SuperHERO: The Next Generation Hard X-Ray HEROES Telescope

Colleen A. Wilson-Hodge1, Jessica A. Gaskin1, Steven D. Christie2, Ronald F. Elsner1, Brian D. Ramsey1, Paul Seller3, Albert Y. Shih2, David W. Stuchlik4, Douglas A. Swartz5, Allyn F. Tenant1, Matthew D. Wilson3

1 NASA Marshall Space Flight Center, Huntsville, AL 35811; 2 NASA Goddard Space Flight Center, 8800 Greenbelt Rd, Greenbelt, MD 20771; 3 Science and Technology Facilities Council, Rutherford Appleton Laboratory, Harwell Campus, Oxfordshire, OX11 0QX, U.K.; 4 NASA Wallops Flight Facility, Code 820, Wallops Island, VA 23337; 5 Universities Space Research Association, Science and Technology Institute, 320 Sparkman Dr., Huntsville, AL 35805

ABSTRACT

SuperHERO is a new high-resolution Long Duration Balloon-borne Hard X-ray HEROES Telescope. The SuperHERO payload, currently in its proposal phase, is being developed jointly by the Astrophysics Office at NASA Marshall Space Flight Center, the Solar Physics Laboratory and the Wallops Flight Facility at NASA Goddard Space Flight Center. SuperHERO is a follow-on payload to the High Energy Replicated Optics to Explore the Sun (HEROES) balloon-borne telescope that recently launched from Fort Sumner, NM in September of 2013, and will utilize many of the same features. Significant enhancements to the HEROES payload will be made, including the addition of optics, novel solid-state multi-pixel CdTe detectors, integration of the Wallops Arc-Second Pointer and a significantly lighter gondola suitable for a Long Duration Flight.

### Astrophysics Goals

- Characterize spatial and spectral emission of a pulsar wind nebula.
- Investigate the mode of high energy processes in a pulsar wind nebula.
- Investigate the hard X-ray emission of a pulsar with a possible secondary component.
- Follow-up NuSTAR observations.

### Improvement over HEROES

- Long Duration Flight for significantly improved sensitivity
- New Baffle with Improved Alignment and Mounting
- Add more optics for increased effective area
- New Gimbals and Mounting system
- Improved detector performance
- Improved thermal design
- Improved pointing accuracy

### Solar Science Goals

- Determine the presence of energetic electrons in the non-flaring solar corona.
- Add more optics for increased effective area.
- Determine the role of energetic electrons in solar flares.
- Investigate the scale of high energy processes in a pulsar wind nebula.
- Investigate the hard X-ray properties of astrophysical targets such as X-ray binaries and active galactic nuclei.

### Long Duration Balloon (LDB) Mission

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

### Added Optics With Improved Alignment and Mounting

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>HEROES</th>
<th>SuperHERO</th>
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<tbody>
<tr>
<td>Detector Type</td>
<td>CdTe</td>
<td>CdTe</td>
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<tr>
<td>Pixel Size</td>
<td>250μm</td>
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<tr>
<td>Energy Channel</td>
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<td>Plate Scale</td>
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<td>Mirror Coating</td>
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<tr>
<td>Processing Rate</td>
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<td>400 events/s</td>
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<tr>
<td>On-axis geometric resolution</td>
<td>25 arcsec</td>
<td>25 arcsec</td>
</tr>
<tr>
<td>Angular resolution</td>
<td>25 arcsec (1 arcsec, 6 arcsec)</td>
<td>25 arcsec (1 arcsec, 6 arcsec)</td>
</tr>
</tbody>
</table>

### Solar Aspect System (SAS)

- Provides improved pointing knowledge
- SAS can provide improved pointing solutions to the Pointing Control System (PCS) (roll is not controlled, only measured)
- SAS can store pointing knowledge (pitch, yaw, roll) for post-processing range enhancement

### Astrophysics Aspect System - Star Camera, Baffle & Shutter

- New Baffle is only 2 feet long, allowing for direct mounting on the optical bench.
- New Cabin software has been improved (bugs seen on previous missions have been found and eliminated).
- Star Camera shutter has been added for solar observations.

### Wallops Arc Second Pointer (WASP)

- Orthogonal pair of pitch & yaw gimbals for fine motion
- Star flights use pair (~1 arcsecond pointing, experiment with lab tests)
- WASP can accommodate a telescope that is 6-7 feet long and 1m in diameter, maybe larger
- Can allow for both astrophysical and solar pointing

### Rutherford Appleton Laboratory (RAL)

- CfTe Many Pixel Detectors
- Three different sizes for improved spatial resolution and performance in background and energy response.
- RAL detector will provide a complete telescope suitable for Explorer mission opportunities
- Cooling schemes have been explored for optimal performance (and also to minimize pointing).