

Simplified templates XS for diboson measurements

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Main goals of an STXS-like common scheme

- Define bins in some process-agnostic observables that have the same distribution for different diboson channels.
 - Straightforward combination of cross section measurements in different channels.
 - Possibility to combine many channels to enhance the sensitivity in particular phase space regions (e.g. in the tails → interesting for EFT interpretations!).
- No additional fiducial requirements related to decay channels.
 - Again, needed to allow the combination of different processes ($WW \rightarrow X$, $WZ \rightarrow X$, $ZZ \rightarrow X$).
 - At the expense of bigger theoretical uncertainties in the extrapolation of the measurement to the larger phase space.
- Tile the full phase space → no empty regions.
- NB: the STXS approach is complementary to fiducial differential measurements.
 - Fiducial definition closer to the analysis phase space → less extrapolation uncertainties but hard/impossible to combine different channels.
 - STXS templates can be multi-differential by definition.

Observables and bin boundaries

- Interesting observables for diboson production:
 - $m(VV), p_T(VV), \dots$
 - $m_{jj}, \Delta\eta_{jj}, \dots \rightarrow$ for VBS topologies
 - #jets (0, 1 and ≥ 2)

- How to choose the bin boundaries?
 - As fine as possible, provided the experimental measurements within each bin are sensitive enough.
 - Particular care to evaluate the theoretical uncertainties.
 - Include bins sensitive to BSM effects.

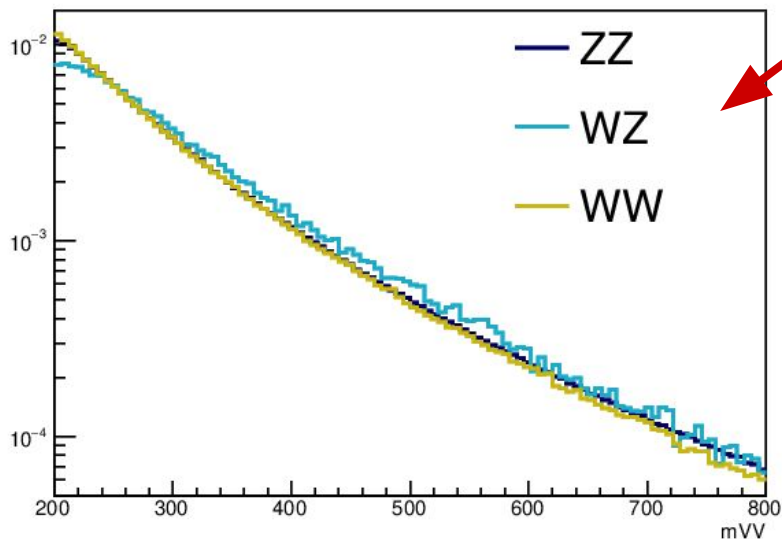
Examples / VV

- **Very preliminary! Take with a grain of salt!**

WW: $WW \rightarrow 2l2\nu$ POWHEG+Pythia8

WZ: $WZ \rightarrow 3l1\nu$ POWHEG+Pythia8

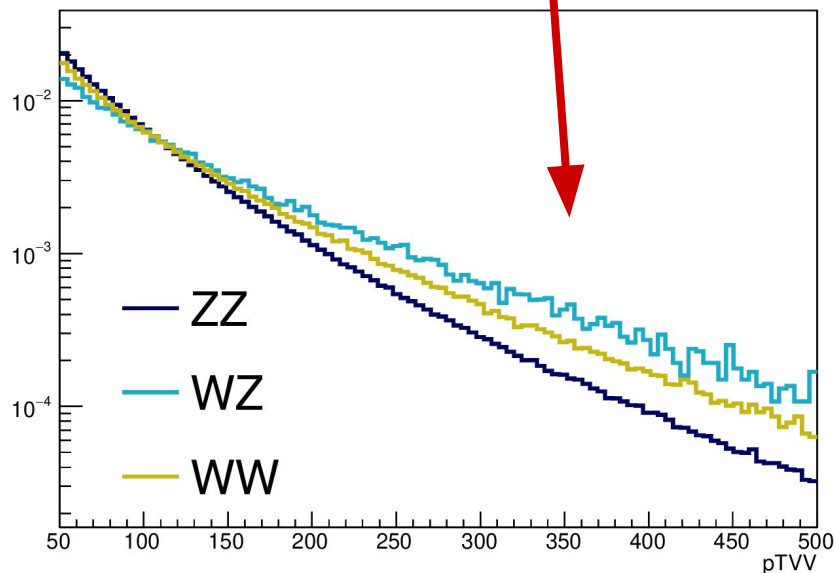
ZZ: $ZZ \rightarrow 2l2\nu$ POWHEG+Pythia8



m_{VV} distribution is similar for different processes.

Some differences for p_{TVV} .

V bosons reconstructed at particle level using dressed charged leptons + neutrinos.



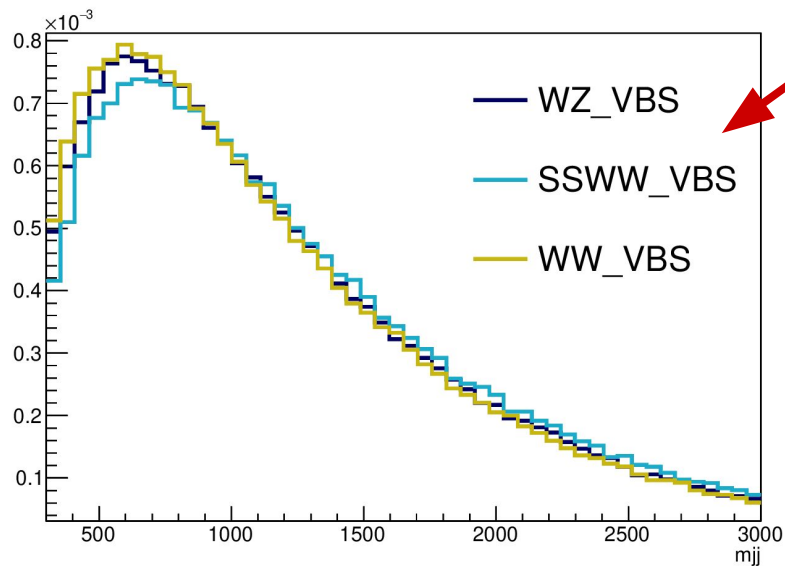
Examples / VBS

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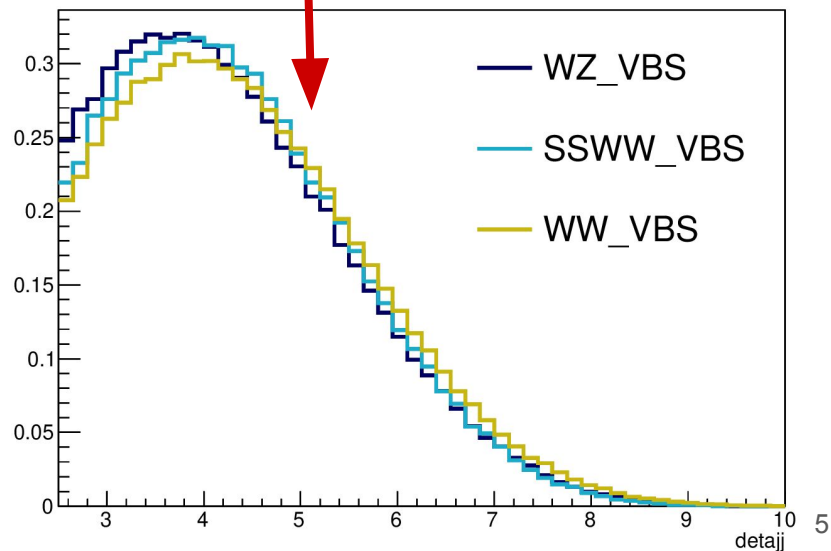
WZ_VBS: $WZjj(\rightarrow 3l1\nu)$ EWK Madgraph5+Pythia8

SSWW_VBS: same sign $WWjj(\rightarrow 2l2\nu)$ EWK Madgraph5+Pythia8

WW_VBS: opposite sign $WWjj(\rightarrow 2l2\nu)$ EWK Madgraph5+Pythia8



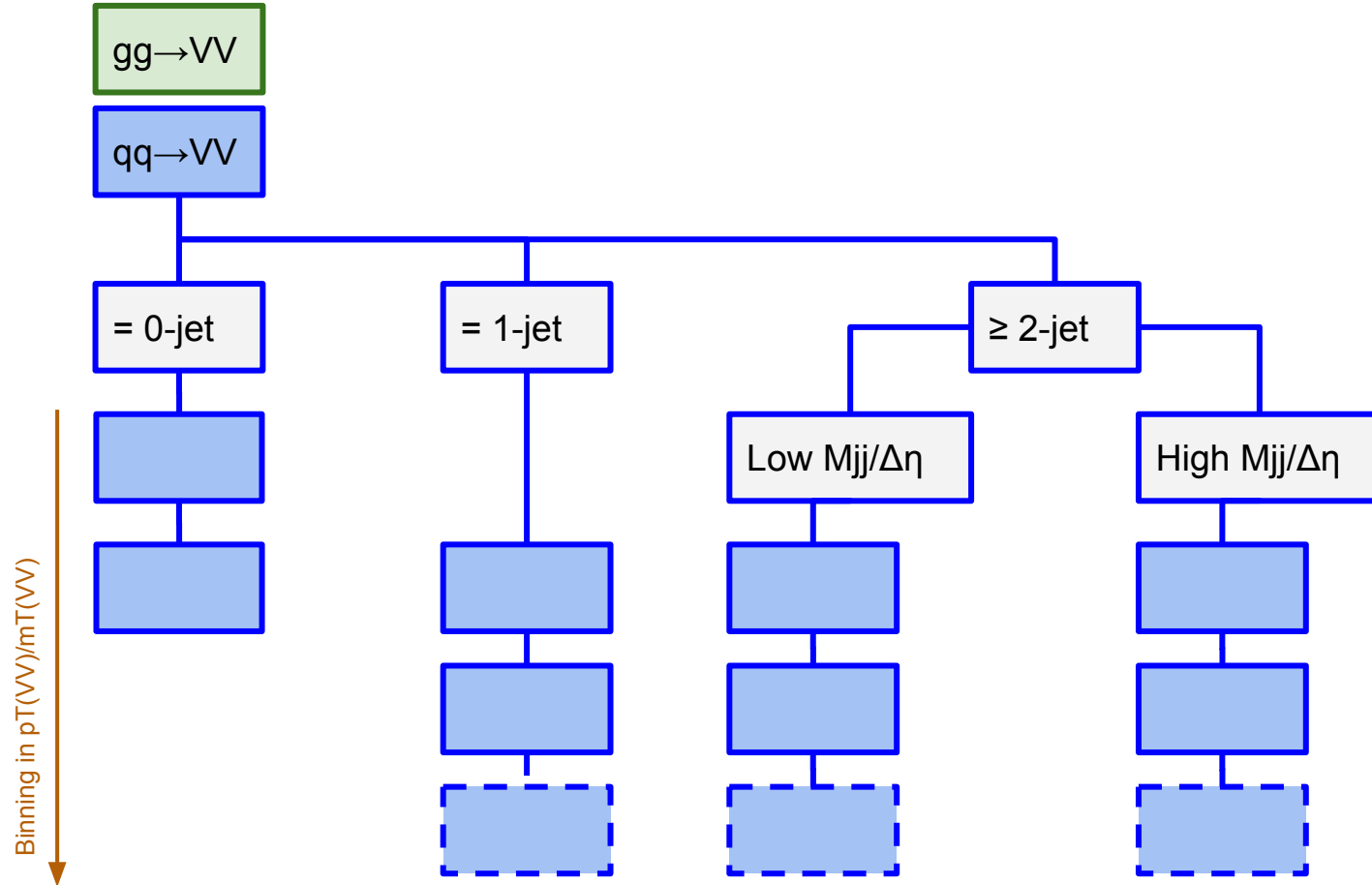
Fairly similar m_{jj} and det_{jj} distributions for different EWK VBS processes



A first proposal

- Define 3 main classes: WW, WZ and ZZ
 - We can separate ggVV and qqVV processes → likely not feasible in the analyses
- Define subcategories with =0, =1 and ≥ 2 jets with $p_T > 30$ GeV [need to converge on the jet definition]
 - Be careful with jet binning uncertainties [could consider resummation safe observables such as tau-jettiness?]
- Define mVV/pTVV [or/and something else] bins within each jet bin:
 - pTVV would be inline with the STXS binning defined in the Higgs case.
- Split the 2 jet bin in 2 sub-categories:
 - Low m_{jj} or low det_{jj} → dedicated to VV+2 jets QCD measurements
 - High m_{jj} and high det_{jj} → dedicated to VBS EW measurements

A first proposal



A first proposal

$gg \rightarrow VV$

$qq \rightarrow VV$

= 0-jet

[]

[]

= 1-jet

[]

[]

[]

EKW VBS

EWK $qq \rightarrow VVqq$

= 0-jet

= 1-jet

≥ 2 -jet

QCD VBS

≥ 2 -jet

Low $M_{jj}/\Delta\eta$

High $M_{jj}/\Delta\eta$

Low $M_{jj}/\Delta\eta$

High $M_{jj}/\Delta\eta$

[]

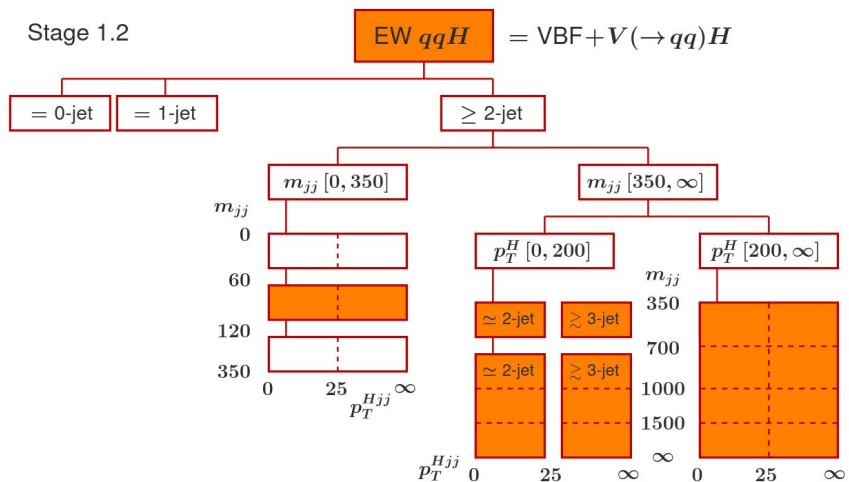
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Binning in $p_T(VV)/m_T(VV)$

Some additional thoughts



- Could be interesting to have the possibility to combine VBS and VBF Higgs measurements for channels that receives contributions from s-channel Higgs diagrams (OS WW and ZZ).

- How to implement the categorization in the analyses?
 - Following what was done in the Higgs case, we can define a Rivet routine to automatically categorize events in each bin
 - Guarantees that everyone uses the same object definitions etc.
- Might be interesting to define additional bins sensitive to the V polarizations?

For the Yellow Report

- We can include a ~1-2 pages section to describe the idea and perhaps provide some preliminary recommendations (stage 0).
- The scheme can be further developed in a later stage, and documented in an LHC EW note.

BACKUP

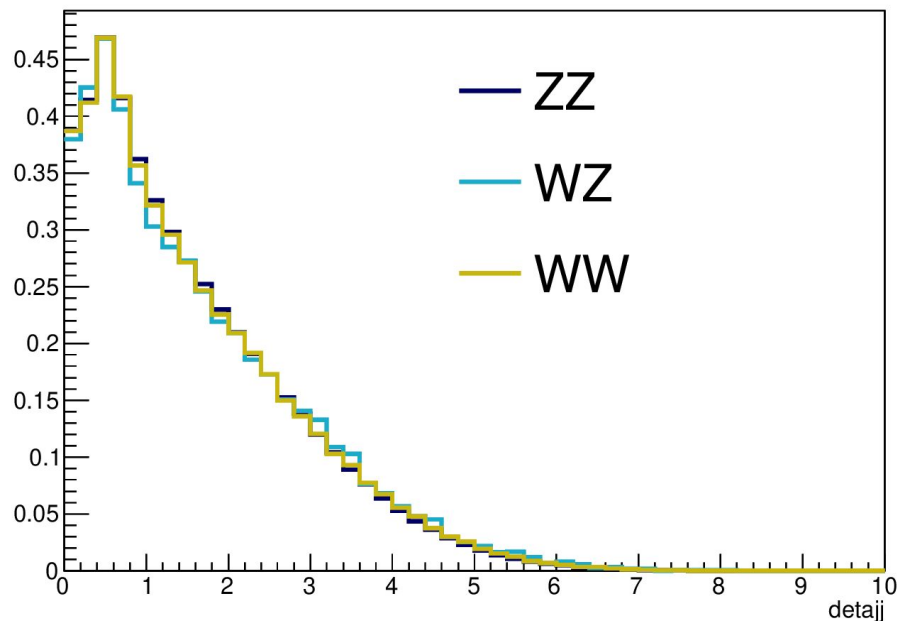
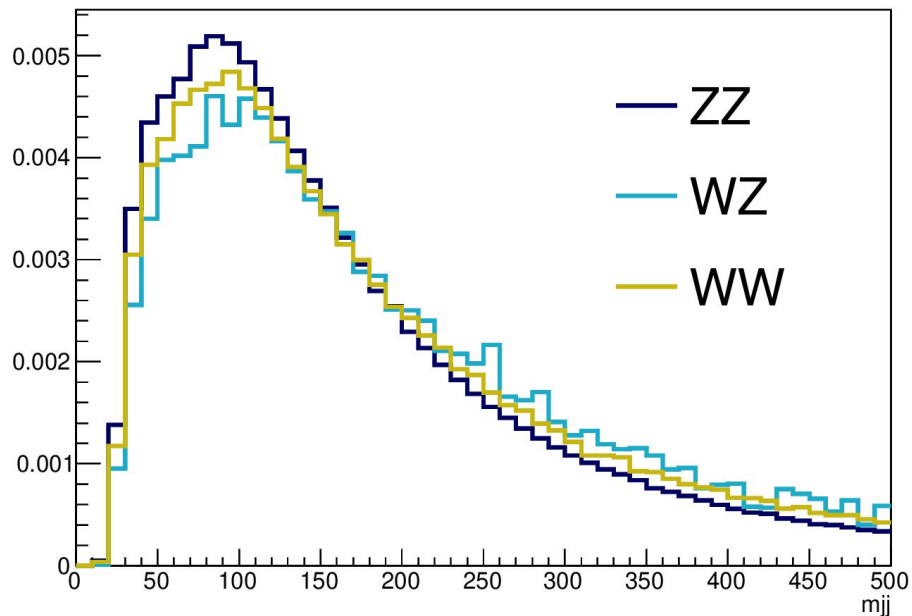
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Examples / VBS

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