

HLT Upgrade

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18 May 2017

- Where are we with the HLT upgrade?
- Which bits of software should we prioritise?
- What's in the recently-released notes?
- What will be in their successors?

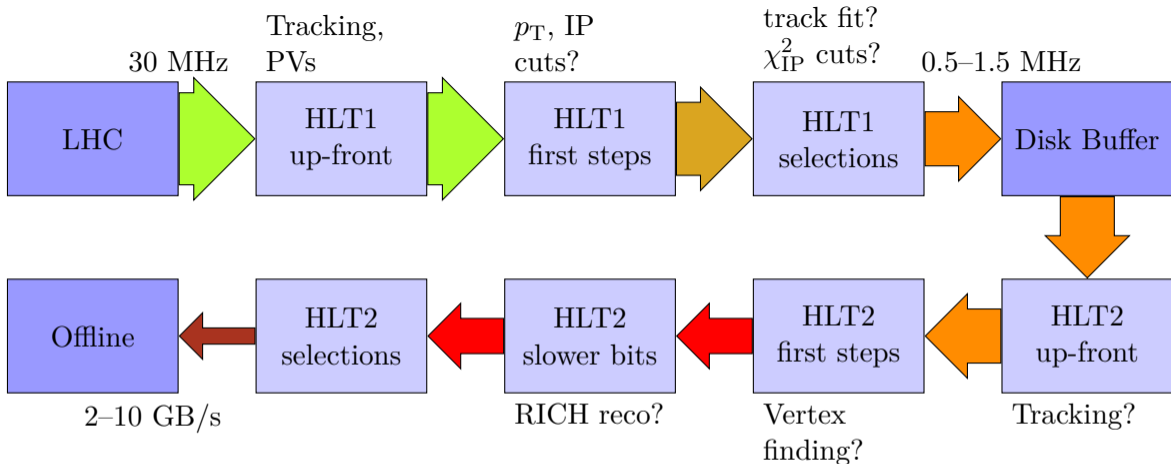
- Framework for the upgrade HLT was set out in the TDR¹, progress since then too...
- New notes about the performance² and bandwidth strategy³ were released this year
- Obviously the huge body of work done by the computing, tracking, RICH *etc.* groups on the software framework and porting of algorithms is critical for the upgrade HLT
- This talk will attempt to describe what the HLT group see as priorities

¹ *LHCb Trigger and Online Upgrade Technical Design Report*, [CERN-LHCC-2014-016](#).

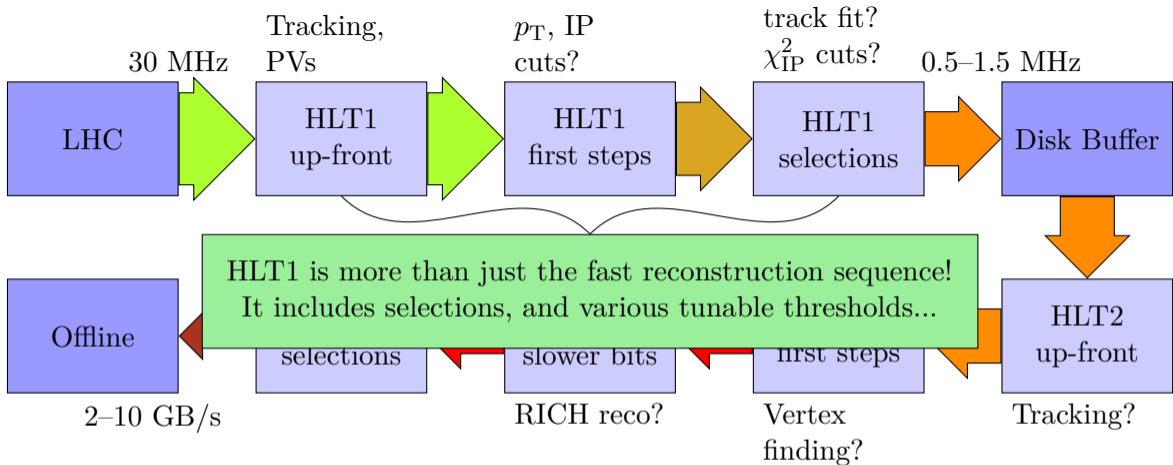
² *R. Aaij, et al., Upgrade trigger: Biannual performance update*, [LHCb-PUB-2017-005](#).

³ *C. Fitzpatrick, et al., Upgrade trigger: Bandwidth strategy proposal*, [LHCb-PUB-2017-006](#).

- Helpful to take a step back and look at the bigger picture of the upgrade HLT...
- Overview first, some more details later
- Next slide: a cartoon of LHC → Offline



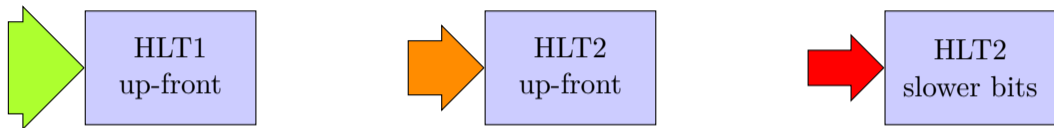
- Lots of ???, clearly there are many iterations between here and 1st collisions...
- Later points in the graph see a lower rate of typically harder-to-process events
 ⇒ time/event more important for earlier components
 ⇒ testing components in isolation can be misleading



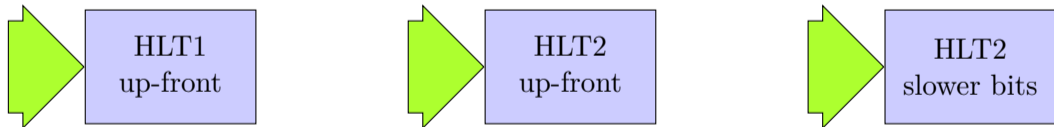
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Where are we with the HLT upgrade?

- Lots of effort has gone into porting the reconstruction (“Brunel”), *i.e.* \approx



- So far this has mostly been done in isolation, *i.e.* \approx



- In reality we will reject events/objects at various stages, to get sensible results we need plug everything together

- Excellent progress on porting the reconstruction algorithms and framework
- So far not so much work on the framework for making selections that we'll need in order to construct HLT1 and HLT2
- HLT1 is relatively simple, we should try to produce a skeleton version of it “soon”
- This would also be a neat way of letting us run “HLT2 algorithms” on HLT1-accepted events, which is more realistic
- We can also instrument old, single-threaded, Moore to process upgrade MC – this is a different way of getting HLT1-accepted upgrade events, but is less desirable

- TDR⁴ considered three scenarios: 2, 5 and 10 GB/s, corresponding (very roughly) to:
 - 2 GB/s – “B physics + some charm”
 - 5 GB/s – “B and charm physics”
 - 10 GB/s – “everything”
- Some obvious statements:
 - “The more the better”
 - “Physicists are good at making the most of what they get”
- How we fit into these resources is defined by the HLT2 selections, which will be decided by the PPG
- More important questions: how fast do we fill the buffer (HLT1 output), and how fast do we empty it (HLT2 throughput)
- Other questions for later: how aggressively will we compress HLT2 output data? Will we still write MDF? How many streams will we write?

⁴LHCb Trigger and Online Upgrade Technical Design Report, [CERN-LHCC-2014-016](#).

- We would like to put together a basic “upgrade HLT1” in the new framework
- Need to make sure everything is in place to...
 - Apply selections – *e.g.* apply cuts to tracks, composite particles, potentially filter between different tracking algorithms
 - Combine particles (*e.g.* TwoTrackMVA)
 - Efficiently share work between *e.g.* different HLT1 selections
- “We need to be able to filter everything, everywhere”

- Selections and sequence tuning at HLT2 will be defined once a baseline HLT1 is usable for tests
- Important to bear it in mind when making design choices
- HLT2 dependency graph will be complex – expect hundreds of selections, expect lots of overlap between them to avoid duplicating work
- Generally: important to discuss how to efficiently share work in HLT1 and HLT2
- Expect to abandon the Run 1–2 model for some use-cases – *e.g.* build HLT2 candidates starting from HLT1 ones⁵, build exclusive B candidates from the Topo...
- Maybe we will need more drastic changes – *e.g.* up-front vertex finding/combinatorics instead of individual selections running `CombineParticles`?
- Need to check how the current model scales to the upgrade, and ensure compatibility between design and use-case. Need to be able to perform studies on combinations

⁵Currently we start from scratch in HLT2 and eventually check overlap with HLT1...

- Public notes were released earlier this year about the upgrade reconstruction performance⁶ and output bandwidth strategy⁷
- Performance note describes the various changes in the reconstruction since the TDR, and updates the performance measurements
- Bandwidth note discusses describes work on the HLT1 selection strategy in the upgrade, and steps towards an “HLT2 bandwidth division”

⁶R. Aaij, et al., *Upgrade trigger: Biannual performance update*, [LHCb-PUB-2017-005](#).

⁷C. Fitzpatrick, et al., *Upgrade trigger: Bandwidth strategy proposal*, [LHCb-PUB-2017-006](#).

- Both notes are due to be updated in 2018 to summarise progress
- New simulated samples of minimum bias and signal events will be generated, test productions started this week (?)
- Physics WGs have selected their signal modes, will provide “offline” selections as multivariate classifiers
 - ⇒ one tuning knob per mode, will be used in the updated bandwidth strategy

What will be in their successors?

- HLT1 performance will be re-evaluated using the latest and greatest developments, and it will need to actually select events
- HLT1 selections (*i.e.* the inclusive MVAs) need to be re-tuned using latest-and-greatest MC
- Disk buffer: need a full treatment. How much can we have? How many hours of collisions does this correspond to?
- HLT2 reconstruction performance needs to be evaluated on HLT1-accepted data, including *e.g.* measurements of how sensitive to HLT1 thresholds the performance is
- More detailed HLT2 selections to cover the majority of the upgrade physics programme
- Need to estimate something about the rest (*i.e.* post-reconstruction parts) of HLT2

- We need to be able to select stuff
- Hope to leverage the huge body of work already done on the upgrade reconstruction to put together something that looks faintly like Moore using the **future** software
- Thanks for all the work everyone is doing! Now we need to see what we can do with it!

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(Please give us $6\times$ the farm budget!)

Backup