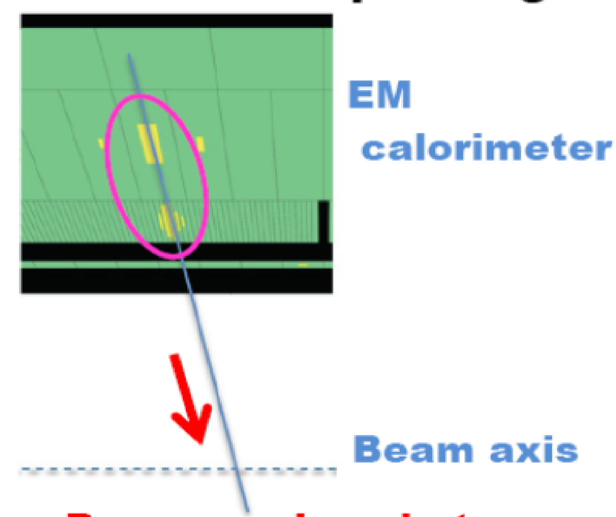
Vertex reconstruction

Vertex position is measured by "pointing method".

- **Unconverted photon :**
  "1st + 2nd layer of EM calorimeter"
- **Converted photon :**
  "1st layer of EM calorimeter"
  + "conversion point ($\gamma \to ee$)"

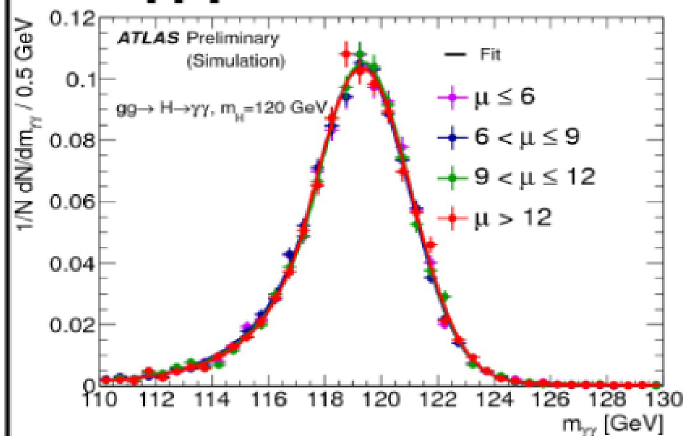
➡ **Robust measurement against pile-up.**

<Calorimeter pointing>

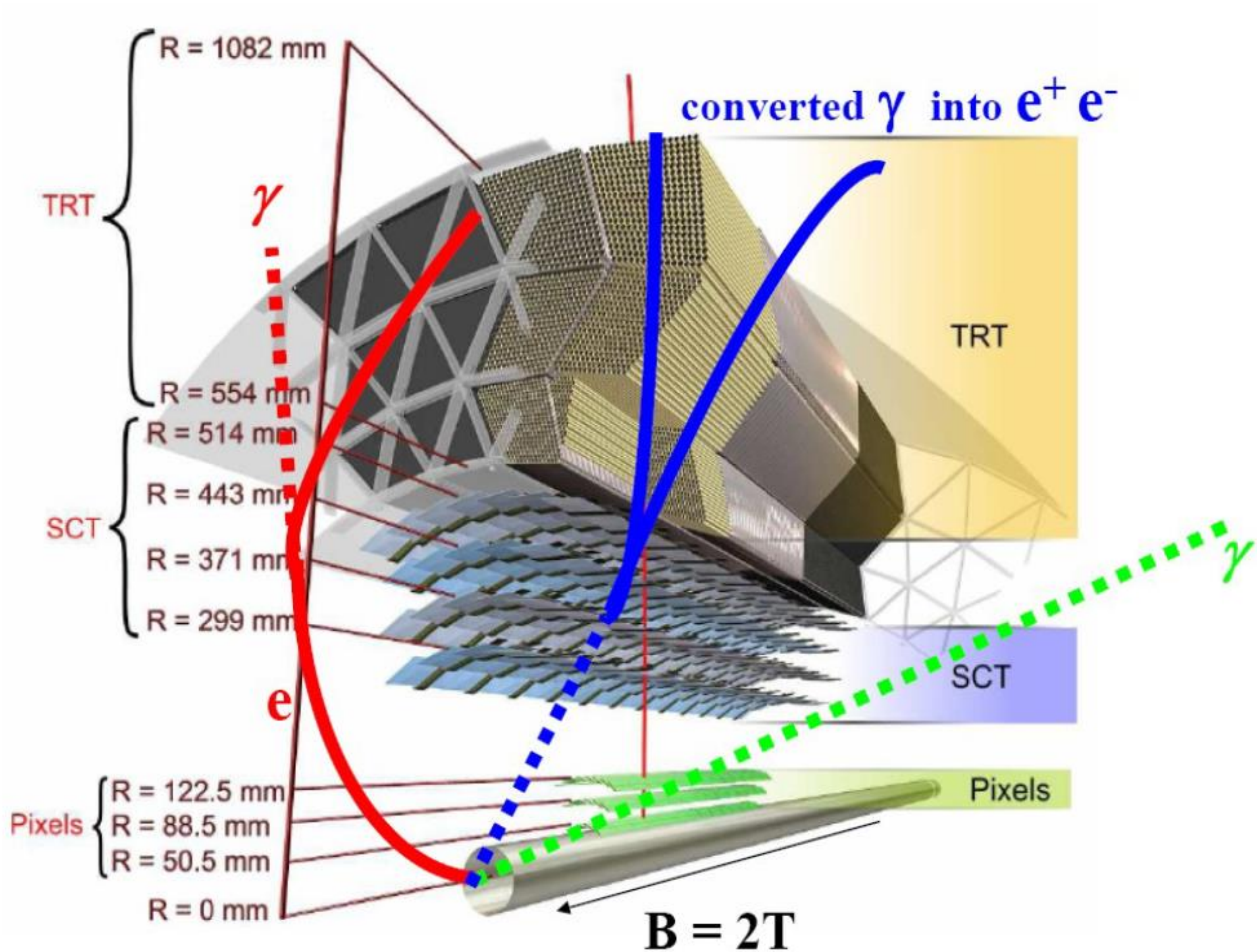


By measuring photon-direction, z of primary vertex is deduced.

<H→γγ peak with various conditions for pile-up>

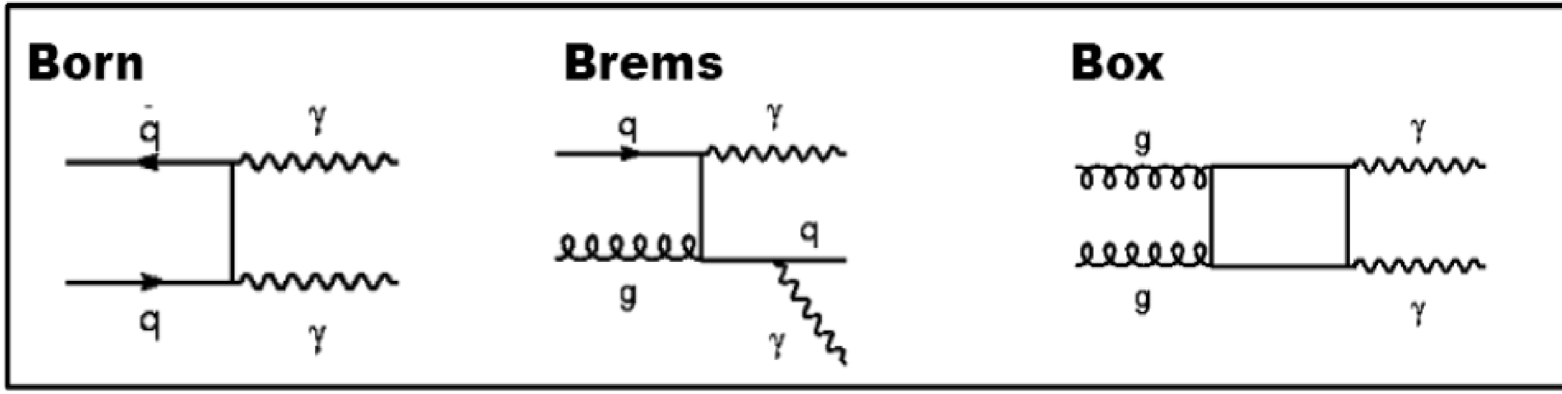


By using "pointing method", M(γγ) resolution also becomes stable against pile-up effect.

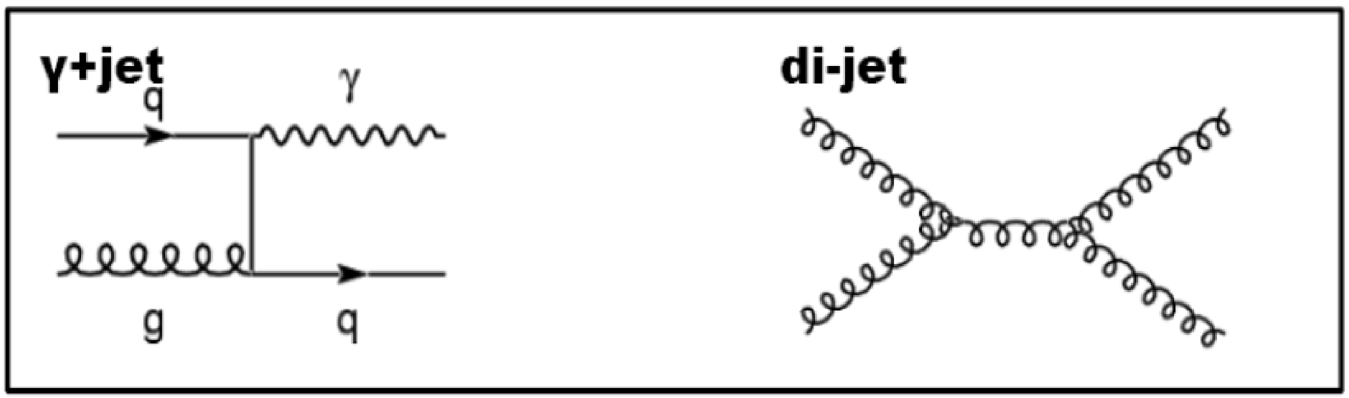

converted γ into e+ e-
R = 1082 mm
TRT
R = 554 mm
R = 514 mm
R = 443 mm
SCT
R = 371 mm
R = 299 mm
Pixels
R = 122.5 mm
R = 88.5 mm
R = 50.5 mm
R = 0 mm
γ
e
TRT
SCT
Pixels
γ
B = 2T

Backgrounds

◆ **Irreducible background (γγ)**



◆ **Reducible background (γ+jet, di-jet)**

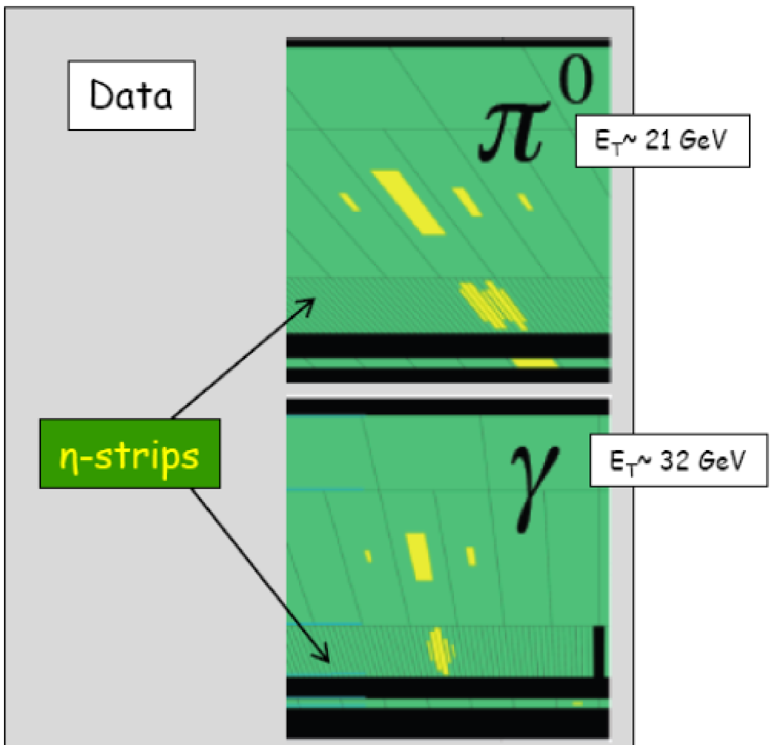


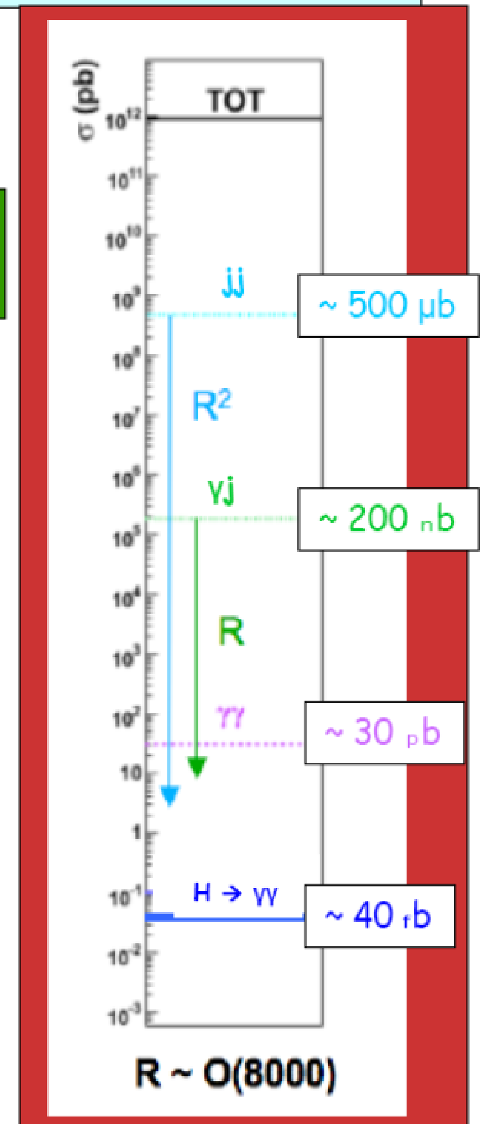
◆ **Drell-Yan (Z→ee)** ・・・ **Very small contribution**

Potentially huge background from γj and jj production with jets fragmenting into a single hard π^0 and the π^0 faking single photon

↓

Determined choice of fine lateral segmentation (4mm η-strips) of the first compartment of ATLAS EM calorimeter





Background decomposition

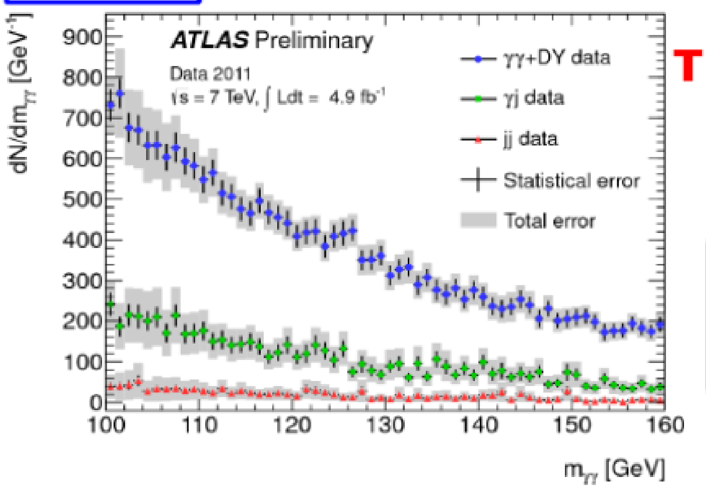
- **Decomposition for "γγ+DY", "γ+jets" and "di-jet" is performed in a data-driven manner.**

  Control sample is obtained from "anti-cut" region that is defined with photon-ID and isolation variables for the two photons.※

- **DY contribution is also estimated by using "eγ events" as a control sample.**

  (Enriched with Z→ee where one electron is faking as photon.)

Result

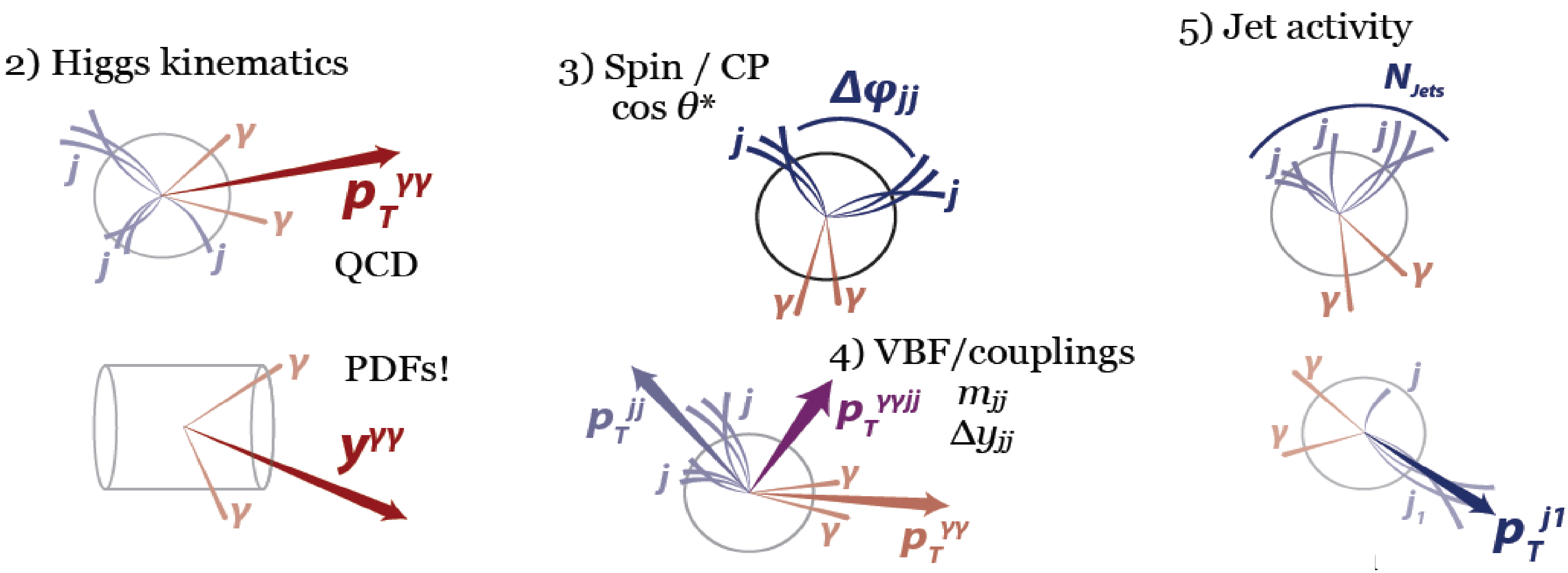


The contribution from irreducible BG (γγ) is dominant. (Fraction = 71%)

(It could be also confirmed that the contribution from Zee is very small. (<1%))

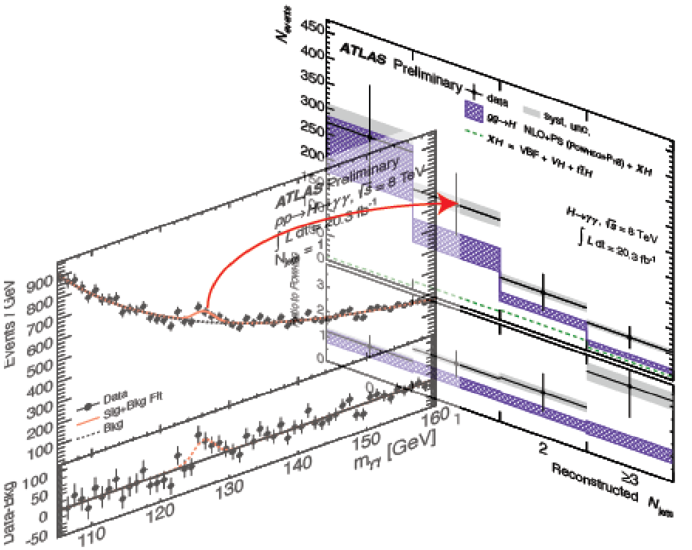
Differential cross-setion

- Higgs: transition from “discovery mode” → precision measurements
- Measurement of ***fiducial*** and differential cross sections are ***corrected for detector effects*** and designed to be as ***model independent*** as possible
- Corrected measured distributions can be
  - direct comparison with theory (without the need of detector simulation)
  - used to probe a variety of physics e.g.
    1) overall cross sections



Analysis overwiew

1. Signal extraction



a) Spit dataset into bins of variable of interest (here 4 N_{jets} bins)

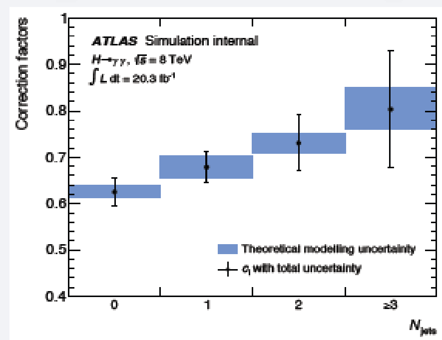
b) For each bin, extract s by an s+b fit to the $m_{\gamma\gamma}$ spectra

c) Large statistical uncertainty due to small s/b

2. Unfold to particle level

and divide by integrated luminosity and bin-width

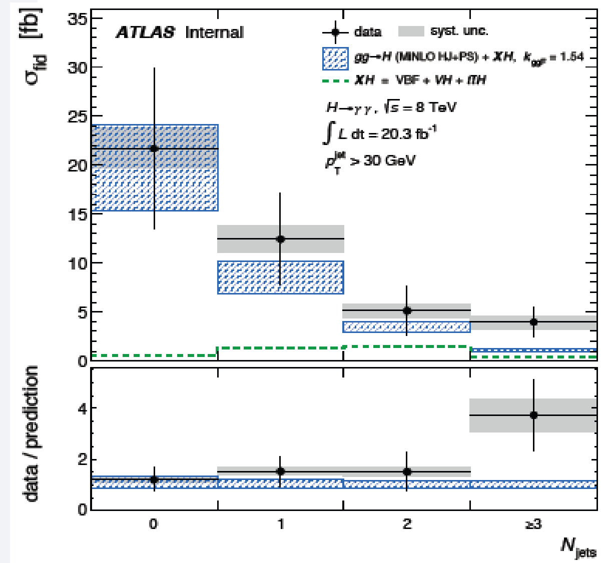
$$\sigma_i = \frac{\nu_i^{\mathrm{sig}}}{c_i \int \mathcal{L}\,\mathrm{d}t}$$



a) correction for detector effects with bin-by-bin unfolding

b) convert to ("differential") cross section by dividing by int. lumi (and bin-width)

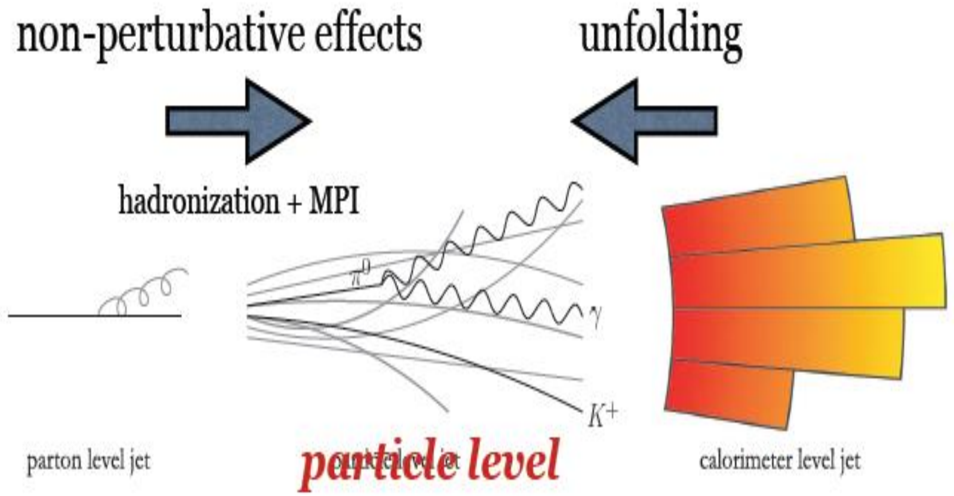
3. Plot and compare with theory



a) compare to **particle level** prediction - i.e. no need for detector simulation

b) Can also compare with analytical calculations (parton level) but then need small parton→particle level (NP) correction

Fiducial definition, photon truth isolation

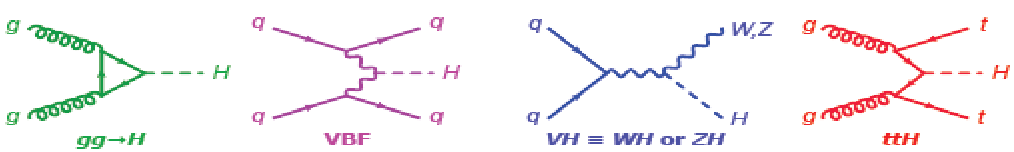


$H \to \gamma\gamma$ fiducial definition:

Two isolated photons fulfilling:

- $p_{T\gamma} / m_{\gamma\gamma} > 0.35$ (0.25) for leading (subleading photon)
- $|\eta| < 2.37$
- isolation criteria: $E_T < 14$ GeV of particles in $\Delta R < 0.4$

- At reco level, photon isolation efficiency very different depending on hadronic activity:
- P(isolated) for a photon is ~99% (~80%) for ggF (ttH)



- Isolation criteria at reco level hence very **topology dependent** - by applying a truth isolation criteria mimicking the reco one - this is much improved