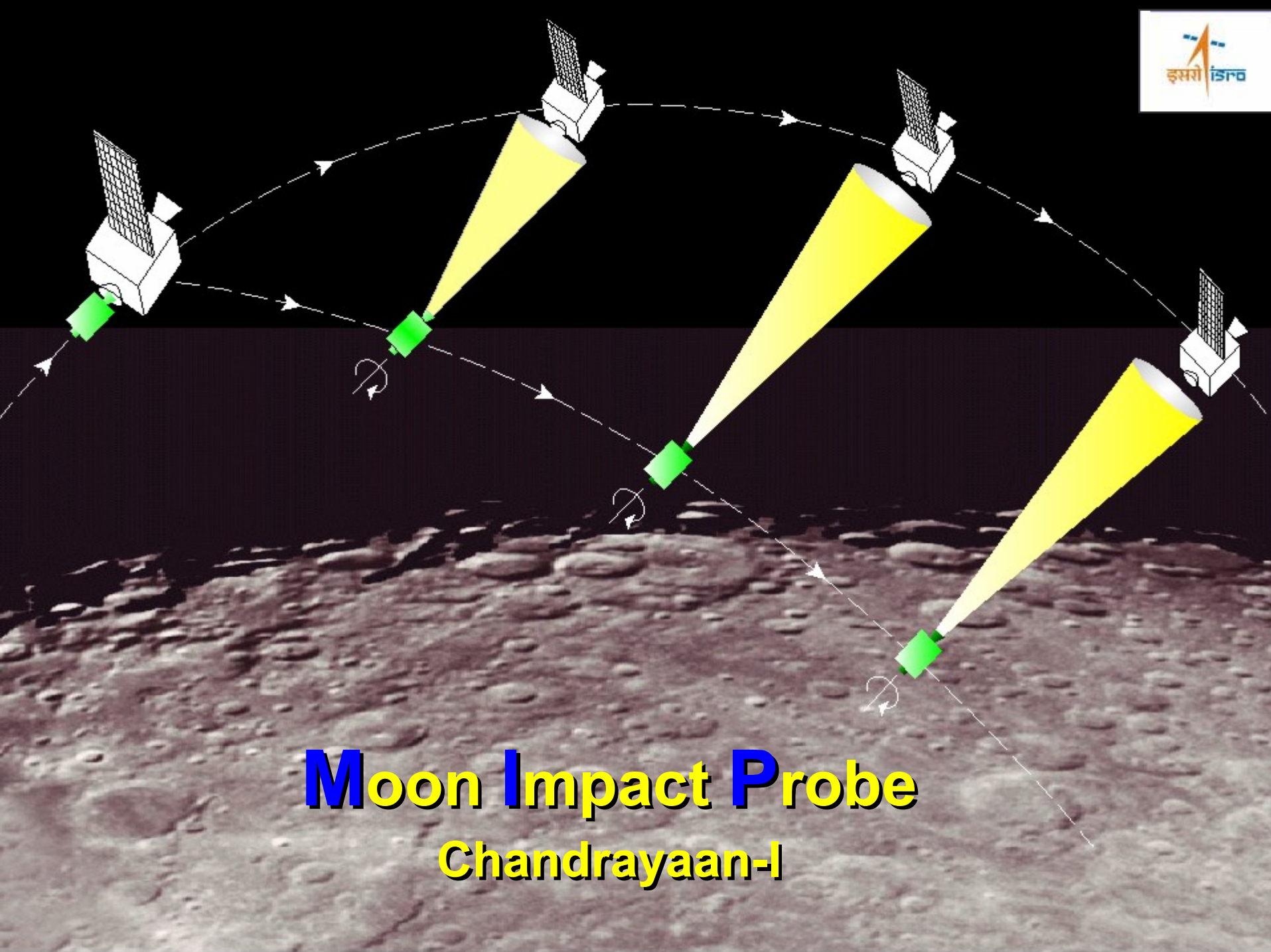
Moon Impact Probe
Chandrayaan-I

MIP OVERALL STATUS

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Moon Impact Probe

- **MIP Mission**
- **Subsystems**
- **Payloads**
  - **Camera**
  - **Radar altimeter**
  - **Mass spectrometer**

MIP Mission Objectives

- **Design, development & demonstration of technologies required for impacting a probe at a desired lunar location**
- **Qualify technologies required for future soft landing missions**
- **Exploration of the moon from close range**

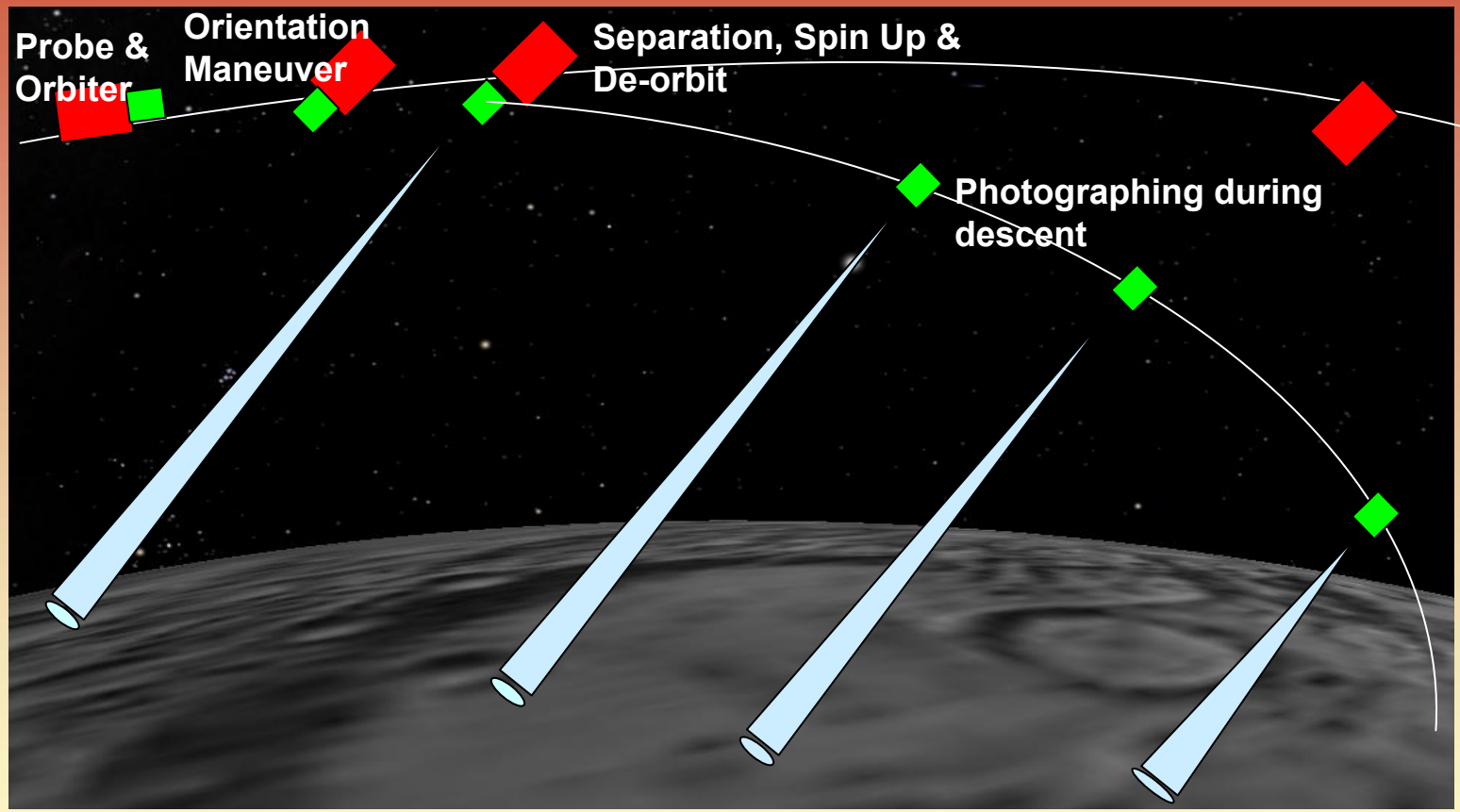
Typical case

Day of Lift –off : 09-04-2007 (01h 44m 9.5s UT)

Arrival at 100 km circular polar orbit : 19-04-2007 (13h 05m 05.75s UT)

Time of MIP separation : 23-04-2007 (08h 34m 42.0s) UT ~ 14-days

MIP Mission



Possible impact site:

Malapert Mountain

Latitude = 86° S; Longitude = 0.0°

Malapert Mountain

Latitude = 860 S; Longitude = 0.00

Mission Sequence

T_0 – 20 min	MIP 'ON' command from the main orbiter (Payloads – ON)
T_0– 17 min	MIP Enable Command from main orbiter (Sequencer Start)
T_0	MIP separation
T_0 + Z sec	MIP 'OFF' command from the main orbiter
T_0 + 30 sec	spin up of MIP
T_0 + 700 sec	De boost start
T_0 + 710 sec	De-spin up of MIP
T_0 + 1822 sec	MIP impact

Mission time of

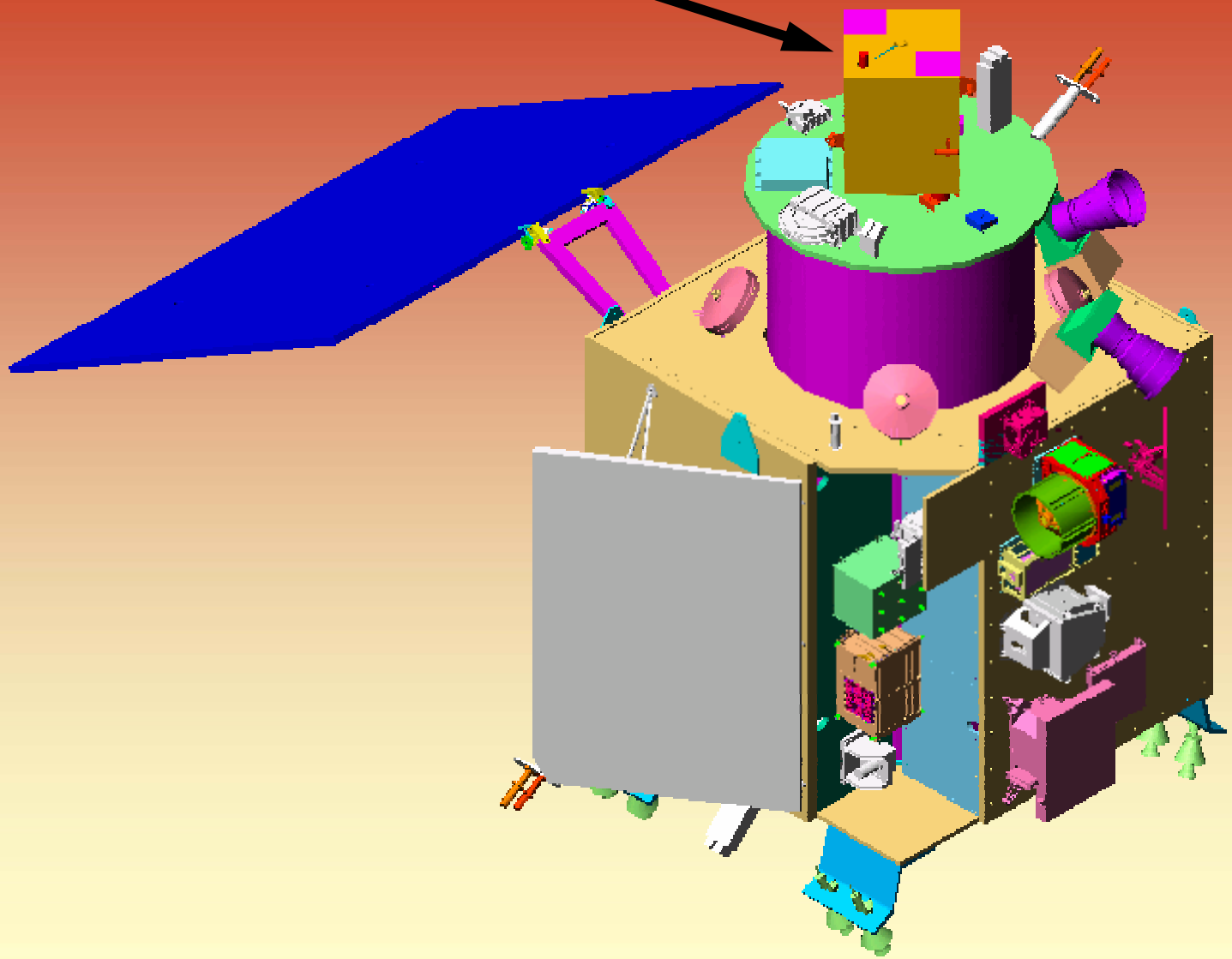
~ 20 + 30 = 50 minutes

Initial orbit : 100km X 100km

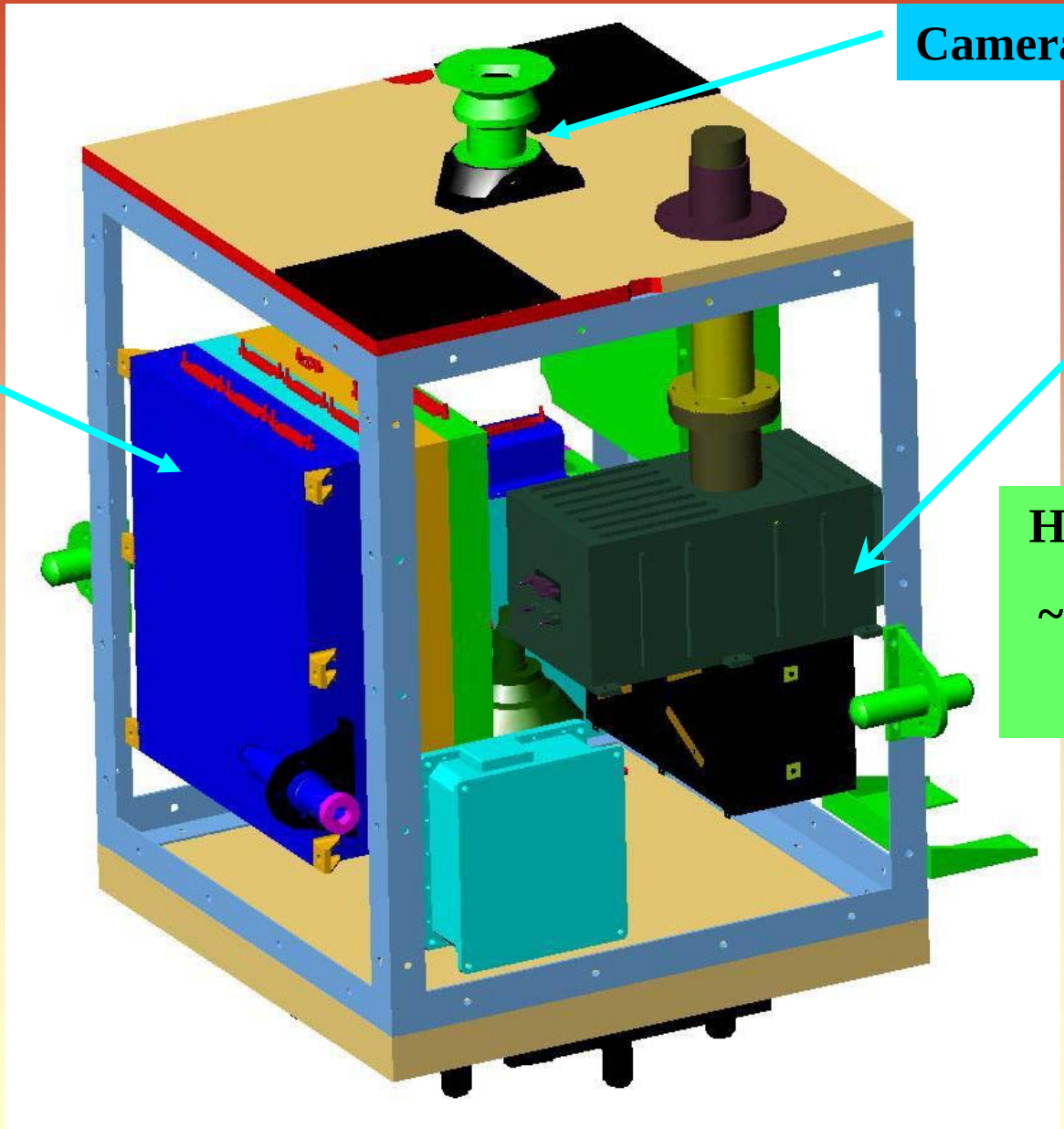
De-orbit velocity : 69 m/s

- Total mission time : 1821.6 s
- Impact velocity : 1678.6 m/s
- Ground Range : 2852.0 km
- Camera covers the region between latitude: 8.6^0 N to 86^0 S

MIP ON CHANDRAYAAN-1



Moon Impact Probe



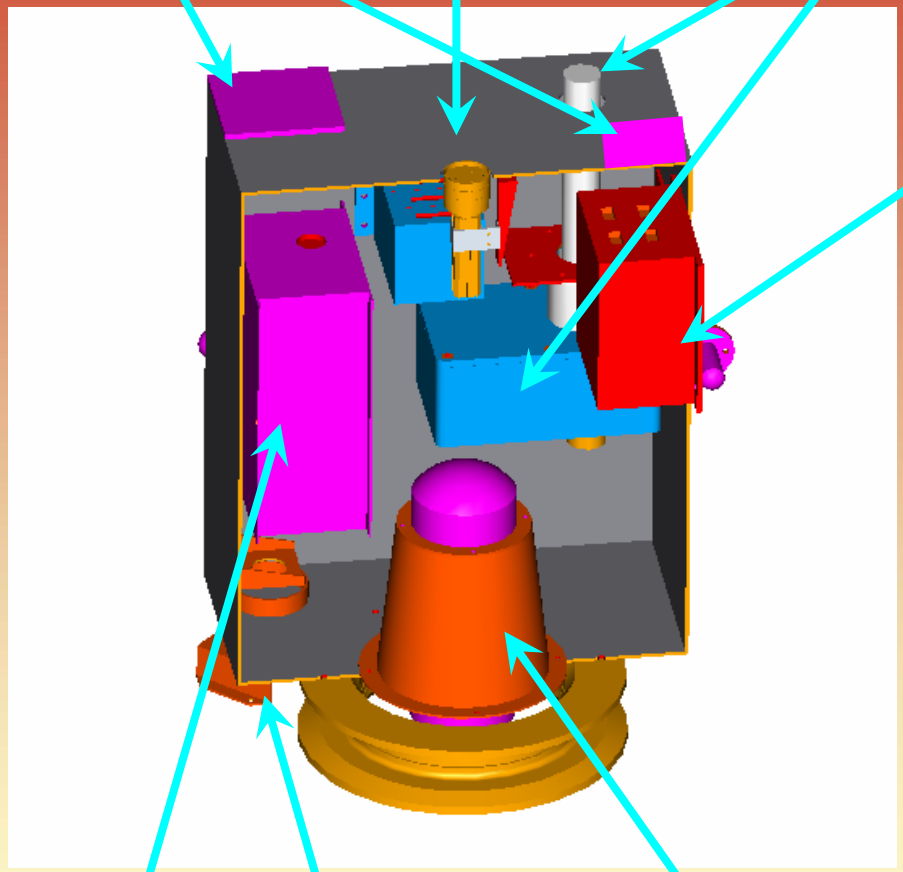
RA antenna

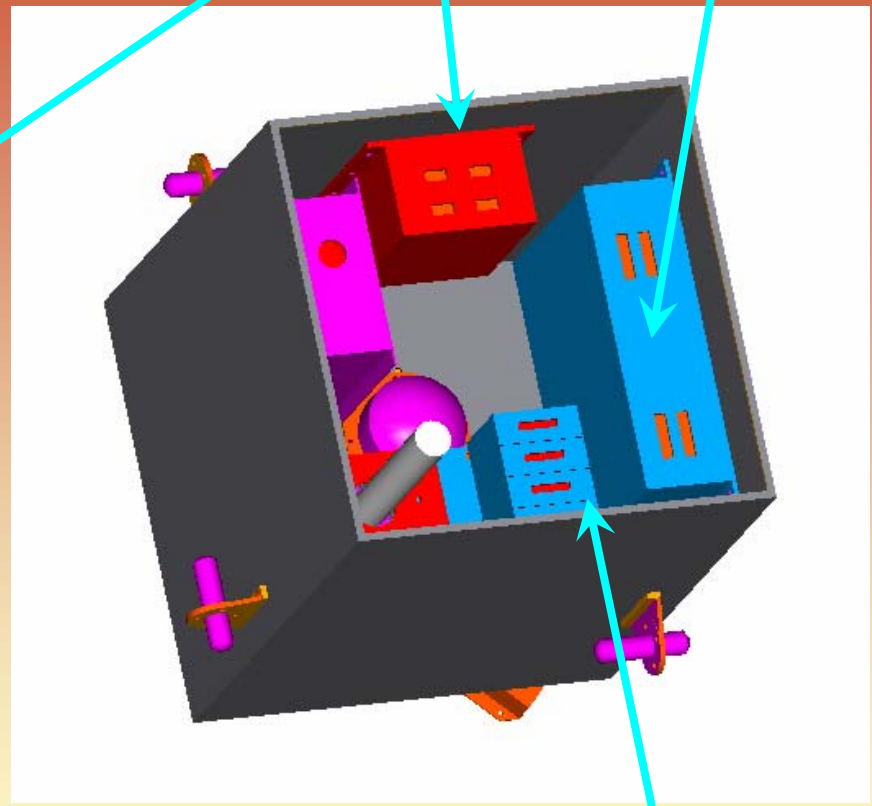
Camera

CHACE

Radar altimeter package

MIP electronics





Battery

Electrical connector

De orbit motor

MTU

MIP Sub systems

Power Sequence Module

Interface: Orbiter - MIP

Battery
Li-Ion, 145W

Sequencer

Pyro CMNDS

Separation System
Ball-lock

MIP structure
Al-honeycomb

MIP Telemetry Unit

Digitisation, Formatting, multi-O/P

(Single card design; RS485/232)

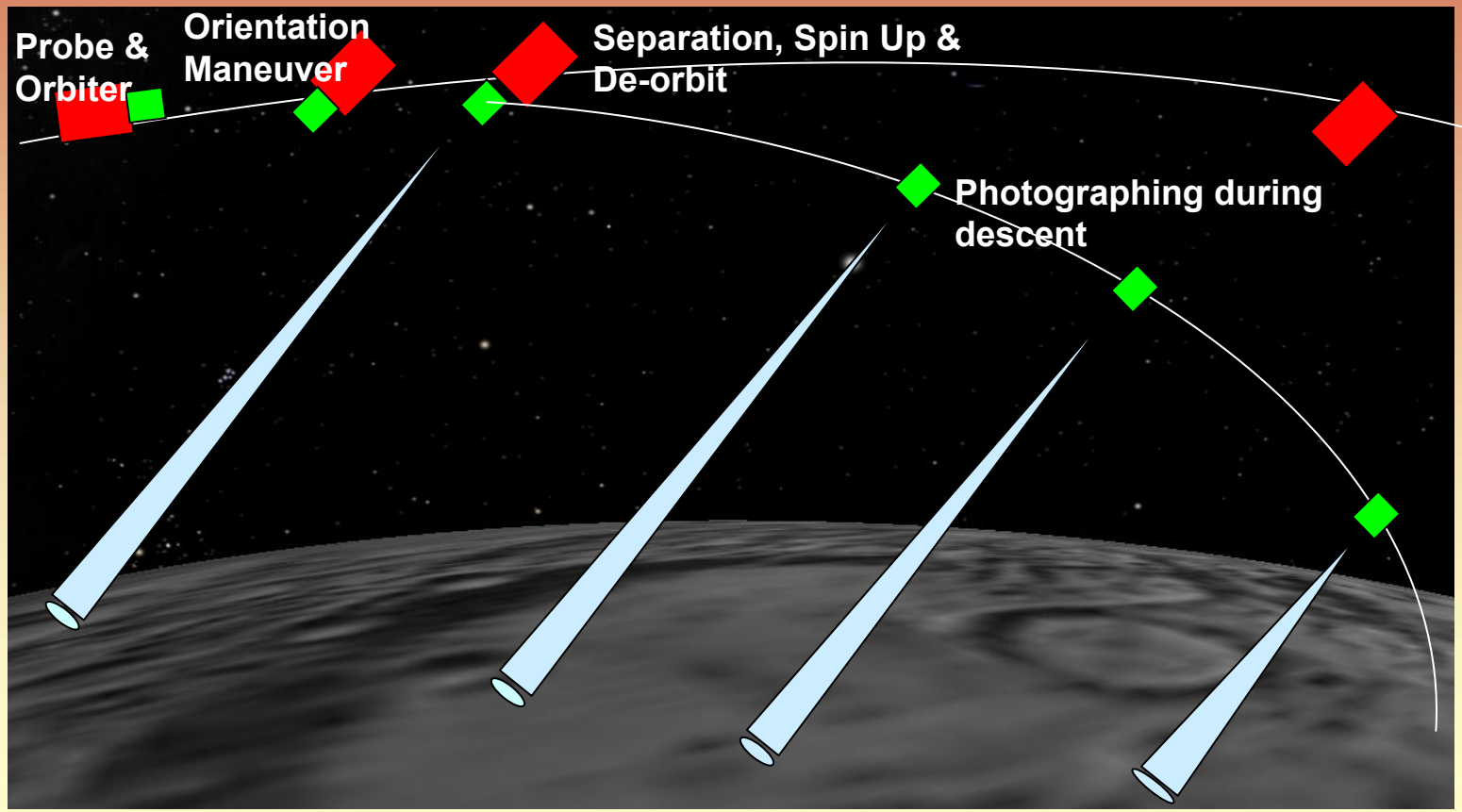
Spin, De-spin
De-orbit
MOTORS

UHF transmitter

RF link: MIP-Orbiter (402.5 MHz)

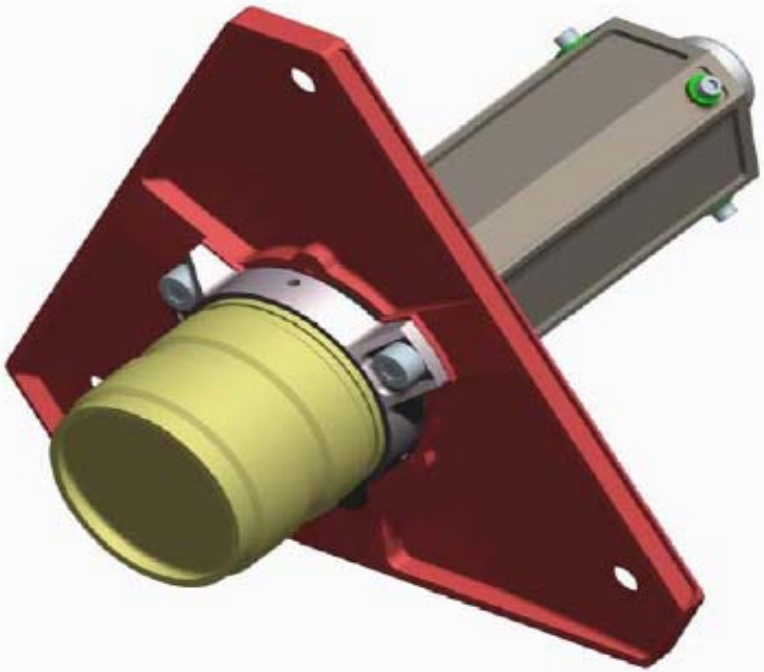
MIP Imaging System (MIS)

Objective : To acquire images of the surface of moon during the descend phase of the probe



Salient Features of the system

- Light weight, small size, analog color camera, PAL : 720 x 576
- Wavelet Based compression algorithm (JPEG 2000)
- Compression ratio : 20 : 1
- Power requirement : 2.4 W, 12V
- Mass : 150 gm



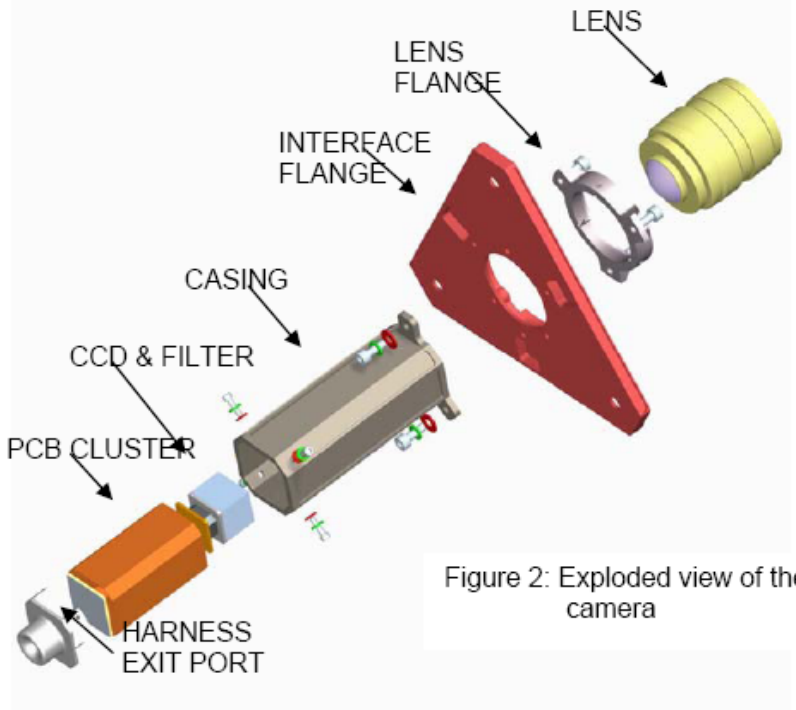


Figure 2: Exploded view of the modified MIP camera

Radar Altimeter

Main Specifications

Transmitter

- Type : FM-CW
- Centre Frequency : 4.3GHz
- Modulation Frequency : 100Hz
- Frequency deviation : ±50MHz
- Transmitted output Power : 1Watt (CW)

General:

- Measurements : 100 per sec (Δt =10 ms)
- DC power requirement : 28V, 725 mA
- Weight : 1.5 kg
- Accuracy : 2m near lower altitudes ($\leq$ 150m)
  : 3% for higher altitudes (150m – 3Km)

Qualification procedures

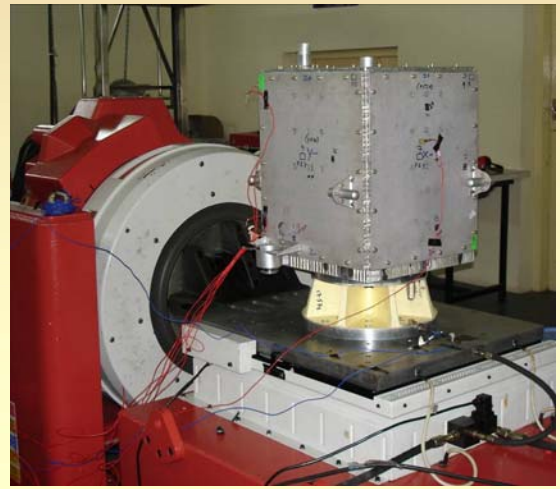
Qualification model subjected to Environ. test levels

Proto-type model flown in the air craft

MIP Radar Altimeter - Aircraft Test Setup

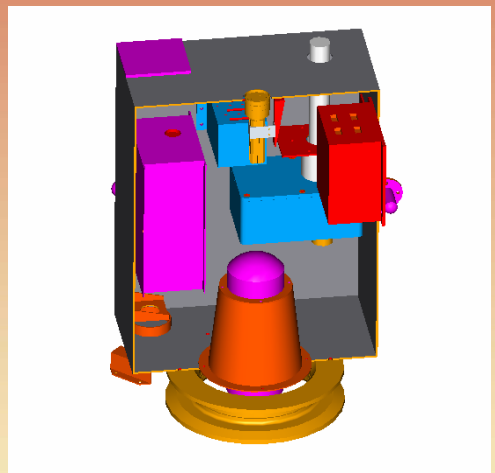
UHF antenna

Field test



MIP structure vib. test

CHandra's Altitudinal Composition Explorer
CHACE



In every 4 seconds (~320m slice of height), one spectrum

mass range : 1 -100 amu, 9 points per amu

A total of ~750 (300+450) spectra acquired

LUNAR AMBIENCE: Our Understanding

LUNAR: Surface pressure – night 2×10^{-12} torr

Day (Estimated) 2×10^{-10} torr

Particle abundance 2×10^{5}/cc.

Earth ~ 760 torr

Earth surface ~ 2.68 X 10^{19} /cc

Expected elements

- He-4
- Ne-20
- H_2
- Ar-40
- Ne-22
- Ar-36
- CH_4
- Ammonia
- CO_2

Lunar Surface measurements

Challenge : Mass analyzer sensitive down to ~ 5X10 $^{-12}$ torr

Specifications

Mass range : 1-100 amu

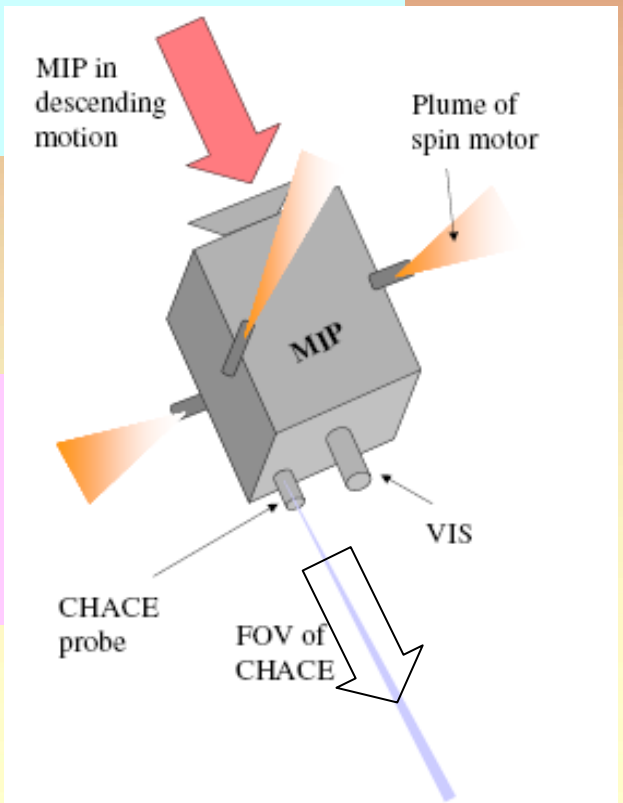
Detector type : Electron multiplier / Faraday cup

Resolution : 0.5 amu in a range of 100 amu

Min. detectable partial press. : 5X10 $^{-14}$ torr (Electron Multiplier)

Power requirements : 24 V_{DC} @ 1.0 A (24 W)

Weight : 3.3 kg



Expectations

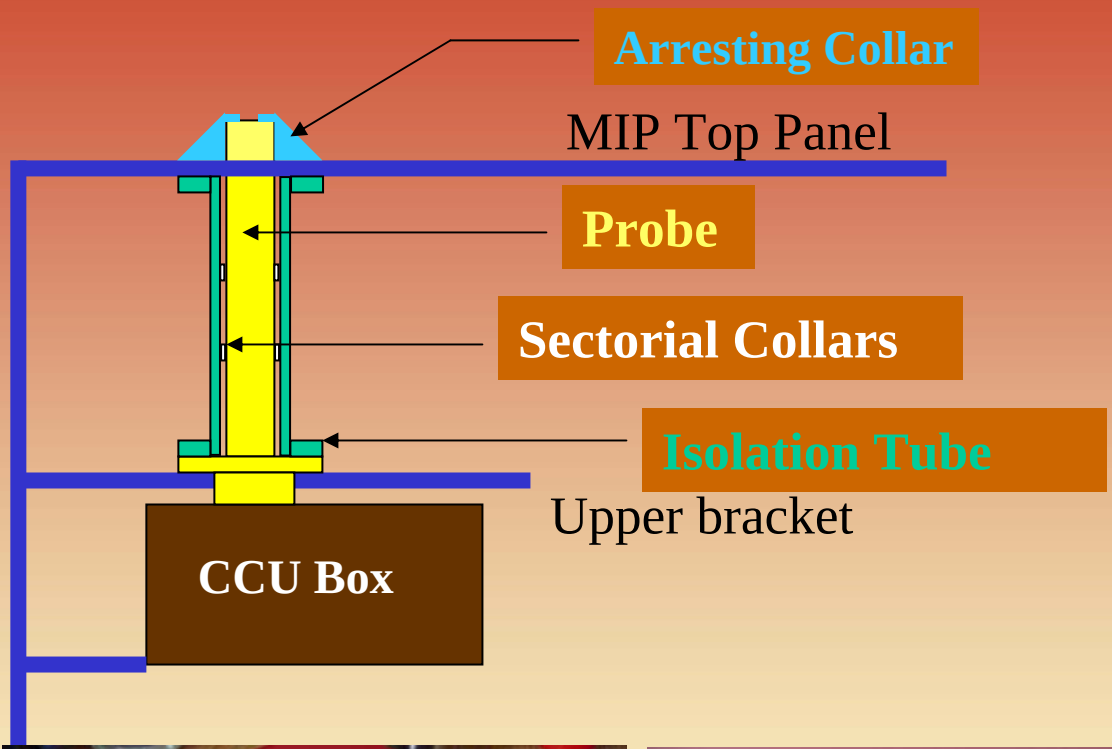
- ❑ Medium Resolution
- ❑ Best sensitivity & dynamic range
- ❑ Avoid the outgassing from nearby sub-system

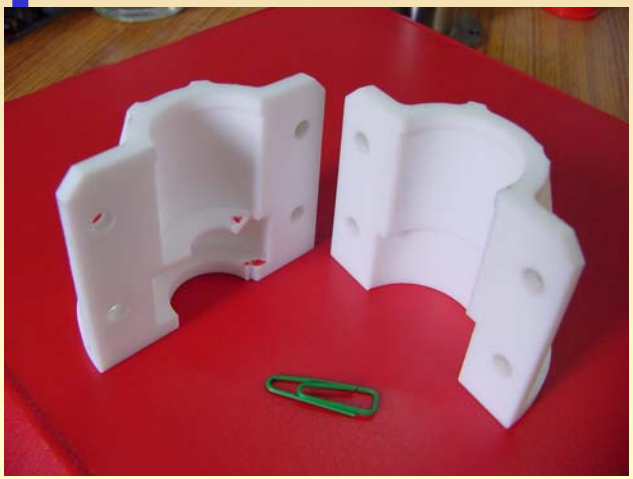
Heritage of QMA in Space Missions

Year	Mission	DR	Sen^{y}	Mass range; Res^{n} (M/ΔM)	Mass (Kg)
1973	Atmos Exp C,D,E	10^{6}	10^{-5} A/torr	1-45 amu; 45	~3
1978	Pioneer Venus Orb.	10^{7}	10^{-5} A/torr	0-46 amu; 50	3.6
1981	Dynamics Exp-2	10^{7}	$4X10^{-6}$ A/torr	2-50 amu; 50	~3
1989	Galileo probe	10^{8}	10^{-6} A/torr	2-150 amu; 150	13
1997	Huygen's probe	10^{8}	$2X10^{-5}$ A/torr	2-141 amu; 150	17
1997	Cassini orbiter	10^{8}	$2X10^{-5}$ A/torr	1-300 amu; 300	11
2008	CHACE, MIP	10^{10}	$5X10^{-1}$ A/torr*	1-100 amu; 200	3

* Inclusive of EM gain

MECHANICAL Reinforcements/Outgassing isolation





STATUS


See You there