

Comparison JHU and MG5 Matrixelements plus Optimal Observables for mc15 ggF $H \rightarrow 4\ell$ sample

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MC Sample

Path to file:

/afs/cern.ch/atlas/groups/HSG2/H4I/run2/2015/MiniTrees/Prod_v03/mc/Nominal/

▶ mc15_13TeV.341505.PowhegPythia8EvtGen_CT10_AZNLOCTEQ6L1_ggH125_ZZ4lep_noTau.root

Conversion MG5 and JHU

▶ $\Lambda = 1000 \text{ GeV}, v = 246 \text{ GeV}$

▶ $\frac{g_2}{g_1} = \frac{v}{4 \cdot \Lambda} \frac{\kappa_{Hzz}}{\kappa_{SM}}$

▶ $\frac{g_4}{g_1} = \frac{v}{4 \cdot \Lambda} \frac{\kappa_{Azz}}{\kappa_{SM}} \cdot \tan \alpha$

▶ $g_1 = \kappa_{SM} \cdot \cos \alpha$

▶ $g_2 = \frac{v}{4 \cdot \Lambda} \cdot \kappa_{Hzz} \cdot \cos \alpha$

▶ $g_4 = \frac{v}{4 \cdot \Lambda} \cdot \kappa_{Azz} \cdot \sin \alpha$

List of Matrixelements: MG5

	κ_{Hgg}	κ_{SM}	κ_{Hzz}	κ_{Azz}	$\cos \alpha$
ME_{SM}^2	1.0	1.0	0.0	0.0	1.0
$ME_{SM, \kappa_{Azz}}^2$	$\sqrt{2}$	$\sqrt{2}$	0.0	$\sqrt{2} \cdot \frac{4 \cdot \Lambda}{v} \approx 23$	$\frac{1}{\sqrt{2}}$
$ME_{\kappa_{Azz}}^2$	$\sqrt{2}$	0.0	0.0	$\sqrt{2} \cdot \frac{4 \cdot \Lambda}{v} \approx 23$	$\frac{1}{\sqrt{2}}$
$ME_{SM, \kappa_{Hzz}}^2$	$\sqrt{2}$	$\sqrt{2}$	$\sqrt{2} \cdot \frac{4 \cdot \Lambda}{v} \approx 23$	0.0	$\frac{1}{\sqrt{2}}$
$ME_{\kappa_{Hzz}}^2$	$\sqrt{2}$	0.0	$\sqrt{2} \cdot \frac{4 \cdot \Lambda}{v} \approx 23$	0.0	$\frac{1}{\sqrt{2}}$
$ME_{\kappa_{Hzz}, \kappa_{Azz}}^2$	$\sqrt{2}$	0.0	$\sqrt{2} \cdot \frac{4 \cdot \Lambda}{v} \approx 23$	$\sqrt{2} \cdot \frac{4 \cdot \Lambda}{v} \approx 23$	$\frac{1}{\sqrt{2}}$

List of Matricelements: JHU

	g_1	g_2	g_4
ME_{SM}^2	1.0	0.0	0.0
$ME_{SM, \kappa_{Azz}}^2$	1.0	0.0	1.0
$ME_{\kappa_{Azz}}^2$	0.0	0.0	1.0
$ME_{SM, \kappa_{Hzz}}^2$	1.0	1.0	0.0
$ME_{\kappa_{Hzz}}^2$	0.0	1.0	0.0
$ME_{\kappa_{Hzz}, \kappa_{Azz}}^2$	0.0	1.0	1.0

List of Optimal Observables

$$\blacktriangleright O_1 = \frac{2 \cdot \mathcal{R}(\mathcal{M}\mathcal{E}_{\text{BSM}}^\dagger \mathcal{M}\mathcal{E}_{\text{SM}})}{\mathcal{M}\mathcal{E}_{\text{SM}}^2}$$

$$\blacktriangleright O_2 = \frac{\mathcal{M}\mathcal{E}_{\text{BSM}}^2}{\mathcal{M}\mathcal{E}_{\text{SM}}^2}$$

$$1. O_{1, \kappa_{Azz}} = \frac{ME_{SM, \kappa_{Azz}}^2 - ME_{\kappa_{Azz}}^2}{ME_{SM}^2} - 1.0$$

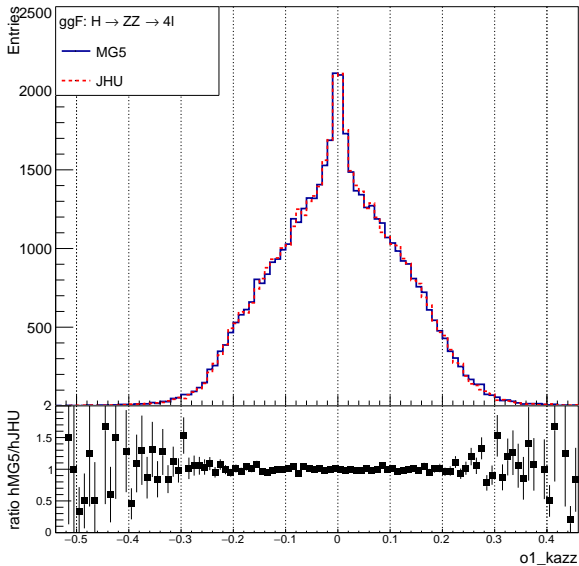
$$2. O_{1, \kappa_{Hzz}} = \frac{ME_{SM, \kappa_{Hzz}}^2 - ME_{\kappa_{Hzz}}^2}{ME_{SM}^2} - 1.0$$

$$3. O_{1, \kappa_{Hzz}, \kappa_{Azz}} = \frac{ME_{\kappa_{Hzz}, \kappa_{Azz}}^2 - ME_{\kappa_{Hzz}}^2 - ME_{\kappa_{Azz}}^2}{ME_{SM}^2}$$

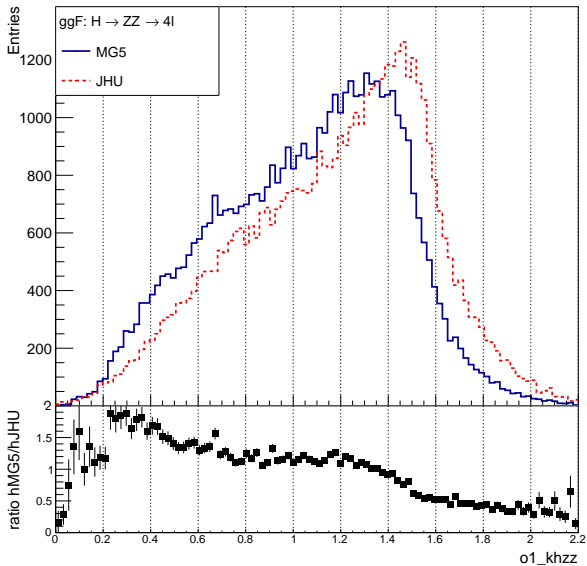
$$4. O_{2, \kappa_{Azz}} = \frac{ME_{\kappa_{Azz}}^2}{ME_{SM}^2}$$

$$5. O_{2, \kappa_{Hzz}} = \frac{ME_{\kappa_{Hzz}}^2}{ME_{SM}^2}$$

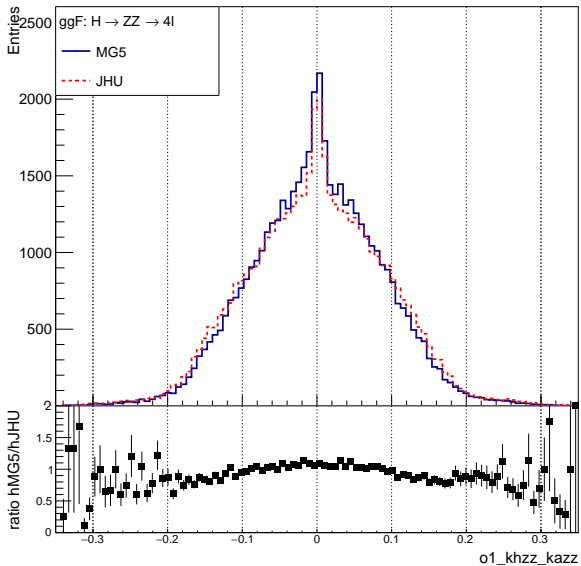
$$O_{1,\kappa_{AZZ}} = \frac{ME_{SM,\kappa_{AZZ}}^2 - ME_{\kappa_{AZZ}}^2}{ME_{SM}^2} - 1.0$$



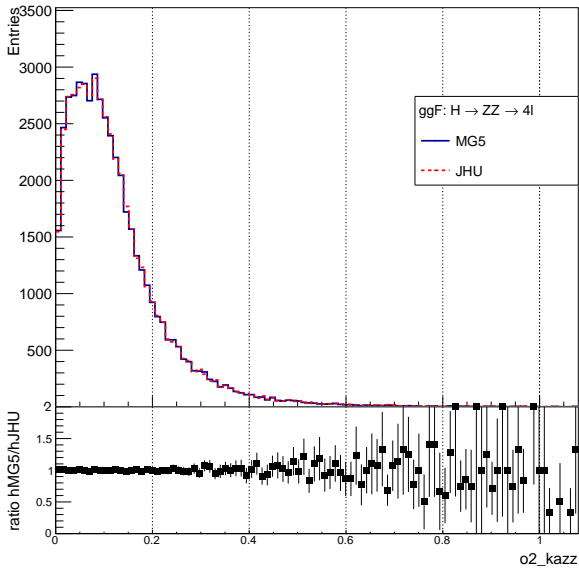
$$O_{1,\kappa_{HZZ}} = \frac{ME_{SM,\kappa_{HZZ}}^2 - ME_{\kappa_{HZZ}}^2}{ME_{SM}^2} - 1.0$$



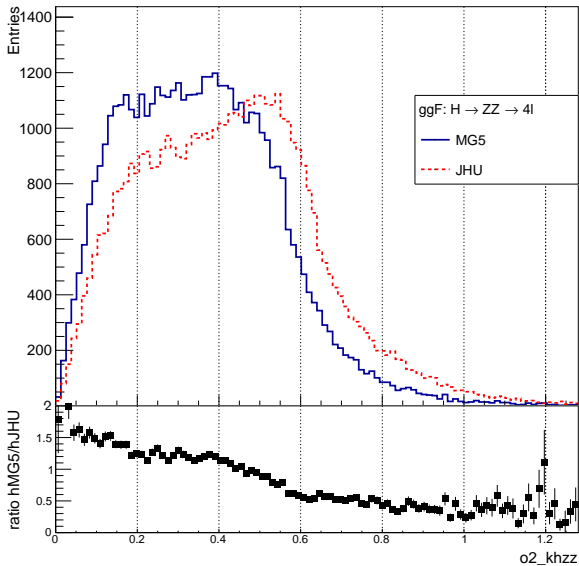
$$O_{1, \kappa_{HZZ}, \kappa_{AZZ}} = \frac{ME_{\kappa_{HZZ}, \kappa_{AZZ}}^2 - ME_{\kappa_{HZZ}}^2 - ME_{\kappa_{AZZ}}^2}{ME_{SM}^2}$$



$$O_{2,\kappa_{AZZ}} = \frac{ME_{\kappa_{AZZ}}^2}{ME_{SM}^2}$$



$$O_{2,\kappa_{HZZ}} = \frac{ME_{\kappa_{HZZ}}^2}{ME_{SM}^2}$$



Conclusion

- ▶ Surprisingly good agreement between JHU and MG5 → No obvious bug in MG5 Optimal Observables, we build them probably (mostly) correctly
- ▶ Offset/Difference for BSM CP-even? First idea was different modelling of interference between JHU and MG5, but then the amplitude sensitive Optimal Observable O2 would not show difference between JHU and MG5. Maybe wrong parameter configuration for MG5 and JHU? Did already check carefully, but will look over it again.