

Entry, Descent & Landing and Mission Outcome

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On Behalf of the Beagle 2 Consortium

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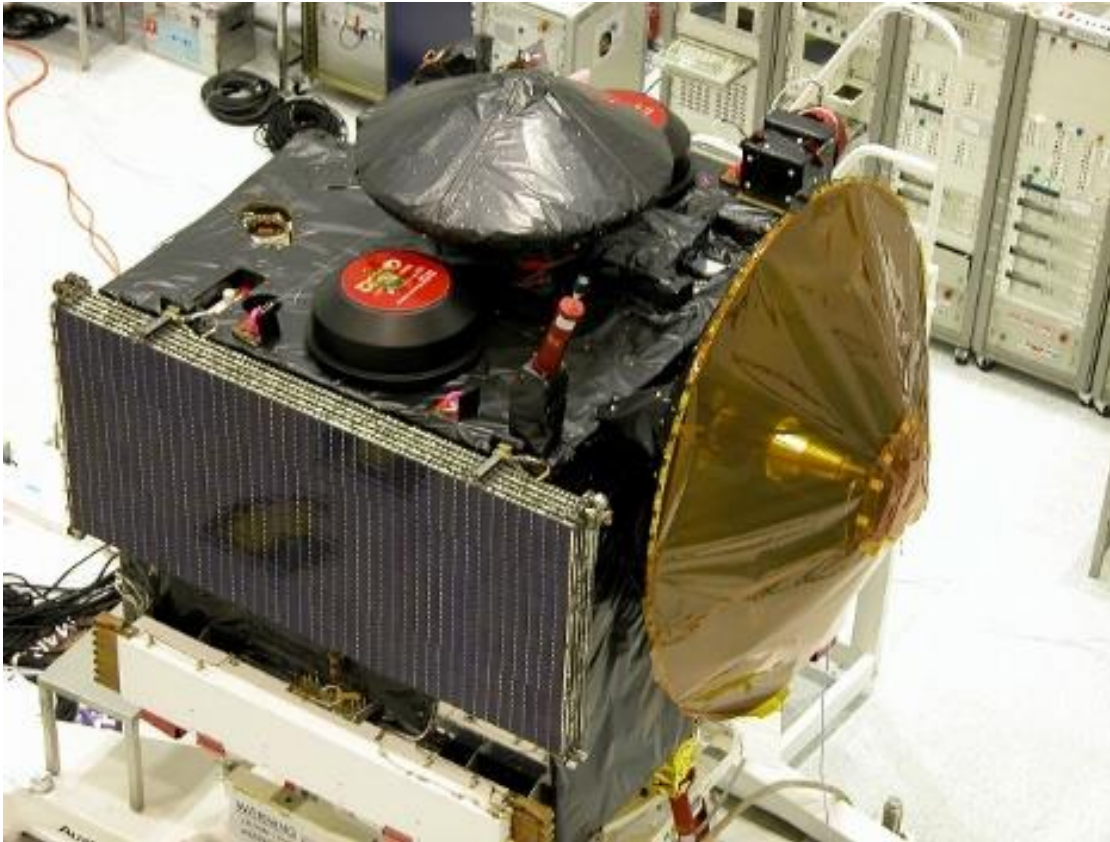
Beagle 2 Discovered

2

Beagle 2 at Baikonur

Delivered for integration February 2003

Launched 2nd June 2003

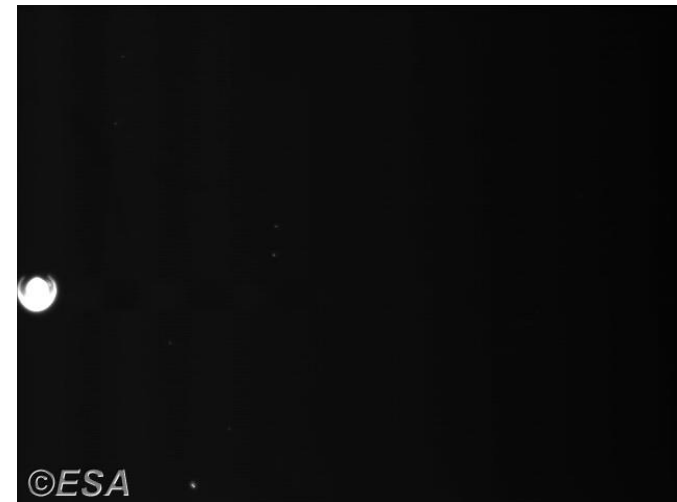
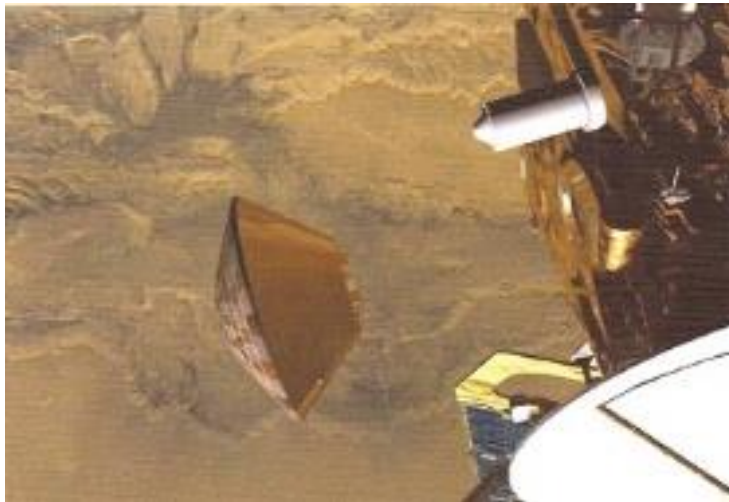


Last Contacts

Cruise checkouts all good:

- Transceiver working as expected; Software uploads good; Voltages, temperatures all within allowable ranges; Battery SoC 100% at separation

7 months later19th December



Mars Express & Beagle 2 SUEM set trajectory, atmosphere entry angle & angle of attack at 20,000 kph & 14 rpm

Christmas Day 2003

5³/₄ days after leaving MEx & 2¹/₂ hours before reaching Mars, Beagle 2 woke up automatically and booted up the Probe Software read for Entry, Descent & Landing



Already 7 non-redundant opportunities for failure since release;

All appear successful.

Supersonic to Subsonic in 4 minutes

Aerobraking from 20000kph decelerating from 120km altitude to 7km, temperature peaked at 1700°C.

The software sensed the deceleration profile and commanded the mortar to fire and deployed the 1.9m drogue parachute.



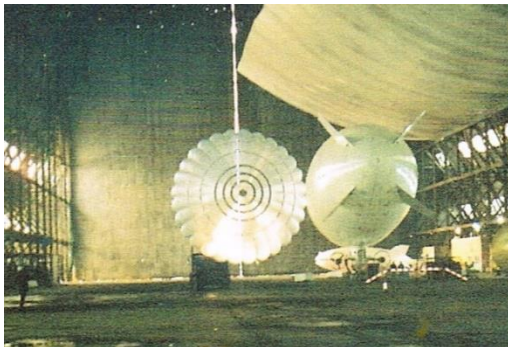
With only the accelerometer and pyro initiators redundant,
another 22 opportunities for failure;
Again all seem good although speed/altitude profile may be affected.

Heatshield Separation & Main Chute Inflation

The software sensed the deceleration profile and commanded 3 bolt cutters to separate the aeroshell;

Pilot chute pulled back, lander moved forward & deployed/inflated the 10m main parachute at 2.6km altitude, 210mph, before slowing to first impact at 58kph (36mph, 16m/s), 4 minutes later.

From drop tests, the collapsed parachute is estimated at 4m spread, consistent with HiRISE image



Another 26 opportunities with only pyro NSIs non-redundant;
Aeroshell release shocks may have lead to hardware issues;
Warm atmosphere may have resulted in higher descent rate;

Surface Detection, Airbag Inflation & Impact

At 275m above surface, Radar Altimeter Trigger (RAT) senses surface; Software then command airbag inflation with first impact at 200g & main chute released;

Once at rest after a further 2 minutes, airbag lacing cut & gas generator released; Lander fell to surface (400g)



34 more opportunities RAT had 2 thresholds, NSIs non-redundant;
Did airbags have time to fully inflate? Could impacts cause damage?
Did the Airbags & AGS move clear or cause blockage later?

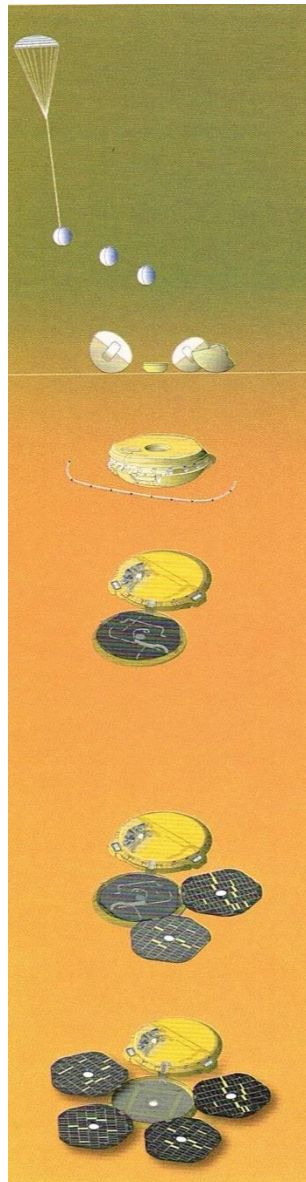
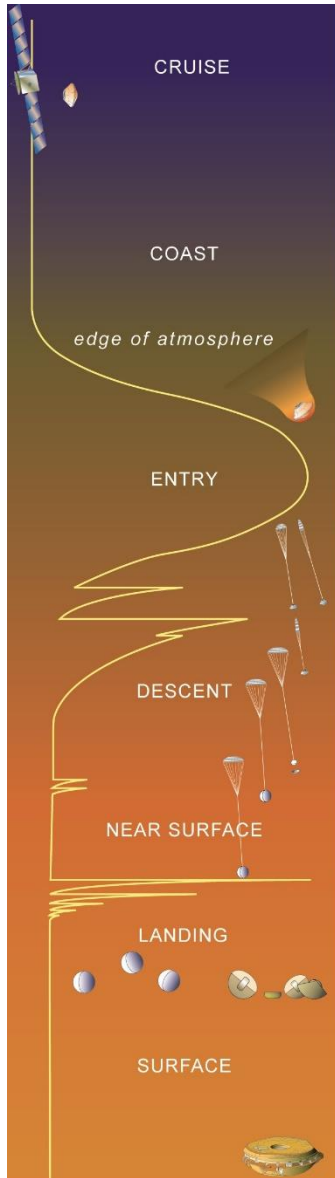
On-Surface Deployment Sequence

Finally Probe Software released the Lander Clampband and central bolt. Probe Software handed over to the Lander Software for on-surface ops. The Lander was then commanded to open and the solar panel release & deployment sequence proceeded.

HiRISE image analysis suggest only 1 or 2 solar panels deployed.



A final 59 opportunities with only NSIs non-redundant;
All software worked correctly.
Impact damage, h/w hang-ups or blockage? Battery?



From release from Mars Express to fully deployed on the surface of Mars:

69

steps in the sequence

Many of these have multiples, some not quantifiable, leading

to:

>148

opportunities to fail

Assuming at least one solar panel deployed

Aerothermal entry successful

Pilot chute deployment & inflation successful

Heatshield separation successful

Main chute deployment & inflation successful

Airbag inflation successful #

Airbag separation initiated successfully #

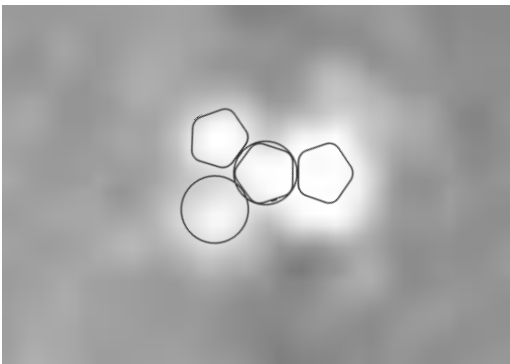
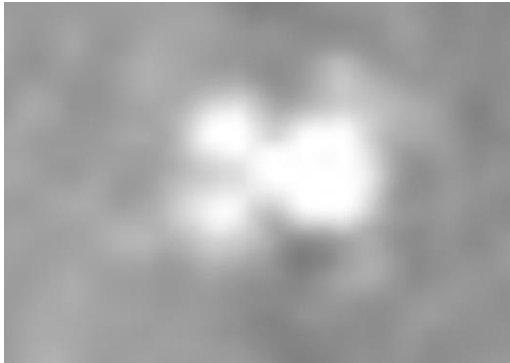
Lid/Base releases & deployment successful #

PSW successfully handover to LSW

LSW initiated following handover

Solar panel hold-downs release successful #

Solar panel deployment started under s/w control but did not complete ##



Next Steps

19 candidate functions or events leading to mission loss have been identified.

Numerous potential causes behind each.

- Hardware malfunction or hang-ups
- Impact damage
- Atmosphere or local terrain features.
- All to be assessed further.

But first, more imaging is being requested & analysis methodology being investigate

