(Low momentum) Hadron-Nucleus interactions in ALICE

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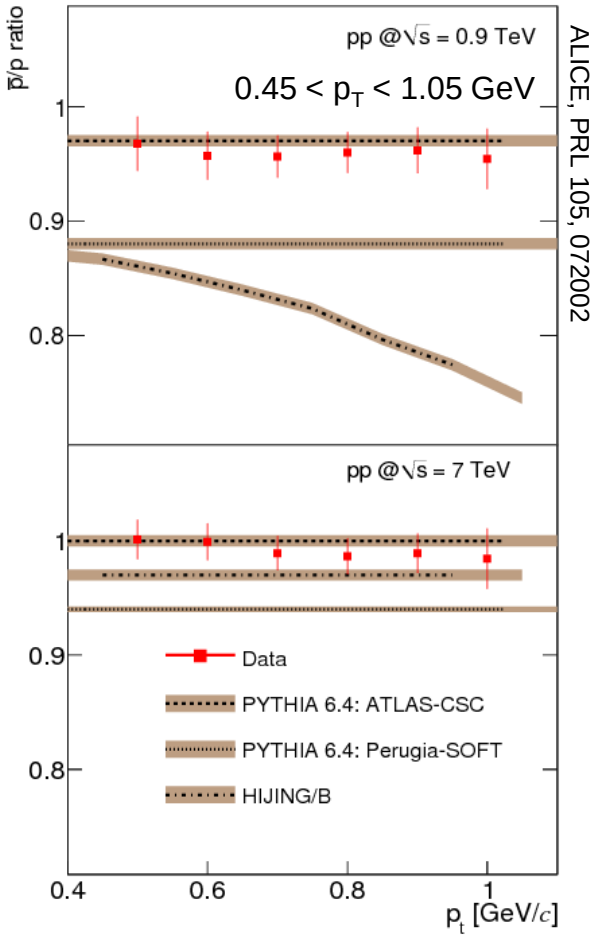
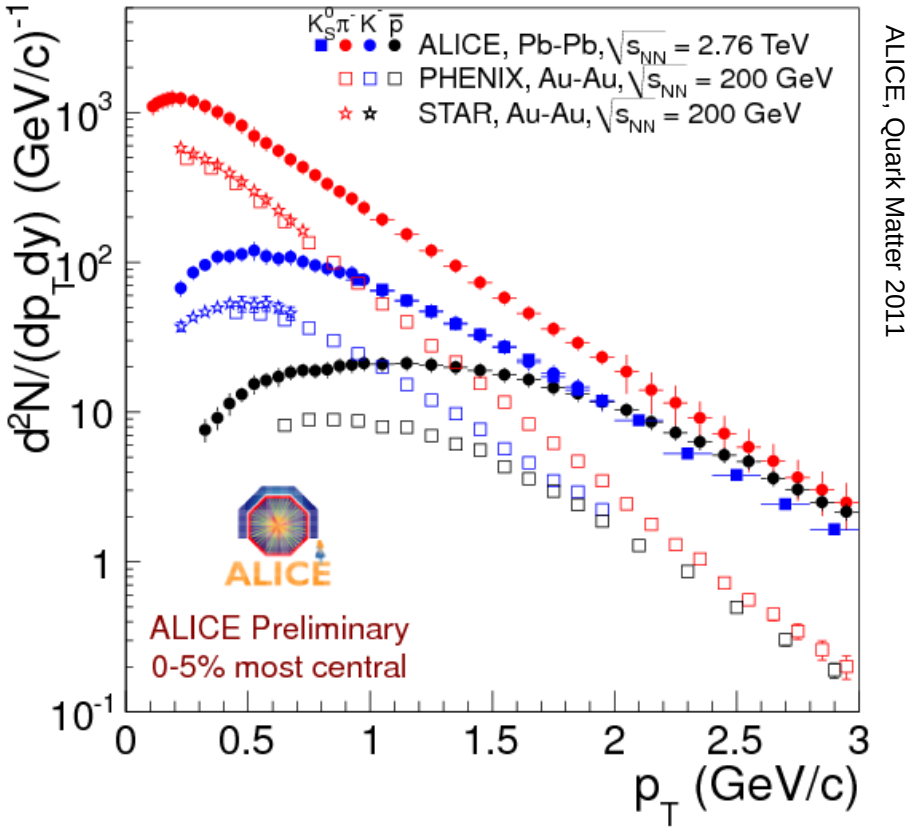
NWO
Netherlands Organisation for Scientific Research

Motivation

Low-momentum hadron production is of interest for ALICE/heavy ion physics





p̄/p ratio: baryon transport in p+p and Pb+Pb (baryon chemical potential)

Pb+Pb:
Radial flow and hadrochemistry

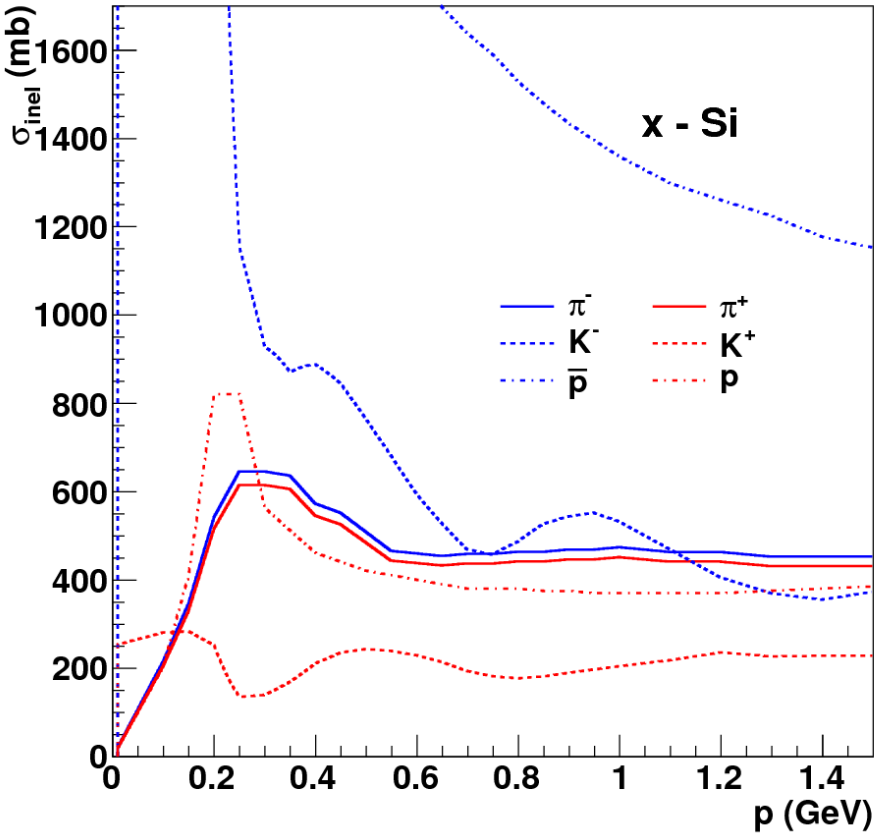
Hadron-nucleus cross sections

- Tracking efficiency depends on hadron-nucleus cross sections
- Inelastic interactions:
  - Track lost after interaction
- Elastic interactions:
  - Track deflected; losses depend on angle+cuts
- Low momentum cross sections: non-trivial momentum, charge dependence

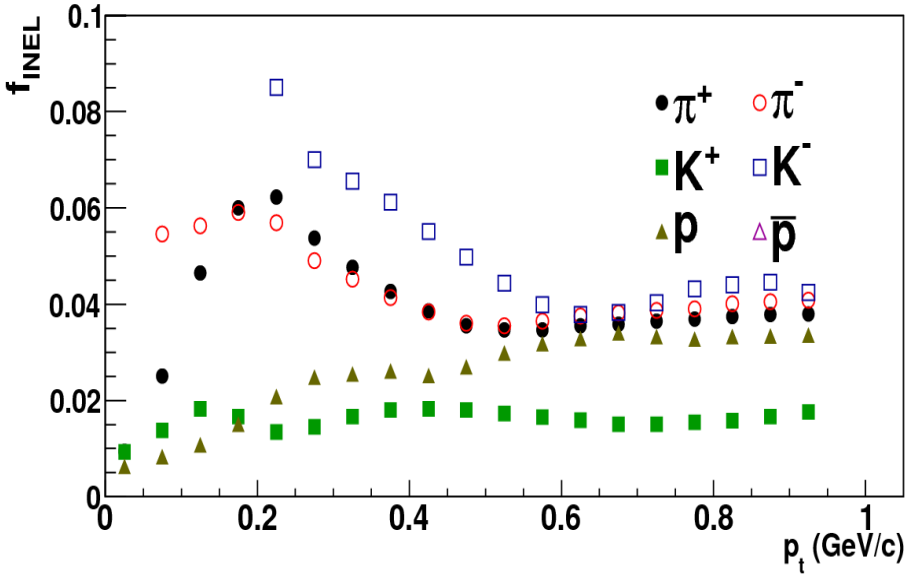
Note: ALICE uses GEANT3 for detector simulation
(GEANT4 validation ongoing)

Inelastic cross sections and efficiency

GEANT3 cross section



Fraction of particles
suffering inelastic collision at R<80 cm



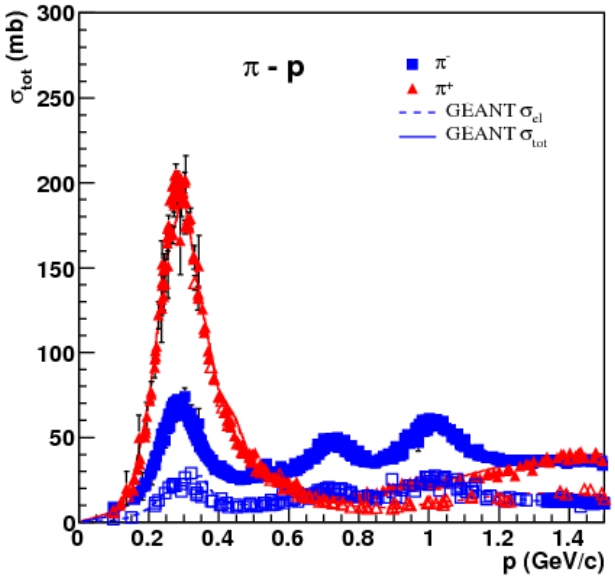
NB: anti-protons off scale

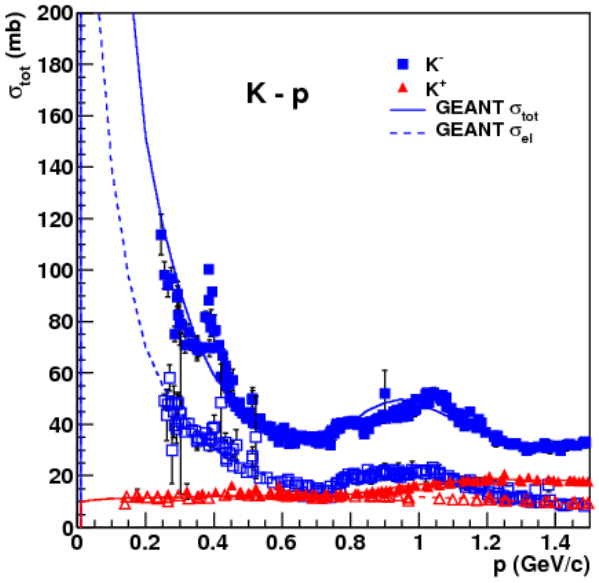
In ALICE: 100 mb for x-Si corresponds to ~1% loss
(depends on material budget)

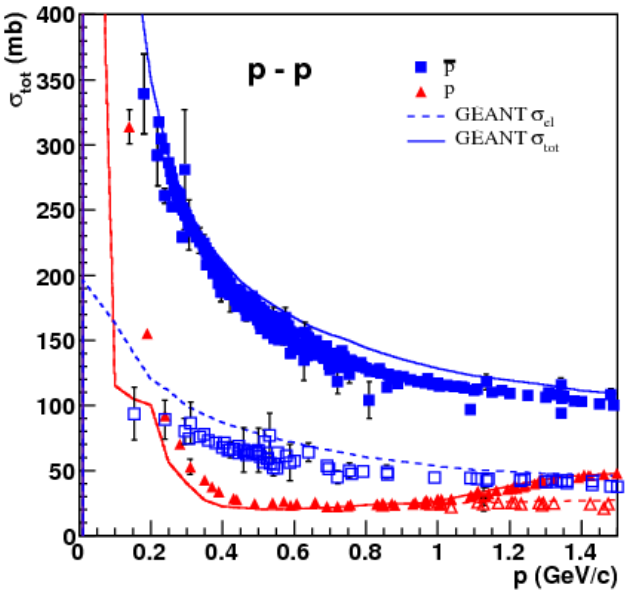
How well do we know the cross sections?

x-p cross sections

Data: PDG





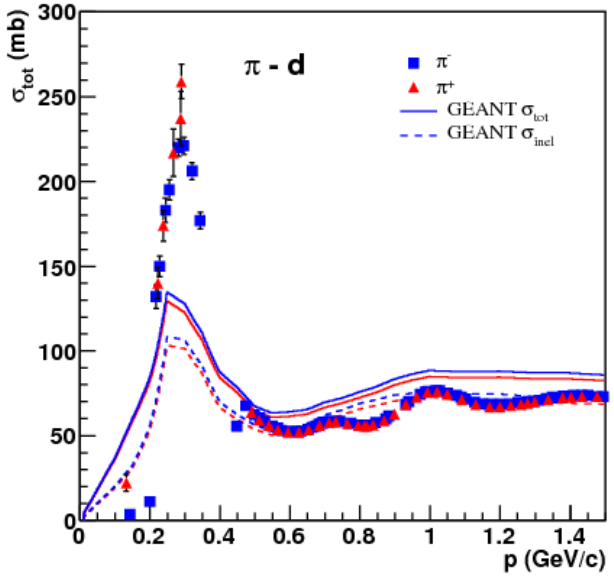


Proton targets:

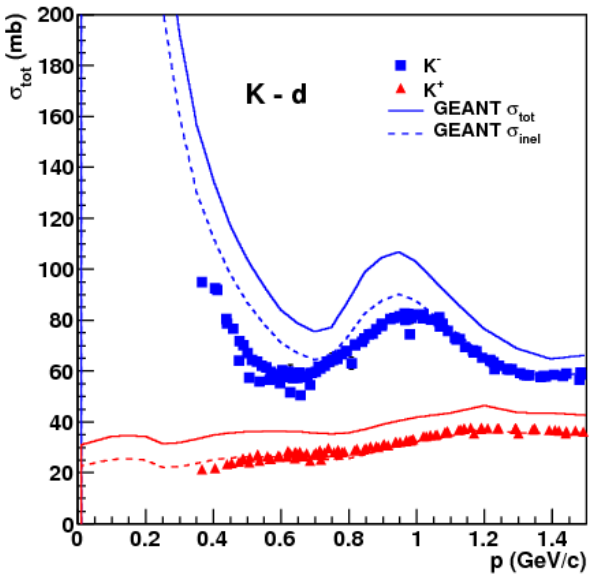
- Lots of data available (PDG)
- Elastic and total cross section
- GEANT3 cross section accurate

x-d cross sections

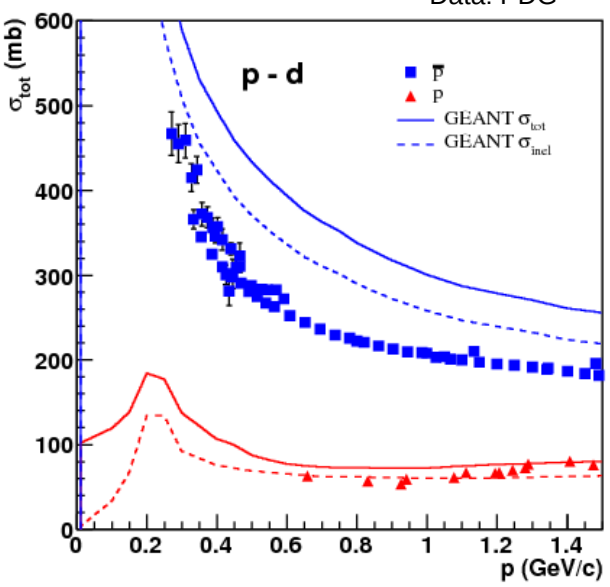
Data: PDG



π: Resonant peak underestimated



K: Cross sections overestimated



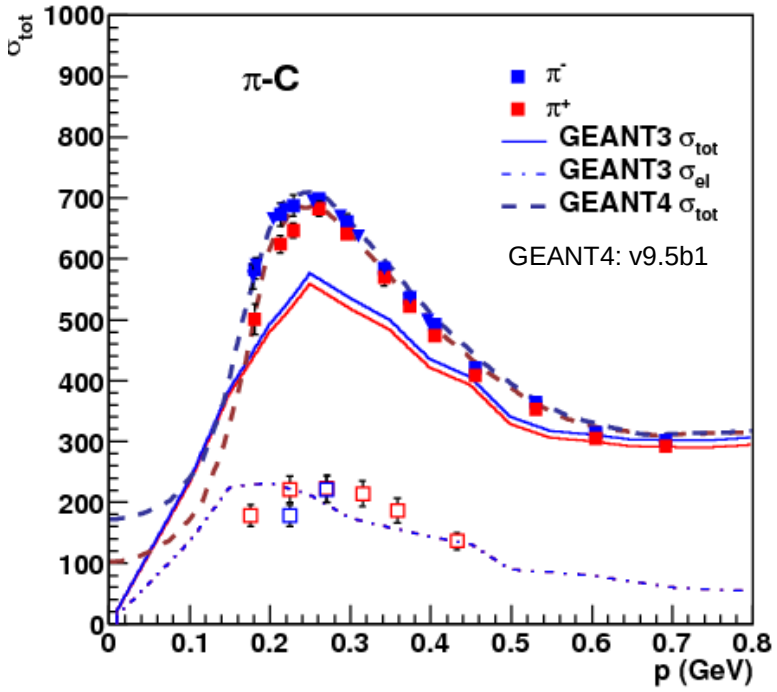
$\bar{p}$: cross section too large in GEANT3

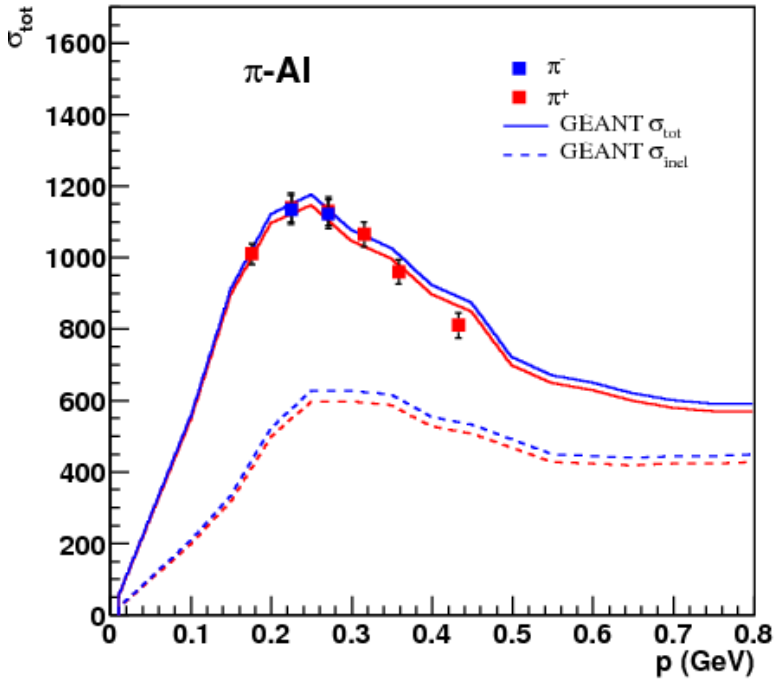
Deuteron targets
- Smallest nucleus
- Lots of data (PDG, total xsec only)

NB: GEANT3(GHEISHA) interpolates from p to Al

π-A cross sections

Data: A.S. Clough et al, Nucl Phys B76, 15
F.Binon et al Nucl Phys B17. 168,
D. Ashery et al PRC23, 2173, A Caroll, PRC 14, 635



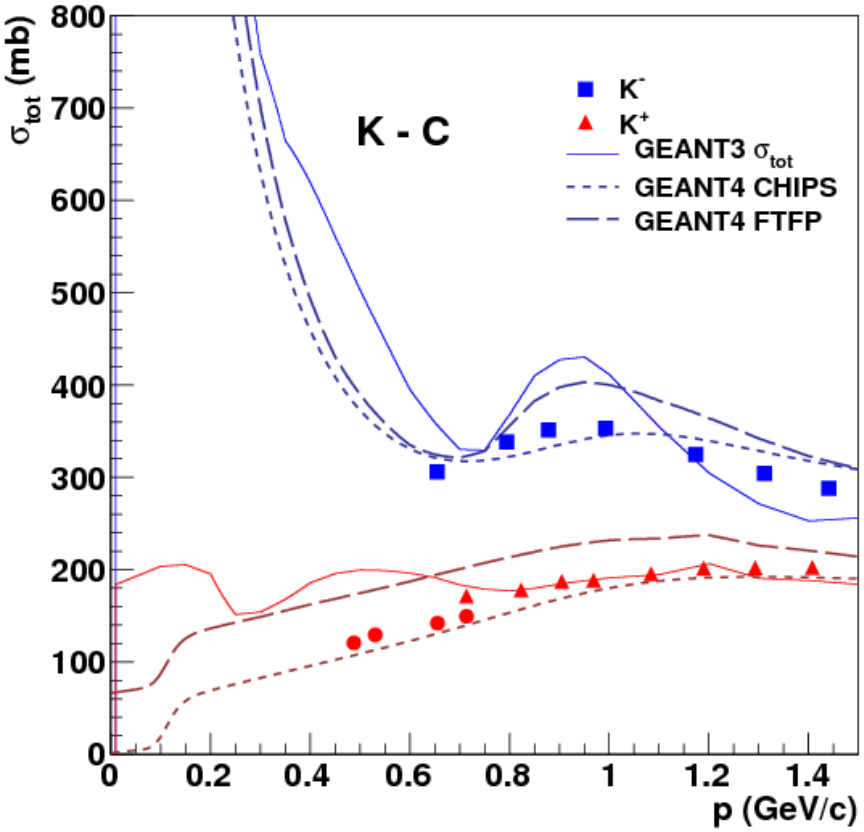


Small charge dependence at low p for C, no dependence for Al
Not much elastic data

GEANT4: good agreement
GEANT3: reasonable agreement

K-A cross sections

Data: D.V. Bugg et al, Phys Rev 168, 1466,
E. Friedmann et al, PRC 55,1304

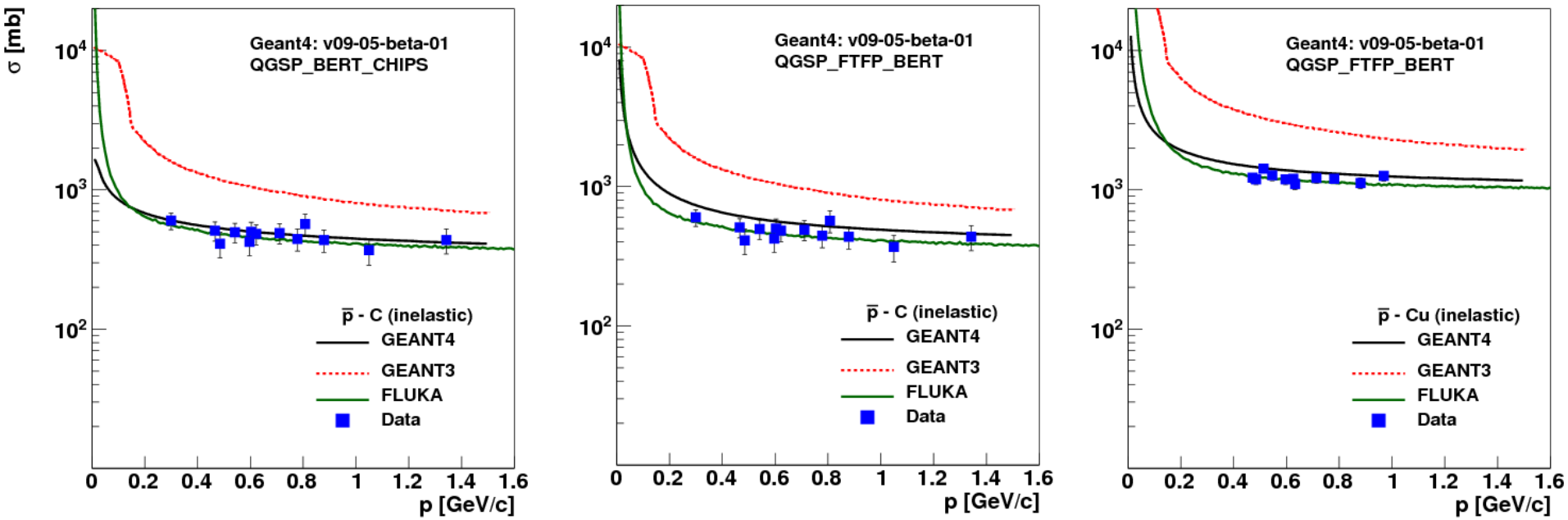


Not much data

GEANT3: Rise of K^- at low p too strong (see K-d)
GEANT4: better agreement with data. CHIPS better than FTFP

p̄-A cross sections

Data: Bendiscioli and Kharzeev, Riv.Nuovo Cim.17N6, 1-142



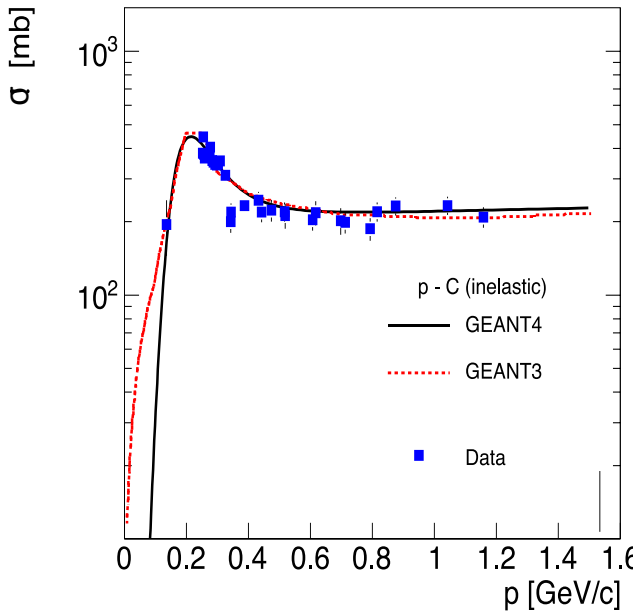
GEANT3: cross section too large by factor 1.5 or so (500-1000 mb)

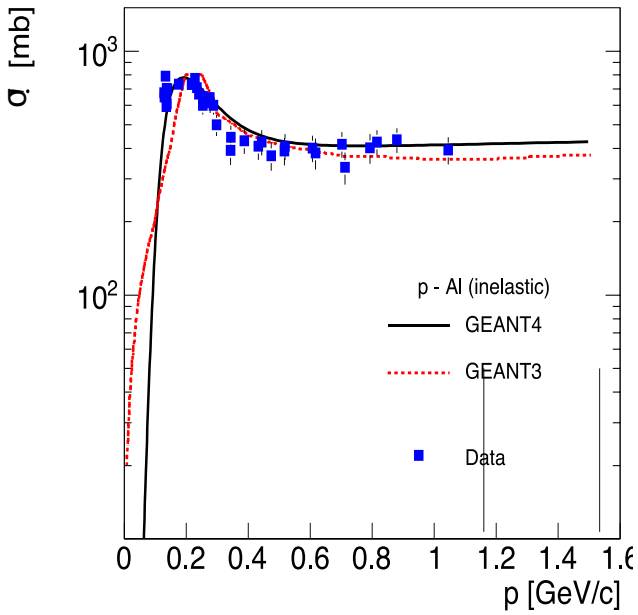
GEANT4 (2 phys lists), FLUKA better

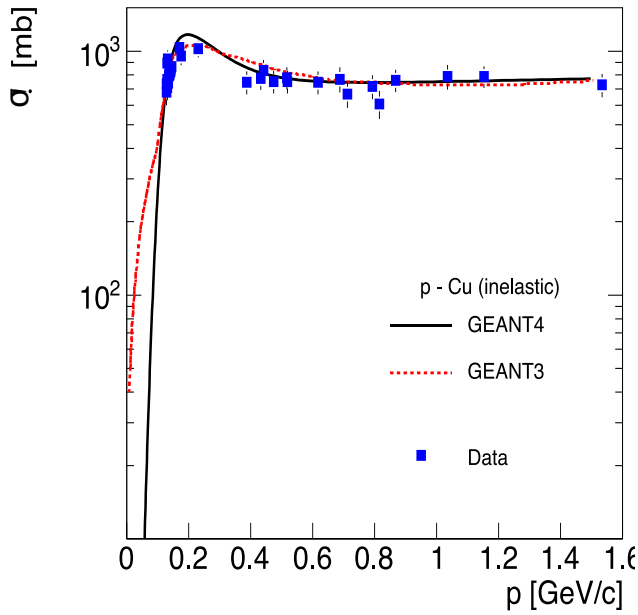
ALICE practice (so far): use GEANT3 + GEANT/FLUKA correction

p-A

data: R.F. Carlson, Atomic Data and Nuclear Data Tables 63 (1996)







Good agreement between data and GEANT3, 4

Conclusion

- Hadron-p cross sections well-tuned in GEANT3
- GEANT3: some disagreements for hadron-A
  - Largest differences for anti-p, K^- (affect results at 5-10% level)
  - Solution until now: use FLUKA-based correction for anti-p
- GEANT4
  - Improvements for all particles
  - Largest effect: anti-p
- Note: non-trivial A-dependence for pions (d to C); not investigated in detail