Triggering considerations for AFP

Mario Campanelli (UCL)

L1 Latency up to phase 2 is 2.5 us. It will increase by a factor ~5 from phase 2 (2023), but then luminosity will be huge.

It means that if no L1Accept signal arrives, the detector data are erased from ROB. This is a hard number, driven by the tacking occupancy.
It would be possible to invent alternative parallel trigger paths, but tracking information is simply too big to be stored, so tracking will not be there unless a L1Accept signal arrives within 2.5 us.

210m case: 0.7 us for proton to reach detector, 0.8 for signal to be back (fast cables) + 0.5us for L1Accept = 2.0us + any processing time at 210m station

420m case: 1.4 + 1.7 + 0.5 = 3.6 us plus processing time, way too late

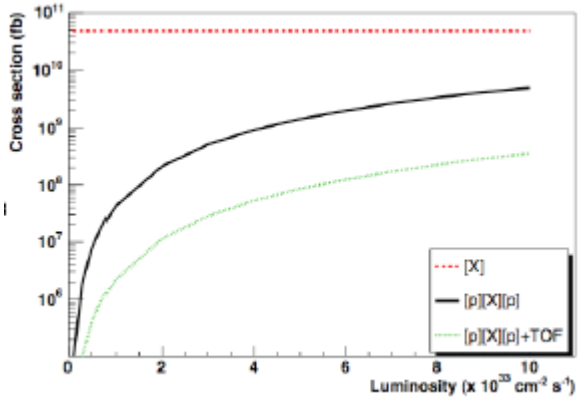
210m triggers

500 ns only available at L1. This is the typical time of a coincidence logic. Not clear if there will be time to feed an associative memory to use the information about the proton position in the 210 m stations to cut on invariant masses or azimuthal de-correlation.

There is probably no time for doing any coincidence with any central L1 system. No timing information available, since no tracking. Even FTK will only be available after a few us, so after L1Accetpt.

L1 rate was 75kHz, will increase to 100 kHz after shutdown.
All jet trigger uses about 20 kHz; realistically, a AFP trigger could use a few kHz of L1 output.
Is it realistic to trigger on this detector under heavy pileup conditions?

1E4 nb cross-section for pXp (no acceptance included)
Corresponds to 1E-29 cm2. Running at 1E34 means 100 kHz. It is ok once acceptance is included, but has to be studied.



420m triggers

A L1 trigger is not possible from the 420m stations, so L1Accept must come from the central detector, or from AFP220.
We did the exercise for H->bb, presented by Andy yesterday.

- Example L1 trigger strategy outlined in **ATL-DAQ-PUB-2009-006**:

L1 item	Rate at 2×10^{33} (kHz)	Rate at 10^{34} (kHz)
J20+J40 + p220 + X_A=0.5 + X_D=1.5 + $\Delta\phi > 2.5$	0.51	12.2
J20+J40 + p220 + X_A=0.5 + X_D=1.5 + $f_T > 0.45$	0.12	2.9

- **J20+J40** is a dijet trigger with jet thresholds of 20GeV and 40GeV
- **P220** is a proton tag at 220m
- $\mathbf{X_A}$ is a cut on the average rapidity of the two jets (assumes that a boosted dijet system exists if a Higgs candidate and one proton tagged at 220m)
- $\mathbf{X_D}$ is a cut on the rapidity separation of the two jets (Higgs decays uniformly in solid angle)
- $\mathbf{\Delta\phi}$ is the azimuthal angle between the jets
- $\mathbf{f_T}$ is the fraction of the transverse energy reconstructed in the dijet system (very affected by soft pile-up activity and needs to be re-studied using latest simulations)

No way to trigger without AFP220 signal (rate explodes). Heavily relies on the new L1Calo topological module. These rates can be studied with 2012 data. Not sure anything can be further gained from an explicit invariant mass cut.

The fast-clear idea

In the previous case, rates are already borderline without pileup, and pileup would increase them by a factor of 4, making them unacceptable.
Also, no trigger on the 420m station, where more than half of the acceptance lies.
Margins are narrow, and depend on exact rates and processing time.

After 2015, L2 and EF will run on a single HLT node, allowing more flexibility.
It is conceivable that special chains could be granted L1Accept even if their rate would normally be too large, provided the bulk of the events there could be rejected very quickly (< 10us).
This would allow waiting for the arrival of the 420m signal, and kill most of the (420+420) events where the coincidence is not present.
For the 220 + 420 case, this extra latency could be enough to get the FTK vertex information plus AFP220 timing.

This is not possible under the current trigger system, so additional study is needed, and some change in the navigation.

An independent trigger system?

Assuming we do not need tracking, we could set up a trigger system independent on Atlas.
Yes, it sounds crazy, but it could make sense in the search for invisible objects.

We could store in a fast buffer the L1 information (L1Calo and L1Muon), as well as the FTK signal once it arrives.

Wait for the arrival of the 420m signal, and timing information; again, most of the events stored in this buffer will be removed by the lack of forward detector confirmation.

For the accepted events, only L1 and FTK information will be available for the analysis.

Would we be brave enough to write a paper about an excess of events with large missing mass from AFP and very little L1Calo activity?

Using leptons?

Under current conditions, leptons much easier, and could be used to trigger without AFP confirmation.
This will change after 2015, and more careful studies will be needed.
Inclusive leptons will be more heavily prescaled with respect to this year, and dileptons will be needed to have unprescaled low-pt triggers.