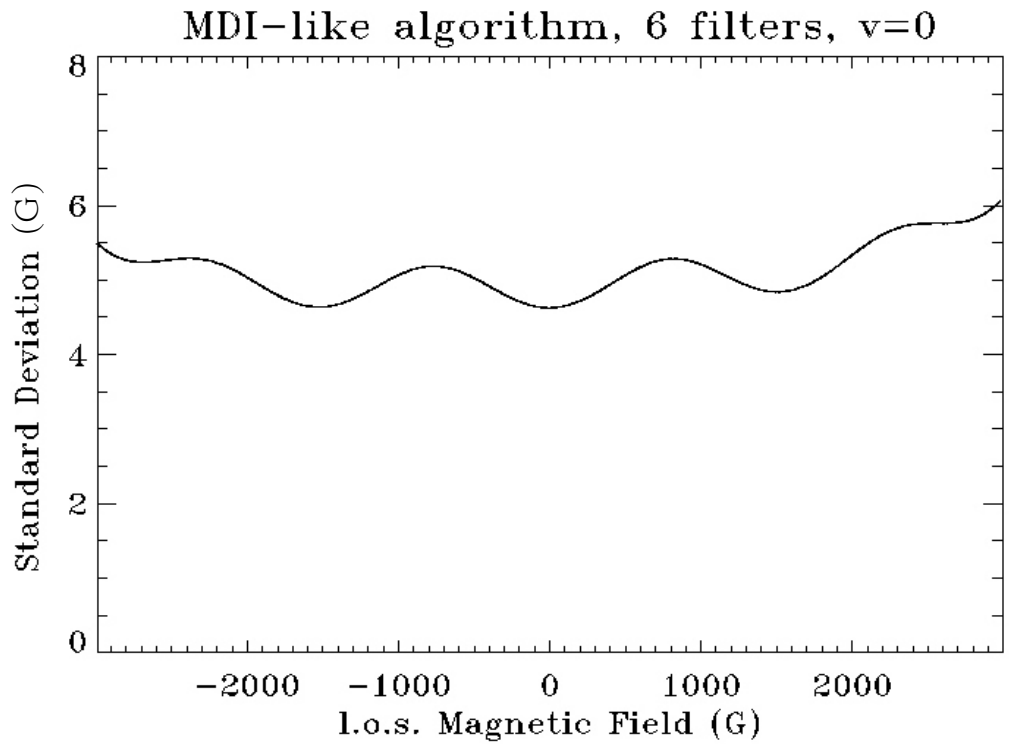
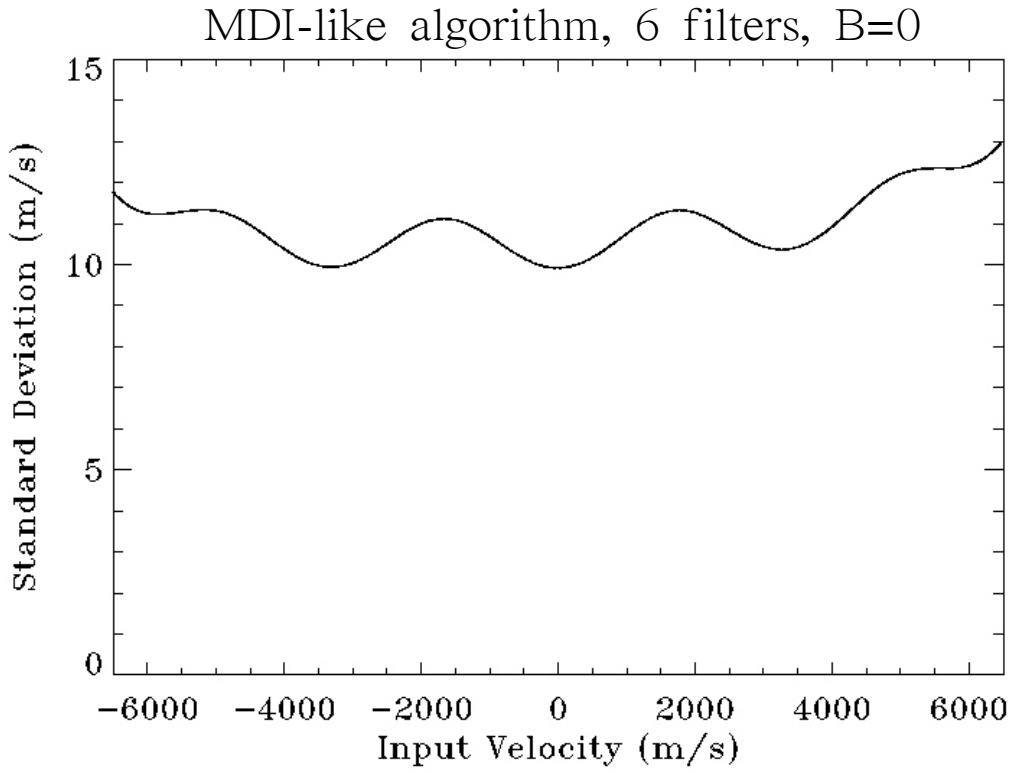
Errors on Doppler Velocity, l.o.s. Magnetic Field Strength, and Continuum Intensity





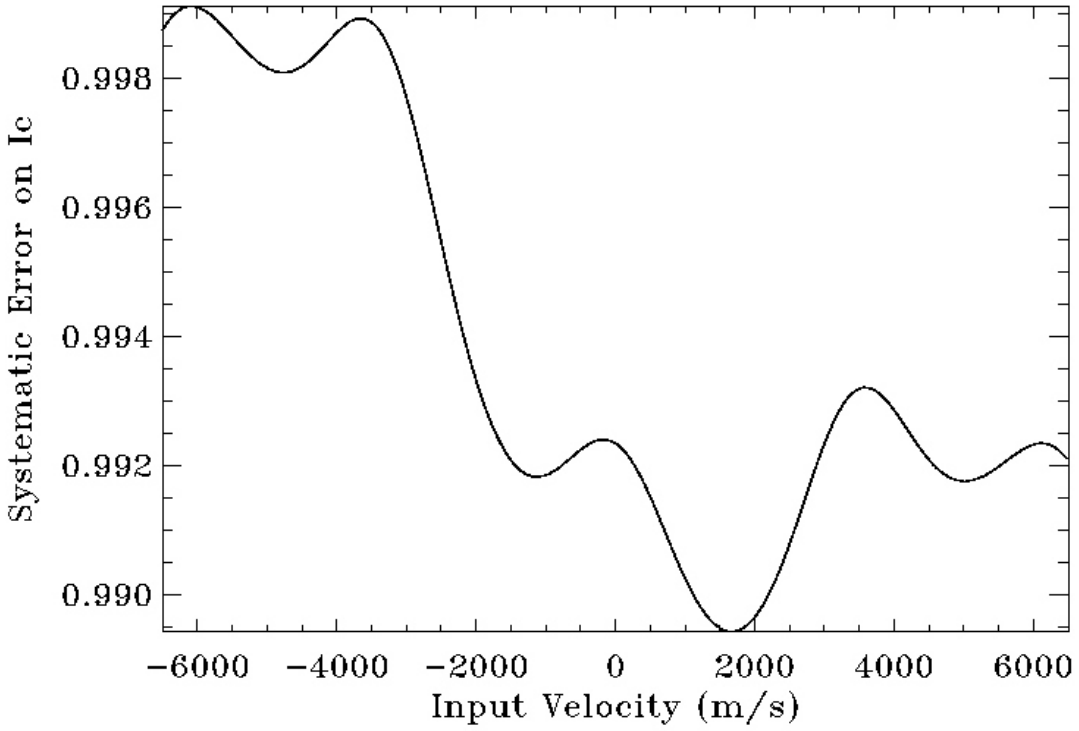
Error on Doppler velocity and l.o.s. field strength, with MDI-like algorithm and 6 filters.
“Best case” scenario:
- perfect knowledge of HMI filter system
- error due to photon noise only (full well of 200,000 electrons)
- at disk center

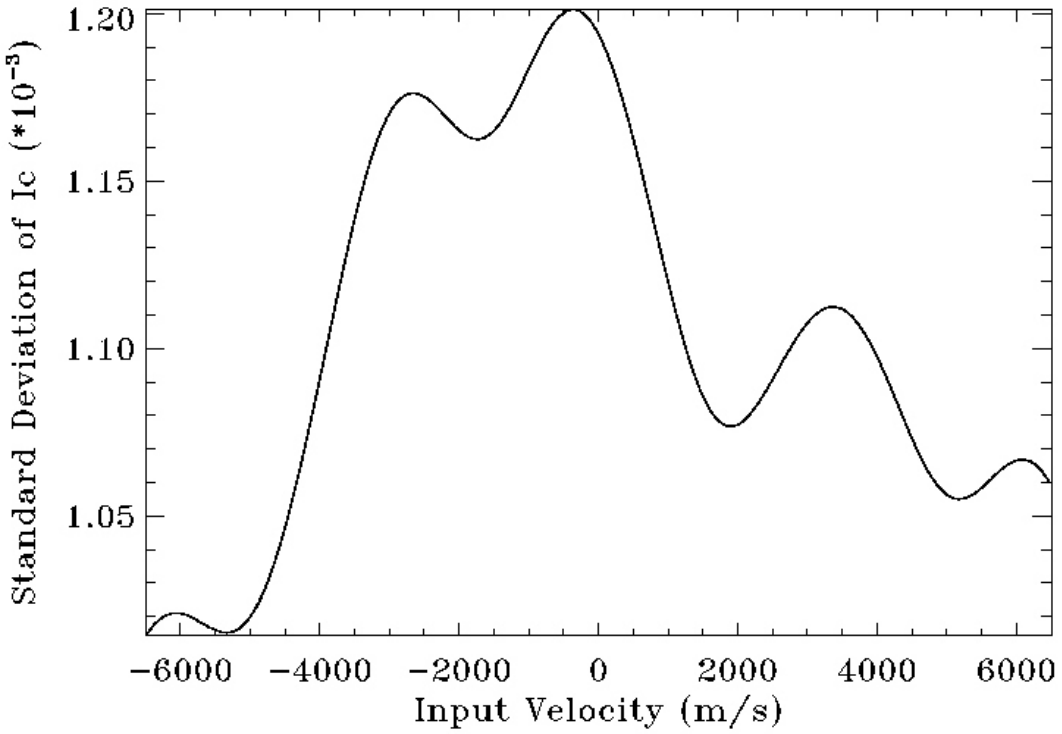
$V = (V_{LCP}+V_{RCP})/2$

$||B||_{l.o.s.} = (V_{LCP}-V_{RCP})*0.2314$

$\Rightarrow \sigma_B = 2 * 0.2314 * \sigma_V$

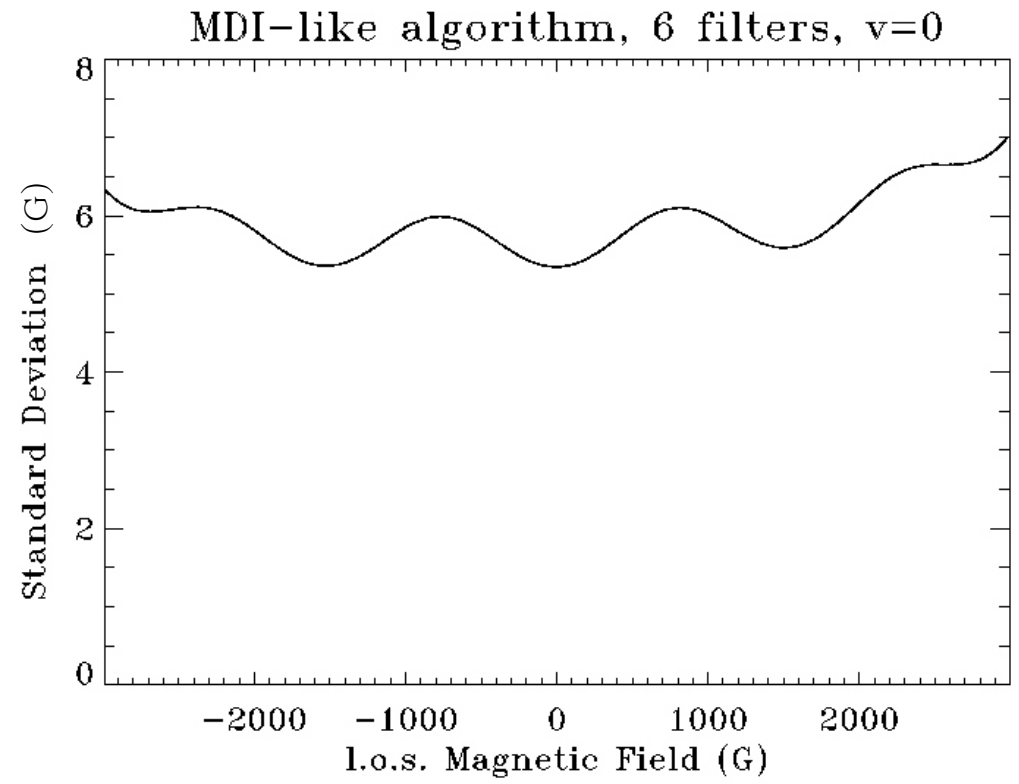
NB: 6500 m/s <=> 3000 G

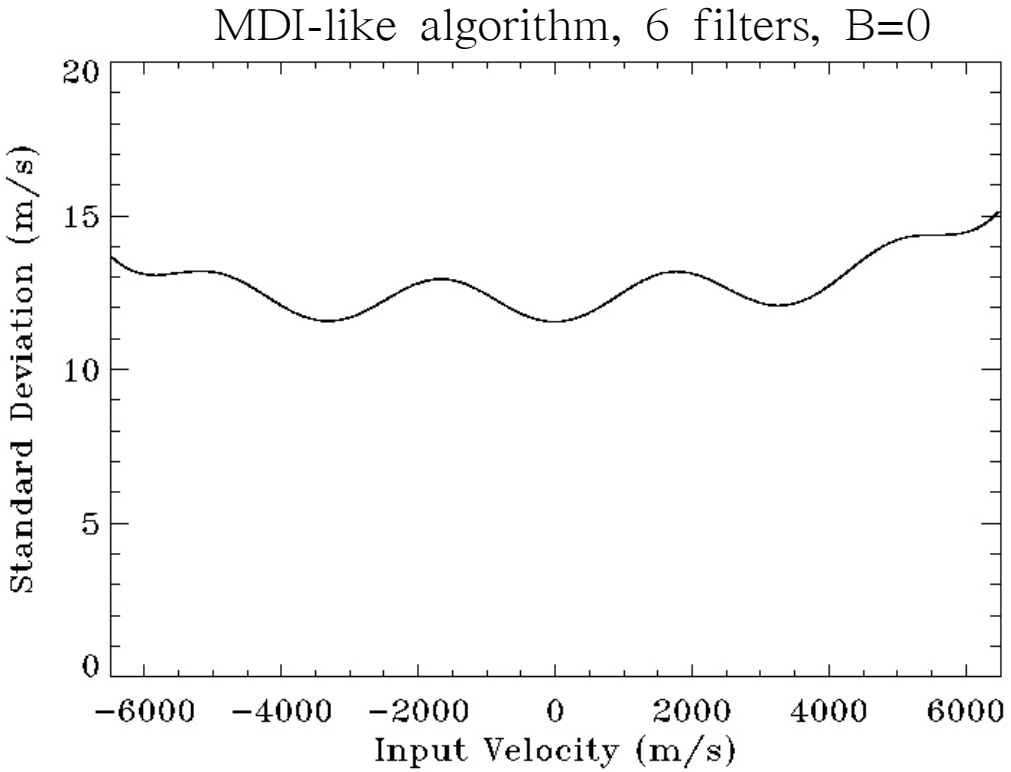




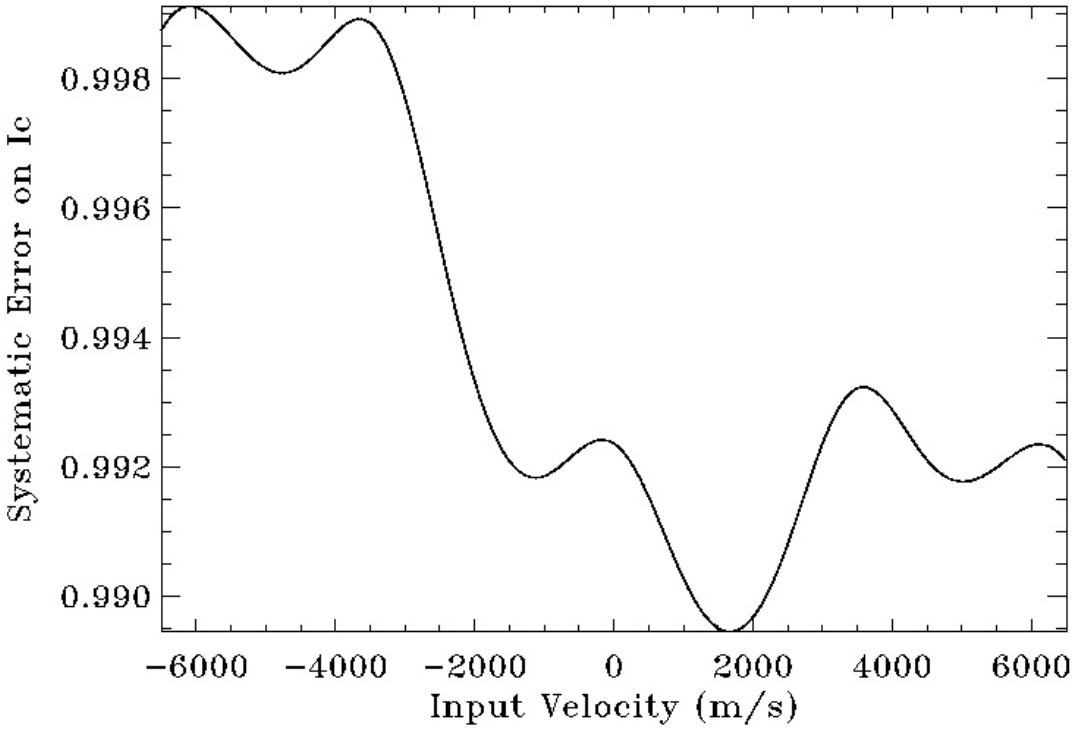
Error on continuum intensity Ic, when Fe I line modeled as $I(\lambda)=Ic-Id*\exp(-\lambda^2/\sigma^2)$

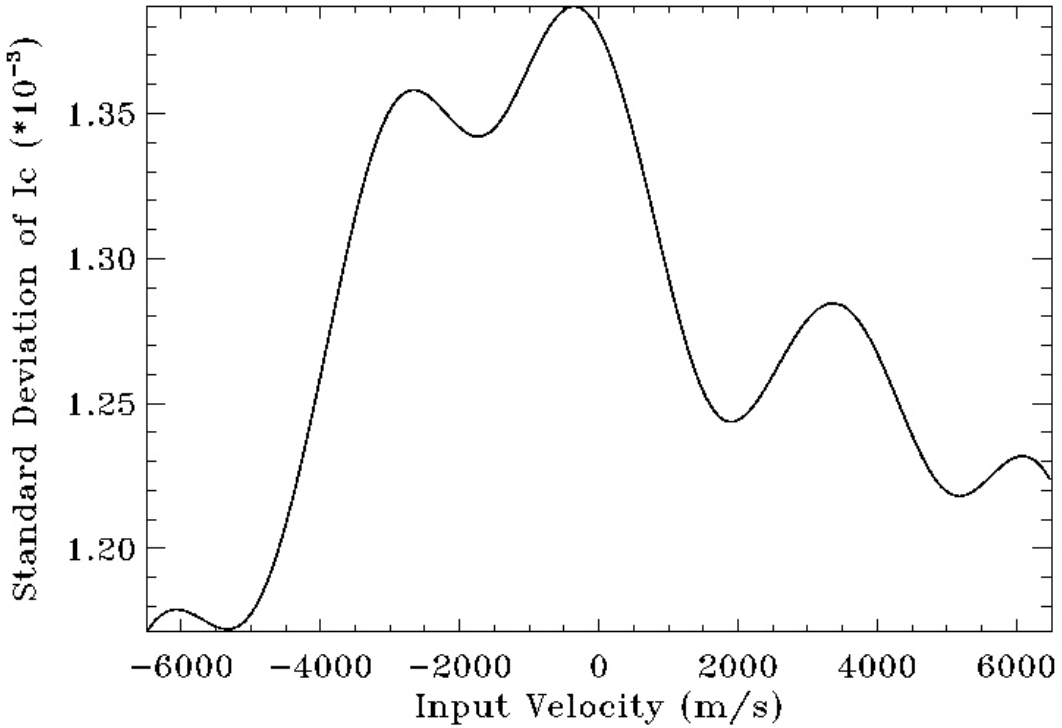
at disk center, B=0, full well= 200,000 electrons





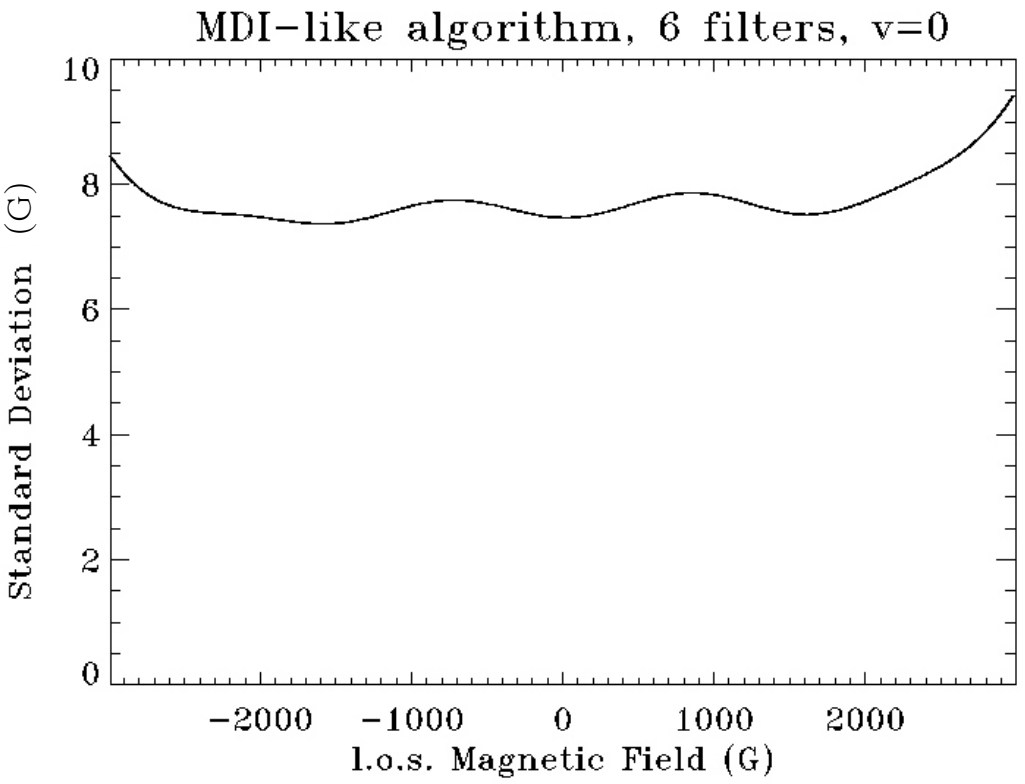
Errors on the Doppler velocity determination in the best case scenario, but with a lower full well (150,000 electrons)

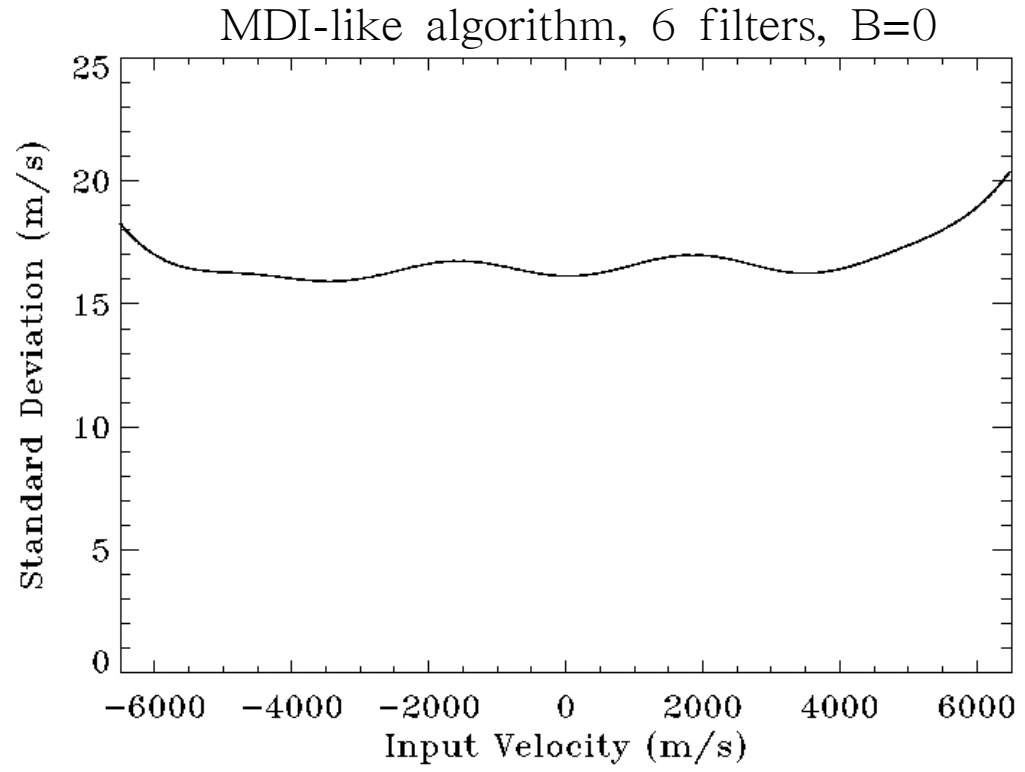




Error on continuum intensity Ic, when Fe I line modeled as $I(\lambda)=Ic-Id*\exp(-\lambda^2/\sigma^2)$

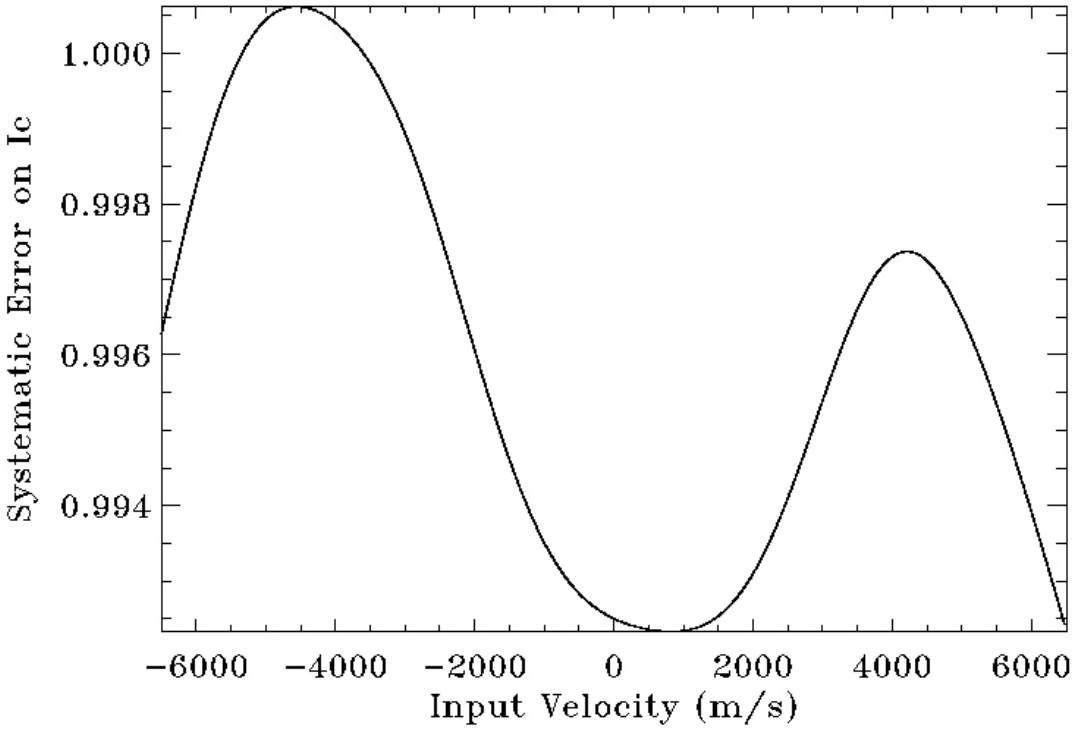
at disk center, B=0, full well= 150,000 electrons

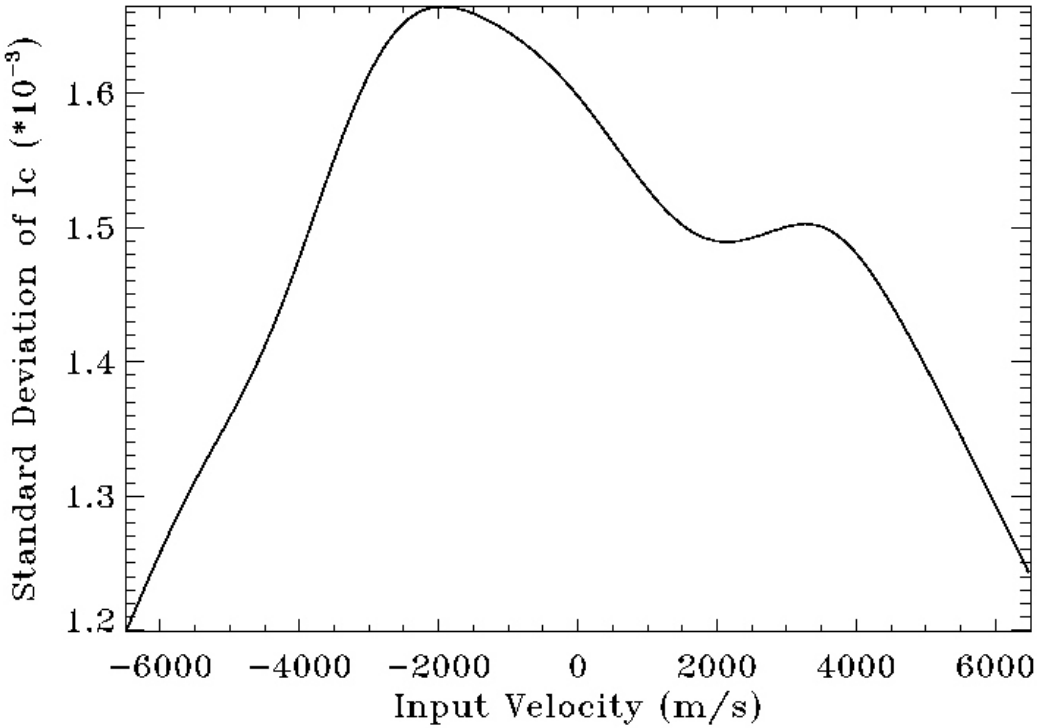




Error on Doppler velocity and l.o.s. B. At 60° from disk center. Effects of:
-solar line broadening
-limb darkening

(full well= 200,000 electrons)

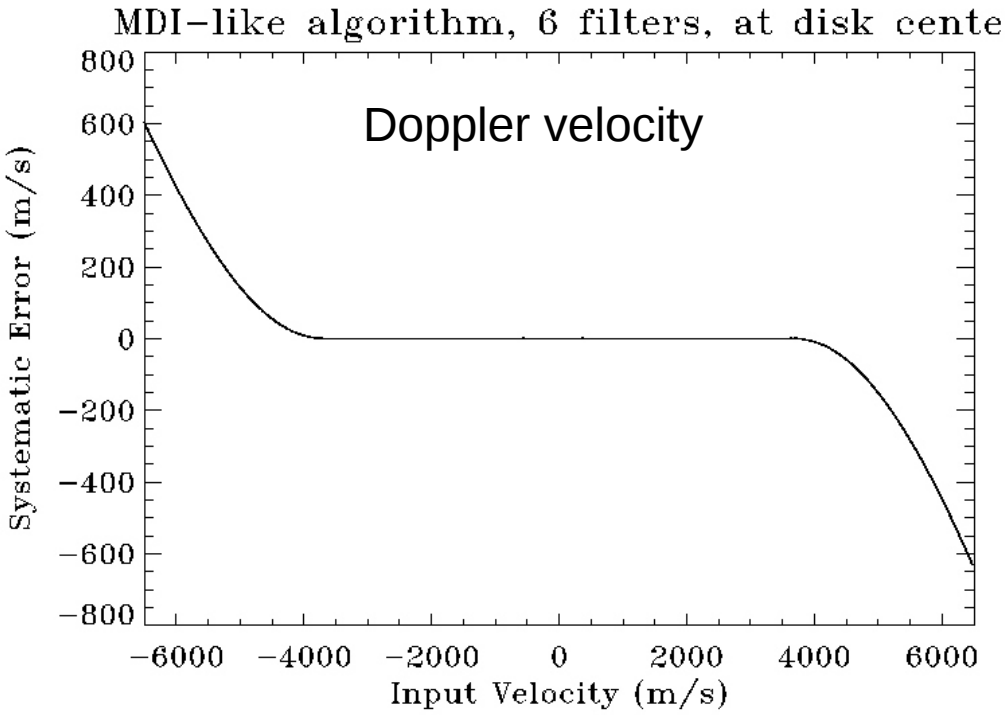


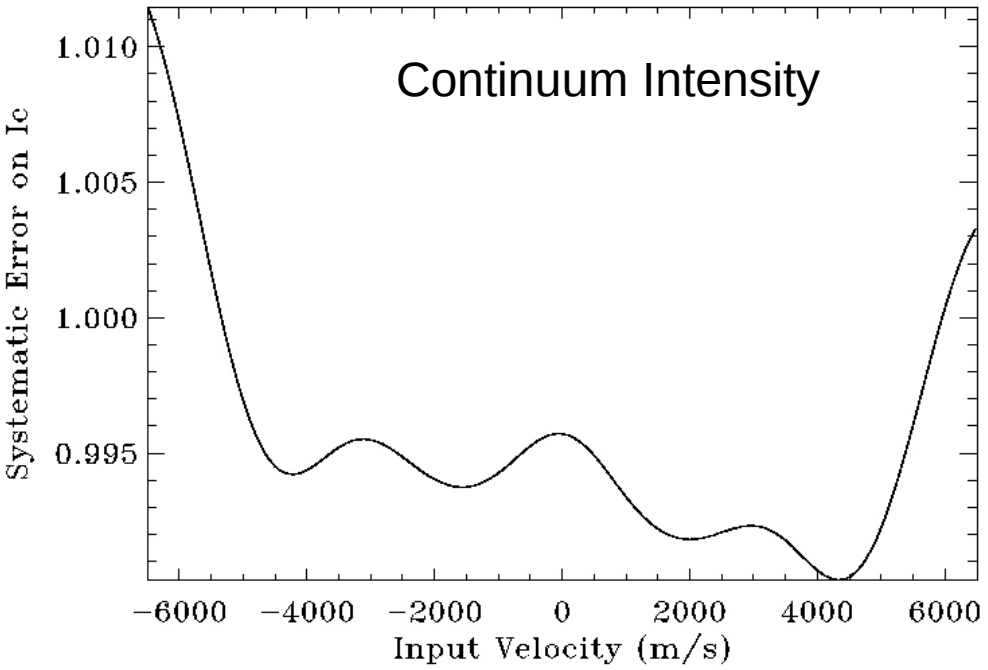


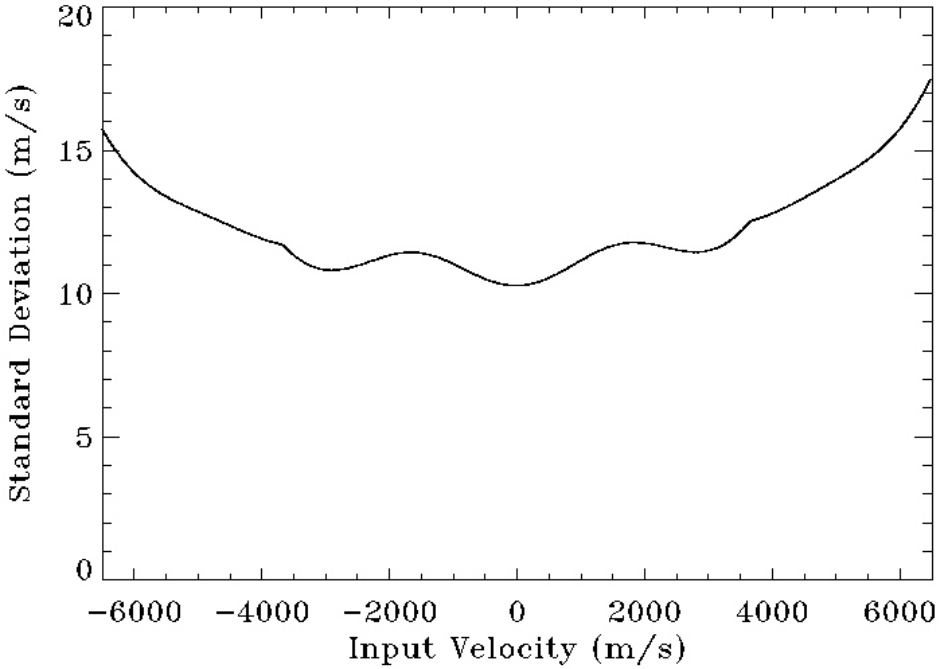
Error on continuum intensity.
At 60° from disk center. Effects of:
-solar line broadening
-limb darkening

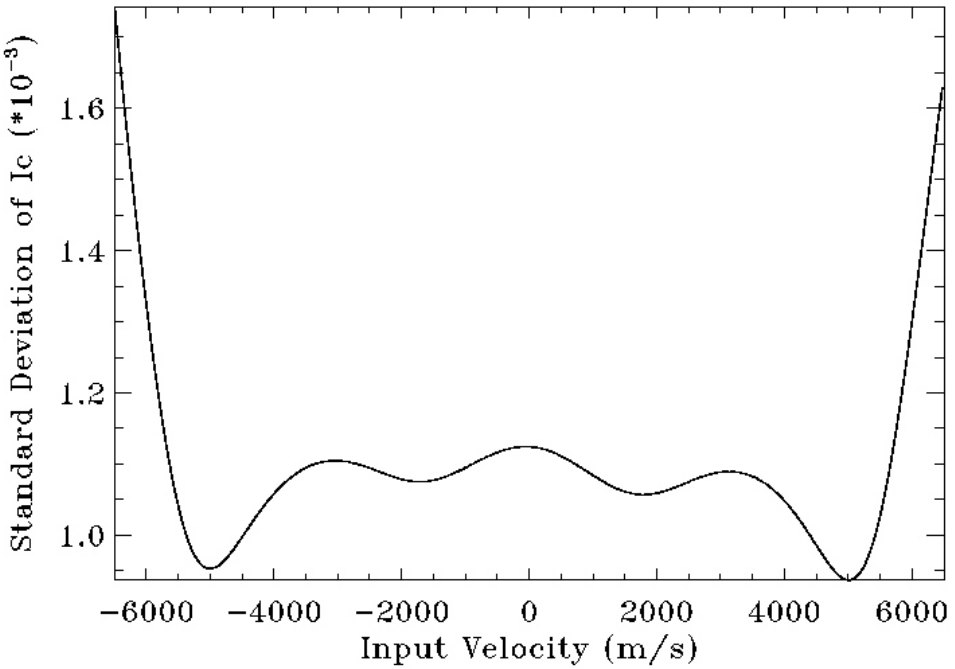
(full well= 200,000 electrons)

Impact of magnetic field: B = 1500 G

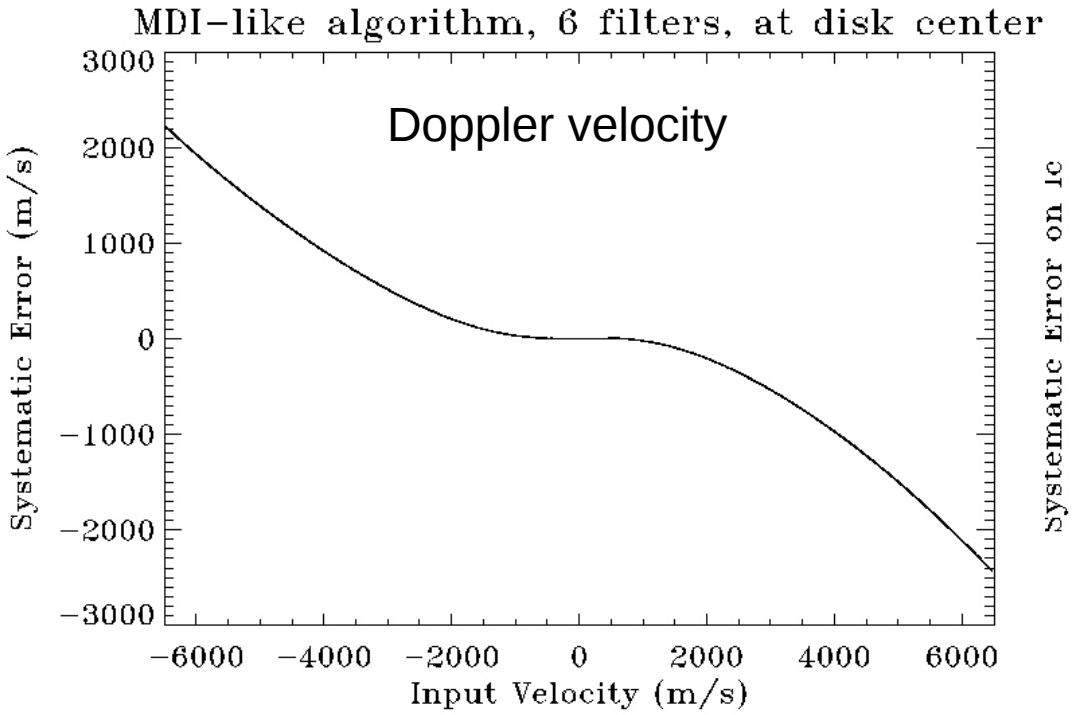


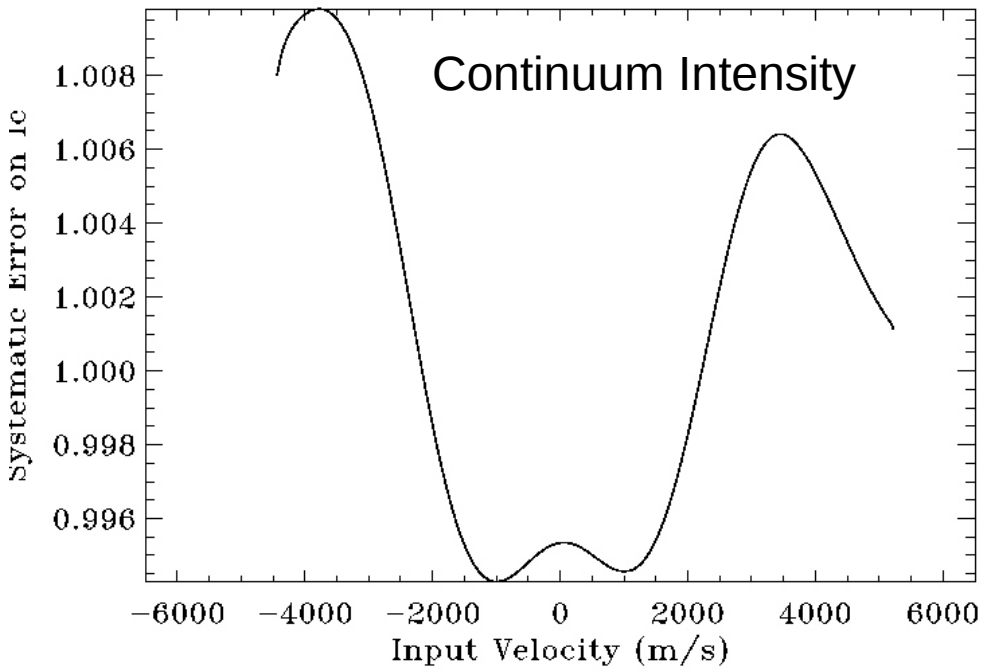


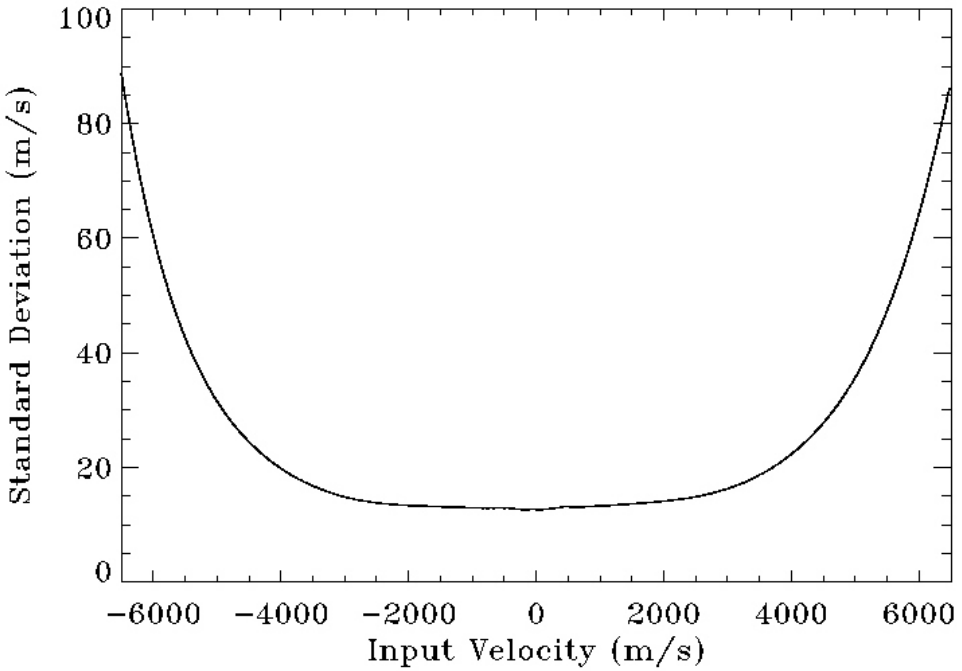


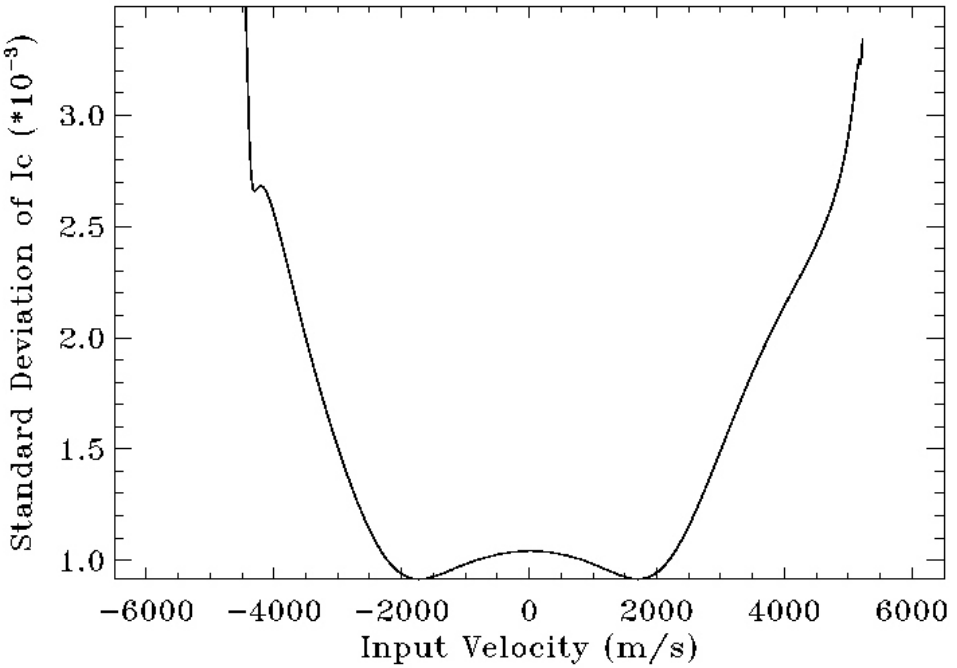


B = 3000 G


MDI−like algorithm, 6 filters, at disk center
Doppler velocity
Systematic Error (m/s)
Input Velocity (m/s)
3000
2000
1000
0
−1000
−2000
−3000
−6000
−4000
−2000
0
2000
4000
6000

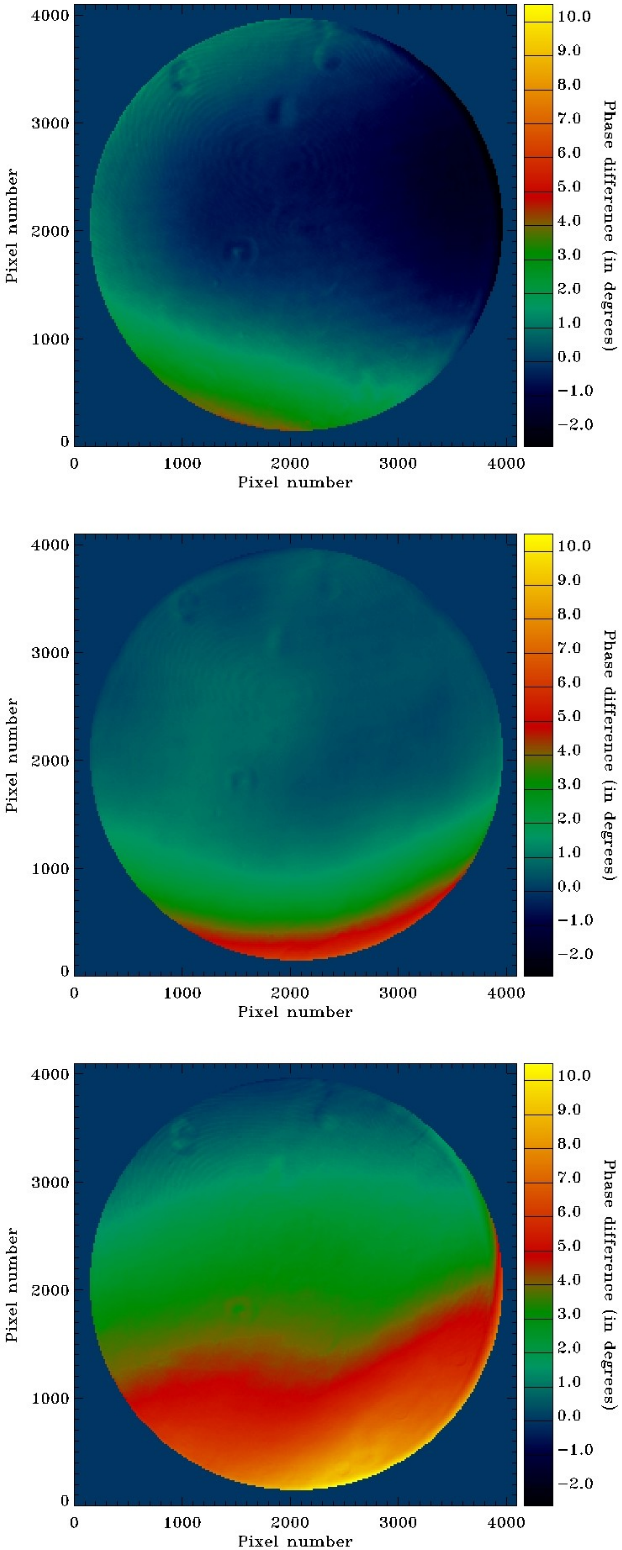

Continuum Intensity
Systematic Error on Ic
Input Velocity (m/s)
1.008
1.006
1.004
1.002
1.000
0.998
0.996
−6000
−4000
−2000
0
2000
4000
6000


Standard Deviation (m/s)
Input Velocity (m/s)
100
80
60
40
20
0
−6000
−4000
−2000
0
2000
4000
6000


Standard Deviation of Ic (*10⁻³)
Input Velocity (m/s)
3.0
2.5
2.0
1.5
1.0
−6000
−4000
−2000
0
2000
4000
6000

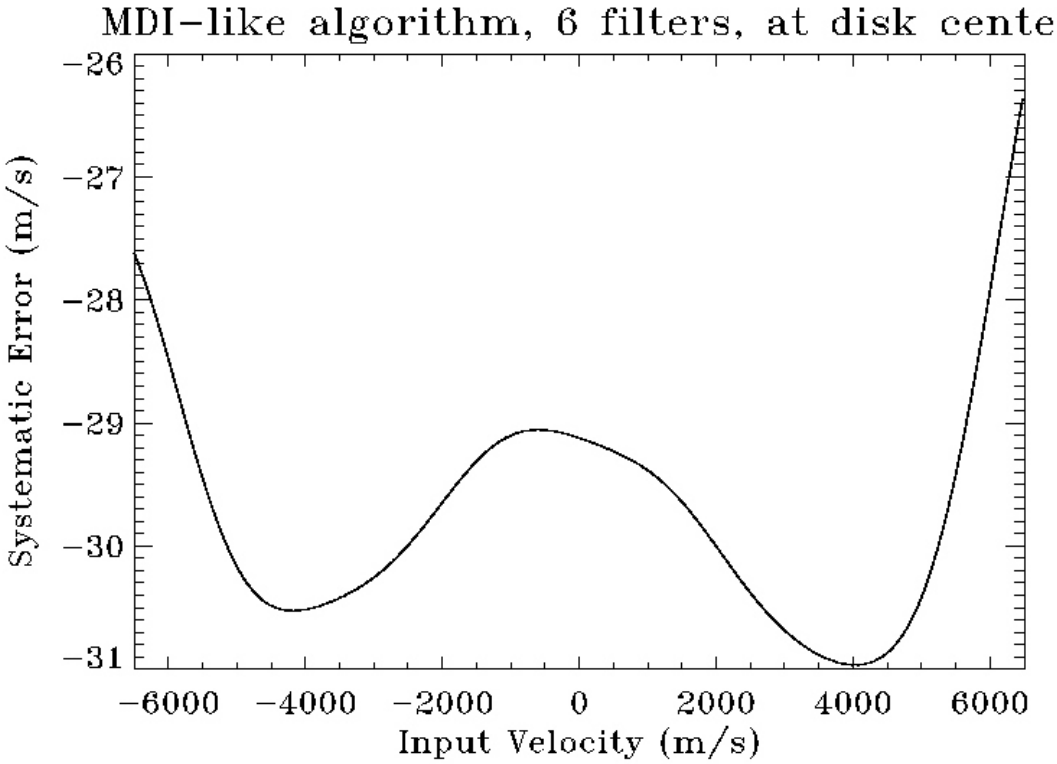
Some Selected Sources of Error on the Observables and Their Impact on the Doppler Velocity

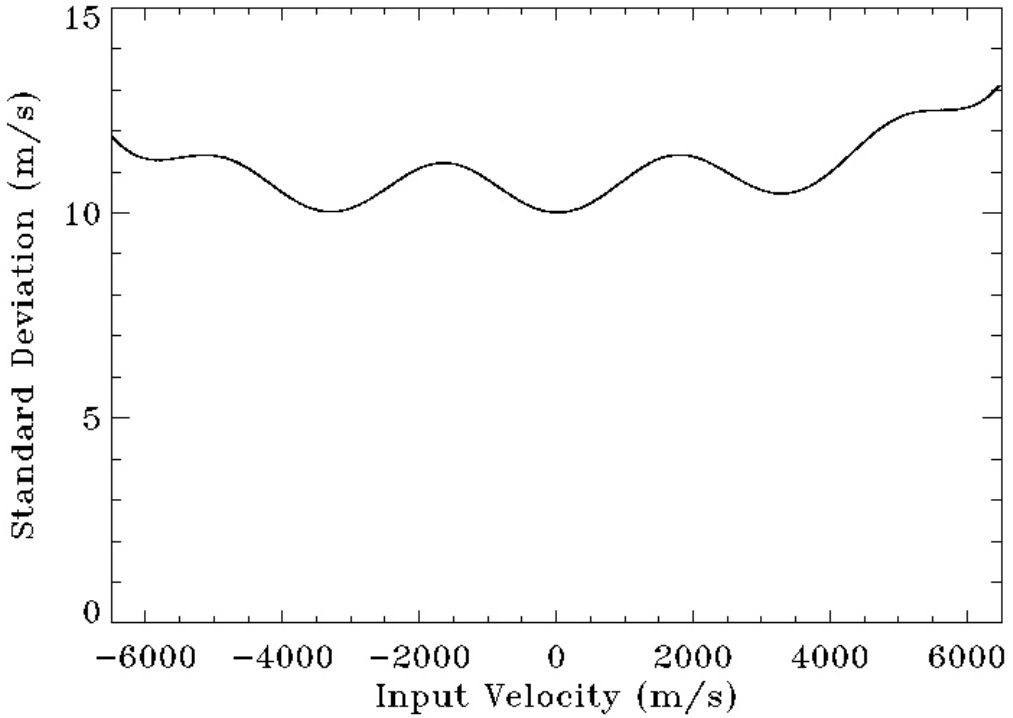
- Error on the determination of the phases and contrasts of the filter elements (*e.g.*, difference between Obsmode and Calmode)
- Presence of I-ripples not accounted for
- Simplistic model for solar line



Phase differences between
Calmode and Obsmode

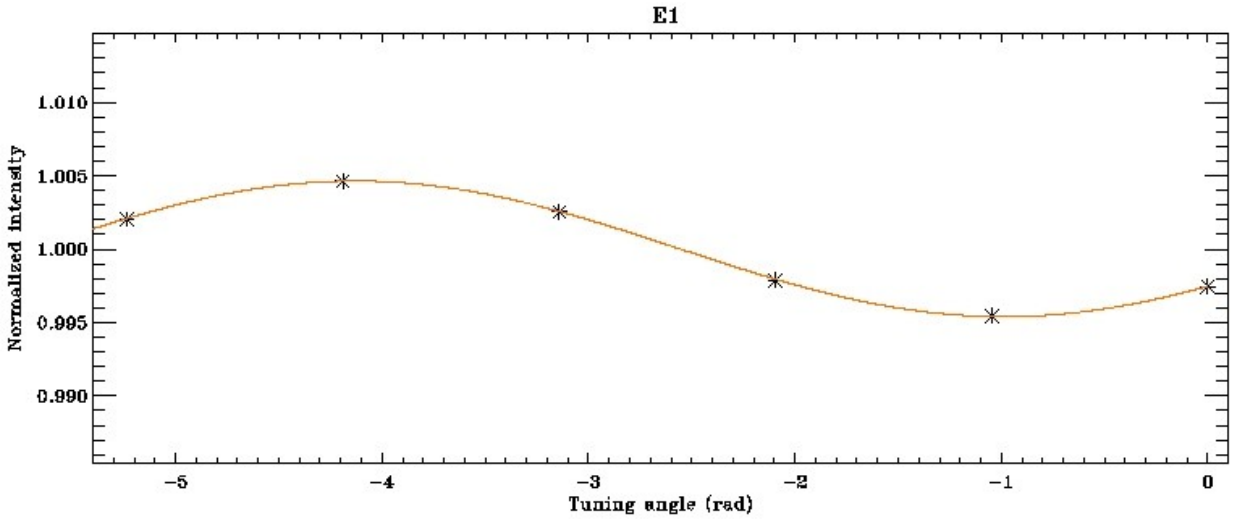
Definition of phase Φ:
$I(\lambda) = [1+B \cos(2\pi \lambda / FSR + \Phi)]/2$

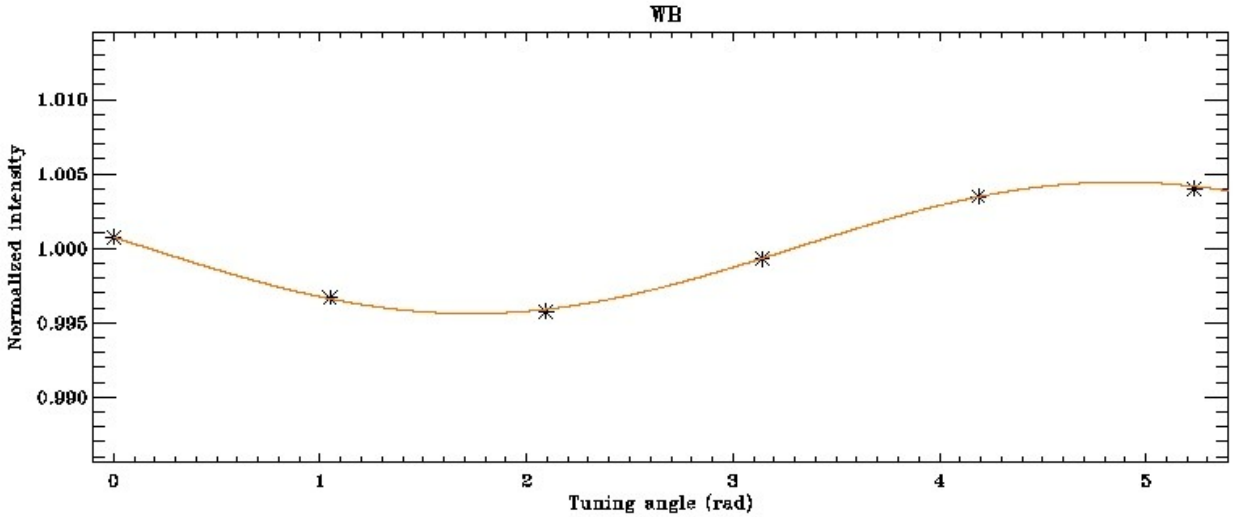


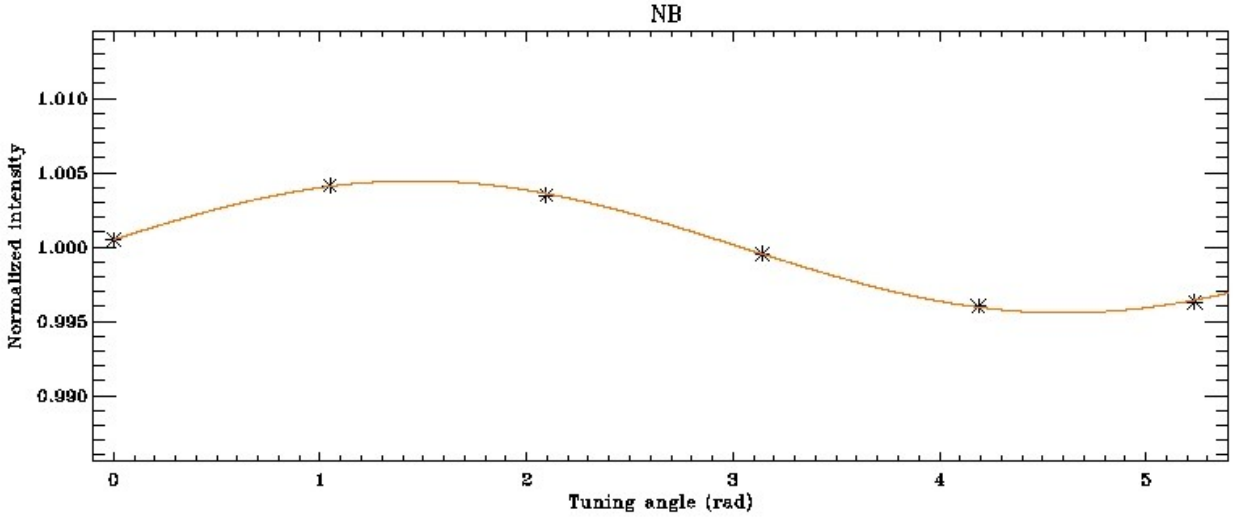


Errors on the Doppler velocity determination when average phase differences between Obsmode and Calmode are not taken into account (1° for NB, 3° for E1).

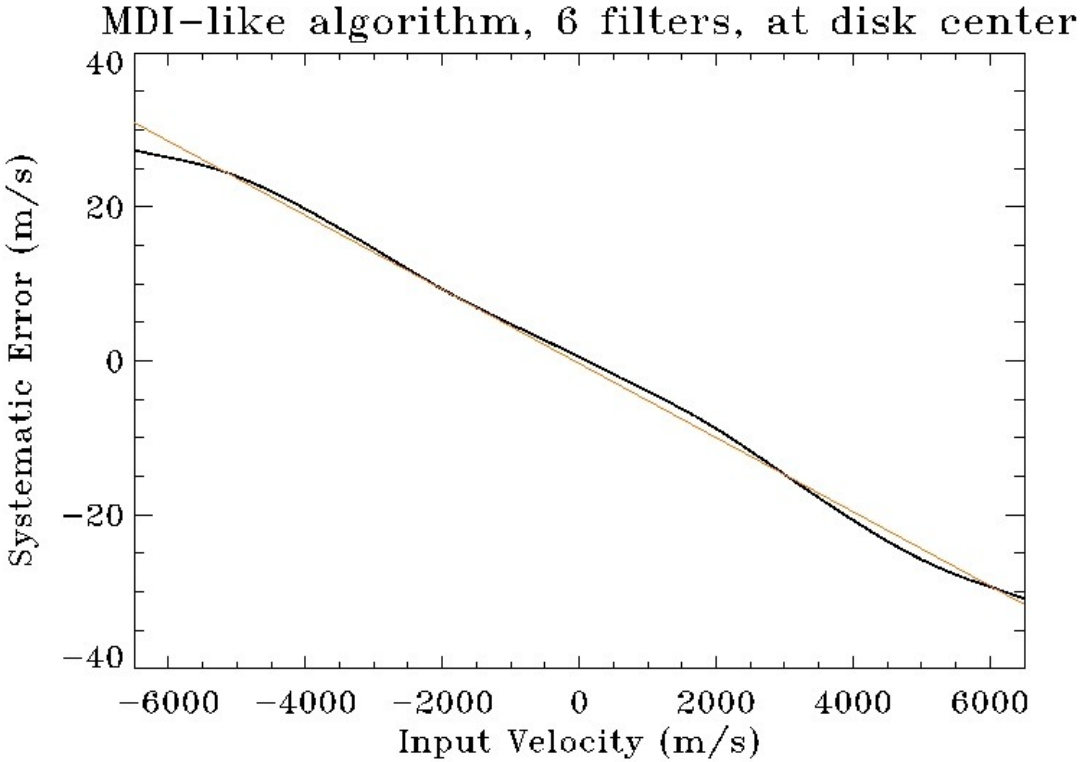
=> almost constant systematic error and no change in std deviation: therefore, not an issue

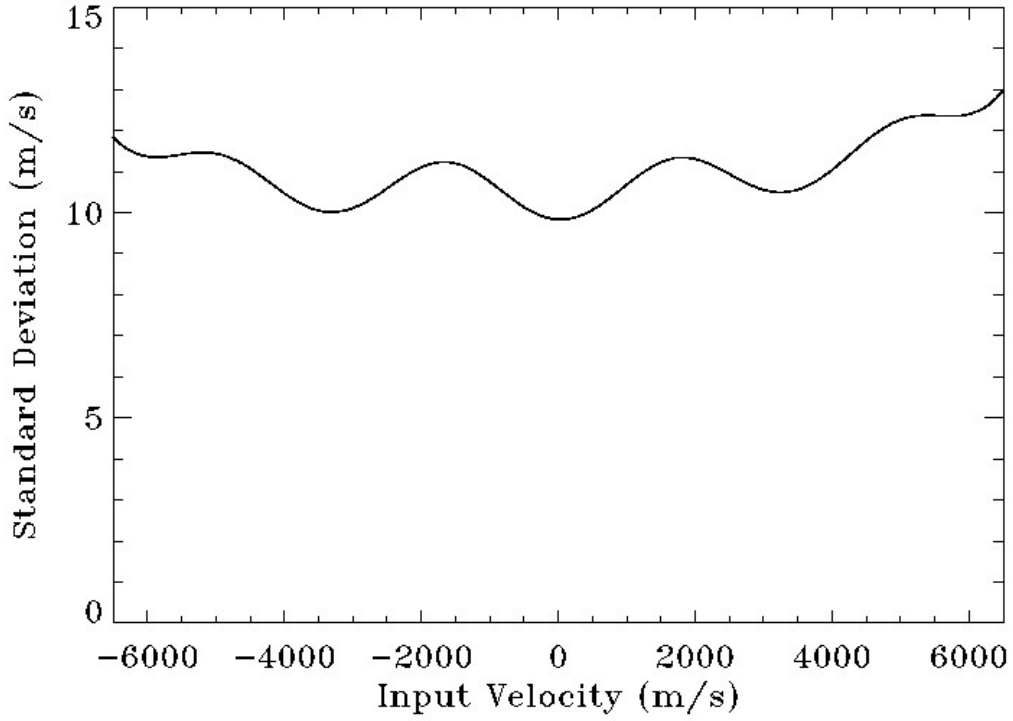






Individual I-ripples:
0.985%
0.858%
0.839%

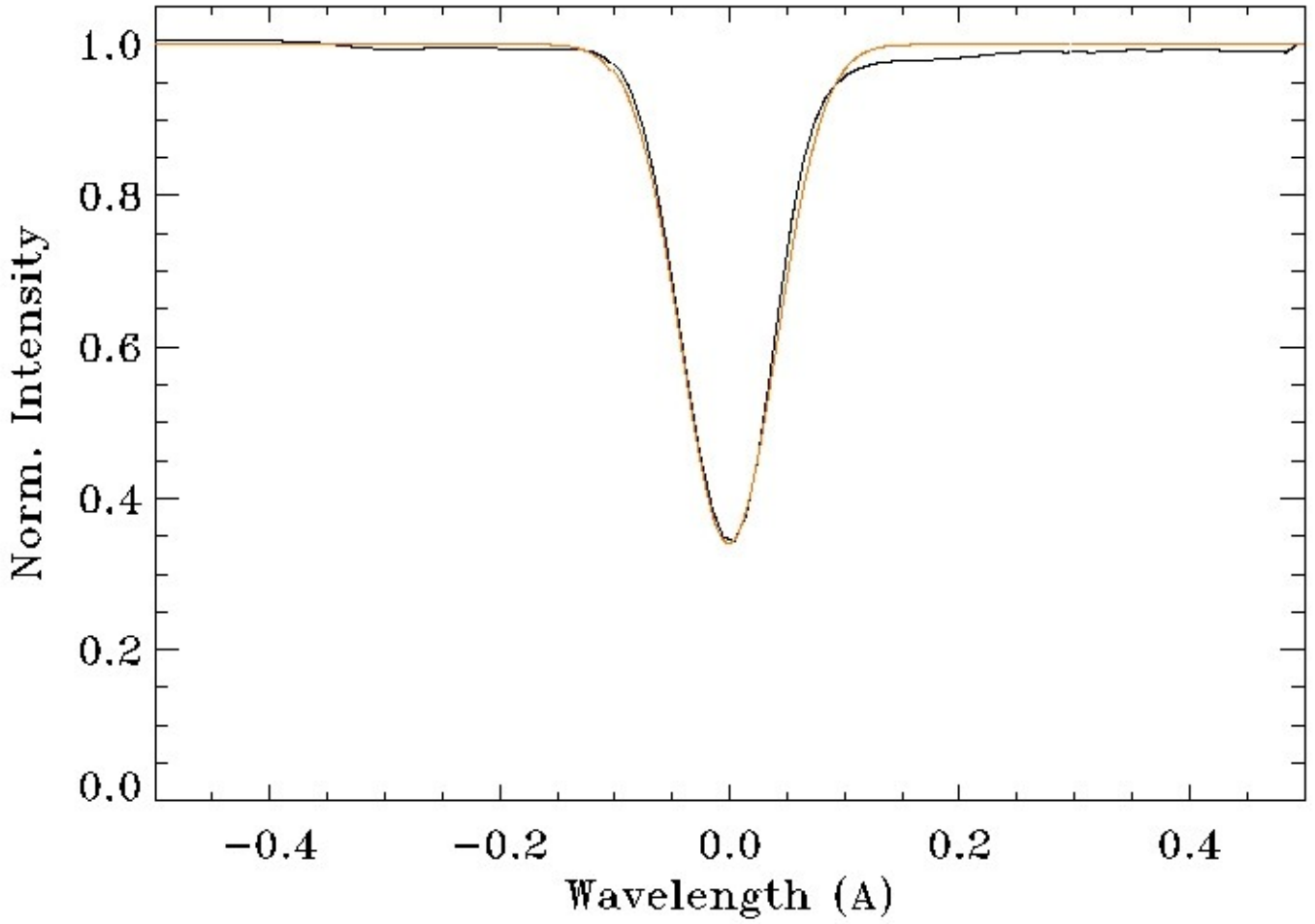


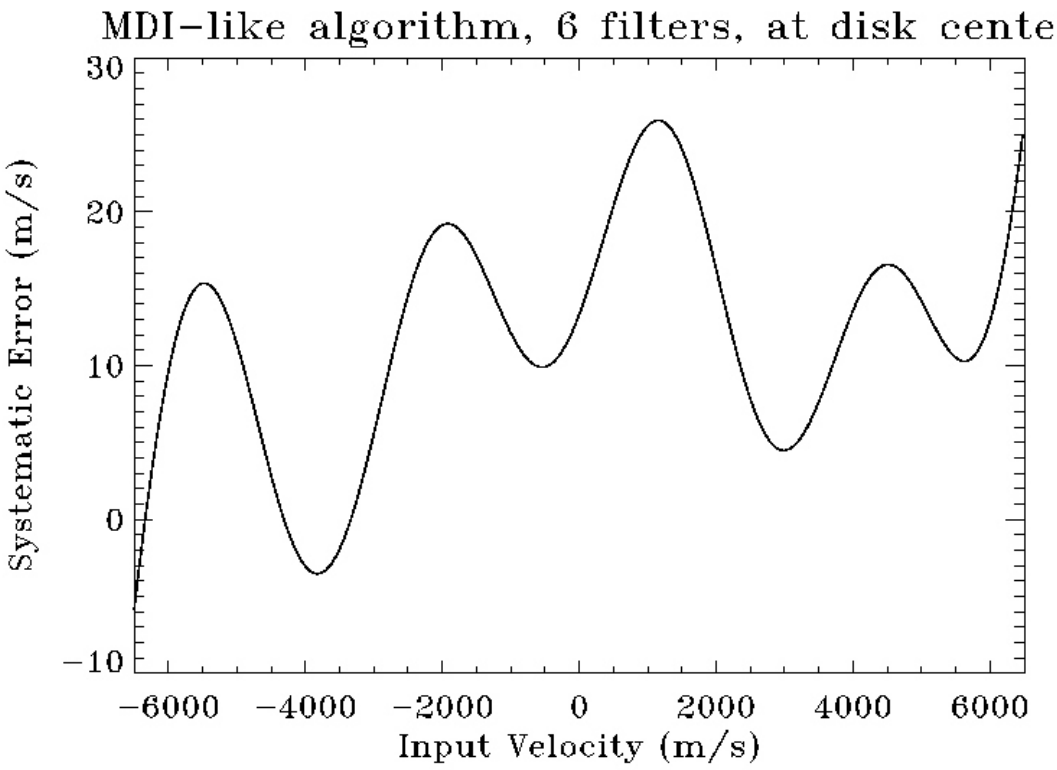


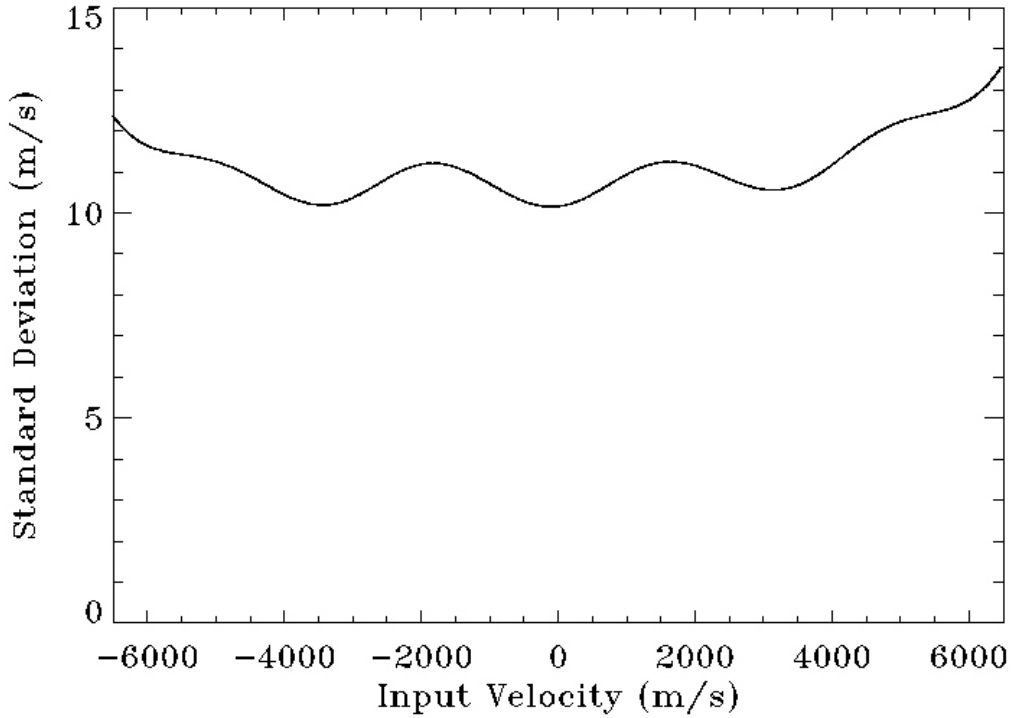
Errors on the Doppler velocity determination when I-ripple of E1 not accounted for in the transmittance models

=> almost linear systematic error and no change in std deviation: probably not an issue because we should be able to use SDO orbital velocity to correct for the systematic error

Black: actual Fe I line (from R. Ulrich) at disk center
Red: Gaussian model for the calculation of look-up tables







Impact of solar line profile used (when Gaussian model is used instead of actual line profile)