FIRS: A New Instrument for Photospheric and Chromospheric Studies at the Dunn Solar Telescope

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Steve Hegwer, Thomas Rimmele, Matt Penn (NSO)

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Solar B, Photosphere to Corona

- Coronal heating
- Vertical wave propagation from the photosphere to chromosphere
- Running penumbral waves
- Normal and inverse Evershed flows
- 3D magnetic structure of sunspots
- Prominence and spicule magnetic fields
- Canopy fields
- Dynamic events and evolution of everything with time
**Multi-Spectral: Multi-Height Diagnostics**

<table>
<thead>
<tr>
<th>Line [Å]</th>
<th>Species</th>
<th>Landé g</th>
<th>Formation Height</th>
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<tr>
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<td>Fe I</td>
<td>1.667, 2.5</td>
<td>mid-photosphere</td>
</tr>
<tr>
<td>8542</td>
<td>Ca II</td>
<td>1.1</td>
<td>low chromosphere</td>
</tr>
<tr>
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<td>photosphere</td>
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<tr>
<td>10830</td>
<td>He I</td>
<td>2.0, 1.75, 1.25</td>
<td>high chromosphere</td>
</tr>
<tr>
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Instrument Requirements

**Multi-Spectral:** Multi-Height Diagnostics

**High Cadence:** Dynamics
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**High Spectral Resolution:** Detailed Physics
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**High Spatial Resolution:** Structure Detail
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with FIRS
**Instrument Requirements with FIRS**

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Dual-arm spectrograph for simultaneous visible and infrared observations

Beam splitter to share the beam with IBIS

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- Increased throughput with 4 slits
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Building a Scan with 4 Slits
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Large IR grating with steep blaze  
300,000 for the IR, 600,000 for the visible (3pm measured with HeNe)
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**High Spatial Resolution:** Structure Detail
Diffraction-limited with HOAO
f/36 and f/108 feed optics for high and low-res modes
"Tower of Power"
aka f/108 feed optics
## FIRS Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>FIRS f/36*</th>
<th>FIRS f/108*</th>
<th>Hinode SOT/SP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telescope</td>
<td>76.2 cm Solar Tower</td>
<td>...</td>
<td>50 cm Aplanatic Gregorian</td>
</tr>
<tr>
<td>Rayleigh limit @ 6302</td>
<td>0.21”</td>
<td>...</td>
<td>0.32”</td>
</tr>
<tr>
<td>Rayleigh limit @ 10830</td>
<td>0.36”</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Rayleigh limit @ 15648</td>
<td>0.52”</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Field</td>
<td>174” x 75”</td>
<td>58” x 25”</td>
<td>160” (320” max) x 151”</td>
</tr>
<tr>
<td>Vis Spatial Sampling</td>
<td>0.30” x 0.08”/pix</td>
<td>0.10” x 0.03”/pix</td>
<td>0.15” x 0.16”/pix</td>
</tr>
<tr>
<td>IR Spatial Sampling</td>
<td>0.30” x 0.15”/pix</td>
<td>0.10” x 0.05”/pix</td>
<td>...</td>
</tr>
<tr>
<td>Nominal Scan Time**</td>
<td>20 min</td>
<td>...</td>
<td>83 min</td>
</tr>
<tr>
<td>6302 Spectral Resolution (Sampling)</td>
<td>0.03 (0.01) Å</td>
<td>...</td>
<td>0.03 (0.02) Å</td>
</tr>
<tr>
<td>10830 Spectral Resolution (Sampling)</td>
<td>... (0.04) Å</td>
<td>...</td>
<td>...</td>
</tr>
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<td>15648 Spectral Resolution (Sampling)</td>
<td>0.17 (0.05) Å</td>
<td>...</td>
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* Assuming use of 40 μm slit
** S/N ~ 10³
FIRS Data

First Light 30 April, 2007

So far: 6 regions, 20 days, various configurations

Best yet: NOAA 11024, 7 July, 2009
Current Status

FIRS standard configuration is complete!

- Observer training July, September 2009
- Released for NSO use 4th quarter 2009
- Released for general use 1st quarter 2010
For the Future

Extended Capabilities:

- Additional visible and IR detectors for simultaneous 6302-8542-10830-15650
- Maybe super-achromatic dual-waveplate modulator for synchronized exposures
- New pair of Wollaston prisms for smaller beam deviation and larger FOV
- More narrow-band filters for extended wavelength coverage
Thank You!

Ask us for a tour

for more information visit:  
http://kopiko.ifa.hawaii.edu/firs/

or contact us:  
jaeggli@ifa.hawaii.edu  
lin@ifa.hawaii.edu