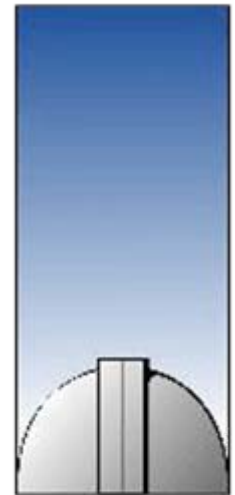


The vertical component of electric current densities in sunspots

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AIP

Why are electric current densities of interest?

Electric currents might play an important role in the formation of finestructures in sunspots.

(see Title et al., ApJ 403, 780, 1993;

Hamedivafa, A&A 407, 761, 2003.)

They are an important ingredient for the extrapolation of the magnetic field up to the corona.

(details in the talk of Thomas Neukirch)

Observations

Three sunspots were observed at the VTT on Tenerife in the year 2001 and 2002 with the Tenerife Infrared Polarimeter.

Spectra in all four Stokes-parameters.

Wavelength: 1089.6 nm (Fe I, $g=1.5$)

Wavelength step: 3.17 pm.

Spatial step: $\sim 1/3$ of an arcsec.

The VTT

The German Vacuum Tower
Telescope on Tenerife (VTT)



Data reduction

Inversion with SIR

(Ruiz Cobo & del Toro Iniesta, ApJ 398, 375 (1992))

Magnetic angles with respect to the LOS are converted to Cartesian coordinates of B , and these are rotated with respect to the solar surface normal.

Geometrical foreshortening is corrected.

The sunspot

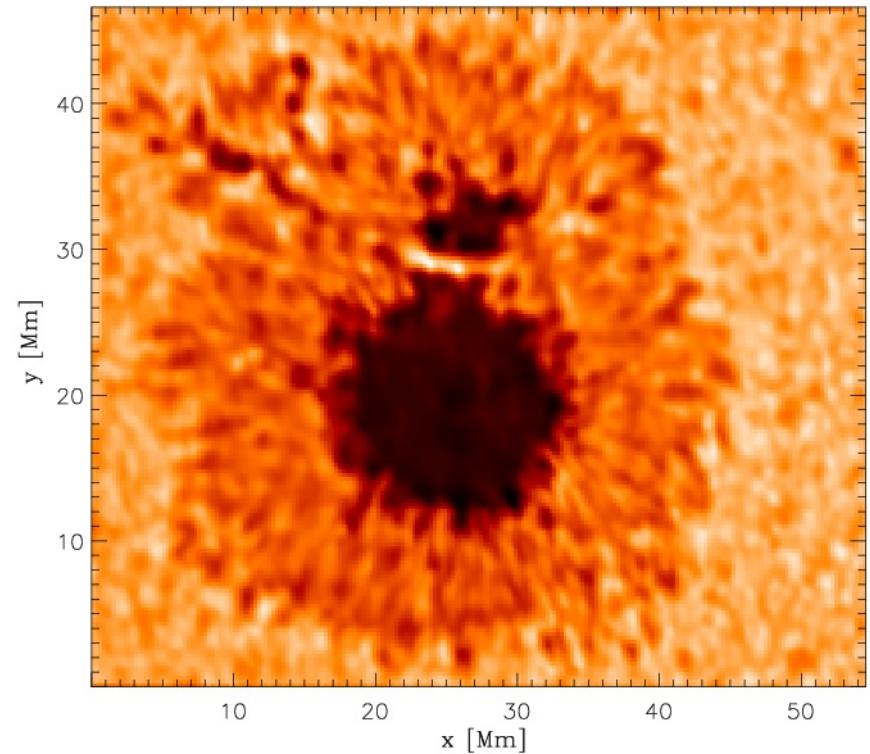
AR 9504

19 June 2001

8N 5E

1089.6 nm

Two subscans.



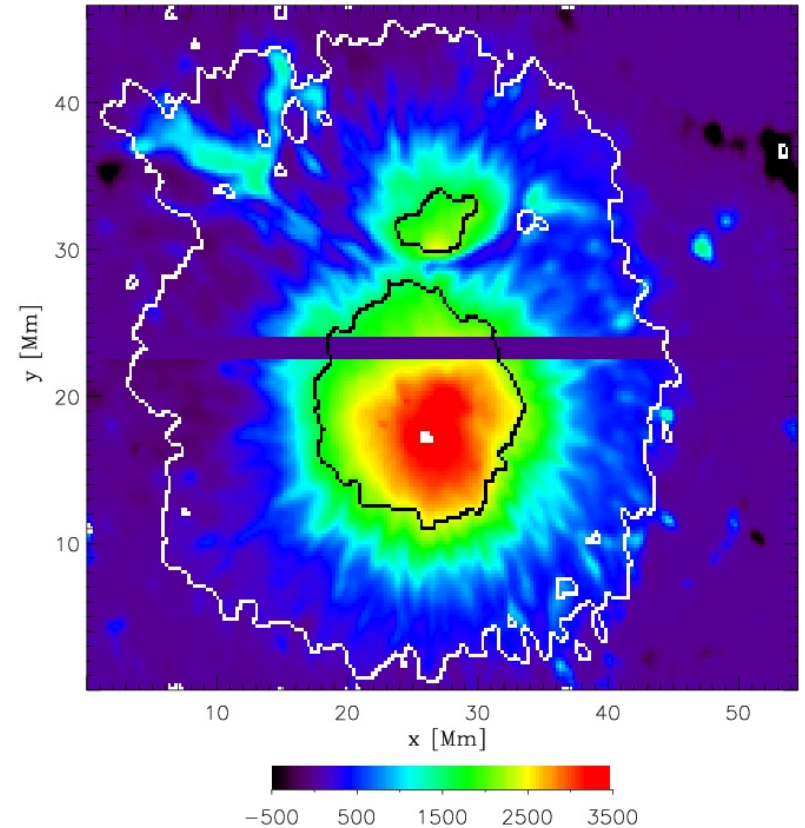
The vertical magnetic field

AR 9504

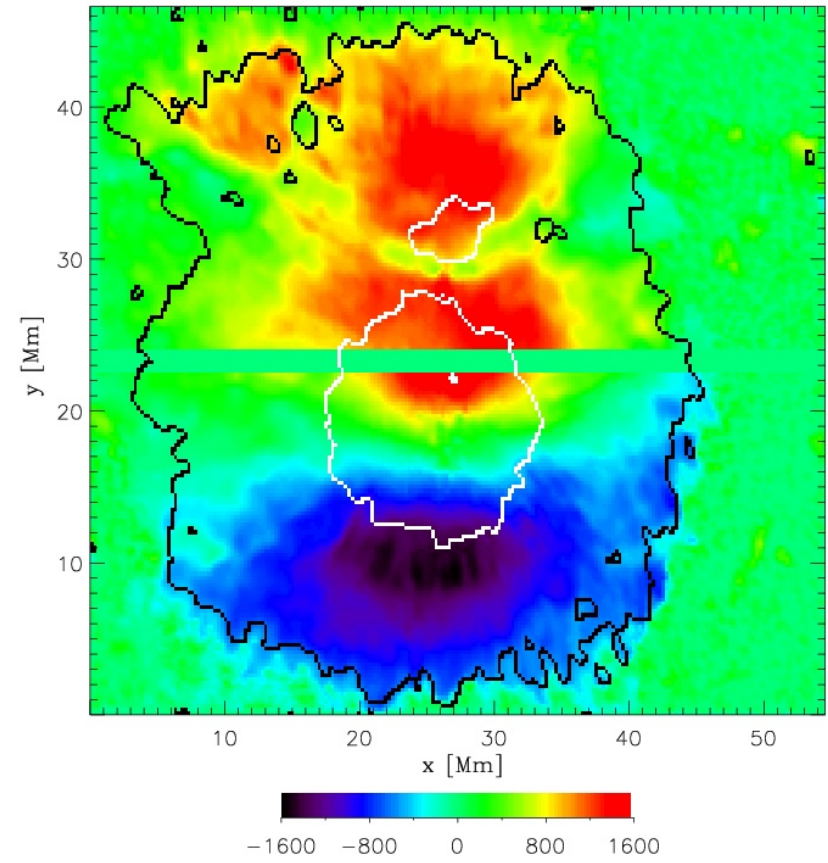
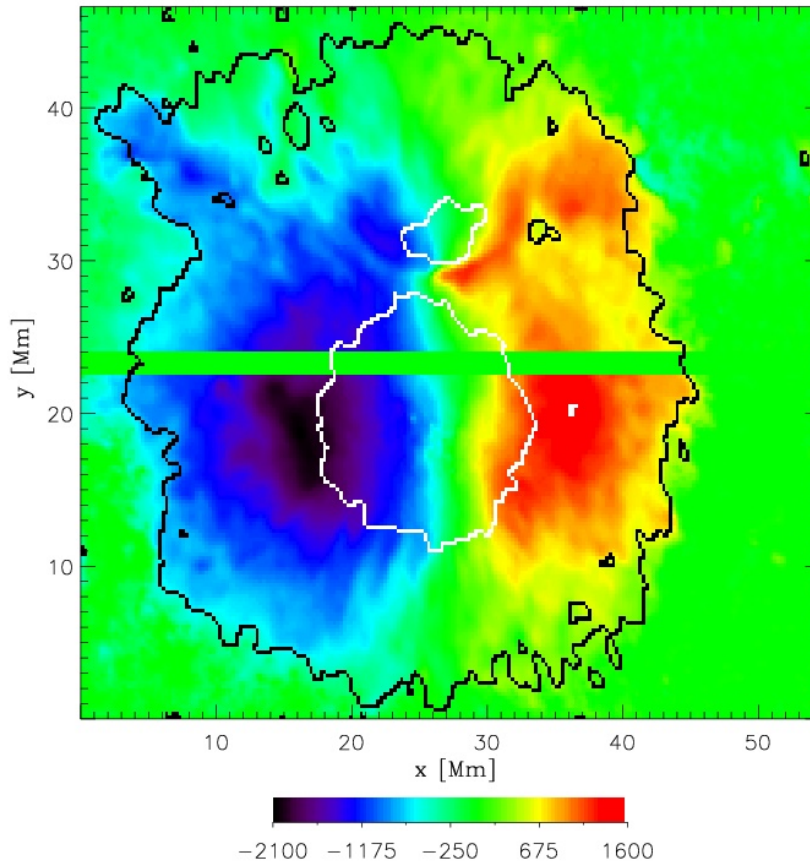
Combined from two
subscans.

Overlapping strip not used.

Note radial structure!



The horizontal magnetic field





Maxwell's equation for currents:
(force-free, no displacement current)



$$\nabla \times \mathbf{B} = \mu \mathbf{j} = \alpha \mathbf{B}$$

$$\mu j_z = \frac{\partial B_y}{\partial x} - \frac{\partial B_x}{\partial y}$$

Electric current densities

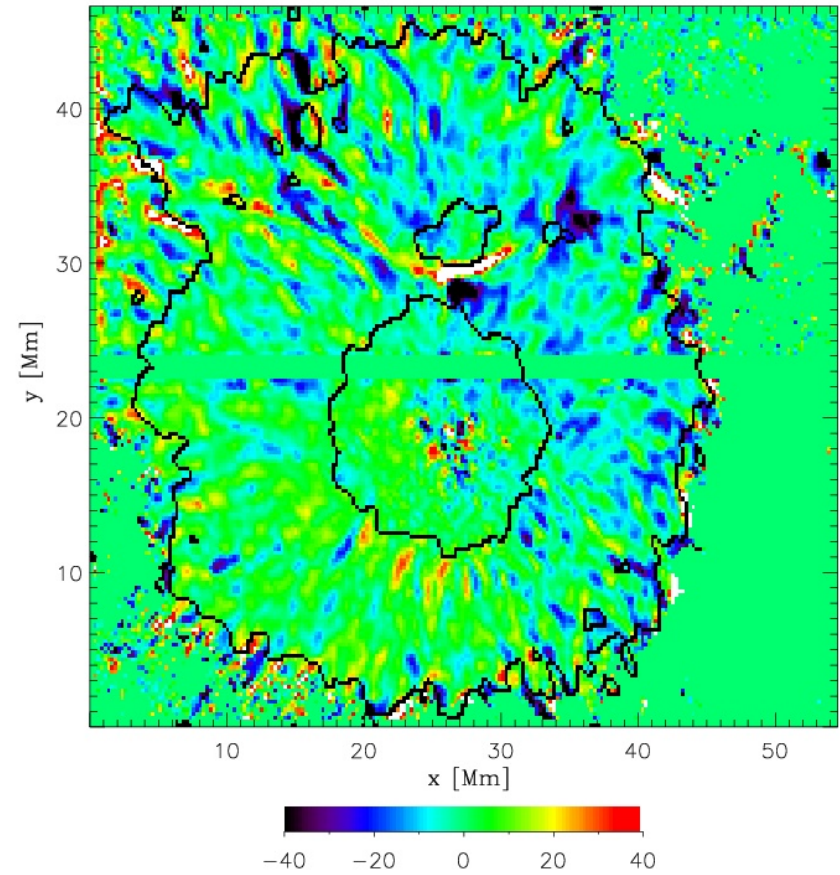
For AR 9504

In [mA/m^2].

Indication of a radial structure

Disturbed areas with high current densities.

Ratio j_z/B_z varies by orders of magnitude across the spot



Some statistics for penumbrae

Current densities

Spot	date	min	max	mean	rms	err
9504	2001-06-19	-100	166	-1.2	12	23
9516	2001-06-30	-38	48	-0.3	6	25
9516	2001-07-01	-57	66	+0.5	9	32



Discussion

Problem: spatial resolution is low.

Neighboring pixel might not belong together.

There is a relation to the penumbral finestructure, but the present results cannot be interpreted to explain the physics of filaments.

It might be problematic to use low resolution magnetic field data for extrapolations.

GREGOR



A new solar telescope with 1.5m diameter, presently under construction on Tenerife.