



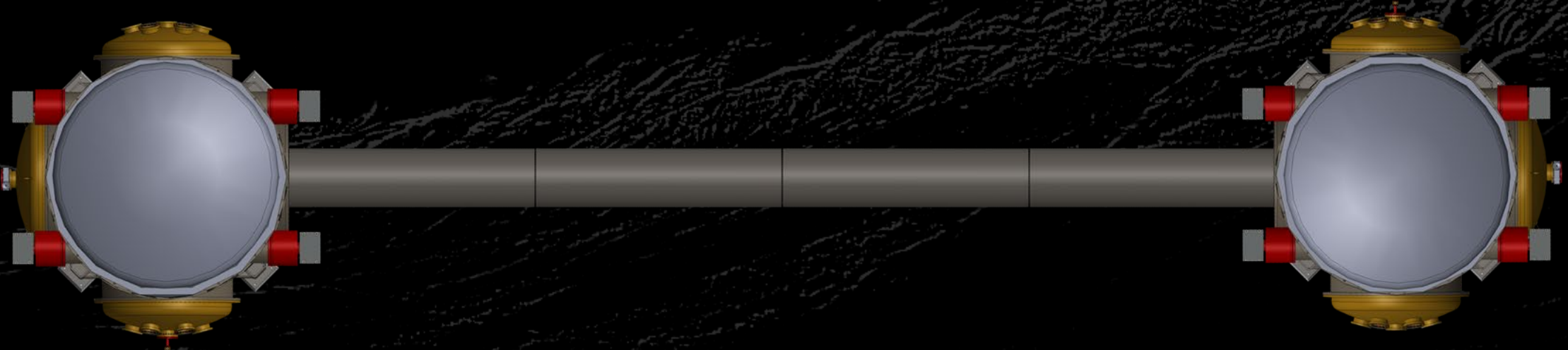
# GEMINI

A new underground seismic-isolation facility at LNGS

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INFN - LNGS



- Two vacuum chambers connected by vacuum tube
- Inertial platform inside each chamber
- Laser-interferometric readout of the relative motion of the two platforms
- Cryosystem connected to one of the two chambers



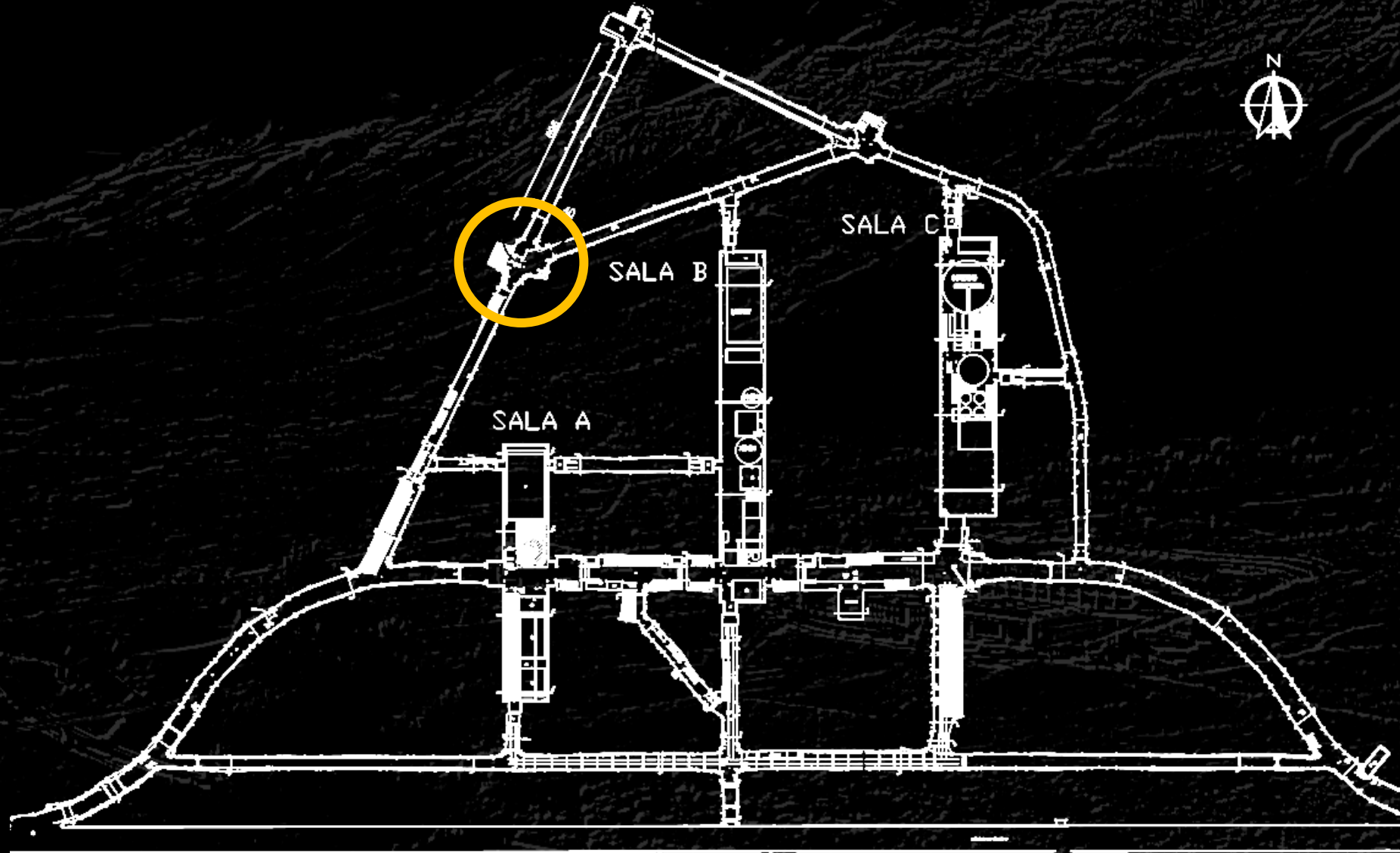
# Background

- Experiment at INFN LNGS
- Collaboration between GSSI and LNGS
- Funded through ETIC (80%) and ASTRA (20%)
- The ETIC funding must be spent within 3 years
- Approach for GEMINI: take LIGO HAM ISI as starting point and modify
- Status:
  - Design changes are being finalized
  - Call of tenders under preparation (must be assigned by end of 2023)

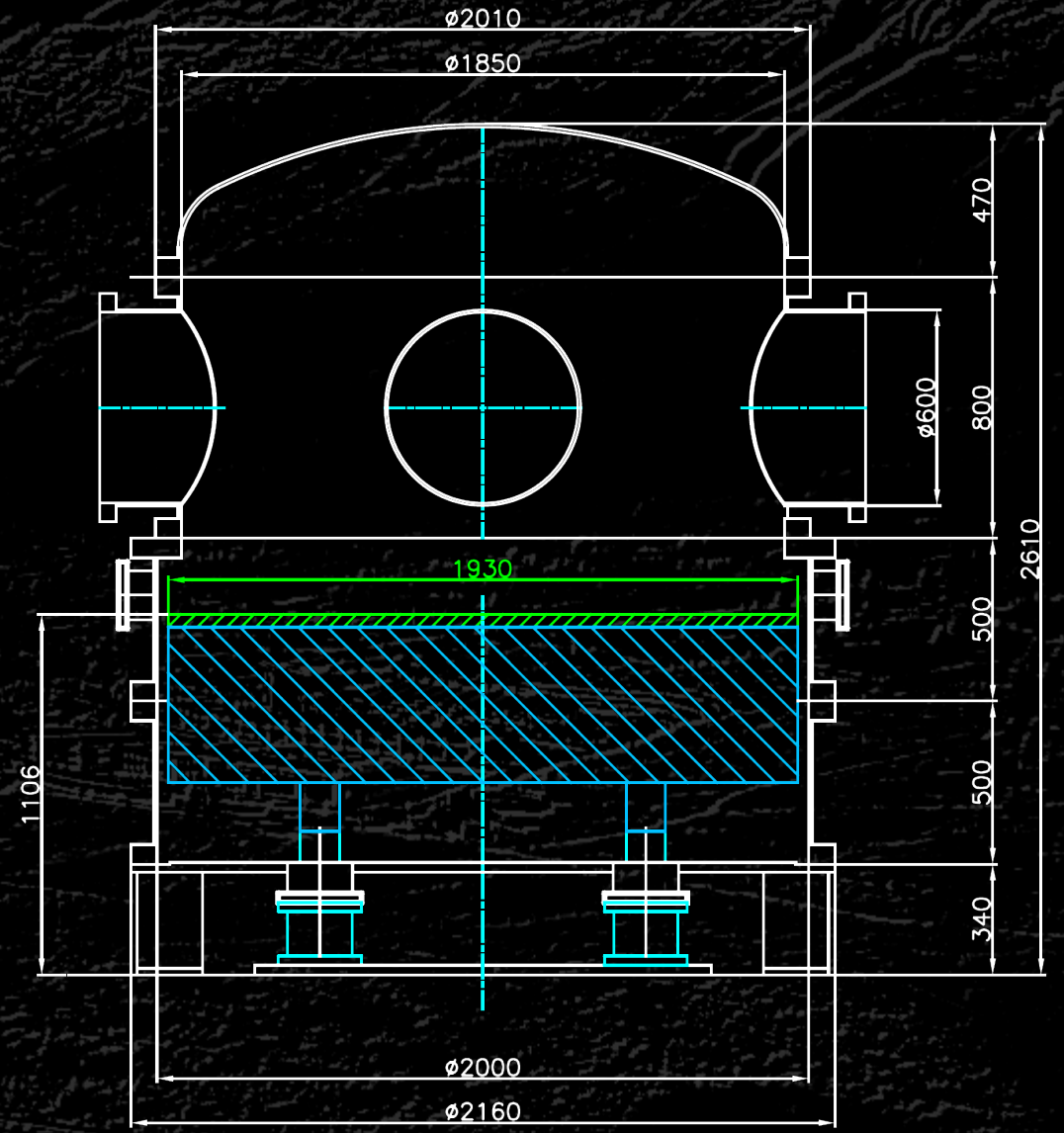
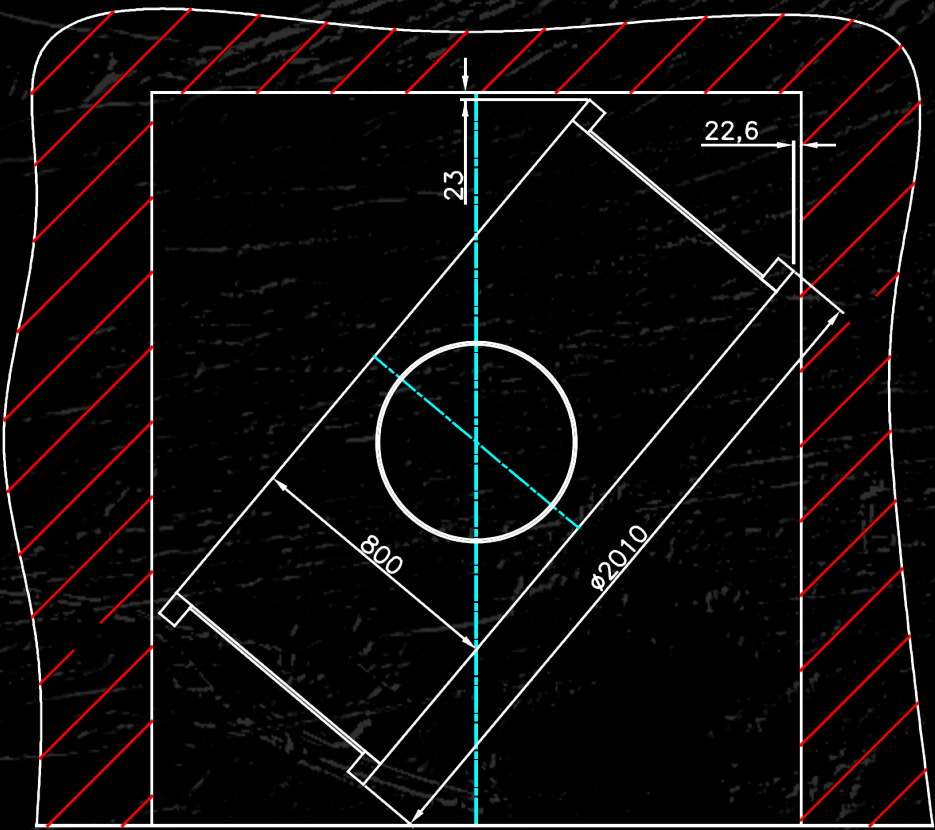


- Test the limits of active seismic isolation in an underground environment
- Inter-platform motion control
- Underground environmental monitoring
- Test new approaches to controls optimization
- Test new inertial sensors

# GEMINI Site

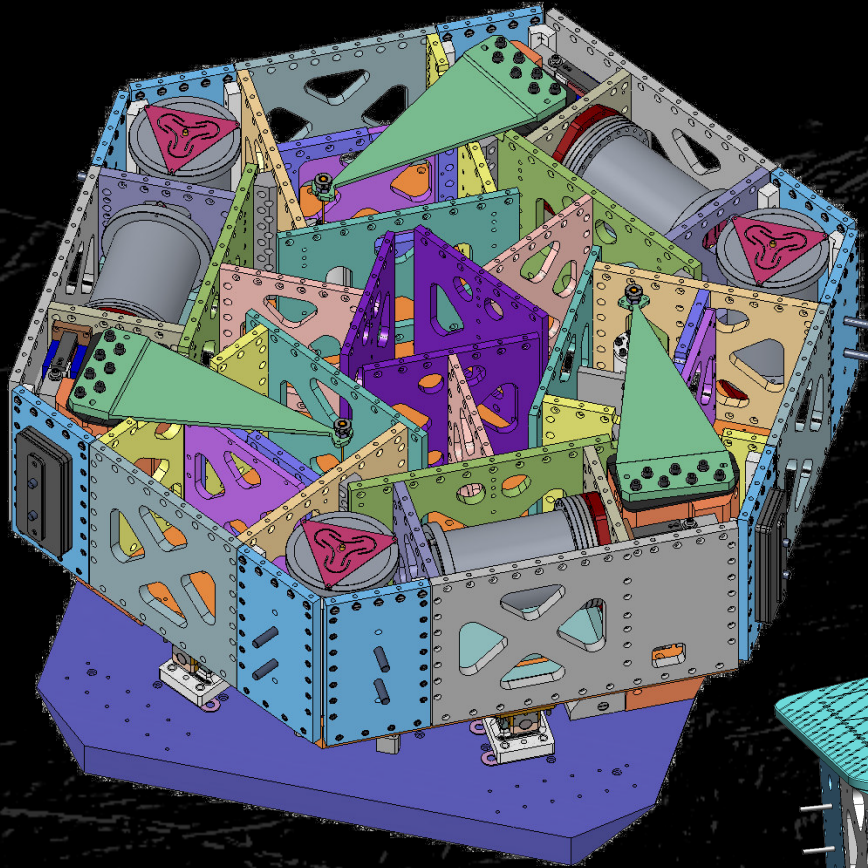


# Challenge: Installation



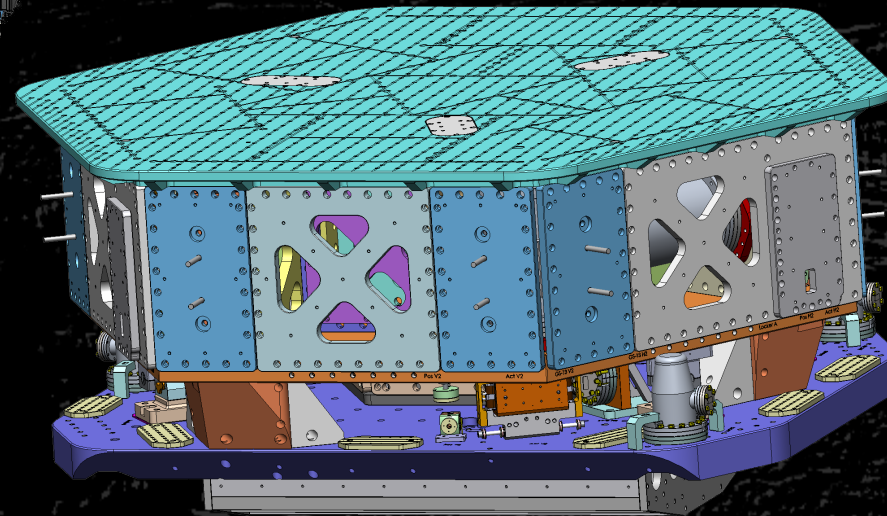


# LIGO HAM ISI: Stage-1

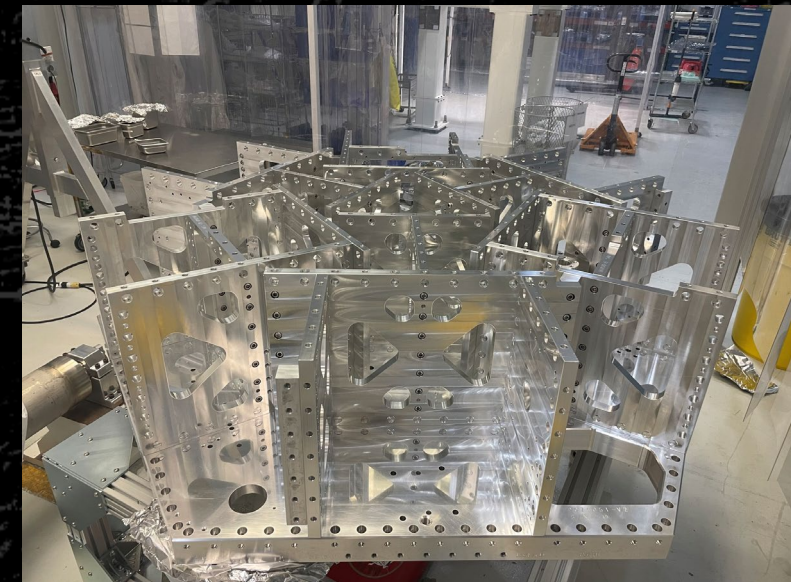


Modifications for GEMINI:

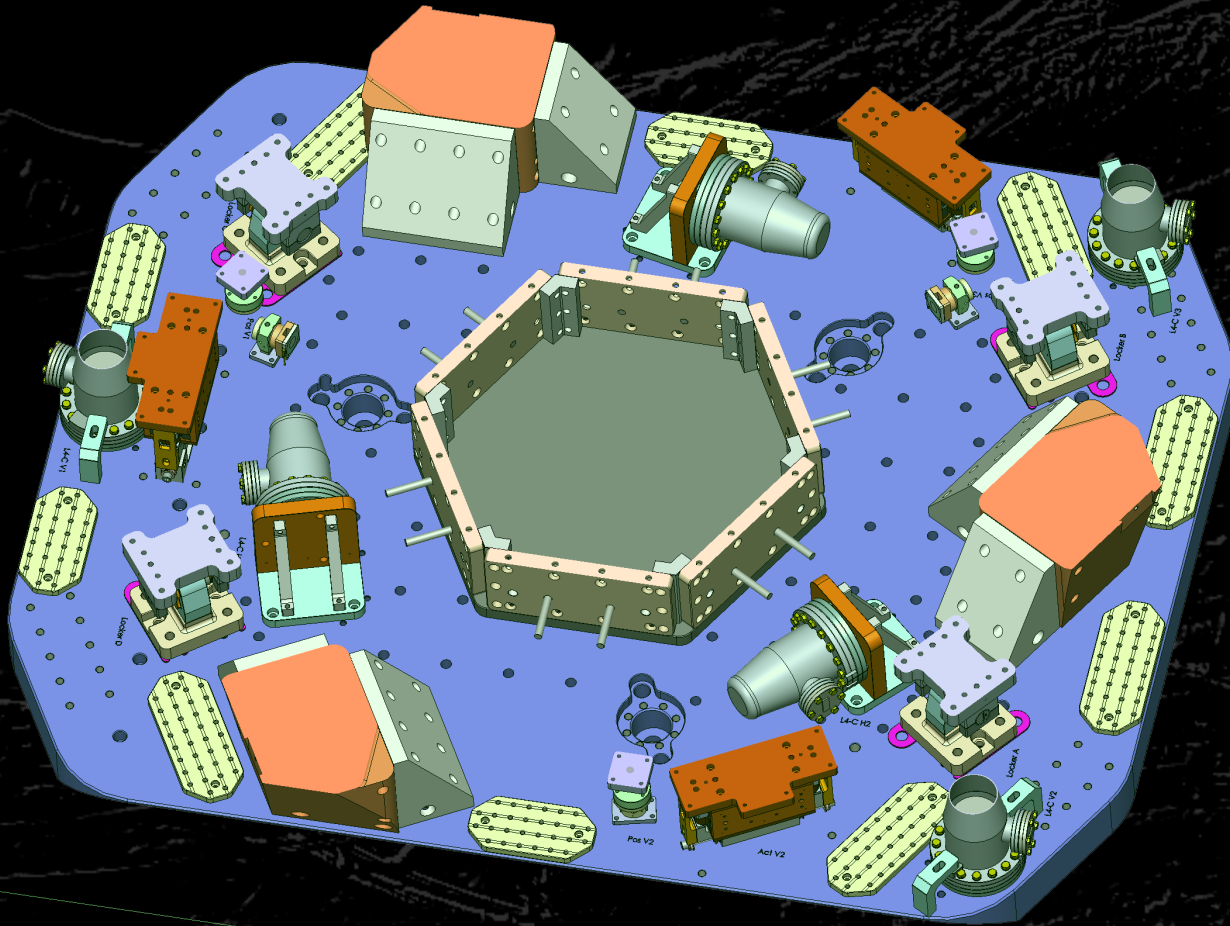
- Slightly smaller table (edges cut)
- 3x Nanometrics T360 per platform will be used as inertial sensors
- BOSEMs will be used as position sensors / actuators



LLO HAM ISI (January 2023)



# LIGO HAM ISI: Stage-0



- Modifications for GEMINI:
- Almost fully redesigned
  - Will stand on three legs
  - Remove L-4Cs
  - Substitute position sensors and actuators by BOSEMs

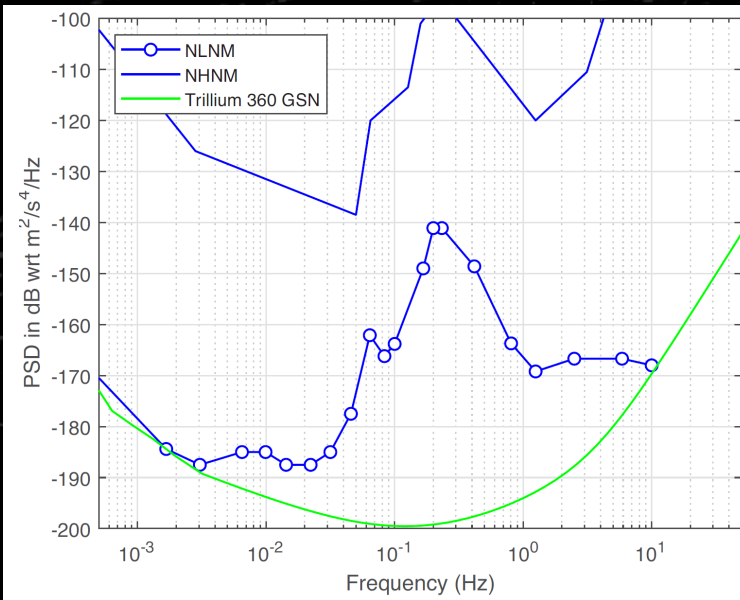
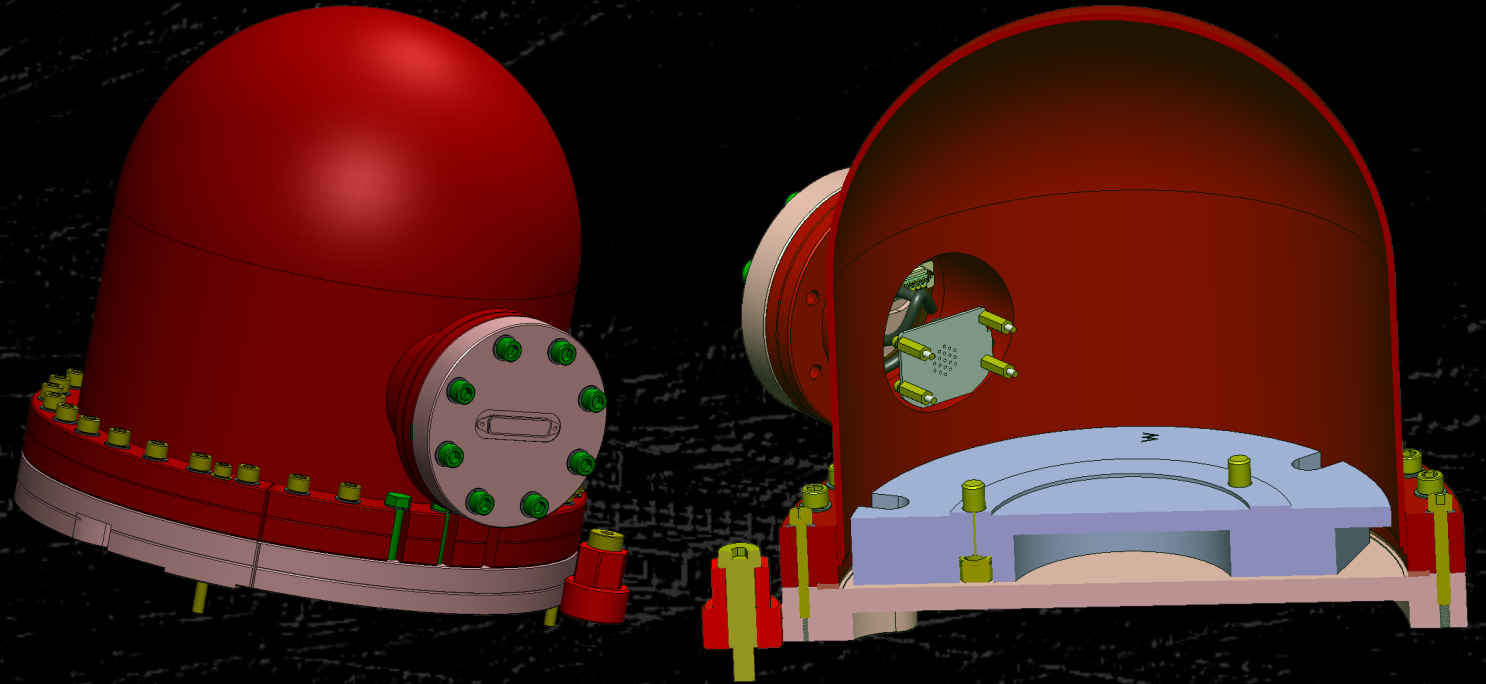


# On-platform Seismometers

## Nanometrics T360 GSN Vault

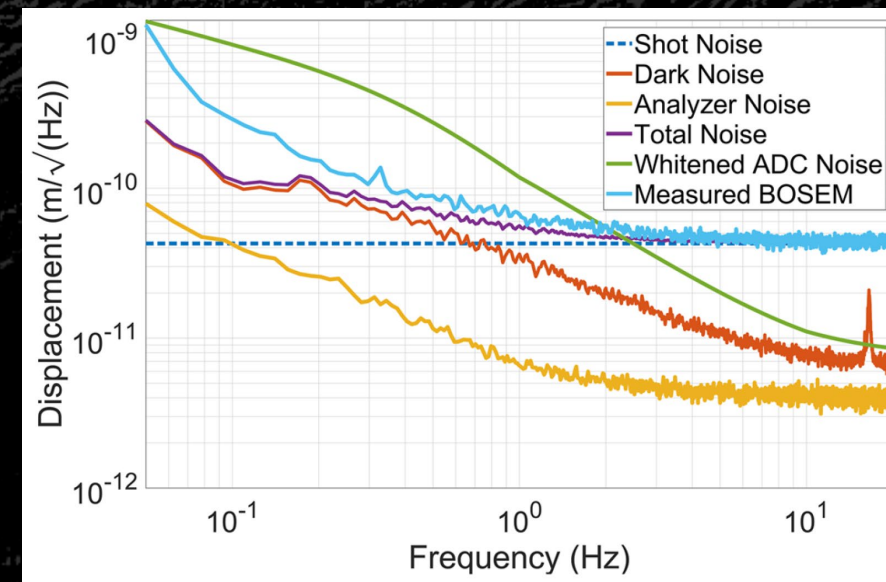
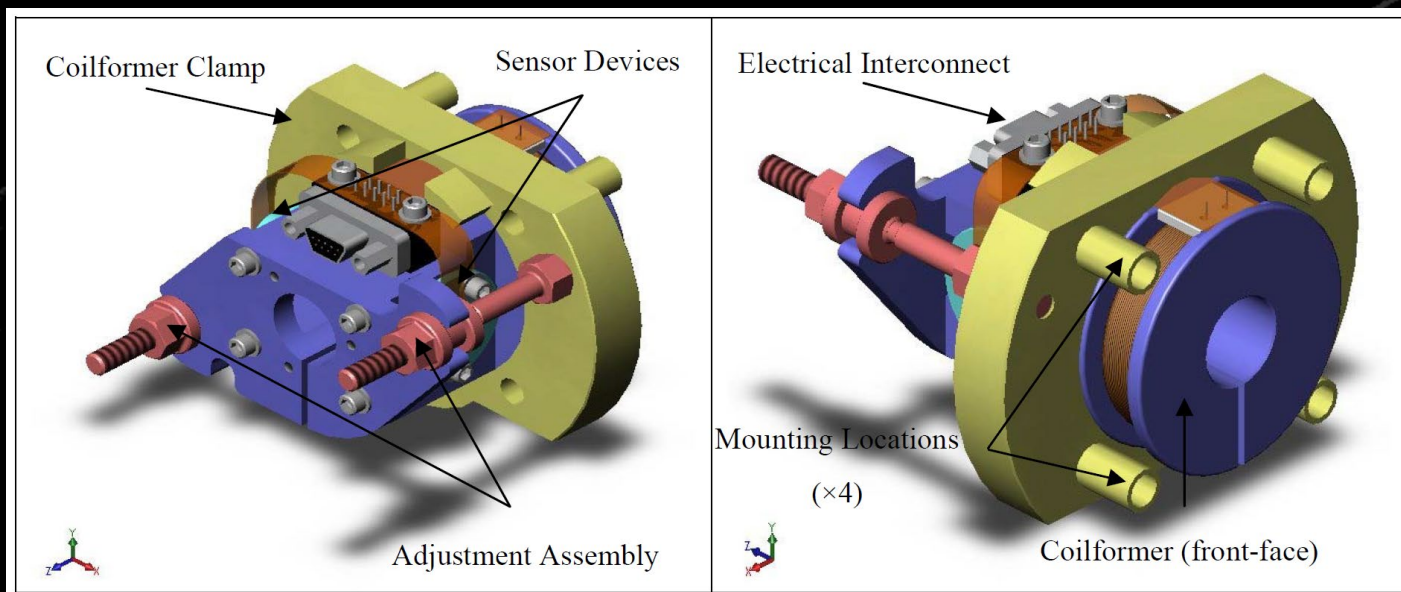


Vacuum pod

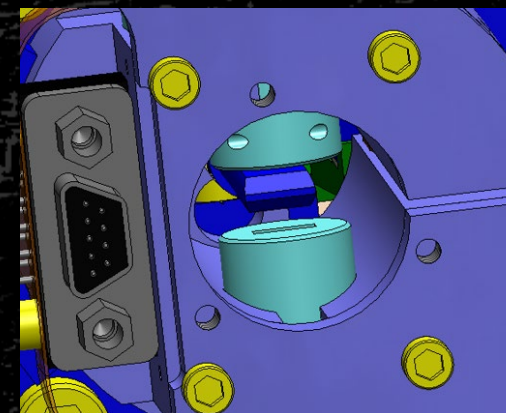


The T360 is not designed for in-vacuum operation, and a vacuum pod is required, which keeps a normal pressure.

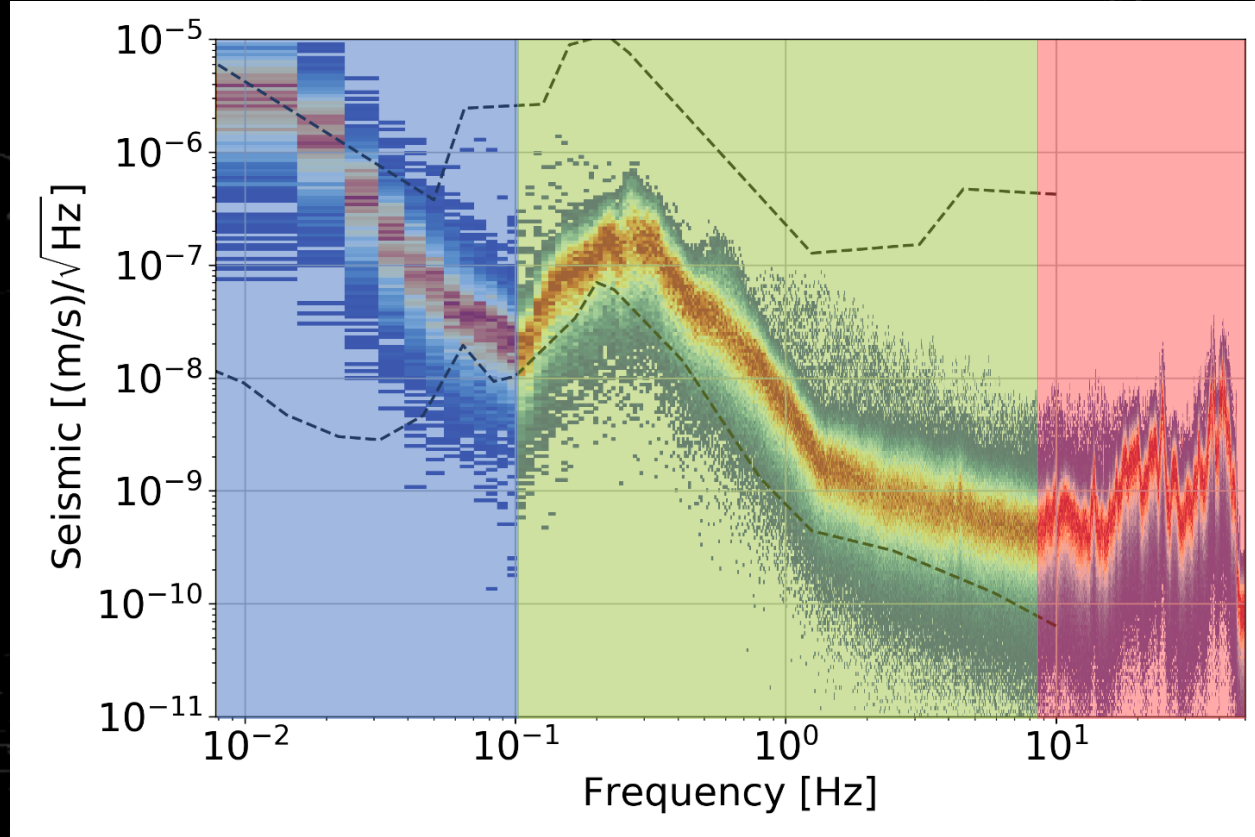
# Birmingham Optical Sensor and Electro-Magnetic Actuator



- Shadow sensor: a flag partially obstructs light cast by an LED onto a photodiode
- Coil actuator
- Recent paper: RSI 94, 014502 (2023)



# Underground Environment



**Blue:** excess noise, which is probably ground tilt produced by pressure fluctuations

**Green:** natural low underground seismic noise

**Red:** excess noise from machines

Important: Analyze  $<0.1$ Hz excess noise and its impact on active seismic isolation