Other Ideas on How to Get To High $\mathcal{L}$

Disclaimer:

- **I'm happy with any solution that gets the job done.**
- **I'm not a proponent of any of the ideas shown here.**
- **Most of the ideas shown here aren't my ideas.**
  - **Instead, most of these ideas come from credible sources.**

Important to consider what we really need from the stereo XFT upgrade:

- **High p_T leptons at high $\mathcal{L}$ (3-4x10^{32} $cm^{-2}s^{-1}$)**
- **Maintain overall performance at all $\mathcal{L}$**

Two issues to consider:

- **Extremely large events (FIFO overflows)**
- **Average data volume $\rightarrow$ mean transfer + processing time**

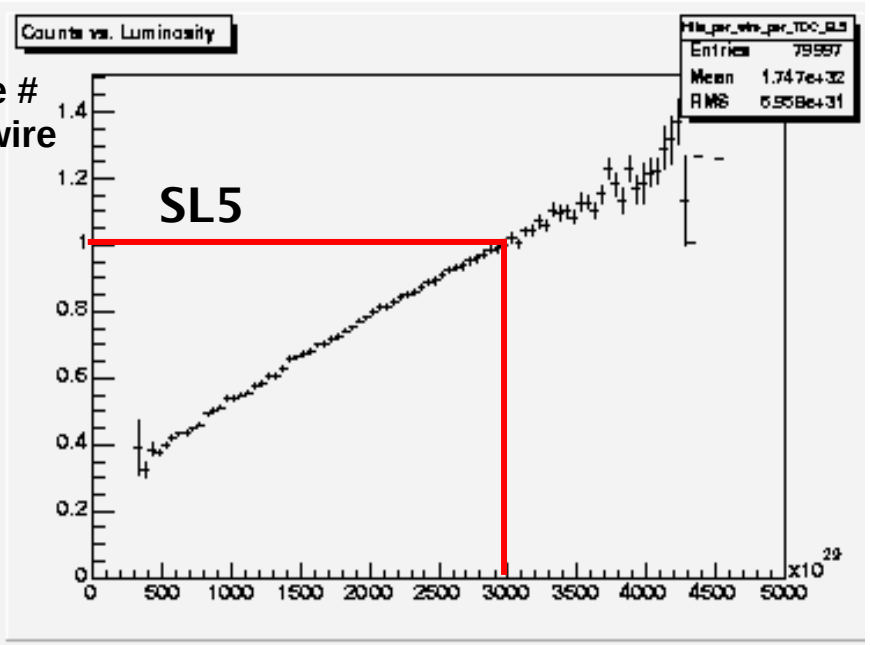
Possible approaches

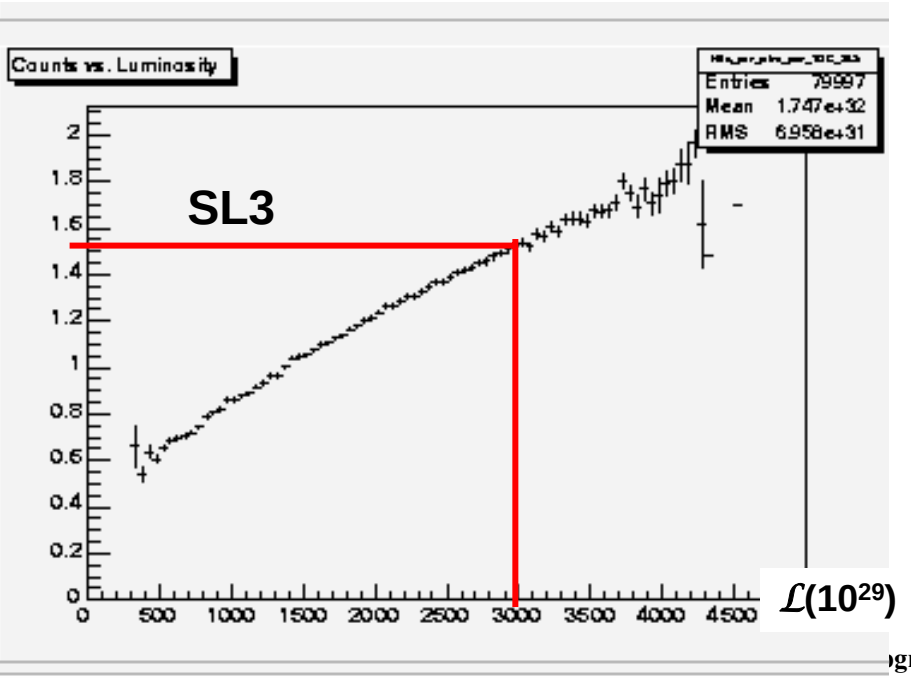
- Reduce SL3 data volume in the Finder
  - Drop SL3 completely
  - OR existing SL3 info down
- Region of interest tracking
- Auto-confirm stereo tracks on large events where FILAR FIFO will be overfilled.
- Abort XFT data transfer on unneeded events

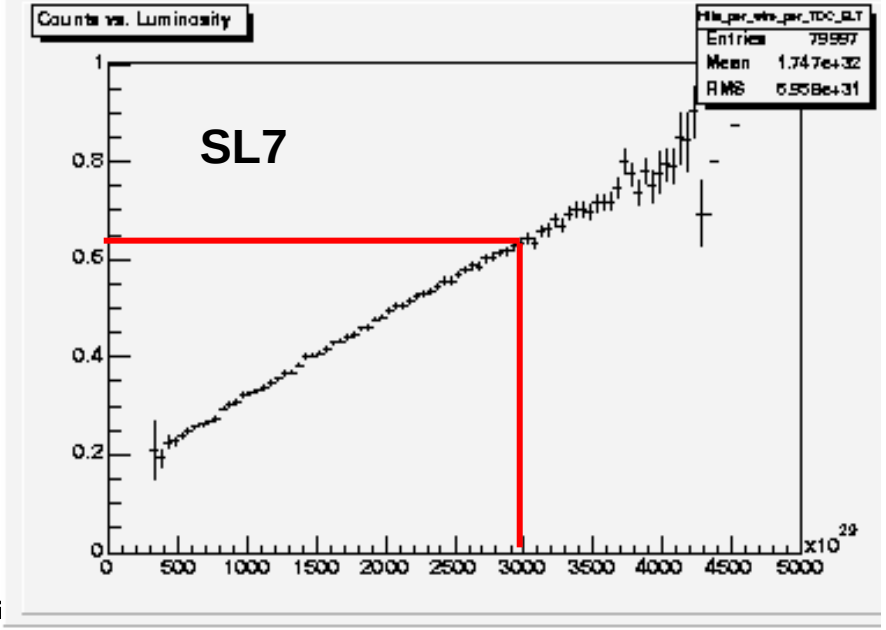
Occupancy versus $\mathcal{L}$

- **mean # of hits per wire for electron triggers**
  - From CDF Note 7039
- **At 3×10^{32} cm^{-2}s^{-1}**
  - SL3: 1.5 hits per wire (starting to saturate)
  - SL5: 1 hit per wire
  - SL7: 0.65 hits per wire

Average # of hits/wire

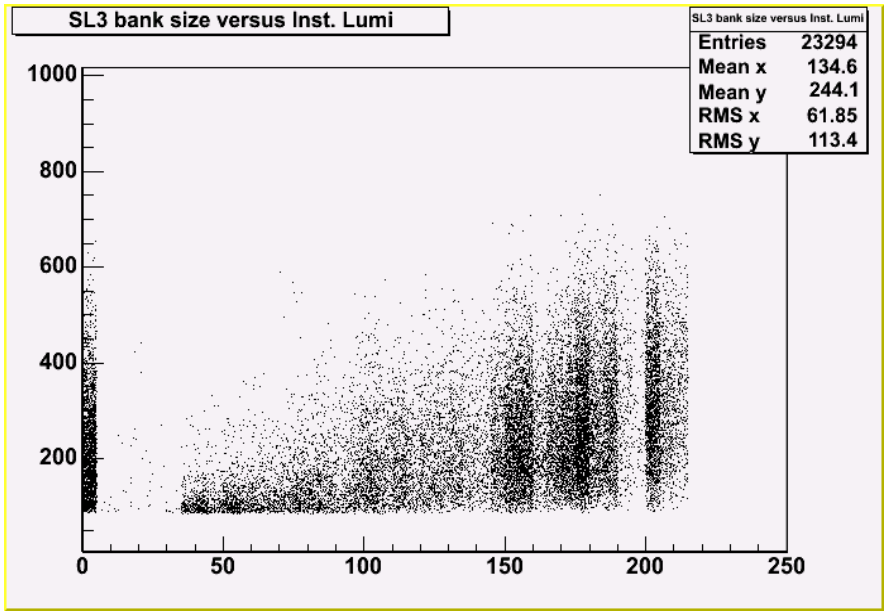


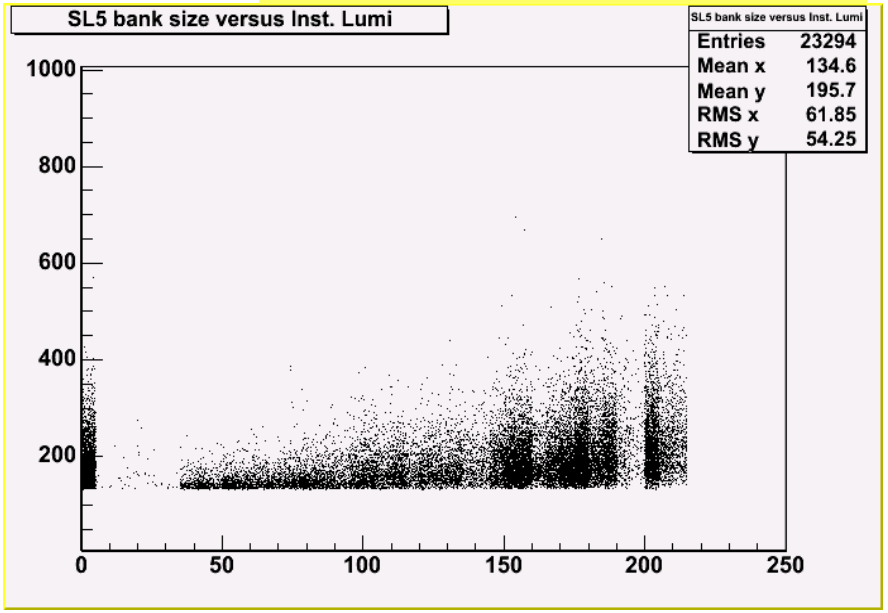


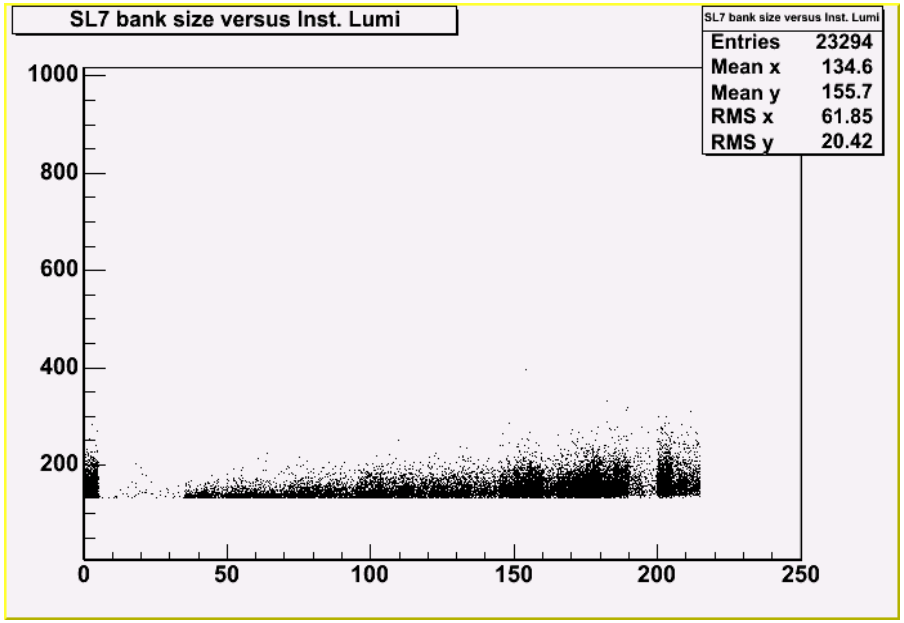


XFT Data sizes

From Alison's TDWG talk on 8-Jun







- **SL3 dominates**
  - Roughly: SL3 = SL5 + SL7
- **We also know that:**
  - SL3 carries the least amount of information.
  - SL3 data is probably too granular.

Reducing SL3 data volume (I)

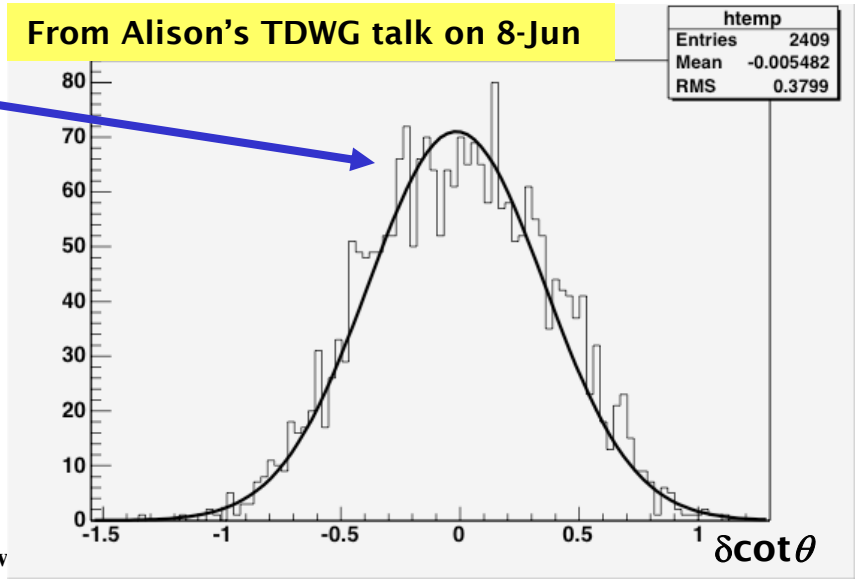
- **At high luminosity, SL3 highly occupied.**
  - Good SL3 hits will help σ_{z0}, but we don't plan to use z_0 in the trigger.
  - Primary stereo need is pointing outward to CMU/CMX/calorimeter
- **Easiest thing is to drop SL3 completely.**
  - When XFT upgrade was rebaselined, we had not presented a compelling reason to keep SL3.
  - From geometry, expect $\delta\cot\theta$ to degrade by a factor of two without SL3.
    - Low $\mathcal{L}$ studies show:

      $\delta\cot\theta$= 0.12 with SL3/5/7

      $\delta\cot\theta$= 0.38 with SL5/7

    - Don't understand why it's x3 worse.
    - Need to know performance at high $\mathcal{L}$
    - Also possible that beam constraint would help.

From Alison's TDWG talk on 8-Jun



Reducing SL3 data volume (II)

- For all superlayers, Finder mask reports 96 bits per cell:
  - 90 pixel bits (15*6) + 6 bits for sparsification.
  - Pixel bits: 18 phi * 5 slope bits
    (18 phi bits denoted as 6 subcell * 3 L2 pixels per subcell)
- Idea: Keep SL3, but reduce granularity
  - Slope bits of limited use in SL3. A 2GeV track gives a segment that is only a few degrees away from radial.
  - Also possible that ϕ binning is finer than needed.
- Implementation options
  - cut number of subcells in half $\rightarrow$ 48 bits/cell
  - cut subcells in half & go to 2 slope bits $\rightarrow$ 21 bits/cell
  - cut subcells in half & drop slope bits altogether $\rightarrow$ 12 bits/cell
  - keep 6 subcells, but go to 2 slope bits $\rightarrow$ 42 bits/cell
  - keep 6 subcells, but drop slope bits $\rightarrow$ 24 bits/cell
- Mods:
  - Depends on the level of precision needed. If it's sufficient to simply OR down existing data, modifications are at the firmware level only. If we want smarter (e.g. 2 slope bits) also have to modify masks.

Region of Interest Tracking

- **Idea: instead of sending stereo pixels for all ϕ, only send pixels near high p_T tracks.**
- **Implementation:**
  - TrackList board has all L1 XFT tracks within ~2μs of L1A
  - TrackList generates output stream corresponding to ϕ regions of high p_T tracks
  - XFT pulsars only send data in those regions
- **Firmware mods:**
  - TrackList A Control FPGA to find regions
  - XFT Pulsar Control FPGA to selectively send regions.
  - Note: becomes more complicated very quickly if we want multiple thresholds (e.g. by trigger type)

Overflow Events

- Regardless of configuration, there will likely be an occasional event in the tail that will overflow the FILAR FIFO.
- Idea: Truncate XFT transfer to PC on events that will overflow the FILAR FIFO. L2 can auto confirm stereo tracks on truncated events.
- Implementation
  - Count data words coming from DATAIO→Control FPGA in XFT Pulsar. If count gets large enough, truncate Slink data transfer and set bit in Slink trailer saying the path was aborted.
  - Internal counter running at Roboclock rate, will have sum before data is sent to PC, so can safely abort before filling FIFO.
  - L2 code recognizes the truncation and auto confirms all tracks.
- Mods:
  - XFT Pulsar Control FPGA: counters plus state machine for abort.
  - L2 software to handle truncated events.

Abort XFT on non-tracking events

- We already do this for SVT.
- Idea: Don't send stereo data on events that don't require tracking triggers. (About ½ of our triggers at high lum are MET and JET)
- Implementation:
  - TrackList board gets L1 trigger bits, compare to a bitmask generated to know which L1 triggers need stereo tracking at L2.
  - Send a signal over to XFT pulsars to abort data transfer if needed.
- Status:
  - TrackList firmware and XFT Pulsar firmware are done. Fanout board for abort signal built. Bitmask generation code is done. TrackList firmware partially tested, XFT pulsar not yet tested.

Summary

- **Reduce SL3 data volume in the Finder**
  - Pro: reduces latency, minimizes large event problem
  - Con: possible loss of information (needs study)
  - Risk: new Finder firmware and mods to L2 tracking software.
  - Comment: needs study on multiple fronts
- **Region of interest tracking**
  - Pro: reduces latency, avoids saturating FIFO from multi-event pile up
  - Con: does not solve single large event problem
  - Risk: new TrackList & XFT Pulsar firmware, new L2 code for sparsification
  - Comment: could be implemented as 2nd phase of quick abort (similar functionality)
- **Auto-confirm L2 stereo tracks on events where FILAR FIFO will be overfilled.**
  - Pro: eliminates single large event problem
  - Con: minimal effect on latency
  - Risk: new XFT Pulsar firmware plus L2 code to recognize truncation
  - Comment: handling overflow arising from multiple events more involved
- **Abort XFT data transfer on unneeded events**
  - Pro: reduces latency, avoids saturating FIFO from multi-event pile up
  - Con: does not solve single large event problem
  - Risk: minimal. Implementation ready to test.
  - Comment: not incompatible with 2 PC solution