instruments as they imaged the impact and resulting crater with visible and infrared spectral imaging; and return collected science data to Earth.

The Impactor was a fully autonomous spacecraft, capable of self navigation while observing the comet's nucleus with an optical camera as it maintained a precise collision course with Tempel 1. Onboard the Impactor was the Impactor Targeting Sensor which returned exceptional detail of the comet's surface. Much of the Impactor's substantial mass was a copper dome, or cratering mass. Copper, one of the noble metals not found in comets, was filtered out of the spectral data. The Impactor was vaporized upon impact with the comet.

Deep Impact Quick Facts

Mission Objective: To study the pristine interior of a comet by excavating a crater and analyzing spectrographic and visual image data.

Start Date: Nov. 1, 1999

Launch Date: Jan. 12, 2005

Mission Events

- Encounter date: July 4, 2005
- Impactor separation: 24 hours prior to impact
- Approach solar phase angle: 63 degrees
- Impactor approach velocity: 23,000 mph
- Flyby spacecraft closest approach to comet: 320 miles

Launch Mass: 2,249 pounds

Prime Antenna Diameter: 3.281 feet (parabolic)

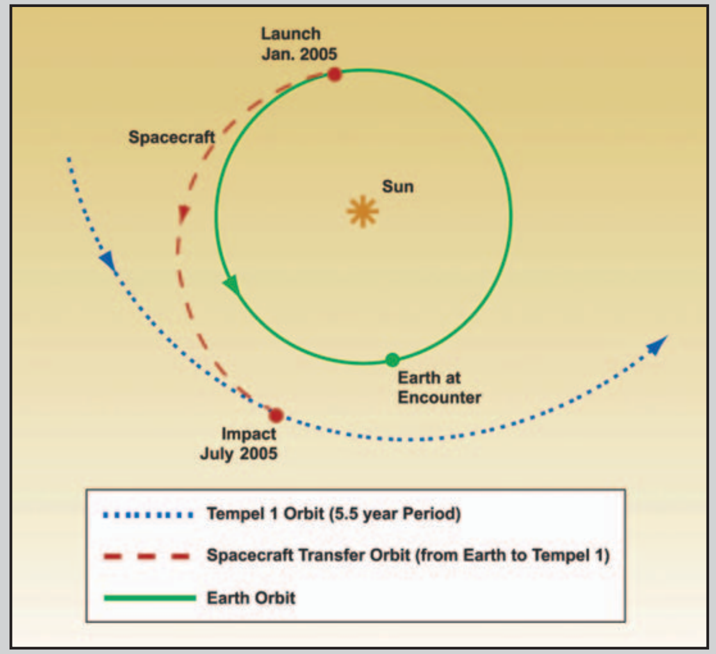
Propulsion System: blowdown hydrazine design

Communication Bandwidths:

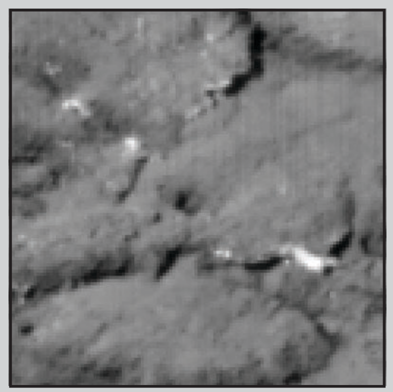
- X-band for Flyby spacecraft (uplink command and downlink telemetry)
- S-band for Impactor communication to and from the Flyby

Maximum Data Rate: 200 kbps

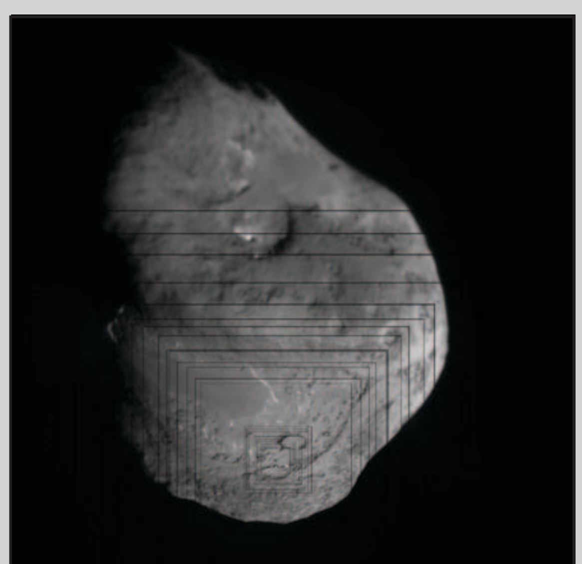
Maximum Solar Array Power: 620 watts at encounter

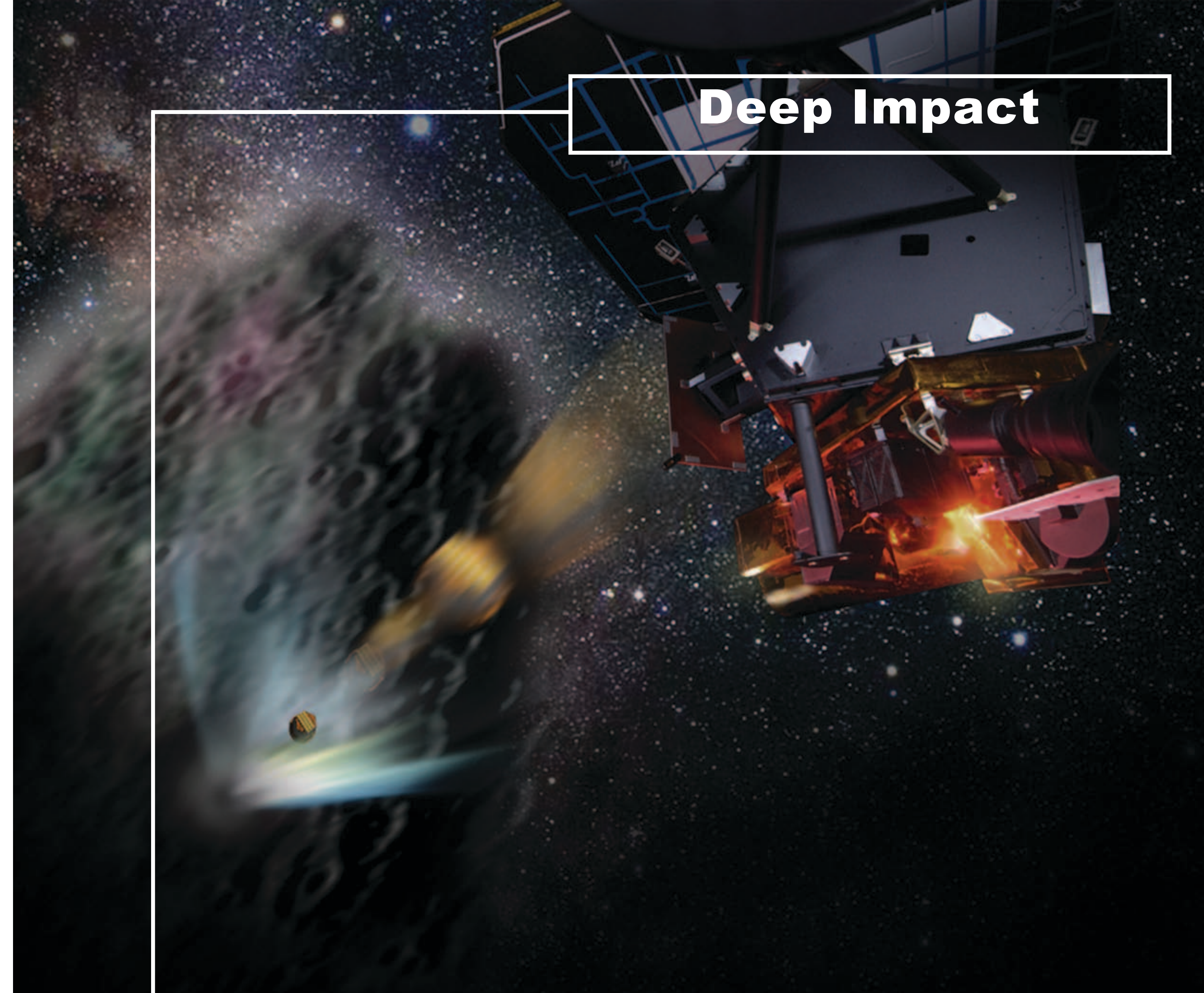


This graphic shows the sequence of mission events leading to impact with comet Tempel 1.



This image shows the view from Deep Impact's probe 30 seconds before it was pummeled by comet Tempel 1. The image was taken by the probe's impactor targeting sensor.
Image credit: NASA/JPL-Caltech/UMD





Deep Impact

Deep Impact was the eighth mission in NASA's Discovery Program and the first mission to attempt impact with a comet nucleus to probe beneath its surface. Ball Aerospace & Technologies Corp. designed and built the cutting-edge, dual-spacecraft system and the instruments that captured the collision. Impact with comet Tempel 1 occurred on July 4, 2005, and gave scientists an unprecedented view of the characteristics of comets and pristine materials inside them.

Ball Aerospace was responsible for the development of the flight system which included all hardware for the mission, except the launch vehicle. Ball Aerospace teamed with scientists, engineers and mission designers from the University of Maryland and NASA's Jet Propulsion Laboratory to design the two Deep Impact spacecraft and science instruments.

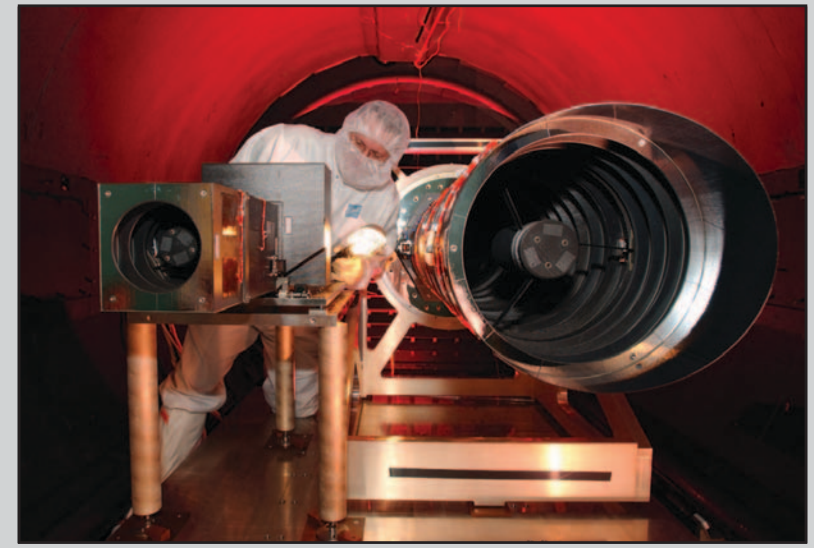
The two spacecraft — the Flyby and Impacter — launched together in January 2005 and separated 24 hours before reaching comet Tempel 1 in July. The comet's orbit was approximately 83 million miles from Earth. The Flyby spacecraft and its platform of instruments flew past the comet and recorded spectral data and images of the impact. The camera-equipped Impactor, slammed into a target site on the sunlit side of the comet at closing speeds of approximately 23,000 mph. Images were taken by the fully-autonomous Impactor up until three seconds before impact, giving scientists visual details never before seen of a comet's surface.

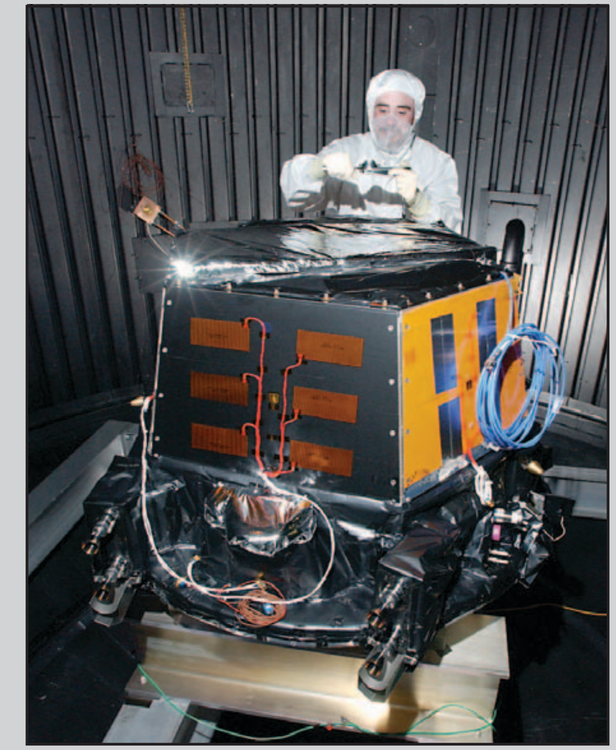
The Flyby spacecraft continued to return spectral data and images until the comet disappeared from view. During that time, the spacecraft endured the debris field in the comet's tail and emerged unscathed. The Flyby, with remaining propellant and fully-functional instruments was put into a storage orbit and awaits a second mission for NASA.

The Flyby employed the High Resolution Instrument (HRI) and the Medium Resolution Instrument (MRI). The HRI was composed of a telescope with a 30-cm (11.8 inch) aperture, and infrared spectrometer and a multi-spectral CCD camera. The HRI CCD camera was able to image the comet with less than 2-m (6 feet) per pixel resolution when the Flyby was 700 km (420 miles) away. The HRI was one of the largest instruments built for planetary science and employed technologies from the Ball Aerospace-built Wide Field Camera 3 developed for the Hubble Space Telescope.

Although most of the components on both of the spacecraft were proven on previous missions to maximize cost efficiency and minimize risk, Deep Impact was a unique mission. The Flyby spacecraft featured a high-throughput RAD750 CPU with a 1553 data bus-based avionics architecture. With it, the Flyby was able to provide telecommunications relay for the Impactor; support the

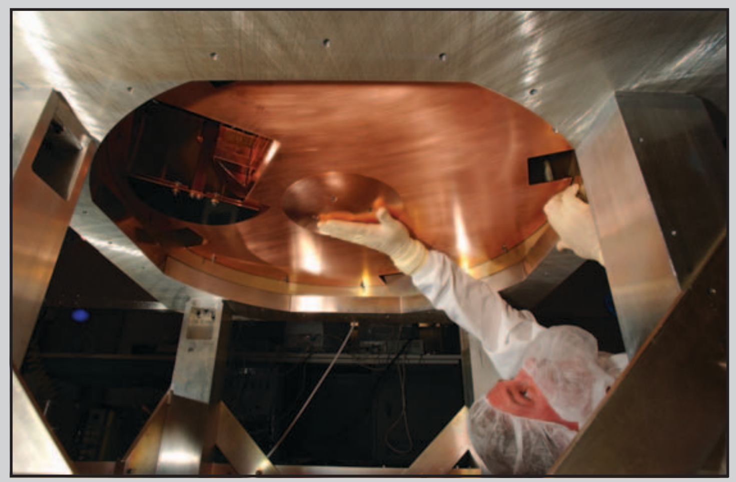
The Flyby imaged the cometary impact using the MRI (left) and the HRI (right). The HRI imaged the comet with less than 2-m (6 ft) per pixel resolution at 700 km (420 miles) away.





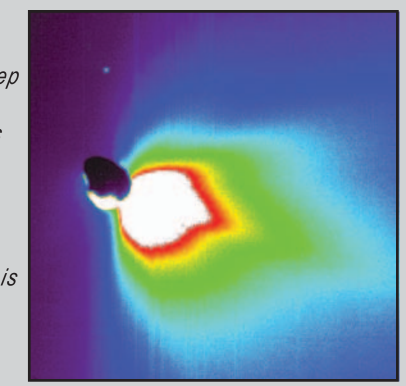
The Impactor is prepared for extensive environmental testing to prove its reliability in deep space.

The Impactor's cratering mass had to be made of a nobel metal, copper, so that it could be easily filtered out of the spectral data.



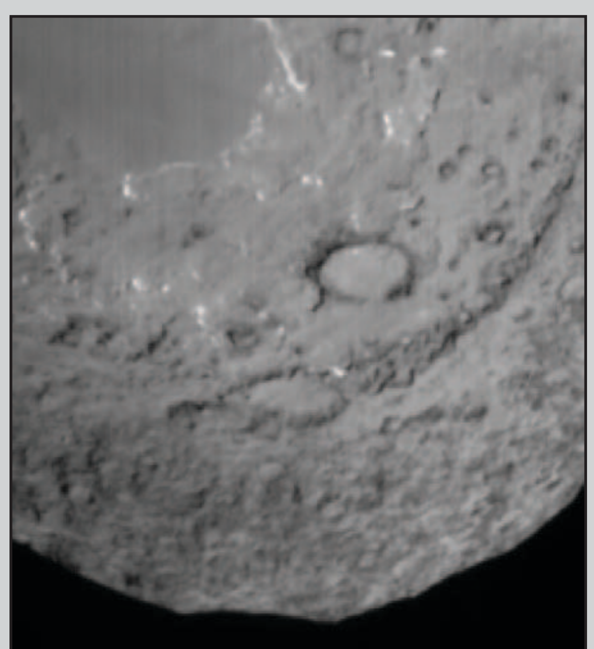
This false-color image shows comet Tempel 1 about 50 minutes after Deep Impact's probe smashed into its surface. The colors represent brightness, with white indicating the brightest materials and black showing the faintest materials. This brightness is a measure of reflected sunlight.

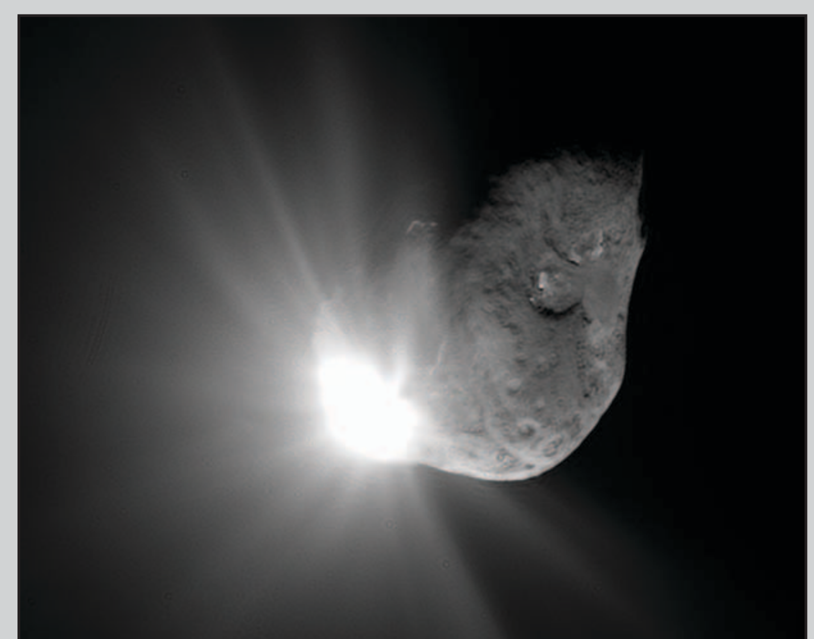
Image credit: NASA/JPL-Caltech/UMD



A "stack" procedure in Ball Aerospace's cleanroom matched both spacecraft into their launch configuration.

This image was taken by the Impactor a few seconds before its collision.





When the Impactor collided with Tempel 1, a bright, small flash was created, which rapidly expanded above the surface of the comet. This flash lasted for more than a second.

Image credit: NASA/JPL-Caltech/UMD