ALICE3 HF Meeting

Multi-Charm baryons : Ξ_{cc}^{++} in non-strangeness decays

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Introduction

- **ML package**
  - **MachineLearningHEP** : https://github.com/ginnocen/MachineLearningHEP
    - Not working for Xicc study, need to fix the issue?
  - **hipe4ml** : https://github.com/hipe4ml/hipe4ml
    - BDT algorithm : XGBoost

- **Input sample**
  - **Signal :** /home/mmazzill/pp14TeV_XiccGun_2T_Dipole_40M_23092021
  - **Background :** LHC21d9i_pp
    - First run of tree creator on hyperloop!

Preselection & Training variable

- **Pre-selection and Training variable**
  - Very loose cuts
    - lnSigmaTOFl < 3 & lnSigmaTOFCombinedl < 5 are already applied to reduce the tree output size
      - NOT considered nSigmaTOF and nSigmaTOFCombined as training variable

Preselection

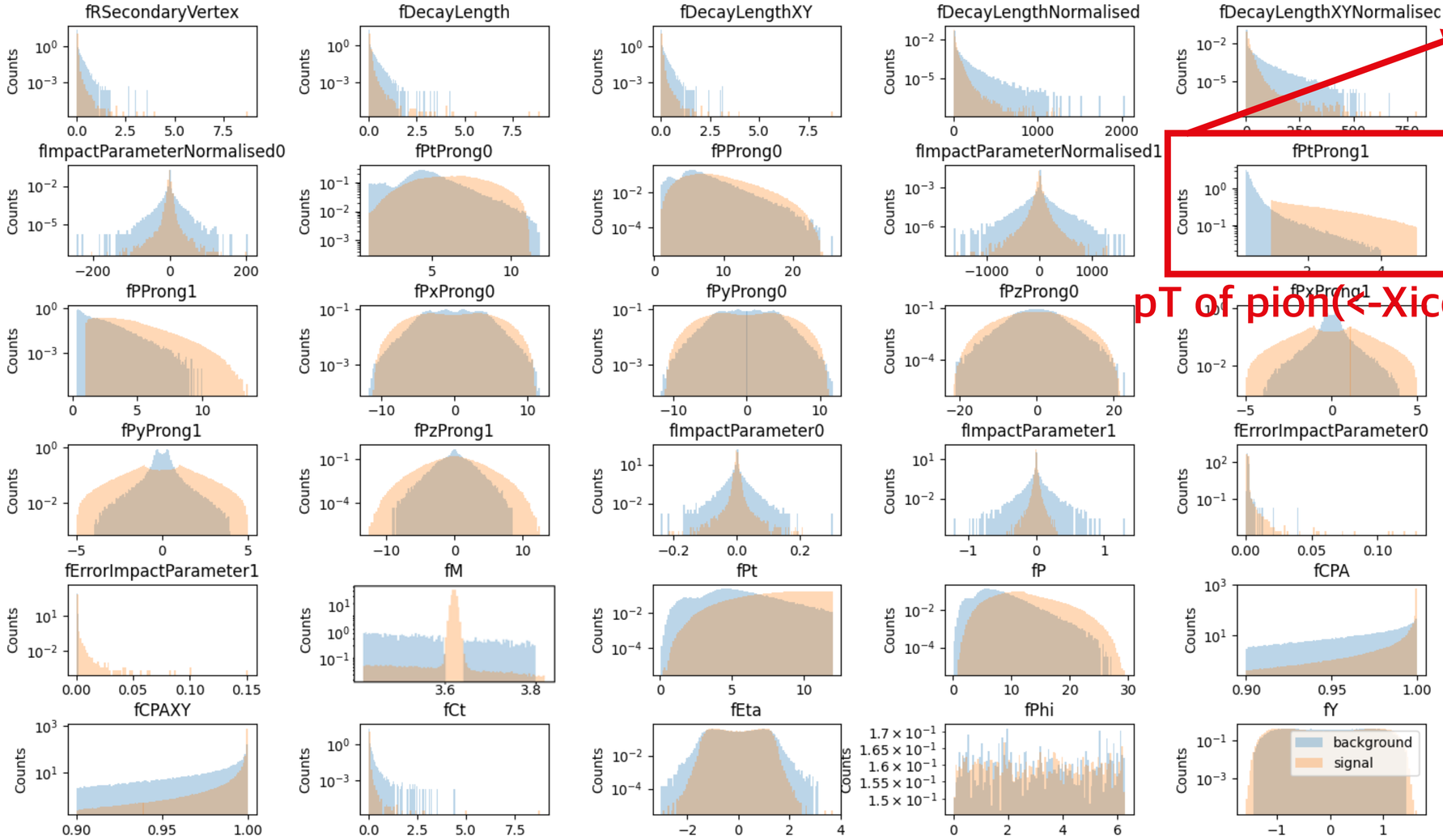
```
#loose preslection
preselection = [
    '-1.44 < fY < 1.44',
    '0.00 < fDecayLength < 10',
    '-10 < fImpactParameter0 < 10',
    '-10 < fImpactParameter1 < 10',
    '0.5 < fPtProng0 < 20',
    '1 < fPtProng1 < 20',
    '0.90 < fCPA < 1',
    '0.90 < fCPAXY < 1',
    '3.4 < fM < 3.8',
    '0 < fPt < 16'
]
```

Training variable

```
("fDecayLength", &fDecayLength);
("fDecayLengthXY", &fDecayLengthXY);
("fDecayLengthNormalised", &fDecayLengthNormalised);
("fDecayLengthXYNormalised", &fDecayLengthXYNormalised);
("fImpactParameterNormalised0", &fImpactParameterNormalised0);
("fPtProng0", &fPtProng0);
("fPProng0", &fPProng0);
("fImpactParameterNormalised1", &fImpactParameterNormalised1);
("fPtProng1", &fPtProng1);
("fPProng1", &fPProng1);
("fImpactParameter0", &fImpactParameter0);
("fImpactParameter1", &fImpactParameter1);
("fErrorImpactParameter0", &fErrorImpactParameter0);
("fErrorImpactParameter1", &fErrorImpactParameter1);
("fCPA", &fCPA);
("fCPAXY", &fCPAXY);
```

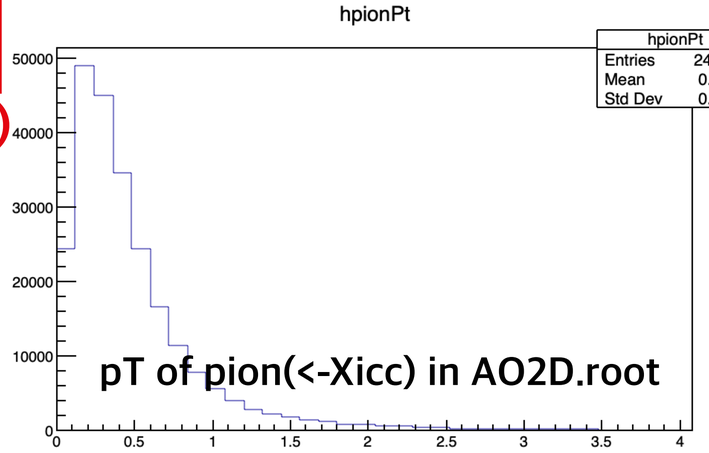
Sig vs Bkg

- **Signal vs background distribution (0 < =pT < 12 GeV/c)**



- **Debugging**
  - The signal dist. starts from 1 GeV/c
  - **Generation level?**
    - ➡ MC Generation is fine

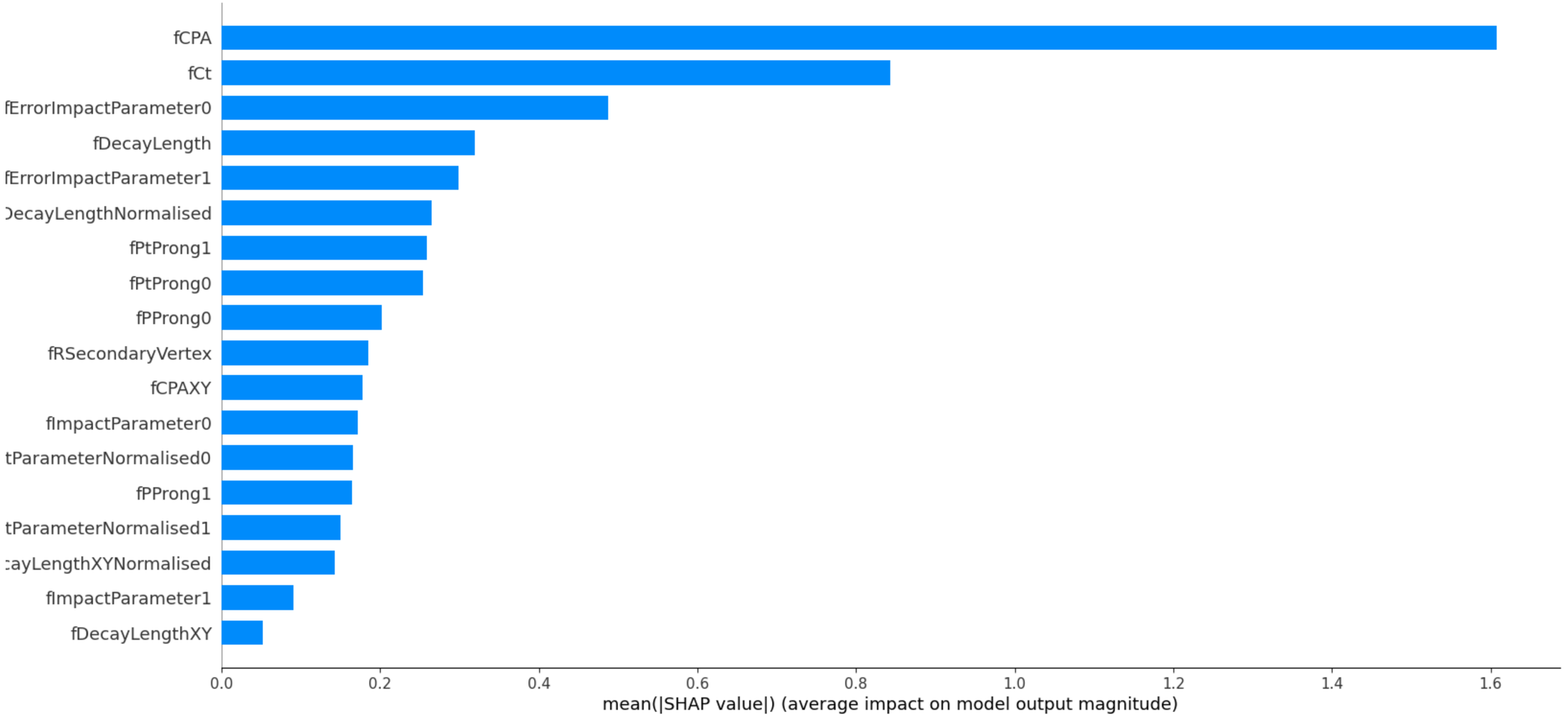
pT of pion(<-Xicc)



- **Selection?**
  - dpl is consistent with hyperloop
    - I will check again 🤔

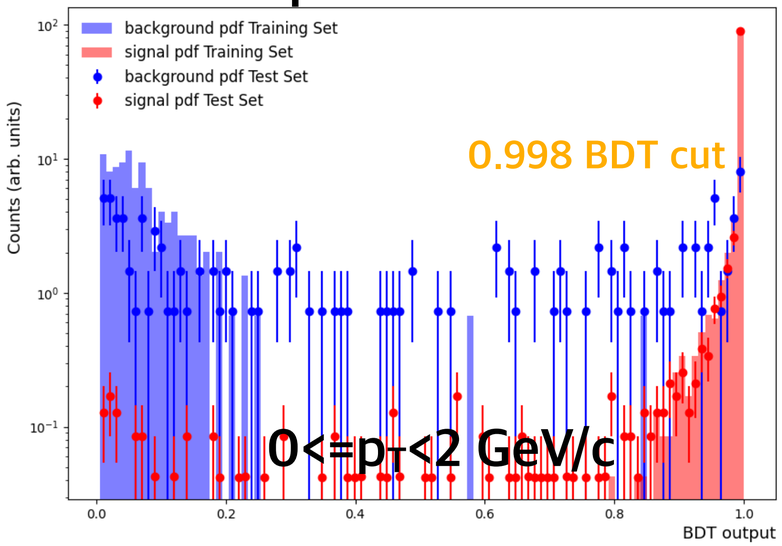
Feature importance

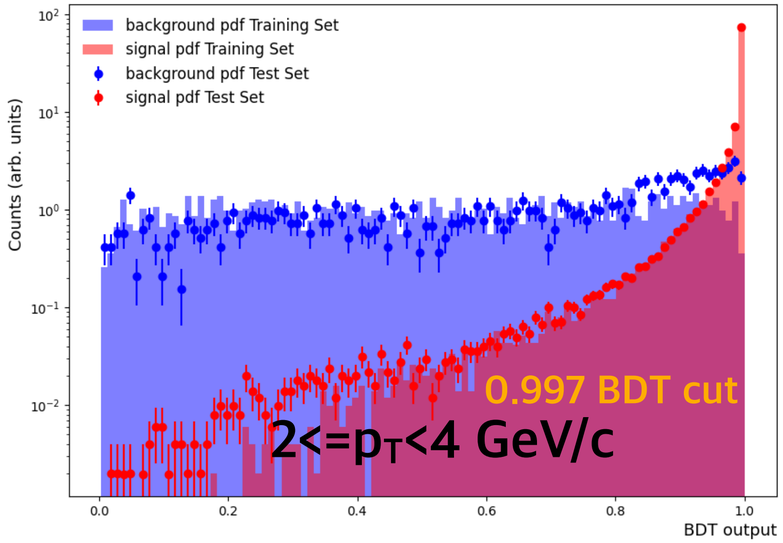
- **Feature importance (4 <= pT < 6 GeV/c)**

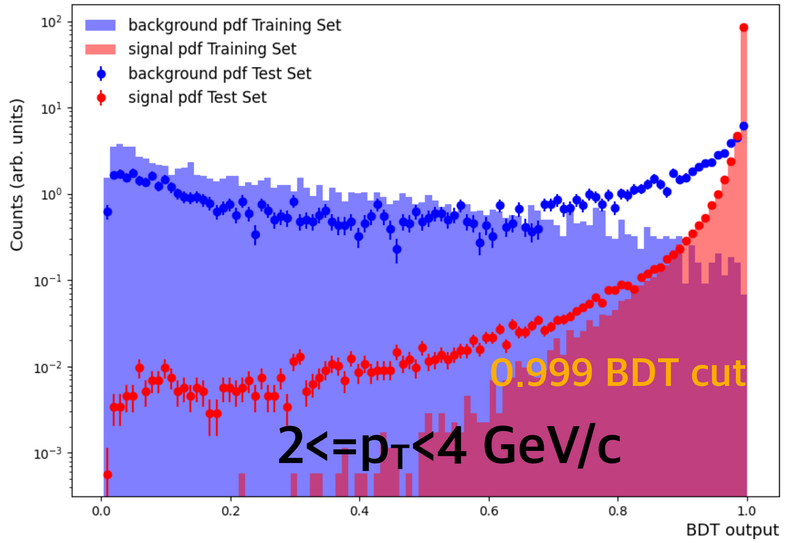


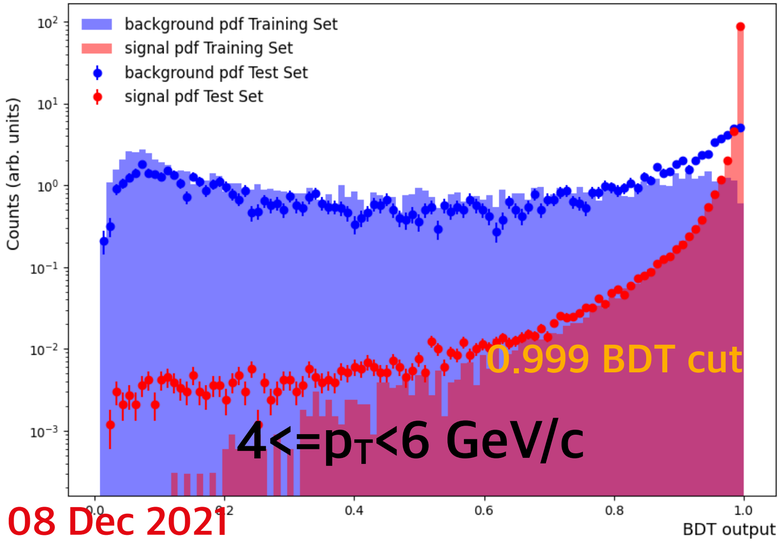
BDT model output

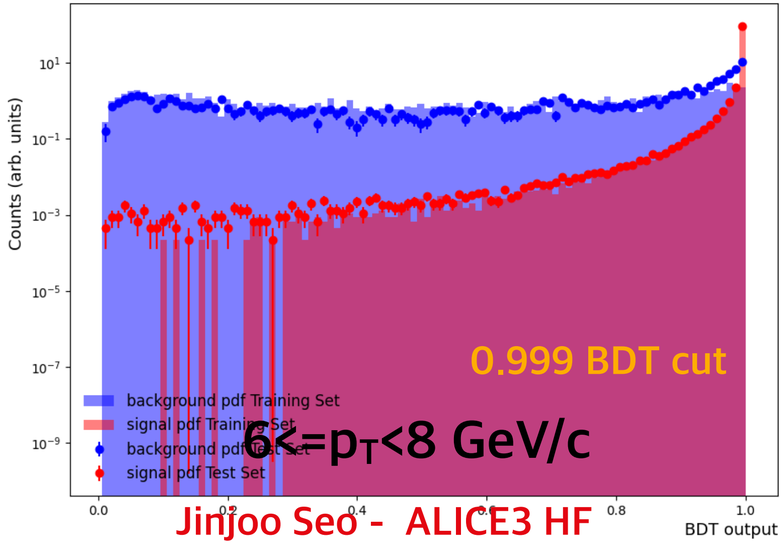
- **Model output**

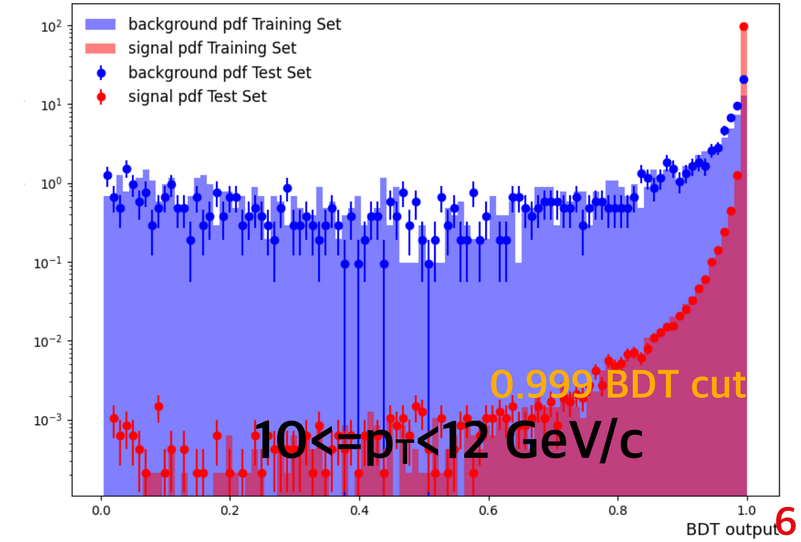






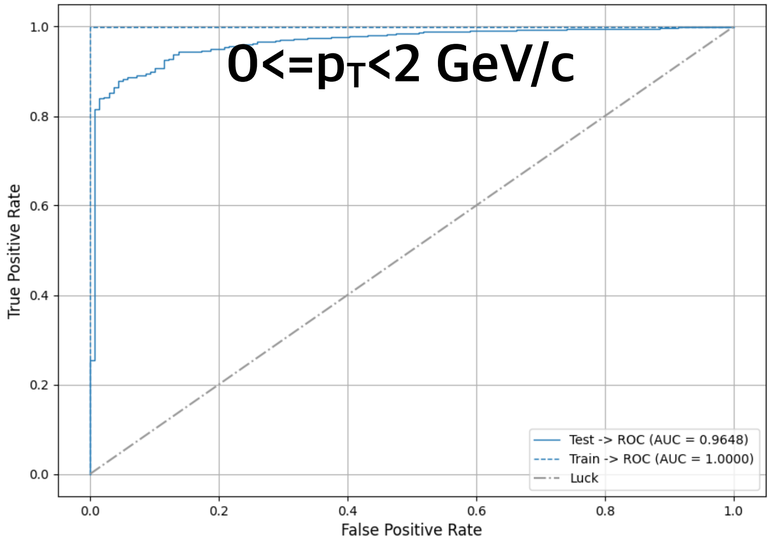


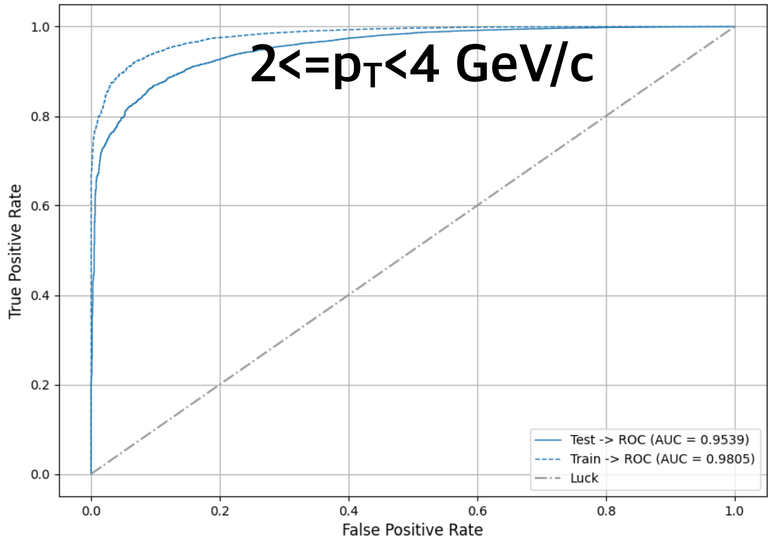


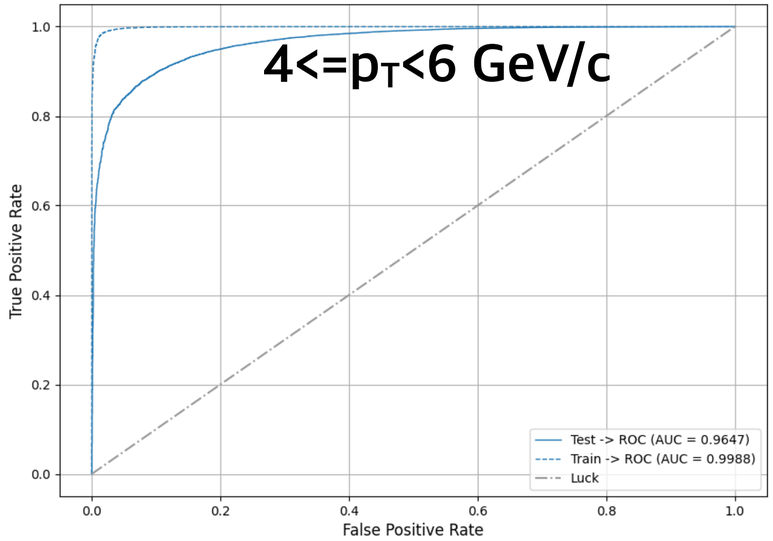


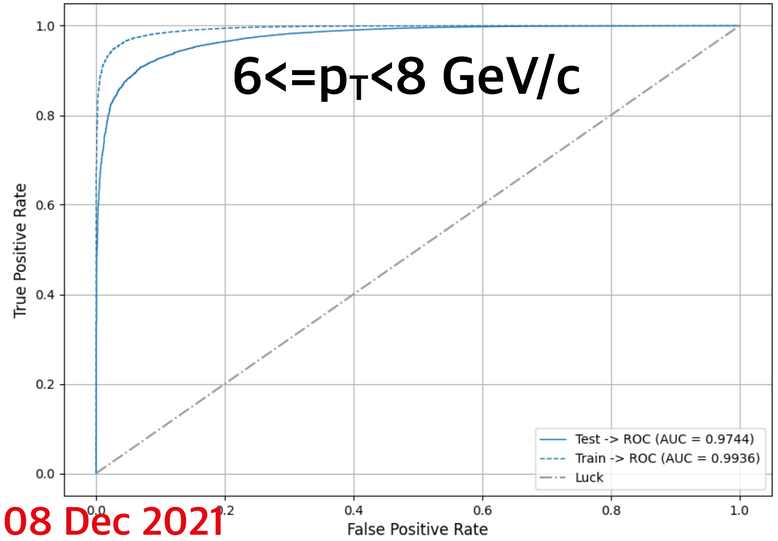
ROC curve

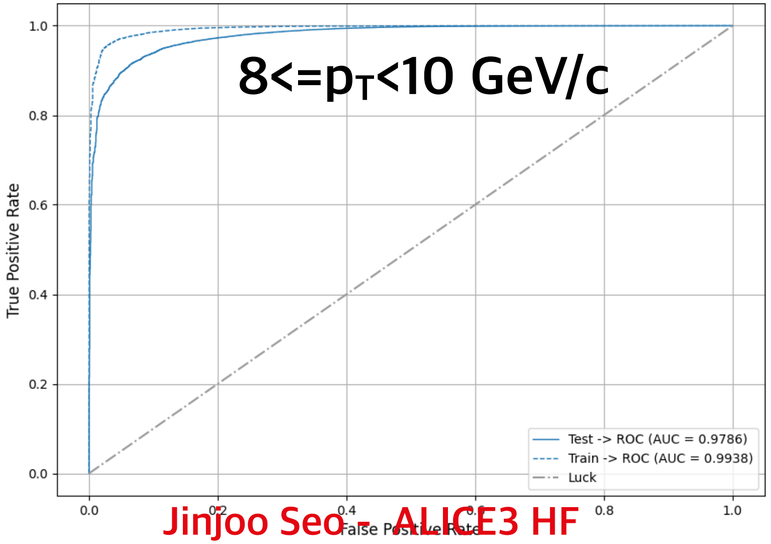
- **ROC curve**

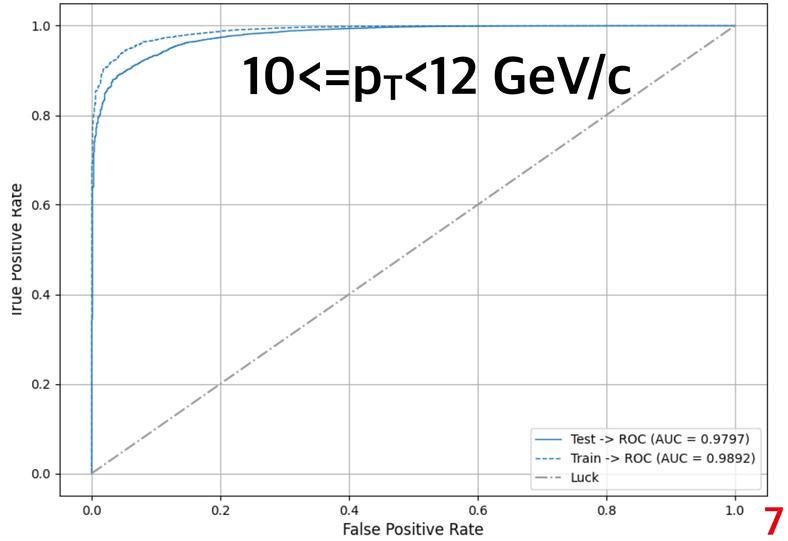






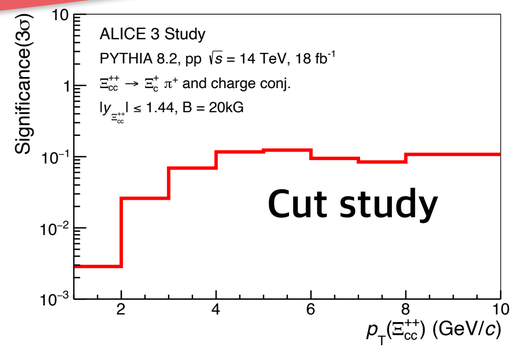


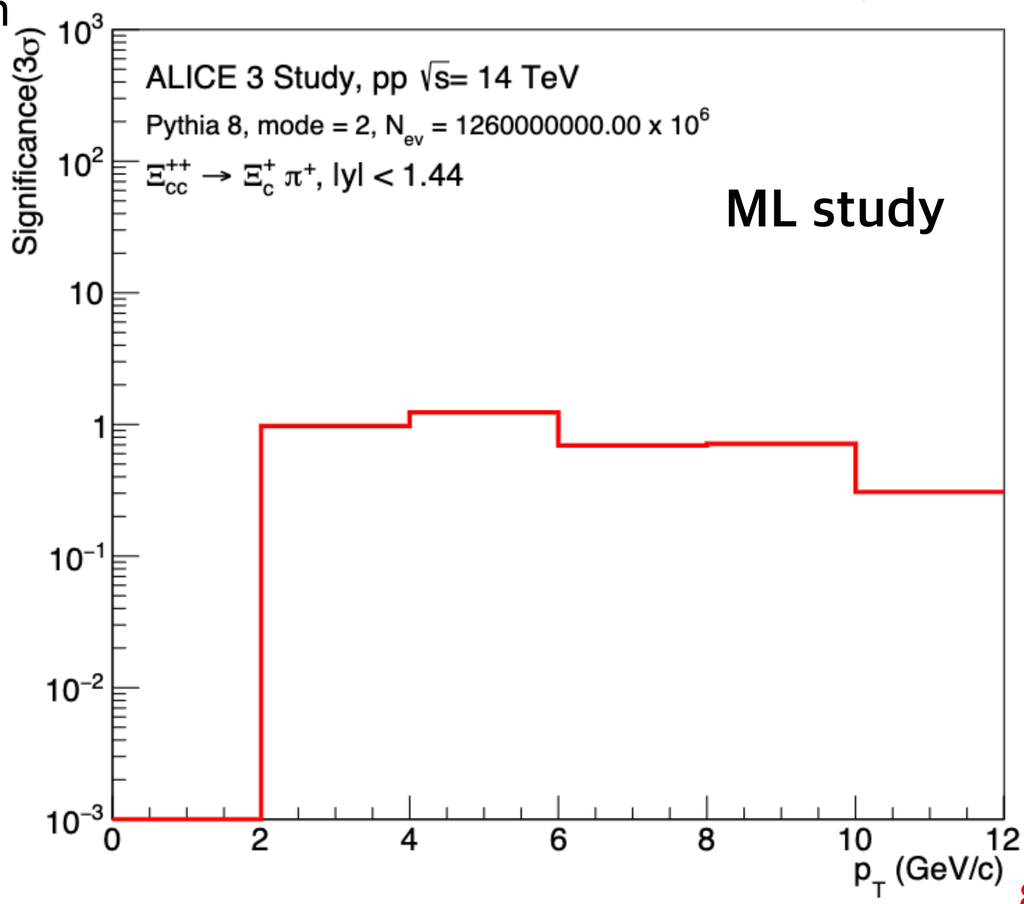




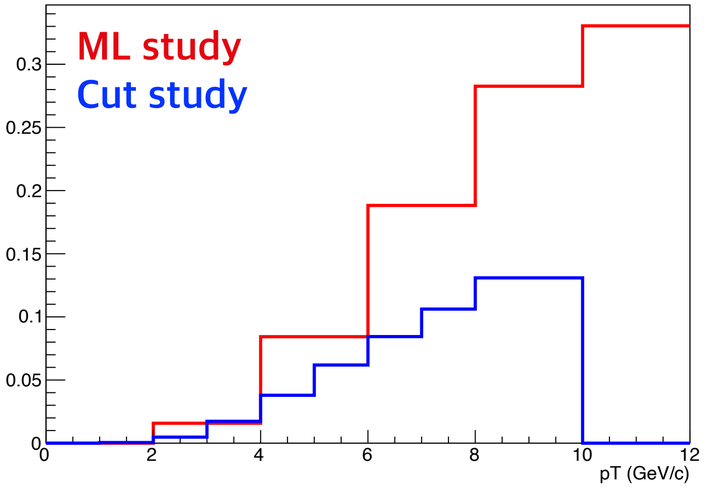
Results

- **ML optimization for Xicc study**
  - Loose pre-selection and BDT cut are applied for each pT bin
  - **Significance :** ~10 times enhancement
  - **Efficiency :** ML study shows higher value up to 0.32 in high pT bin
  - **Bkg/evts :** ML study is 60~90% lower than Cut study
    - ML study : This work
    - Cut study : Previous work without ML

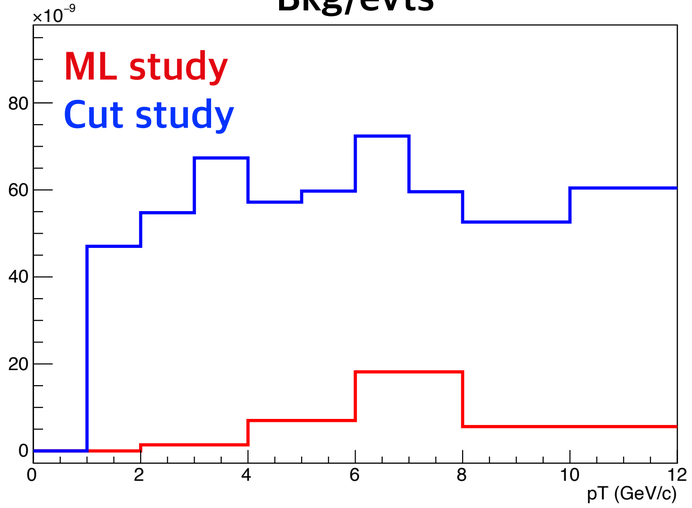




Efficiency

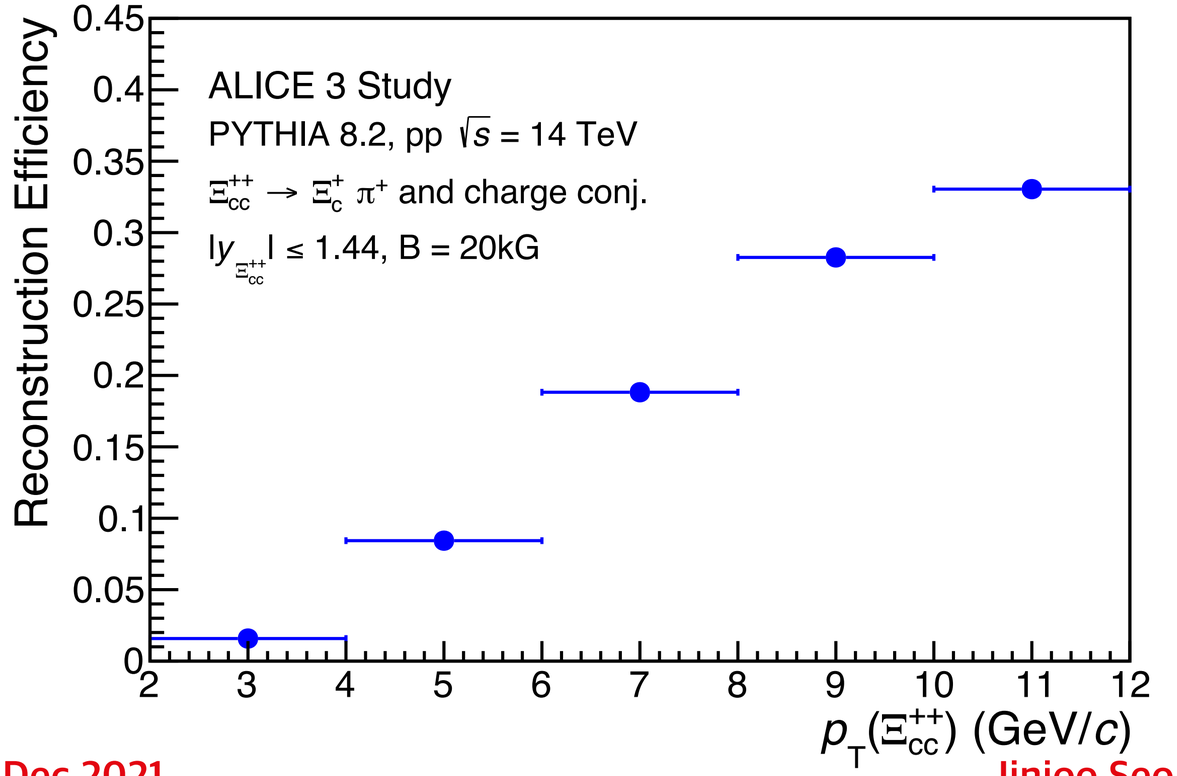


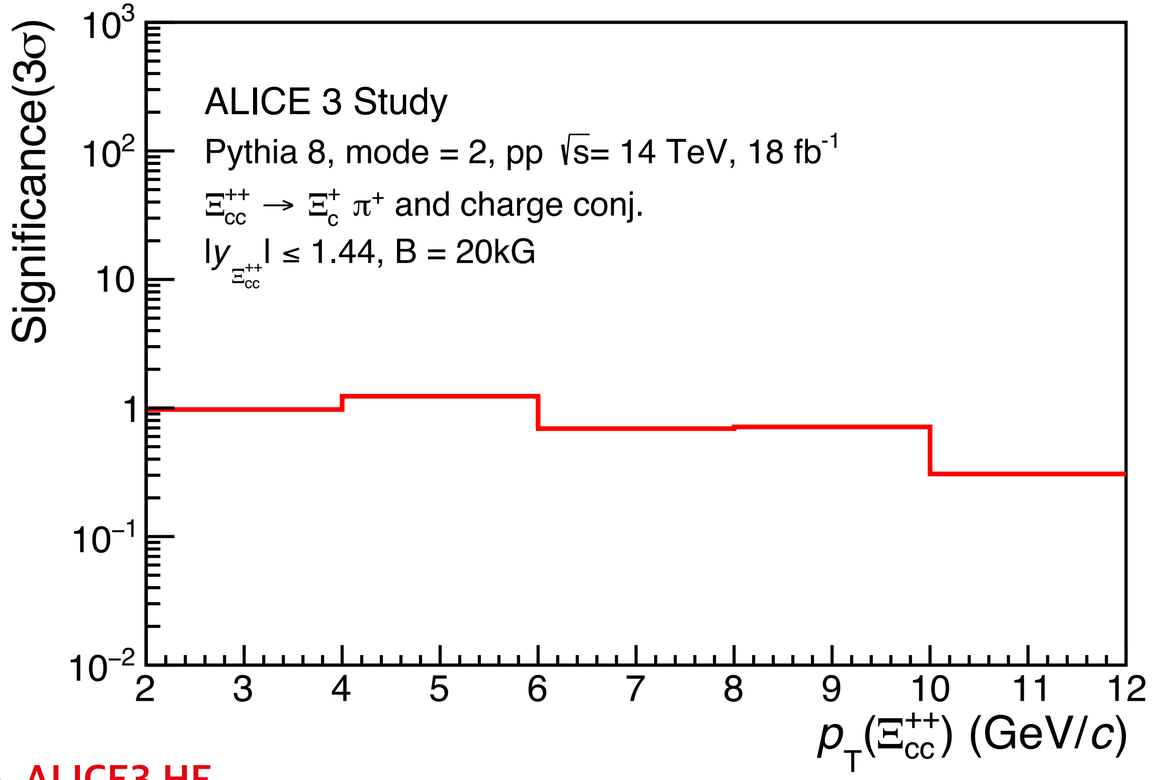
Bkg/evts



Results

- **Performance study : Ξ_{cc}^{++} on non-strangeness decay** $\Xi_{cc}^{++} \rightarrow \Xi_c^+ \pi^+ \rightarrow (pK^-\pi^+)\pi^+$
  - **Efficiency** : Increases with p_T due to higher momentum π^+
  - **Significance**
    - Signal/event : Theoretical expectation(cross section, 39 nb) + PYTHIA 8 (p_T shape) + efficiency + BR(0.03%) arXiv:hep-ph/9710339
    - Large uncertainty on production cross section(factor 200) and branching ratio(factor 5)





Status and Plan

- **Status**
  - **Comparison**

	Background/event	efficiency	S/B (per candidate/event)	S/sqrt(B)
Jinjoo	2.5e-8	0.04	1.6e6	25.2
Bernhard	3.3e-11	0.002	6e7	348
LHCb	1e-12	0.0003	3e8	300

- **Plan**
  - Consider the training with Xic selection, nSigmaTOF info and impact parameter product
    - Signal sample is ready
    - PR needs to confirm by Vit

Back up

Multi-Charm baryon

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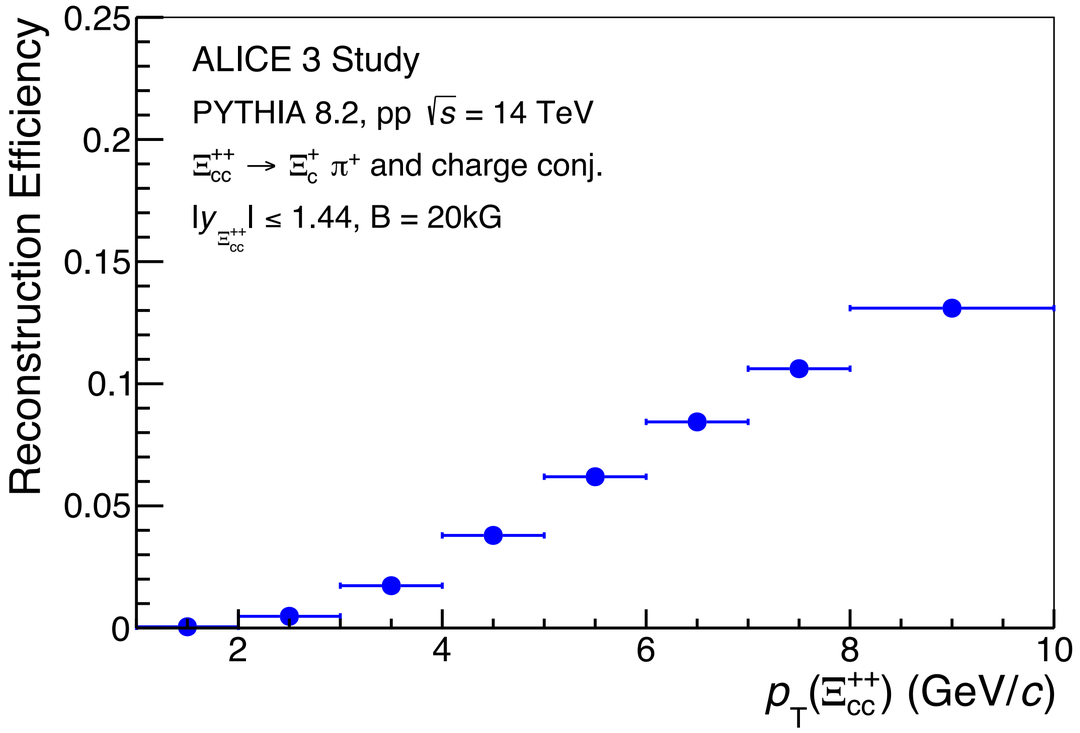
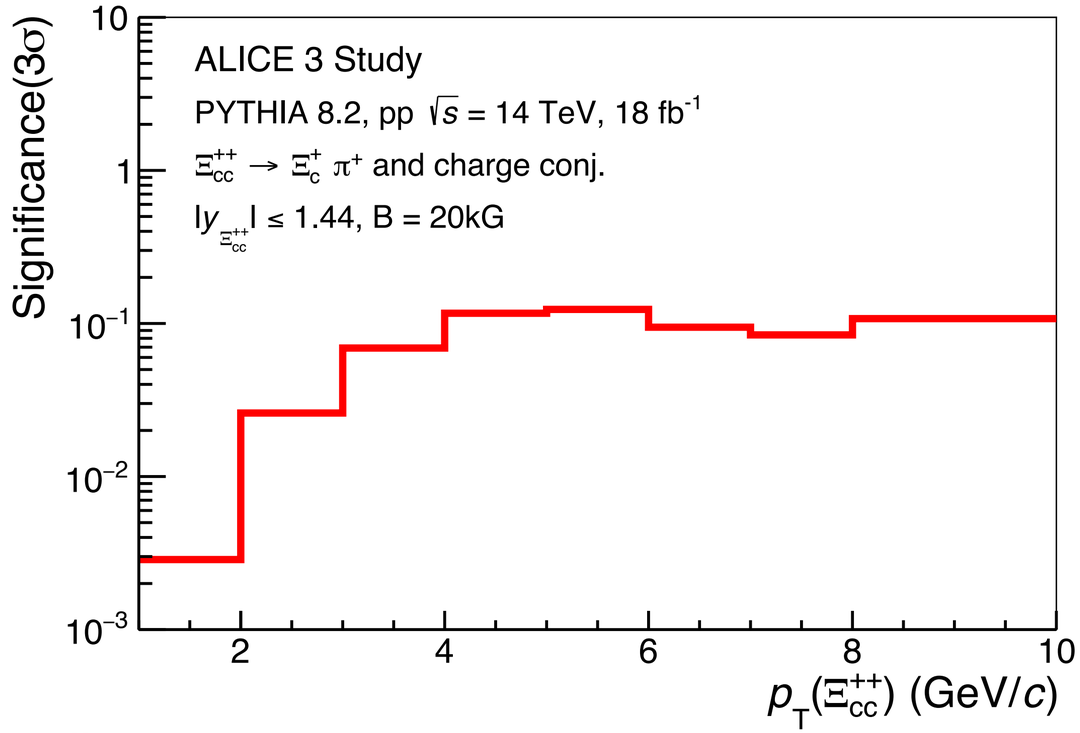
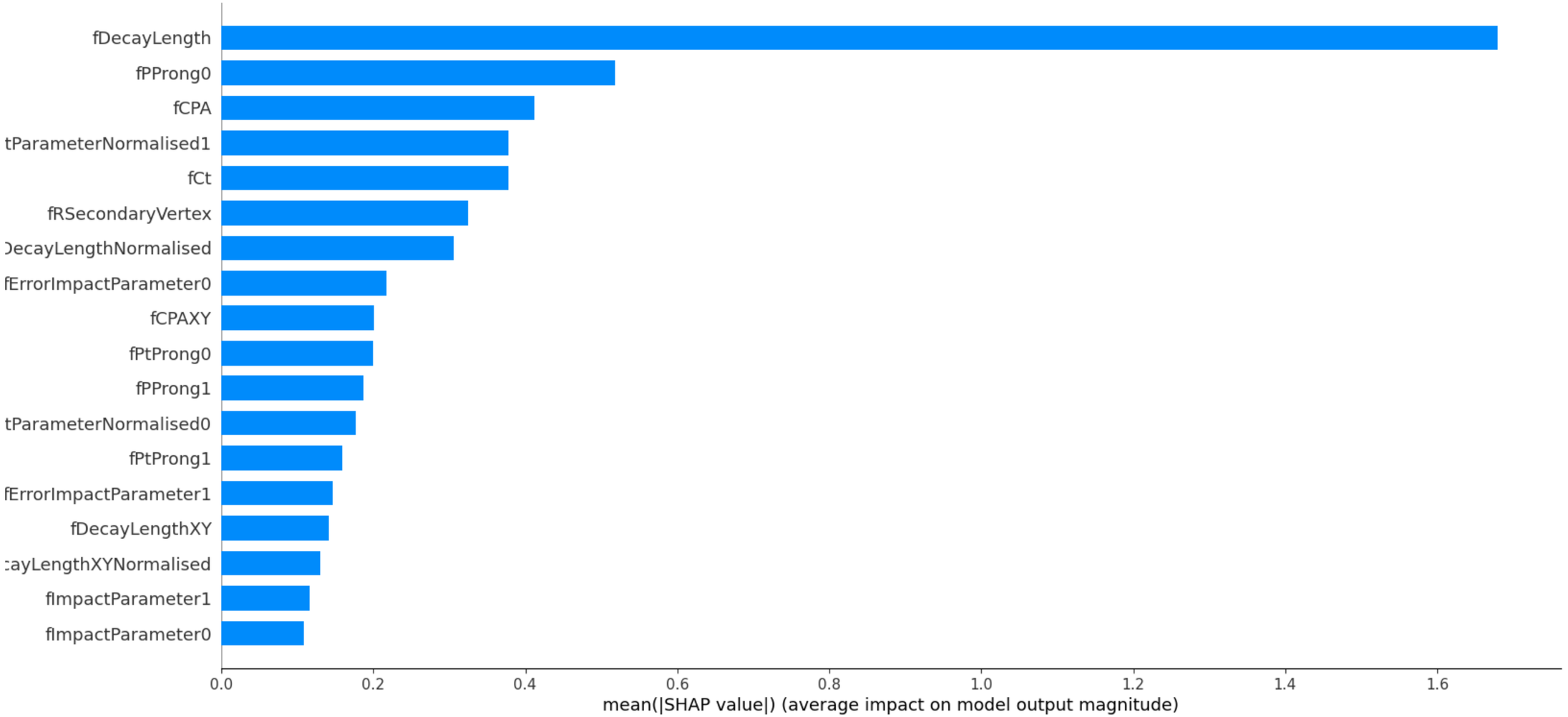




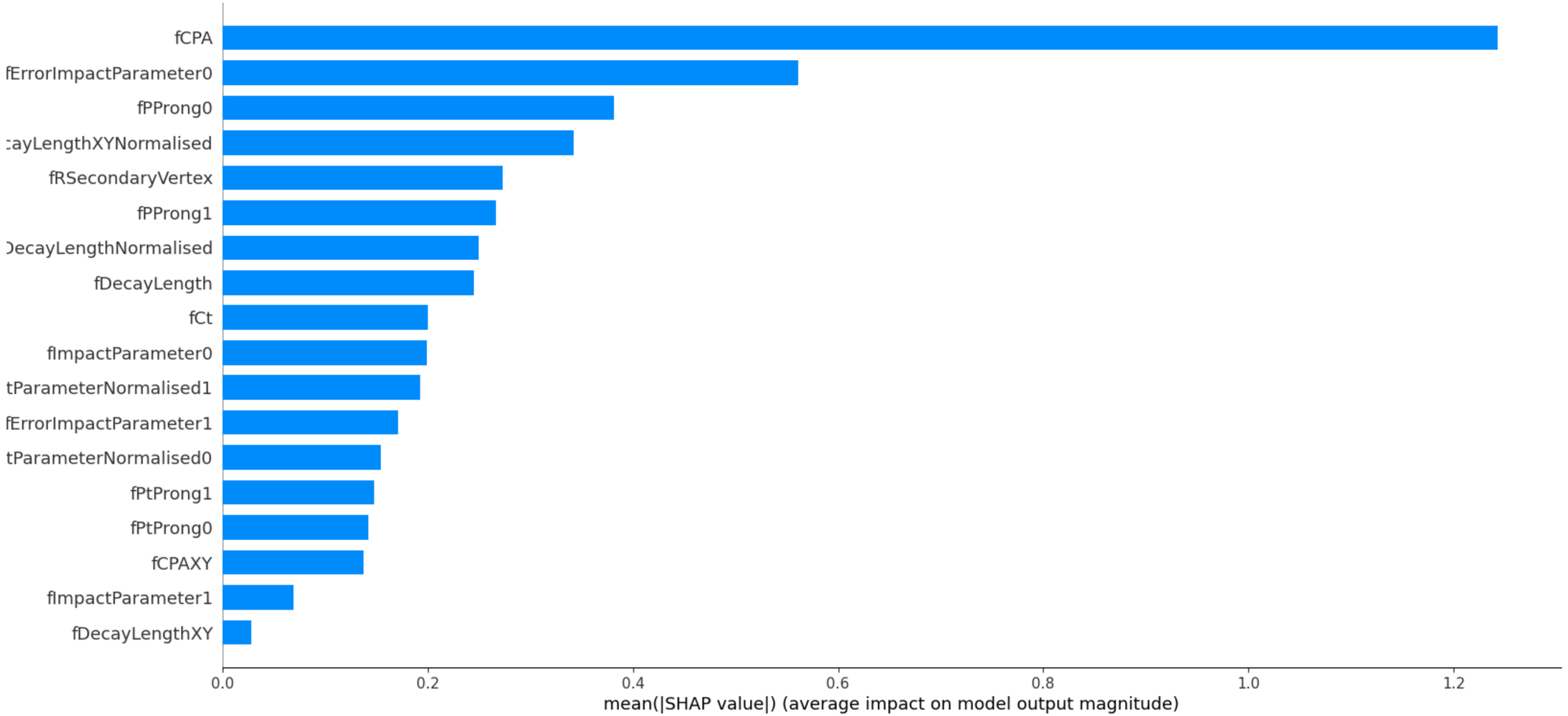
Status

- **Feature importance (0 <= pT < 2 GeV/c)**



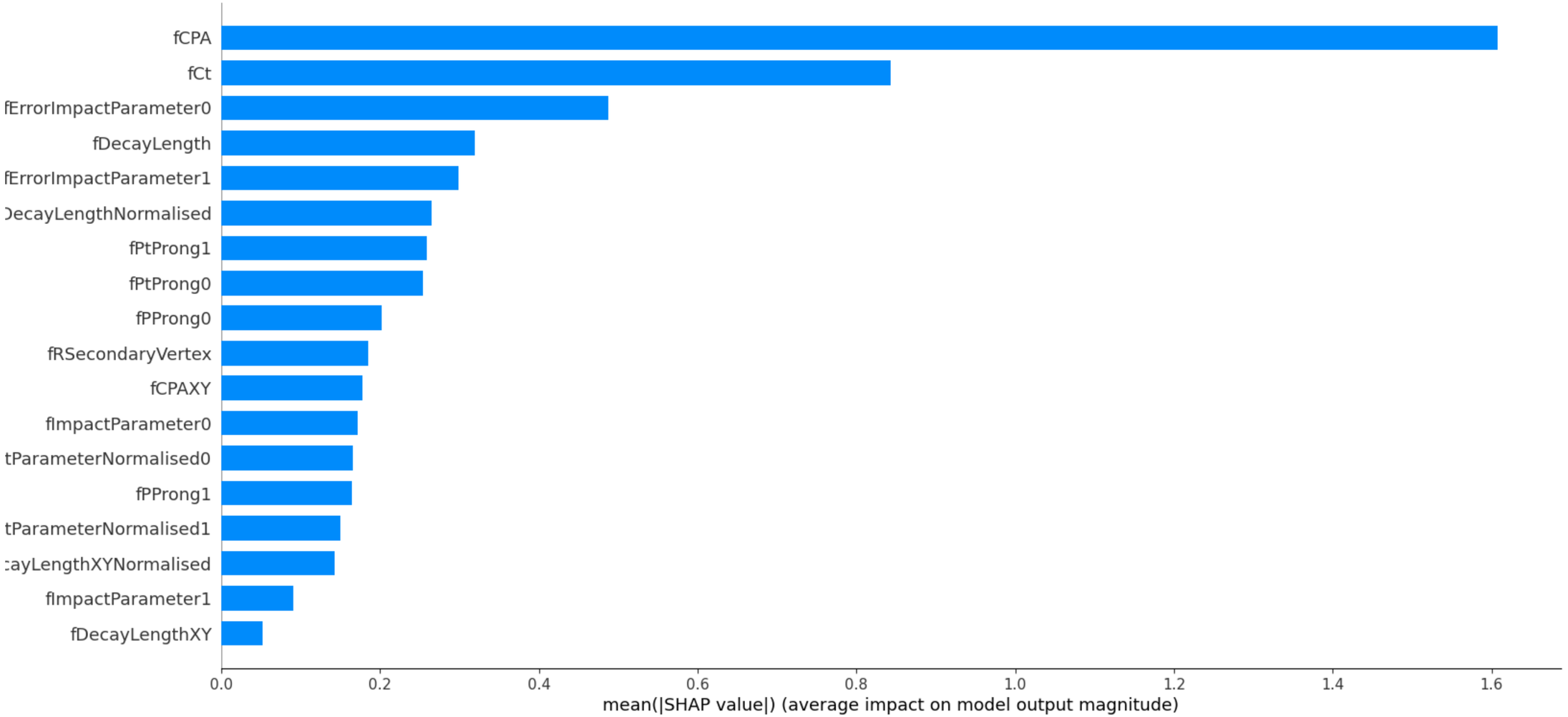
Status

- **Feature importance (2 <= pT < 4 GeV/c)**



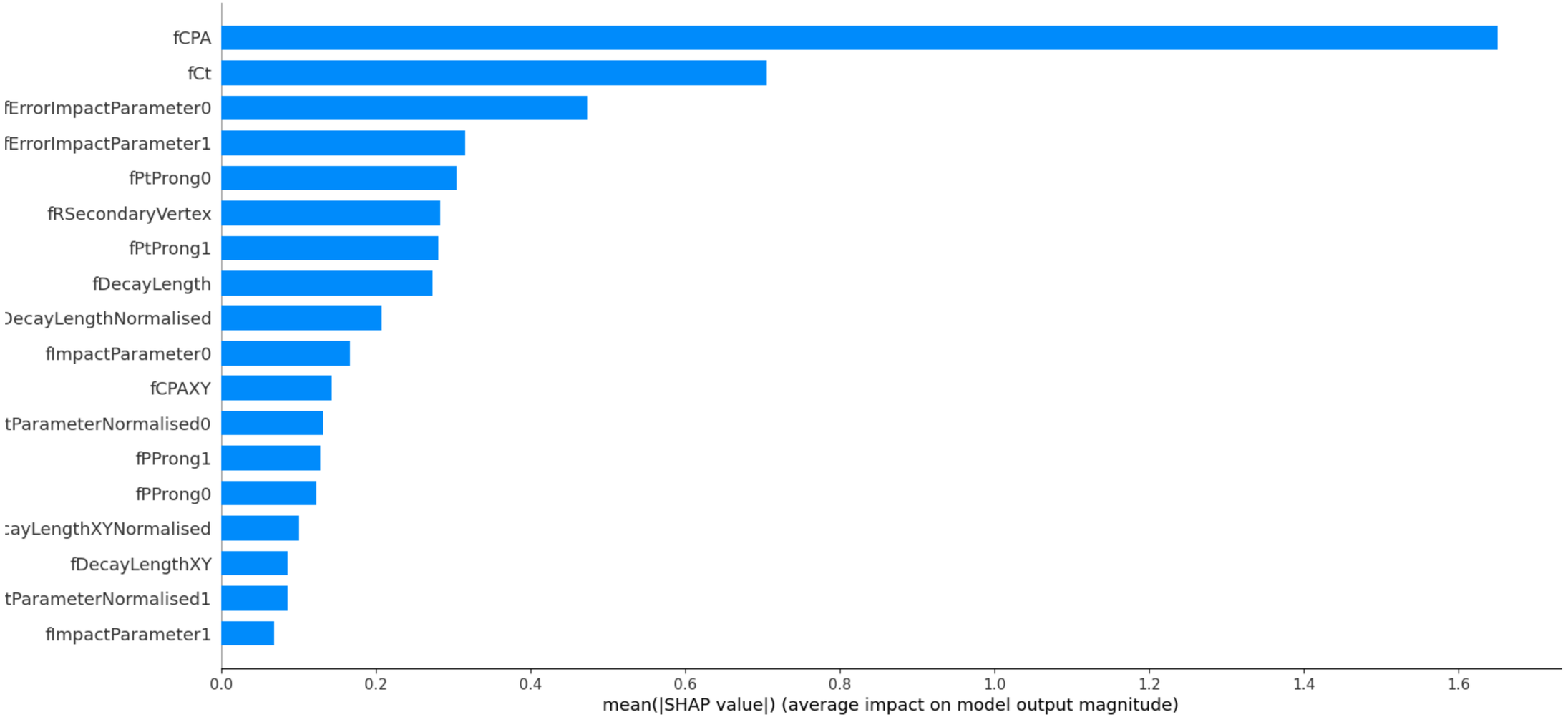
Status

- **Feature importance (4 <= pT < 6 GeV/c)**



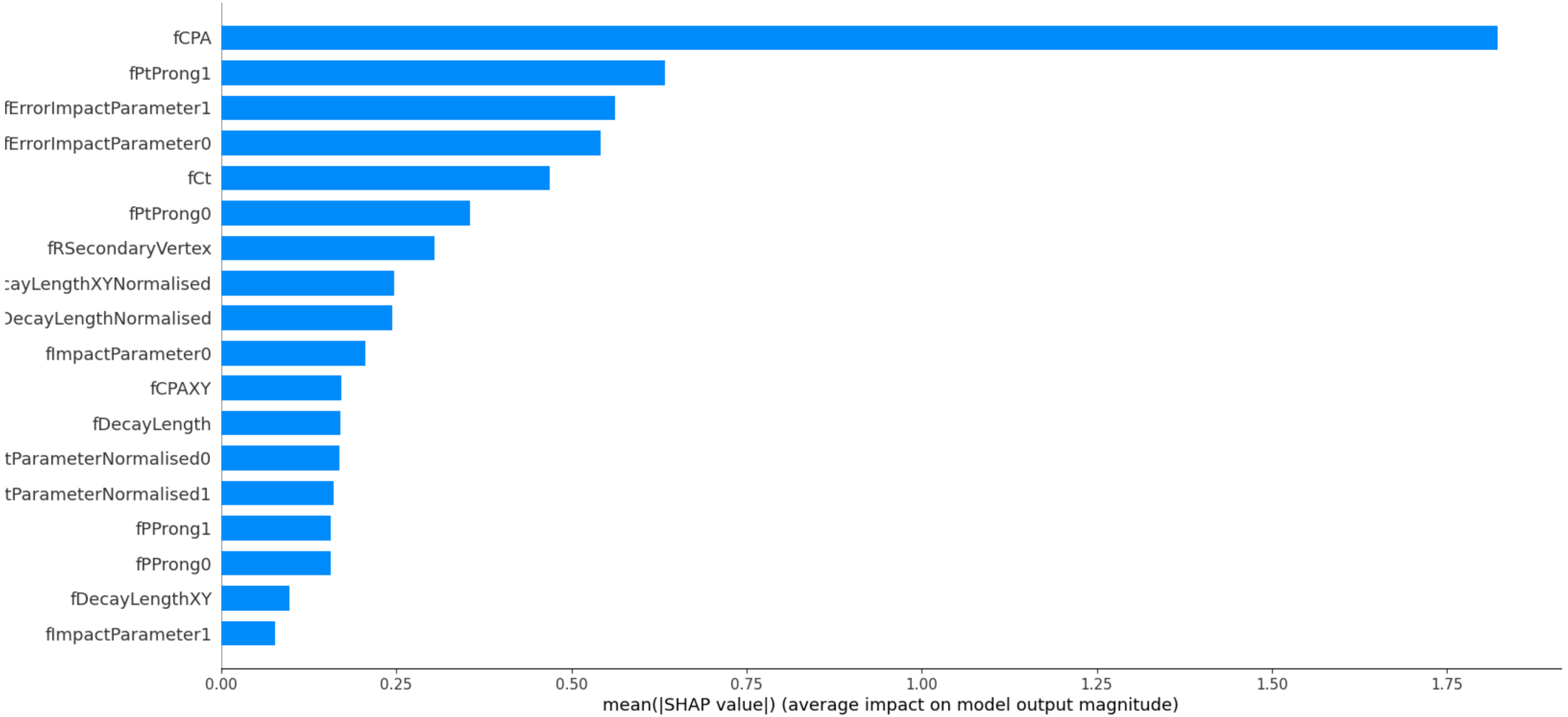
Status

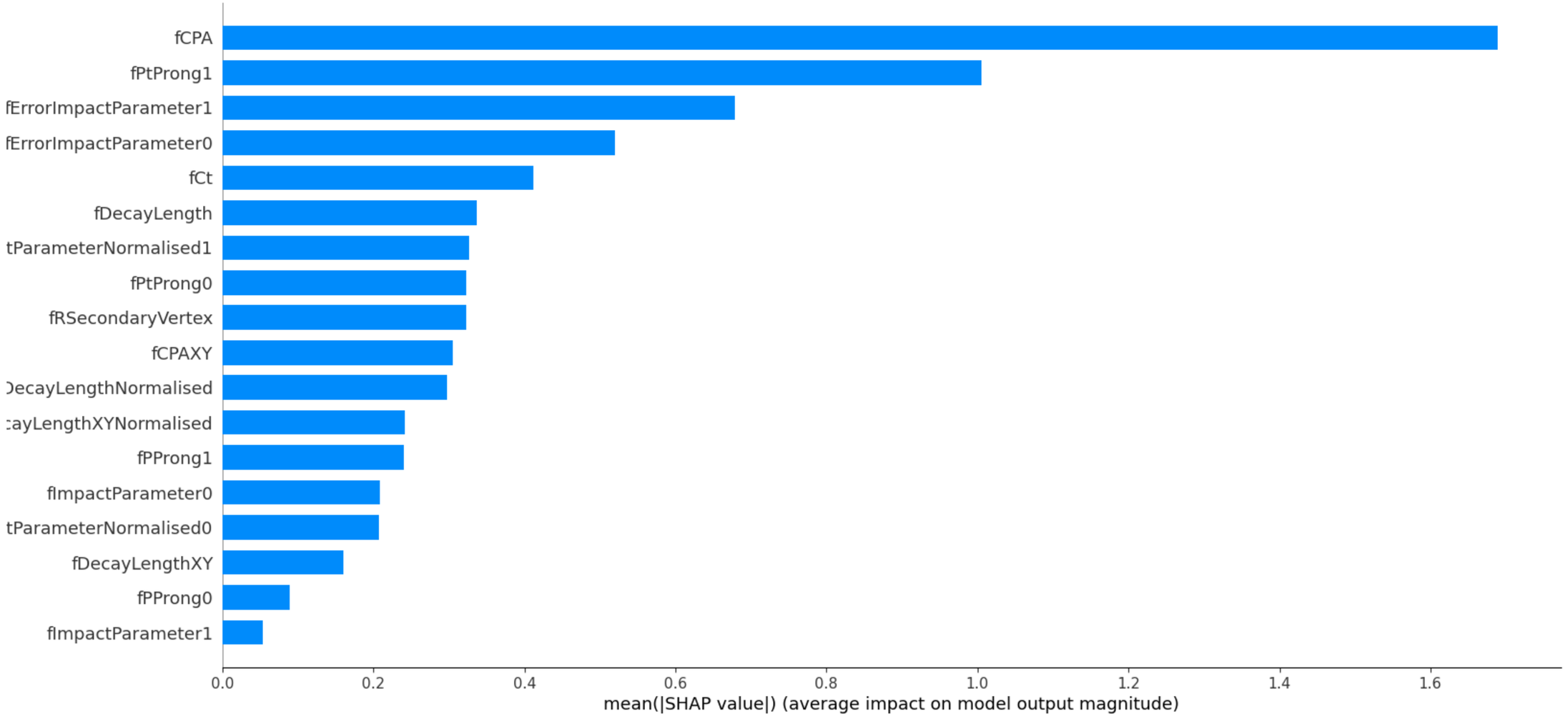
- **Feature importance (6 <= pT < 8 GeV/c)**



Status

- **Feature importance (8 <= pT < 10 GeV/c)**



Status

- **Feature importance (10 <= pT < 12 GeV/c)**