First results from the AQG-B07 absolute quantum gravimeter

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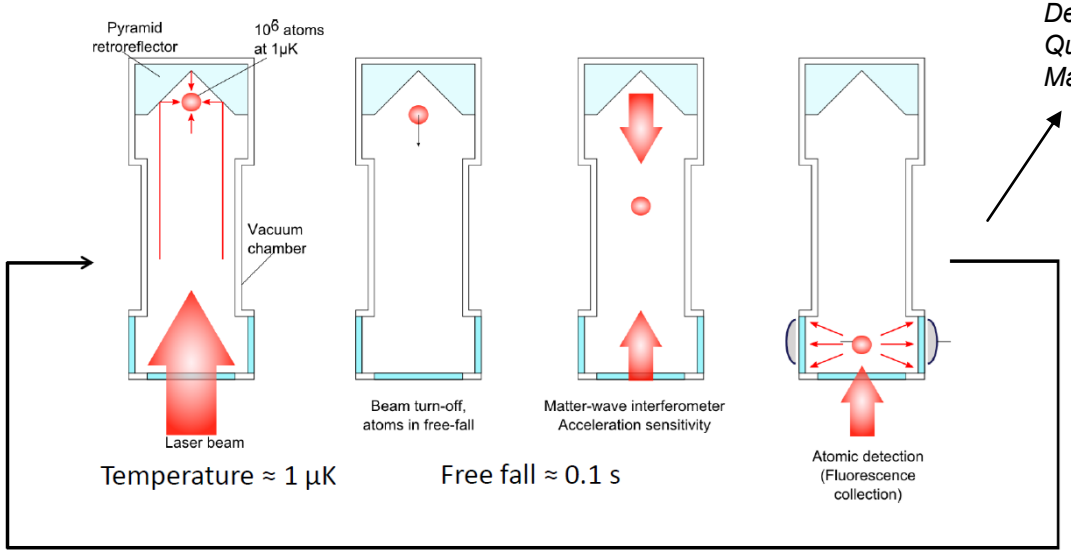
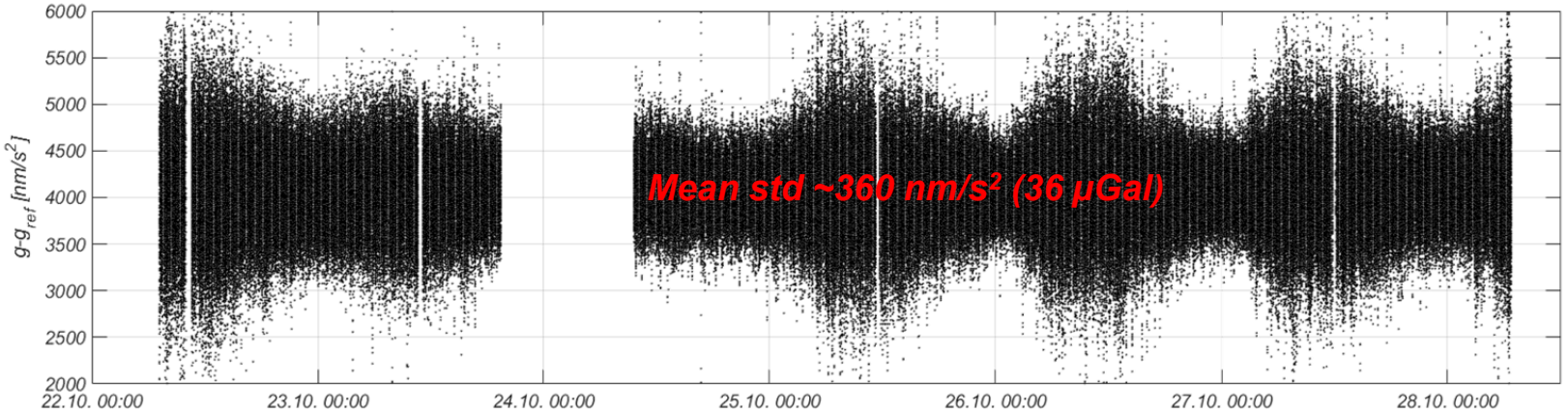
Absolute Quantum Gravimeter AQG-B07

Simplified principle of operation



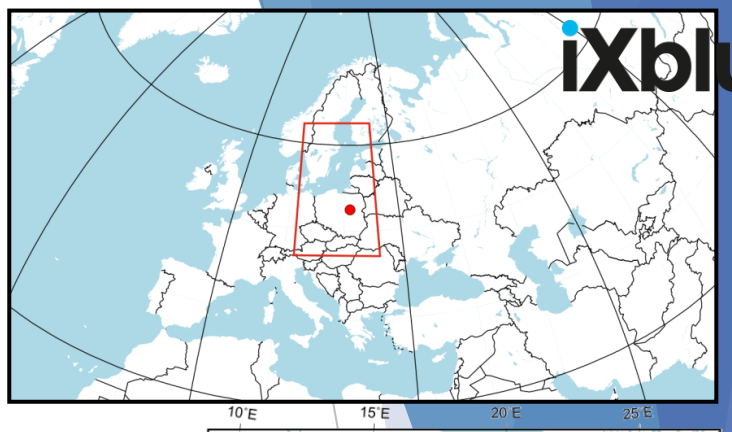
Vermeulen, P., Antoni-Micollier, L., Mazzoni, T., Condon, G., Ménoret, V., Janvier, C., Desruelle, B., Landragin, A., Lautier-Gaud, J., and Bouyer, P.: Operating the Absolute Quantum Gravimeter outside of the laboratory, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-8969, https://doi.org/10.5194/egusphere-egu2020-8969, 2020.

Example raw record (**~2Hz**):



g_{ref} = **9 812 500 000 nm/s^2**

Borowa Gora Observatory

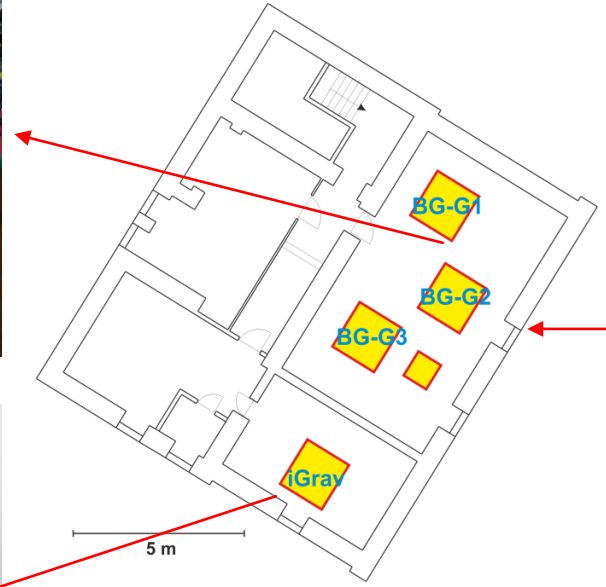


Borowa Gora Geodetic-Geophysical Observatory

- located ~35 km north of Warsaw
- owned by the Institute of Geodesy and Cartography

Gravimetric infrastructure:

Gravimetric Laboratory



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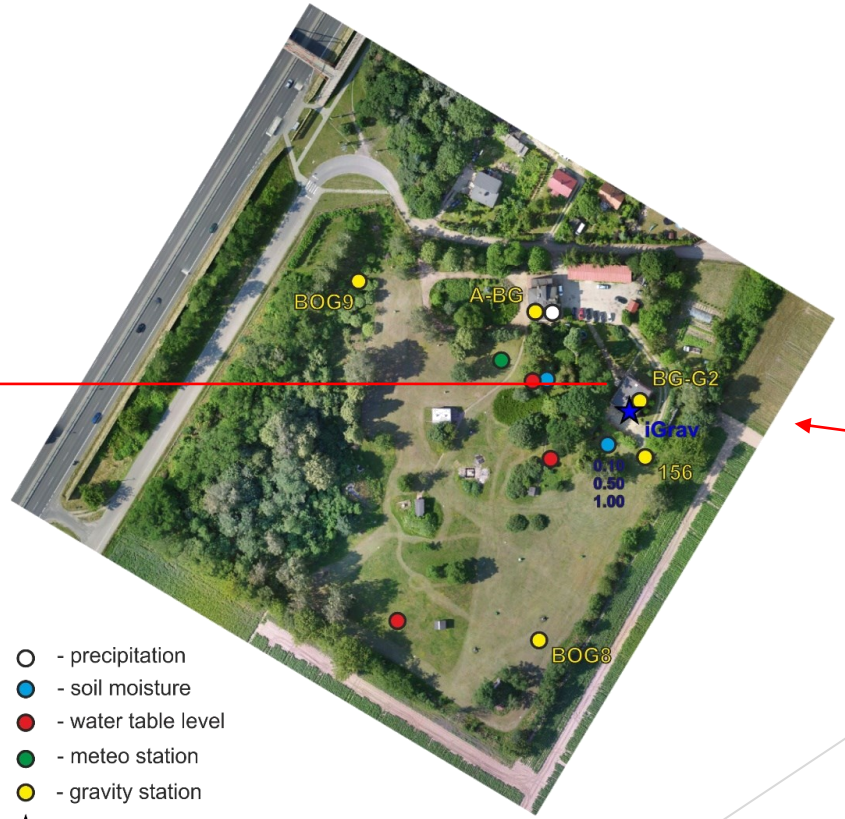
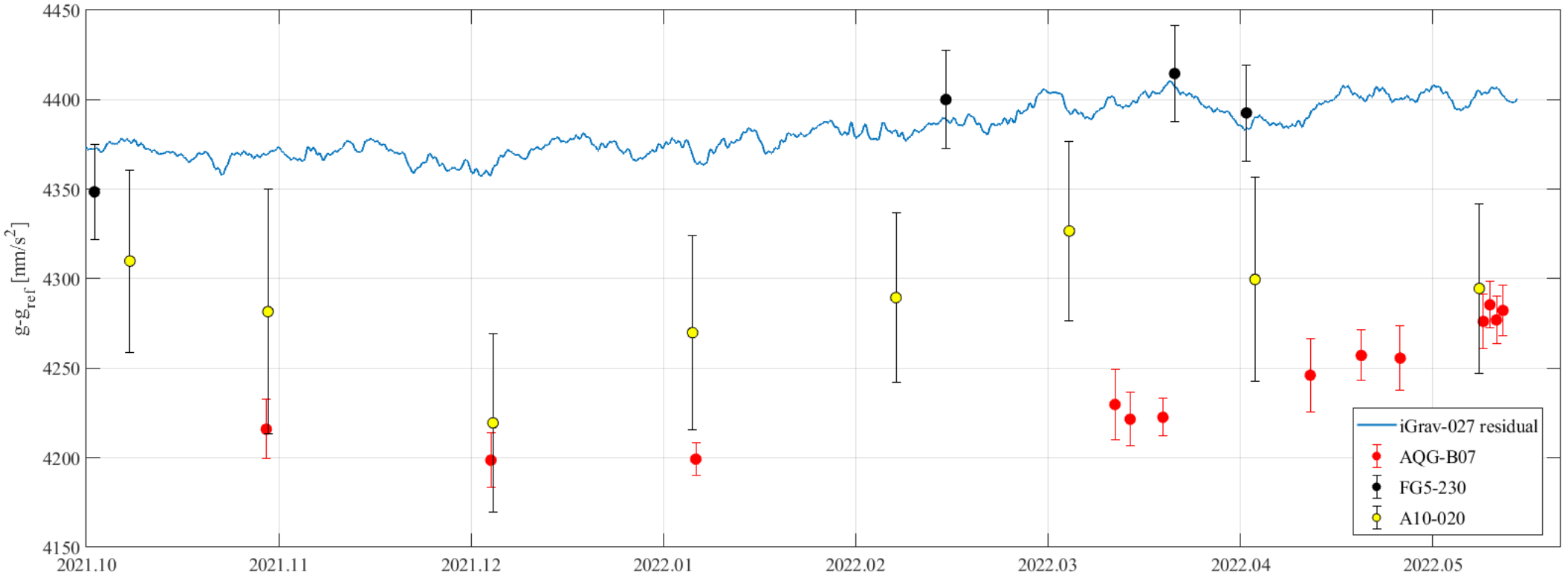


EGU22-4718, EGU General Assembly 2022, Vienna, Austria & Online | 23–27 May 2022

Periodic gravity determinations

Periodic absolute gravity determinations vs. continuous gravity monitoring (Borowa Góra) – BG_G2

- absolute gravimeters: A10-020 (IGiK), AQG-B07 (IGiK), FG5-230 (WUT)
- iGrav ~tied to BG gravity reference function
- Systematic offsets: AQG – A10 (-44 nm/s^2), AQG – FG5 (-150 nm/s^2), AQG – iGrav (-157 nm/s^2)
- **AQG-B07 offset is under evaluation**



Periodic gravity determinations

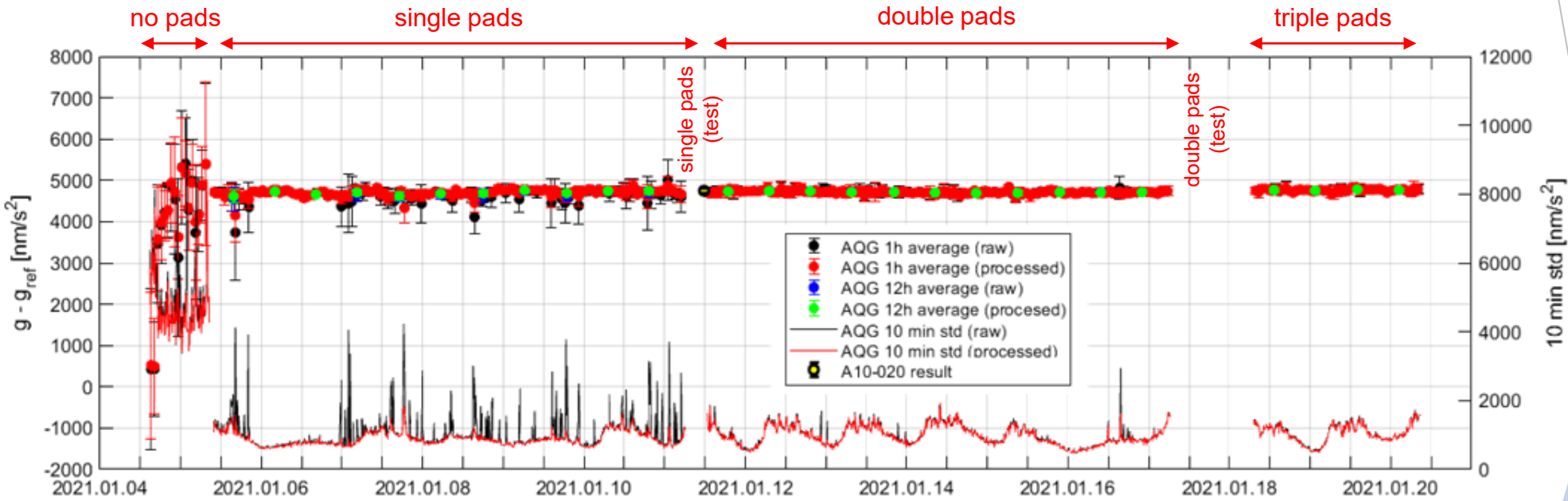
Periodic absolute gravity determinations vs. continuous gravity monitoring (Borowa Góra) – BG_G2

- *iGrav, A10, FG5 shifted to AQG*
- Absolute gravimeter to iGrav-027 RMS: **AQG (26 nm/s²)**, A10 (24 nm/s²), FG5 (16 nm/s²)
- Error bars: AQG-B07 (std 1h average blocks), A10-020, FG5-230 (standard uncertainty)
- **AQG-B07 uncertainty budget is also under evaluation**

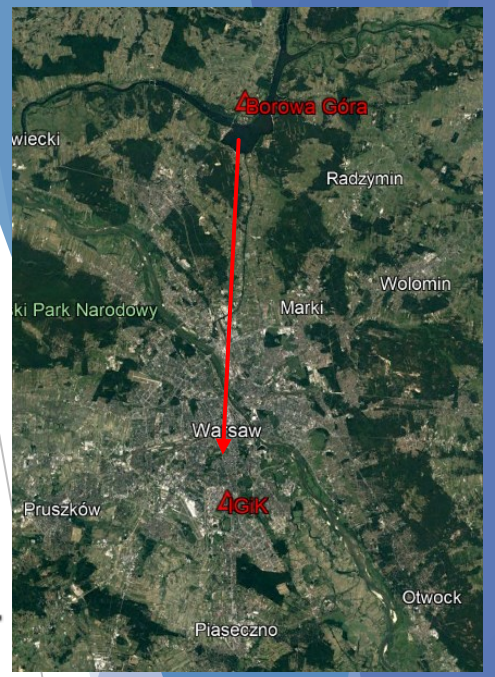
Survey in urban environment

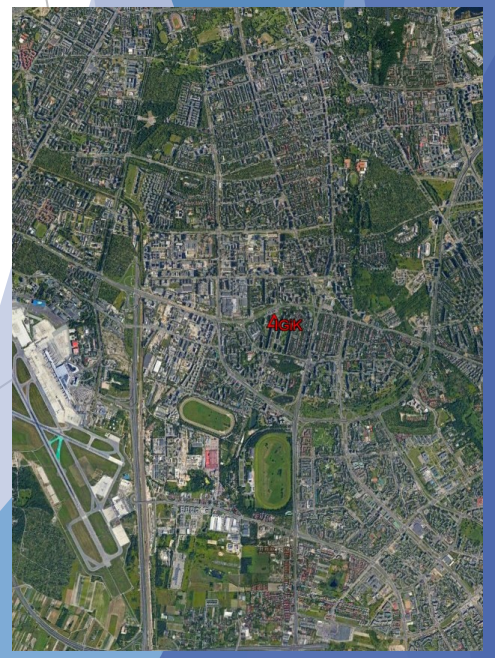
AQG-B07 installation at IGiK (Warsaw) – January 2022

- Complete record with increasing number of rubber pad layers
- No pads generated a poor result, pads added the next day, weekly more layers of pads



	No pads (last 8-9 hours)	Single pads	Double pads	Triple pads (ongoing)
Mean [nm/s²]	…4587 (…4648)	…4660 (…4694)	…4717 (…4715)	…4764 (…4763)
Std 1h [nm/s²]	806 (636)	139 (86)	39 (38)	34 (33)
Std 12h [nm/s²]	-	62 (48)	18 (16)	13 (12)
Mean Std [nm/s²]	5457 (4965)	1186 (915)	1050 (1019)	1103 (1082)

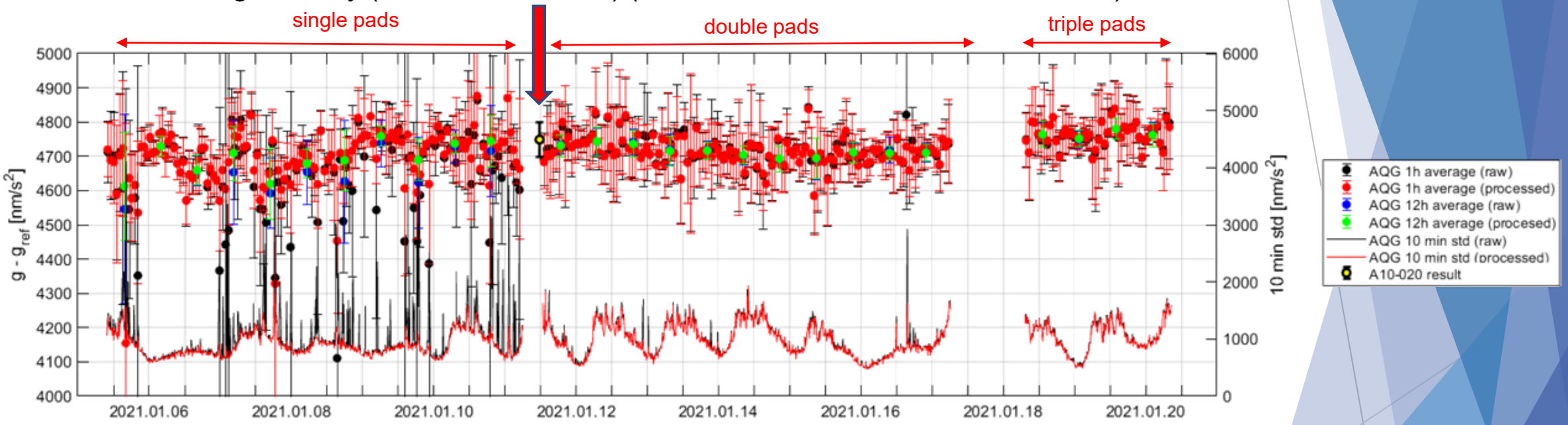




Survey in urban environment

AQG-B07 installation at IGiK (Warsaw) – January 2022

- Single layer of pads exhibited spikes in gravity tracking => added second layer (improved stability)
- A10-020 single survey (…4749 ± 50 nm/s^2) (+40-50 nm/s^2 to AQG, **BG consistent**)



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Survey in urban environment

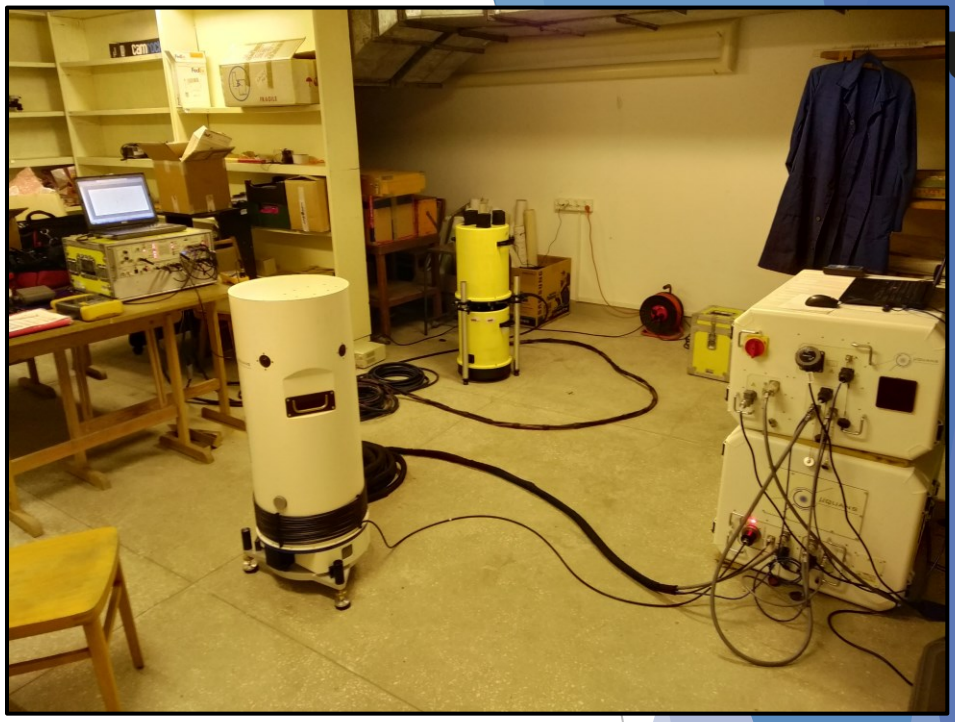
AQG-B07 vs A10-020 side by side measurement (37 hours)

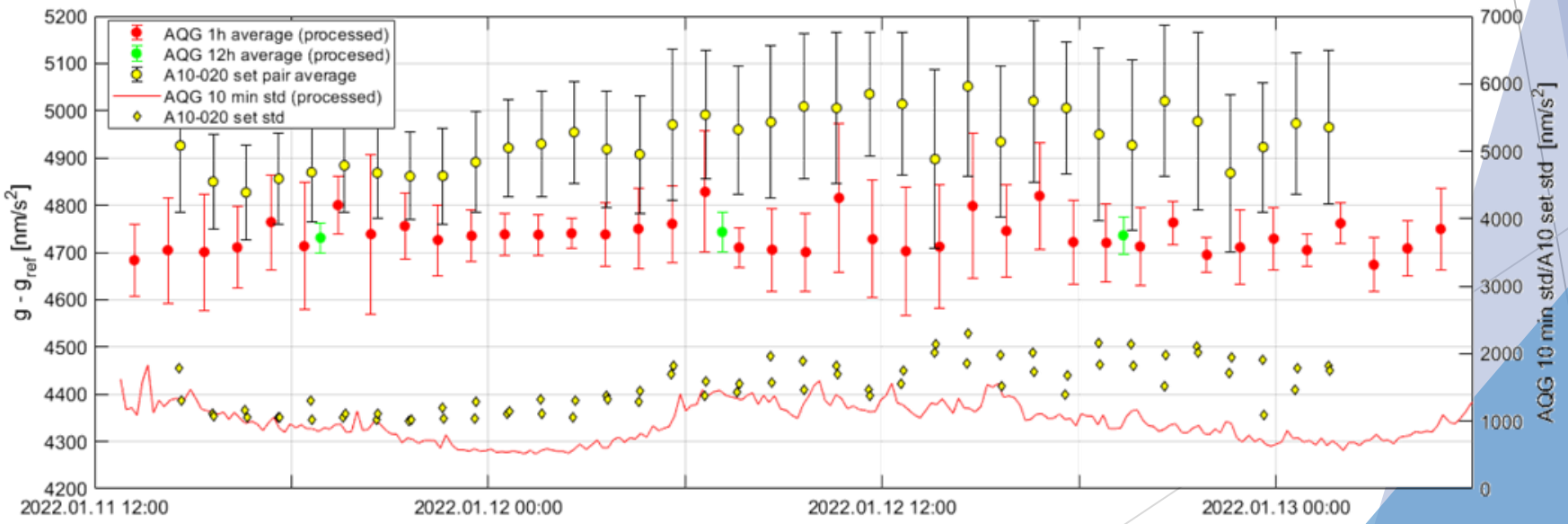
- AQG-B07 – double pads (AA point)
- A10-020 – 2 sets (red/blue) every 60 minutes (AB point)

Gravity difference ~200 nm/s^2

A10 set std = 60.3 nm/s^2

AGQ 1h std = 33.3 nm/s^2





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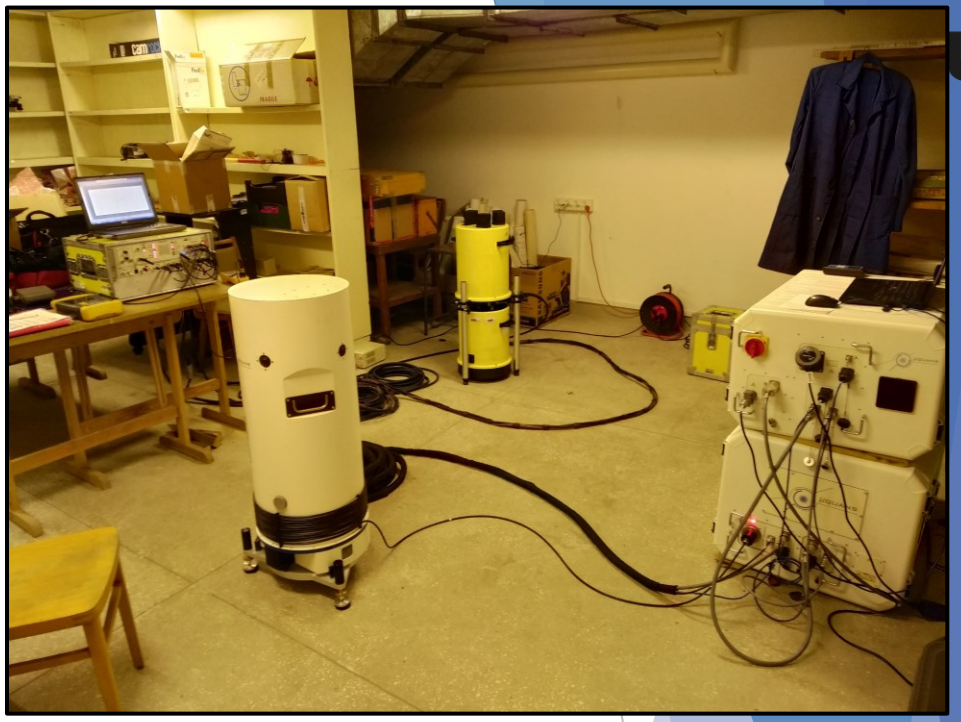
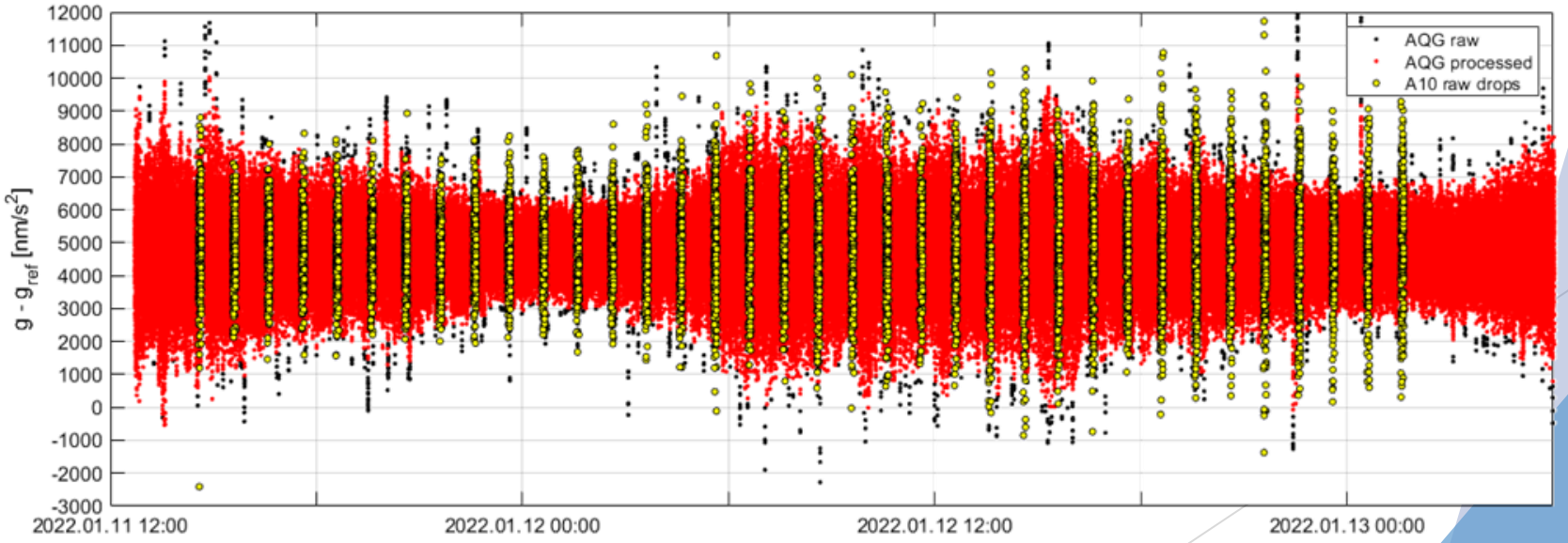




AQG-B07 vs. seismometer record

AQG-B07 vs. REF-TEK Seismometer (2 weeks side by side record in December 2021)

- One strong earthquake:

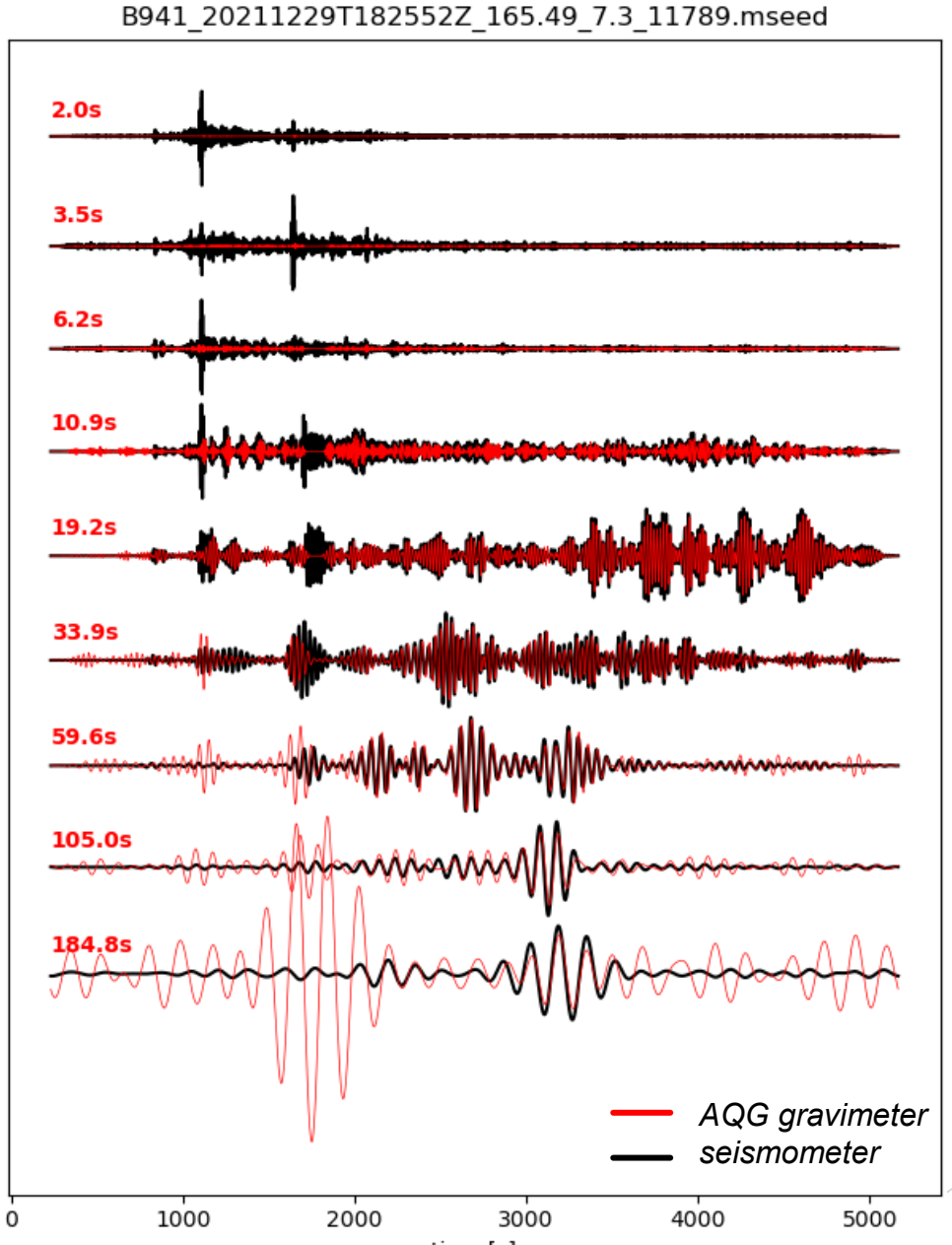
  2021-12-29 18:25:52,

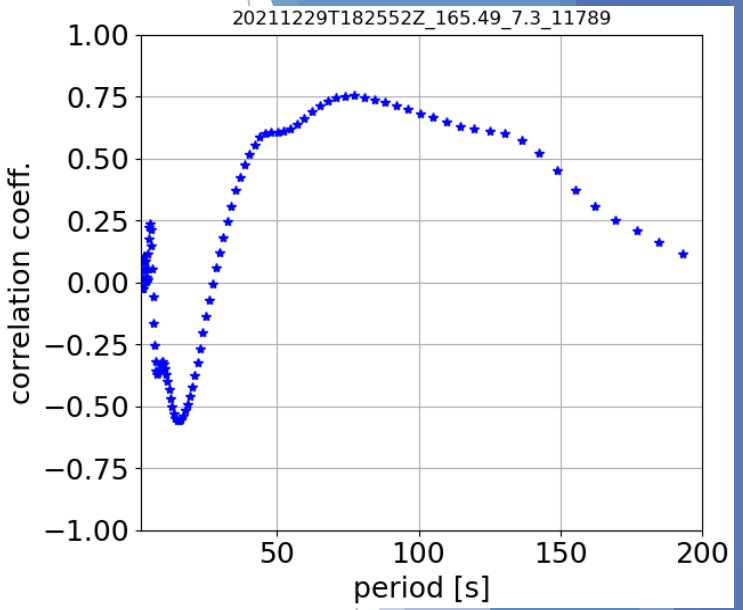
  depth 165 km,

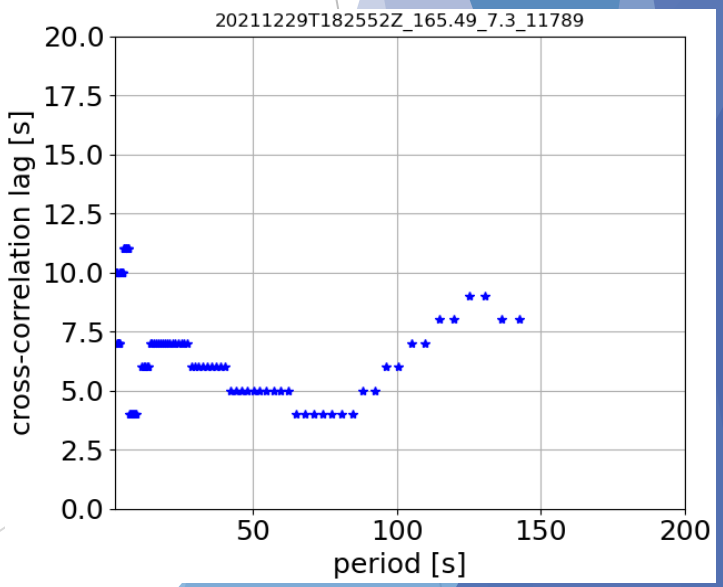
  mww 7.3,

  NNE of Lospalos, Timor Leste

- Filtering of the signal by a set of Gaussian filters: 108 central periods, between 2 and 220 s





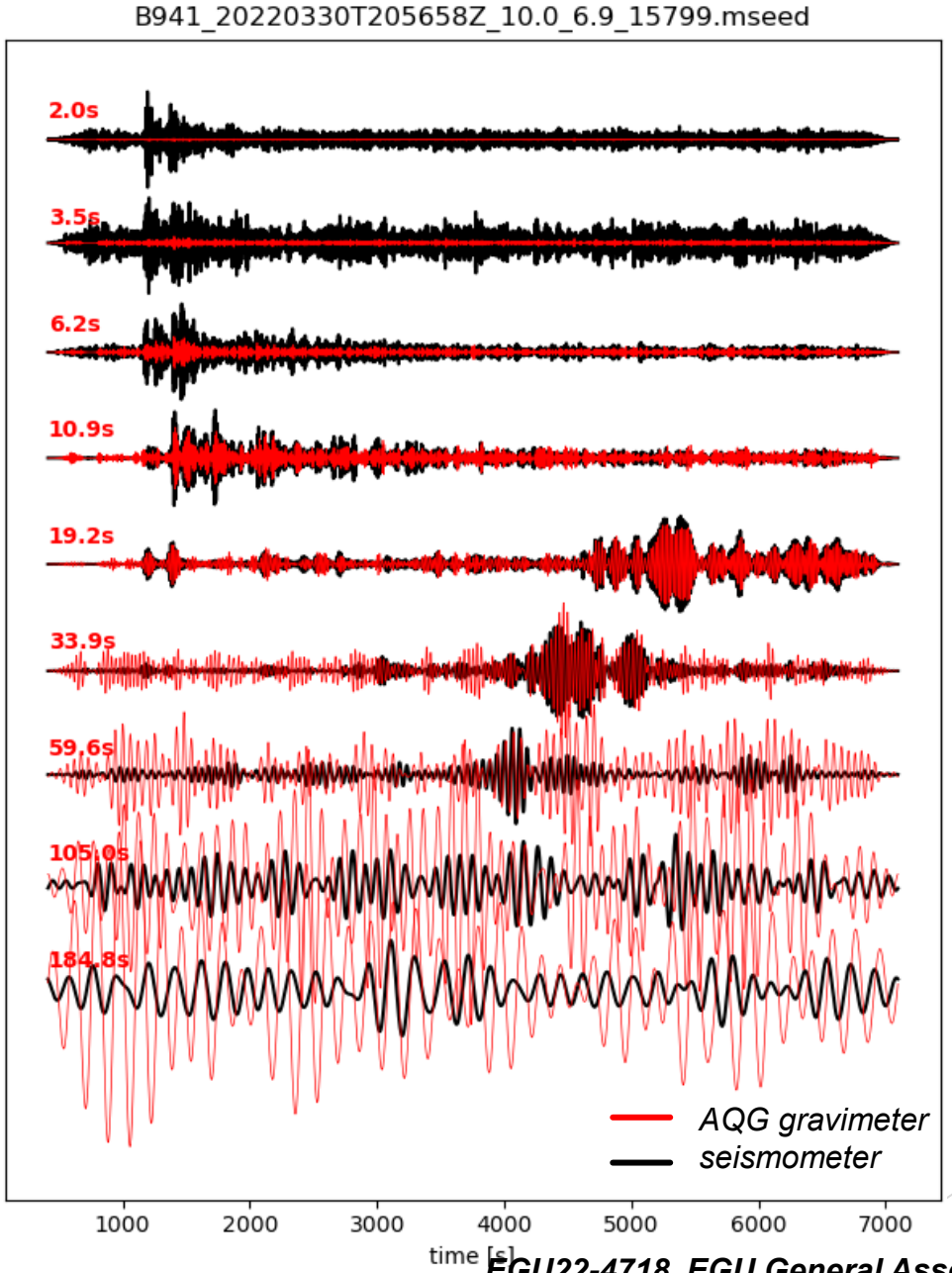


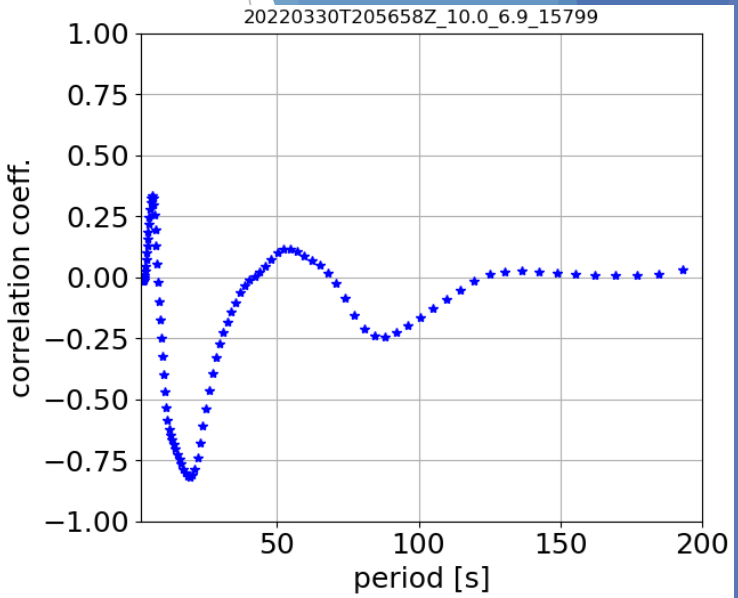
This part of work has been done in the research project No. 2017/27/B/ST10/01600 financed from the funds of the Polish National Science Centre.

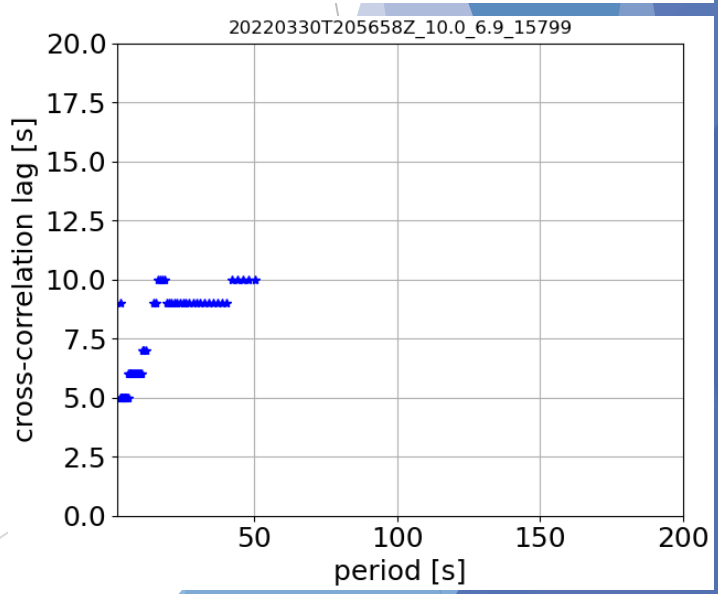
AQG-B07 vs. seismometer record

AQG-B07 vs REF-TEK Seismometer

- Other earthquake:
  2022-03-30 20:56:58,
  depth 10.0 km,
  mww 6.9,
  286 km ESE
  of Tadine, New Caledonia
- Filtering of the signal by a set of Gaussian filters: 108 central periods, between 2 and 220 s







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Summary

- Initial results indicate **high consistency** between AQG-B07 and iGrav-027 residual **below 30 nm/s^2** level for survey performed in laboratory conditions
- AQG-B07 gravity determinations are within the same level of consistency with both A10 and FG5 type gravimeters
- Gravity determinations under urban environment show potential of using the AQG-B07 gravimeter for gravity monitoring in urban environments. Several day continuous gravity tracking show **<20 nm/s^2** stability when averaged in 12h blocks
- AQG-B07 sensitivity in seismic events frequency range indicates that only very strong events can be recorded by the instrument
- Detected phase lag (7-10 sec) between AQG-B07 and the seismometer is in agreement with the AQG gravimeter processing chain
- Systematic offset and uncertainty budget of the AQG-B07 are still under evaluation (work in progres), however, systematic offset is stable over first 6 months of measuements and it does not show indications of drift like behaviour