In-situ Geomagnetic Absolute Orientation with the AUTODIF Instrument

by

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Directional Drilling
&
Magnetic Observatories

Interesting link revealed to us in 2000

Royal Meteorological Institute - Geophysical Center :

- –Magnetic observatory of Dourbes & Manhay
- –Magnetic Valley structure

Thanks for the invitation

Directional Drilling
&
Magnetic Observatories

What do we have to offer to directional drilling community?

In-Situ (local) magnetic field measurements. This will improve your positioning accuracy by:

- Eliminate crustal variation
- Eliminate diurnal variation

Products & Services from our Group: In Field Referencing

In situ magnetic orientation measurements (automatic)

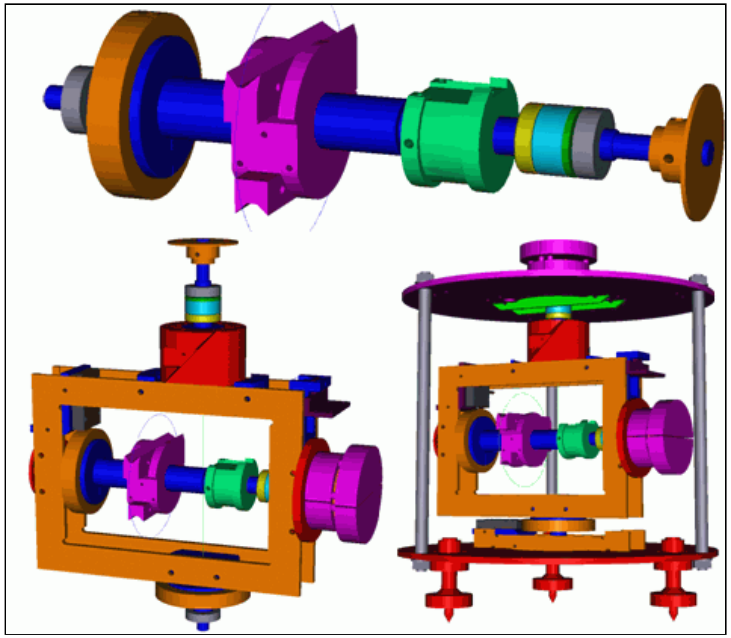
- **By our new robotized instrument AUTODIF**
- Measures, logs and sends data on the magnetic declination and dip angles
- 0.002° accuracy with respect to True North and Zenith
- Up to 4 samples/hour

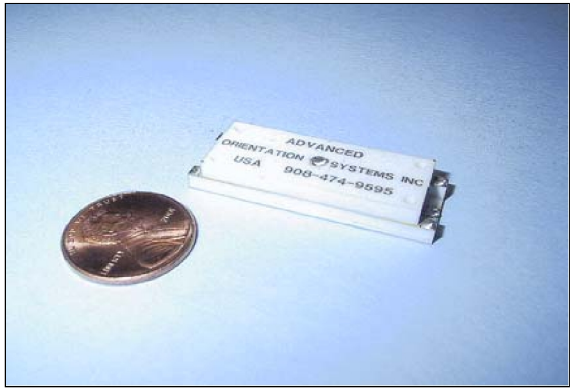
Field deployment conditions

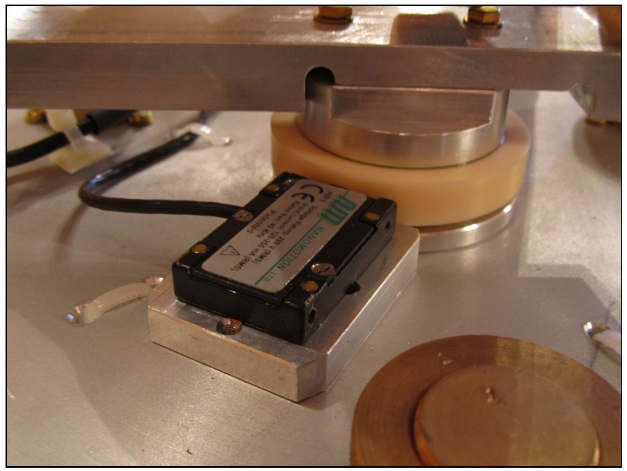
- Nonmagnetic environment & shelter
- Stable nonmagnetic support (pillar, tripod,..) allowing leveling
- Need for installation of and view on distant target (~100m)
- Need for azimuth determination of target (sunshot or gyro)
- Battery operated

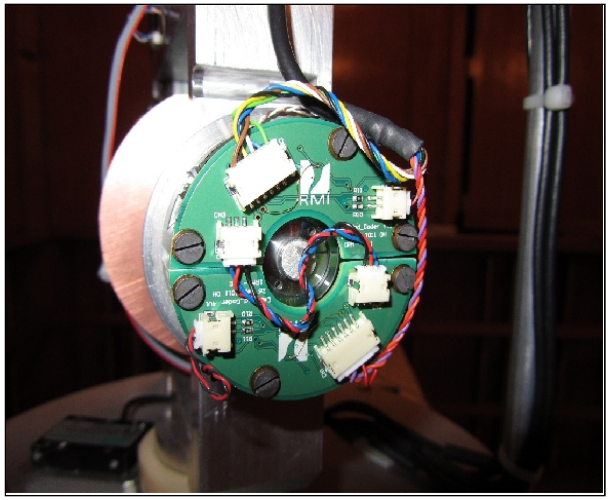
Details on AUTODIF instrument

- A robotized theodolite, non-magnetic:
  - frame
  - angular encoders
  - motors
  - level





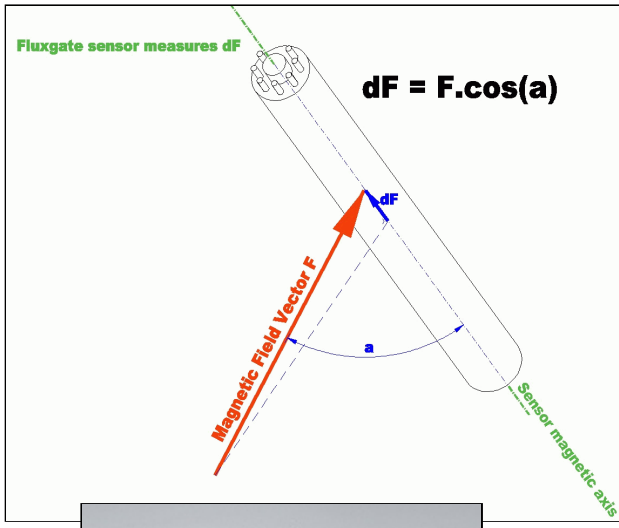


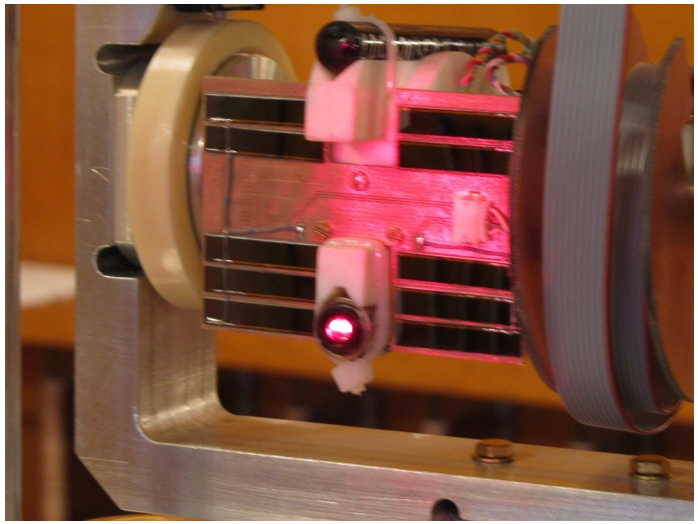


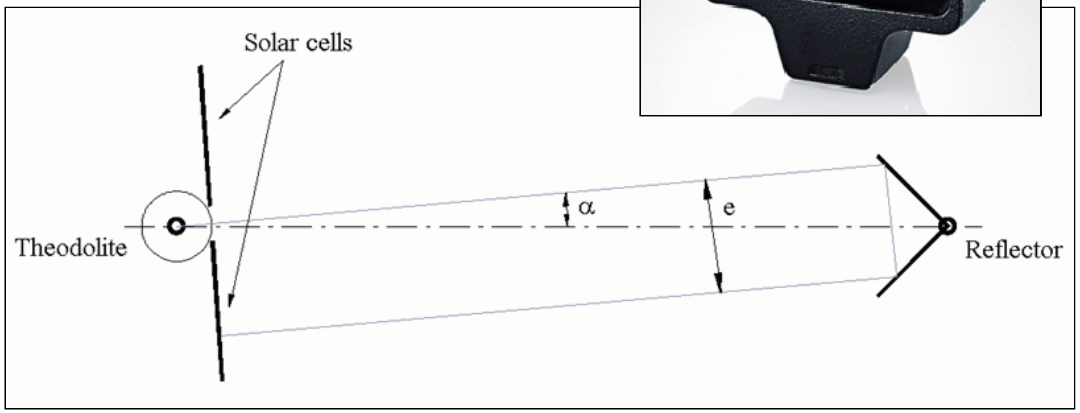
Details on AUTODIF instrument

- Uses the Diflux measurement protocol
  - Directional properties of a fluxgate sensor find orientation of magnetic field vector
  - Four step sequence eliminates collimation errors and sensor magnetization error
  - 0.1 nT fluxgate noise guarantees 1 second of arc orientation capability

- Laser beam instead of telescope
  - Laser installed parallel to fluxgate sensor (collimation!)
  - True North reference is laser light beam with known azimuth (previously measured)
  - Distant target is a corner cube reflector
  - Photocells precisely align laser beam on target

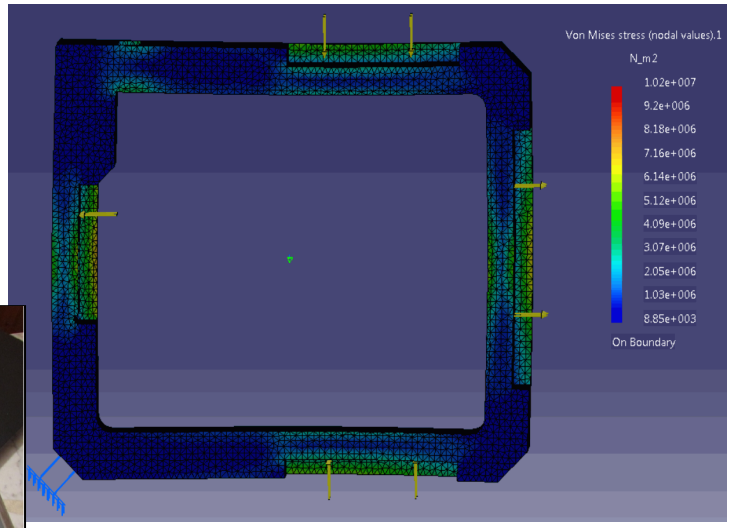


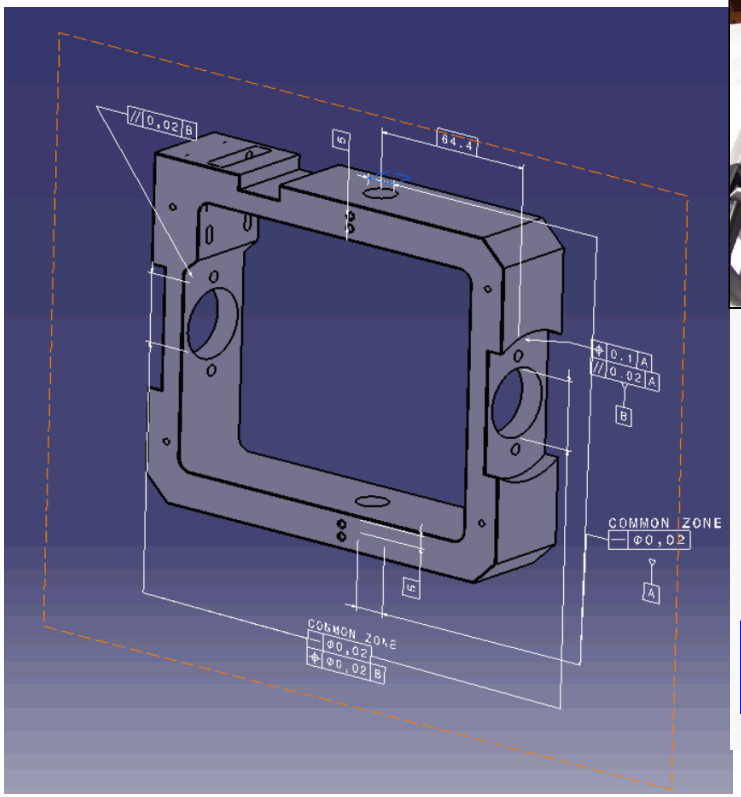


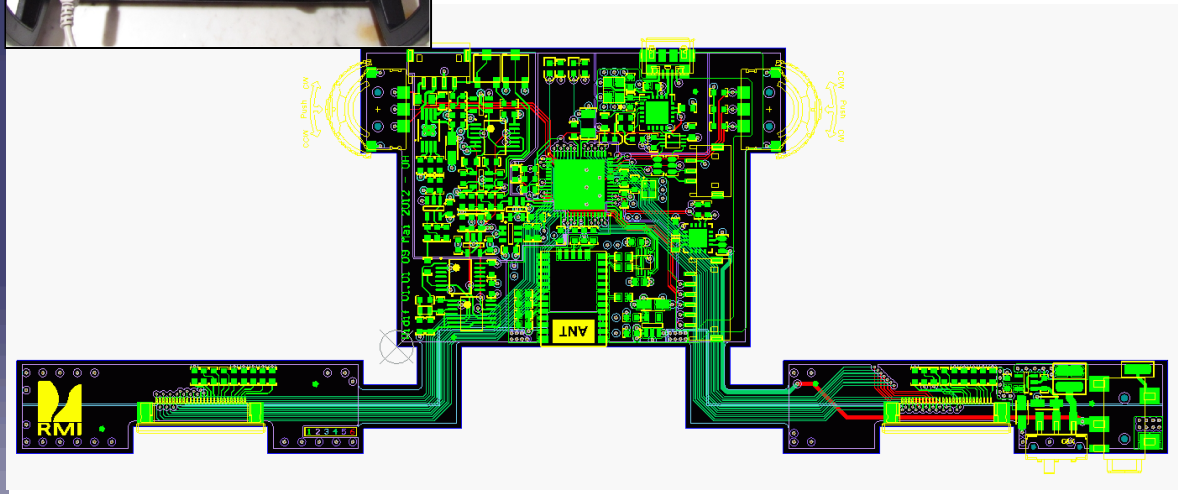


Details on AUTODIF instrument

- Modern manufacturing techniques and quality assessment:
  - Stress/strain + thermal simulation
  - Dimensional accuracy control
  - Multilayer smd PCB & flex design
  - Latest CNC machinery

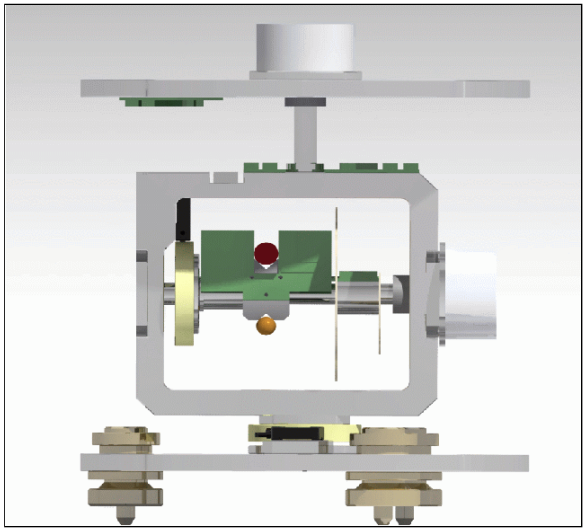


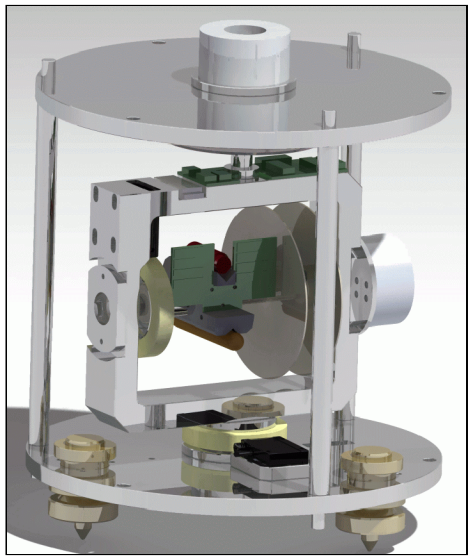




Details on AUTODIF instrument

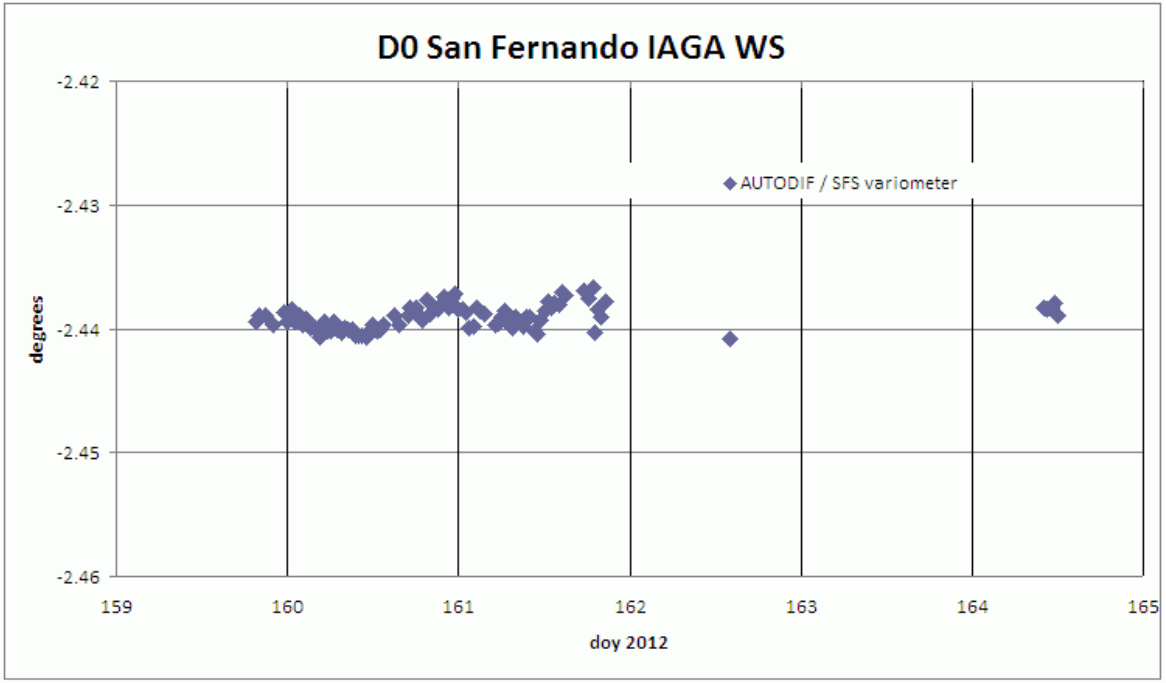
- Lab version
- Ruggedized version (against humidity, dust)





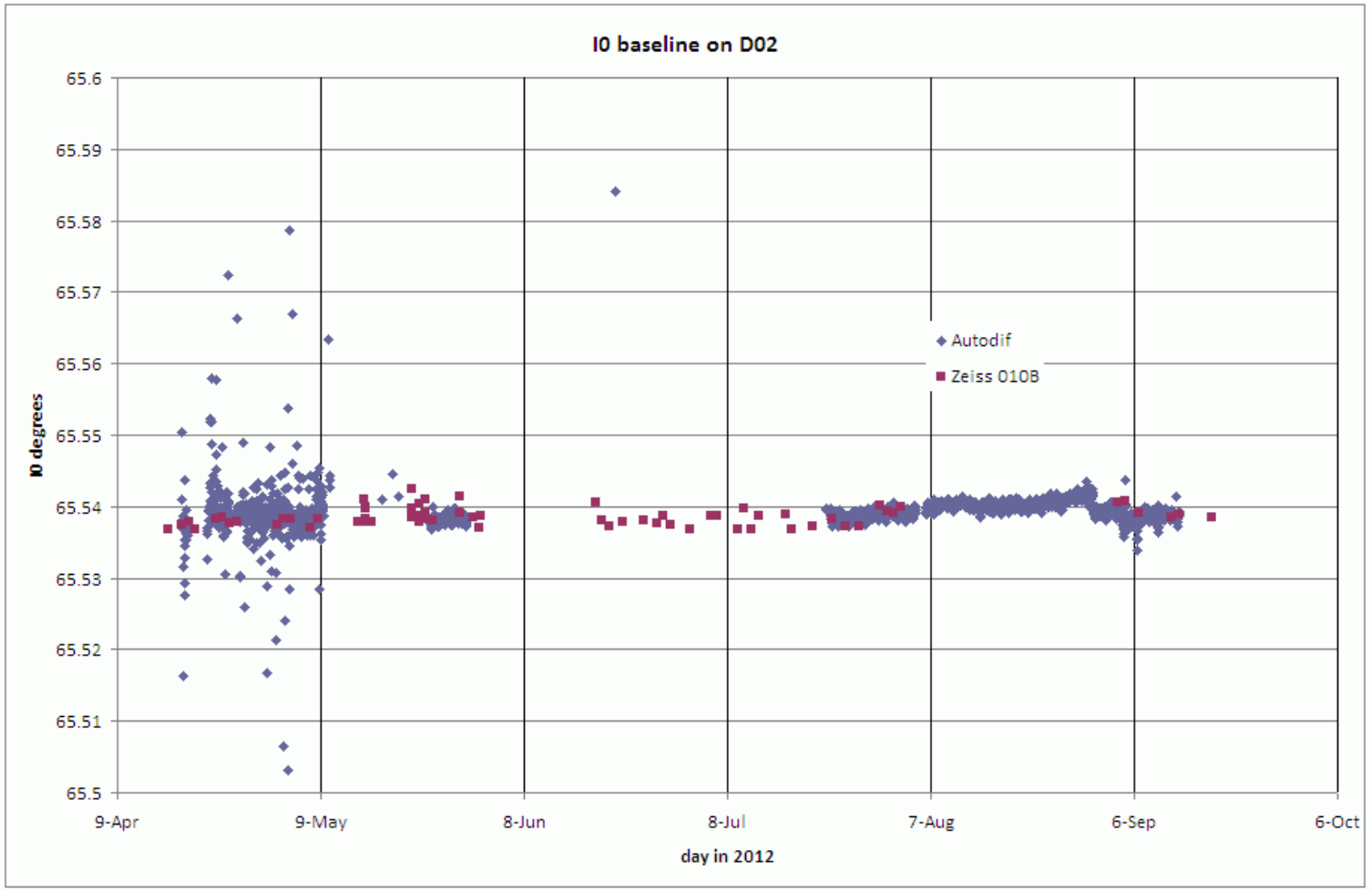
Details on AUTODIF instrument

- Error budget
  - Horizontal reference errors: 0.005°
  - Angular encoder orientation errors : 0.002°
  - Vertical reference errors : 0.001°
  - Magnetic orientation errors: 0.0005°
- Testing & actual measurements: baseline determination



Details on AUTODIF instrument

Long-term baseline comparison with manual method (dip)

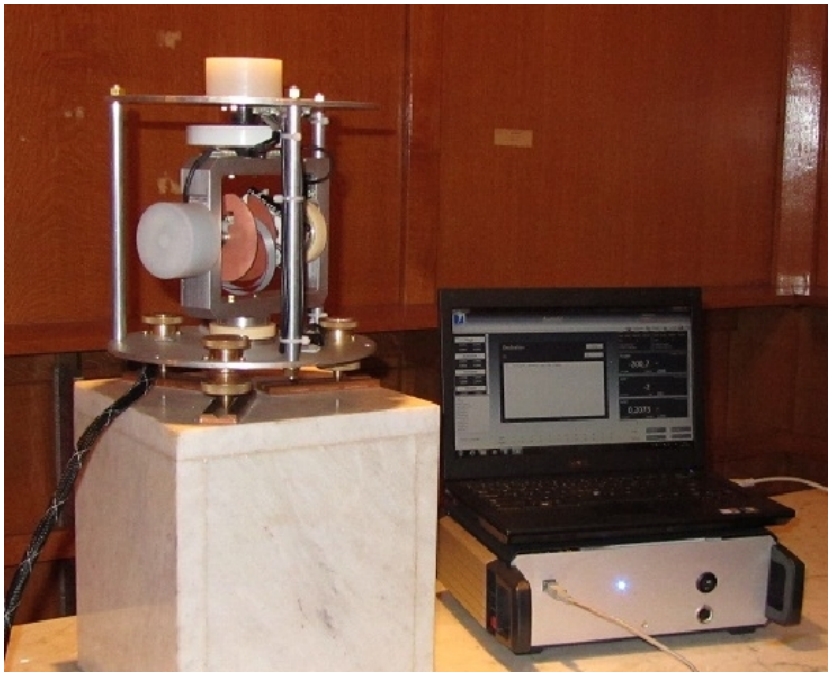


Details on AUTODIF instrument: access to data

- Graphical User Interface controls the instrument
  - Hosted on W7 PC
  - Gives detailed operating condition of the running AUTODIF
  - Displays and logs real-time raw sensor and motor data
  - Accessible from any connected PC
- Data delivery
  - As Magnetic Declination and Dip measurements every x minutes
  - As baseline of companion variometer (Lama)
  - As raw data with all real-time parameters

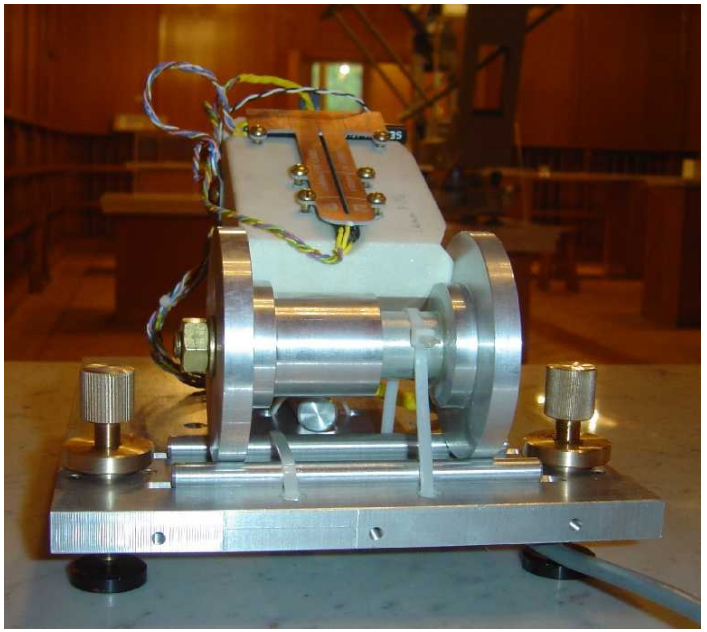
Availability of the AUTODIF instrument

- 2 instruments deployed in Belgian observatories
- 1 instrument to be deployed in Austrian Observatory CONRAD december 2012
- 2 instruments available in early 2013
- Next batch of 5 instruments built in 2013



Other Products & Services from our Group

- Lama variometer (for higher time resolution)
  - Measures, logs and sends data on the magnetic declination and dip angles.
  - 0.0005° resolution
  - Up to 12 samples/minute
  - Overall accuracy up to 0.1%
  - Also 0.1nT field strength data
- Lama deployment
  - Needs nonmagnetic environment, pillar and shelter
  - Needs data logger hut
  - Needs companion DIflux for baseline determination (once per week)



Other Products & Services from our Group

- In situ magnetic orientation measurements (manual)
  - Measures the magnetic declination and dip angles (spot measurement).
  - 0.001° accuracy with respect to True North and Zenith
  - Field strength data too
- Field conditions
  - Need for nonmagnetic environment
  - Need for sunshot or North seeking gyro measurement

Thank you for your attention