Trigger Studies

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Outline of I&T Project

Data taking mode:

Only elements and data flow relevant for this project are shown here.

Tracker → TEM/GEM Hardware Trigger Box → 3-in-a-row information

MC → Software Trigger Box (*) → 3-in-a-row information

*TriggerAlg does this job but some information has to be made available/explicit for this project.
**Outline of I&T Project**  
(without Real Data)

MC mode:

*TriggerAlg does this job but some information has to be made available/explicit for this project.*
What is the 3-in-a-row information?

16 bit word per every tower.
What is the 3-in-a-row information?

There are two sources of 3-in-a-row information:

Contribution from the Digis:

➢ A modified version of TriggerAlg calculates the 3-in-a-row bitword for every tower.
➢ This information is put in TDS and made available through the Svac tuple.

Contribution from the TEM:

➢ I&T will provide a Traker Request variable (TkrReq) for every tower, layer, view and tray end.
➢ 3-in-a-row bitwords are formed from TkrReq.
Analysis of 2 towers Data

As expected the agreement is perfect for MC data. Any inconsistency will appear as an off-diagonal element. In case the disagreement is too small to be "seen" the analysis tool (root macro) reports such inconsistency.
Simulating Inconsistencies

Case 1: A given hit produces a trigger request, but its time over threshold is so low that by the time the readout takes place the hit has faded away. (missed hit) Digi Bitword < TEM Bitword

Case 2: A trigger request is issued. While waiting for the readout a noise hit takes place (Spurious hit). Digi Bitword > TEM Bitword

* The inconsistent events shown here were simulated with made up rates, actual rates should be different from this.
Studying Inconsistent Events

Let's take as an example Run=18 and Event_ID=95416, that was found to be inconsistent in the present simulation:

| Run=18 | Event_ID=95416 | Digi=61888 | Svac=65472 |

Bins 0,...,15 are the possible combinations of 3-in-a-row. There are two possible values for each bin:
- 0 = inactive combination
- 1 = active combination

Combinations 9, 10 and 11 are inactive according to the digis, but 8 and 12 are active, thinking in terms of layers this means that layer 11 has no hits. Svac reports a trigger request in every of those layers.

**Conclusion:** Most likely there was a hit in layer 11 that was gone when the readout took place.
Are all 3-in-a-row combinations equally efficient?

Assuming an homogeneous flux and identical layers, one expects every combination to trigger the same number of times:

* Entries are not individual events. An event that has a hit in every layer will contribute with an entry in every bin.
Are all 3-in-a-row combinations equally efficient?  
A nonphysical model... 
that might be physical with enough data

- Muon source at the top of the tower
- Isotropic
- Monoenergetic (10 Gev)
- 20K events

For such an ideal model the number of triggers can be calculated for each combination n:

\[
f(n) = A \left( 1 - \frac{(B - n)}{\sqrt{C^2 + (B - n)^2}} \right)
\]

B=Distance from the source to the bottom layer in units of tray thickness \(\approx 18\)
C=half width of tower divided by tray thickness \(\approx 5.2\)

Seems like all combinations are equally efficient...
The concept and the implementation of the project are clear. Thanks to Steve, Eduardo, Heather and Anders.

Root Macros for analysis are ready for real data. What about a common place to put this kind of tools?

Detailed statistics on how the instrument is triggering are intrinsically interesting. Several side studies can derive from this project (energy and direction dependence, trigger “extrapolation” between towers, etc).

Looking forward to start working with real data...