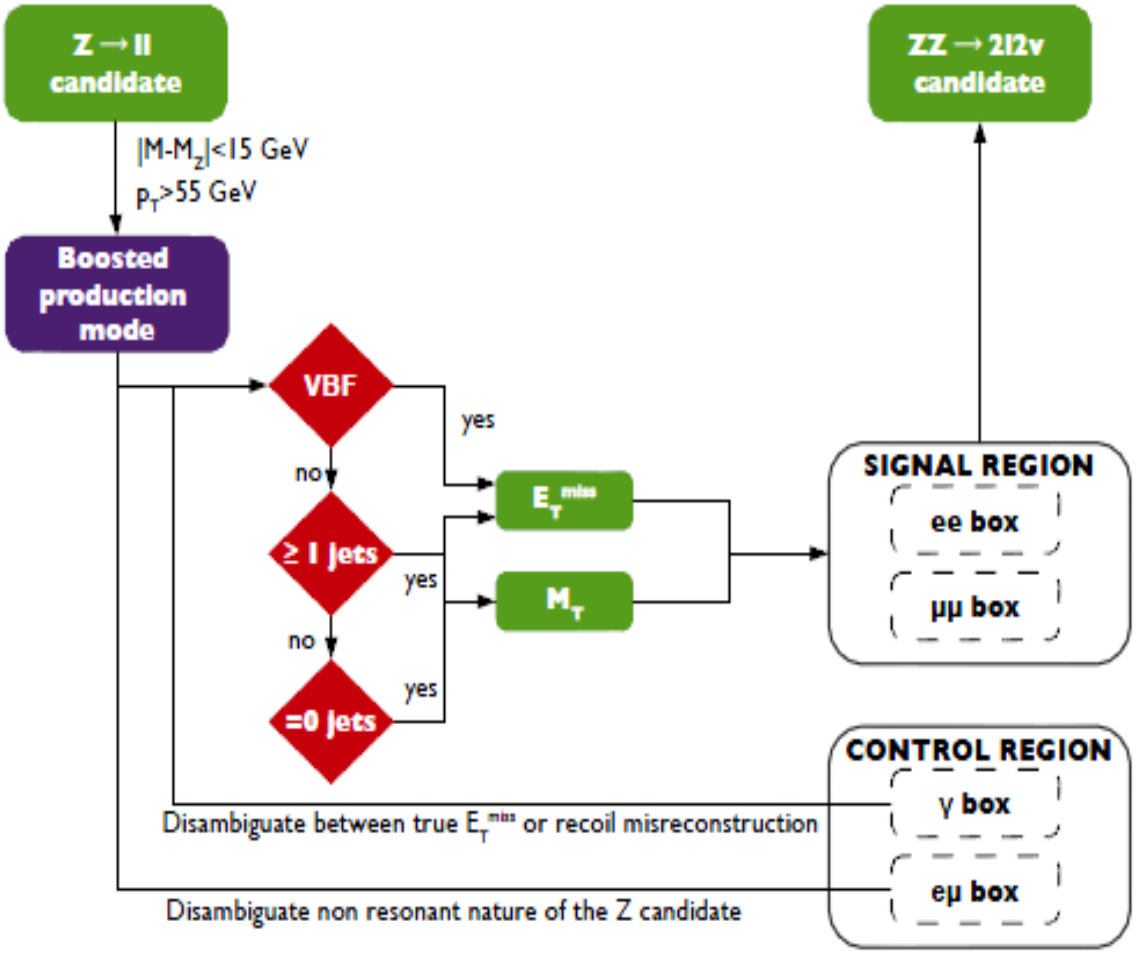
Challenges for Run2 In the ZZ→2l2ν

Loïc Quertenmont

23-24 January 2014

Blegian Scalar Sector Workshop, IIHE

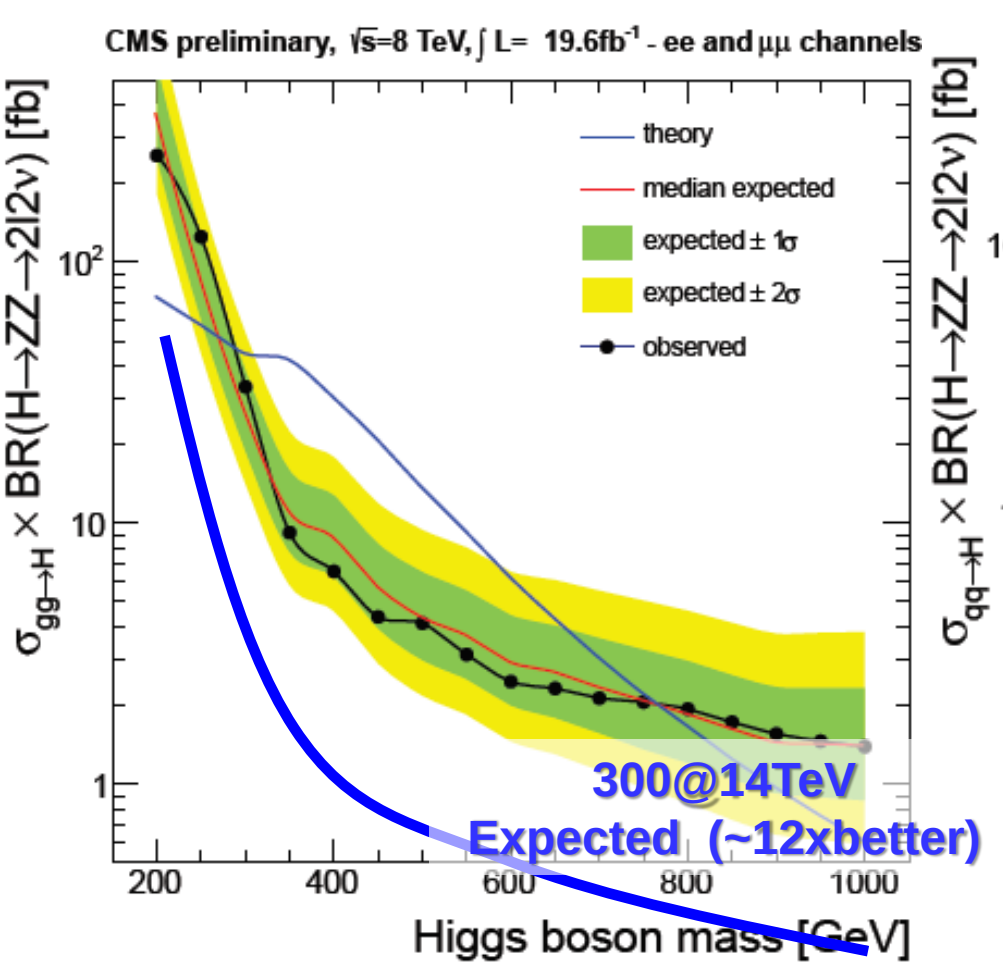
2l2v: Introduction

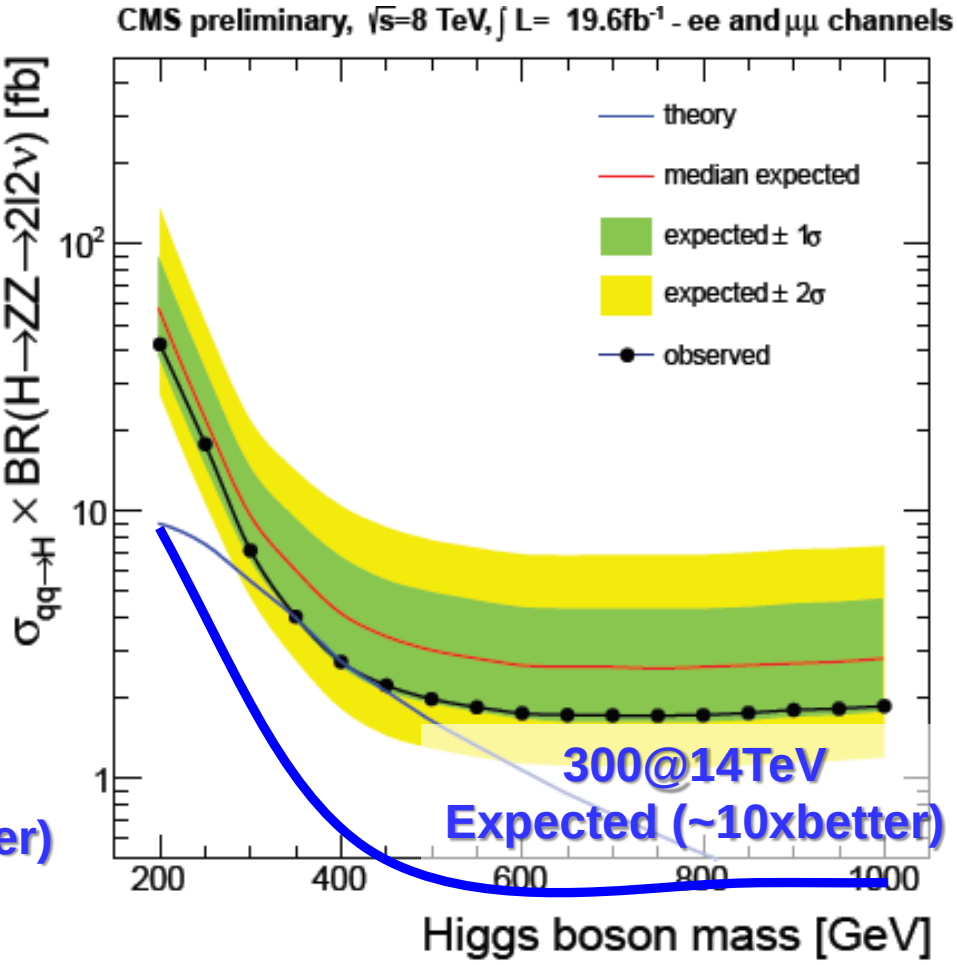


- **Overall workflow used for many 2l+MET final states**
  - **H→ZZ→2l2v**
    - **BSM**
  - **σ(pp→ZZ→2l2v)**
    - **aTGC**
  - **Z (H→invisible)**
  - **H(125) Width**
- **All these channels covered by the same people (Involving ULB and UCL) thanks to flexible and common ntuples/framework**

loic.quertenmont@cern.ch

Projections to Run2

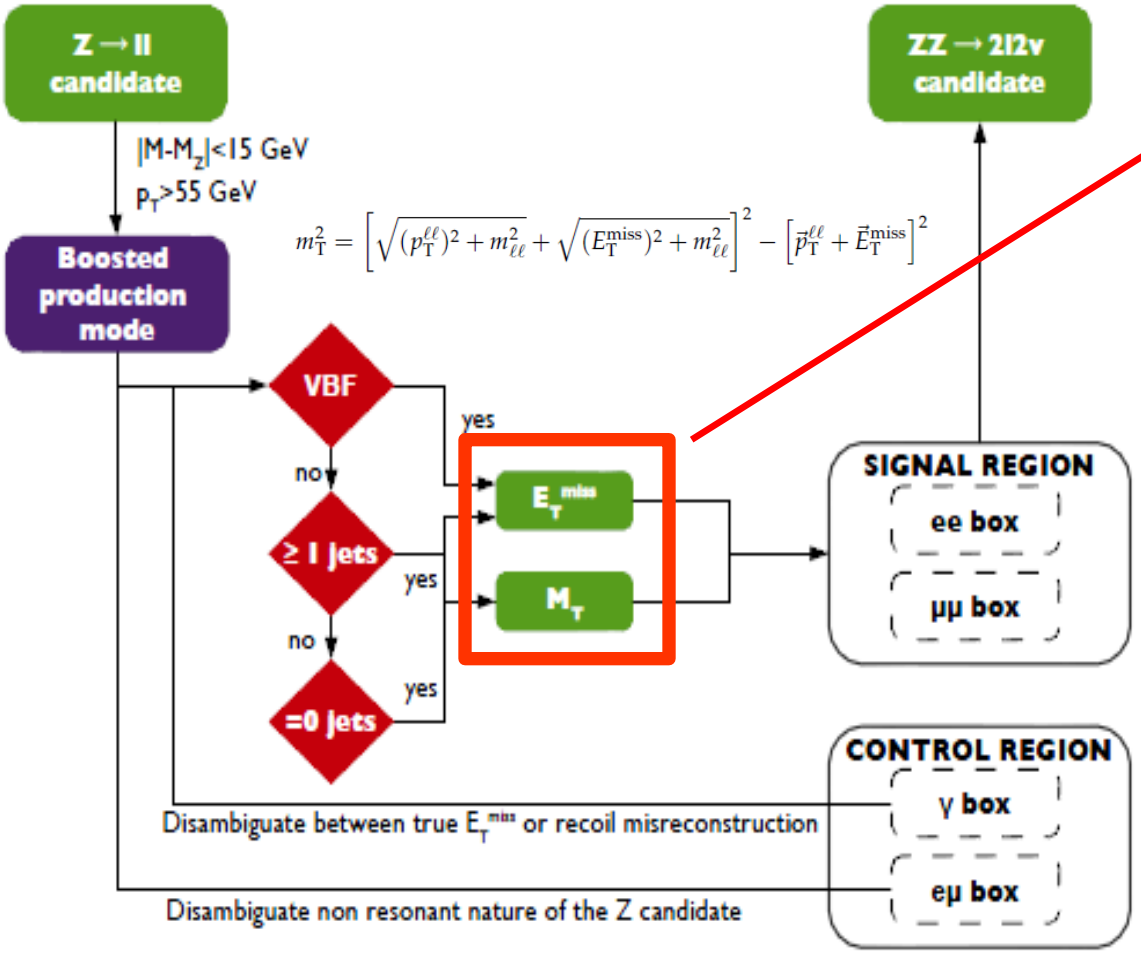




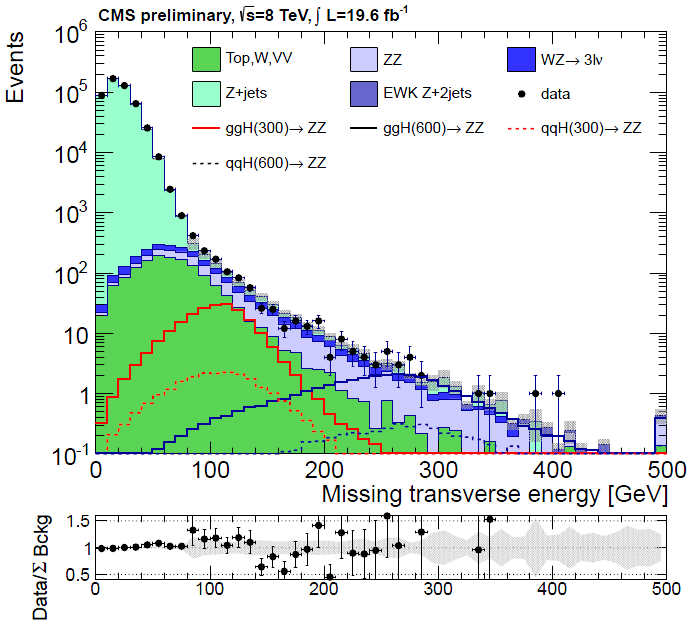
- **Very simple projections → Int.Luminosity scaling + Stirling scaling**
- **Assuming, backgrounds rate are not scaling up**
- **Assuming detector performances remain unchange → PU !!!!**

loic.quertenmont@cern.ch

MET in Run2



- **MET is critical**
- **~50 <PU>**
  - **OOTPU ?**
- **MET developments PU resilient**



loic.quertenmont@cern.ch

possible MET algorithms

- AN 2012/079: Study of the performance of pseudo-MET variables in a high-pileup regime

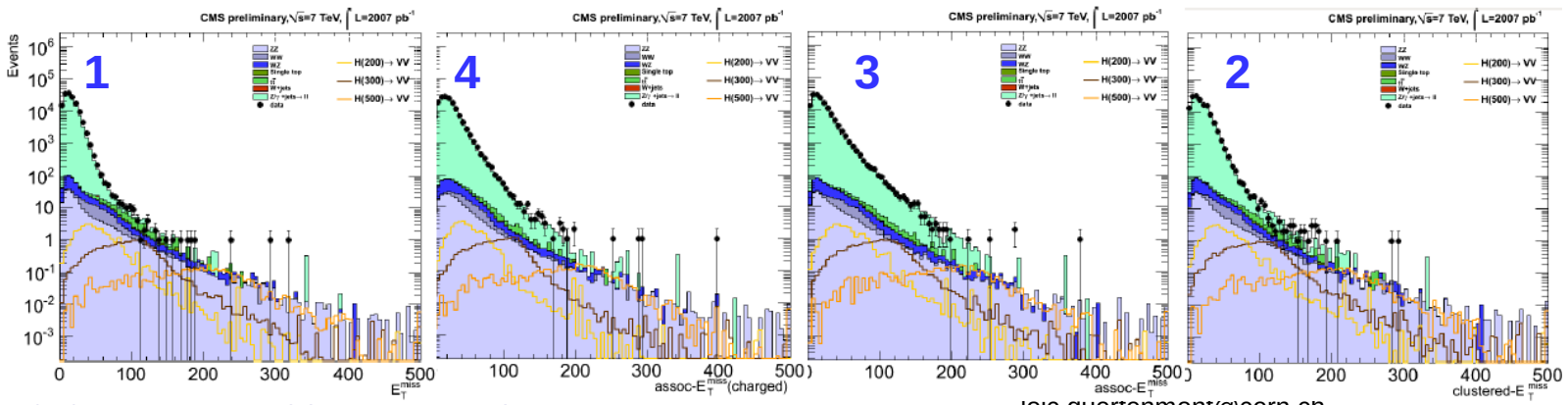
- Several flavours of MET can be built using « particle-flow » objects and vertex information
  - Charged particles are easilly **associated** to a vertex
  - Neutral particles can be **associated** assuming that they are coming from the same vertex than the surounding charged particles

- The more information is used the better the resolution…

- BUT if we get too much energy from the PU events, then the bias is large too

- For real MET events, all these algorithms are expected to give comparable MET estimates

	Particles	Charged associated			Neutral associated		
		pVtx	oVtx	unass.	pVtx	oVtx	unass.
1	E_T^{miss}	■	■	■	■	■	■
2	clustered$-E_T^{miss}$	■ (jet)			■ (jet)	■ (jet)	■ (jet)
	central $- E_T^{miss}$	■	■	■	■	■	■ $\lvert\eta\rvert < 2.4$
3	assoc$-E_T^{miss}$(charged)	■					
4	assoc$-E_T^{miss}$	■			■		
	assoc $-$ Fwd$-E_T^{miss}$	■			■		■ $\lvert\eta\rvert > 2.4$
	assoc$-E_T^{miss}$(othervtx)		■			■	
	clean$-E_T^{miss}$	■		■	■		■



loic.quertenmont@cern.cn

Combining MET variables…

- At the exception of PF Met, all these MET variable are missing an important part of the information (the neutrals, the forward particles, the unclustered particles, etc.)
- For that reason, these variables ALONE can not performs better than the PF MET.
- On the other hand, those variables are more robust to PU than the PF MET.
- We can **reduce the instrumental (DY) background by combining** these new MET variable with the standard PF MET.

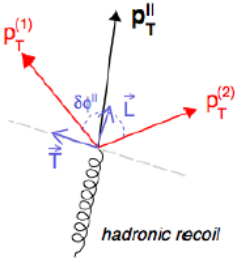
Minimizing METs

- For events with real (central) MET,
- The MET should be well reconstructed independently on the estimator used.
- Not true for fake/instrumental/PU MET

Reducing METs

- Hadronic recoil misreconstruction?

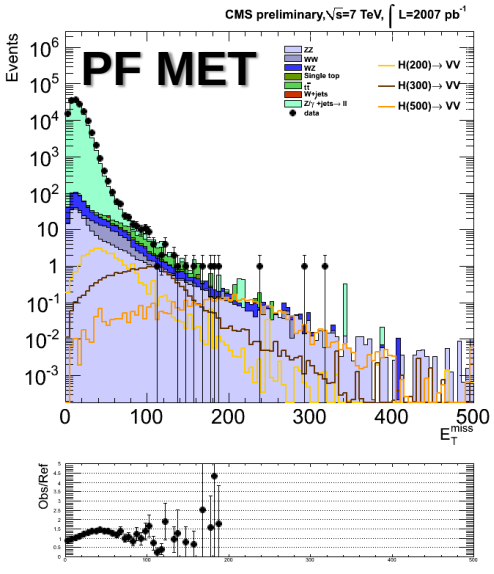
arXiv.0808.0269

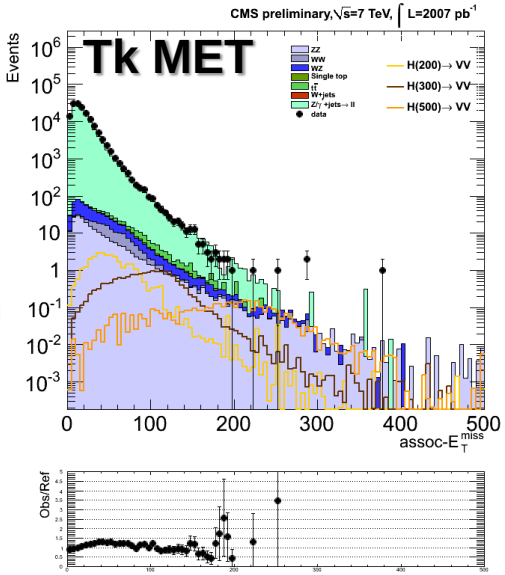


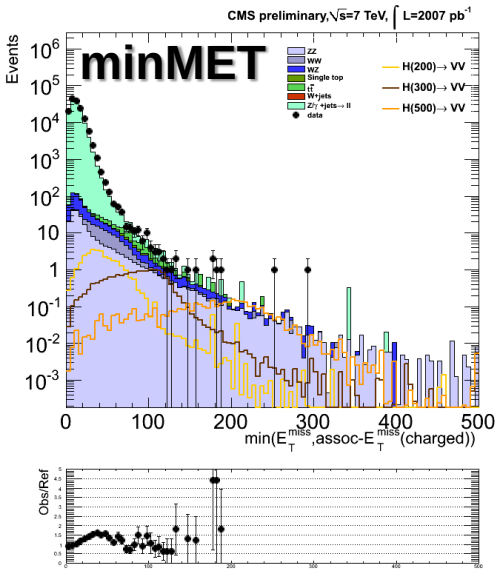
- Recoil is MET – Z P_T
- Reduced-MET: sum in quadrature of **minimum dilepton balance against Longitudinal/Transverse directions.**

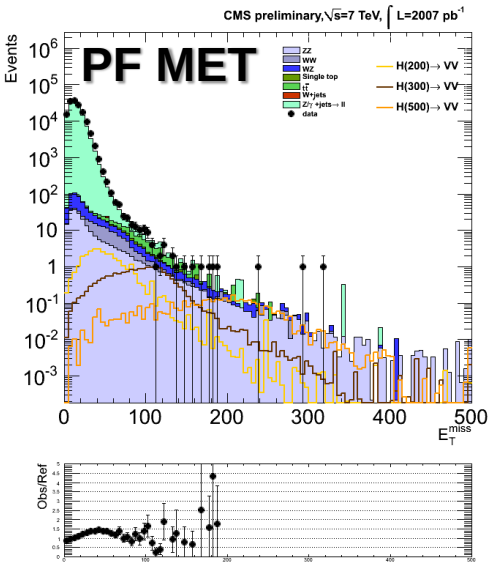
loic.quertenmont@cern.ch

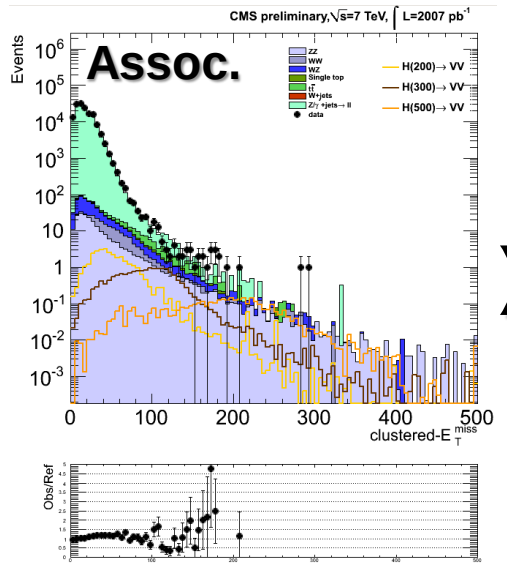
minMET and redMET

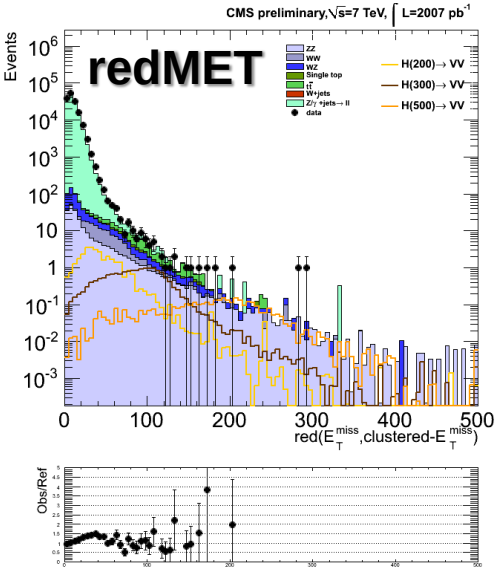
min(

, 

) = 

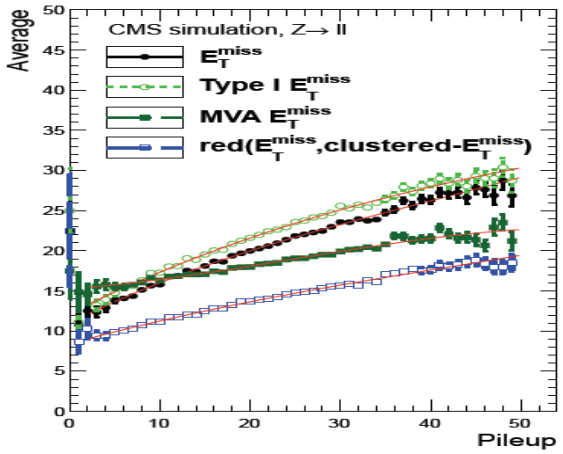
red(

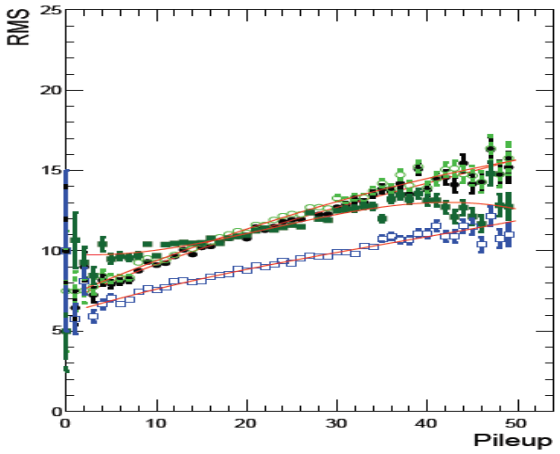
, 

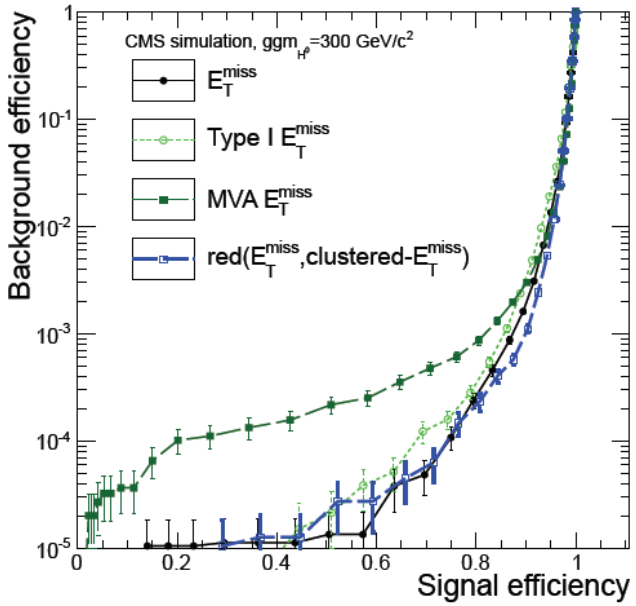
) = 

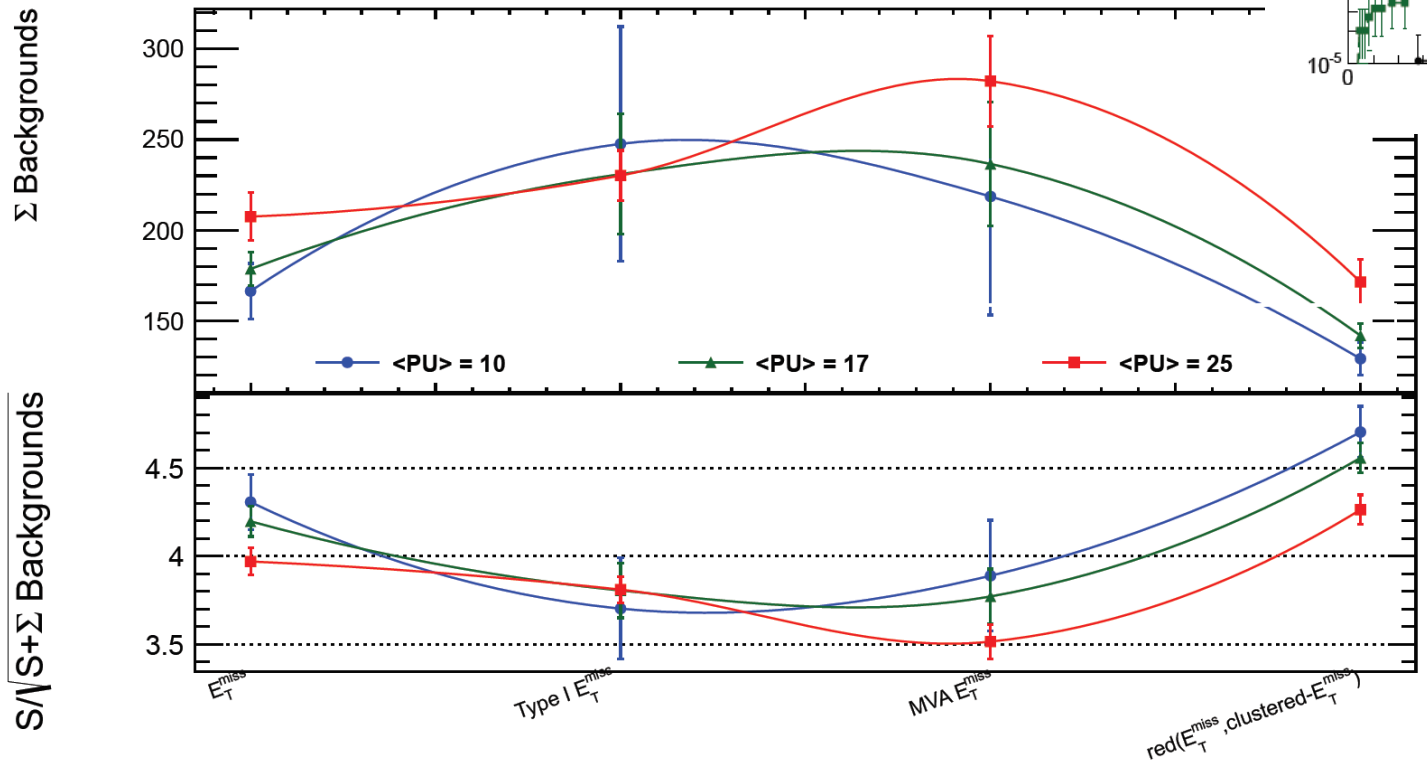
loic.quertenmont@cern.ch

Performances







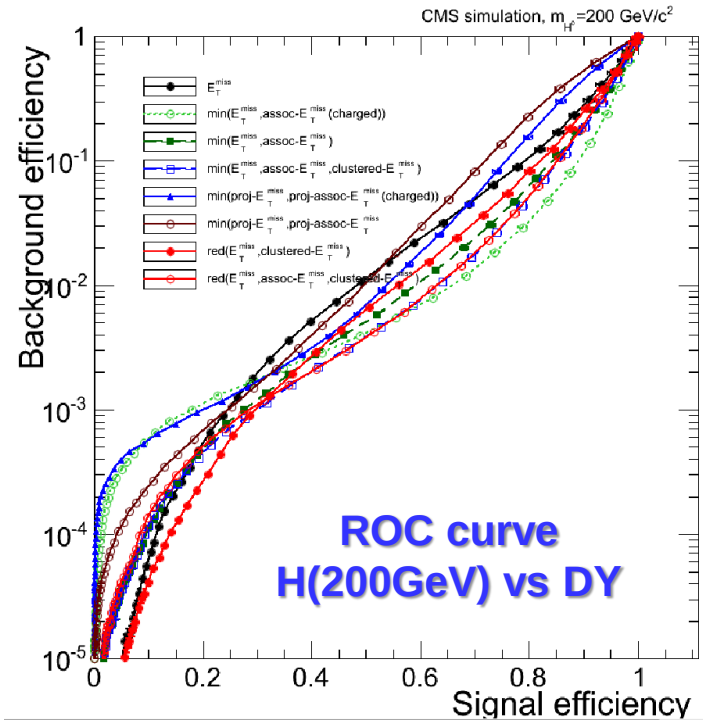


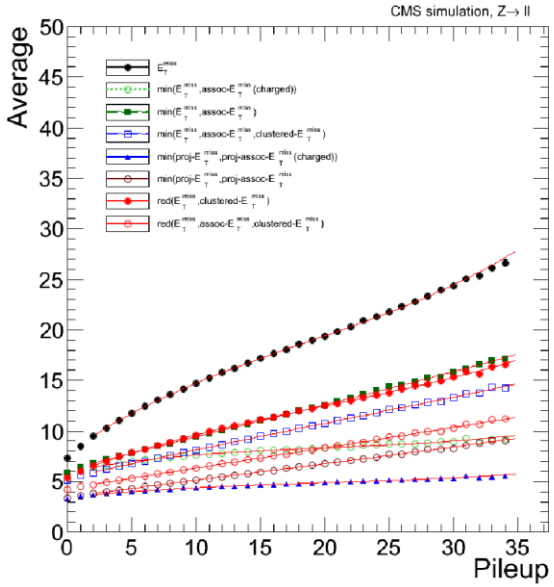
Effect of PU on Sensitivity for dilepton events

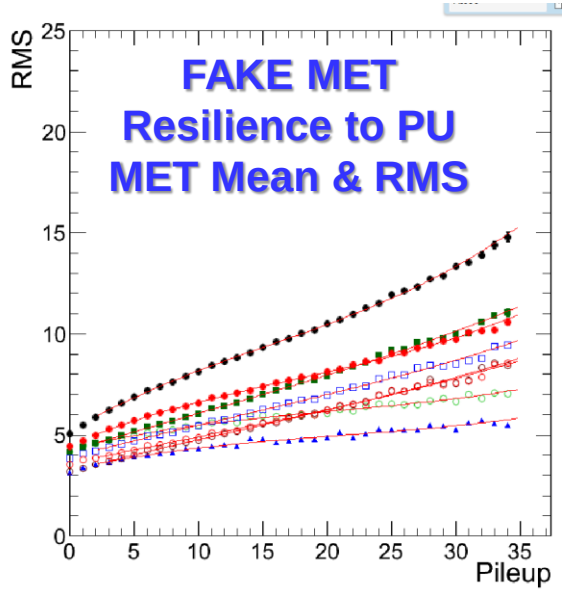
Performances (full study)

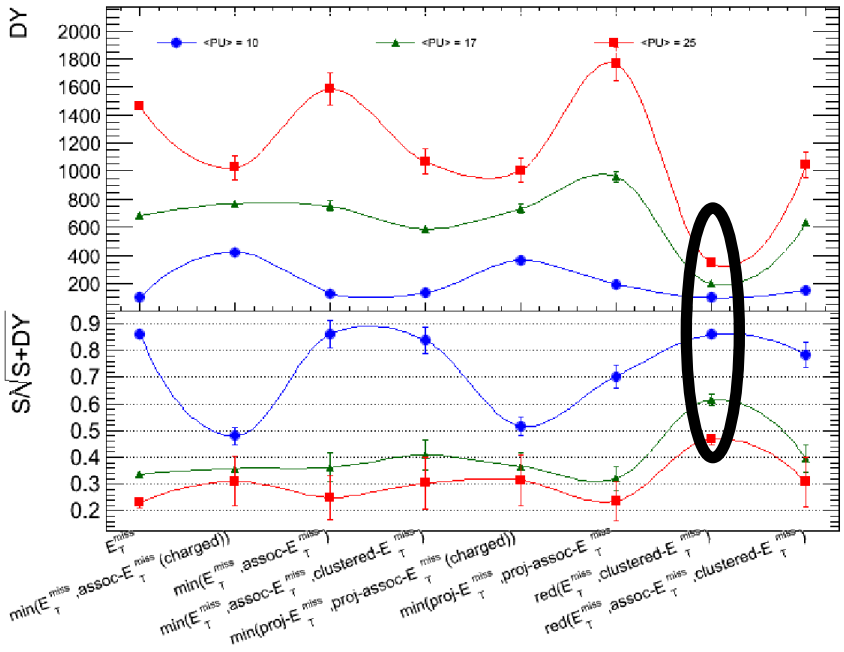
CMS AN2012-079

Study of the performance of pseudo-MET variables in a high-pileup regime



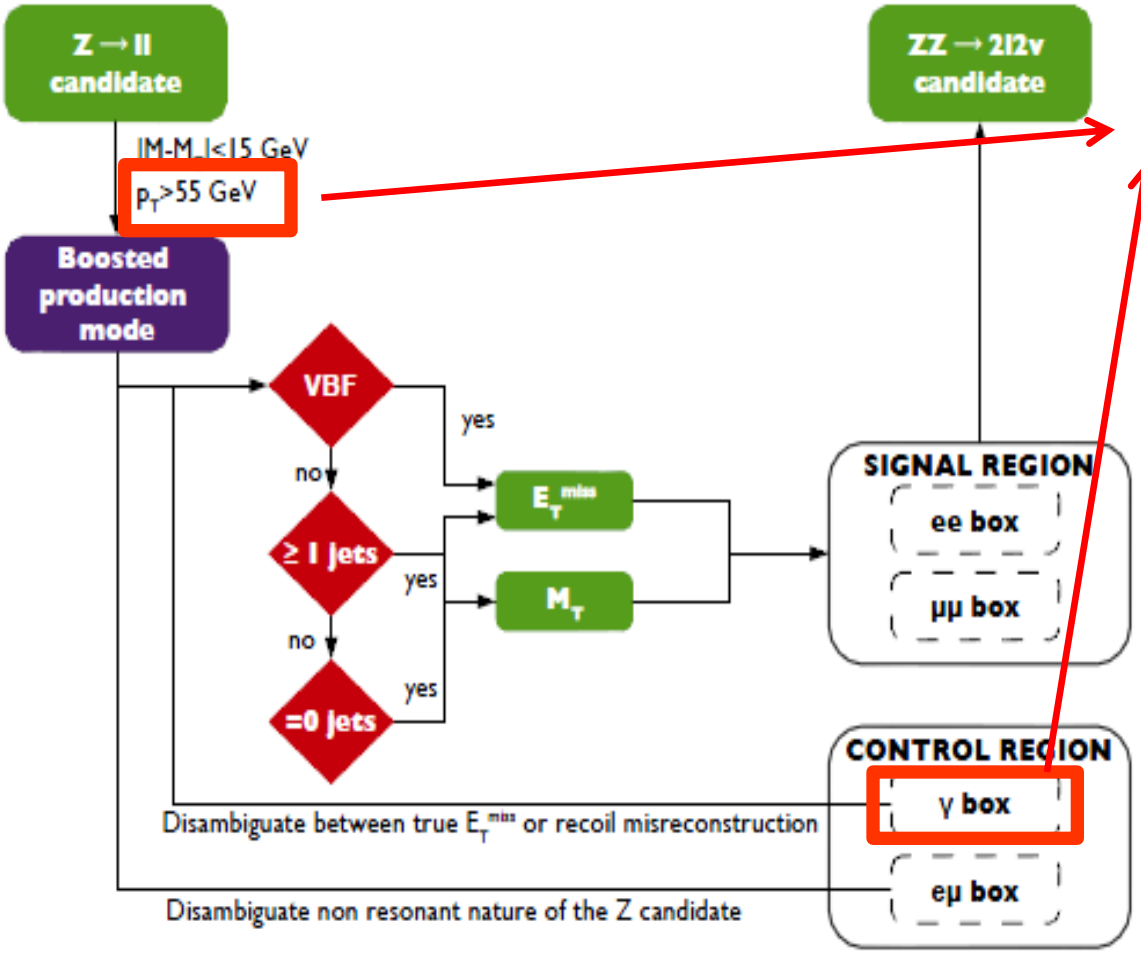




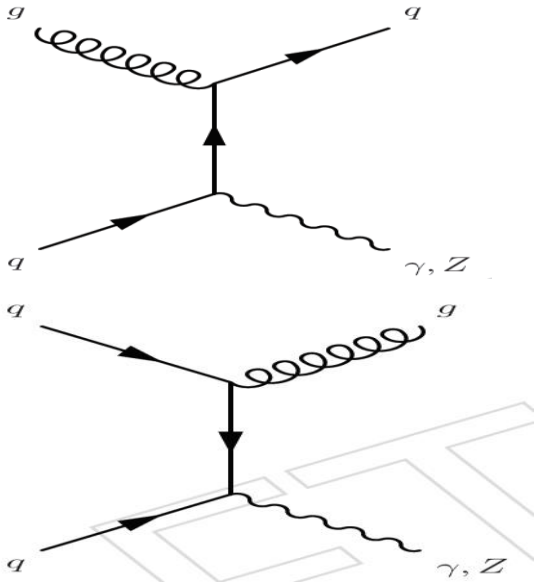


Effect of PU on Sensitivity for dilepton events

Gamma+Jets in Run2



- **Z+Jets (MET) background estimated using gamma+Jets**
- **Large phothon samples are needed (low P_T too)**
  - **Triggers!!!**
- **ZpT cut partially driven by photon sample**



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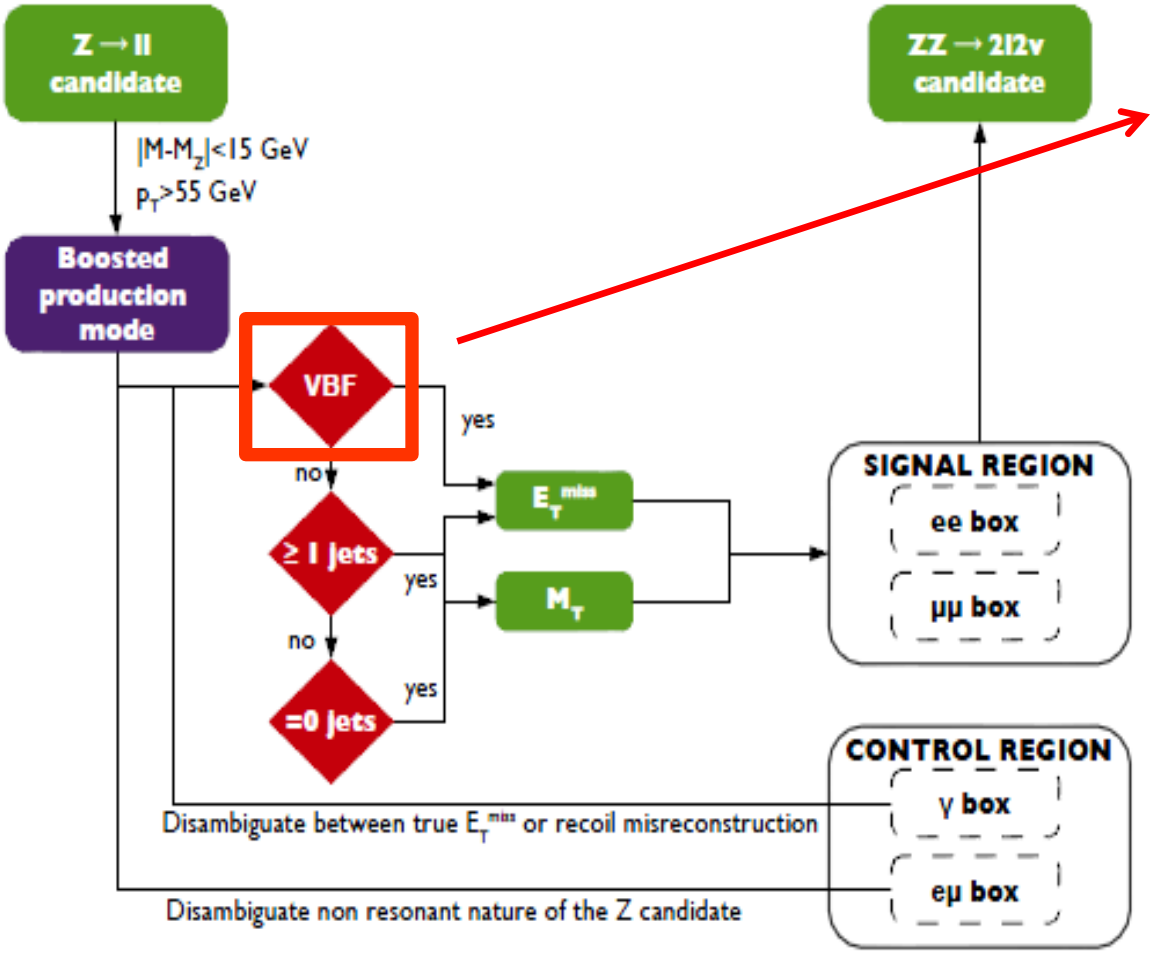
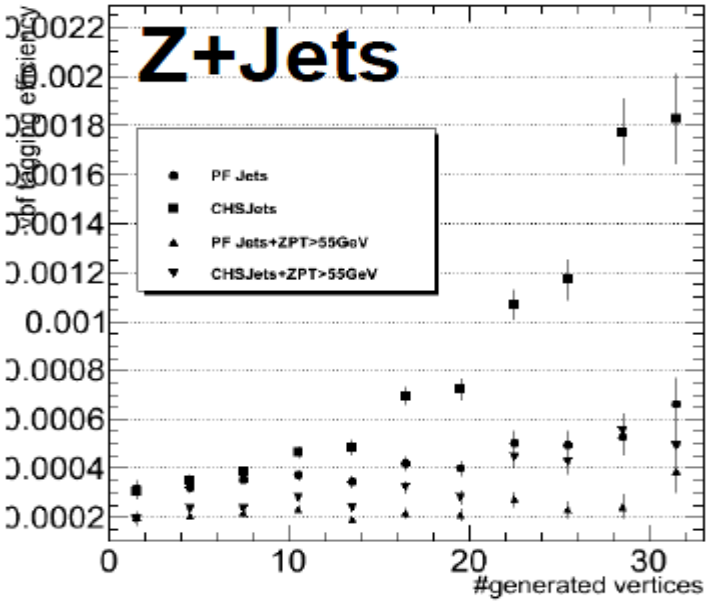
VBF in Run2

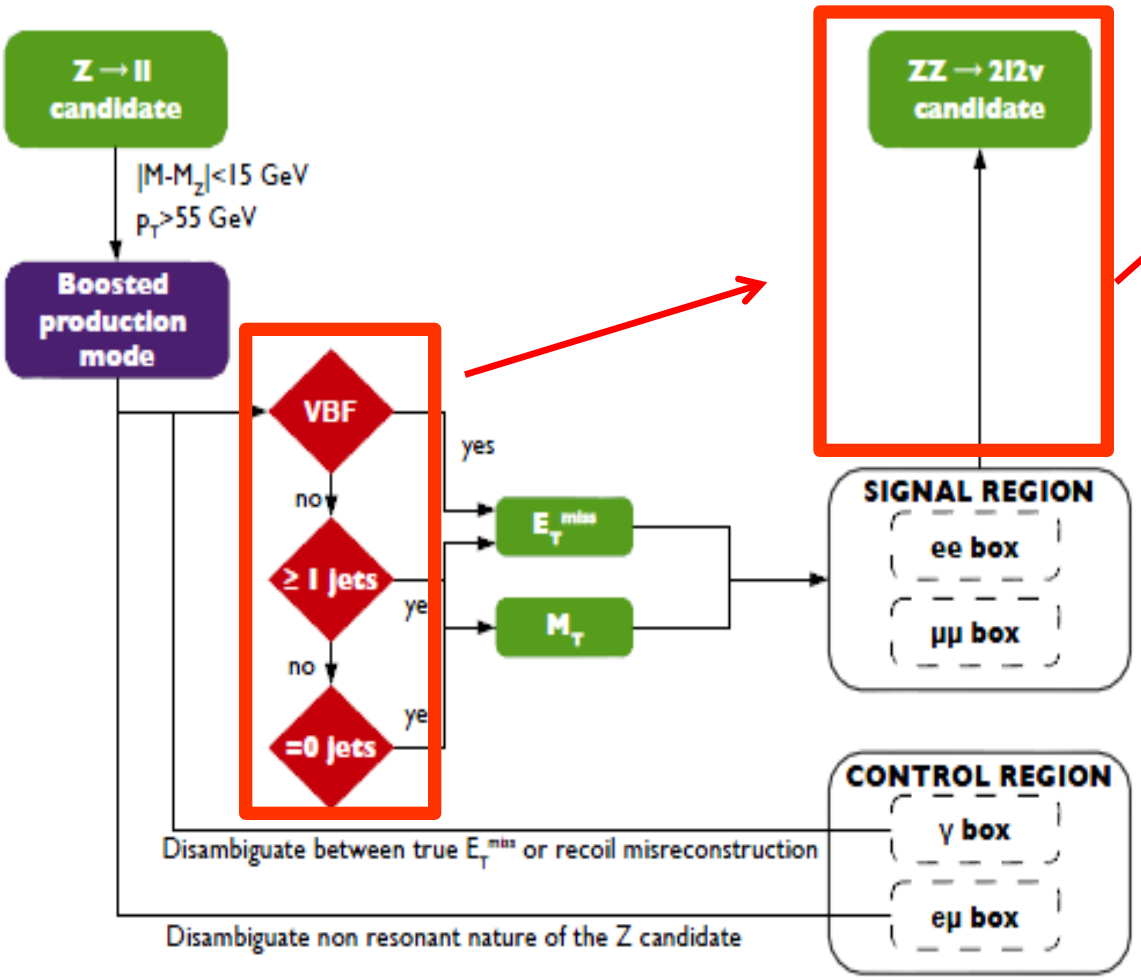


- **Tagging: 2Jet pT>30GeV, DeltaEta>4 Mjj>500**
- **fake rate increase with PU**
- **50% of the time, one of the VBF Jet is in tracker acceptance**
- **PU cleaning using Jet' tracks – vtx association**
- **Sensitivity improve if VBF category is split in 2**



loic.quertenmont@cern.ch

Categ. and Stat. Analysis in Run2



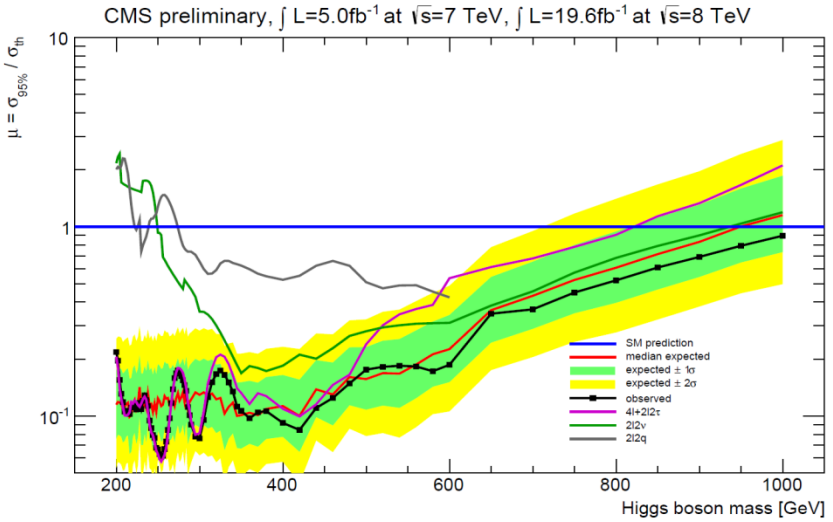
- **Analysis can be improve by using more sophisticated statistical analysis**
- **Currently 1DShape-Based**
  - **BDT as cross-check (no significant improvements)**
- **MVA ? MEM?**
- **2D shape ? (MT, Mll ?)**

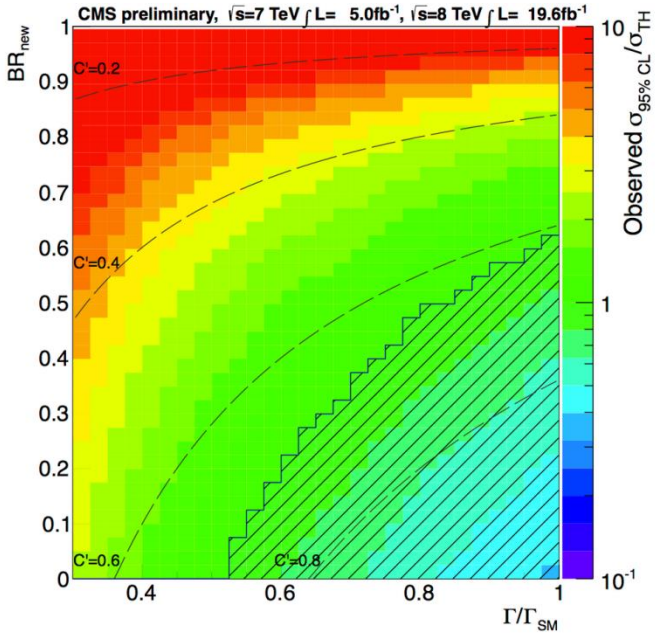
- **3 event categories**
  - **VBF, 0Jet, >0Jet**
  - **VBF0tk, VBF1tk, 0jet, 1jet, 2jet, >2Jets…**
  - **Mjj pT bins?**

loic.quertenmont@cern.ch

(B)SM models

- **Standard model-like Higgs**
  - Same production mechanism, couplings and width than SM
  - Combining 7 and 8TeV, VBF and GF





- **Additional Higgs Singlet mixing with SM h**
  - Narrower with,
  - lower xsections, unknown BRnew

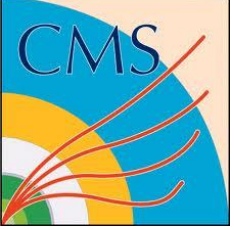
$$\mu' = C'^2 \cdot (1 - BR_{\text{new}})$$

$$\Gamma' = \Gamma_{\text{SM}} \cdot \frac{C'^2}{1 - BR_{\text{new}}}$$

- **2HDM**
  - Being discussed

- **Anything else ?**

loic.quertenmont@cern.ch



No conclusion !
Further Discussion ?