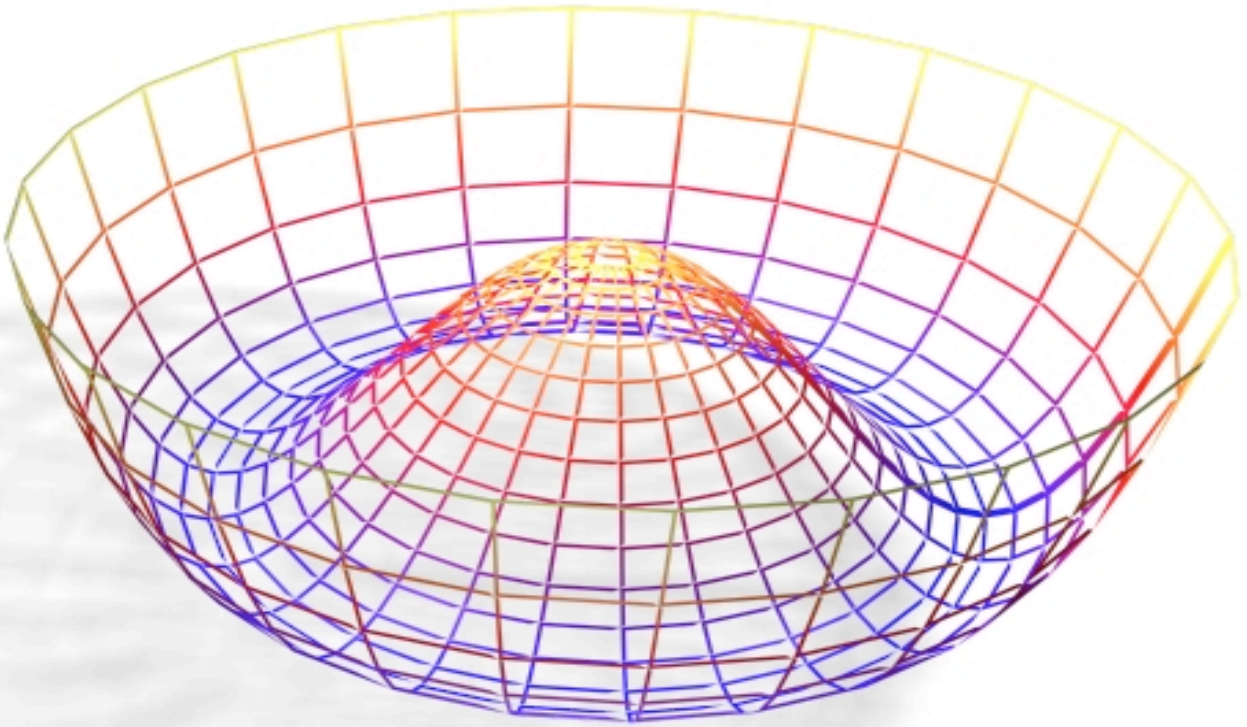
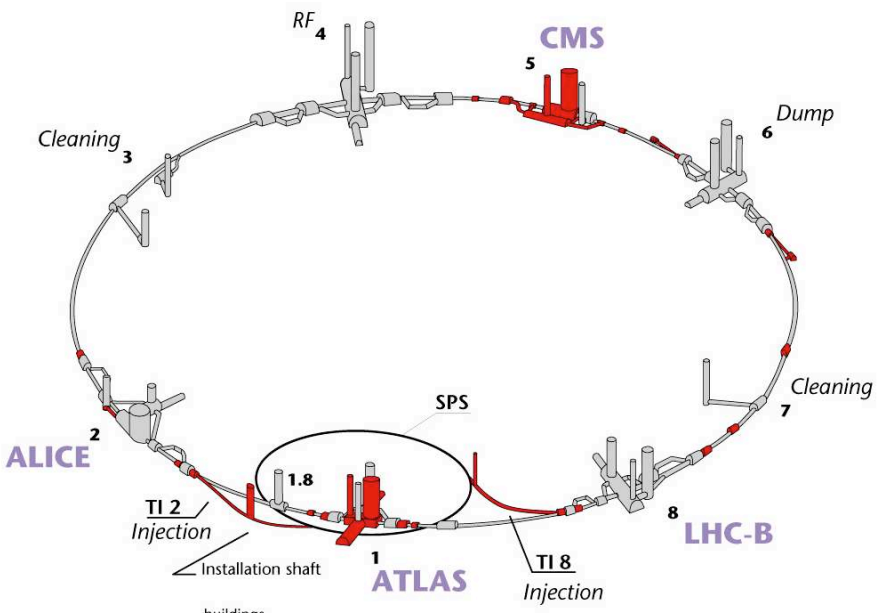
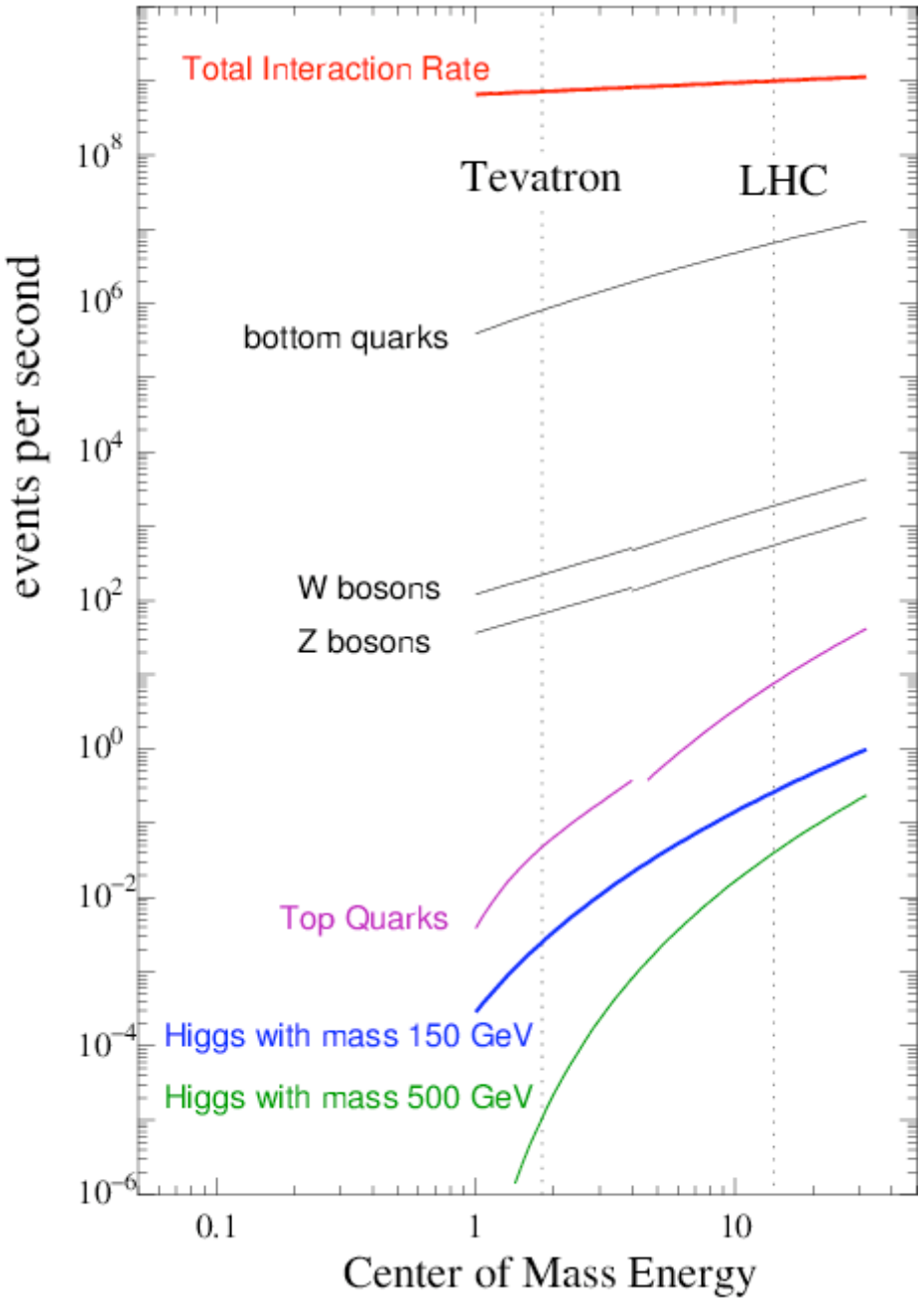
A little bit about the ATLAS Trigger



Kyle Cranmer (NYU)

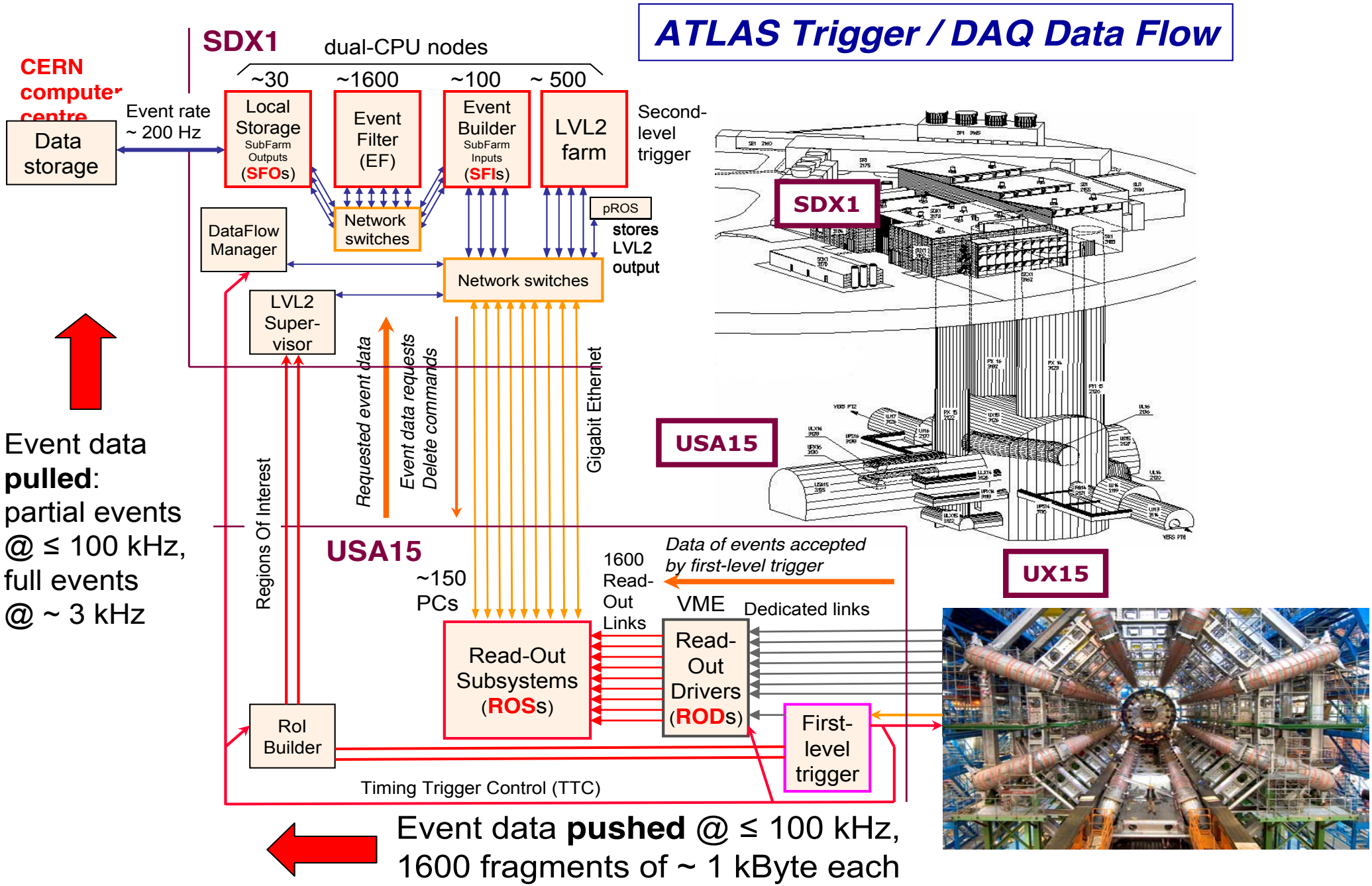
The LHC





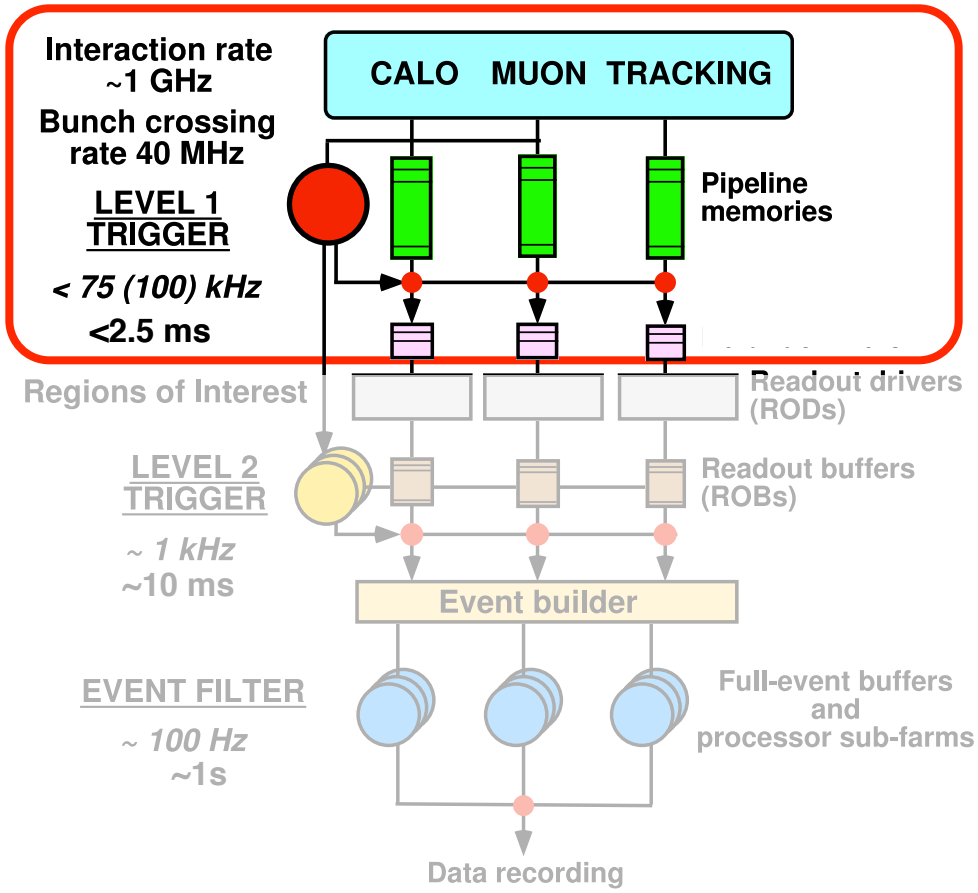
- 26 km in circumference
- p-p @ $\sqrt{s} = 14$ TeV
- Instantaneous Luminosity $\approx 10^{33} - 10^{34}$ cm^{-2}s^{-1}
- "pile-up" : 2-20 inelastic collisions per bunch crossing
- 40 MHz bunch crossings

The ATLAS Trigger



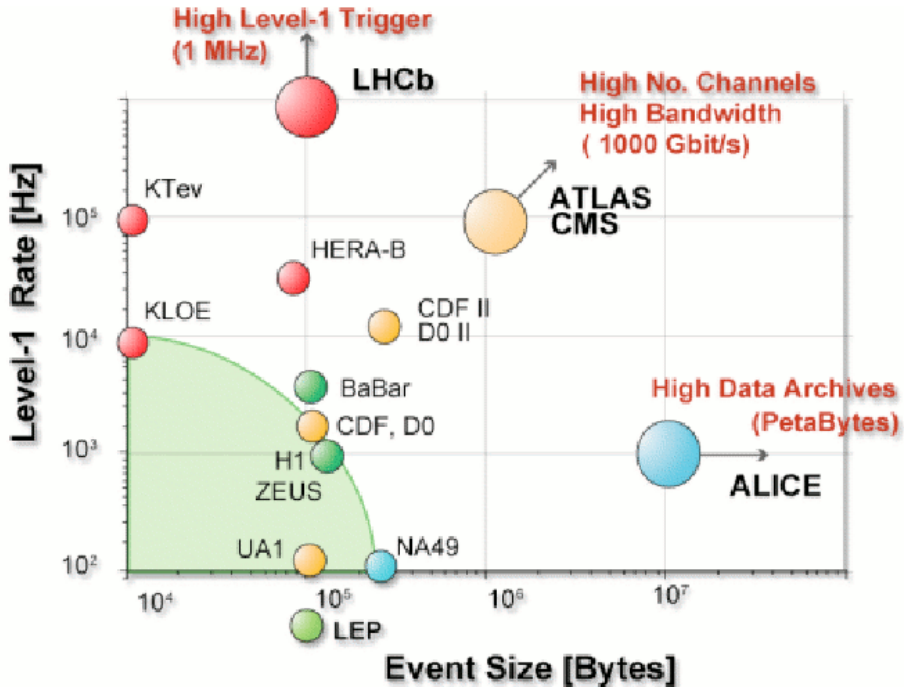
Triggering

The ATLAS Trigger is based on a 3 level design



Level1 is a firmware trigger

- only Calo & Muon
- makes decision in <2.5 ms,
- output rate of 100kHz
- seeds “Regions of Interest”



Triggering

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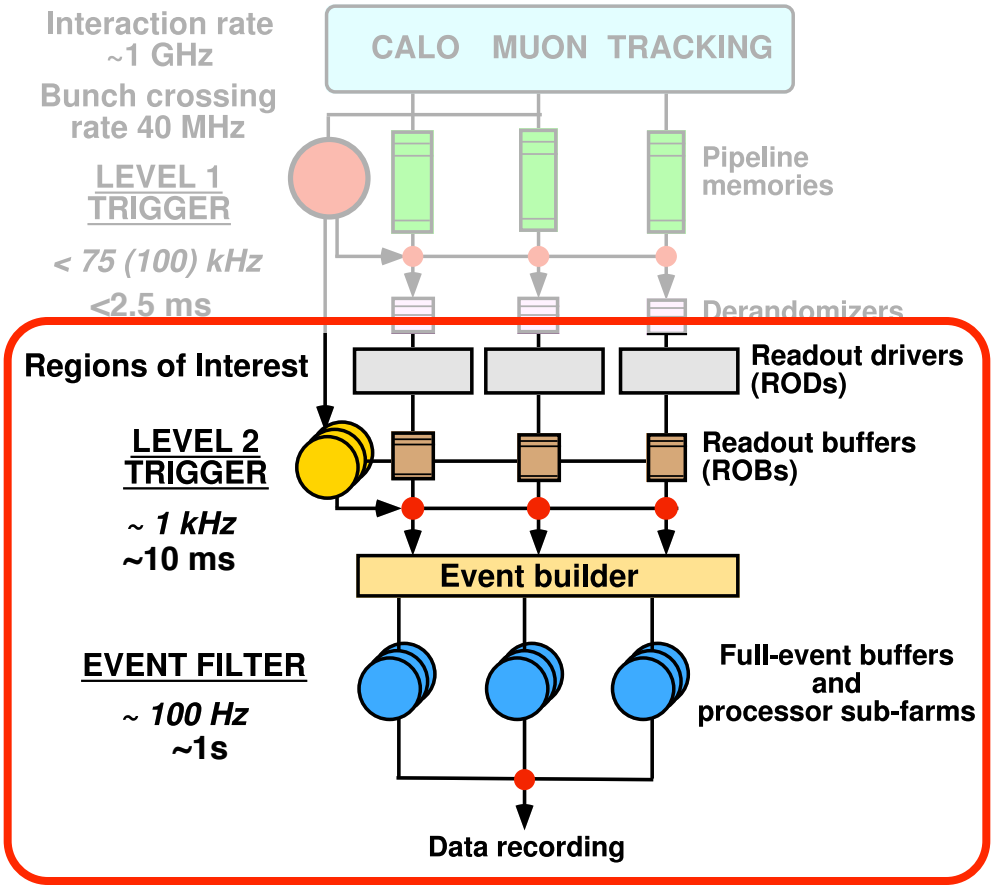
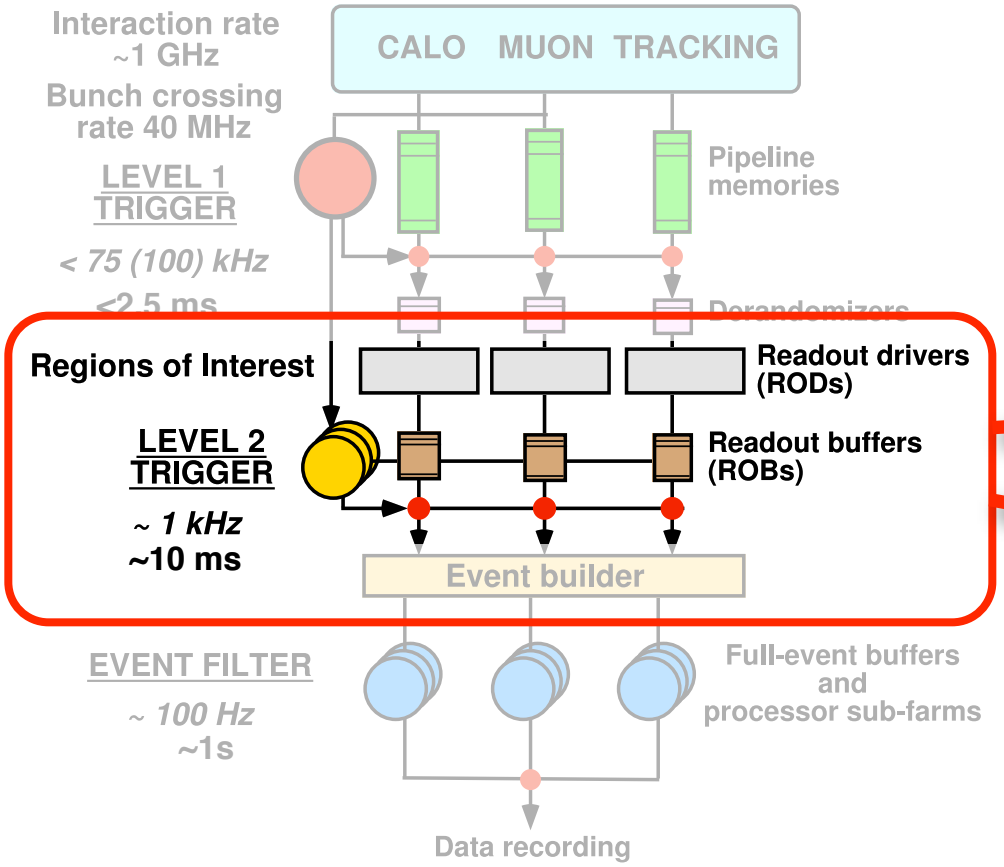


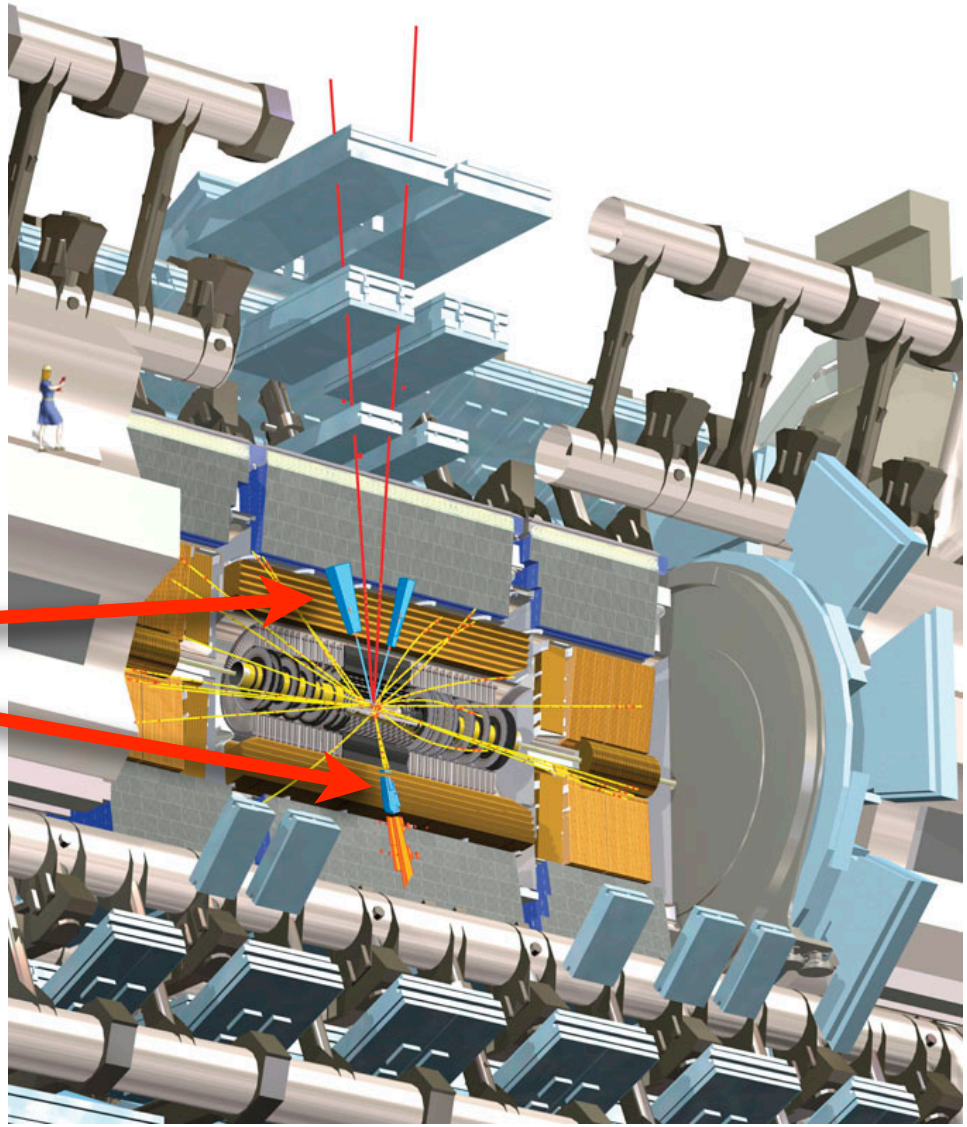
Level2 and Level3 use the same software infrastructure as offline

- Together they form the High-Level Trigger

Triggering

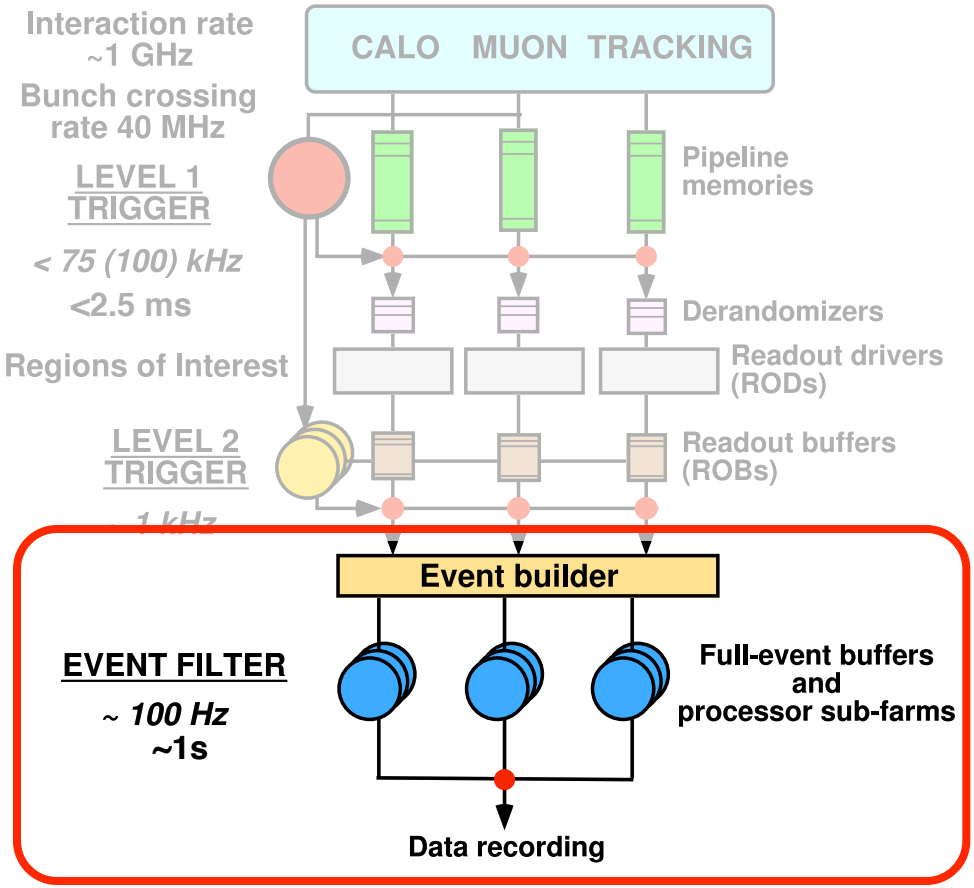
The Level2 Trigger algorithms are restricted to a “Region of Interest”





Triggering

The ATLAS Trigger is based on a 3 level design



Level3 (the EventFilter)

- can access to the entire event
- about 1 second for decision
- output rate of 200 Hz

Studies of trigger menu at higher luminosities where pile-up is important are lagging.

Some Terms

Pile-Up:

- More than one p-p collision in the event (in time pile-up)
- effects from surrounding bunch-crossings
- induces non-linear effects in trigger rate
- At 10^{34} cm^{-2} s^{-1} expect ~25 collisions per bunch-crossing

Threshold:

- cut on quantity at a given level. Eg: Jet pT > 200 GeV

Trigger Rate:

- rate that we select events, usually dominated by QCD or junk

Pre-scale:

- keep only a fraction of events that satisfy a threshold
  - a way to add low thresholds without overwhelming rate
  - useful for understanding performance of higher thresholds
  - Not a good way to select new physics

Rough Scale for Un-Prescaled Thresholds

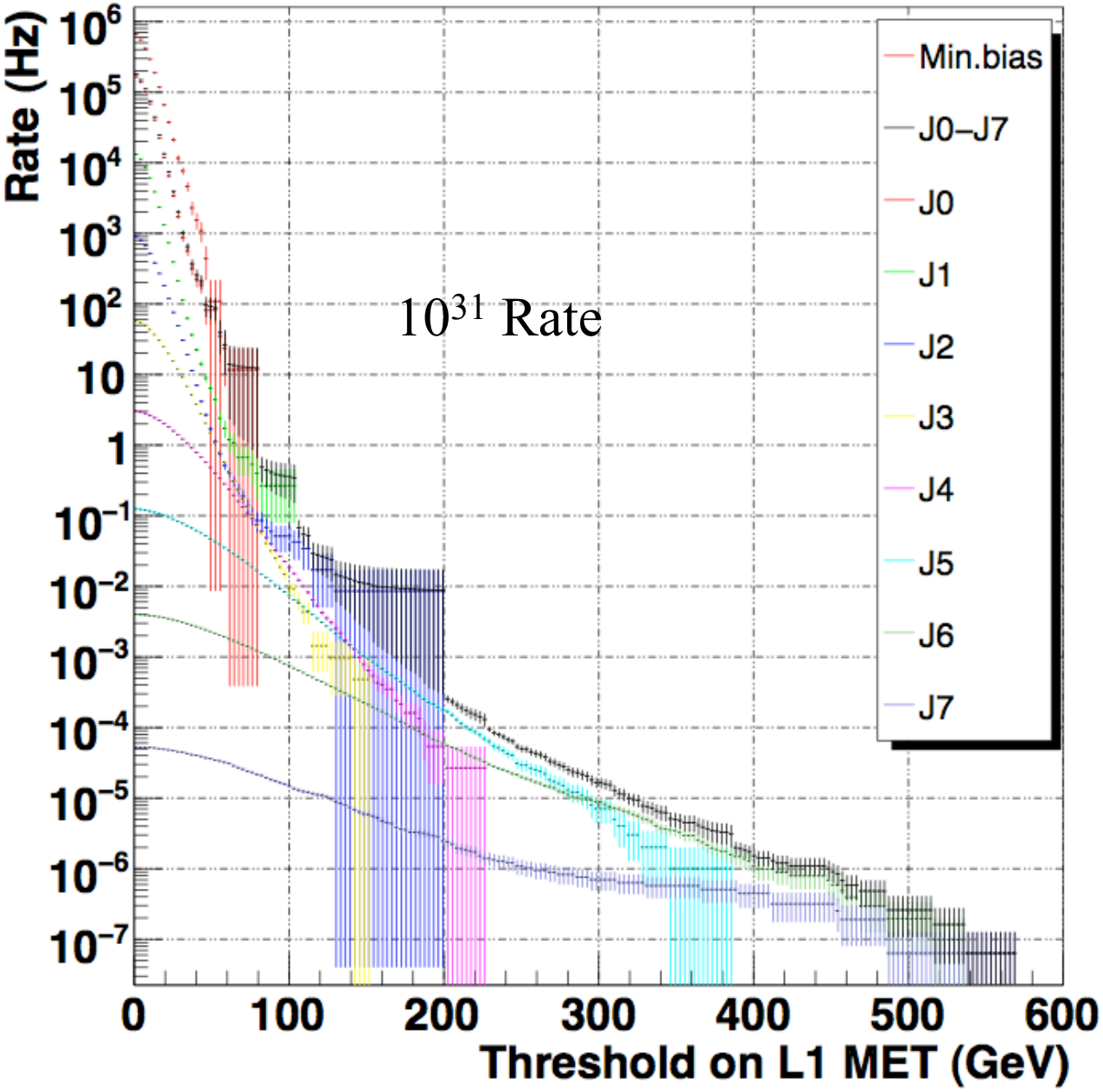
Rates & Menu for high luminosity (10^{34}) are very preliminary

These are just rough scales for the thresholds

Isolated Electron	25 GeV
2 Isolated Electrons (Photons)	15 GeV (20 GeV)
Non-Isolated Electron or Photon	60 GeV
1 Muon	20 GeV (6 GeV at L1 w/ prescale)
2 Muons	6 GeV
1 Electron + 1 Muon	~10 GeV + 6 GeV
1 Tau	~60 GeV
1 Jet	~400 GeV
2 Jets	~300 GeV (also forward jet triggers from L1)
3 Jets	~100 GeV
4 Jets	~60 GeV
b-tagged Jets	slightly lower thresholds than jets
MissingET	~100 GeV
Jet + MissingET	70 GeV + 70 GeV
SumEt & Sum Jet Et	500 GeV - 1 TeV
tau + MissingET	25 GeV + 40 GeV
Many other combinations	
B-physics (J/Psi etc.)	low pT muons + vertexing

10^{31} Rate for L1 MET

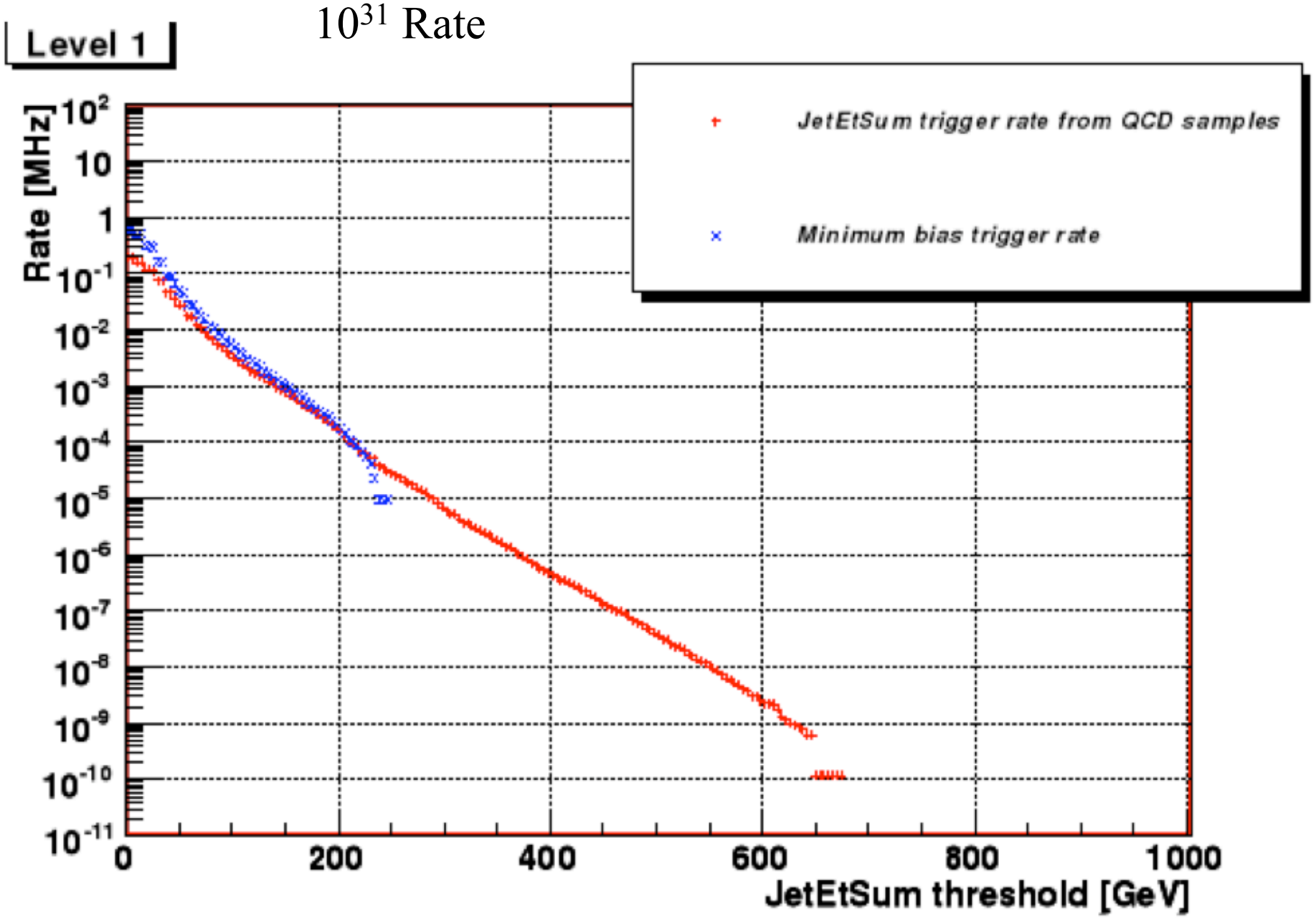
Rate is integral of the distribution from threshold to infinity



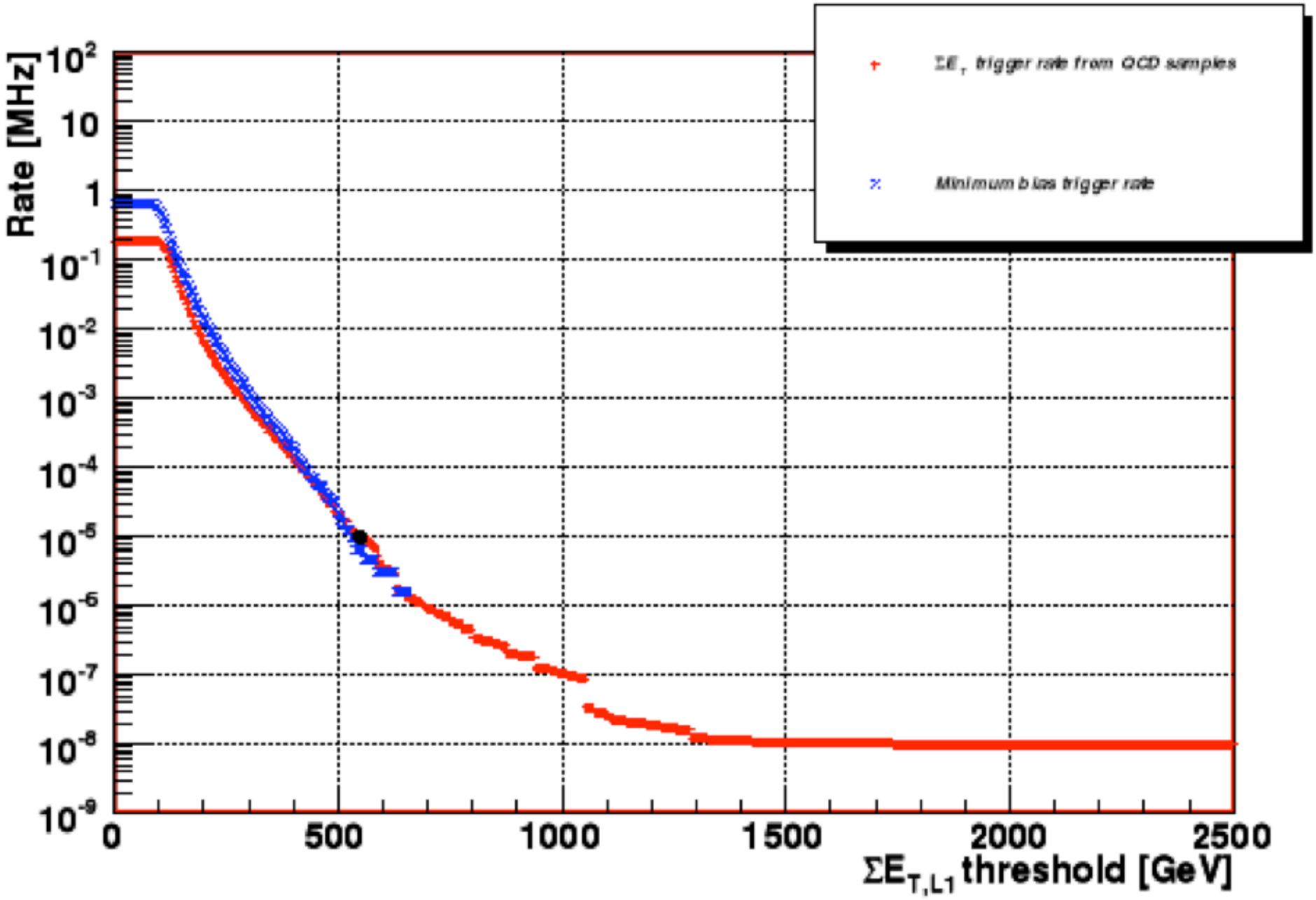
Rate goes up at least 3 orders of magnitude for 10^{34}

In practice, non-linear effects tend to make rates even higher

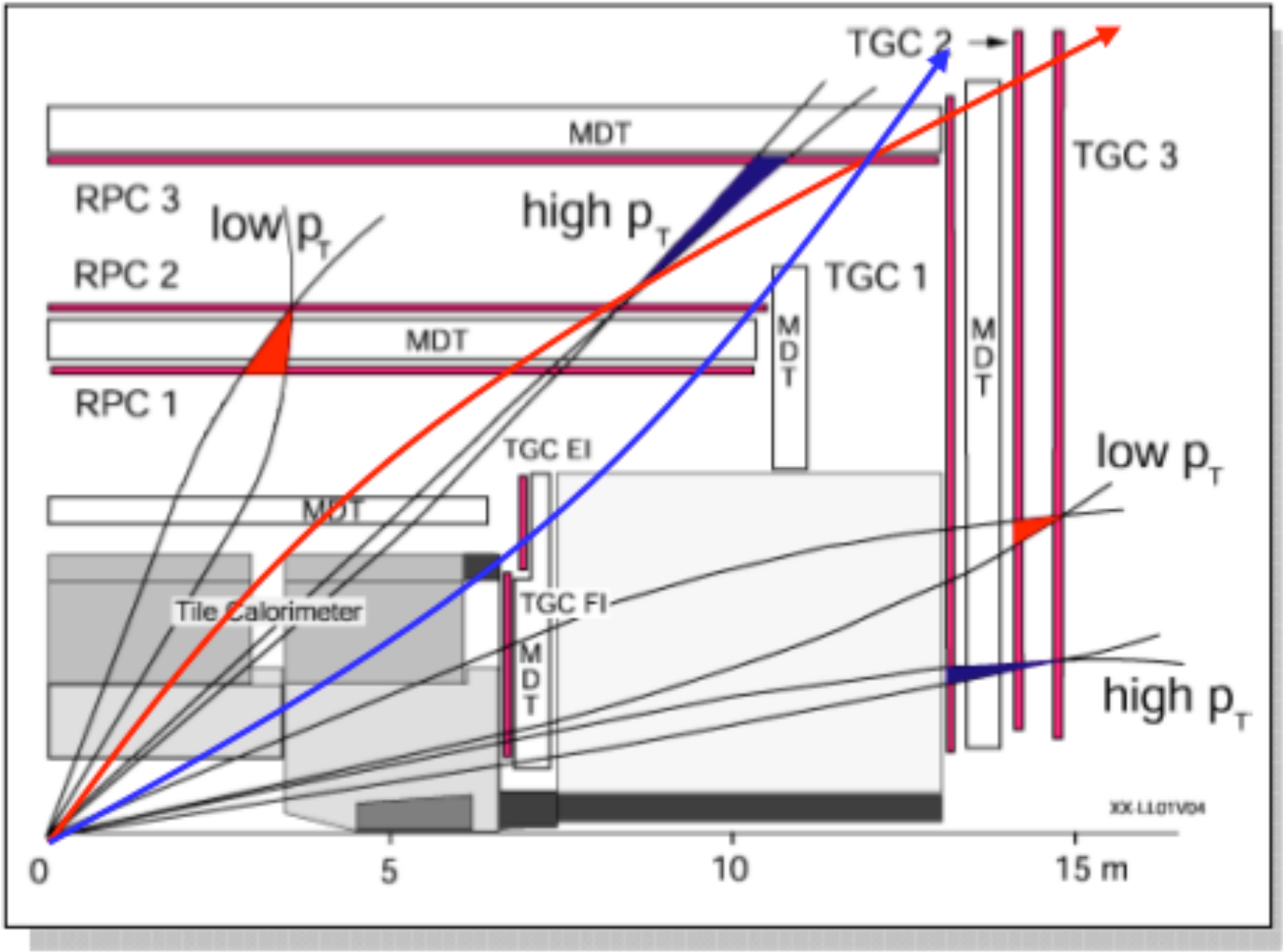
10^{31} Rate for Jet Et Sum



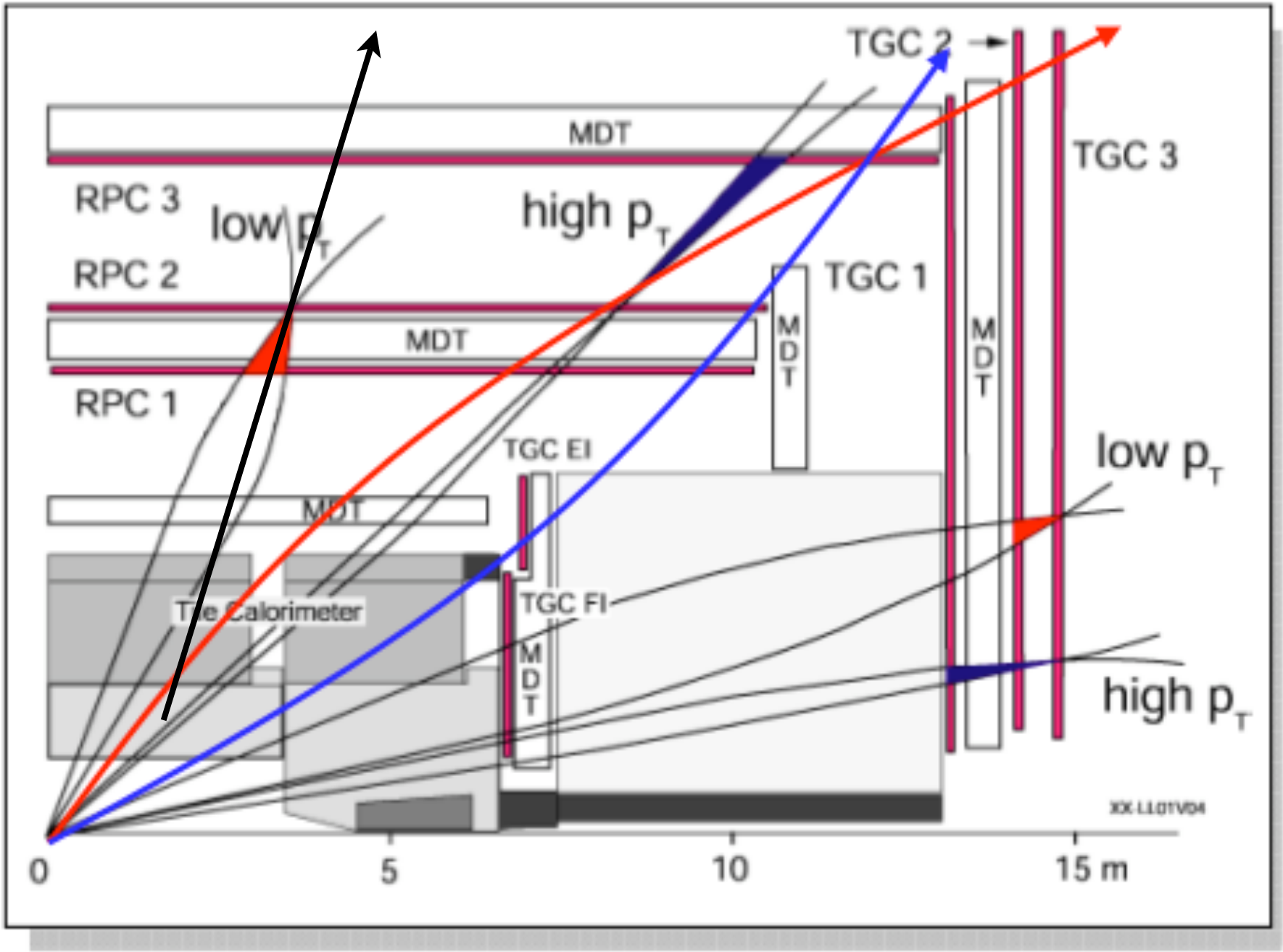
10^{31} Rate for L1 SumET



L1 Muon


TGC 2
MDT
TGC 3
RPC 3
low p_T
high p_T
RPC 2
TGC 1
MDT
MDT
MDT
RPC 1
TGC EI
low p_T
MDT
Tile Calorimeter
TGC FI
MDT
high p_T
0
5
10
15 m

L1 Muon


TGC 2
MDT
TGC 3
RPC 3
low p_T
high p_T
RPC 2
TGC 1
MDT
MDT
MDT
RPC 1
TGC EI
low p_T
MDT
Tile Calorimeter
TGC FI
MDT
high p_T
0
5
10
15 m

Slides Stolen From Min-Bias Studies

Where is the Momentum Limit ?

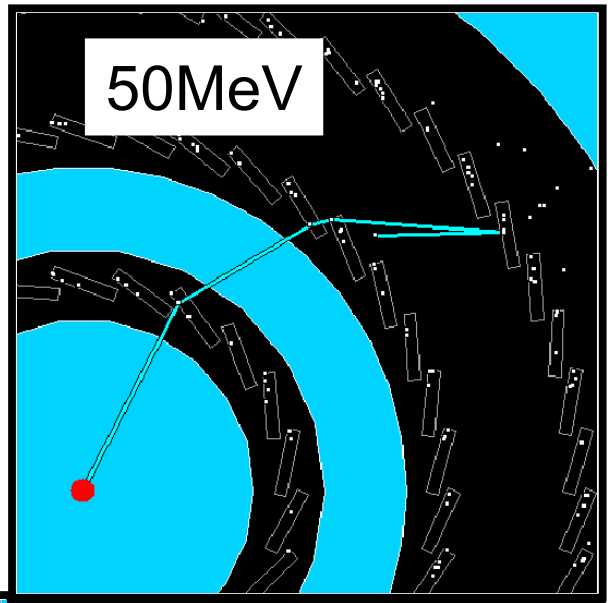
- Tracker is in principle sensitive to soft tracks
  - Pt = 400 MeV - tracks reach end of TRT
  - Pt = 150 MeV - tracks reach last SCT layer
  - Pt = 50 MeV - tracks reach all Pixel layers

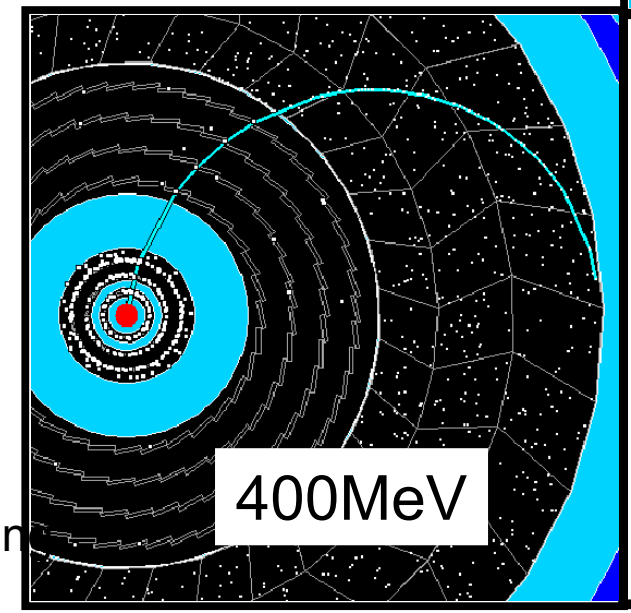
  → Do not need to run with low field

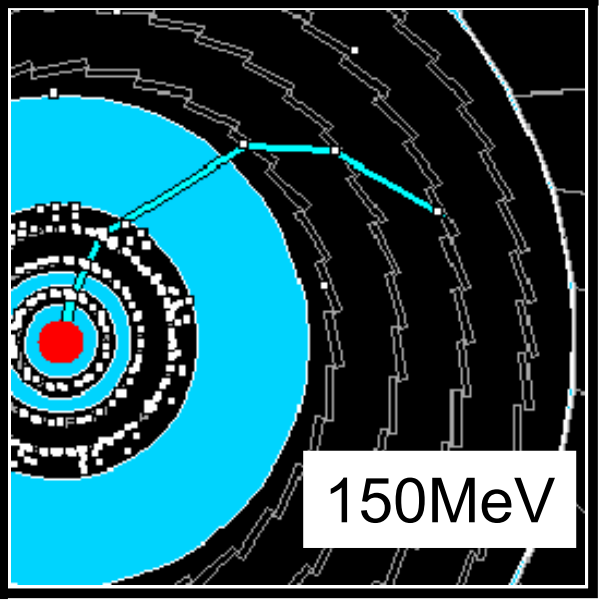
- Event graphics using Fatras simulation
  - Tools are there to tune for such tracks

A.Salzburger

M.Elsing Talk in SM meetin



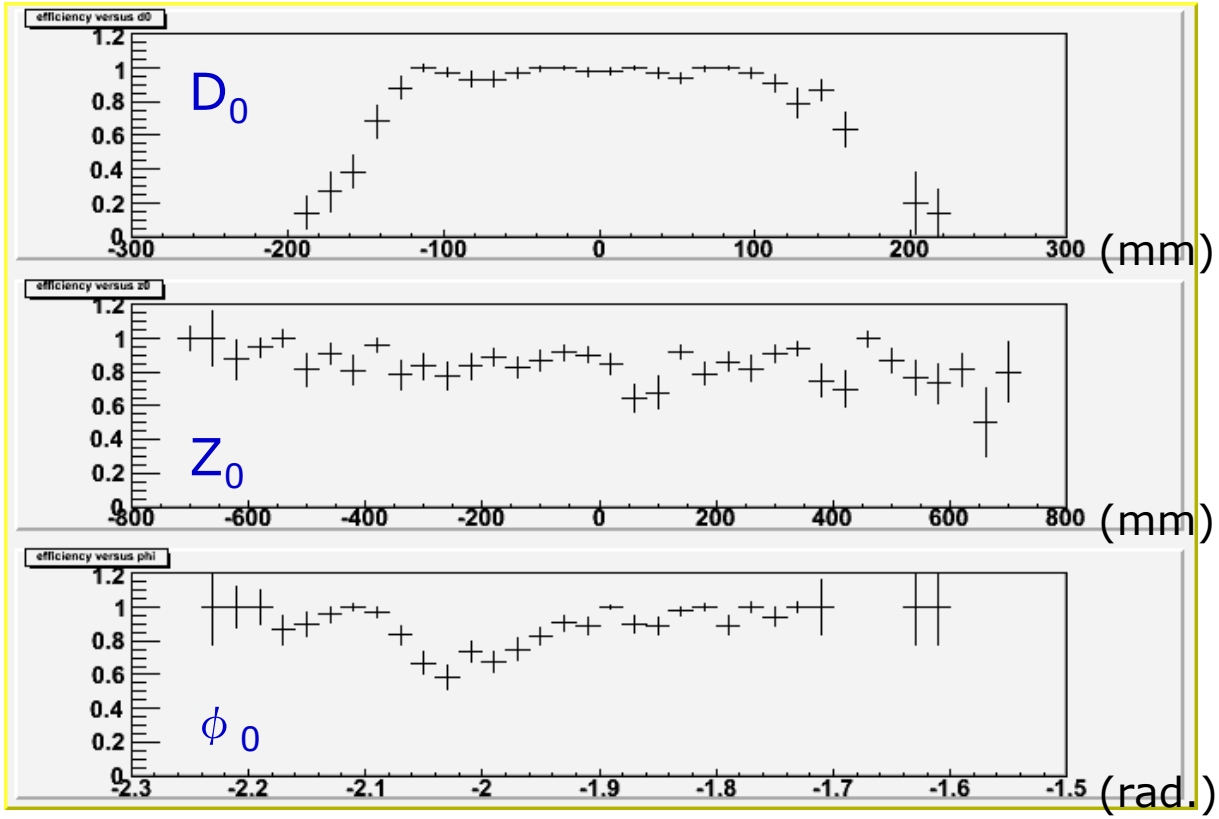


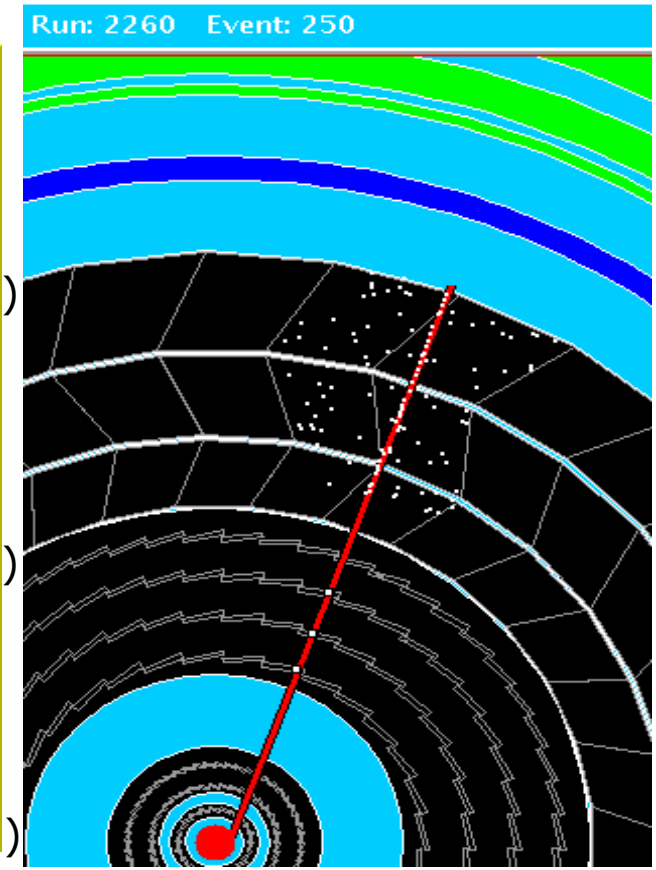


LvL2 Inner-Detector Algorithm

Just to show that tracking can work for non-pointing sources like cosmics

- Uses the LVL2 tracking algorithm IDScan
  - Shifting the space points in x so it looks like the cosmic comes from the IP
  - TRT extrapolation is also working
  - Currently trying to get to work for SiTrack algorithm too
- This has been run on simulated data and real cosmic ray events from SR1





J. Boyd

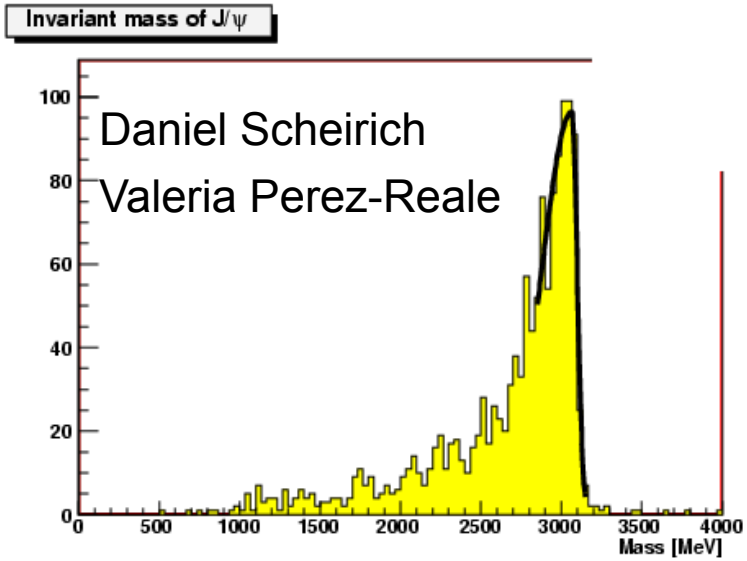
J/Psi studies in the HLT

- Method 1:
  $\Delta\eta$ x $\Delta\varphi$ = **0.4 x 0.4**,
  CSC data (no pileup)
  - Kinematical cuts
    - pT(e^+) >1 GeV
    - pT(e^-) >1 GeV
    - $|\eta|$ < 2.47
    - crack region excluded

Trigger step	Efficiency J/ψ→e+e-	Efficiency BB→μX	Mean time
L1	80.9%	33.1%	
L2 Calo	70.1%	20.0%	2.6 ms
L2 ID-Calo	63.9%	14.8%	16.4 ms
Inv. mass	42.6%	4%	

Just an example of tracking and vertexing in the HLT.

This is an old plot, just to give a feeling



Things people look consider

L1 Efficiencies for very low-pT muons: