BuSca: a *Buffer Scanner* at HLT1 to detect LLPs beyond the SM

V. Kholoimov, A. Oyanguren, V. Svintozelskyi, J. Zhuo, B. Jashal

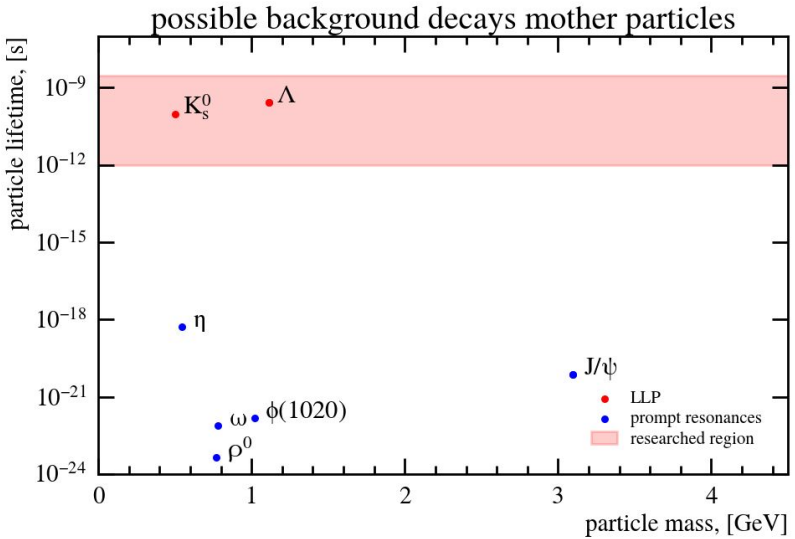
2nd Computing Challenges workshop (COMCHA), A Coruña
04 October 2024

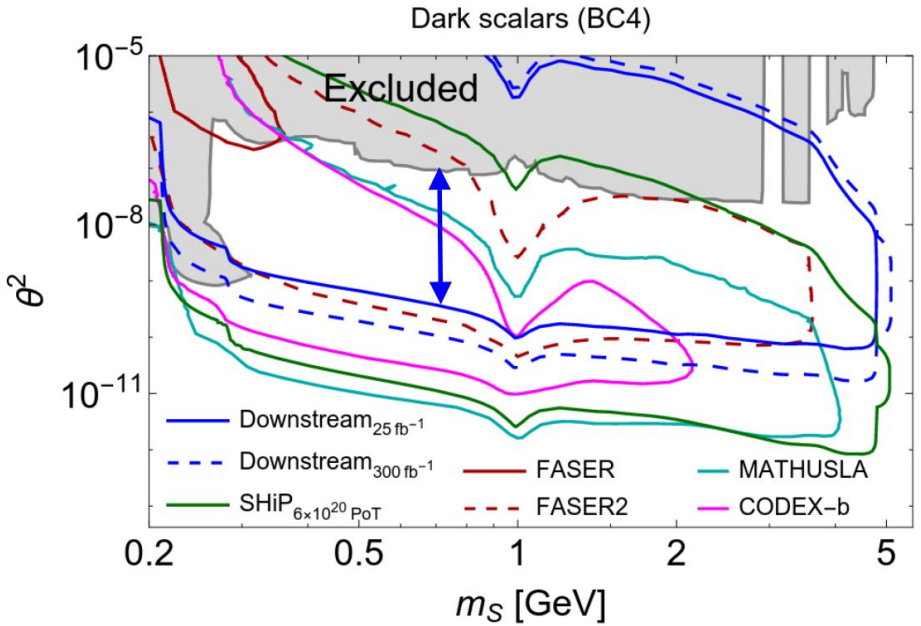
Outline

- Motivation
- BuSca in LHCb dataflow
- Implementation
- Selection algorithm
- Expected background
- Trigger lines
- Throughput impact
- Same sign reconstruction
- Prospects

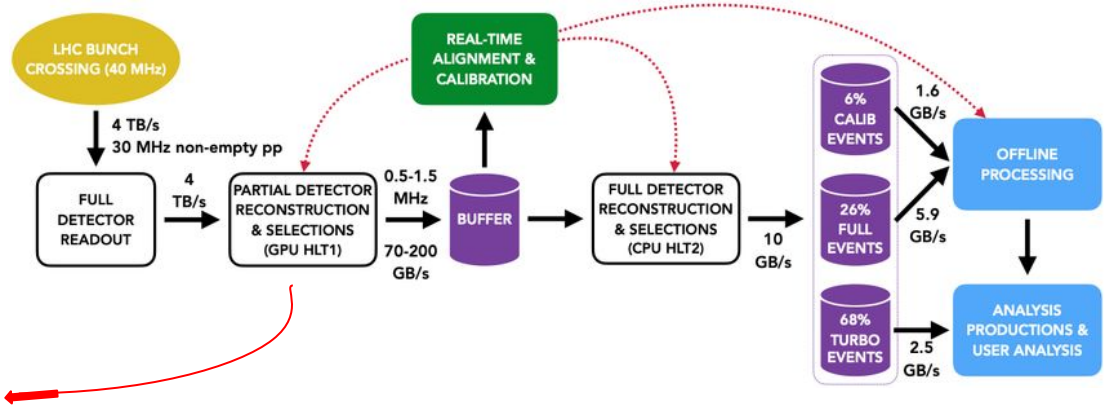
Motivation

No prompt SM background resonances in downstream region





BuSca in LHCb dataflow



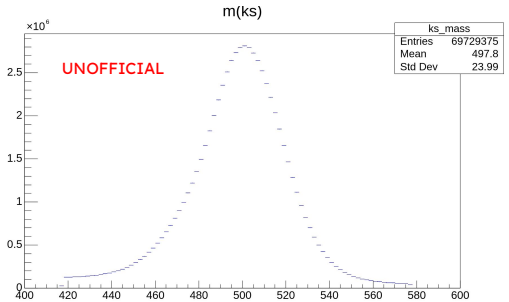
Buffer Scanner: write two values from selected events to histogram

Difficulties in adding extra lines, we don't have enough bandwidth (1 MHz) → we introduce a HLT1 model independent algorithm which does not trigger events, but fill 2D histogram (*BuSca: Buffer Scanner*)

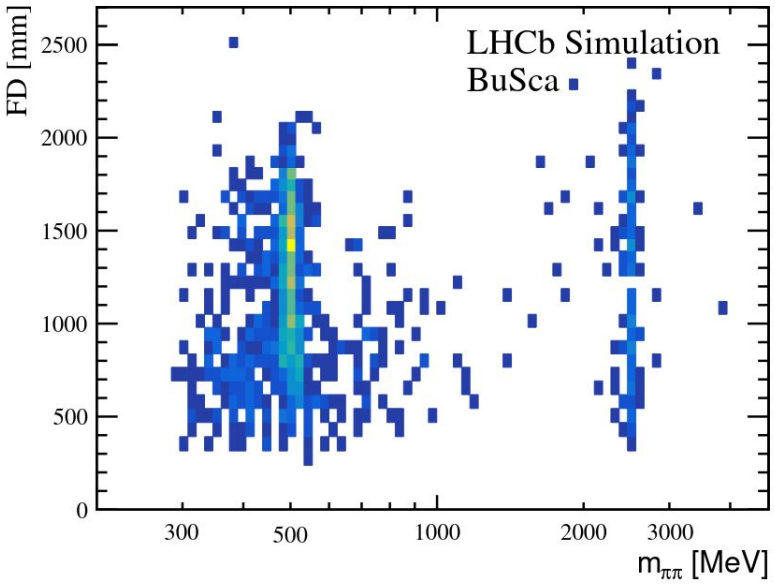
Implementation

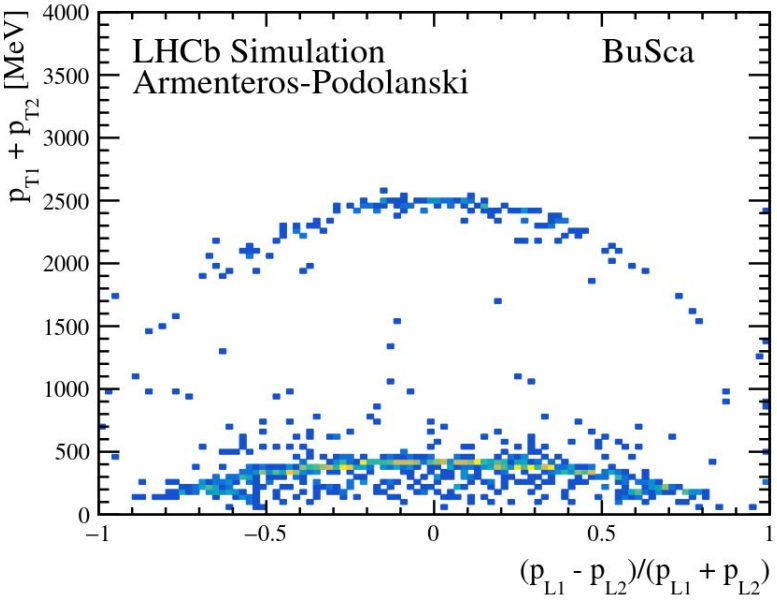
Monitoring features:

- Use a single algorithm instance shared between all streams
- Do inter-stream aggregation on GPU, through atomic operations
- Accumulators are kept on device for multiple sequence run, and periodically reset once every second
- Use Gaudi interface
- Can be used for data-driven studies without triggering the events



Histograms



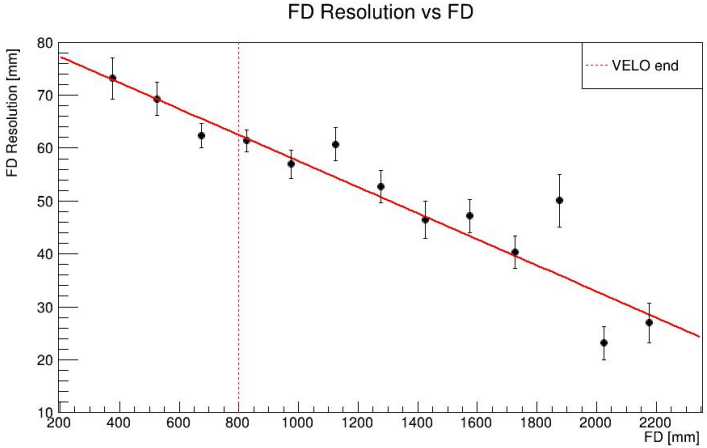


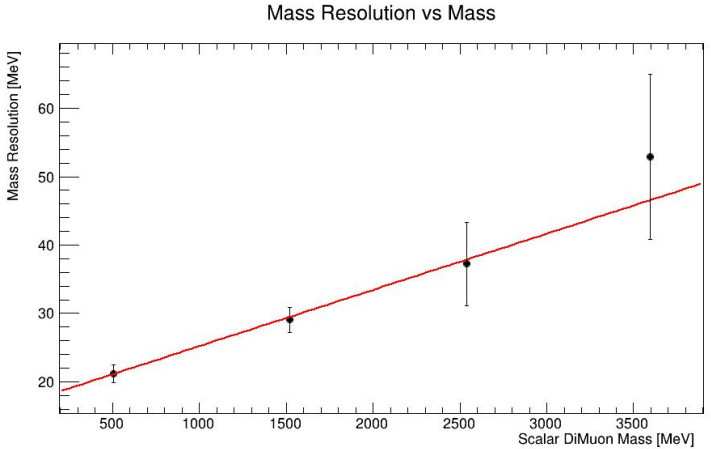
MASS/FD and Armenteros Podolanski plot

Technical implementation (*Binning scheme*)

In the first stage we will use Gaudi Histograms to present data in online monitoring framework.

- Adaptive binning (#σ)
- FD vs Mass



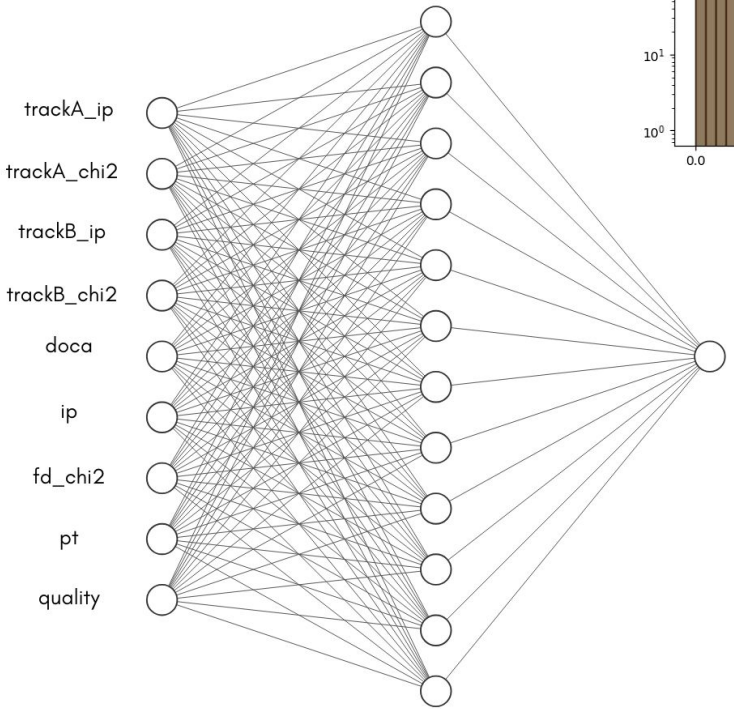


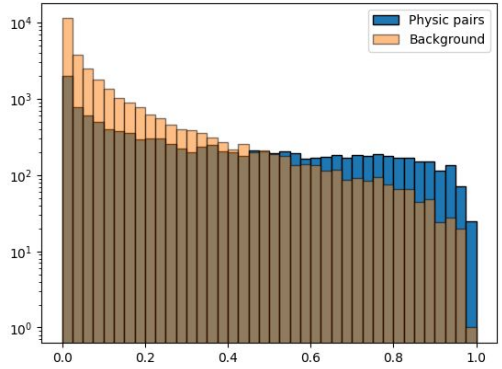
Selection algorithm

Quality NN, which is used for physic pairs selection.

- 9 inputs
- 12 nodes
- [0; 1] output

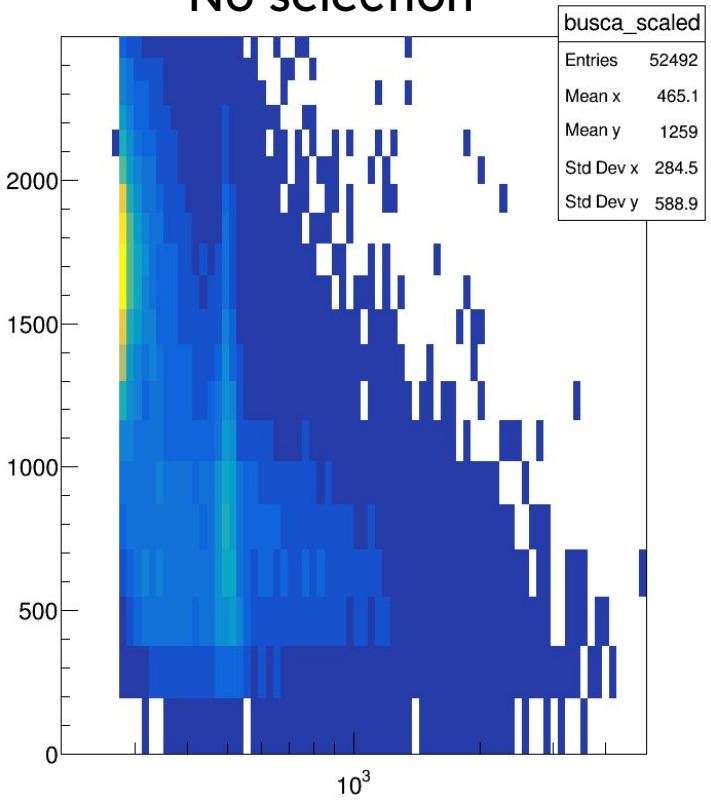
Trained on MinBias using physics pairs.



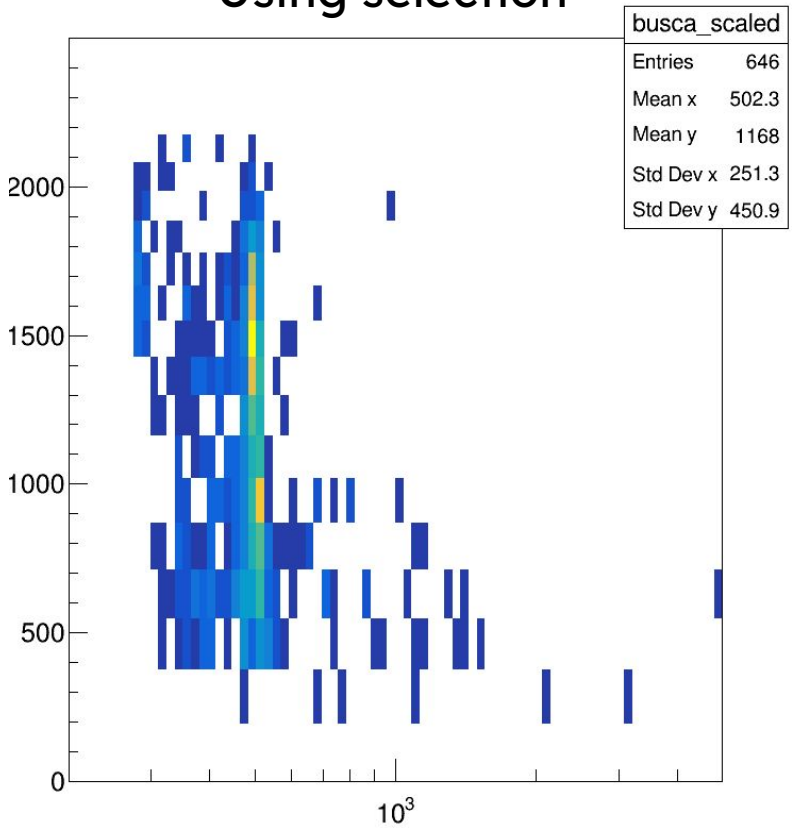


Selection usage example

No selection



Using selection



Background evaluation

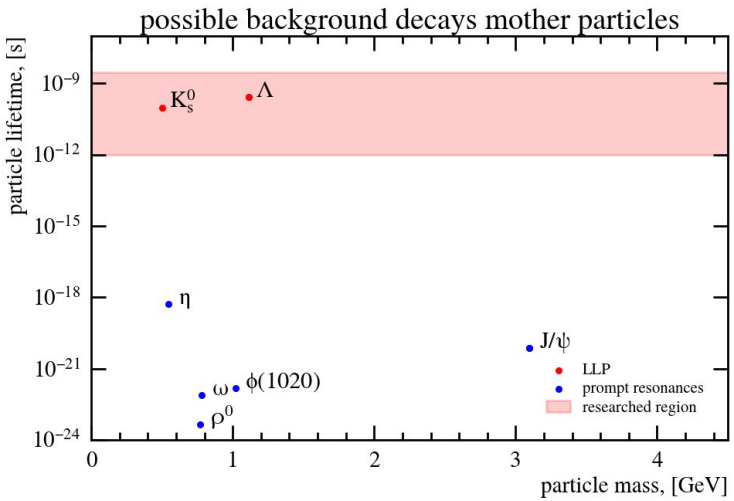
Hadronic resonances

J/ψ, ψ, φ(1020), ψ(2S), ψ(3770), ψ(4160), which were important in the Run1 BSM search analysis

In downstream region can be produced *only in MI*

Strange candidates: SM particles with large lifetimes: K_S, Λ_0

Have to be vetoed

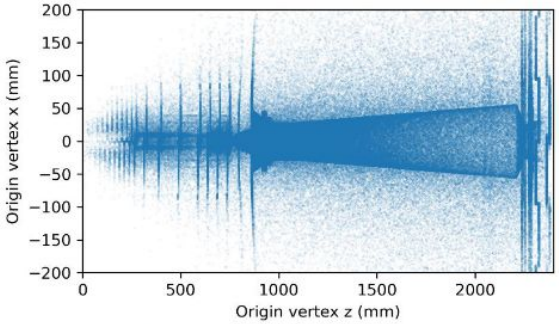


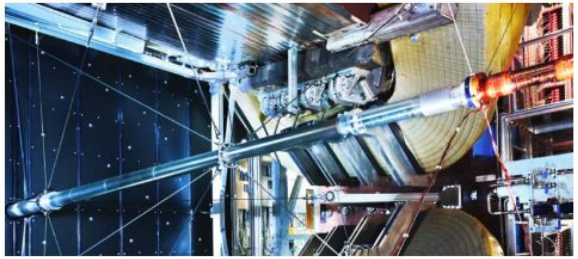
Combinatorial background:

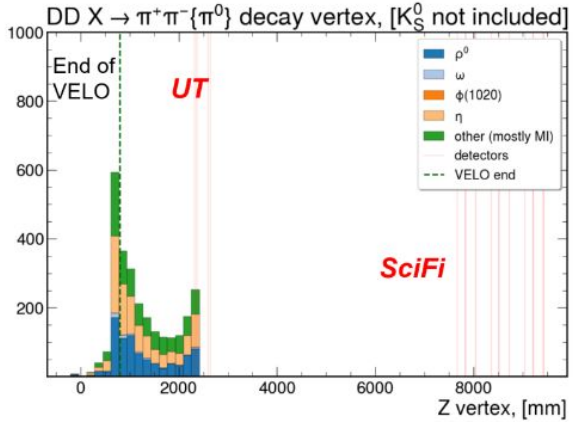
Random pair combination of muons or misidentified pions, coming from different *b*-hadron decays (semileptonic decays, etc…)

Should be rejected by NN using quality parameters

Material Interaction

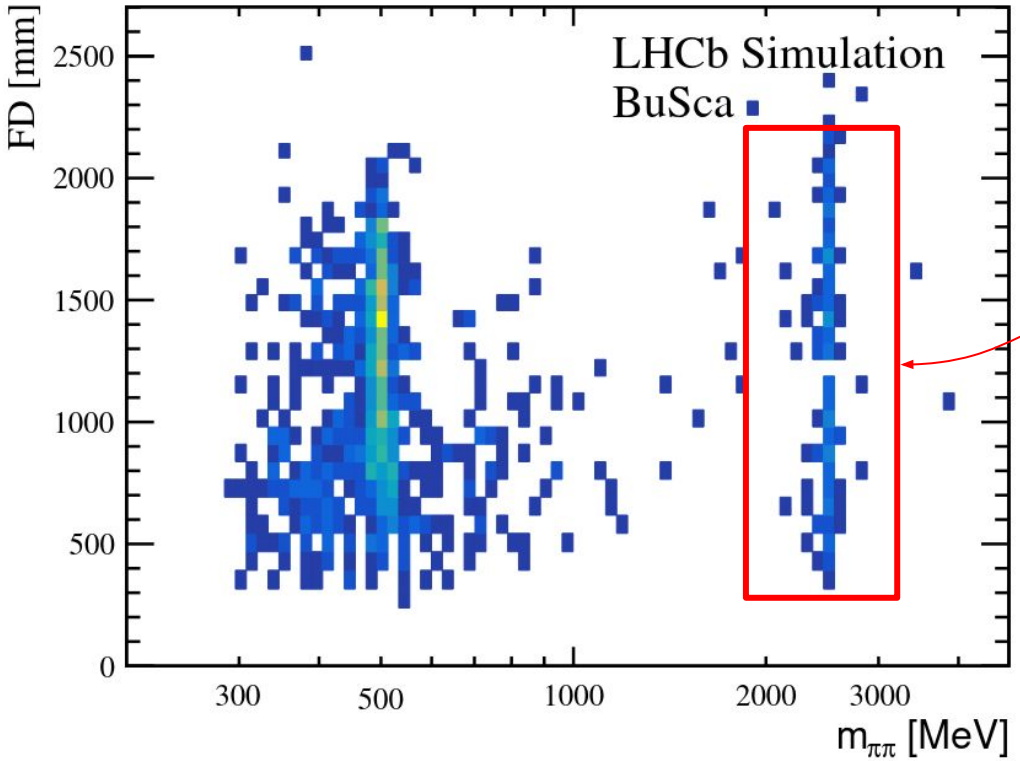






Production of light resonances due to material interaction

What if we gonna see something

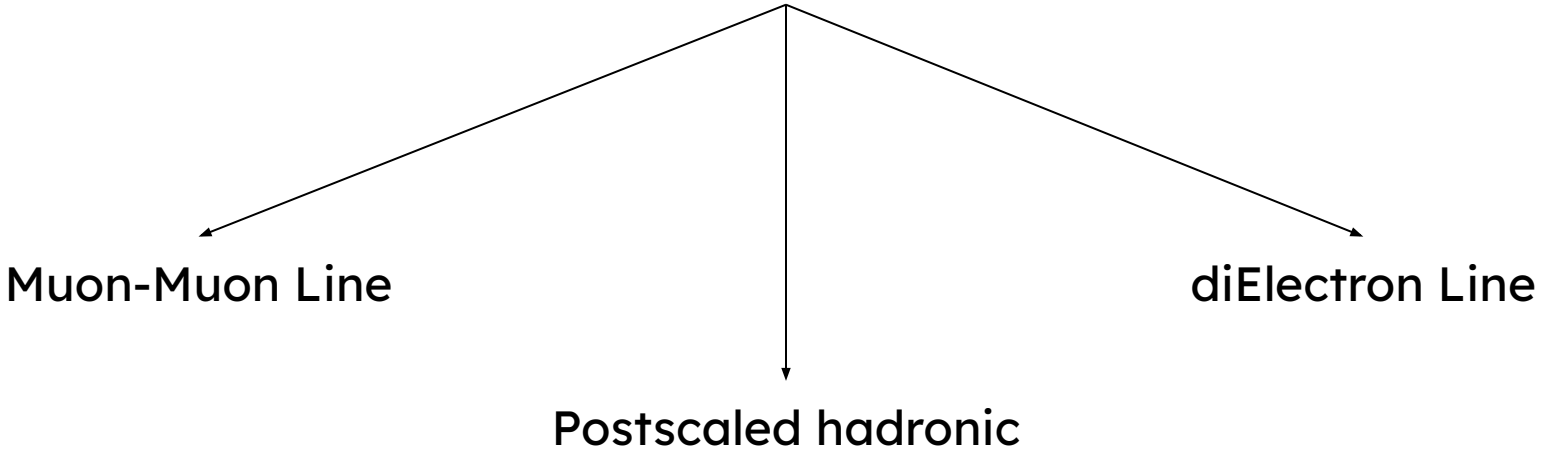


Turn on the trigger and try to catch this again
-> pass to HLT2

configurable mass and FD window

a place where the initial idea grows *beyond* belief

Trigger lines

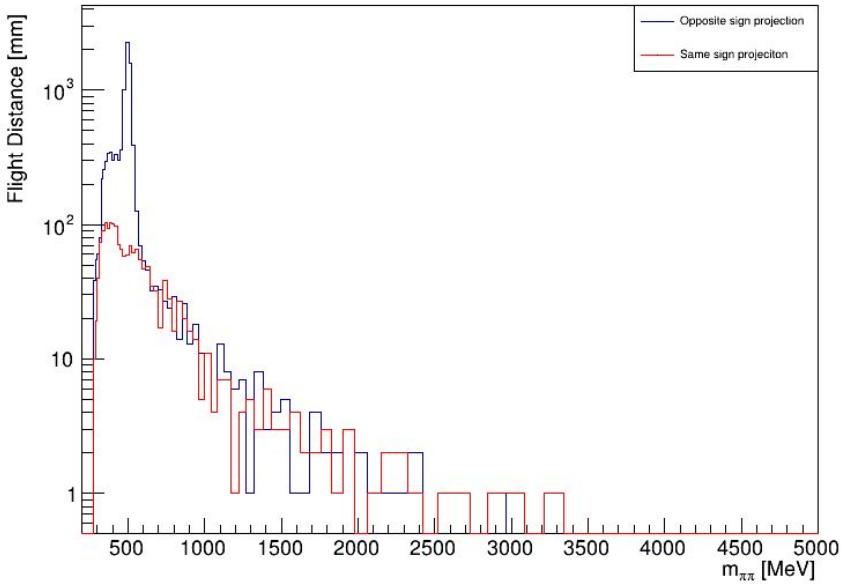


Background evaluation + First attempts to catch NEW PARTICLES

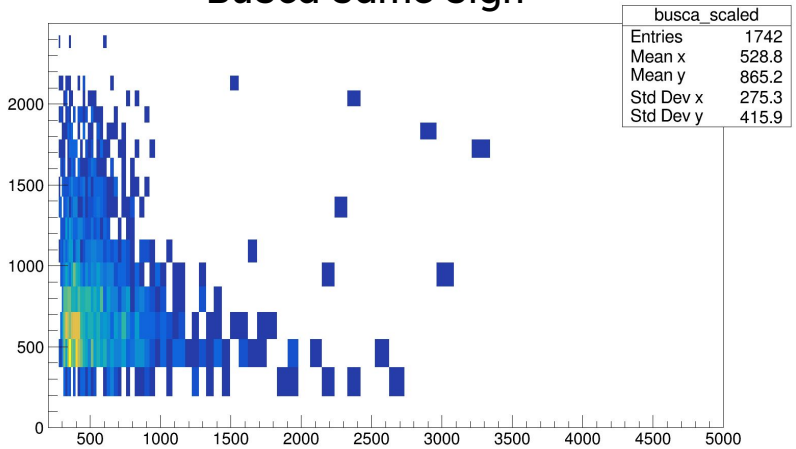
Same Sign Downstream Vertexing

almost perfect way to evaluate combinatorial background

x projection of BuSca plot

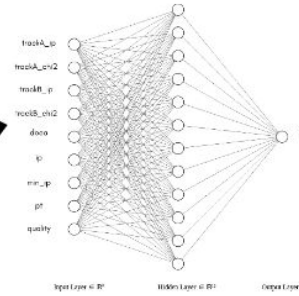


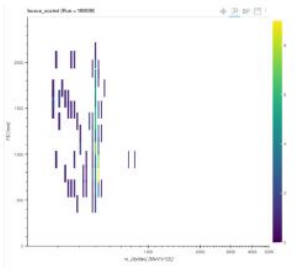
BuSca Same Sign

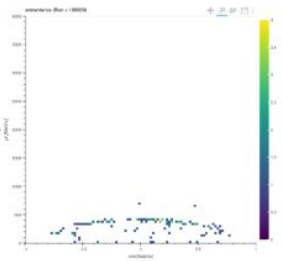


BuSca scheme

Online Monitoring

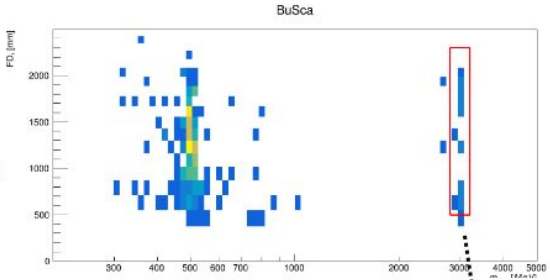


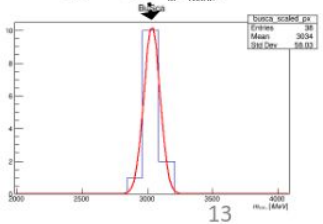




Create HLT1 lines

HLT1DownstreamBuSca



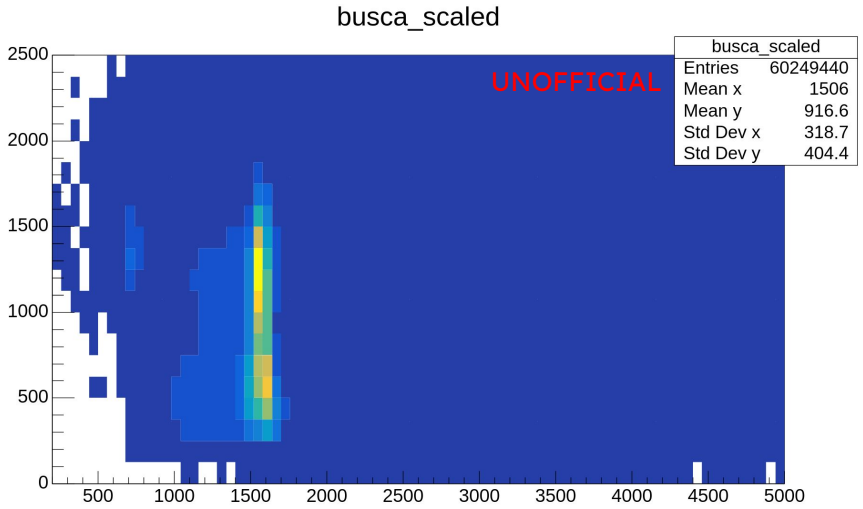


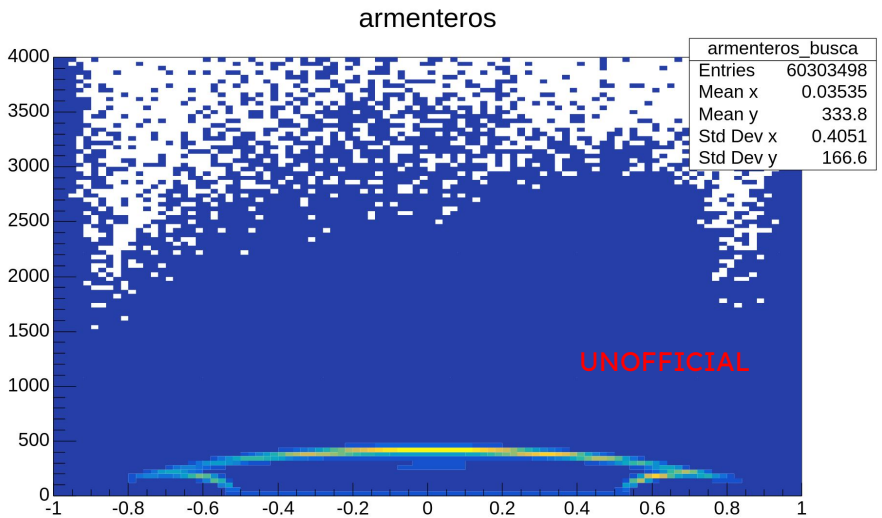
- HLT1_BuSca_Mass
- HLT1_BuSca_PID
- HLT1_BusCa_Multitrack

- HLT1DownstreamBuSca_prescaled (bkg studies)

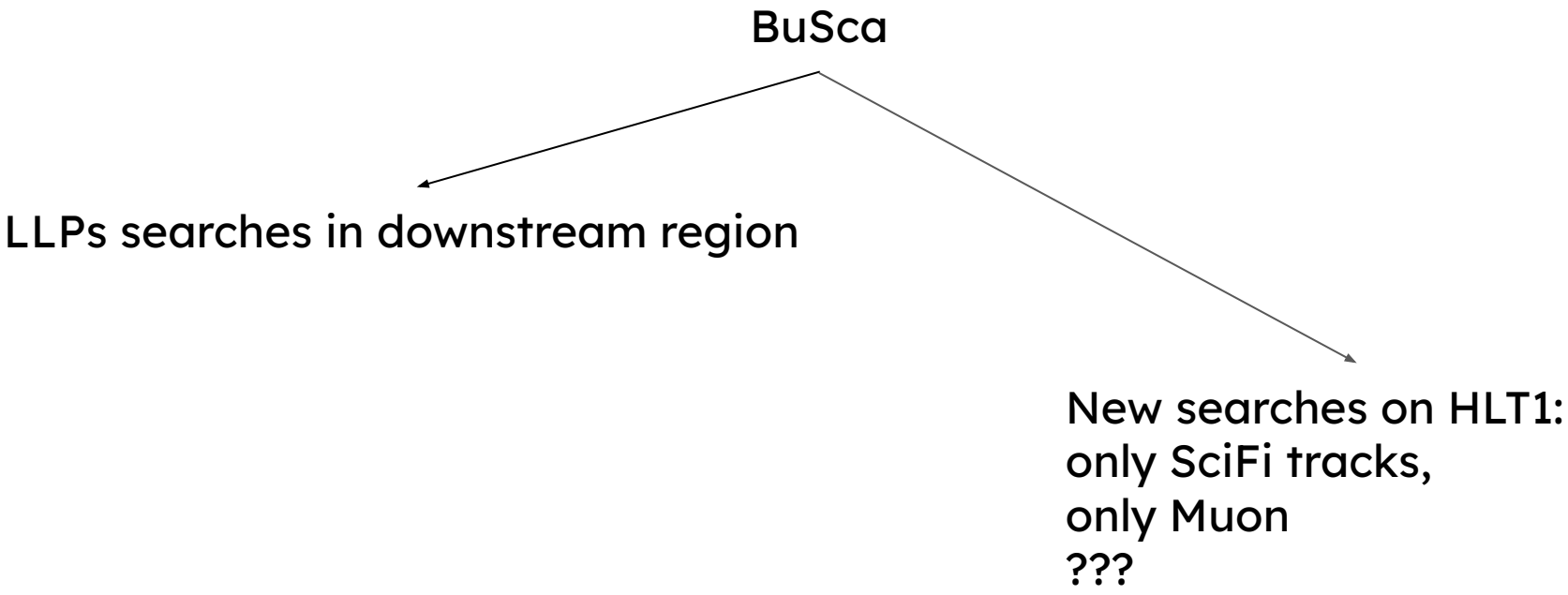
Prospects

- Data ! (1 hour of data from last night)





Prospects


BuSca
LLPs searches in downstream region
New searches on HLT1:
only SciFi tracks,
only Muon
???

Conclusions

LHCb new trigger scheme has amazing possibilities to increase the capabilities.

BuSca - HLT1 model independent LLPs search algorithm which does not trigger events, but fill 2D histogram.

Already used in data-taking!

Still room for improvement at HLT1: optimize BSM reconstruction, better match with muons.

backup