Single Top :
b-tagging Studies Update

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Outline

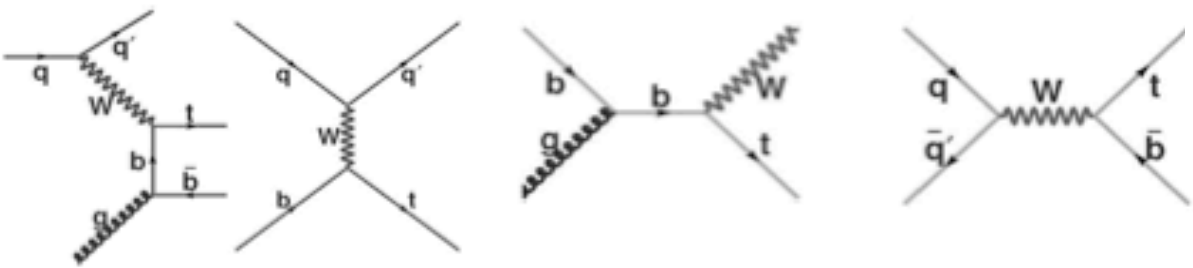
- Preliminary look at b-tagging efficiency and light jet rejection
  - Sept 2005, cone 0.7, no TruthInfo accessed
  - Dec 2006, cone 0.7, accessing TruthInfo
  - March 2006, cone 0.4 reprocessed
- Using as reference the talks of:
  - L. Vacavant, Rome Workshop
  - J.B. deVivie, May 2005 b-tagging group
  - L.Vacavant, Feb 2006, pg15
- Comparison between LHSig and FabSV
- Adding now W* and Wgluon channels

Release 10.0.1
ATL-PHYS-COM-036

Single Top at LHC

- All 3 contributing mechanisms in SM:

W-g (t-channel) W+t W* (s-channel)



Decay modes:

- W* : W* → t bbar → ($l^+\nu b$) bbar
- Wg: q'g → t q bbar → ($l^+\nu b$) q bbar
- W+t: bg → t W → ($l^+\nu b$) qq'

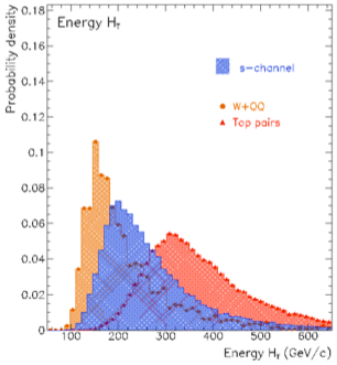
1 leptons + MET
+ ≥ 2 jets
+ 1(2) b-tags

Channel	σ x BR(pb)
W-g	54.2
W+t	17.8
W*	2.2
ttbar	246
Wbb	66.7
W+jets	3,850

Common selection for all 3 single-top samples :

- 1 High pT Lepton + mET
→ reduce non-W events
- At least two high-p_T jets
→ reduce W+jets events

- Single-top ~22-26%
- ttbar ~ 38%
- WQQ ~ 1.5% , W+njets < 1/1000



Samples

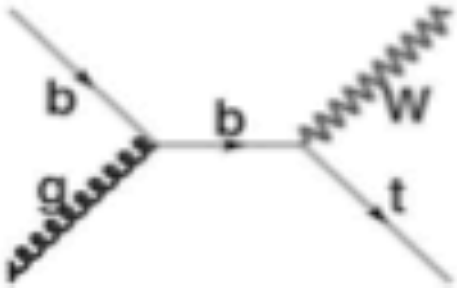
- 65000 events from rome.004531/0.recov10.wt_pl_mh.*
- 50000 events from rome.004540.recov10.s-chan.py
- 50000 events from rome.004511.recov10.w-gluon.py

- Objects accessed:
  - ConeTowerParticleJets (Cone 07)
  - BJetCollection (btagging was run only for cone 0.7 jets)
  - Cone04TowerParticleJets (Cone 0.4)
  - BJetCollection - Btagging was rerun following the instructions at: https://uimon.cern.ch/twiki/bin/view/Atlas/BTagging#Running_the_b_Tagging
  - ElectronCollection and METFinal

Summary on b-tagging algs

- Historical » taggers:
  - **IP2D**: transverse impact parameter
  - **IP3D**: 2D+longitudinal
  - **SV1, SV2**: inclusive secondary vertex **SV1+IP3D** (we call it FabSV)
- New taggers:
  - Lifetime2D: transverse impact parameter
  - **lhSig**: secondary vertex + impact parameter (2D&3D)
- Tagging weights:
  - For each taggers discriminative variables are selected (iifetime taggers: impact significances $S=d_0/\sigma(d_0)$) and calibration functions are built:
    - Track weight: likelihood ratio $w_t=P_b(S)/P_u(S)$
  - Jet weight: $W_j= \Sigma \ln w_t^i$
- Generalization of the weight for various taggers, can be combined by summing them up (IP3D + SV1).

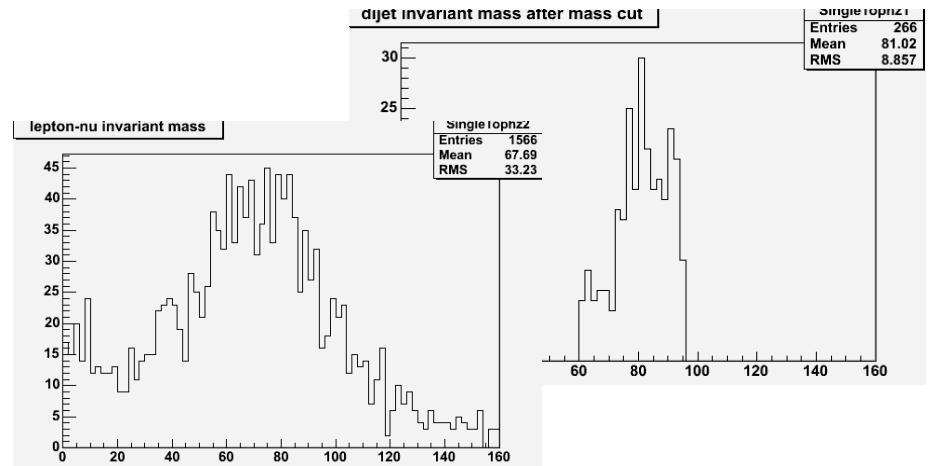
Wt channel



Selection of a specific topology

- Number of high-p_T jets Njet) = 3
- Presence of a high-p_T b-tagged jets
  → Only **one** b-jet in W+t events
- Presence of a W-boson mass peak
  → requires 60 < M(j,j) < 90 GeV/c^2

1 b-jet
2 light jets

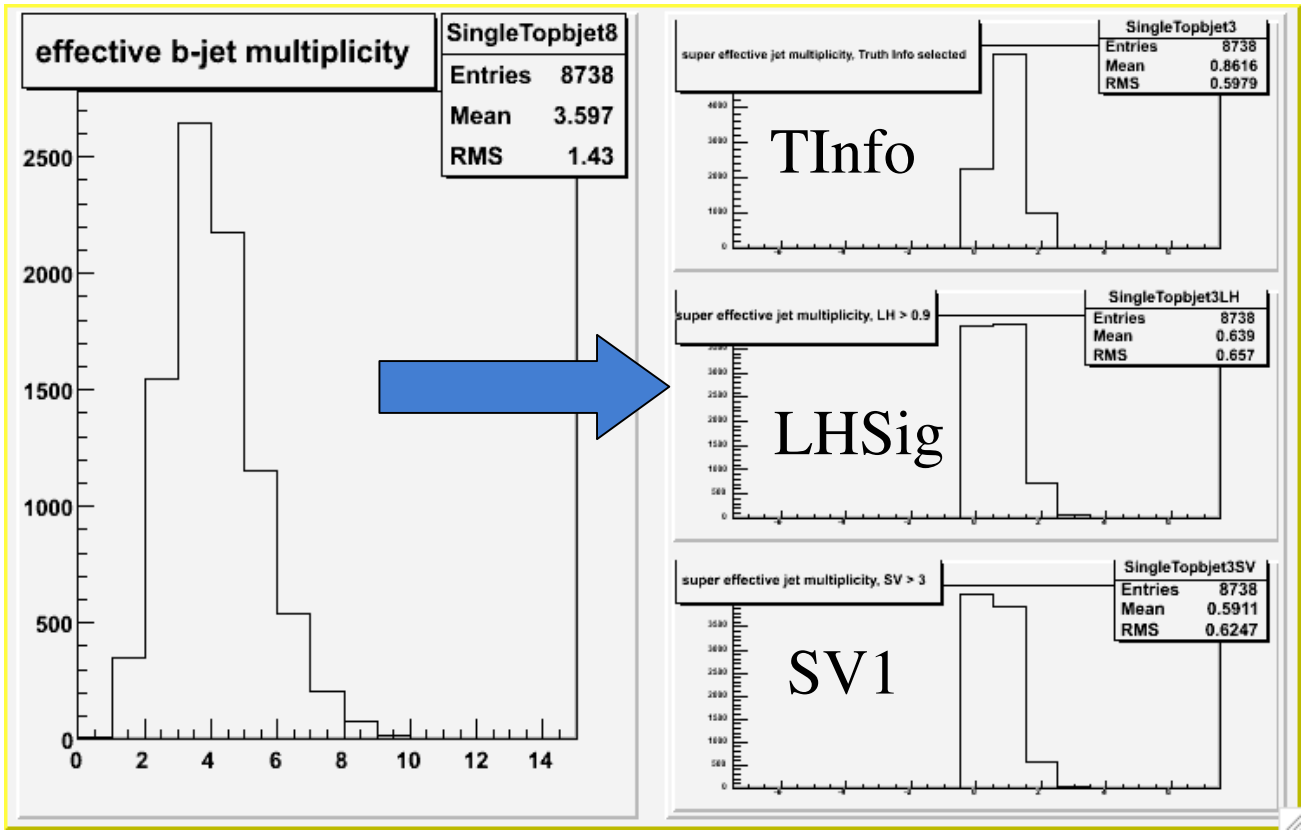


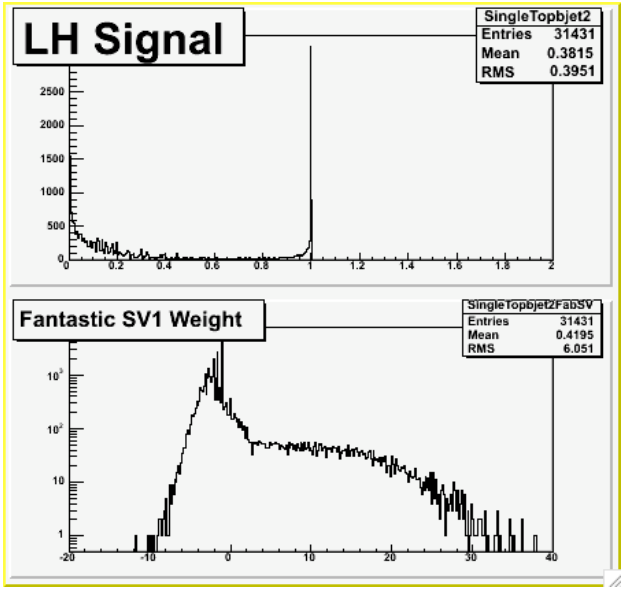
32028 evts with 1 one P_T ele (XRatio > 0.6)
28582 evts with MET > 20 GeV
12175 evts with 1 and only 1 b-jet (Lhsig > 0.9, E_T > 50, η < 2.5)
1566 evts with 2 jets (3 total) E_T > 30, η < 2.5

<u>2.4% final acceptance (3% TDR)</u>

Wt: b-jet selection

From the Btag collection jets are selected using TruthInfo, LHSig and SV1

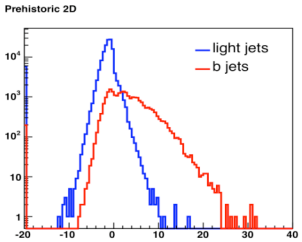


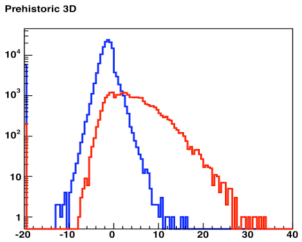


Wt: btag Info

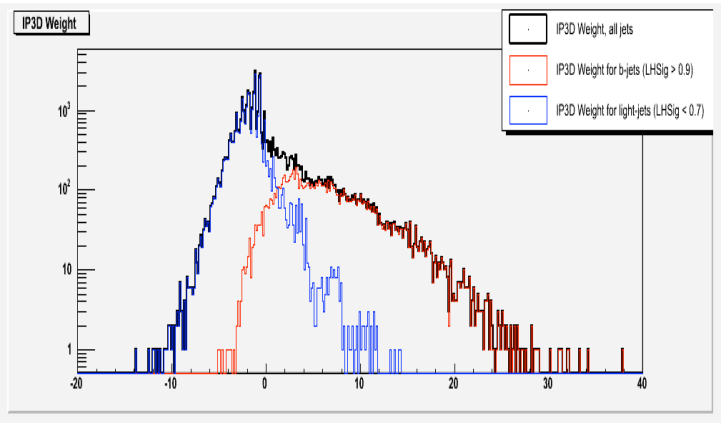
- Weights accessed from AOD:
  - m_bjetwSV1[j] = (*newBJets)[j]->weightForTag(); (SV1+IP3D)
  - m_bjetwSV1[j] = (*newBJets)[j]->weightForTag("SV1");
  - m_bjetwIP2D[j] = (*newBJets)[j]->weightForTag("IP2D");
  - m_bjetwIP3D[j] = (*newBJets)[j]->weightForTag("IP3D");
- Various web pages/instructions suggest a cut at

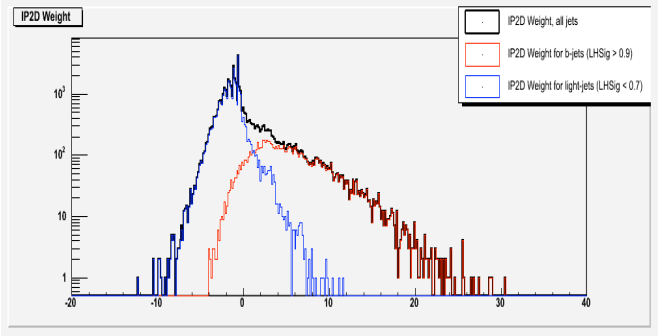
  <u>Weight > 3.0 to select b-jets</u>





- We tested various value of the cut , from 1 to 9 and compared with lhSig.





B-tagging performance estimators

- b-jet efficiency ε_b as function of variable cut:
  - Denominator:
    - jets defined as b using MC truth with $p_T > 50$ GeV/c, $|\eta|<2.5$
  - Numerator:
    - ditto + cut on a tagging weight
- light-jet rejection $R_u = 1 / \varepsilon_u$
  - R=100 means 1% mistag rate
  - light jets: u, d, s, g

Wt: btag efficiencies

Efficiencies are calculated in the following way:
Denominator: number of jets matched with the b-parton (Tinfo), with $P_T > 50$ GeV, $\eta < 2.5$
Numerator: ditto with cut on weight/likelihood

IP2D Cut	Eff Ip2D	SV1 Cut	Eff SV1	LHSig cut	Eff LHsig
1	0.60 0.63	1	0.63 0.63	0.1	0.80 0.75
2	0.54 0.55	2	0.59 0.59	0.2	0.76 0.72
3	0.49 0.48	3	0.55 0.57	0.3	0.72 0.69
4	0.43 0.41	4	0.53 0.54	0.4	0.70 0.67
5	0.38 0.35	5	0.51 0.51	0.5	0.68 0.66
6	0.33 0.28	6	0.48 0.48	0.6	0.67 0.65
7	0.29 0.21	7	0.46 0.46	0.7	0.65 0.63
8	0.25 0.18	8	0.43 0.43	0.8	0.63 0.61
9	0.21 0.14	9	0.41 0.40	0.9	0.60 0.57

Cone 0.7
Cone 0.4

Light Jet rejection

- light-jet rejection $R_u = 1 / \varepsilon_u$
  - R=100 means 1% mistag rate
  - light jets: u, d, s, g

	R_u (ε_b = 50%)	R_u (ε_b = 60%)
IP2D	166 (125) (158 -109)	25 (50) (55-57)
LHSig	NA (172-NA)	33 (33) (66-NA)
SV1	333 (100) (505-325)	100 (33) (184-156)

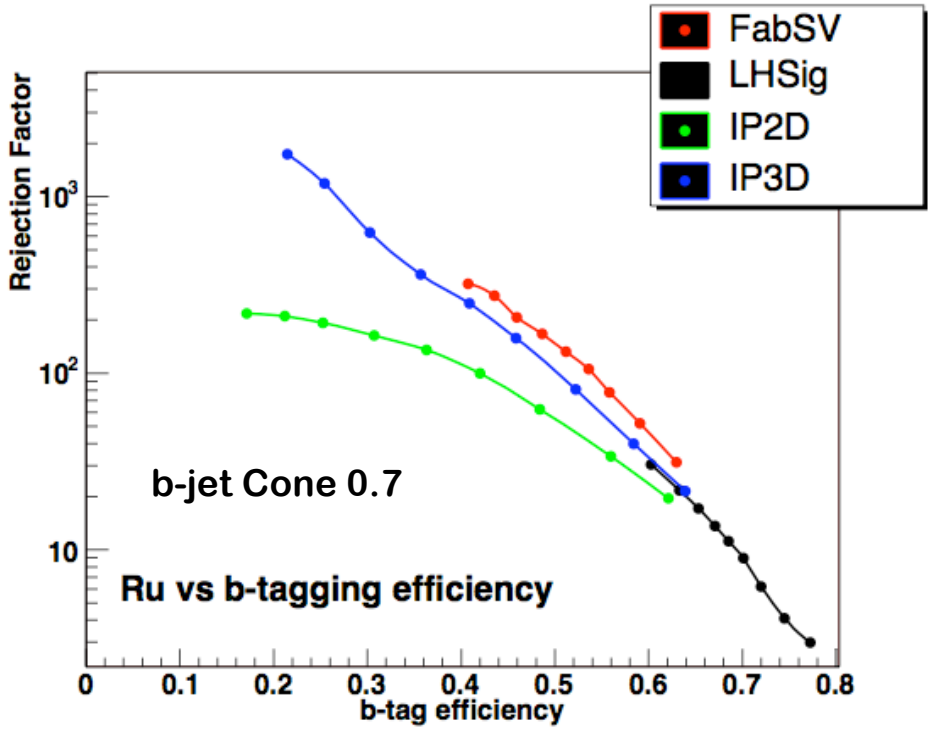
Wt Cone 0.7

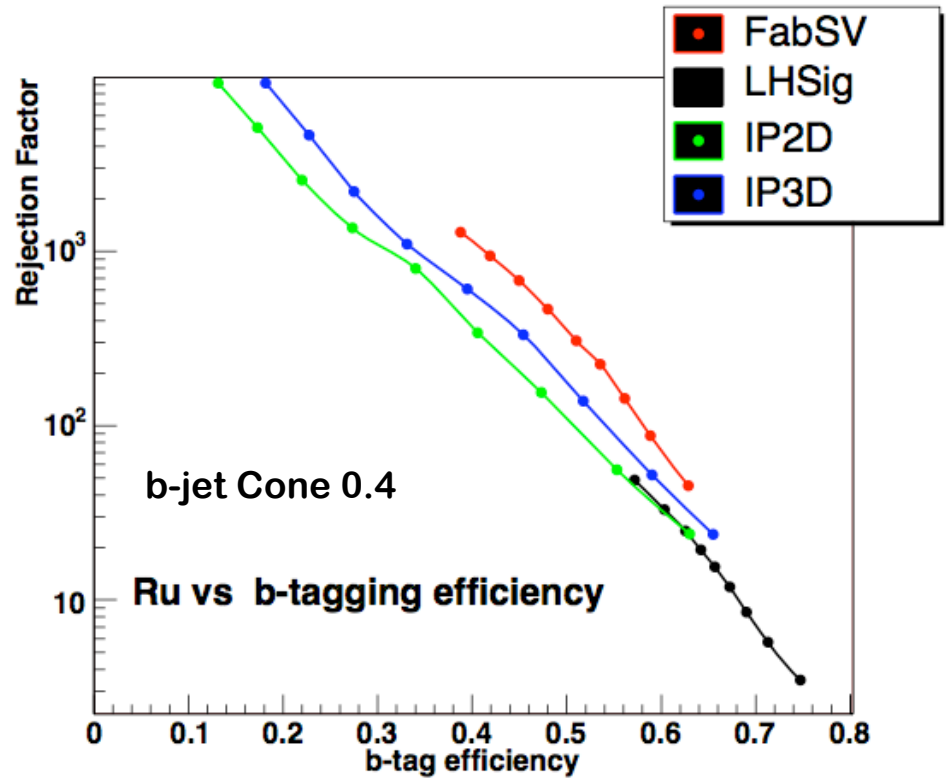
WH sample (L.V.)

ttbar sample (L.V.)

Wt Cone 0.4

Rejections


FabSV
LHSig
IP2D
IP3D
Rejection Factor
10^3
10^2
10
b-jet Cone 0.7
Ru vs b-tagging efficiency
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
b-tag efficiency


FabSV
LHSig
IP2D
IP3D
Rejection Factor
10^3
10^2
10
b-jet Cone 0.4
Ru vs b-tagging efficiency
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
b-tag efficiency

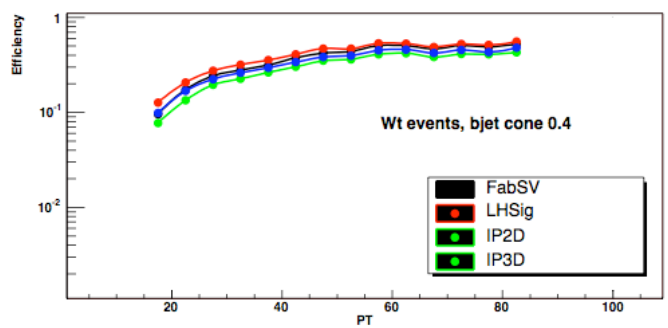
Wt: Efficiencies (P_T and η)

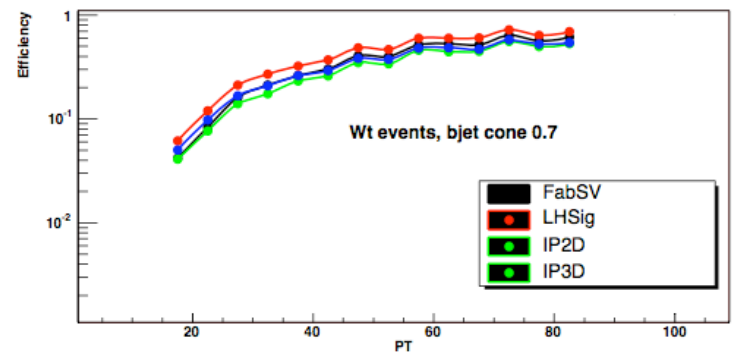
Efficiencies are calculated in the following way:

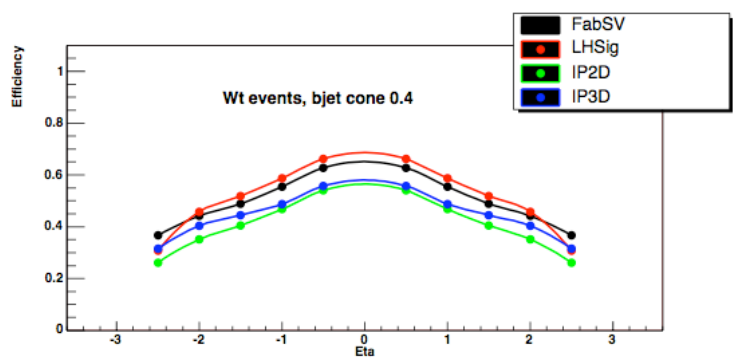
<u>Denominator</u>: number of b-partons with P_T and η in given interval;

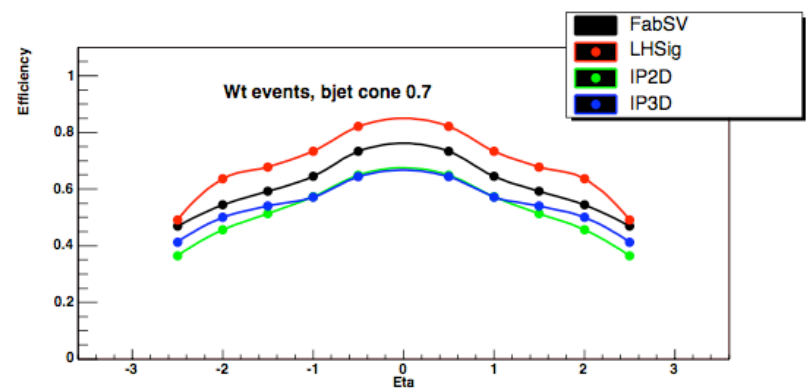
weight/likelihood cut fixed

<u>Numerator</u>: bjets matched with the b-parton (parton level info) with P_T and η in given interval and cut on weight/LHSig.

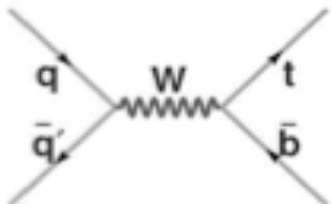








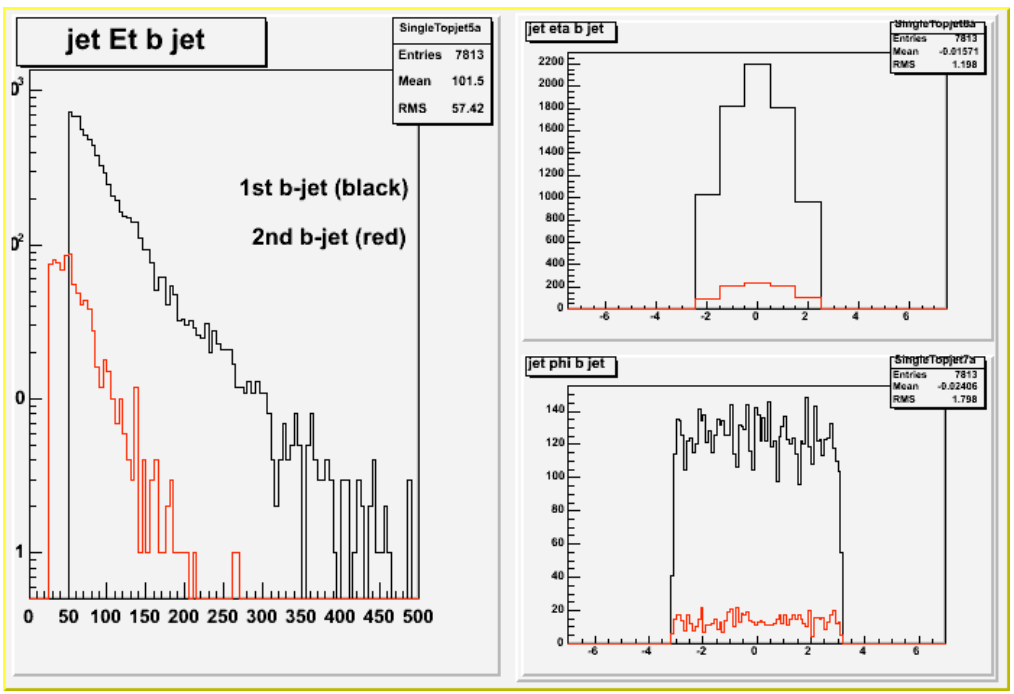
s-channel



Selection criteria

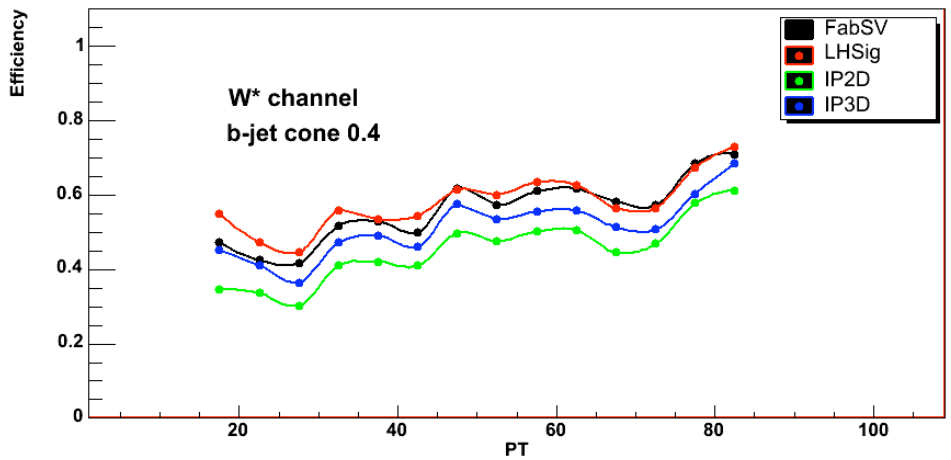
- Number of jets : N(jet) = 2
- Presence of two high p_T jets
- Presence of two central, high-p_T b-tagged jets
- Reconstruct M_{lvb} within $m_{top} \pm 25$ GeV/c^2
- Window in H_T

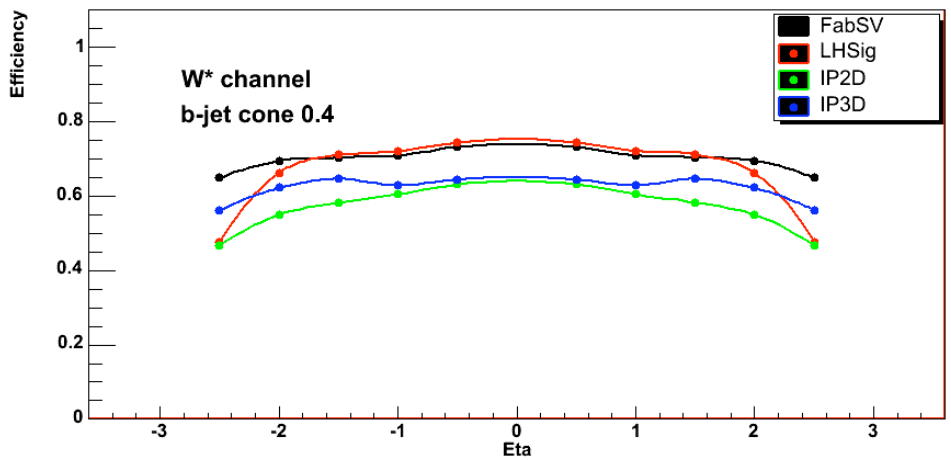
2 bjets only

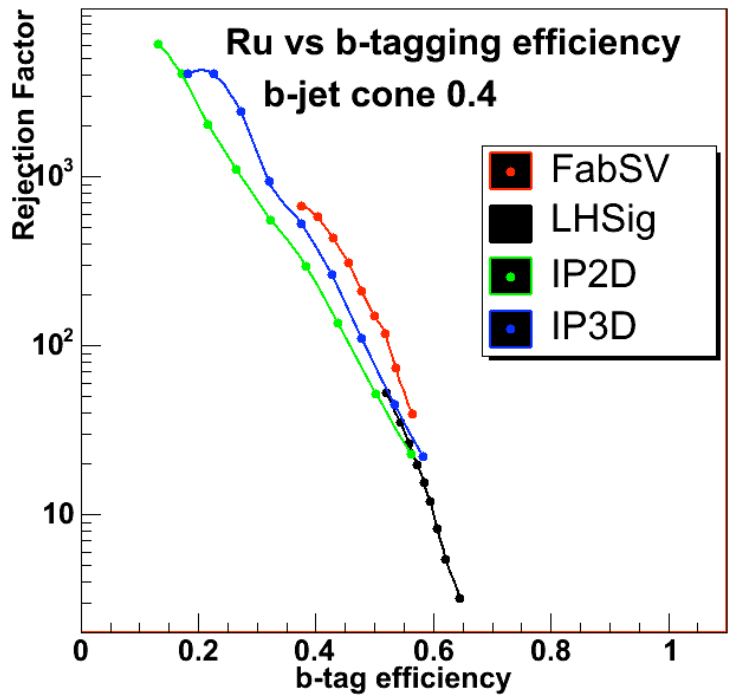


One high pt ele (Et > 20)	40%
+ one b-jet > 50	38%
+one ele + 2 jets (1 tagged)	19%
+one more b-jet > 25	4%

s-channel

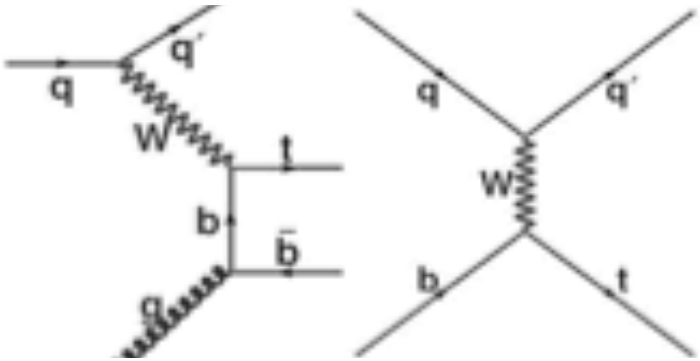


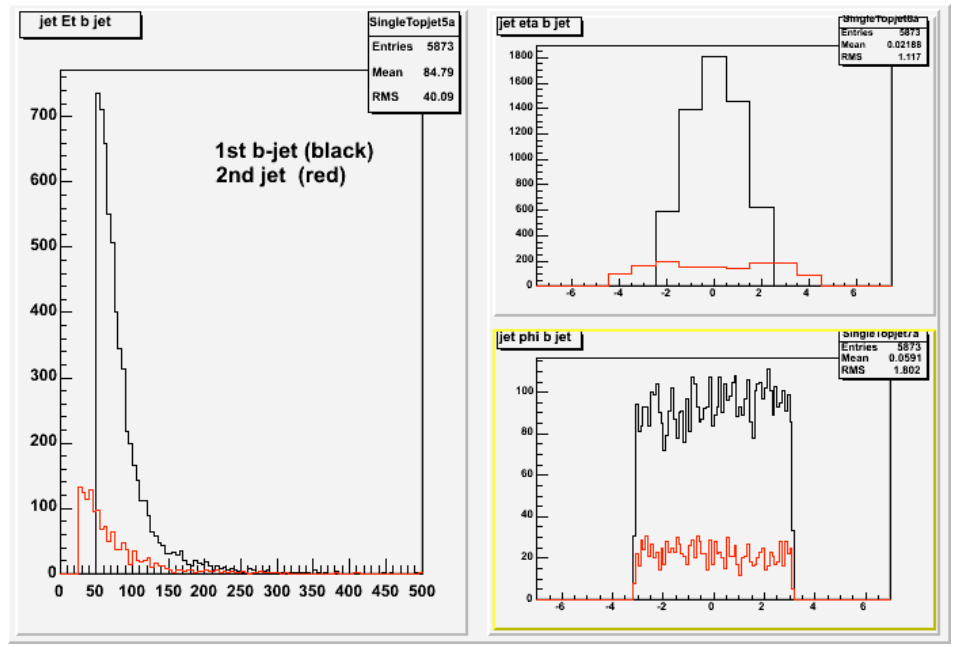




Highets E_T bjet used for Studies - small statistics

Wg channel



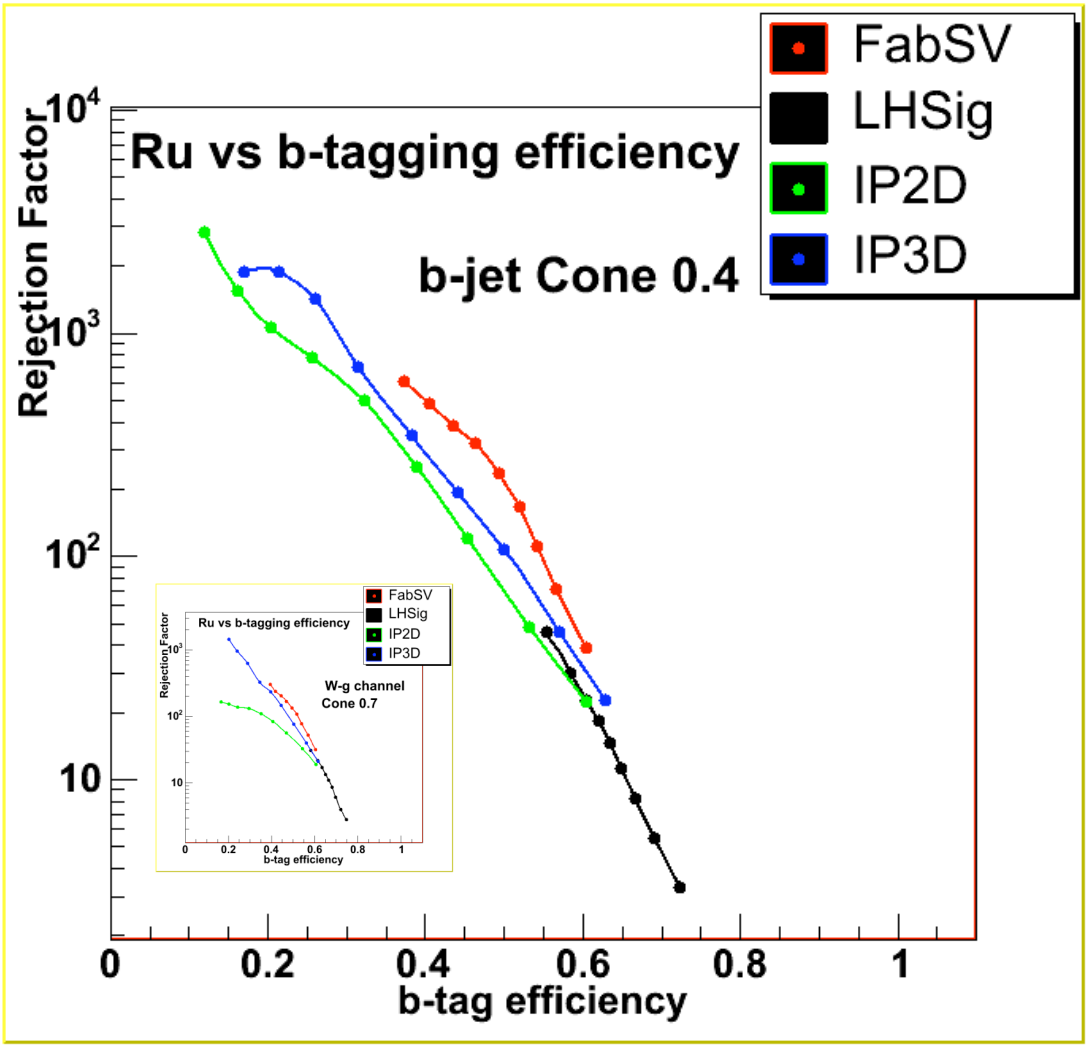


Selection criteria

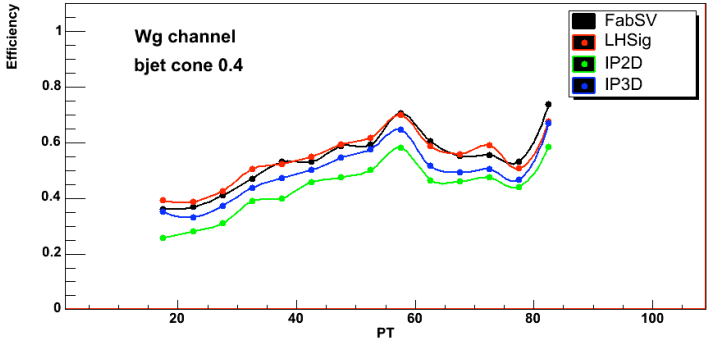
- Number of jets : N(jet) = 2
- Presence of a high-p_T b-tagged jets (p_T>40GeV/c)
  Wg evts have 1 b-jet escaping the acceptance
  → requires **only** 1 b-tagged jet
- Presence of a high-p_T forward jet
  → 1 jet with $|\eta|>2.5$ and $p_T \geq 50$GeV/c
- Reconstruct $M_{l\nu b}$ within ±25 GeV/c^2
- Window in H_T

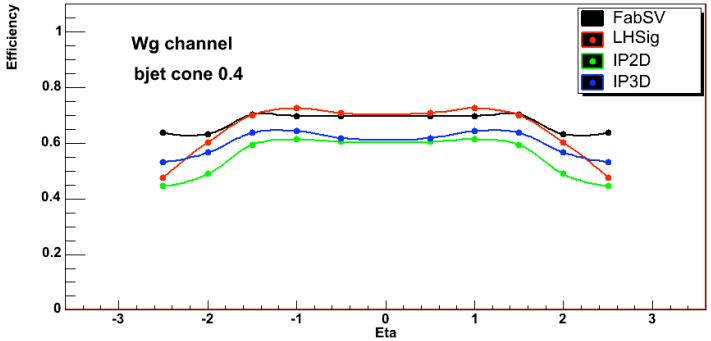
One high pt ele	41%
+ one b-jet > 50	28%
+ 1 more jet > 30	6.7%

Wg channel



Highets E_T bjet used for Studies - small statistics





Conclusions

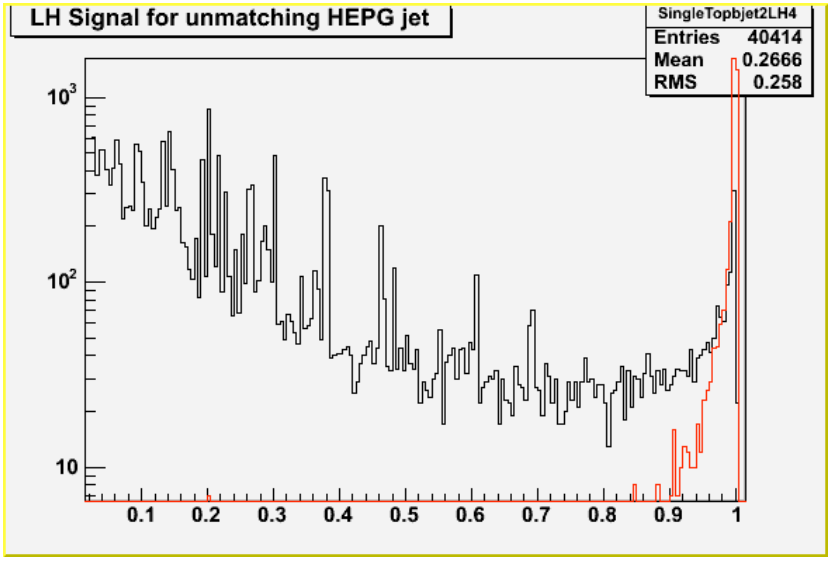
- B-Tag studies on Wt, W-g, W* AOD samples:
  - Preliminary tests on various b-tag algorithms, as out of the box on Rome samples for single top were performed
  - Reprocessing of data to obtain cone 0.4 bjets was done;
  - Generally good agreement with previous studies (L.V.)
  - LHSig has slightly higher efficiency to select b-jets (LHSig > 0.9) in the data but has a very poor rejection factor.
  - SV1 has slightly lower efficiency, but much higher rejection factor.
  - More studies will be done, on background especially.
  - More testing with DC3 data, coordinating with Arnaud's group.
  - Internal note out (Wt): ATL-COM-PHYS-036

Backup Slides

B-tag efficiencies

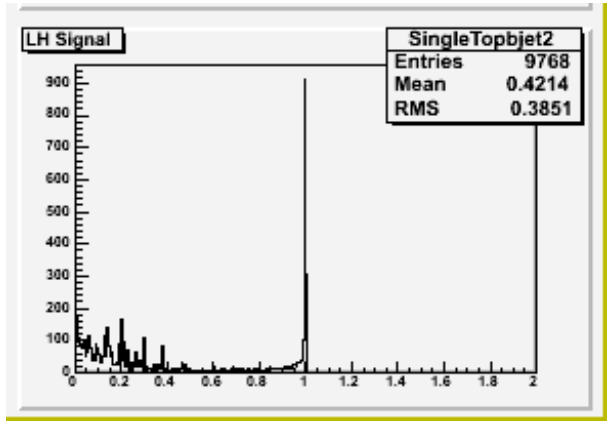
Cross check of LHSig distribution using a different tagger as selector.

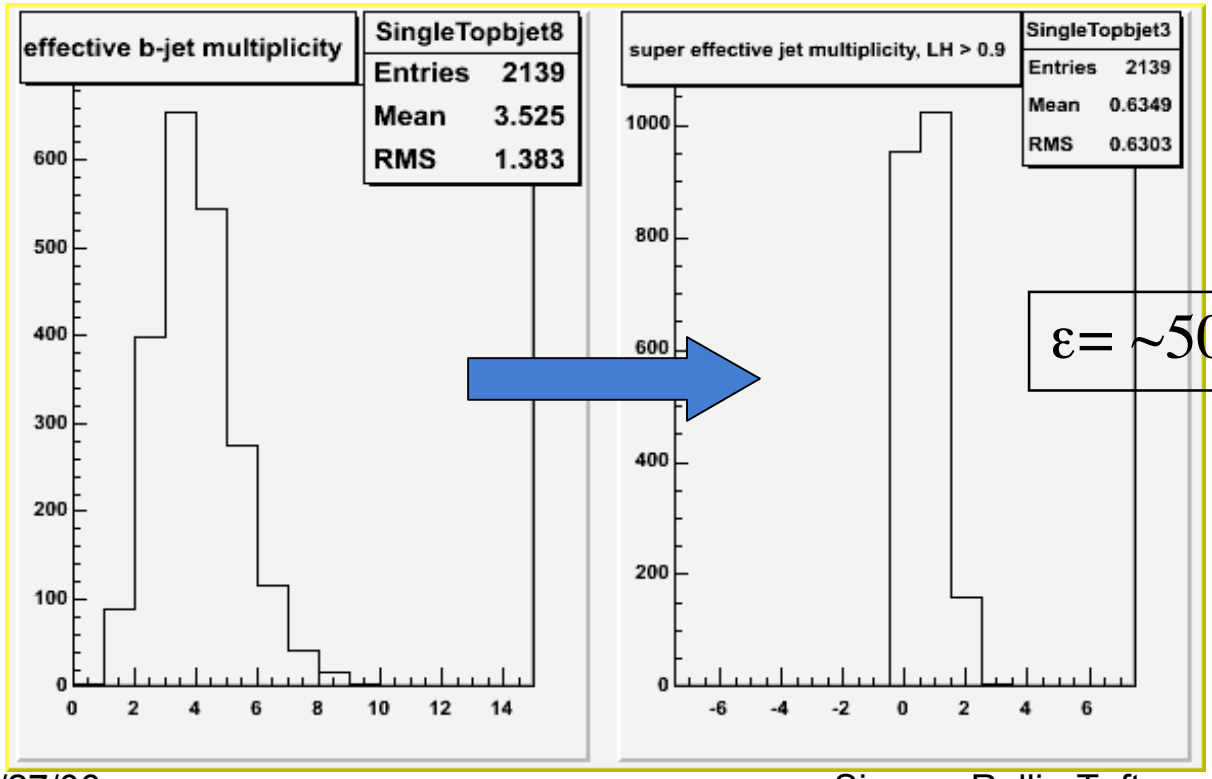
LHSig distribution:
IP2D > 3.0 (red)
IP2D < 1.0 (black)



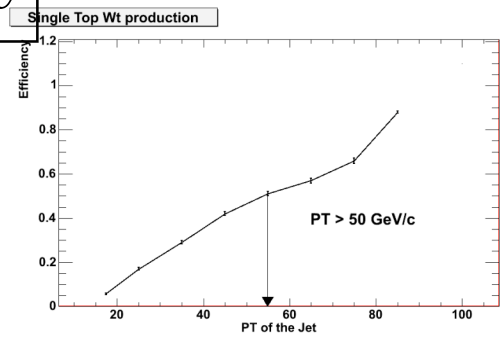
Wt: Rome selection (0.7)

- In the BTagCollection a jet was selected if:
  - E_T > 50 GeV, η < 2.5
  - <u>LHSig > 0.9</u>





ε= ~50%

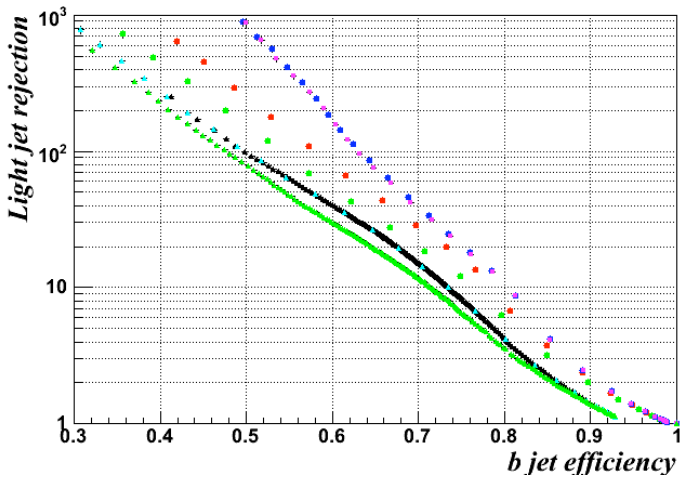


Performance (WH) 10.5.0

- WH sample
  - (m_H=120 GeV)
  - release 10.5.0

Light quark rejection rates

@ ε_b = 50 (60) %



J.-B. de Vivie, *V.Kostyukhin*
A. Rozanov, L Vacavant

	IP2D	IP3D	SV1+IP3D	SV2+IP3D	IhSig (à la 10.5.0)
Rome Conditions	130 (50)	208 (72)	672 (155)	708 (153)	100 (41)

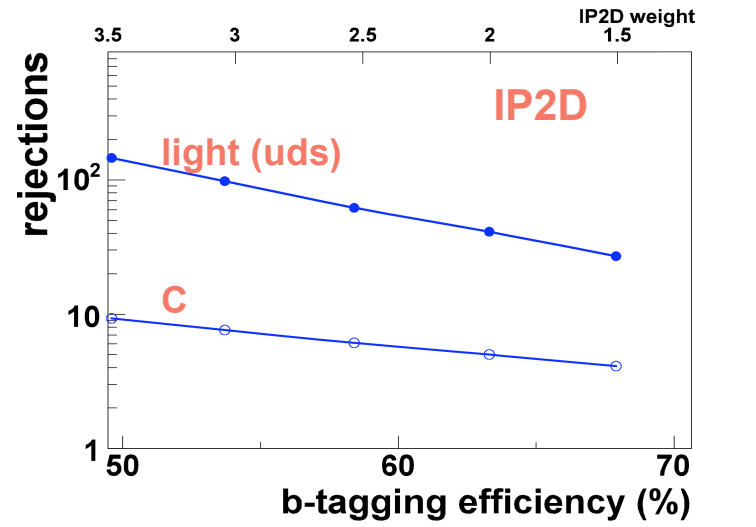
109 (57) 325 (156)

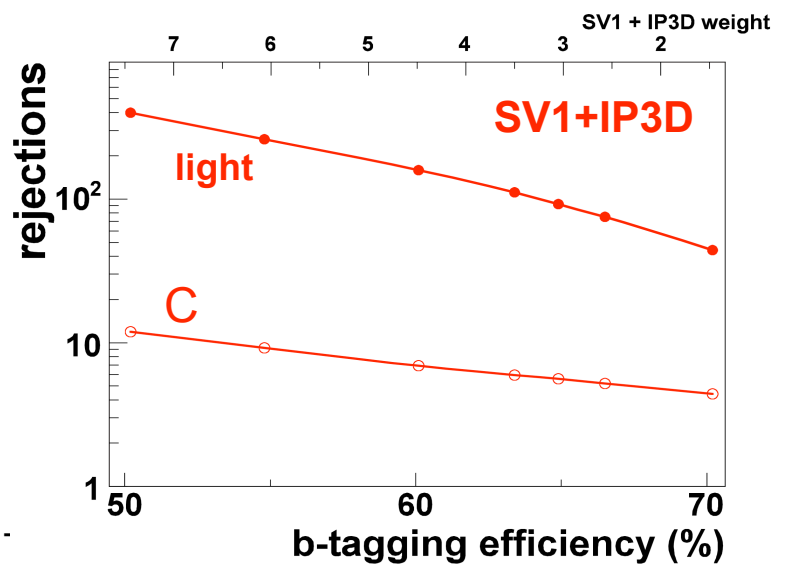
Performance ($t\bar{t}$) 10.0.1

- $t\bar{t}$ samples
  - Release 10.0.1

	R_u(e=50%)	R_u(e=60%)
IP2D	140 (158)	50 (55)
SV1+IP3D	400 (505)	160 (184)

F. Hubaut, E. Monnier, P. Pralavorio, B. Resende, C. Zhu

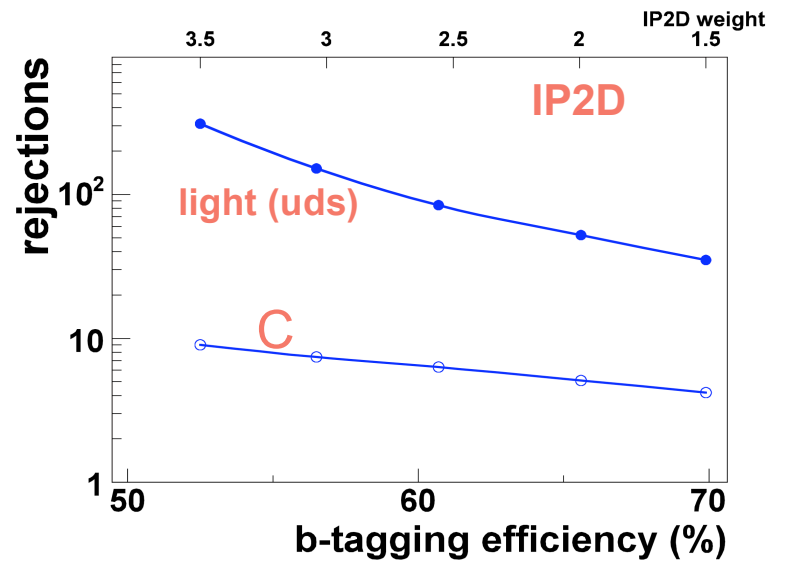
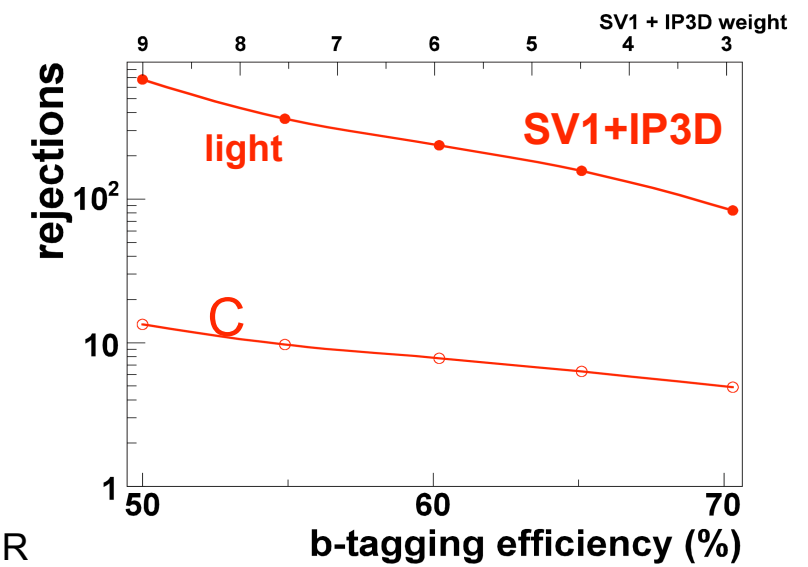




Performance ($t\bar{t}$) 11.0.41

F. Hubaut, E. Monnier, P. Pralavorio, B. Resende, C. Zhu

- $t\bar{t}$ samples
  - Release 11.0.41
  - Rejection improved by
    - 20% for Rc and
    - 50% for Ruds at ε=60%



	e=50%	e=60%
R_c	10 / 13	6 / 8
R_{uds}	500 / 680	90 / 230