LSC glitch group report

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for the LSC glitch group

LSC/Virgo meeting
2007 October 24
Hannover, Germany

LIGO-G070703-00-Z

The glitch group

- Goals
  - Investigate data quality for burst and inspiral searches
  - Rapid feedback to operators and commissioning teams
  - Contribute to the definition of data quality flags and vetoes
  - Provide guidance on the use of data quality flags and vetoes in the burst and inspiral searches
- Organization
  - glitch group home page
  - Subgroup of the LSC detector characterization committee
  - Off-site analysis of all of S5 covered in 3-4 day shifts
  - Collect and summarize data from many online resources
  - Weekly glitch teleconference to discuss most recent shifts
  - Report to weekly S5 and detector characterization calls
  - Interact with burst and inspiral groups through joint members

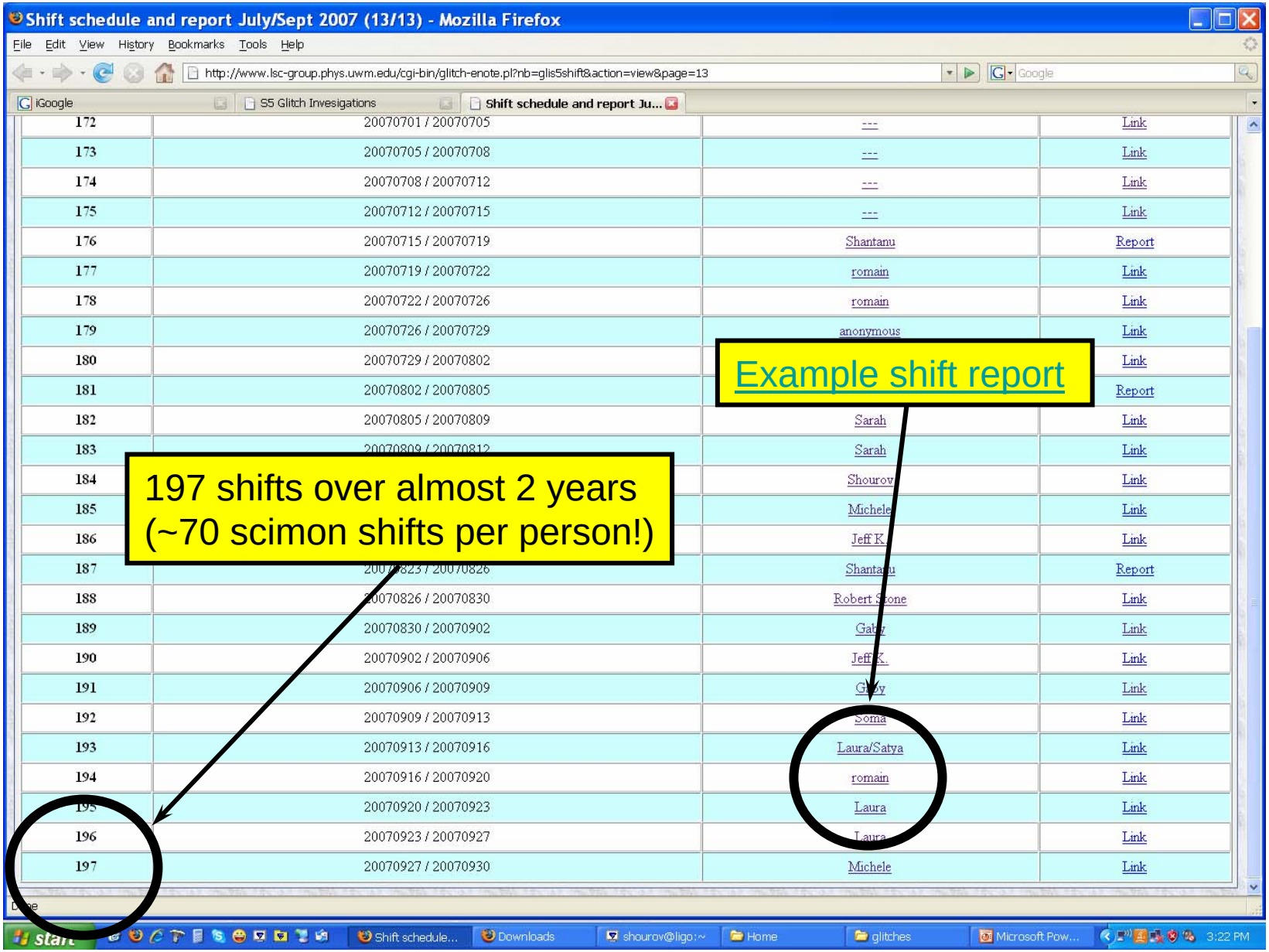
People

- Many people have contributed to the glitch group:

  L.Blackburn, L.Cadonati, S.Caudill, S.Chatterji, J.Dalrymple, S. Desai, A.DiCredico, J.Garofoli, R.Gouaty, L.Goggin, G.Gonzalez, A.Gretarsson, D.Hoak, E.Katsavounidis, J.Kissel, S.Klimenko, A.Mercer, S.Mukherjee,S. Mohapatra, F.Raab, K.Riles, P.Saulson, R.Savage, R.Schofield, P.Shawhan, J.Slutsky, R.Stone, M.Zanolin, N.Zotov, J.Zweizig
- These people bring expertise from many groups
  - burst group
  - inspiral group
  - operators
  - commissioning
- There is much to do, more help is always welcome!

Example shift report

S5 glitch shifts



172	20070701 / 20070705	---	Link
173	20070705 / 20070708	---	Link
174	20070708 / 20070712	---	Link
175	20070712 / 20070715	---	Link
176	20070715 / 20070719	Shantanu	Report
177	20070719 / 20070722	romain	Link
178	20070722 / 20070726	romain	Link
179	20070726 / 20070729	anonymous	Link
180	20070729 / 20070802		Link
181	20070802 / 20070805		Report
182	20070805 / 20070809	Sarah	Link
183	20070809 / 20070812	Sarah	Link
184		Shourov	Link
185		Michele	Link
186		Jeff K.	Link
187	20070823 / 20070826	Shantanu	Report
188	20070826 / 20070830	Robert Stone	Link
189	20070830 / 20070902	Gaby	Link
190	20070902 / 20070906	Jeff K.	Link
191	20070906 / 20070909	Gaby	Link
192	20070909 / 20070913	Soma	Link
193	20070913 / 20070916	Laura/Satya	Link
194	20070916 / 20070920	romain	Link
195	20070920 / 20070923	Laura	Link
196	20070923 / 20070927	Laura	Link
197	20070927 / 20070930	Michele	Link

Example shift report

Glitch Shift Sep 16 2007 16:00:00 UTC - Sep 20 2007 16:00:00 UTC - Mozilla Firefox

File Edit View History Bookmarks Tools Help

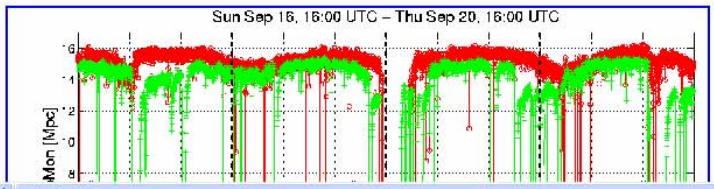
http://lsc.phys.lsu.edu/romain/glitchReport/glitch_report-20070916-20070920.html

Glitch Shift Sep 16 2007 16:...

Summary

- **General**
  - On Sep 18, Keith Riles posted an entry which shows the list of frequency lines found by the powerFlux pulsar search program run over the 1st year of S5. These lines are found to be coincident within 10 mHz between H1 and L1. Here is the elog entry.
  - Kleine Welle plots from Sep 18 and Sep 19 are missing for L1.
  - Many Block Normal and Inspiral events in L1 with oscillations in AS_DC, AS_AC. They look similar to the ones observed by Shantanu in July (wednesday call report)
- **Report for day beginning Sep 16 2007 16:00:00 UTC (873993614 - 874080014)**
  - H0: 21:00-24:00 UTC: sensemon range affected by high winds.
  - H1:
  - H2: Hump noise (range 60-200 Hz) before a lock loss at 22:00 UTC. This was the same problem as the one described there. This noise is coherent with POB and RM UL coil.
  - L1: 2 lock losses due to earthquakes (at 00:28 and 08:18 UTC).
- **Report for day beginning Sep 17 2007 16:00:00 UTC (874080014 - 874166414)**
  - H1:
  - H2:
  - L1:
- **Report for day beginning Sep 18 2007 16:00:00 UTC (874166414 - 874252814)**
  - H1:
  - H2: A TCS laser glitch was observed by Cheryl Vorvick (elog entry)
    "H2 TCSY laser power started behaving bad mid way through shift causing some glitchiness on the range. Once its laser head temperature got tweaked, it got better."
  - L1:
    Tuesday maintenance: Jeff Kissel and Brian O'Reilly made an attempt to measure the REFL_I calibration.
    After the maintenance, it was not possible to acquire the science mode until 21:00 UTC due to high environment noise.
    At the end of the shift the sensemon range was again affected by high environmental noise.
- **Report for day beginning Sep 19 2007 16:00:00 UTC (874252814 - 874339214)**
  - General: at about 08:50:27 UTC, the 3 ifos were taken out of science mode by an earthquake in Indonesia (Mag 6.6)
  - H1:
  - H2:
  - L1: At the end of the shift, the duty factor was affected by an earthquake in Indonesia (out of science from 9:09 UTC to 11:48 UTC).

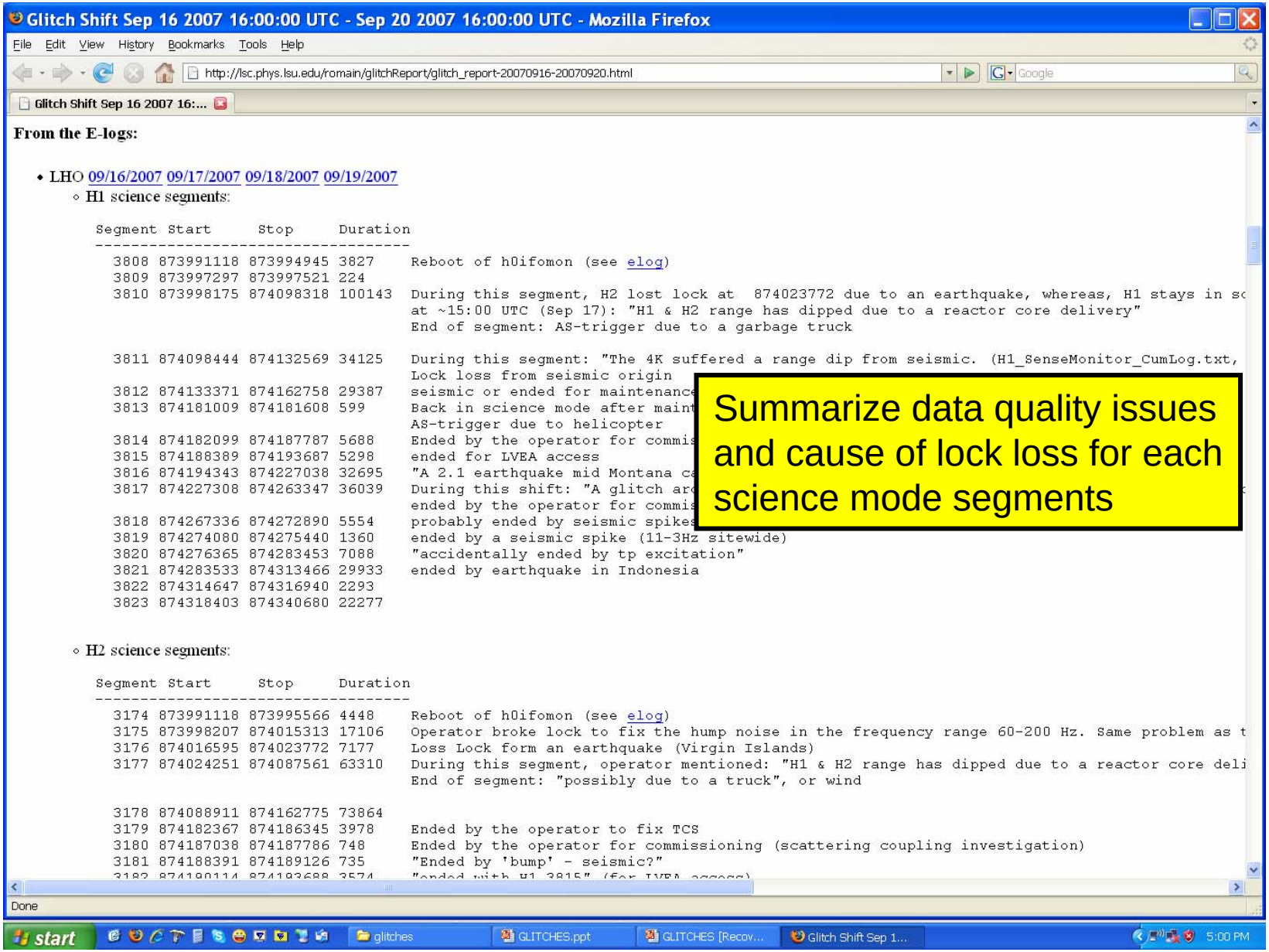
Summary of major daily events which may impact glitchiness



Done

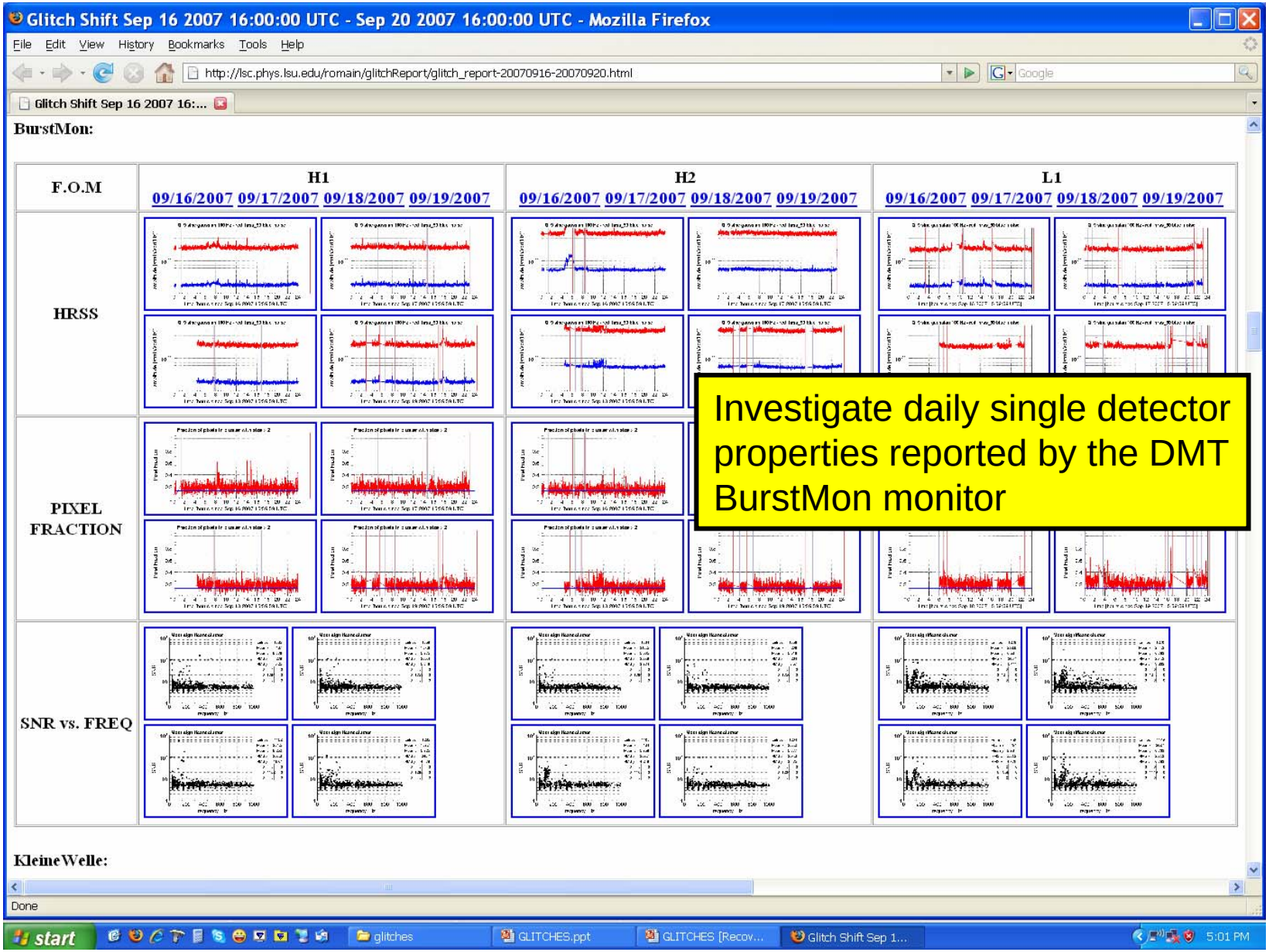
start glitches GLITCHES.ppt GLITCHES [Recov... Glitch Shift Sep 1... 5:00 PM

Example shift report



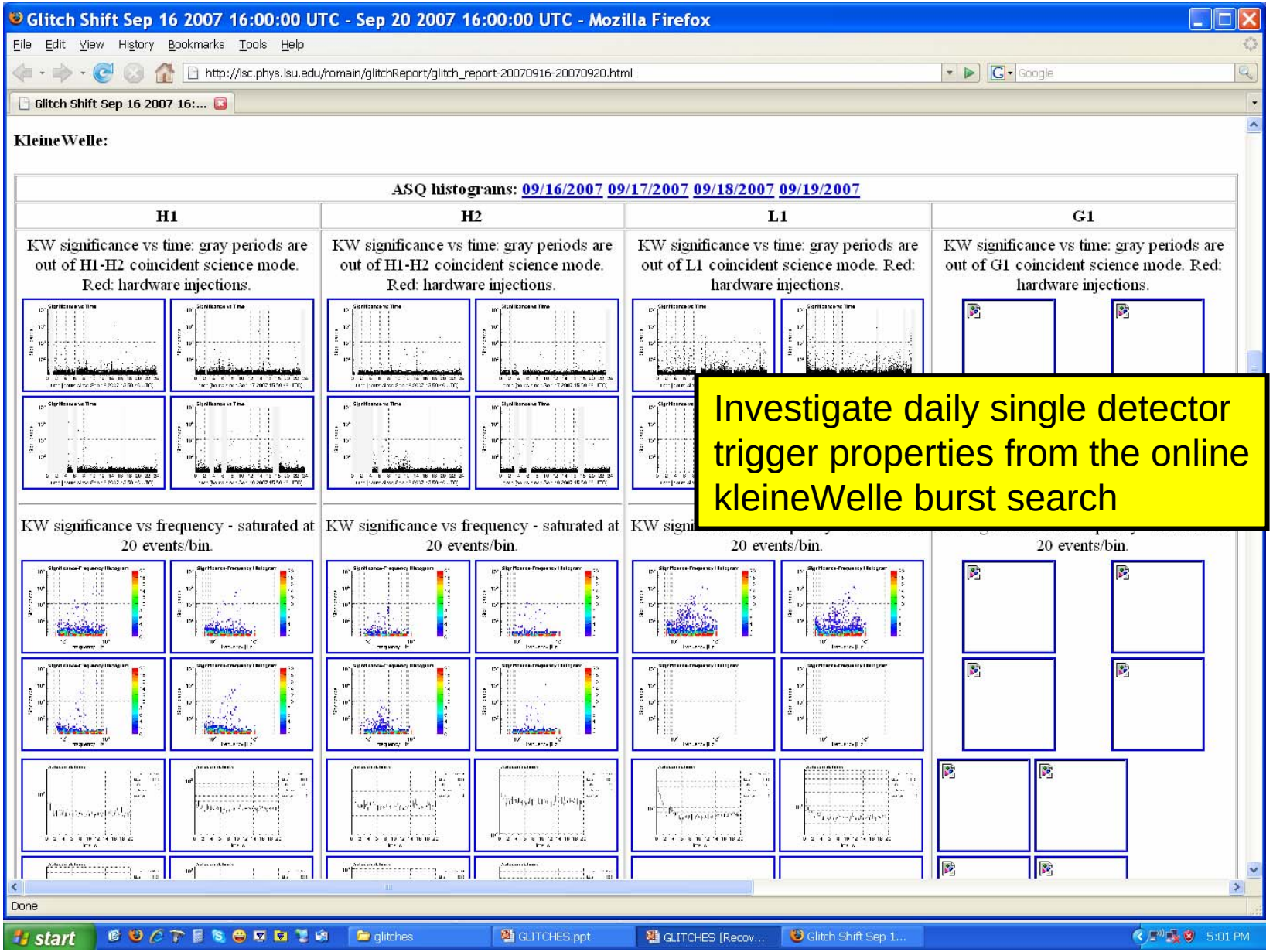
Summarize data quality issues and cause of lock loss for each science mode segments

Example shift report



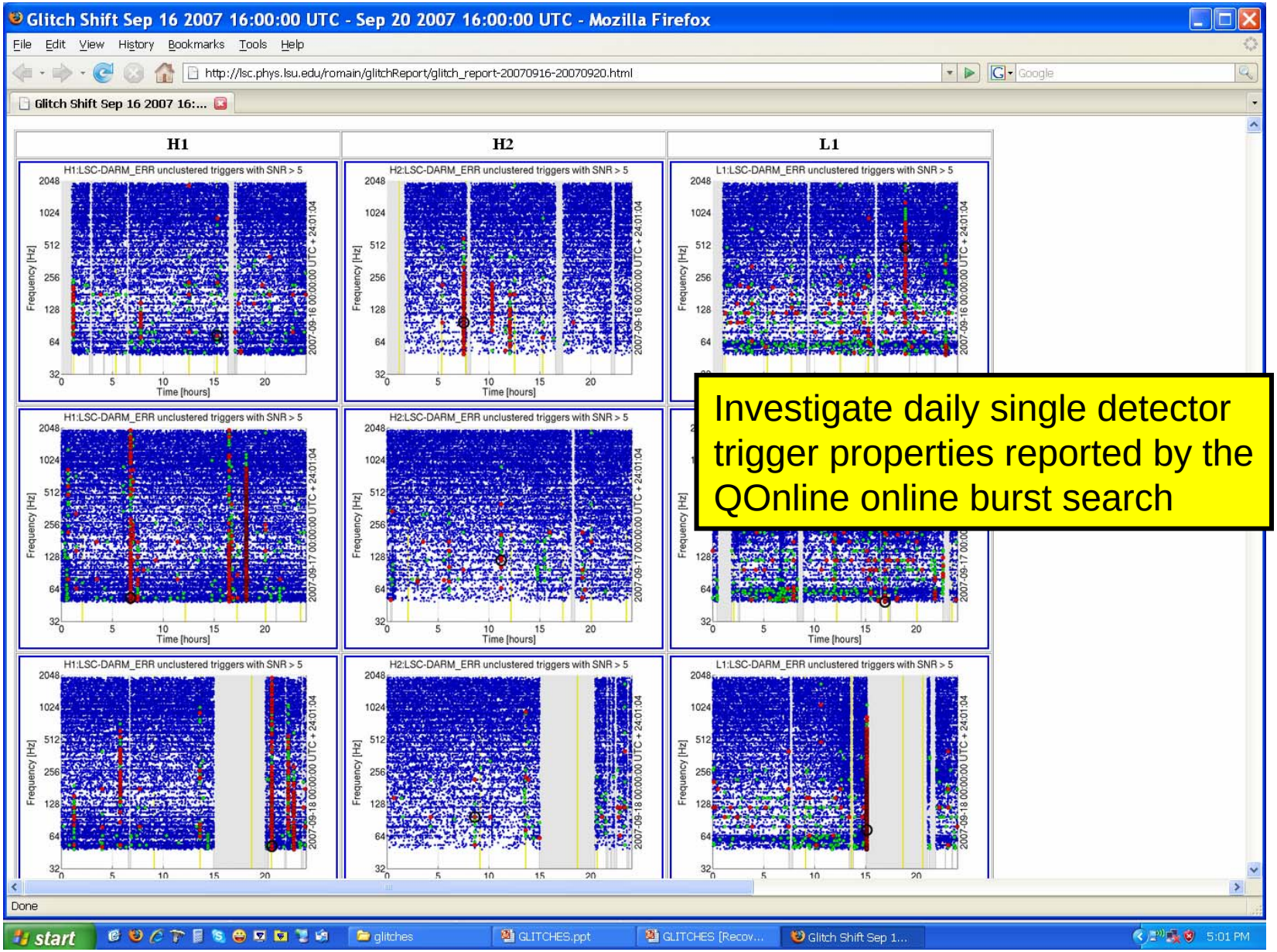
Investigate daily single detector properties reported by the DMT BurstMon monitor

Example shift report



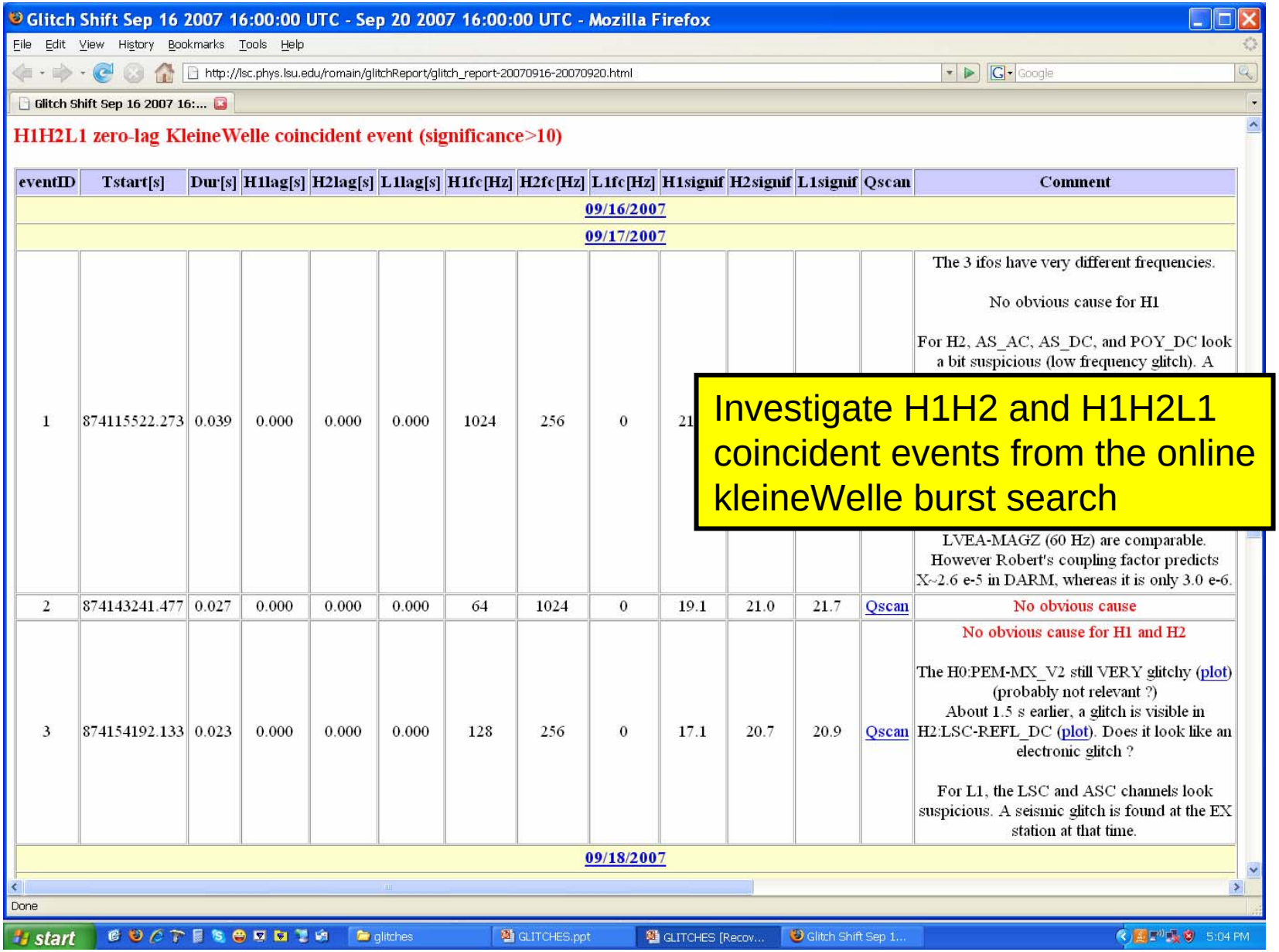
Investigate daily single detector trigger properties from the online kleineWelle burst search

Example shift report



Investigate daily single detector trigger properties reported by the QOnline online burst search

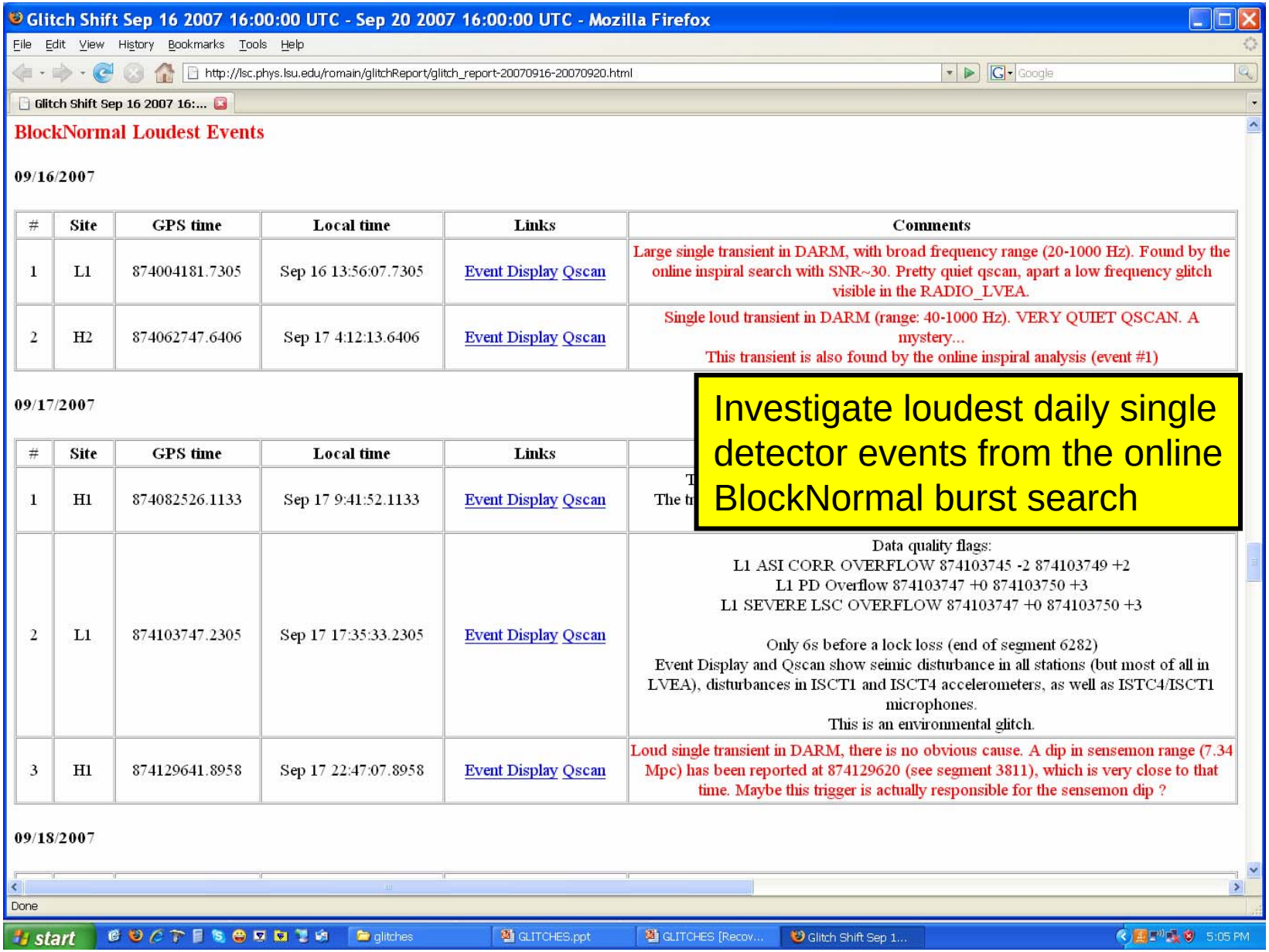
Example shift report



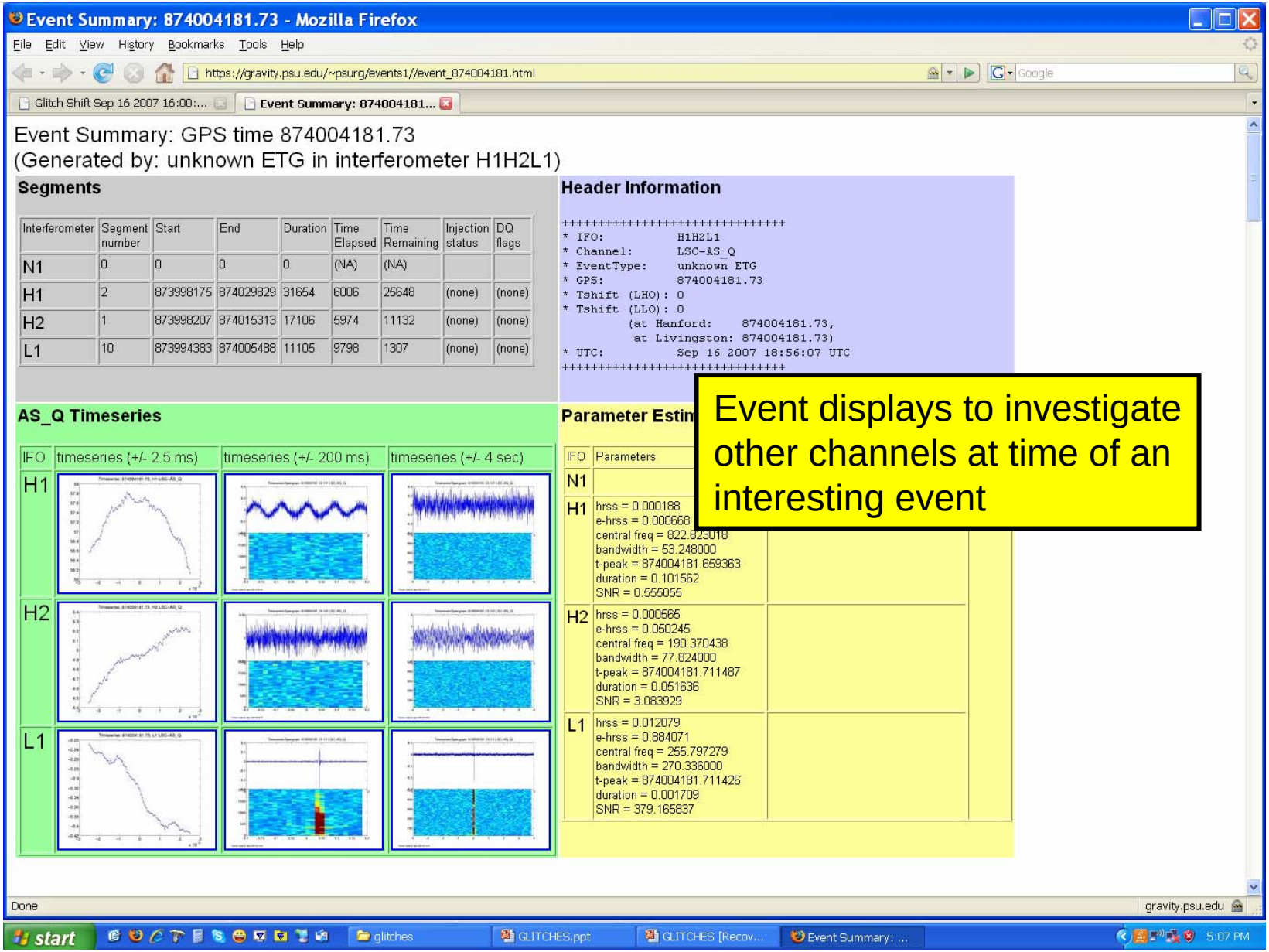
eventID	Tstart[s]	Dur[s]	H1lag[s]	H2lag[s]	L1lag[s]	H1fc[Hz]	H2fc[Hz]	L1fc[Hz]	H1signif	H2signif	L1signif	Qscan	Comment
09/16/2007													
09/17/2007													
1	874115522.273	0.039	0.000	0.000	0.000	1024	256	0	21				The 3 ifos have very different frequencies. No obvious cause for H1 For H2, AS_AC, AS_DC, and POY_DC look a bit suspicious (low frequency glitch). A LVEA-MAGZ (60 Hz) are comparable. However Robert's coupling factor predicts X~2.6 e-5 in DARM, whereas it is only 3.0 e-6.
2	874143241.477	0.027	0.000	0.000	0.000	64	1024	0	19.1	21.0	21.7	Qscan	No obvious cause
3	874154192.133	0.023	0.000	0.000	0.000	128	256	0	17.1	20.7	20.9	Qscan	No obvious cause for H1 and H2 The H0:PEM-MX_V2 still VERY glitchy (plot) (probably not relevant ?) About 1.5 s earlier, a glitch is visible in H2:LSC-REFL_DC (plot). Does it look like an electronic glitch ? For L1, the LSC and ASC channels look suspicious. A seismic glitch is found at the EX station at that time.
09/18/2007													

Investigate H1H2 and H1H2L1 coincident events from the online kleineWelle burst search

Example shift report



Example shift report



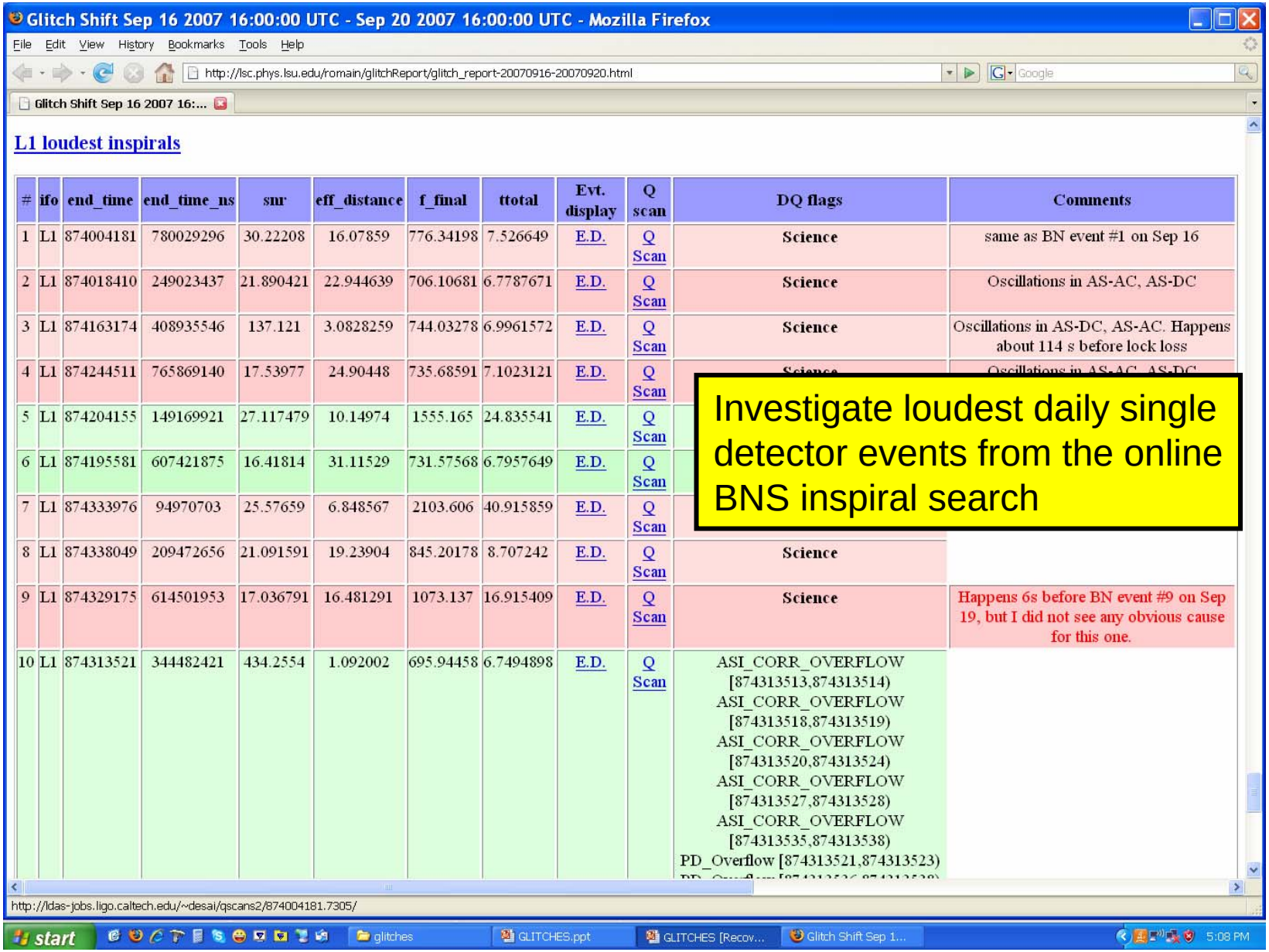
Interferometer	Segment number	Start	End	Duration	Time Elapsed	Time Remaining	Injection status	DQ flags
N1	0	0	0	0	(NA)	(NA)		
H1	2	873998175	874029829	31654	6006	25648	(none)	(none)
H2	1	873998207	874015313	17106	5974	11132	(none)	(none)
L1	10	873994383	874005488	11105	9798	1307	(none)	(none)

```
++++++++++++++++++++++++++++++++
* IFO:           H1H2L1
* Channel:       LSC-AS_Q
* EventType:     unknown ETG
* GPS:           874004181.73
* Tshift (LHO): 0
* Tshift (LLO): 0
          (at Hanford:    874004181.73,
           at Livingston: 874004181.73)
* UTC:           Sep 16 2007 18:56:07 UTC
++++++++++++++++++++++++++++++++
```

IFO	timeseries (+/- 2.5 ms)	timeseries (+/- 200 ms)	timeseries (+/- 4 sec)
H1			
H2			
L1			

IFO	Parameters
N1	
H1	hrss = 0.000188 e-hrss = 0.000668 central freq = 822.823018 bandwidth = 53.248000 t-peak = 874004181.659363 duration = 0.101562 SNR = 0.555055
H2	hrss = 0.000565 e-hrss = 0.050245 central freq = 190.370438 bandwidth = 77.824000 t-peak = 874004181.711487 duration = 0.051636 SNR = 3.083929
L1	hrss = 0.012079 e-hrss = 0.884071 central freq = 255.797279 bandwidth = 270.336000 t-peak = 874004181.711426 duration = 0.001709 SNR = 379.165837

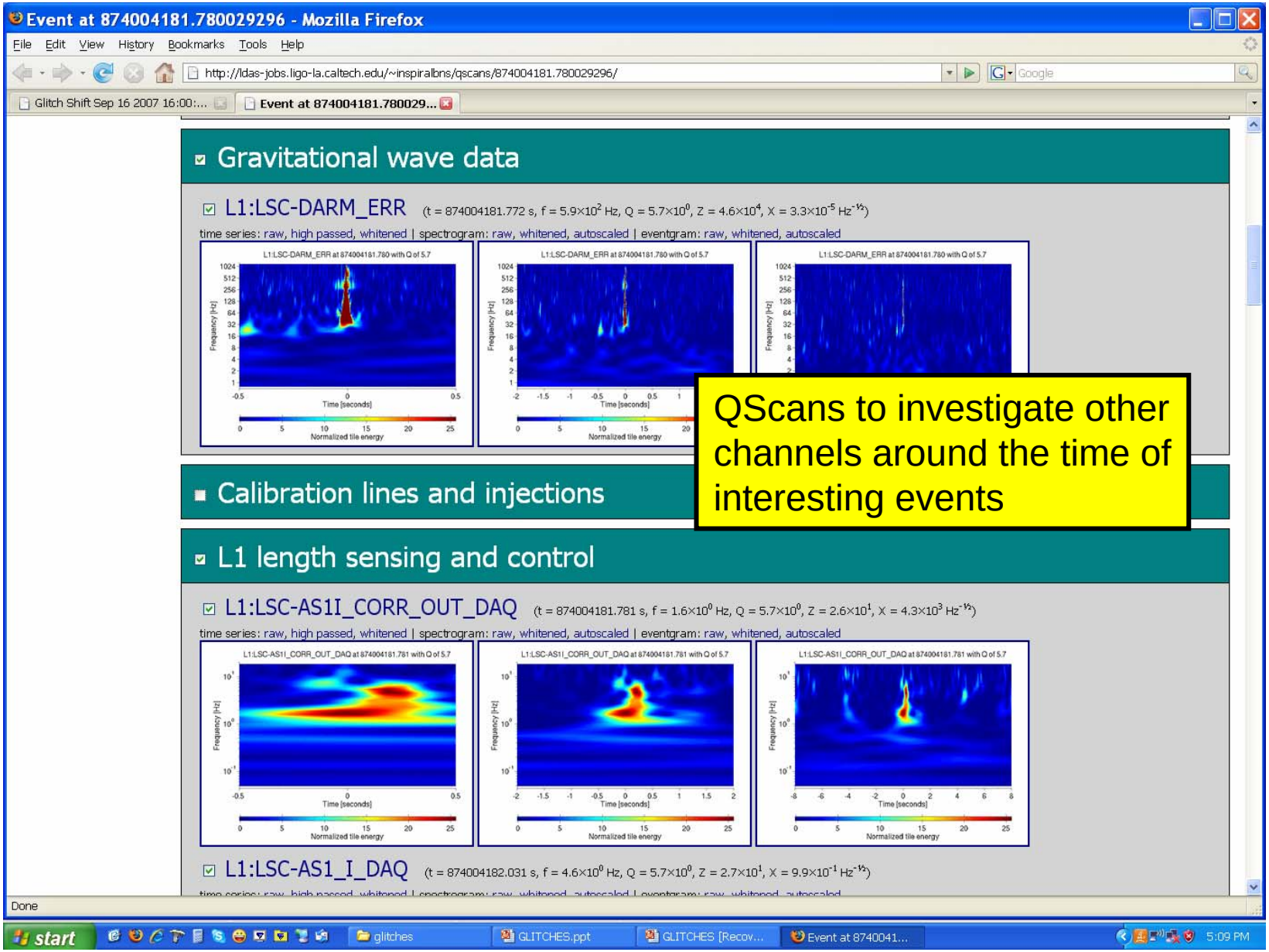
Example shift report



#	ifo	end_time	end_time_ns	snr	eff_distance	f_final	ttotal	Evt. display	Q scan	DQ flags	Comments
1	L1	874004181	780029296	30.22208	16.07859	776.34198	7.526649	E.D.	Q Scan	Science	same as BN event #1 on Sep 16
2	L1	874018410	249023437	21.890421	22.944639	706.10681	6.7787671	E.D.	Q Scan	Science	Oscillations in AS-AC, AS-DC
3	L1	874163174	408935546	137.121	3.0828259	744.03278	6.9961572	E.D.	Q Scan	Science	Oscillations in AS-DC, AS-AC. Happens about 114 s before lock loss
4	L1	874244511	765869140	17.53977	24.90448	735.68591	7.1023121	E.D.	Q Scan	Science	Oscillations in AS-AC, AS-DC
5	L1	874204155	149169921	27.117479	10.14974	1555.165	24.835541	E.D.	Q Scan		
6	L1	874195581	607421875	16.41814	31.11529	731.57568	6.7957649	E.D.	Q Scan		
7	L1	874333976	94970703	25.57659	6.848567	2103.606	40.915859	E.D.	Q Scan		
8	L1	874338049	209472656	21.091591	19.23904	845.20178	8.707242	E.D.	Q Scan	Science	
9	L1	874329175	614501953	17.036791	16.481291	1073.137	16.915409	E.D.	Q Scan	Science	Happens 6s before BN event #9 on Sep 19, but I did not see any obvious cause for this one.
10	L1	874313521	344482421	434.2554	1.092002	695.94458	6.7494898	E.D.	Q Scan	ASI_CORR_OVERFLOW [874313513,874313514) ASI_CORR_OVERFLOW [874313518,874313519) ASI_CORR_OVERFLOW [874313520,874313524) ASI_CORR_OVERFLOW [874313527,874313528) ASI_CORR_OVERFLOW [874313535,874313538) PD_Overflow [874313521,874313523)	

Investigate loudest daily single detector events from the online BNS inspiral search

Example shift report

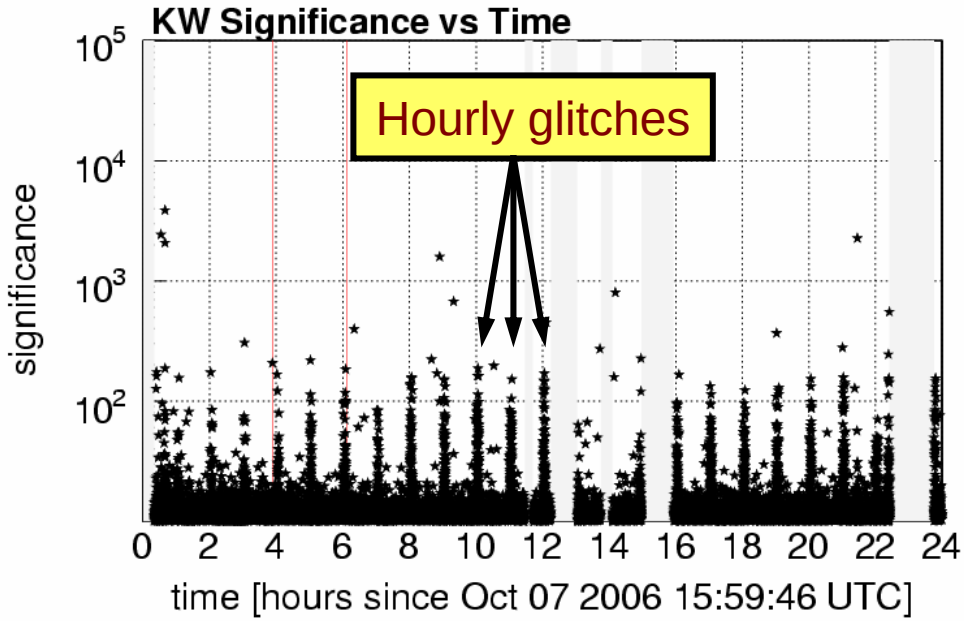


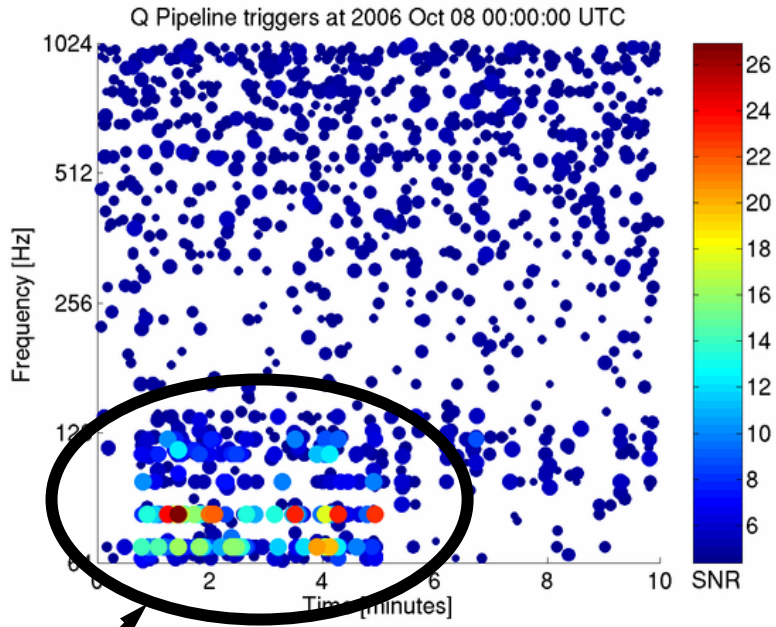
Glitch zoo

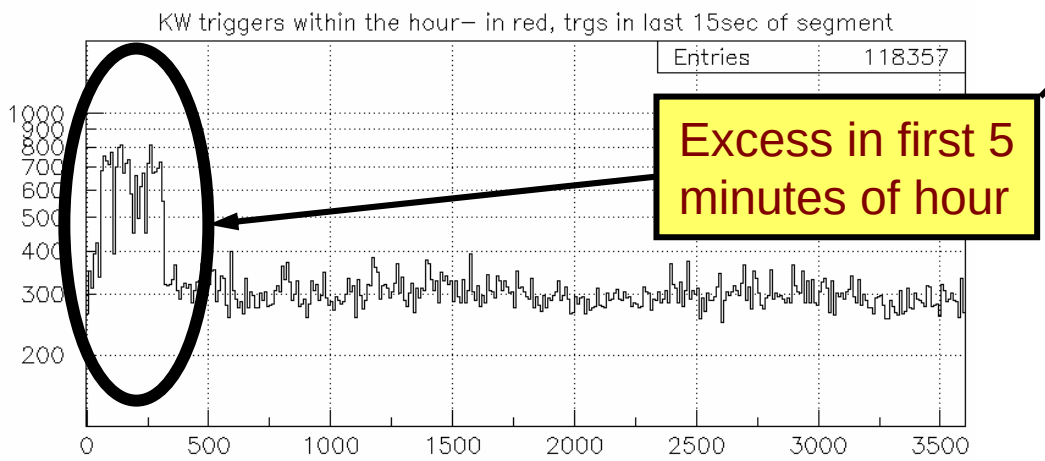
Only a small sample…

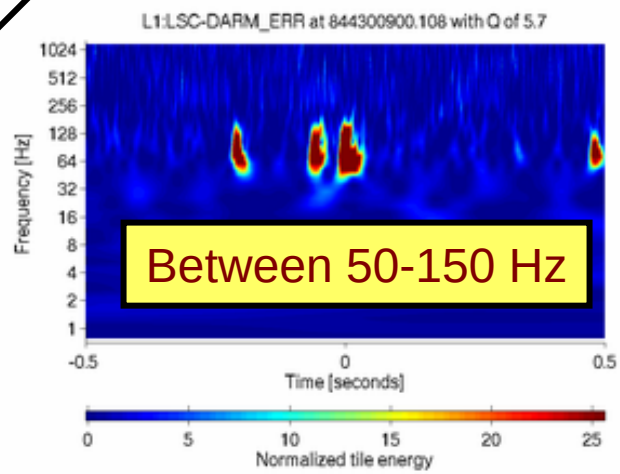
Data corruptions

- Data corruption linked to hourly saving of detector state





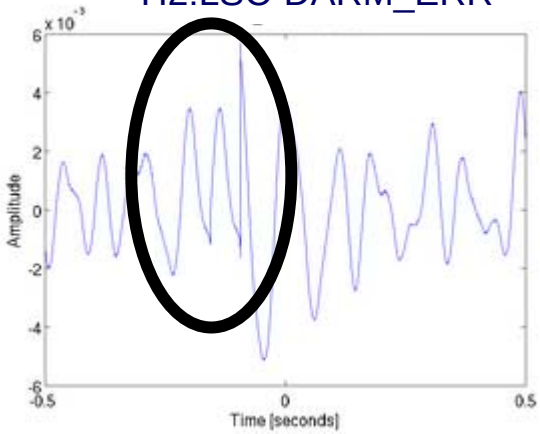




Data corruptions

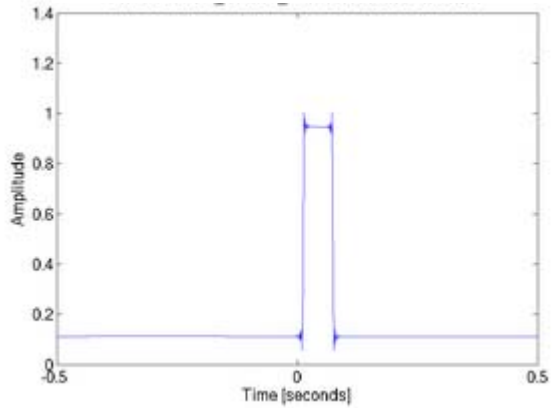
Discussion in the glitch group rapidly identified data corruptions of various flavors, through examination of loudest events…

H2:LSC-DARM_ERR



1/16 sec data repeats, inconsistency between fb0 and fb1, found in late march, CHECKSUM_MISMATCH data quality flag

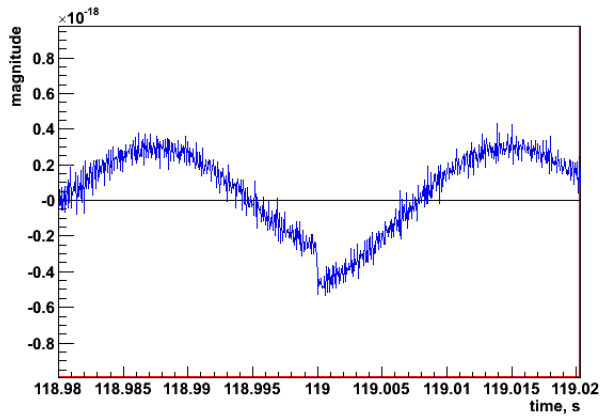
L1:SUS-ETMX_OPLEV_YERROR



Last week of july, found numerous data valid errors in LLO x-end station channels, likely due to a hardware failure in l1iscex, which has been replaced.

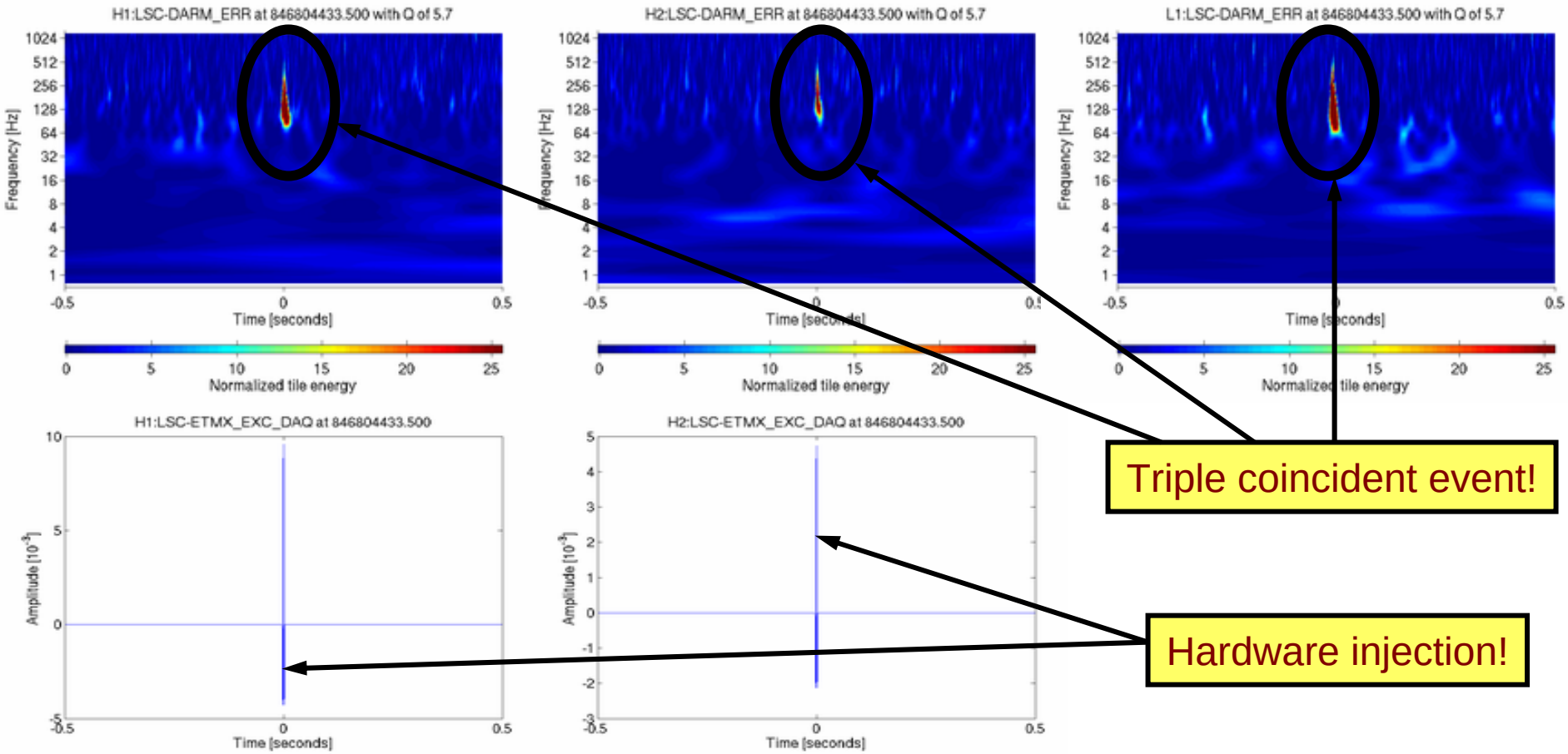
… and helped prompt diagnosis of software artifacts

Coherent WaveBurst analysis found glitches like this, on high-passed data, and asked support of the glitch team. Promptly found to be an artifact of the new frame library version v6r20, Frv v4r12



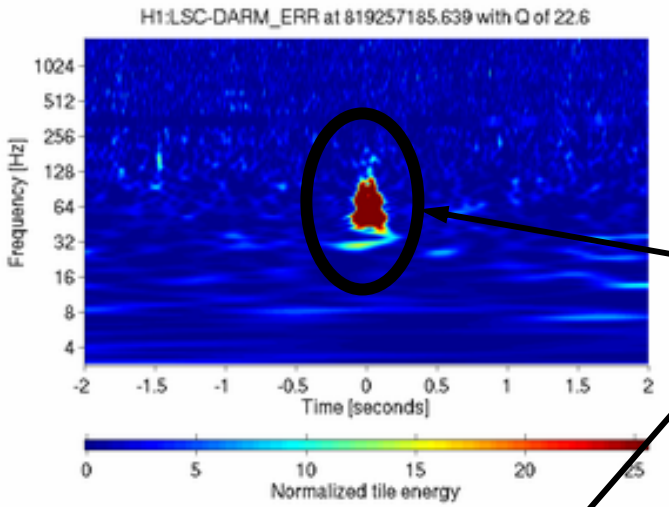
“Blind” injections

- Failure to record injections in state vector led to “blind” injections
- Immediately noticed in kleineWelle H1H2L1 triggers during glitch call.
- Immediately diagnosed as injections by looking in injection channel.

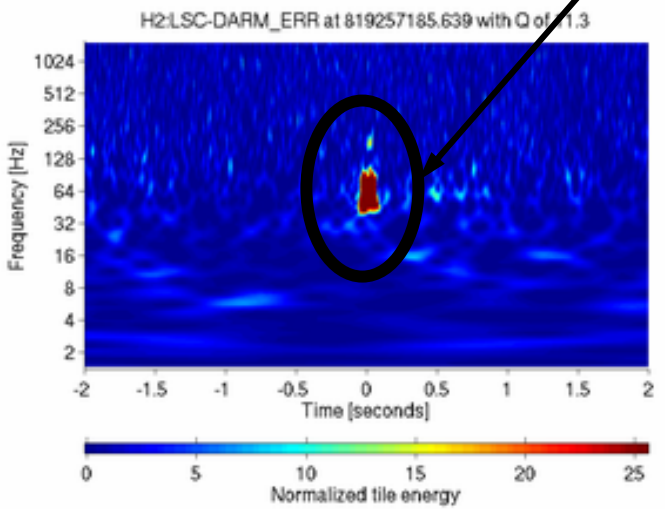


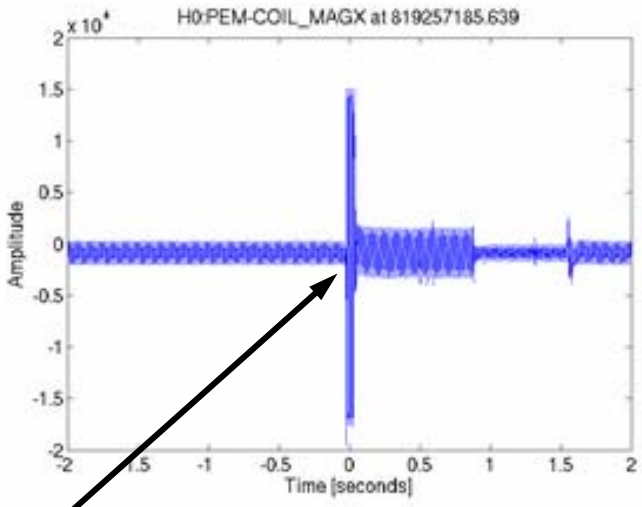
Power line glitches at LHO

- Large power line glitches produce coincident glitches in H1 and H2
- Led to the development of a new data quality flag

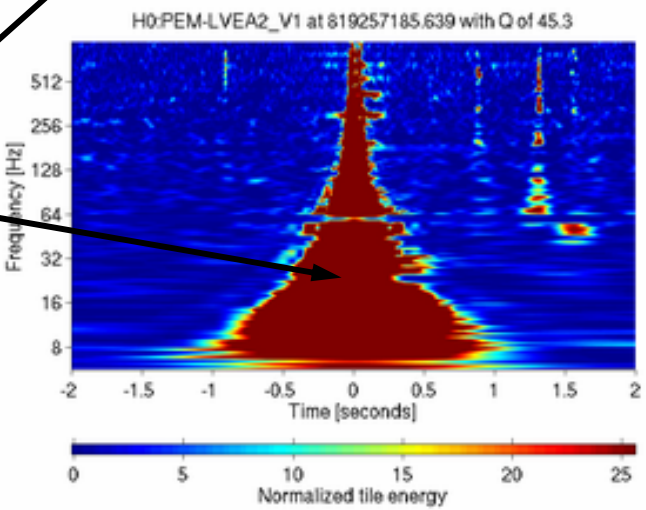


Coincident H1 and H2 glitch

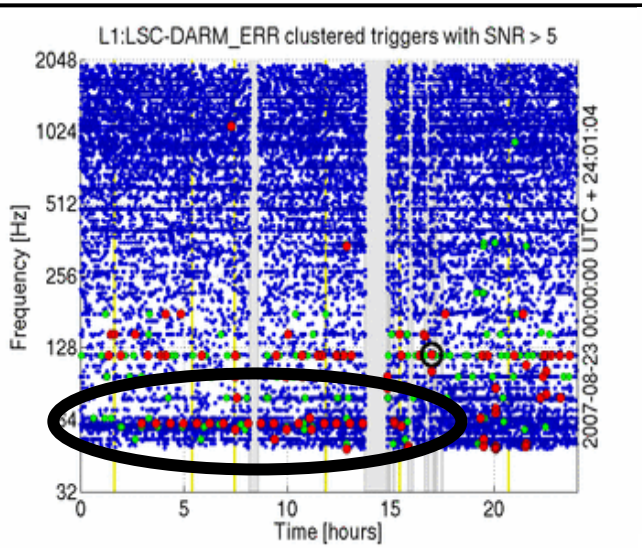


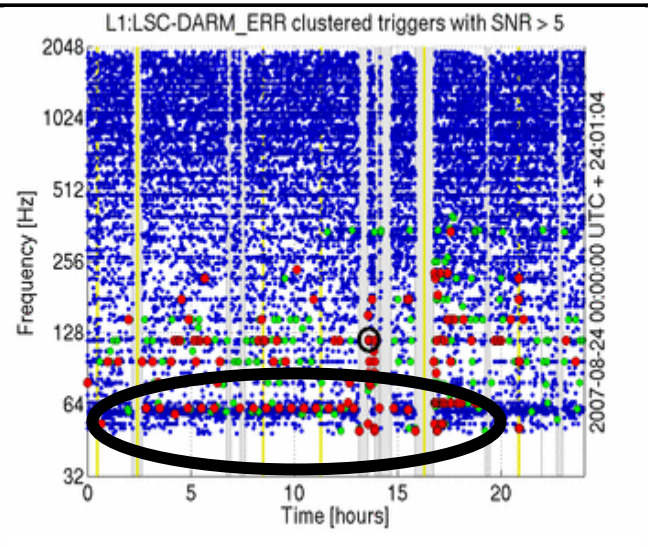


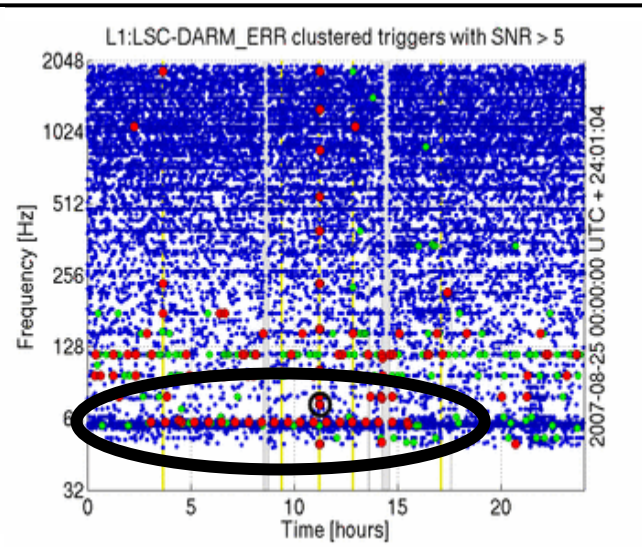
Jumps in power line amplitudes



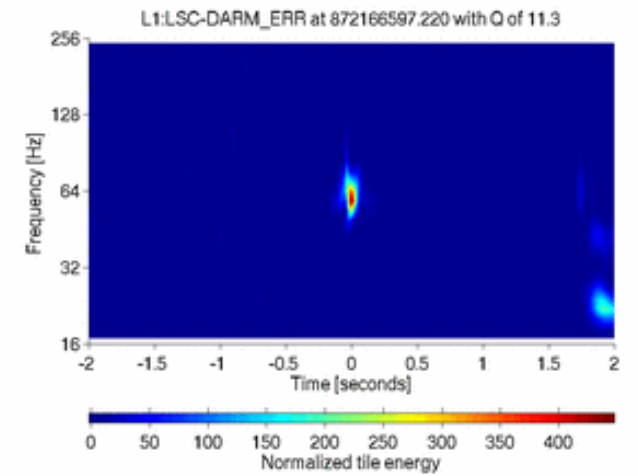
Power line glitches at LLO EY

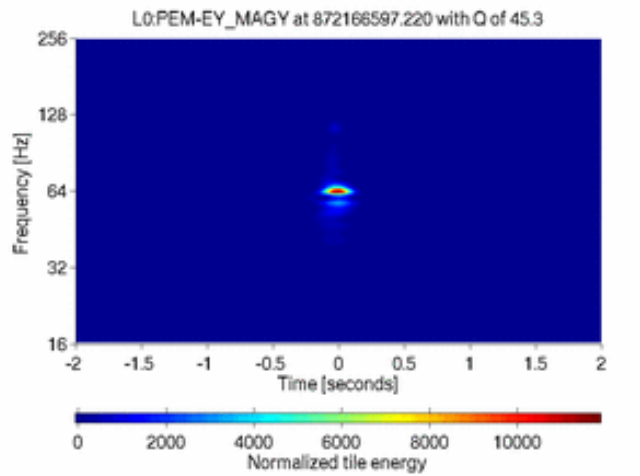


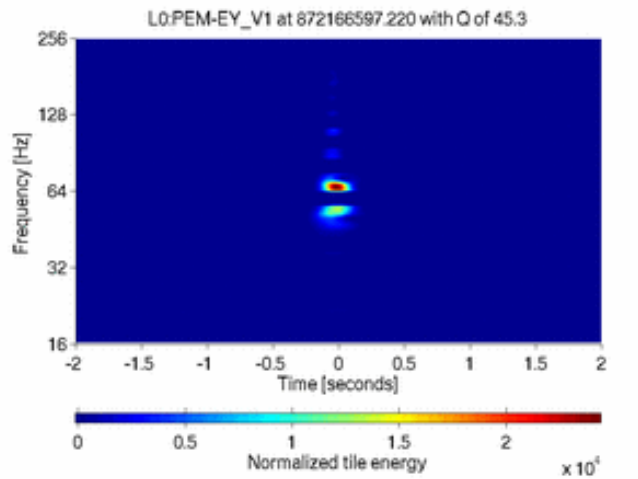




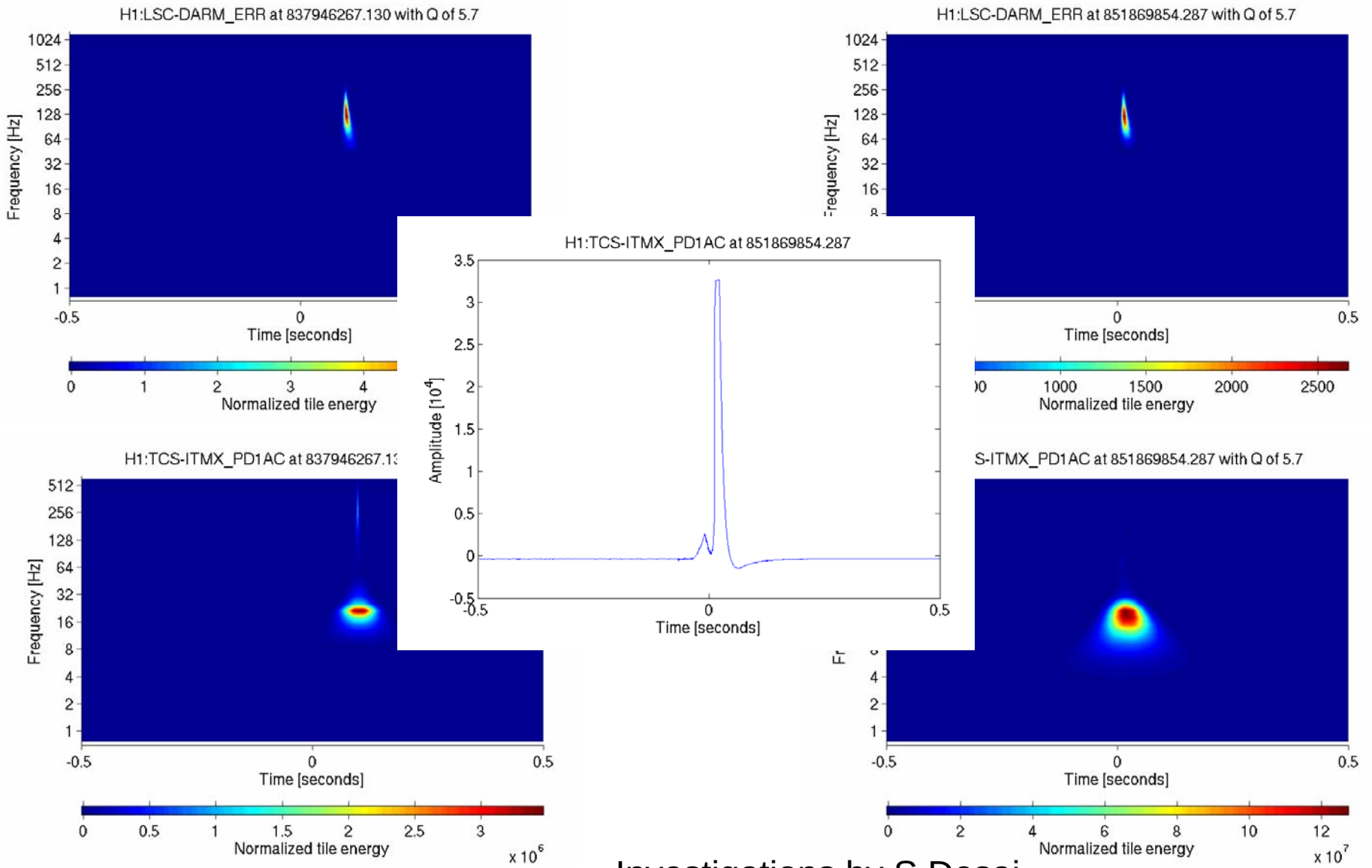
Quasi periodic SNR>20 glitches in gravitational channel associated with power line and magnetometer glitches at Y-end station





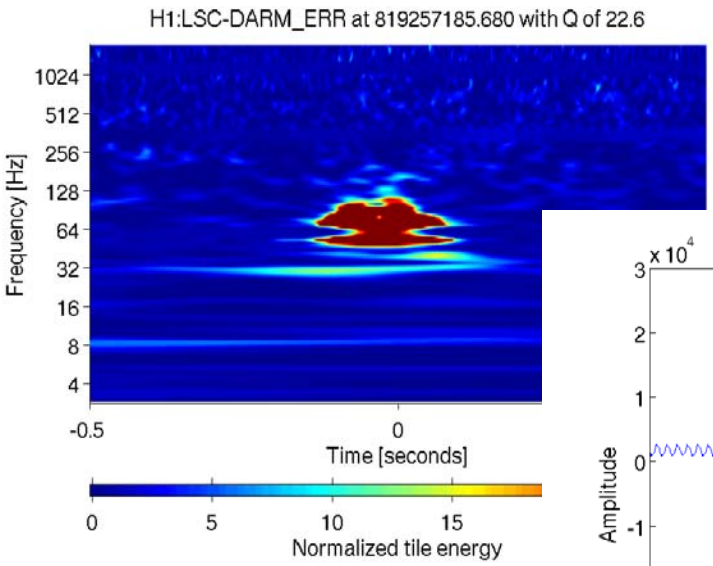


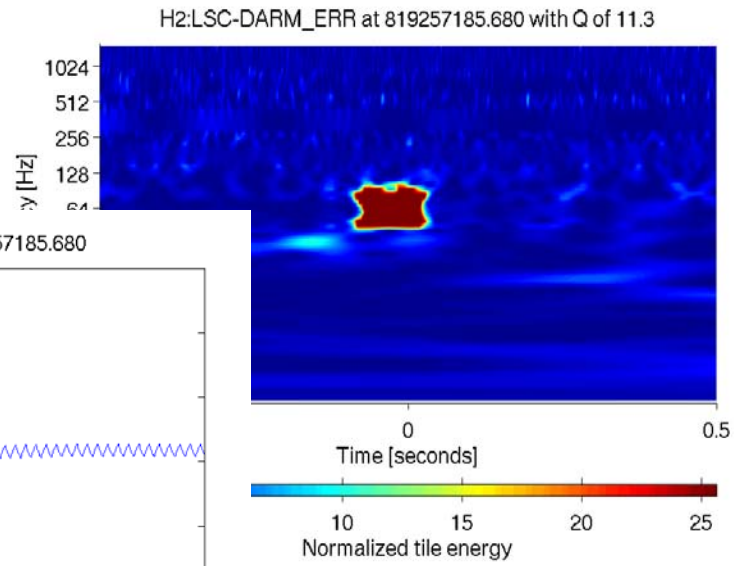
Thermal compensation glitches

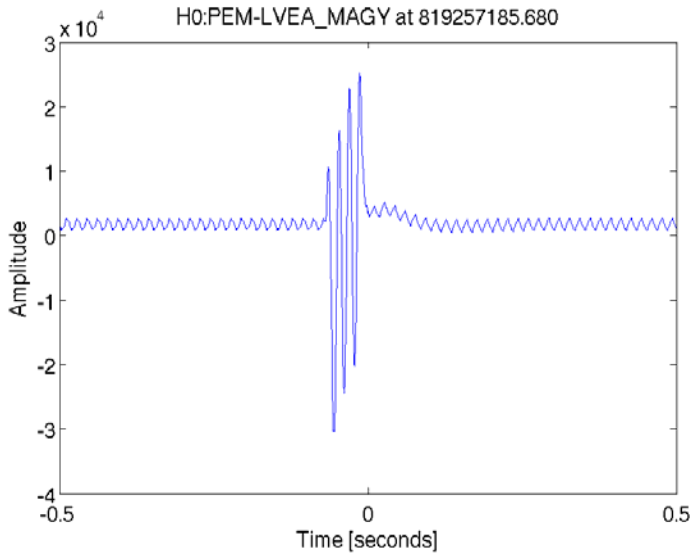


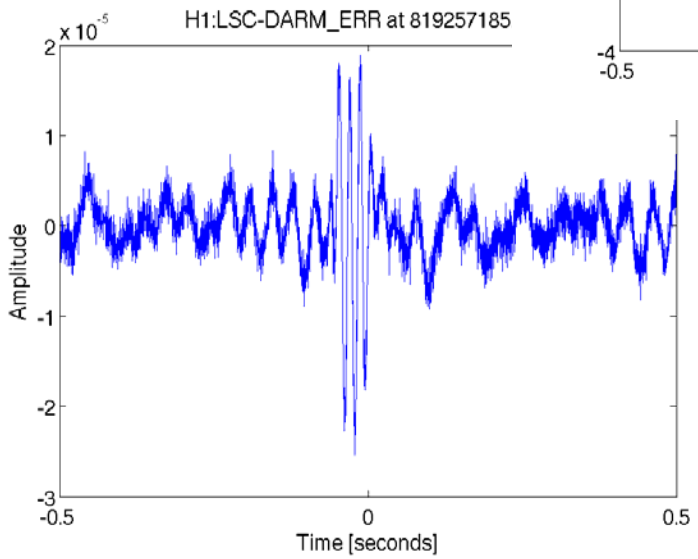
Investigations by S.Desai

Power line glitches at LHO

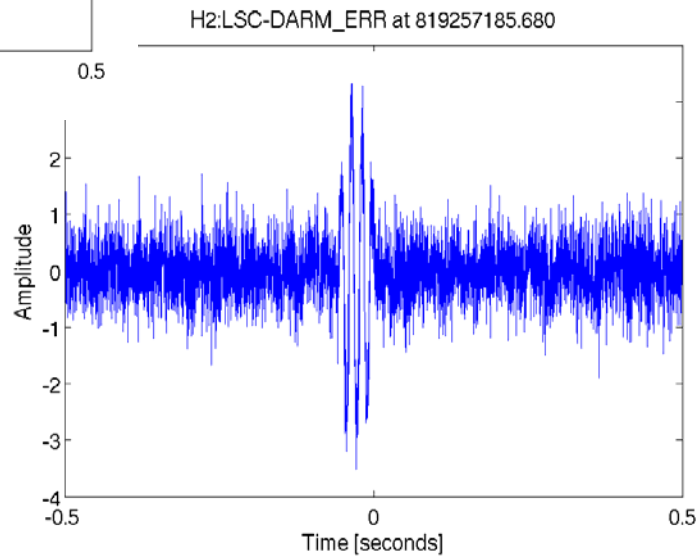








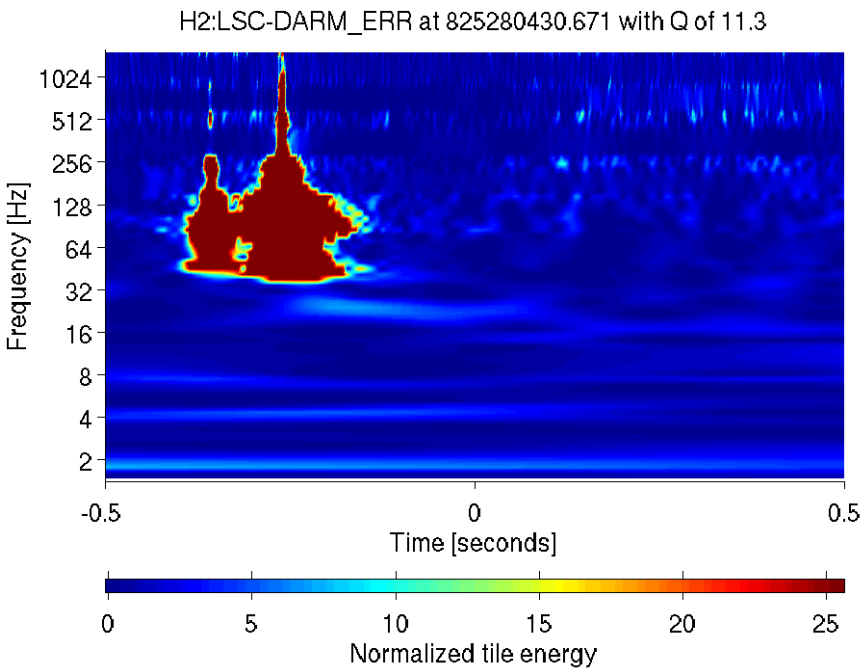
A big transient seen in all magnetometers and volt-meters



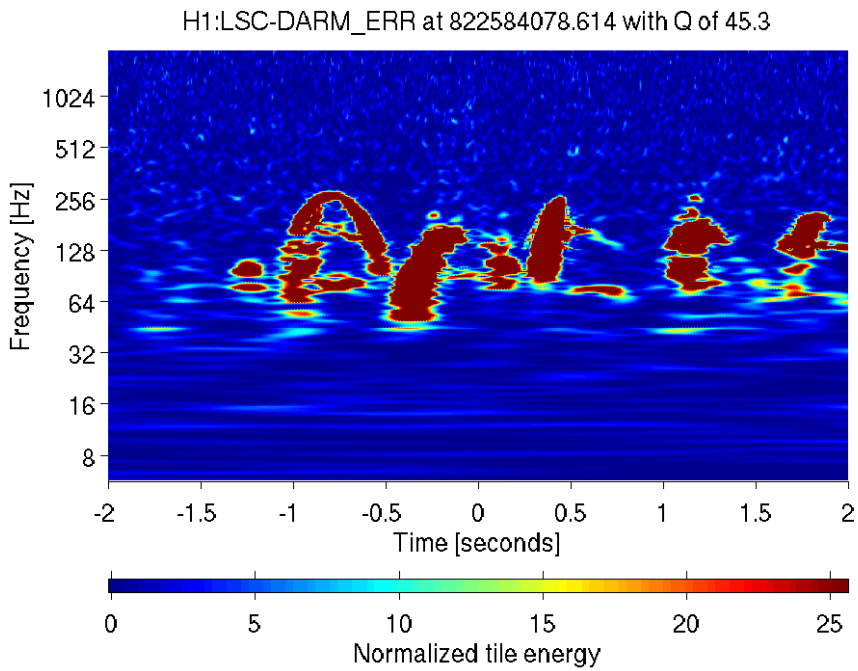
Coupling between H1 and H2

Swinging optics from an unlocked detector produces glitches in locked detector

H2 when H1 is not locked



H1 when H2 is not locked



Data quality flags under investigation by Blackburn and Katsavounidis

Data quality

Data quality flags

- Data quality flags are created when problems are identified
- Inserted into LSC segment and data quality database
  - Can query directly with LSCsegFind
  - Can retrieve with segwizard (one day latency)
  - Displayed in QScans (one day latency)
- Many data quality flags inserted automatically
- Should not be applied arbitrarily
- Need to test
  - Efficiency at vetoing glitches in gravitational-wave channel
  - Lost observation time
  - Risk of vetoing a true gravitational-wave signal
- Divide flags into categories depending on severity and use

Example data quality flag

Burst and Inpsiral:

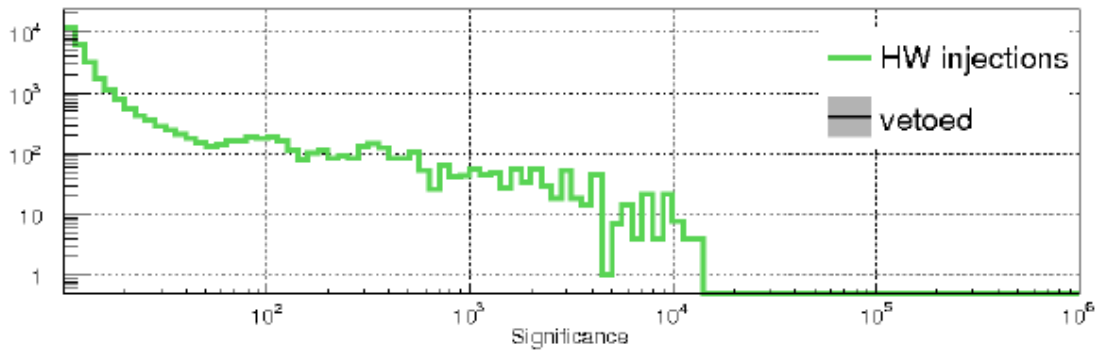
- OUT_OF_LOCK
- OUT_OF_SCIENCE_MODE
- PRE_LOCKLOSS_N_SEC
- MISSING_DATA
- INJECTIONS

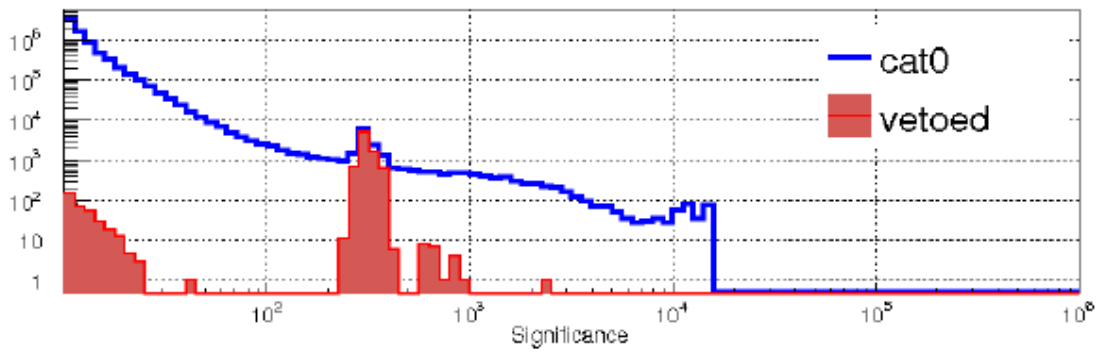
Burst only:

- CALIBRATION_DROPOUT
- SEVERE_LSC_OVERFLOW

CALIBRATION_DROPOUT_AWG_STUCK:V4

```
DeadTime:                8405/23437595 = 0.036%
Significance >  10       8718/ 7206555 = 0.121%
Significance >  50       8369/   60842 = 13.755%
Significance > 100       8369/   30536 = 27.407%
Significance >1000          1/    3796 = 0.026%
```





Example data quality flag

Burst and Inpsiral:

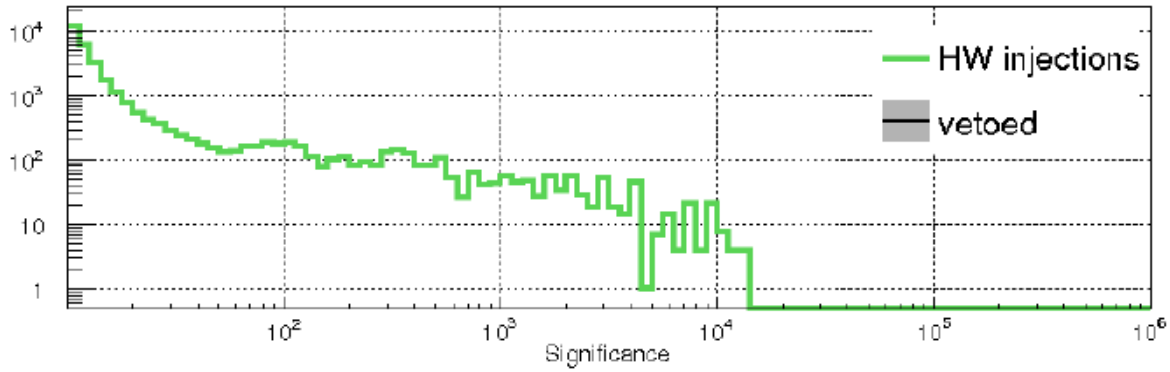
- OUT_OF_LOCK
- OUT_OF_SCIENCE_MODE
- PRE_LOCKLOSS_N_SEC
- MISSING_DATA
- INJECTIONS

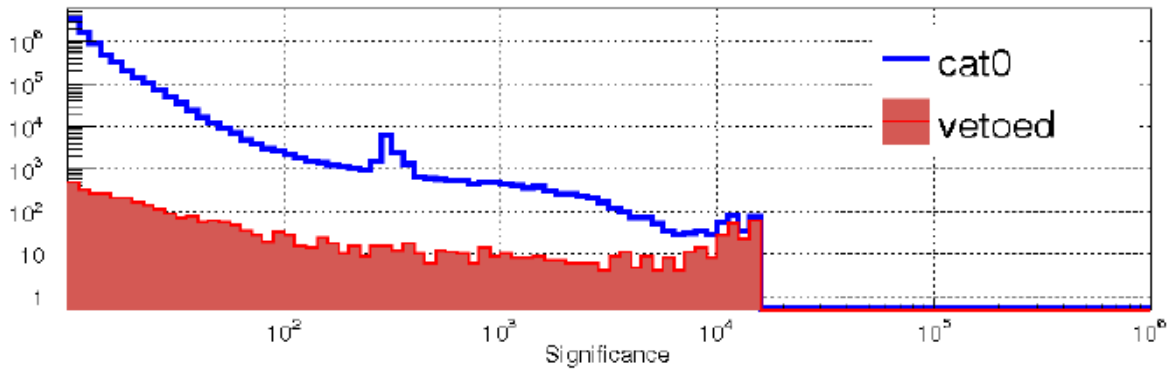
Burst only:

- CALIBRATION_DROPOUT
- SEVERE_LSC_OVERFLOW

SEVERE_LSC_OVERFLOW:V2

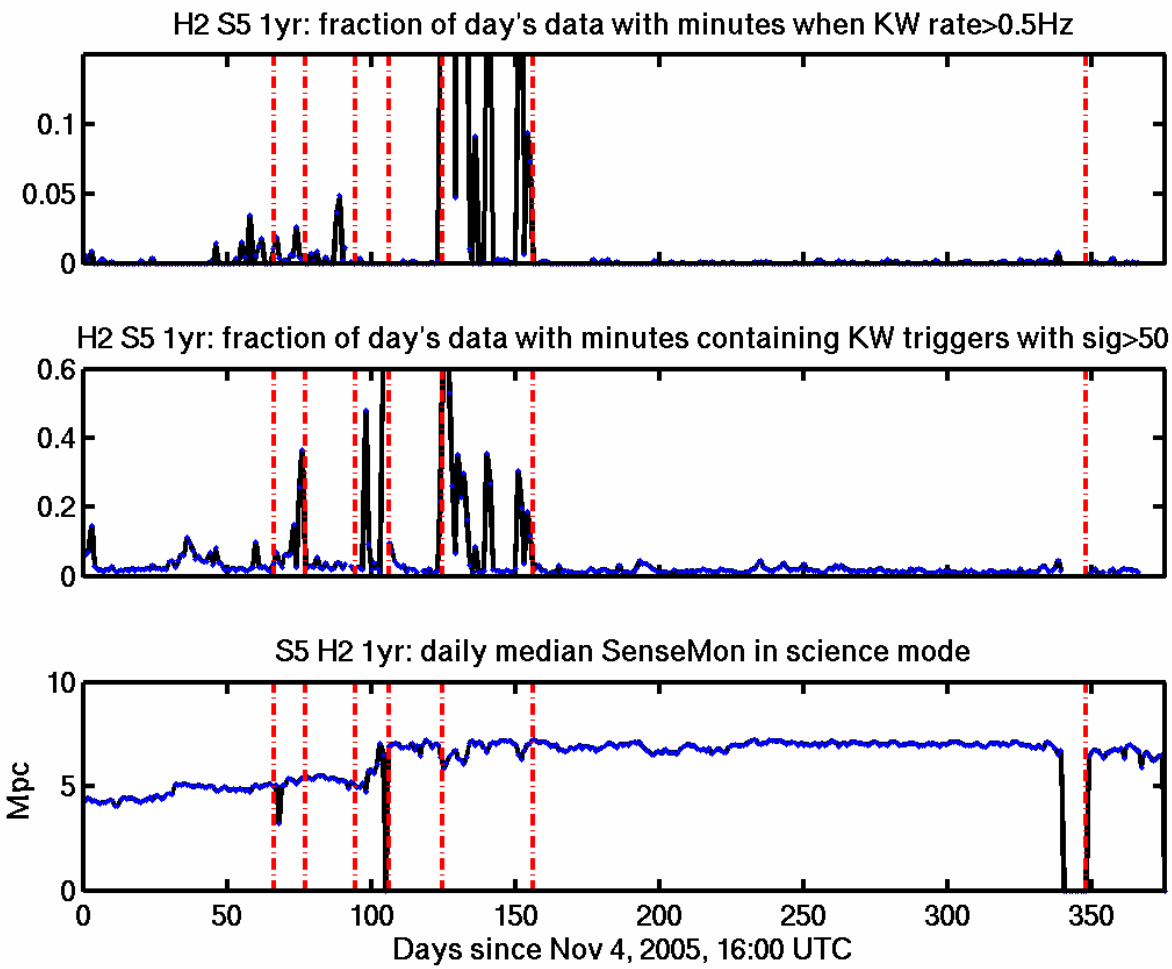
```
DeadTime:                2315/23437595 = 0.010%
Significance >  10       3316/ 7206555 = 0.046%
Significance >  50        805/   60842 = 1.323%
Significance > 100        587/   30536 = 1.922%
Significance >1000        318/    3796 = 8.377%
```





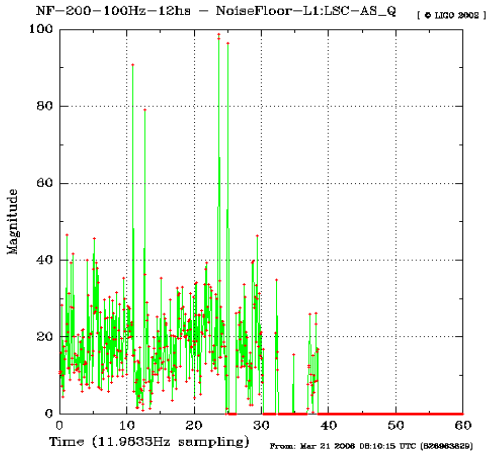
Data quality epochs

- Identify periods where detector behavior was different enough to require a separate study of data quality flags and vetos



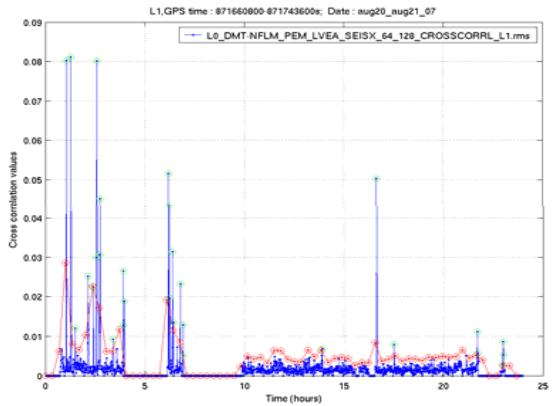
Other activities

Tracking non-stationary of noise



Online

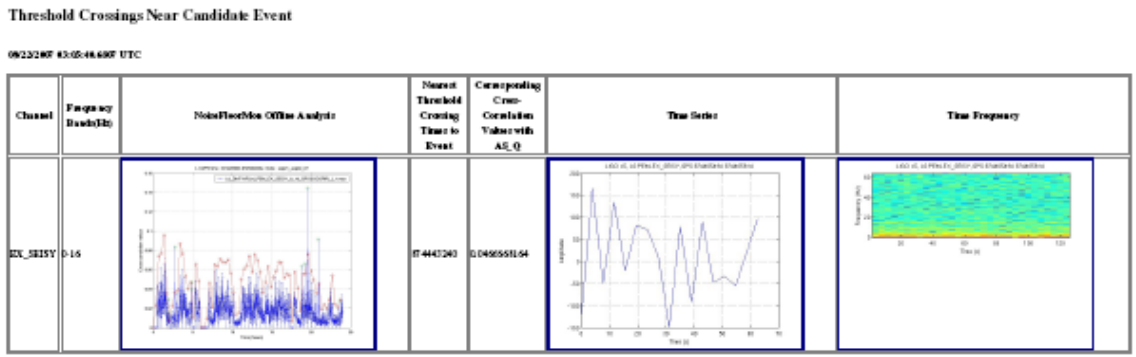
Monitor checks PEM couplings with AS_Q at each site. Offline analysis consists of implementing running median in the time domain, setting a threshold, and identifying threshold crossings.



Offline

Offline results available at
http://www.phys.utb.edu/~soma/MNFTresults/NoiseFloorMon_daily.html

More detailed analysis is conducted around events of interest. A seismic DQ flag is in the works.



Listening to glitches

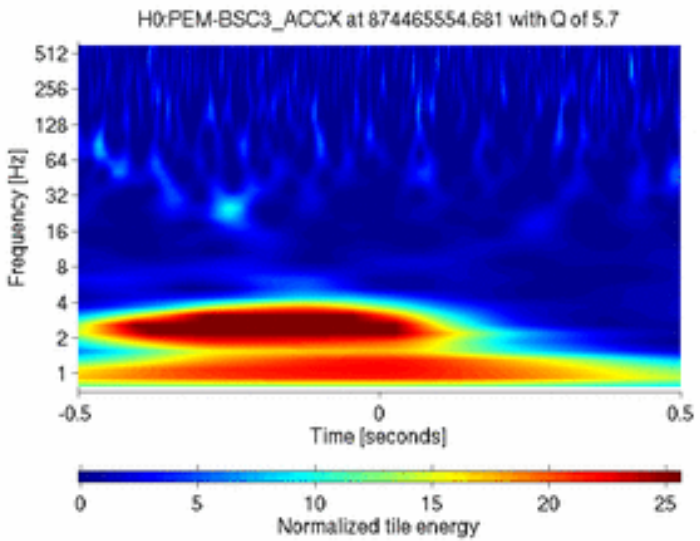
- Work by Syracuse group (Saulson, Smith, Hartnett, Evans)
- Goal
  - To hear the different character of glitches
  - Hope the classification will lead to clues to the origin and solution of glitches from different sources
- You can hear a lot of different things going on
  - seismic noise and upconversion
  - violin modes
  - mirror modes
  - Locking and unlocking transients
  - cross-talk from swinging mirrors when H1 or H2 unlocked
- Following up interesting events from burst search

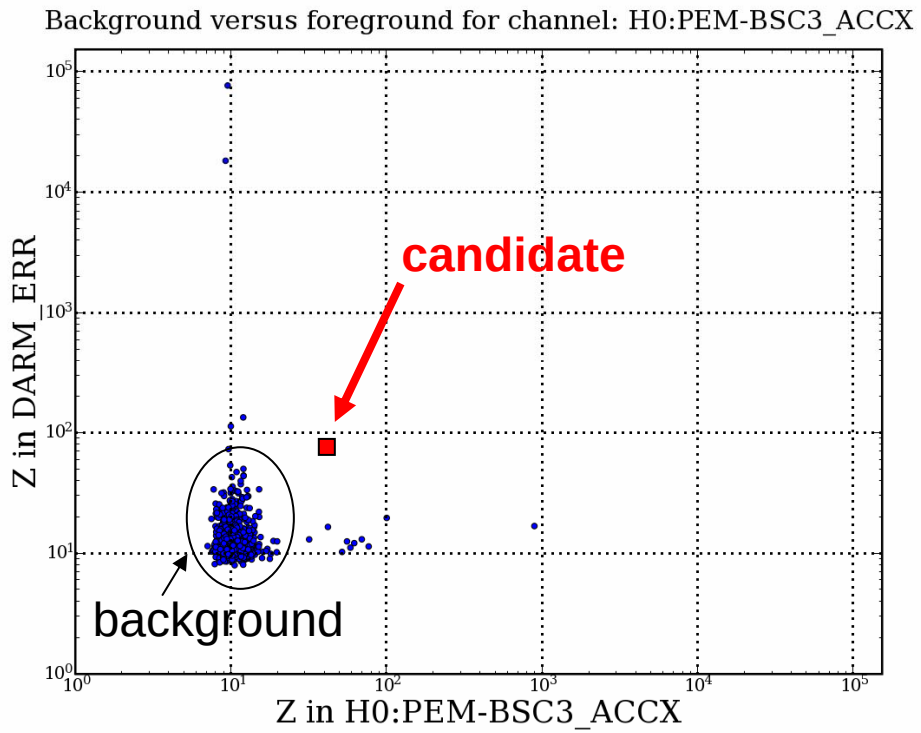
Follow-up of interesting events

- How relevant is a glitch observed in an auxiliary channel?
- Estimate background by running QScans are random times

Example: qscan at 874465554 (burst candidate)

Accelerometer glitch (Z = 41.9)





significant glitch ? ⇒ needs more investigation…

Present and future

Post S5 focus

- Focus has now shifted from feedback to operations and commissioning to support for data analysis
  - Follow-up of candidate events (Gouaty, Blackburn)
  - Develop new data quality flags (Zweizig)
  - Identification of detector epochs (Gonzalez, Cadonati)
  - Study effectiveness of data quality flags (Cadonati, Slutsky)
  - Study effectiveness of vetoes (Katsavounidis)
  - Catalog and classification of glitches (Desai, Mukherjee)
  - Post S5 glitch studies (Schofield, Slutsky)
- Initial focus on first year of S5 identified by analysis groups
- Need to collect and summarize results from all of S5
- Need to analyze detector logs to develop single issues data quality flags

Astrowatch and S6

- Astrowatch
  - Provide feedback to commissioning teams on data quality
  - Provide data quality support on request for interesting events during the astrowatch period (GRBs,SGRs, etc.)
  - Develop infrastructure necessary to meet S6 goals
- S6
  - Automated production of many data quality flags
  - Rapid response to support real time data analysis
  - Develop organized way for operators to
  - Recommendations based on S5 experience:
    - Database to track changes to the detectors including changes to auxiliary and environmental channels
    - Method for operators and scimons to identify data quality issues in a format that is easily used by data analysis groups.

End