MANCHESTER 1824
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MET+jets differential cross sections:

Limit setting

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Methodology

Fiducial regions	*Differential observables*	*Regions*
VBF-like *2jet, high m_{jj}, $\Delta y(j,j)$*	**m_{jj} , $\Delta\phi(j,j)$** *when two jets*	**SR 0l**
Dijet-like *two high p_T jets*	**MET** *always*	**CR 1e**
Monojet-like *one central high p_T jet*	**MET vs. p_T^{j1}** *monojet*	**CR 2e**
		CR 1μ
		CR 2μ

Motivation

Phase spaces highlight different DM production processed

Fit multiple observables - greater sensitivity

Fit multiple regions - CRs constrain modelling of SM V+jets processes

Challenge: treatment of modelling uncertainties when simultaneously fitting to multiple observables and constraining using multiple regions (with different V+jets contributions)

Statistical methods

Re-interpret using a likelihood-profile method

(mostly consider upper limits using CLs method)

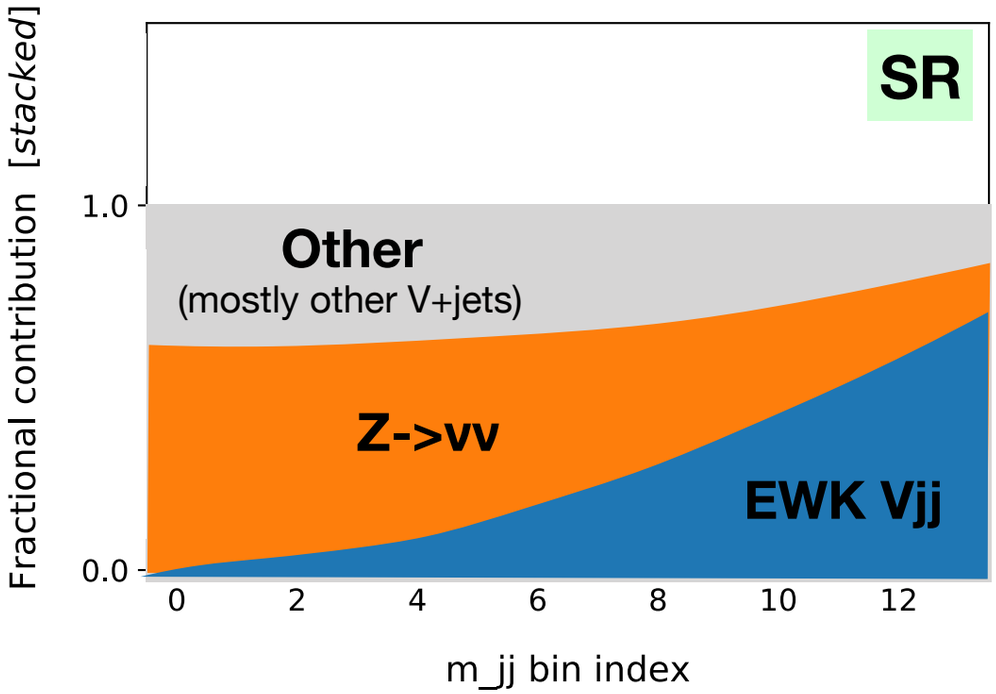
$$\chi^2\left(\vec{x};\vec{c},\vec{\theta}\right) = \left(\vec{x} - \vec{p}(\vec{c}) - \sum_i \theta_i \vec{\epsilon}_{\theta_i}\right)^T \mathrm{Cov}^{-1} \left(\vec{x} - \vec{p}(\vec{c}) - \sum_i \theta_i \vec{\epsilon}_{\theta_i}\right)$$

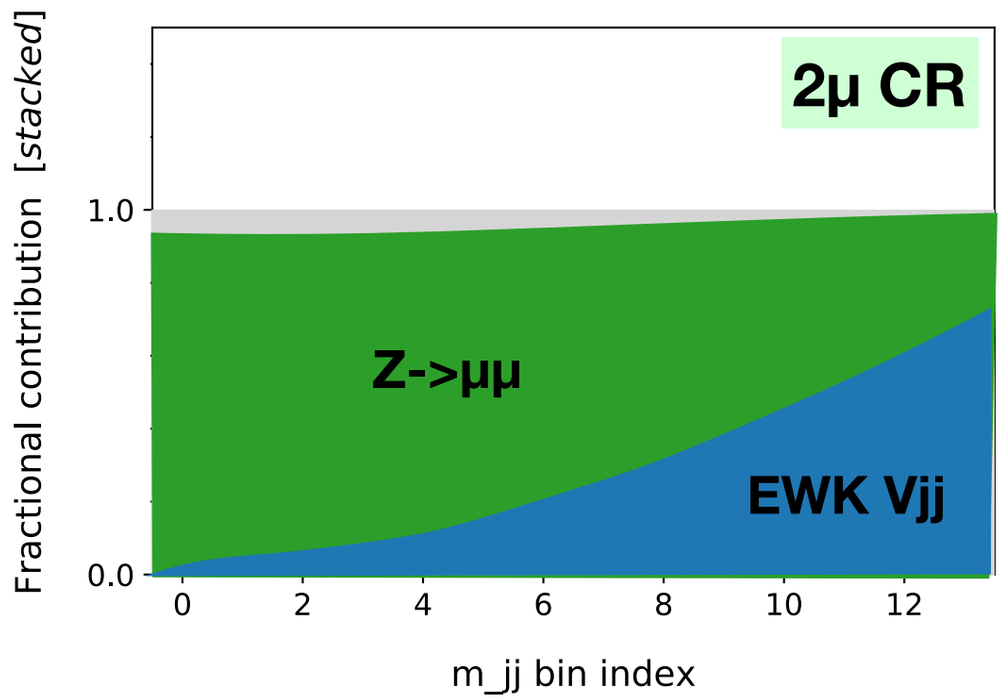
$$\mathcal{L}\left(\vec{x};\vec{c},\vec{\theta}\right) = \mathcal{N} \cdot e^{-\frac{1}{2}\chi^2\left(\vec{x};\vec{c},\vec{\theta}\right)} \cdot \prod_i \pi\left(\theta_i\right)$$

- Each uncertainty can be put in covariance matrix and/or treated as NPs
- All model and experimental systematics modelled as Gaussian
- Uncertainties in cov matrix must be *symmetric* and *absolute*
- NPs allowed to be a*symmetric* and *relative*
- Could have free floating NPs if needed
- Currently treating all systematics as NPs, so we can study their pulls and constraints
- Signal models modify the prediction, p(c) where c are parameters of interest

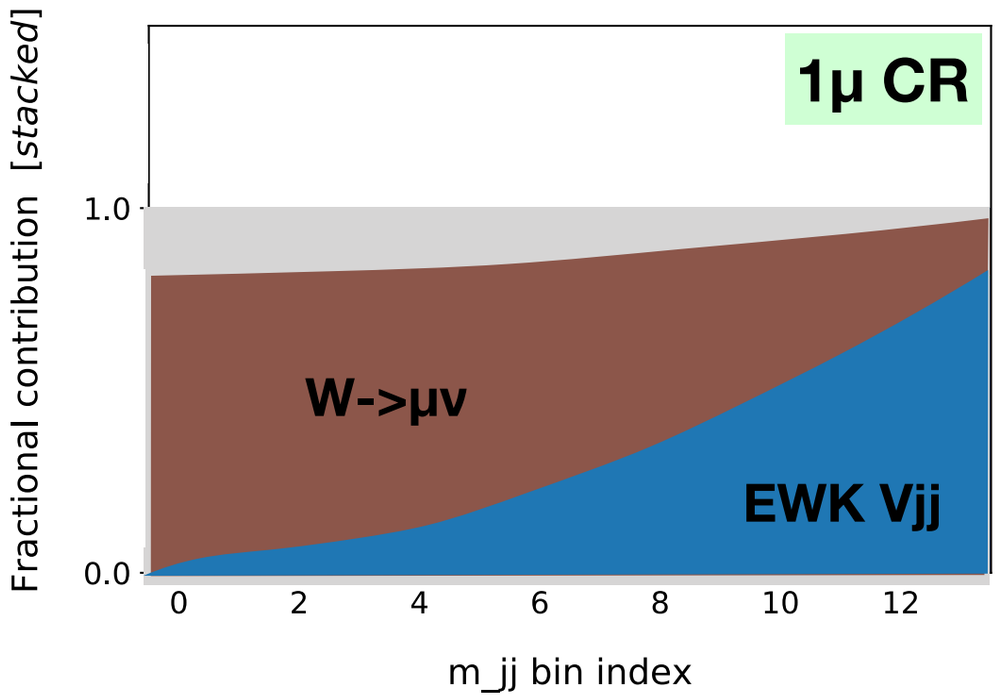
SM fractional contribution

VBF-like, m_{jj}

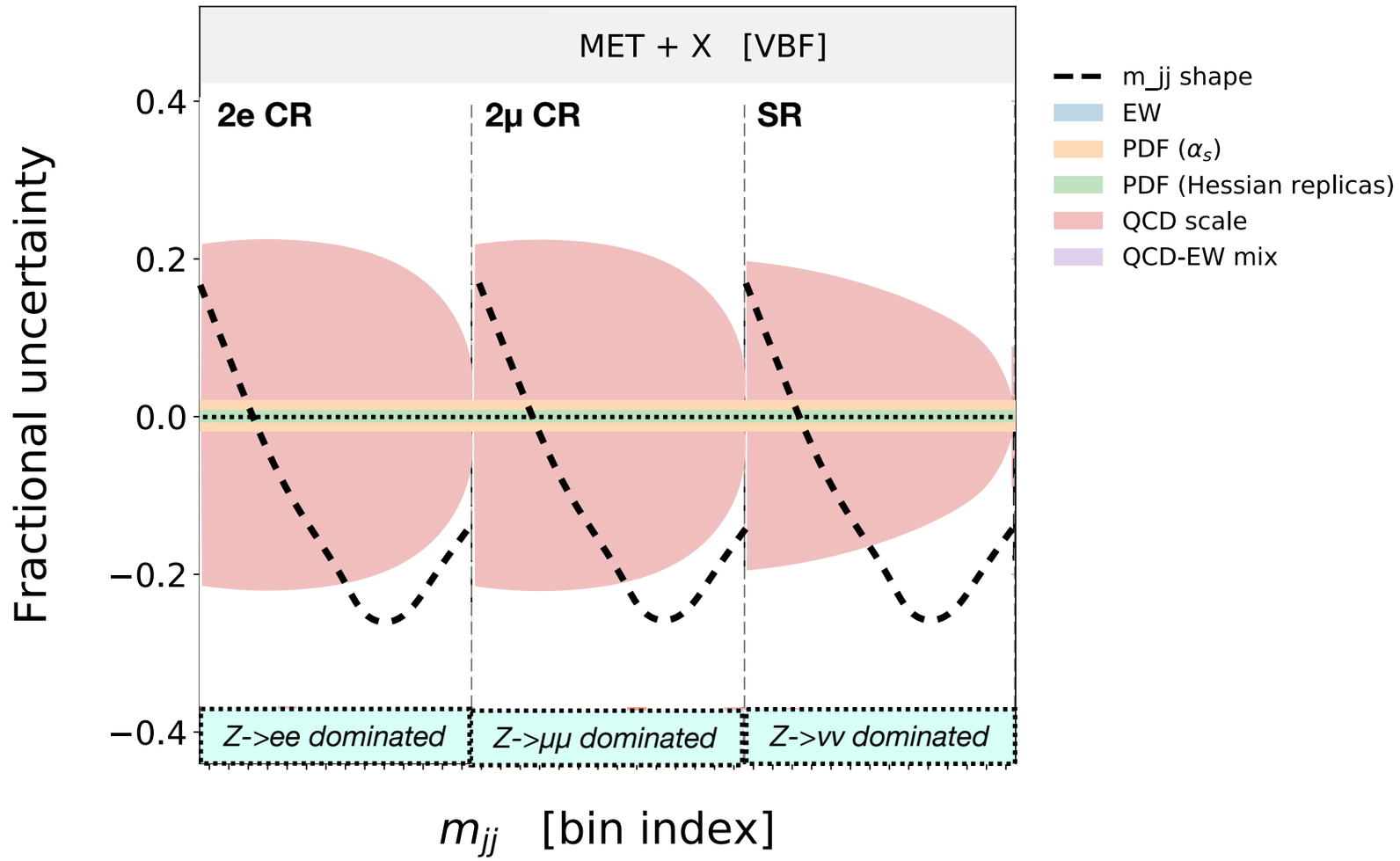




- **SR** dominated by Z->νν and Vjj
- **2μ CR** dominated by Z->μμ and Vjj
- **1μ CR** dominated by W->μν and Vjj
- Same treatment for 2e and 1e
- *Use CRs to constrain V+jets modelling systematics in SR*



V+jets “uncertainties” on SM



Current strategy

- Modelling >> experimental stats and systematics (few %), so important that we treat them rigorously. Otherwise end up with poor data/SM agreement (even when SM is true), leading to biased reinterpretations.
  - **~20% uncertainty** from **envelope** of **SM scale variations** (falls off with mjj due to falling V+jets fraction)
  - 107 PDF replicas treated as individual variations, combine to O(%) **[incorrect combination method!]**
  - PDF (alpha_s) also O(%), which is the envelope of two variations
  - Currently use nominal scale choice to model mjj, then treat the correction as a **Gaussian constrained one-sided NP**
- Not yet included EWK Vjj systematics, but will consider them *uncorrelated with V+jets*

Discussion points

m_{jj} shape correction

- **Current:** use nominal Sherpa as SM prediction. Treat difference w.r.t. alternative scale choice as a “modelling uncertainty”. Fit as a NP with a Gaussian constraint.
- **Problems with method:** NP pulls != 1 not well motivated. Constraint artificially favours correction slightly below 1.
- **Alternative (unconstrained NP):** too much freedom to fit NP pulls other than 1. Artificial broadening of model uncertainty, since dramatic shape corrections are considered justified.
- **Alternative (prefit correction to mjj prediction):** still an uncertainty on the shape correction. What do we use?
- Treatment needs to work when fitting to Δϕ(j,j) and MET at the same time.

Combination of processes and regions

- **Current:** model systematics considered 100% correlated between different V+jets processes, regions, phase spaces, and within wide range of energies.
- Plan to slightly decorrelate processes.

Enveloping of QCD scale uncertainties *(7-point variations)*

- Dominant uncertainties of O(10-20%) compared with O(few %) experimental precision - need to get right!
- Preserve correlations between bins, processes and regions

Combination of PDF uncertainties

- **Current:** each of 107 variations is treated as independent source. This is an overestimate. Can we combine and preserve correlations between processes, regions and bins?