Developments of a spectro-polarimeter observing multi-wavelength windows simultaneously at Hida observatory

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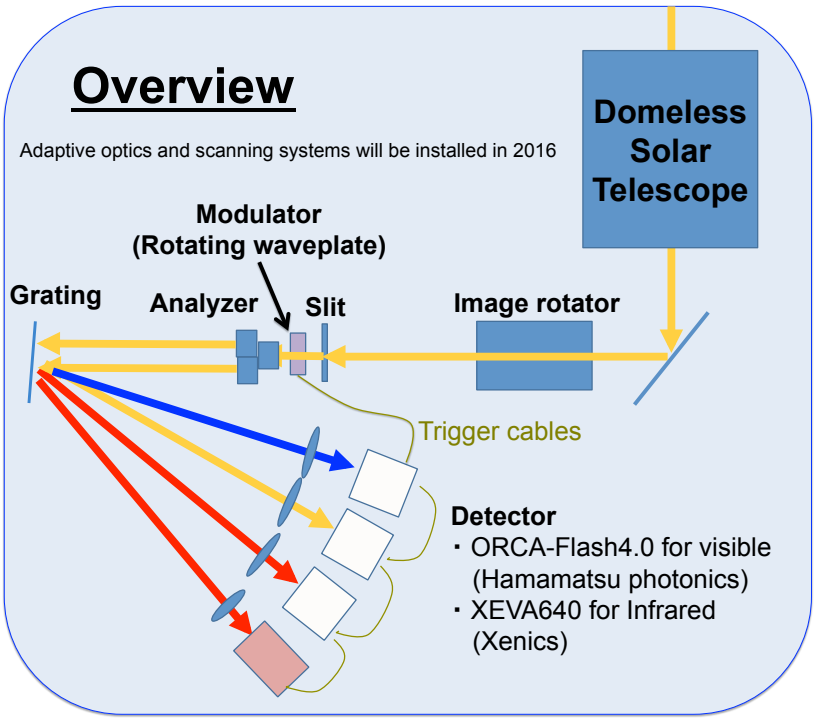
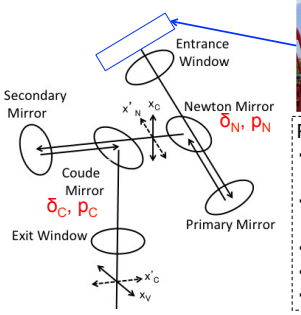
To obtain full Stokes spectra in multi-wavelength windows simultaneously, we are developing a new spectro-polarimeter on the Domeless Solar Telescope at Hida Observatory. The new polarimeter consists of a 60 cm aperture vacuum telescope, an adaptive optic system, an image rotator, a high dispersion spectrograph, polarization modulator and analyzer composed of a continuously rotating wave plate whose retardation is nearly constant in 450 - 1100 nm and a polarimetric beam splitter located closely behind the focus of the telescope, fast and large format CMOS cameras and an infrared camera. The slit spectrograph allows us to obtain spectra in as many wavelength windows as the number of cameras. We developed the polarization modulator and the analyzer, and calibrated instrumental polarizations of the image rotator.

Overview

Adaptive optics and scanning systems will be installed in 2016



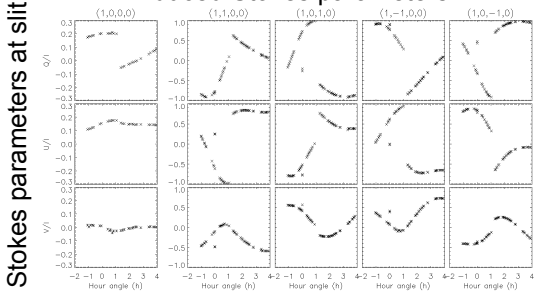
Calibration of the telescope



Remotely controllable turret with linear polarizer

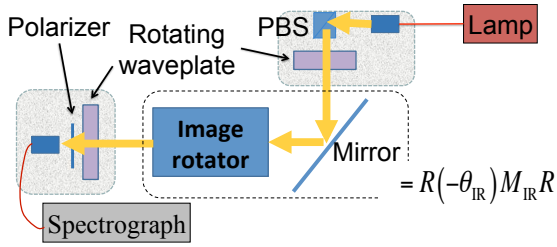
Parameters of model (Anan et al. 2012)
- Retardation of Newton and Coude mirrors δ_N, δ_C
- Diattenuation of Newton and Coude mirrors p_N, p_C
- Stray light s
- Zenith distance of the sun θ_{ZD}
- Hour angle of the sun θ_{HA}

Induced Stokes parameters



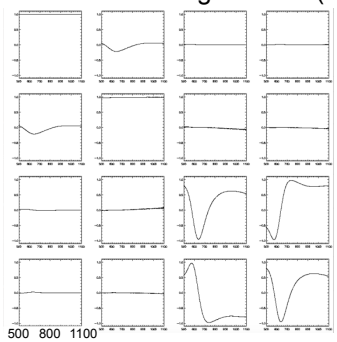
Mueller matrix of the image rotator and a mirror

We measured Mueller matrix of the image rotator and a mirror with dual rotating waveplates (Ichimoto et al. 2006)

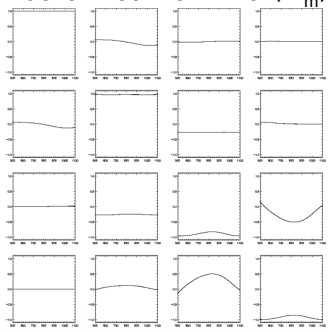


$$= R(-\theta_{IR}) M_{IR} R(\theta_{IR}) M_m$$

Mueller matrix of image rotator (M_{IR})

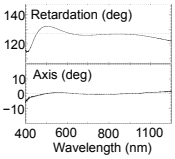


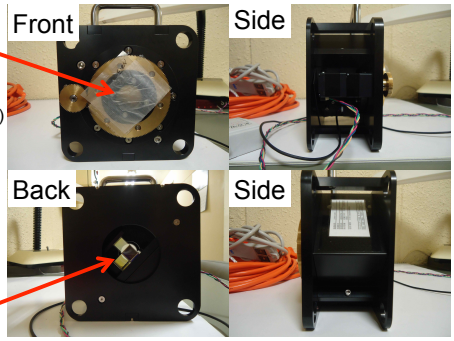
Mueller matrix of mirror (M_m)



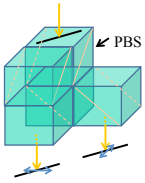
Modulator

Waveplate
- 5 layers of wavelength films having the birefringence (HI-Retax produced by LUCEO)
- Rotating with a period of 4 s

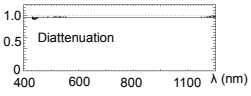




Analyzer



Polarizing Beam Splitter (PBS)
- Dielectric multi-layer polarizing coating on hypotenuse surface (produced by SIGMAKOKI)



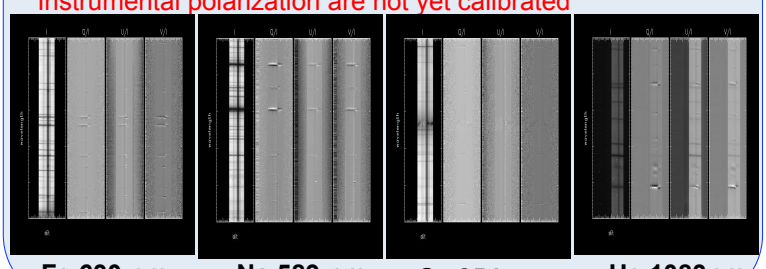
Trigger of camera

Photomicrosensor (OMRON) produce signal to trigger for cameras to start a sequence of 100 exposures

Error of rotating angle of the waveplate at the exposure ~ 0.09 deg ⇔ sensitivity ~ 10^{-4}

First light? (2016.9.2)

Instrumental polarization are not yet calibrated



Fe 630 nm | Na 589 nm | Ca 854 nm | He 1083nm

Acknowledgements

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