Polarization calibration techniques and scheduling for the Daniel K. Inouye Solar Telescope

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Polarization Calibration

- Inouye Solar Telescope is a reality
- Polarization Calibration Challenges
  - Wavelength diversity
  - Accuracy of 0.05%
- Divide and Conquer
  - Group method
  - Allocation of errors
  - Validity of calibrations
- Scheduling
  - Drivers for recalibration
  - Look ahead and behind
Contributors

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Polarization Calibration Challenges

- SPEC-0001: Full Stokes polarimetry to an accuracy of 0.05%
- 4 Spectro-polarimeters operate from 380nm to 5000nm
- 3 S-Ps operate *simultaneously* from 380nm to 2500nm
- Observing through a time varying polarizing telescope
Measure me**

*Valid from 380nm to 5000nm
+As bright as the Sun
Divide the optical path into ‘groups’ separated by Elevation and Coudé-Azimuth rotations and by calibration optics.

- **Infer** first group $X_{12}$ from observations
- **Calibrate** remaining groups using polarization states generated at Gregorian focus
  - $X_{34} = M_4 \#\# M_3$
  - $X_{56} = M_6 \#\# M_5$
  - $M_i$ Modulation matrix for each instrument configuration
Divide allowable errors

The error ‘matrix’: Allowable crosstalk from any one Stokes parameter into another.

\[
\begin{bmatrix}
0.01 & 0.1 & 0.1 & 0.1 \\
0.0005 & 0.01 & 0.005 & 0.005 \\
0.0005 & 0.005 & 0.01 & 0.005 \\
0.0005 & 0.005 & 0.005 & 0.01 \\
\end{bmatrix}
\]

Flat field accuracy

- \( I = 1.0000 \)
- \( Q,U,V = 0.1000 \)
What Triggers Polarization Calibrations?
Reconfiguration of light distribution or of an instrument
Standard Observations

<550nm

<900nm

>1000nm
Standard Observations

• Each instrument has defined ‘Standard Data Sets’
  – Associated standard calibration operations
  – Pipeline data processing

• Configure the Coudé into ‘Standard Optical Configurations’
  – Multiple instruments can contribute their standard data sets
Duration of valid calibrations

Mirror Contamination
Schedule ahead and behind

Duration of valid calibration

Time of observation

0.000
5

0.001

0.003

Time

Hours? Days? Weeks?

Determine during Integration, Test, and Commissioning
Polarization Calibration

- Subdivide the calibration problem
- Model and test calibration technique
- Utilize Standard Observations
- Adapt scheduling for duration of calibration validity