



MEMORANDUM

Swarm satellite thermo-optical properties and external geometry

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Added Table 2 with optical properties (absorption, diffuse and specular reflection coefficients)	28/01/2019	12	-

DISTRIBUTION

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1 INTRODUCTION

Modelling of non-gravitational forces acting on the Swarm satellites as they orbit Earth requires knowledge of the thermo-optical properties and geometry of the outer surfaces of the spacecraft. These are provided in this document.

2 REFERENCE DOCUMENTS

- [RD-1] External Layout, DT0217691_07_00_00, Issue 9, Astrium Limited, 2010
- [RD-2] Swarm Thermal Mathematical Model Description, SW.RP.EAU.SY.00009, Issue 5, Astrium Limited, 2009
- [RD-3] AOCS Environment and Satellite Modelling and Parameterisation, SW.TN.EAD.SY.00059, Issue 2.1, EADS Astrium, 2011

3 SATELLITE GEOMETRY

The external satellite geometry is specified in [RD-1]. The technical drawings with measurements are repeated here in Figure 1 to Figure 7, which show the Swarm satellite in flight and launch configuration, i.e. with boom deployed and stowed, respectively.

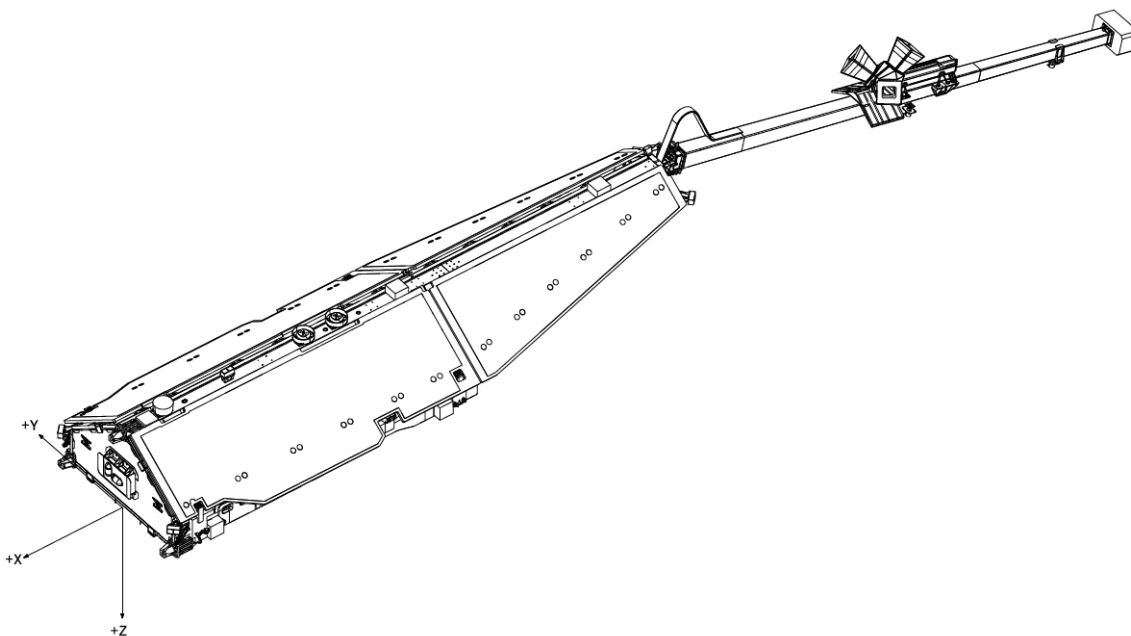


Figure 1 Isometric view on Swarm satellite in flight configuration (boom deployed). The satellite body fixed reference frame is indicated by the +X, +Y and +Z axis.

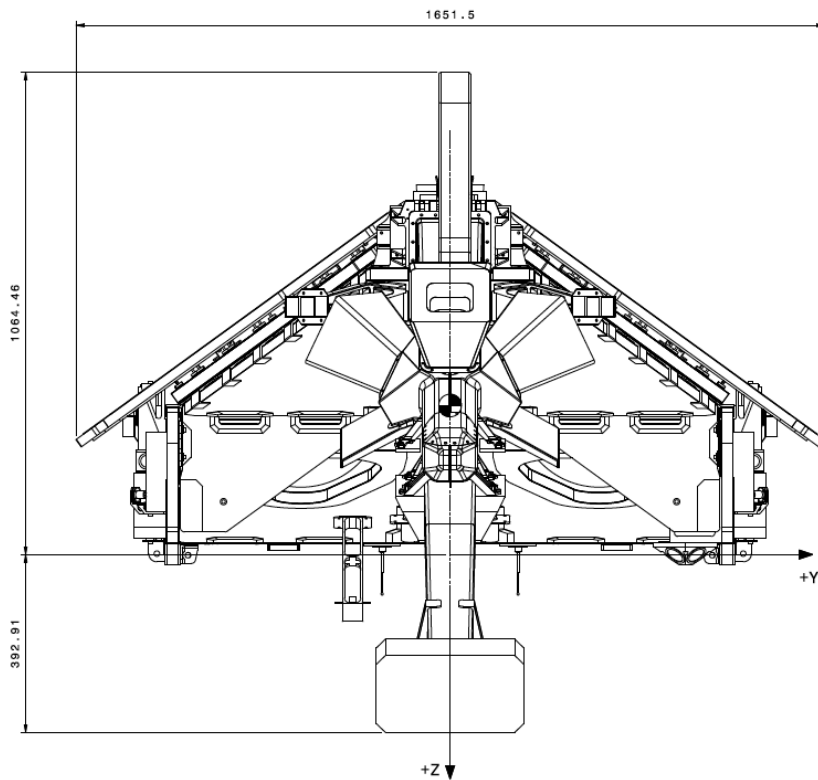


Figure 2 View on -X face of Swarm satellite in flight configuration (boom deployed)

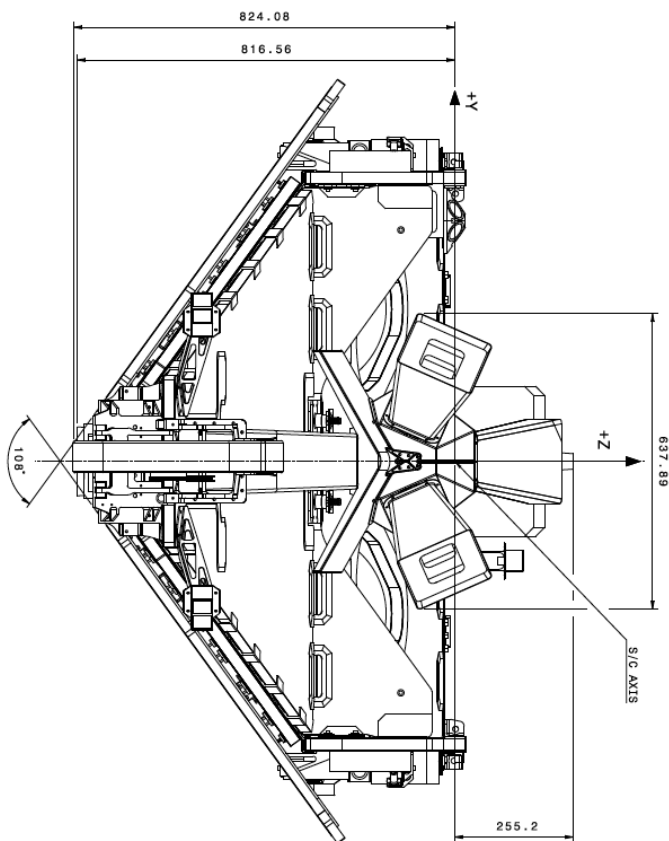


Figure 3 View on -X face of Swarm satellite in launch configuration (boom stowed)

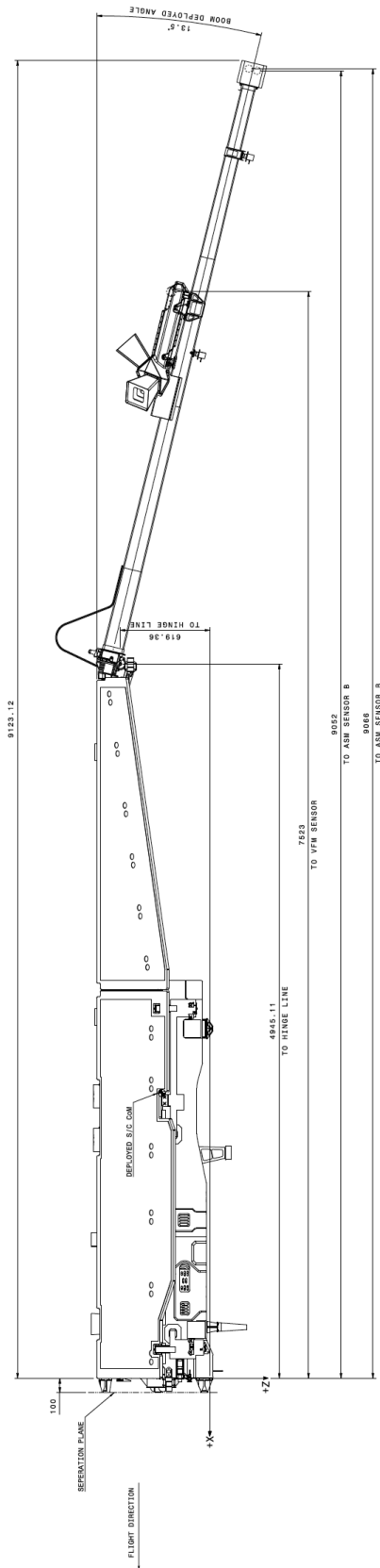


Figure 4 View on -Y face of Swarm satellite in flight configuration (boom deployed)

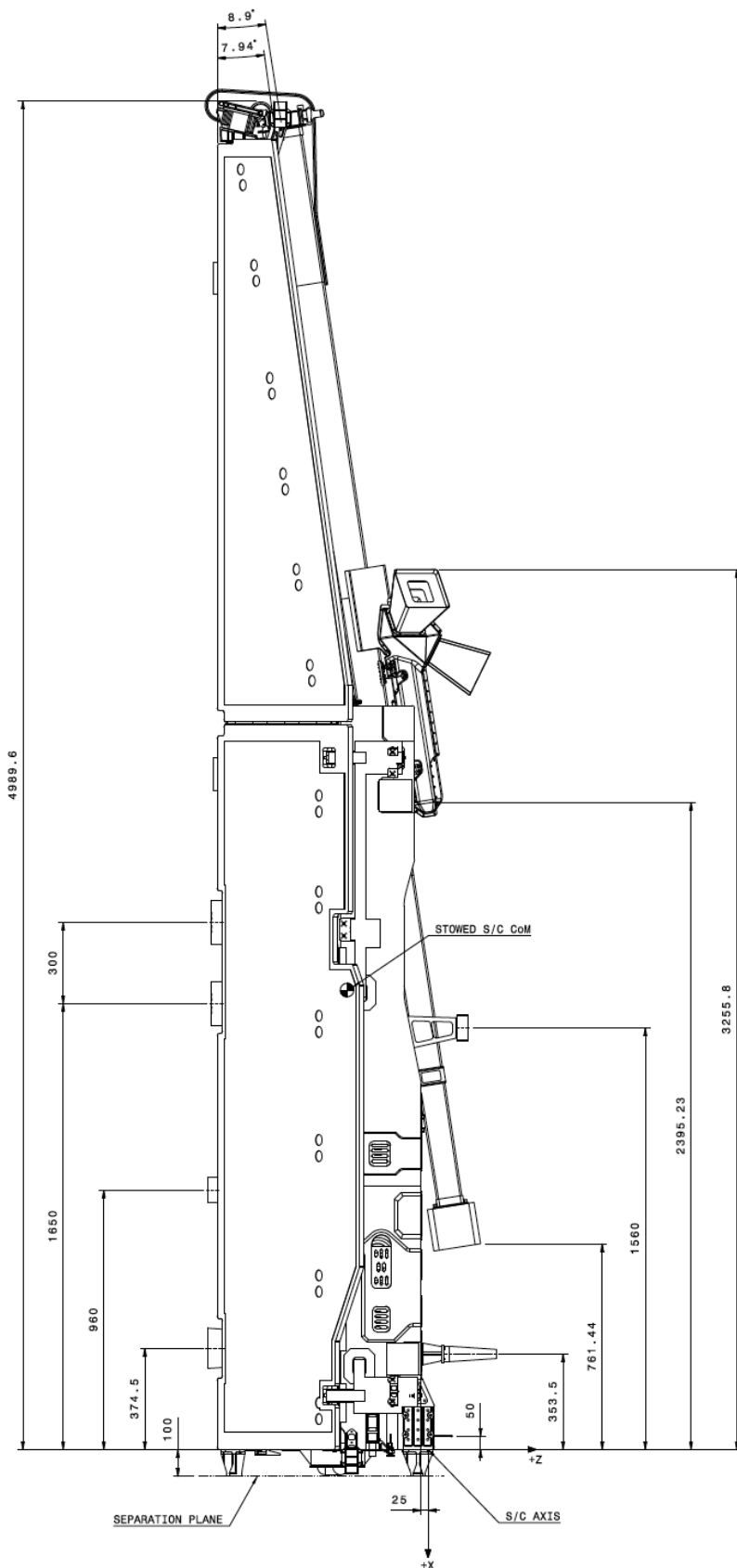


Figure 5 View on -Y face of Swarm satellite in launch configuration (boom stowed)

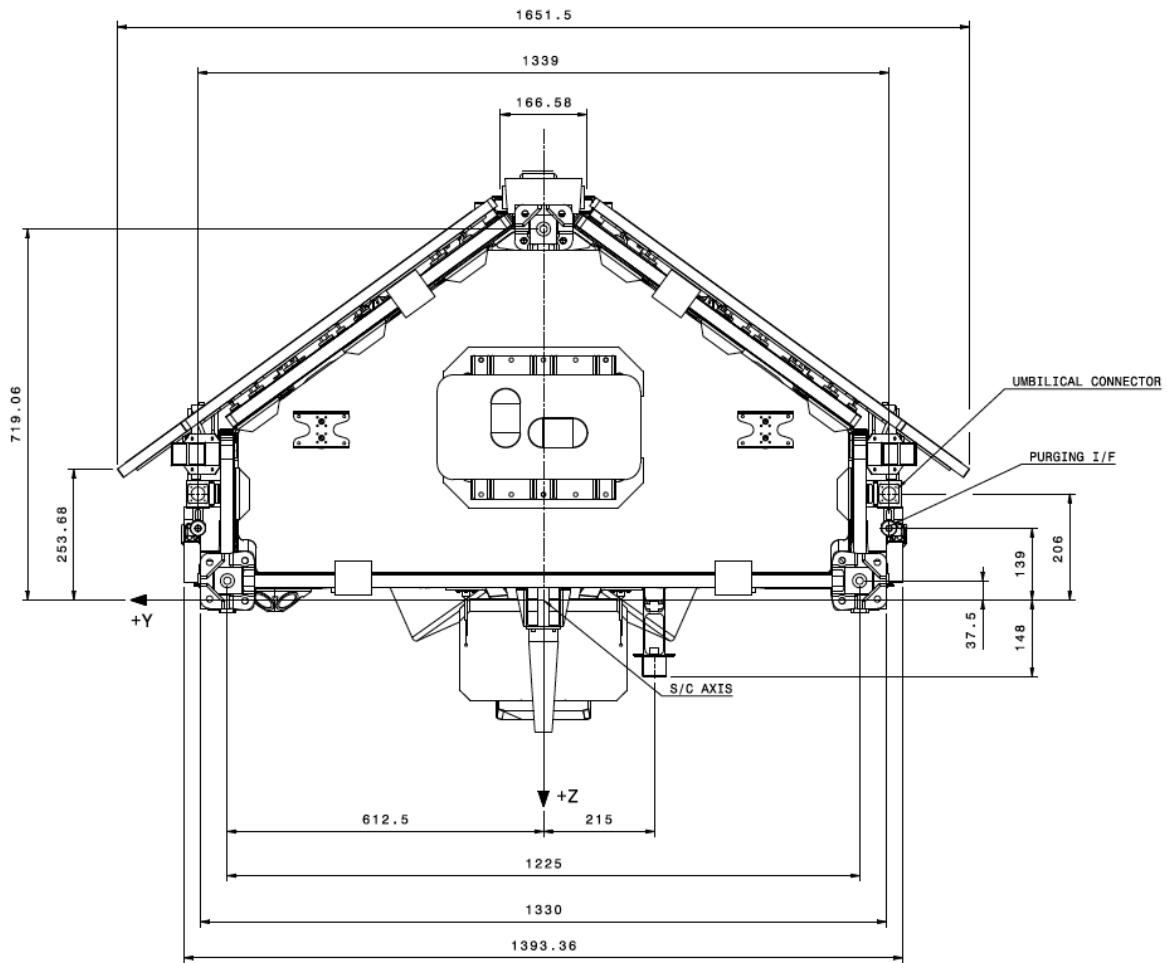


Figure 6 View on +X face of Swarm satellite in launch configuration (boom stowed)

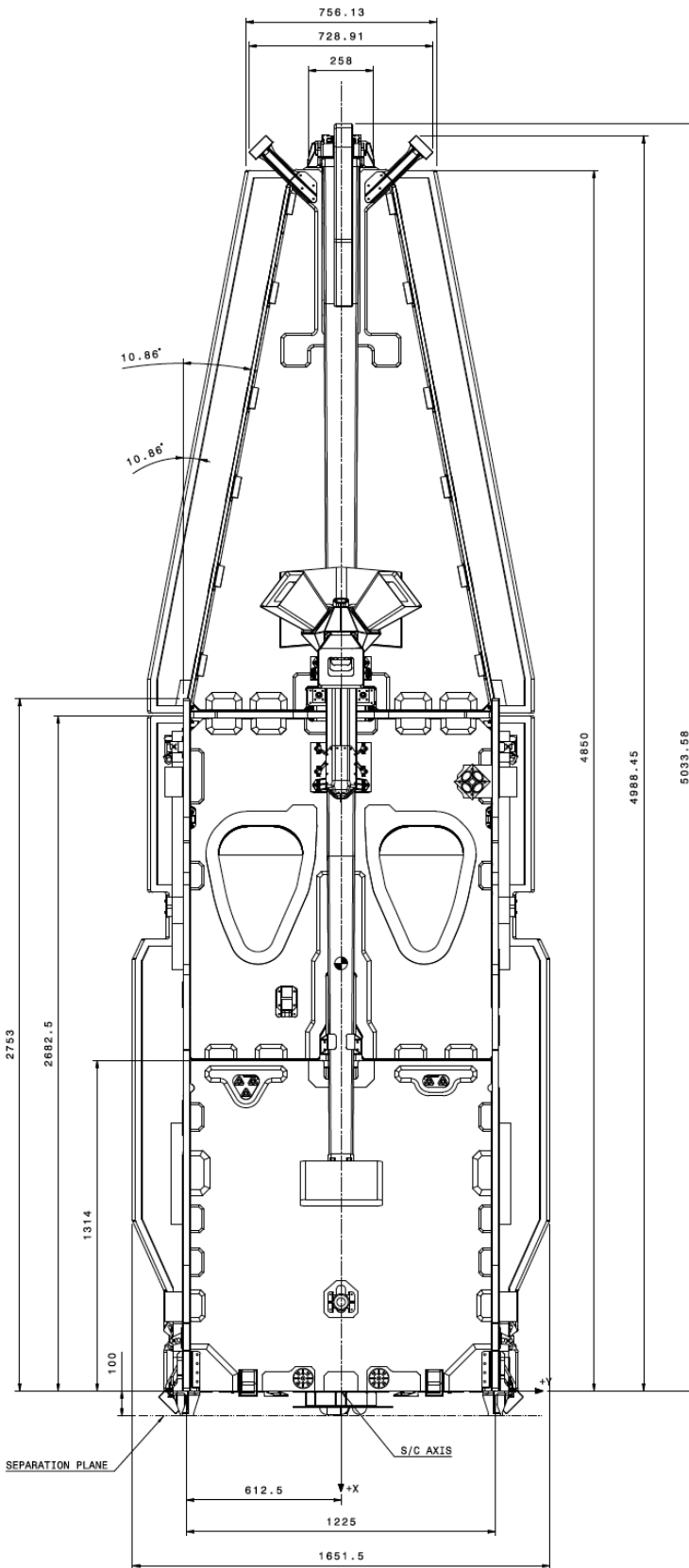


Figure 7 View on +Z face of Swarm satellite in launch configuration (boom stowed)

4 THERMO-OPTICAL PROPERTIES OF OUTER SURFACES

The thermo-optical properties provided in [RD-2] are listed in Table 1. Figure 8 illustrates the Swarm spacecraft from different angles and indicates the location and orientation of the panels. The solar absorptivity is provided separately for beginning of life (BoL) and end of life (EoL) only when these values are different. Coefficients of diffuse and specular reflectivity are provided in [RD-3] and listed in Table 2.

Table 1 Thermo-optical properties of the Swarm satellites. The complex shape of CESS brackets, optical bench, launch brackets, antennas, etc. is not reflected.

Panel	Area (m ²)	Area Normal Vector			Area (%)	Material	IR-Emissivity	Solar-Absorptivity (BoL/EoL)
		X	Y	Z				
Nadir I	1.540	0.0	0.0	1.0	15%	Aluminum/Alodine Foil	0.100	0.368/0.52
					70%	OSR Radiator	0.780	0.050/0.230
					10%	Black Kapton	0.780	0.930
					5%	Beta Cloth	0.800	0.400
Nadir II	1.400	-0.19766	0.0	0.98027	12%	OSR Radiator Glass Mirrors	0.780	0.050/0.230
					10%	Beta Cloth	0.800	0.400
					78%	Black Kapton	0.780	0.930
Nadir III	1.600	-0.13808	0.0	0.99042	8%	OSR Radiator	0.780	0.050/0.230
					92%	Black Kapton	0.780	0.930
Solar Array +Y	3.450	0.0	0.58779	-0.80902	78%	Solar Cell	0.718	0.920
					22%	RTV Adhesive	0.719	0.837
Solar Array -Y	3.450	0.0	-0.58779	-0.80902	78%	Solar Cell	0.718	0.920
					22%	RTV Adhesive	0.719	0.837
Zenith	0.500	0.0	0.0	-1.0	100%	Black Kapton	0.780	0.930
Front	0.560	1.0	0.0	0.0	90%	Aluminum/ Alodine Foil	0.100	0.368/0.52
					10%	White Paint	0.820	0.190/0.220
Side Wall +Y	0.753	0.0	1.0	0.0	95%	Black Kapton	0.780	0.930
					5%	Beta Cloth	0.800	0.400
Side Wall -Y	0.753	0.0	-1.0	0.0	95%	Black Kapton	0.780	0.930
					5%	Beta Cloth	0.800	0.400
Shear Panel Nadir front	0.800	1.0	0.0	0.0	100%	Beta Cloth	0.800	0.400
Shear Panel Nadir back	0.800	-1.0	0.0	0.0	100%	Black Kapton	0.780	0.930
Boom +Y	0.600	0.0	1.0	0.0	40%	Black Kapton	0.780	0.930
					60%	Beta Cloth	0.800	0.400
Boom -Y	0.600	0.0	-1.0	0.0	40%	Black Kapton	0.780	0.930
					60%	Beta Cloth	0.800	0.400
Boom Zenith	0.600	-0.23924	0.0	-0.97096	80%	Black Kapton	0.780	0.930
					20%	Beta Cloth	0.800	0.400
Boom Nadir	0.600	0.22765	0.0	0.97374	100%	Beta Cloth	0.800	0.400

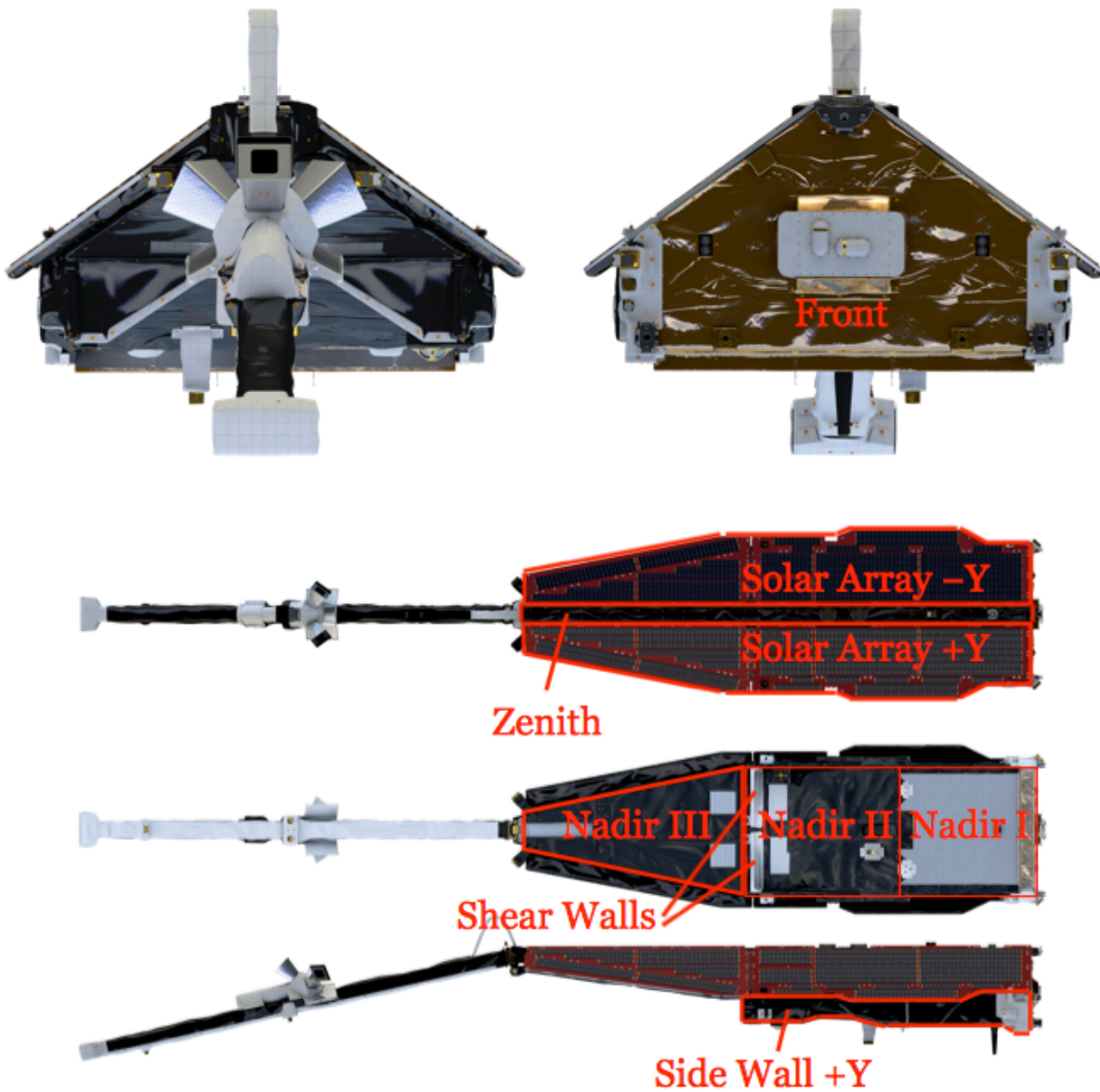


Figure 8 Illustration of the panels listed in **Table 1**. Artwork created by ESA/ATG MediaLab.

Table 2 Optical properties of the Swarm satellites (BoL).

Material/Part	Absorption	Diffuse Reflection	Specular Reflection	Used for
Black Kapton	0.93	0.07	0.00	Side walls below panel ("apron"), boom, big "inclined plates" on +Z side, small plate between panels -Z side
Beta cloth	0.45	0.00	0.55	Absolute scalar magnetometer (ASM), ram side boom, bulk head ("front edge")
White paint (EFI)	0.19	0.81	0.00	+X electric field instrument (EFI)
OSR	0.05	0.95	0.00	+Z panel
Aluminium foil	0.20	0.80	0.00	+X panel and items
Optical bench MLI (Beta cloth)	0.40	0.60	0.00	Vector field magnetometer (VFM)
Optical bench radiator	0.07	0.05	0.88	Optical bench radiator
Star trackers	0.95	0.05	0.00	Star trackers
Solar panels	0.90	0.10	0.00	Solar panels
General (estimated)	0.58	0.04	0.38	All others smaller parts