Downstream and T-Track reconstruction at the first level of LHCb trigger

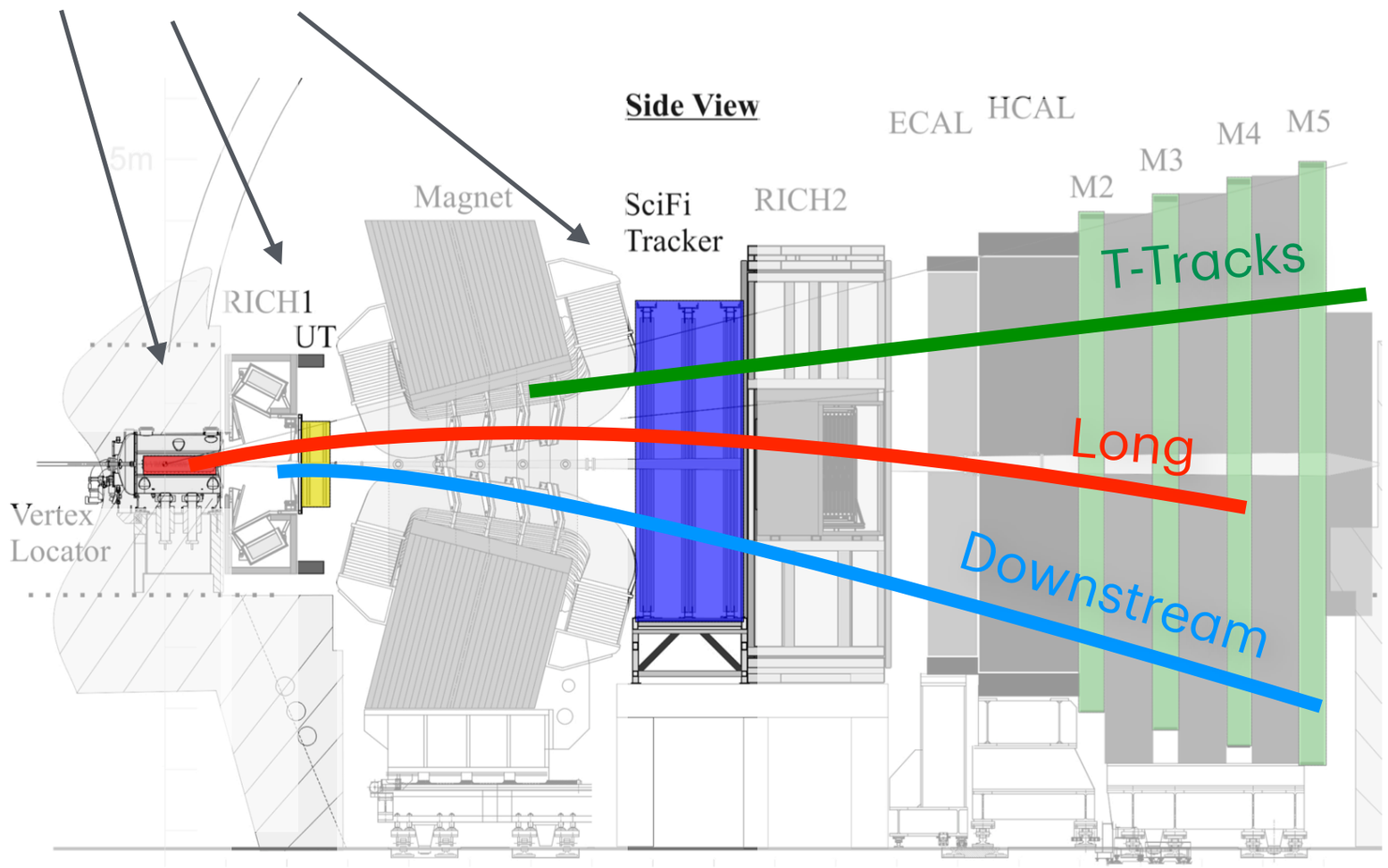
Arantza De Oyanguren Campos, Brij Kishor Jashal, Jiahui Zhuo, Valerii Kholoimov
Volodymyr Svintozelskyi

IFIC, Univ. of Valencia and CSIC (ES)

LHCb in Run 3 overview

- Single-arm experiment, specialized on b-physics
- No hardware trigger, first high-level trigger on GPUs
- Three tracking detectors: VELO, UT, SciFi
- Different types of tracks:
  - Long: VELO + SciFi
  - Downstream: UT + SciFi
  - T-Tracks: SciFi

Because of the new trigger on GPUs, we can do downstream and T-Traack reconstruction!

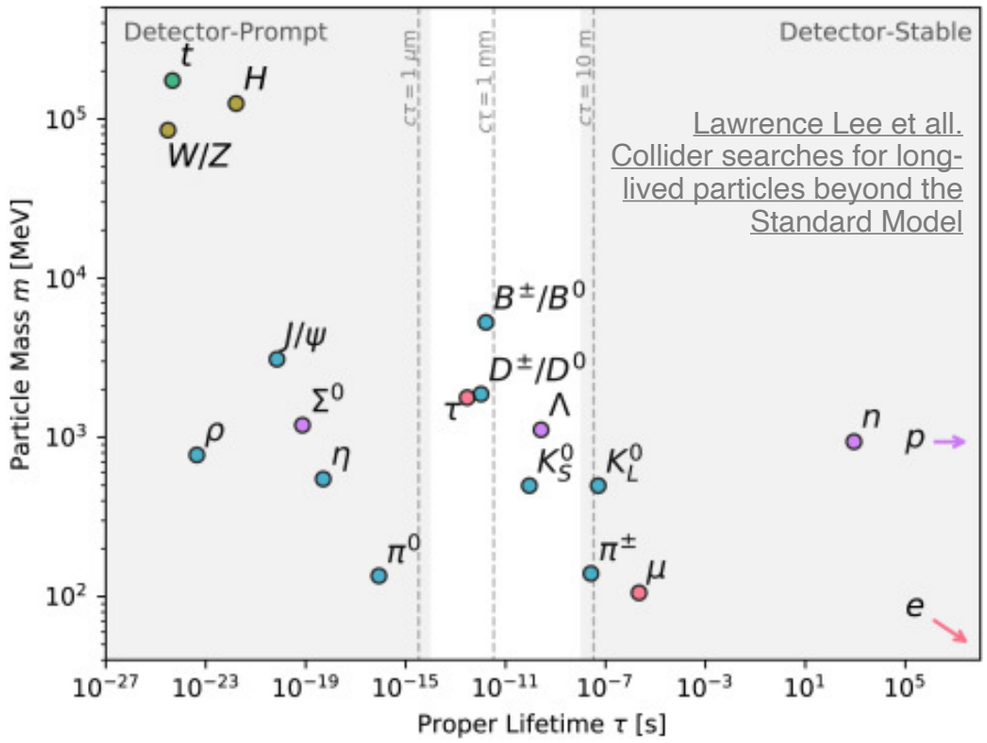


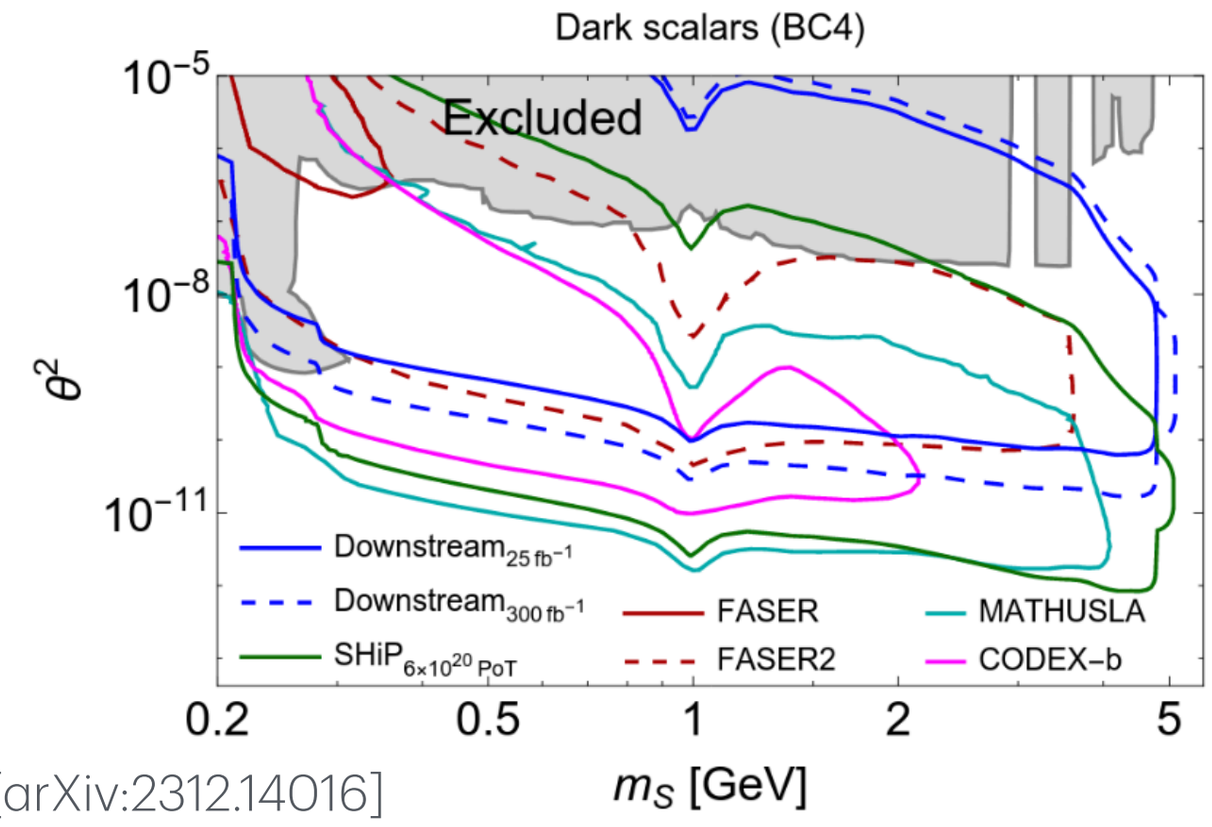
Why downstreams/T-Tracks?

- In SM, K_s^0 and Λ^0 are the only particles mostly decaying within

$$1\text{m} < c\tau < 10\text{ m}$$

- Analysis involving these particles may benefit a lot





[arXiv:2312.14016]

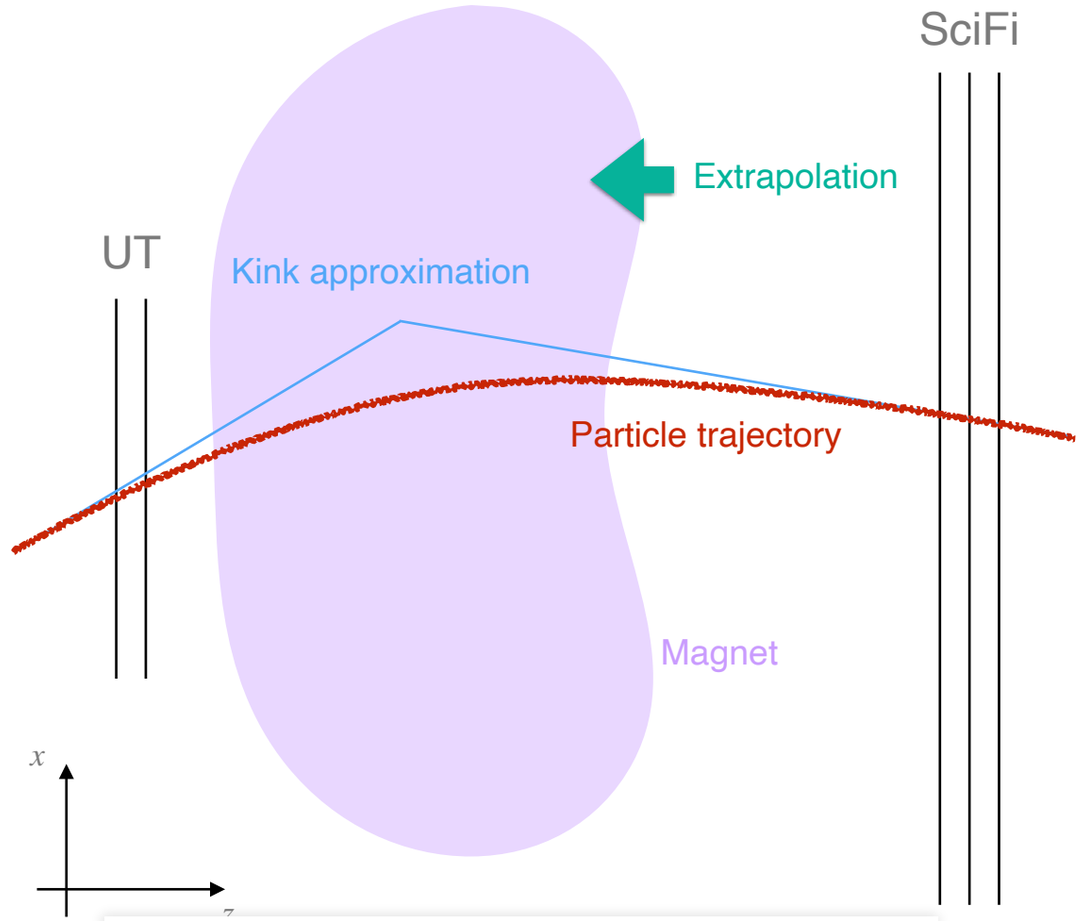
- LHCb sensitivity region is extended by two orders of magnitude, due to downstream reconstruction

- It's expected, that the ability to trigger T-Track candidates will extend it even further

Downstream reconstruction

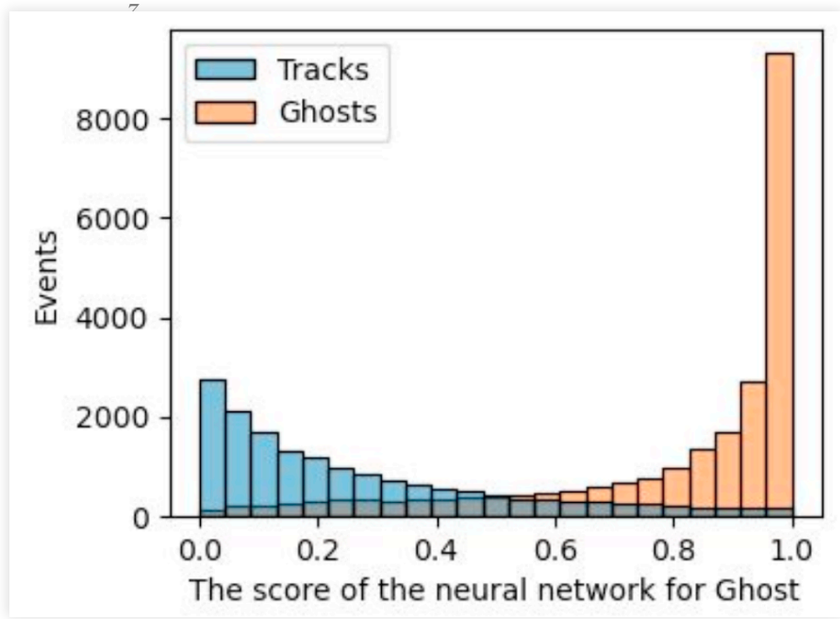
Downstream track reconstruction:

- Algorithm starts with SciFi tracklets
- Kink extrapolation towards UT region
- Search for corresponding UT hits
- Track fitting & NN-based fake rejection



Two-track vertex reconstruction:

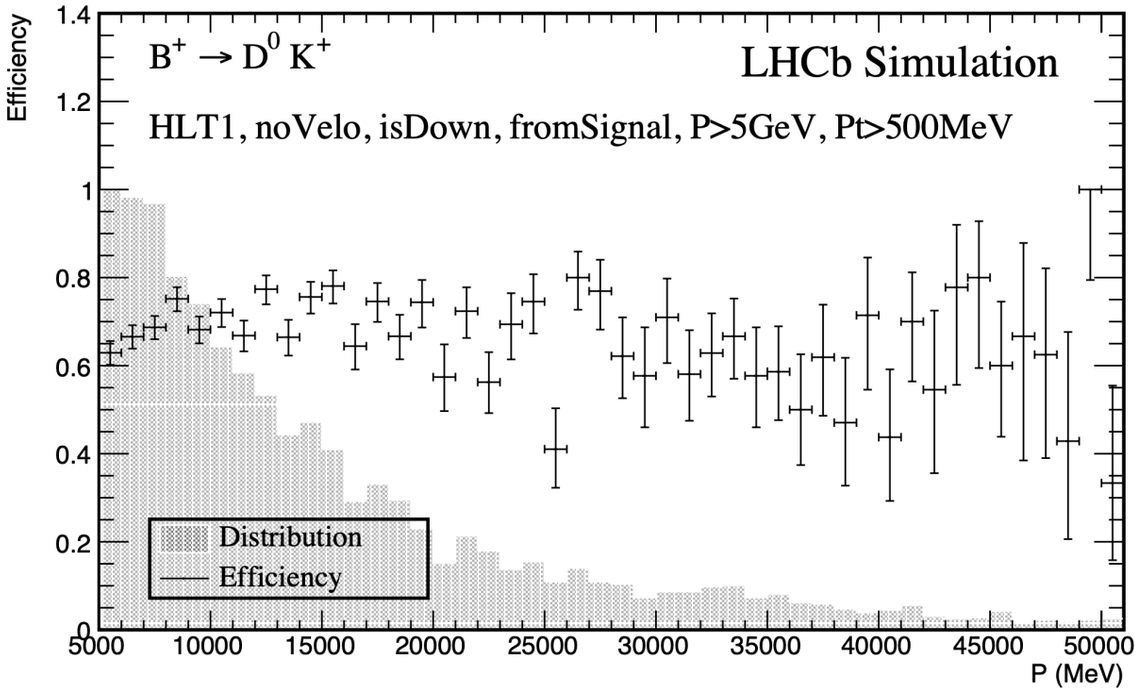
- Nonlinear extrapolation of tracks
- Kalman-filter based vertexing
- NN for candidate selection & triggering



ACAT 2024: Tracking and vertexing downstream the LHCb magnet at the first stage of the trigger.

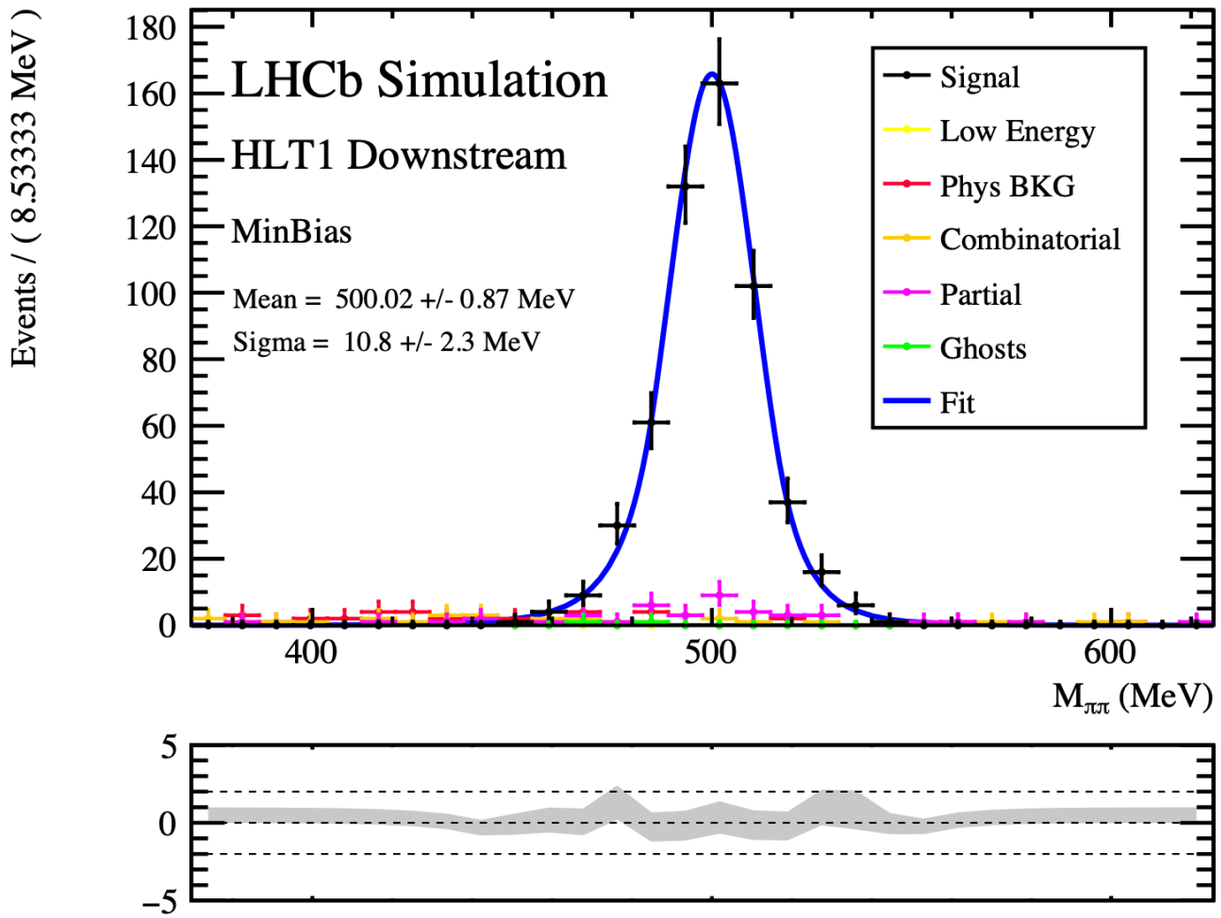
Downstream performance

Tracking efficiency for $B^+ \to D^0 K^+$



SciFi track reconstruction efficiency $\approx 90\,\%$ is included!

Mass plot of K_s^0

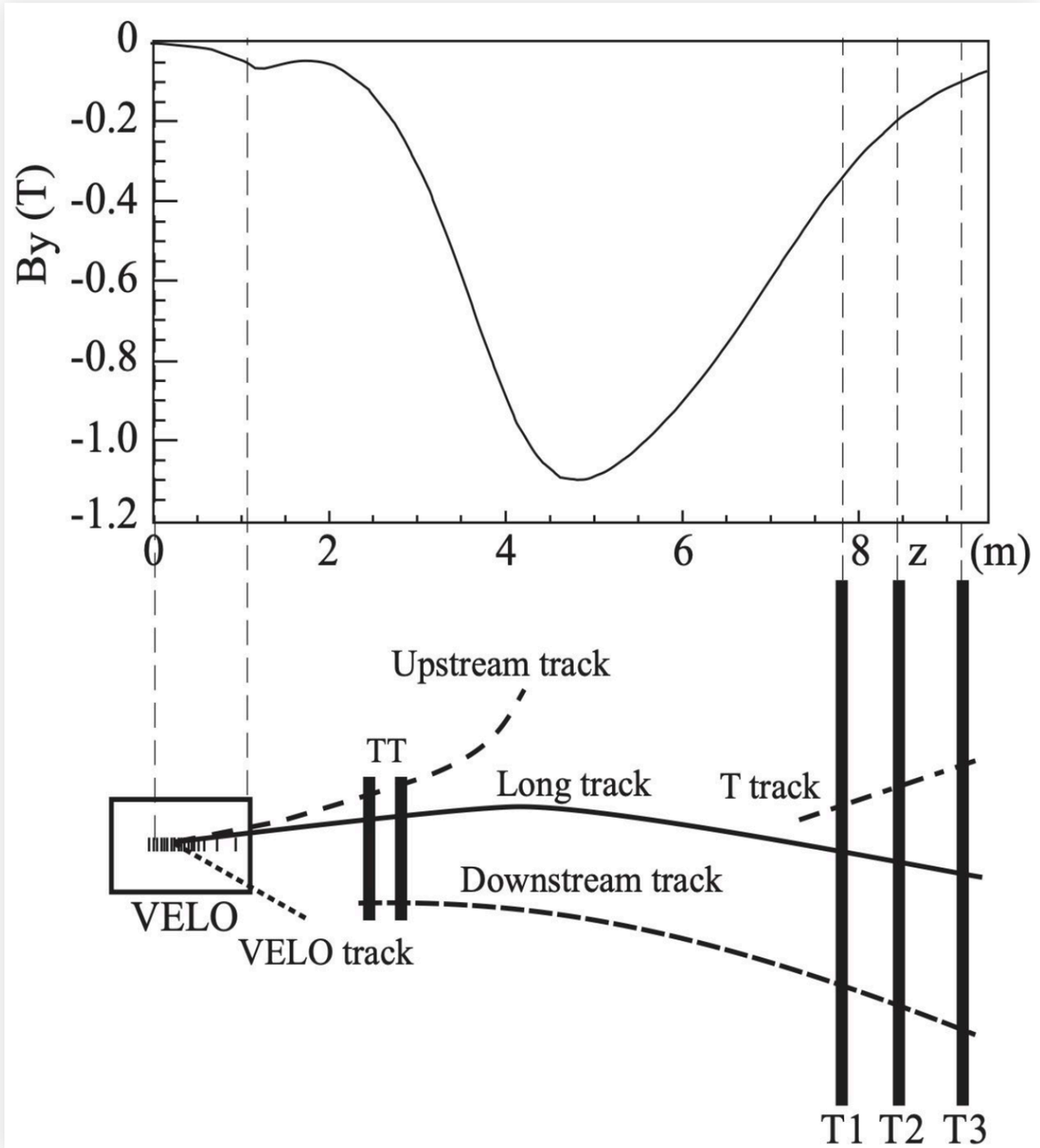


T-Track reconstruction

Big challenges at HLT1:

- Strict throughput requirements apply constraints on algorithm design
- Nonlinear extrapolation through a strong magnetic field
- Poor track momentum resolution
  $\approx 10\,\%$

For the moment, the biggest challenge is an efficient selection of tracks - work in progress



Summary

- The first implementation of Downstream track & vertex reconstruction at HLT1!
- Small effect on throughput: only $\approx 4\,\%$ drop (2025 conditions)
- Expected data taking already in 2025!
- T-Track selection algorithm is in development