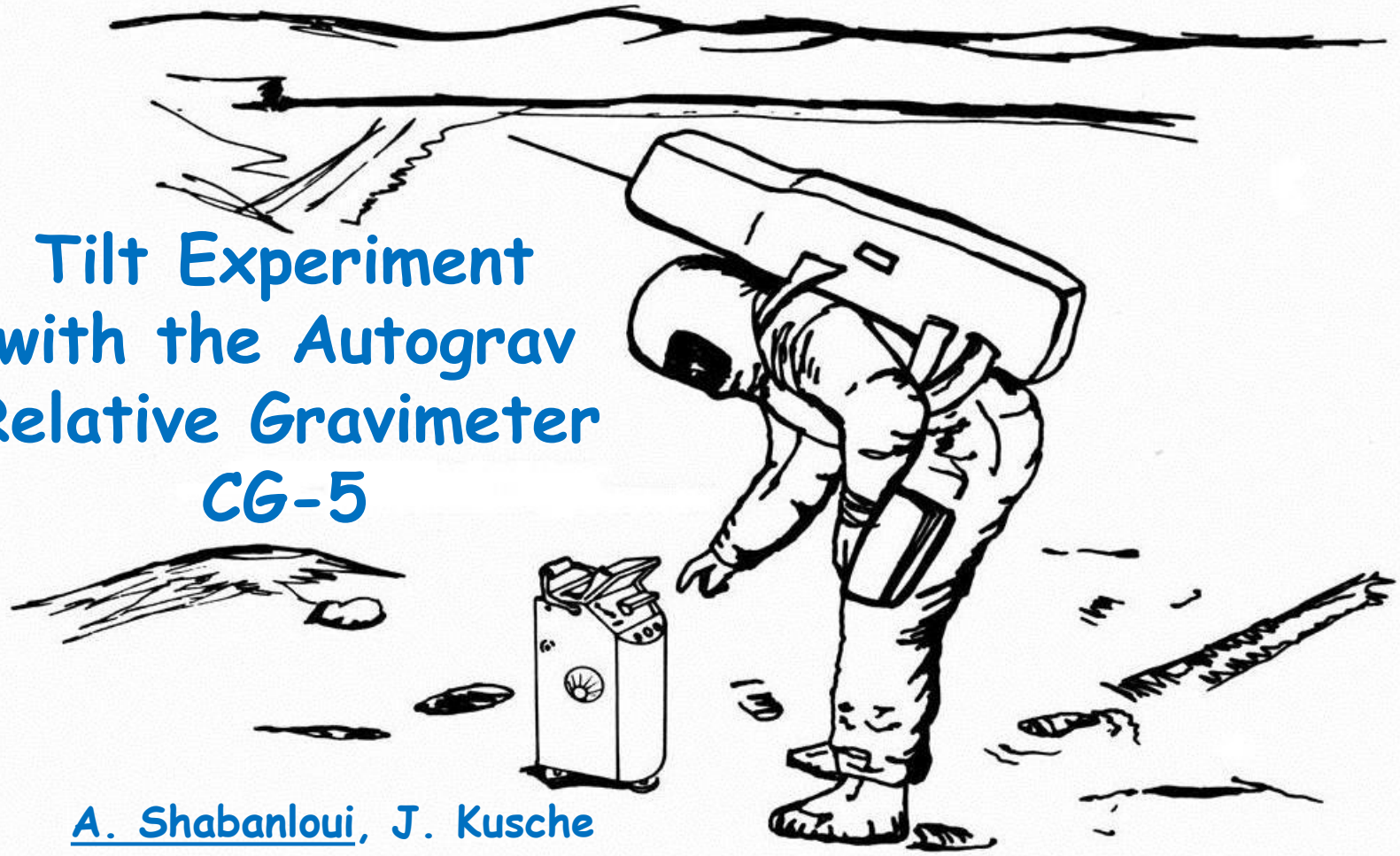
Tilt Experiment with the Autograv Relative Gravimeter CG-5



A. Shabanloui, J. Kusche

Geodetic Week 2013, Essen

9th Oct. 2013

Outline

- Introduction to CG-5 (Autograv Scintrex)
- Atmospheric Effects
- Data Analysis
- Experiments (Bonn and Bad-Homburg)
- Tilt Experiments
- Summary & Outlook

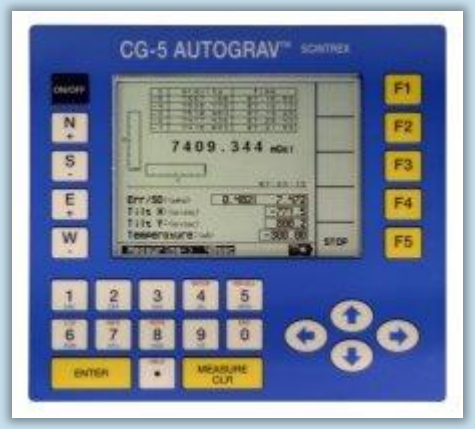
Autograv Scintrex CG-5

CG-5 Autograv Scintrex	
Sensor Type	Fused quartz using electrostatic nulling
Resolution(Reading)	1 Micro-Gal
Standard Deviation	5 Micro-Gal
Opearting Range	8000 Milli-Gal
Drift	0.02 mGal/day
Tilt Componsation	±200 arcsec.
GPS receiver	Standard < 15m, CG-5 clock synchronisation
Key fob	30 m (line of sight)
Smart Battery (fan)	2 x 6.6 (Ah), Full day op.
Weight	8 kg. (portable)

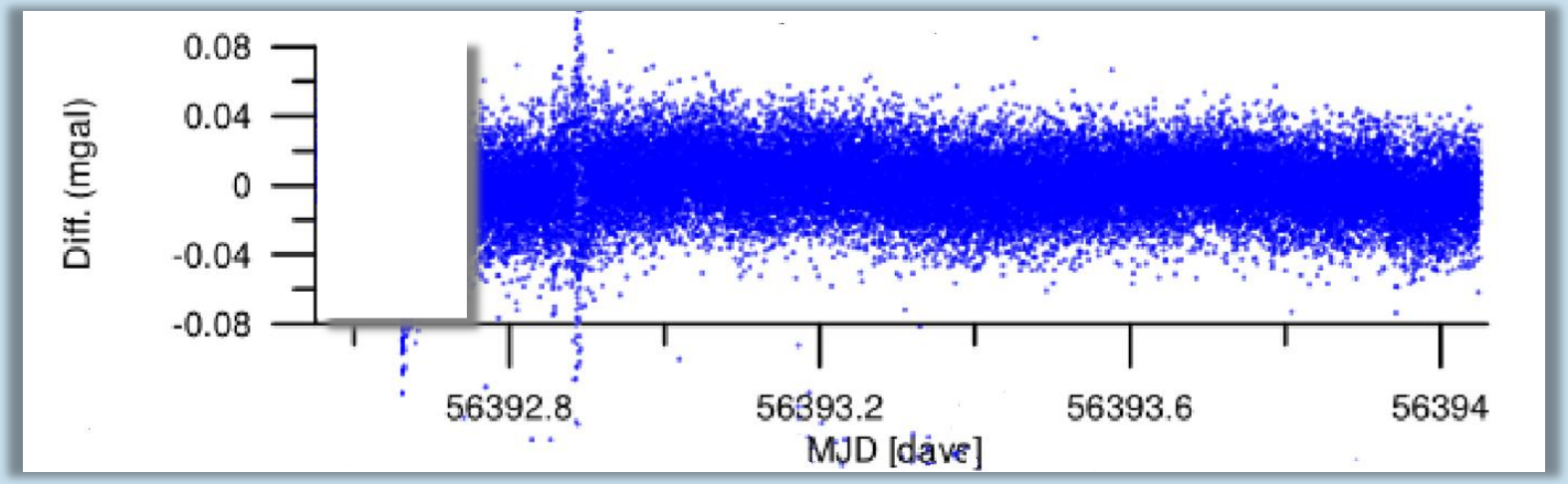
AUTOgrav: All effective corrections have been automatically considered!

Autograv Scintrex CG-5 contd.

- Dis-avdantages:
  - Keyboard sensitivity! (2 sec. Pause!)
  - Firmware stability! (hanging)



  - Single observation [1 Hz] has an accuracy of around 80 Microgal!

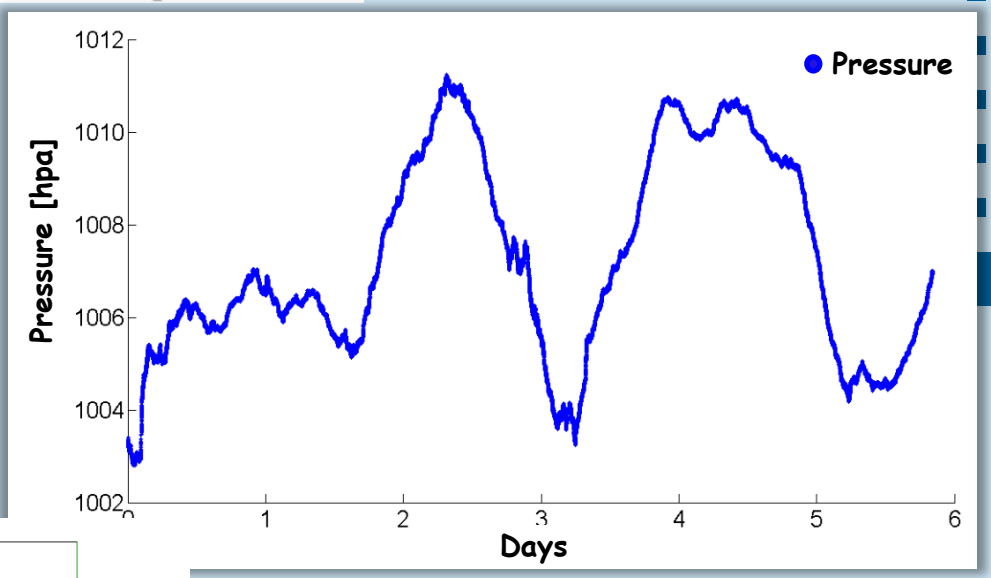


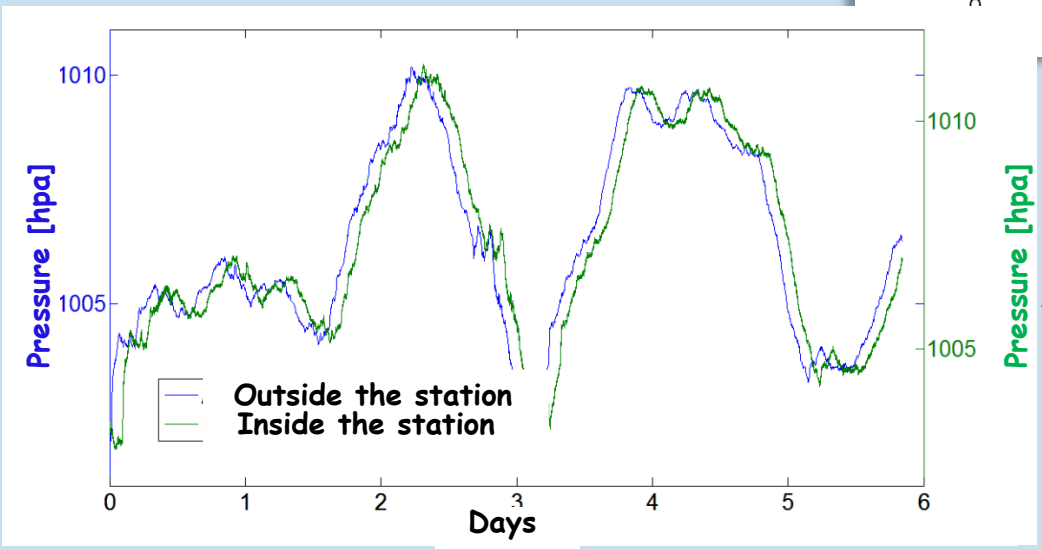
  - Standard deviation (Time window of 60 sec ~ 5 Micro-Gal)

Atmospheric effects

- Pressure

$$\Delta g_p = -0{,}3 \cdot \Delta p \; [\mu Gal]$$





✓ Neglectable (if pressure changes are less than 17 [hPa])

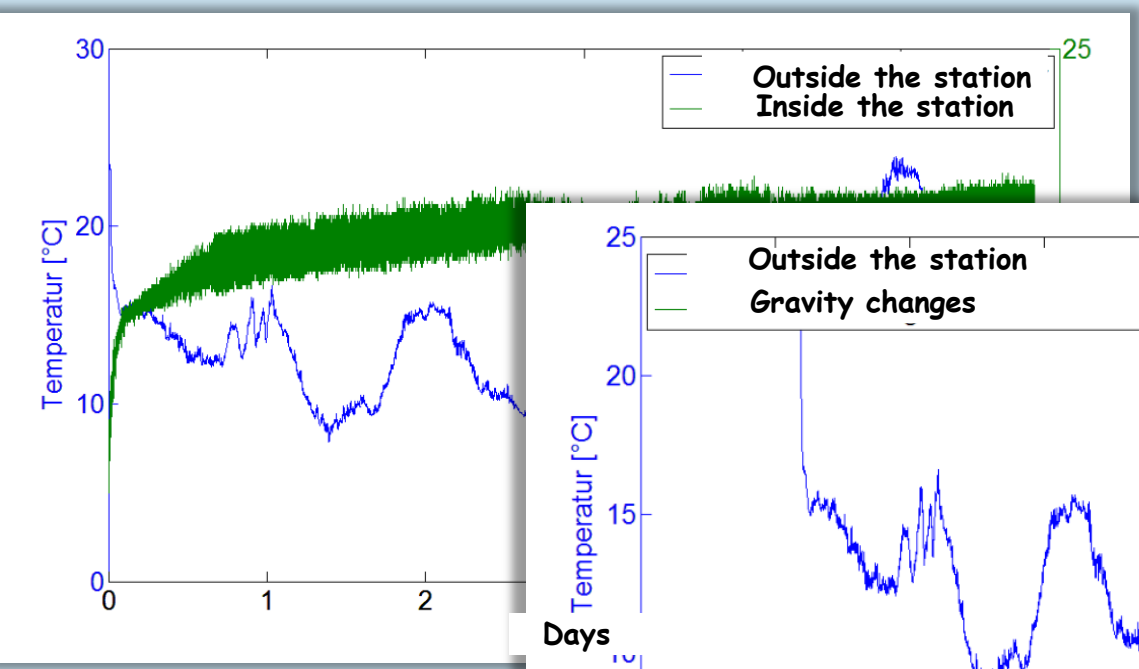
Atmospheric effects

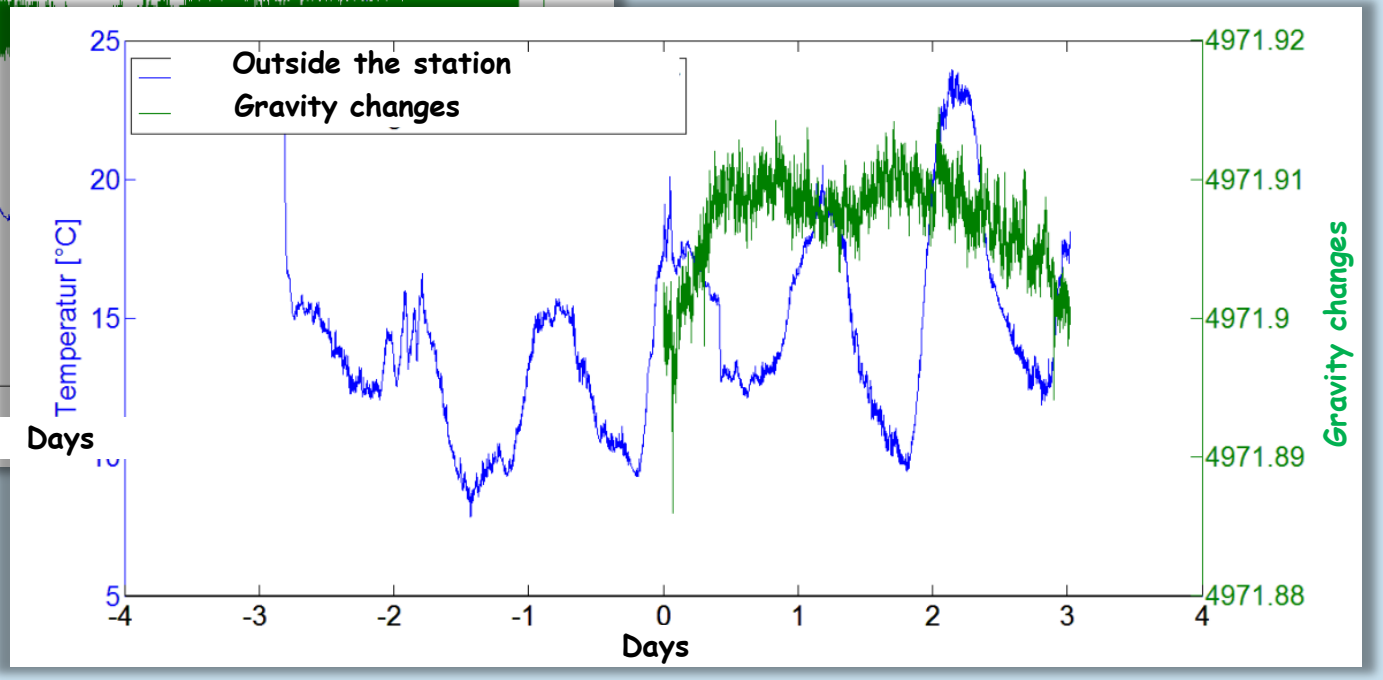
- Temperature

$$TEC = Tempco \cdot Temp$$

-0.122 mGal/mK

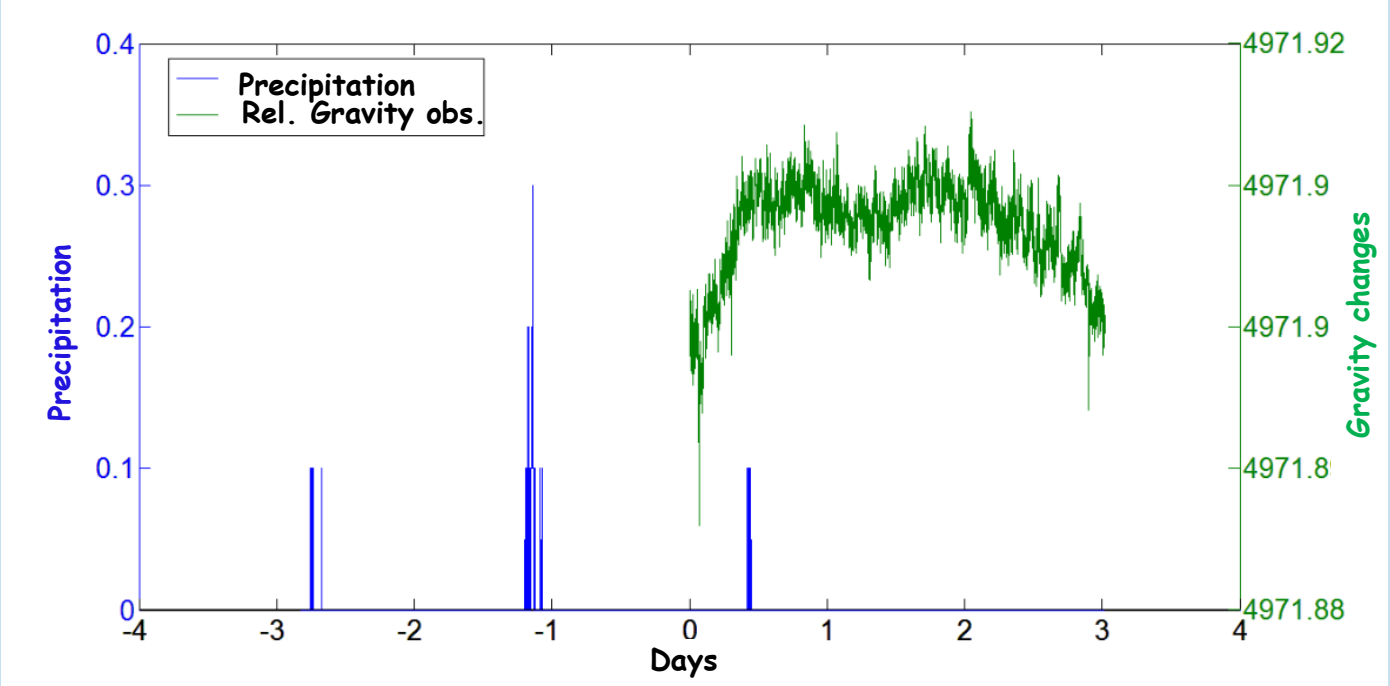
Measured in vaccum!





Atmospheric effects

- Precipitation: changes in the mass!



- Atomospheric effects can be neglected in the normal conditions!

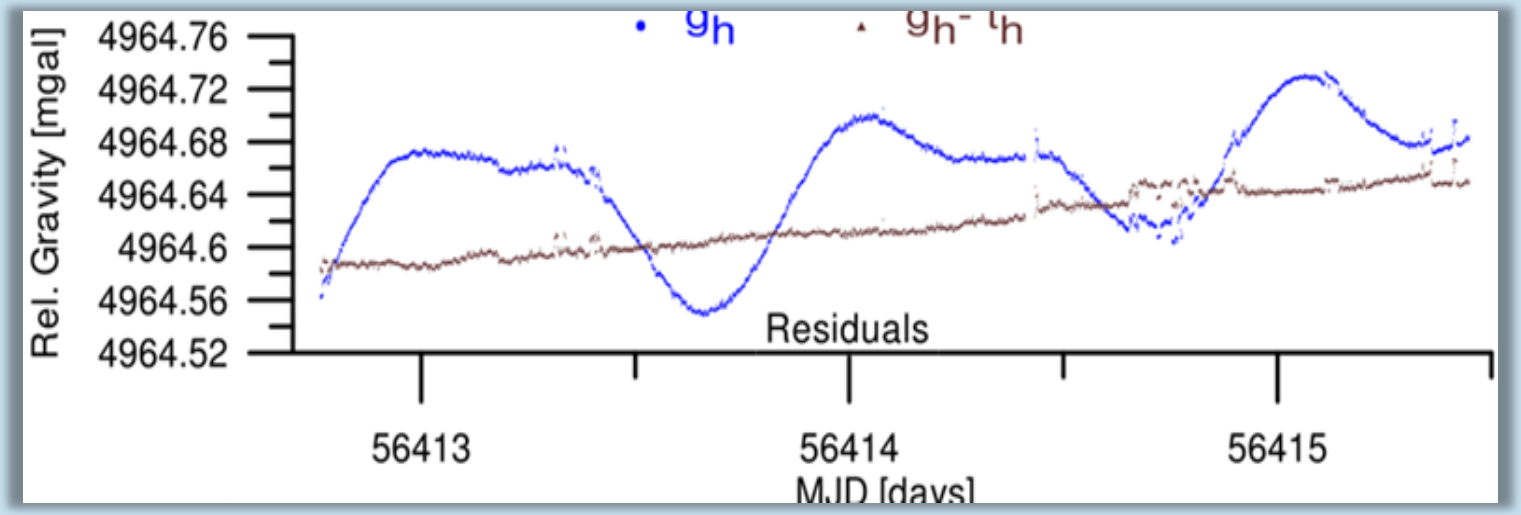
Data Correction and Analysis

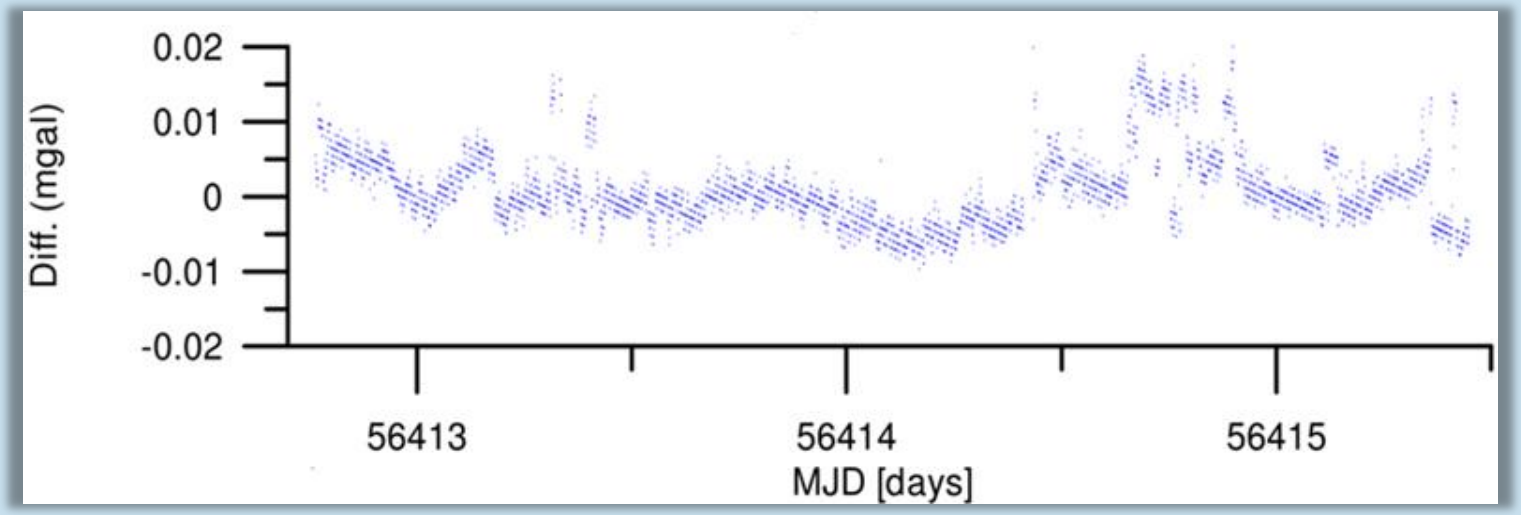
Corrections:

- Drift (Manual or Automatic)
  - ✓ Automatically corrected!
- Tide
  - ✓ Internal (Longman-Formula, precision problem!)
  - ✓ External (ETERNA precision less than 5 Microgal)
- Tilt (less than 200 arcsec.), recommended less than ±10 arcsec.
  - ✓ Automatically corrected!
- Temperatur changes (Internal and External)
  - ✓ CG-5 is very sensitive to temperature change
  - ✓ Disply heating system
  - ✓ Tilts more than 200 arcsec. cause strong temp. changes
- Filters
  - ✓ Noisy sample filter
  - ✓ Seismic noise filter

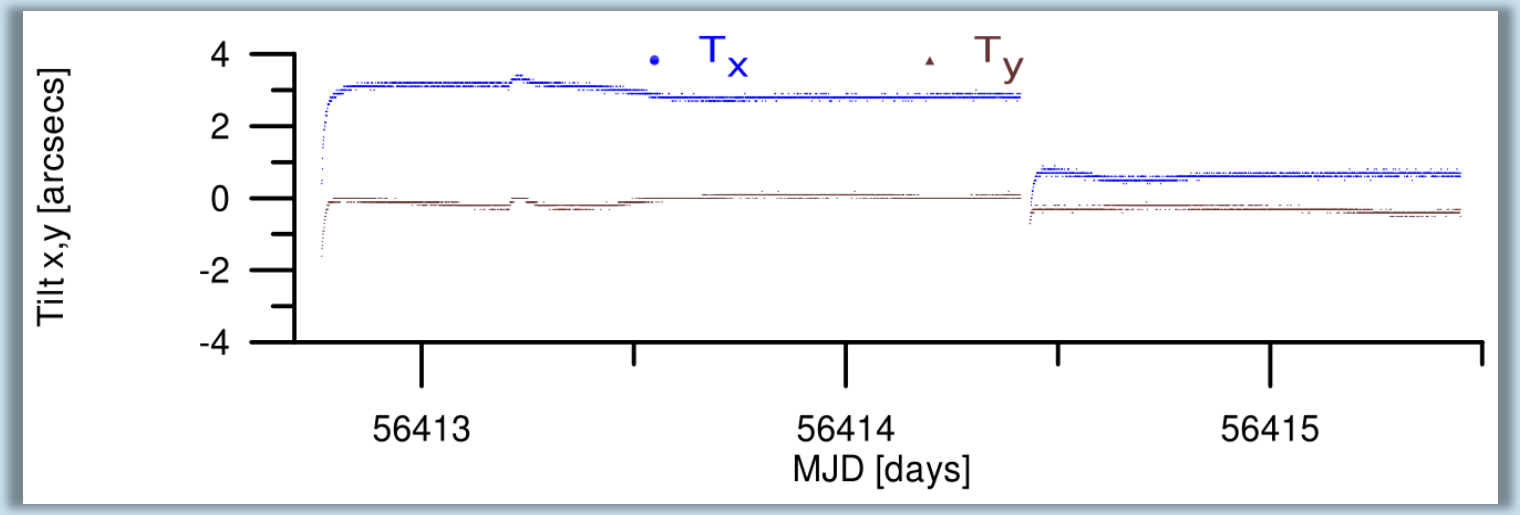
BLACK BOX!

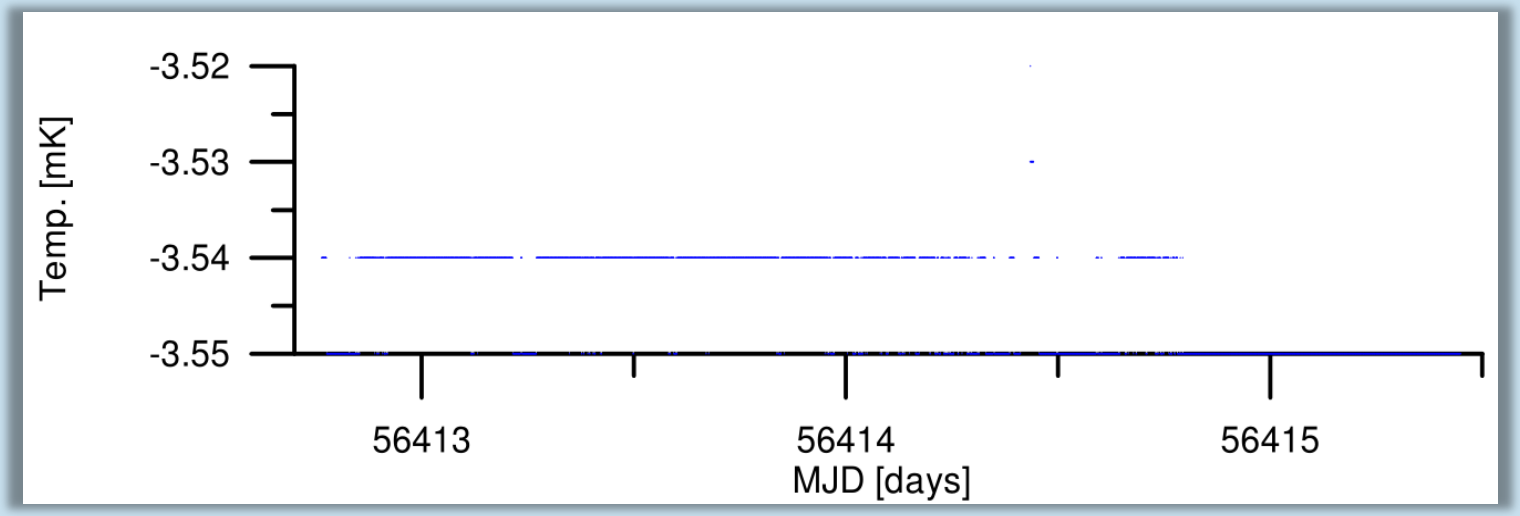
Drift Experiment (Bonn, May 2013)





Experiment (Bonn, May 2013)



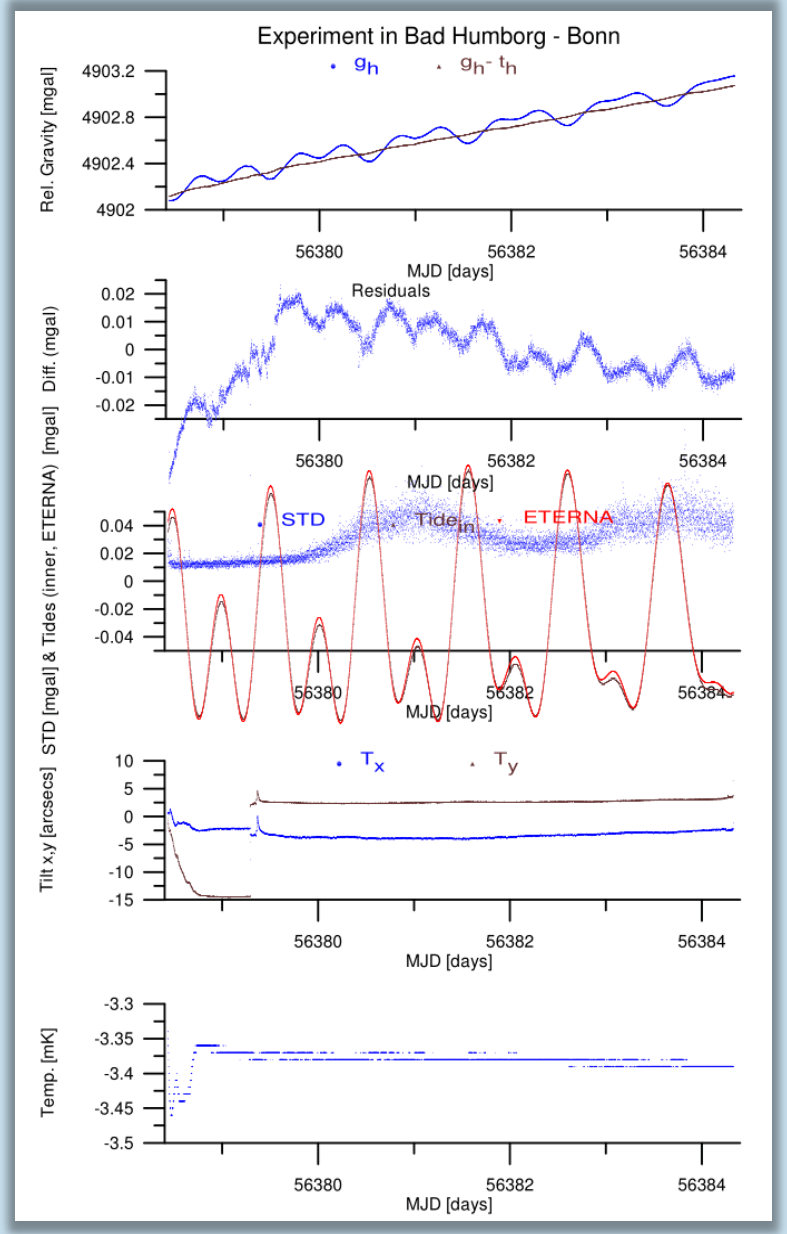


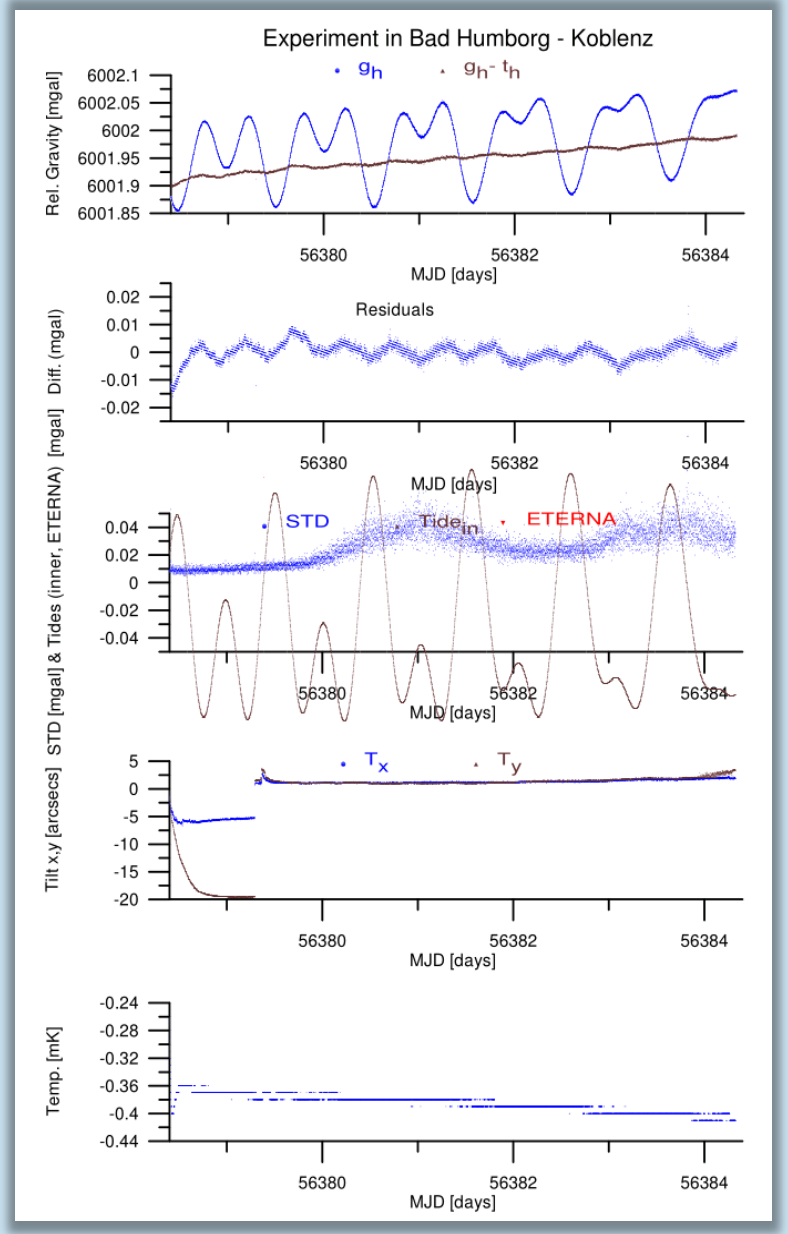
Experiment in Bad-Homburg Castle

Castle Bad-Homburg

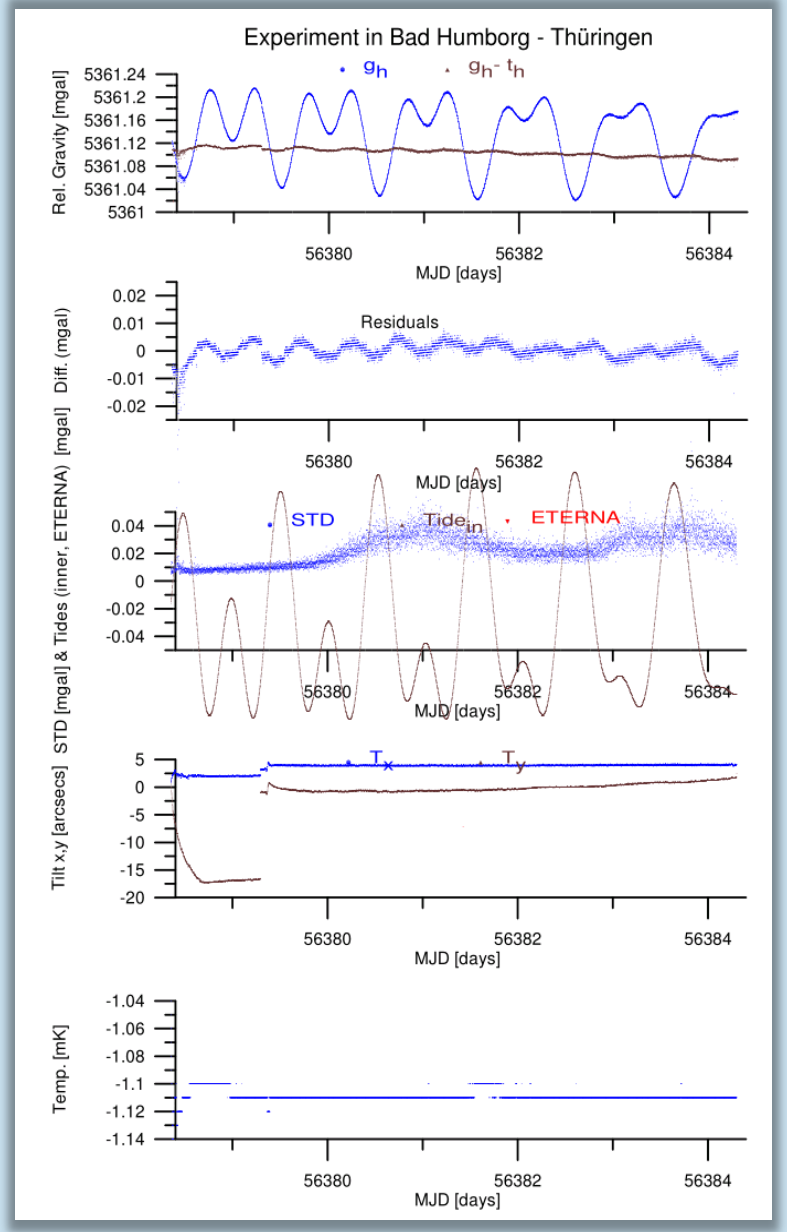
Different CG-5s

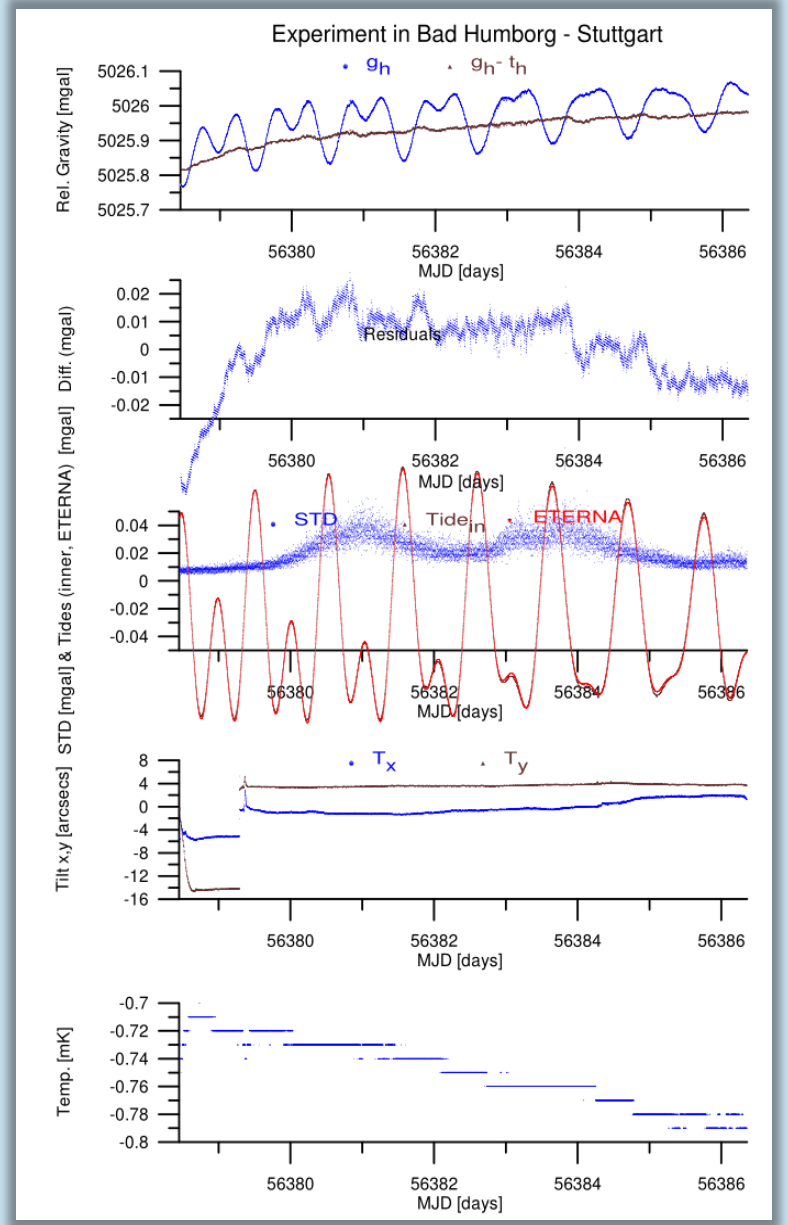
Bad-Homburg Experiment (Bonn vs. Koblenz)



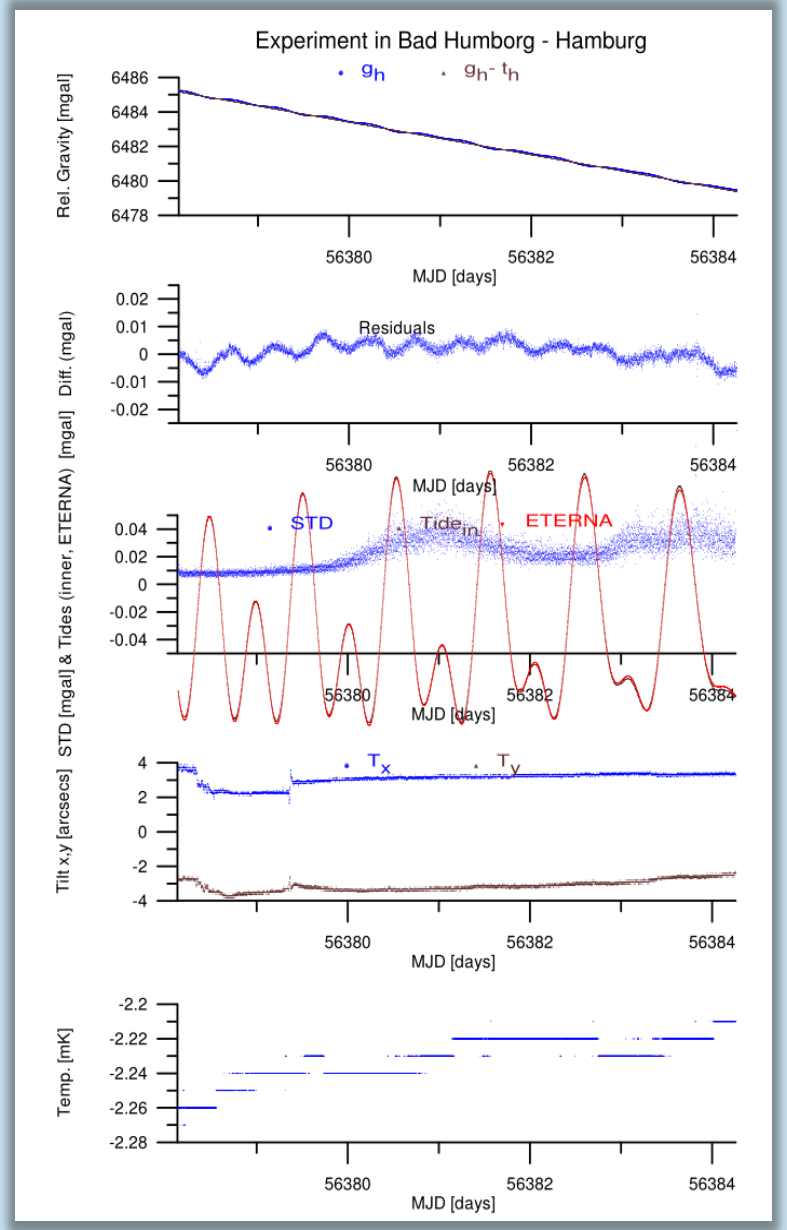


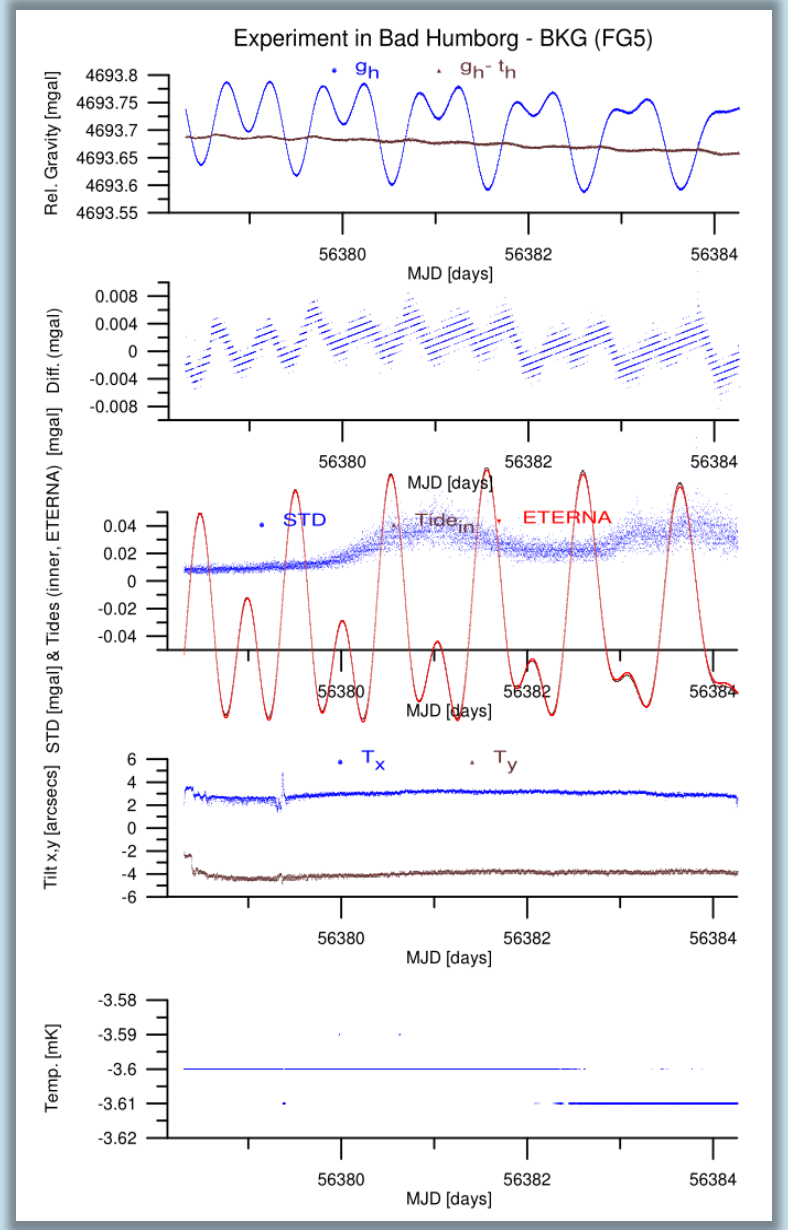
Bad-Homburg Experiment (Thüringen vs. Stuttgart)





Bad-Homburg Experiment (Hamburg vs. BKG)





Tilt

Piza, Italy

Tilt Experiment

23 [mm]

8 [◦]

Disc Thicknesses [mm]

2.9 [mm]

1 [◦]

Tilt Experiment procedure (angle & time)

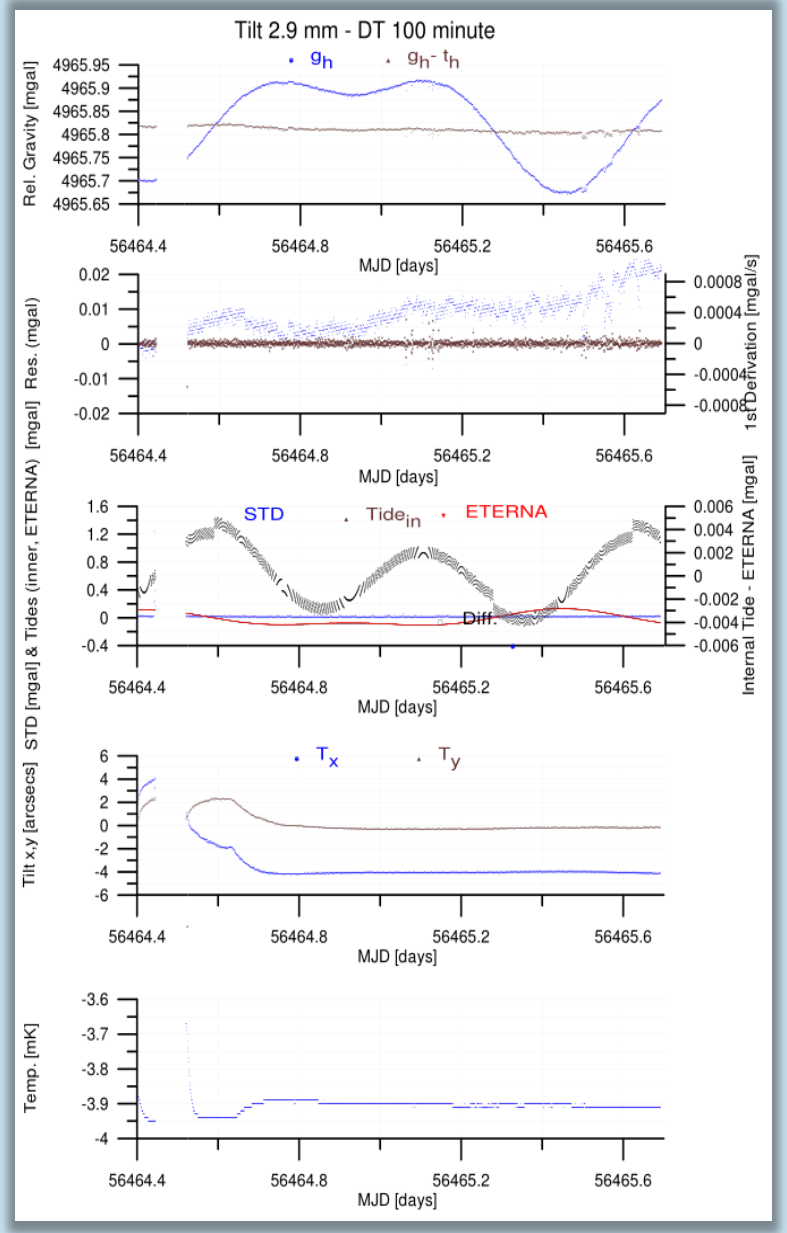
1) Level CG-5 & measure for one [h]

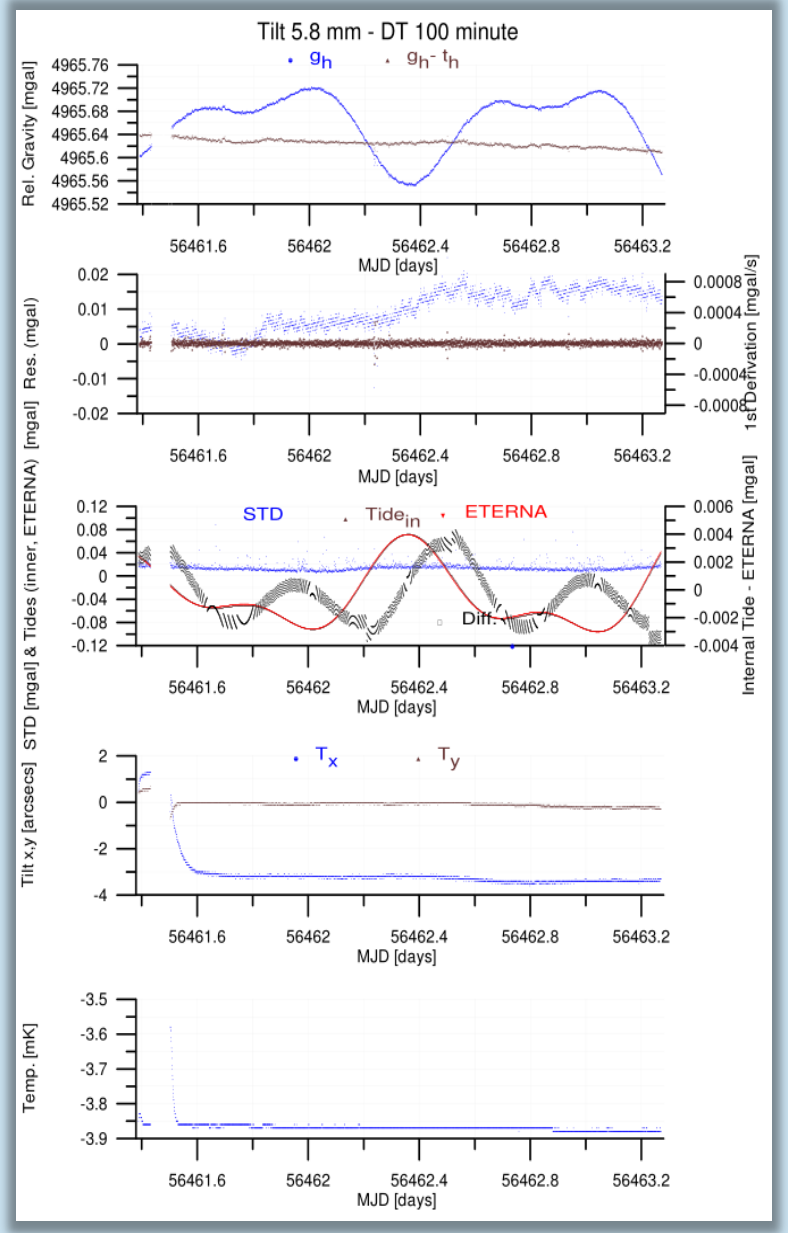
2) Turn off and Tilt it with the different tilt angles & waiting for 100 [min]

3) Remove disc, turn on, level it and take measurment for at leaset 24 [h]

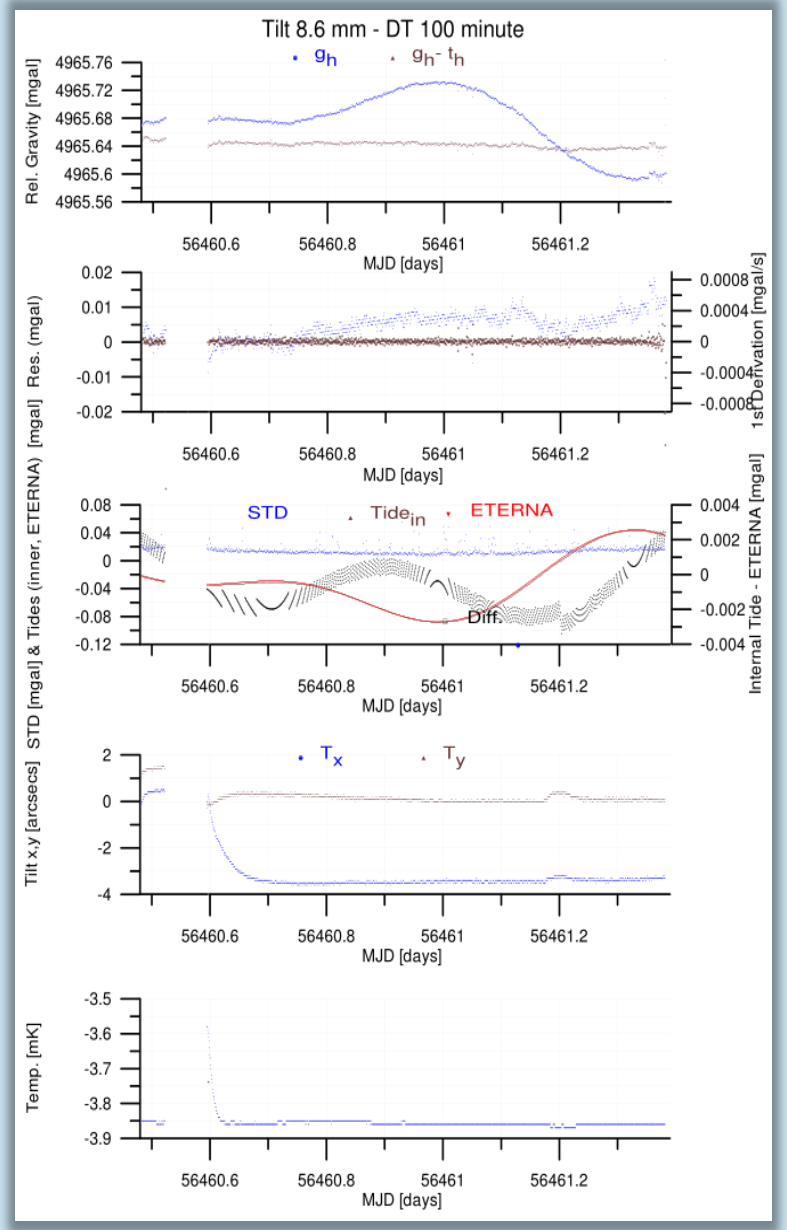
Finding the critical angle

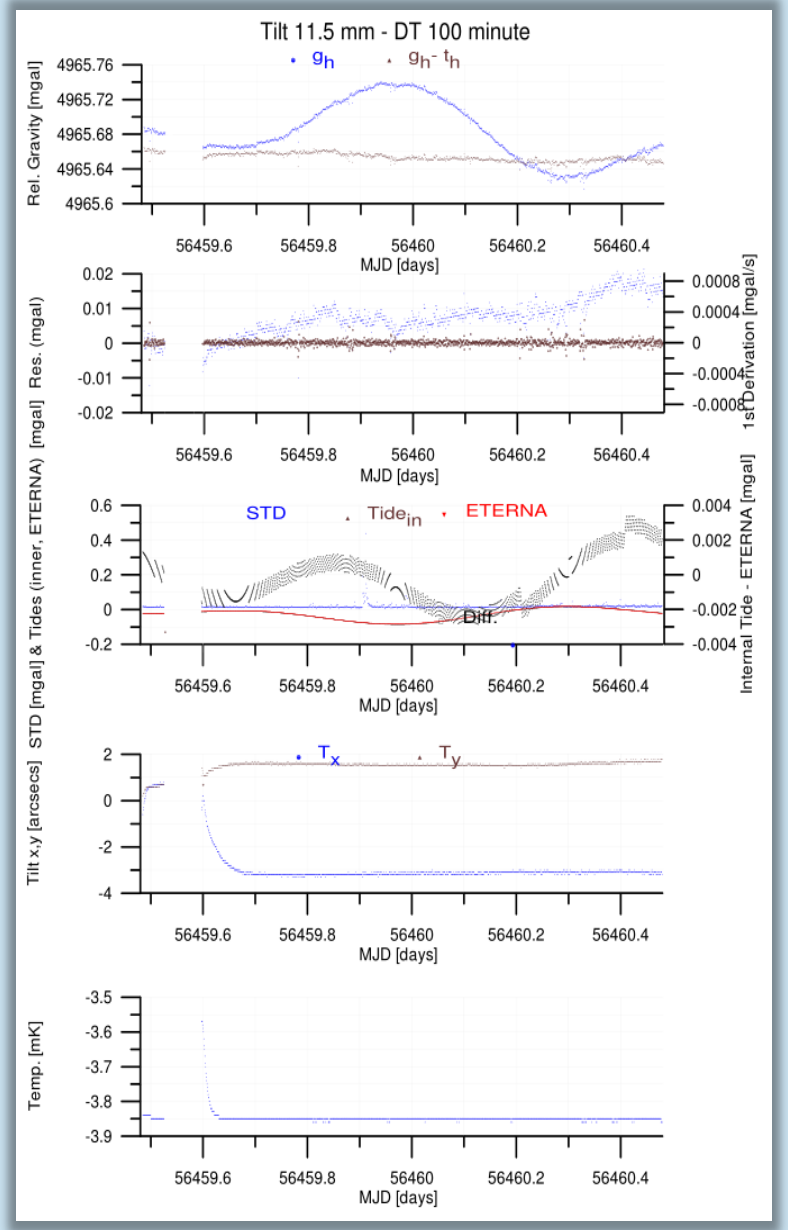
Tilt Experiment at Bonn, diff. angles



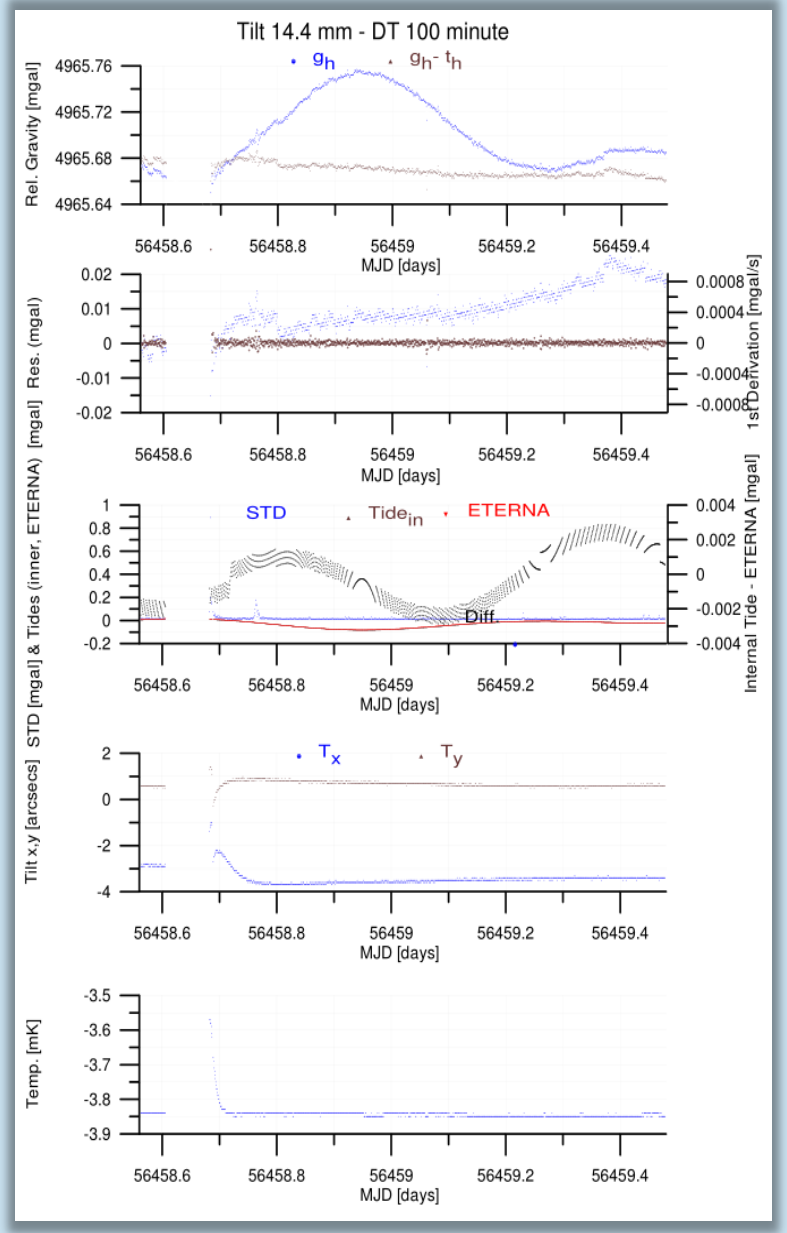


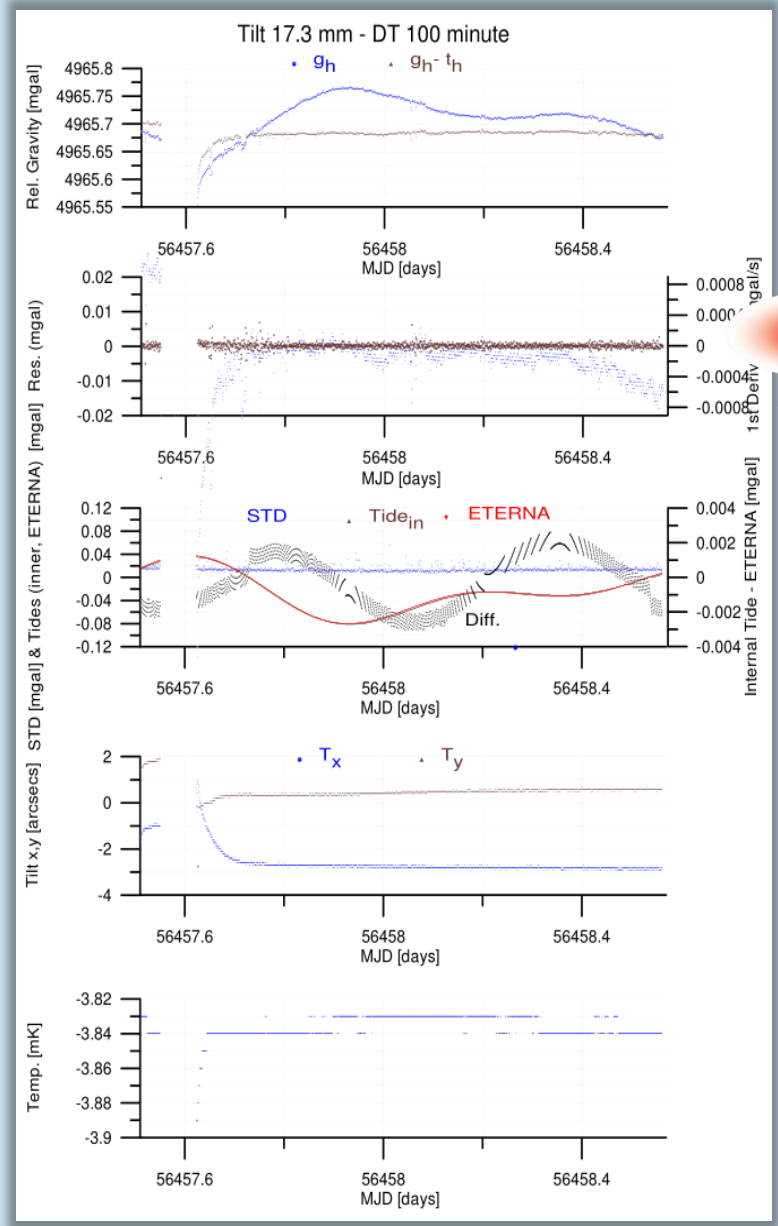
Tilt Experiment at Bonn, diff. angles



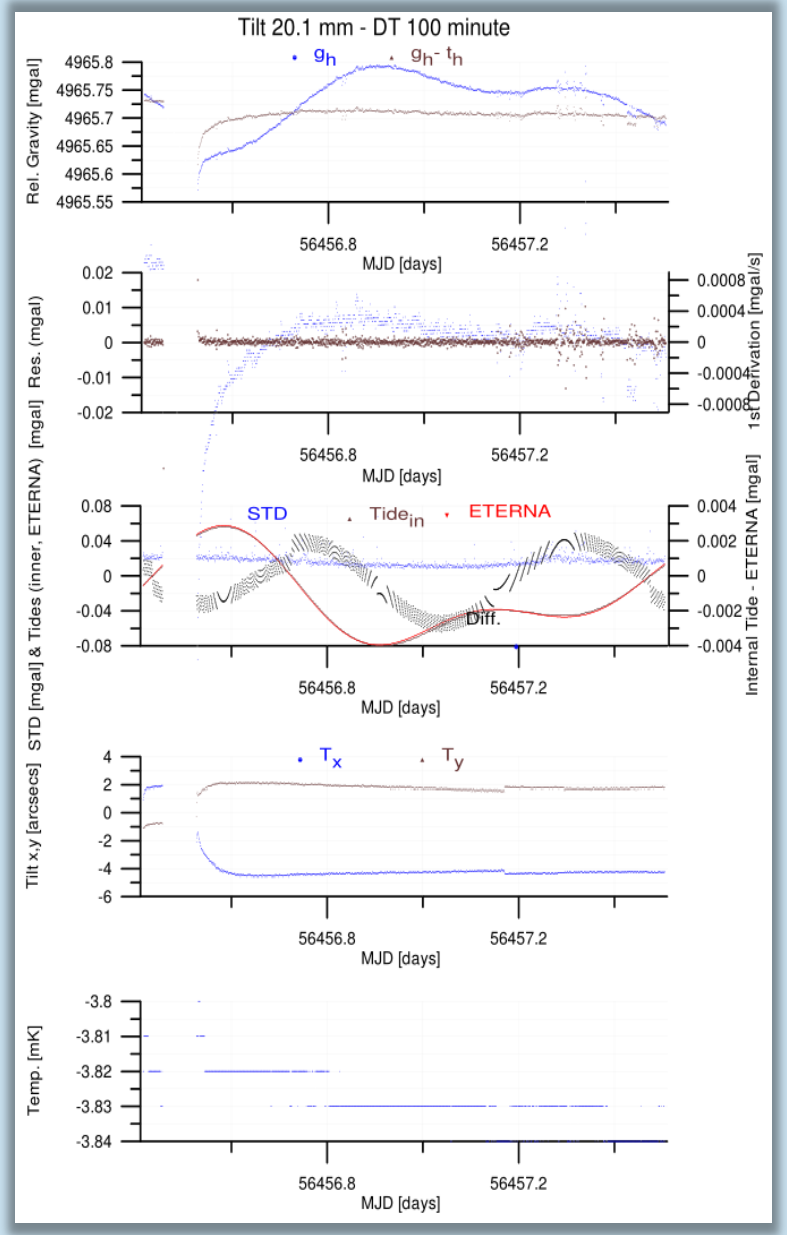


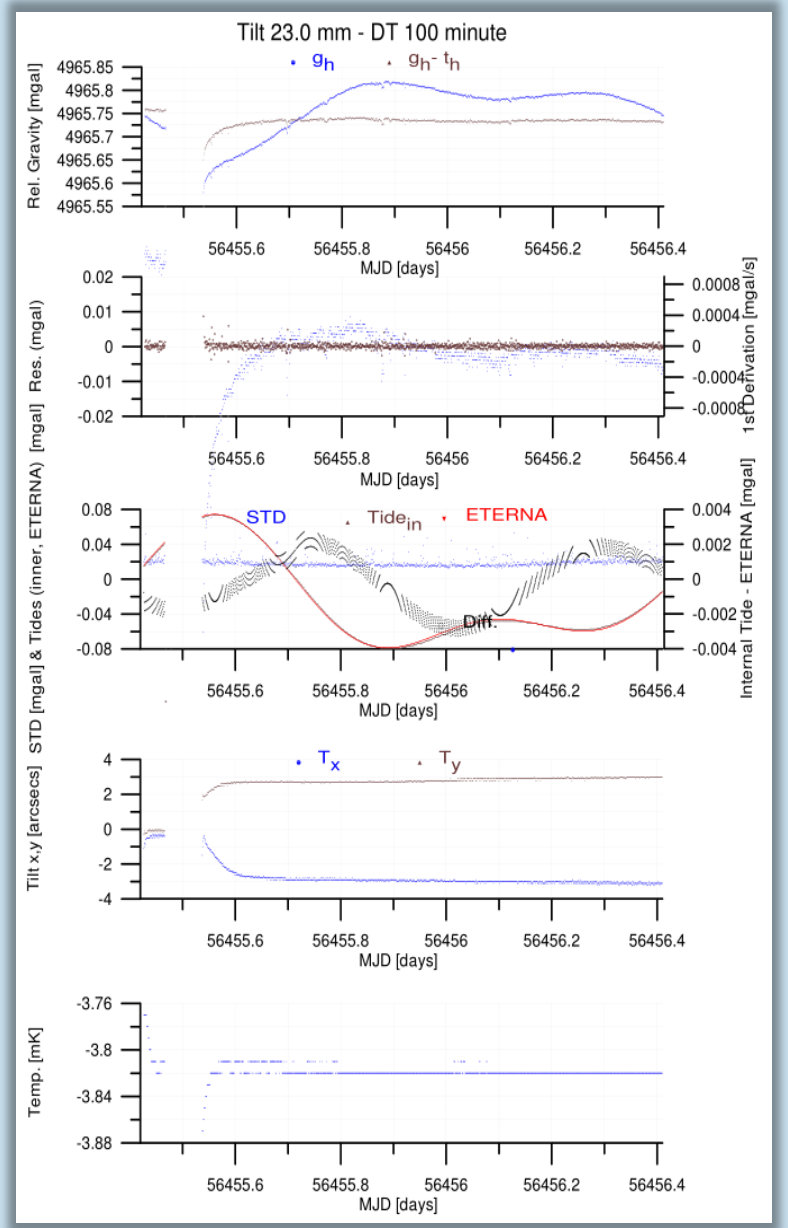
Tilt Experiment at Bonn, diff. angles





Tilt Experiment at Bonn, diff. angles





Tilt Experiment procedure (angle & time)

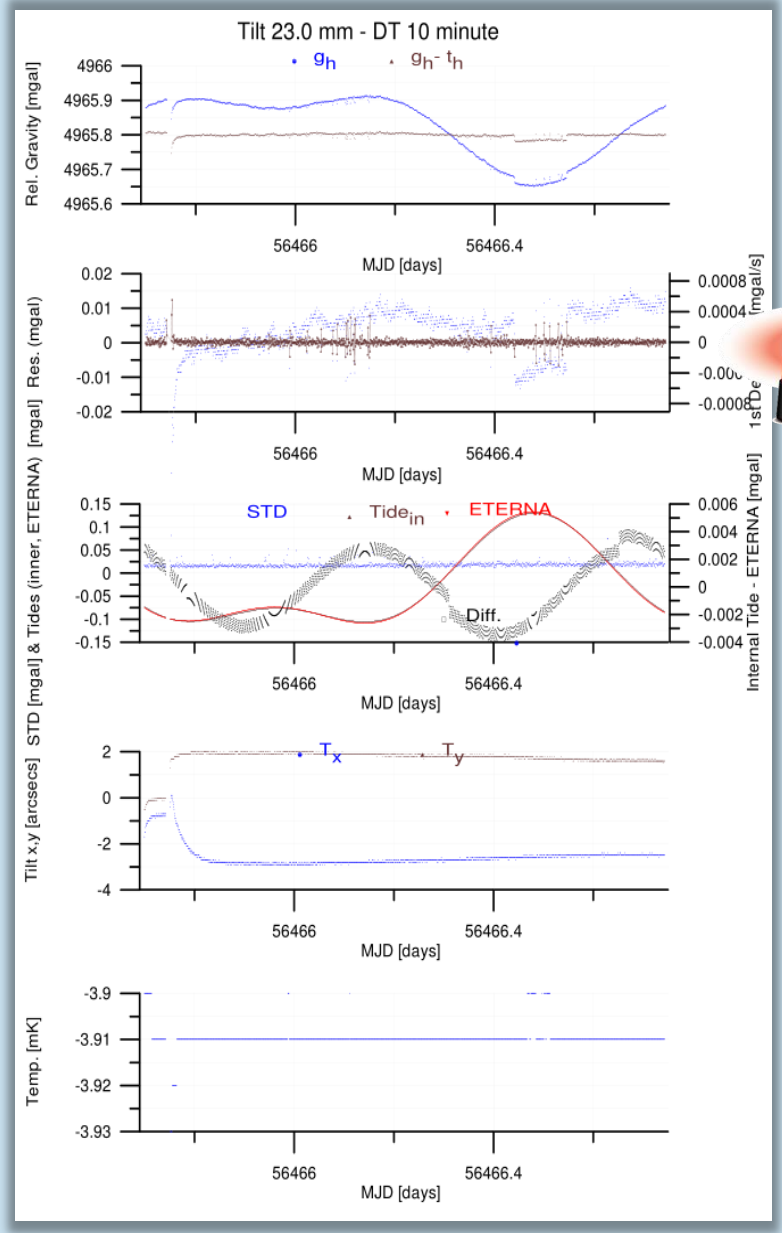
1) Level CG-5 & measure for one [h]

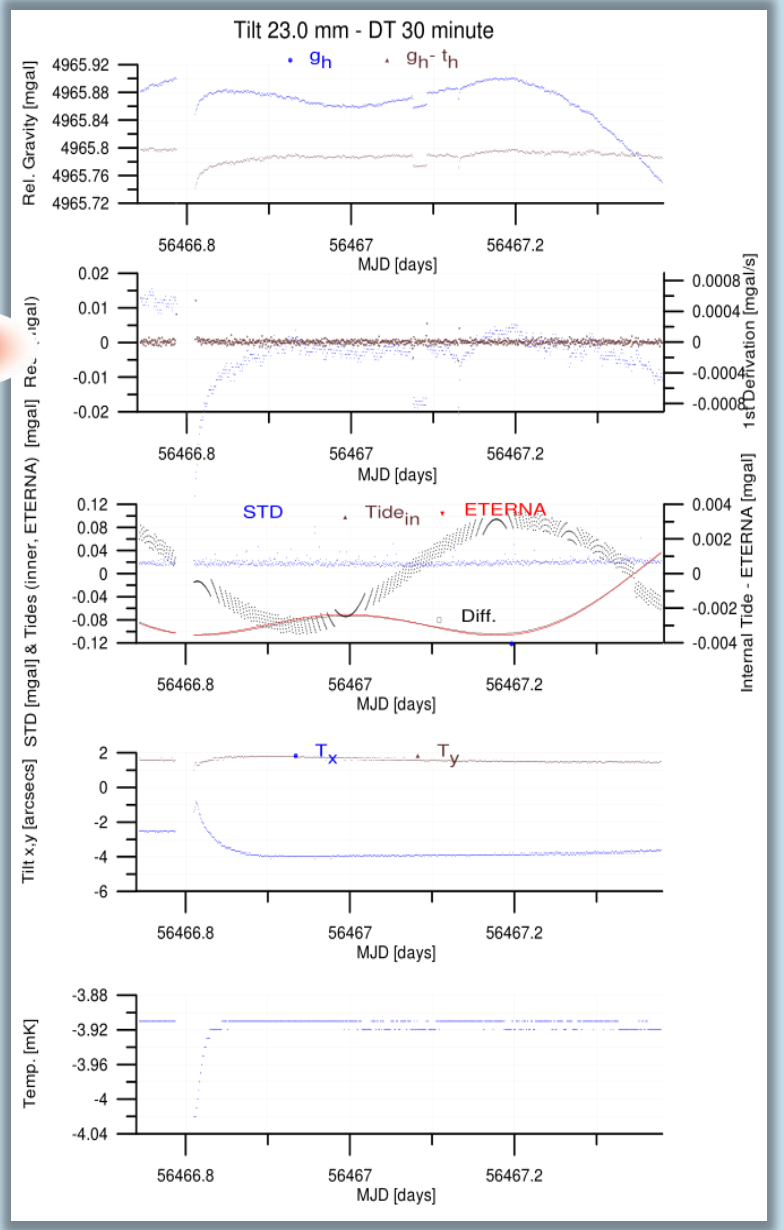
2) Turn off and Tilt it with the angle 8 (Disc 23 [mm]) & waiting for 10, 30, 60 , 90 [min]

3) Remove disc, turn on, level it and take measurment for at leaset 24 [h]

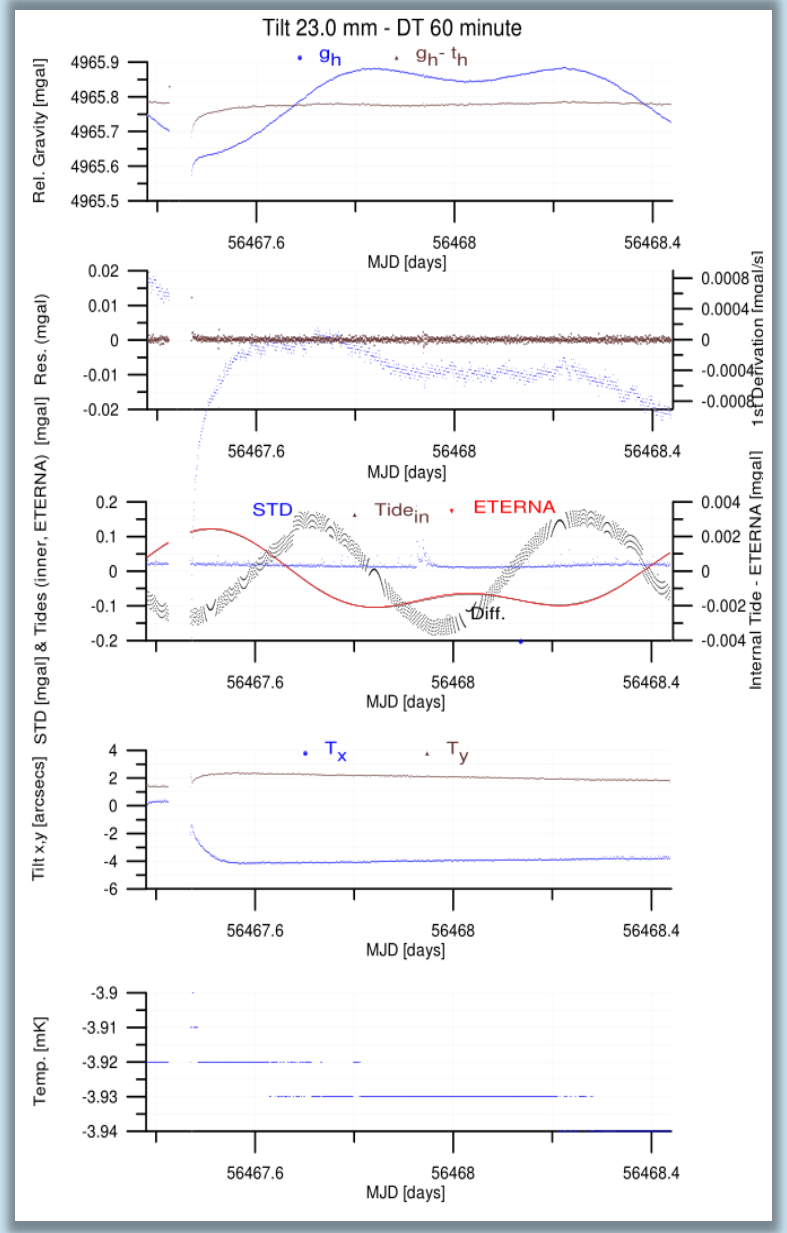
Finding the critical time

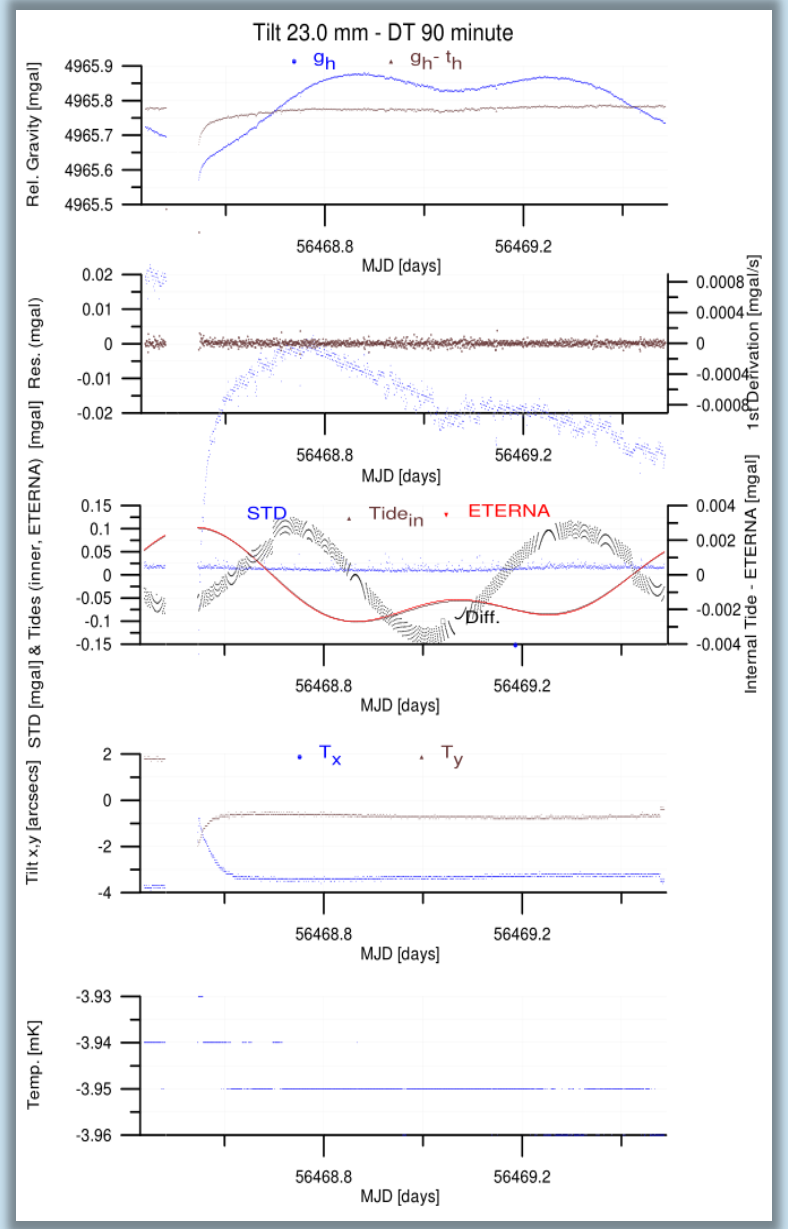
Tilt Experiment, angle 8 [◦] & diff. time





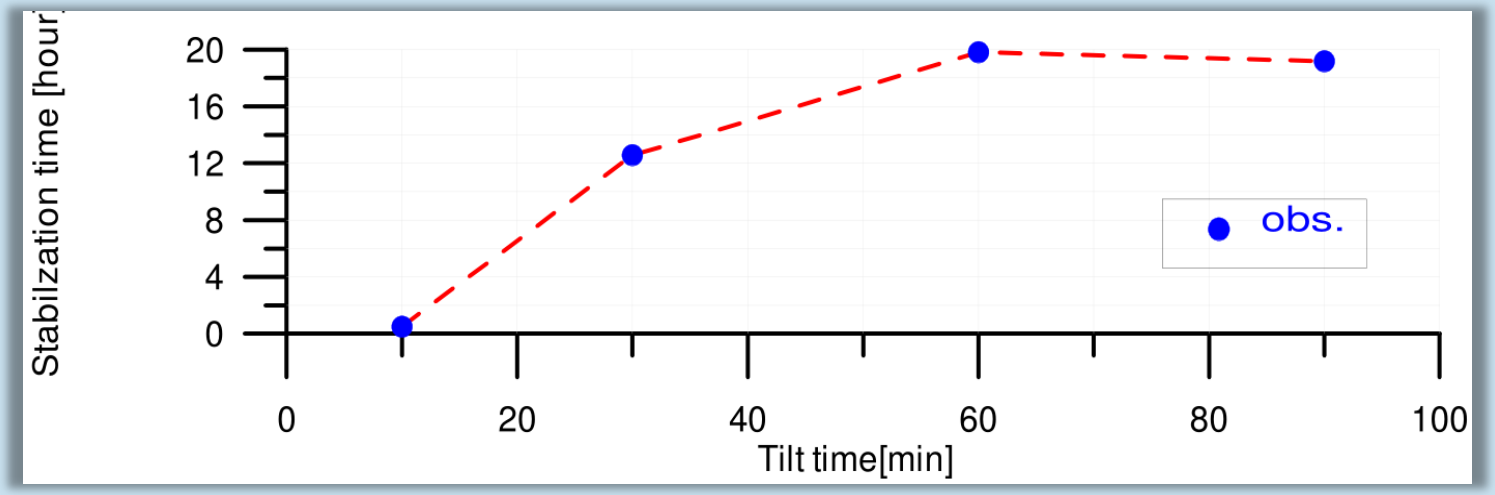
Tilt Experiment, angle 8 [◦] & diff. time





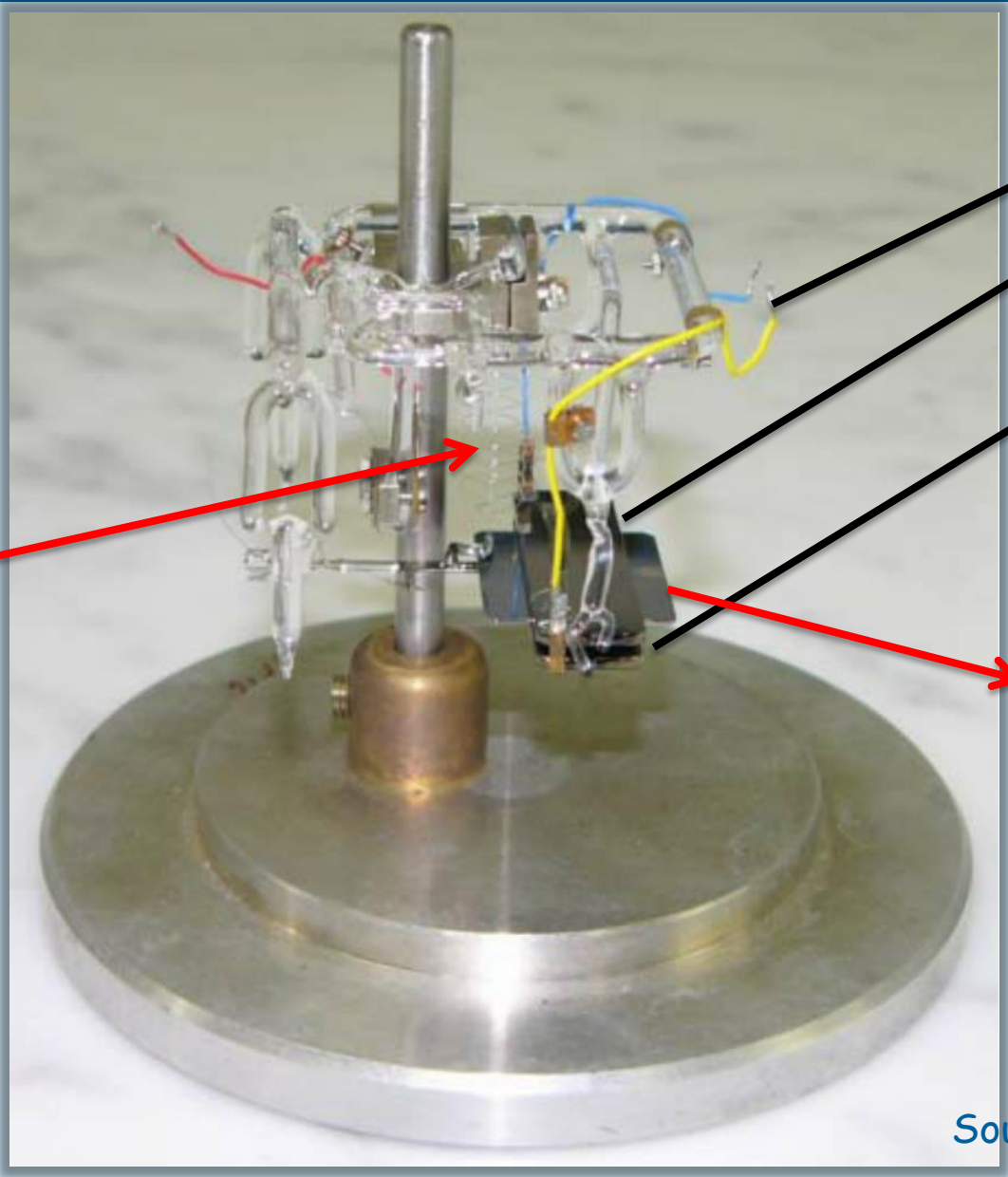
Functional relationship (tilt time & instrument stablization)

Tilt angle of 8 [◦]	
Tilt time [min]	Offset[mGal] / Stab. Time [hour]
10	-55 / 0.5
30	-43 / 12.6
60	-85 / 19.82
90	-89 / 19.18



$$s(\Delta t) = 0.81 + 0.66\Delta t - 0.005\Delta t^2$$

Reasons (CG-5 Sensor ?)



Source: IGM (Mr. Schuler)

Solution

- ✓ Caution in transport
- ✓ Check the „USER Check Voltage“ before starting to take measurement
  - ✓ If „USER check Voltage“ approaches zero, wait at least 14-20 [h]
- ✓ Use a Gyroscope!
- ✓ Other ideas

Summary & Outlook

- ✓ Autograv is very sensitive instrument to the tilt!
- ✓ Critical angle and time, and stabilization function have been found for the Bonn CG-5.
- ✓ Causes for the tilt offset are not clear exactly!
- ✓ Shake effect is another important effect, but has not been investigated!

Thank you
for your attention!