

# QUICK UPDATE

## 8 TeV–13 TeV comparisons

G. Aad et. al. [Number 6](#), Number 1

University of Glasgow

2016-09-14



University  
of Glasgow | Experimental  
Particle Physics

# a single, big image



an animated image (compatible with Adobe Reader)

a video (compatible with Okular)



# itemized list

- item
- item
  - subitem
  - subitem
    - subitem
- item
- item

# enumerate list

- 1 item
- 2 item
  - 1 subitem
  - 2 subitem
    - 1 subitem
- 3 item
- 4 item

# description list

A item

B item

A subitem

B subitem

A subitem

C item

D item

# description list with checkmarks

✓ item

✓ item

✓ subitem

● subitem

● subitem

✓ item

✗ item

# links

- URL: <http://info.cern.ch/hypertext/WWW/TheProject.html>
- hyperlink: TheProject
- hyperlink: ATL-COM-PHYS-2014-1471

# mathematics

- $H^+ \rightarrow tb$
- lepton  $p_T$  and  $\eta$

# mathematics

Jet pull is a variable that can be constructed from particles within a jet cone.  
The procedure is as follows:

- Select a pair of jets in an event.
- Build a vector sum of calorimeter cells within each jet.

$$\vec{p} = \sum_i \frac{E_T^i |r_i|}{E_T^{\text{jet}}} \vec{r}_i$$

- $\vec{r}_i$ : position of jet cell  $i$  relative to jet centre
- $E_T^i$ : transverse energy of cell  $i$
- $E_T^{\text{jet}}$ : transverse energy of jet

Each cell is assigned to the closer jet in  $(\eta, \phi)$  space.

# jet shape and pull

Jet shape is influenced by color flow. The pull vectors are different for the singlet and octet cases. For the singlet case the pull vector of one jet points towards the centre of the other jet and for the octet case the pull vector of one jet points somewhat away from the centre of the other jet.

The relative angle of the pull vector with respect to the connection line between the jet centres is a useful measure.

# emoticons

- smiley: 😊
- frownie: 😞
- neutralie: 😐

centered text

some centered text

some more centered text

# blocks

## block 1

item  
item

## block 2

item  
item

## columns (2)

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## multiple columns (2)

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# multiple columns (4)

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# positioning by textblock

- item 1
- item 2
- item 3

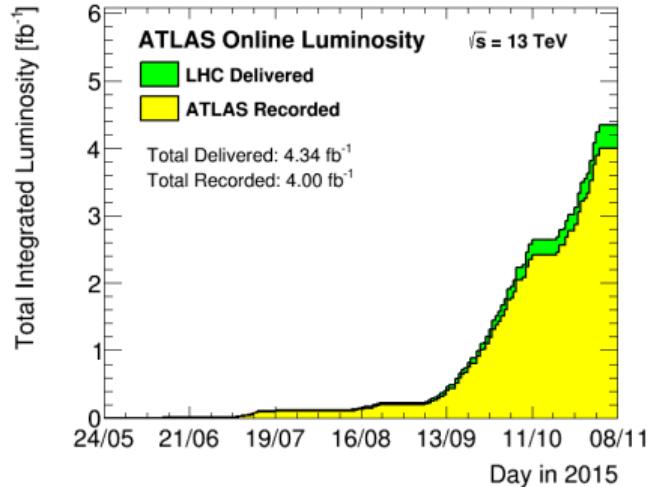
- item 1
- item 2
- item 3

- item 1
- item 2
- item 3

- item 1
- item 2
- item 3

# positioning by textblock

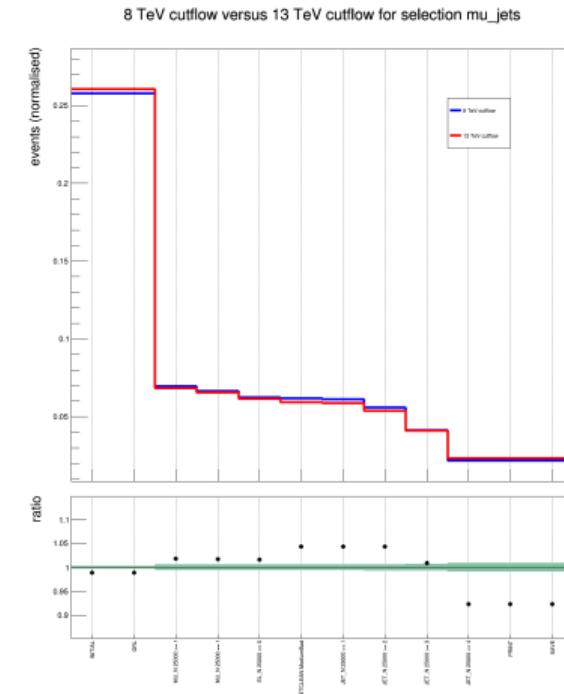
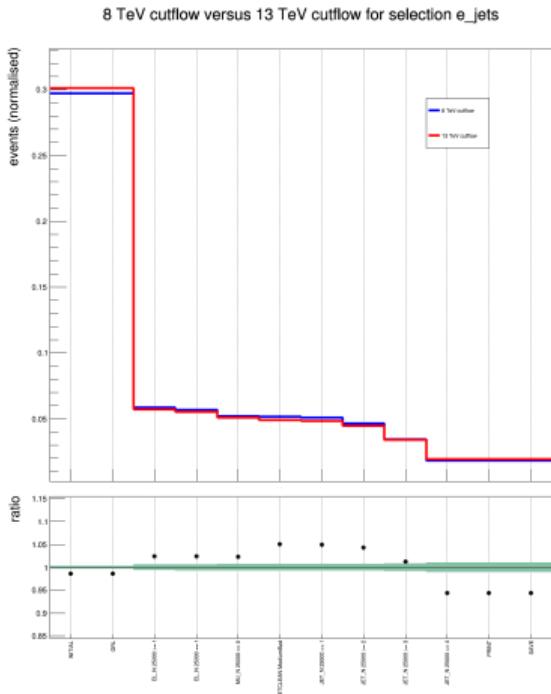
- suppressed with respect to other Higgs modes
- $H \rightarrow b\bar{b}$  has the largest branching ratio (0.577 for  $m_H$  125 GeV)
- irreducible background from  $t\bar{t}b\bar{b}$
- other backgrounds:  $t\bar{t}$  production in association with light quarks ( $u, d, s$ ) or gluon jets (called  $t\bar{t} + \text{light}$ ), and  $t\bar{t} + c\bar{c}$



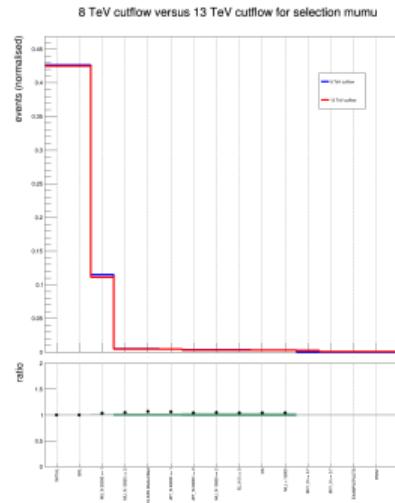
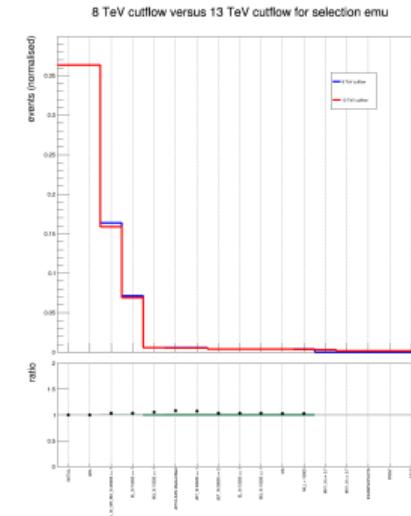
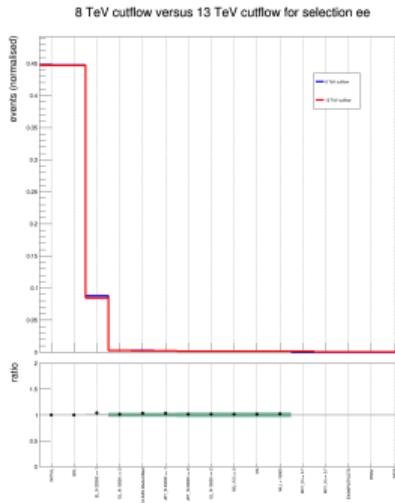
$\sqrt{s}$ (TeV)	7	8	13	14
$t\bar{t}H$ ( $m_H = 125$ GeV) (pb)	0.086	0.130	0.5085	0.611
$t\bar{t}$ (pb)	177	253	832	950
$S/\sqrt{B}$	0.00646	0.0082	0.0176	0.0198

$7 \text{ TeV} \rightarrow 13/14 \text{ TeV}: S/\sqrt{B}$  changes by factor of  $\simeq 3$

# 8 TeV vs. 13 TeV: cutflow for $\ell + \text{jets}$

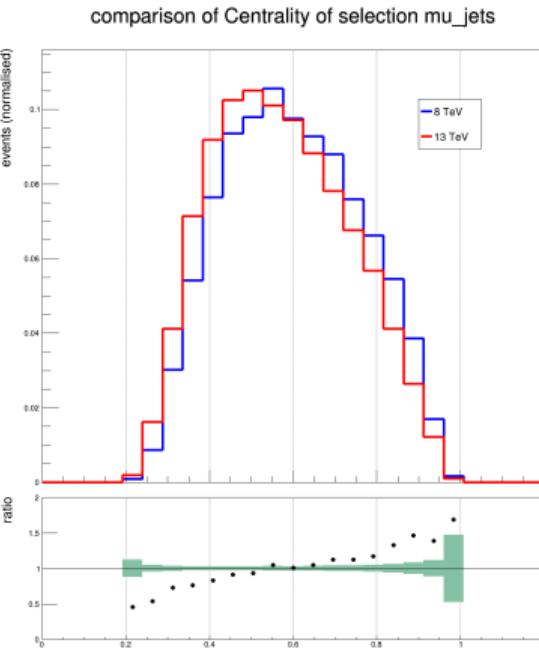
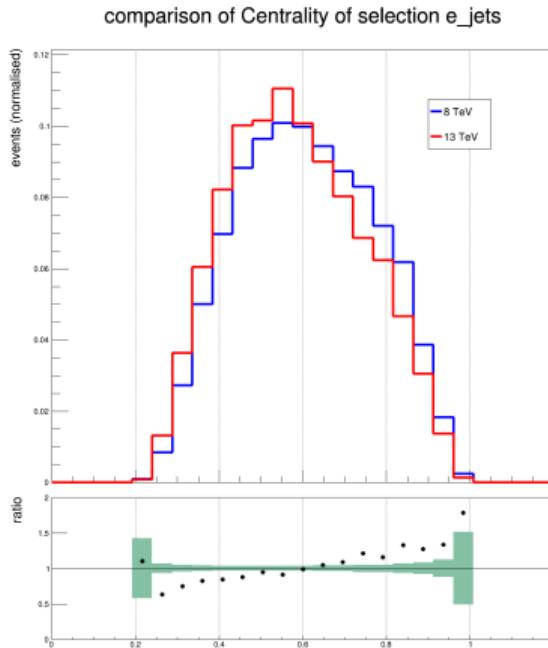


# 8 TeV vs. 13 TeV: cutflow for dilepton

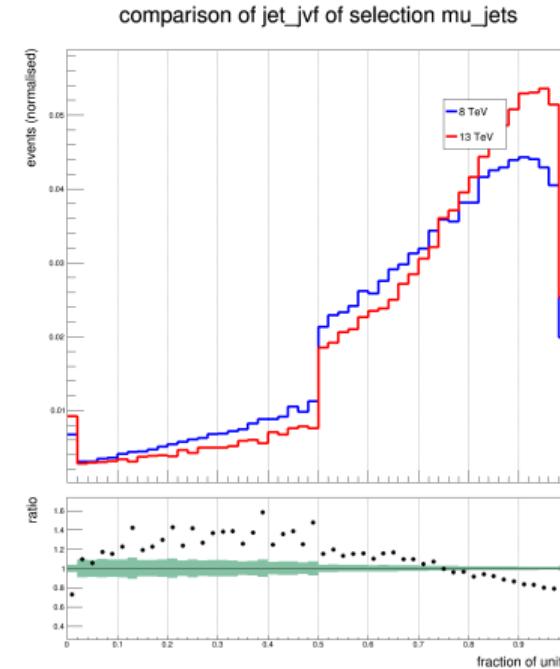
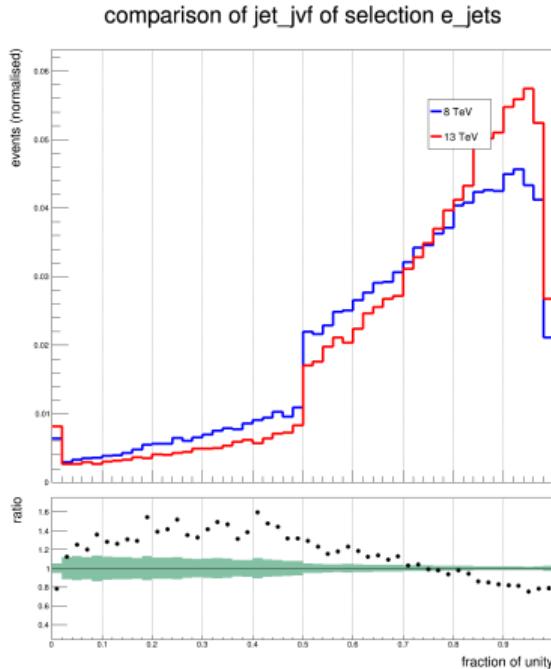


I3PD+SV1: <https://indico.cern.ch/event/387410/contribution/9/material/slides/0.pdf>

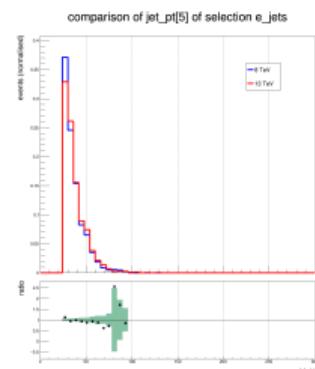
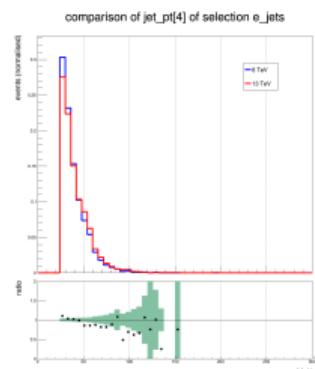
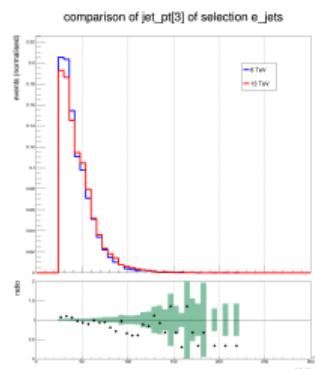
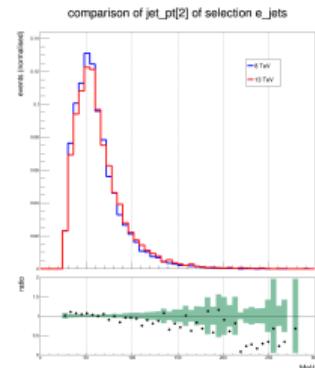
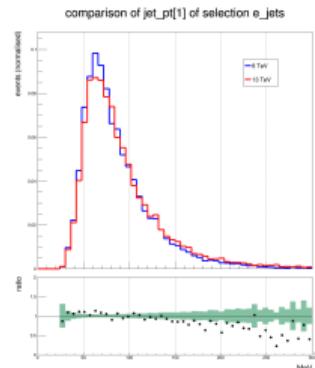
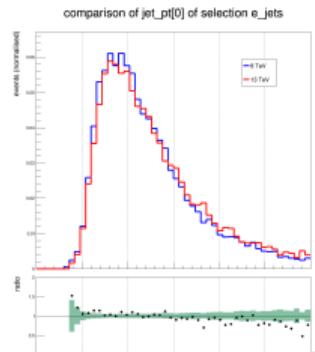
# 8 TeV vs. 13 TeV: centrality



# 8 TeV vs. 13 TeV: JVF

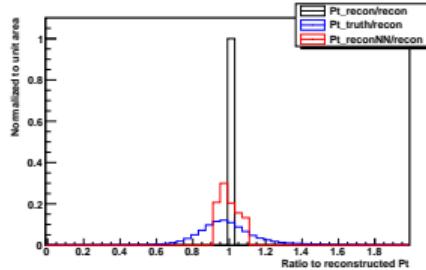


# 8 TeV vs. 13 TeV: subleading jets $p_T$ of $e$ selection

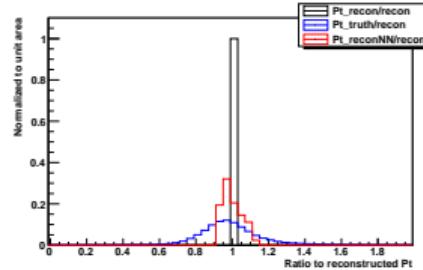


# $p_T$ ratio results for training with epochs of interest

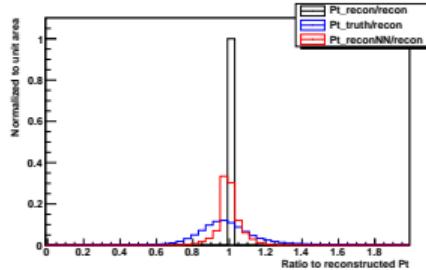
40 epochs:



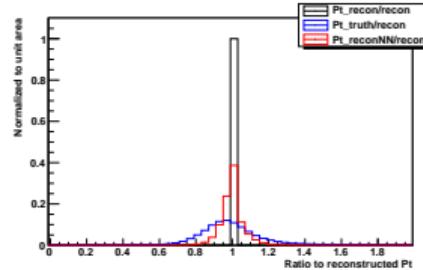
100 epochs:



145 epochs:



300 epochs:



# neural networks and input variables

Four neural networks with progressively increasing input information were defined, all trained through 250 epochs (training cycles). NN0 comprises only the  $\mu$ -in-jet and  $p_T$ -only NN corrections, as opposed to further NN corrections.

neural network designation	input variables
NN0	no new neural network applied
NN1	$E_t$ , SumPtTrk, Width
NN2	$E_t$ , SumPtTrk, Width, MET
NN3	$E_t$ , SumPtTrk, Width, MET, METPhi, JetPhi

# per-event $M_{b\bar{b}}$ resolutions with use of MET direction

$M_{b\bar{b}}$  resolutions for  $VH_{b\bar{b}}$  for progressively decreasing MET energy cut requirements for various neural networks, shown to 3 significant figures:

selection	events	NN0	NN1	NN2	NN3
$VH_{b\bar{b}}$	23686	0.133	0.129	0.131	0.131
$VH_{b\bar{b}} + \text{MET} < 100 \text{ GeV}$	22654	0.132	0.130	0.129	0.131
$VH_{b\bar{b}} + \text{MET} < 70 \text{ GeV}$	21094	0.131	0.128	0.129	0.129
$VH_{b\bar{b}} + \text{MET} < 40 \text{ GeV}$	15050	0.128	0.126	0.126	0.126
$VH_{b\bar{b}} + \text{MET} < 20 \text{ GeV}$	6174	0.130	0.127	0.126	0.127

# per event $M_{b\bar{b}}$ resolutions with use of MET direction

Here, the physical processes are ranked according to the effectiveness of the corresponding behaviour they induce in NN3, where a greater effectiveness is taken to mean a smaller resolution value. *Caveat:* Systematic uncertainties are not given their due consideration.

selection	events	NN0	NN1	NN2	NN3
$VH_{b\bar{b}} + \text{MET} > 100 \text{ GeV}$	1032	0.121542	0.129038	0.13072	<b>0.116975</b>
$VH_{b\bar{b}} + \text{MET} < 40 \text{ GeV}$	15050	0.128387	0.125939	0.125637	<b>0.125963</b>
$VH_{b\bar{b}} + \text{MET} < 20 \text{ GeV}$	6174	0.129539	0.127454	0.126029	<b>0.127043</b>
$VH_{b\bar{b}} + \text{MET} < 70 \text{ GeV}$	21094	0.131248	0.128119	0.128908	<b>0.128825</b>
$VH_{b\bar{b}} + \text{MET} < 100 \text{ GeV}$	22654	0.132004	0.129924	0.129095	<b>0.130467</b>
$VH_{b\bar{b}}$	23686	0.132823	0.129032	0.131202	<b>0.131303</b>
$VH_{b\bar{b}} + \text{MET} > 20 \text{ GeV}$	17512	0.135974	0.13137	0.13366	<b>0.132341</b>
$VH_{b\bar{b}} + \text{MET} > 40 \text{ GeV}$	8636	0.140116	0.135415	0.140013	<b>0.140551</b>
$VH_{b\bar{b}} + \text{MET} > 70 \text{ GeV}$	2592	0.143505	0.15228	0.151469	<b>0.155914</b>

# $m_{b\bar{b}}$ value results for training with epochs of interest

$m_{b\bar{b}}$  resolution results (Gaussian fit) for training with epochs of interest:

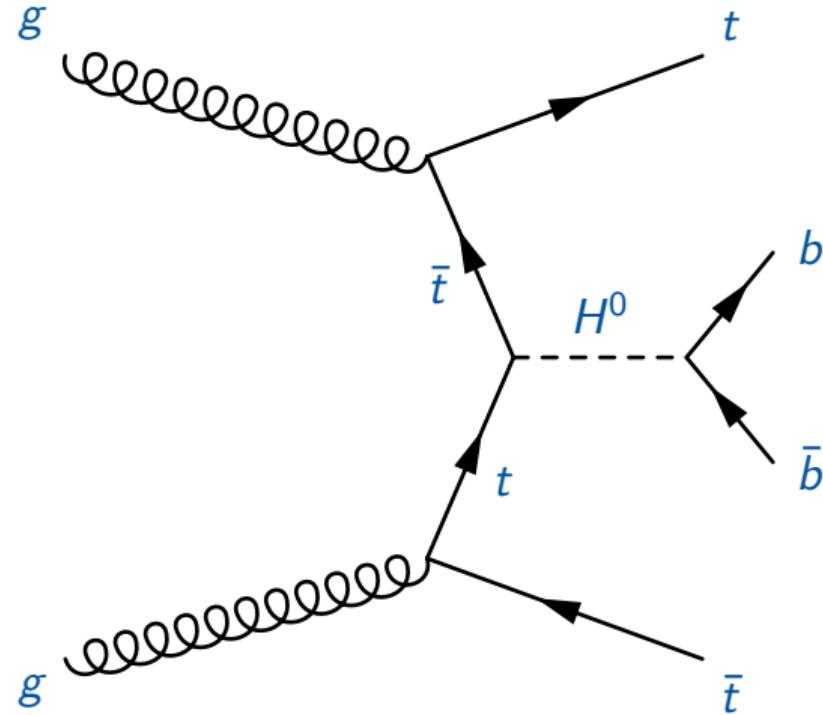
subset		epochs			
		40	100	145	300
	training	0.137	0.138	0.138	0.138
	training test	0.139	0.139	0.139	0.139

# $m_{b\bar{b}}$ resolutions with and without MET

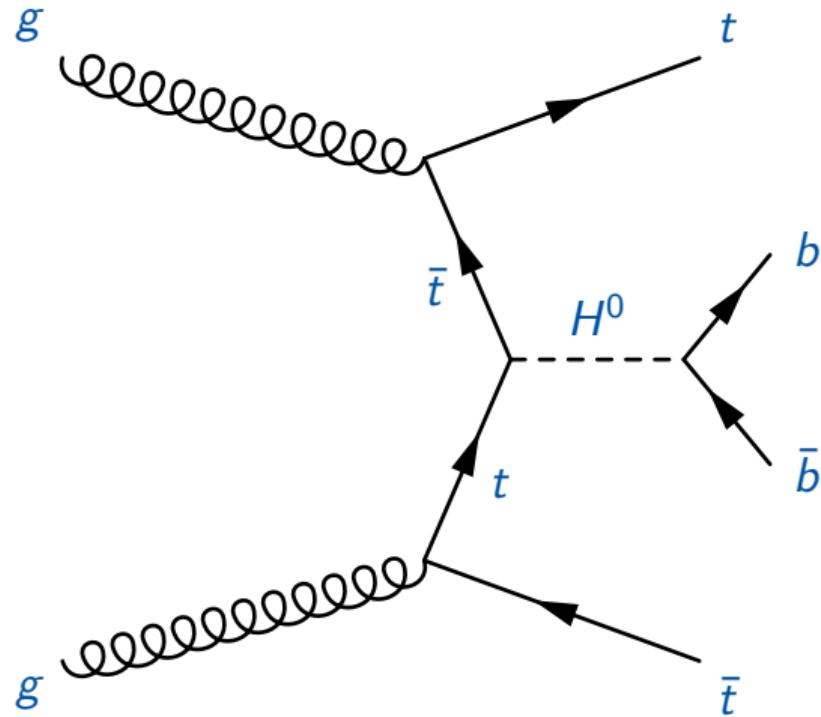
comparison of  $m_{b\bar{b}}$  resolutions for various channels both excluding and including the MET variable with various epochs:

number of epochs		$l\nu bb$	$llbb$	$\nu\nu bb$	all
50	without MET	0.135159	0.138616	0.135159	0.137488
	with MET	0.130047	0.137266	0.136842	0.138516
	change	-3.78%	-0.97%	+1.24%	+0.75%
100	without MET	0.134537	0.138781	0.13656	0.13743
	with MET	0.129719	0.137265	0.136247	0.138948
	change	-3.58%	-1.09%	-0.22%	+1.1%
150	without MET	0.13676	0.138464	0.137943	0.13747
	with MET	0.138292	0.137261	0.137344	0.138948
	change	+1.12%	-0.87%	-0.43%	+1.07%
500	without MET	0.139041	0.139451	0.13849	0.13827
	with MET	0.139225	0.137261	0.136398	0.138948
	change	+0.13%	+1.6%	-1.51%	-0.48%

# Feynman diagram

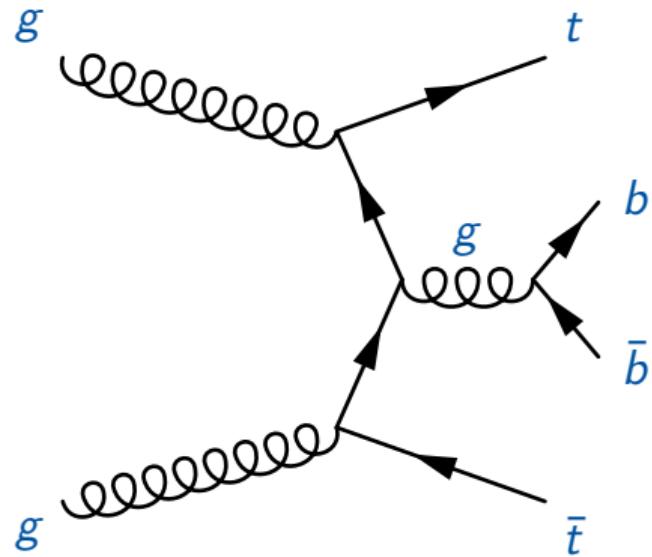
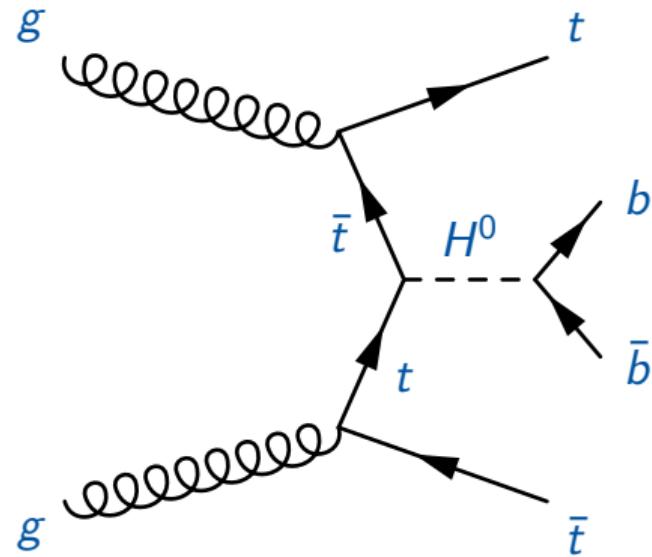


# Feynman diagram with text



Nulla consequat massa quis enim.  
Donec pede justo, fringilla vel, aliquet  
nec, vulputate eget, arcu. In enim justo,  
rhoncus ut, imperdiet a, venenatis vitae,  
justo. Nullam dictum felis eu pede mol-  
lis pretium.

# Feynman diagrams



# embedded data

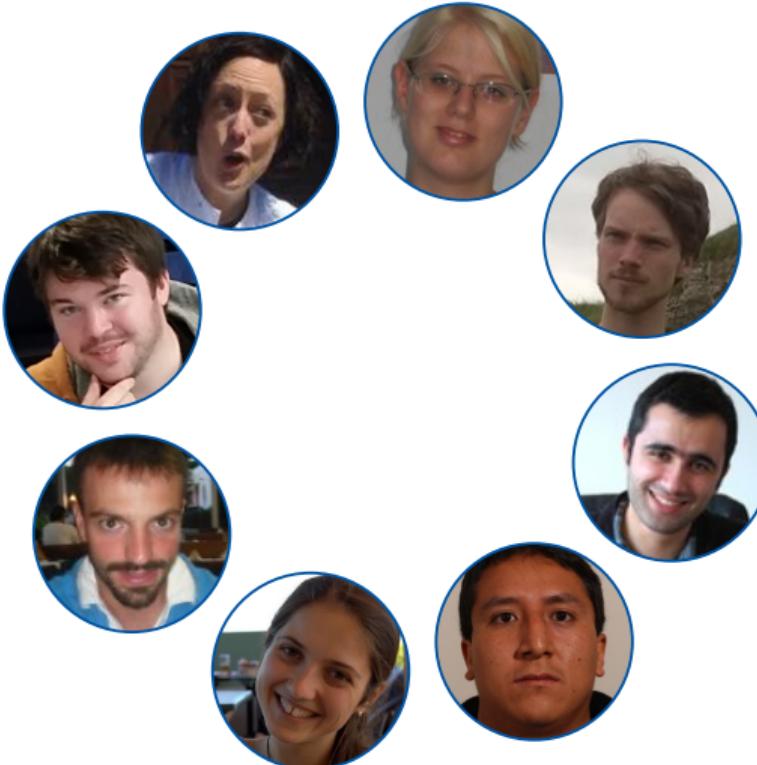
The following is an embedded data file:



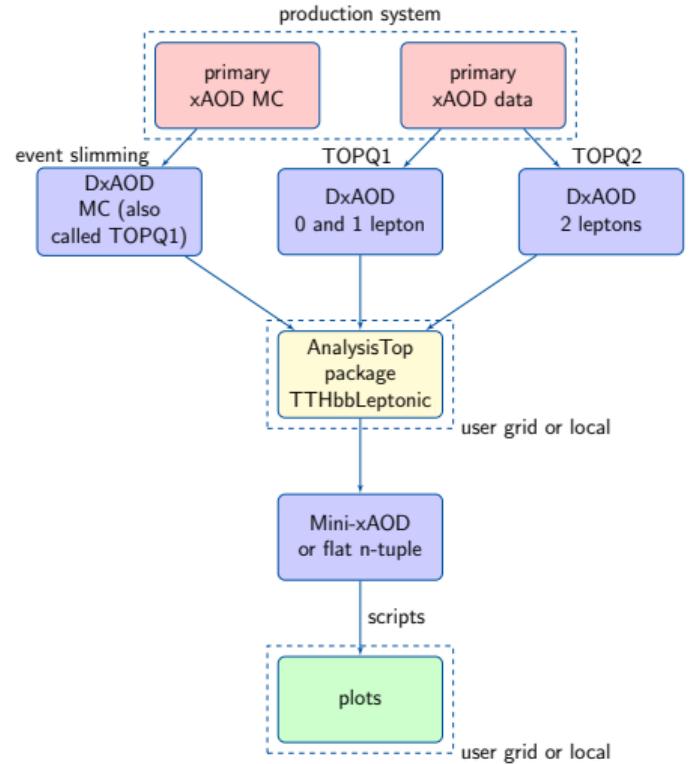
The following is an embedded sound file:



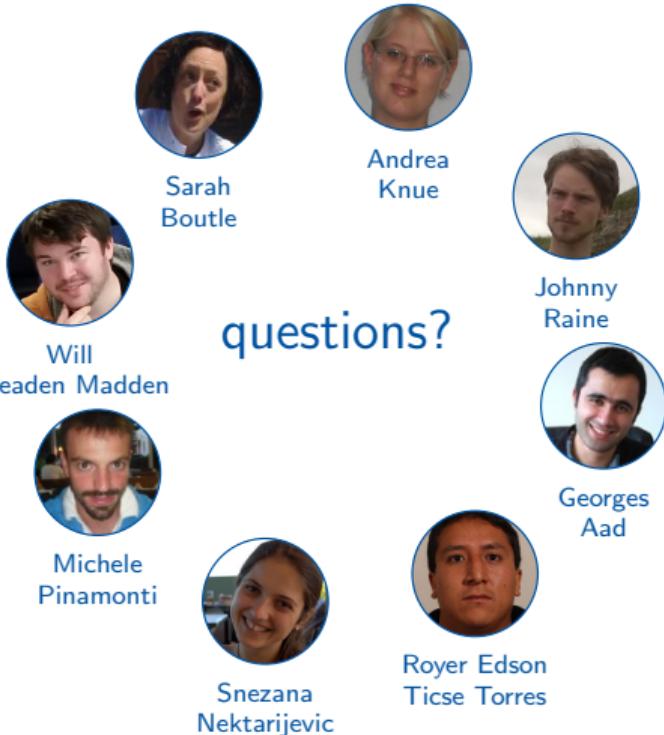
# TTHbbLeptonic development team



# analysis framework



# questions?



END