# Simultaneous spectro-polarimetric observation in multi spectral lines

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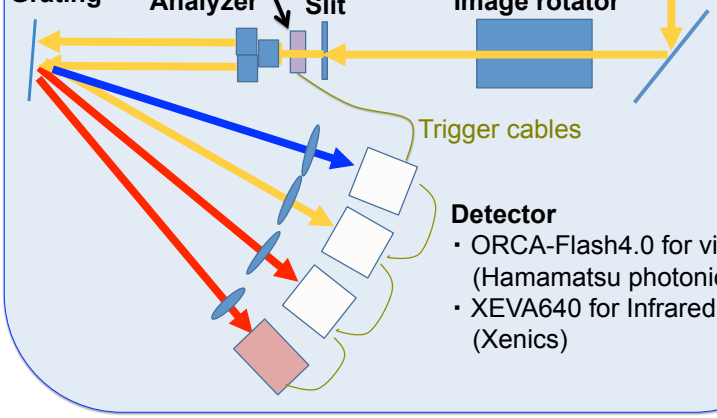
In order to select the best spectral line to extrapolate coronal magnetic fields, we developed a new spectro-polarimeter on the Domeless Solar Telescope at Hida Observatory. The new polarimeter consists of a 60 cm aperture vacuum telescope, an image rotator, a high dispersion spectrograph, polarization modulator and analyzer composed of a continuously rotating wave plate whose retardation is nearly constant in 500 - 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 polarimeter allows us to obtain full Stokes spectra in as many wavelength windows as the number of cameras simultaneously.

## Overview

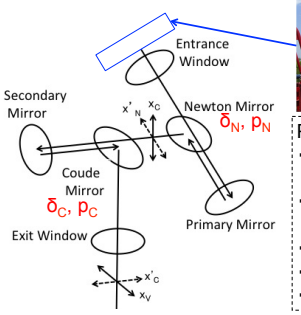
Adaptive optics and scanning systems will be inserted in 2017

**Domeless Solar Telescope**




**Detector**
- ORCA-Flash4.0 for visible (Hamamatsu photonics)
- XEVA640 for Infrared (Xenics)

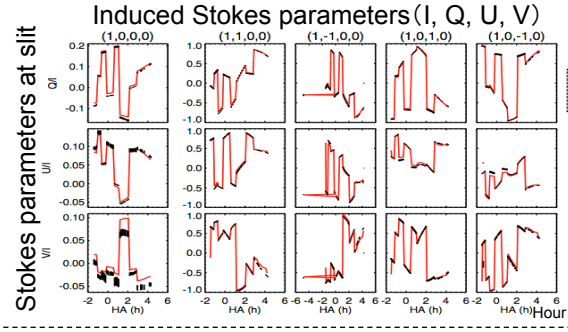
## Calibration of the telescope




Remotely controllable turret with linear polarizer

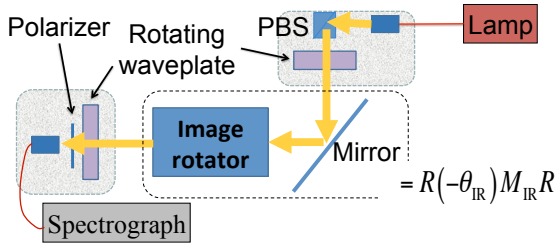
Parameters of model (Anan et al. 2012)
- Retardation of Newton and Coude mirrors $\delta_N$, $\delta_C$
- Diattenuation of Newton and Coude mirrors $p_N$, $p_C$
- Stray light s
- Zenith distance of the sun $\theta_{ZD}$
- Hour angle of the sun $\theta_{HA}$

Induced Stokes parameters (I, Q, U, V)



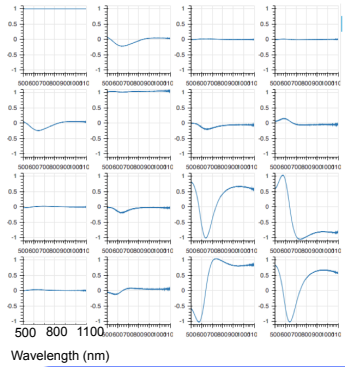

## Mueller matrix of the image rotator and a mirror

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

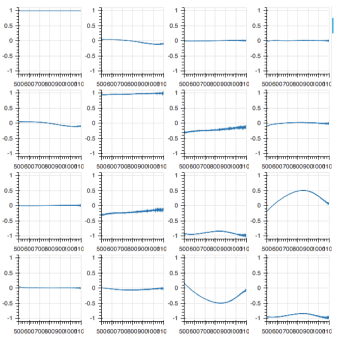



$$= R(-\theta_{IR}) M_{IR} R(\theta_{IR}) M_m$$

Mueller matrix of image rotator ($M_{IR}$)

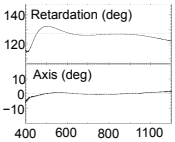


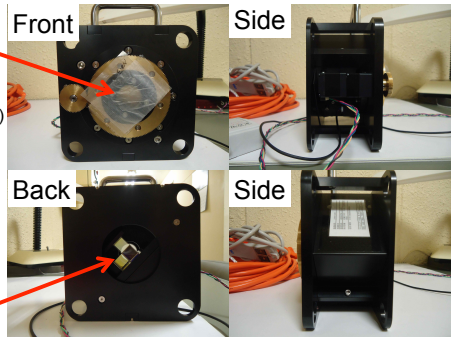

Mueller matrix of mirror ($M_m$)



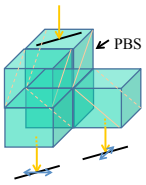
## Modulator

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

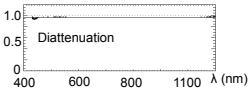



## Analyzer




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

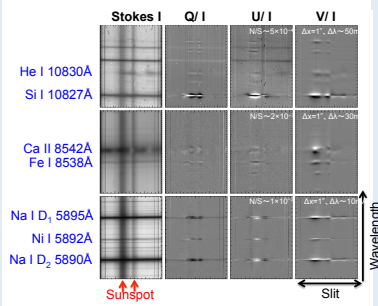



## Trigger of camera

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

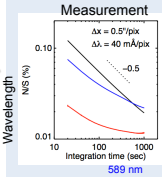
Error of rotating angle of the waveplate at the exposure ~ 0.3 deg ⇔ sensitivity ~ $3\times10^{-4}$

## First light (2016.11.26)

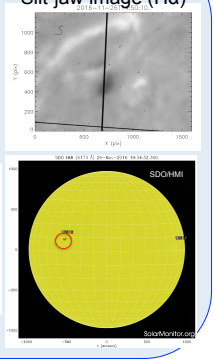



Slit : 128" × 1.2"
Integration time : 20 sec
Contrast
for Q&U : ± 5 %
for V : ± 10 %

Measurement




Slit-jaw image (Hα)

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