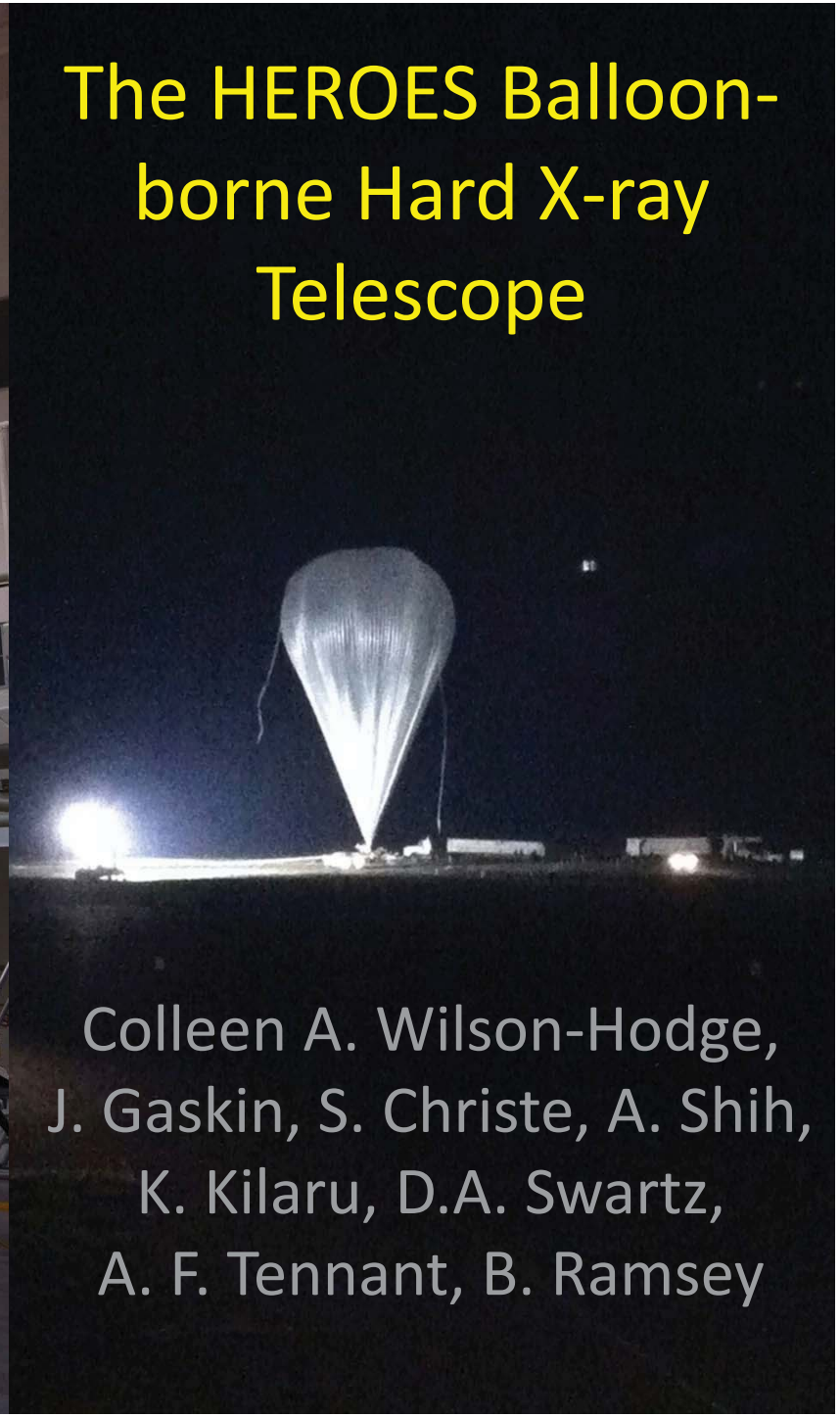
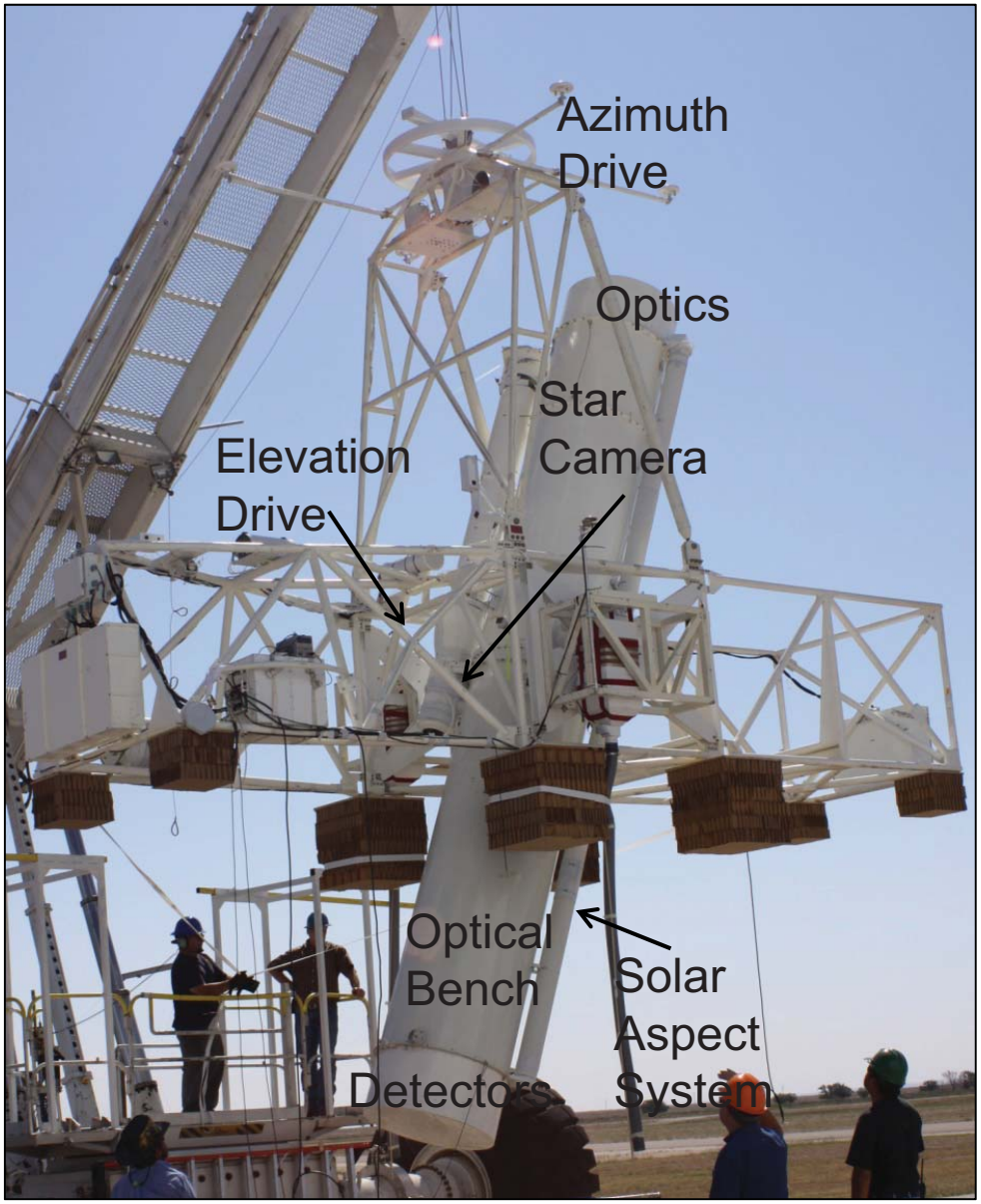
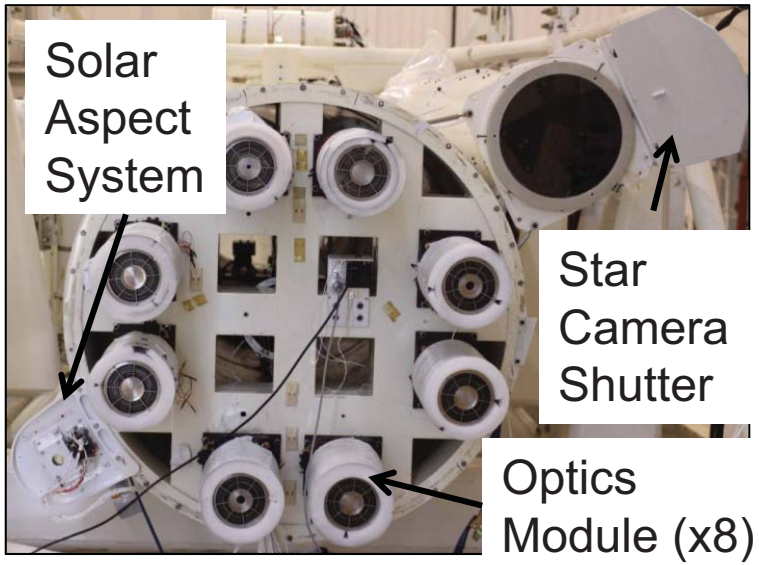
The HEROES Balloon-borne Hard X-ray Telescope

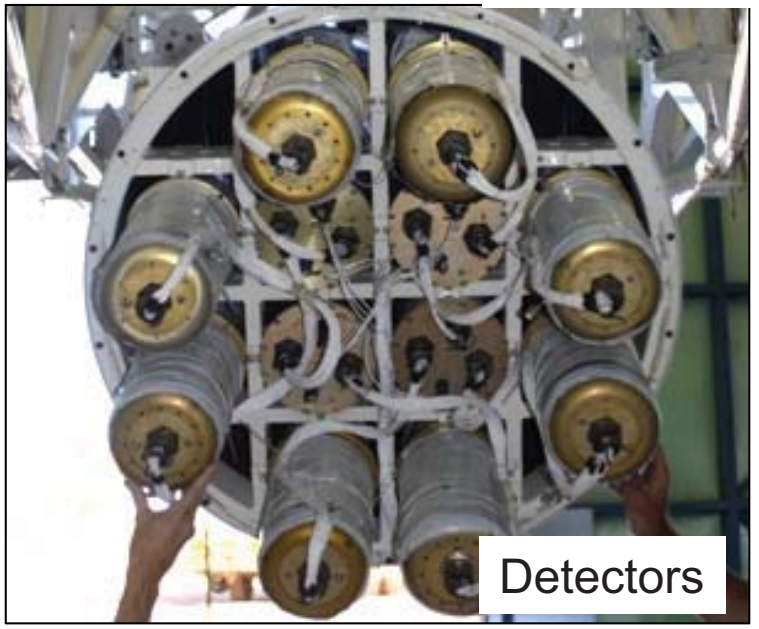


Colleen A. Wilson-Hodge, J. Gaskin, S. Christe, A. Shih, K. Kilaru, D.A. Swartz, A. F. Tennant, B. Ramsey

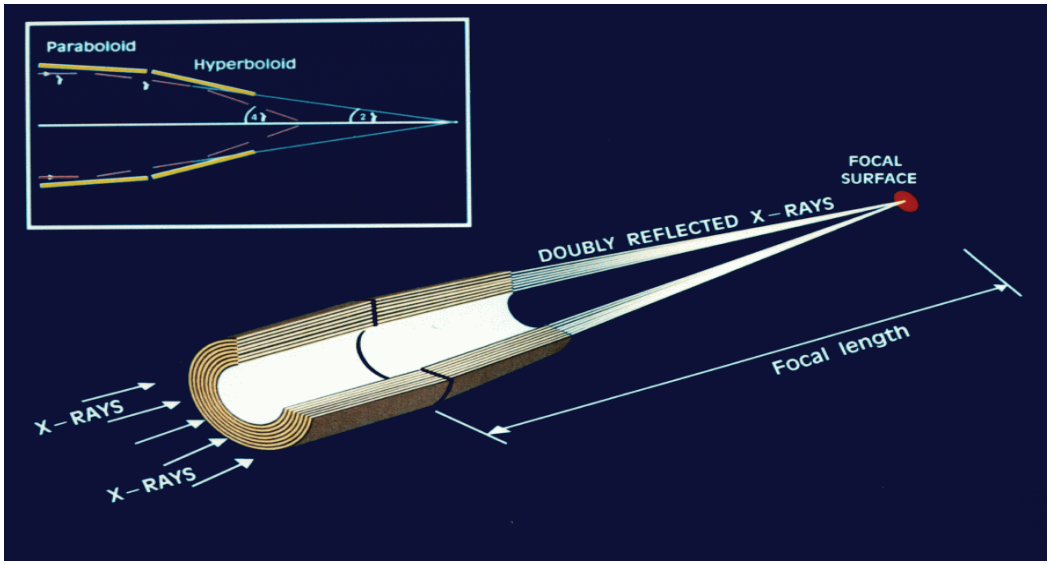
HEROES - Astrophysics Meets Solar







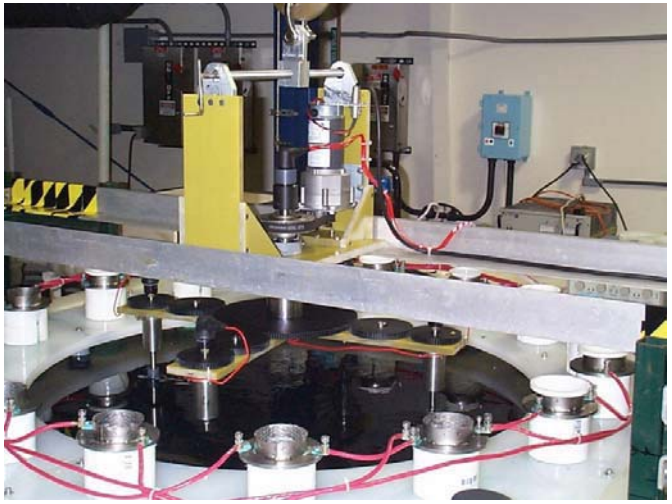
Grazing Incidence Optics

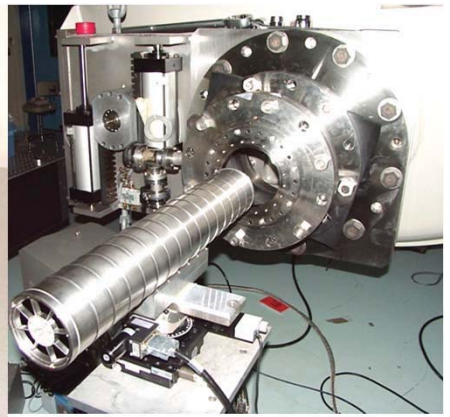


HEROES hard X-ray optics are full-shell electroformed-nickel-replicated (ENR) mirrors coated with iridium to enhance high-energy reflectivity.

They are conical approximations to Wolter Type 1 geometry, with a monolithic shell structure containing both “parabolic” and “hyperbolic” segments.

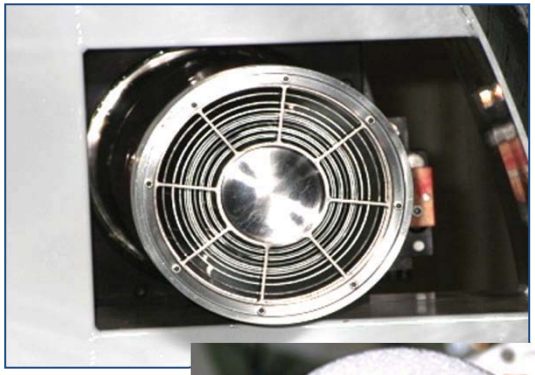
* Developed in-house at MSFC

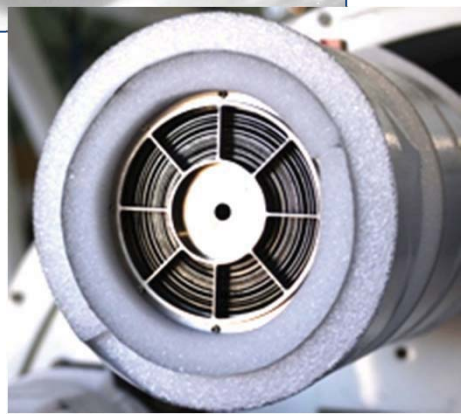


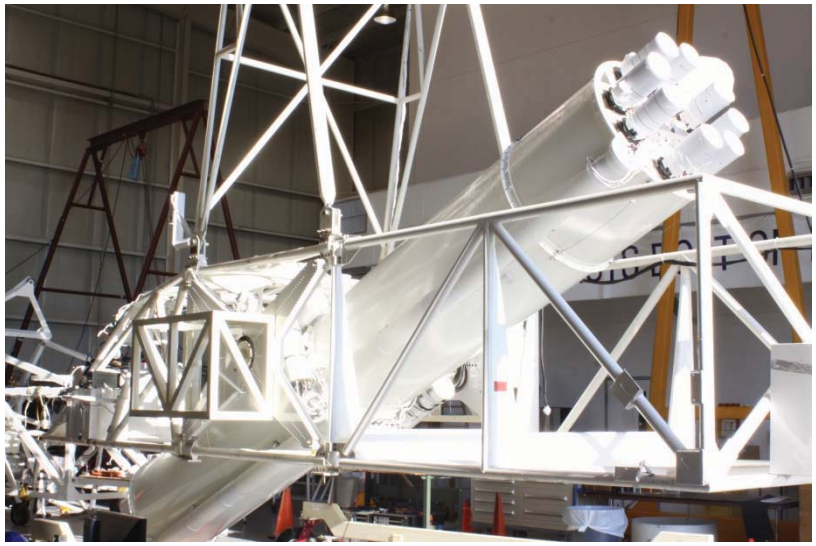


HEROES Optics

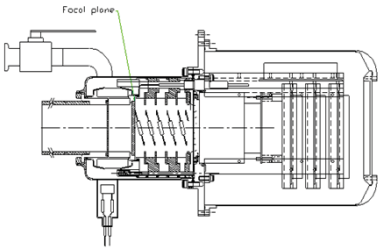
Mirror shells per module	14 (6 mod), 13 (2 mod)
Inner, outer shell diameters	50, 94 mm
Total shell length	610 mm
Focal length	6 m
Coating	Sputtered iridium, ~ 20 nm thick
Number of mirror modules	8
Effective area	~ 85 cm^2 at 40 keV, ~ 40 cm^2 at 60 keV
Angular resolution (module)	~25-30 arcsec FWHM
Field of View	9 arcmin at 40 keV 5 arcmin at 60 keV







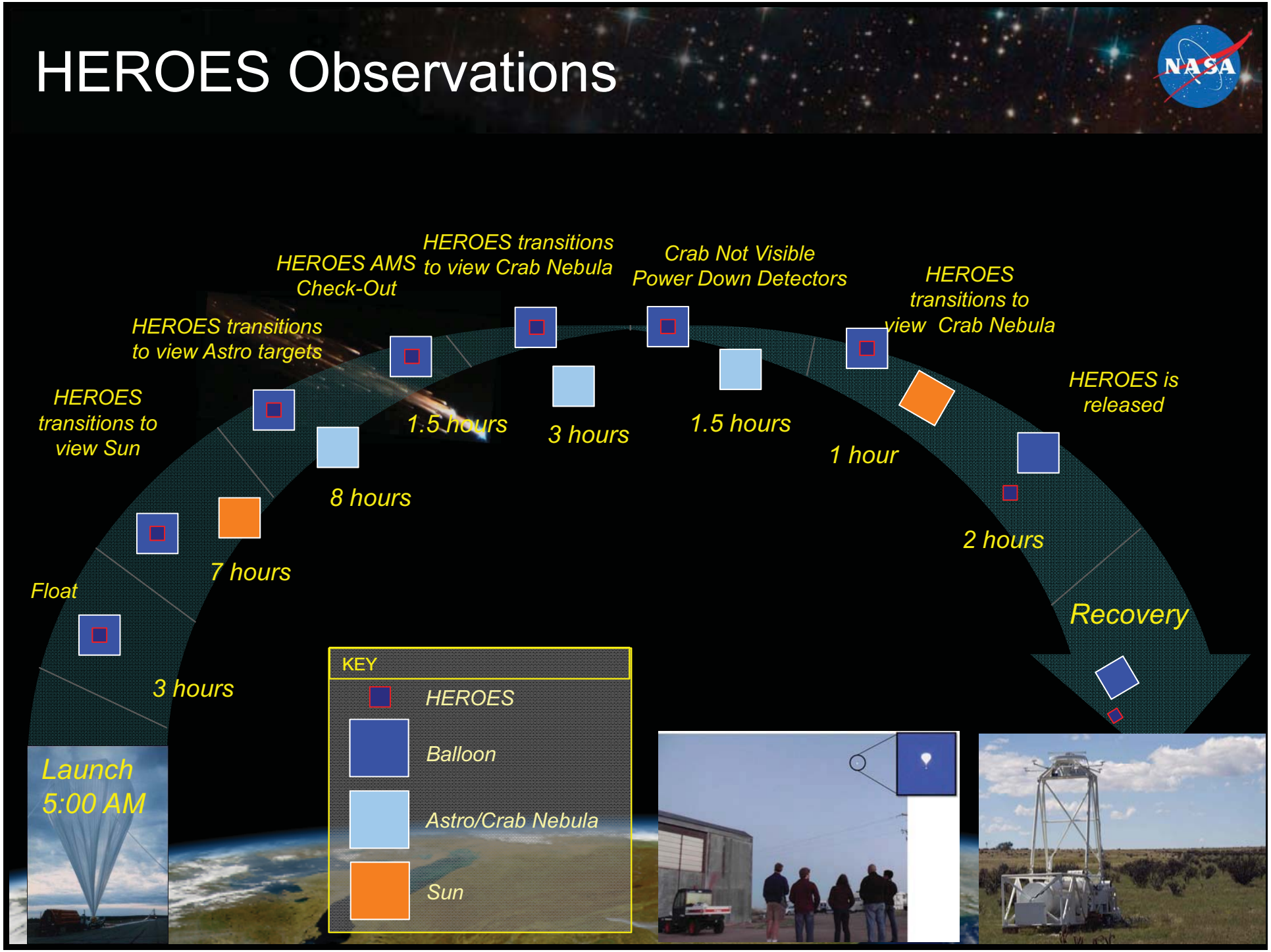
HEROES Detectors



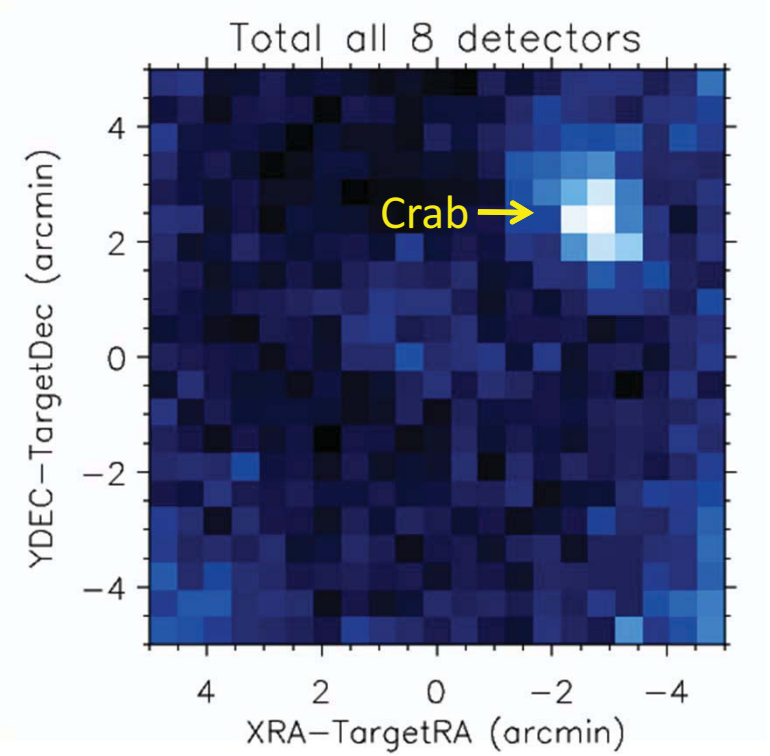
- **Imaging Gas Scintillation Proportional Counters**

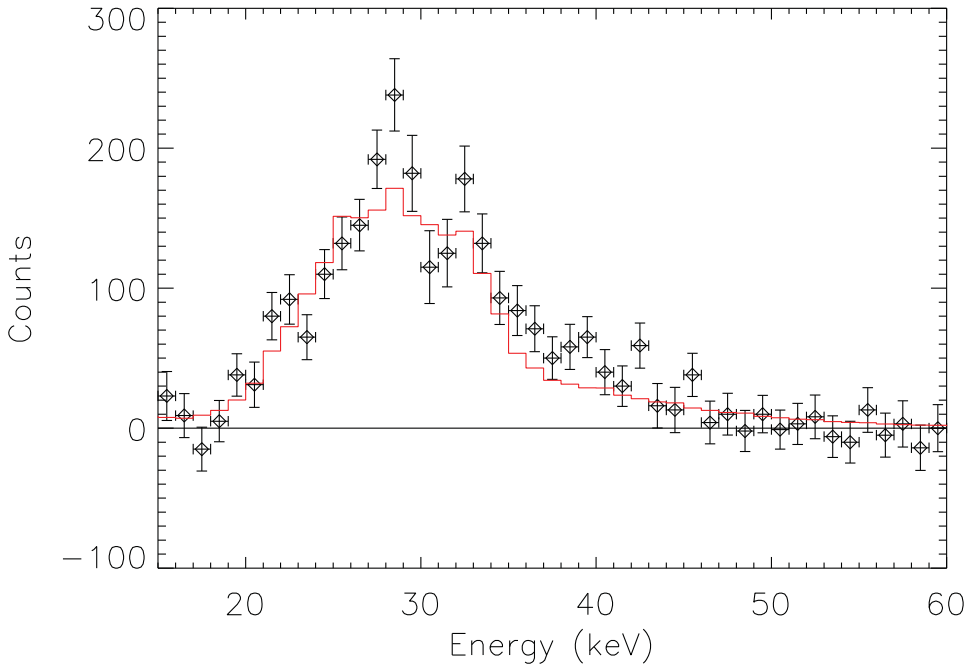
Total Sensitive Area	Approximately 20 cm^2
Fill Gas	56 mm of Xenon + Helium (96/4) at 10^6 Pa
Entrance Window	3.2 mm Be
Light Emitting Region	4 mm deep
Exit Window	7 mm Sprasil
Phototube	Hammamatsu 4268, position sensitive, quartz window
Quantum Efficiency	99% @ 40 keV 89% @ 60 keV
Energy Resolution (FWHM)	5% @ 30 keV 3% @ 60 keV
Position Resolution (FWHM)	420 um (15-25 keV) 330 um (25-35 keV) 400 um (35-35 keV)

HEROES Observations



HEROES Astrophysics Analysis - Crab

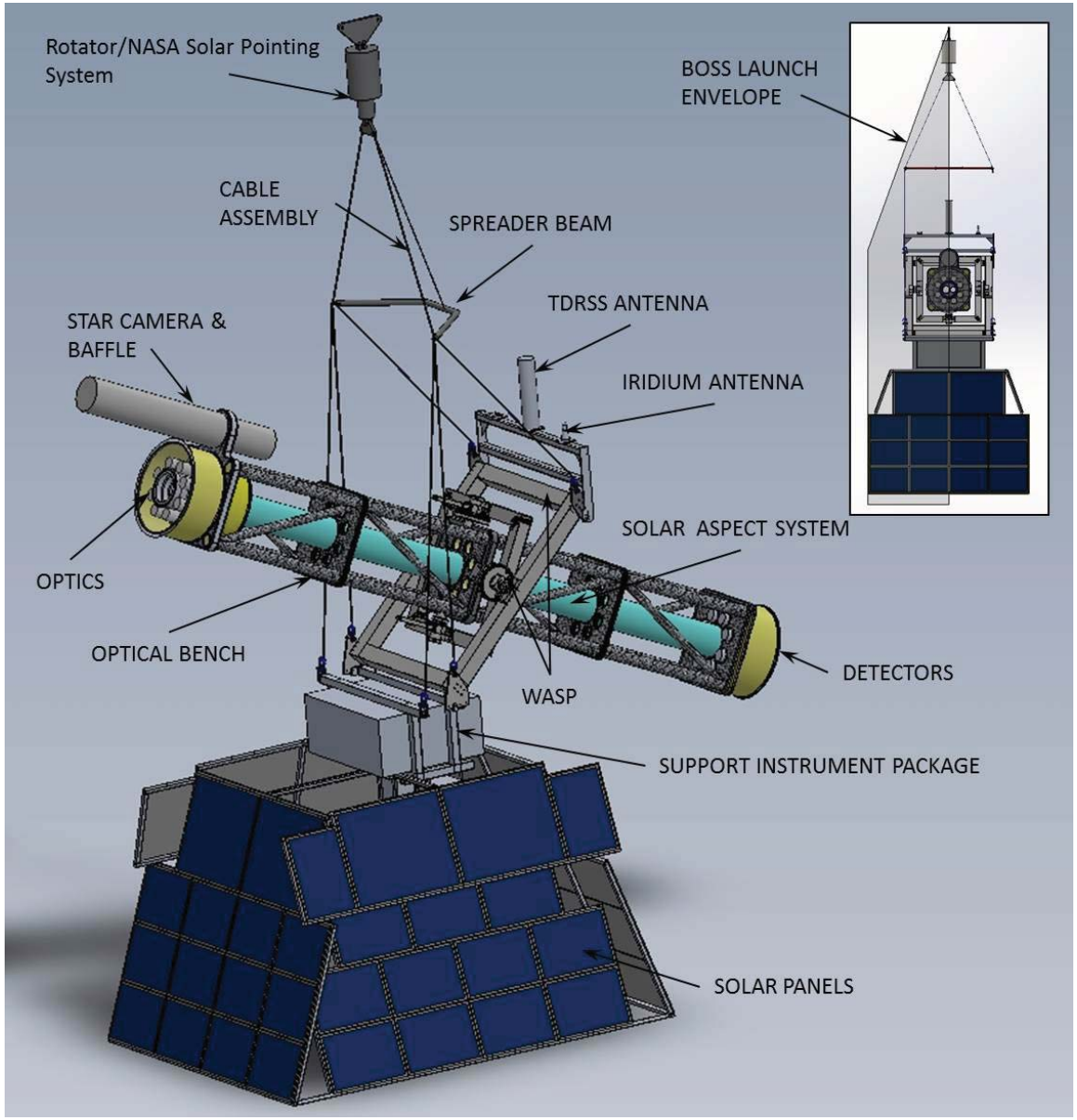




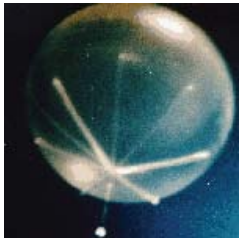
- The Crab Nebula was observed for 3 hours
- It was detected about 4’ off-axis
- Spectrum is consistent with expected values
- Star camera misalignment with rising elevation found in post-flight testing

MSFC & GSFC

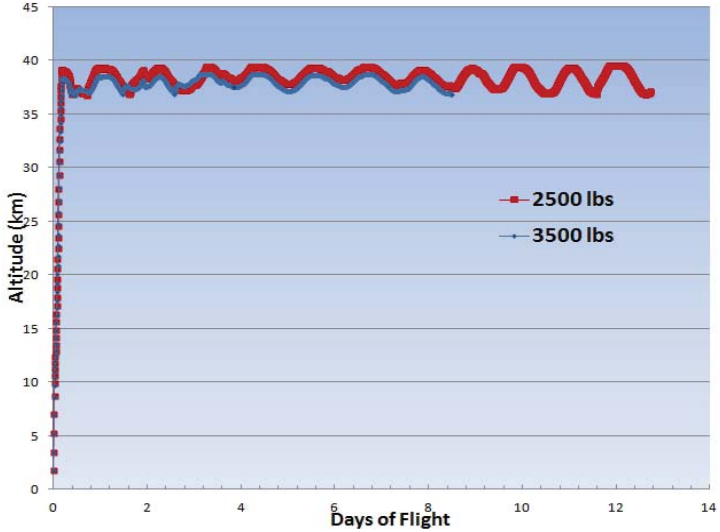
SuperHERO – LDB Payload (See Poster)



LDB flights can last more than three weeks, offering improved sensitivity over the HEROES payload. However, a complete redesign of the payload is necessary.



- Mass Minimization
- Power (Solar Panels)
- Thermal Analyses
- Flight Profiles

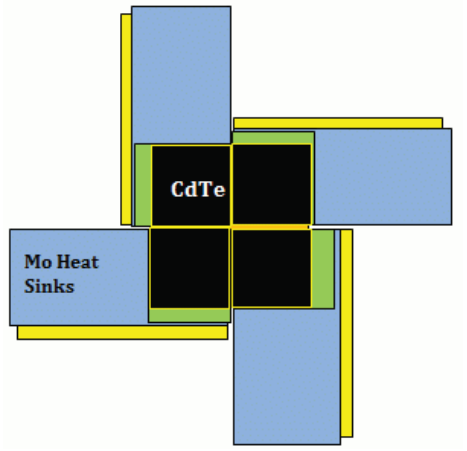


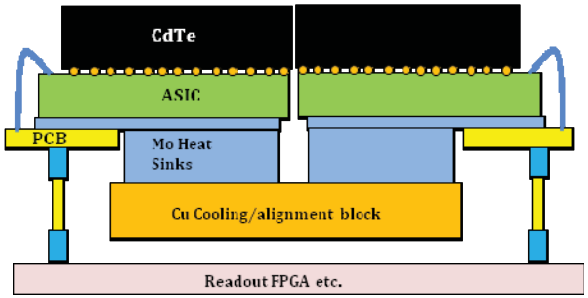
New detectors

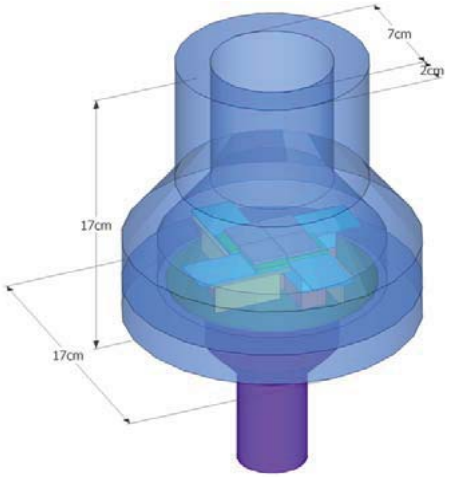
Rutherford Appleton Laboratory (RAL)
CdTe Many Pixel Detectors

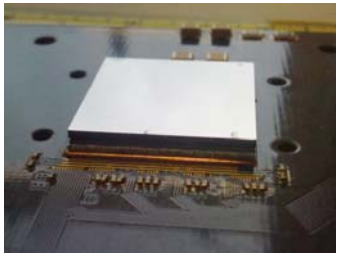
Detectors	HEXITEC (CdTe)	NuSTAR (CdZnTe)
Spatial Resolution	250 µm	600 µm
Energy Resolution	1.3 % @ 60 keV	1.3 % @ 68 keV
Size (2x2 detector array)	~4 x 4 cm	~3.84 x 3.84 cm
Pixels	160 x 160	64 x 64
Max. Count Rate	~2.5M counts s^{-1} cm^{-2}	~3000 counts s^{-1} cm^{-2}

[¥]Harrison, F., et al. [2013] *ApJ*, **770**, 103









These detectors allow for improved spatial resolution, response and background rejection when coupled with active shielding.

•RAL's detectors will provide a complete telescope suitable for Explorer mission opportunities.

•Cooling schemes have been explored for optimal performance (and also to minimize power)