

ACES: DAQ Plans for Upgrades

Approximate Content

- o Excuses
- o Executive summary
- o Parameter space
- o Detector Readout
- o Event Building
- o Technology
- o (another) Summary

- As always fruitful discussions with Pierre, Beat & Frans
- See also presentations DAQ@LHC (2013) — sister event to ACES

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❑ Poor excuses

- ❑ Concentrate on the hardware DataFlow

- ❑ Software ...

 - o Dataflow, Control, Configuration, Monitoring, etc ...

 - ... is a separate >1 hr presentation

- ❑ Storage and infrastructure

 - o Have their challenges too: data organisation over the disks, recovery from failures

- ❑ Compute power ... nothing new to say

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□ Executive Summary

□ Run 3 (2020–2022)

- o ATLAS and CMS: No major upgrades in the DAQ systems currently foreseen
 - Beyond the standard 5-year replacement cycle—impact of newer technologies
- o ALICE and LHCb: Major upgrades
 - ALICE: ~2 orders of magnitude higher data rates, raw event size ~23 Mbyte
 - o Continuous un-triggered read-out of the TPC— contributes ~90% of event
 - o ALL interactions recorded (50 kHz)
 - o Storage bandwidth limited to ~20 GByte/s (averaged over fill)
 - o Strategy: Retain ONLY online fully reconstructed events—DISCARD raw data
 - o Evolution of Run 1 strategy where, for the TPC, only clusters were retained
 - o Online computing becomes an ALICE Online & Offline computing centre—O²
 - LHCb: ~40 times higher data rate
 - o No custom-hardware trigger Levels foreseen
 - o Dedicated event building network/infrastructure foreseen at 40 MHz!

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□ Executive Summary ... cont.

□ Run 4 (mid. 2025–2028)

- o ALICE and LHCb: No upgrades in the DAQ systems currently foreseen
- o ATLAS and CMS
 - 200–1000 kHz (Level-1) detector readout rates (cf. today's 100 kHz)
 - 10 kHz x ~5 Mbyte/s to storage
 - ATLAS: Piece meal event-building??
 - CMS: full building event building at Level-1 rate

□ Run 5 etc ...

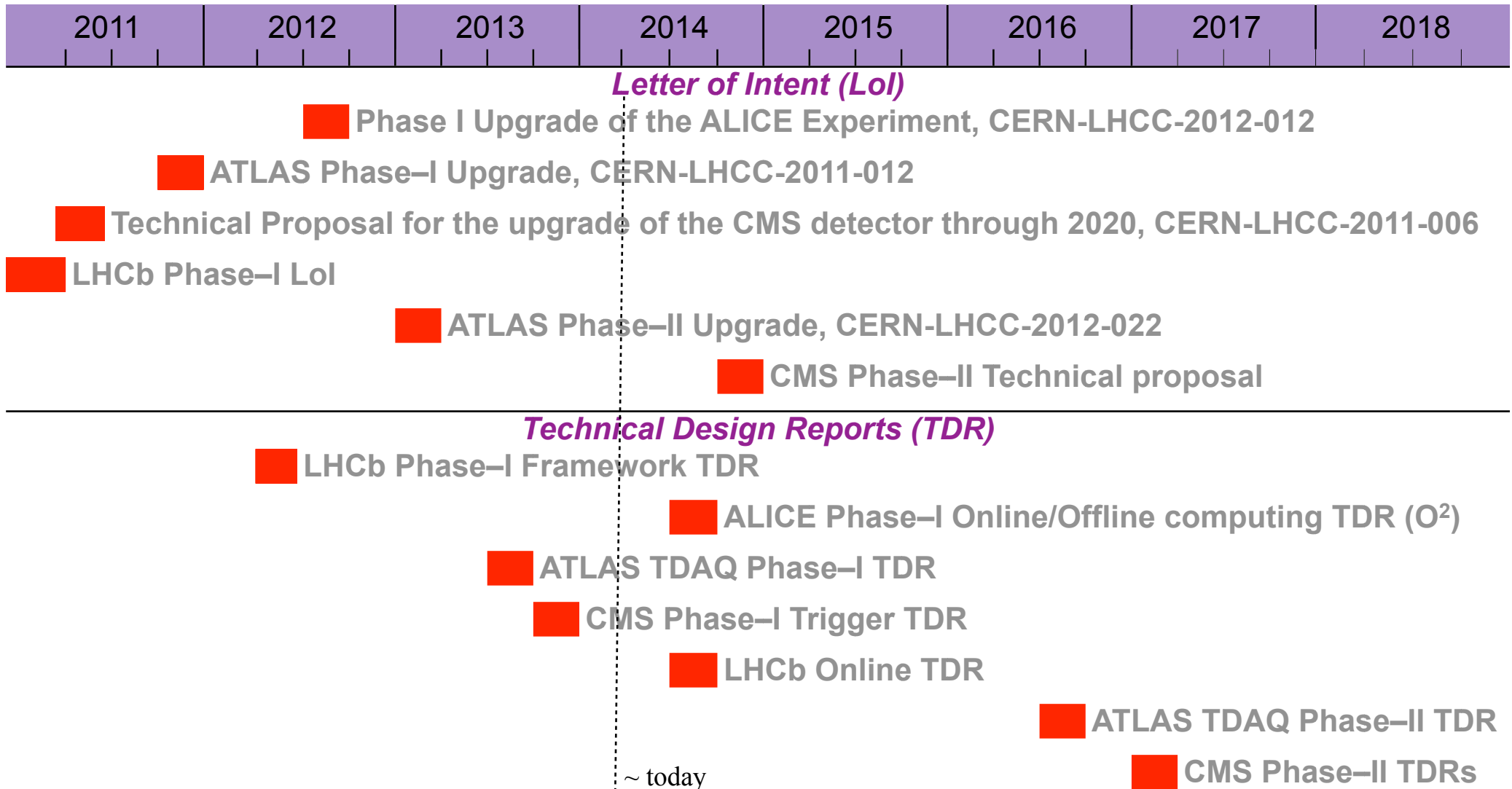
- o Not on anyones radar ... yet

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□ Timelines and/or reading list

□ All experiments actively discussing & planning their upgrades

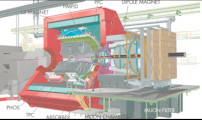
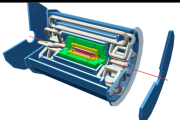
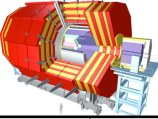
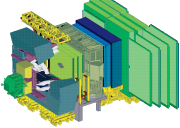
o Some Upgrades being implemented now



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□ Driving parameters

□ Today (Run 2)

		# of Trigger levels	Level-x Rate (kHz)	Event Size (MB)	Network BW (GB/s)	Storage GB/s	kHz
	ALICE (Pb-Pb)	2	Lvl-1 0.5 HLT 0.5	30	12.5	15	0.5
	ATLAS	2	Lvl-1 100 HLT 1	2	50	1	1
	CMS	2	Lvl-1 100 HLT 1	~1	100	1	1
	LHCb	3	Lvl-0 1000 HLT-1 200 HLT-2 12.5	0.055	55	0.7	12.5

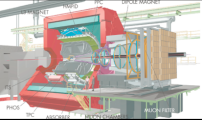
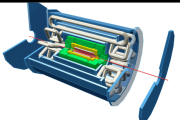
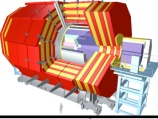
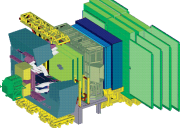
□ Note

- o ALICE event size is after the Level-1 selection, i.e. events with TPC
- o Bandwidth includes compression factors

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□ Driving parameters ... cont.

□ Tomorrow (Run 3)

		# of Trigger levels	Level-x Rate (kHz)	Event Size (MB)	Network BW (GB/s)	Storage GB/s	kHz
	ALICE (Pb-Pb)	1	Lvl-1 O ² 50	23	230	80	50
	ATLAS	2	Lvl-1 100 HLT 1	2	50	1	1
	CMS	2	Lvl-1 100 HLT 1	~1	100	1	1
	LHCb	2	LLT 40000- 20000 HLT 40	0.100	4000	5	50

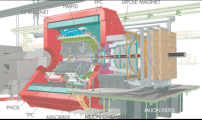
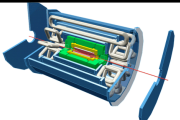
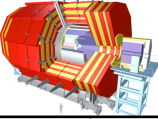
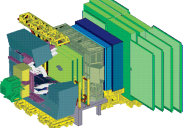
□ Note

- o ALICE: reconstructed event gives a factor five reduction in event size
- o LHCb: Low-Level-Trigger (LLT)
- o ATLAS and CMS: No major upgrades in the DAQ systems currently foreseen

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□ Driving parameters ... cont.

□ Next Week (Run 4)

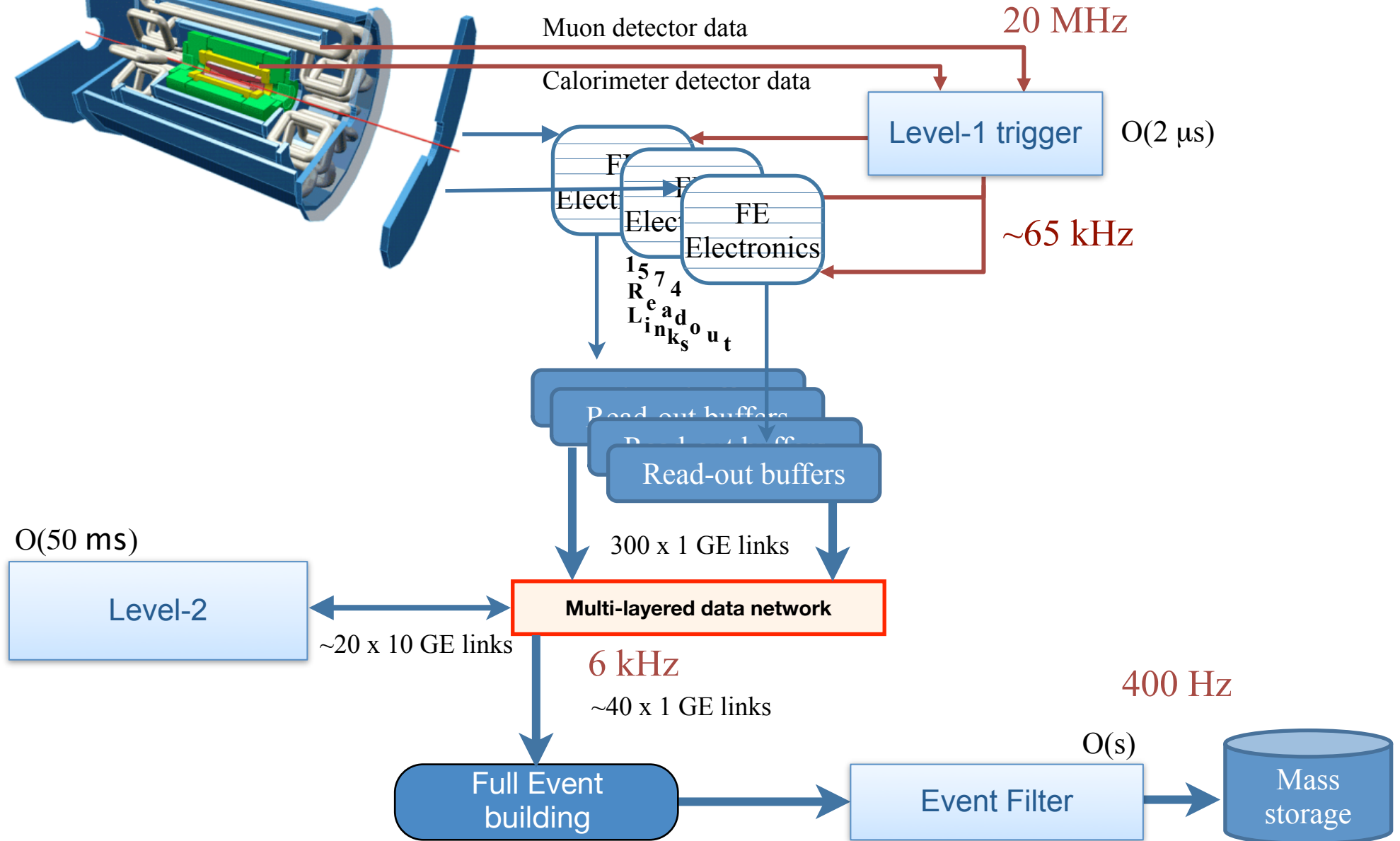
		# of Trigger levels	Level-x Rate (kHz)	Event Size (MB)	Network BW (GB/s)	Storage GB/s	kHz
	ALICE (Pb-Pb)	1	Lvl-1 O ² 50	23	230	80	50
	ATLAS	3	Lvl-1 > 200 HLT 10	~5	1000	50	10
	CMS	2	Lvl-1 1000 HLT 10	~5	5000	50	10
	LHCb	2	LLT 40000- 20000 HLT 40	0.100	4000	5	50

□ Note

- o ATLAS: Two stage hardware trigger (Level-0 and Level-1)
 - See this presentation in this workshop
- o CMS: Numbers for feasibility studies ... not yet design parameters

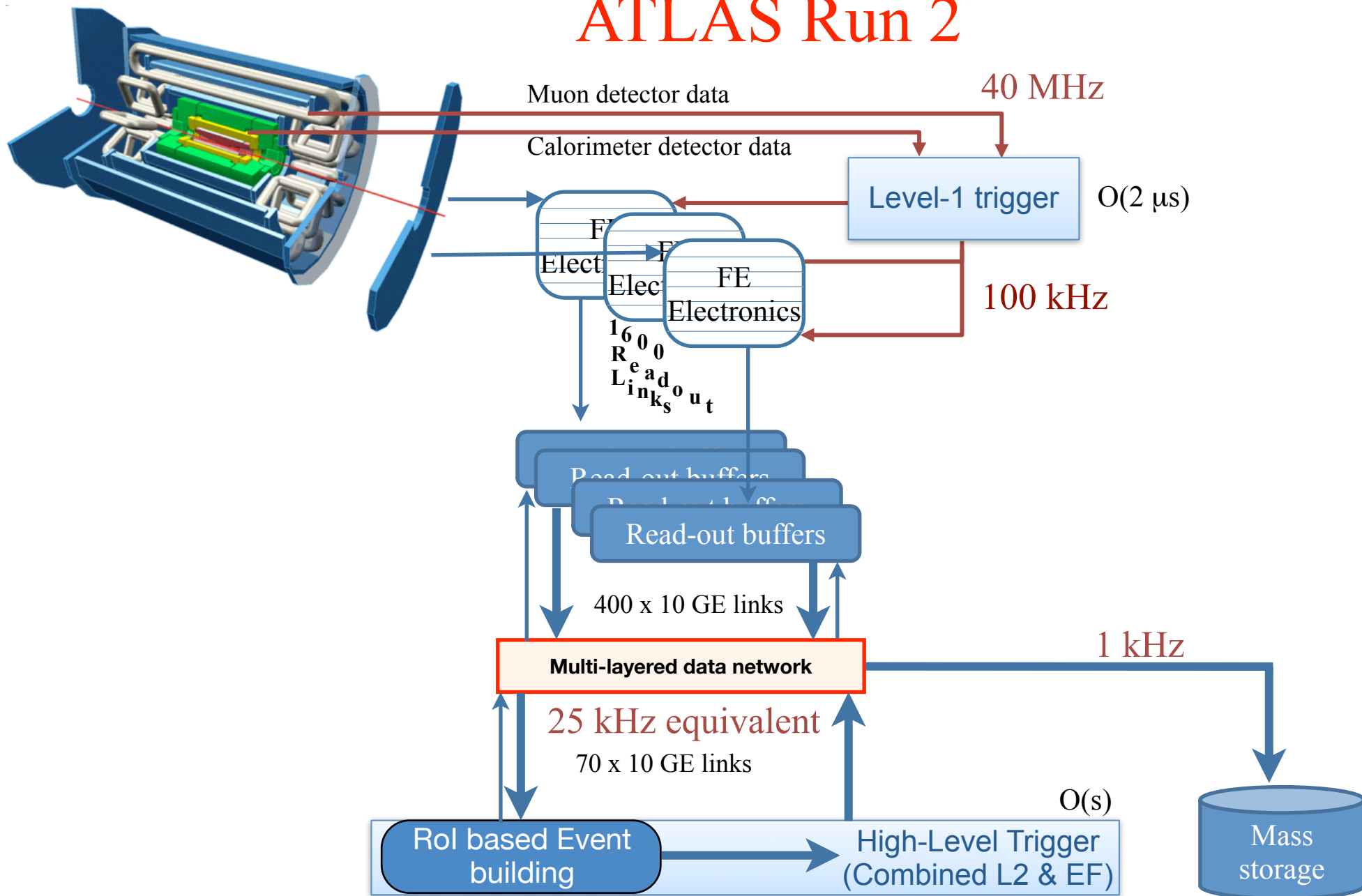
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ATLAS Run 1



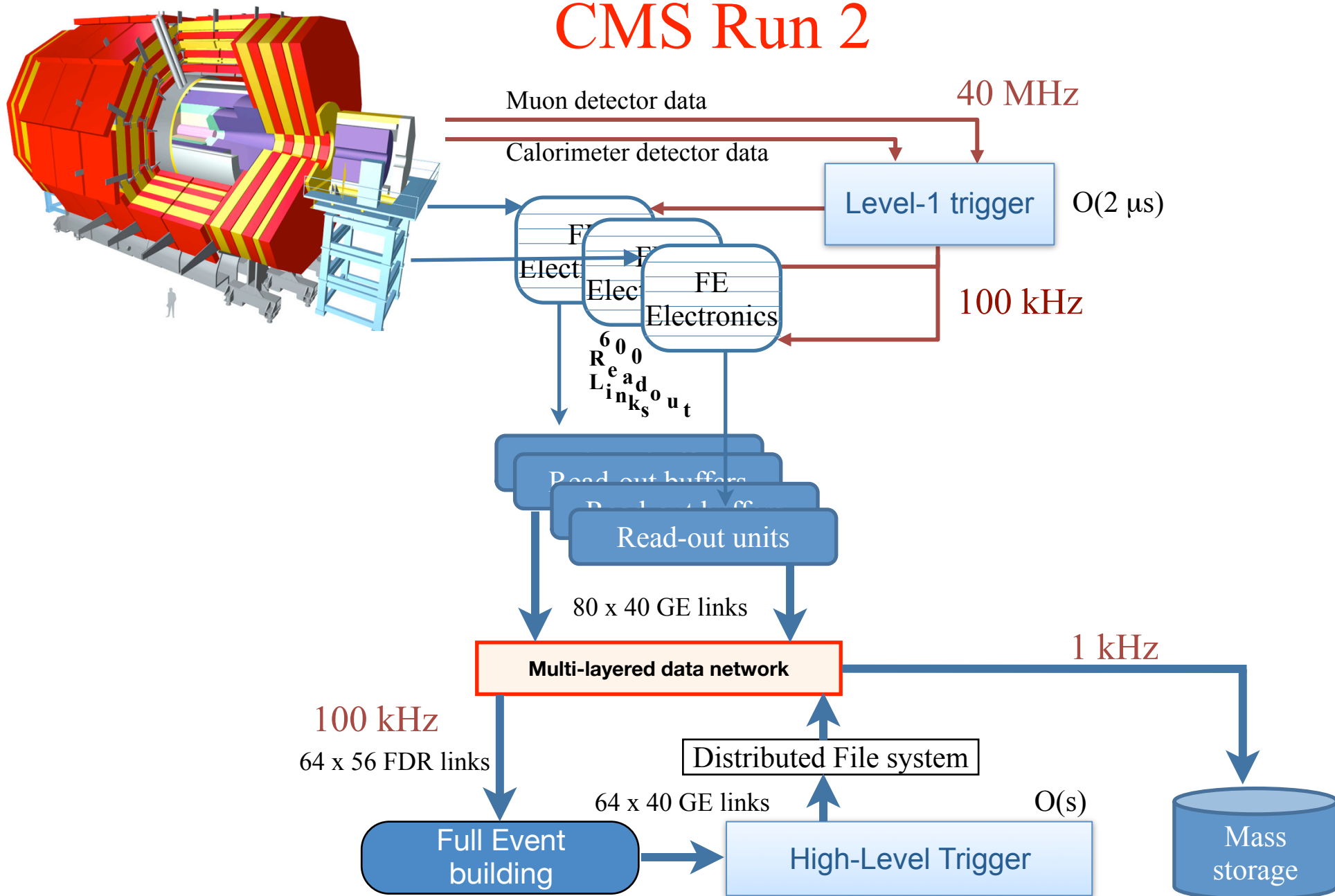
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ATLAS Run 2



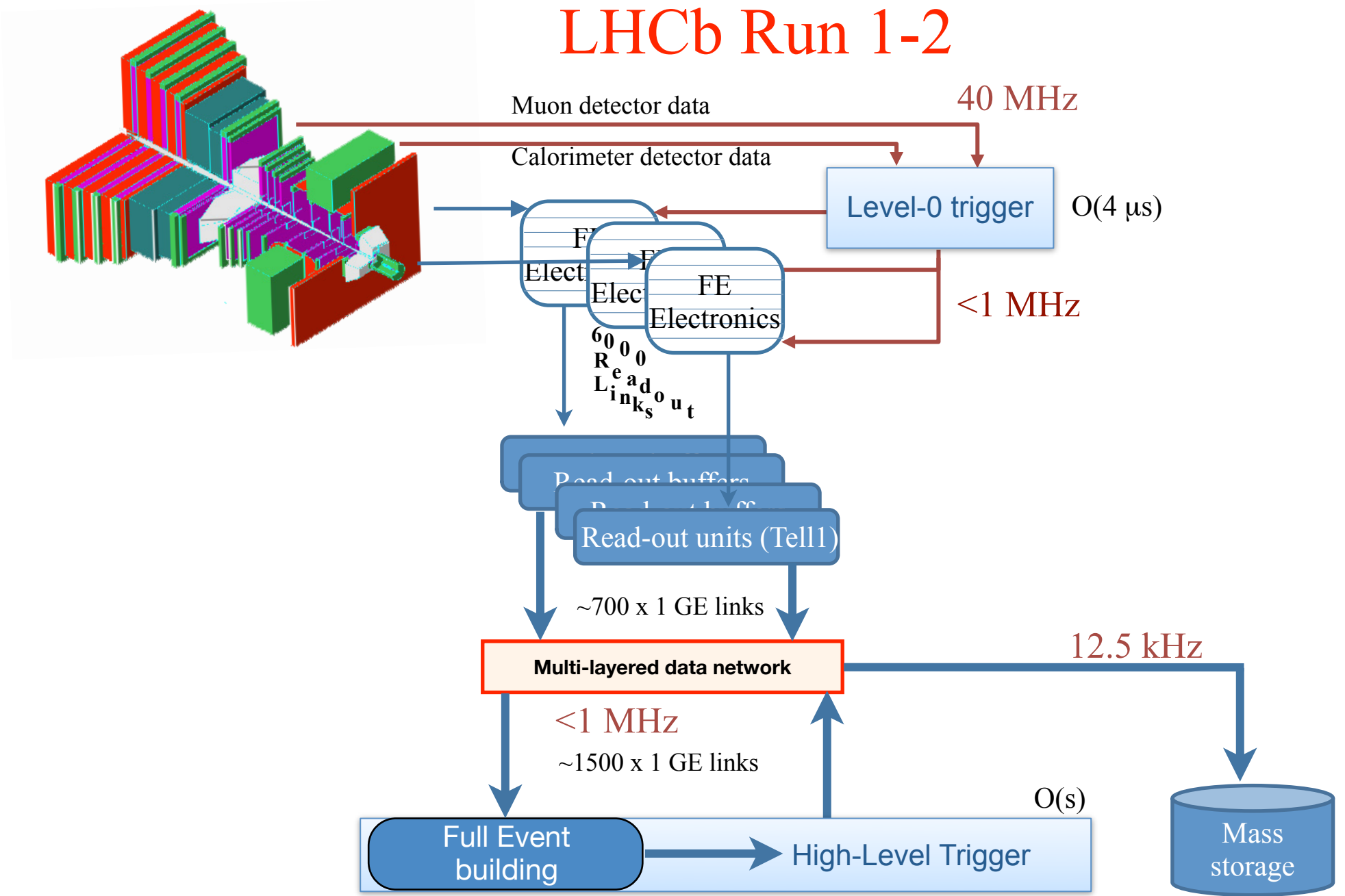
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CMS Run 2



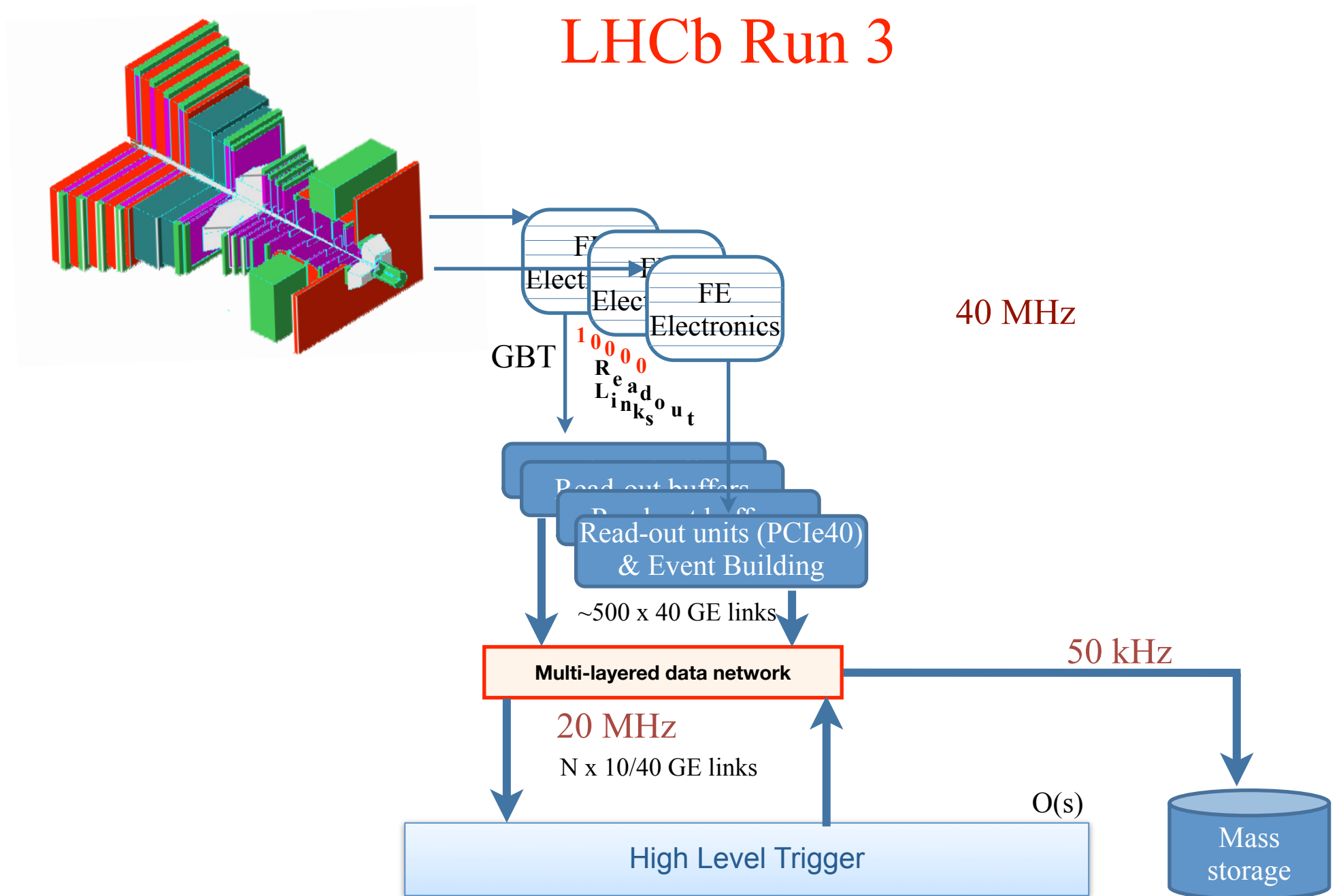
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LHCb Run 1-2



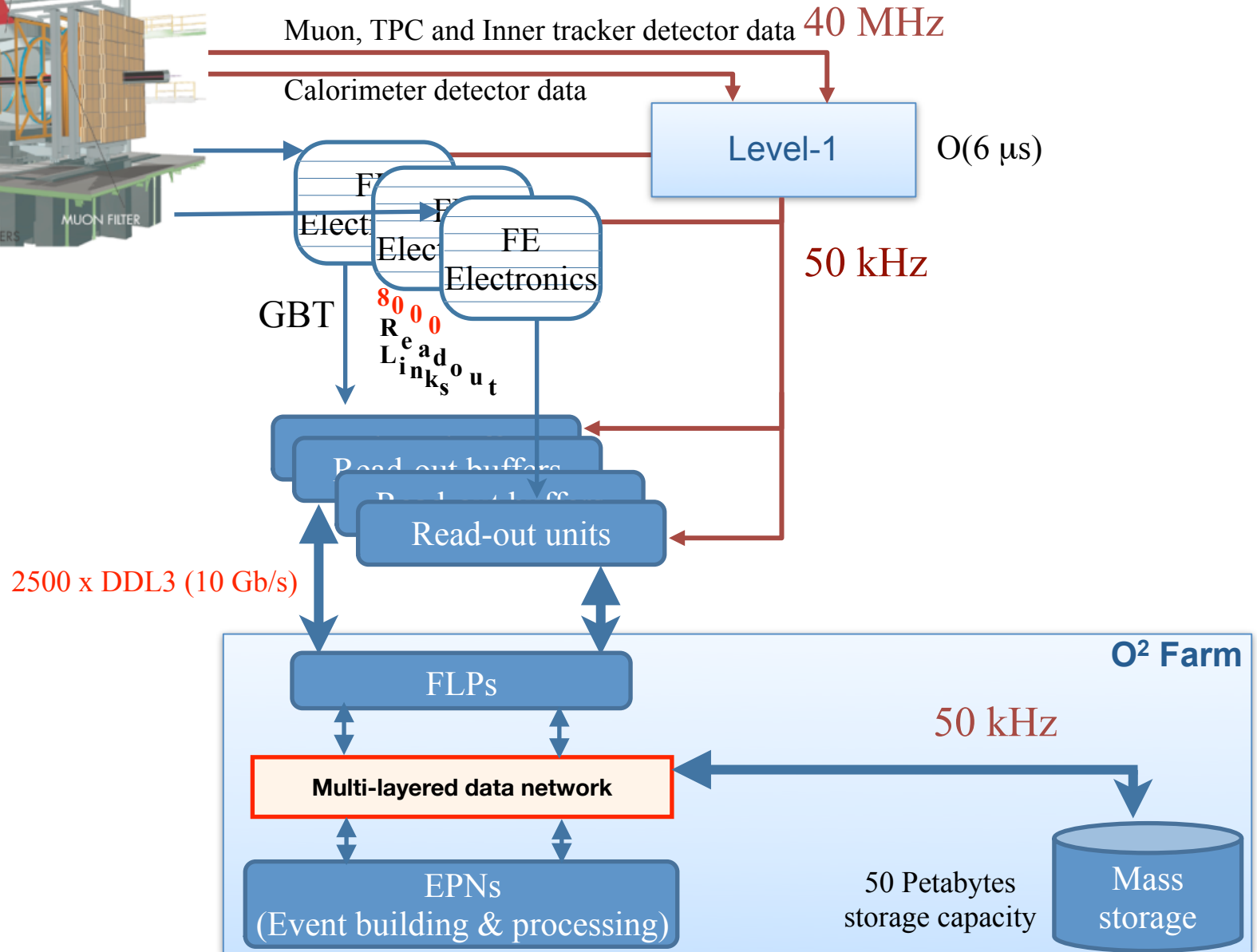
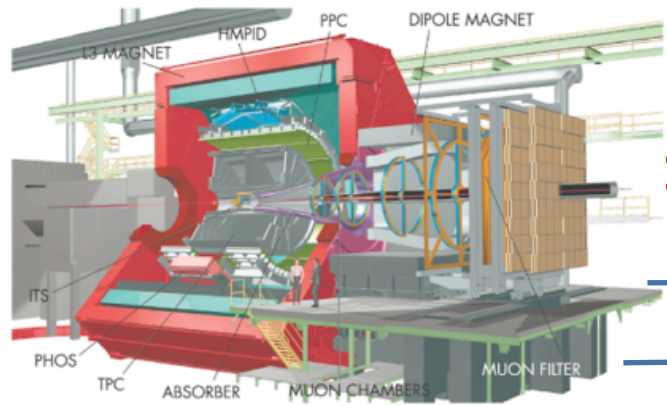
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LHCb Run 3



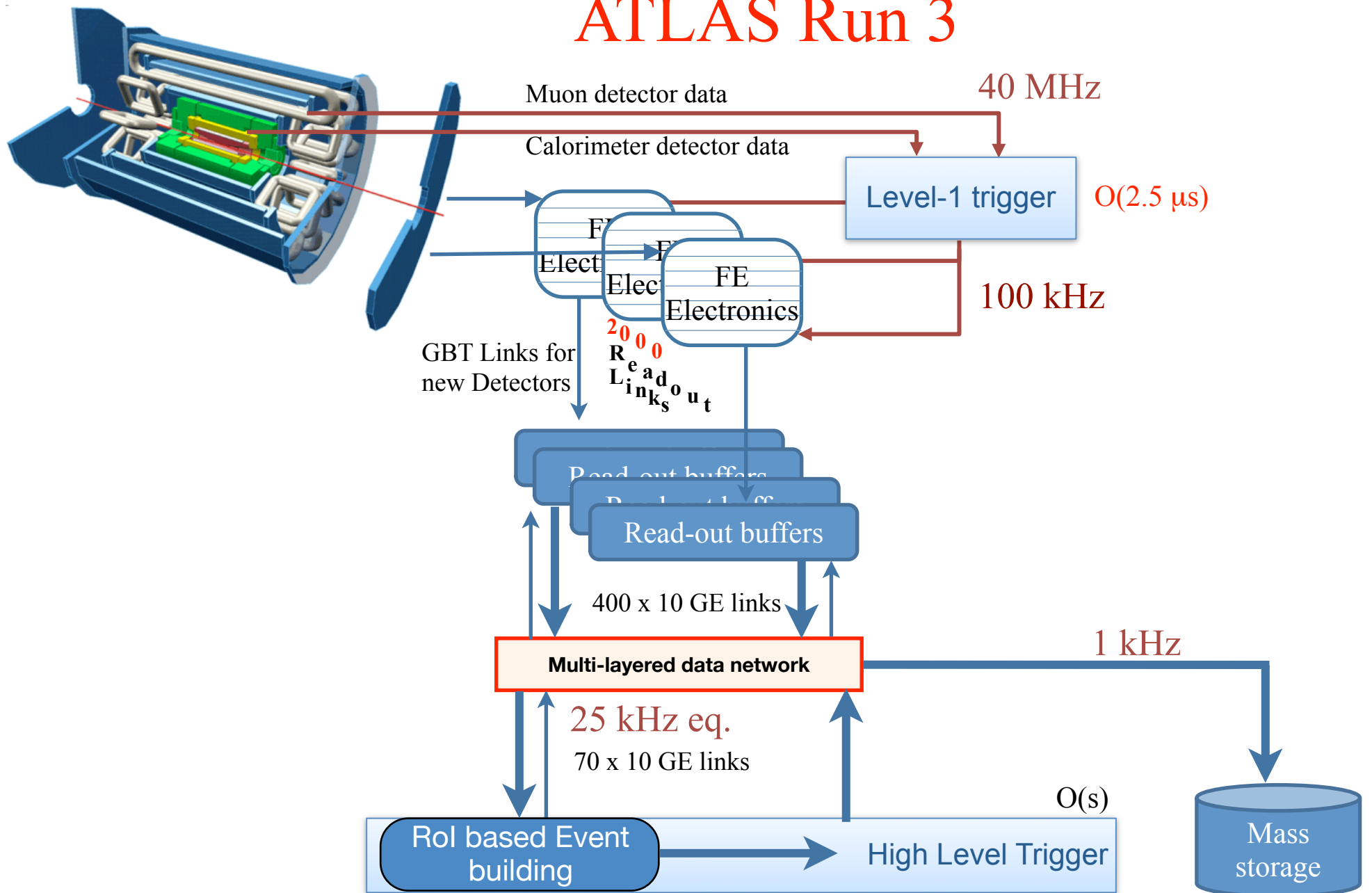
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ALICE Run 3



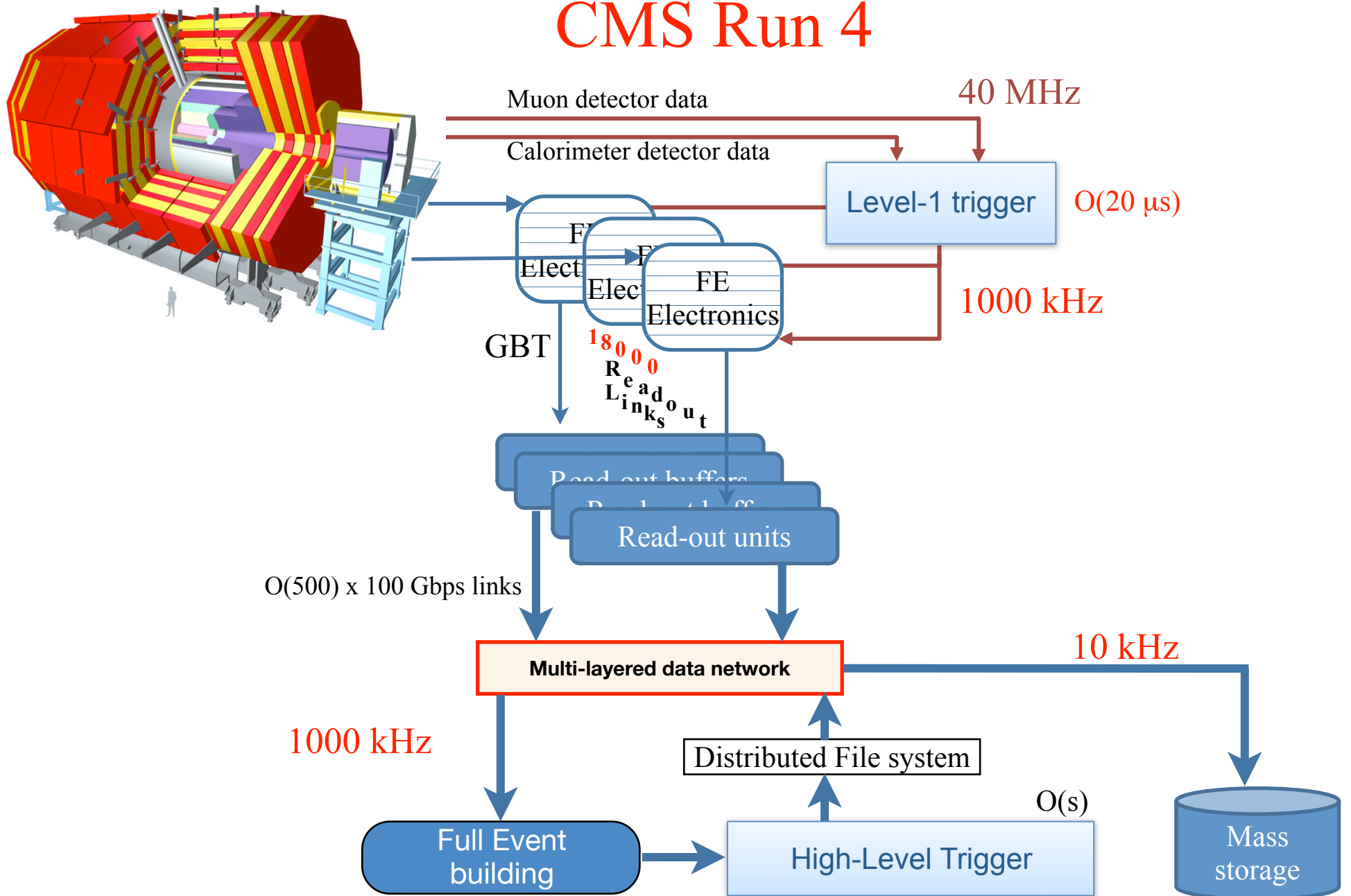
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ATLAS Run 3



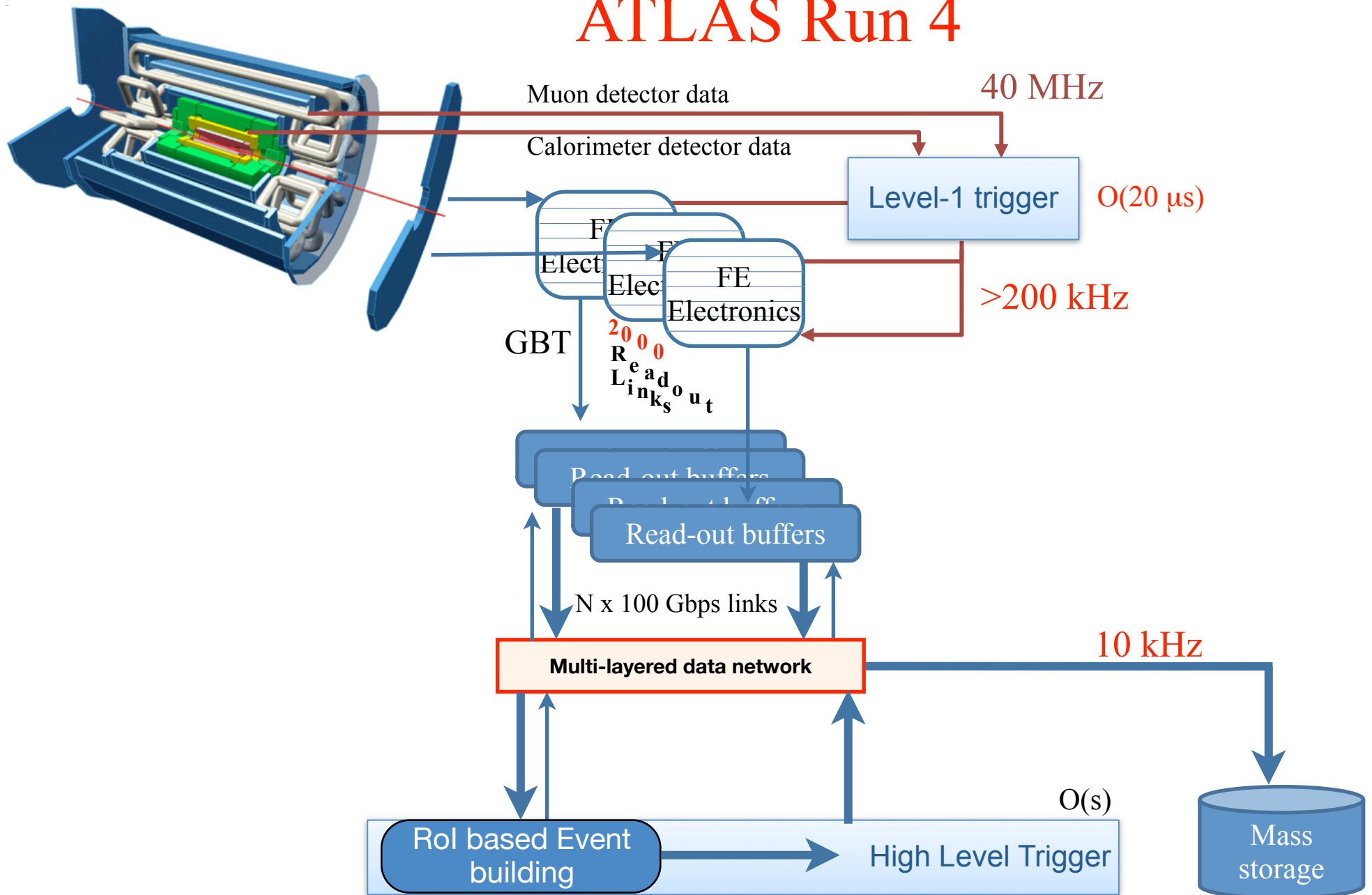
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CMS Run 4



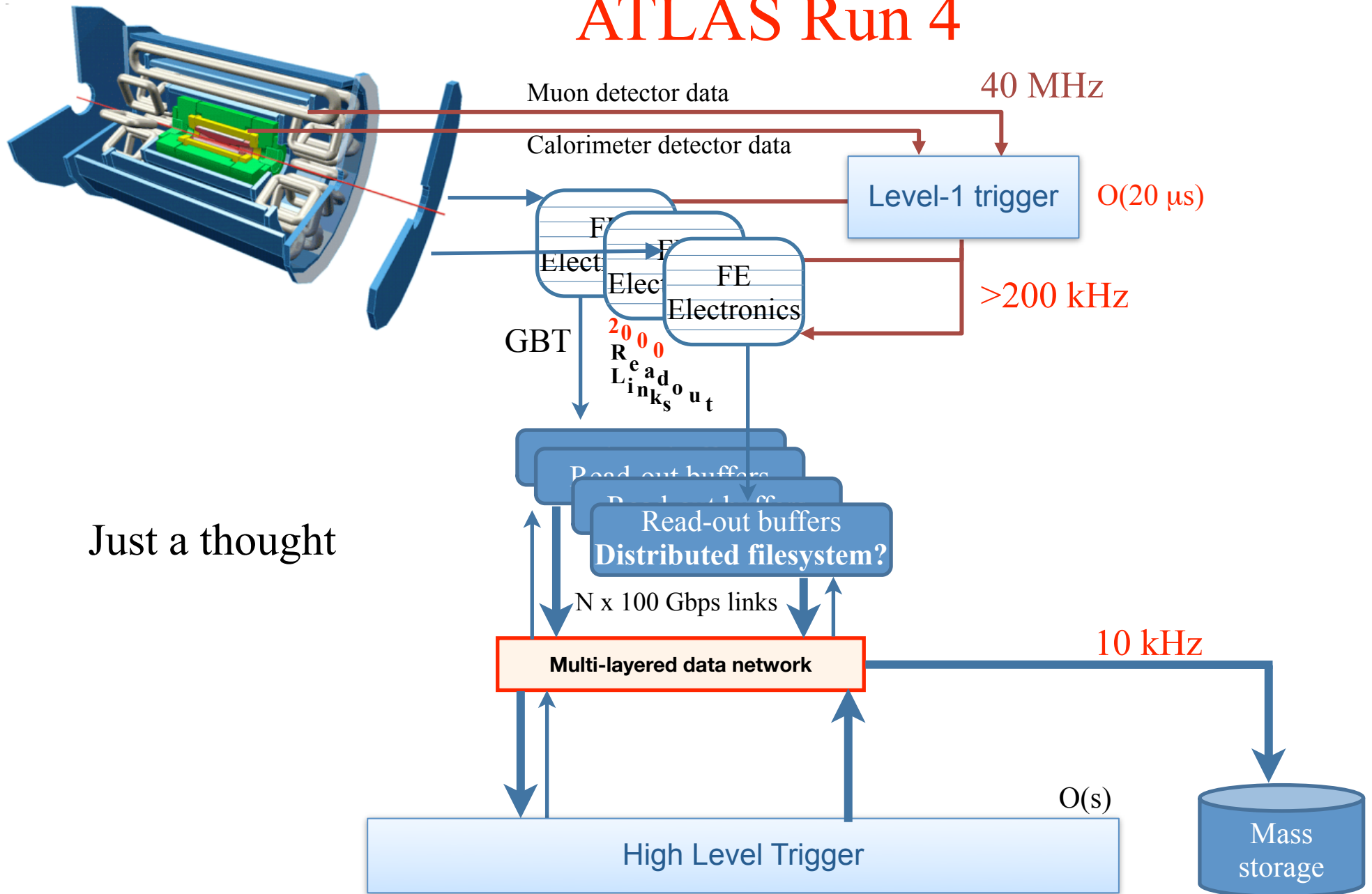
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ATLAS Run 4

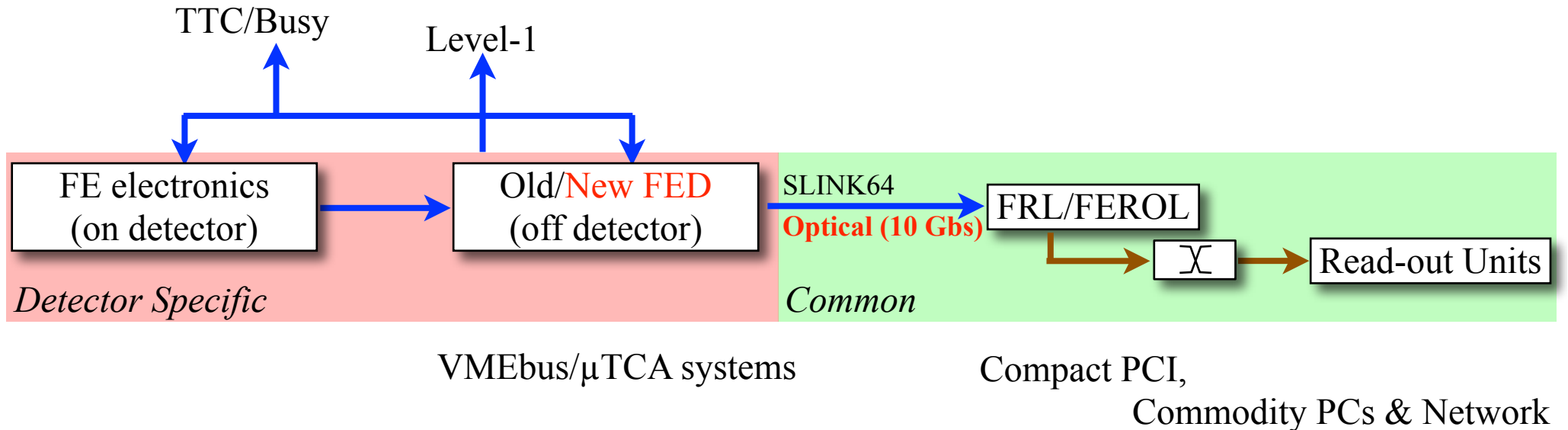


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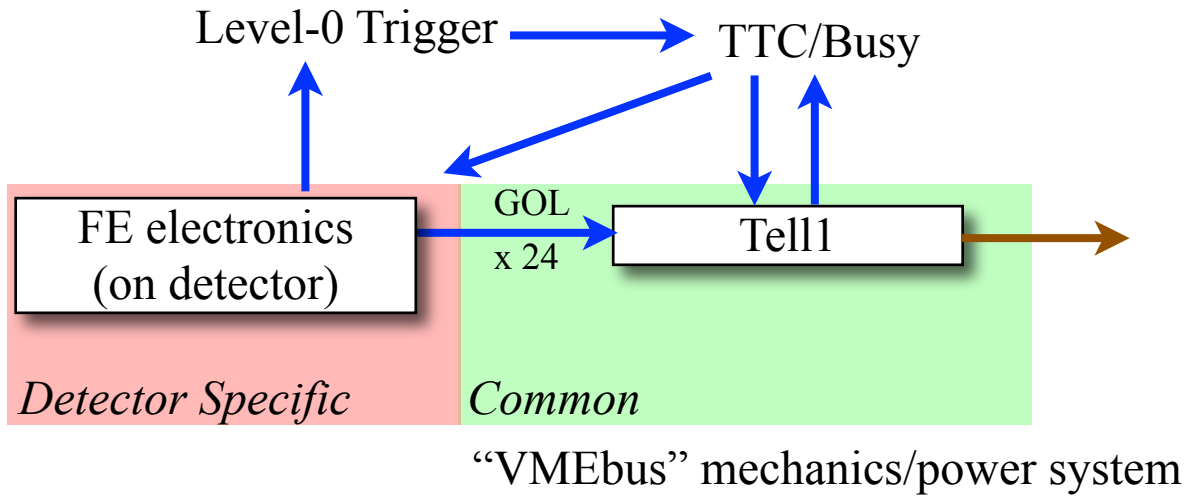
ATLAS Run 4



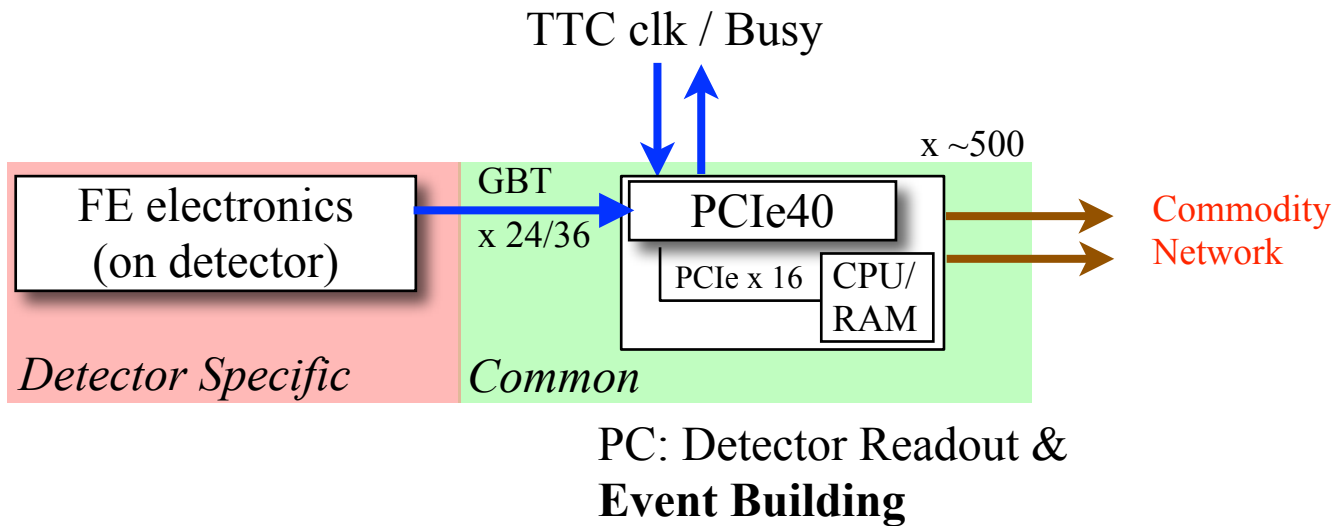
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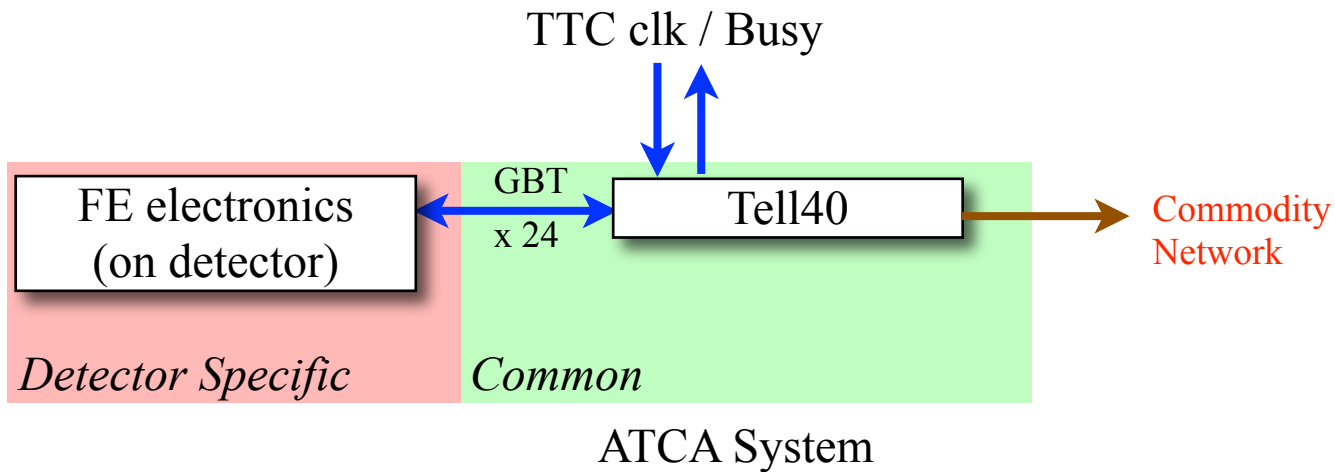
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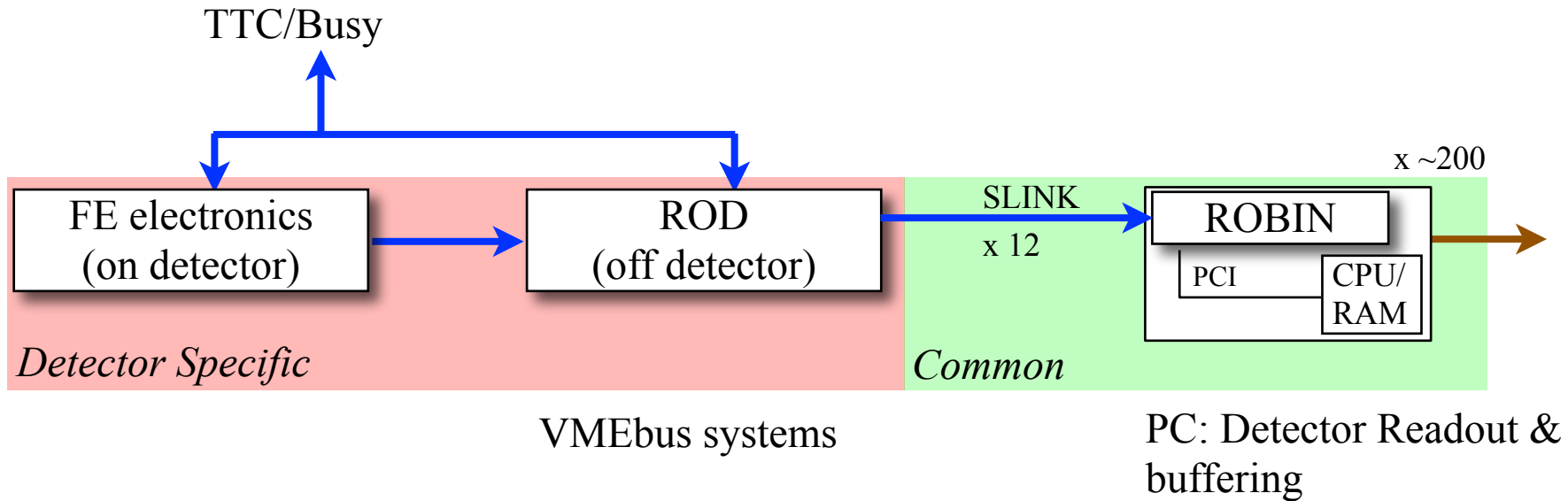
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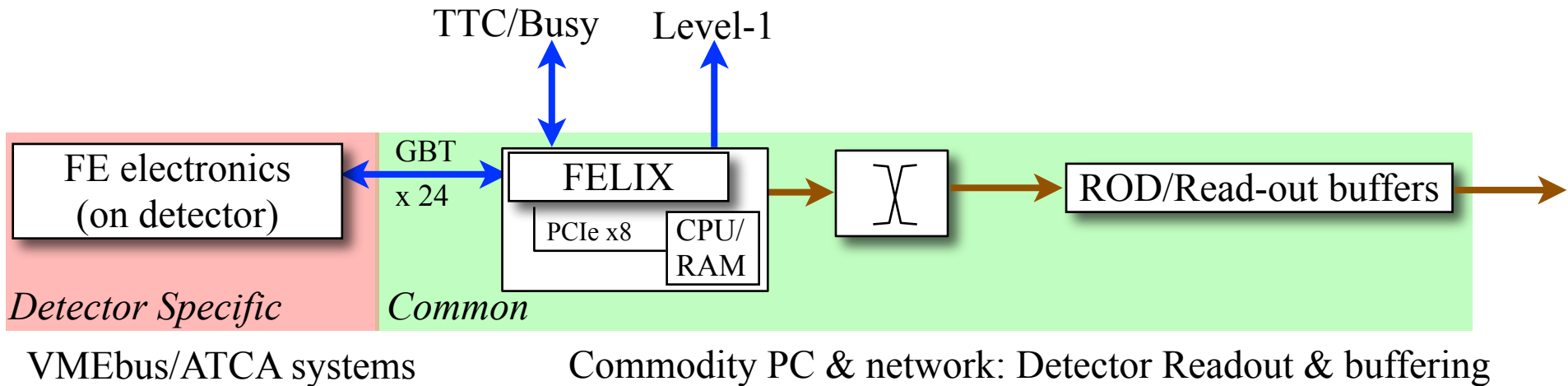
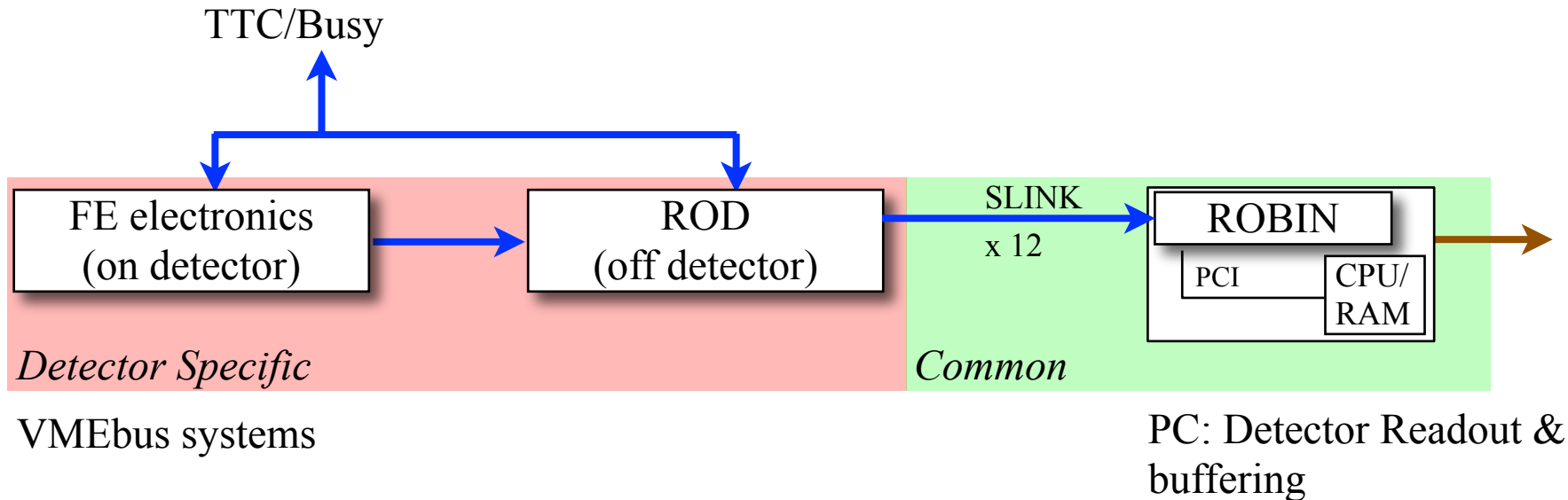
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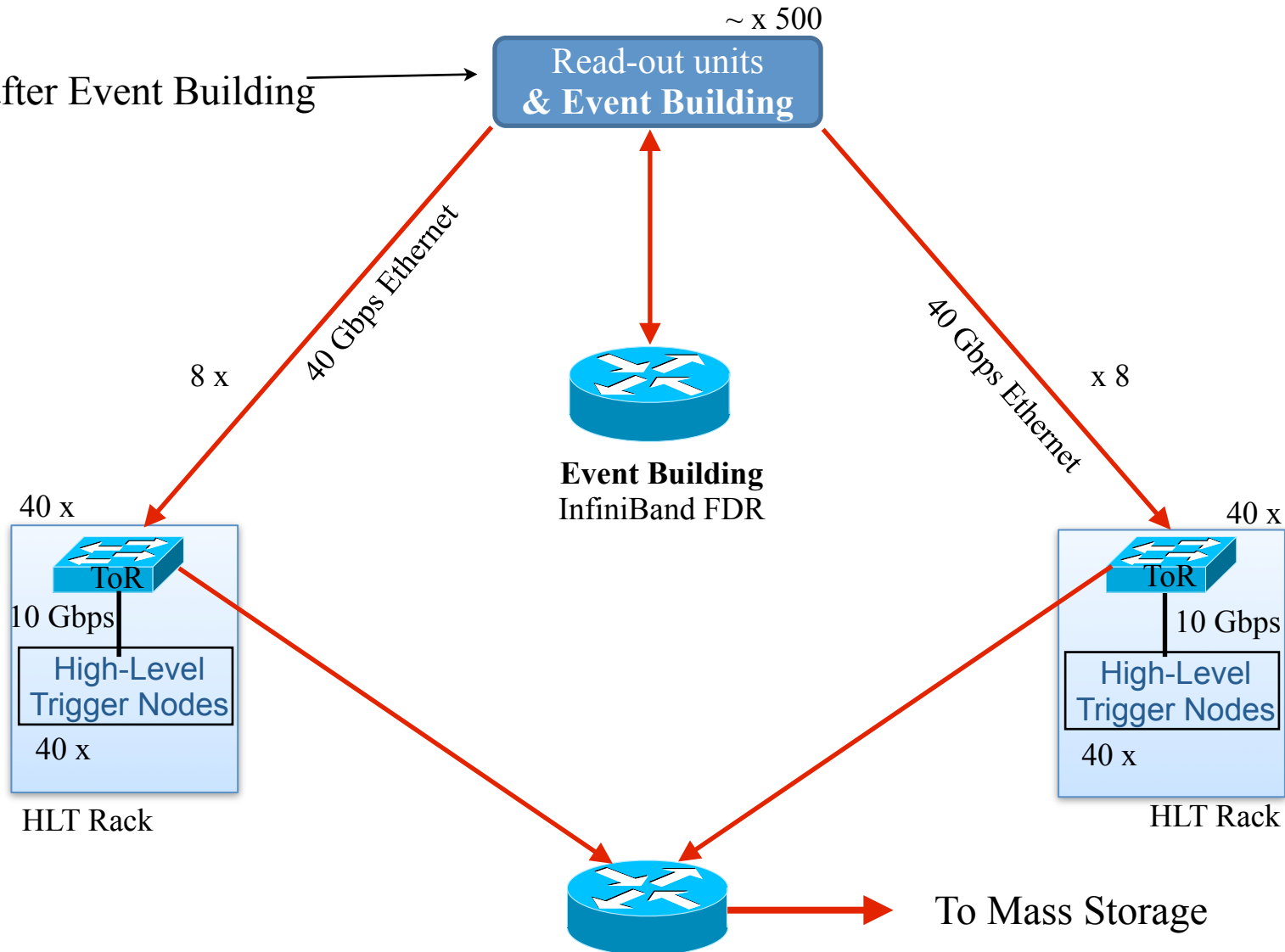
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Multi-layered data network

“Event Building” LHCb Run 3

Option:
Selection after Event Building
(HLT-0)



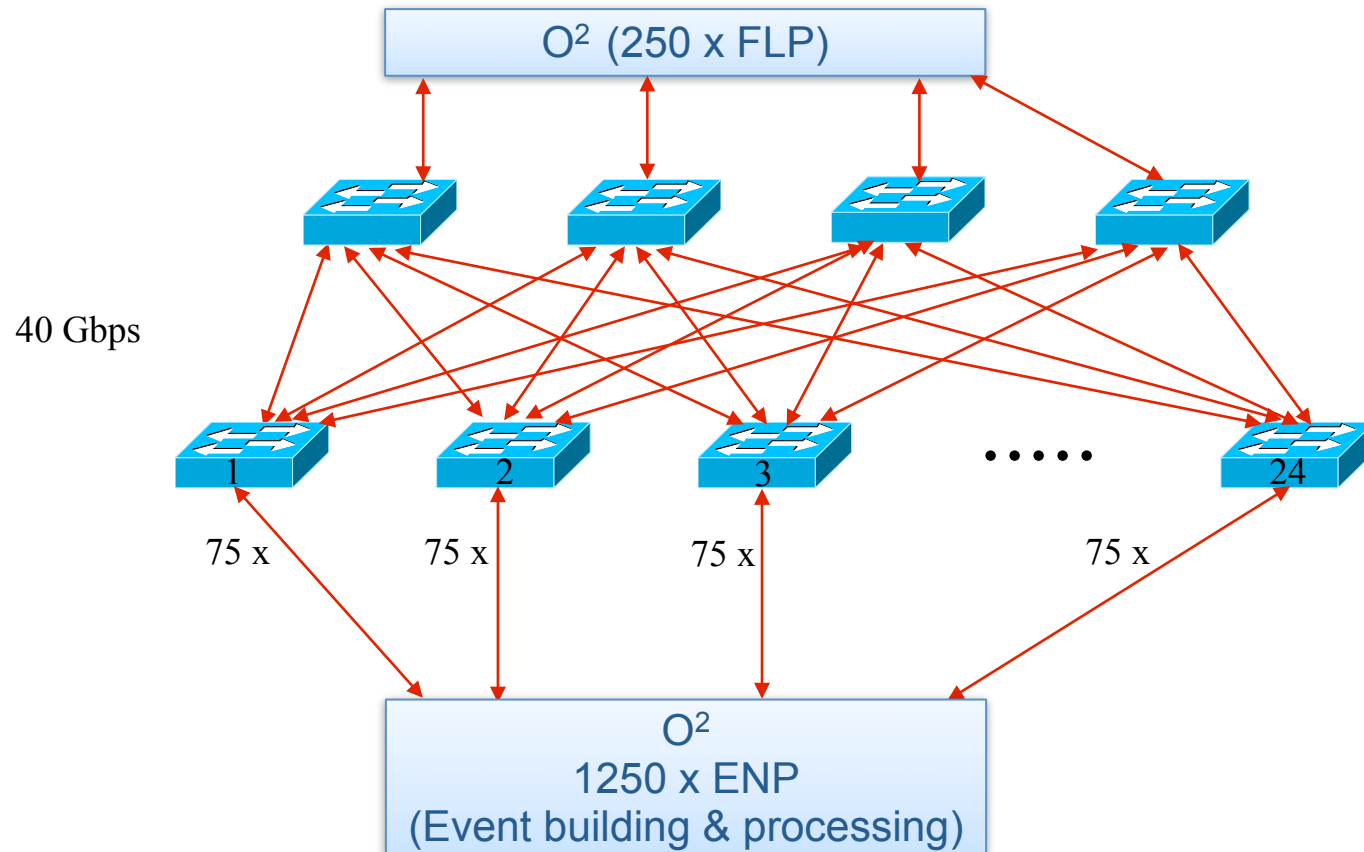
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Multi-layered data network

“Event Building”

ALICE Run 3



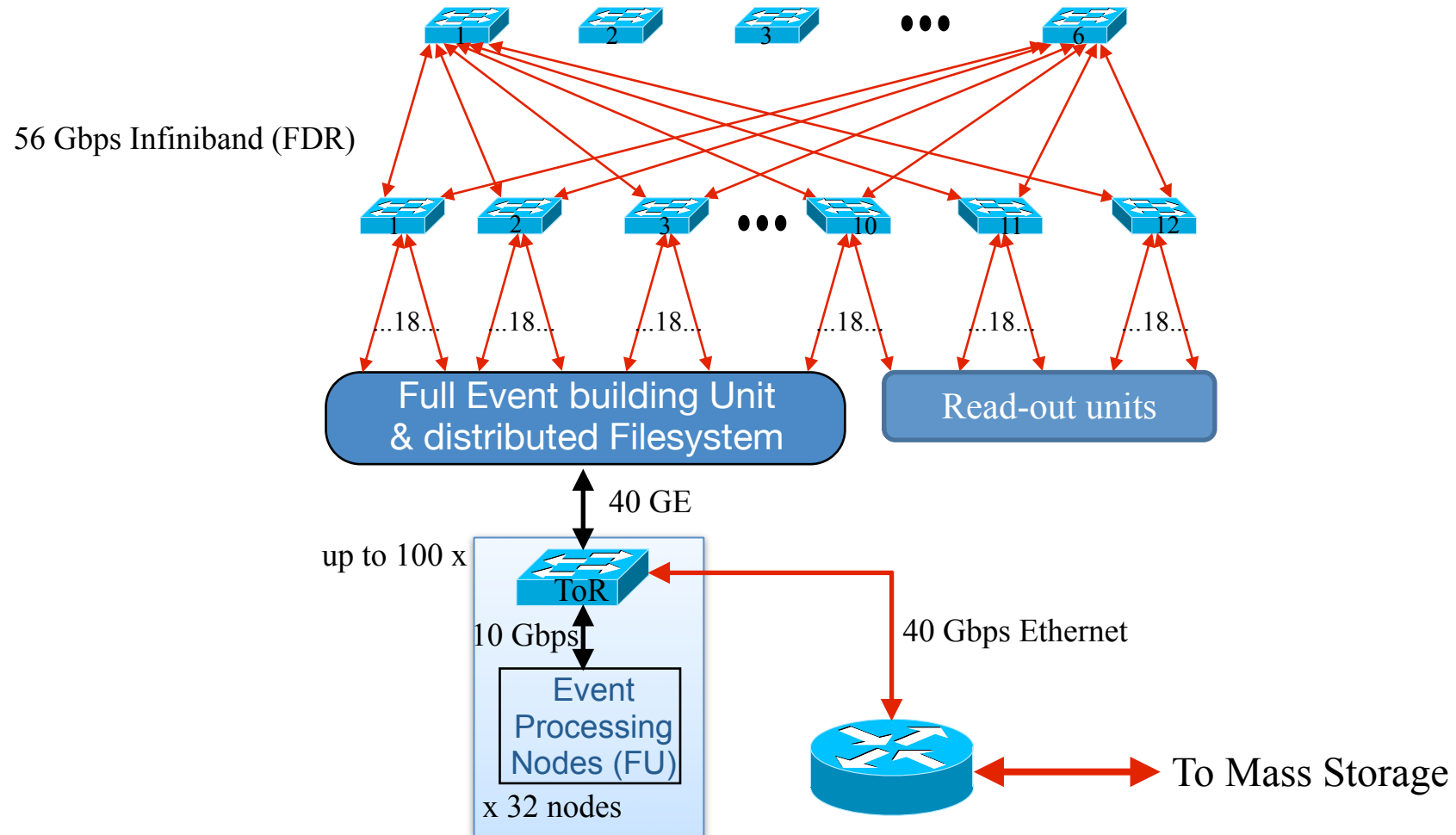
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Multi-layered data network

“Event Building”

CMS Run 2–3



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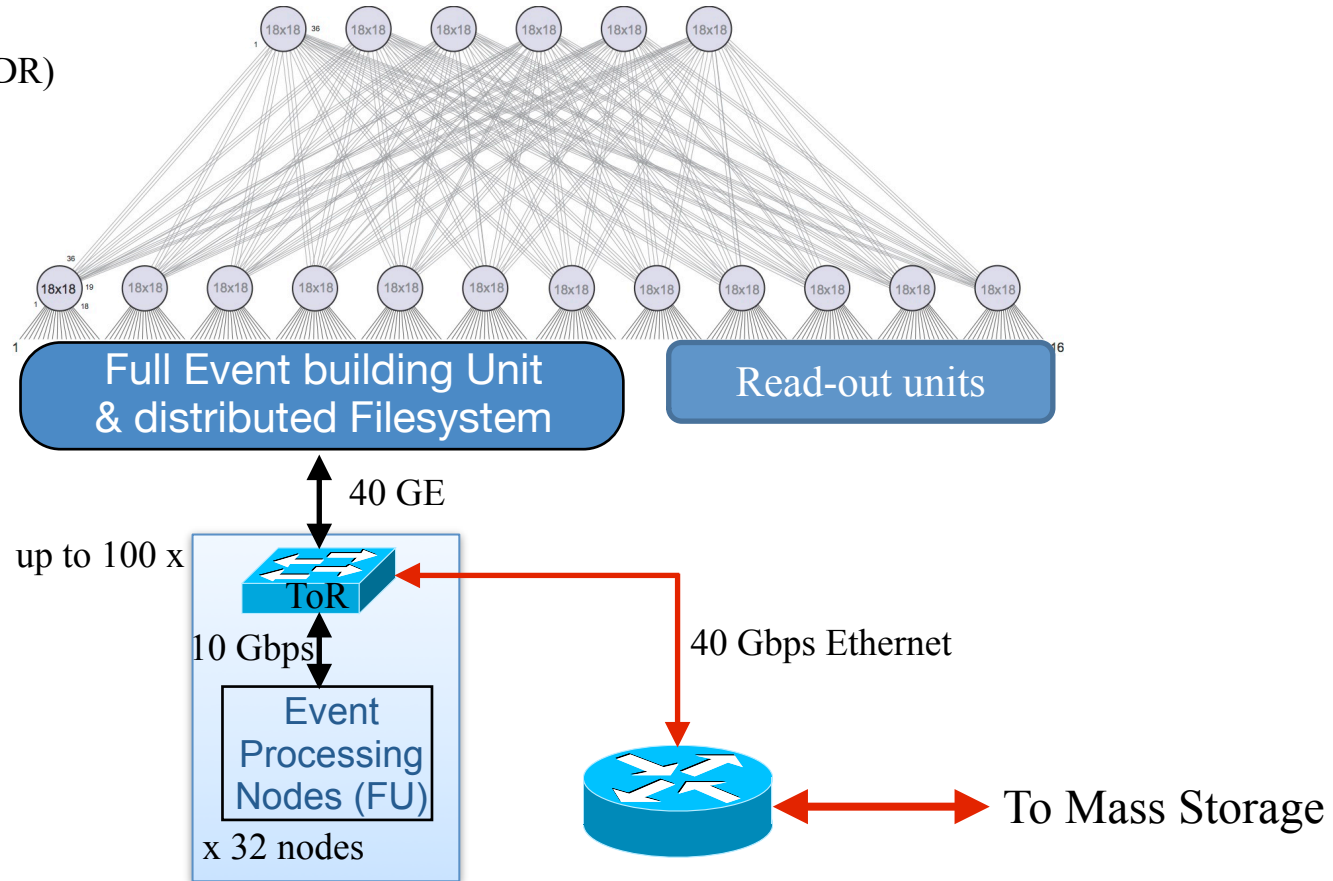


Multi-layered data network

“Event Building”

CMS Run 2–3

56 Gbps Infiniband (FDR)

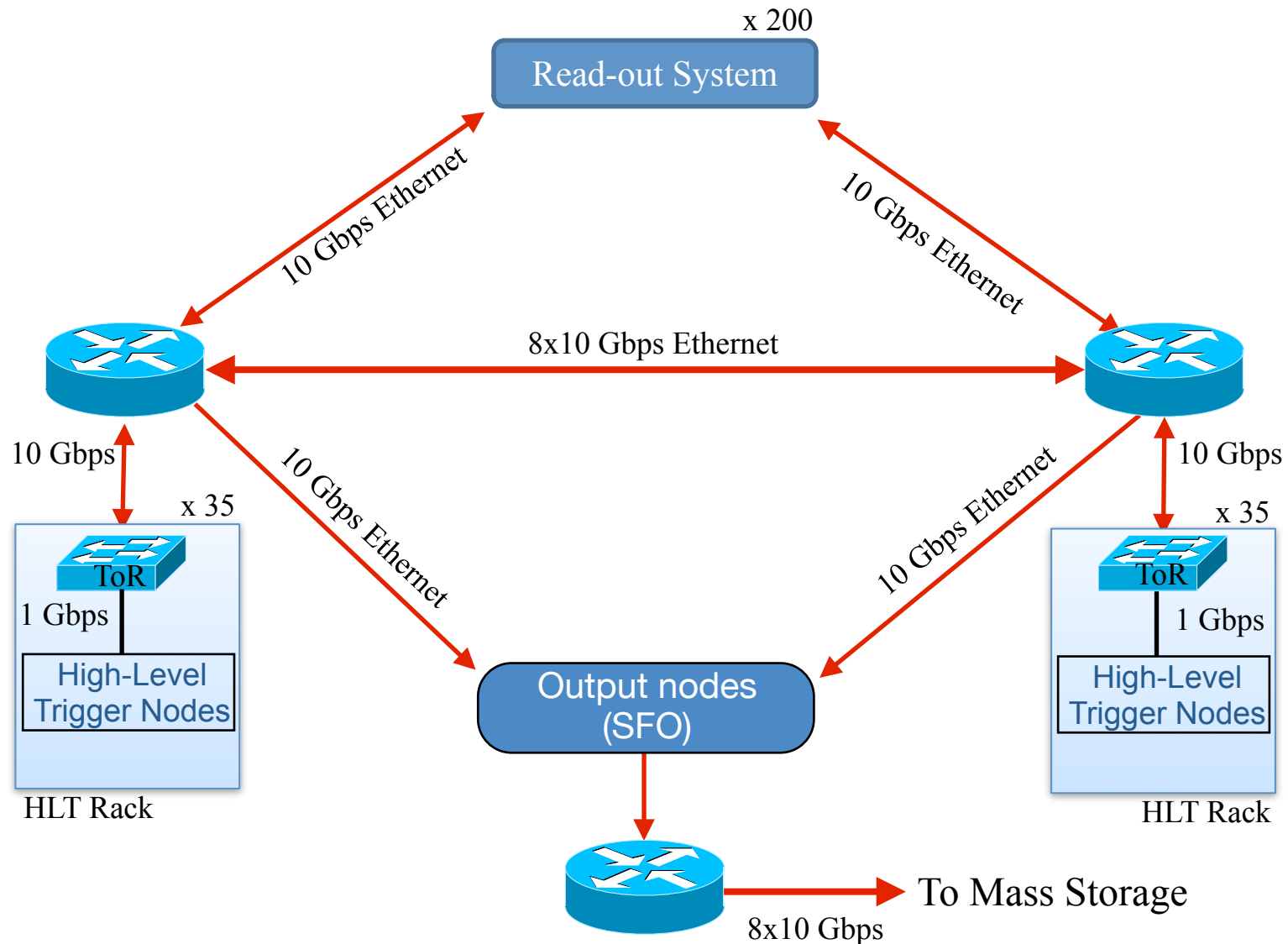


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Multi-layered data network

“Event Building” ATLAS Run 2 (-3?)



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□ Technology

- Squeeze even further the use of custom hardware in DAQ systems
 - Reduce to interfacing of front-end links, i.e. GBT, to commodity links
 - Reduce complexity and need for “in house expertise on custom hardware”
- Increased deployment of industry standards
 - PC (servers) clusters, PCIe & Multi-Gigabit Ethernet and/or Infiniband networks
 - and / or their replacements
 - C++, TCP/IP, UDP, distributed file systems, Web services etc.
- Do the minimum at Level-1
 - Maximise Detector ReadOut bandwidth

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□ Summary

- o Drawing pictures is easy hides the enormous amount of detailed work required
 - and then there is the installation/commissioning
- o Apologise again, to colleagues for not covering Control/Configuration/Monitoring
 - Whether it be Dataflow or Control/configuration/Monitoring
- o GBT predominant ...
- o CMS: Distributed File system ... this is cool
 - Coupled with event building at Level-1 rate, de-couples DAQ system from HLT
- o Online computing systems no longer exclusively used for Online
 - LHCb & ATLAS: Using the online farm as Tier-1 during non-beam
 - LHCb: also use Online farm for deferred trigger processing
 - o Targeting usage of 80% - “.. we are not quite yet there for Run2 ... on good track”
- o ALICE going further with with O²
- o Increased use of Commodity hardware
 - Transit as early as possible from custom rad-hard links to commodity network
 - o See PCIe40, Tell40 and FELIX in LHCb, ALICE and ATLAS

Commodity Technology continues to gain grounds ...

... ideas and performance of DAQ systems too!