MDI and HMI Dopplergrams of active regions
Cross calibration with Solar-B

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SOT 17

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Outline

1. Cross calibration of Dopplergrams: MDI $\leftrightarrow$ ASP
2. Prospectives for **H**elioseismic and **M**agnetic **I**mager
3. Cross-calibration HMI/MDI $\leftrightarrow$ Solar-B
4. Solar-B NFI Dopplergrams measured in magnetic lines

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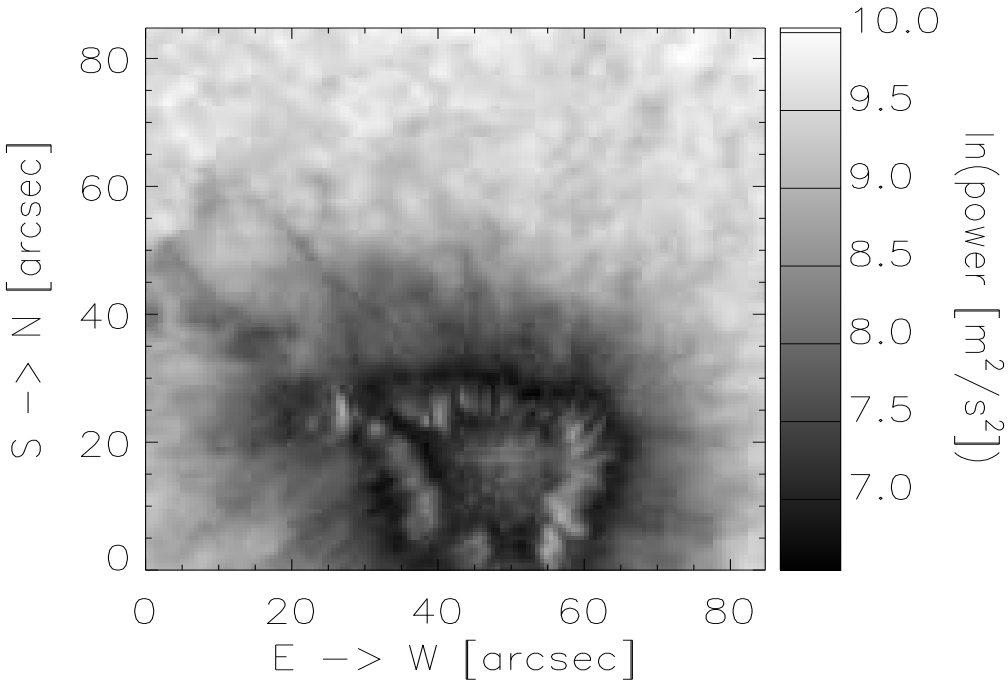
Power maps



NOAA AR 10822

MDI / HMI Dopplergrams

MDI: 5 filtergrams in Ni I 6768 Å, g=1.42

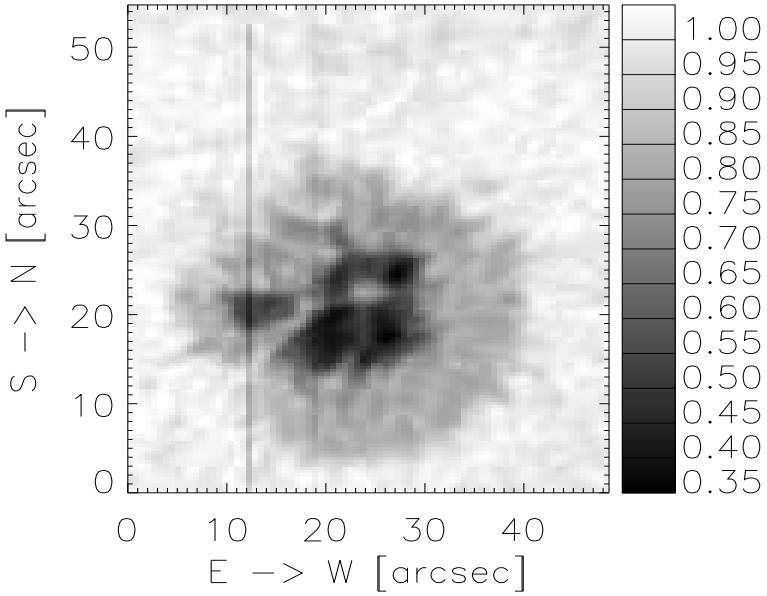
HMI: 5 or 6 filtergrams in Fe I 6173 Å, g=2.49

Fourier Algorithm + Lookup table

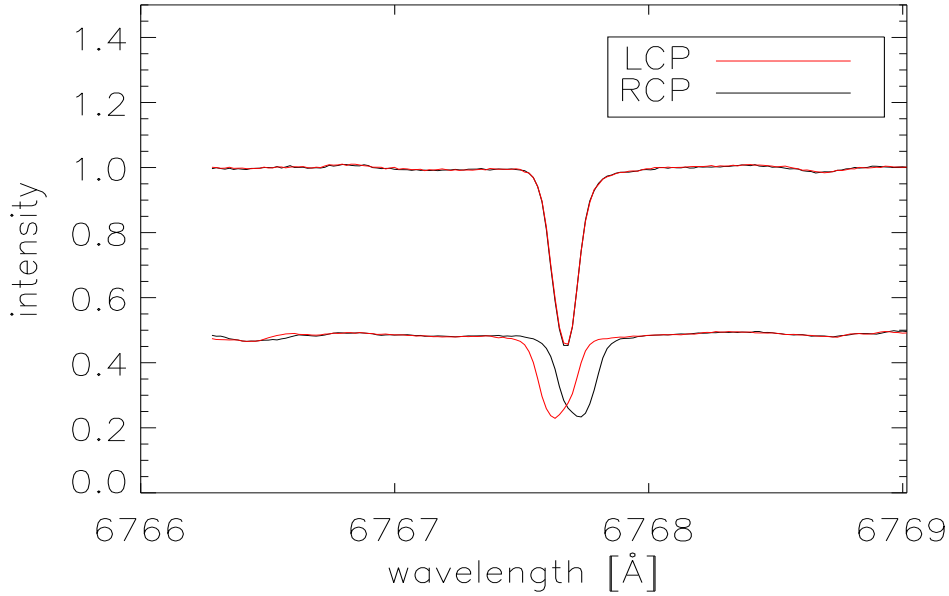
$$V = \frac{1}{2}\left(V_{LCP} + V_{RCP}\right)$$

Both lines are not available for Solar-B

Line profiles from ASP



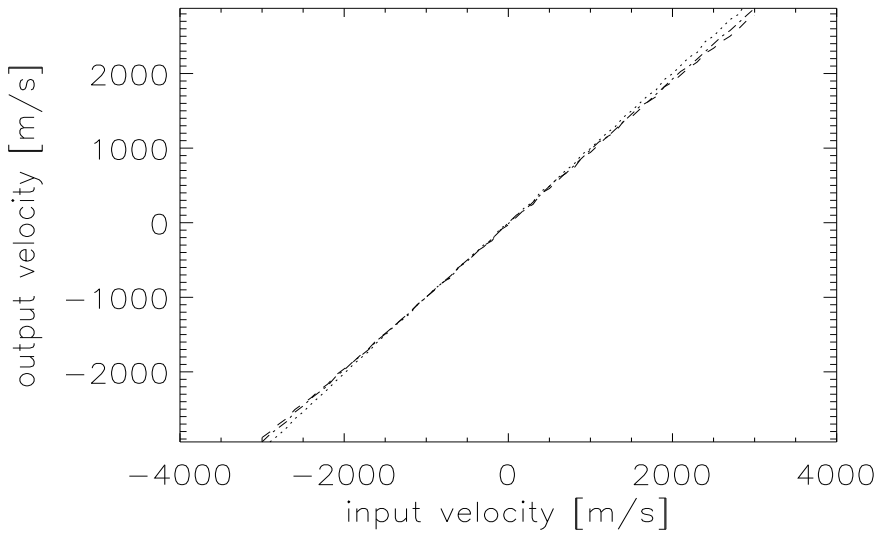
NOAA AR 10752



Line profiles

Velocity sensitivity factor

$$\delta\lambda = \lambda_0 \frac{v_{in}}{c}$$

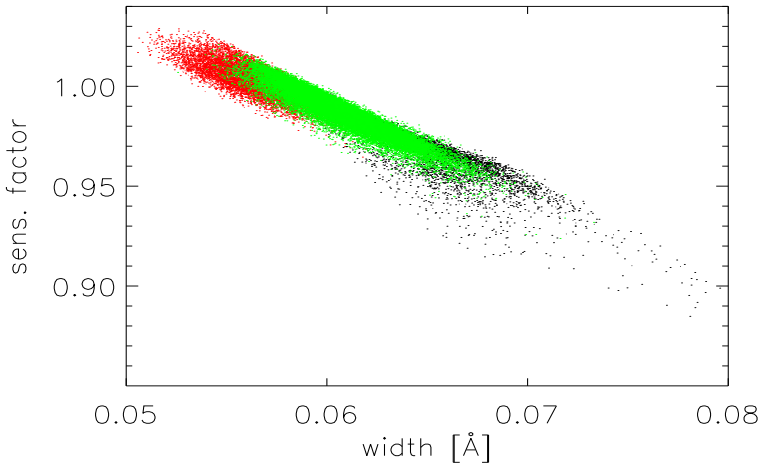


$$v_{out} = s_f v_{in} + o_f \qquad v_{corr} = (v_{MDI} - o_f)/s_f$$

Line width - "Velocity Sensitivity Factor"

ASP maps at disk center from different campaigns

Ni I 6768



Quiet Sun

Plage Region

Sunspot

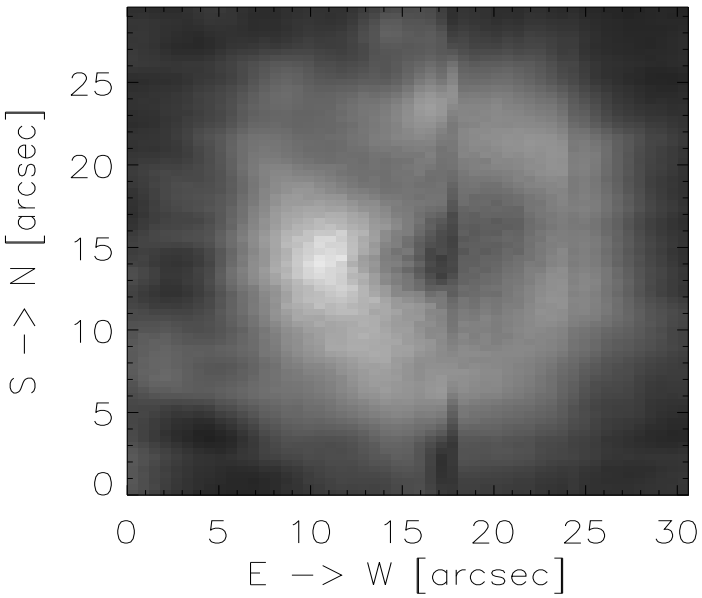
$$I(\lambda) = I_c \left(1 - Ae^{-\frac{(\lambda-\lambda_0)^2}{2\sigma^2}}\right)$$

$$f_j = \sum_{k=0}^{N-1} F_k e^{2\pi \mathrm{i} kj/N}$$

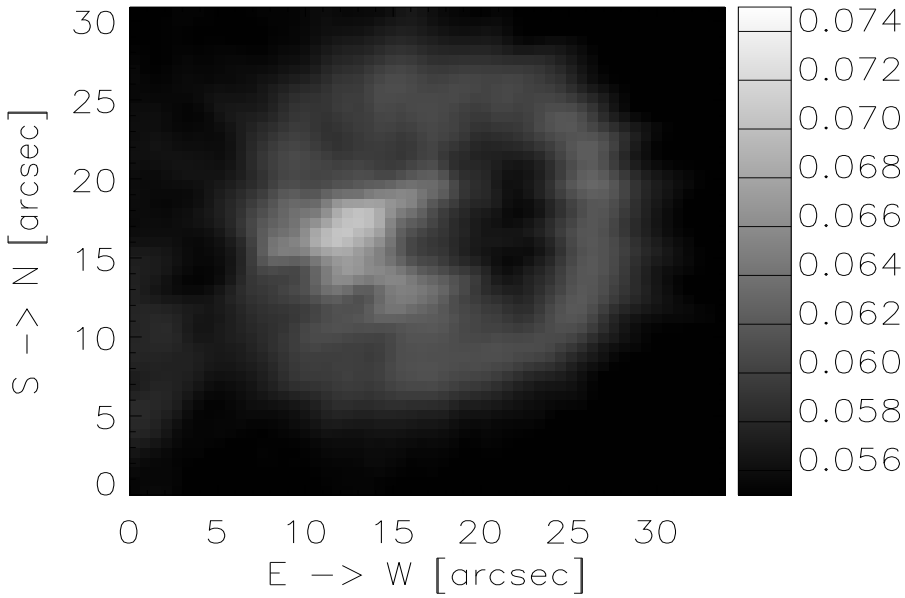
$$\sigma \approx \frac{N\Delta\lambda}{2\pi}\sqrt{\frac{2}{3}\ln\frac{|f_1|}{|f_2|}}$$

Width MDI–ASP

ASP



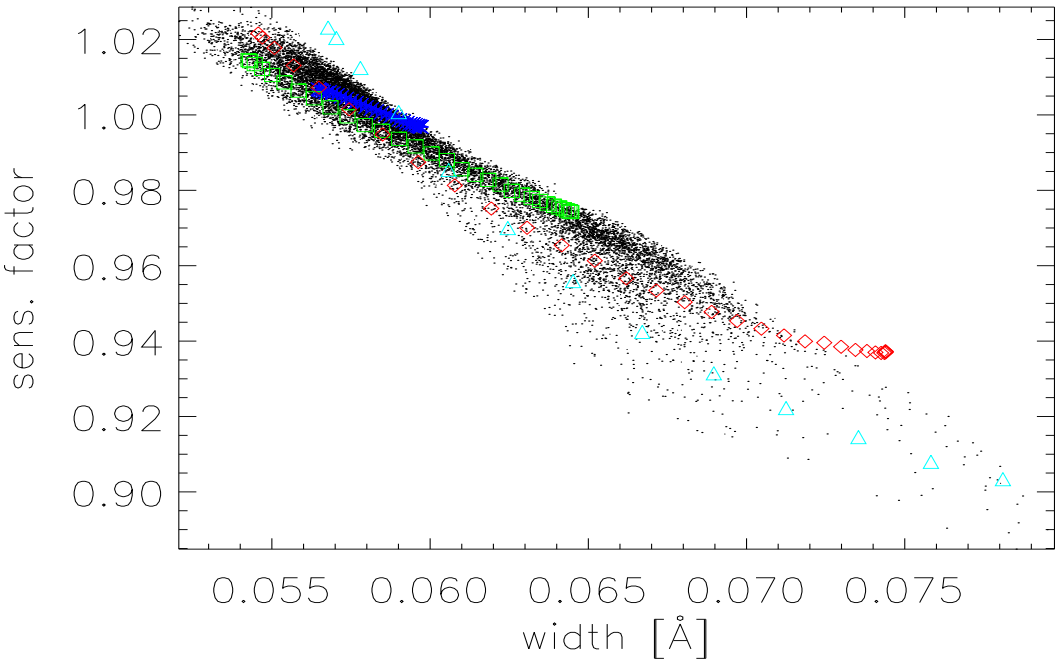
MDI



NOAA AR 10750

Zeeman splitting explains velocity sensitivity factor

NOAA AR 10750



◇ 500, ◇ 1000, ◇ 1500, ◇ 2000 Gauss

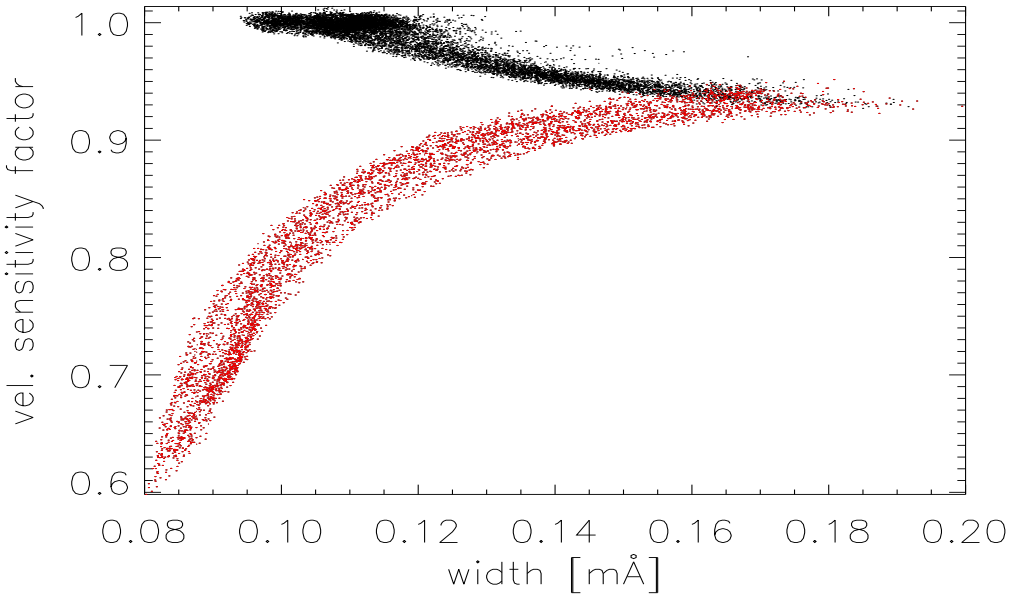
Inclination: $0^\circ \ldots 90^\circ$

Calculated with STOPRO (Solanki, 1987)

HMI: Line Width – Velocity Sensitivity Factor

Extension to completely split lines

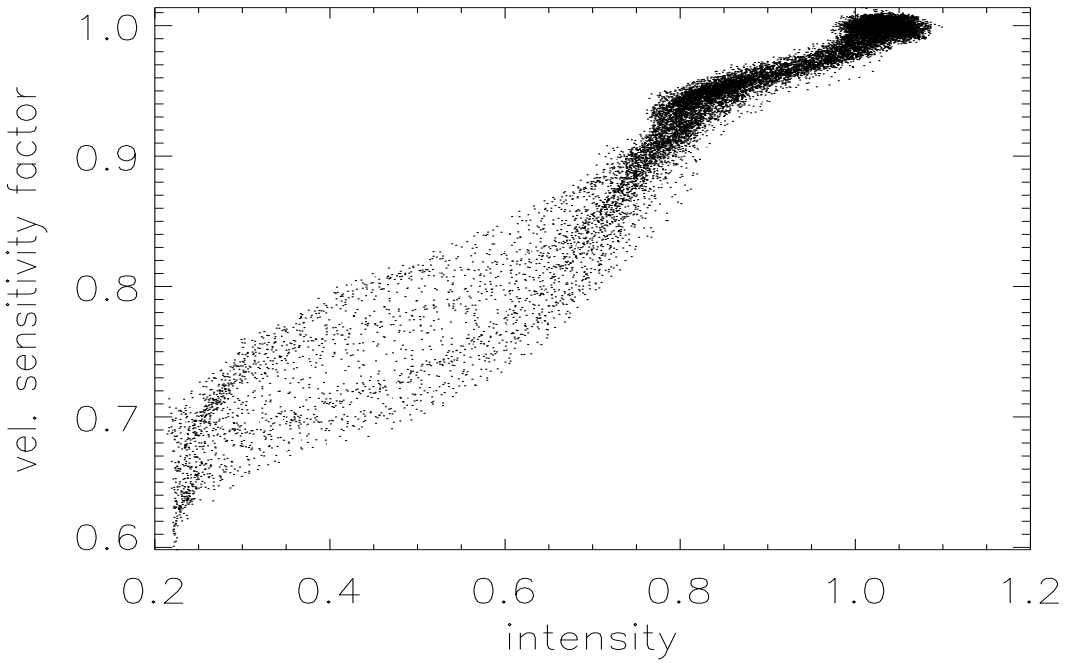
NOAA AR 9856 in Fe I 6173 Å



$$|\arg(f_1) - \arg(f_2)/2| > s$$

$$|\arg(f_1) - \arg(f_2)/2| < s$$

HMI: Intensity – Velocity Sensitivity factor



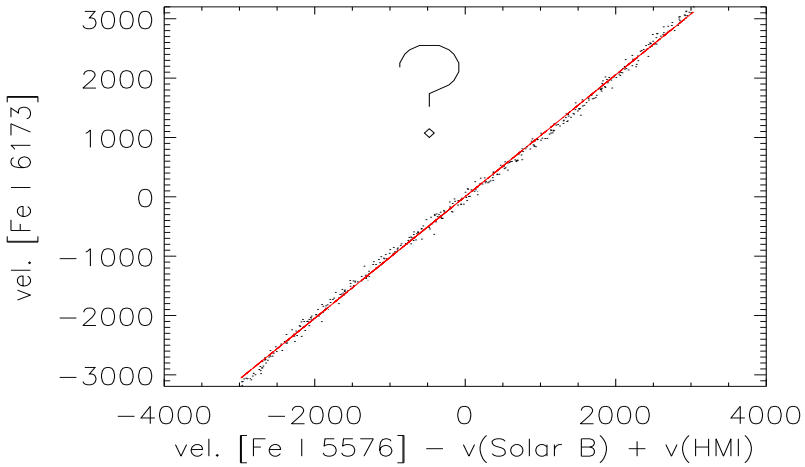
SP - Maps from Solar B

Spectro-Polarimetric maps with perfect seeing

- Solar-B SP maps in line with similar formation height (Fe I 5250.6 Å)
  - Inverting Fe I 5250.6 Å
  - Synthesizing Fe I 6173 Å

Nonmagnetic line (Solar-B) – Magnetic line (HMI)

Cospatial - Cotemporal Measurements of Solar-B and HMI:

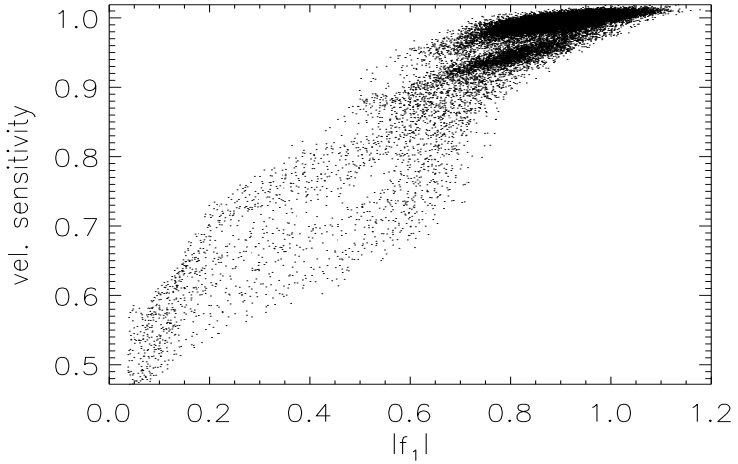


Parameterized lookup table: (Continuum Intensity, Width, Magnetic field strength / Inclination)

- Non-magnetic line providing "true velocity"
- ...but: different temperature sensitivity
- ...and: different formation height

Calibrating Solar-B NFI Dopplergrams in magnetic lines

Fe I 6301.5



$$R = \frac{F1 + F2 - F3 - F4}{F1 - F2 - F3 + F4} := \frac{NOM}{DEN}$$

$$f_1 = (NOM+DEN)+\mathrm{i}(NOM-DE$$

Observables:

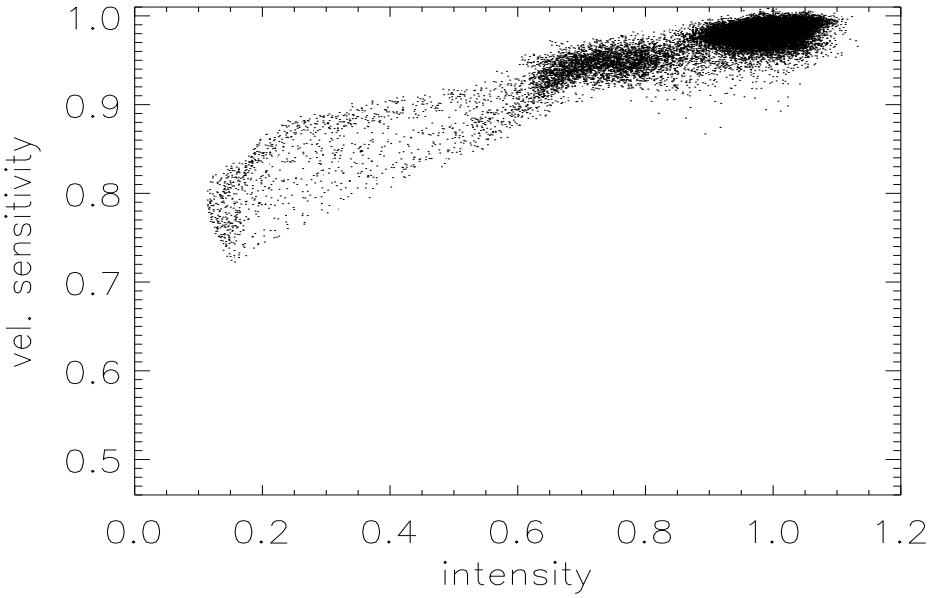
$\arg(f_1)\ \ (\propto v)$

$|f_1|$

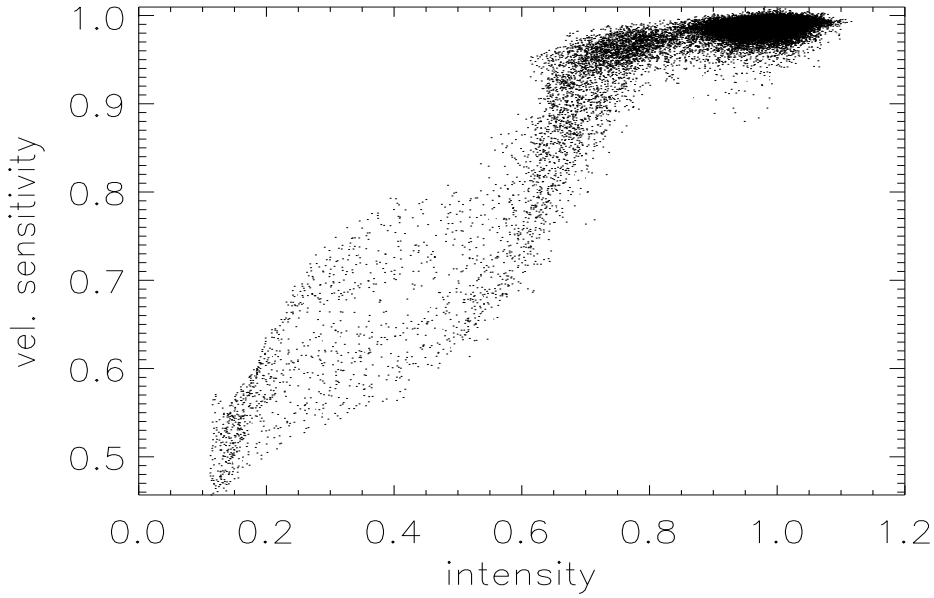
Thanks to Bruce Lites for the data

Intensity – Velocity Sensitivity factor

Fe I 6301.5



Fe I 6302.5



Conclusion

– Solar-B will help to calibrate HMI and MDI Dopplergrams in active regions

– NFI Dopplergrams in magnetic lines might be corrected with the help of spectro-polarimetric maps.