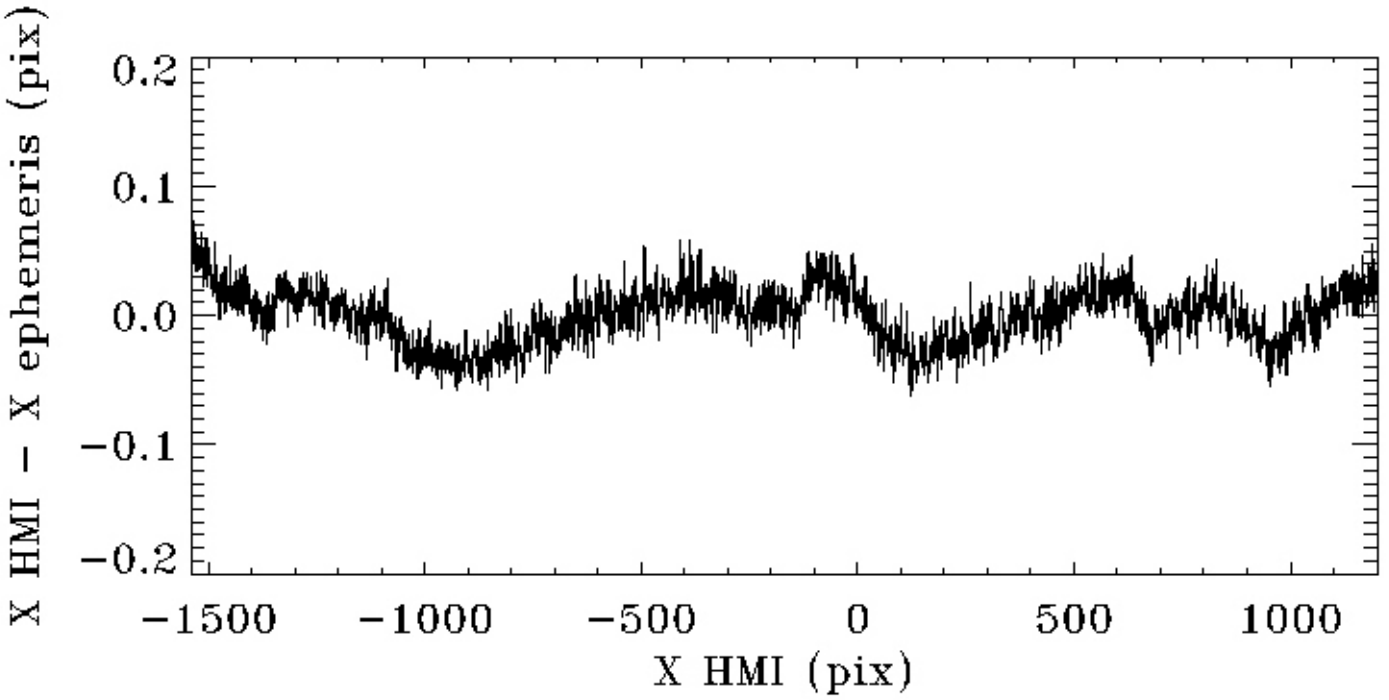
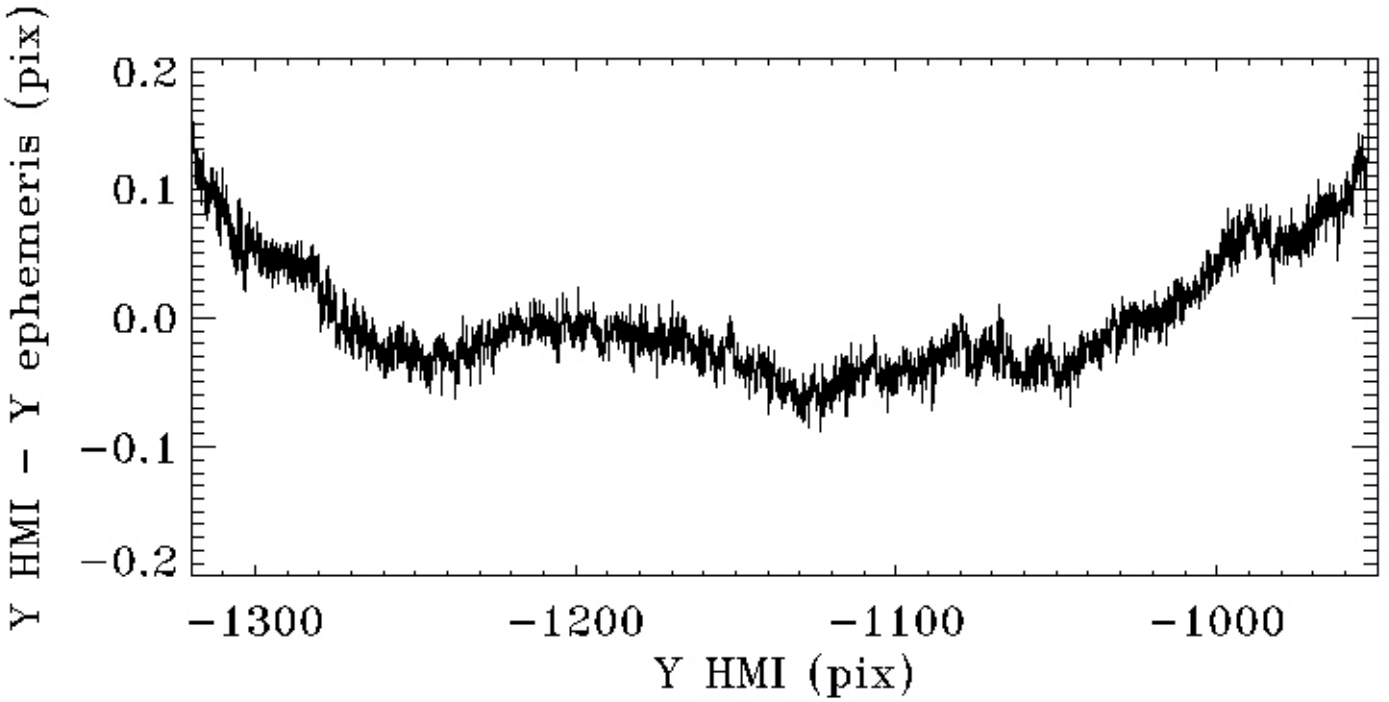
Residual Distortion



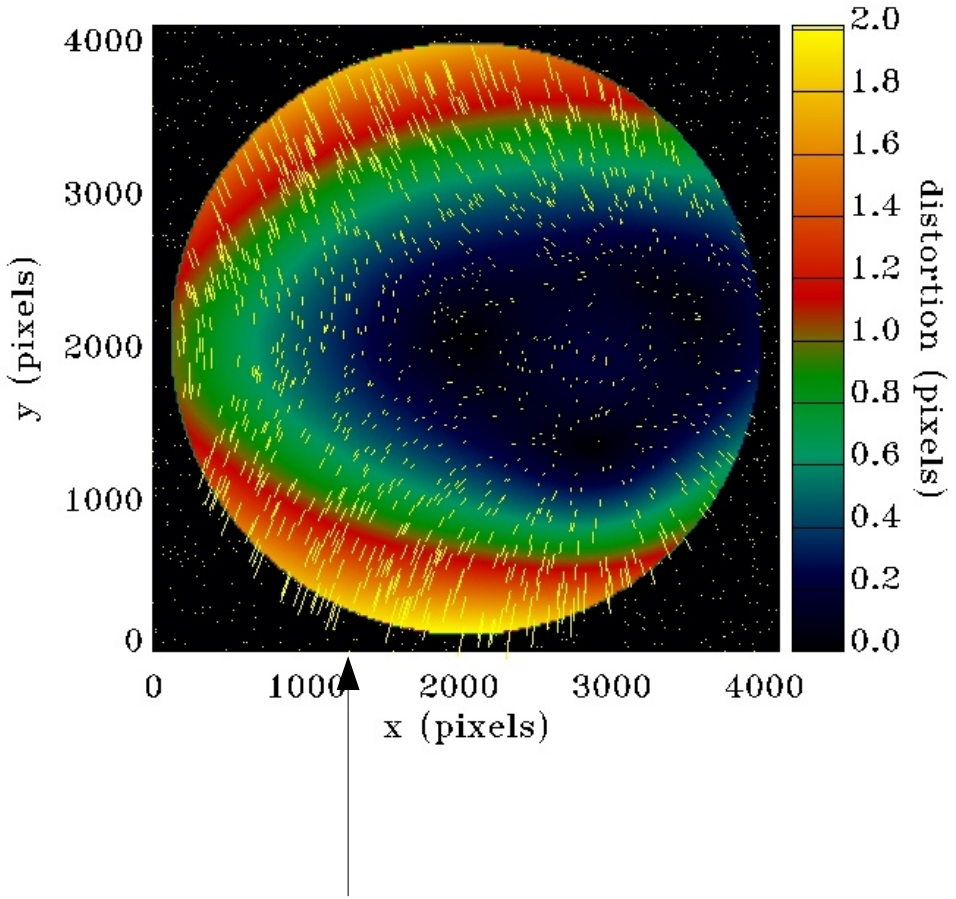


- using Venus transit data of June 5-6, 2012.
- level 1 data with distortion removed and PSF corrected
- for side camera and only along the path of Venus
- least-squares fit of CDELT1 and CROTA2 to minimize X & Y differences between measurements and ephemeris
- residual distortion error ≤0.05”
- CROTA2 known better than 0.002 degrees,
- CDELT1 known better than 0.000042”/pixel

Side Note on HMI Distortion

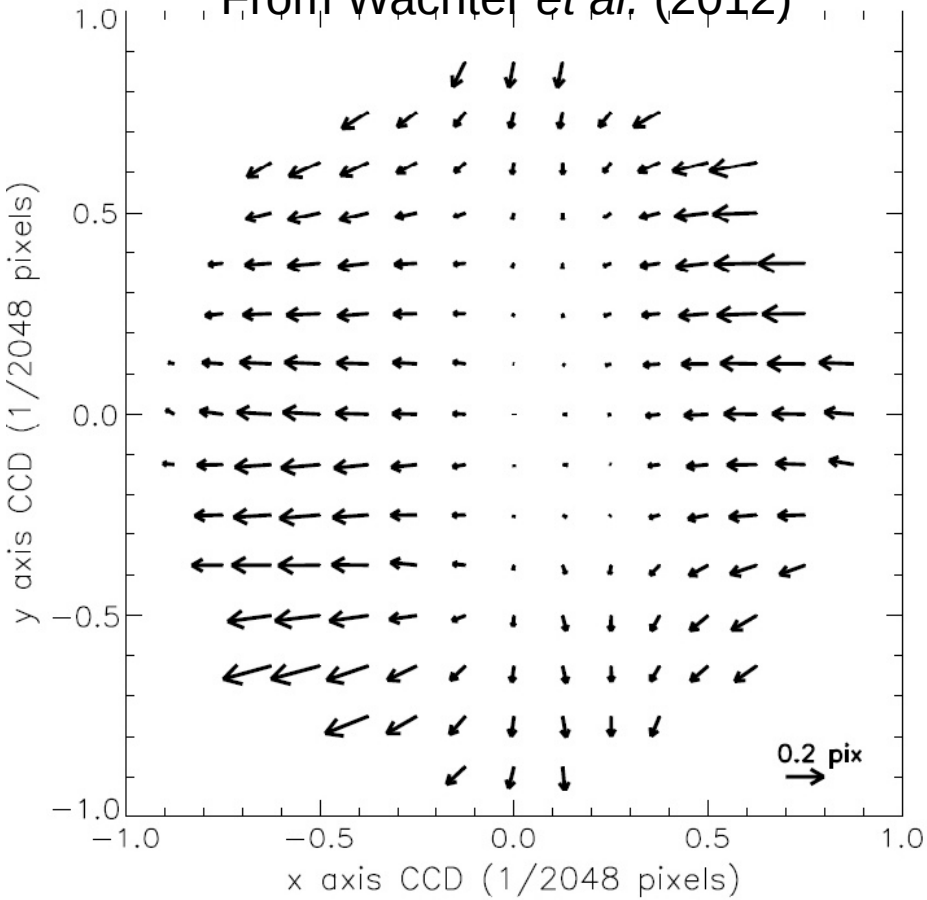
- obtained from ground data (random-dot target + moving alignment legs, Wachter *et al.* 2012)
- distortion as a function of field position is expanded into Zernike polynomials up to 23rd order
- when we correct images for distortion to obtain HMI observables, we use polynomials of order 6 separately for x and y. Distortion is mostly “pincushion” type in upper half, and “barrel” type in lower half (aka “mustache” distortion)
- elliptical distortion could be further corrected using roll data from space

Front camera at best focus:



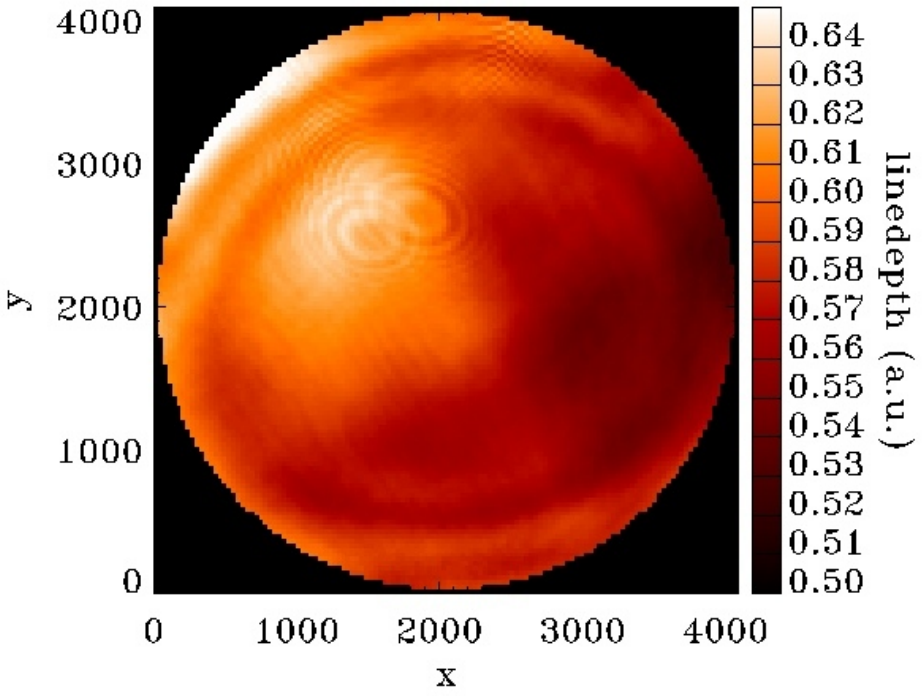
Max distortion: 2 pixels

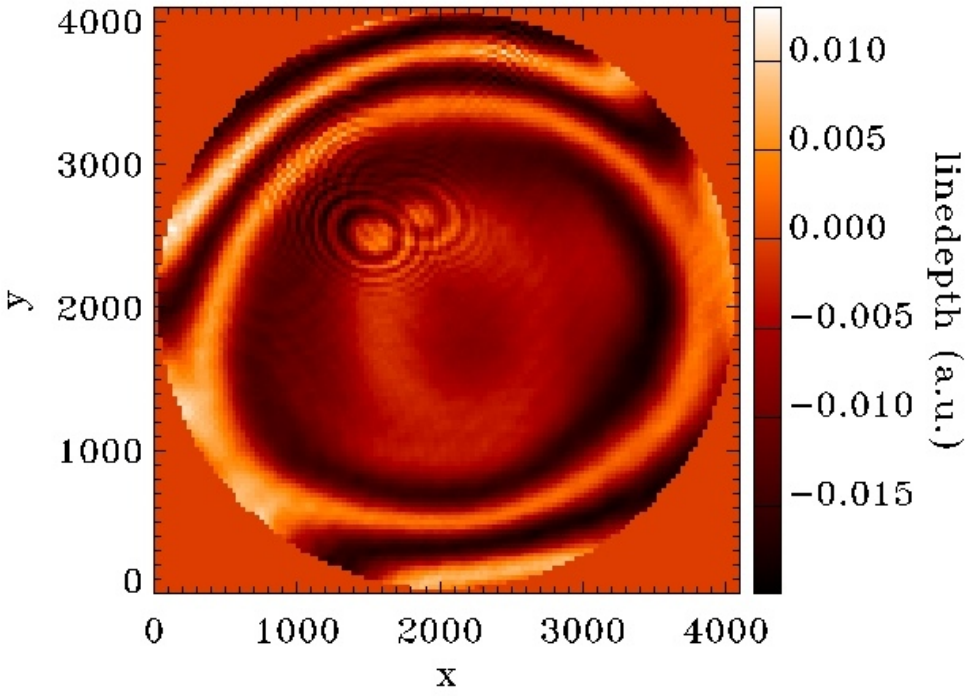
Front – side cameras:
From Wachter *et al.* (2012)



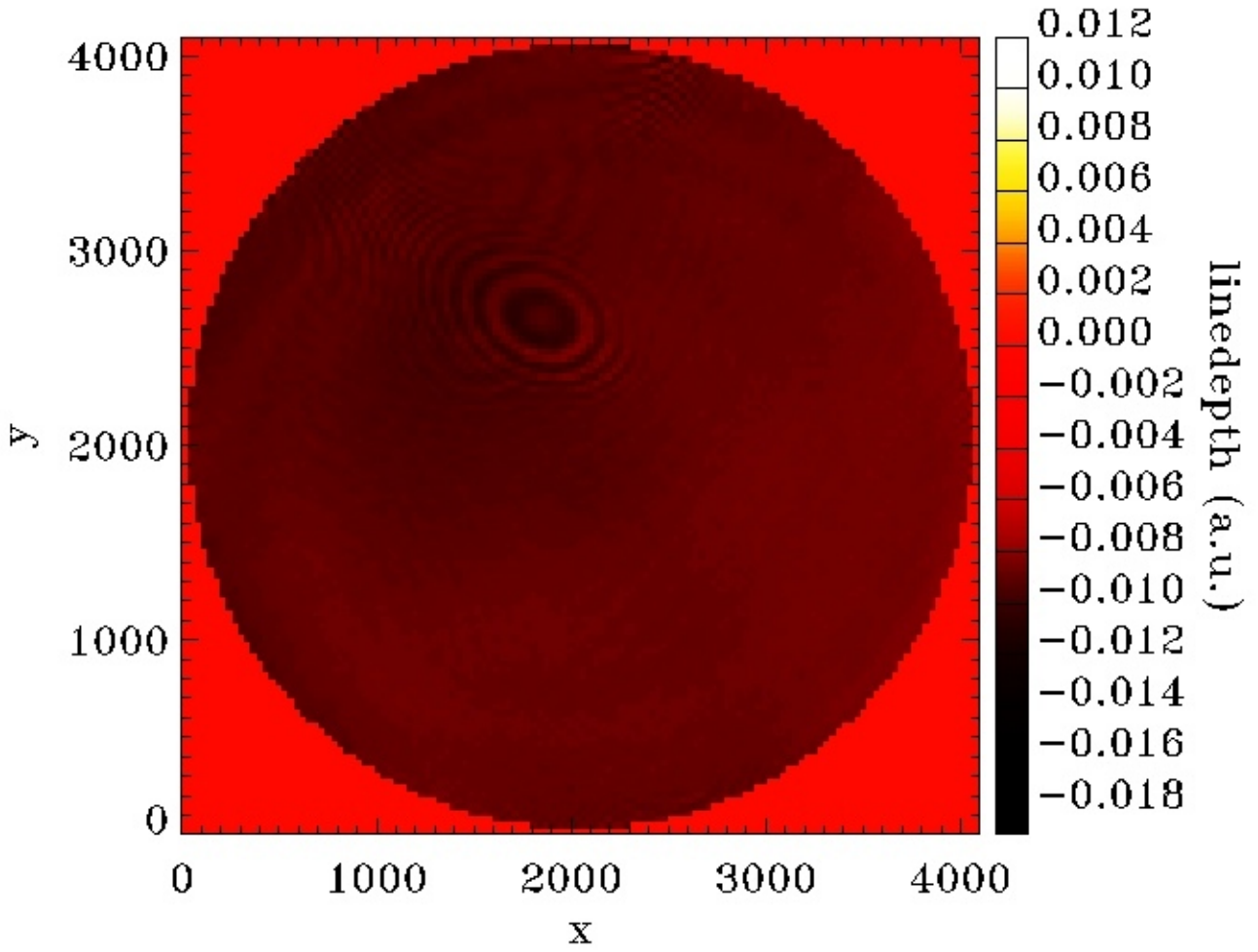
Max difference: 0.28 pixels

Residual Fringe Pattern in the Observables



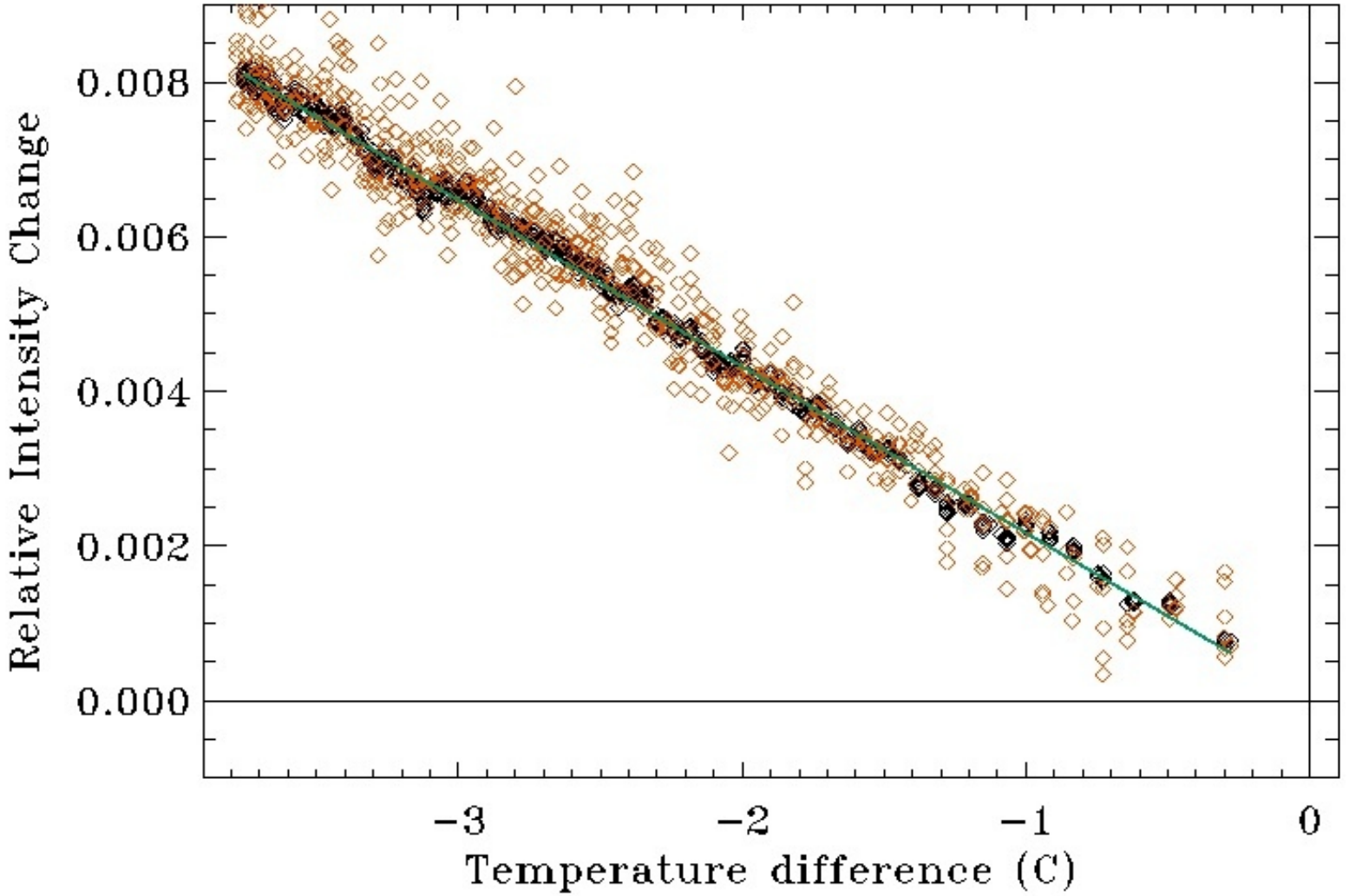


Front window acts like a weak Fabry-Perot interferometer: creates interference fringes on calmode images. Phase maps are produced from calmode, and are needed to produce look-up tables for MDI-like algorithm –> phase-maps have to be corrected



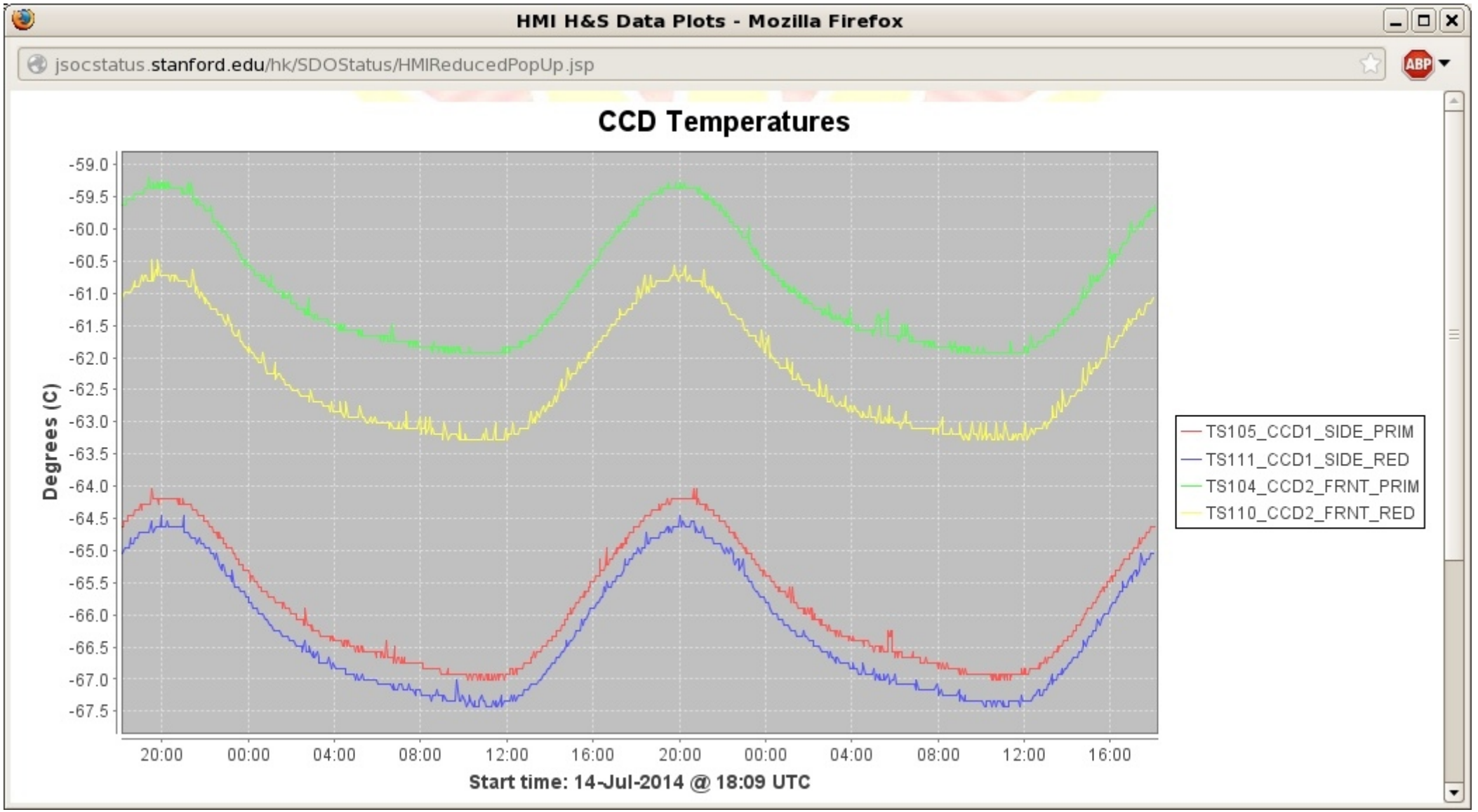
Correction not perfect: some small-scale fringes remain

Temperature Dependence of CCD Gain

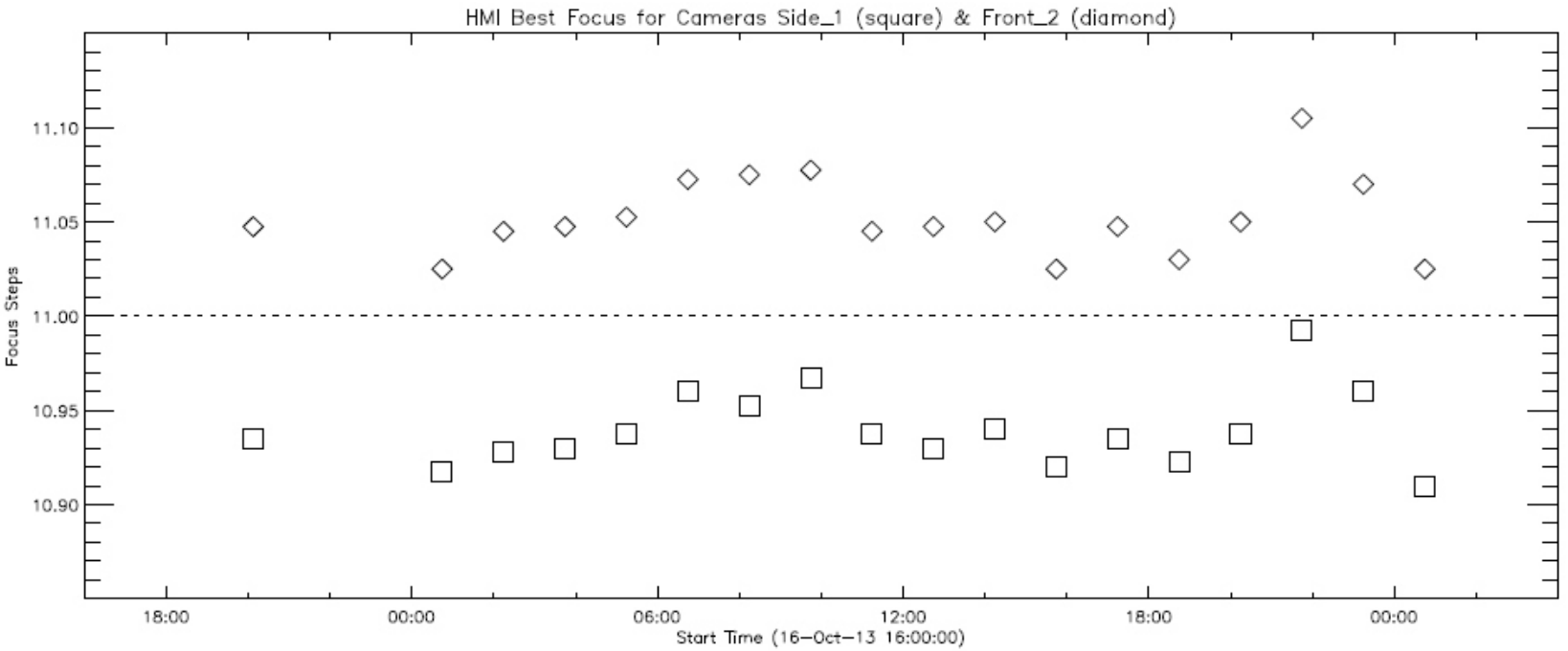


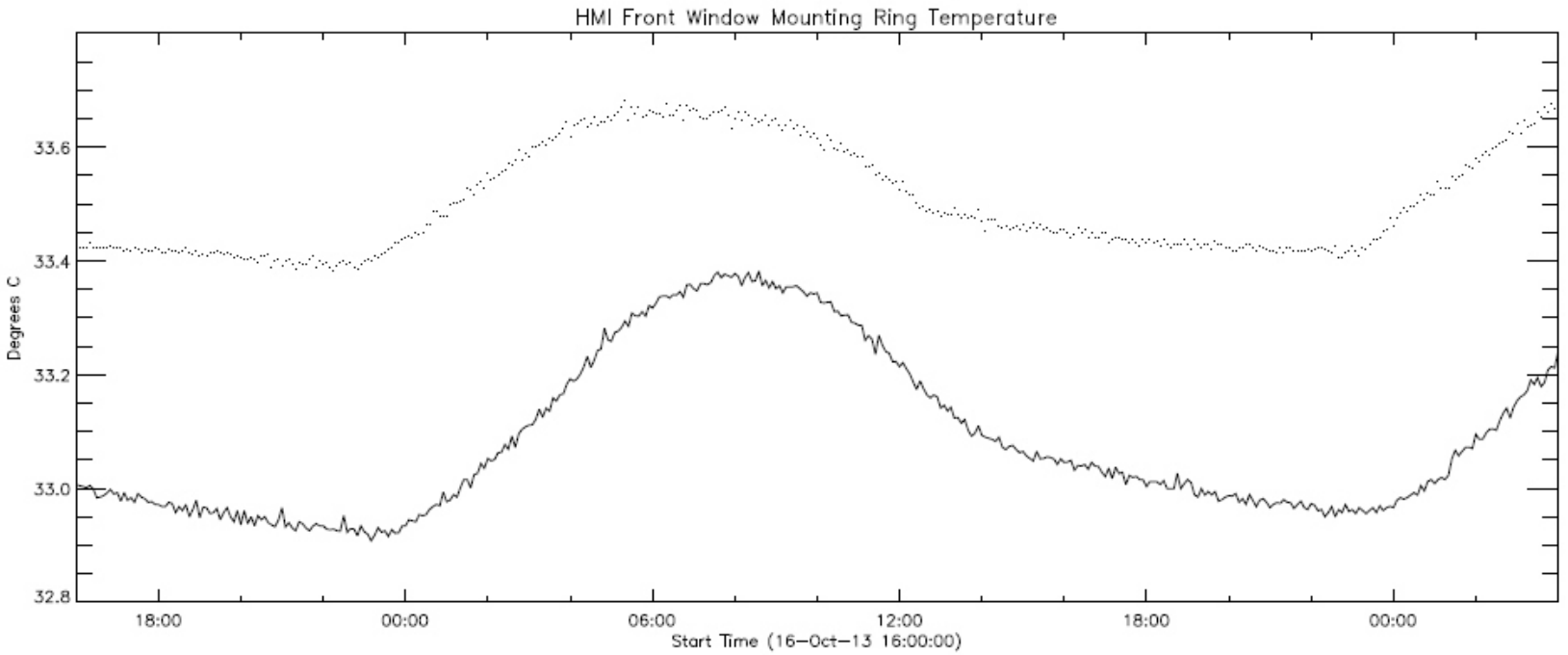
CCD gain varies with temperature. Effect not corrected in the observables code.

Peak-to-peak daily variation in CCD temperature: about 2.5-3 degrees C -> relative intensity change of about 0.65%
Should not impact Dopplergrams and magnetograms, but impacts continuum intensity



Daily Focus Change

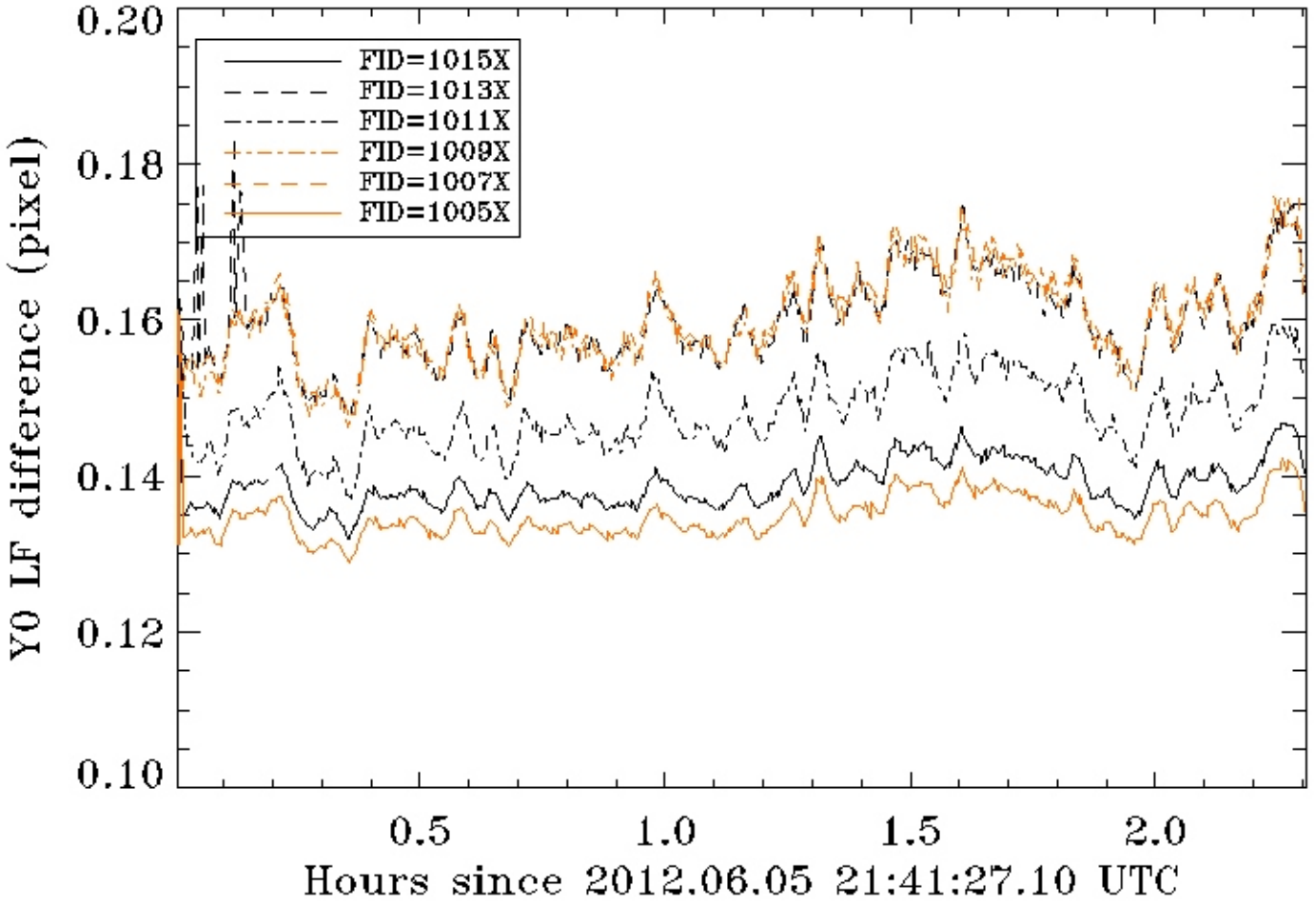




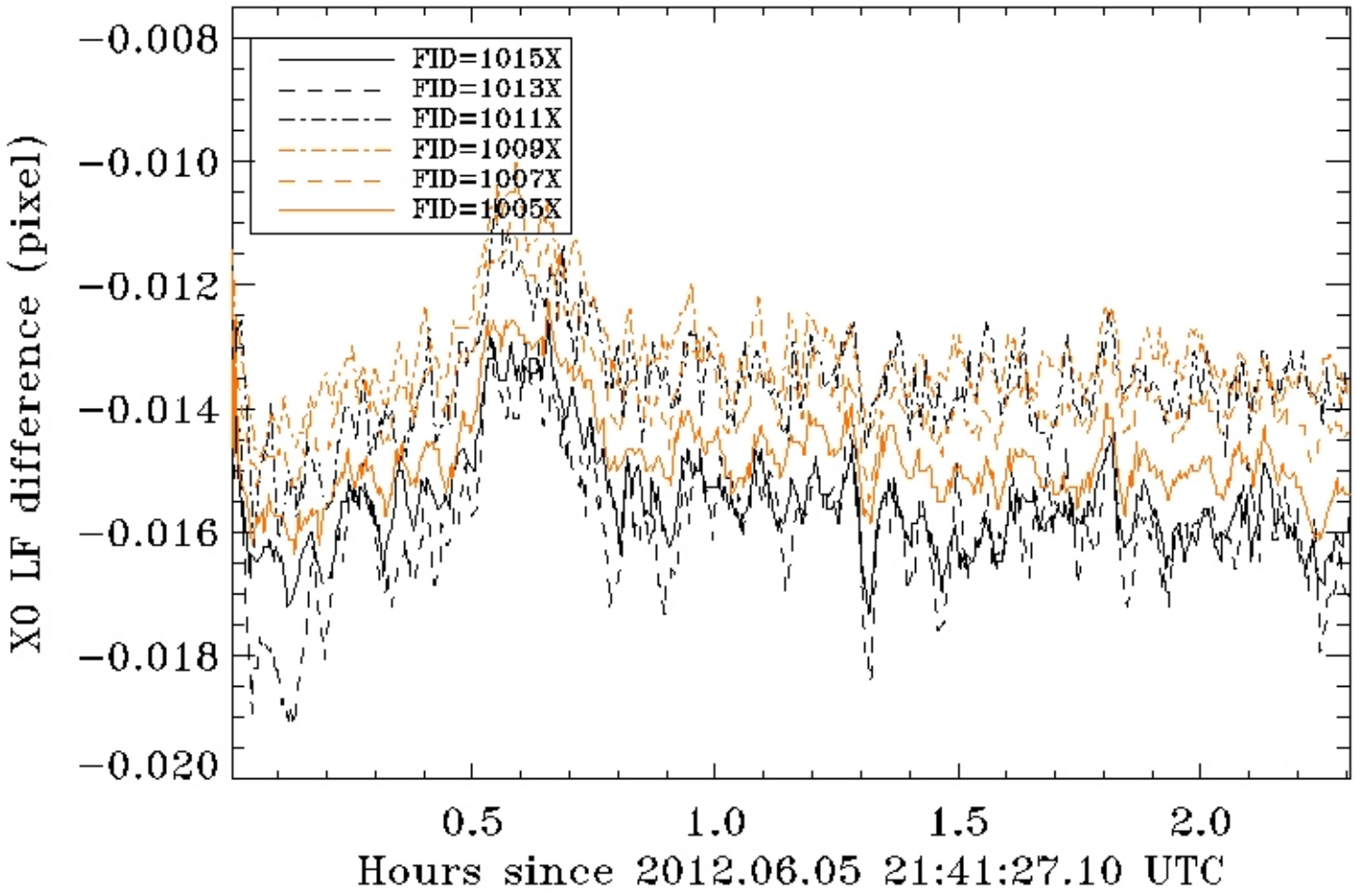
- Plot and analysis by Rock Bush

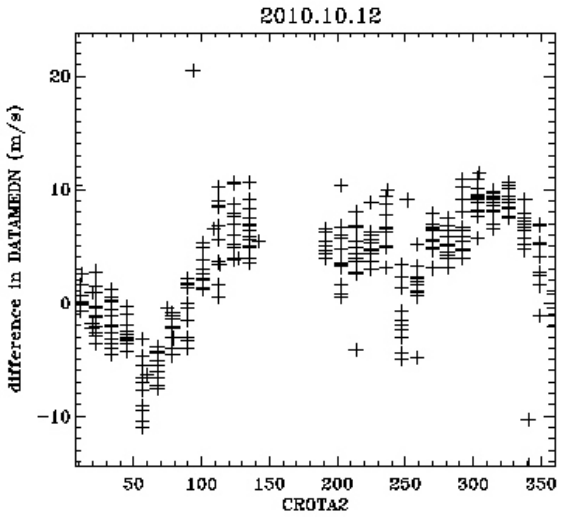
- mainly impacts DATARMS

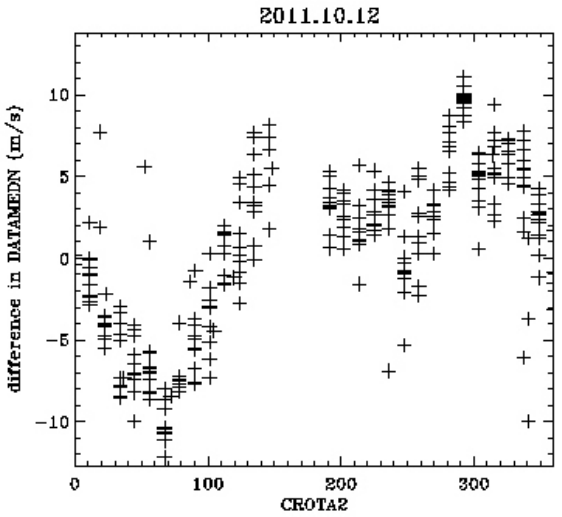
Sun Center Position Error In the Observables

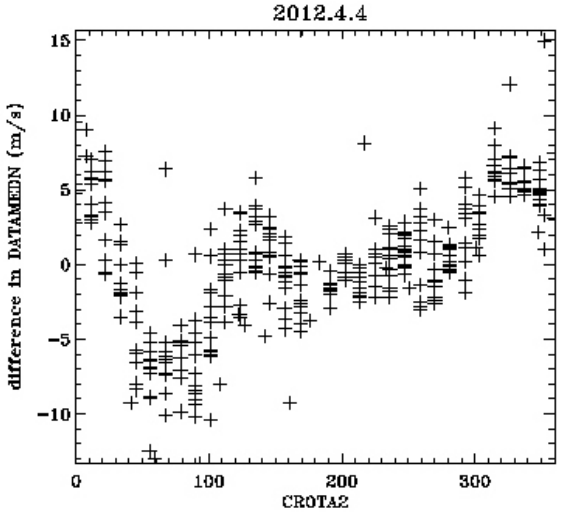


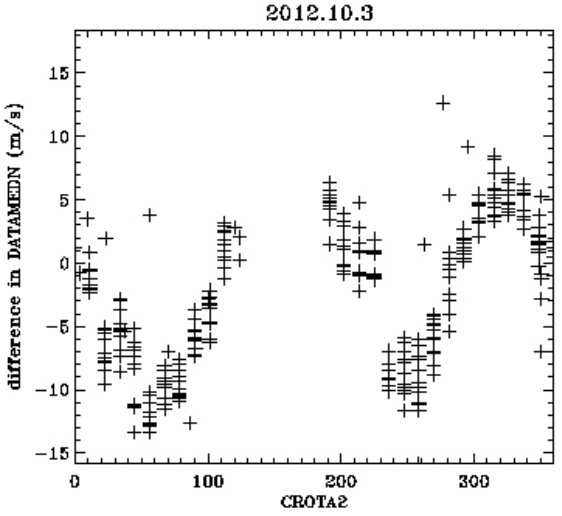
- un-distortion algorithm estimates the center of the solar disk after distortion removal rather than rerunning limb-finder -> there is a difference with limb finder results
- error mainly in the Y axis, of the order of 0.15 pixels (CRPIX2)

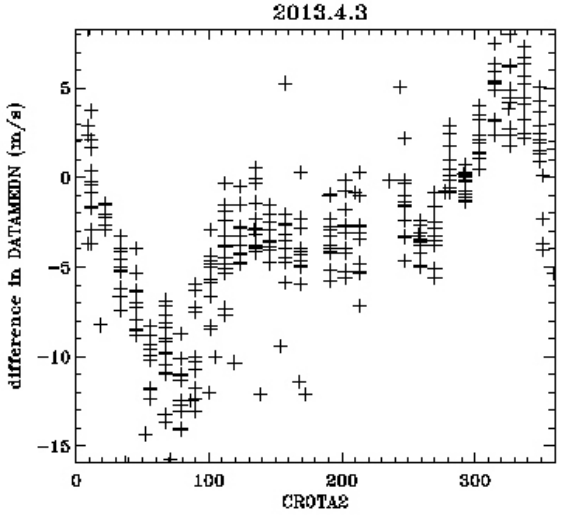

FID=1015X
FID=1013X
FID=1011X
FID=1009X
FID=1007X
FID=1005X
−0.008
−0.010
−0.012
−0.014
−0.016
−0.018
−0.020
X0 LF difference (pixel)
0.5
1.0
1.5
2.0
Hours since 2012.06.05 21:41:27.10 UTC







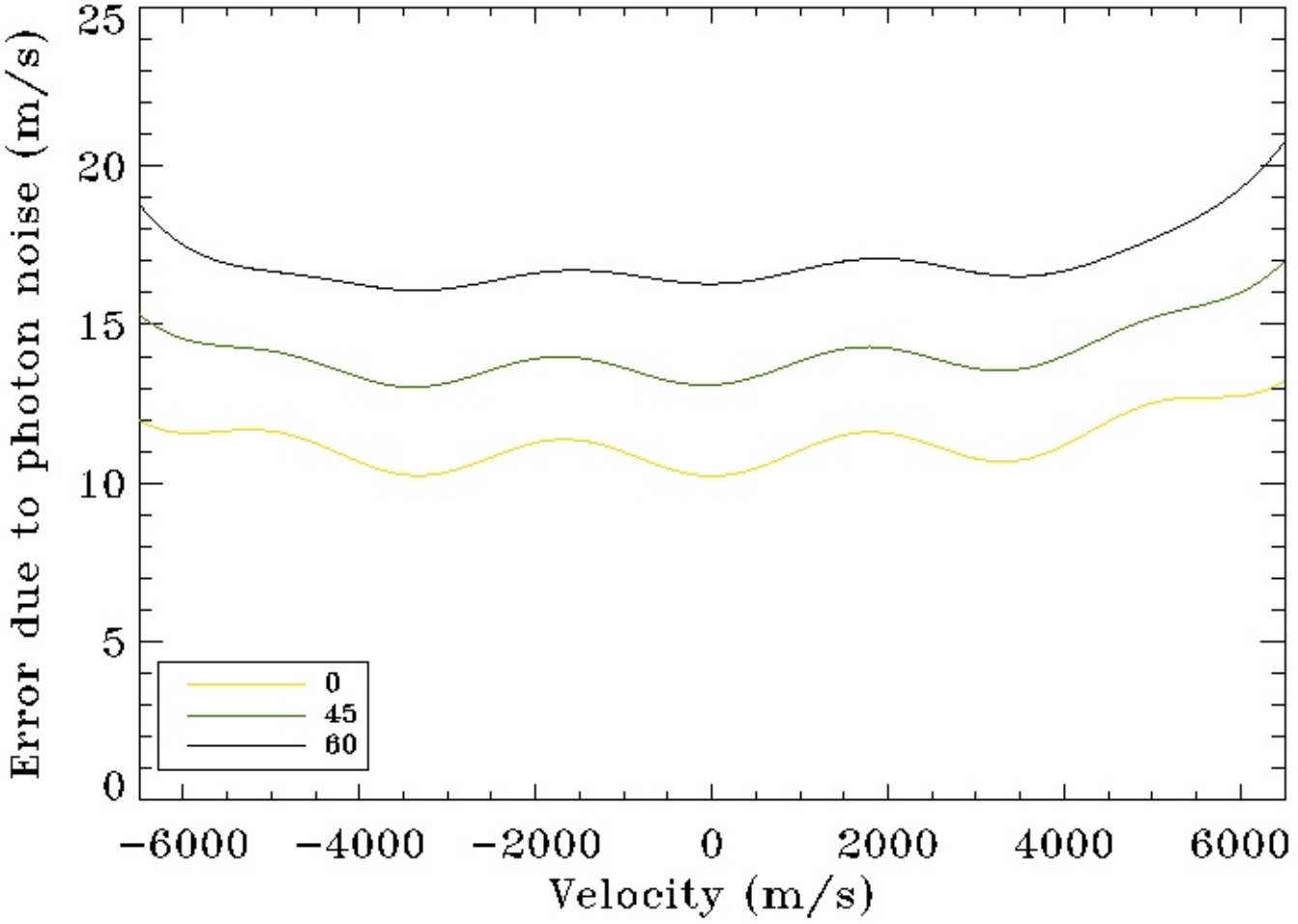




Estimate of Systematic Error on Doppler Velocity

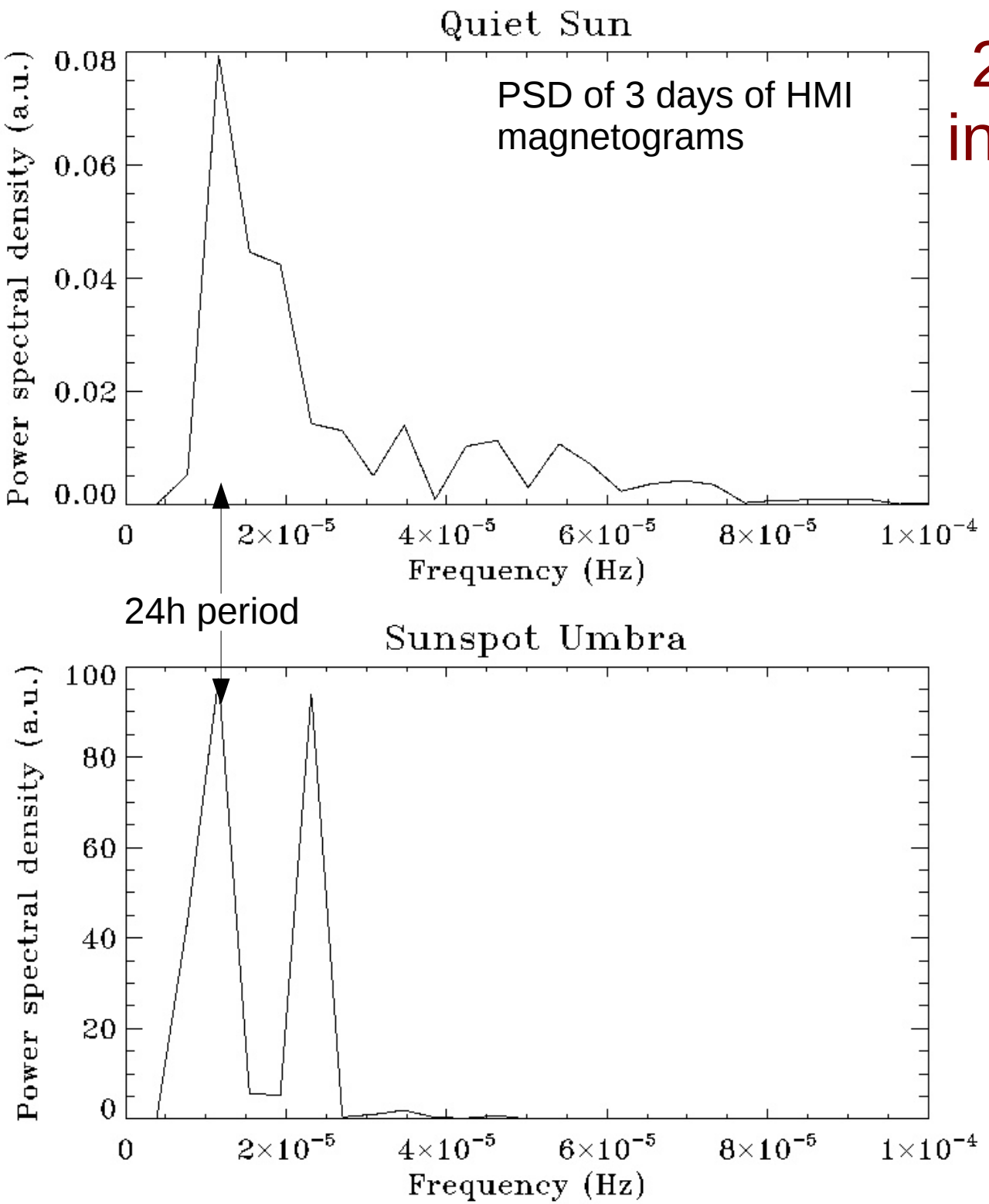
- estimated from HMI rolls
- median velocity across the solar disk varies by about 20 m/s peak-to-peak with CROTA2

Estimate of Doppler Velocity Error Due to Photon Noise



Theoretical estimates of the photon noise on Dopplergrams at 3 different heliographic longitudes and for the MDI-like algorithm

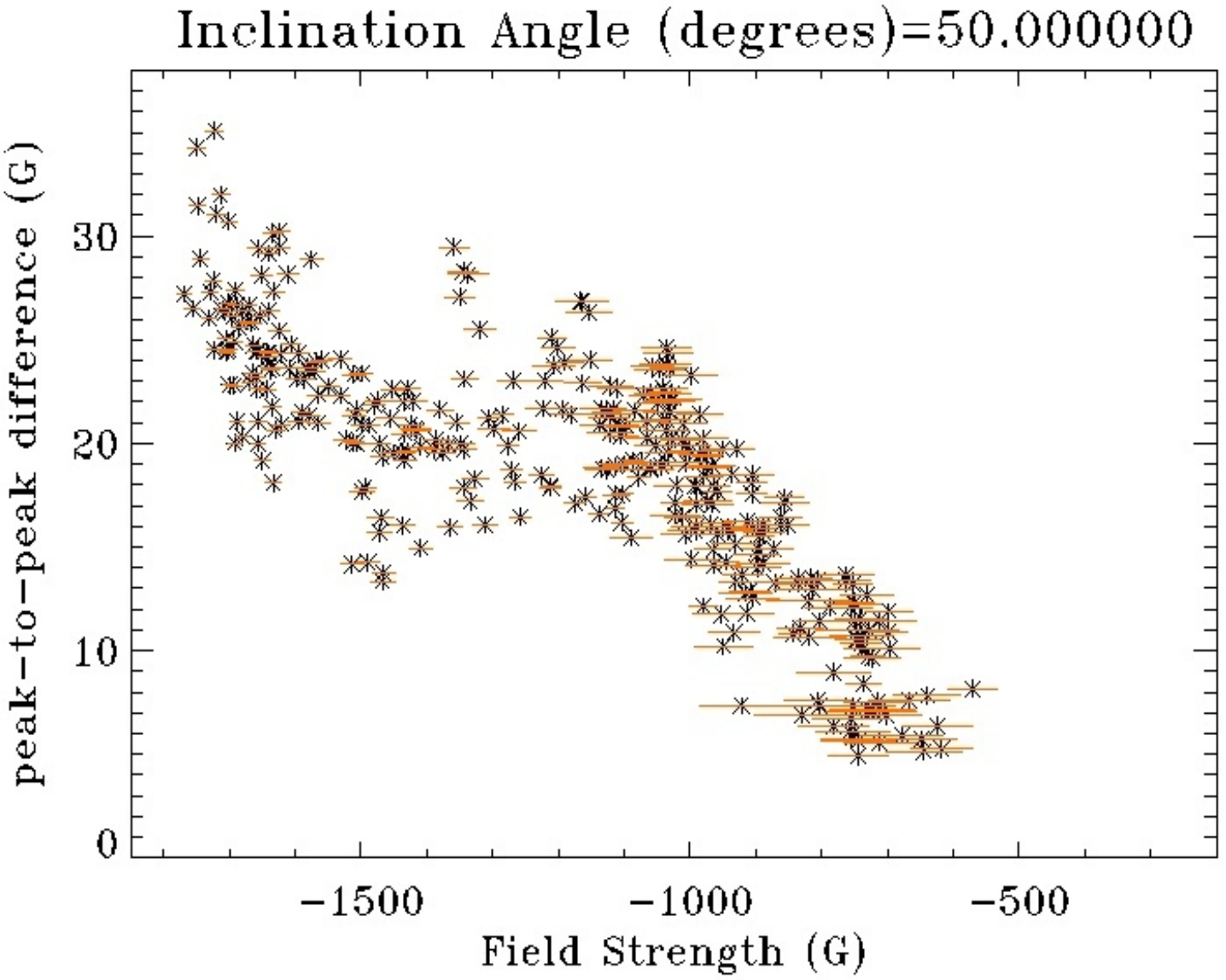
24 Hour Oscillations in Magnetograms and Dopplergrams



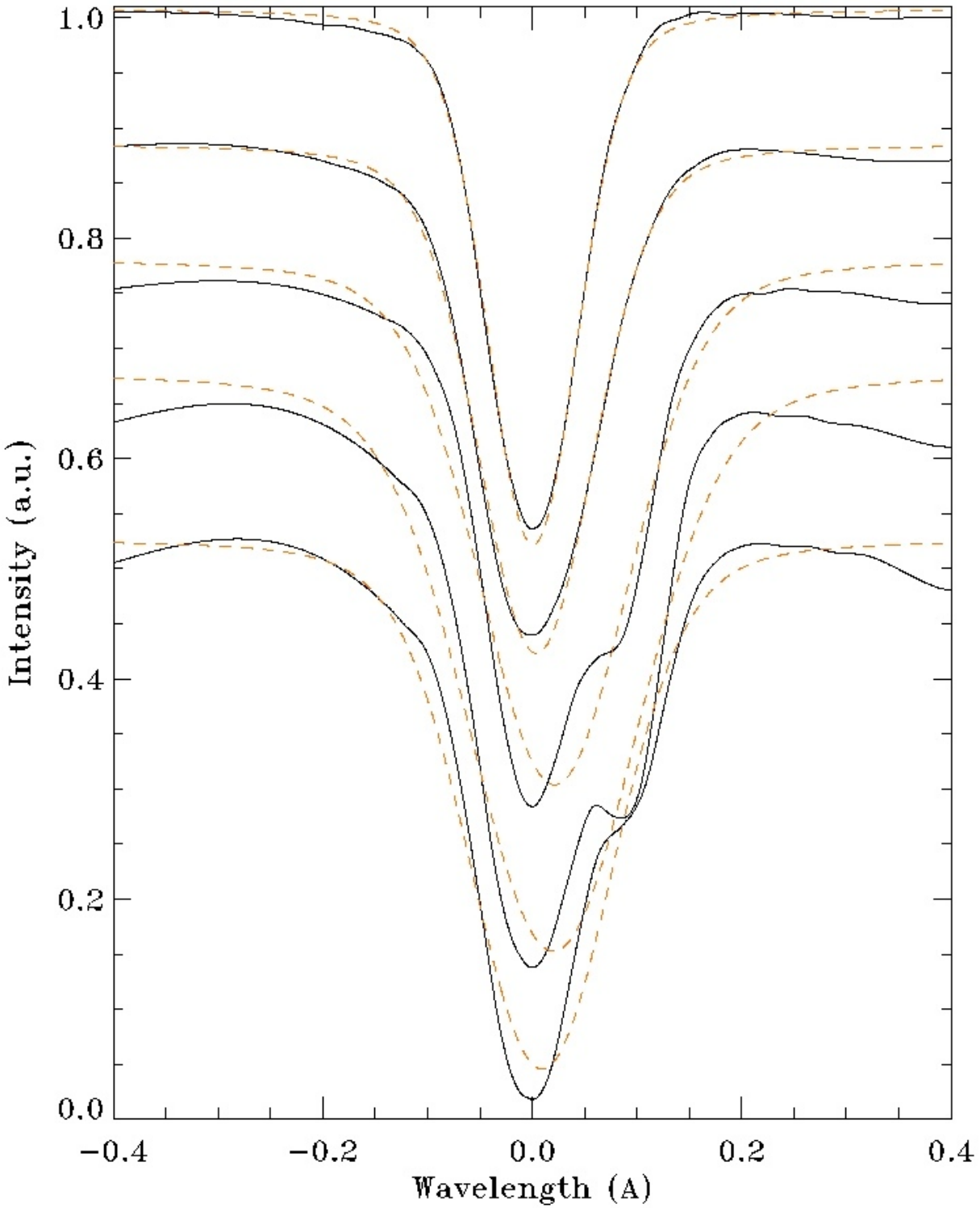
- presented by Phil

Here, I just summarize origin of problem :

- uncertainty on filter transmission profiles
- uncertainty on Fe I line profile
- problems with the polynomial correction
- oscillations larger in sunspot than quiet Sun.
- sunspots also affected by: saturation due to limited dynamic range of HMI

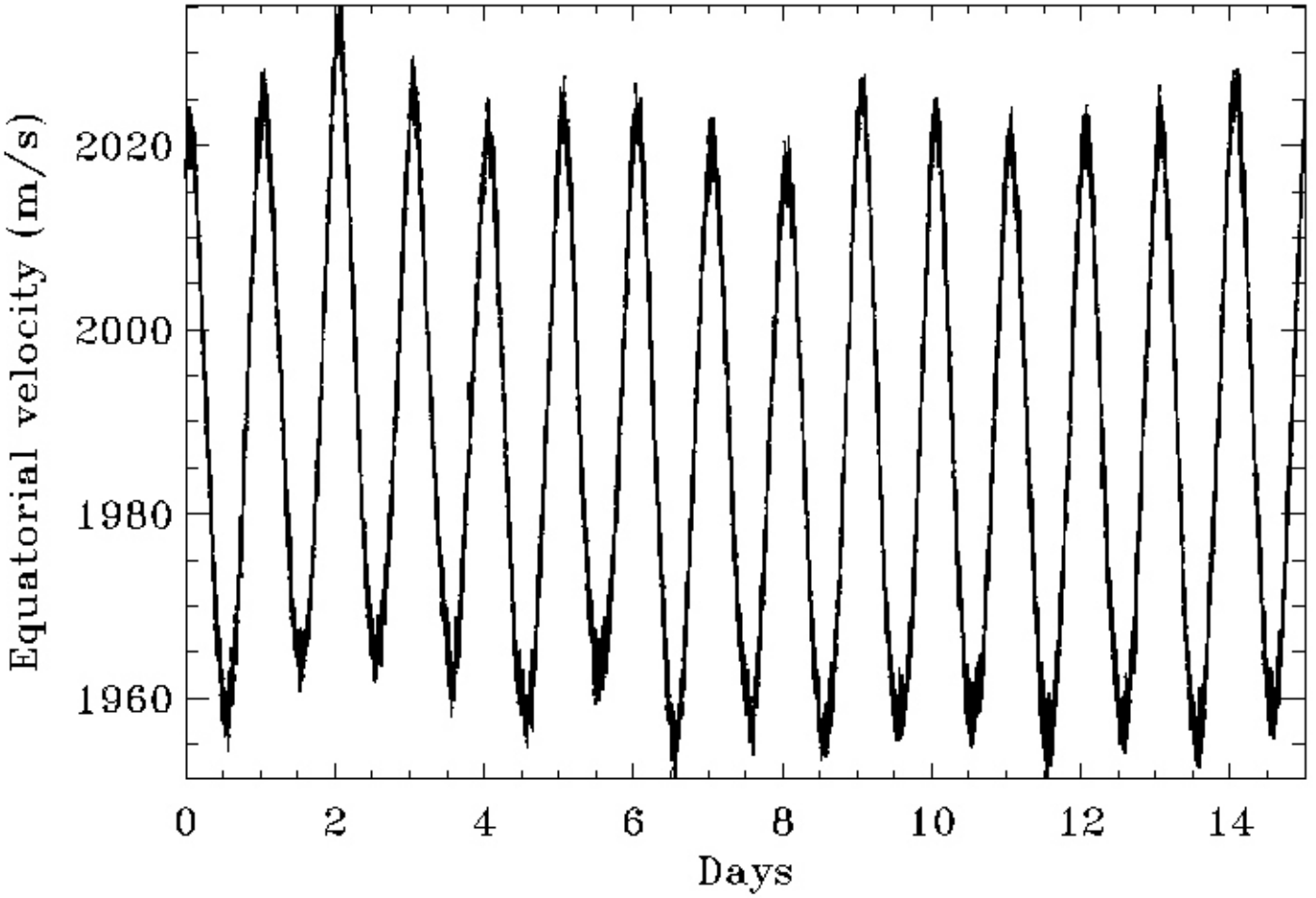


Analysis done with IBIS data (from Wachter & Rajaguru) on June 8, 2007 of NOAA 10960, and with HMI data: 3 days of December 2011, on NOAA 11384
Obtained from MDI-like algorithm applied to LCP and RCP line profiles observed by IBIS

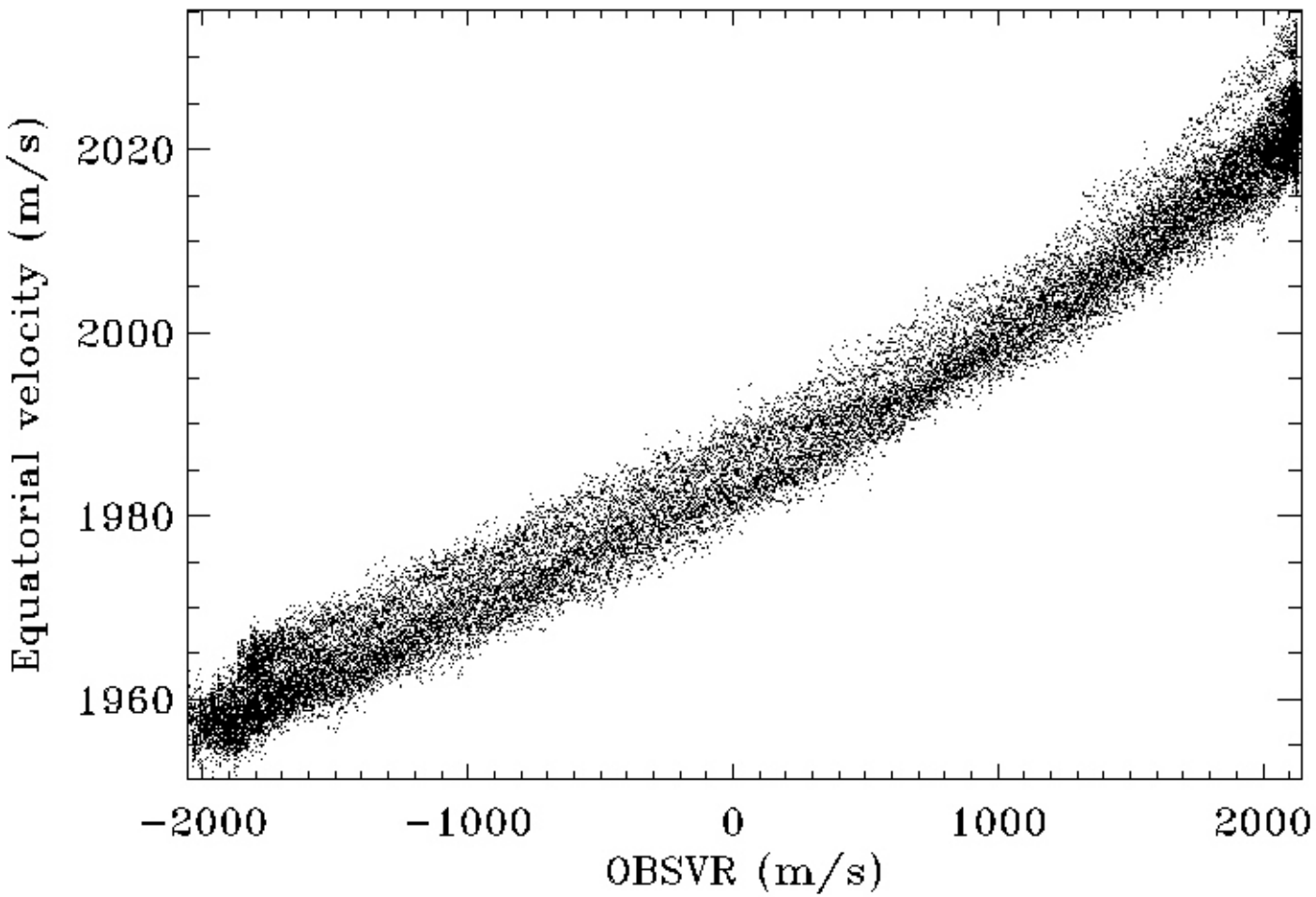


Fe I line profile observed by IBIS at different locations in the quiet Sun and in NOAA 10960.
In red is the result of a fit by a Voigt profile.

24 Hour Oscillations in Solar Rotation Rate

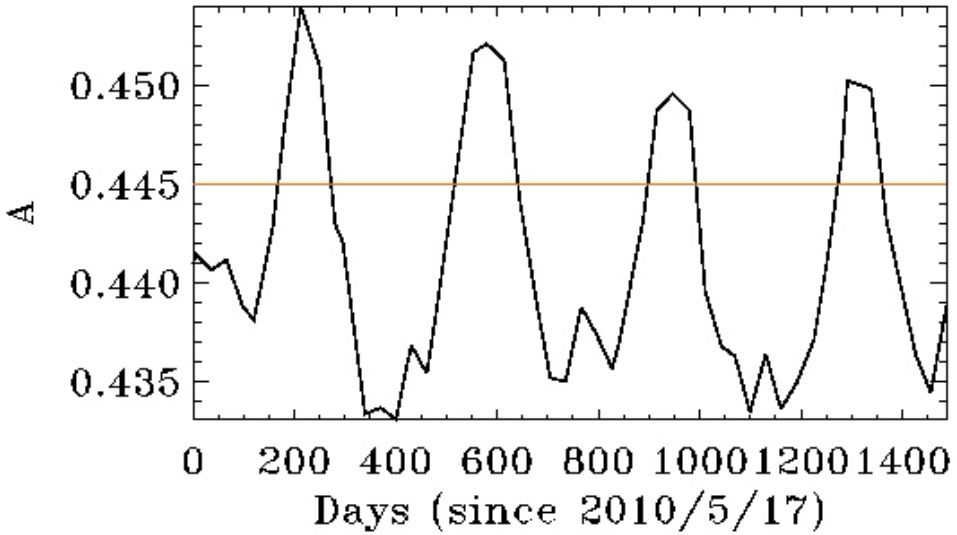


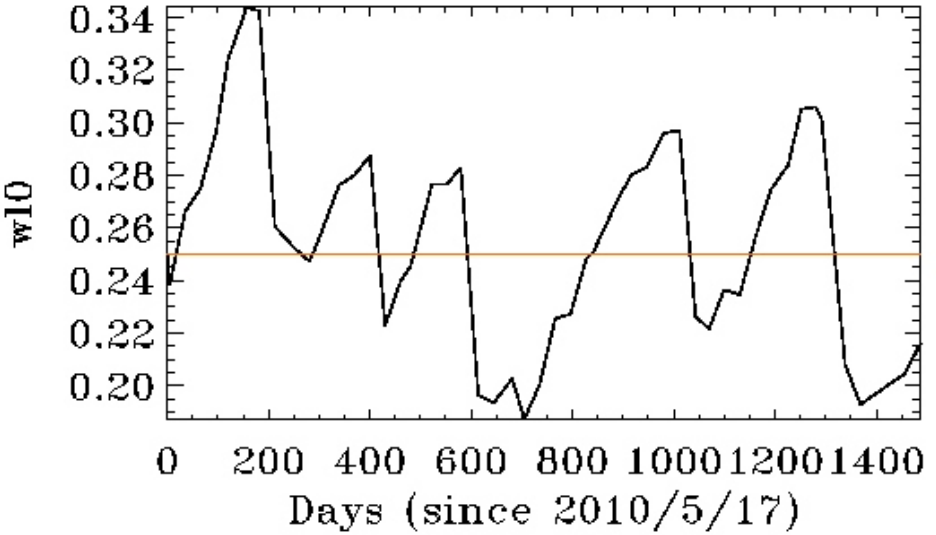
15 days of solar equatorial rotation velocity, produced by Phil's code
Calibration is poor near limb (for instance, center-to-limb variation of Fe I line is poorly known, and therefore look-up tables are probably sub-optimal)

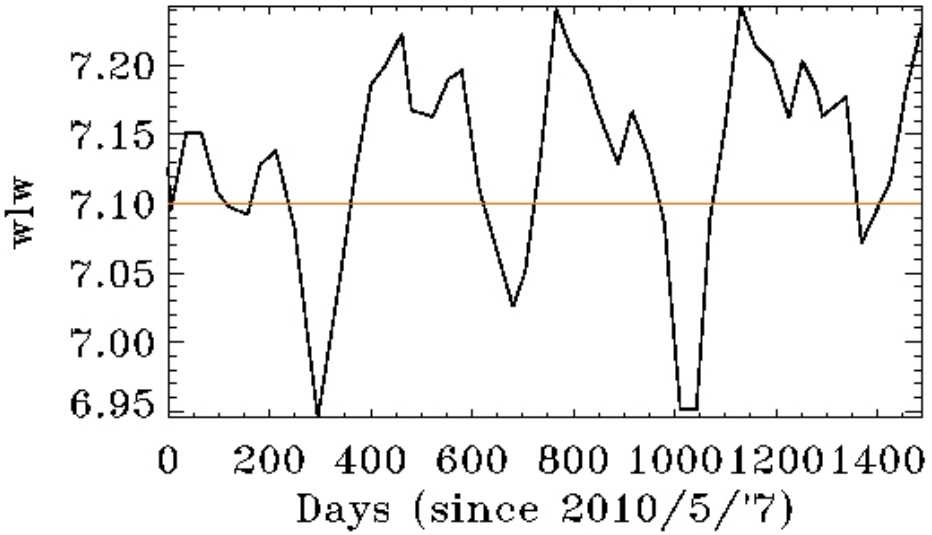


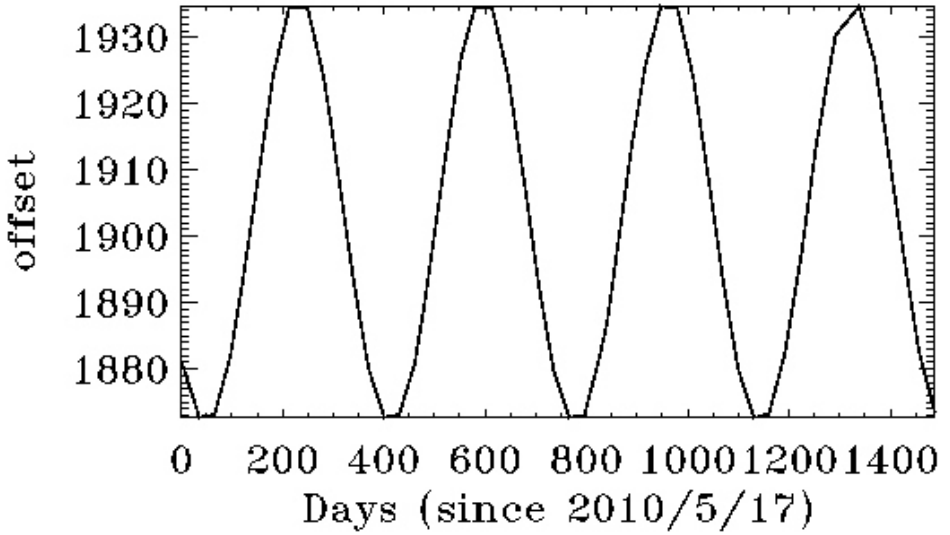
Equatorial rotation velocity as a function of the Sun-SDO radial velocity (15 days worth of data).

Height of Formation Correction



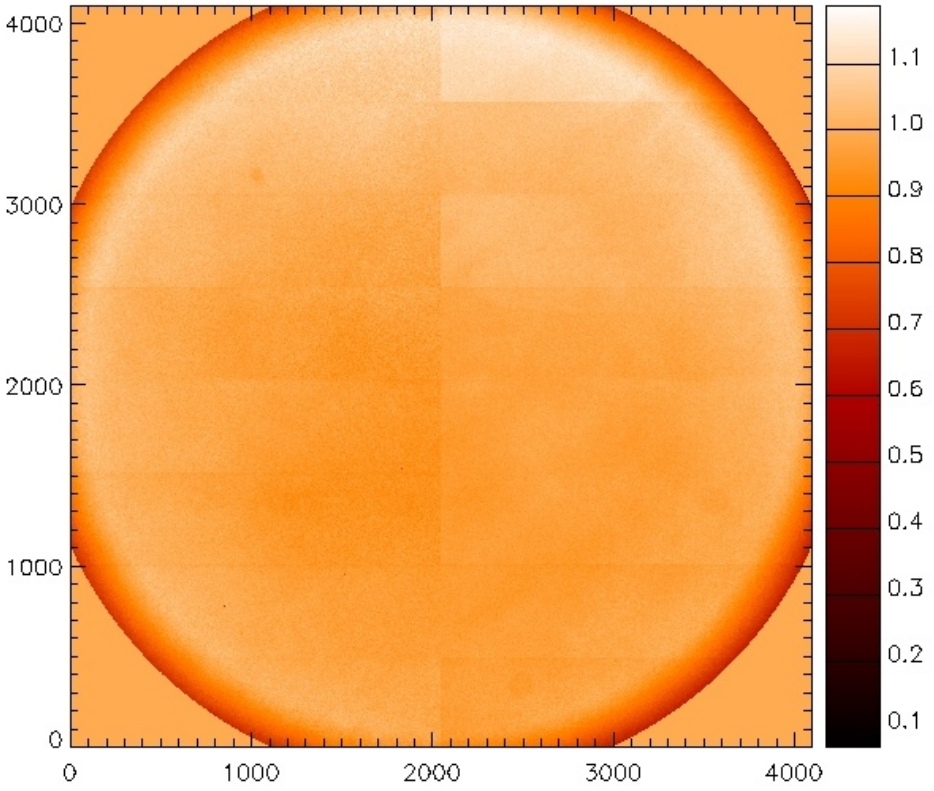


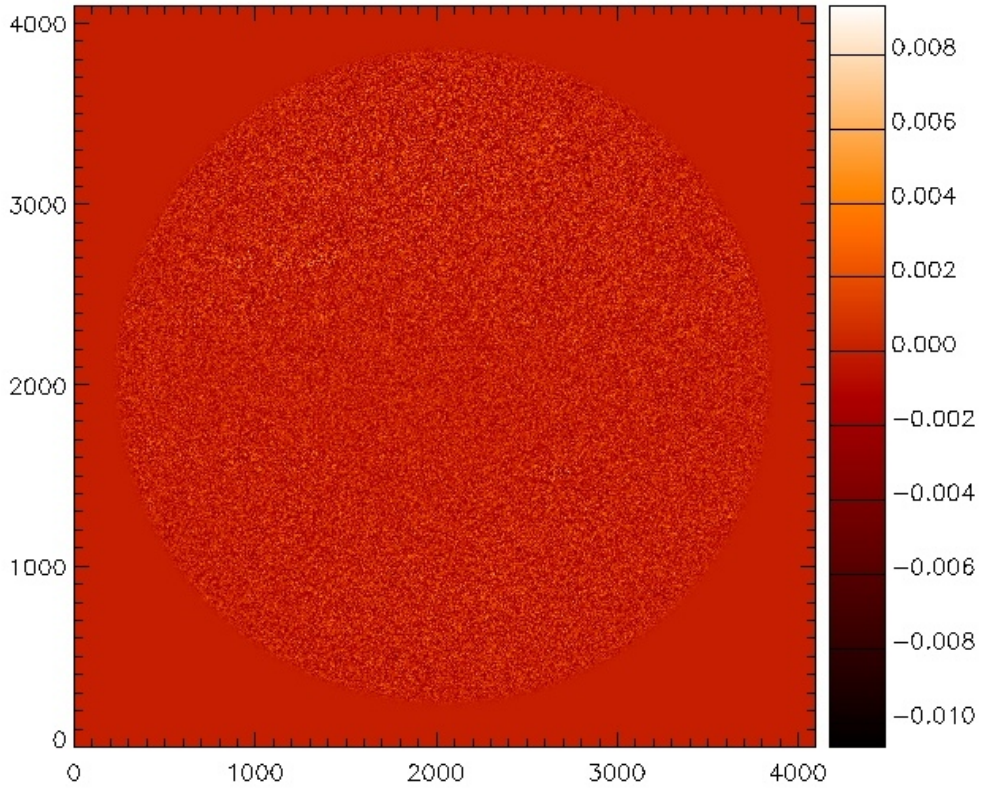




R_SUN= R_SUN-0.445*exp(-(wl-10.-OBS_VR/(0.690/6173.*3.e8/20.)-wl0)^2/wlw)
Error on the correction translate into slight mis-registrations (up to about 0.02 pixels) with an annual period

Residual Flat Field Error





Difference between PZT/offpoint flat-field and rotational flat field is less than 0.1%
-> this satisfies requirements