The rapidity gap study for diffractive events in ep collision

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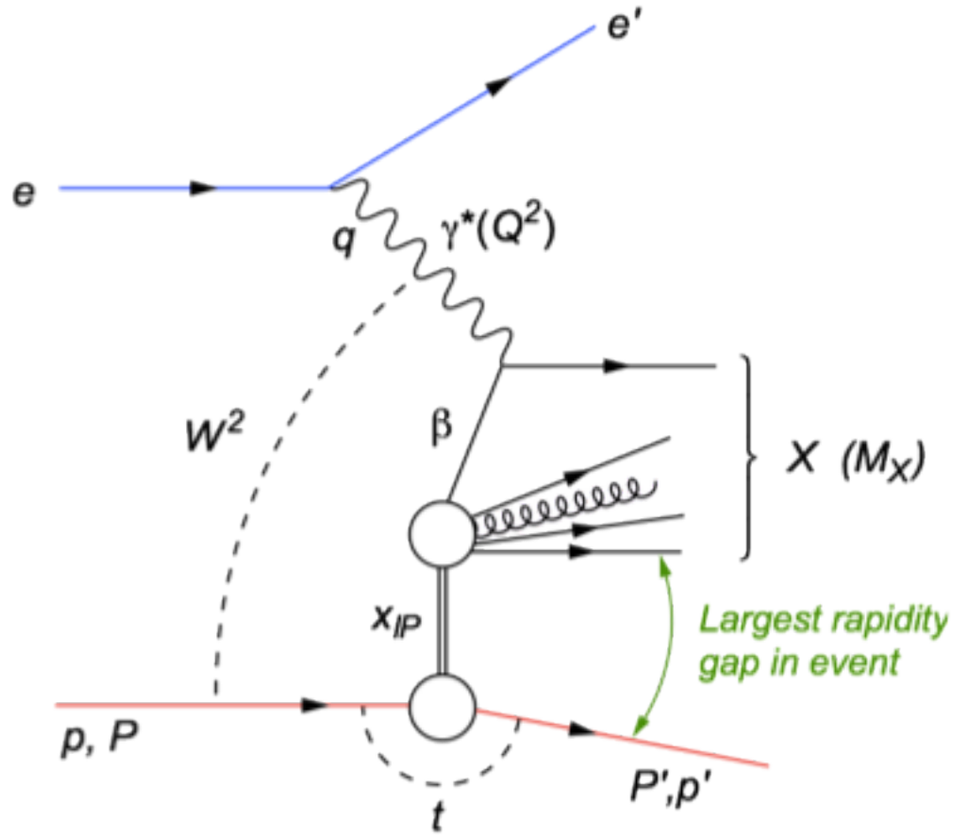
Diffractive events in ep

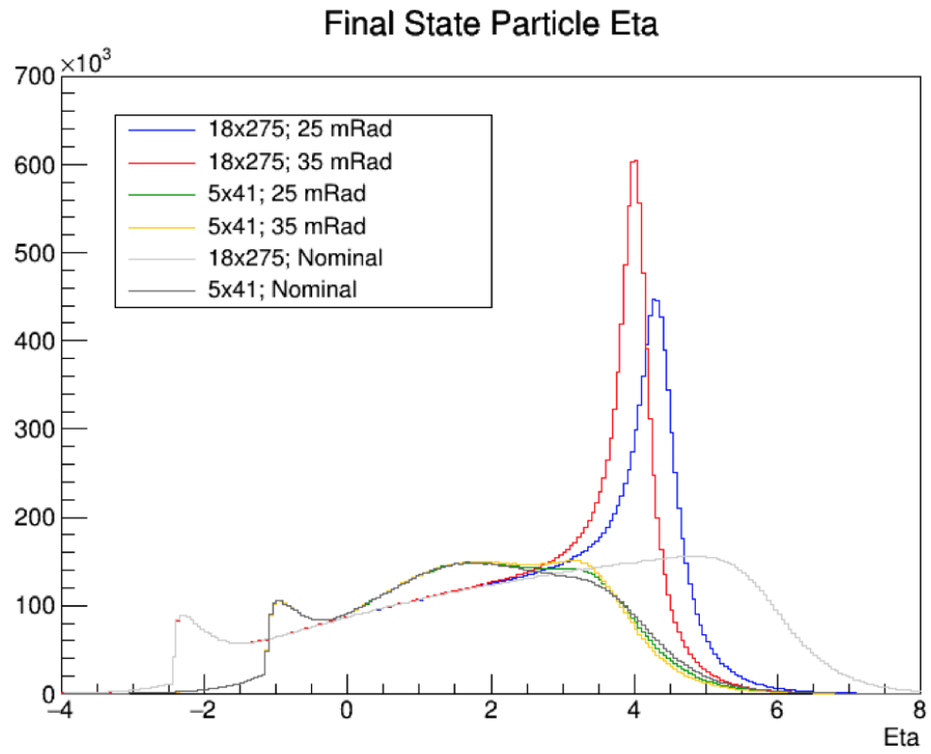


- One technique to tag on diffraction is to require a "rapidity gap" in the detector. This means that there is a region in the detector from the hadron beam towards the center of the detector in which there is no activity from the hadronic final state.
- The efficiency for detecting, and the purity of, diffractive events therefore depends strongly on the rapidity coverage of the detector.

Previous Pythia8 configuration

```
pythia.readString("Beams:idA = 11");
pythia.readString("Beams:idB = 2212");
pythia.readString("Beams:eA = 18.");
pythia.readString("Beams:eB = 275.");
pythia.readString("PDF:lepton2gamma = on");
pythia.readString("PDF:lepton2gammaSet = 1");
photonFlux = new Lepton2gamma2(11);
pythia.readString("Photon:Wmin = 5.0");

pythia.readString("SoftQCD:all= on”);
pythia.settings.parm("PhaseSpace:Q2Min", 1.e-09);
pythia.settings.parm("Photon:Q2max",2);
pythia.settings.parm(“PhaseSpace:mHatMin",1.0);

pythia.readString("SpaceShower:dipoleRecoil = on");
pythia.settings.forceParm("PhaseSpace:pTHatMinDiverge",1
pythia.readString("PhaseSpace:pTHatMin = 1.624”);
pythia.readString("SpaceShower:pTmaxMatch = 2”);
pythia.readString("SigmaElastic:Coulomb=on");

pythia.readString("PartonLevel:MPI = on”);
pythia.readString("MultipartonInteractions:pTmin = 1.9")
pythia.readString("PartonLevel:all= on");


pythia.readString("PDF:pSet = 2”);
pythia.readString(“PhotonPhoton:pT0Ref=3.0");

//set random
pythia.readString("Random:setSeed = on");
pythia.readString("Random:seed=0");
```

We did not add the beam effects in our previous study.



(b) Pseudorapidity Projection

Distributions for the four beam energy and crossing angle combinations. Colored lines show the distributions with all beam effects included , while the grayscale lines show the distributions obtained from the head-on collisions with no other beam effects included.

Pythia8 configuration

- We use the Pythia8 events including beam effects (cross angle, crab cavity, beam energy spread, angular beam divergence, bunch length) for our simulation based on Brian's framework;

```
Beams:frameType = 2 //The beams are back-to-back, but with different energies

Beams:idA = 2212
Beams:idB = 11

Beams:eA = 275
Beams:eB = 18

Beams:allowMomentumSpread = on
Beams:sigmapxA = 0.000150
Beams:sigmapyA = 0.000150
Beams:sigmapzA = 0.00068

Beams:sigmapxB = 0.000202
Beams:sigmapyB = 0.000187
Beams:sigmapzB = 0.00109

Beams:allowVertexSpread = on
Beams:sigmaVertexX = 0.084
Beams:sigmaVertexY = 0.008
Beams:sigmaVertexZ = 0.0
```

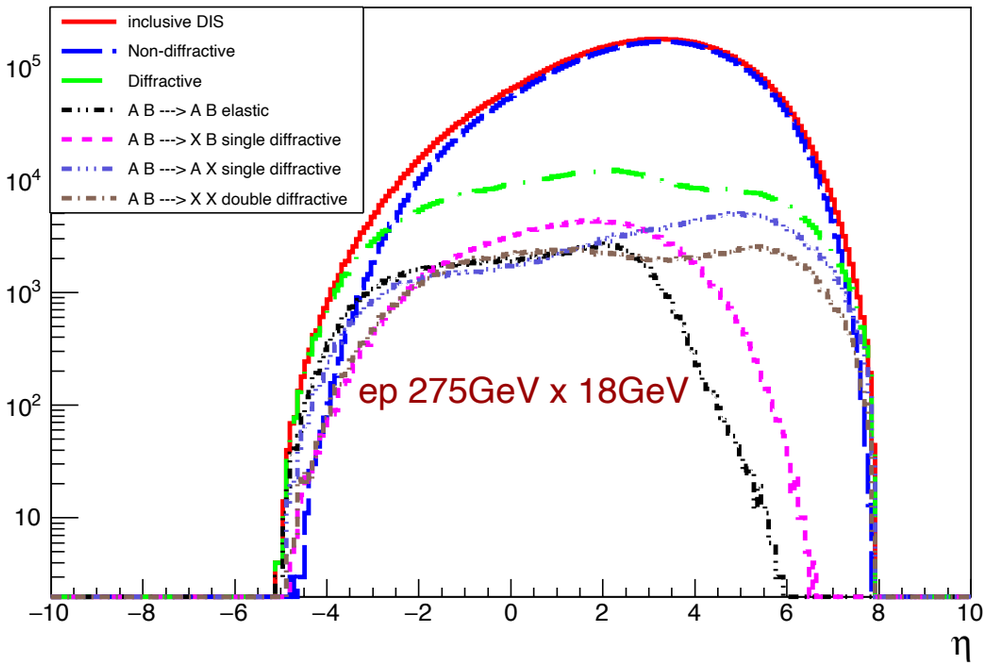
If we allow the momentum spread, Pythia8 would add deltaPxA, deltaPyA, deltaPzA, deltaPxB, deltaPyB, deltaPzB due to the beam effects to the beam momentum. The The cross section for softQCD process in ep collision without any beam effect is **3.876e-02mb;** if we add all the beam effects, the cross section would become **2.516e-03mb.** For pp collision or WeakBosonExchange:ff2ff(t:gmZ) in ep, there is no such big difference. The main difference comes from the momentum spread.

Pythia8 configuration

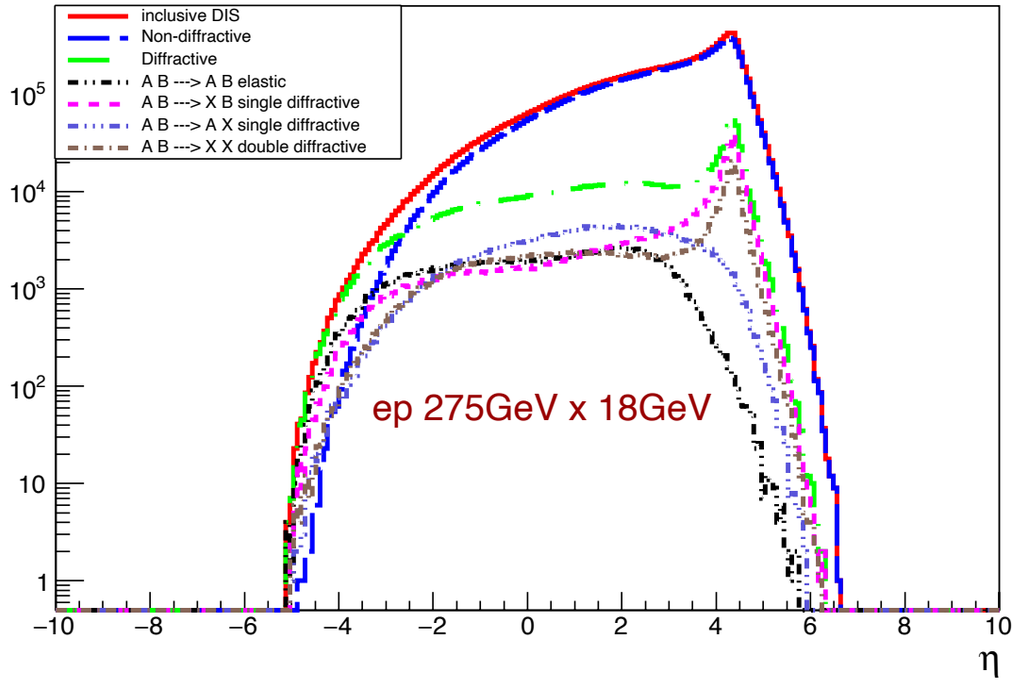
```
Beams:frameType = 3 //the beams are not back-to-back, and therefore the
three-momentum of each incoming particle needs to be specified

Beams:idA = 2212
Beams:idB = 11

Beams:eA = 275
Beams:eB = 18

Beams:pxA = -6.8742839
Beams:pyA = 0
Beams:pzA = 274.91407
Beams:pxB = 0
Beams:pyB = 0
Beams:pzB = -18.0

Beams:allowMomentumSpread = off

Beams:allowVertexSpread = on
```

If we only consider the beam angle and not allow momentum spread due to other beam effects. The cross section for softQCD process in ep collision is **3.875e-02mb**, this cross section is consistent with the one without any beam effects. But if we allow the momentum spread and add other beam effects, again the cross section would vary significantly. I am still checking which effect dominates the difference.

If we only consider the cross angle



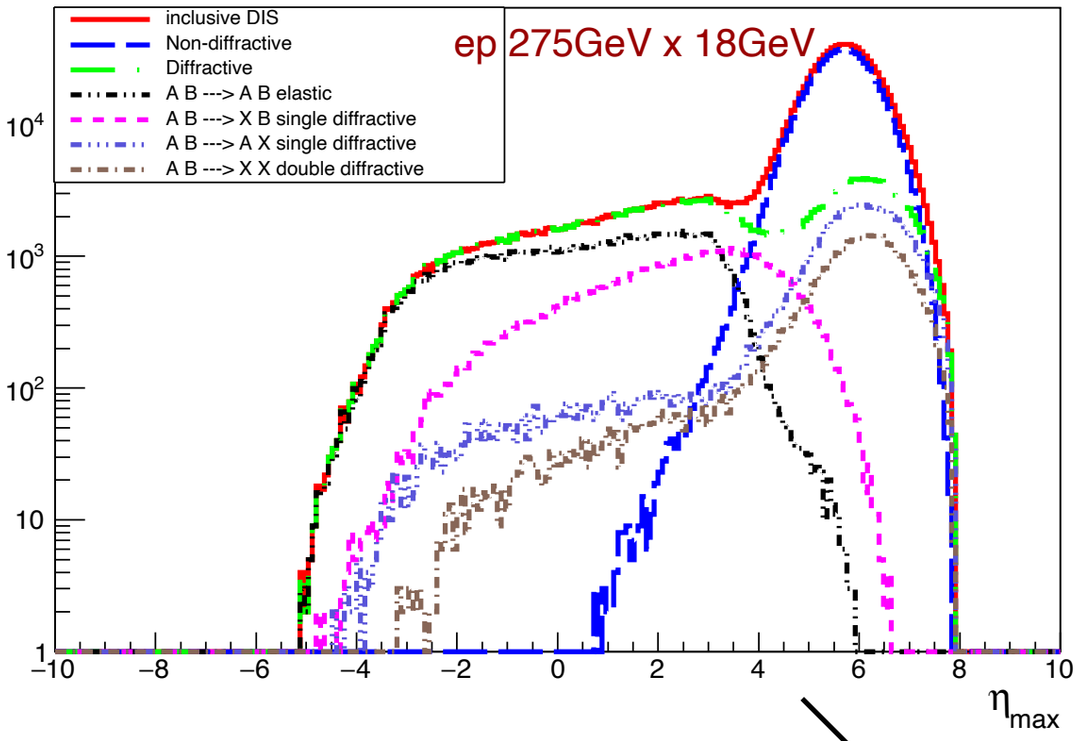
Cross angle effect



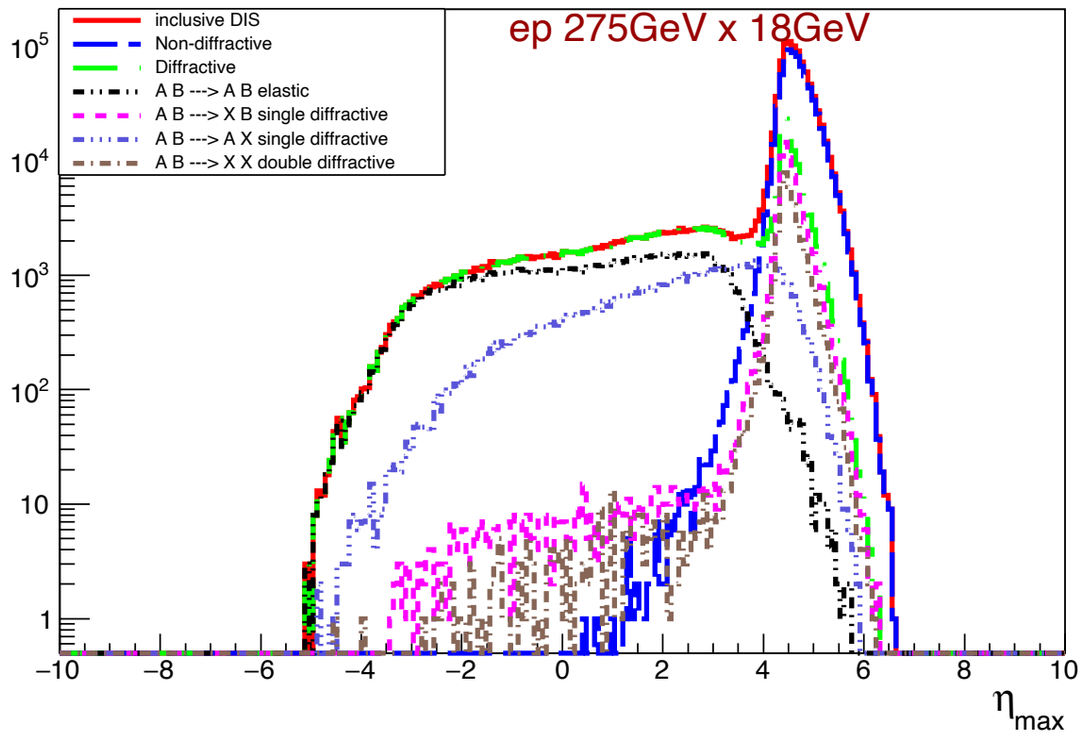
Here “Diffractive” includes these four processes:

- A B -> A B elastic
- A B -> X B single diffractive
- A B -> A X single diffractive
- A B -> X X double diffractive

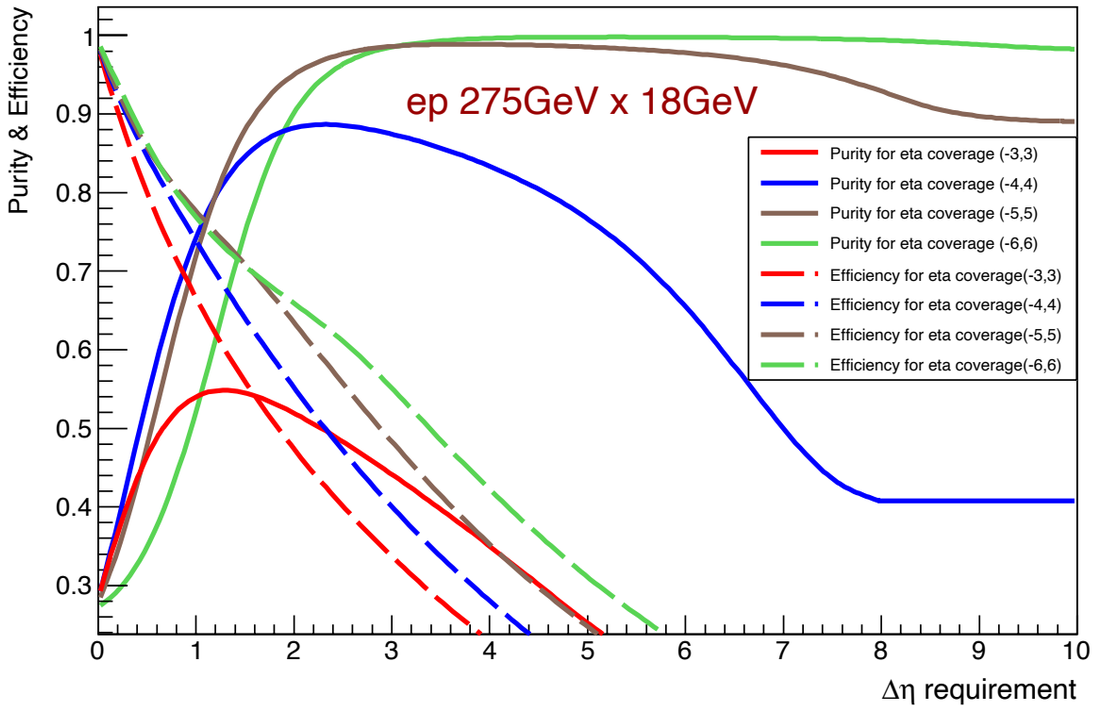
The most forward eta distribution for subprocesses



Cross angle effect

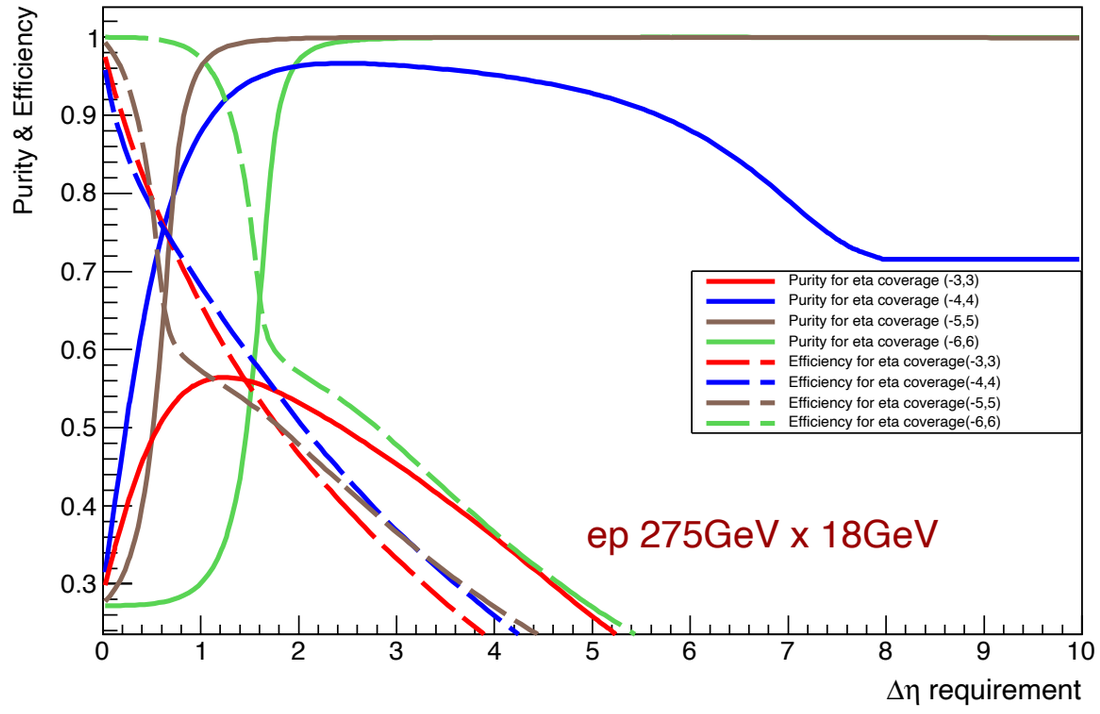


The purity and efficiency for different detector coverer



- Here we show the purity and efficiency vs. eta gap requirement for different detector coverage assumption;

Cross angle effect



Thanks.