Status of the secondary target for the hypernuclear experiment
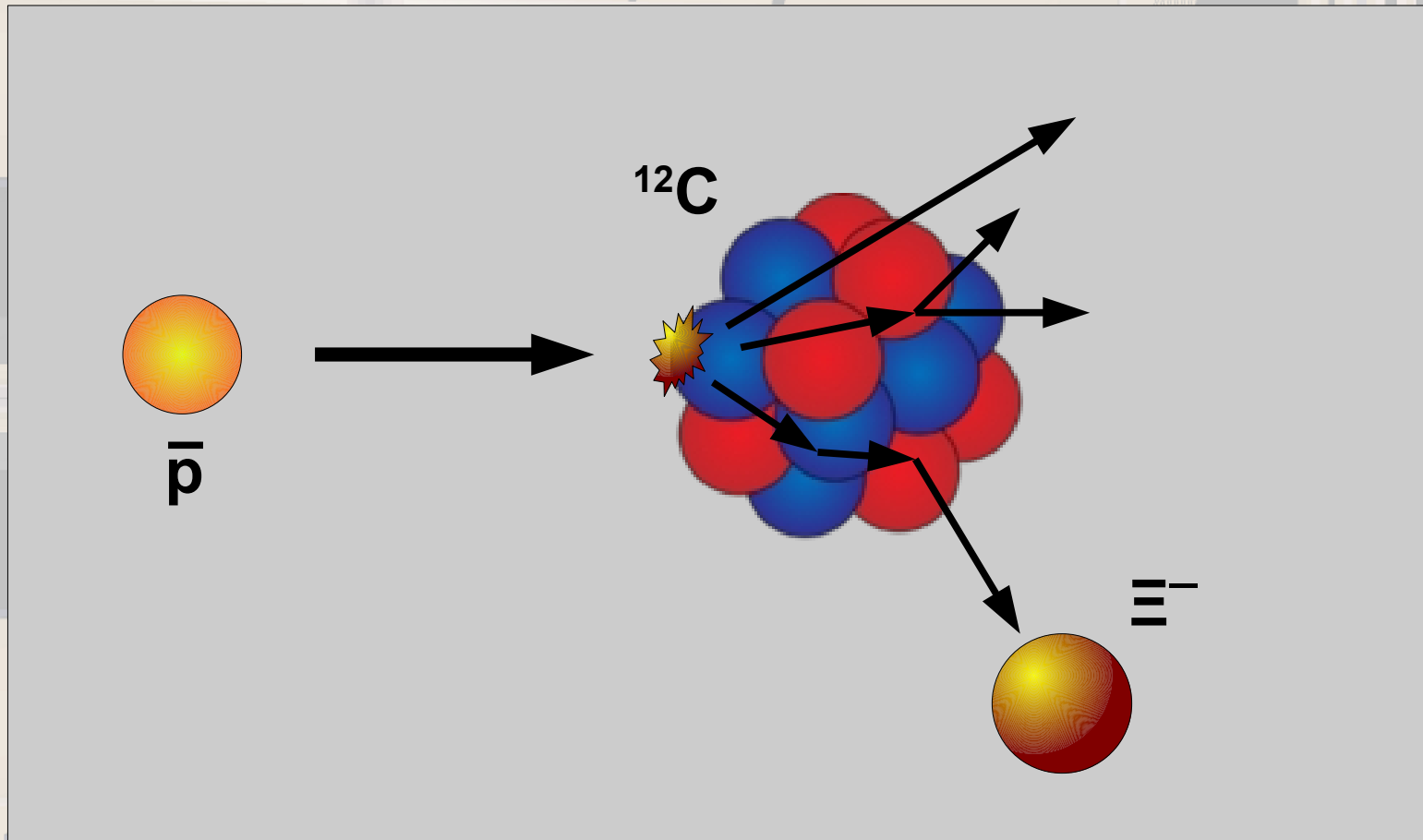
Sebastian Bleser

Helmholtz-Institut Mainz
Johannes Gutenberg-Universität

PANDA-Meeting September 8th, 2015
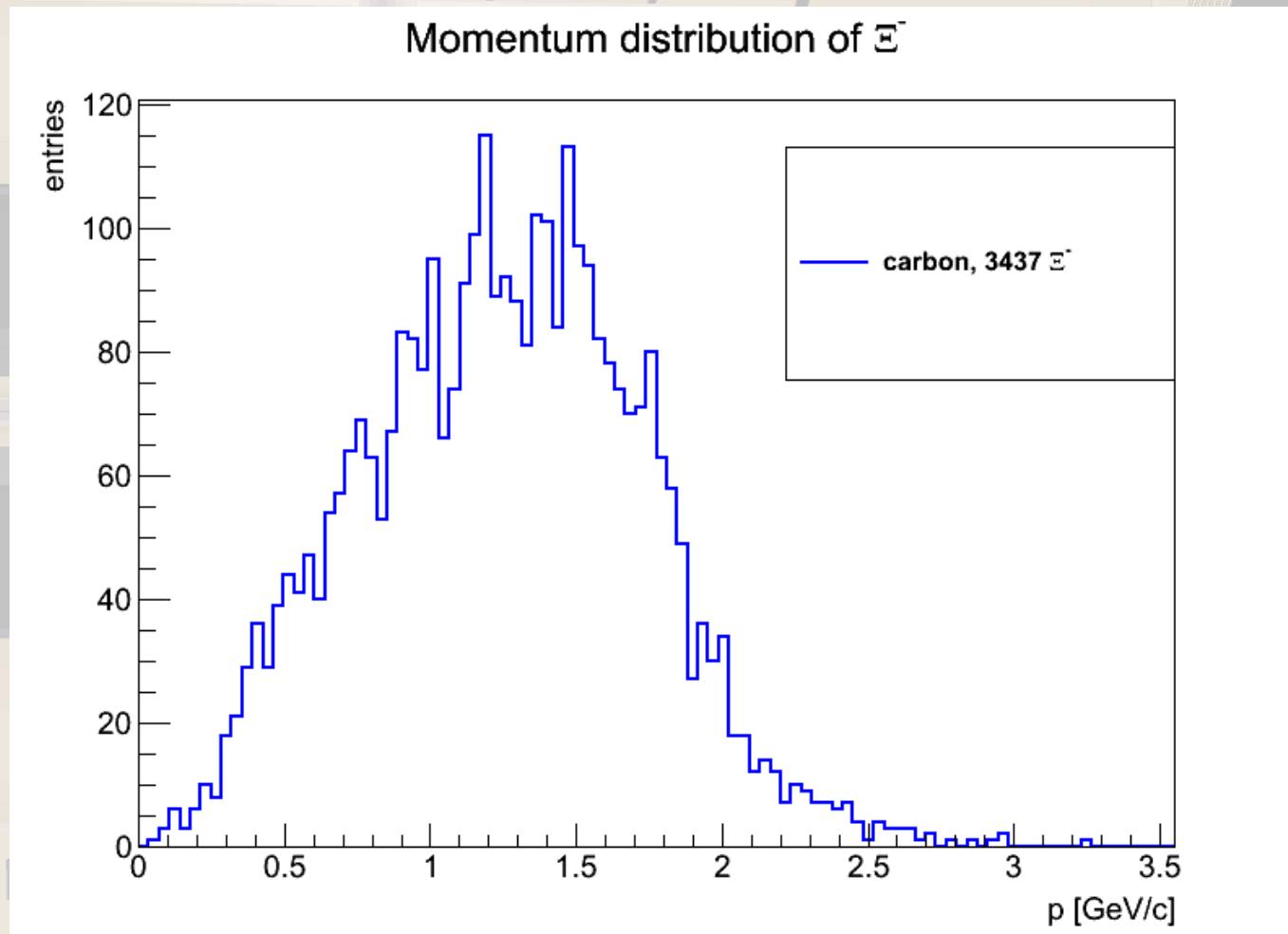
HELMHOLTZ | GEMEINSCHAFT

Helmholtz-Institut Mainz

Primary reaction

Primary reaction

Momentum distribution of Ξ^-

carbon, 3437 Ξ^-

HELMHOLTZ | GEMEINSCHAFT

Helmholtz-Institut Mainz

Simulation of Ξ^- in geometry

Geant4 simulation with Ξ^- from GiBUU / generator with parametrized events

absorber layers
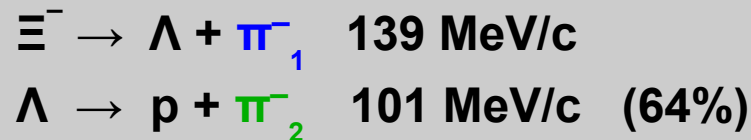
sensor layers

absorber in corners

absorber window

target chamber

10.0

y

x

Desired case: Ξ^- stopped in absorber

Simulation of Ξ^- in geometry

absorber layers

sensor layers

absorber in corners

absorber window

target chamber

10.0

y

x

π^-_1

π^-_2

Bad case: Ξ^- decay

$\Xi^- \rightarrow \Lambda + \pi^-_1$ 139 MeV/c

$\Lambda \rightarrow p + \pi^-_2$ 101 MeV/c   (64%)

HELMHOLTZ | GEMEINSCHAFT

Helmholtz-Institut Mainz

Simulation of Ξ^- in geometry

Ξ^- from our generator

Geant4 simulation with our geometry

Passage of Ξ^-, decay in flight or at rest after stopping in volumes ≠ absorbers

Passage of Ξ^-, stopping in absorbers

Placing of $^{11}_{\Lambda\Lambda}Be$ at the stopping points
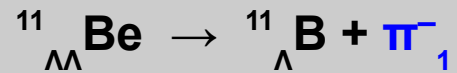
Detection of $^{11}_{\Lambda\Lambda}$Be

Concept: Pion tracking

Simulation steps:

- **phase space decay by Geant4**

$$^{11}_{\Lambda\Lambda}\text{Be} \rightarrow {}^{11}_{\Lambda}\text{B} + \pi^-_1$$

$$^{11}_{\Lambda}\text{B} \rightarrow {}^{11}\text{C} + \pi^-_2$$
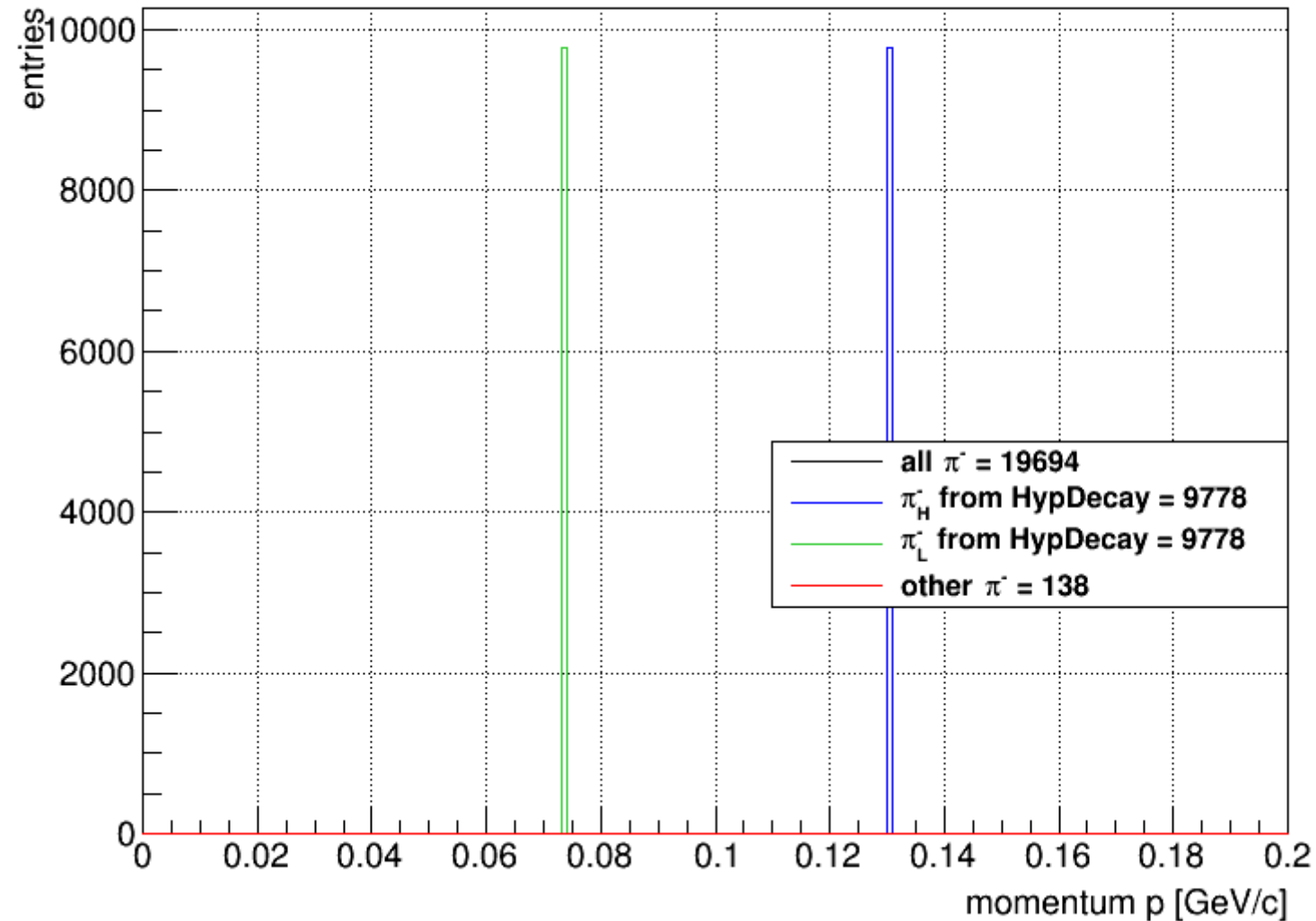
- **smearing of the pion points in sensors with spatial resolution**

- **track finding and track fitting for π^-_1 and π^-_2**

- **momentum reconstruction**
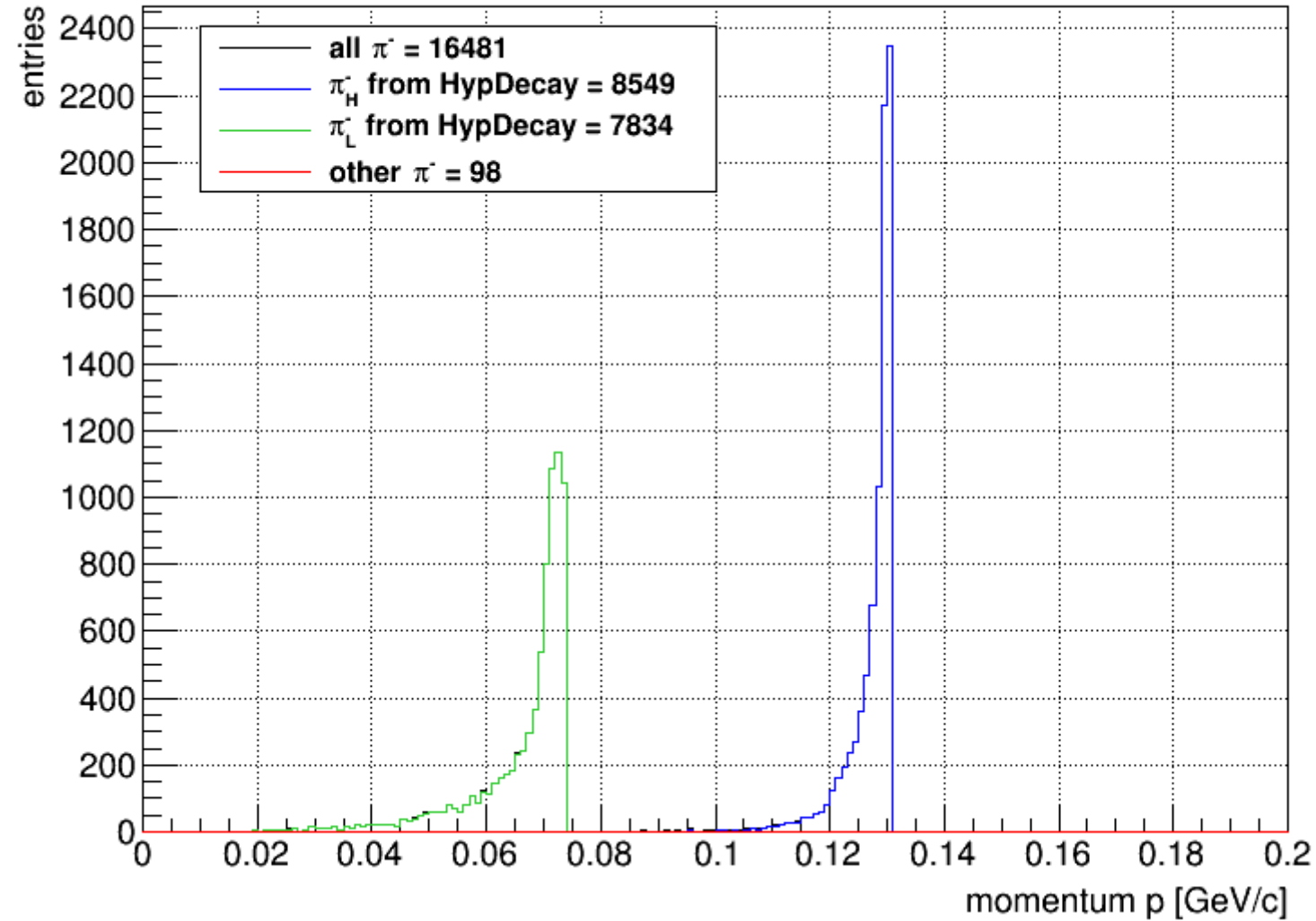
expected momentum distribution:

HELMHOLTZ | GEMEINSCHAFT

Helmholtz-Institut Mainz
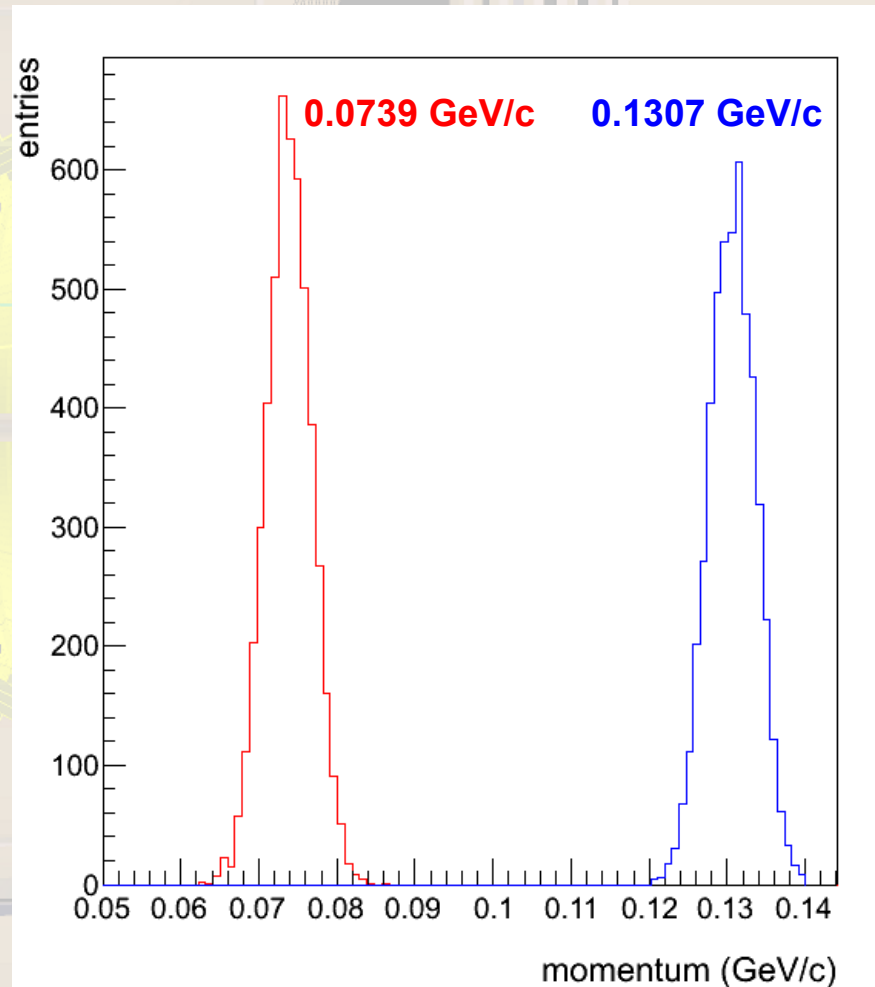
Simulation result at π⁻ vertex

Simulation result at first π⁻ point

Simulation result of π⁻ points

Simulation of Ξ^- in geometry

absorber layers

sensor layers

absorber in corners

absorber window

π^-_1

π^-_2

10.0

x

y

target chamber

HELMHOLTZ | GEMEINSCHAFT

Helmholtz-Institut Mainz

Pion tracking result

Reconstructed momenta for all pions:

result
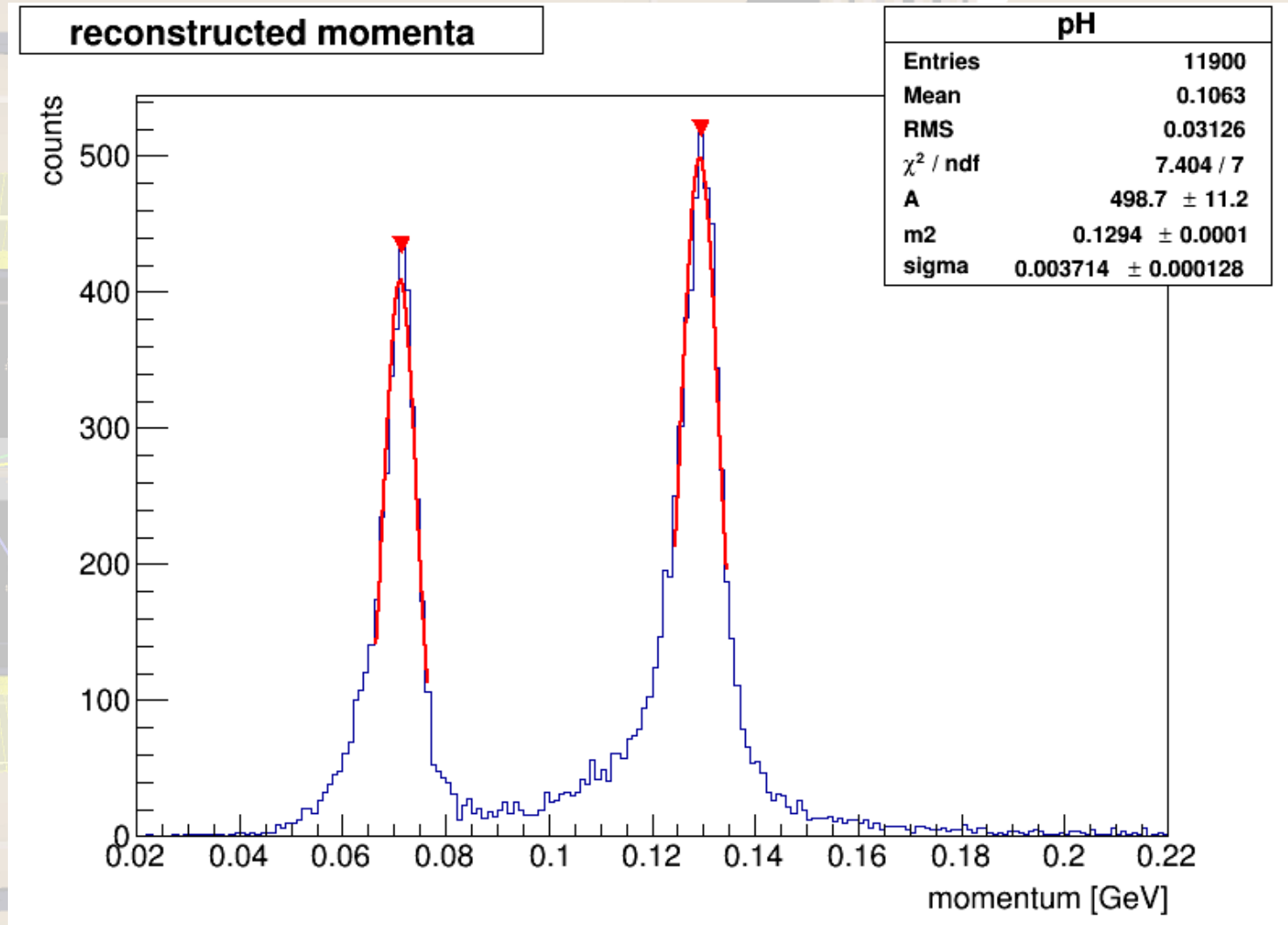
p_1 = 129.39 MeV/c

p_2 = 71.26 MeV/c

res_1 = 6.7 %

res_2 = 10.7 %

efficiency = 58.6 %

reconstructed momenta

pH	
Entries	11900
Mean	0.1063
RMS	0.03126
χ^2 / ndf	7.404 / 7
A	498.7 ± 11.2
m2	0.1294 ± 0.0001
sigma	0.003714 ± 0.000128

momentum [GeV]

HELMHOLTZ | GEMEINSCHAFT
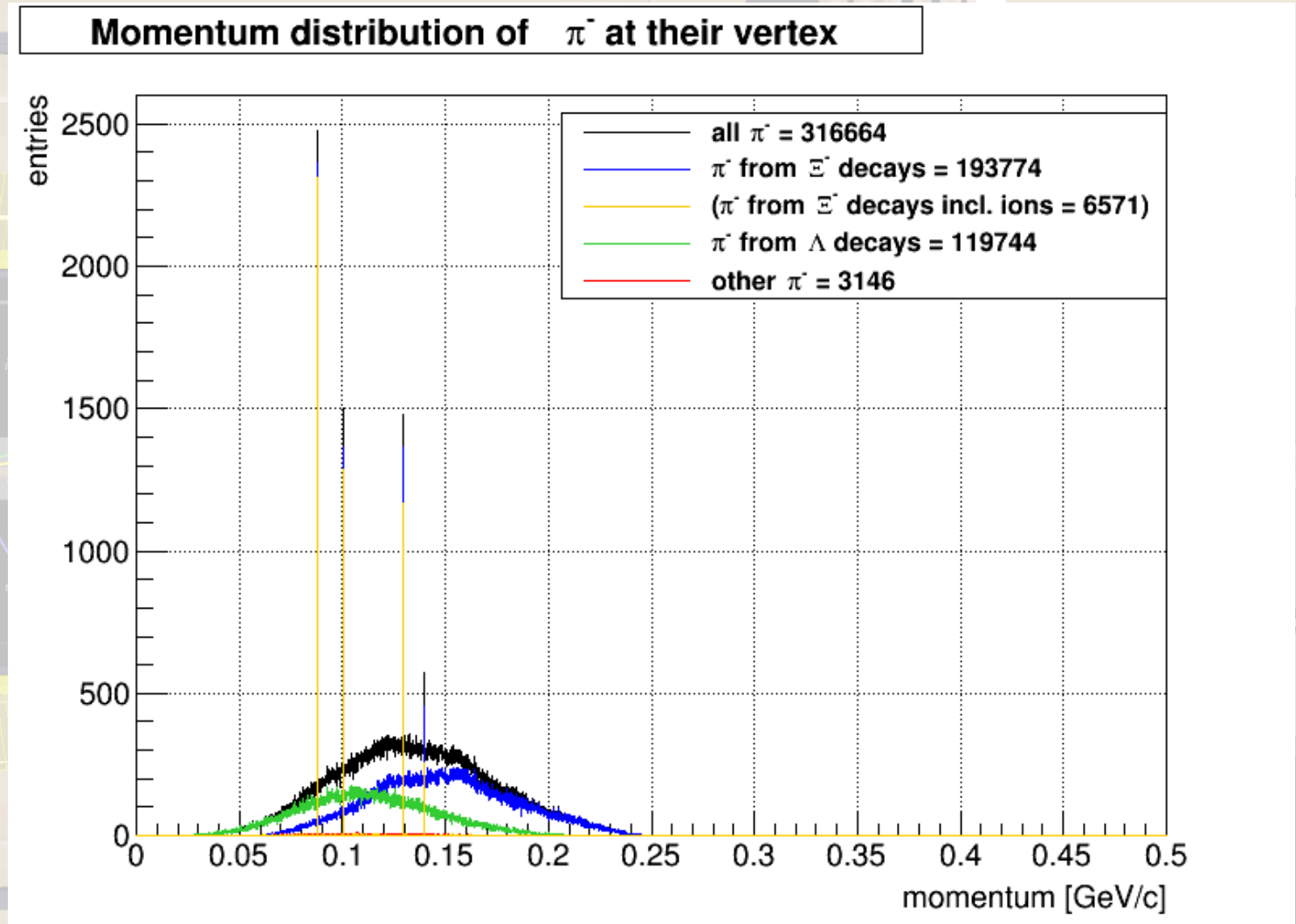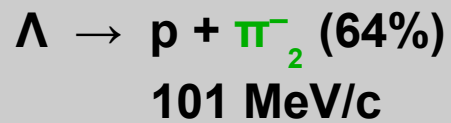
Helmholtz-Institut Mainz

Pion tracking result

Reconstructed momenta for correlated pions:

result

efficiency = 33.3 %

$\pi_L + \pi_H$ correlation

hvtx201	
Entries	3256
Mean x	0.1281
Mean y	0.07103
RMS x	0.01385
RMS y	0.01002

Pion background from Ξ^- decays

Analysis of the Ξ^- simulation result

$\Xi^- \rightarrow \Lambda + \pi^-_1$
139 MeV/c

$\Lambda \rightarrow p + \pi^-_2$ (64%)
101 MeV/c

Momentum distribution of π^- at their vertex

Legend:
- all π^- = 316664
- π^- from Ξ^- decays = 193774
- (π^- from Ξ^- decays incl. ions = 6571)
- π^- from Λ decays = 119744
- other π^- = 3146

x-axis: momentum [GeV/c]
y-axis: entries

Pion background from Ξ^- decays

Analysis of the Ξ^- simulation result

$$\Xi^- \rightarrow \Lambda + \pi^-_1$$

139 MeV/c

$$\Lambda \rightarrow p + \pi^-_2 \ (64\%)$$

101 MeV/c
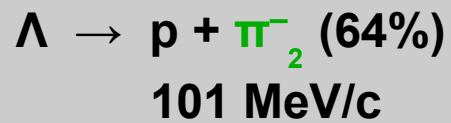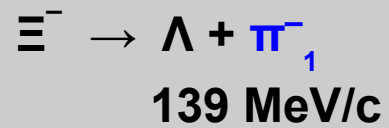
Momentum distribution of incident Ξ^- at 1st layer

- all π^- = 180514
- π^- from Ξ^- decays = 133166
- π^- from Λ decays = 45550
- other π^- = 1798

HELMHOLTZ | GEMEINSCHAFT

Helmholtz-Institut Mainz
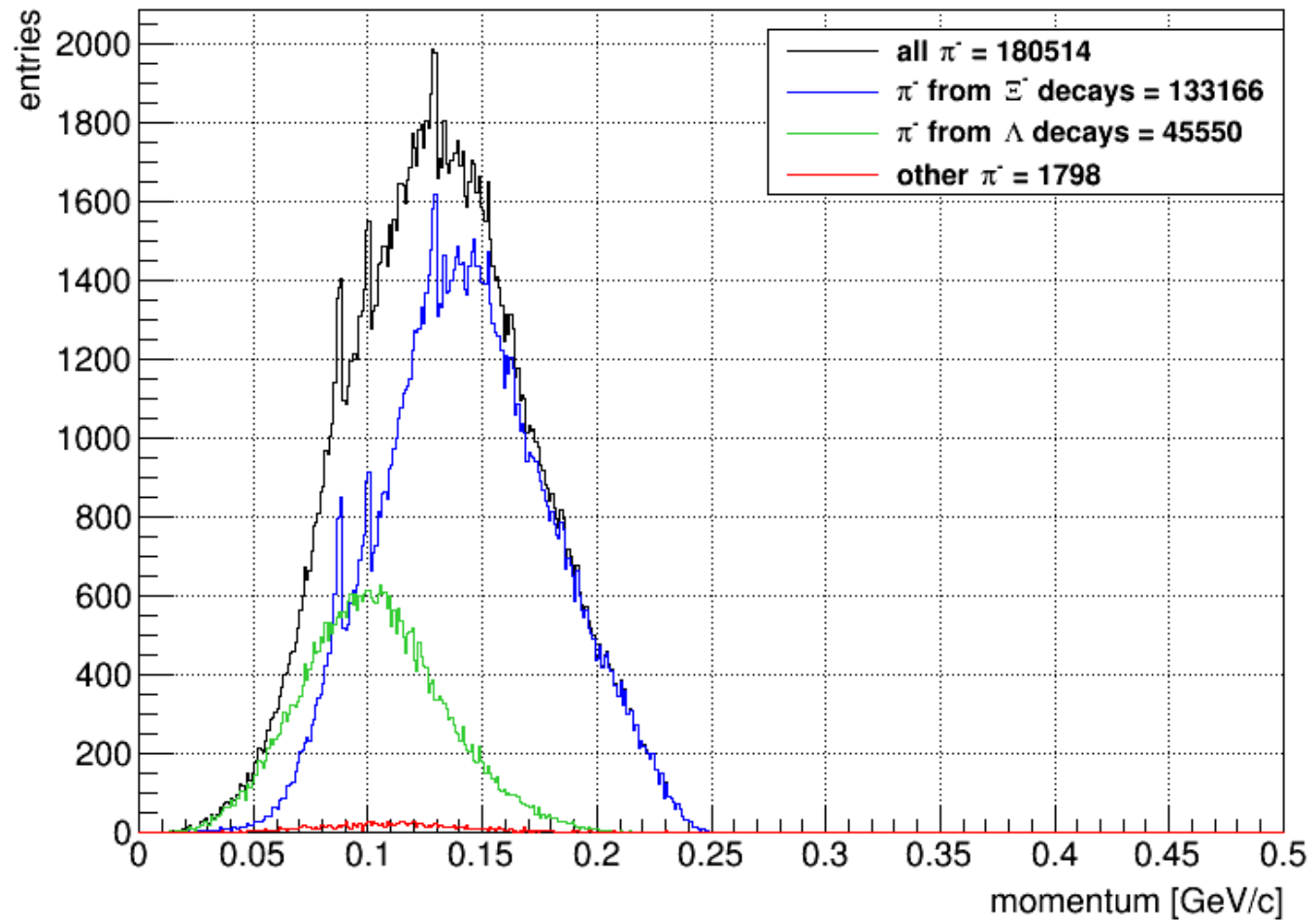
Pion background from Ξ^- decays

Reconstructed momenta for all pions

reconstructed momenta of π^- from Ξ^--Decays and $^{11}_{\Lambda\Lambda}$Be-Decays
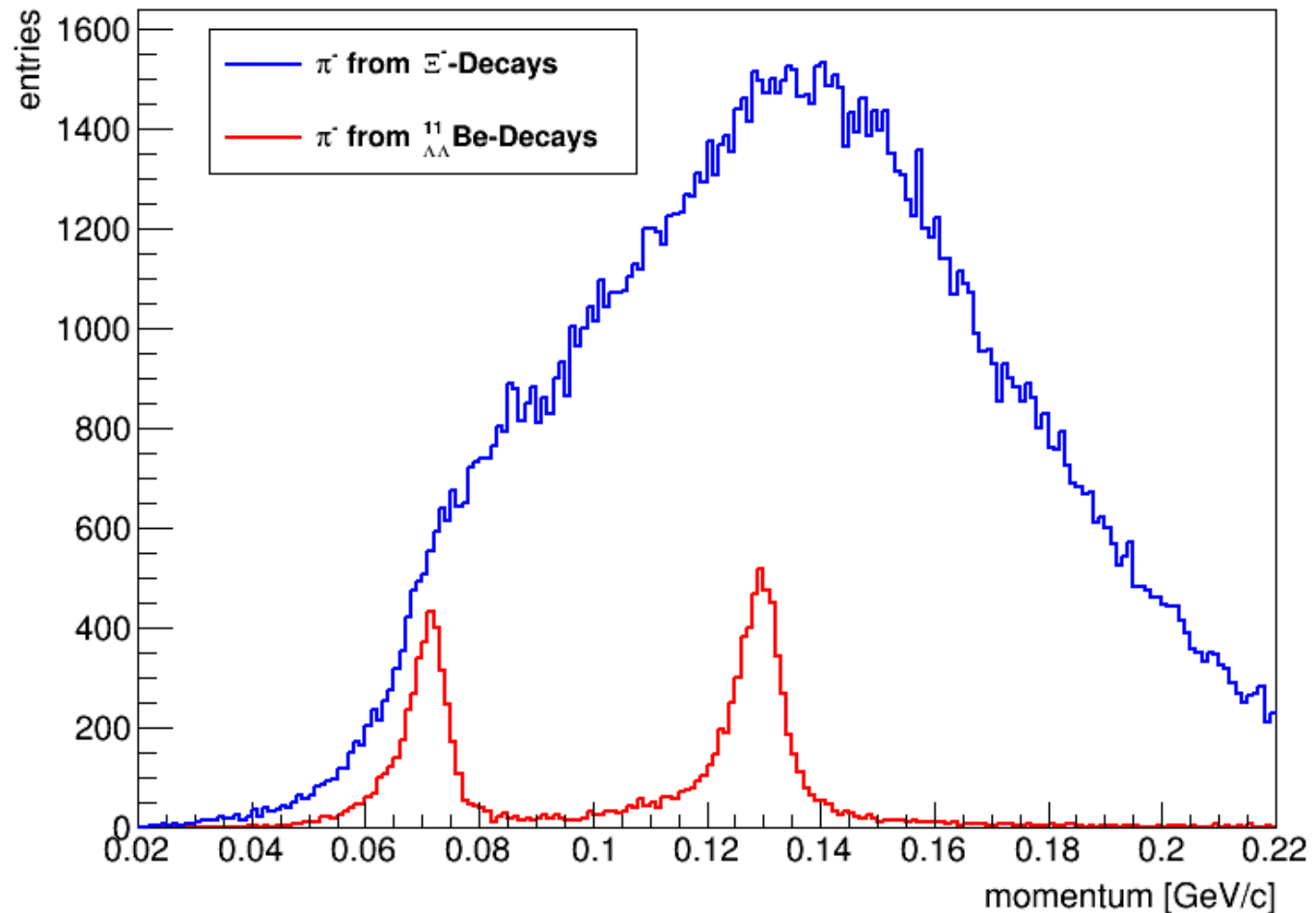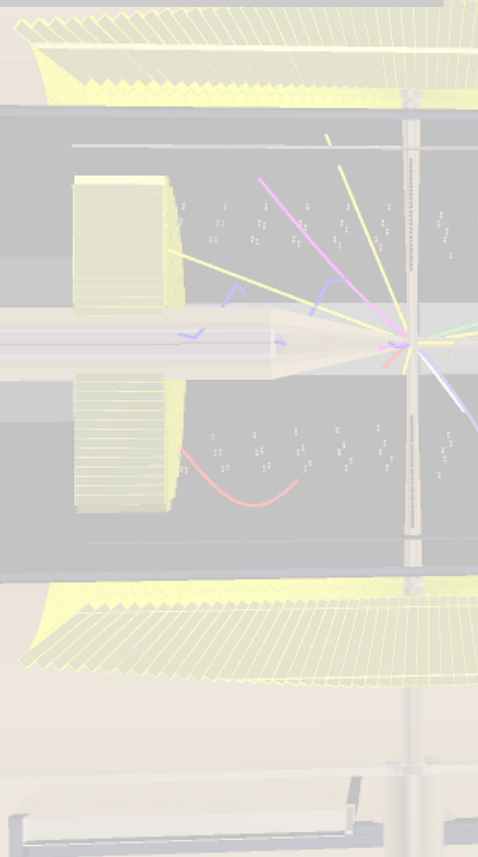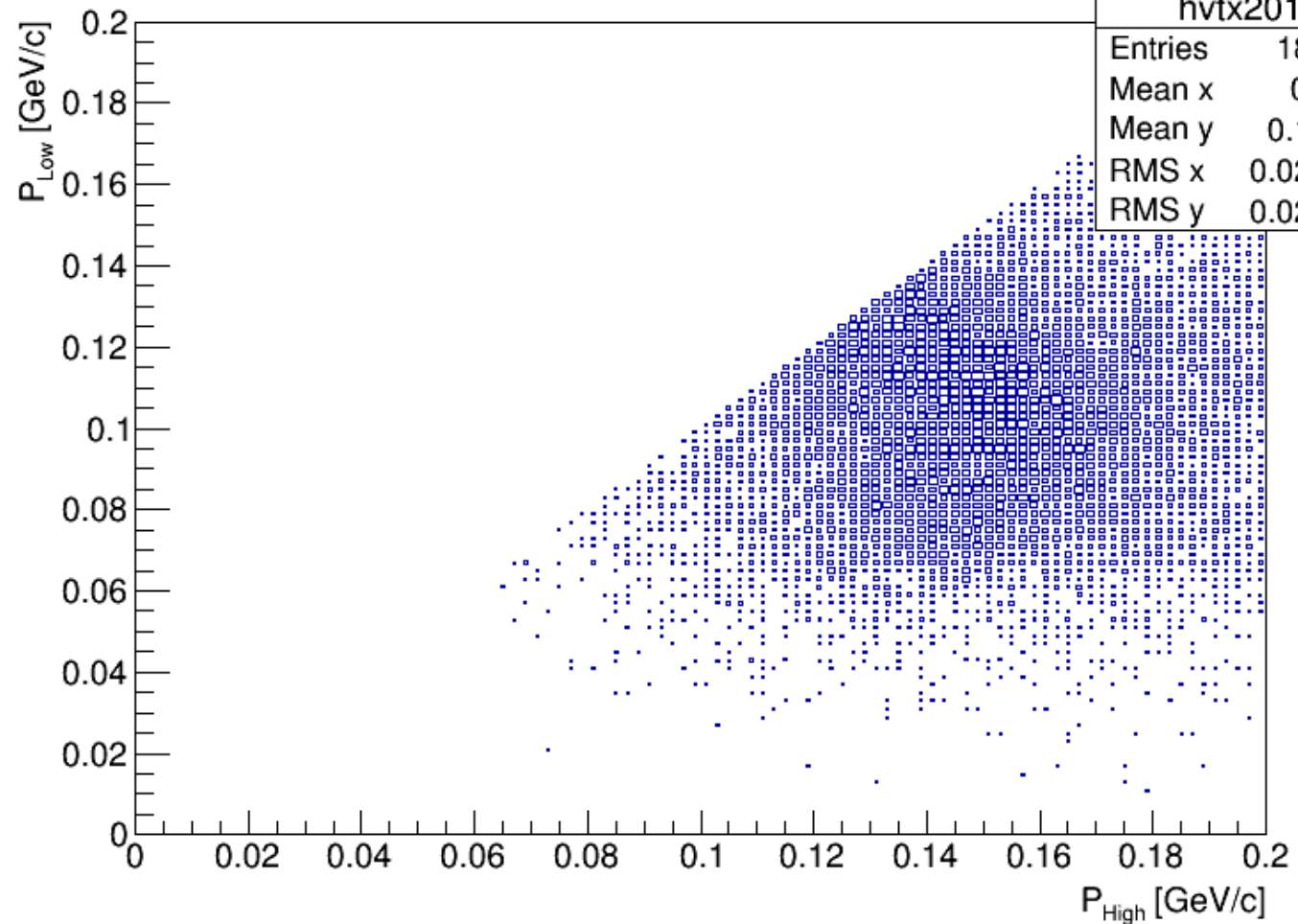
- π^- from Ξ^--Decays
- π^- from $^{11}_{\Lambda\Lambda}$Be-Decays

Pion background from Ξ^- decays
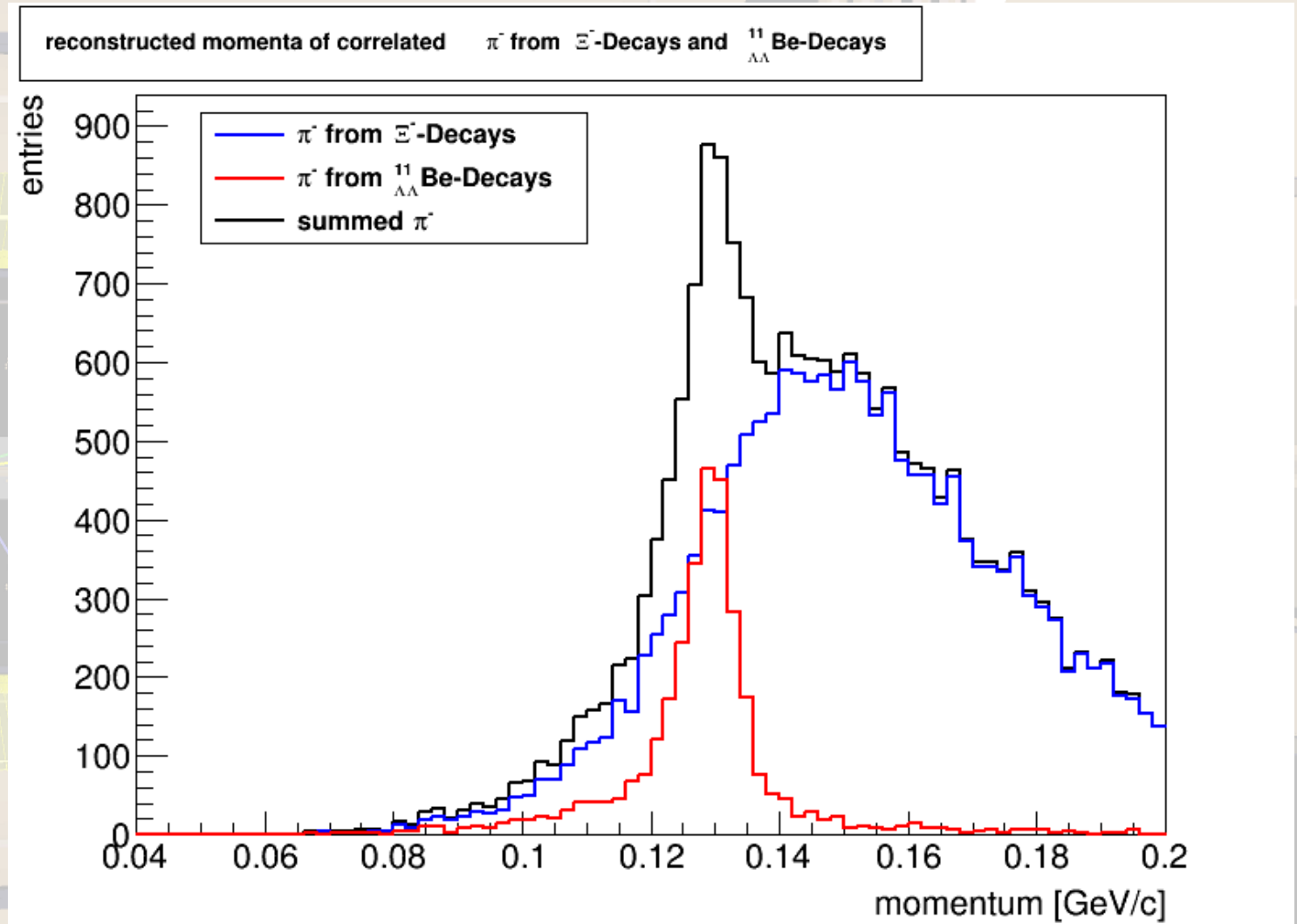
Reconstructed momenta for correlated pions
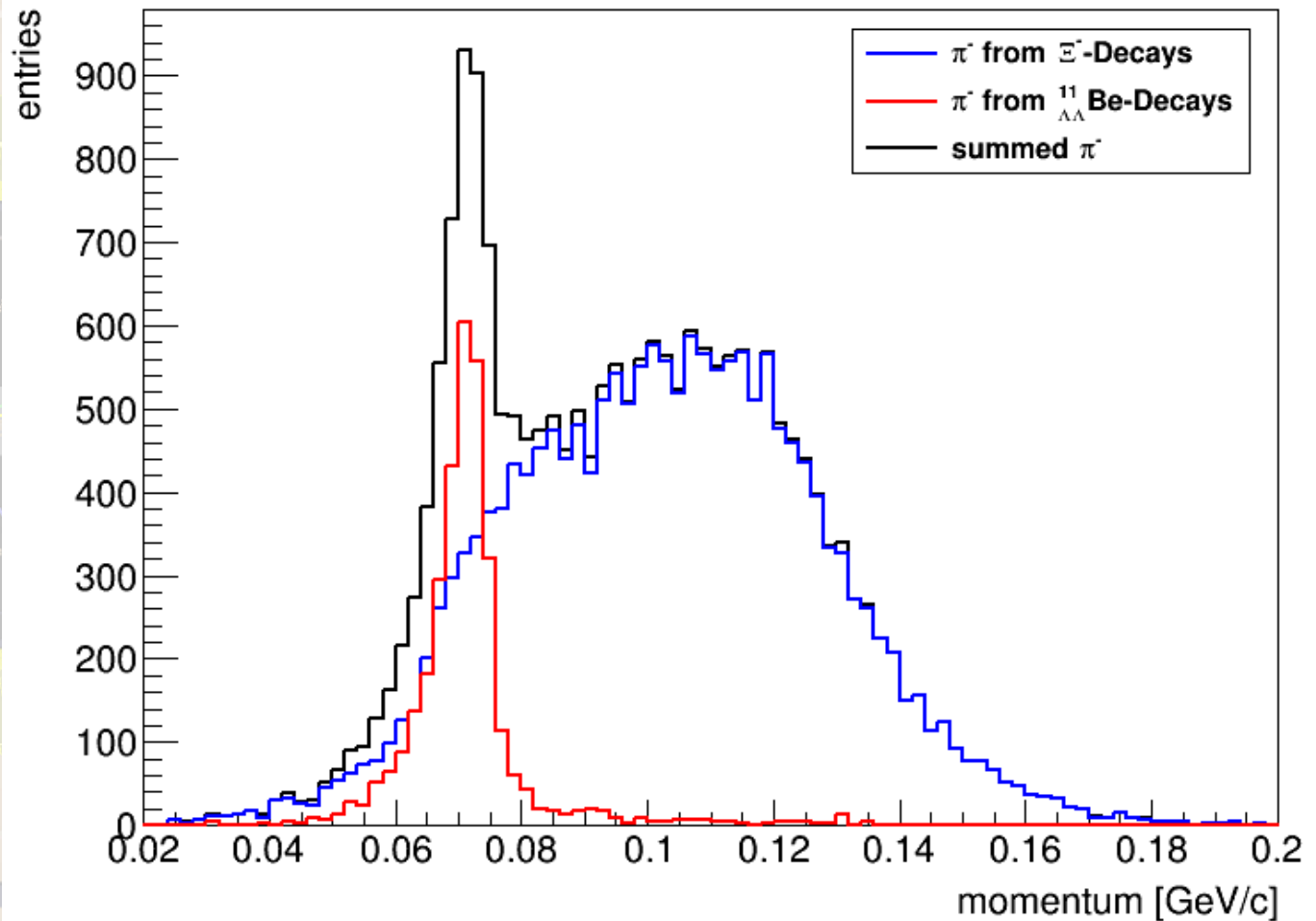
Pion tracking in comparison

Reconstructed momenta for correlated pions in x projection

Pion tracking in comparison

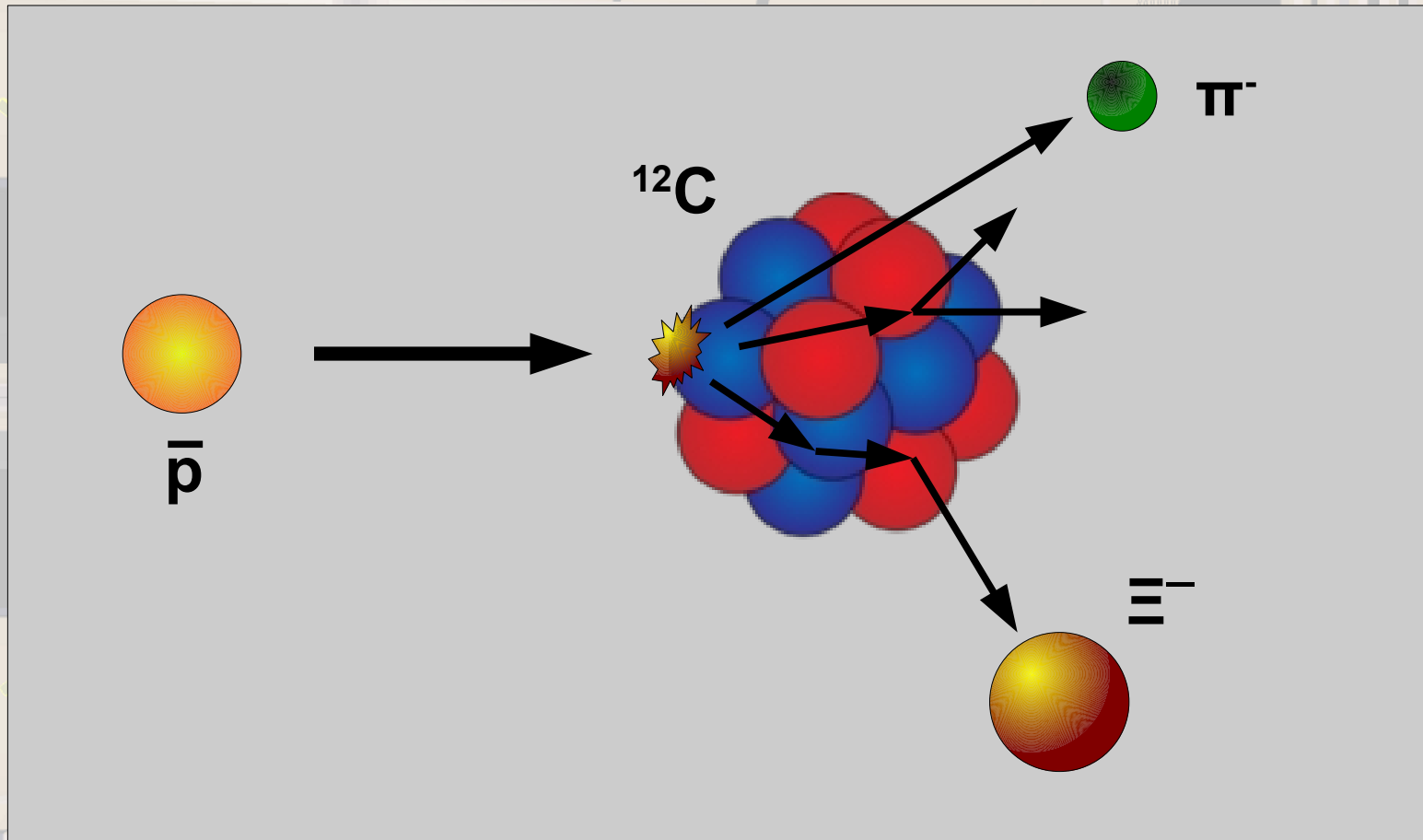**Reconstructed momenta for correlated pions in y projection**

reconstructed momenta of correlated π^- from Ξ^--Decays and $^{11}_{\Lambda\Lambda}$Be-Decays

Legend:
- π^- from Ξ^--Decays
- π^- from $^{11}_{\Lambda\Lambda}$Be-Decays
- summed π^-

y-axis: entries
x-axis: momentum [GeV/c]

HELMHOLTZ | GEMEINSCHAFT

Helmholtz-Institut Mainz

Primary reaction

Pion background from GiBUU

Analysis of the GiBUU simulation result

Momentum distribution of Pions from GiBUU

hisPionMomDistr_carbon2	
Entries	7900981
Mean	0.5174
RMS	0.3974
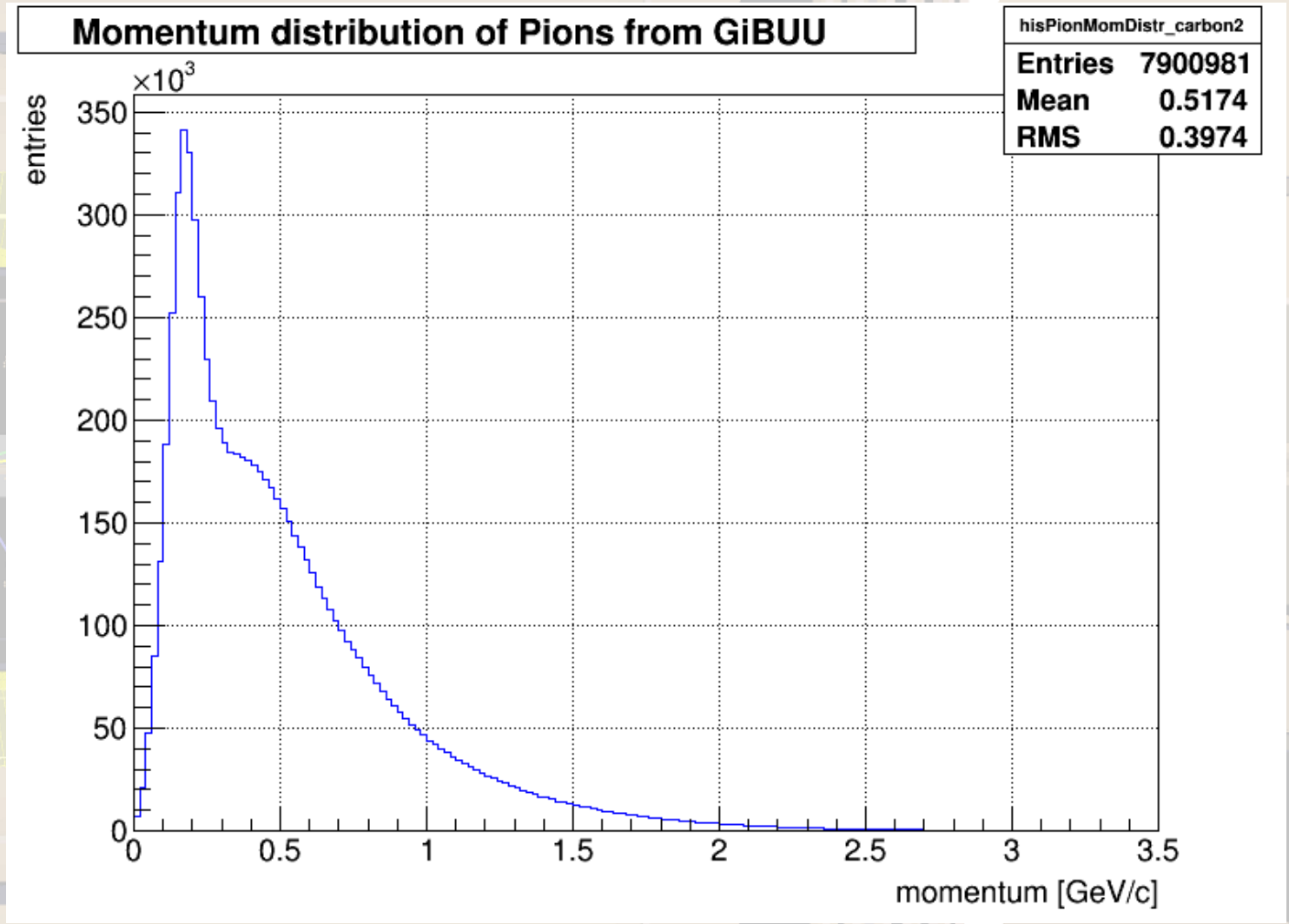
Background reduction

Analysis of the GiBUU simulation result

- **No vertex difference for:**

$$^{11}_{\Lambda\Lambda}\text{Be} \rightarrow {}^{11}_{\Lambda}\text{B} + \pi^-_1$$

$$^{11}_{\Lambda}\text{B} \rightarrow {}^{11}\text{C} + \pi^-_2$$
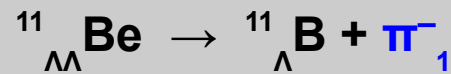
- **Primary π^- from primary vertex (0, 0, -55)**

Vertex difference between π^- from Ξ^- and from Λ

hisPionVertexDiff	
Entries	119735
Mean	2.322
RMS	2.46
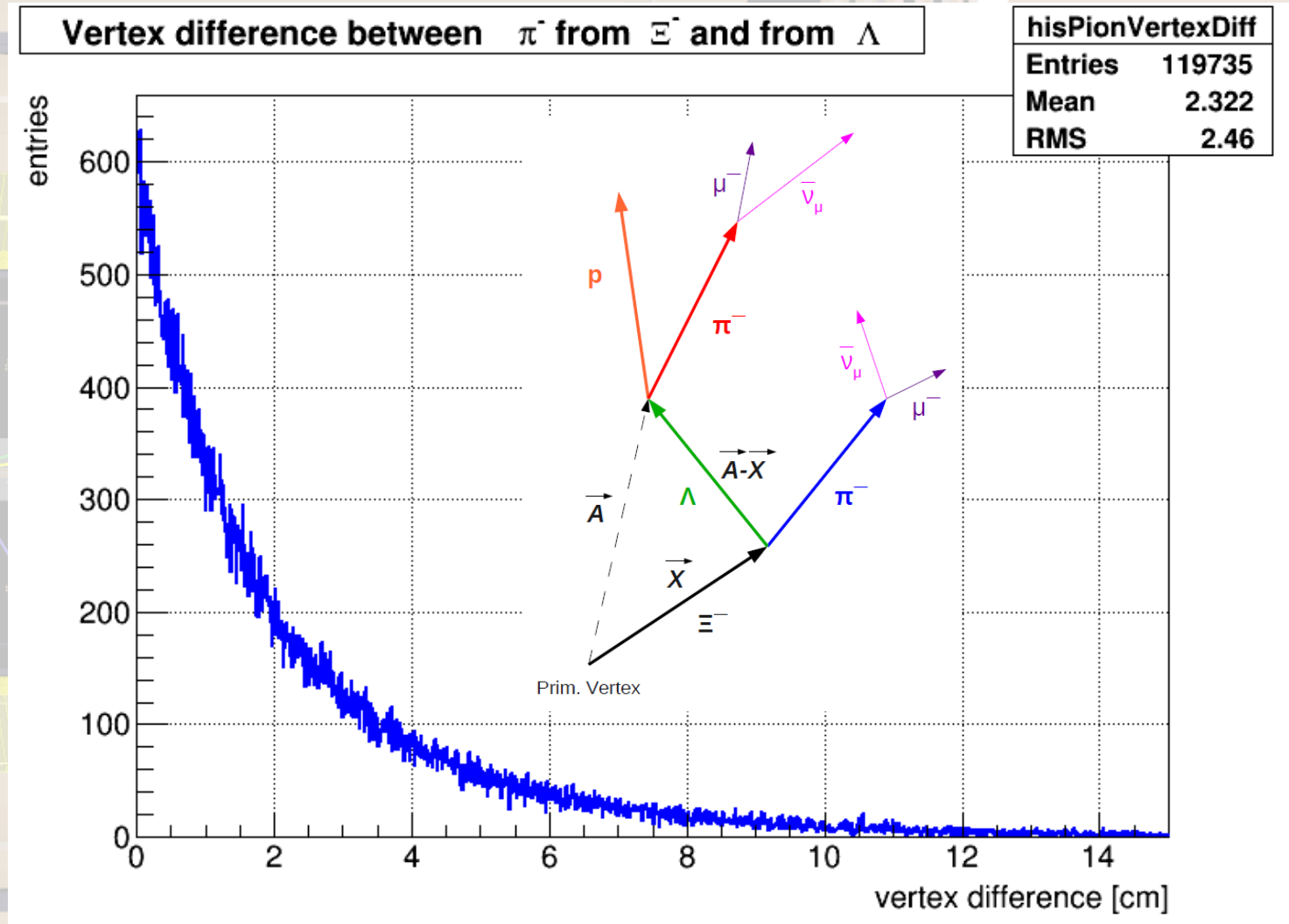
Outlook

- **ongoing GiBUU simulations to get more statistics**

- **tracking of the background π^- from primary reactions**

- **vertex reconstruction for π^-**

- **taking pions from Ξ^- decays at rest into account (capture and conversion probability $\approx 5\%$)**

- **looking for signatures and properties of the background π^- to cut on (as displaced vertices, transverse momentum and other observables)**

- **analyzing the possibility to tag the non mesonic weak decay of $^{11}_{\Lambda\Lambda}$Be**