

Analysis of heavy-flavor particles in ALICE with Run 3 software



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CERN Summer Student Session 2021

August 11, 2021



About Me

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- **Education:**
 - Integrated Masters Student at National Institute of Science Education and Research.
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- **Cern Summer Studentship:**
 - EP-AIP
- **After CERN?**
 - PhD in Physics

Alice & heavy-flavor particles

- Alice (A Large Ion Collider Experiment) is an experiment designed to study the properties of quark-gluon plasma (QGP).
- Particles with charm(c) or beauty (b) quarks or antiquarks are known as heavy flavoured (HF) particles, example D mesons. The study of heavy-flavor particles is one of the aims of ALICE.
- Study of HF particles is useful as it can provide us with insights into the mechanics of charm-quark interactions inside the QGP.
- Measurement of heavy-flavour particles is an important part of ALICE experiment in the upcoming Run 3.

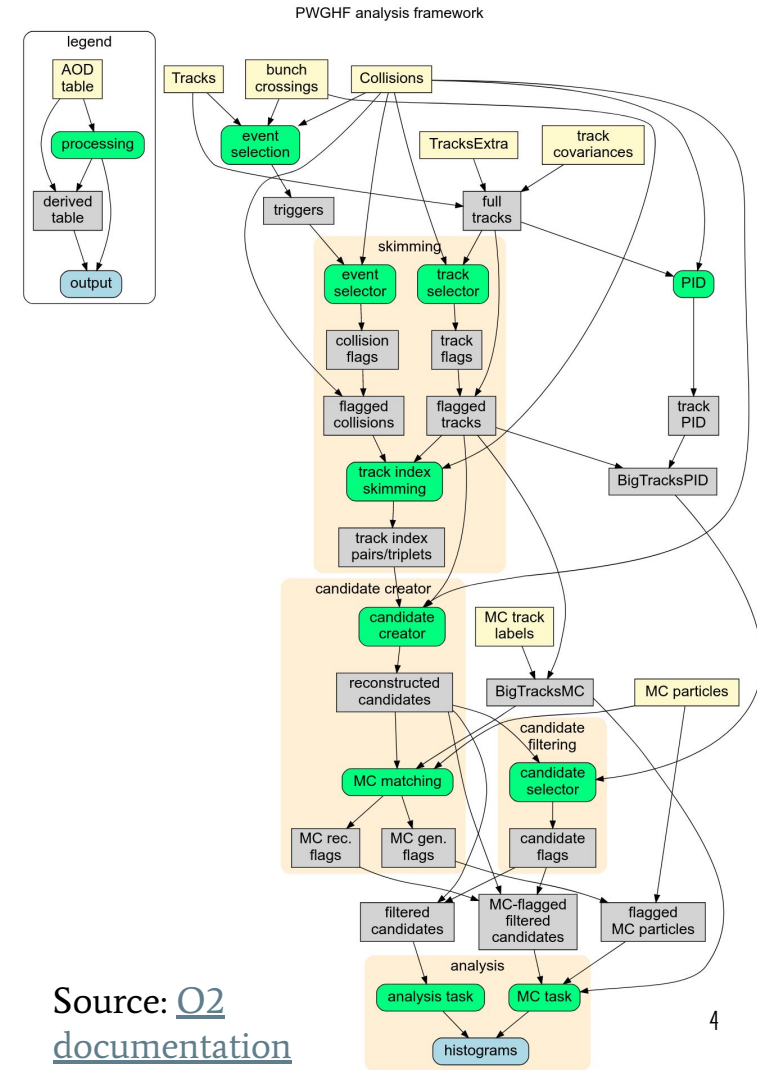
Alice O² software

O² project is the ALICE computing model for RUN 3 and 4, it is designed to cope with the amount of data throughput from the detectors after the upgrade.

The O² software will also provide a modular framework where smaller building blocks can be attached to each other to perform a task.

The flowchart shows the building blocks of the heavy-flavor analysis framework.

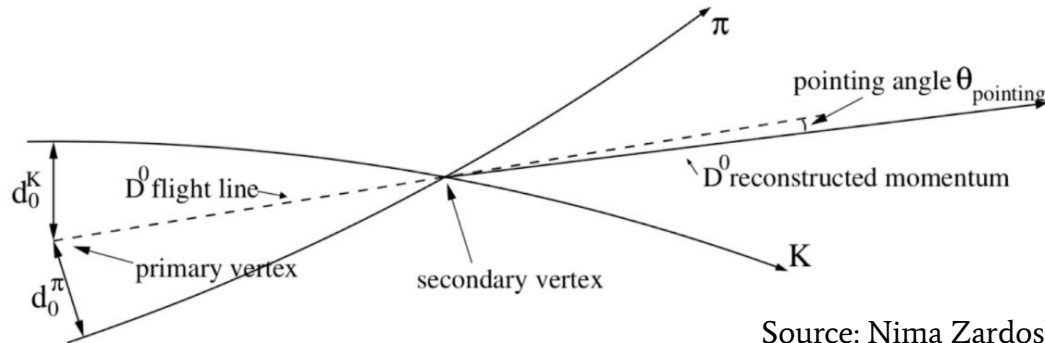
Heavy-flavour particles are detected through their decays to other particles measured in the detectors. My project concentrates on working with Candidate filtering component.



Alice O^2 software

Candidate creation blocks calculates and stores the the table with possible candidates and quantities needed for the final candidate selection (eg: cosine of pointing angle and decay length). The candidate filtering component of the framework receives the possible candidates table and in this step we have to apply final selection criteria using topological cuts and the output table containing the filtered table is forwarded to the analysis block for any further analysis.

Important selection variables :



Source: Nima Zardoshti

Project objective:

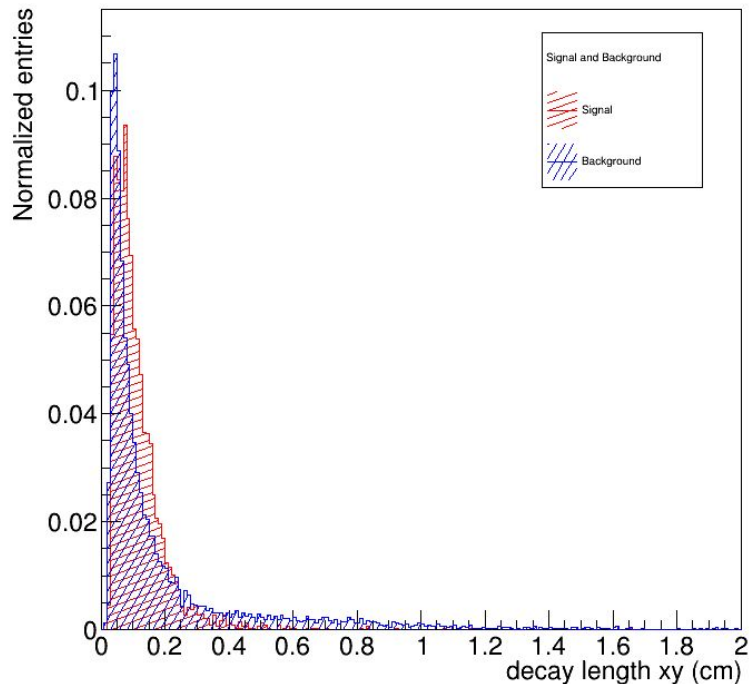
- To reproduce a heavy-flavor Run 2 selection criteria analysis within the new Run3 O2 framework.
- Investigate the selection criteria using Run 3 Monte Carlo simulations with ML techniques.

Strategy

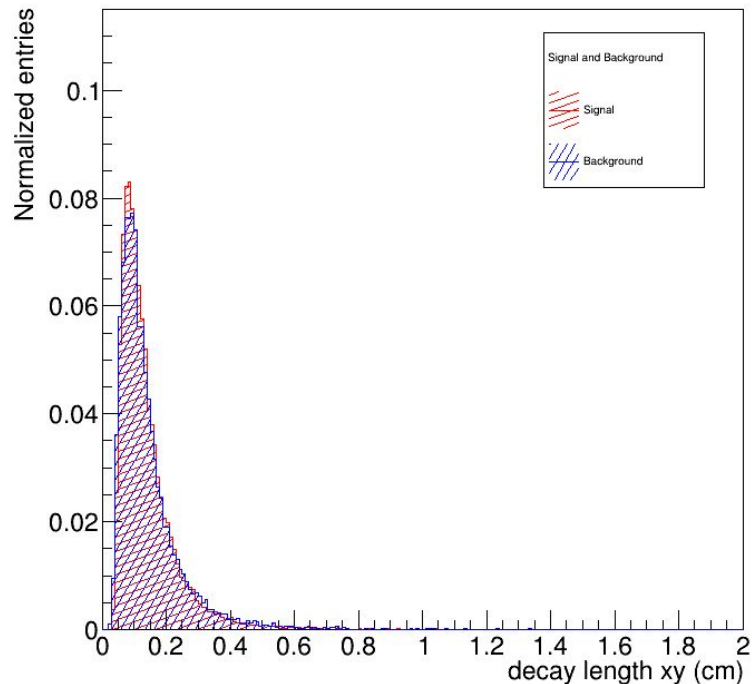
- Updating the analysis block to create 2D signal and background histogram without any selection criteria using Monte Carlo simulations.
- These histograms will contain the distribution of signal and background of selection variables for each p_T bin.
- Using the above histograms, we get a significance Vs. Cut value curve for each p_T bin and each variable.
- We can find the maximum significance value and optimal cut for each p_T bin for each variable using the significance histograms.
- Try to get optimal cut using ML and compare with rectangular cut.

Decay length comparison: with and without cuts

Decay length XY w/o selection cuts

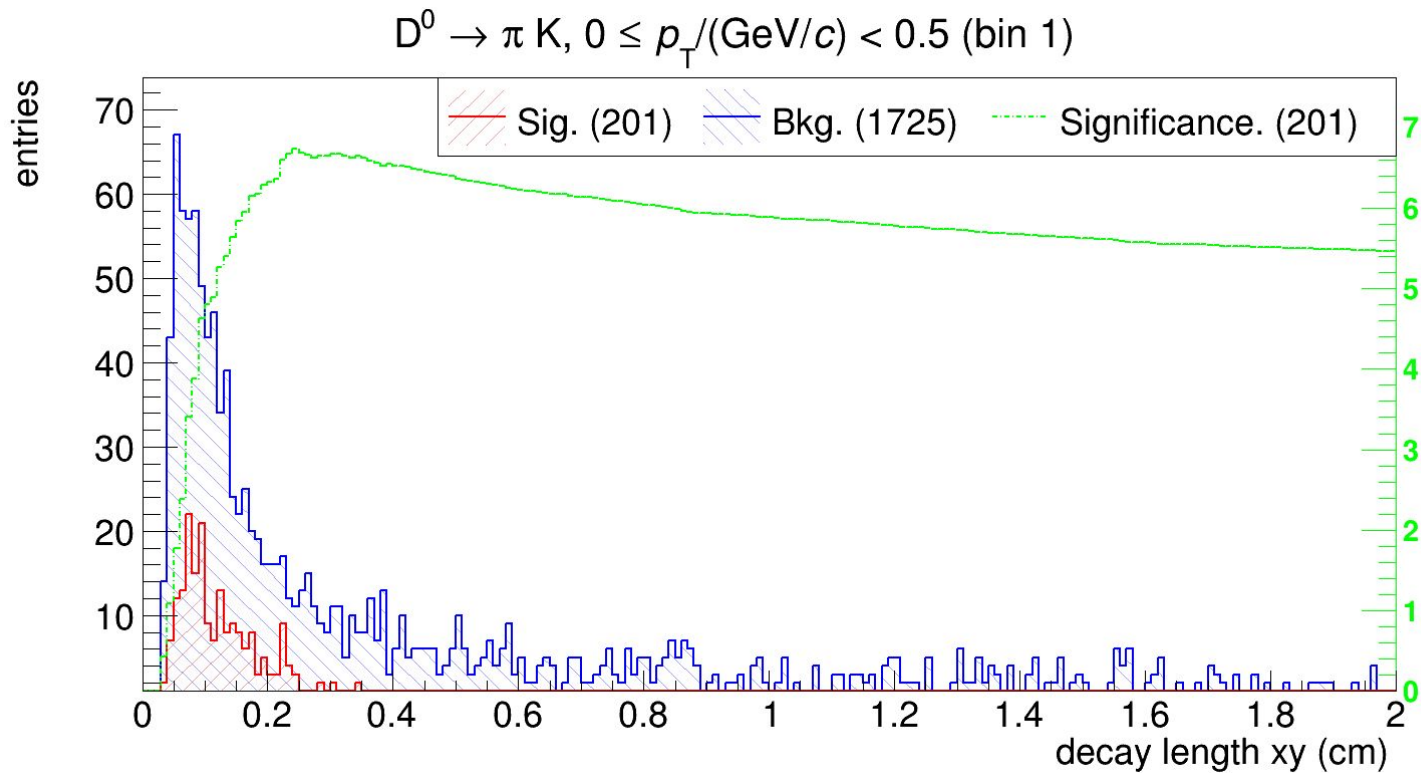


Decay Length XY with selection cuts



Significance plot

$$Sig = \frac{S}{\sqrt{S+B}}$$



Summary and Outlook

- Added histograms of variables Vs p_T in heavy-flavor D0 Analysis block.
- Added calculation and plotting of significance curve in the Run3Analysisvalidation framework.
- Completed calculations of cut for D0- $\rightarrow\pi^+k^-$ decay channel using Run 2, p-p MC LHC17p data.
- Going forward
 - I will optimize selection criterias using ML techniques and compare them with rectangular cuts we got from significance curve.

Thank you for your attention !

