STARDUST

Bringing a Comet Home

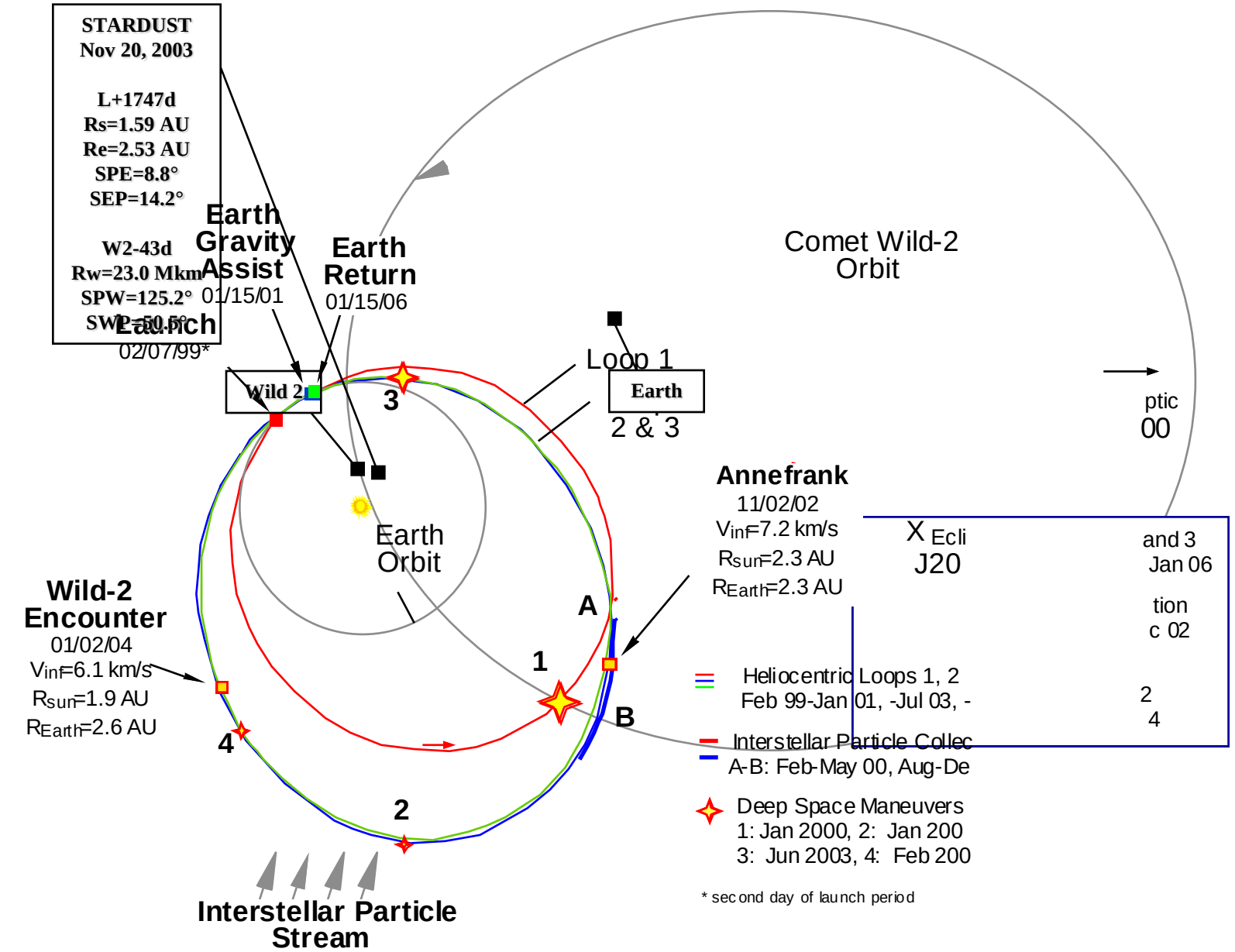
Joe Vellinga, LM Program Manager

December 1995 to January 15, 2006

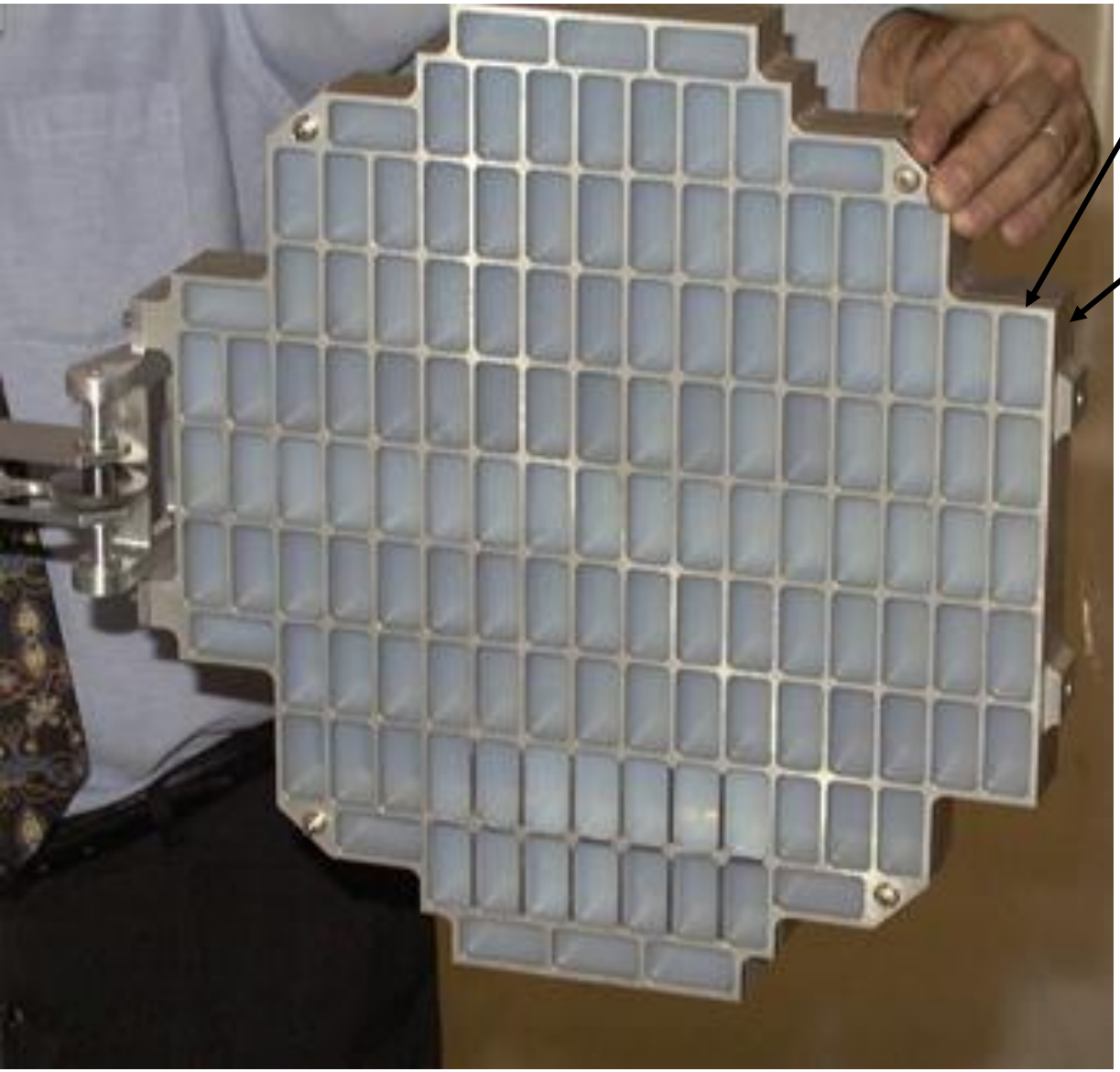
Discovery 4 Mission	PI Don Brownlee @ Univ of Wash	Managing Agency	Industrial Partner
NASA	University of Washington	JPL Jet Propulsion Laboratory California Institute of Technology	Lockheed Martin

STARDUST

Trajectory Overview

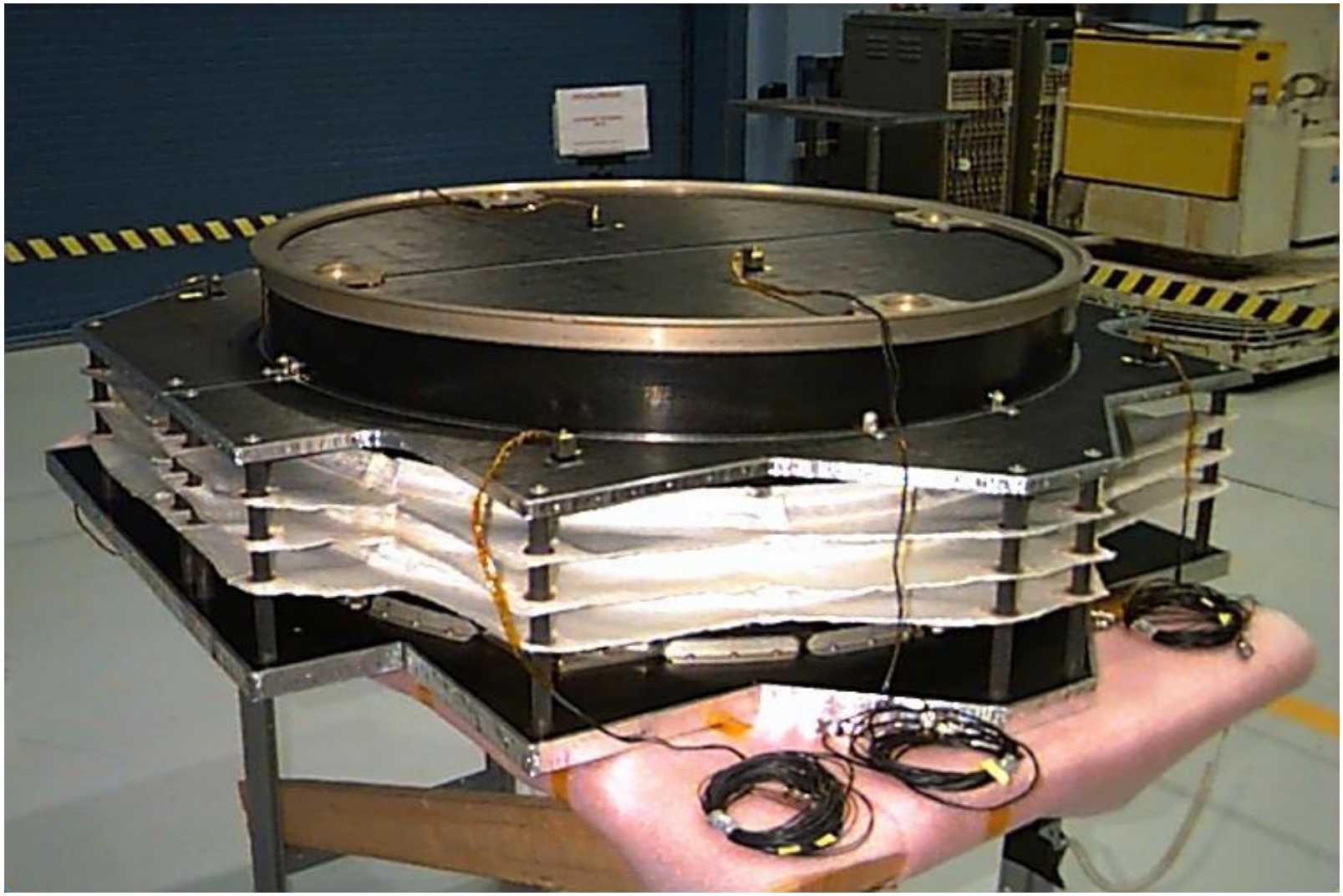


Aerogel Sample Collector

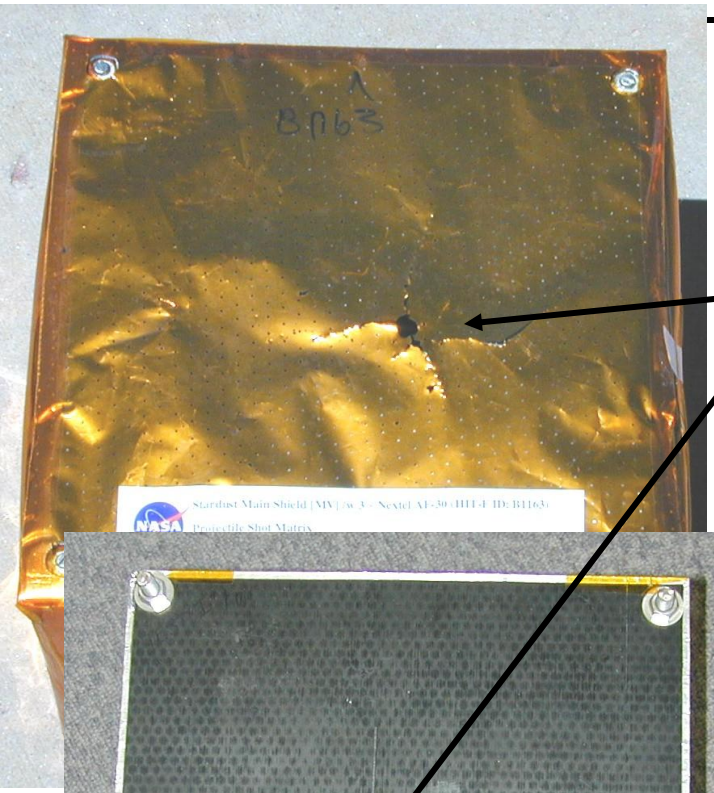


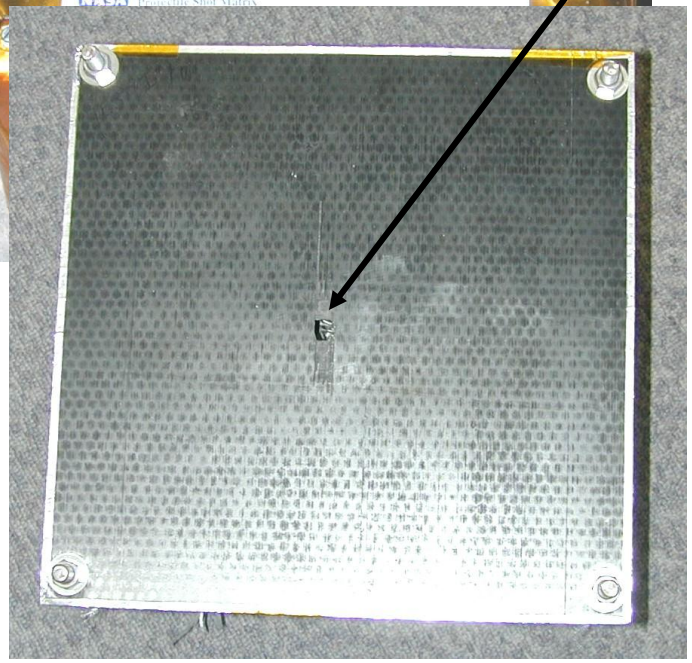
Particle Carrot Track

Whipple Shield



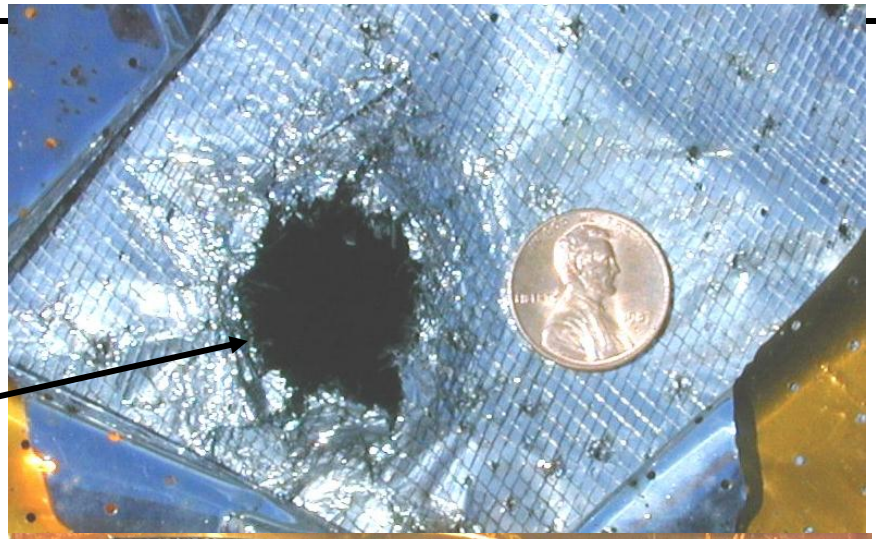
Whipple Shield Does Its Job





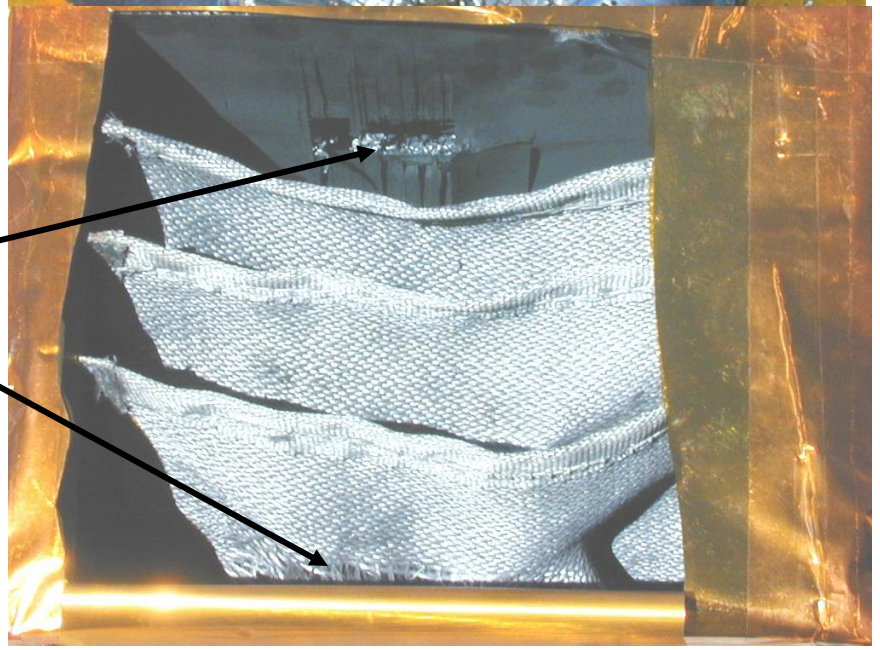
1 cm

2 cm



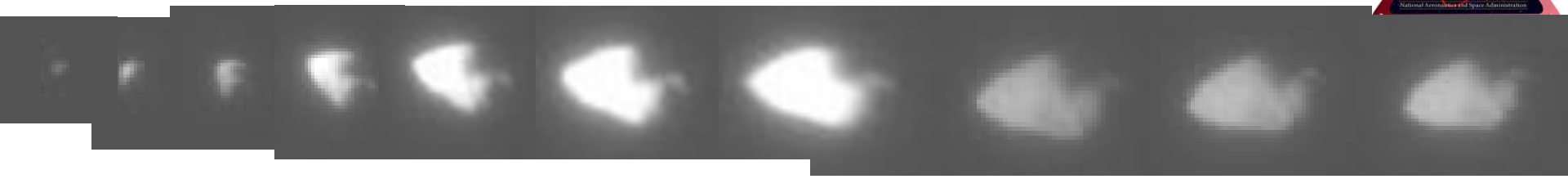
5 cm

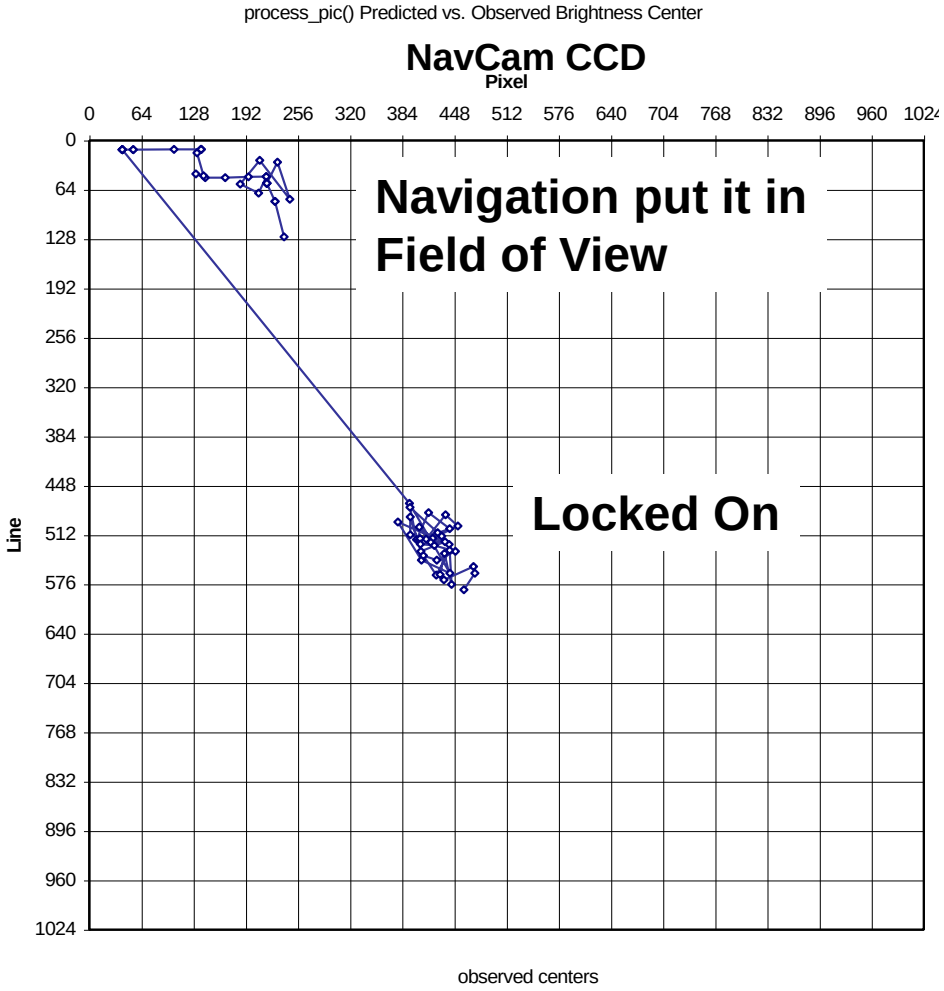
11 cm

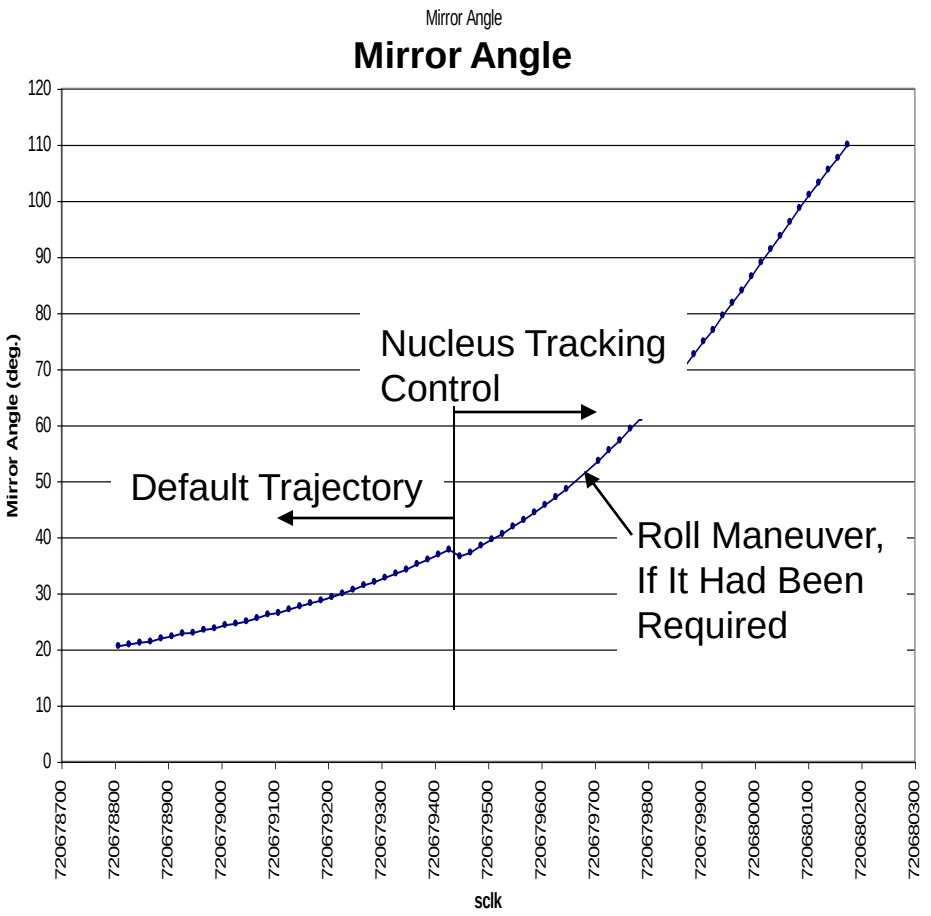


Stardust Assembled

AnneFrank Encounter 2 Nov 2002

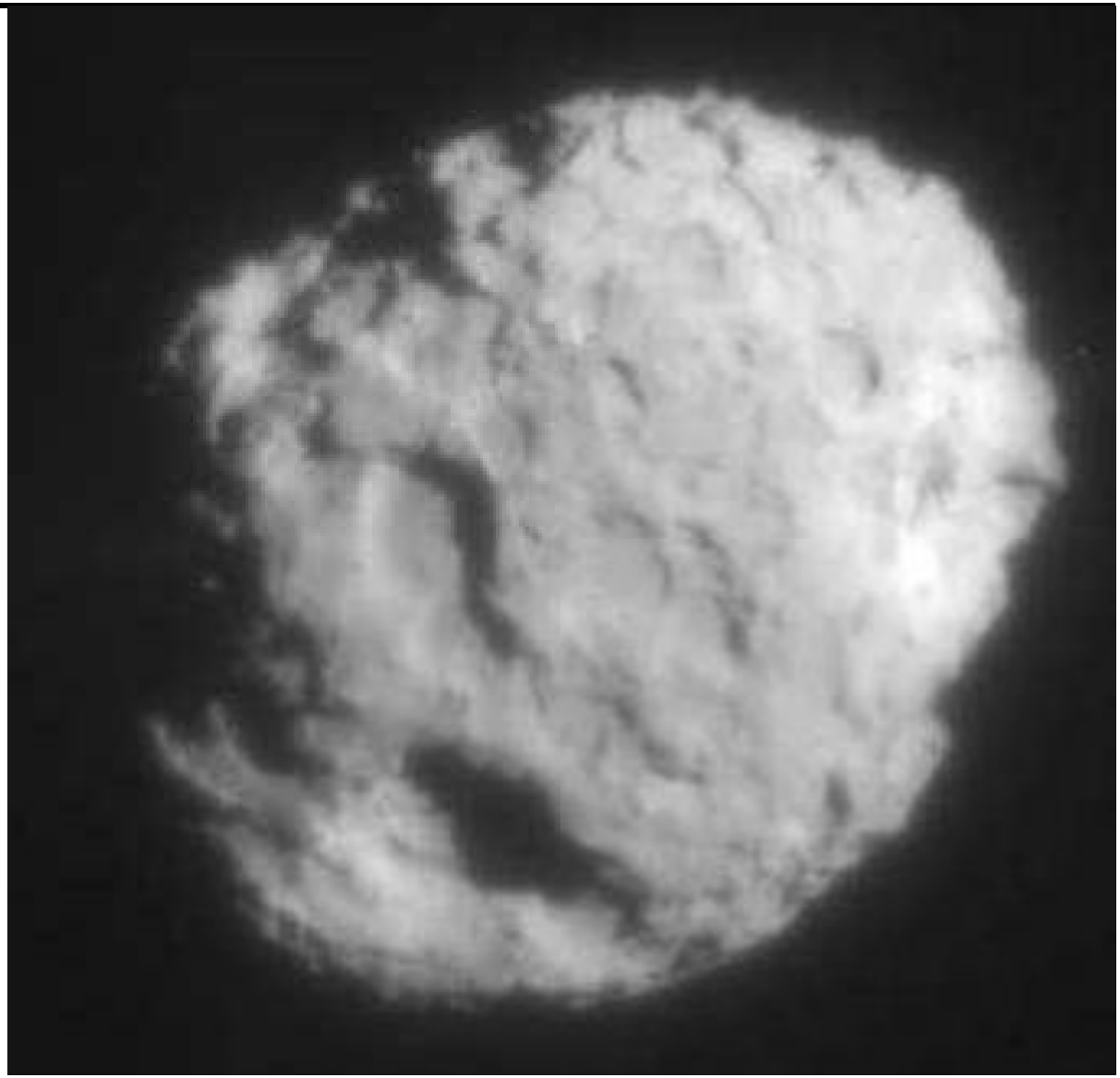




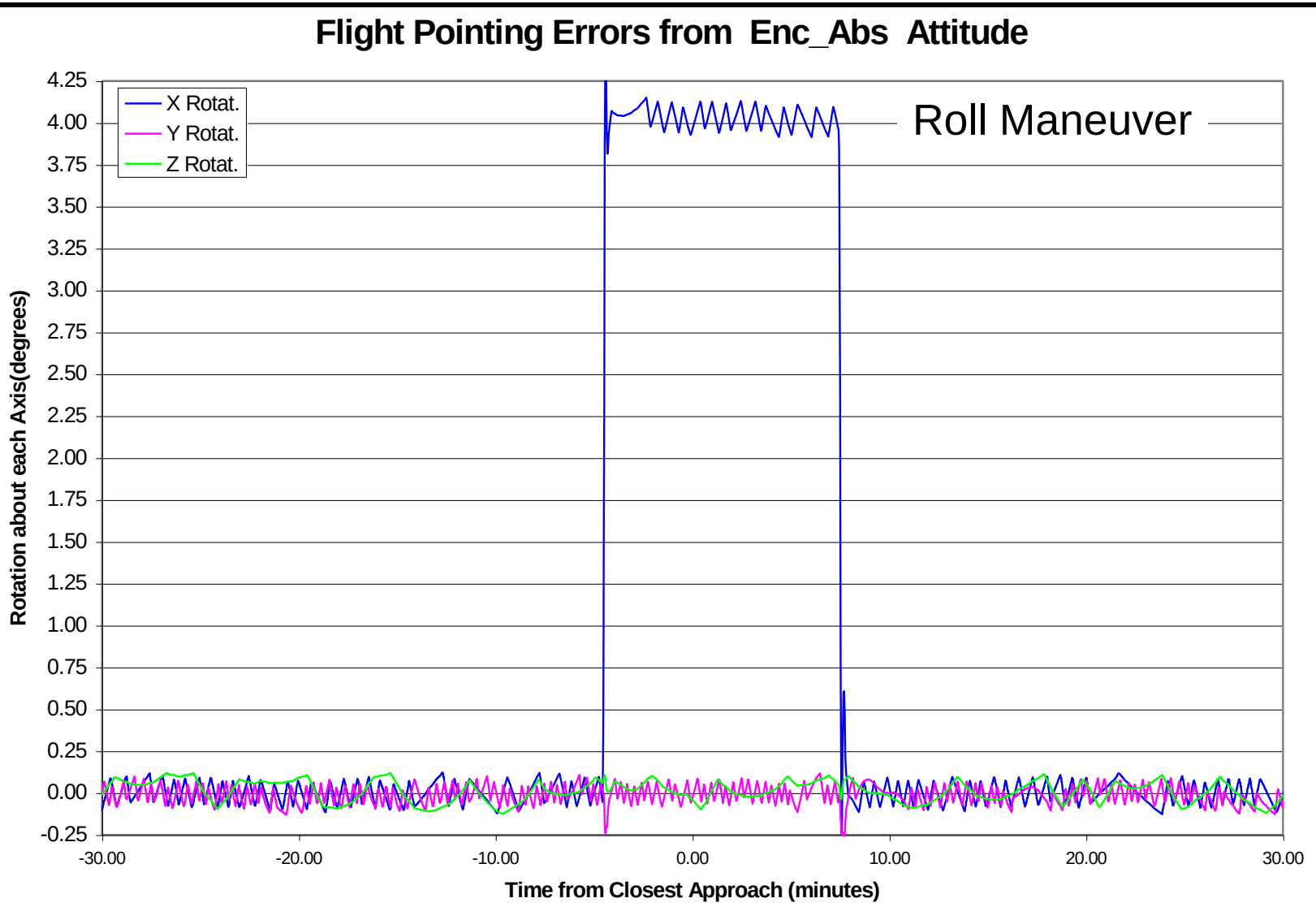


First Image Released Near Wild 2 Closest Approach

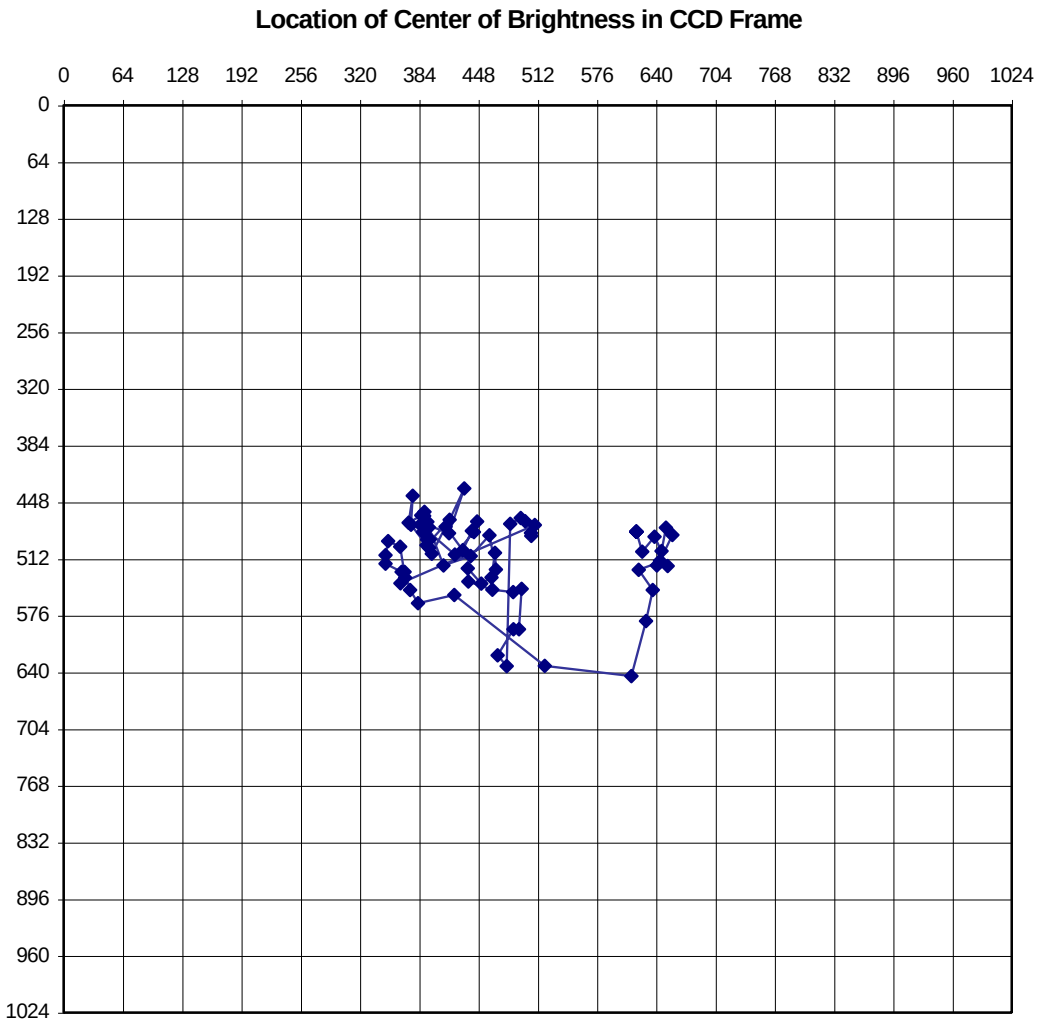
- Many Flat Bottomed Craters
- Jets May be Coming From Walls of 'Sublimation Craters'



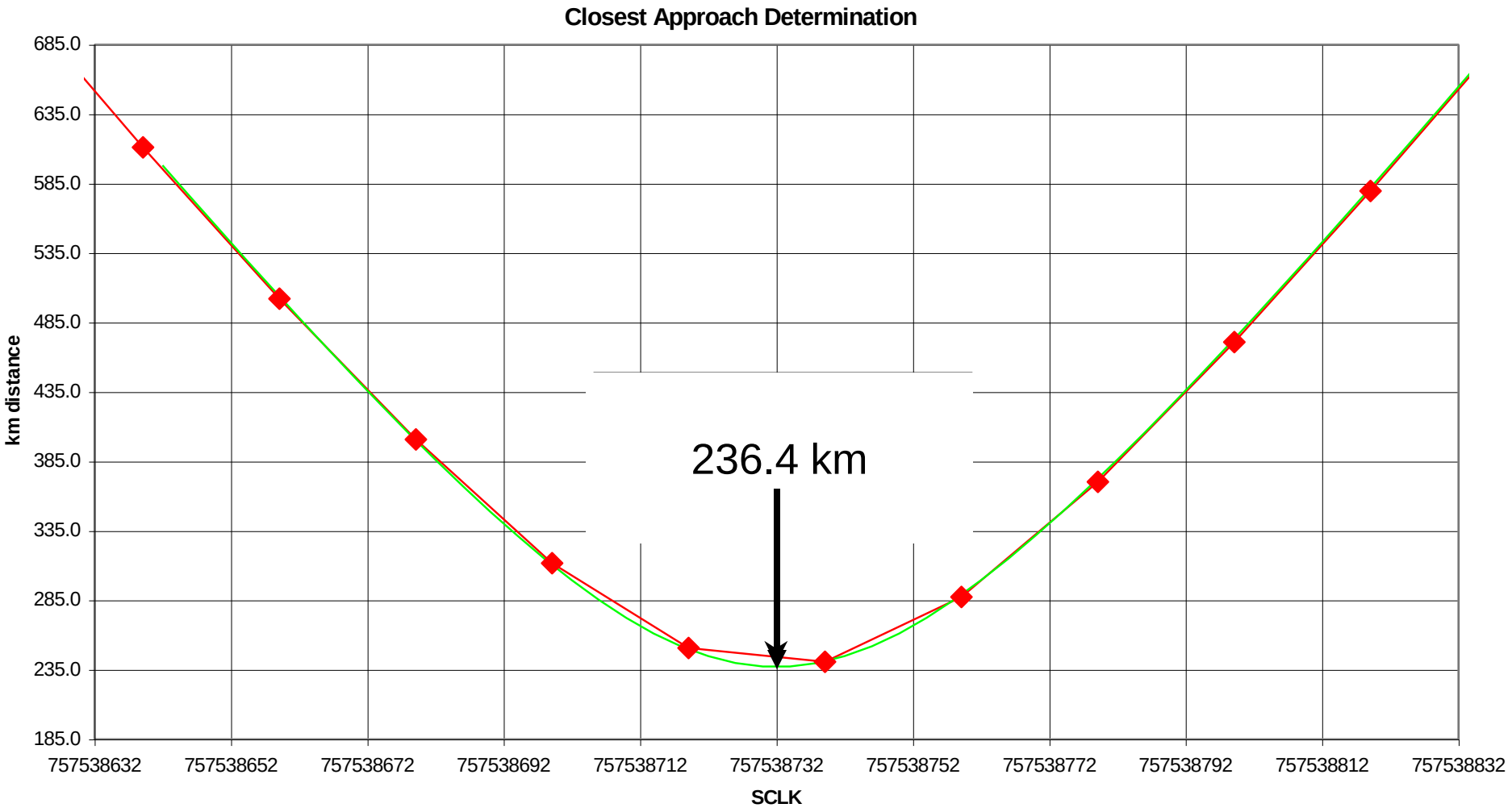
Encounter Attitude Control



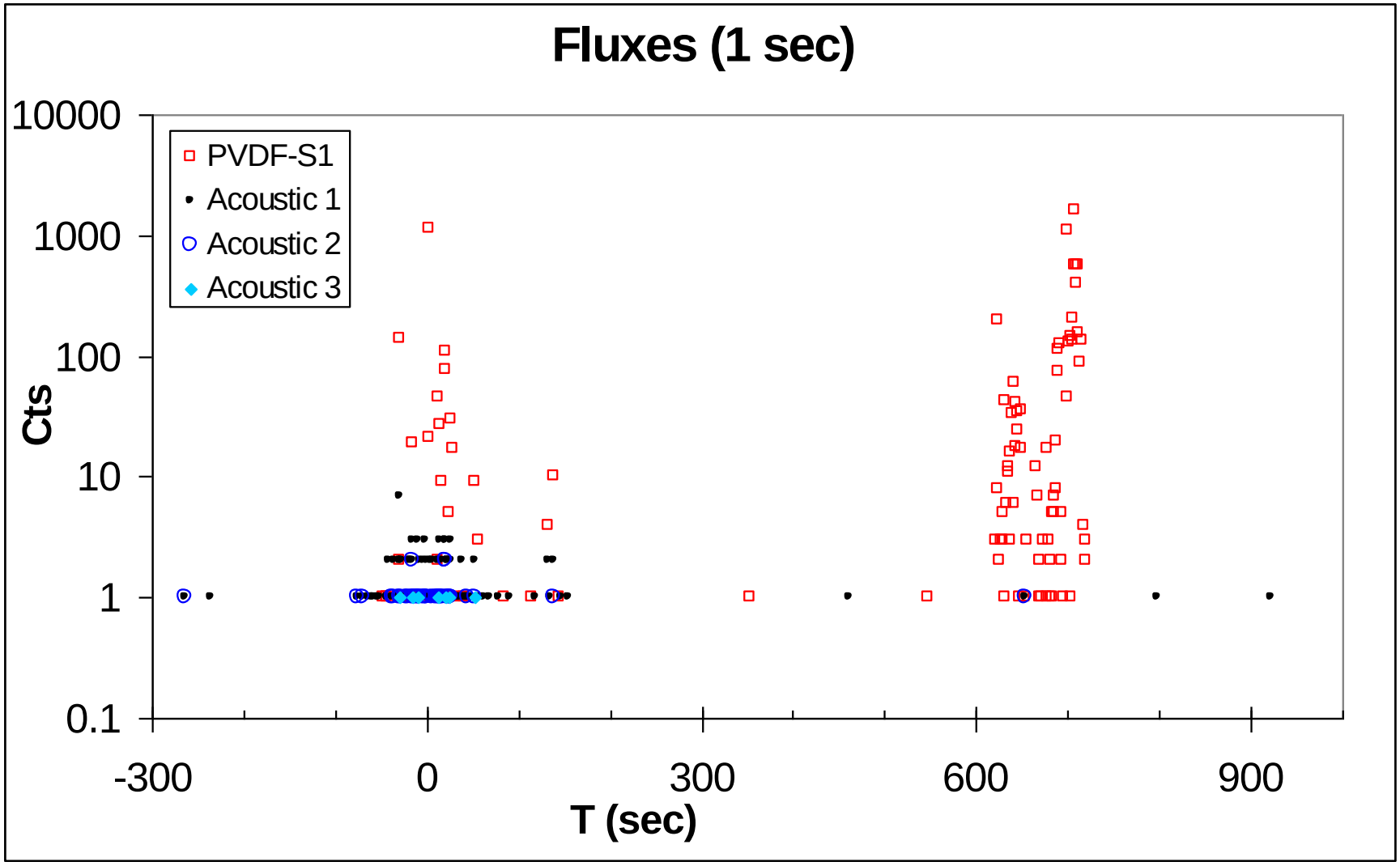
Nucleus Tracking



Closest Approach



Particle Fluxes




2004 U.S. LIFE SCIENCES SALARY SURVEY, PAGE 1829
18 June 2004
Science
Vol. 304 No. 5678
Pages 1701–1856 $10
Stardust
AT COMET WILD 2
AAAS

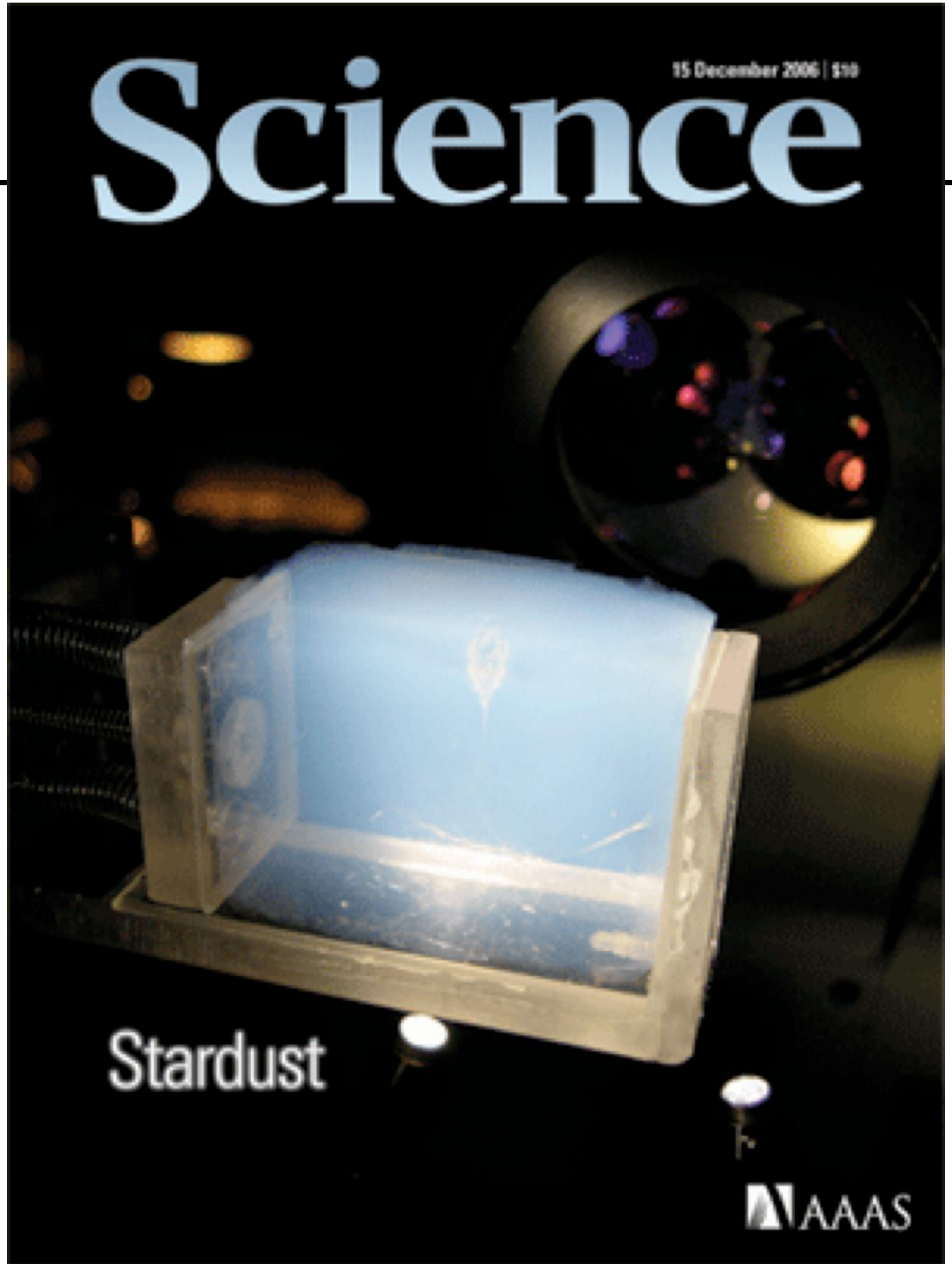
6 National Awards

- **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

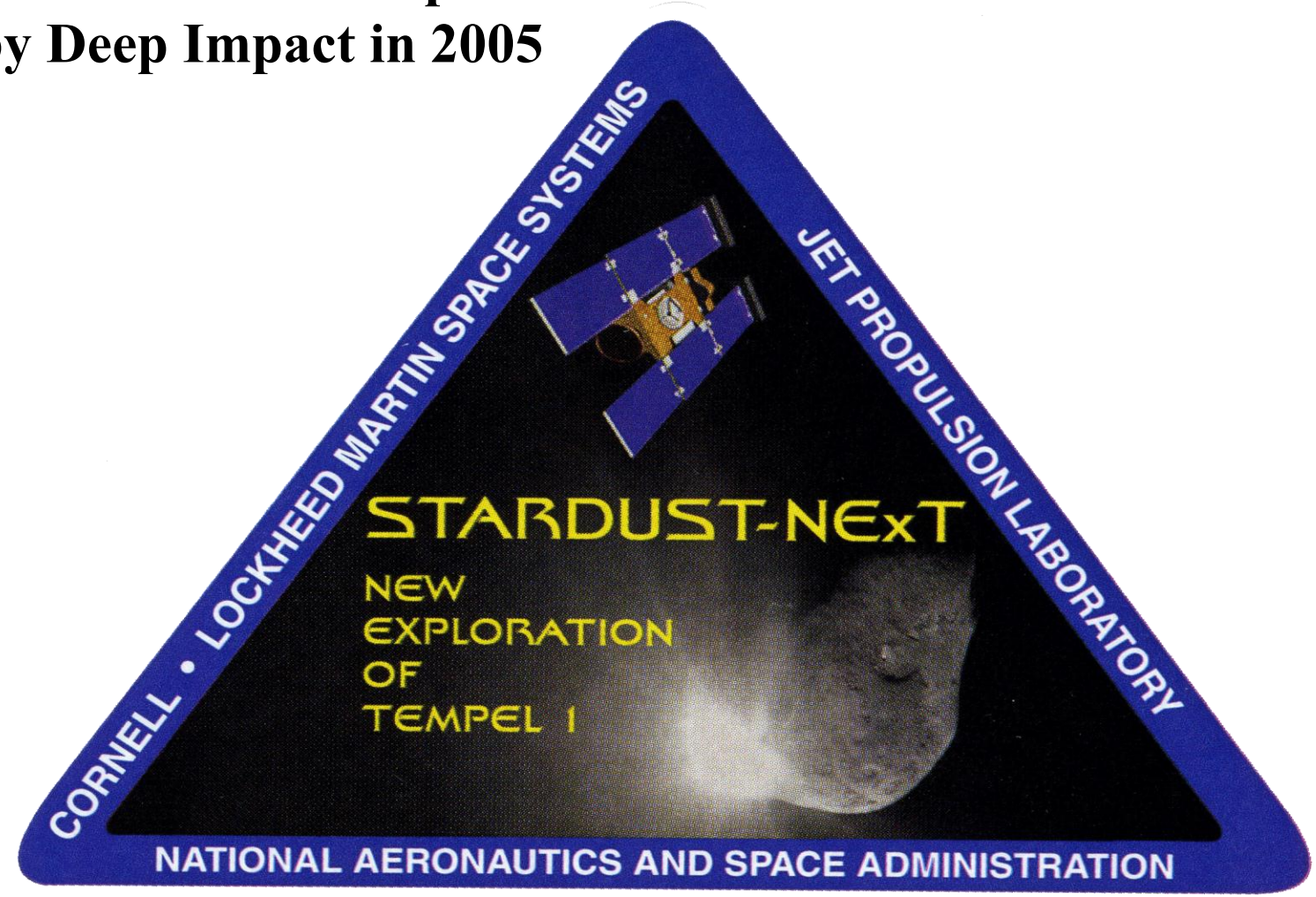
Try to Launch This . . .

Or this . . .

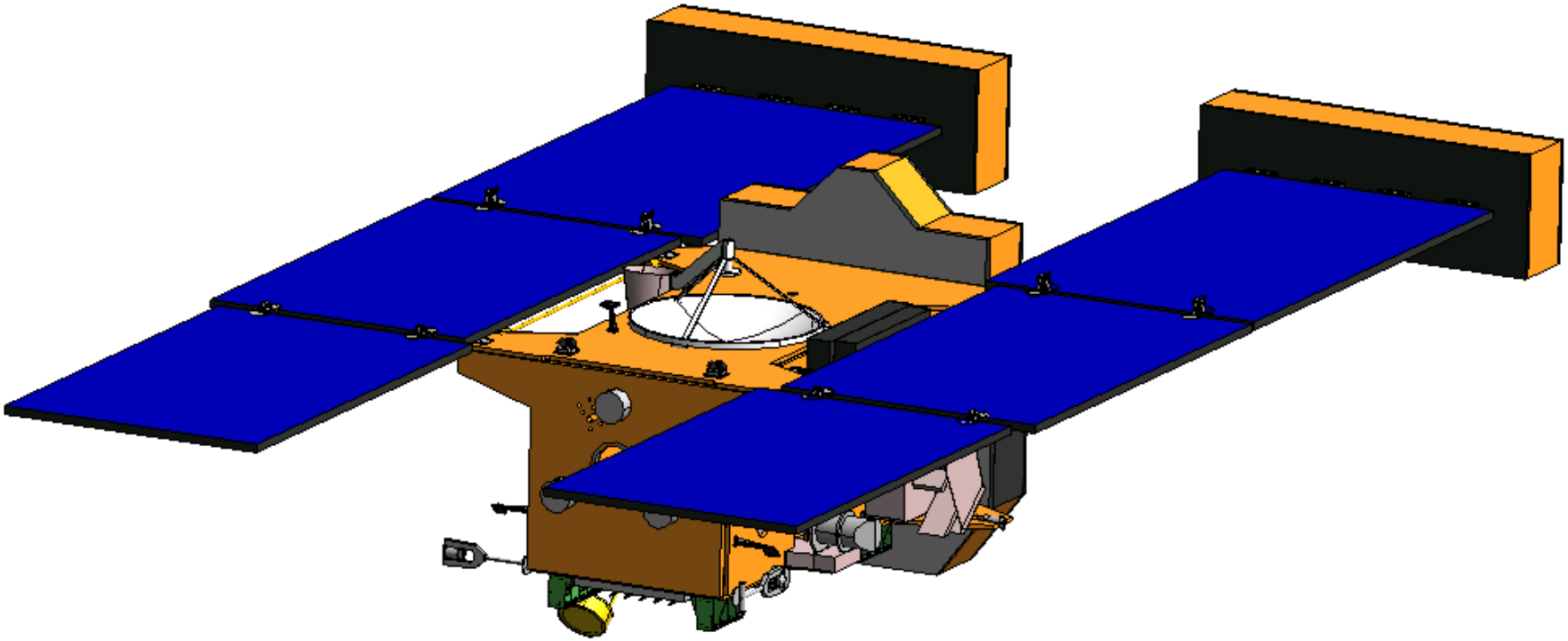

Science
15 December 2006 | $10
Stardust
AAAS

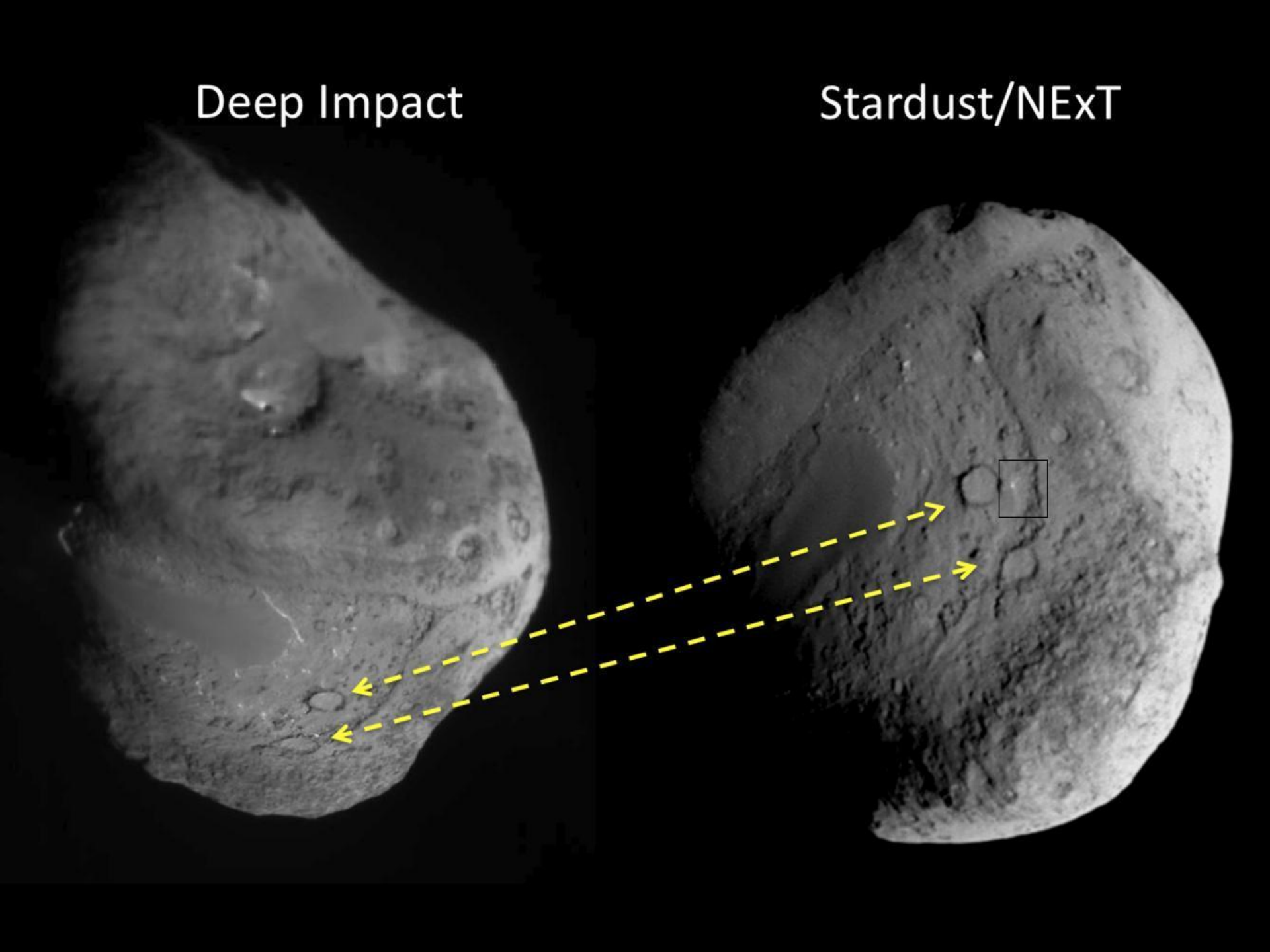
STARDUST NExT

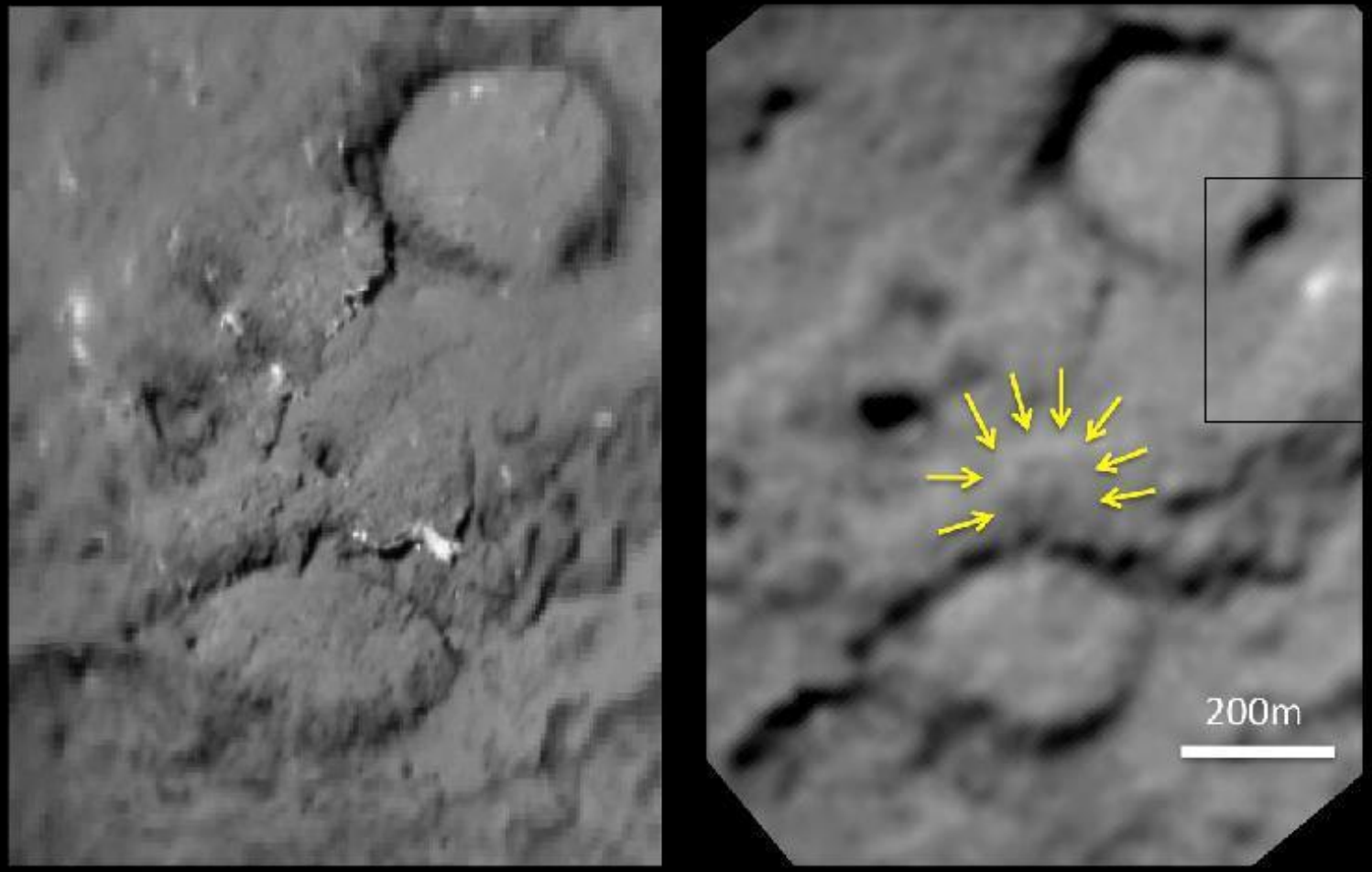
- **Extended and completed the investigation of Comet Tempel 1 initiated by Deep Impact in 2005**



STARDUST NExT Vehicle



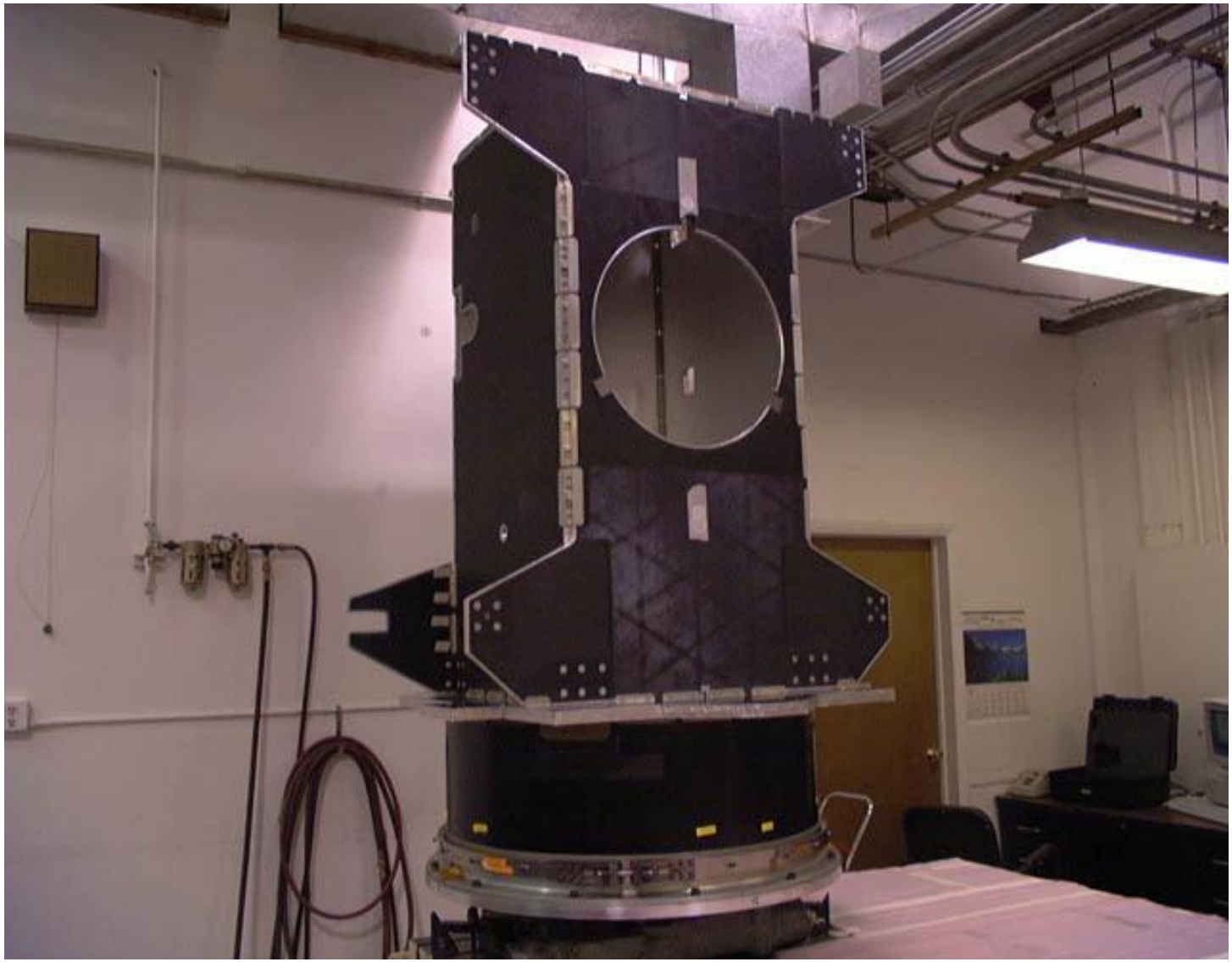

Deep Impact
Stardust/NExT


200m

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**