Inspiral Upper Limit: Detector Characterization Needs

- Nelson Christensen
- Carleton College

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- Joint ASIS/DC/Upper Limits session
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Inspiral Upper Limit Group

Detector Characterization Sub-group

IUL Detector Characterization

- Sukanta Bose
- Nelson Christensen
- Gabriela Gonzalez
- Gregg Harry
- Joe Kovalik
- Nergis Mavalvala
- Adrian Ottewill
- Tom Prince
- David Reitze
- Julien Sylvestre

Need to know and understand detector in order to accept or reject potential binary inspiral events.

Two Types of “Noise”

- (1) False gw events due to linear coupling of noise into the gw channel.
- We will analyze the channels in the same frequency range as the gw channel

- (2) False gw events due to non-linear coupling of noise.
- Vague, but in general implies looking for "strange behavior" at the "same time" as the gw event.
- Similar concern for Burst Group?

Veto Strategies

- (1) Template search tells us, “Here is a candidate event.”
- Examine all important environmental channels and search for a “problem.”

- (2) All environmental channels are constantly monitored.
- Vetoes are generated and we tell our team all times to reject candidate events.

Identify Important Channels to Monitor

- Nergis Mavalvala and Gabriela Gonzalez have identified channels that we believe we should monitor.

Important Channels

- **Pre-Stabilized Laser:**
- *** frequency**:
- - error point (demod) 16 kS/s
- - actuation points (fast piezo) 16 kS/s
- - reference cavity transmission 256 S/s
- ***intensity**
- - ISS error point PD or 1811 DC 16 kS/s
- - RFAM   1811 AC

- **Pre Mode Cleaner:**
- - error point (demod)   16 kS/s
- - actuation point (piezo) 2 kS/s
- - transmission PD 256 S/s
- **Input Optics:**
- *mode cleaner
- - error point (demod) 16 kS/s
- - actuation points (mc length) 2kS/s
- - (psl freq/vco) 16 S/s
-   intensity:
- - mc transmission ISS error point PD 16 kS/s
- - actuation: laser current shunt 16 kS/s

Important Channels

- Interferometer Sensing and Control:
- (All LSC channels 16 kS/s)
- (All ASC channels 2kS/s)
- # of LSCchans # of ASC channels
- ifo controls:
- all error points:
- I + Q for 3 ports =6 2 x 5 WFS + 2 x 2 QPDs
- = 14
- all actuator points:
- 6 TMs + 2 freq =8 2 x 6 TMs + 2 IB = 14

- *ifo power mons:
- reflection port 16 kS/s
- antisymmetric port 16 kS/s
- rec cav pickoff 16 kS/s
- arm cavities transmission 2chan @ 2 kS/s
- ASC optical levers 2 x 7 dof 2 kS/s

Important Channels

- **SUS channels:**
- ***Coil monitors**: 2048 Hz; 5/mirror: ITMX,ITMY,RM,BS,ETMY,ETMX
- ***Coil Sum:** 16384 Hz; 1/mirror: ITMX,ITMY,RM,BS,ETMX,ETMY
- ***Sensor channels:** 256 Hz; 5/mirror: RM, BS, MC1, MC2, MC3, SM1, SM2, MMT1, MMT2, MMT3, FM1, FM2, ITMX, ITMY, ETMY, ETMX.

  Dominated by ADC noise above 20 Hz.

- **PEM Channels:**
- ***Accelerometers:** 2048 Hz; 3(x,y,z)/location: PSL2, HAM(7,8,9,10), BSC4,5,6,7,8,9(2),10(2), BT4,5
- ***Magnetometers:** 2048 Hz; 3(x,y,z) times 2(MAG1,MAG2) per location: BSC1,9,10
- ***Microphones:** 2048; locations: PSL2, HAM7,8,9,10, BSC1,3,4,5,6,7,8,9,10,BT4,5
- ***Tiltmeters:** 256 Hz; 3(x,y,t)/location: LVEA,MY,EX, EY
- ***Seismometers:** 256Hz; 3(x,y,z)/location: LVEA, MY, EX, EY, MX.
- ***Power monitors:** 2048 Hz, LVEA,OUT, EX, EY, MX,
- ***Vacuum monitors?** (PEM_MX_V1,2...): 2048 Hz; LVEA(3), MX

Studies of Channel

- Calibration - get channel signals into physical units
- Characterize – understand what is good and bad behavior for the channel
- Determine what is a *glitch*, *burst* or *bizarre* event. Set some threshold for veto.
- Does anything in the channels look like a *chirp*?

Divide and Conquer

- Divide up the control and environmental channels among sub-group members
- Each person will be responsible for their channels
- Understand your channels. Baby-sit them. Know when they are *naughty* or *nice*.
- Try to determine what a *burst* or *glitch* is for each channel.
- Develop some rough transfer function for each channel.

An experimental sage of the sub-group advised:

Get in there with an oscilloscope and see that channel first hand.

Not good enough to look at logged data – see it an all time scales, fast and slow.

Sub-group members need to spend time at Hanford or Livingston to accomplish this.

How to declare a veto?

- Monitor all important channels
- Look for bursts in control and environmental channels
- Look for chirps in same
- Some algorithm for declaring a *veto* based on the results

Establish a Calibration Database

- We need a database of the calibration – characterization results for the important control and environmental channels.
- What would database be?
- Meta-Database? Maybe? IUL members need access and ability to record our observations

Three Software Tasks

Look for bursts

Bandpass and look for bursts

Look for chirps

Look for Bursts

- Look for bursts in control and environmental channels
- Just like what Burst Group will do.
- Code by Julien Sylvestre and others - DMT
- Inspiral UL needs to work with Burst UL – similar needs and worries.

Bandpass Filter the Data then Look for Bursts

- Bandpass data from control and environmental channels.
- Frequency band will correspond to where we expect to see inspiral events (~100 Hz to few'00 Hz)
- Look for *bursts* in the filtered data.
- Code under development: DMT or LDAS

Look for Chirps

- Run the data from control and environmental channels through inspiral templates. Not all templates – subset.
- Do we see *chirps* in the channels?
- Identify, Characterize and Classify environmental *chirps*.
- Use existing inspiral template code.

Open Questions

- Data conditioning? Removal of lines (60Hz etc) and other correlations?

  -Probably not at first. We need to understand the raw data from channels.

- Where will we do our analysis? Caltech or our home institutions? Likely, both.

Harder Problems

- Upconversion
- Bilinear couplings
- We have not developed a plan for this yet.

Game Plan

- Start testing this with E2 and E3 data
- Sub-group will concentrate effort (initially) on some stretch of 100's of seconds of good E2 data
- Finalize list of important channels to monitor
- Divide up channels amongst sub-group members.
- Get started ASAP