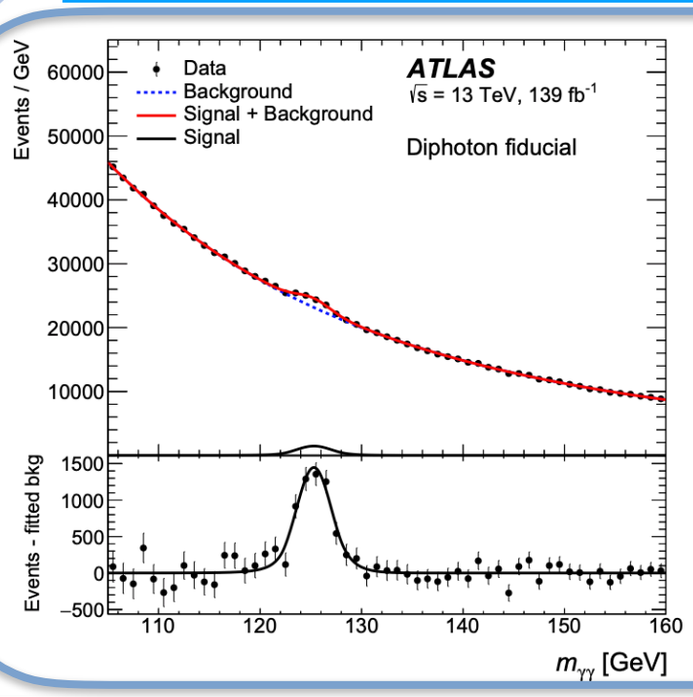
Inclusive and differential fiducial measurements in the diphoton channel using full Run2 dataset at ATLAS

Fábio Lucio Alves (Nanjing University) on behalf of the ATLAS experiment

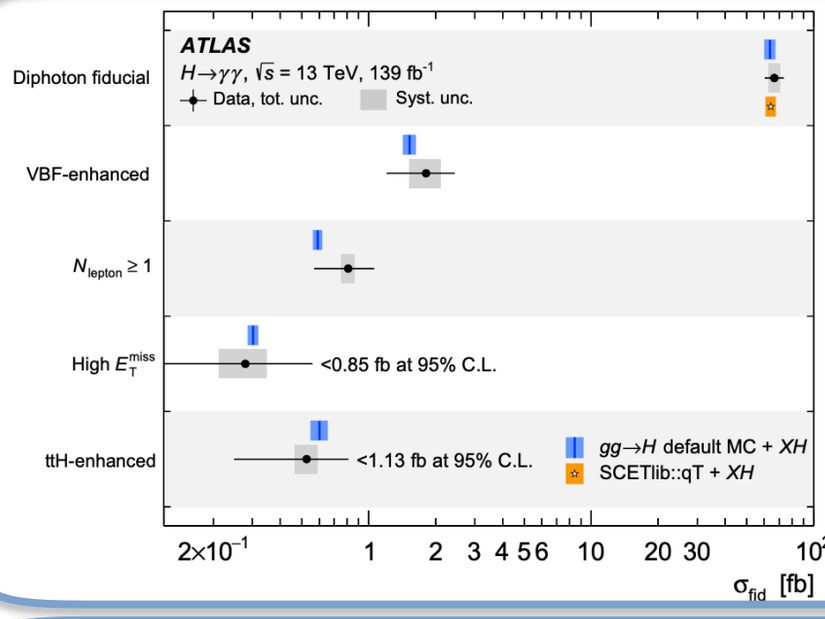
ICHEP2022, Bologna(IT),6-13 July 2022

Higgs boson decay in diphoton channel at ATLAS



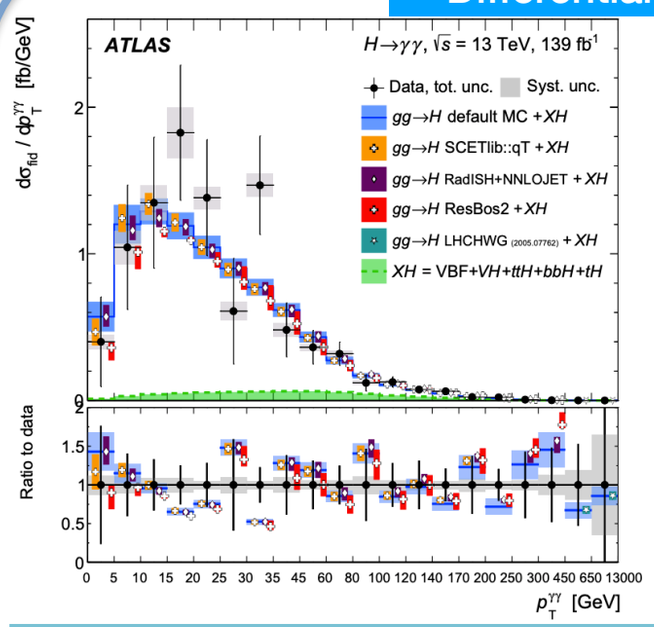
- **Signature:** two reconstructed isolated photons
  - Narrow peak over smoothly falling background (excellent photon energy resolution)
  - Diphoton vertex requirement:
    - Neural Network algorithm takes as input information from tracks, primary vertex and directions of the photons
      - benefits the mass resolution (~11% improvement for inclusive case)
- **Main backgrounds:**
  - continuum $\gamma\gamma$ production (reducible), γjet and $jetjet$ (irreducible)

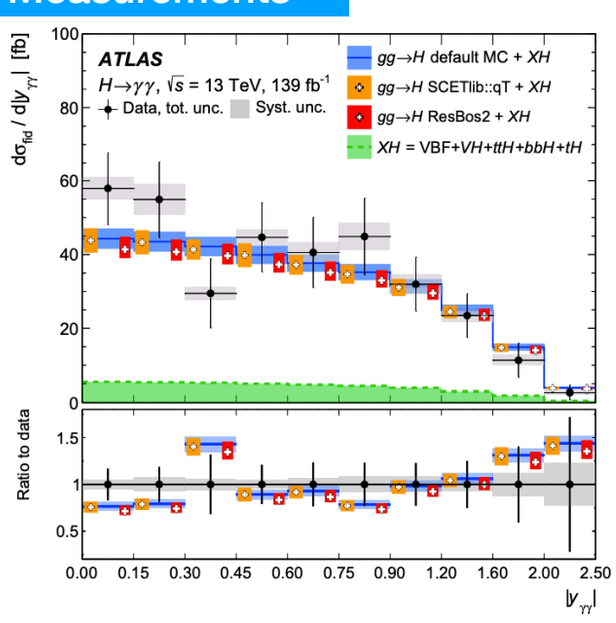
Inclusive and Differential Fiducial Measurements



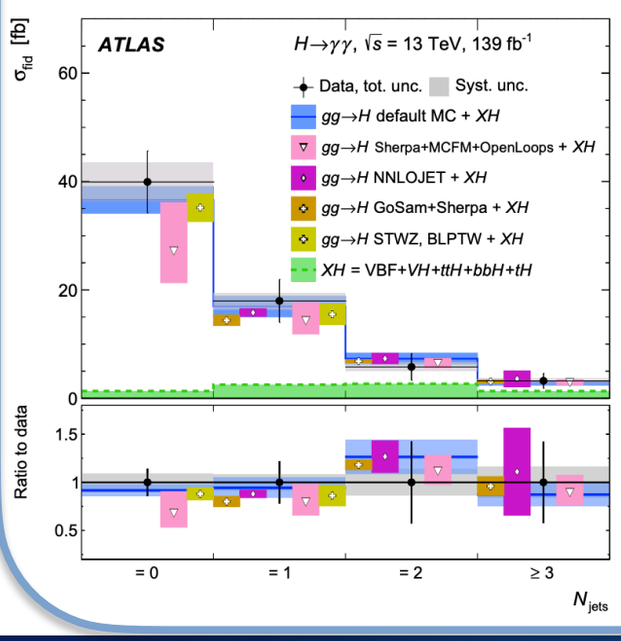
- **Test the SM Higgs boson properties and probe for BSM contributions**
- **Fiducial region:** closely match the detector-level analysis and object selections
  - subset regions of the inclusive fiducial region sensitive to different Higgs boson production modes are measured
- **Differential measurements** in 1D and 2D observables
  - signal yield extracted from data
  - binning choice: >= 2sigma significance
  - correct to detector inefficiencies (MC response matrix)

Differential Measurements



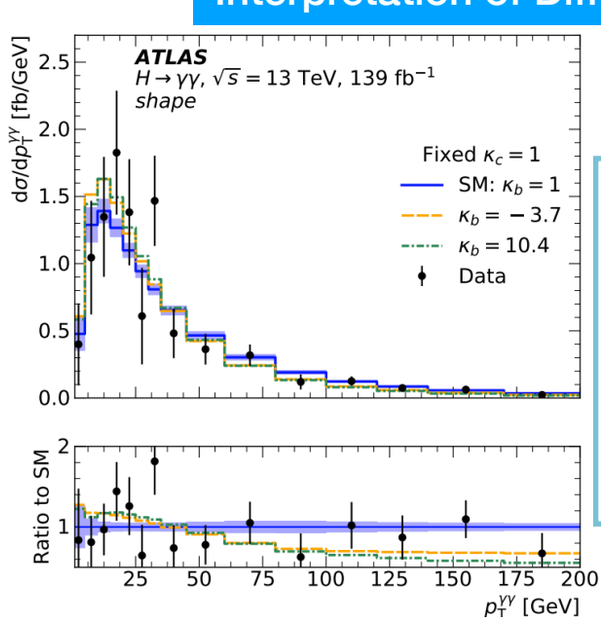


- **Fiducial inclusive measurement:** $\sigma_{fid} = 67 \pm 5(stat.) \pm 4(sys.) fb$
  - in agreement with the SM = $64 \pm 4\ fb$
- $p_T^{\gamma\gamma}$ (p-value compatibility to SM = 86%) is sensitive:
  - low pT region to b- and c-quarks couplings
  - high pT region to top quark coupling and BSM effects
- $|y^{\gamma\gamma}|$ (p-value compatibility to SM = 76%) is sensitive to the PDF of protons

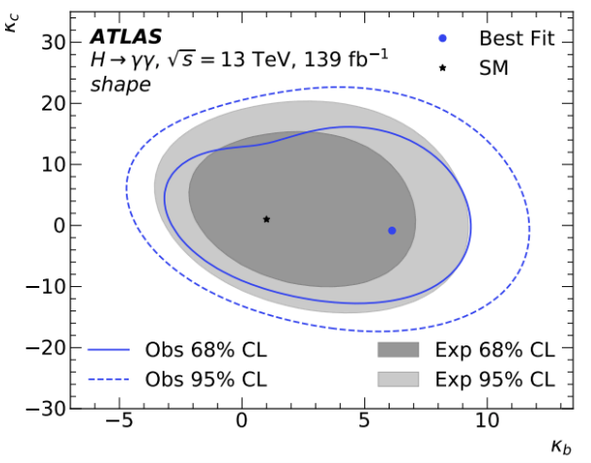


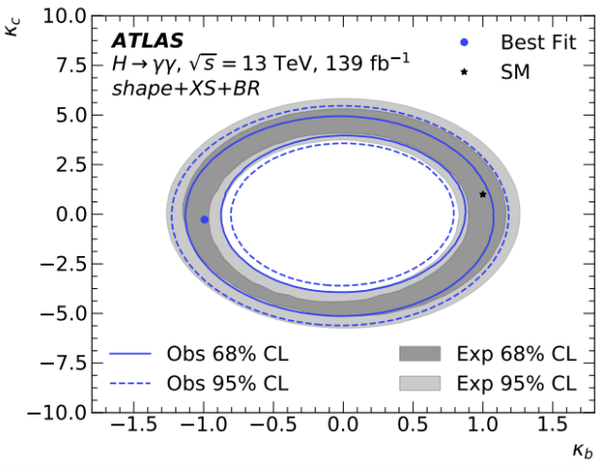
- N_{jets} (p-value compatibility to SM = 95%):
  - sensitive to different Higgs boson production modes
- Additional observables are measured in 1D and 2D differential distributions

Interpretation of Differential Measurements



- $p_T^{\gamma\gamma}$ spectrum provides indirect measurement of the c- and b-quarks Yukawa couplings (κ_c and κ_b):
  - shape-only and shape+normalization information are used for the fitting





- Limits on κ_c and κ_b are set from a profile likelihood method:
  - most sensitive region of $p_T^{\gamma\gamma}$ spectrum < 200 GeV
  - Stronger constraints from shape+normalization
- Shape+normalization constrain on κ_b is comparable to direct searches while κ_c provides stronger constraints (a factor of 3 more stringent for the observed result and a factor of 4 for the expected result)

All measurements in good agreement with the SM

For more information:
[1]: Measurements of the Higgs boson inclusive and differential fiducial cross-sections in the diphoton decay channel with pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector (arXiv:2202.00487)