Run 13 direct photon ALL

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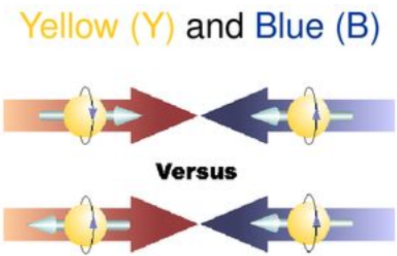
September 10, 2020

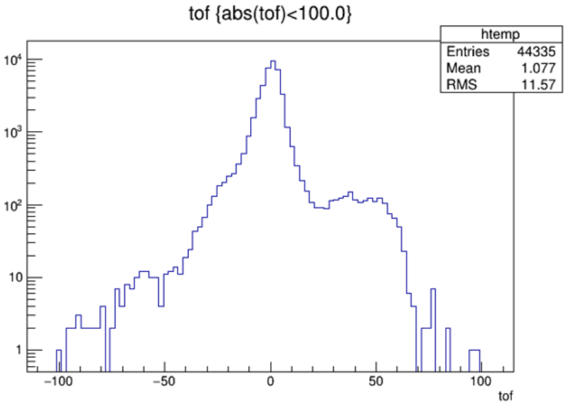
Direct photon ALL



$$A_{LL} = \frac{\Delta\sigma}{\sigma} = \frac{\sigma_{++} + \sigma_{--} - \sigma_{+-} - \sigma_{-+}}{\sigma_{++} + \sigma_{--} + \sigma_{+-} + \sigma_{-+}} = \frac{1}{P_B P_Y} \frac{N_{++} - RN_{+-}}{N_{++} + RN_{+-}}$$

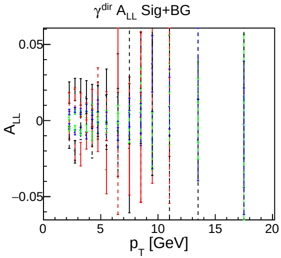
- Different runs have different polarization P_B and P_Y, so measured in a run-by-run basis.
- Even and odd crossings have difference electric circuits, so measured separately.
- There are also four spin patterns, so total eight groups.
- For particles in isolation cone:
  - Loose cut: ToF $<$ 50 ns, E $>$ 0.15 GeV
  - Tight cut: ToF $<$ 10 ns, E $>$ 0.5 GeV

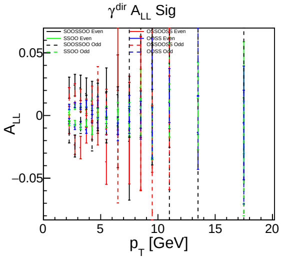
ToF distributions

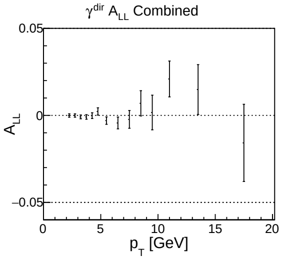


From John and Milap's jet ALL AN

Discrepancies in loose cuts

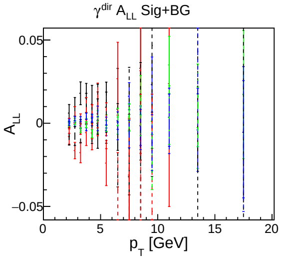


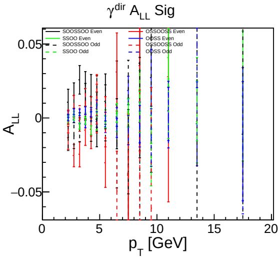


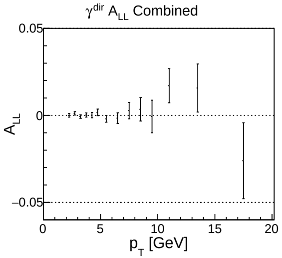


p_T [GeV]	F	p
2-2.5	5.901	8.709e-07
2.5-3	12.4	1.554e-15
3-3.5	8.116	9.932e-10
3.5-4	5.853	1.009e-06
4-4.5	3.334	0.00157
4.5-5	1.223	0.2864
5-6	1.704	0.104
6-7	1.256	0.2686
7-8	0.7887	0.5968
8-9	0.5234	0.8174
9-10	1.299	0.2471
10-12	0.697	0.6747
12-15	0.9198	0.4899
15-20	0.6332	0.7287

Better agreement in tight cuts

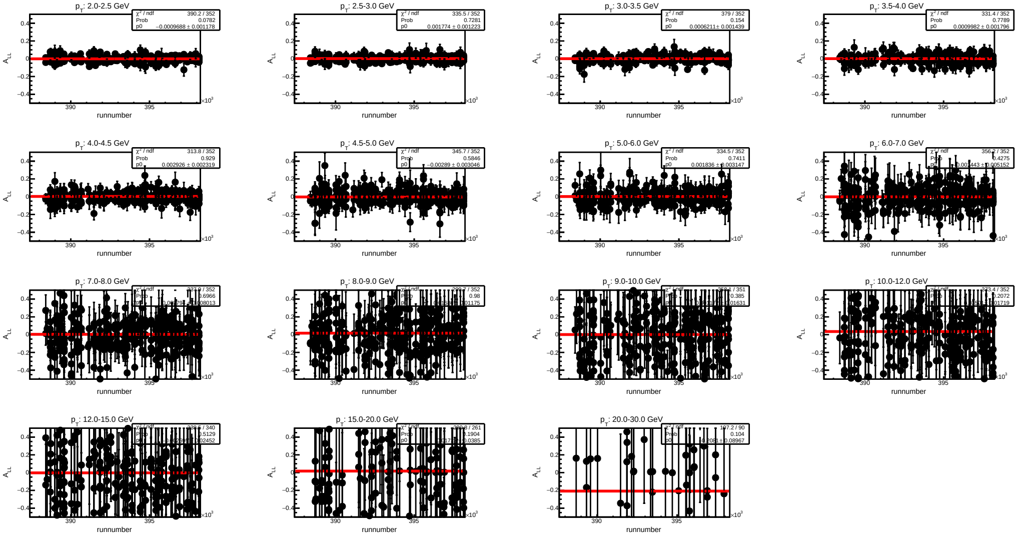




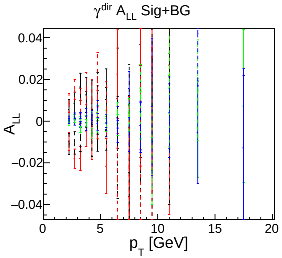


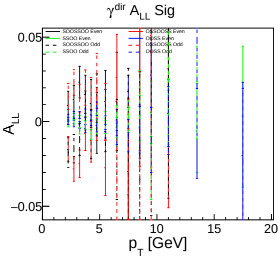
p_T [GeV]	F	p
2-2.5	1.254	0.2697
2.5-3	3.282	0.001815
3-3.5	3.933	0.0002903
3.5-4	1.777	0.08792
4-4.5	1.724	0.09921
4.5-5	1.125	0.3442
5-6	0.8223	0.5686
6-7	0.9596	0.4593
7-8	1.065	0.3837
8-9	0.4716	0.8556
9-10	0.9886	0.4377
10-12	0.9743	0.4482
12-15	0.6964	0.6752
15-20	0.8313	0.5613

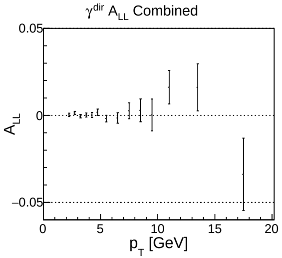
Run-by-run fitting



Cross check in fill-by-fill analysis

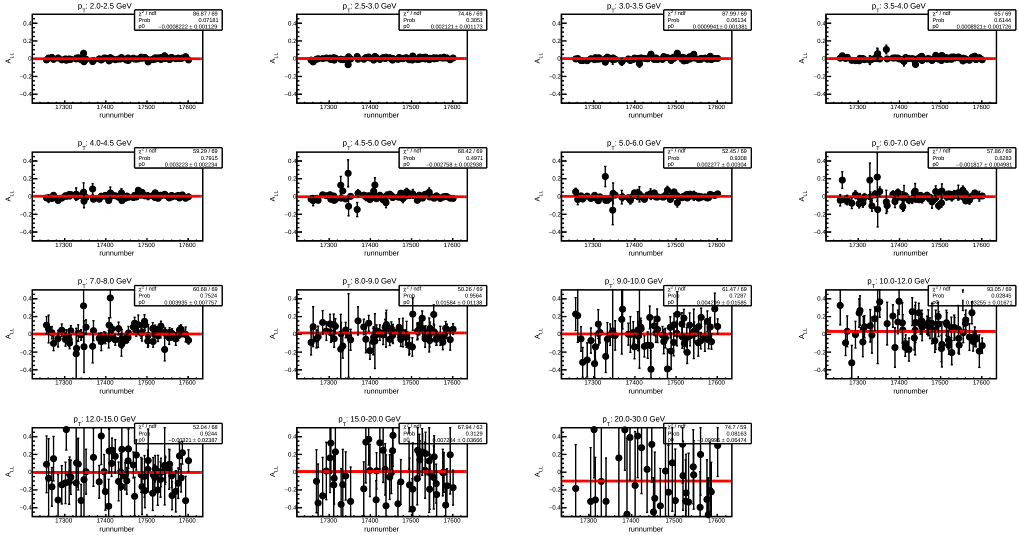






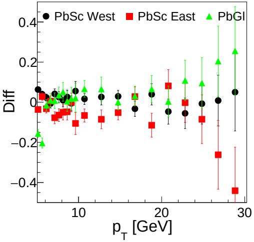
p_T [GeV]	F	p
2-2.5	1.824	0.08209
2.5-3	4.494	8.618e-05
3-3.5	3.533	0.001139
3.5-4	2.027	0.05136
4-4.5	1.883	0.07174
4.5-5	1.326	0.2373
5-6	0.8033	0.5851
6-7	0.6962	0.6753
7-8	1.029	0.4103
8-9	0.5332	0.8092
9-10	0.7743	0.6092
10-12	0.8879	0.5162
12-15	0.8807	0.5219
15-20	1.345	0.2288
20-30	0.6968	0.6748

Fill-by-fill fitting

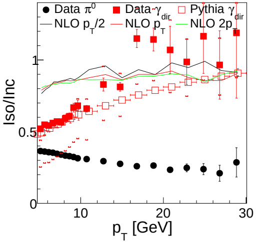


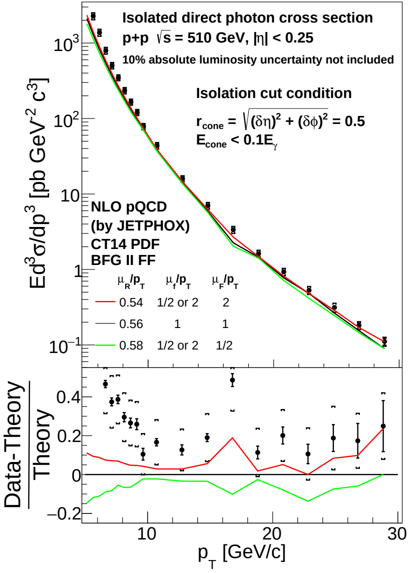
Cross section in tight cuts

Diff in parts



Isolated/Inclusive ratio

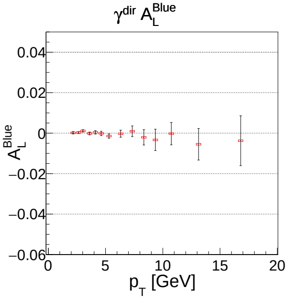




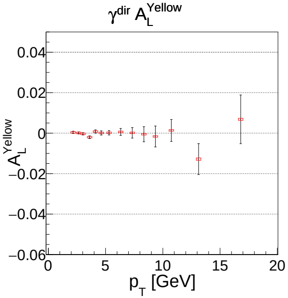
Systematic uncertainties

- False asymmetry in background due to ghost cluster: low pT
- Uncertainty of relative luminosity: 3.853e-4
- Global scaling uncertainty from polarization: 6.6%
- Uncertainty of background fraction estimation
- Uncertainty from eta background

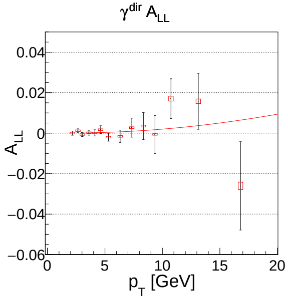
AL(L) with systematic uncertainties



Blue beam AL

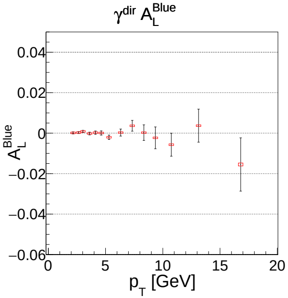


Yellow beam AL

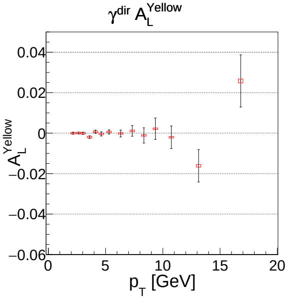


ALL

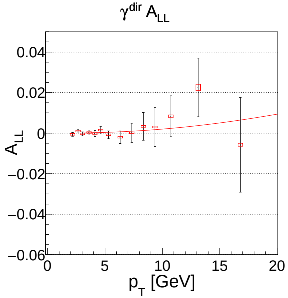
AL(L) with Inseok's calibration



Blue beam AL

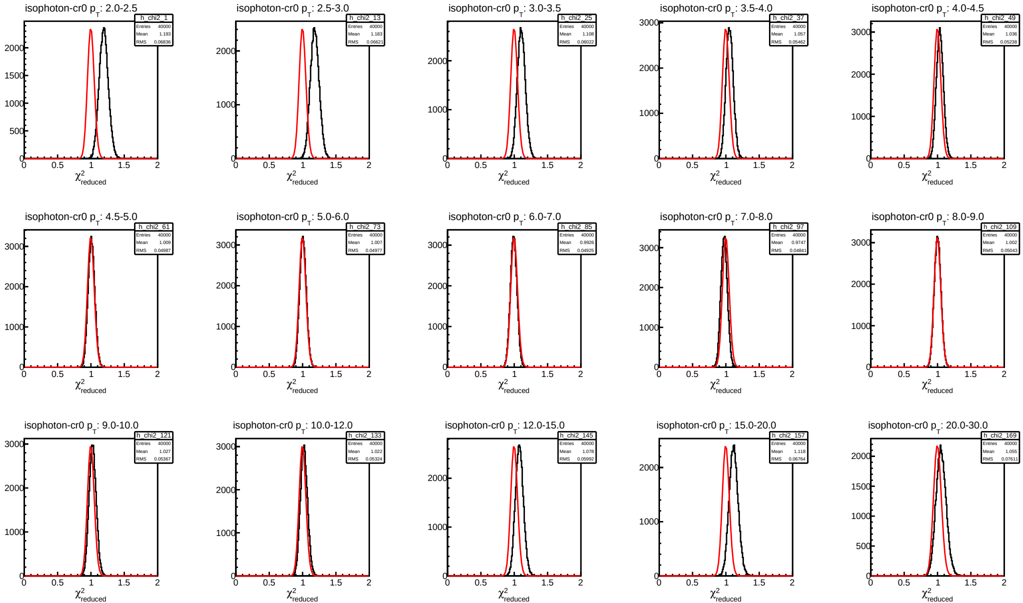


Yellow beam AL

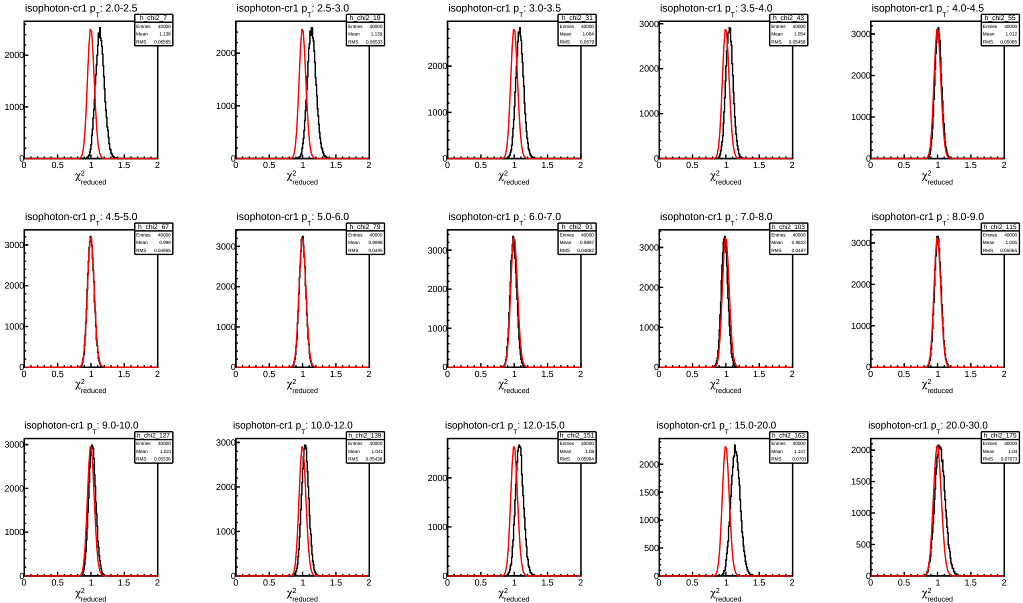


ALL

Bunch shuffling: even crossings



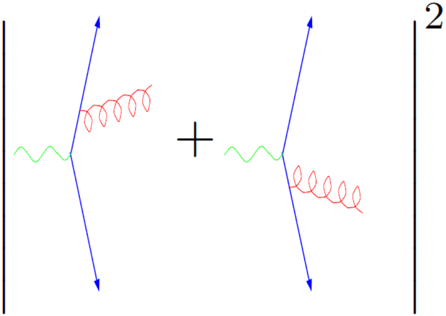
Bunch shuffling: odd crossings



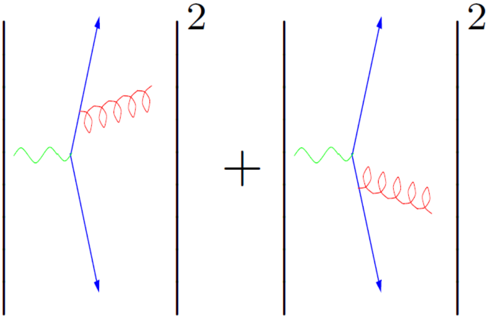
Conclusions for ALL

- Discrepancies from spin patterns come from previous ghost events and can be removed by using tight cuts.
- Agreement with partonic NLO calculations in isolated cross section needs loose cut.
- Will use loose cut for cross section and tight cut for ALL.

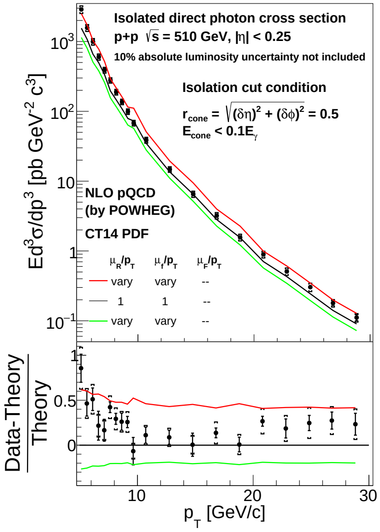
$$\frac{d\sigma_{\mathrm{ME}}}{dx_1 dx_2} \sim$$



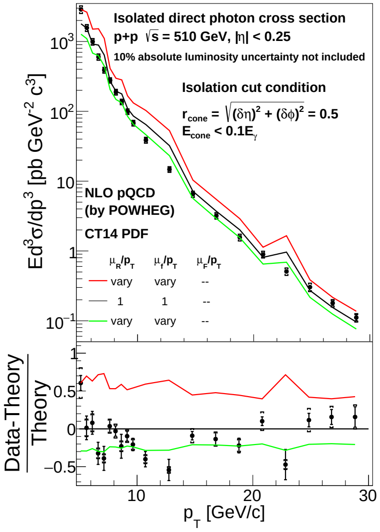
$$\frac{d\sigma_{\mathrm{PS}}}{dx_1 dx_2} \sim$$



POWHEG with different vetoes for isolated direct photon

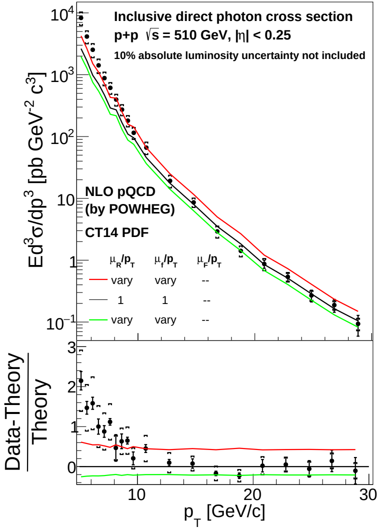


With MPI (default veto)

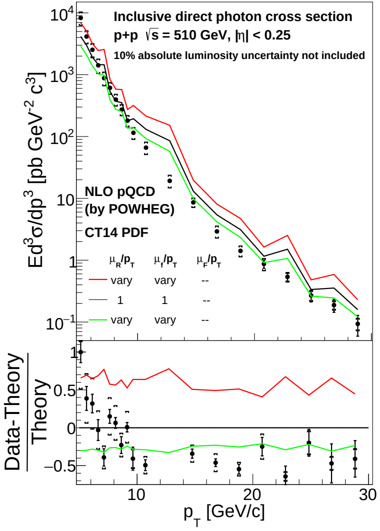


With MPI (QED-QCD veto)

POWHEG with different vetoes for inclusive direct photon

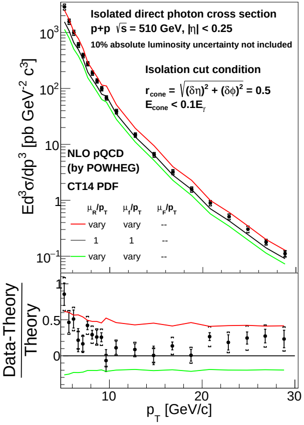


With MPI (default veto)



With MPI (QED-QCD veto)

POWHEG w/o MPI for isolated direct photon

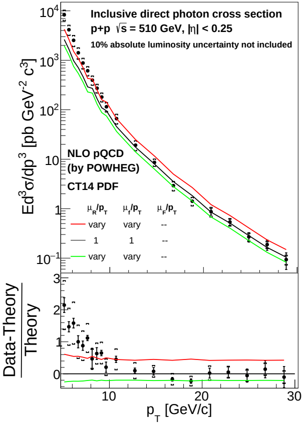


With MPI

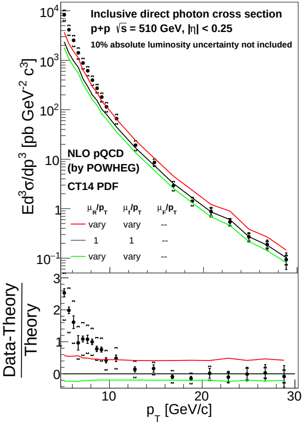
Without MPI

Pure hard processes

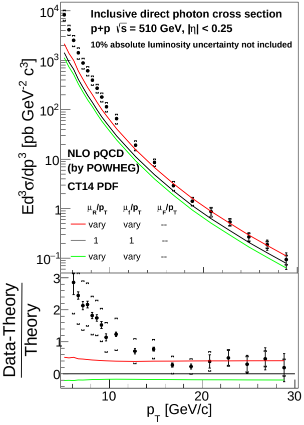
POWHEG w/o MPI for inclusive direct photon



With MPI

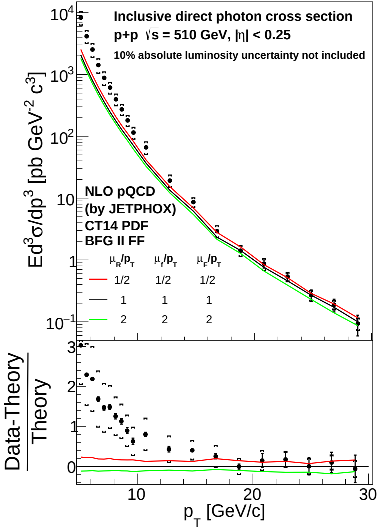


Without MPI

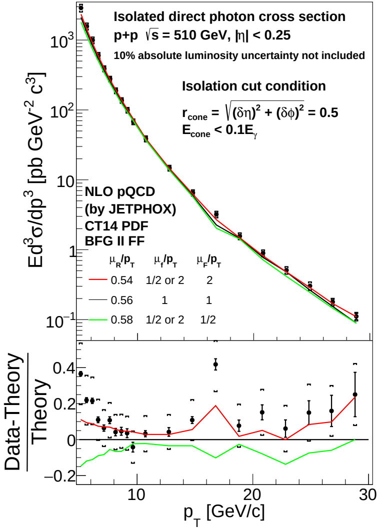


Pure hard processes

JETPHOX for direct photon

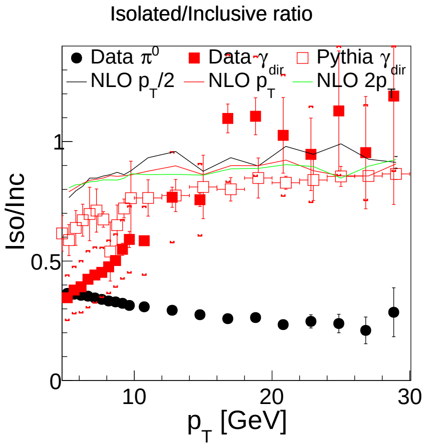


Inclusive

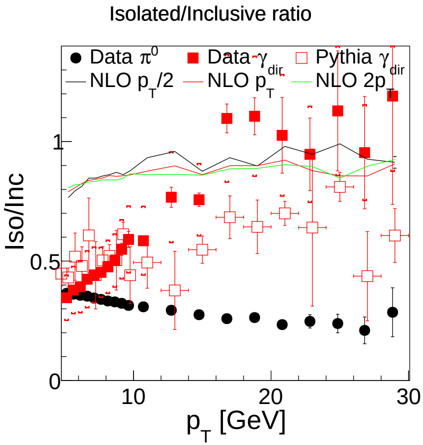


Isolated

POWHEG with MPI (different vetoes) for isolated over inclusive ratio

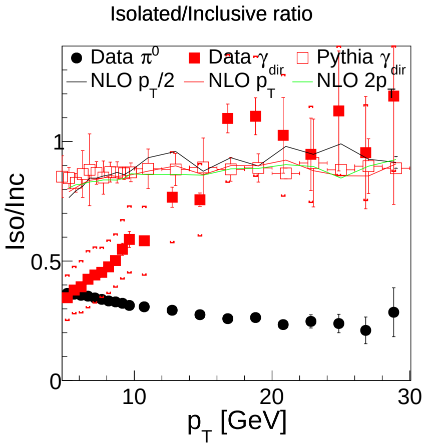


With MPI (default veto)

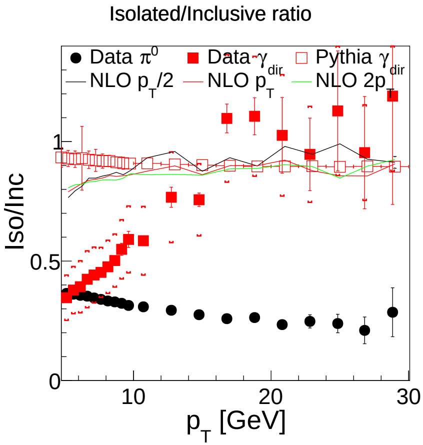


With MPI (QED-QCD veto)

POWHEG without MPI for isolated over inclusive ratio



Without MPI



Pure hard processes

Conclusions for POWHEG study

- POWHEG with MPI and default veto agrees data at high-pT, while with QED-QCD veto agrees data at low-pT.
- MPI is important in the isolated to inclusive ratio.
- POWHEG with pure hard processes is just like JETPHOX without fragmentation processes, as expected.