Jet Systematic Uncertainty in $H \to Z\gamma$ Analysis

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Outline

- The presentation is structured as follows :
  - Jet systematic estimation method
  - Current jet systematic estimation results
  - Comparison between Run2 and Run3
  - Prunning strategy
  - Prunning results
  - Summary and Next to-do lists

Method on Jet Systematic Estimation

- We first took ggF channel as the first step to investigate the estimation procedure
- Ntuple cross-checks
  - Event yields compared in each categories
    - Nominal yields in nominal sample (produced by Mingxu : /eos/atlas/atlascerngroupdisk/phys-higp/PHOTON/HZG/Run3/ProcessedSample/H2Zy-Run3-v3)
    - Nominal yields in systematic samples (produced by Zijiang : /eos/user/z/zijiangw/Zy_Run3/package_syst/sample)
    - Event yields are normalized to cross-section [fb]

mc23a ggH category	nominal	systematic
1	0.058844382568763745	0.058844382568763745
2	0.23593365966757246	0.23593365966757246
3	0.963957422813774	0.963957422813774
4	1.176787932494392	1.176787932494392
5	1.2966969946983566	1.2966969946983566
6	1.7389188755051084	1.7389188755051084
7	5.981597648627854	5.981597648627854
8	9.592929987666396	9.592929987666396
9	0.8166484971093504	0.8166484971093504
10	3.82704378327212	3.82704378327212
11	10.861606532318614	10.861606532318614

- **Perfect agreement observed ! Ready to extract systematics**

Method on Jet Systematic Estimation

- Configurations :
  - Campaigns : mc23a + mc23d
  - Categories : 11
  - Selections : Category_Run3 == xx && llg_passallcuts == 1
- How to derive systematic uncertainty ?
  - First calculate nominal yields from HZG_Tree
  - Then calculate variation yields (up, down) from HZG_Tree_JET_xxx_Systematic
  - The relative difference is calculated in percentage and assigned as up/down uncertainty

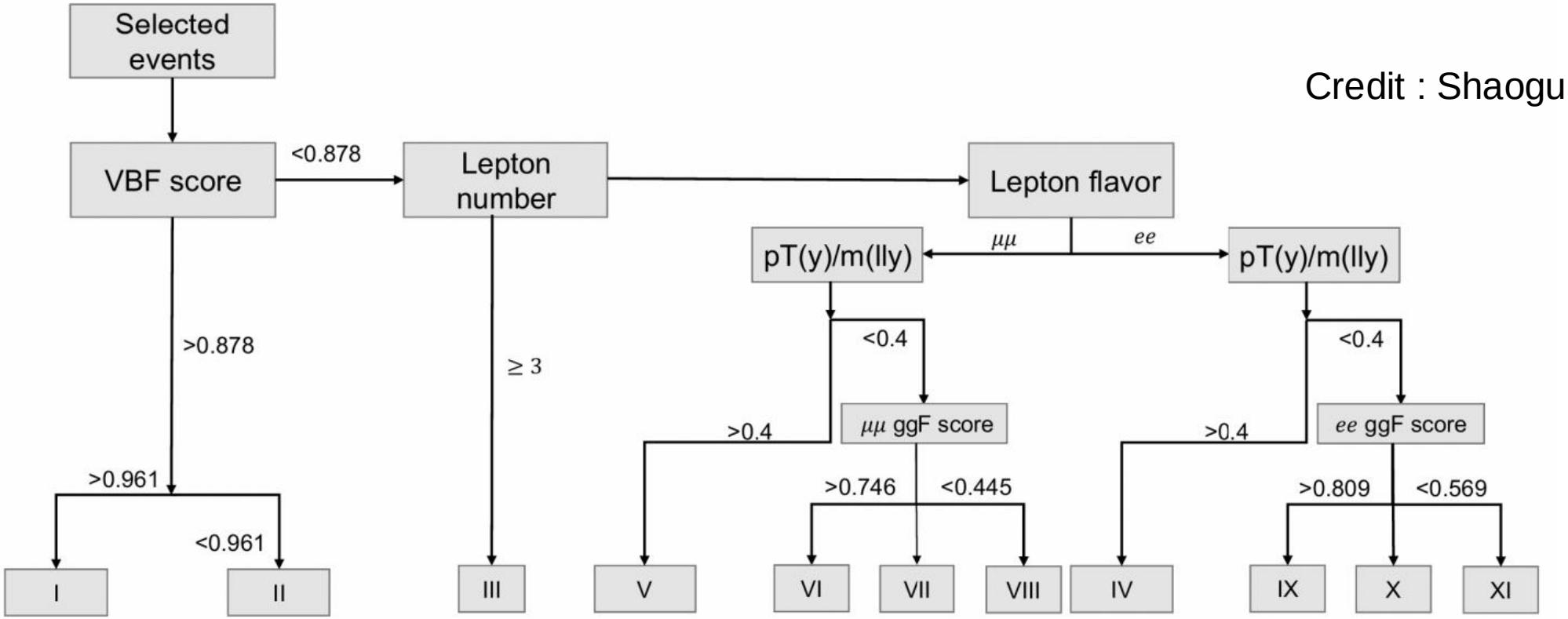
$$\text{Yields} = \text{mc\_weight\_final} * \text{xs} * \text{lumi} \,/\, \text{sumofweights}$$

Different sumofweights are calculated for nominal and variations

$$\text{Systematic uncertainty} = \frac{\text{Yields}(\pm 1\sigma)}{\text{Yields}(\text{nominal})} - 1$$

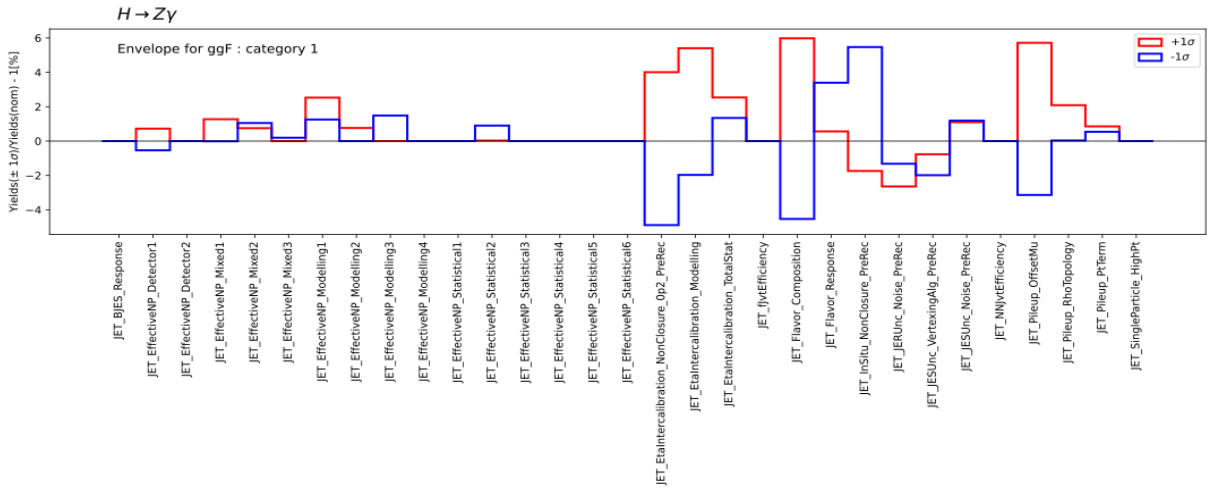
Brief recap on category definition

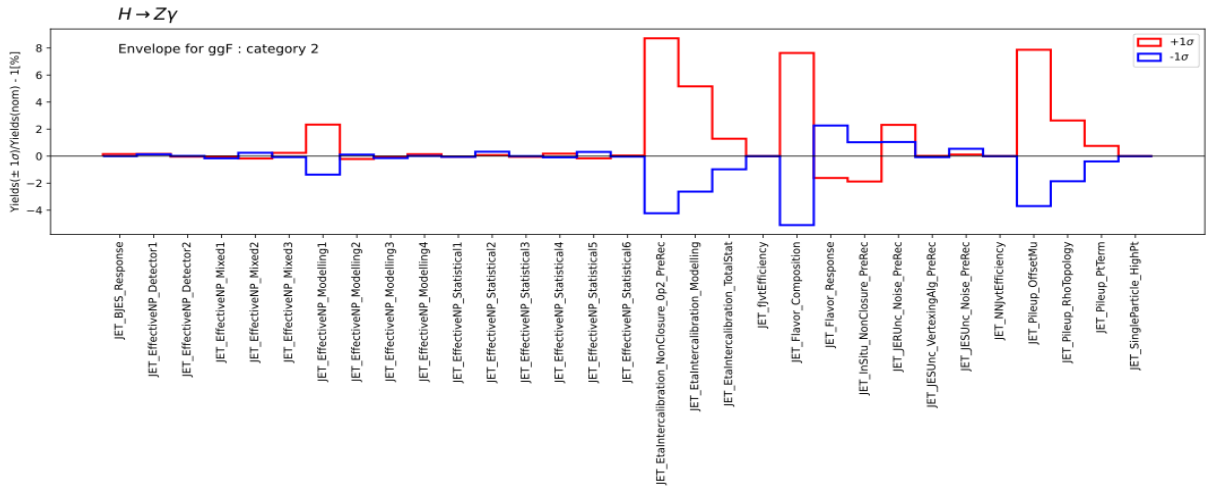
- Overview of Run3 categorization
  - 11 categories defined in this analysis

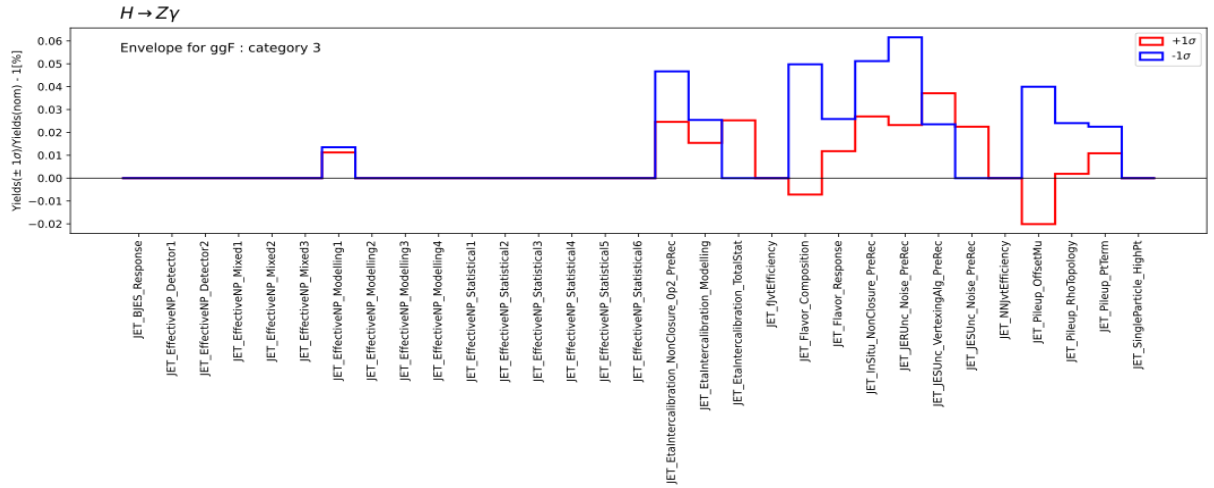


Credit : Shaoguang

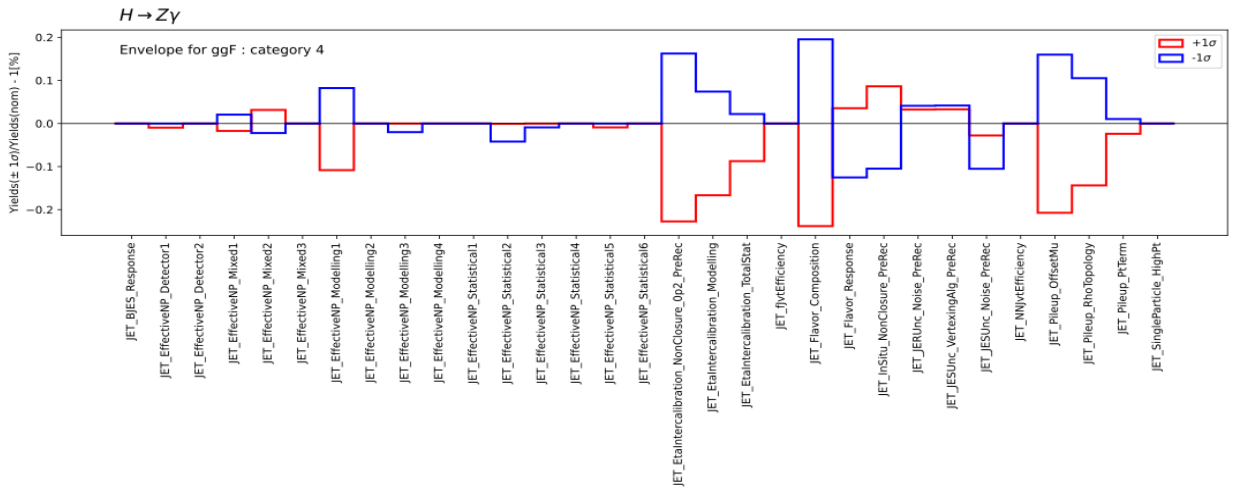
Estimation results in each category – ggF

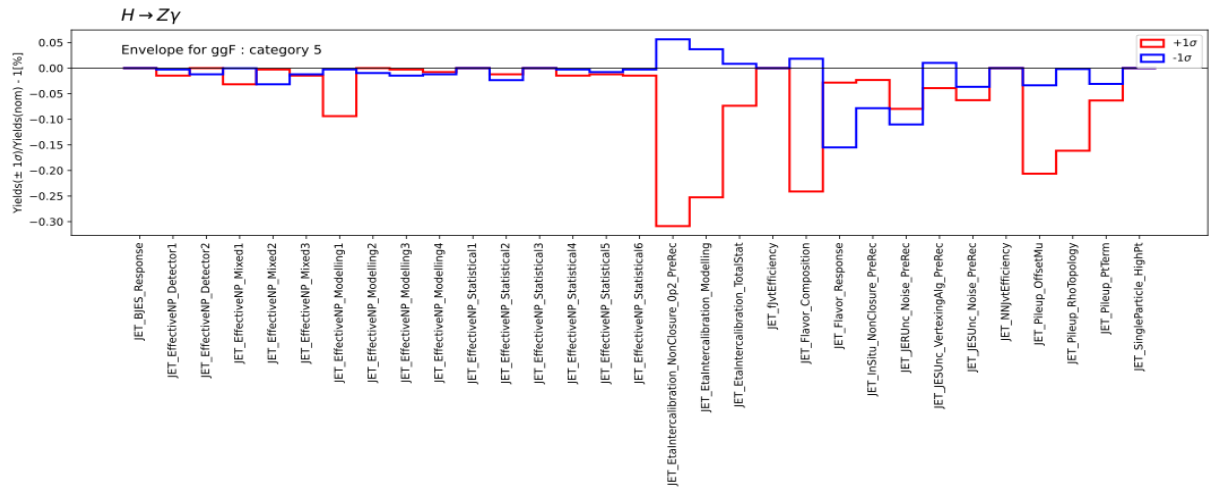


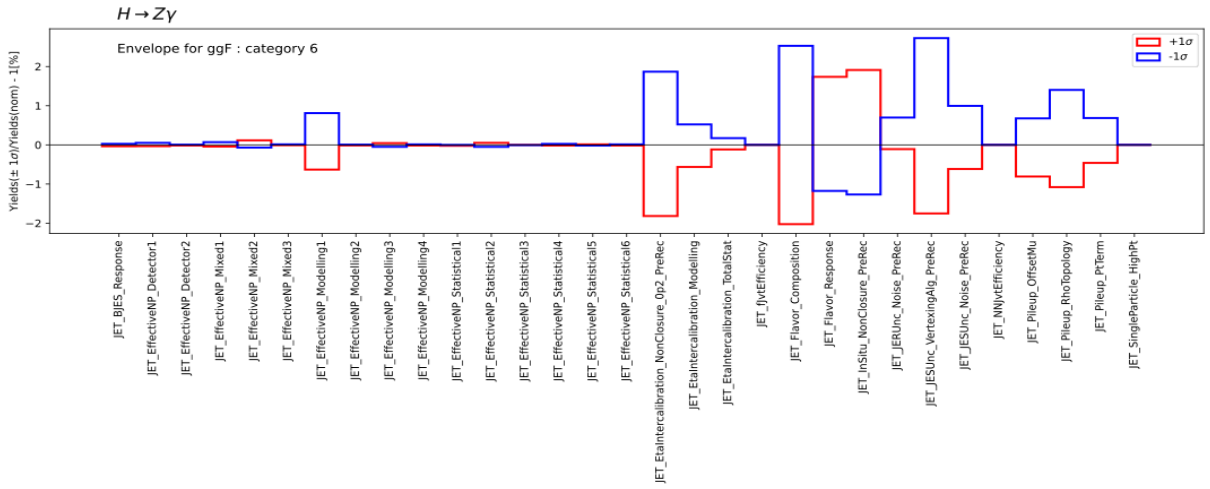


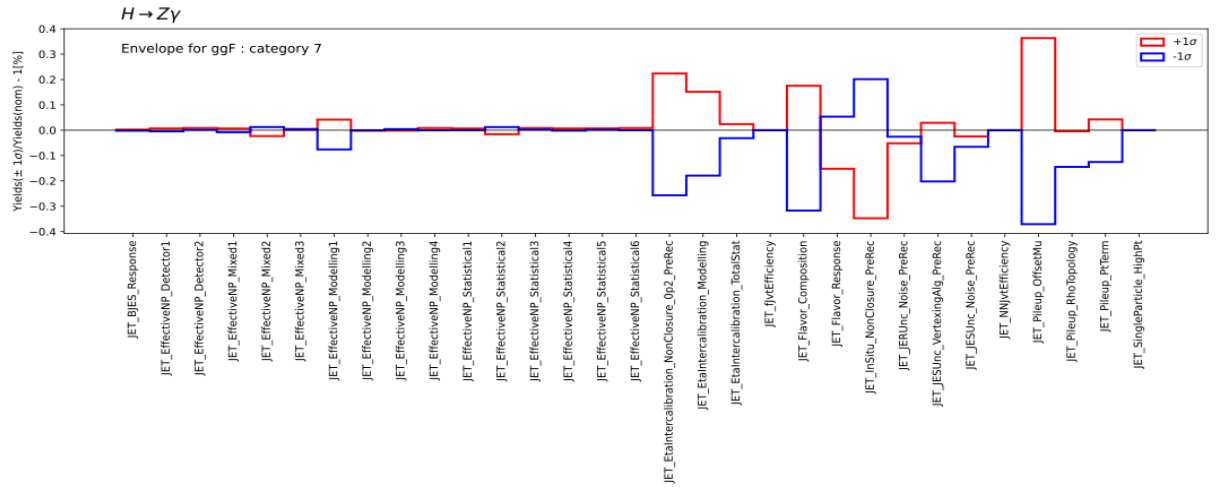


Estimation results in each category – ggF

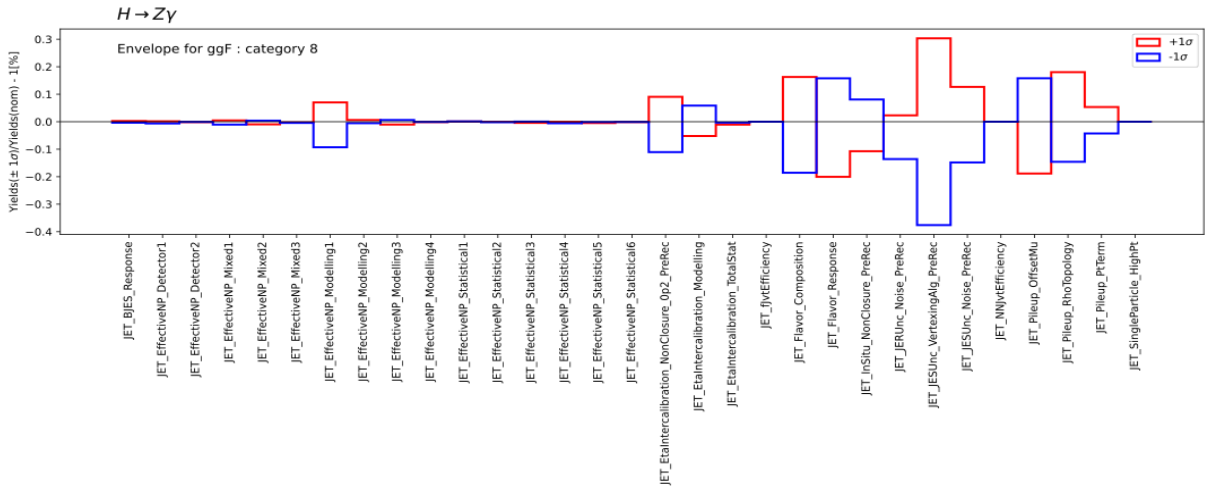


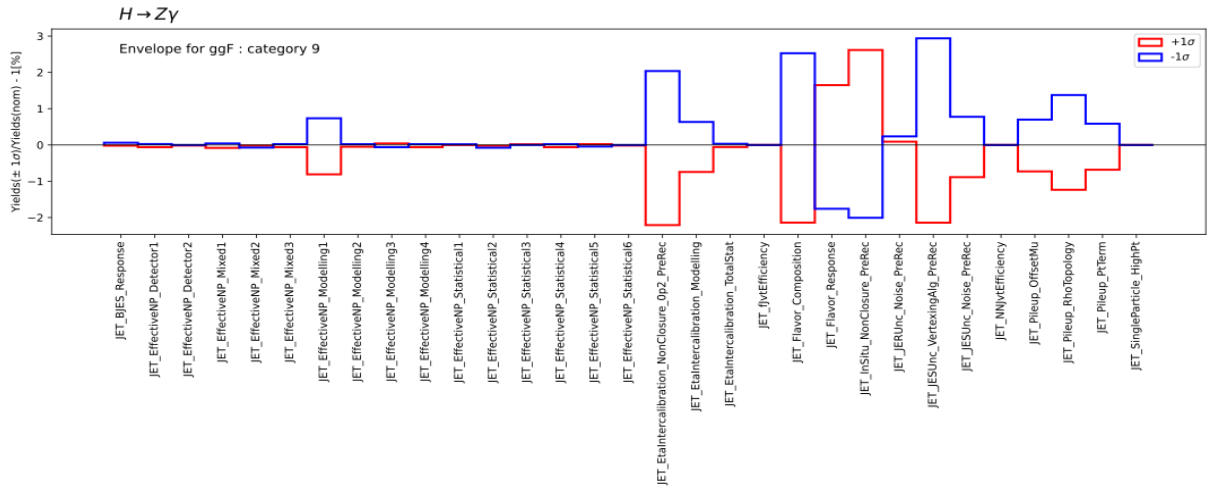


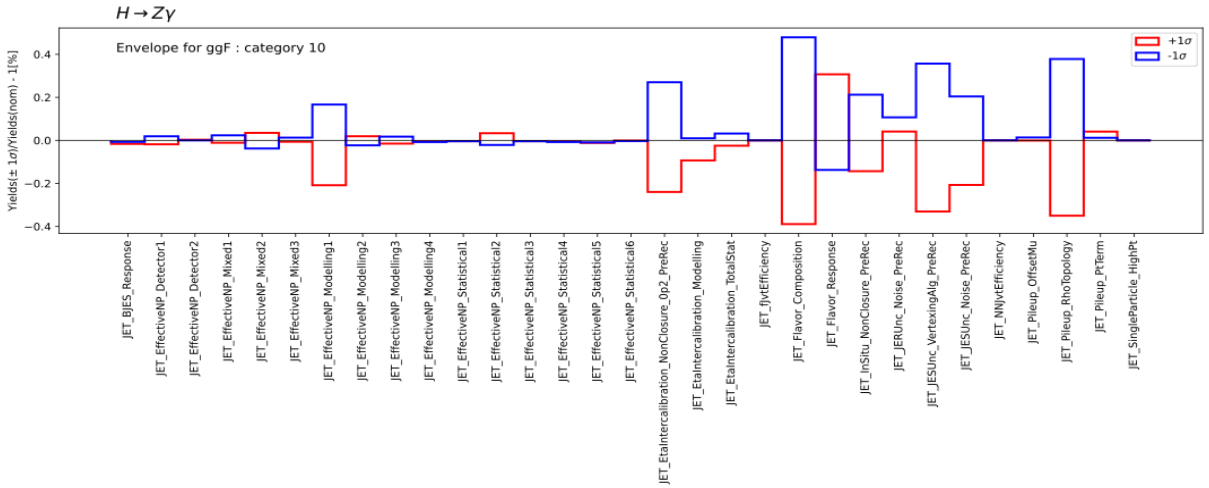


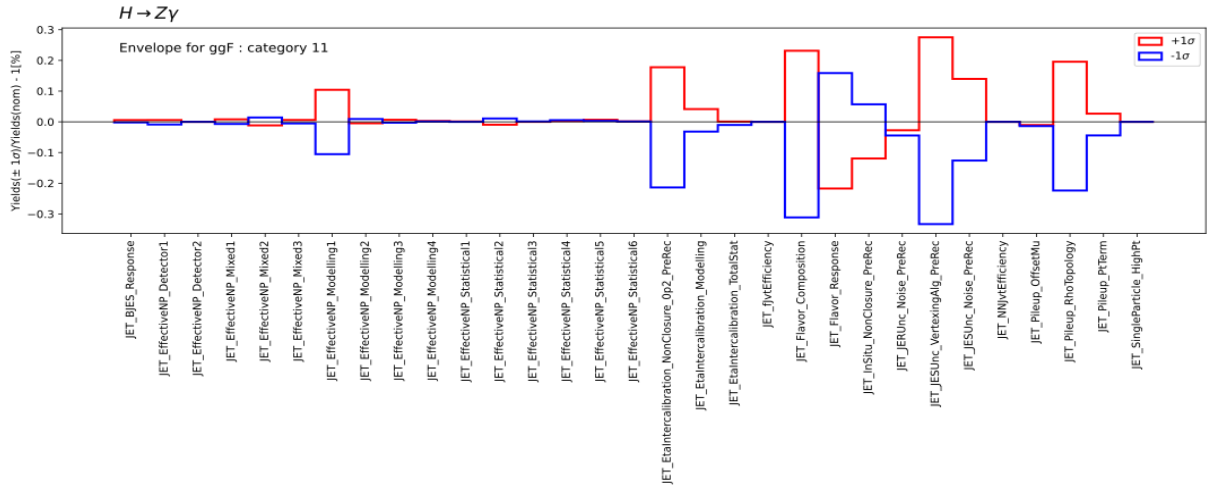


Estimation results in each category – ggF







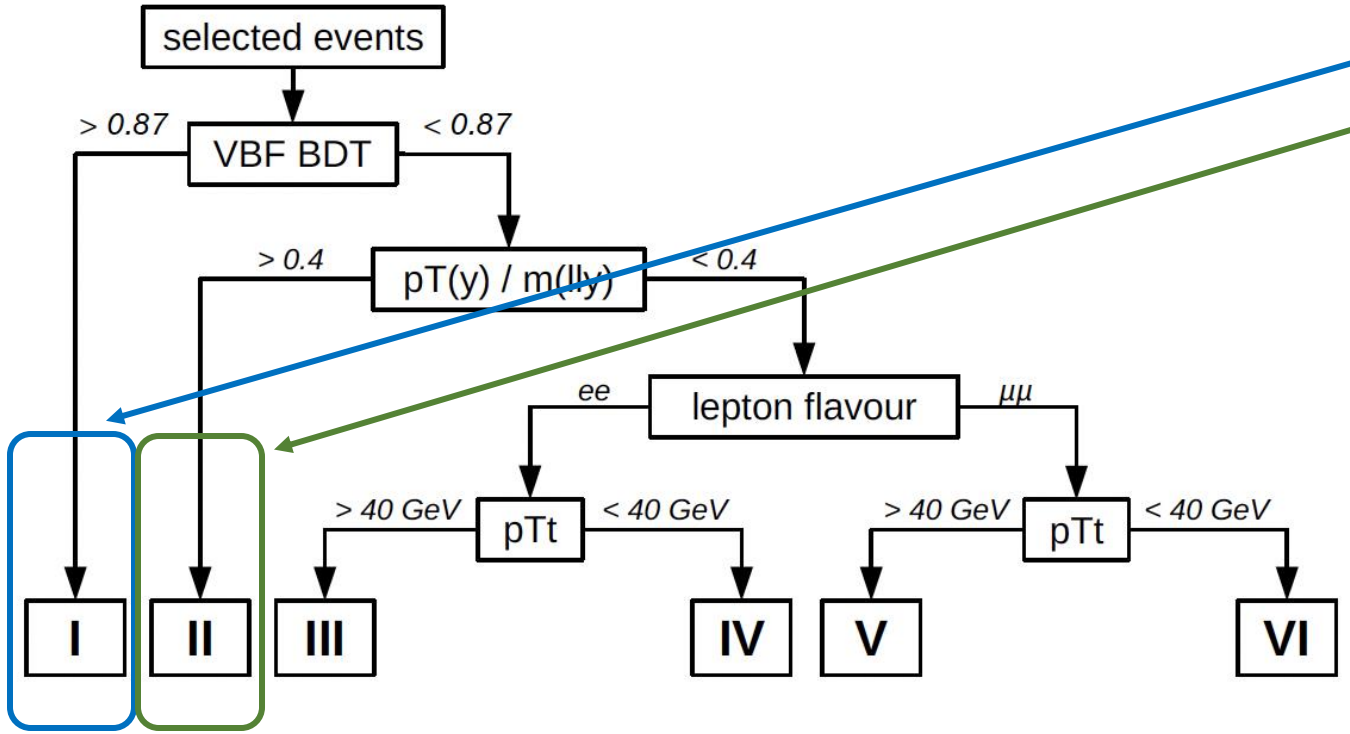


Estimation results in each category – ggF

- A quick summary of dominant jet systematic sources
  - JET_Flavor_Composition
  - JET_Flavor_Response
  - JET_JESUnc_VertexingAlg_PreRec
  - JET_JESUnc_Noise_PreRec
  - JET_Pileup_OffsetMu
  - JET_Pileup_RhoTopology
  - JET_EtaIntercalibration_NonClosure_0p2_PreRec
  - JET_EtaIntercalibration_Modelling
  - JET_EtaIntercalibration_TotalStat

Comparision between Run2 and Run3

- Comparison motivation:
  - To check the robustness of estimation method
  - To findout large deviation and treatment



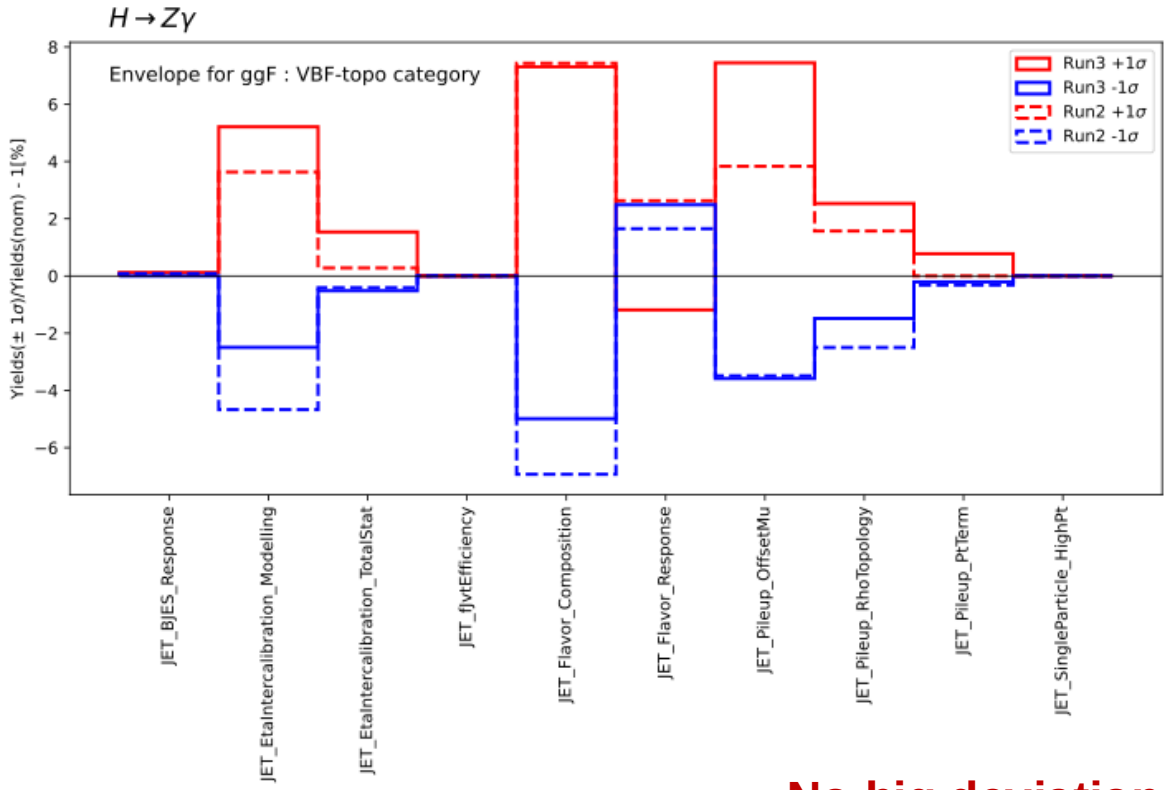
- Most sensitive categories in Run2
  - VBF-topo
  - High relative p_T

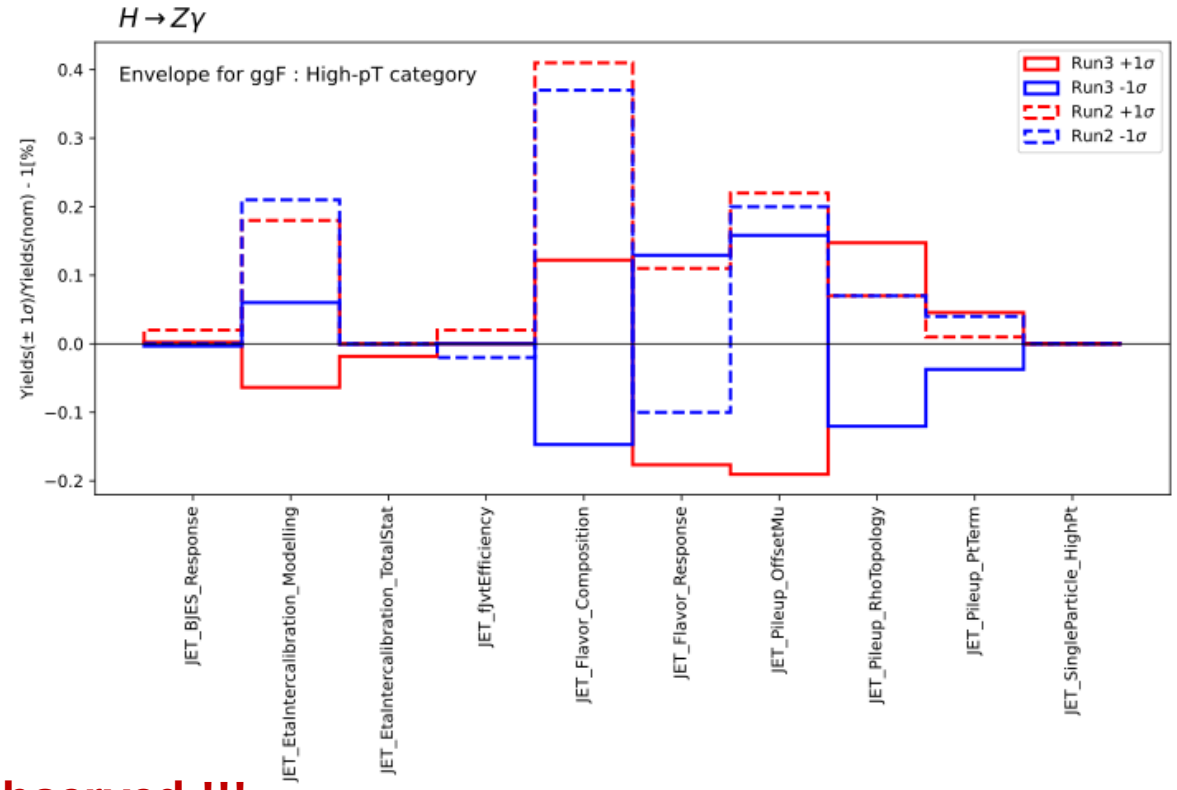
- The categories definition in Run2 and Run3 have changed a lot
- Necessary to find a similar region which is comparable

- Comparison in both categories are performed

Comparison between Run2 and Run3

- In order to reach a comparable results, same sources of jet systematic are considered in this comparison
  - Figure 1: Comparing VBF-topo category in Run2 with Category 1+2 in Run3
  - Figure 2: Comparing High-pT category in Run2 with Category 4+8 in Run3





No big deviation observed !!!

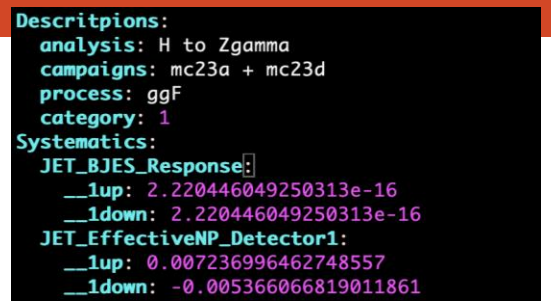
List of different jet systematic sources

- Differences in jet systematic sources are summarized here :

	Only used in Run 2		Only used in Run 3	
Systematic Source	JET_EffectiveNP_1	JET_JER_EffectiveNP_1	JET_EffectiveNP_Detector_1	JET_EffectiveNP_Statistical3
	JET_EffectiveNP_2	JET_JER_EffectiveNP_2	JET_EffectiveNP_Detector_2	JET_EffectiveNP_Statistical4
	JET_EffectiveNP_3	JET_JER_EffectiveNP_3	JET_EffectiveNP_Mixed1	JET_EffectiveNP_Statistical5
	JET_EffectiveNP_4	JET_JER_EffectiveNP_4	JET_EffectiveNP_Mixed2	JET_EffectiveNP_Statistical6
	JET_EffectiveNP_5	JET_JER_EffectiveNP_5	JET_EffectiveNP_Mixed3	JET_EtaIntercalibration_NonClosure_0p2_PreRec
	JET_EffectiveNP_6	JET_JER_EffectiveNP_6	JET_EffectiveNP_Modelling1	
	JET_EffectiveNP_7	JET_JER_EffectiveNP_7restTerm	JET_EffectiveNP_Modelling2	JET_InSitu_NonClosure_PreRec
	JET_EffectiveNP_8restTerm	JET_JvtEfficiency	JET_EffectiveNP_Modelling3	JET_JERUnc_Noise_RreRec
	JET_EtaIntercalibration_NonClosure_highE	JET_Pileup_OffsetNPV	JET_EffectiveNP_Modelling4	JET_JESUnc_VertexingAlg_PreRec
	JET_EtaIntercalibration_NonClosure_negEta		JET_EffectiveNP_Statistical1	JET_JESUnc_Noise_PreRec
	JET_EtaIntercalibration_NonClosure_posEta		JET_EffectiveNP_Statistical2	JET_NNJvtEfficiency

- **JER systematics are missing** in Run3 Ntuple production, please check !

Summary and Next todos



- Summary
  - Start from ggF sample
  - Done to prepare the output for the workspace
  - Envelope has been taken (in between variation and nominal yields) and assigned as uncertainties
  - First jet systematic estimations in 11 categories are derived
  - Comparisons between Run2 and Run3 estimation have been performed in VBF-topo and high relative pT categories, with generally good agreement observed
- Next todos
  - More samples (including VBFH, VH, ggZH and etc.) will be checked in the next week
  - Should we use prunning ?