LHCb Turbo (LLP) Triggers

4th LLP Workshop

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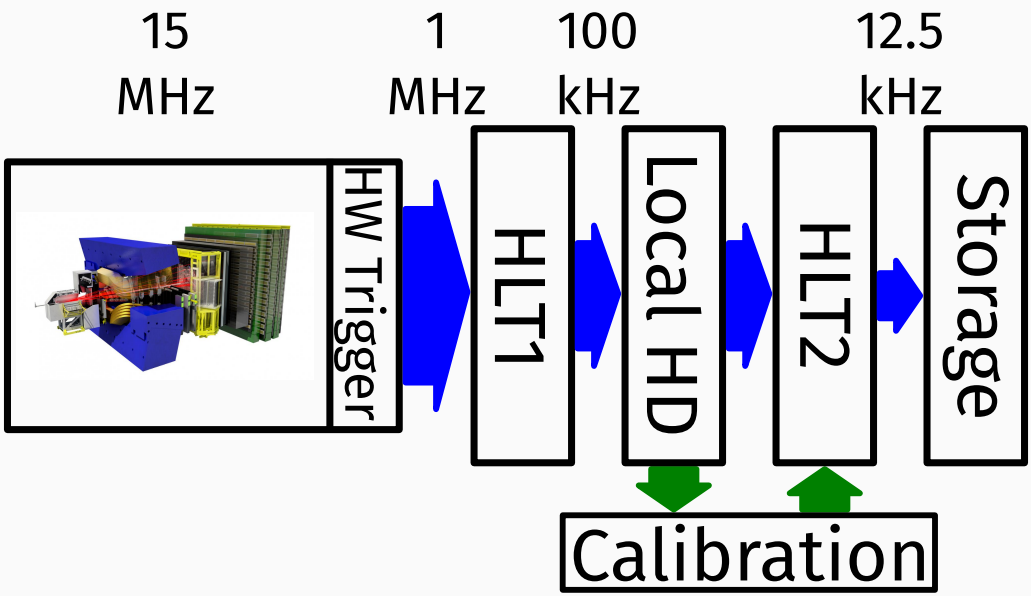
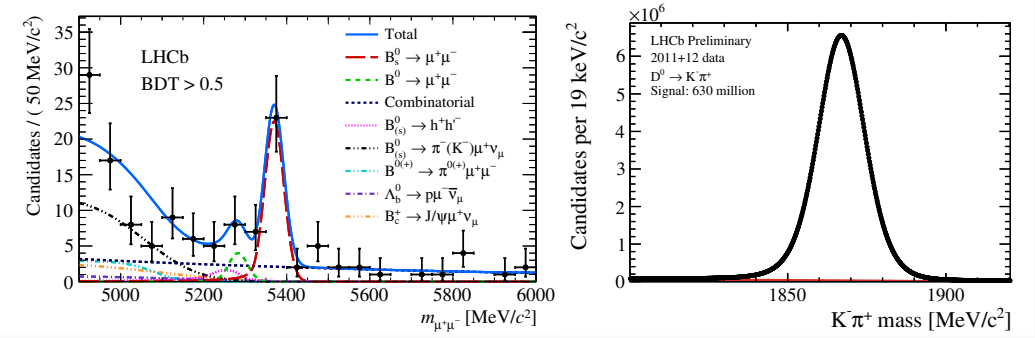
Nikhef, Amsterdam


15
MHz
1
MHz
100
kHz
12.5
kHz
HW Trigger
HLT1
Local HD
HLT2
Storage
Calibration

Trigger Requirements

- LHCb needs an extremely versatile trigger



- High efficiency for rare decays
- High purity for signals with large rates

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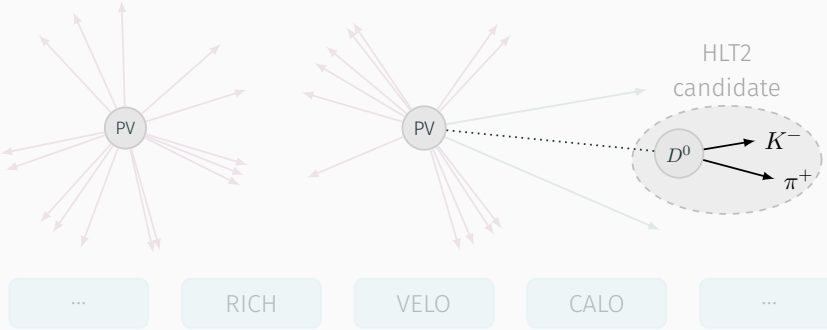
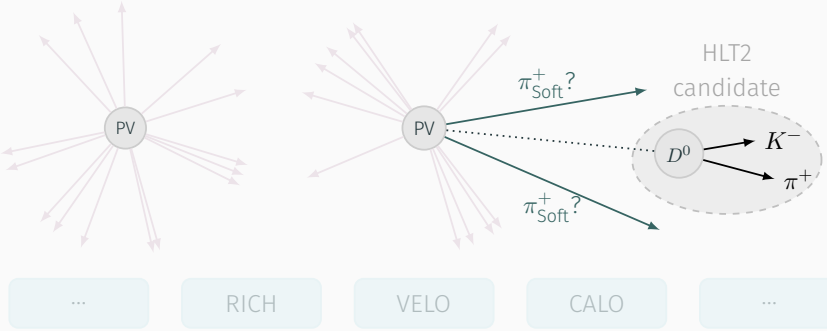
LHCb-CONF-2016-005

The Turbo persistence model



- **Turbo**: Save only the objects involved in the trigger decision, plus all PVs
  - Tracks and neutral objects and their clusters
  - Decay vertices

The Turbo persistence model



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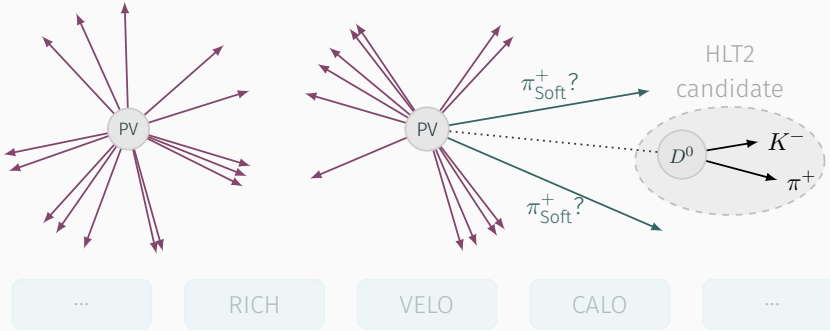
- **TurboSP**: Completely flexible specification of additional objects to save

The Turbo persistence model



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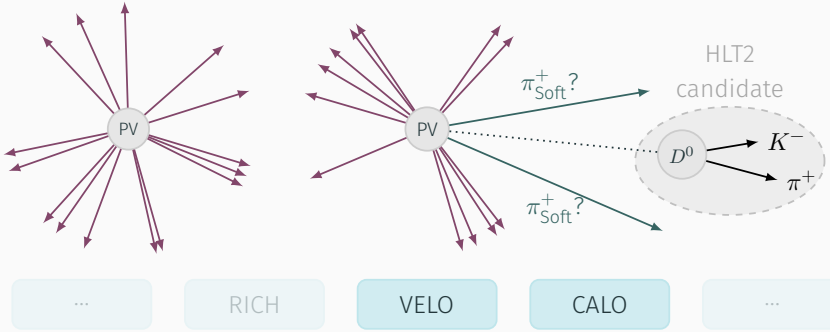

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  - Tracks and neutral objects and their clusters
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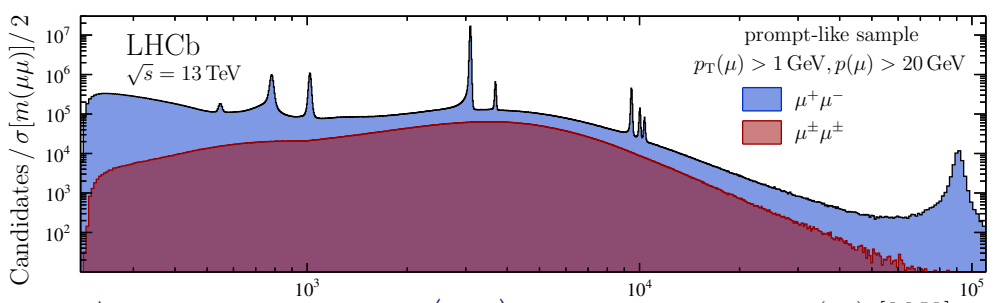
- **TurboSP**: Completely flexible specification of additional objects to save
- **Turbo++**: The entire reconstruction
- **TurboX**: Selective raw banks

Dark Photon Search

- Search for prompt $A' \to \mu^+\mu^-$ impossible without Turbo
- Also impossible without best-quality μID available online
- One of the first published analyses based on Turbo
- Competitive limits



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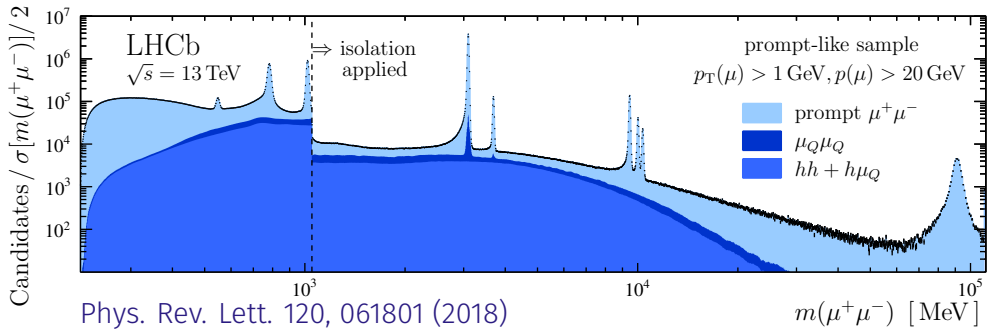

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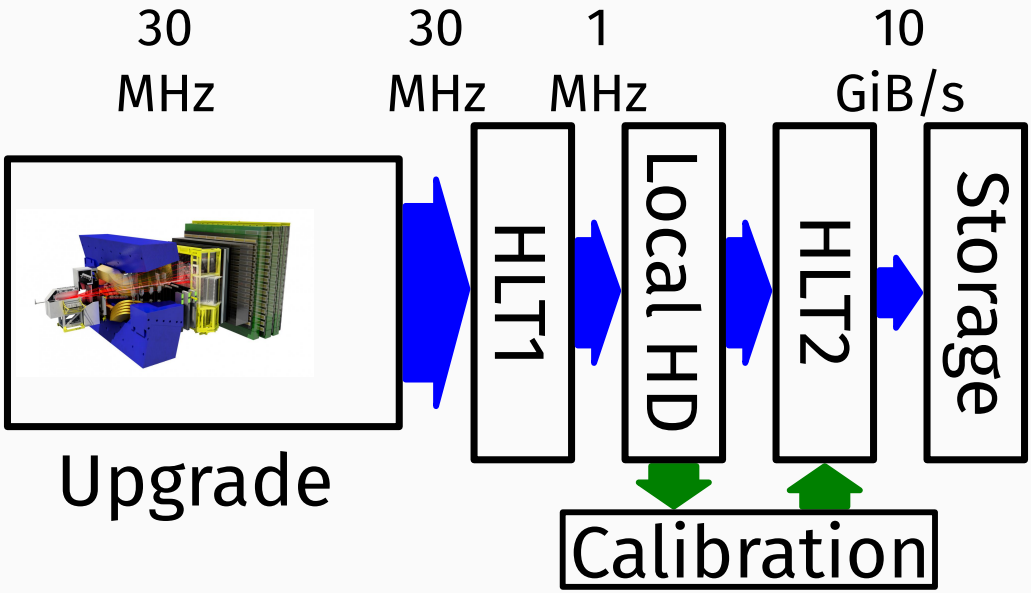
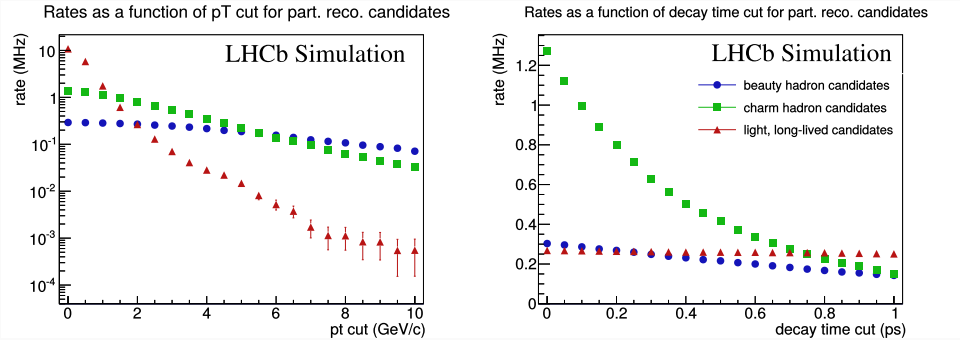
Run II Displaced Jets

- Jet reconstruction based on Particle Flow followed by Jet Clustering
- Jet reconstruction re-optimized for Run II
- Lines running in 2018 include displaced signatures
  - Displacement based on constituent tracks
  - Single and Dijet tagged with b-vertices or muon
  - Jets must originate in vertex detector
- Algorithm developed for general secondary vertex search in jets


30
MHz
30
MHz
1
MHz
10
GiB/s
HLT1
Local HD
HLT2
Storage
Upgrade
Calibration

Upgrade Event Anatomy

- Upgrade pileup of 5 will put signal rates in the order of MHz



- Triggering becomes classifying

LHCb-PUB-2014-027

Upgrade Turbo

- Exercise: extrapolate Run II stream size to Upgrade
- Will have $5\times$ luminosity and $2\times$ the efficiency
- No pile-up effect for pure Turbo events

Streams sizes in GB/s

	TURBO	FULL	Total
Run 2	0.1	0.5	0.6
Run 3	1	15	16

- 16 GB/s not realistic
- Only handle: move FULL triggers to TURBO

Turbo LLPs

- Full software trigger opens up new possibilities
- Turbo very successful for dark photon search
- Have to balance rate versus event size for jets
- Run II Jet triggers a good starting point
- Identify and exploit general signatures
  - Cheap to store extra leptons
- Careful selection of control channels
- Early availability of simulated samples crucial for optimization