

Prompt Photon Production in Photon-Photon Collisions

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single-resolved

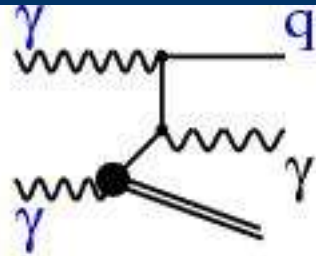
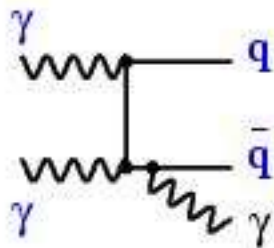


Figure 1: Diagram of the single-resolved process. The double line indicates the photon remnant and the dark circle a resolved photon.

double-resolved



Figure 2: Diagrams of double-resolved processes. The double lines indicate the photon remnant and the dark circles a resolved photon.



FSR ->
part of NLO

Figure 3: Diagram of a direct process with Final State Radiation (FSR).

sensitive to quark/gluon structure of the photon

compared to jets:

pro: no hadronisation

con: two orders of magnitude smaller cross-section

Preselection:

Anti-tagged photon-photon events

(no electron detected -> photons quasi-real)

Further cuts

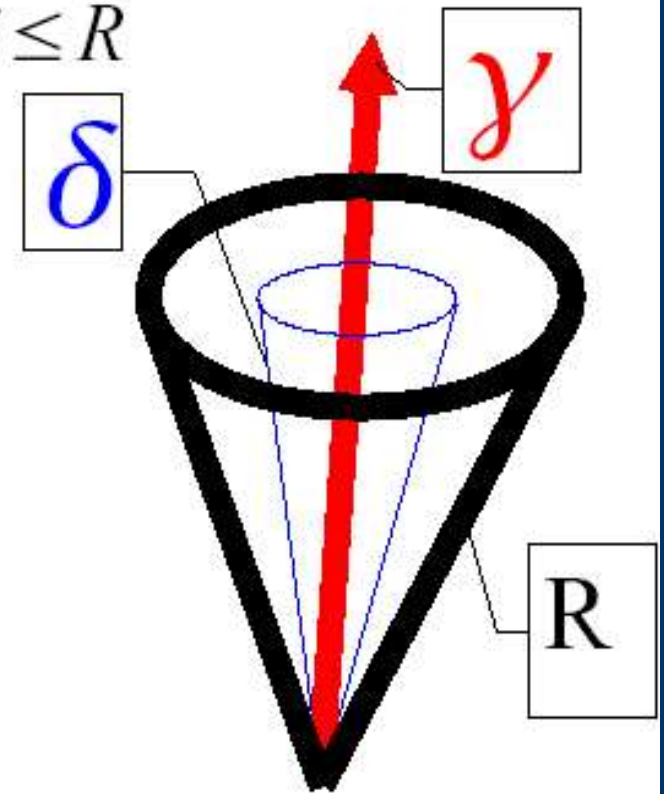
Isolation

- Criterion proposed by Frixione:

$$\sum_{hadrons,i} E_{T,i} \Theta(\delta - R_{i,\gamma}) \leq \epsilon E_{T,\gamma} \frac{1 - \cos(\delta)}{1 - \cos(R)}; \delta \leq R$$

with $R=1$, $\epsilon=0.2$

- Advantages:
 - Infrared safe
 - Background suppression
 - Similar efficiencies for single and double resolved processes

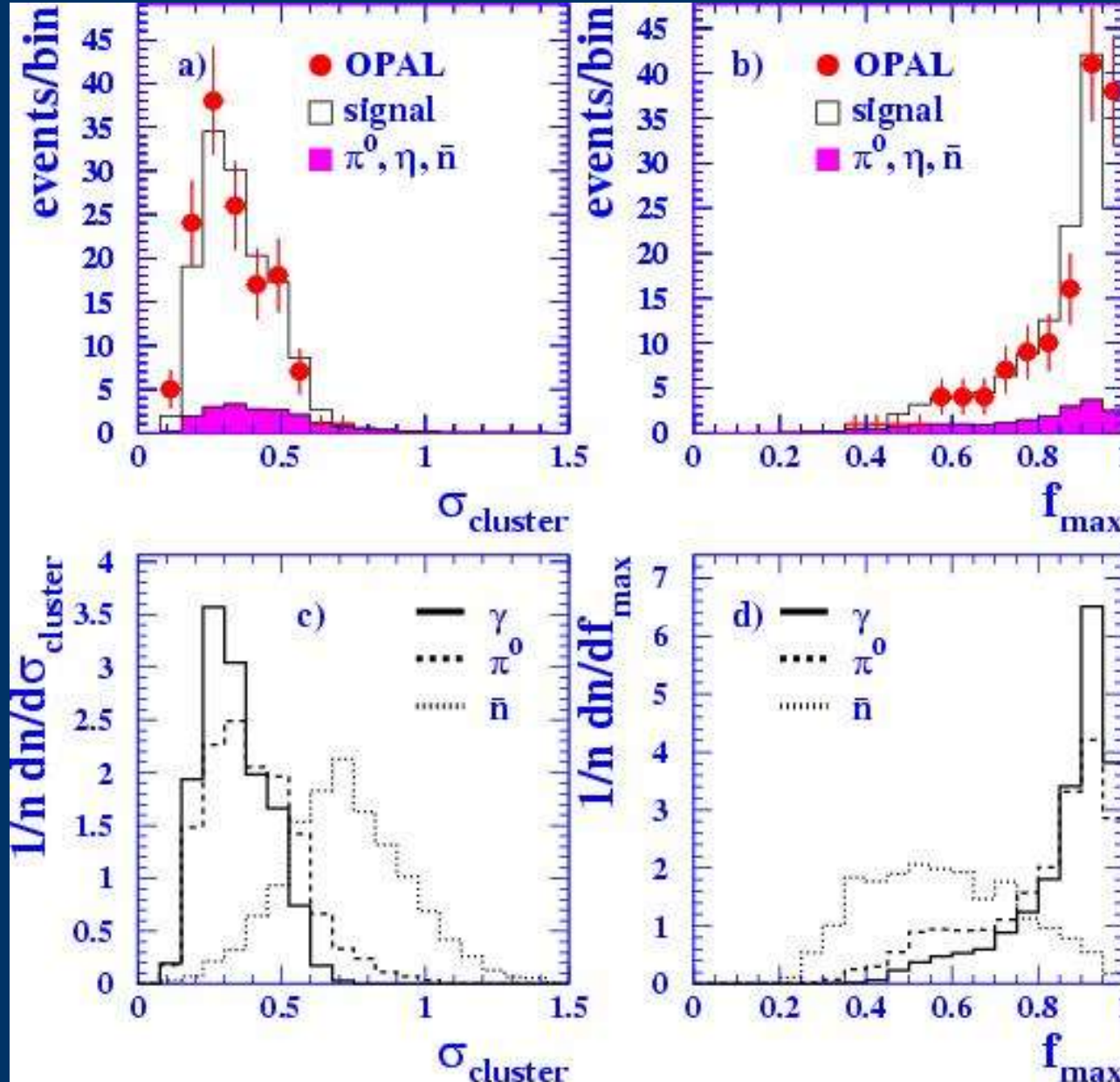


Data & Monte Carlo

- **Data:** OPAL 1997–2000 at $\sqrt{s_{ee}} = 183 - 209 \text{ GeV}$
Integrated luminosity 648.6 pb^{-1} $\langle \sqrt{s_{ee}} \rangle = 196.6 \text{ GeV}$
- **Monte Carlo:**
 - Signal:
 - PYTHIA, HERWIG (only single resolved)
 - PHOJET: *FSR–photons*
 - Background: η, π^0, \bar{n}
 - PHOJET
 - Single particle generator: Study of ECAL showers

Shower shape variables in ECAL

110 events
after
background
subtraction



$$x_{LL}^{\pm} = \frac{p_T^y (e^{\pm\eta_{jet}} + e^{\pm\eta_\gamma})}{\sum_{hadrons, jet, \gamma} (E \pm p_z)}$$

x 'fraction of initial photon's momentum participating in hard interaction'

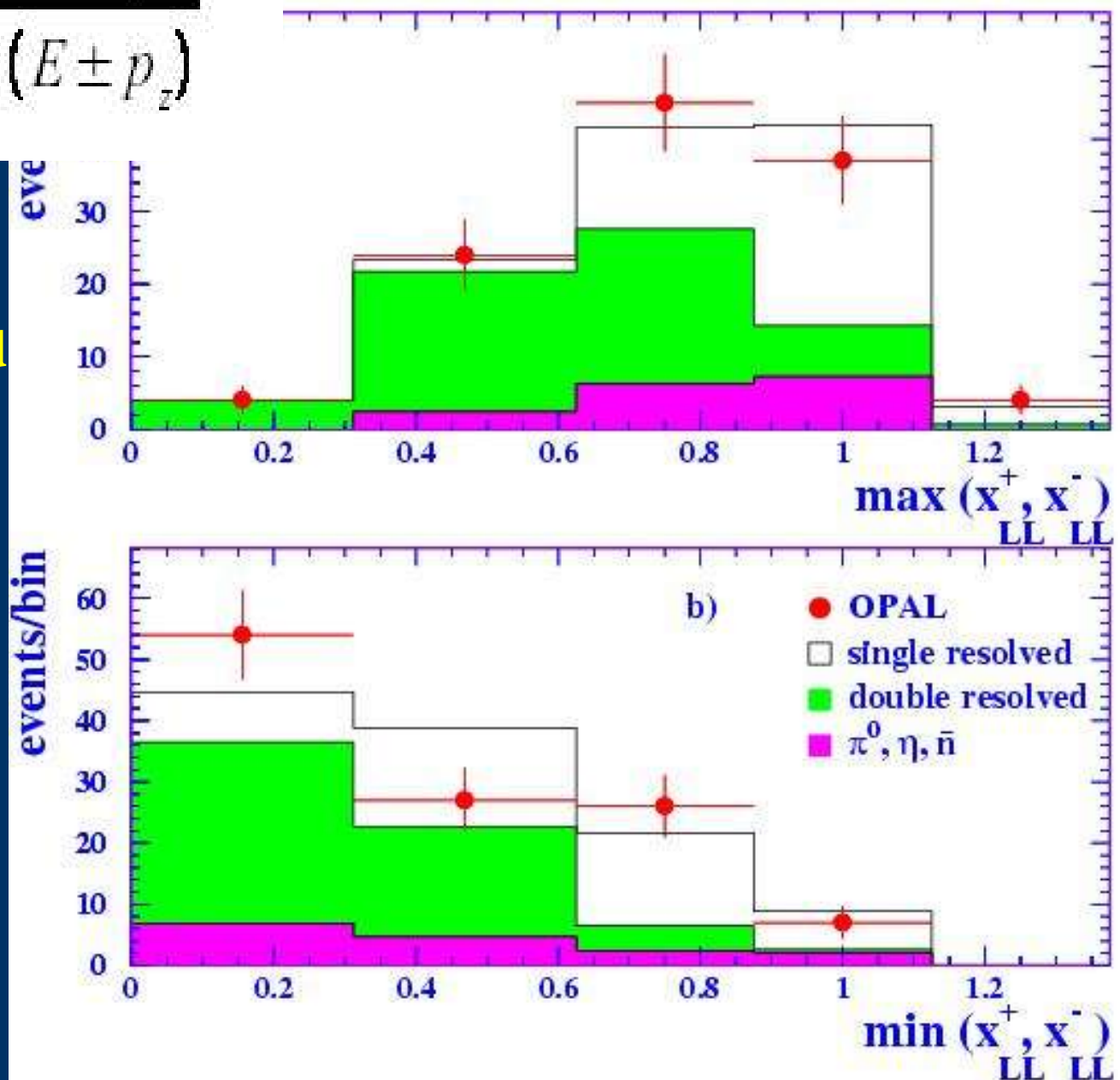
single-resolved:

$x^+ < 1$ and $x^- = 1$

(or v.v)

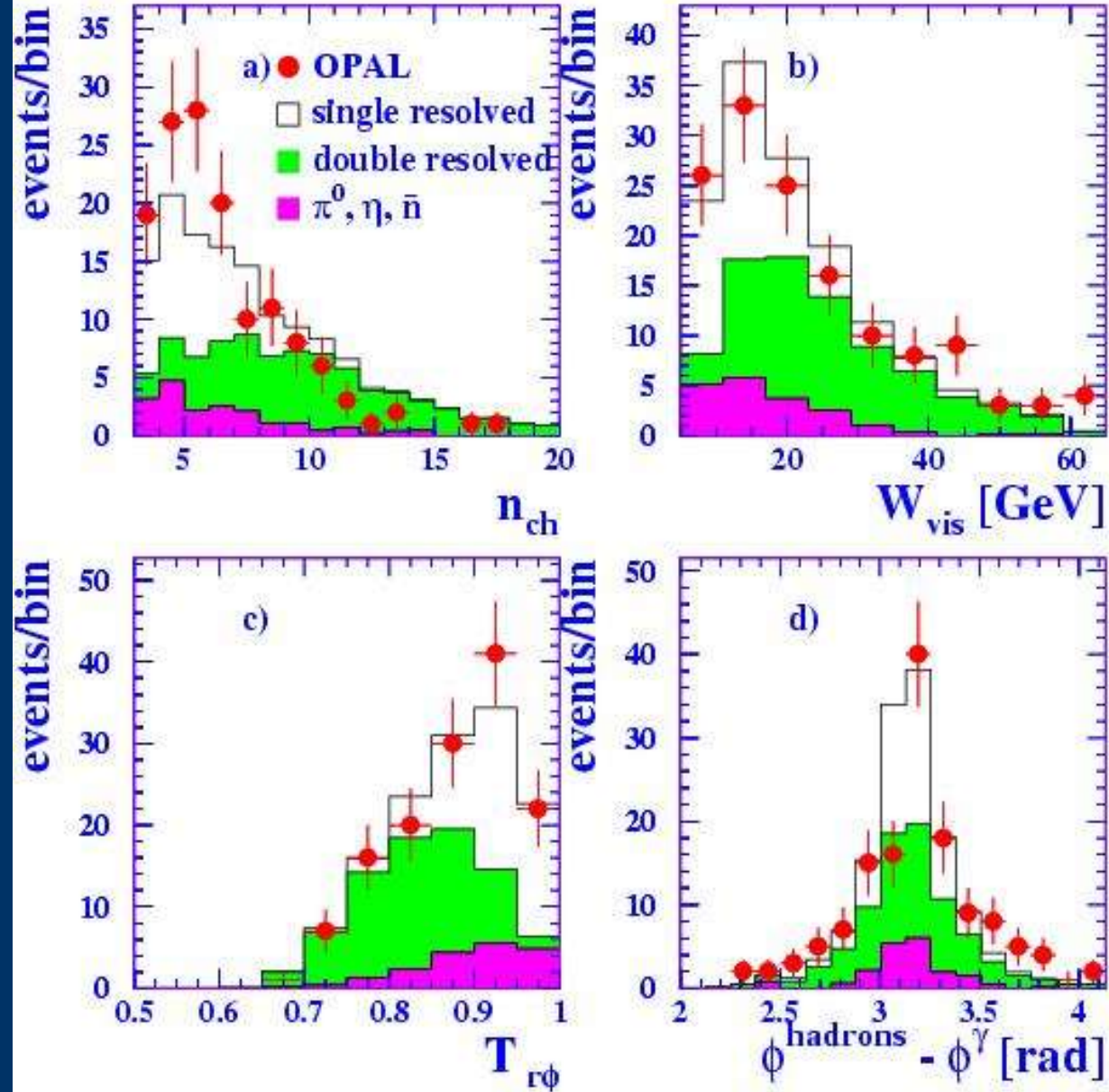
double-resolved

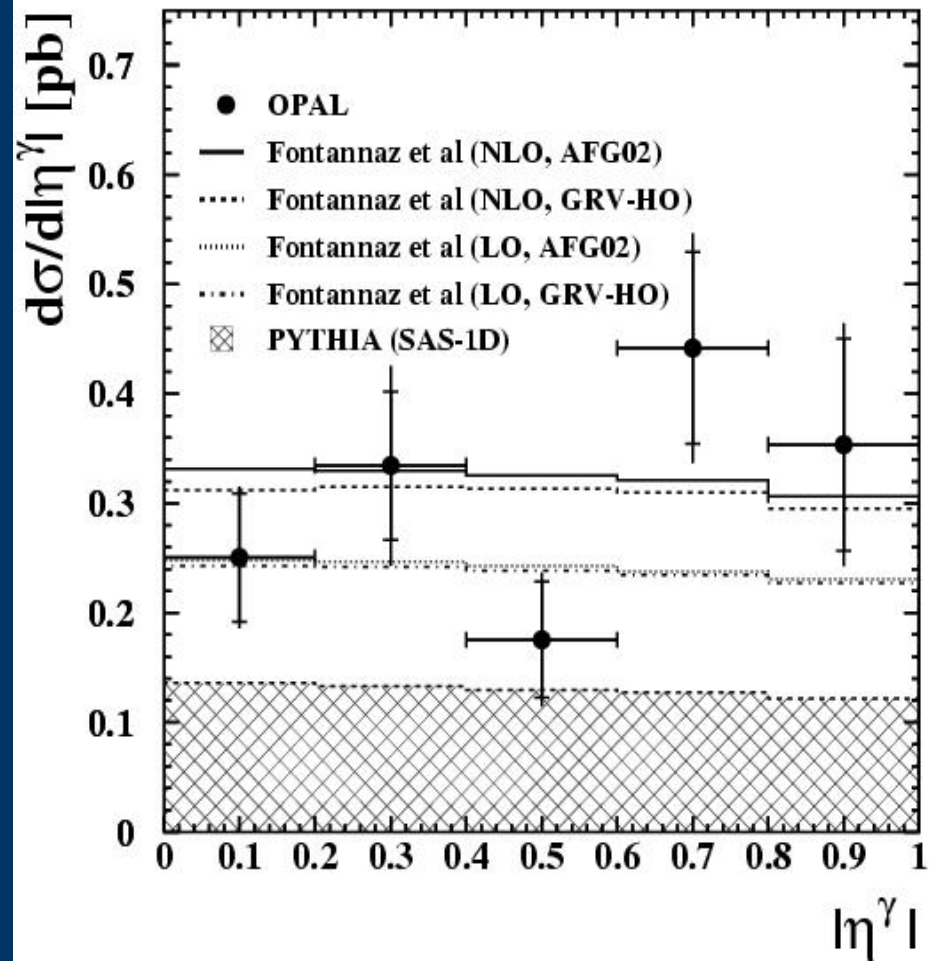
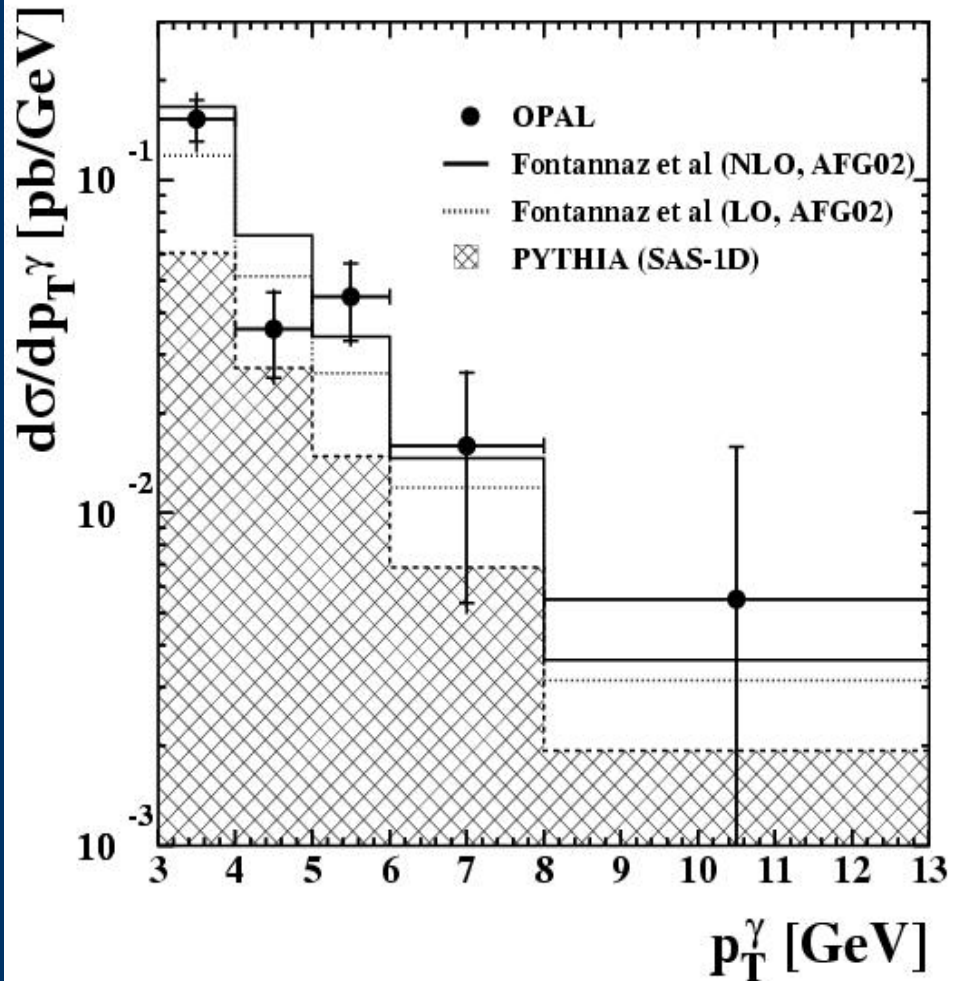
$x^+ < 1$ and $x^- < 1$

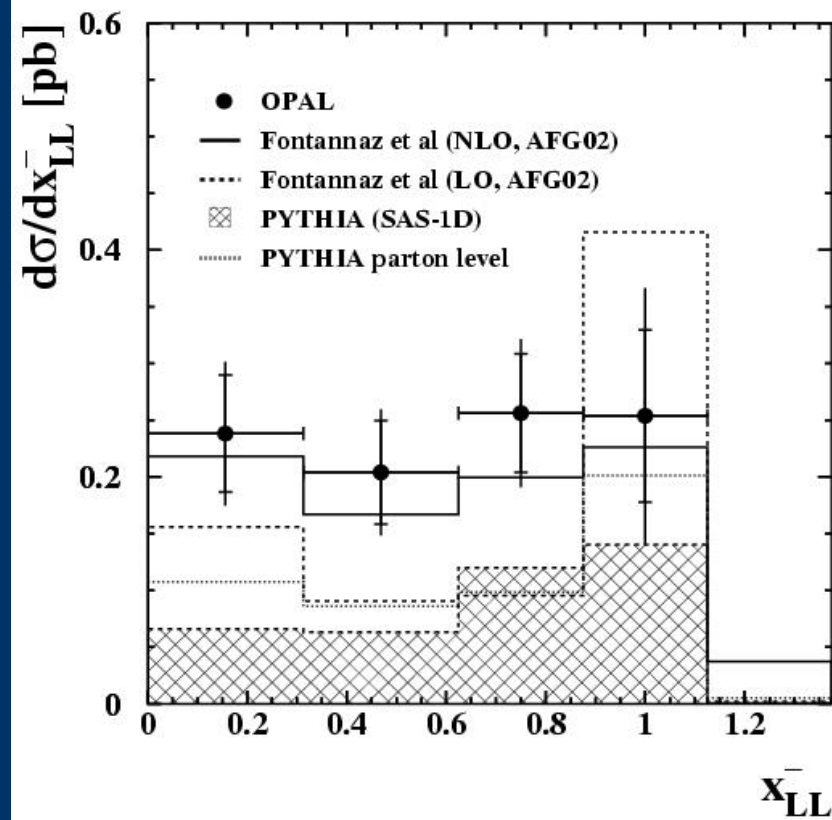
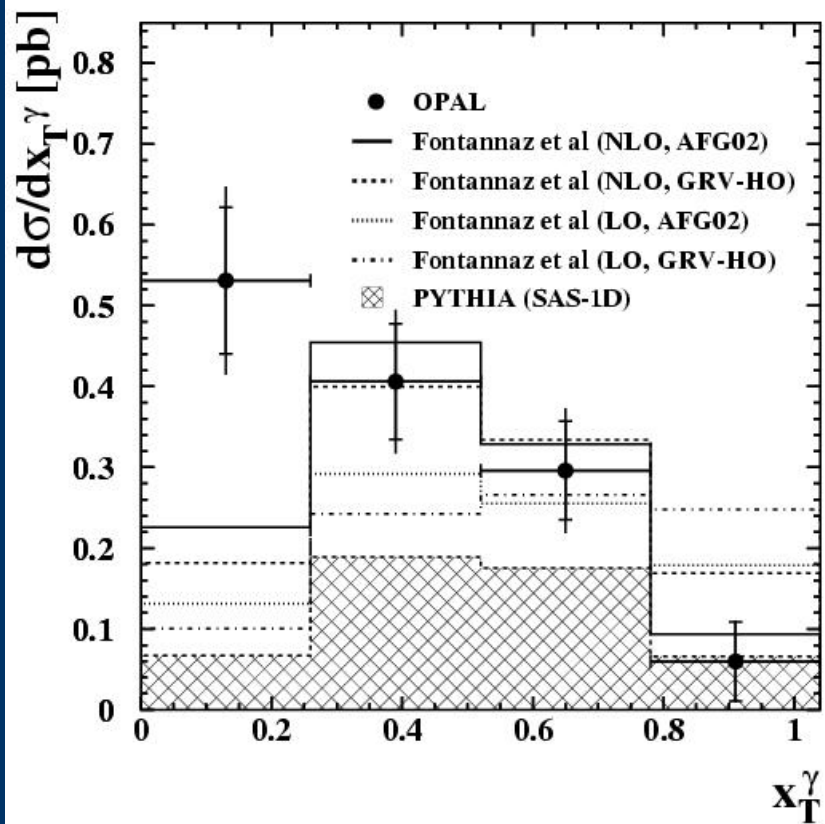


mixture of single- and double-resolved taken from data

compare kinematic variables for data and MC...







..loose ends on OPAL

- Joachim has made a detailed study of pizero production in photon-photon collisions at OPAL (since it is a potential background for the prompt photon analysis). This includes a comparison to NLO QCD.

This nice result is only contained in his thesis -> paper ?

- Johannes Elmsheuser, Akos Csilling and myself are still working at finalising the preliminary measurement of the process -> $b\bar{b}$ using the whole OPAL data set (electron and muon tags)
So far only a preliminary result, very interesting (and often cited)
 - much higher than NLO QCD (confirmed by other LEP collaborations)
 - important background for LC
 - excess observed in many processes (gamma-p, p - p...)
- AKS parton distributions of the photon
 - published first paper in 2002 but not much happened in 2003