



Status of Detector Commissioning

LSC Meeting, March 2001

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Promises at Aug 00 LSC meeting

- Power recycled Michelson locks
 - Carrier or sideband resonance
- Arm cavity locks
 - Feedback to ITM or ETM
- ...get both locking at same time...
- ...add second arm cavity...
- ...full interferometer!



Livingston overview: what's new

- ❑ Installation/alignment of remaining in-vacuum components – Nov. 2000
- ❑ Beam sighted down arm cavities – Jan. 2001
 - Within $< 3 \mu\text{rad}$ of optic centers
- ❑ Some realignment of input optics beam required
- ❑ 4 km arm cavity (longest ever!) locked – Feb. 2001
- ❑ Full interferometer locking underway
- ❑ Learning about differences in seismic environment between both sites
- ❑ E3: first 'coincidence' run – Mar. 2001
 - LLO X arm cavity locked for $\sim 80\%$
 - PEM channels acquired at both observatories



Hanford overview: what's new

- ❑ Initial full ifo locking – Oct. 2000
 - Intentionally reduced buildup
- ❑ E2: recombined interferometer – Nov. 2000
- ❑ Full ifo locking with no intentional loss – Jan. 2001
 - Carrier power recycling gain: 15
 - Hour long lock stretches
 - Sensitivity spectra noisy as expected
- ❑ Noise reduction studies
 - Sensing noise
 - PSL/IO frequency noise
 - Electronics noise (low input power, less filtering)
- ❑ Olympia earthquake – Feb. 2001
 - Damage to magnets on several suspended optics
 - Under repairs

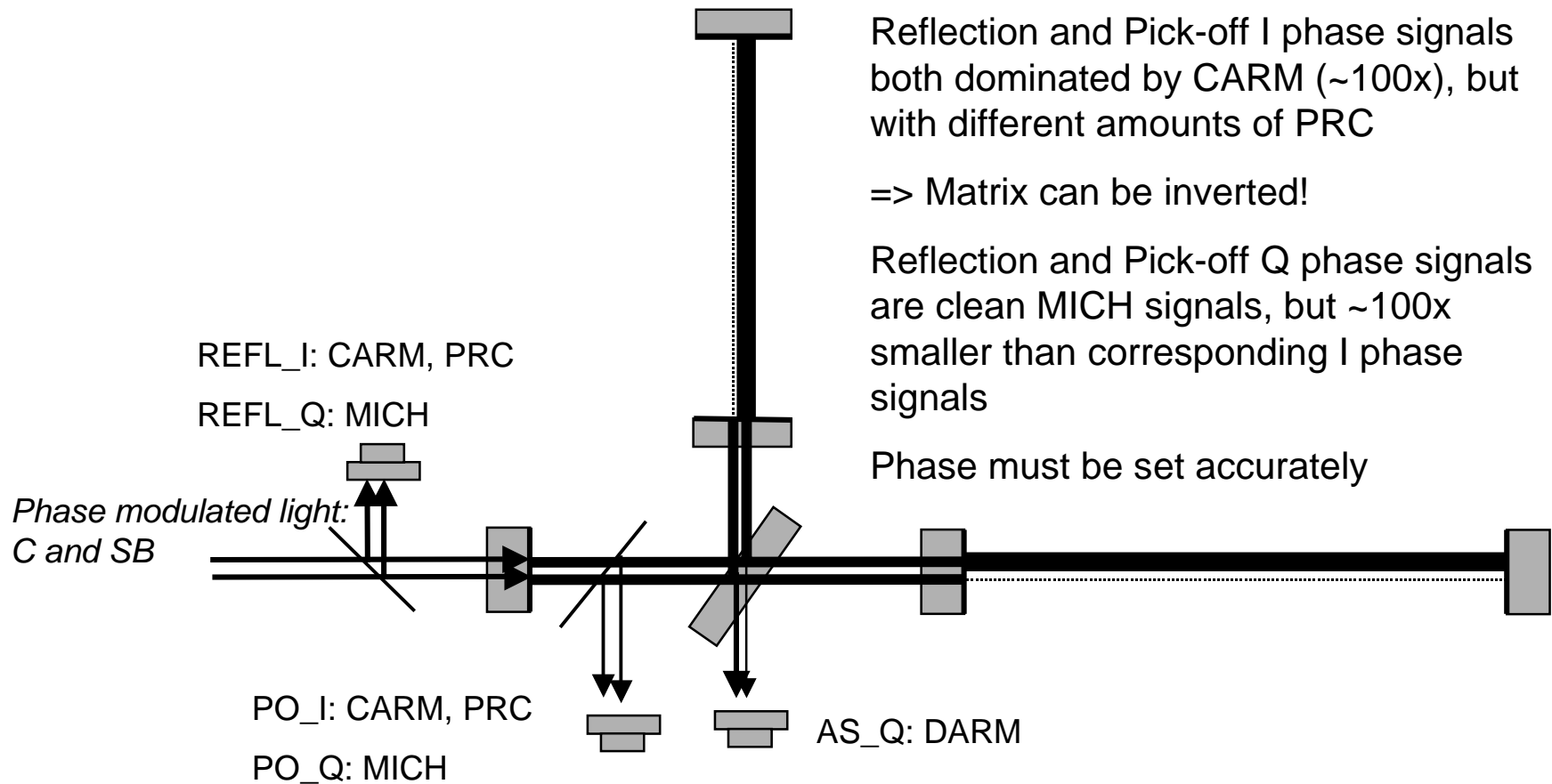


Interferometer Locking: lock acquisition

- ❑ Masterminded by Matt Evans (CIT grad student). His reward:
 - PhD thesis
 - Acquisition C code named for him: “Matt’s code”
- ❑ Basic problem
 - Sensing matrix goes through singularity as both arm cavities start building up power
- ❑ Solution implemented
 - Judicious use of light power levels to estimate when matrix determinant too small; turn of controller till dofs coast through singularity
- ❑ LSC digital controls made it possible
 - “Matt’s code” interfaced with “Rolf’s code”
- ❑ All testing of actual C code was done using E2E model of full ifo
 - Angular fluctuations not included had to rethink use of signals a few times

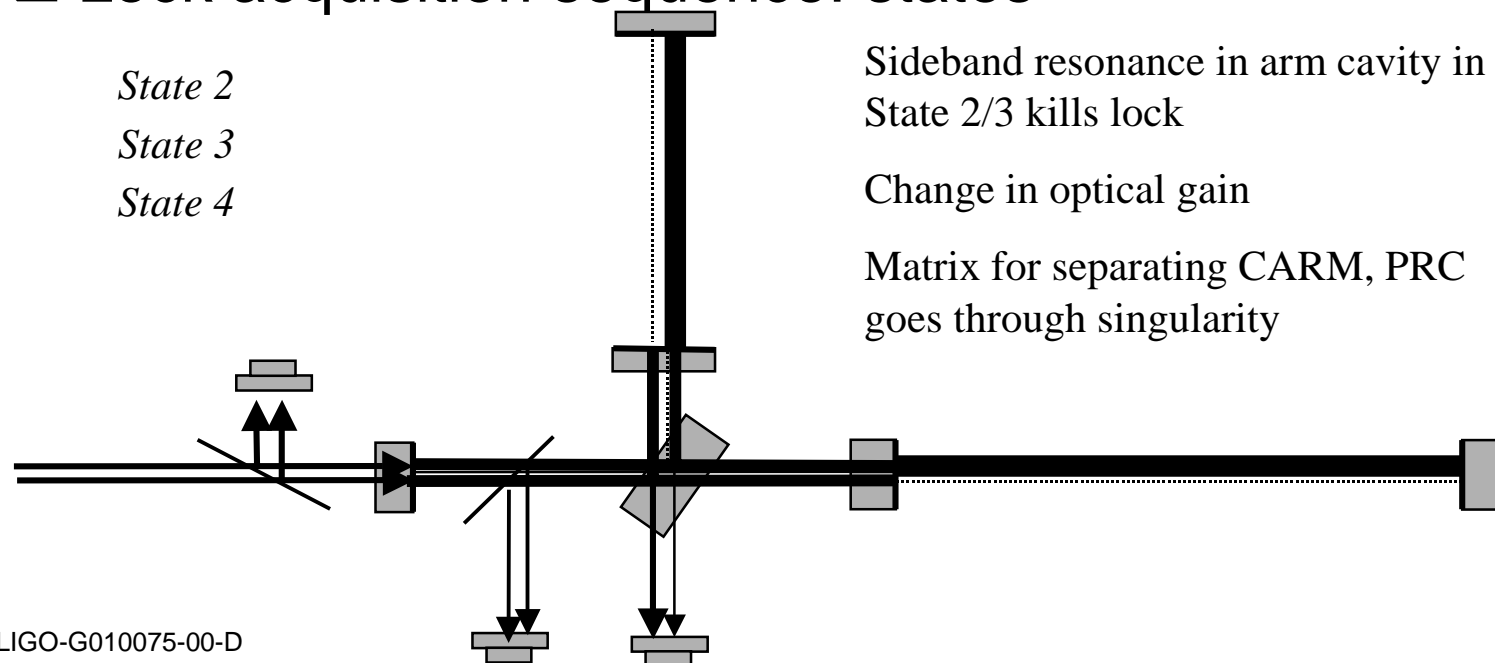


Length Sensing Matrix: very near resonance



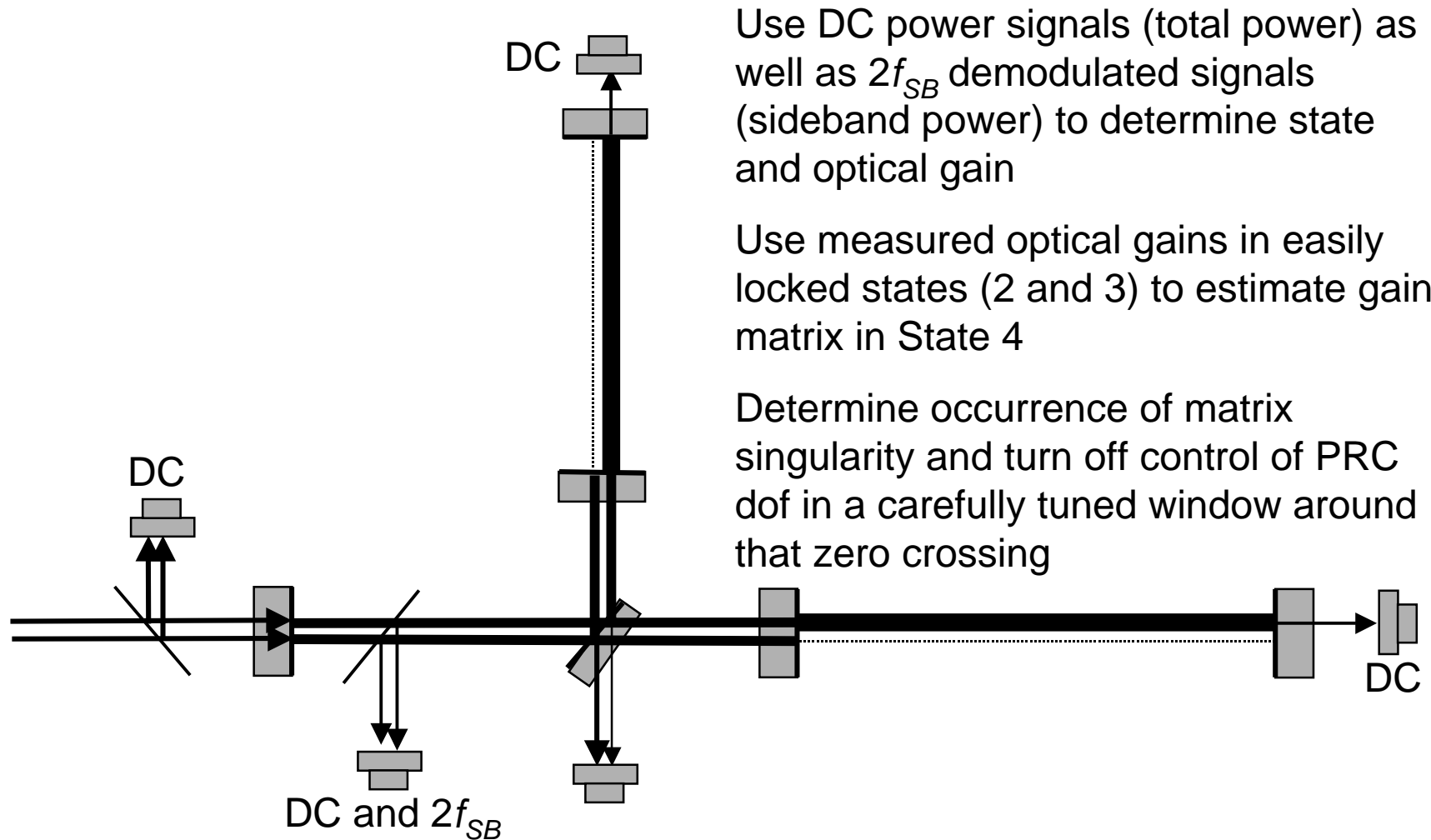
Lock acquisition: the problem

- Sensor signals, \mathbf{S} , are related to degrees of freedom, \mathbf{D} , via the optical gain matrix, \hat{G}
 - \hat{G} depends on buildup of fields in the ifo, i.e. $\hat{G}(t)$
 - \hat{G} must be invertible, i.e. $\det(\hat{G}) \neq 0$
- Lock acquisition sequence: states



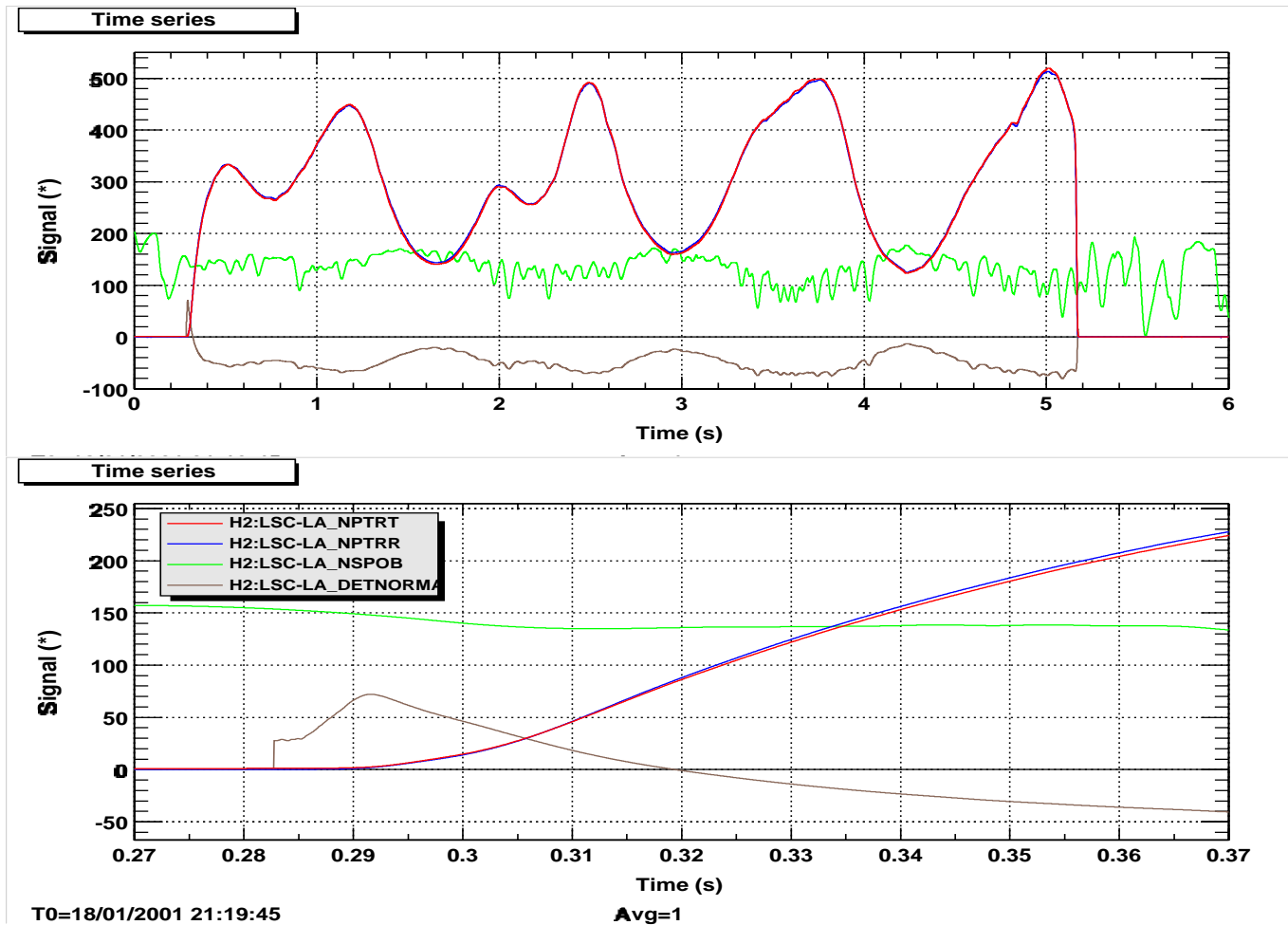


Lock Acquisition Program a.k.a. Matt's code



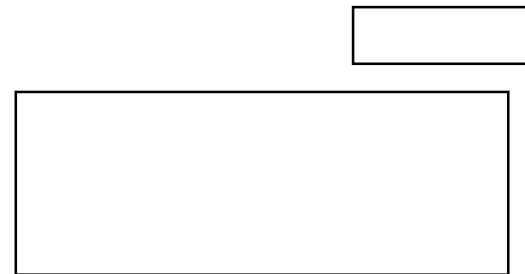


Matt's Code in Action





Full Interferometer Locking



S. Whitcomb



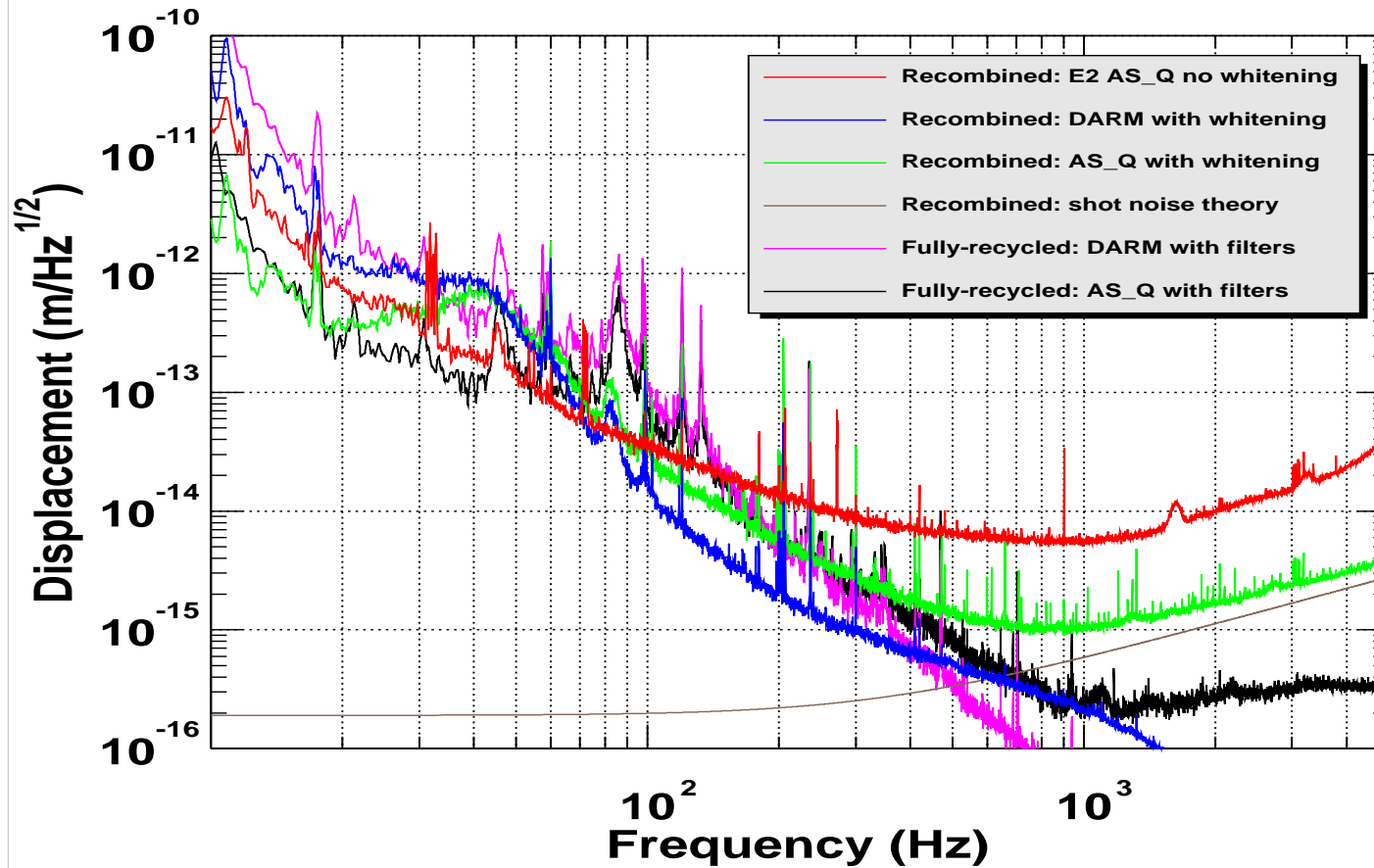
From “first lock” to stable high buildup lock

- ❑ Optical lever damping for angular dof on several optics
 - Mitigate 1.06 μm light coupling problem
- ❑ Improved signal-to-noise on critical light power signals (dynamic range)
- ❑ Wavefront sensor on antisymmetric port \rightarrow ETM angles differentially
- ❑ Detour to run recombined configuration
 - First look at ‘differential mode’
 - E2: >90% duty cycle for lock



Displacement Sensitivity

Calibrations: Recombined and Recycled



M. Landry



What's next?

Near future

□ LHO 2km

- Repairs – expect to re-commission in 05/01
- Improvements – new 1.06 μm insensitive OSEMs

□ LHO 4km

- Expect to begin commissioning in 05/01

□ LLO 4km

- Characterize environmental noise better
- Proceed with full interferometer locking
- Identify in-vacuum problems that must be fixed in next vent
- Vent coordinated with installation/repair effort at LHO