Characterizing glitches in OPLEV.

Summer Research Project

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Why

Why do we need this flag?

- Optical levers (OPLEVs) can be used for both the alignament and also characterizing mirror motions.
- Currently we see a lot of glitches in the OPLEVs.
- We believe they might be due to change in OPLEV's laser power

Why LASER power has glitch?

- Glitches may be caused by mode mismatch in LASER cavity

Main purpouse

- Develop a script to identify and characterize glitches in OPLEV
- Develop a tool for online monitoring of the OPLEVs channels

the GlitchFinder code

Data are first bandpassed and then the peaks of the filtered time series above a certain threshold are identified. The resonance frequencies of the optics are below 10 Hz, so we use a pass band of 15-100 Hz which also removes high frequency noise.

GlitchFinder algorithm

- Download the data time series from the server
- Filter the time series
- Flag the peaks above a threshold
- Check for coincidence with alignment channels
- Identify glitches that have no correlation with alignment channels

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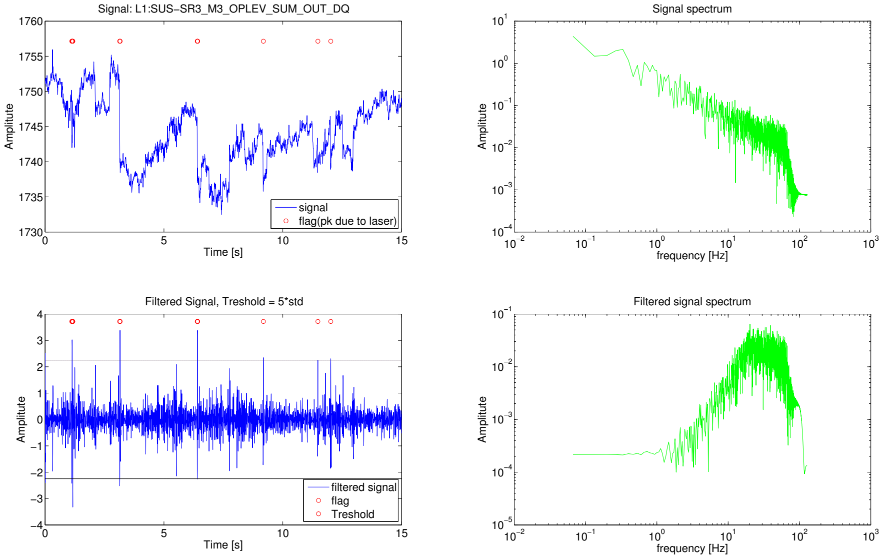
Throughout the slides the thresholds are expressed in units of standard deviation (std) of filtered data

GlitchFinder example



Test runs

We run GlitchFinder on 3 hour data from the following two channels:

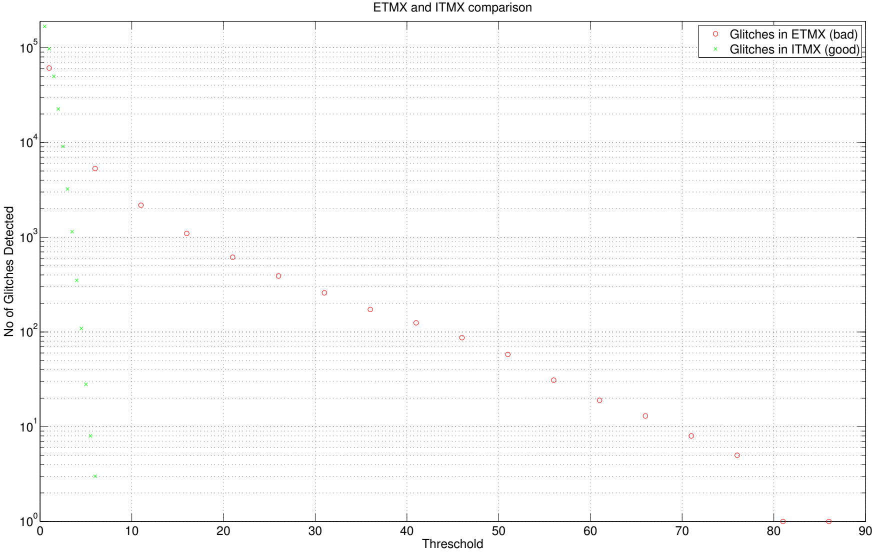
- $L1 : SUS - ITMX\_L3\_OPLEV\_SUM$
- $L1 : SUS - ETMX\_L3\_OPLEV\_SUM$

Questions:

- How can we distinguish between:
  - "Bad": Too much glitches for being used in the feedback loop
  - "Good": Could be used in the loop without fallout
- What is the time and amplitude distribution of the glitches?
- What is the optimal threshold to identify glitches?
- What is the rate of false positives?

False positives may be avoided by performing a coincident analysis with the OPTICALIGN channel.

ITMX and ETMX comparison



More runs

We then looked at one week of data to get more statistics:

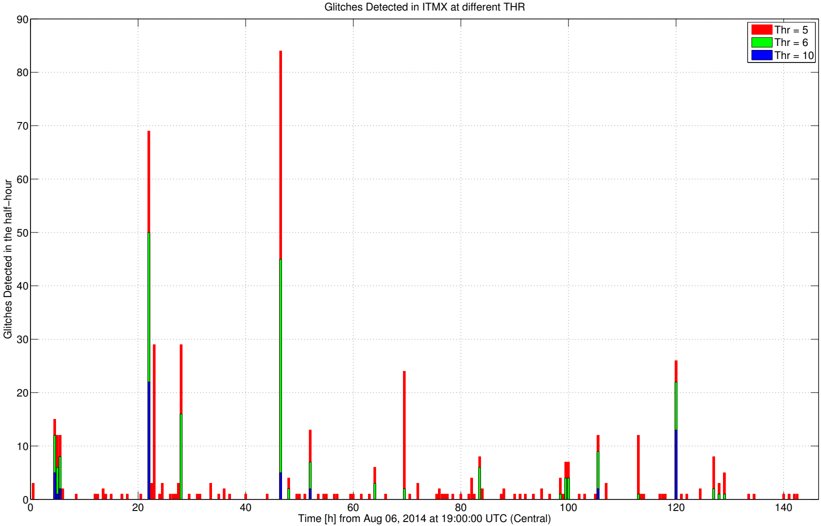
Next slides show:

- Distribution of glitche amplitudes.
- Number of triggers in each half-hour during that week.

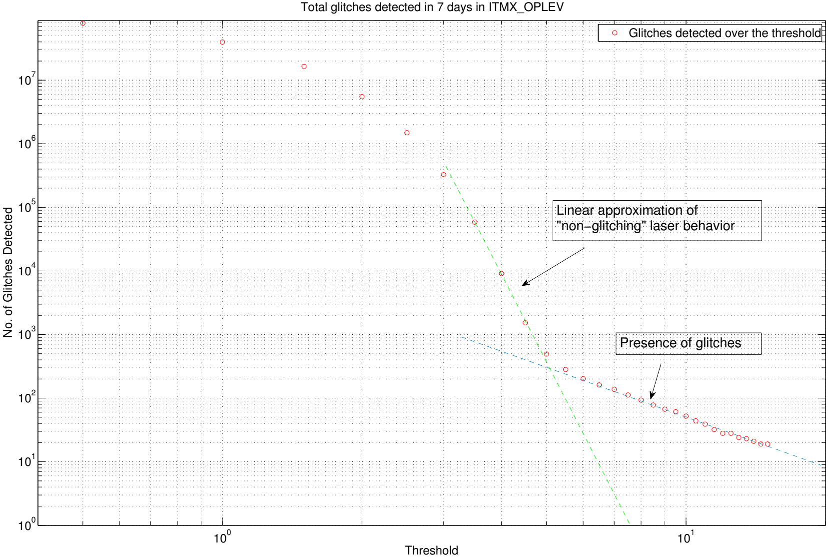
Analyzed channels:

- L1:SUS-ITMX_M3_OPLEV_SUM_OUT_DQ
- L1:ISI-HAM4_OPLEV_SUM_IN1_DQ
- L1:SUS-ETMX_M3_OPLEV_SUM_OUT_DQ

$L1 : SUS - ITMX\_M3\_OPLEV\_SUM$: Glitches vs Time



$L1 : SUS - ITMX\_M3\_OPLEV\_SUM$: Glitches distribution



Summary of ITMX OPLEV results

Observation

In the one week-long data stretch GlitchFinder found 13 half-hour with glitches.
Overall GlitchFinder produced 117 triggers (thr=7.5):

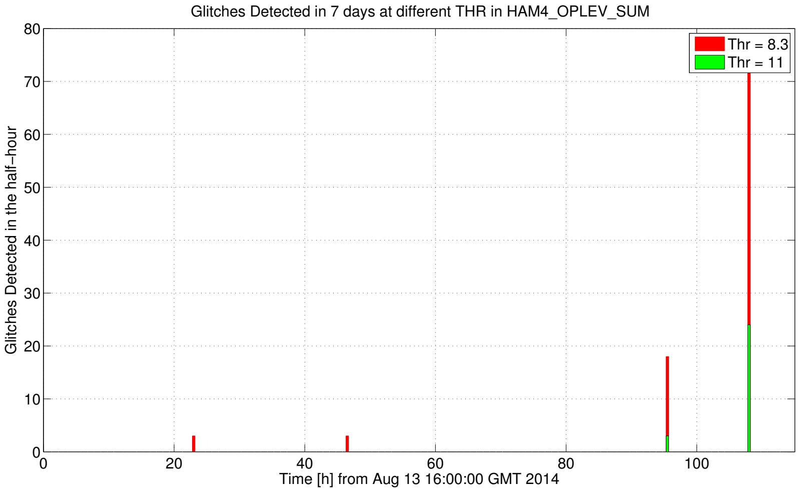
- 18 triggers were just above threshold and the time series looked smooth
- 1 was coincident with a trigger in the OPTICALIGN channel but the correlation with the alignment channels did not pick this one
- 98 were loud and may be considered as real glitches

False positives ratio for this run: $16 \pm 4\%$

Conclusions

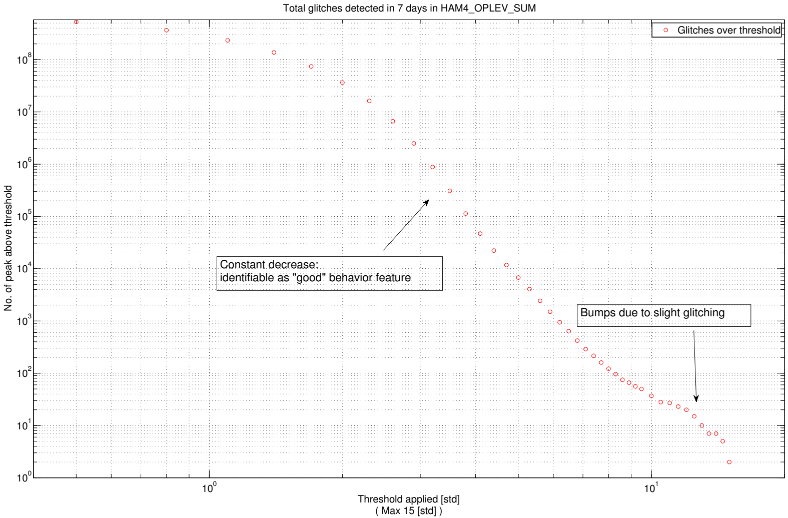
- ITMX Laser is not behaving as good as we thought
- As we can see from the previous plot, we expect from linear approximation that a "good" laser to show no amplitude (filtered) above threshold of ≈ 7.5

L1:ISI-HAM4_OPLEV_SUM_IN1_DQ: Glitches vs Time



$L1:SUS-SR2\_M1\_OPTICALIGN\_P\_OFFSET$ and $L1:SUS-SR2\_M1\_OPTICALIGN\_Y\_OFFSET$ channels had been used for cross check

L1:ISI-HAM4_OPLEV_SUM_IN1_DQ: Glitches Distribution



We can believe that this the distribution for a "good" Laser

Summary of HAM4 OPLEV results

Observation

In the one week-long data stretch GlitchFinder found 4 half-hour with glitches.
Overall GlitchFinder produced 96* triggers (thr=7.5):

- 6 triggers just above threshold but the time series looks OK
- None of the triggers have any coincident with OPTICALIGN channels
- 90 were loud and may be considered as real glitches

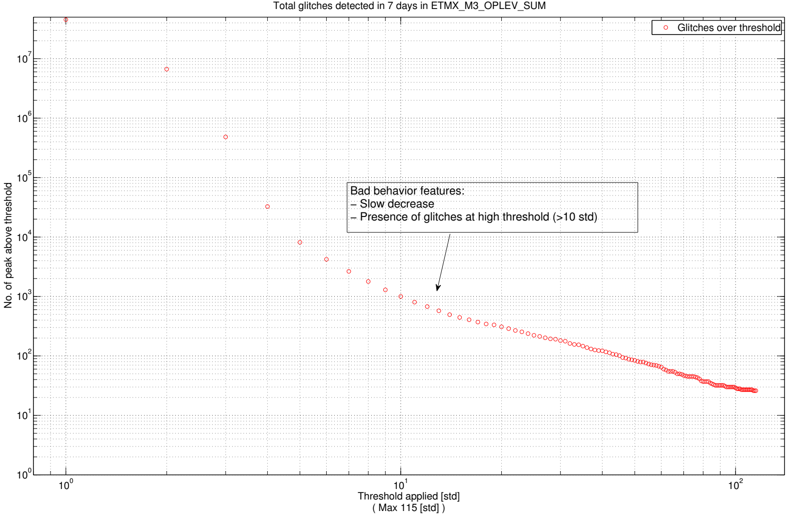
False positives ratio for this run: $6.25 \pm 2.5\%$

Conclusion

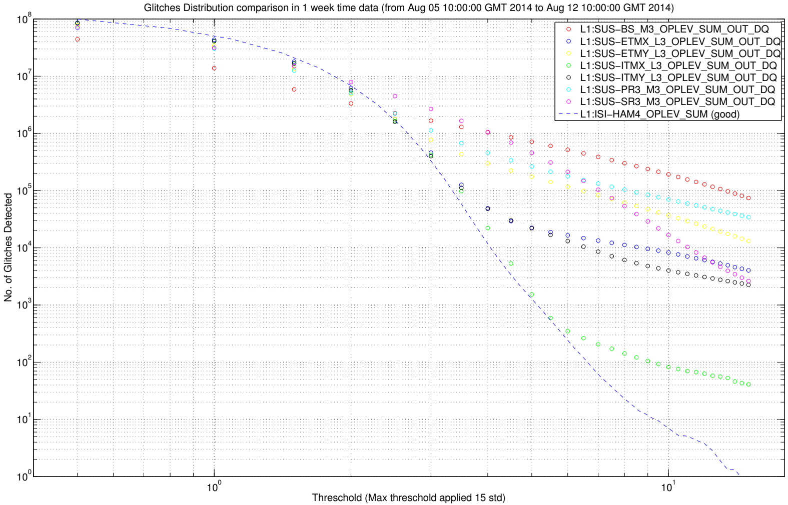
- HAM4 laser looks good.
- After this two run GF efficency in glitch detection: $88 \pm 11\%$

*: to compare this number with the triggers in ITMX we have to remember that sampling frequency is 4 times higher in HAM4.

L1:SUS-ETMX M3 OPLEV SUM DQ: Glitch Distribution



Comparison between main optics OPLEV channels: Glitch Distribution



Summary on main optics OPLEV channels

About channels from 8/5/14 to 8/12/14

- All analyzed channels show high rate of glitches.
- $L1 : SUS - ITMX\_L3\_OPLEV\_SUM\_OUT\_DQ$ seems to be the channel with lower number of glitches

Conclusion

- Due to the high rate glitches, it would be difficult to use the OPLEVs for optics control.

GlitchFinder online

We developed a script to be used on online data for glitches detection.

GlitchFinder online features:

- Real-time data analysis and glitch detection
- Look at a large number of channels at the same time
- Trigger alert message
- Archiving the times of the triggers

Online GlitchFinder is almost ready and will be tested soon. We are going to use this script also for LASER characterization.

Suggestions and comments are welcome!

Thank you!

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