

Status of Some Aspects of LIGO



Jay Marx
LSC meeting
Hanford
March 20, 2006



Topics to discuss briefly

- S5-- commissioning progress
- Enhancements to Initial LIGO
- Advanced LIGO--and other "politics"
- LIGO management topics
- Virgo and LIGO
- Education and Outreach
- Our challenge in the next year

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- S5 goal is NSB condition for AdvLIGO funding
 - » “at least a year’s data of coincident operation at the science goal sensitivity”
 - Performance goals for S5
 - » H1, L1 over 10 Mpc inspiral range, H2 over 5 Mpc
 - Sensitivity and duty cycle--- where we stand

Commissioning progress

- February commissioning break -substantially improved sensitivity

	Before break	After break (best)
L1	~10 Mpc	~12 Mpc
H1	~11 Mpc	~14.5 Mpc
H2	~5 Mpc	~7 Mpc

- Congratulations to commissioning team--great job!!!
- Will implement similar changes in LLO in April



S5 Performance to February 21

NS-NS Inspiral Range Histogram

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.



Duty Cycle since S5 Began

- Goal--85% single, 70% triple
- Duty cycle thus far falling significantly short:

L1	55.1%
H1	63.9%
H2	72.5%
Any two	66.7%
Triple	38.4%

Next commissioning focus---
Improve duty cycle and coincidence
lifetime

Opportunity to enhance sensitivity and increase the chances of observing GW sources

- e.g., for NS-NS inspirals # galaxies~ (sensitivity)**2.7

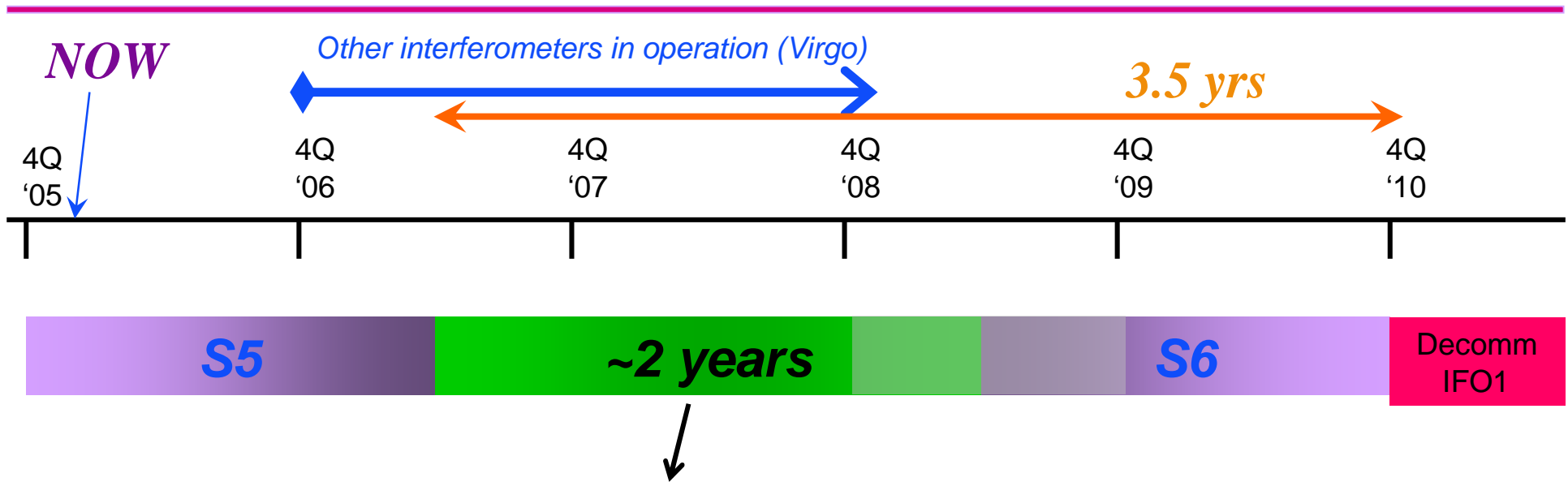
Factor of 2 reduction in strain noise,

⇒ factor of ~6.5 increase in number of galaxies we “see”

- There are many ideas but there are constraints:
 - Money (we have ~\$1M-\$1.5M set aside)
 - People (too many people doing too many things)
 - Timing- ~3.5 years between end of S5 and decommissioning of interferometers to install Advanced LIGO components
 - e.g. ~2 years for installation and commissioning and 1 ½ years for data taking with enhancements



Time Scale



- Between S5 & AdvLIGO, there is time to improve the interferometers...
 - 1) How to apportion time between commissioning and science run?
 - 2) Substantial improvements on 2 IFOs or moderate improvements on 3?
 - 3) Coordinate science runs with VIRGO / GEO



Planning for Enhancements

- Favored approach- Use Advanced LIGO technologies wherever possible- experience will reduce AdLIGO commissioning time

- What enhancements to implement?
 - Output mode cleaner
 - Increase laser power
 - Other???

- Contingency options should AdLIGO be delayed?

- Rana et al are working on a plan
 - Talk on Tuesday
 - Discussion session on Wednesday----- join in!



Advanced LIGO politics--good news

- Construction start in FY08 in good shape
 - » President's Budget for NSF has funding for all NSF MREFCs ahead of AdvLIGO
 - » If Congress agrees with President's budget, AdvLIGO at head of line for FY08 start (+ NSB agreement in May)

- Cautions-
 - » Congressional action of FY07 budget request still ahead
 - » NSF request for MREFC funding in FY07 is big increase over this year
 - Highest priority for MREFC is always projects that have already begun- other projects will need more \$\$
 - FY07 new starts ramp up funding in FY08
 - ALMA facing big cost increase will need more \$\$ in FY08



Advanced LIGO

- Next big event
 - » NSF Baseline Review May 31-June 2 @ MIT-- critical step
 - ~30 outside reviewers-- scope, cost, technical soundness, risks, etc.
 - David, Carol, Dennis, rest of AdvLIGO team have much to do to be ready
 - » Then NSF asks for construction funding as part of FY08 budget process

- Advanced LIGO must become an increasing focus for LIGO-- challenge;
 - Concern about people being stretched too thin
 - » Inevitable collisions with other priorities; must be managed effectively

- Adv. LIGO status-- Upcoming talk by David Shoemaker



November 2005 NSF Review-- *important outcomes*

- “All three instruments have achieved, and slightly surpassed, the design requirement “
- “ ... we recommend that the requested 2-year extension of the current cooperative agreement be granted at the requested budget level.”
- “...we recommend that the cooperative agreement with Caltech covering the operation of the initial LIGO be continued through the construction of Advanced LIGO. “
- Next step-- NSB meeting March 28-29;
 - » Expect will decide- no recompetition until after Advanced LIGO. A VERY important outcome!



LIGO management topics

- Implementation of an integrated structure for LIGO, encompassing Laboratory and LSC ~completed
 - » LIGO Directorate (LIGO Director, LSC Spokesperson, LIGO Lab Deputy Director) structure functioning well
 - » LSC retains independent governance
 - New by-laws being considered by LSC Council
 - » LSC major stakeholders now part of Oversight Committee
 - » LSC- major voice in search for LIGO Executive Director
 - Search committee and thru Oversight Committee
 - » LSC full partner in new advisory structures (below)



LIGO Laboratory Board

- Set up by Caltech---required when a non-professorial faculty member directs a major research entity
- Functions-
 - *Consult with and advise* Directorate concerning significant decisions affecting the LIGO Laboratory as well as significant issues pertaining to the institutional interests of Caltech and MIT.
 - *Meet Caltech requirement* of a knowledgeable member of the professorial faculty to be cognizant of the governance of LIGO Laboratory and act as an internal advocate at Caltech
- Members-
 - Executive Director--Marx
 - Deputy Director--Whitcomb
 - 2 Caltech Faculty-- Barish, Thorne
 - 2 MIT (at least 1 Faculty)--Shoemaker, Katsavounidis
 - 2 LSC (including the Spokesperson)-- Saulson, chair of LSC Analysis Committee
- Bottom line---advice from LIGO and friends



LIGO Academic Advisory Council (LAAC)

- Function-- Advise the LIGO Executive Director and Directorate on issues related to education of students and postdocs who are participating in LIGO
 - » 1. *Serve as an advocate* with the LIGO Directorate for the educational aspects across all of LIGO for undergraduates, graduate students, and postdoctoral students.
 - » 2. Provide a mechanism to *gather and evaluate information* concerning LIGO's educational program and recommend improvements to the LIGO Directorate.
 - » 3. Work with LIGO collaborating institutions, help to ensure that the postdoctoral students, graduate students, and undergraduates associated with LIGO get a broad education and quality mentoring in the wide range of science involved in LIGO.
- Membership:
 - » 3 Faculty members-- (Caltech, MIT, other LSC institution)
 - Kip Thorne (chair), Nergis Mavalvala, Nelson Christensen

- Things being considered--
 - » Information gathering about where there are problems or opportunities for improvement
 - » Setting up and keeping current a thesis and analysis topics data base
 - » Student/postdoc pizza night at LSC meetings beginning August-- talk to LAAC members about issues, concerns (management pays for pizza and doesn't attend!!!)
 - » Things to improve educational experience of summer undergraduates



Virgo and LIGO MOU

- MOU with Virgo about joint analysis of data moving ahead rapidly
- Spirit of teamwork, not competition thanks to Peter, Stan and Benoit
 - » Discussion at LSC Council
 - » We hear that, in general Virgo is comfortable with the draft
 - » Stan and Jay visit Virgo in early April
 - » If all goes well signing in early summer???
- Looking ahead to coordinating science running, commissioning, upgrades and shutdowns with Virgo and other instruments around the world
 - » Important step towards optimizing world sensitivity and duty cycle



Education and Outreach

- Science Education Center going up at Livingston
 - » 8000 ft² facility complete in fall 2006
 - » 50 hands-on exhibits (~2/3 from SF Exploratorium)
 - » School groups, families, club visits, teacher development

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.



More Education and Outreach

- At Hanford in 2005- 3000 visitors incl. 700 students
 - » Monthly public events (movies, lectures, stargazing, etc.) to celebrate World Year of Physics
- Einstein's Messengers--- "I give it a 4-star rating"
 - » Developed by NSF and shown to science press at AAS (with excellent talk by Nergis)
AAAS (with excellent talk by Gaby)
 - » Available by on-line streaming video
 - » Copy to each LSC institution; more can be purchased
 - » Supplementary educational materials for classroom being developed over next 6-9 months. Grant proposal with Dale Ingram as PI



Our challenges in the next year

- Be prepared for a detection
 - » Think through the checks and balances, process for getting whole LSC on board, for communicating with rest of scientific community, etc. Where/how to announce? Be prepared before the excitement and stress hits.....plan ahead!!
- Handle the “richness of opportunities” e.g.(too much to do)-
 - » Get the interferometers to high duty cycle, robust operation
 - » Take and analyze lots of data
 - » Continue producing quality scientific results
 - » Move towards enhancements of initial LIGO- what, who, how
 - » Prepare for start of Advanced LIGO construction in about 18 months
- Keep the momentum going in external education and outreach
- Keep effectively training and educating the next generation of leaders in the field





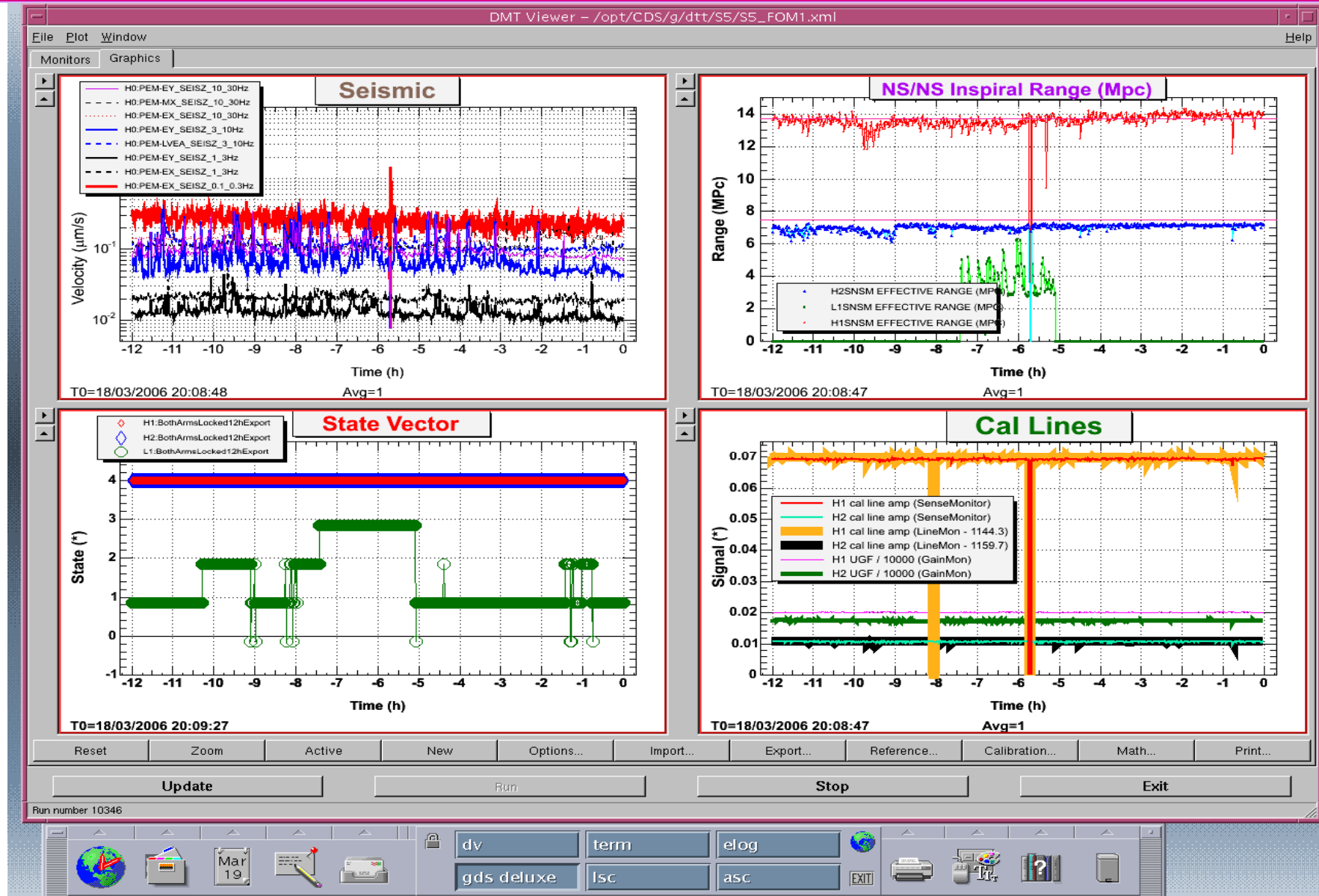


Science-mode statistics for S5 run

- Up to Mar 20 2006 01:31:02 UTC
- Elapsed run time = 3249.5 hours
- | Sample | Hours | Percent | |
|-------------|--------|---------|------------------------------|
| ----- | ----- | ----- | |
| H1 | 2075.2 | 63.9 | since Nov 4, 2005 8:00 PST |
| H2 | 2356.7 | 72.5 | since Nov 4, 2005 8:00 PST |
| L1 | 1658.2 | 55.1 | since Nov 14, 2005 12:00 CST |
| H1+H2 | 1897.6 | 58.4 | since Nov 4, 2005 8:00 PST |
| H1+L1 | 1261.4 | 41.9 | since Nov 14, 2005 12:00 CST |
| H2+L1 | 1316.5 | 43.8 | since Nov 14, 2005 12:00 CST |
| H1+H2+L1 | 1154.3 | 38.4 | since Nov 14, 2005 12:00 CST |
| One or more | 2768.9 | 85.2 | since Nov 4, 2005 8:00 PST |
| Two or more | 2166.8 | 66.7 | since Nov 4, 2005 8:00 PST |
| (H1orH2)+L1 | 1423.6 | 47.3 | since Nov 14, 2005 12:00 CST |



H1 & H2 on this past Saturday night





S5 Performance to February 21

Coincidence Factor by Week

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↔
start delay

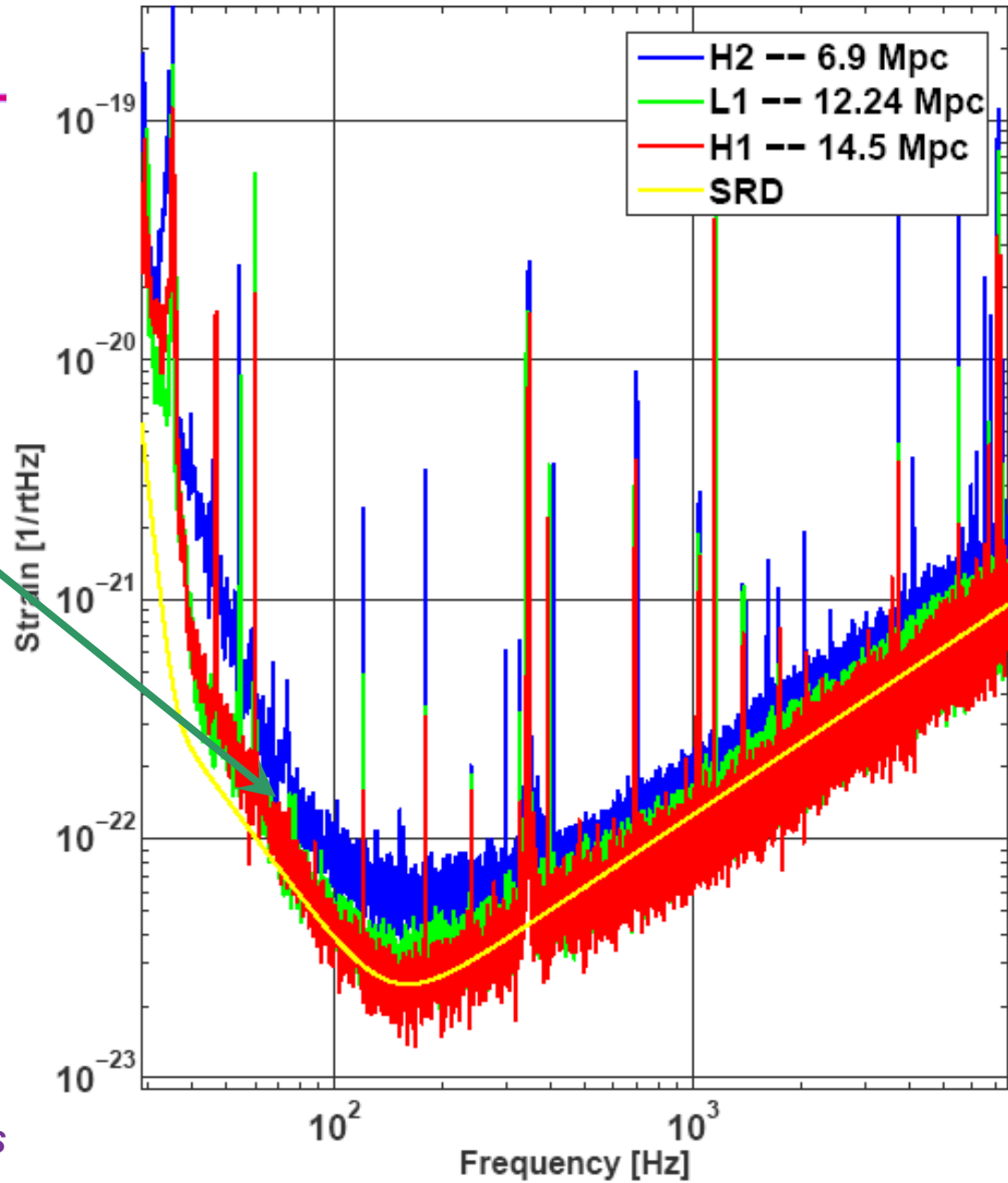
↔
commissioning break

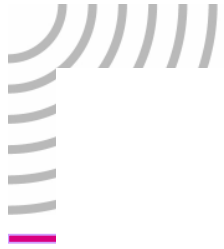
- 11 papers on observational results submitted since last March LSC meeting (9 from S2, 2 from S3)
 - » PRL: 2; PRD: 6 accepted, 2 in review; CQG/Amaldi proceedings 1
- Analysis well along for S4 data
 - » Results from many groups reported here and some papers in draft
- Analysis for S5 data-- going well
 - » Some preliminary physics analyses presented here; and sensitivity characterization.
- Results from S4 & S5 (preliminary) to be presented at APS meeting in April--TBD at this meeting
- Mechanisms for reviewing and approving results working well; but lots of work.
 - » More active reviewers needed



State of the Detectors

- Sensitivity improvements from the recent '2 week' commissioning period.
- Much less 'mystery' noise

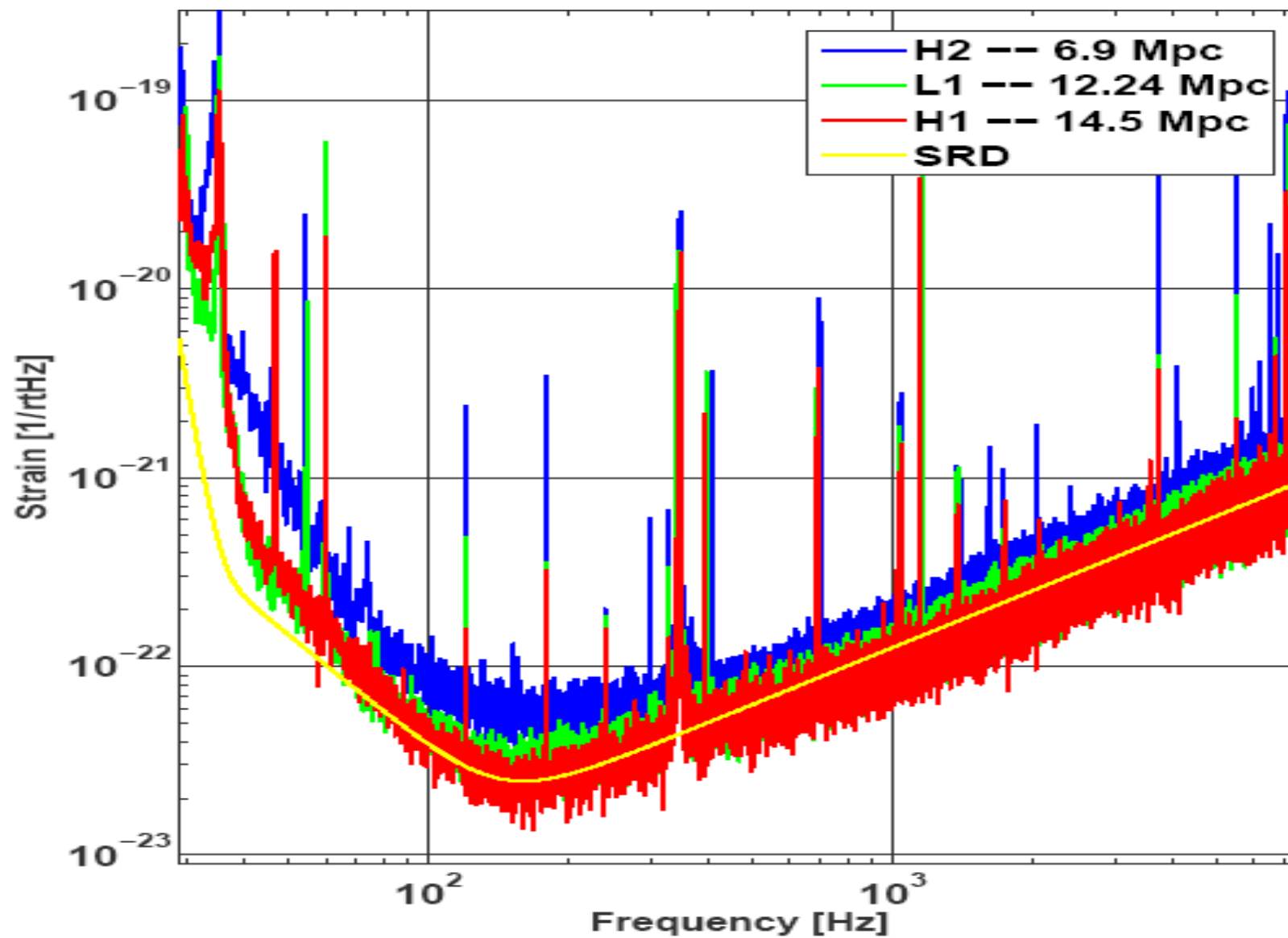




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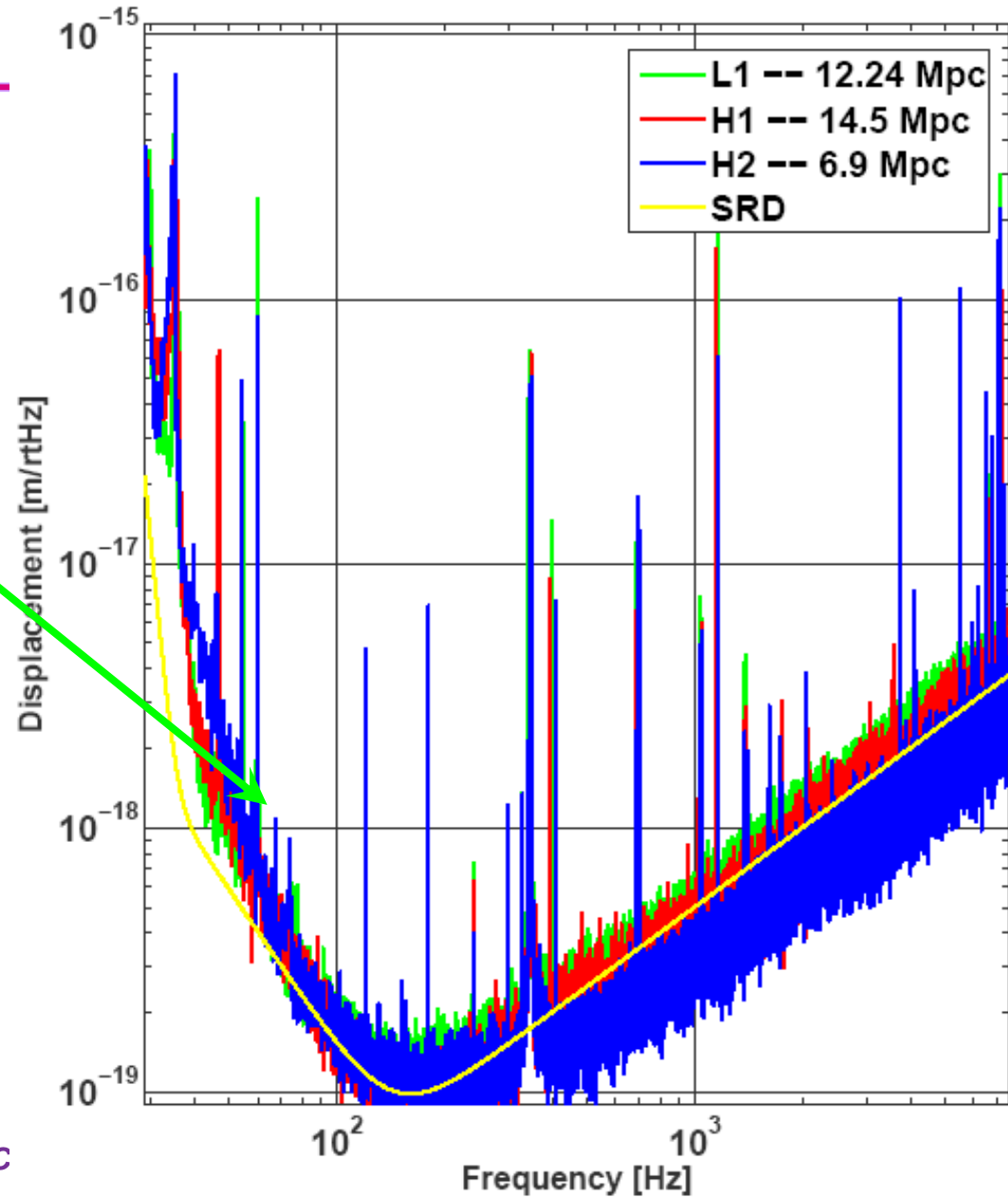


State of the Detectors



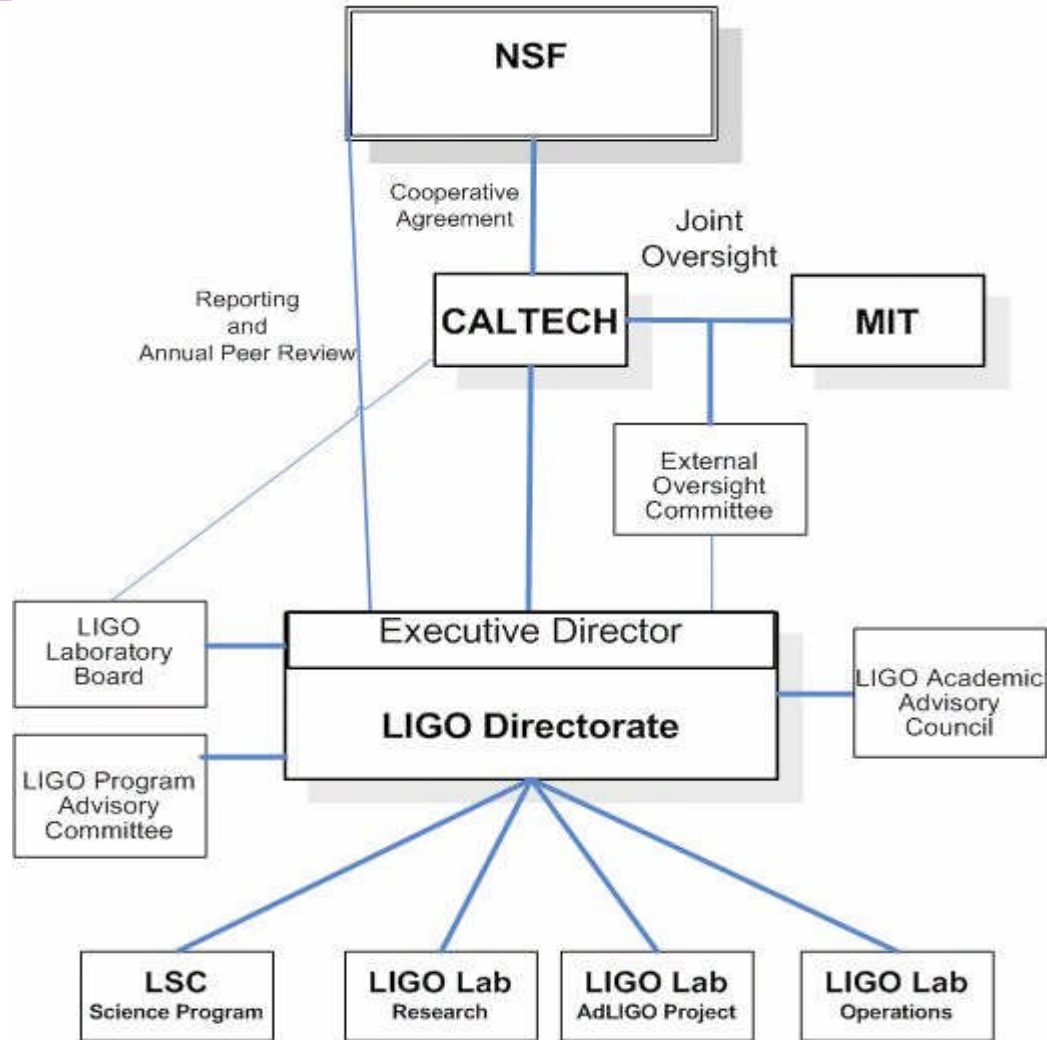
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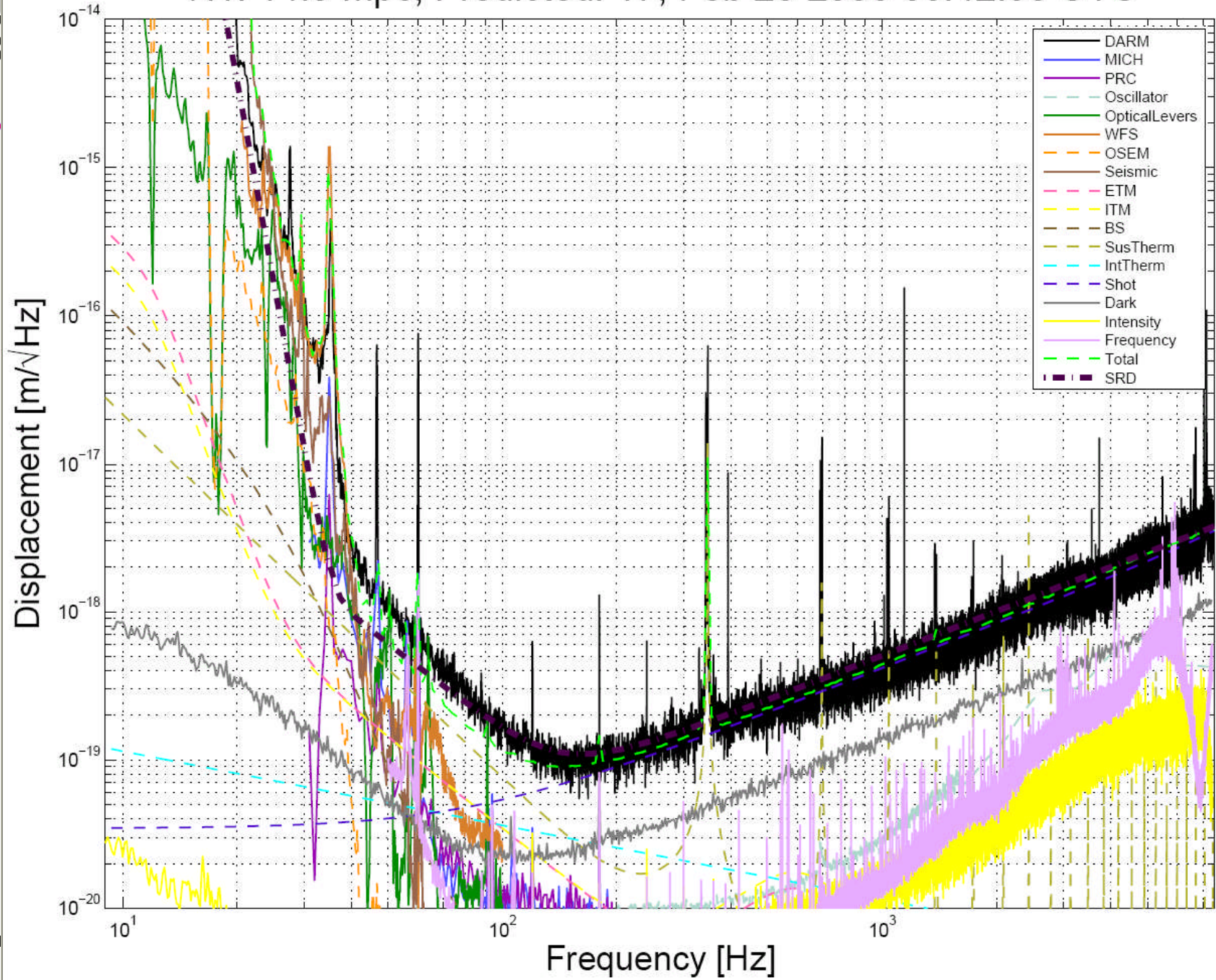


LIGO Organization





H1: 14.5 Mpc, Predicted: 17, Feb 20 2006 05:42:50 UTC



Main improvement through reducing the HVAC air flow rate.

(details in R. Schofield's LHO elogs)

Believe it is upconversion of some sort...

- » Output Electronics
- » Optical (scattering)
- » Mechanical

