Spectro-polarimetry of NLTE lines with THEMIS/MSDP

Chromospheric Magnetic Structures

Results and prospects

P. Mein, N. Mein, A. Berlicki,B. Schmieder

1) V-profiles and B// vertical structure

NaD1 : comparison MDI, response functions, spots and faculae,

Hα : compromises between Signal/Noise ratios and resolutions xy,t

2) Q,U – profiles:

Prominences Hα and D3

3) Prospects:

High **spatial resolution**: example of canopies, constraints on vector B

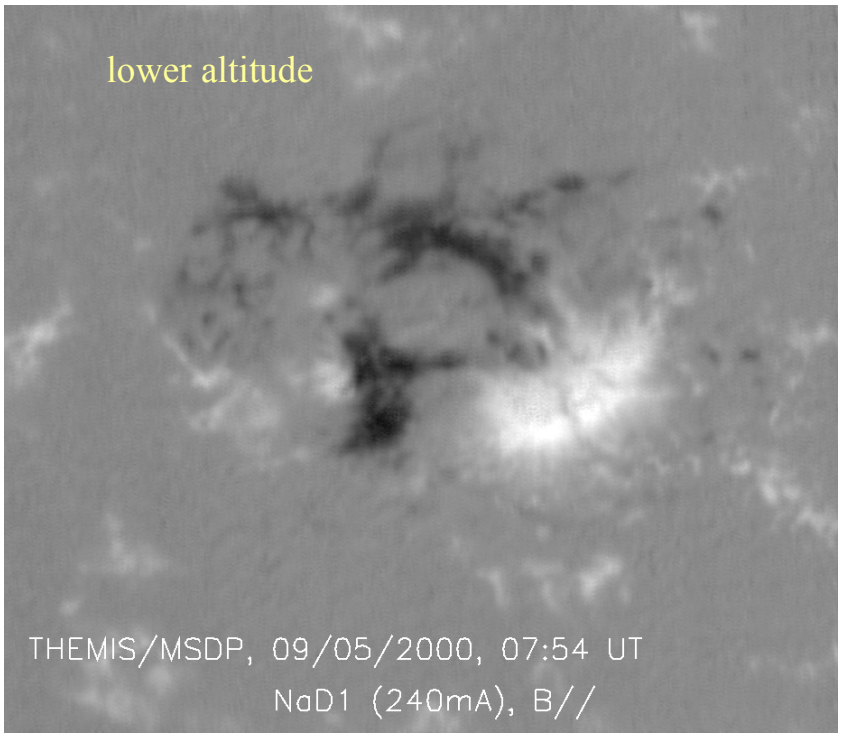
Fast events over **large fields**: simultaneous D1 and Hα observations for xyz t analysis

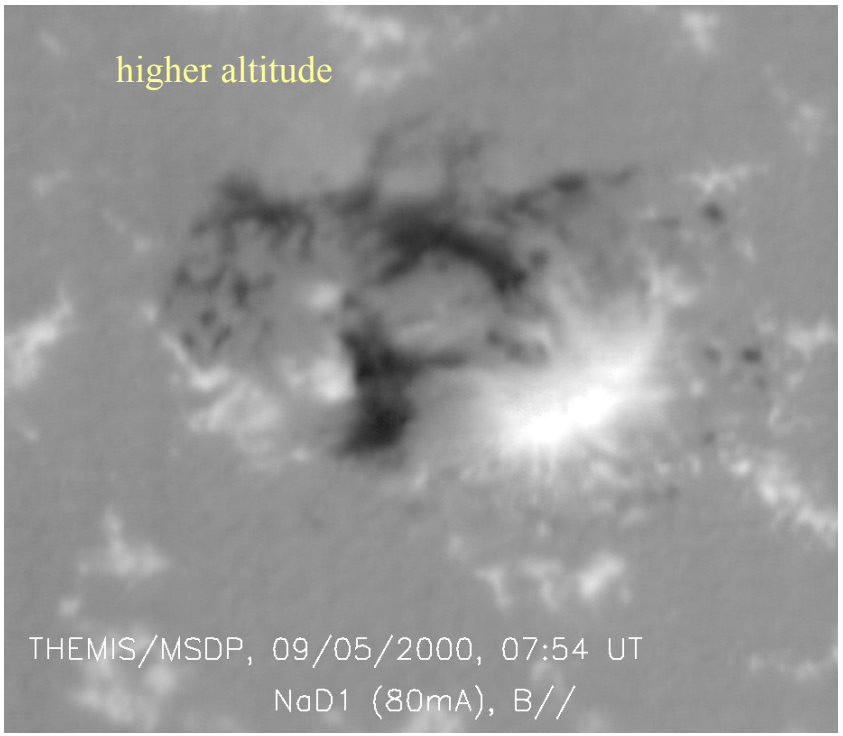
1) V-profiles and B// vertical structure

THEMIS/MSDP May9, 2000

E18, N21

- Observations of Na D1 (I +/- V)
- $B_{//}$ calculated at *several depths in the line profile* from $\{\lambda_d(I+V) - \lambda_d(I-V)\}$

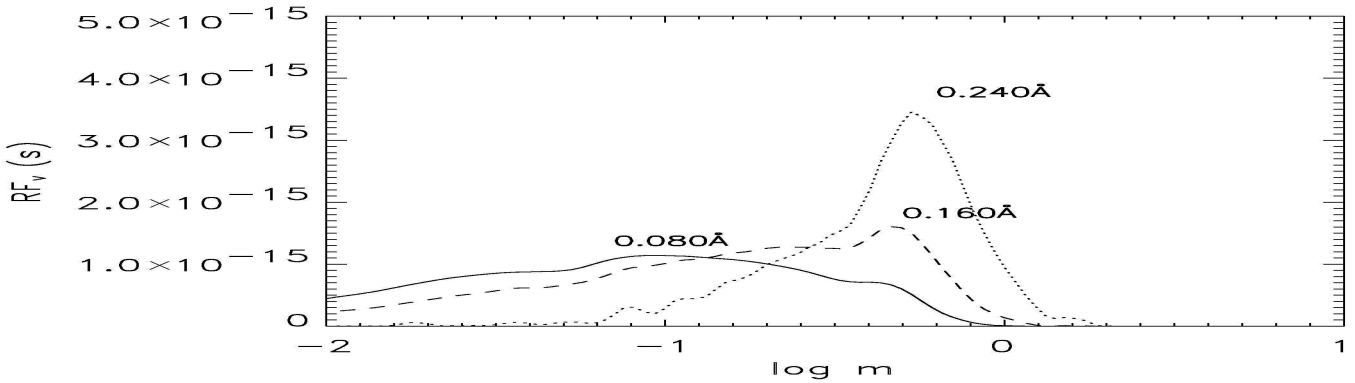




M.T Eibe, G. Aulanier, M. Faurobert, P. Mein & J-M Malherbe, 2002, A&A381,290

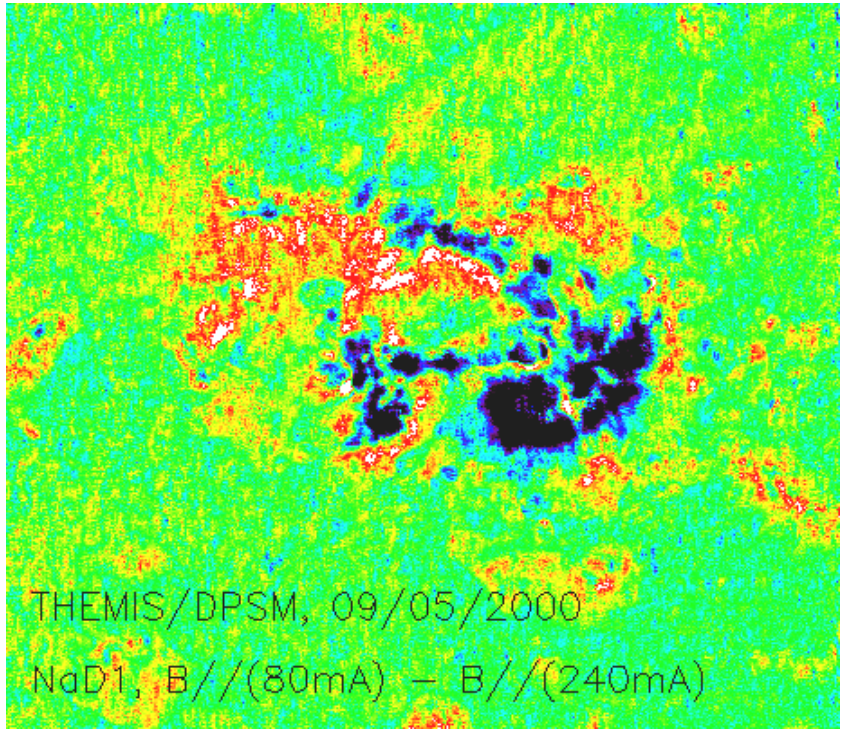
B// Response Functions

(Maltby spot model)

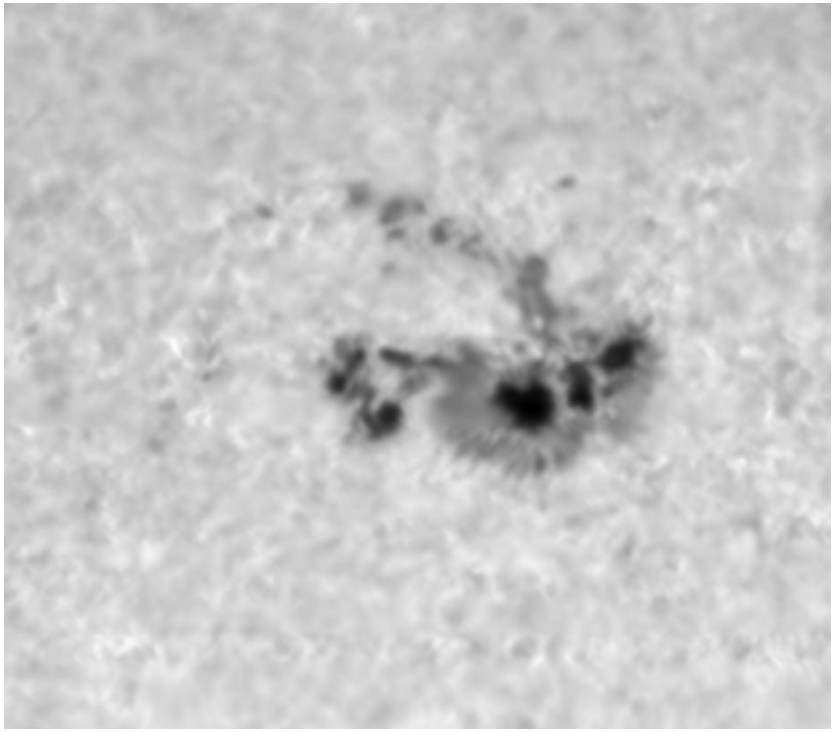


M.T. Eibe et al, 2002, A&A381, 290

Gradient of B//



Intensity +/-0.24 Angst



blue : *d*B// /*d*LOS < 0 red : *d*B// /*d*LOS > 0

LOS Gradient of Magnetic Flux

NaD1 from IVM / 6302 FeI from ASP

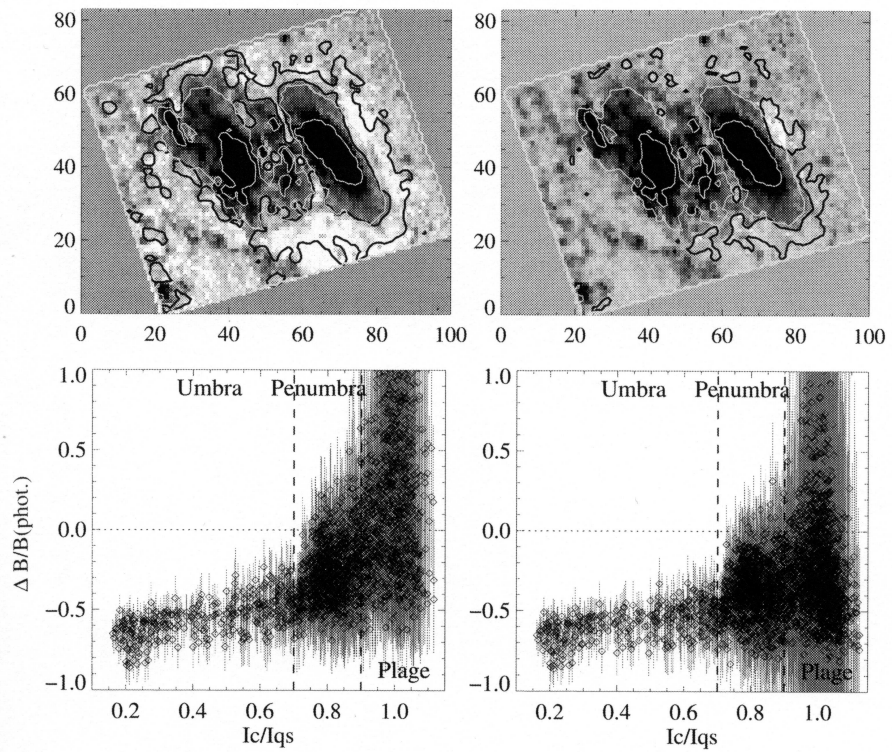
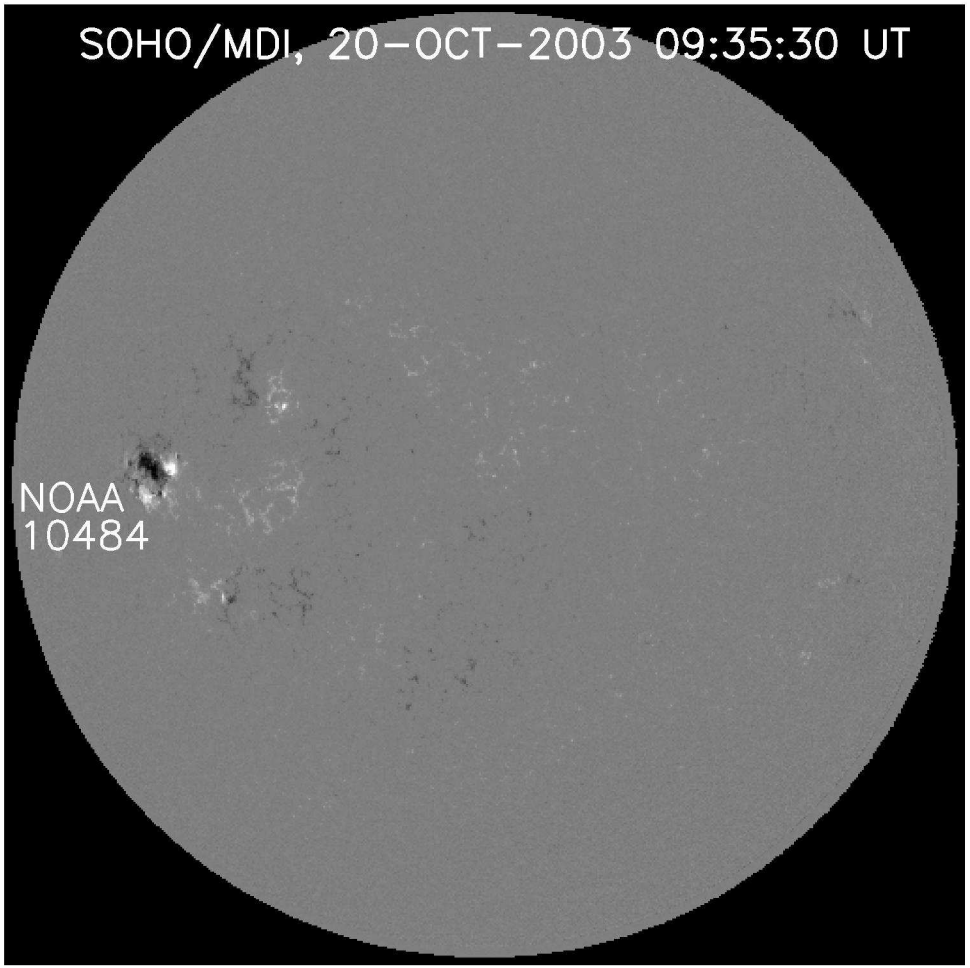


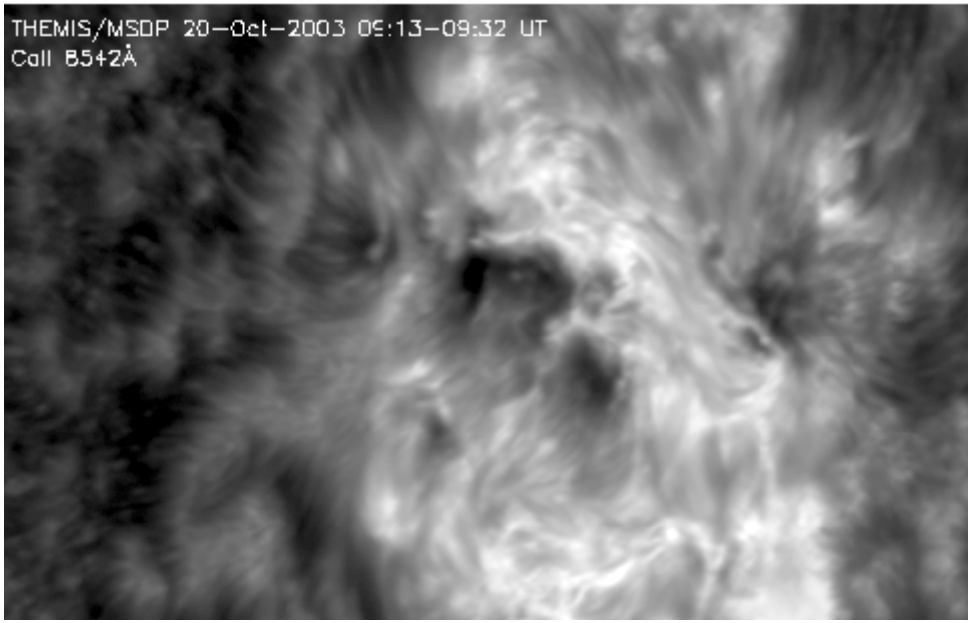
Figure 4. Top, left: image of the fractional change in total magnetic flux $B = \sqrt{B_\ell^2 + B_t^2}$, *dark areas* have negative fractional flux change and *light areas* (highlighted by *black contours*) have positive flux change with height. *White contours* indicate photospheric umbral/penumbral boundaries for reference. Both the structure of the fractional flux variation and the location of the super-penumbra are visible. *Bottom, left:* fractional change now plotted as a function of quiet-Sun normalized continuum intensity. The 2σ error bars reflect the uncertainties in both the photospheric and chromospheric flux measurements, and only points above the noise are considered. *Right, top/bottom*: same, but with the photospheric magnetic fill fraction applied to the chromospheric data as per Equation (3).

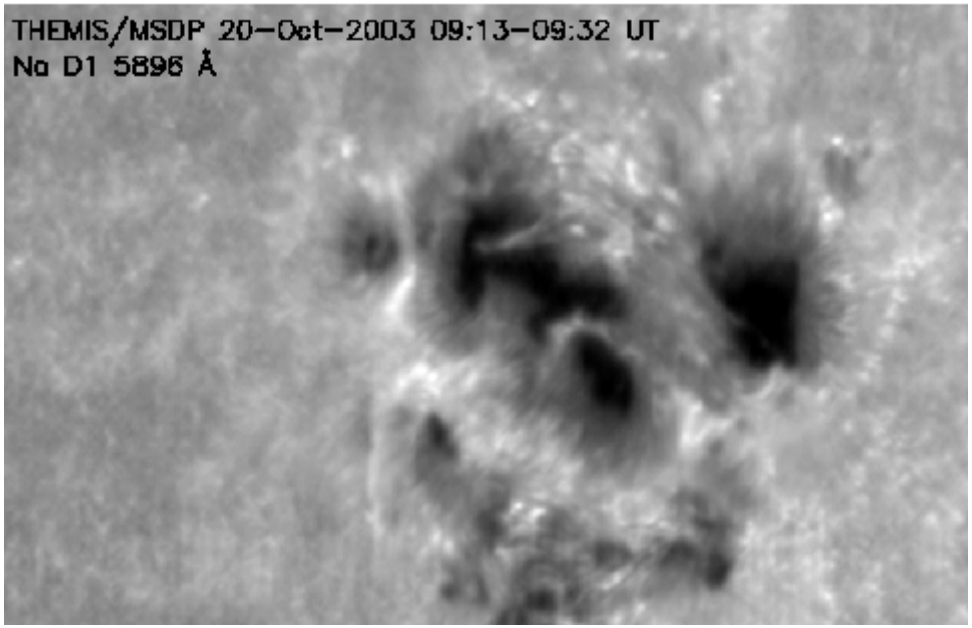
K.D Leka & T.R Metcalf, 2003, SP 212,361

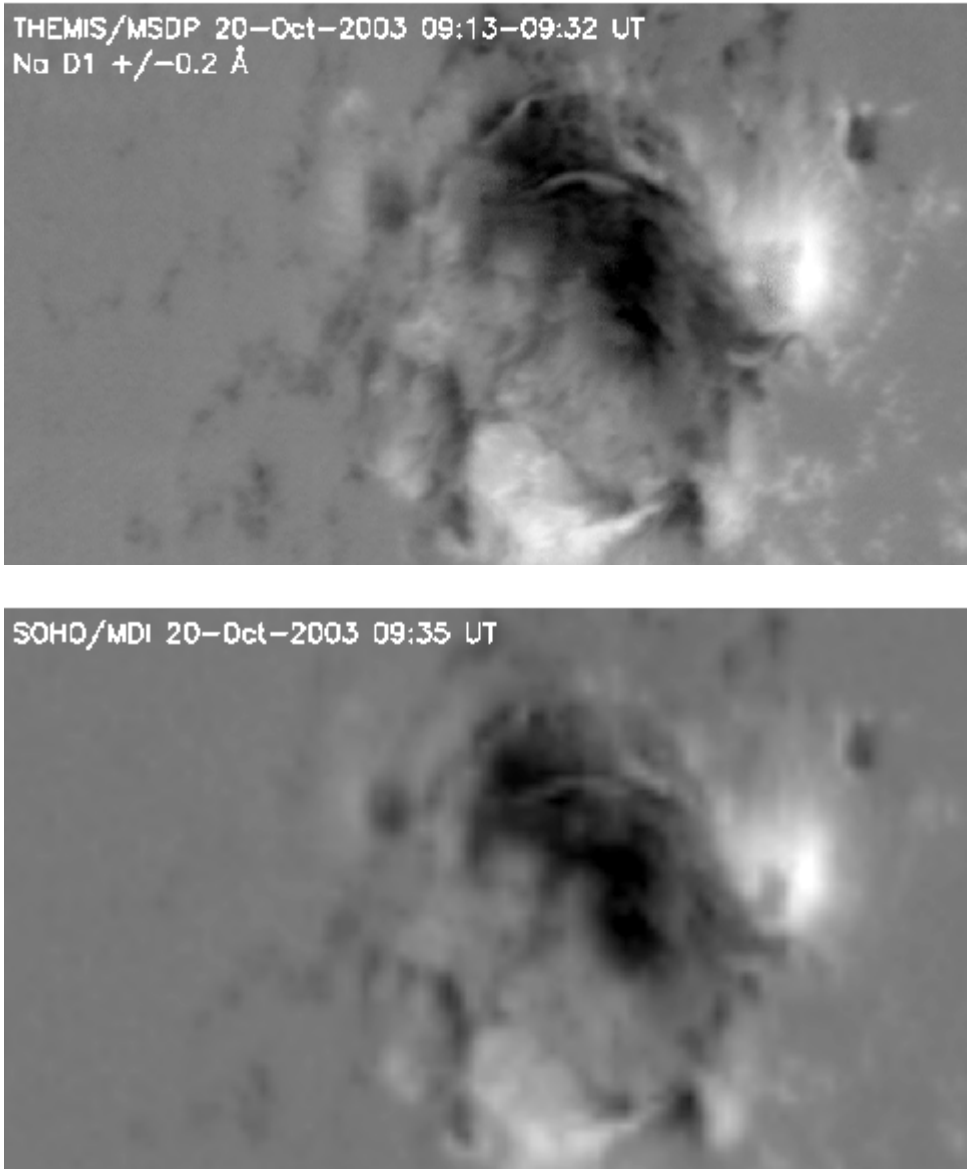
B// in Active Region near the limb (2003)



THEMIS/MSDP simultaneous CaII + NaI

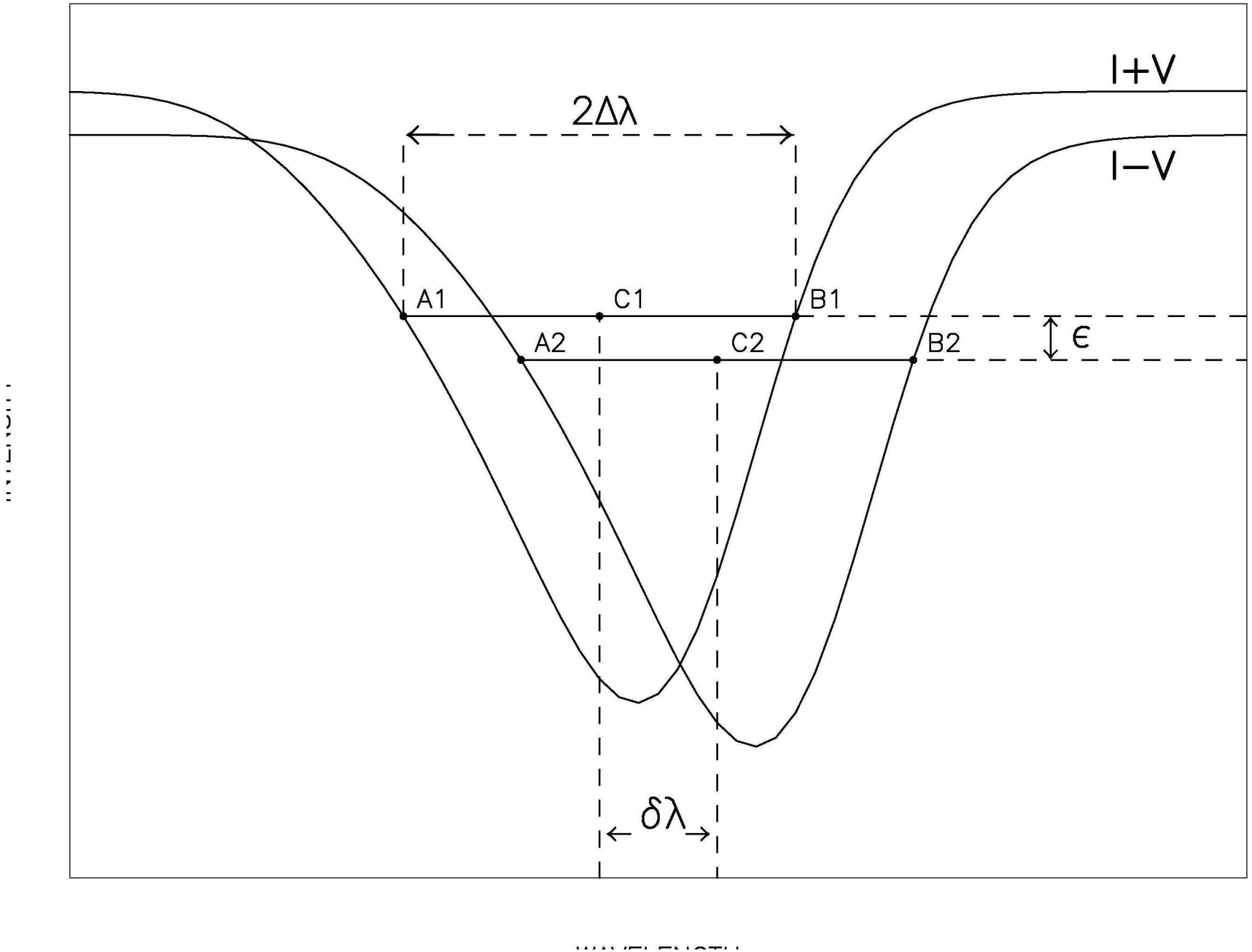






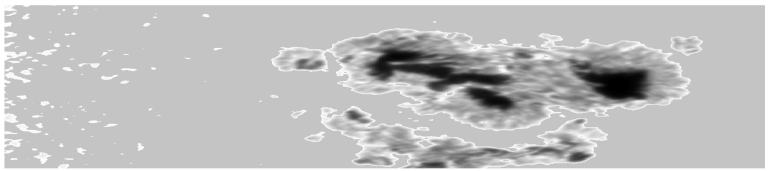
A.Berlicki, P.Mein, B.Schmieder (submitted)

B// derived from « bisector » method

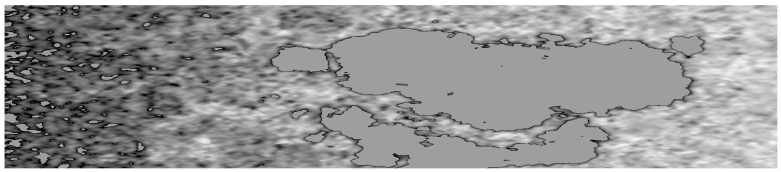


Selection by Intensity Threshold

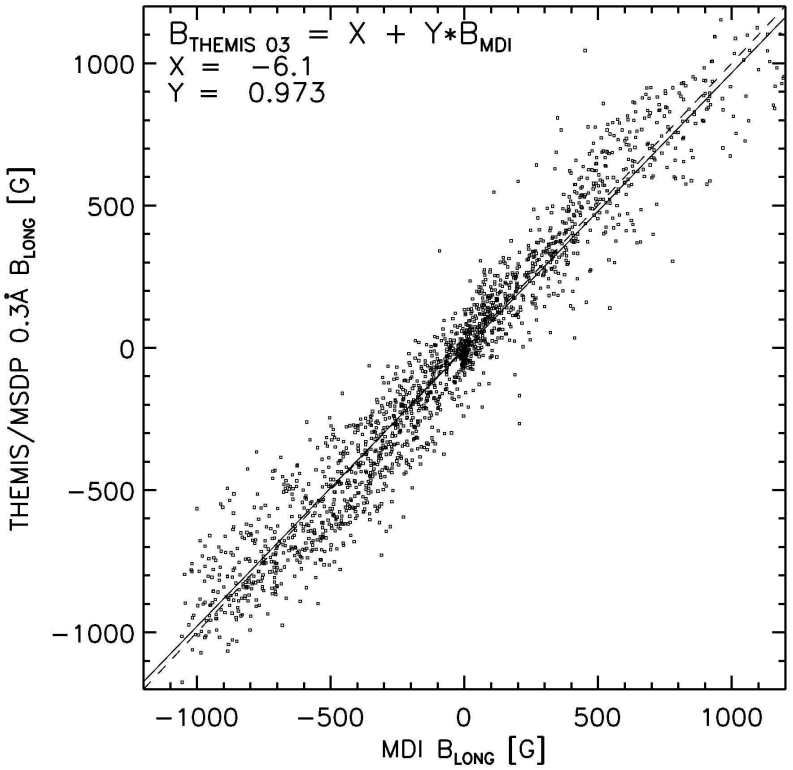
« dark »



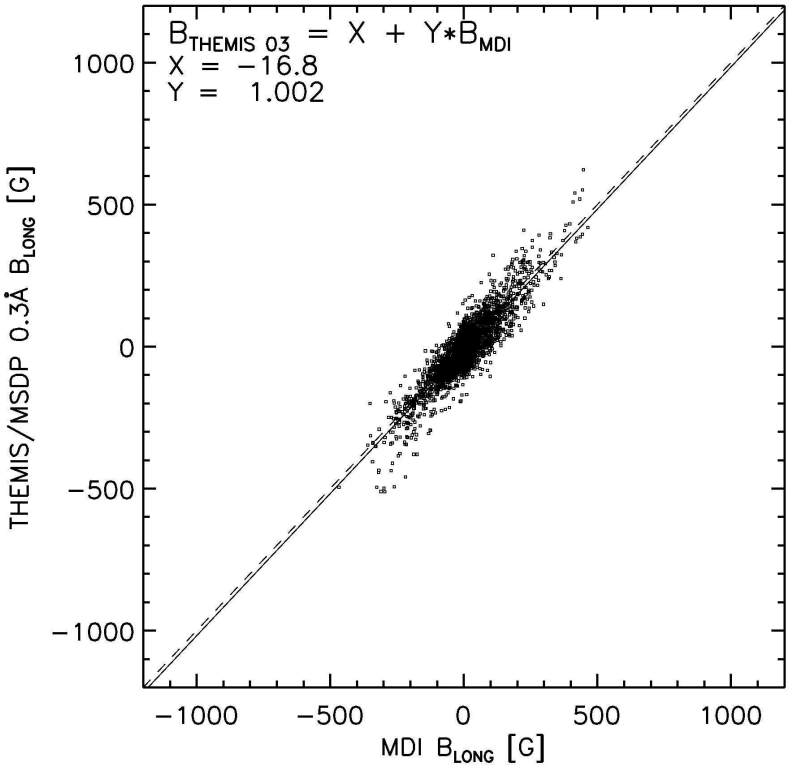
« bright »



Comparison MSDP (NaD1, 0.3 Angst) / MDI



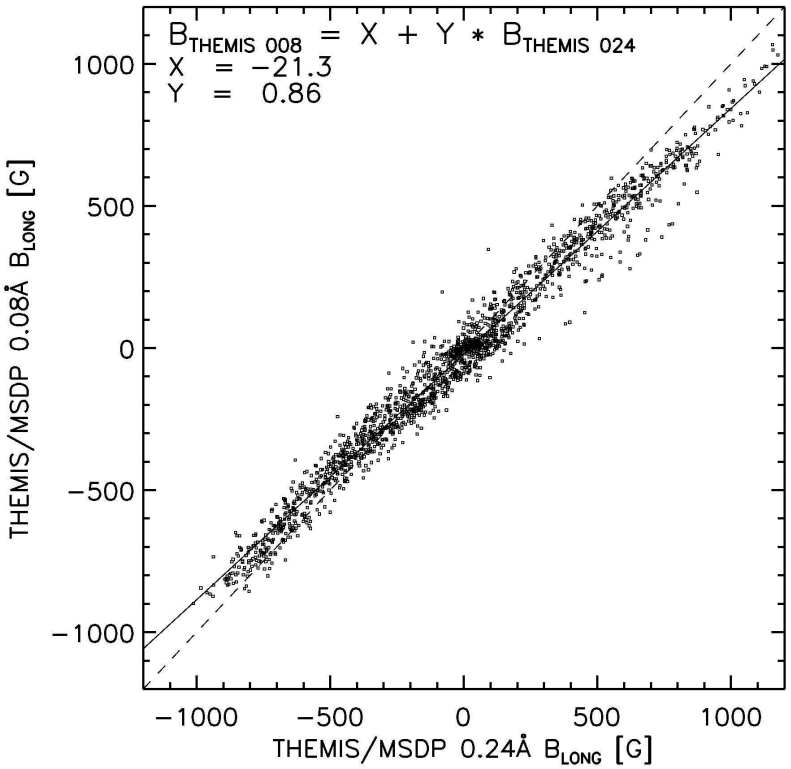
« dark » regions
(umbrae,penumbrae)



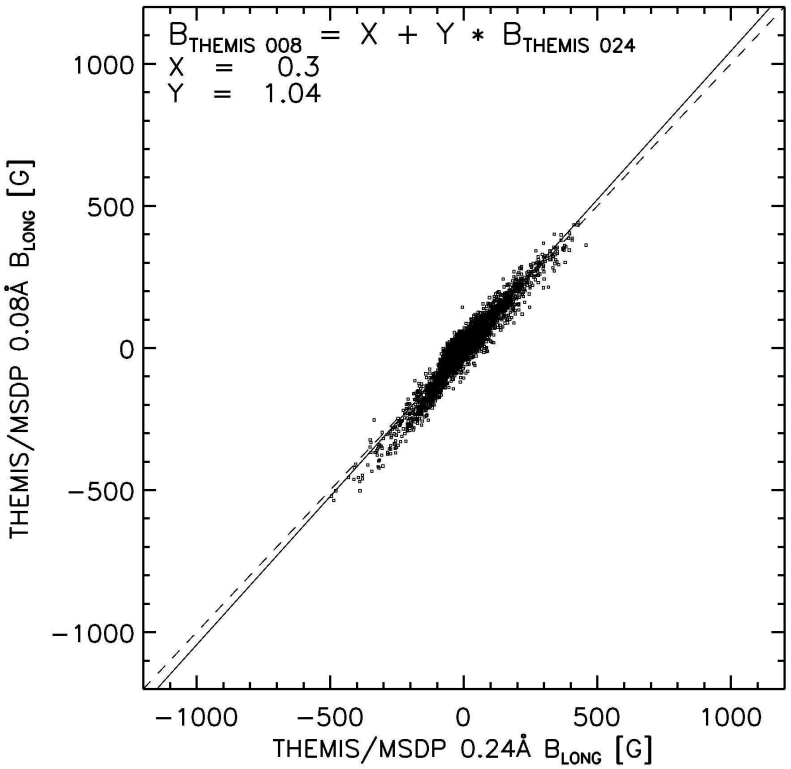
« bright » regions
(plages, network)

LOS gradient of B//

MSDP 0.08Angst / 0.24 Angst

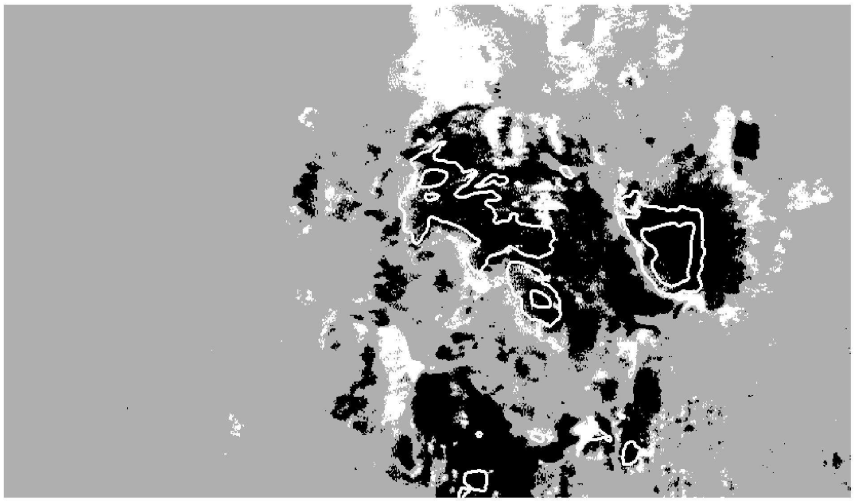


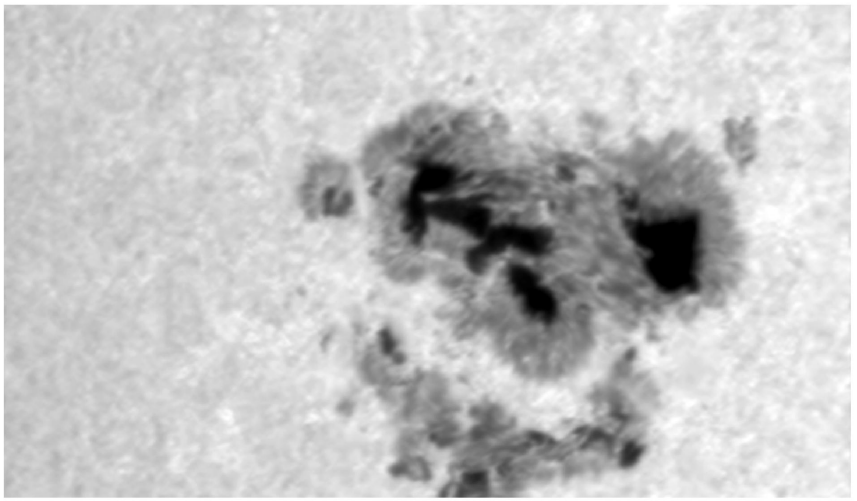
« dark »



« bright »

Gradient of LOS Magnetic Field





Black = dB// / dLOS < 0
White = dB// / dLOS > 0

A.Berlicki, P.Mein, B.Schmieder, 2005 (submitted.)

Conclusions:

1 Good correlation MDI Ni / MSDP NaD1 0.3 Angst

2 NaD1: Photosphere – chromosphere B// from same line, same solar points, same time

3 Spots: B// decreases with height

→ diverging lines of force

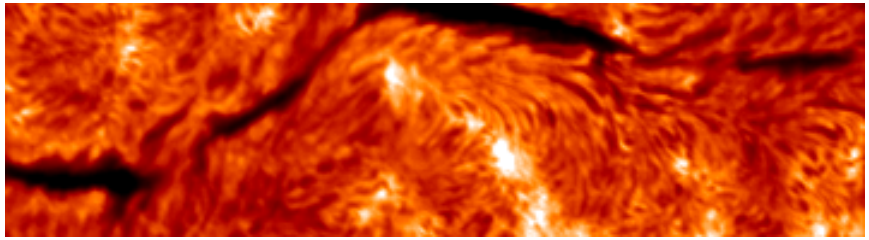
4 Faculae: B// increases globally with height

→ high spatial resolution needed (canopies, see below)

5 Center – limb: perspective effects

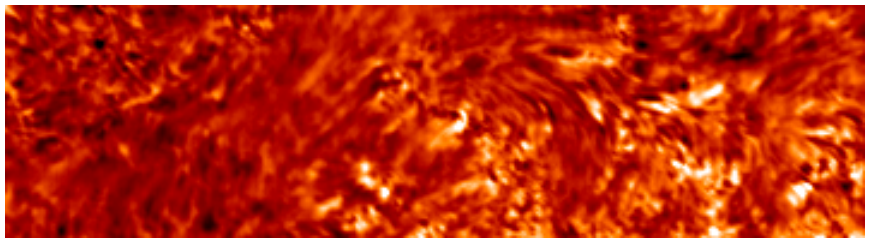
B// from Hα observations with THEMIS/MSDP

Intensity



Line center

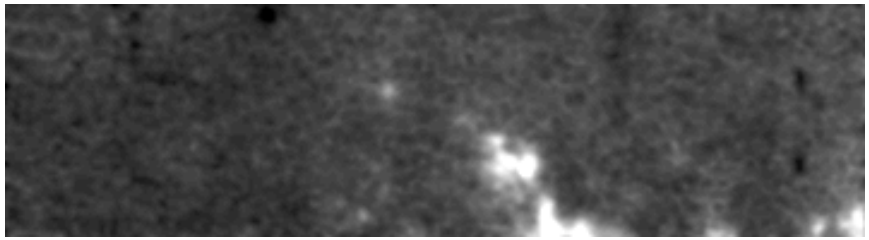
Doppler Velocity



+/-27pm

B//

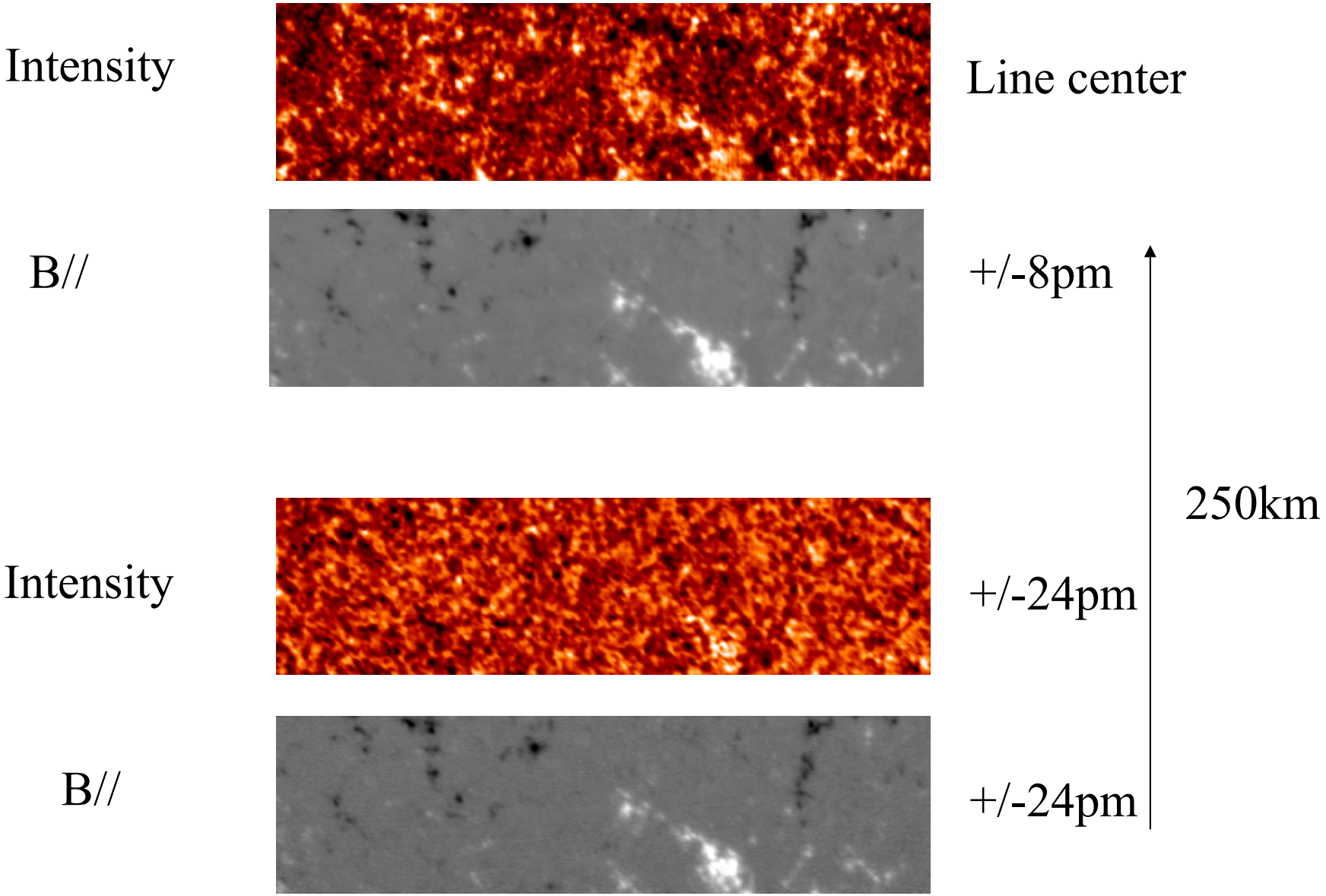
Smoothing 3*3 arcsec



+/-27pm

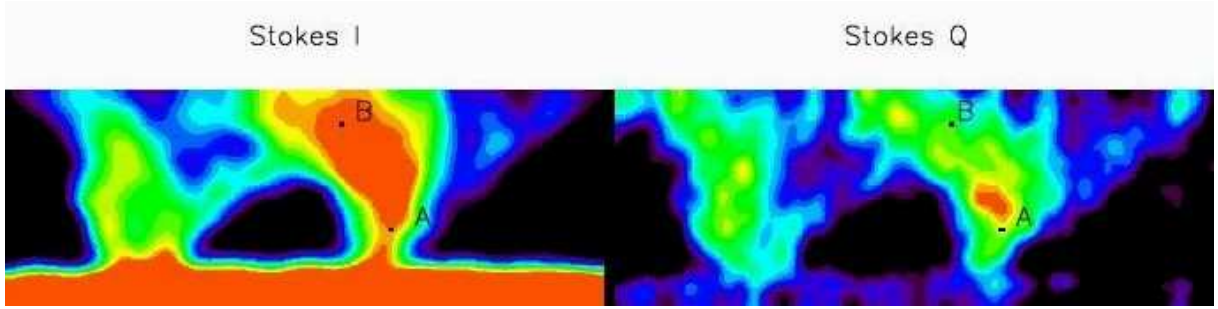
Observations B. Schmieder (2004, JOP178)

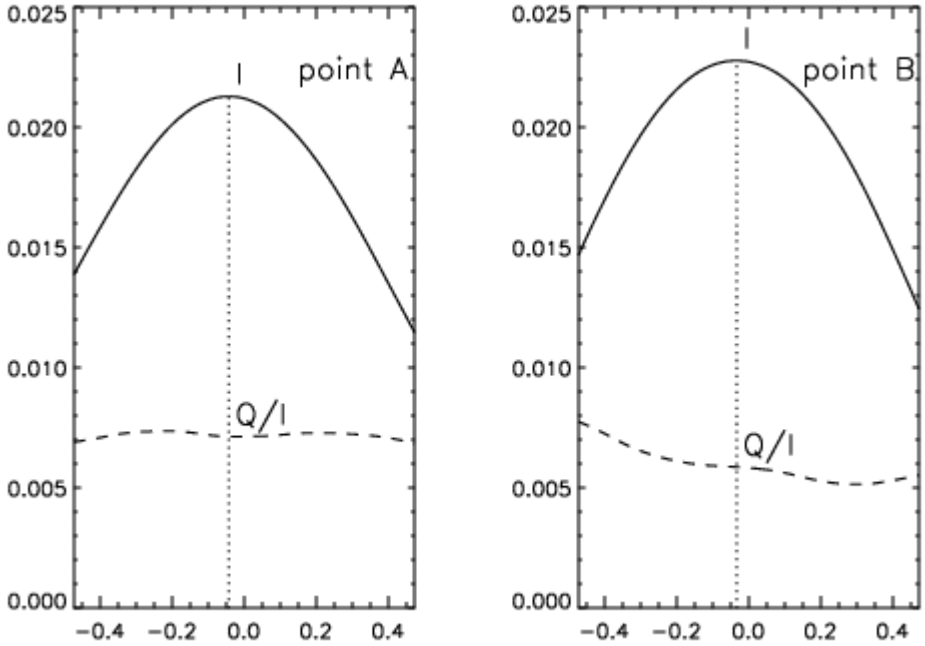
Comparison with NaD1



2) THEMIS/MSDP Q,U profiles

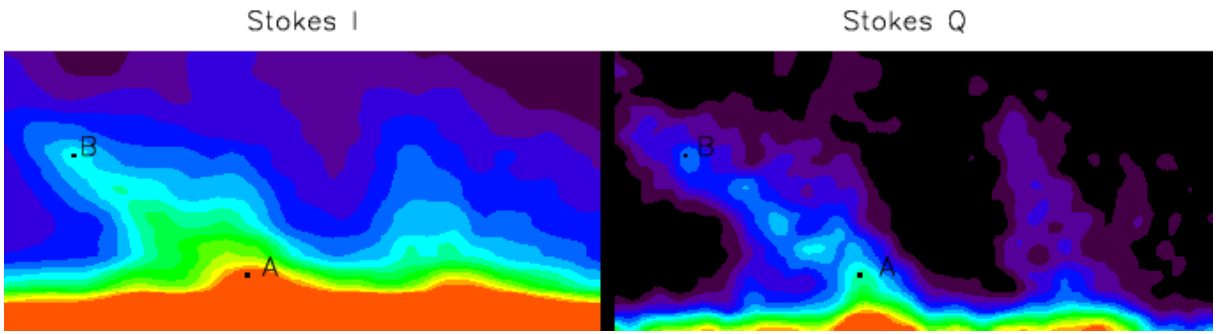
Hα prominences

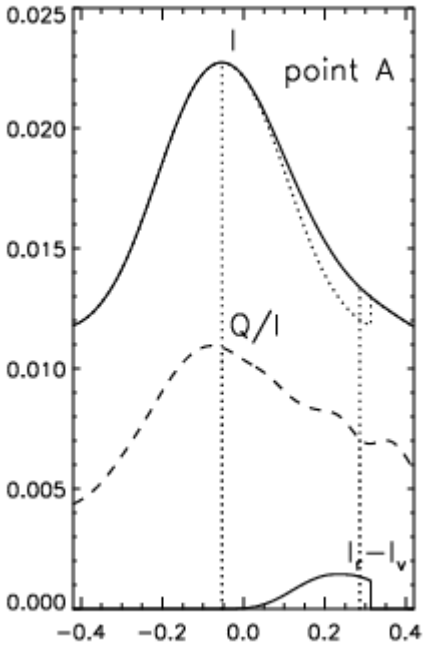


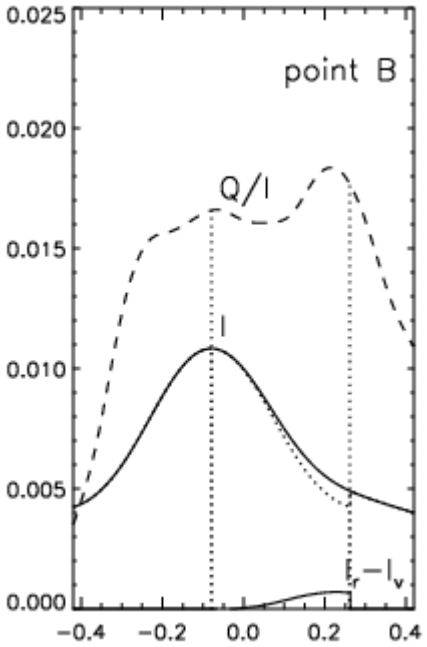


Observ. P. & N. Mein
(July 2004)

D3 prominences







Conclusion for limb observations:

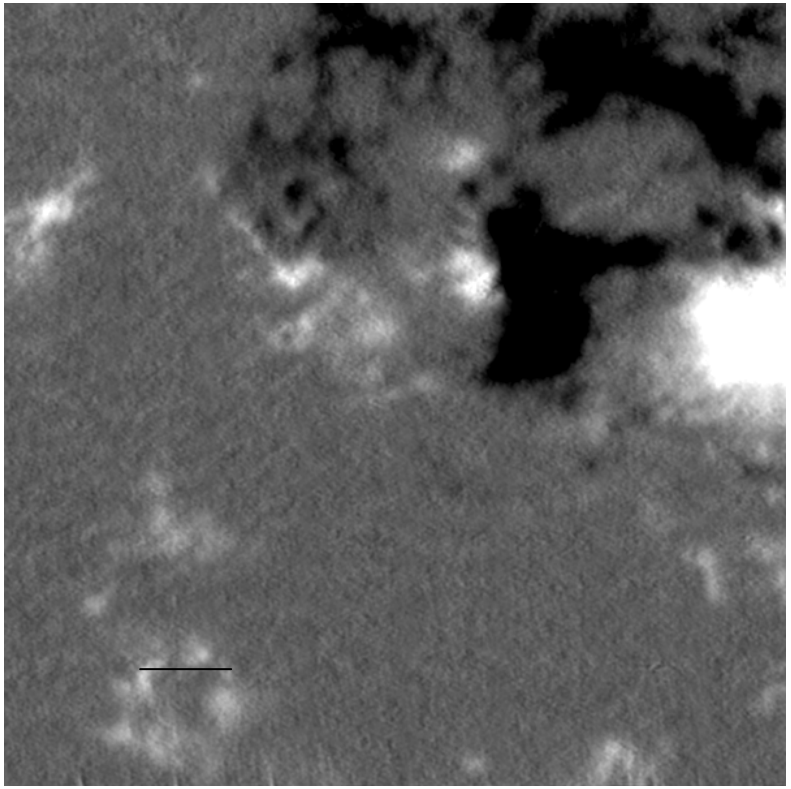
- MSDP allows adjustments of 2D-smoothing to increase S/N ratio (ex 3*3 arcsec)
- In case of time sequences (active prominences, spicules…) possible different compromises (resol. x,y,t) according to desired quantities (V,Q,U,doppler..)
- Better results with Hα (light, spectral resolution)
- With blaze angle of predisperser grating = 62 degrees

  ⟶ twice more light for D3 and Hα

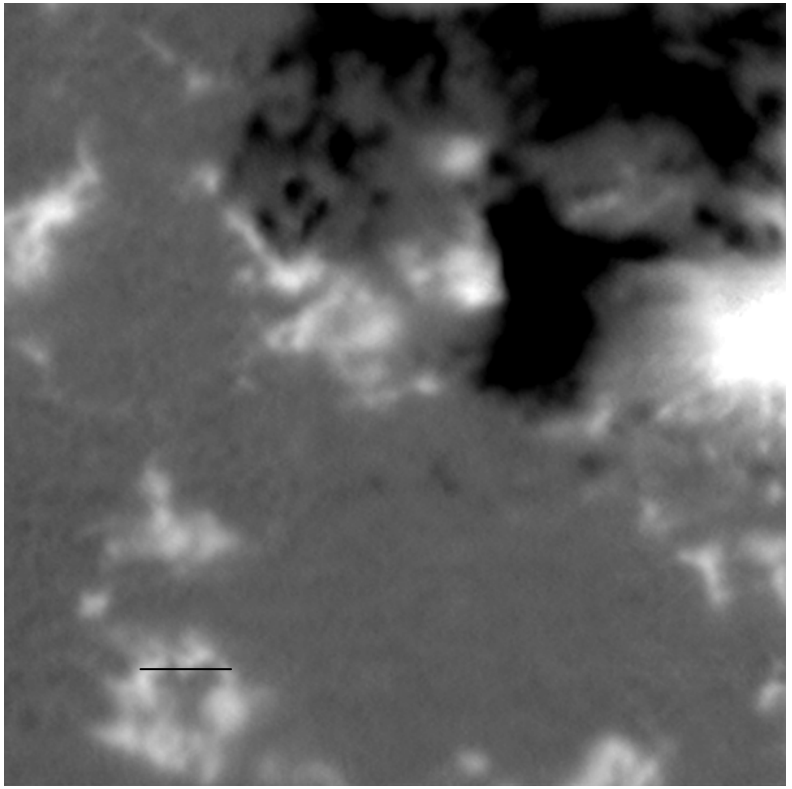
Prospects: High Spatial Resolution with THEMIS/MSDP

LOS Magnetic Field

NaD1 +/- 320 mA

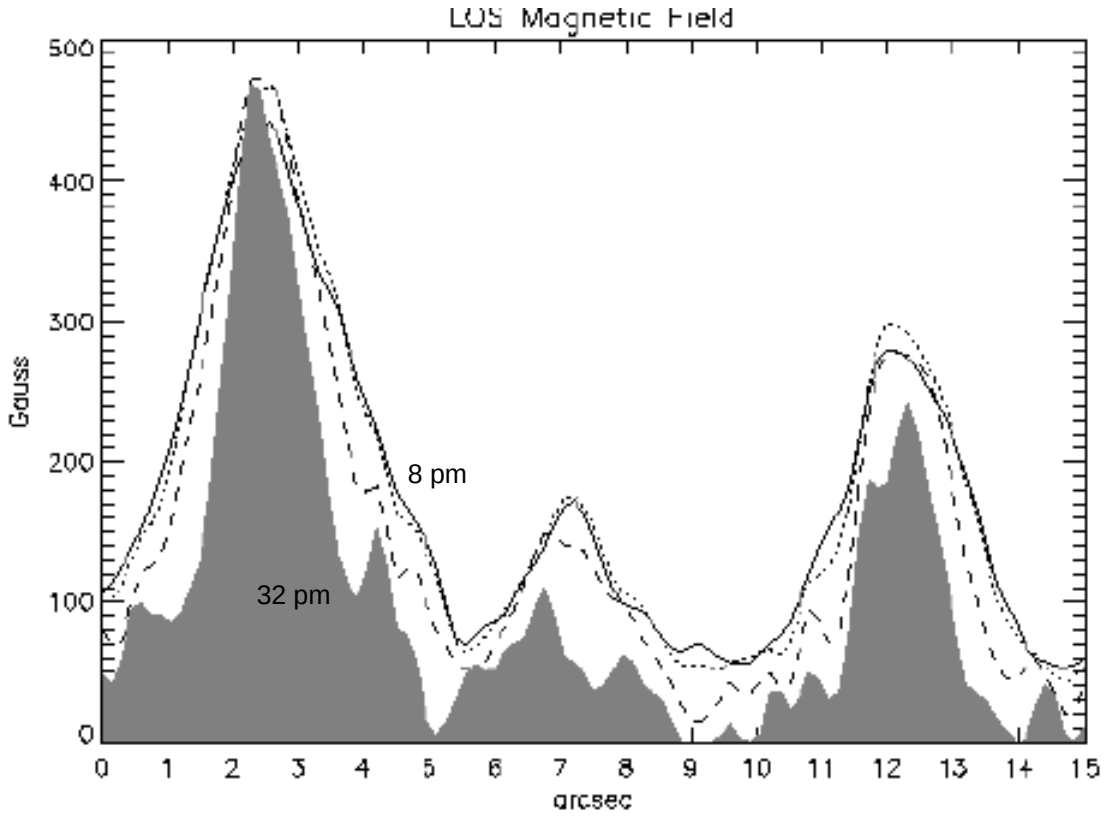


NaD1 +/- 80mA



15 arcsec

Obs. J-M Malherbe, May 2000



THEMIS/MSDP, J-M Malherbe, 2000

- **Larger size of facular magnetic structures at high levels**
- **Canopy models**

Prospects: **Spatial Resolution** with **THEMIS/MSDP**

Expectations 2005

- New cameras 1000*1500, pixel **0.2 arcsec** < MTR cameras
- **Tilt** - mirror
- Physical pixel-size > IPM cameras

→ smaller aperture of output transfer optics

better spatial resolution

higher **potential well**

Programmes

- **Canopies**: 3D structure
- **B//** and **Velocity//** at **different levels**

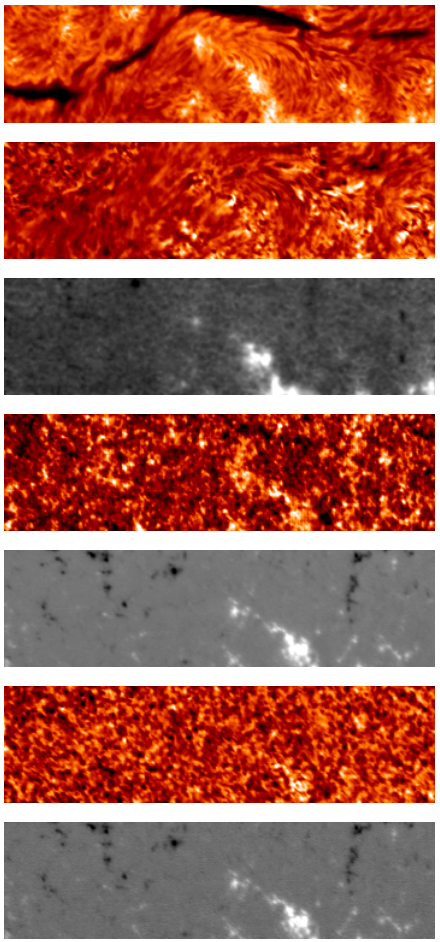
+ accurate **geometry** of magnetic features

+ possible center-to-limb perspectives

→ constraints on **chromospheric vector B**

and coronal **extrapolations**

Fast Events over Large 3D Fields
THEMIS/MSDP 2005



- With **I+V, I-V** typical expected scans:

  3' * 3' within **3 mn** (**beam- exch. 5mn**)

  or **3' * 1'** within **1 mn**

- pixel **0.2 arcsec**

- **Simultaneous D1 and Hα** : several levels

  from **Photosphere** to **Chromosphere**

- **Hα** alone = X-steps twice larger

  ⟶ twice **faster**

Can be **alternated** with

QUV grid-**MTR** observations

within **5 mn**