

Earthquakes study for advanced interferometers  
Outcome of the GWADW 2015 – Controls Workshop

G1500652  
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People involved in this effort so far (alphabetical order):

- Sebastien Biscans
- Michael Coughlin
- Arene Fiori
- Ryan Fisher
- Jan Harms
- Fabrice Matichard
- Duncan MacLeod
- Paolo Ruggi
- Brett Shapiro
- Bas Swinkels
- Krishna Venkateswara

## Goals:

1. Monitoring earthquakes at the sites (LIGO/VIRGO)
2. Analyzing and understanding the consequences of the earthquakes on the interferometers
3. Finding a solution to prevent lock losses during earthquakes

- Earthquake monitor developed by J. Harms and M. Coughlin ([G1400811](#))
- Developed in python.
- Two purposes:
  - estimate the arrival time of P-waves and S-waves
  - estimate the maximum amplitude of the event
- Output of the monitor: xml file

**Action item (Jan, Micheal):**

Run the EQ monitor on a computer (MIT? Idas?)

**Action item (Duncan, Jan, Micheal, Ryan):**

Propagate the output information from the earthquake monitor to the summary pages

**Action item (Michael, Sebastien):**

Test the monitor at LASTI

- Each event will be monitored
- With the help of the detchar group, display plots for each event online
- (in a 'summary pages' kind of style) → Earthquakes page
- Which channels to monitor?

**Action item (from everybody):**

Define sensible channels to monitor → **need help from the commissioners!!!**

Define which type of plots (time series, ASD, coherence, ...) should be display in the webpage

- Please put the channels and plots you would like to see in the attached excel table

	A	B	C	D
1	<b>LIGO</b>			
2	<b>Channels</b>	<b>ASD</b>	<b>time series</b>	<b>coherence (with...)</b>
3	<IFO>;HPI-ITMX_STSINF_B_X_IN1_DQ			<IFO>;HPI-ETMX_STSINF_B_X_IN1_DQ
4	<IFO>;HPI-ITMX_STSINF_B_Y_IN1_DQ			<IFO>;HPI-ETMX_STSINF_B_Y_IN1_DQ
5	<IFO>;HPI-ITMX_STSINF_B_Z_IN1_DQ			<IFO>;HPI-ETMX_STSINF_B_Z_IN1_DQ
6	<IFO>;HPI-ETMX_STSINF_B_X_IN1_DQ			<IFO>;HPI-ITMX_STSINF_B_X_IN1_DQ
7	<IFO>;HPI-ETMX_STSINF_B_Y_IN1_DQ			<IFO>;HPI-ITMX_STSINF_B_Y_IN1_DQ
8	<IFO>;HPI-ETMX_STSINF_B_Z_IN1_DQ			<IFO>;HPI-ITMX_STSINF_B_Z_IN1_DQ

Based on the data that we will gather on earthquakes, we need to answer some questions (non-exhaustive list):

- Can we classify earthquakes in some meaningful categories (e.g. strong, medium, weak earthquakes,...)?
- Starting from which magnitude do we start to care?
- In which way does an earthquake hurt the interferometer?
- Is that reasonable to think that we can prevent lock loss during an EQ?
- If not, can we still help in some other ways (prevent trips, damage, etc.)? Safe mode?
- Do earthquakes generate tilt? (it seems unlikely. Need to be checked)
- Where do we take action (seismic level, cavity level, ...)?
- ...

Several possible strategies to reduce the impact of earthquakes on the interferometers are possible.

These are some very general ideas that I just put there as a reminder.

Some might not work but it's worth thinking about it.

- Reducing the digital gain/ increasing the analog gain to avoid trip during small earthquakes
- Reducing the power in the cavities during big earthquakes ('safe mode')
- Switching to higher blends (let the common ground displacement be)
- Switching to lower blends (use the extra signal provided by the EQ to increase the inertial control authority)

More to come!

**Action item (Sebastien):**

To avoid disturbances at the sites, these “ideas” will be detailed and modeled first and tried off-sites if possible (LASTI)