

Development of new solutions for fast simulation¹

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¹Disclaimer: all plots shown here are unofficial LHCb results

Motivation

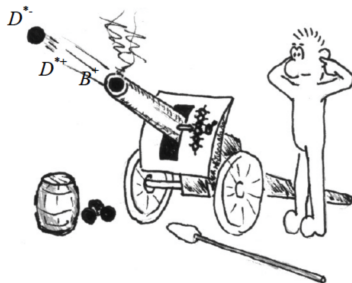
- Simulated data used to determine the selective efficiency of a measurement.
- It is **quite desirable** to have more simulated data than experimental.
- Number of simulated events, which we can get is limited by the available computing power.
- Time of one simulation \propto number of particles in one event.

Possible solutions:

- Increase computing power (\$\$)
- Implement faster MC simulations
- Decrease number of simulated particles (??)

Particle Gun

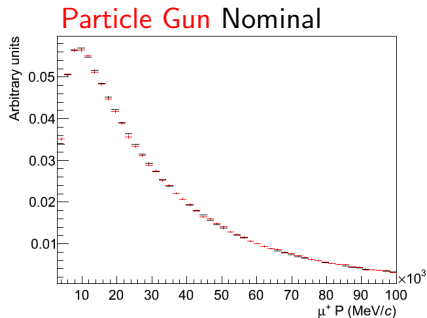
- Simulation of signal particles (only)
- This approach decrease computational time tremendously



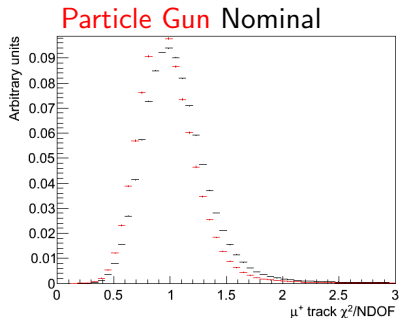
	Full Simulation	Particle Gun	
Generation	0.3s/event	0.015s/event	Factor of 20
Simulation	66s/event	2.7s/event	

Particle Gun

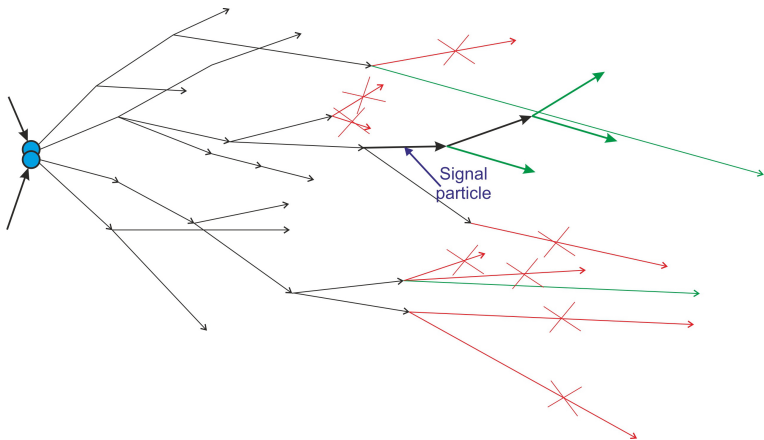
Good resemblance for kinematic variables



Track quality agreement is bad

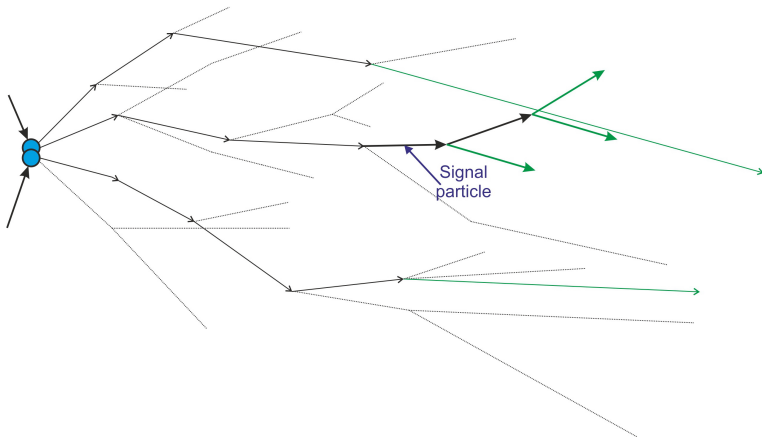


Alternative method



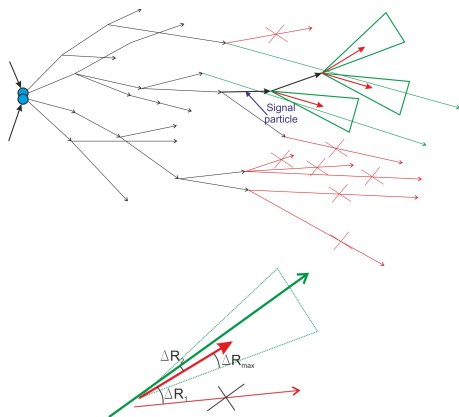
Let's add some more particles from the event.

Alternative method



Let's add some more particles from the event.

ΔR cuts



$$\Delta R = \sqrt{\Delta\varphi^2 + \Delta\eta^2}$$

φ – azimuth angle,

η – pseudorapidity

Typical values:

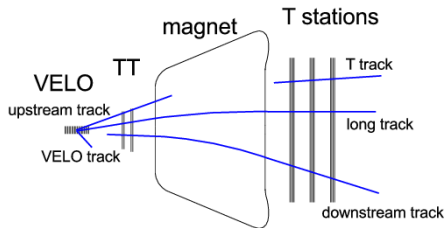
- $0 \leq \Delta R \leq 5$ over one event
- $\Delta R_{max} = 0.2 \dots 0.5$ for jet clustering

Extreme cases:

- $\Delta R_{max} = 0 \simeq$ Particle Gun
- $\Delta R_{max} = 42 \simeq$ Full Simulation

$$\Delta R_2 < \Delta R_{max} < \Delta R_1$$

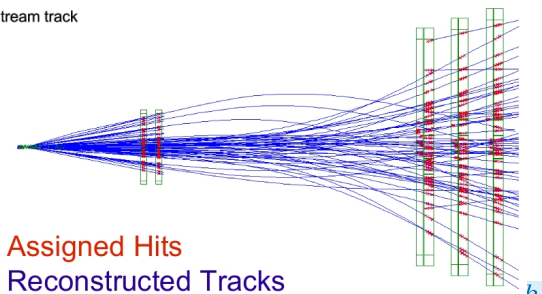
Tracking at the LHCb

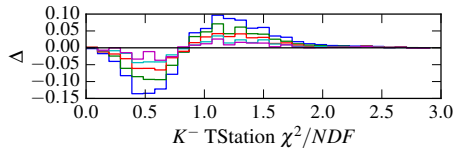
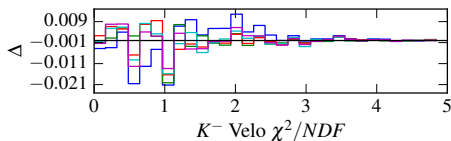
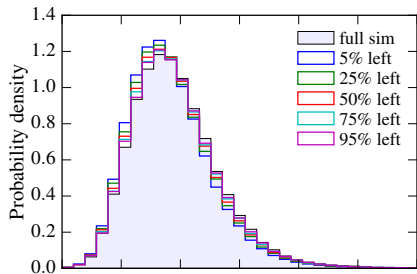
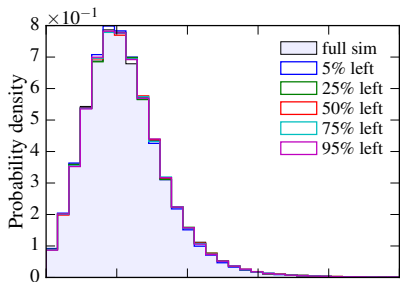


Less particles \Rightarrow Better tracking efficiency

χ^2 of tracks consist of:

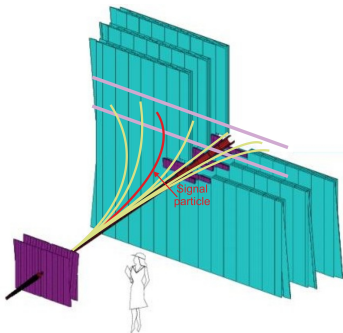
- χ^2 of tracks inside VELO
- χ^2 of tracks inside T Stations
- χ^2 of track matching



Tracking quantities. ΔR cuts

Accuracy of tracking depends on number of retained particles

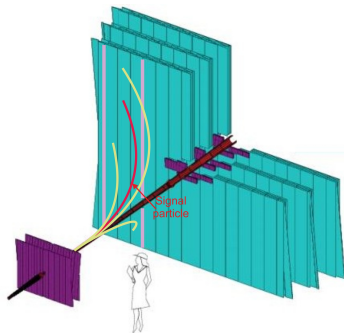
T Station cuts



Selecting horizontal stripes

Assumption: track matching won't be so good

Reason: we would have more candidates for matching

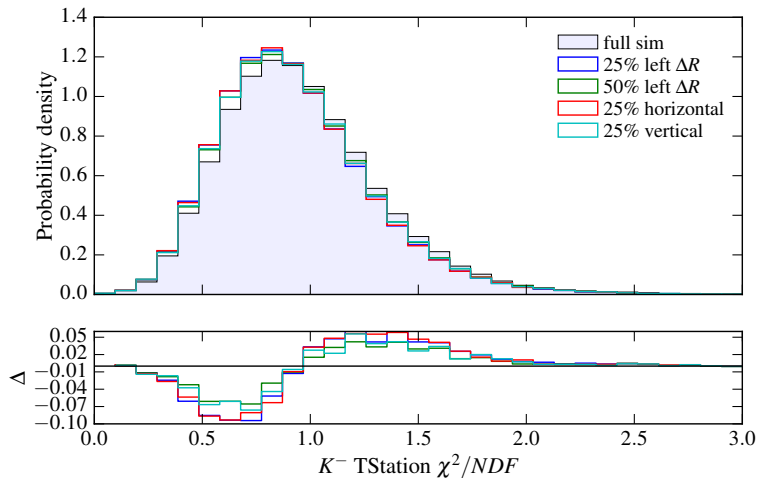


Selecting vertical stripes

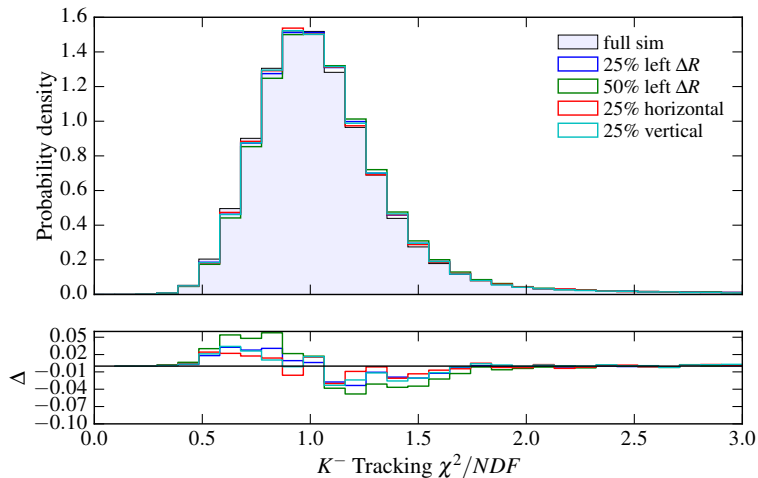
Assumption: T-Station χ^2 won't be so good

Reason: Large error in vertical direction

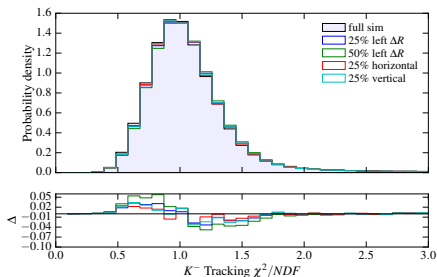
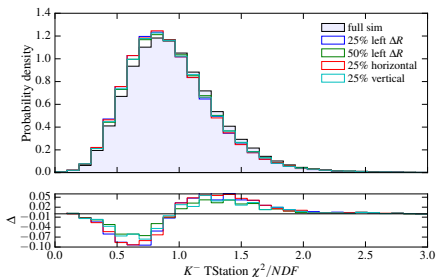
Tracking quantities. T Station cuts



Tracking quantities. T Station cuts

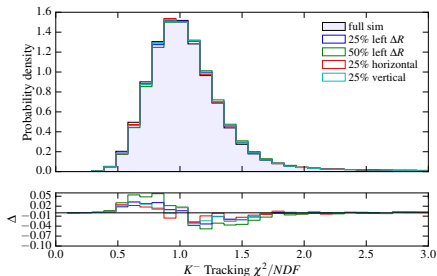
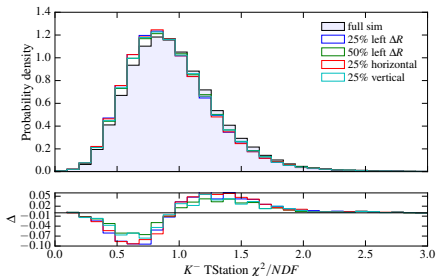


T Station cuts conclusion



- Vertical cut gives improvement for TStation χ^2
- Vertical & Horizontal cuts has (almost) the same overall χ^2 distributions
- VELO χ^2 distributions are statistically the same for all cuts

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Horizontal cut gives improvement for Matching

Summary

Good news

- Improved agreement between reduced and full simulations was obtained.
- Easily vary between Full Simulation and Particle Gun-like.
- Digitalization and Reconstruction software are working with reduced events.
- Full compatibility with other speeding-up methods.

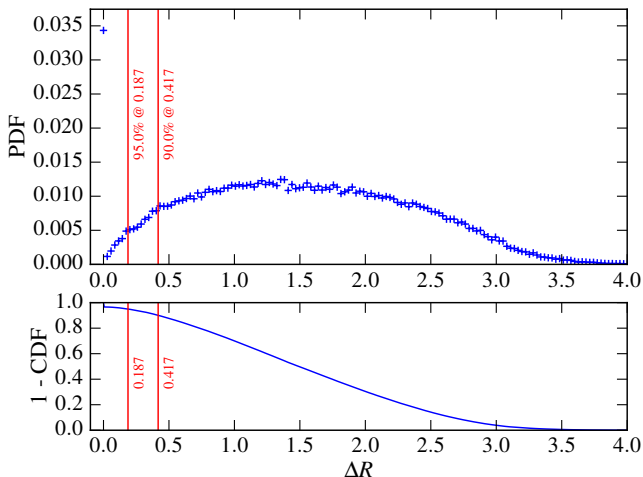
Not so good news

- Simple ΔR cut not good enough to achieve good accuracy and speed at the same time.

Future Plans

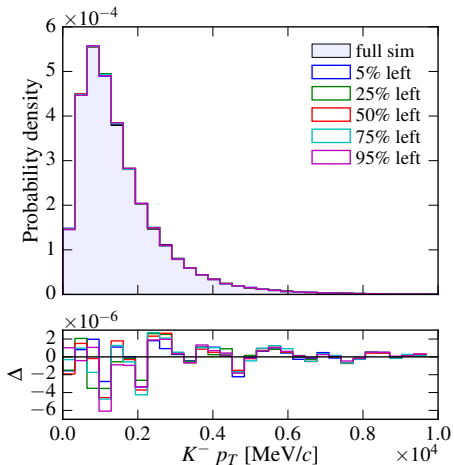
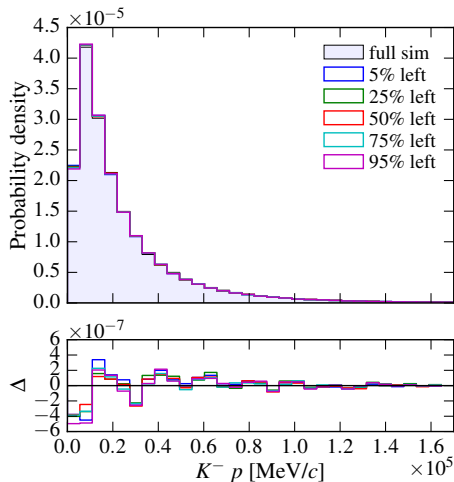
- Obtain more data.
- Implement cross-like cut.

Cut value



Distribution of minimal ΔR values in event with signal
 $D^{*+} \rightarrow D^0 (\rightarrow K^- \pi^+) \pi^+$

Kinematic quantities. Particle Gun



Good description of kinematics.

Tracking quantities. T Station cuts

