STARDUST

Bringing a Comet Home

Joe Vellinga, LM Program Manager

December 1995 to January 15, 2006

Discovery 4 Mission  PI Don Brownlee @ Univ of Wash
Managing Agency
Industrial Partner
Aerogel Sample Collector

1 cm Interstellar Grid

3 cm Comet Grid

Particle Carrot Track
Whipple Shield Does Its Job

1 cm
2 cm
5 cm
11 cm
Stardust Assembled
 процесс_pic() Predicted vs. Observed Brightness Center

**NavCam CCD**

0 64 128 192 256 320 384 448 512 576 640 704 768 832 896 960 1024

Pixel

Line

**Mirror Angle**

0 10 20 30 40 50 60 70 80 90 100 110 120

Mirror Angle (deg.)

**Nucleus Tracking Control**

**Default Trajectory**

**Roll Maneuver, If It Had Been Required**

**Navigation put it in Field of View**

**Locked On**

observed centers
First Image Released Near Wild 2 Closest Approach

- Many Flat Bottomed Craters
- Jets May be Coming From Walls of ‘Sublimation Craters’
Encounter Attitude Control

Flight Pointing Errors from Enc_Abs Attitude

Rotation about each Axis (degrees)
- X Rotat.
- Y Rotat.
- Z Rotat.

Roll Maneuver

Time from Closest Approach (minutes)
Nucleus Tracking

Location of Center of Brightness in CCD Frame
Closest Approach

Distance = 237 km
(9 km closer)
Time = 757538732 SCLK
(87 seconds early)

236.4 km
6 National Awards

• Popular Mechanics Breakthrough Award, Stardust, October 2006
• Aviation Week Program Excellence Award, Stardust, November 2006
• National Space Club Nelson P. Jackson Aerospace Award, Stardust, March 2007
• Aviation Week Laureate Award, Stardust, March 2007
• Rotary Stellar Award, Stardust Flight and Recovery Team, May 2007
• Smithsonian National Air & Space Museum Current Achievement Award, Stardust Comet Sample Return Mission Team, April 3, 2008
Why Sample

Return

Try to Launch This . . .

Or this . . .
STARDUST NExT

- Extended and completed the investigation of Comet Tempel 1 initiated by Deep Impact in 2005
STARDUST NExT Vehicle
Lessons Learned

- Get LV/KSC Launch Mass Commitment up front
  - Error Revealed Half Way Through Phase B (366 kg to 312 kg)
- One STL is Marginal; Should have Two (Workload & Side Swap)
- Need Strong System Engr Leadership of Software Dev & Test
- Strong, but Small Project Offices (JPL/LMA)
- Contractor Assumes More-than-normal Responsibility - Trust
- Spend Reserve $ on Risk Reduction Opportunities
  - SoftSim
  - ATUs
- S/C Can Despin Themselves (28 kg saved)
- One Sided 4 Thruster Attitude Control Works But…
- SDSTs, TWTAs, IMUs Can be Turned Off and On
- Cruise Mission Ops Can be Efficient
  - < 6 EP at LM for much of mission
  - 12 month & 6 month periods with no contact
Stardust Structure
Stardust was a Successful FBC Project

- Schedule: Phase B 9 months; Phase C/D 28 months to launch – Ready to Launch of 1st Day of Window
- Launched Under Budget - $1M to Phase E
- How
  - No Creep (Requirements, Processes, Team)
    - Science Team Wanted Volatiles Added – NO
    - ARC wanted Heatshield Instrumentation – NO (twice)
  - Very Little Iteration
  - Adequate but Lean Staff (Project Office & LM)
  - Bounding Analyses
  - Adequate – Design, Analyses, Tests
  - Offloaded People
  - EVM Straight forward & Integrated at LM & JPL