EIC_NET Bologna

Pietro Antonioli
Francesco Noferini
Roberto Preghenella

Generale

- **Studio delle potenzialità di un rivelatore a tempo di volo per l'identificazione di particelle a EIC**
  - → ampia esperienza del gruppo di BO con sistemi TOF estesi
  - → sistema TOF di ALICE: $\varepsilon > 99\%$, $\sigma < 60$ ps
  - → possibile TOF futuro (MRPC, UFSD) con $\sigma = 20$-30 ps

- **attività di networking / workshops (svolte e previste)**
  - ✓ 1x partecipazione al workshop MCEGs for future ep and eA facilities (Desy)
  - ✓ 1x partecipazione al workshop EIC Software Meeting (Trieste)
  - ✓ 2x partecipazione al EIC User Group meeting (Parigi)
  - → 1x partecipazione al workshop MCEGs for eA facilities (Vienna)
  - → partecipazione alla giornata nazionale EIC_NET (Bari)

- **attività di simulazione**
  - → partecipazione alle riunioni del EIC Software Working Group
  - → studi MC sulle prestazioni di un TOF a EIC
  - ✓ milestone 2019: studi preliminari delle accettanze e delle prestazioni per la particle identification con rivelatori a tempo di volo in diverse configurazioni
  - → milestone 2020: studio preliminare delle prestazioni di un rivelatore TOF a EIC per la ricostruzione di barioni charmati Λ_c e Σ_c

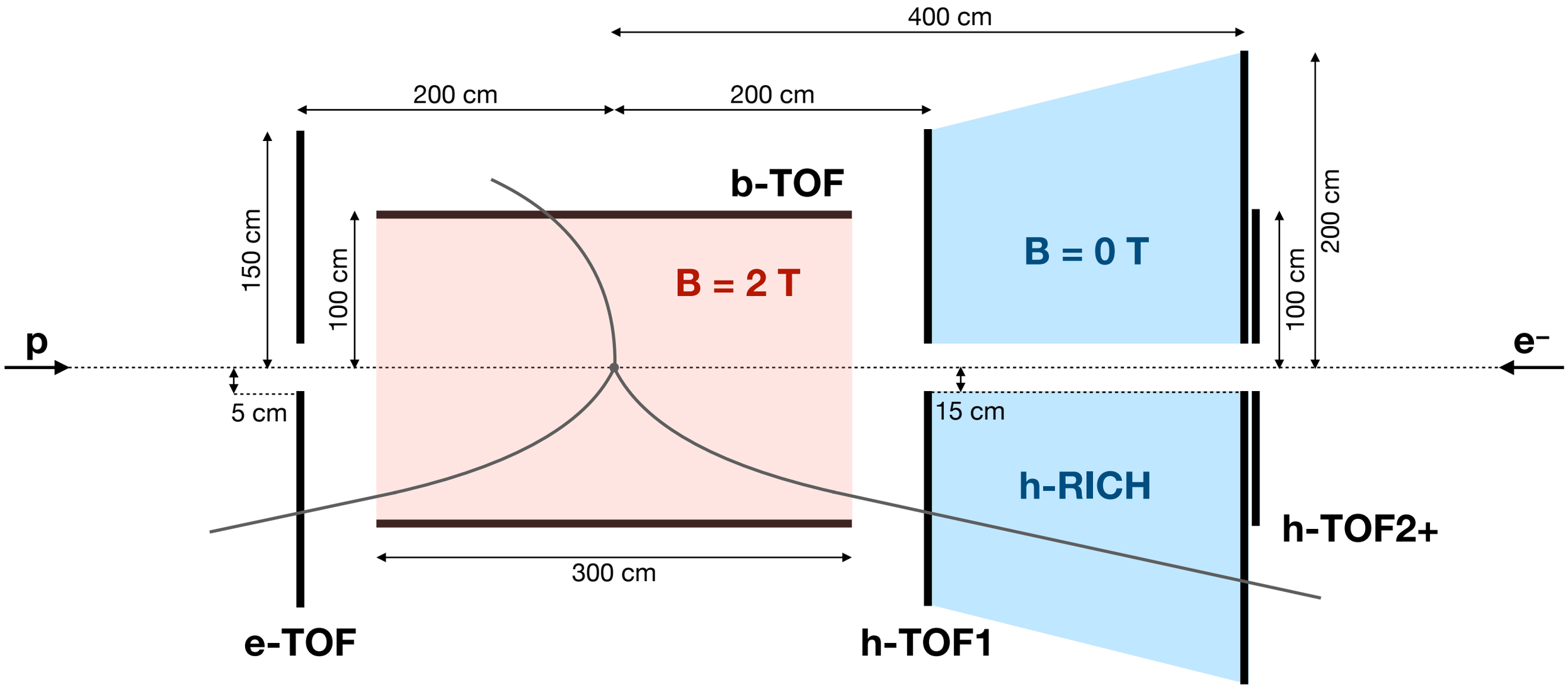
- **assegnazioni e spese 2019**
  - → 2.5 k€ inizialmente assegnati, insufficienti
    - → 1.5 k€ per missioni attività di networking internazionale (spesi 2 k€, 0.5 € da DTZ.GR3)
    - → 1.0 k€ per missioni attività di simulazione (spesi 1 k€)
  - → 1.0 k€ ulteriori assegnazioni a giugno
    previsione ulteriore spesa 1.0 k€ per missioni attività di simulazione e networking nazionale

- **richieste 2020**
  - → 3.0 k€ per EIC User Group meeting in USA (1 persona) + networking
  - → 1.5 k€ per missioni attività di simulazione

Studio delle potenzialità di un rivelatore TOF per la PID a EIC

<u>Milestone 2019:</u> studi preliminari delle accettanze e delle prestazioni per la PID con rivelatori TOF in diverse configurazioni

TOF configuration layouts



	η_{min}	η_{max}	area (m^2)	σ_t (ps)
e-TOF	-4.1	1.1	7	20
b-TOF	-1.2	1.2	19	20
h-TOF1	1.1	3.3	7	20
h-TOF2	1.4	4.0	12.5	20
h-TOF2+	2.1	4.0	3 x 3	20 / √4

several potential configurations studied with emphasis on different phase-space and physics (η → x) coverage

h-TOF2+ extension with 3 additional 20 ps layers at high-η for higher *p*

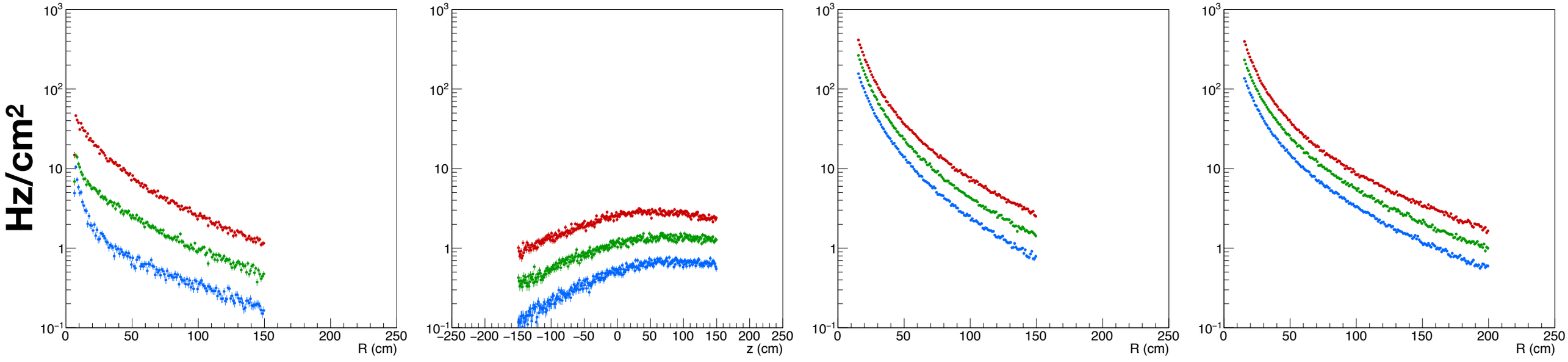
Charged-particle flux

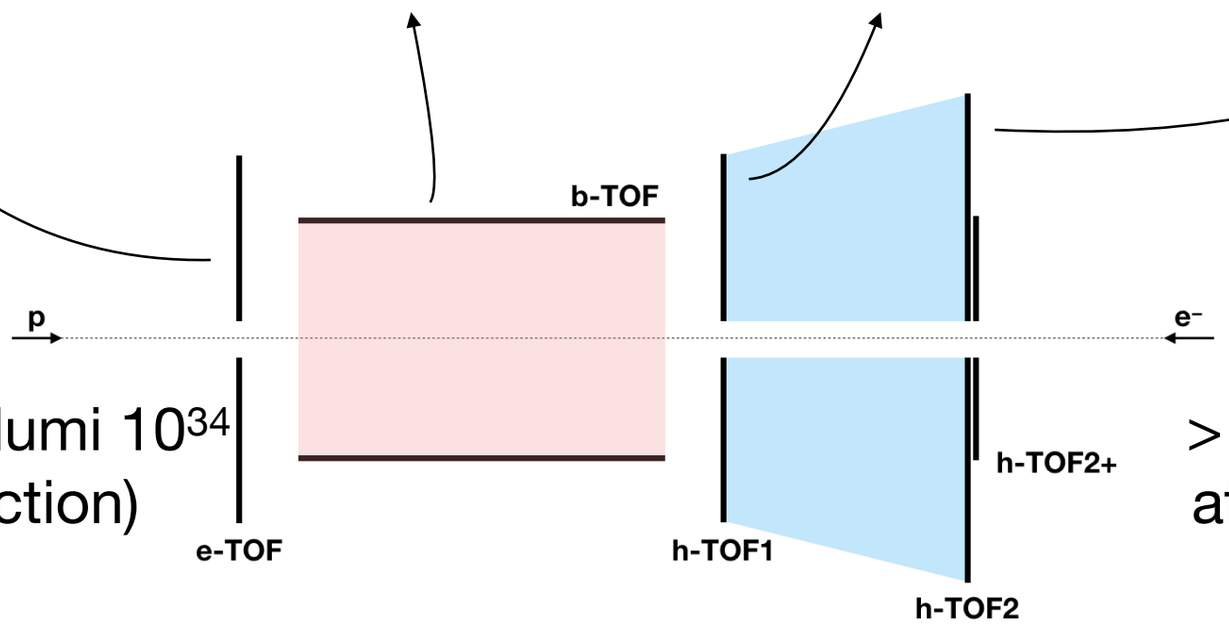
Pythia 6.4.28
CT10 PDF set
e⁻p min.bias
$\mathscr{L} = 10^{33}$ cm^{-2} s^{-1}

e^- + p (GeV)	5 + 50	10 + 100	20 + 250
σ_{tot} (μb)	230	330	502

important to study expected working conditions

caveat: no backgrounds from secondaries and beam-induced included





moderate event at high-lumi 10^{34} at backward η (e-direction) and mid-rapidity

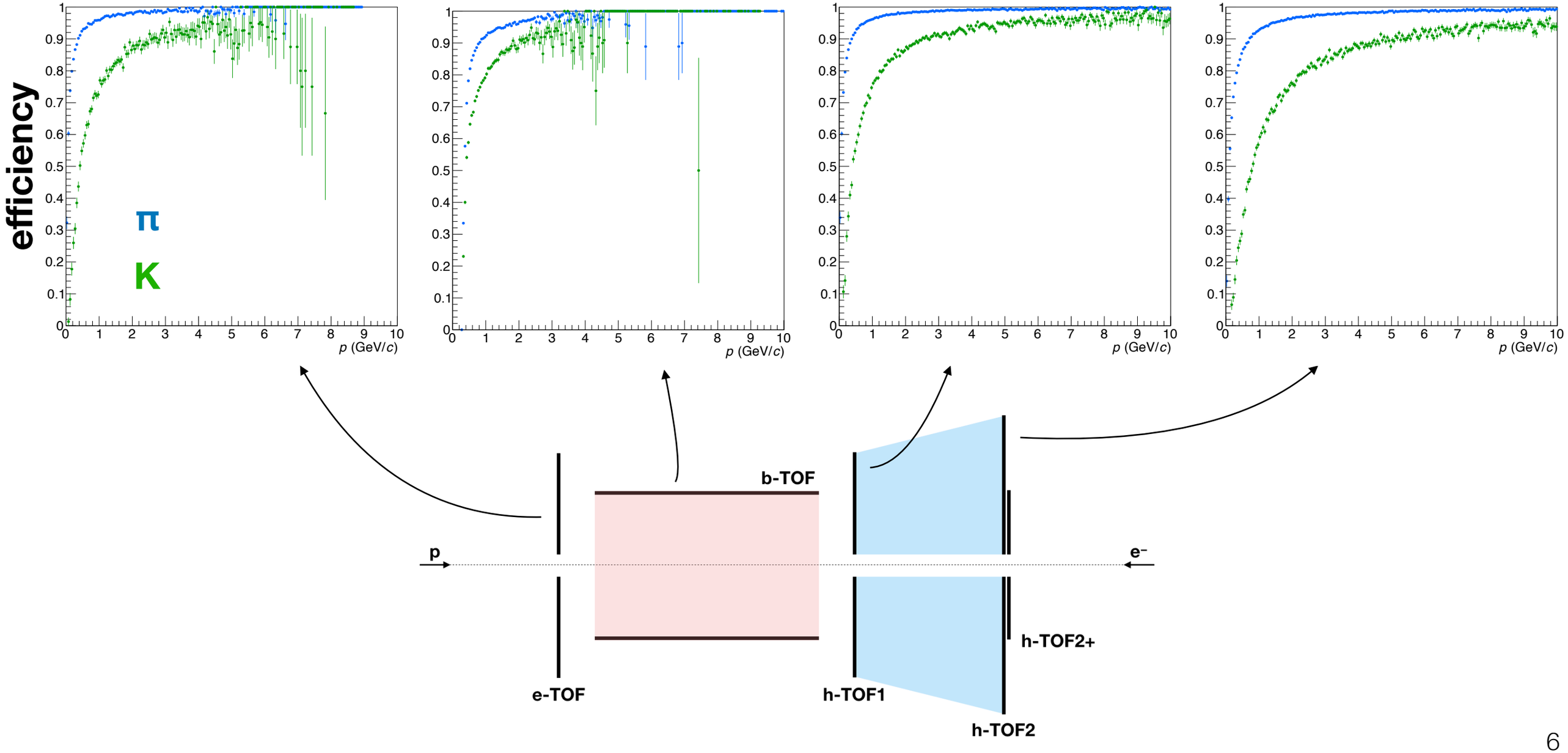
> 1 kHz at high-lumi 10^{34} at forward η (p-direction)

Identification efficiency

Pythia 6.4.28
CT10 PDF set
e⁻p DIS, $Q^2 > 1$
10 + 100 GeV

number of particles hitting the detector surface
over
number of particles generated in the detector η acceptance

accounting for propagation in B, outside B and in-flight decays of π and K

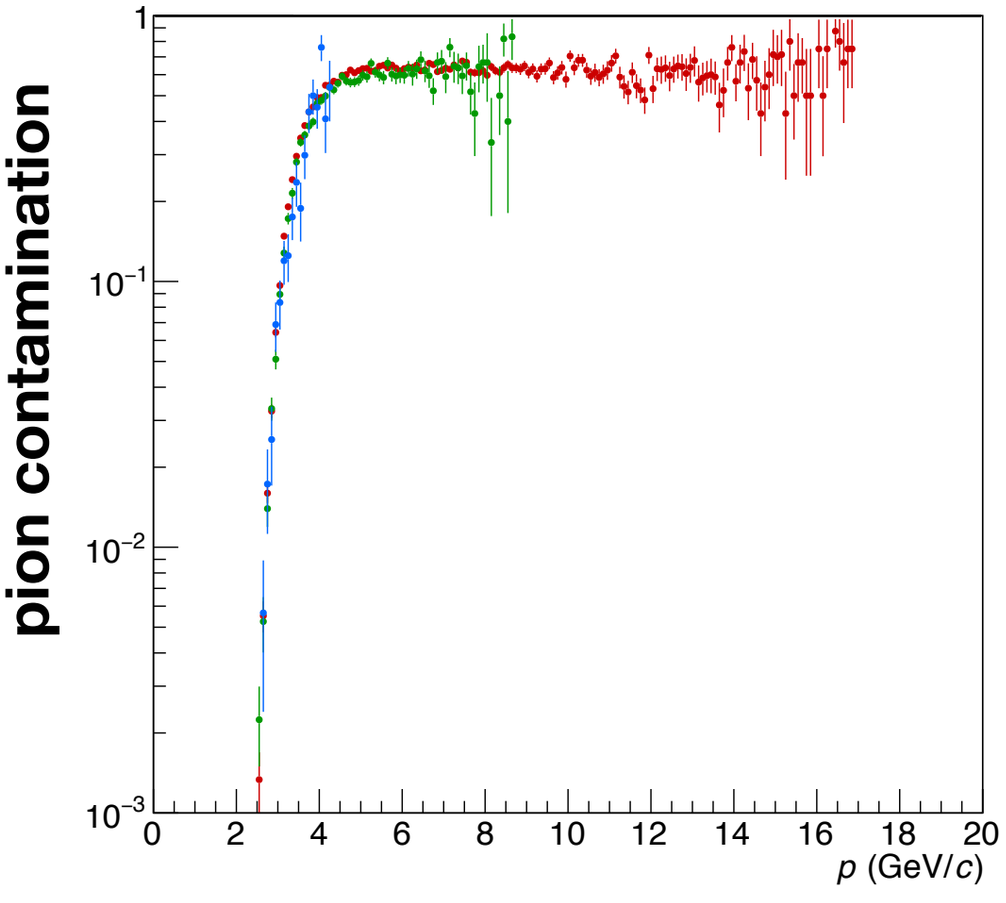


e-TOF kaon purity

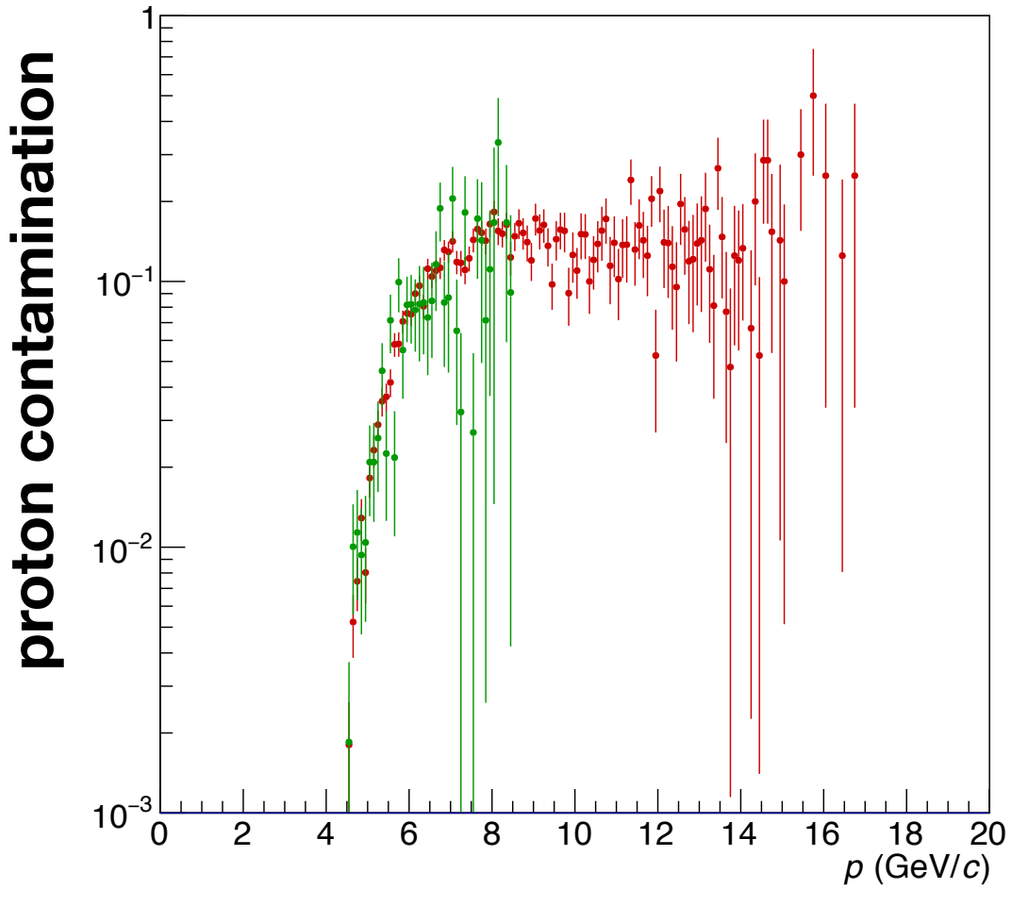
Pythia 6.4.28
CT10 PDF set
e^-p DIS, $Q^2 > 1$

e^- + p (GeV)	5 + 50	10 + 100	20 + 250
σ_{tot} (μb)	0.37	0.42	0.53

3σ PID cuts
contamination = $N_{wrong\text{-}id}$ / $N_{kaon\text{-}id}$



< 1% up to 2.7 GeV/c



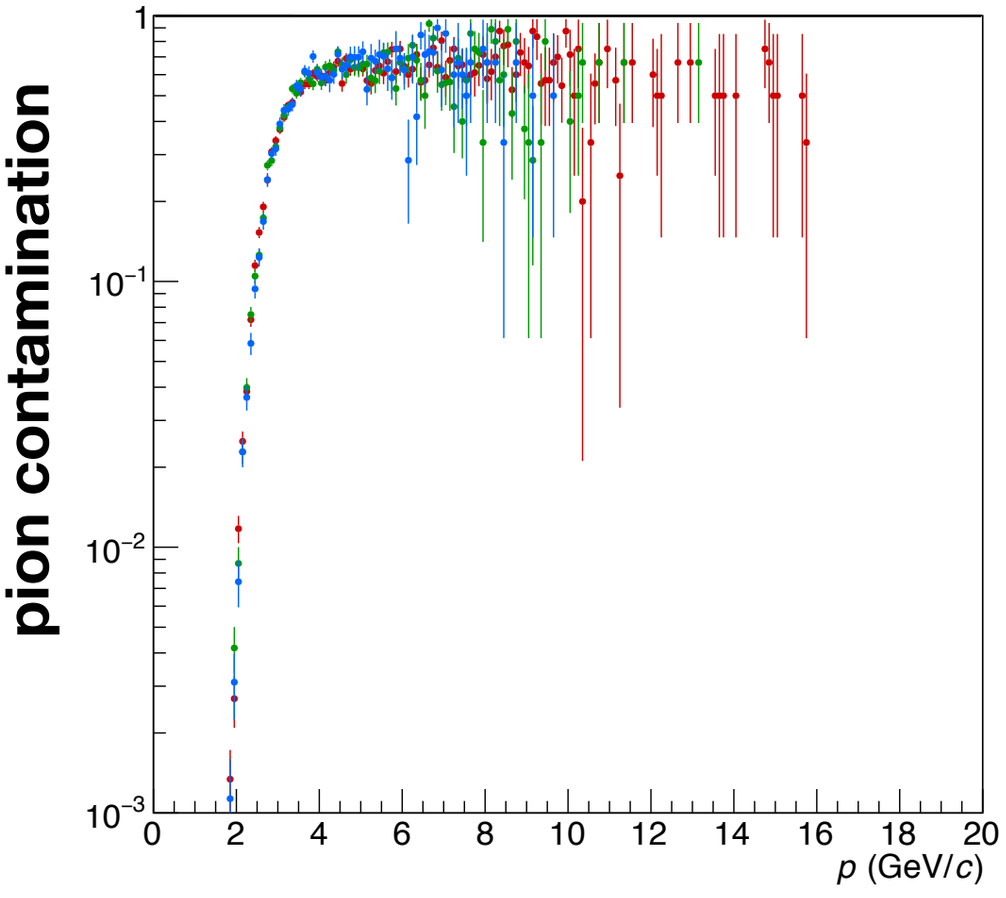
< 1% up to 4.5 GeV/c

b-TOF kaon purity

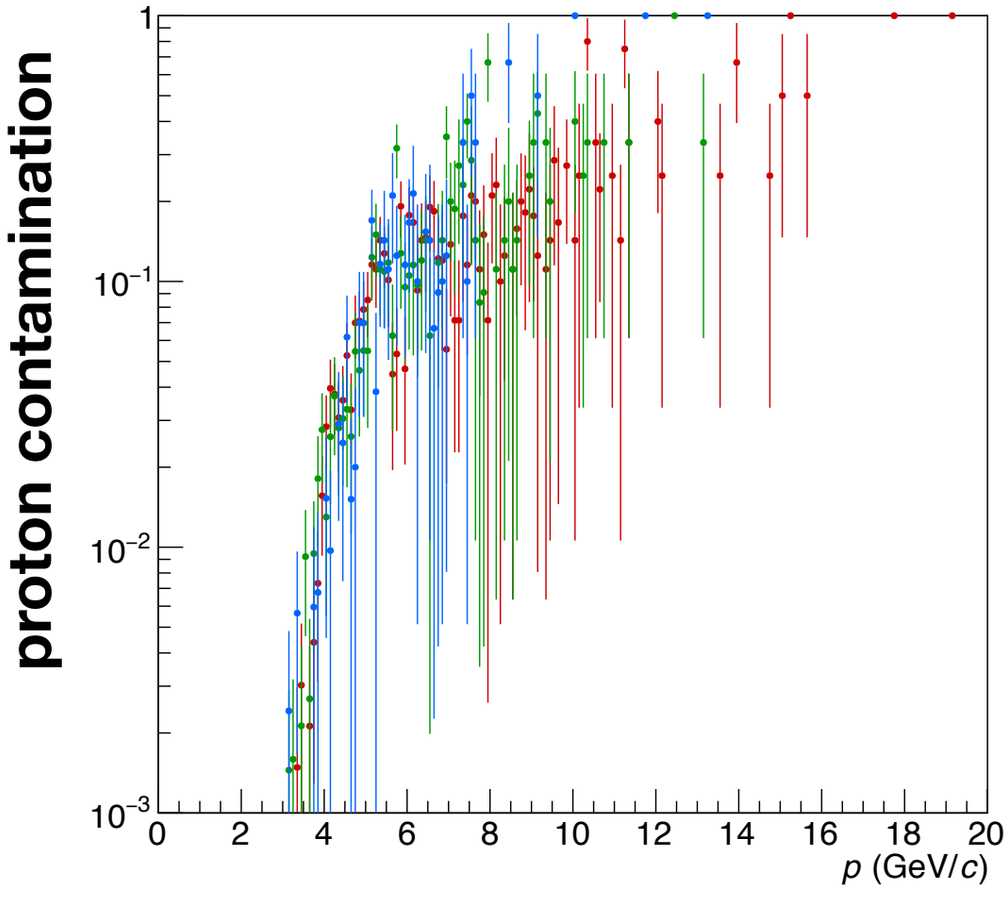
Pythia 6.4.28
CT10 PDF set
e^-p DIS, $Q^2 > 1$

e^- + p (GeV)	5 + 50	10 + 100	20 + 250
σ_{tot} (μb)	0.37	0.42	0.53

3σ PID cuts
contamination = $N_{wrong\text{-}id}$ / $N_{kaon\text{-}id}$



< 1% up to 2.0 GeV/c



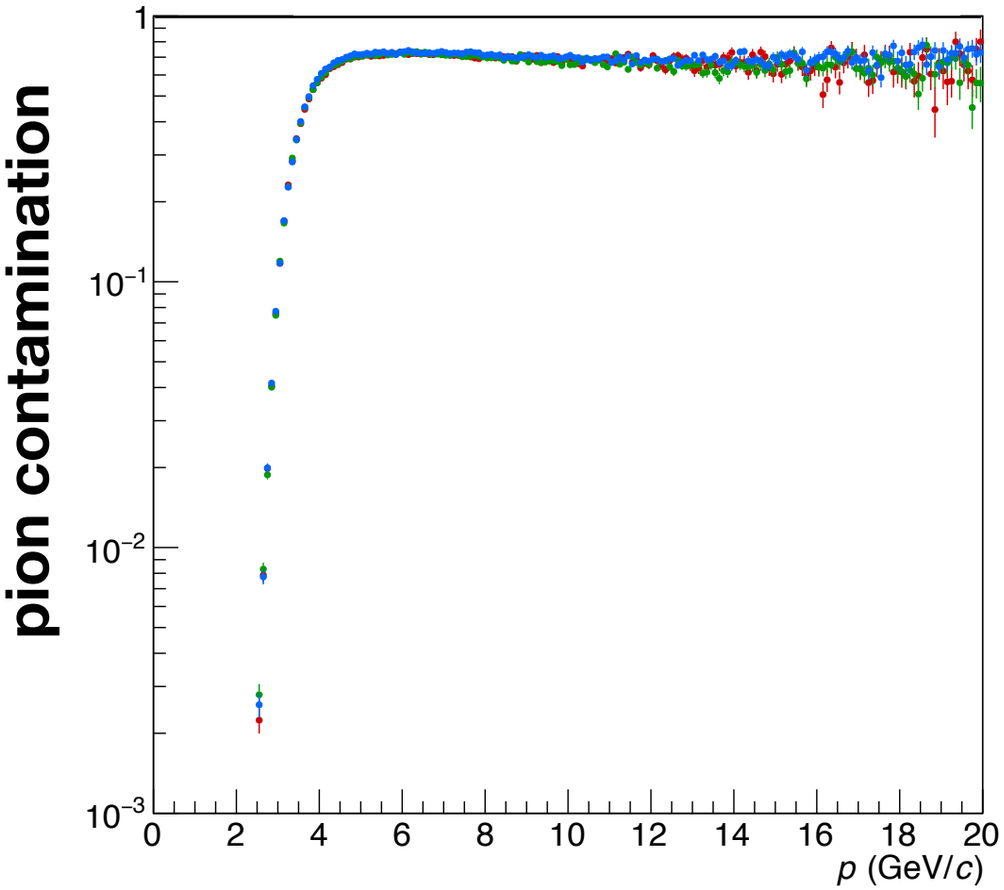
< 1% up to 3.5 GeV/c

h-TOF1 kaon purity

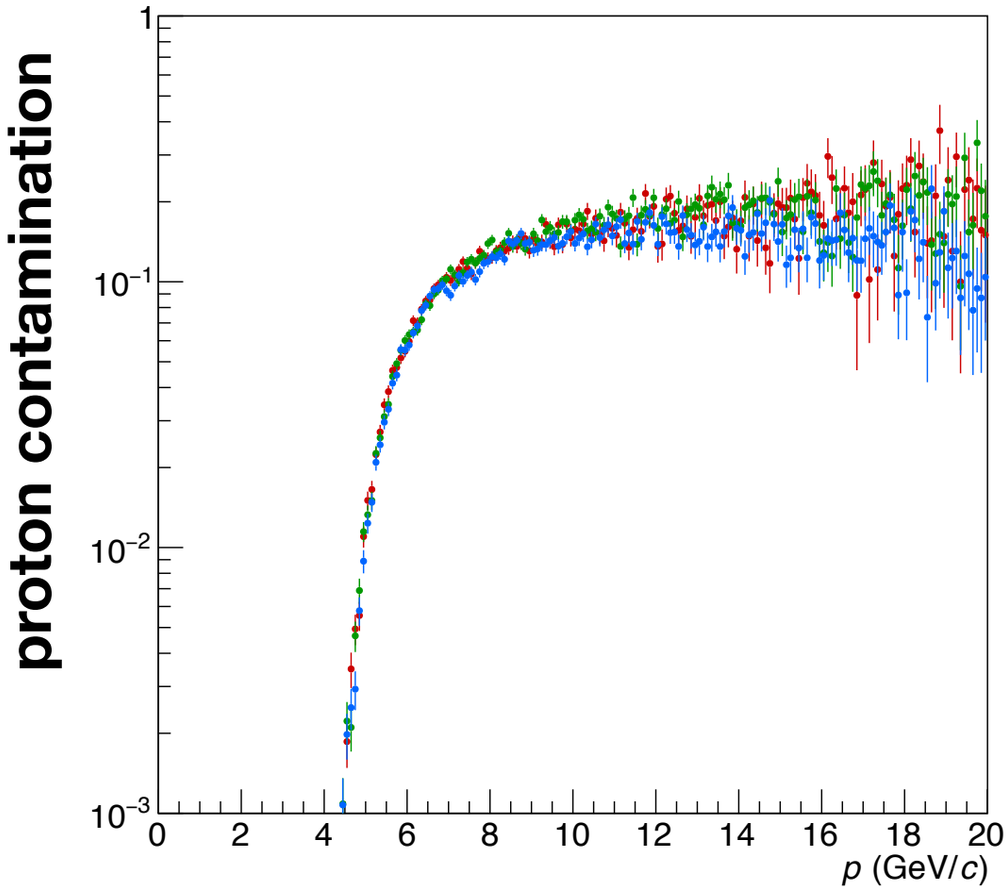
Pythia 6.4.28
CT10 PDF set
e^-p DIS, $Q^2 > 1$

e^- + p (GeV)	5 + 50	10 + 100	20 + 250
σ_{tot} (μb)	0.37	0.42	0.53

3σ PID cuts
contamination = $N_{wrong\text{-}id}$ / $N_{kaon\text{-}id}$



< 1% up to 2.7 GeV/c



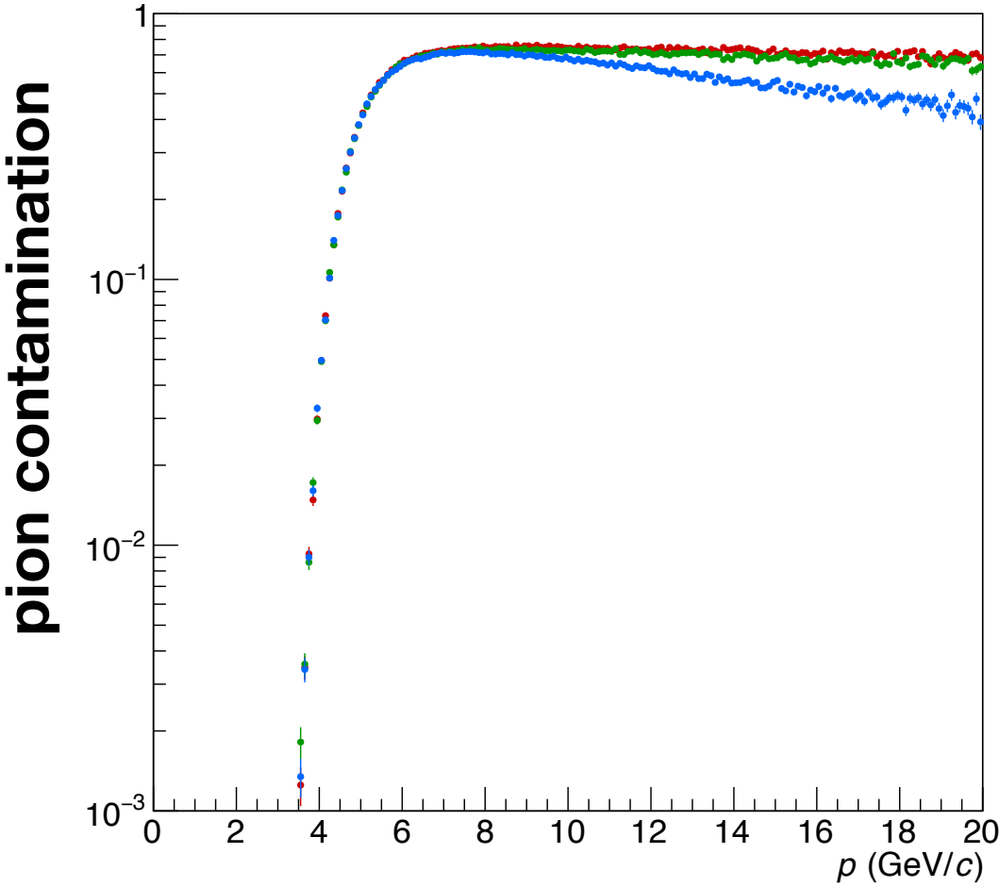
< 1% up to 5.0 GeV/c

h-TOF2 kaon purity

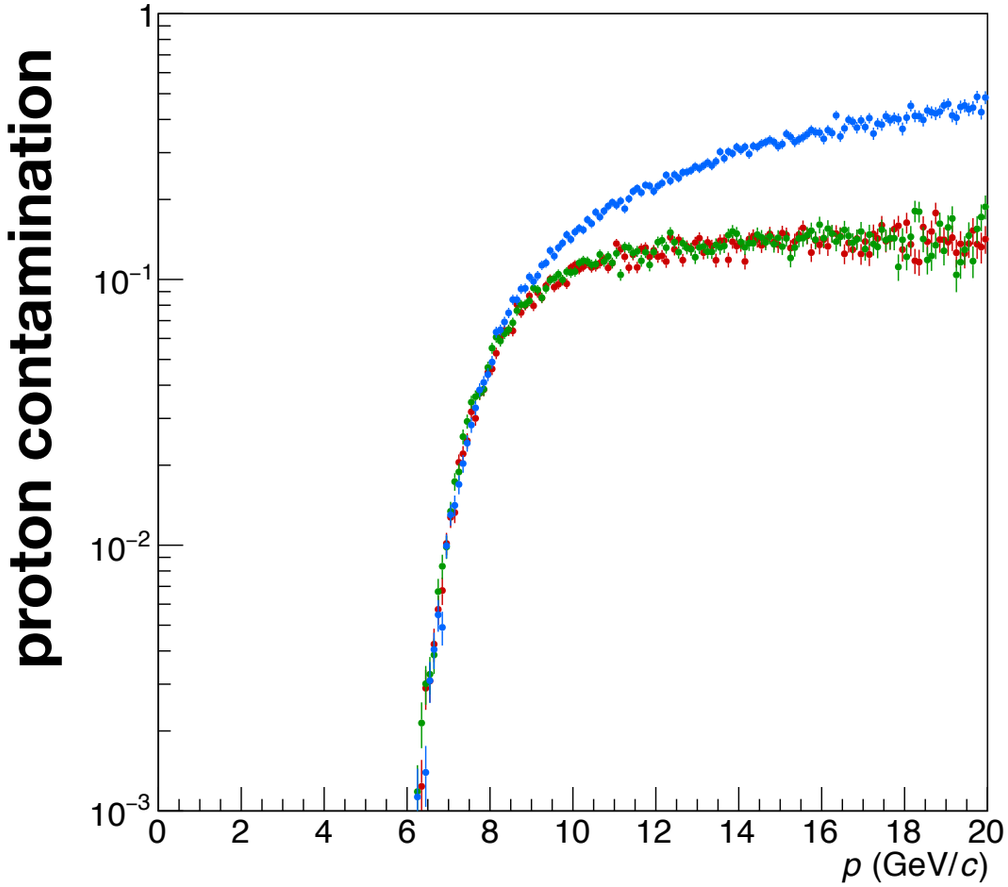
Pythia 6.4.28
CT10 PDF set
e^-p DIS, $Q^2 > 1$

e^- + p (GeV)	5 + 50	10 + 100	20 + 250
σ_{tot} (μb)	0.37	0.42	0.53

3σ PID cuts
contamination = $N_{wrong\text{-}id}$ / $N_{kaon\text{-}id}$



< 1% up to 3.8 GeV/c

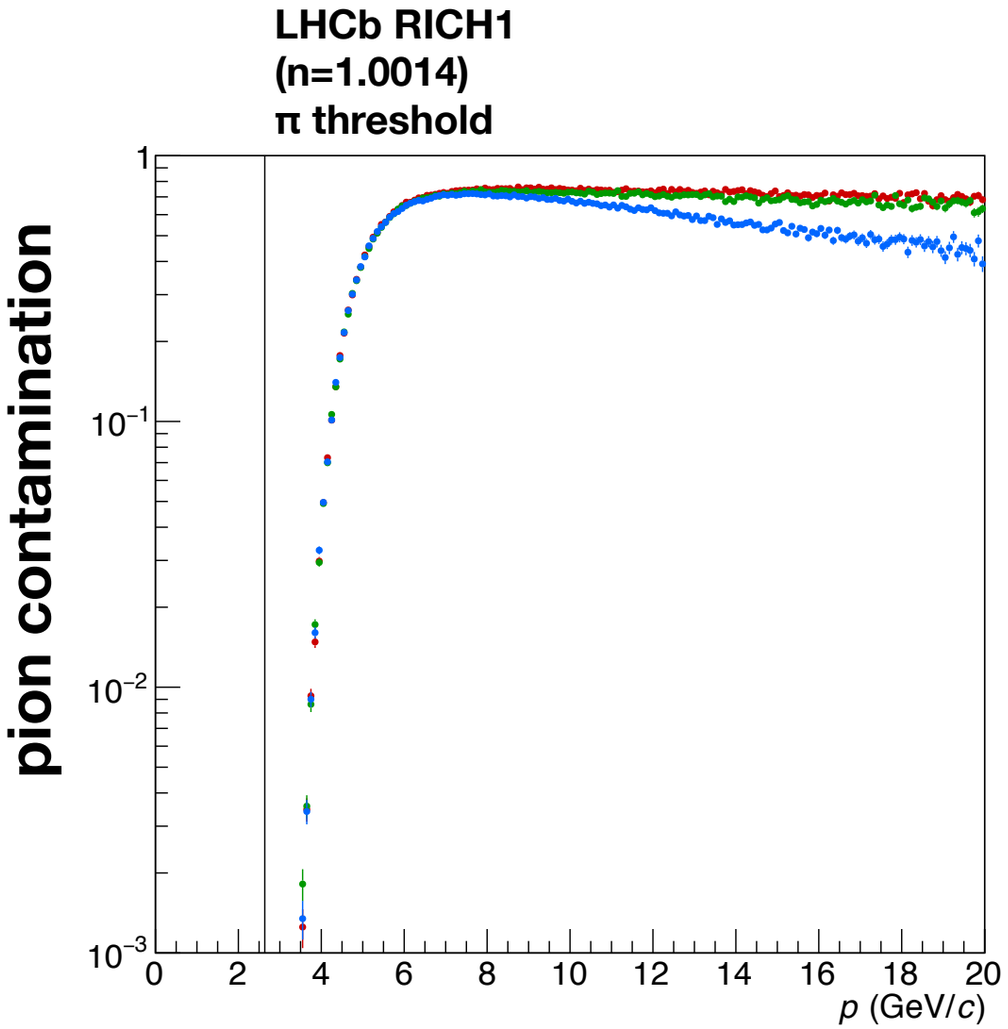


< 1% up to 7.0 GeV/c

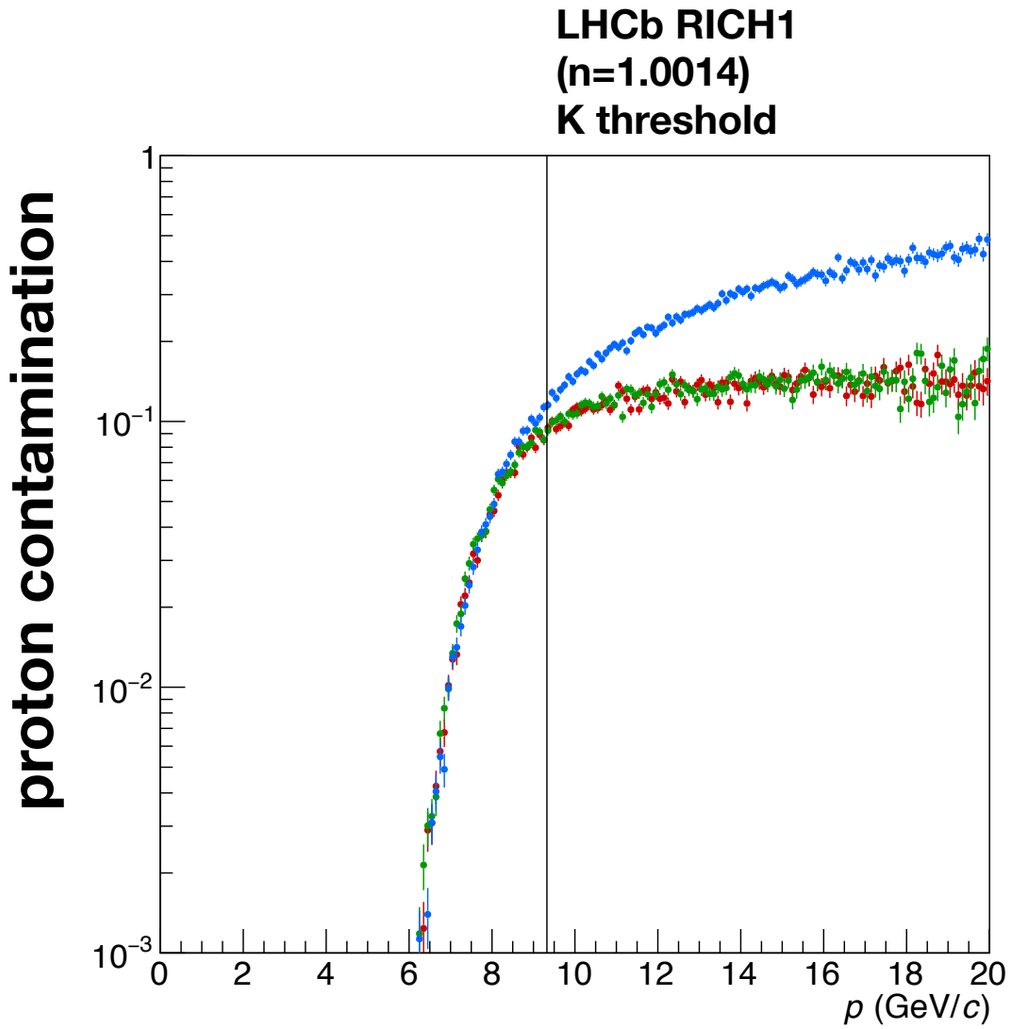
h-TOF2 kaon purity

Pythia 6.4.28
CT10 PDF set
e^-p DIS, $Q^2 > 1$

e^- + p (GeV)	5 + 50	10 + 100	20 + 250
σ_{tot} (μb)	0.37	0.42	0.53



< 1% up to 3.8 GeV/c



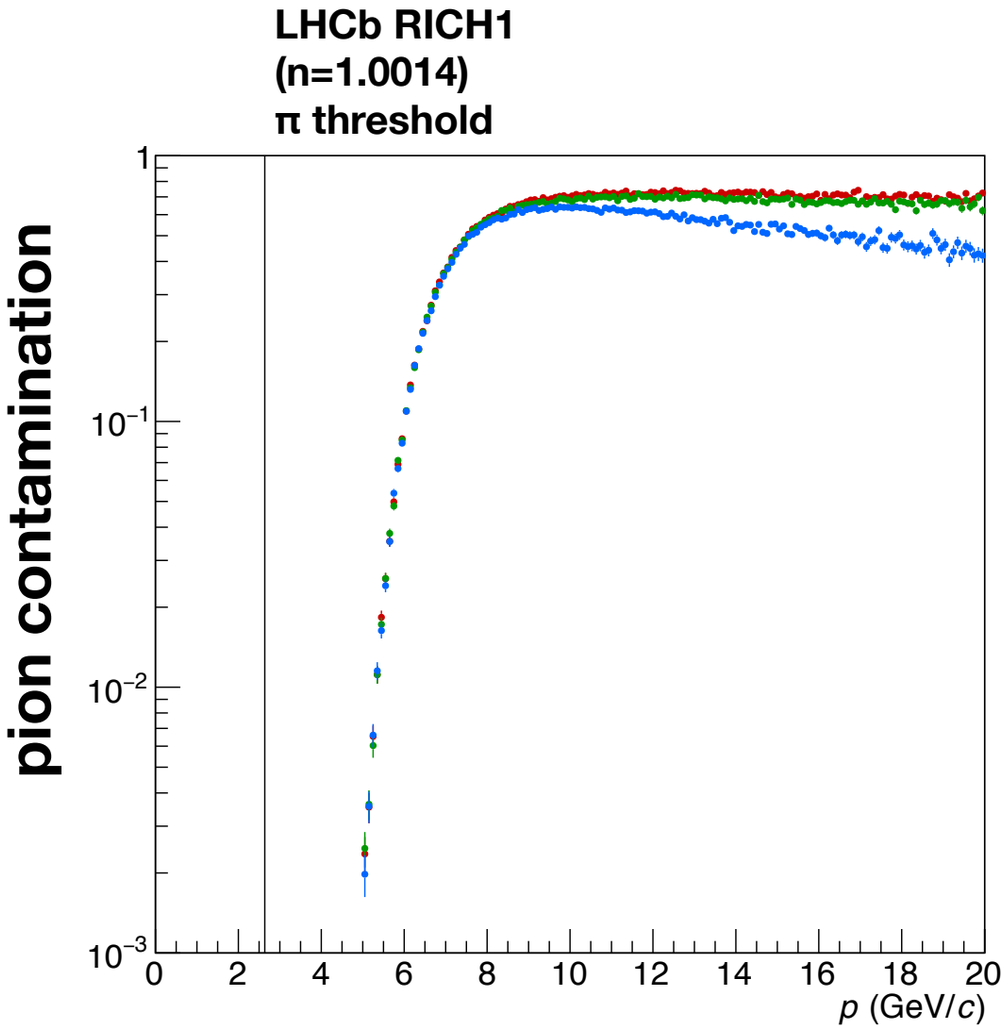
< 1% up to 7.0 GeV/c

h-TOF/RICH synergy: no pion contamination, kaon purity > 99% up to 7.0 GeV/c

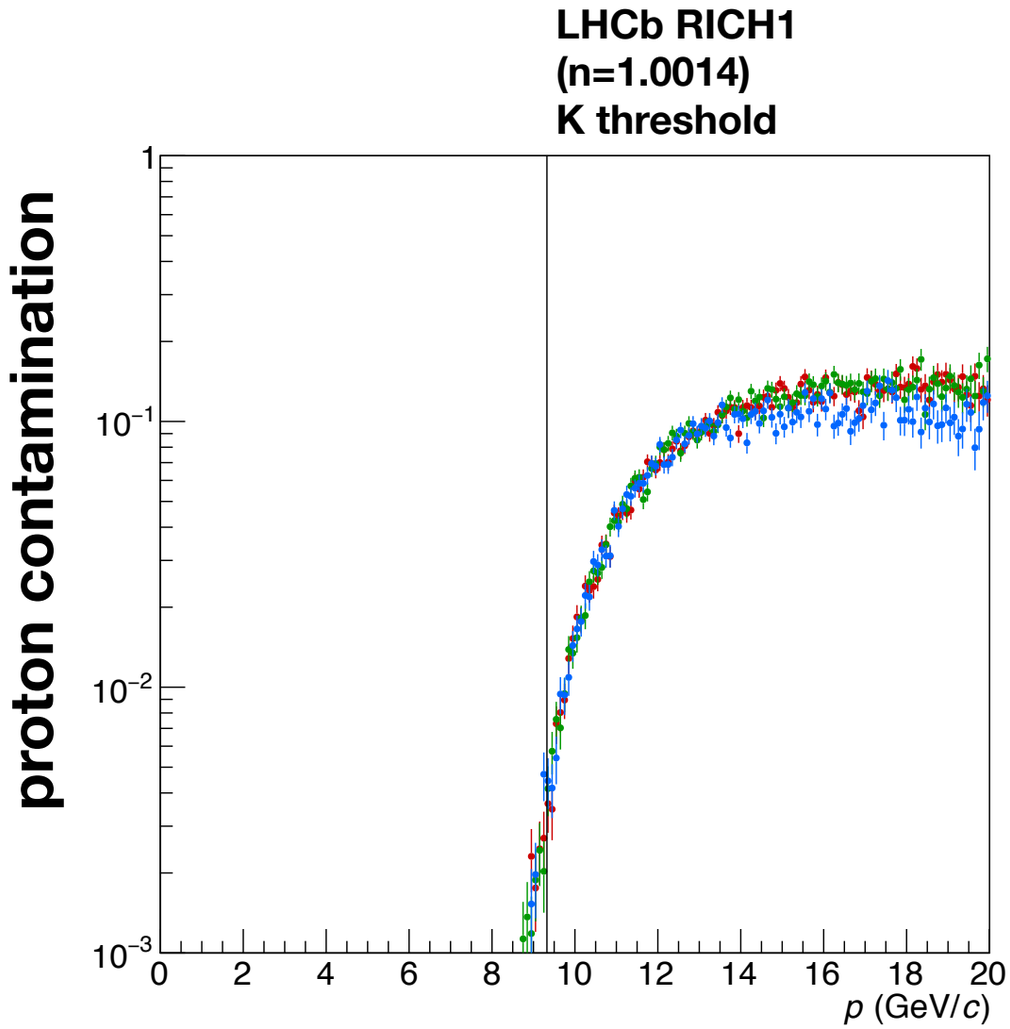
h-TOF2+ kaon purity

Pythia 6.4.28
CT10 PDF set
e^-p DIS, $Q^2 > 1$

e^- + p (GeV)	5 + 50	10 + 100	20 + 250
σ_{tot} (μb)	0.37	0.42	0.53



< 1% up to 5.3 GeV/c



< 1% up to 9.5 GeV/c

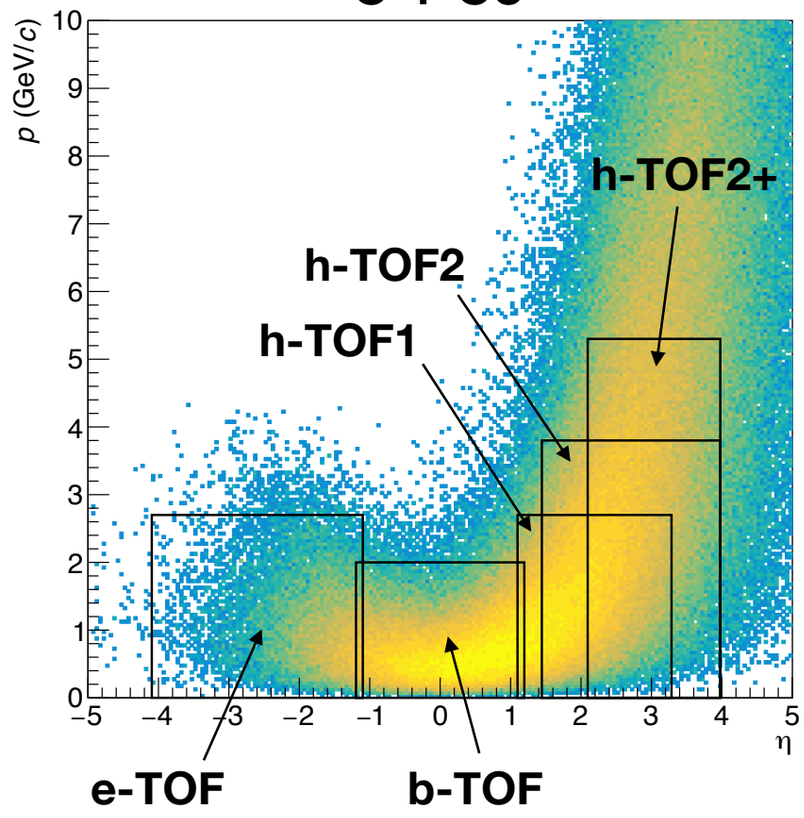
h-TOF/RICH synergy: no pion contamination, kaon purity > 99% up to 9.5 GeV/c

TOF kaon ID summary

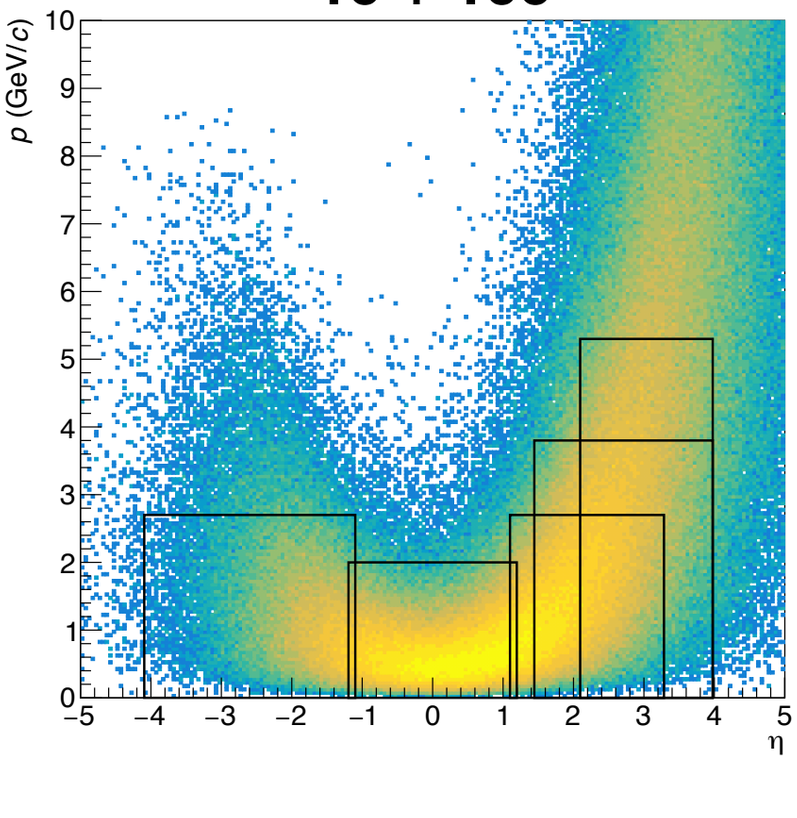
Pythia 6.4.28
CT10 PDF set
e^-p DIS, $Q^2 > 1$

e^- + p (GeV)	5 + 50	10 + 100	20 + 250
σ_{tot} (μb)	0.37	0.42	0.53

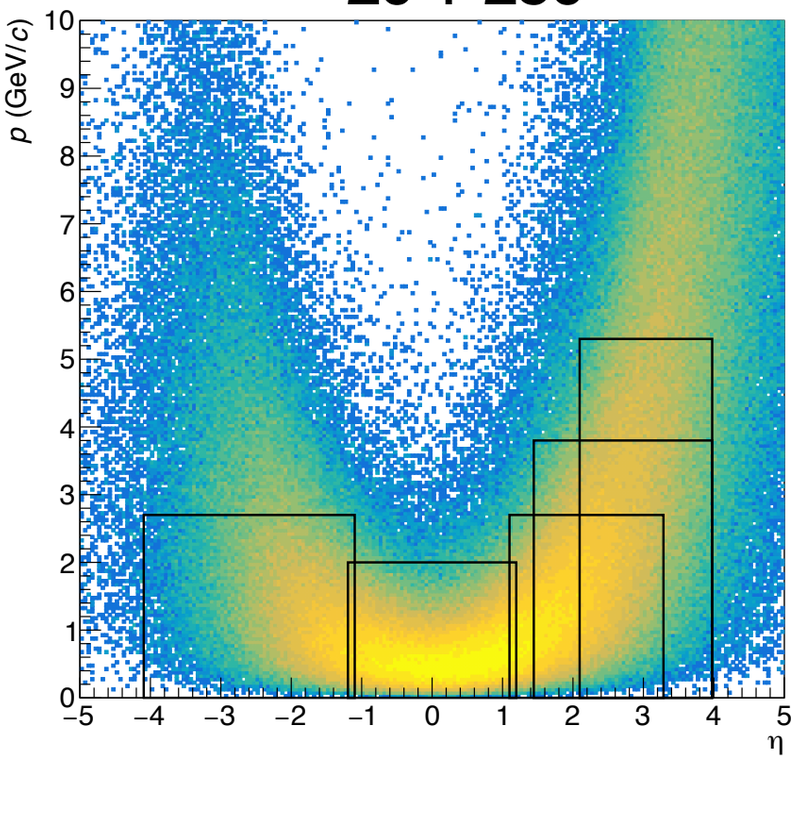
5 + 50



10 + 100



20 + 250

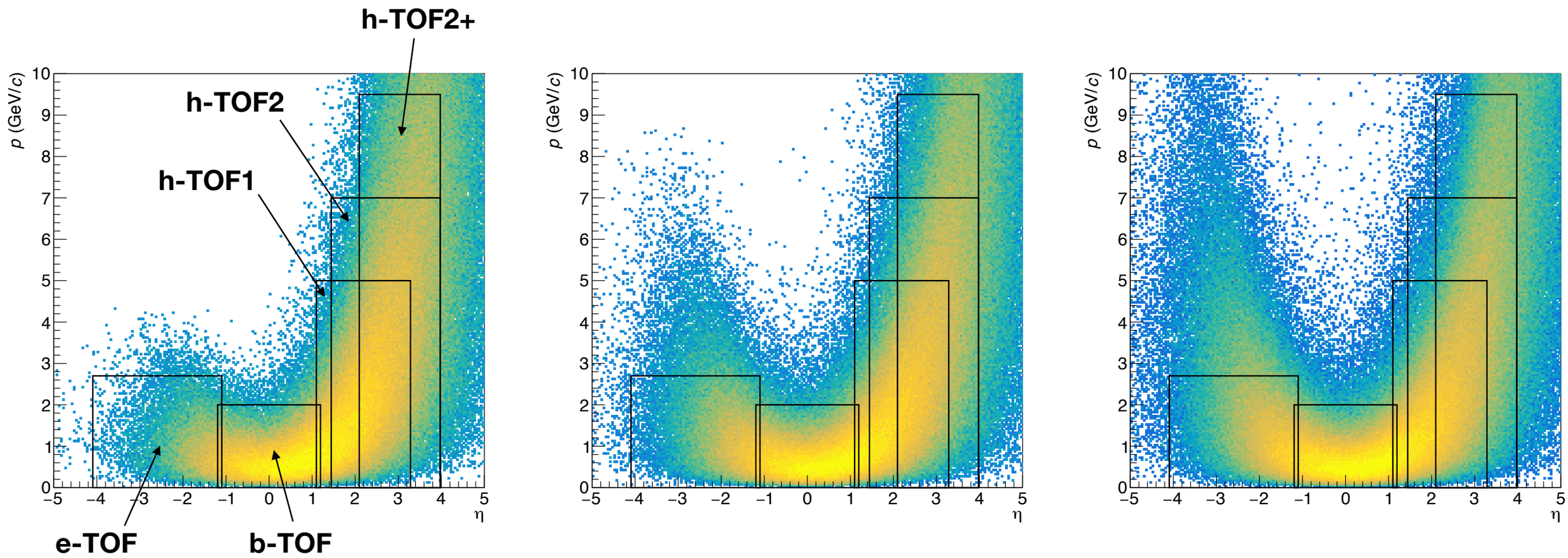


tested PID acceptance coverage for different TOF configurations

TOF kaon ID summary

Pythia 6.4.28
CT10 PDF set
e^-p DIS, $Q^2 > 1$

e^- + p (GeV)	5 + 50	10 + 100	20 + 250
σ_{tot} (μb)	0.37	0.42	0.53



h-TOF/RICH synergy: no pion contamination, high kaon purity up to higher *p*

Summary

- **participation to EIC-related meetings, workshops**
  → networking with people involved in MC, software and PID studies
  → building links with Italian EIC groups for common/coordinated MC effort/interests

- **developed a framework for fast MC (Pythia6 + Delphes)**
  → good experience, baseline for current and near-future studies (shared experience)
  → will stay in touch with EICUG for full GEANT4 simulation tools
  → will stay in touch with MC community for developments in ep/A event generators

- **tested several TOF configurations in different beam conditions**
  → will test one additional configuration, run the tool and make plots
  → 2019 milestone considered completed, large collection of plots/results (not all shown today)
  → think about PID in a more general way
  → TOF interaction/synergy with other PID systems (eg. RICH)

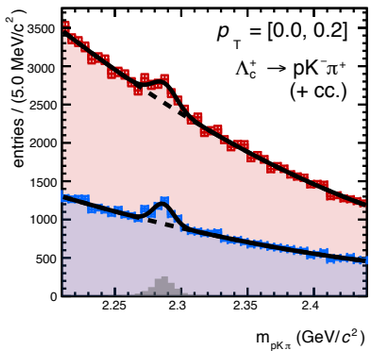
- **similar involvement for next year**
  → networking, simulation activities on TOF performance + physics
  → 2020 milestone will build on top of experience/expertise gained in 2019

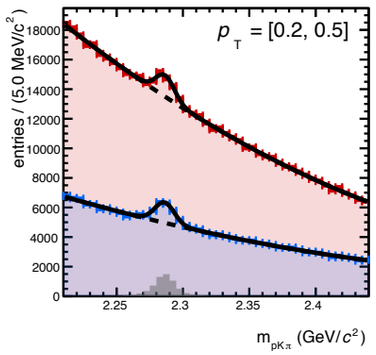
Studio delle potenzialità di un rivelatore TOF per la PID a EIC

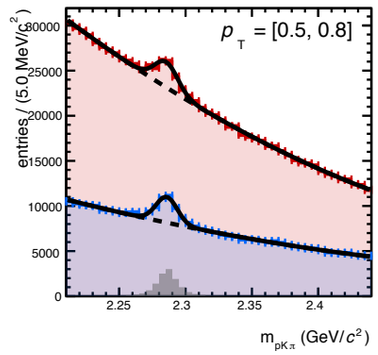
<u>Milestone 2020:</u> studio preliminare delle prestazioni di un rivelatore TOF a EIC per la ricostruzione di barioni charmati Λ_c e Σ_c

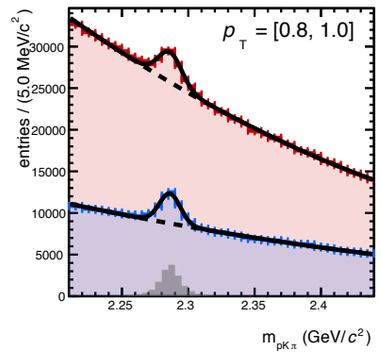
Λ_c – all processes, low Q^2

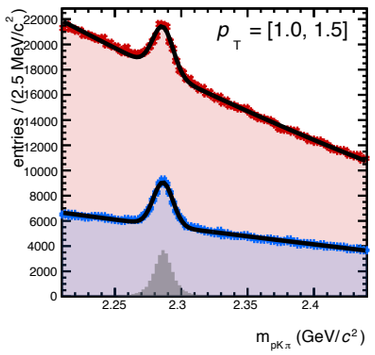
very-preliminary study
improve it in 2020

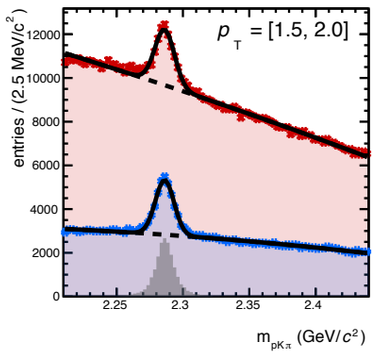


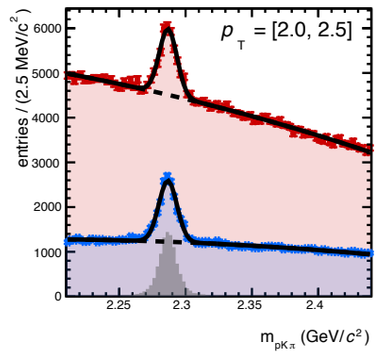


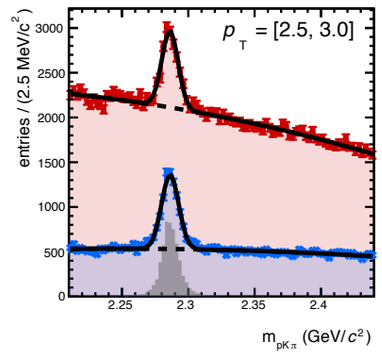


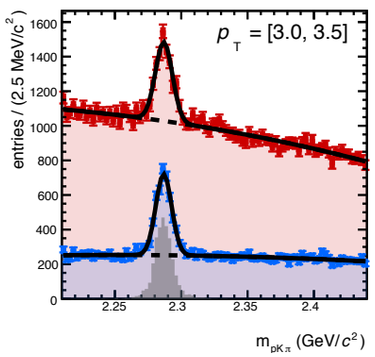


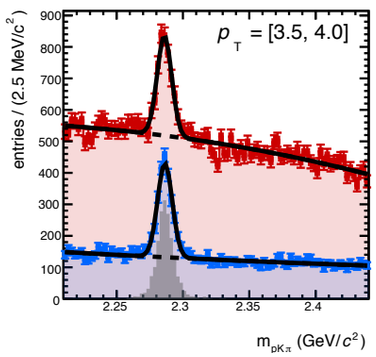


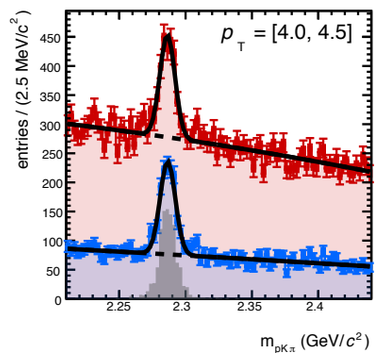


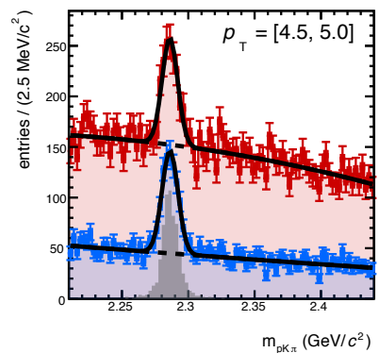


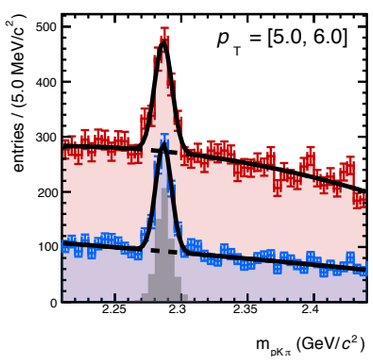


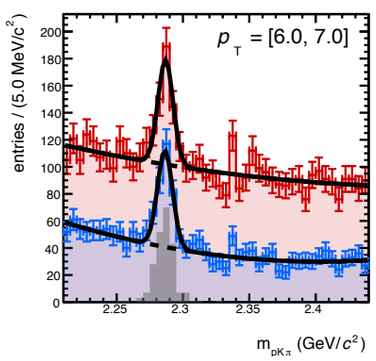


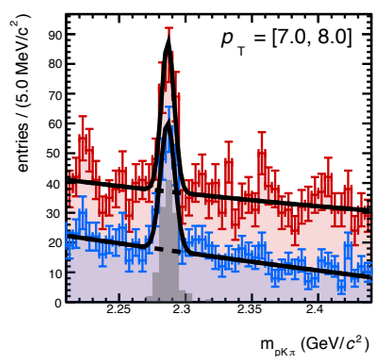


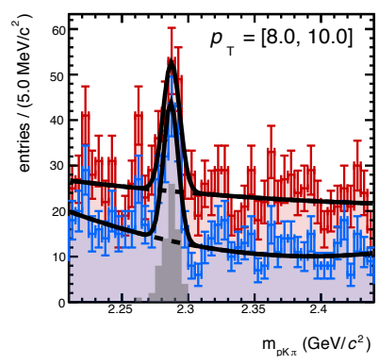






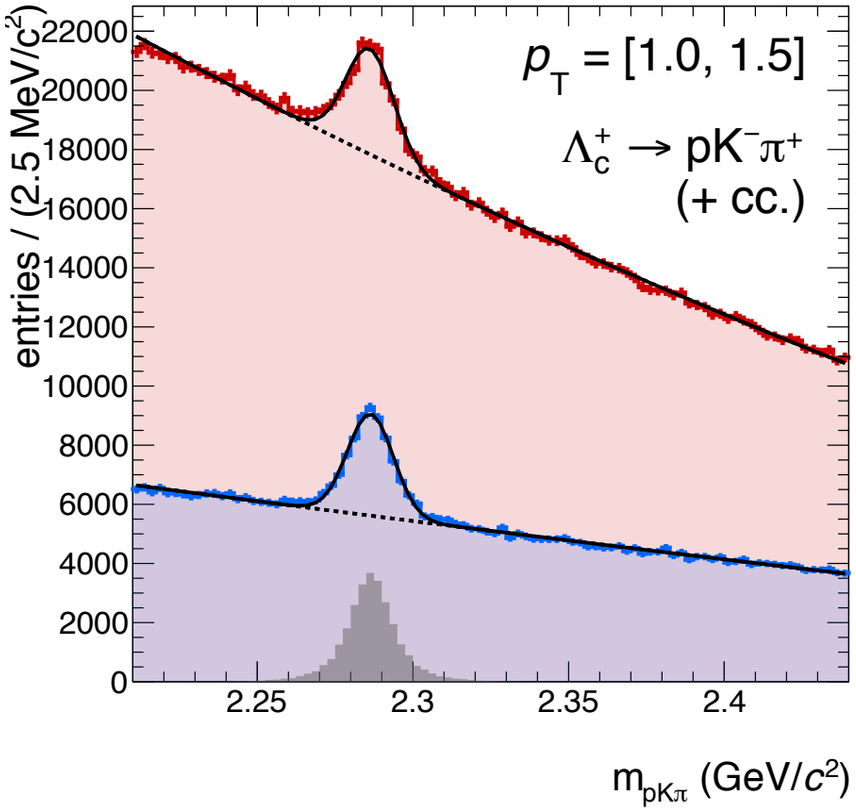






$2 < Q^2 < 4$

$0.01 < y_{\text{inelasticity}} < 0.95$



$\int \mathscr{L} = 10\ \text{fb}^{-1}$

125 d ($\mathscr{L} = 10^{33}$)