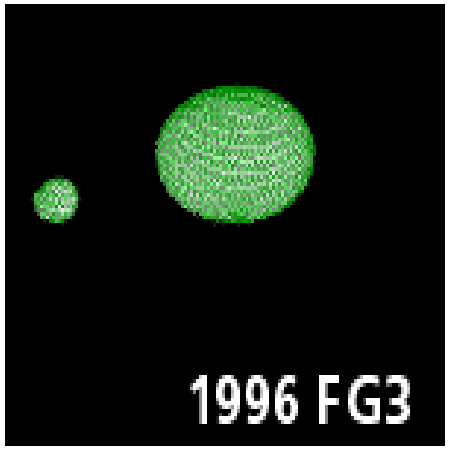
MarcoPolo-R
Preliminary mission design

Science and Robotic Exploration Directorate,
Advanced Studies and
Technology Preparation Division

Target Overview

- Name: 1996 FG3
- Class: C-type binary
- Orbit: 0.69 to 1.42 AU from Sun
- Inclination: 1.99 deg
- Eccentricity: 0.3498
- Orbital period: 1.08 years



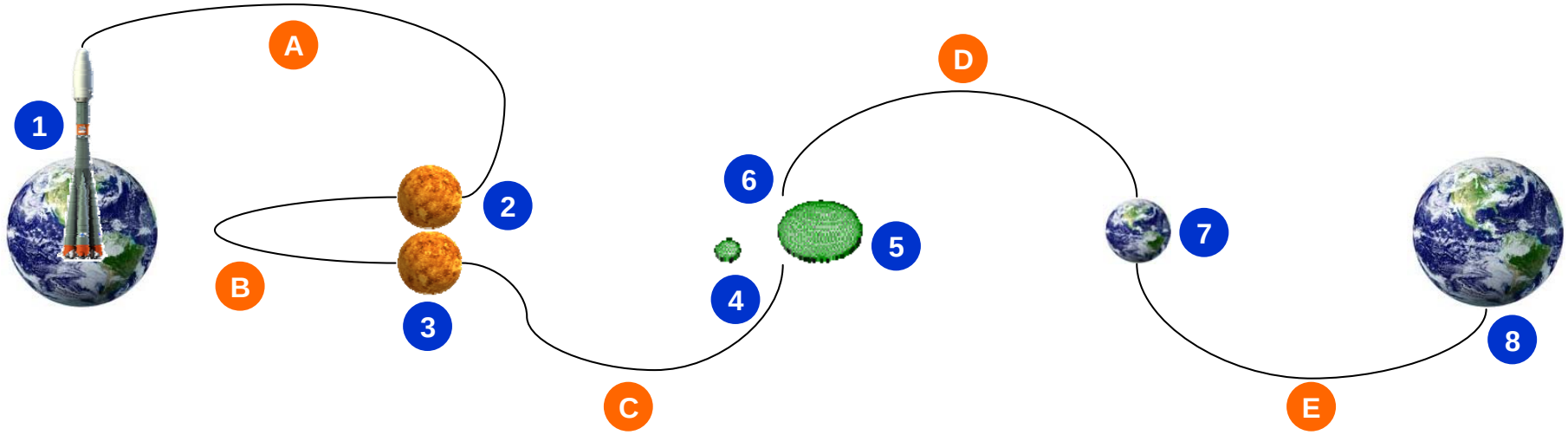
- Primary
  - ✓ Diameter: 1.4±0.2 km
  - ✓ Mass: 2.1 E12 kg
  - ✓ Geometric albedo: 0.035
  - ✓ Spin period: 3.595±0.002 hrs
  - ✓ Density: 1.4±0.3 g.cm^-3
  - ✓ Taxonomic type: C
  - ✓ Surface temperature up to 200^{o}C

- Secondary
  - ✓ Secondary to primary diameter ratio: 0.28±0.02
  - ✓ Orbital semimajor axis: 3.1±0.5 km
  - ✓ Orbital eccentricity: 0.1±0.1
  - ✓ Orbital period around primary: 16.14±0.01 hrs

S/C design

- ~ 1.5-1.6 tons launch mass
- Electric propulsion
- 6.7 to 8 year mission
- Baseline launch in 2021
- Backup opportunities in 2022, 2023
- Stay time at the asteroid between 180 and 265 days (see minimum required timeline in later slides)
- Science orbits (global characterisation) around the asteroid: node placed such that 9/21 or 15/3 Sun Synchronous Orbits are obtained
- Science orbits altitude could be between 1 and 5 km, not frozen yet, requires further analysis
- Payload mass allocation 25 kg, including maturity margins

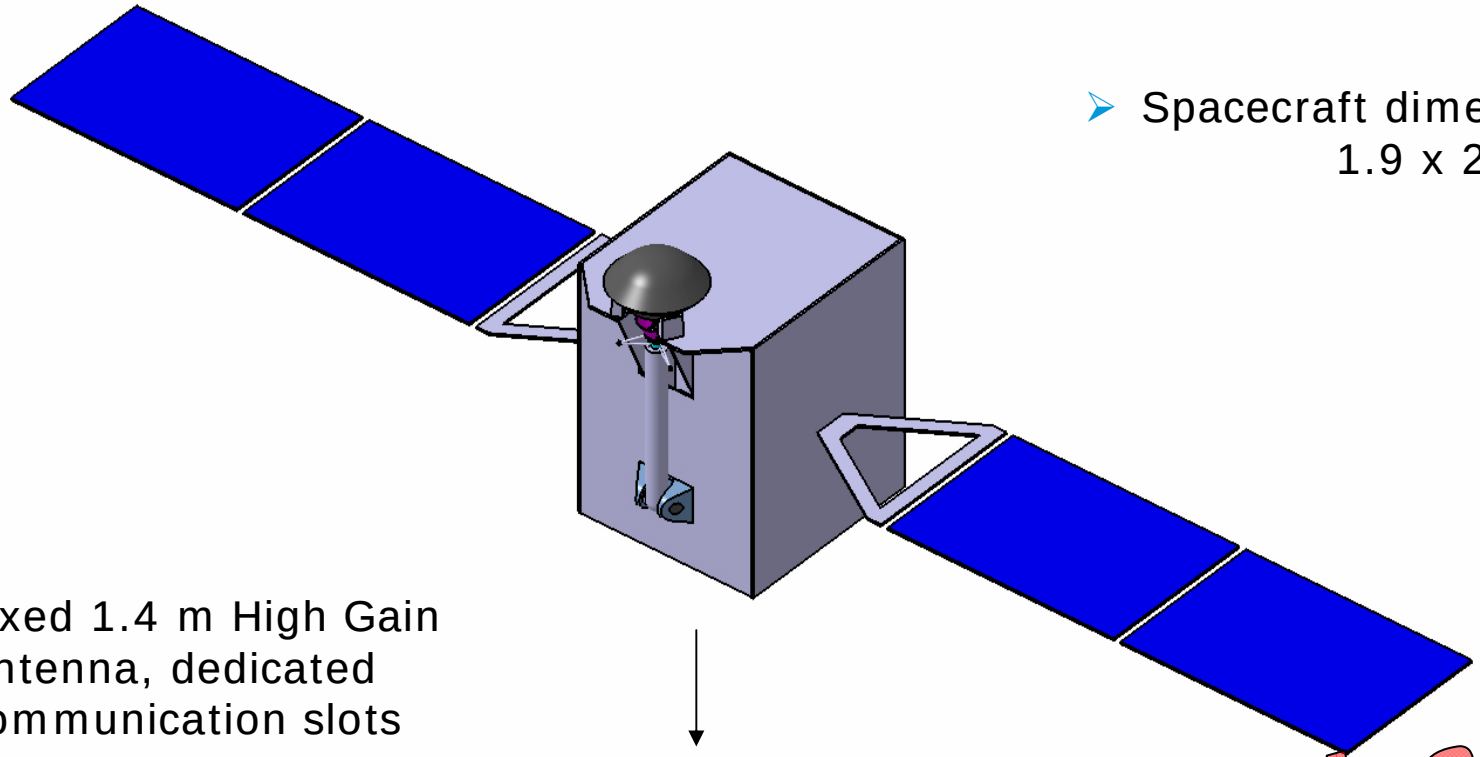
Baseline mission architecture



1. Soyuz ST launch from Kourou (FR)
2. First Venus Swing-by
3. Second Venus Swing-by
4. Arrival to 1996 FG3
5. Observation & sample collection
6. S/C Departure (Return to Earth)
7. Earth Swing-by
8. ERC return to Earth

EP thrust and coast arcs

S/C Deployed



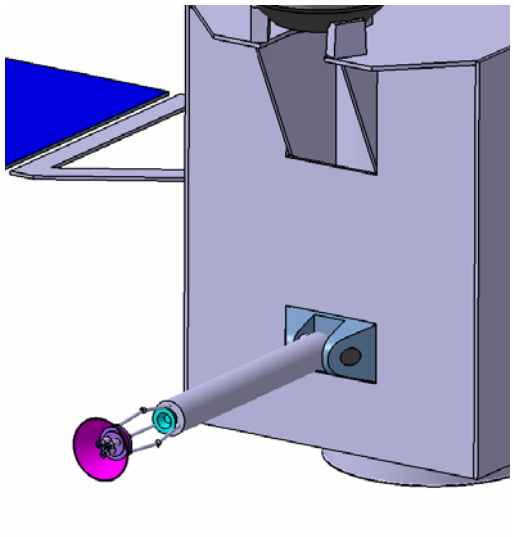
- Spacecraft dimensions: 1.9 x 2 x 3 m^3

- Fixed 1.4 m High Gain Antenna, dedicated communication slots
- 100 Gbit max total in-situ science data download capability

Direction to asteroid's surface

Preliminary

S/C during sampling



Direction to asteroid's surface

Touch and go sampling approach (< 2 seconds touchdown on the surface)

Preliminary

Proposed Marco Polo R Timeline

	days	distance	comment
SEP Approach (before stay at asteroid)	120	1 million km - 100 000 km	
	24	100 000 km - 4500 km	Slow approach used for asteroid detection
	6	4500 km – 500km	Min. approach distance similar to Rosetta
Close Approach Trajectory	6	500 km - 100 km	4° full pictures of binary system from ~50 km
Transition to Global Mapping + binary system mapping	15	100 km - 10 km	
Global Mapping + sensors/instrument calibration	28	10 km	

Preliminary

Proposed Marco Polo R Timeline

	days	distance	comment
Global mapping / far global characterization	21	5km	Duration = average Rosetta/Marco Polo
Global mapping /close global characterization	14	1-2 km TBC	Closer global mapping
Detailed gravity mapping	0	200 m	No dedicated radio science, done together with global observations
Local characterization	35	100 m TBC	As Marco Polo
Landing	35	0	Marco Polo duration (70 days) was sized for 5 landing attempts, to be reduced
Additional science	0		TBD as time available
Asteroid escape preparation	7		As per Marco Polo, SEP impact TBD

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