JUSTUS-LIEBIG-
UNIVERSITÄT
GIESSEN

Belle II

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ErUM-FSP T09 Belle II

JENNIFER 2
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Slow pions from XYZ decays

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E. Prencipe, O. Skorenok

Outline

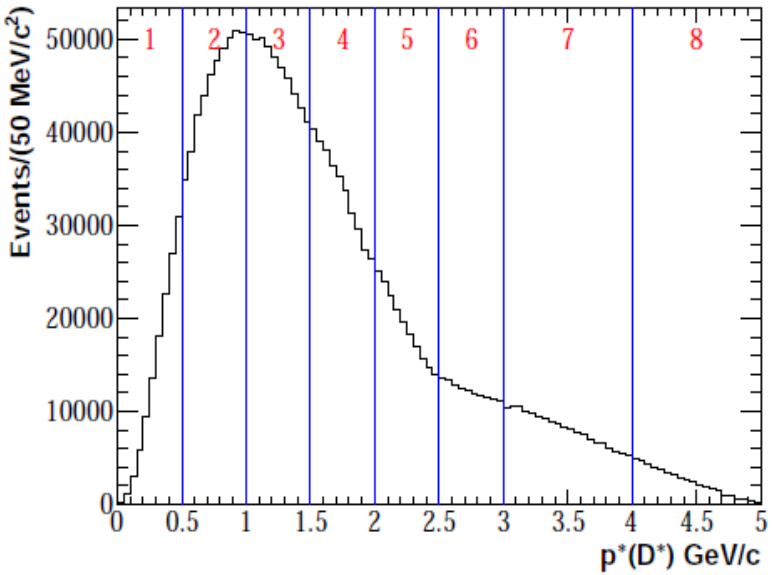
- Impact of slow pion detection on physics analysis
- Examples from:
  - BaBar analysis
  - Belle II studies:
    - semi-leptonic decays
    - heavy-light systems
    - charmonium resonant states
    - Ks tracking efficiency studies
- Summary

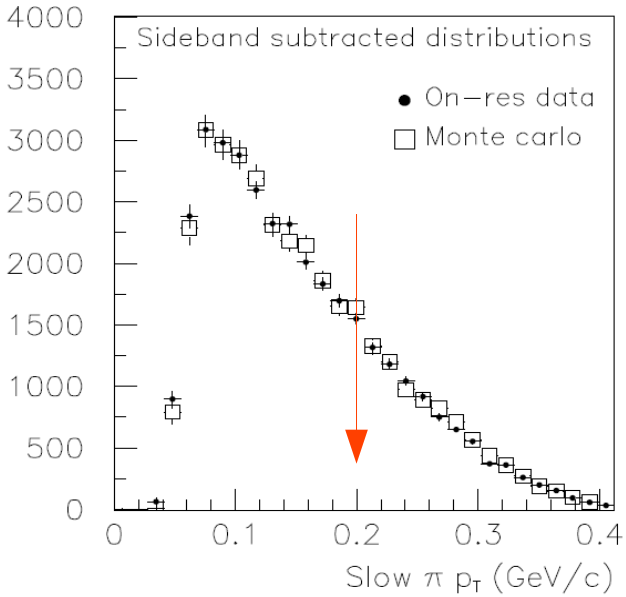
Introduction

- From BaBar:
  - study of tracking efficiency: $D^{*+} \rightarrow D^0\pi^+$
  - very soft pion momentum: p_T<120 MeV/c;
  - cannot be found with DCH pattern recognition;
  - tracks curl up, do not penetrate DCH (inner r = 24 cm);
  - BaBar SVT: designed for $p_T \in$ [50-120] MeV/c ⇒ p_T limit: 50 MeV/c

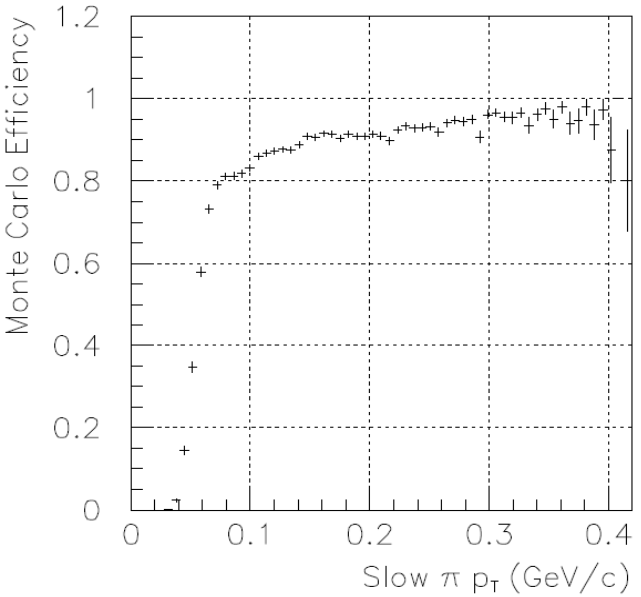
pions stop in the beam pipe material

NIM. A 704, 44 (2013)





arXiv:hep-ex/0012042



Semi-leptonic

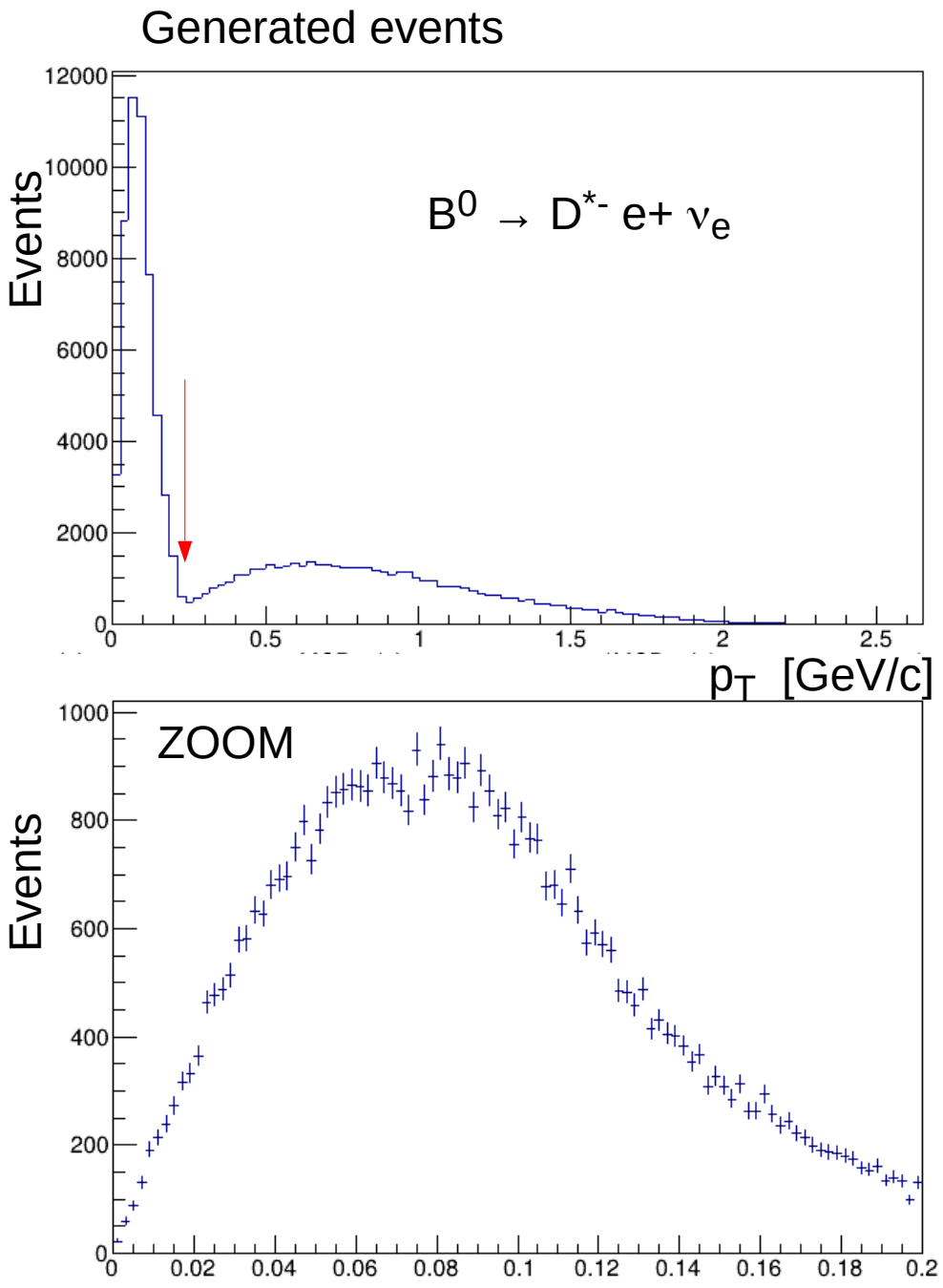
S. Lange

Semi-leptonic B decays

- Semileptonic:
  simulation performed with HQET in EvtGen;

- 50.7% events in $p_T < 0.2$ GeV/c
- 32.4% events in $p_T < 0.1$ GeV/c

Fraction is very high !

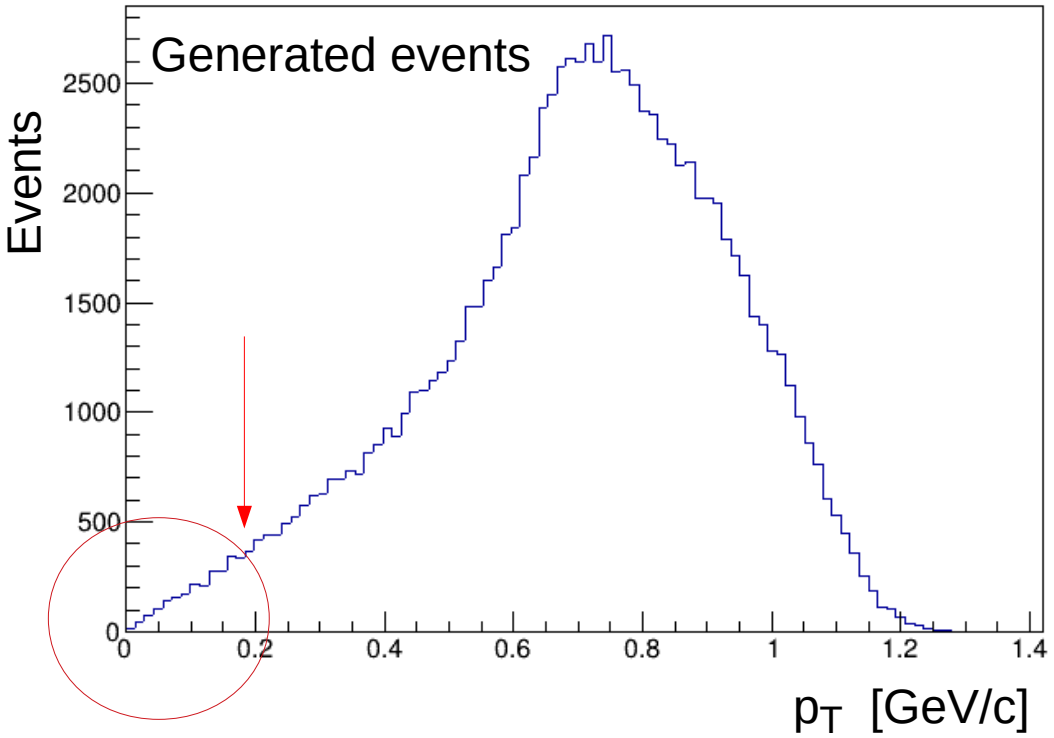


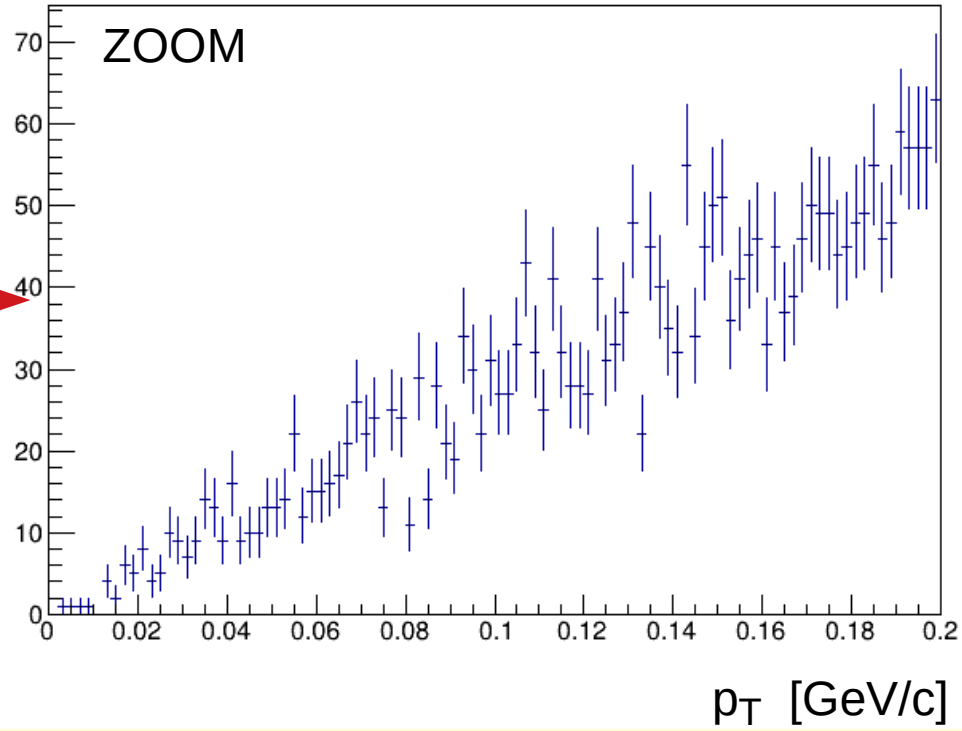
Charmonium: X(4014) study

PhD thesis, Klemens Lautenbach

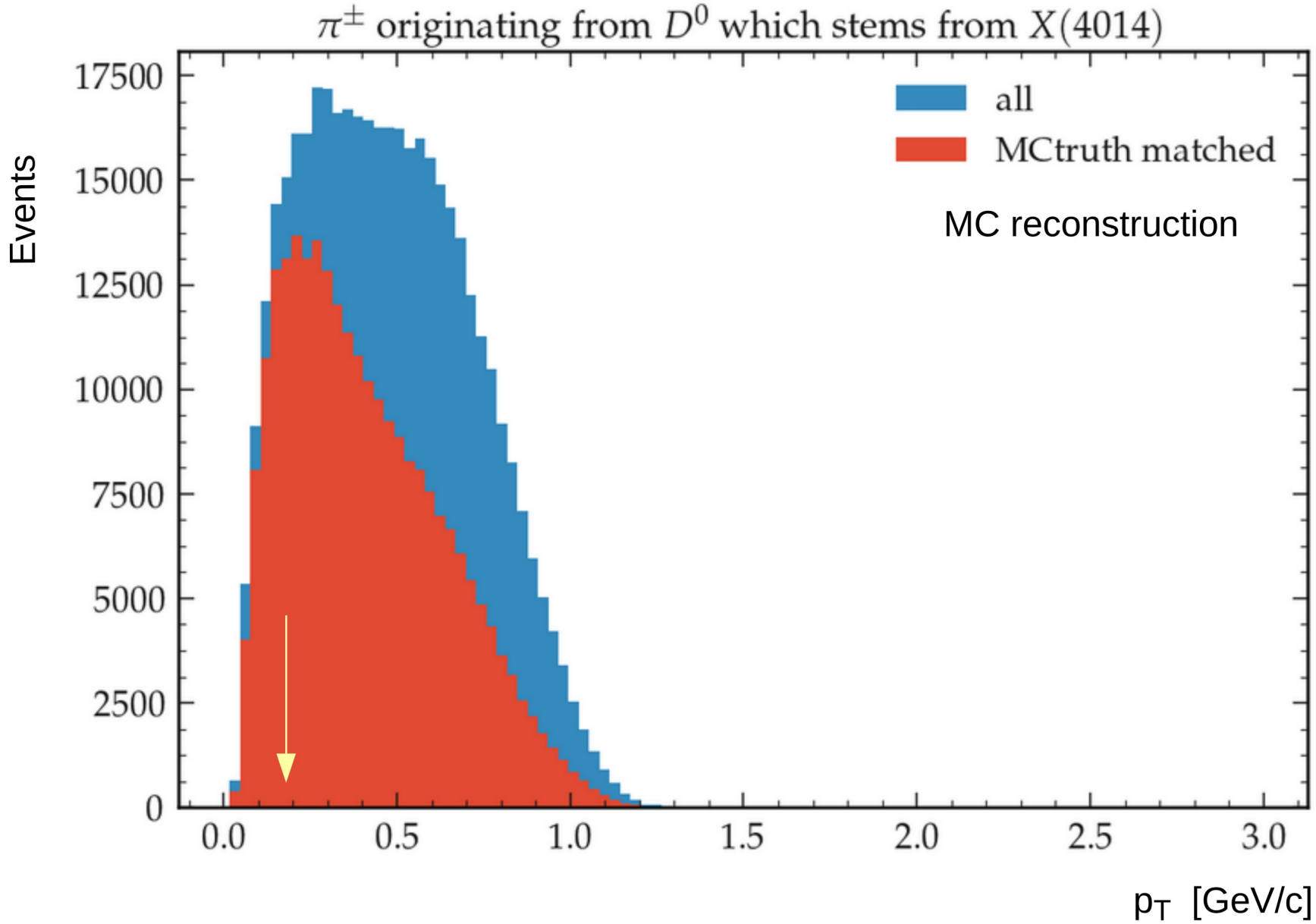
Slow pions in heavy-mass charmonium-like states

- $X(4014) \to \overline{D}^{0*} D^{0*}$, charged pions only from D decays (not D*): fraction is small
  - 2.7% events in $p_T < 0.2$ GeV/c
  - 0.69% in $p_T < 0.1$ GeV/c
  - release 3-XX

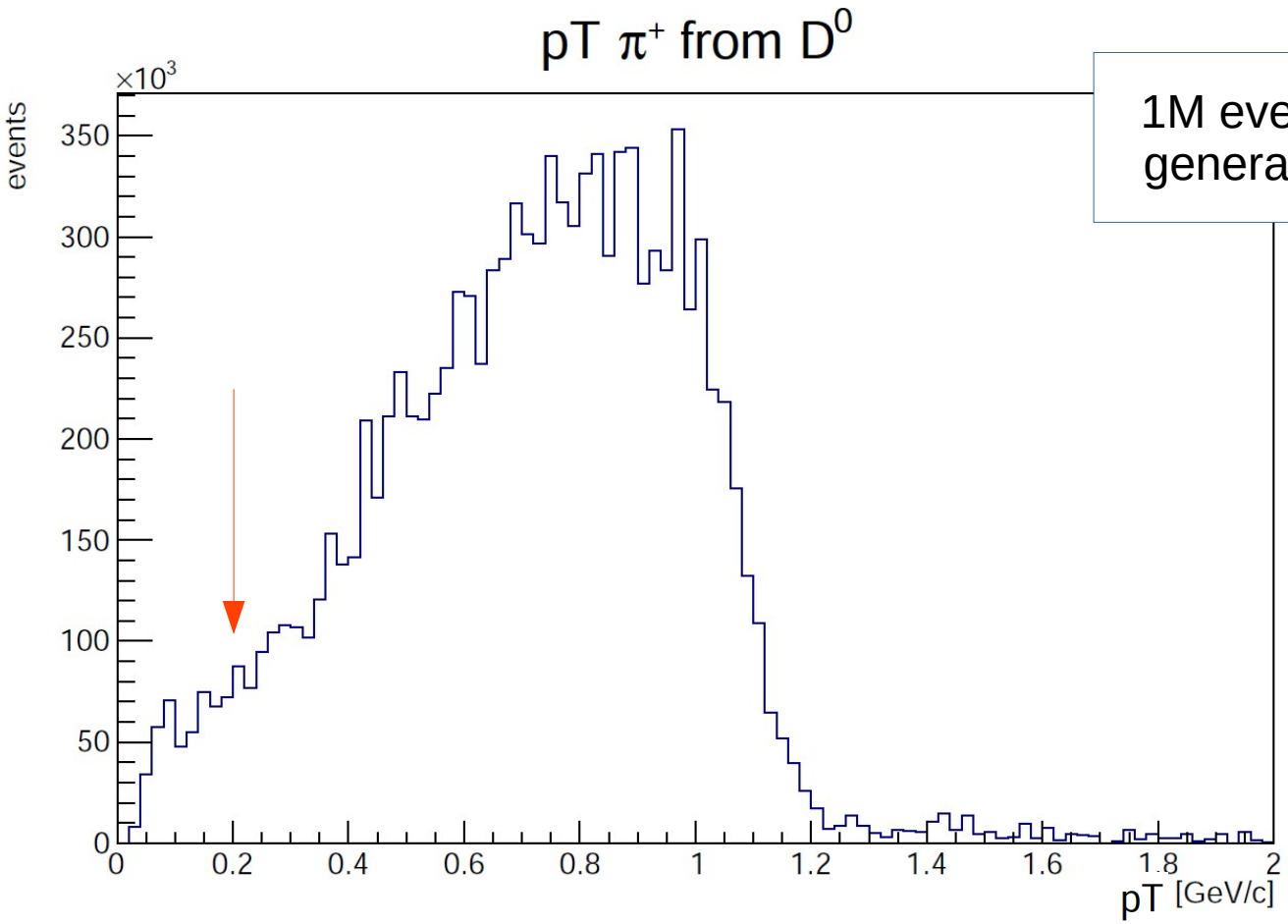




Switch on additional MC truth matching



Systematics: study of $X(4014) \to \overline{D}^{*0} D^{*0}$, $D^{*0} \to D^0 \pi^0$ and $D^0 \gamma$



New study in release 5-XX:
Small fraction confirmed:

4.3% for p_T<0.2 GeV/c
1.5% for p_T<0.1 MeV/c

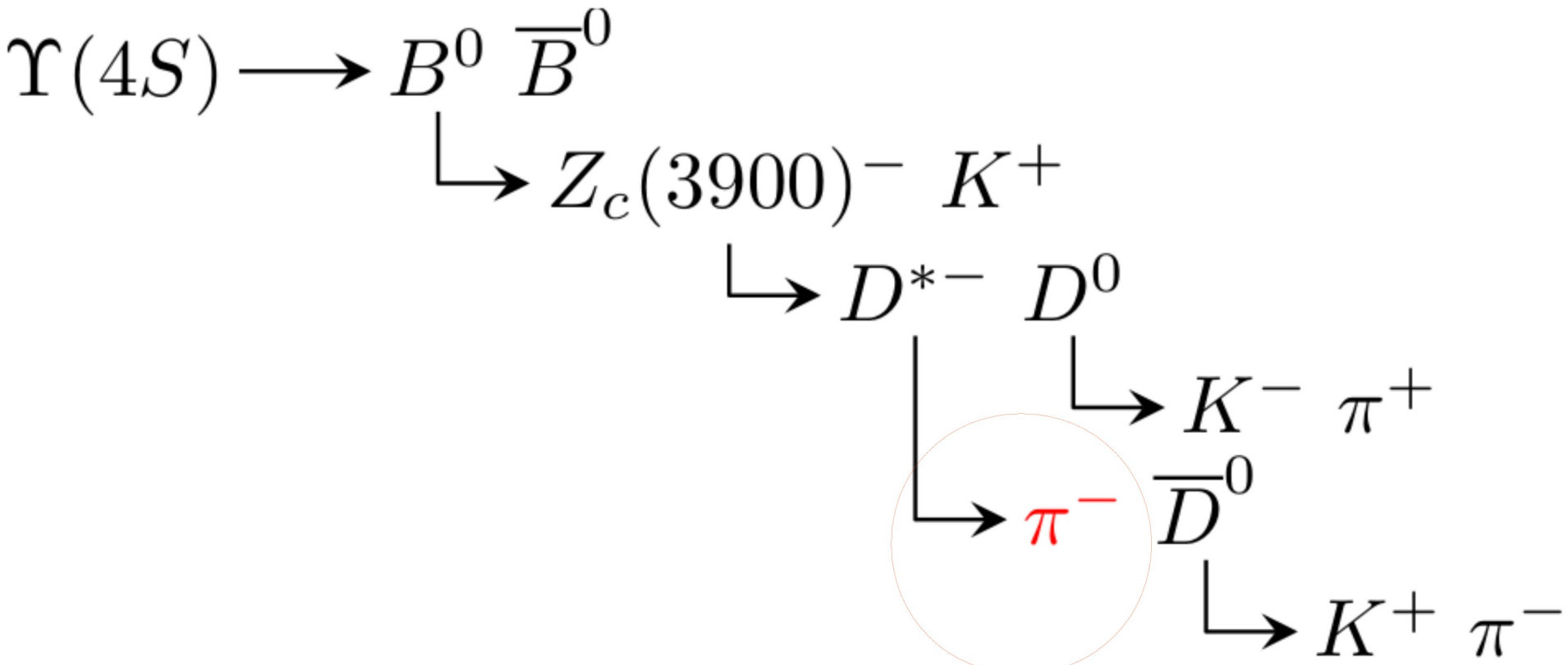
Bachelor thesis, Caroline Grün, E.P.

Charmonium:

Charged Z decays

PhD thesis, David Münchow

The decay chain



Generation of Events

- Based on example.py in reconstruction/examples/
- Only two small changes:

1. Added own decay file:

```
evtgeninput.param('userDECFile', '/home/onsen/basf2/work/own-DD-
analyse.dec')
```

2. Swiched on/off PXD in the component list:

```
# detecor simulation
components = [
    'MagneticField',
    'BeamPipe',
#    'PXD',
    'SVD',
    'CDC',
    'TOP',
    'ARICH',
    'BKLM',
    'ECL',
    ]
add_simulation(main, components)
```

Hit Requirement for VXDTF

- Needs $\geq$3 hits to find Helix
- Uses PXD and SVD (6 layer)
  - 2 layer PXD
  - 4 layer SVD

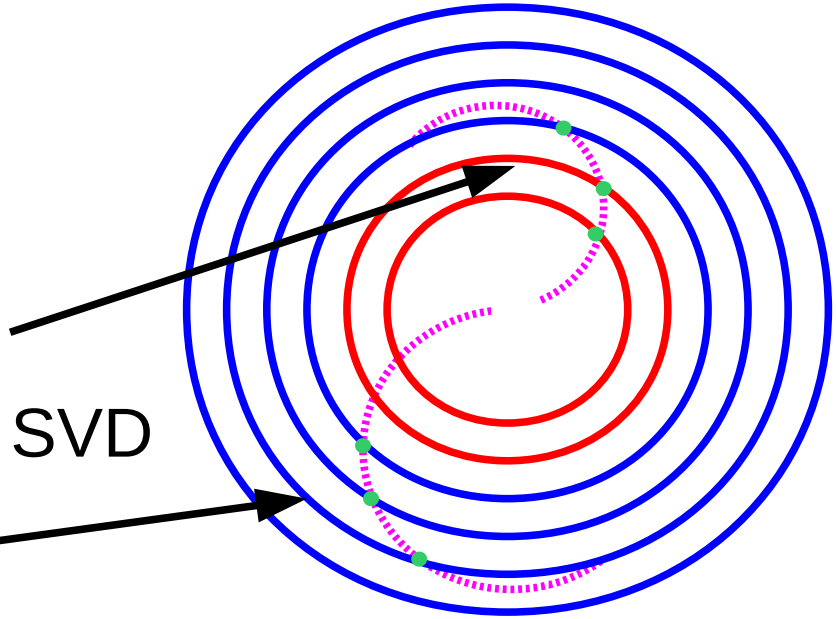
SIMULATION WITH PXD+SVD:

- Minimum p_T for SVD+PXD:
  - tracking hits: 2 in PXD and 1 in SVD

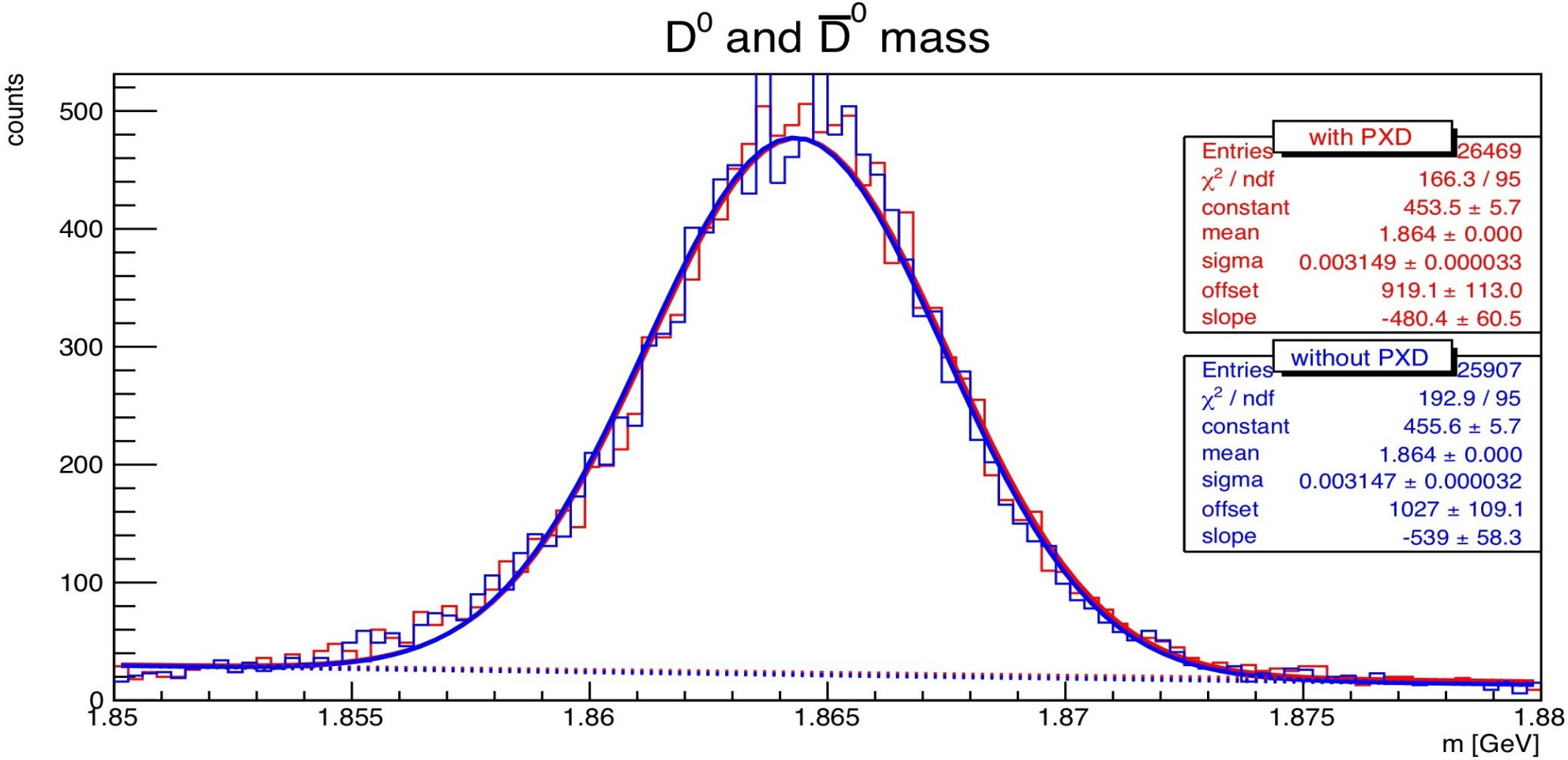
SIMULATION WITH SVD ONLY:

- Minimum p_t for SVD only:

  tracking hits: 3 in SVD → HLT

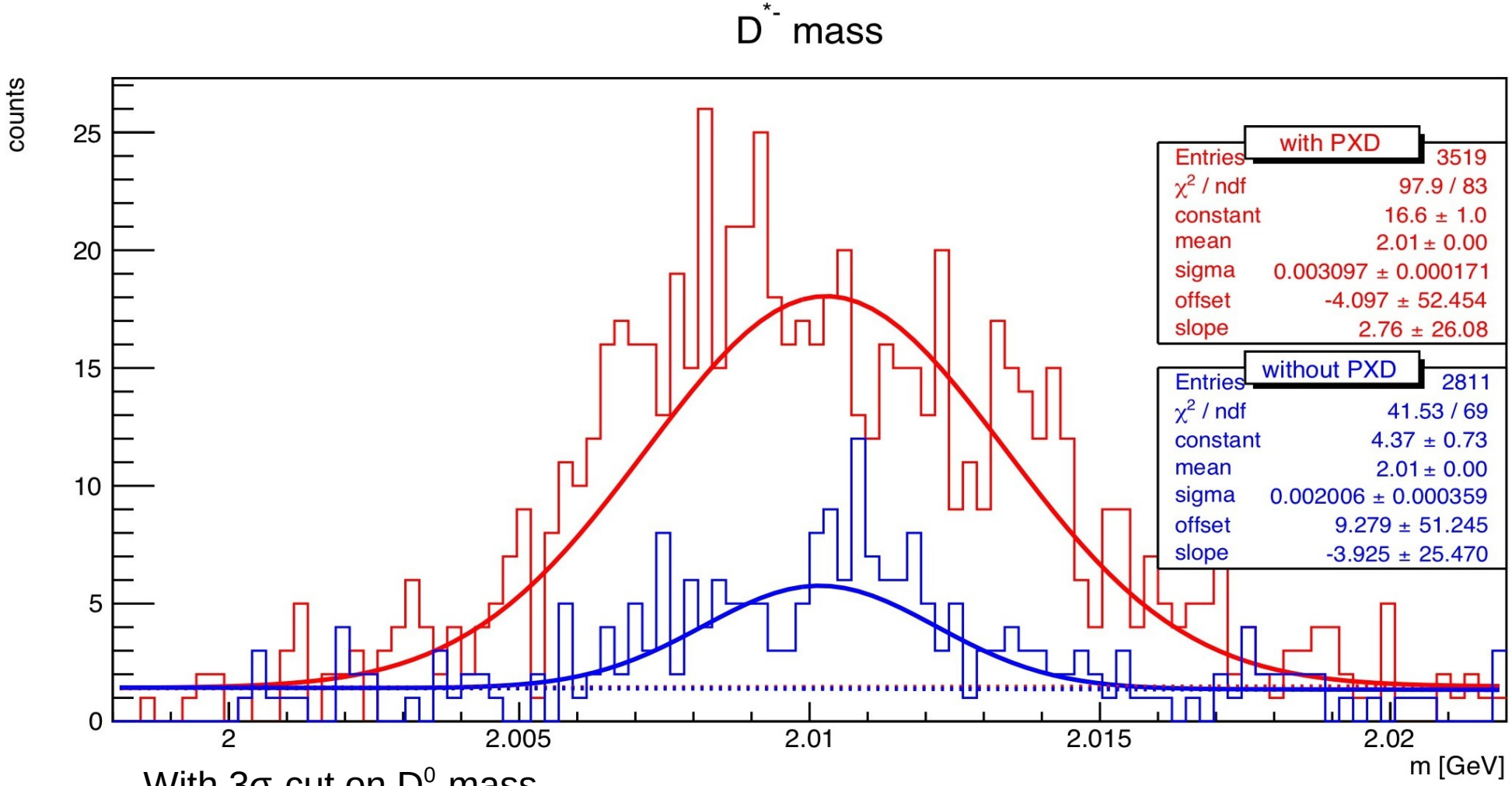


D^0 mass



- 10k simulated events
- Each event contains 1 D^0 and 1 $\overline{D}^0$ mesons from B^0
- Additional D^0 or $\overline{D}^0$ from $\overline{B}^0$ possible
- With PXD: 11932 events, without PXD: 11980 events → no significant difference found!

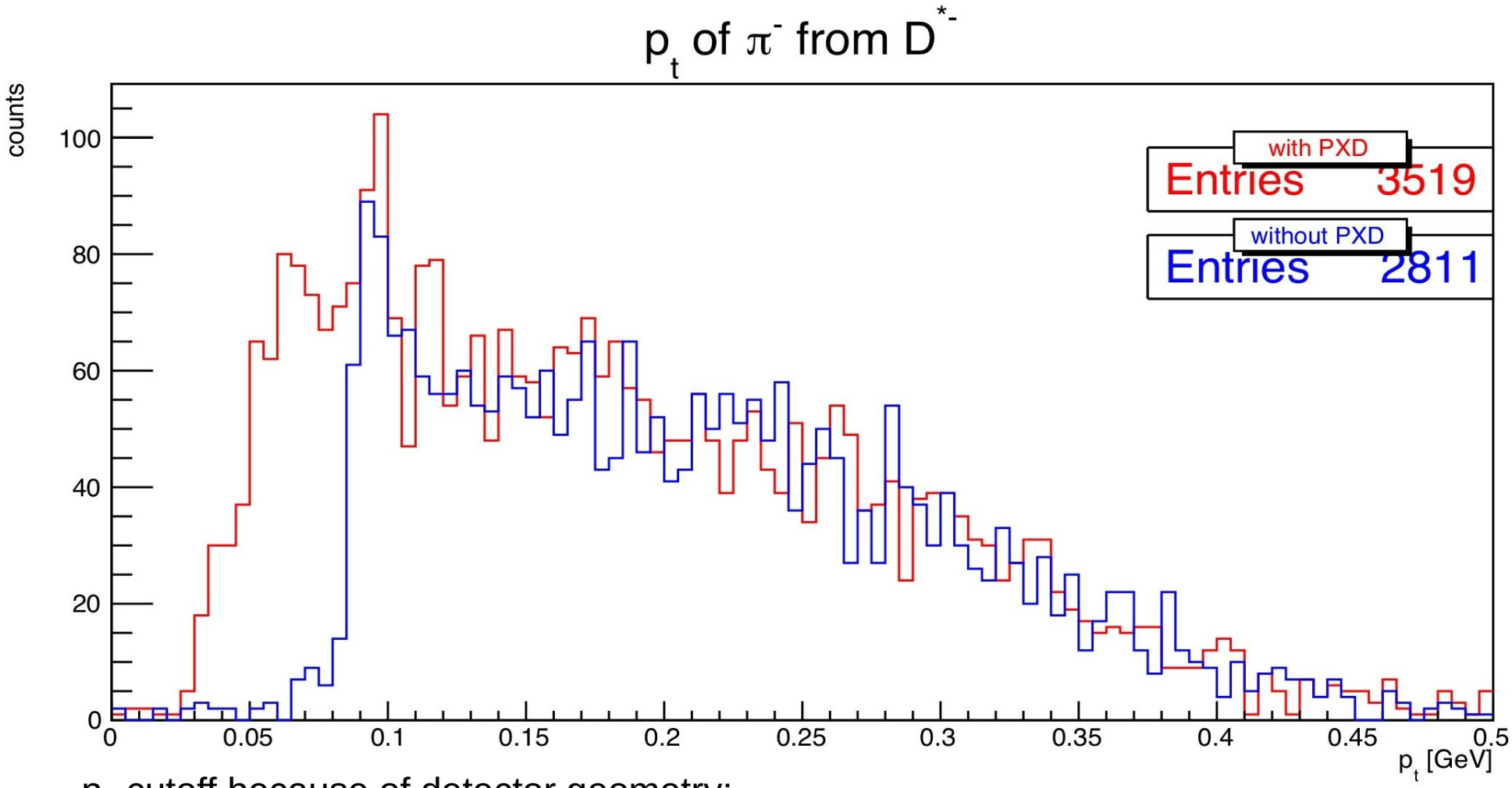
D^{*-} mass



With 3σ-cut on D^0-mass

	Mean:	Yields:
· with PXD:	2.01 GeV (fixed)	537±25
· without PXD:	2.01 GeV (fixed)	92±10

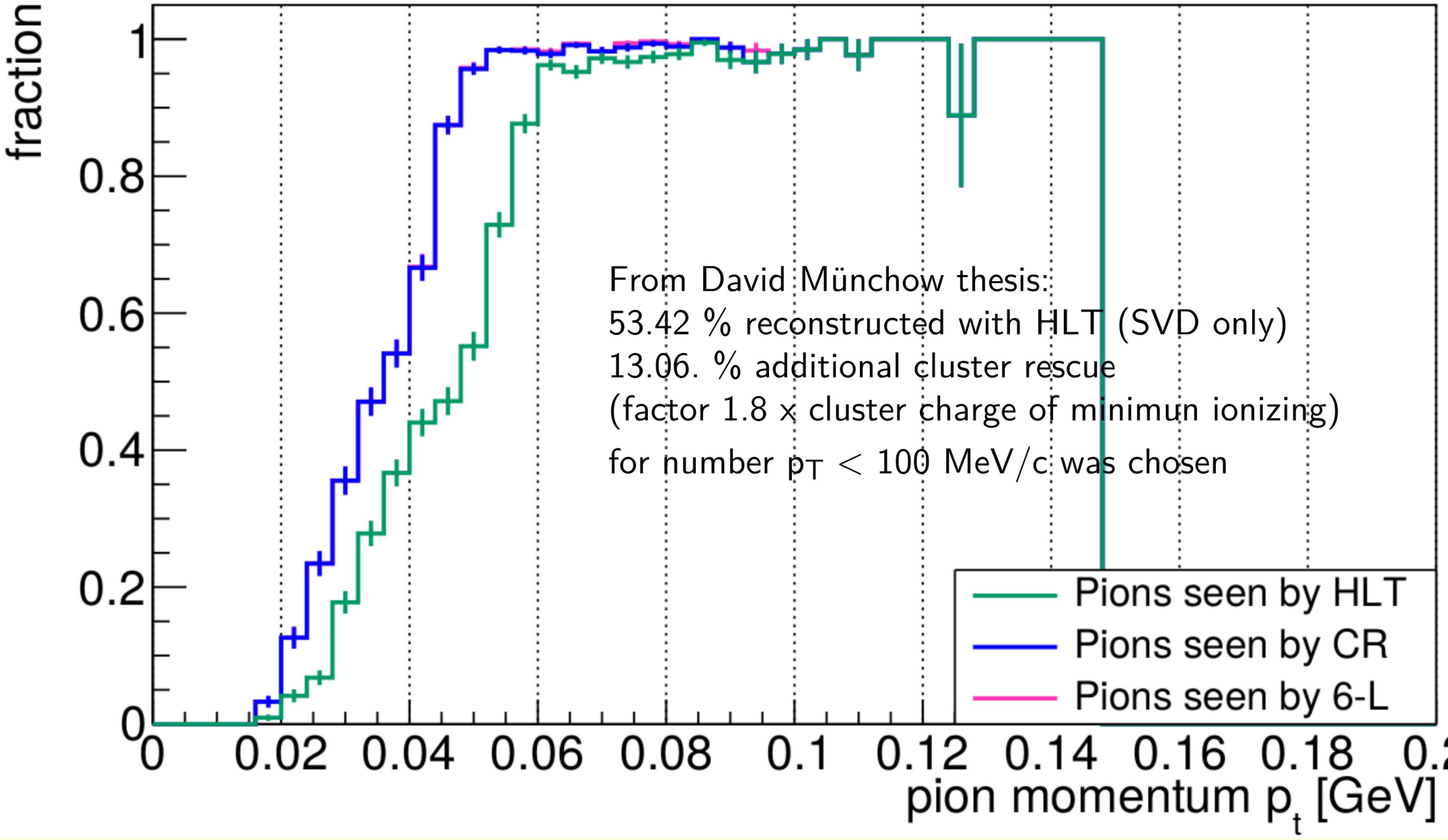
p_T of slow π^- from D^{*-}



p_T cutoff because of detector geometry:

- with PXD ≈85 MeV/c
- without PXD ≈40 MeV/c

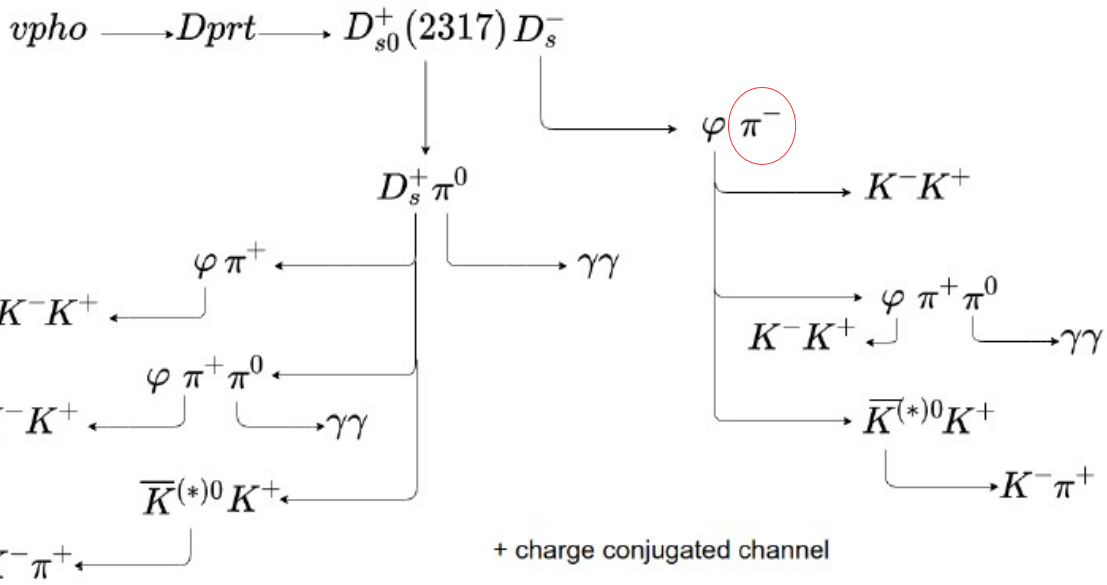
Without PXD about **20%** less slow pions. Almost all very slow pions below 85 MeV/c are lost.


fraction
1
0.8
0.6
0.4
0.2
0
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
pion momentum p_t [GeV]
From David Münchow thesis:
53.42 % reconstructed with HLT (SVD only)
13.06. % additional cluster rescue
(factor 1.8 x cluster charge of minimun ionizing)
for number $p_T < 100$ MeV/c was chosen
Pions seen by HLT
Pions seen by CR
Pions seen by 6-L

Charmonium: Heavy-light systems

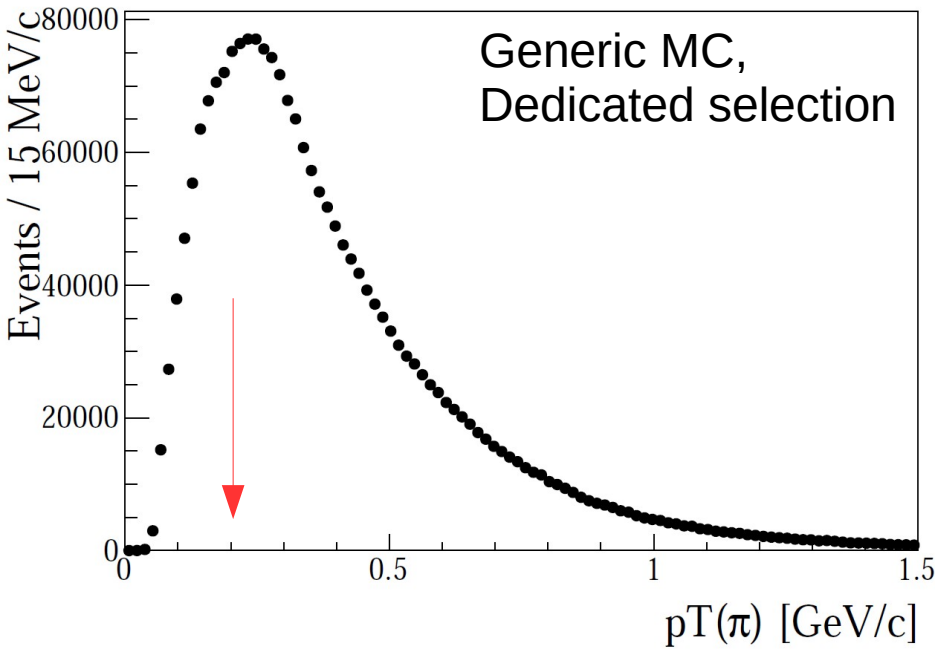
Master thesis, Dmytro Meleshko, E.P.

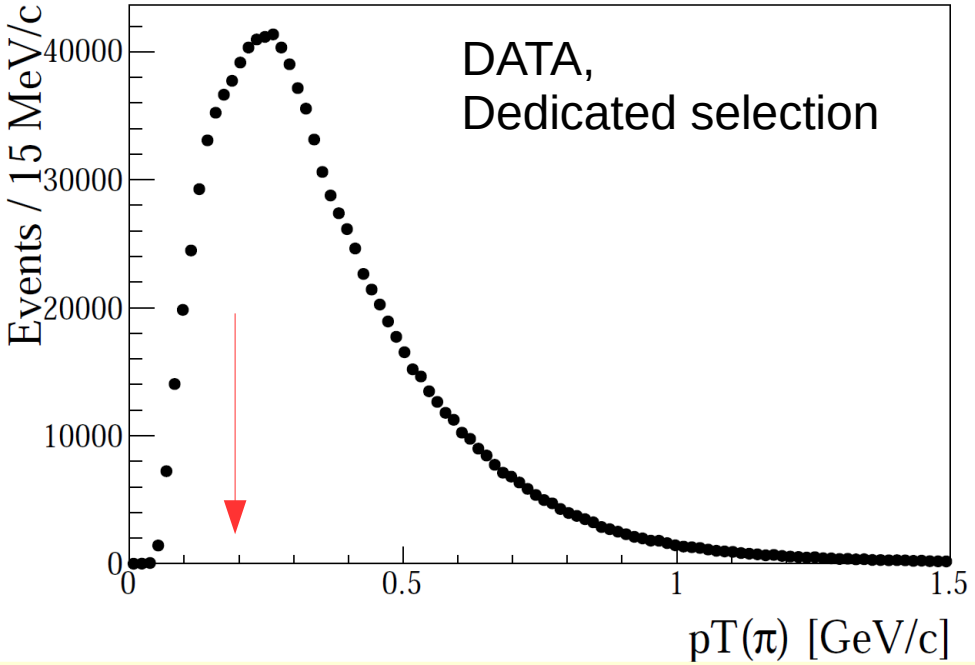
Analysis of $e^+e^- \to D_s^+ D_{s0}^*(2317)^-$ X, X = anything



Belle analysis

- JETSET model in EvtGen
- Vitrual photon as mother particle
- Low-energy photons
- Low momentum charged pions
- Run over all Υ(nS)
- 21.7%(22.7) MC(DATA), p_T<0.2 GeV/c
- 3.3%(3.2%) MC(DATA), p_T<0.1 GeV/c





Ks tracking efficiency study

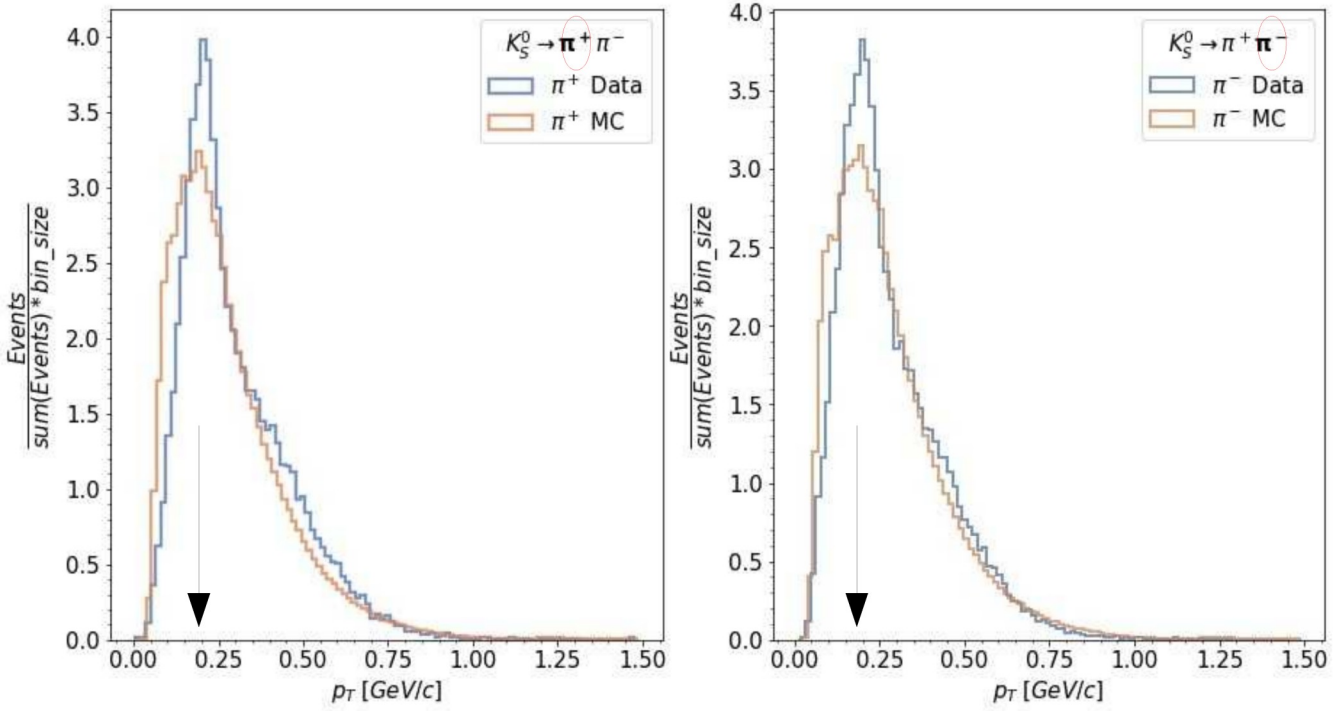
Master thesis (ongoing), Alex Skorenok, E.P.

Slow pions from Ks in tracking/correction studies

$B^0 \rightarrow K^+K^-K_S$

P_T [GeV/c]	GEN. MC (DATA) π+	GEN. MC (DATA) π-
0.00 - 0.10	8.59% (3.56%)	9.15% (4.97%)
0.00 - 0.15	22.46% (13.12%)	22.46% (16.59%)
0.00 – 0.20	37.88% (29.53%)	37.58% (33.74%)
0.00 – 0.25	48.03% (32.24%)	48.08% (47.18%)

PID applied
Release 5-XX



Summary

- Semileptonic has 50% entries below $p_T = 200$ MeV/c in generation
- Charmonium-like with D^*: not high impact seen!
- Heavy-light systems in charmonium: it depends on the analysis

  - D_{sJ}^* states below DK threshold: 22% below $p_T = 200$ MeV/c
- Neutral Z states have only few percent (there is no charged π from D^* decays)
- Charged Z states:

  - Without PXD there would not be any charged pions detected for p_T <85 MeV/c

  - 1/6 of all charged pions below $p_T = 100$ MeV/c can be "rescued" by clustering
- Ks tracking efficiency study in hadronic decays: ~30% events for p_T<200 MeV/c