Status
Multi

Nicolas du Fresne von Hohenesche
Institut für Kernphysik, Mainz

February 10, 2014

Old Method

Double ratio

$$Acc = \frac{N_{h\_rec}/N_{DIS\_rec}}{N_{h\_gen}/N_{DIS\_gen}} = \frac{M_{rec}(\text{from rec DIS})}{M_{gen}(\text{from gen DIS})}$$

As used in April 2013 release, but error estimation more complicated
Assumption: hadron and DIS events are independent

$$A_h = \frac{N_{h\_rec}}{N_{h\_gen}} \text{ and } A_{DIS} = \frac{N_{dis\_rec}}{N_{dis\_gen}}$$

$$\Delta Acc = \Delta(A_h/A_{DIS}) = A_h/A_{DIS} \times \sqrt{((\Delta A_h/A_h)^2 + (\Delta A_{DIS}/A_{DIS})^2)}$$

New Method

Single ratio

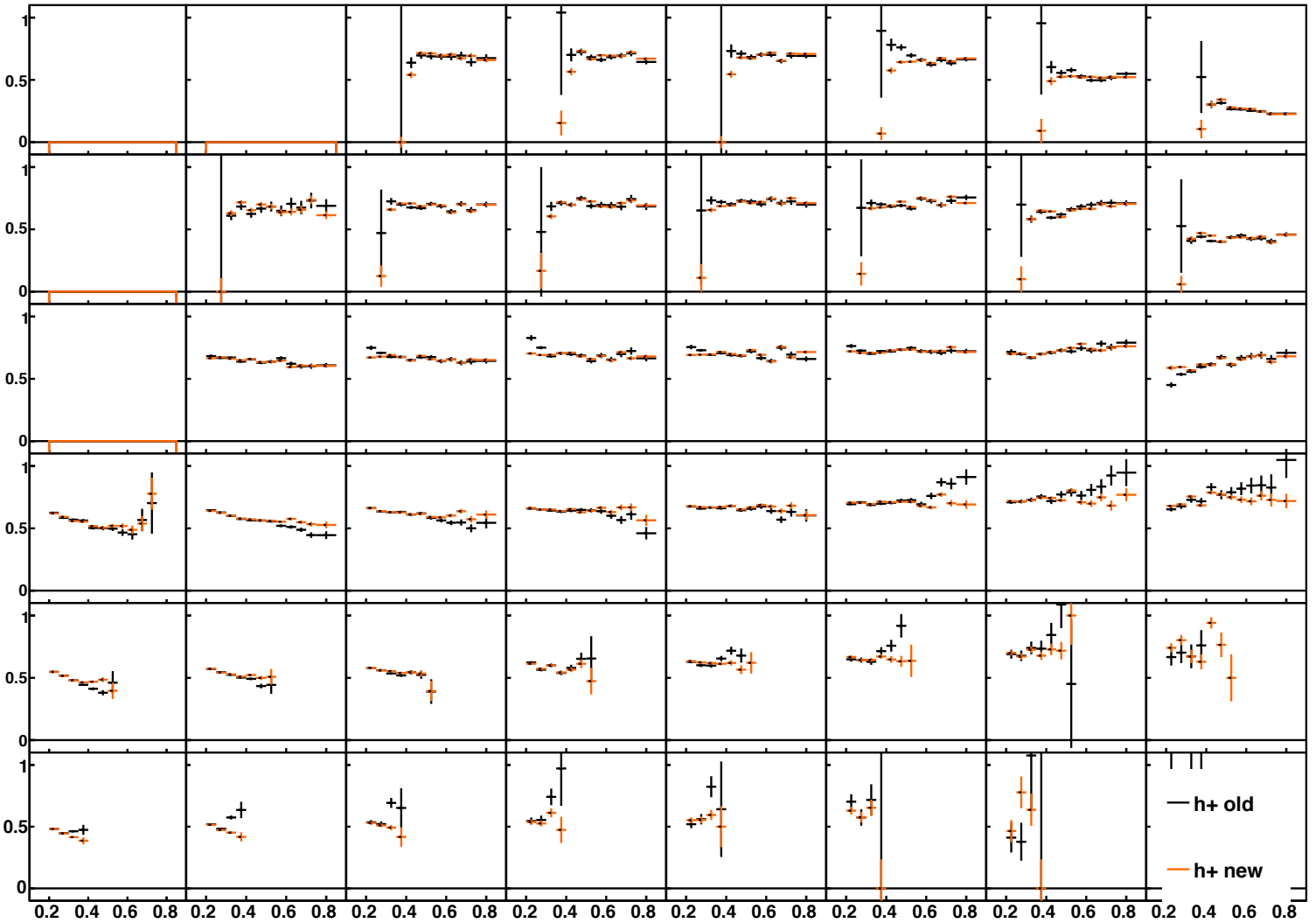
$$Acc = \frac{N_{h\_rec}(\text{from rec DIS})}{N_{h\_gen}(\text{from rec DIS})}$$

Advantage: Easier error estimation and muon acceptance is out

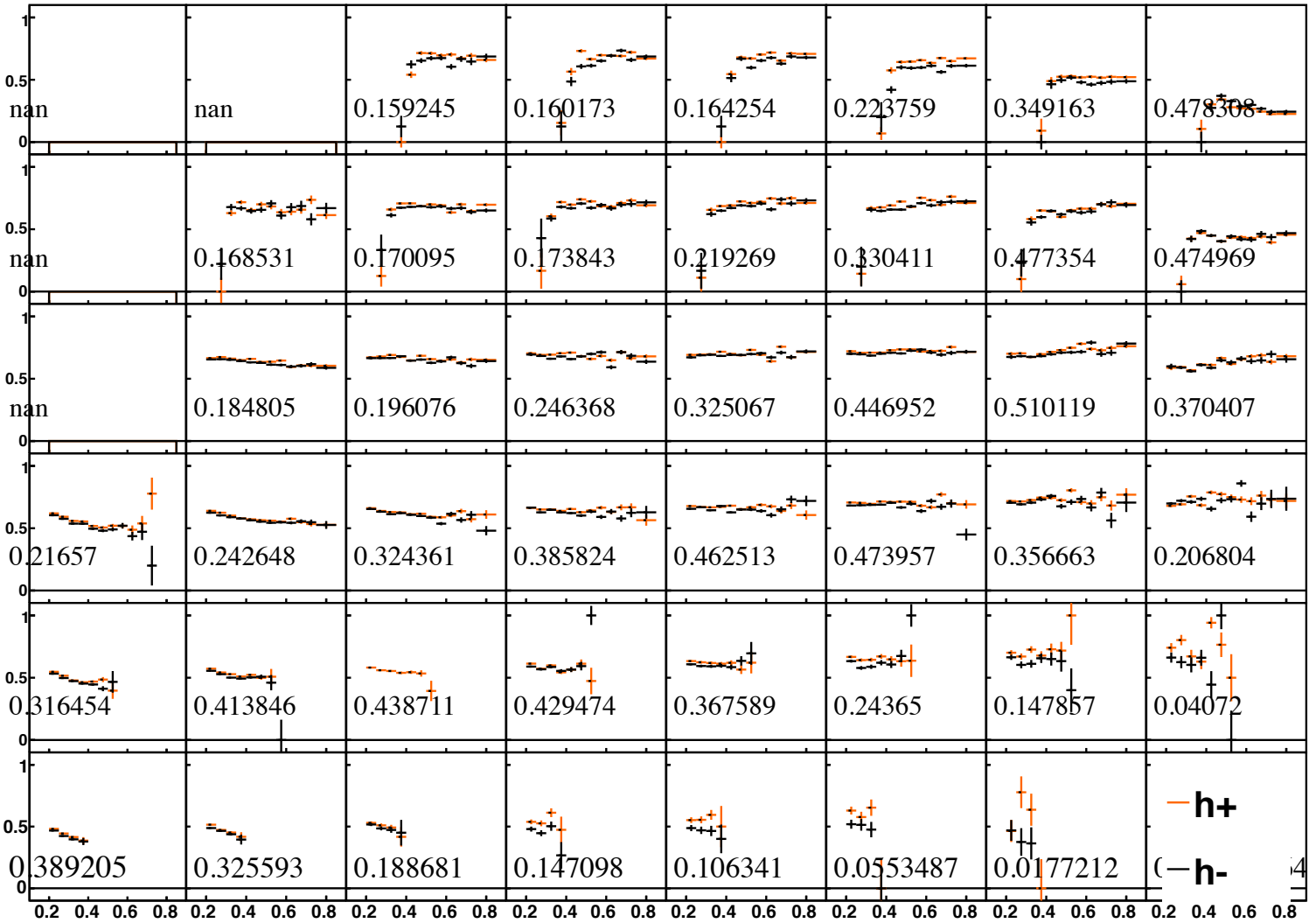
$$(\Delta Acc)^2 = \frac{(A+1)(G-A+1)}{(G+2)^2(G+3)}$$

with A for accepted events and G for generated events

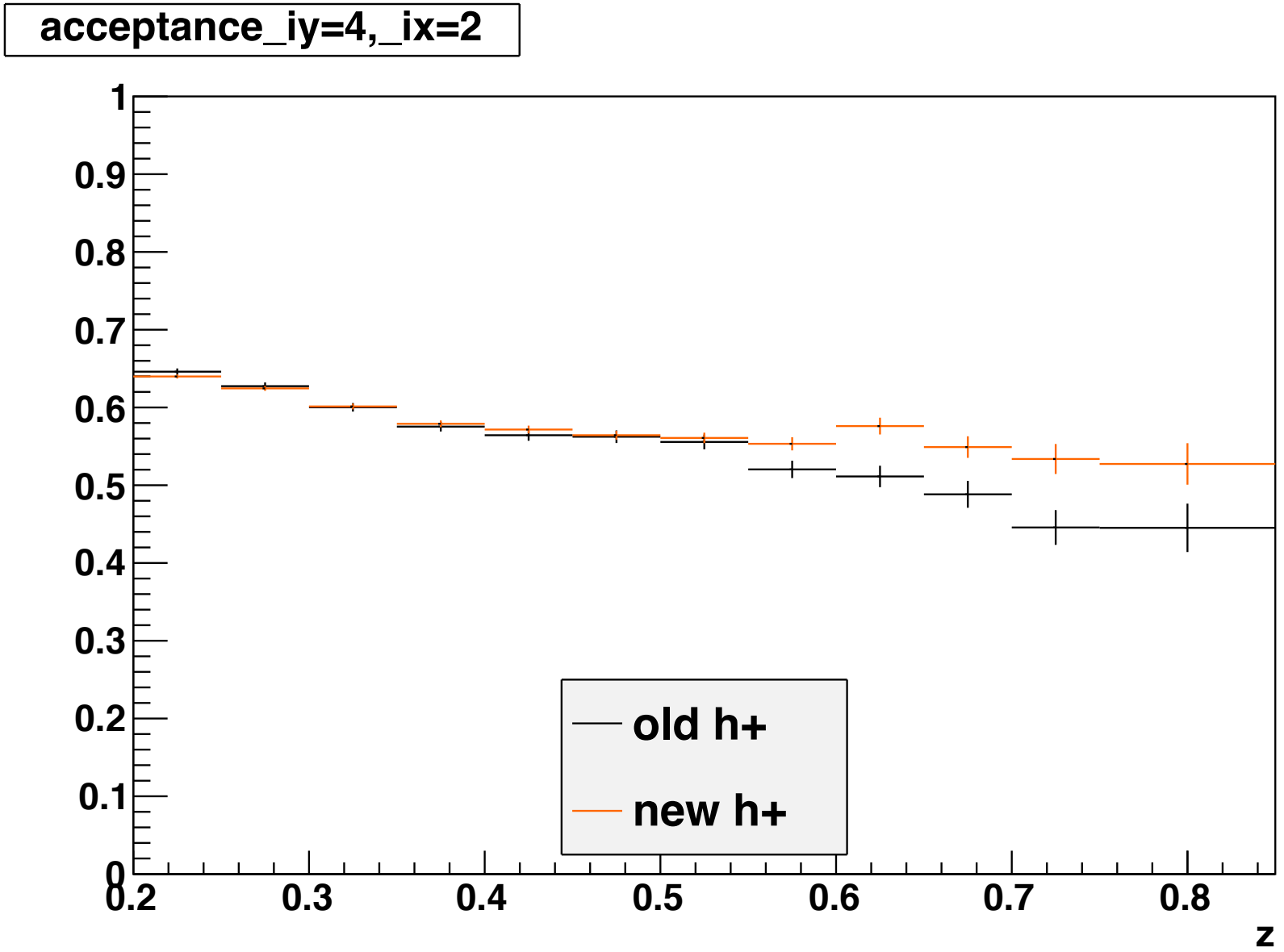
Comparison Old/New for h^+



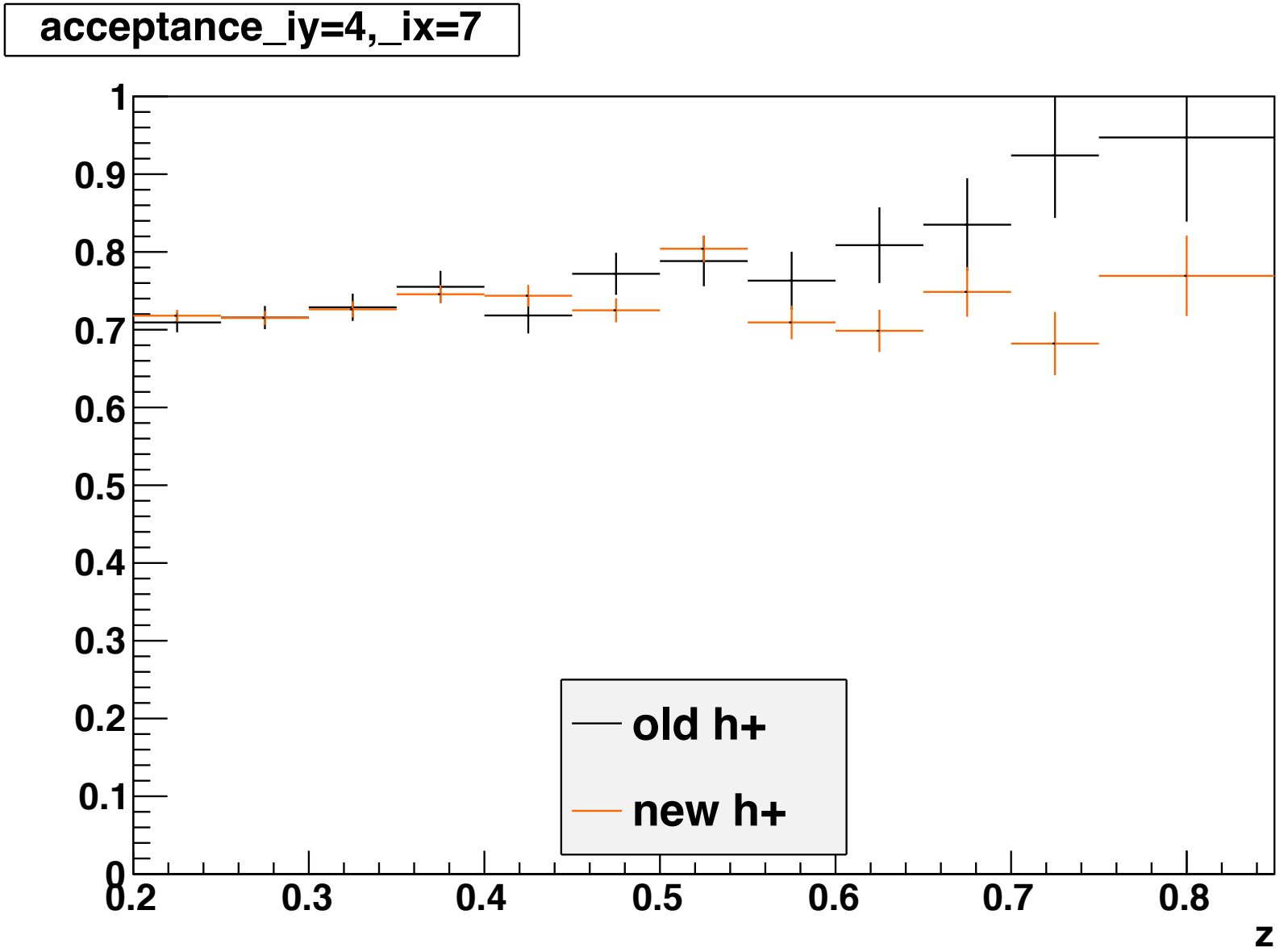
New for $h^{+/-}$ with muon acceptance



Closer Look 2,4



Closer Look 7,4



Acceptance Comparison

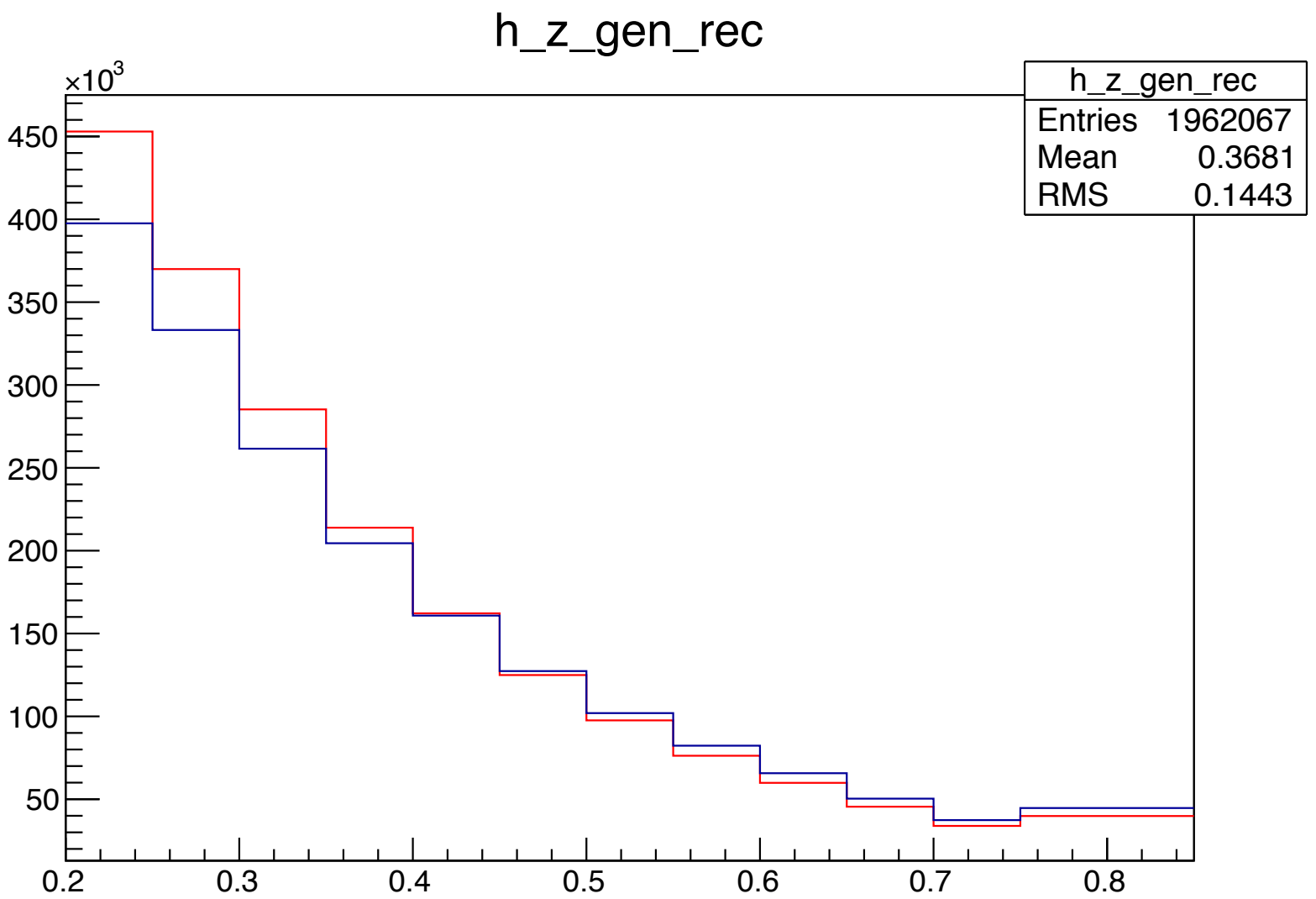
$$Acc = \frac{N_{h\_rec}/N_{DIS\_rec}}{N_{h\_gen}/N_{DIS\_gen}} = \frac{N_{h\_rec}(z)}{N_{h\_gen}(z)} \cdot \frac{N_{DIS\_gen}}{N_{DIS\_rec}}$$

vs.

$$Acc = \frac{N_{h\_rec}(z)(\text{from rec DIS})}{N_{h\_gen}(z)(\text{from rec DIS})}$$

Where the blue numbers are the same!
Why do we see a z-dependence?
Looking at acceptance(ϕ_μ) in correlation of the hadron angle and z
Under construction, discussion with DVH

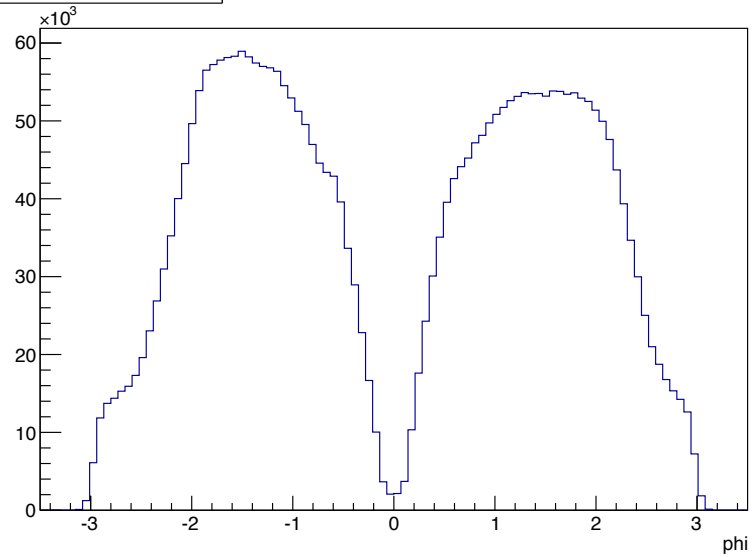
gen vs genrec



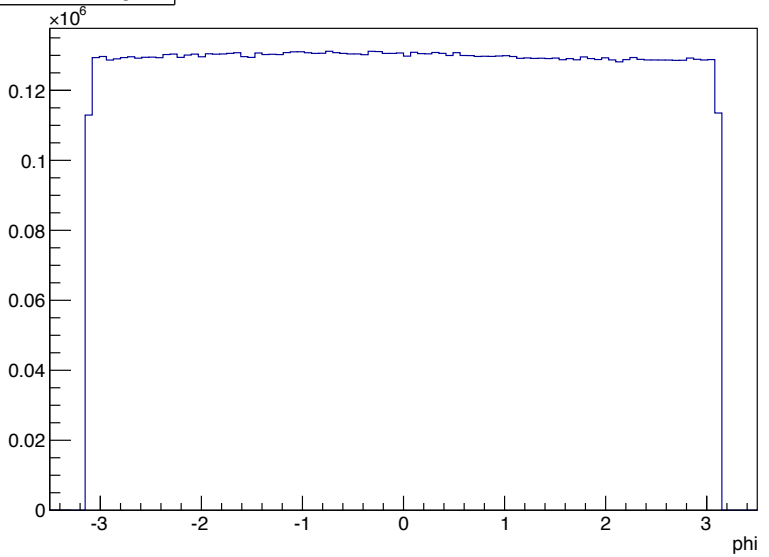
gen_rec and gen(scaled)

Muon Phi Distribution

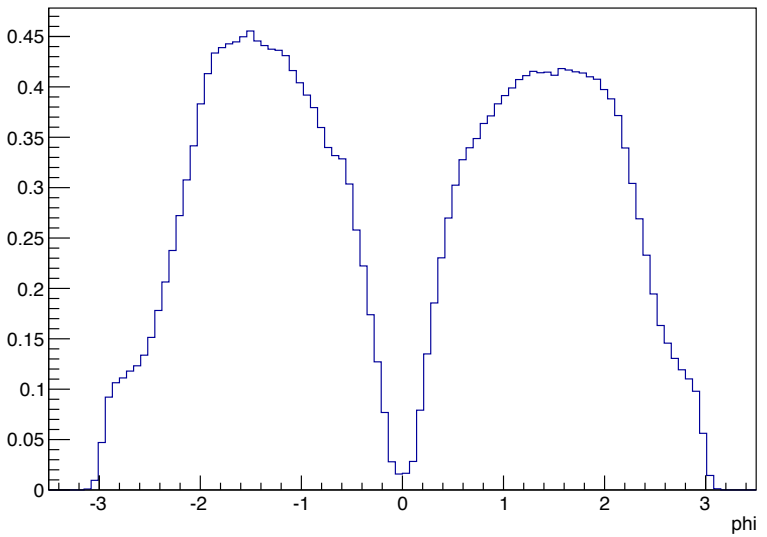
Reconstructed phi



Generated phi



Acceptance phi



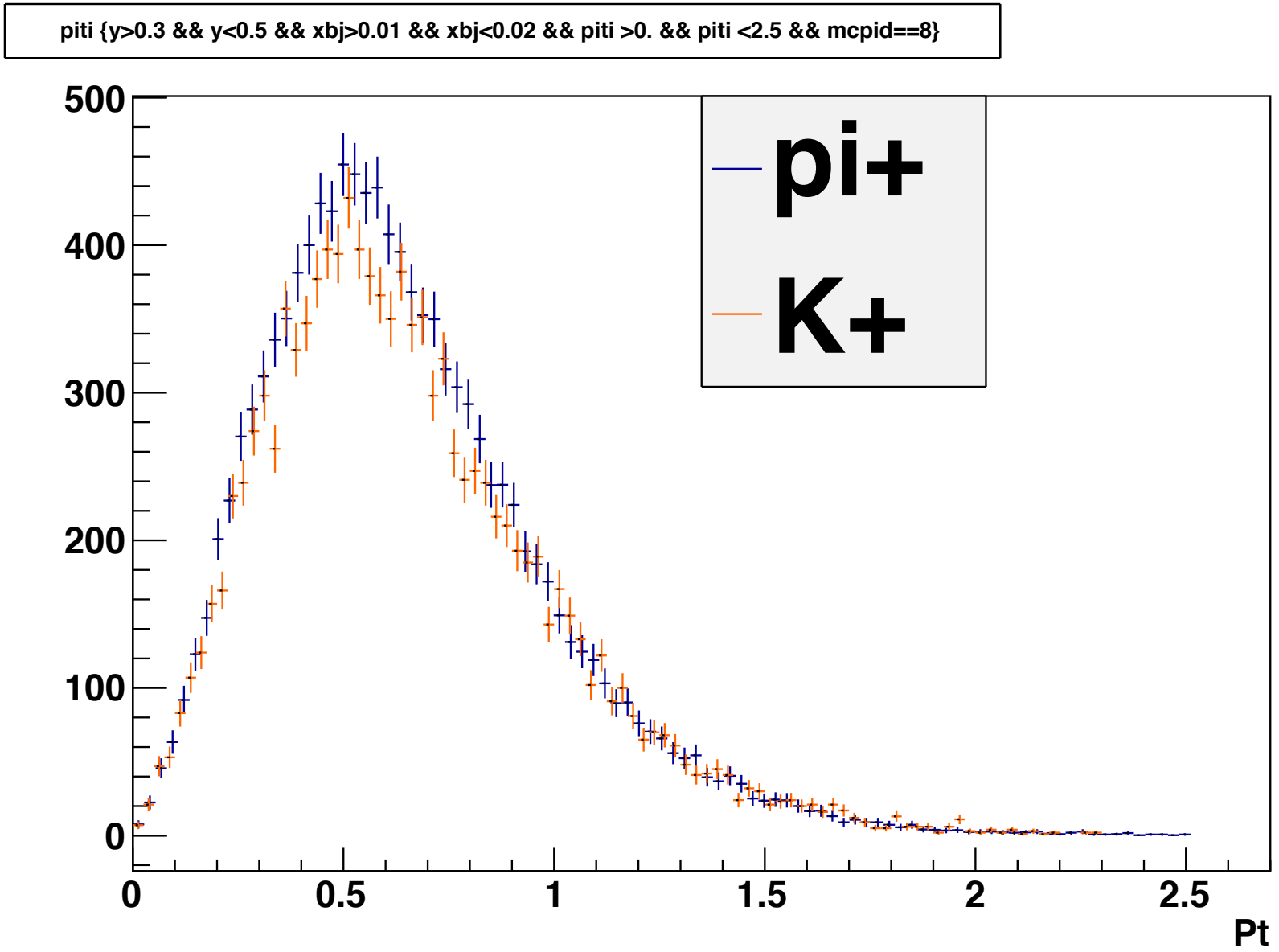
Using Only $h^{+/-}$ Acceptance

RICH not simulated in MC
Track reconstruction not sensitive on PID (p, K, π)
Using different P_h cuts (in GeV)

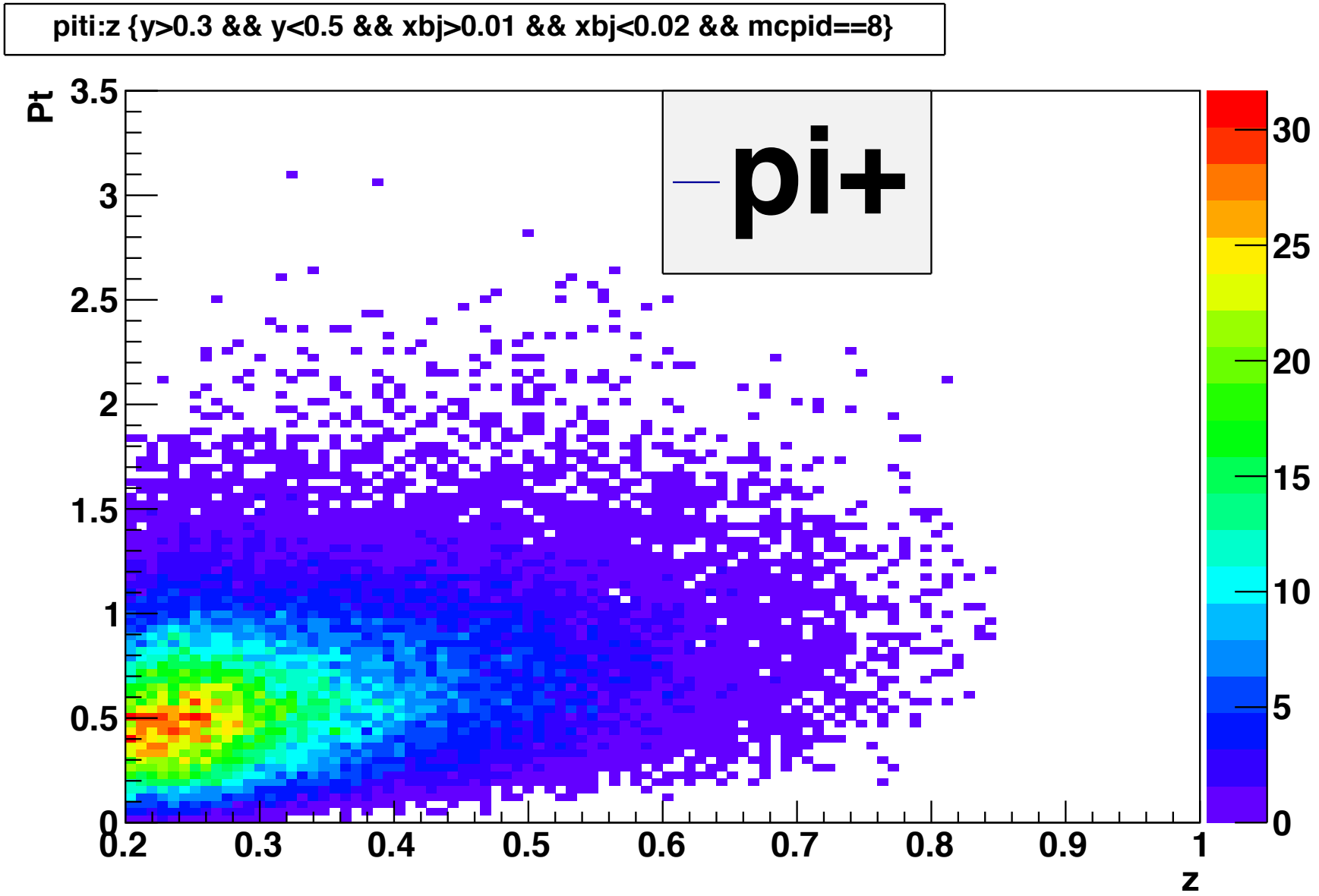
$10 < P_\pi < 40$ und $12 < P_K < 40$

Using unidentified hadron acceptance (10-40 GeV) for h and π
and unidentified hadron acceptance (12-40 GeV) for K

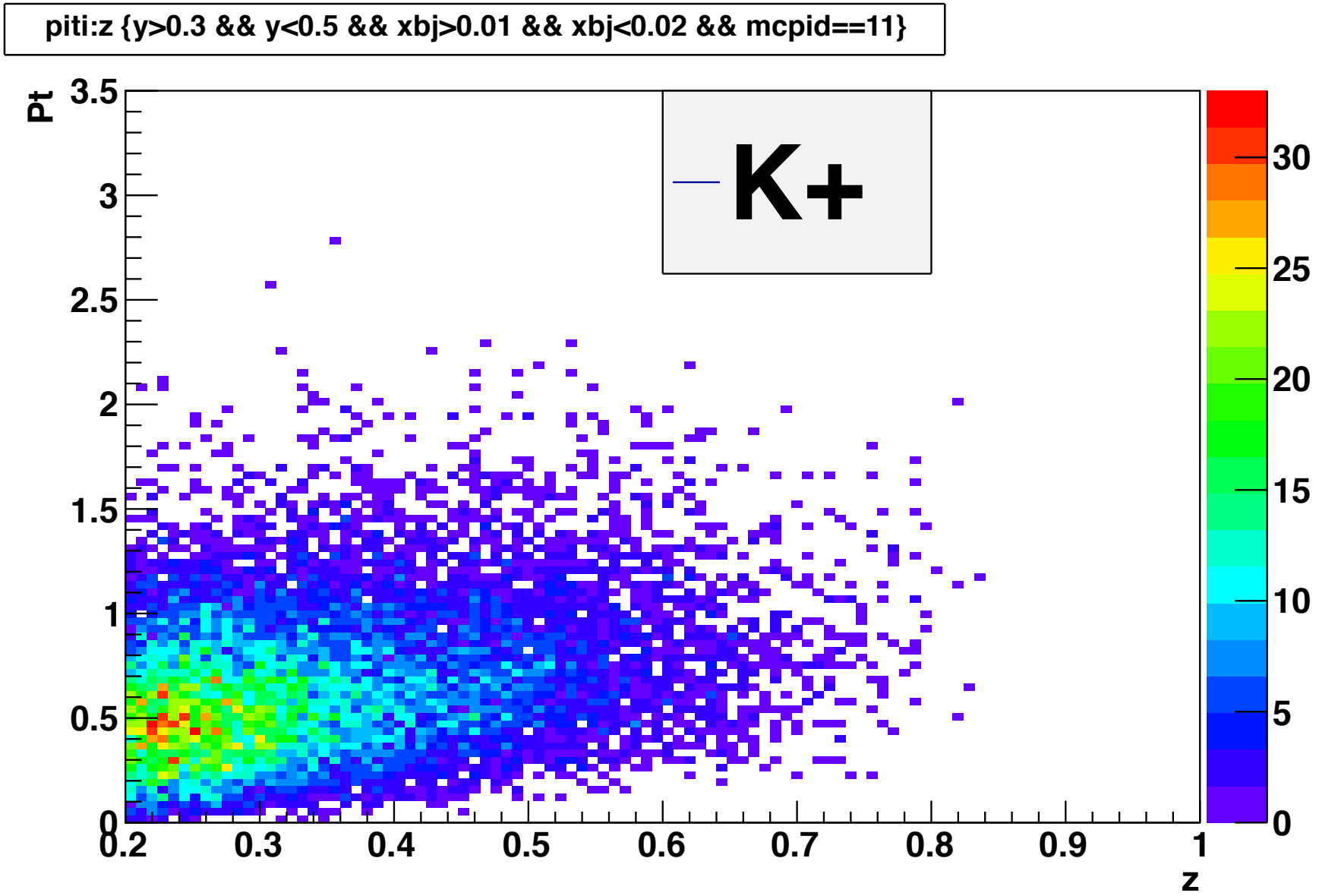
Pt of Pions and Kaons



Pt vs. z for Pions



Pt vs. z for Kaon



Multiplicites

- Factorisation theorem
- SIDIS cross section in leading-twist

Hard scattering cross section
Parton distribution function
Fragmentation functions

$$\sigma^{\mathrm{h}} = \sum_i \sigma^0 \cdot q_i(x) \cdot D_i^h(z, Q^2)$$

Extraction of FF from hadron multiplicities

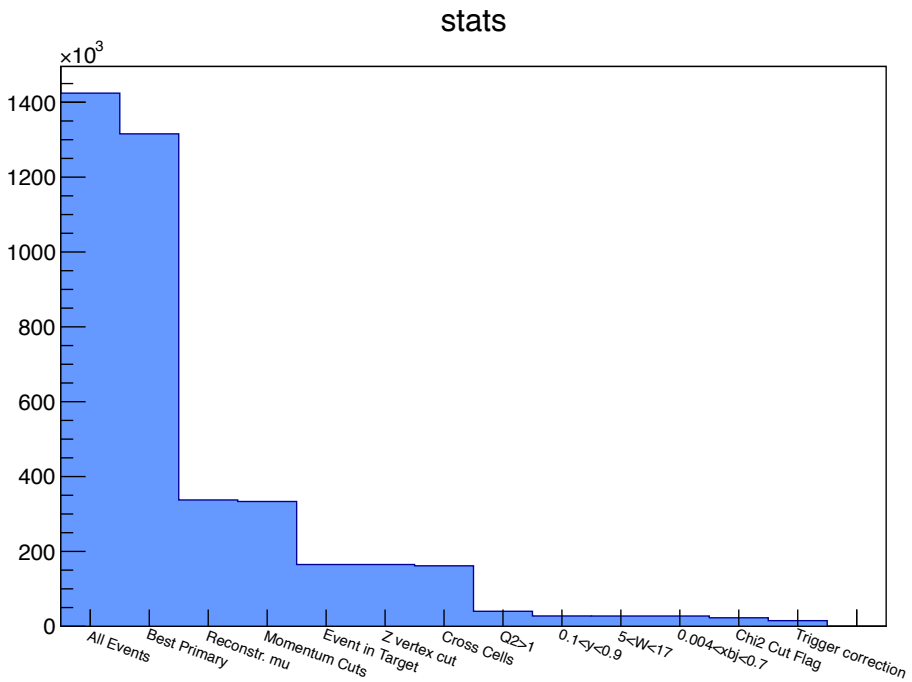
$$M^h(x, Q^2, z) = \frac{1}{\sigma^{DIS}} \frac{d\sigma^h}{dx\, dz\, dQ^2} = \frac{\sum_q e_q^2\, q(x, Q^2)\, D_q^h(z, Q^2)}{\sum_q e_q^2\, q(x, Q^2)}$$

Depends on the unpolarised parton distribution functions $q(x, Q^2)$

DIS Selection

- Rescale momentum function
- Best primary vertex with
  - PaAlgo::InTarget()
  - Target Cells Z cut -59 to -33, -20 to 32 and 39 to 67 (all cm)
  - PaAlgo::CrossCells()
- Outgoing μ' Incoming μ
- 140 < Beam energy < 180 GeV
- $Q^2 > 1\,\mathrm{GeV}^2$
- 0.1 < y < 0.9
- 5 < W < 17 GeV
- BMS Chi^2 Cut flag
- Middle trigger correction
- Only OT and MT
- Radiative correction PaAlgo::GetRadiativeWeigth(x,y,2)

Stats DIS



- Nick (phast 133): 15008
- Quiela (phast 126): 15009

Hadron Loop

For unidentified hadron candidates:

- Loop over outgoing particles
- Reject μ'
- ZFirst > 350 cm and ZLast > 350 cm
- RICH cuts
  - $0.01 < \theta < 0.12$
  - RICH pipe cut
- PID with RICH
- z cut $0.2 < 0.85$
- momentum cut 10 - 40 GeV for π
- momentum cut 12 - 40 GeV for K

Agree on the raw numbers of π, K and p (± 2)

Summary RICH cuts

Pion

if like(e) > 1.8 like(π)
like(π) > like(K), like(p), like(e), like(bg)
else
like(π) > like(K), like(p), like(bg)
and:
like(π)/like(2cd) > 1.02
like(π)/like(bg) > 2.02

Kaon

if like(e) > 1.8 like(π)
like(K) > like(π), like(p), like(e), like(bg)
else
like(K) > like(π), like(p), like(bg)
and:
like(K)/like(2cd) > 1.08
like(K)/like(bg) > 2.08

Summary RICH cuts

Proton

above threshold:
if like(e) > 1.8 like(π)
like(p) > like(π), like(K), like(e), like(bg)
else
like(p) > like(π), like(K), like(bg)

bellow threshold (9.5 - 18.9 GeV):
Not a pion or kaon
and
like(p)/like(2cd) > 1.08
like(p)/like(bg) > 2.08
or
all like = 0

RICH unfolding

Experimental method to extract RICH efficiencies and missidentification
Tagging hadrons from known decays

$\Lambda^0 \to p + \pi^-$ for protons, $K_s^0 \to \pi^+ + \pi^-$ for pions and $\phi \to K^+ + K^-$ for kaons

RICH table example

- $\pi^+ \to \pi^+ \approx 98\%$
- $\pi^+ \to K < 2\%$
- $\pi^+ \to p < 1\%$

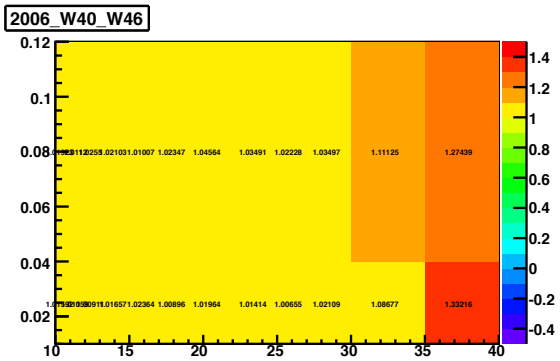
Hadron momentum dependence

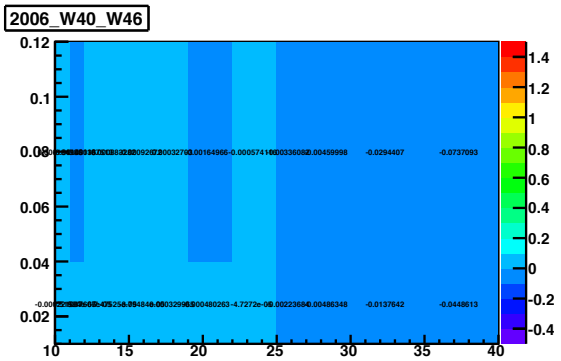
$$\begin{pmatrix} I_\pi \\ I_K \\ I_p \end{pmatrix} = \begin{pmatrix} P_\pi^\pi & P_K^\pi & P_p^\pi \\ P_\pi^K & P_K^K & P_p^K \\ P_\pi^p & P_K^p & P_p^p \end{pmatrix} \begin{pmatrix} T_\pi \\ T_K \\ T_p \end{pmatrix}$$

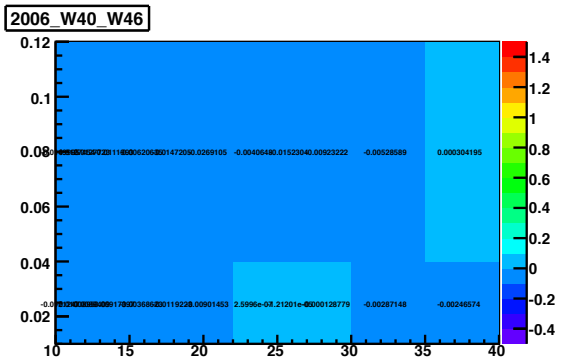
$$\vec{T} = \vec{I} \cdot P^{-1}$$

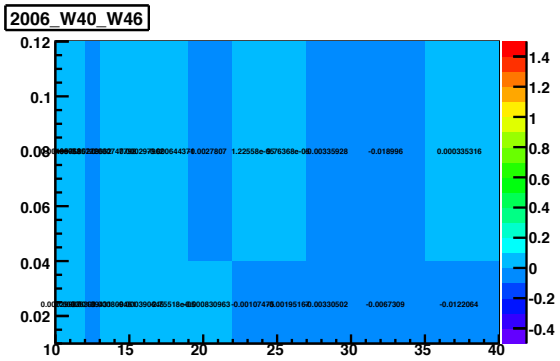
Inverting 3x3 matrices for each bin (2 x 12 x 2)

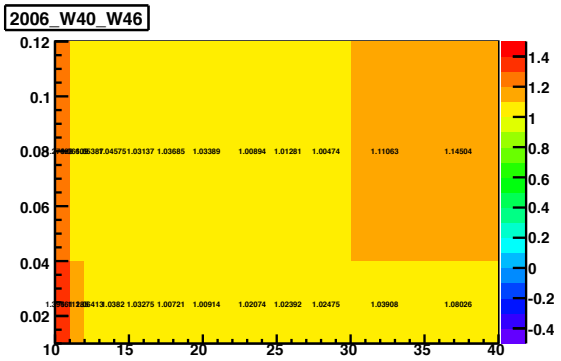
Inverted RICH table^{+}

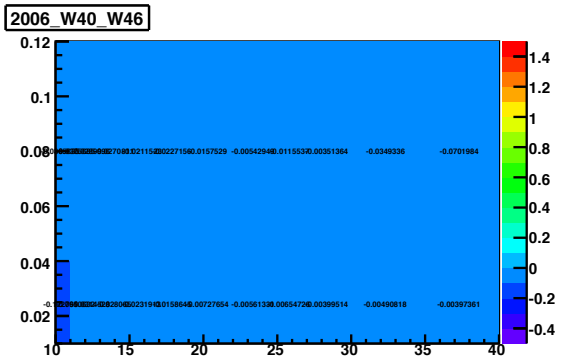


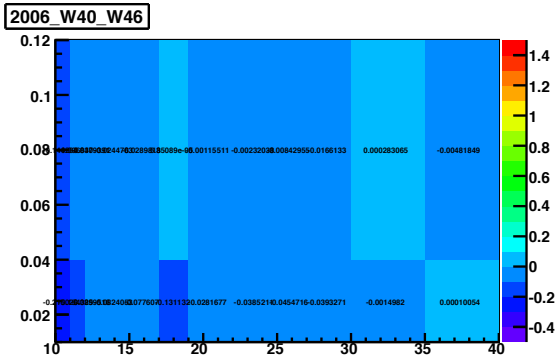


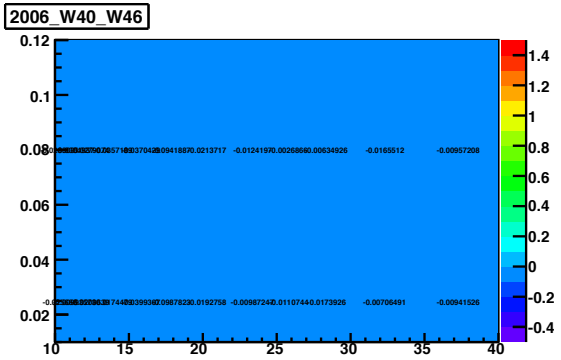


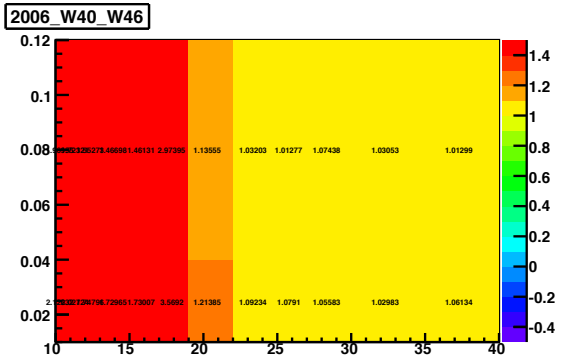




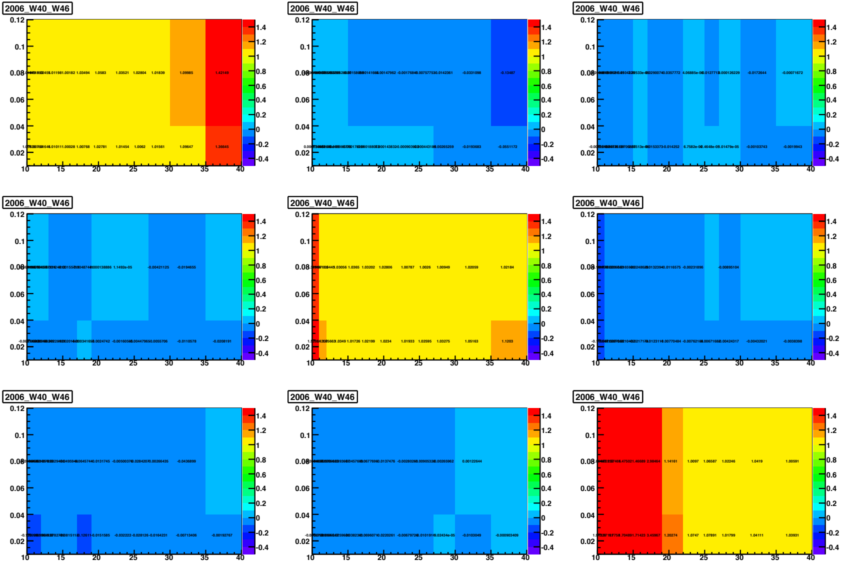








Inverted RICH table⁻



Real number of Hadrons

RICH unfolding:
true π = $\pi \cdot P^{-1}(\pi \rightarrow \pi)$ + K $\cdot P^{-1}(\pi \rightarrow K)$ + proton $\cdot P^{-1}(\pi \rightarrow proton)$

...
...

Radiative correction:
Weighting each hadron with PaAlgo::GetRadWeight(x,y,2)

Hadron acceptance:
Already discussed

$H = H \cdot rich(inv) \cdot RAD \cdot \frac{1}{acc}$