In Situ Elements Overview

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TSSM

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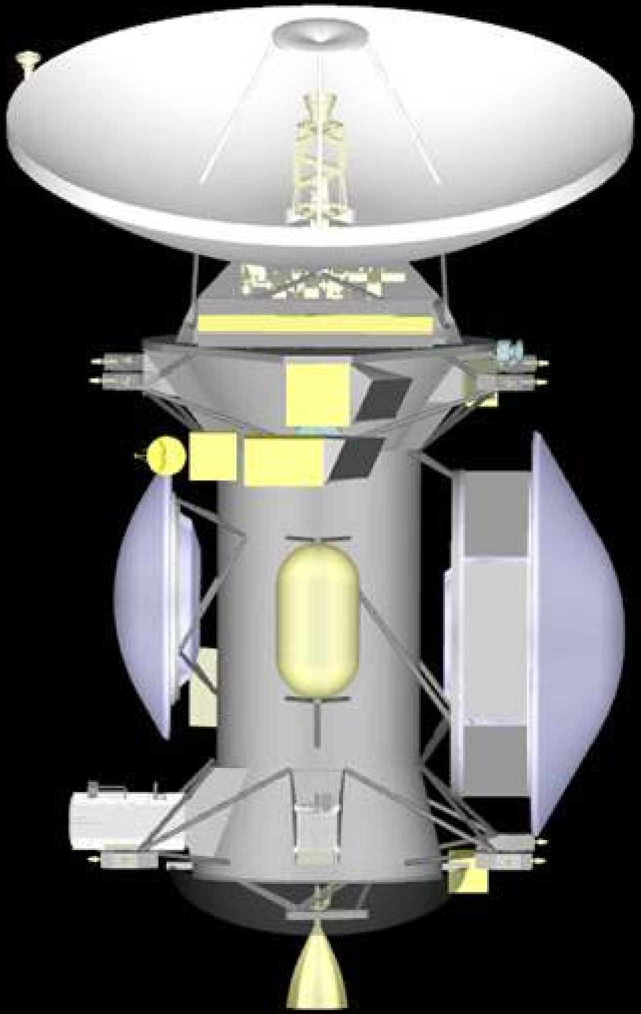
In-Situ Elements Carried to Titan

- **In situ elements to be carried by orbiter to Titan**
  - Montgolfière: 2.6 m aeroshell, 600 kg, interface structure with radators mounted
  - Lander: 1.6 m aeroshell, 190 kg
  - (optional) “Geosaucer”
- **ISE’s have no flight control system – targeting will be performed by the orbiter**
- **Orbiter also acts as data relay for the ISE’s**

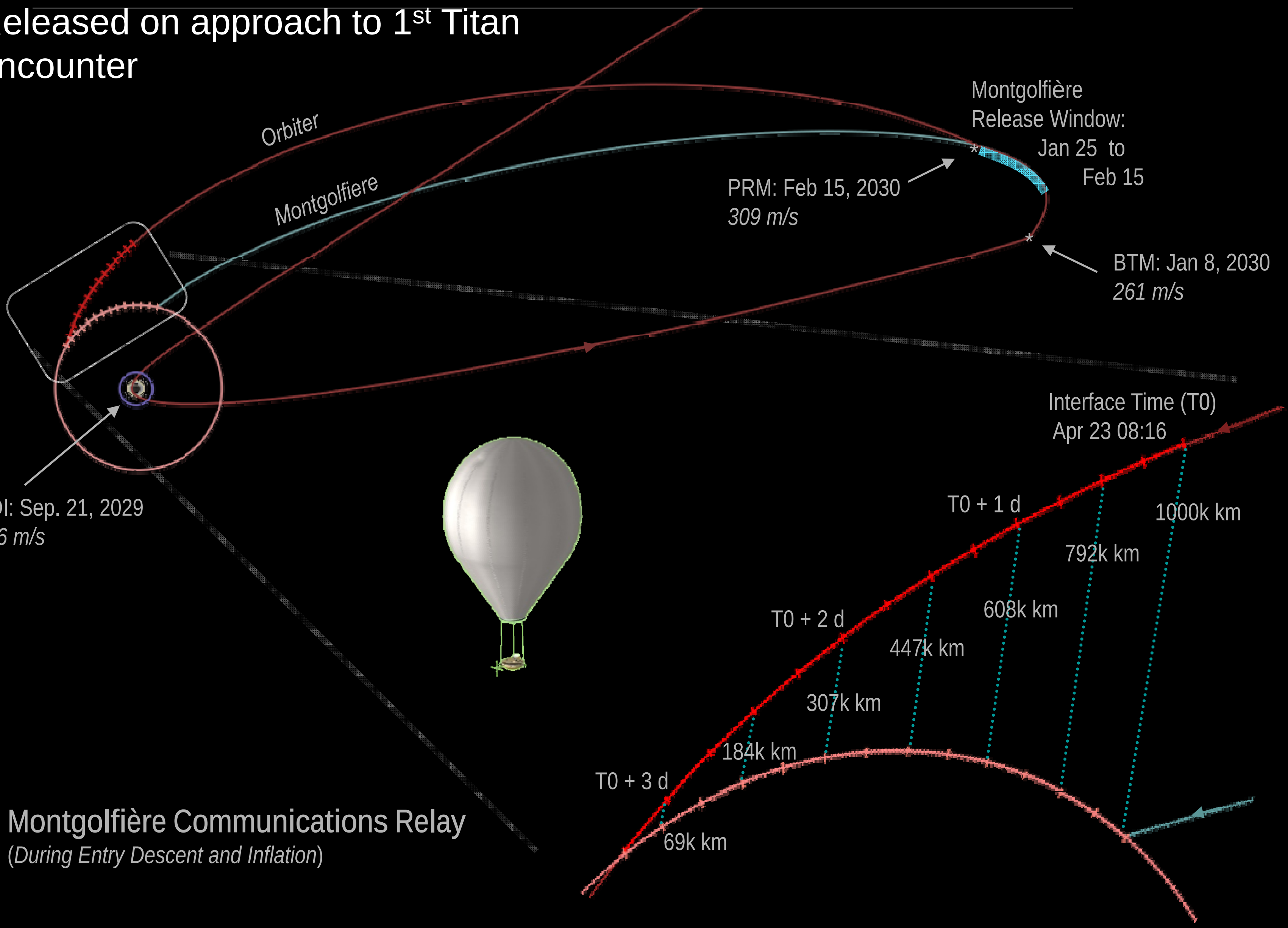


Summary of the Montgolfière

- Balloon: 10.5 m diameter (~130 kg); heating by MMRTG
- Balloon to be provided by CNES
- Gondola: 144 kg, incl. 21.5 kg instrumentation
- Power generation by MMRTG (100 W)
- Floating altitude 10 km; only altitude control
- Prime mission 6 months (+6 months extended)
- At least one circumvention

Montgolfière Delivery

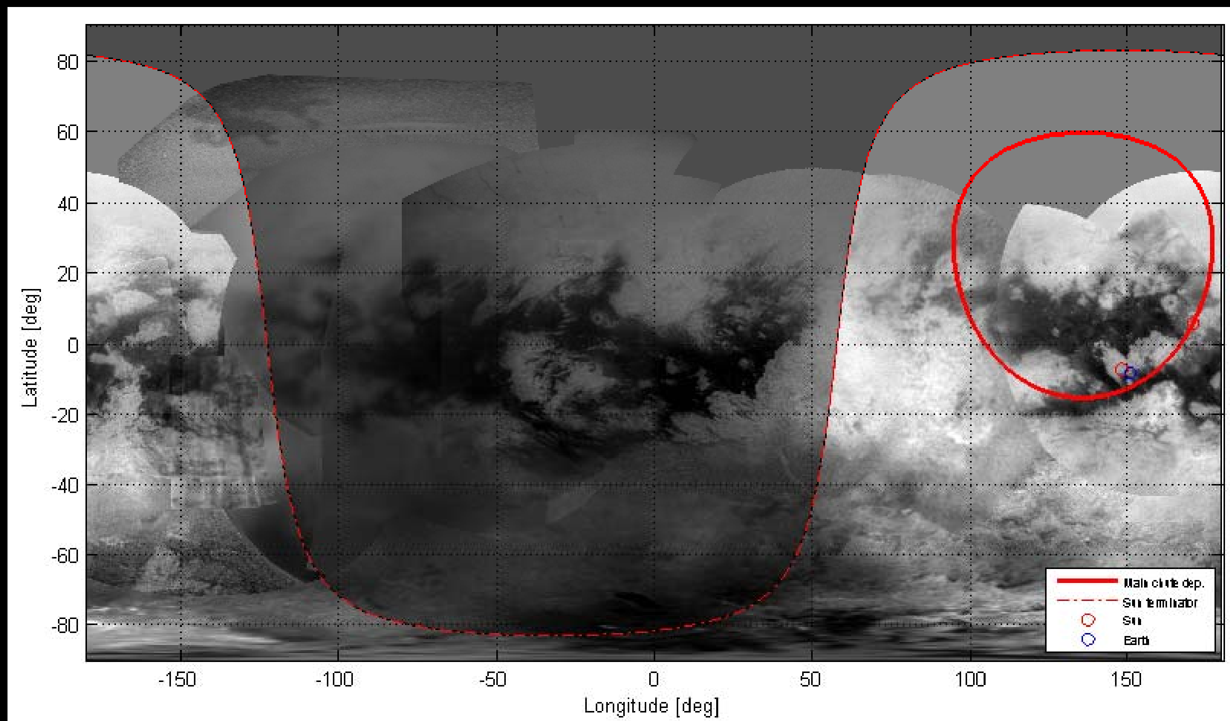
Released on approach to 1st Titan encounter



Montgolfière Communications Relay

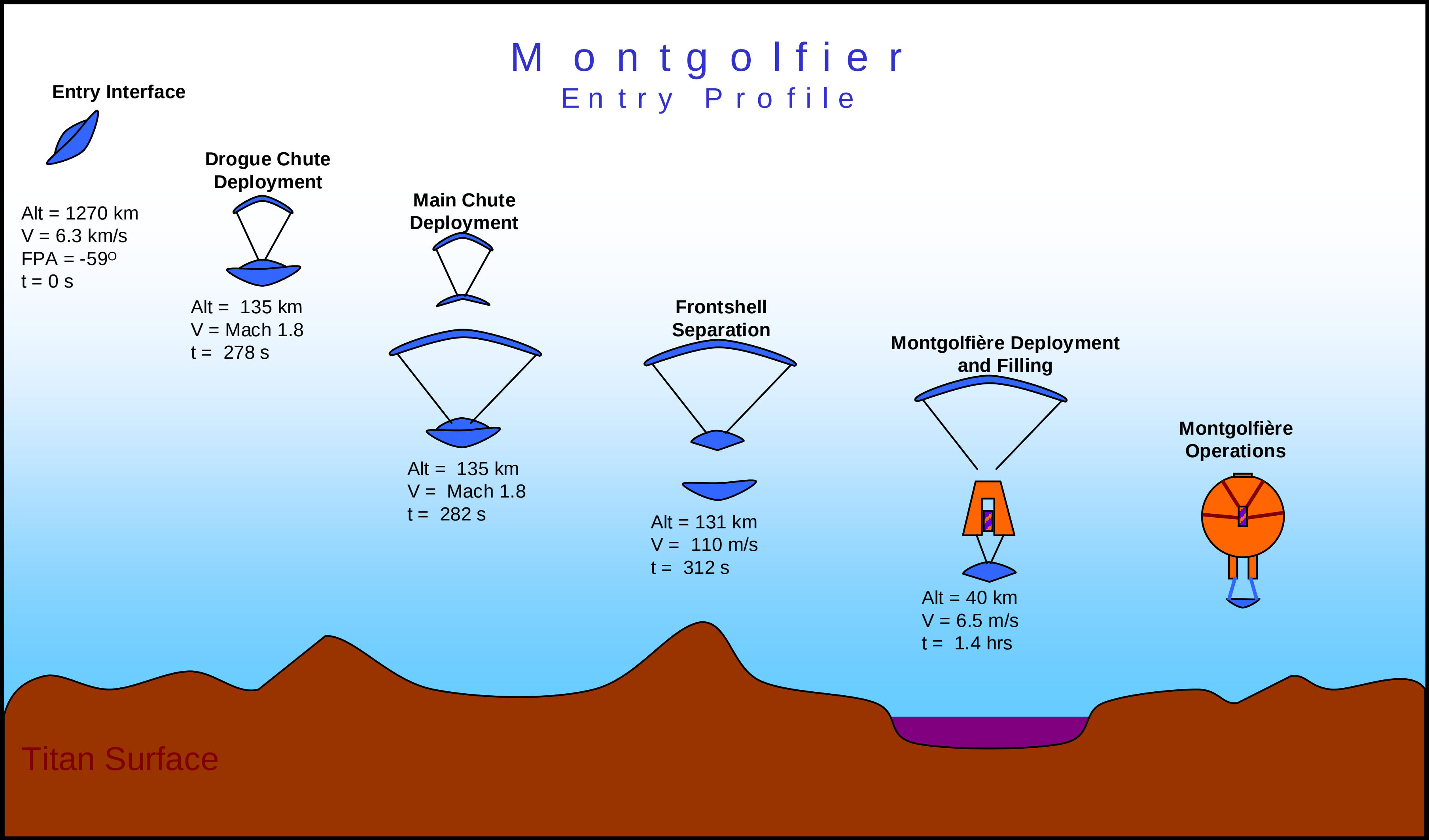
(During Entry Descent and Inflation)

Montgolfière Target



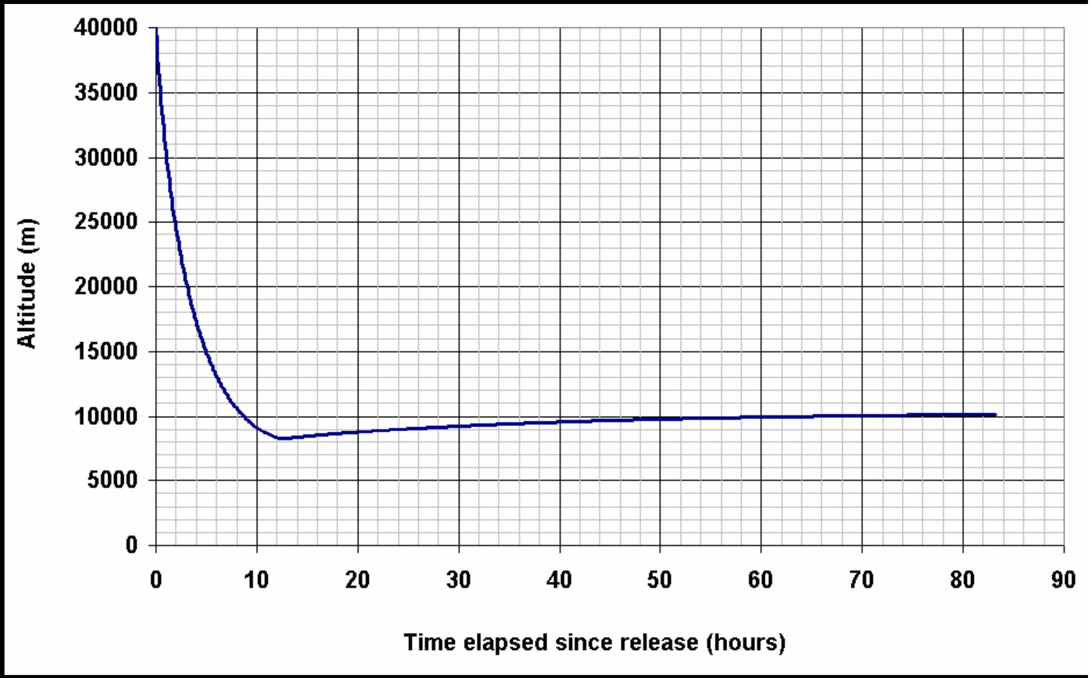
- **Montgolfière will be targeted at 20° N (strongest zonal winds expected)**
- **Flight path angle constrained between 59 and 65°**

Montgolfière Descend Scenario

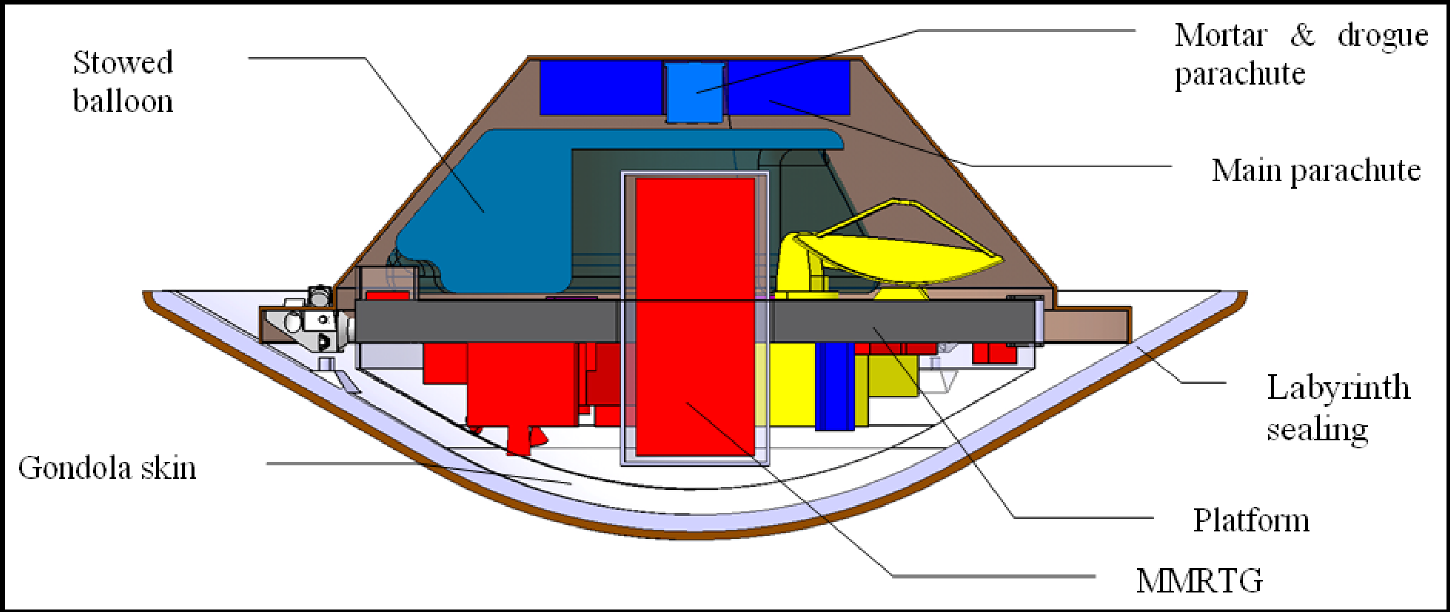


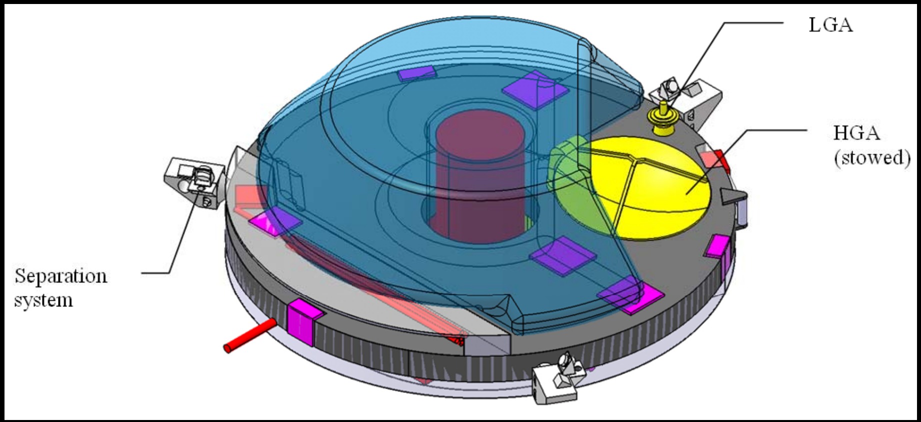
Balloon Filling Phase

- Balloon would be released at ~40 km
- The air-flow from the descent is used for its filling
- Heating of the inside gas starts simultaneously
- Stable altitude is reached after about 13 hours

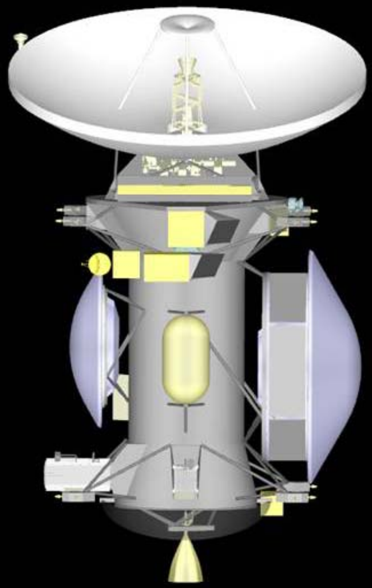


Montgolfière Configuration

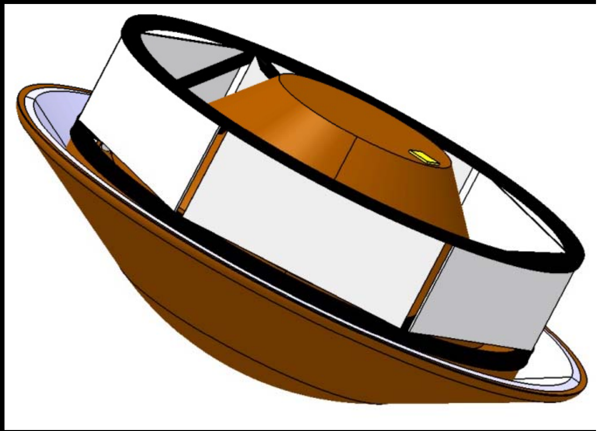




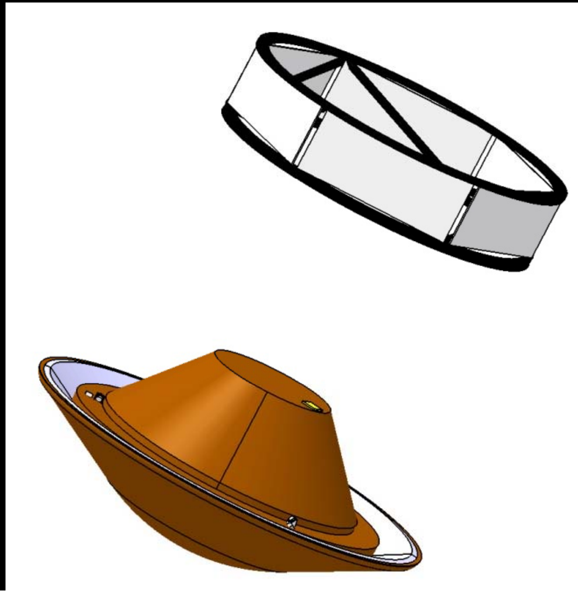
Interface Structure and Thermal Control



- **The back shield is higher – requiring larger distance from mounting interface**
- **The interface structure will also be used for cooling of the MMRTG during cruise**



- **Prior to entry the interface structure will be separated for optimization of floating mass**



Montgolfière Notional Instrumentation

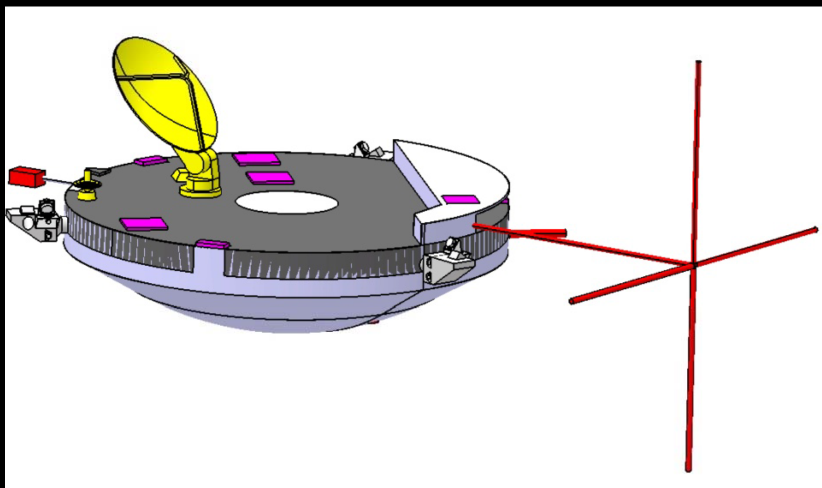
Instrument	Description	Science Contributions	Mass (kg) w/o margin
BIS	Balloon Imaging Spectrometer (1–5.6 µm).	Mapping for troposphere and surface composition at 2.5 m resolution	3
VISTA-B	Visual Imaging System with two wide angle stereo cameras & one narrow angle camera.	Detailed geomorphology at 1 m resolution	2
ASI/MET	Atmospheric Structure Instrument and Meteorological Package.	Record atmosphere characteristics & determine wind velocities in the equatorial troposphere	1
TEEP-B	Titan Electronic Environment Package	Measure electric field in the troposphere (0 – 10 kHz) and determine connection with weather.	1
TRS	> 150 MHz radar sounder	Detection of shallow reservoirs of hydrocarbons, depth of icy crust and better than 10 m resolution stratigraphic of geological features.	8
TMCA	1 – 600 Da Mass spectrometer	Analysis of aerosols and determination of noble gases concentration and ethane/methane ratios in the troposphere	6
MAG	Magnetometer	Separate internal and external sources of the field and determine whether Titan has an intrinsic and/or induced magnetic field.	0.5
MRST	Radio Science using s/c telecom system	Precision tracking of the montgolfière	0

TOTAL 21.5 kg

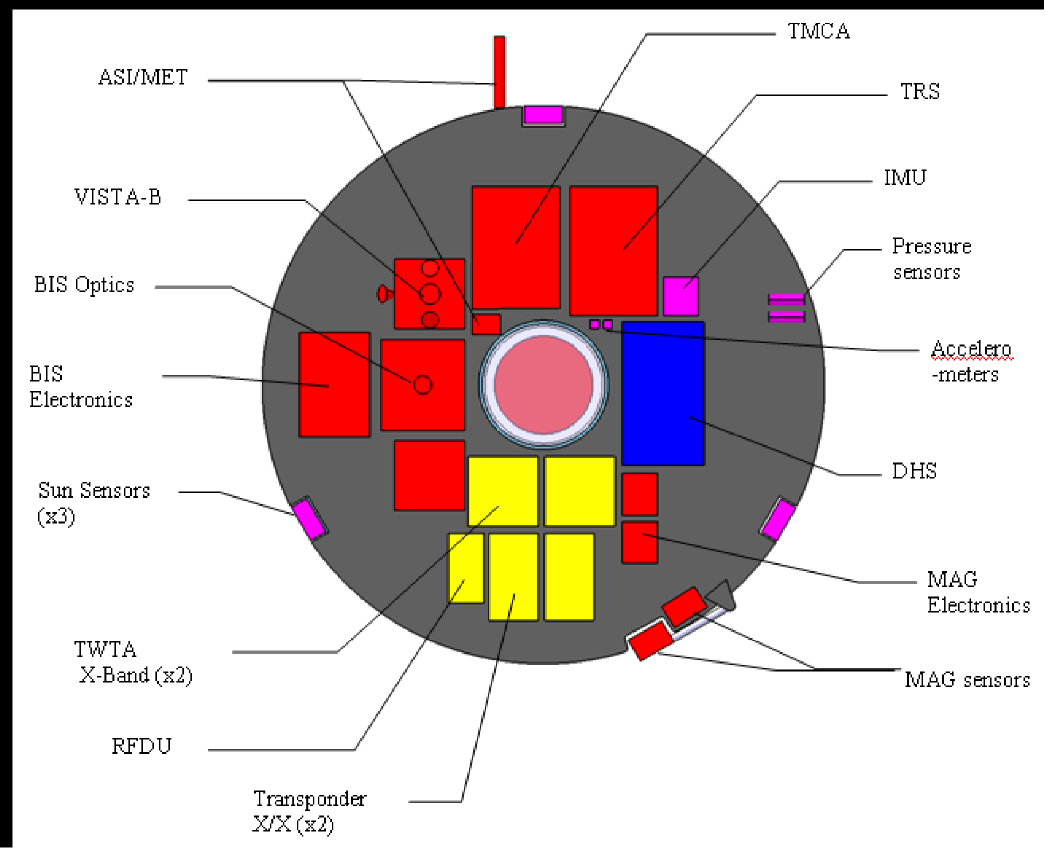
20% system margin applies

Instrument accommodation

Gondola in deployed configuration



Communication equipment on zenith side

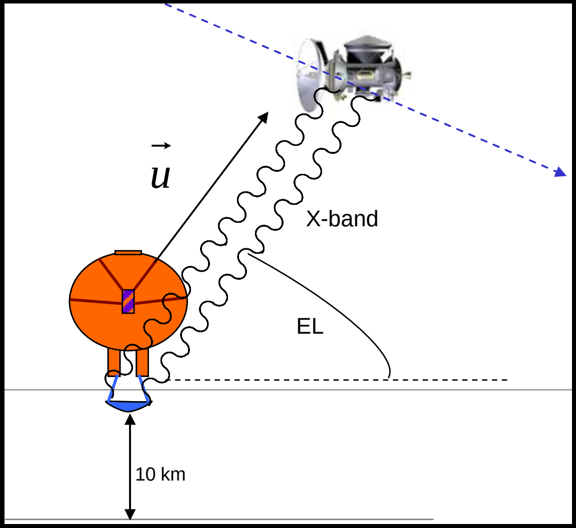


Accommodation of instruments below the central platform

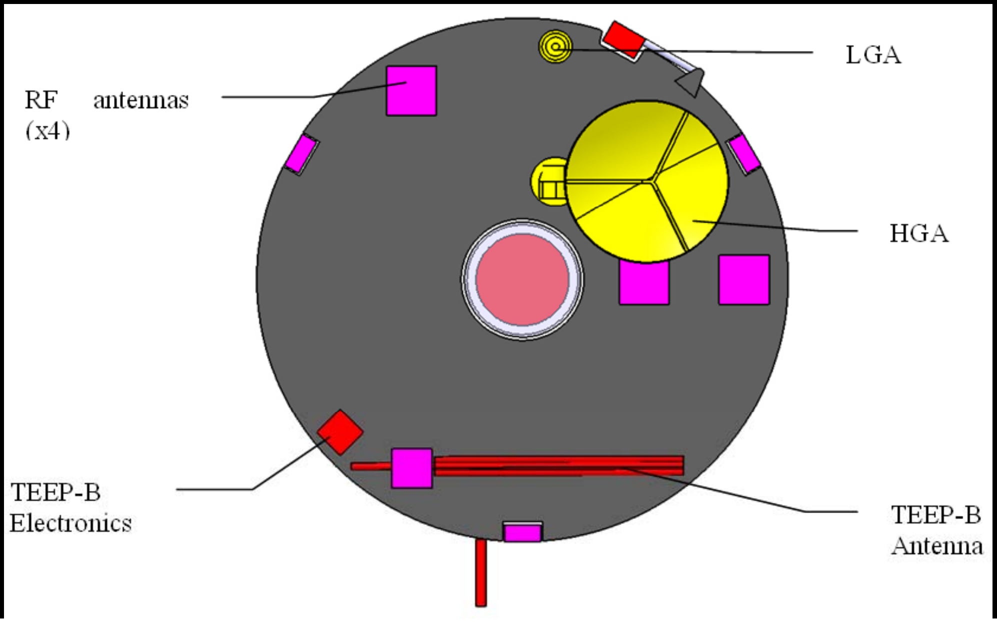
Spot heating with RHU's

Communications

- **High gain antenna has 2 axis degrees of freedom**
- **Orbiter is tracked during pass for uplink**
- **Direction determination by phase measurement of beacon signal**

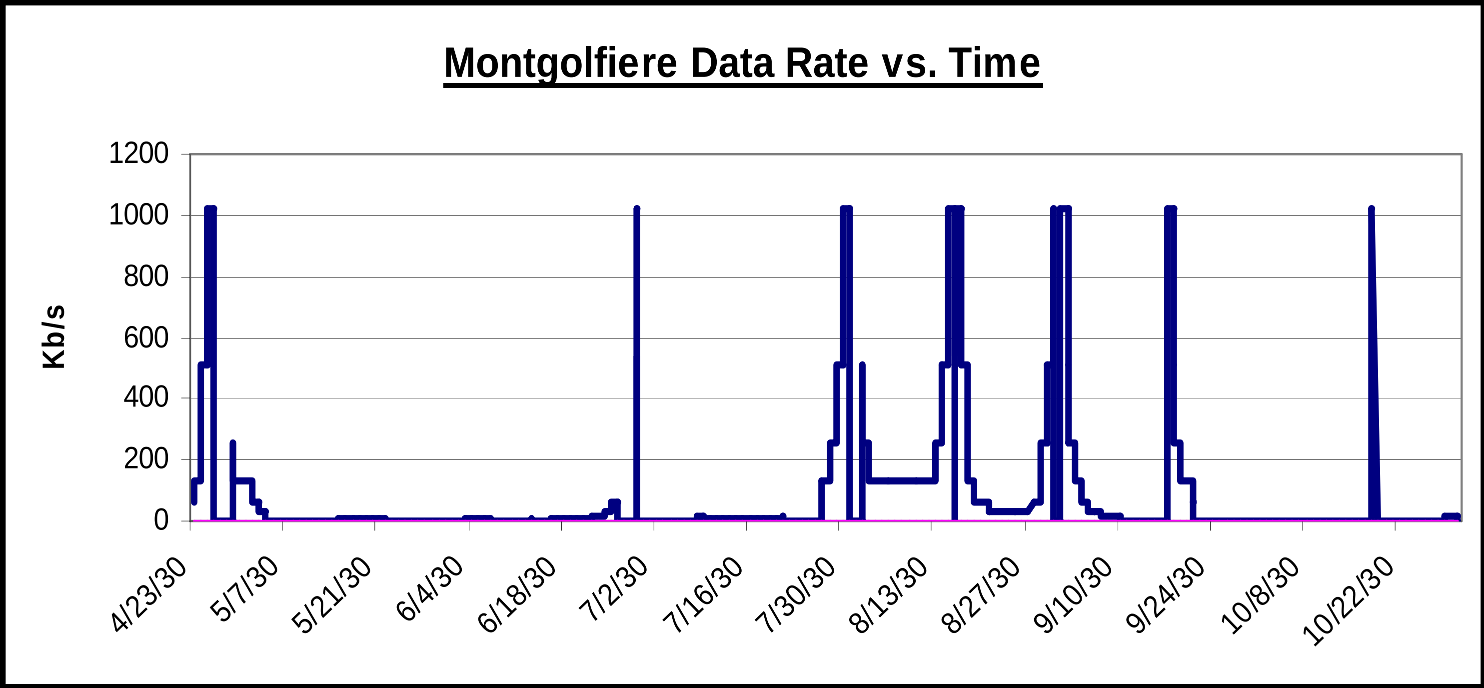


Direction to earth determined by sun sensors



Montgolfière Data Transmission

Uplink is determined by passes and distance

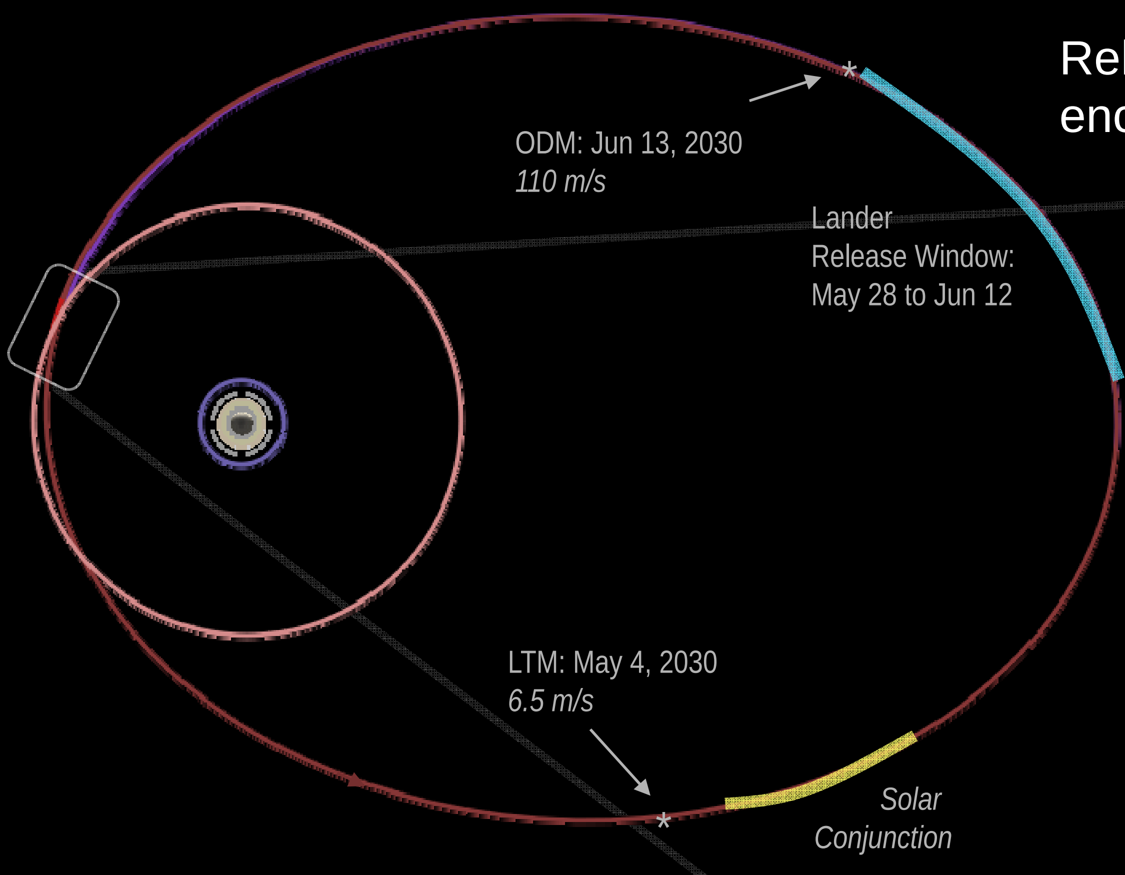


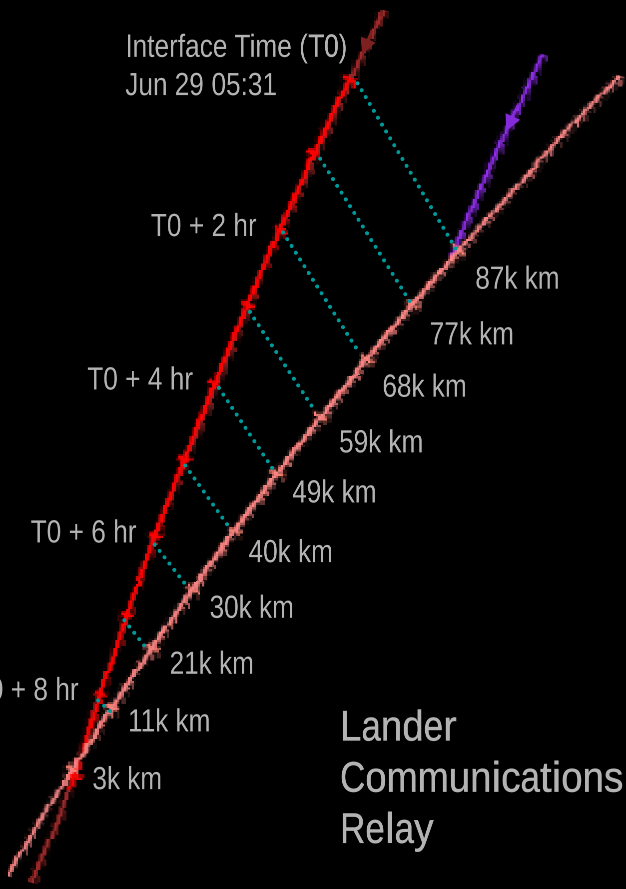
Summary of the Lander

- Landed mass 85 kg, including 23 kg instrumentation
- Target: Kraken Mare (72° **N) – floating capability**
- Battery powered
- Lifetime: 6 hours descent & 3 hours on surface
- Delivery on 2nd Titan flyby – orbiter in close vicinity

Lander Delivery

Released on approach to 2nd Titan encounter

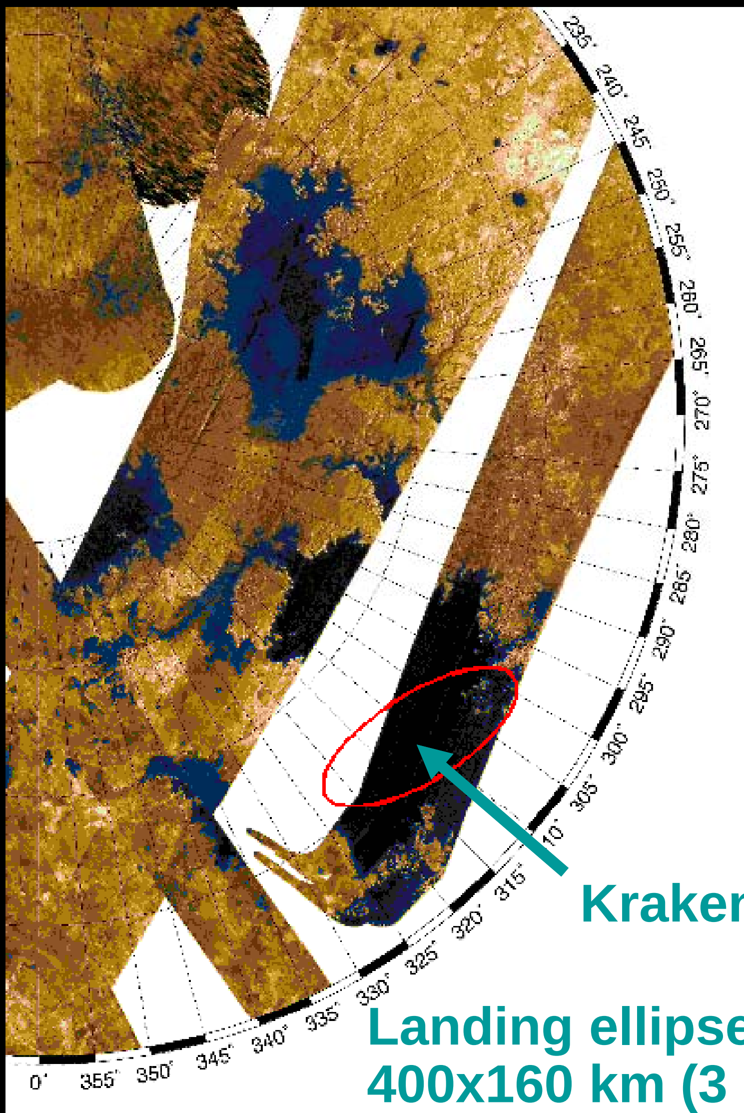


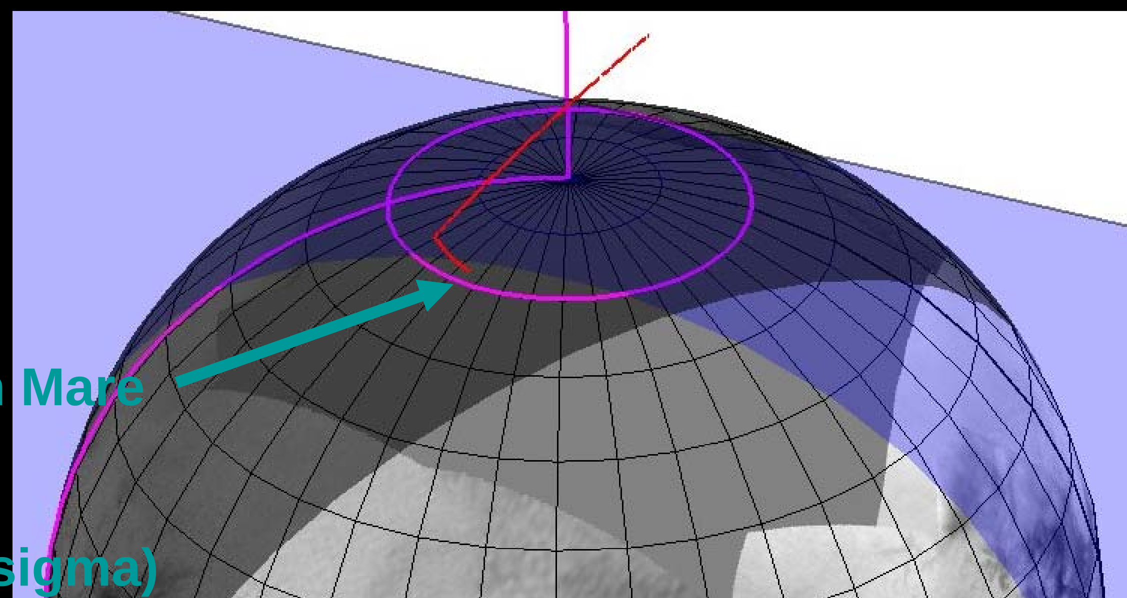


Lander Communications Relay

Lander Target

- Entry in westerly direction, descend in easterly direction
- Landing error ellipse dominated by uncertainty of wind model at lower altitudes
- Landing is close to terminator (20°)
- Saturn in Gibbous P. is 2.5x full moon

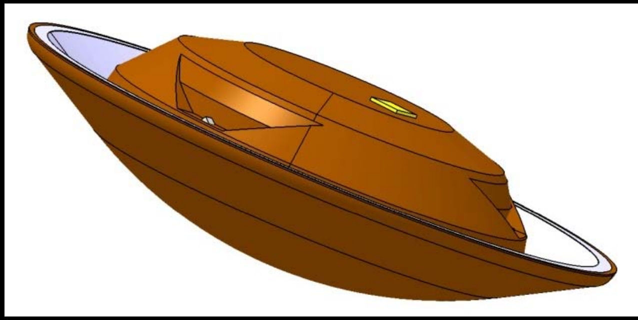




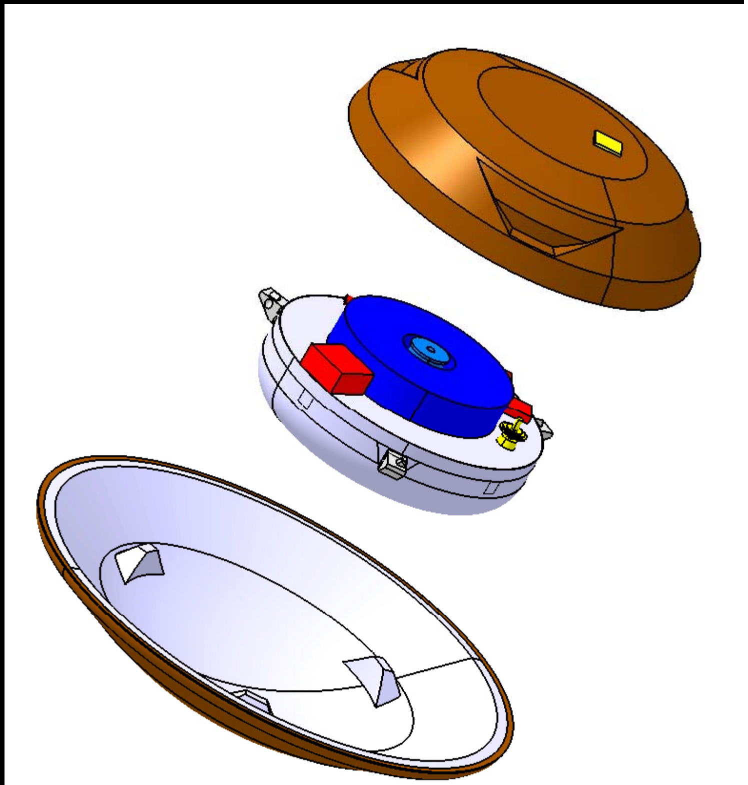
Kraken Mare

Landing ellipse
400x160 km (3 sigma)

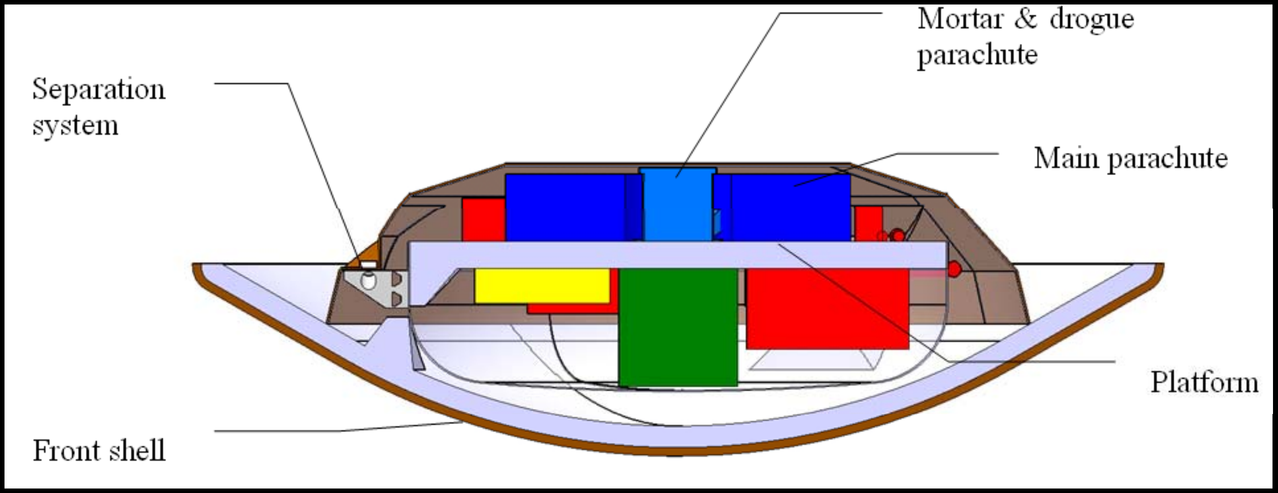
Lander Descend Scenario

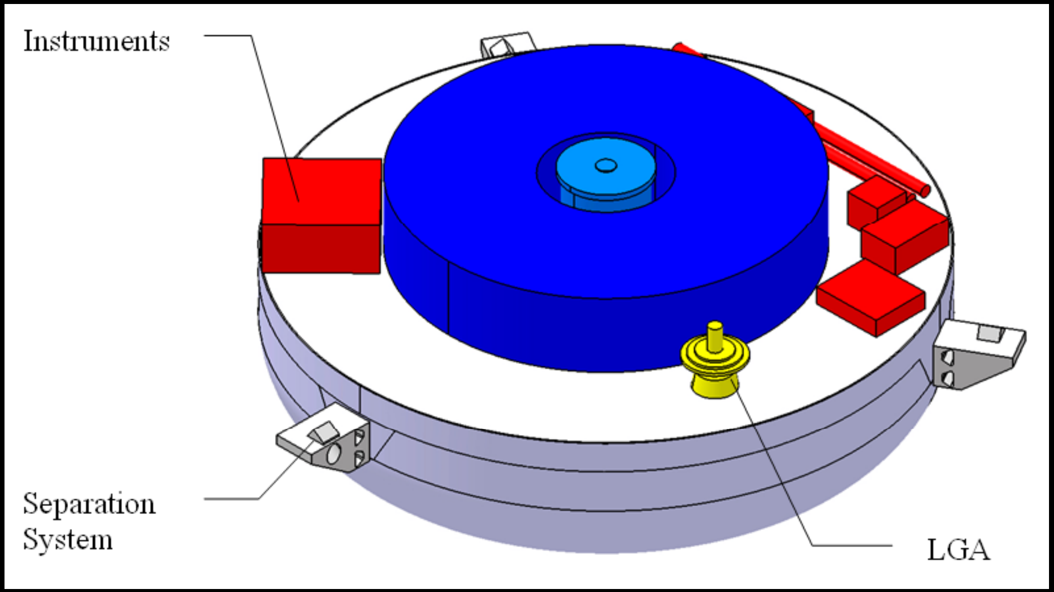


- **Descent scenario similar as for Montgolfière**
- **Single main parachute foreseen**
  - Longer time spent for atmospheric sampling



Lander Configuration





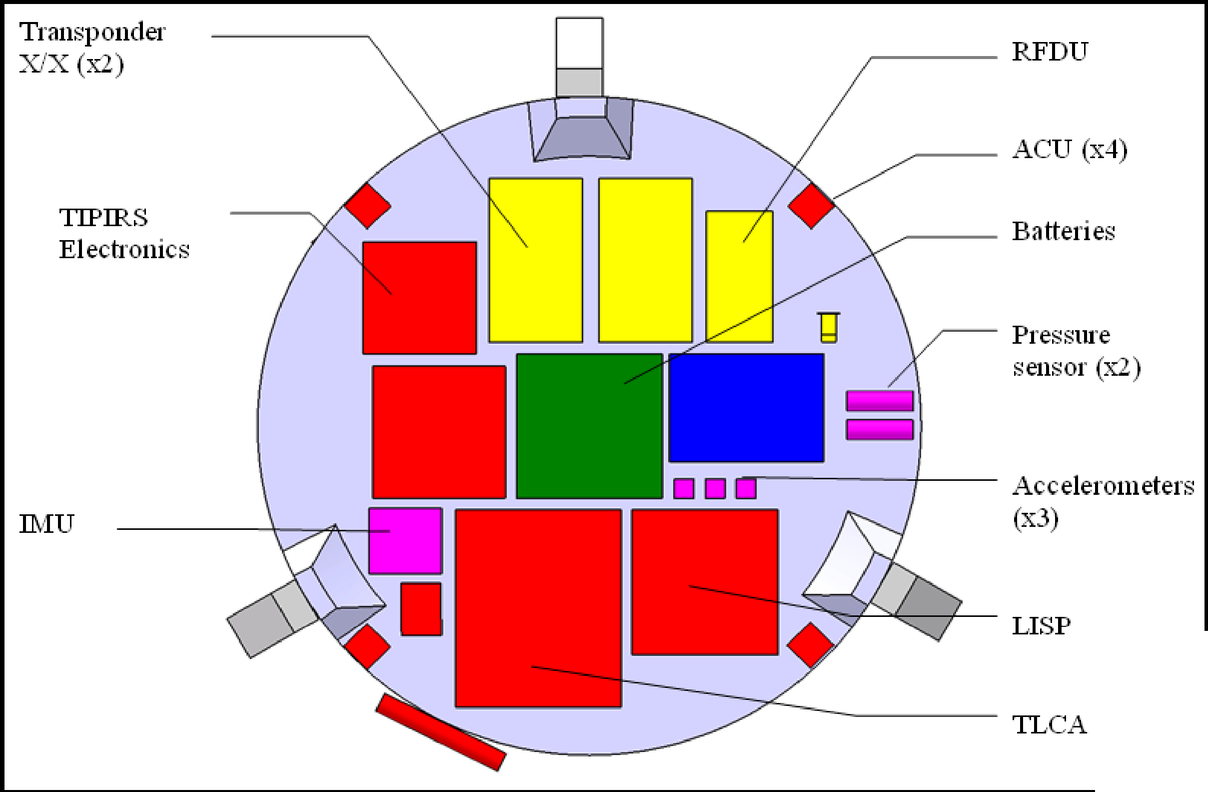
Lander: Notional Instrumentation

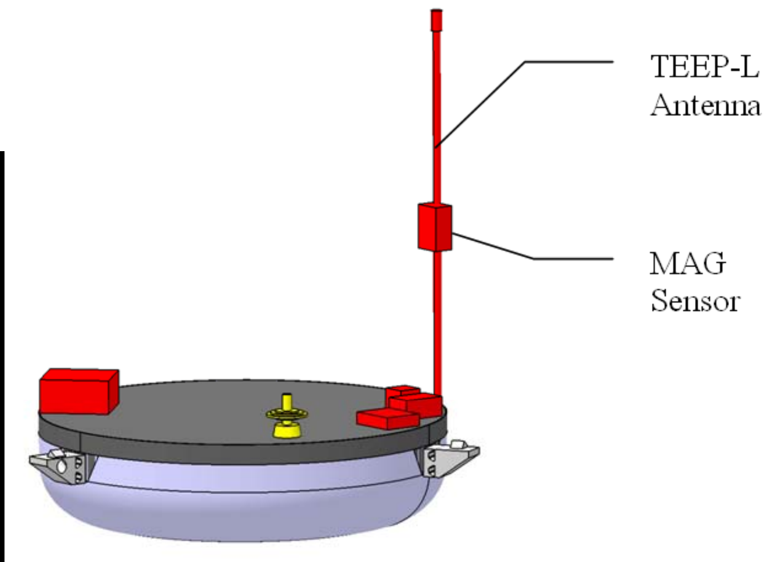
Instrument	Description	Science Contributions	Mass w/o margin (kg)
TLCA	Titan Lander Chemical Analyzer with 2-dimensional gas chromatographic columns and TOF mass spectrometer. Dedicated isotope mass spectrometer.	Perform isotopic measurements, determination of the amount of noble gases and analysis of complex organic molecules up to 10,000 Da.	23.0
TiPI	Titan Probe Imager using Saturn shine and a lamp	Provide context images and views of the lake surface.	1.0
ASI/MET-TEEP	Atmospheric Structure Instrument and Meteorological Package including electric measurements	Characterize the atmosphere during the descent and at the surface of the lake and to reconstruct the trajectory of the lander during the descent.	1.5
SPP	Surface properties package	Characterize the physical properties of the liquid, depth of the lake and the magnetic signal at the landing site.	1.5
LRST	Radio Science using spacecraft telecom system	Precision tracking of lander	0

TOTAL 27.0 kg

20% system margin applies

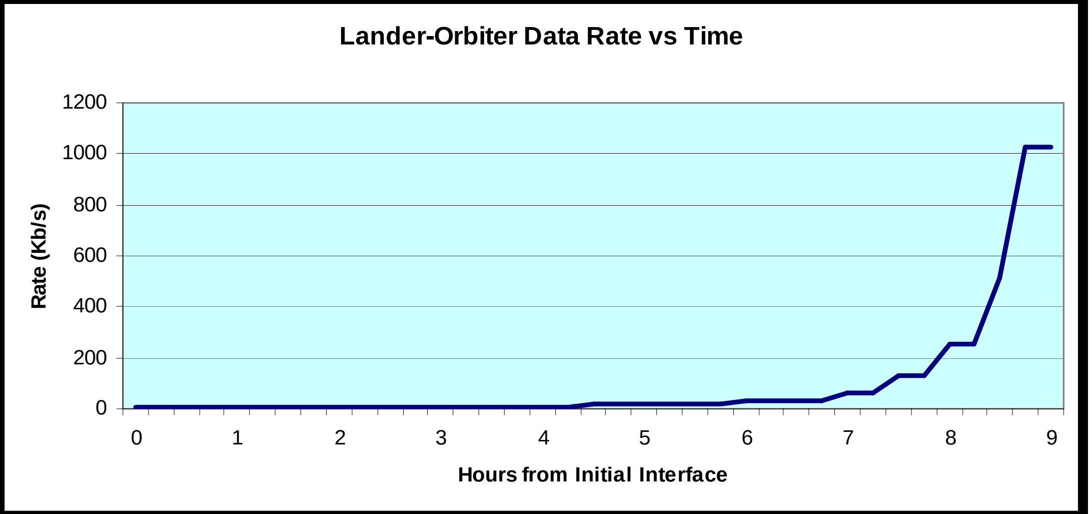
Instrument Accommodation

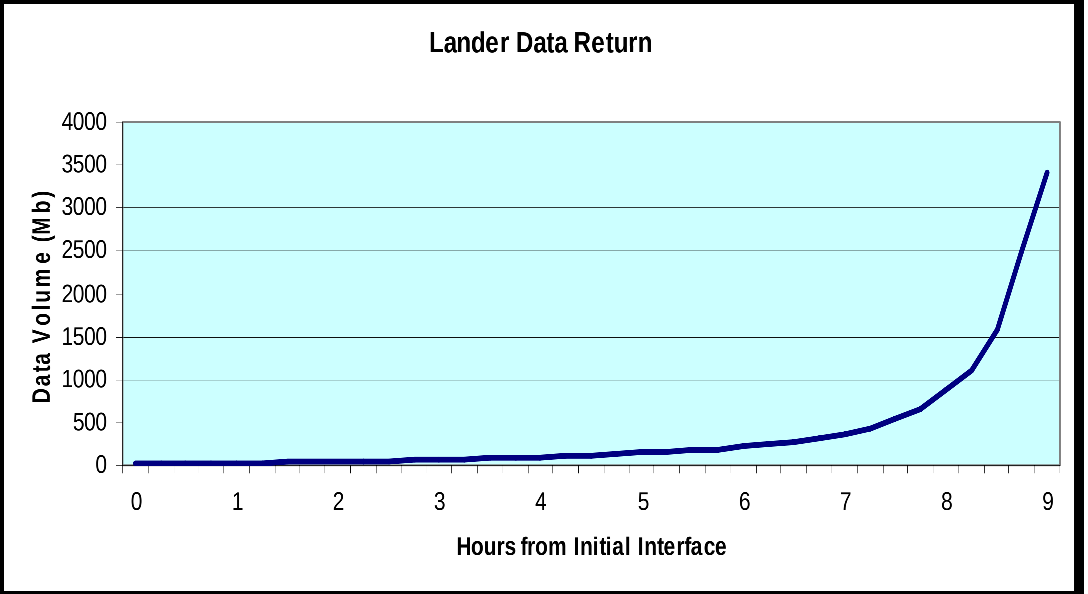




Lander Data Transmission

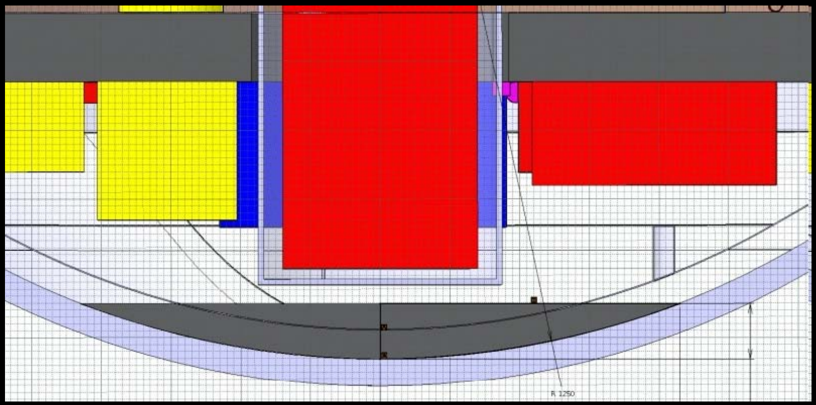
- **Data rate capability is a function of distance**
- **Distance to orbiter between 87k km – 3k km**
- **Duration of link to orbiter 9 h (=Lander lifetime)**
  - Orbiter sets below horizon
  - There is flexibility in the release phasing to accommodate longer link duration
- **Total data: 3.4 Gb**





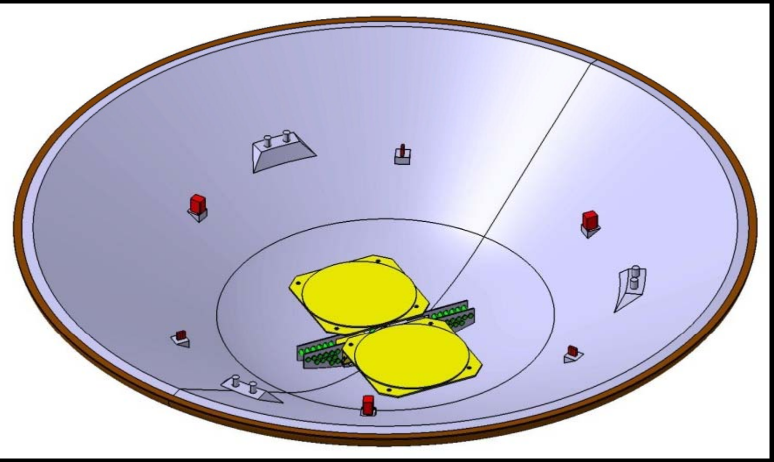
Geosaucer

- **Using available volume between nadir skin of gondola and inner side of heatshield**
- **Package descends to the surface uncontrolled after separation from the Montgolfière**
- **Data transmission via patch antenna to orbiter**
- **Design in early stage, as available space must be taken into consideration**



Instrumentation: Seismometer, Magnetometer, Radio-science

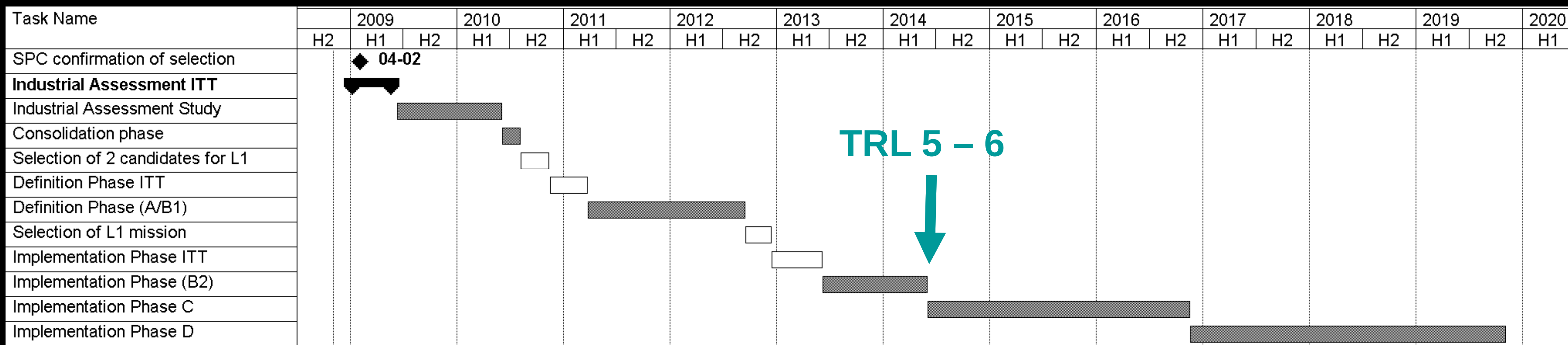
Max. mass: 20 kg



Key Critical Technologies

- **Balloon envelope**
  - Material needs assessing with respect to
    - Mass, operations under cold conditions, rigidity
    - Compatibility with packaging for 10 years
  - Inflation
  - Validation & testing is required
- **CNES has defined a development plan**
  - Includes analysis, test and verification
    - start Q2/2009, duration 6 years
    - TRL 5 in 5 years
  - Substantial investment for Phase A planned
- **Test & verification of deployment sequence needed**
  - Validation by drop tests

ESA Development Schedule



- **ESA project schedule includes in the early phases *Cosmic Vision* mission selection process**
- **Technology development expected to be continuously conducted in parallel**
  - Development of integration model (RPS) and flight demonstrators included in phases above
  - TRL 5 – 6 required by start of C/D Phase
  - Well before TSSM project PDR
- **Instrument preparations/studies in parallel with system study**

Summary & Conclusion

- The provision of two *in situ* elements is commensurate with a Cosmic Vision L-class mission
- The development of critical technologies appears to be feasible within the available time (5 – 6 years)
- The TSSM mission builds on Cassini-Huygens type collaboration between NASA and ESA