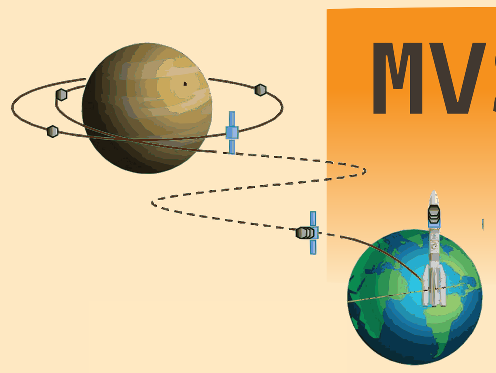
MVSE Mission Phase A/0 Study: A Proposal for Understanding the Dynamics of Induced Magnetospheres



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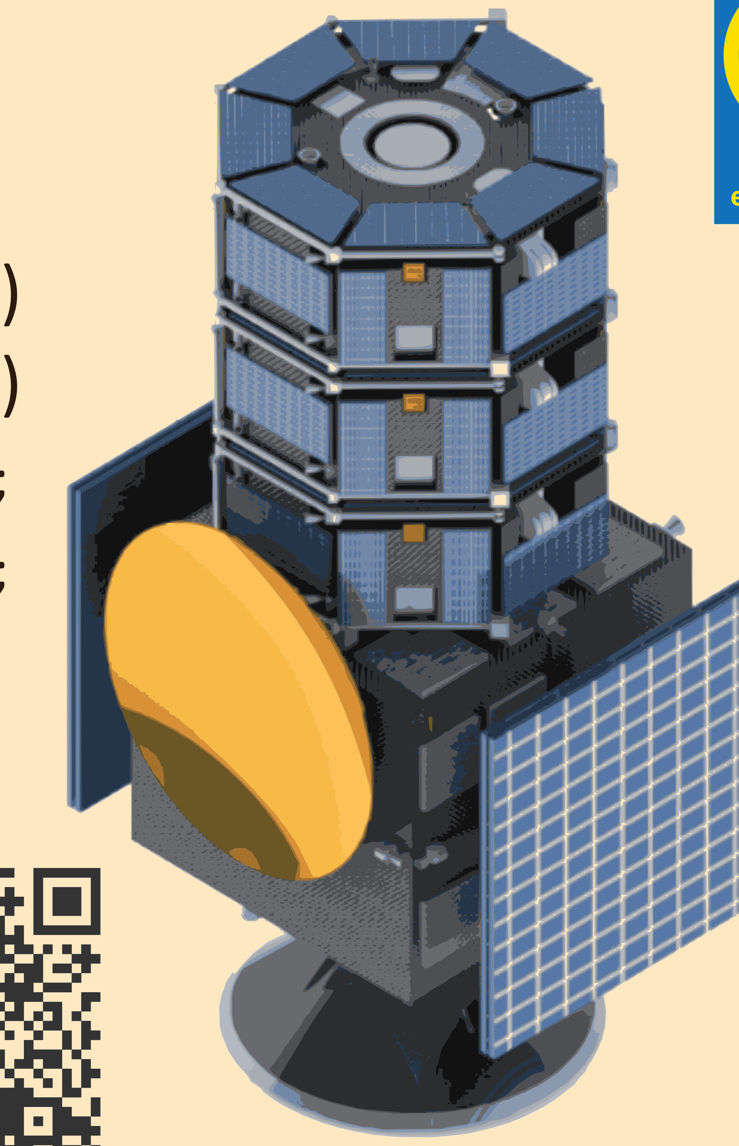


1 INTRODUCTION

- **Multi-spacecraft mission concept to study Venusian magnetosphere**
- Concurrent engineering by 32 international students with engineering and science backgrounds; advice from experts of ESA and academia
  - Summer School Alpbach 2022: Scientific definition and baseline design
  - Post Alpbach Summer School Event 2022 using COMET tool: Refinement of design, proof of feasibility (incl. ESA margins), consistency check with COMET
- L-Class Mission

2 SCIENCE CASE

- **How does the sun drive the dynamics of an induced magnetosphere?**
- Mission Objective 1: Observe the reactions of an induced magnetosphere (MS) to the variations of the solar wind (SW) conditions
  - Measure: change of magnetosphere structure
  - Measure: variation of heating process
- Mission Objective 2: Observe the reactions of an induced magnetosphere to solar eruptive events such as interplanetary Coronal Mass Ejections (ICMEs), Corotating Interaction Region (CIR), and Solar Flares

3 SCIENTIFIC MEASUREMENT AND INSTRUMENT REQUIREMENTS

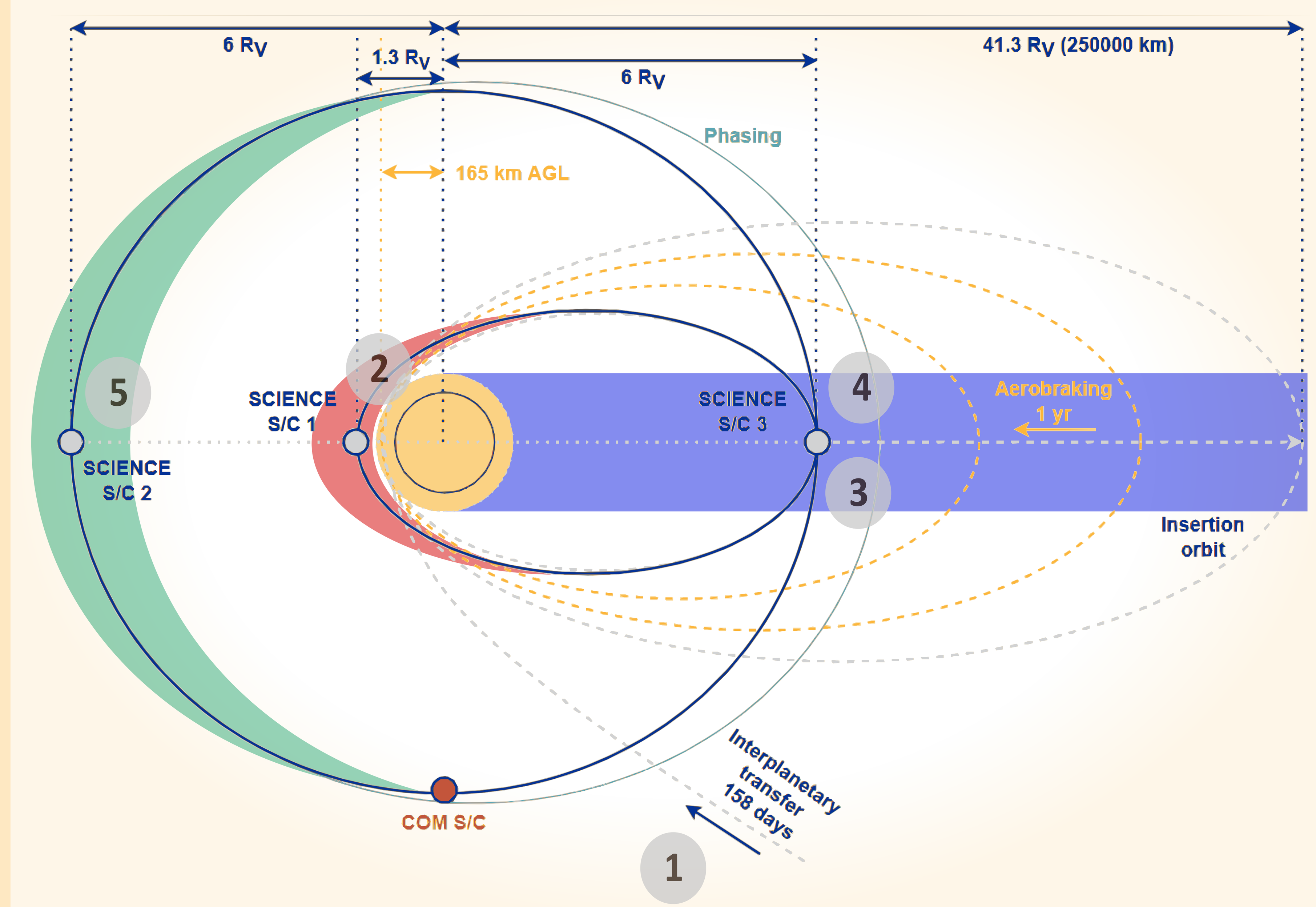
- SR 1: measurements of 3D magnetic fields → electromagnetic waves
- SR 2: measurement of ≥2 electric field components → plasma oscillations
- SR 3: measurements of ion and electron distributions → density, velocity and temperature
- SR 4: measurements of ion composition → common pickup ions from Venusian atmosphere
- SR 5: science spacecraft in: i) dayside and ii) downstream the bow shock and iii) magnetotail
- SR 6: SR5 for sufficient duration to measure reactions to solar wind and changes in magnetotail
- SR 7: observation of >10 CME events → 2 years science + 1 year trajectory

4 WHY VENUS?

- purely induced magnetosphere
- accessibility
- similarity to Earth

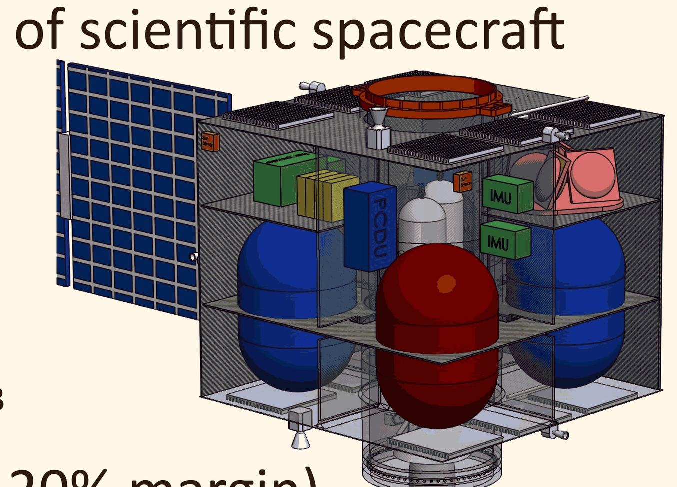
5 TRAJECTORY

	Manoeuvre	ΔV / m/s
1	Deep Space Manoeuvre	30
2	Venus Orbit Insertion	640
3	Pericythe Raise	181
4	Circularisation	1155
5	Phasing	11
	End of Life	11
	Total	**2028**



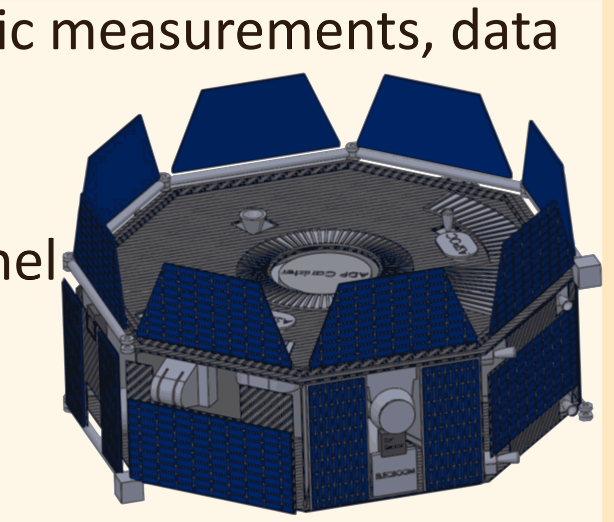
6 TRANSFER STAGE

- Functions: Orbital delivery of scientific spacecraft
  Data transmission to Earth
- Design Drivers: Propellant volume allocation
- Characteristics:
  Cubic shape: 2 x 2 x 2.2 m^3
  Peak power: 1103 W (incl. 20% margin)



7 SCIENCE SPACECRAFT (3x)

- Functions: Collection of scientific measurements, data transmission to transfer stage
- Design Drivers:
  Solar array surface, radiator panel size,electronics accomodation
- Characteristics:
  Octagonal shape: height 0.7 m;
  diameter 2 m, Peak power: 491 W (incl. 20% margin)



Instruments	Variable
Fluxgate magnetometer (x2)	$\vec{B}$
Search coil magnetometer (x1)	$\delta\vec{B}$
Spin-plane double probe (x4)	$\vec{E}$
Electrostatic analyzer (x2)	VDF
Mass analyzer (x1)	$^{m}/_{q}$
High energy particle instrument (x1)	E

Mass Budget		
Science spacecraft		Transfer stage
Mass / kg		Mass / kg
29.14	Attitude and Orbit Control	67.09
28.56	Communicatons	45.01
60.72	Instruments	
36.91	Mechanisms	13.24
83.11	Power	102.42
	Propulsion	156.99
104.49	Structure	352.10
11.63	Thermal	26.38
17.73	Harness	38.16
74.46	System Margins (20%)	160.28
1.37	Fuel, Oxidizer, Propellant	1924.02
448.1	Total Wet Mass	2885.70

8 CONCLUSIONS

- MVSE mission sheds light on how the sun drives the dynamics of the induced Venusian magnetosphere
- L-Class Mission; 4230 kg launch mass
- Feasibility proven (incl. ESA margins); consistency checked with COMET tool; no technical showstoppers
- Three spin-stabilised scientific spacecraft in resonant orbits; simultaneous measurements i) up and ii) downstream the bow shock, iii) in the magnetotail
- Transfer stage performs orbital delivery and communication to Earth

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