Status report on $b\bar{b}(H \rightarrow b\bar{b})$ analysis using leptonic channel

Stefano Lacaprara, Ugo Gasparini, Massimo Nespolo, Antonio Branca, Andrea Gozzelino, Tommaso Dorigo, Alberto Zucchetta, Mia Tosi

INFN Padova

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Intro

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- Neutral SUSY Higgs, low mass $\Phi \rightarrow b\bar{b}$;
- Use associate production to reject hadronic background $pp \rightarrow b\bar{b}H \rightarrow b\bar{b}b\bar{b}$

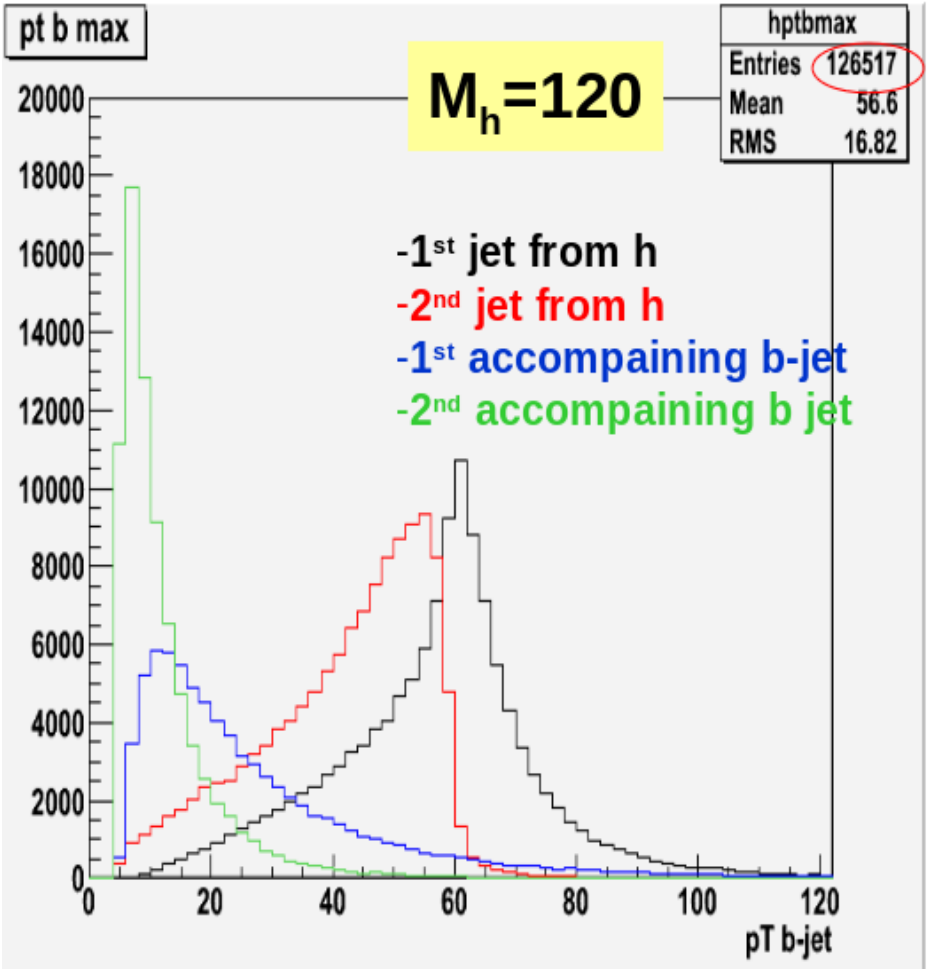
signature multiple $b-tag$ jets in the event;
  - a non-isolated muon from b decay;
  - reconstruct $b\bar{b}$ invariant mass;

background mostly QCD, with real or mis-tagged b-jets;
  - $t\bar{t}$, Zbb, ZZ, WZ, ...

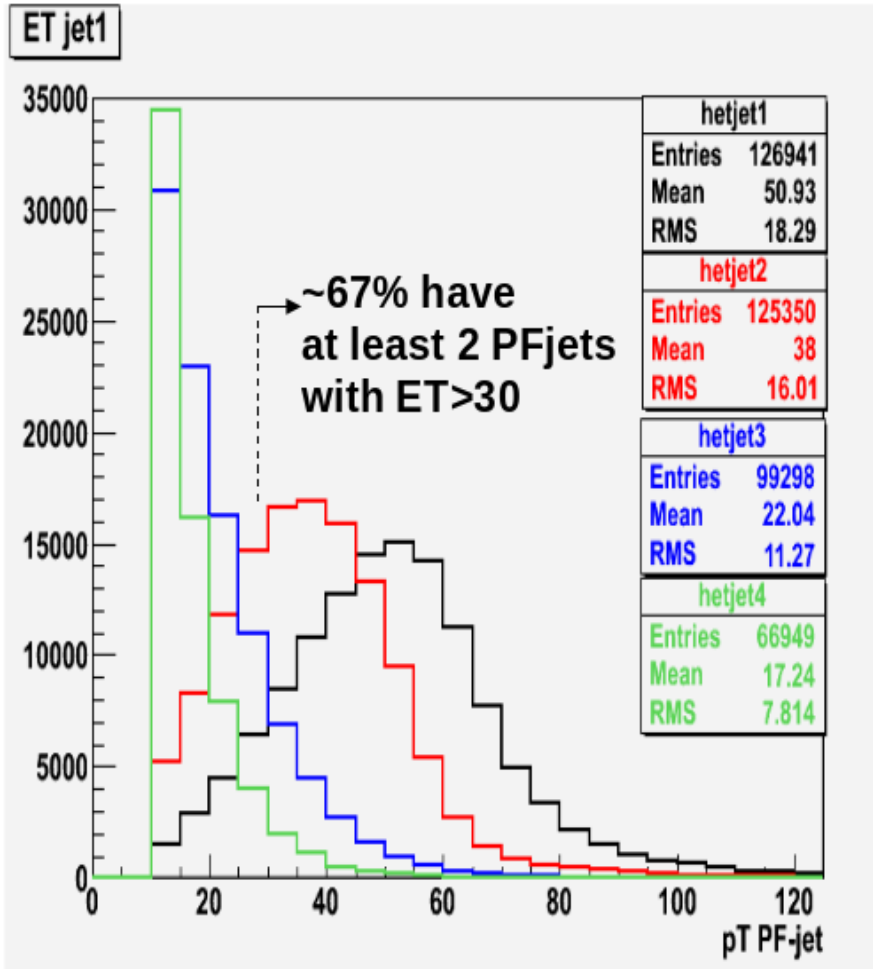
- Which Trigger?
- Which sensitivity for $\int \mathcal{L}dt = 300\ pb^{-1}$ – $1\ fb^{-1}$?

Building blocks for a Trigger path: B-Jet p_t

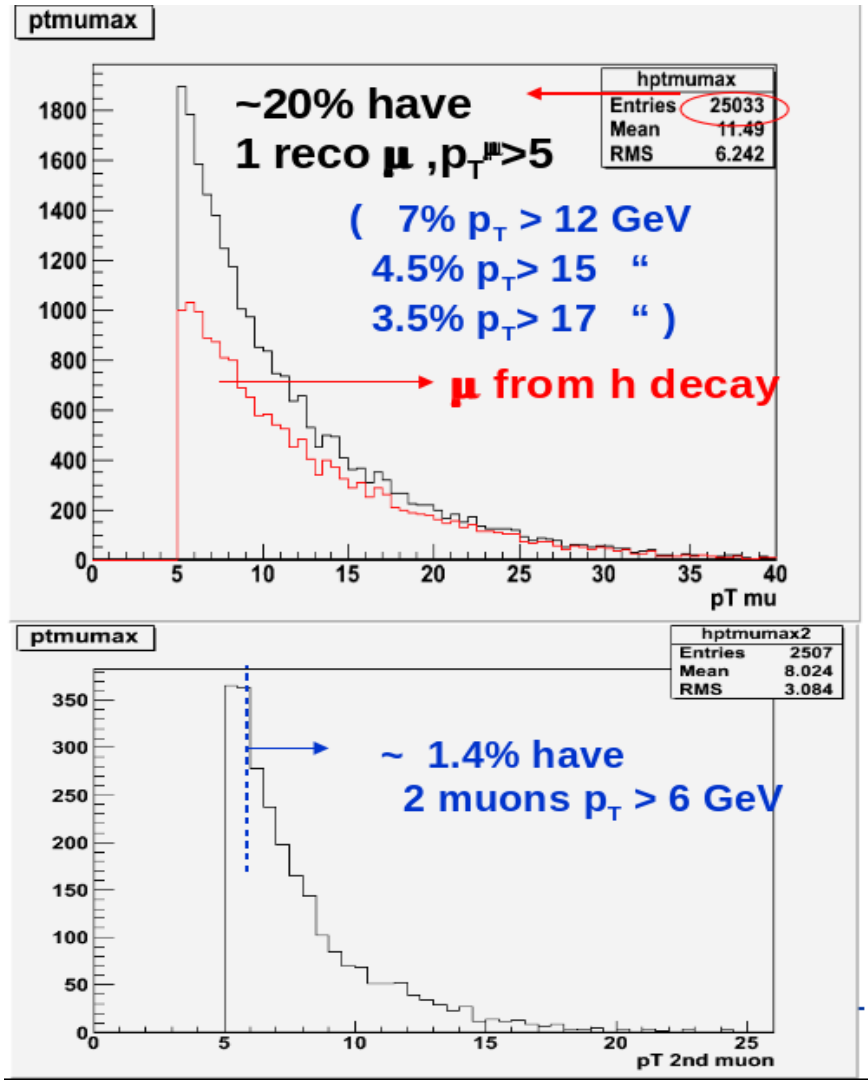
Generation (~126 kev)

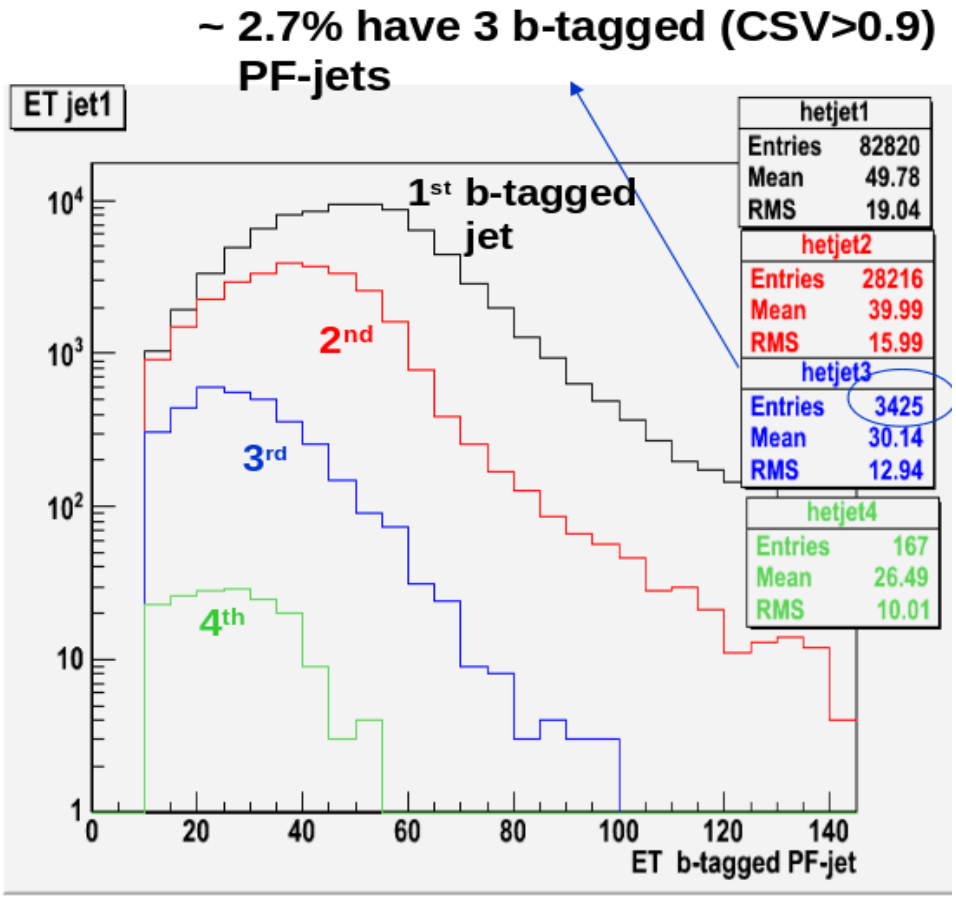


Reconstruction (PFjets)



Building blocks (II): Mu p_t and $B - tag$





Which Trigger?

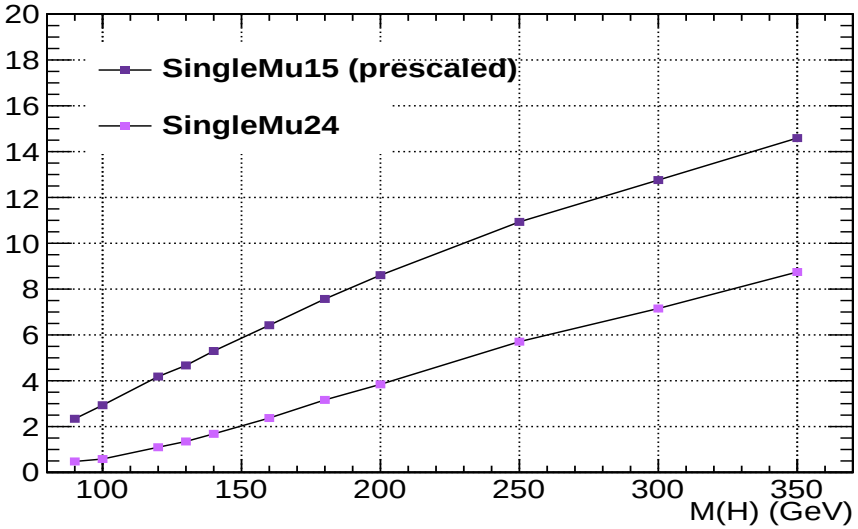
Which HLT trigger path?

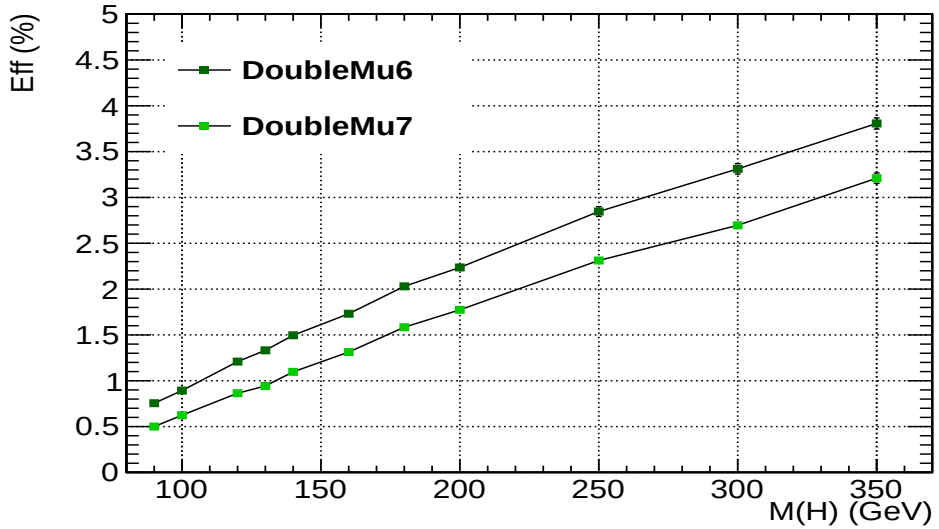
- Look for muon at HLT: requires one b semi-leptonic decay
- pure leptonic Non isolated lepton: foreseen threshold for single $\mu : p_t > 24\ GeV$;
- For double $\mu : p_t > 6(7)\ GeV$;
- hadronic+lepton trigger
- b-tag+hadronic+lepton trigger
- lepton+HT threshold too high

Warning

- Efficiency for $M(H) = 90 - 350\ GeV$;
- Rate using OpenHLT, on run 149181 ($\mathcal{L} \sim 1.4 \cdot 10^{32}$) scaled to $5 \cdot 10^{32}$;

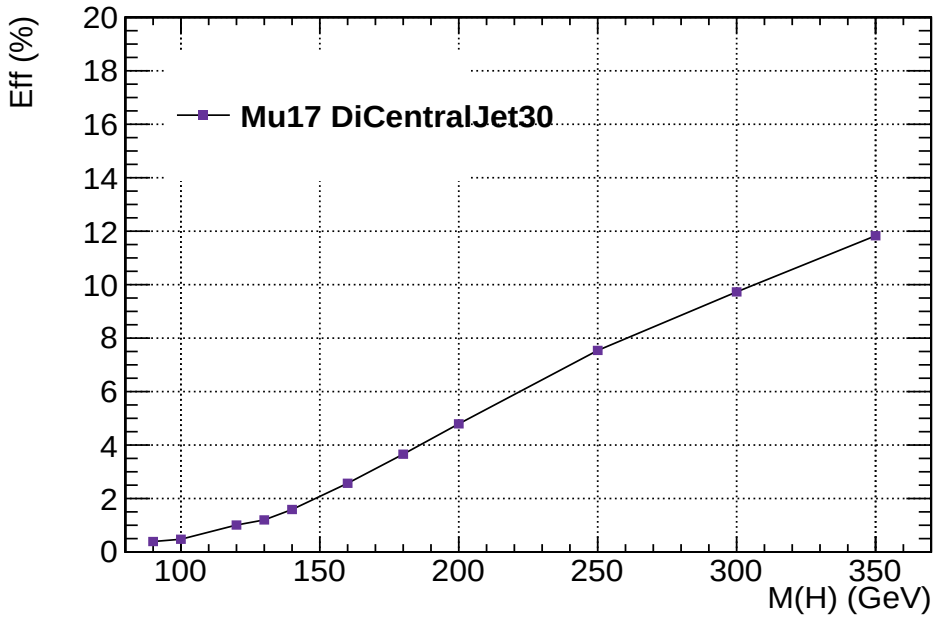
Pure leptonic trigger: Single and DoubleMu





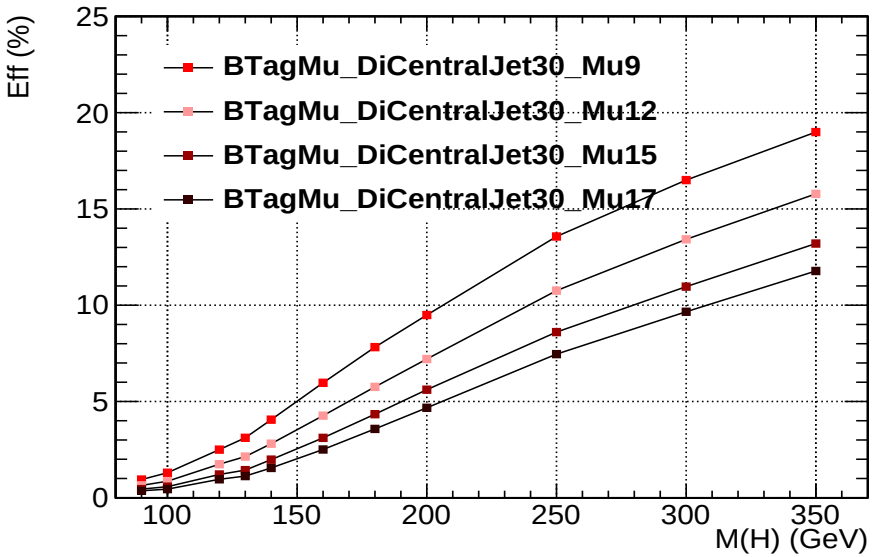
- Benchmarck for $M_H = 120\ GeV$
- SingleMu $\epsilon(p_t > 15\ GeV) = 4.2\%$ $\epsilon(p_t > 24\ GeV) = 1.1\%$
- DoubleMu $\epsilon(p_t > 6\ GeV) = 1.2\%$ $\epsilon(p_t > 7\ GeV) = 0.9\%$

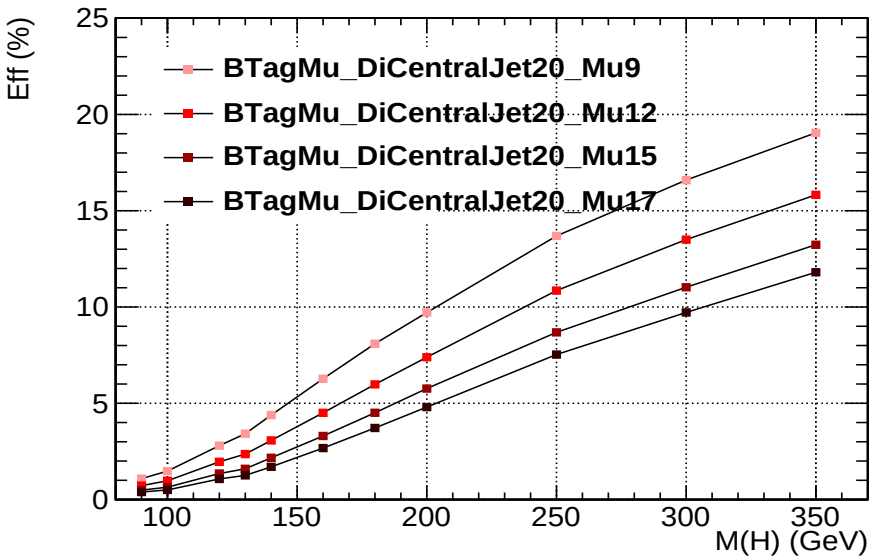
leptonic-hadronic trigger Mu17+DiCentralJet30



- Already in the HLT table (top): rate ~ 4 *Hz* (found (8.7) *Hz* in HLT_v4 table for $5 \cdot 10^{32}$)
- Benchmark for $M_H = 120$ *GeV* $\epsilon = 1.0\%$
- No explicit b-tagging required
- The Mu threshold is quite high, possible to lower it including BTag?

Add BTagMu to leptonic-hadronic trigger

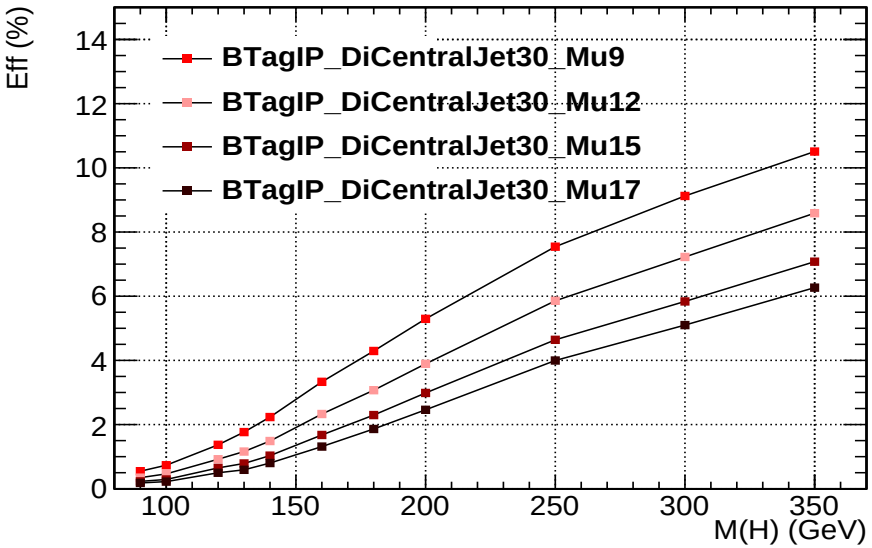


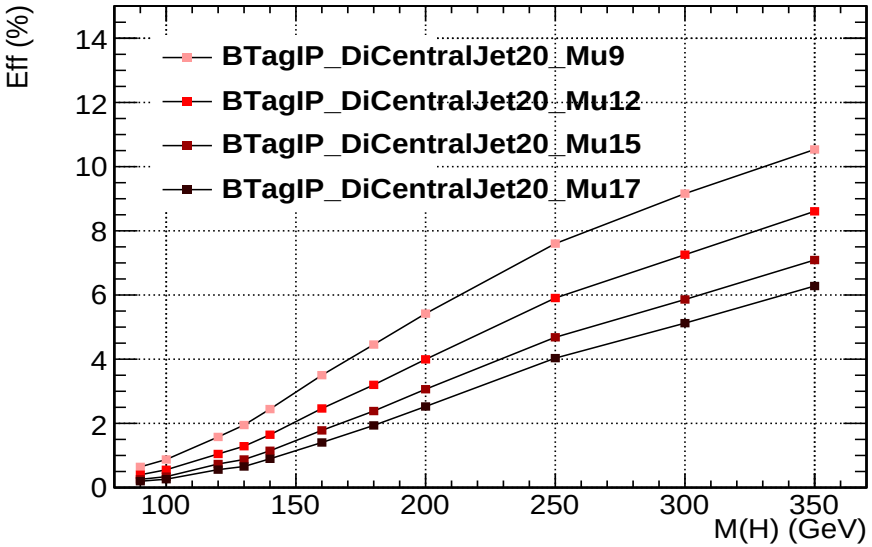


$M_H = 120\ GeV$	$\epsilon(\%)$	$Rate(Hz)$
μ17_DiCen*Jet*30	1.0	4
BTagMu+	0.96	3.6
μ15	1.21	4.6
μ12	1.74	7.5
μ9	2.5	11.2
BTagμ DiCen*Jet*20 μ17	1.01	3.9
μ15	1.35	5.1
μ12	1.96	8.3
μ9	2.8	12.7

- Adding BTagMu reduces rate only a little;
- (please note a possible factor 2 in absolute rate estimate, relative rate is ok)

Likewise with BTagIP





$M_H = 120\ GeV$	$\epsilon(\%)$	$Rate(Hz)$
μ17_DiCen*Jet*30	1.0	4
BTagμ+	0.96	3.6
BTagIP+	0.5	0.6
μ15	0.65	0.8
μ12	0.92	1.2
μ9	1.37	2.0
BTagIP DiCen*Jet*20 μ17	0.56	0.7
μ15	0.73	0.9
μ12	1.0	1.4
μ9	1.6	2.2

- Adding BTagIP reduces a lot rate but efficiency as well;
- Possibly very sensitive to PU;
- (please note a possible factor 2 in absolute rate estimate, relative rate is ok)

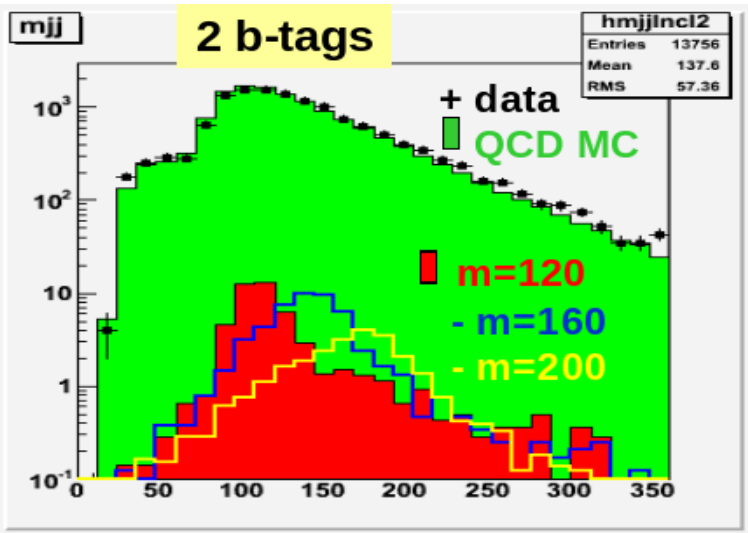
A note on L1 seed

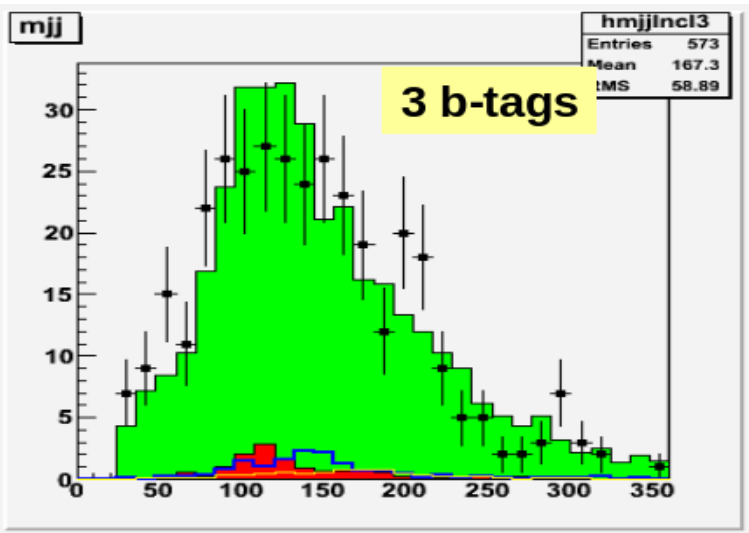
Which L1 Seed?

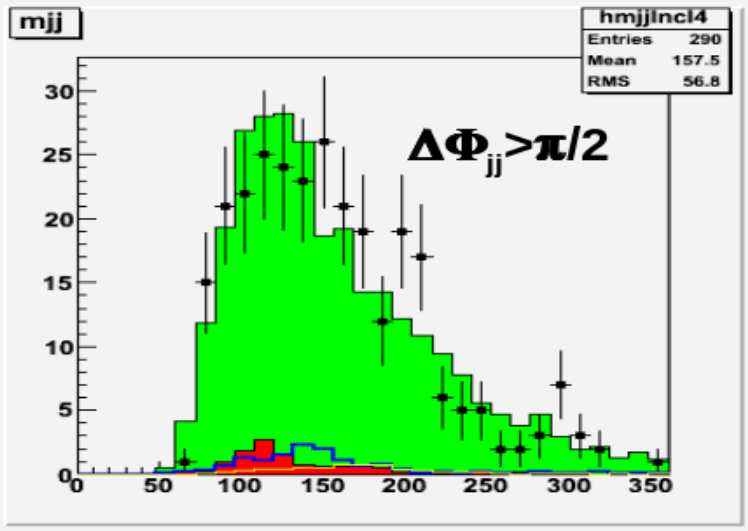
- Tried to look at previous HLT trigger with the lowest, unprescaled L1Seed *L1_Mu7_Jet20_Central*;
- Tried also pure leptonic L1 trigger *L1_SingleMu7* (expected to be prescaled) and the HLT efficiency is significantly higher;
- example: BTagMu_DiCentralJet30_Mu15 has:
  - $\epsilon = 1.2\%$ with *L1_Mu7_Jet20_Central*.
  - $\epsilon = 1.6\%$ with *L1_Mu7_Jet10_Central*.
  - $\epsilon = 2.4\%$ with *L1_SingleMu7*
- Checked also the prescaled *L1_Mu3_Jet20_Central* and the HLT efficiency is unchanged;
- Why? Looks strange to me . . .

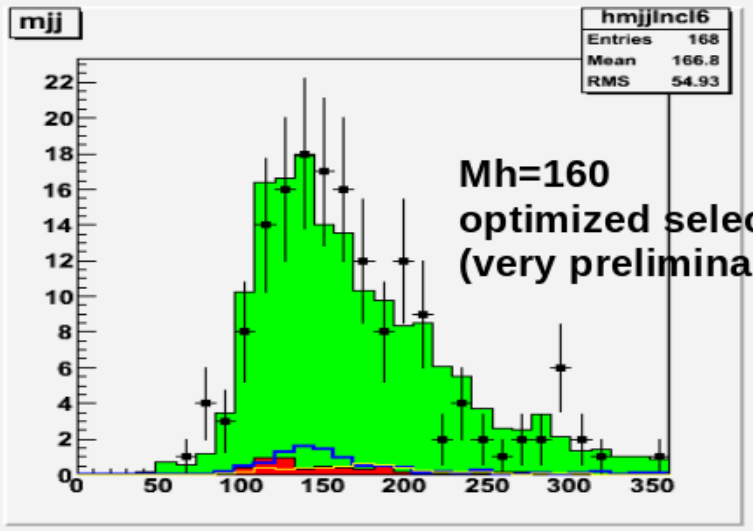
Sensitivity with Mu17+DiCentralJet30: $M_{b-jet,b-jet}$

what does efficiency $\sim$ few % really mean?









Trigger:
P_T^{μ}>17

central dijets>30

b-tag: CSV>0.9

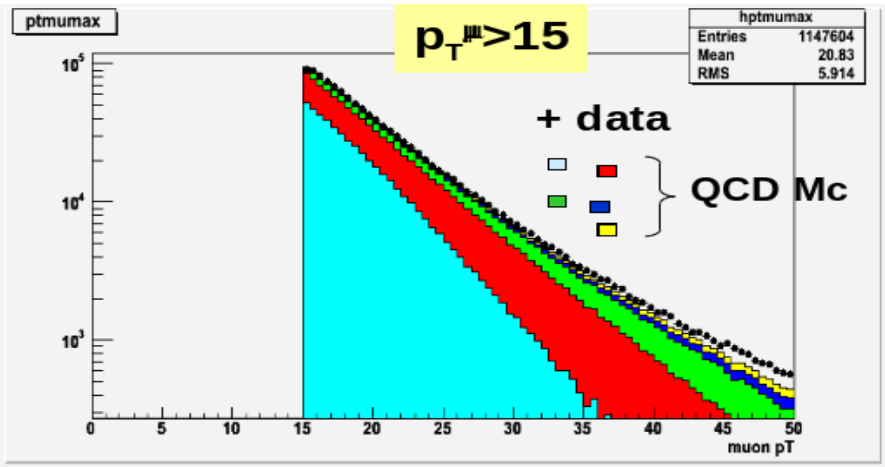
$\eta_{1,2}$<2.0
$ET_{1,2}$>40,35

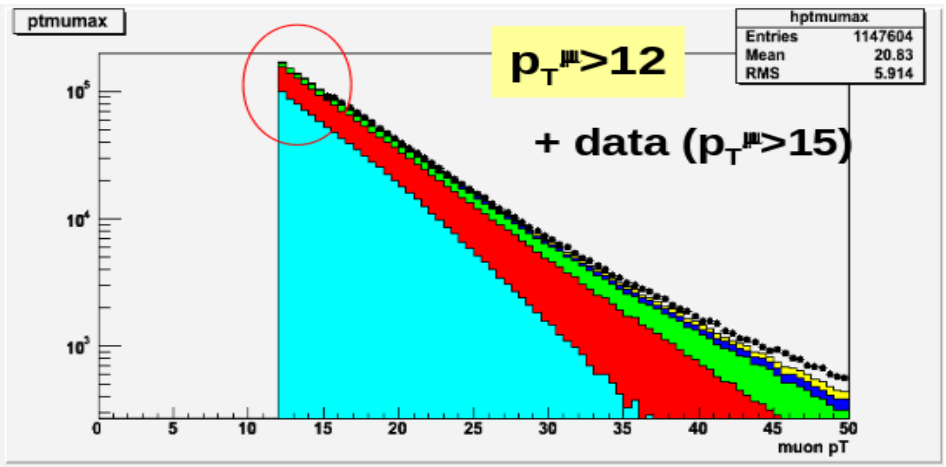
Expected sensitivity for 2011: Very preliminary

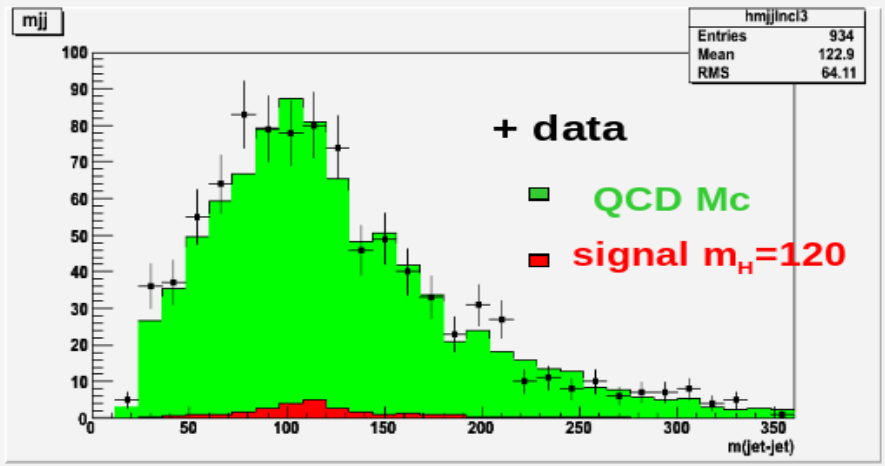
	Mass	$\tan\beta = 30$			$\tan\beta = 35$		
	GeV	S	B	$S/\sqrt{B+S}$	S	B	$S/\sqrt{B+S}$
$300/pb$	120	125	2200	2.6	170	2200	3.6
$300/pb$	160	100	1900	2.3	130	1900	3.0
$300/pb$	200	33	1200	0.9	45	1200	1.3
$1/fb$	120	420	7200	4.8	570	7200	6.6
$1/fb$	160	330	6200	4.0	430	6200	5.4
$1/fb$	200	110	3700	1.8	150	3700	2.4

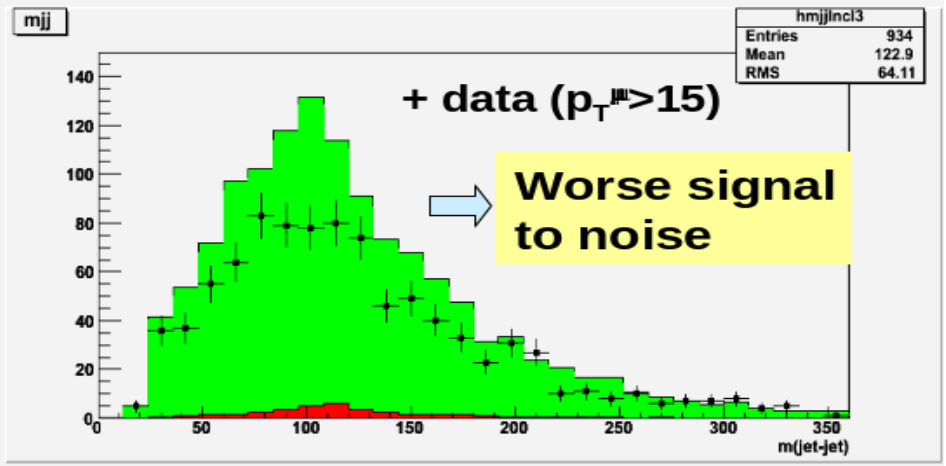
- pure statistical estimate;
- no syst (background shape will be major challenge);
- improvement on analysis also possible (cut optimization, MVA, ...).
- What do we gain in lowering the muon threshold?

Lowering the Mu threshold: 15 and 12 GeV









w.r.t. $\mu > 17\ GeV$:

$\mu > 15$: $S \approx \times 1.4$ $B \approx \times 2.8$

$\mu > 12\ GeV$, $S \approx \times 2$ $B \approx \times 4.3$

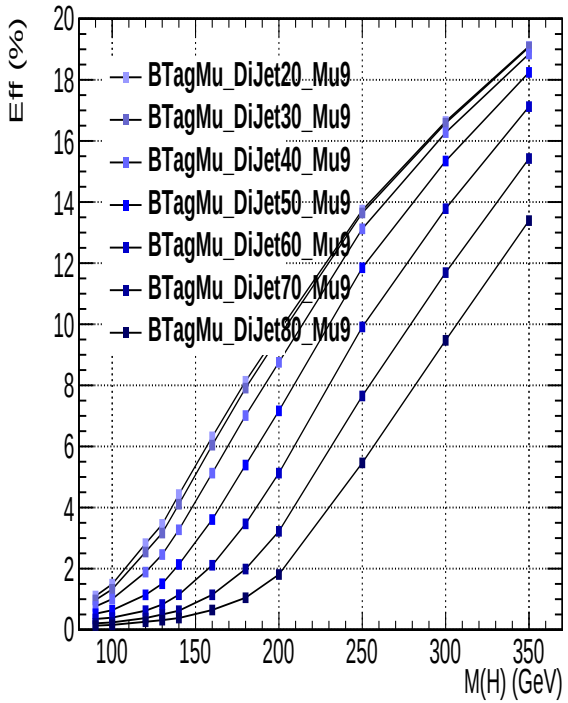
Conclusion

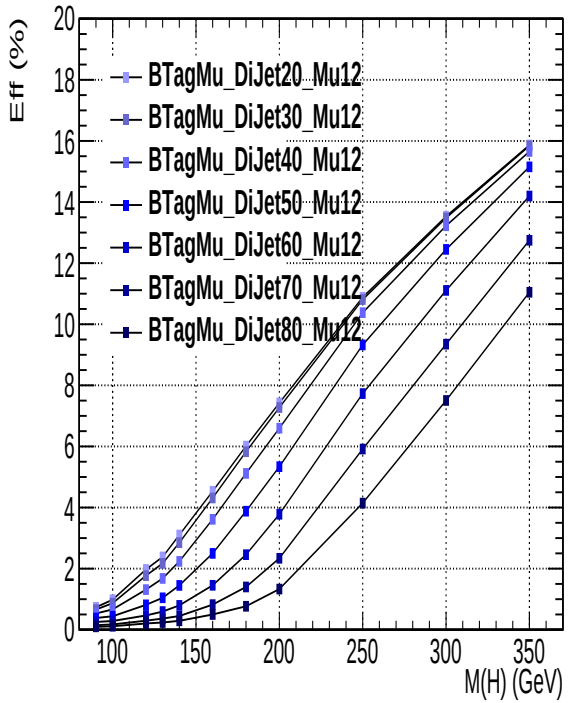
Trigger

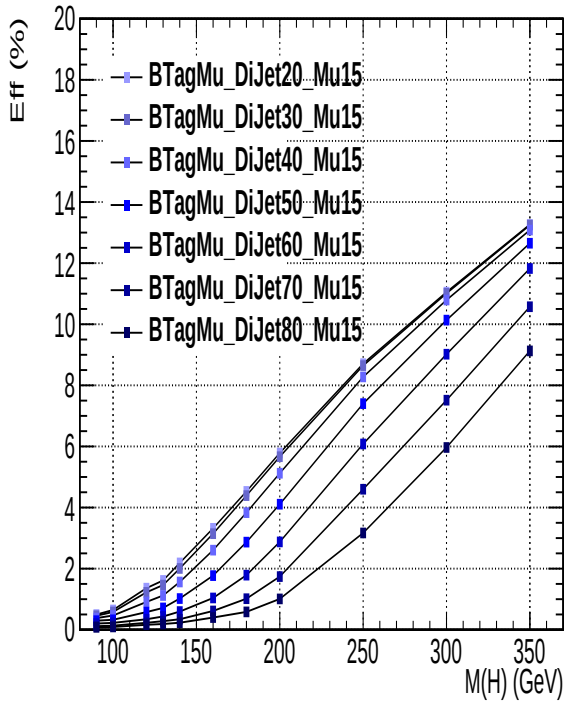
- Most promising is a combined trigger:
  - such as **Mu17_DiCentralJet30**: Mu threshold at HLT same as for the analysis ...
  - **BTagMu** add something to the game, but not so much;
  - **BTagIP** efficiency drops a lot;
  - Looking at **BTag** +Mu +3 Jets: *in progress*;
- Pure Di-Muon trigger maybe also possible;
- But, preliminary results show that analysis is less sensitive with lower Mu threshold
- Proposed HLT trigger PATH
  - Already in table Mu17_DiCentralJet30
  - New BTagMu_Mu15_DiCentralJet30
  - Possible but not high priority BTagIP_Mu12_DiCentralJet30

Backup slides

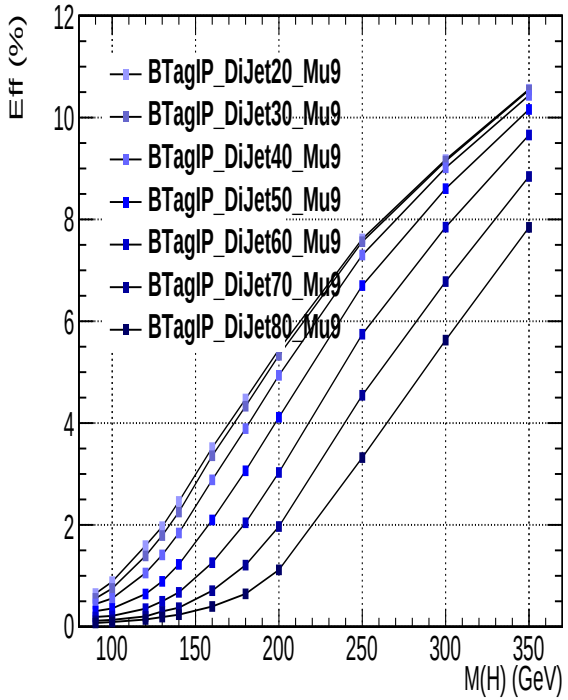
HLT: BTagMu_DiJetX_MuY (not Central)

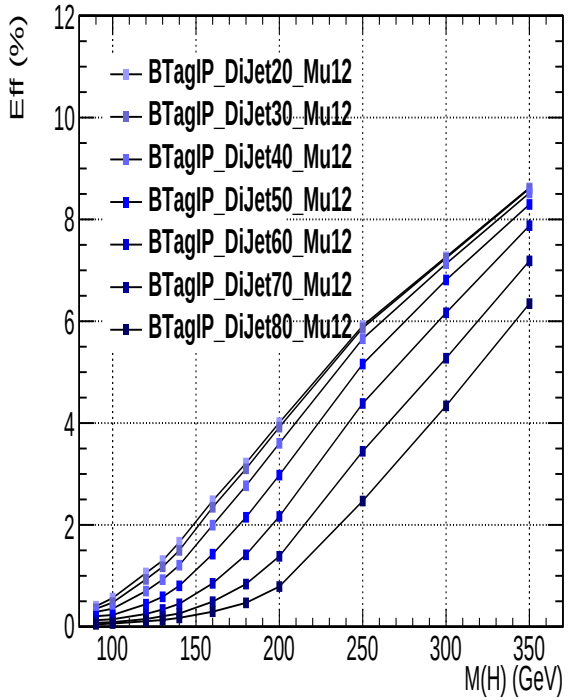


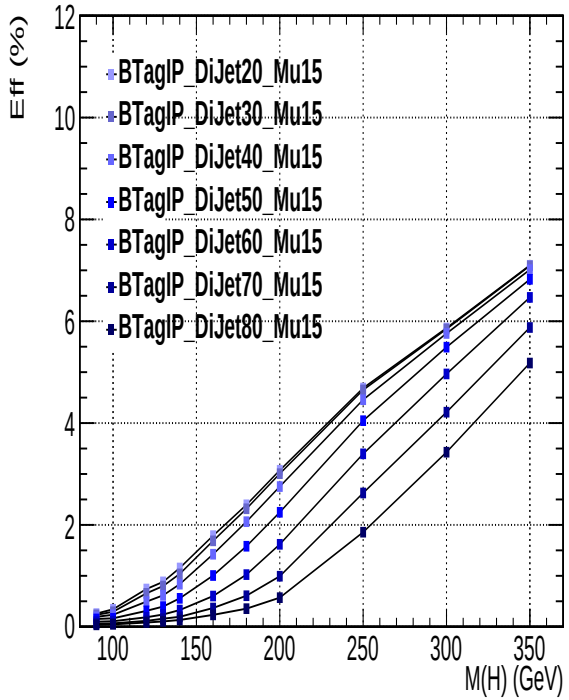




HLT: BTagIP_DiJetX_MuY (not Central)







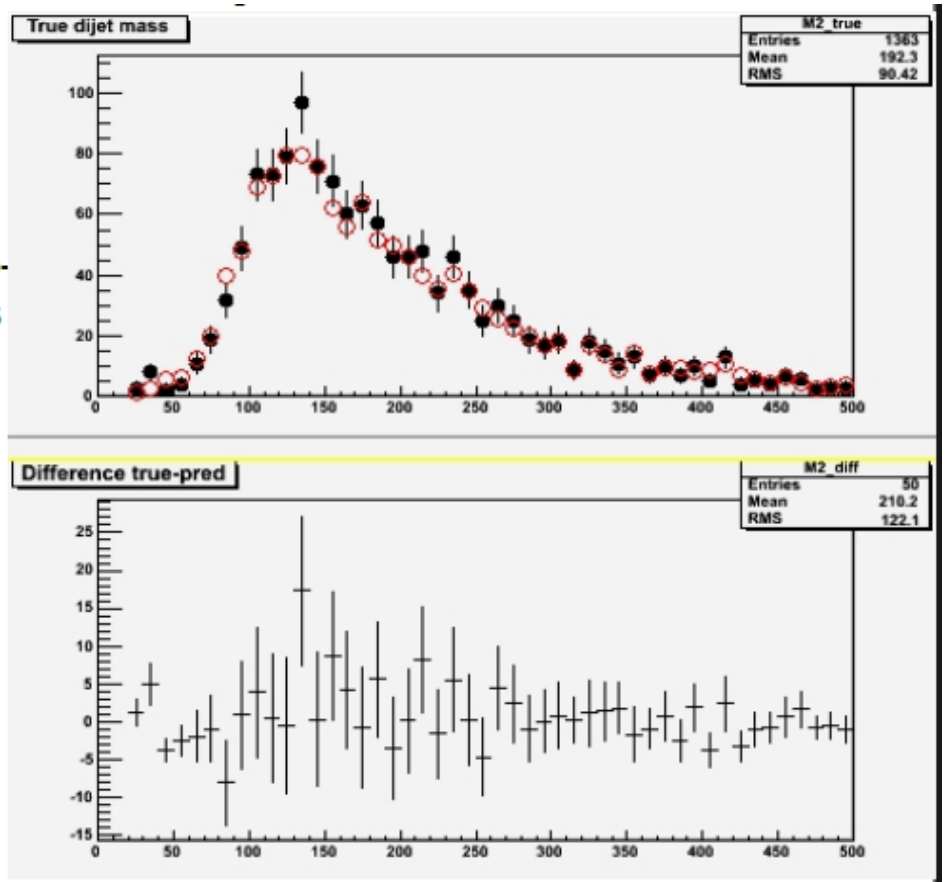
Data-driven approach to Background Shape of Mass Spectrum

Using events with 2 jets, it is possible to parametrize the probability that both contain a b-tag as a function of jet and event characteristics

We study the dependence of the double-b-tagging rate on kinematics, then extract the double-btag probability with a multi-variable approach (Hyperball method):

$P(bb)[E_T^1, \eta^1, N_{trk}^1, N\mu^1, P_T^\mu, E_T^2, \eta^2, N_{trk}^2, N\mu^2, P_T^\mu, \Delta\Phi_{12}, H_T, E_T^{max}(|\eta|>2.5)]$

We plan to produce a data-driven estimate of the shape and normalization of the dijet mass distribution with an error <2%



Test on small sample, single-b-tags
black: mass spectrum of jet 1-2 in 3-jet events
red: tag matrix ABSOLUTE prediction