

MASCOT Asteroid Nanolandings: From Ryugu and Didymoon towards Future Missions at '2021 PDC', Apophis 2029, and Beyond

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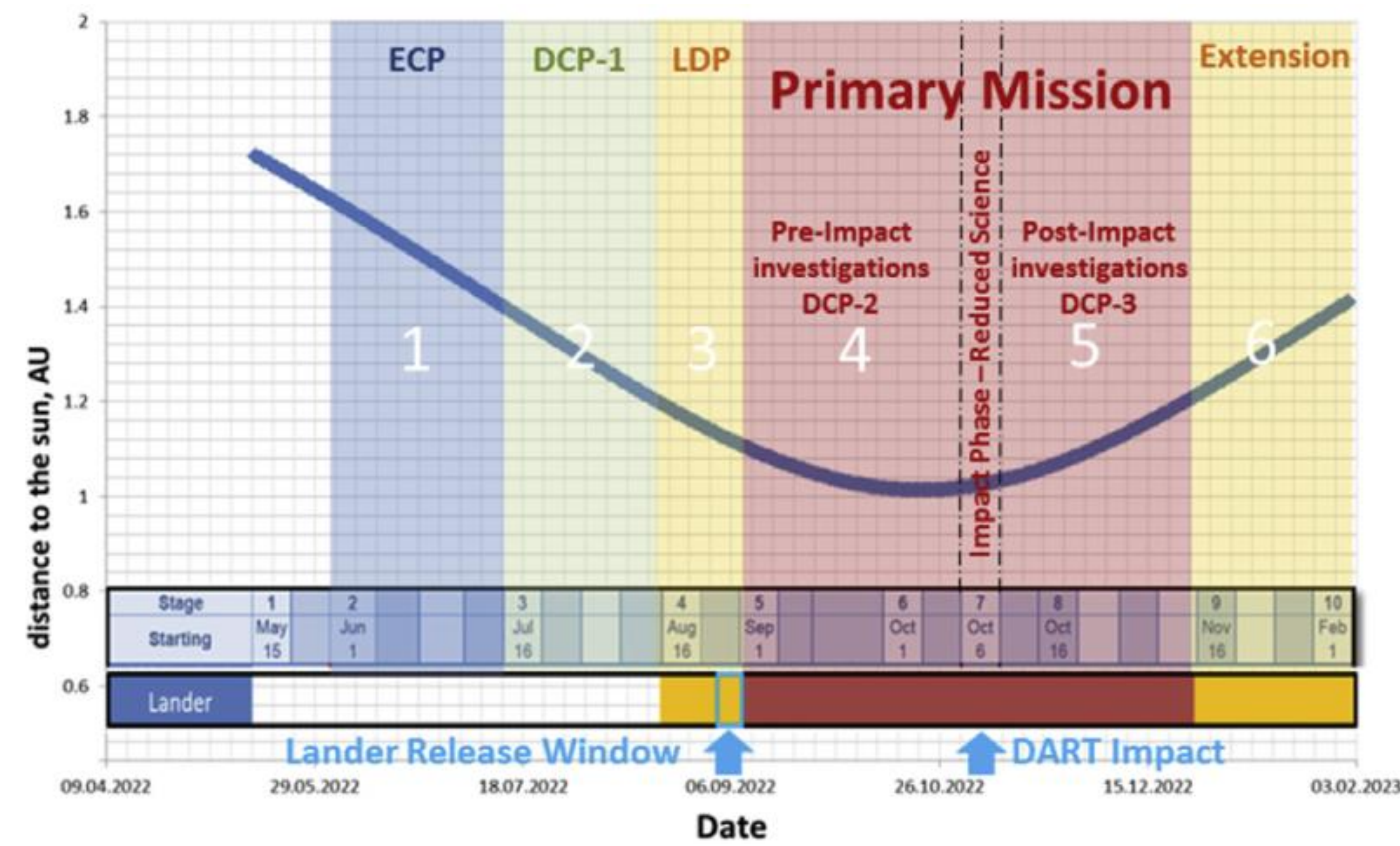
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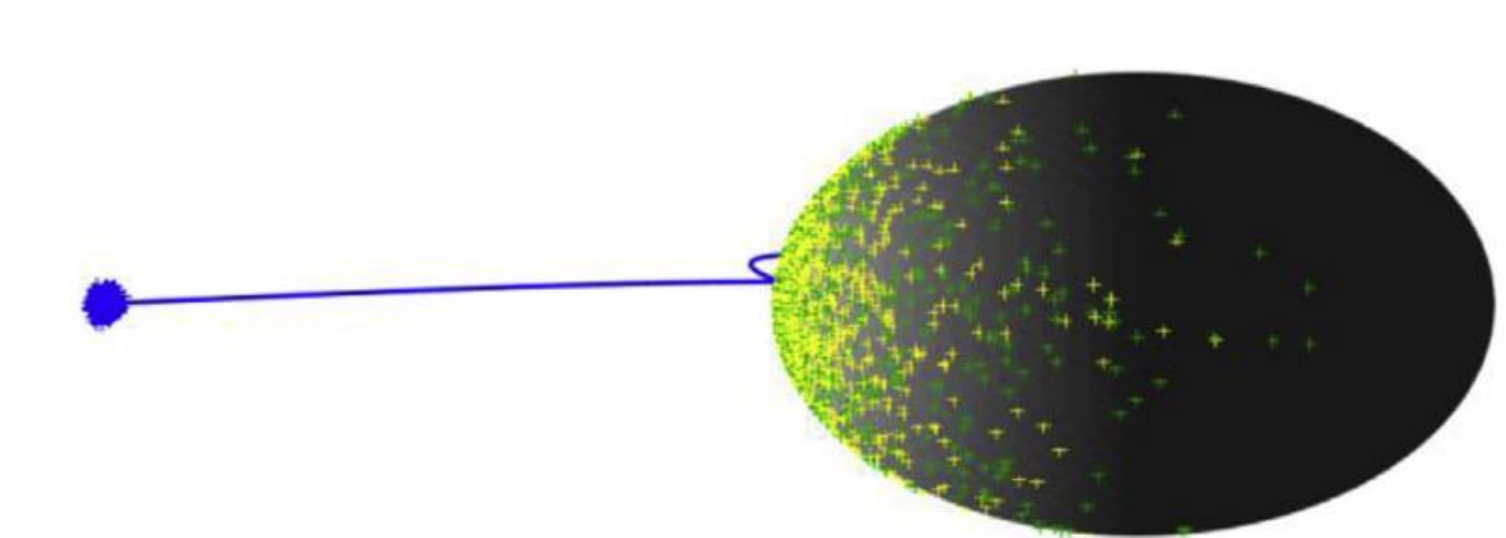
point of departure: MASCOT2, the Mobile Asteroid Surface Scout nanolander designed for ESA's impact observation probe AIM to binary NEA (65803) Didymos as a long-life system for fathoming the interior of 'Didymoon' before, during, and after the impact of DART.



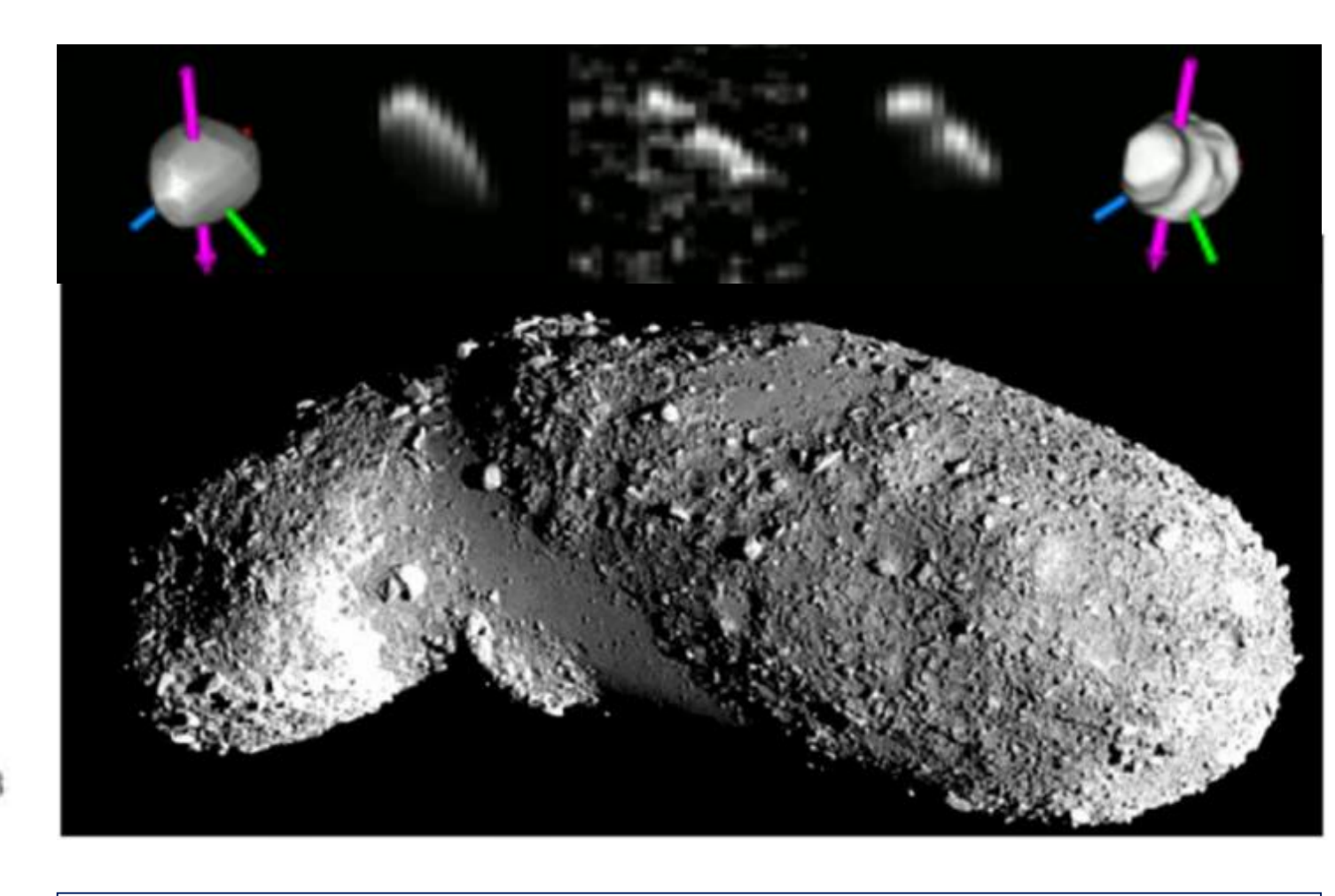
just separated from AIM – landed, self-righted, ready to relocate – opening the solar panel and extending antennae at operating site



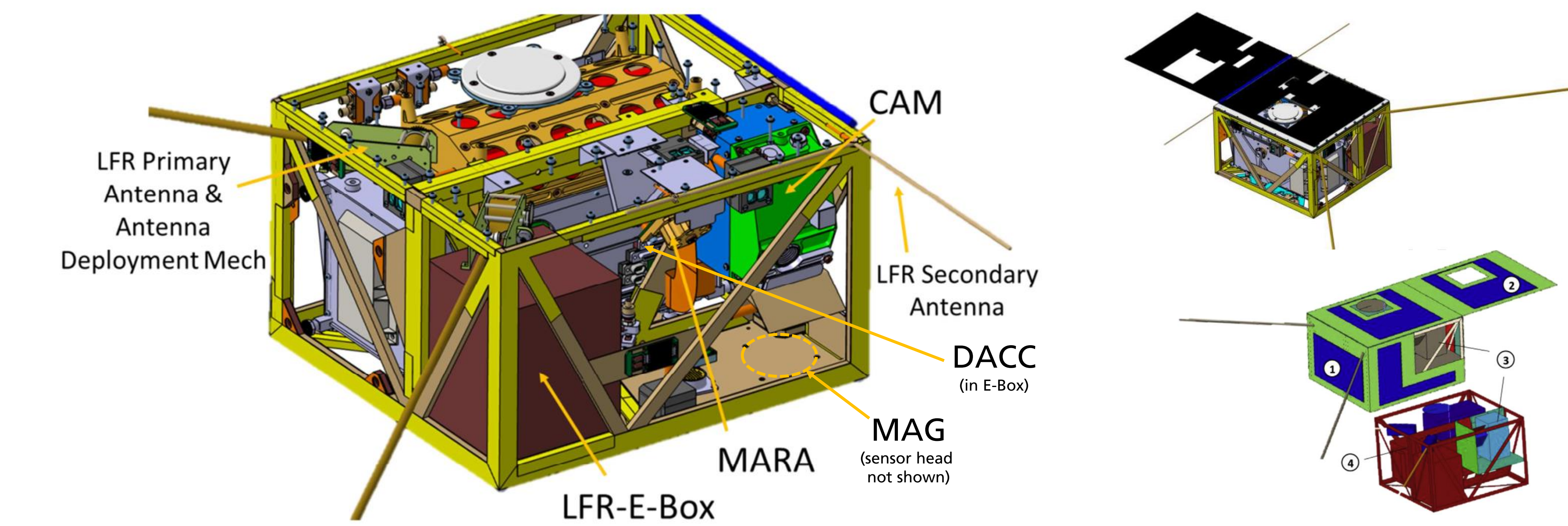
MASCOT2's timeline passing through a special event
all operations center on the DART impact – a familiar concept when looking ahead to the Apophis fly-by



sighting landing sites
MASCOT2 slipping through L2 onto a very simple 'Didymoon'

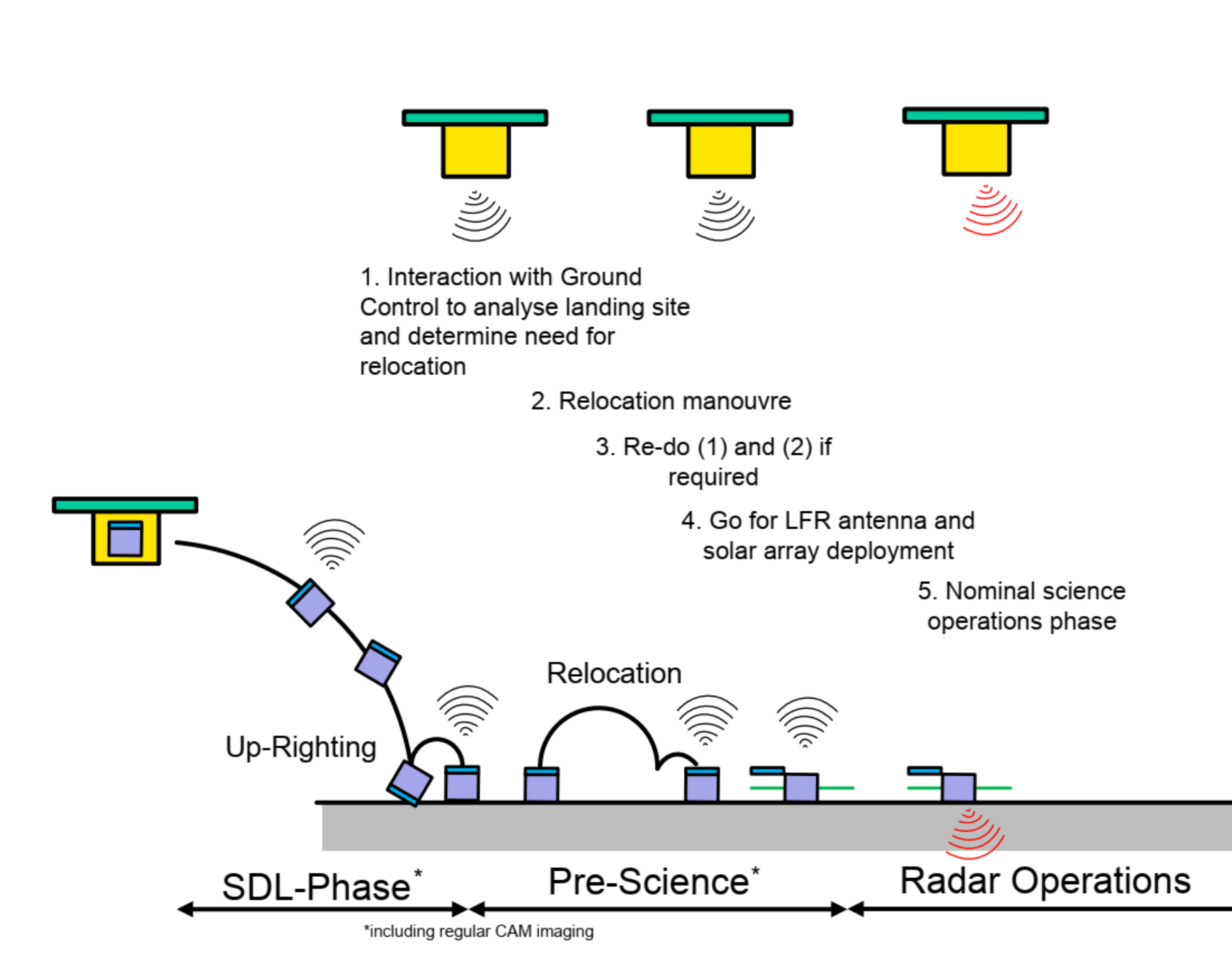


(25143) Itokawa imaged by HAYABUSA
↑ (99942) Apophis, also S-type, might look more like this

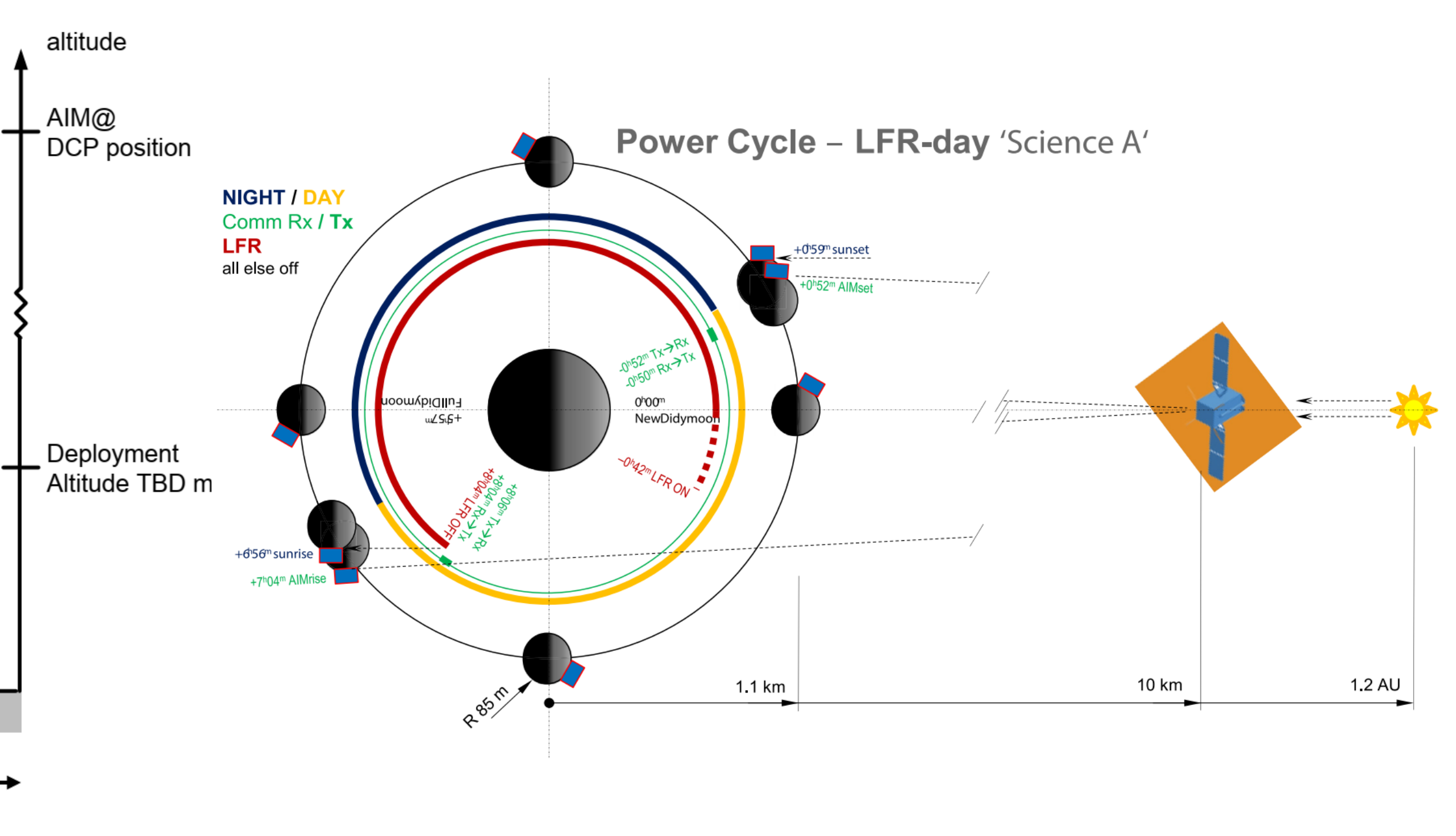


inside MASCOT2

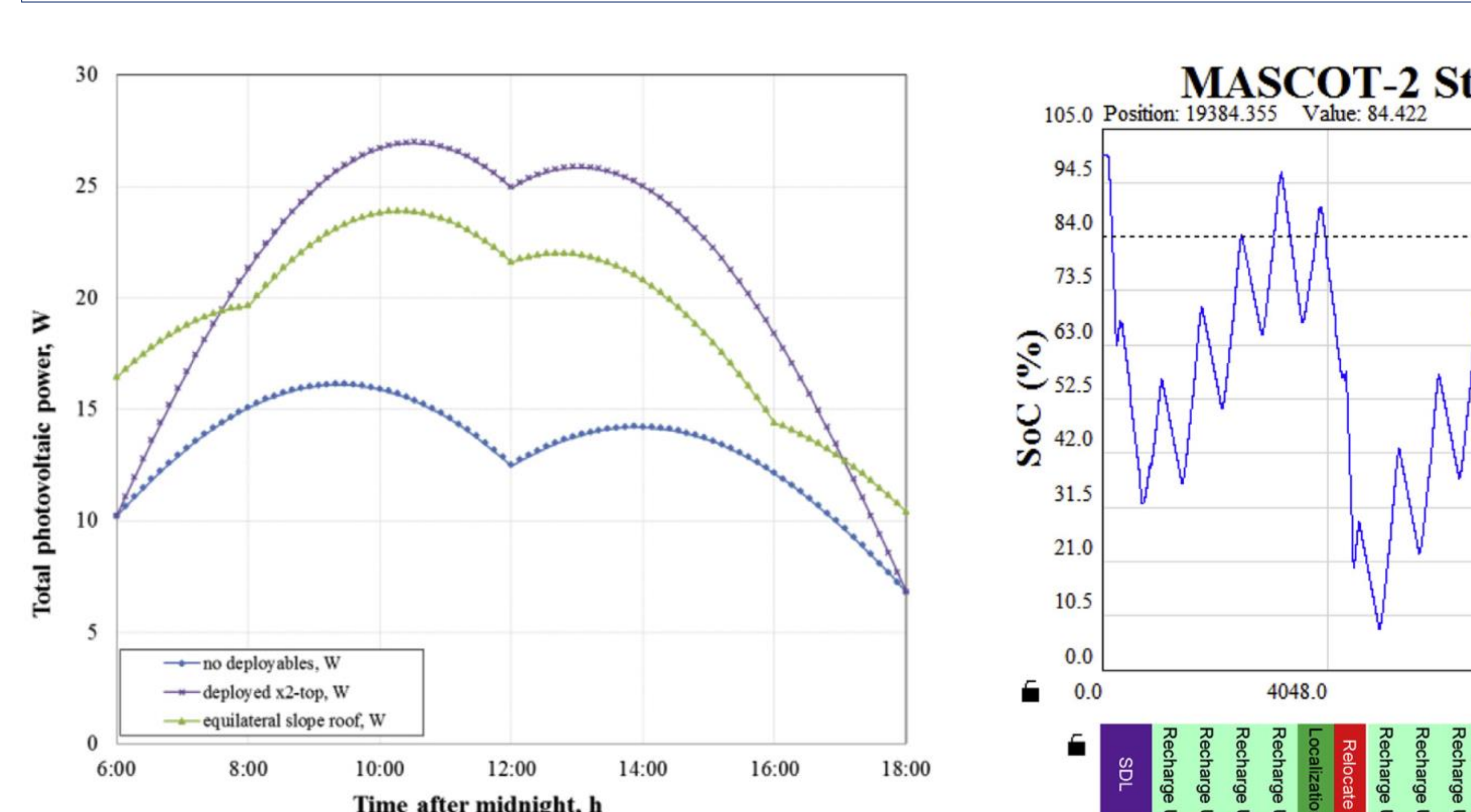
radiant MASCOT2
LFR antenna configuration (top) and thermal model



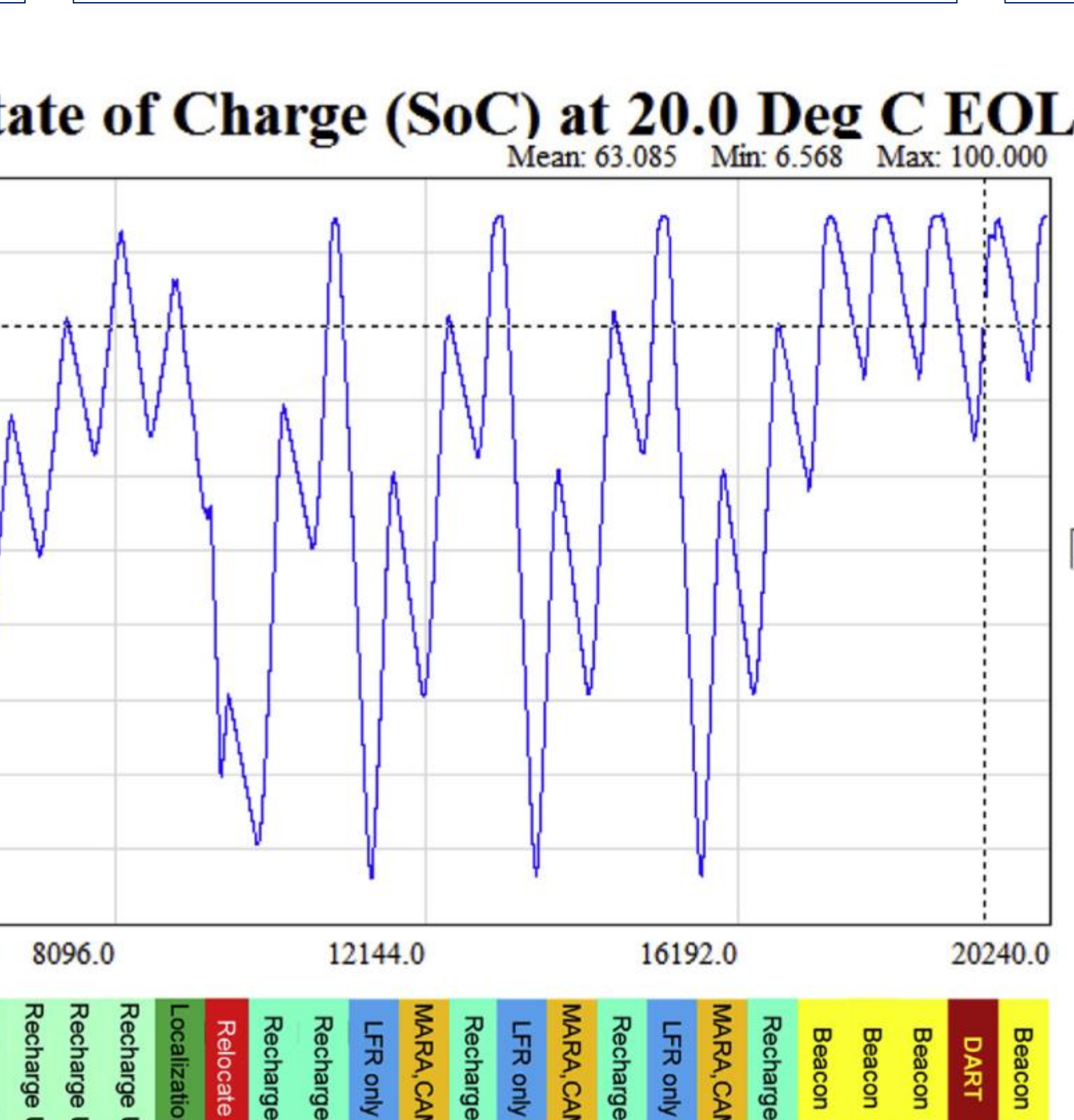
MASCOT2 separation, descent, landing, relocation, operation
after landing somewhere on one hemisphere, MASCOT2 moves to the optimal site for LFR



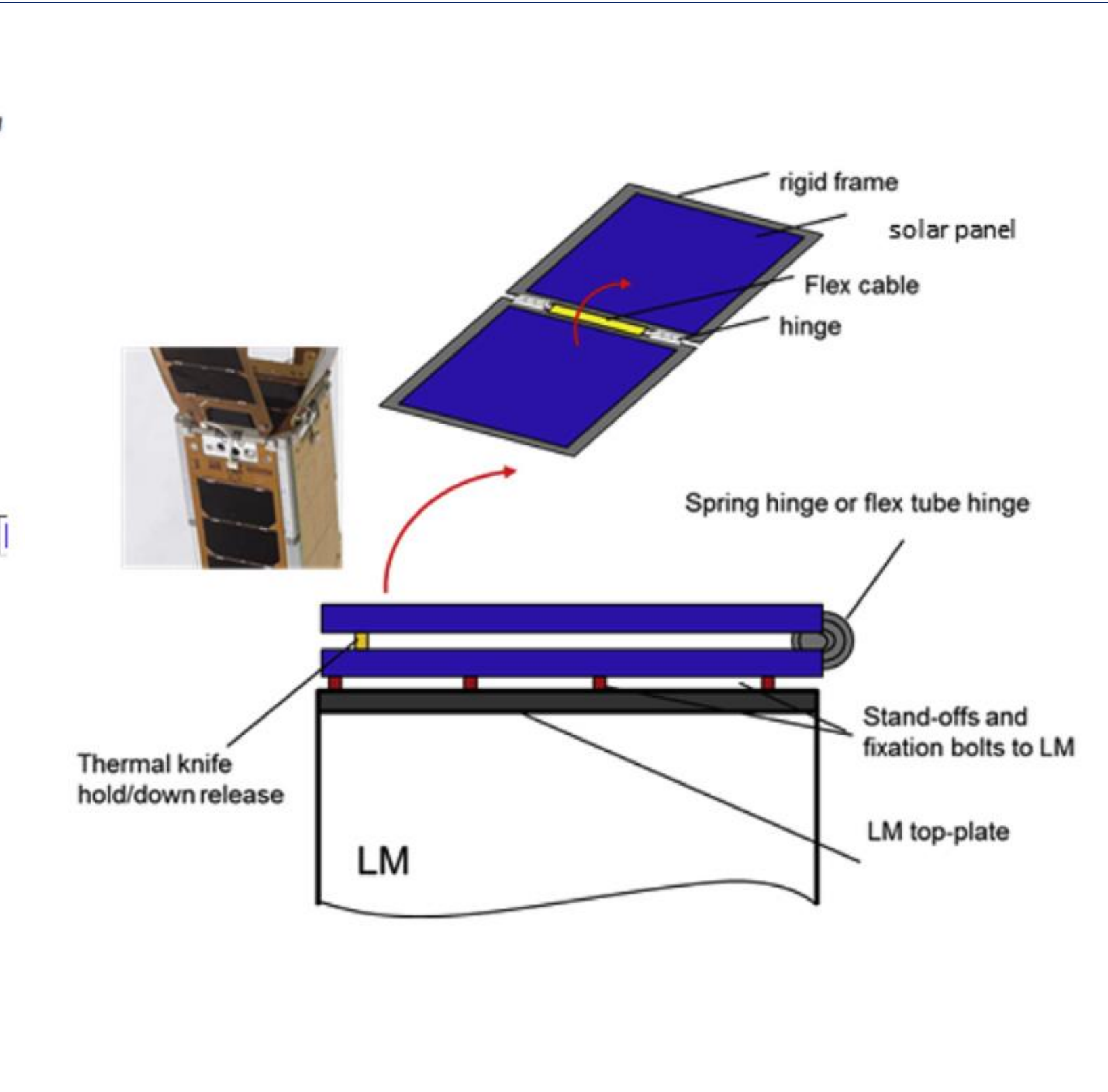
a day in the life of MASCOT2
the rotation of 'Didymoon' in its orbit sets the clock for science and communication



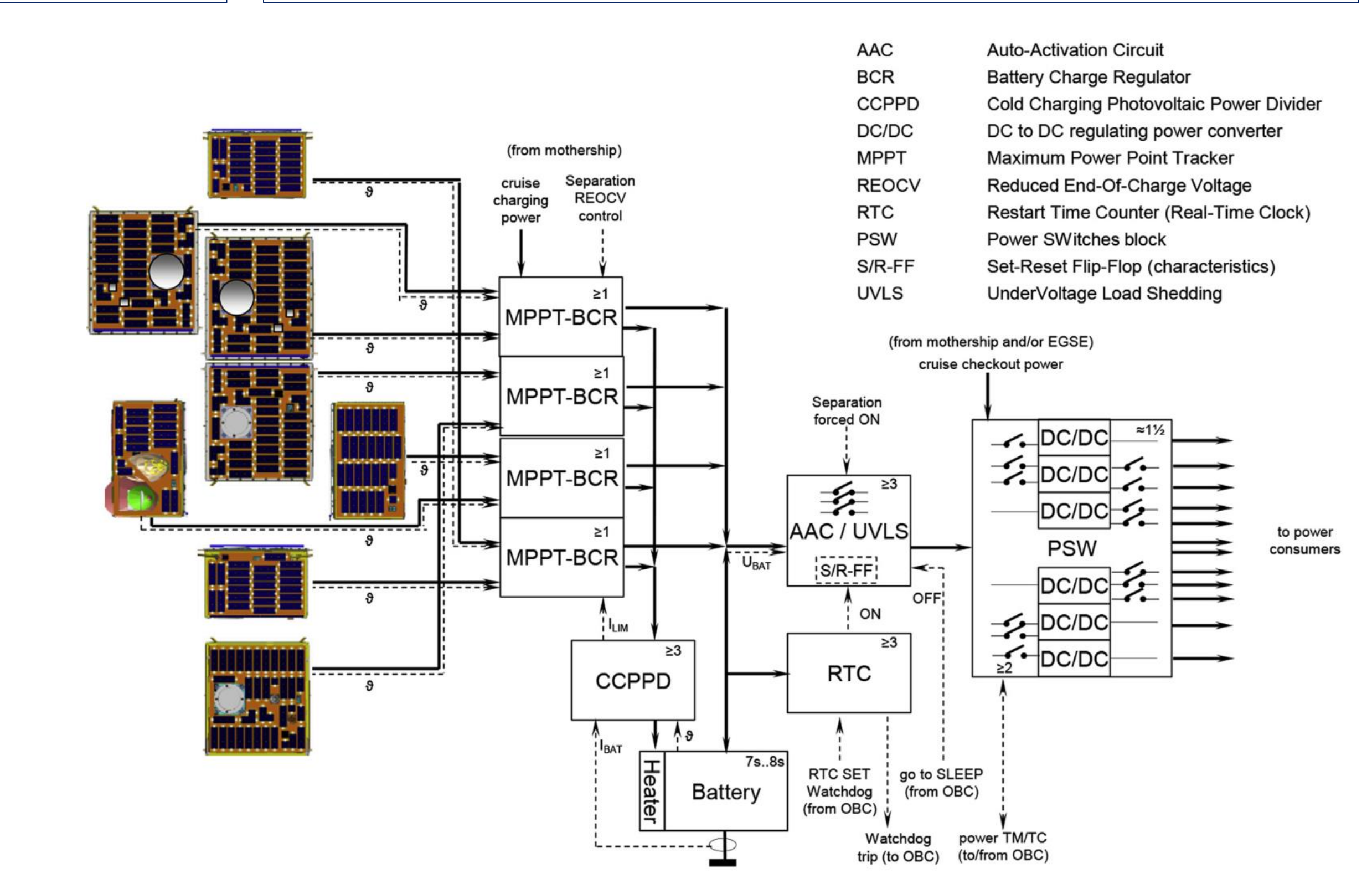
here comes the Sun
MASCOT2 solar panel variations with and without deployables, shaping power



brick your day
synched to asteroid rotation, daily chores are defined by sunshine and science goals for modular autonomy



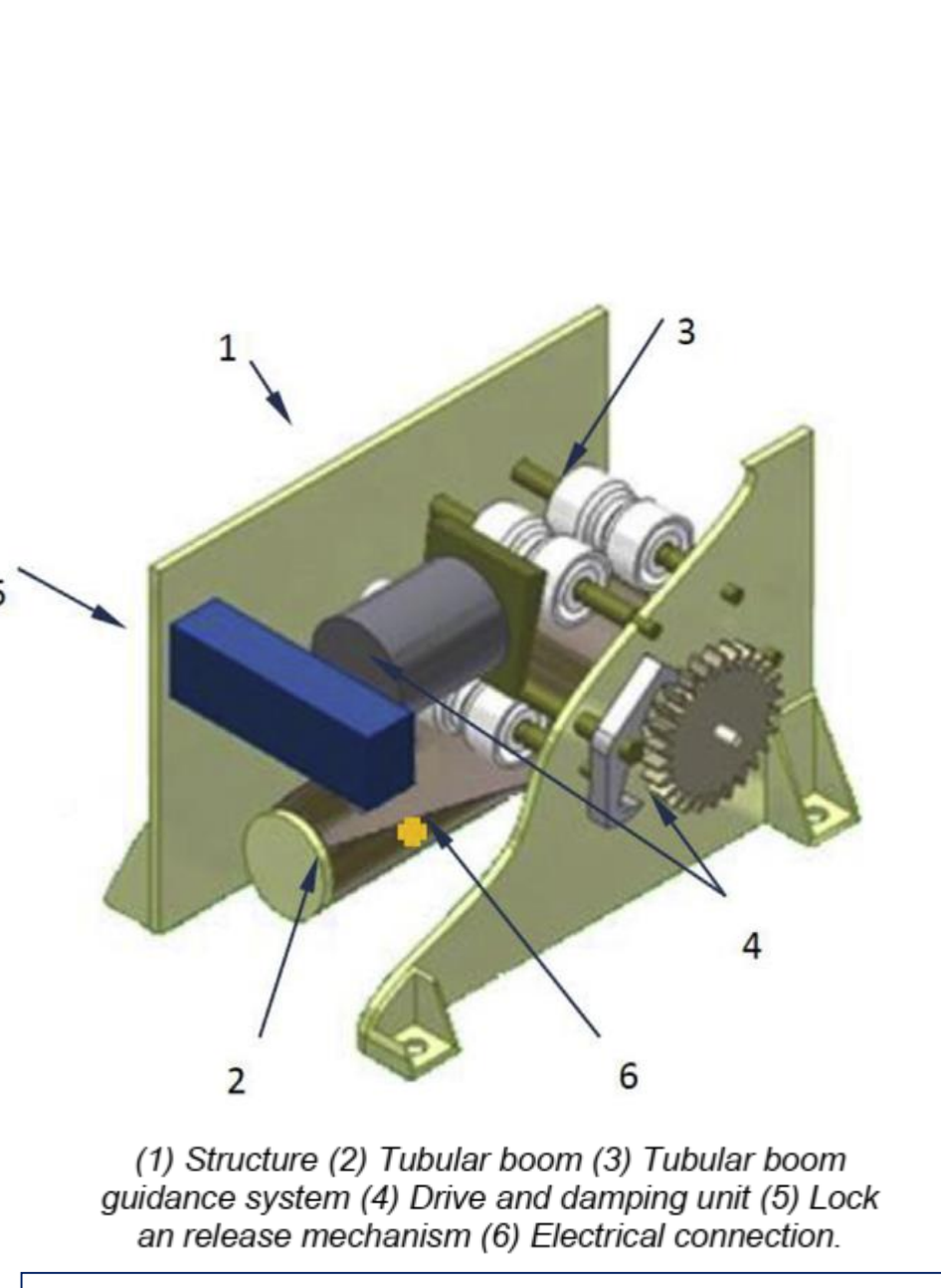
when power unfolds
deployable solar arrays with DLR GoSolAr membrane technology



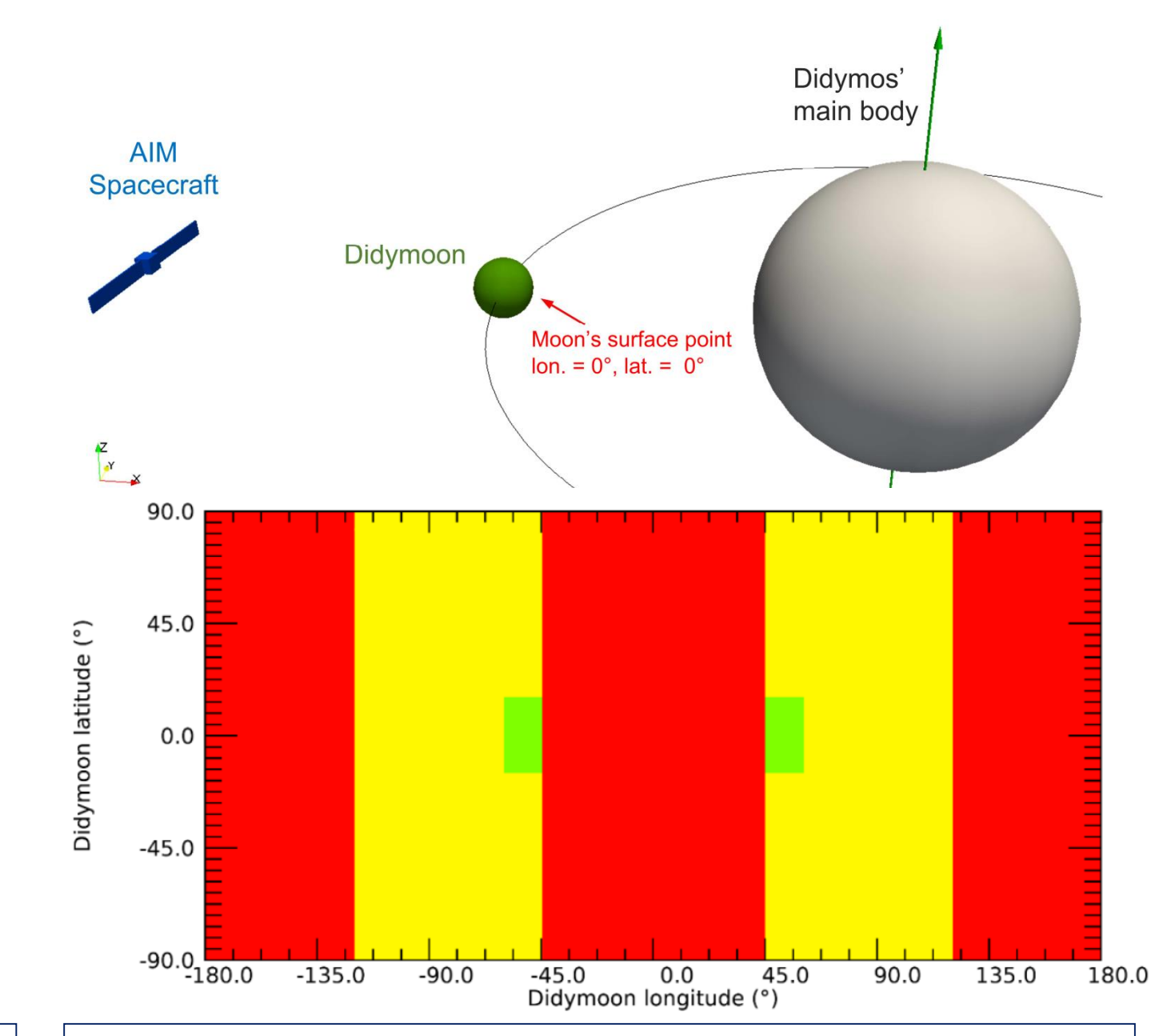
energy for the keeping
efficiency-optimized power subsystem for highly variable power demand and unpredictable places



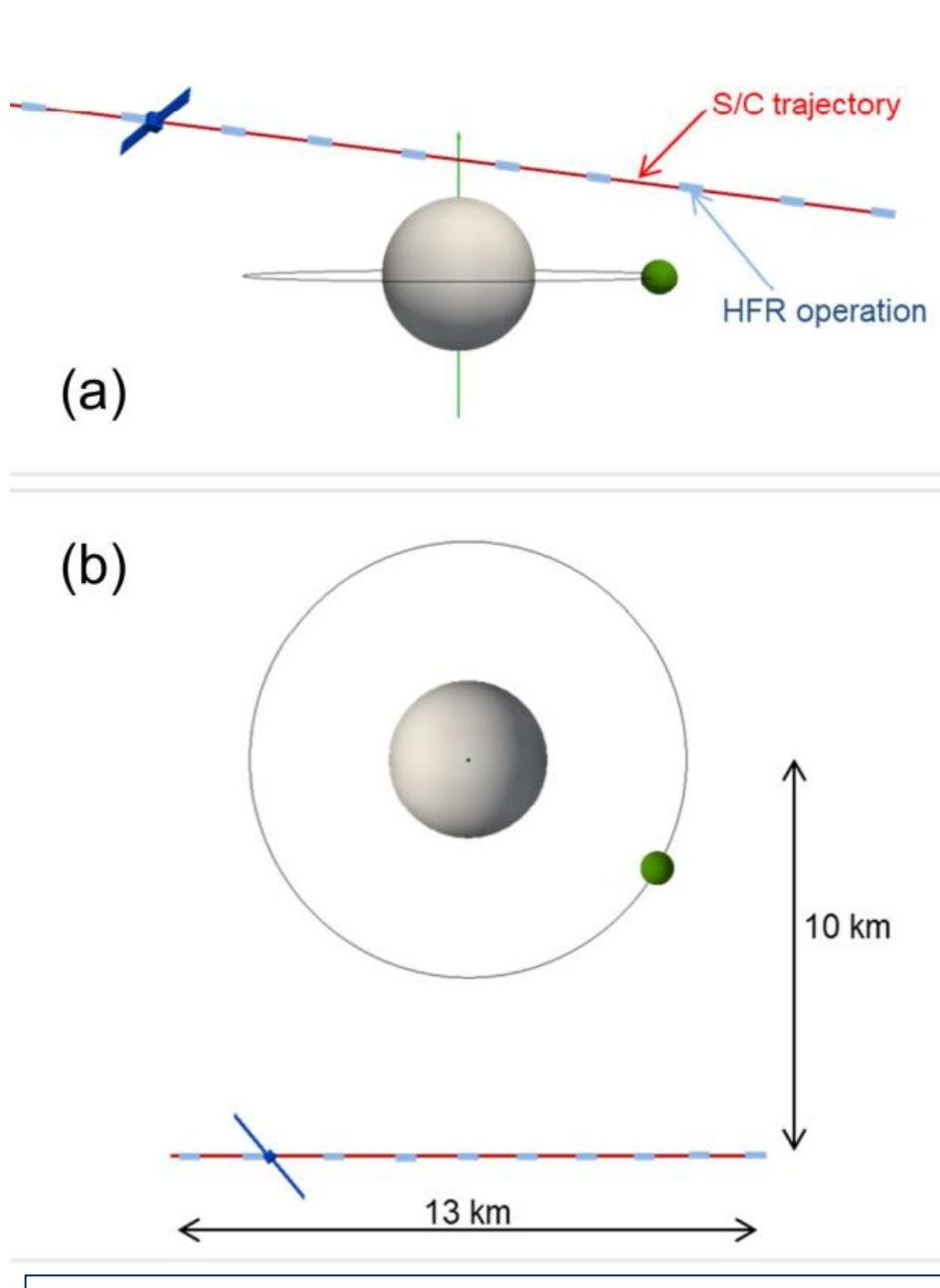
HFR ultra-broadband dual-polarized antenna
↑ 3D model – lightweight plate frame design – prototype ↑



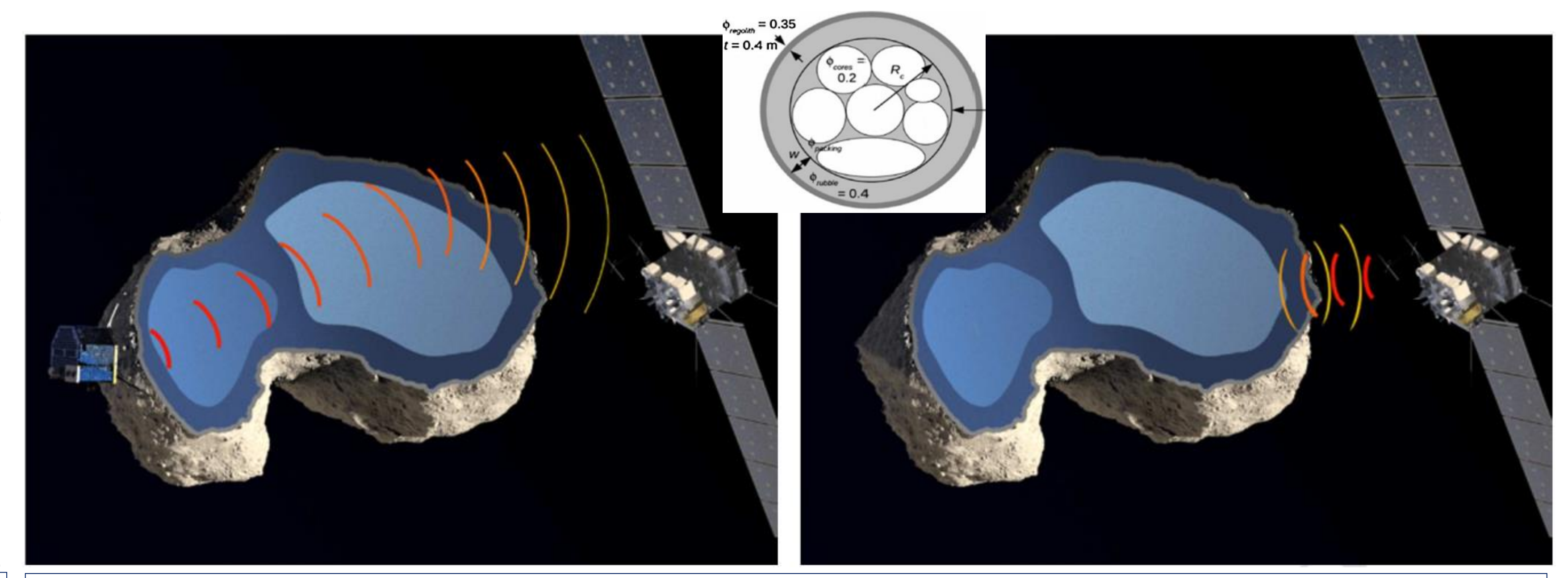
LFR antenna deployer
controlled tubular boom drive mechanism



AIM at a moonlet
MASCOT2 & LFR operation locations (green)



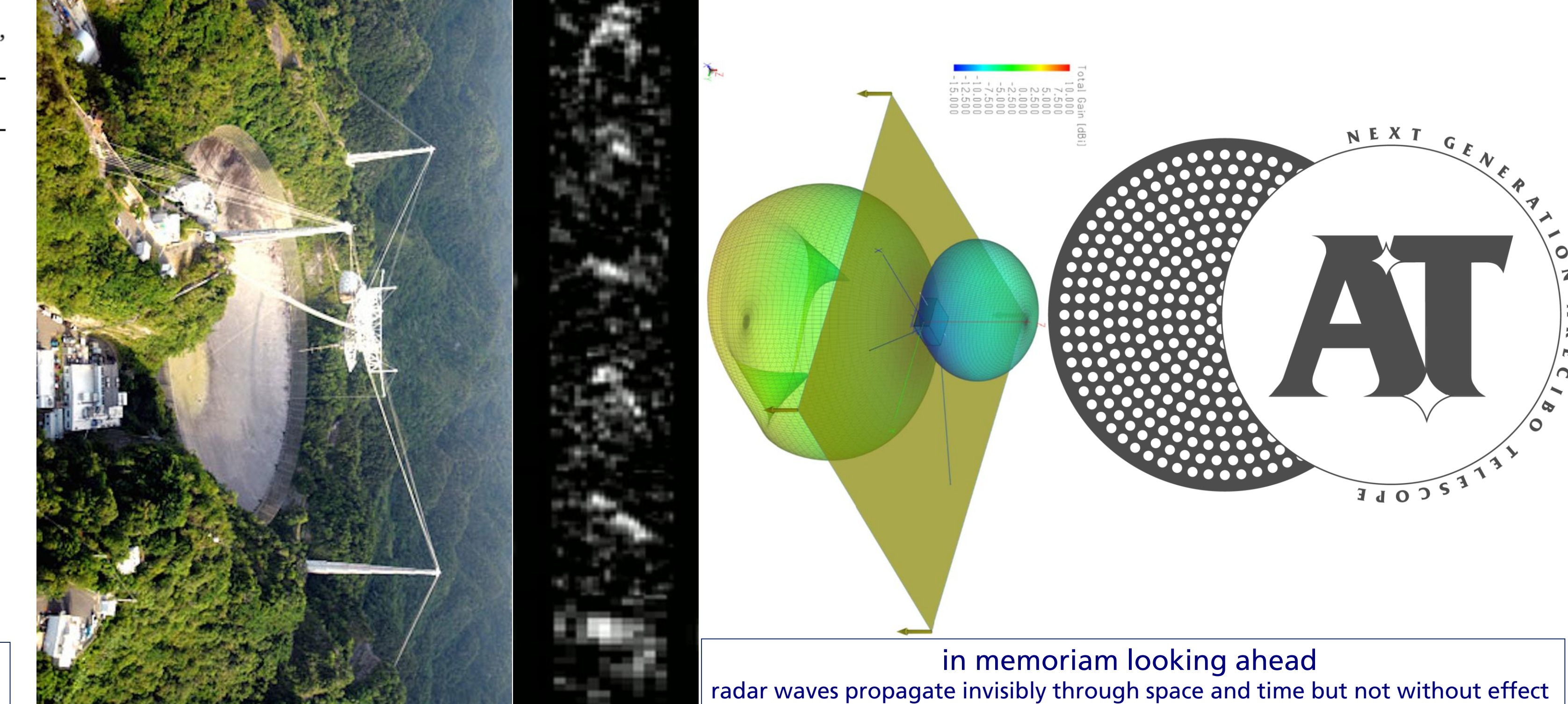
AIM at distance
stationkeeping HFR operation cycle



looking inside from the outside
bistatic low-frequency radar (LFR) scans deep tomography – monostatic high-frequency radar (HFR) scans the upper regolith structure

Subsystem	CBE mass, kg	Maturity margin	Mass incl. margin, kg
Mobility	1.02	9%	1.11
GNC	0.44	36%	0.60
Data Handling	0.56	11%	0.62
Communications	0.88	18%	1.04
Power	3.43	11%	3.81
Structure	2.23	20%	2.67
Thermal	0.22	10%	0.2424
Harness	1.33	8%	1.44
Payload			2.31
LFR	1.05	22%	1.28
DACC	0.12	25%	0.15
MARA	0.37	5%	0.39
CAM	0.47	4%	0.49
Total Lander	12.12		13.83
MASCOT MESS	0.82	16%	0.95
MASCOT total	12.94	+5% system margin	14.79
			15.53

an instrument-sized lander
complete with 4+ science instruments, communication and mobility



in memoriam looking ahead
radar waves propagate invisibly through space and time but not without effect

	Main characteristics and performance of the bistatic radar and high frequency monostatic radar for the AIDA/ AIM mission.	
	Bistatic Radar	Monostatic Radar
Frequency: nominal	50–70 MHz	300–800 MHz
Frequency: extended	45–75 MHz	Up to 3 GHz
Signal	BPSK	Step frequency
Resolution	10–15 m (1D)	1 m (3D)
Polarization	Circular (AIM)	Linear (Mascot)
Tx power	12 W	Tx: 1 Circular Rx: OC and SC 20 W
Pulse repetition	5 s	1 s (typical)
Sensitivity	Dynamics = 180 dB	NEσ0 = –40 dB m ² /m ²
Mass		
Electronics	920 g	920 g
Antenna	470 g	230 + 100 g
Total w/o margin	1390 g	1250 g
Power max/mean	50 W/10 W	50 W/10 W
Typical Data (Gbit)	1	0.3
		300 Gbit

the radars for AIM & MASCOT2
bistatic low-frequency radar (LFR) and monostatic high-frequency radar (HFR) are compact instruments fit for small orbiters and nanolandings

MASCOT2 was from the start designed to support the planetary defense exercise that is the joint NASA-ESA AIDA mission. Although MASCOT2 is not going to sit within 85 m of DART's ground zero, we are ready to go to Apophis and all the others. We welcome 2021 PDC!

FM-level of detail designs and lessons learned by MASCOT on HAYABUSA2 provide a sound basis for responsive nanolander studies and designs like MASCOT2, fit for small spacecraft and ready for the 1-in-1000 years chance.

for daily updates during the PDC 2021 & more visit us at https://gla-my.sharepoint.com/:f/g/personal/i_moore_3_research_gla_ac_uk/Eg-ISGBxOL1Lj9i89EGGYOABFNltvITj8df4PnLXHkZkQ?e=sXLol2

