Search for the Standard Model Higgs boson decaying to a bottom-quark pair with the ATLAS detector

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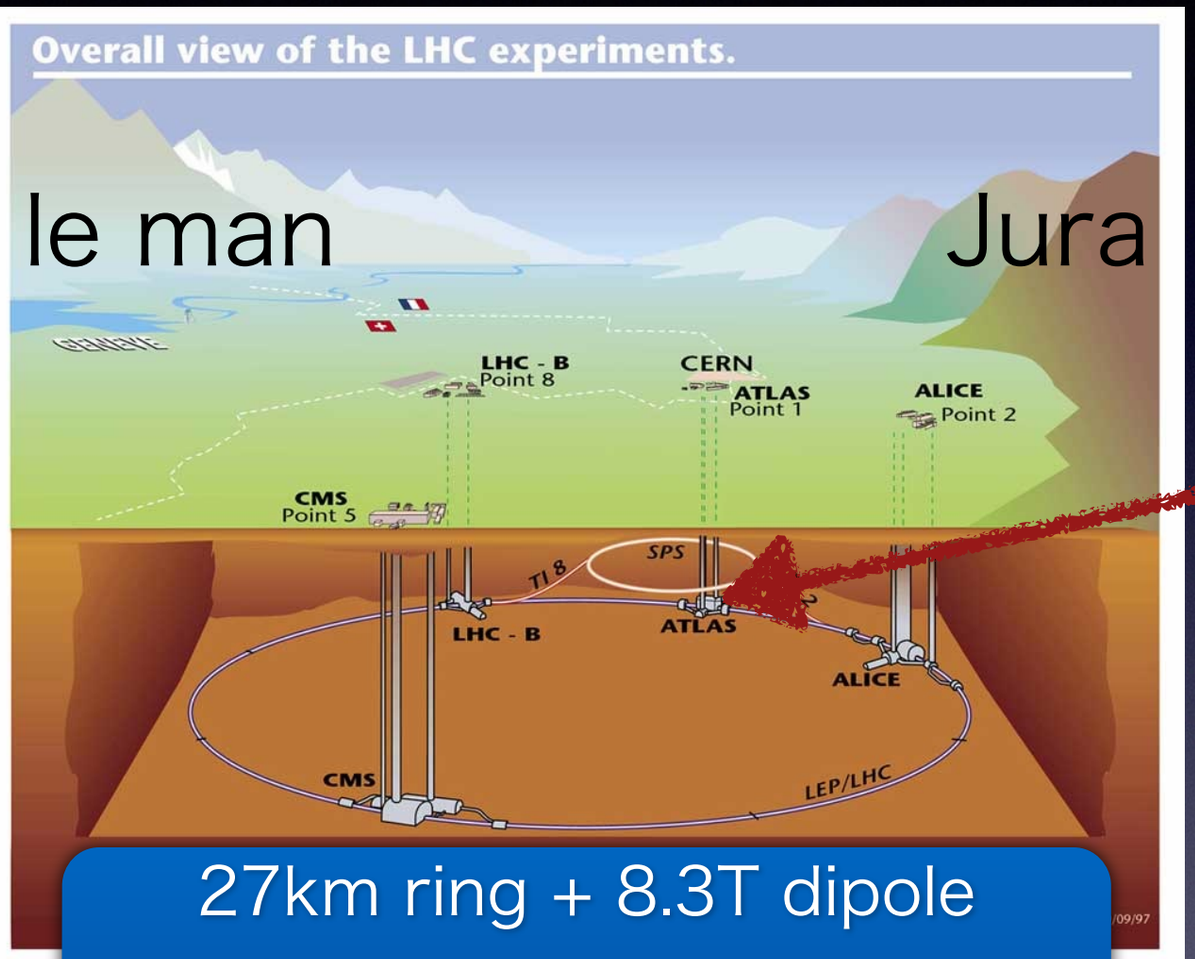
LHC-ATLAS experiment



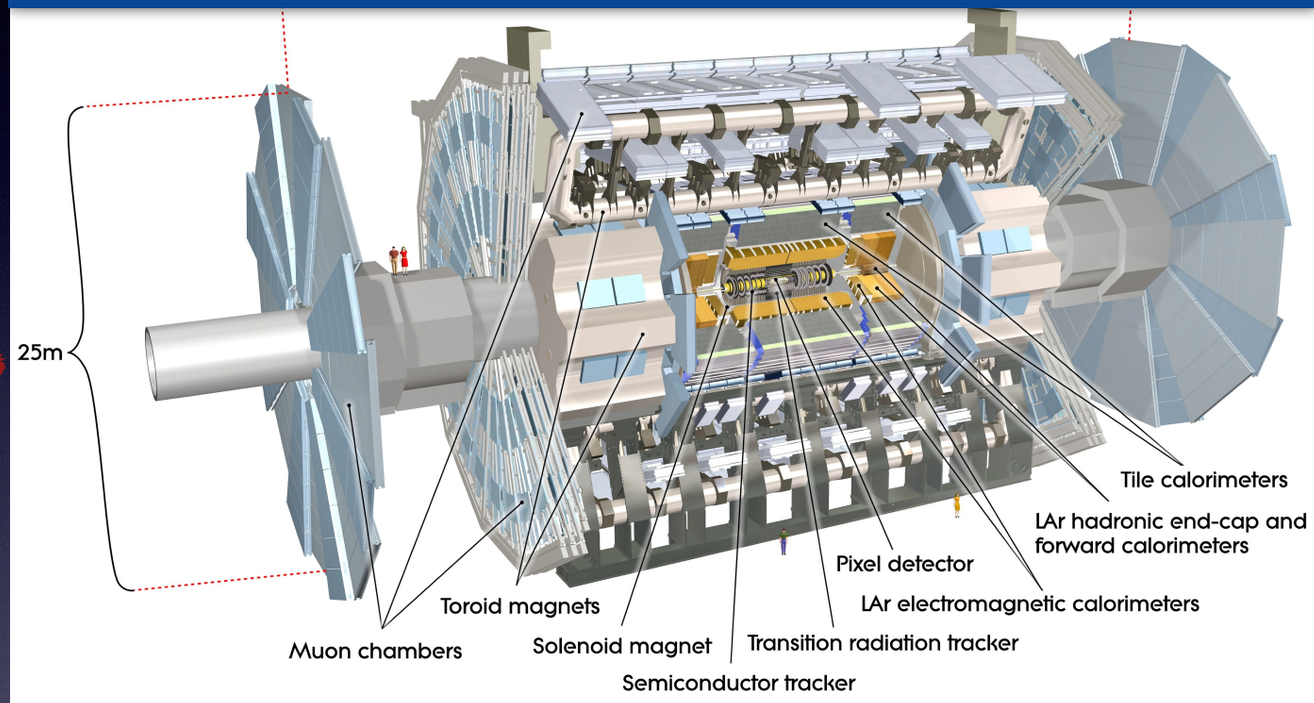
27km ring + 8.3T dipole

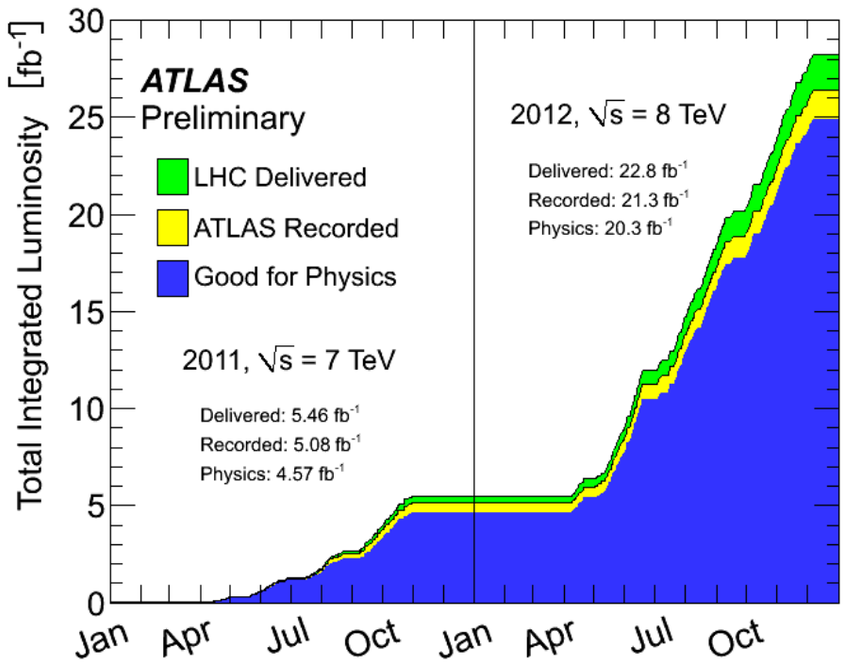
8TeV: highest energy

$7.7 \times 10^{33} cm^2 s^{-1}$:

highest luminosity p-p collider

ATLAS: General purpose detector@LHC

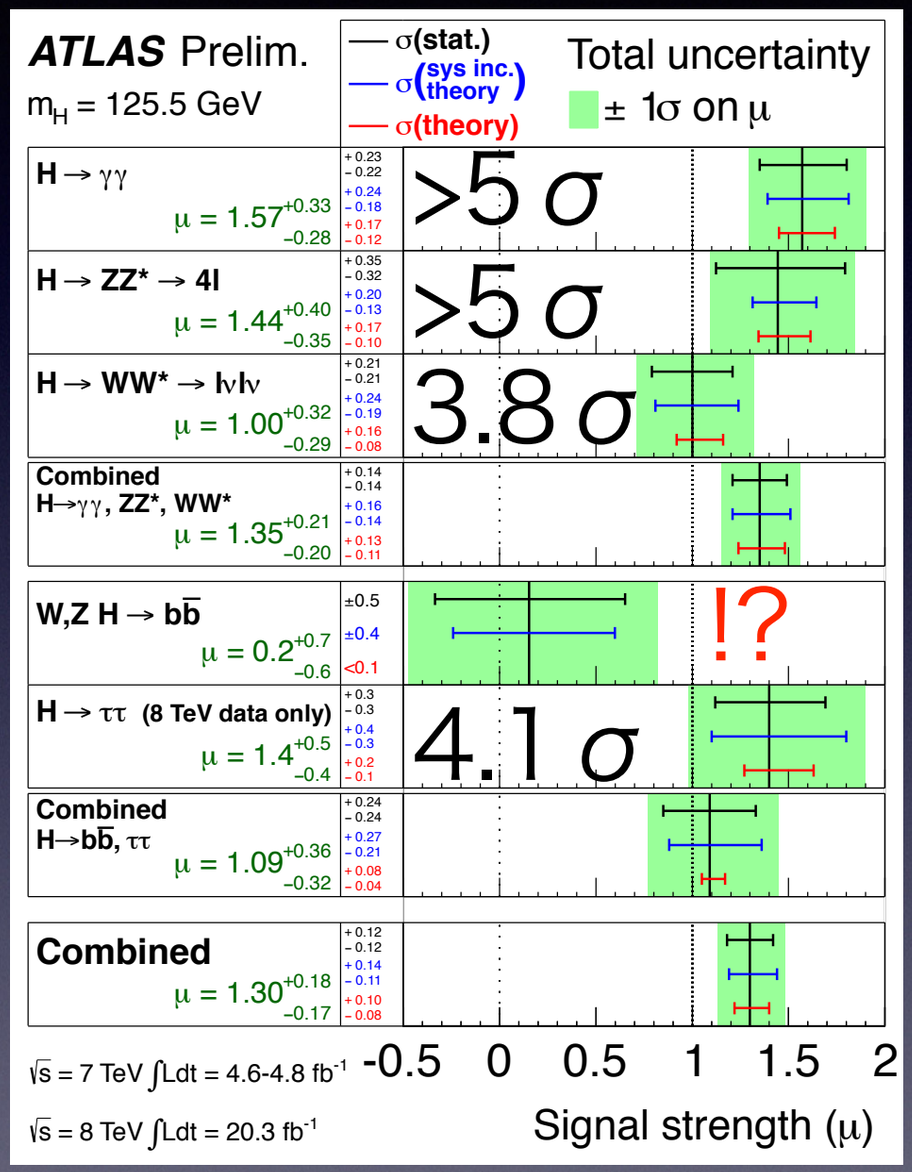


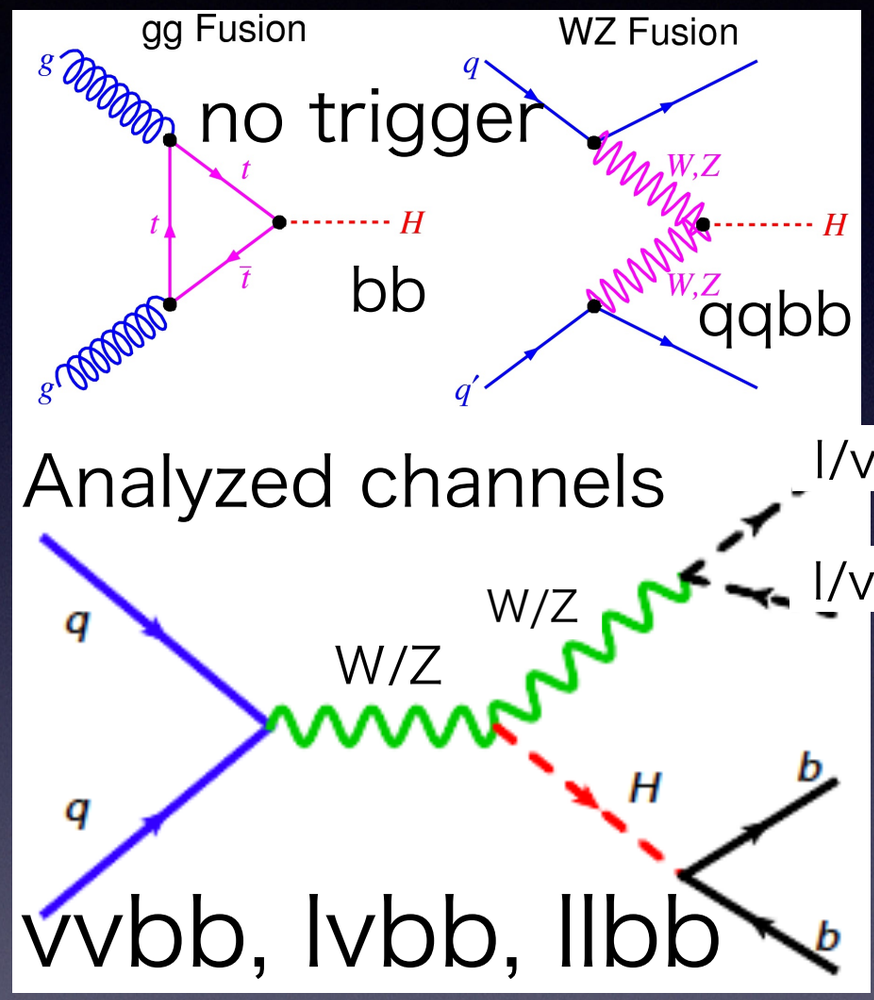


available data: 8TeV, 20.3/fb

~90% of delivered !

Higgs->bb analysis





Next is H->bb

How to suppress & control huge background

H->bb has the largest branching ratio(~57%)

Final state have only jets -> no trigger

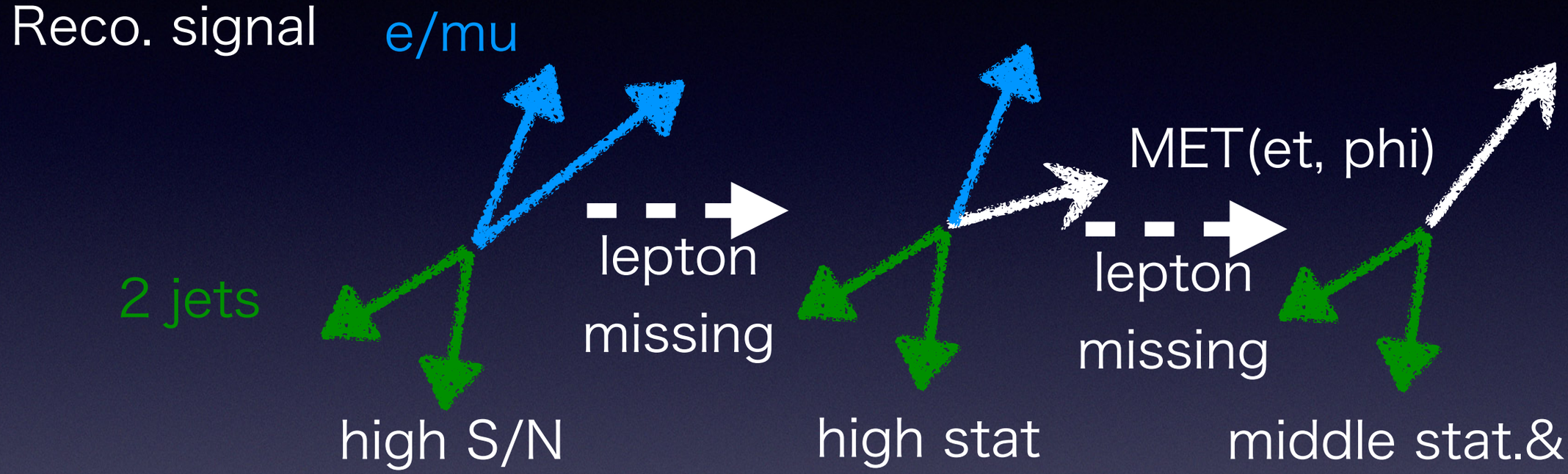
Focus on W/Z associate production

-> trigger leptons from W/Z decay

https://twiki.cern.ch/twiki/bin/view/AtlasPublic/HiggsPublicResults

Object selection

ZH->llbb: 2lep. WH->lvbb: 1lep. ZH->vvbb: 0lep.



Define the 3 channels using loose leptons to maximize the acceptance !

Jet definition
- pT > 20 GeV
- |eta| < 2.5
- pileup rejection

2 or 3 jets

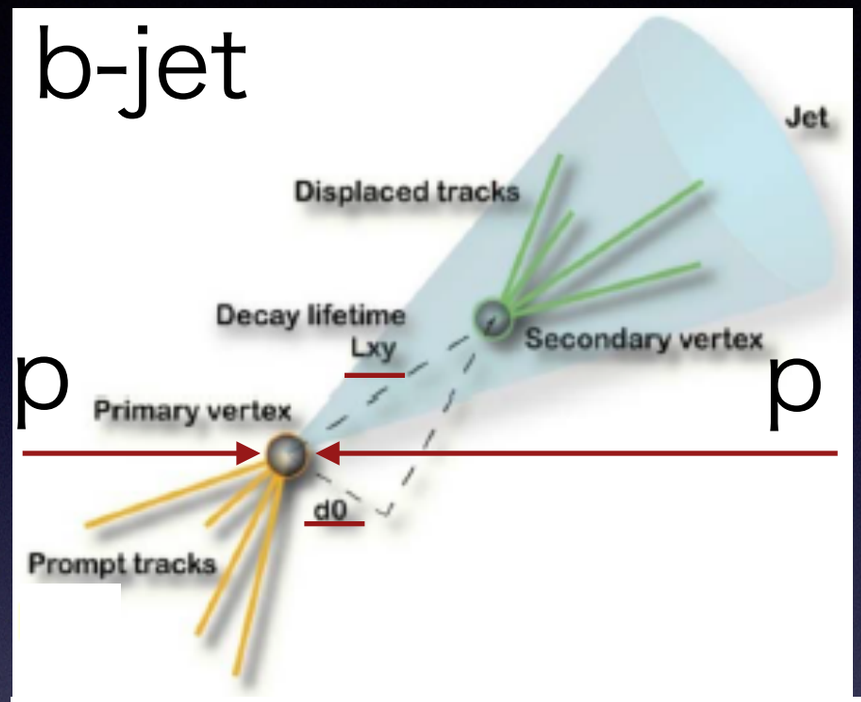
leading jet pT > 45 GeV

Lepton definition
- pT > 7 GeV
- |eta| < 2.5(e), 2.7(mu)
- isolation

0-2 lepton

leading lepton pT > 25 GeV

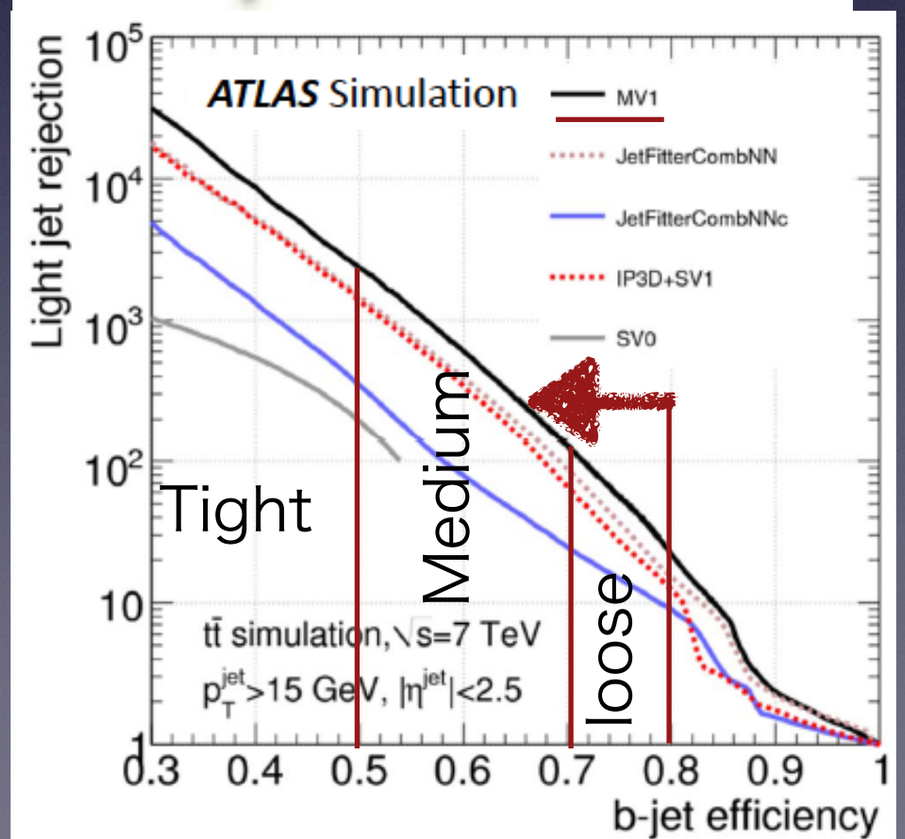
b-tagging



b-tagging: identify b-quark origin jet(b-jet)

b-quark has long life time: $c\tau \sim 470\mu m$

$\mathrm{L_{xy}} \sim 5mm(p_T = 50GeV)$ > vertex resolution



NEW: define 3 b-tagged categories

- tight(50%)…high b-jet purity
- medium(70%)…conventional region
- loose(80%)…additional region

flavor fraction determination

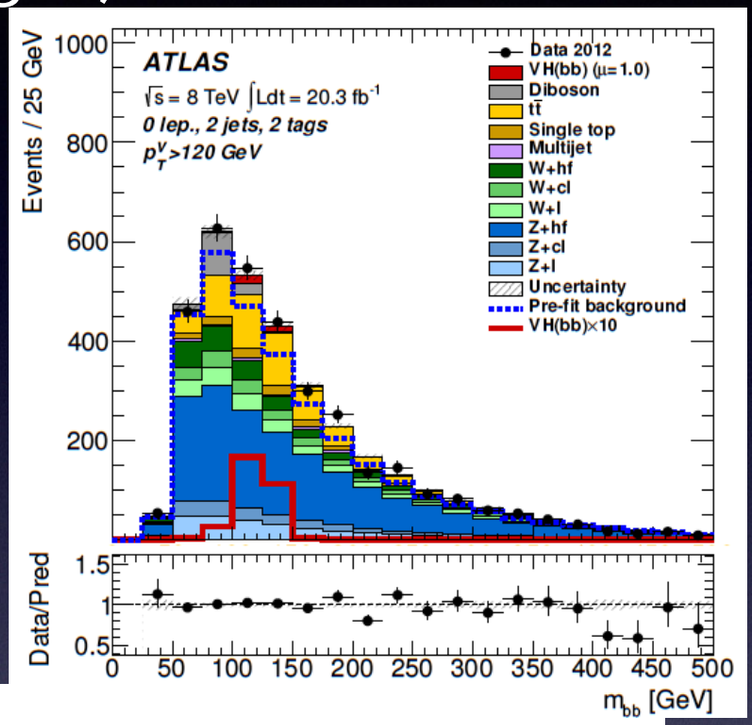
How do we estimate W/Z+jets flavor(b, c, light) fraction ?

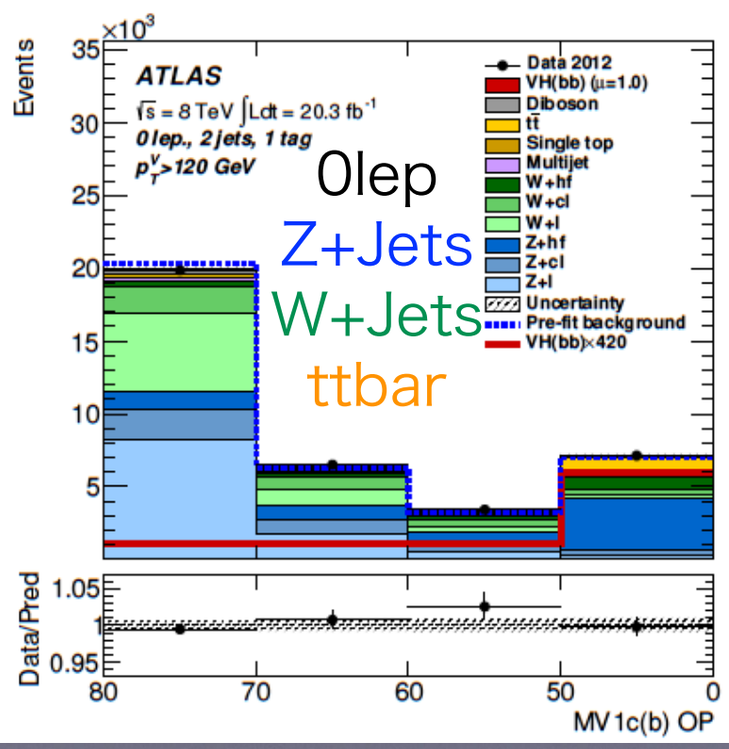
W+2jet MC mbb(2tag) and b-tag(1tag) distribution

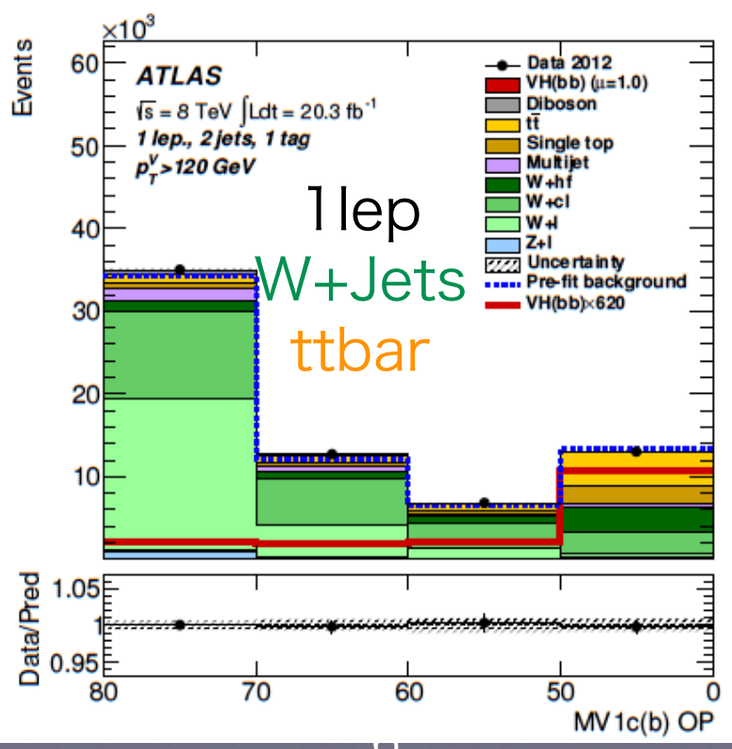
mbb is most sensitive variable for higgs

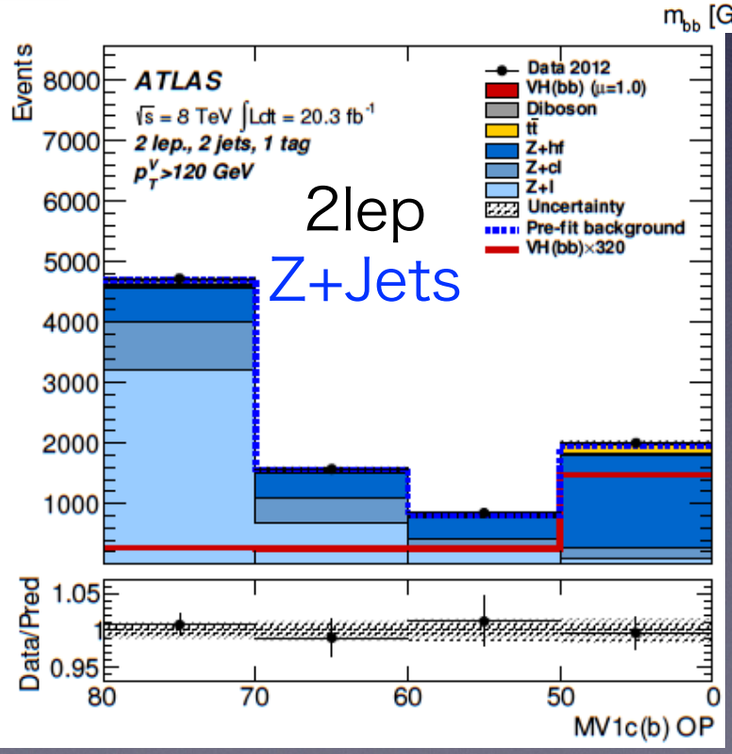
but have less information about the BKG flavor

b-tag weight have a strong constraint







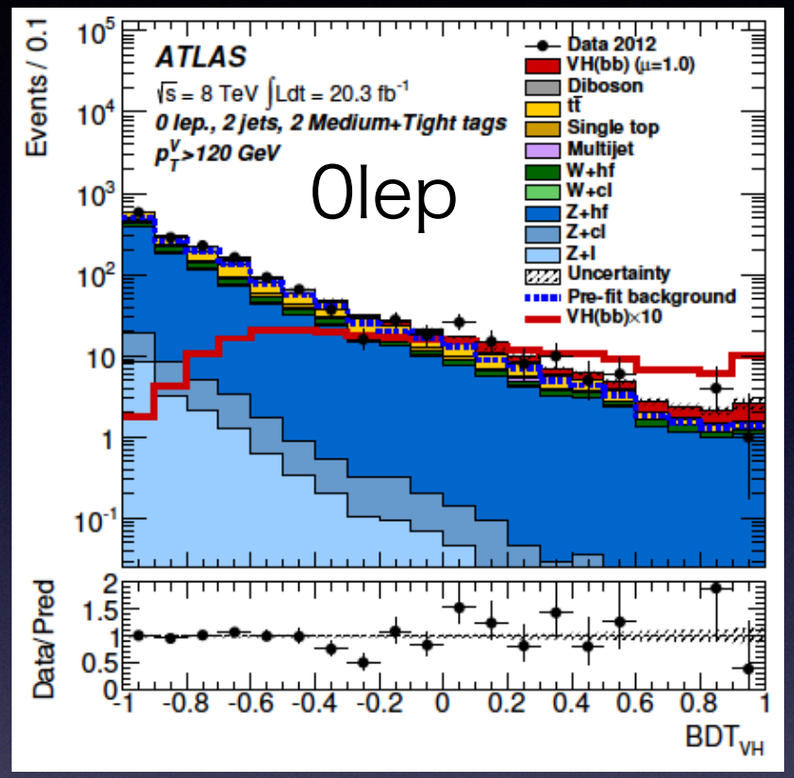


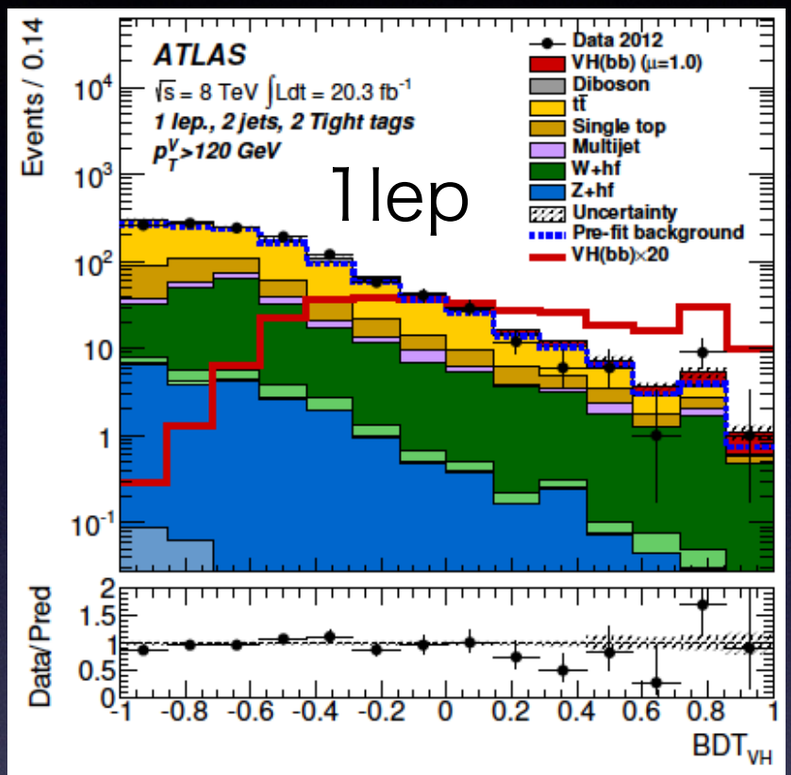
right side is b rich(dark color) and left side is light flavor rich(light color)

BDT(MVA) distribution

input variables

Variable	0-Lepton	1-Lepton	2-Lepton
$p_{\mathrm{T}}{}^{\mathrm{V}}$		×	×
$E_{\mathrm{T}}^{\mathrm{miss}}$	×	×	×
$p_{\mathrm{T}}^{b_1}$	×	×	×
$p_{\mathrm{T}}^{b_2}$	×	×	×
m_{bb}	×	×	×
$\Delta R(b_1, b_2)$	×	×	×
$\lvert\Delta E_{\mathrm{T}} a(b_1, b_2)\rvert$	×		×
$\Delta\phi(V, bb)$	×	×	×
$\lvert\Delta E_{\mathrm{T}} a(V, bb)\rvert$			×
H_{T}	×		
$\min[\Delta\phi(\ell, b)]$		×	
m_{T}^{W}		×	
$m_{\ell\ell}$			×
$MV1c(b_1)$	×	×	×
$MV1c(b_2)$	×	×	×
	Only in 3-jet events		
$p_{\mathrm{T}}^{\mathrm{jet}_3}$	×	×	×
m_{bbj}	×	×	×



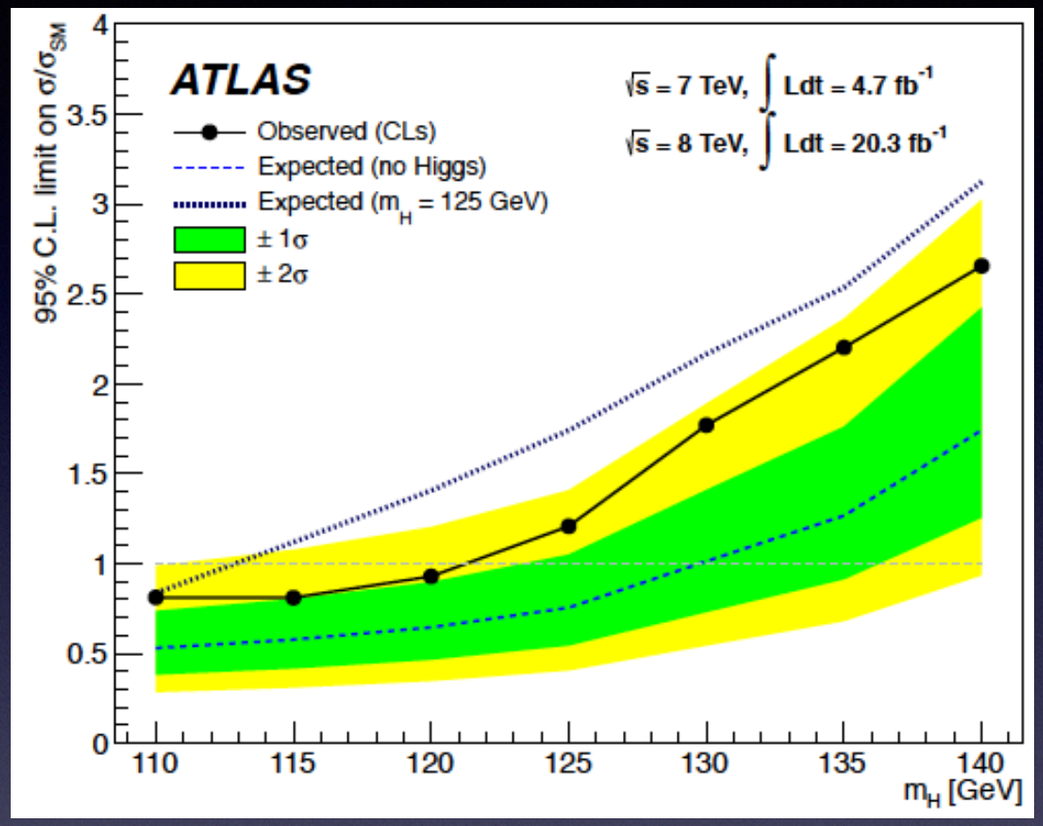


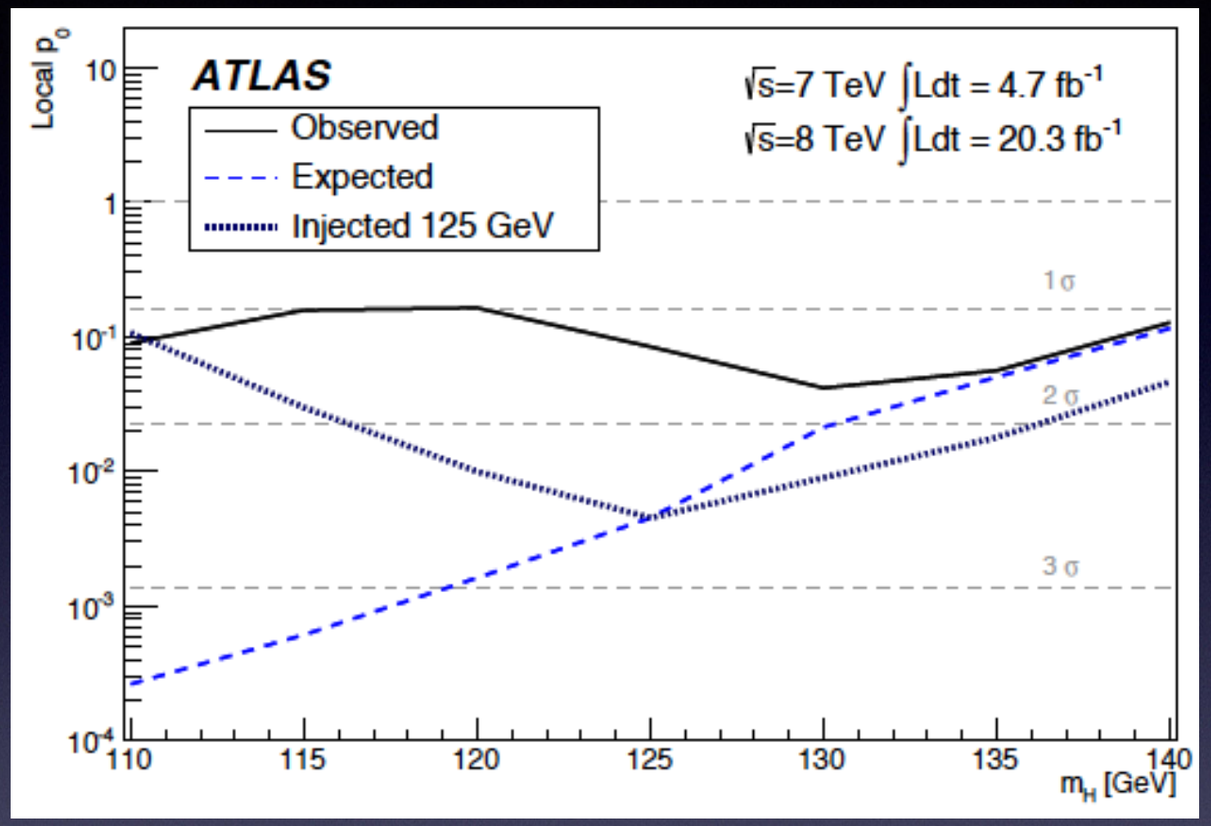
2jet2(Medium+)Tight btag

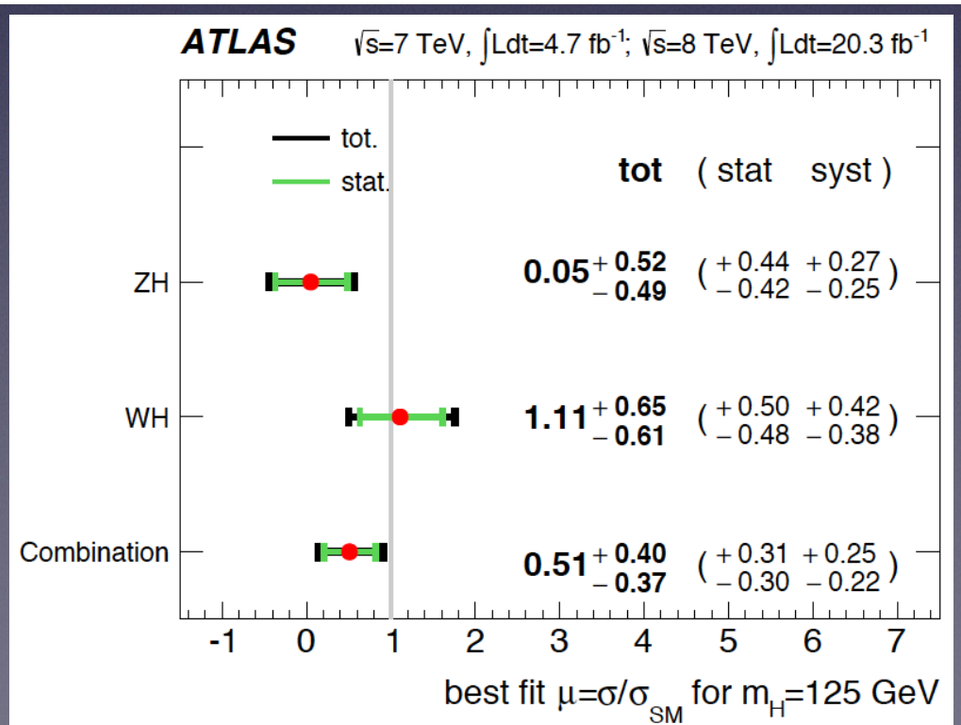
BDT inputs are optimized for each channel.

Globally fit using b-tag dist. and BDT output.

Result







Exp. Limit: 0.8 (OLD 1.3, 60% better)

Obs. Limit: 1.2

Exp. Significance: 2.6 σ

Obs. Significance: 1.3 σ

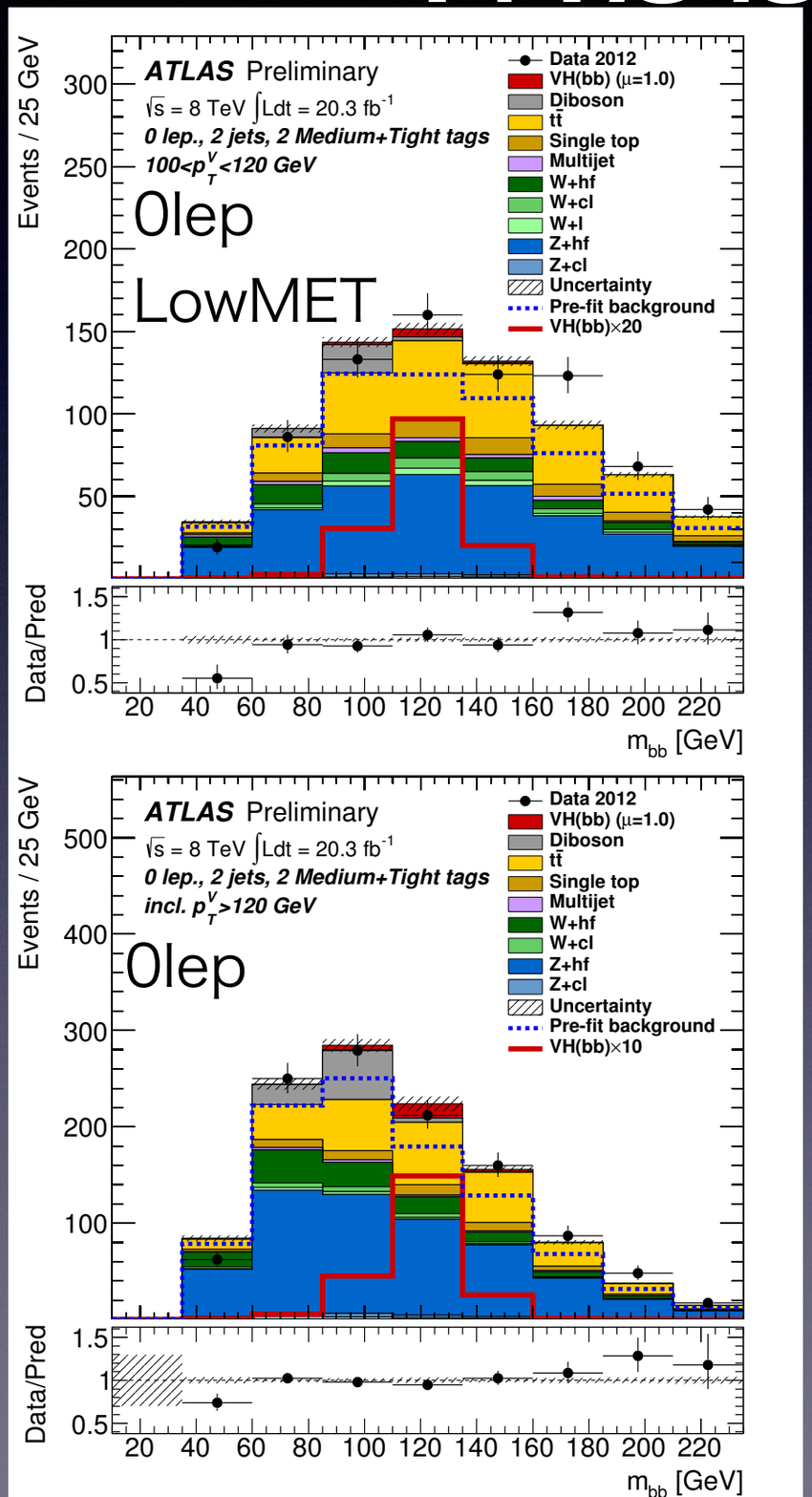
$\mu = 0.51 \pm 0.39$

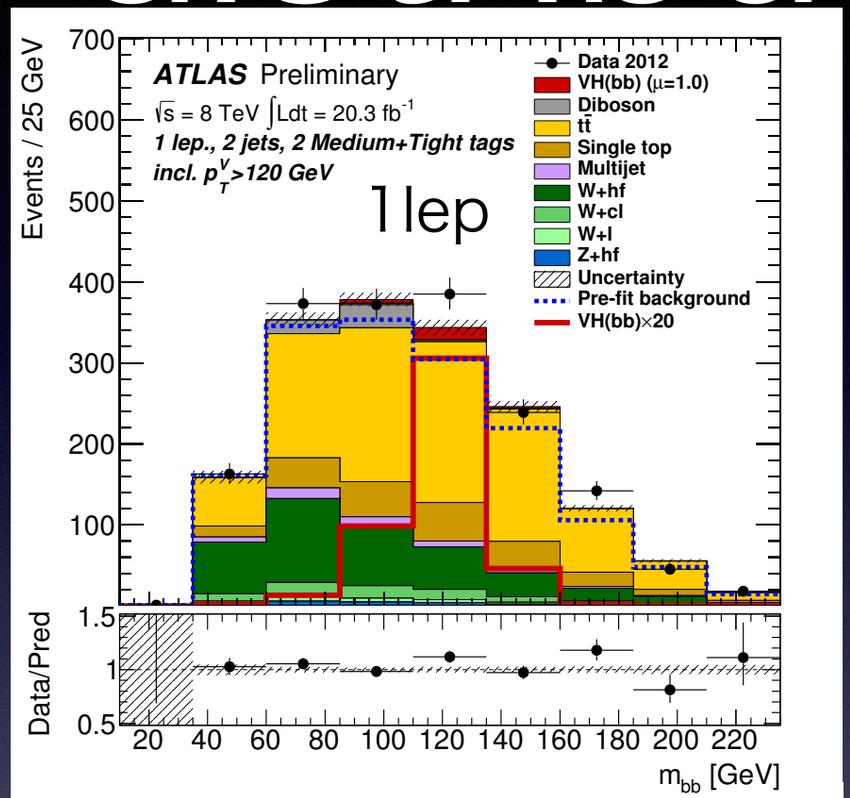
Run2 data will give us an answer !!

http://arxiv.org/abs/1409.6212

Backup

Mbb distribution





2jet2Medium+Tight tag

LowMET: a new region

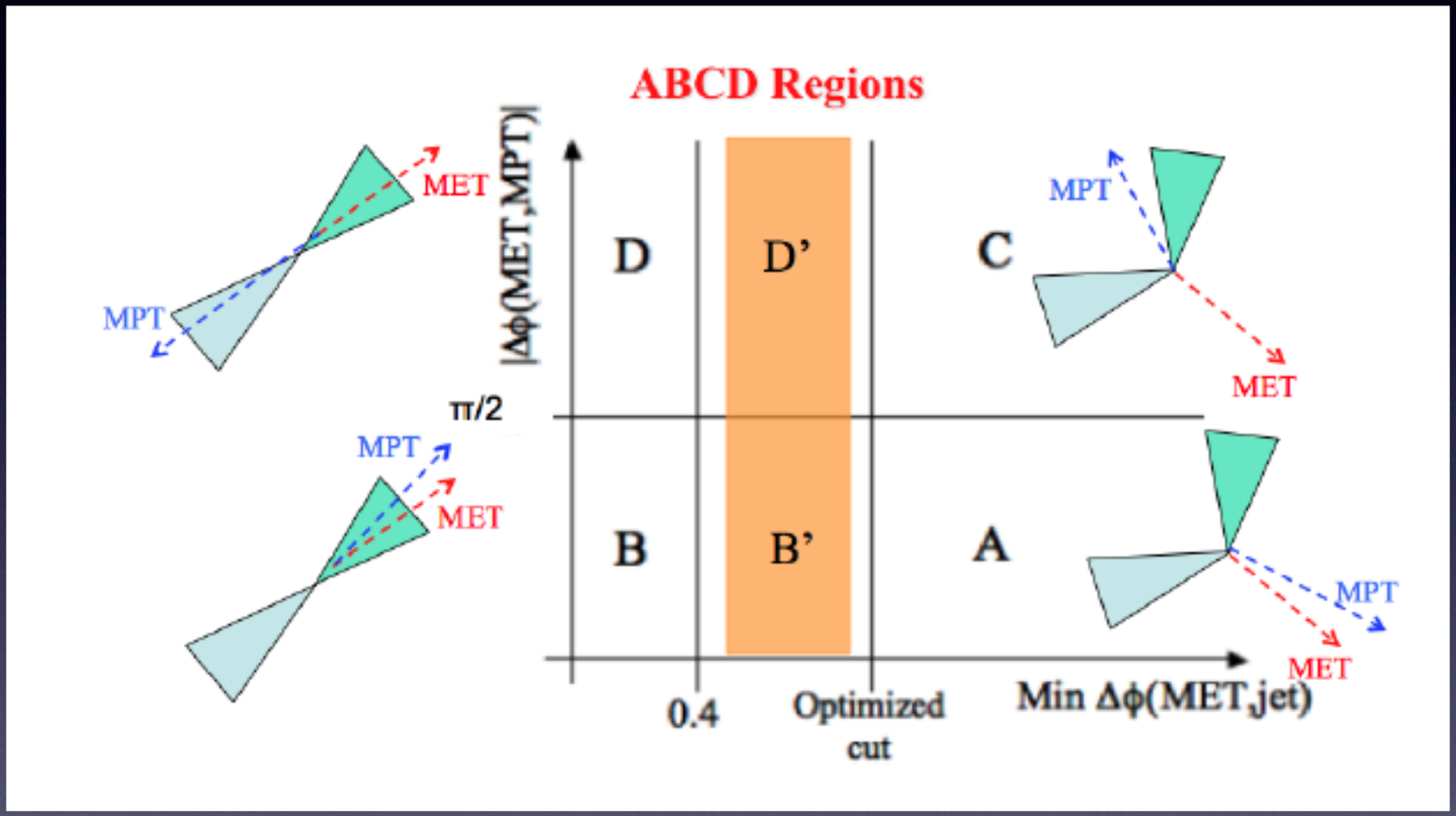
CUT base ONLY

Good Data/MC agreement

BDT training

Variable	0-Lepton	1-Lepton	2-Lepton
p_{T}^{V}		×	×
$E_{\mathrm{T}}^{\mathrm{miss}}$	×	×	×
$p_{\mathrm{T}}^{\mathrm{jet}_1}$	×	×	×
$p_{\mathrm{T}}^{\mathrm{jet}_2}$	×	×	×
m_{dijet}	×	×	×
$\Delta R(\mathrm{jet}_1, \mathrm{jet}_2)$	×	×	×
$\lvert\Delta\eta(\mathrm{jet}_1, \mathrm{jet}_2)\rvert$	×		×
$\Delta\phi(V, \mathrm{dijet})$	×	×	×
$\lvert\Delta\eta(V, \mathrm{dijet})\rvert$			×
H_{T}	×		
$\min[\Delta\phi(\ell, \mathrm{jet})]$		×	
m_{T}^{W}		×	
$m_{\ell\ell}$			×
$MV1c(\mathrm{jet}_1)$	×	×	×
$MV1c(\mathrm{jet}_2)$	×	×	×
	Only in 3-jet events		
$p_{\mathrm{T}}^{\mathrm{jet}_3}$	×	×	×
m_{jjj}	×	×	×

ABCD method


ABCD Regions
|Δφ(MET,MPT)|
π/2
D
D'
C
B
B'
A
MET
MPT
MPT
MET
MPT
MET
MET
MPT
0.4
Optimized cut
Min Δφ(MET,jet)