

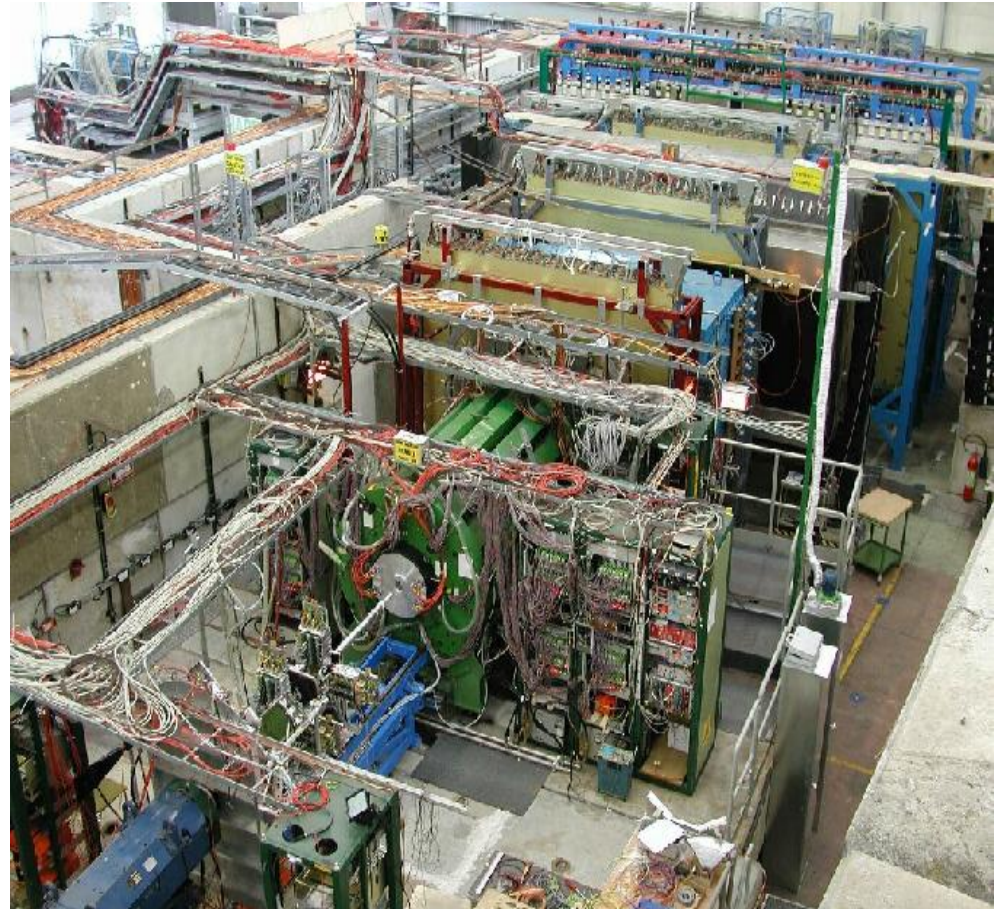
HARP-CDP results on the Geant4 validation

A. Zhemchugov
(Dubna)

for the HARP-CDP group

The HARP experiment

- The hadron production experiment at CERN PS
- Data taken in 2001-2002
- Beam p , π^\pm , K , d
- Beam momenta **1.5-15 GeV/c**
- Target nuclei from H_2 to **Pb**



The comparison presented is based on the HARP-CDP analysis of p and π^\pm interactions with Beryllium, Copper and Tantalum targets

Validation conditions

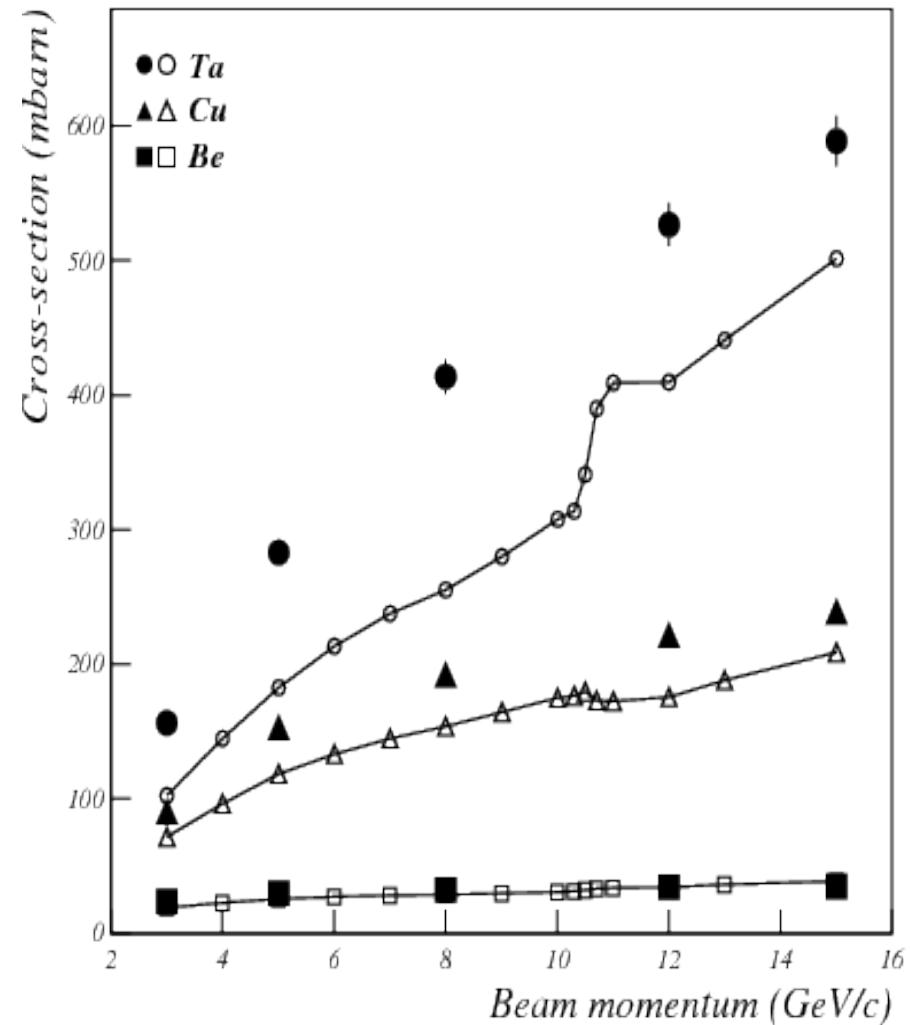
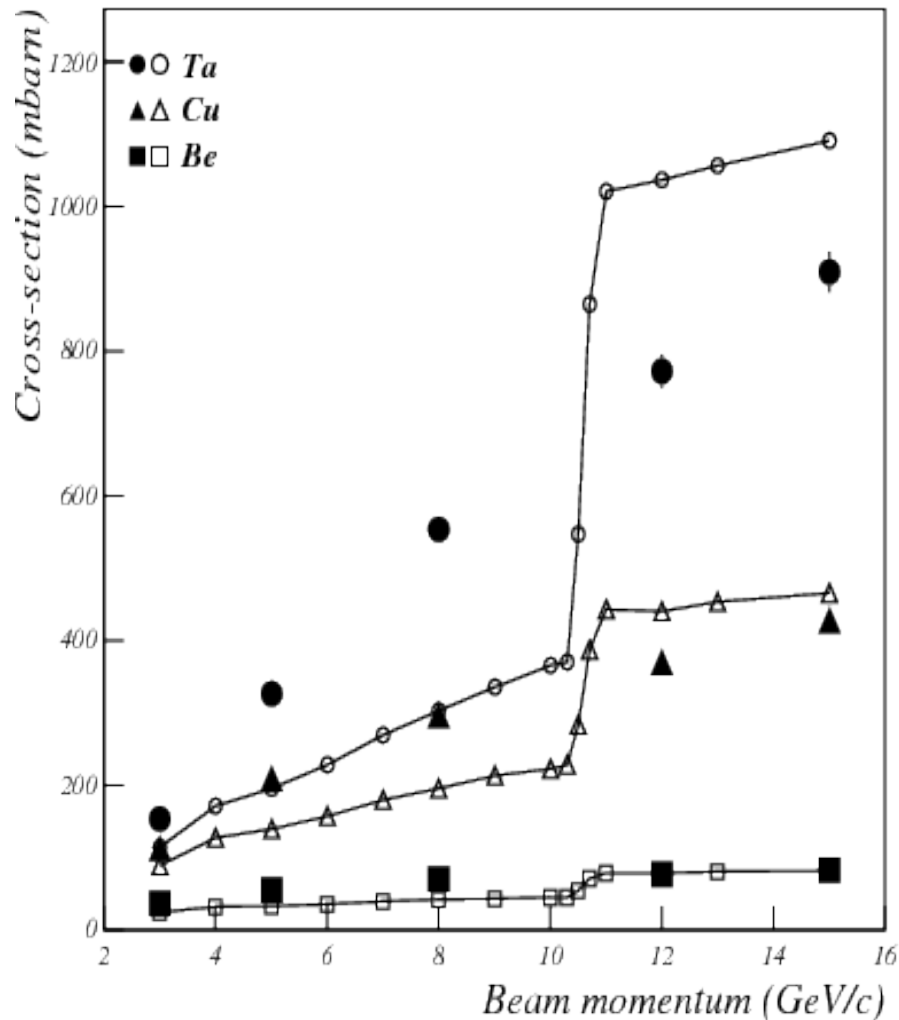
- Geant4 version 4.9.3 (18 Dec 2009) was used
- Test program, derived from a G4 example, reproduced ideal HARP conditions
 - Beam particles bombard a thin ($1\% \lambda$) target
 - MC truth information of secondaries collected
 - Production cross-sections computed from MC, and then compared with experimental ones
 - Standard physics lists were tested: QGSP_BERT, QGSP_BIC, FTFP_BERT, QGSP_EMV
 - Three targets: light (Be), medium (Cu) and heavy (Ta)

Comparison: QGSP_BERT (proton beam)

$20^\circ < \theta < 50^\circ$

π^+

$50^\circ < \theta < 125^\circ$

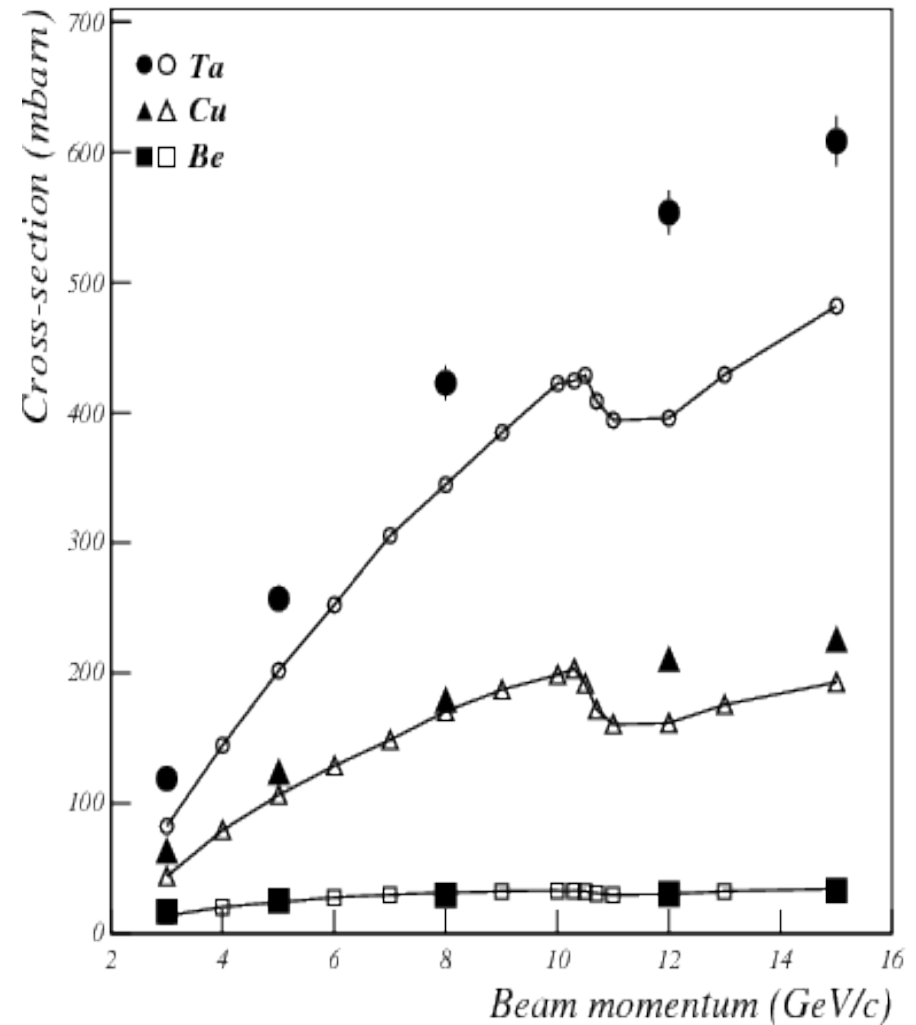
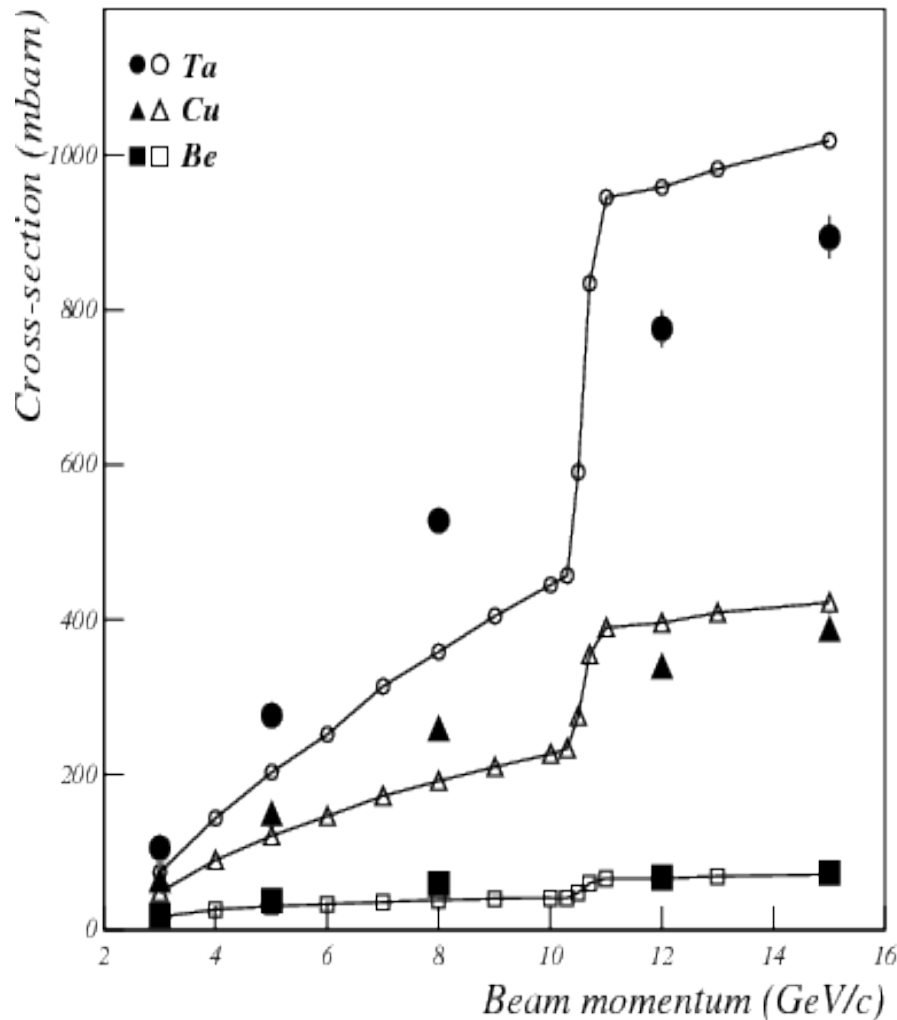


Comparison: QGSP_BERT (proton beam)

$20^\circ < \theta < 50^\circ$

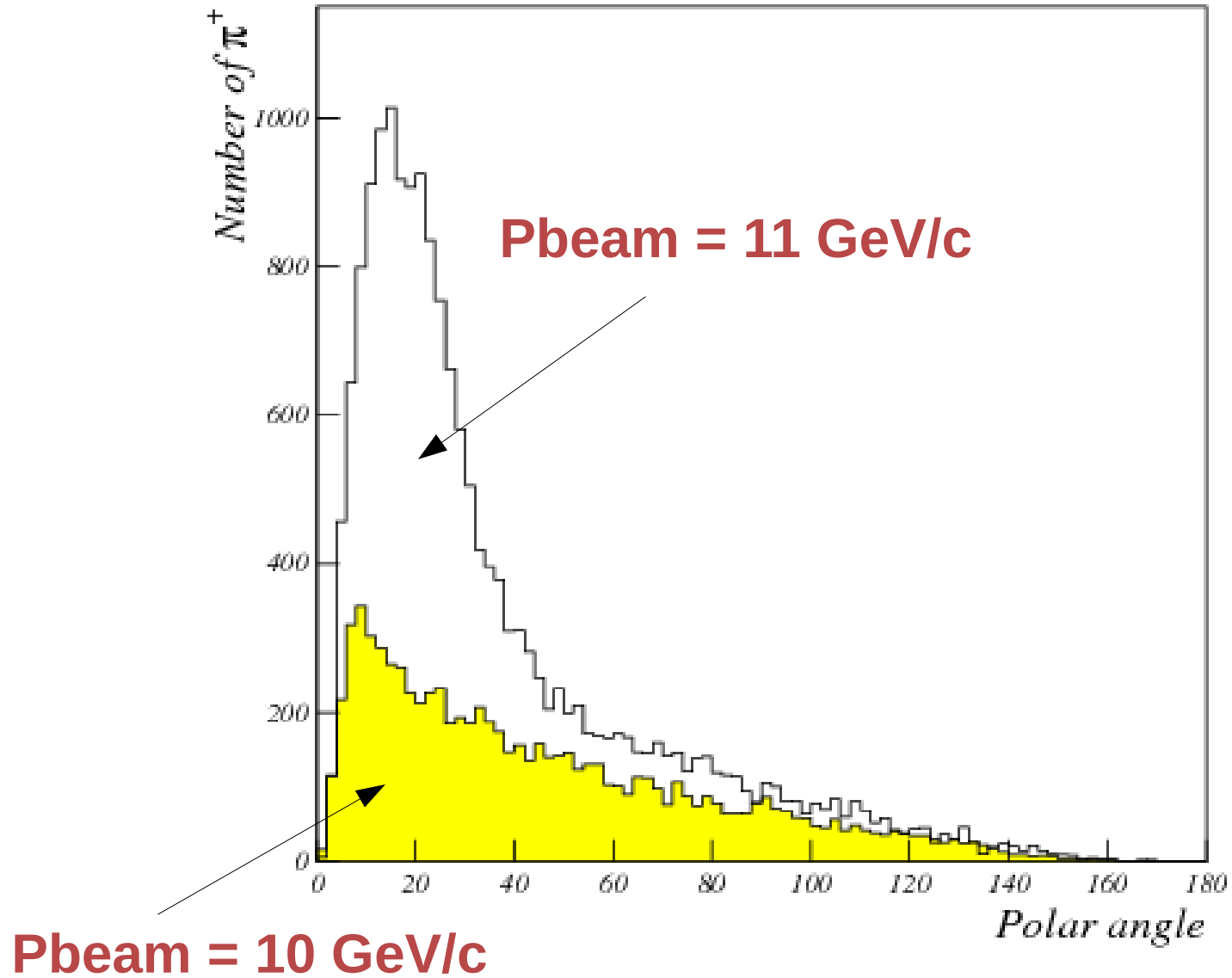
π^-

$50^\circ < \theta < 125^\circ$



Comparison: QGSP_BERT (proton beam)

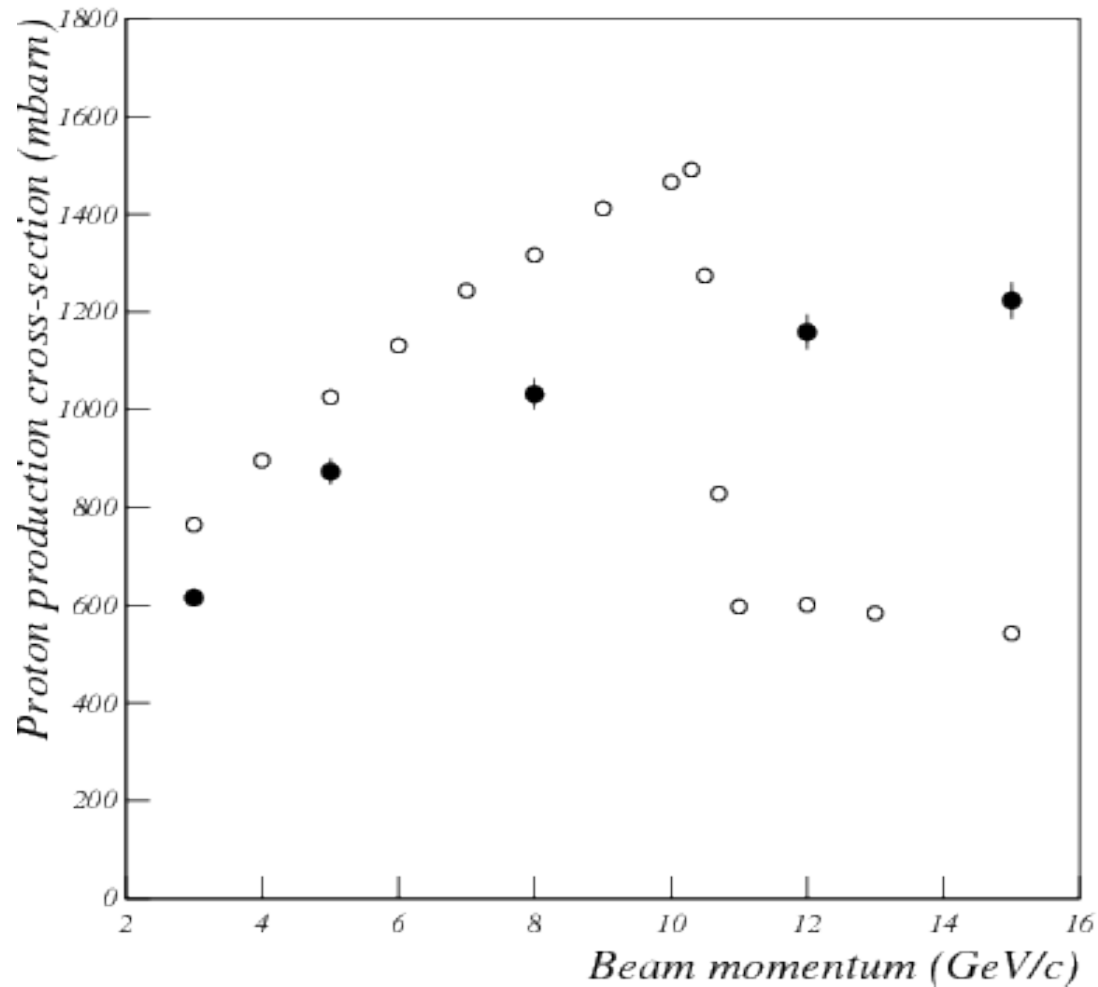
π^+



Comparison: QGSP_BERT (proton beam)

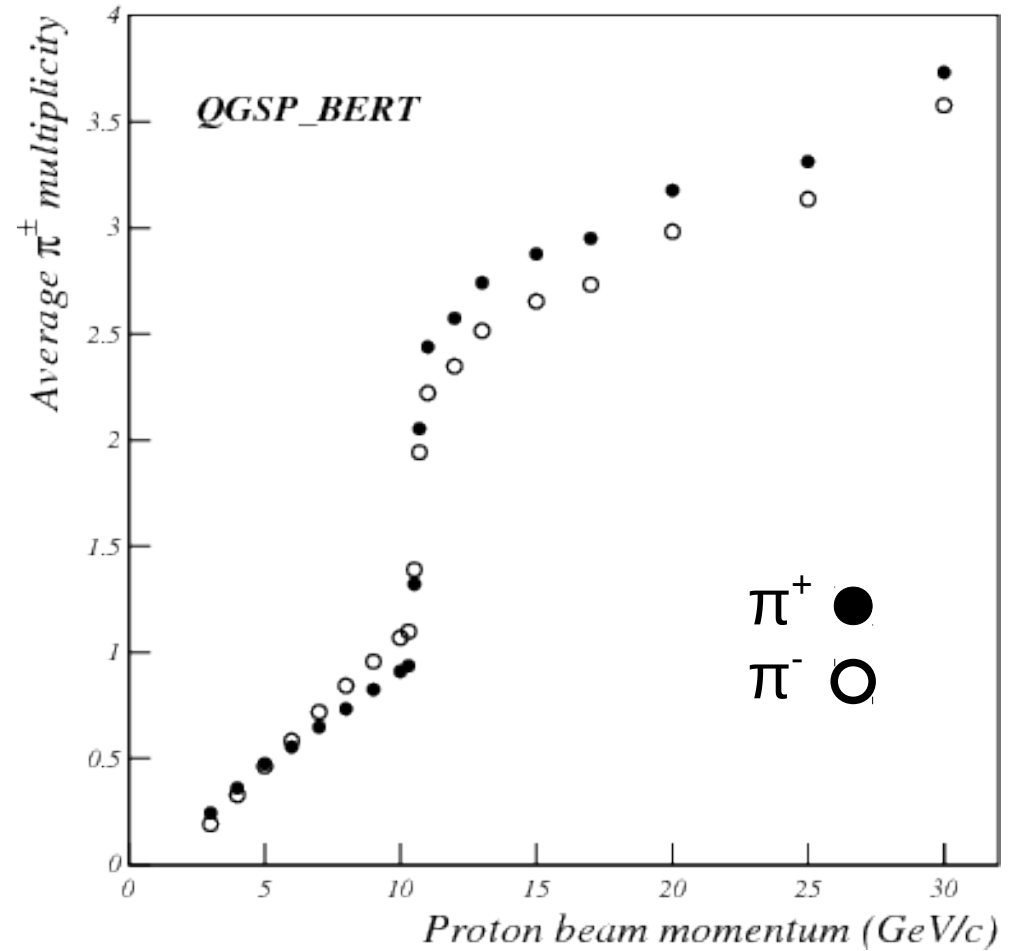
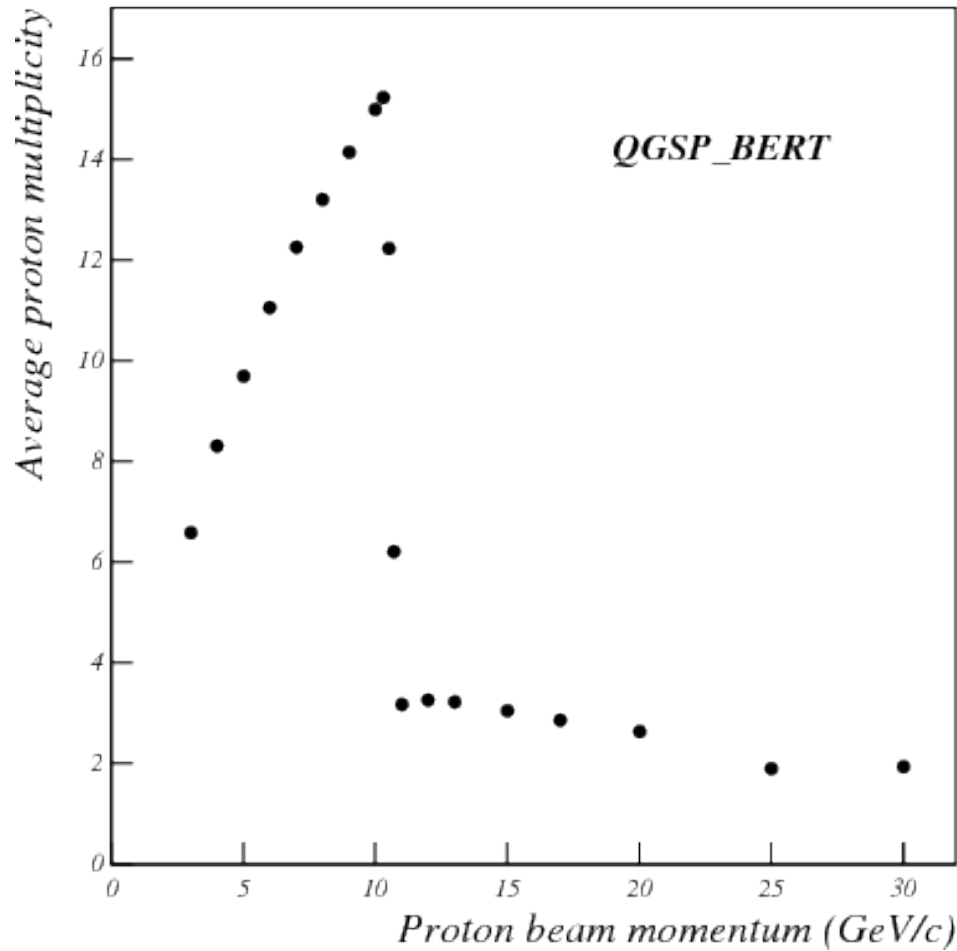
p

QGSP_BERT $20 < \Theta < 50$, $300 < P_T < 720$



QGSP_BERT multiplicity (proton beam)

proton multiplicity MC only pion multiplicity

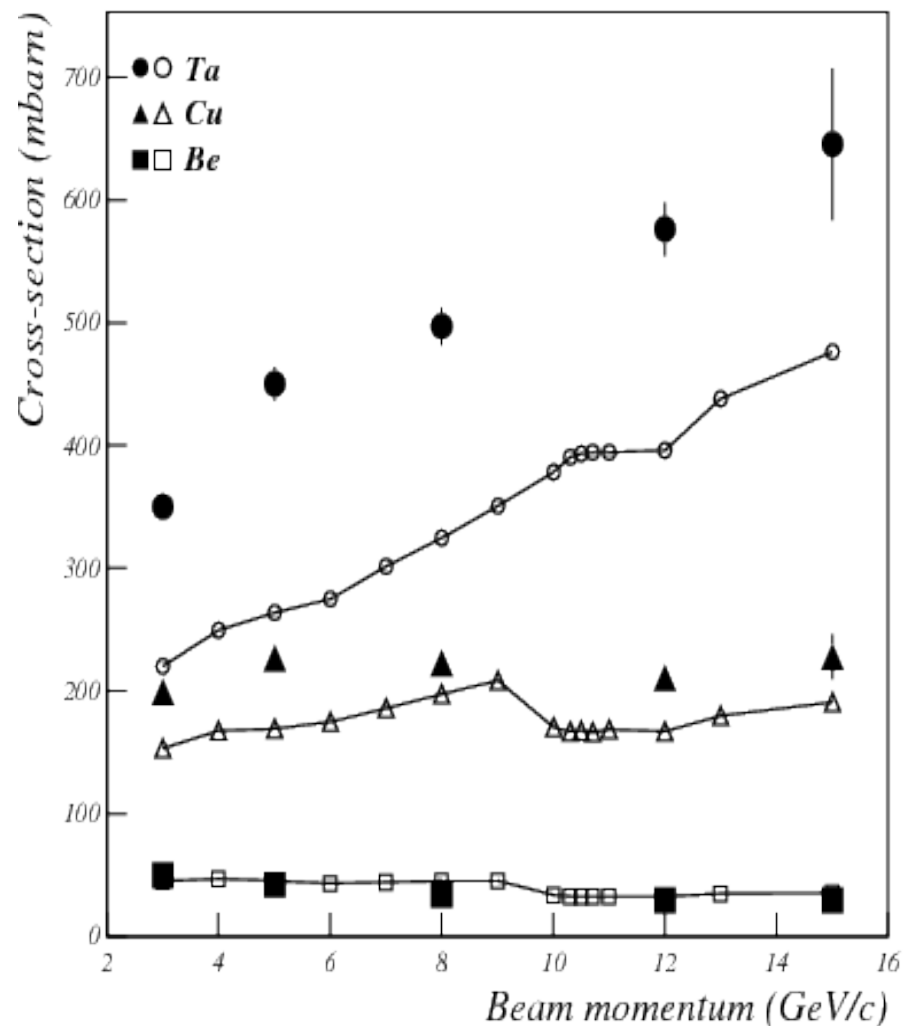
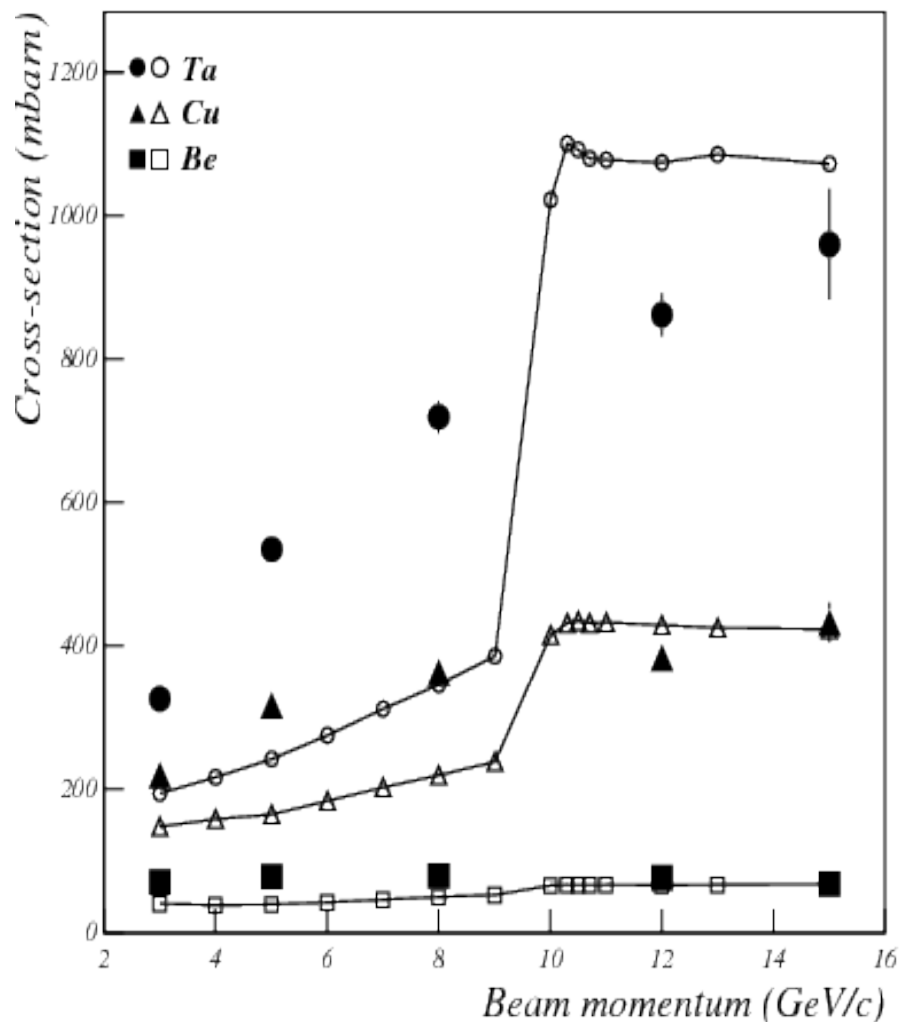


Comparison: QGSP_BERT (π^+ beam)

$20^\circ < \theta < 50^\circ$

π^+

$50^\circ < \theta < 125^\circ$

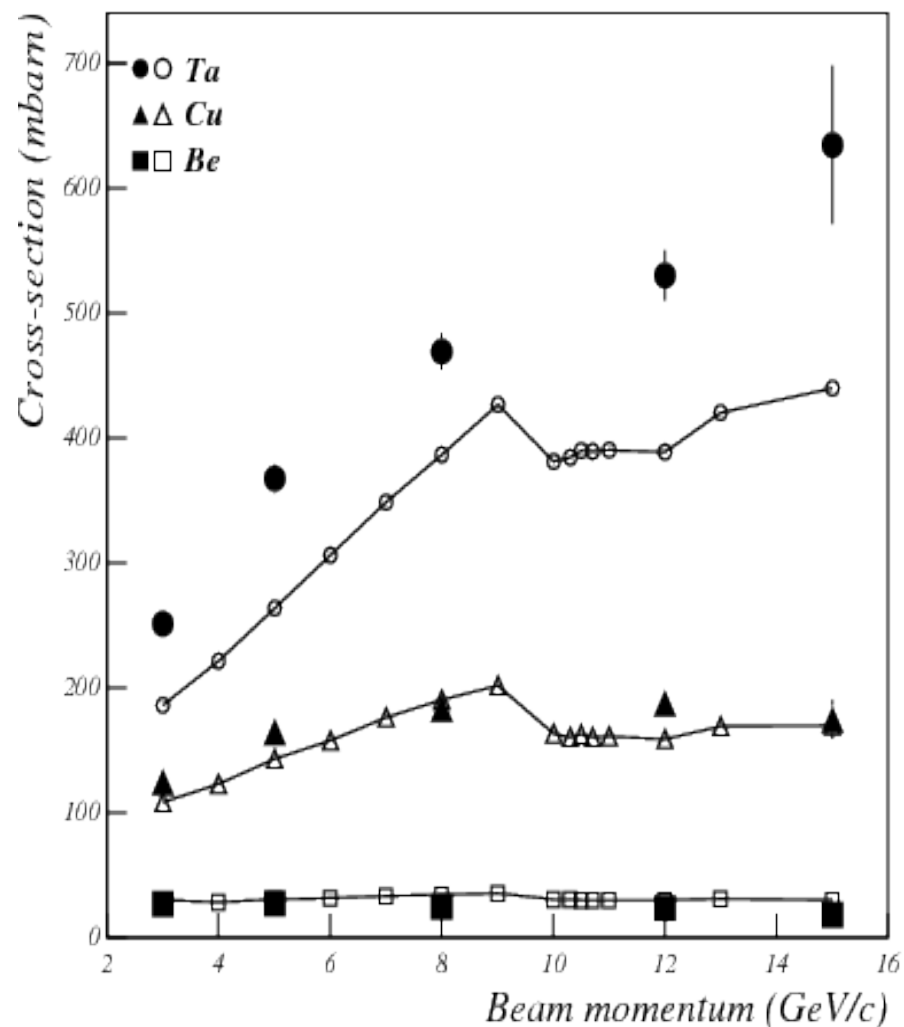
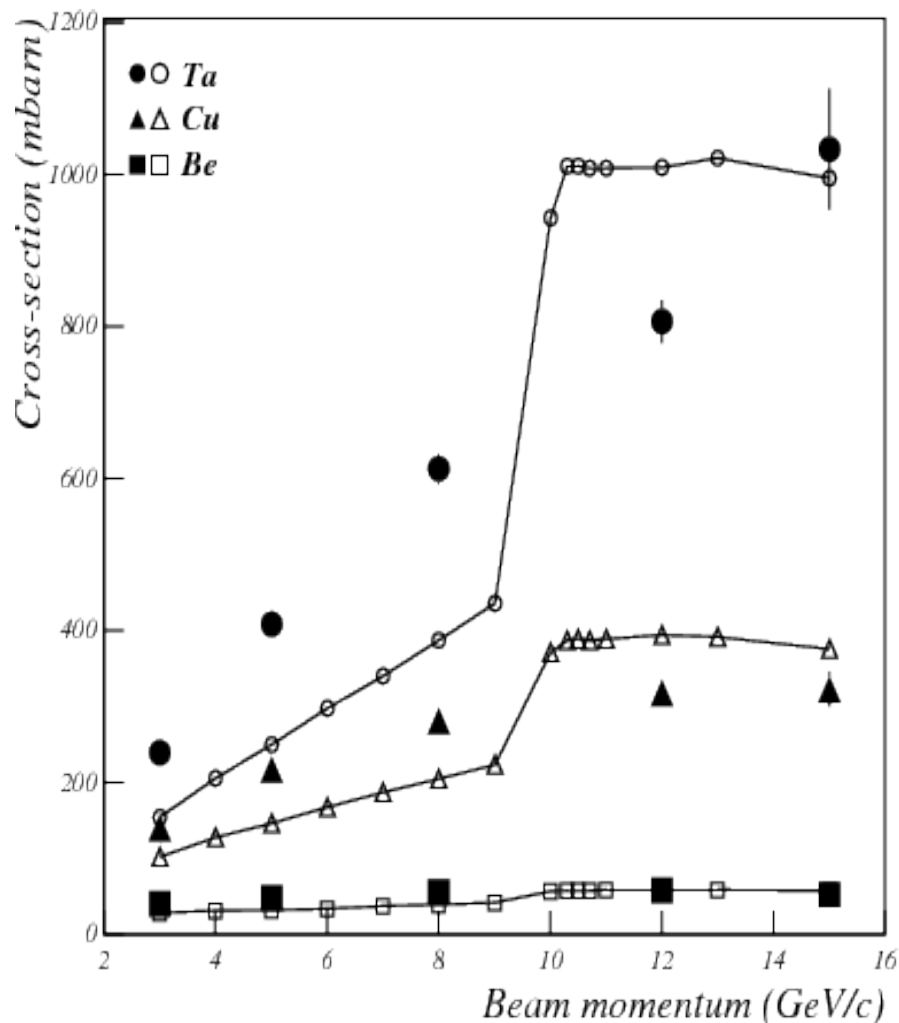


Comparison: QGSP_BERT (π^+ beam)

$20^\circ < \theta < 50^\circ$

π^-

$50^\circ < \theta < 125^\circ$

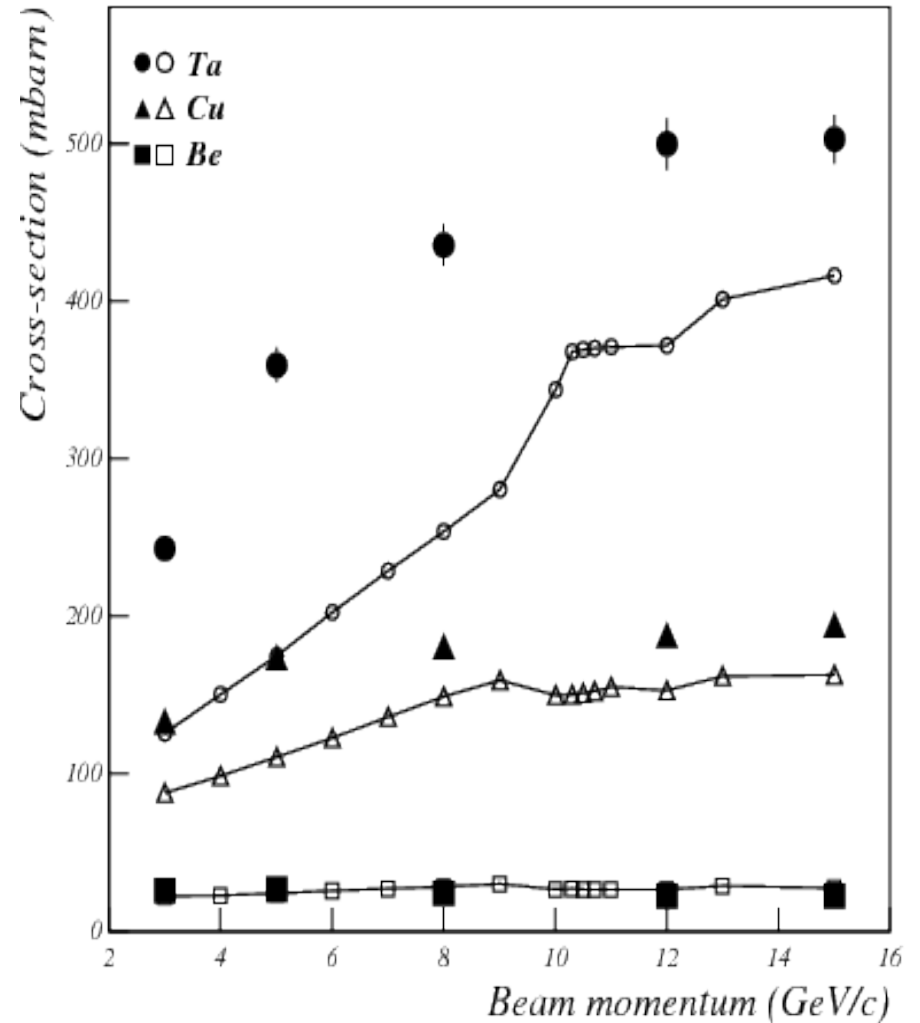
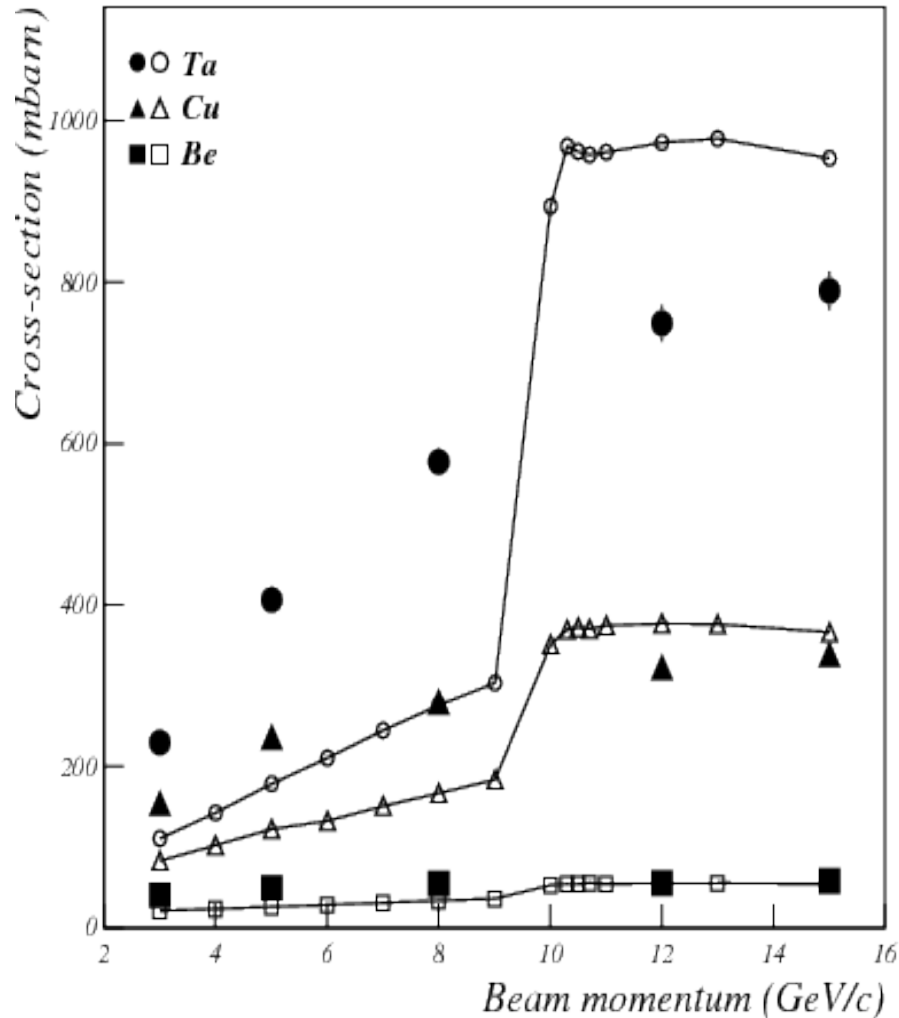


Comparison: QGSP_BERT (π^- beam)

$20^\circ < \theta < 50^\circ$

π^+

$50^\circ < \theta < 125^\circ$

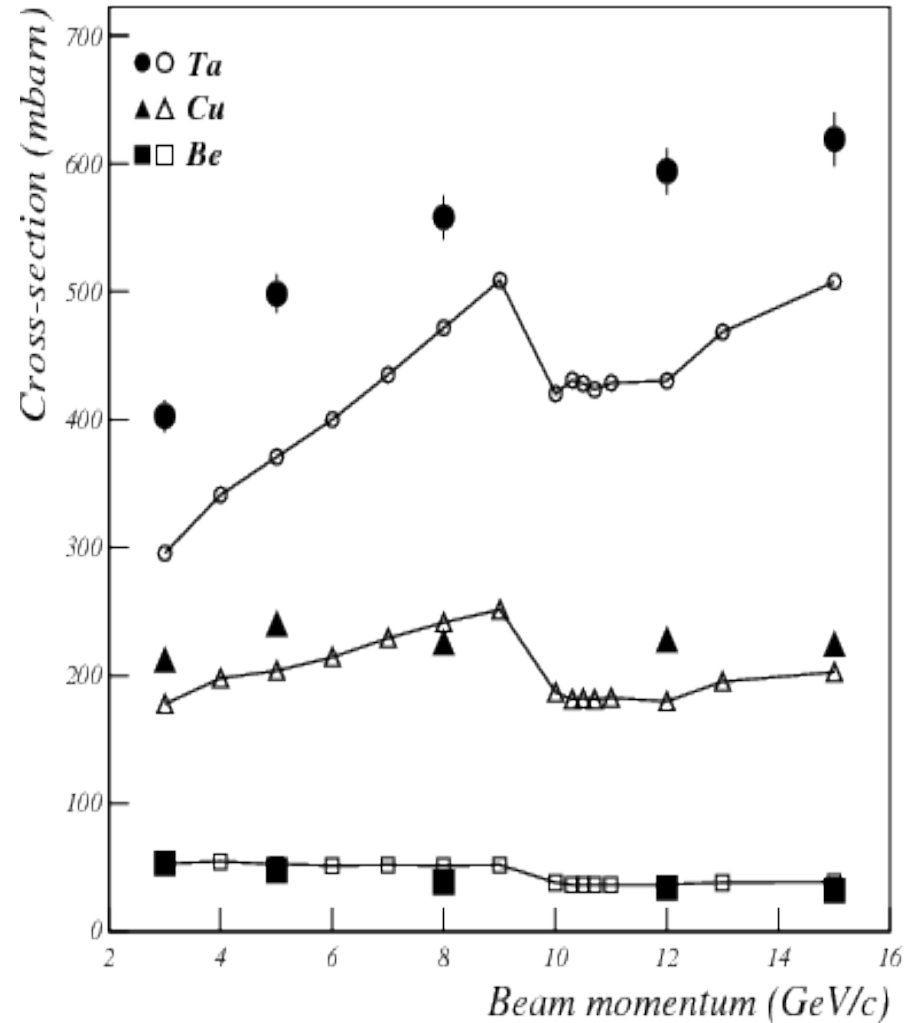
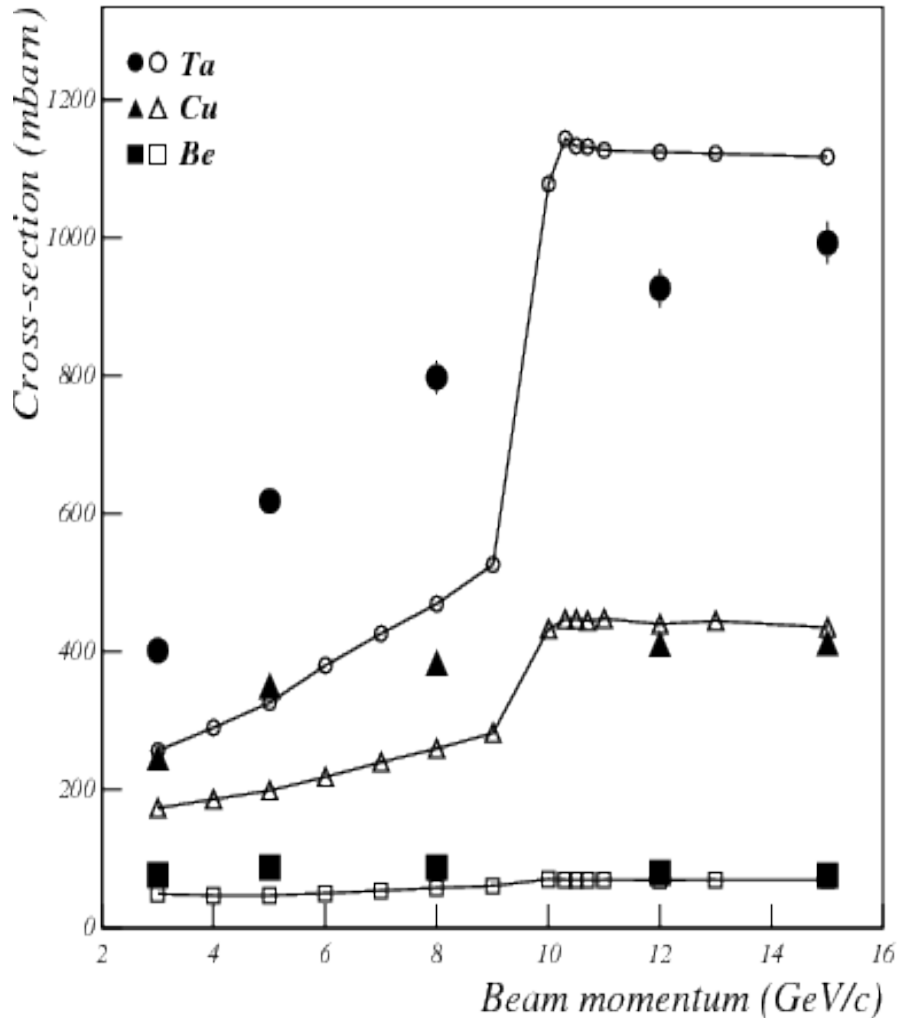


Comparison: QGSP_BERT (π^- beam)

$20^\circ < \theta < 50^\circ$

π^-

$50^\circ < \theta < 125^\circ$



Comparison: FTFP_BERT (proton beam, Ta)

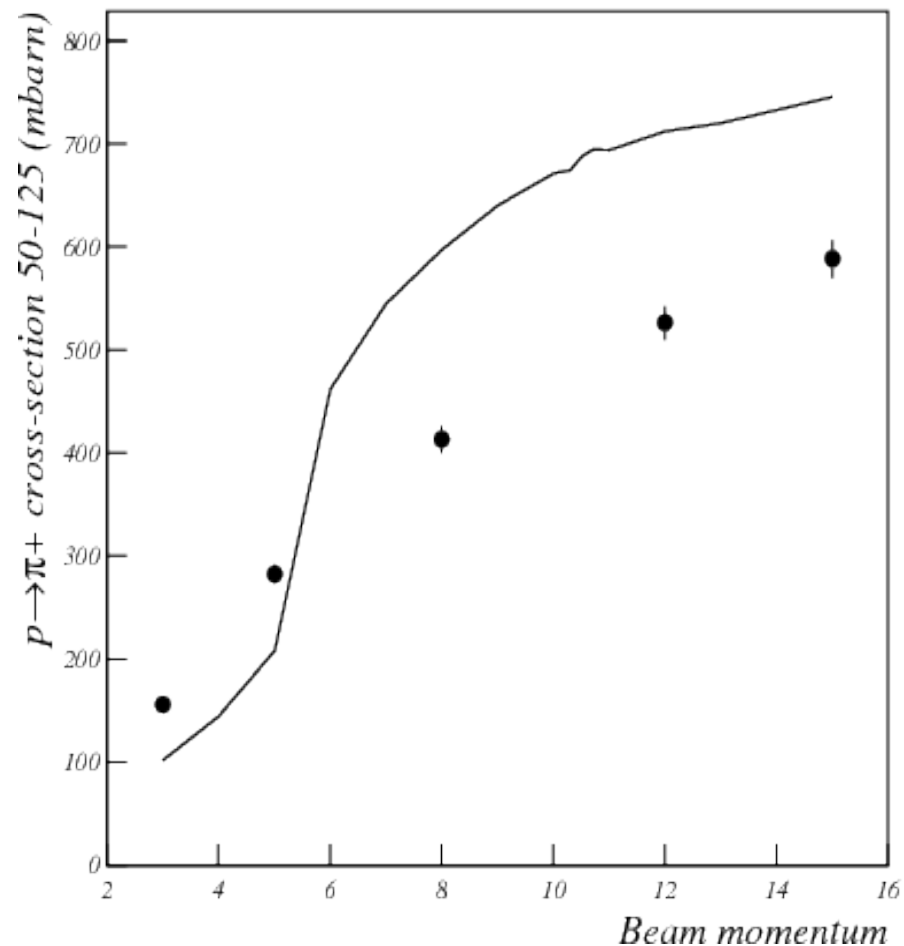
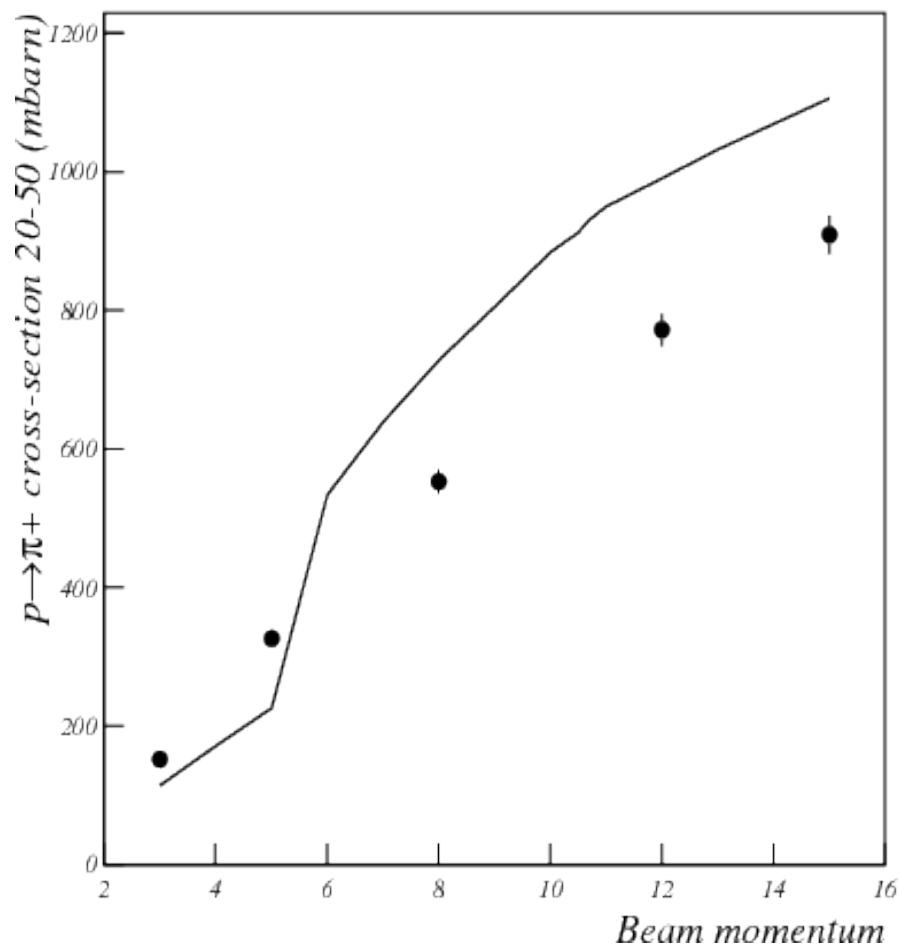
$20^\circ < \theta < 50^\circ$

π^+

$50^\circ < \theta < 125^\circ$

Tantalum_ftfp_bert

Tantalum_ftfp_bert



Comparison: FTFP_BERT (proton beam, Ta)

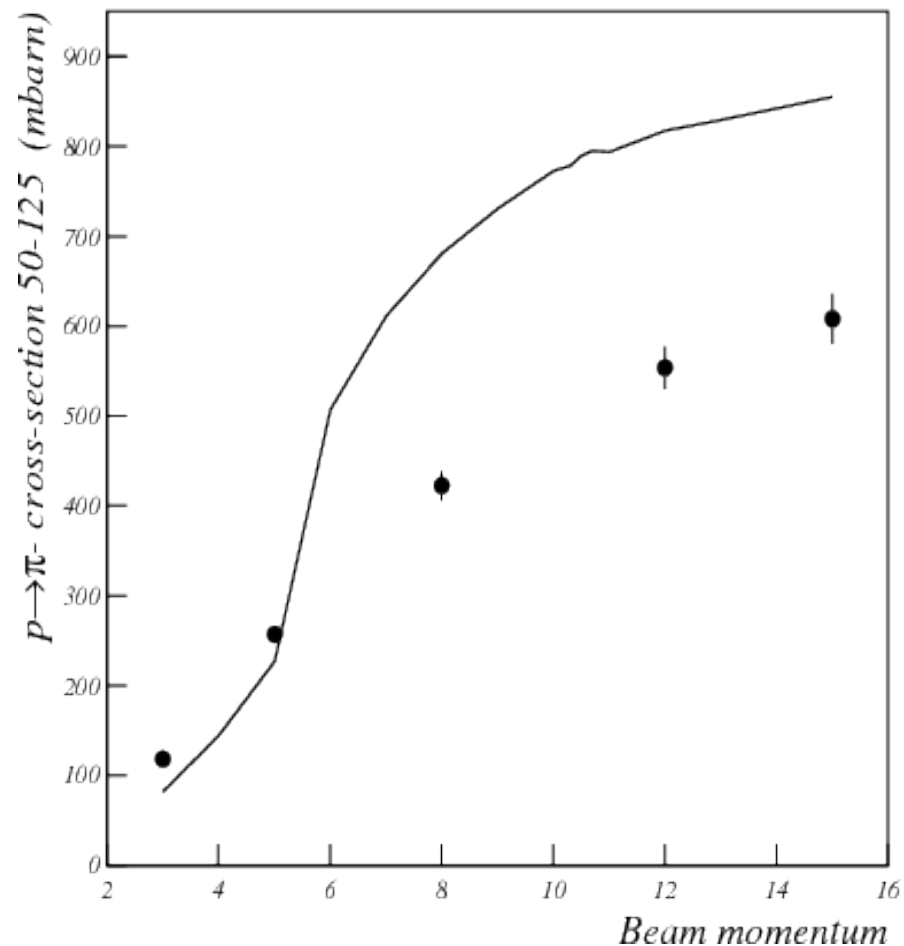
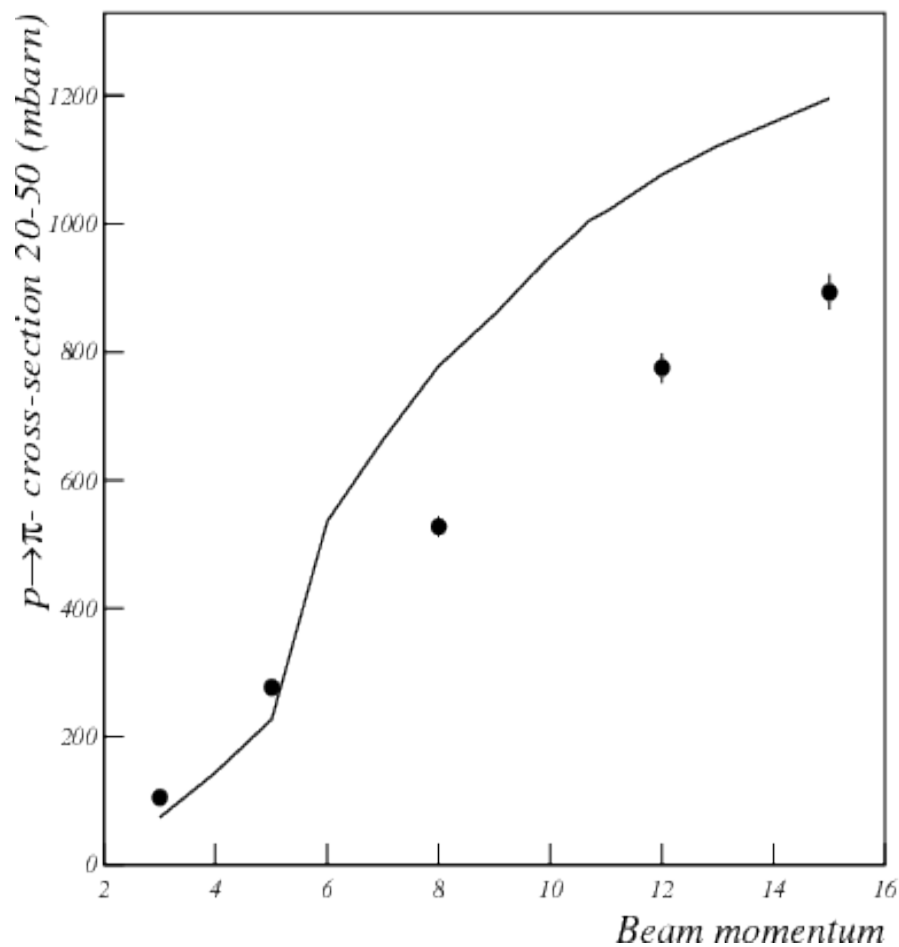
$20^\circ < \theta < 50^\circ$

π^-

$50^\circ < \theta < 125^\circ$

Tantalum_ftfp_bert

Tantalum_ftfp_bert



Comparison: QGSP_BIC (proton beam, Ta)

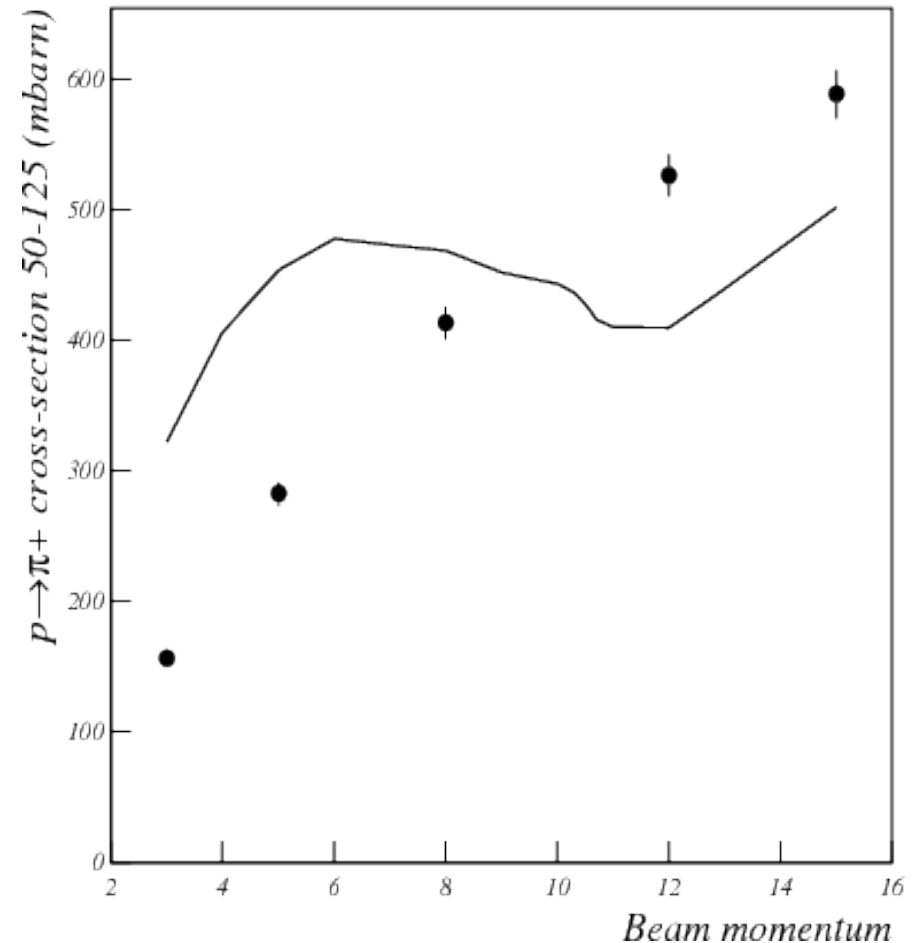
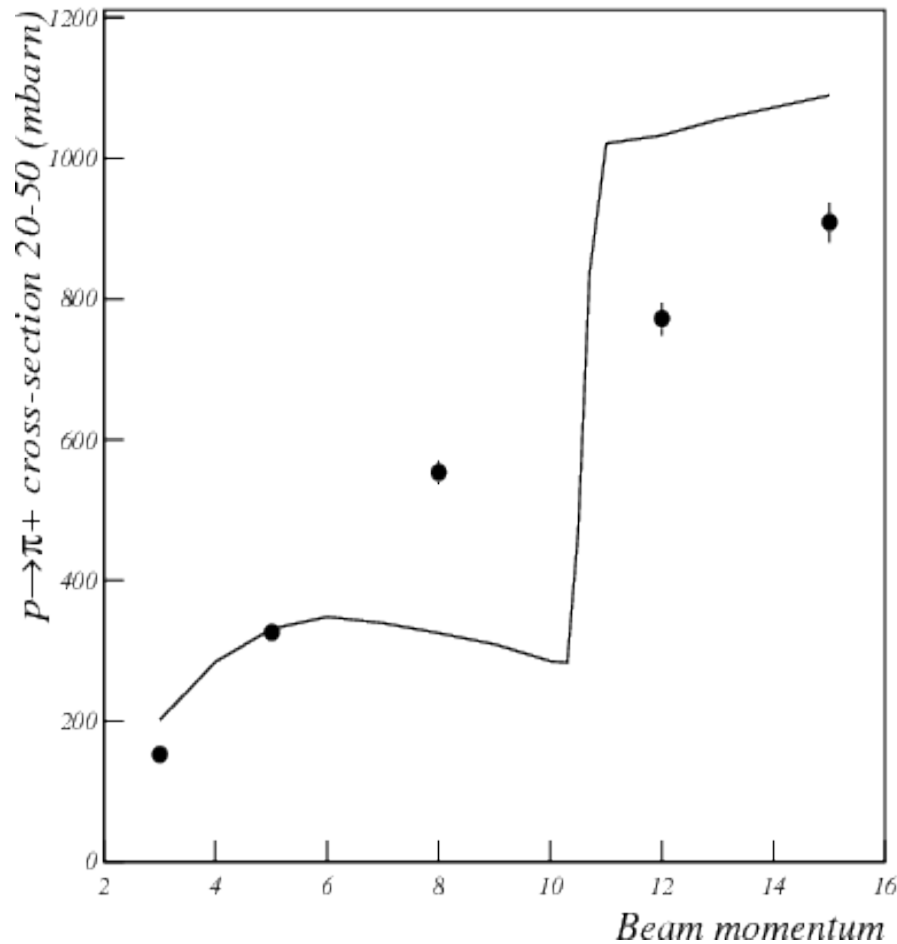
$20^\circ < \theta < 50^\circ$

π^+

$50^\circ < \theta < 125^\circ$

Tantalum_qgsp_bic

Tantalum_qgsp_bic



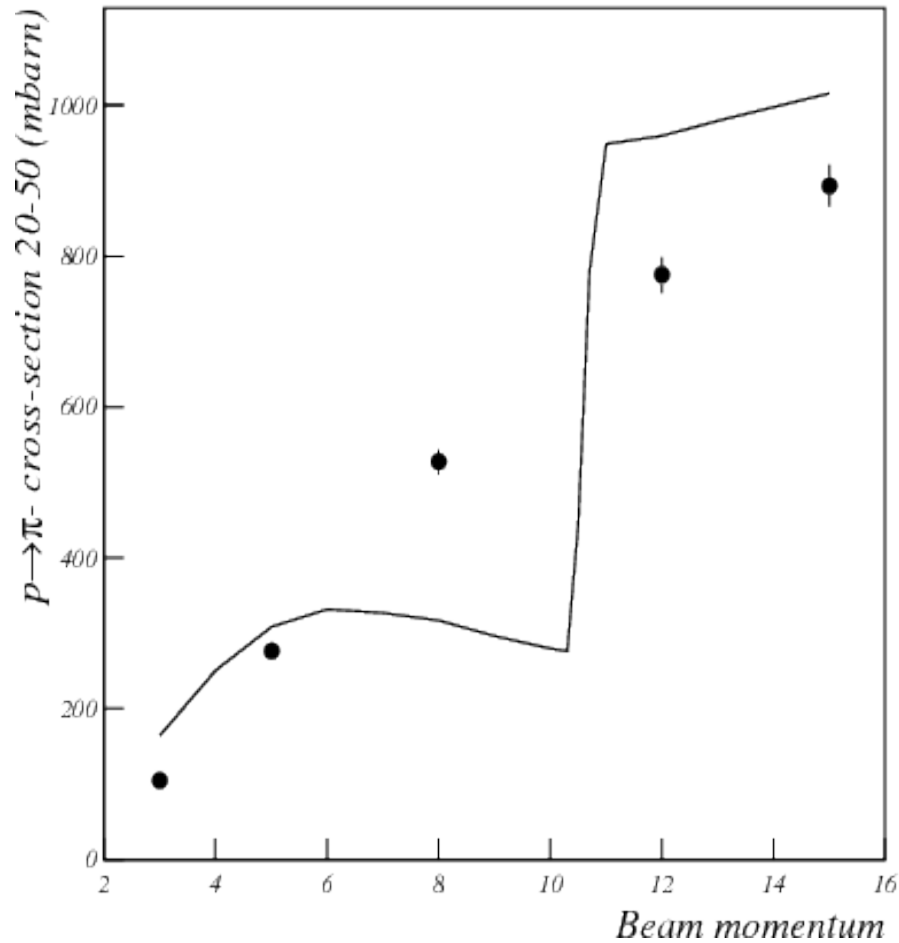
Comparison: QGSP_BIC (proton beam, Ta)

$20^\circ < \theta < 50^\circ$

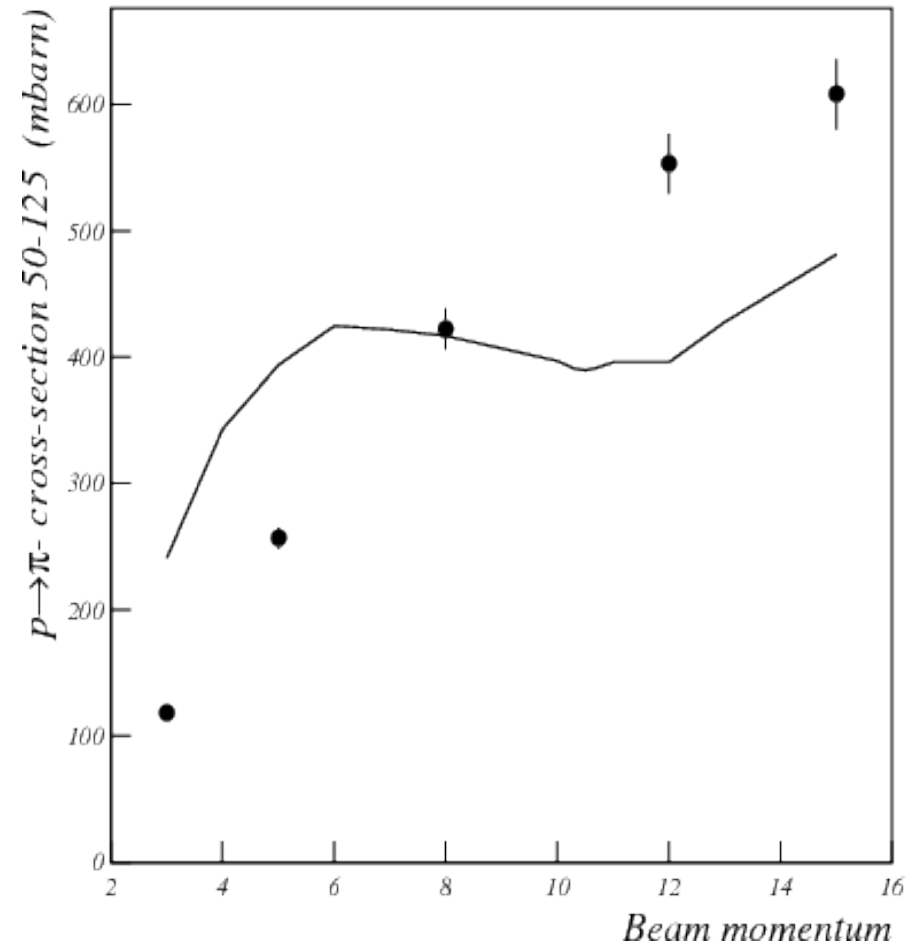
π^-

$50^\circ < \theta < 125^\circ$

Tantalum_qgsp_bic



Tantalum_qgsp_bic



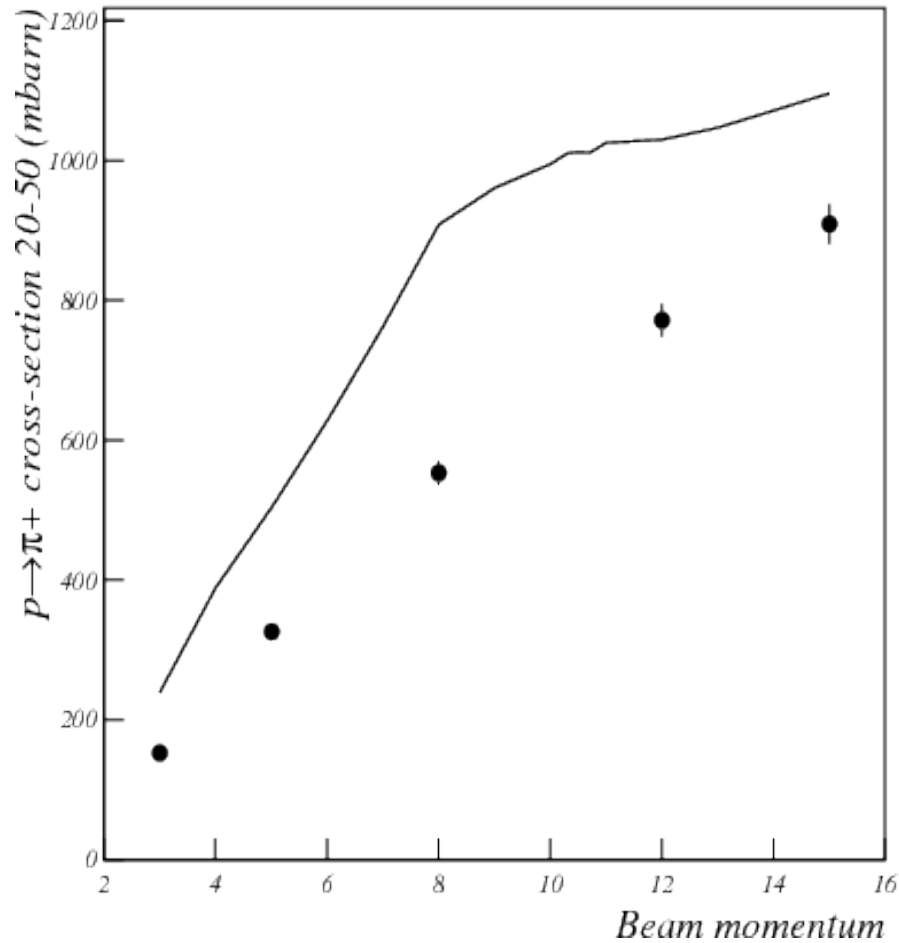
Comparison: QGSP_EMV (proton beam, Ta)

$20^\circ < \theta < 50^\circ$

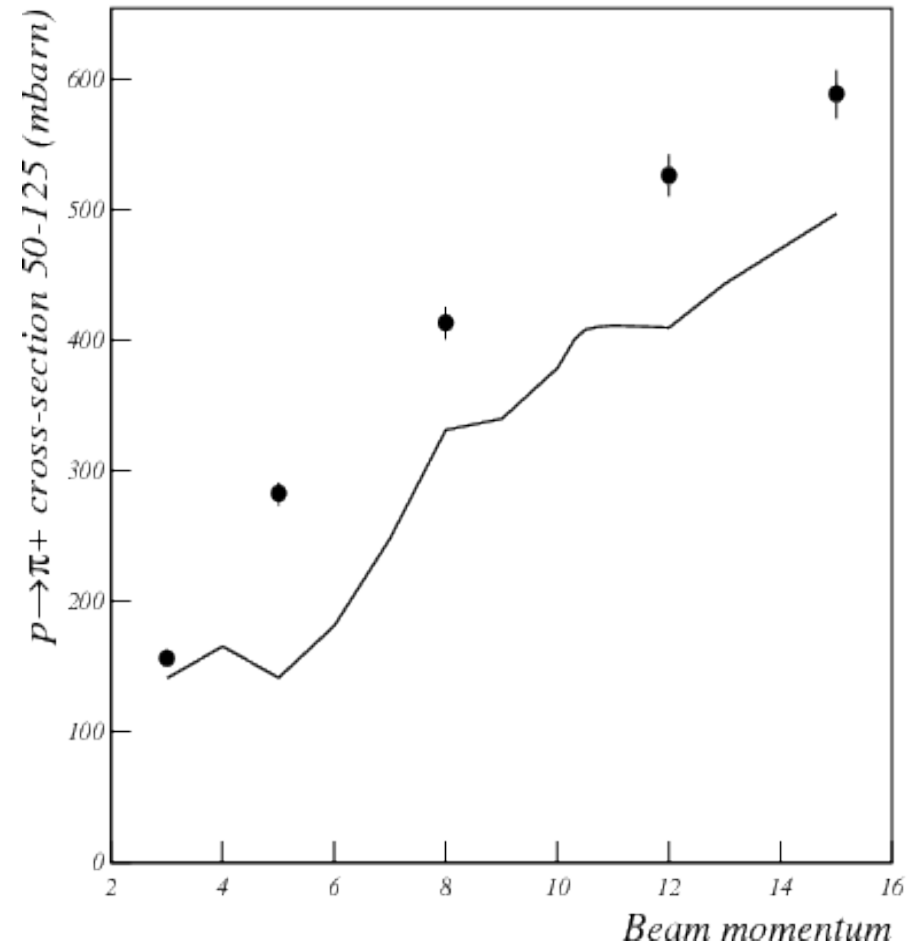
π^+

$50^\circ < \theta < 125^\circ$

Tantalum_qgsp_emv



Tantalum_qgsp_emv



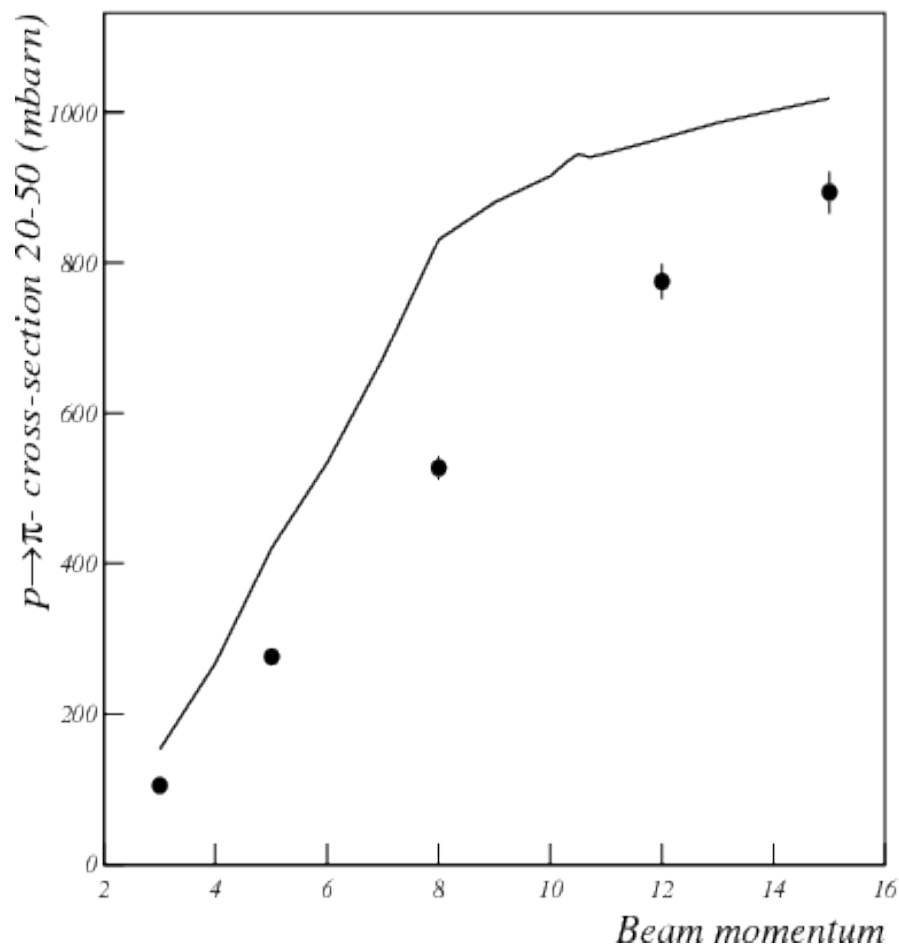
Comparison: QGSP_EMV (proton beam, Ta)

$20^\circ < \theta < 50^\circ$

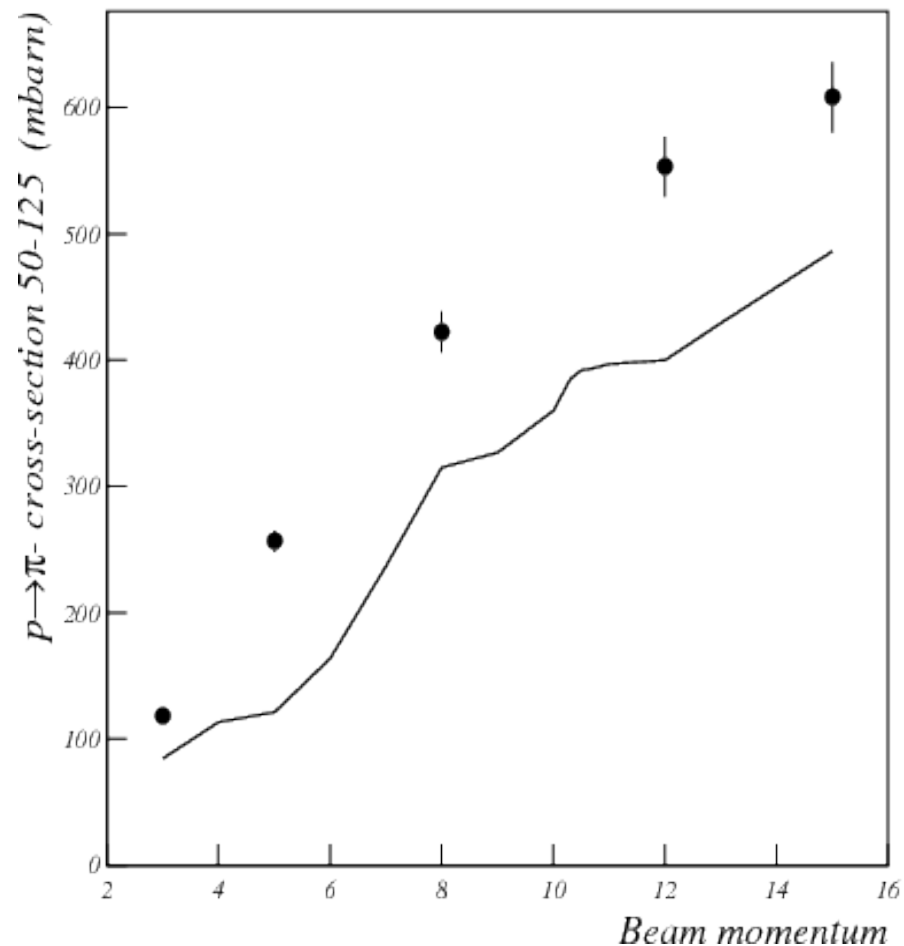
π^-

$50^\circ < \theta < 125^\circ$

Tantalum_qgsp_emv



Tantalum_qgsp_emv



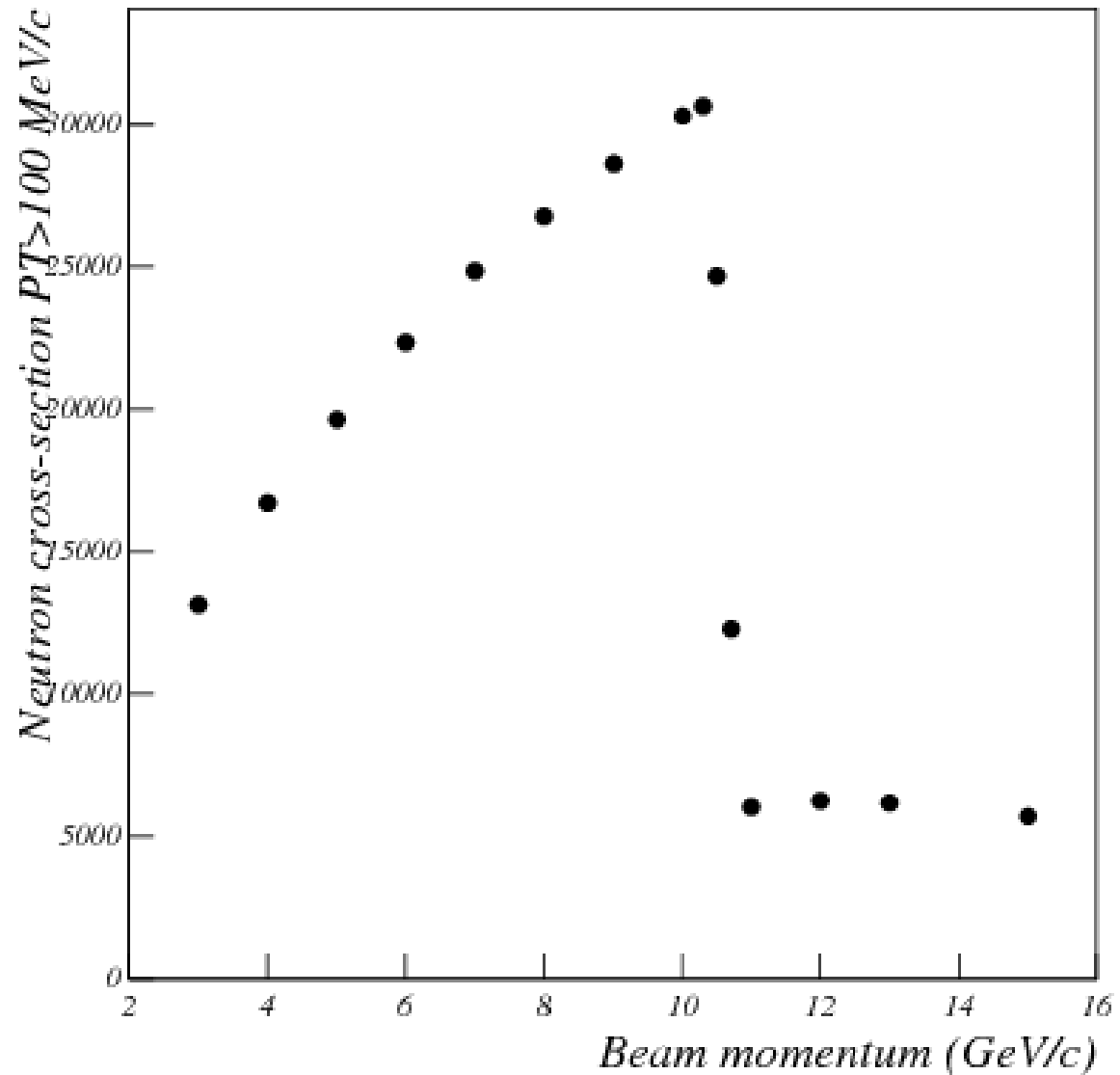
Summary

- Hadron production cross-sections, used in Geant4, have been compared with experimental data in a wide range of beam momenta, for several nuclei and physics lists.
- In absolute scale, the Geant4 cross-sections are reasonably compatible with measured ones
- Significant disagreement with data appears in the region, corresponding to a transition between different models.
- Abrupt jumps of the cross-section have been observed in case of QGSP_BIC and QGSP_BERT. It reflects directly in the number of secondaries produced.
- Cross-sections for QGSP_EMV and FTFP_BERT lists are smooth, but differ from experimental ones by up to 20-50% in absolute value.

backup

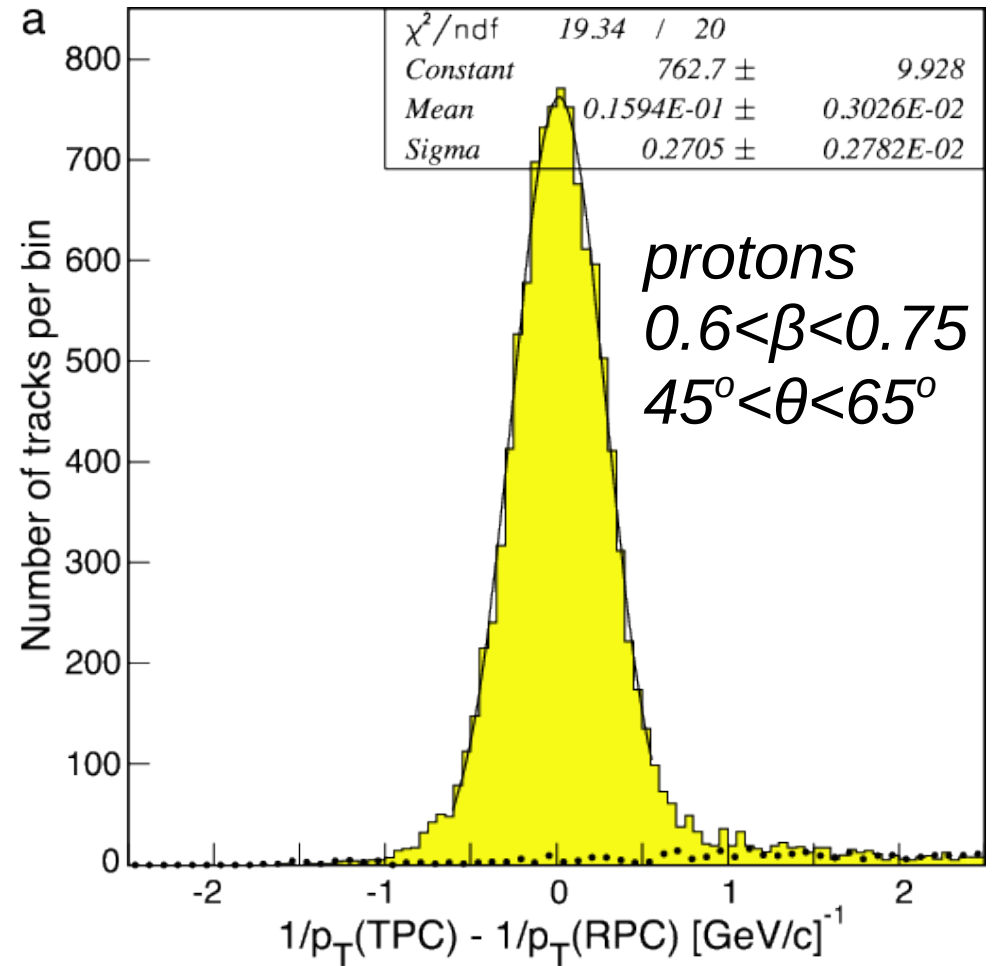
QGSP_BERT: neutrons (proton beam, Ta)

ta_qgsp_bert



The HARP large angle spectrometer performance

- $0.20 < \sigma(1/P_T) < 0.25 \text{ (GeV/c)}^{-1}$
- TOF resolution 175 ps
- dE/dx resolution 16% for tracks longer than 300 mm



Particle identification

