Lessons Learned in the Decommissioning of the Stardust Spacecraft

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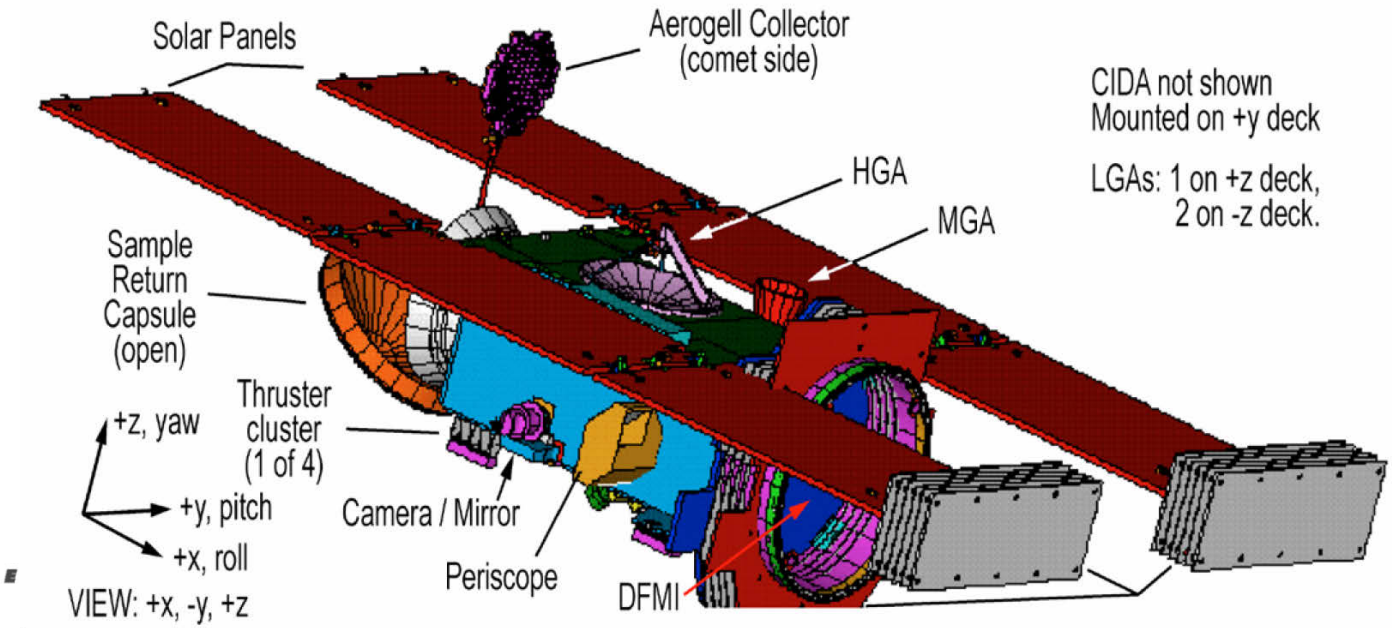
Overview

Stardust

- Launched February 1999
- Built and operated by Lockheed Martin
- Asteroid Anne Frank Flyby 2002
- Comet Wild 2 Flyby 2004
- Earth Return – Sample Return Capsule – 2006

Stardust NExT

- New mission to comet Tempel 1 selected in 2007 (Stardust NExT)
  - PI: Joe Veverka, Cornell
  - Operations: Lockheed Martin Space Systems
  - Navigation and Project Management: JPL



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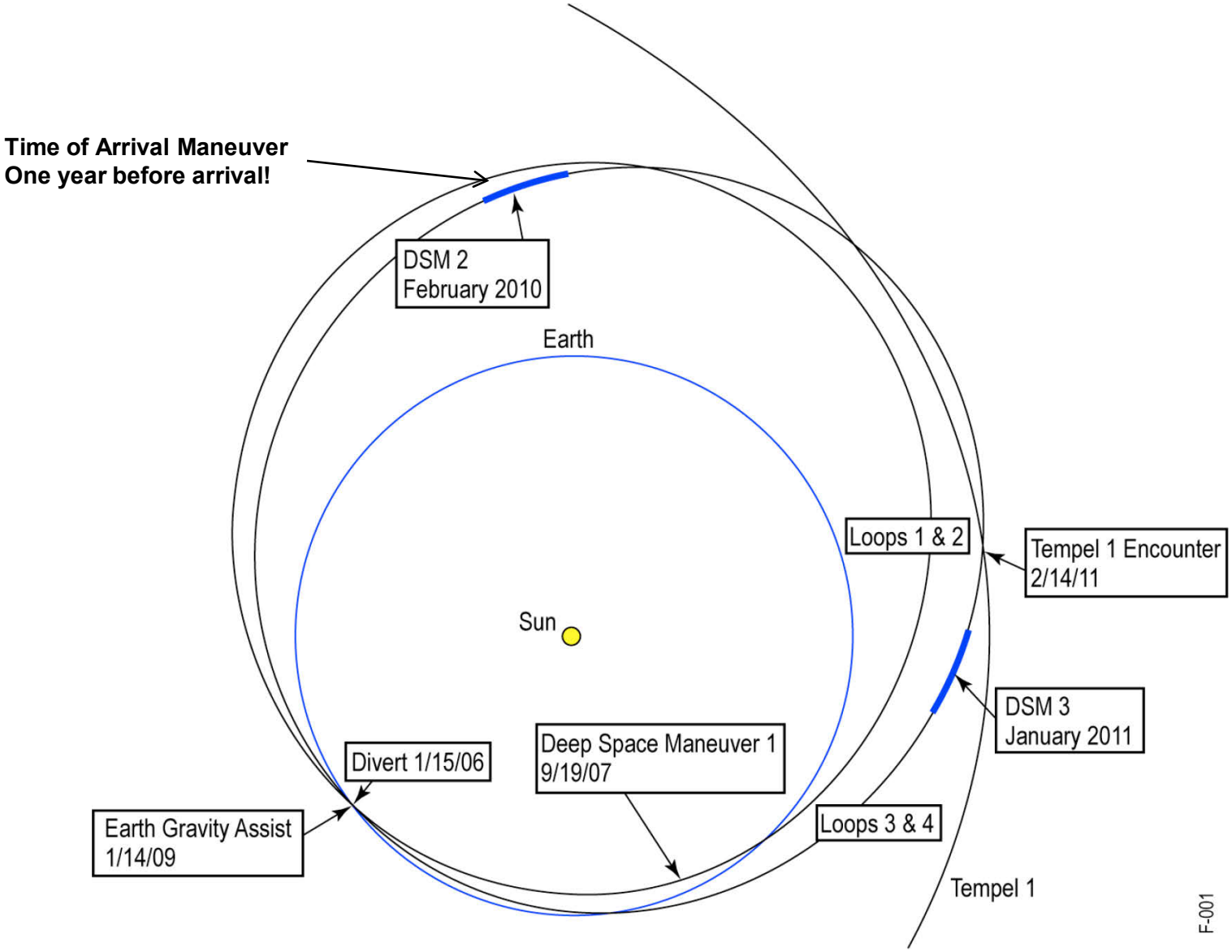
Mission Plan



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Fuel Management

- Launch: 87 kg
- Beginning of Stardust NExT: 17 kg
- How do you estimate remaining fuel?
  - Bookkeeping
  - PGS
- At time of TOA Burn, estimated ~9 kg remaining. Used ~7 kg for TOA adjustment.
- Plan rest of mission down to the gram – and keep some margin
  - Required extensive communication between teams
  - Detailed planning
  - Stick to the plan
- Late surprise – 615 grams less
  - Re-plan – Weekly Op-Nav only no daily science imaging for a while
  - Comet was too dim to detect, so no science lost
- Encounter – Finally
- Decommissioning – March 21, 2011
- Tank was empty!

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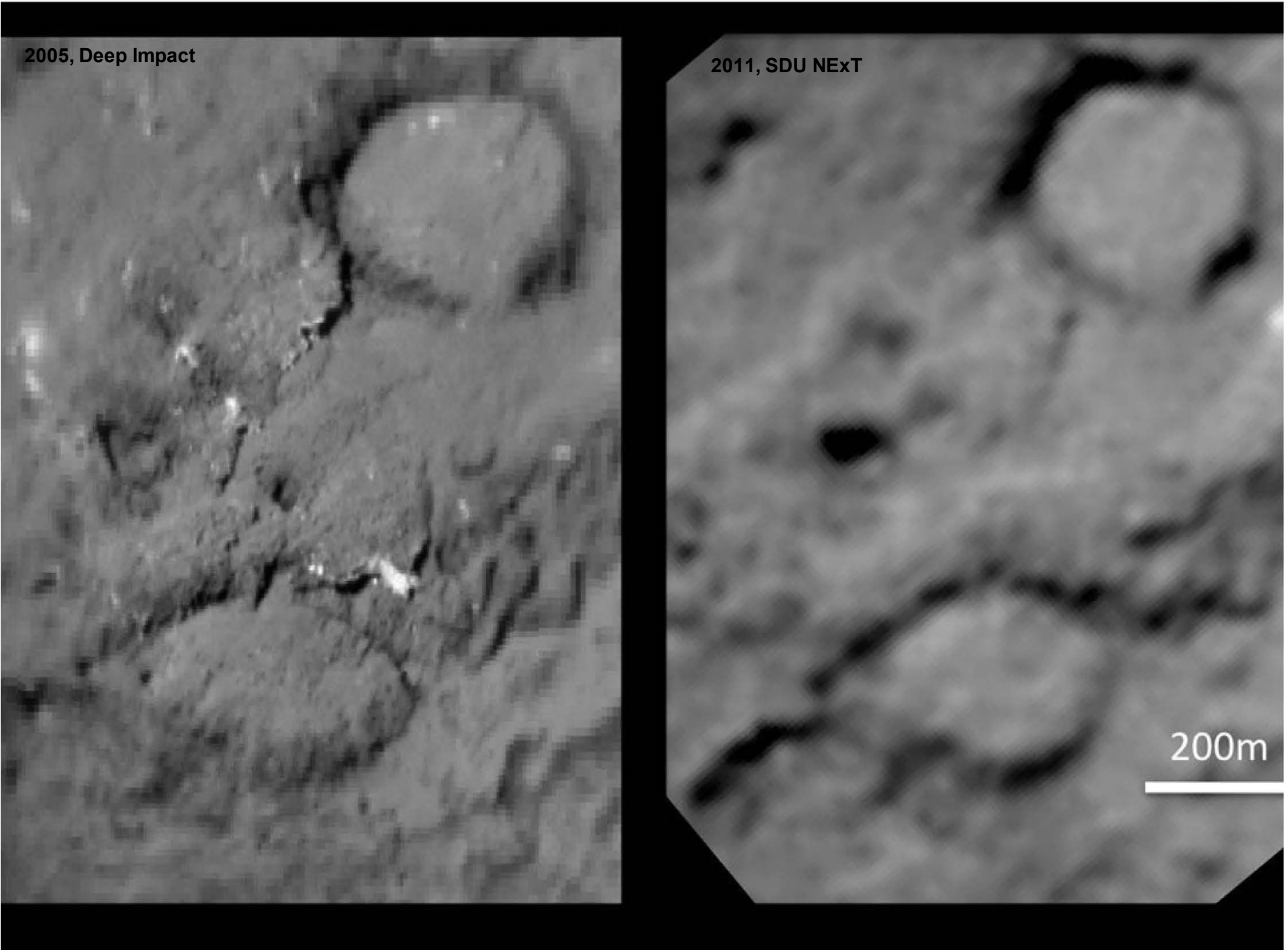
Tempel 1 Flyby
February 14, 2011

Impact – July 4, 2005
Deep Impact Mission


2005, Deep Impact
2011, SDU NExT
200m

Conclusions

- Prime mission + Mission of Opportunity used everything this spacecraft had to offer
  - Both sides of the redundant bus were used
    - Side A electronics functioned nominally for 11 years – was still functioning nominally when decision was made to swap sides to access additional life in back-up IMU
    - Side B electronics functioned 'as new' after 11 years 'storage' in space
  - RCS thrusters functioned nominally up to 2x their life test cycles
    - Still functioning when decision was made to swap to back-up string for mission reliability
  - System had total 12 years successful space operation
- Fuel management during Prime Missions: challenging, but working with large design margins
- Fuel management during extended missions or missions of opportunity:
  - Use every tool available to evaluate consumables
  - Plan for the worst case – inconvenience is much better than failure
  - Be vigilant and adaptable
  - Communicate – all teams need to be aware of the challenge and interdependencies
- PMs – listen to team leads and external advisors – will ultimately use these inputs to make difficult decisions

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