HMI Instrument Status

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Overview

- The damned thing works!
- Any questions?
Overview

• **Calibration Status**
  – Image quality
  – Wavelength dependence
  – Polarization
  – Miscellaneous

• **Outstanding issues and plans**
Observing Scheme

- Make I, Q, U, V, LCP, RCP from filtergrams
  - Identify bad pixels
  - Correct for flat field and exposure time
  - Fill in space
  - Correct for solar rotation and jitter (spatial interpolation)
  - Correct for acceleration effects and fill in time (temporal interpolation)
    - Nyquist criterion almost fulfilled for Doppler and LOS
    - Nyquist is grossly violated for vector measurements in case of long framelines
    - Clever tricks exist
  - Apply demodulation matrix

- MDI-like and/or least squares for Doppler and LOS

- Fast and/or full inversion for vector field
  - First average in time if desired
**Framelist Example**

### 5 Position Framelist

<table>
<thead>
<tr>
<th>Time(s)</th>
<th>0</th>
<th>8</th>
<th>16</th>
<th>24</th>
<th>32</th>
<th>40</th>
<th>48</th>
<th>56</th>
<th>64</th>
<th>72</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuning</td>
<td>I1</td>
<td>I2</td>
<td>I3</td>
<td>I4</td>
<td>I5</td>
<td>I1</td>
<td>I2</td>
<td>I3</td>
<td>I4</td>
<td>I5</td>
</tr>
<tr>
<td>Doppler pol.</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
</tr>
<tr>
<td>Vector pol.</td>
<td>1 2</td>
<td>1 2</td>
<td>1 2</td>
<td>1 2</td>
<td>1 2</td>
<td>3 4</td>
<td>3 4</td>
<td>3 4</td>
<td>3 4</td>
<td>3 4</td>
</tr>
</tbody>
</table>

- **Time**: Time of first exposure at given wavelength since start of framelist execution
- **Tuning**: I1, I2, ... specify the tuning position
- **Doppler pol.**: Polarization of image taken with Doppler camera
  - L and R indicate left and right circular polarization
  - Used for Doppler and line of sight field
- **Vector pol.**: Polarization of image taken with vector camera
  - 1, 2, 3, 4: Mixed polarizations needed to make vector magnetograms
  - Used for vector field reconstruction
- **T data from the two cameras may be combined**

![Graph showing measurement points](Image)
• Too complicated for me to figure out
  – So, what to do?
Delegate!
Polarization

• **Status**
  – Things look good
  – Instrumental polarization appears low, about 0.02%

• **To do**
  – Better estimate and correct for instrumental polarization
  – Decide on exact settings and order
    • Min crosstalk
    • Min wear
  – Zero point for temperature dependence
More LED Ratio
Framelist Choices Polarization Scheme

- **Options 1 and 2 – Cameras not combined**
  - Same polarimetric noise per unit time
  - Option A (LCP/RCP on one, Mod A on other) is relatively fast (vector@90s)
    - Some Stokes parameters are made from differences over long time intervals (40-50s)
    - Significant acceleration effects
  - Option C (LCP/RCP on one, Mod C on other) is slower (vector@135s)
    - But all differences are close in time (4s)
    - Almost no acceleration effects

- **Options 3 and 4 – Cameras combined**
  - Depends on ability to combine the cameras
  - Option L (LCP/RCP on one, linear on other) only vector combined (vector@90s)
    - Better polarimetry than 1 and 2
    - Calibrations on vector camera does not impact Doppler continuity
  - Option X (Mod A divided on cameras) combines to make both (vector@45s)
    - Even better polarimetry
    - Also better Doppler
    - But calibrations interrupt Doppler

- **Time averaging helps**
### Framelist Examples – Polarization Scheme

#### Option 1

<table>
<thead>
<tr>
<th>Time(s)</th>
<th>0</th>
<th>...</th>
<th>32</th>
<th>40</th>
<th>...</th>
<th>72</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuning</td>
<td>I1</td>
<td>...</td>
<td>I5</td>
<td>I1</td>
<td>...</td>
<td>I5</td>
</tr>
<tr>
<td>Doppler</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
</tr>
<tr>
<td>Vector</td>
<td>1 2</td>
<td>1 2</td>
<td>3 4</td>
<td>3 4</td>
<td>3 4</td>
<td>3 4</td>
</tr>
</tbody>
</table>

#### Option 2

<table>
<thead>
<tr>
<th>Time(s)</th>
<th>0</th>
<th>...</th>
<th>32</th>
<th>40</th>
<th>...</th>
<th>72</th>
<th>80</th>
<th>...</th>
<th>112</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuning</td>
<td>I1</td>
<td>...</td>
<td>I5</td>
<td>I1</td>
<td>...</td>
<td>I5</td>
<td>I1</td>
<td>...</td>
<td>I5</td>
</tr>
<tr>
<td>Doppler</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
</tr>
<tr>
<td>Vector</td>
<td>A B</td>
<td>...</td>
<td>A B</td>
<td>C D</td>
<td>...</td>
<td>C D</td>
<td>...</td>
<td>L R</td>
<td>L R</td>
</tr>
</tbody>
</table>

L=LCP, R=RCP, 1, 2, 3 and 4 combinations of I, Q, U and V, A=I-Q, B=I+Q, C=I-U, D=I+U.
### Framelist Examples – Polarization Scheme

#### Option 3

<table>
<thead>
<tr>
<th>Time(s)</th>
<th>0</th>
<th>...</th>
<th>32</th>
<th>40</th>
<th>...</th>
<th>72</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuning</td>
<td>I1</td>
<td>...</td>
<td>I5</td>
<td>I1</td>
<td>...</td>
<td>I5</td>
</tr>
<tr>
<td>Doppler</td>
<td>L</td>
<td>R</td>
<td>L</td>
<td>L</td>
<td>R</td>
<td>L</td>
</tr>
<tr>
<td>Vector</td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

#### Option 4

<table>
<thead>
<tr>
<th>Time(s)</th>
<th>0</th>
<th>...</th>
<th>32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuning</td>
<td>I1</td>
<td>...</td>
<td>I5</td>
</tr>
<tr>
<td>Camera 1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Camera 2</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>
Outstanding Issues

- To combine or not to combine - that is the question!
- Better polarization and potentially Doppler if combined
  - But
    - Flatfield
    - LED ratio drift
    - Detune difference
    - Roll angle variability
    - PSF/MTF/OTF difference including focus difference
    - ...
- Some other issues
  - ISS gain
  - Camera gain
  - Image center
  - Window temperature
    - Affect focus and depolarization
  - Polarization
    - Order, settings,
Plans

- No combination for Doppler
  - So no X

- Probably no combination for vector
  - So probably A or C

- May change later

- Run calibrations once in a while
  - Darks
  - Focus
  - Detunes
  - Flat fields
    - PZT
    - Offpoint
  - Roll maneuvers
  - ...
Conclusion - Continued

• Instrument works!
• Some issues to resolve
• Have lots of data:
  – Type A: 129 hours
  – Type C: 192 hours
  – Type L: 44 hours
  – Type M: 13 hours
  – Type X: 25 hours
  – Sim M: 1.4 hours
  – Fast Q: 23 hours
  – Fast V: 22 hours
  – Fast H: 20.5+ hours
  – Roll: 18 hours
  – Offpoint: 24 hours
  – Various: ?? hours
  – Total 562 hours