LABORATÓRIO DE INSTRUMENTAÇÃO
E FÍSICA EXPERIMENTAL DE PARTÍCULAS
partículas e tecnologia

Selection of B mesons at low transverse momentum

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Project goal

Study the decay of B mesons with low transverse momentum (pT)

Why??

Quark Coalescence

Thought to play a more noticeable role in quark hadronization, when the b quark (and thus the resulting B hadron) travel with smaller momentum and may more easily bind with other quarks in the surroundings

Problem!

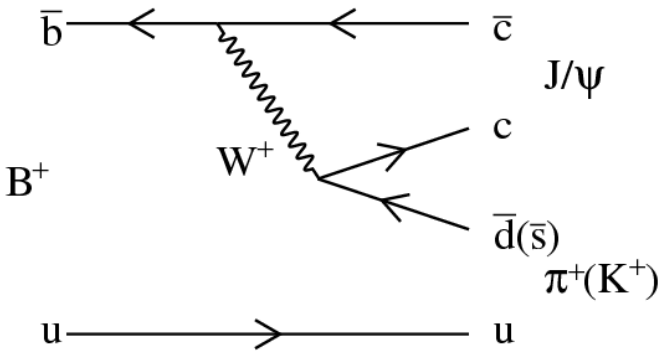
Low pT region is characterized by a larger level of other physics processes mimicking the meson decay (background events)

Solution

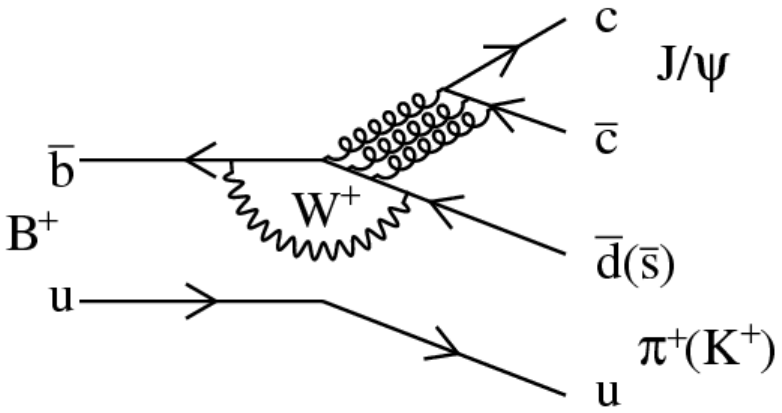
Learn and apply machine learning techniques to optimally classify signal (B meson decays) from the more abundant background

$B^+ \to J/\psi\, K^+$

Explore observable properties of the decay to optimize its selection (signal vs background separation) employing CMS data and simulation to train machine learning algorithms

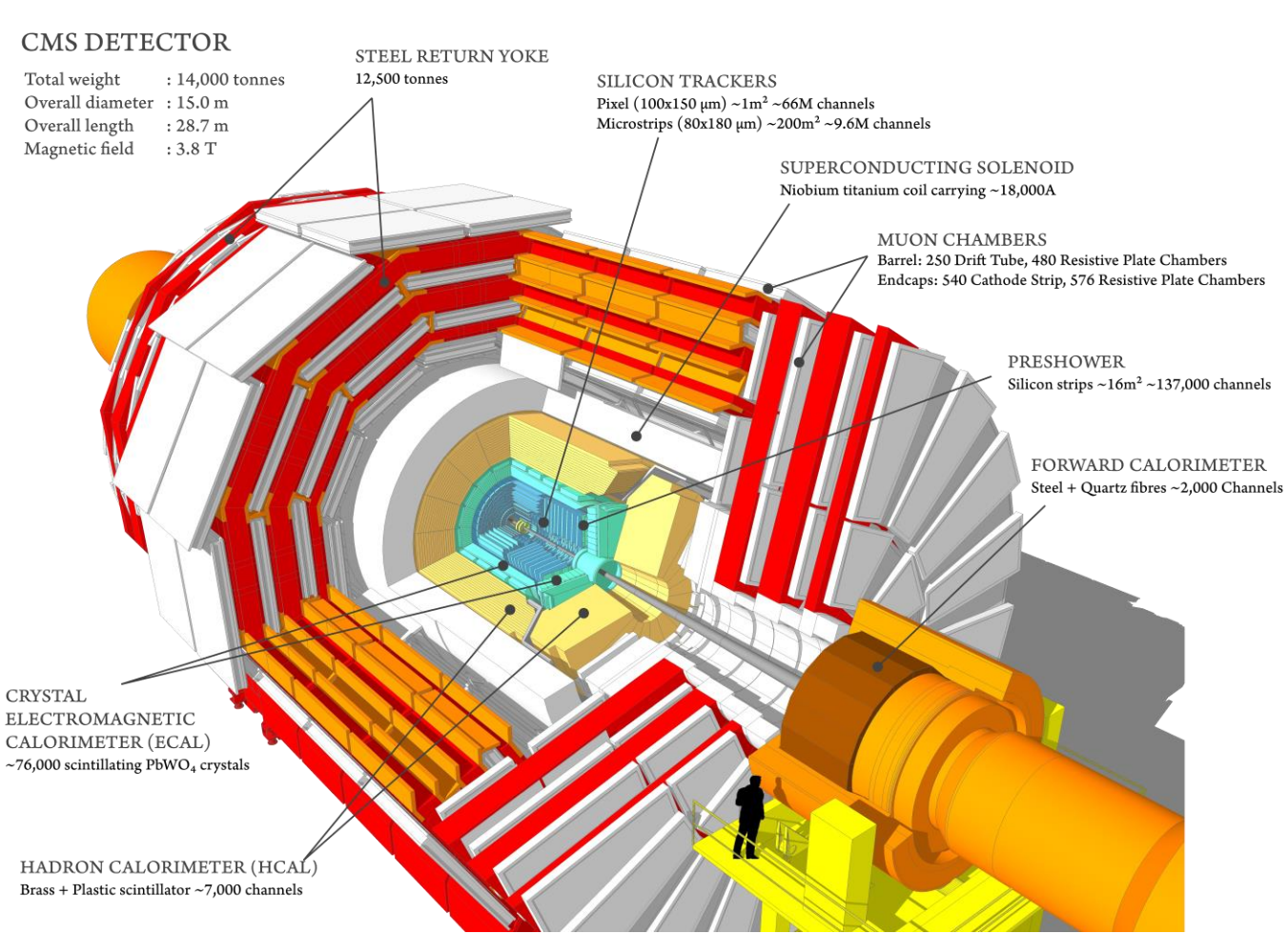


Tree level



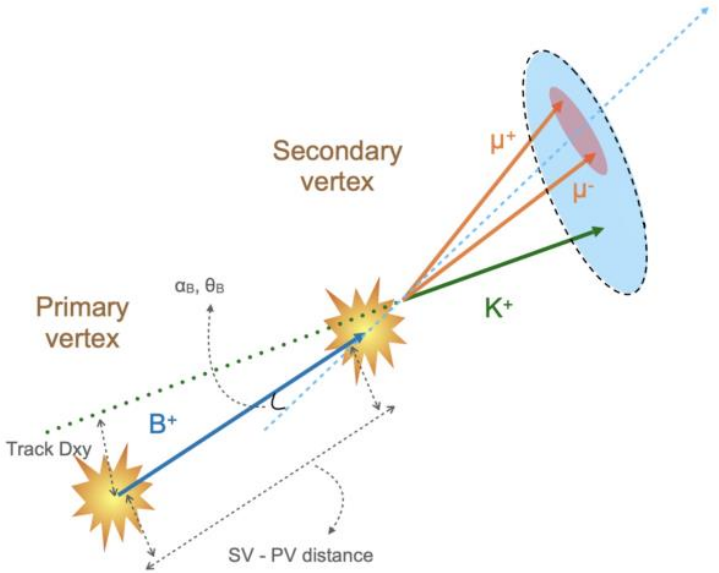
One-loop level

Feynman diagrams for B + → J/ψ K+ decays

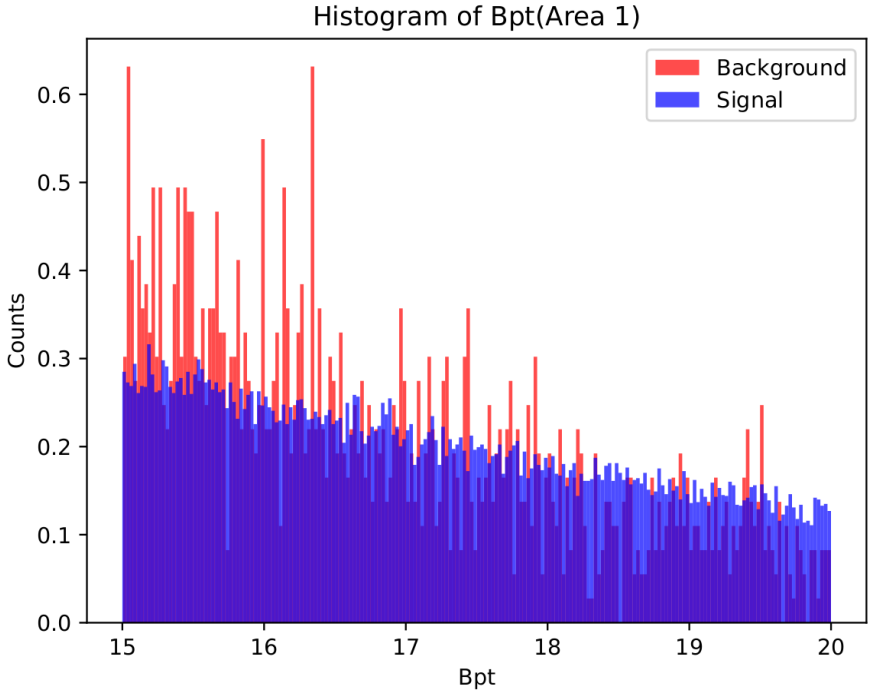


Source: CMS Collaboration

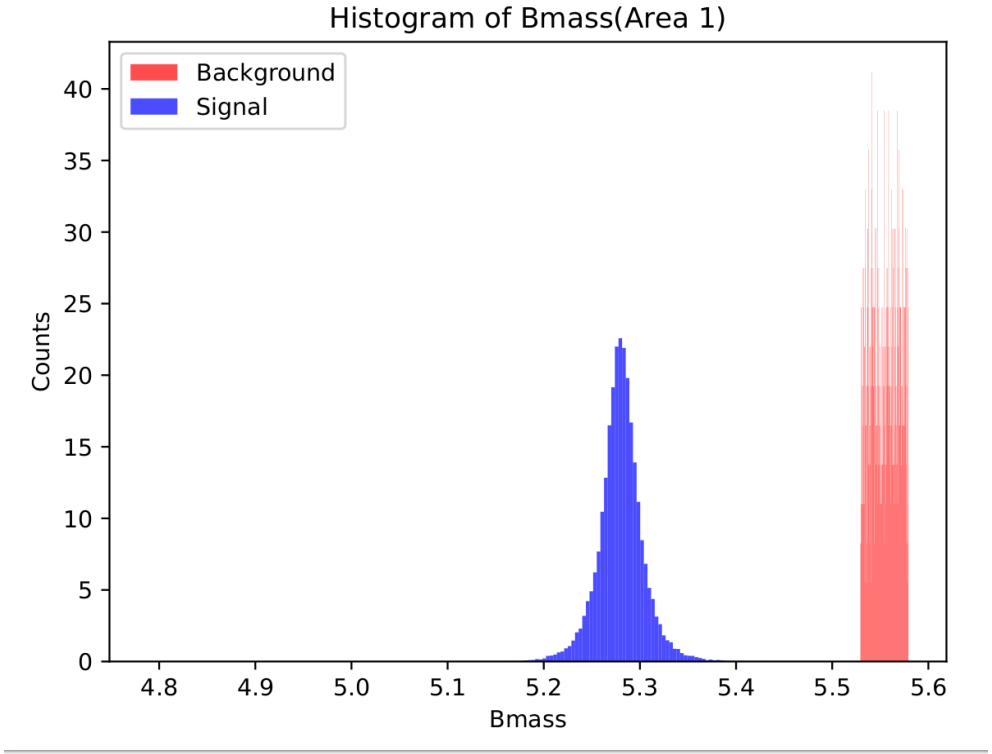
Observable properties



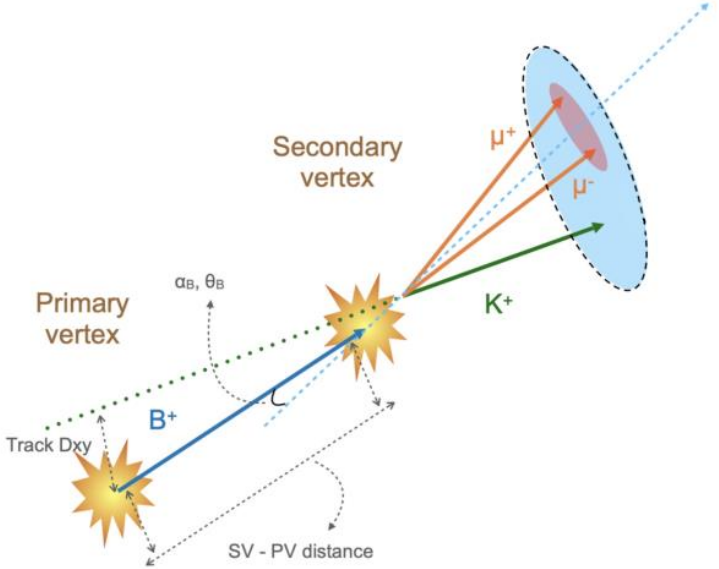
Bpt – B meson's Transverse momentum

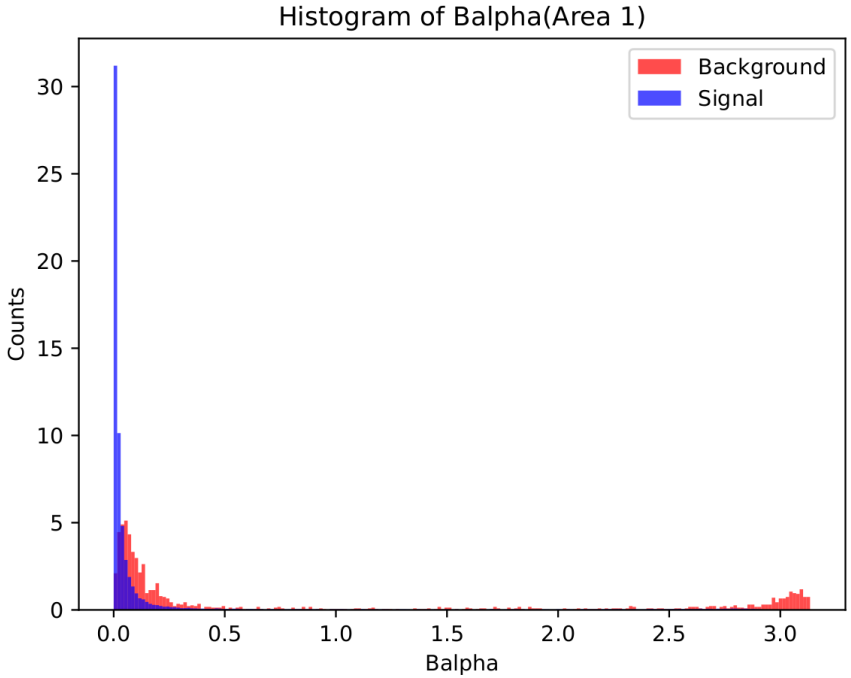


Bmass – B+ mass

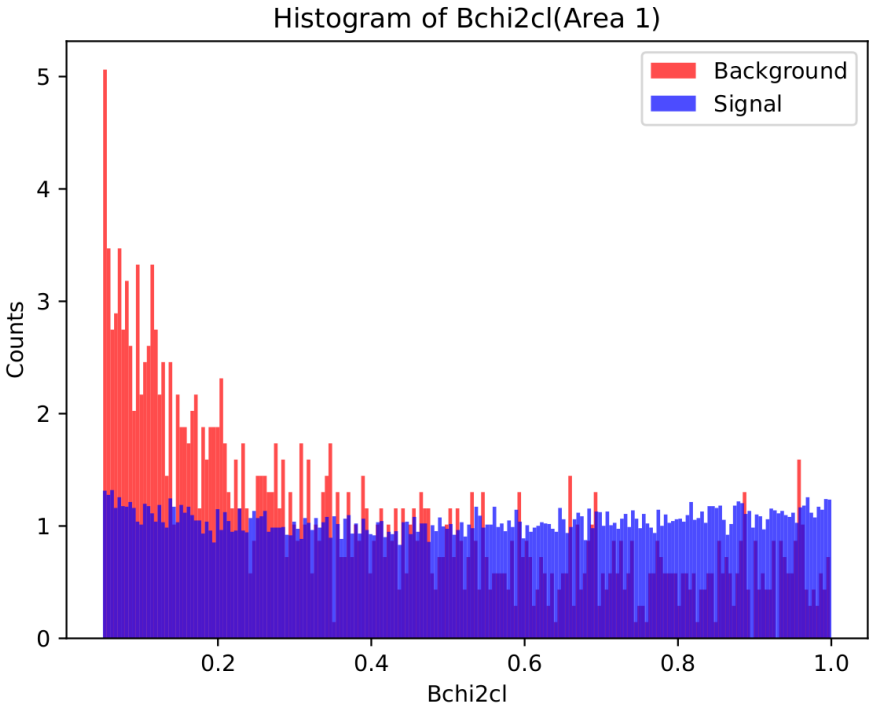

Histogram of Bmass(Area 1)
Background
Signal
Counts
0
5
10
15
20
25
30
35
40
4.8
4.9
5.0
5.1
5.2
5.3
5.4
5.5
5.6
Bmass

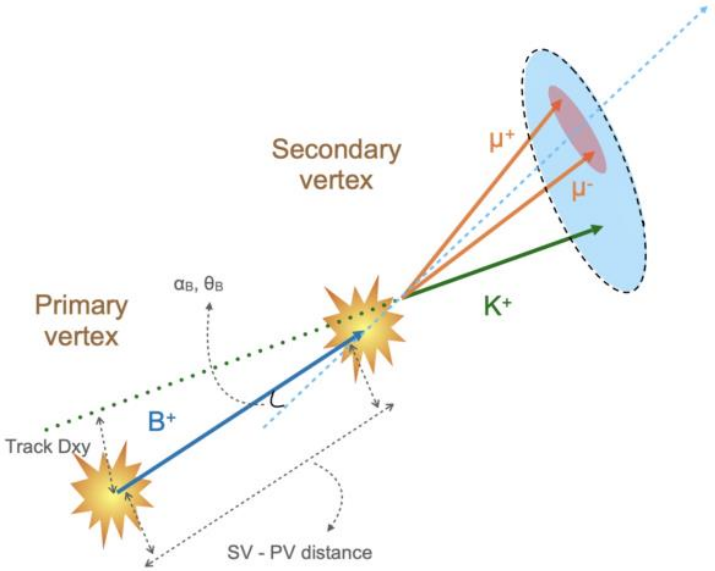
Balpha – Angle between B+ meson displacement(SV –PV distance) and its 3d momentum



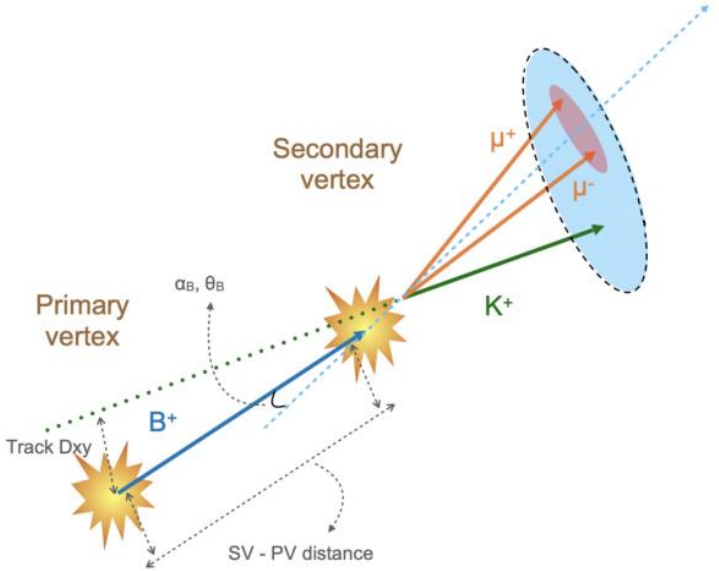


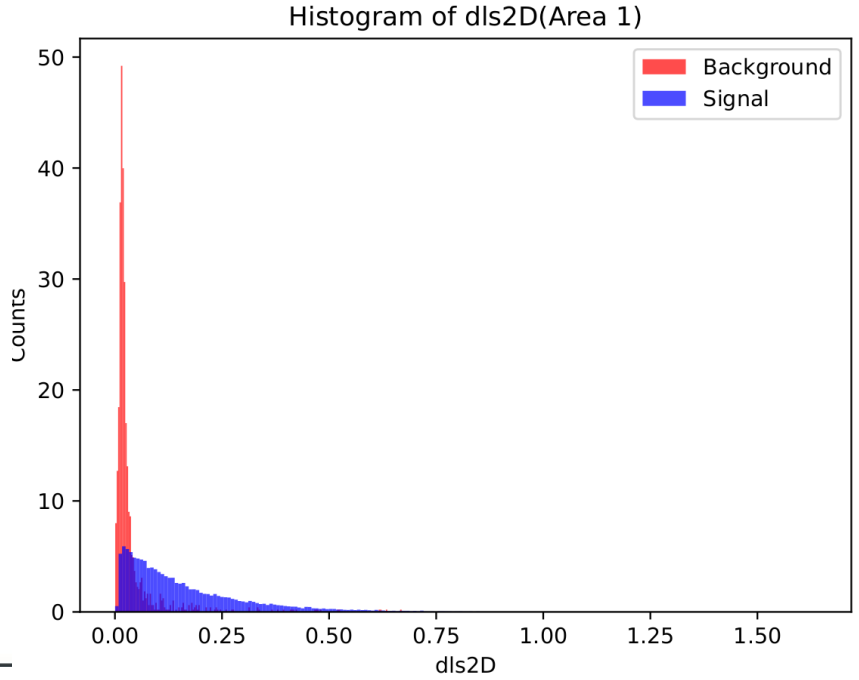
Bchi2cl – Chi square probability of the secondary decay vertex



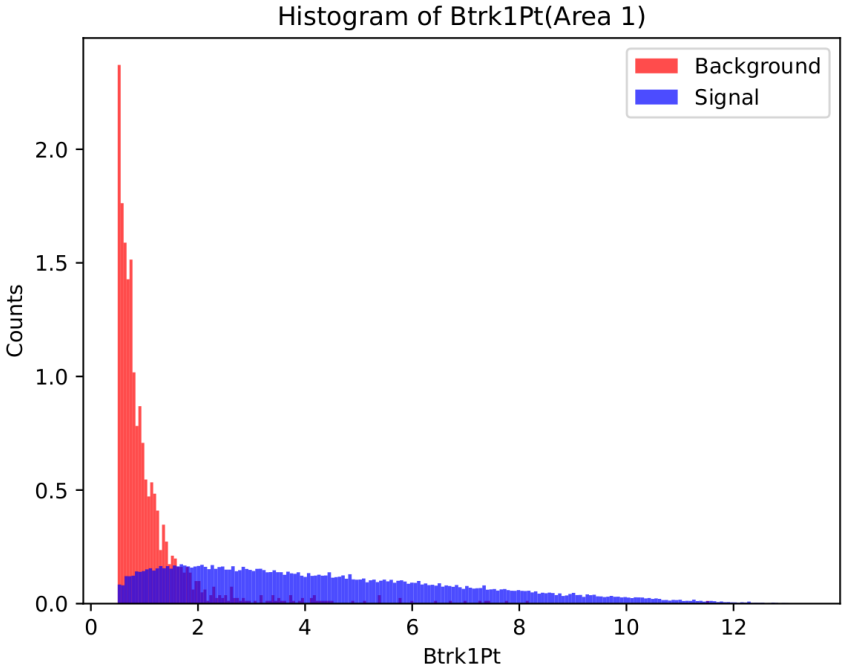


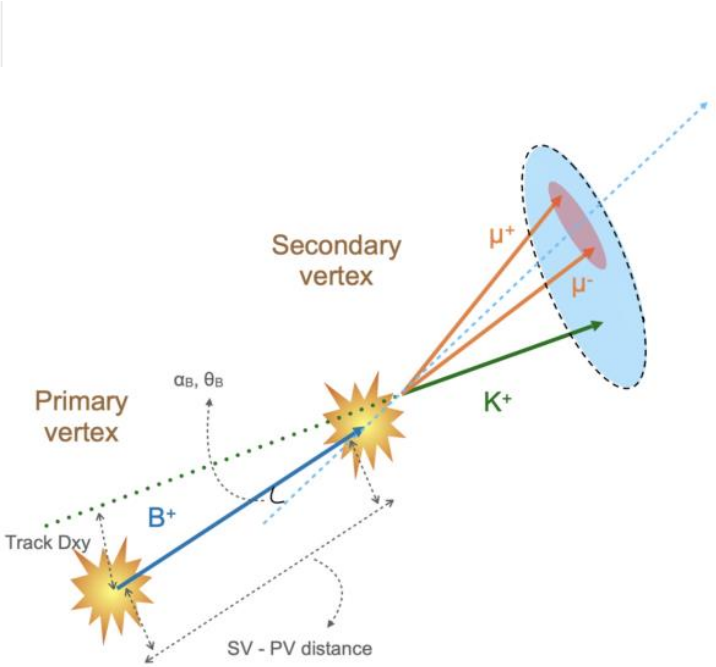
dls - Decay length normalized by its uncertainity





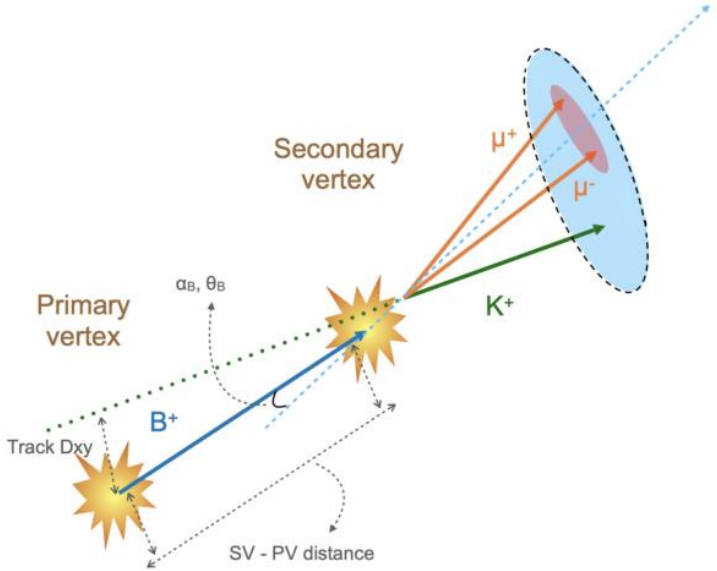
Btrk1Pt – Track's tranverse momentum

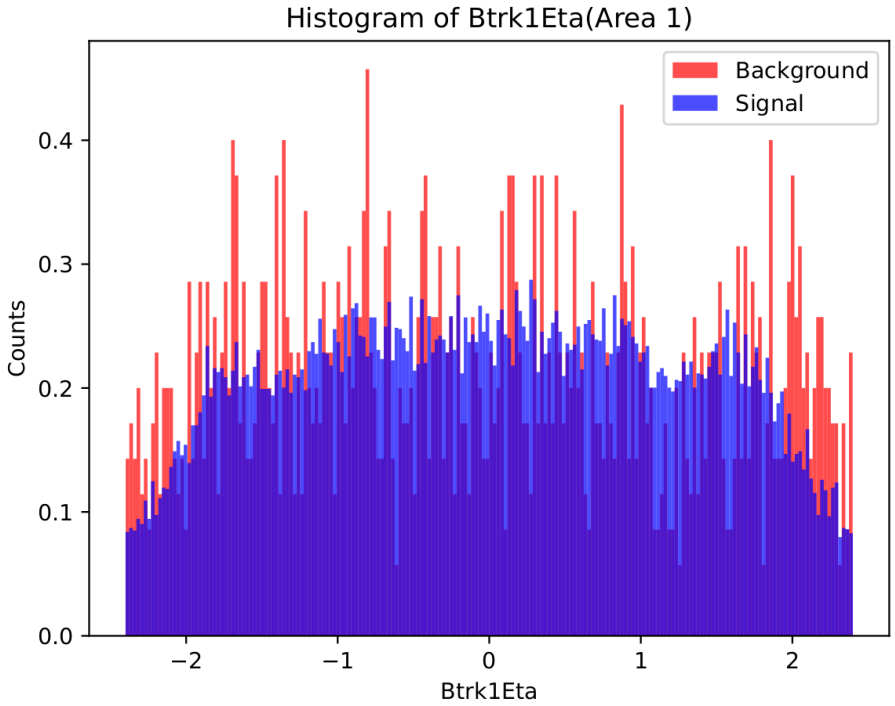




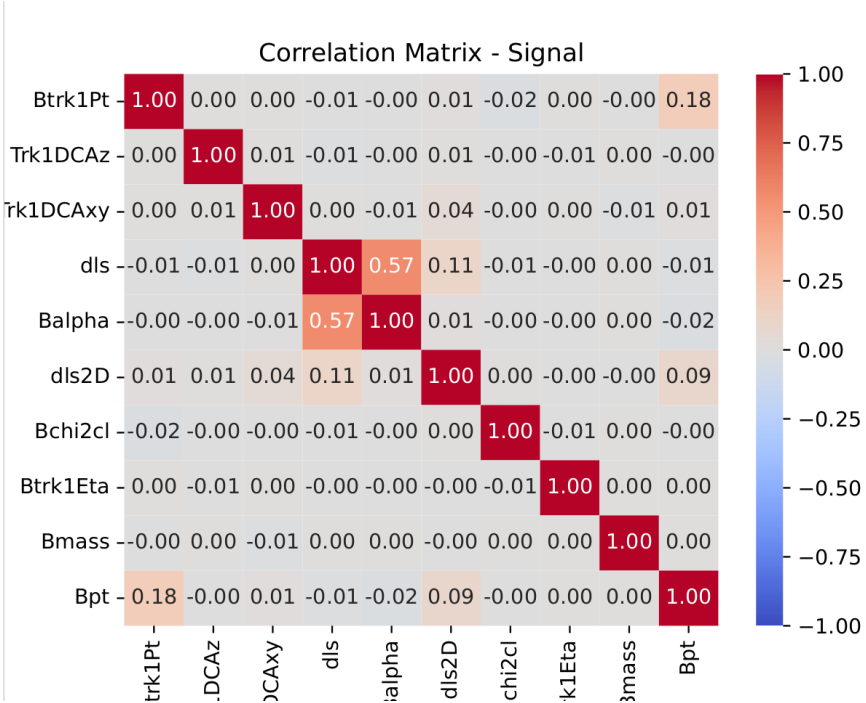
$$\eta \equiv -\ln\left[\tan\left(\frac{\theta}{2}\right)\right],$$

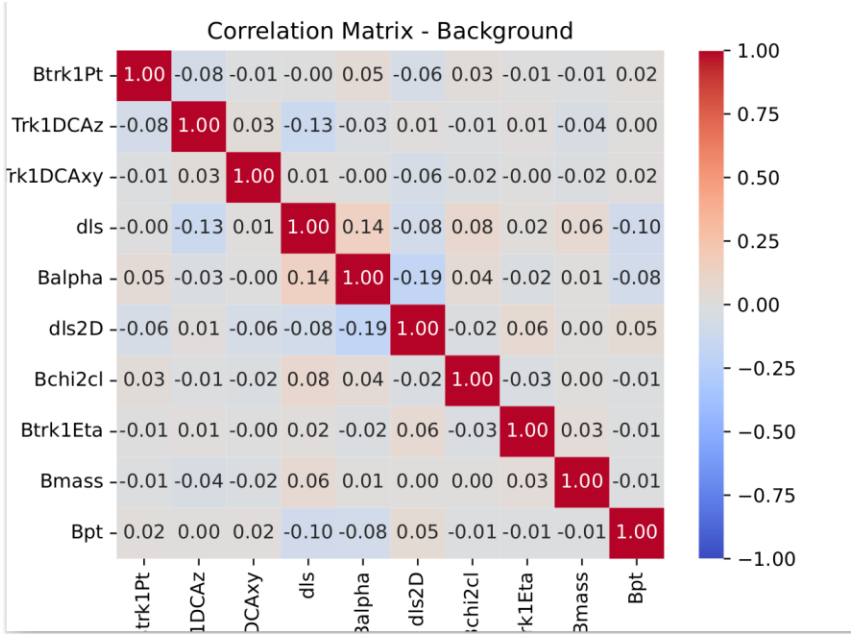
Btrk1Eta – track's pseudorapidty





Correlation between variables





Future goals

- Employ the studied variables to train ML algorithms
- Algorithms that may be tried: BDT, NN(pyTorch), or others found to be useful!
- Repeat the procedure to the more challenging low pT region

Thanks!

DISCUSSION