AUTOMATIC AND REMOTELY CONTROLLED MANUAL ABSOLUTE GEOMAGNETIC MEASUREMENTS WITH THE ADS INSTRUMENT

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• Typical geomagnetic measurements

- Continuous monitoring, typically in geomagnetic observatories

- Geomagnetic field surveys (ground / airborne, regional / local)

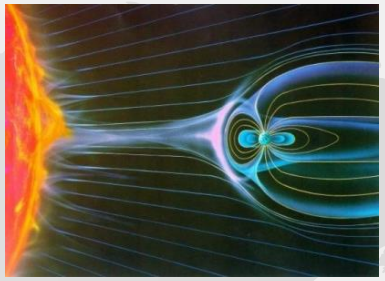
- Satellite missions

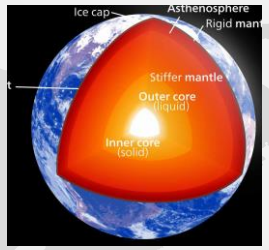
- **Use of continuous geomagnetic measurement data**

  - Scientific research, e.g.:
    - Modelling of the Earth and Earth-Sun interaction
    - Earthquake prediction

  - Communication, transport, power transport security

  - Mining applications (directional drilling)

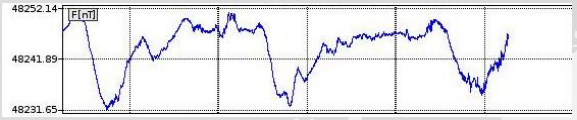




• General procedure of geomagnetic observatory measurements

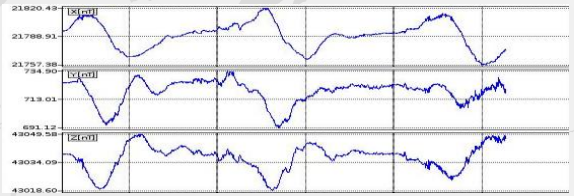
- Continuous **scalar** measurement of the field vector by atomic instrument (**F**)

Automatic absolute instrument, No calibration needed



- Continuous direction and length **variation** measurement of the field **vector** by **fluxgate magnetometer** (**X**,**Y**,**Z**)

Automatic recording instrument, Regular calibration is required

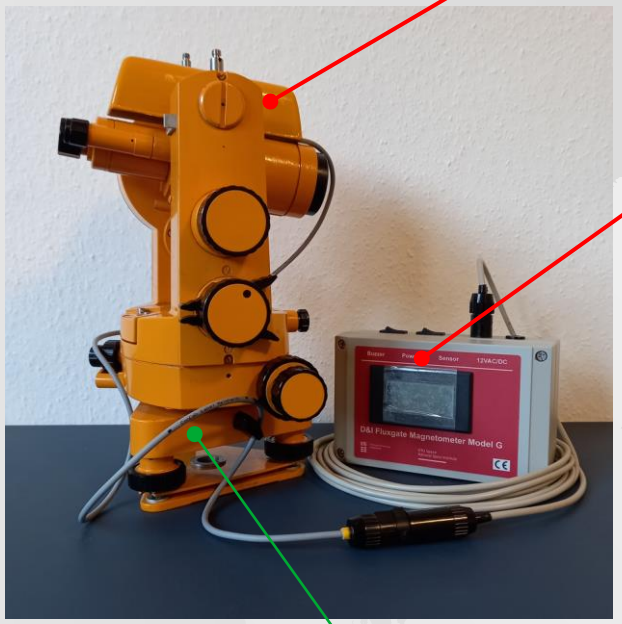


- Calibration of fluxgate magnetometer's direc-tions and scale/offset parameters „Base line determination" Declination/Inclination (**D/I**) theodolite

Manually operated instrument
Should be used at least once every week

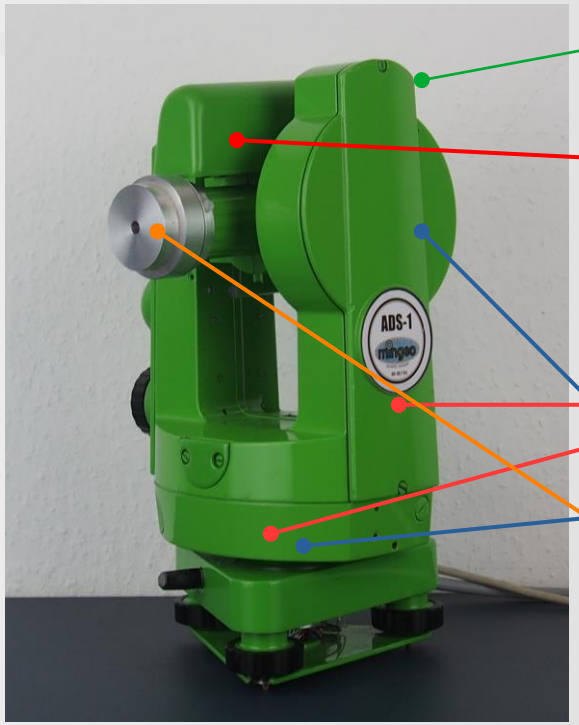
• Problems of the conventional manual D/I measurements

- Relatively complicated procedure, needs a trained observer
- Human presence can disturb observatory recordings, care must be taken for clothes and accessories
- In many cases, measurements carried out at remote locations (high travel costs and long travel time)
- Needs a far geographic reference mark that is visible from the instrument's pillar
- During active magnetic periods (solar storms), precision is decreased
- Time elapsed between the measurements increases the data processing errors
- Poor light conditions can cause difficulties



- **Problems with the automa-**
- **tization of the D/I measurements**

- Instrument can have non or very low magnetic parts
- Very high requirements for
  - mechanical accuracy
  - angle reading accuracy
- Automatic recognition of the azimuth mark through the telescope
- Very low number of users, low volume production



ADS - Automatic Digital Station

Zeiss Theodolite converted to be non magnetic

Single axis magnetometer *(full field range)*

Without manual controls

Two piezoelectric motors

Two digital angle encoders

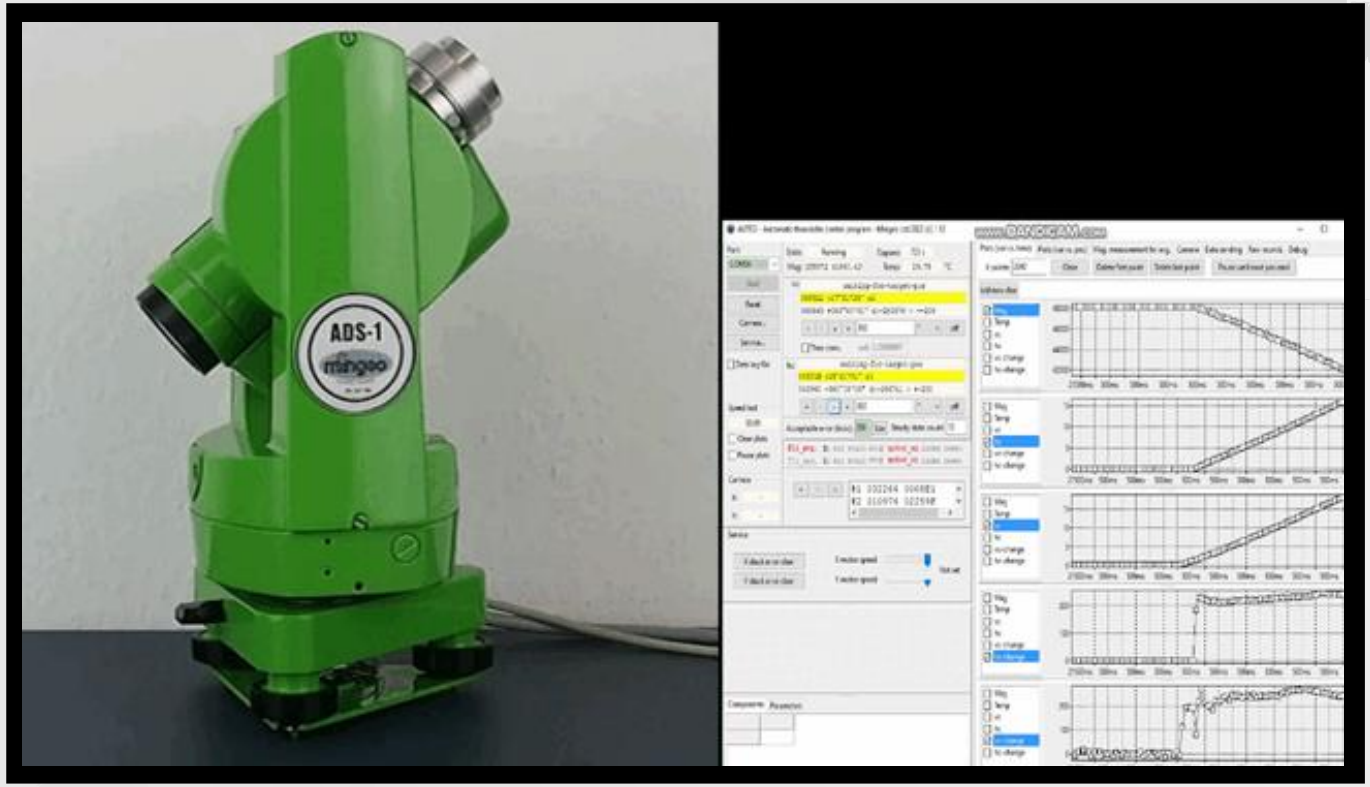
Custom made digital camera module

Controlling electronics

Special image processing algorithm

• Advantages of automatic absolute geomagnetic measurements

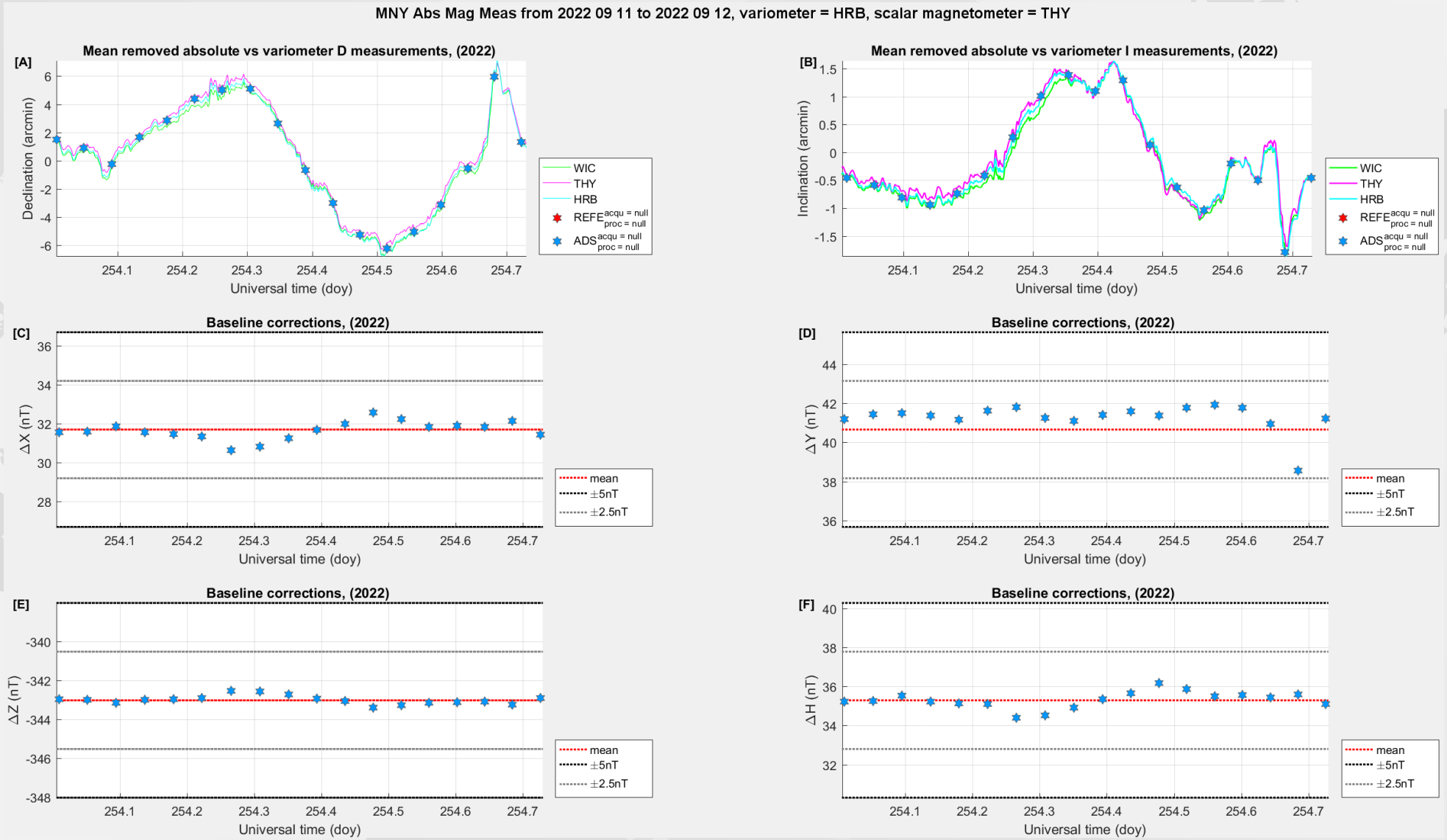
- Does not need trained operator and travel costs / travel time
- No human disturbance at the observatory
- Avoid of human reading errors, more accurate reference mark reading
- Easy to increase measurement frequency, even to continuous mode
- Possibility to carry out measurements at nighttime when magnetic activity is lower



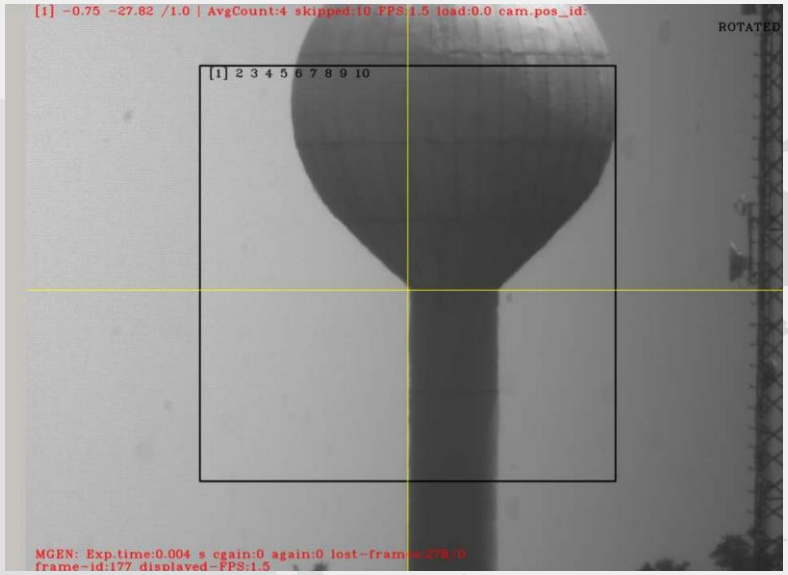
- **Working with ADS:**
  - Remotely controlled „manual" mode:
    - Internet connection required
    - Conventional measurement sequence executed remotely
    - Reference mark recorded by the digital camera image is remotely checked by the operator
  - Fully automated mode:
    - Different measurements sequences are possible
    - Programmable measurement schedule or even, continuous mode is possible
    - One measurement takes 7-25 minutes, depending on the measurement sequence and the required accuracy
  - Theodolite levelling can not be checked/readjusted remotely, but we experienced that levelling stays very stable over long time

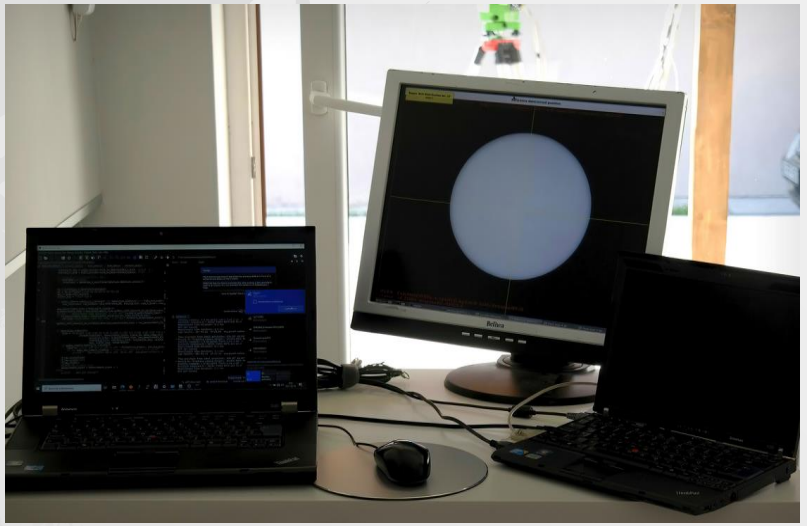
- **Testing ADS**
  - We are testing different measuring schemes (conventional and experimental methods)
  - Check/verification:
    - Comparing results to nearest geomagnetic observatory data
    - Comparing results to local manual absolute measurements
  - In progress: comparing results to a local reference instruments (dIdD magnetometer)

• ADS test measurement data



- **Camera and image processing tests**
  - By taking more images, the resolution of the reference mark direction reading can be better than 1 arcsecond
  - Works well with nearby indoor references and outdoor night references (light source in a distance)
  - Most of fixed targets, even the texture of a wall surface can be used as reference
  - Daytime outdoor references: further tests and developments are required to eliminate the effect of the changing conditions (e.g. effect of shadows)
  - It is possible to use the Sun or Sun's shadow as moving geographic reference marks





• Conclusions

- An automated D/I instrument is developed which is based on Zeiss non magnetic theodolite, and has non-magnetic piezzoelectric motors, high accuracy digital angle encoders and digital camera

- The primarly goal of this instrument is to allow to operate geomagnetic observatories in unmanned or nearly unmanned manner

- Accuracy of final (calibrated) geomagnetic observatory data can be increased

- Possible decrease of the reference mark distance

- Tests results are promising, data scattering is low

- Test measurement data quality fulfills the INTERMAGNET standards

•THANK YOU FOR YOUR ATTENTION!

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