

Standalone track-reconstruction on GPUs at LHCb Lukas Calefice (Technische Universität Dortmund/Sorbonne Université)

in collaboration with Louis Henry, Christina Agapopoulou, Brij Kishor Jashal, Arthur Hennequin, Lorenzo Pica, Arantza de Oyanguren Campos, Jiahui Zhuo

Upgrade I of the LHCb tracking system



- Changes in operating LHCb for Run 3: - Run at $\mathscr{L}_{inst.} = 2 \cdot 10^{33} \text{cm}^{-2} \text{s}^{-1}$ with $\langle \mu \rangle = 5.2$ (**x5 increase** compared to Run 2) - targeting $\sqrt{s} = 14$ TeV
- planned to take $\mathscr{L}_{int} = 50 fb^{-1}$ of data
- Entire new set of tracking detectors (VELO, UT, SciFi) to deal with larger track multiplicity and radiation damage - VELO and SciFi are installed and being commissioned

Upgrade I of the LHCb trigger system



- Trigger yields saturated with increasing luminosity for fully hadronic modes due to tight $E_{\rm T}$ cuts in the L0 hardware trigger
- UT will be installed in autumn this year
- Replaced read-out electronics of all subdetectors for triggerless readout at 40MHz
- → remove hardware trigger for Run 3
- Software triggers (HLT1 and HLT2) need higher throughput of events with respect to Run 2 \rightarrow Redesign of the trigger system with HLT1 on GPUs with the Allen project

HLT1 algorithm sequence

Track reconstruction with the Seeding & Matching approach in HLT1

SciFi geometry



Physics and computing performance



SciFi HybridSeeding

Adding Y information

search window in y for initial uv-layer

- Two iterations with varying initial layers to account for hit inefficiencies and p_{\min} assumption
- Two-hit combination from hit in T1 hit and T3 hit inside a search window
- Search window size given by p_{\min}
- Propagate combination back to z=0,
- \rightarrow prediction of x position in T2 from offset x(z=0)
- Build three-hit combination with all hits in a given search window around predicted position
- Search for and add hits in the remaining x-layers \rightarrow accept seeds with $n_{\rm hits}^{\chi_z} > 5$
- Fit with parabolic model + fixed cubic correction

NVIDIA RTX A6000(GPU

NVIDIA RTX A5000(GPL

- long tracks from B decays (p > 5GeV): ~83% (92%)
- long electrons from B decays (p > 5GeV): ~ 70% (75%)
- very good for low (transverse) momentum
- Ghost rate:

Used for

HLT

- 9% (5%) for all reconstructed tracks (p > 3GeV, pT > 0.5GeV)
- SciFi tracks can be used independently for physics
- UT+SciFi matching can provide downstream tracks
 - \rightarrow very beneficial for decay modes with $K_{\rm S}^0$ and Λ^0

193.85

167.43

• Throughput on NVIDIA RTX A5000: ~170kHz HybridSeeding: A standalone track reconstruction algorithm for scintillating fibre tracker at LHCb - arXiv:2007.02591

15th Pisa Meeting on Advanced Detectors, 22.05.22-28.05.22