

# ИТЭФ в upgrade и поисках хиггсов

- Статья по поискам ТБХ в каналах  $WW \rightarrow l\nu/l\nu$  и  $l\nu qq$  (Run I)
- Влияние FCal на поиски бозона Хиггса при условиях HL-LHC
- ИТЭФ в Run-II по изучению канала  $H \rightarrow WW \rightarrow l\nu/l\nu$  → А. Гаврилюк
- ИТЭФ в редакционной коллегии Top WG
- Предварительные планы группы

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*ОИЯИ, Дубна, Россия, 23.09.2015*

# ИТЭФ и статья по ТБХ

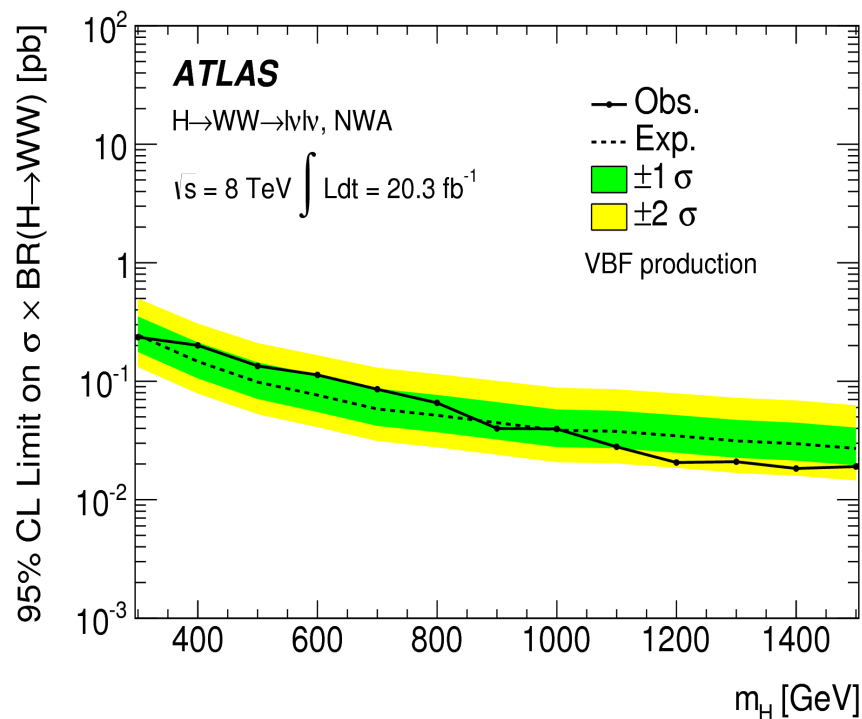
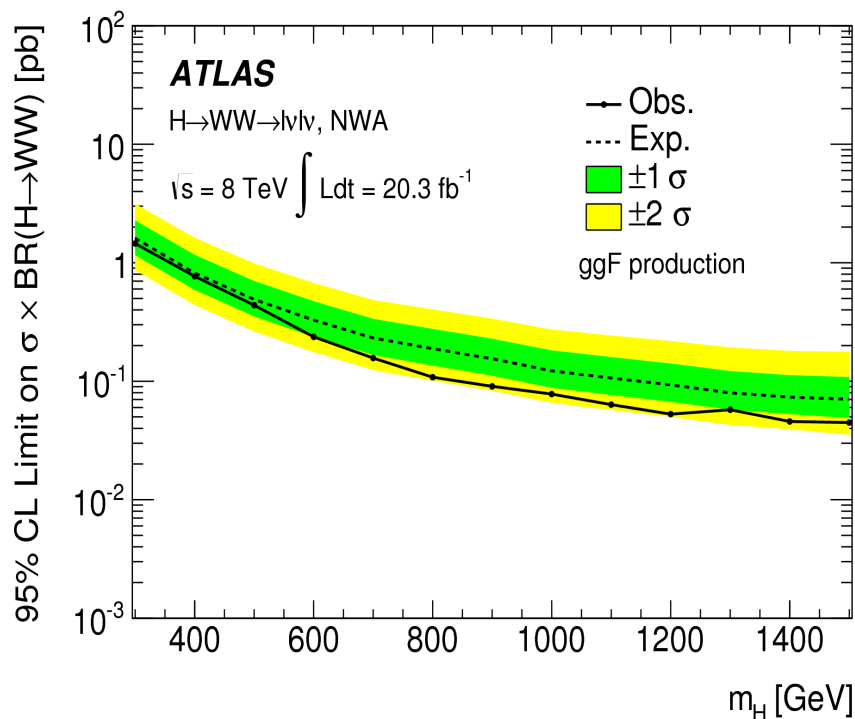
Название: Search for a high-mass Higgs boson decaying to a W boson pair in pp collisions at  $\sqrt{s}=8$  TeV with the ATLAS detector  
<https://atglance.web.cern.ch/atglance/analysis/detailAnalysis.php?readonly=true&id=4628>

- Смотрели как SM-like H (**CPS, NWA**), так и BSM (2HDM, EW singlet)
- Каналы распада  $H \rightarrow WW \rightarrow l\nu l\nu$ ,  $l\nu qq$ , полные данные 2011-12 г.г.
- Международная группа в составе 25 чел.
- Editorial Board: P.J. Clark, A.Kiryunin, K. Lohwasser, L.Mandelli (chair)
- <http://arxiv.org/pdf/1509.00389v1>, послана в JHEP 01.09.2015

Реально анализ в канале  $l\nu l\nu$  (**CPS, NWA**) был завершён в конце 2014 г, но пришлось долго ждать завершения анализа  $l\nu qq$  и BSM  $l\nu l\nu$

# Исключение $H$ в канале $H \rightarrow WW \rightarrow l\nu/l\nu$

arXiv:1509.00389,  
submitted to JHEP

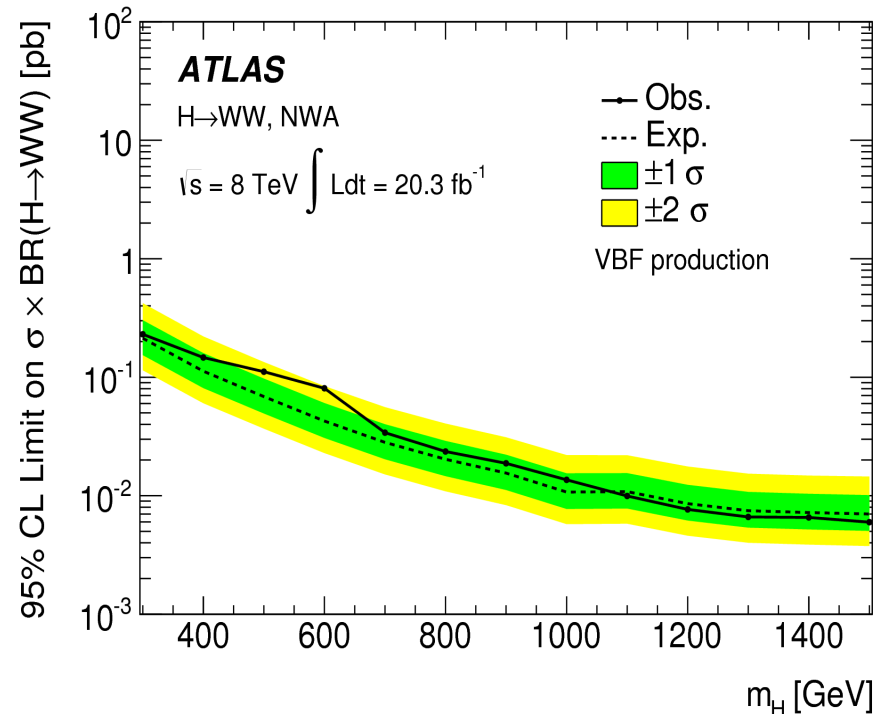
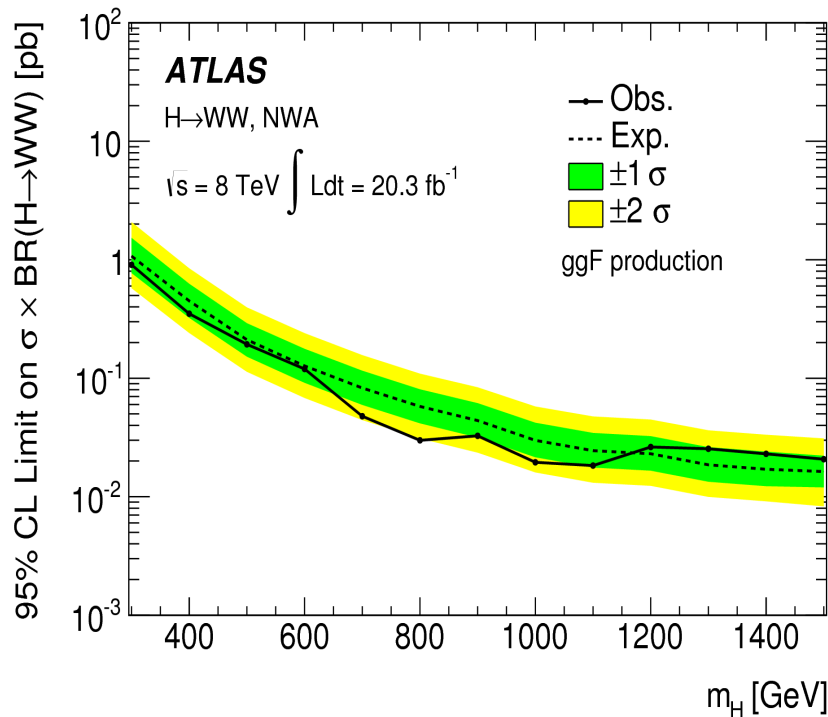


Для ggF (VBF) механизмов исключаются сечения рождения  $H \rightarrow WW$   
40-1500 фб (20-250 фб) при массе ТБХ в области 300-1500 ГэВ

Для продвижения в область больших масс необходимо повышать  
суммарную энергию протонов в с.ц.м. до 13 -14 ТэВ

# Исключение H в каналах $H \rightarrow WW \rightarrow l\nu/l\nu + l\nu q\bar{q}$

arXiv:1509.00389,  
submitted to JHEP



Для ggF (VBF) механизмов исключаются сечения рождения  $H \rightarrow WW$   
20-1000 фб (5-250 фб) при массе ТБХ в области 300-1500 ГэВ

При массах  $> 1$  ТэВ, где ожидаемые сечения малы, канал  $l\nu q\bar{q}$  несколько более чувствителен, чем  $l\nu/l\nu$  благодаря большому в 6 раз branching ratio

# FCal and $H \rightarrow WW \rightarrow l\nu l\nu$ channel at HL-LHC

- Real FCal coverage for jets potentially can be reduced when HL-LHC will start the operation

Reason: positive ion build-up at high  $|\eta| \rightarrow$  reduced HV in LAr gap  
(assumption: no change of current FCal, no miniFCal in front of current FCal)

- One of questions from LAr Phase-II upgrade community:

how (VBF) Higgs boson searches will be affected by possibly reduced coverage for tagging jets and  $E_T^{\text{miss}}$  ?

- A study was performed to provide some answers
  - For **jets** it is based on the Common Analysis Framework (CAF) of the  $H \rightarrow WW$  (HSG3) Working Group for **8 TeV** data
  - For  **$E_T^{\text{miss}}$**  a modified private ITEP group code is used

# Results for SM-like high mass Higgs boson

Table shows fractions of events after **all the VBF selections** survived the additional cut on the jet coverage

Process/ coverage	H(300 GeV)	H (600 GeV)	H (900 GeV)	Total backgr.	Data 2012
$ \eta <4.5$	1	1	1	1	1
$ \eta <4.3$	0.98	0.98	0.97	0.98	57/57
$ \eta <4.1$	0.93	0.95	0.93	0.93	56/57
<b><math> \eta &lt;4.0</math></b>	<b>0.90</b>	<b>0.92</b>	<b>0.90</b>	<b>0.91</b>	<b>56/57</b>
$ \eta <3.9$	0.87	0.89	0.86	0.88	54/57
$ \eta <3.7$	0.77	0.80	0.76	0.80	48/57
$ \eta <3.5$	0.66	0.67	0.63	0.72	44/57
<b><math> \eta &lt;3.3</math></b>	<b>0.53</b>	<b>0.53</b>	<b>0.60</b>	<b>0.61</b>	<b>38/57</b>
$ \eta <3.0$	0.33	0.32	0.31	0.42	26/57

- Sizeable and  $m_H$  -independent loss of acceptance for the signal
- Smaller loss of total background acceptance; agreement with data
- About 90% (55%) survival probability for the coverage  $|\eta|<4.0$  (3.3)

# Exclusion of FCal from MET calculation

(after discussion with the expert, M. Testa)

## Remove forward region from MET calculation

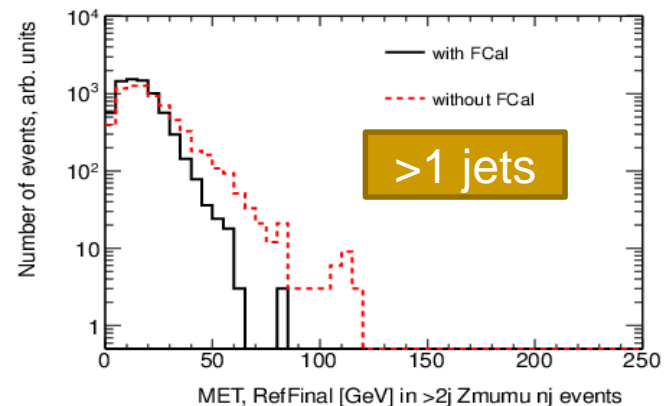
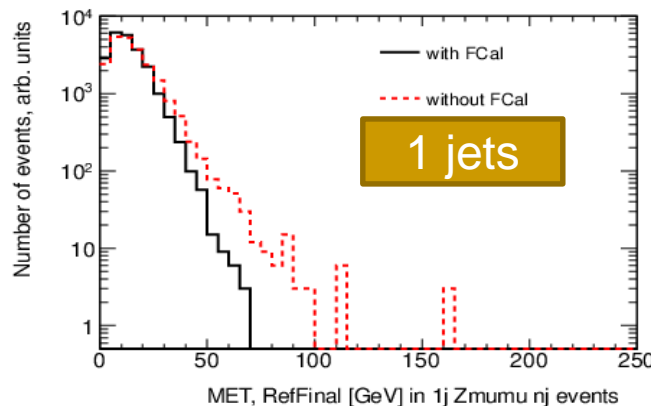
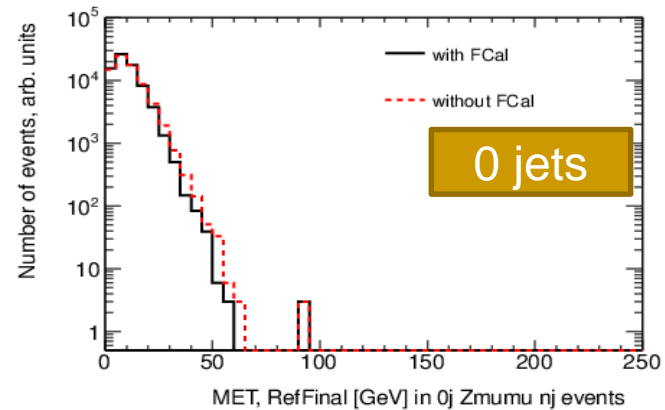
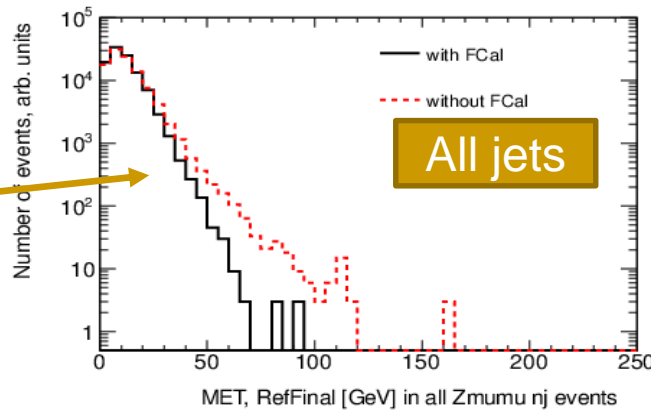
- MET terms per region for p1328 D3PD's from related TWiki  
Regions: CentralReg, EndcapRegion, ForwardReg; per region:  
 $REF_{final\_etx} = RefEle\_etx + RefGamma\_etx + RefTau\_etx + MuonBoy\_etx + Jet\_etx + CellOut\_Eflow\_etx$   
MET w/o FCal:  $MET\_Ref\_new\_etx = REF_{final\_etx} (central) + REF_{final\_etx} (endcap)$
- Use (modified) ITEP group private code for HWW analysis
  - reduction of huge amount of D3PD (NTUP\_COMMON) variables
  - select only events with two high- $p_T$  leptons
  - TSelector-based “reduced” HWW analysis in ROOT
  - MET\_TST and MET\_CST options for HL-LHC: tests → А. Гаврилюк
- Use 14 TeV MC samples for HL-LHC studies → backup  
No  $H \rightarrow WW \rightarrow l\nu l\nu$ ,  $WW \rightarrow l\nu l\nu$  samples,  $t\bar{t}$  sample is very small

# Example: MET for background QCD ( $Z \rightarrow \mu\mu$ ) + jets

## 1 event per bunch crossing, i.e. no pile-up

With FCal:  
Mean: 11.3  
Rms: 7.3

W/o FCal:  
Mean: 16.4  
Rms: 9.5



**Big right tails especially for non-zero jet case after exclusion of the FCal.  
Increase of mean by 50% and rms by 30% after exclusion of the FCal.  
In 2012 year MC at  $\mu \approx 20$  effects seen here were less pronounced: backup**

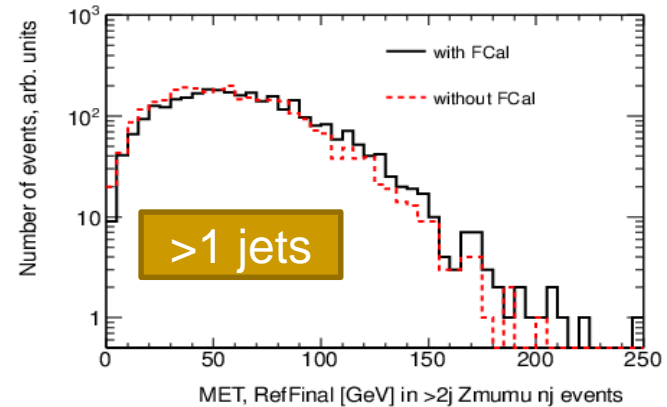
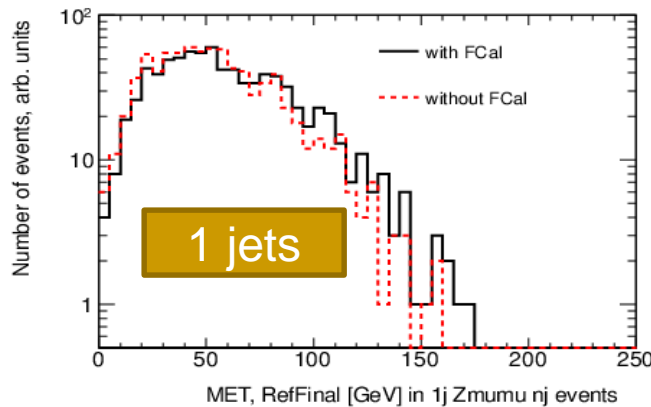
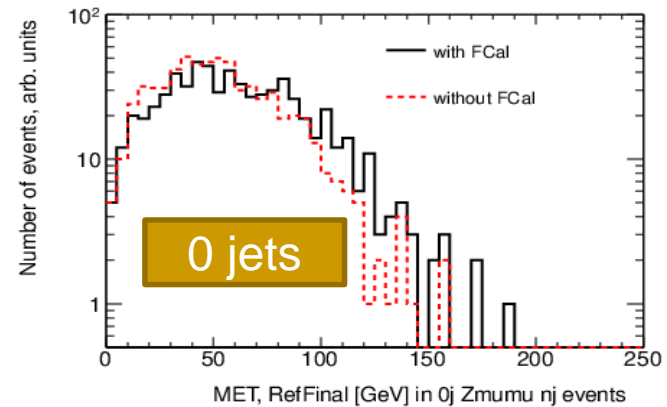
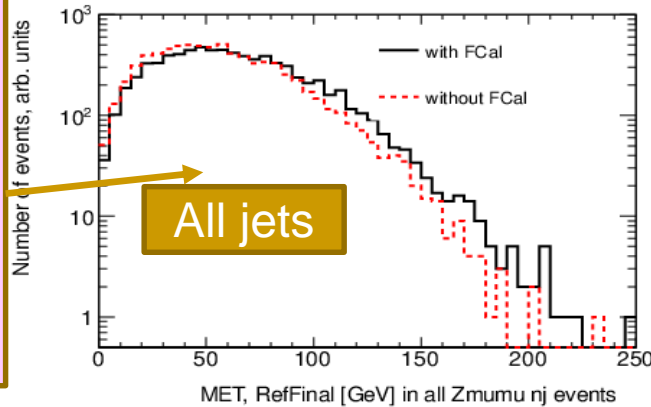


# Example: MET for background QCD ( $Z \rightarrow \mu\mu$ ) + jets

## 140 events per bunch crossing

With FCal:  
Mean: 64.4  
Rms: 34.2

W/o FCal:  
Mean: 58.0  
Rms: 31.3



**Decrease of mean and rms by about 10% due to exclusion of FCal**  
**Increase of mean and rms by a factor of 5-6 w.r.t. no pile-up case**

# ИТЭФ в редакционной коллегии Top WG

По поручению руководства ATLAS один из физиков ИТЭФ в составе международной редакционной коллегии в течение 4 лет рецензирует часть статей и отчетов группы по топ-кварку (Top WG). В 2015 г. подготовлена и послана в журнал одна статья.

Название: Measurement of the top quark pair production cross section in pp collisions at  $\sqrt{s}=7$  TeV in the  $\ell+\tau$  channel and of the top quark branching ratios into channels with leptons and quarks with the ATLAS detector  
<https://atglance.web.cern.ch/atglance/analysis/detailAnalysis.php?readonly=true&id=4842>

- Editorial Board: E. B. Kuutmann, J. Hobbs, Y. R. Peters (chair), I.T.
- <http://arxiv.org/pdf/1506.05074v2>, послана в Phys. Rev. D в июне 2015 г., принята к публикации 17.09.2015

Работа над статьей заняла около года из-за малости analysis team

# Предварительные планы группы

- ATLAS database support and development: 0.5? FTE
- Support of ATLAS computers at CERN:  $\approx 0,17$  FTE
- Shifts in ACR (calorimeter desk):  $\approx 0,2$  FTE
- Data quality shifts in LAr (for qualification)  $\approx 0,2$  FTE
- Physics: BSM  $H \rightarrow WW \rightarrow l\nu/l\nu$  searches at 13 TeV
  - First results based on MC15: study of kinematics
  - MC16-based optimization studies like we did at 8 TeV
  - Analysis of 2015 and 2016 data at 13 TeV/further optimization
  - Participation in Editorial Board
- Upgrade phase2: more MC studies  $\approx 0,4$  FTE

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# Backup slides

# Results for SM Higgs boson: $\Delta Y(jj) > 3.6$ , $M(jj) > 600$ GeV

Table shows fractions of events after **all the VBF selections** survived the additional cut on the jet coverage

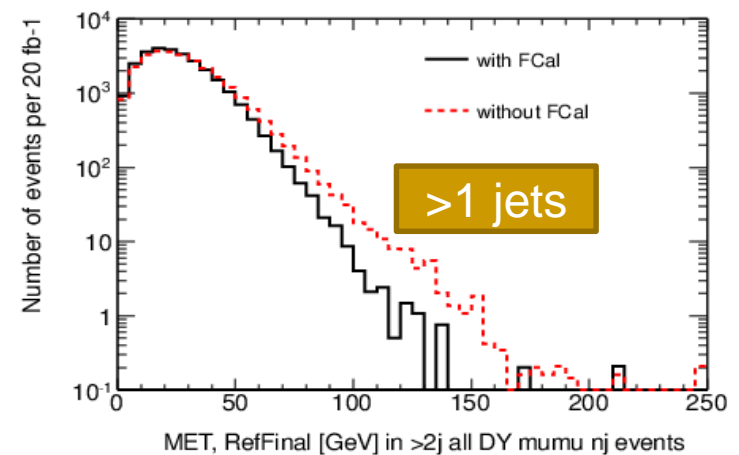
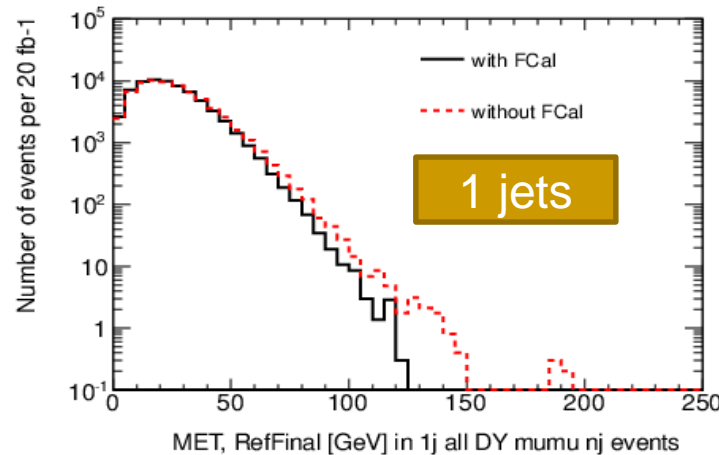
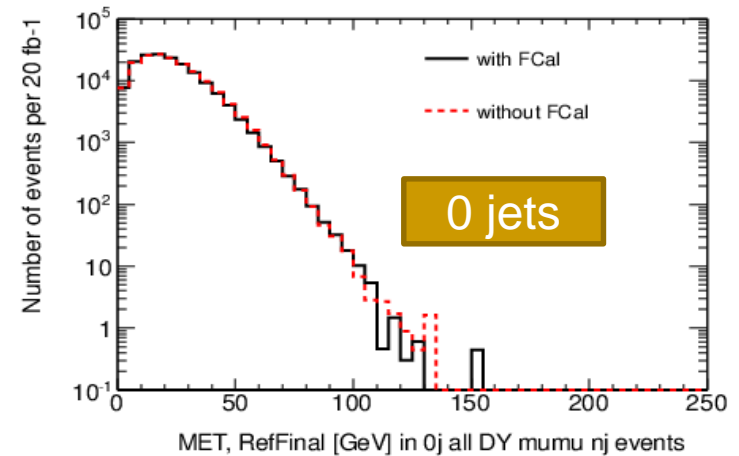
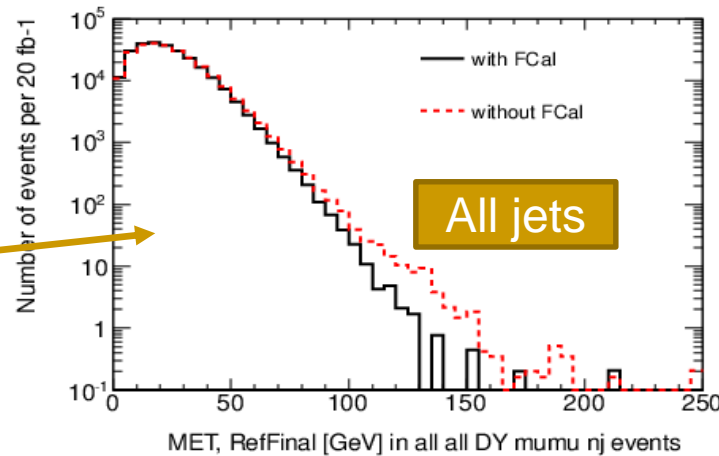
Process/ coverage	VBF H	ggF H	Total H	Total backgr.	Data 2012
$ \eta  < 4.5$	1	1	1	1	1
$ \eta  < 4.3$	0.98	0.96	0.97	0.97	20/20
$ \eta  < 4.1$	0.93	0.91	0.93	0.93	20/20
<b><math> \eta  &lt; 4.0</math></b>	<b>0.90</b>	<b>0.88</b>	<b>0.90</b>	<b>0.89</b>	<b>20/20</b>
$ \eta  < 3.9$	0.87	0.84	0.86	0.87	19/20
$ \eta  < 3.7$	0.77	0.73	0.77	0.80	17/20
$ \eta  < 3.5$	0.66	0.62	0.65	0.70	15/20
<b><math> \eta  &lt; 3.3</math></b>	<b>0.55</b>	<b>0.47</b>	<b>0.54</b>	<b>0.56</b>	<b>14/20</b>
$ \eta  < 3.0$	0.34	0.29	0.33	0.38	8/20

- Sizeable loss of acceptance for signal, a bit higher for ggF
- Similar loss of total background acceptance; agreement with data
- About 90% (50%) survival probability for the coverage  $|\eta| < 4.0$  (3.3)

# Example: MET for background QCD ( $DY \rightarrow \mu\mu$ ) + jets

With FCal:  
 Mean: 23.2  
 Rms: 13.6

W/o FCal:  
 Mean: 23.9  
 Rms: 14.3



**Strong elongation of high-MET tails for 1j and >1j events without FCal. Similar situation for EW ( $Z \rightarrow \mu\mu$ ) + 2 jets and for ee-case**

# 14 TeV MC samples for high luminosity

- Relevant physics processes:  $Z \rightarrow ee/\mu\mu$  ,  $t\bar{t}$   
still no  $H \rightarrow WW$ ,  $WW$ , single top,  $Z \rightarrow \tau\tau$  with dilepton final state(?)
- ITK Lol VF geometry, 50mm beam spot, 25ns bunch spacing
- Tight trigger, Pythia8 pile-up, 17.3.13.5
- **1, 80, 140 or 200 events per bunch crossing**
- Only 50-100K events per sample
- Format: NTUP\_COMMON, analysis with private code  
Note: TST and CST versions of MET from METUtility ATLAS package were implemented into our private code, thanks to M. Testa, see backup
- HWW group cuts for jets in 2012 year data:  
 $p_T(\text{jet}) > 25(30)$  GeV at  $|\eta| < (>) 2.4$ ,  $|JVF| > 0.5$  to protect against pile-up  
“looser” jet cleaning to kill events with “bad” jets