

NKG-CAG-2022

The NKG absolute gravimeter intercomparison in Onsala

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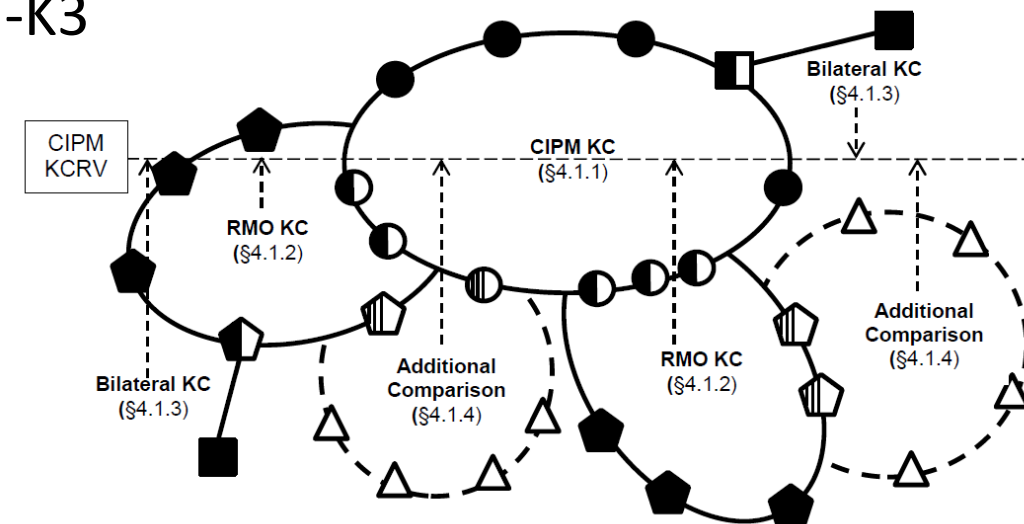
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Background

- For Nordic absolute gravity (AG) timeseries it is essential that AGs are compared to make sure their measurements are compatible
- There are 5 AGs in the Nordic Countries
 - 1 participated in all International and European comparisons (ICAGs & ECAGs)
 - 1 participated in most ICAGs and ECAGs
 - 3 did not (or rarely) participated in ICAGs or ECAGs
- Bilateral comparisons have taken place
 - eg. FGI and Lantmäteriet compare every year
- Idea: Organize Nordic comparison to give opportunity to all Nordic AGs to be compared and linked to the latest ECAG and ICAG

Organization of NKG-CAG-2022

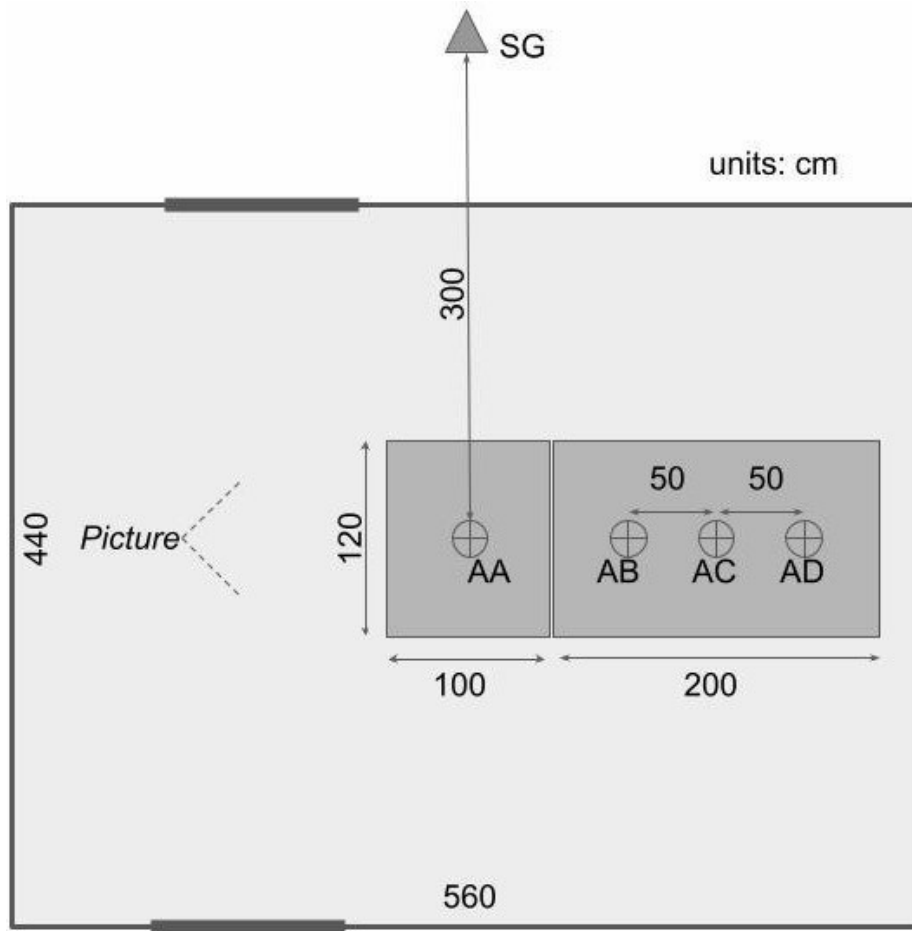
- Organized under umbrella of the NKG:
 - Administrator: Lantmäteriet (Andreas Engfeldt)
 - Local organizer: Onsala Space Observatory (Maxime Mouyen)
 - Pilot laboratory: Finnish Geospatial Research Institute (Mirjam Bilker-Koivula)
- Additional comparison as described in §4.1.4 of the CCM-IAG Strategy for Metrology in Absolute Gravimetry
- Obtain traceability to SI by link to EURAMET.M.G-K3
 - Participants of National Metrological Institutes (NMI) and/or Designated Institutes (DI)
 - Minimum of 2 NMI/DI's
- Publish results in scientific journal
- Store results in AGrav database



Onsala Space Observatory, May-July 2022



The new gravity building



Co-located with SG in neighbouring room



AA AB AC AD

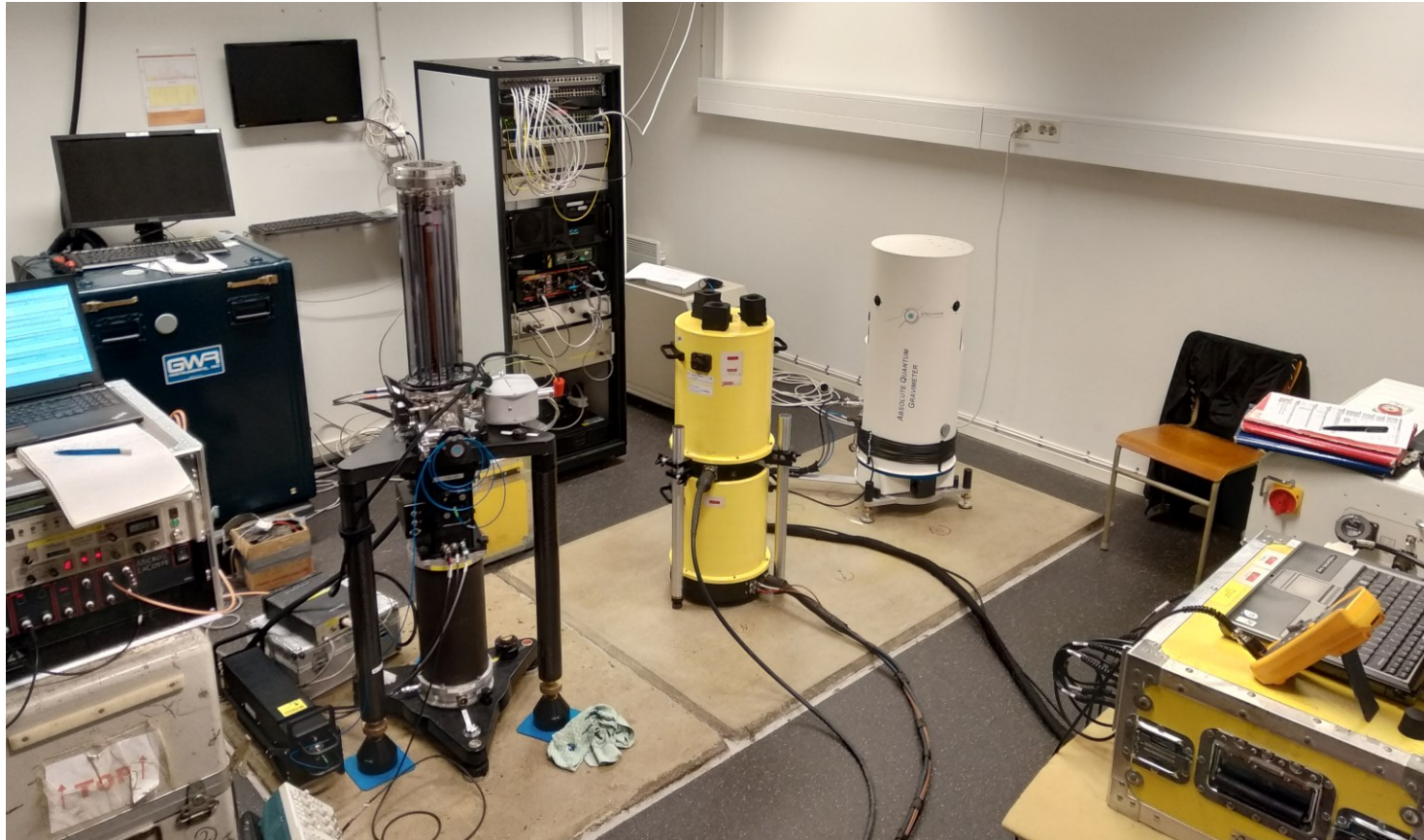
Participants & Schedule

	Instruments	Organizations	In last ECAG	NMI/DI
Scheduled	19	15	8	2
Cancelled	4	3	0	0
Withdrawn	2	1	0	0
Results of	13	11	8	2

Week	Institution	Instruments	
19	Lantmäteriet, Gävle	FG5X-233	
19	Leibniz-University Hannover	FG5X-220	
22	Inst of Geodesy and Cartography, Warszawa	A10-020 / AQQ-B07	
22	Univ. Strasbourg	FG5-206	
23	Pecny	FG5-215	
23	FGI/NLS Finland	FG5X-221	
24	Royal Observatory of Belgium	FG5-202	
24	DTU Space	A10-019	
24	NERC	FG5-229	CANCEL
25	GFZ Potsdam	AQQ	CANCEL
25	NMBU/Kartverket	FG5-226 / FG5X-250	
26	BKG, Frankfurt	FG5X-301, AQG-A02 (issues)	
26	Faculty of Geodesy and Cartography Warsaw	FG5-230	
27	TU Delft	FG5X-234 (issues)	
27	Geoscience Montpellier	FG5-228, AQG-A01	CANCEL

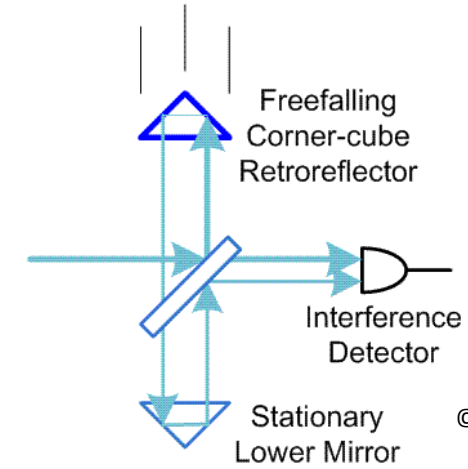
Instrument types

6 FG5X, 4 FG5, 2 A10, 1 AQG



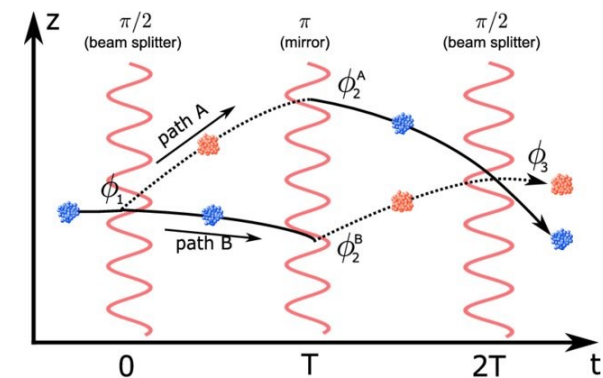
From left to right: FG5X, A10, AQG

FG5X, FG5, A10 (laser interferometry)



© Jongmin Lee

AQG (atom interferometry)



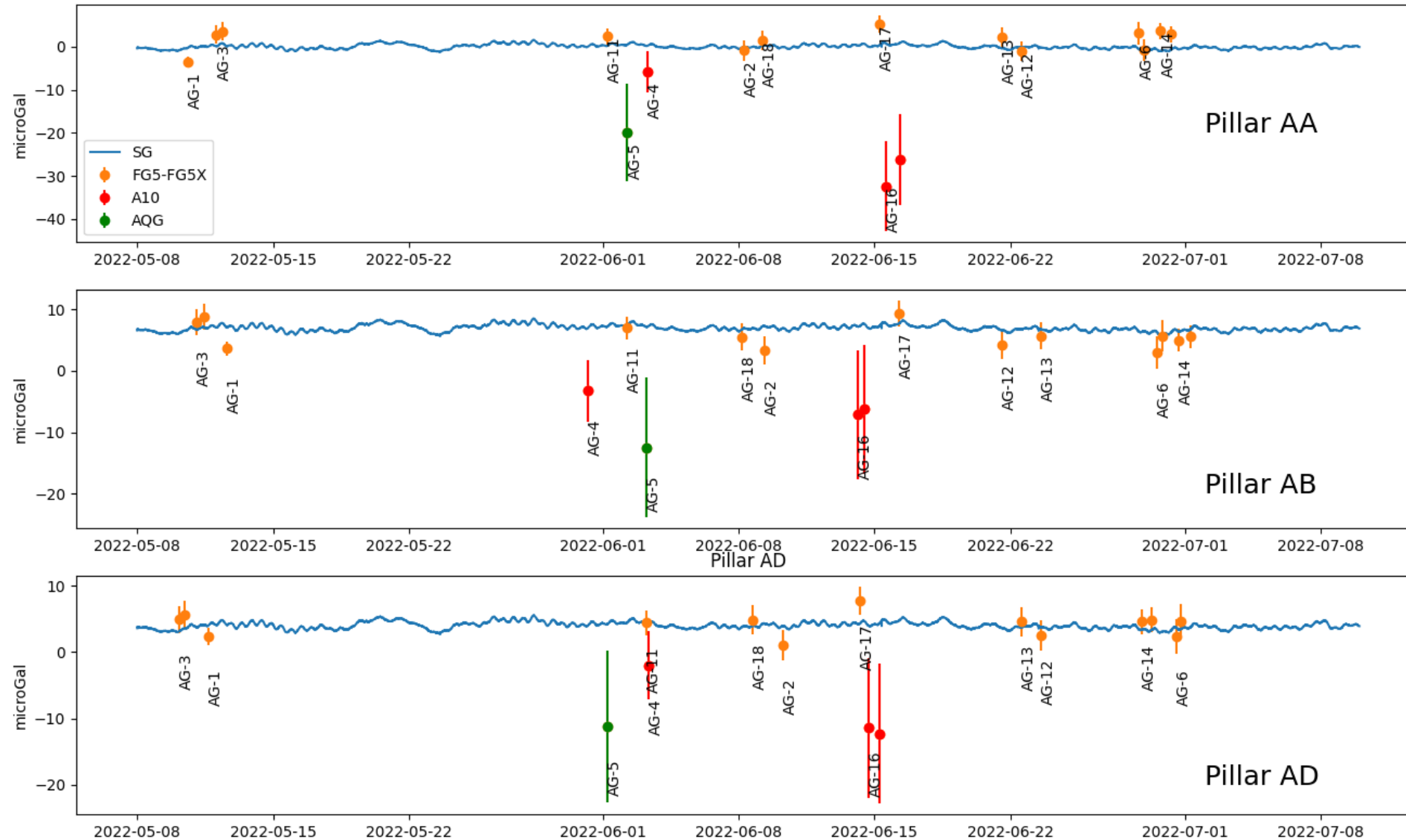
Hauth et al.,
2014

Procedure

Described beforehand in Technical Protocol

- Measurements
 - 3 locations, at least over night
 - Spread out over 9 weeks
 - Local gravity variations measured by co-located superconducting gravimeter GWR SG 054
- Follow procedures of ECAGs and ICAGs as much as possible
- Corrected for gravimetric Earth tides, atmospheric and polar motion effects on gravity. - in compliance with the International Gravity Reference System and Frame processing standards.
- Results provided by participants for each station: Gravity value at reference height, preferably the effective height (1.21 m for FG5 and 1.27 m for FG5X), gravity gradient used and combined standard deviation.
- Pilot laboratory transfers values to comparison height (1.25 m) using final gradient values

Very preliminary results



SG time series corrected according to Wziontek et al. 2020

- variation of $\pm 1.5 \mu\text{Gal}$ for the duration of the comparison

AG data and standard deviations as given by participants

- g-values transferred to 1 m using old gradients

Next steps

- Combination of data

- Weighted least-squares adjustment: $g_{ik} = g_k + \delta_i + \varepsilon_{ik}$

with weights: w_{ik} ($w_{ik} = u_o^2/u_{ik}^2$ where u_o is the unit weight)

- And weighted condition $\sum_i w_i \delta_i = d$

d is linking converter determined from degrees of equivalence (DoEs) of the linking participants

- Result:

- Comparison reference values (CRVs) for each site
- Degrees of equivalence (DoEs) for each instrument
= difference of measured gravity and CRV

gravity value measured by gravimeter i on station k

gravity on station k

instrument bias

Timeline

13.5.2022	Approbation of the Technical Protocol by all the NKG-CAG-2022 participants
29.5.2022	Deadline for sending the completed form of annex A to the Pilot Laboratory (Mirjam.Bilker-Koivula@nls.fi)
9.5. – 7.7.2022	Comparison at the Onsala Space Observatory
1.8.2022	Presentation of the results by the participants to the Local Organisation (Andreas.engfeldt@lm.se) and the Pilot Laboratory (Mirjam.Bilker-Koivula@nls.fi) (Annexes B and C)

31.10.2022	Draft A (confidential) presented to the participants
2.12.2022	Deadline for comments on Draft A
31.1.2023	Draft B (in public form) presented



**Greetings from the
NKG CAG 2022 !**
(Some of the participants)

