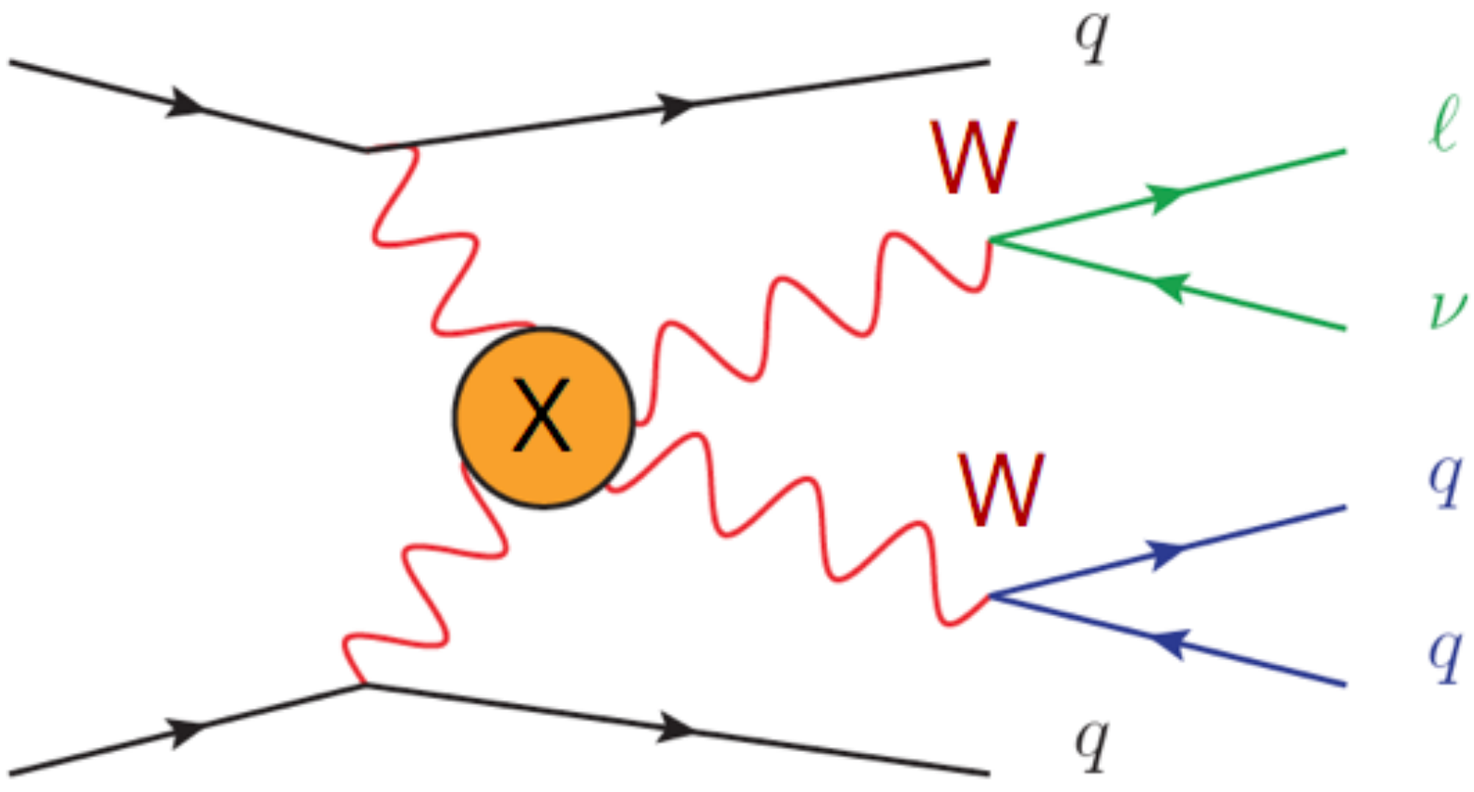
VBS WV semileptonic

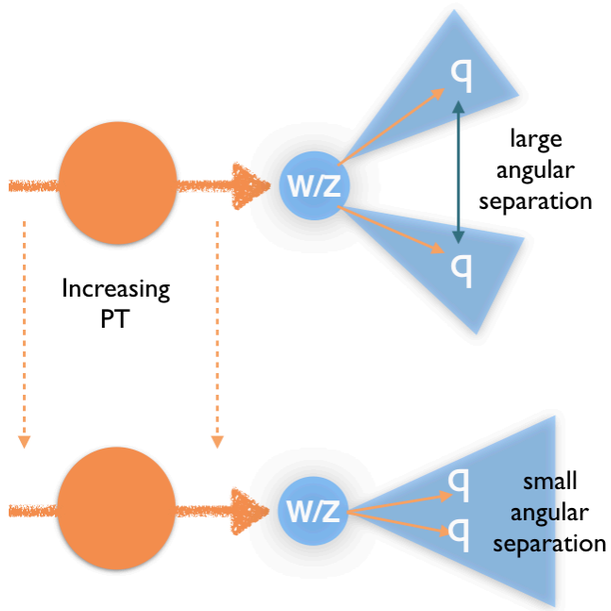
Viviana Cavaliere, Robert Les, Tatsumi Nitta, Koji Terashi

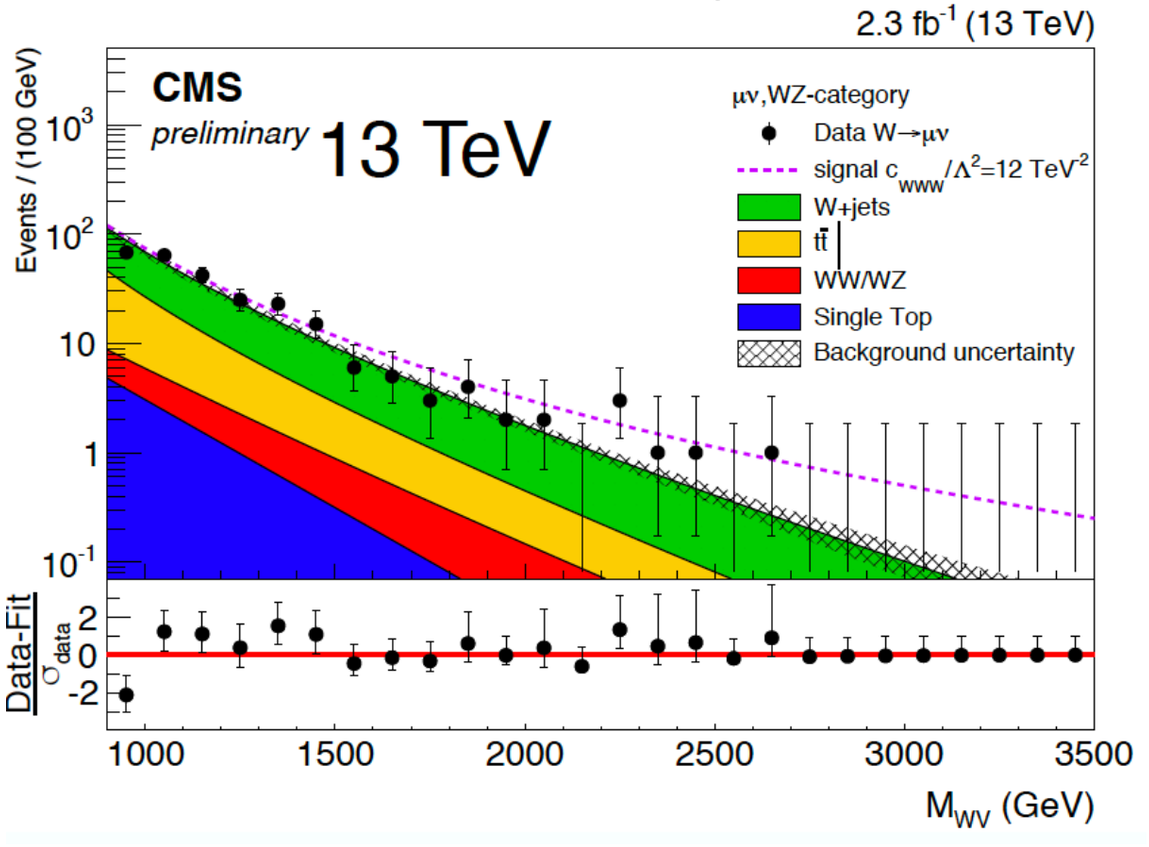


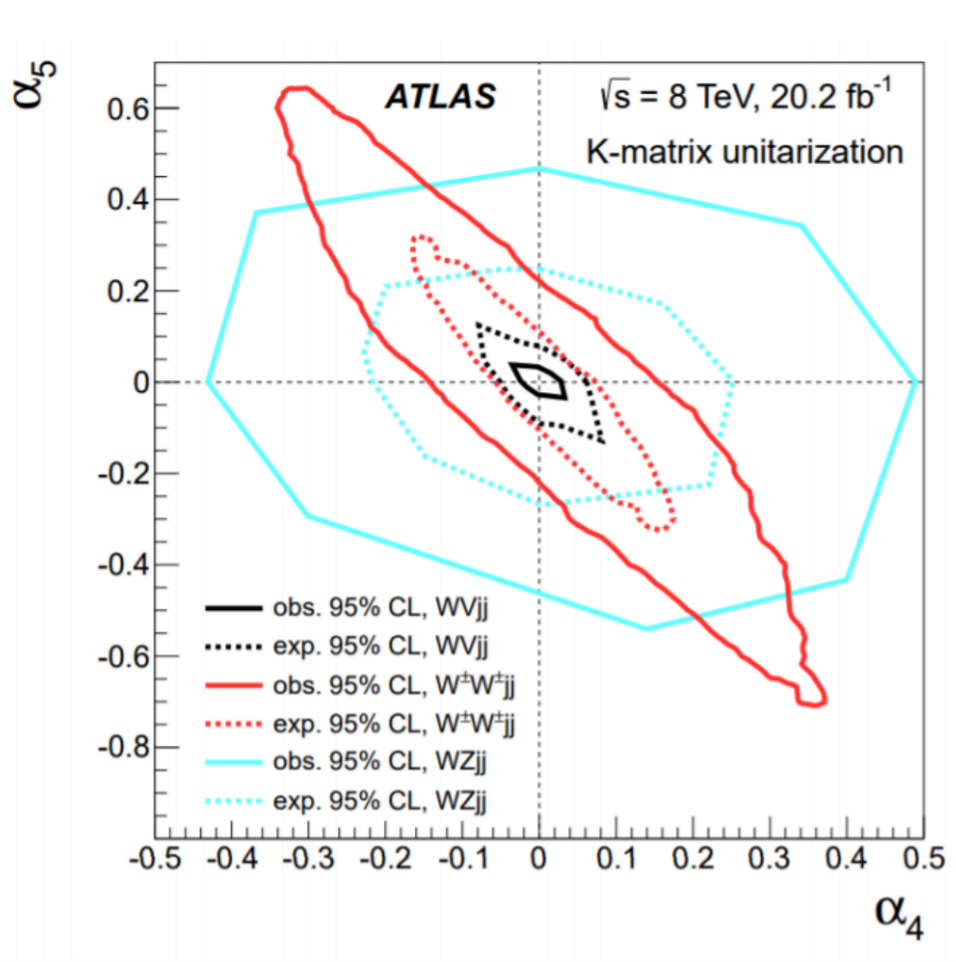
WW/WZ->lvjj

- Identify leptonically decaying W boson while other W or Z boson decays to jets
- Select dijet events and boosted events such that the decay jets merge into a single jet

Maximizes sensitivity to aQGC

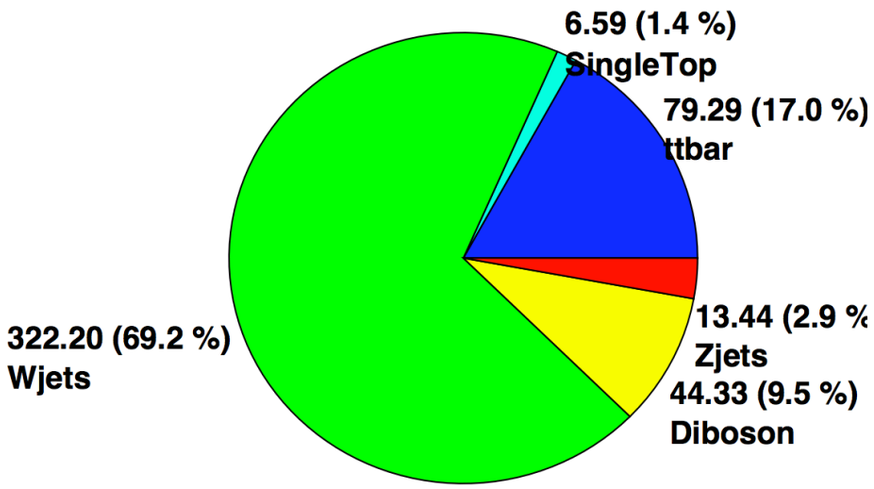


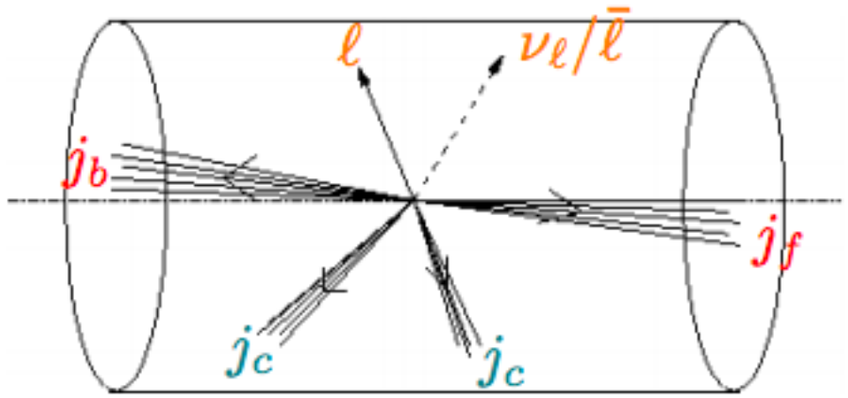


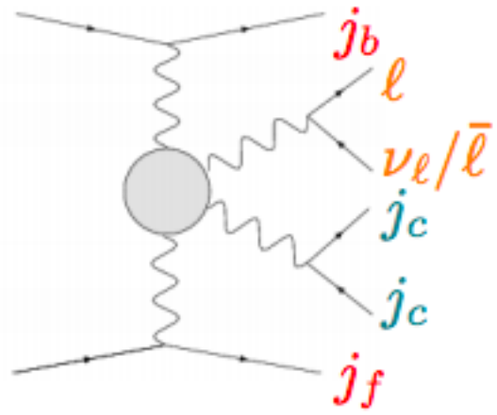


Goal

Estimate sensitivity for VBS and aQGC in 1 lepton channel at HL/HE-LHC.







HL-LHC

1.Request VBS specific sample.
(VBS, aQGC, large amount of W+jets)
2. TRUTH DAOD + smearing function
3. Event selection, SR definition
4. Estimate sensitivity @ 3000 fb-1
5. Limits on aQGC
6. Can we isolate the longitudinal component?

HE-LHC

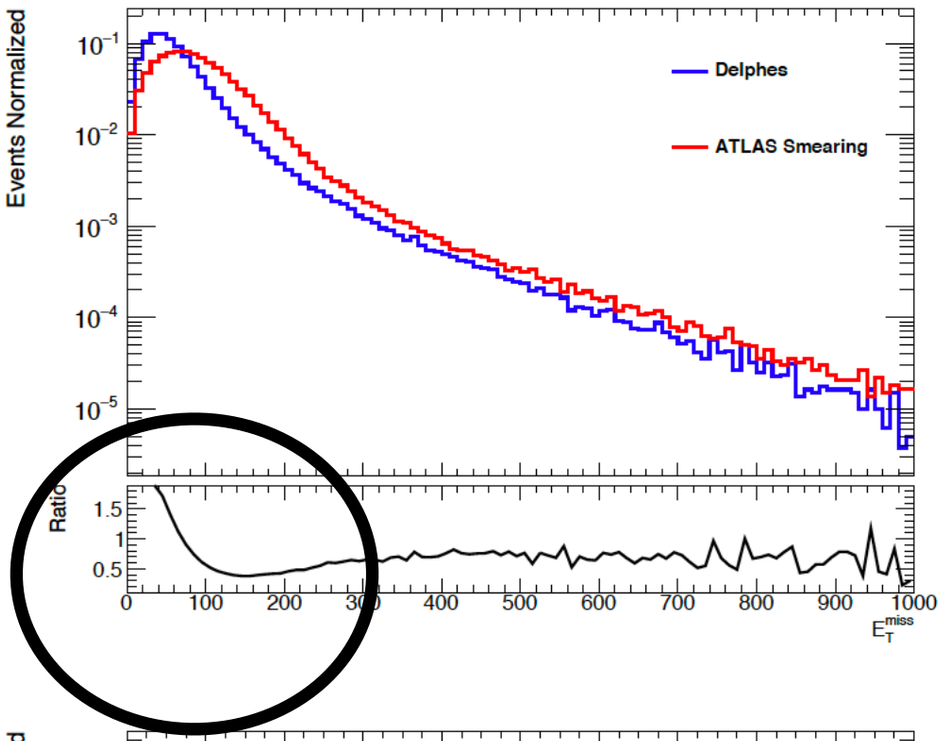
1.Produce events locally
2. Detector simulation with Delphes
3. Event selection, SR definition.
4. Main Question:

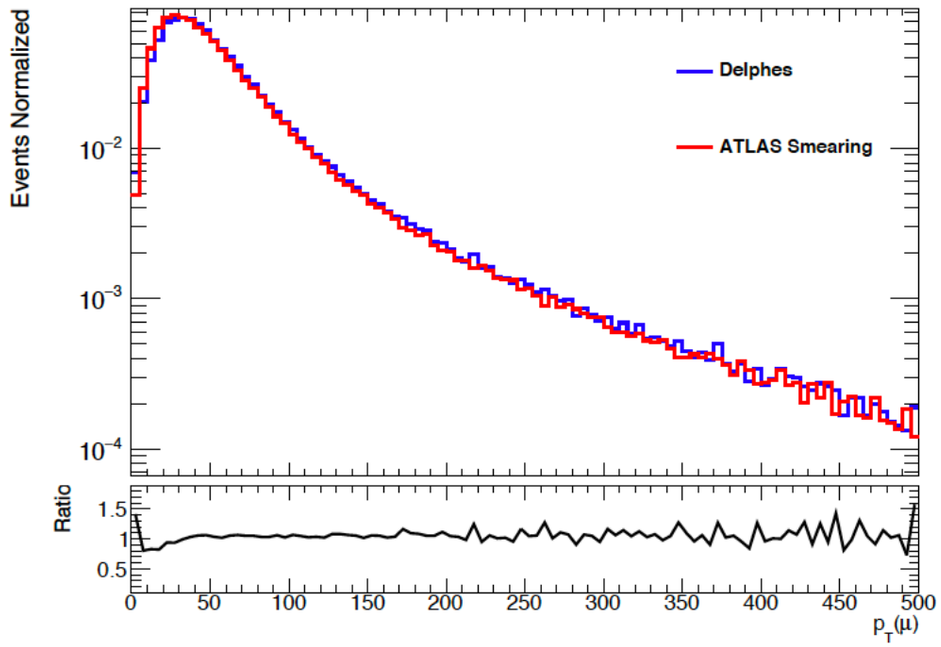
- Can we still do precision EWK physics?
- How about pileup effects?

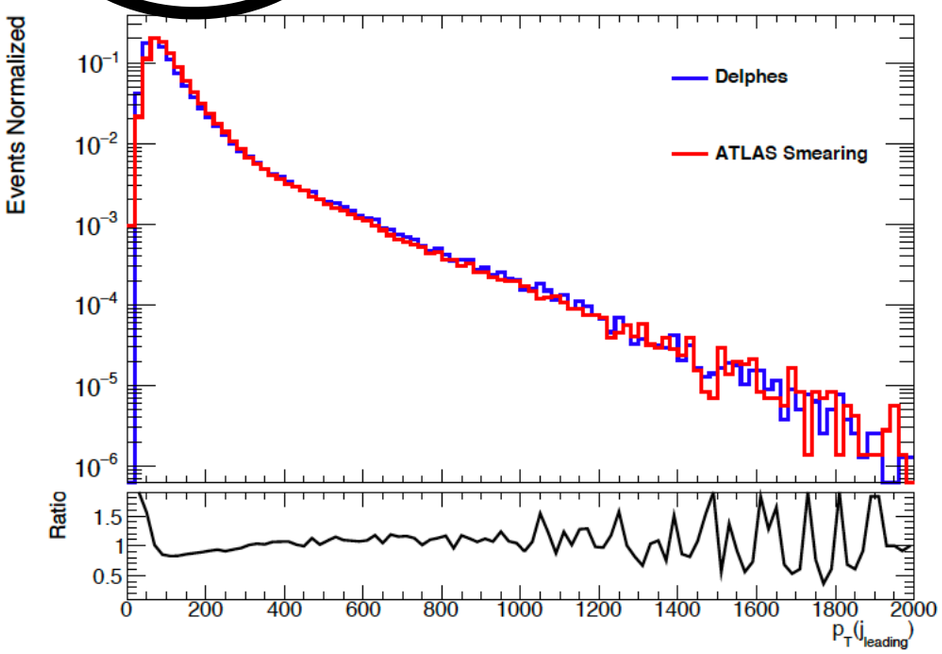
Workflow for HL-LHC

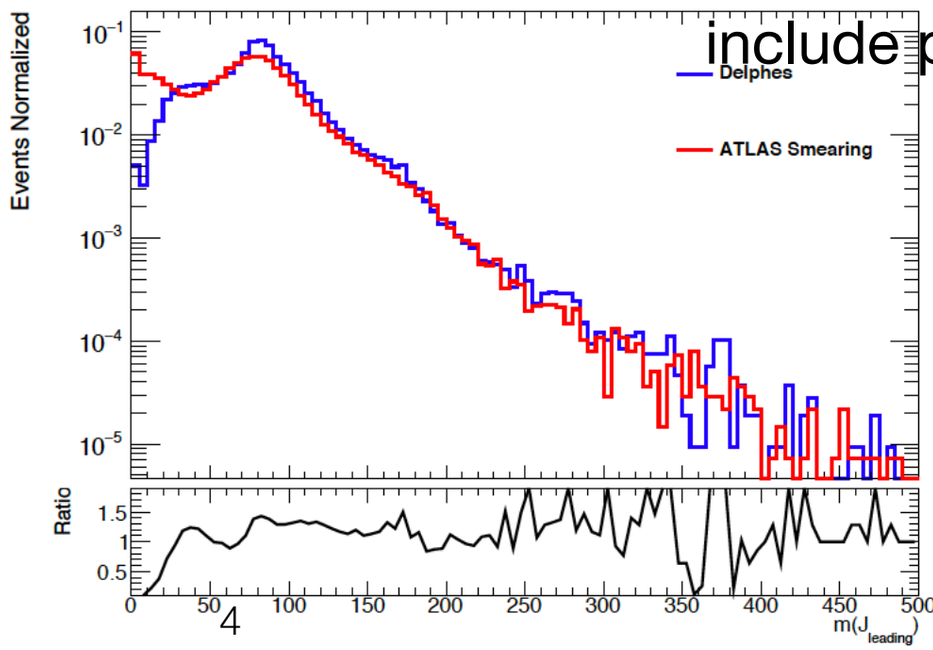
- Use ATLAS Smearing functions
- Working on a pub note with Early Sep Timescale

Robert Les









Caveat, Delphes does not include pileup and uses PFlow

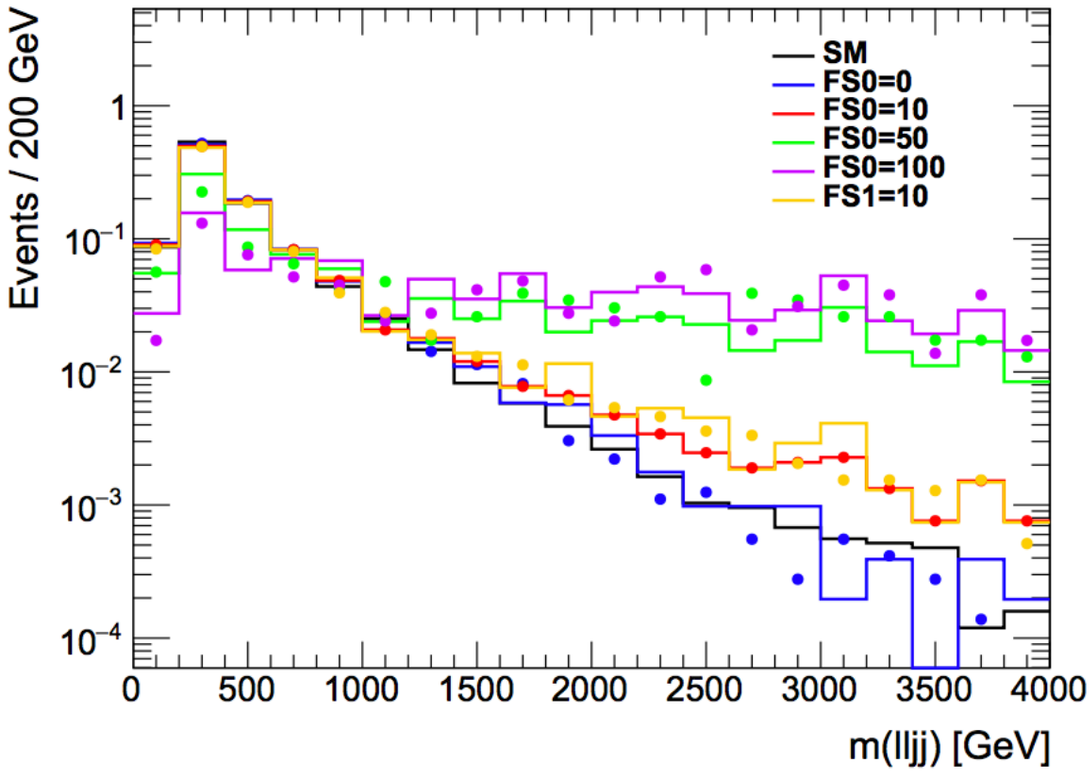
Plans for aQGCs

Robert Les

$$\mathscr{L} = \mathscr{L}_{sm} + \sum_n \frac{f_n}{\Lambda^4} \mathscr{O}_n$$

- We want to generate VBS MC with aQGC EFT incorporated
- In Eboli model there are 21 dim-4 operators which satisfy SU(2)L × U(1)Y symmetry
  - 3 “Scalar” operators labeled FSn -
  - 10 “Tensor” operators labeled FTn (n=appropriate integer)
  - 8 “Mixed” operators labeled FMn
- Madgraph UFOs by authors available with all the operators ready —> generation takes long time
- Madgraph has a feature that can reweigh matrix element after generation to that of a different model or parameter choice
- Tested to work well with aQGC samples as long as you stay within type (FS/FM/FT) and enough stats in phase space reweighing to (stats in tails)

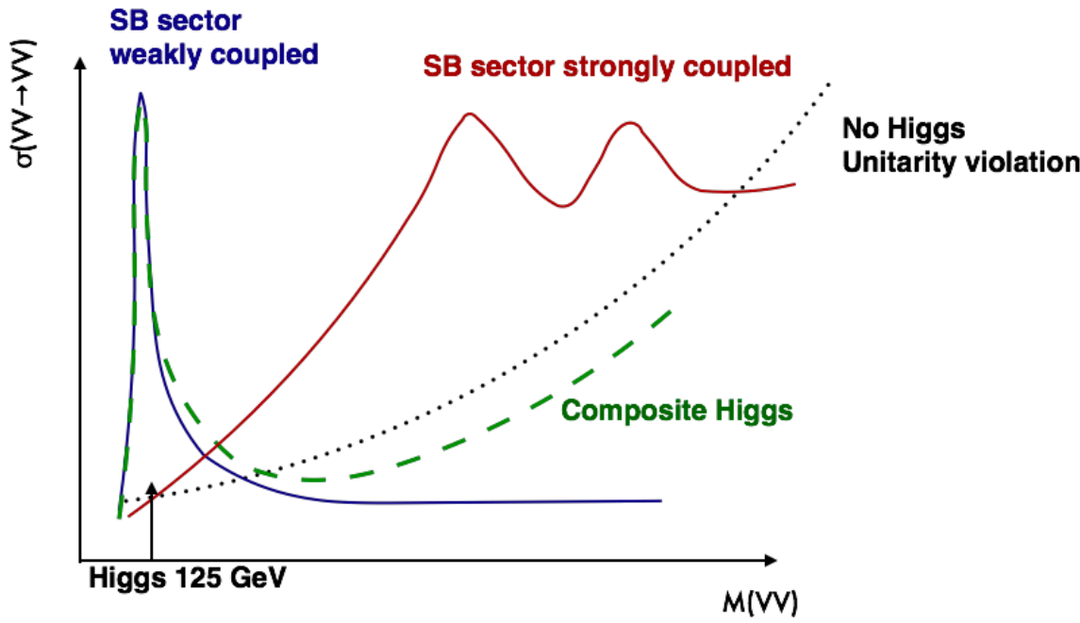
Invariant mass of VV pair under aQGC



points=simulated distributions
lines=reweighted distributions

Longitudinal Polarization

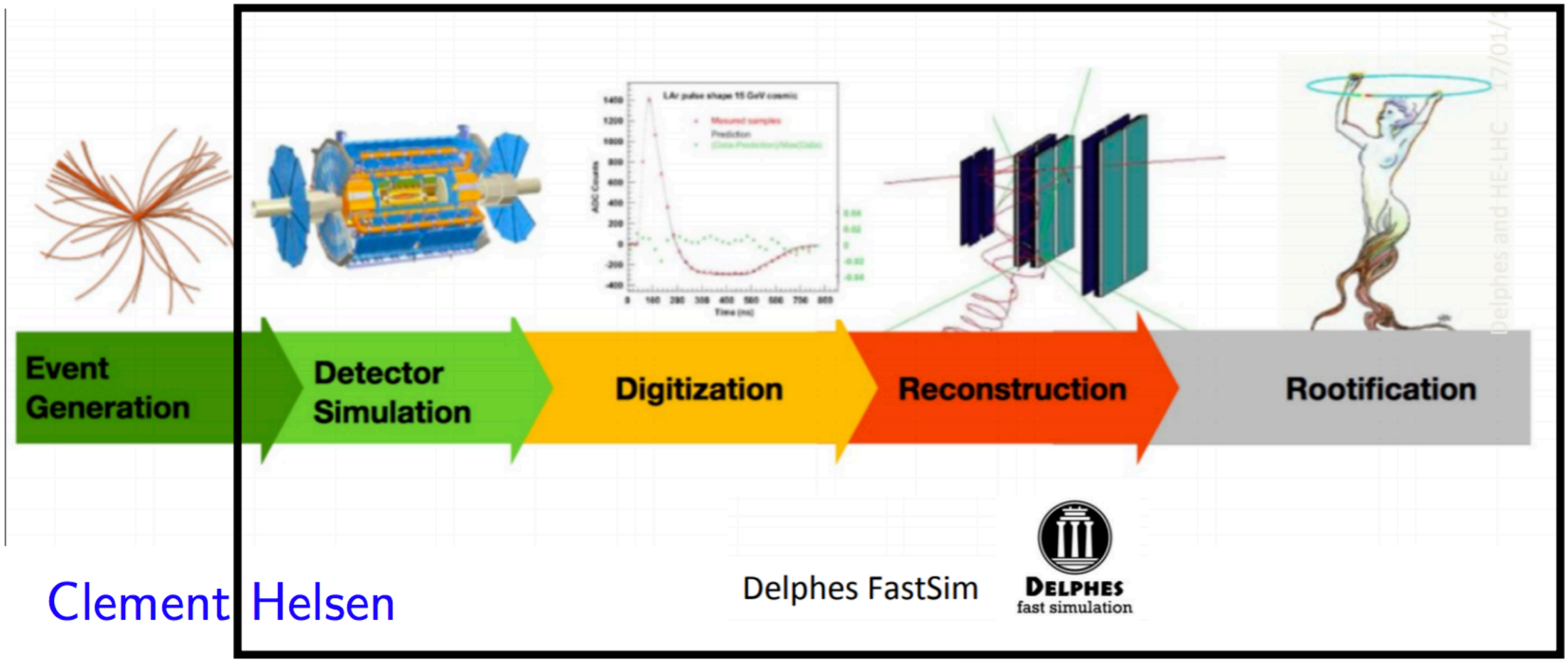
- Can we isolate the longitudinal component?
  - $V_L V_L$ scattering linked to the mechanism responsible for the EWSB
- Started generating samples:



- The baseline is to use MadGraph without specifying W/Z decay. Then a modified version of the DECAY package is used to keep track of the polarization information. (Instructions from Marc Andre Pleier)
- Alternative: use Whizard

HE-LHC

For HE-LHC 27TeV analysis will use Delphes framework

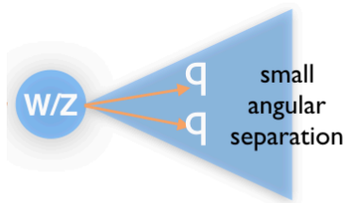


- Started generating some samples at 27 TeV with Pythia 8 showering
  - Using Madgraph v2.6.1
  - Shower with Pythia8
- Run Delphes with the card provided by Delphes authors for HE-LHC
- Expanded one of the example c++ code to analyze events

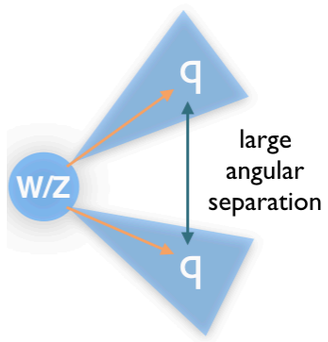
	13 TeV	27 TeV	ratio
WWlvqq	1.7	9.5	5.59
WZlvqq	0.25	1.2	4.8
ttbar	695	3123	4.49
W+jets	17881	45466	2.54

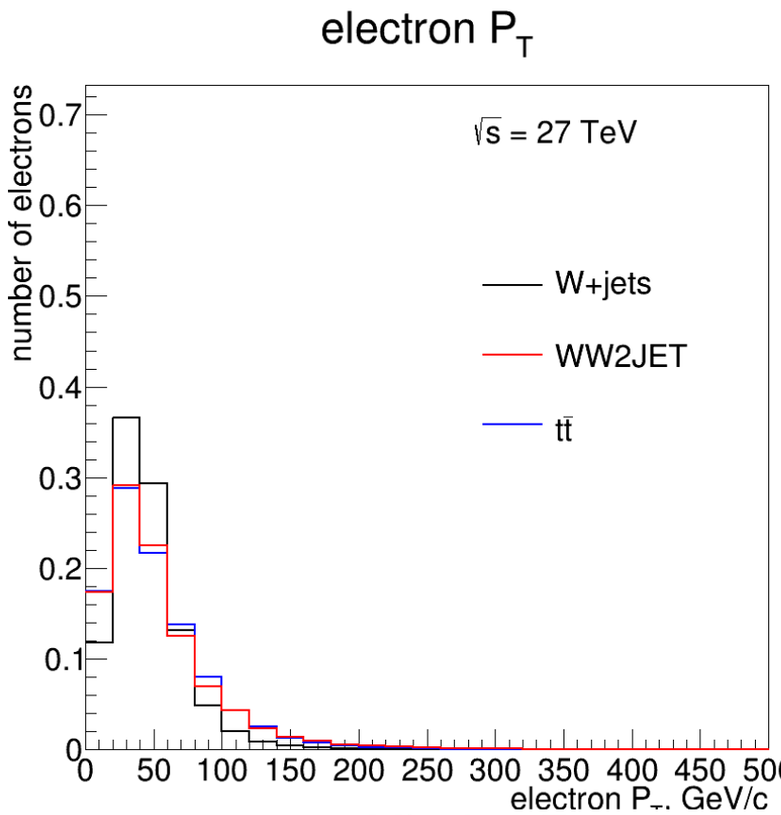
Selection

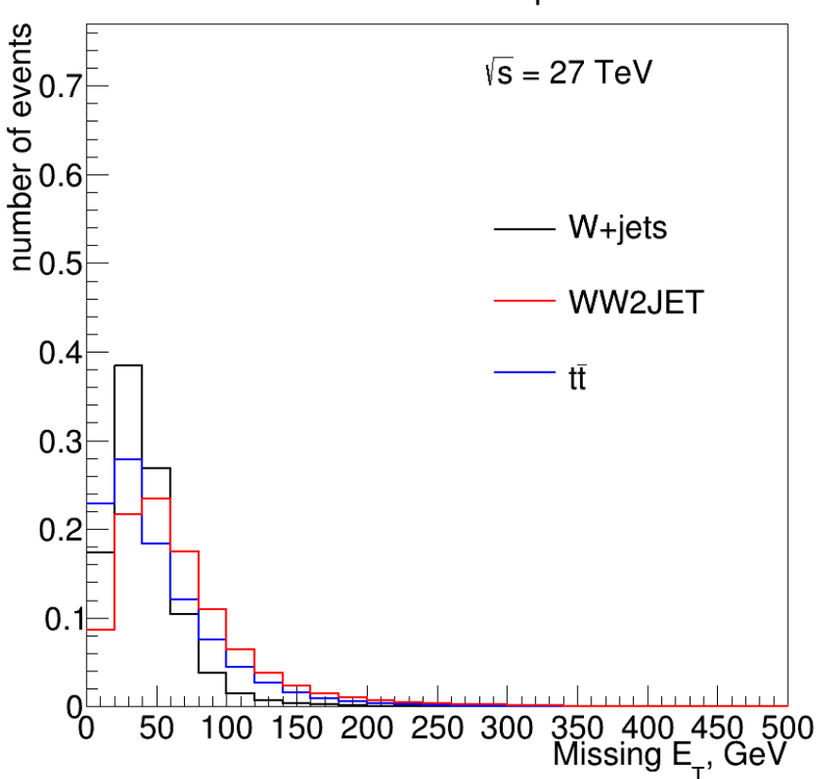
- Exactly one lepton with pt >30 GeV
- Met > 40 GeV (mostly to reduce the multijet contribution)
- TagJets: 2 jets with highest Mjj and Eta1*Eta2 >0
  - Tagjet1 >40 GeV
  - Tagjet1 >30 GeV
- 2 categories:
  - Boosted: Antikt 1.0 jet with 200 GeV
    - Mass compatible with W/Z and 2 prong structure



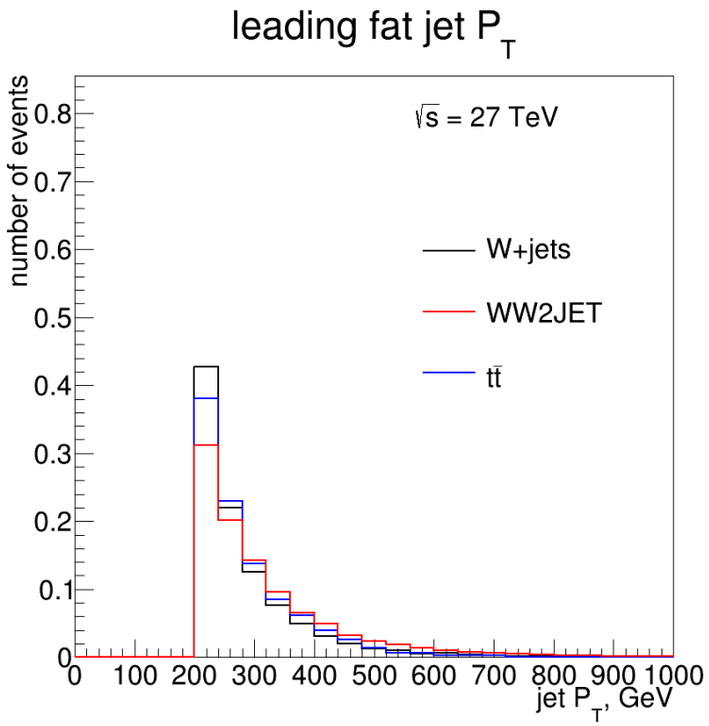
  - Resolved : 2 small R jets
    - Antikt 0.4
    - 2 jets with mass compatible with W/Z

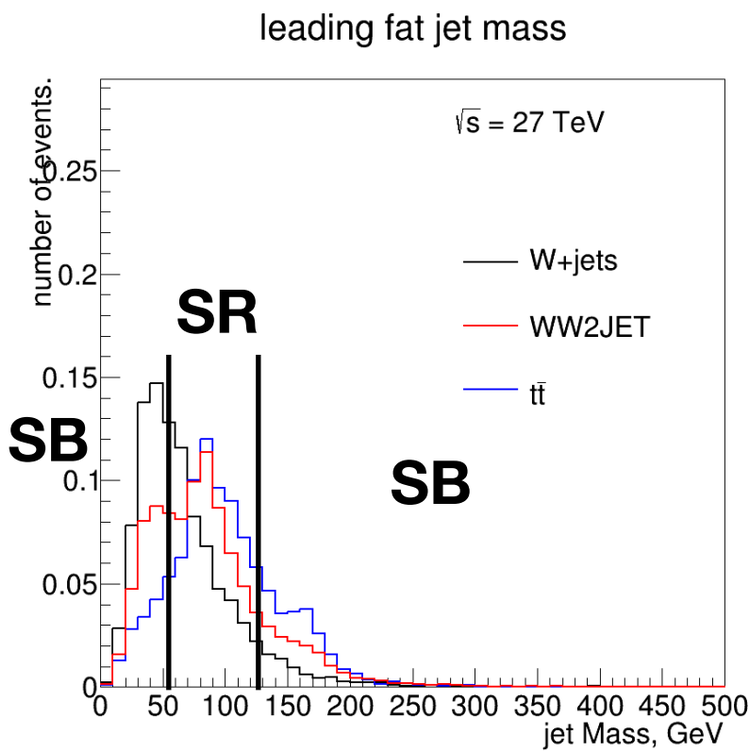






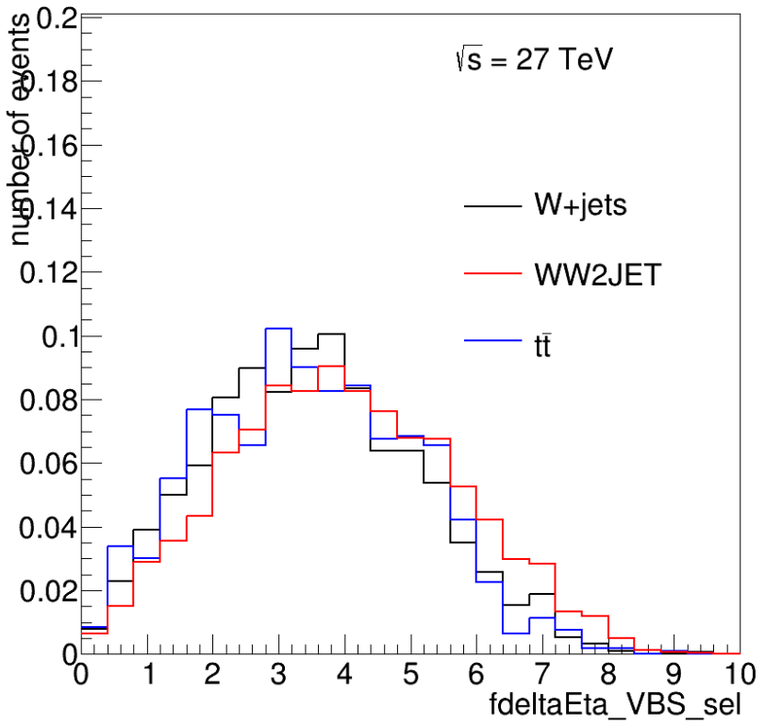
Kinematic plots

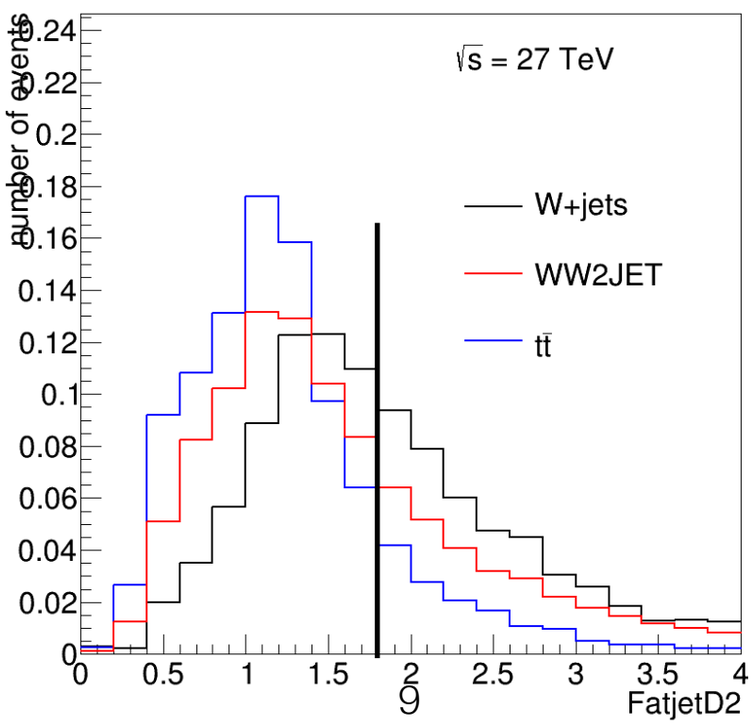


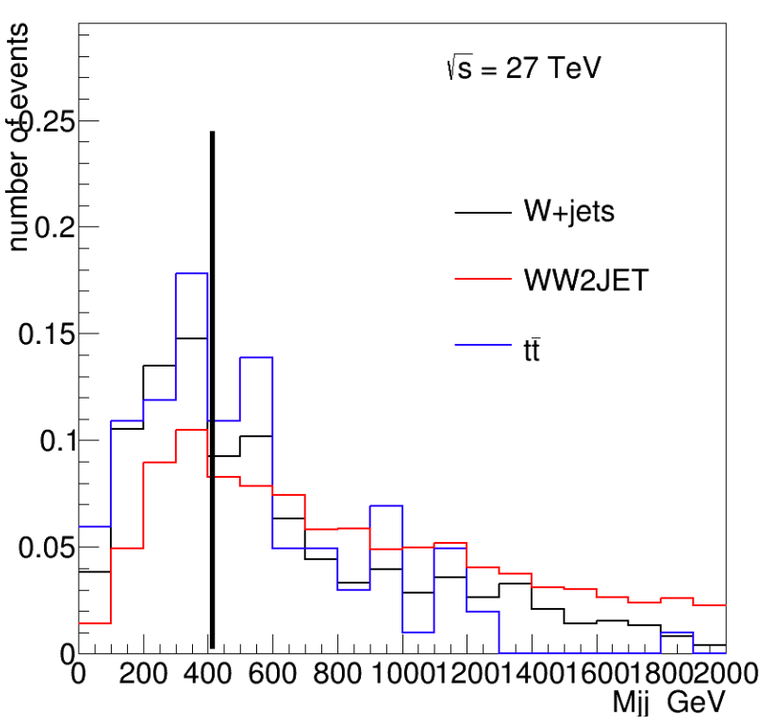


Using non-trimmed jets

- Use the jet mass (or dijet mass) to defined a Signal Region and a Sideband Region
- Loose D2 cut is applied also

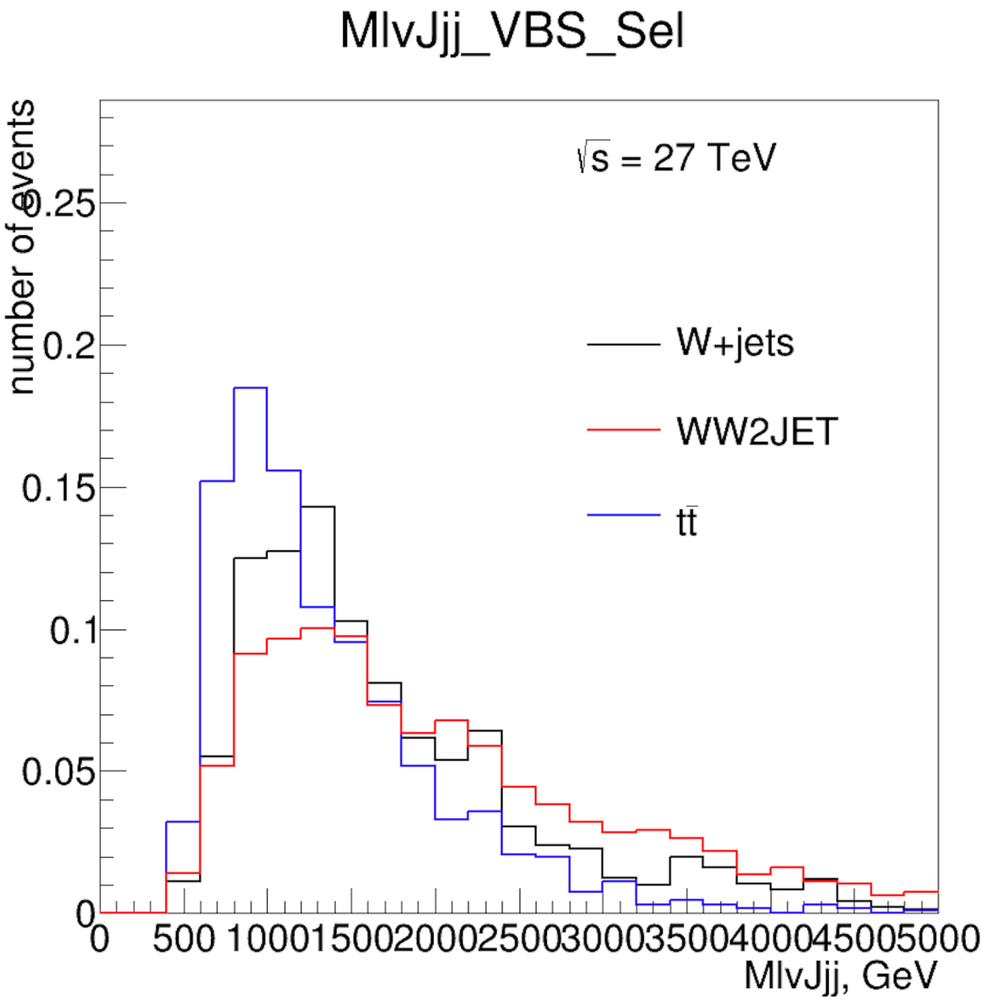






Sensitivity

- Estimating significance of WW+WZ EWK
- Fit to MlvJjj:
  - Signal (5% systematic)
  - ttbar (5 % normalization systematic)
  - W+jets (10 % normalization systematic)
- Shape systematic:
  - Applying difference between Sherpa and Madgraph at 13 TeV
  - Plan to include a mass and pt smearing of 20%

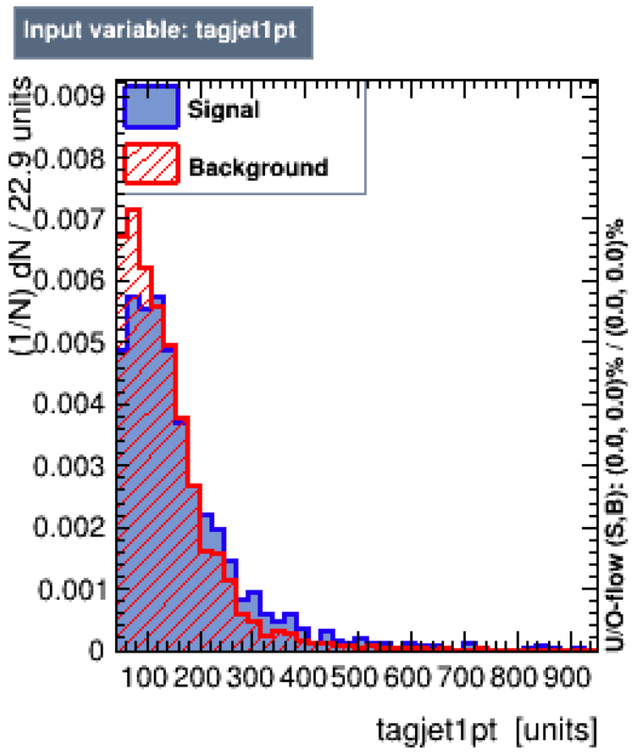


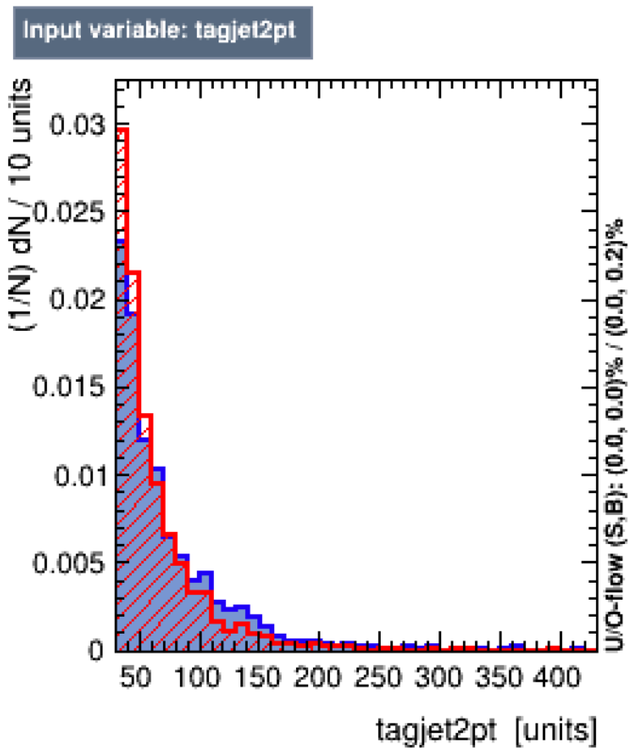
Luminosity needed to reach 5 sigma

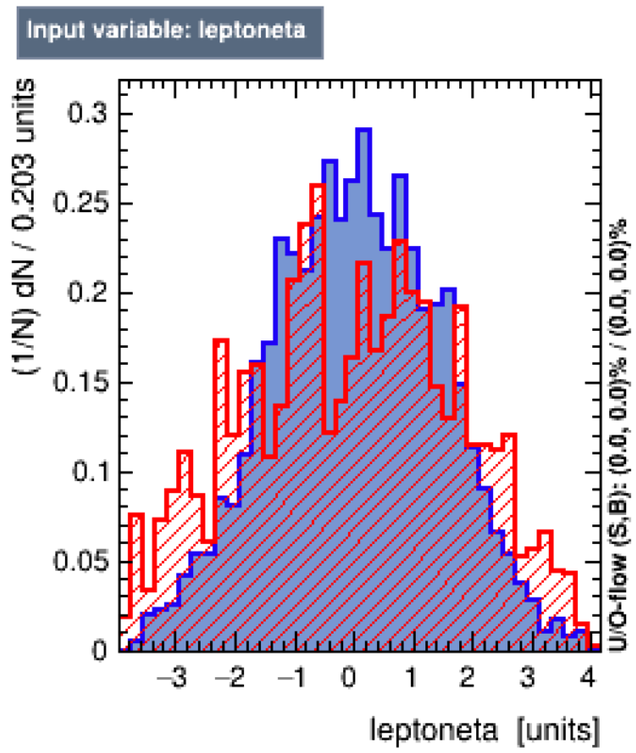
	no syst	w syst
Signal Region only	300 fb^{-1}	400 fb^{-1}
with Mass sideband regions	300 fb^{-1}	350 fb^{-1}

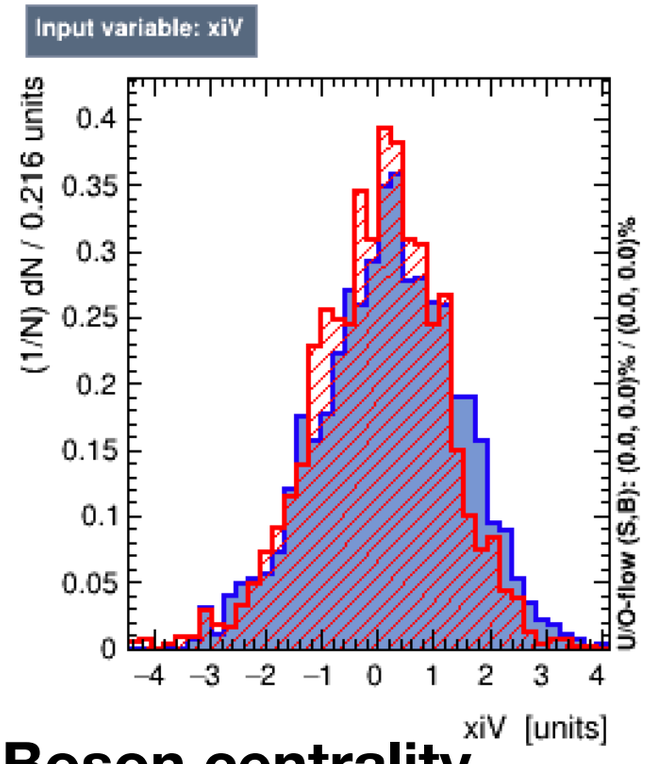
Can we do better ? Use BDT? Especially helpful if we want to separate the longitudinal component

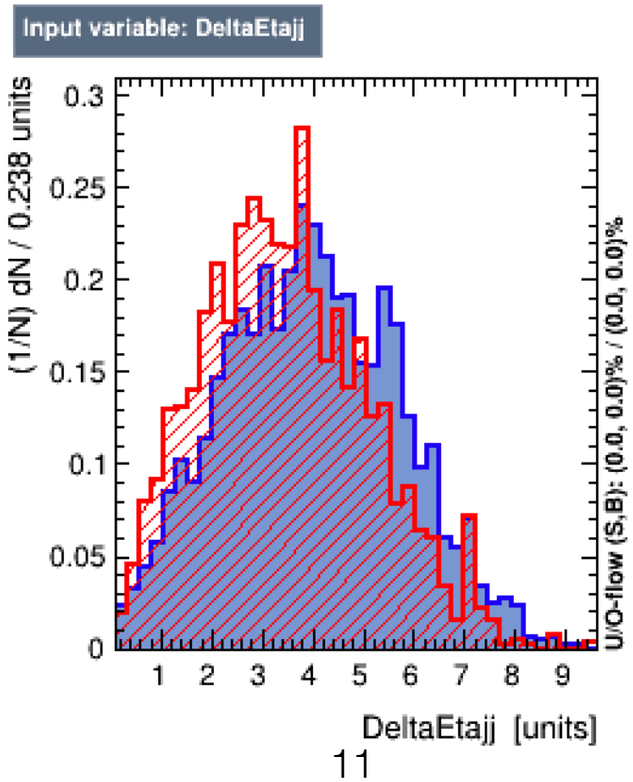
BDT

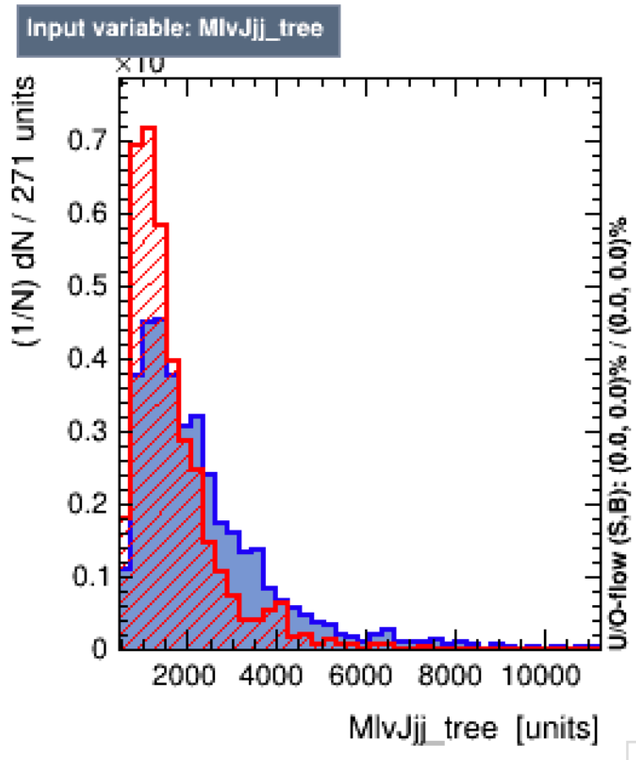








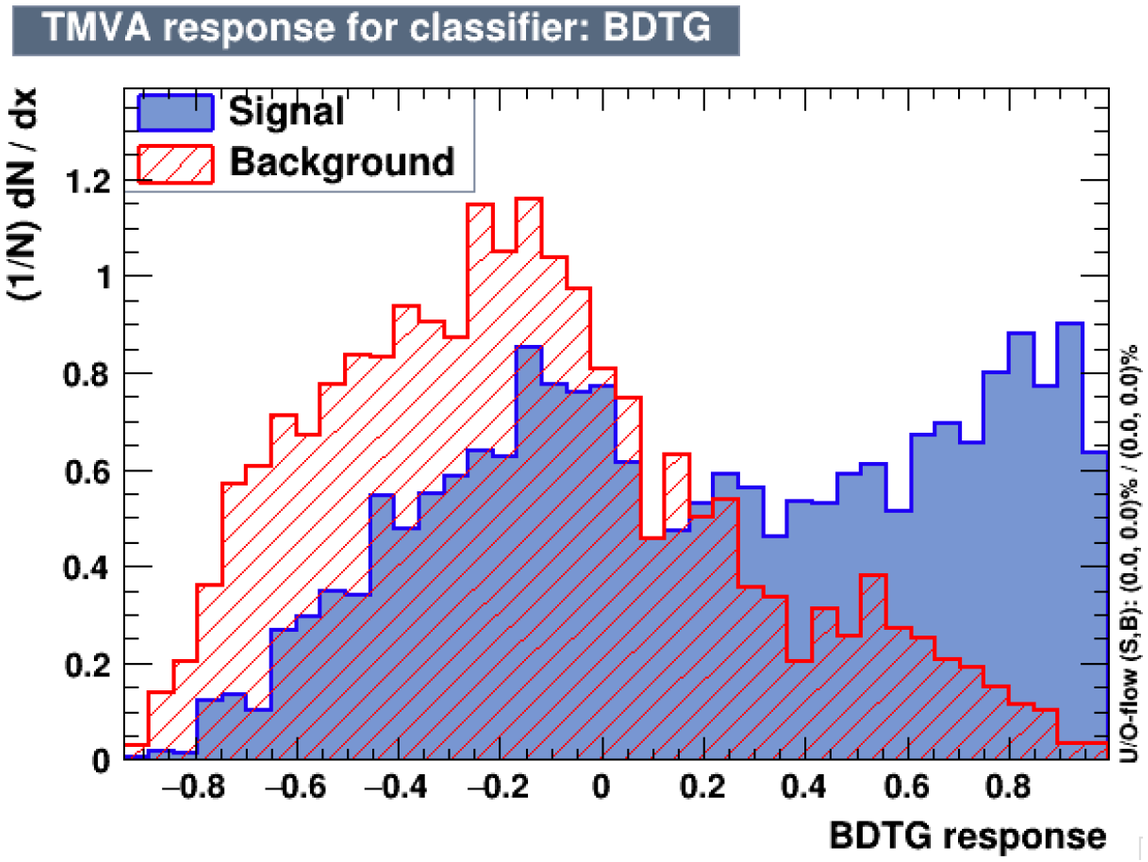


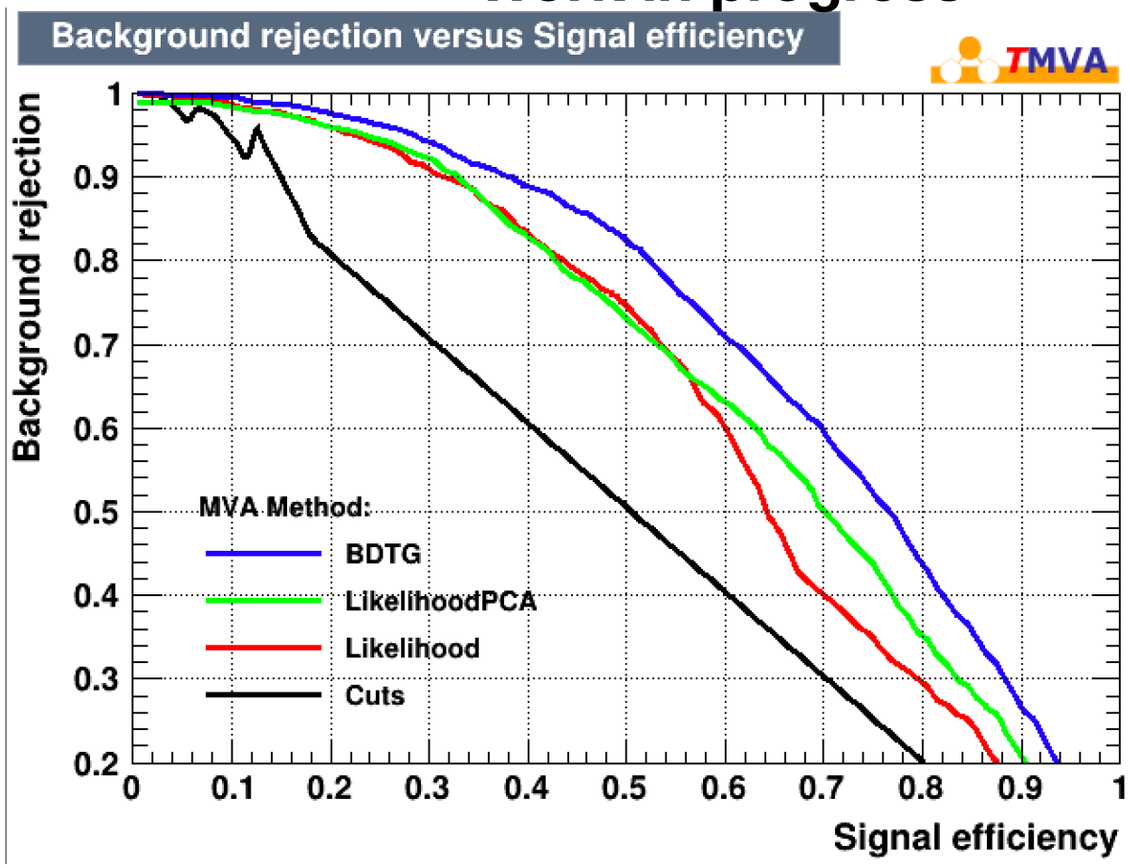


Boson centrality

BDT

Work in progress





- Very low stats left —> probably need some more MC

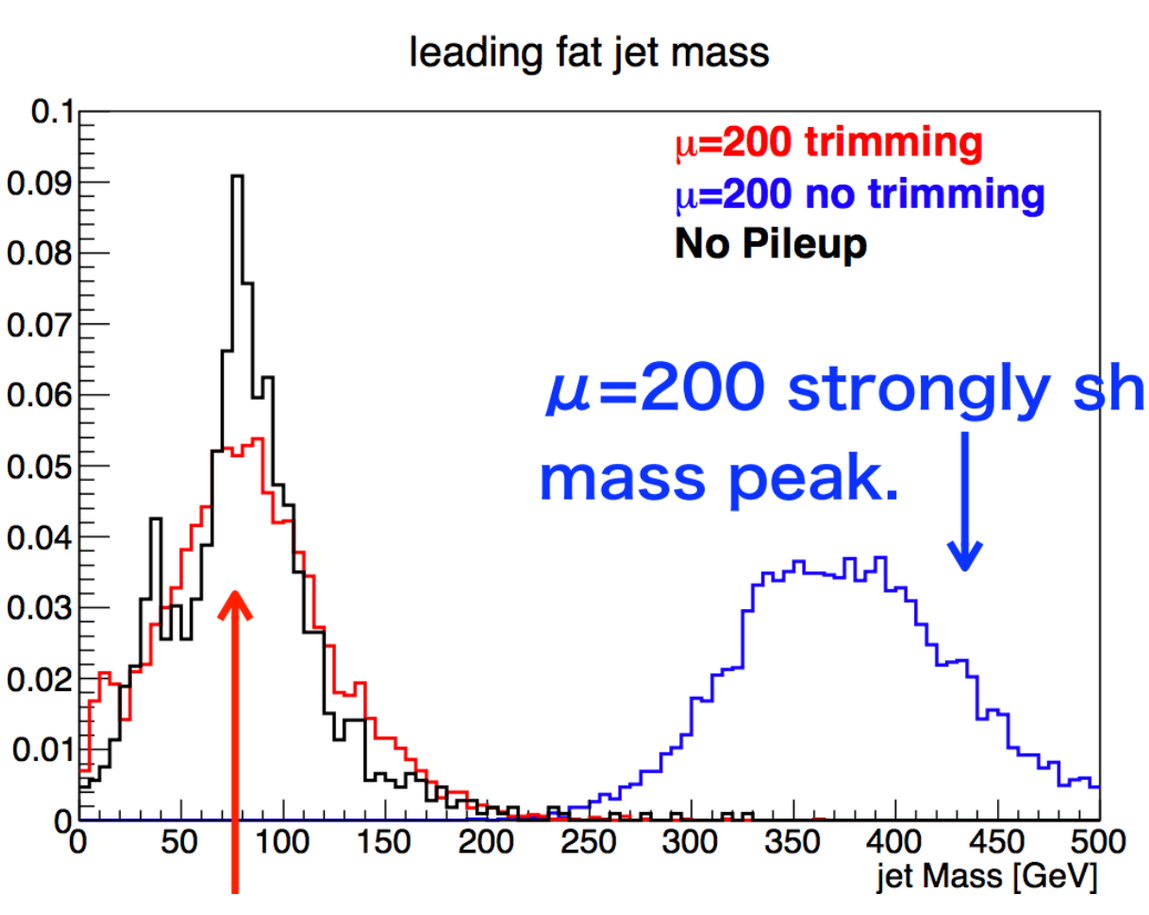
- Fitting directly the BDT response

Luminosity needed to reach 5 sigma

	no syst
Signal Region only	250 fb^{-1}

Pileup

- Not considering PU for now
- Tried adding PU to Delphes, following suggestions from Delphes authors
- Requires generating min bias events with Pythia
- Use (PileUpMerger) and change the input to the subsequent algorithms from Delphes/ stableParticles to PileUpMerger/stableParticles.



Trimming seems to do good

- **Our aim is to demonstrate that with the current offline tools we can go back to the variable with no PU**
- **Studying higher PU points**

Studies made by K. Terashi

Conclusion

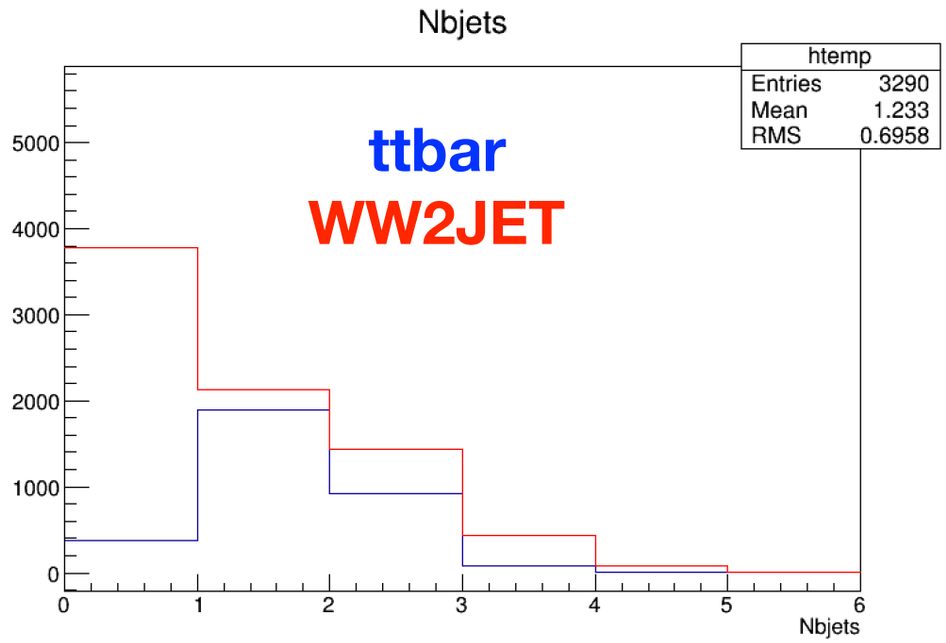
- Studies planned for LHC Yellow-Report:
  - VBS semileptonic VV (most likely only 1 lepton) and aQGC search
  - Investigating possibility of separating longitudinal component
  - Exotic VV → semileptonic resonance search
- HL-LHC at 300/3000fb–1 with ATLAS smearing functions
- HE-LHC at 27TeV with Delphes
- HL-LHC Studies:
  - Early Sep Pub note expected
- HE-LHC Studies:
  - Privately produced MC
  - Several studies investigating Delphes and pile-up effects
  - Write-up strategy still to be decided

Plots and tables

1. Some kinematic plots with and without PU?
2. Discriminant variable (mlvJjj or BDT) for the discovery significance
3. Table of lumi needed to reach 5 sigma with and without systematics
4. aQGCs exclusion parameters plots
5. possible BDT for isolating the longitudinal component

Backup

Selection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Entries 3290
Mean 1.233
RMS 0.6958
ttbar
WW2JET
5000
4000
3000
2000
1000
0
0
1
2
3
4
5
6
Nbjets