Hands On challenge: Efficiency estimation in fully hadronic B decay

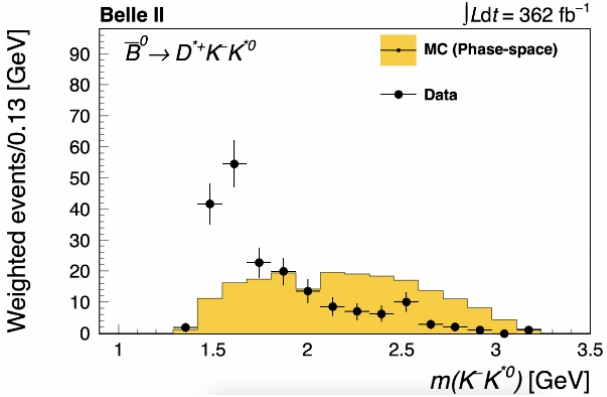
Federico Testa for the Bhadronic challengers

Overview of the challenge – Efficiency biases

- **Specific case:** $\overline{B}^0 \to D^{*+} K^- K^{*0}$

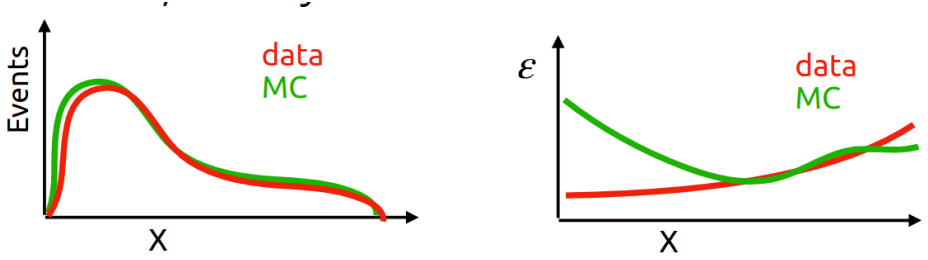
  Dalitz decay is unknow → modelled as phase space in our MC

  Can not evaluate efficiency just as $\epsilon = \frac{N(reco)}{N(gen)}$



Challenges

1) Estimate efficiency taking into account Dalitz dependencies
2) Check other relevant dependecies of the efficiency
3) Assign a systematics uncertainty

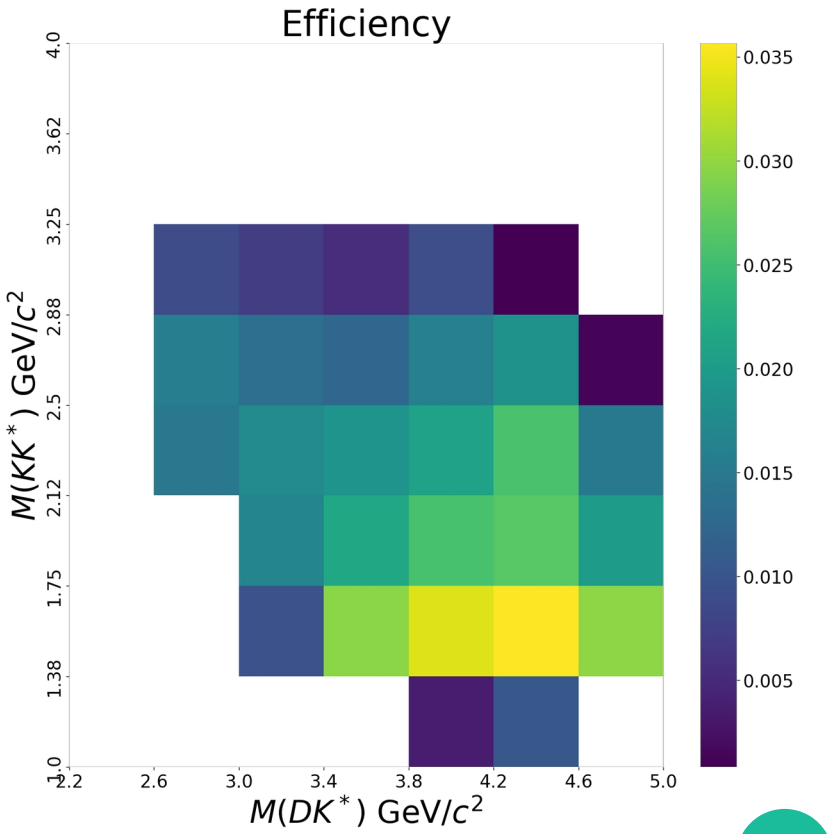


Challenge 1: extimation of the efficiency

- The approach we took was to measure the **efficiency as a function of** the invariant masses M(KK*) and **M(DK*)** on a sample of Signal MC
- Use a grid in M(KK*) and M(DK*) and take the efficiency as N_{reco} / N_{gen} in each bin

  How to use it…
- Weight each events according to its “position” in the 2D plane in order to obtain the efficiency corrected events

In this way we make our efficiency extimation <u>partially</u> independent of our modelling of the decay in the MC

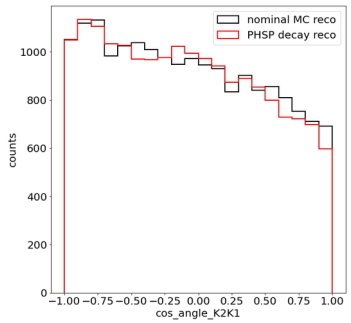


Challenge 1: Check additional dependencies

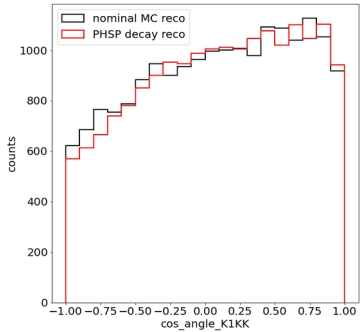
- The Dalitz plane carries all the relevant kinematic information of the B decay
- K^{*0} is a vector particle and its polarization could introduce new degrees of freedom in the angle distributions that do not average out
- Statitic is to low to make a 3D bin to encompass other dependencies
- Discrepancy however seems under control

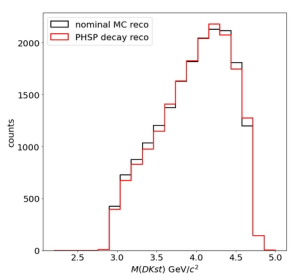
Add a systematic uncertainty due to the fact that we can not properly take into account such dependencies

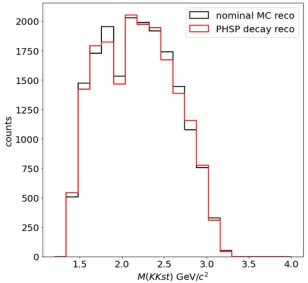
```
Decay K*0sig
1.0   K+  pi-  VSS;
Enddecay
```

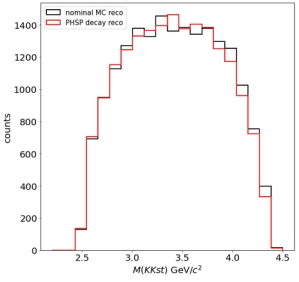



```
Decay K*0sig
1.0   K+  pi-  PHSP;
Enddecay
```







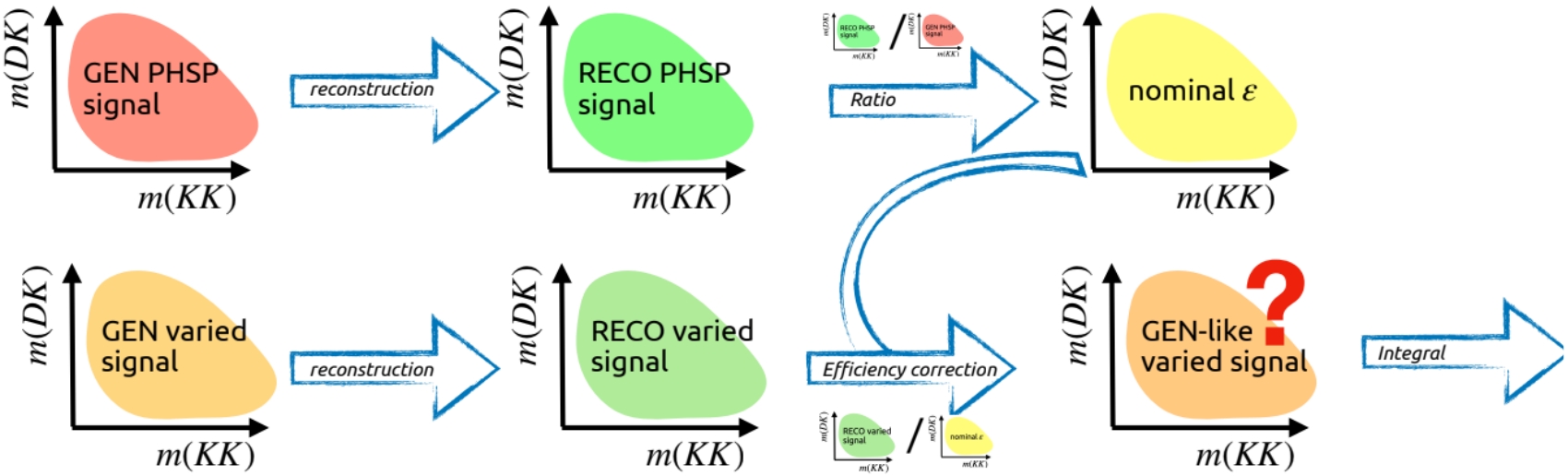


Challenge 3: quote systematic uncertainties

- **We want to check if our procedure work on different Dalitz models:**
  - Presence of resonance in the Dalitz decay
  - Different decay model for the vector particle in the channel (K^{*0})
- **Generate 1M events for two control channel:**
  - $\overline{B}^0 \to D^{*+} a_1(1260)^-$
  - $\overline{B}^0 \to D^{*+} K^- K^{*0}$ with PHSP decay for the K^*
- **How ?**

Challenge 3: quote systematic uncertainties

- **Correct for the efficiency and check if the integral sum up to the number of events generated**
- **Quote the difference as systematic uncertainty**



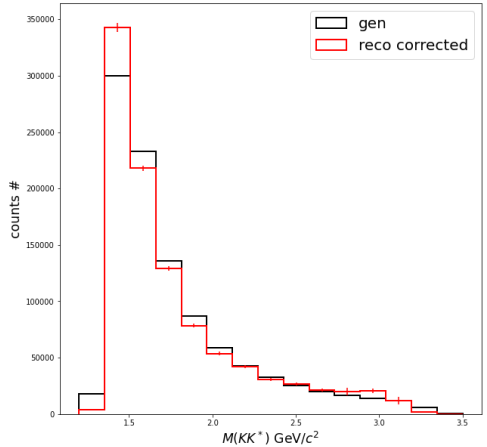
Is this compatible with 1M generated events?

Challenge 3: quote systematic uncertainties

Use as metric CT = N(Gen like)/N(Gen)

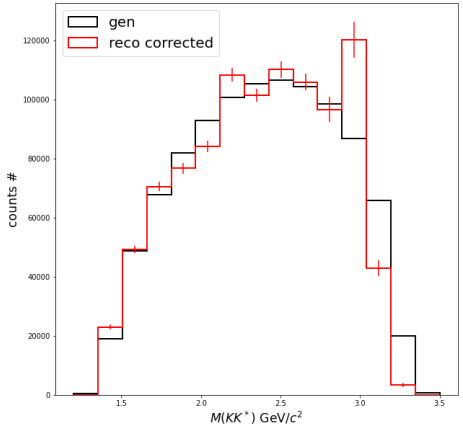
$\overline{B}^0 \to D^{*+} a_1(1260)^-$

CT = 0.999 +/- 0.001



$\overline{B}^0 \to D^{*+} K^- K^{*0}$

CT = 0.993 +/- 0.001



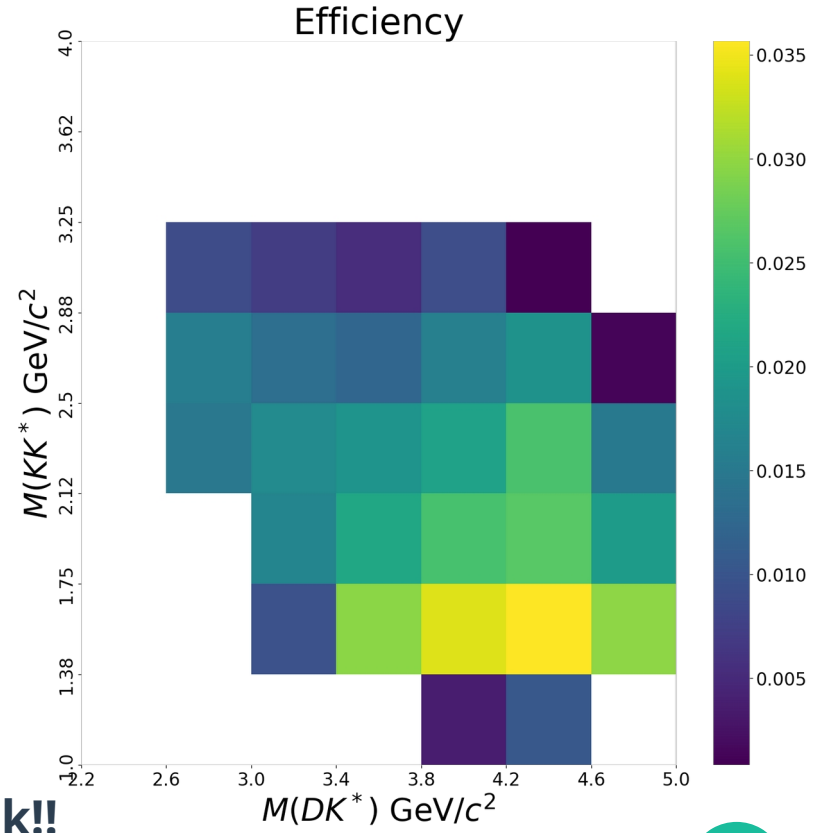
The discrepancy from one will be used as a systematic uncertainty for the measurement of the branching fraction

Conclusions

1) **Estimate efficiency taking into account Dalitz dependencies**

2) **Check other relevant dependecies of the efficiency**

3) **Assign a systematics uncertainty**



Many thanks to Valerio for the help during the week!!