Laser Interferometer Gravitational-Wave Observatory (LIGO)

Engineering Run 3. (E3)

March 9-12(13) 2001 @ LLO-LHO

LSC 2001 Spring Meeting

Baton Rouge, LIGO Livingston Observatory

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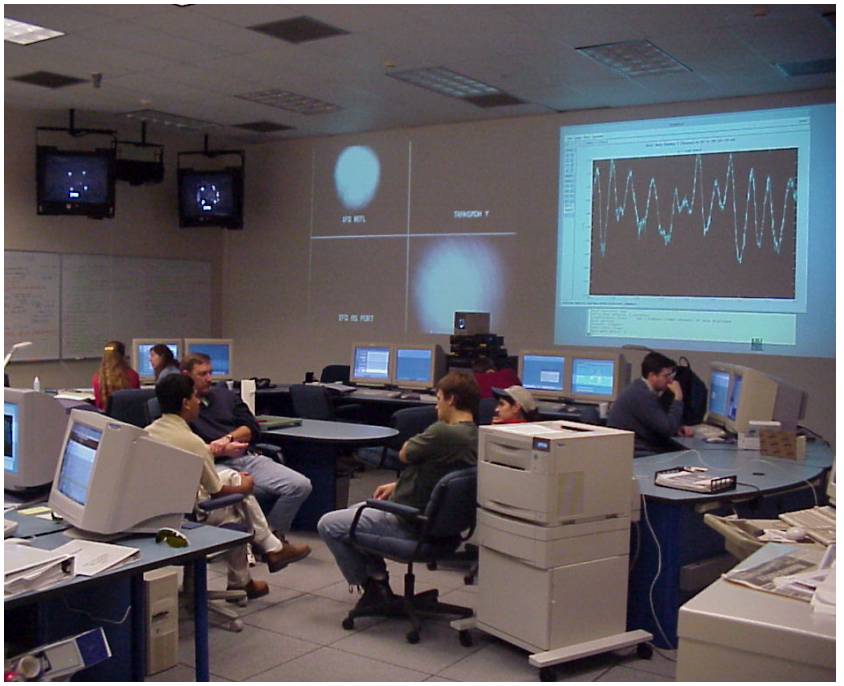
March 15 2001

Engineering run 3. (E3) 9-12(13) LLO-LHO

- First joint engineering run between LIGO sites
  - X-arm locked for LLO
  - PEM for LHO
- Principal goals:
  - High up time
  - High overlap time
  - Help off site members to get hands on experience with the detector
  - Record excellent data for investigations
  - Hone our skills, identify bottle necks



http://blue.ligo-wa.caltech.edu/engrun/E3/

E3 run summary: E3 run is a success!

- **Smooth operation and great learning experience!**
  - ~0.9Tb **of continuous data is on tape by LDAS**
  - ~450Gb **of RDS data was recorded during the 3+1 days**
  - **We estimate that the X-arm was locked** 80-90% **of the time during 72 hour run and close to** 95+% **for the extra day**
  - **Minor problems fixed quickly and effectively by experts**

- **Strong LSC interest!**
  - 13+ **scientific investigations**
  - 10+ **monitors running on the Data Monitoring Tool**
  - **Close to** 20 **off site scientists and 8 operators gave shifts**
  - **Large number of very interested scientists were working in the control ro computer users room nearly around the clock**

E3 up-time at LLO

- Estimated up-time is around 86% for the official run period
  - not counting scheduled down-time
  - assuming that locks of 30 seconds or longer are useful
  - Exceptional up-time (95+%) for the extra day after the run

Reduced Data Sets

- We recorded more than 450Gb of data from important channels
  - available from the /export/raid2(1)/E3/ disk of FORTRESS (DECATUR)
- Few (~20) frames were lost and gaps were kept minimal
  - some data loss is expected in various channels (subsystem reboots)
- Datasets were backed up on tape

Real Time Data Transfer

- Real time transfer of few channels from LLO to LHO
  - We successfully transmitted and merged frames from the two observatories
  - ~5 PEM channels were transmitted
  - The transfer was bandwidth limited (12Kb/sec)
    - We need more bandwidth to make real time merging practical
- Try to set up two way transfer and merging

Computing

- Smooth operations
  - Minor problems with non vital systems fixed quickly
- **Periodic backup ensured safety**
- To ensure secure operation for long term runs:
  - We NEED redundancy for bottleneck systems
    - Tape restore can take hours!
    - FedEX overnight is a day lost!

Operators and Scientists on the Shifts

Date	Shift	Expert Trainee	Operators
Fri Mar 9	Day	Giaime (LSU) Heng (LSU)	Riesen, Langdale
	Eve	Daw (LSU) Brown (Wisconsin)	Traylor, Watts
Sat Mar 10	Owl	Nash (Fermilab) Searle (Australia)	Overmier, Fyffe
	Day	Whiting (Florida) Greenwood (Louisiana)	Riesen, Langdale
	Eve	Johnson (LSU) Simicevic (Louiaiana Tech)	Lormand, Roddy
Sun Mar 11	Owl	Nash (Fermilab) Searle (Australia)	Overmier, Fyffe
	Day	Shawhan (CIT) McHugh (Loyola)	Riesen, Langdale
	Eve	Giaime (LSU) Simicevic (Louisiana Tech)	Lormand, Roddy
Mon Mar 12	Owl	Daw (LSU) McClelland (Australia)	Traylor, Watts
	Day	Shawhan (CIT) Sutton (Pennsylvania State)	Riesen, Langdale

Visitors Supporting the E3run in LLO

Scientist	Institute	Estimated arrival to site
Rich Abbott	CIT	March 5
Rolf Bork	CIT	March 5
Duncan Brown	Wisconsin	March 8
Dick Greenwood	Louisiana Tech	March 9
Gabriela Gonzalez	Pennsylvania State University	March 9
Chris Hawkins	Florida	March ??
Ik Siong Heng	LSU	March 8
Peter King	CIT	March 8
Albert Lazzarini	CIT	March 9
Nergis Mavalvala	CIT	March 5
Martin McHugh	Loyola	March 11
David McLelland	Australia	March ??
Thomas Nash	Fermilab	March 8
Benoit Mours	CIT/LAPP/Annecy	March 11
Steve Penn	Syracuse	March 11
Keith Riles	University of Michigan	March 9
Antony Searle	Australia	March 8
Peter Shawhan	CIT	March 9
Neven Simicevic	Louisiana Tech	March 10
Patrick Sutton	Pennsylvania State	March 8
Andrea Vicere'	CIT	March 8
Larry Wallace	CIT	March 7
Bernard Whiting	Florida	March ??

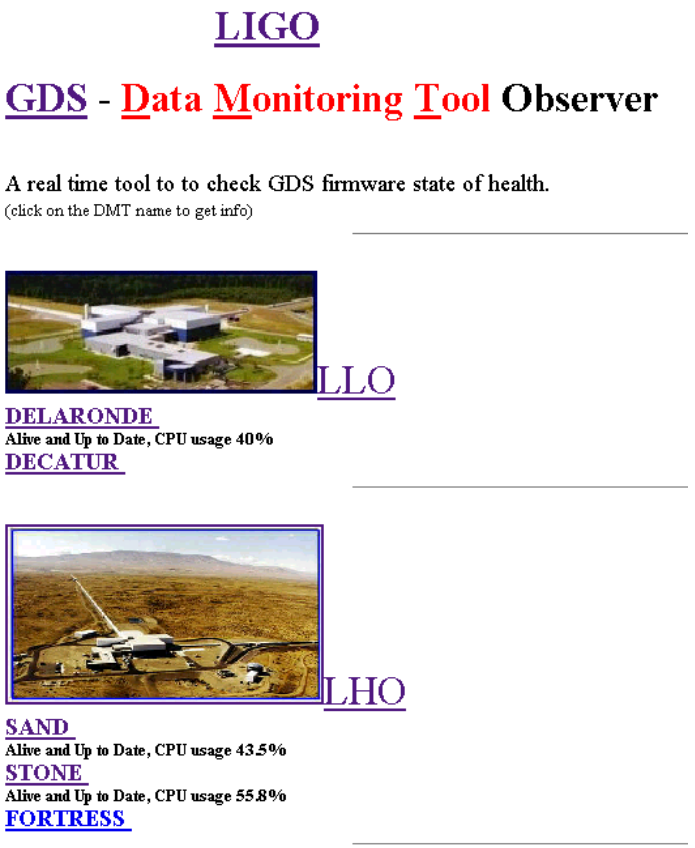
Proposed investigations

1. Quantify fraction of noise in 5-50 Hz band due to seismic motion.
2. Quantify correlations between GW channel and other channels.
3. Quantify environmental correlations between sites
4. Identify & catalog environmental disturbances
5. Quantify calibration stability & stationarity of data
6. Investigate angular fluctuations
7. Check data against detailed tidal prediction
8. Investigate sources of lock losses
9. Quantify timing precision (intra- and inter-site)
10. Check data integrity end-to-end
11. Check data merging
12. Quantify strength and stability of line noise in GW channel
13. Investigate occurrence and propagation of frequency noise

and others may evolve …

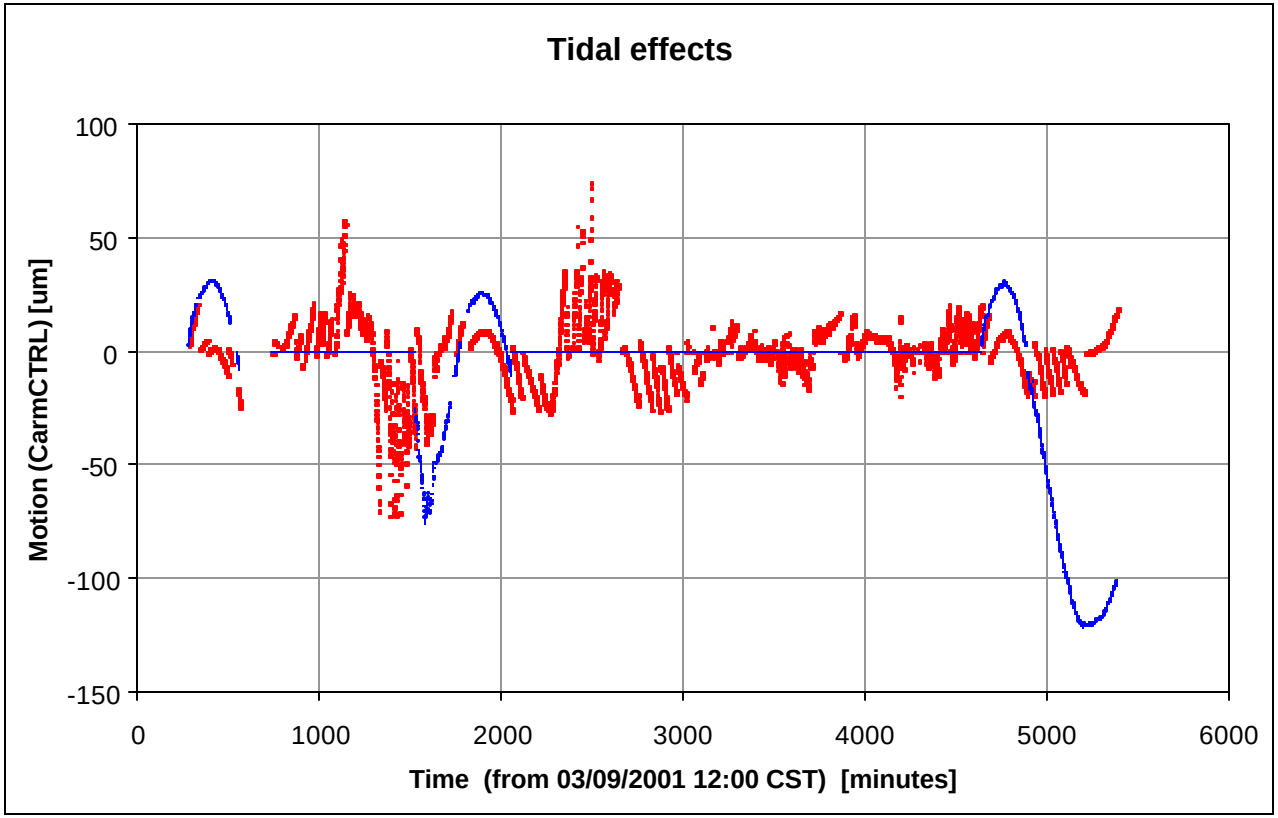
Data Monitoring Tool

- Hanford
  - Both SAND and STONE in operation
  - 3 monitors on SAND
  - 5 monitors on STONE
- Livingston
  - Never before so many monitors running on DELARONDE… (10)
- High loads were manageable (<70%)



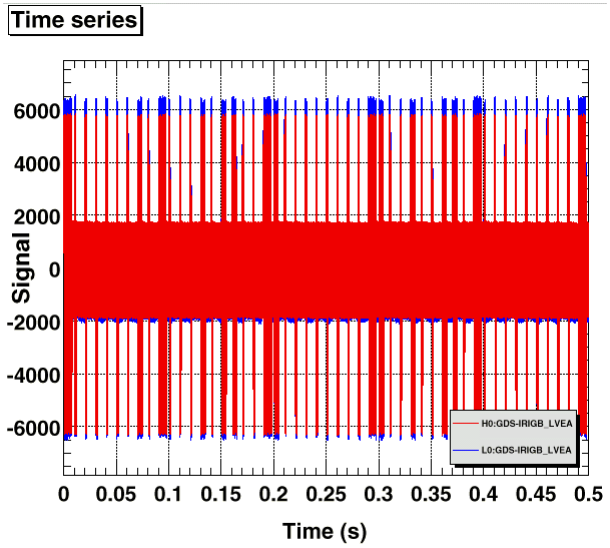
http://blue.ligo-wa.caltech.edu/gds/dmt/Monitors/spi.html

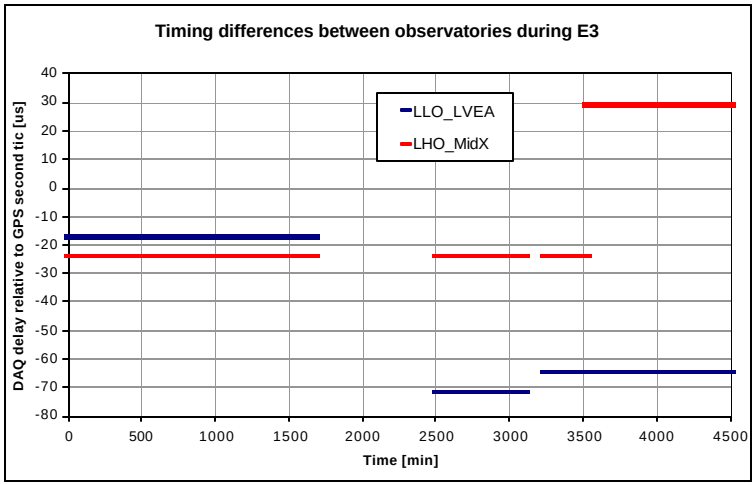
Example 1: Tidal effects



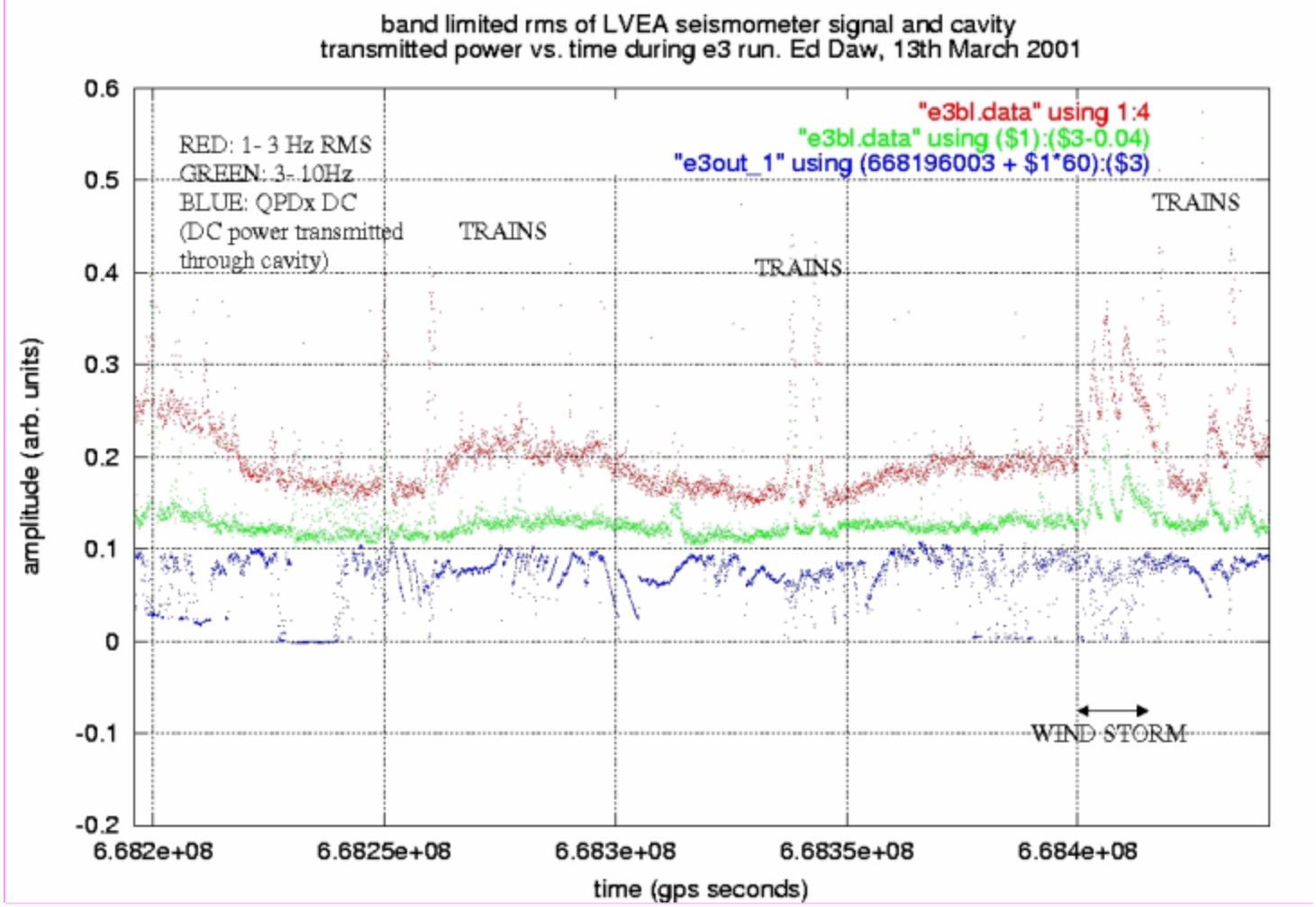
Example 2: Site to site timing

- Ensure that we don't have large timing shifts between the observatories
- IRIG-B signals
  - Codes agree
  - Phases coincide
- Indications for site to site timing difference of less then 100 µs





Example 3. Seismic activity during E3



Conclusions

- The E3 run is a success
  - » Principal goals:
    - High up time — Excellent
    - High overlap time — Excellent
    - Help off site members to get hands on experience with the detector — You rate it ☺
    - Record excellent data for investigations — OK
    - Hone our skills, identify bottle necks — Definite success

- Summary of experiences, data analysis and a lot more needs to be done !