Probing the Pomeron quark structure using γ+jet and dijet events

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- Resolved Pomeron model
  - Protons interact via a **double Pomeron exchange**
  - Diffractive mass produced from the interaction of two quarks/gluons from **each of Pomerons**

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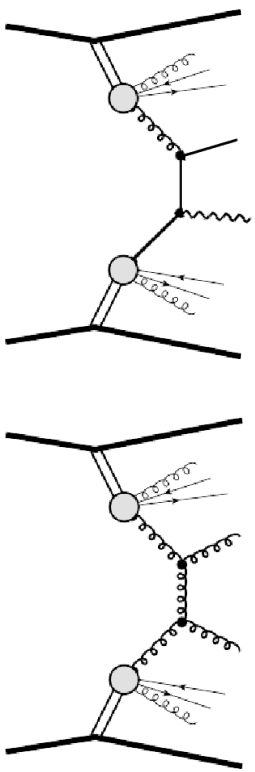
  - **New constraints** on quark densities difference
- Other models as **Soft Color Interaction (SCI)** model does not use Pomeron to describe DPE

Why γ+jet and dijet events?



- **γ+jet** inclusive production
  - Herwig process ID 1800
  - Main mechanism : q+g
  - High σ dependance on quark PDFs
  - $\sigma \simeq 1$ pb after cuts and selection
- **dijet** inclusive production
  - Herwig process ID 1500
  - Main mechanism : g+g
  - Low σ dependance on quark PDFs
  - $\sigma \simeq 1{,}000$ pb after cuts and selection
- **All leading order subprocesses** implemented

Purpose: evaluate $\frac{\sigma_{\gamma+jet}}{\sigma_{dijet}}$ for various PDFs patterns to determine if measurement is sensitive to Pomeron quark structure

Herwig ID 1800 and 1500: list of Subprocesses

IHPRO	1 + 2	®	3 + 4	c/f conn.
41	$q + q^-$	®	g + g	2 3 1 4
42	$q + g$	®	q + g	3 1 2 4
43	$q^- + q$	®	g + g	3 1 2 4
44	$q^- + g$	®	q^- + g	2 3 1 4
45	$g + q$	®	q + g	2 3 1 4
46	$g + q^-$	®	q^- + g	3 1 2 4
47	$g + g$	®	g + g	2 3 1 4
51	g+ q	®	g+ q	1 4 2 3
52	g+ q^-	®	g+ q^-	1 3 4 2
53	g+ g	®	$q + q^-$	1 4 2 3
61	$q + q^-$	®	g+g	2 1 3 4
62	$q^- + q$	®	g+g	2 1 3 4
63	$g + g$	®	g+g	2 1 3 4
71	g+ q	®	$M(S=0) + q'$	1 4 3 2
72	g+ q	®	$M(S=1)_L + q'$	1 4 3 2
73	g+ q	®	$M(S=1)_T + q'$	1 4 3 2
74	g+ q^-	®	$M(S=0) + q^{-\prime}$	1 4 3 2
75	g+ q^-	®	$M(S=1)_L + q^{-\prime}$	1 4 3 2
76	g+ q^-	®	$M(S=1)_T + q^{-\prime}$	1 4 3 2

Table 12: Direct photon subprocesses.

IHPRO	1 + 2	®	3 + 4	c/f conn.
1	$q + q$	®	$q + q$	3 4 2 1
2	$q + q$	®	$q + q$	4 3 1 2
3	$q + q'$	®	$q + q'$	3 4 2 1
4	$q + q^-$	®	$q'+ q^{-\prime}$	2 4 1 3
5	$q + q^-$	®	$q + q^-$	3 1 4 2
6	$q + q^-$	®	$q + q^-$	2 4 1 3
7	$q + q^-$	®	$g + g$	2 4 1 3
8	$q + q^-$	®	$g + g$	2 3 4 1
9	$q + q^{-\prime}$	®	$q + q^{-\prime}$	3 1 4 2
10	$q + g$	®	$q + g$	3 1 4 2
11	$q + g$	®	$q + g$	3 4 2 1
12	$q^- + q$	®	$q^{-\prime} + q'$	3 1 4 2
13	$q^- + q$	®	$q^- + q$	2 4 1 3
14	$q^- + q$	®	$q^- + q$	3 1 4 2
15	$q^- + q$	®	$g + g$	3 1 4 2
16	$q^- + q$	®	$g + g$	4 1 2 3
17	$q^- + q'$	®	$q^- + q'$	2 4 1 3
18	$q^- + q^-$	®	$q^- + q^-$	4 3 1 2
19	$q^- + q^-$	®	$q^- + q^-$	3 4 2 1
20	$q^- + q^{-\prime}$	®	$q^- + q^{-\prime}$	4 3 1 2
21	$q^- + g$	®	$q^- + g$	2 4 1 3
22	$q^- + g$	®	$q^- + g$	4 3 1 2
23	$g + q$	®	$g + q$	2 4 1 3
24	$g + q$	®	$g + q$	3 4 2 1
25	$g + q^-$	®	$g + q^-$	3 1 4 2
26	$g + q^-$	®	$g + q^-$	4 3 1 2
27	$g + g$	®	$q + q^-$	2 4 1 3
28	$g + g$	®	$q + q^-$	4 1 2 3
29	$g + g$	®	$g + g$	4 1 2 3
30	$g + g$	®	$g + g$	4 3 1 2
31	$g + g$	®	$g + g$	2 4 1 3

Table 11: QCD subprocesses.

Simulation parameters and Cuts

- **FPMC generator** has been used (N = 1,000,000 events for each interaction)
  - $0.015 < \xi < 0.15$ (AFP 210 metres)
  - $0.0015 < \xi < 0.15$ (AFP 210+420 metres)
- Jet reconstruction with **antikT algorithm** (FastJet package)
  - R = 0.6 (ATLAS Standard)
  - $p_{T,jet(s)} > 20\ \mathbf{GeV}$
- Photon selection: $p_{T,\gamma} > 20\ \mathbf{GeV}$
- Photons and jets are central in ATLAS ($\eta < 2.5$)
- Data normalized for $L = 300 pb^{-1}$ (3 weeks low luminosity dedicated run)

- u+d+s = constant, d=s and d/u $\in \{0.25,0.5,1,2,4\}$
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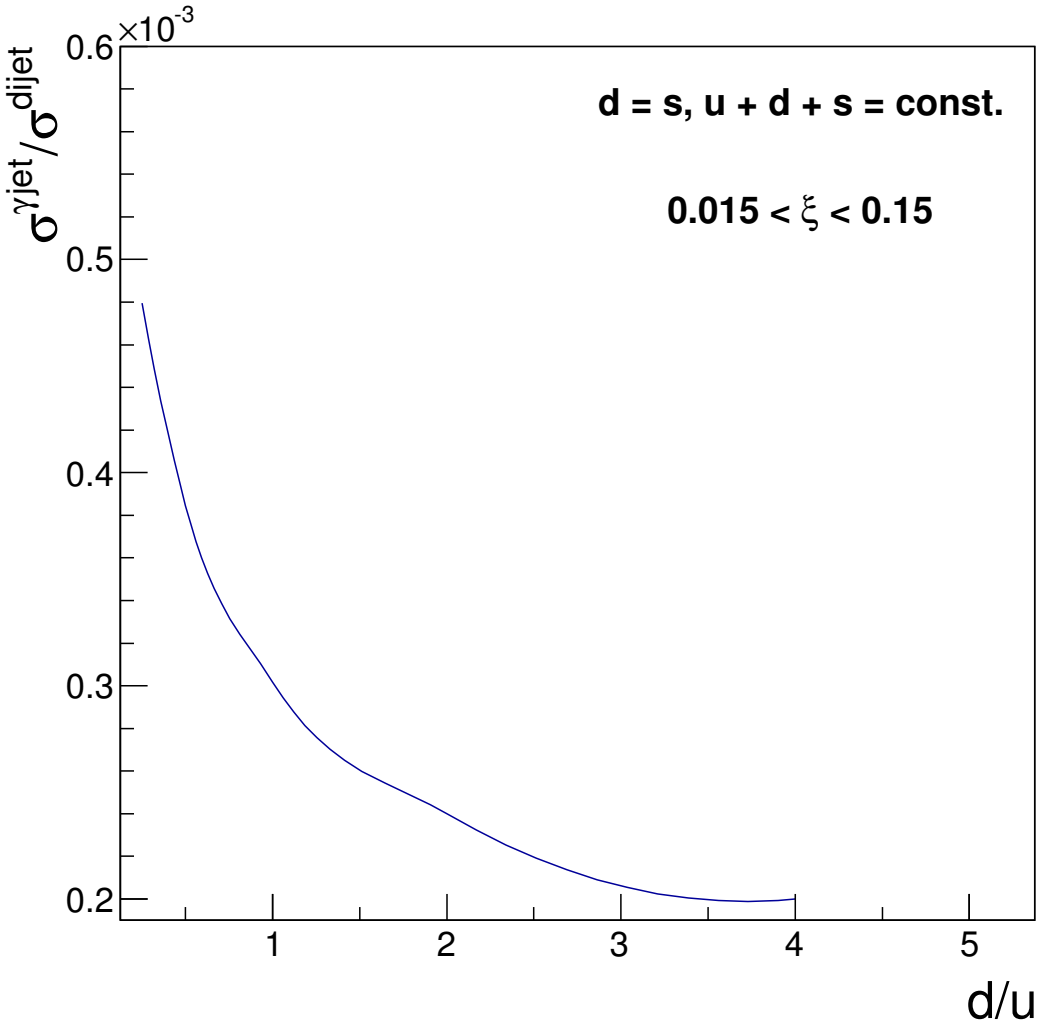
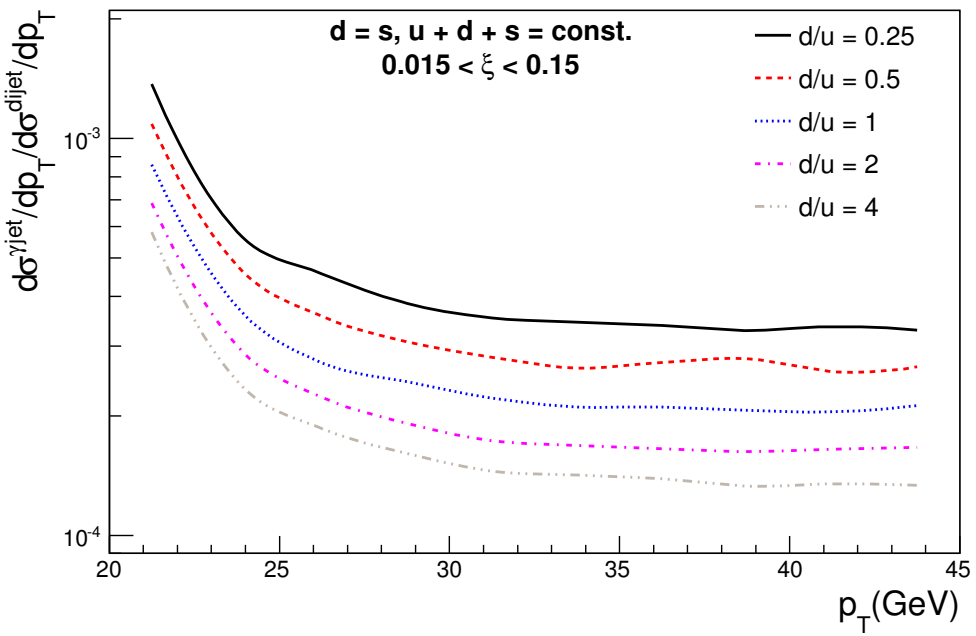
d/u results : cross-section ratio

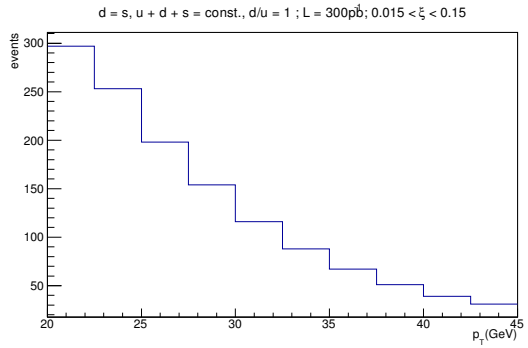


- Cross-sections **after** jet and γ selection ($p_T > 20$ GeV)
- Cross-sections ratio varies by **a factor 2.5**

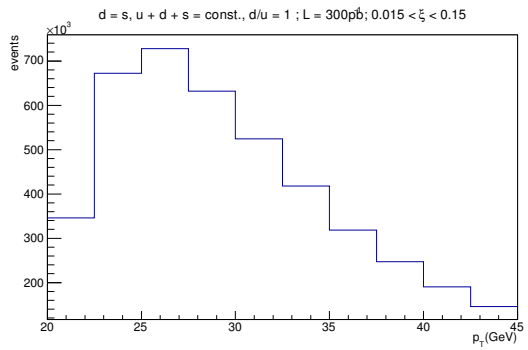
d/u results : $p_{T,jet}$ differential cross-section ratio, $\sqrt{s} = 14$ TeV



γ+jet



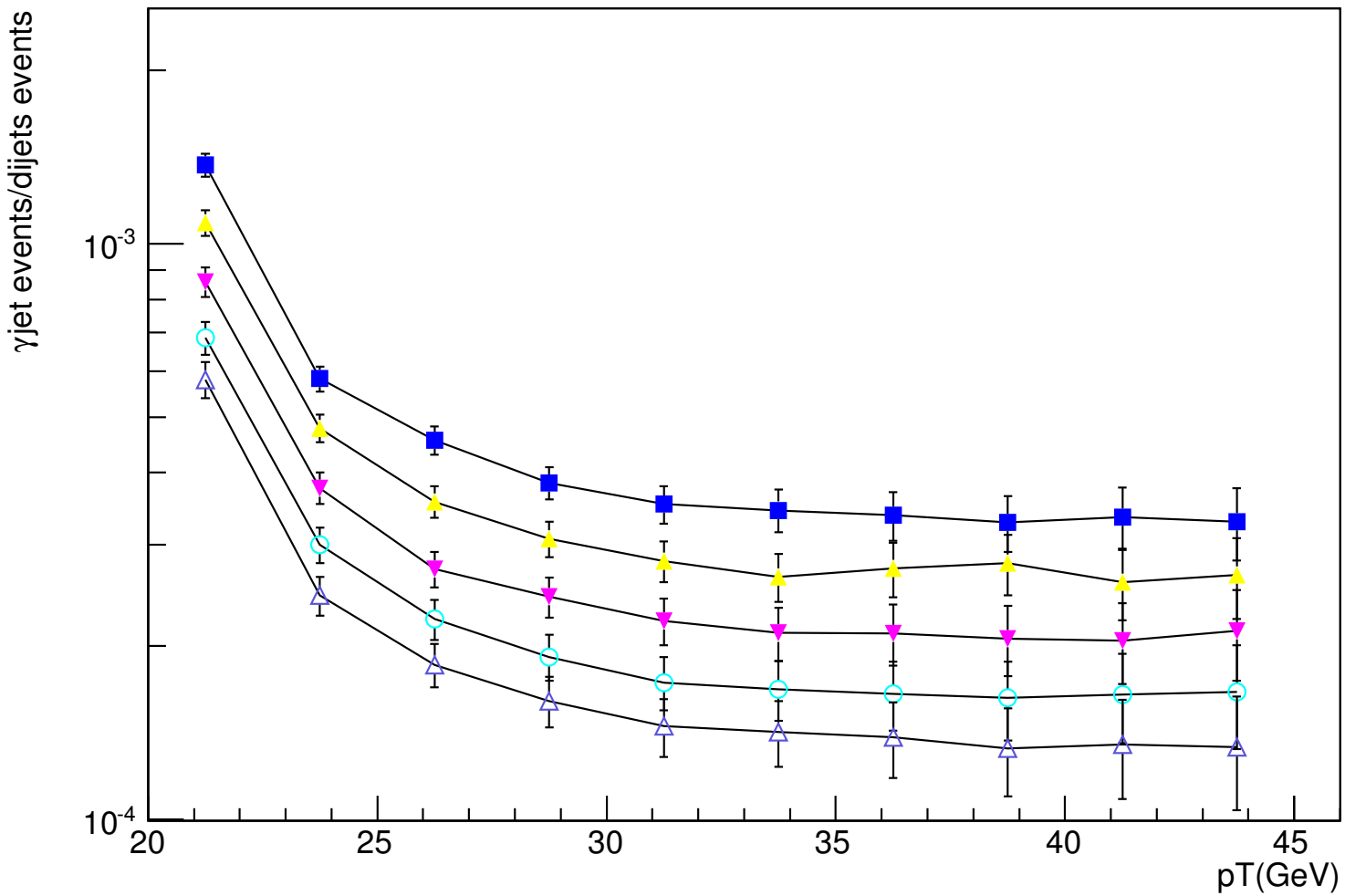
Dijet



- Cross-sections integrated on **2.5 GeV bins**
- Cross-sections ratio varies by **a factor 4**
- Jet Energy Scale (JES) systematics should compensate (but not resolution)
- Statistical uncertainty driven by γ+jet

d/u results : $p_{T,jet}$ differential cross-section ratio, $\sqrt{s} = 14$ TeV

Statistical uncertainty ($L = 300\ pb^{-1}$, AFP 210m)



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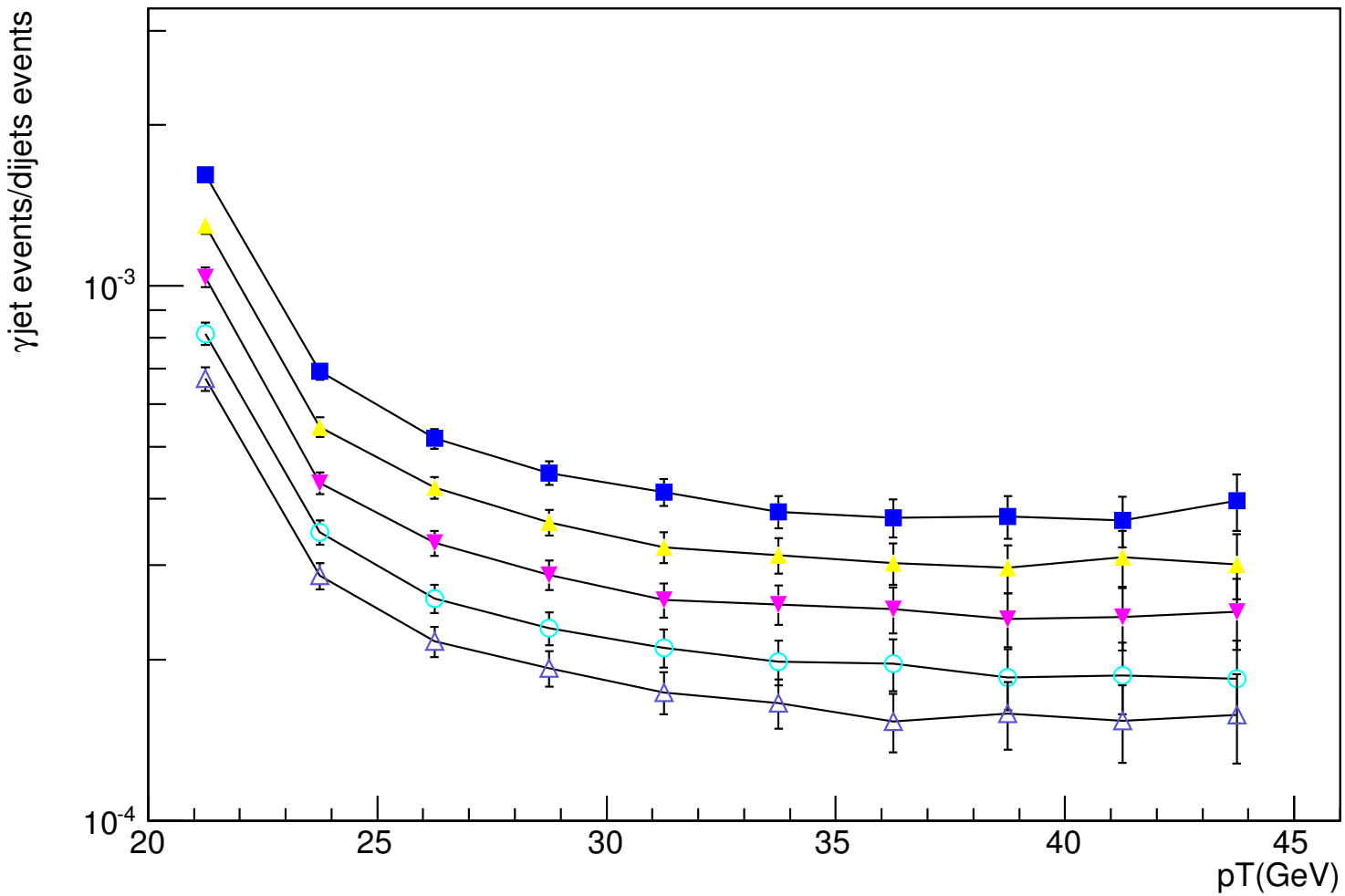
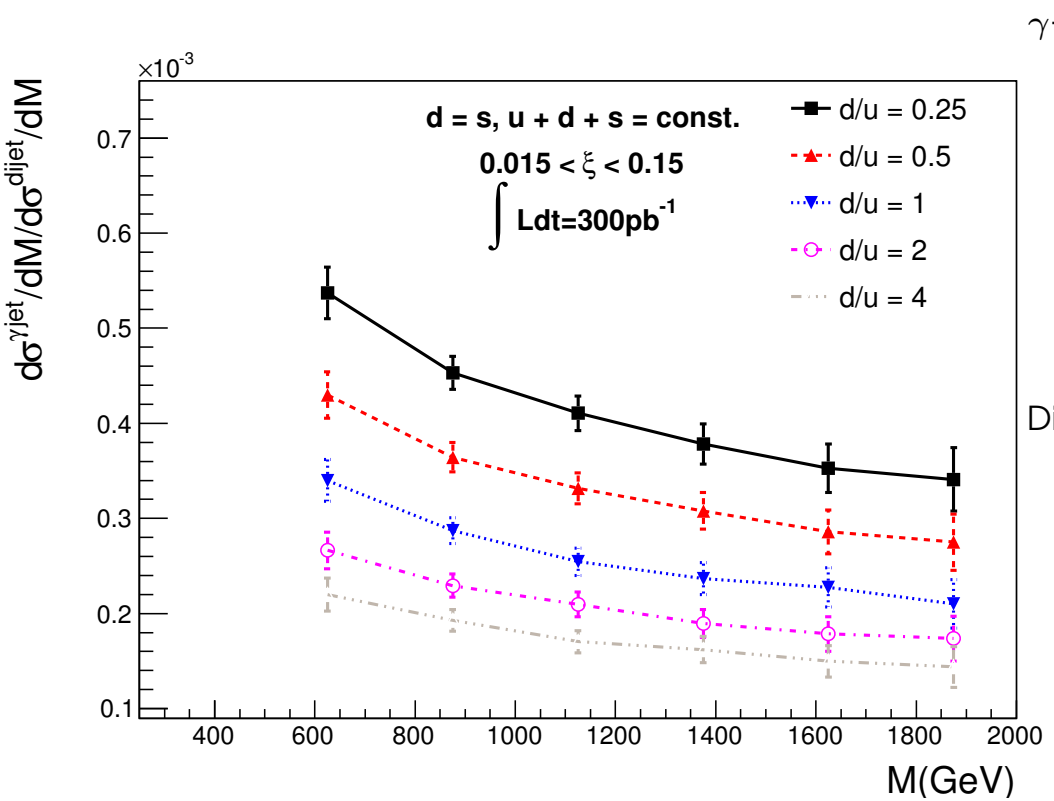
Statistical uncertainty ($L = 300\ pb^{-1}$, AFP 210+420m)



d/u results : $M_{p-p}(= \sqrt{\xi_1 \xi_2 s})$ differential cross-section ratio, $\sqrt{s} = 14\ \mathrm{TeV}$



- Cross-sections integrated on **250 GeV bins**
- Cross-sections ratio varies by **a factor 1.5**
- Systematics should almost compensate (AFP measurement)
- Statistical uncertainty driven by γ+jet

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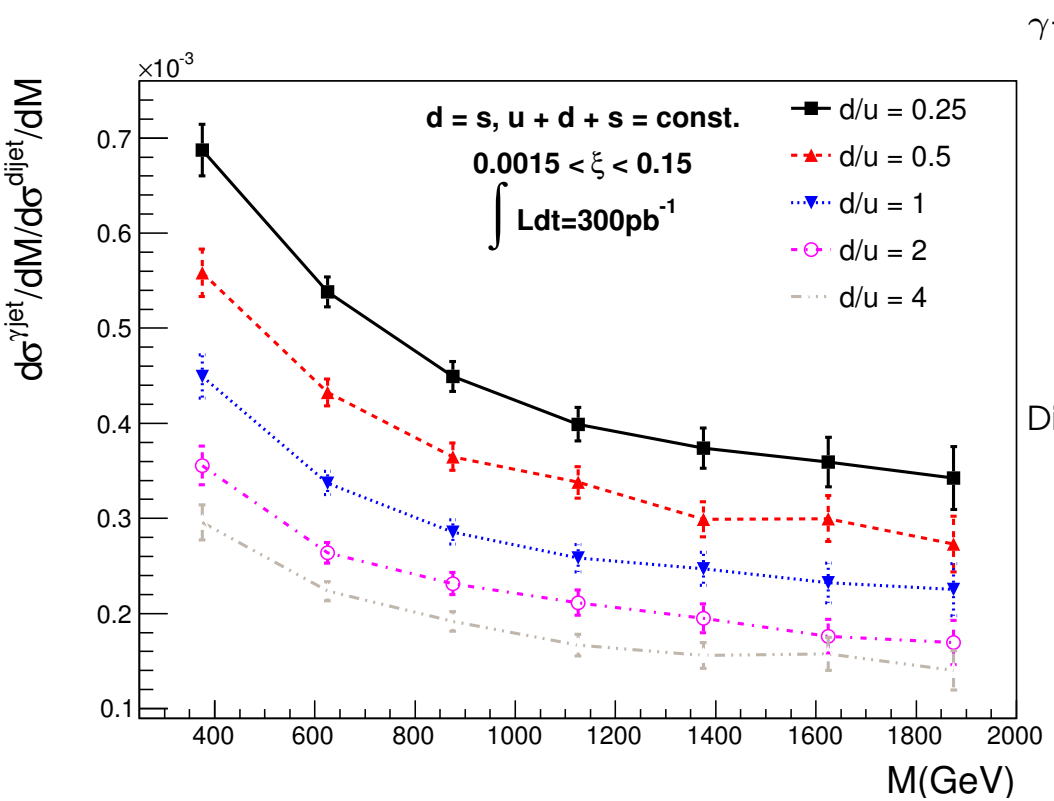
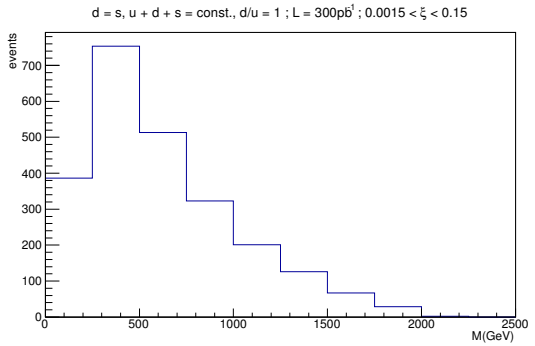


γ+jet



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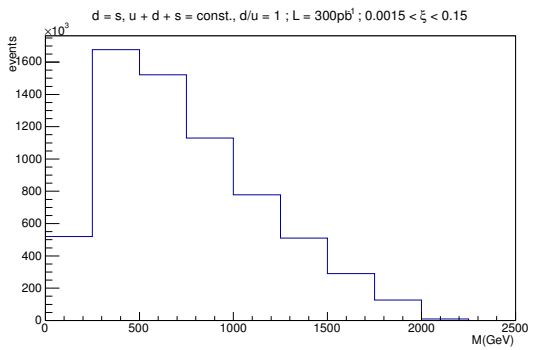

- Cross-sections integrated on **250 GeV bins**
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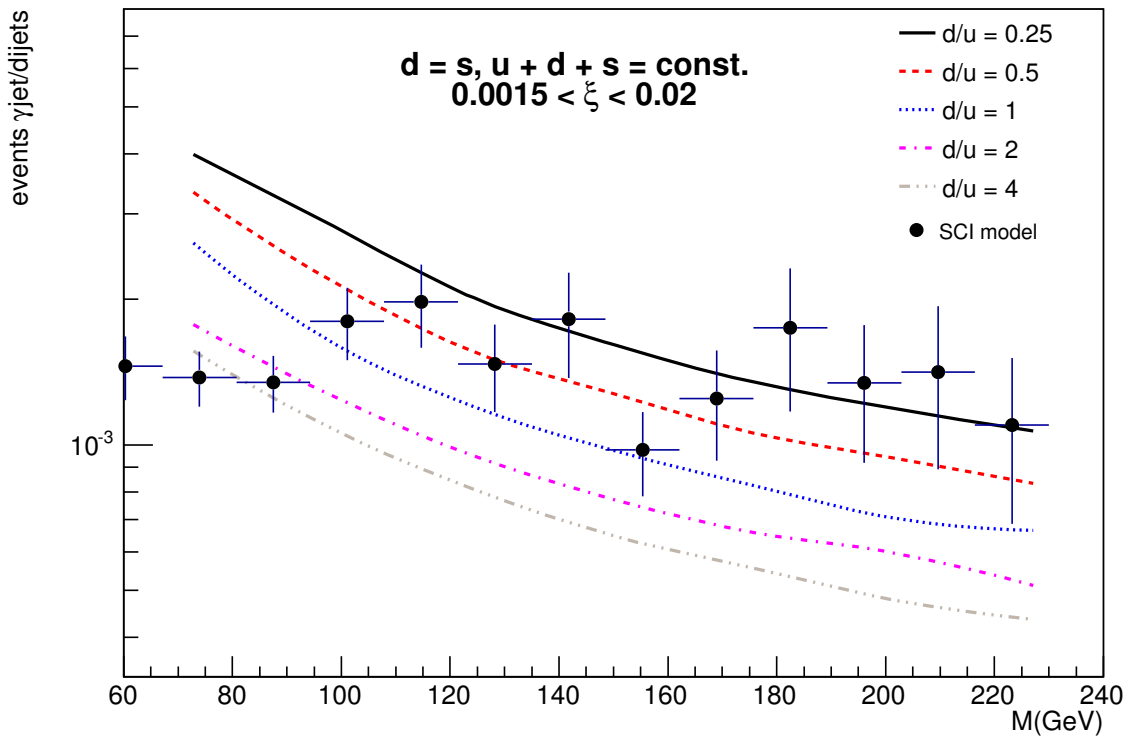
$M_{p-p}(=\sqrt{\xi_1\xi_2 s})$ observable : A way to discriminate Pomeron from SCI model?



- Need to be out from the SCI **background** : $\xi < 0.02$ (probably overestimated)
- SCI : **flat** distribution
- **Preliminary plot**

Conclusion

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  - Requires dedicated **low luminosity runs**
  - Measurement would be relevant as of $\boldsymbol{L = 300\ pb^{-1}}$ ($\simeq$ 3 weeks of data) with AFP 210 m
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- Study of **d/s** in progress. **A paper is being drafted**.

Back-up slides

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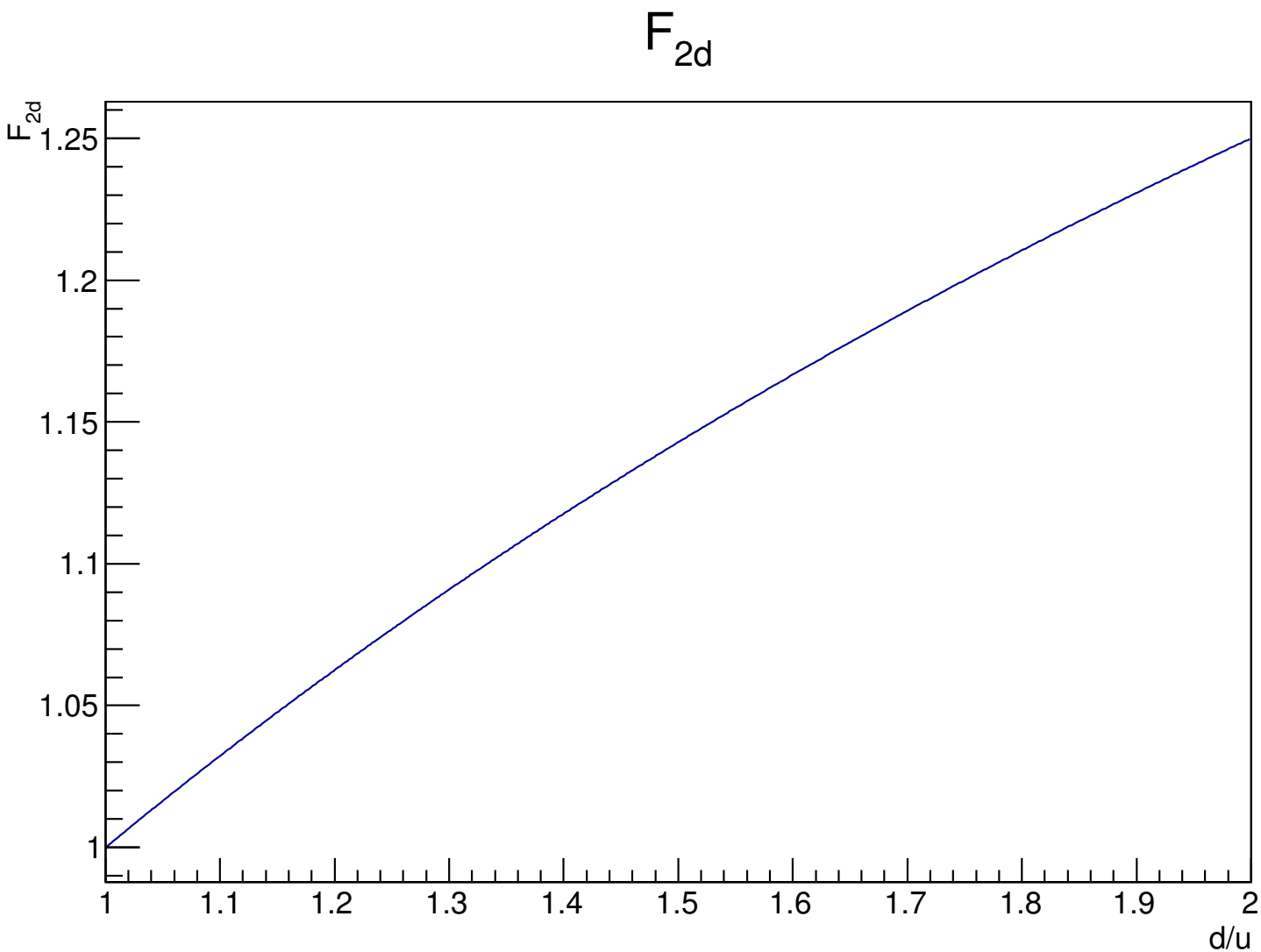
F_2^D variations



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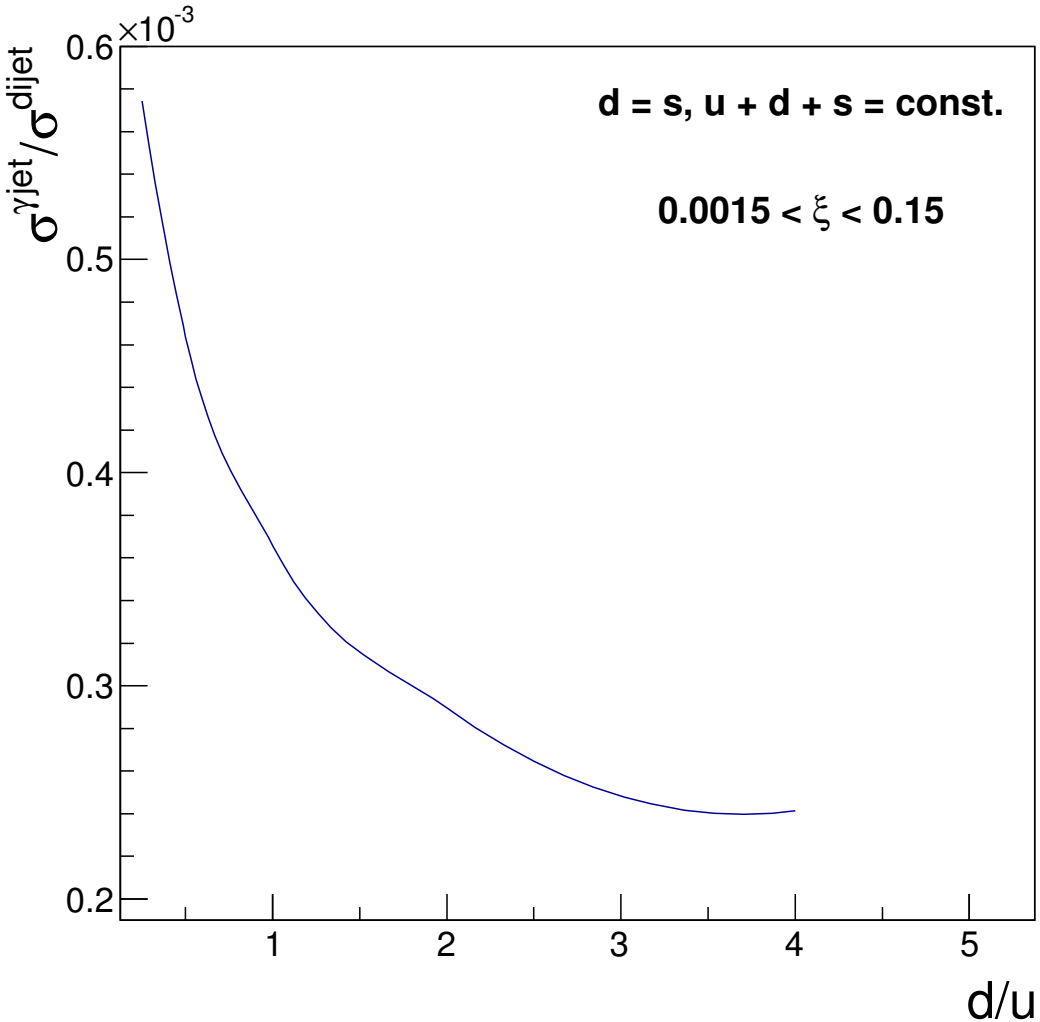

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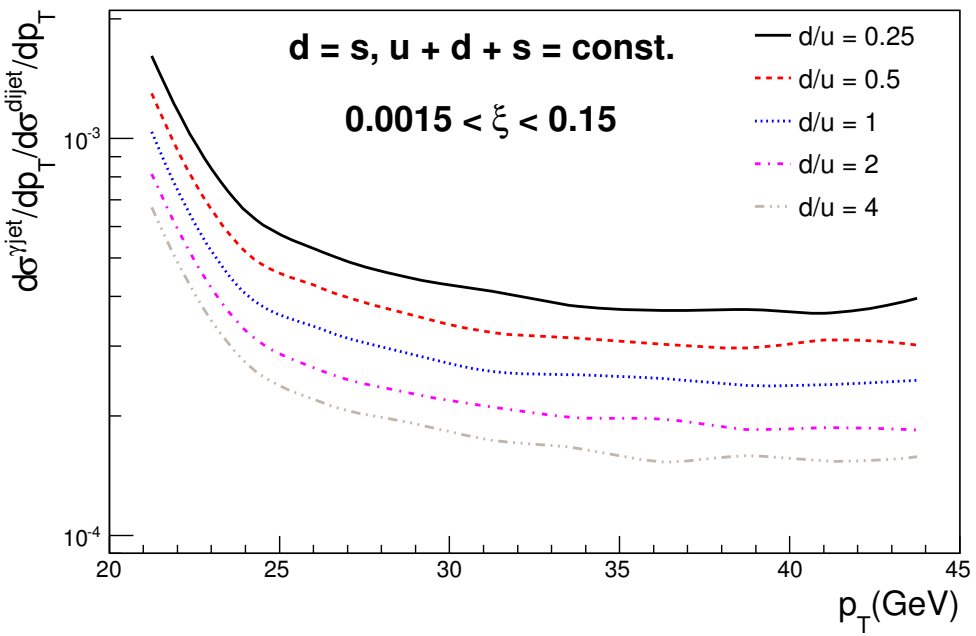
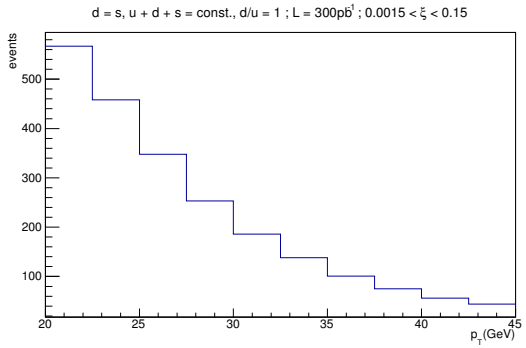
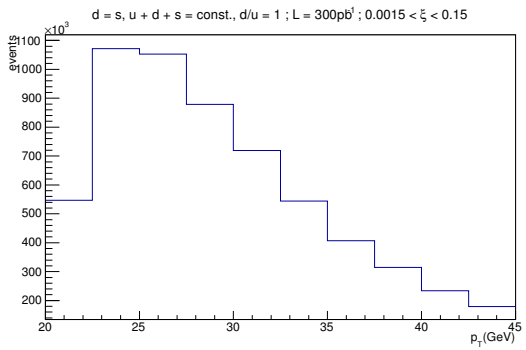


γ+jet



Dijet



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