Summary of technical working group session

- One-sliders
  - Undergraduate students
  - Graduate students
  - Postdocs

Get the rest from the web

LIGO-G1301093

Students

On your left:
1. Christina Bogan
2. Joris van Heijningen
3. Laetitia Canete
4. Eric Quintero
5. Ryan DeRosa
6. Kate Dooley
7. Christian Gräf
8. Thomas Abbott
9. Jessica McIver

On your right:
1. Johannes Eichholz
2. Tomoki Isogai
3. Alexander Khalaidovski
4. Sina Köhlenbeck
5. Zach Korth
6. Brett Shapiro
7. Dmitry Simakov
8. Mathieu Blom

A high power beam in high-order Laguerre-Gauss mode

Christina Bogan, Ludovico Carbone,
Andreas Freise, Benno Willke

Science Objectives:

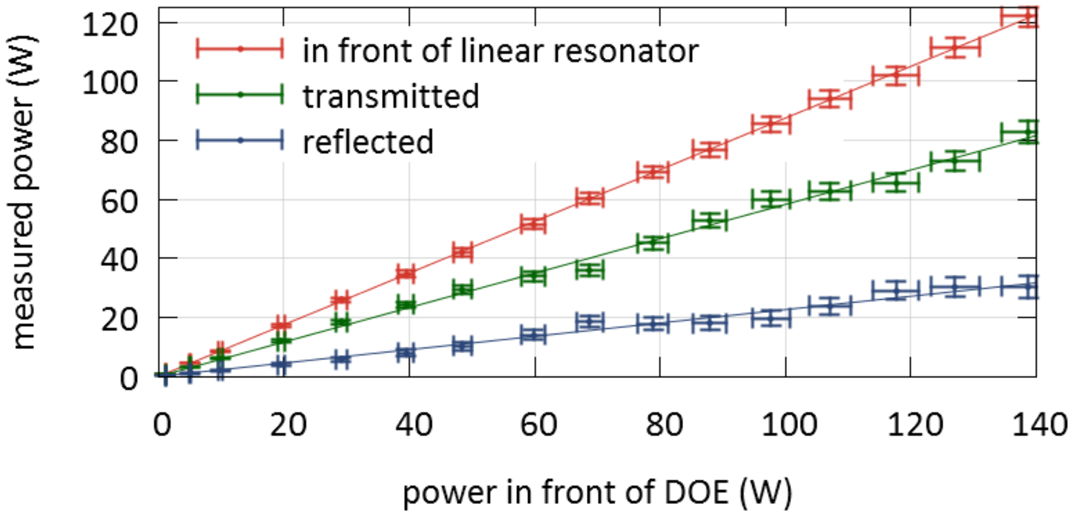
- demonstrate a high power LG33 mode for possible implementation in a future GWD
- analyse the technical noise of this ‚new' laser source
    - including power, frequency and beam pointing noise

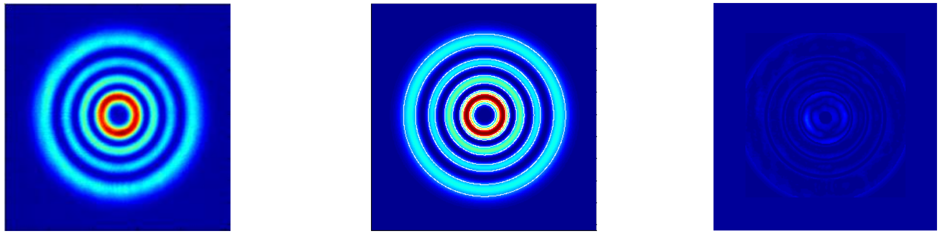
Results:

- verified phase plate conversion efficiency of 75%
- LG33 mode with 82,6W with a purity of more than 95%

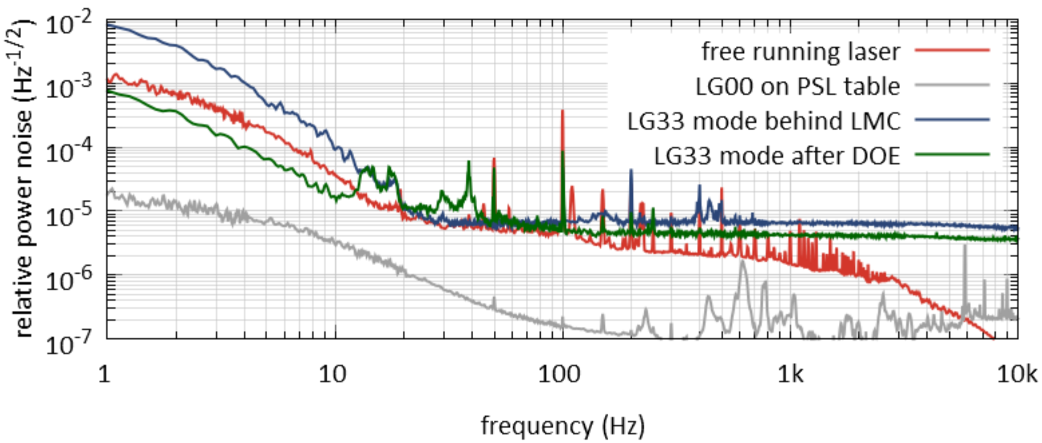
Preliminary Results:

- power noise higher than free running laser --- reason unknown





Measurement Fit Residual



Coating Thermal Noise Experiment THOR

Johannes Eichholz,

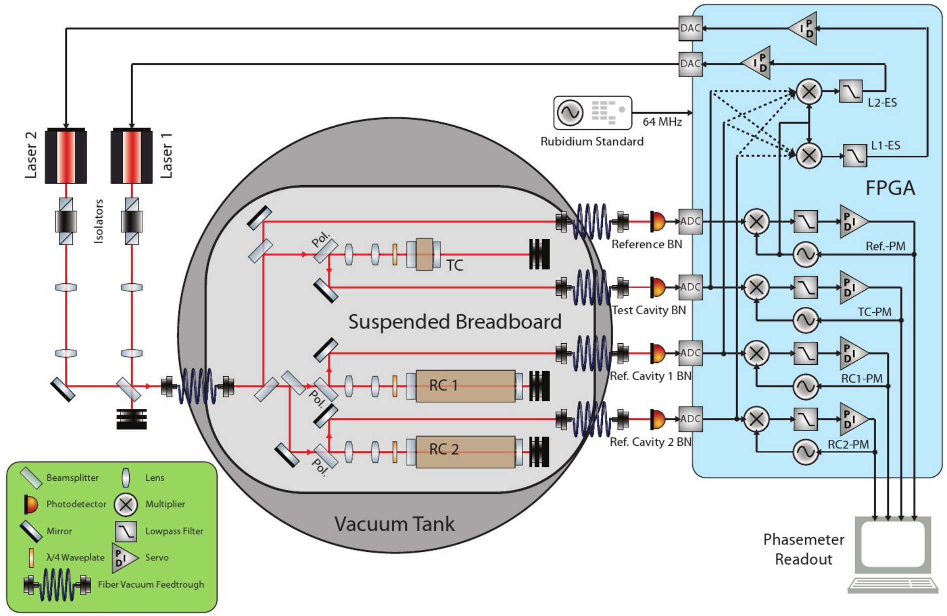
Michael Hartman, Guido Mueller, David Tanner, University of Florida

Science Objectives:

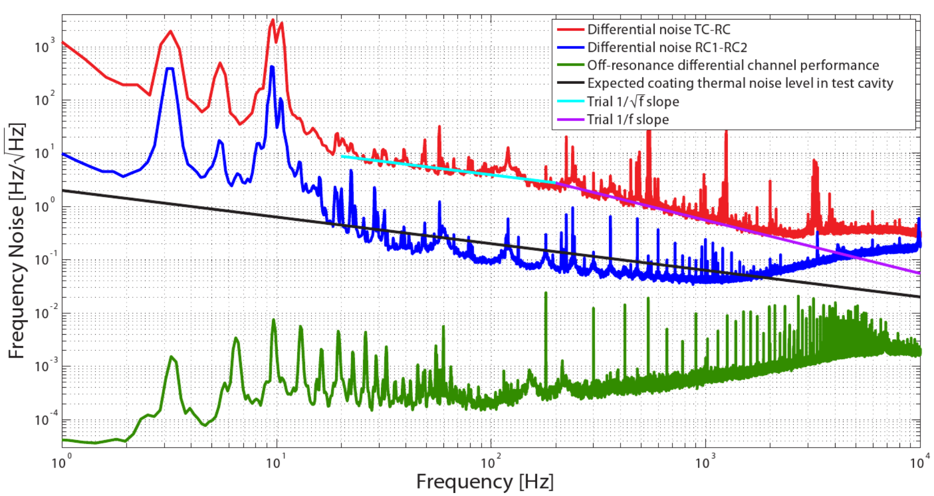
Measure coating thermal noise in aLIGO band as a function of beam size and temperature

Status Report

Dual reference system operational, test cavities under investigation



Noise performance curves



Results:

- **Reference system meets requirements**
- **CTN in test cavities in preliminary measurements masked by other noise?**

Outlook:

- **Variation of beam sizes coming soon**
- **2nd, cryogenic setup under construction**
- **Expect cold data around 12/13**

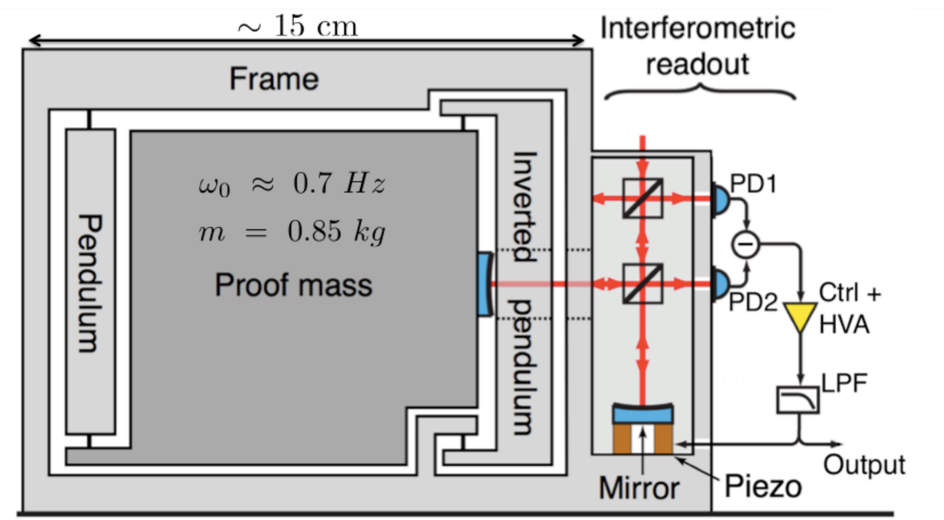
Monolithic Accelerometer with an interferometric readout

Joris van Heijningen

Jo van den Brand, Alessandro Bertolini,David Rabeling, Martin Doets, **Nikhef Amsterdam**

Science Objectives:

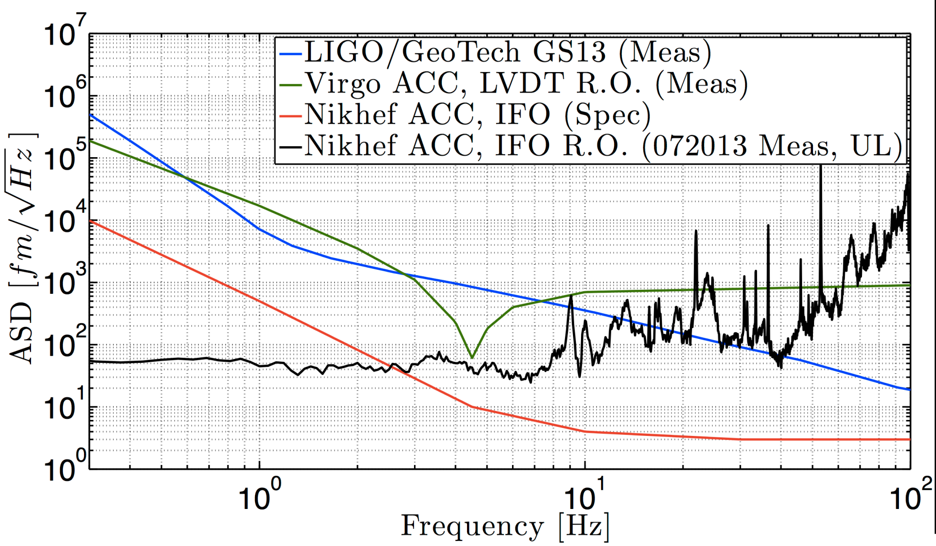
Measure the residual motion of MultiSAS, a suspension to suspend sensing optics for AdVirgo, requirement: ~ fm per √Hz @ 10 Hz



A. Bertolini et al., NIM A, 556, pp 616-623 (2006)

M.B. Gray et al., Opt.Quant.Electron., 31, pp 571-582 (1999)

Humble comparison: readout noise, mass fixed



Results:

- Fringe visibility/ contrast at 95%
- Bandwidth expected to be 5 - 350Hz
- Not yet in vacuum
- Readout noise a factor 20 too high: 50 fm per √Hz
- Expect to be at 2.5 fm per √Hz, noise sources under investigation
- Can't wait to go into vacuum!

Filter Cavity Experiment

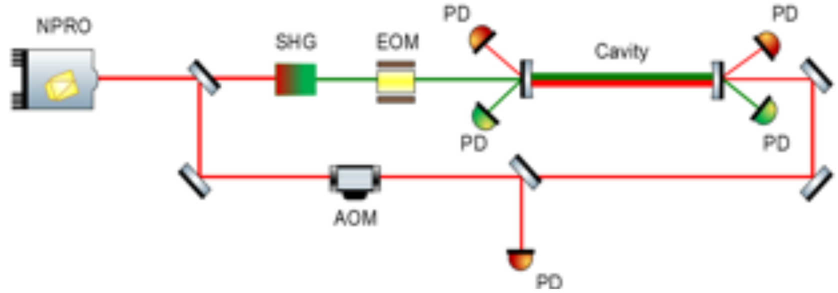
Tomoki Isogai,

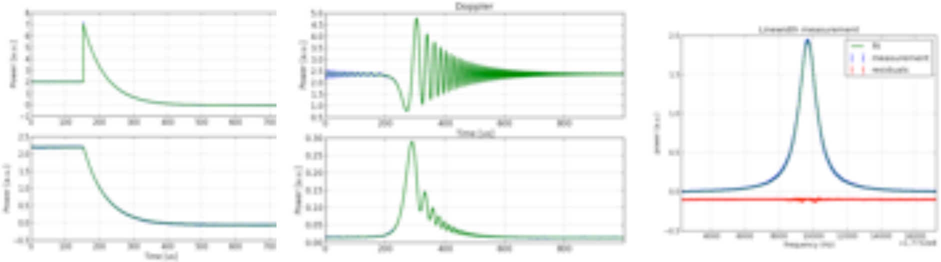
Lisa Barsotti, Mattew Evans, Patrick Kwee,
John Miller, Eric Oelker

LIGO MIT

Science Objectives:

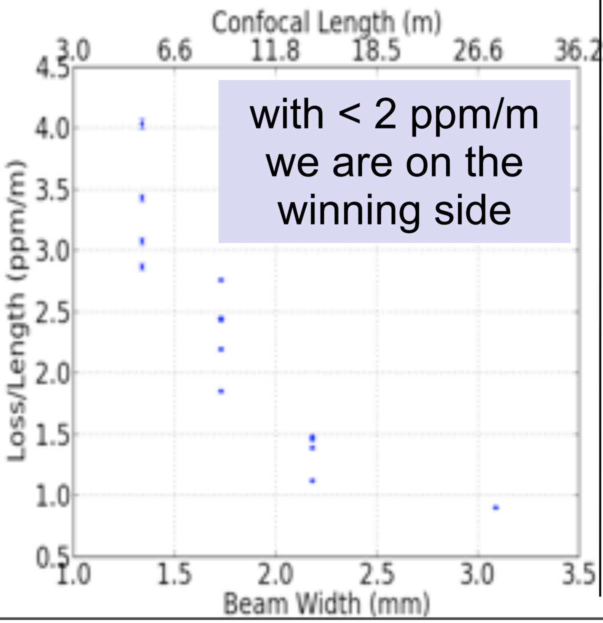
- **Measure loss of mirrors as a function of beam size**
- **Design a realistic filter cavity**



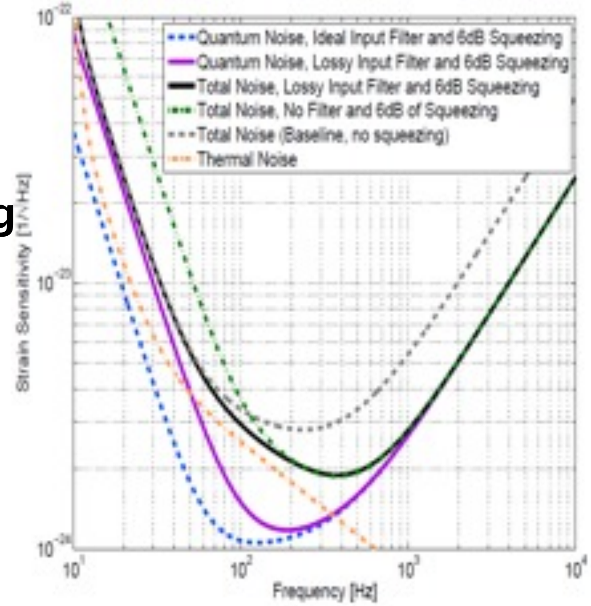


Various Loss Measurement Methods

16m filter cavity, which can fit in the existing vacuum system, is long enough for aLIGO

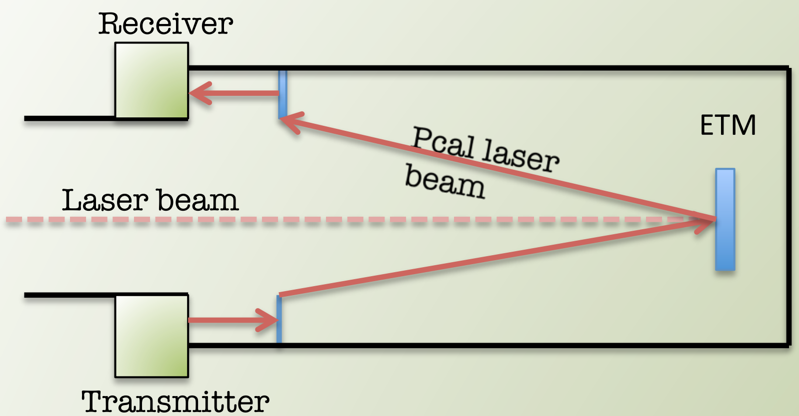


Frequency-dependent squeezing using a filter cavity seems to be a promising way to go beyond the quantum noise for aLIGO



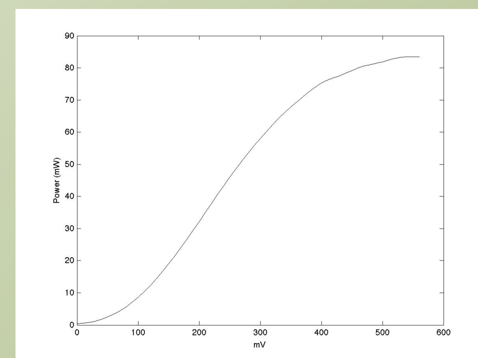
Optical Follower Servo for the Photon Calibrator

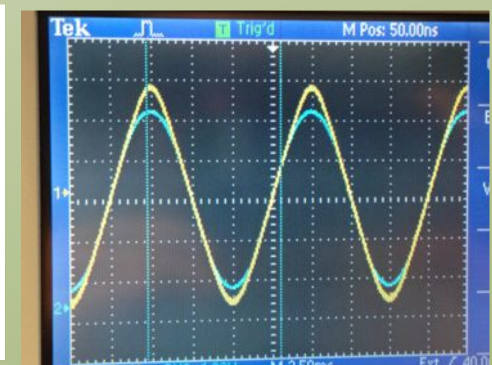
Laetitia CANETE, university Claude Bernard Lyon 1



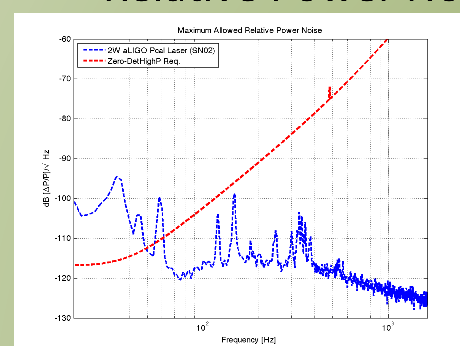
Aims:

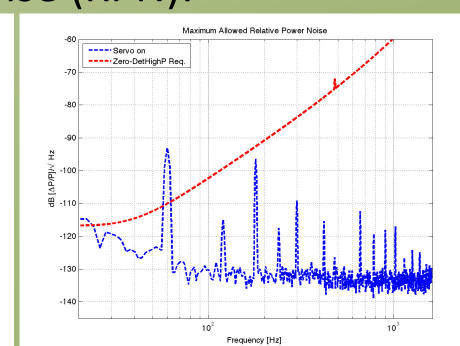
- Allow deeper modulation depth by compensating for saturation in the AOM:



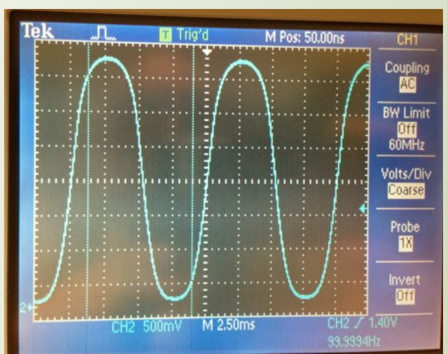


- Reduce noise inherent to the laser, the Relative Power Noise (RPN):

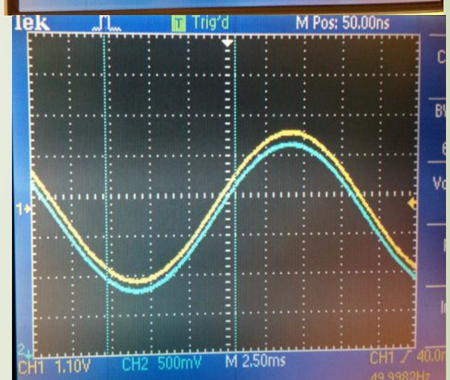




- Reduce harmonics noise due to the non linearity of the modulation process



Saturated waveform



Waveform with OFS (blue)

Function generator (yellow)

Surface absorption in crystalline silicon @ 1550nm

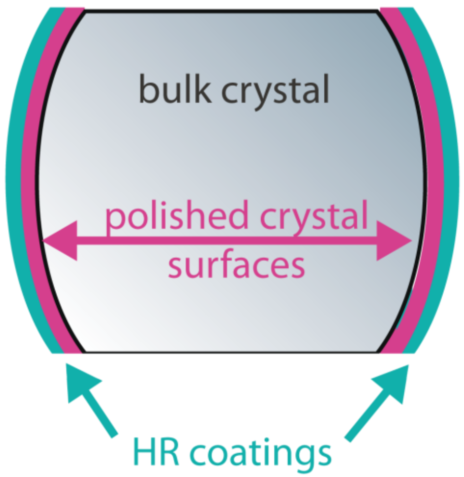
Alexander Khalaidovski[1],

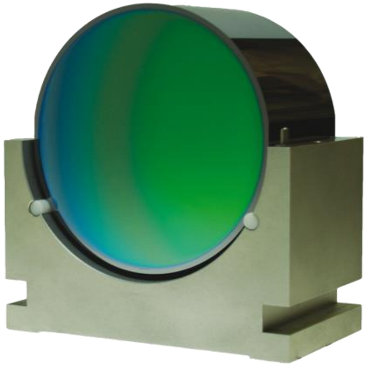
Jessica Steinlechner[2], Roman Schnabel[2],

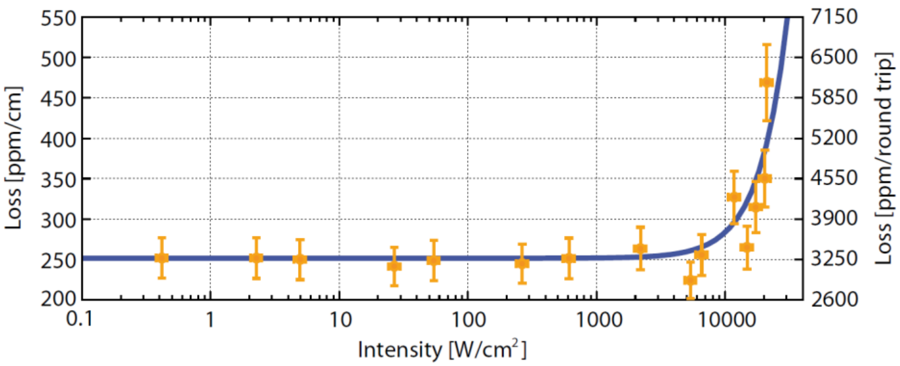
(1) ICRR Tokyo (2) AEI Hannover

Science Objective:

Measure optical absorption in crystalline silicon at 1550nm in view of a potential use in the Einstein Telescope







Khalaidovski *et al*, CQG **30** (2013) 165001

Results:

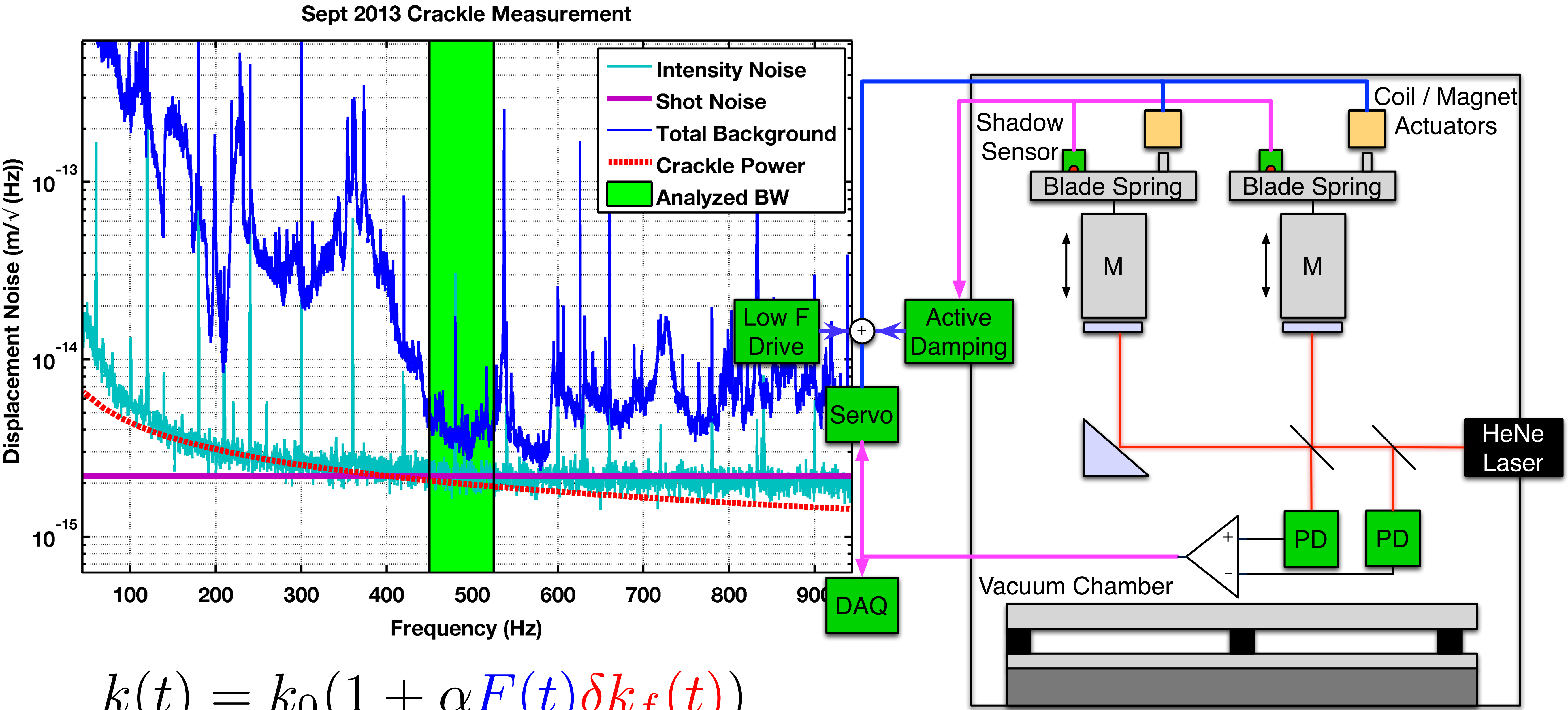
- **A rather high round-trip absorption of 3200 ppm was measured, even at low intensities**
- **In view of our measurement procedure (differing from other groups), the discrepancy with literature data could be explained by surface absorption**

Outlook:

- **Set of measurements planned for direct and indirect analysis**
- **Joint measurements with Glasgow and Jena groups**

Crackle!

E. Quintero - CalTech



$$k(t) = k_0(1 + \alpha F(t)\delta k_f(t))$$

Crackle noise is **discrete**, **impulsive** events spanning a broad range of sizes in response to slowly changing external conditions.

The AEI Suspension Platform Interferometer

Sina Köhlenbeck,

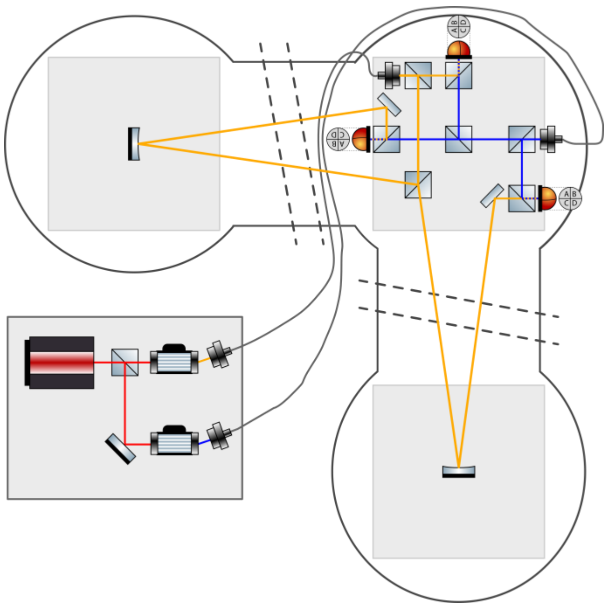
Katrin Dahl and Conor Mow-Lowry for the AEI 10m Prototype team

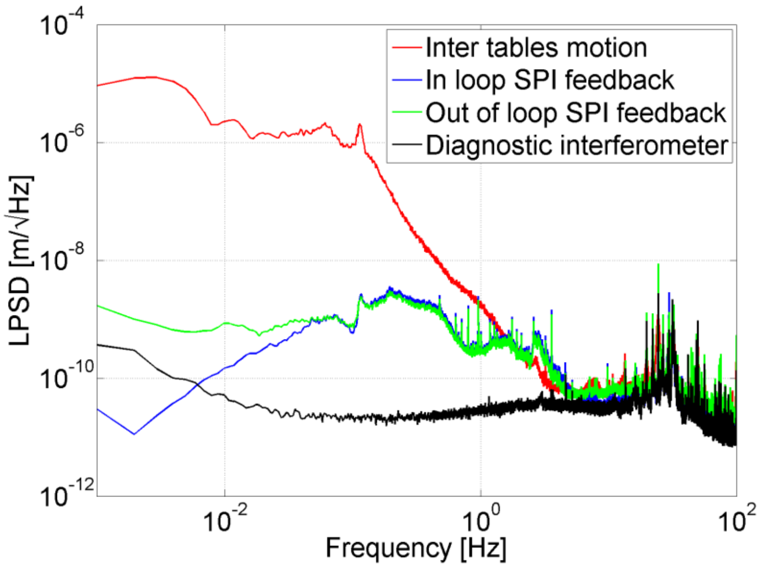
Science Objectives:

- **Measure the relative table motion between two seismically isolated optical benches**
- **Signals used for feedback control**

Status report:

- **Installed and under commissioning**





Results:

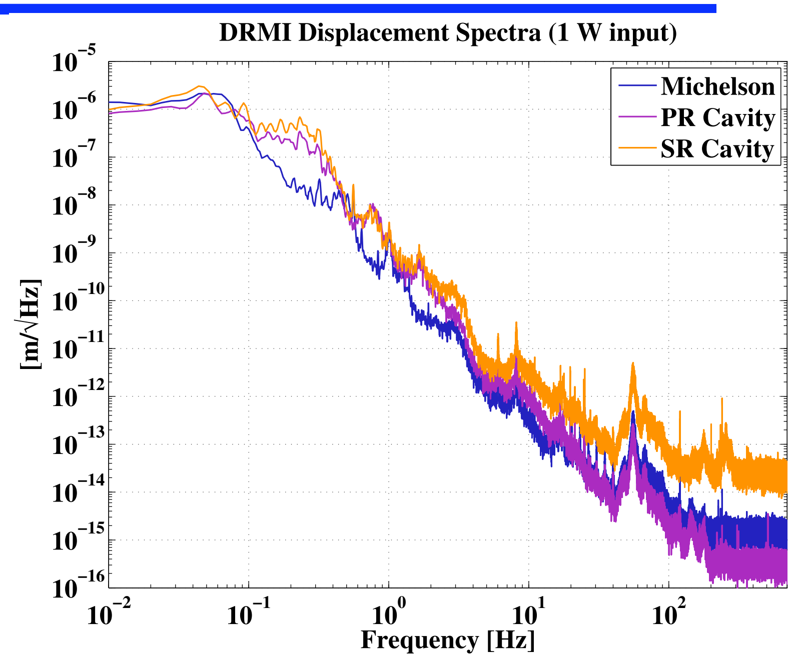
- **Diagnostic interferometer noise level below the requirement of 100pm/√Hz @ 10mHz**
- **Installed the path length difference stabilization**
- **Longitudinal degree of freedom controlled**

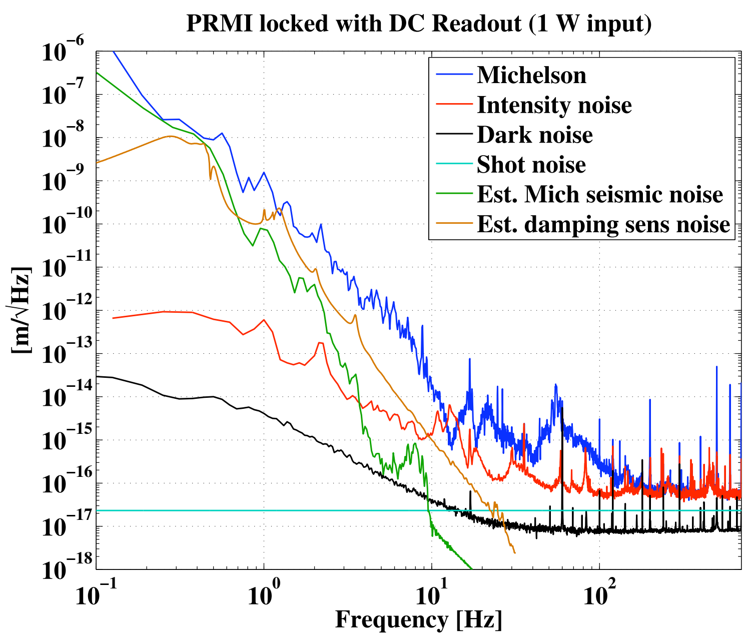
Outlook:

- **Optimize the filters for control**
- **Investigate on angular degrees of freedom**

LIGO Livingston Commissioning

- Dual-Recycled Michelson locked
- Power-Recycled Michelson locked with DC readout
- Seismic isolation and suspension characterization



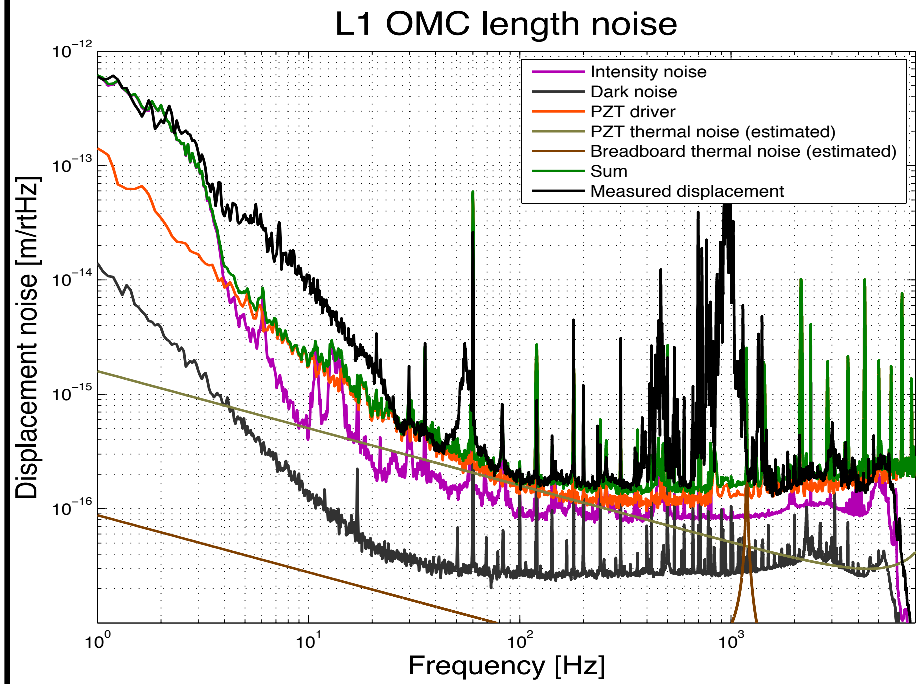


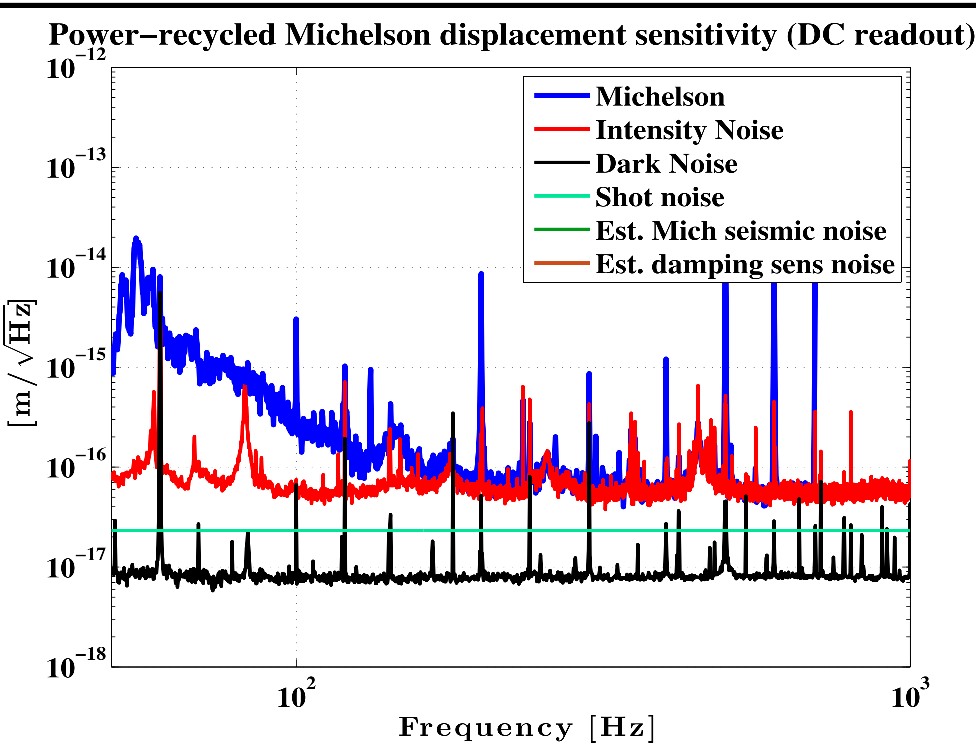
- DRMI continuing with 10-20 W input
- 3f locking scheme demonstration
- Quad suspension noise
- HIFO X

OMC commissioning/characterization

Zach Korth et al., CIT-LLO

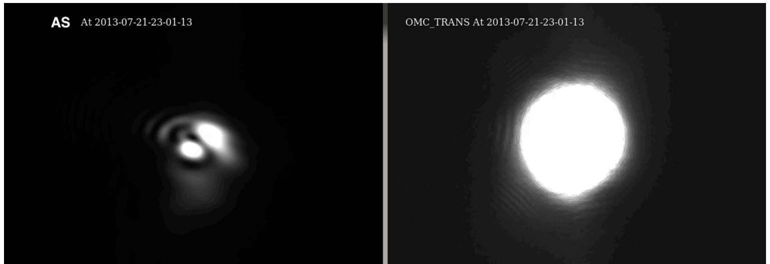
- aLIGO OMC has been installed and is operating on the L1 interferometer
- Locked with required ~100 Hz bandwidth
- Length noise was measured
  - Looks good, save for some peaks near 1 kHz (see right)
- Used to attain high-frequency PRMI sensitivity of 5 x 10^{-7} m/√Hz
- Backscatter measured to be < 10^{-8}





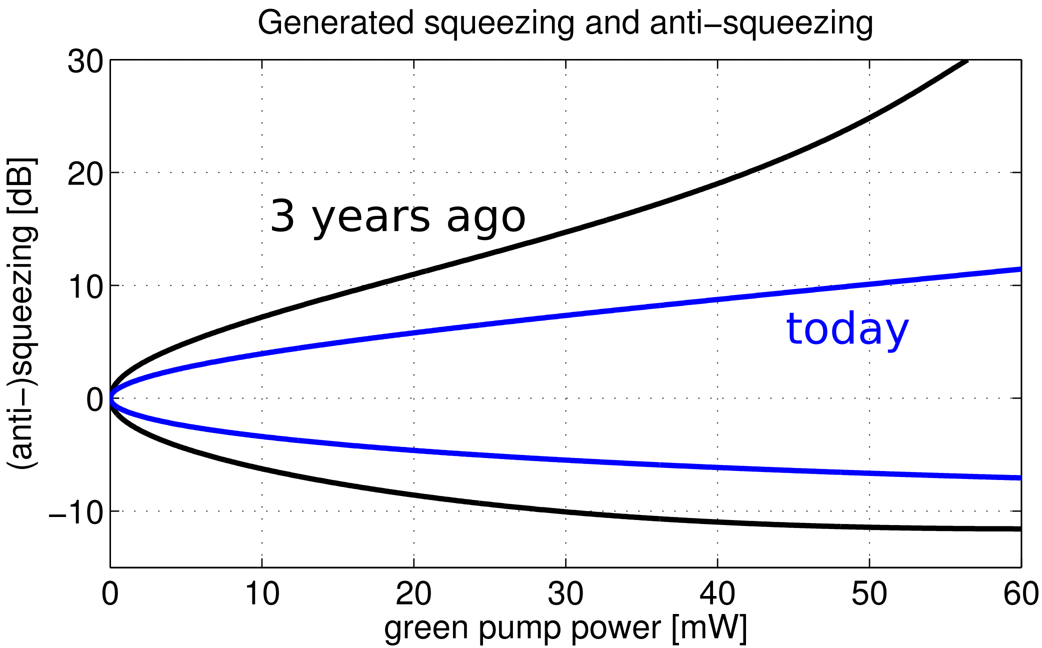
Things we have learned so far:

- Mode matching from IFO to dark port is not quite right
- We should not use our OMC PZTs (Noliac) to above 100 V.
- We have some excess intensity noise generated in the interferometer between the IMC and the dark port.

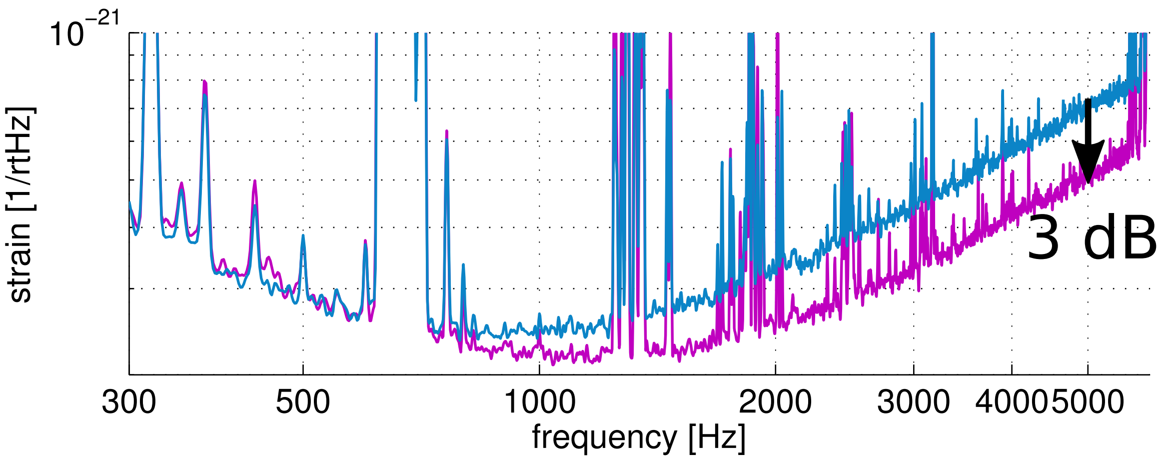


Squeezing at GEO600

- Kate Dooley, AEI



Generated squeezing has dropped.

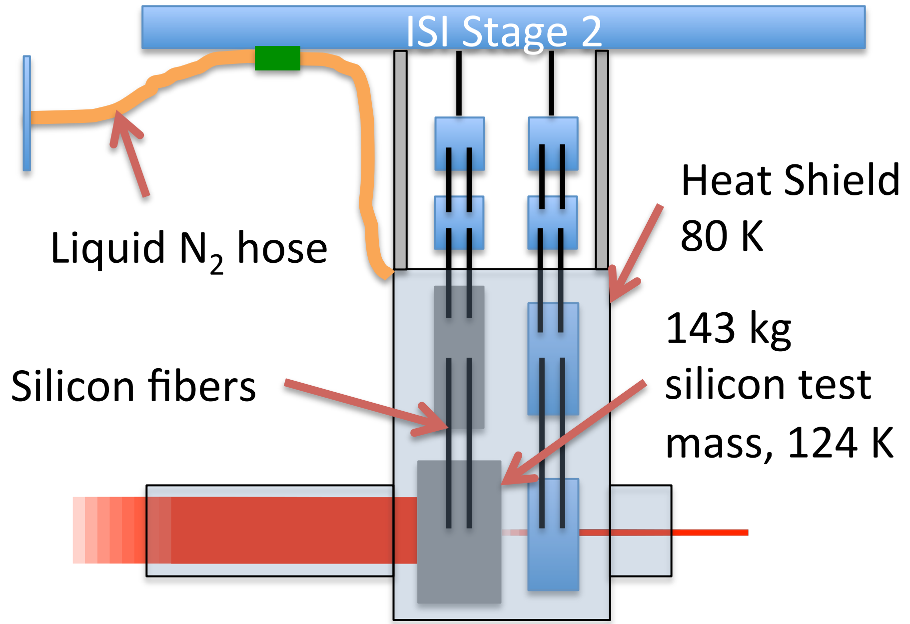


Restoring the squeezer will increase our observed squeezing to > 4.0 dB.

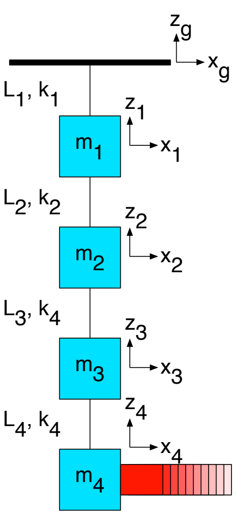
Cryogenic LIGO III Suspensions

Brett Shapiro
Stanford University

- Modeling of cryogenic suspensions for LIGO III (blue team in strawman T1200031)
- Stanford experiments studying test mass cooling technology



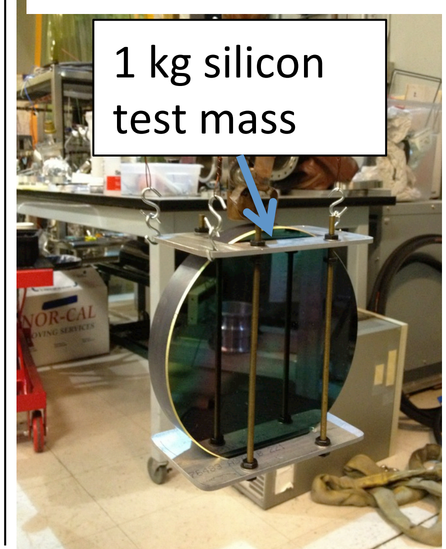
LIGO III quad conceptual design

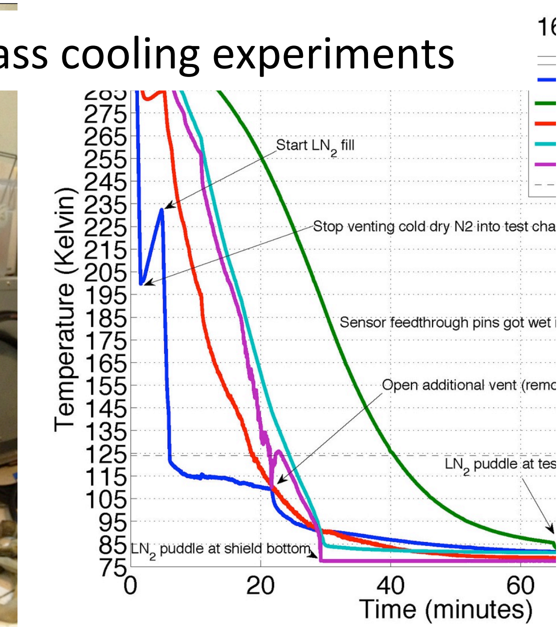


To beat aLIGO performance with larger test masses, 3 options:

- Push the payload capacity of the seismic systems (ISIs)
  - hard, but moderate noise
- Reduce test mass weight
  - easiest, but noisiest
- Install 4th stage of springs
  - hard, but quietest

Stanford test mass cooling experiments





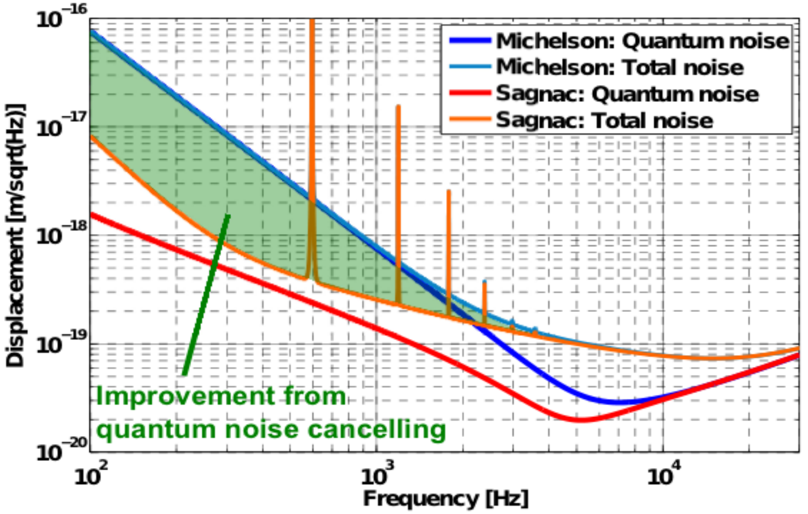
The Glasgow Sagnac Speed Meter proof-of-principle experiment

Christian Gräf[1], Bryan Barr[1], Angus Bell[1], Alan Cumming[1], Stefan Danilishin[2], Neil Gordon[1], Giles Hammond[1], Sabina Huttner[1], Sean Leavey[1], Harald Lück[3], John Macarthur[1], Roland Schilling[3], Borja Sorazu[1], Ken Strain[1], and Stefan Hild[1]

[1]SUPA, Institute for Gravitational Research, University of Glasgow, UK.

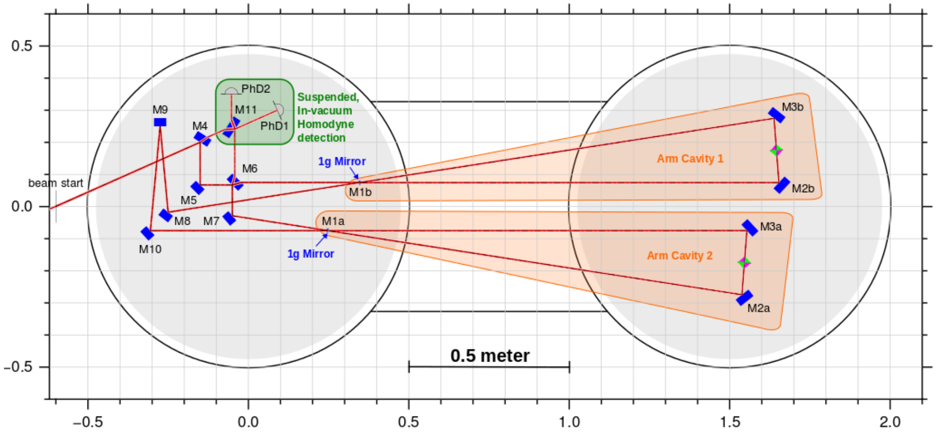
[2]Institute of Physics, The University of Western Australia, Australia.

[3]Albert-Einstein-Institute Hannover, Germany.



- Setting up an **ultra-low noise Sagnac interferometer** experiment with **high optical power and low-mass mirrors**
- Design optimised to achieve a **better sensitivity** than an **equivalent Michelson interferometer** could achieve in the **few 100Hz range**

> **➢ Aim: Experimental verification of back-action noise reduction in a Sagnac Speed Meter interferometer**



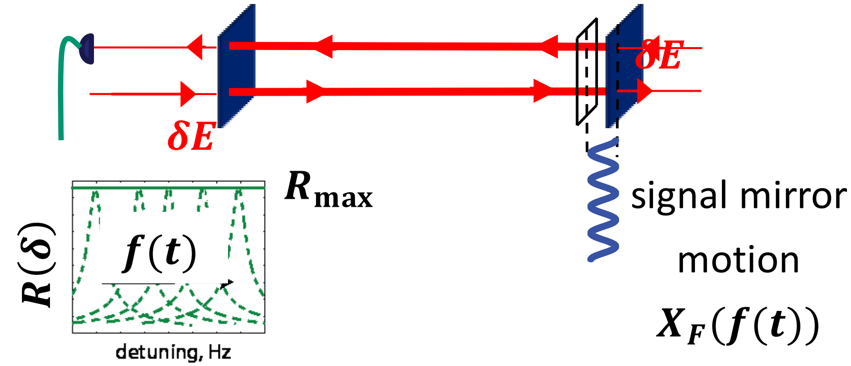
Dynamical tuning in signal recycled GW detectors

Dmitry Simakov,

Albert Einstein Institute, Hanover

Science Objectives:

- **Following the instantaneous frequency of chirp-signal with detector tuning to increase sensitivity**
- **Developing the time-domain model for the non-stationary detector response on signal and noise**

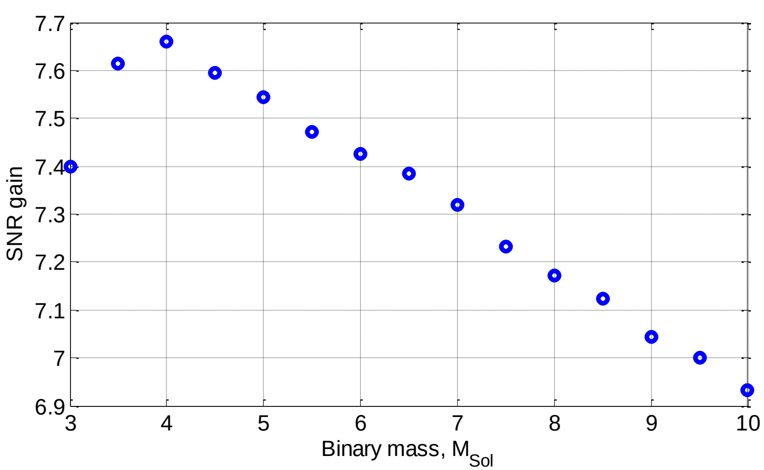


Signal and displacement noise:

- $I(f) = R_{\max}(A_F)(X_F(f) + \delta X(f))$

Noise (white):

- $S(f) = C_0$



Results:

The analysis of the shot noise and GW-signals during DT

- **The shot noise remains white**
- **During resonant tracking the slowly changing amplitudes evolve stationary**

The calculated gain of signal-to-noise-ratios is

- **~17 for the shot-noise limited detector**
- **~7 with thermal noise**

Suspensions Drift Monitor

Problem: Suspension drift on day time-scales, causing alignment and lock loss.

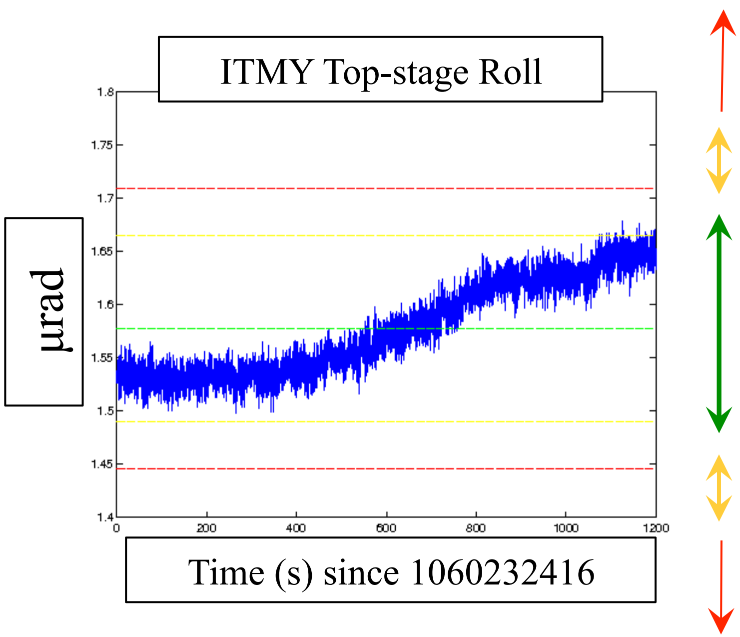
Solution: A tool that will monitor drifting and provide a simple visual indication of when a suspension system has drifted too far.

Thresholds

Nominal condition → Within 2σ from mean

Medium condition → Beyond 2σ, less than 3σ

Poor condition → Beyond 3σ

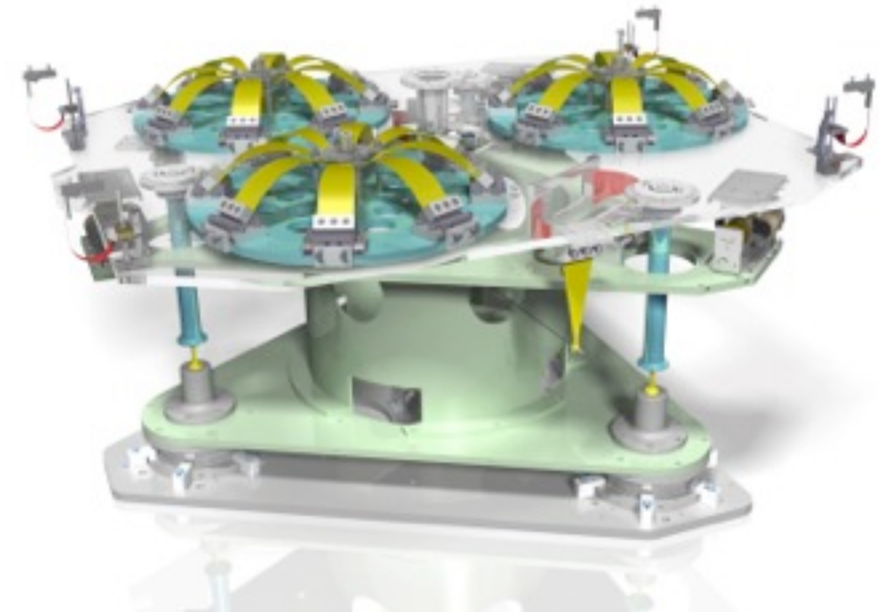


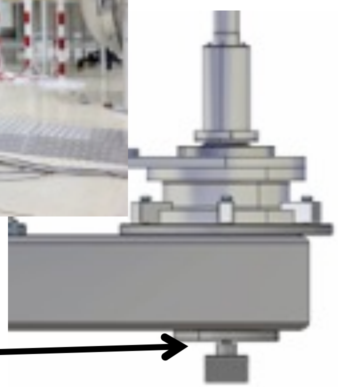
AdV External Injection Bench Seismic Attenuation System (EIB-SAS)

Mathieu Blom , A. Bertolini, E. Hennes, A. Schimmel, H.J. Bulten, M.G. Beker, F. Mul, M. Doets, J.F.J. van den Brand.
Nikhef Amsterdam

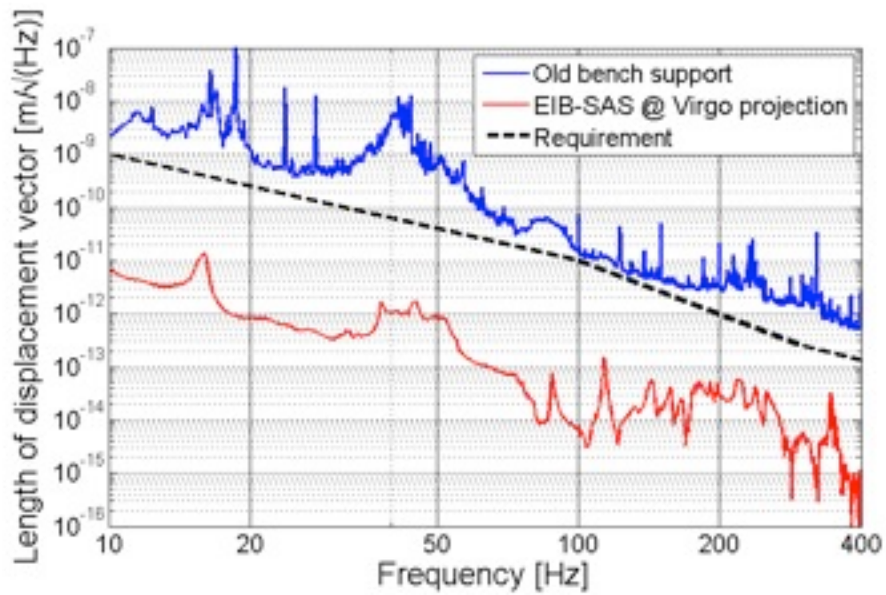
Science Objectives:

- Eliminate beam jitter introduced by external injection bench for Advanced Virgo





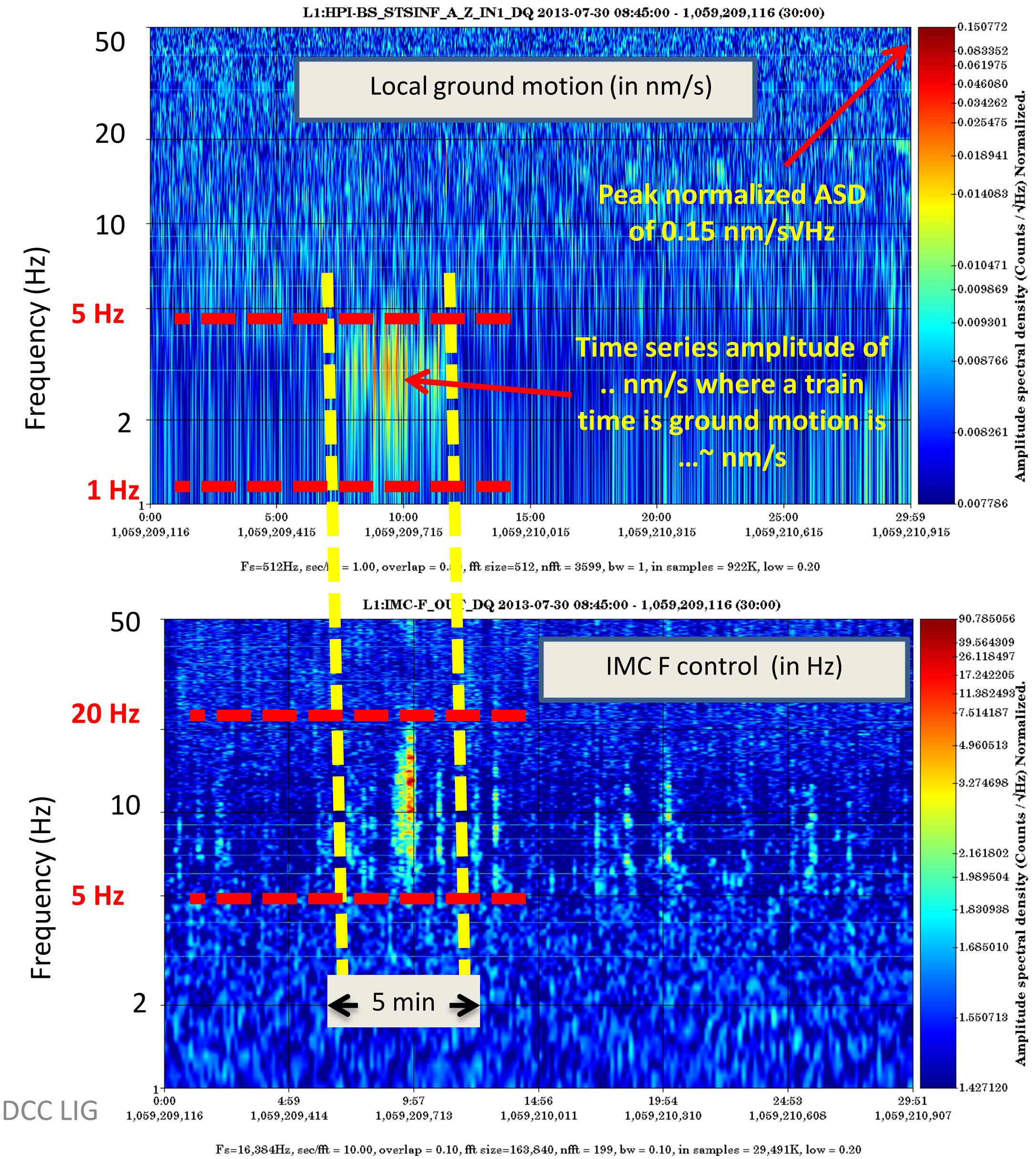
Piezo shaker system



Update on investigations by the detector characterization working group on the aLIGO seismic isolation subsystem - Jess McIver for the detchar SEI team. DCC # G1300916

Seismic-IMC upconversion (investigation)

- **Who**: Alex Lombardi, Jess McIver, Marissa Walker, Josh Smith
- **Overview**: A collection of many examples of elevated ground motion and concurrent IMC signal at Livingston. [Link]
- **Results**: Showed ground motion to IMC upconversion *at significantly smaller* ground motion amplitudes than typical for trains. [LLO alog 7725]
- **Future plans**: To test whether the upconverted noise seen in the IMC affects the DRMI or PRMI signal, and if so, what is the threshold of elevated seismic noise that produces this effect.
- **Detchar SEI team:** Jess McIver, Michael Coughlin, Alex Lombardi, Sydney Chamberlin, Laura Nuttall, Scotty Dossa, Chase Kernan, Ryan Quitzow-James, Kalina Nedkova.
- Support: Duncan Macleod, Chris Pankow, Ryan Fisher
- SUS team: Thomas Abbott, Marissa Walker, TJ Massinger, Sarah Zuraw



DCC LIG