Measurement of Higgs' Z boson associated production & decay into $b$-quark pair

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Introduction

What are we looking for?

- $H$ produced associated with a $Z$ boson ($ZH$ mode)
- $H$ decays into pair of $b$ quarks

Why $H \to b\bar{b}$?

- has largest branching fraction
  ⇒ measure $H$’s dominant decay
- direct study of Higgs-quark coupling

Why $ZH$?

- most sensitive to $H \to b\bar{b}$:
  - relatively less background
  - effective lepton trigger
- can probe high transverse momentum ($p_T$) regime
  ⇒ sensitive to BSM physics
Introduction

Last round of analysis:
- Xsec consistent with SM
- Total uncertainties range from 30% to 80%!
- Stat. unc. (green bars in plots) contributes the most

This time:
- Harmonise/optimise analysis regions
- Streamline workflow
  ⇒ What’s missed & what’s redundant?
- New $b$-tagger
- Combine $H \rightarrow b\bar{b}$ & $H \rightarrow c\bar{c}$ analysis
  (2nd gen. quark!)
Harmonisation & optimisation

My study includes:

1. Electroweak correction on diboson
2. Effect of jet multiplicity on likelihood fit
3. Impact of CRs on MVA training
4. Redefining control regions (CRs)

- CRs are places with little signal
- Signal region (SR) is between two cuts, above & below are CRs
- Old CR cuts (yellow lines) were derived in WH channel & applied to ZH, convenient but not optimised
- Using the desired yield I derived the new cuts (magenta lines)
Harmonisation & optimisation

Some distribution after likelihood fit:

Using old CR cuts

Using new CR cuts

- New CR cuts give better data/MC agreement & slightly higher significance
Adams Ruby made an automated visual inspection tool for ATLAS detector modules

- Module design keeps updating ⇒ need to calibrate parameters
- Module photos taken manually ⇒ need alignment tool
- I developed softwares for colour matching, alignment & cropping
- Only 1/4 images require human attention with our tools
- Qualified last month!
Prospect

- Analysis group aims to publish the first $VH(bb/cc)$ paper in 2023
- Would work on different aspects of this analysis for a bigger picture
- Expect to submit my thesis in 2024

Thank you!