Chandra X-ray Observatory

Ball Aerospace & Technologies Corp. played a prominent role in the Chandra X-ray Observatory, the third of NASA's four Great Observatories. Chandra looks into the X-ray region of the electromagnetic spectrum, a region where scientists can study some of the hottest spots in the universe. Ball Aerospace built the aspect camera and the science instrument module for the TRW-built Chandra X-ray Observatory. Chandra was launched on the Space Shuttle Columbia in July 1999.

Ball Aerospace & Technologies Corp.
1600 Commerce Street
Boulder, Colorado 80301
http://www.ballaerospace.com

(303) 939-6100
Fax: (303) 939-6104
E-mail: techops@ball.com

Aspect Camera

Science Instrument Module

Ball Aerospace & Technologies Corp. is involved in all four of NASA's Great Observatories:

- Hubble Space Telescope, launched in 1990. By the fourth and final servicing mission in 2003, Ball Aerospace will have built seven science instruments for the Hubble mission. Ball Aerospace also has three standard star trackers on Hubble that have operated continuously since launch.
- Compton Gamma Ray Observatory, launched in 1991. Ball Aerospace built the Oriented Scintillation Spectrometer Experiment and two standard star trackers.
- Chandra X-ray Observatory, launched in 1999. Ball Aerospace built the aspect camera and the science instrument module.
- Space Infrared Telescope Facility, scheduled for launch in 2001. Ball Aerospace is building the cryogenic telescope assembly and two of the three science instruments.

Aspect Camera

Ball Aerospace's aspect camera is a state-of-the art star tracker that provides extremely accurate, real-time attitude information to the Chandra X-ray Observatory. This information is used to determine where in the sky Chandra is pointing and if Chandra has drifted during a typical two-hour observation.

Ball Aerospace's aspect camera also provides imaging data for *post-facto* ground processing at the Smithsonian Astrophysical Observatory's Chandra X-ray Observatory Center in Cambridge, Mass. Researchers use this data to study X-ray images of objects ranging from comets in our own solar system to quasars at the very edge of the observable universe.

The aspect camera is located near the mirrors and consists of a small telescope with a charge-coupled device focal plane, associated focal plane read-out electronics and an onboard processor that processes the focal plane data to produce star image location reports. Onboard star image locations are resolved to ≤0.8 arcsec, and *post-facto* algorithms yield ≤0.2 arcsec star location accuracies.

Science Instrument Module (SIM)

The science instrument module, or SIM, built by Ball Aerospace, is the housing that holds Chandra's two X-ray cameras. The SIM, located at the tail of the observatory, consists of two high-precision mechanisms and the related graphite structures required to support and to move Chandra's science instruments to desired positions at the focal point of the telescope. Two axes of operation are accommodated: translation and focus. The translation axis uses linear bearings and a ball screw actuator. The focus mechanism is a unique design that uses flexures as primary structure and a motor-driven actuator to support the SIM during launch and to focus it after launch.

Critical to the SIM is Ball Aerospace's thermal design that keeps one of the cameras extremely cold, about -185 °F, and one of the cameras near room temperature, about 60 °F. This dual-temperature environment is important because the two cameras have different X-ray sensing elements with optimum performance at different temperatures.