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# Preparation for combination of Heavy Resonance Searches at CMS

This is a preparatory twiki designed to organise the preparation for a combination of CMS analyses searching for heavy new resonances as predicted by BSM models such as WED or HVT models.

The goal is to outline procedures and datacard requirements that allow for a smooth combination procedure once all individual analyses have passed their approval.

Interesting thoughts to the combination and BSM models to be considered were presented here (interesting slides for combination:

[https://indico.cern.ch/event/881563/contributions/3730910/attachments/1981776/3301585/200205\\_Zucchetta.pdf](https://indico.cern.ch/event/881563/contributions/3730910/attachments/1981776/3301585/200205_Zucchetta.pdf)).

## Contacts

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## Datacard requirements

### General

Before pre-approval:

- Ensure orthogonality to other CMS analyses with the same final state!

At the approval stage:

- Provide two sets of datacards and workspaces for the combination:
  - ◆ As used in the analysis proper
  - ◆ With the signal rate normalised to the cross section of the BSM model times the branching fraction of the considered channel. For example:  $\text{rate signal} = \text{xs\_BSM} * \text{BR\_XtoWW} * \text{BR\_SM\_final\_state}$
  - ◆ **ATTENTION:** for a signal scaled to the BSM cross section an additional yield uncertainty has to be added for PDF and renormalisation scales if they are not already considered
- The datacards should be provided in the following directory structure:
- CADI\_line\* with subfolders **datacards** and **workspaces**
- The datacards and workspaces for the combination should have names ending on "\_combination.\*"

\* analyzers should make sure that the datacards follow the requirements and naming schemes listed below

### Processes

- Signal process called **Signal**
- Background processes **Background**
- Data denoted by **data\_obs** # The mass range of the signal?

## Yields

- Signal yield:  $xs\_BSM * BR\_XtoVV/l * BR\_SM\_final\_state$

## Systematics

The following naming scheme should be used for systematic uncertainties that are going to be correlated between analysis. If the systematic uncertainty is particular to the single analysis and does not need to be correlated the analyzers may choose the name by themselves under consideration of the naming scheme below:

- Each nuisance should start with **CMS**
- If necessary add label for different data taking years e.g. **CMS2016**
- Add analysis specific label e.g. for an X -> VV -> 2j analysis a good label would be **VV\_JJ**
- Custom name of the systematic uncertainty e.g. **Bin1**

Systemtic	Systematic name	type	nuisance type
pdf	pdf_accept	log-normal	signal acceptance uncertainty due to PDF variation
pdf	pdf_scale	log-normal	signal efficiency uncertainty due to PDF variation
scale	qcd_scale	log-normal	signal yield uncertainty due to renormalisation scale
lumi	CMS2016_lumi	log-normal	yield uncertainty due to luminosity measurement
pileup	CMS2016_scale_pu	log-normal	yield uncertainty due to pileup
object tagging	CMS2016_eff_objectname	log-normal	yield uncertainty due to object tagging: V (V-tagging with tau21), deepV/H (V/H tagging with DeepJet), b (b-tagging), e/m/t (Electron/Muon/Tau-Identification), (deep)bb ((deep) double-b-tagger)
tagging pT extrapolation	CMS2016_extr_objectname	log-normal	pT extrapolation uncertainties
lepton scale/resolution	CMS2016_scale_e/m/t, CMS2016_res_e/m/t	log-normal	yield uncertainty
lepton scale/resolution	CMS2016_sig_p1_e/m/t, CMS2016_sig_p2_e/m/t	shape	nuisance parameters for the effect on the signal shape
JES/JER	CMS2016_scale_j, CMS2016_res_j	yield	nuisance for jet energy scale/resolution uncertainties
JES/JER	CMS2016_sig_p1_j, CMS2016_sig_p2_j	shape	nuisance for jet energy scale/resolution uncertainties on signal shape (mean/width)
jet mass (SD) scale/resolution	CMS2016_scale_mass, CMS2016_res_mass	yield	
jet mass (SD) scale/resolution	CMS2016_sig_p1_mass, CMS2016_sig_p2_mass	signal shape	signal shape nuisance on mean (p1) and width (p2) due to jet mass uncertainties
trigger uncertainties	CMS2016_trigger_name	log-normal	nuisance for trigger efficiency uncertainties name = [MET, HT, e/m/t, etc.]

-- DanielaSchafer - 2020-04-23

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