

Ground Motion Studies at MINOS

James T Volk

Fermilab

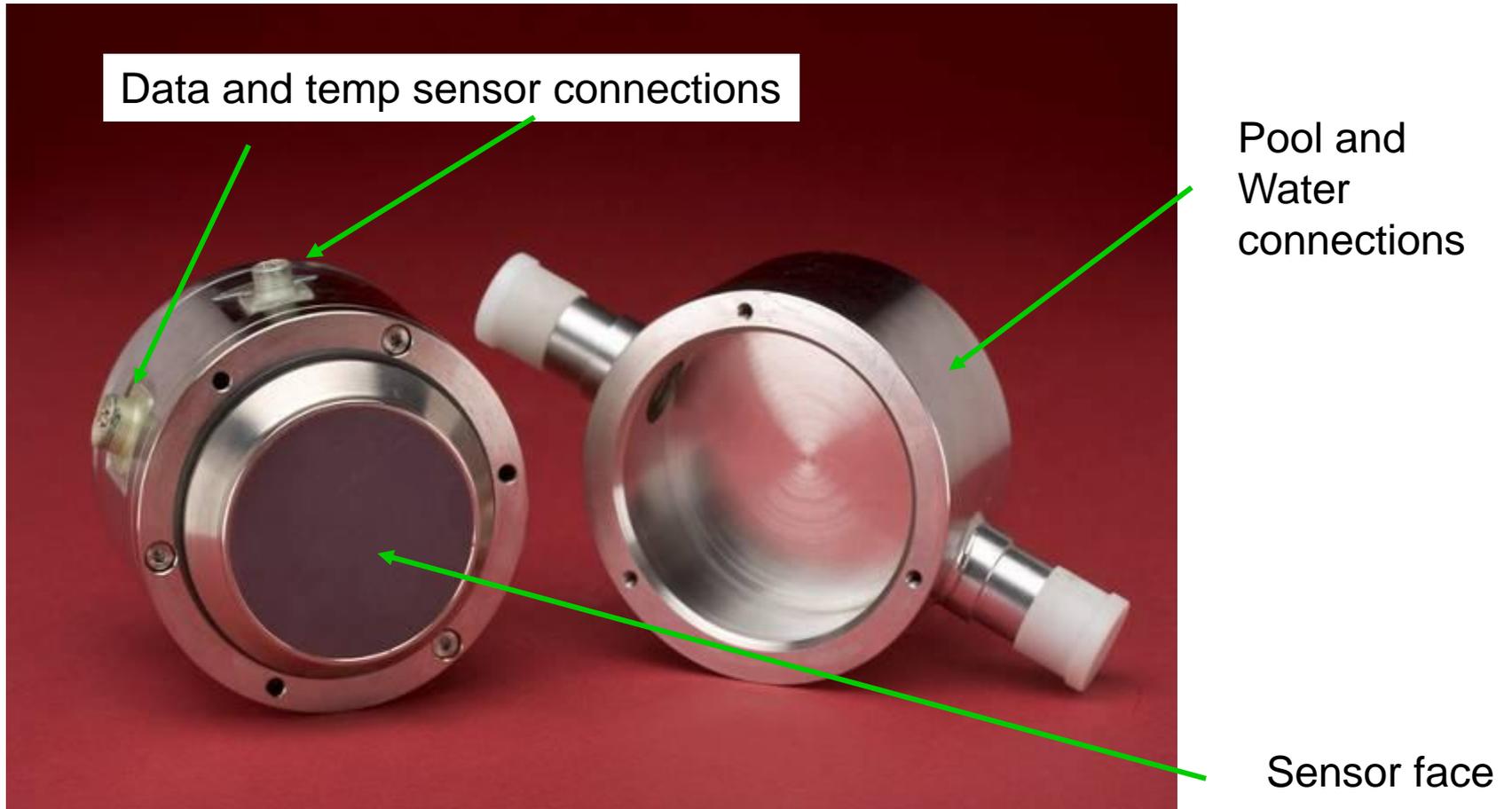
Types of ground motion

- There is fast ground motion > 1 hertz
 - Vibration due to pumps, LCW, cryogenics
 - Traffic near and far cars, trains, airplanes
 - Earth quakes
 - Monitored with seismometer, geophones, accelerometers
- There is slow ground motion < 1 hertz
 - Tidal motion Periods of 12 hrs, 24 hrs, weeks, months, years
 - Sump pumps and wells periodic and non periodic lasts several hours
 - Slow sinking of floor
 - Movement due to rain and seasonal changes
 - Monitored using hydrostatic water levels

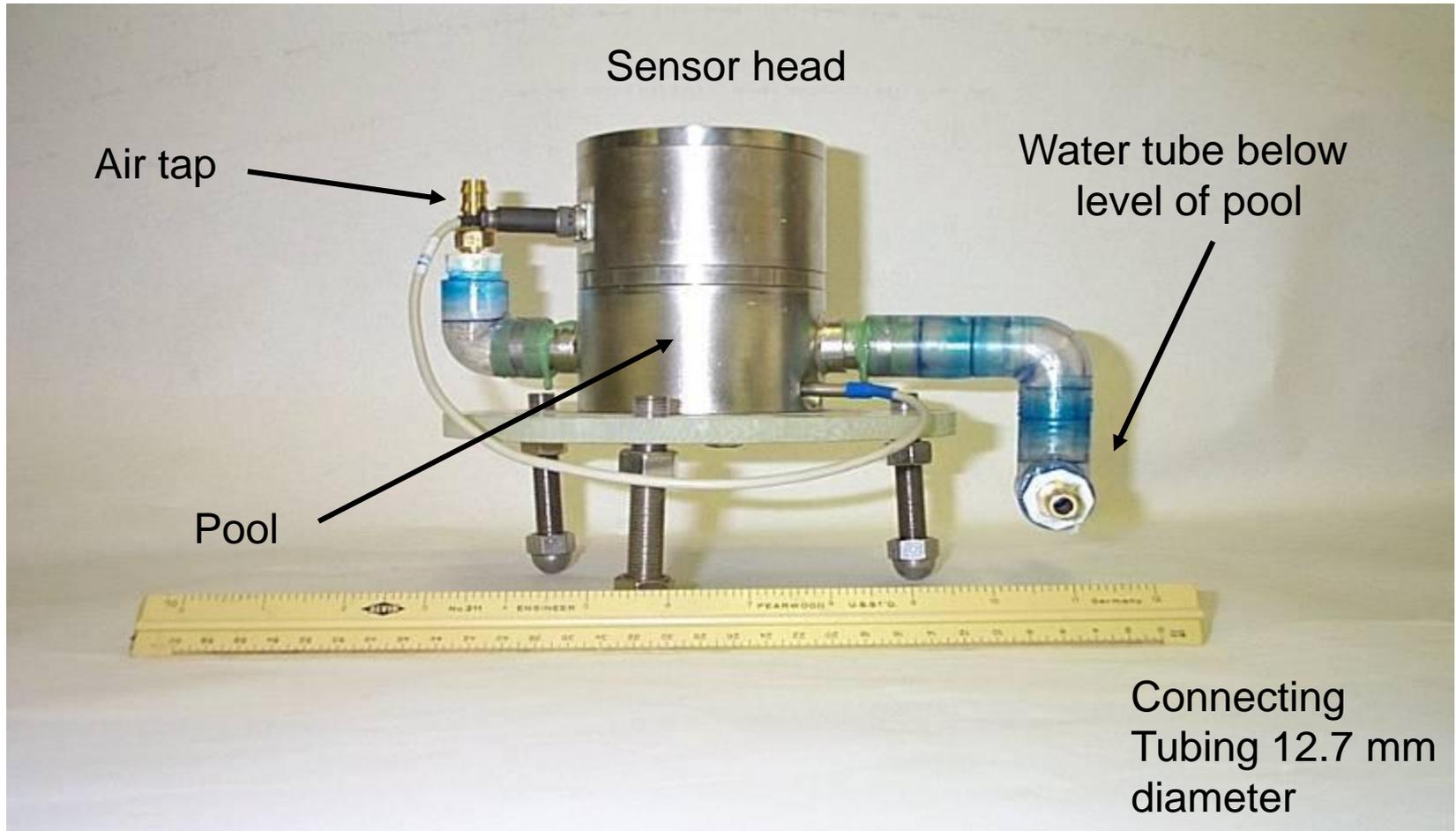
Why look at Ground motion

- Future accelerators will have significantly smaller beams sizes and higher beam power
- Movement of accelerator components will cause dispersion, emittance growth and mis-steering of the beam
- Need to characterize this motion to design feed back and feed forward controls
- Need to understand rock mechanics for cavern design
- MINOS hall at top of Galena-Plattville dolomite
- It takes years of data to understand what is happening

Budker Sensors



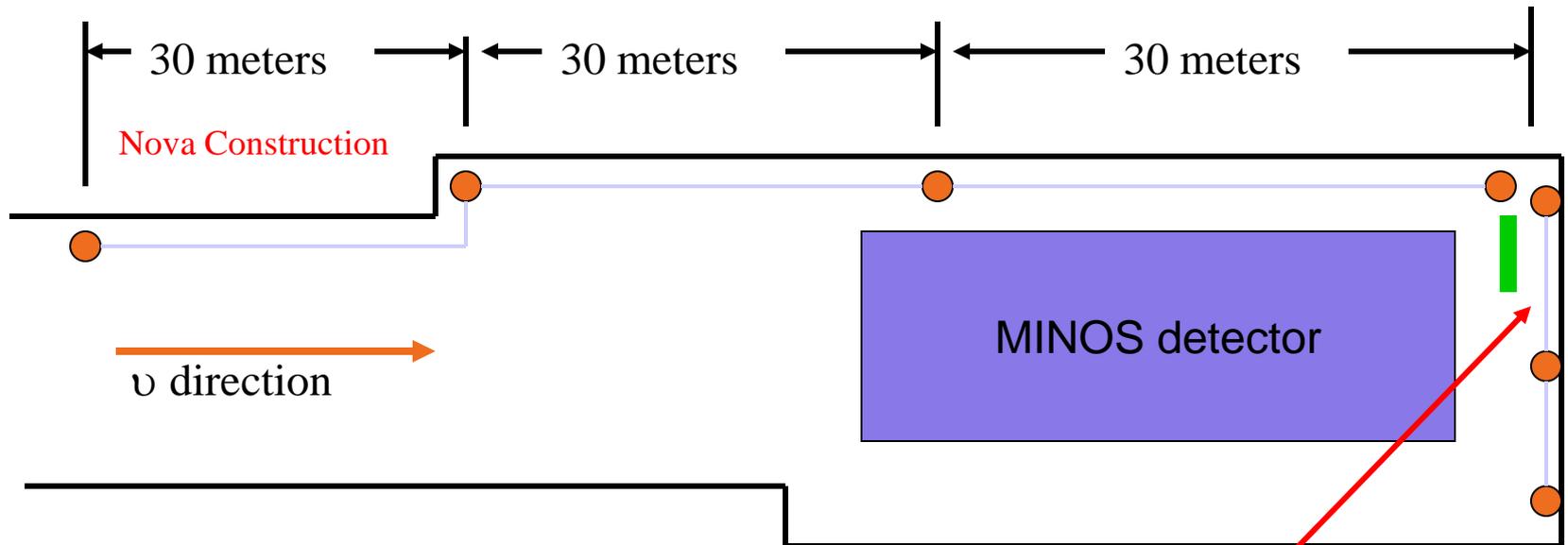
MINOS water level sensor



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Layout of MINOS water level

Depth of floor 100 meters below grade
406 feet above sea level Maquoketa shale



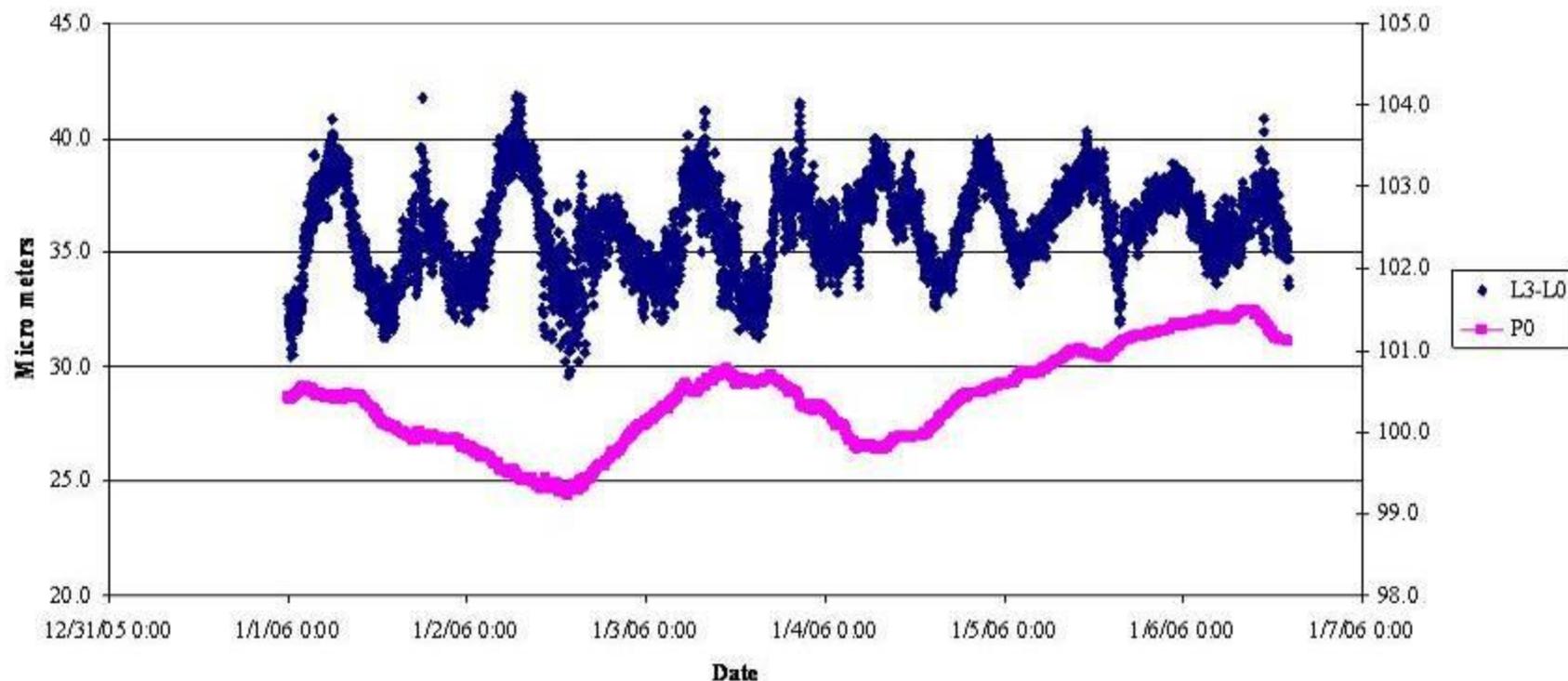
- Sensor
- Water line

Not to scale

Location of
Horizontal and
Vertical seismometer

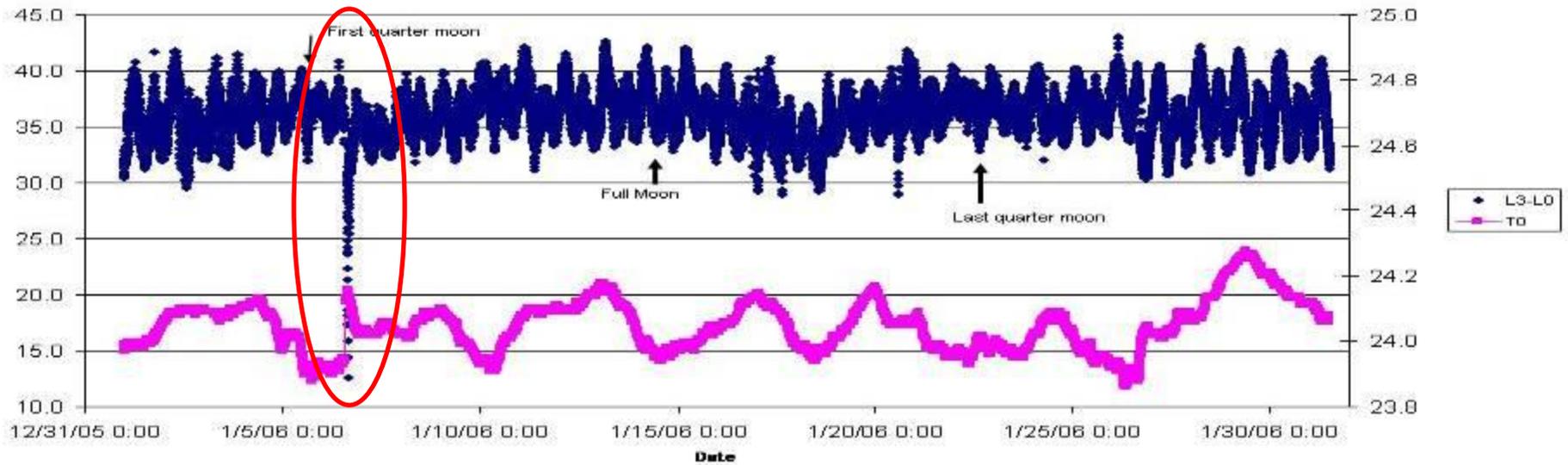
Difference between two sensors 90 meters apart in MINOS hall

L3-L0 and Pressure MINOS hall



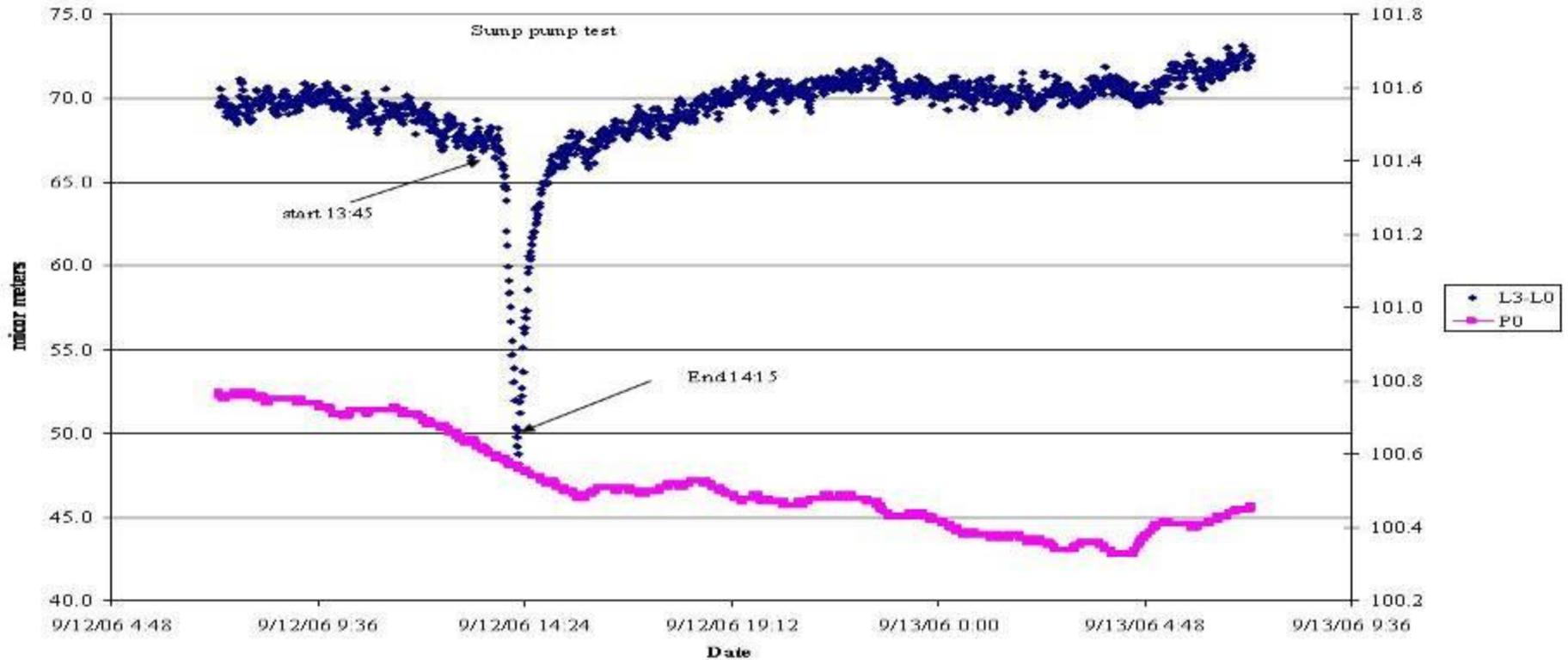
Two sensors 90 m apart MINOS hall

L3-L0 and Temperature

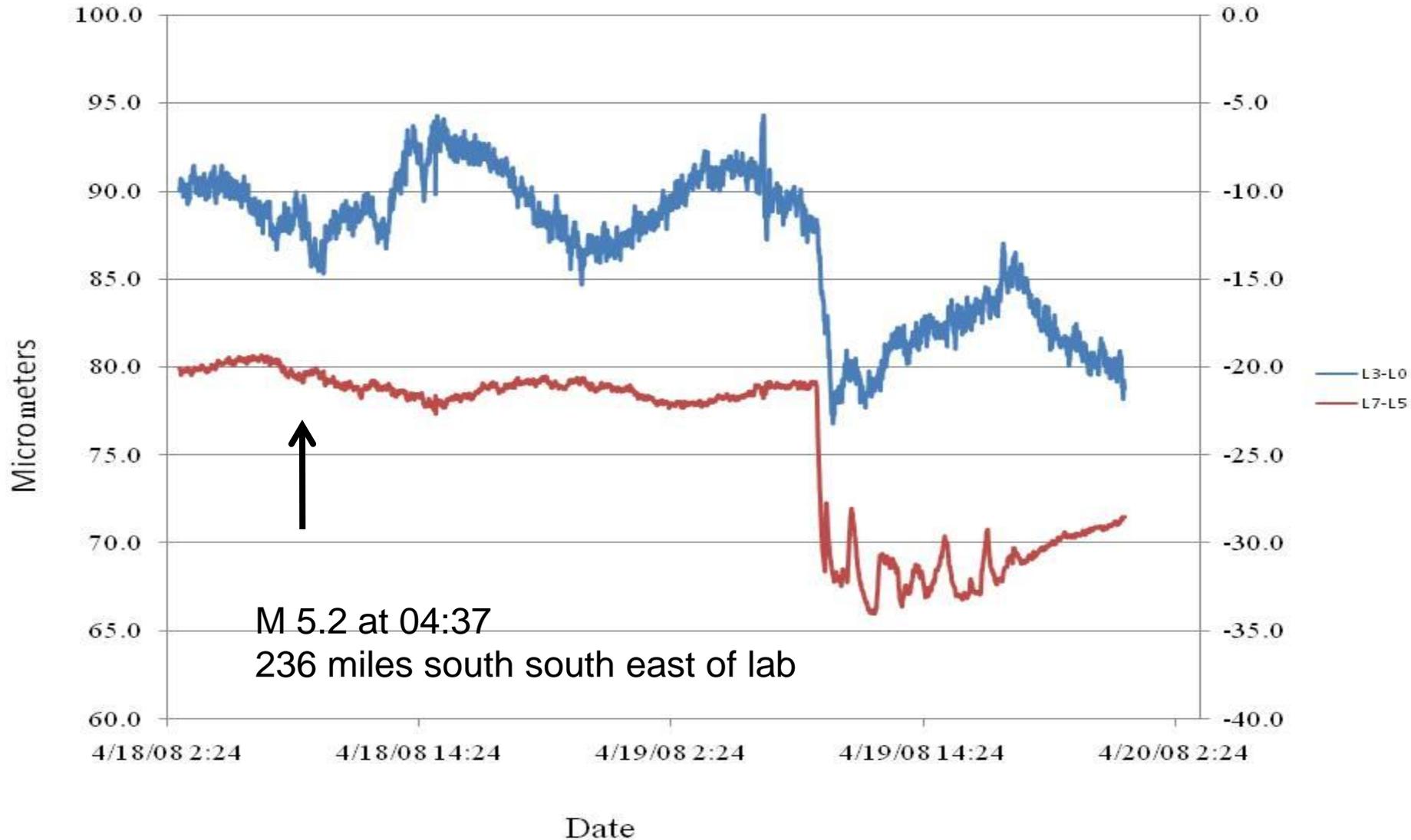


September 2006 sump pump test

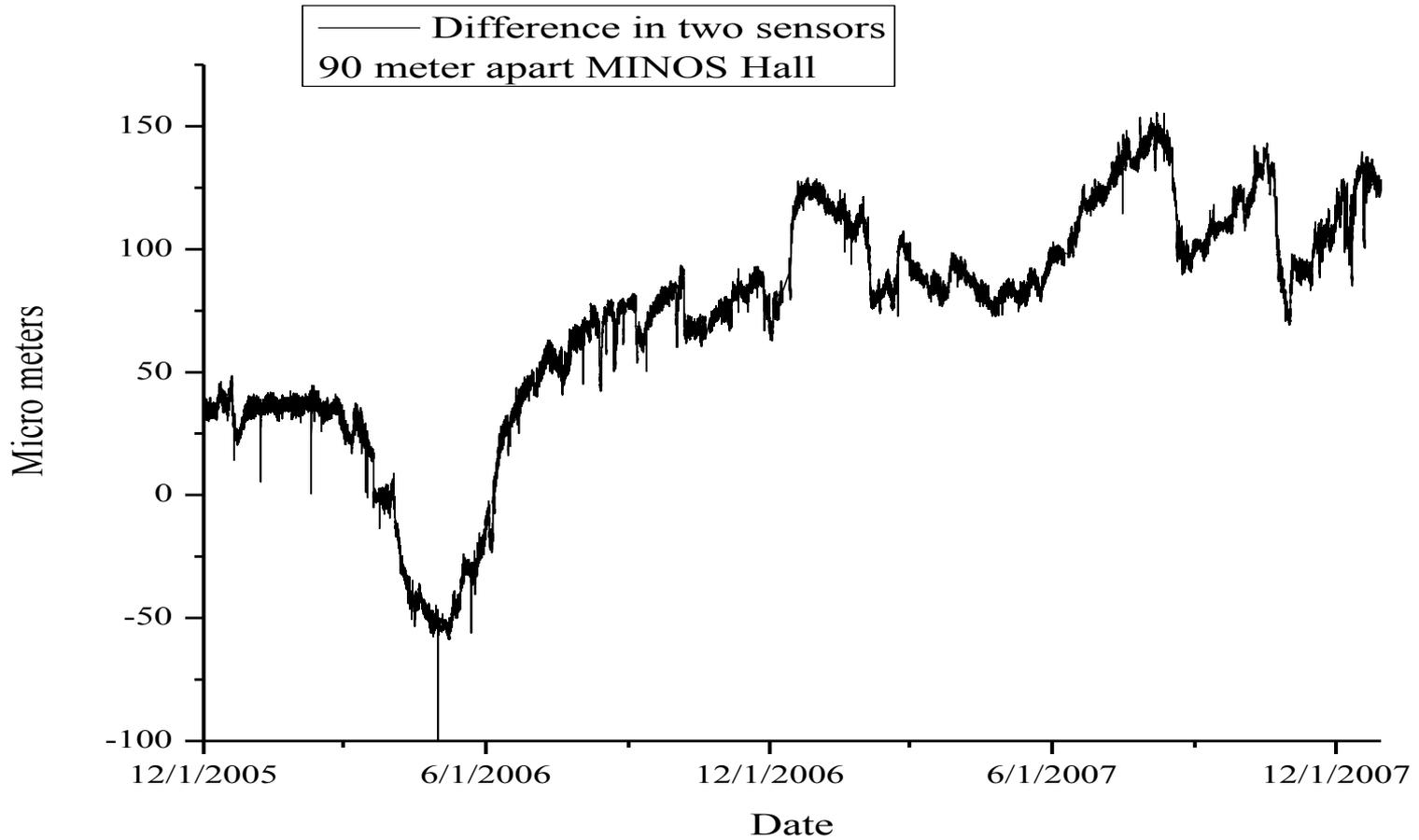
L3-L0 and pressure



Earthquake April 2008

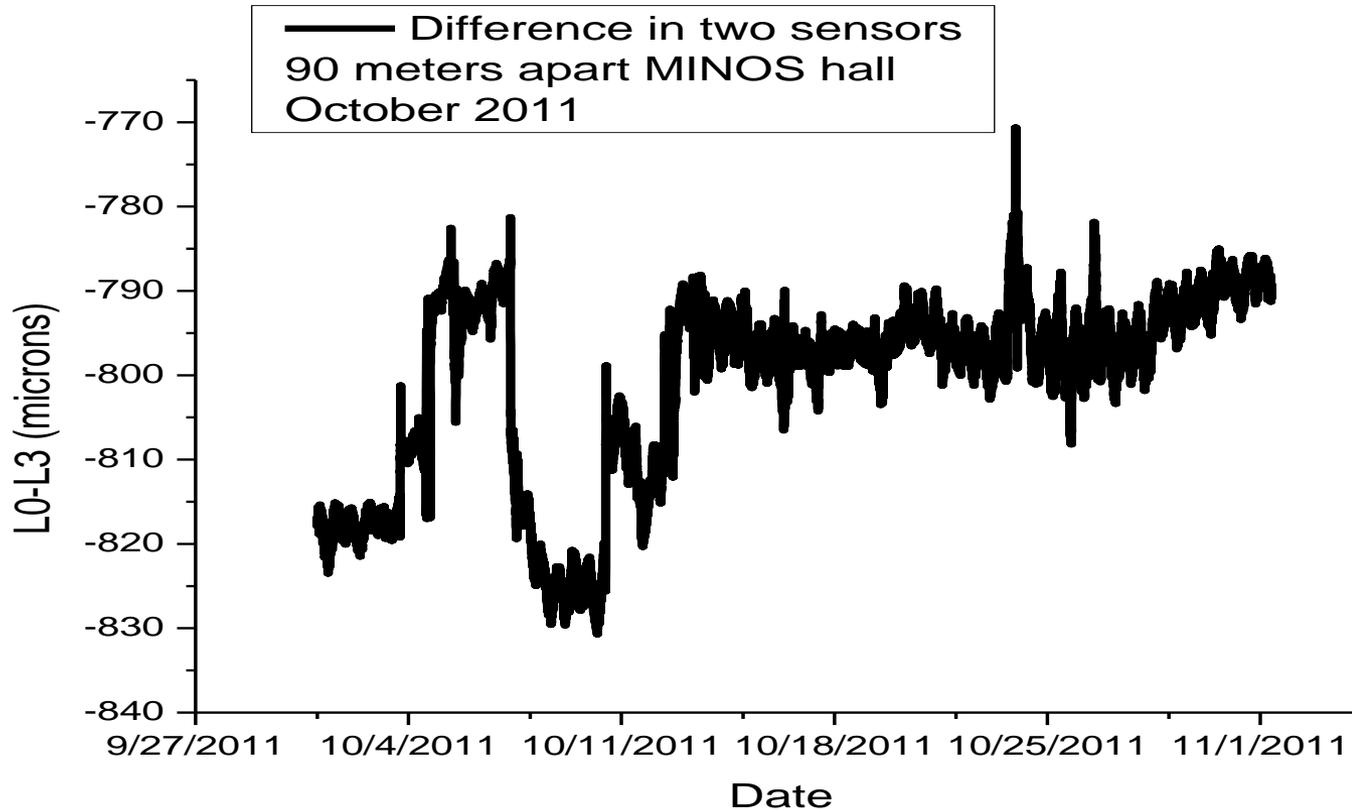


MINOS Hall tilt for 2 years



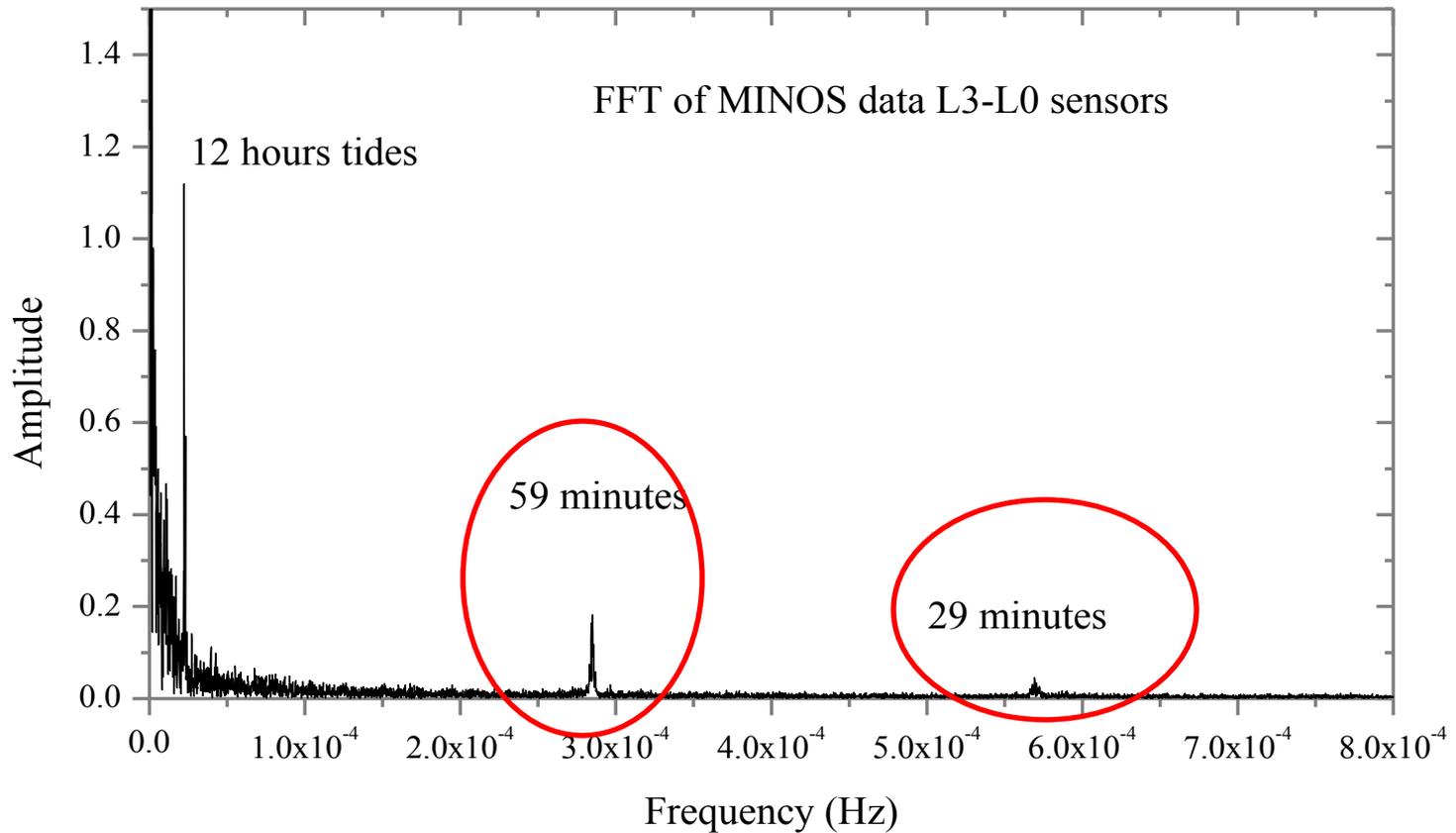
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L0-L3 for October 2011

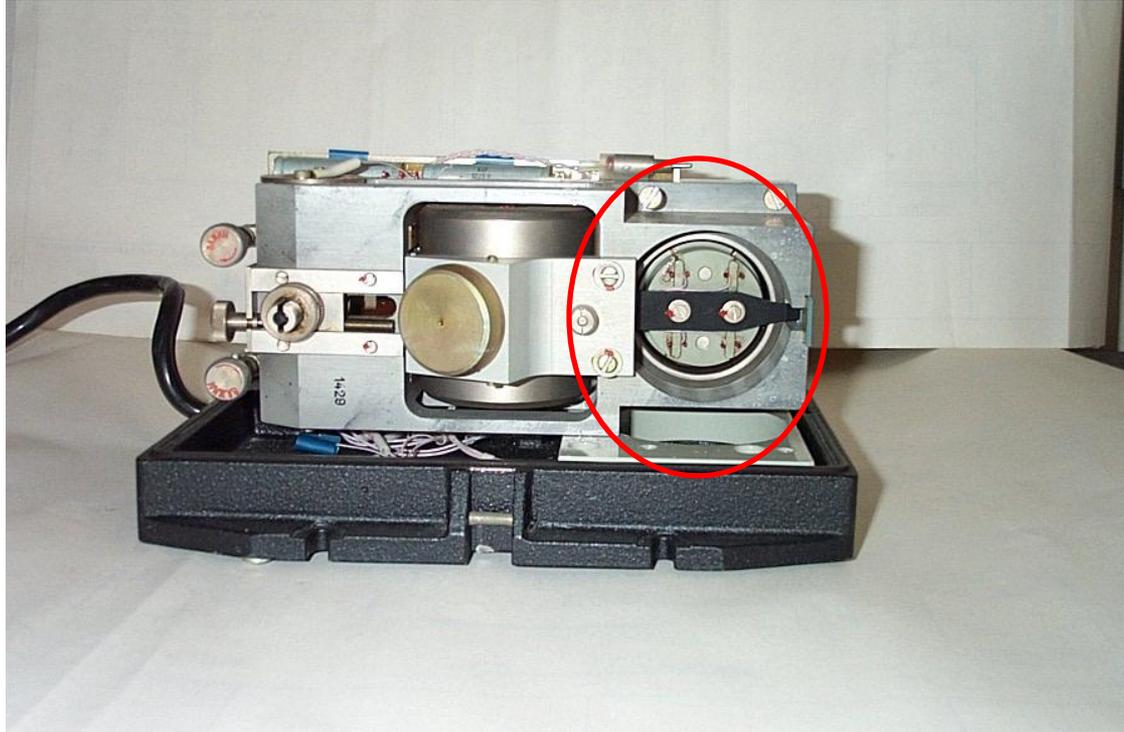


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FFT of MINOS data difference between two sensors

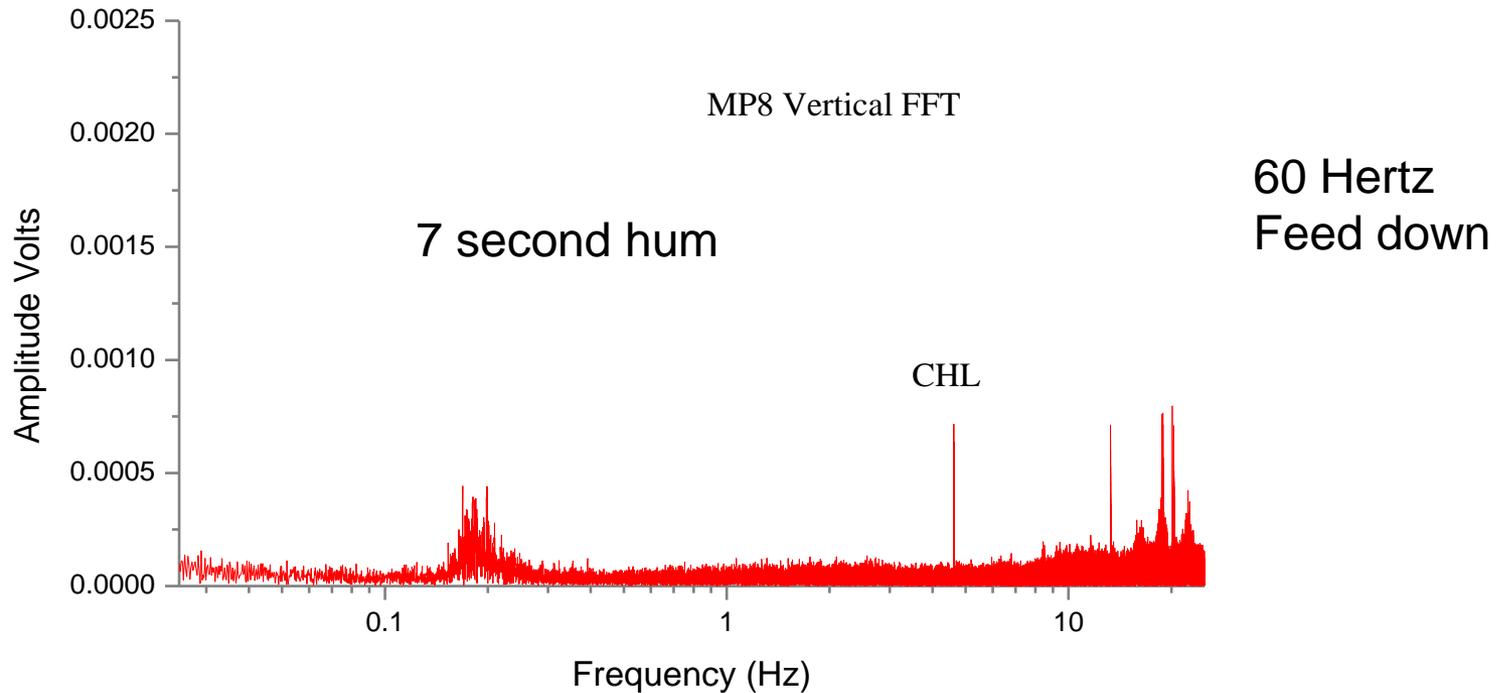


Budker Horizontal Seismometer

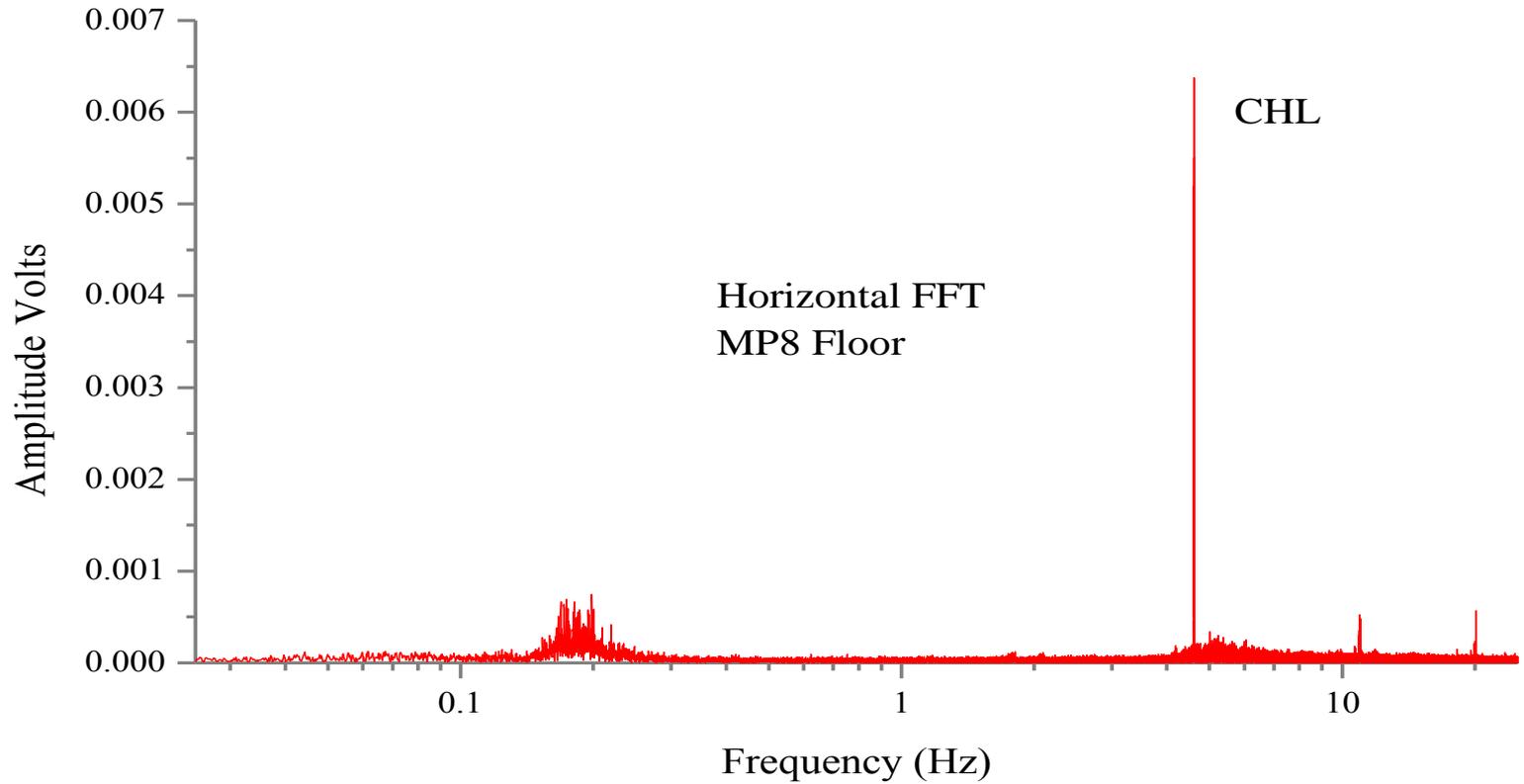


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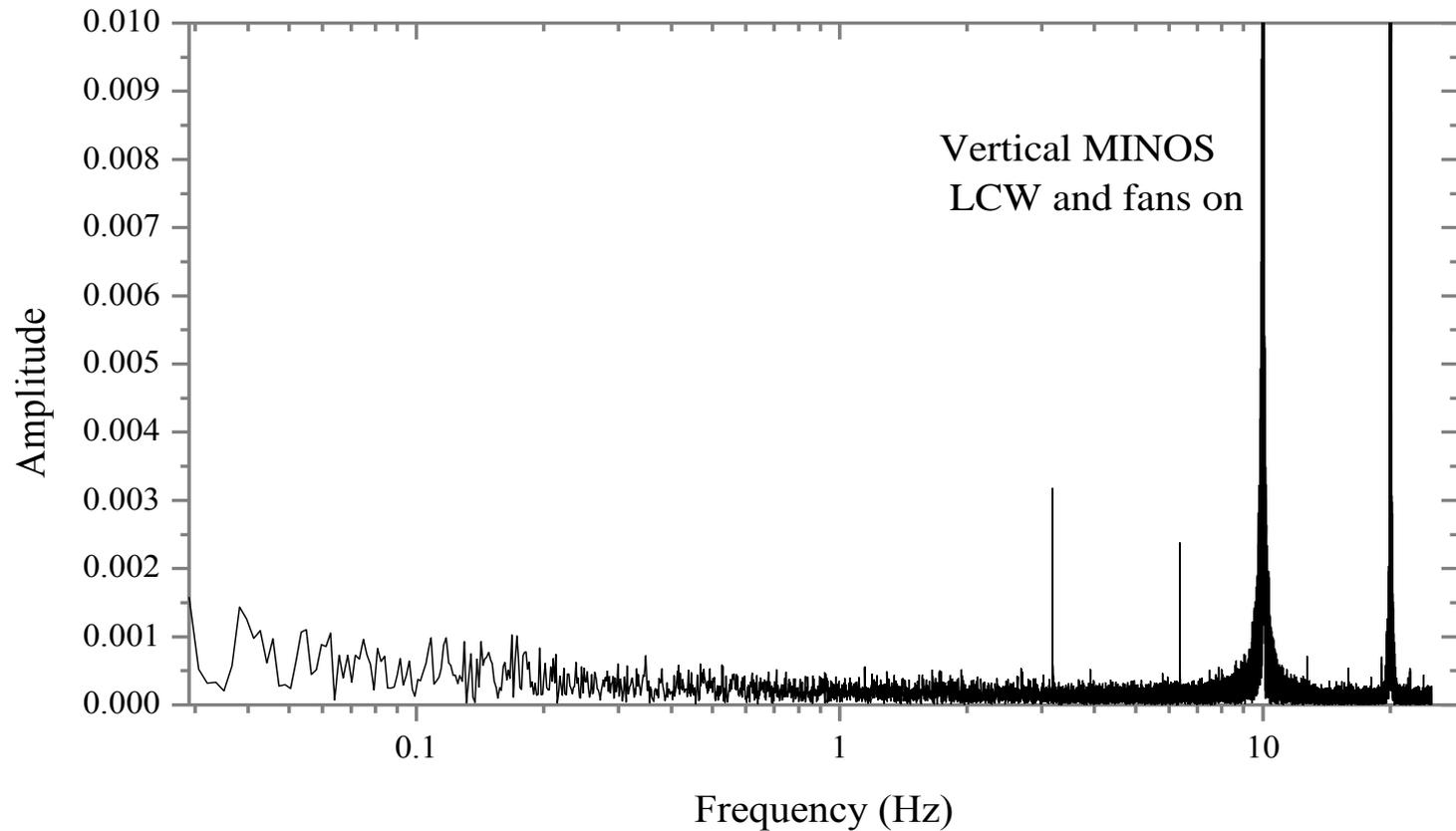
Vertical motion at grade Fermilab log scale



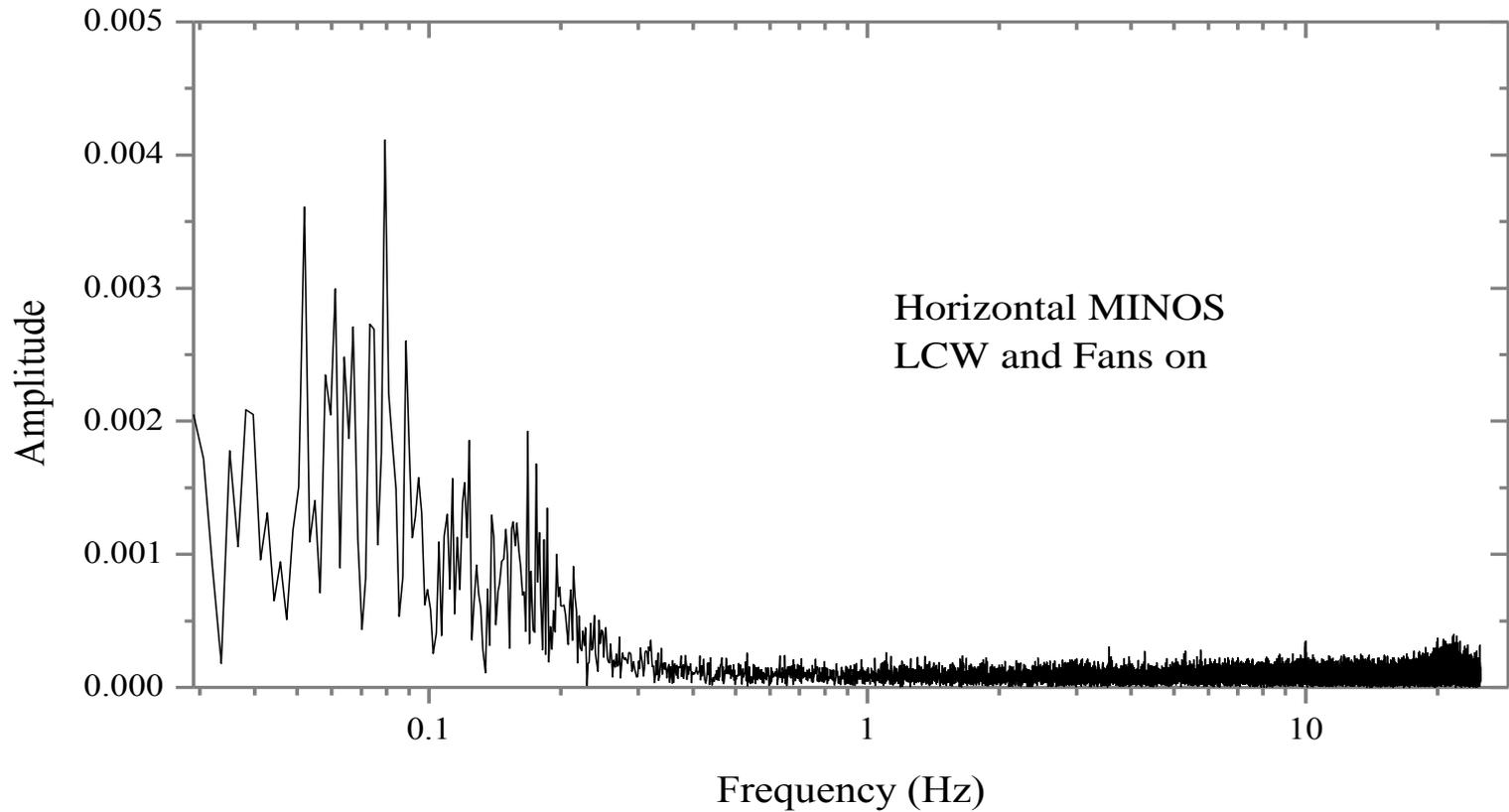
Horizontal motion at grade Fermilab log scale



Vertical motion MINOS hall log scale



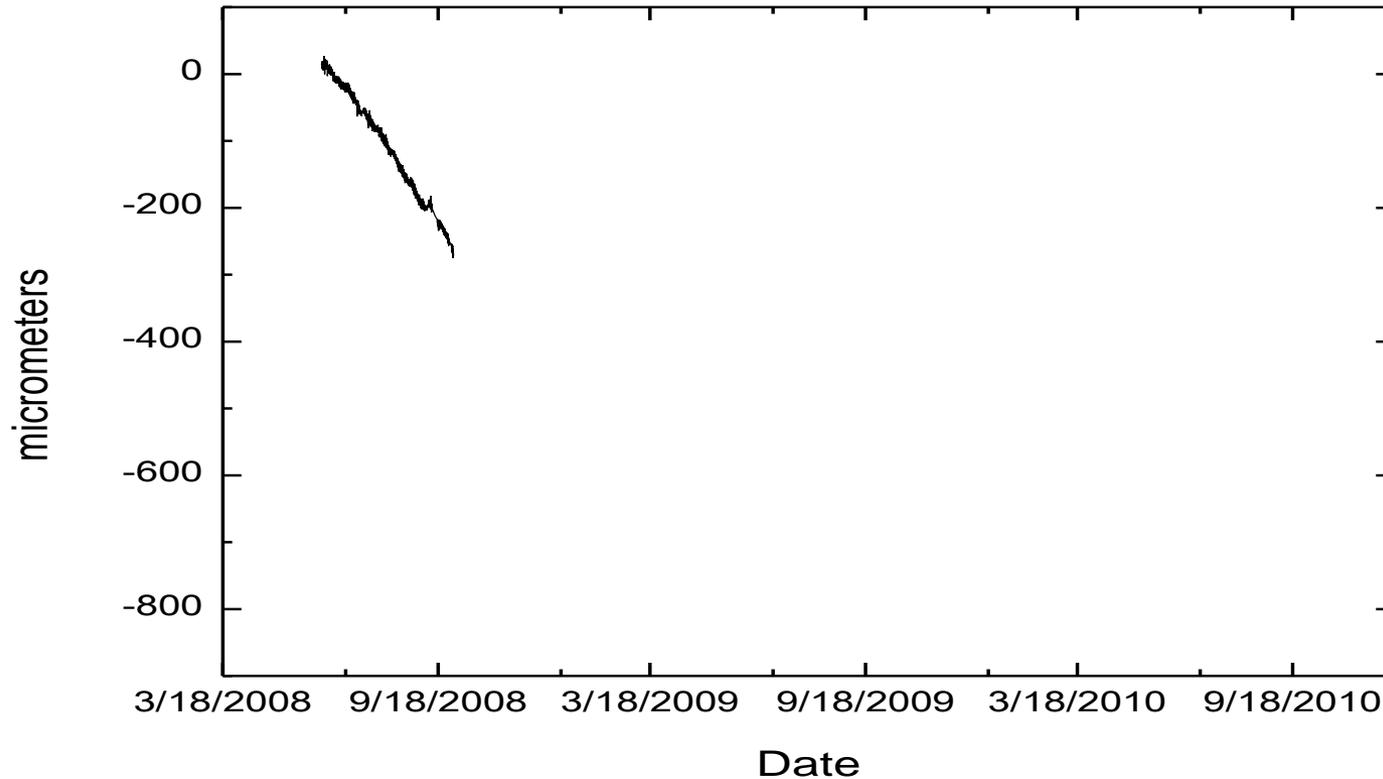
Horizontal motion MINOS hall log scale



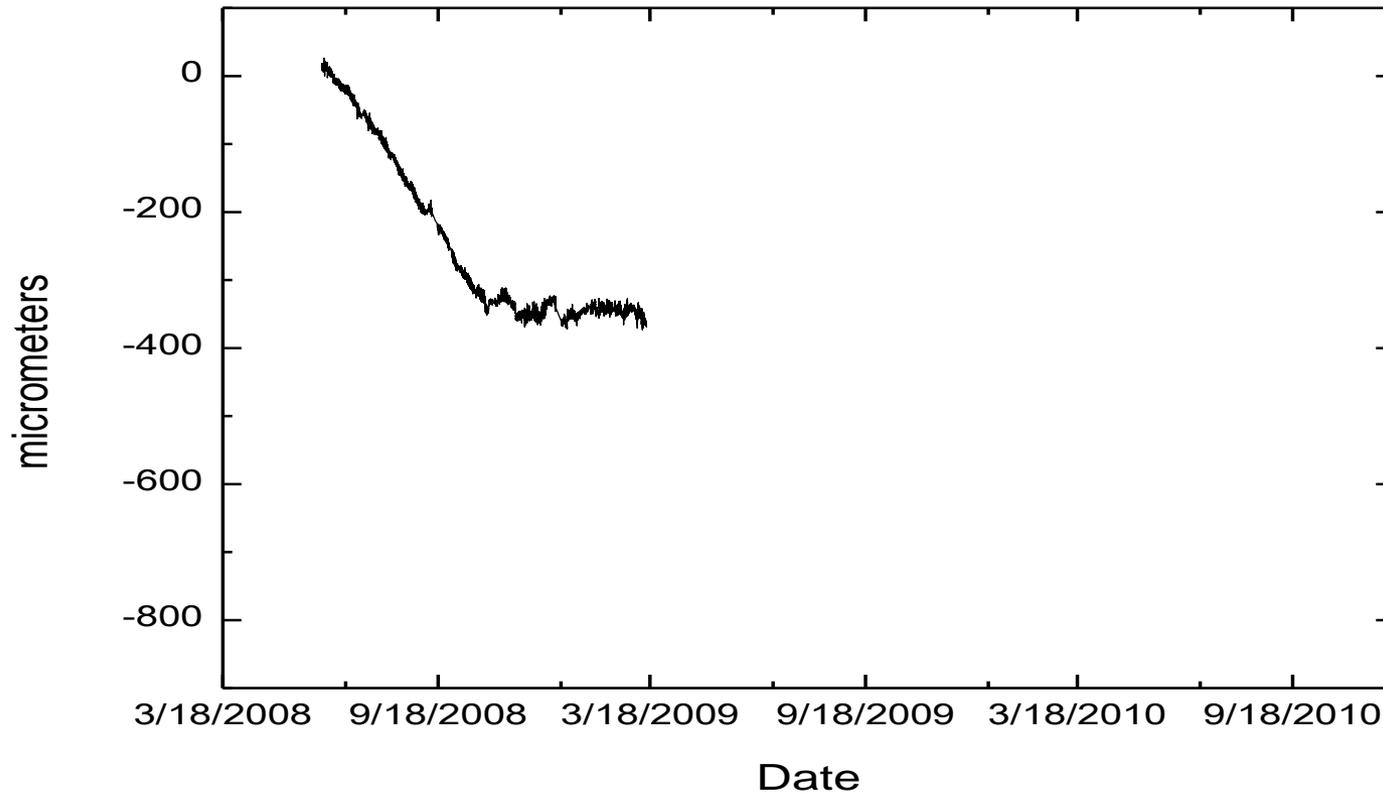
What is expected from these studies?

- Monitor the fast motion with seismometers
- Determine what frequencies are excited in floor by construction
- Monitor the slow motion with HLS systems
- Need both North-South and East-West leg

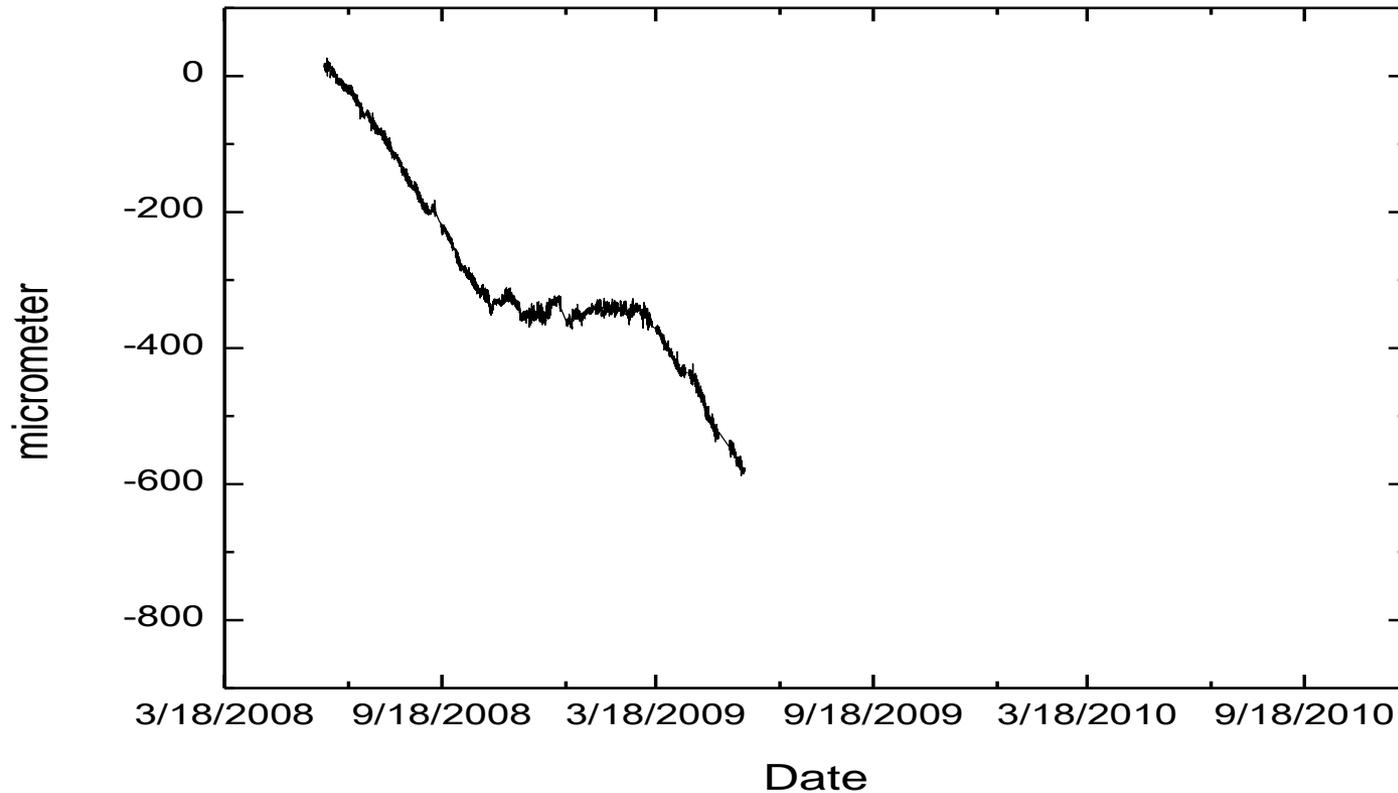
LaFarge Mine difference in two sensor 120 meters apart March 08 to September 08



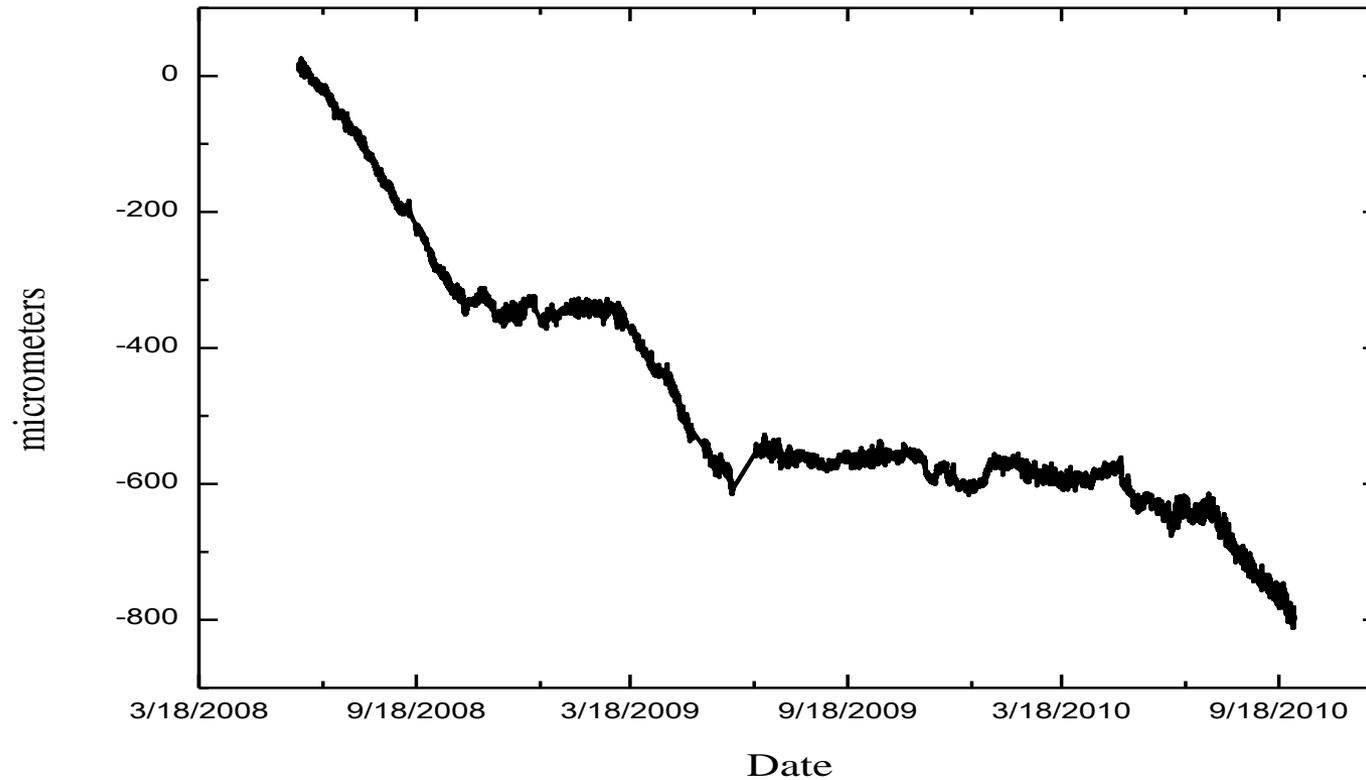
LaFarge Mine difference in two sensor 120 meters apart March 08 to March 09



LaFarge Mine difference in two sensor 120 meters apart March 08 to May 09



LaFarge Mine difference in two sensor 120 meters apart March 08 to October 2010

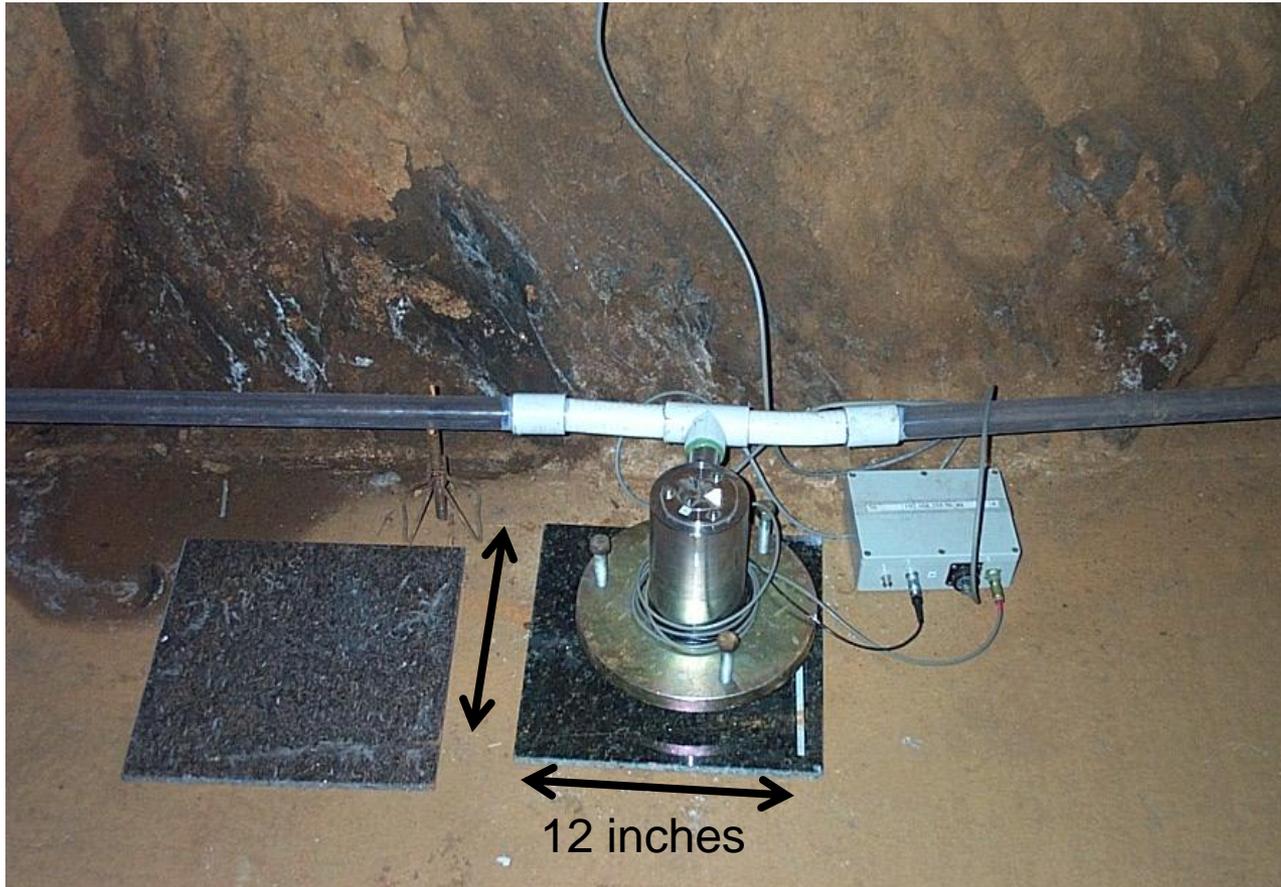


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Next steps

- The seismometers will stay where they are data is available on ACNET
- There may be a desire to instrument the detectors that would require buying some seismometers or accelerometers
- Nova Construction will require removal of North South leg of HLS system
- Moving to east side in the hall will result in a shorter system
- The personnel passage could have a longer system on east side
- The new system will be single half filled pipe
- The ground motion data base will be updated

Installation at 4850 ft level Sanford lab



Have 6 more sensor available

Length of system
100 meters
Set by PoE

Summary

- Have 6 years of HLS data and 4 years of seismometer data
- Useful for Project X, LNBE, Muon Colliders and ILC
- Build single pipe half filled system
- Add more sensors for ATL law study
- Require 1 week and two techs to help