# Ground Motion Studies at Fermi National Accelerator Laboratory

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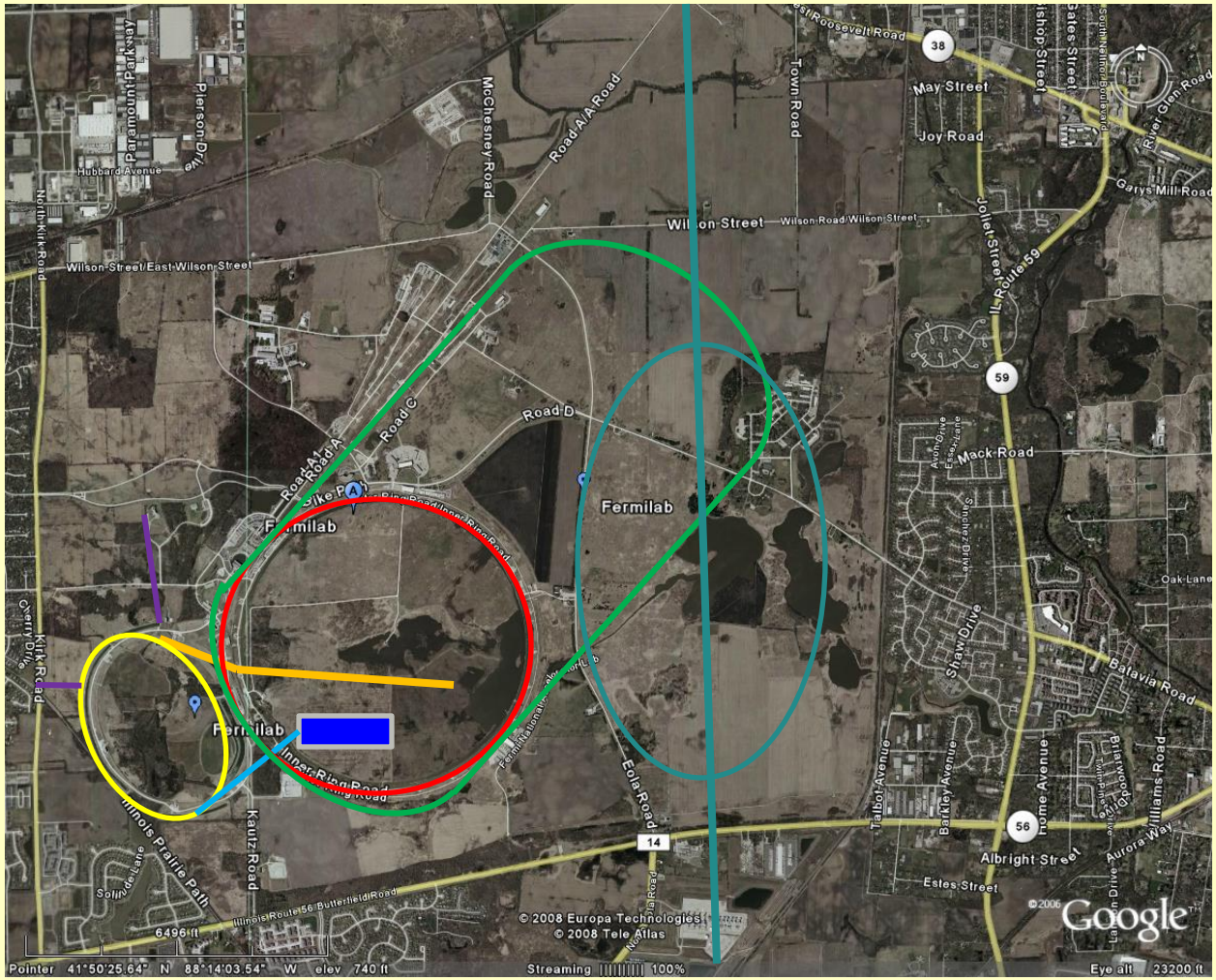
# Future Plans at Fermilab




Project X an 8 GeV Superconducting LINAC

Intense ν beams to NUMI 890 km north and DUSEL 1480 km west

Muon Cooling test facility

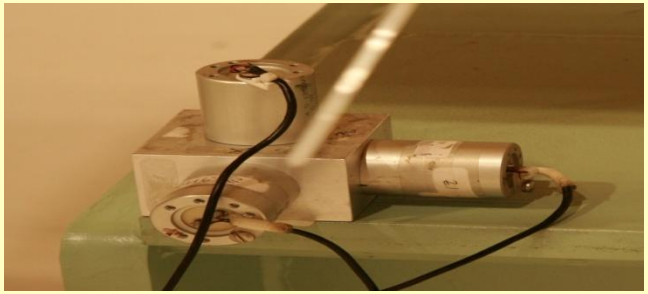
Muon Collider

International Linear Collider

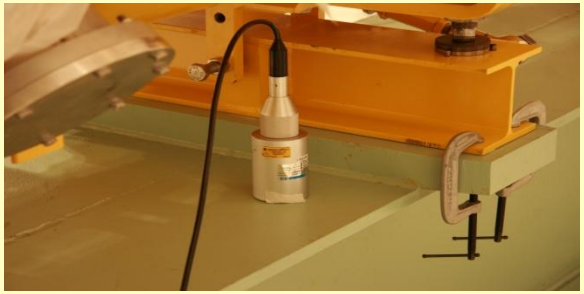
# Ways to Monitor Ground Motion

Water levels

BUDKER seismometer



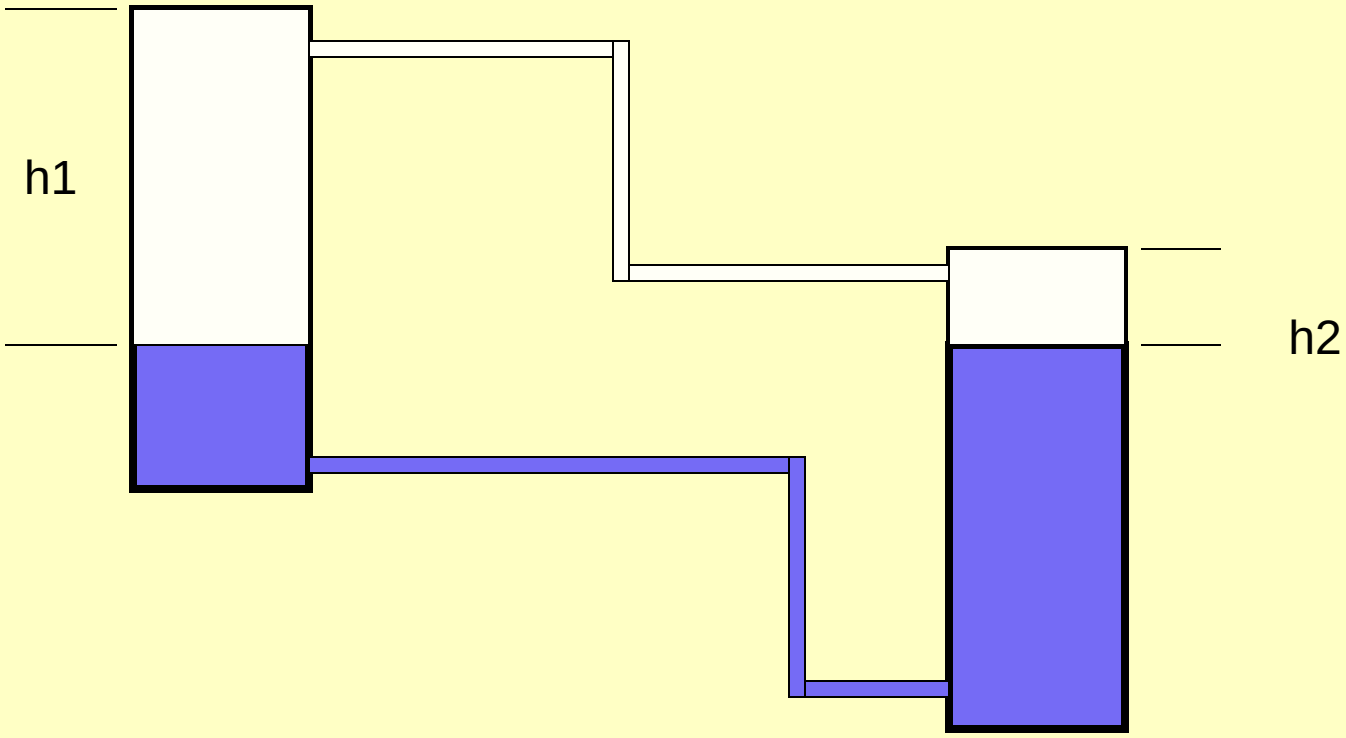
Geophone



Sercel Seismometer

# Hydro static water Levels Systems

Water seeks it's own level



# Hydro static water Levels Systems

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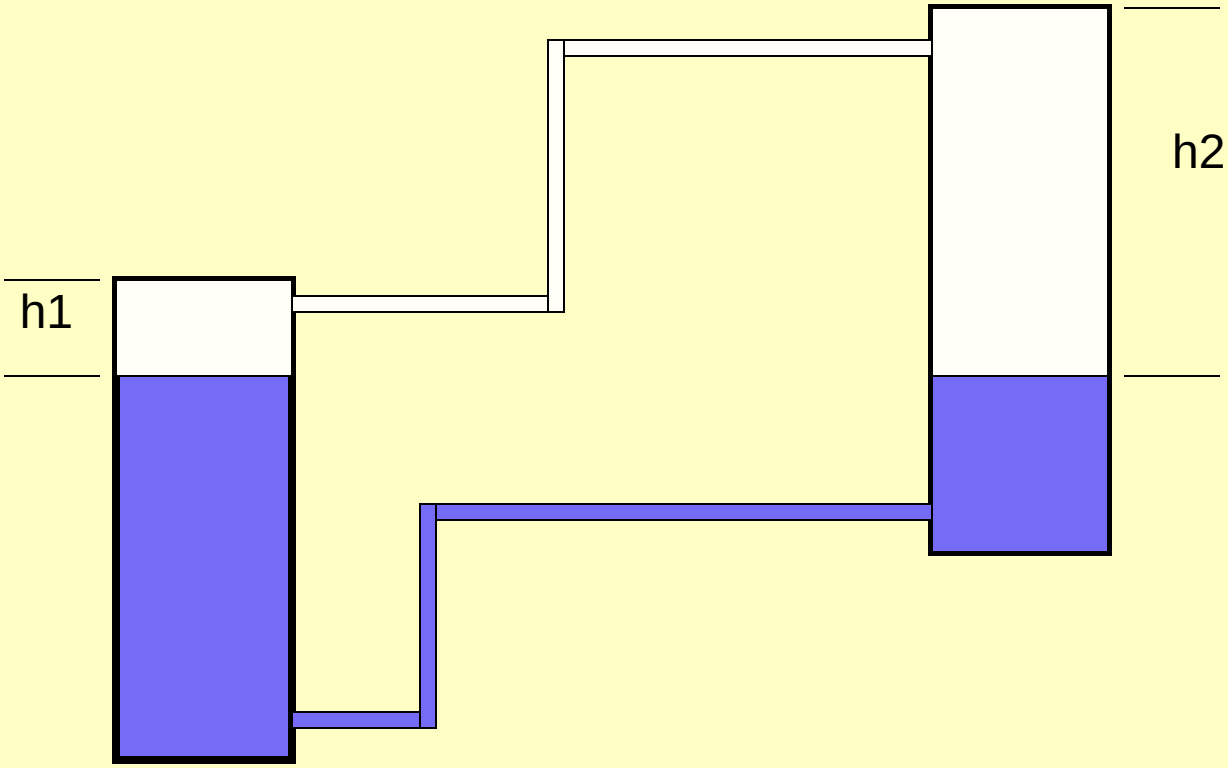
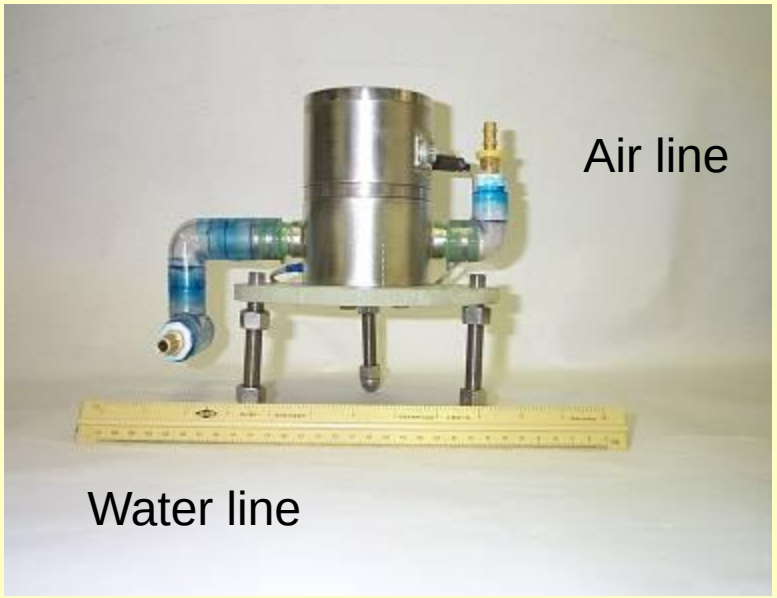


# Hydro static water Level Systems HLS

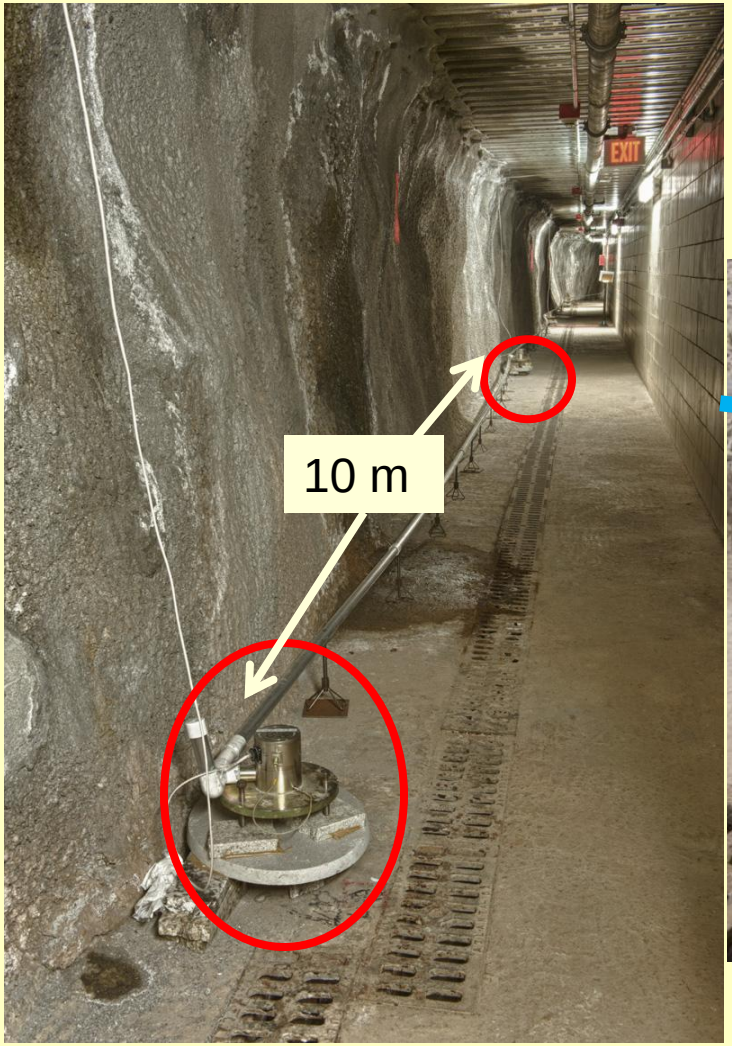
BUDKER sensor
Capacitive pickup
Accuracy 1 micrometer
Cost $1200 per channel

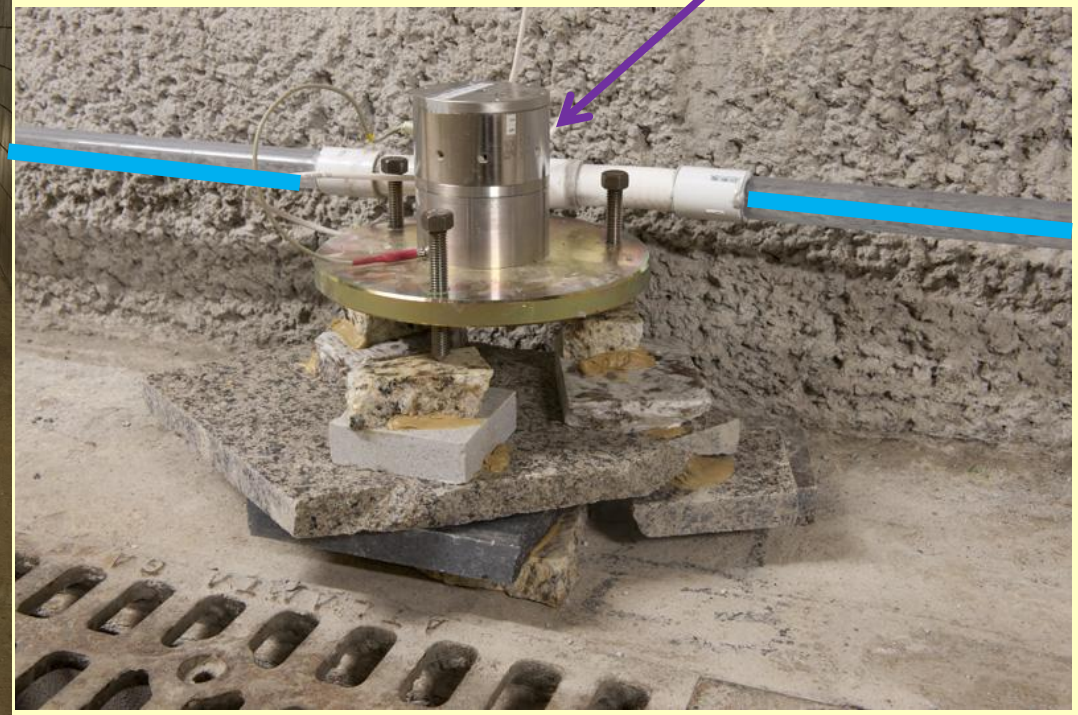



Capacitive sensor  Water pool

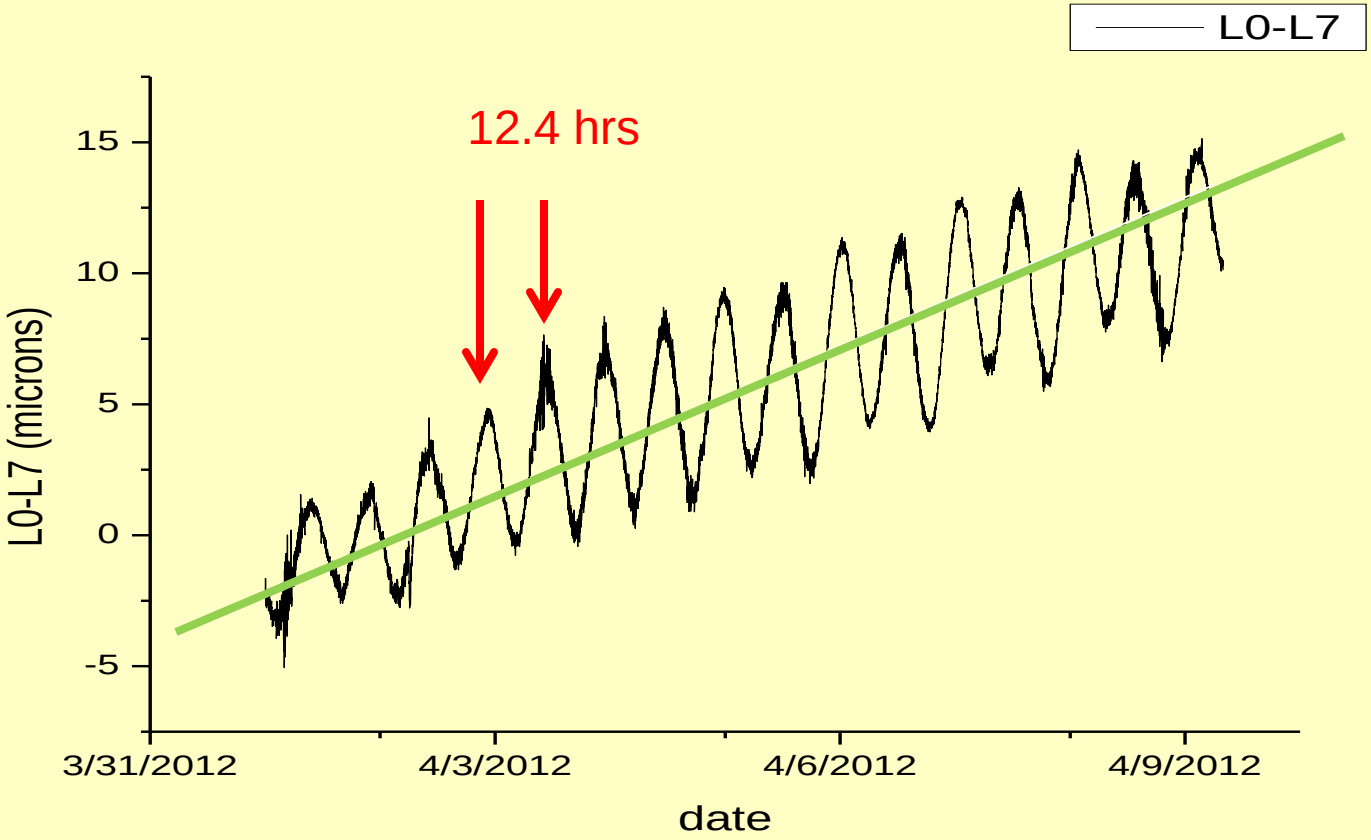
On stand with water and
Air line connections

# MINOS-2 HLS



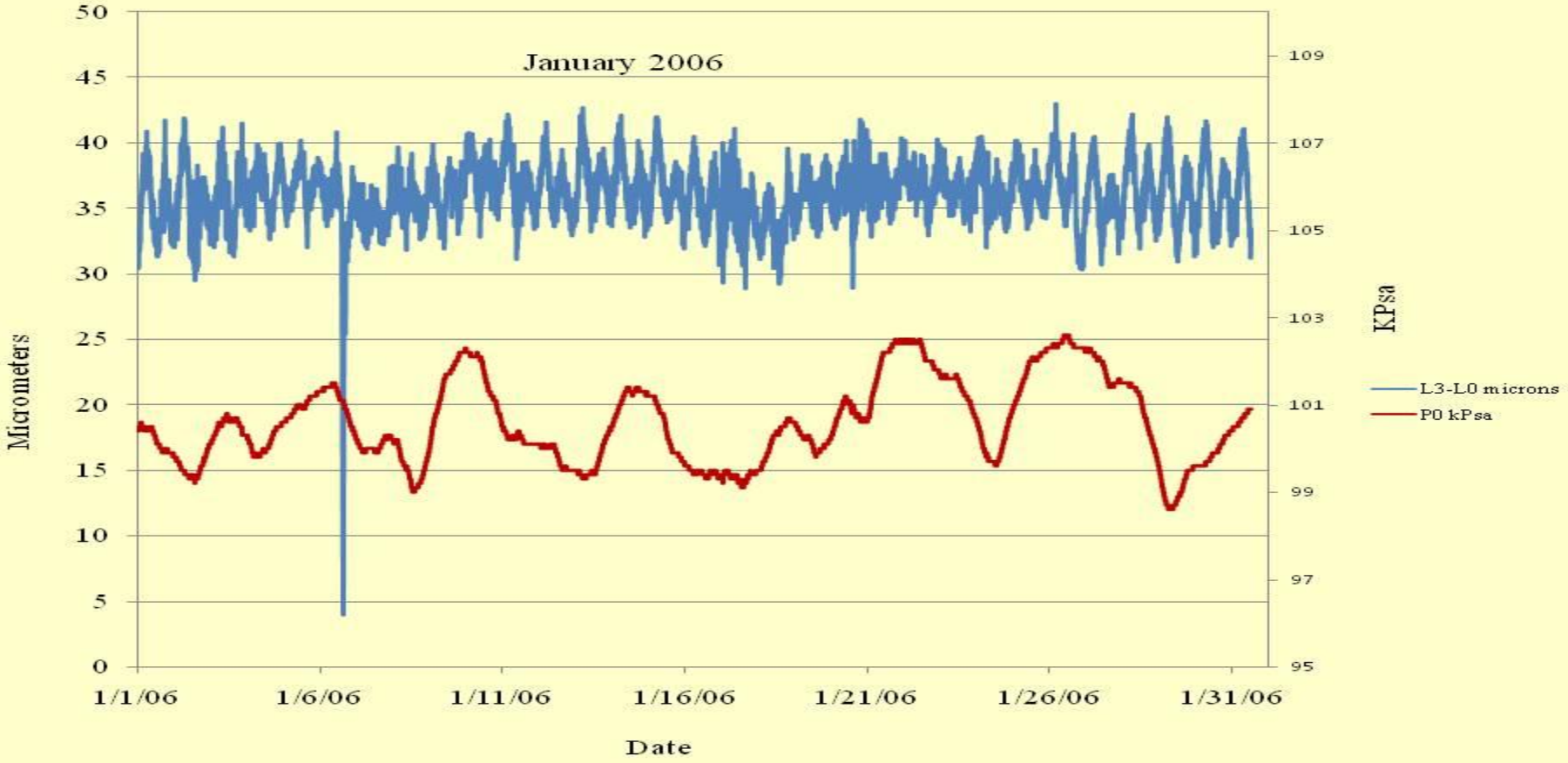



# Difference in two sensors 70 meters apart



# January 2006 MINOS

Difference in two sensors 90 meters apart

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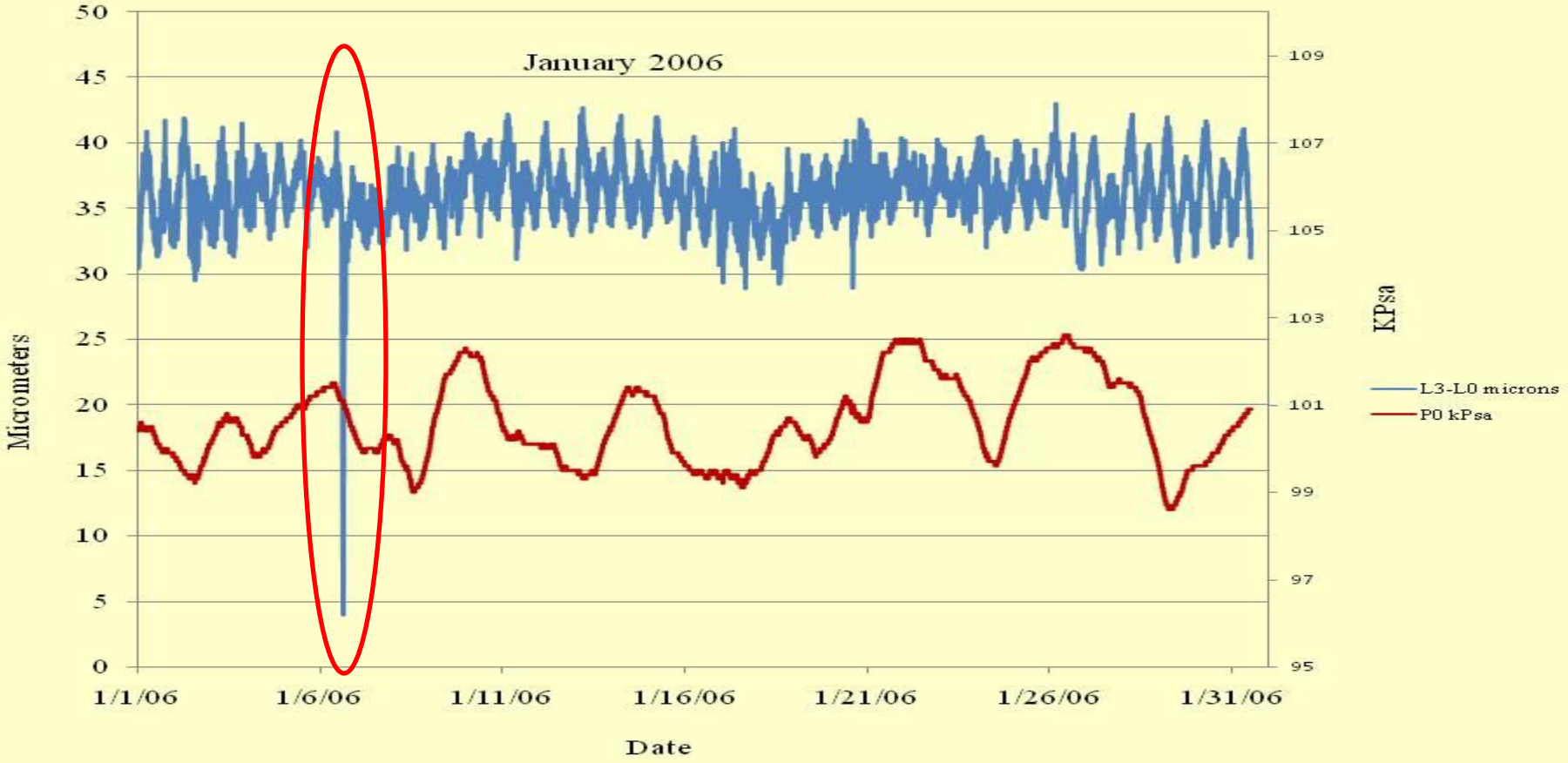
# January 2006 MINOS

Difference in two sensors 90 meters apart

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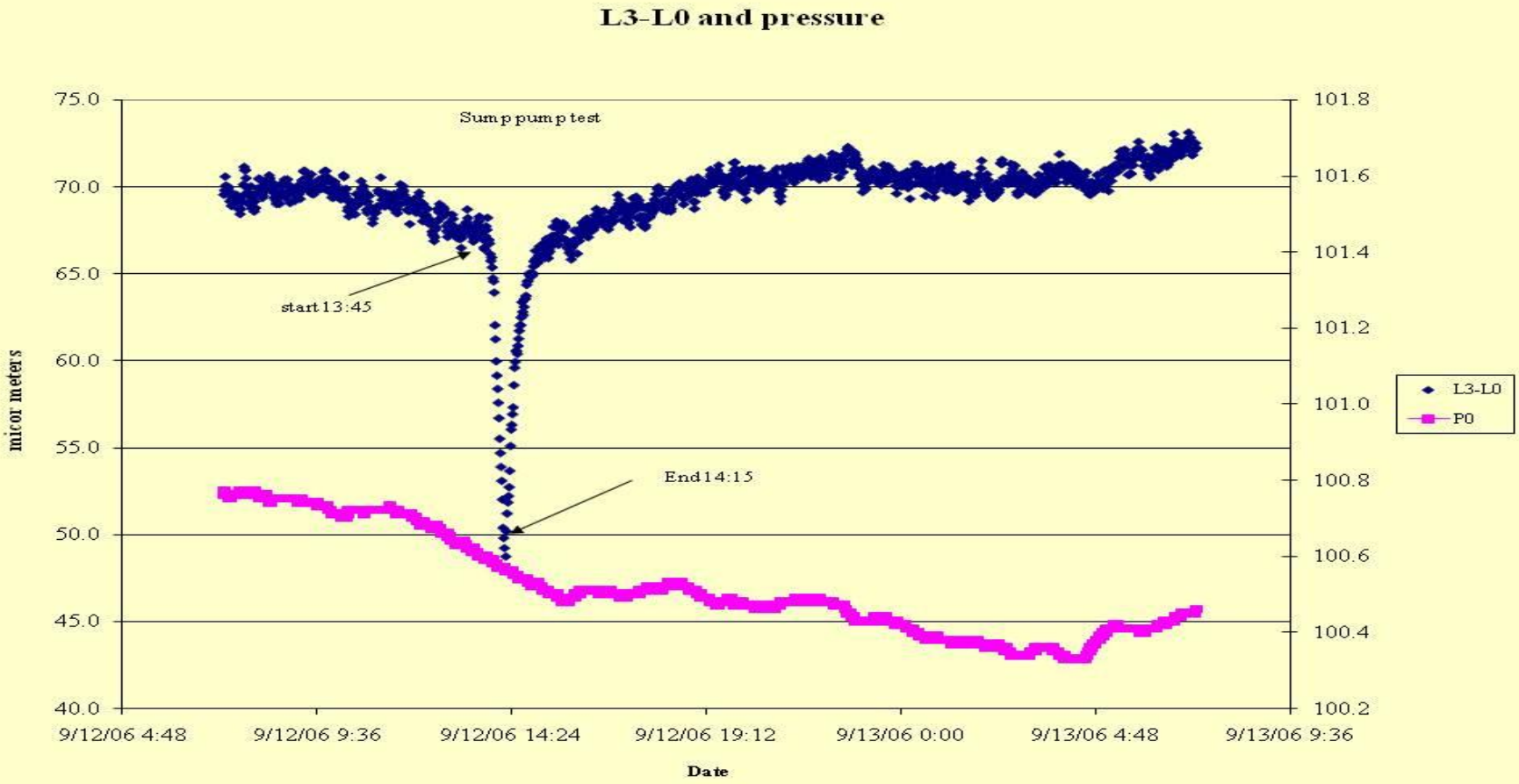
# Sump Pump Test

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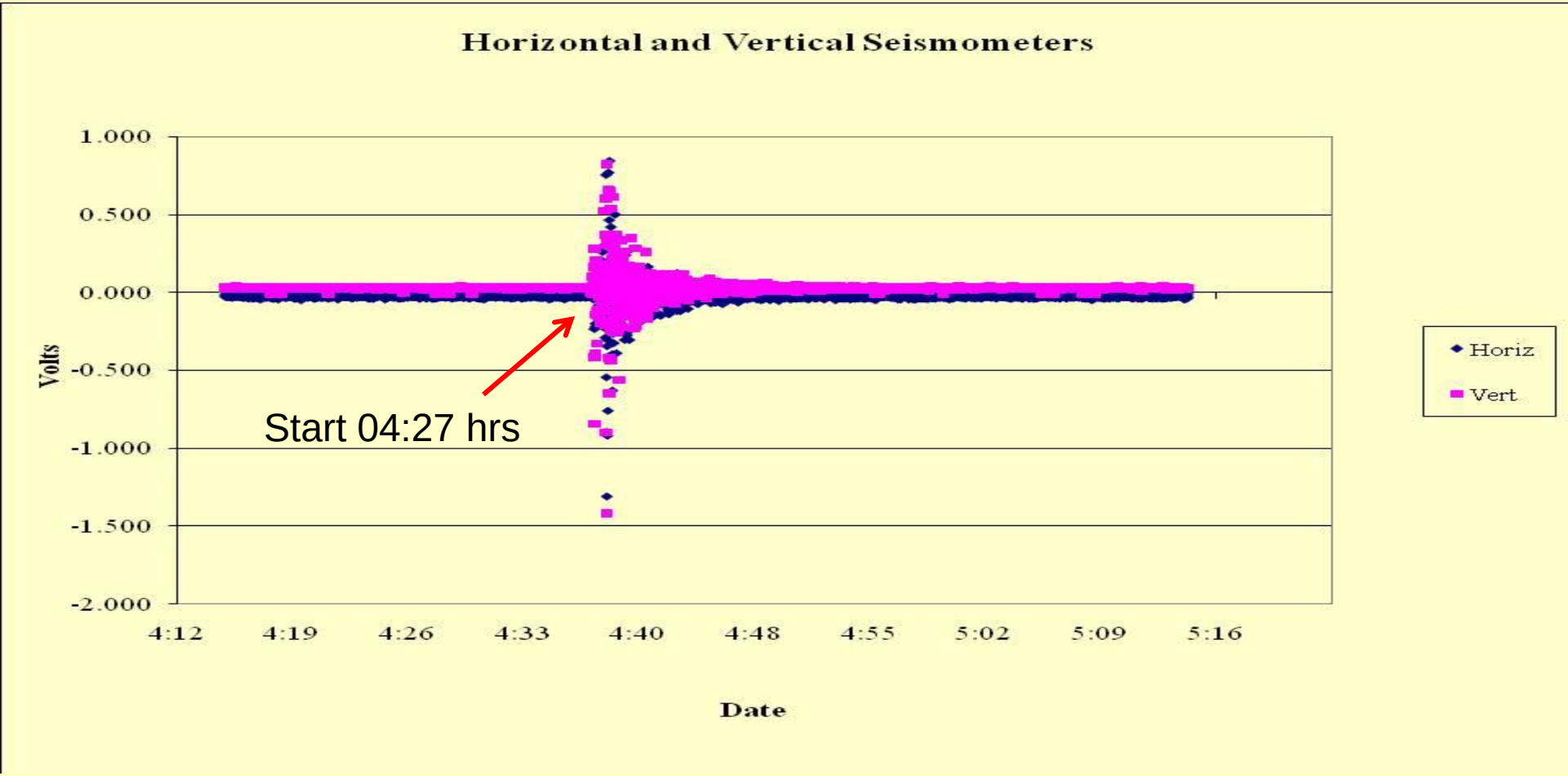
# Earth quake April 18 at 04:27 hrs CDT 380 km (236 miles) south south east of Fermilab

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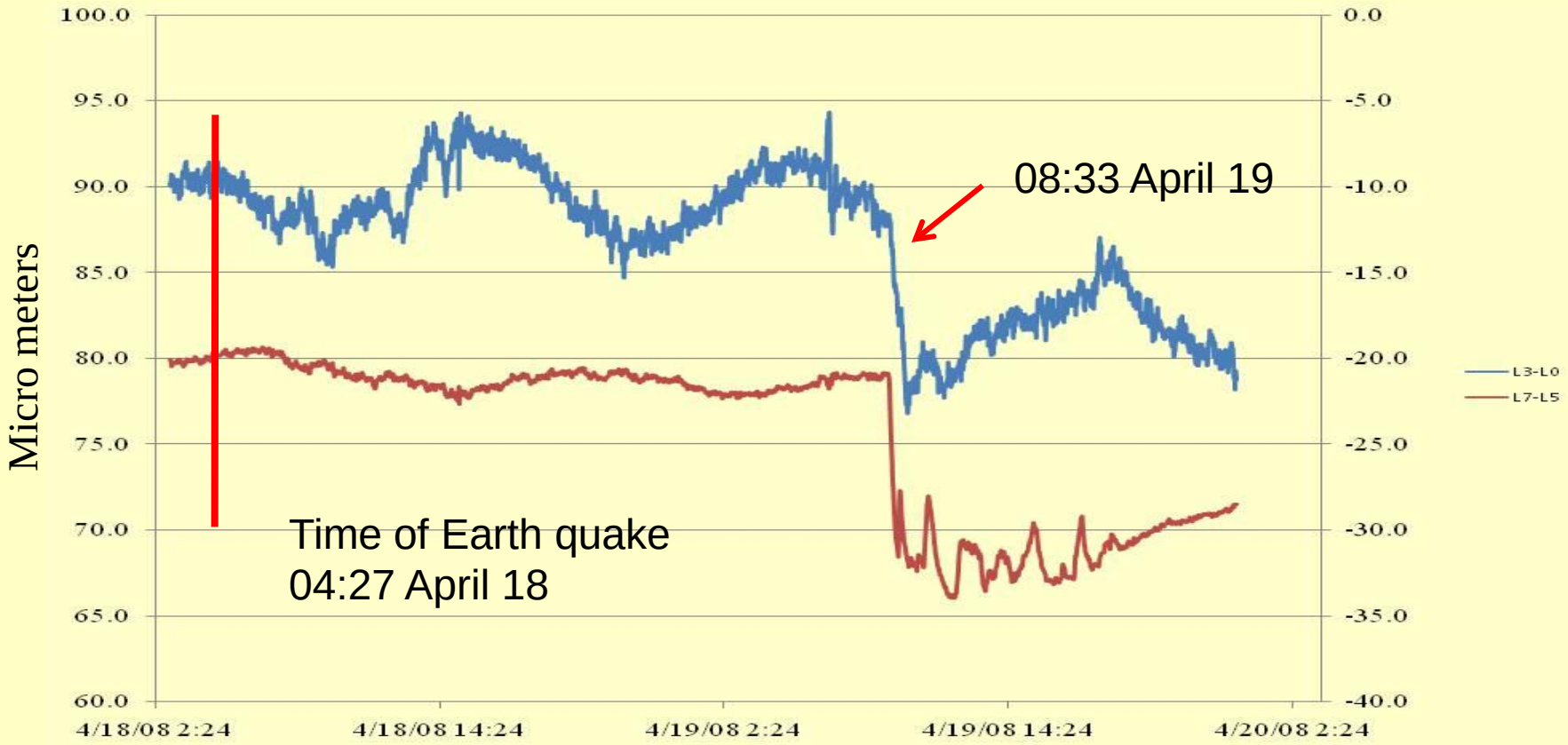
# North South and East West sensors difference MINOS hall



# LaFarge Mine North Aurora


There is a dolomite mine 7 km from the MINOS hall.
It is in the Galena Platteville layer 125 meters below the surface.
It is room and pillar Construction
There are 5 HLS sensors in an abandoned drift in the mine.

# The LaFarge Mine North Aurora Ill


Entrance to mine 390 meter decline

In the Galena Platteville dolomite 120 meters below grade

If the ILC were built at Fermilab this would be the preferred depth and strata

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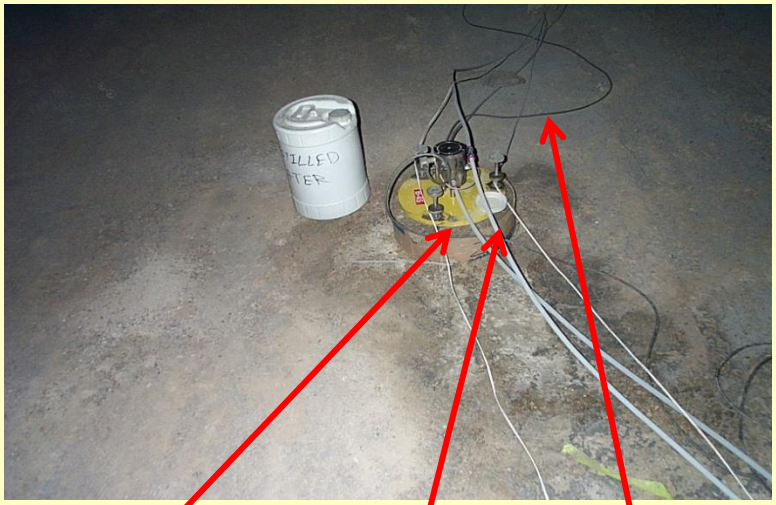
# Budker Sensors in South 5 drift

Station 3

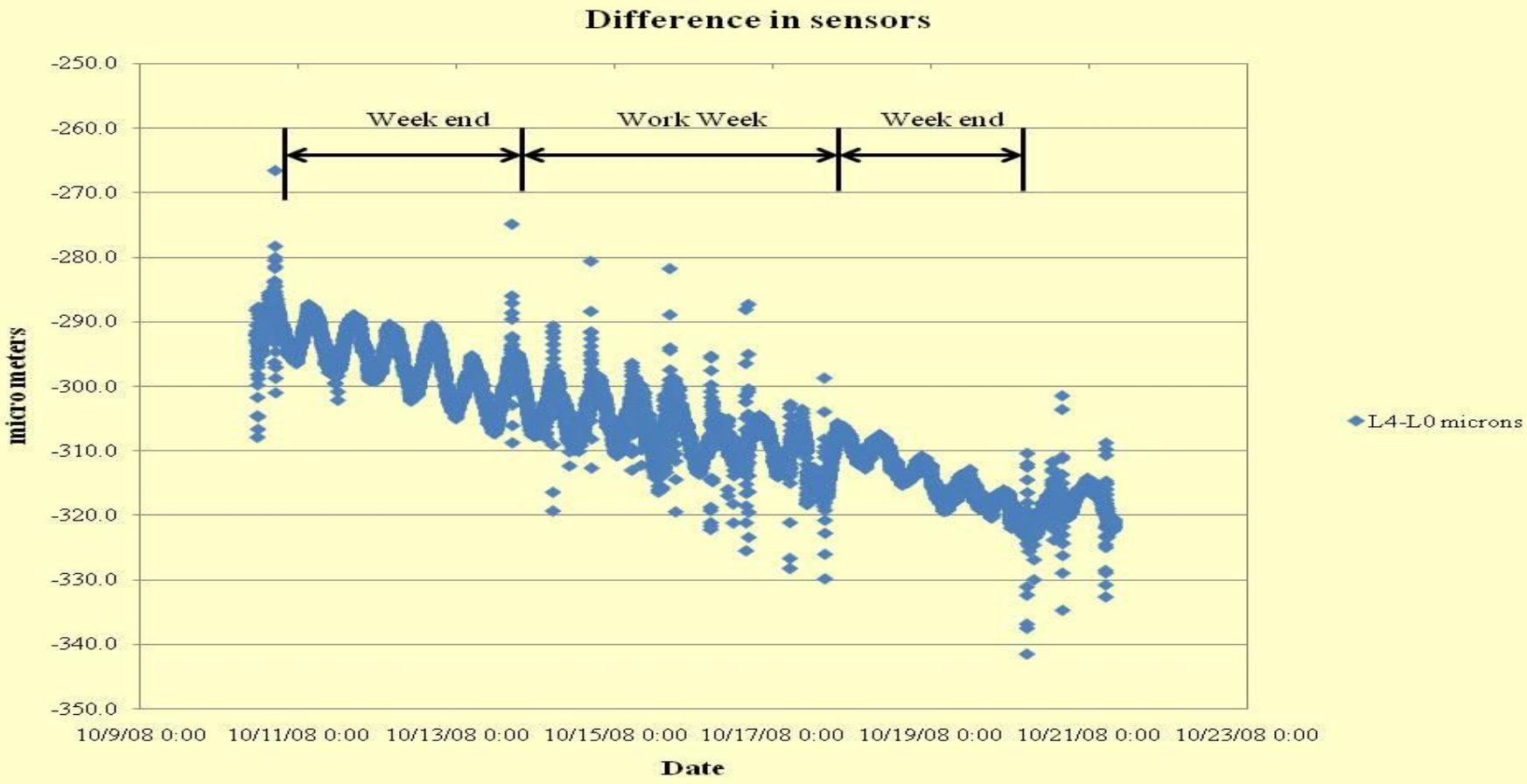


Water line Air line Data cable

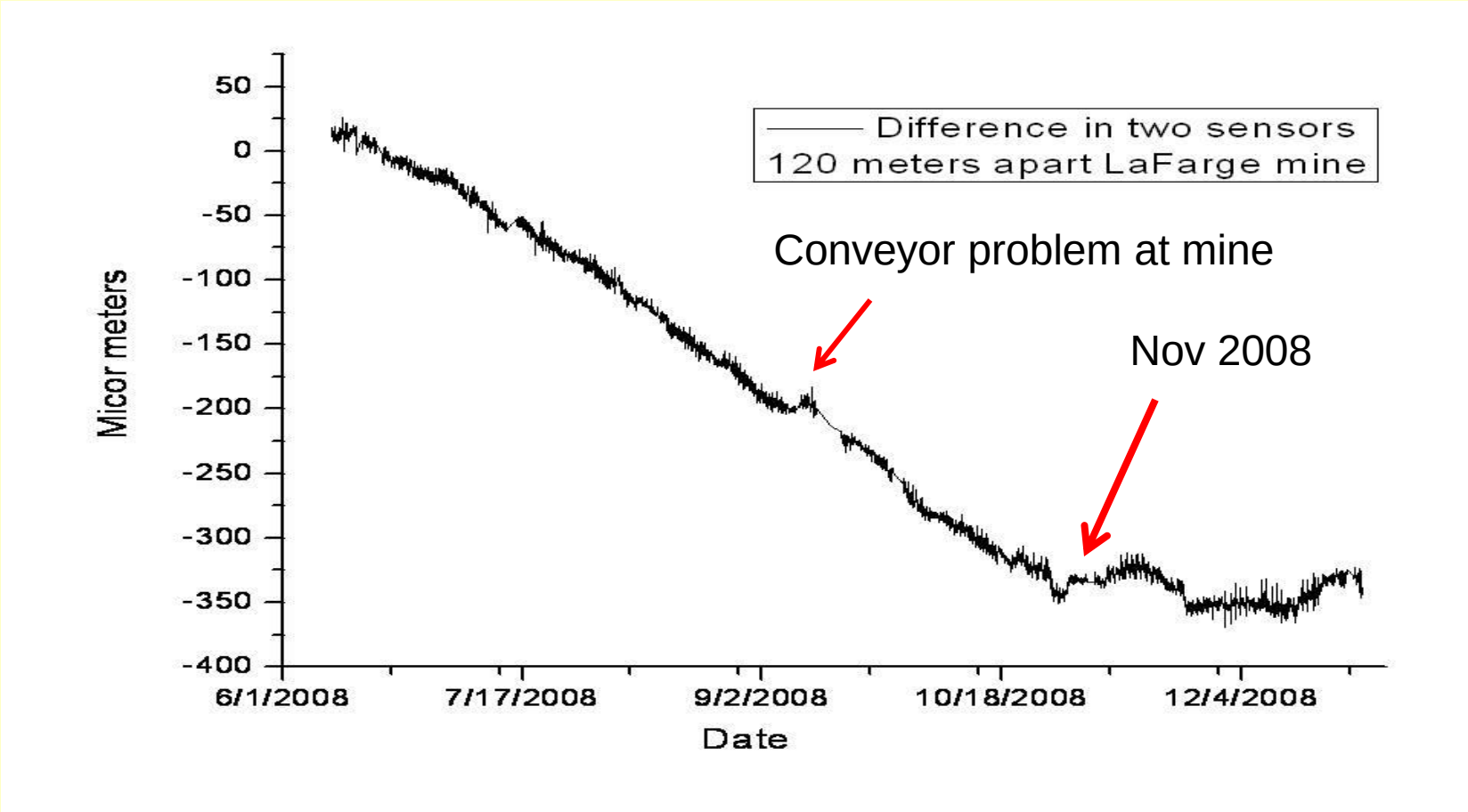
Station 4

Note built up concrete pillar this is to make up for difference in floor elevation

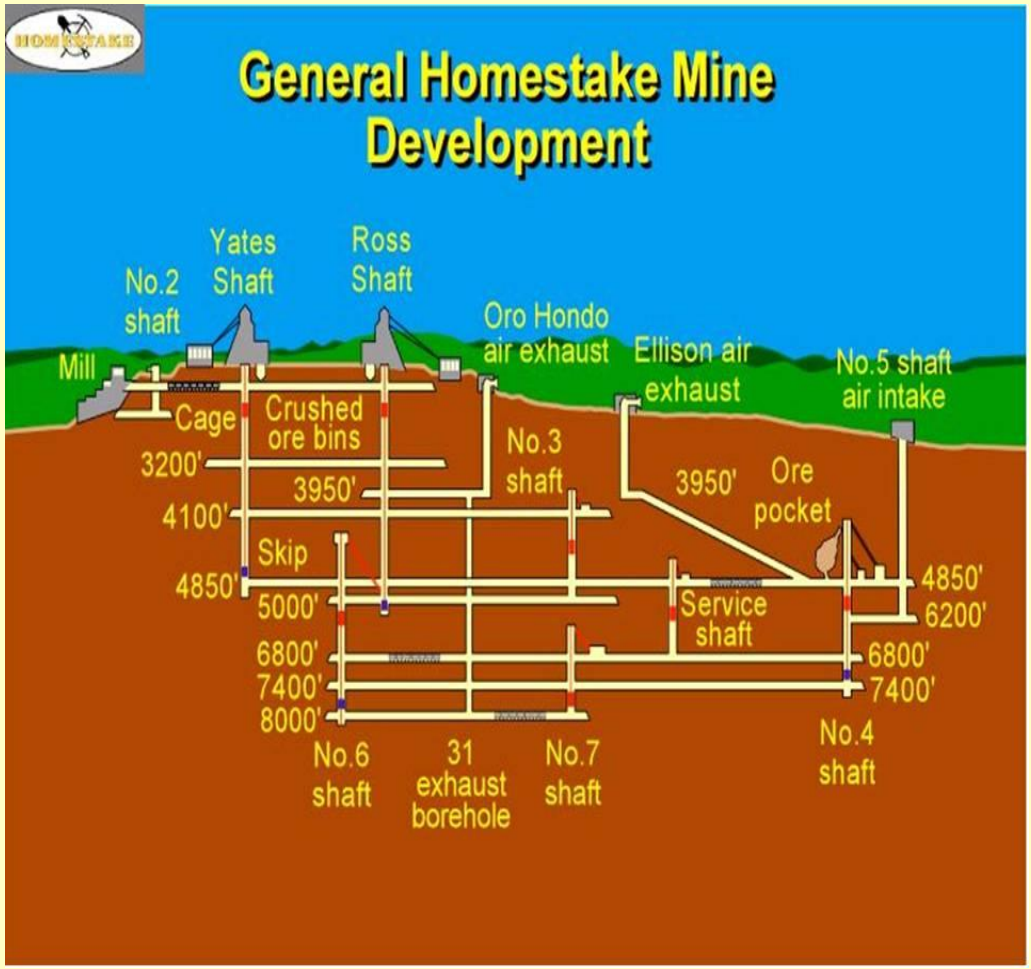
# Difference in two sensors 60 meter apart



# New setup in S5 drift 7 months of data



# DUSEL



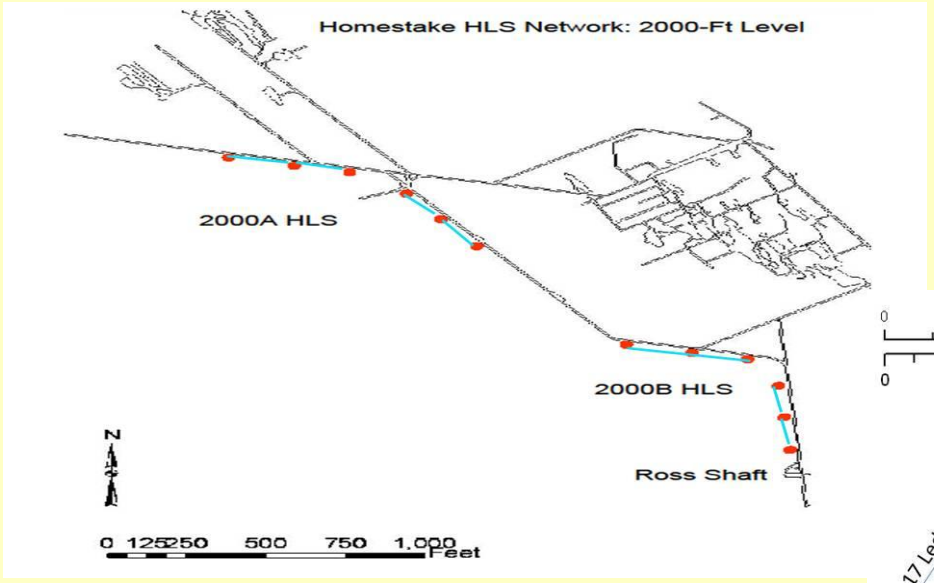

Deep Underground Science and Engineering Lab

In the Homestake Gold mine in Lead SD

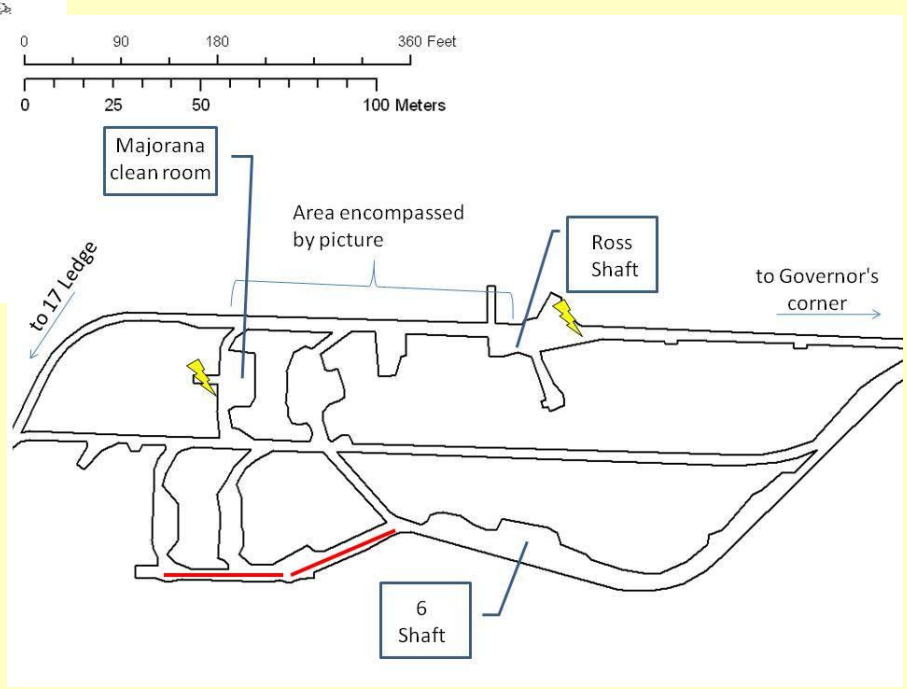
Lowest drifts 8000 ft (2400 meters) flooded to 4850 ft (1470 meters)

In January 2009 there will be 12 Tevatron style HLS installed at 2000 ft
In the summer 12 HLS at the 4100 ft (1242 m) to monitor tilt during dewatering process

# HLS layout at 2000 and 4850 foot level




2 independent stations
7 meters between sensors

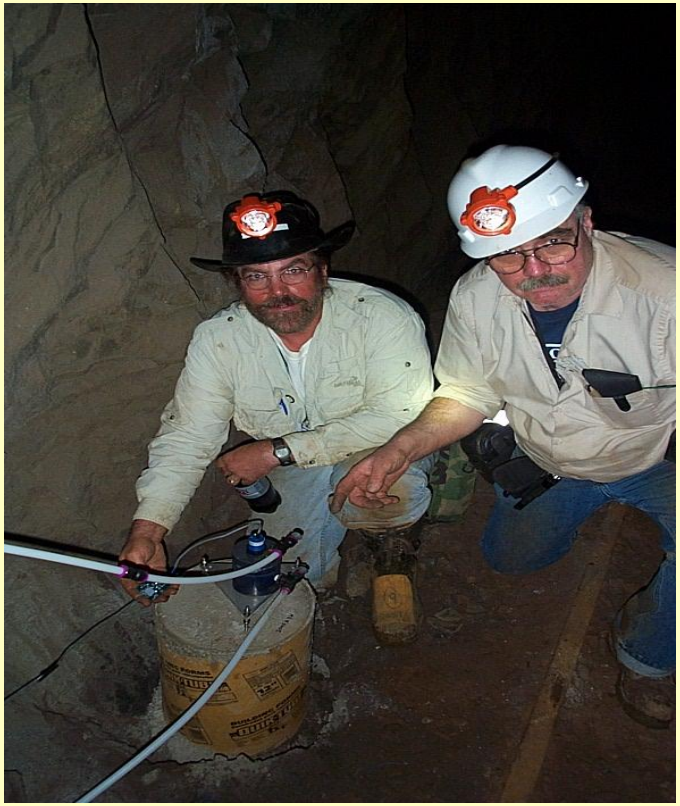



4 independent stations
200 ft between HLS

# HLS at DUSEL

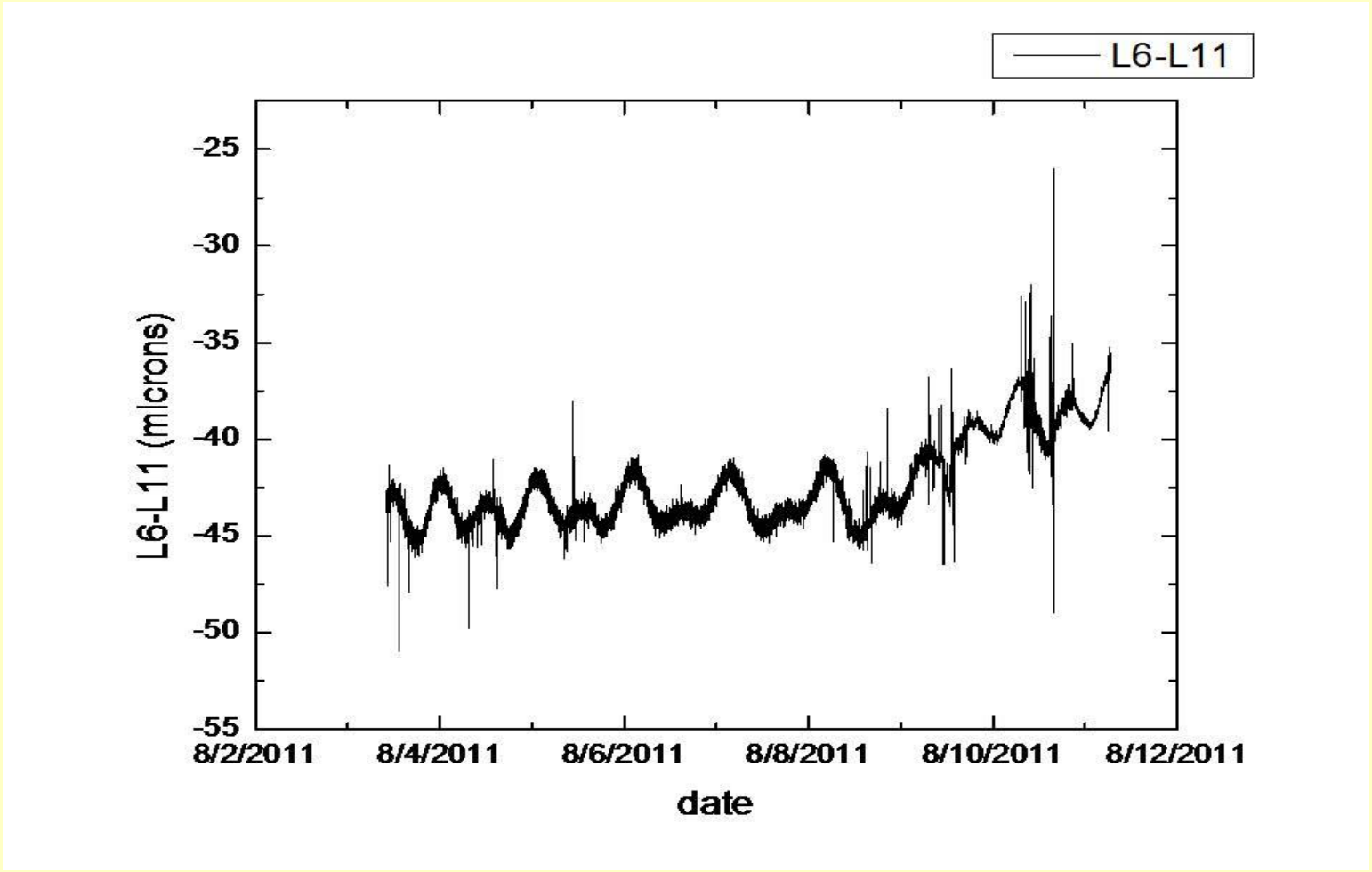
Tom Trancynger filling system with water

Jason Van Beek terminating data cable

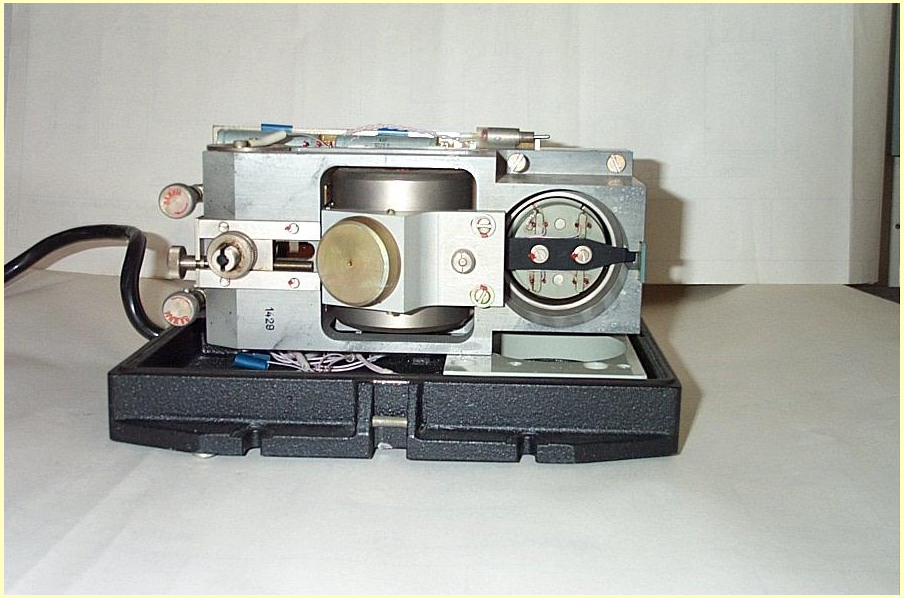


Larry Stetler of SDSM&T and Jim Volk

# Floor tilt 4850 ft level Homestake mine



# Russian Seismometer



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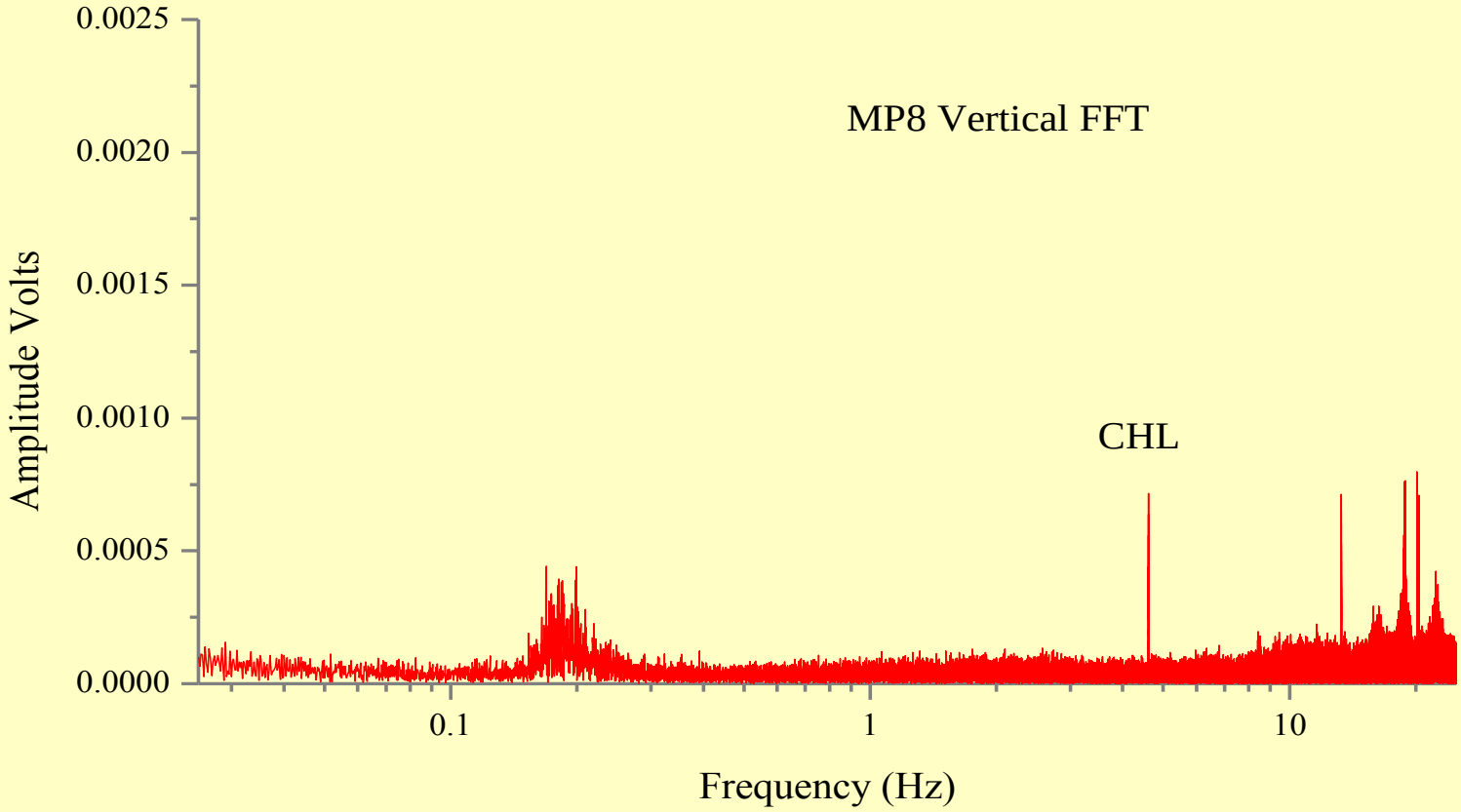
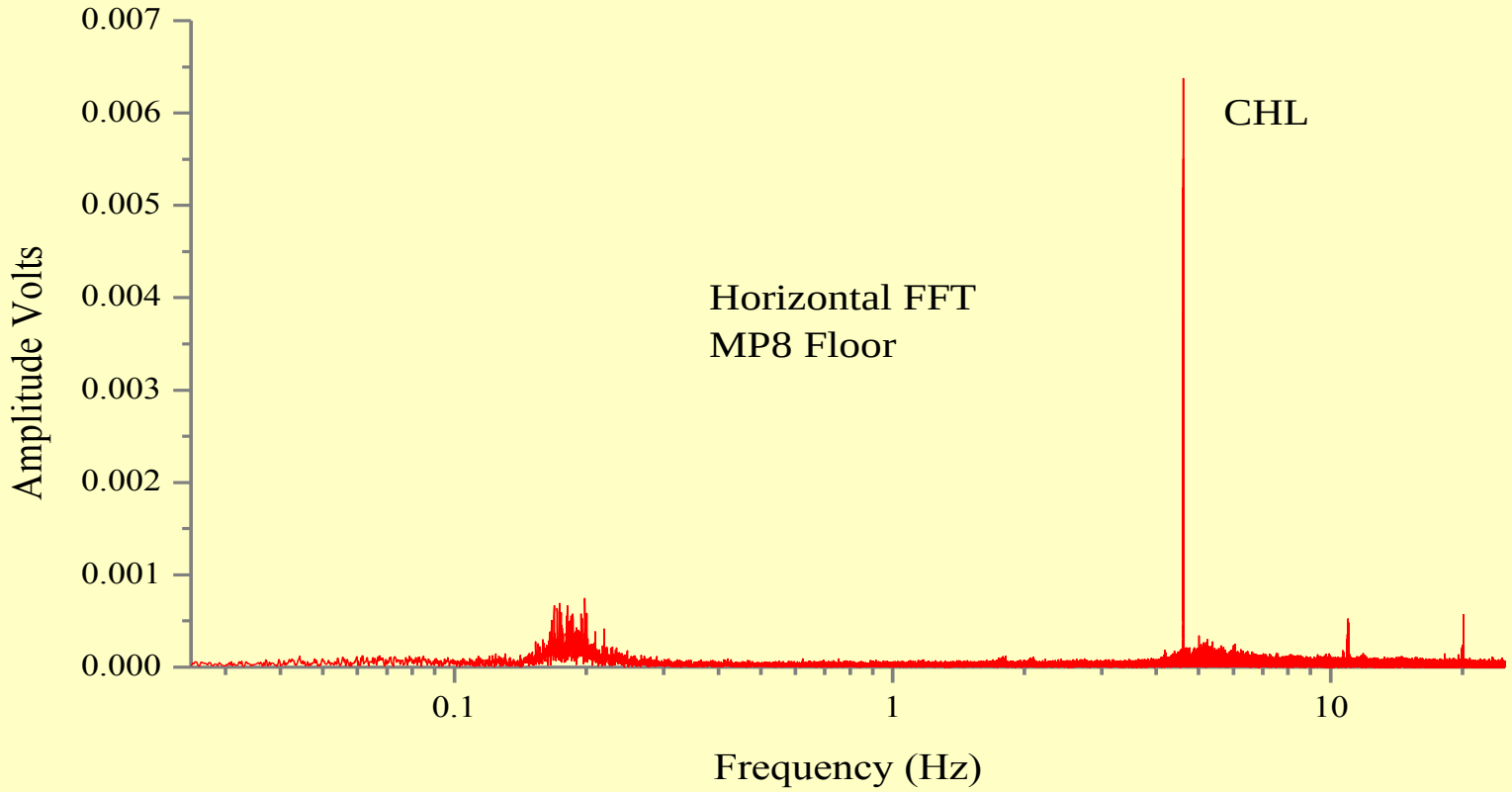
# Vertical motion at grade Fermilab log scale



# Horizontal motion at grade Fermilab log scale



# Central Helium Liquifier

Large compressors

# Summary

- There are several HLS system taking data at Fermilab in the Homestake mine.
- They are accurate and reliable can run for several years.
- They are useful for determining ground motion and tilt.
- The data are available at; http://dbweb1.fnal.gov:8100/ilc/ILCGroundApp.py/index
- There are natural sources of motion: tides, rain fall, earth quakes both large and small.
- There are cultural sources such as sump pumps.
- Plans for new systems in the works.