2016 Airborne Gravimetry for Geodesy Summer School

National Geodetic Survey

ADVANTAGES OF FEEDBACK AND GPS GUIDANCE IN AN ADVANCED TECHNOLOGY AIRBORNE GRAVITY METER

Nigel Brady

DYNAMIC GRAVITY SYSTEMS BACKGROUND

- Dynamic gravity Systems (DgS) was founded in April 2013 by Daniel Aliod (Electrical Engineer) and Nigel Brady (Geophysicist) with a combined experience of over 50 years in the gravity business.
- Build new airborne, marine and land gravity systems as well as service, repair and upgrade zero length, metal spring based gravity meters (LaCoste & Romberg, Micro-g, ZLS and DgS).
- We have delivered or are currently building 5 new and 3 upgraded dynamic gravity systems

WHY AIRBORNE GRAVITY?

Advantages

- Cover very wide area cost effectively
- Consistent coverage (line spacing and altitude)
- Access to rough or restricted terrain and coastlines
- Data and hardware typically has rapid access to processing and maintenance personnel after every flight

Disadvantages

- High cost of equipment and personnel vs land survey
- Logistics and reliability in remote locations
- Weather, aircraft and pilot delays
- Hardware is exposed to a very high acceleration environment
- Lower resolution

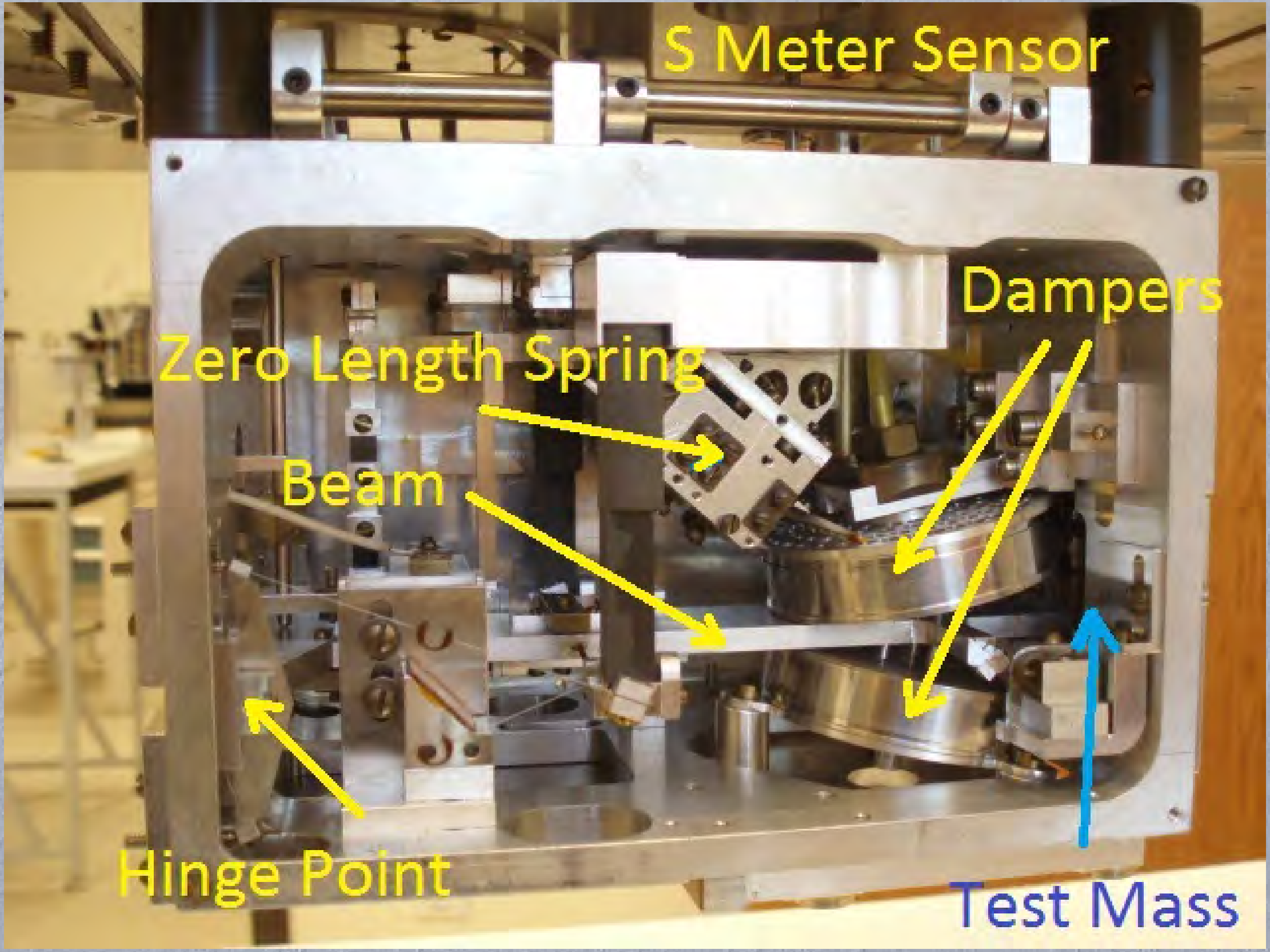
WHY AIRBORNE GRAVITY?

- Sensitive enough for oil, gas, mineral and water exploration
- Detection and mapping of faults and other structural geology
- Continental shelf mapping
- Ice shelf mapping in Antarctica and Greenland
- Geoid mapping
- Volcanic hazard monitoring

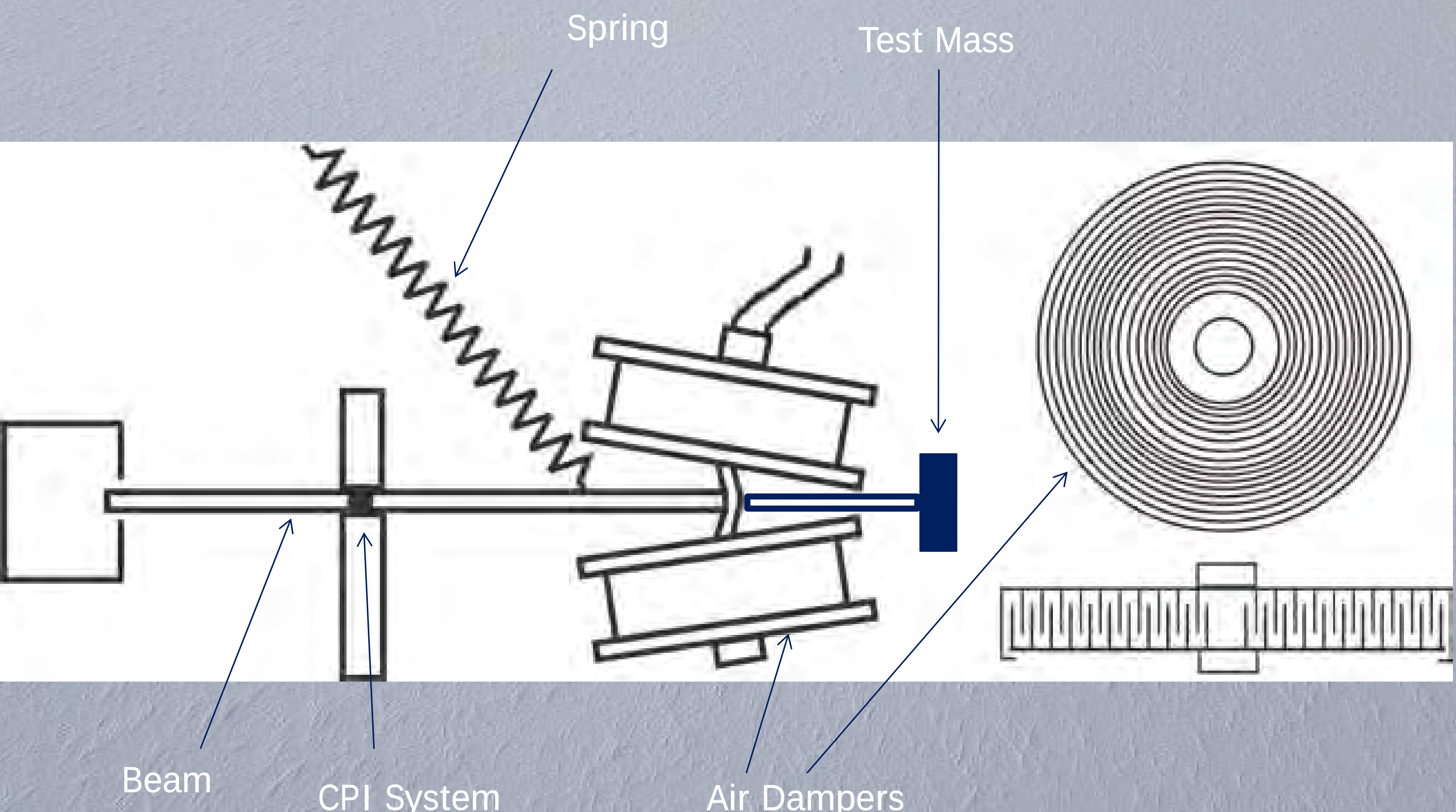
THE ADVANCED TECHNOLOGY AIRBORNE GRAVITY SYSTEM

- Reliability and Sensitivity of the metal spring gravity sensor.
- Full-feedback, magnetically damped system with worldwide range provides faster response and much lower sensor errors.
- Higher accuracy and repeatability is maintained during turbulent flight conditions (No cross coupling).
- No spring tension motor, gearbox or measuring screw required (no mechanical moving parts aside from the clamp).
- Completely redesigned electronics and data acquisition system integrated with the sensor and temperature controlled.
- Data acquisition rate of 10 Hz for airborne system.
- GPS timing synchronization for data collection and GPS aided platform control for airborne system.
- Easy system setup and operation.
- Price

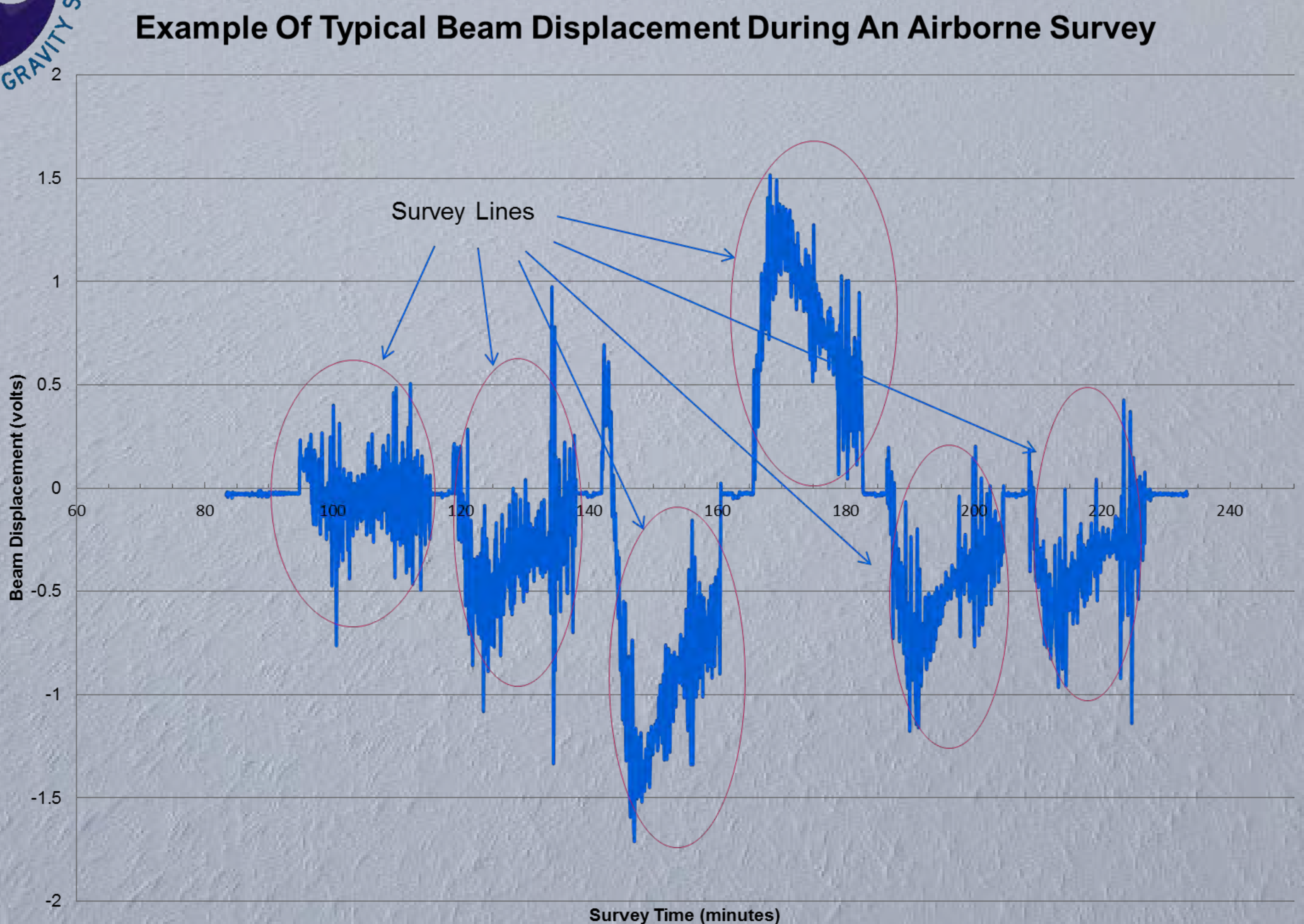
A LITTLE HISTORY…
THE LACOSTE & ROMBERG AIR DAMPED SENSOR



AIR SEA II SENSOR SCHEMATIC



THE LACOSTE & ROMBERG SENSOR



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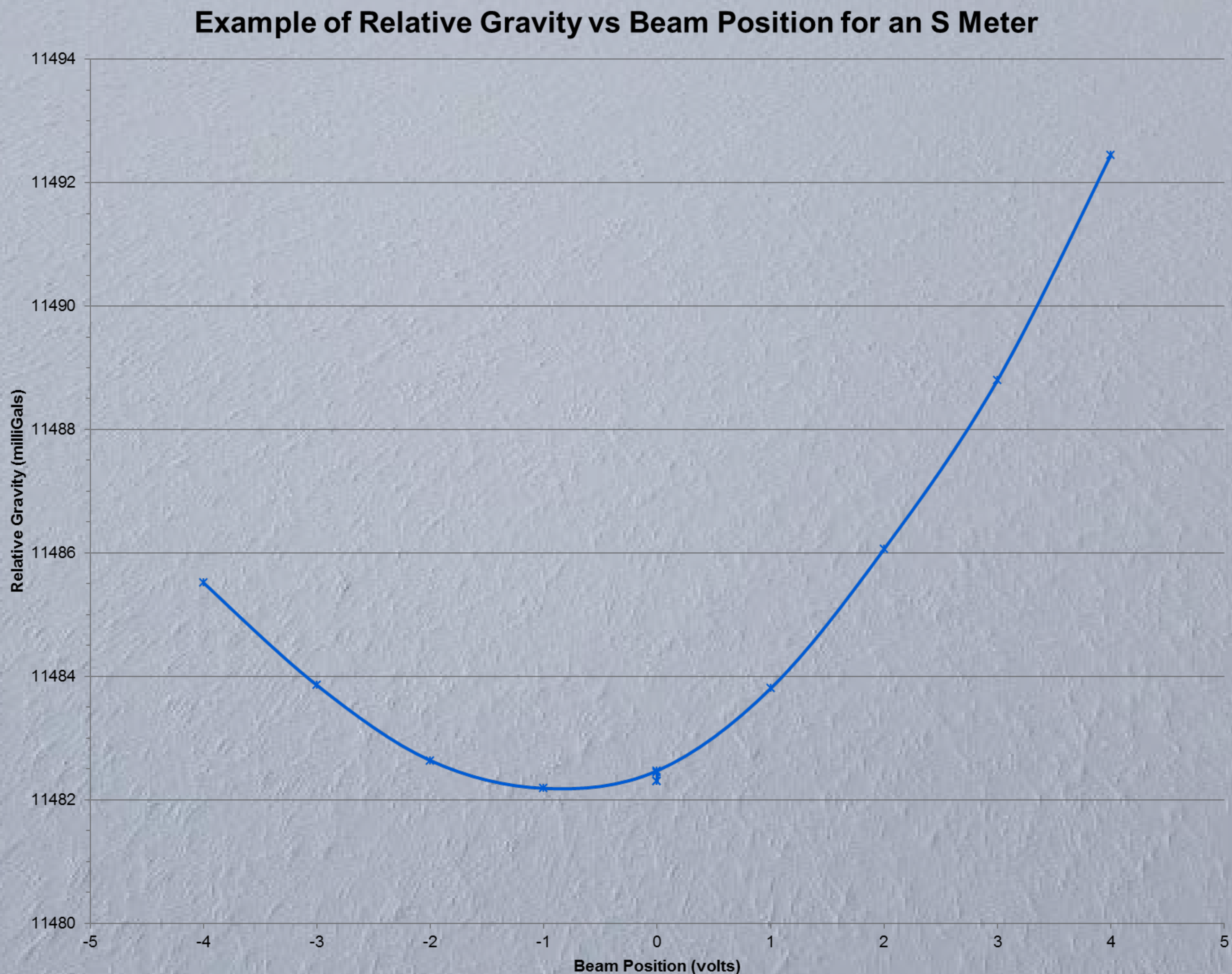

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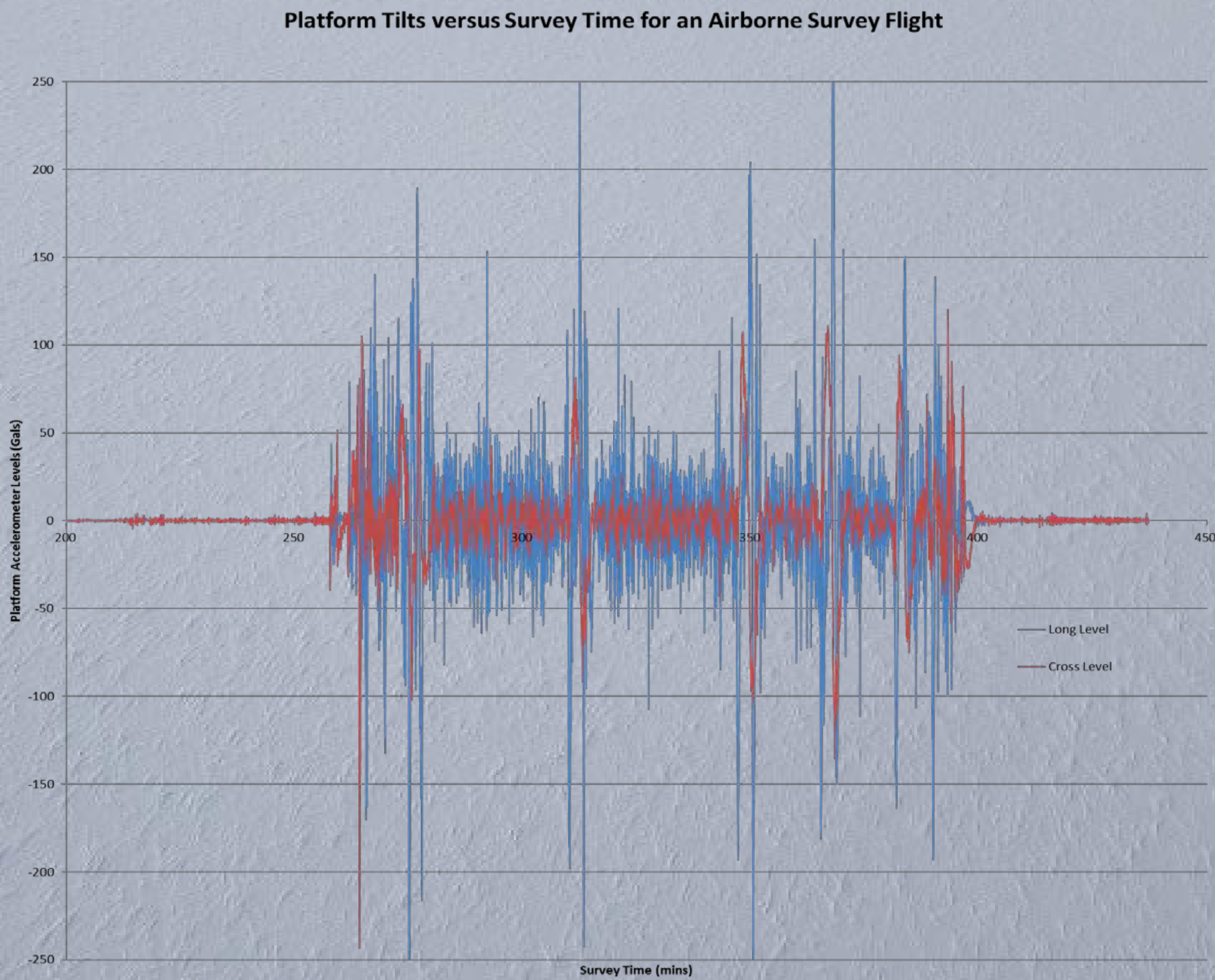

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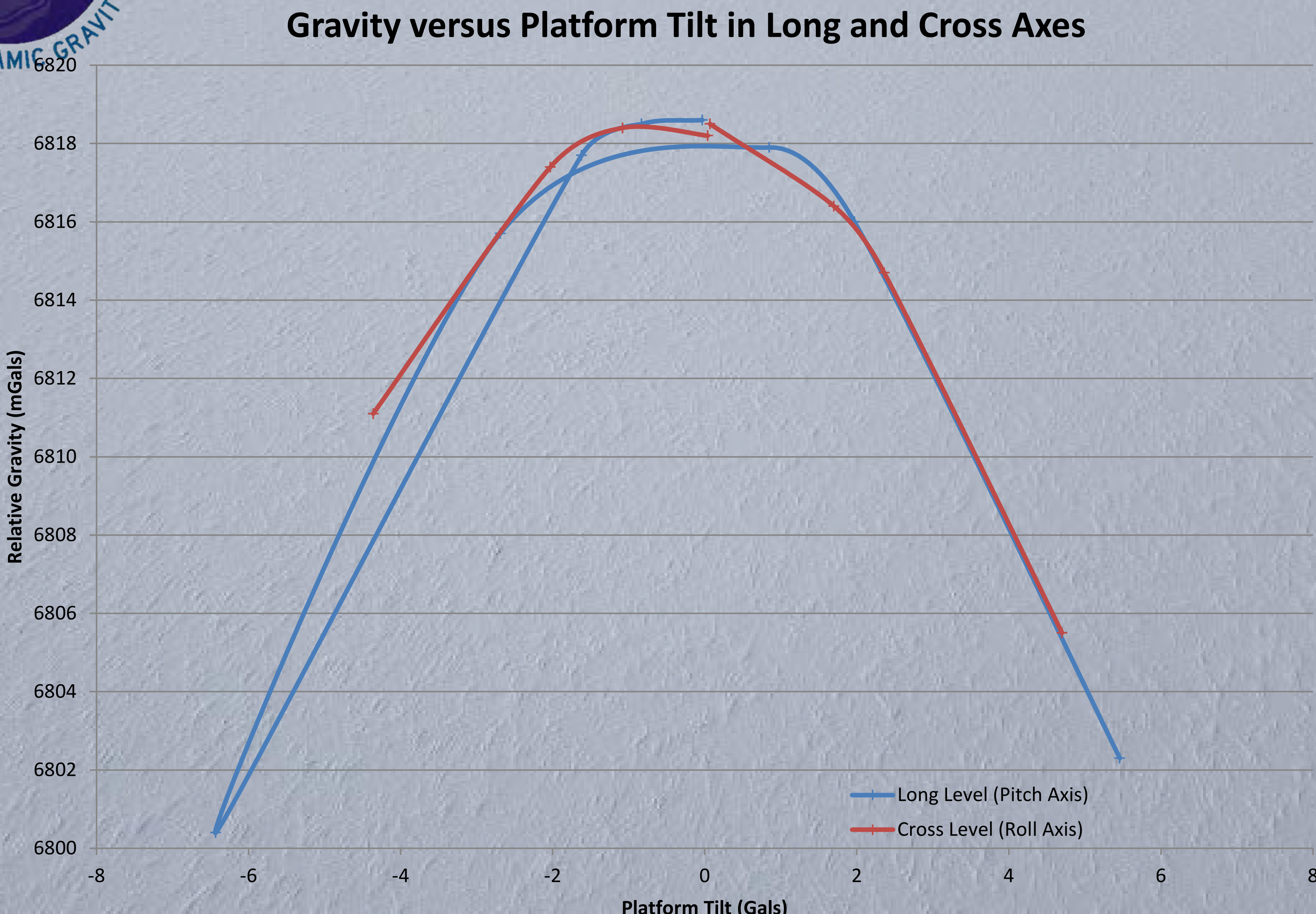

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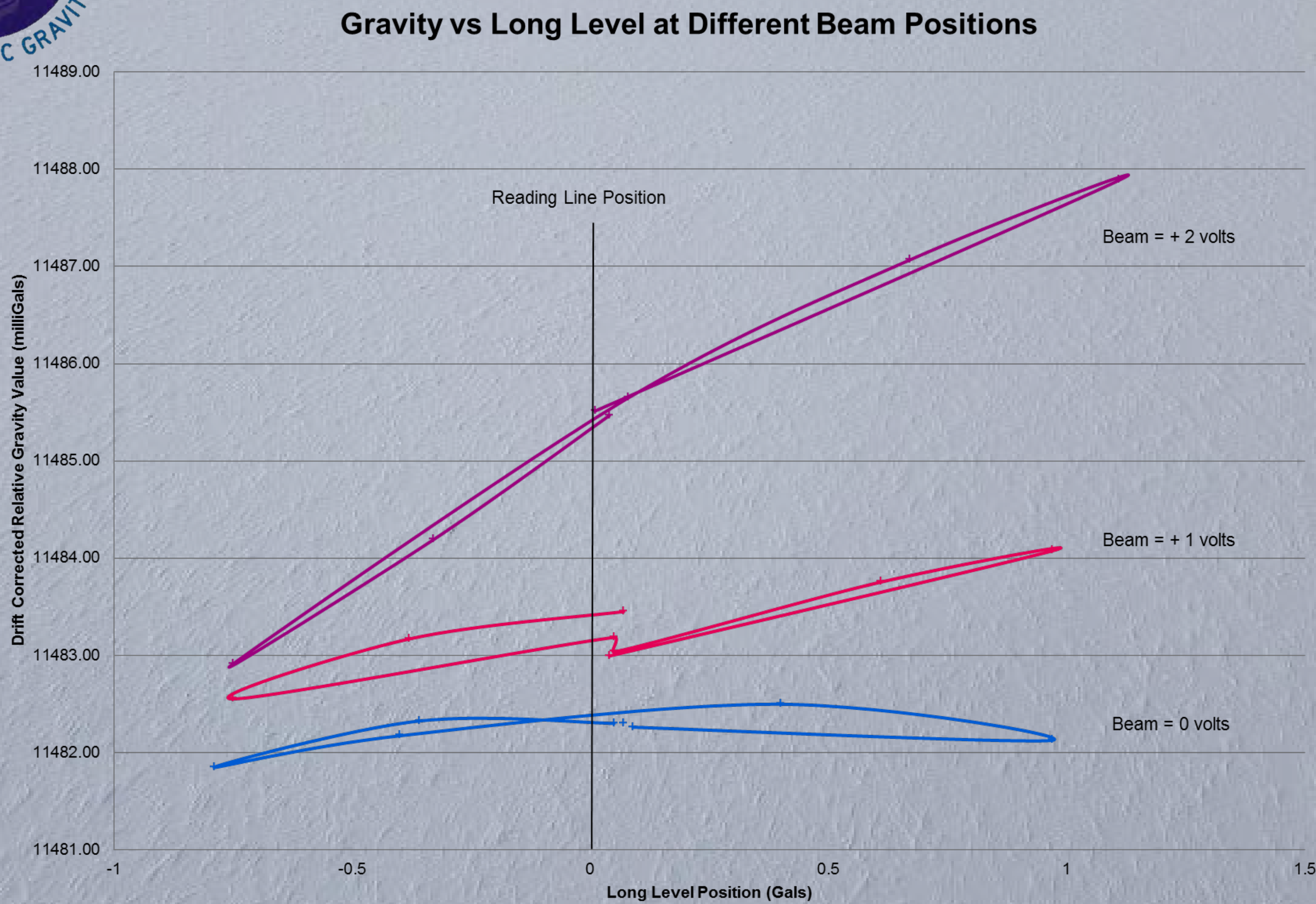

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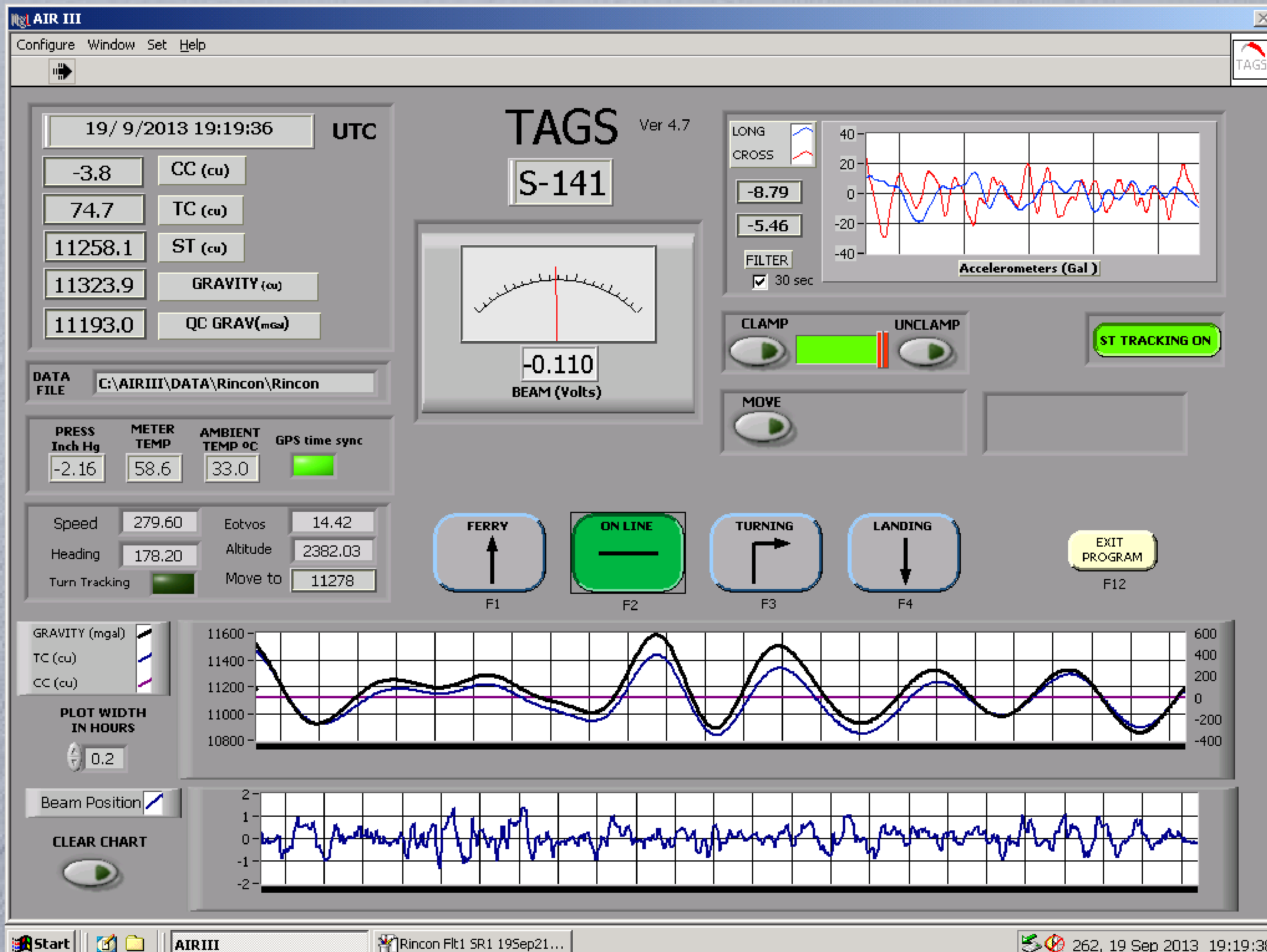
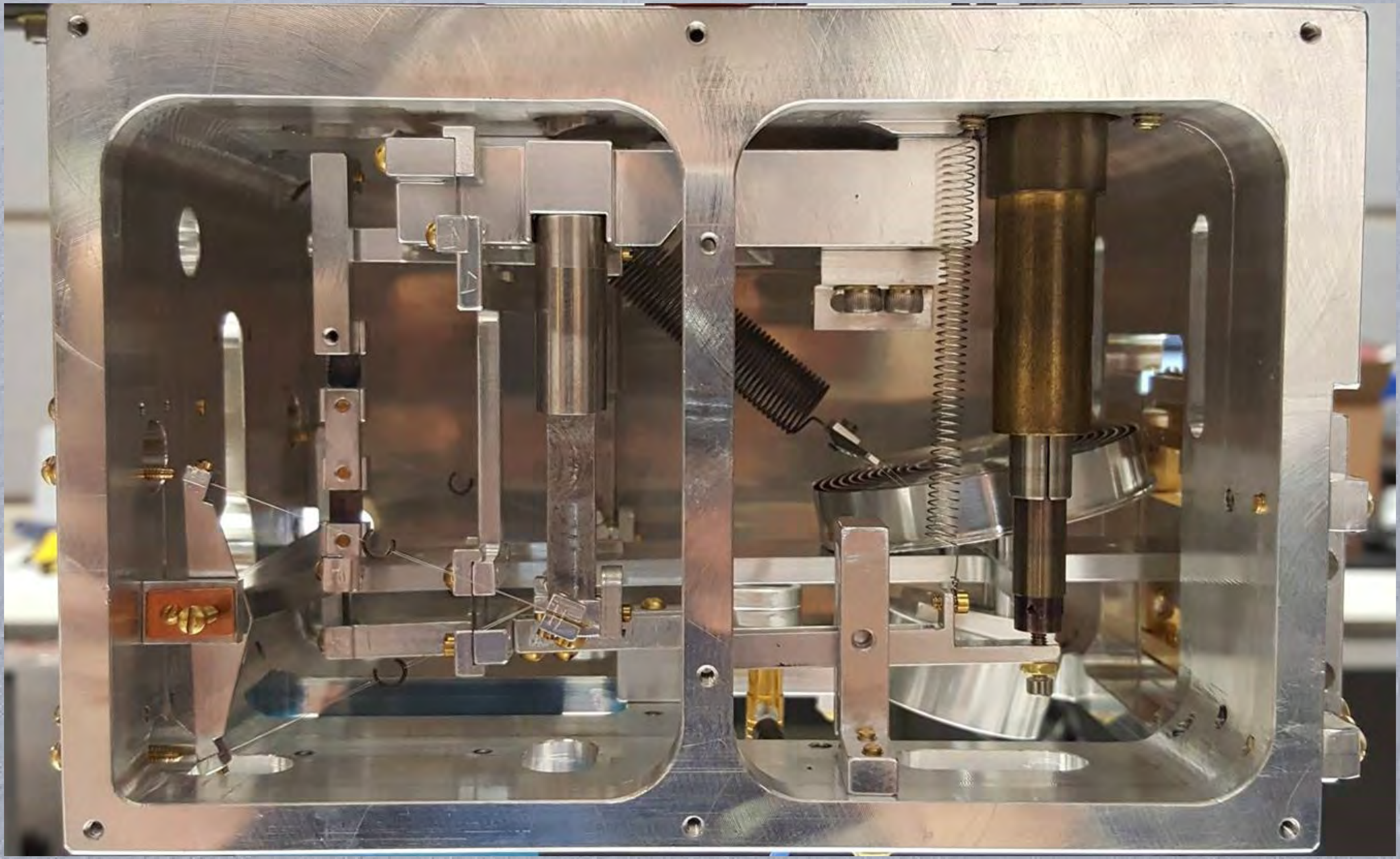


dynamicgravitysystems.com

DGS FULL FEEDBACK SYSTEM



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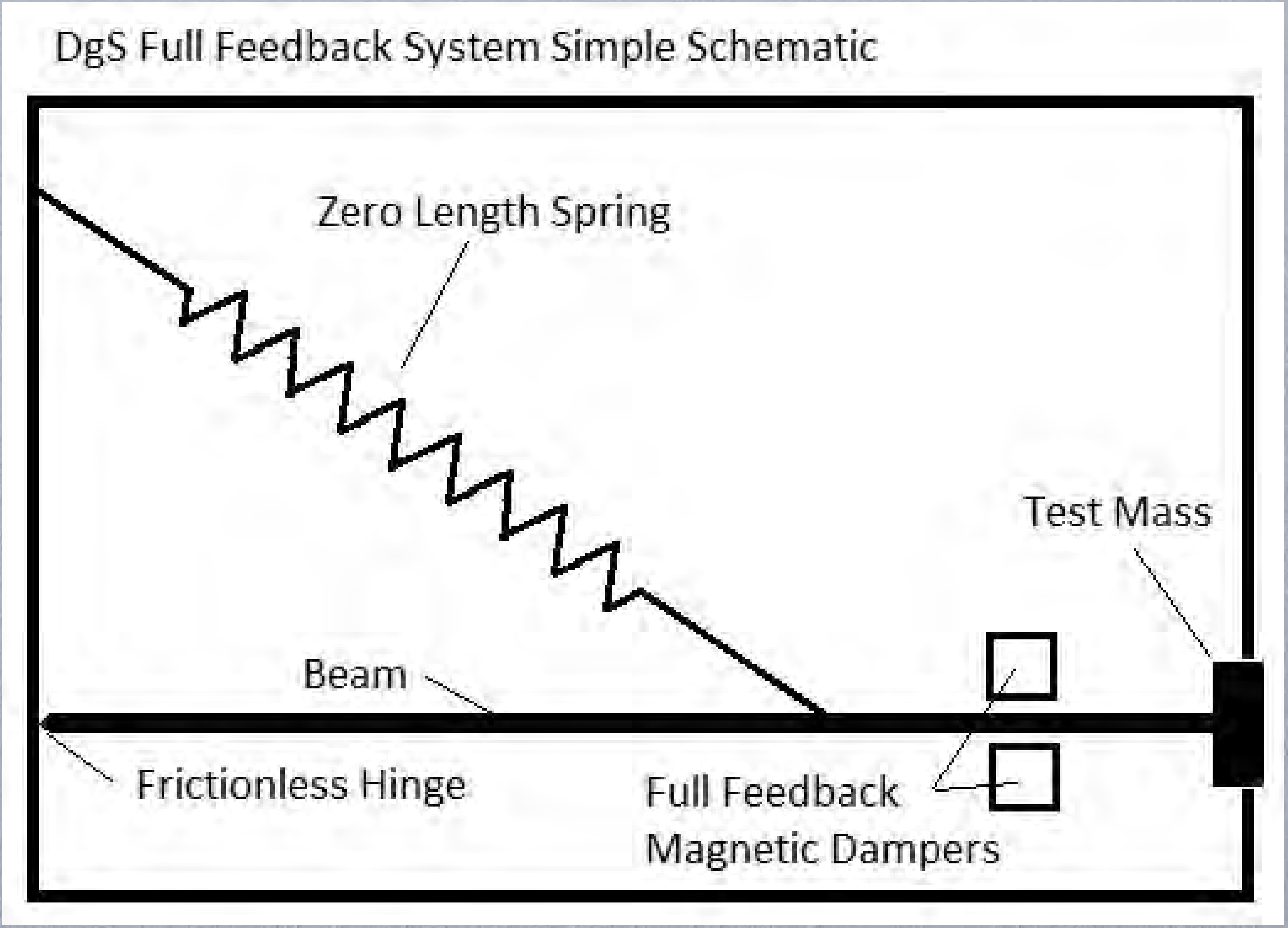

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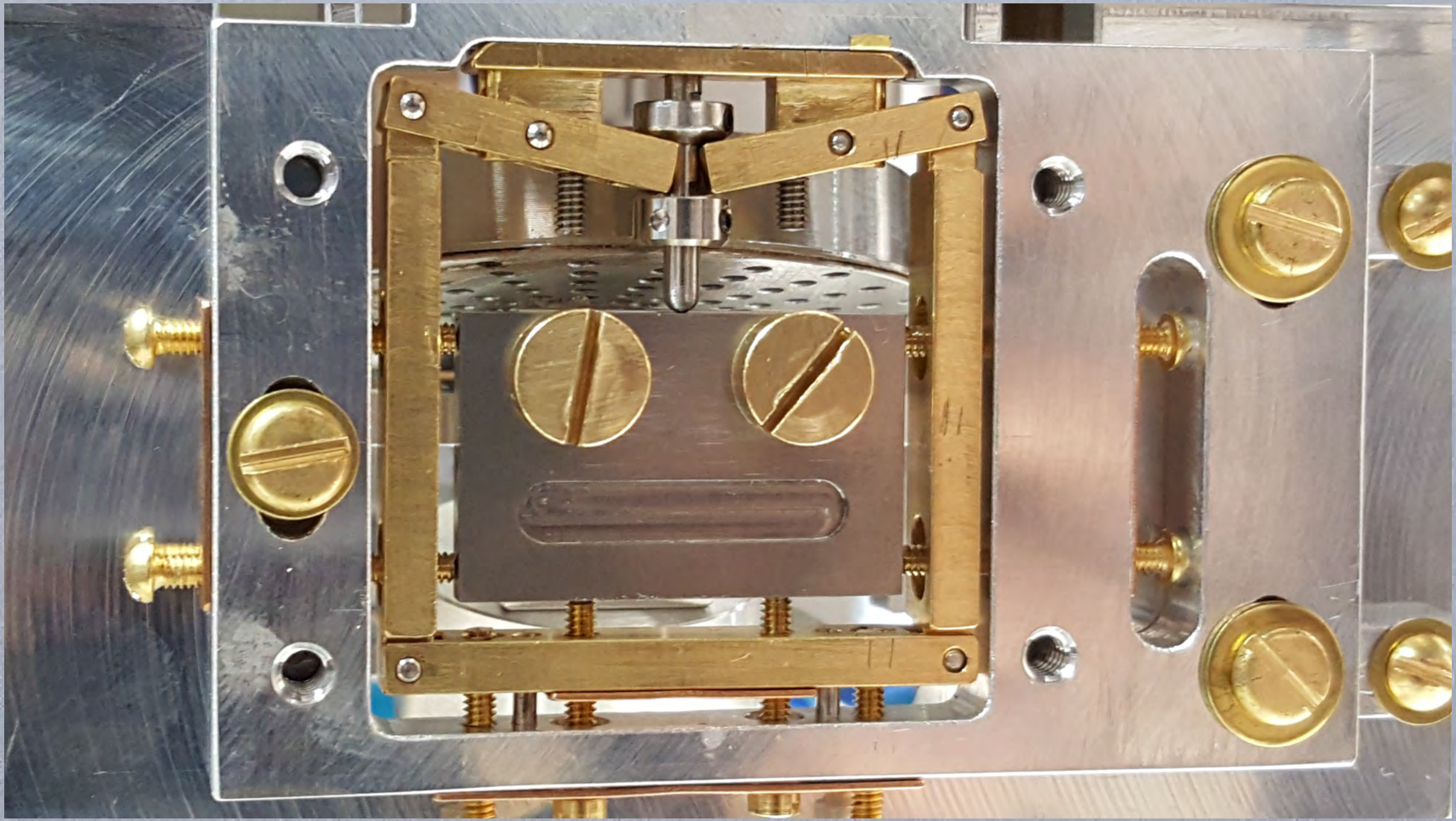

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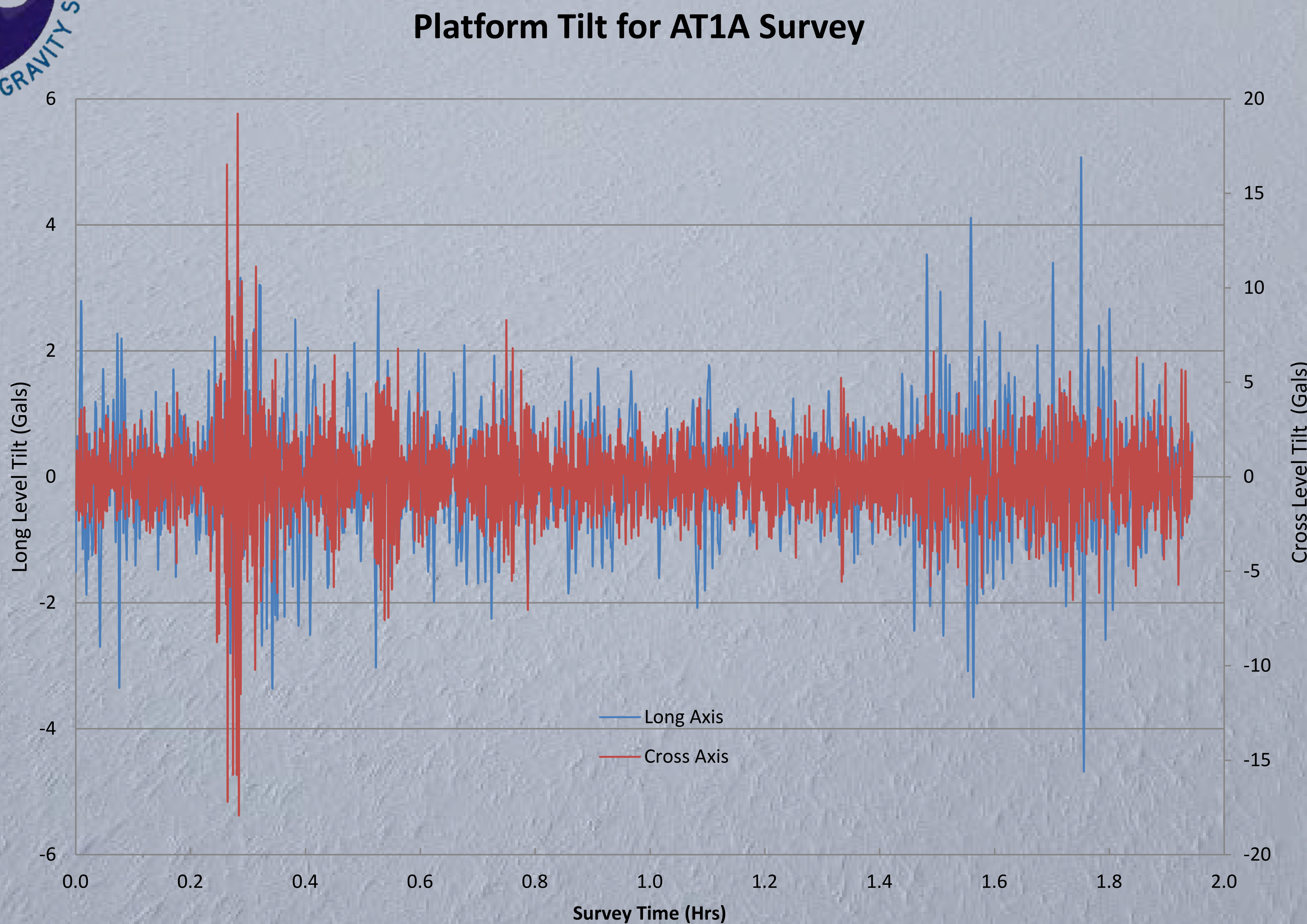
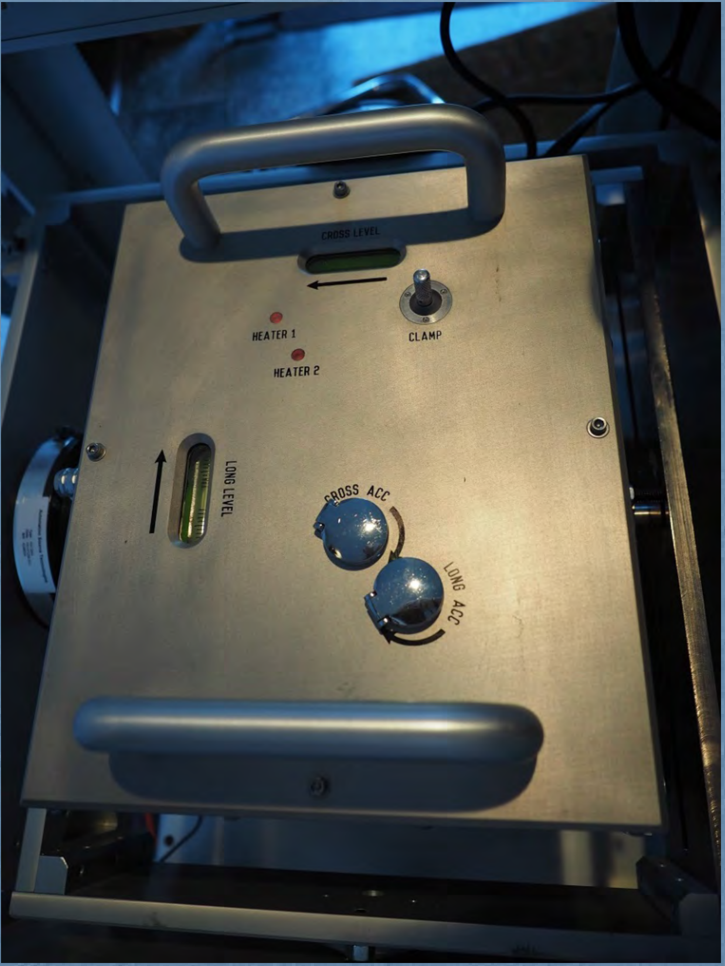


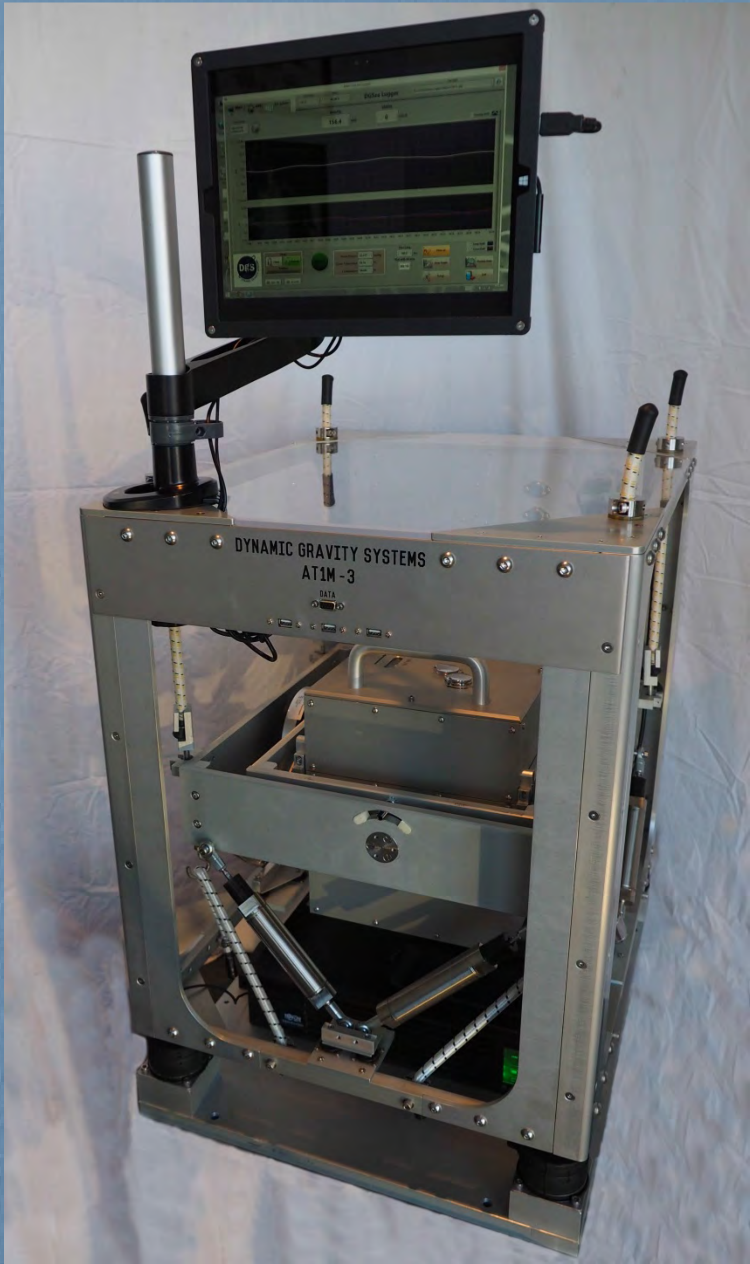
DGS FULL FEEDBACK SENSOR

ADVANTAGES OF THE FULL FEEDBACK SYSTEM

- Beam is locked at the reading line (0 volts) by the feedback electronics
- Effectively reduces cross coupling errors and corrections to zero for virtually all motions
- Eliminates errors caused by non linearity of the beam position when it is non zero
- Eliminates errors caused by imperfections in the counter screw
- Reduces significant errors caused by the combination of platform off level and beam non zero
- Data retains high sensitivity of the zero length spring and is much more repeatable and consistent
- Maintains data quality much better in turbulence and during course deviations

THE DYNAMIC GRAVITY SYSTEM





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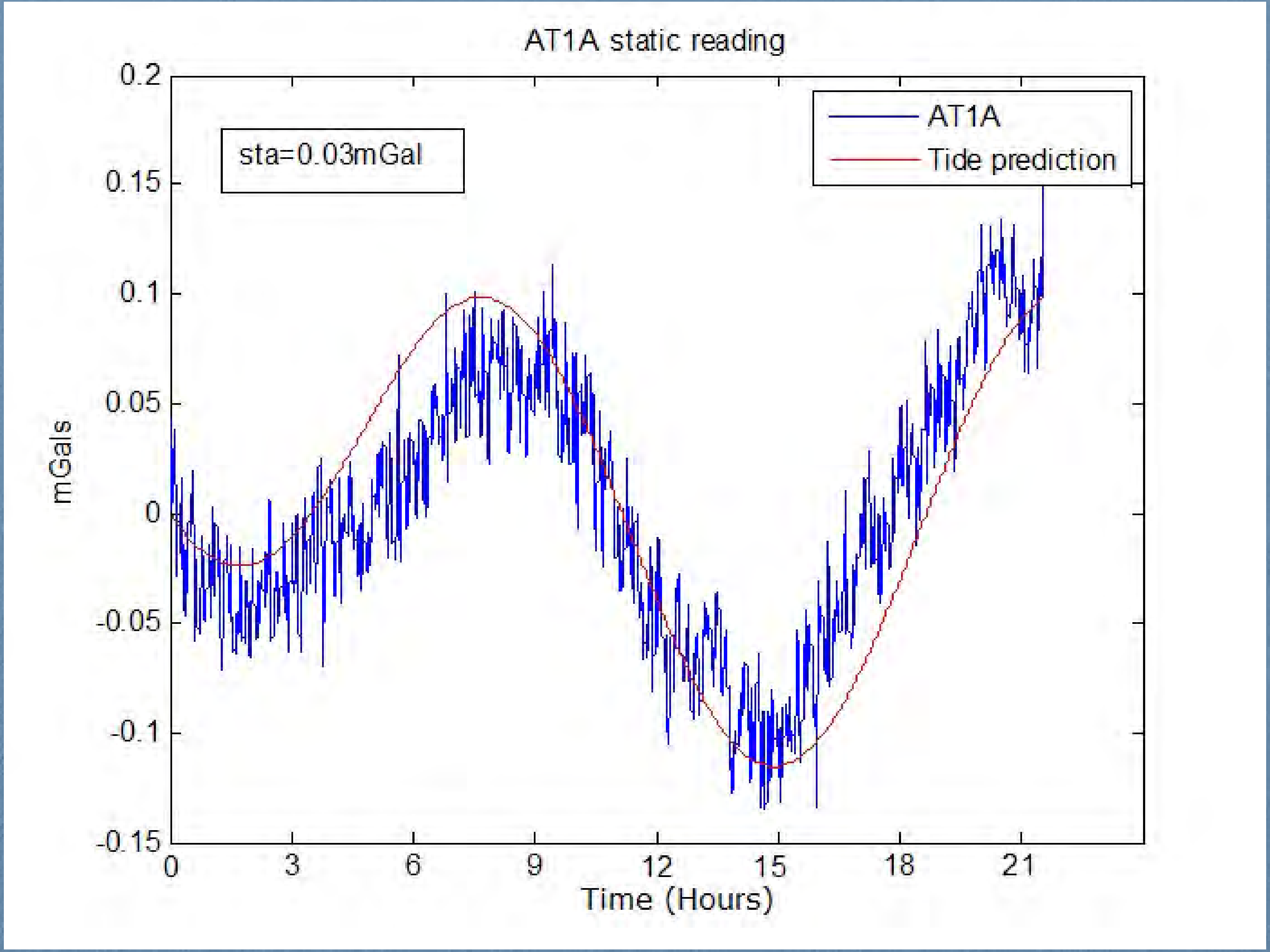

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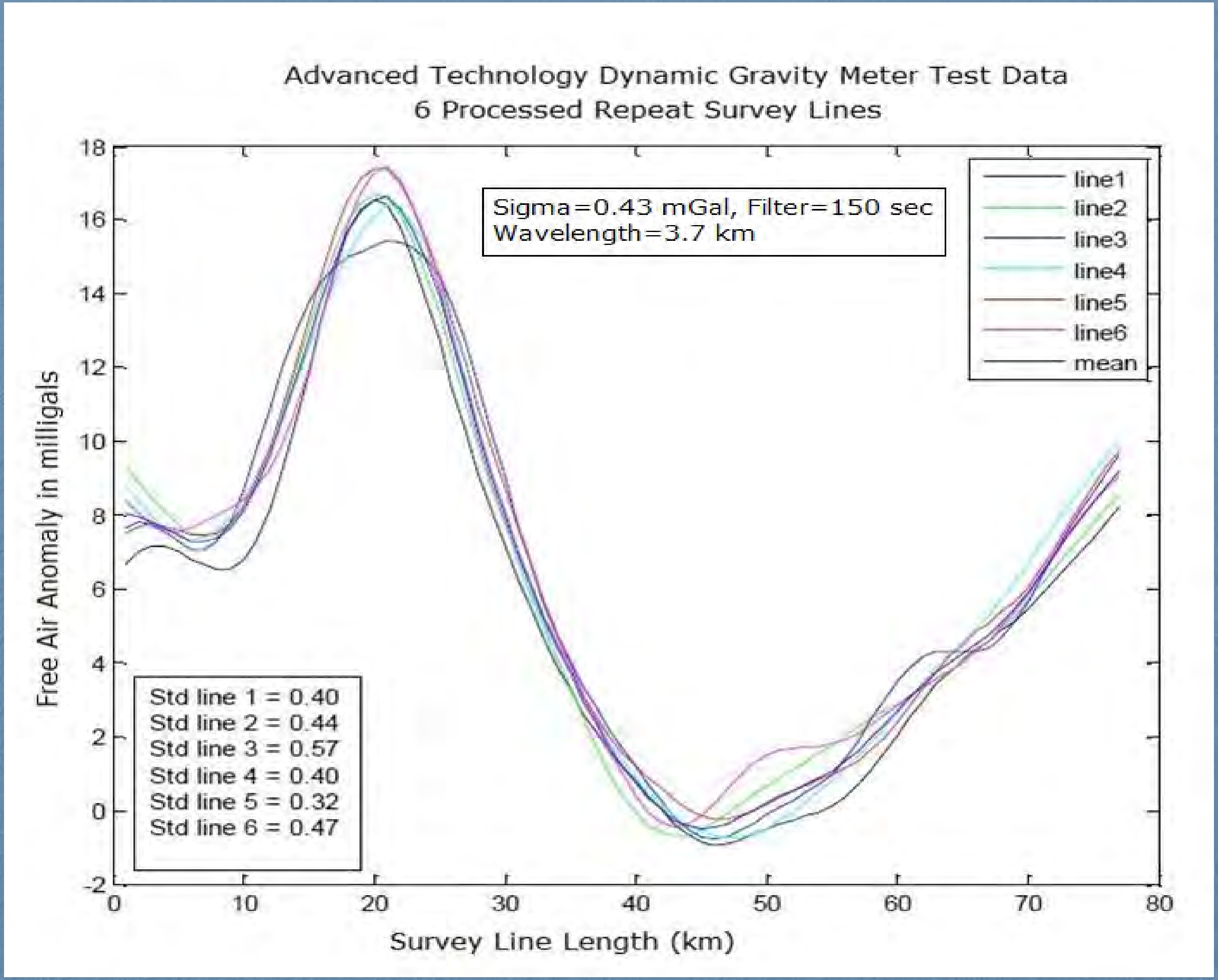

ROSETTA - ANTARCTIC AIRBORNE GRAVITY PROJECT

Objective:

Obtain baseline measurements of the Ross Ice Shelf

- Gravity and magnetic data to determine water depth and ocean floor topography beneath the shelf
- Radar, LIDAR and imaging systems to map ice thickness and fine structure (ICEPOD)

Project:

- 36 flights using an LC-130 aircraft operating from McMurdo Station
- Ross Ice Shelf = 487,000 km² x 350 m thick on average

Science Team:

- Lamont Doherty Earth Observatory (LDEO), Columbia University, NY
- Scripps Oceanographic Institute, San Diego
- USGS, Denver
- Dynamic Gravity Systems, Denver
- GNS, Wellington

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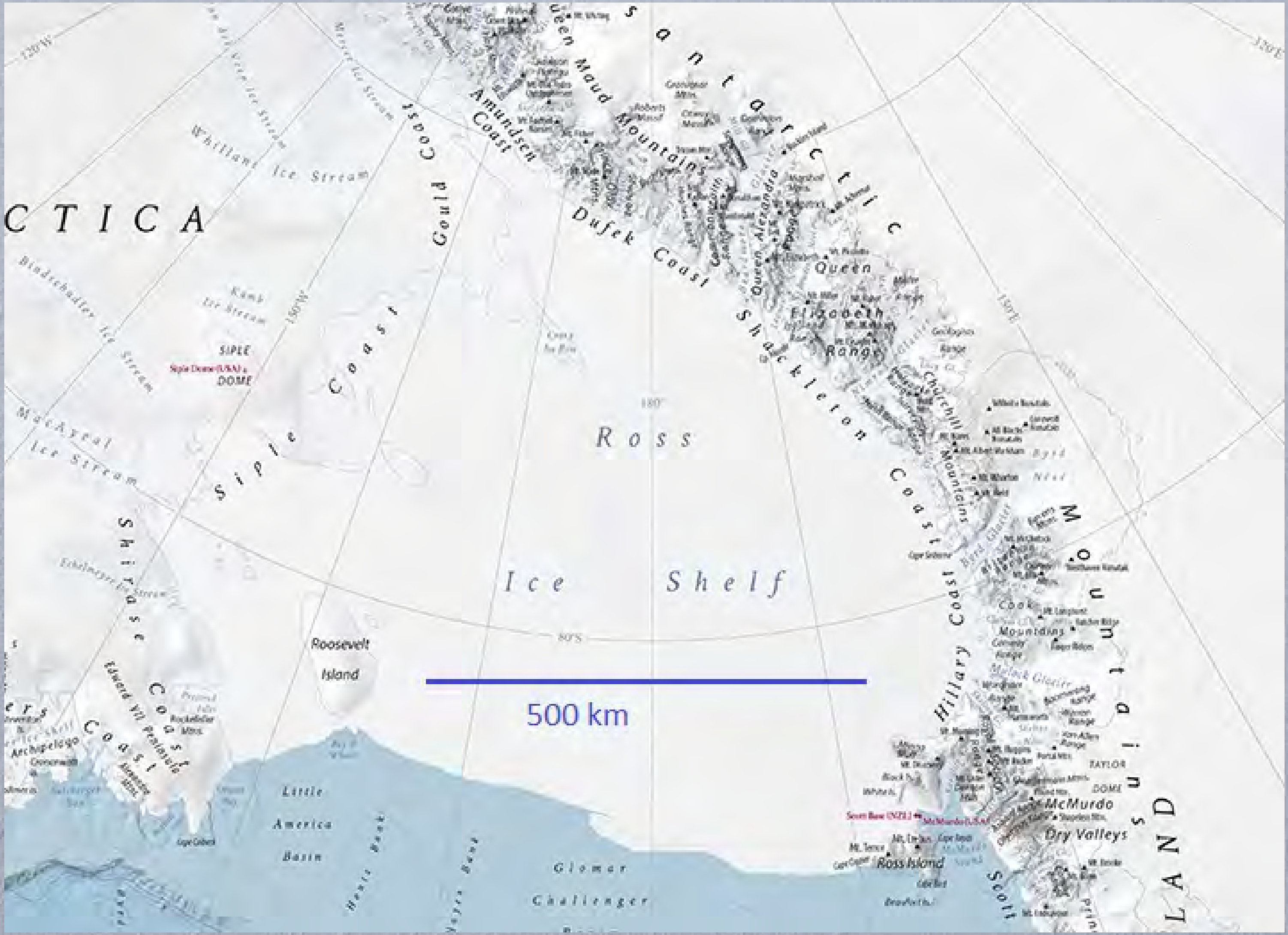

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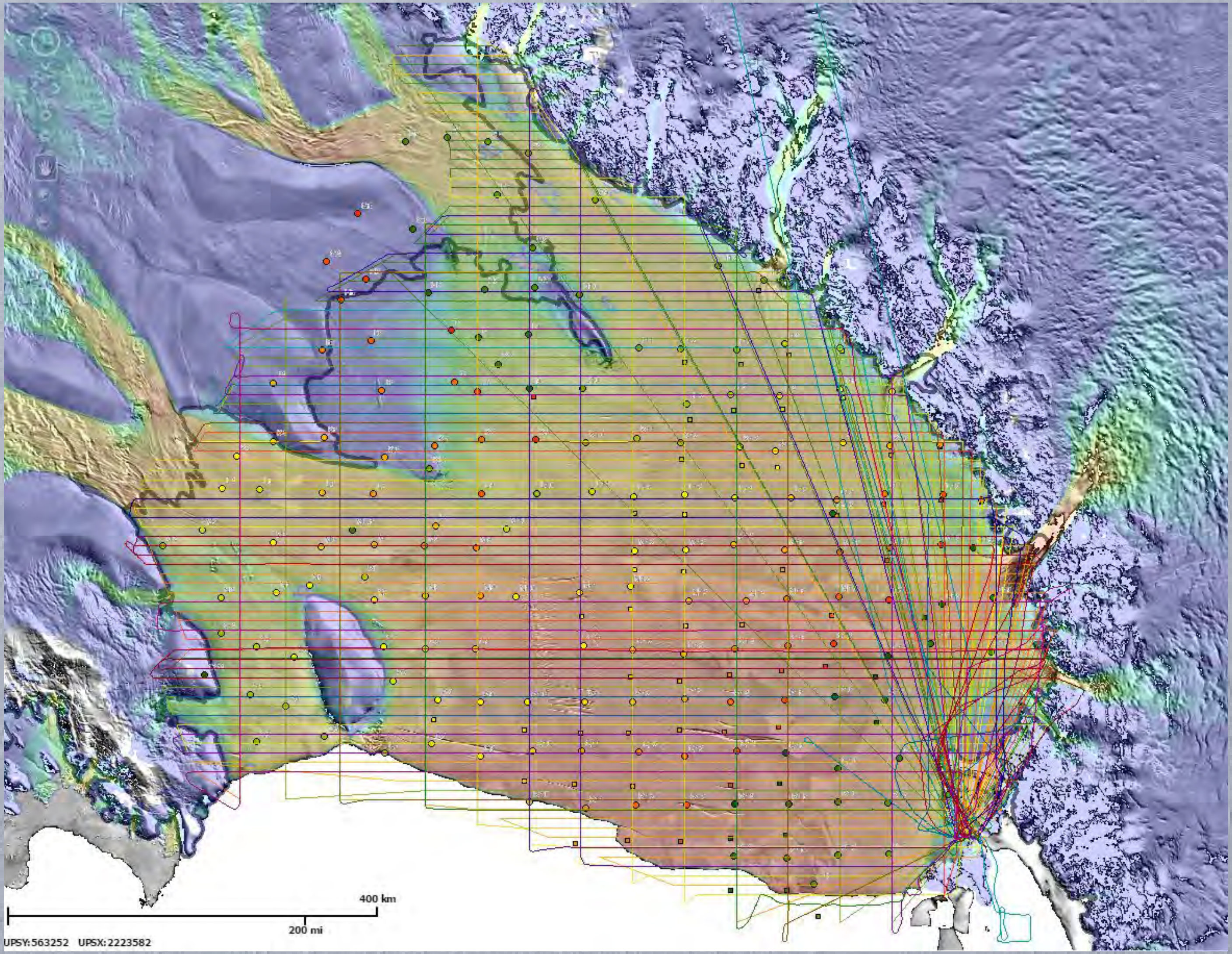
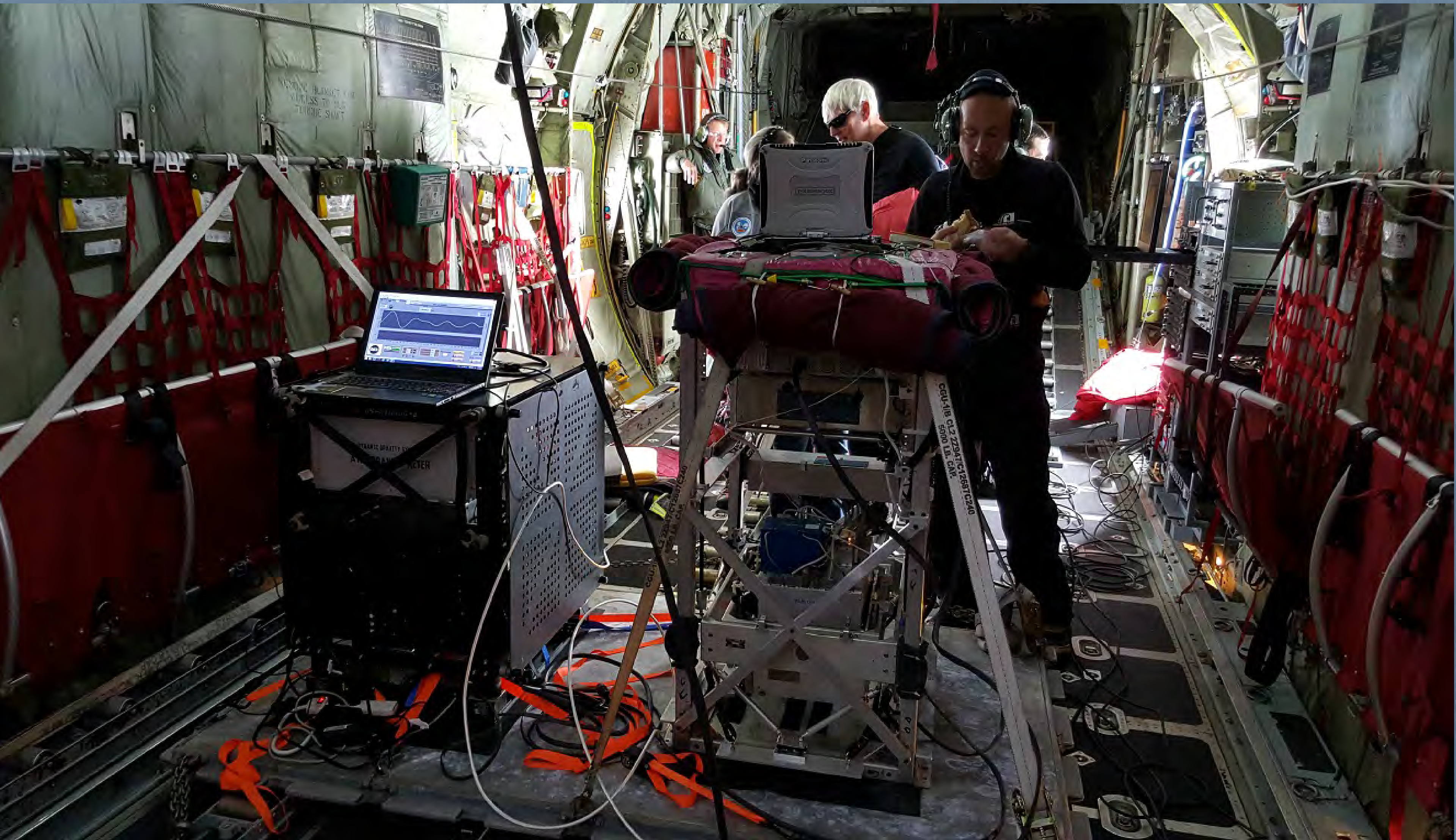


ROSETTA AIRBORNE GRAVITY

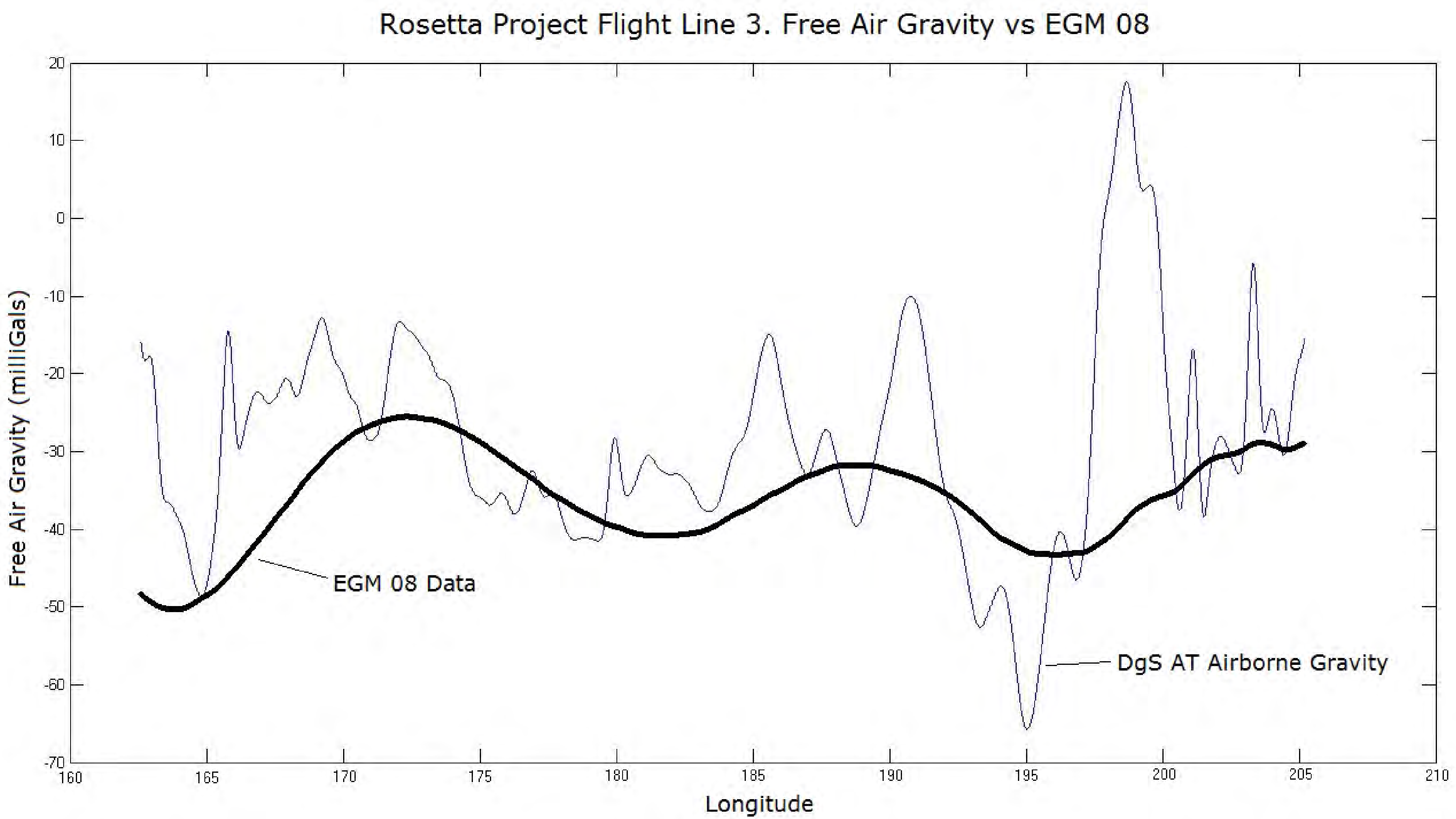
DgS DYNAMIC GRAVITY SYSTEMS

ROSETTA AIRBORNE GRAVITY



AIRBORNE GRAVITY

ROSETTA PROJECT GRAVITY PROFILE



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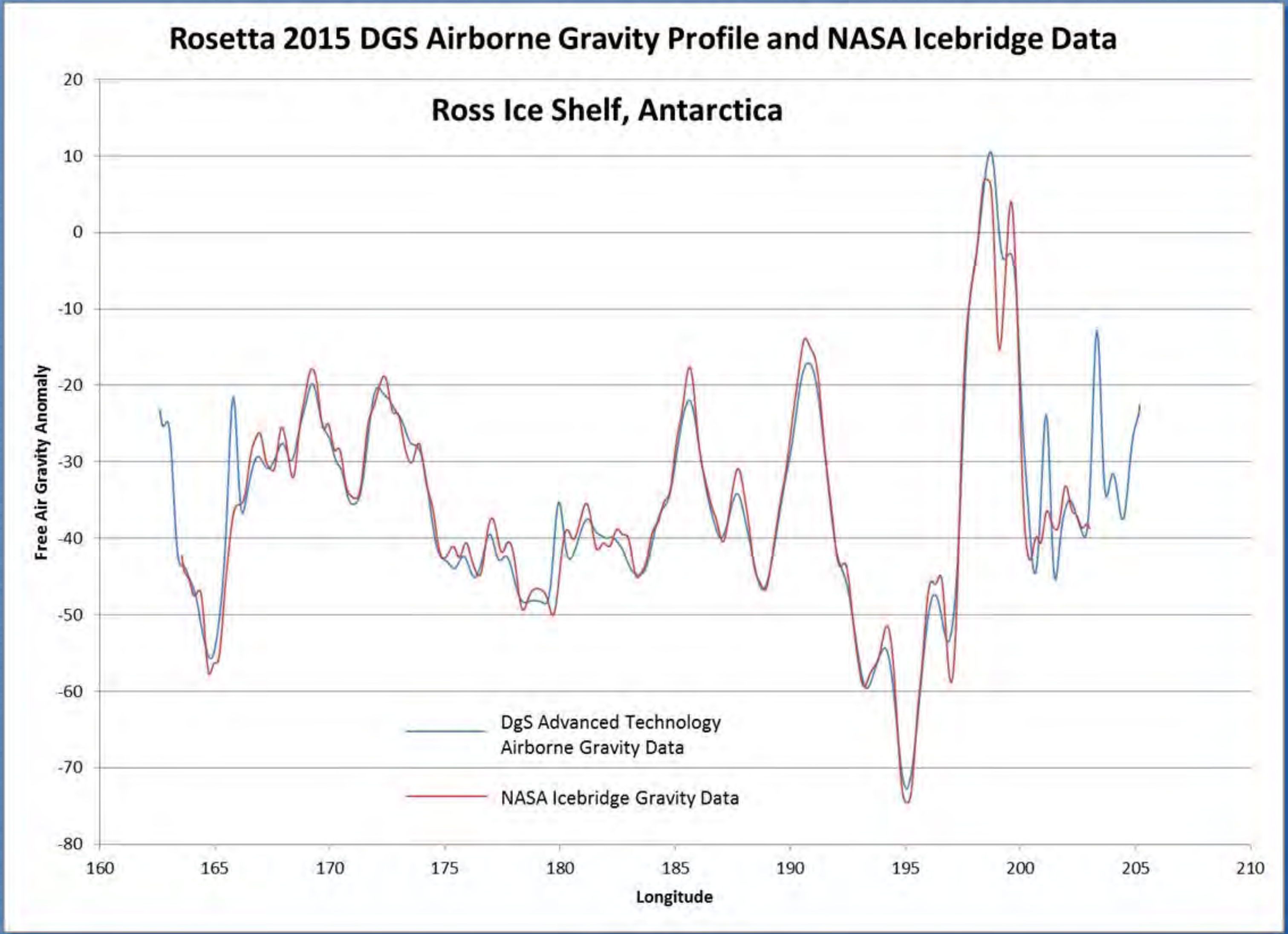
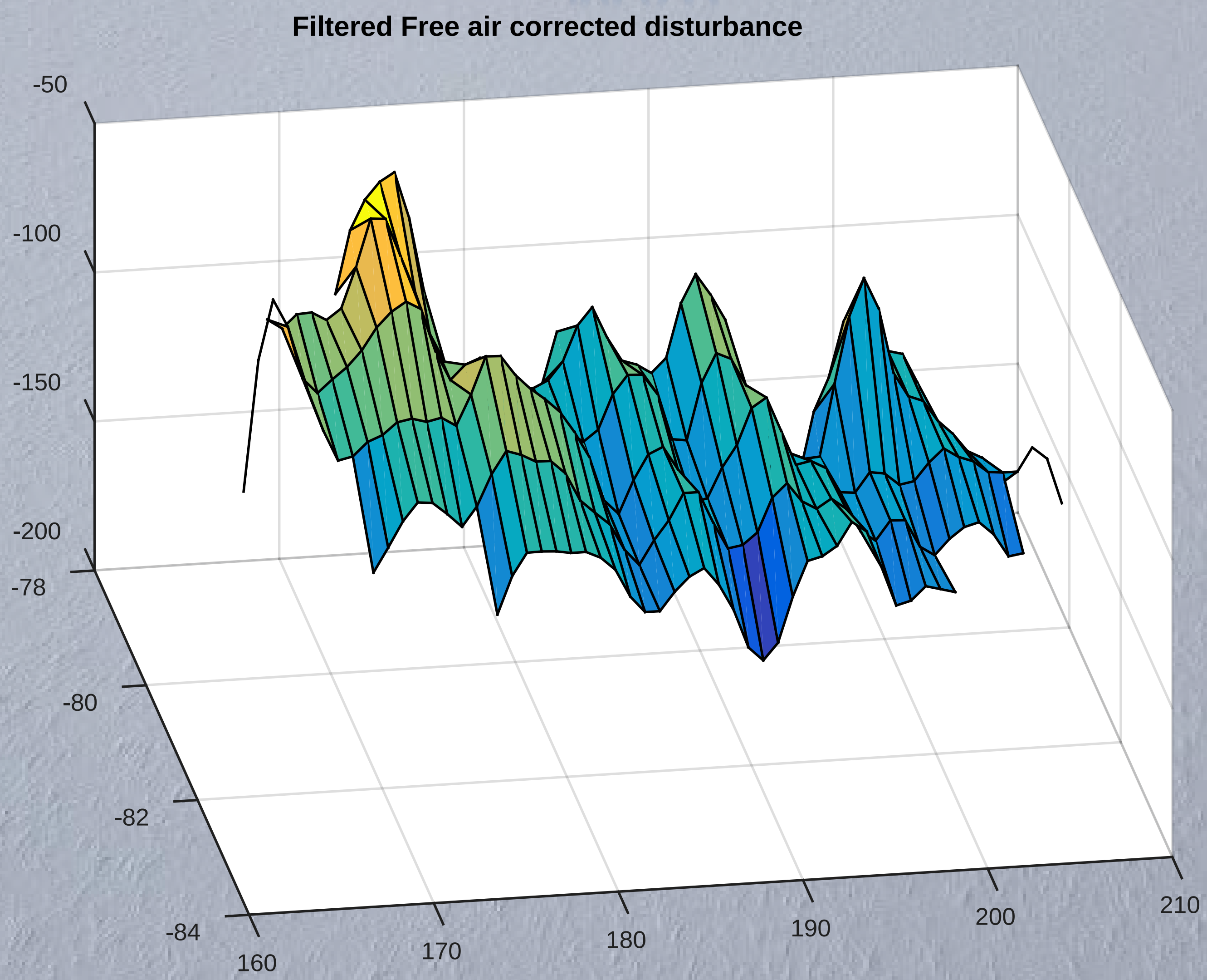


ROSETTA PROJECT EXAMPLE GRAVITY MAP



ROSETTA PROJECT – SOUTH POLE

ROSS ICE SHELF – ANTARCTICA

SUMMARY - DGS ADVANCED TECHNOLOGY AIRBORNE GRAVITY SYSTEM

- The system shows dramatic improvement over older zero length spring based systems
- Lab and field results show almost no cross coupling effects and extremely stable, near zero drift gravity in static testing
- The system requires no operator control during flight
- The platform guidance improvements allow for drape survey flights and minimize the effects of aircraft course corrections
- Very low setup, calibration and maintenance requirements compared to other systems
- Faster delivery and much lower cost than other systems
- Older zero length spring sensors can be upgraded to Advanced Technology systems

DYNAMIC GRAVITY SYSTEMS

Contact Information

- Web – www.dynamicgravitysystems.com
- Email – info@dynamicgravitysystems.com
- Phone - +1 303 815-6376 (Nigel Brady)
- Address: 7120 W 117th Ave
  Denver
  Colorado 80020
  U.S.A.