Measurement of open beauty production at LHC with CMS

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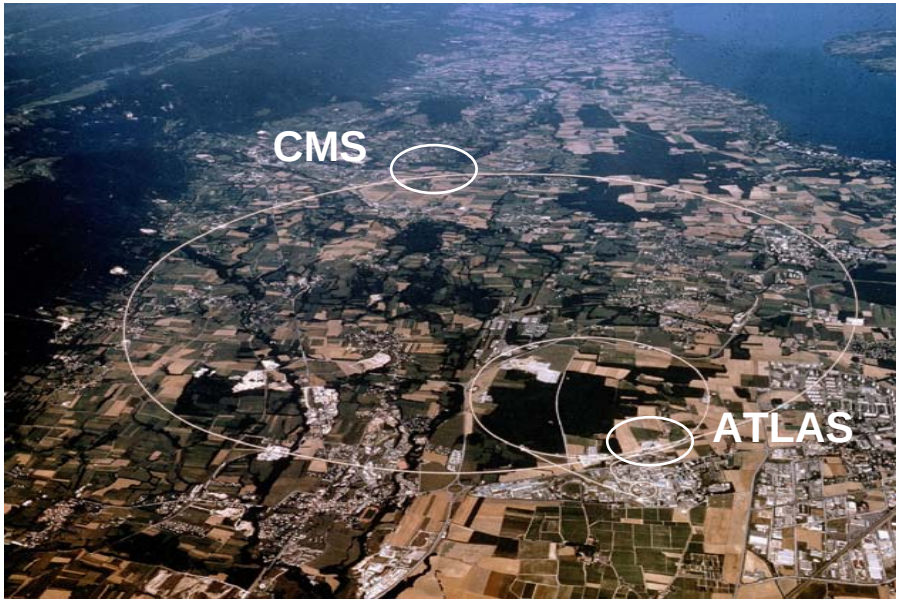
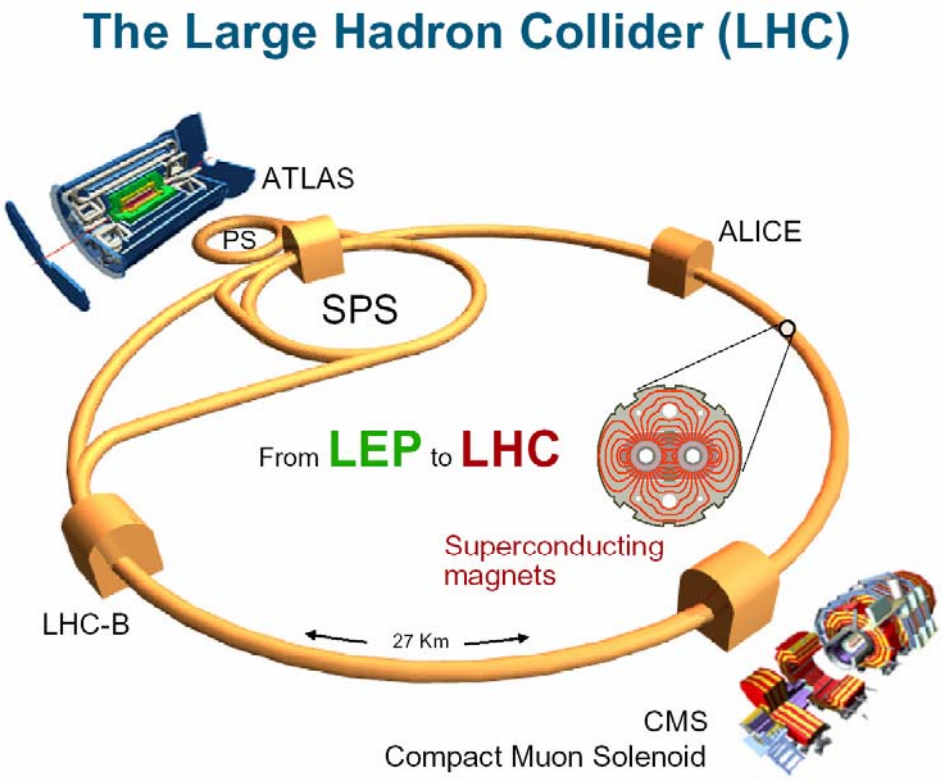
Large Hadron Collider (LHC)



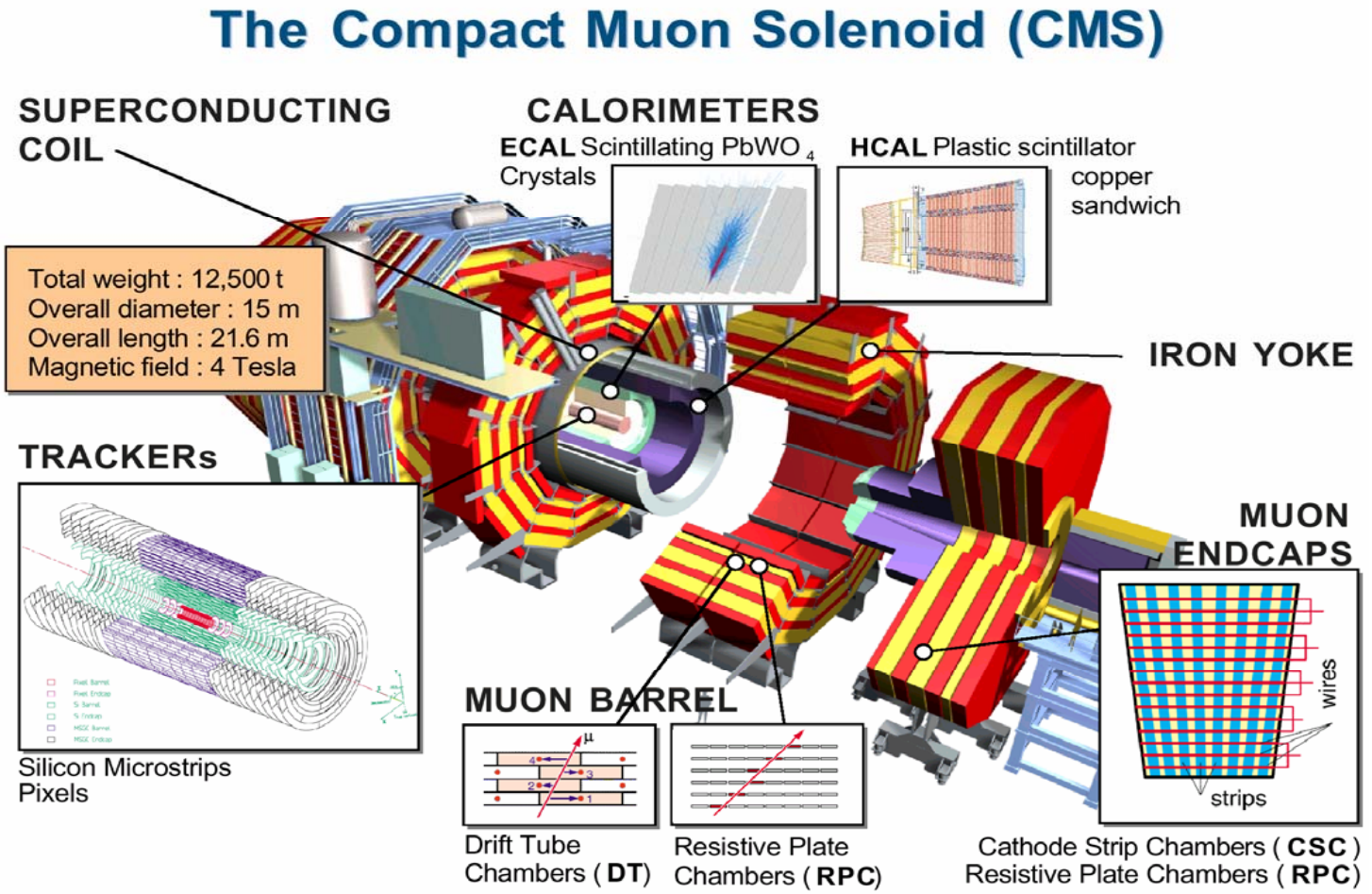


- Design luminosity L = 10^{34}cm^{-1}s^{-1}
  ~ 100 fb^{-1}/ year
  Pile up ~ 20 collisions/crossing
  40 MHz pp bunch-crossing rate
- Start-up luminosity L ≈ 10^{33}cm^{-1}s^{-1}
  ⇒ ~ 10 fb^{-1}/ year
- expected completion : mid 2007

	Beams	Energy		Luminosity
LEP	e^+ e^-	200	GeV	10^{32} cm^{-2}s^{-1}
LHC	p p	14	TeV	10^{34} cm^{-2}s^{-1}
	Pb Pb	1312	TeV	10^{27} cm^{-2}s^{-1}

The CMS detector

Onion structure
- **Tracker**
- **Calorimeters**
- **Muon system**

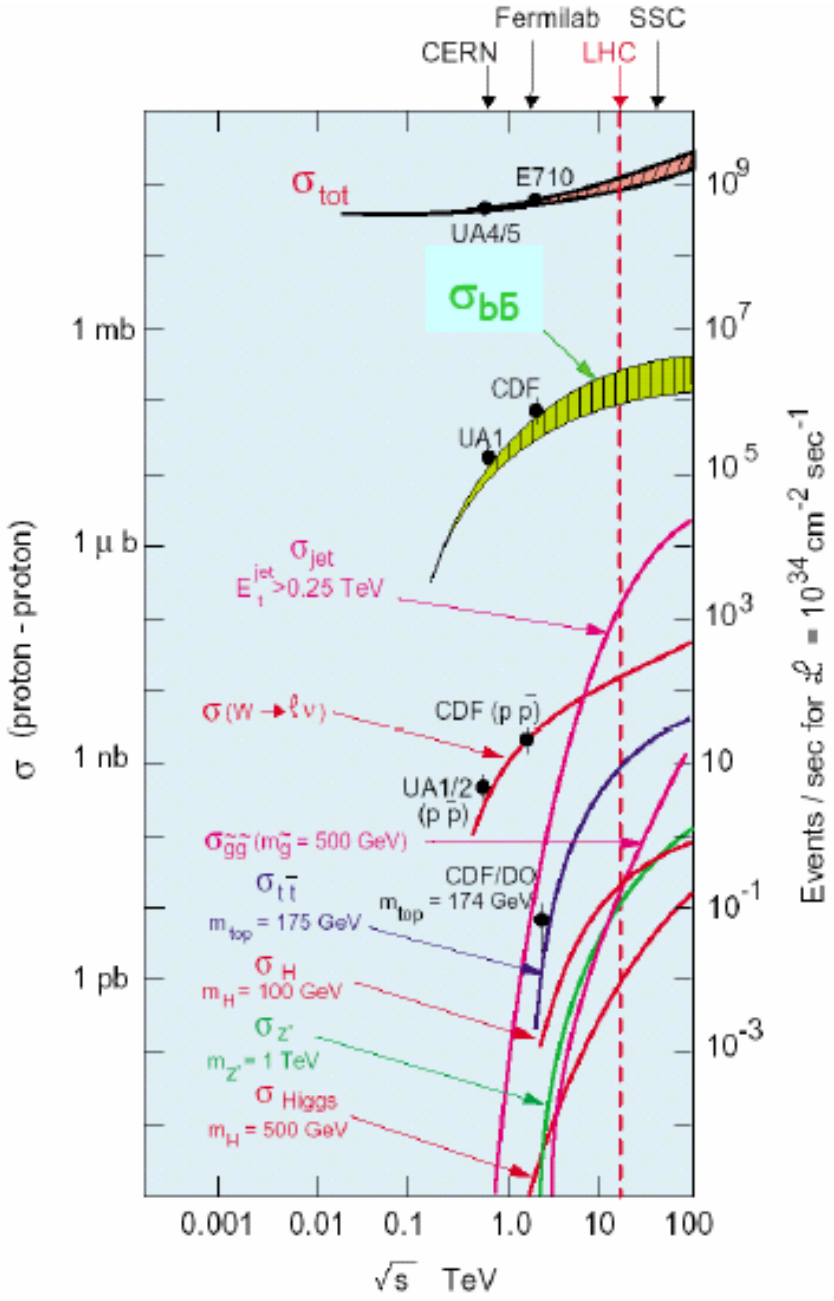


Precise

e, μ, γ, jets, E_T

Efficient

b tagging, τ detection



B production

- *b production* at hadron colliders
  - **Huge cross section**
  - **Challenge for perturbative QCD**
  - **New physics searches: b jets as a signal feature**

Analysis

- **B production total cross section**
- **Differential cross sections $d\sigma/dp_t$, $d\sigma/d\eta$**
  - **Selection (b-tag)**
    - **semileptonic b-decays into muons**
  - **Background (b purity)**
  - **Trigger efficiency**
  - **Luminosity**

Event selection

QCD event Generation: PYTHIA

Full simulation of the detector

Trigger

Level-1:

"single μ",

p_t>14 GeV/c, |η| < 2.1

ε = 18 %

High Level Trigger:

"muon + b-jet",

P_t^{μ} >19GeV/c, E_t^{jet}>50GeV, |η| < 2.4

ε = 60 %

Off-line selection

- **B-tagged jet: E_t > 50 GeV, |η| < 2.4**

  ε = 65 % (barrel), 55 % (endcap)

  Muon associated with B-tagged jet

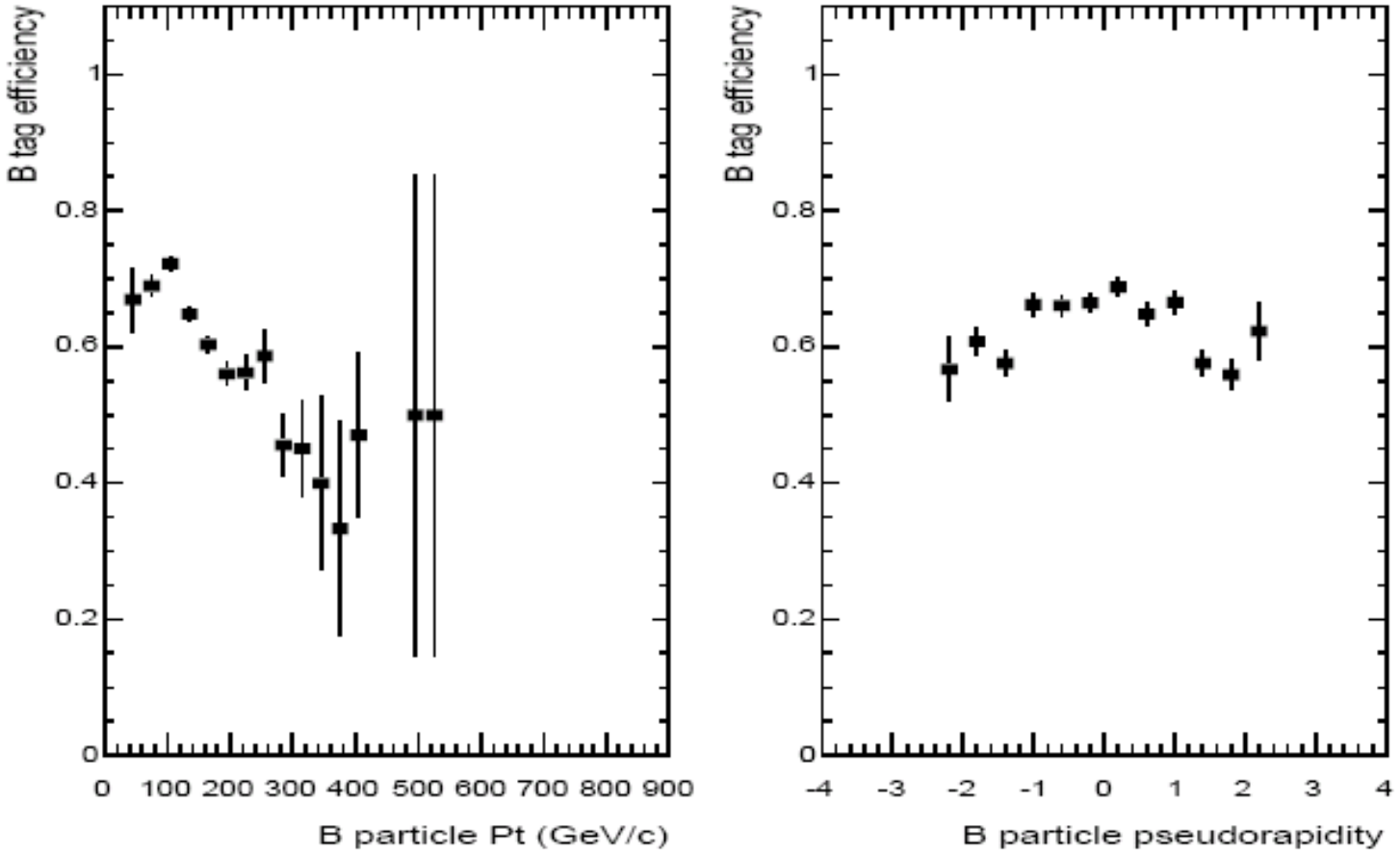
  ε = 75 %

- The most energetic *b* tagged jet as the reconstructed B-particle candidate

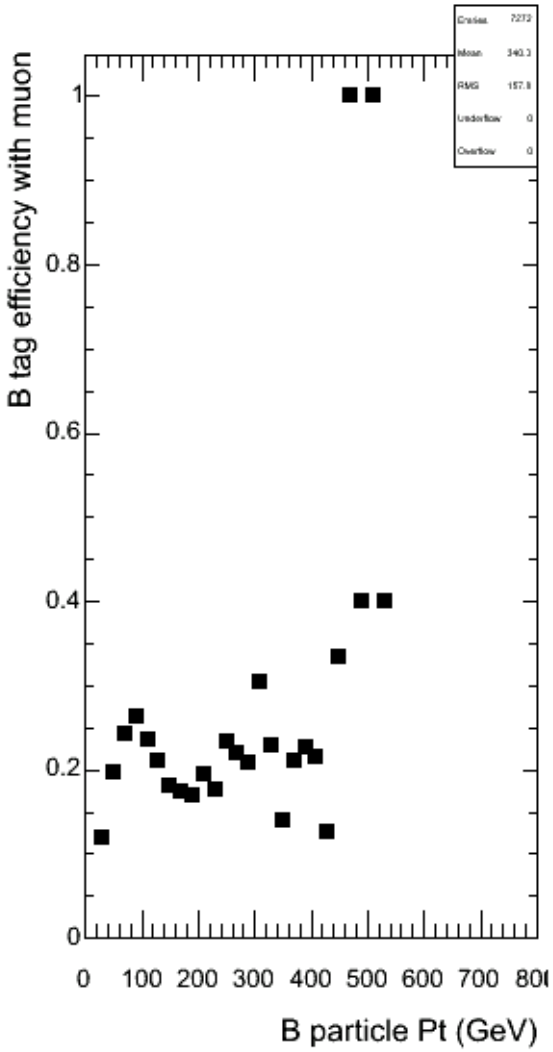
B tagging efficiency

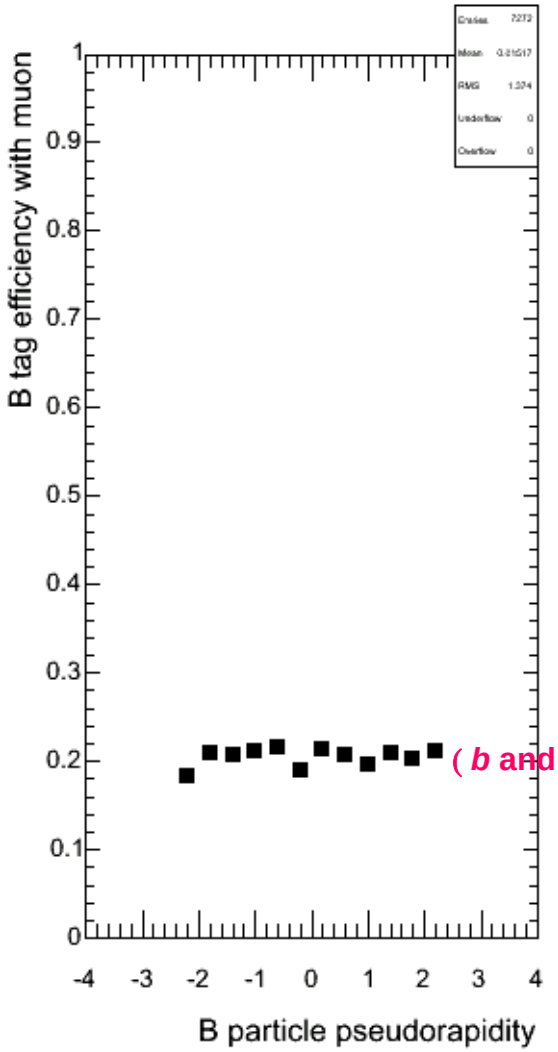
B tag:

inclusive secondary vertex reconstruction in jets



B tagging with muon efficiency

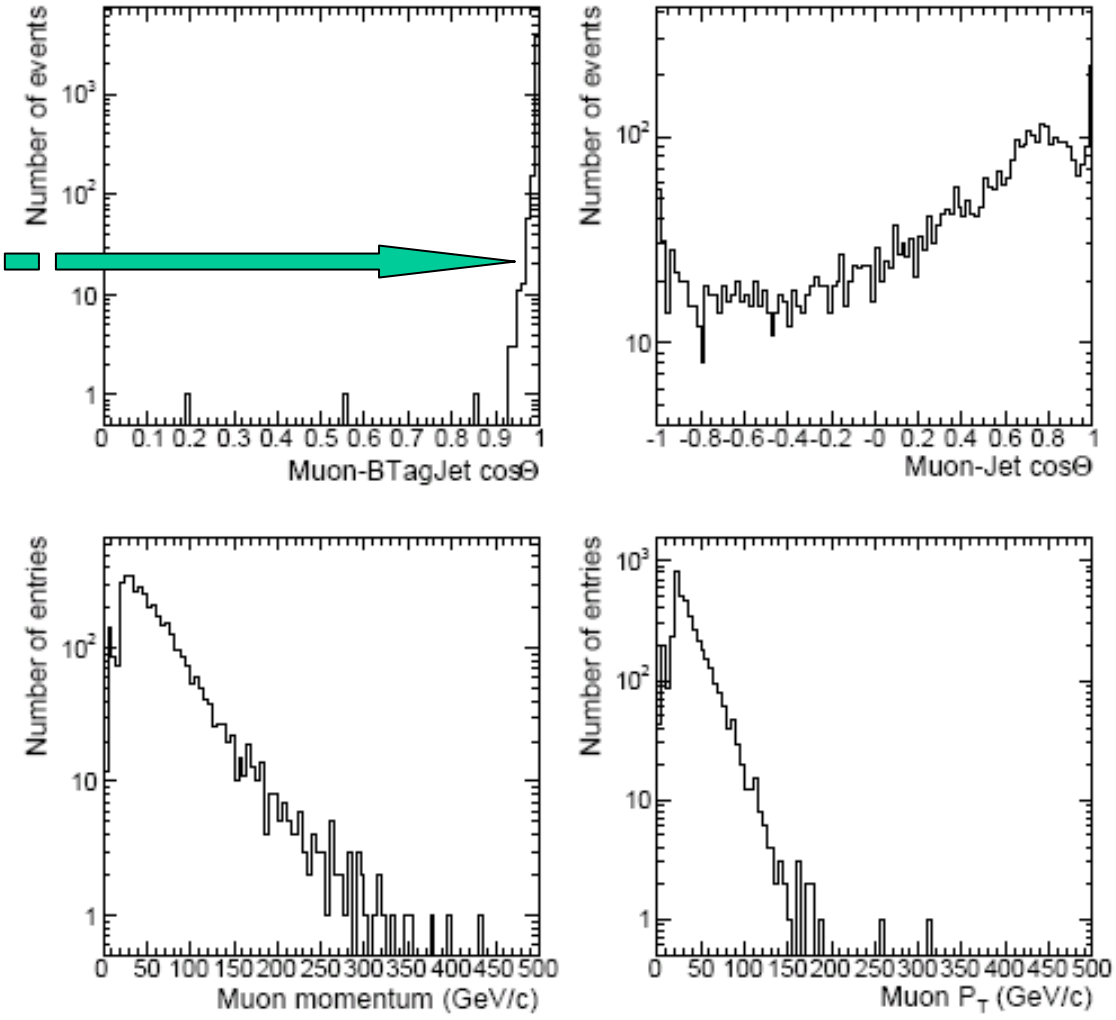




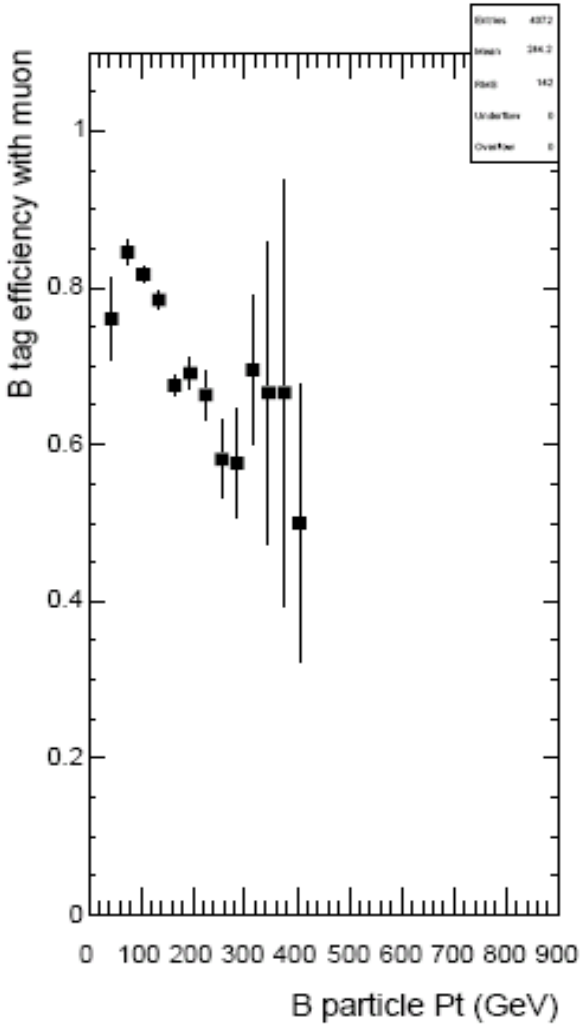
(*b* and *c* semi-leptonic decays)

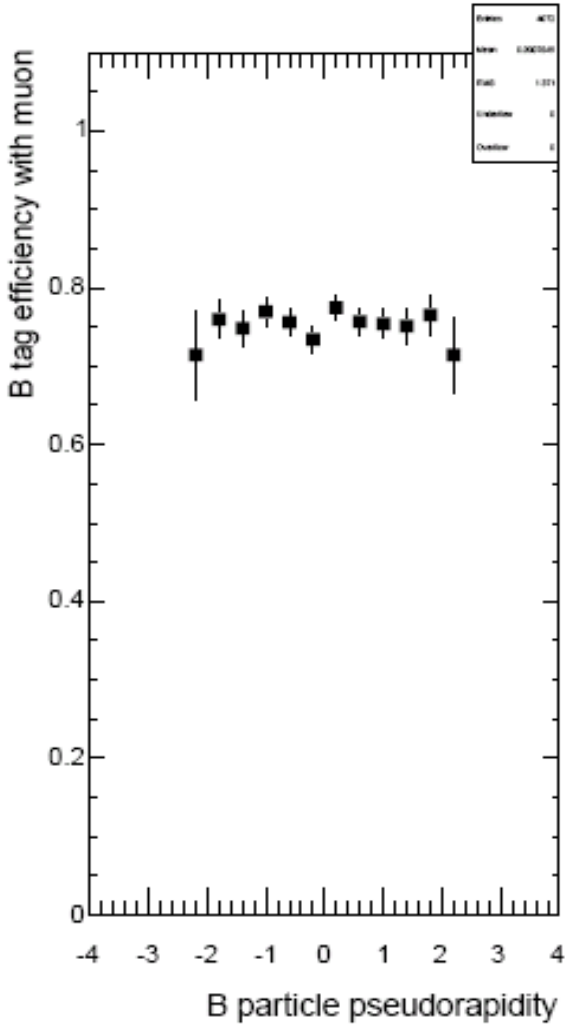
B tagging with muon

The tagged muon is inside of the *b* jet



B jet-muon association efficiency

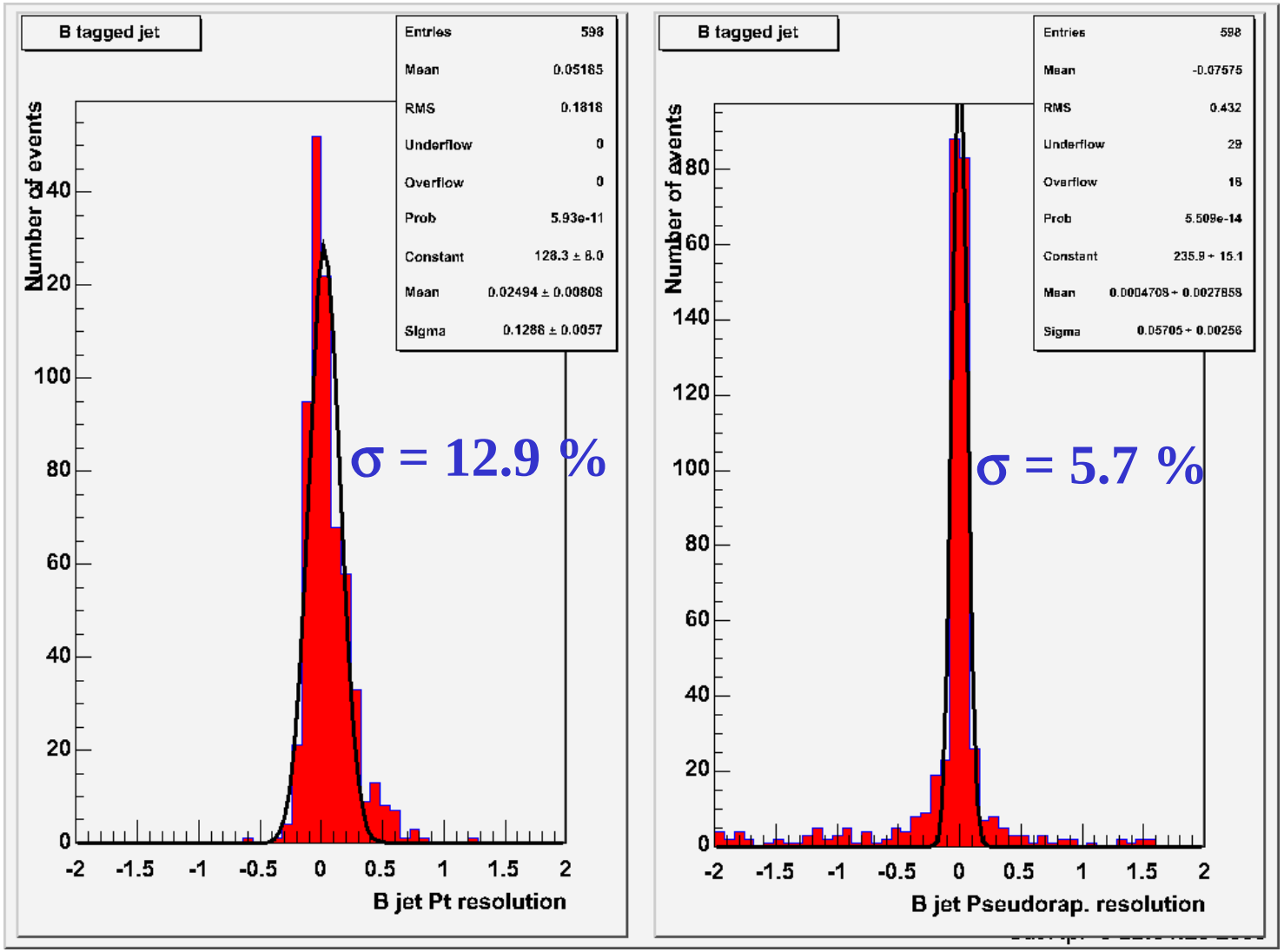




~ 75 %

B jet resolution

P_t > 170 GeV/c



Event selection

2.5 M simulated events processed

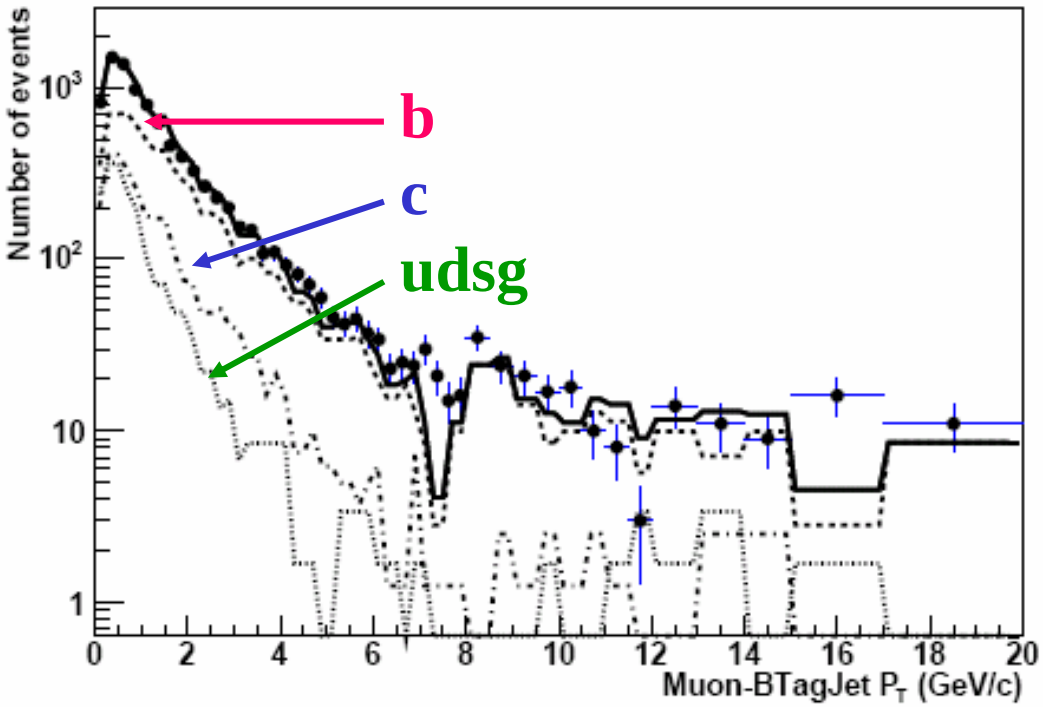
Estimate for 10 fb^{-1}

$\hat{p}_T$, GeV/c	σ^{QCD}, μb	$N^{QCD}_{generated}$, events	$b\bar{b}$ purity, %	$c\bar{c}$ fraction, %	uds fraction, %	$N^{b\bar{b}}_{expected}$, events
50 – 80	20.9	198993	66	32	2	1.4 M
80 – 120	3.0	294986	66	32	2	6.1 M
120 – 170	0.5	291982	72	26	2	5.1 M
170 – 230	0.1	355978	71	26	3	2.4 M
230 – 300	2.4×10^{-2}	389978	73	24	3	0.9 M
300 – 380	6.4×10^{-3}	283983	70	25	5	0.3 M
380 – 470	1.9×10^{-3}	191989	68	27	5	88 k
470 – 600	6.9×10^{-4}	190987	64	29	7	34 k
600 – 800	2.0×10^{-4}	94996	60	31	9	10 k
800 – 1000	3.6×10^{-5}	89999	60	30	10	2.0 k
1000 – 1400	1.1×10^{-5}	89998	55	31	14	0.5 k

Fit results

QCD events **MC: 230 < P_t < 300 GeV/c**

Muon P_t w.r.t. the closest B jet



Nb =5250 (56 %
Nc = 2388 (26%
Nudsg= 1740(18%

9378 events

Fit:

Nb =5222 ± 501
Nc = 2050 ± 728
Nudsg =1778 ±341

9050 events

Systematics (≥10 fb^{-1})

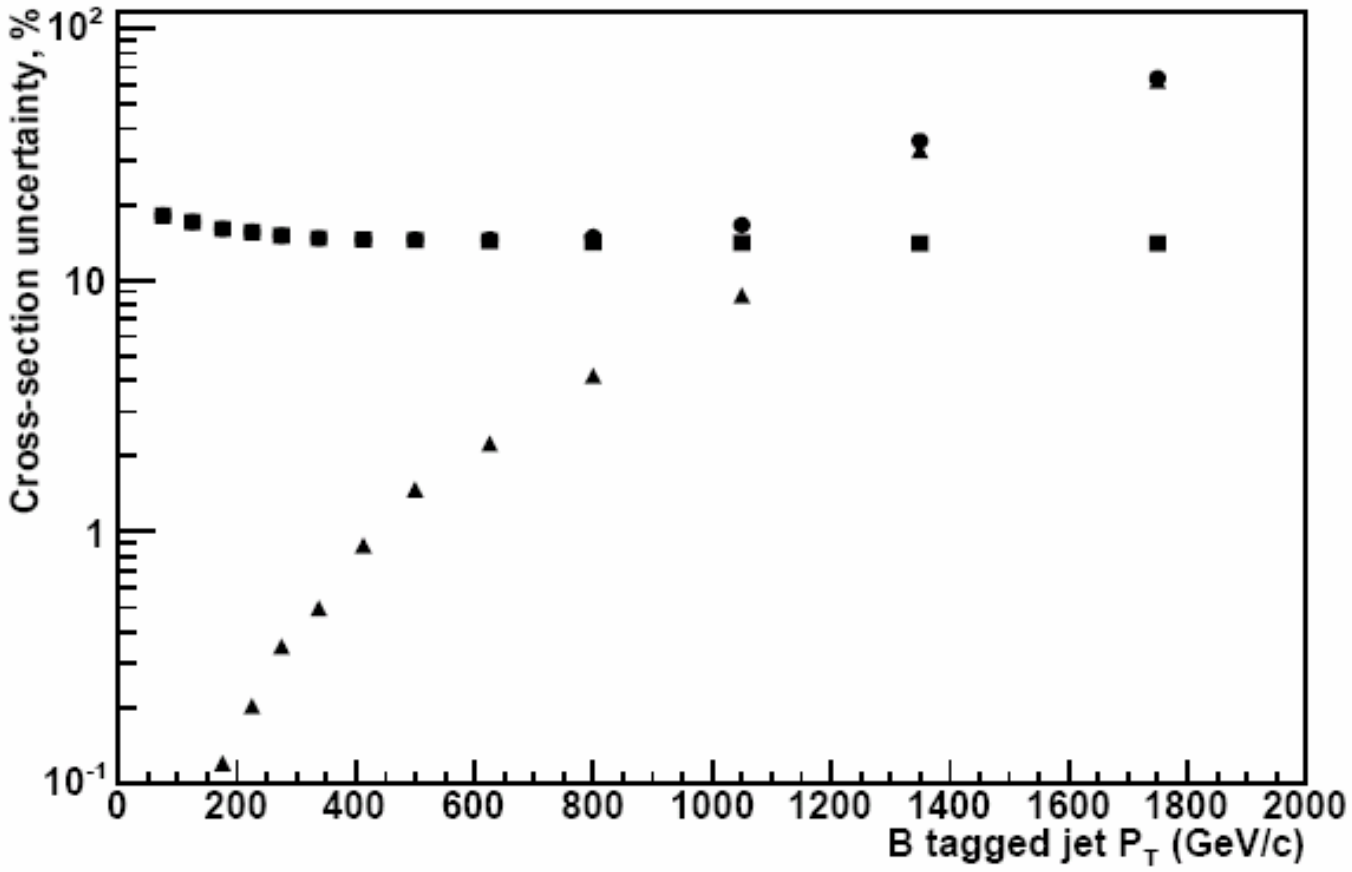
- luminosity 5 %
- tagging 5 %
- event selection 6 %
- trigger 3 %
- jet energy scale 12%
- misalignment 2 %
- fragmentation 9 %
- tt background 0.7 %
- muon
  - Br. Ratio 2.6 %
  - Eff. 1.0 %

total = 18 %

B phase space

- *B* hadron
  - $P_t > 50$ GeV/c
  - $|\eta| < 2.4$

b-quark P_t reach



We can reach 1.5 TeV as the highest measured B hadron P_t

Conclusions

- **~16 M *b* events to be selected at 10 fb^{-1} by CMS (one year of low lumi LHC)**
- ***b* purity in a range from 70 % to 55 %**
- **Up to 1.5 TeV B hadrons P_t reach**
- **New test of QCD is coming**