Probing gluon spin by polarized pp collisions

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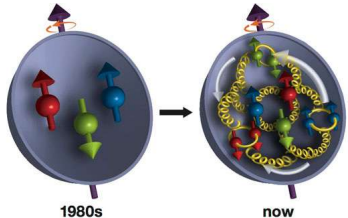
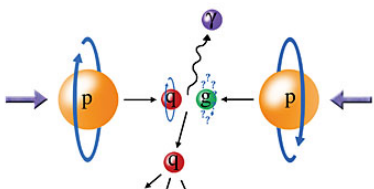
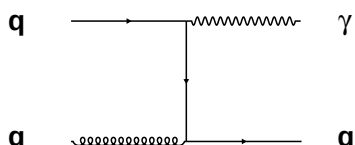
Motivation

- Proton spin puzzle.

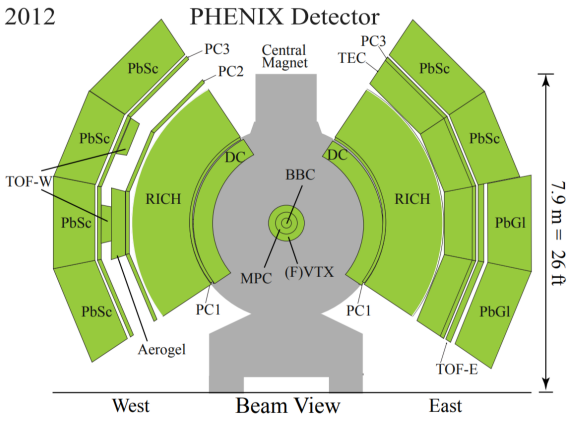


- Direct photon: the "golden" channel.





PHENIX detector



Direct photon signal extraction

Source of direct photon:

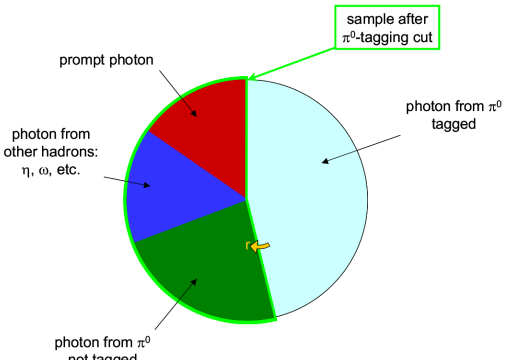
- Compton scattering: $g + q \rightarrow \gamma + q$.
- Annihilation: $q + \bar{q} \rightarrow \gamma + g$.
- Parton fragmentation to photon.
- Quark bremsstrahlung.

Source of direct photon background:

- Decay photons from hadrons (π^0, η, ω, η').

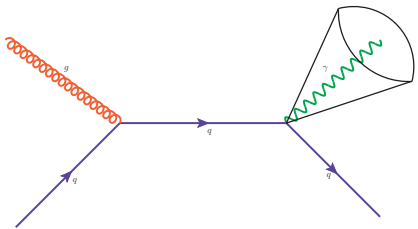
Yield of direct photon:

- $N_{dir} = N_{incl} - (1 + A)(1 + R)N_{\pi^0}$.
  - R: π^0 one photon missing ratio.
  - A: Other hadrons' to π^0's photon ratio.



π^0-tag method.

Isolation cut



$r = \sqrt{(\delta\eta)^2 + (\delta\phi)^2} = 0.5$

Isolation cut requirement:
$\sum E_{neutral} + \sum E_{charged} < 0.1 E_{\gamma}$

- To make apple with apple comparison, measured cross section should transform to what is calculated in theory.
- JETPHOX gives isolated direct photon cross section at NLO. But the isolation cone does not include the detector acceptance.
- Use Pythia to match the measured and calculated cross section.

List of systematic uncertainties for direct photon cross section

- Global energy scale, geometry and energy non-linearity.
- Pi0 yield extraction.
- Shower merging.
- Geometrical acceptance.
- Photon conversion.
- ERT trigger efficiency and normalization.
- MB trigger bias.
- Pileup effect.

Global energy scale, geometry and energy non-linearity

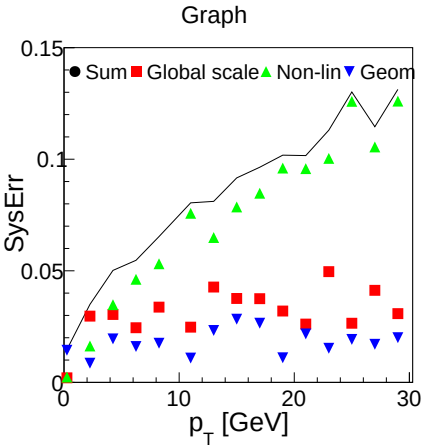
Basic idea:

- These effects influence cross section through acceptance.
- Acceptance is calculated by FastMC.
- Acceptance is reconstructed yield over truth yield.
- These effects influence the reconstructed yield, by tuning reconstruction parameters in FastMC.

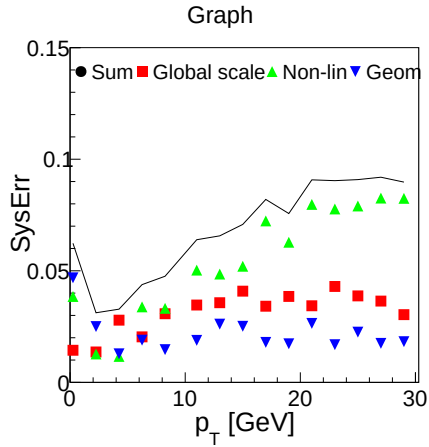
Tuning of reconstruction parameters

- **Global energy scale:**
  Gamma_En(double px, double py, double pz, double& eout, int& itw,
  double& ximp, double& yimp, double& zimp)
  eout *= 0.993;
- **Geometric misalignment:**
  GetImpactSectorTower(double px, double py, double pz,
  int& sec, int& iz, int& iy, double& zz, double& yy,
  double& phi0, double& ximp, double& yimp, double& zimp)
  // Systematics in position measurements
  ysec *= 1.01;
  zsec *= 1.01;
- **Energy non-linearity:**
  Gamma_En(double px, double py, double pz, double& eout, int& itw,
  double& ximp, double& yimp, double& zimp)
  if(sec>5) et1 *= pow(et1/2,+2./120.+2./300.); // Add'l attenuation for PbGl
  else et1 *= pow(et1,-2./800.+2./300.); // Add'l attenuation for PbSc

Systematic uncertainties from FastMC

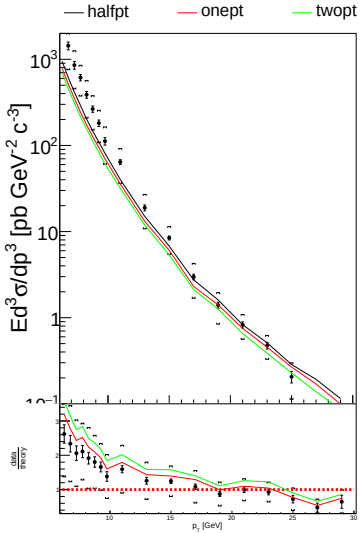


Single photon simulation.

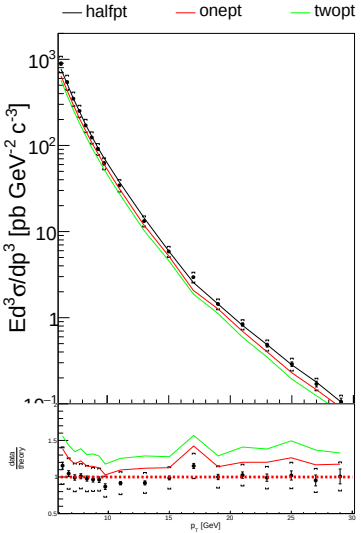


Single pi0 simulation.

All systematic uncertainties for cross section

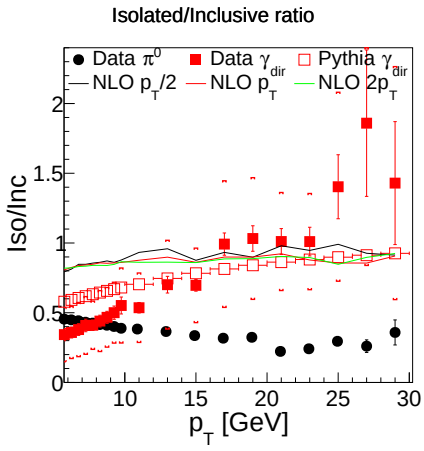


Inclusive direct photons

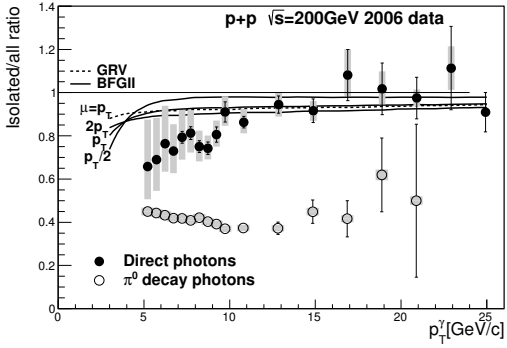


Isolated direct photons

Isolated over inclusive ratio



From this analysis. The NLO calculations are for direct photons.



From run 6.