Validation of low mass diffraction dissociation (hA thin target)

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Abstract

A low mass single diffraction (LMSD) dissociation model was validated for hadron-nucleus interactions with the hadron momentum in the range 31-320 GeV/c (NA49, NA61, E597). The validation is presented in terms of different spectra of secondary particles, simulated by FTFP_BERT physics list with activated or not LMSD.

1 Motivation

The main motivation was to improve the simulation of secondary mesons in the proton-nucleus interaction used for the formation of of accelerator based neutrino beams. The low mass single (projectile) diffraction (LMSD) process, which produces secondary mesons in very forward region, was not implemented in GEANT4 . It was possible to implement LMSD using extended Drell-Hiida-Deck model, taking into account that, according to the specification of the GEANT4 hadronic cross-section, LMSD is related to the hadronic elastic cross-section. The latter, in GEANT4 , includes the coherent elastic and single diffraction cross-sections.

Here we describe shortly the LMSD generator and show the validation results for proton-nucleus interactions.

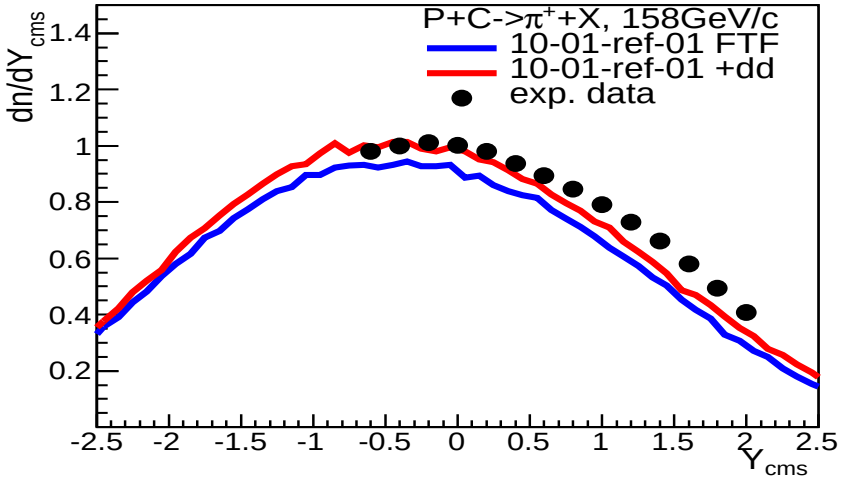
2 G4LMsdGenerator description

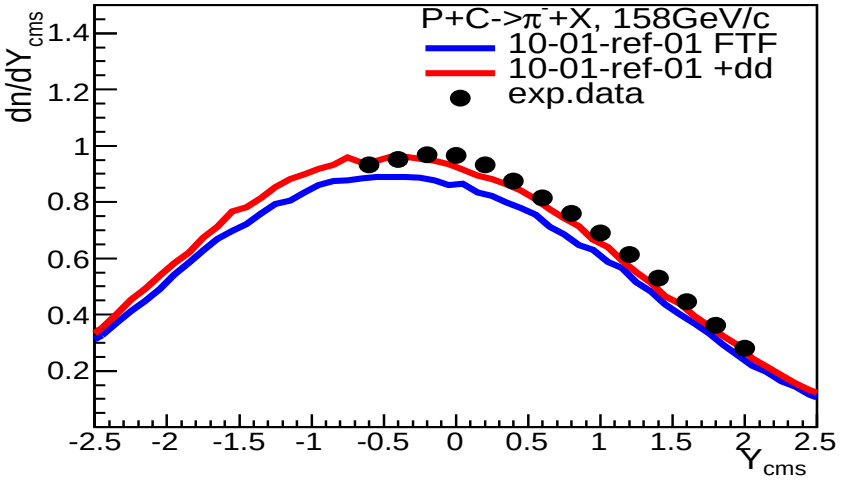
1. The single diffraction dissociation model was developed utilizing the quark-diquark representation of elastic scattering [1]. The model predicts the mass spectrum of diffractively excited hadron.

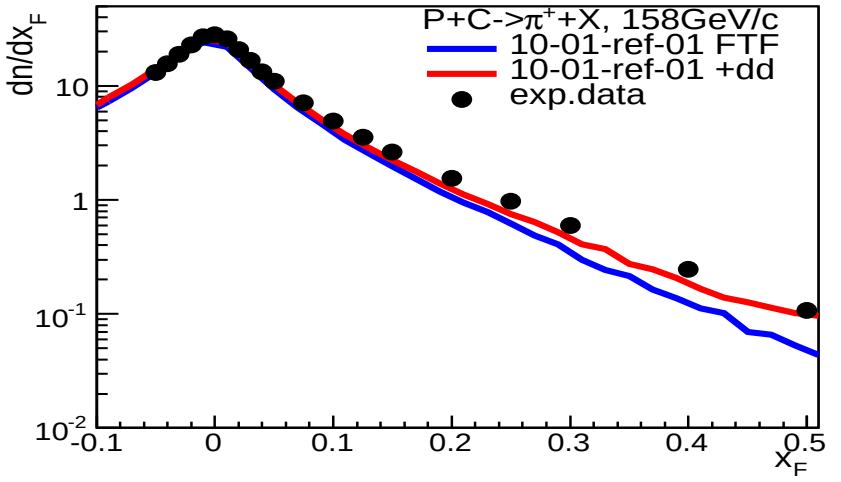
2. The Glauber-Gribov model [2] allows us to calculate the ratio of the single-diffraction to elastic hadron-nucleus cross-sections.

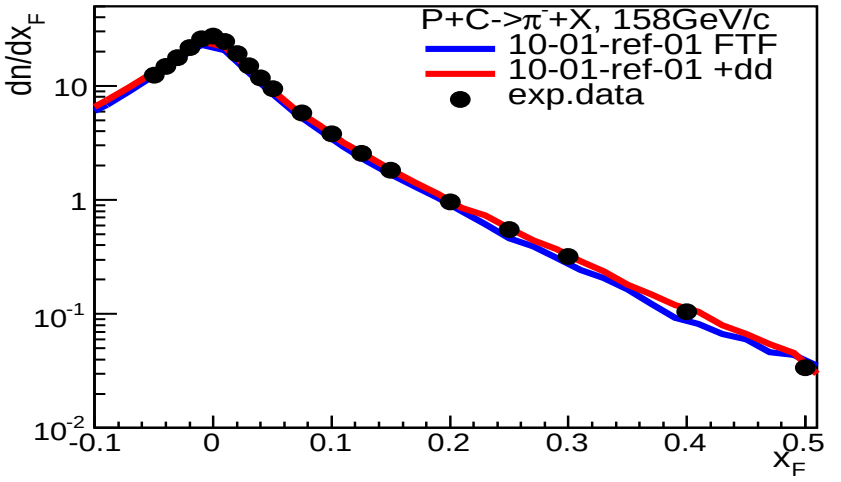
3. The ratio can be used for the activation of the G4LMsdGenerator generator modifying the existing hadron-nucleus elastic constructor (new G4HadronHElasticPhysics(verboseLevel,true)). Therefore it will be admixture of the diffraction dissociation secondaries in the very forward elastic kinematics.

4. A projectile $(p, n, \pi^{\pm}, K^{\pm})$, interacting with a target, gets a momentum, increasing (diffractive excitation) its mass according to the model spectrum. The excited hadron being elastically scattered is represented by a kinematically allowed Roper resonance, which in turn experiences recursive decays down to not short-lived particles [3].

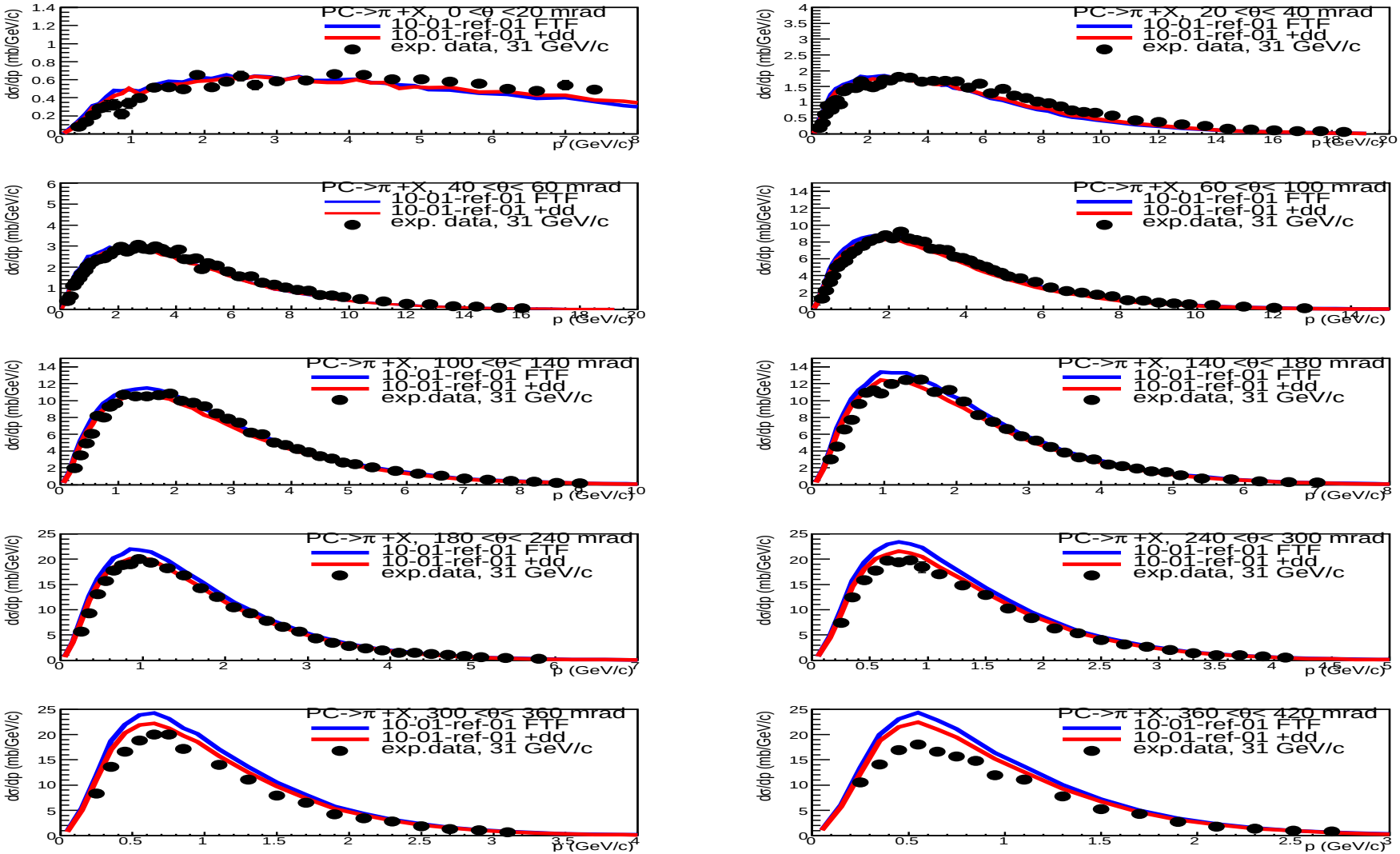








Data from NA49 experiment.



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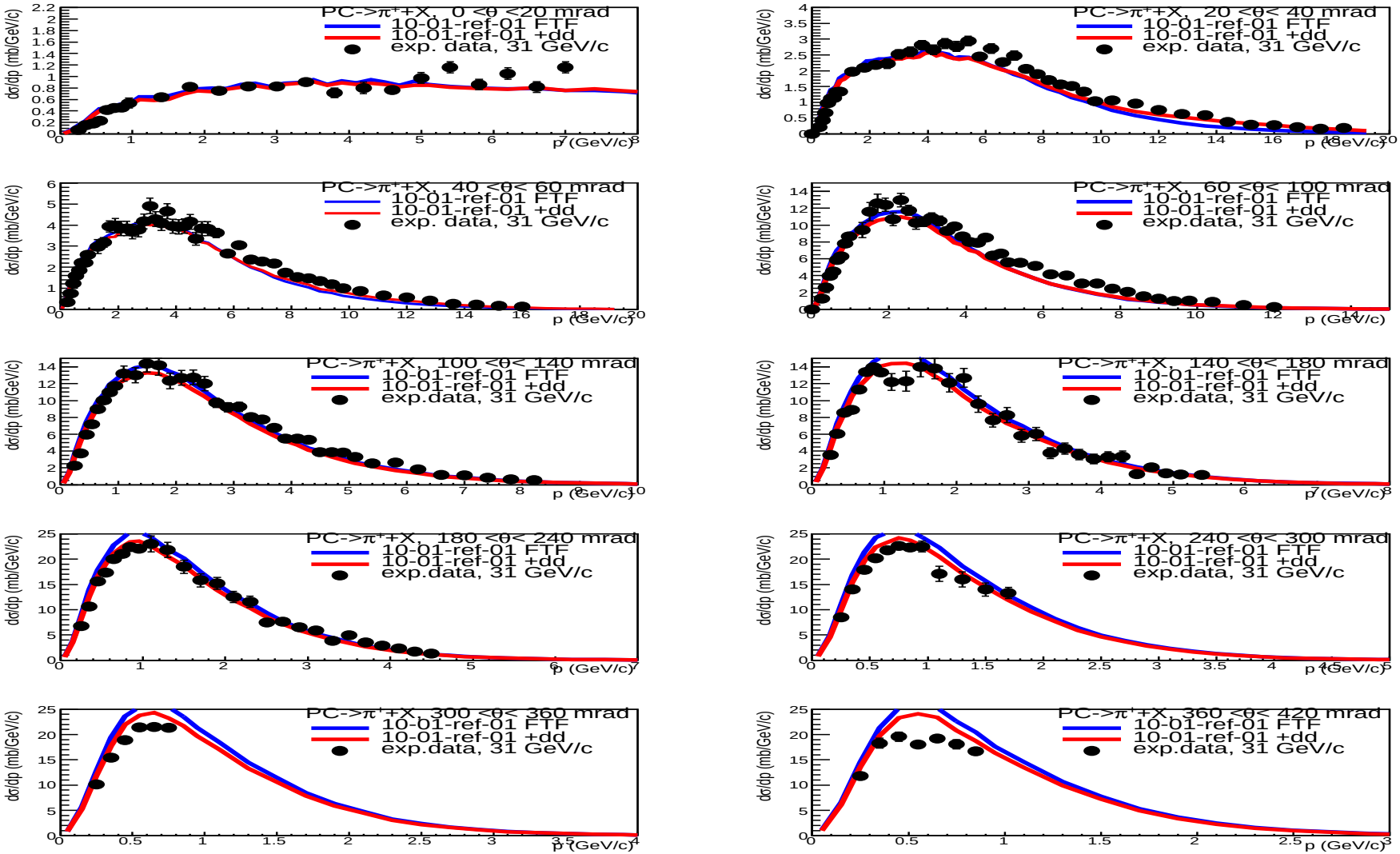

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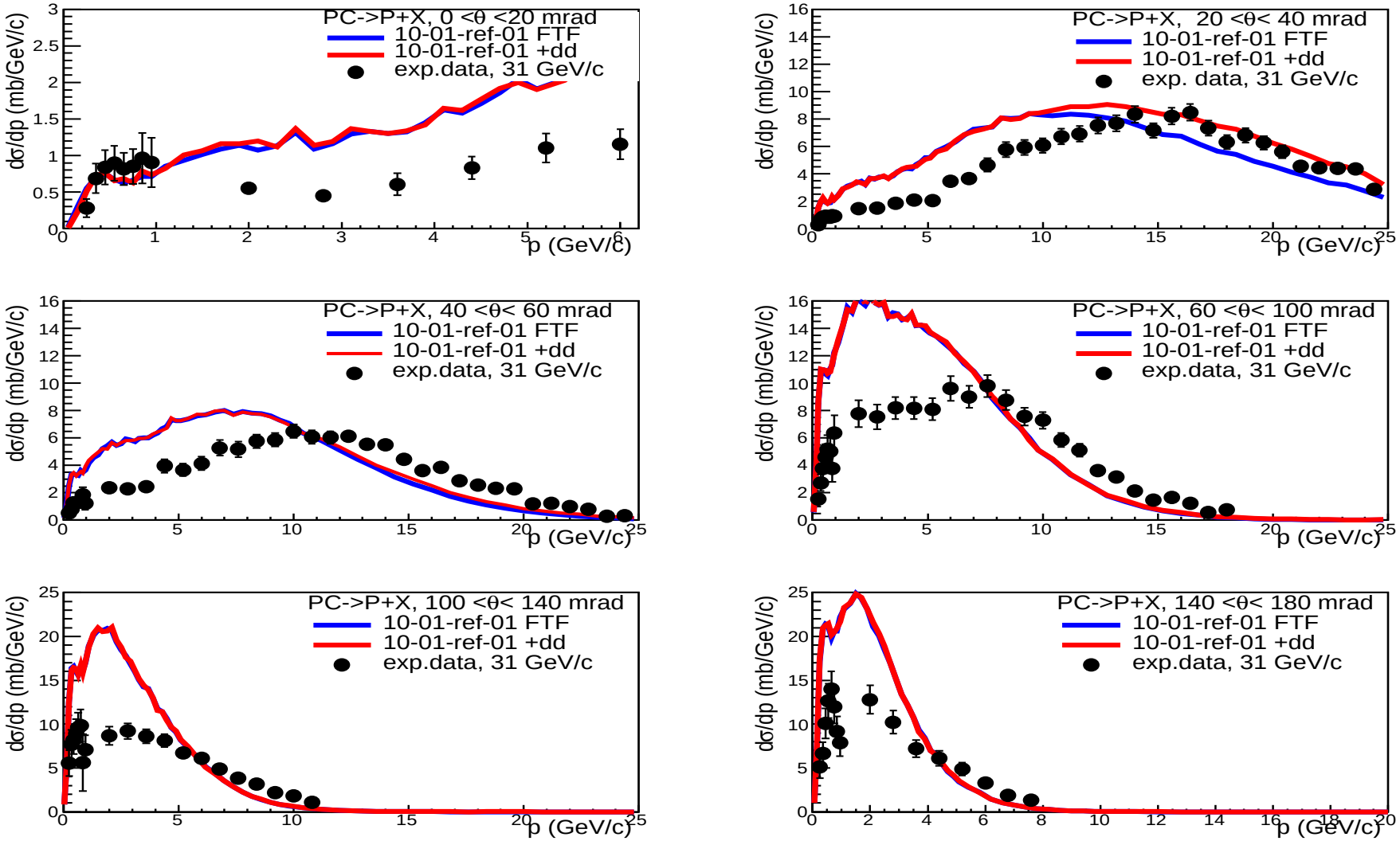

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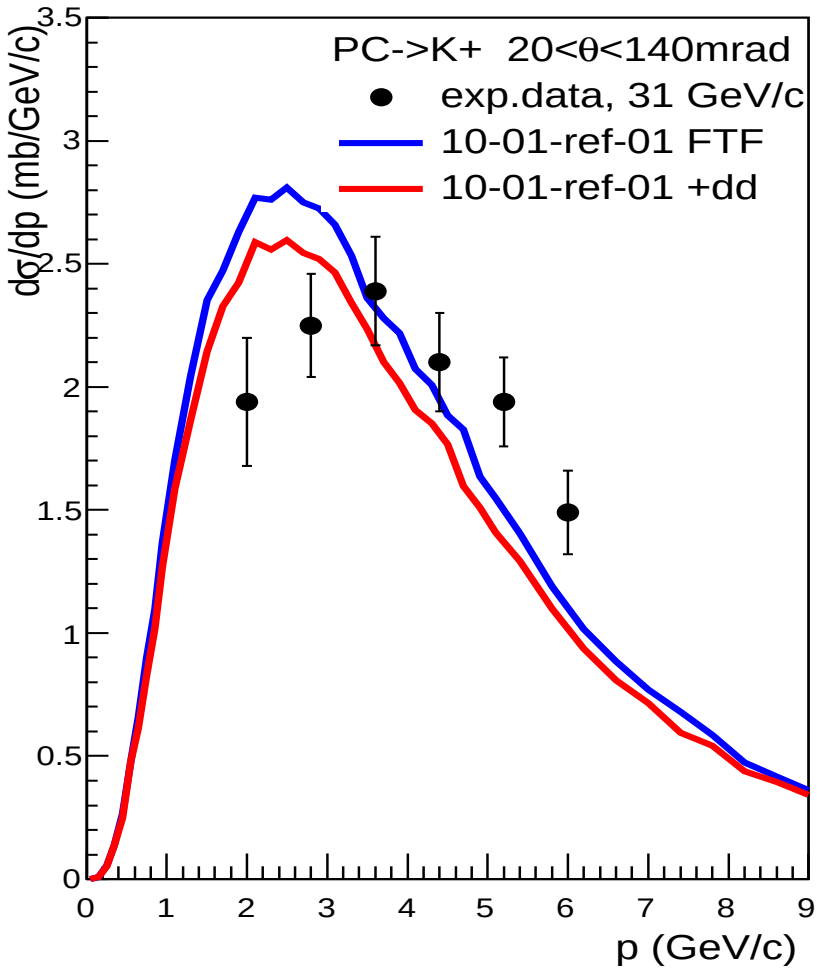

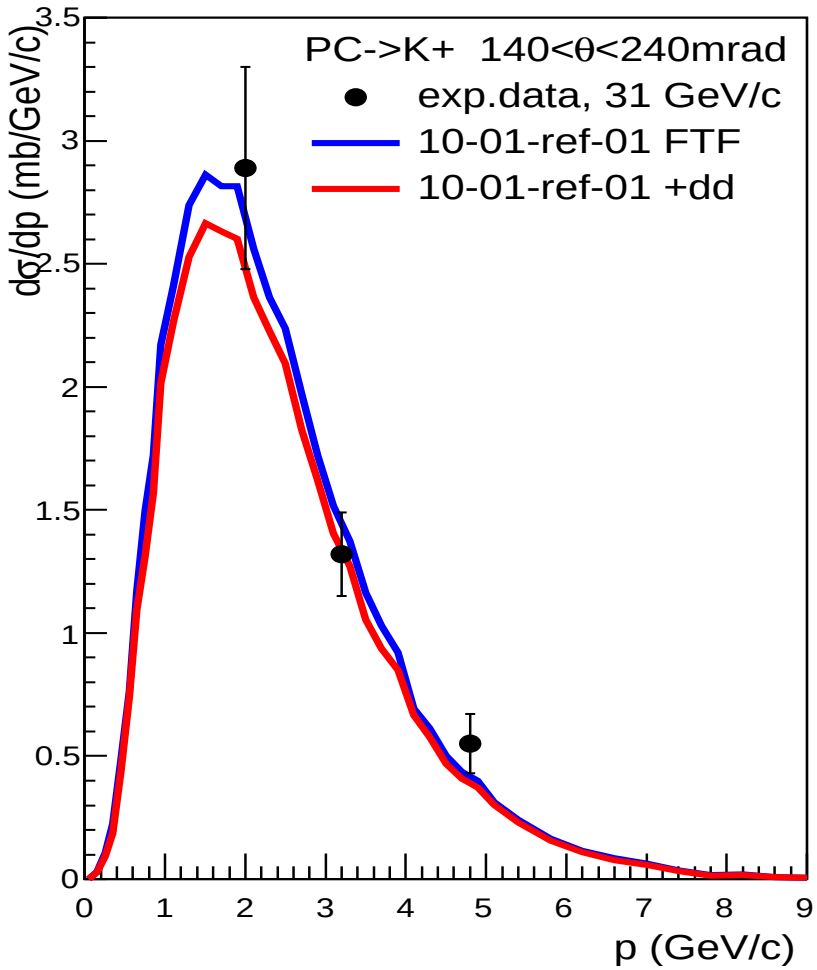

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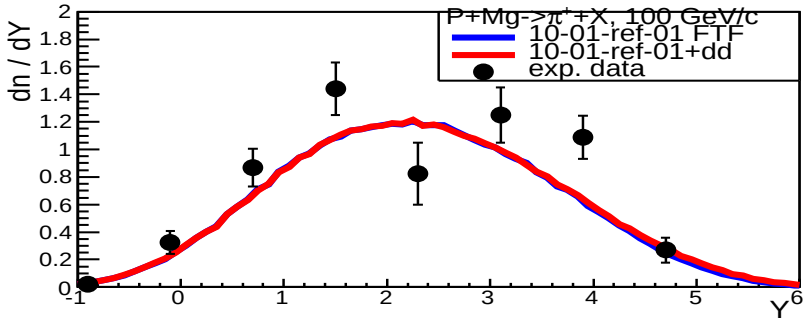

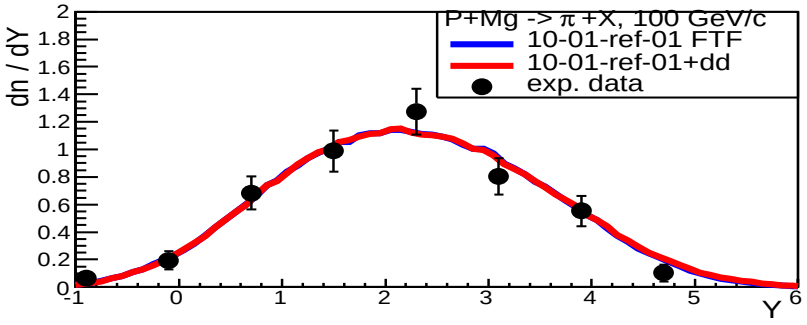

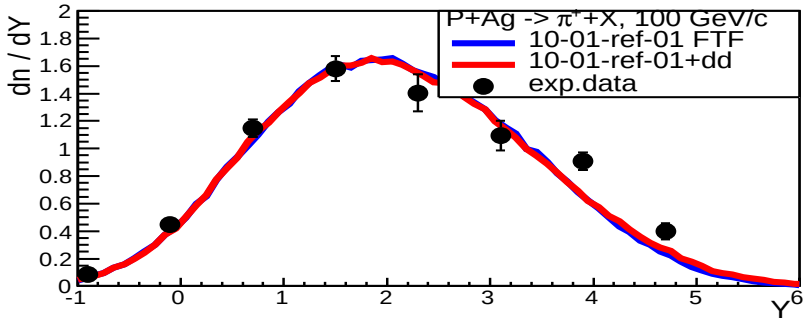

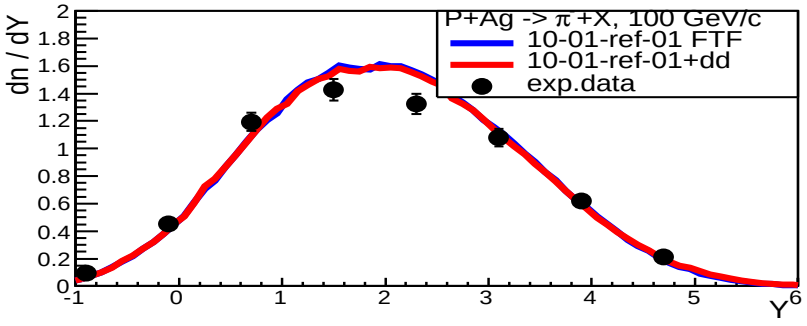

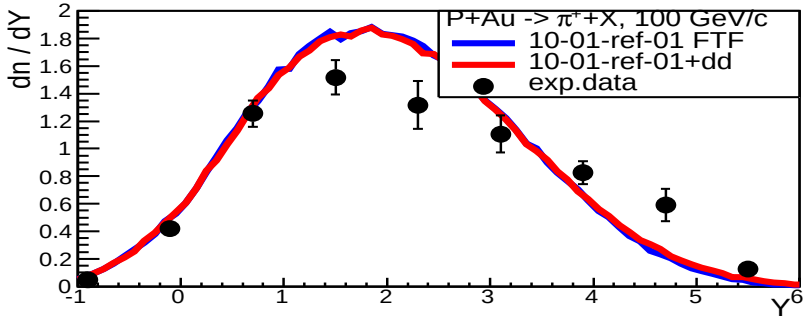

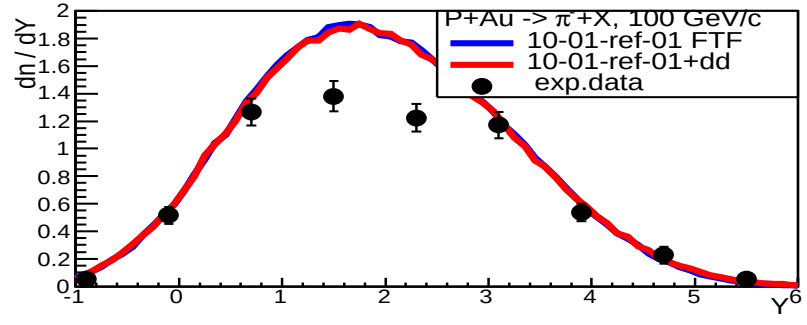

Data from E597 experiment.

3 How to activate G4LMsdGenerator in Geant4 physics list

In some physics list, say FTFP_BERT.icc,
(geant4/source/physics_lists/lists/include) we change hadron elastic physics constructor to be G4HadronHElasticPhysics and set the diffraction flag:

```
// Hadron Elastic scattering
// G4HadronElasticPhysics* hElastic =  new G4HadronElasticPhysics(ver);

  G4HadronHElasticPhysics* hElastic =  new G4HadronHElasticPhysics(ver);
  hElastic->SetDiffraction(true);

  this->RegisterPhysics( hElastic );
```

4 Summary

1. The low mass single diffraction generator was tested for the hadron-nucleus interactions in the momentum range 31-320 GeV/c showing reasonable results.
2. The model extension to higher excitation masses, comparison with more experimental data and improving the model accuracy are current plans.

References

[1] V.M. Grichine, EPJ +129 (2014) 112.

[2] V.M. Grichine, EPJ C62 (2009) 399, NIM B267 (2009) 2460.

[3] V.M. Grichine, EPJ +130 (2015) 131.