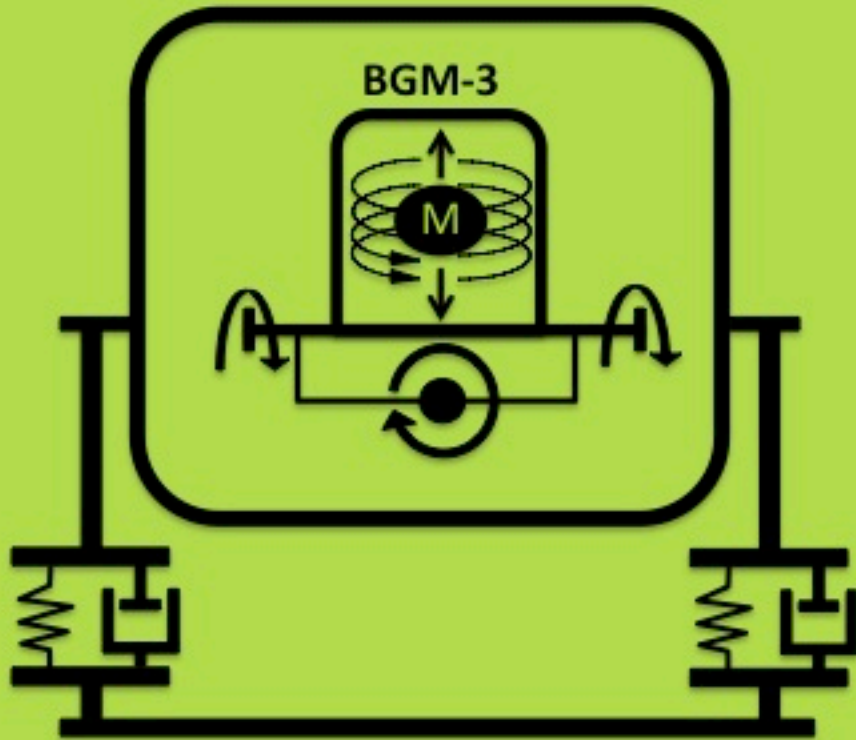


POTENTIAL FIELDS POOL EQUIPMENT

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James Kinsey
Woods Hole Oceanographic Institution
2014 InMarTec Meeting

What is PFPE?

- Potential Fields Pool Equipment (PFPE) supports the US research fleet in obtaining gravity and magnetic data.
- Provide:
 - Equipment
 - Technical Support
- While founded to support UNOLS vessels, we now support gravimetry work throughout NSF.



Infrastructure Prior to PFPE

- Prior to 2007, only 4 gravimeters were permanently installed on US research vessels
 - BGM-3 gravimeters on the *Conrad/Ewing/Langseth* and the *Melville*
 - LaCoste and Romberg gravimeters on the *Kilo Moana* and *Palmer*
- Agreement with the Naval Oceanographic Office (NavO) provided access to their gravimeters.
- NavO terminated their gravimeter program in 2007 forcing US scientists to find a new solution.



Installing a NavO BGM-3 in Alvin in 1999.

2007 Fugro Acquisition

- In 2007, Fugro offered to sell used BGM-3 gravimeters and spare parts to the UNOLS community
- WHOI, SIO, and UAF successfully submitted a proposal to acquire this equipment (NSF-OCE-0705964)
- This equipment was refurbished and delivered to UNOLS by Randy Herr

Acquired equipment included:

- 7 working gravimeters
- 4 gyros
- 8 horizontal accelerometers
- Over 20 power supplies
- Over 20 boards



BGM-3 testing in Randy Herr's "Lab"

7 Years, 8 Gravimeters, and 9 Ships Later

Prior to PFPE:

- *Conrad/Ewing/Langseth*
- *Melville*

2008

- *Knorr*
- *Revelle*
- *Healy*

2011

- *Thompson*

2012

- *Kilo Moana*

2014

- *Palmer*
- *Sikuliaq*



PFPE – Motivation

- The acquisition of these gravimeters resolved the problem of *providing* gravimeters to the UNOLS fleet.
- It did not provide for the ***long-term financial and technical support of this instrumentation.***
- In June 2009, the Potential Fields Pool Equipment facility was formed at WHOI.
- A 2009 NSF award for \$239k provided initial support equipment to PFPE.
- A 2010 award provided PFPE with a 5 year operating budget to support gravimetry on UNOLS vessels.
 - In 2014, PFPE expanded to include USAP and receive support form Polar Programs.

PFPE – Goals

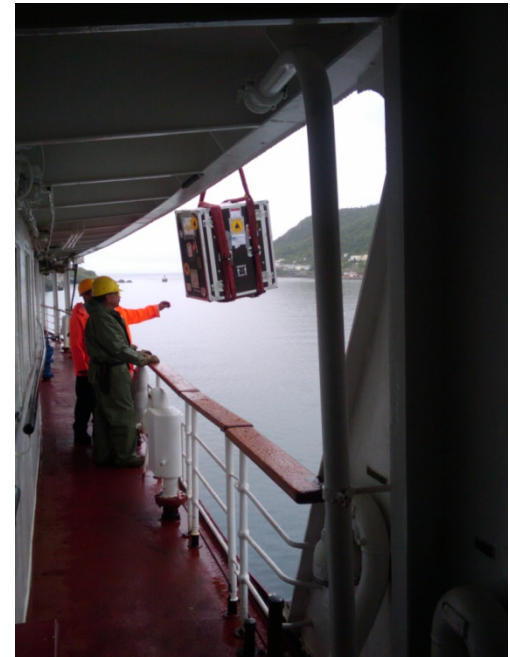
- PFPE provides the community with:
 - A supply of spares for maintaining the at-sea BGM-3s
 - Repair or refurbish sensors as necessary
 - Technical Support including on-shore support for the at-sea gravimeters and helping establish best practices.
 - Pool equipment
- PFPE does **NOT** post-process or archive marine gravity data
 - Such efforts are better suited toward other researchers or community initiatives – i.e., R2R.

Pool Gravimeters

- Pool gravimeters available for use on ships of opportunity.
- Have been used in the Red Sea, Guaymas Basin, Galapagos Spreading Center, the Arctic, Central Pacific, and Puget Sound.



Left, 2008 Oceanus install for the Red Sea cruise. Right, 2010 install on the CCGS Louis S. St Laurent for Law of the Sea work in the Arctic.



PFPE – Additional Resources

- Also available for community use :
 - A SeaSPY towed marine magnetometer
 - Land Gravimeters



PFPE: Technical Support

- Provide full sparing for at-sea units
 - Gyro refurbishments with long-life bearings
- In-house repair capability
 - As necessary developing replacement parts
 - Repairing sensors as necessary
- Beginning development of next generation data buffers
- 24/7 technical support
- Annual service visits
- Emergency visits when required
- The leading (and likely the only) center of expertise for BGM-3 gravimeters

Software

- Developing software to provide:
 - Ship-to-shore gravity ties
 - In port tests
 - Near realtime data visualization
 - Logging of repairs and other tasks
- Working with R2R to
 - Ensure critical meta-data is injected into their pipeline
 - Log maintenance info into electronic logs.



Software

The screenshot displays the GravGui software interface, which is used for data collection and processing. The interface is divided into several sections:

- Status Lights:** A row of seven circular indicators at the top, labeled RGS, FGS, GPS, DNV, DEP, HDG, and LINK. These are highlighted with a red oval and labeled "Data and gravimeter status lights".
- Control Panel:** On the left side, there are buttons for "Lock/Unlock", a "Gaussian" filter dropdown, a "Samples" input field (set to 181), a "Set" button, "Used samples" (181), "Port mode", and "Sea mode". These are circled in red and labeled "Filter settings".
- Main Plots:** Two large line graphs in the center. The top graph plots "Depth [m]" (red line) and "Gravity [mgal]" (green line) against time. The bottom graph plots "Heading [deg]" (black line) and "Speed [knots]" (blue line) against time. These are circled in red and labeled "Real time plots".
- Raw Sensor Data:** A vertical list on the right side of the main plots displays various sensor readings, including "Raw counts", "Fill counts", "Raw gravity", "Reduced gravity", "Latitude", "Longitude", "Depth", "Heading", "DNV status", "NO_DNV_ERROR", "Sensor", "Scale factor", and "Bias". This list is circled in red and labeled "Raw sensor data".
- Gravity Tie Interface:** A separate window on the right side, titled "GravGui", contains a form for recording data. It includes fields for "Ship:", "Personnel:", "Port/Pier/Berth:", "Gravity station number:", "Station name:", and "mGal at pier:" (set to 980624.2). It features buttons for "Start recording", "COMPLETE!", "Plot", "Generate report", and "Compute bias". This window is circled in red and labeled "Gravity tie interface".
- Calibration Tools:** At the bottom of the main interface, there are two buttons labeled "Gravity tie" and "In-port test", which are circled in red and labeled "Calibration tools".

2014 Activities

- Permanent installations on *Palmer* (in Australia) and *Sikuliaq*
- Temporary installation on *Falkor* (foreign vessel)
- Gravity tie only software running on *Knorr*, *Melville*, and *Palmer*.
- Newer software with in-port tests running on *Sikuliaq*
- Finalizing metadata formats for ingestion into R2R.
- Close to finalizing deal with NGA.



Installs in Tasmania, Honolulu, and Woods Hole.



2015 – Anticipated Activities

- Will distribute new software to all ships during service visits in 2015.
- Plan to release best practices manual in Feb 2015.
- Removing gravimeters from the *Melville* and *Knorr* in anticipation of installation on the *Ride* and *Armstrong* in 2015.
- Renewal proposal will be submitted in August 2015
- In anticipation of the renewal proposal:
 - Feedback from operators on what works (and what doesn't work) is crucial.
 - PFPE tracks many of the science outcomes but doesn't have the whole picture.
 - Information from the operators on who is using gravity data is always appreciated.

More Information

- Information on the pool gravimeters is located on the MISO website (Google 'PFPE WHOI')

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MISO Facility

Multidisciplinary Instrumentation in Support of Oceanography

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TowCam

Marine BGM-3 Gravimeters

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Potential Fields Pool Equipment 'PFPE' - Ship BGM-3 Gravimeters

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Background


In late 2006, an opportunity arose to acquire used BGM-3 gravimeters and spare parts from a commercial survey company, Fugro-Robertson, Inc. It was envisioned that acquisition of these gravimeters would result in permanently installed meters on several UNOLS Class 1 vessels, and that several meters that could be staged and installed on other ships on an as-needed basis (e.g., "pool gravimeters"). In order to take advantage of this opportunity, a group of scientists at University of Alaska at Fairbanks (UAF), Scripps Institution of Oceanography (SIO), and Woods Hole Oceanographic Institution (WHOI) wrote an unsolicited NSF proposal with WHOI as the lead institution to acquire the Fugro gravimeters and spares. That proposal (NSF-OCE-0705964) was funded in 2007 and over the course of the next 2 years, 4 gravimeters were permanently installed on the USCGS Healy, R/V Knorr, and R/V Revelle. This increased the number of permanently deployed BGM-3 gravimeters from two (the systems on the R/V Melville and R/V Marcus Langseth) to six. Two additional gravimeters were designated as pool gravimeters and, since 2008, have been deployed on cruises to the Pacific, Red Sea, and the Arctic.

The acquisition of seven BGM-3 gravimeters in 2007 through the NSF grant significantly increased the number resolved the problem of providing gravimeters to the UNOLS fleet, however it did not provide for the long-term financial and technical support of this instrumentation. To address this need, WHOI initiated a discussion with the marine gravity community and UNOLS ship operators to establish a gravimeter pool to share equipment and technical expertise with the ultimate goal of ensuring that all of the deployed BGM-3 gravimeters are well maintained and supported so that they can obtain high-quality marine gravity data. The pooling of equipment was intended to facilitate the purchase spares and needed repairs to gravimeters throughout UNOLS, thereby reducing the financial costs and logistical burden to the



[Enlarge Image](#)

One of the PFPE BGM-3 gravimeters during initial testing and refurbishment carried out by Mr. Randy Herr.



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