Towards the establishment of the Absolute Gravity Network Ireland

Przemyslaw Dykowski[1], *Paul Kane*[2], *Jan Krynski*[1], *Aidan Burke*[2], *Katy Fitzpatrick*[2], *Geoff Bell*[3], *Michael Aiken*[3]

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General information

- Project title: **Absolute Gravity Network Ireland (AGN Ireland)**
- Goal: Establish a **modern gravity control** based on absolute gravity measurement techniques across the whole island of Ireland
- Cooperation:
  - **Institute of Geodesy and Cartography**, Centre of Geodesy and Geodynamics, Warsaw, Poland
  - **Ordnance Survey Ireland**, Dublin, Republic of Ireland
  - **Ordnance Survey of Northern Ireland**, Land and Property Services, Belfast, Northern Ireland

Begining of cooperation: June 2018

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Preparatory phase

Documentation analysis:

- **International Gravity Standardization Network 71** (*IGSN71*) – historical data materials – station coordinates, station descriptions (*to identify any **existing gravity stations**, their locations and possibilities of re-survey)*
- **Active GNSS network** for Ireland documentation – station coordinates, station descriptions (*possible **co-location of gravity and GNSS** stations)*
- **Ireland levelling network** maps and schematics – station coordinates, station descriptions (*to evaluate the possibilities of **co-locating gravity**, levelling and GNSS stations)*
- **Spatial gravity data** from the Dublin Institute of Advanced Studies (DIAS) (*to help with the design of the gravimetric calibration baseline)*

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Absolute Gravity Network design

The design of the network includes

- **50 - field stations** of gravity control (*outdoors*)
- **6 - stations of the gravimetric calibration baseline** (*indoors*)

With additional surveys on:

- **7 - IGSN71** stations

Important remark (*for all stations*):

- **precise position and orthometric height determination**

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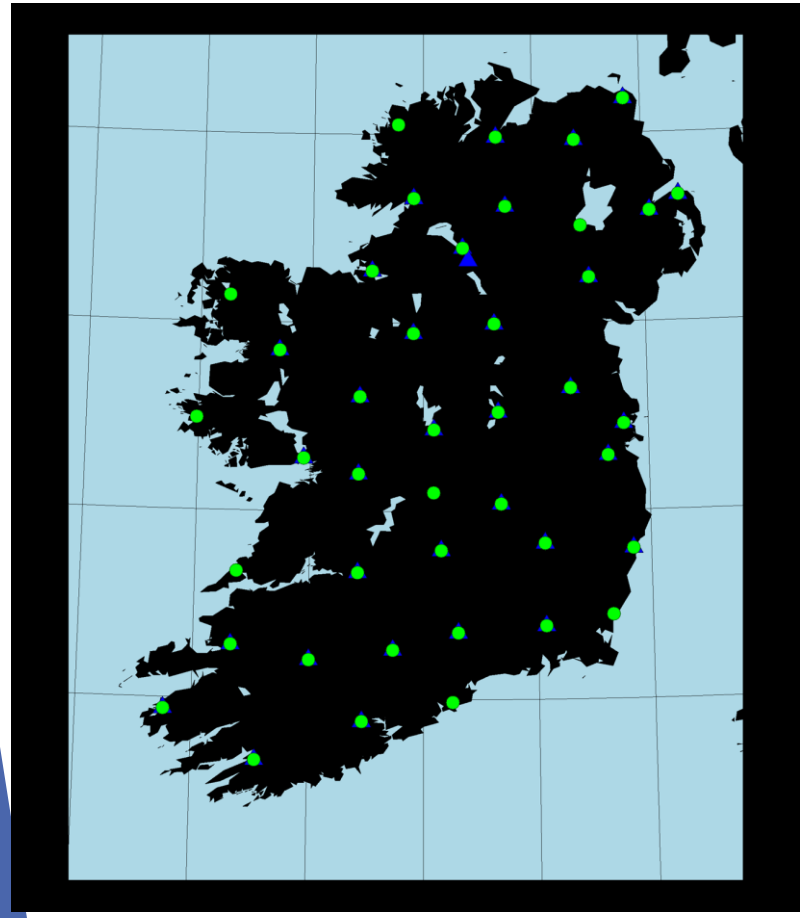
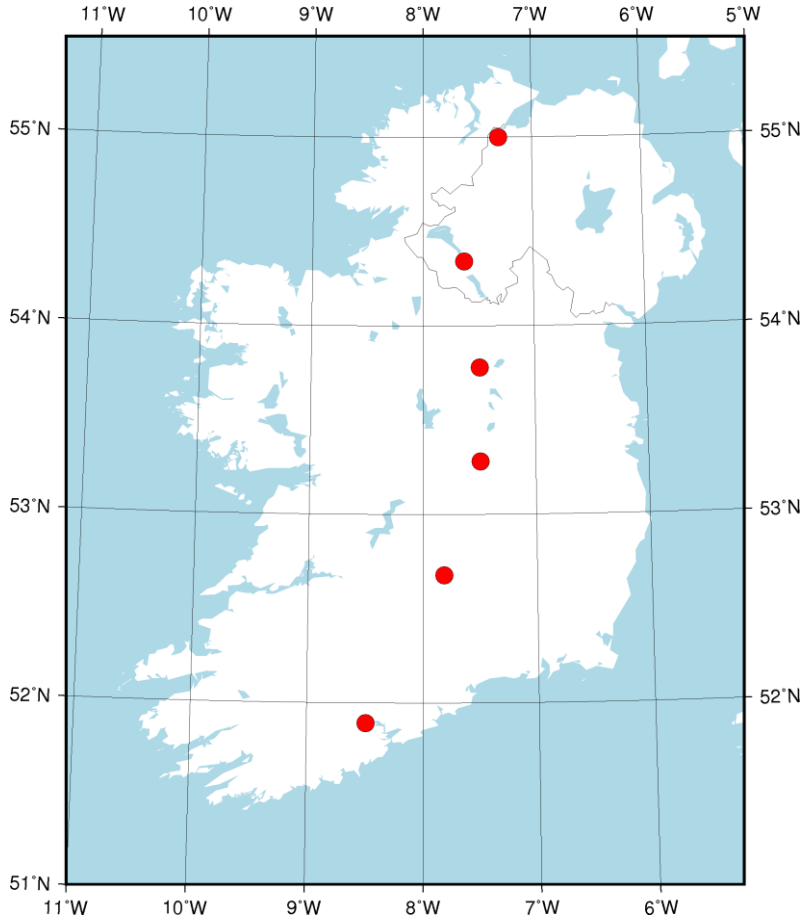
Absolute Gravity Network design

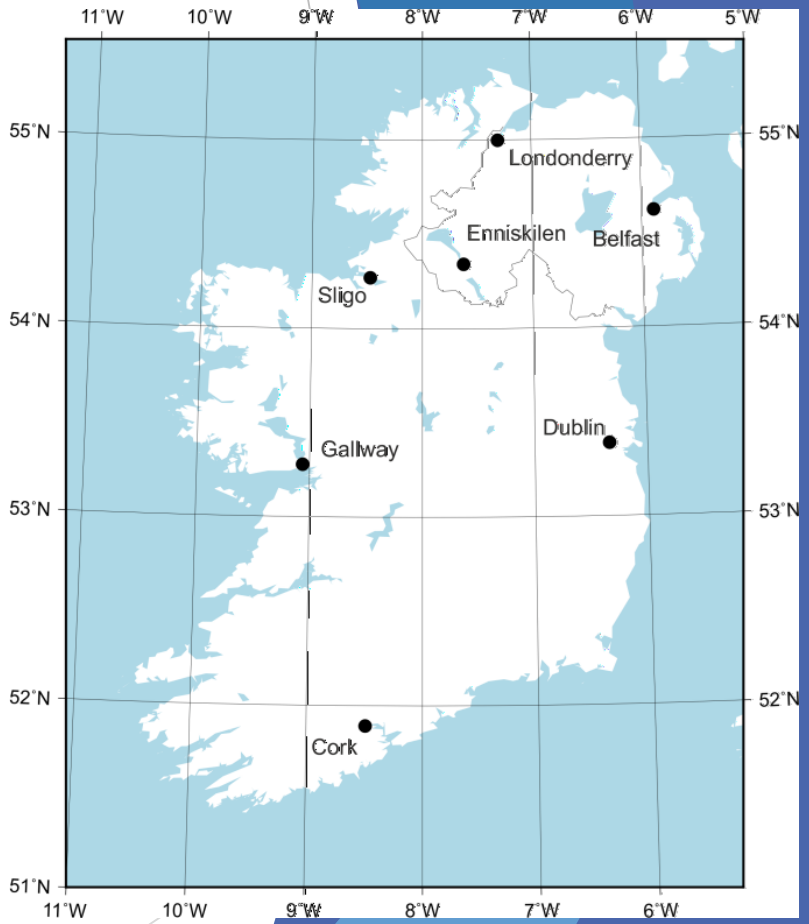
Gravity control



Calibration baseline



IGSN71 stations



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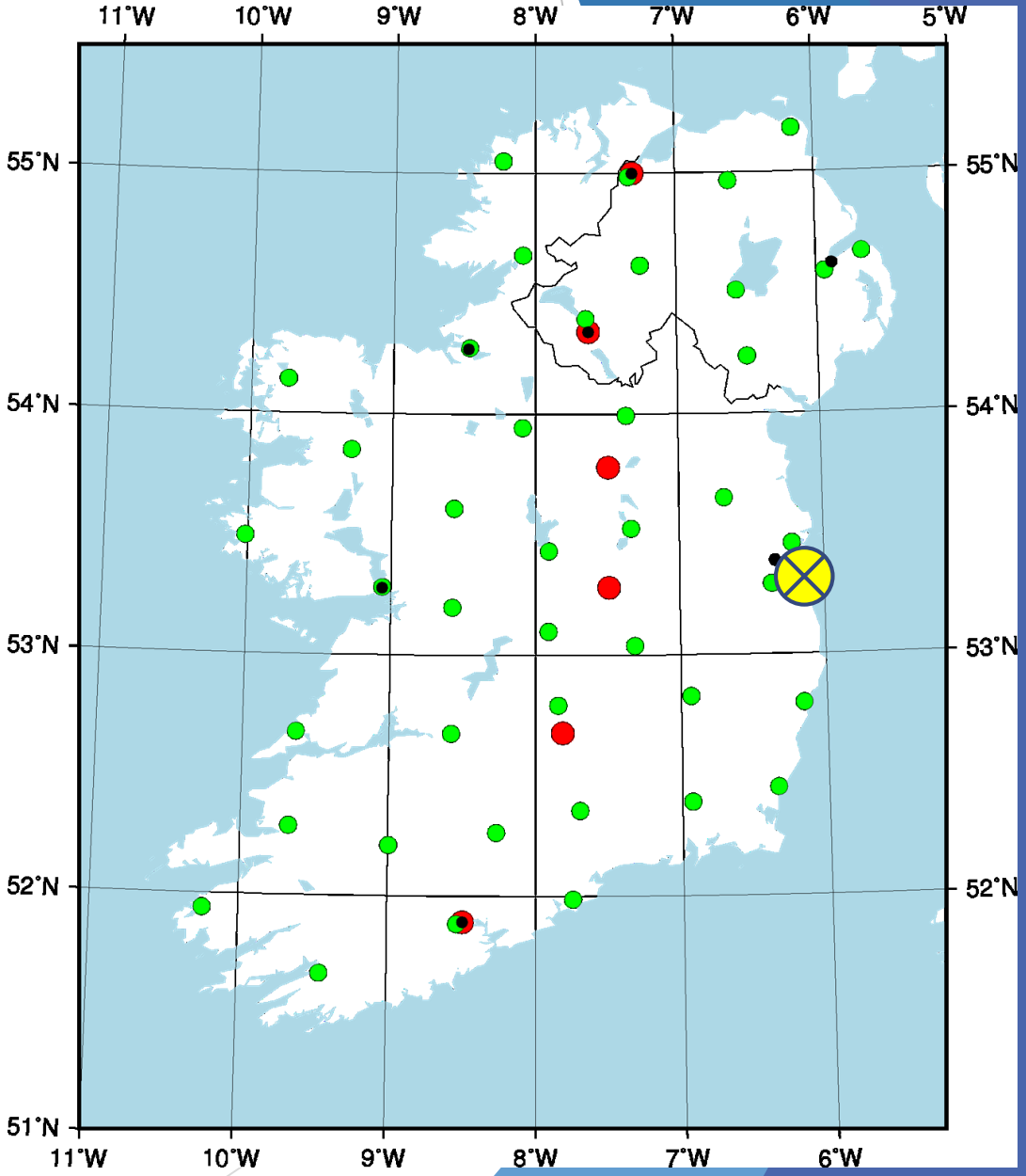
Absolute Gravity Network design

Additionally at OSi Headquaters (*Phoenix Park, Dublin*)

- Core site (⊗) for **repeated surveys with A10 gravimeter** (*start/finish each campaign*)
- Tidal gravity station (⊗) (*LaCoste&Romberg G-1084 gravimeter*) for **long term gravity monitoring** – evaluation of the Ocean Tidal Loading



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Methodology

- **Absolute gravity values** will be obtained primarily with **absolute gravity measurement techniques**
- Gravity value will be determined with the use of a **field absolute gravimeter (A10 type)**
- **Vertical gravity gradient** will be determined at **each station** to reduce the gravity value to the benchmark level
- Survey plan assumes **2 stations surveyed per day** (~2 hours at a station)
- Expected **total uncertainty** of gravity determination at benchmark level is <10 μGal (1 σ)
- Re-processing: IAGBN processing standards (updated within IGRS)

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Methodology

Quality control of the **gravity reference level**

Metrological calibrations (*internal quality control*)

- **Laser, rubidium clock and barometer** of the A10 absolute gravimeter will be calibrated against national metrological standards

Absolute gravimeter comparisons (*external quality control*)

- Participation of the A10 absolute gravimeter in **absolute gravimeter comparison campaigns** performed under the supervision of BIPM and/or EURAMET

Relative gravimeters

- **Scale factor determinations** of all used instruments (*at least once a year*)

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Methodology

Horizontal position determination

Direct Observation

- **2 hours static observations** using geodetic quality GNSS equipment and simultaneously on at least two control stations (***centimetre level accuracy***)
- Control network: **EUREF IE/UK 2009 CORS network** approved by the EUREF symposium in 2010 as the realization of ETRF2000 in the UK and Ireland

Indirect Observation

- **2 hours static observations** using geodetic quality GNSS equipment on two ancillary stations which form a **well conditioned triangle** with the gravity station (*bearing and distance*)

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Methodology

Orthometric height determination

- **spirit levelling** from a minimum two control benchmarks from the OSi or OSNI levelling networks
- **Republic of Ireland** reference: **MSL Malin Head**
- **Northern Ireland** reference: **MSL Belfast**
- MSL Belfast difference to MSL Malin Head is taken into account (37 mm)
- Expected **sub-centimetre accuracy level** with respect to the control framework

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Activities in 2018/2019

2018.05.14-16 – participation with the A10-020 absolute gravimeter in EURAMET Regional Absolute Gravimeter Comparison in the Wettzell Observatory, Germany (***link to the international gravity reference level from ICAG2017 in Wuhan, China***)

- ~15 absolute gravimeters from Europe participated

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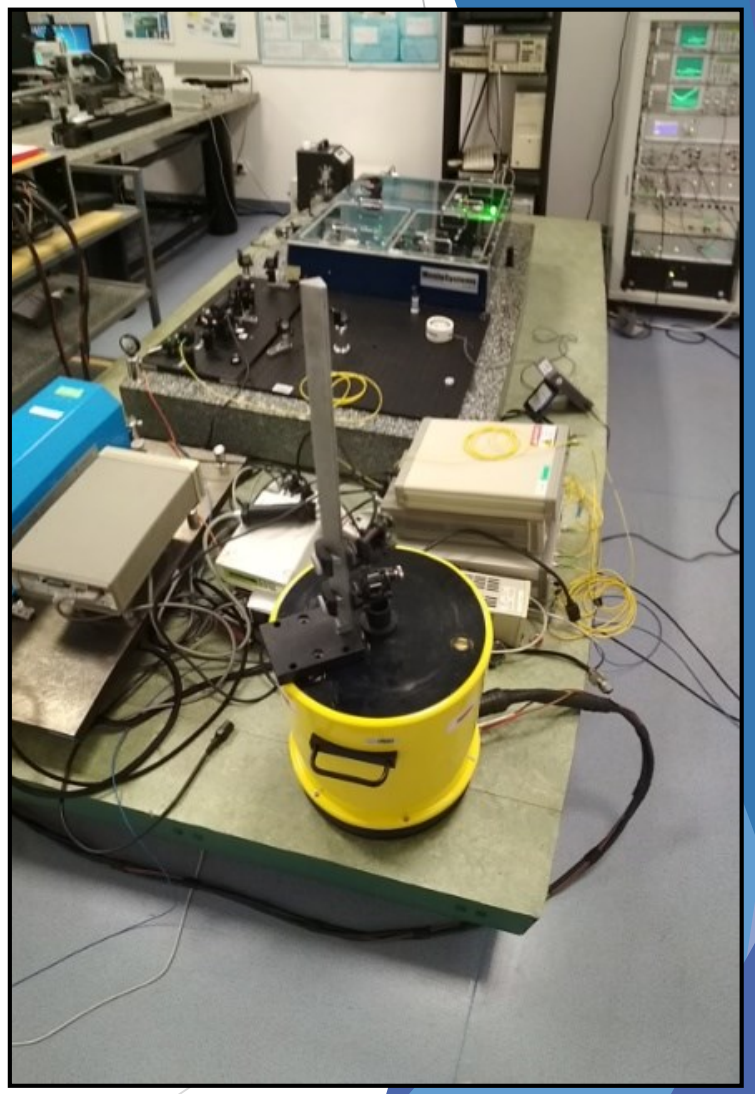
Activities in 2018/2019

2018.06.07-15 – laser, rubidium clock and barometer calibration of the A10-020 absolute gravimeter in the Polish Central Office of Measures

2018.10.17-19 – Calibration of LaCoste&Romberg gravimeters (*G1012 and G1036 used in Ireland*) on three spans of the Central Gravimetric Calibration Baseline in Poland



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Activities in 2018/2019

2018.09.03-20 – First gravity survey trip to Ireland (*absolute gravity – A10-020 gravimeter*)

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Activities in 2018/2019

2018.09.03-20 – First gravity survey trip to Ireland (*vertical gravity gradient*)

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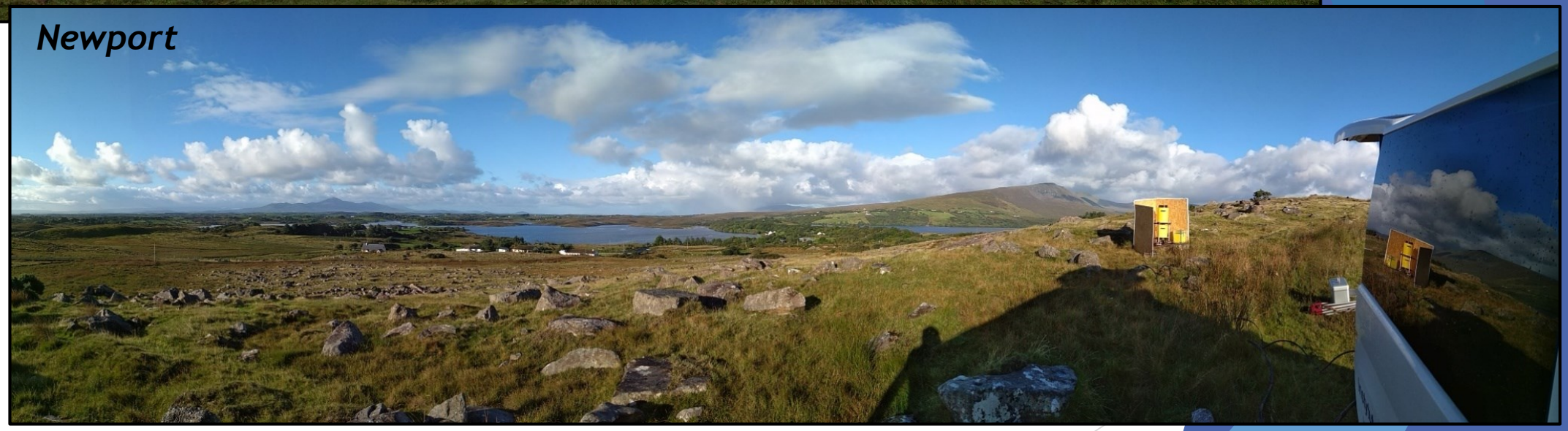
Activities in 2018/2019



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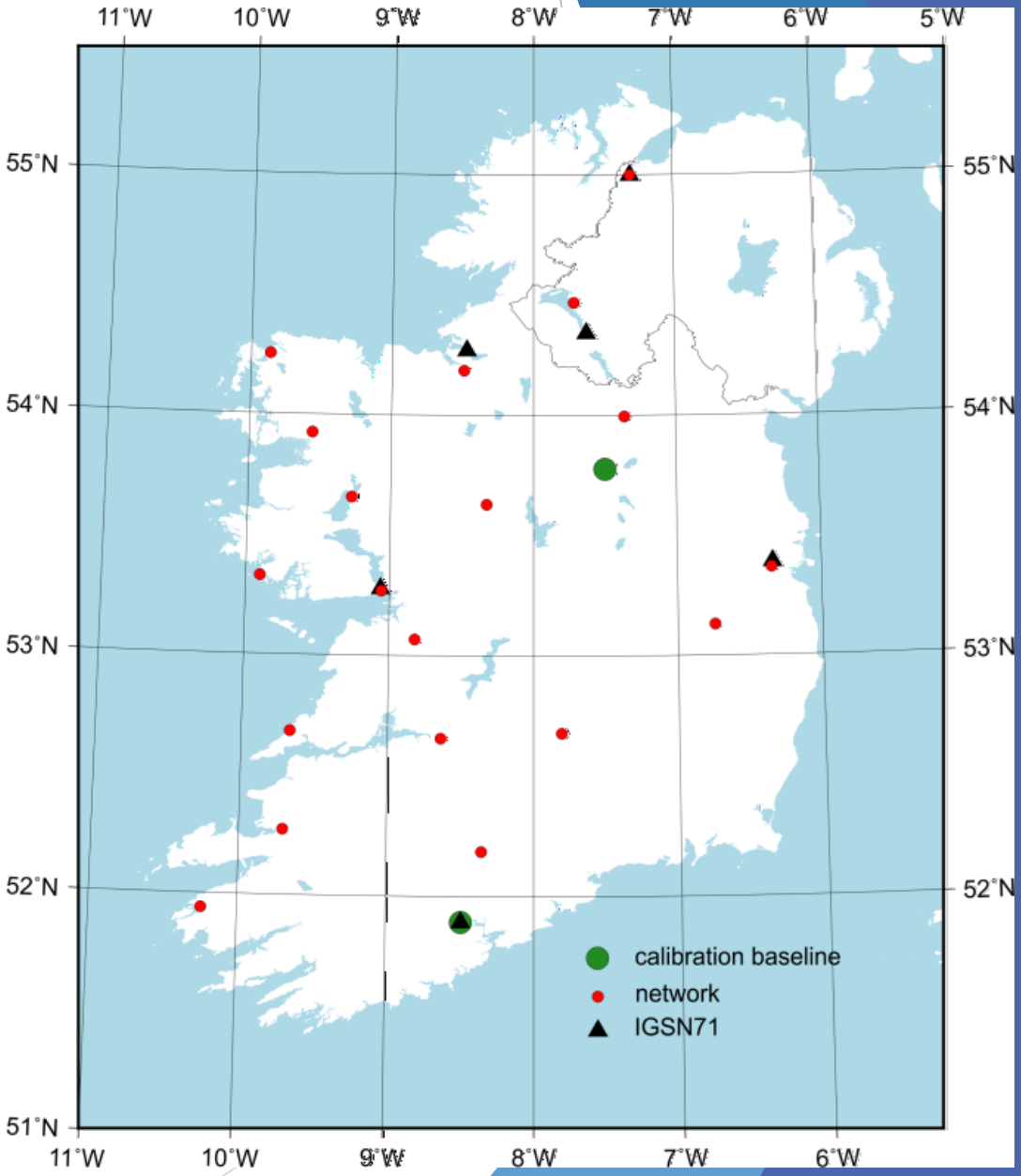
Activities in 2018/2019

2018.09.03-20 – First gravity survey trip to Ireland

- In total 27 stations *(~40% of planned survey work*)
  - 6 IGSN71 stations
  - 22 stations with **absolute gravity (*A10-020*)**
  - 23 stations with **vertical gravity gradient (*LCR gravimeters*)**



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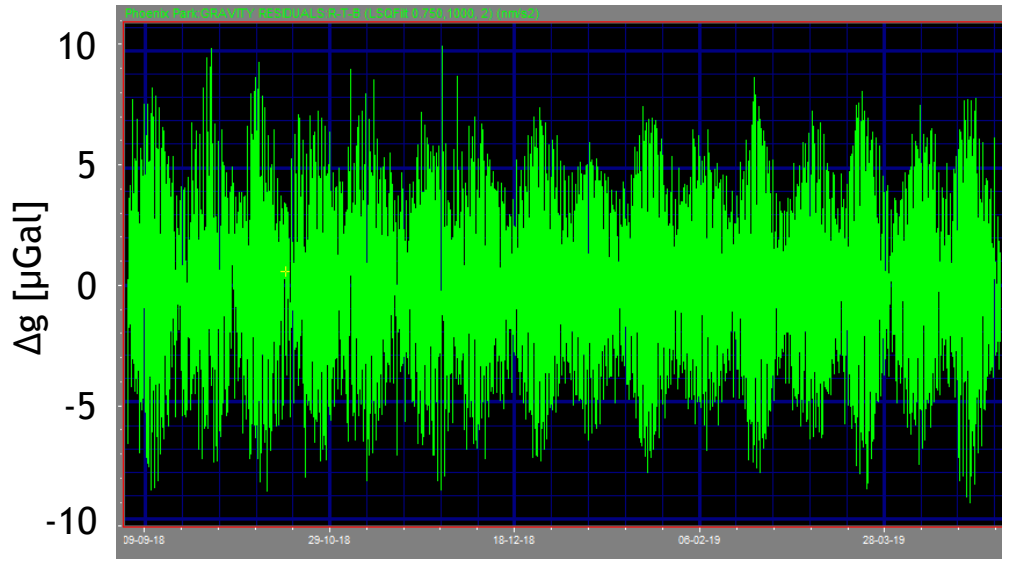
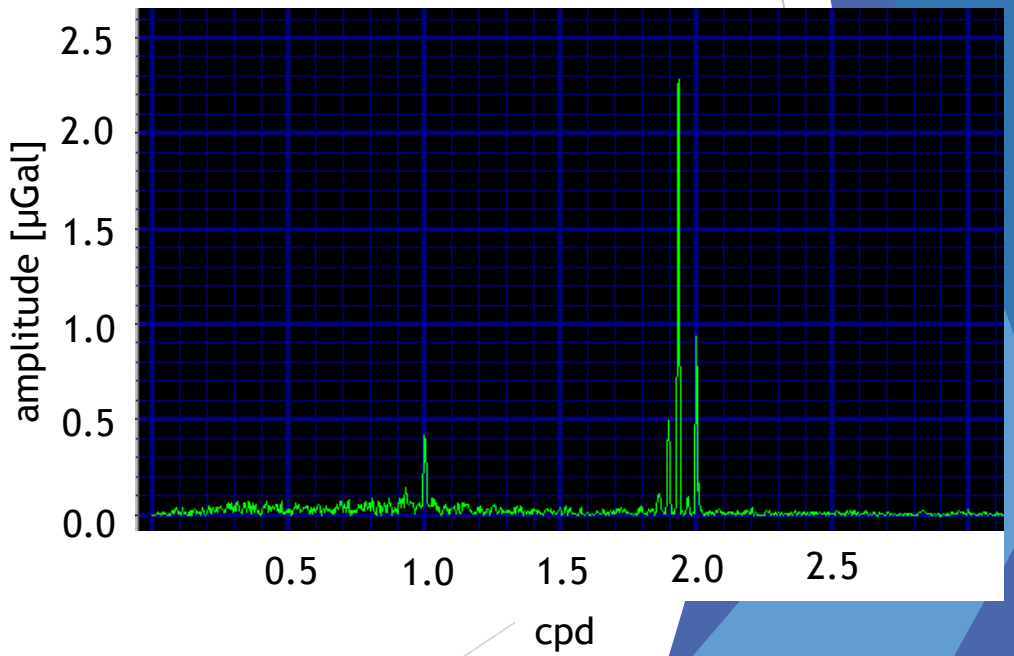
Activities in 2018/2019

2018.09.03 – Tidal record setup at OSi headquaters (*Phoneix Park, Dublin*)

- LaCoste&Romberg model G-1084 (*LRFB-300 feedback*)
- Sampling rate: ~2Hz, data completnes till now: 100% (*252 days*)
- Ocean Tidal Loading within ± 10 µGal with clear discrepancies of 2-4 µGal (*FES04 and FES14*)





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Plans 2019/2020

2019.03-05. – **A10-020 gravimeter service at Micro-g LaCoste Inc. (USA)**

2019.06-07. – A10-020 gravimeter calibration at the Central Office of Measures (Poland)

2019.08-09. – second absolute gravity/vertical gravity gradient campaign in Ireland

2019.10-11. – LaCoste&Romberg gravimeter calibration (Poland)

2020.04-05. – third absolute gravity/vertical gravity gradient campaign in Ireland

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