KLM TRIGGER STATUS AND PLAN

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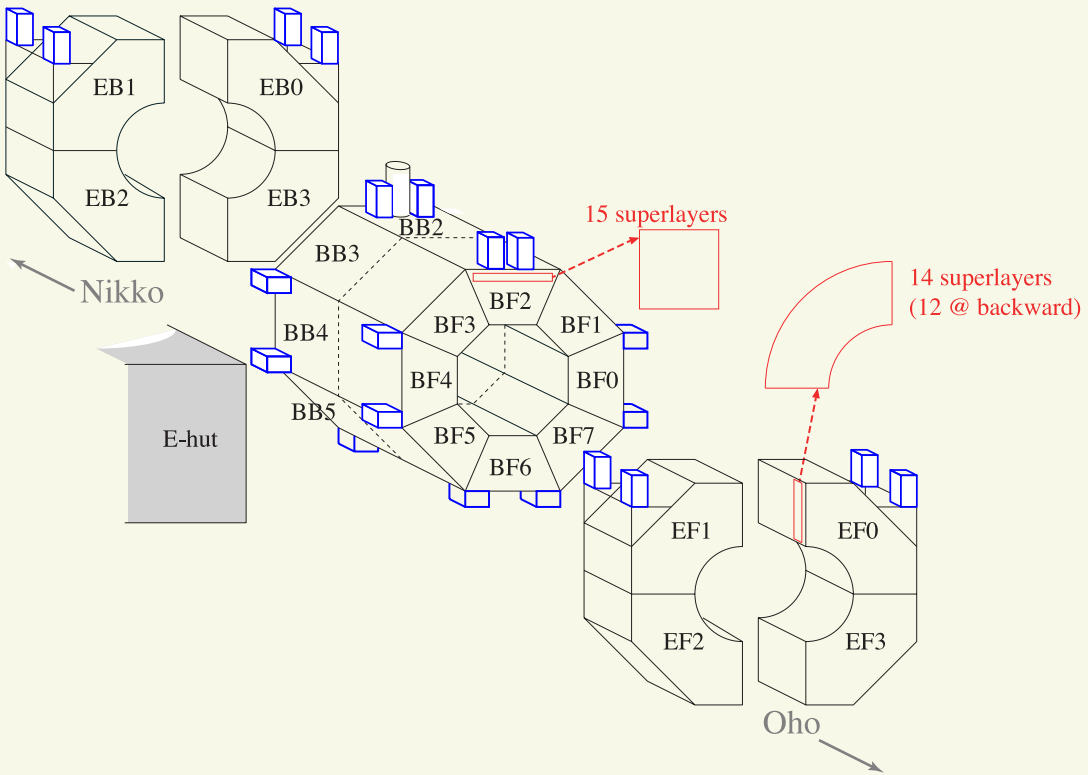
- ✓ KLM structure overview
- ✓ KLM trigger design
- ✓ Trigger status and plan

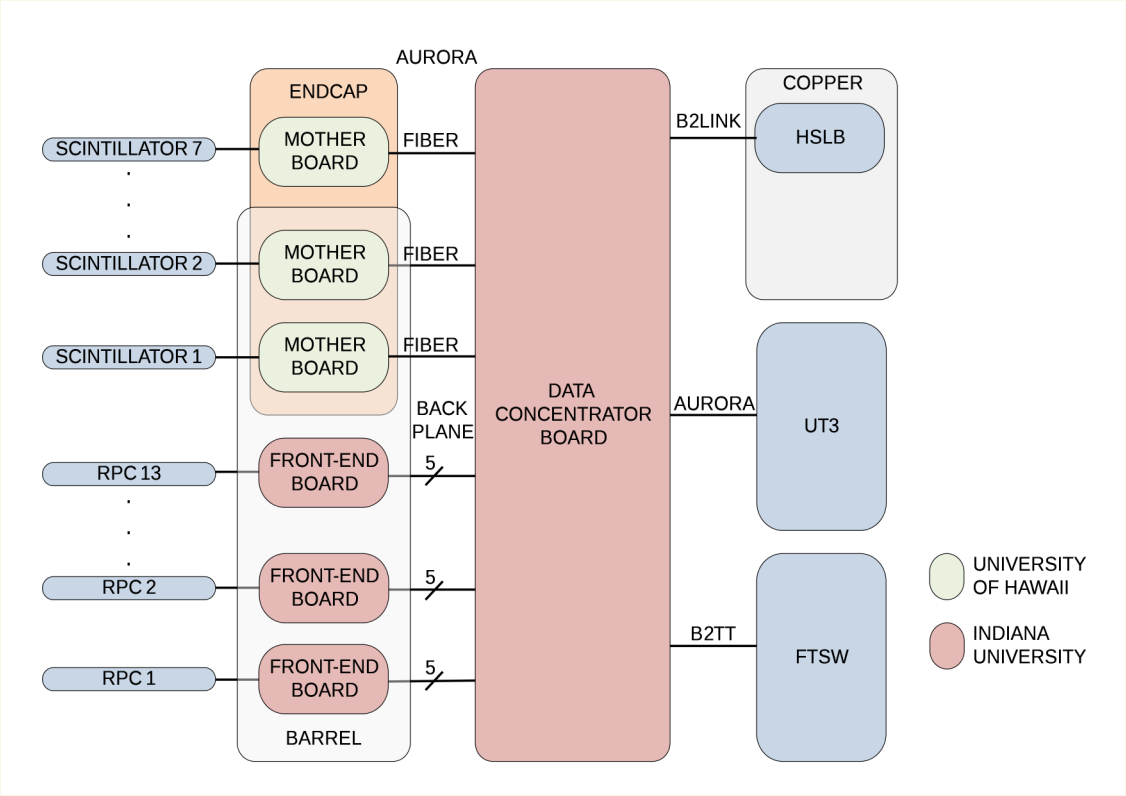
KLM structure

- KLM is divided into a barrel and endcaps;
- The barrel is divided into forward and backward halves,
  - eight sectors (octants) in each half,
  - 15 layers in each sector;
- Endcaps are divided into four sectors (quadrants) each,
  - 14 layers in the forward endcap;
  - 12 layers in the backward endcap;
- Two inner barrel layers and entire endcaps are instrumented with scintillator strips;
- 13 outer barrel layers are instrumented with RPCs.



Readout electronics

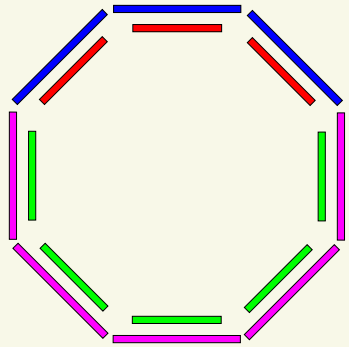
- Each module is connected to a FE board;
- In the barrel all FE boards of the same sector are connected to one data concentrator, 16 DCs in total.
- In the endcaps all FE boards of the same sector are connected to two DCs, 16 DCs in total.
- Data concentrators talk to FTSWs, UT3s, COPPERs.



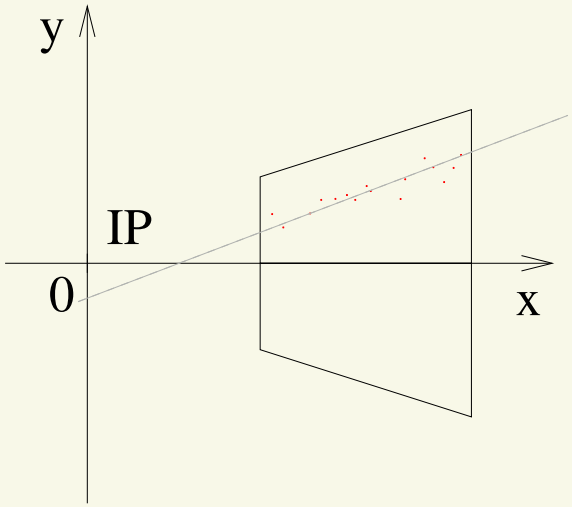
Installation status

- Barrel
  - All scintillator FEE was installed;
  - RPC FEE installation is almost finished, some minor fixes are left;
  - Readout from all sectors was started.
- Endcaps
  - Most of FEE was installed; need to fix several FEE boards before installation and change some cables;
  - One crate is connected to readout.
- All sectors, both barrel and endcaps, were connected to the KLM UT3.

Bunch of FW versions



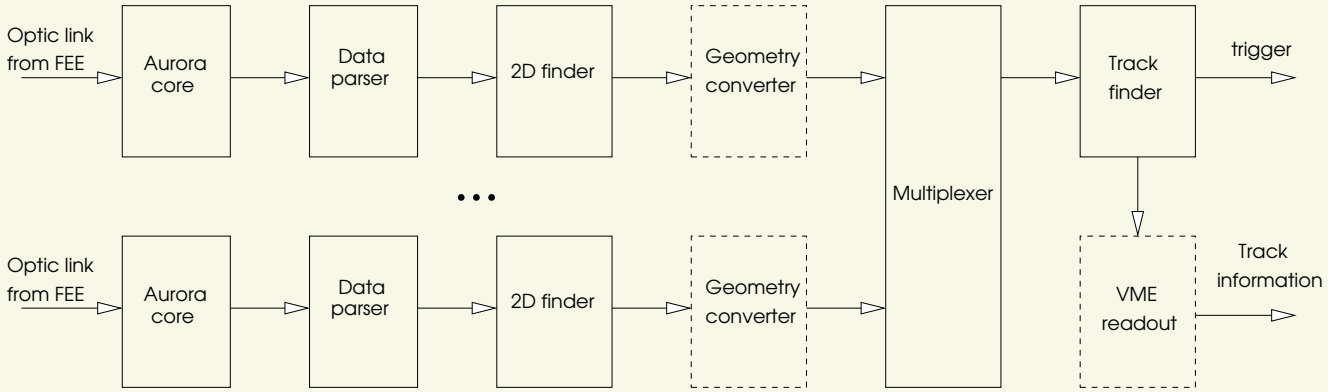
- Raw trigger data stream recorder;
- Scintillators only for CRT
  - Scintillator modules are combined into four groups, arbitrary shown with different colors on the picture;
  - Trigger is generated when there are simultaneous signals in all four groups.
- Coincidence track finder
  - Sectors are processed independently in parallel;
  - Coincidence between several layers generate a trigger;
  - Individual sectors trigger outputs are ORed.
- χ^2 track finder for the physics run
  - Same as above but assume that track is a straight line and calculate impact parameter and χ^2 of the track.



All versions were verified with ISim simulation, software simulation and with randomly generated data.

General FW structure

- General structure of all versions of FW is similar.
- 127 MHz clock is used.
- FEE sends information about 1D hits;
- FW reconstructs 2D hits as coincidences in ∼50 ns (6 clock cycles) window;
- 2D hits are matched in ∼50 ns (6 clock cycles) window to form a track.
- Outputs of individual sectors are multiplexed before or after track finder, depending on the version.



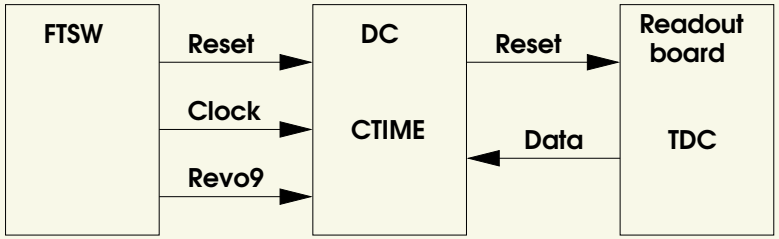
Timing issues: scintillators

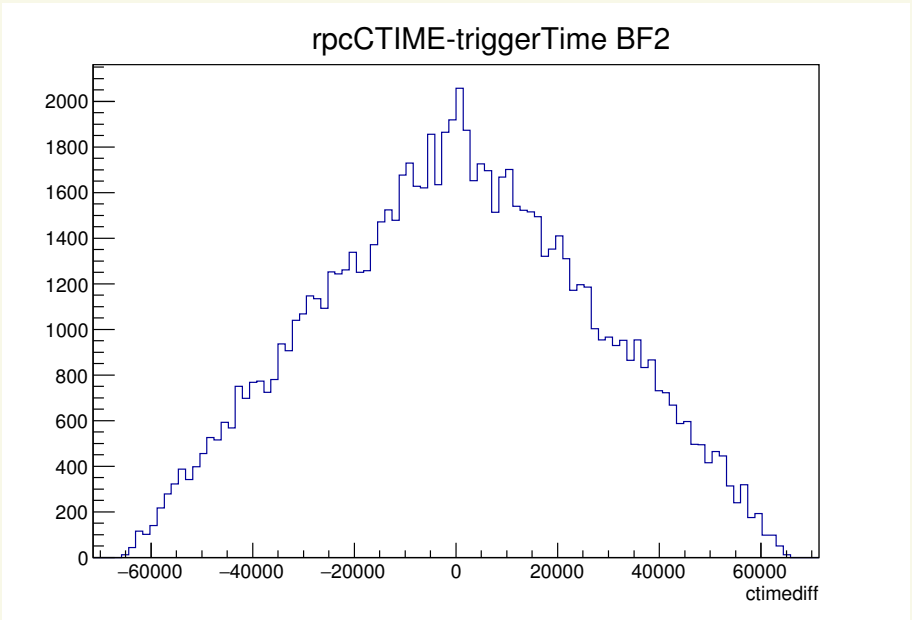
- ! However, no triggers were generated with real data.
- Scintillator hit rate is rather slow. We can use UT3 to record several minutes of raw trigger stream and look at it by eye. We expect to see bunches of hits with close timings ($\leq$ 6). Typical fragment of data stream is below.

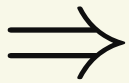
sector	layer	axis	δCTIME	δT
4	1	0	55933	580221
12	1	0	1	2
12	1	1	9	9
11	2	0	46929	440146
11	2	0	9	9
11	2	0	9	9
15	1	1	28141	28141
15	1	1	9	9
7	2	1	3	3
12	1	1	65215	130753
1	1	1	27327	223935
1	2	0	31060	96596
1	1	1	13	13
2	1	1	0	1
8	2	0	12795	668155
13	1	0	14328	45399
13	2	1	13	13
1	2	0	60288	584578
1	2	1	17	17
1	1	0	9	9

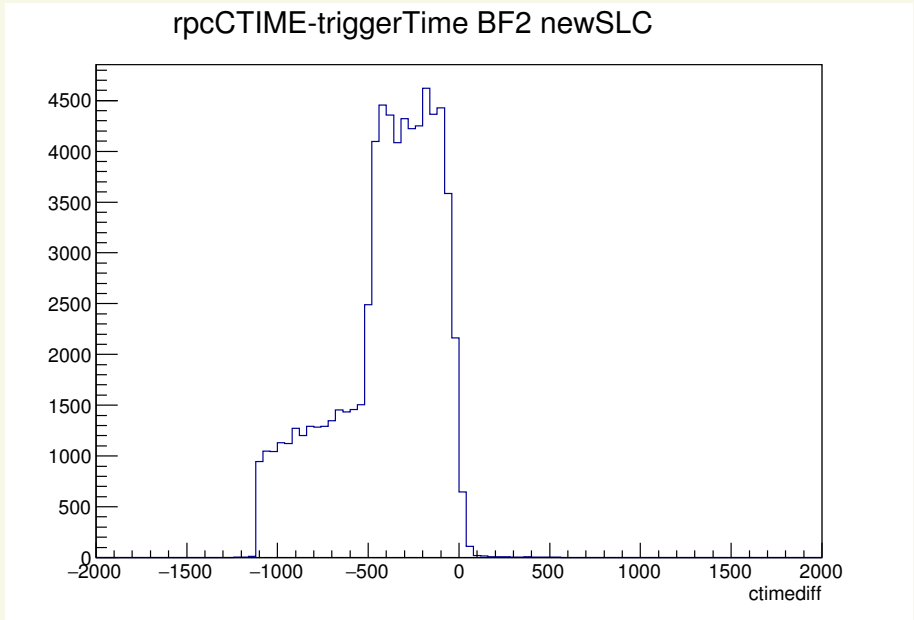
Timing issues: RPC

- ! RPC hit rate is much higher and UT3 overfills fast.
- TDC counter (254 MHz clock, 9 bit) is set by readout board
- CTIME counter (127 MHz, 16 bit) is set by Data concentrator.
- Time of hit arrival to DC varies, but less than TDC span.
- We need both TDC and CTIME for a hit time stamp.
- Until recently CTIME distribution in event was very broad.









KLM trigger status and plan

- ✓ All barrel hardware and most of endcap hardware installed.
- ✓ All sectors are connected to UT3.
- ✓ Data flow from all barrel sectors confirmed.
- ✓ Several functional versions of KLM trigger FW written.
- ! No triggers are generated with real data.

- ➢ Collaborate with the FE FW developers (Isar, UH and Brandon, UI) to better understand issues with trigger data stream.
- ➢ Both FE FW developers are busy and DAQ is a priority, therefore we need to pinpoint the exact problem with incoming data.