



---

# E7 Lessons Learned

*Albert Lazzarini*  
*LIGO Laboratory*

*LIGO-G020013-02-E*

*Lessons Learned from E7*

*LIGO Laboratory at Caltech*



# Lessons Learned

---

- LDAS performed very well in all aspects
  - » There is still a lot to be done to get ready for S1 ...
- System is robust and *invisible*
  - » Most of the LDAS analyses were being run, managed by remote users on client PCs throughout the country
  - » Kent was very ill throughout most of the run;
    - Stuart, Peter and others were able to provide the needed support
    - The programming team at Caltech provided critical support also
- Experience from 4 days of shifts at LLO
  - » Need Control Room visibility, monitoring tools for LDAS jobs
    - This is an LSC issue
  - » 3D visualization tools could help the operations and science teams
    - f-t displays updated in realtime
    - Dynamic  $f_1 - f_2$  displays
  - » Many of the science shift tasks could be automated, reducing fatigue during late hours
    - lots of repetitive tasks

LIGO-G020013-02-E



---

# E7 Lessons Learned

## LDAS Software

*Kent Blackburn*

*LIGO Laboratory*

*LIGO-G020013-02-E*

*Lessons Learned from E7*

*LIGO Laboratory at Caltech*



# LDAS Job Summary

---

	Hanford LDAS	Livingston LDAS	MIT LDAS	CIT-TEST LDAS	TOTAL
<b>Total Jobs</b>	<b>63600</b>	<b>48775</b>	<b>280</b>	<b>915</b>	<b>113570</b>
<b>Database Rows</b>	<b>4188188</b>	<b>2789132</b>	<b>1062</b>	<b>2096</b>	<b>6980478</b>

- LDAS for full E7 Run: Dec. 28th, 2001 - Jan. 14th, 2002
  - » Approximately one job every 10 seconds (averaged).
  - » Approximately five rows every second (averaged).
- Greater than 90% of jobs completed successfully
  - » LHO roughly 92%; LLO roughly 95%; Not checked elsewhere.
- Pre-Release testing revealed 0.3% failure rate!
  - » Pre-release dominated by dataConditionAPI thread problems.
  - » Fraction due to mpiAPI/wrapperAPI communications issues.



# LDAS E7 Failure Modes

---

- Thread safety in dataConditionAPI cause multiple jobs to be lost at once.
  - » Caused roughly half of all failures directly due to LDAS bugs.
- Number of files per directory used to store data products by the managerAPI filled up twice near end of run - *deleting pre-E7 files fixed each time.*
- Locked segments *wrapping* around from N<sup>th</sup> frame directory to first frame storage directory not found by frameAPI - *this only occurred once.*
- Twice users killing jobs involving the metaDataAPI caused all jobs using database to fail - *restarting metaDataAPI fixed.*
- Known communication issues between mpiAPI and wrapperAPI caused node table to confuse available node list - *restarting mpiAPI fixed.*
- Use of stderr and stdout in LAL/LALwrapperAPI cause managerAPI to become unresponsive to requests - *new LAL code submitted to fix.*
- Bugs in LAL/LALwrapper cause jobs to fail - *subsequent LAL releases fixed.*
- *Pilot errors* in scripts caused job failures - *external user scripts corrected.*



# LDAS E7 Failure Modes

---

- Time server drop out - *caused frames to not be available for requested time intervals*
- The dataConditionAPI failed to collect data from both the frameAPI and metaDataAPI in a timely manor to continue processing -- *This was only an issue for periodic search, which did not run on-line*



# LDAS

## Cost of getting ready for E7

---

- Dedicated ~ 6 weeks of schedule to getting ready
  - » Beta release functionality had to be deferred
- More than 2 weeks of testing required to ensure high probability of robustness, success
- LSC LAL shared object C code has evolving in parallel
  - » LDAS had to rely on *dated* LAL/LALwrapper code for integrated tests
- Significant increase time spent in meetings with LSC in order to integrate codes, planning for E7, etc.



# Open Issues Raised Post-Run

---

- LDAS users from the LSC would like top level visibility into all search codes running on LDAS systems in the form of a GUI
  - » Agreed in LSUG meeting that this is not be an LDAS function, but should reside in super-job control GUI/proxy outside of LDAS and visible in control rooms. Note: This type of interface is planned for GriPhyN/LDAS.
- Creators of driver scripts used to control job submittal would like more standardized error reporting
  - » Functionality did in fact exist in LDAS, but only just appearing in the E7 release and was not widely known. Additionally, most driver scripts used a job-control library which didn't expose this information - plans are to extend the job-control library.
- LAL/LDAS Software Users Group not comfortable with responsibilities of allocation and scheduling resources
  - » Requests made that new LSC Computing Committee manage these.





# LDAS

High priority items needed to get back on track with LDAS (slipped)schedule.

- 
- Rework configuration & build rules to support migration towards beta & final releases of LDAS.
  - Create new diskCacheAPI; pull out this functionality from frameAPI.
  - Improve reliability of dataConditionAPI (thread issues).
  - Add common resampling library to LDAS for use in both the frameAPI & dataConditionAPI
  - Extend system monitoring to track API shutdowns & restart, core files & debugging, job & database statistics and user account management.
  - Add interpolation, Kalman filters, regression and replace intermediate() function.
  - Reduce memory usage in dataConditionAPI by average of ~ 5x



# LDAS

High priority items needed to get back on track with LDAS (slipped)schedule.

---

- Move LDAS API processes onto new datasever
- Improve documentation, interfaces, and table designs per LSC recommendation
- Implement new TCL channel management interface to better control datasockets.
- Add new detector geometry metadata to LDAS pipeline to better support use of ALLEGRO bar data in stochastic search code
- Add job load monitoring commands to support GryPhyN integration
  - » Continue providing LSC and GriPhyN support on day-to-day bases.



---

# E7 Lessons Learned

## LDAS Databases

*Peter Shawhan*

*LIGO Laboratory*

*LIGO-G020013-02-E*

*Lessons Learned from E7*

*LIGO Laboratory at Caltech*



# Database Insertion Statistics During the E7 Run

		LHO	LLO
Segments:	IFOLocked	17919	5899
GDS triggers:	BitTest	34640	17761
	ChannelReadOutError	26	–
	eqMon	28	–
	glitchMon	1790683	1056375
	Glitch	271430	201113
	Lock transition	140468	11328
	MC_F violin mode	11016	7156
	Rho2 [from CorrMon]	511	195
	TFCLUSTERS	290295	68551
	TimeSliceError	1755	23762
	TID	1663	–
LDAS inspiral:	template	428970	176655
	FCT	2970	24295
LDAS burst:	power	1082676	411127
	slope	17561	58044
	TFCLUSTERS	1700621	2519617

Over 10 million  
entries added!



# Database Insertion Issues

---

- DMT segments and triggers
  - » Insertions handled by “SeqInsert” process to preserve sequence
  - » Occasional LDAS job failures caused SeqInsert to go into “error state”
    - Required human intervention
    - Delayed LDAS search codes which were checking for segments
  - » Midway through run, SeqInsert was modified to be “fault-tolerant”
- Events from LDAS search jobs
  - » No technical problems
  - » A few “learning curve” issues on the part of search code authors
- Overall insertion rate was easily handled by LDAS



# Database Retrieval Issues

---

- Database contents can be retrieved
  - » Database queries can be submitted using `guild` or `getMeta`
  - » LIGO\_LW files of database records can be converted to ASCII, read into Matlab, or parsed by a C program
- ... but there are limitations
  - » LDAS limits query output to 10000 rows
    - Action item: develop code to fetch more rows, concatenate files
  - » Have to direct query to the appropriate database
  - » Some data will need to be copied to multiple databases
    - Action item: develop software tools to facilitate copying
  - » Sophisticated “event analysis tool” still under development
- The real challenge: how to make sense of all the information



---

# E7 Lessons Learned

## LDAS Hardware

*Stuart Anderson*

*LIGO Laboratory*

*LIGO-G020013-02-E*

*Lessons Learned from E7*

*LIGO Laboratory at Caltech*



# LDAS Hardware + Data Archive

---

- Interface between LDAS and CDS
  - » Disk failure worked
  - » Shared QFS filesystem worked, but...
  - » Still improving coordination
    - a) Control room monitoring of disk cache was not established until data was lost
    - b) Differing versions of frame data are expensive to manage downstream.





# LDAS Hardware + Data Archive

---

- Data archive
  - » Good choice of tape drive at observatories but poor robotics
  - » Good choice of robotics and tape drive for central archive
  - » Growing dissatisfaction with HPSS
    - Need to accelerate evaluation of SAM-QFS alternative (SUN product)
- Software management
  - » Multiple test/development LDAS systems are essential
  - » Software mirroring tools are mature and useful
  - » Realtime development of software release policy is painful.
    - Still need to differentiate between core LDAS/LAL software versus individual search codes



# LDAS Hardware + Data Archive

---

- Data management
  - » Reduced data sets are needed now
  - » Replication or distributed access to metadata is needed.



---

# E7 Lessons Learned

**DMT**

*John Zweizig  
LIGO Laboratory*

*LIGO-G020013-02-E*

*Lessons Learned from E7*

*LIGO Laboratory at Caltech*



# DMT Use During E7

---

- Monitors used in c.r. to track IFO/PE status
  - » IFO performance (lock statistics, line tracking, servo stability checks)
  - » Environmental noise
- Many (>4M) triggers generated
  - » Transient searches (glitchMon, ZGlitch)
- Locked segments used to steer analysis jobs



# DMT Lessons Learned

---

- Operational status visibility
  - » Lack clear top-level summaries, acoustic alarms
- Monitor status
  - » No record of which monitors running
  - » Performance statistics not readily available.
- DMT trends not available in control room
  - » History is lost when DMT is restarted.
  - » Need to display trends with data viewer



# Multiple frame builders

---

- Control room tools, DMT and LDAS use different data paths.
  - » Control room, DMT use 1s for fast response
  - » Analysis uses 16s to reduce overhead
  - » DMT frame broadcaster reduces fb0 load.
- Data lost at LLO when fb2 not rebooted.
- Needs better monitoring and status visibility
  - » GDS tools on 16s frames where possible



---

# **E7 Lessons Learned Search Group Rediness**

*Shawhan, Anderson  
LIGO Laboratory*

*LIGO-G020013-02-E*

*Lessons Learned from E7*

*LIGO Laboratory at Caltech*



# Inspirational Searches:

## Experience from the E7 Run (Shawhan)

---

- Template and FCT search codes were run on-line during E7
  - › Both used “flat” (non-hierarchical) algorithms
  - › Restricted to a high-mass region of parameter space
  - › Used transfer function measured for H2 interferometer during E6
  - › Jobs submitted by scripts to analyze data only for times when the interferometer was locked
  - › Not all of the data was processed
- Lessons learned
  - › Job scripts had to be babysat due to various failure modes
  - › Job execution times include non-negligible overhead from time spent in data conditioning API, etc.
  - › Need to get reasonably reliable calibration info in a timely fashion





# Inspiral Searches

## Plans (Shawhan)

---

- Near-term activities
  - » Detector characterization studies
    - Investigate time variability of interferometer behavior
    - Correlate inspiral candidates with environmental transients
  - » Exercise procedures for setting trigger thresholds, and study efficiencies, using simulated events buried in Gaussian noise
  - » Analyze the “playground” data
- Longer-term plans
  - » Develop veto conditions using “playground” data
  - » Study efficiencies using simulated events superimposed on E7 data
  - » Analyze all of the E7 data for each interferometer
  - » Combine results (using TBD statistical method) to set an upper limit
  - » Develop hierarchical search algorithms



# Periodic Source Status (Anderson)

---

## 3 source categories and 4 algorithms

- » All sky unbiased
  - Sum short power spectra (no doppler correction)
- » Known pulsar
  - Heterodyne narrow BW
  - Coherent frequency domain
- » Wide area search
  - Hierarchical Hough transform



# Periodic Source Status (Anderson)

---

- No E7 real-time analysis was performed
- Post-run Time->Freq pre-processing (SFT) is proceeding and may be of more general use
- 1-of-4 algorithms is being developed for LDAS
  - » All 4 algorithms to use LAL
- Still developing core search code