WFIRST & AFTA Update

Neil Gehrels (GSFC)  
SDT Co-Chair

David Spergel (Princeton)  
SDT Co-Chair

AAAC
November 30, 2012
WFIRST Summary

- WFIRST is the highest ranked large space mission in 2010 US Decadal Survey
  - dark energy
  - exoplanet microlensing and coronagraphy
  - NIR sky for the community (GI program)

- Measurements:
  - NIR sky surveys for BAO & weak lensing
  - NIR monitoring for SNe & microlensing
  - Option coronagraph for exoplanet imaging

- Enabled by US-developed large format HgCdTe detectors
WFIRST Activities

WFIRST
• 2010: WFIRST ranked 1st in large mission category by Astro2010
• 2011: Science Definition Team #1 formed to study WFIRST
• 2011: Nobel prize for acceleration of universe
• 2011: Free-floating planets detected by ground microlensing
• 2012: WFIRST science conference at Caltech (February)
• 2012: SDT #1 final report: arXiv 1208:4012

AFTA-WFIRST
• 2012 NASA announces receipt of two 2.4m telescopes (June)
• 2012 Ad-hoc science group considers applicability for WFIRST science
  - white paper: arXiv 1210.7809
• 2012 WFIRST-AFTA science conference at Princeton (September)
• 2012 SDT #2 formed to study using 2.4m telescope for WFIRST science
  - working with Project team at Goddard and JPL

Program to package & characterize HgCdTe IR detectors (govt, industry, academia)
Two 2.46 m telescopes have been transferred to NASA:

- Designed as a TMA system but tertiary mirror is not applicable for science mission
- Primary mirror is f/1.2, on 6-axis system
- Compact design is similar to the dynamic test unit shown here
- Thermal control heaters are already on the shell
- 6 struts position the secondary mirror
- 6 actuators at the base of the SM struts
- 1 focus actuator on the SMA for fine focus
- Long struts to spacecraft bus provide approximately 1.5m of available space for aft optics, instruments, etc.
SDT Charter

- Determine science requirements and key mission parameters
- Work with Project office to develop a Design Reference Mission using one of the 2.4m telescope assets
- Use telescope "as is"
- Maintain the technical viability for a 2022 launch
- Incorporate modularity in design and attach points to facilitate on-orbit servicing and I&V testing. Consider GEO orbit.
- Keep overall mission cost as low as possible
- Study including a coronagraph instrument as an option
- Study utilizing optical communication as an option
Design Concepts

- **DRM1**
  - 1.3 meter off-axis telescope
  - Single channel payload
  - 5 year mission
  - Atlas V Launch Vehicle

- **DRM2**
  - 1.1 meter off-axis telescope
  - Single channel payload
  - 3 year mission
  - Falcon9 Launch Vehicle

- **AFTA-WFIRST**
  - 2.4 meter on-axis telescope
  - 1-channel payload + coronagraph
  - 5 year mission
  - Falcon9 or Atlas V Launch Vehicle
Design Concepts

- 2.4 meter on-axis telescope
- 1-channel payload + coronagraph
- 5 year mission
- Falcone9 or Atlas V Launch Vehicle
Field of View

6x3 H4RG @ 0.11”/p, 0.28 sq.deg

0.425 wide°

0.874°

JWST [all instruments]

HST [all instruments]

Moon (average size seen from Earth)
CANDELS fields on DRM1 focal plane from J. Kruk
Advantages of 2.4m Telescope

- All configurations studied have excellent science performance relative to Astro2010 goals:
  - DRM 1: Astro2010 prescription
  - DRM2: Low cost, but capable due to larger pixel count

- Gift telescope at no cost to NASA.

- Existing hardware.

- Telescope PSF is factor of 1.8 – 2.2 better than DRM 1 & 2
  - Angular resolution scales at $\sim \lambda / D$
  - Enables optional coronagraph

- Larger mirror gives factor $\sim 2$ better sensitivity (0.8 mag deeper)
## Near IR Capabilities

<table>
<thead>
<tr>
<th>instrument</th>
<th>telescope</th>
<th>pixel scale</th>
<th>field of view</th>
<th>wavelength</th>
</tr>
</thead>
<tbody>
<tr>
<td>WISE</td>
<td>0.4m</td>
<td>2.75 arcsec</td>
<td>47 arcmin</td>
<td>3 – 28 µm</td>
</tr>
<tr>
<td>ISO</td>
<td>0.6m</td>
<td>12 arcsec</td>
<td>3 arcmin</td>
<td>2.4 – 240 µm</td>
</tr>
<tr>
<td>Akari</td>
<td>0.7m</td>
<td>1.5 arcsec</td>
<td>10 arcmin</td>
<td>1.8 – 180 µm</td>
</tr>
<tr>
<td>Spitzer</td>
<td>0.85m</td>
<td>1.2 arcsec</td>
<td>5.2 arcmin</td>
<td>3 – 8 µm</td>
</tr>
<tr>
<td>Hubble/NICMOS</td>
<td>2.4m</td>
<td>0.04 – 0.20 arcsec</td>
<td>0.2 – 0.9 arcmin</td>
<td>0.8 – 2.5µm</td>
</tr>
<tr>
<td>Hubble/WFC3 IR</td>
<td>2.4m</td>
<td>0.13 arcsec</td>
<td>2 arcmin</td>
<td>0.9 – 1.7 µm</td>
</tr>
<tr>
<td><strong>AFTA-WFIRST</strong></td>
<td>2.4m</td>
<td>0.11 arcsec</td>
<td>25 x 52 arcmin</td>
<td>1.0 – 2.0 µm</td>
</tr>
</tbody>
</table>
WFIRST provides a factor of 100 improvement in IR surveys
Coronagraph Science

from J. Kasdin

Adapted from Mawet et al. 2012
• SDT Meetings
  • Nov 19-20, 2012  GSFC
  • Jan 10-12, 2013  JPL / Caltech
  • Mar 14-15, 2013  GSFC
  • plus weekly telecons

• Report due April 30, 2013

• Independent cost estimate by end April

• AAS evening public session in Long Beach - Jan 8, 2012
WFIRST & AFTA

- The most pressing fields in astrophysics require a near infrared survey capability.
- WFIRST can satisfy all of the observational requirements of Astro2010

WFIRST is technologically mature

New Science Definition Team studying use of 2.4m telescope for WFIRST science.
- Existing telescope, free to NASA
- Exquisite imaging & sensitivity
- Optional coronagraph included in study

Report due on April 30, 2013