



### **Simple benchmarks** Final remarks on pion absorption

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**Simulation Project** 

### Outline



- short reminder on the setup
- validation/comparison plots
- conclusion



# **Pion absorption benchmark**



- (see talk given on 3<sup>rd</sup> of March 2004 at the Physics Validation meeting)
- general idea: thin target (Al,Cu,Au) experiment to study individual pion-nucleus process
- experimental data
  - K. Nakai at al., PRL 44, 1446 (1980)
  - D. Ashery et al, PR C23, 2173 (1991)
- simulation
  - G4 setup initially developed by Isidro Gonzalez (Alice)
    - 'fake' thin target experiment large block of material, tracking stopped as soon as a process occurs
    - using QGSP\_BERT physics list
  - Fluka 'bypass' provided by Alfredo Ferrari
    - using the new parametrisation based on the internal Fluka model



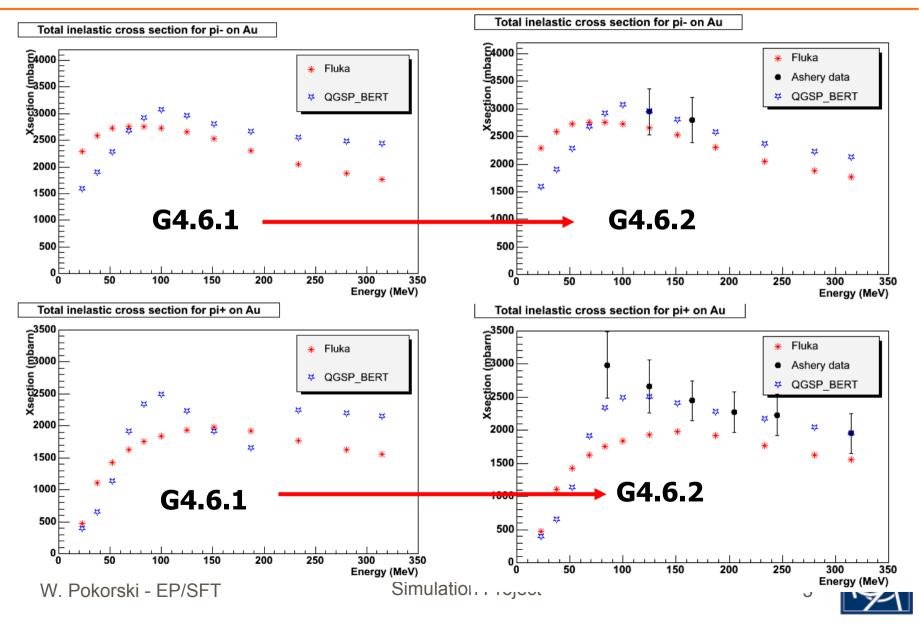
### **Total inelastic cross section**



Total inelastic cross section for pi- on Al Total inelastic cross section for pi- on Cu Xsection (mbarn) 008 00 (uJaqu) 600 Fluka # Fluka Ashery data Ashery data 1600 Section 1400 1200 QGSP BERT QGSP BERT 27 Ť 뀩 \* 600 1000 23 21 ᅏ 22 800 \* \* 400 600 400 200 200 0 L 0 . 1 0 250 250 50 100 150 200 300 350 50 100 150 200 300 350 ſ٥. Energy (MeV) Energy (MeV) Total inelastic cross section for pi+ on Al Total inelastic cross section for pi+ on Cu 006 (mbarn) 008 (mbarn) (uredina) (nredina) Fluka \star Fluka 800 Ashery data Ashery data X2ection X2ection Xsection 22 700 QGSP BERT QGSP BERT 27 22 쁖 600 ¥ 1 22 23 500 **†** 쯑 \* 800 \$ \* 400 600 300 400 200 200 100 = 0 E 0 L 0 50 250 350 100 150 200 300 300 50 100 150 200 250 350 Energy (MeV) Energy (MeV) **Simulation Project** W. Pokorski - EP/SFT

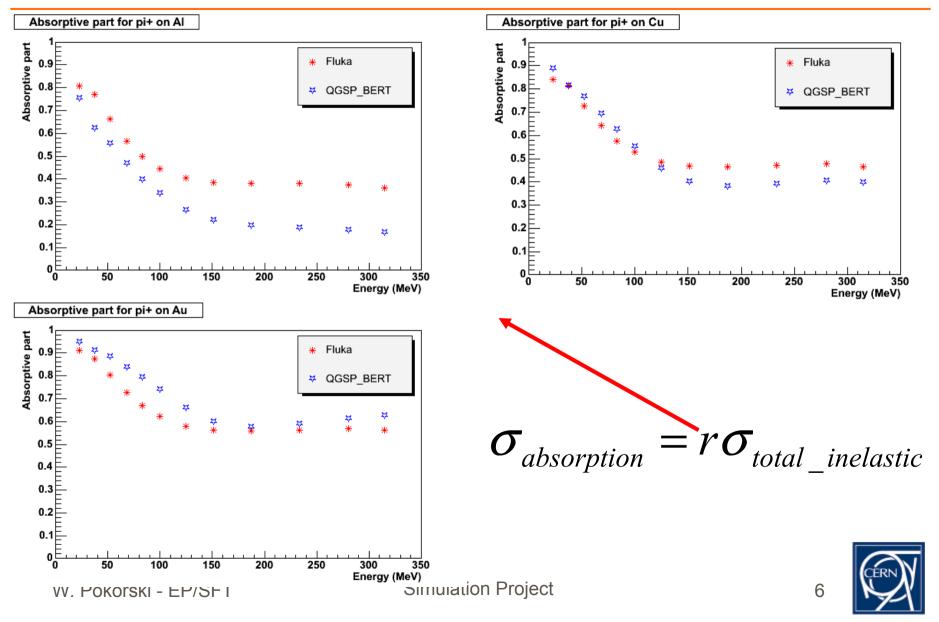
### **G4: Au cross section table corrected**





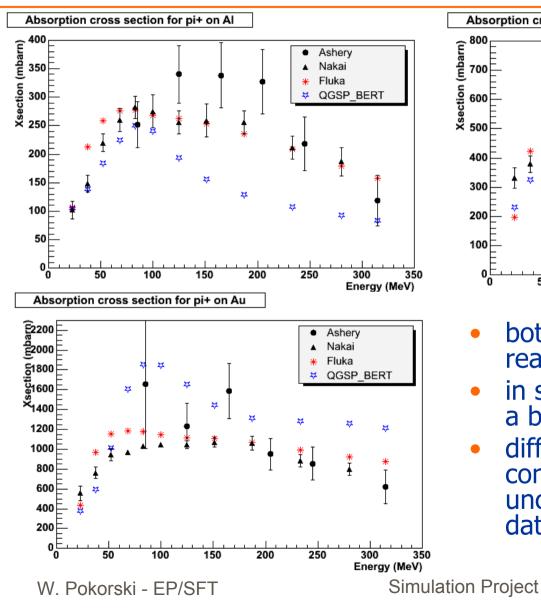
### **Absorptive part for pi+**

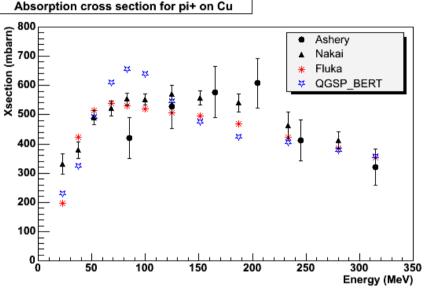




## **Absorption Xsection for pi+**





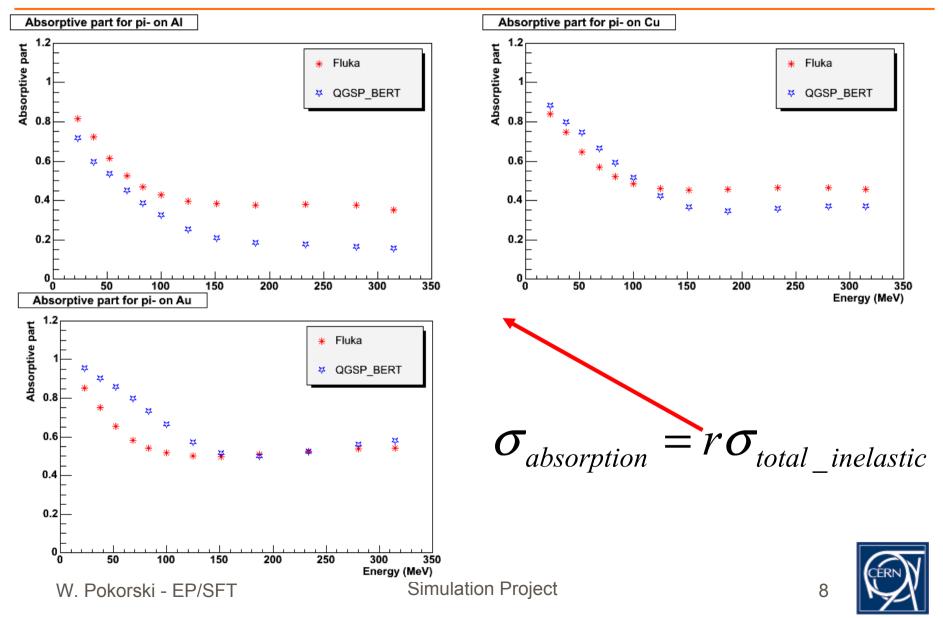


- both G4 and Fluka show reasonable agreement
- in some cases Fluka seems to be a bit better
- difficult to make more conclusions because of big uncertainties in the experimental data



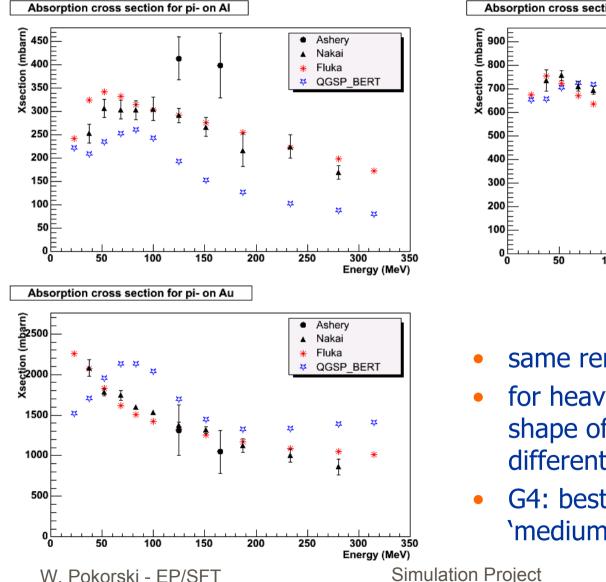
### Absorptive part for pi-



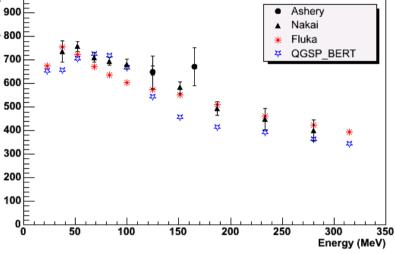


### **Absorption Xsection for pi-**





### Absorption cross section for pi- on Cu

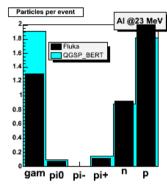


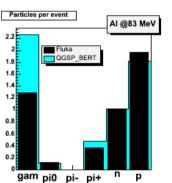
- same remarks as for pi+
- for heavy material (Au) the shape of the QGSP\_BERT quite different (?)
- G4: best agreement for 'medium-weight' materials

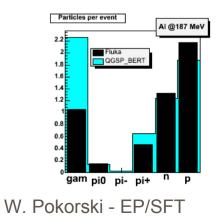


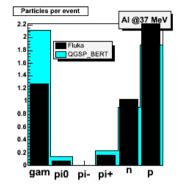
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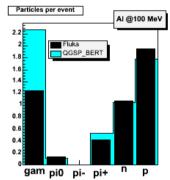
# Particle spectra for pi+ on Al

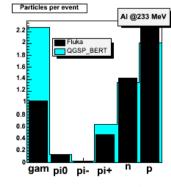














2

1.8

1.6

1.4

1.2

0.8

0.6

0.4

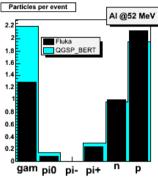
0.2

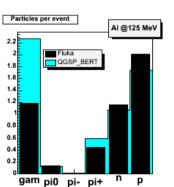
Particles per event

Fluka

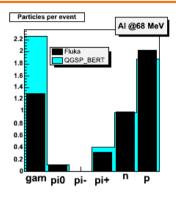
QGSP\_BERT

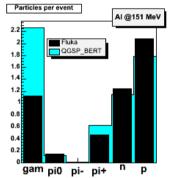
gam pi0 pi- pi+ <sup>n</sup> p

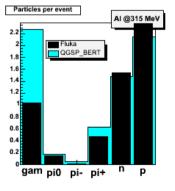




AI @280 MeV











### Particle spectra for pi+ on Cu

Cu @37 MeV

Particles per event

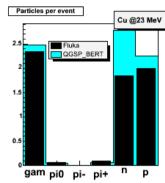
Fluka

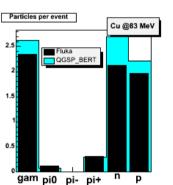
QGSP\_BERT

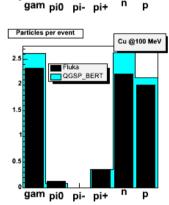
2.5

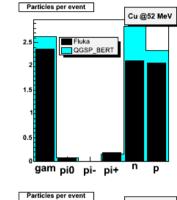
1.5

0.5



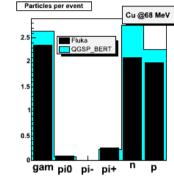




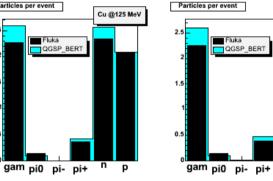


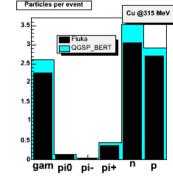
Fluka

QGSP\_BERT

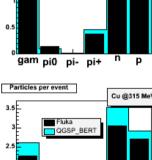


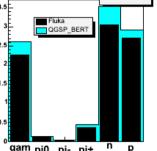
Cu @151 MeV



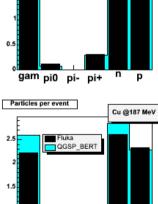








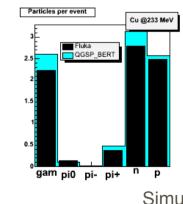
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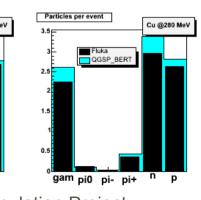


gam pi0 pi-pi+ <sup>n</sup> p

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0.5





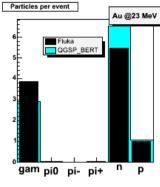
Simulation Project

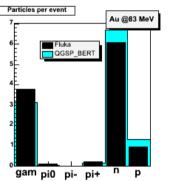
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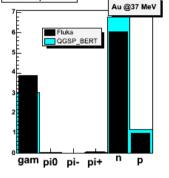
1.5

0.5

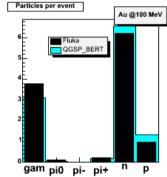
### Particle spectra for pi+ on Au

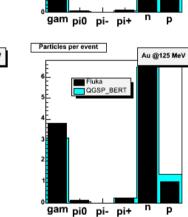






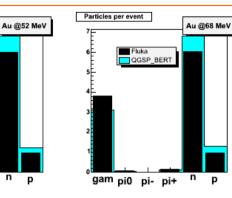
Particles per event

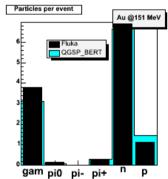


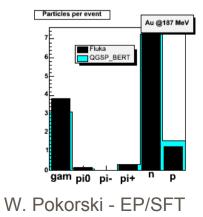


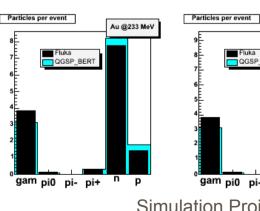
Particles per event

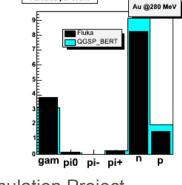
Fluka QGSP\_BERT



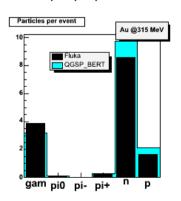








Simulation Project



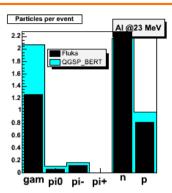


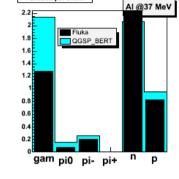


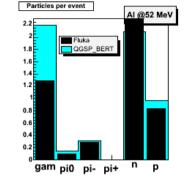
### Particle spectra for pi- on Al

Particles per event









AI @125 MeV

2.2

2

1.8

1.6

1.4

1.2

0.8

0.6

0.4

0.2

Particles per event

Fluka

QGSP\_BERT

2.2

2

1.8

1.6

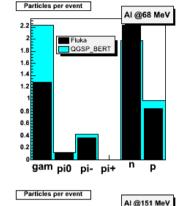
1.4

1.2

0.8

0.6

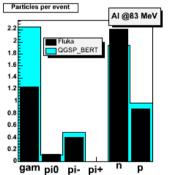
0.4

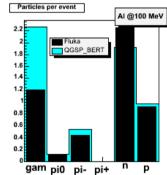


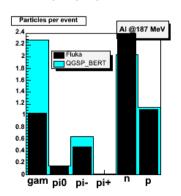
Fluka

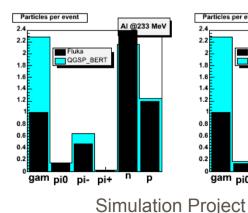
QGSP\_BERT

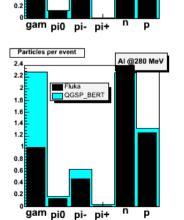
gam pi0 pi- pi+ <sup>n</sup> p

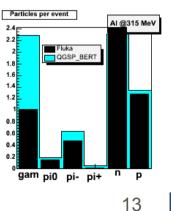










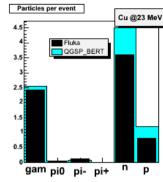


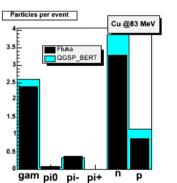


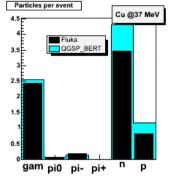
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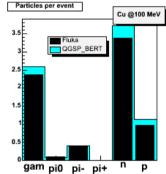


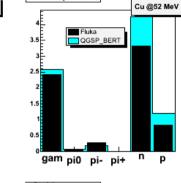
### Particle spectra for pi- on Cu



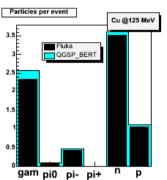


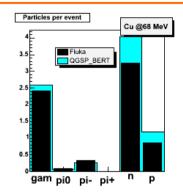


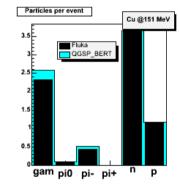


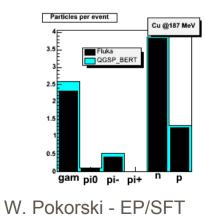


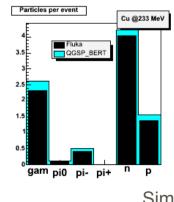
Particles per event

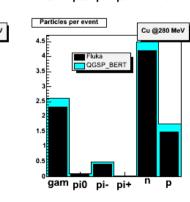








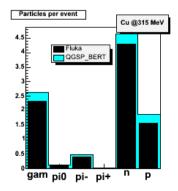




Simulation Project

2.5

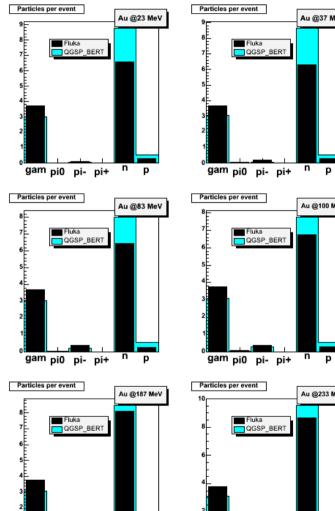
0.5





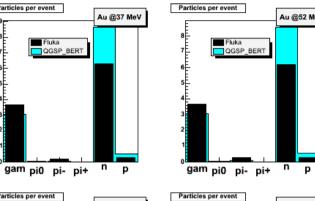


### Particle spectra for pi- on Au



gam pi0 pi- pi+ n p

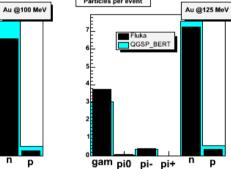
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Au @233 MeV

р

gam pi0 pi- pi+ n



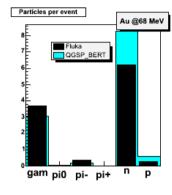
Particles per event

Simulation Project

Fluka

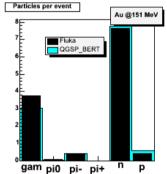
QGSP\_BERT

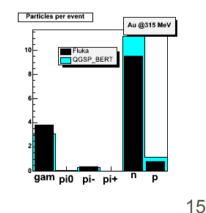
gam pi0 pi- pi+ <sup>n</sup> p



Au @52 MeV

Au @280 MeV







### Summary



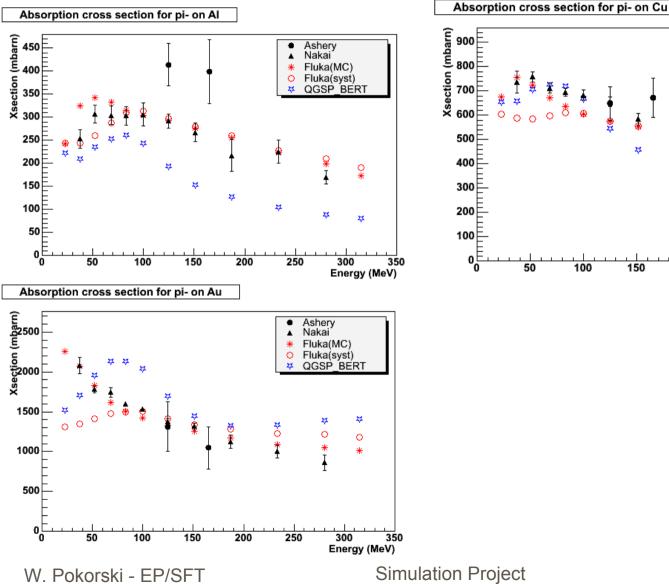
- Both Geant4 and Fluka results show reasonable agreement between simulation and experimental data
- In some cases Fluka seems to be a bit better than G4 with QGSP\_BERT, but hard to judge because of big uncertainties in the experimental data
- BUT: how well do we need to reproduce that data????
- bug corrected in G4 cross section tables
- additional motivation for Fluka to move to the new parametrisation
- LCG note on pion absorption benchmark in preparation

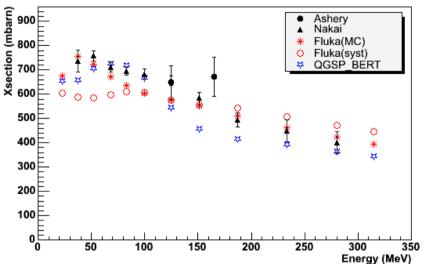
Simulation Project



# Fluka parametrisations (1/2)

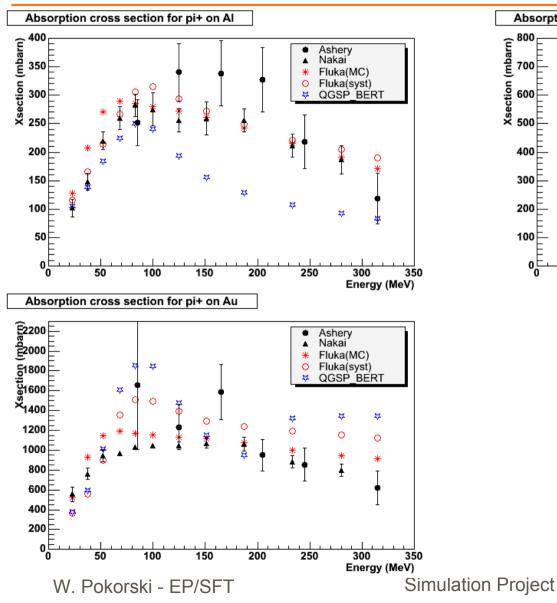












Absorption cross section for pi+ on Cu

