

Commissioning of Advanced LIGO

A photograph showing a person in a white cleanroom suit and green safety glasses working on the complex optical bench of the Advanced LIGO. The person is positioned on the left side of the frame, looking towards the camera. The optical bench is a large, intricate assembly of metal components, including mirrors, lenses, and support structures, with several green laser beams visible. The background is a cleanroom environment with circular access ports.

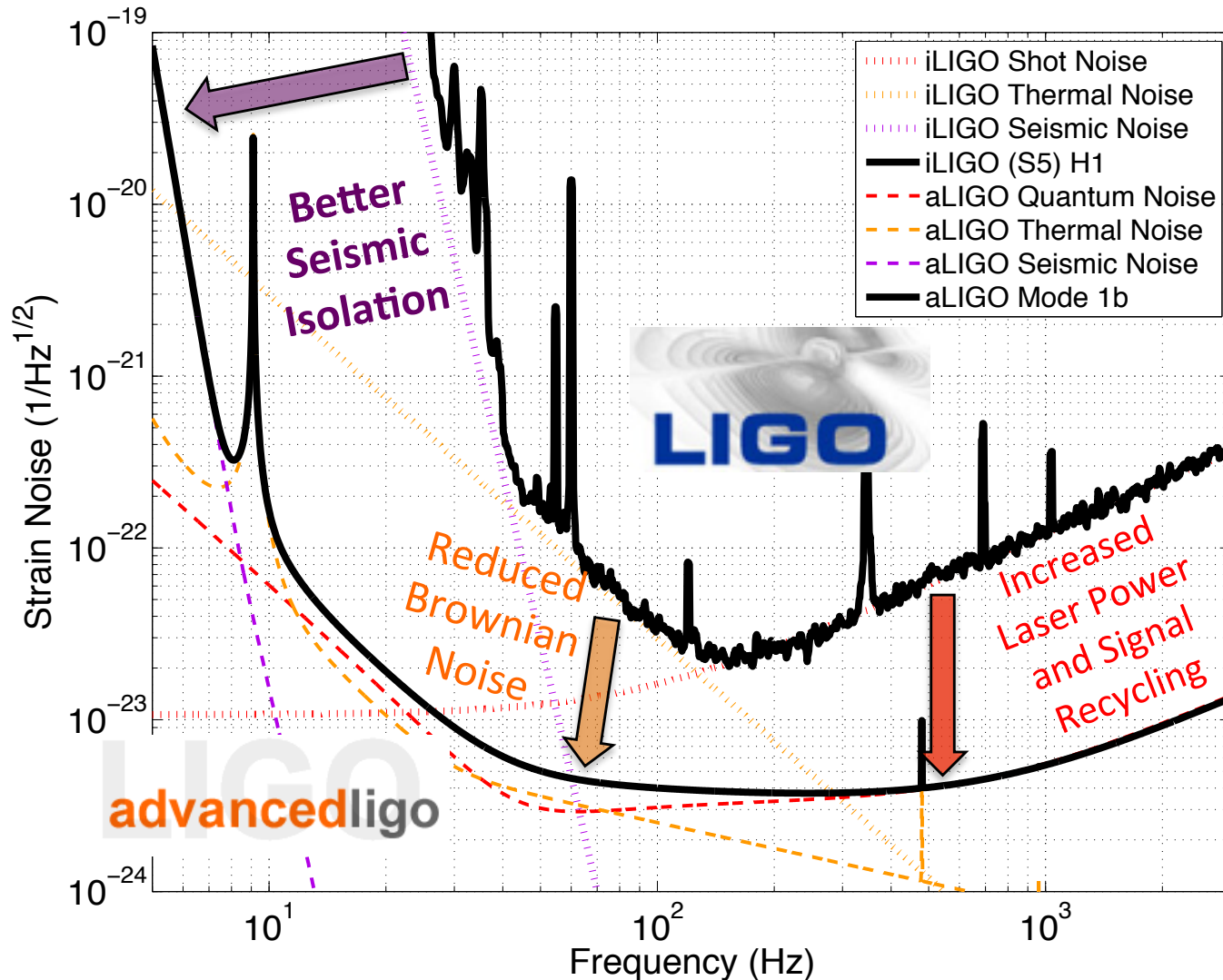
**Kiwamu Izumi
for aLIGO commissioning team**

LIGO-G1400529-v2

26/May/2014 GWADW at Takayama

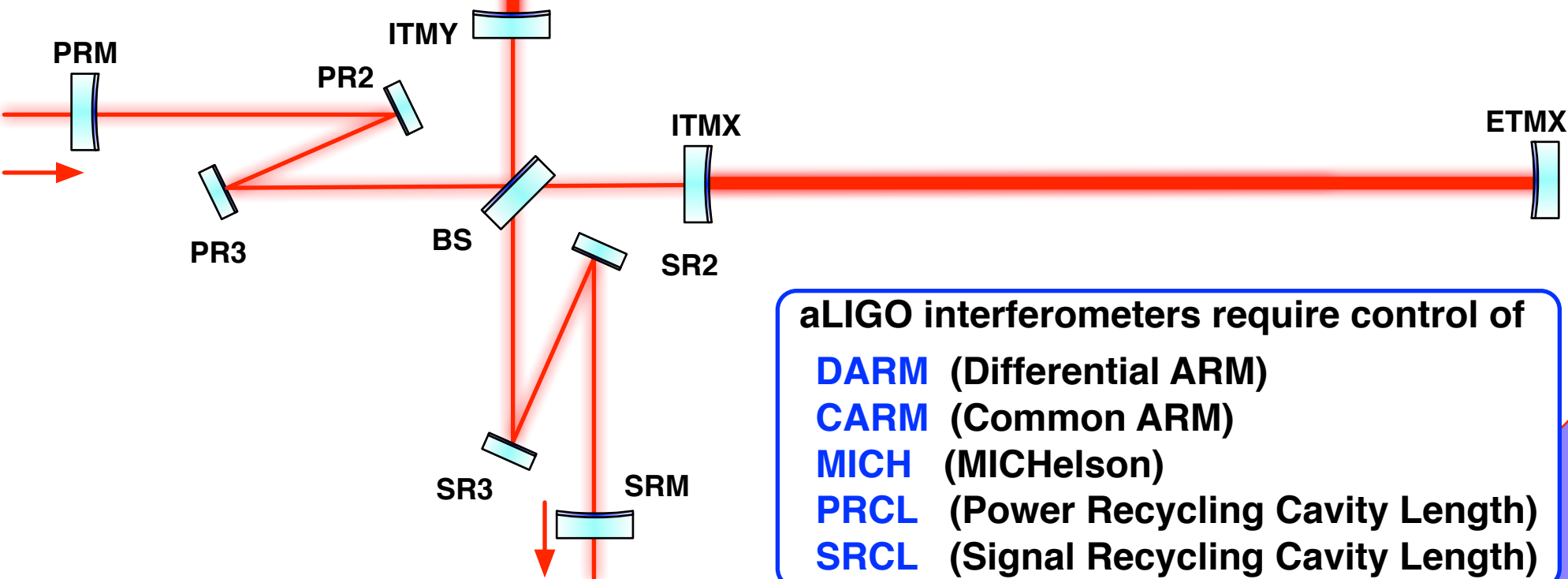
Advanced LIGO

▣ Aims to increase the sensitivity by a factor of ~10



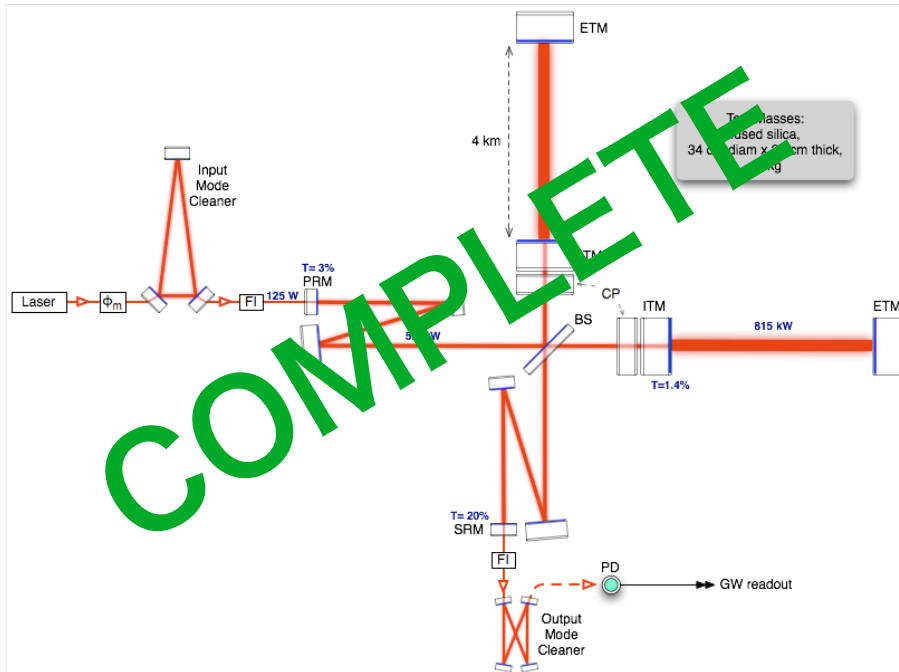
Optical Layout

- Dual Recycled Fabry-Perot Michelson
- Folded stable recycling cavities
- More complication in sensing and control due to signal recycling



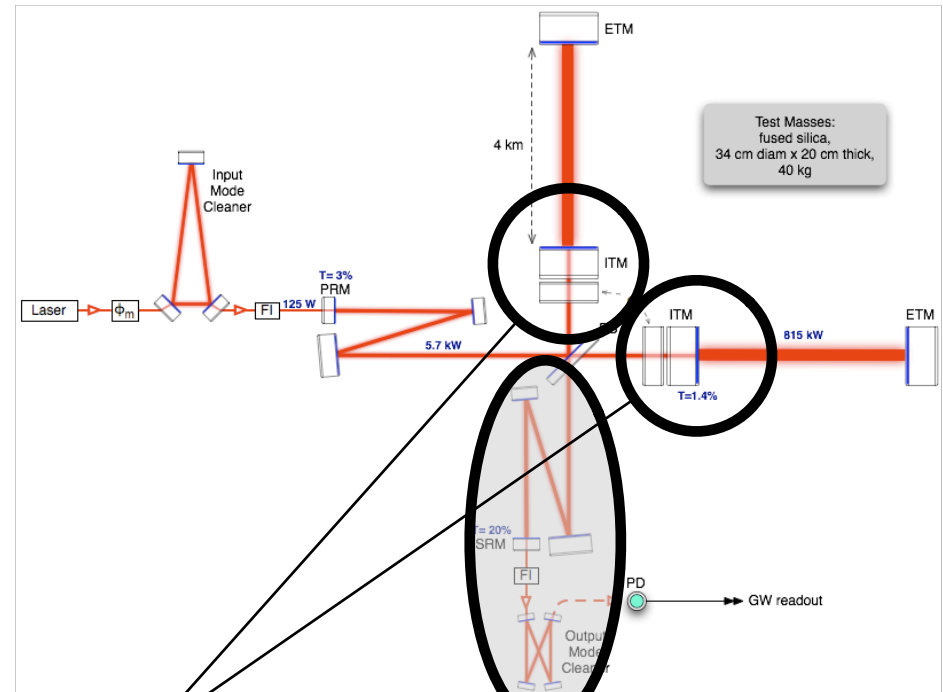
Installation Status

Linvingston



COMPLETE

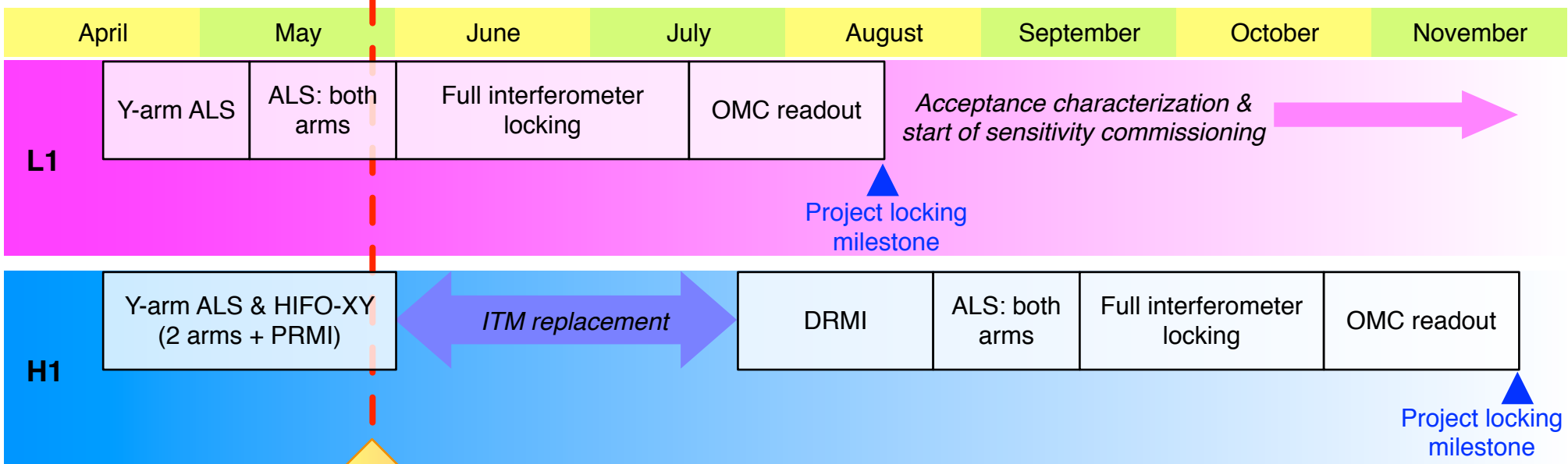
Hanford



will be swapped
being installed

Time Line

2014



P. Fritschel G1400397

Goals: we must provide

- Fully locked interferometer.
- Stable operation for 2 hours.



Latest Commissioning Works

Commissioners measuring a transfer function in the middle of night at LHO

Commissioning Status

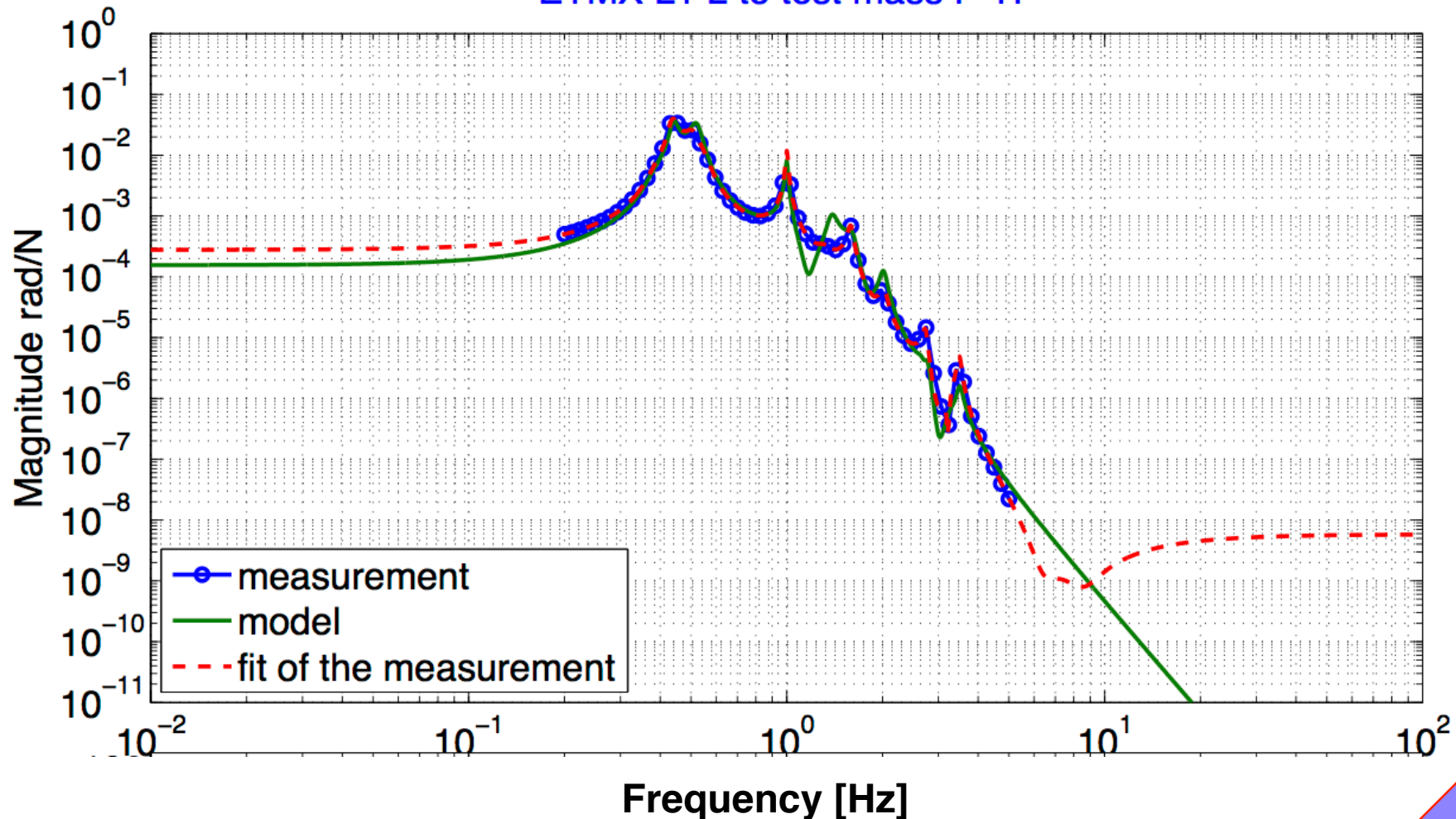
- **PSL** was commissioned and works as designed
- **Input Mode Cleaner** has been fully commissioned
- All the **seismic isolators** works as designed and fully automated
- All the **suspensions** works as designed and fully automated
- **DRMI** has been fully commissioned at LLO
- **ALS** has been commissioned at both LHO and LLO

We are ready for the full lock

Suspension Tunings

- Necessary for interferometer control
- Models well agree with the actual behaviors

ETMX L1 L to test mass P TF



DRMI (and PRMI)

- has been fully commissioned at LLO
- Locked by the 3rd harmonic demod (3f) scheme
- Consequently PRMI was commissioned in LHO
- Good agreement with the models

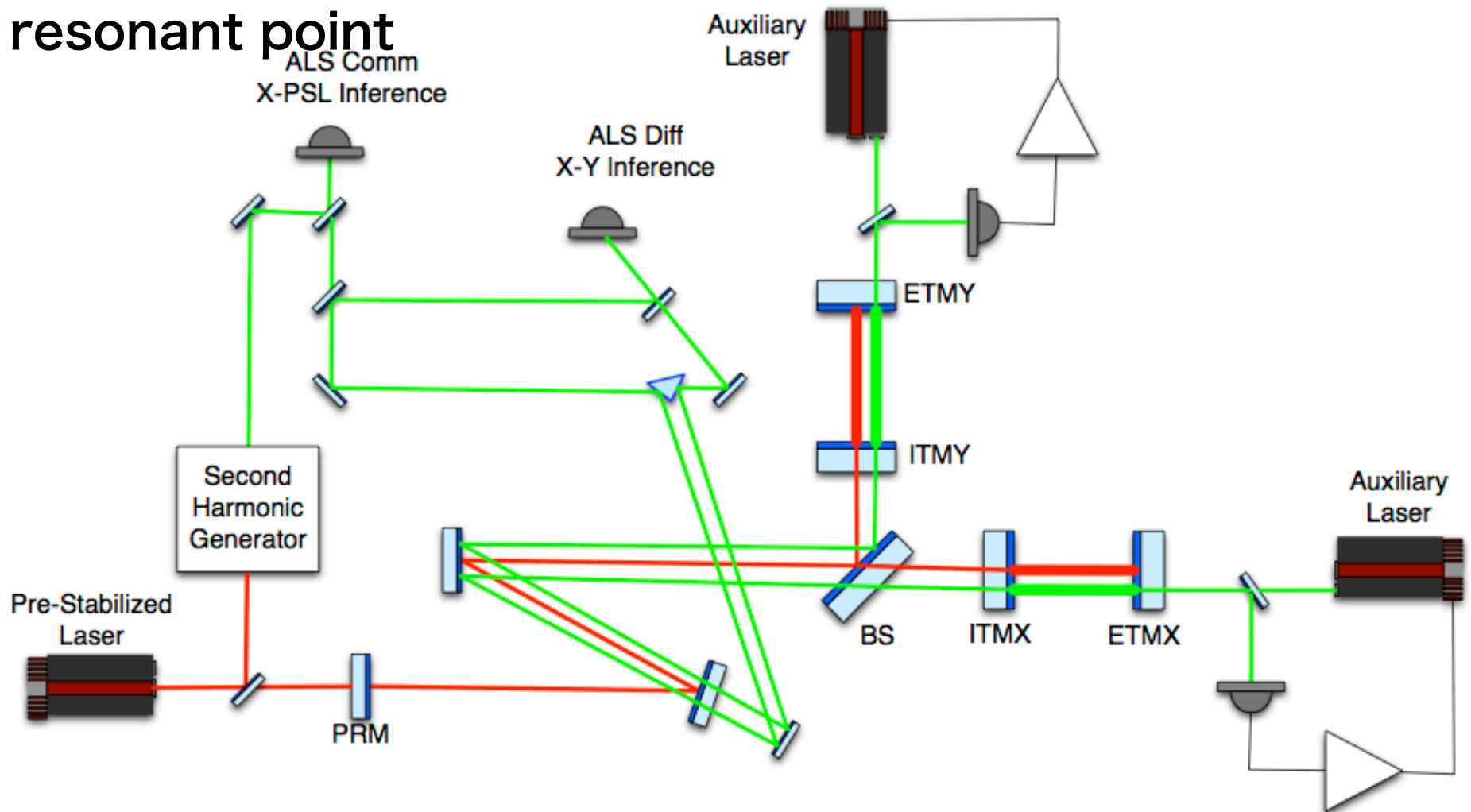
↓Sensor \ W/m →	MICH (meas./model)	PRCL (meas./model)	Phase Δ deg MICH-PRCL
ASAIR 45	0.98	34	86
REFL 9	0.75	0.74	83
REFL 45	1.0	0.91	88
REFLAIR 27	4.3	3.5	81
REFLAIR 135	1.8	1.9	81

Table: LSC Sensing Matrix in LLO PRMI sideband lock (ref: LLO alog 11381)

A. Effler G1400366-v1

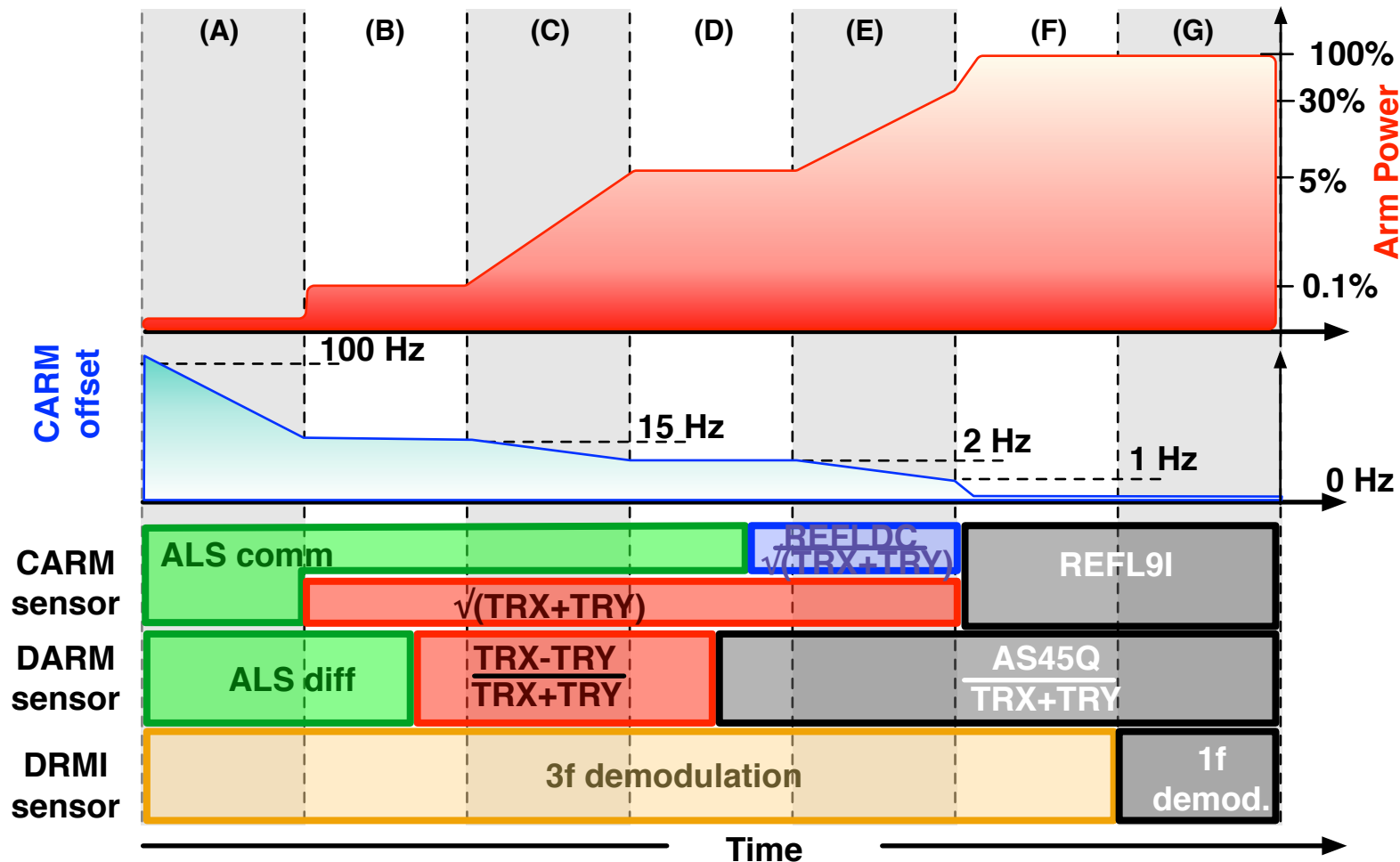
Arm Length Stabilisation

- Controls the **common** and **differential** modes of the arms
- Allows to park the arm lengths and laser frequency at a **off resonant point**



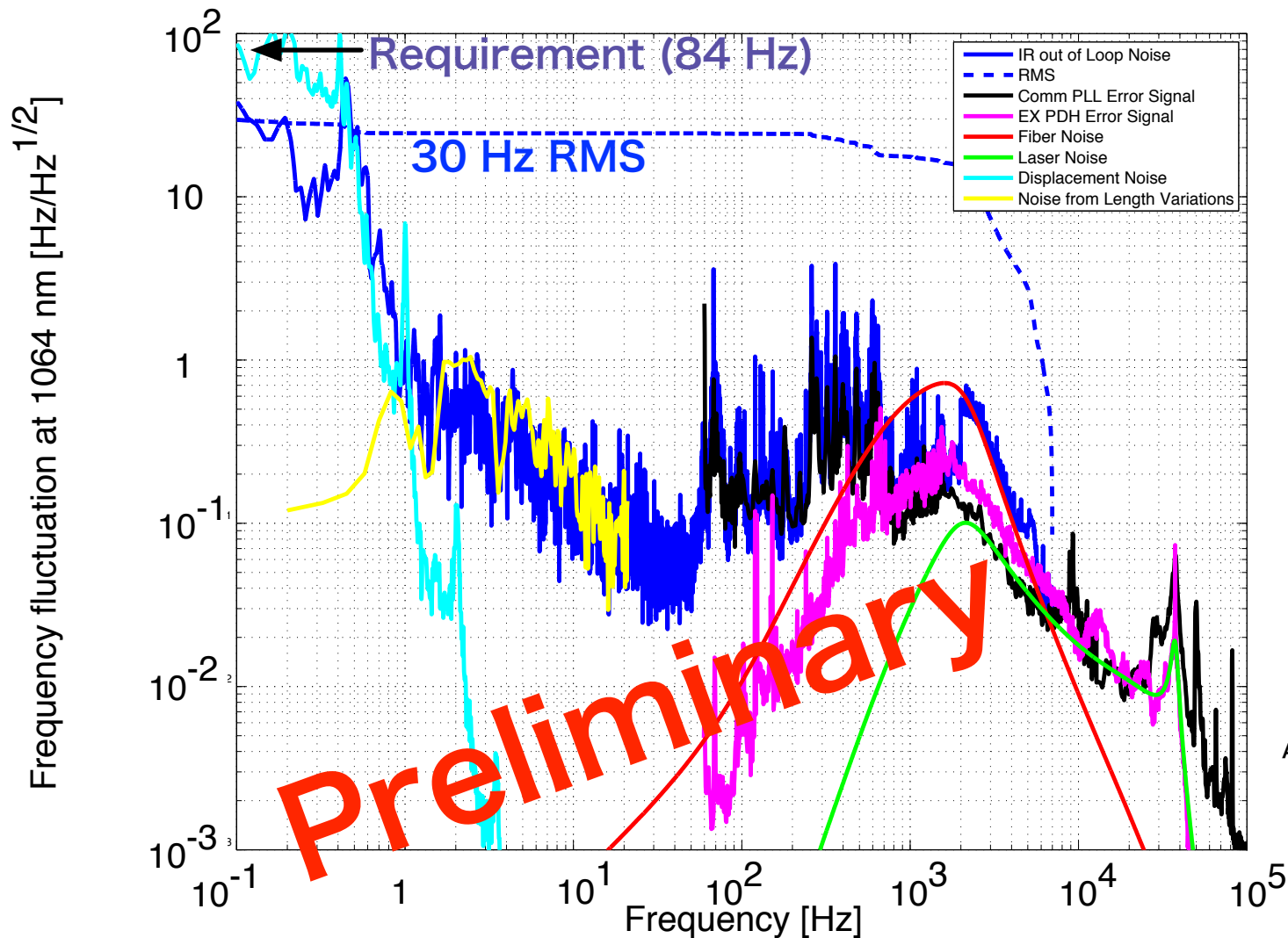
Locking process

- ▣ Arm cavities are set off-resonant by ALS.
- ▣ DRMI is held by the 3rd harmonic demod signals (3f signals).
- ▣ Bring the arm cavities to the resonance.



Common mode ALS

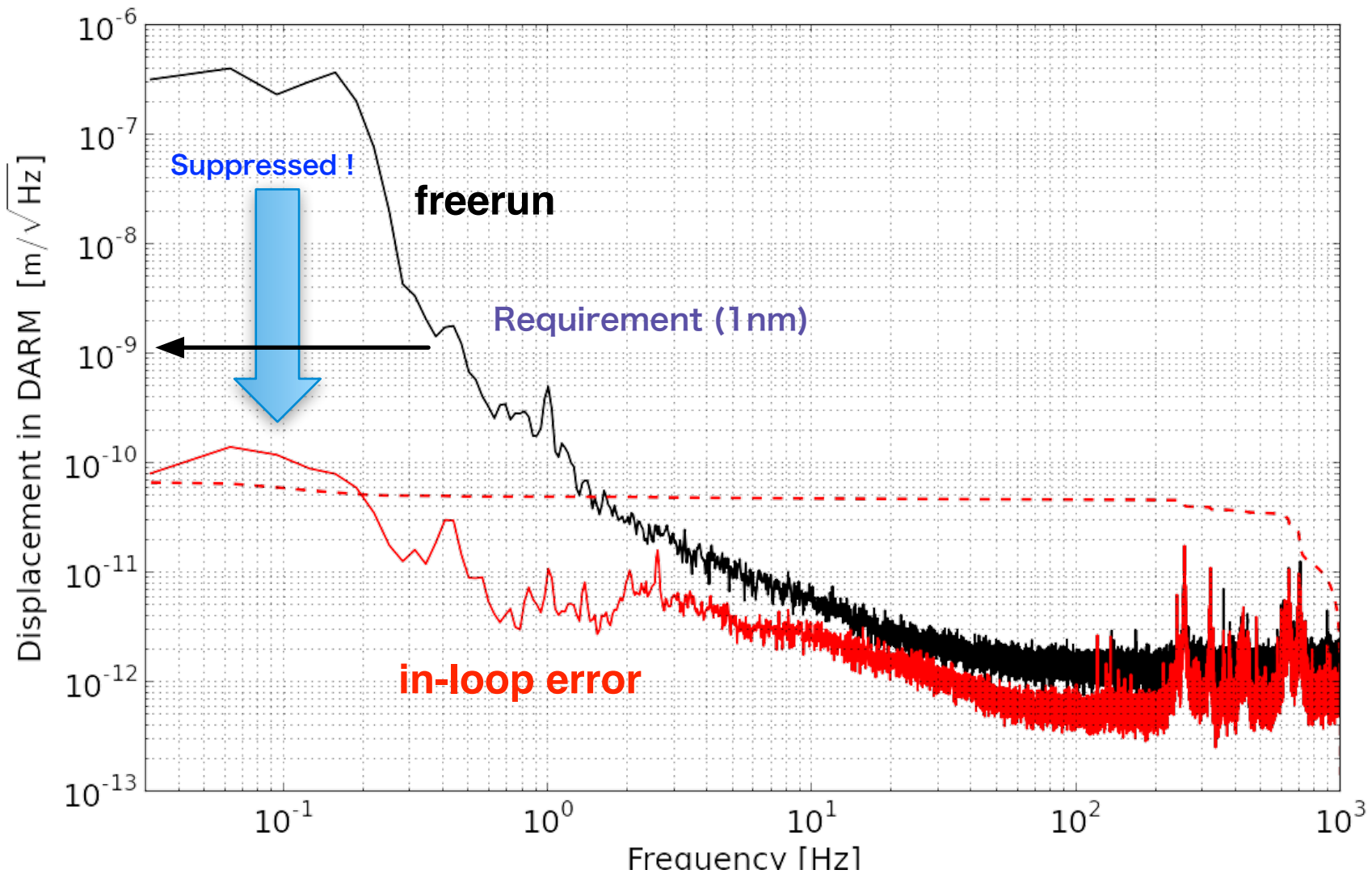
■ Noise performance is understood.



A. Staley G1400001-v1

Differential mode ALS

■ has been commissioned



Current locking effort

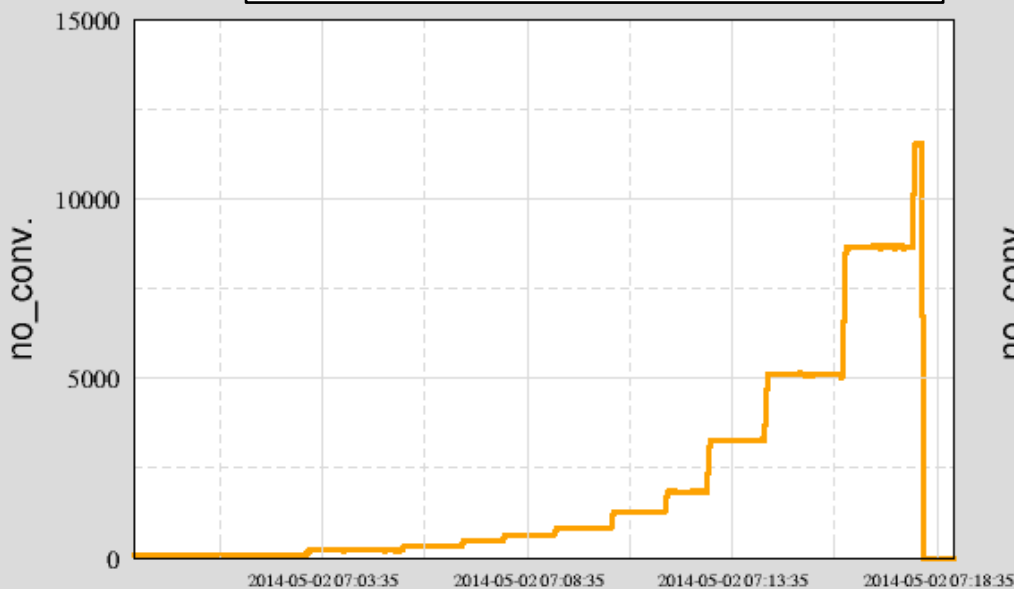
- ▣ LLO succeeded in reducing the CARM offset to 30 pm.
(all five DOFs were locked by IR signals.)
- ▣ Close to the fully locked interferometer

D. Martynov LLO alog 12430

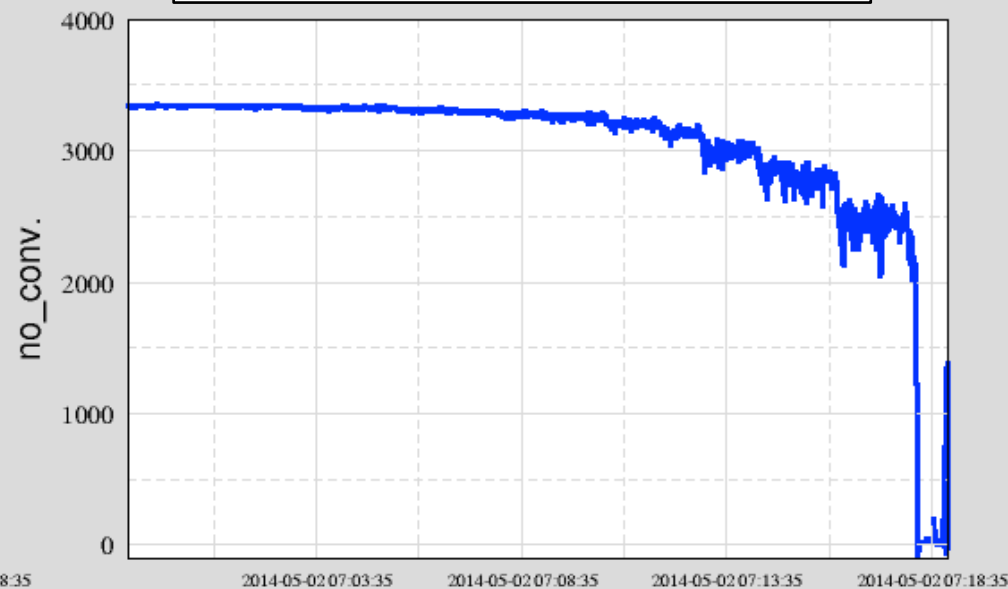
— MEAN

Trend from 14-05-02-06-59-00 to 14-05-02-07-18-59

Y arm cavity power (a.u.)



Reflected light (a.u.)



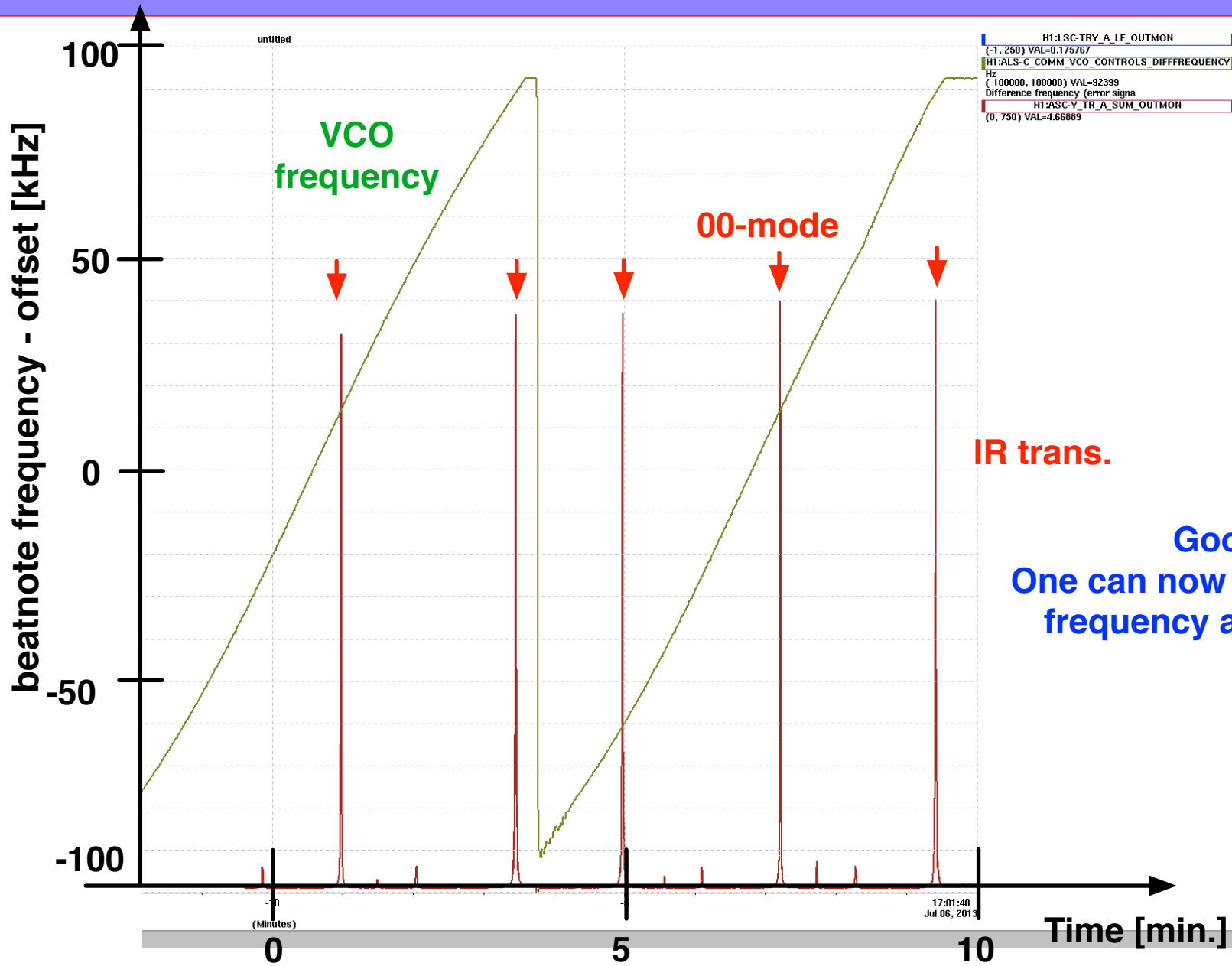
Summary

- ▣ LLO completed installation of all the in-vacuum hardwares.
 - ▣ LHO will finish the installation by August
 - ▣ DRMI has been fully commissioned
 - ▣ ALS has been commissioned
- ▣ We will fully lock both interferometers in this year**

Appendix

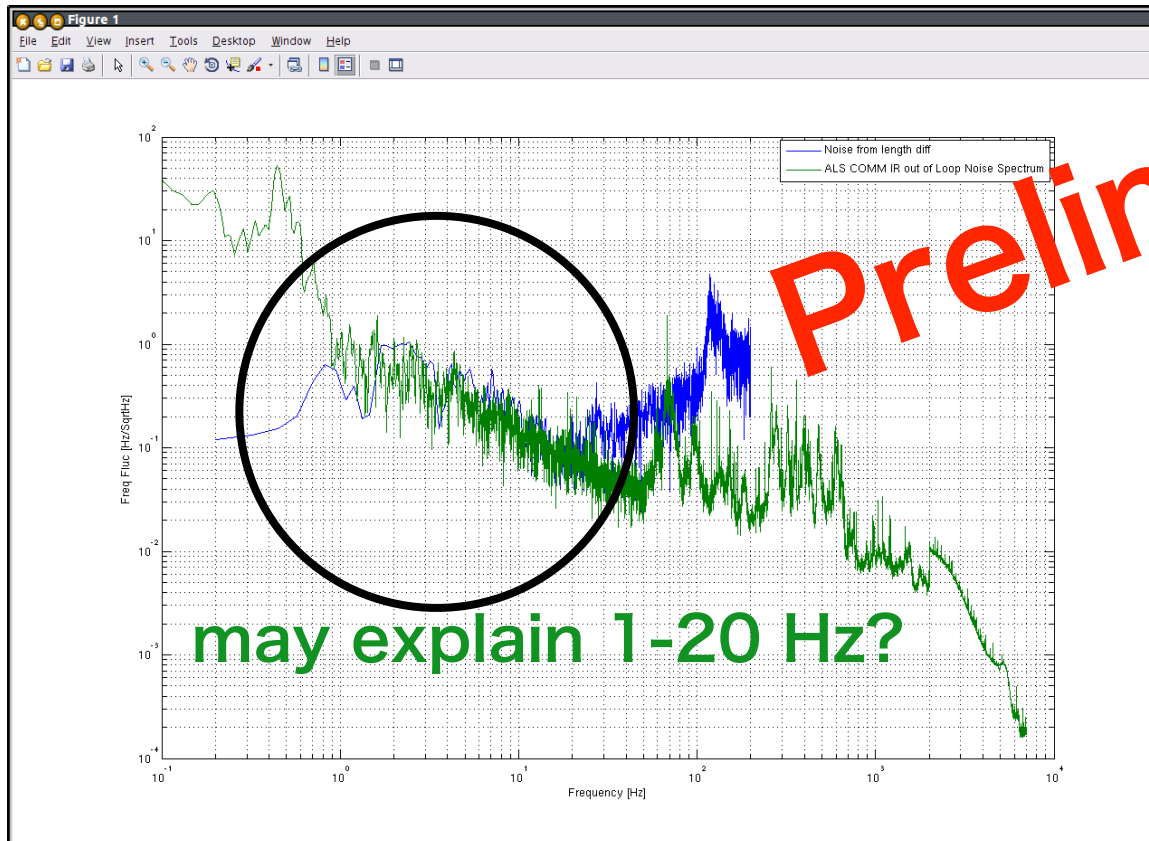
Backup Slides

Demonstration of Freq. Tuning



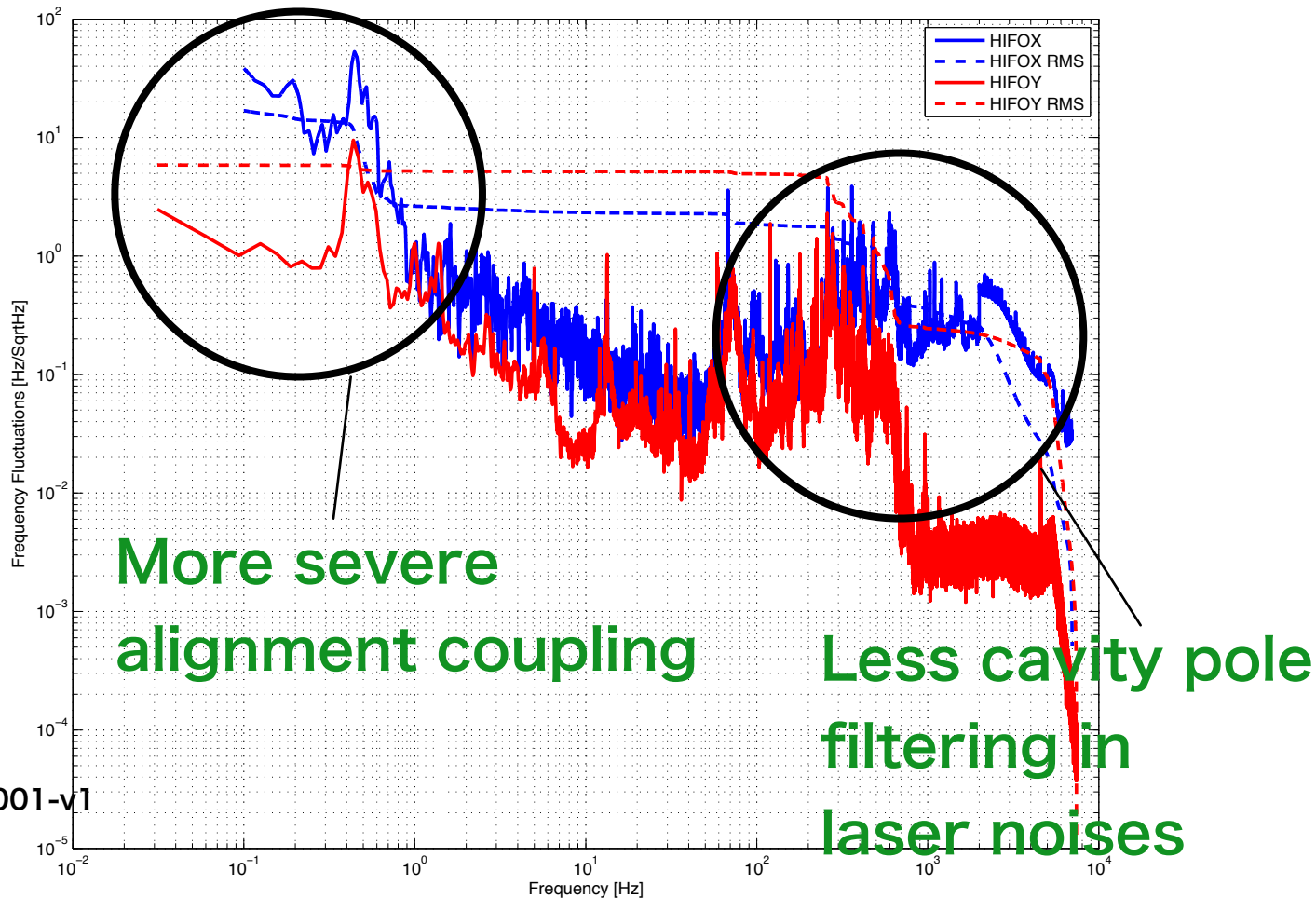
Doppler Noise in Green light

- X(Y) green is delivered to the corner station through a different path than the infrared laser.
- Modulation in the path length introduces a Doppler shift in the beatnote frequency.

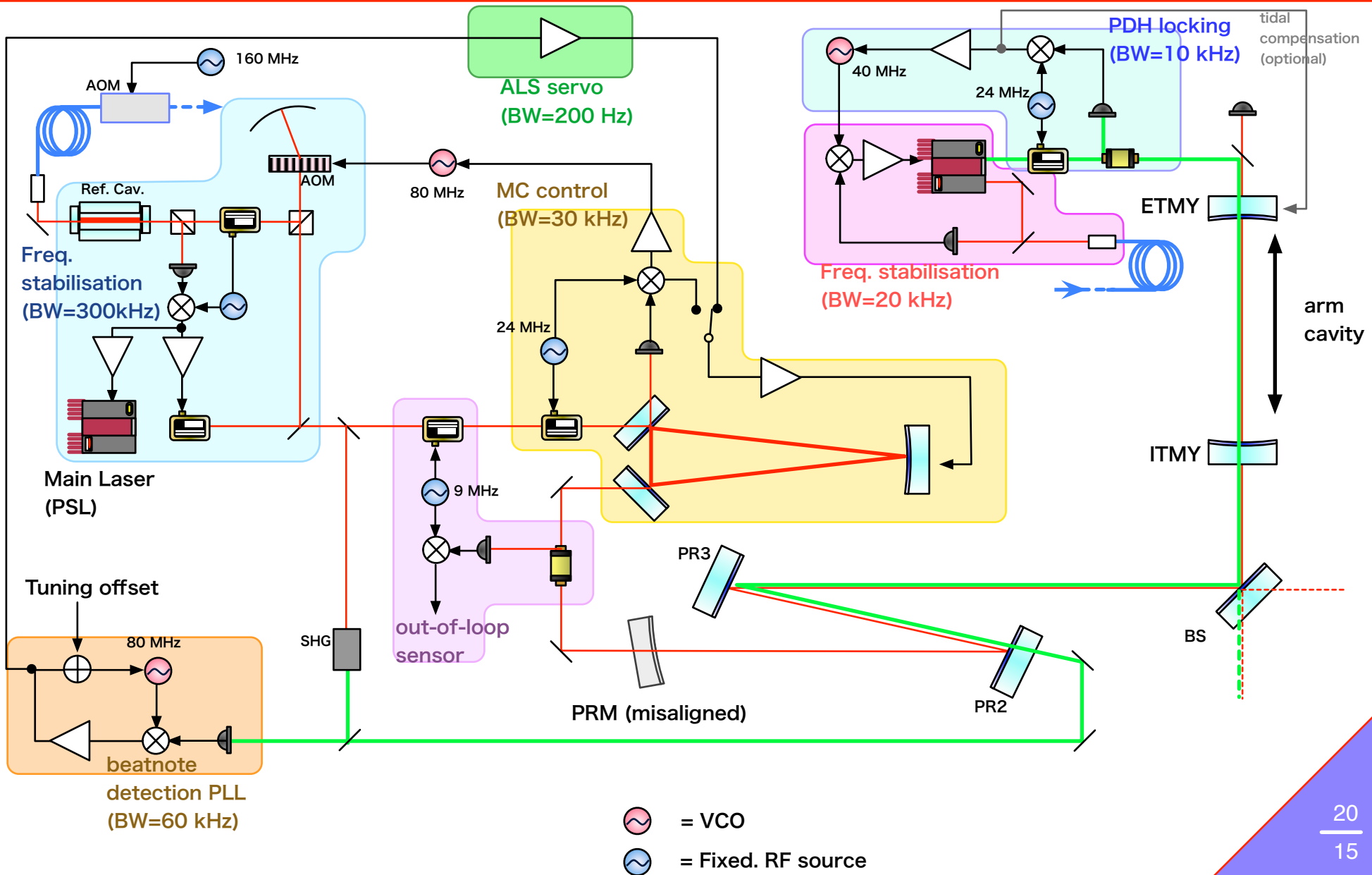


Low Finesse Arm Cavities

- ▣ Reflectivity of test masses at 532 nm were found to be out of spec. → Lower finesse for green light
- ▣ This impacted on performance of ALS



HIFO-Y setup



HIFO-Y noise

Noise Budget

