Prospects for combined Higgs measurements at the HL-LHC with the ATLAS detector

**INTRODUCTION**
- Detailed measurements of Higgs boson properties are an important motivation for the High Luminosity LHC (HL-LHC).
- Prospects for measuring Higgs boson cross sections, signal strengths, branching ratios and determining couplings to individual fermions and bosons were studied for the HL-LHC with 3000 fb$^{-1}$, extrapolating the Run 2 analyses with 36 fb$^{-1}$ or 80 fb$^{-1}$.

**ANALYSIS STRATEGY**
- Five main production modes (ggF, VBF, WH, ZH, ttH) and seven different decay channels (H → γγ, H → bb, H → ZZ, H → WW, H → ττ, H → μμ, H → Zγ) are considered.
- Event categories based on event topology and kinematics to separate the different production processes.
- Event yields scaled to 3000 fb$^{-1}$ and taking into account the change in total cross sections from 13 to 14 TeV.

**RESULTS**
- **Global signal strength:**
  - Including uncertainties in predicted cross sections and BRs.
  - Relative uncertainty  
    | Total | Stat | Exp. | Sig. theory | Bkg. theory |
    |-------|------|------|-------------|-------------|
    | μ     | 2.5% | 2.4% | 0.6%        | 1.3%        |
    | ▶     | 1.7% | 1.0% | 1.3%        | 1.0%        |

- **Production cross sections (Assuming SM BRs)**
- **Production-modes XS in different decay channels**

- **Branching ratios (Assuming SM cross section)**

- **Coupling vs. particle mass**
  - $\kappa_F$ constrained to be positive.
  - No BSM contribution to Higgs boson total width.
  - The effective couplings $\kappa_F$ and $\kappa_V$ and the total width modifier $\kappa_H$ are expressed in terms of $\kappa_F$ and $\kappa_V$.

- **Generic kappa model with BSM in total width**
  - With BSM contribution to the Higgs boson total width.
  - The ggF, H → gg, H → Zγ and H → γγ loop processes are parametrised using the $\kappa_g$, $\kappa_{Zγ}$, $\kappa_{γγ}$ modifiers.
  - $\kappa_{Wγ}$, $\kappa_{Zγ}$ ≤ 1.

**CONCLUSION**
- The precision of the cross sections on the main production modes and the branching ratios of the main decay channels are about 2–8%.
- Not only W(Z) H, H → γγ but also V(tt) H, H → ZZ* and the two rare decays (H → μμ, H → Zγ), will still be limited by statistical uncertainty.

**REFERENCES**