Tree-level bremsstrahlung calculation

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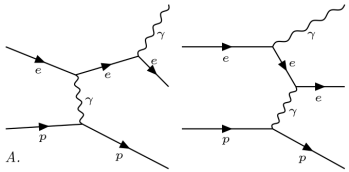
Far-Backward meeting

Introduction

- Precision tree-level calculation in T. Haas, V. Makarenko, Eur.Phys.J.C 71 (2011) 1574
- Model by Vladimir Makarenko is available in makar.web.cern.ch/bh/ (link in the paper no longer works)
- With several fixes and *ifort* compiler the model runs in Xubuntu 20.04 (should work on any linux)
- Tested with Born process for the basic diagrams:



- The reason is long running time for radiative and loop corrections
- Output to HepMC3 was added to the model, final state proton is also included
- Validation will be shown against Bethe-Heitler parametrization for our energies
- Working on introducing initial crossing angle for impact on photon polar angles

Cross section in 18x275 GeV beams

- Born process is the result of the tree-level calculation
- Bethe-Heitler formula refers to the parameterization in GETaLM generator
- Identical overlap in photon energy and polar angle
- Total cross section is well compatible
- Beam divergence is not applied for a direct comparison

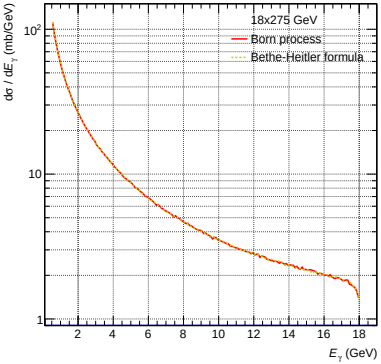


Figure: Photon energy

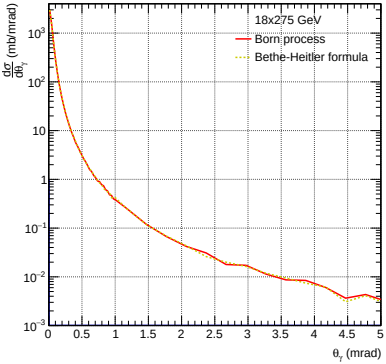


Figure: Photon polar angle

Cross section in 10x100 GeV beams

- Born process is the result of the tree-level calculation
- Bethe-Heitler formula refers to the parameterization in GETaLM generator
- Again the distributions and total cross sections are well compatible
- Beam divergence is not applied for a direct comparison

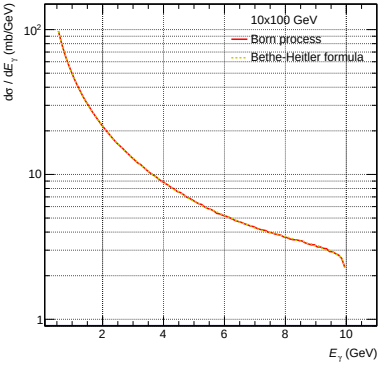


Figure: Photon energy

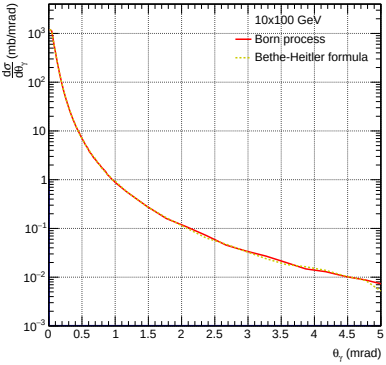


Figure: Photon polar angle

Cross section in 5x41 GeV beams

- Born process is the result of the tree-level calculation
- Bethe-Heitler formula refers to the parameterization in GETaLM generator
- Total cross section from Born process is an order of magnitude less than Bethe-Heitler formula
- Need to investigate integration parameters for lower energies

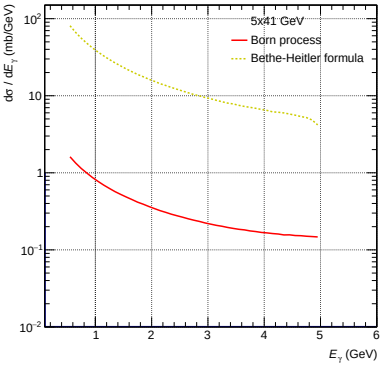


Figure: Photon energy

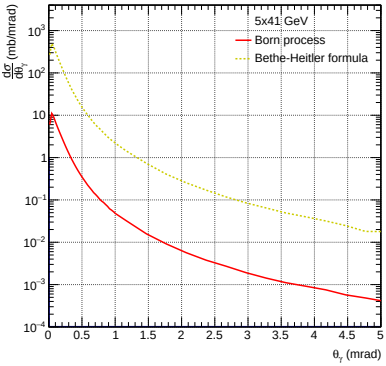
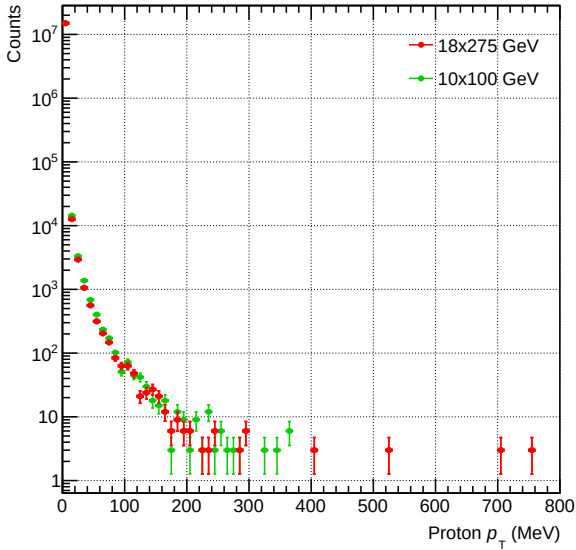


Figure: Photon polar angle

Proton recoil

- Transverse momentum of scattered protons
- 18x275 and 10x100 GeV beams
- Shows zero for 5x41 GeV, likely because of integration issues
- Very first result of its kind
- Reaches to $\mathcal{O}(100)$ MeV



Summary

- Diagram integration has to be tuned for the lowest energy
- Works well for higher energies
- First results on proton recoil in bremsstrahlung
- Initial kinematics in the model has several simplifications for head-on beams
- Generalization for beams crossing at an angle was marked as todo item in the original codes – working on it now
- The crossing angle will have an impact on angular distribution