Combined BSM CP-odd and CP-even signal model for H4ℓ EFT analysis Moriond17

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MPP Higgs Meeting

Max-Planck-Institut für Physik
(Werner-Heisenberg-Institut)

Introduction

- Moriond 2017: Measure CP-even and CP-odd BSM couplings simultaneously
- Building a 2D signal model for ggF and VBF+VH production modes:

1. Is it possible to build a 2D model with the current EFT samples?
2. Are MC statistics sufficient, so that $\Delta_{rel}(N_{MC}) << \Delta_{rel}(N_{Data})$?

$\mathcal{L}_{\text{Moriond2017}} \approx 35\ \text{fb}^{-1} \rightarrow N_{\text{exp}} \approx 75$

$\Rightarrow$ Requirement: $\frac{\Delta N}{N} < 12\%$ within region of interest

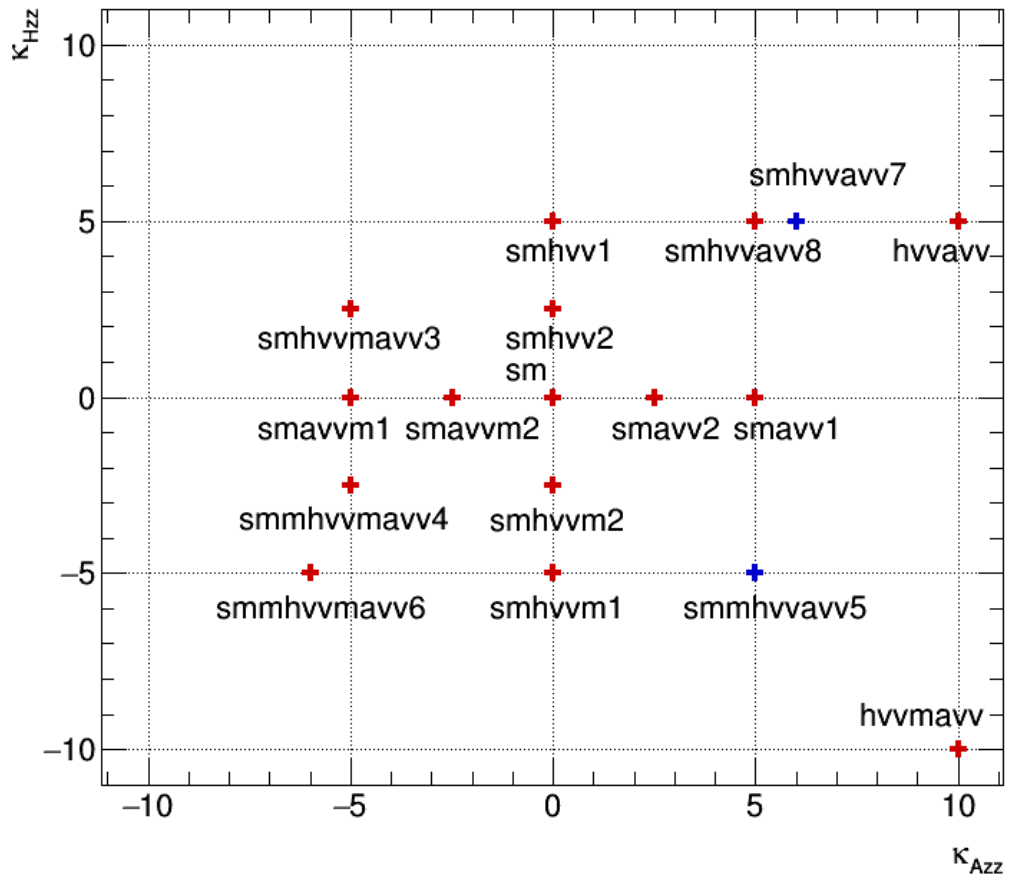
- Region of interest: Due to the additional degree of freedom take $\approx$ 2-3 times the expected limits for 1D ICHEP scans

Not excluded range at 95% CL	κ_{HVV}		$\kappa_{AVV} \cdot \sin\alpha$	
	expected	observed	expected	observed
	$[-6.3, 5.1]$	$[0.9, 7.5]$	$[-6.3, 6.5]$	$[-9.7, 11.0]$

$[\kappa_{\text{Hzz}} \cos(\alpha), \kappa_{\text{Azz}} \sin(\alpha)] = [-20, 20] \times [-20, 20]$

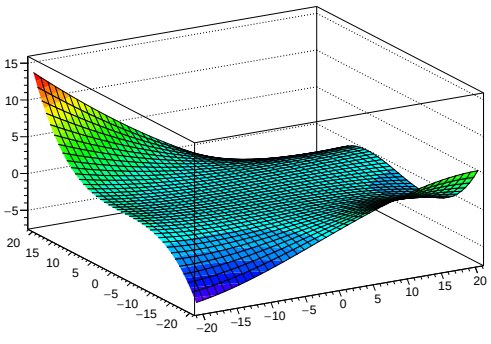
VBF(+VH)

- Best VBF input set studied by Verena based on MC truth samples
- Sample set not available for VHlep $\rightarrow$ VBF-VHhad-only model

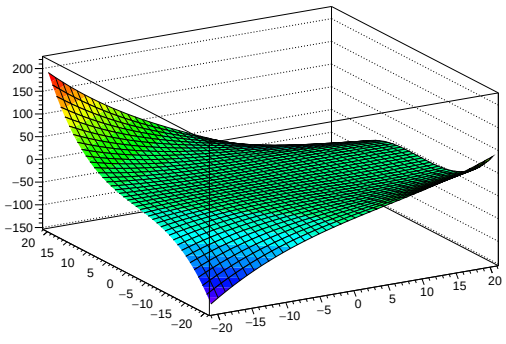


VBF: Number of expected events in simplified cross section categories no best prediction scaling

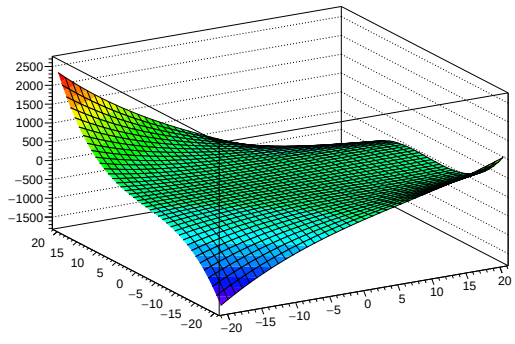
VH-lep



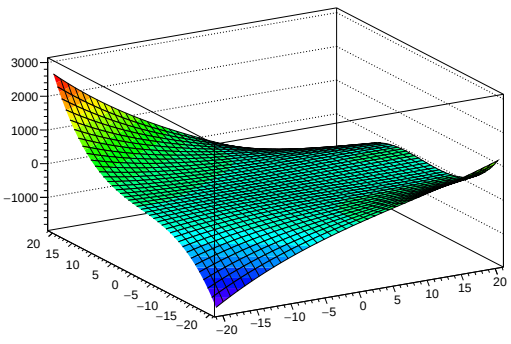
ggF-enriched



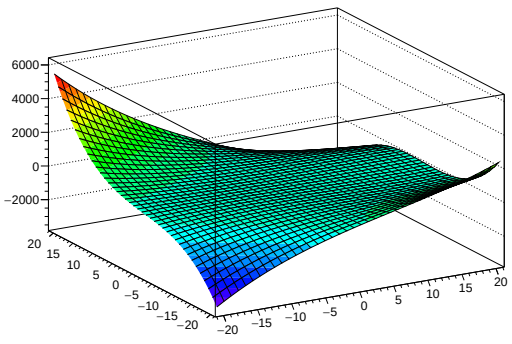
1-jet



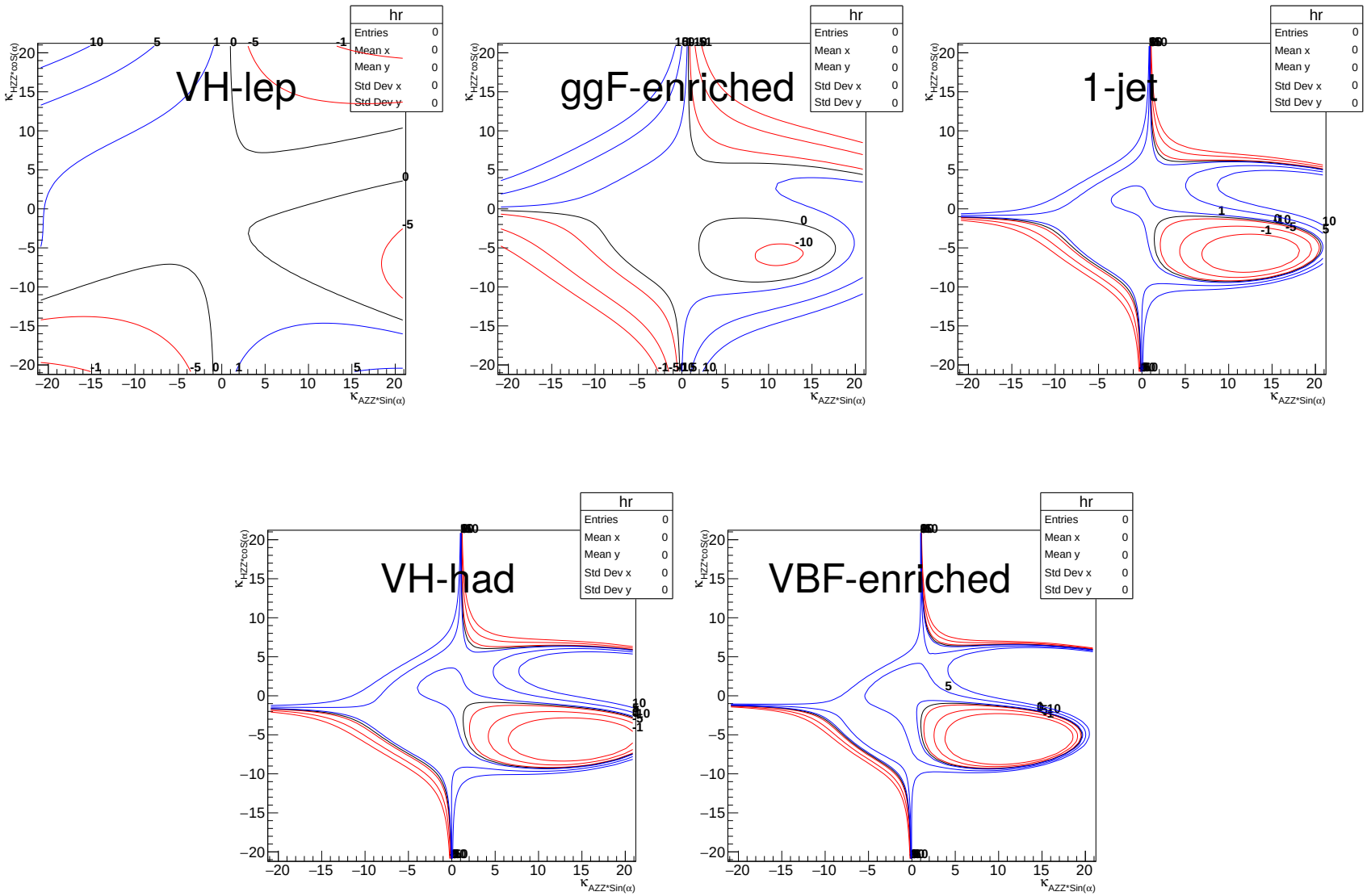
VH-had



VBF-enriched



VBF: Contours for number of expected events in simplified cross section categories no best prediction scaling

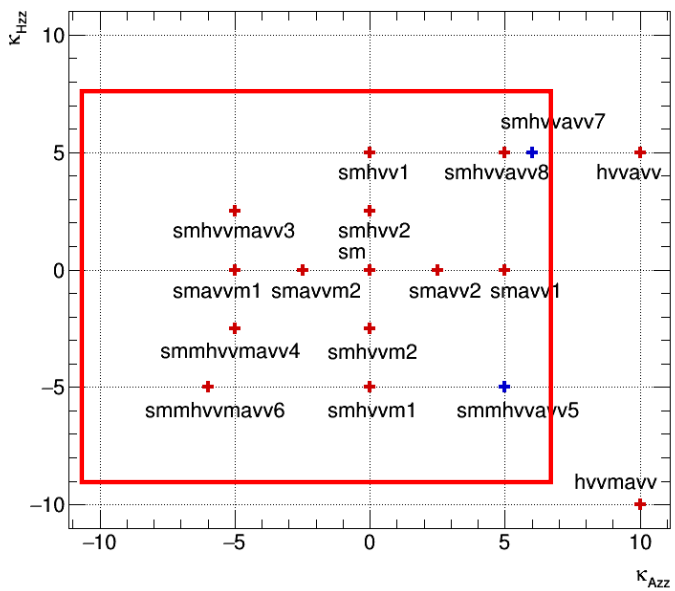


VBF+VH

- Negative number of expected events in all categories

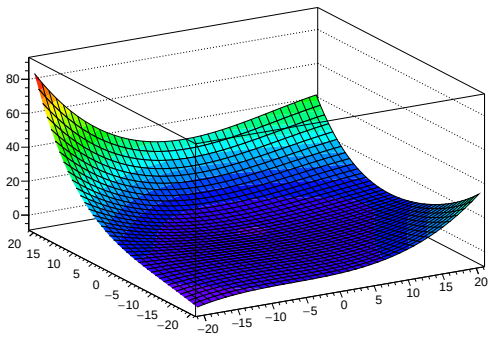
$\Rightarrow$ Our proposed basis can clearly not be used

- First studies for BSM CP-odd and CP-even presented in last H4ℓ meeting on Tuesday (17th Oct 2016):
- Valerio Bortolotto 'Preliminary 2D scan KHVV vs KAVV'
- Next try: Use Valerio's proposed basis (available for both VBF+VH)

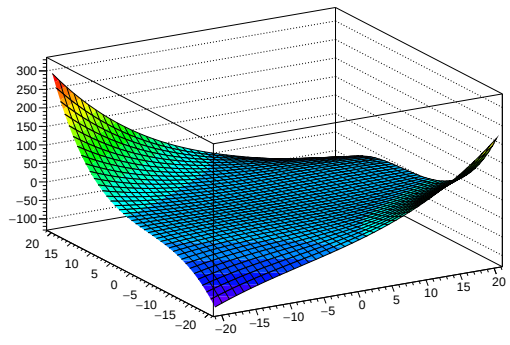


VBF+VH: Number of expected events in simplified cross section categories no best prediction scaling

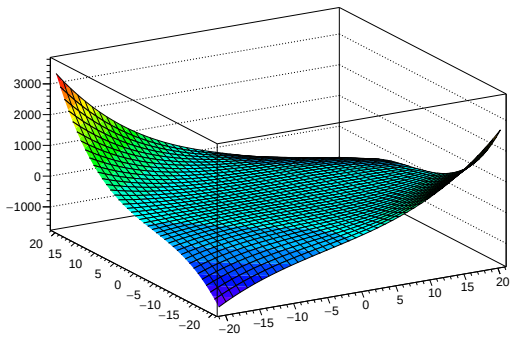
VH-lep



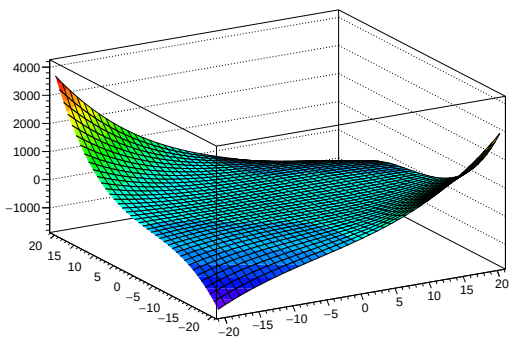
ggF-enriched



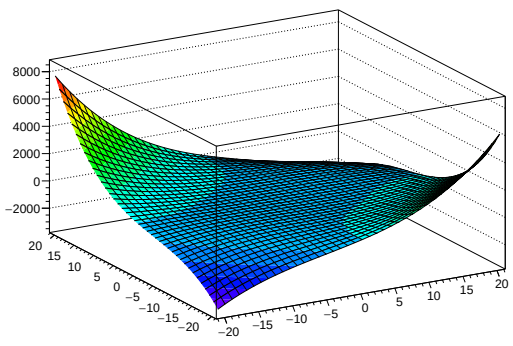
1-jet



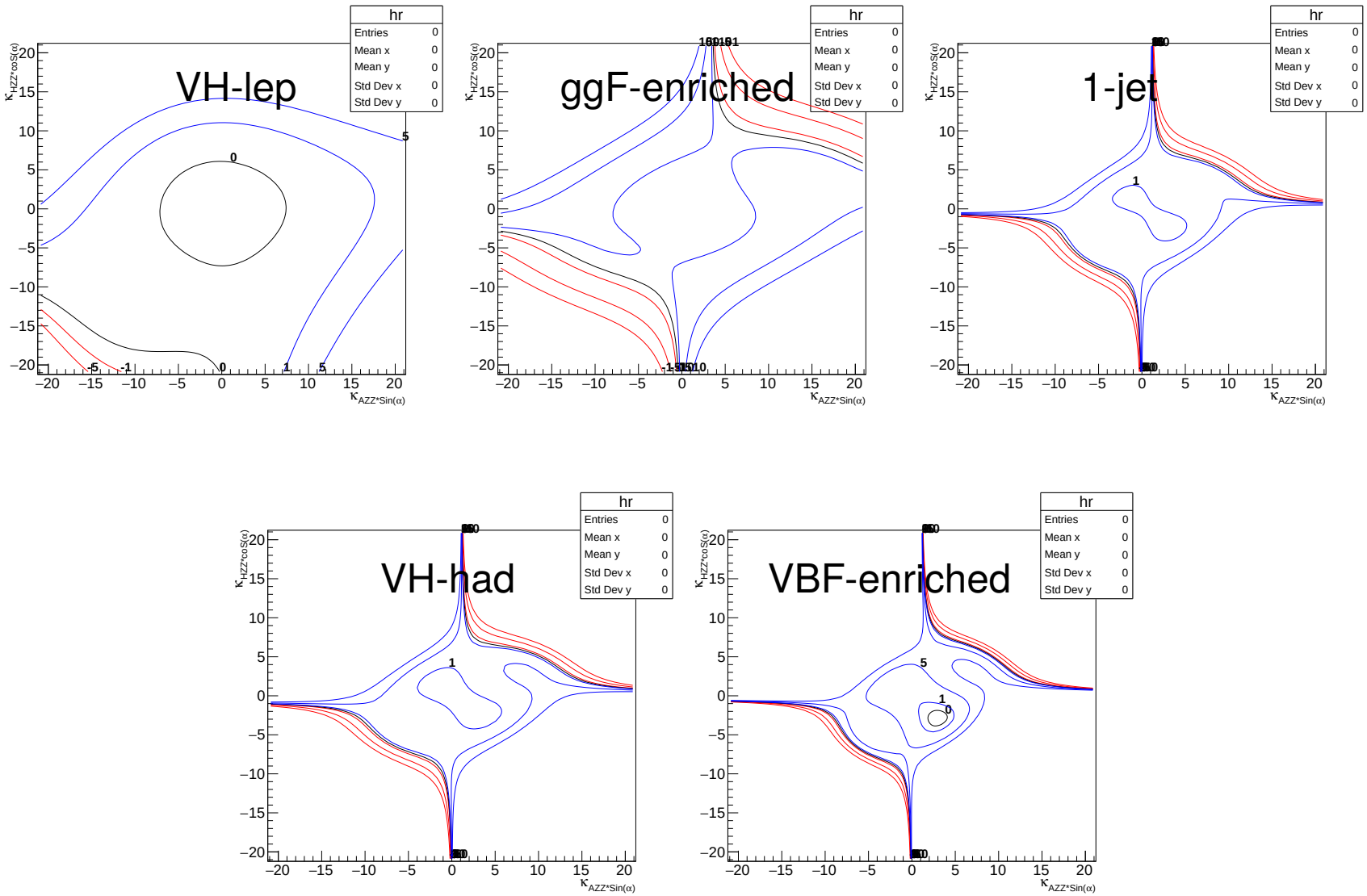
VH-had



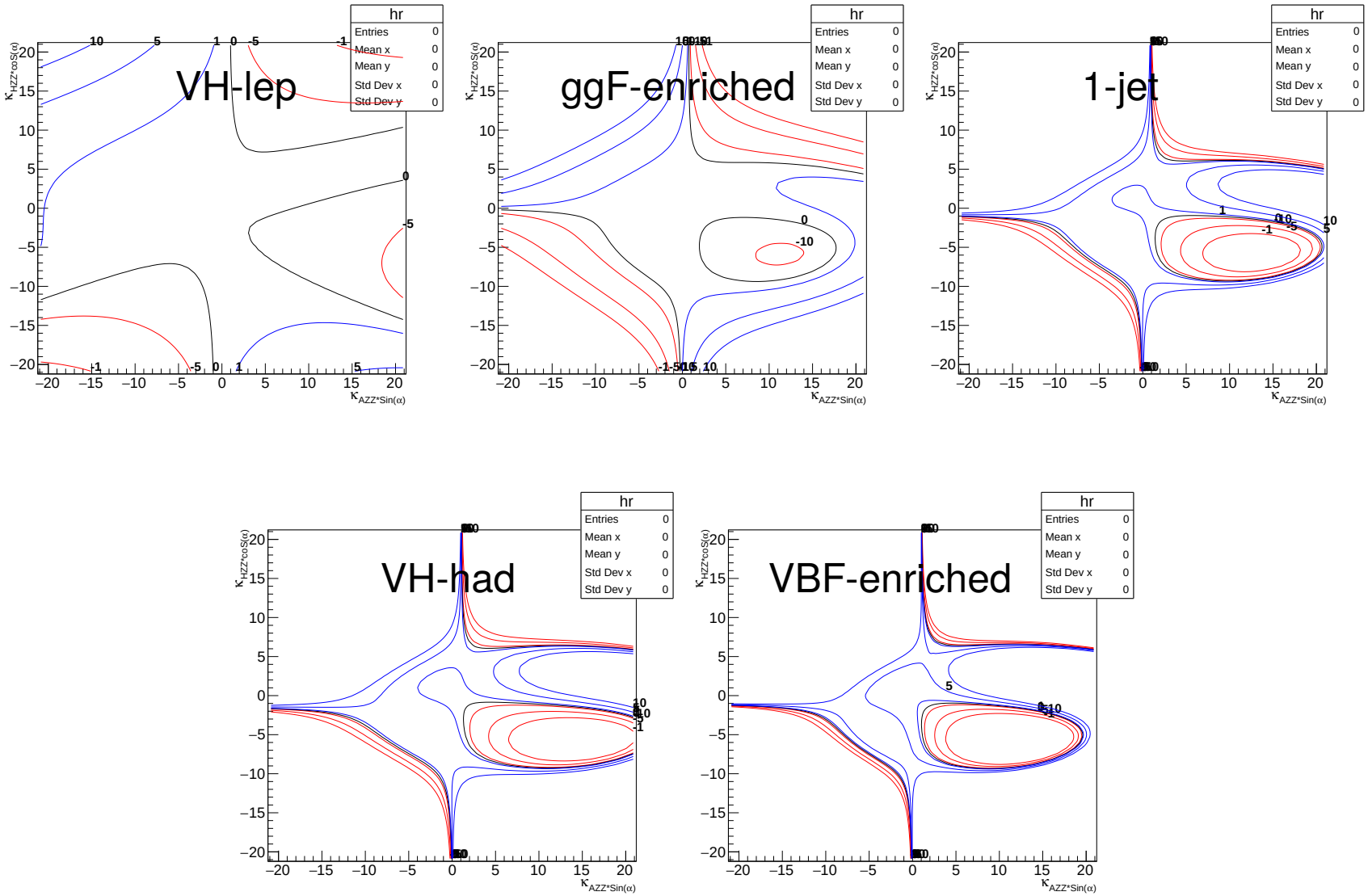
VBF-enriched



VBF+VH: Contours for number of expected events in simplified cross section categories no best prediction scaling



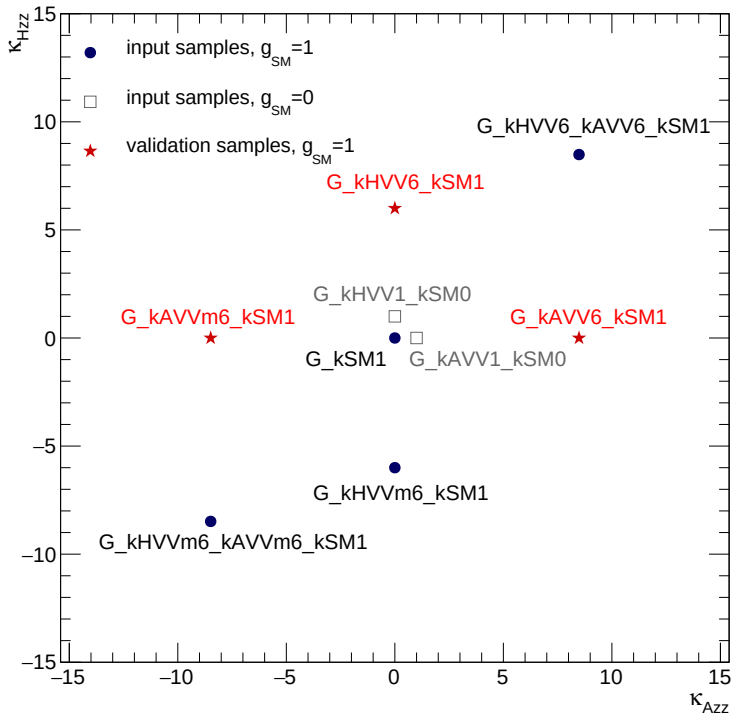
OUR BASIS: Only VBF: Contours for number of expected events in simplified cross section categories no best prediction scaling



- Still negative number of expected events in all categories, but better performance than our basis

ggF

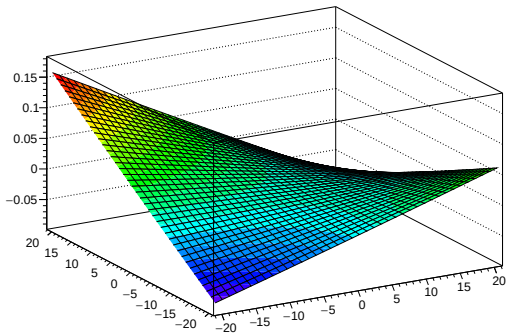
- 2D basis already used to create ggF model for ICHEP MPI analysis



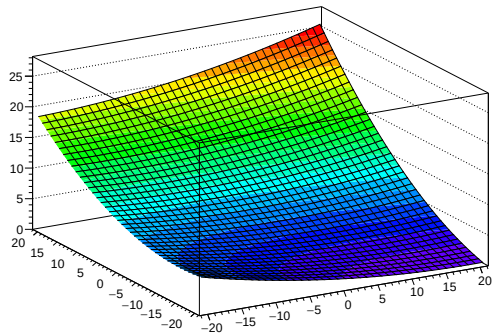
⇒ Check that there are no negative number of expected events in whole phase space region

ggF: Number of expected events in simplified cross section categories

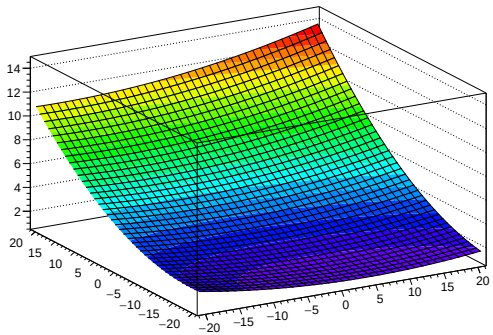
VH-lep



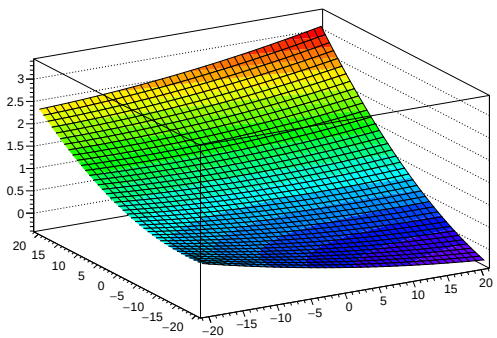
ggF-enriched



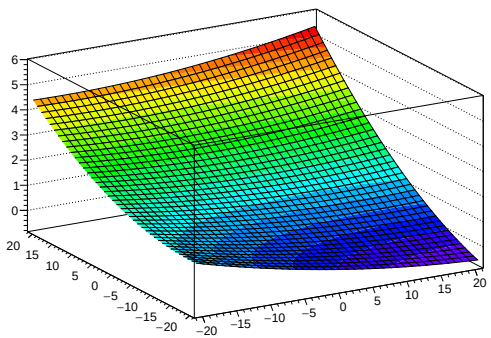
1-jet



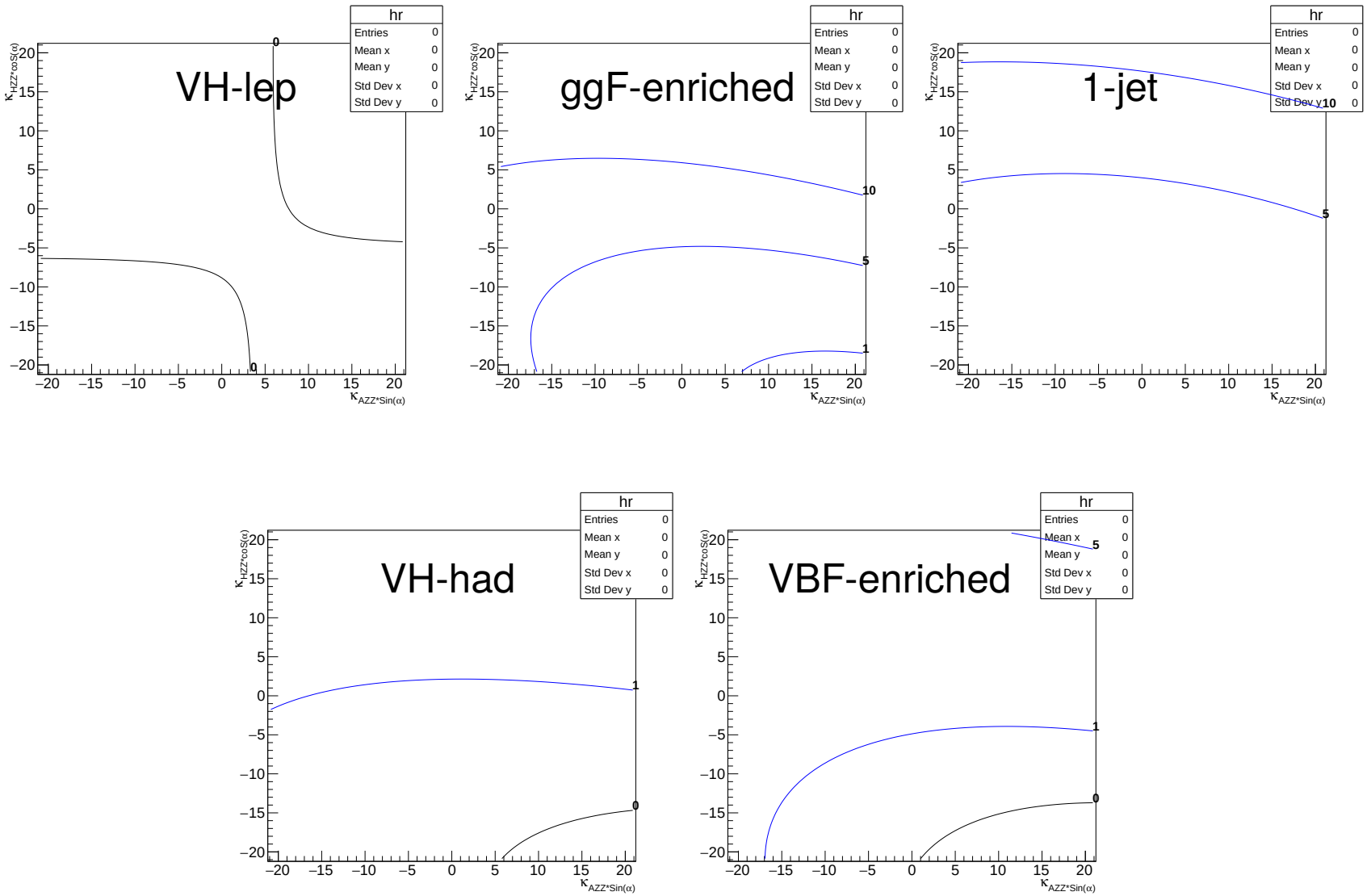
VH-had



VBF-enriched



ggF: Contours for number of expected events in simplified cross section categories

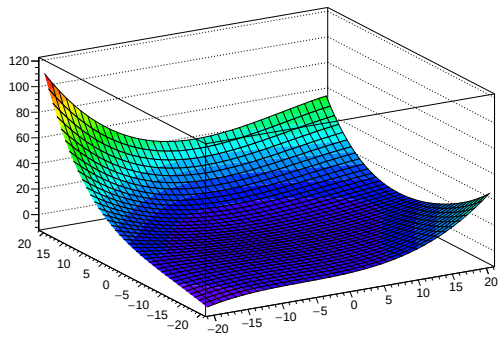


ggF+VBF+VH basis

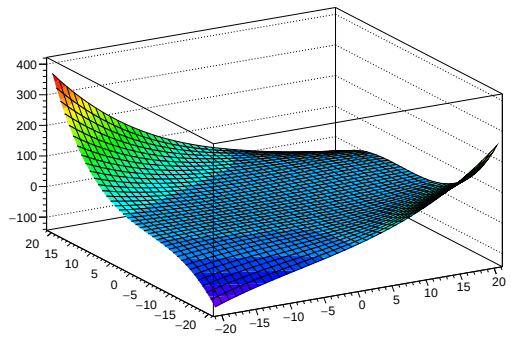
- ggF 2D basis looks fine, except for VH-lep (already known problem), and outer phase space region in VBF and VHhad category
- Plan: Build 2D basis with ggF and VBF+VH basis with best prediction scaling
- Perform preliminary scan on Moriond dataset $\mathcal{L} = 35\text{fb}^{-1}$

ggF+VBF+VH: Number of expected events in simplified cross section categories

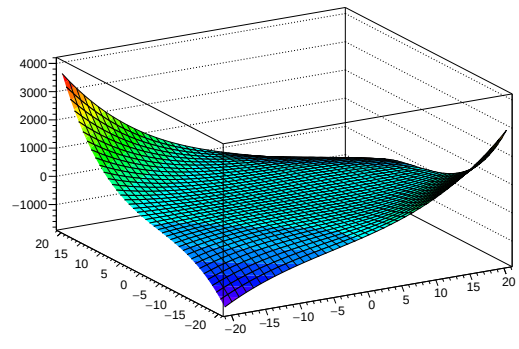
VH-lep



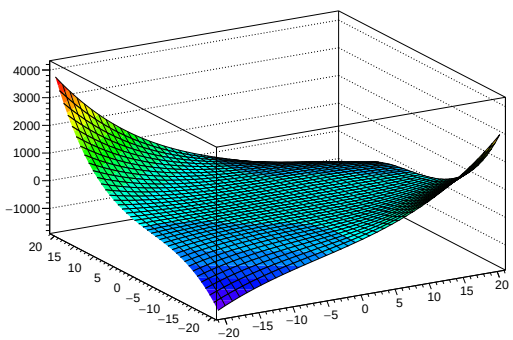
ggF-enriched



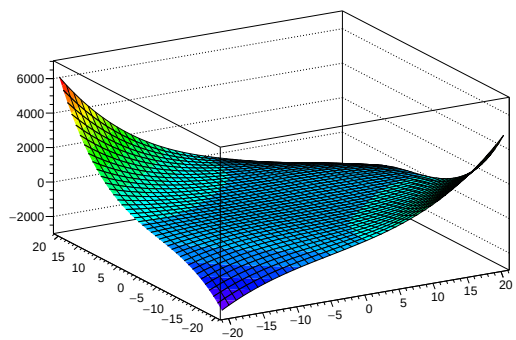
1-jet



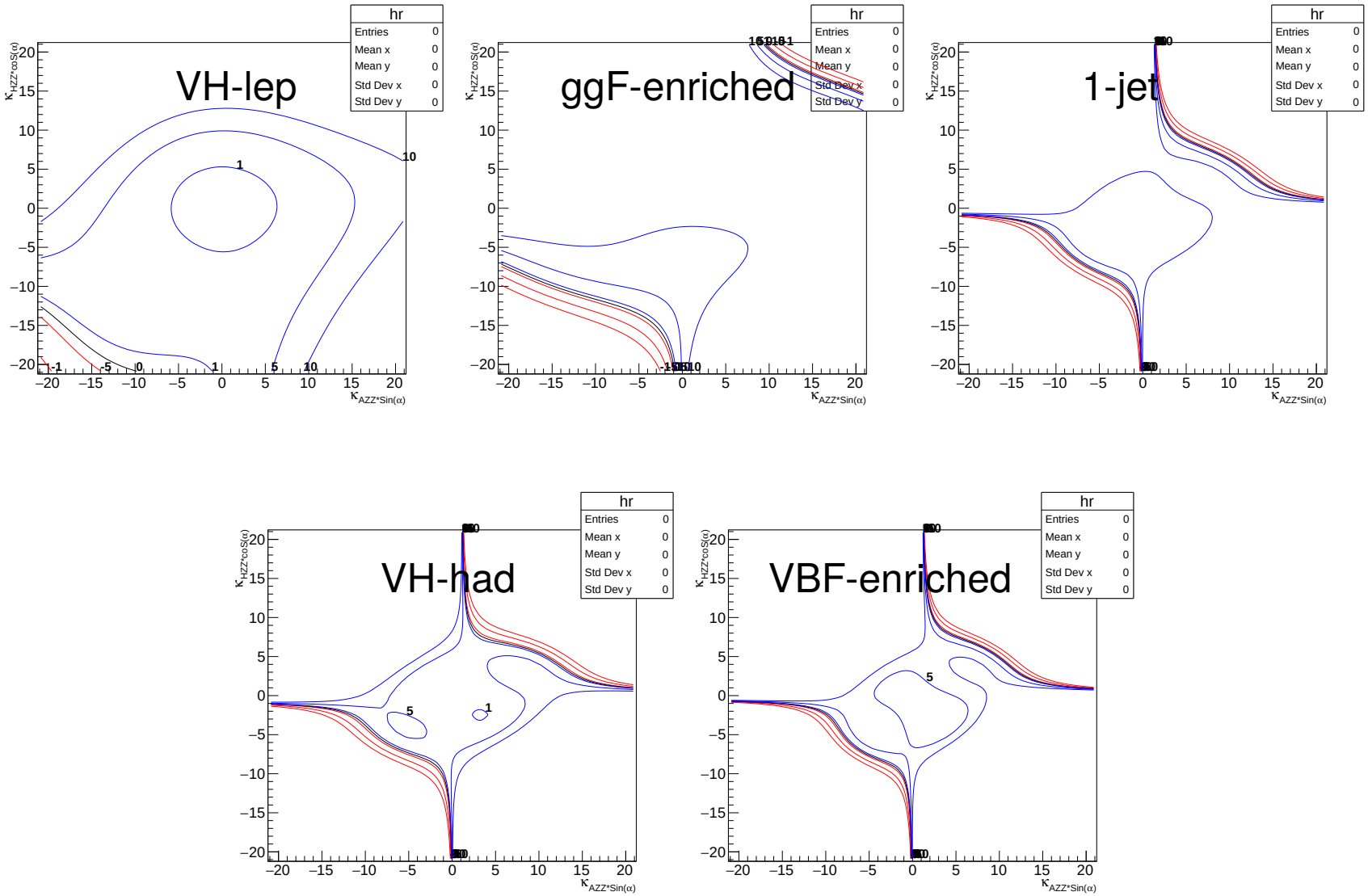
VH-had



VBF-enriched



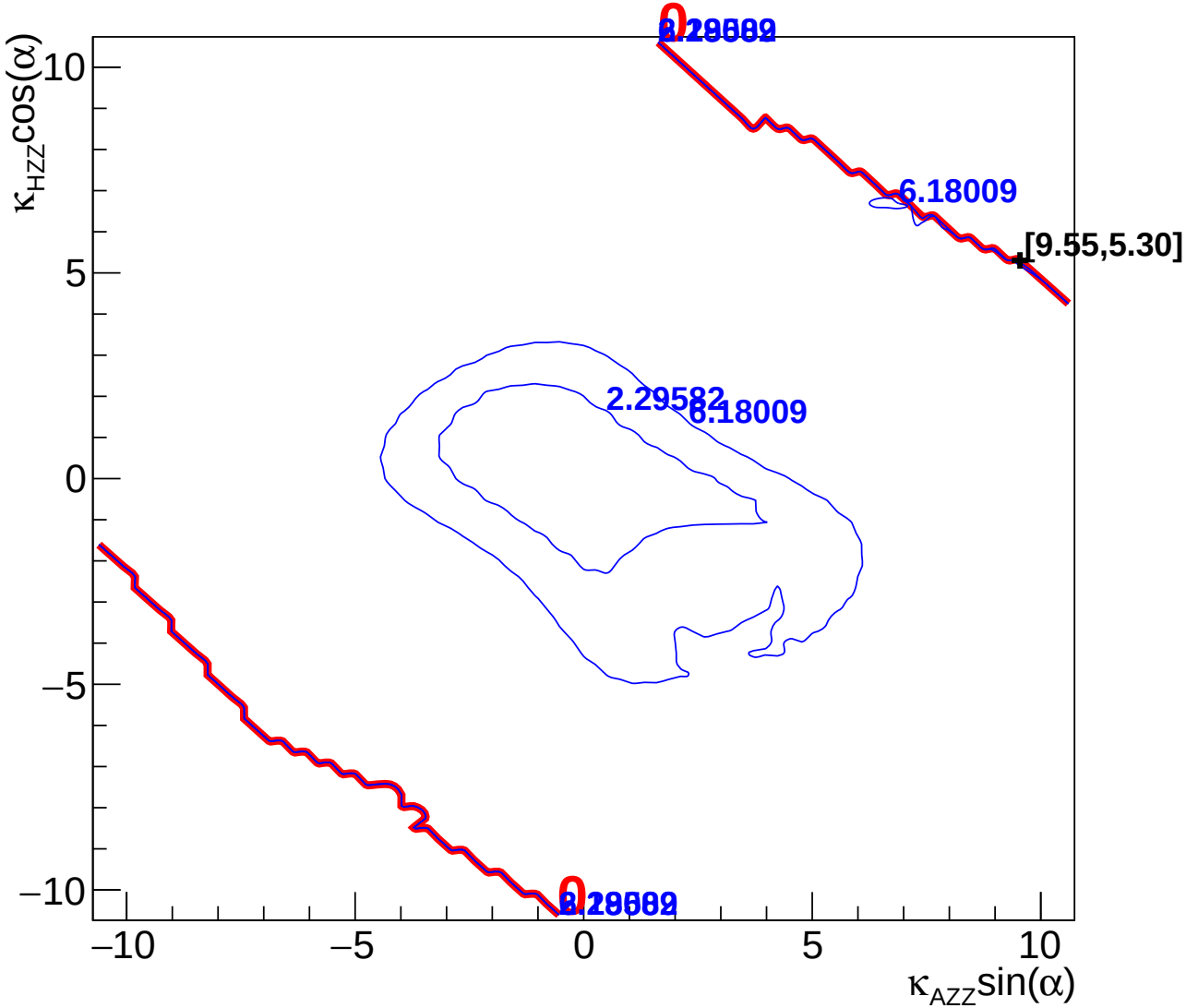
ggF+VBF+VH: Contours for number of expected events in simplified cross section categories



Preliminary fit with Moriond17 dataset

- ggF, VBF+VH, ZZBkg
- ggF and VBF+VH scaled to PowHeg
- Number of expected events fit
- $\mathcal{L} = 35\,\text{fb}^{-1}$

2D-scan: Combined fit of $\kappa_{\mathrm{Azz}} \cdot s_\alpha$ vs $\kappa_{\mathrm{Hzz}} \cdot c_\alpha$ with $\mathcal{L} = 35\mathrm{fb}^{-1}$



Relative morphing error

- Do extenive tests, that fit worked correctly
- Check relative morphing error of VBF+VH signal model in region of interest:

  $\kappa_{\text{Hzz}} \cdot c_\alpha$: [-6,4]

  $\kappa_{\text{Azz}} \cdot s_\alpha$: [-5,7]

Relative morphing error: VBF+VH, kAzz, kHzz