Flavour on a forward detector at 50 and 100 TeV

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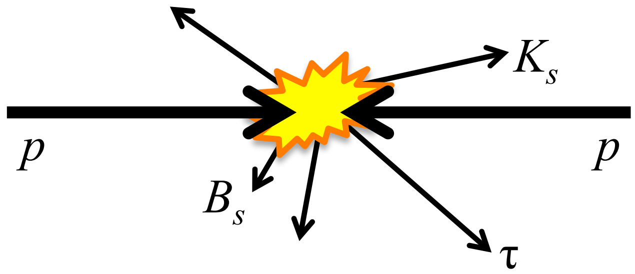
Introduction

- Very high energy hadron colliders are being proposed, such as FCC-hh or SppC
- How would those collisions look in an LHCb-like detector?
- Study with simplified version of LHCb tracking system

➔ Study to satisfy our curiosity, it's not a proposal for a detector!

Setup

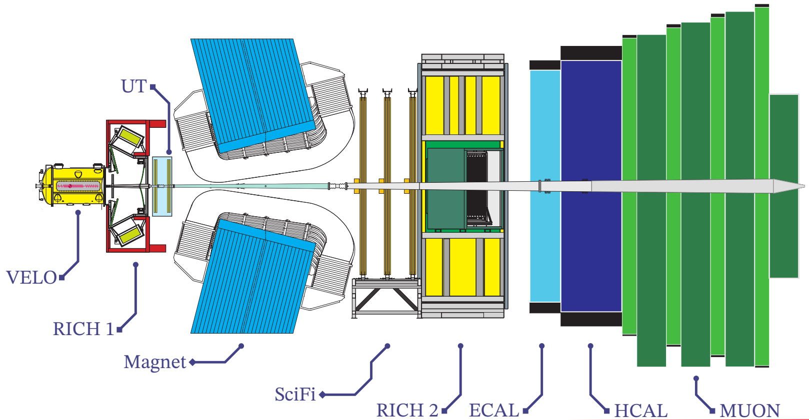
1. pp collisions with Pythia8
   at 13TeV, 50TeV and 100TeV



2. Decay of prompt particles

$$\tau \to \mu\mu\mu \qquad K^0_S \to \mu^+\mu^-$$
$$D^0 \to K^+K^-, \quad D^0 \to K^0_S\pi^+\pi^-, \quad D^0 \to \pi^+\pi^-\mu^+\mu^-$$
$$B^0 \to \mu^+\mu^-, \quad B^0_s \to \mu^+\mu^-, \quad B^0_s \to J/\psi\phi$$

3. Track reconstruction
   and momentum measurement
   with a LHCb-like tracking system:
   - VeloPix, UT, SciFi
   - Magnet kick



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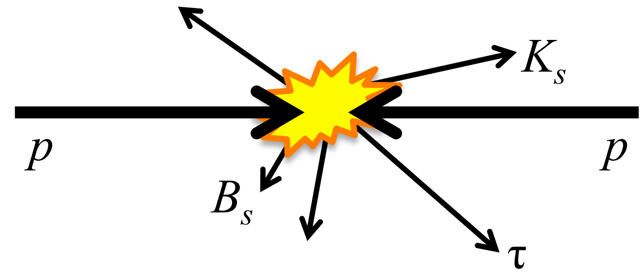

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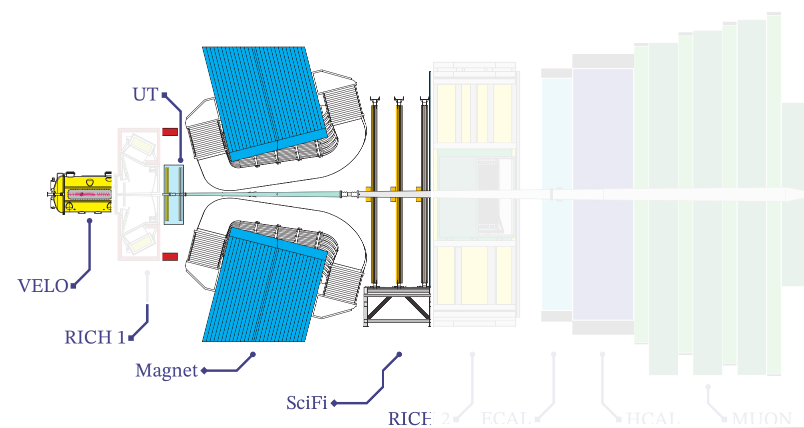

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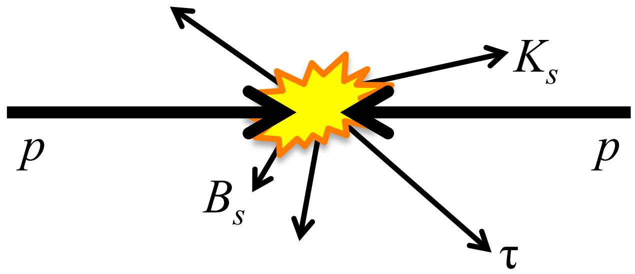

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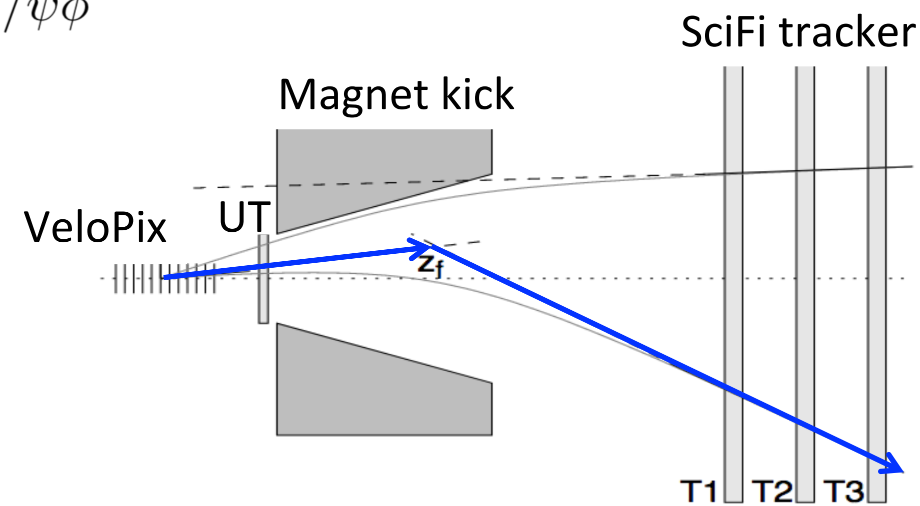
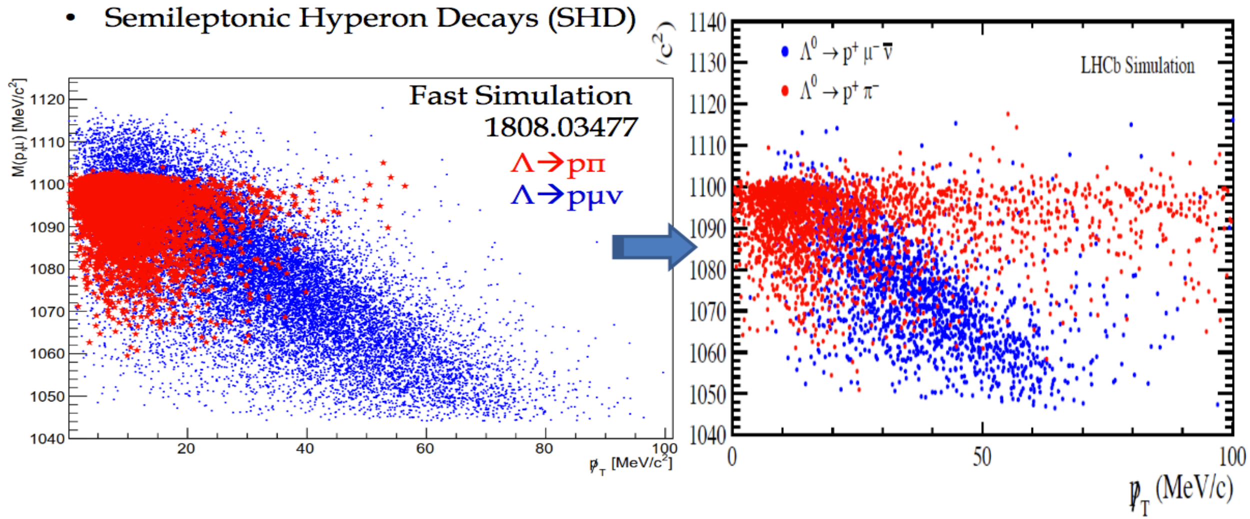


Setup

<u>Does not take into account:</u>

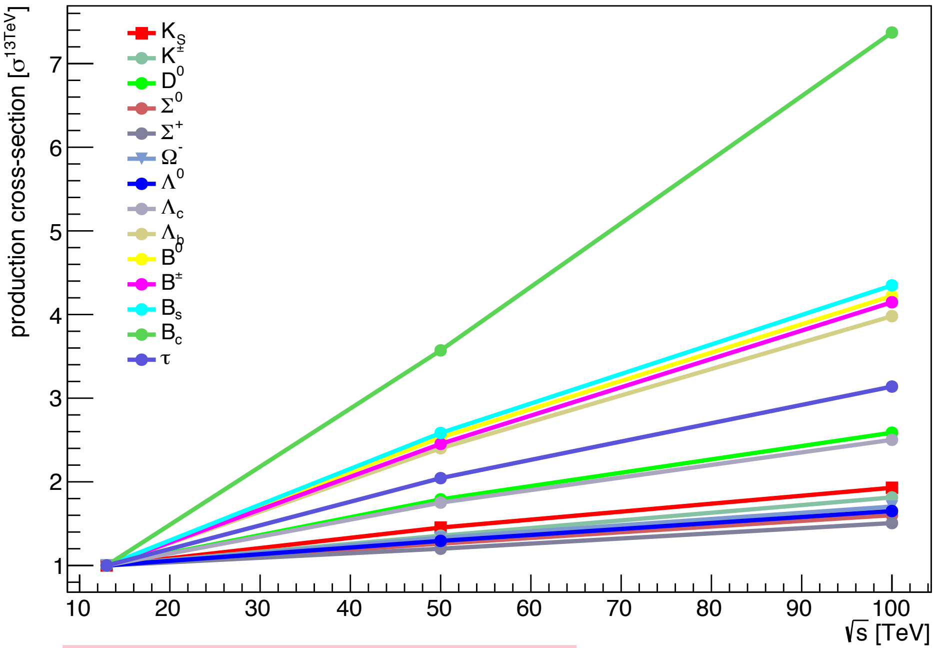
- Pile-up
- Occupancy effects
- Multiple scattering
- Calorimetry
- …



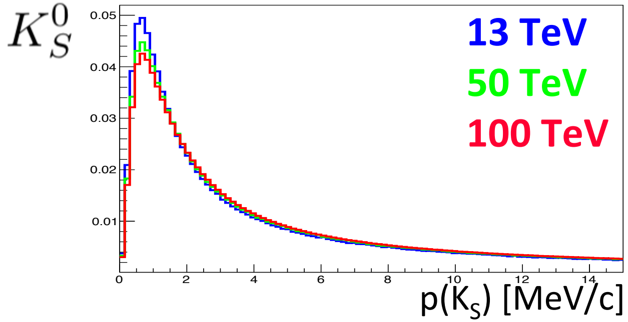
+ reproduces LHCb efficiencies to leading order
+ Mass resolutions for downstream tracks are ok, a little optimistic for long tracks

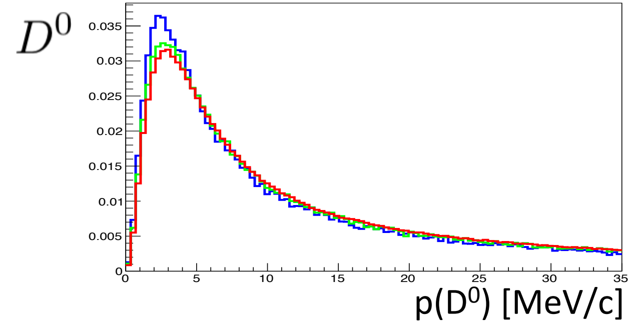
Prompt production

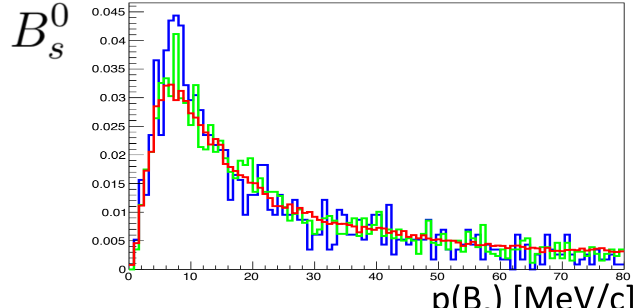
Production cross-sections normalized to 13TeV



	50TeV	100TeV
K_S	1.5	1.9
D^0	1.8	2.6
B_s	2.6	4.3

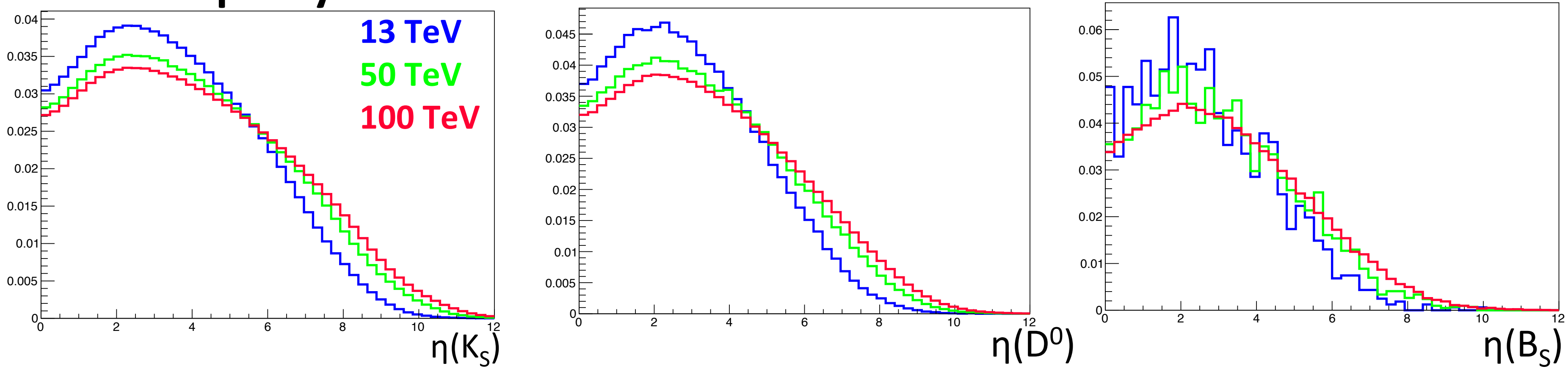




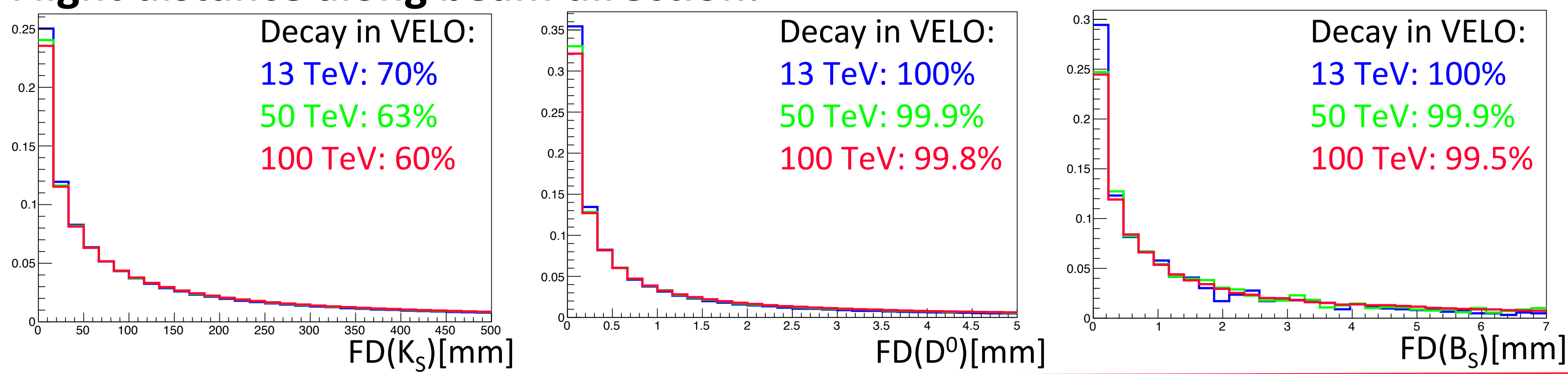


Prompt particles

Pseudo rapidity:

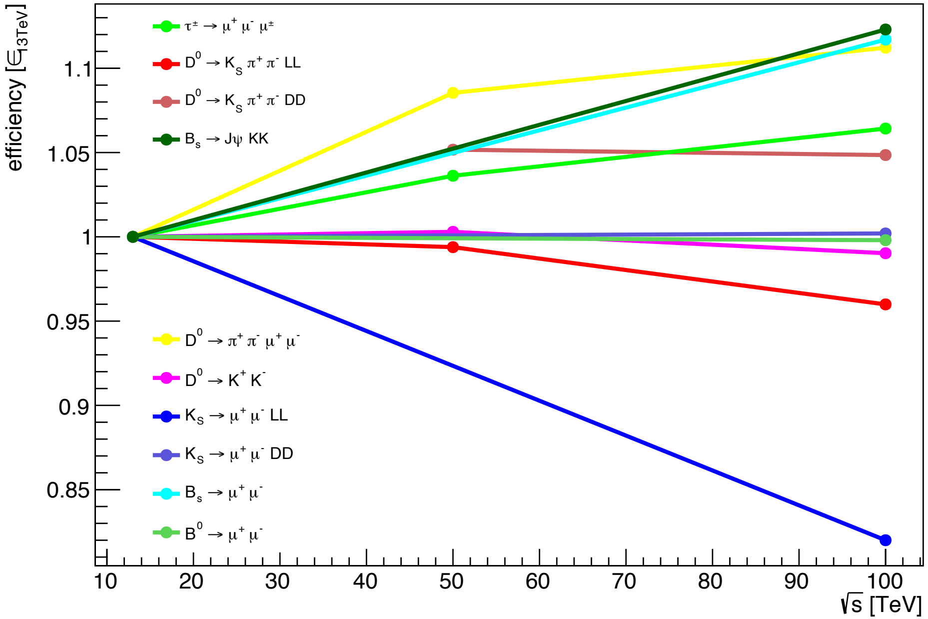


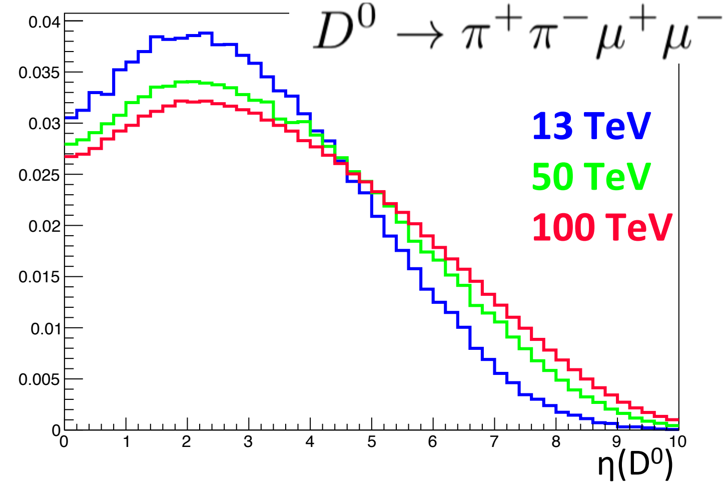
Flight distance along beam direction:

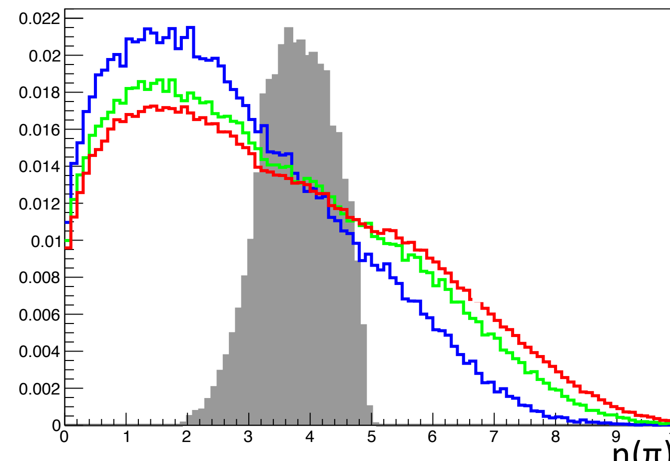


Efficiencies

Efficiencies normalized to 13TeV





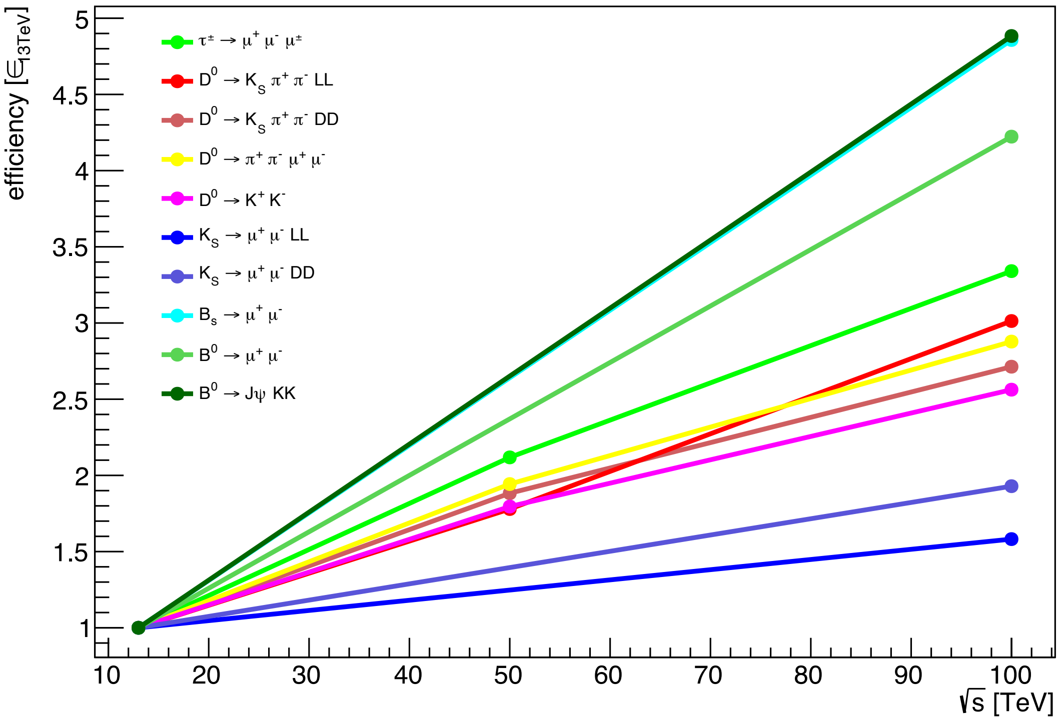


Most efficiencies increase

→ Pseudo rapidity of daughters comparable to 13TeV in LHCb acceptance

Statistics gain

Production cross-section × efficiency normalized to 13TeV

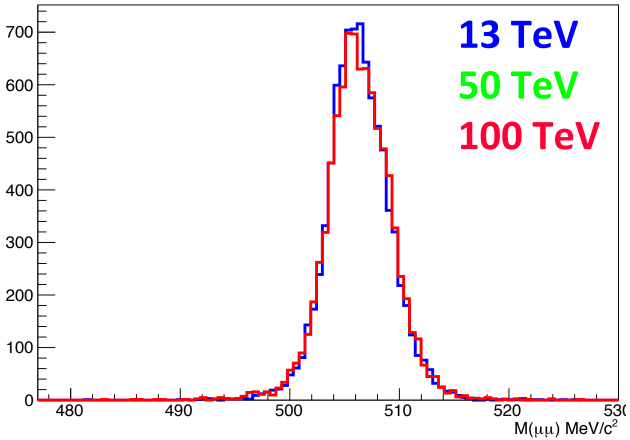


	50TeV	100TeV
$K_S^0 \to \mu^+\mu^-$		1.58
$K_S^0 \to \mu^+\mu^-$		1.93
$D^0 \to K^+K^-$	1.80	2.56
$D^0 \to \pi^+\pi^-\mu^+\mu^-$	1.94	2.88
$B_s^0 \to \mu^+\mu^-$		**4.86**
$B_s^0 \to J/\psi\phi$		**4.88**
$\tau \to \mu\mu\mu$	2.12	3.34

Increase in yields per fb^{-1} go from 70% (K_S decays) to up to factor 5 for B_s decays.

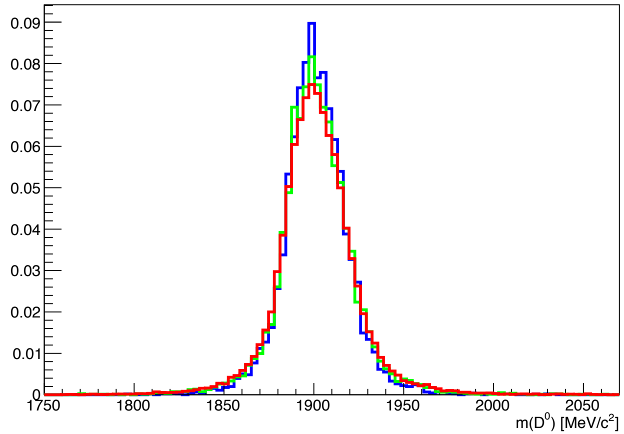
Mass resolutions

$K_S^0 \to \mu^+\mu^-$ (LL)



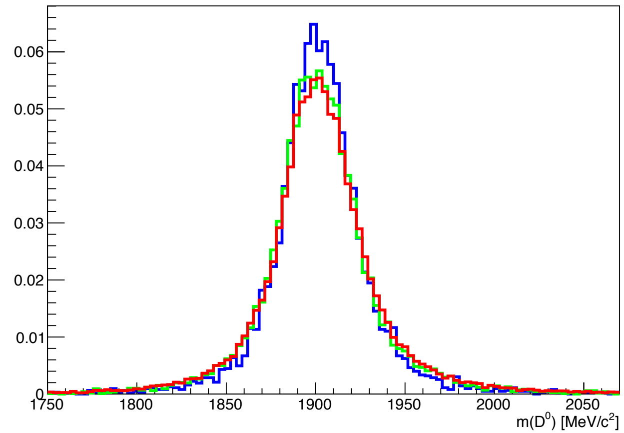
13TeV: 2.92 MeV/c^2
100TeV: 3.20 MeV/c^2

$D^0 \to K_S^0\pi^+\pi^-$ (K_S is LL)



13TeV: 19 MeV/c^2
50TeV: 21 MeV/c^2
100TeV: 23 MeV/c^2

$D^0 \to K_S^0\pi^+\pi^-$ (K_S is DD)

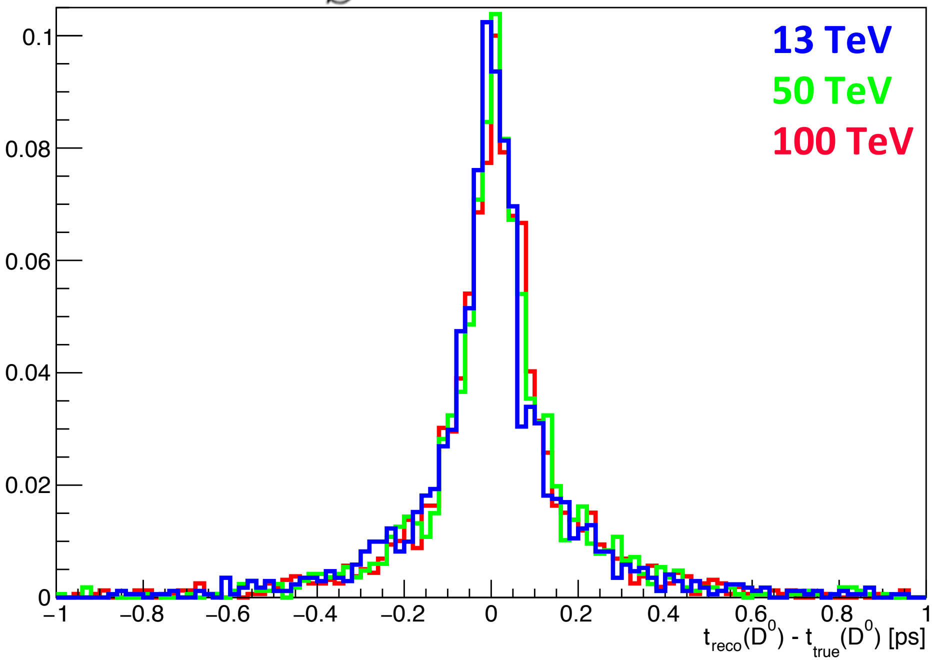


13TeV: 25 MeV/c^2
50TeV: 28 MeV/c^2
100TeV: 29 MeV/c^2

- 4% increase in width for K_S
- 15% increase in width for D^0
- small worsening (4-15%) in mass resolutions for B mesons

Decay-time resolution

$D^0 \rightarrow K^0_S \pi^+ \pi^-$



$t_{reco} - t_{true}$:

13TeV: 0.20 ps

50TeV: 0.19 ps

100TeV: 0.19 ps

→ Decay-time resolution stable.

Conclusion

- Very high energy hadron colliders are being proposed, such as FCC-hh or SppC
- How would those collisions look in an LHCb-like detector?
- Study with simplified version of LHCb tracking system
- Testing a spectrum of interesting decays
- Large increase in statistics at 100 TeV compared to 13 TeV
- LHCb-like detector would have similar acceptances and resolutions, despite almost 10 fold energy