Instrumental developments and scientific programs at Istituto Ricerche Solari Locarno (IRSOL)

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Bamboo Sea, China

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IRSOL

- IRSOL = Istituto Ricerche Solari Locarno
- Observatory specialized in polarimetry

Scientific Staff

- Dr. Michele Bianda
- Dr. Renzo Ramelli
- Dr. Daniel Gisler
- Lucia Kleint (PhD student)

+ Collaborations with other institutes worldwide;

in particular with ETH-Zurich (prof. Jan Stenflo, prof. Svetlana Berdyugina, ...)

Outline

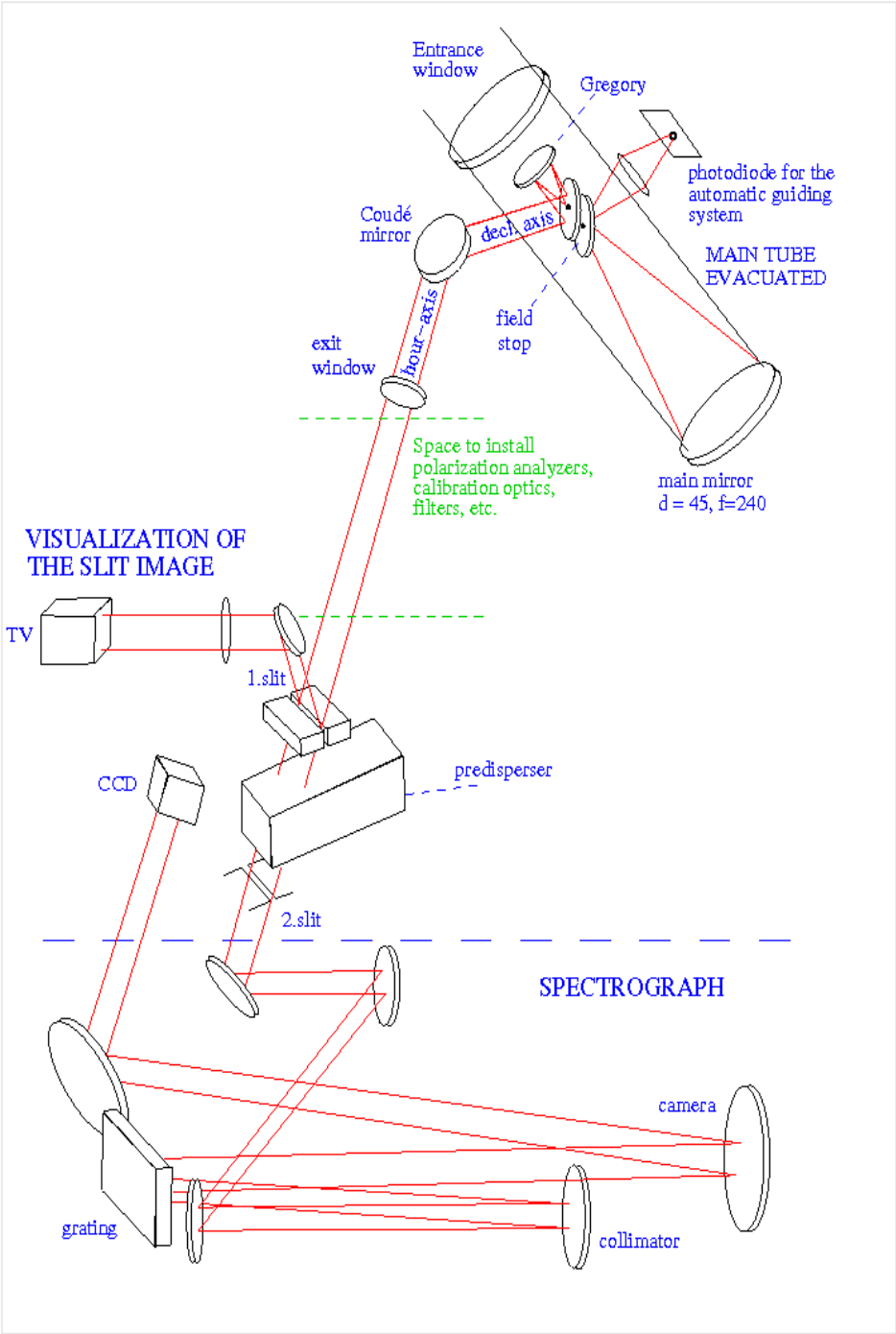
- Instrumentation
  - Telescope + Spectrograph
  - ZIMPOL (new version ZIMPOL3)
  - Why polarimetry at IRSOL?
  - Recent instrumentation:
    - Fabry- Perot filter system
    - Adaptive optics
- Scientific programs
- Future projects
- Conclusion

The IRSOL instrumentation

Telescope

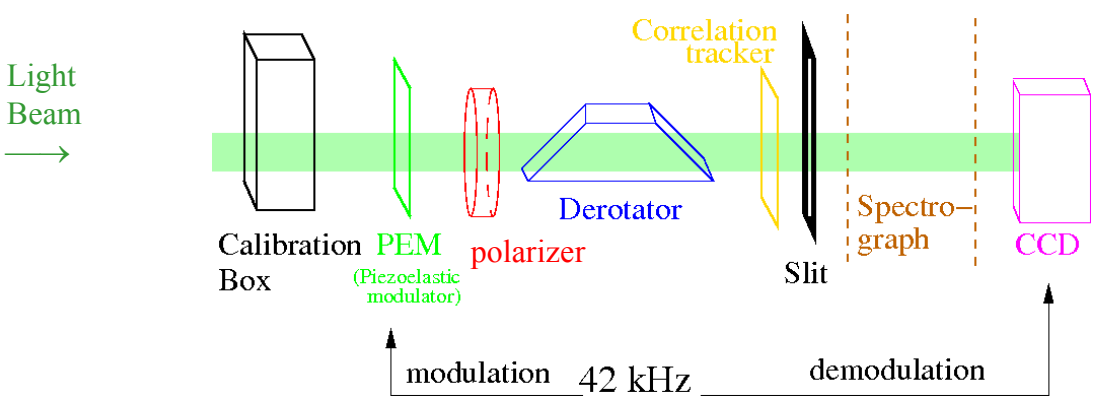
- **Telescope:** Gregory - Coudé, evacuated
  - Diameter of primary mirror: 45 cm
  - Total focal length: 25 m
- **Spectrograph:**
  - focal length: 10 m
  - grating 18 cm × 36 cm
  - 316 lines / mm
  - blaze 63°

Telescope layout



ZIMPOL polarimeter

- ZIMPOL-polarimeter ***(Zurich Imaging Polarimeter,*** developed at ETH-Zurich) allows precise full Stokes measurements free form seeing induced spurious effects (modulation 42 kHz).
- Polarimetric accuracy depends primarily on photon statistics. 10^{-5} level can be reached with long enough exposure time.

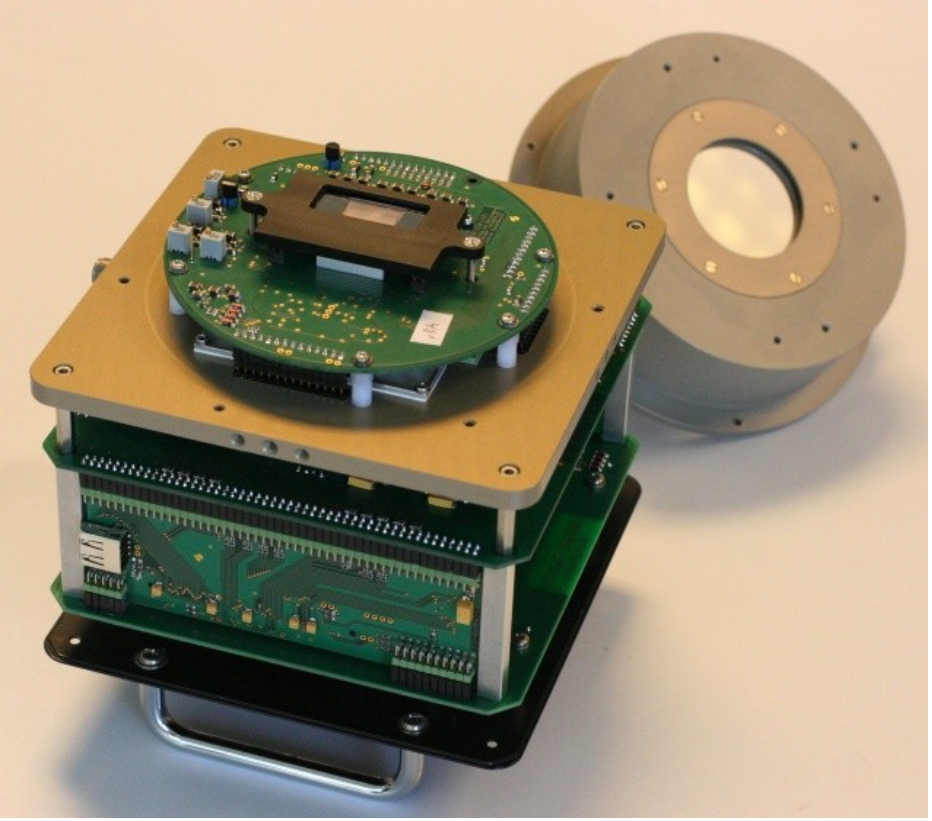


ZIMPOL - setup

ZIMPOL3

New generation camera system

ZIMPOL3



Improvements with respect to ZIMPOL2:

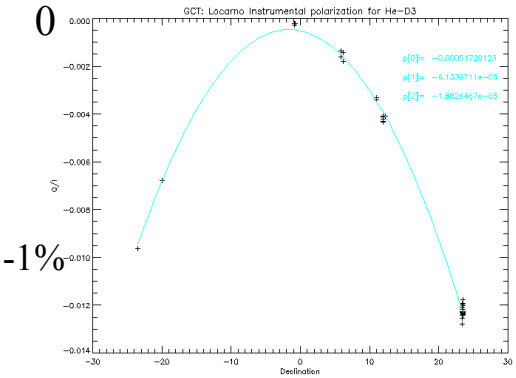
- more efficient and faster
- exposure and readout simultaneously
- larger chip
- based on newer technology (replace components available on the market)
- more flexible system, more functions (readout modes binning, subframe readout, different demudalation schemes, electronic compensation of telescope offset)
- more compact
- easy connection through ethernet from any computer
- night astronomy application: longer integration time, better cooling

Advantages of GCT at IRSOL + ZIMPOL

- Very good polarimetric and spectral accuracy
- Large amount of observing time available:
  - Flexibility, fast reaction to particular solar events
  - Good for monitoring or for projects requiring long observation time
  - Good for testing and development of new instrumentation
- Measurements down to the near UV (390 nm or more)
- Instrumental polarization is small and almost constant over one day of observations (easy to correct – depends on declination only)

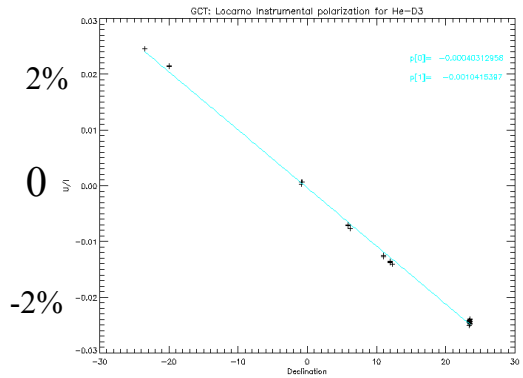
Crosstalks

I → Q



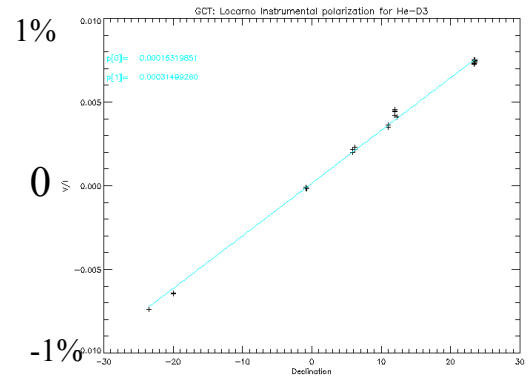
Declination

I → U



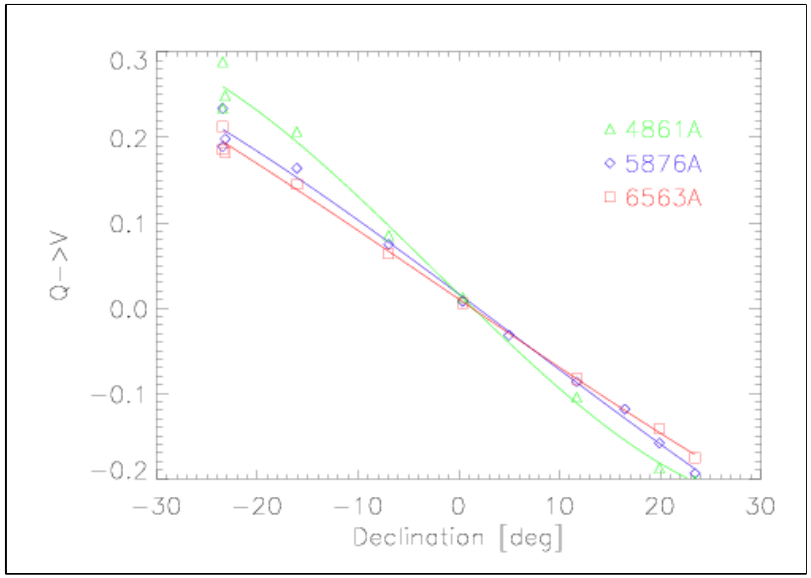
Declination

I → V

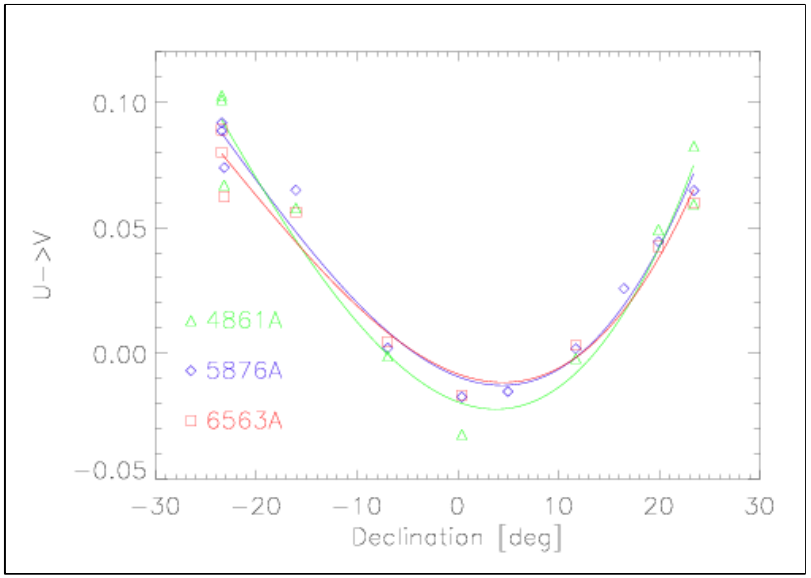


Declination

Q → V



U → V



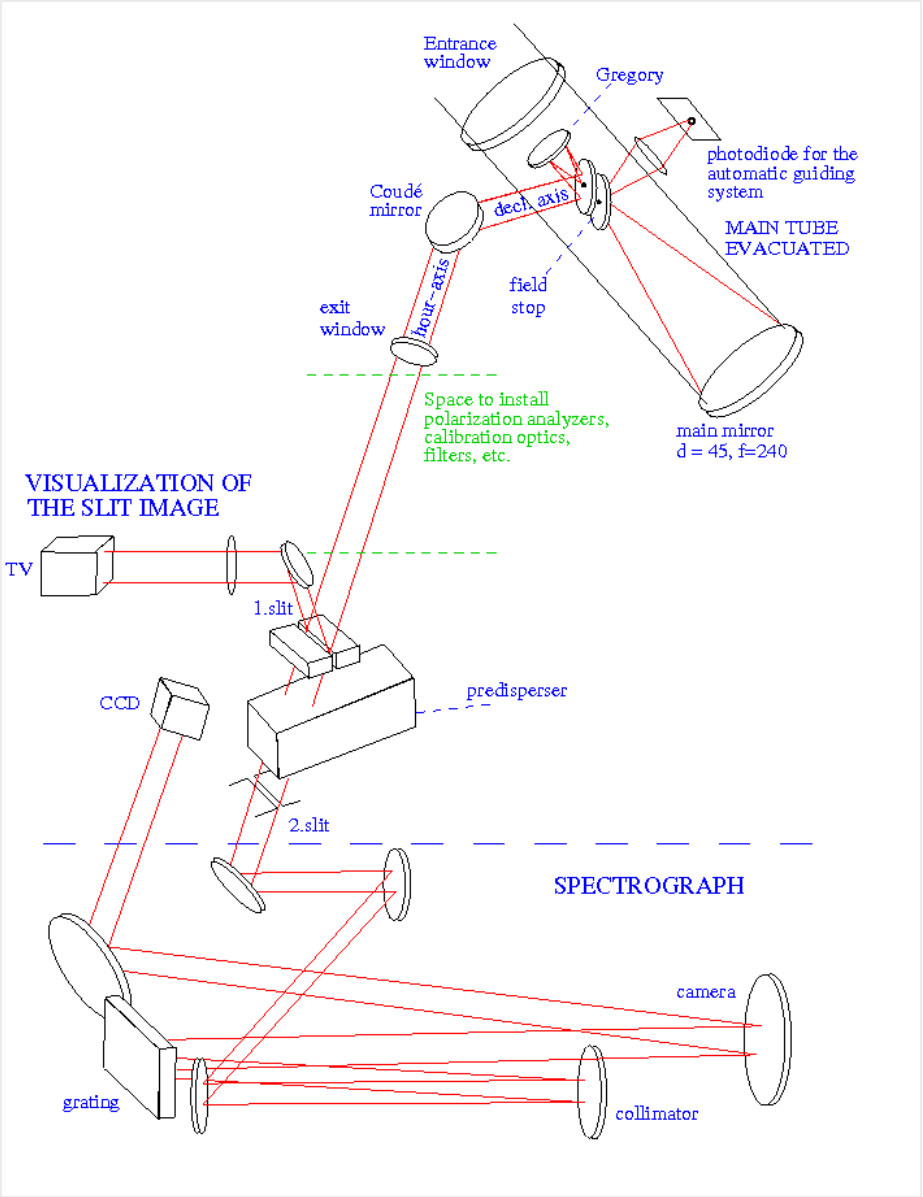
Recent instrumentation

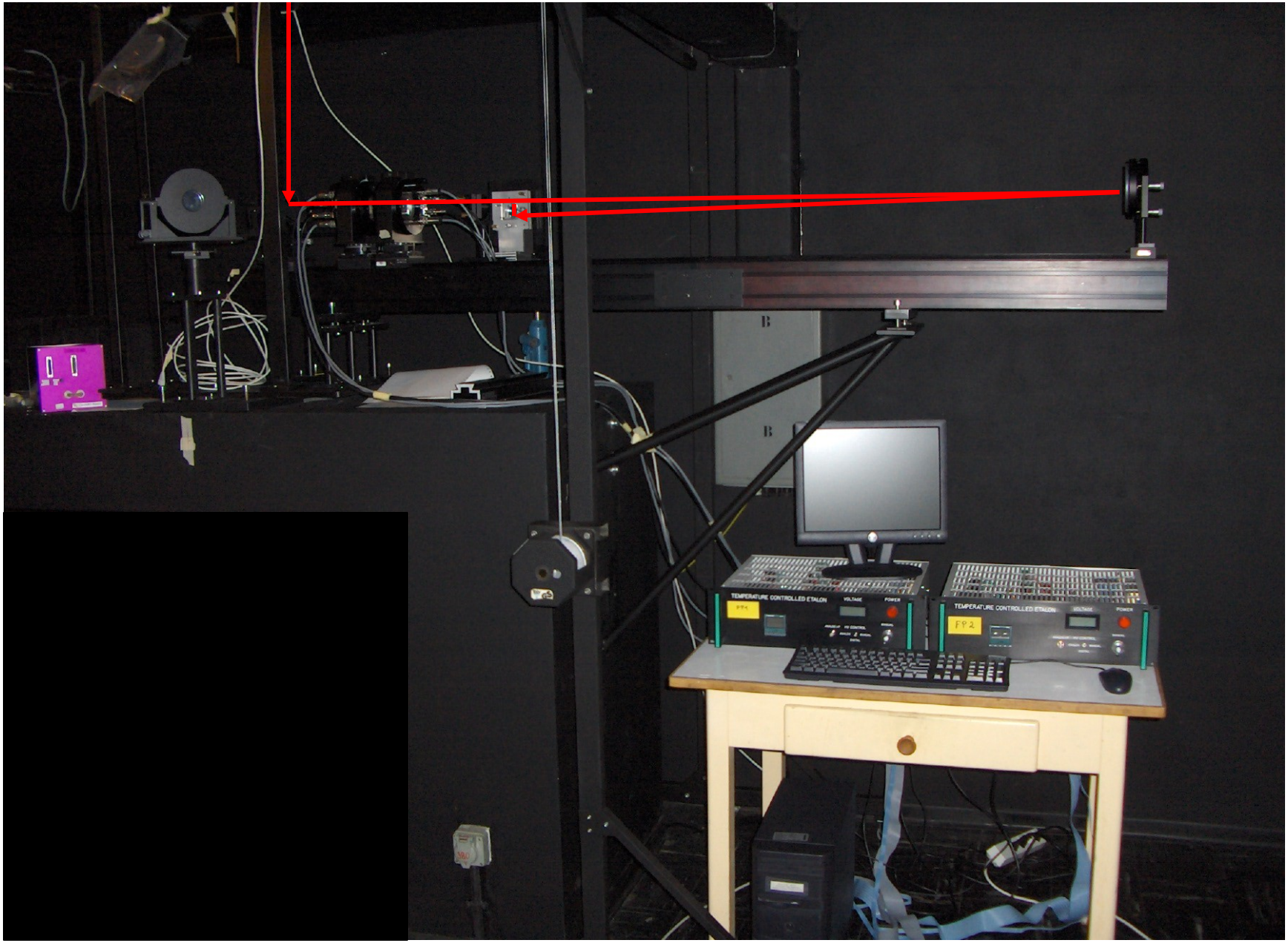
- Fast tunable narrow band filter system

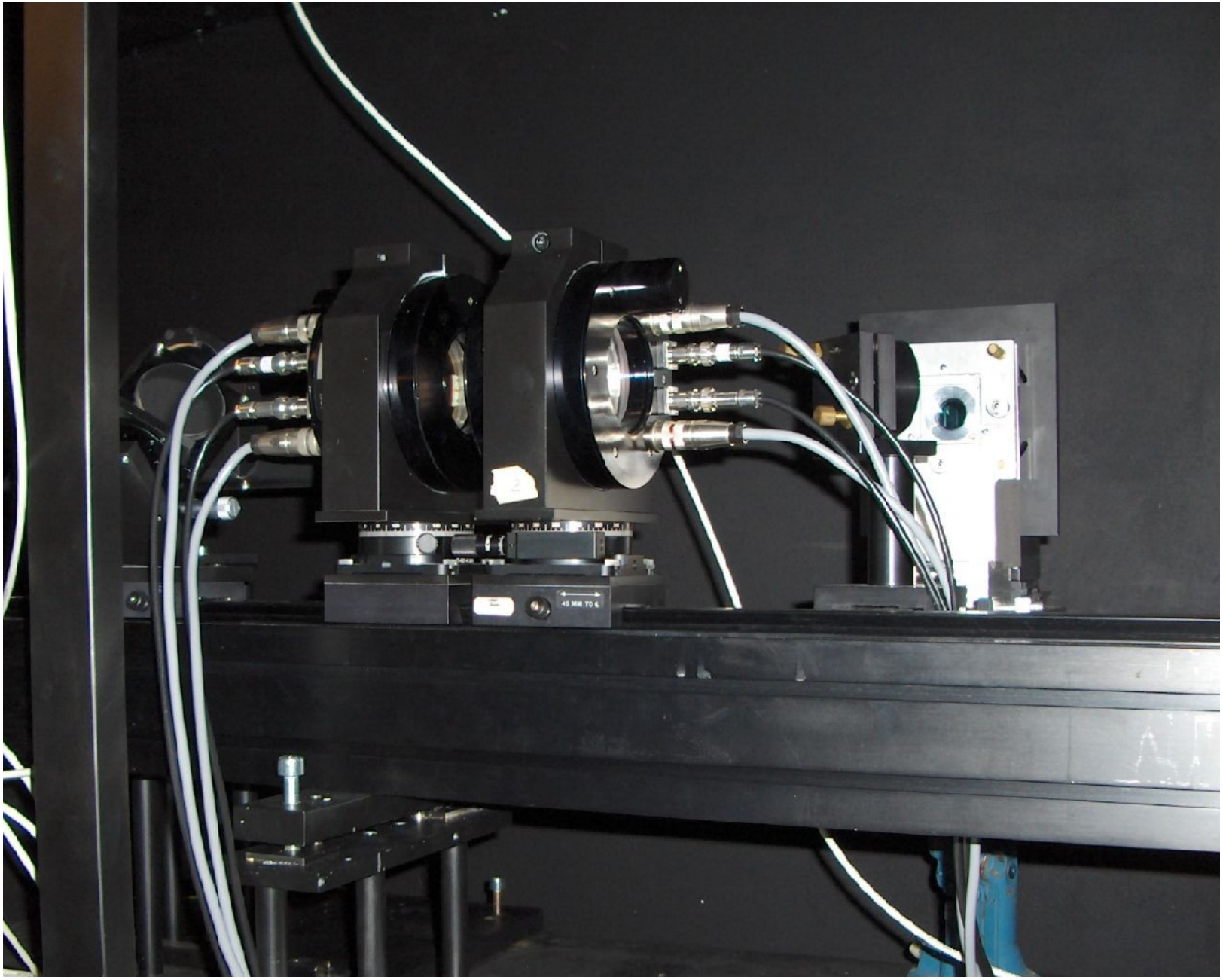
  → monochromatic imaging

  - two lithium niobate Fabry-Perot etalons
  - Bandwidth ~ 30 mA

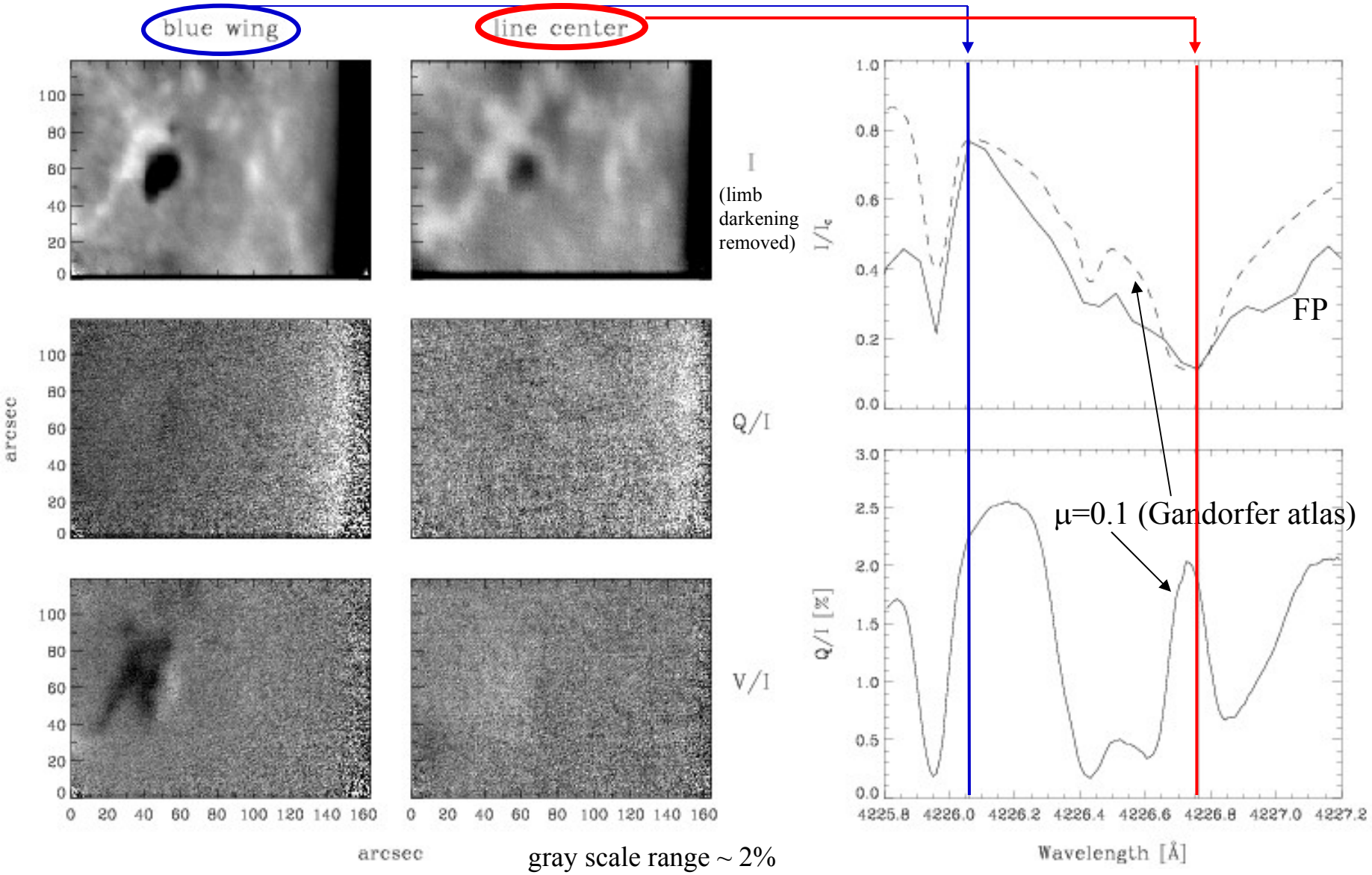
- AO system




TEMPERATURE CONTROLLED ETALON
VOLTAGE
POWER
FP1
TEMPERATURE CONTROLLED ETALON
VOLTAGE
POWER
FP2


45 MM TO 6

Example of FP recording in the Ca I 4227 A line



31 August 2006

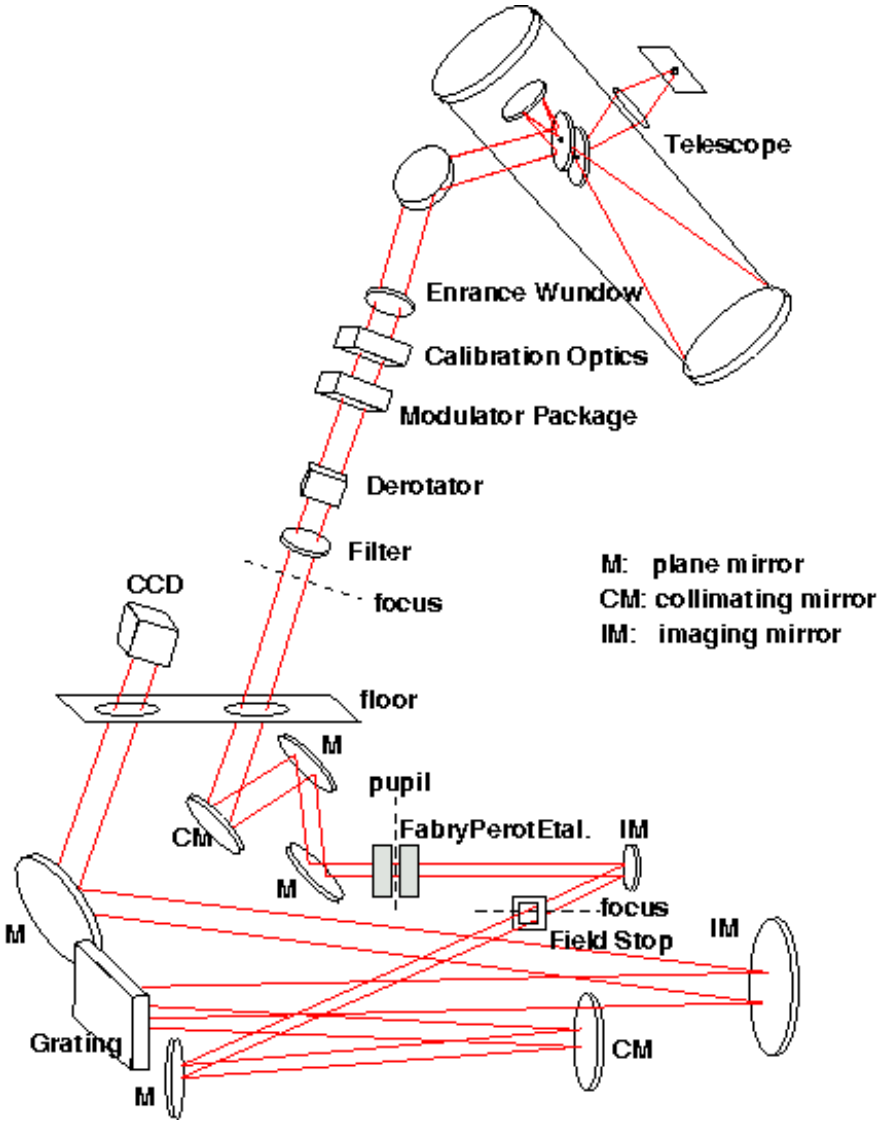
(A. Feller, PhD thesis, 2007)

New setup with FP+spectrograph

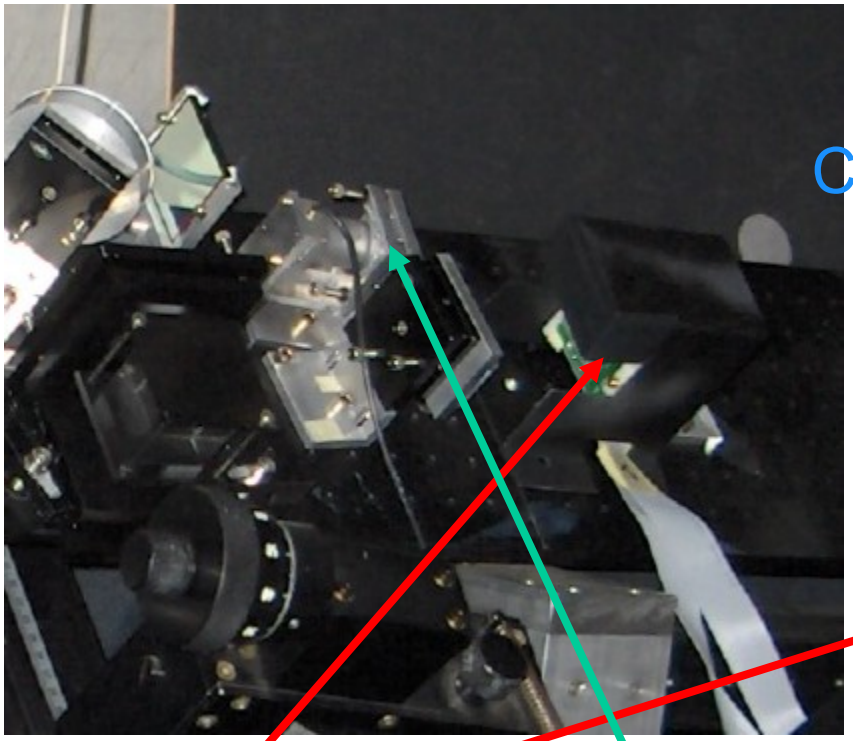
- First tests made by Kleint, Feller et al.

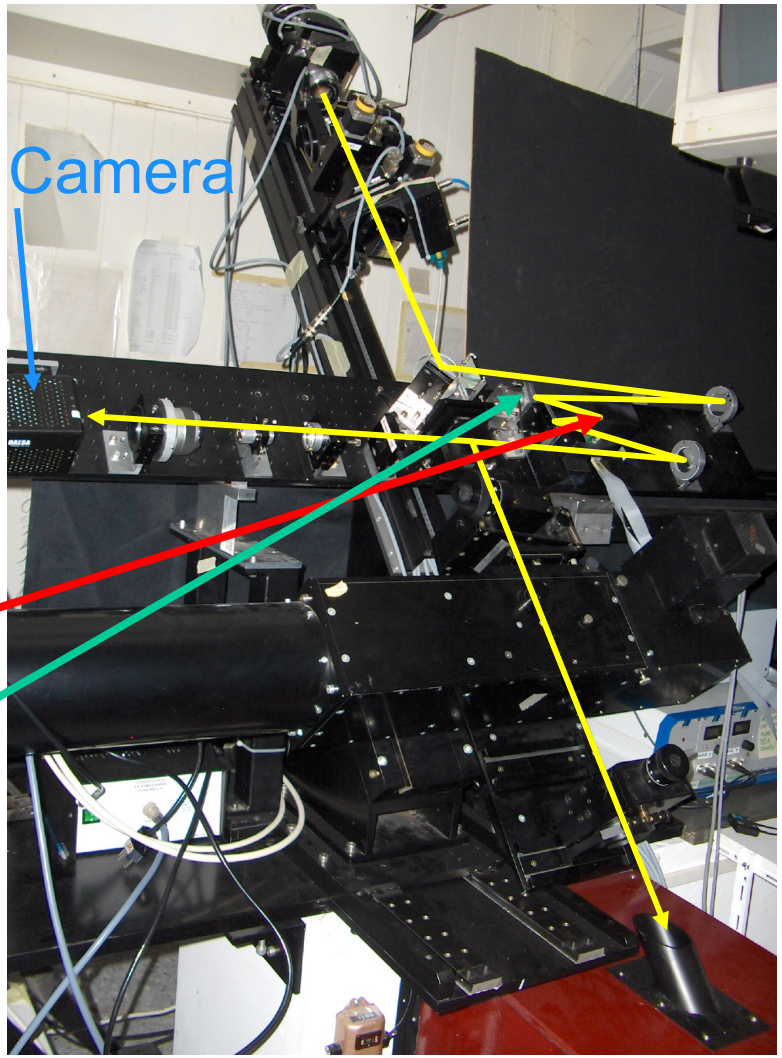
- This setup allows to explore any spectral line without having to buy a specific narrow band filter

- Possible to obtain simultaneously on the same CCD two or more monochromatic images at slightly different wavelengths (corresponding to the transmissions peaks of the FP) (ex. 2 wings of a spectral line, or 1 wing + core)



Adaptive optics





Deformable mirror

Tip-tilt mirror

Scientific programs

Scattering polarization and the Hanle effect

- The high polarimetric accuracy (down to 10^{-5} level) allows interesting measurements of scattering polarization (specially near to the limb)
- Scattering polarization & Hanle Effect → powerful tool to get information about magnetic fields that are weak or/and tangled on scales below the spatial resolution (to which Zeeman is blind)

Examples of results obtained at IRSOL

- Hanle effect measured in the quiet chromosphere (Bianda et al., 1998)
- 2 Volumes of "Second Solar Spectrum Atlas" (Gandorfer, 2000/2002)
- Determination of novel constraints on impact polarization in solar flares (Bianda et al., 2005)
- Discovery of vast amount of hidden magnetismus in the solar photosphere (Trujillo Bueno et al.- Stenflo, Nature 2004)
- Measurements of polarization in molecular lines (e.g. Berdyugina et al. 2006 ; Asensio Ramos et al. 2004)
- Measurements of full Stokes profiles in prominences in Hα, He-D3 and H β (Ramelli et al., 2005)
- He-D3 full Stokes spectropolarimetric measurements in spicules (Ramelli et al., 2005)
- BaII D2 line observations to verify the theoretical predictions of Belluzzi et al. (Ramelli et al., 2007)
- ....

Future research at IRSOL

- Different observing programs on solar magnetism and polarimetry (with FP or spectrograph)
- Synoptic type programs (eg. Variations of the Hanle-effect signatures with respect to heliographic latitude and solar cycle phase)
- Coordinated type programs with other observatories
  - Simultaneous observations of solar features with complementary sets of instruments
  - Supporting type observations that complement the science of another project

Conclusion

- Interesting research projects mainly in polarimetry and solar magnetism are carryed out at IRSOL.
- We are open to new collaborations