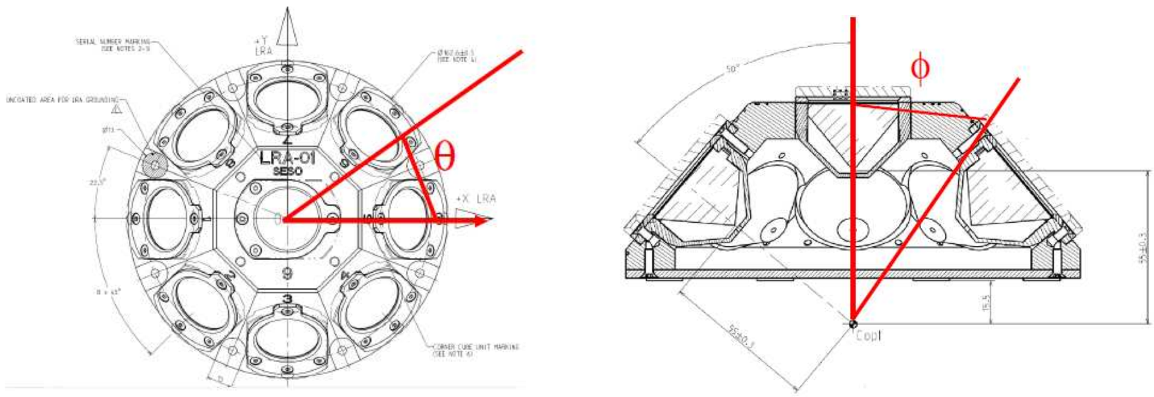


Table 15 : Total Range Correction (function of the incidence angles and depending on the Cube Corner used)

4.10 ALTIKA ANTENNA CHARACTERISTICS

4.10.1 PLAN DE REFERENCE POUR LA MESURE DU TPG ANTENNE

La valeur du TPG antenne est incluse dans le terme global de correction de TPG instrument.

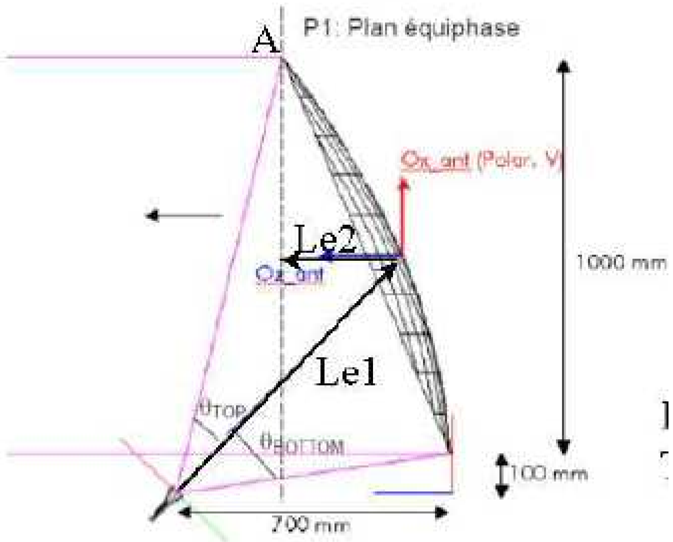


Figure 4.10-1 Antenne et plan de référence pour mesure de TPG

Le plan de référence pour la mesure du TPG antenne est le plan **P1** décrit sur la Figure 4.10-1 ci-dessus.

Il s'agit du plan équiphase qui passe par le point A, sommet de la parabole.

Les coordonnées du point A dans le repère mécanique antenne sont données ci-dessous (en mm) :

	$X_{A\text{-}RME}$	$Y_{A\text{-}RME}$	$Z_{A\text{-}RME}$
Coordonnées du point A	378.98056	1292.23241	472.38578

Position du repère RME dans le repère PIM (en mm) :

	Z_{PIM}
Z RME	-320.400

4.10.2 DISTANCE A CORRIGER POUR LA MESURE DU TPG ANTENNE

La distance à corriger sur la mesure nadir est définie ci-dessous.

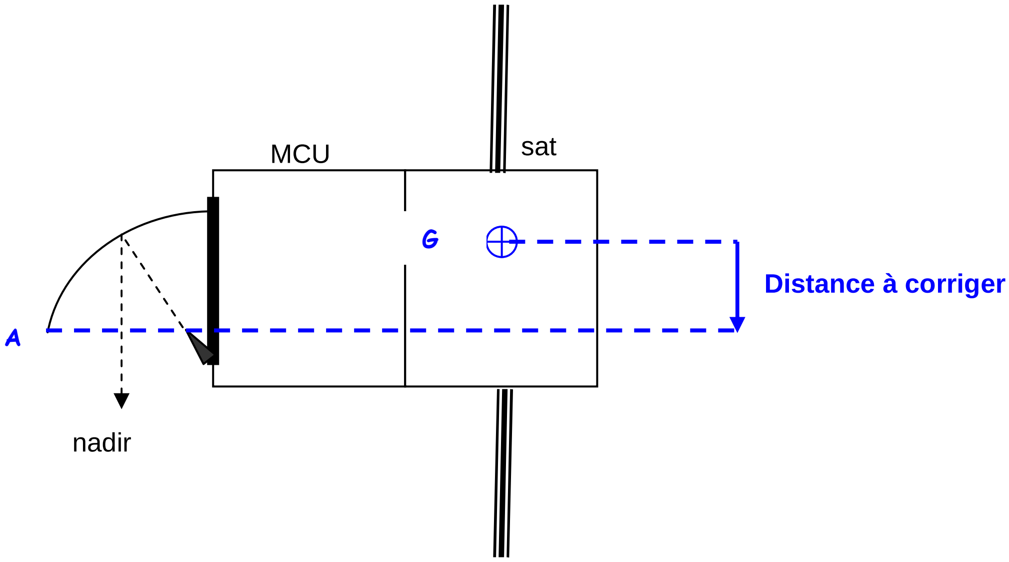


Figure 4.10-2 Description de la distance à corriger

Dans le repère PIM	Axe Z
Position du plan équiphase (en mm)	151.986

Table 16 : Position du plan équiphase dans le repère PIM

Soit, distance à corriger par rapport au CoG satellite (en Z) = 159.286 mm

DIFFUSION CNES			
Name	**Sigle**	**Bpi**	**Ex.**
AURIOL A.	DCT/PO/AL	2002	X
JAYLES C.	DCT/PO/AL	2002	X
NOUBEL J.	DCT/PO/AL	2002	X
PICOT N.	DCT/PO/AL	2002	X
SENGENES P.	DCT/PO/AL	2002	X
STEUNOU N.	DCT/PO/AL	2002	X
BUZON P.	DCT/RF		X
PERELMUTTER P.	Pour DCT/PO/AL	2002	X
MALECHAUX M.	DCT/SB/CC	2002	X
GUINLE T.	DCT/ME/OC		X
LACHIVER JM.	DCT/ME/OC		X
MAZEAU S.	DCT/ME/OC		X
TOURAIN C.	DCT/ME/OC		X
DIDELOT F.	DCT/ME/OC		X
FERRAGE P.	DCT/ME/OT	2002	X
SALCEDO C.	DCT/PO/MI	2532	X
SARTHOU M.	DCT/PO/TN	2525	X
DELACROIX D.	DCT/PO/TN	2525	X
BARRAILH JP.	DCT/RF		X
SOULE P.	DCT/RF		X
CLARAC L.	DCT/PS/CMI	1501	X
MENOT F.	DCT/PS/CMI	1501	X
NICOLAS C.	DCT/PS/CMI	1501	X
QUEYRUT O.	DCT/PS/CMI	1501	X
CHOMETTE A.	DCT/PS/CMI	1501	X
CERRI L.	DCT/SB/OR	1323	X
HOURY S.	DCT/SB/OR	1323	X
MERCIER F.	DCT/SB/OR	1323	X
COUHERT A.	DCT/SB/OR	1323	X
DESJONQUERES JD	DCT/SI/AR	601	X
RODRIGUEZ-SUQUET R.	DCT/SI/AR	601	X
BERTHON J.	DCT/SI/OP	3601	X
COSTES V.	DCT/SI/OP	3601	X
BRICOUT J.N.	DCT/TV	1714	X
SERIEYS C.	DCT/TV/SM	1714	X
DOCUMENTATION – SARAL			X