

IAG Project – Novel Sensors and Quantum Technology for Geodesy

QuGe

[WG Q.1: Quantum gravimetry in space and on ground](#)

4th meeting

09/06/2022

Meeting Agenda

16:00 - 16:10 Welcome, adoption of the agenda (F. Pereira/M. Van Camp)

16:10 - 16:30 General information on activities in 2022 (F. Pereira)

16:30 - 17:10 Contributions by the WG members

- Ashton: update on the USGS's acquisition and planned use of their new AQQ
- Federica: update with the news from Italy
- Olivier: update on MAGIC/NGGM missions as well as quantum activities at ESA\EOP
- Nan: QGG and hybrid concept
- Others ?

17:10 - 17:30 Discussion on future actions (All)

17:30 - 17:45 Other business (All)

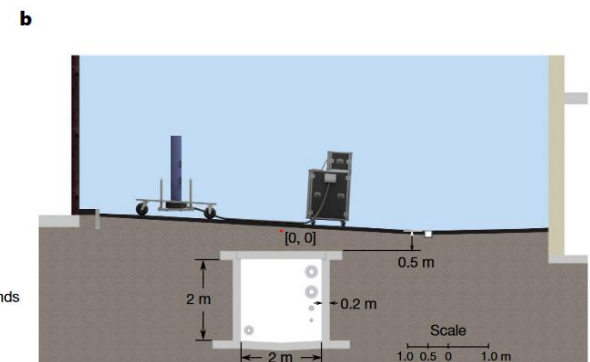
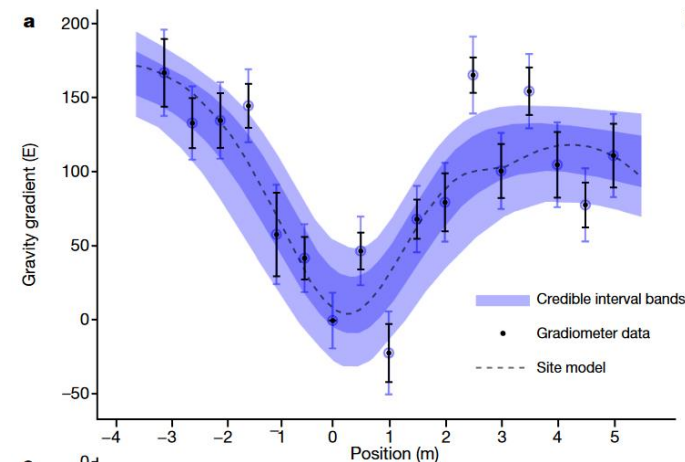
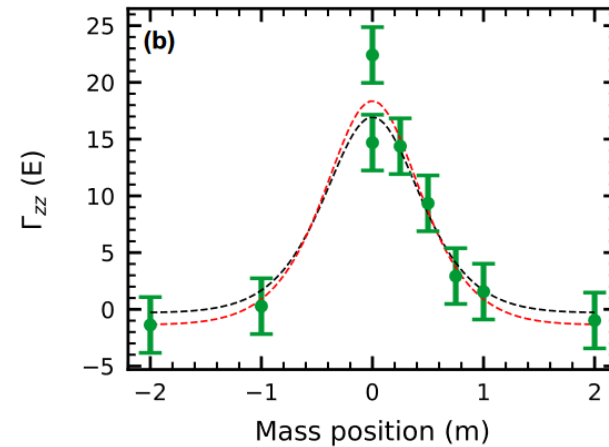
Activities in 2022

A few *published* papers of interest

Camille Janvier, Vincent Ménoret, Bruno Desruelle, Sébastien Merlet, Arnaud Landragin, and Franck Pereira dos Santos

Compact differential gravimeter at the quantum projection-noise limit, Phys. Rev. A 105, 022801 (2022)
<https://journals.aps.org/prabstract/10.1103/PhysRevA.105.022801>

Ben Stray, Andrew Lamb, Aisha Kaushik, Jamie Vovrosh, Anthony Rodgers, Jonathan Winch, Farzad Hayati, Daniel Boddice, Artur Stabrawa, Alexander Niggebaum, Mehdi Langlois, Yu-Hung Lien, Samuel Lellouch, Sanaz Roshanmanesh, Kevin Ridley, Geoffrey de Villiers, Gareth Brown, Trevor Cross, George Tuckwell, Asaad Faramarzi, Nicole Metje, Kai Bongs & Michael Holynski
Quantum sensing for gravity cartography, Nature volume 602, pages 590–594 (2022)
<https://www.nature.com/articles/s41586-021-04315-3>



More (preprints and published papers of interest)

Alexey V. Veryaskin, Michael E. Tobar

Can Traditional Terrestrial Applications of Gravity Gradiometry Rely Upon Quantum Technologies ? A Side View

arXiv:2108.05519

<https://doi.org/10.48550/arXiv.2108.05519>

Laura Antoni-Micollier, Daniele Carbone, Vincent Ménoret, Jean Lautier-Gaud, Thomas King, Filippo Greco, Alfio Messina, Danilo Contrafatto, Bruno Desruelle

Detecting volcano-related underground mass changes with a quantum gravimeter

<https://doi.org/10.1002/essoar.10510251.1>

Nassim Zahzam, Bruno Christophe, Vincent Lebat, Emilie Hardy, Phuong-Anh Huynh, Noémie Marquet, Cédric Blanchard, Yannick Bidel, Alexandre Bresson, Petro Abrykosov, Thomas Gruber, Roland Pail, Ilias Daras, Olivier Carraz

Hybrid electrostatic-atomic accelerometer for future space gravity missions

arXiv:2206.00634

<https://arxiv.org/abs/2206.00634>

A. Alonso et al (~250 authors)

Cold Atoms in Space: Community Workshop Summary and Proposed Road-Map

arXiv:2201.07789

<https://arxiv.org/abs/2201.07789>

R. A. Carollo, D. C. Aveline, B. Rhyno, S. Vishveshwara, C. Lannert, J. D. Murphree, E. R. Elliott, J. R. Williams, R. J. Thompson & N. Lundblad

Observation of ultracold atomic bubbles in orbital microgravity

Nature volume 606, pages 281–286 (2022)

<https://www.nature.com/articles/s41586-022-04639-8>

Industry mapping

Invitation sent to different companies

France: [iXBlue](https://www.muquans.com/). <https://www.muquans.com/>

Australia: [Nomad Atomics](https://www.nomadatomics.com/) <https://www.nomadatomics.com/>

Singapore: [Atomionics](http://www.atomionics.com/) <http://www.atomionics.com/>

UK : [Teledyne e2v](#)

Italy: [AtomSensors](http://www.atomsensors.com/index.php/en/) <http://www.atomsensors.com/index.php/en/>

US: [AOSense](https://aosense.com/) <https://aosense.com/>

Australia: [Q CTRL](https://q-ctrl.com/) <https://q-ctrl.com/>

Got replies from [iXblue](#) and [Nomad Atomics](#)

Who could contact who ?

Organize presentations at our next meeting

CAS Cold Atom, also known as **Zhongke Kuyuan**, offers quantum precision measurement instruments including a cold atom absolute gravimeter. The startup is based in Wuhan, China.


<https://www.cascoldatom.com/>

Papers at EGU 2022

G4 – Satellite Gravimetry, Gravity and Magnetic Field Modeling

G4.1

[Modern Concepts for Gravimetric Earth Observation](#)

Convener: Jürgen Müller  | Co-conveners: Sergei Kopeikin , Sébastien Merlet^{ECS} , Munawar Shah^{ECS} , Wenbin Shen 

[Abstract submission](#)

G4.4 **EDI** 

[New tools for terrain gravimetry](#)

Convener: Daniele Carbone  | Co-conveners: Jean Lautier-Gaud , Eleonora Rivalta , Filippo Greco , Karl Toland^{ECS} 

[Abstract submission](#)

G4.1 Modern Concepts for Gravimetric Earth Observation

Second session on Atom Interferometry on Ground and in Space

[Optimization and characterization of a differential quantum gravimeter](#)

Camille Janvier, Vincent Ménoret, Sébastien Merlet, Arnaud Landragin, Franck Pereira dos Santos, and Bruno Desruelle

[Evaluation of the AQG-A02 and AQG-B02 absolute quantum gravimeter accuracy](#)

Julian Glässel, Marvin Reich, Andreas Güntner, Hartmut Wziontek, Reinhard Falk, and Axel Rülke

[Gravity data acquisition and validation of the interferometric measurement concept with the transportable absolute Quantum Gravimeter QG-1](#)

Waldemar Herr, Nina Heine, Ernst M. Rasel, Jürgen Müller, and Ludger Timmen

[Quantum navigation with multi-axis atomic interferometry and hybrid](#)

Yueyang Zou, Mouine Abidi, Philipp Barbey, Ashwin Rajagopalan, Christian Schubert, Matthias Gersemann, Dennis Schlippert, Sven Abend, and Ernst M. Rasel

[Results of the MOCAS+ study on a quantum gravimetry mission](#)

Federica Migliaccio, Khulan Batsukh, Giovanni Battista Benciolini, Carla Braitenberg, Öykü Koç, Sergio Mottini, Alberto Pastorutti, Tommaso Pivetta, Mirko Reguzzoni, Gabriele Rosi, Lorenzo Rossi, Fiodor Sorrentino, Guglielmo Maria Tino, and Alfonso Vitti

[Gravity field recovery of the MOCAS+ quantum mission proposal](#)

Öykü Koç, Mirko Reguzzoni, Lorenzo Rossi, Federica Migliaccio, Khulan Batsukh, and Alfonso Vitti

G4.4 New tools for terrain gravimetry

[First results from the AQG-B07 absolute quantum gravimeter](#)

Przemyslaw Dykowski, Maxime Arnal, Vincent Menoret, Marcin Sękowski, Kamila Karkowska, Monika Wilde-Piórko, and Jan Kryński

[First results from an absolute atom interferometry gravimeter at Mt. Etna volcano](#)

Daniele Carbone, Laura Antoni-Micollier, Vincent Ménoret, Jean Lautier-Gaud, Filippo Greco, Thomas King, Alfio Messina, Danilo Contrafatto, and Bruno Desruelle

Other activities

Q gravimetry on the GGOS (Global Geodetic Observing System, IAG) website



Some Input was provided in response to a request from Martin Sehnal, GGOS - Global Geodetic Observing System, Director of Coordinating Office, Federal Office of Metrology and Surveying (BEV)

It is online. Read <https://ggos.org/item/quantum-gravimetry/>



Quantum Gravimetry

Space domain: ESA program

Listen O. Carraz presentation

Space domain: Horizon Europe call

Ambition of the European Commission: push the development of QT for Earth Observation and prepare a future mission
This is related to the Quantum Flagship program

From the Work Programme 2021-2022:

HORIZON-CL4-2021-SPACE-01-62 : Quantum technologies for space gravimetry

The enhancement of the TRL up to TRL5 for cold atom interferometry (including Bose-Einstein Condensates) components is a key objective of this call.

=> Project selection expected later this month

From the (draft) Work Programme 2023-2024:

HORIZON-CL4-2023-SPACE-01-63: Quantum Space Gravimetry Phase-A Study

HORIZON-SPACE-2024-01-64: Quantum Space Gravimetry Phase-B study & Technology Maturation

Conferences

COSPAR 2022 - 44th Scientific Assembly - 16-24 July 2022

H0.5 – Advanced Methods for Geodesy, Metrology, navigation and Fundamental Physics.

<https://www.cospar-assembly.org/admin/sessioninfo.php?session=1108>

The Event will be organized as a joint one together with the IAG (International Association of Geodesy) project 'Novel Sensors and Quantum Technology for Geodesy (QuGe)'.

1	CARIOQA : a pathfinder for spatial atom interferometry	<i>Quentin Beauvils</i>
2	Results of the MOCAS+ study for a quantum gravimetry mission	<i>Mirko Reguzzoni</i>
3	Satellite Gradiometry based on a New Generation of Accelerometers and its Contribution to Earth Gravity Field Determination	<i>Qinglu Mu</i>
4	Towards Hybrid inertial navigation based on atom interferometry for space applications	<i>Dennis Knoop</i>
5	Improved Modeling for Hybrid Accelerometers Onboard Future Satellite Gravity Missions	<i>Alireza Hosseiniarani</i>

+ 3 more sessions on Relativistic geodesy, Laser ranging instrumentation, accelerometers, AOCS and POD ...

Conferences

IUGG 2023: Joint Symposium (with IAVCEI, IAPSO)

S12 on New Technologies for Geosciences.

IUGG 2023 is open to ideas for joint symposia with other IAG Commissions and with other Associations.

Importance to participate in symposia being organized by other IAG Commissions in 2022 :

- **2nd International Symposium of Commission 4: Positioning and Applications** (September)
- **Gravity, Geoid, and Height Systems 2022** (Hybrid, September)
- **Reference Frames for Applications in Geosciences** (REFAG) (October).

International Conference on “Quantum sensors and tests of new physics”

October 5th-7th 2022 in Hannover (Germany)

Registration deadline is **June 30th**

More information can be found on the homepage <https://www.conference-qsnp.uni-hannover.de/>