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# Triggering on charmonia decaying to hadrons

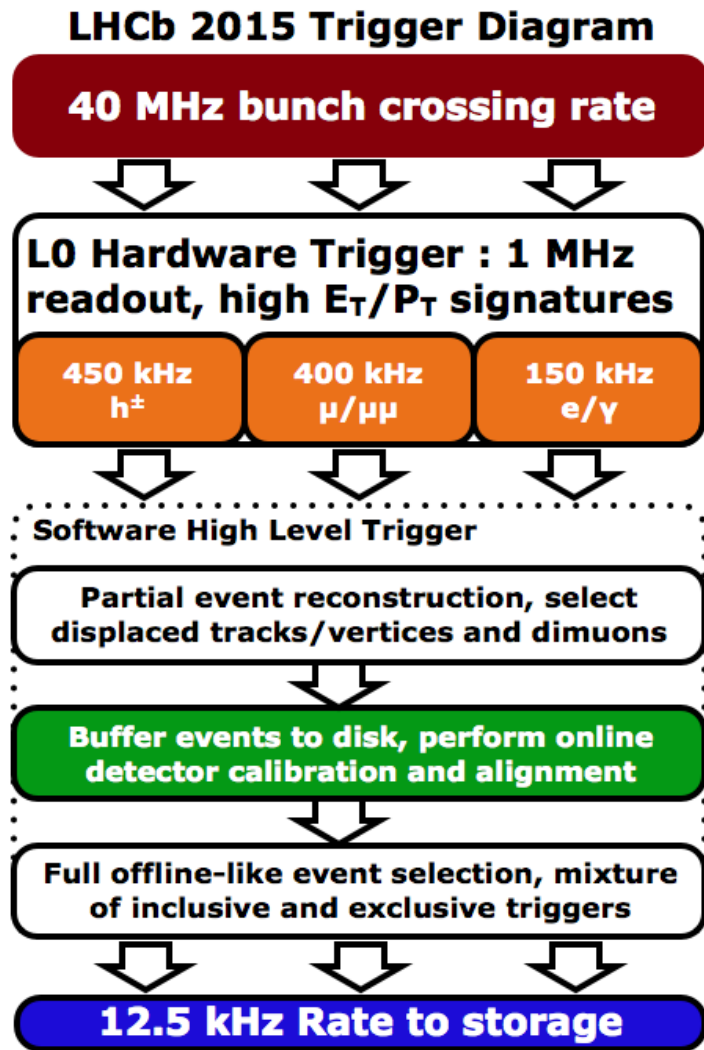
Sascha Stahl, CERN

Mini-workshop on charmonium production at LHCb

16/06/2017

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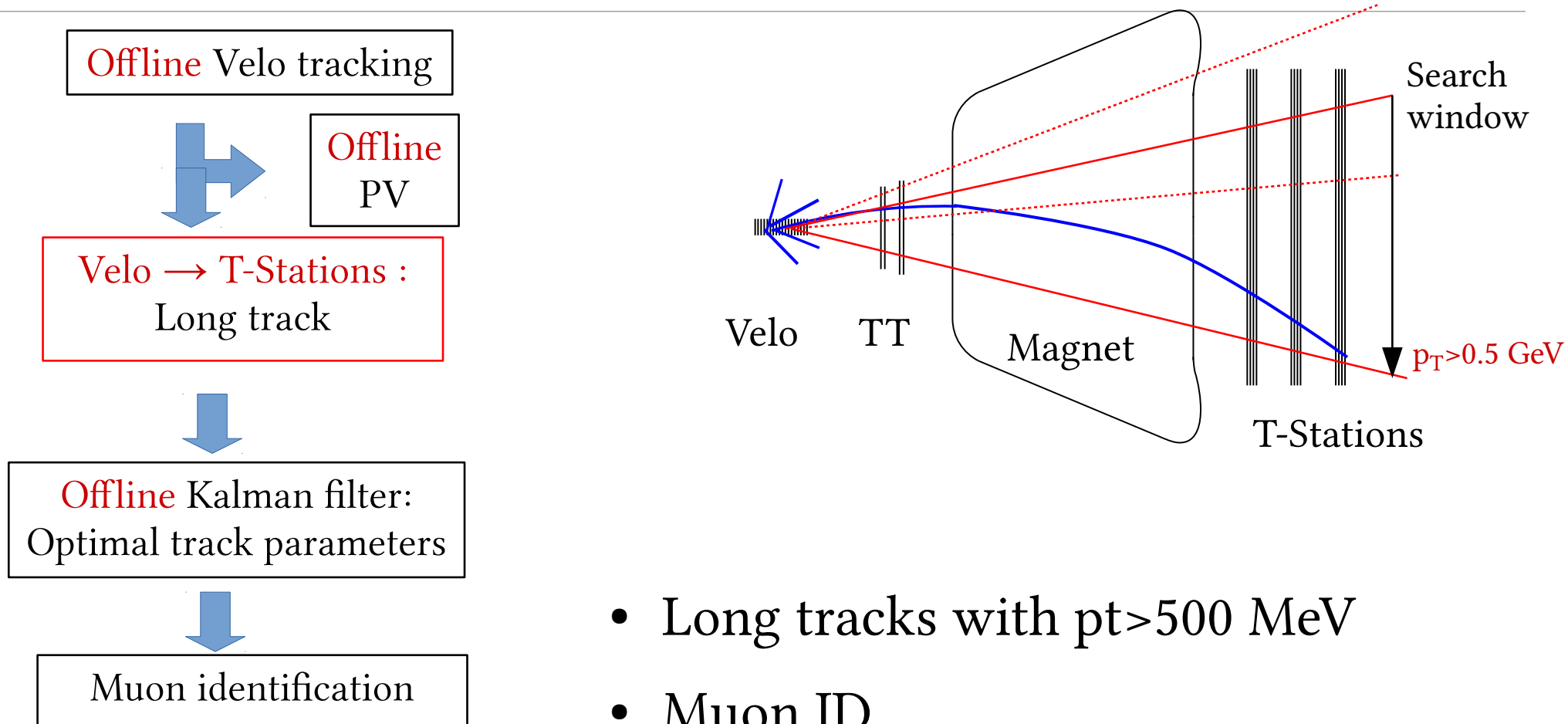
# HLT layout



Line	Threshold
L0DiMuon	$1.8^2 \text{ GeV}^2$
L0Muon	1.9 GeV
L0Photon	3.1 GeV
L0Electron	2.7 GeV
L0Hadron	3.9 GeV

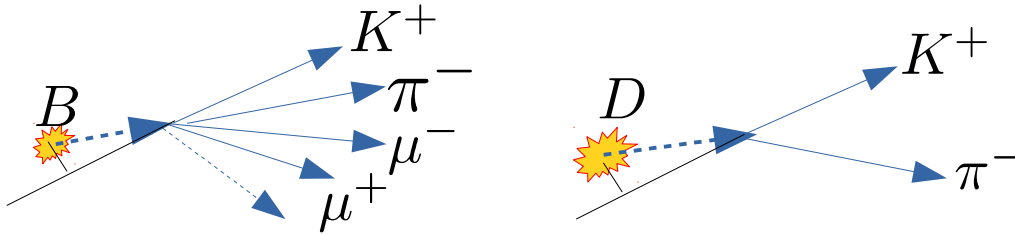
Except L0DiMuon all lines cut on the number of charged particles in event (SPD hits < 450)

# HLT1 trigger



- Long tracks with  $p_T > 500 \text{ MeV}$
- Muon ID

# HLT1 trigger



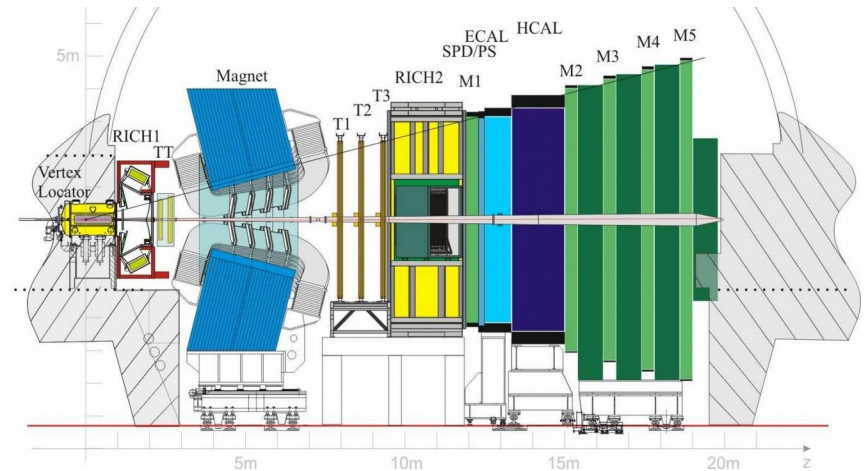
- Inclusive charm and beauty triggers:
  - Single and two track selections  
→ ~90 kHz
- Inclusive muon triggers:
  - Single and dimuon selections
  - Special low  $p_T$  track reconstruction
  - → ~20 kHz
- Exclusive triggers:
  - Lifetime unbiased trigger selections, DiProton selection ...

#	Regex	Inclusive [kHz]	[MB/s]	[kB/event]
1	<a href="#">Hlt1.*</a>	123.0 ± 1.9	7003.7	58.3
2	<a href="#">Hlt1.*TrackMVA.*</a>	88.7 ± 1.6	5330.3	61.6
3	<a href="#">Hlt1(Di Multi)Muon.*</a>	13.0 ± 0.7	875.1	68.9
4	<a href="#">Hlt1LowMult.*</a>	11.0 ± 0.6	267.7	25.0
5	<a href="#">Hlt1TrackMuon.*</a>	9.6 ± 0.6	569.0	60.7
6	<a href="#">Hlt1CalibTracking.*</a>	5.9 ± 0.4	351.0	60.9
7	<a href="#">Hlt1DiProton.*</a>	2.7 ± 0.3	129.8	49.2
8	<a href="#">Hlt1B2.*</a>	2.1 ± 0.3	134.7	65.7
9	<a href="#">Hlt1SingleMuon.*</a>	1.9 ± 0.3	105.4	56.8
10	<a href="#">Hlt1IncPhi.*</a>	1.4 ± 0.2	89.1	65.2
11	<a href="#">Hlt1.*Electron.*</a>	1.1 ± 0.2	62.0	57.7
12	<a href="#">OTHER</a>	1.0 ± 0.2	48.5	51.4

# HLT2

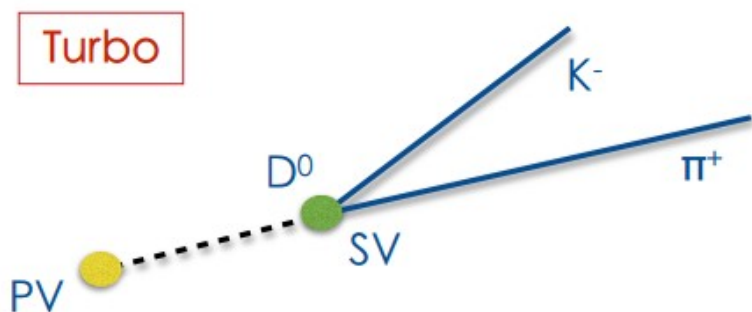
- **Full event reconstruction available like offline**
  - >400 different selections
- Biggest constraint is output bandwidth (~800 MB/s)
- Two paths
  - Full stream: With raw event (~60 kb/event), offline processing needed
  - Turbo stream: Save trigger candidate and trigger reconstruction (10 – 60 kb/event)

→ ideal for high rate channels

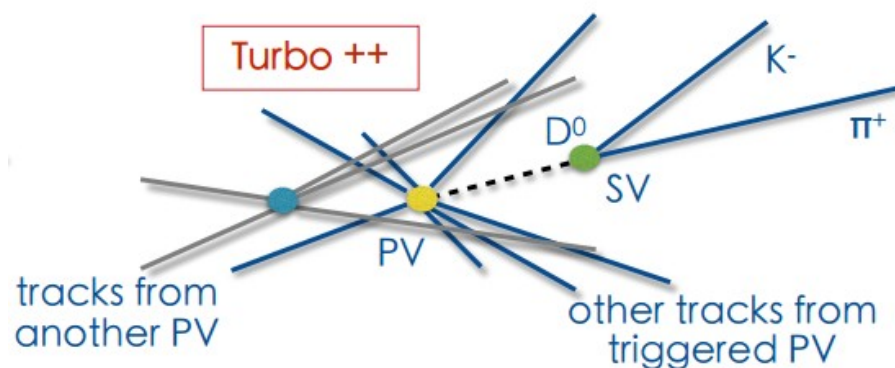


Selections	Rate
CcDiHadron	~ 120 Hz
JPsi (2016)	~ 350 Hz

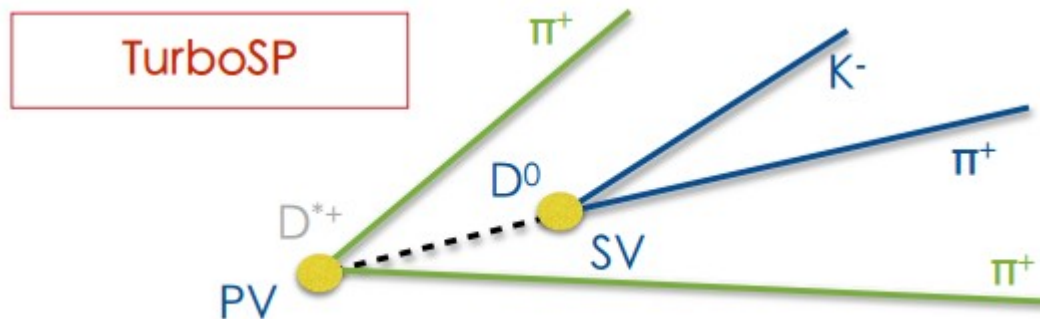
# Turbo stream options



12 kb/event



55 kb/event



12 - 55 kb/event

# Turbo analyses

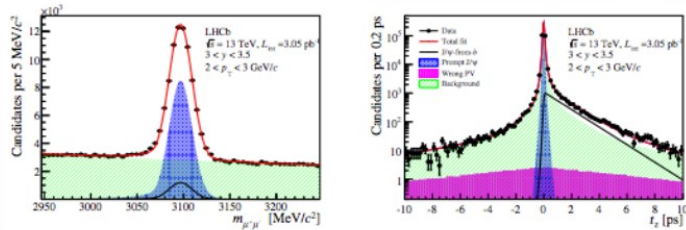
## Turbo

From today's talks

### $J/\psi$ production in inclusive b-decays

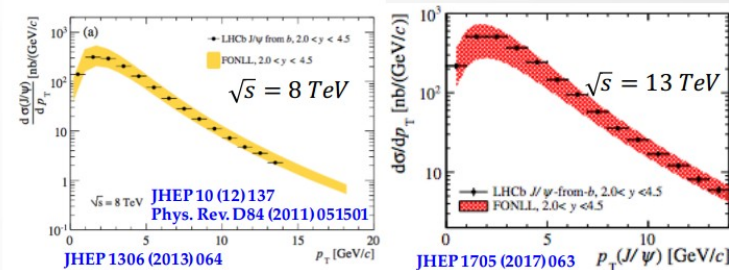
- Simultaneous invariant mass and pseudo-proper decay time  $t_z$  fit to separate prompt  $J/\psi$  and  $J/\psi$  from b-decays

$$t_z = \frac{(z_{SV} - z_{PV}) \times M_{J/\psi}}{p_z}$$



### Results:

- Differential cross-section measurement described by FONLL prediction



### $J/\psi$ production in jets

The fraction of the jet transverse momentum carried by the  $J/\psi$  meson,

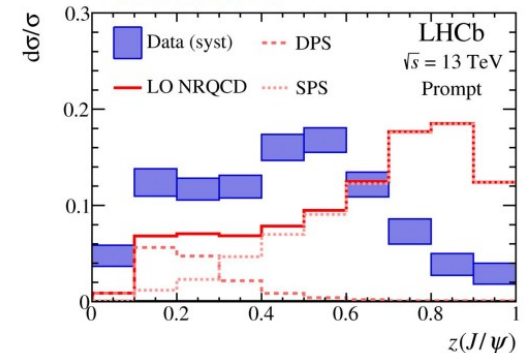
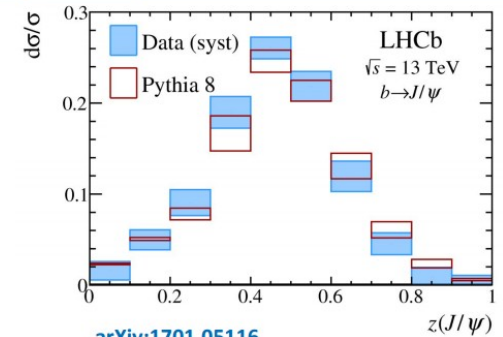
$$z \equiv p_T(J/\psi) / p_T(\text{jet}),$$

is measured using jets with

$$p_T(\text{jet}) > 20 \text{ and } 2.5 < \eta(\text{jet}) < 4.0.$$

The result for  $b \rightarrow J/\psi X$  decays agrees with pythia predictions.

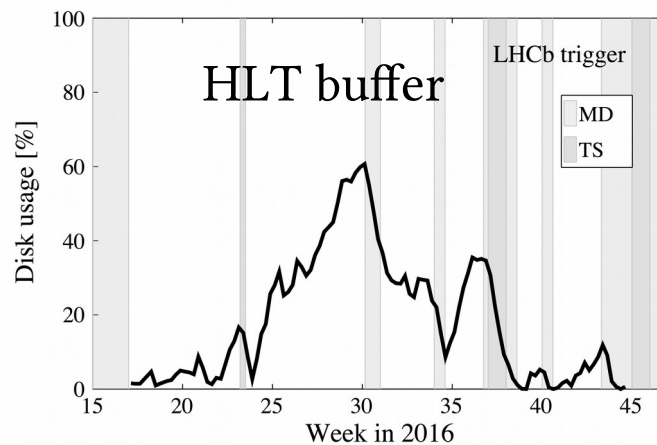
The results for prompt  $J/\psi$  production do not agree with predictions based on fixed-order non-relativistic QCD.



## Turbo++

# Questions

- Which Hlt1 selections would improve your efficiency?
  - New selections should not exceed O(kHz).



- RICH in Hlt1 to reduce rate? See [here](#), Chris Jones
  - Would require a clear use case and persons willing to work on this



# Questions

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- Hlt2:
  - Any selections missing?
- Better use of Turbo stream?
  - Had Jpsi line in Turbo stream with 350 Hz (used for jet analysis)
  - Moved back to Full stream with down scaled rate.
  - TurboSP gives a lot of flexibility