NASA Sample Return Missions
GENESIS & STARDUST
NASA's First Sample Returns Since Apollo

2 April 2013

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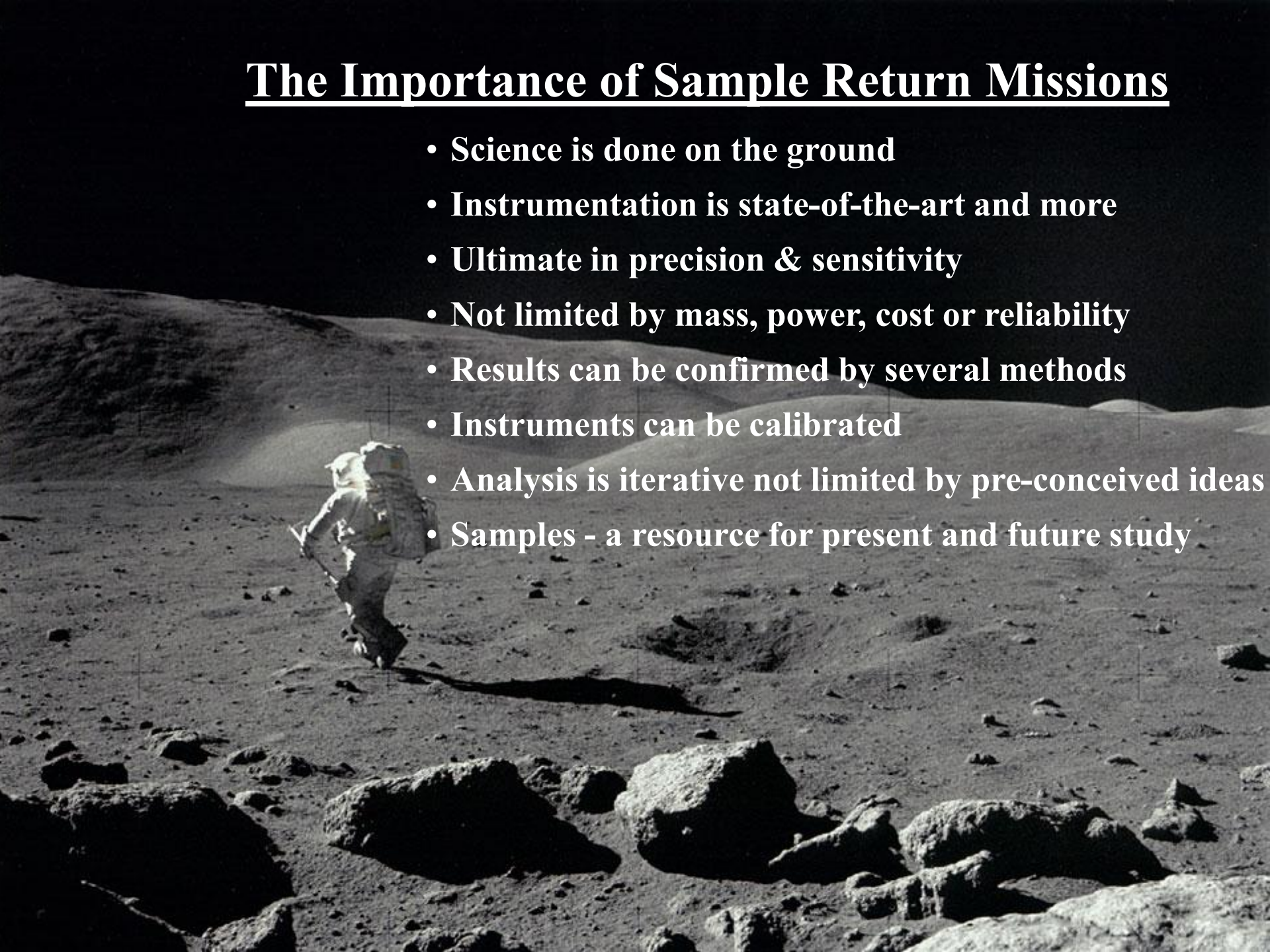
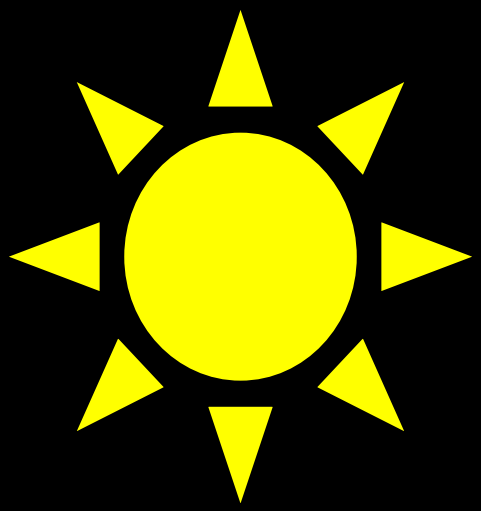
The Importance of Sample Return Missions

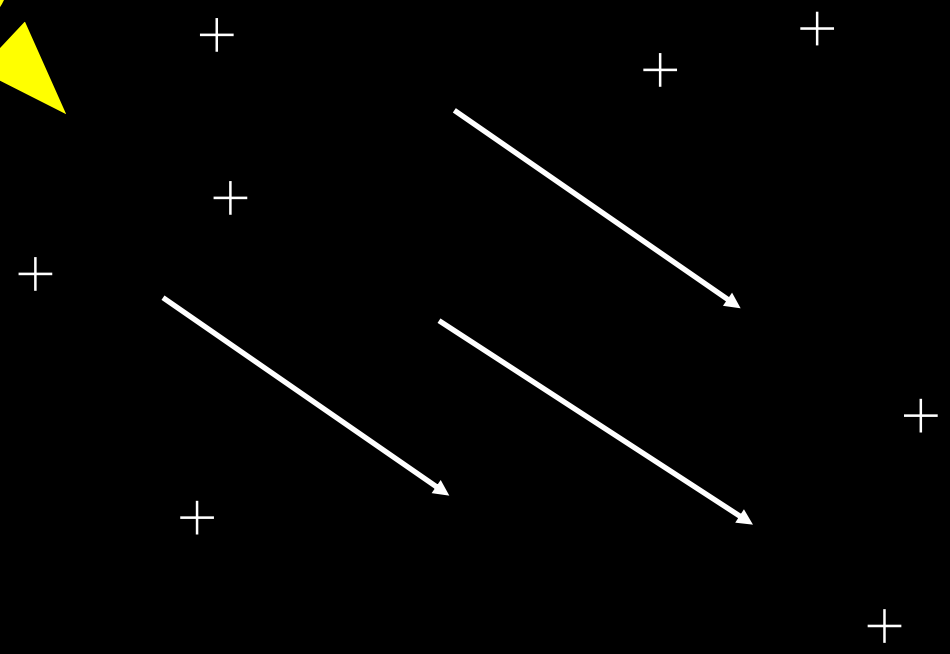
- Science is done on the ground
- Instrumentation is state-of-the-art and more
- Ultimate in precision & sensitivity
- Not limited by mass, power, cost or reliability
- Results can be confirmed by several methods
- Instruments can be calibrated
- Analysis is iterative not limited by pre-conceived ideas
- Samples - a resource for present and future study



Mission Concept

Capture the Sun!

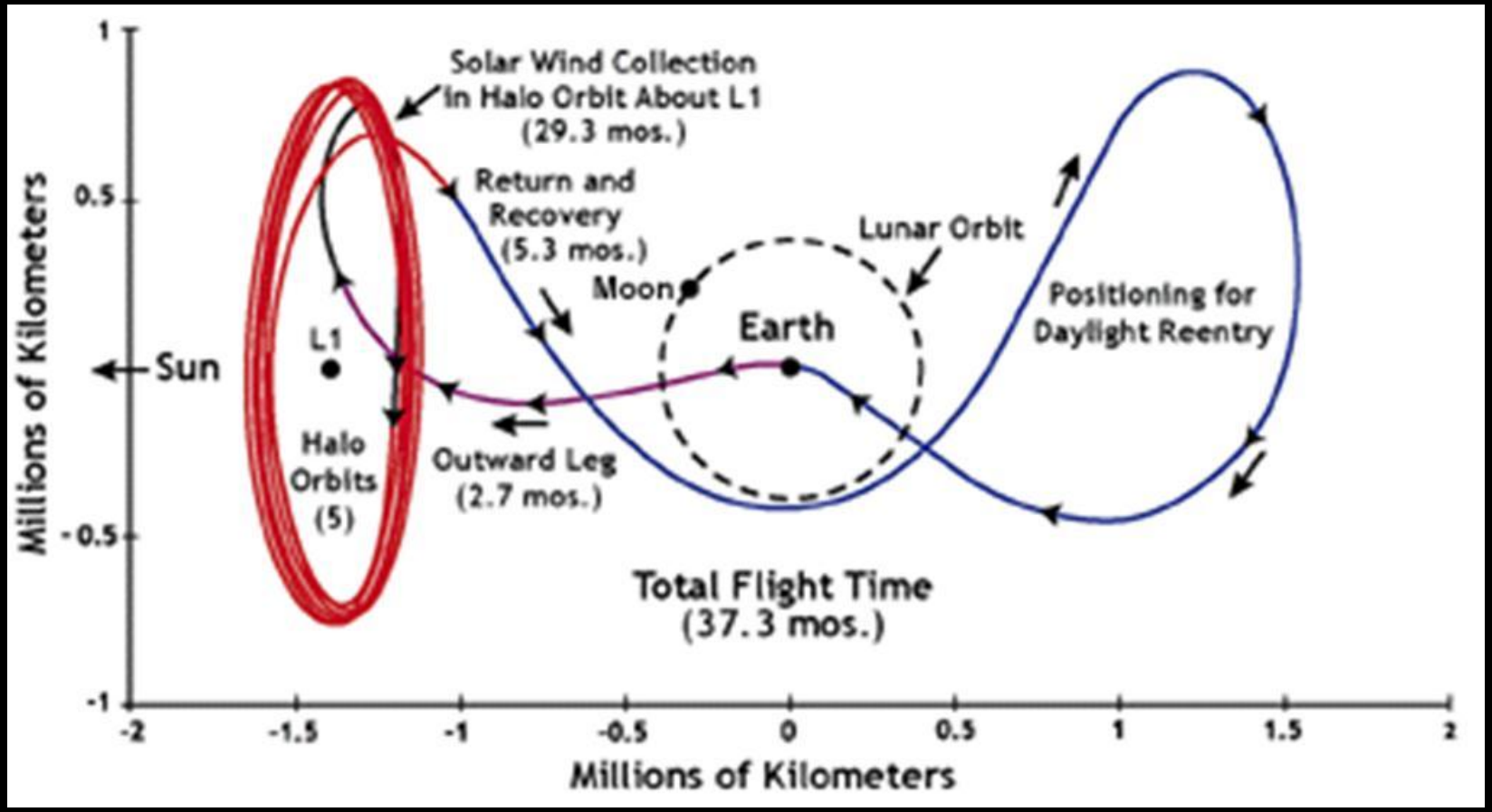




The sun makes up more than 99% of the material in our solar system, yet we don't know its composition.

The materials in our solar system are thought to have formed from the initial solar nebula which formed the sun.

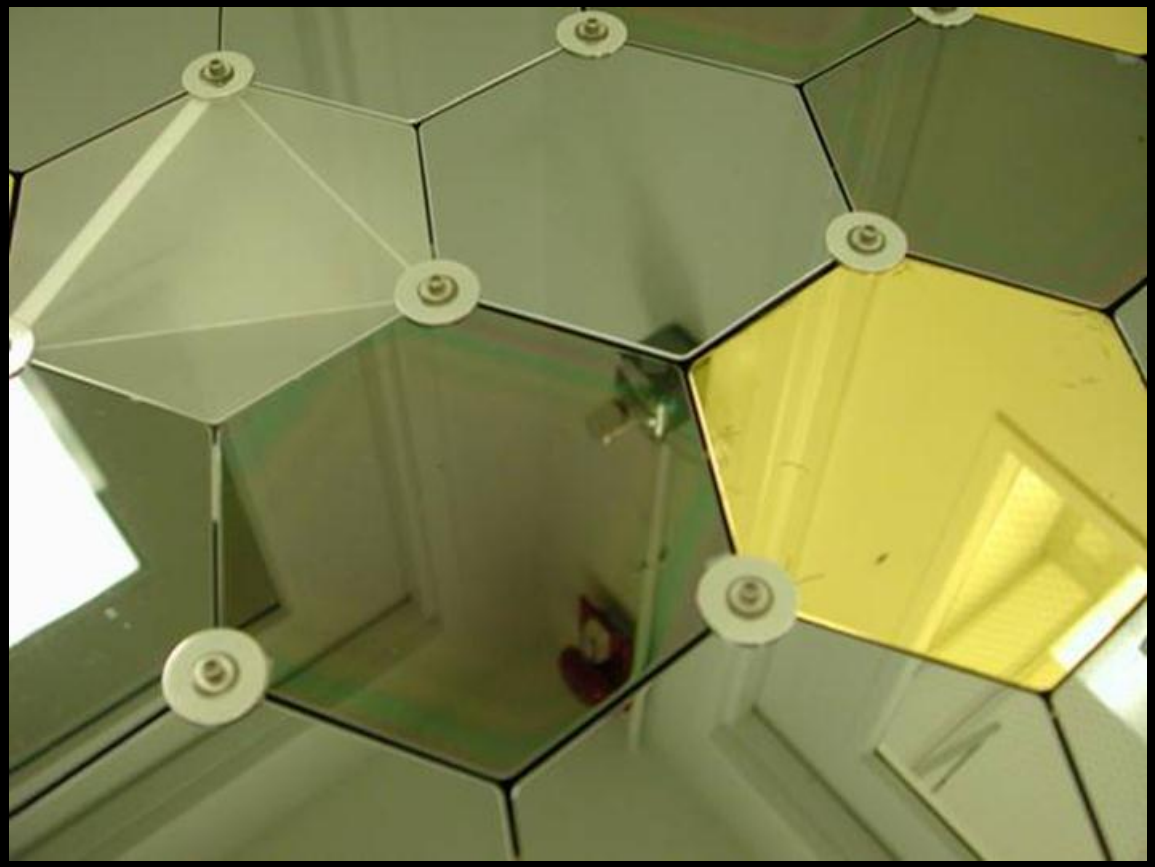
Where do you go to catch the Sun?



You have to go outside of the Earth's magnetic sphere.

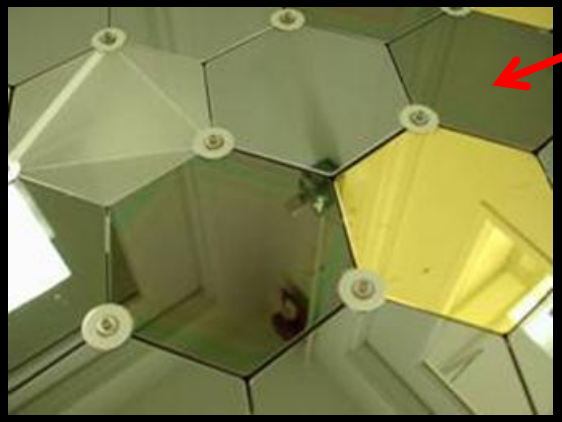
How do you catch the Sun?

- In Ultra-clean, ultra-pure Collectors

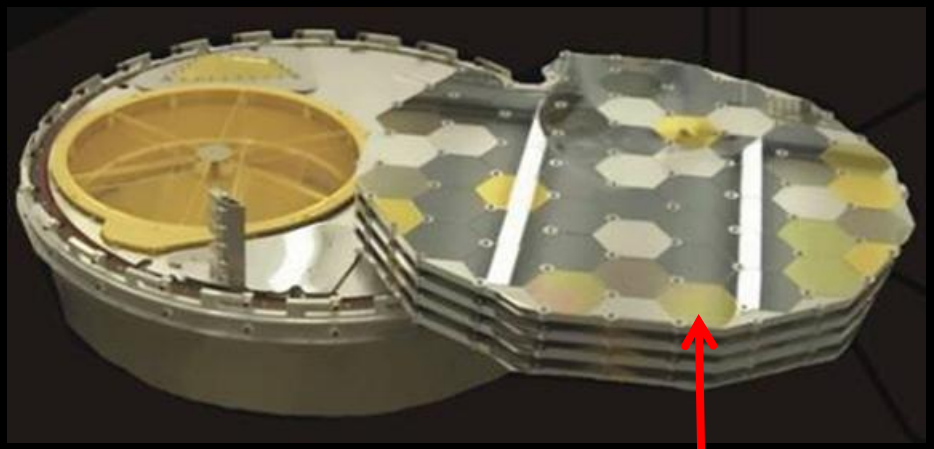


Silicon, Gold, Sapphire, and Diamond

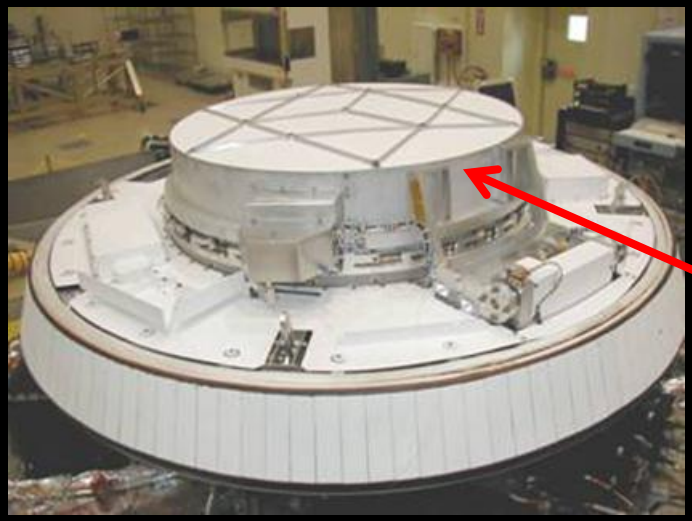
Spacecraft Assembly



Collectors on arrays



Arrays inside canister

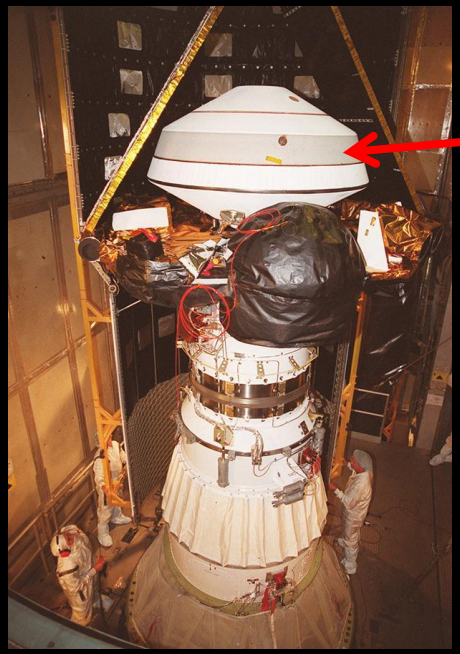


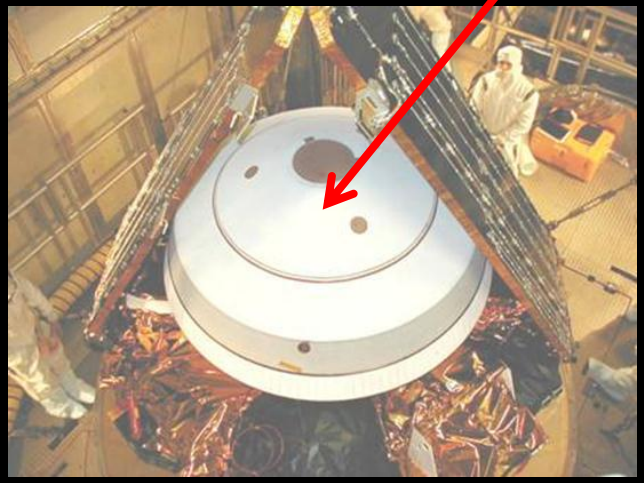
Canister inside Spacecraft Capsule

10, 9, 8….Go for Launch

Spacecraft in launch configuration

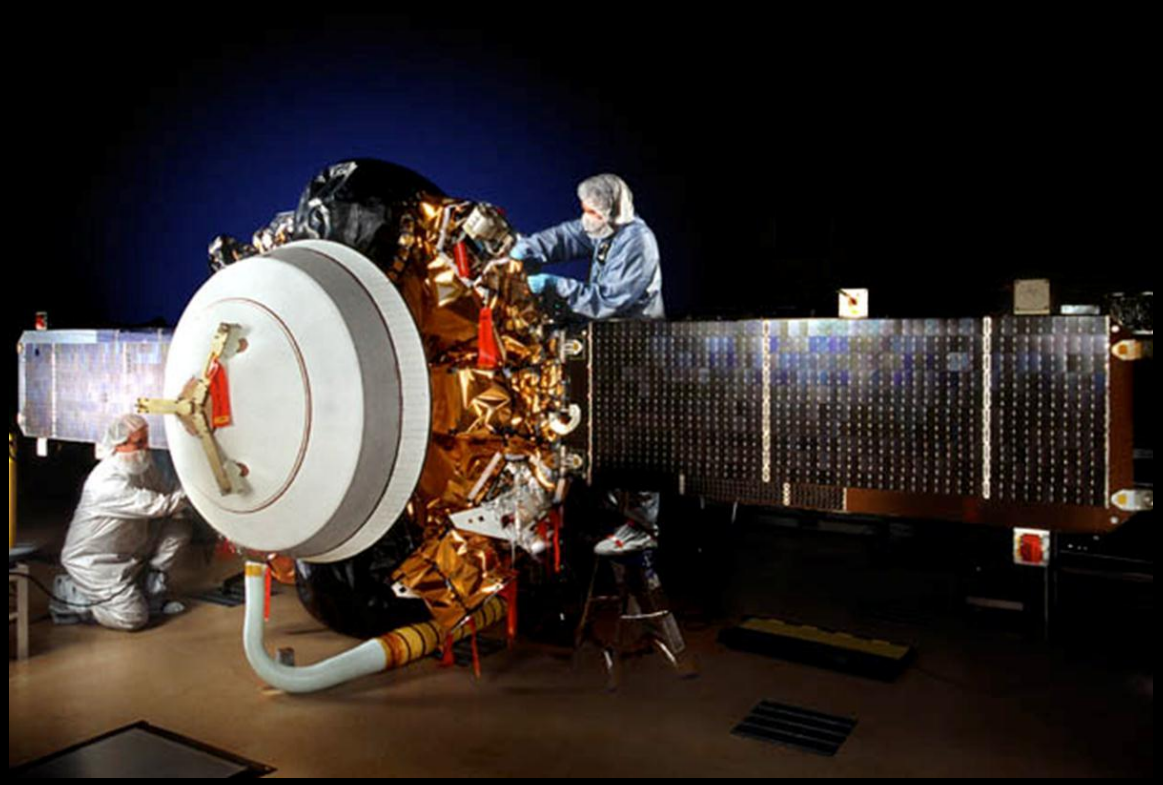
capsule



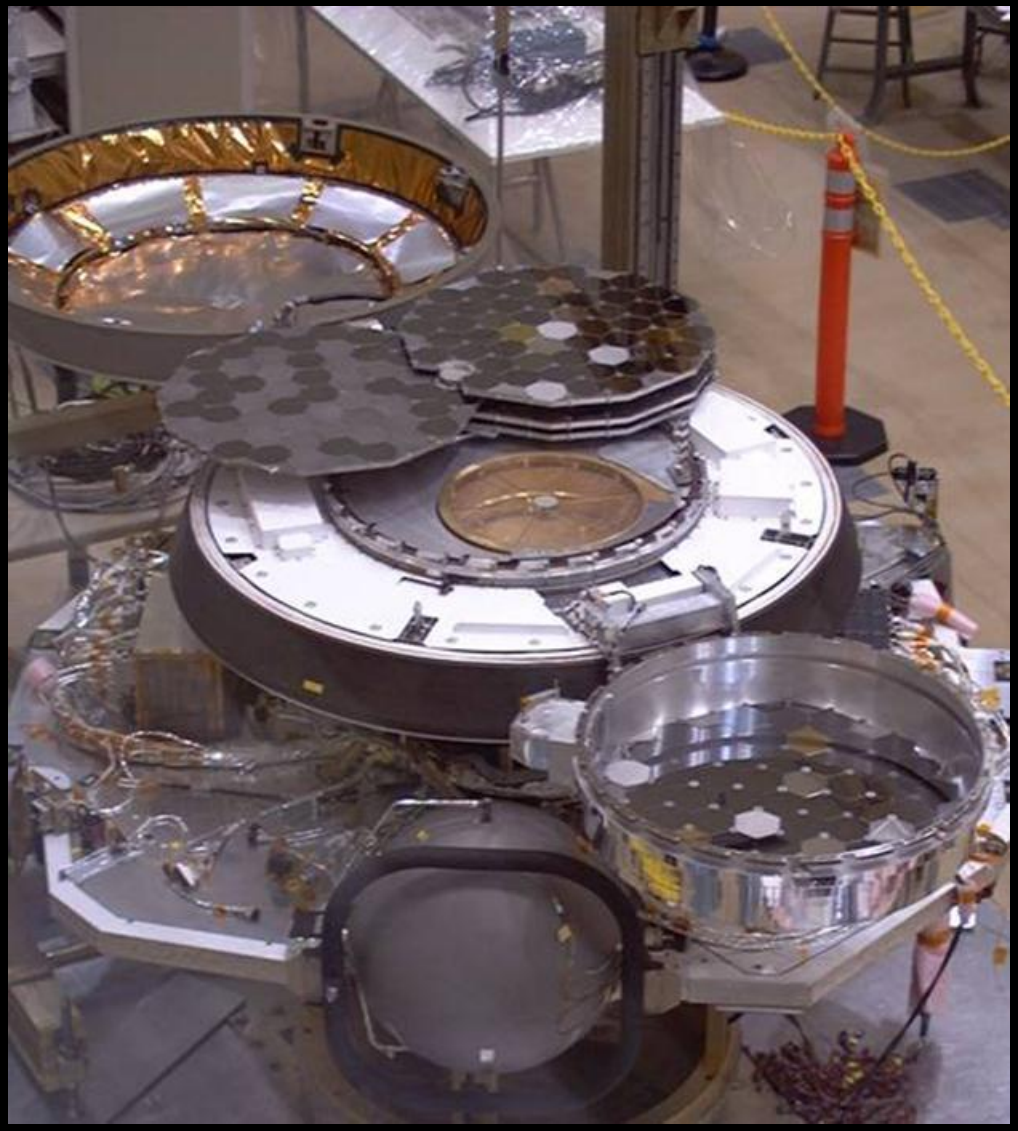


Launch: August 8, 2001

Genesis Configuration in Cruise



Genesis Configuration on Orbit



Coming Home: Midair Capture at UTTR

- Science collection ended 2 Apr 2004
- **Return to Earth 8 Sep 2004**

But, On 8 September 2004

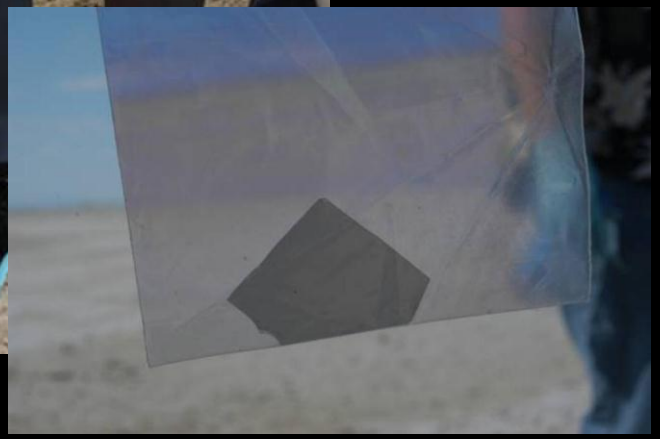
There was no parachute for the helicopter to catch!

It's good to plan for contingency!

But remember! We had to keep the samples clean!

We built a large cleanroom in Utah where we could take it back and clean and package any broken samples!

Here, you can see that the canister is open and laying on its side. Where you see the gold color, there should be the bottom of the canister.



We had to turn the canister upside down in order to keep the pieces of collectors inside.

Recovering Science

The Recovery Team worked until nightfall to get everything back to the cleanroom.

As a result, the concentrator targets, the number one science goal of Genesis, were recovered nearly in tact!

Back in the Cleanroom

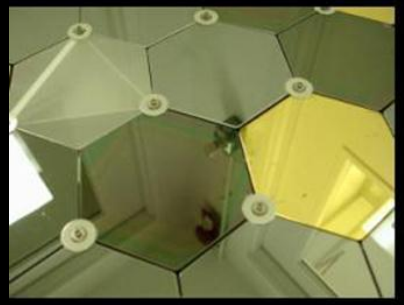
Turning the canister upside down saved the samples, but it made our next job a little harder!

We had to take everything apart upside down too!

Genesis was supposed to bring back 308 collectors with solar wind.

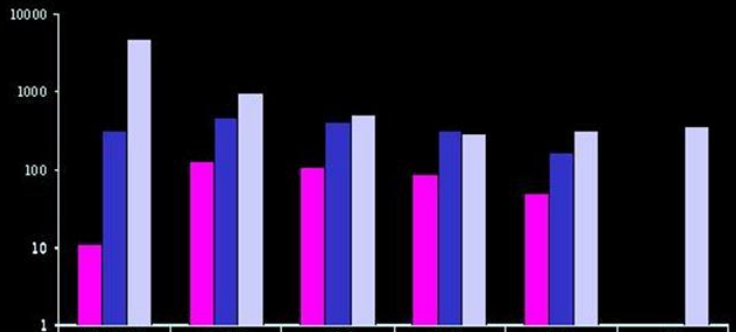
Collector Status

Instead of This



We have This

- 10,000 Individually Documented Collector Pieces



	Si+DOS	AuOS	AlOS	SOS	Sap	Os
> 2.5 cm	11	130	110	89	50	
< 2.5 cm, > 1 cm	310	465	427	311	173	
< 1 cm	4772	974	504	298	310	367

- Regime Identification
  - Fragment Mixing Necessitates Thickness Measurement

How many pieces do you think we had in the end?

Genesis achieved 100% of its mission goals!

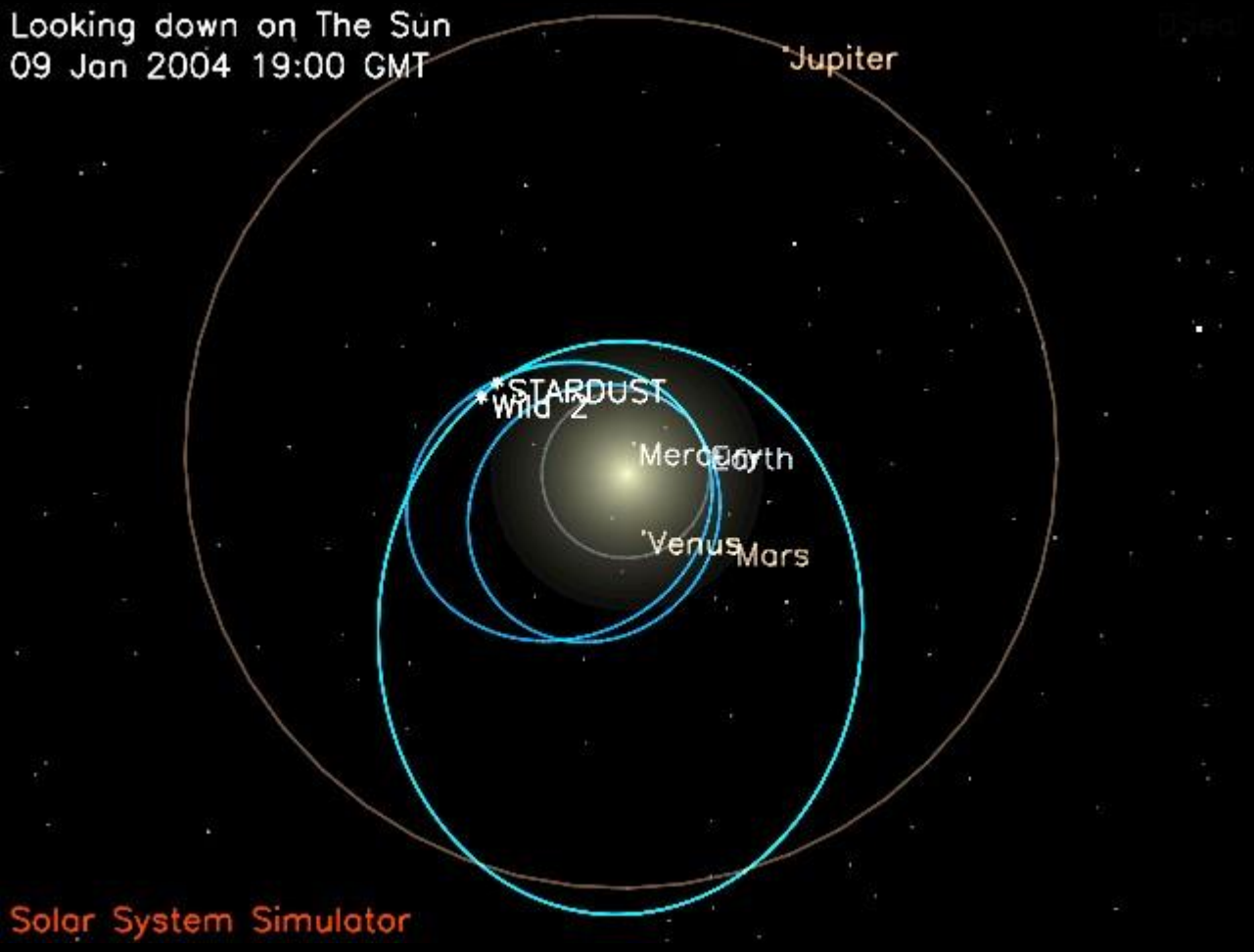
How?

If you are going to have a problem on a mission, have it on Earth. On Earth, you have plenty of time, plenty of resources, and plenty of brilliant students like yours to solve the problem!

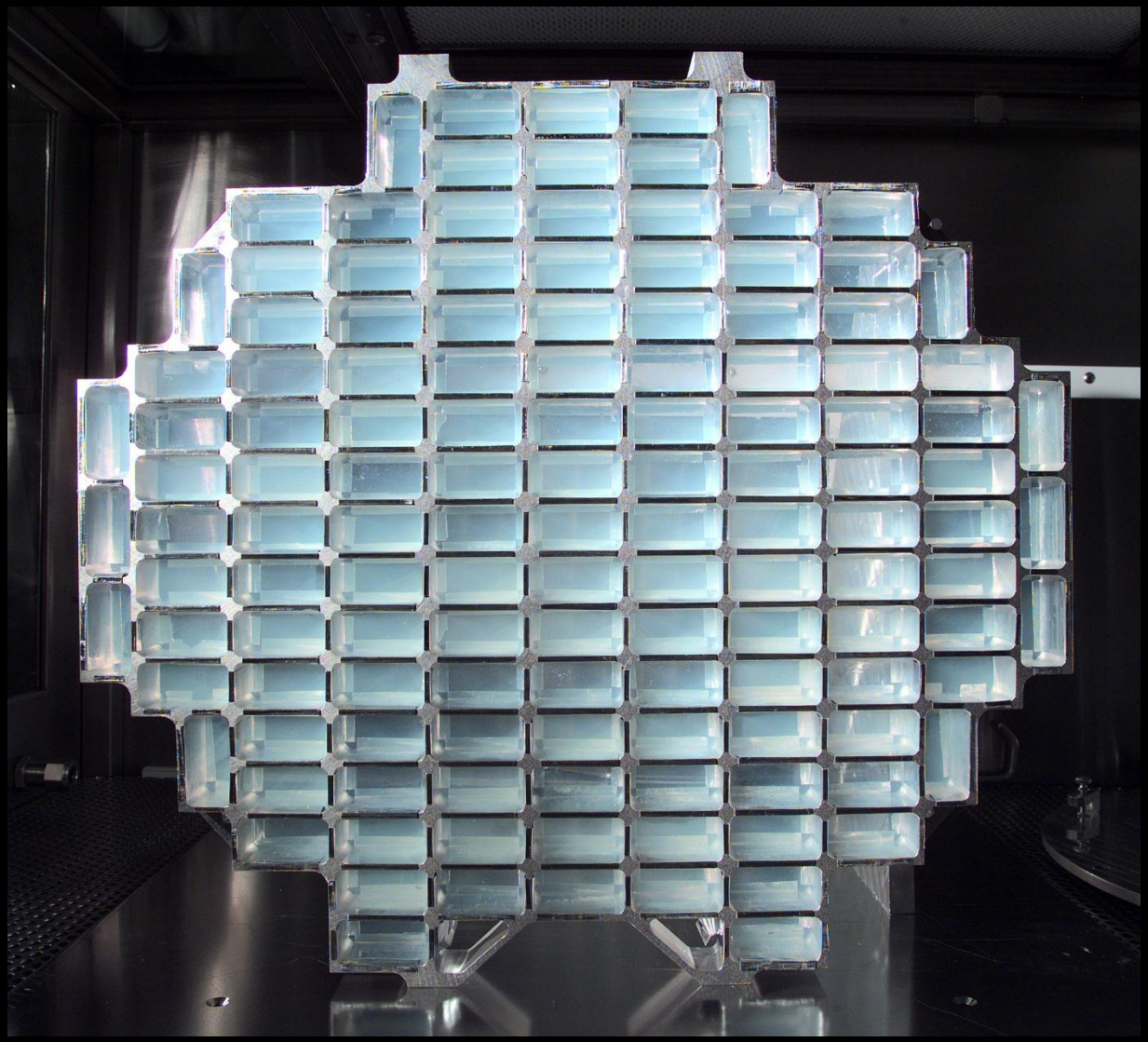
What have we learned?

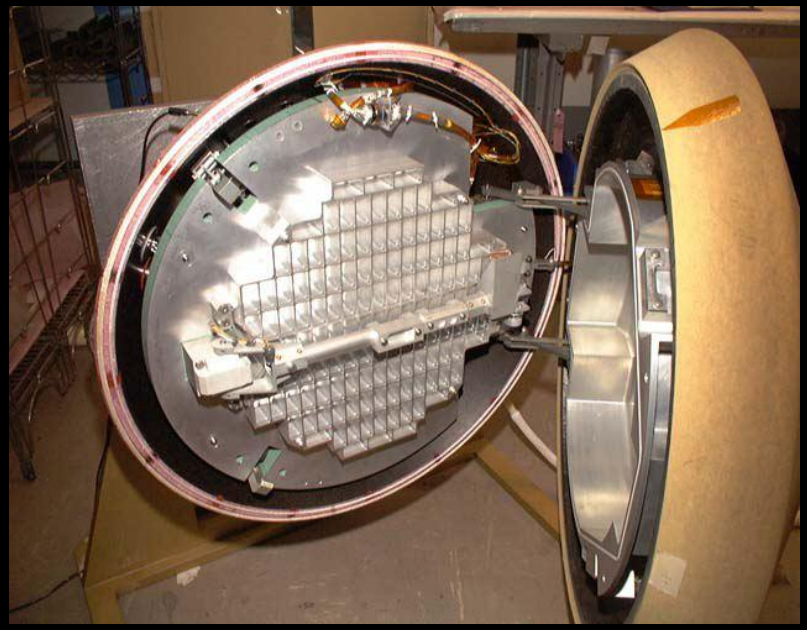
- Measuring the elemental and isotopic composition of the sun, especially oxygen and nitrogen, two of the most abundant materials in the solar system
- Enabled scientists to better understand isotopic variations in Meteorites, Comets, Lunar Samples, and Planetary Atmospheres
- According to theory, the oxygen & nitrogen isotopes on the sun & Earth should => BUT THEY DON'T
- **We need to rethink our ideas about the formation of the solar system!**

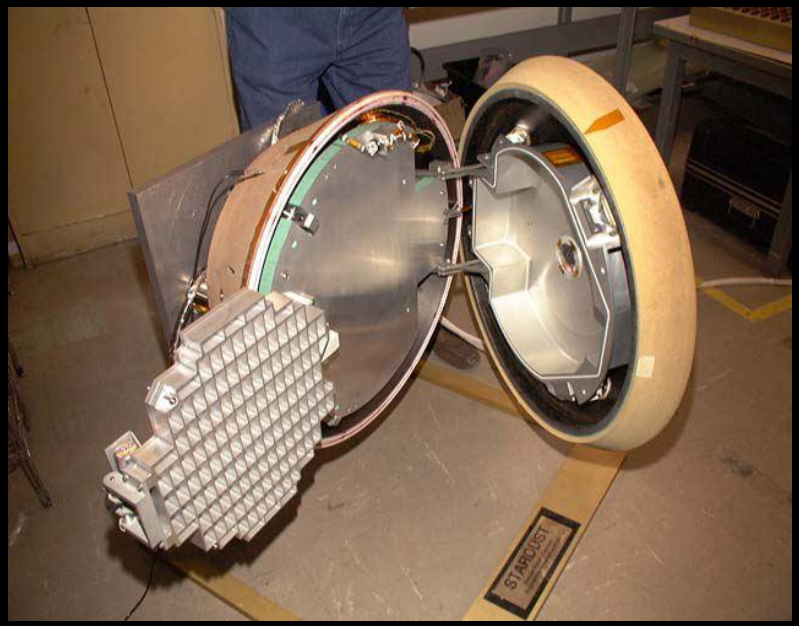
STARDUST

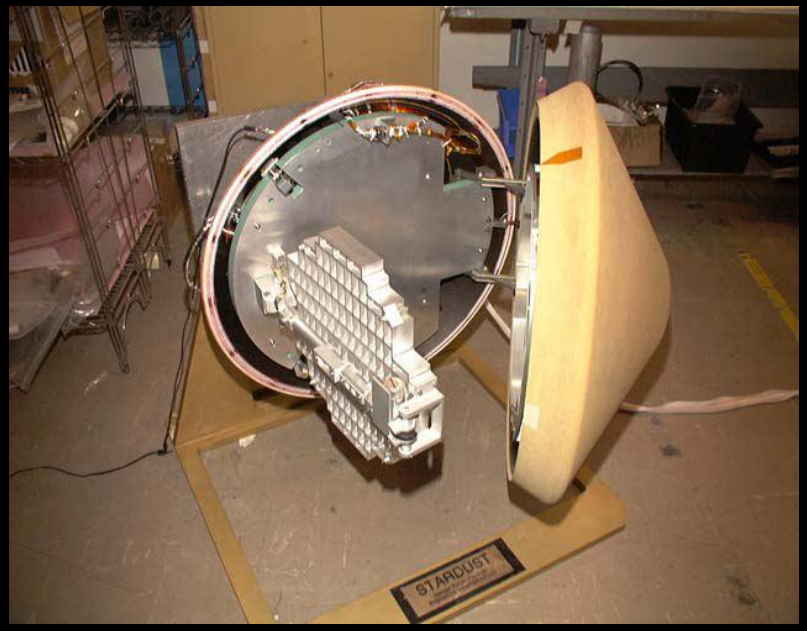

Looking down on The Sun
09 Jan 2004 19:00 GMT
Jupiter
STARDUST
Wild 2
Mercury
Earth
Venus
Mars
Solar System Simulator

Aerogel Trays



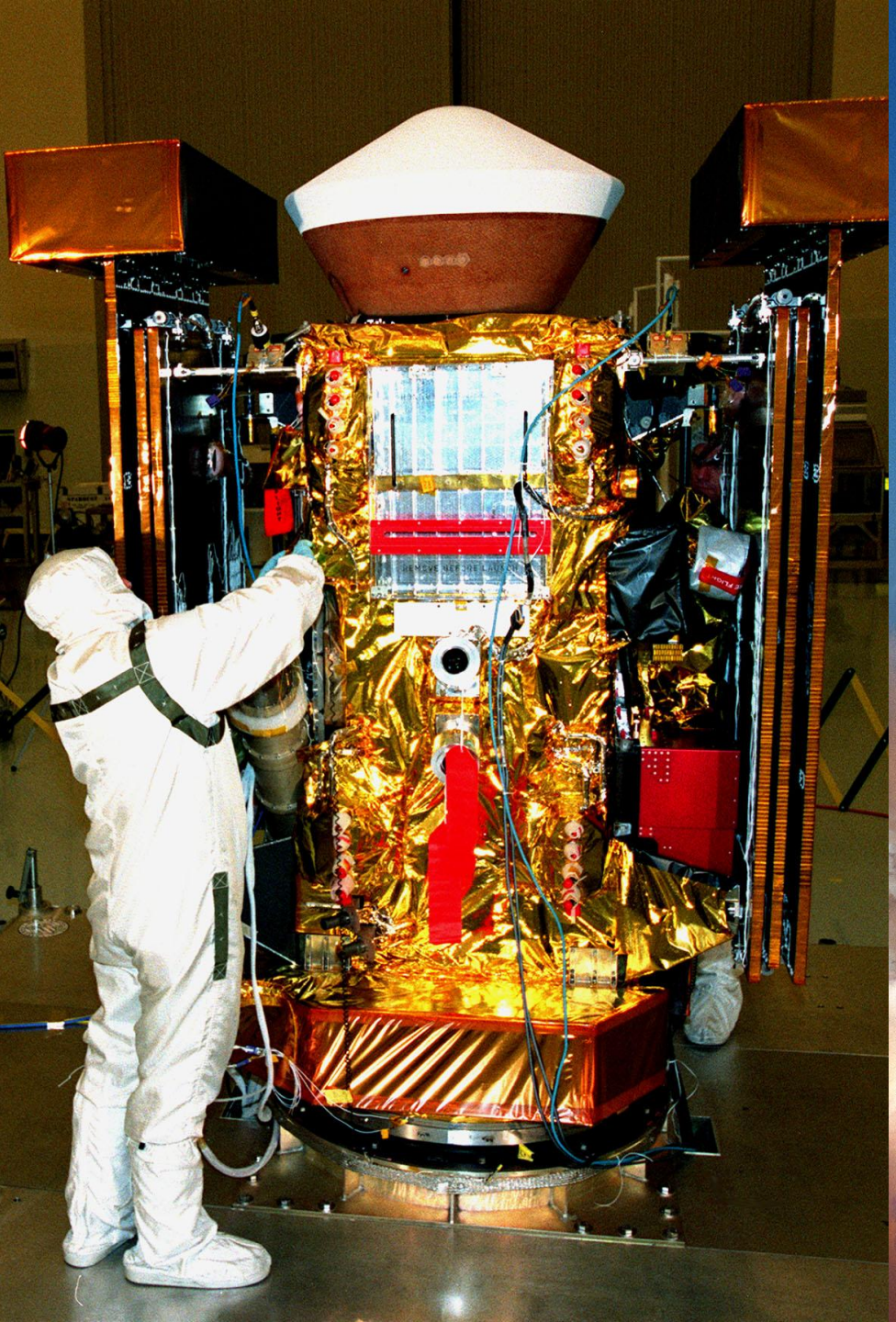



STARDUST


STARDUST


STARDUST

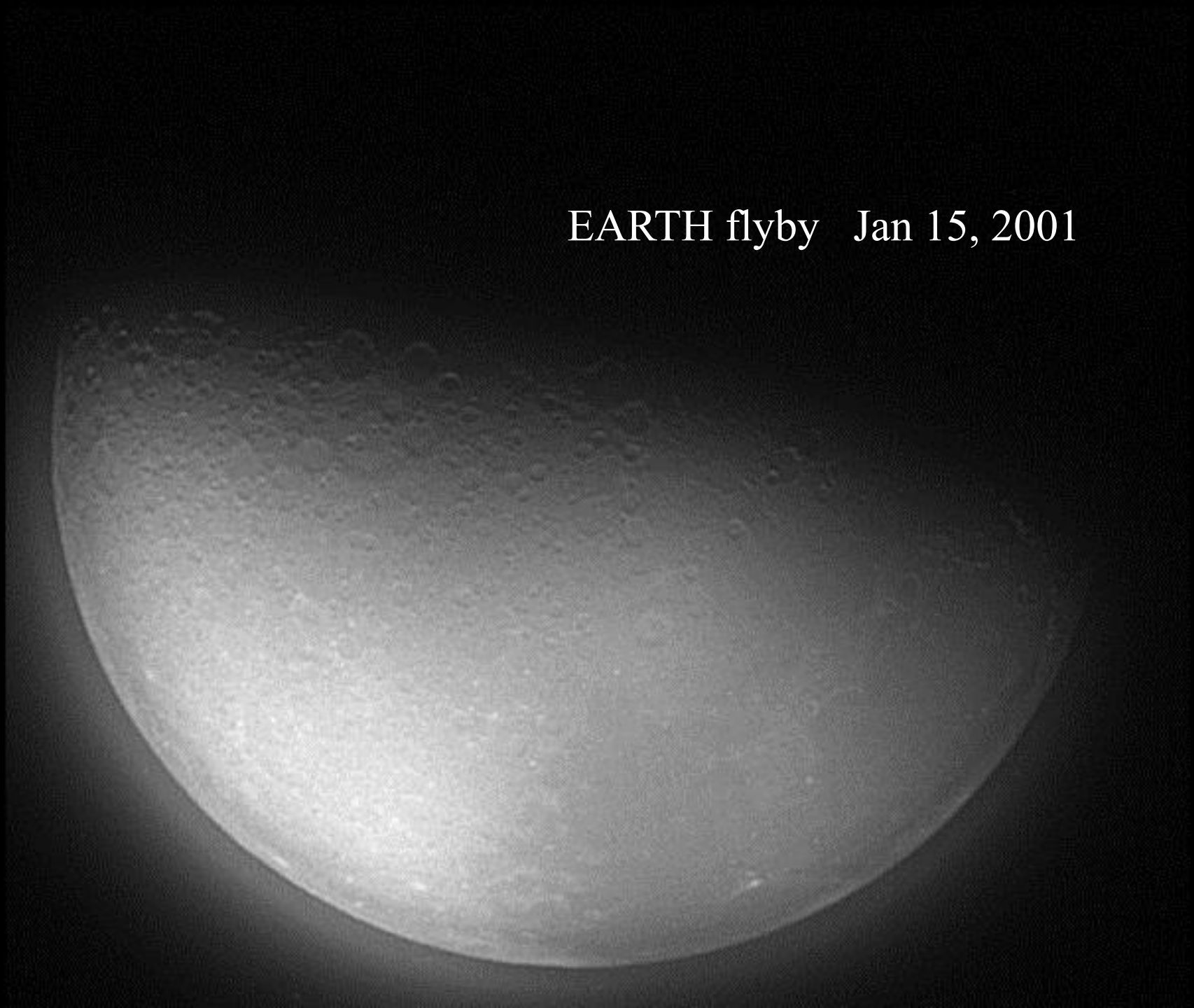
STARDUST



Launch 7 Feb 1999

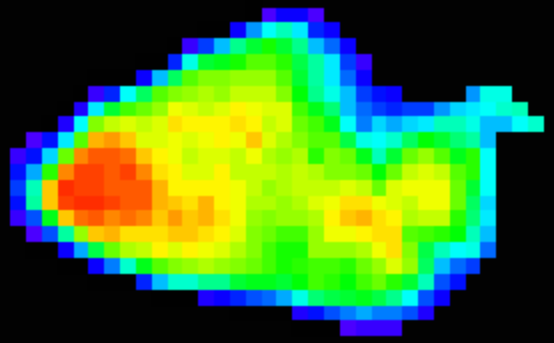
STARDUST

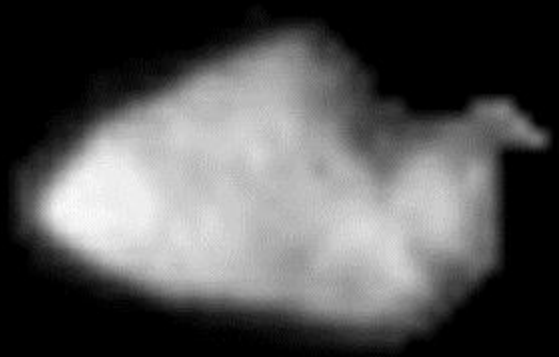
EARTH flyby Jan 15, 2001



Annefrank Flyby

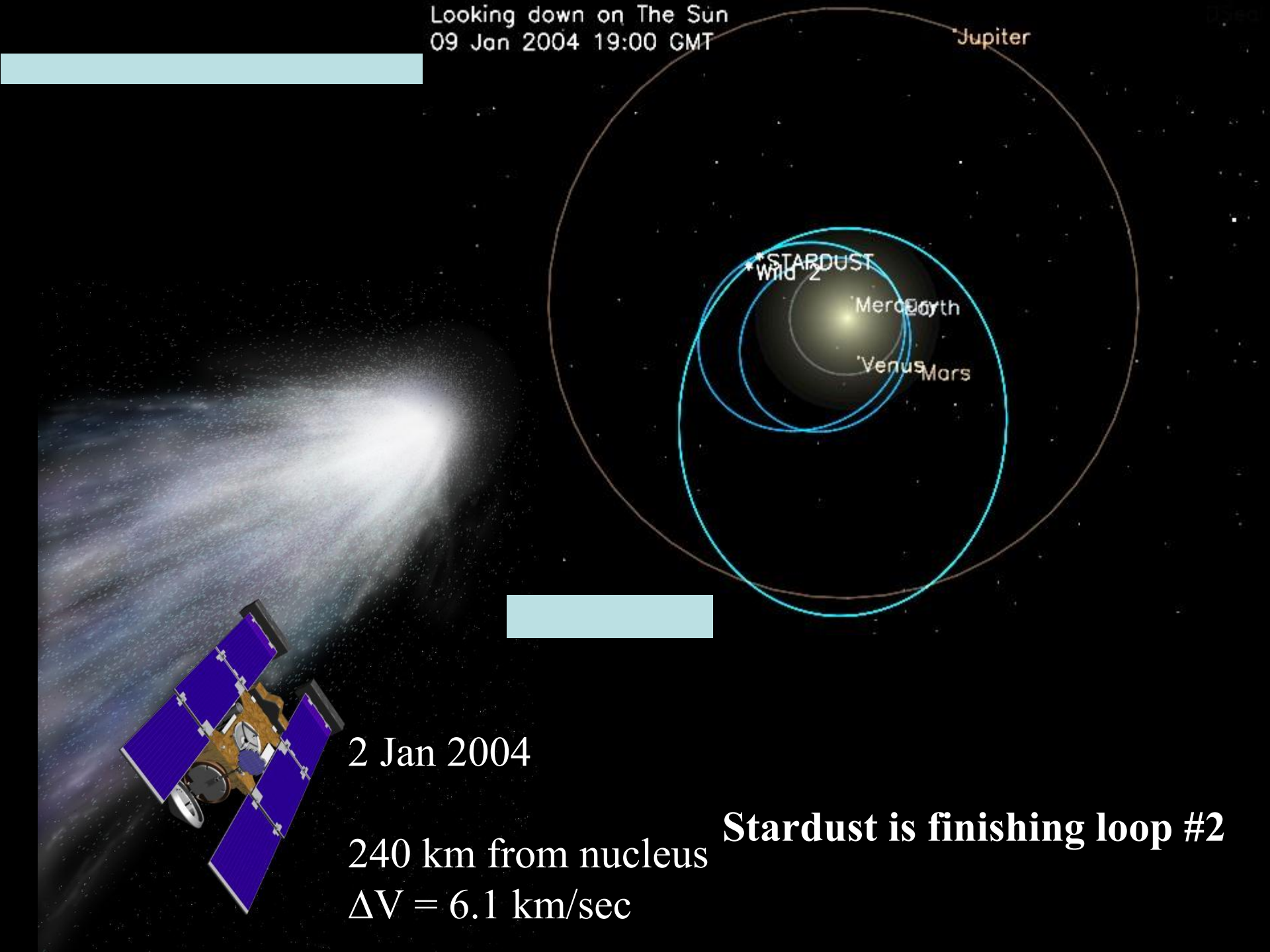
Nov 2, 2002
Asteroid 5535





3300 km from an S type asteroid

The STARDUST camera resolution was sufficient to show that Annefrank was about 8 km in length, twice the predicted size based on observations from Earth. The surface reflects about 10% to 20% of the sunlight, slightly less than predicted. A few craters many hundreds of meters are seen as well as surface brightness variations due to changes in solar illumination as well as albedo variation. These variations are exaggerated in the false color image to the left



2 Jan 2004

240 km from nucleus

$\Delta V = 6.1$ km/sec

Stardust is finishing loop #2

Comet Wild 2 is shown in this image taken by the Stardust navigation camera during the spacecraft's closest approach to the comet on January 2. The image on the left was taken within a distance of 500 kilometers (about 311 miles) of the comet's jets.

Return

15 January 2006

Let the science begin!

The End of a Long Journey….

3 billion miles
and
18 feet

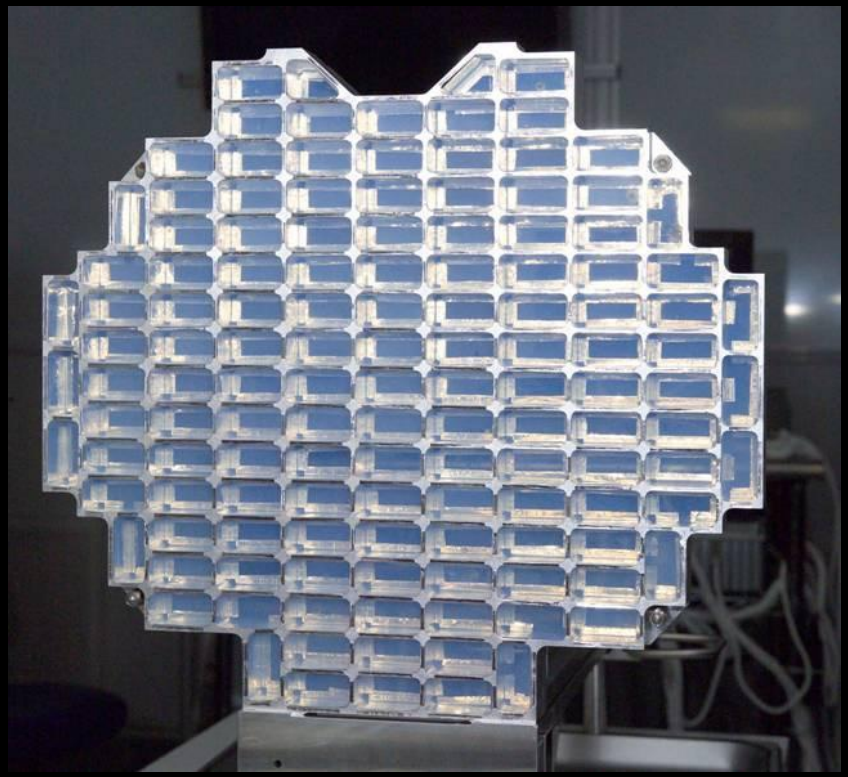
EARTH RETURN

Jan 15, 2006

Removal of the Sample Canister from the Stardust spacecraft within hours following re-entry and recovery. This task was undertaken in a special cleanroom that had been constructed in building 1012 at UTTR.

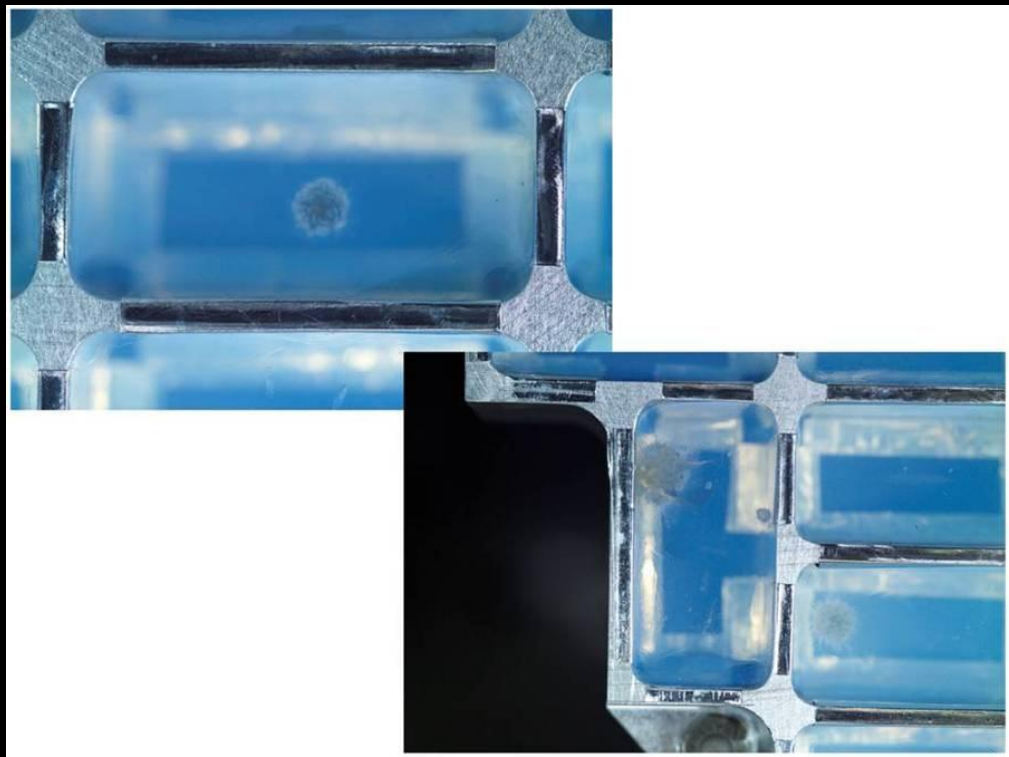
First Looks

We Have Comet Dust!

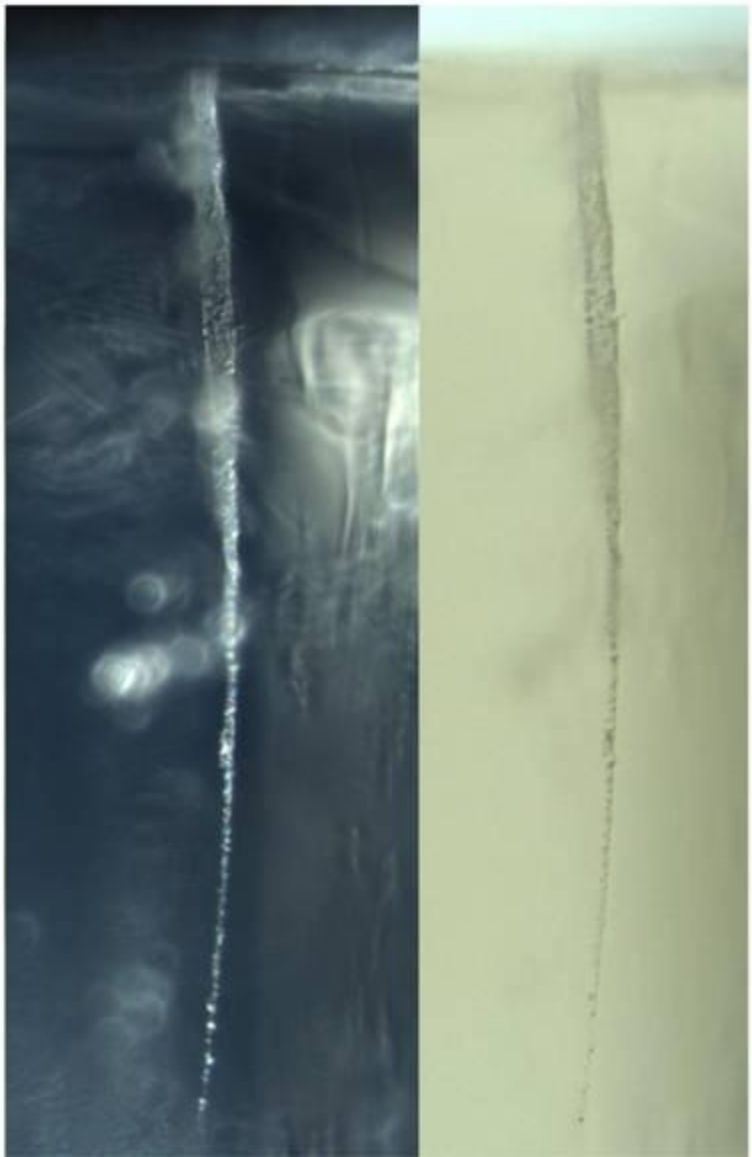


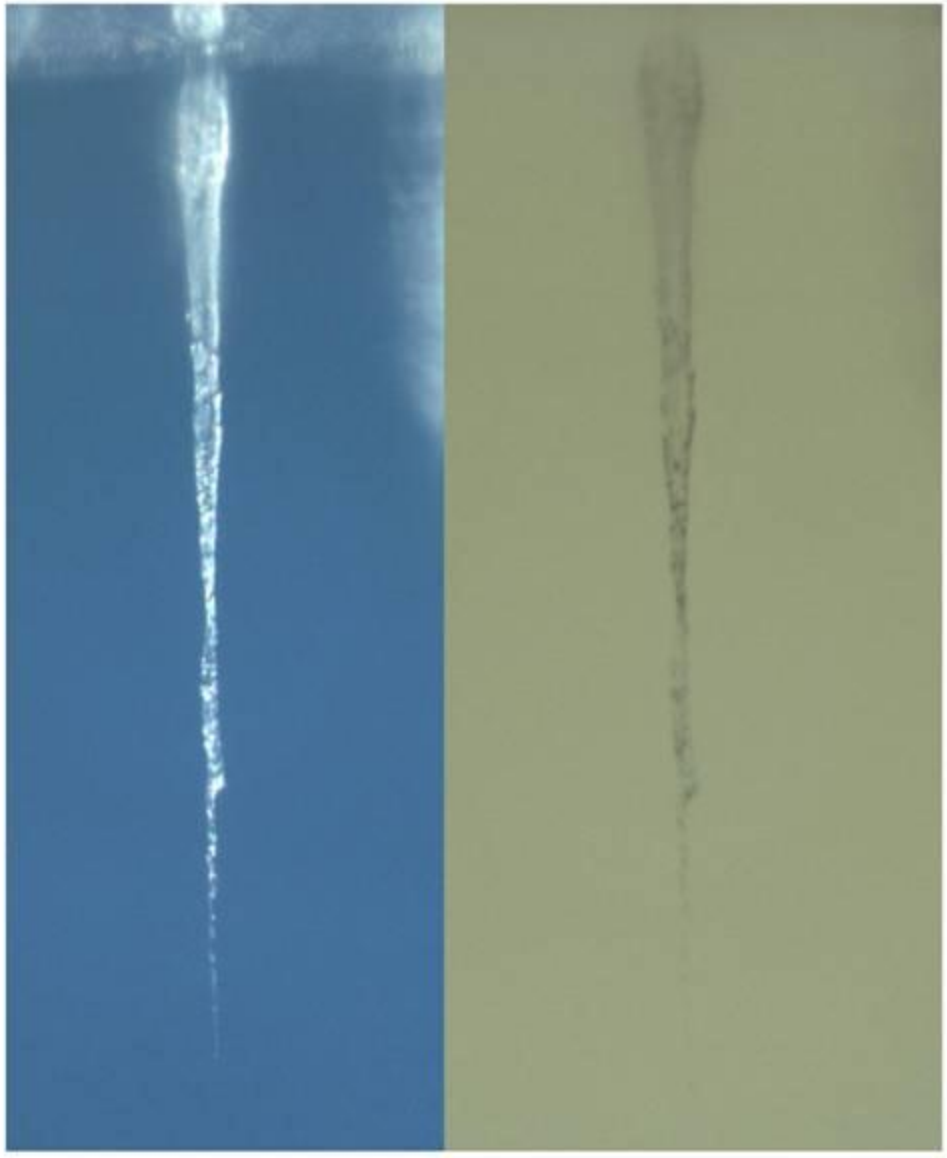
Aerogel Trays

Impacts in individual cells.



Tracks in the aerogel collectors illuminated with both lighting conditions. Each lighting method offers some advantages in examining these small tracks. The yellowish-green light source does a really nice job at showing the terminal particles at the end of the tracks and other debris scattered along the track length.





Conclusions

Genesis & Stardust are both highly successful sample return missions.

The data from Genesis & Stardust mean even more together than alone.

Genesis & Stardust directly demonstrate the scientific value of sample return missions.

Lesson Learned: Bring it home!

GODSPEED
OSISRIS-ReX!