University of Glasgow

Technological Advances: Seismic/Suspensions

Giles Hammond

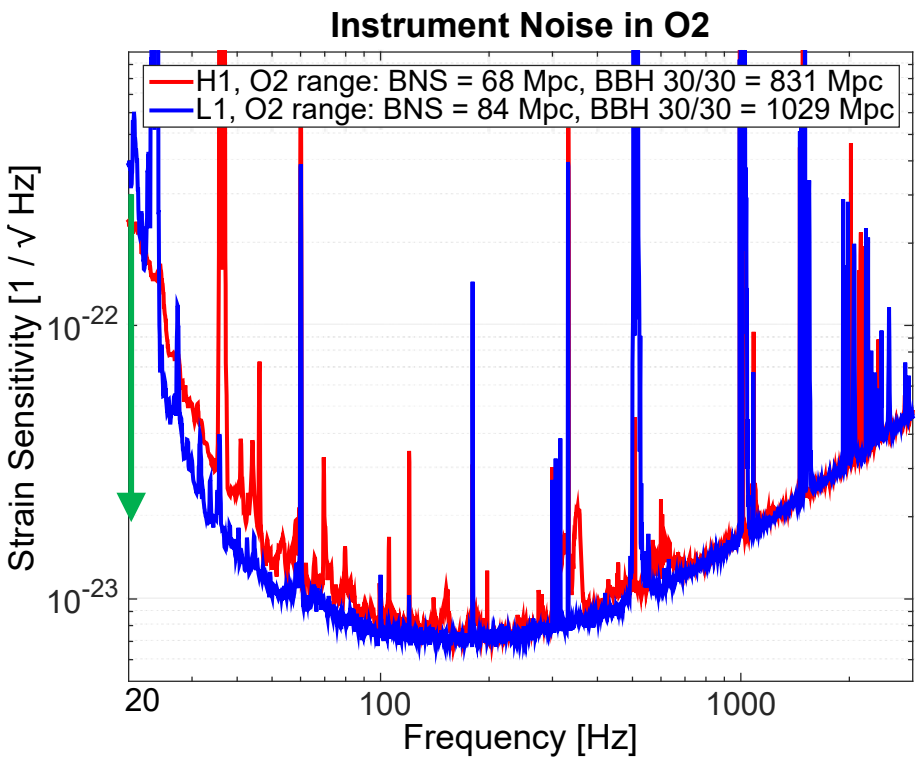
Institute for Gravitational Research

University of Glasgow

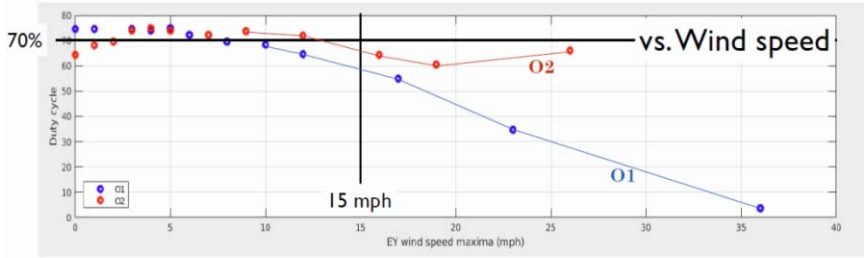
LIGO G1701267

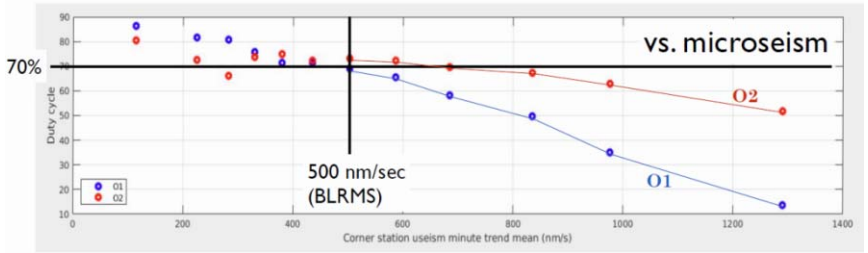
DAWN III meeting, Syracuse NY, July 6th-7th 2017

Highlights



- Good progress on commissioning
- Improved duty cycle during excess noise (wind/earthquakes) with tilt sensors





- Well engineered solution to install/commission robust monolithic suspensions
- Bounce/Roll mode dampers
- Collaboration with KAGRA via the ELITES programme

Work towards aLIGO Design Sensitivity

- To realise aLIGO design sensitivity will require coordinated effort to address low frequency noise

  - Scattered light, lots of work done during O1/O2 break at LLO. Better baffling and absorbers
  - Length-Angle decoupling (cross-coupling in suspensions/actuators)
  - Implementation/operation of seismic subtraction arrays (aLIGO/AdVIRGO)
  - Characterisation of thermal/magnetic effects with seismic/suspensions (violin modes track temperature variation)

- Switching out ETMs to operate with improved coatings
- End reaction masses with annular cutouts to reduce squeeze film damping
- Charging; seems to be a reliable method for in-situ charge measurement and mitigation

A+ and 3rd Generation Technology

- **A+**
  - Newtonian noise subtraction using seismometer arrays: optimising the array
  - Make use of current ISI, but implement tilt sensors
  - Larger diameter beamsplitter suspension
  - Monolithic suspensions with thinner fibres (for bounce/roll/violin modes)
  - Stray light modelling & analysis
  - Laser damage thresholds & contamination control
- **3rd Generation (LIGO Voyager/Cosmic Explorer/Einstein Telescope)**

Newtonian Noise

- Site selection (surface/underground/existing infrastructure), optimum location for multiple 3rd generation detectors
- Modelling of NN from atmospherics sources (infrasound) and structures
- Design/modification of site infrastructure
- Deployment of borehole seismometers (for 3D array)
- Low frequency torsion pendula (e.g. TOBA/TORPEDO)

A+ and 3rd Generation Technology

- **3rd Generation cont ….**

Seismic Noise

- Sensors with improved tilt-horizontal coupling and noise performance
- Study of upconverted noise e.g. crackling noise
- Development of new control strategies to provide best IFO performance
- Seismic platform interferometer?

Suspensions

- Large cryogenic silicon mirrors (150-200kg) with low absorption
- Large silica mirrors (150kg-200kg)
- Cooling strategies for 123K and 20K & temperature control
- Silicon or silica springs in the final suspension stage => protective coatings
- Low temperature sensors/actuators, sensing more DOF's
- Handling/fabrication of heavy suspensions, re-engineering SUS cage
- Cooldown time, how to commission a cryogenic IFO

University of Glasgow

Opportunities

- With LIGO India, we need to seize the opportunity to implement the detector with A+ upgrades (researcher exchange between India and LVC)
- Build on some of the successful collaborative efforts
  - Seismic array monitoring for NN subtraction (aLIGO/AdVIRGO)
  - Collaborative activities with KAGRA (initiated under the ELITES program). Learn from the cryogenic work being undertaken in Japan
  - Need to ensure good engagement with the worldwide prototype network (Caltech 40m, AEI10m, Glasgow 10m, Gingin)
  - Opportunities for sensor development in the area of interferometric readout and accelerometers (SWG/Nikhef), and low frequency torsion pendula (KAGRA, ANU)