Geant4 Hadronic Validation vs Experimental Data in the Intermediate Energy Range

Status of Work at FNAL

Sunanda Banerjee, Julia Yarba

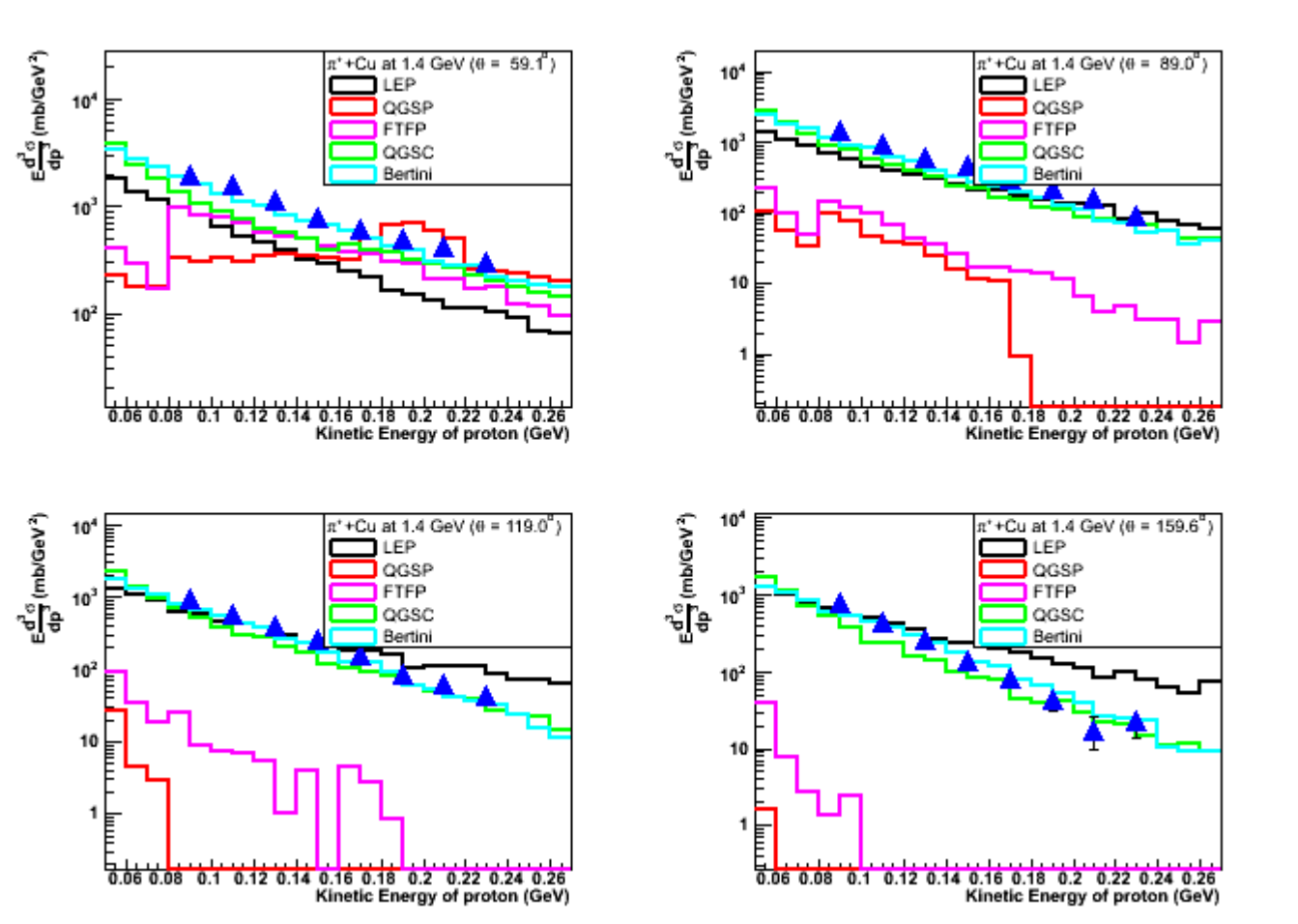
Geant4 Harronic Group Meeting

January 24, 2008

General Information

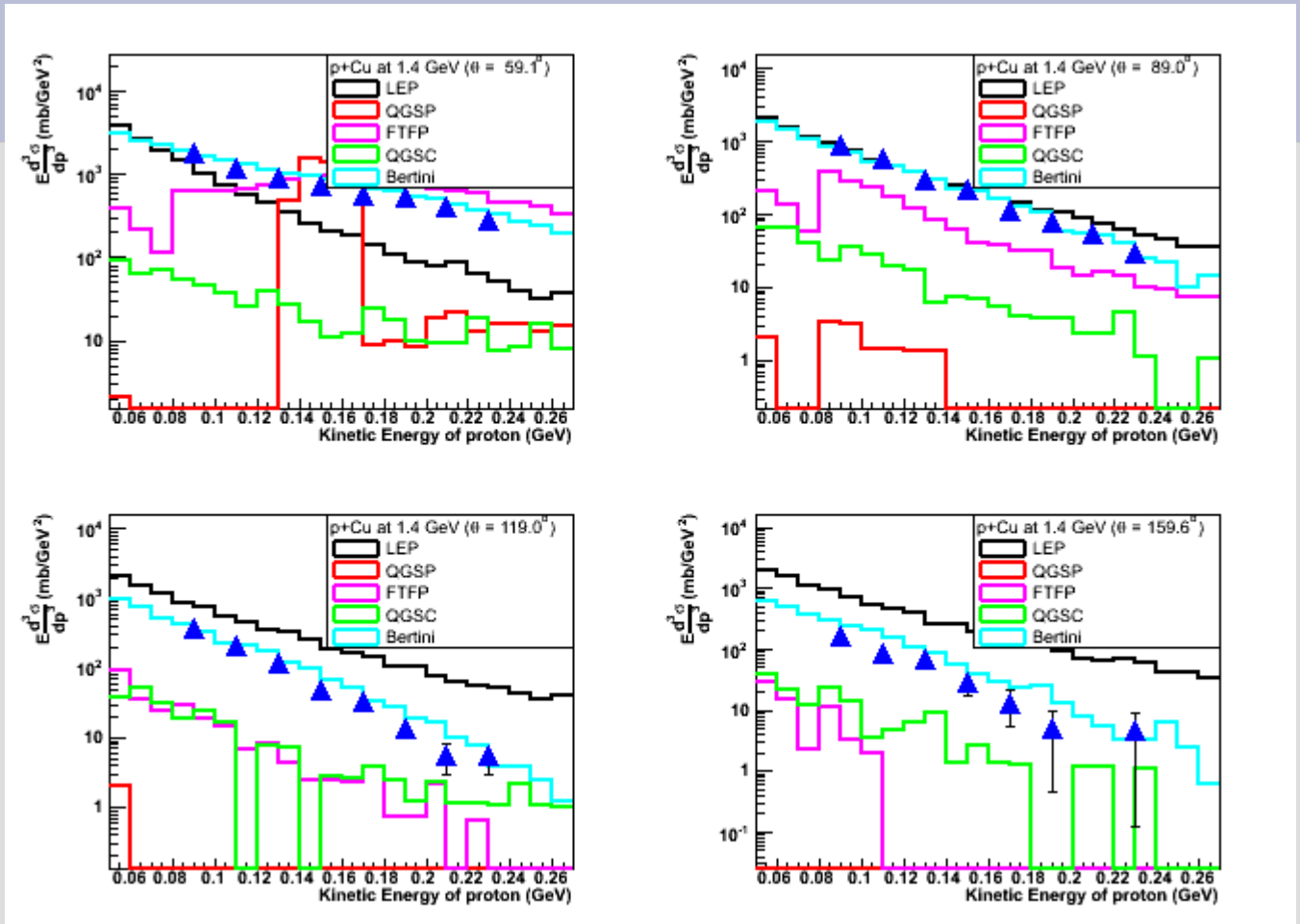
- Extend and improve validation of the Geant4 hadronic models in the intermediate energy range (little efforts until recently)
- Follow-up of earlier efforts: p Be, p C, p Pb, pi+ C, pi+ Pb in the 5-9GeV range (reports by S.Banerjee, J.Yarba in Sept.07, Nov.07)
- Data Sets: ITEP-148-1983, Phys.Atom.Nucl. v42, p116
- Measurements of current interest: inclusive proton production in pi+/p-nucleus interactions, inclusive neutron production in p-nucleus interactions; beam energy 1-9GeV; Cu, Pb targets
- Data for incl. neutron production extend at a few MeV KE
- Data quality: stat.err.1-10%, syst.err.quoted at 5-6%
- Geant4.9.0.p01; model-level (LEP, QGSP, QGSC, FTFP, Bertini)

pi+ Cu -> p X at 1.4GeV



Bertini is closest; QGSP OK at large angles, underestimates at small angles

p Cu -> p X at 1.4GeV



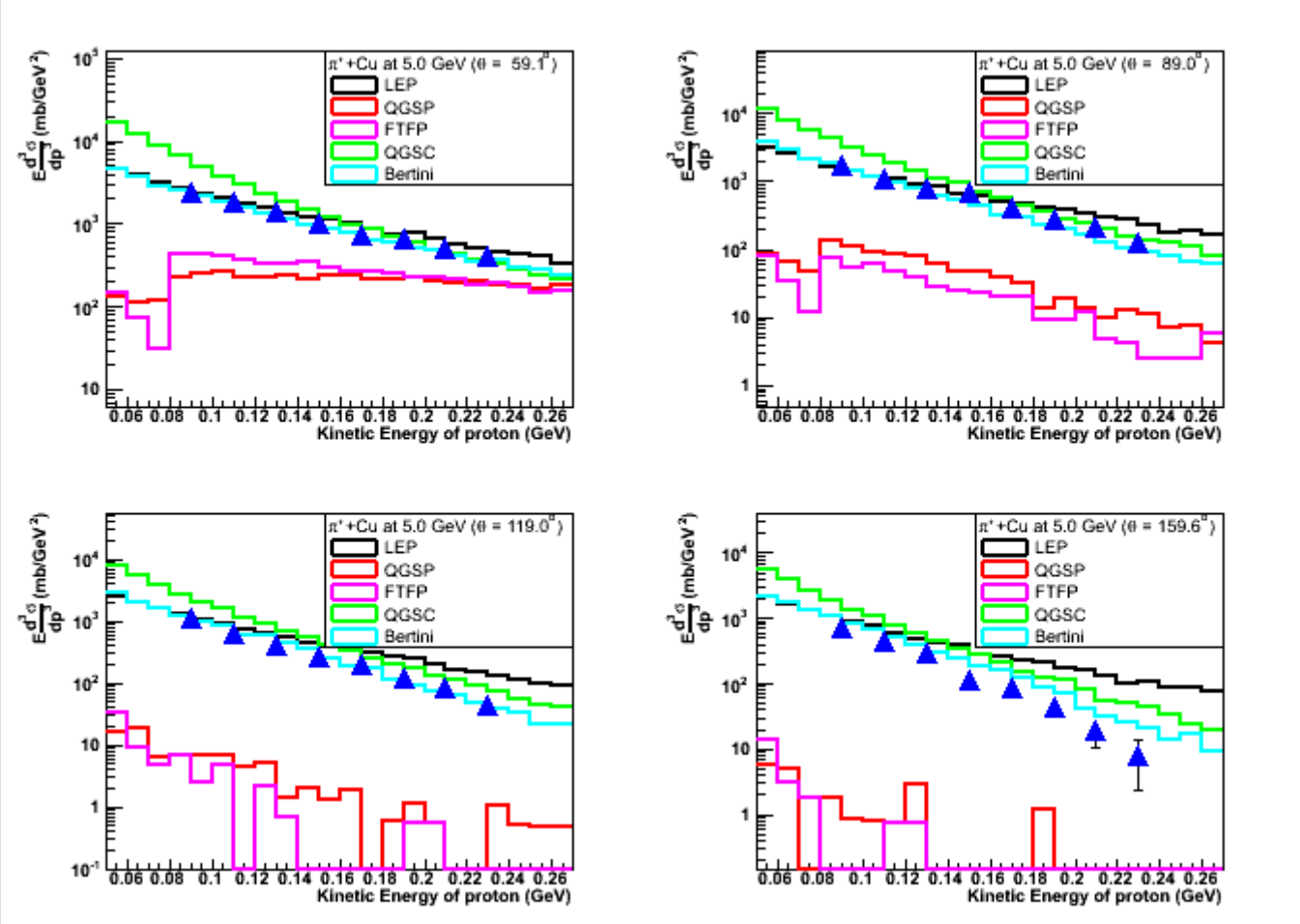
Bertini is closest;
other models are off

Frequent error from either QGSP (not exactly valid at this E), QGSC (should be valid)

*** G4Exception : 007 issued by G4HadronicProcess
GeneralPostStepDoItFailed.

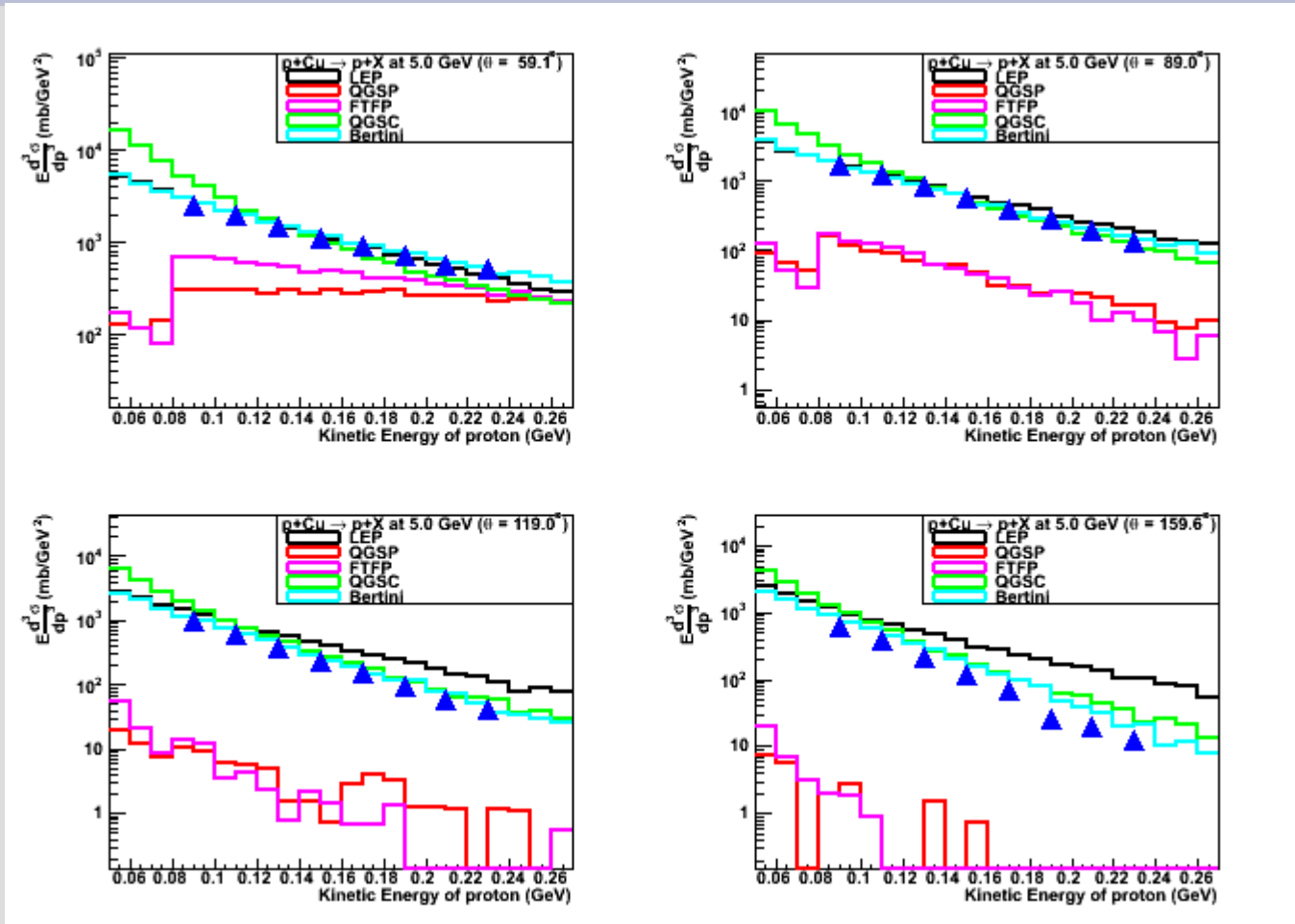
*** Fatal exception *** (will be fixed in v4.8.3) ***

pi+ Cu -> p X at 5.0GeV



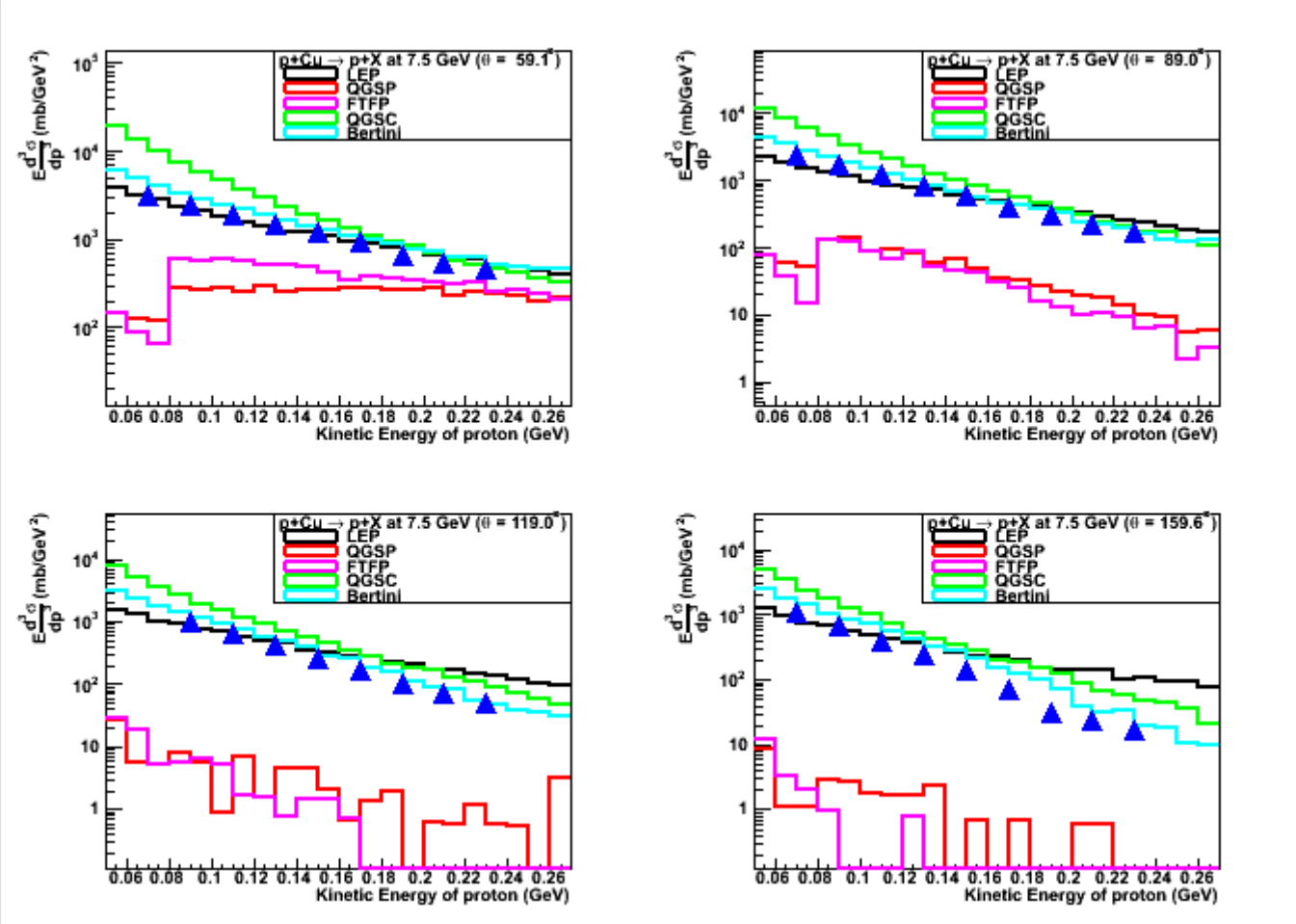
Bertini OK; QGSP is worse than LEP in this case

p Cu -> p X at 5GeV



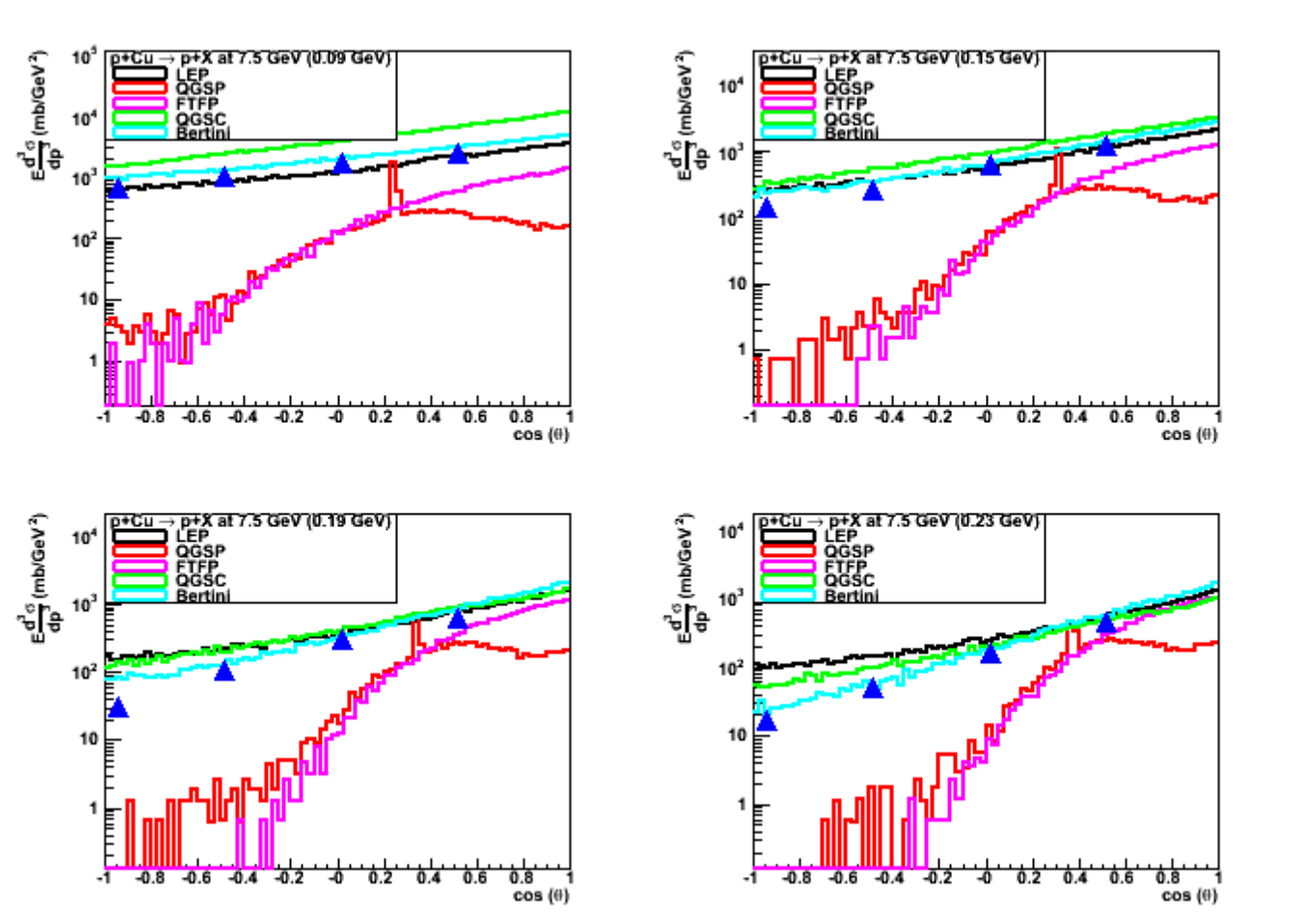
Bertini, QGSC describe data; LEP is OK in fwd hemisphere, off in bck hemisphere

p Cu -> p X at 7.5GeV



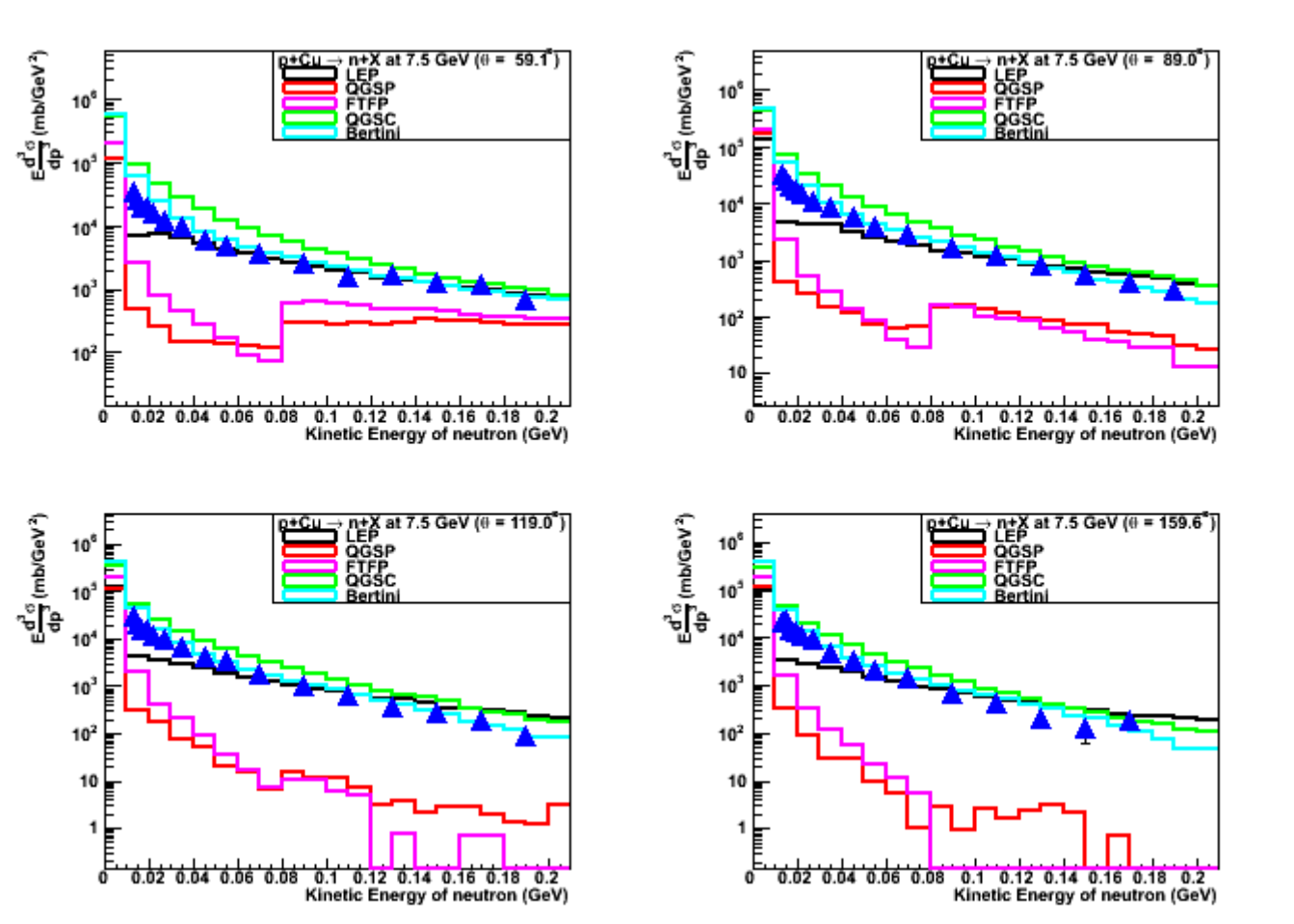
Bertini close to data; LEP OK in fwd hemisphere, off in bck hemisphere

p Cu -> p X at 7.5GeV, angular distributions



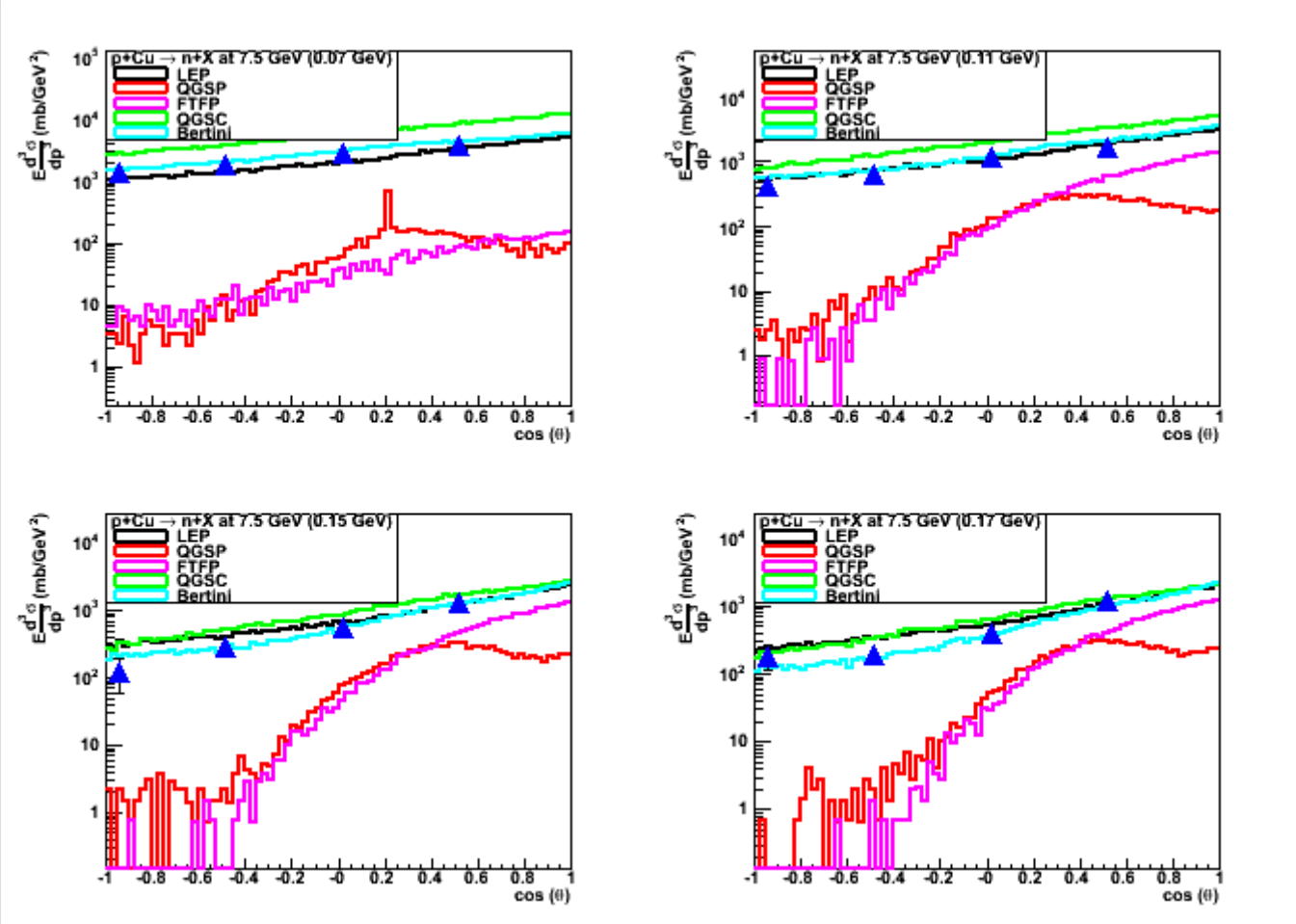
Bertini reasonable vs data; LEP OK in fwd hemisphere, off in bck hemisphere

p Cu -> n X at 7.5GeV



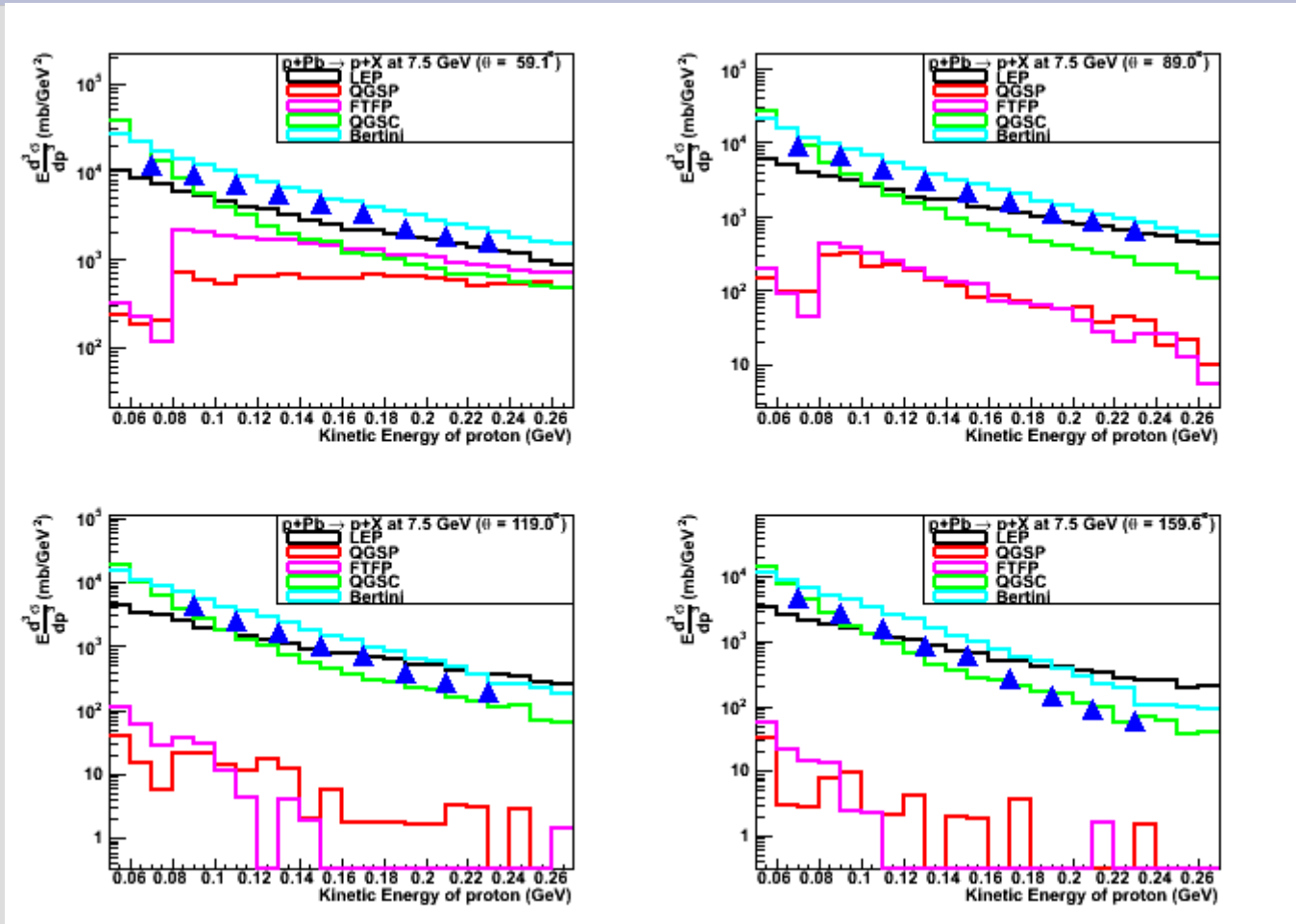
Bertini close to data; QGSC overestimates, especially at low KE; LEP underestimates at low KE

p Cu -> n X at 7.5GeV, angular distributions



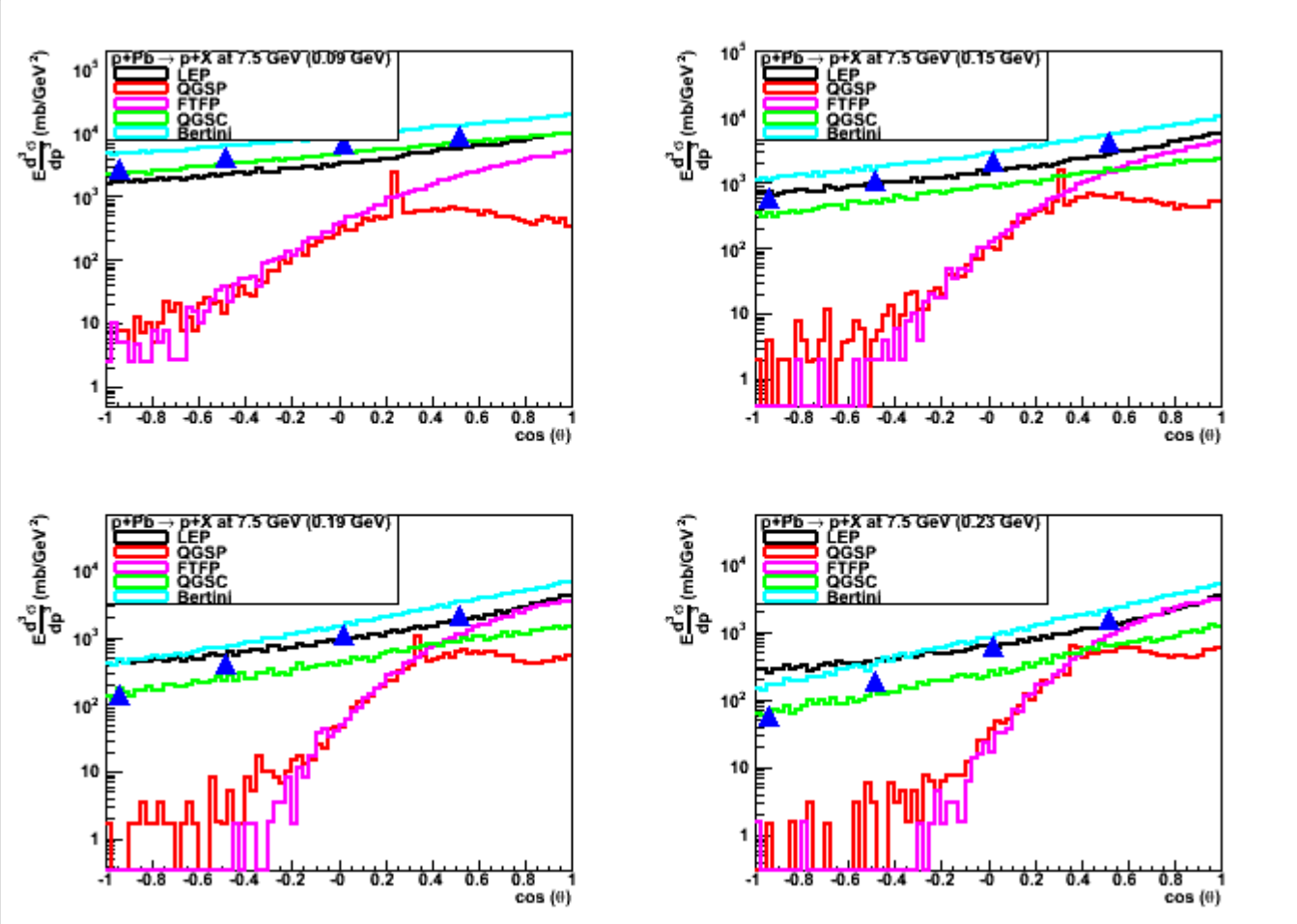
Bertini reasonable; LEP underestimates at low KE; QGSC overestimates at low KE

p Pb -> p X at 7.5GeV

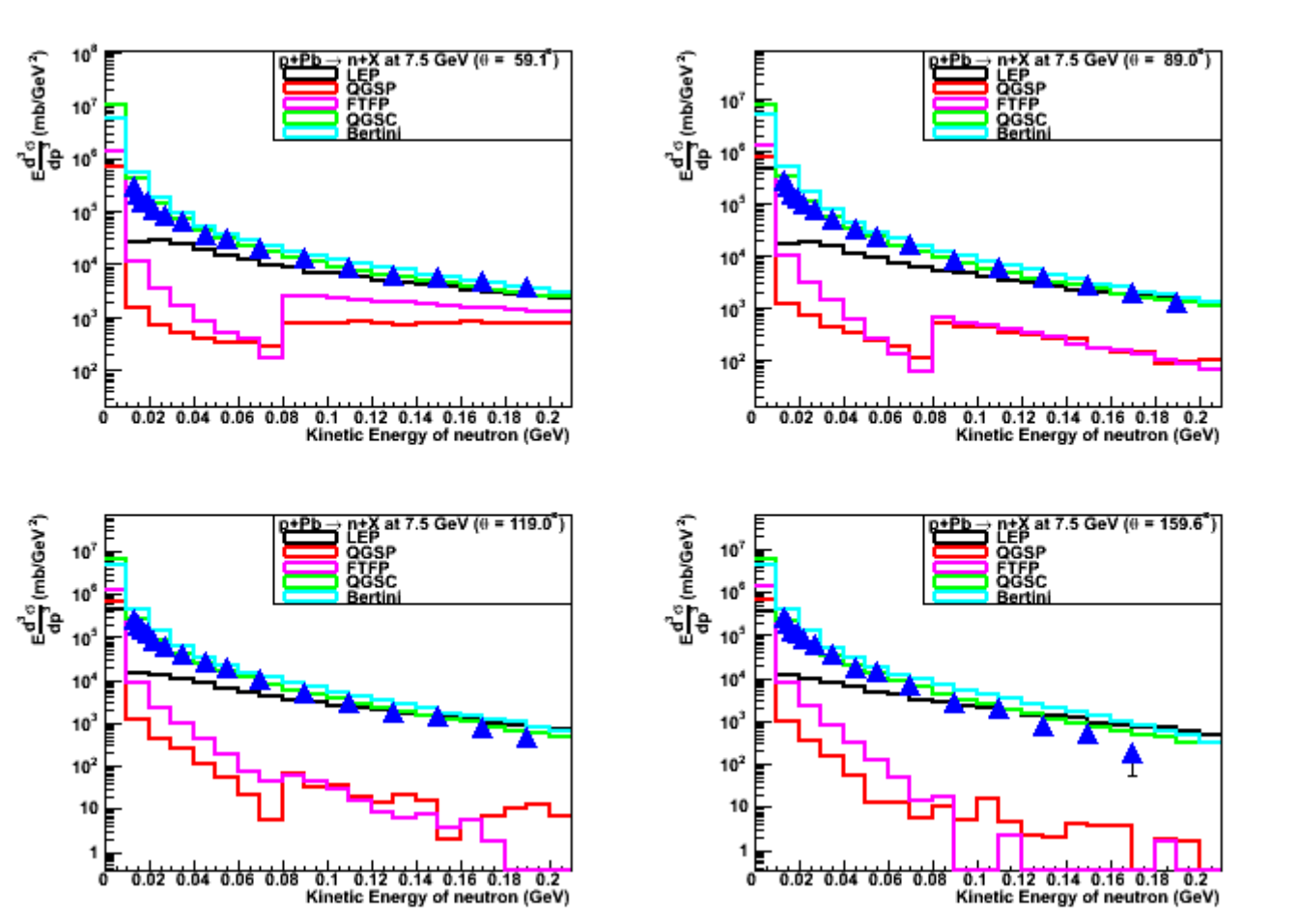


LEP is more reasonable overall, except very bck final state particles (QGSC is OK in bck)

p Pb -> p X at 7.5GeV, angular distributions

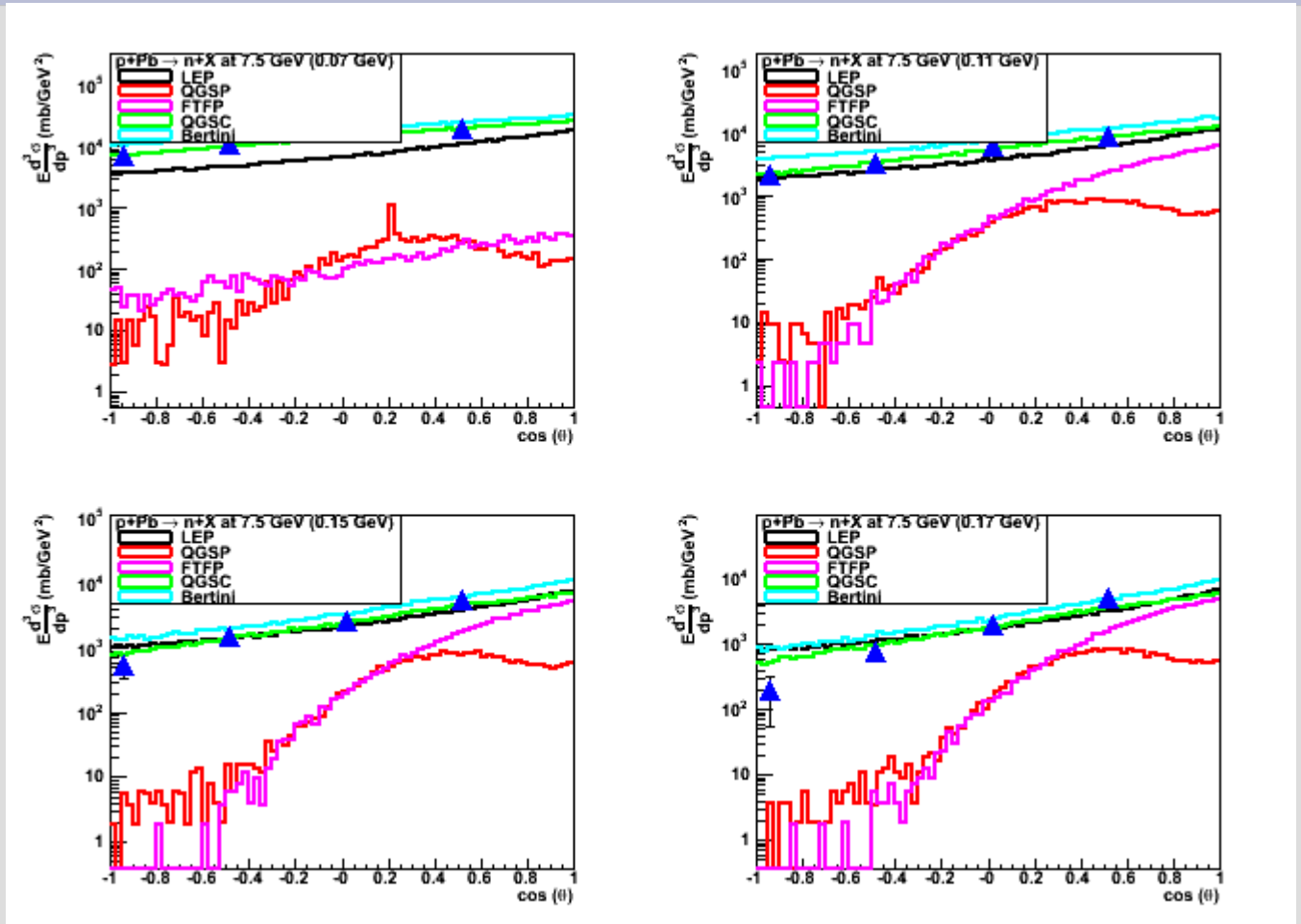


p Pb -> n X at 7.5GeV



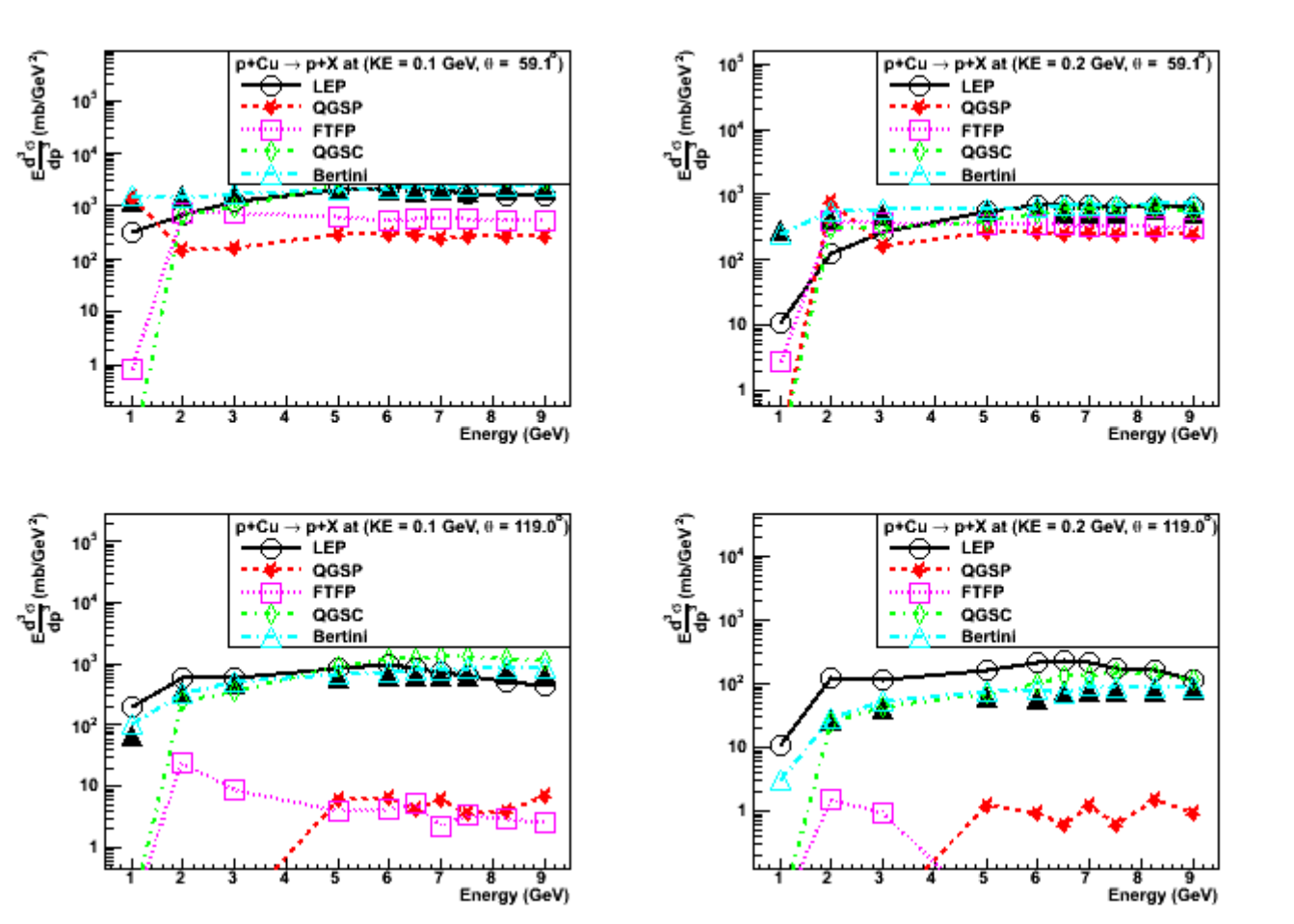
Bertini, QGSC close to each other, describe data

p Pb -> n X at 7.5GeV, angular distributions



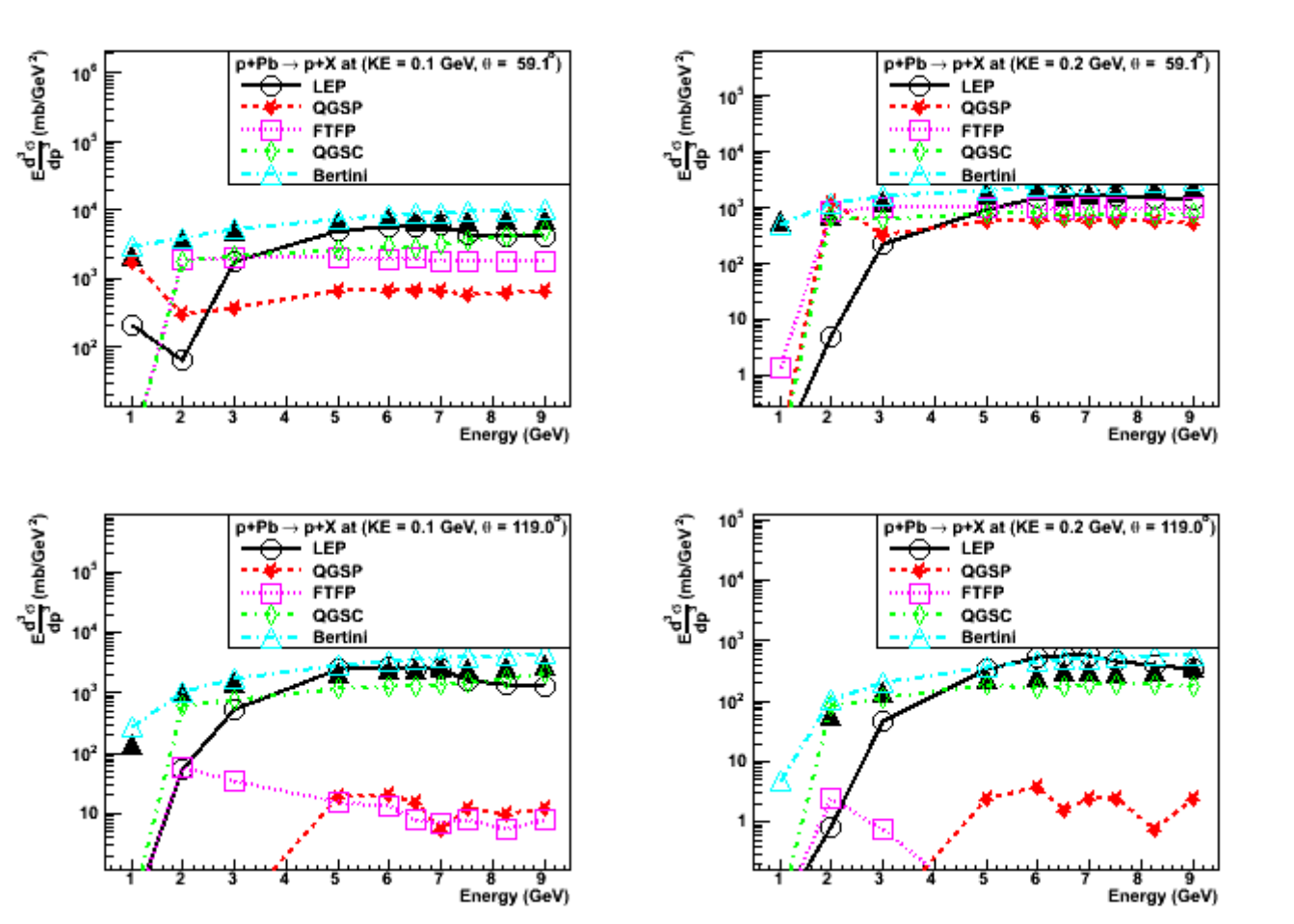
Bertini, QGSC close to each other, describe data

p Cu -> p X as a function of beam energy



Bertini, QGSC close starting at ~2GeV, very different at low energies; QGSP, FTFP off

p Pb -> p X as a function of beam energy



LEP is close to data starting at ~5GeV; Bertini OK at low energies; QGSC off at low energies

CPU Performance

	p Cu (7.5GeV)	p Pb (7.5GeV)	pi+ Cu (5.0GeV)
Bertini:	0.0029	0.0041	0.0024
FTFP:	0.0024	0.0028	0.0019
LEP:	0.0011	0.0012	0.0009
QGSP:	0.0023	0.0026	0.0020
QGSC:	0.0352	0.0476	0.0300

Summary

- Over a variety of comparisons, predictions by theory-driven Bertini model appear to be closer to the exp. data than the outcome of other G4 models, for targets “up to Cu”; QGSC is comparable in some cases
- For heavier targets (Pb) predictions by LEP are closest with exp.data for p A -> p X , pi+ A -> p X
- For p A -> n X even for heavier targets (Pb) Bertini's predictions are closer to the data; QGSC comparable
- LEP is the fastest; QGSP, FTFP, Bertini ~2x as much CPU; QGSC – order of magnitude larger CPU !