

# Forward Proton Detectors and the 750 GeV Resonance preliminary results

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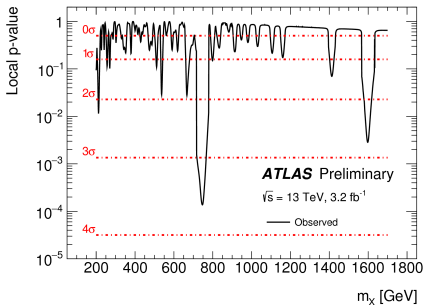
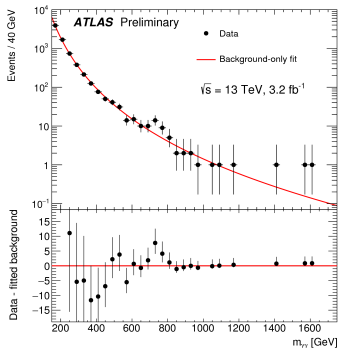
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**Low-x Meeting 2016**

**6 – 11 June 2016**

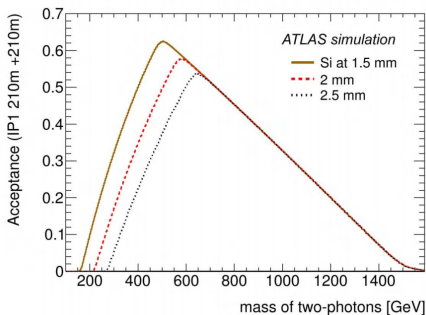
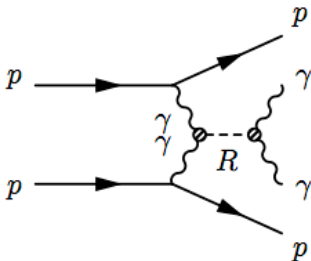
# Di-photon resonance at 750 GeV



- ATLAS and CMS observed an excess around 750 GeV in  $\gamma\gamma$  events (ATLAS-CONF-2015-081; CMS-PAS-EXO-15-004)
- Decay to  $\gamma\gamma \rightarrow$  exclusive two-photon production mechanism is possible:

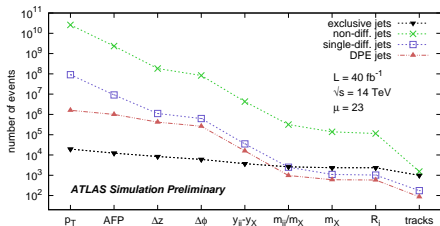
$$pp \rightarrow p + \gamma\gamma + p \rightarrow p + R + p \rightarrow p + \gamma\gamma + p$$

# Production in two-photon process



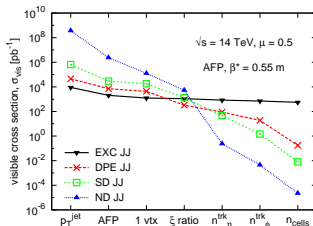
- L.A. Harland-Lang, V.A. Khoze, M.G. Ryskin, **JHEP 1603 (2016) 182**
- Lack of signal at 8 TeV with signal visible at 13 TeV compatible with production only via two-photon
- The observed width not compatible with coupling only to photons (but possible if two resonances)

## Double tag, high lumi



ATL-PHYS-PUB-2015-003

## Single tag, low lumi



Eur. Phys. J. C 75 (2015) 320

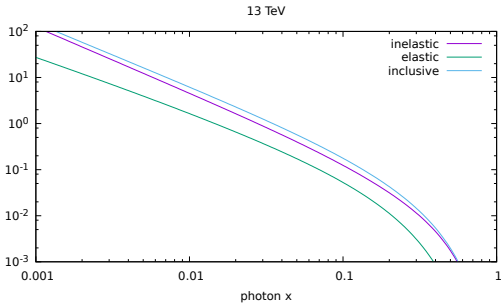
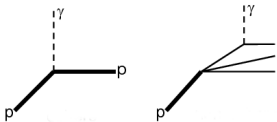
- It is possible to measure exclusive events with a single arm
- For exclusive jets this required going to low  $\mu$
- The background is very high and even the double-tag measurement is extremely difficult

- Exclusive measurement – detection of all final state particles
- Energy-momentum conservation:

$$\sum E = \sqrt{s}, \quad \sum p_x = \sum p_y = \sum p_z = 0$$

- Typically, due to limitations of the detectors, it is not possible to check all components of the four-momentum
  - Soft exclusive production ( $pp \rightarrow pp\pi^+\pi^-$ ) at high  $\beta^*$  and with vertical detectors: only  $p_x$  and  $p_y$
  - Exclusive jets with horizontal detectors:  $E$  and  $p_z$
- $(E, p_z) \leftrightarrow (M, y) \leftrightarrow (\xi_1, \xi_2)$
- One can probe the energy-momentum conservation using only a single variable (*i.e.*  $\xi_1$  or  $\xi_2$ )

# Photon fluxes



## ■ elastic:

$$f(x) = \frac{\alpha}{2\pi x} \left(1 + (1-x)^2\right) \left(\log A - \frac{11}{6} + \frac{3}{A} - \frac{3}{2A^2} + \frac{1}{3A^2}\right), \quad A = 1 + \frac{0.71 \text{ GeV}^2}{Q_{\min}^2}$$

$$Q_{\min}^2 = -2m_p^2 + \frac{1}{2s} \left[ (s + m_p^2)(s - xs + m_p^2) - (s - m_p^2) \sqrt{(s - xs - m_p^2) - 4 * m_p^2 xs} \right]$$

M. Drees and D. Zeppenfeld, Phys.Rev. D39 (1989) 2536

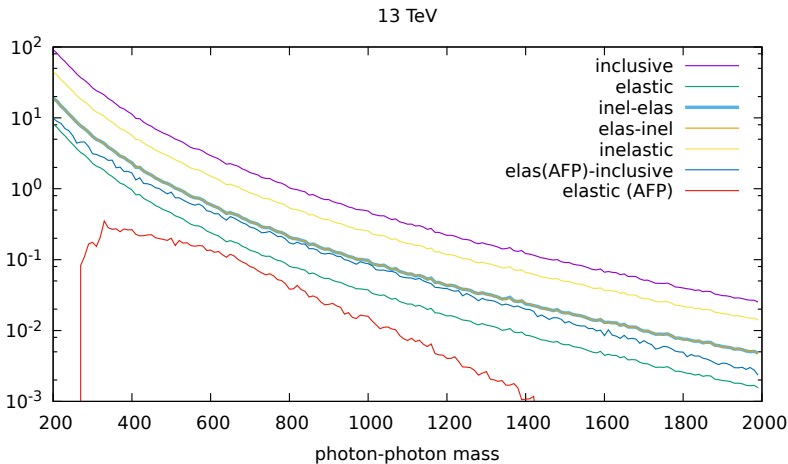
## ■ inclusive: MRST2004qed\_proton

## ■ inelastic: inclusive – elastic

# Photon-photon luminosity – mass dependence

Forward  
Proton  
Detectors  
and the 750  
GeV  
Resonance

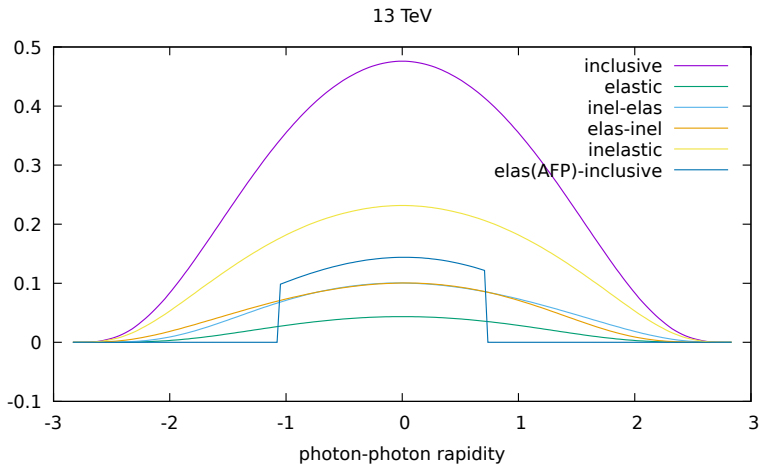
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# Photon-photon luminosity – rapidity dependence

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GeV  
Resonance

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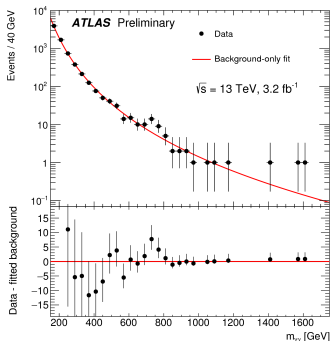




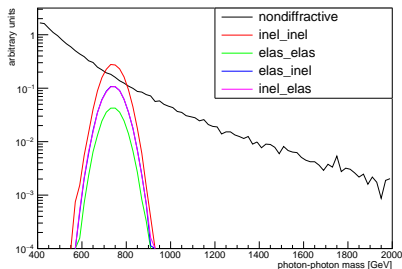
# Signal and background simulation

Forward  
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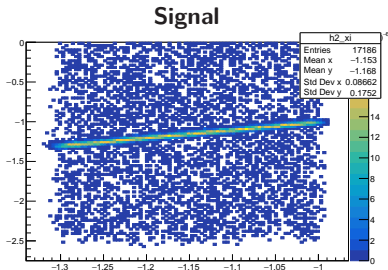
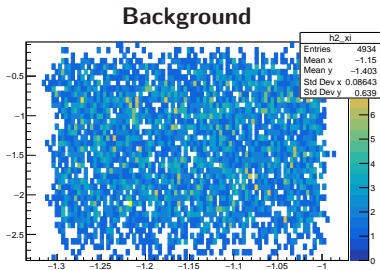
- Background: non-diffractive  $\gamma\gamma$  (Pythia)
- Signal:
  - collinear approximation (also for inelastic)
  - $\sigma(\gamma\gamma \rightarrow R)$  – arbitrary
  - width – arbitrary
- Pile-up added to signal and background (parametrised soft SD)
- Resolution of  $\gamma$  energy included
- Proton energy resolution included



# Exclusivity cut

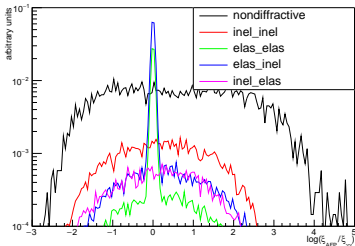
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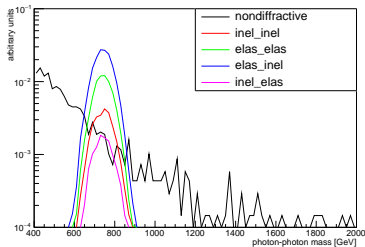
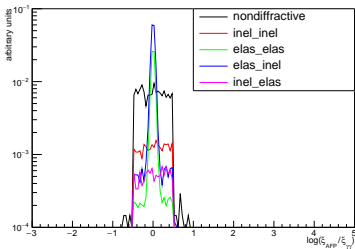


- Clear correlation between  $\xi_{\text{AFP}}$  and  $\xi_{\gamma\gamma}$  for signal events
- Discriminating variable:

$$\log(\xi_{\text{AFP}}/\xi_{\gamma\gamma})$$



# Results

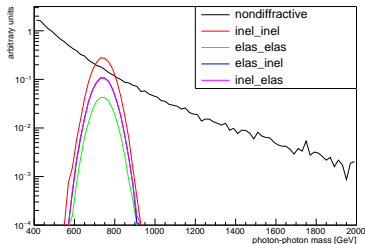


- Loose selection (to account for not included effects)
- Signal efficiency: 0.25
- Background reduction

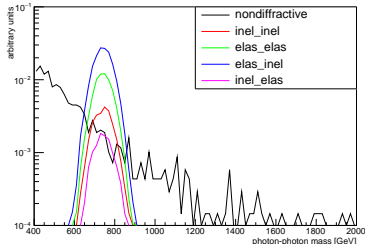
pile-up ( $\mu$ )	5	10	20	40
bkg. reduction	260	130	66	34

- 750 GeV resonance (if real) can be produced in  $\gamma\gamma$  fusion
- Goal: the exclusive measurement with both protons tagged
- Semi-exclusive measurement – single side needed
- ND background suppression by a factor of  $\sim 66$  for  $\mu = 20$

## No proton requirements:



## Single tag exclusivity:



## Plans:

- Kinematic effects due to dissociation
- Realistic acceptance and pile-up model
- Backgrounds from SD  $\gamma\gamma$  production