
Simulating the ALICE DAQ/trigger/HLT
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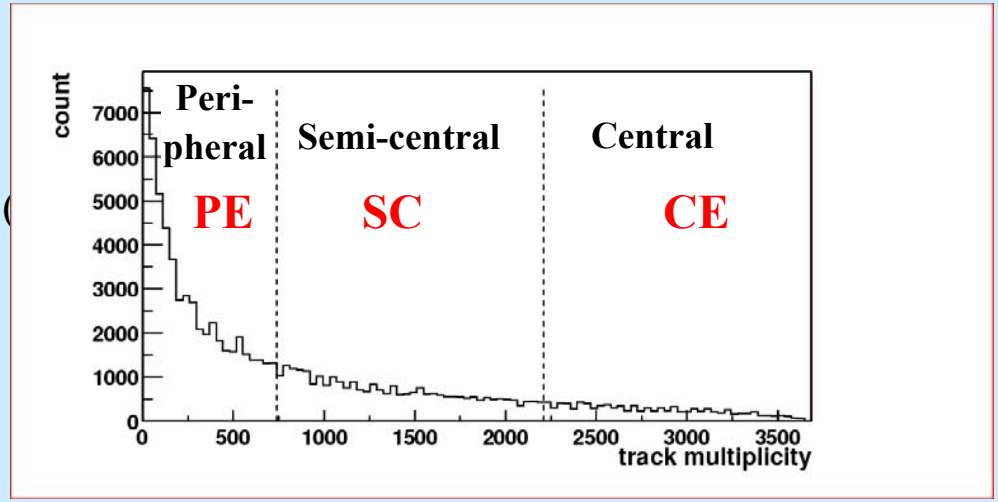
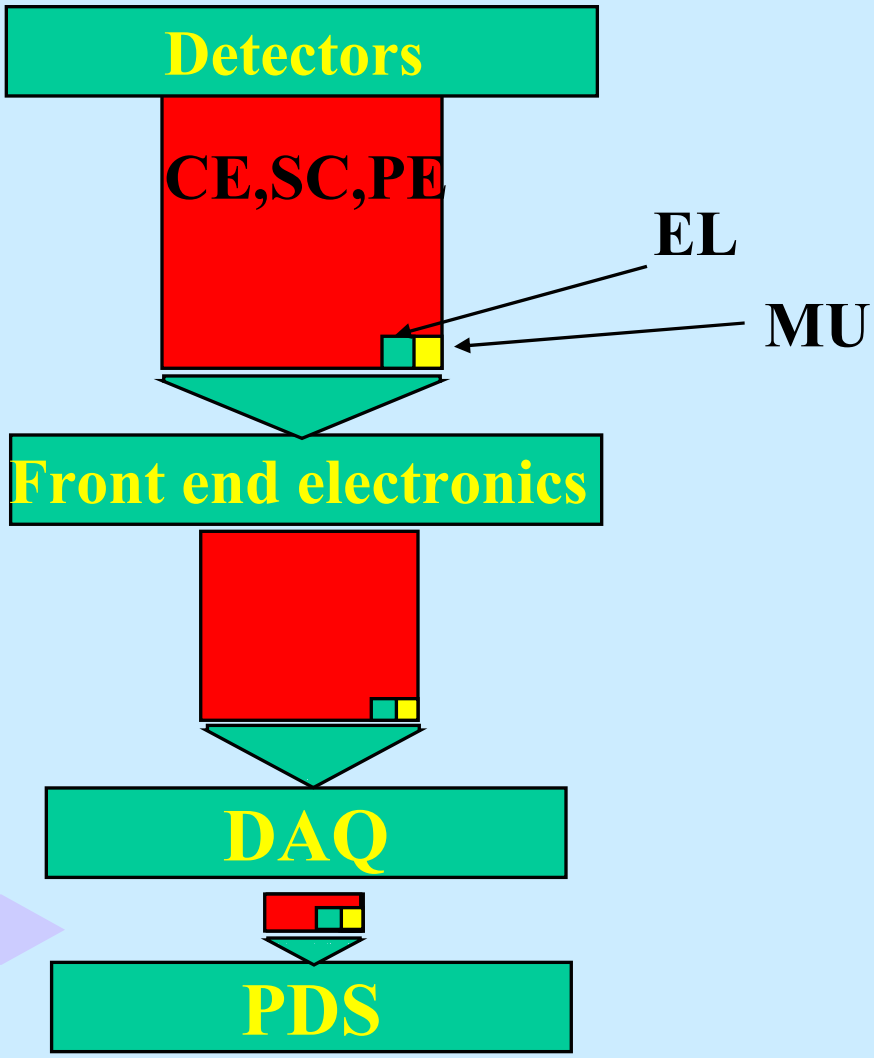
LHC DAYS IN SPLIT 2004

A problem has to happen…





~25 GByte/sec

~1.25 GB/sec

Want to accept all rare decays

- Of course ALICE will loose most of interesting (Electron –EL , and Muon -MU) events.
- But, need to be able to quantify this before start to successfully design DAQ/Trigger/HLT to recover the EL and MU events

ALICE DAQ/Trg/HLT simulation
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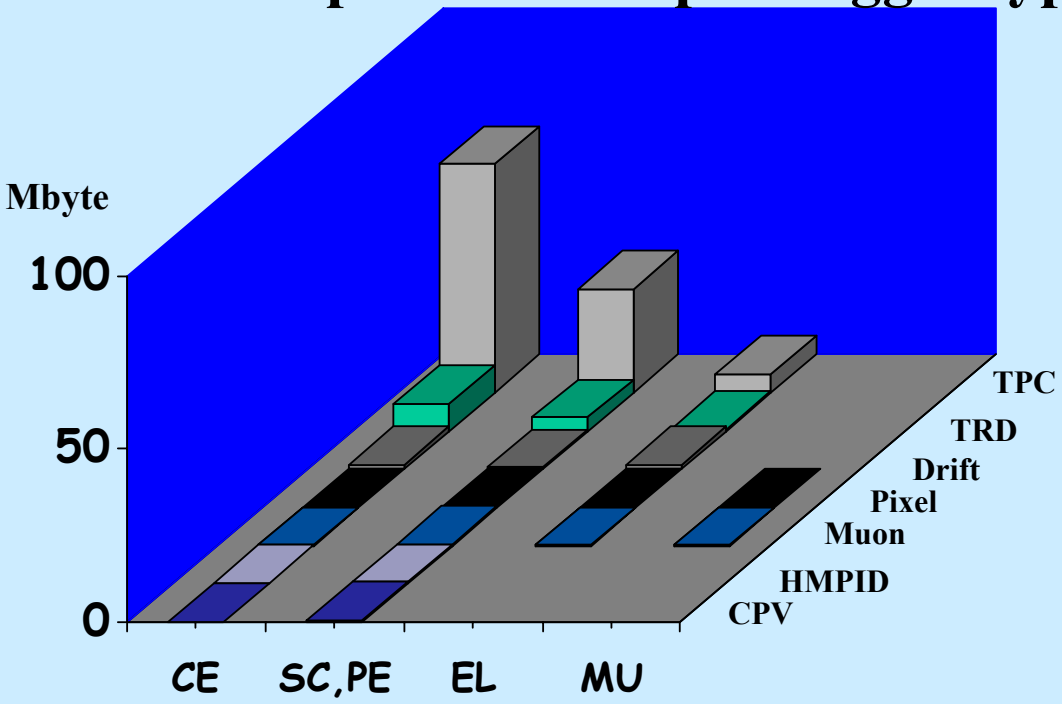
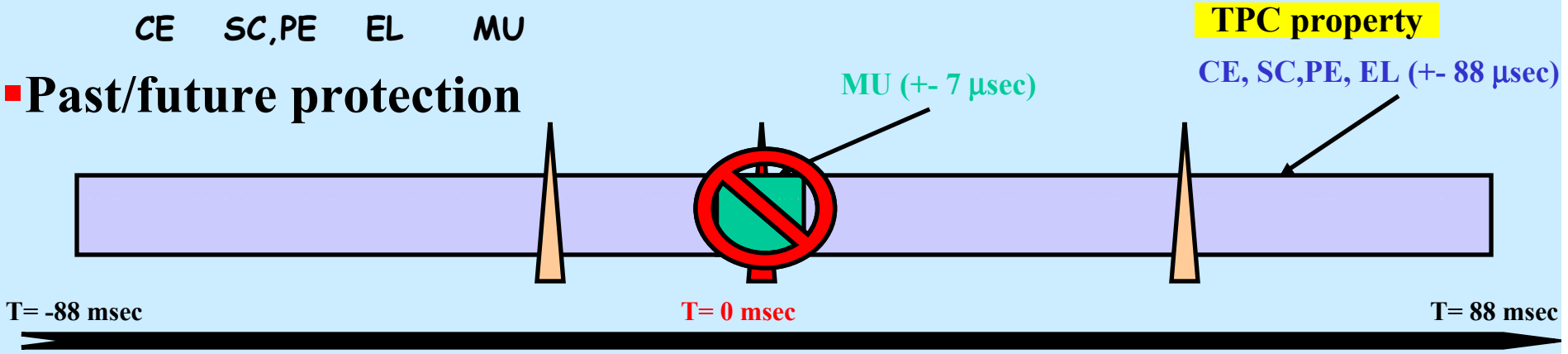
What are we dealing with in ALICE?

- **Event sizes per detector per trigger type**



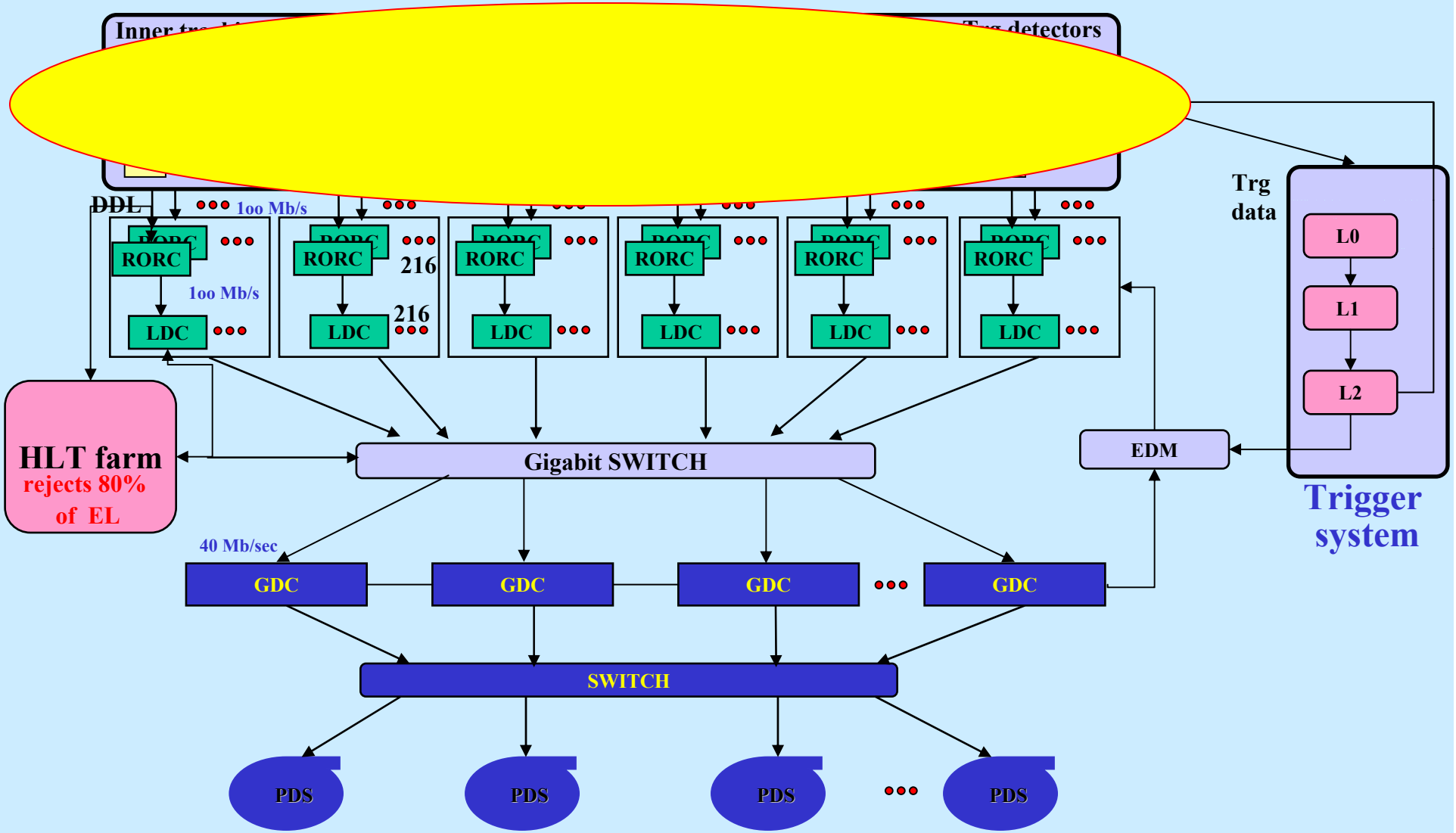
- **Different triggers involve different detector sets**

- **Past/future protection**



fraction accepted = $e^{-2*P/F\_time*InteractionRate}$ **~25% for 8000 Hz**

ALICE DAQ/Trigger/HLT (What is simulated)



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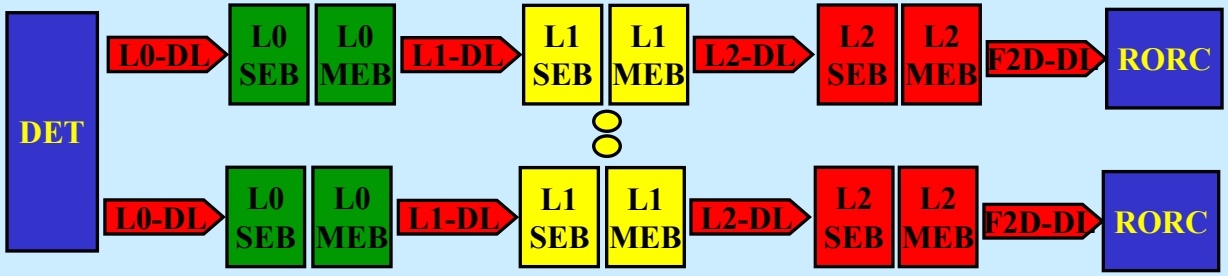
ALICE detector readout electronics model



- SEB- single event buffer
- MEB-multi event buffer
- DL-transmission delay

	read out time	L0			L1					L2				
		MEB			SEB		MEB			SEB		MEB		
		In	Out	sz	In	Out	In	Out	sz	In	Out	In	Out	sz
Pixel	0.01						.01	.1	4	.01	256	.01	E/D	10
Drift	4.0	0	172	1									1600	4
Strips	0.01	0	153.6	1			.01	154	2					
TPC	88						2.5	E/D	8					
TRD	3.55	.01	33.5				0	$2*10^4*E$	300					
TOF	0.01	.1	3	16			0	60	16					
PHOS	2.0						.01	.1	4					
HMPID	0.01	0	4.8	1			0.01	8.2	4001					
MUON	0.01	0	0	1	0	32	0	.1	1	0		0	.1	8
CPV	1.5						.01	.1	4					
PMD	2.0						.01	.1	4					

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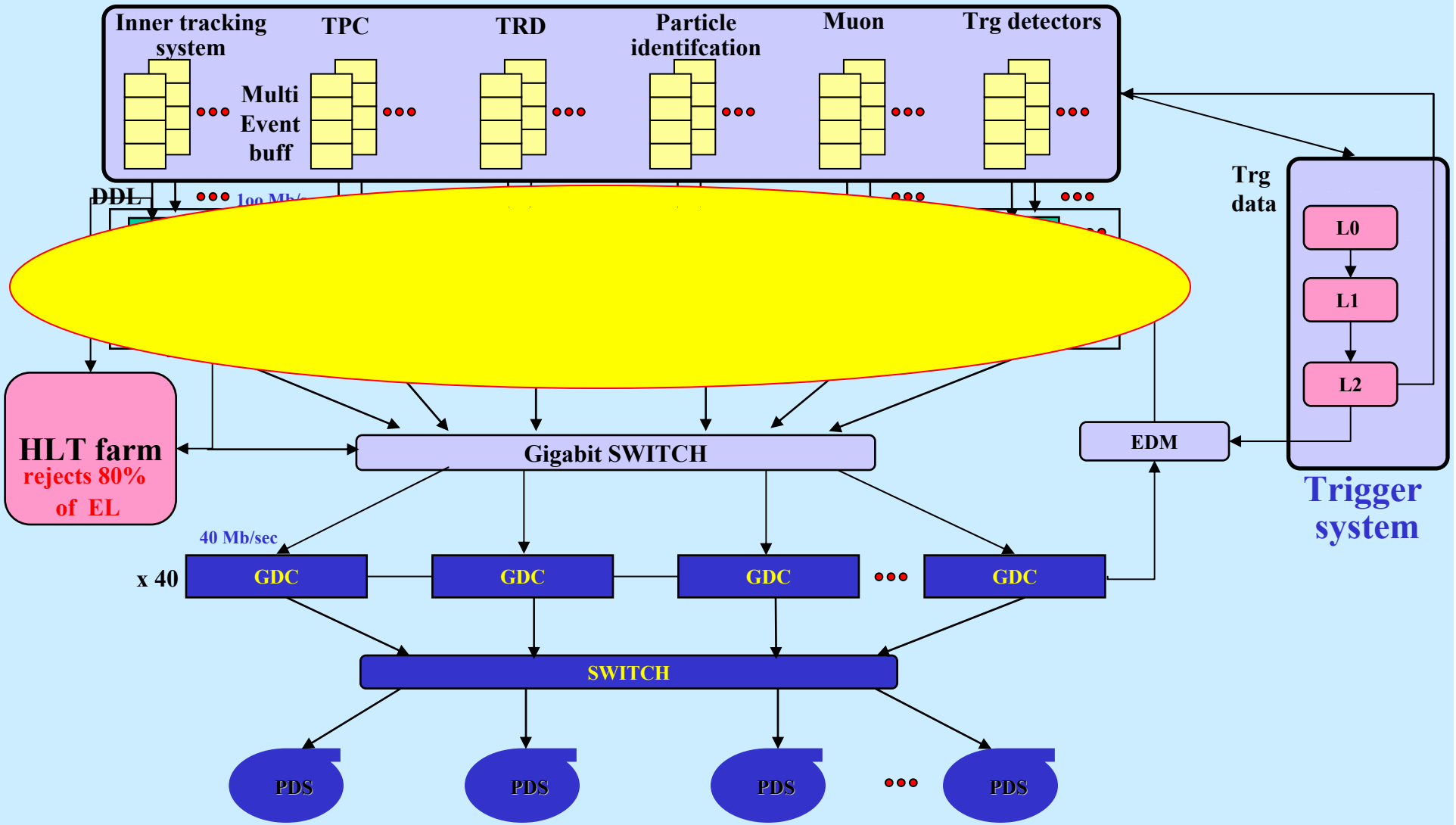
ALICE DAQ/Trigger/HLT (What is simulated)



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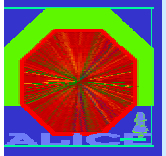
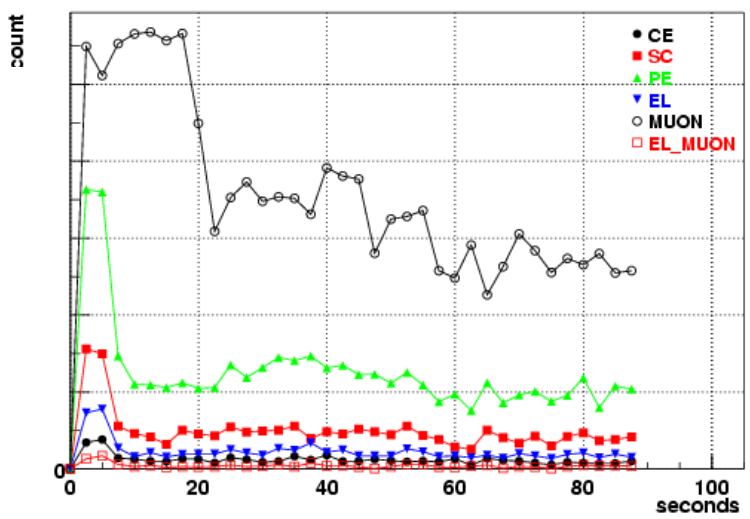
Detector parameters/Pb-Pb event sizes

Detector	DDL	RORC	LDC	high	low	High MU	Low MU	High EL	Low EL
Pixel	10	10	10	0.24	0	0.14	0.14	0.24	0.14
Drift	72	36	9	1.50	0			1.50	1.50
Strips	8	4	4	0.22	0			0.22	0.22
TPC	216	216	216	75.90	0			6.33	4.5
TRD	18	18	18	8.00	0			0.27	0.27
TOF	20	10	3	0.18	0				
PHOS	4	4	1	0.02	0	0.02	0.02	0.02	0.02
HMPID	20	10	3	0.12	0				
MUON	28	14	5	0.15	0	0.15	0.15	0.15	0.15
CPV	20	10	3	0.12	0				
PMD	6	3	3	0.12	0	0.12	0.12	0.12	0.03



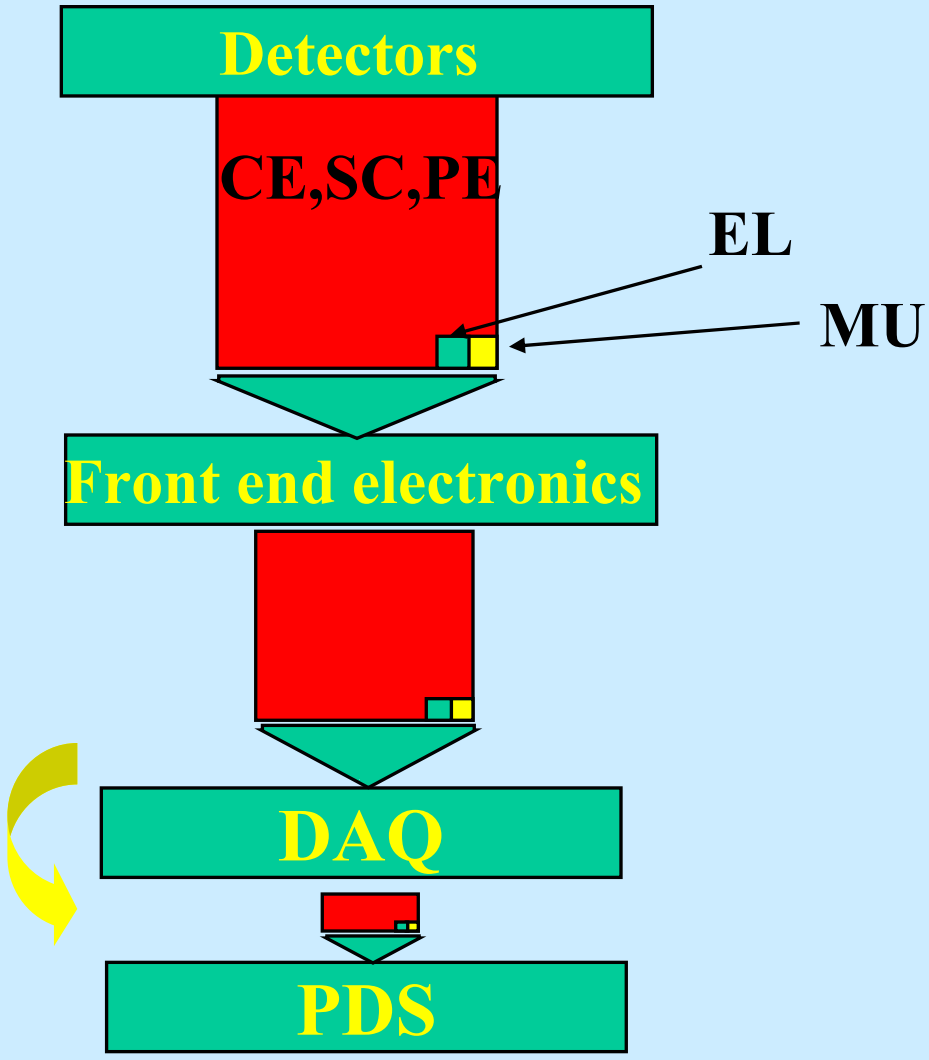
Results:As expected,we have a problem



~25 GByte/sec

(limited by DDL rates)

~1.25 GB/sec



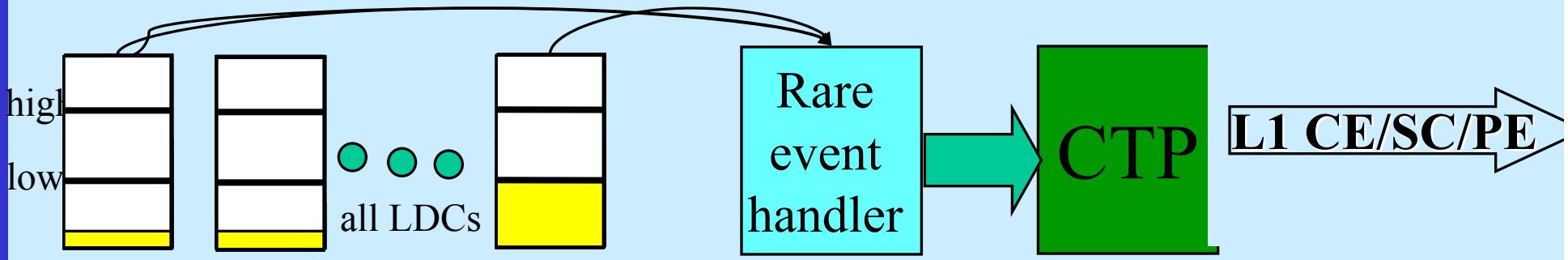
Simulation shows a huge reduction of the original rare decays (Electron-EL and Muon-MU) due to various backpressures,caused by central-CE semicentral –SC, and peripheral-PE blocking the event buffers in detectors

The proposed solution

- High/low level **at LDC to inform the Trigger to block "non important" high bandwidth triggers (CE, SC, PE) to prevent multi-event buffer getting full**

At high level any **LDC buffer for any detector blocks CE,SC,PE**

CE,SC,PE restarted when **all** LDCs fall below **low level**



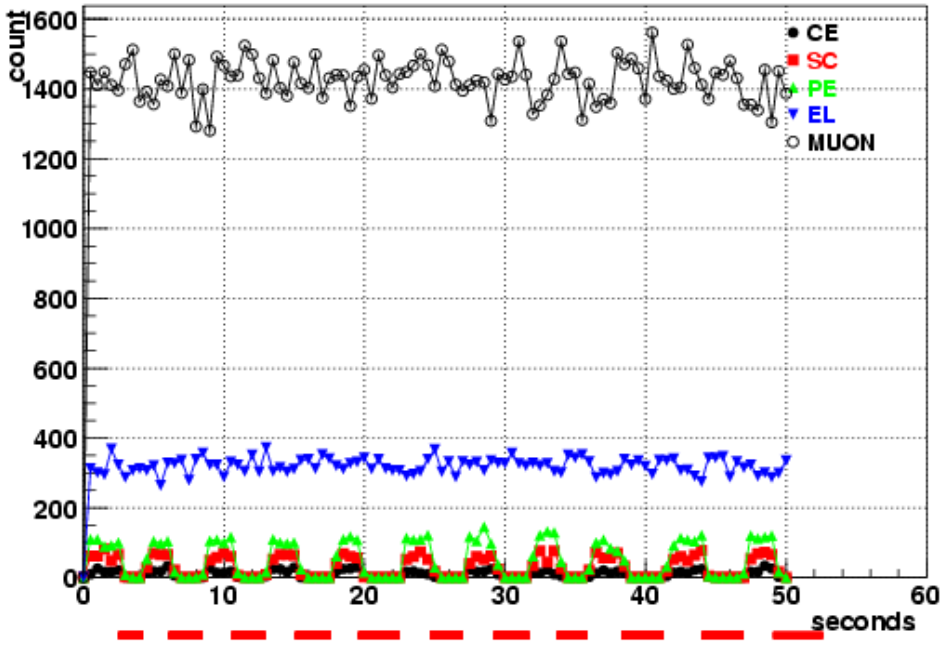
- Downscaling (when a fraction of a trigger type is outright rejected) is designed in the Trigger, so can use
  - use to prevent excessive CE, SC, PE fraction during on times
  - cannot on its own solve problem as extremely sensitive (simulation showed!) on exact running conditions

? Will this mechanism work?
? If so, will it require new hardware, or will a software solution work?

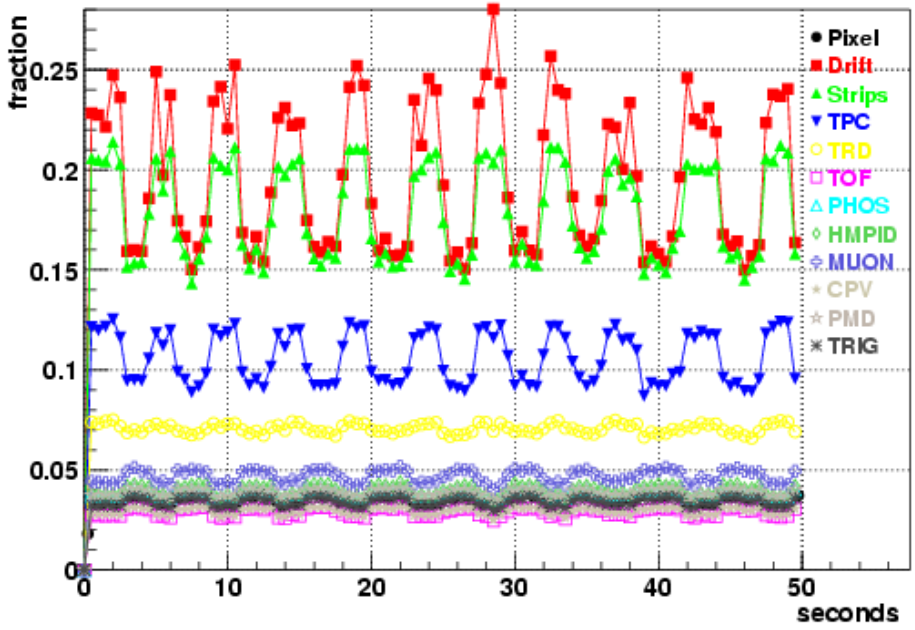
Pb-Pb results

- **LDC high/low control, downscaling by 0.2 of PE,SC and CE events**

L2 rates

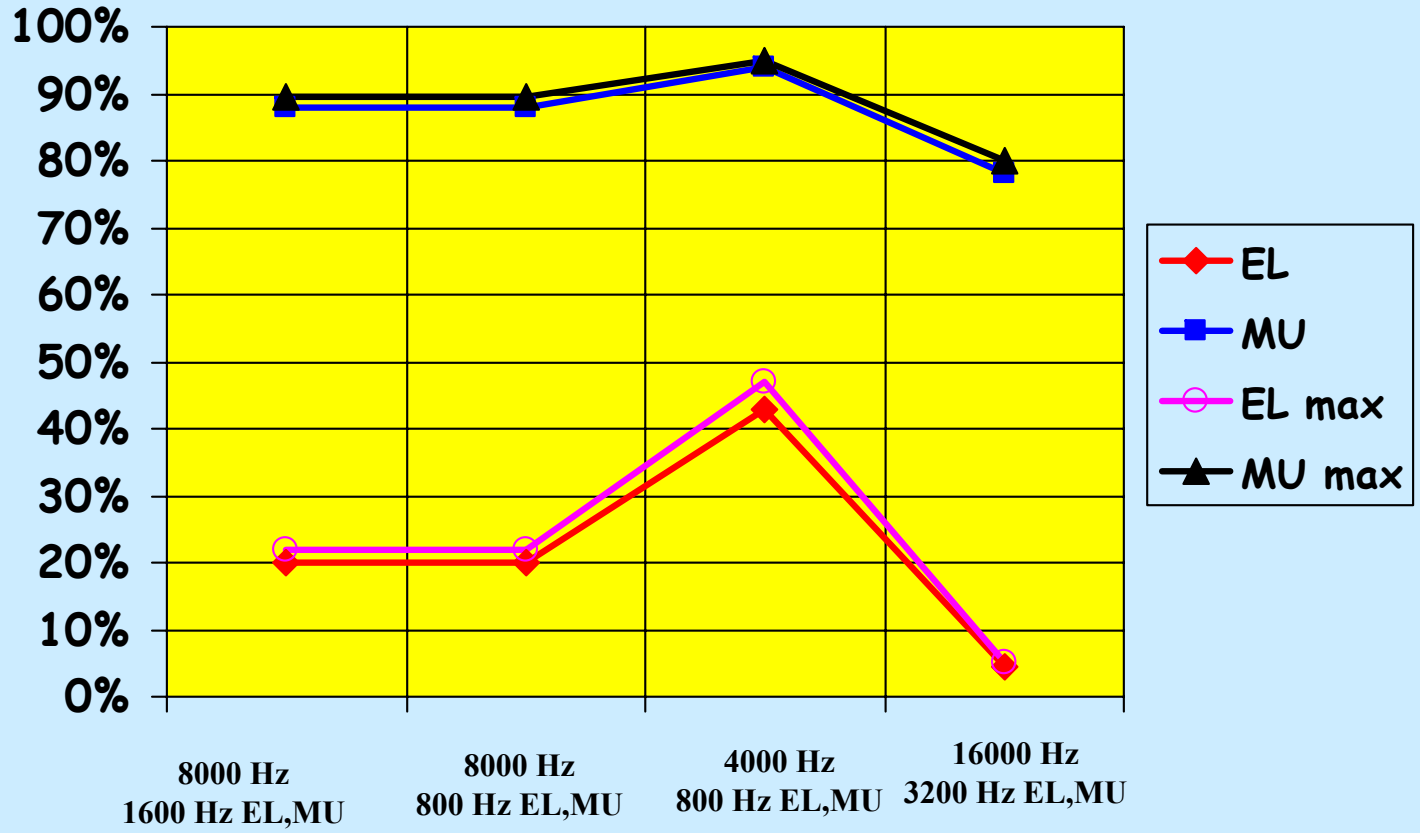


Fraction of time detector busy



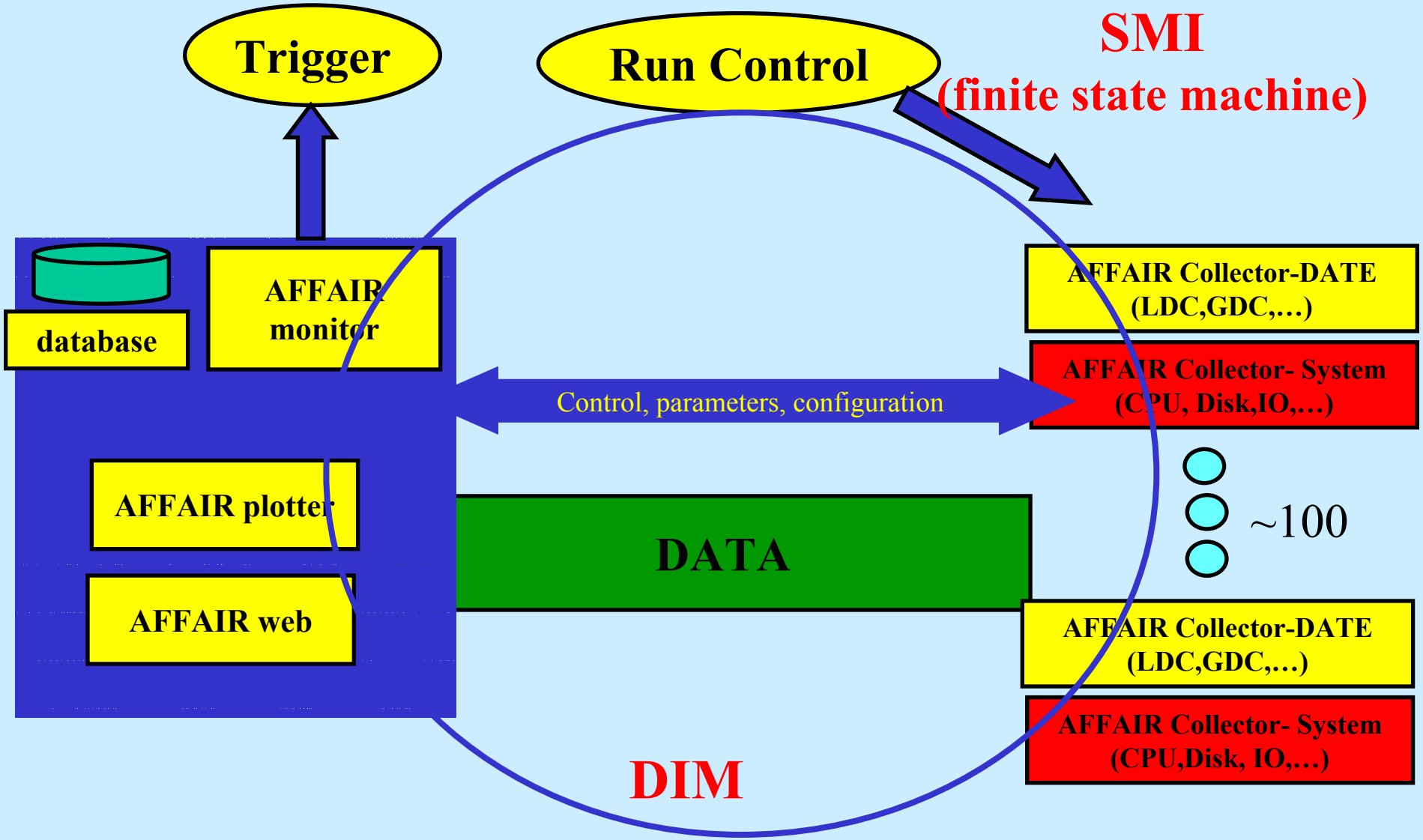
Excellent, stable behavior!

Pb-Pb results with different running conditions



- Very high percentage of max rate (i.e. only P/F considerations: $n/N = e^{-2*P/F*Rate)}$) accepted for both electron and muon events for all reasonable running/physics conditions
  - No backpressure rate limitation,detectors not busy
- Further study showed delays for LDC high/low feedback of several 100 msec do not degrade behavior
  - software solution allowed

Feedback part of DAQ monitoring system:AFFAIR



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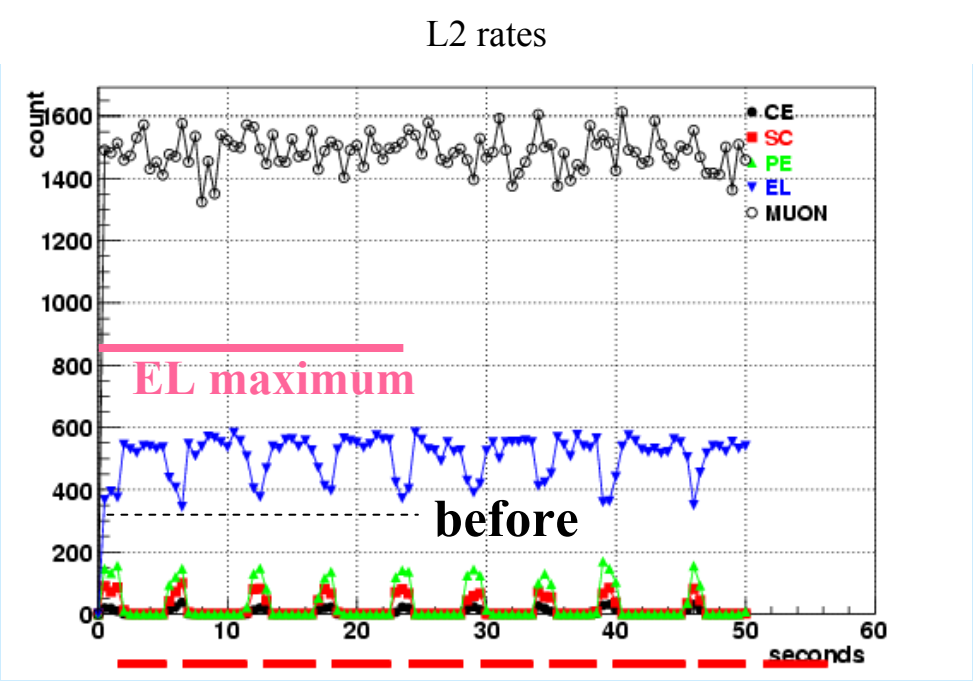
Pb-Pb - 1 PE P/F violation

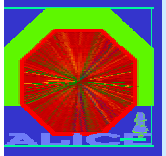
- 60 % of events are Peripheral
  - Assume can analyze events with up to one peripheral event, i.e. they do not enter P/F consideration



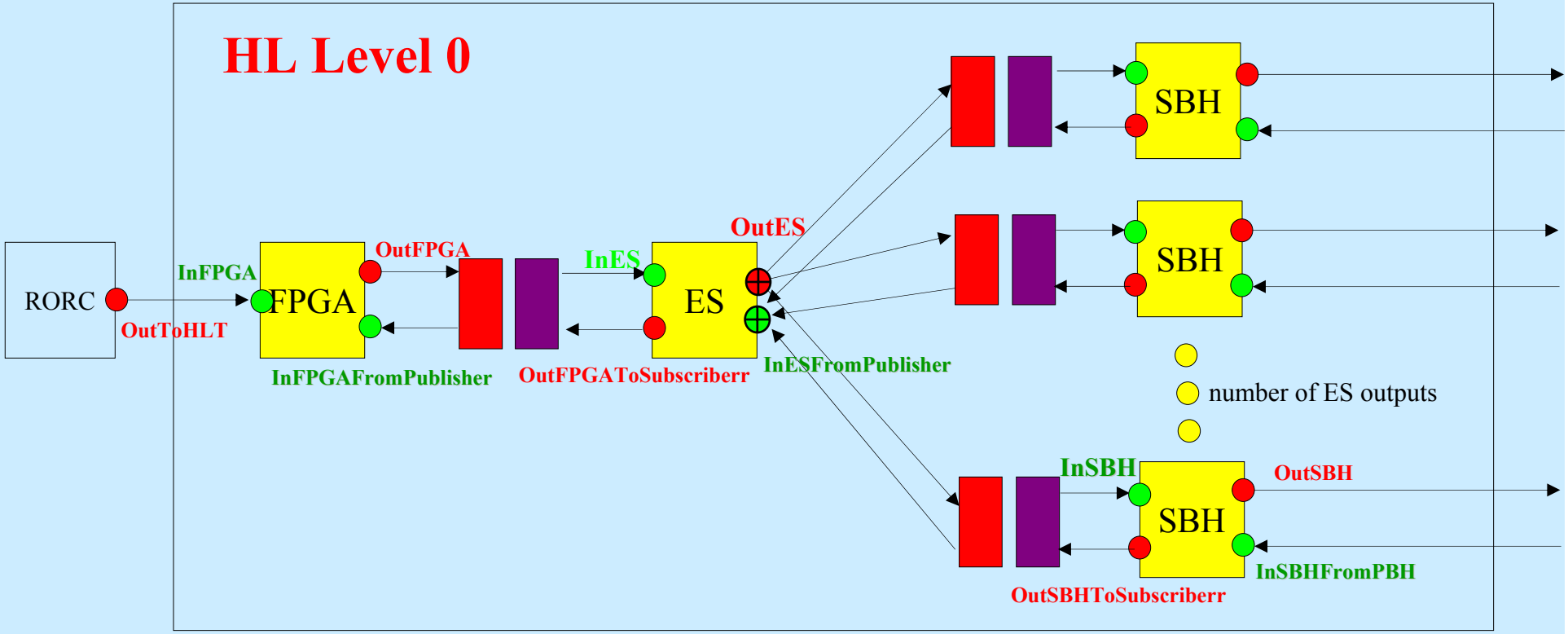
- **Electron rates significantly increase, but not near max rate:higher rates cause the detectors to be busy**

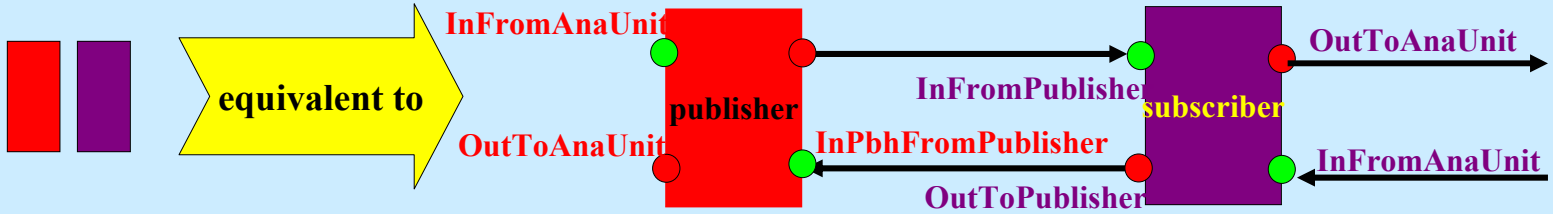
Conclusions

- **Have a useful tool to investigate ALICE DAQ/Trigger/HLT behavior**
- **It enabled to conclude that:**
  - **Pb-Pb with LDC high/low rate control and downscaling accepts EL and MU events at close to maximally possible rates(at our conditions)**
    - P/F domination only
  - **When 1 Peripheral event allowed to violate P/F, rates significantly increased, but detector properties do not permit limit to be only P/F considerations**
- **Can test how detector improvements/degradation influences rates**
- **But there might be more…**



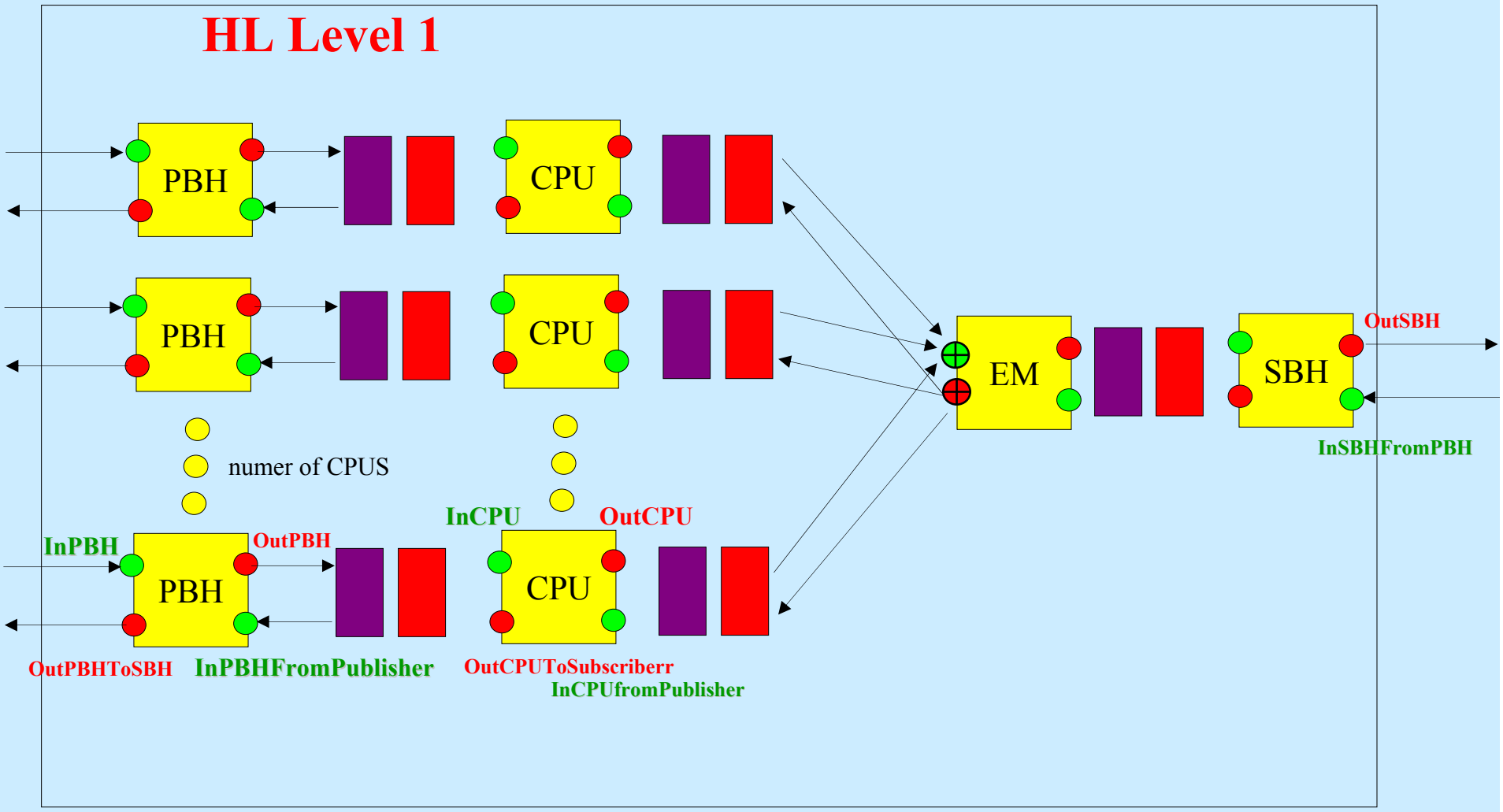
Detailed simulation of HLT (coding slowly under way…)



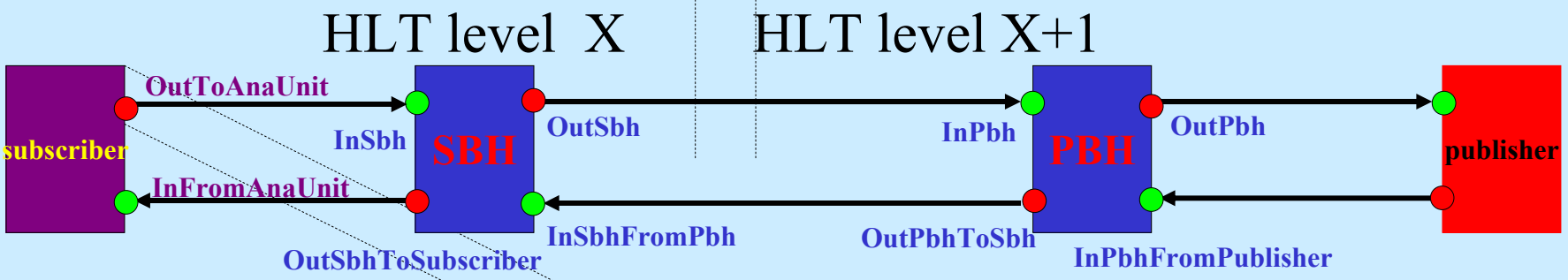


⊕ multiple input ports
⊕ multiple output ports
● single input port
● single output port

Simulation of HLT, cont....

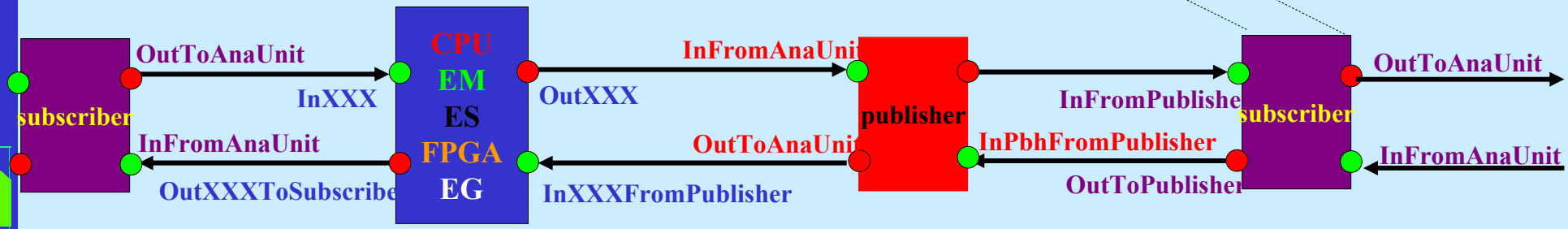


Subscriber and publisher ports, and connection to Sbh, Pbh and Analysis unit



input port.Can be single or multiple

output port.Can be single or multiple

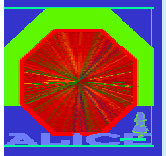


Analysis unit

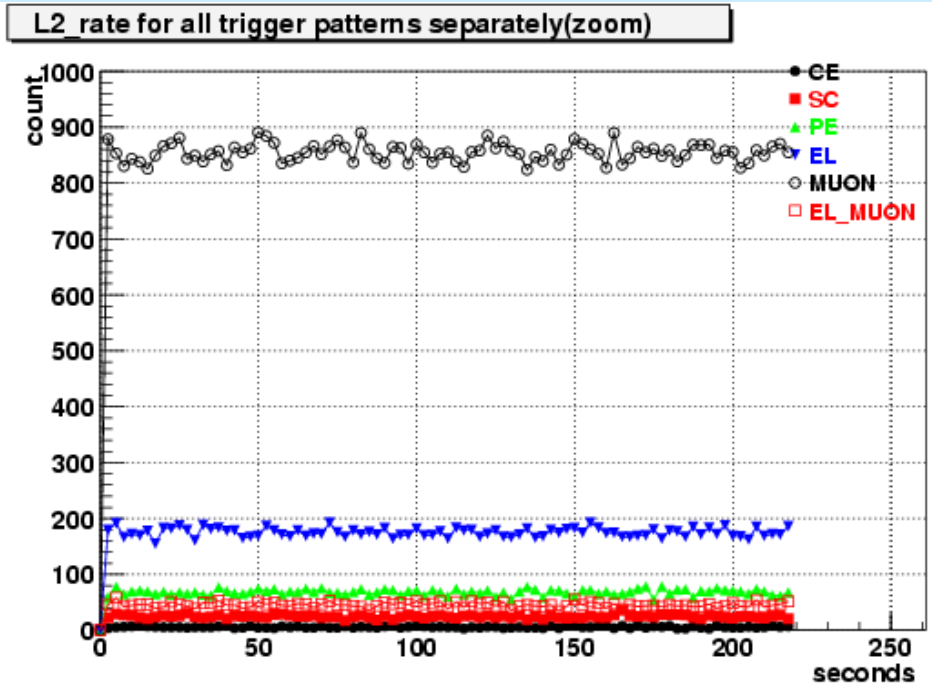
Downscaling sensitivity (no LDC high/low control)

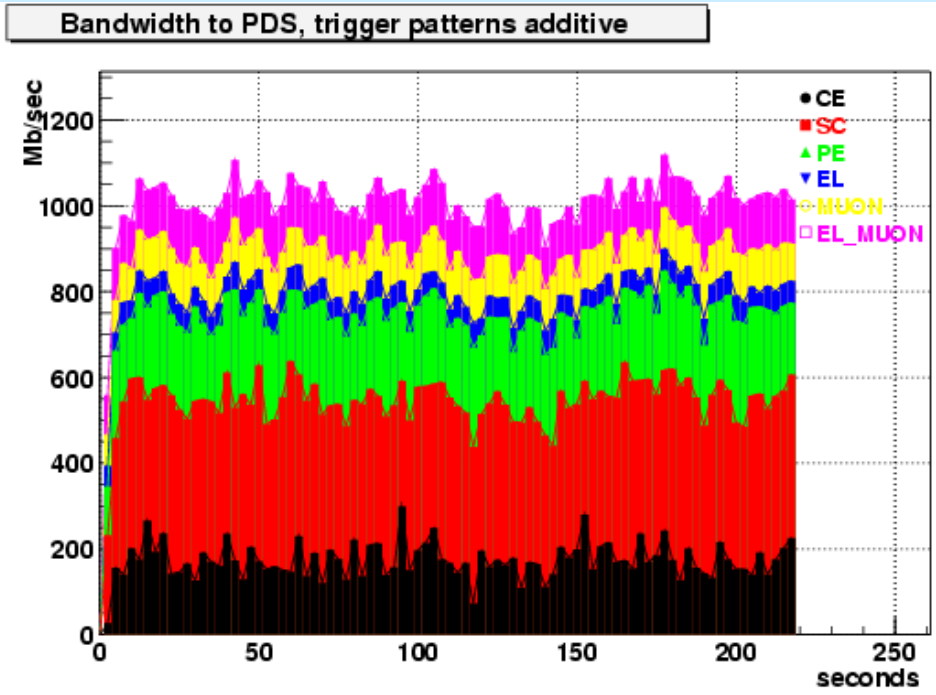
- **scan downscaling factors from below saturation to above saturation**
  - **max MUON rate about 1000 Hz (changed from before 700 Hz, on request from lhcc committee) at creation**
  - **max EL rate about 800 Hz at creation**

- **DAQ/trigger conditions such that downscaling of ~0.1 (i.e. factor 10) of CE,SC, PE events results in system to just about plateau**



Downscaling by 0.07





Max EL and MU rates, bandwidth under maximum(1.25 GB/sec)

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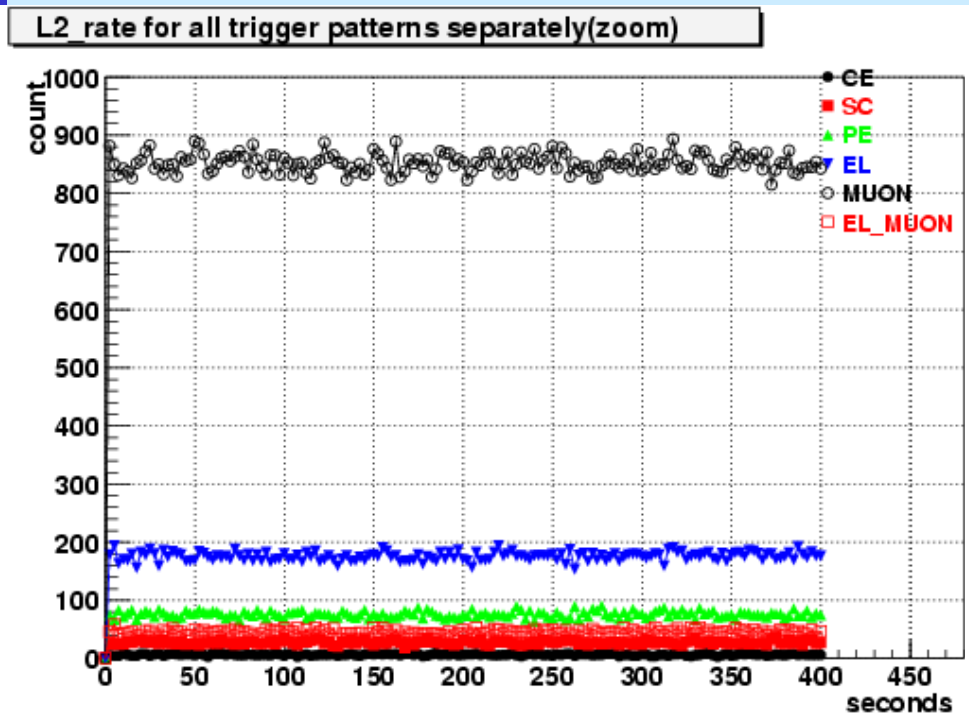
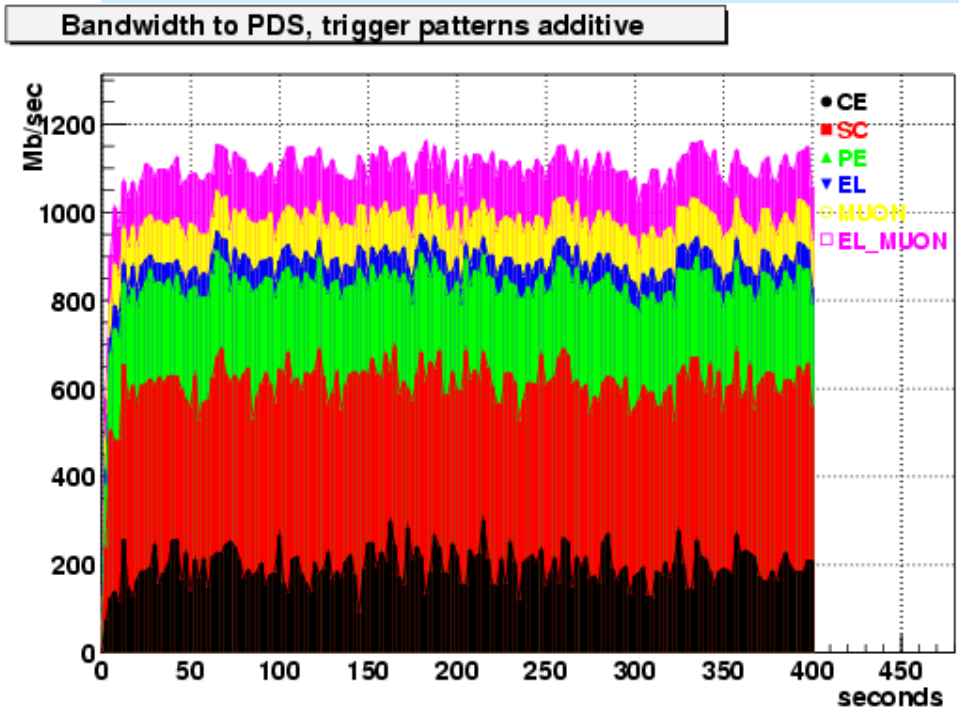
Downscaling by 0.08





Max EL and MU rates, bandwidth under maximum(1.25 GB/sec)

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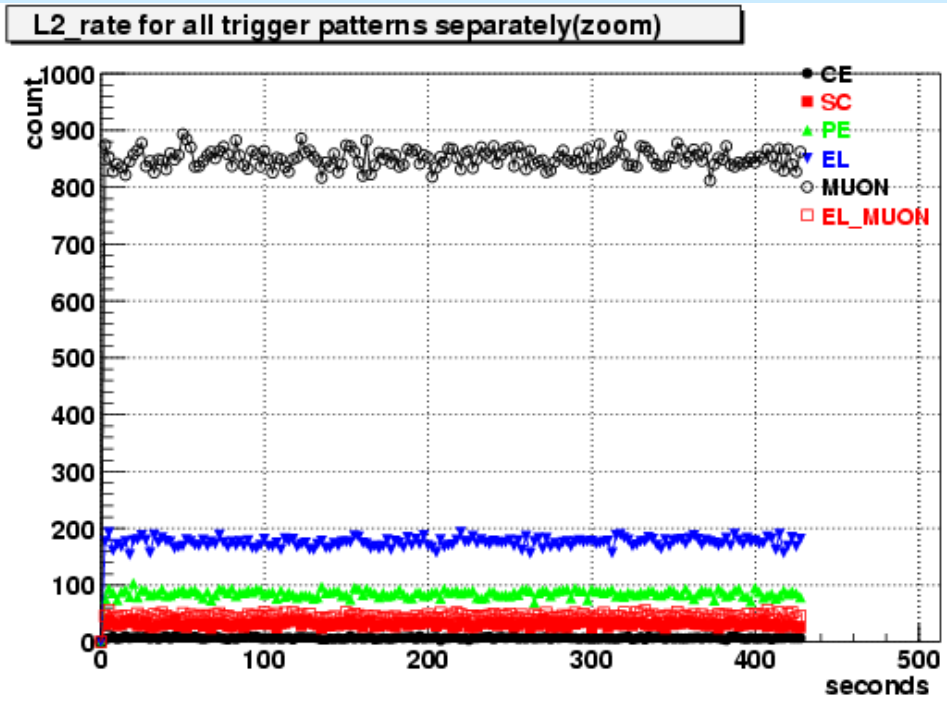
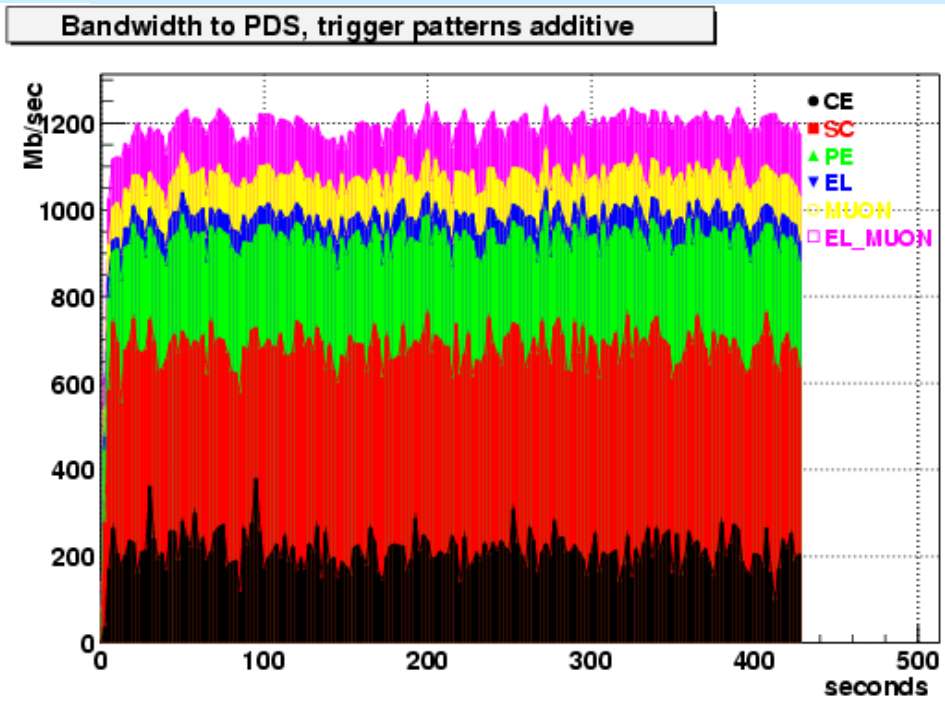
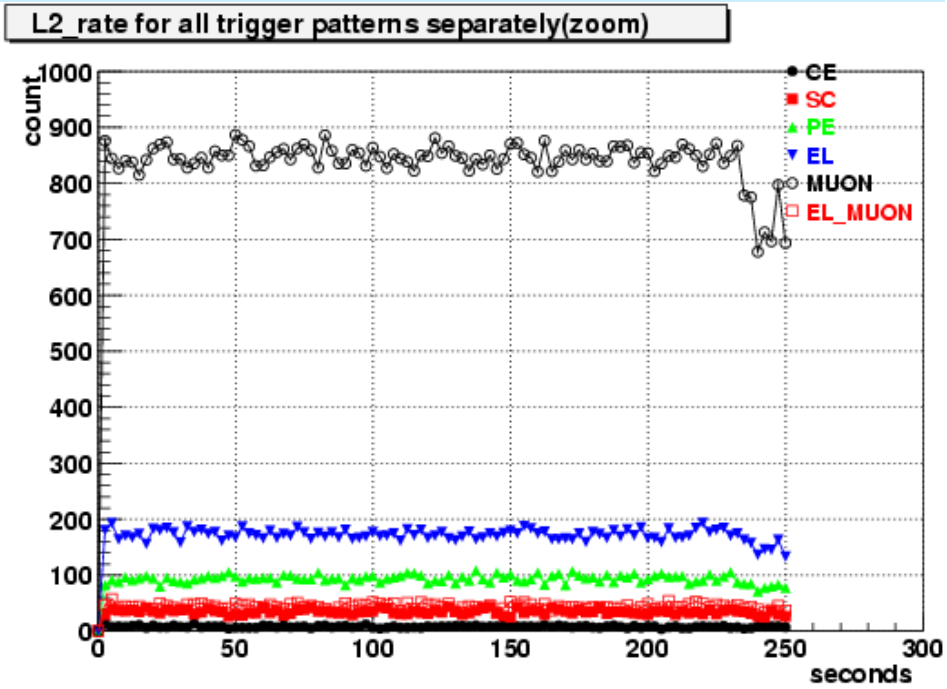
Downscaling by 0.09

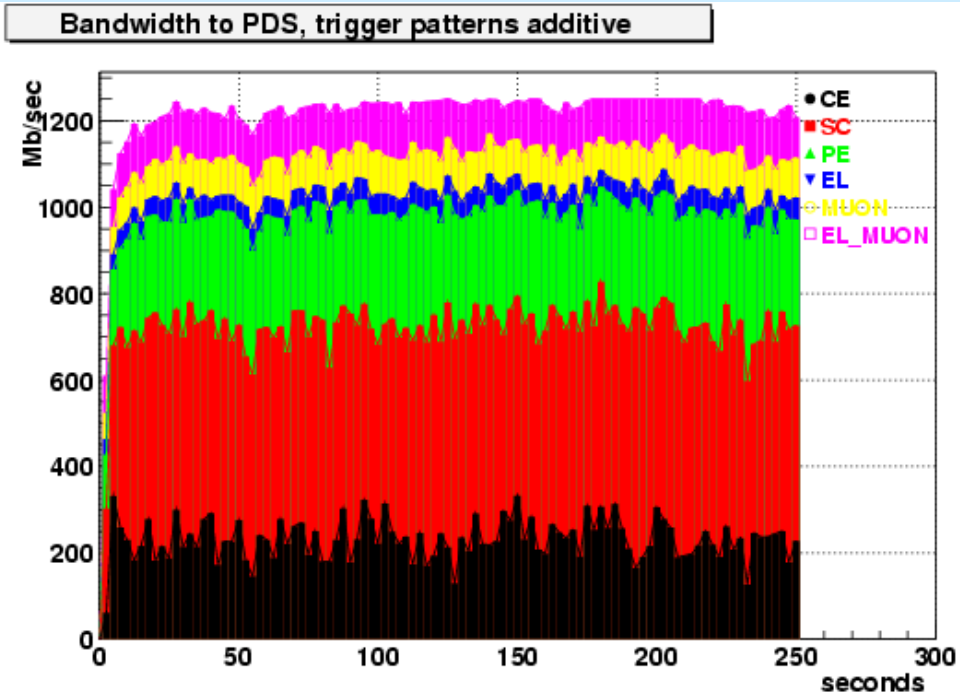




Max EL and MU rates, bandwidth just under maximum(1.25 GB/sec)

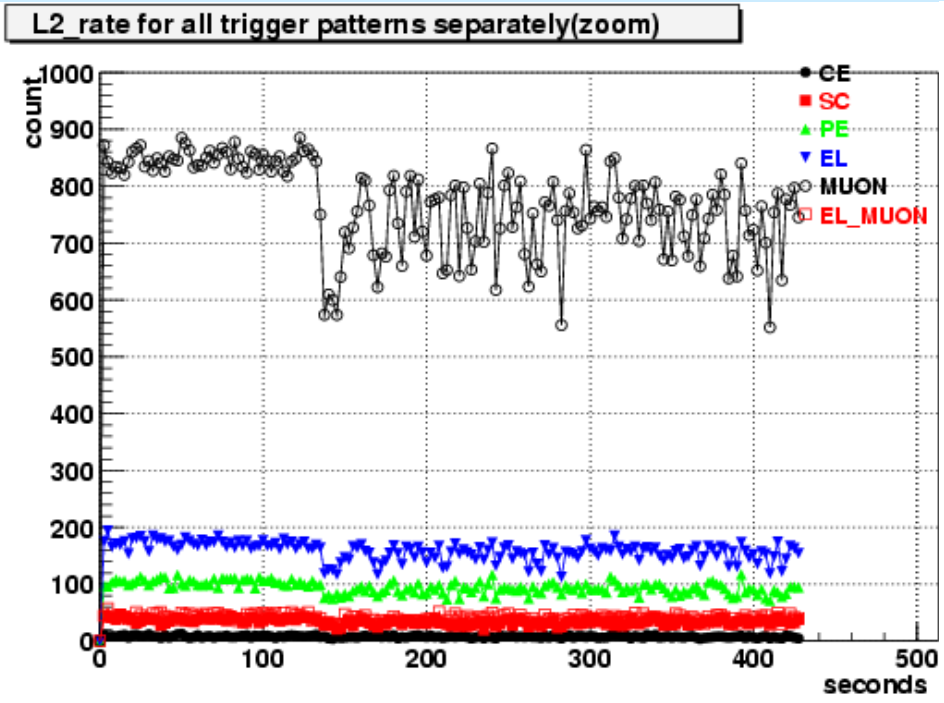
Downscaling by 0.1

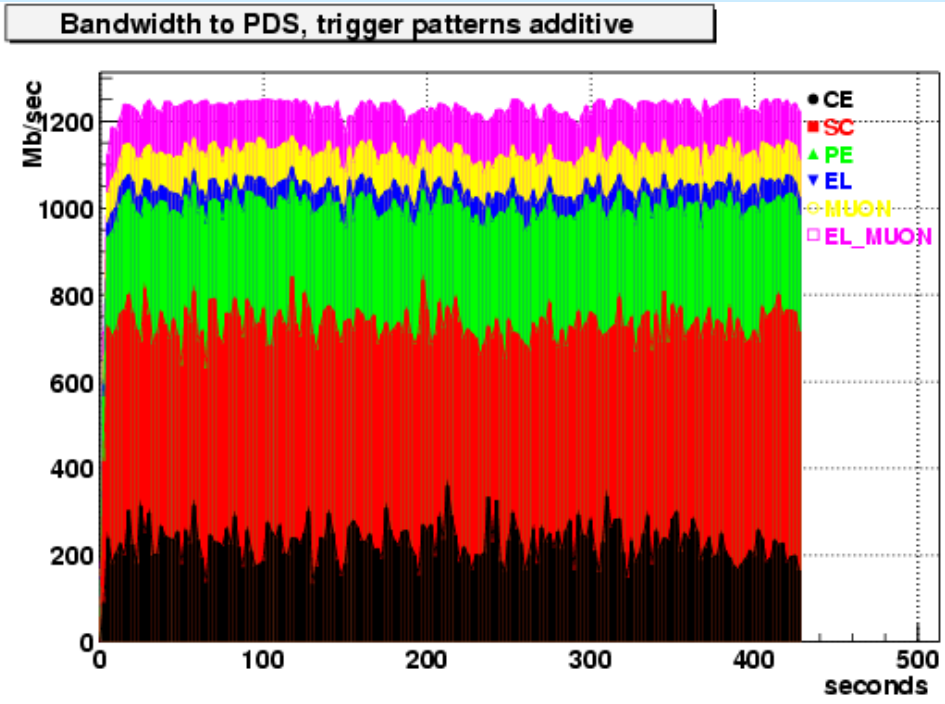




EL and MU rates start to decrease, bandwidth at maximum(1.25 GB/sec)

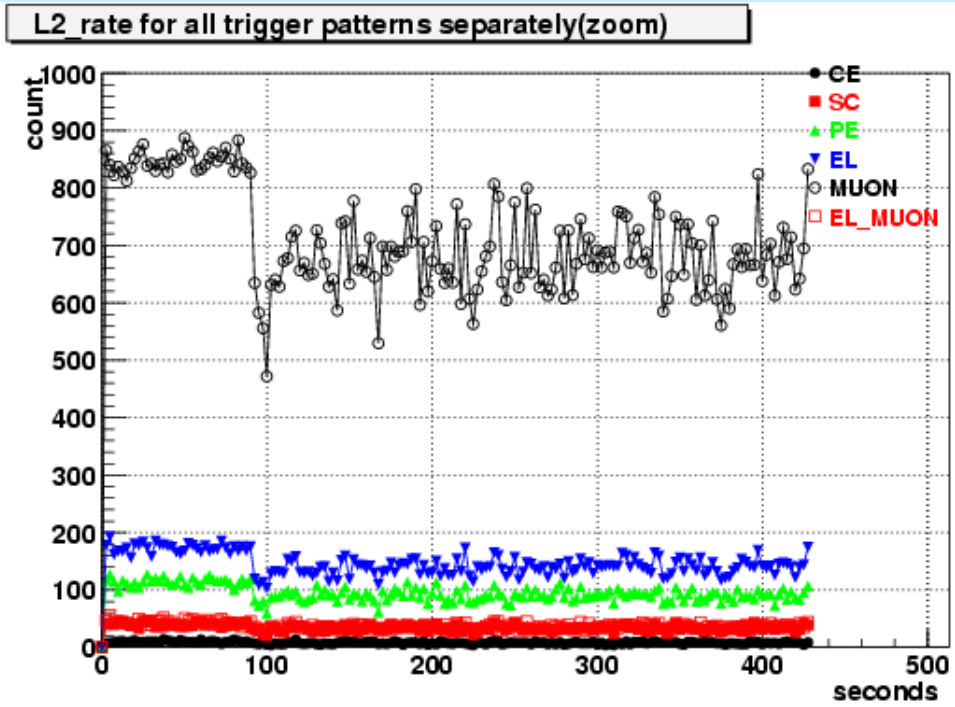
Downscaling by 0.11

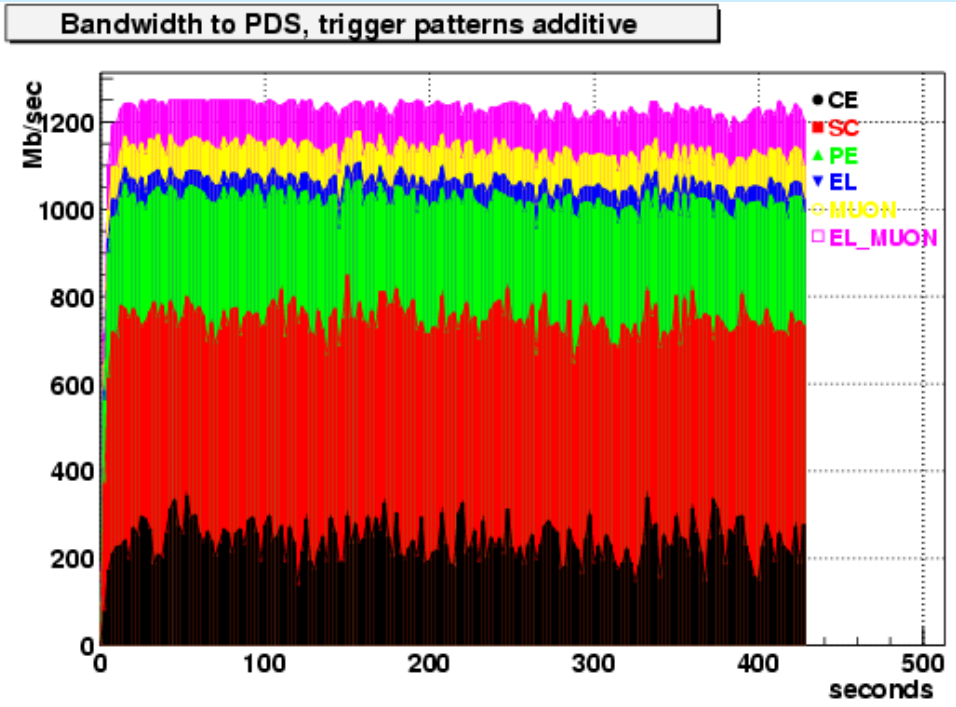




EL and MU rates decrease, bandwidth at maximum(1.25 GB/sec)

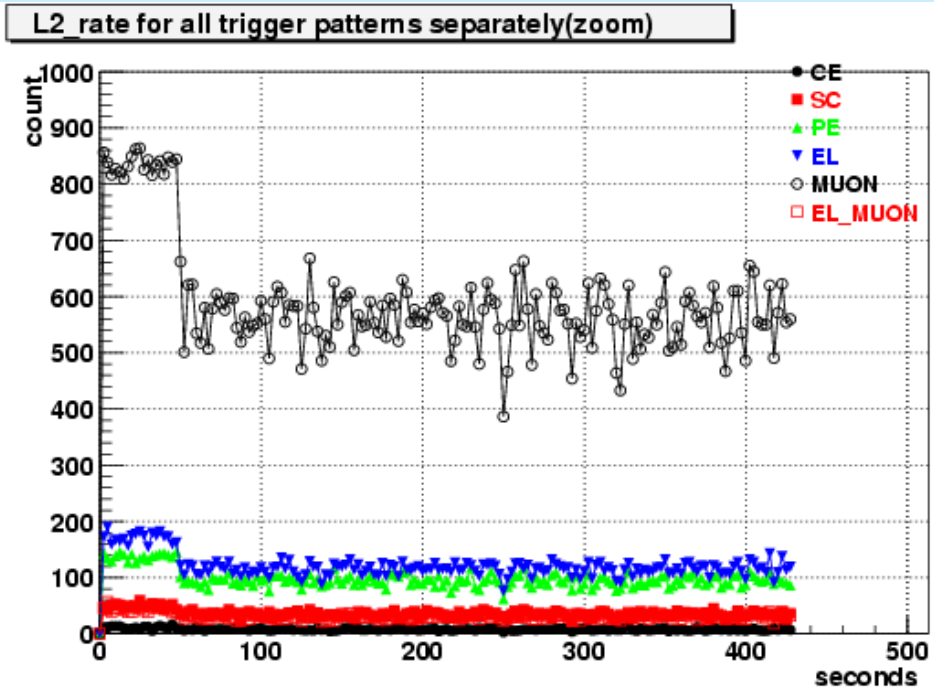
Downscaling by 0.12

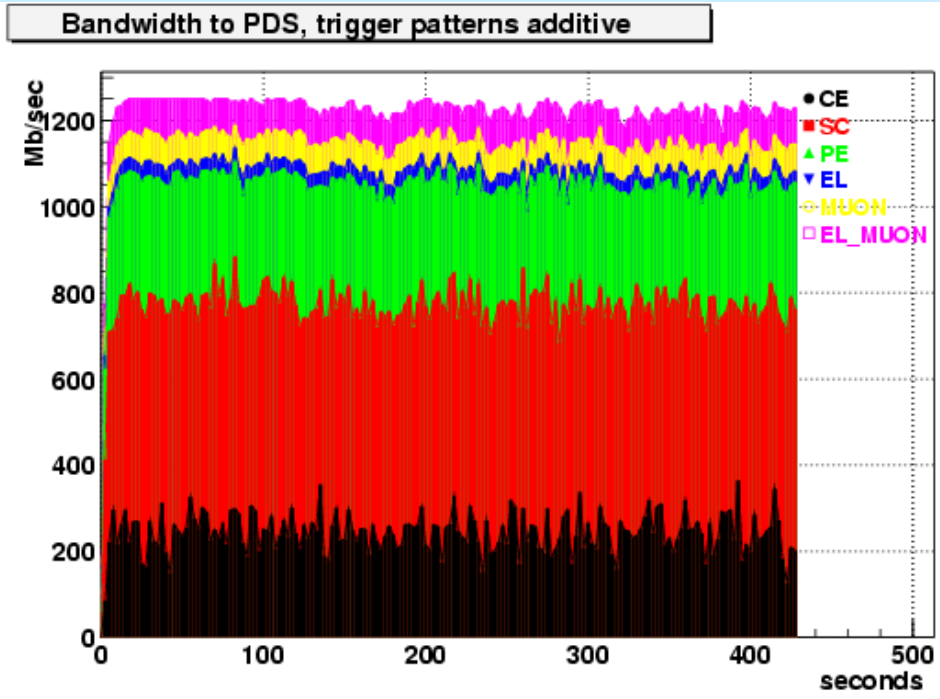




EL and MU rates decrease more than for 0.11, bandwidth at maximum(1.25 GB/s

Downscaling by 0.15

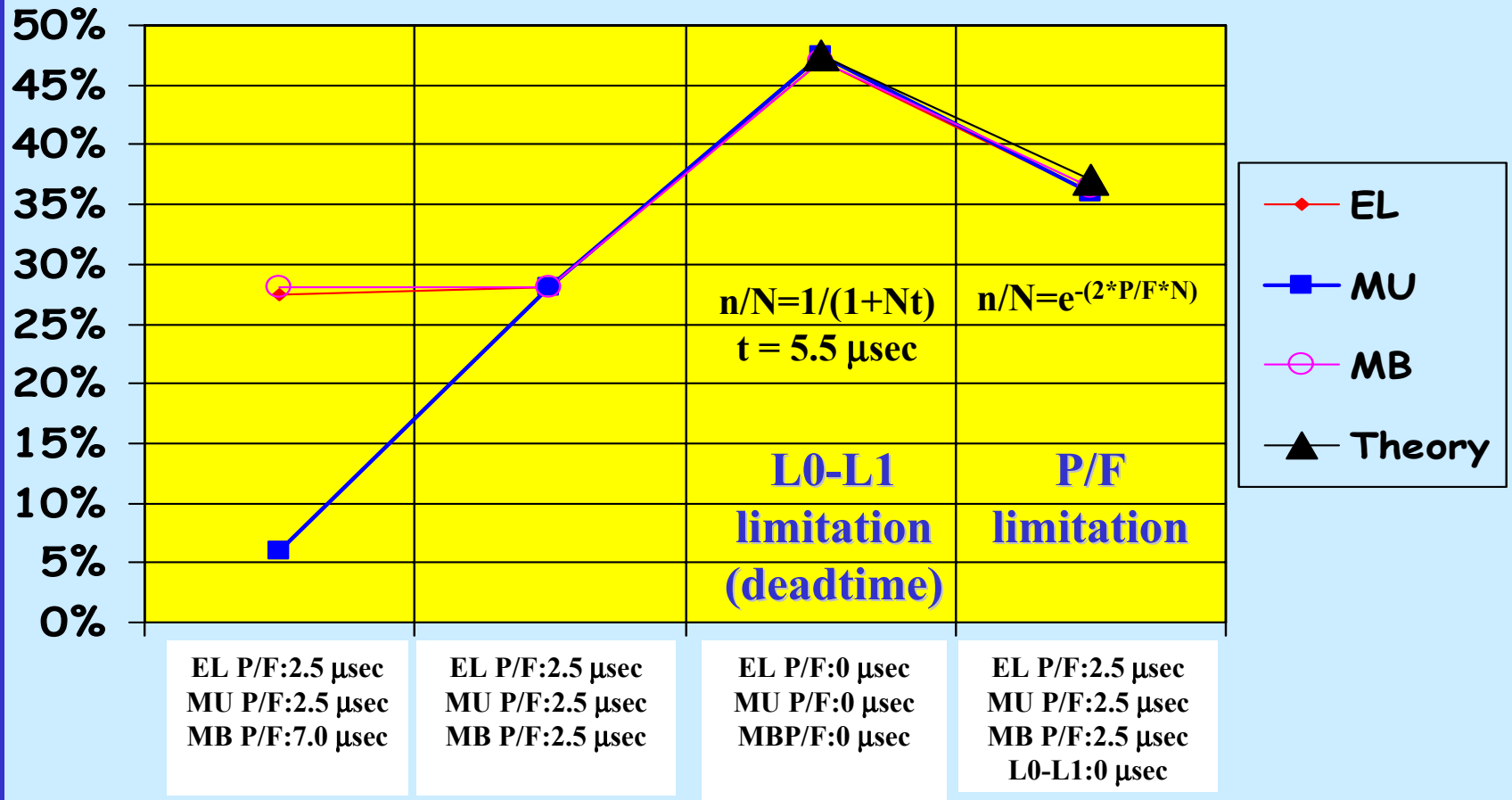




EL and MU rates significantly decrease, bandwidth at maximum(1.25 GB/sec)

p-p 200 kHz

30 Hz MB, 20 Hz EL, 20 Hz MU

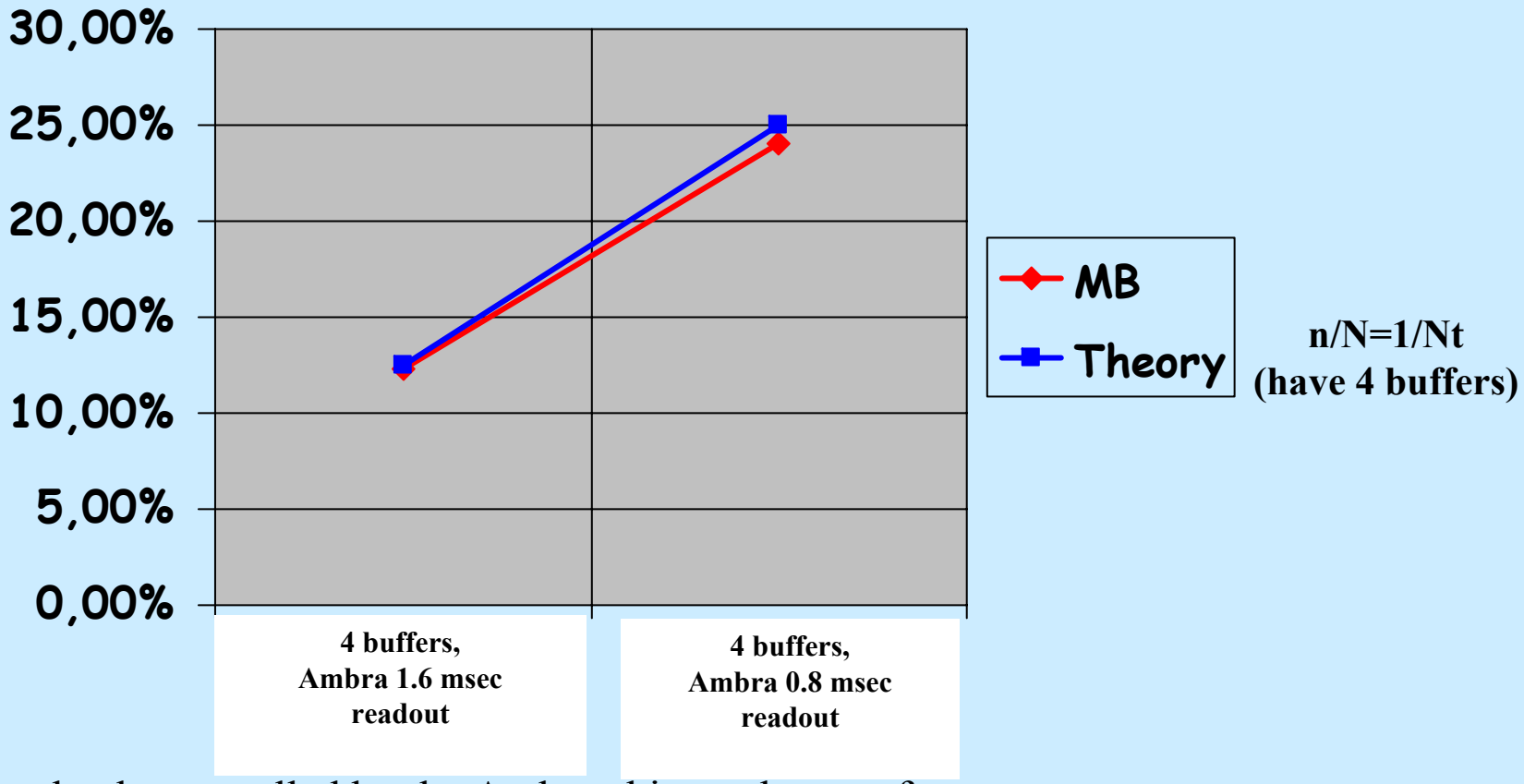


Rate dominated by combination of P/F and L0-L1 time

For MU at P/F= 7 µsec, rate close to max assuming only P/F, since L0-L1 time < P/F time (5.5<7)

p-p 5 kHz

Mode to collect maximum amount of MB p-p events



Rate completely controlled by the Ambra chip readout performance

Why simulate?

conditions:

1000s of elements separately involved in DAQ

different event types require different detector sets read out and different P/F protection

- **numerous alternate designs involved: online compression, region of interest readout, L3 decisions …**
- **1000s of separate events processed in parallel at same time**

Not obvious at all that it is possible to achieve the physics requirements!

Create a simulation of the DAQ to test the throughput rates for all alternate designs and conditions

Foresight initially used to define specification

Due to slowness of execution (days/simulated second) switched to Ptolemy