CHIPP workshop on High Energy Frontier

First CMS Physics Results

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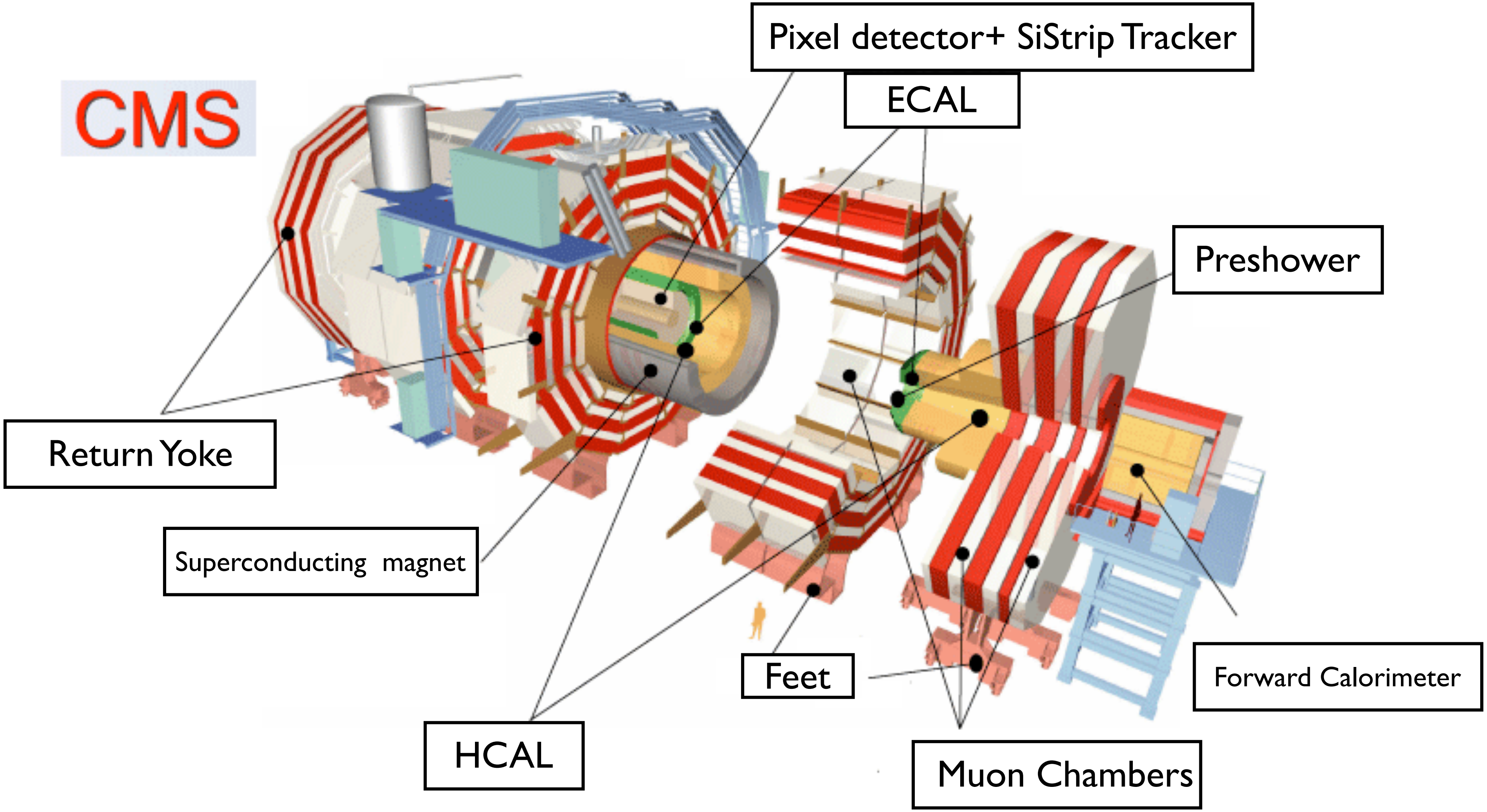
On behalf of Swiss CMS Groups (UZH, ETHZ,PSI)

01.09.2010



Weight: 12500 t
Diameter: 15 m
Length: 21.6 m
Magnetic field: 4 T

End of november 2009: first collisions at 0.9 TeV

Mid of december 2009: first collisions at 2.36 TeV

End of March 2010: first collisions at 7 TeV

Outline

1. Promt and non-promt J/Ψ cross section (CMS PAS BPH-10-002)

2. Inclusive D^0 production

3. Commissioning of b-jet Identification (CMS PAS BTV-10-001)

4. Inclusive b-jet production (CMS PAS BPH-10-009)

5. Open beauty production cross section with muons (CMS PAS BPH-10-007)

6. Hadronic Event Shapes (CMS PAS QCD-10-013)

7. Measurements of Inclusive W and Z Cross sections (CMS PAS EWK-10-002)

8. Performance of Methods for Data-Driven Background Estimation in SUSY Searches (CMS PAS SUS-10-001)

9. Search for heavy Stable Charged Particles (HSCP) (CMS PAS EXO-10-004)

Charm and Beauty

J/Ψ Promt and non-promt cross section in pp collisions at 7TeV.

CMS PAS BPH-10-002

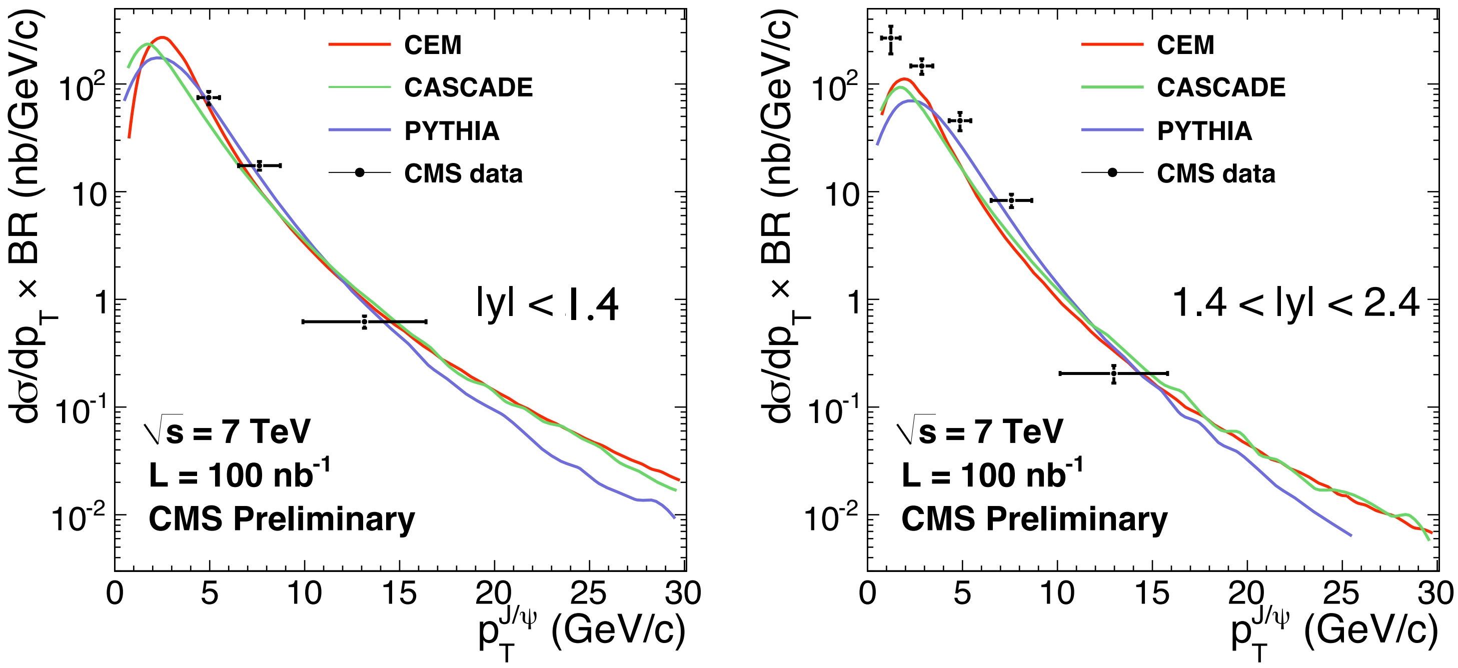
$$\frac{d\sigma}{dp_T}(J/\psi)\cdot \mathrm{BR}(J/\psi \to \mu^+\mu^-) = \frac{N_{\mathrm{corr}}(J/\psi)}{\int L dt \cdot \Delta p_T}$$

$N_{\mathrm{corr}}(J/\psi)$ -The J/ψ yield, corrected for the J/ψ selection efficiency, in a given p_t bin

$\int L dt$ -Integrated luminosity

Δp_T -Size of the p_t bin

$\mathrm{BR}(J/\psi \to \mu^+\mu^-)$ -Branching ratio (5.88±0.10)%



Comparison of the measurement of the prompt production

The cross section is significantly higher than the predicted in 1.4<|y|<2.4. The discrepancy is mostly observed at low p_t values

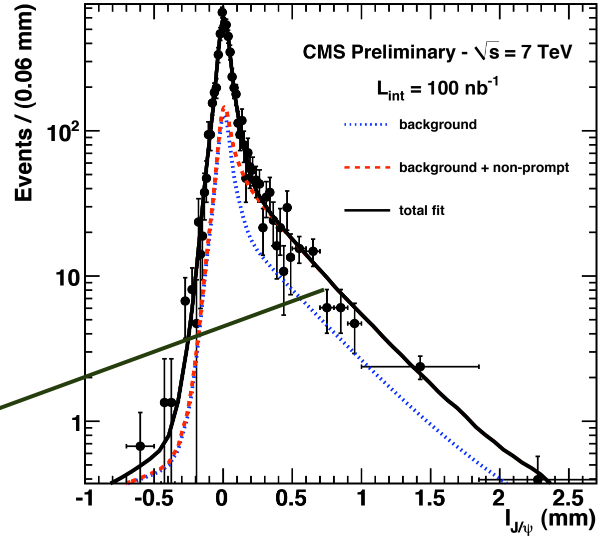
Differential cross section for non- prompt J/Ψ.

Non-prompt J/Ψ production: decay of the B-hadrons.

Prompt- non prompt separation: distribution of the J/Ψ decay length.

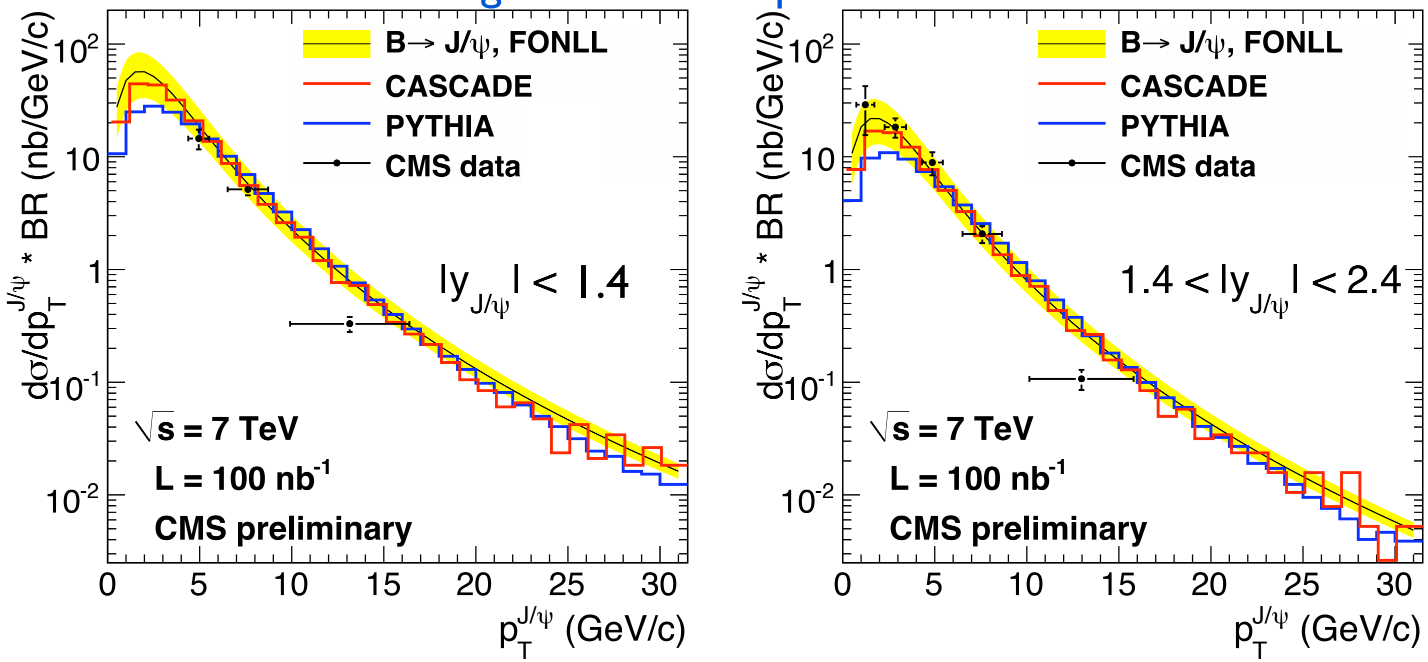
$$l^{J/\psi} = L_{xy} \frac{m^{J/\psi}}{p_T}$$

L_{xy} -most probable transverse decay length in lab frame.



Typical exp. tail for non-prompt J/Ψ

Good agreement with predictions!



Final Result:

$$BR(J/\psi \to \mu^+\mu^-) \cdot \sigma(pp \to J/\psi + X) = (289.1 \pm 16.7(\text{stat}) \pm 60.1(\text{syst}))\ \text{nb}$$

Inclusive D^0 production

$$D^0 \rightarrow K^- \pi^+$$

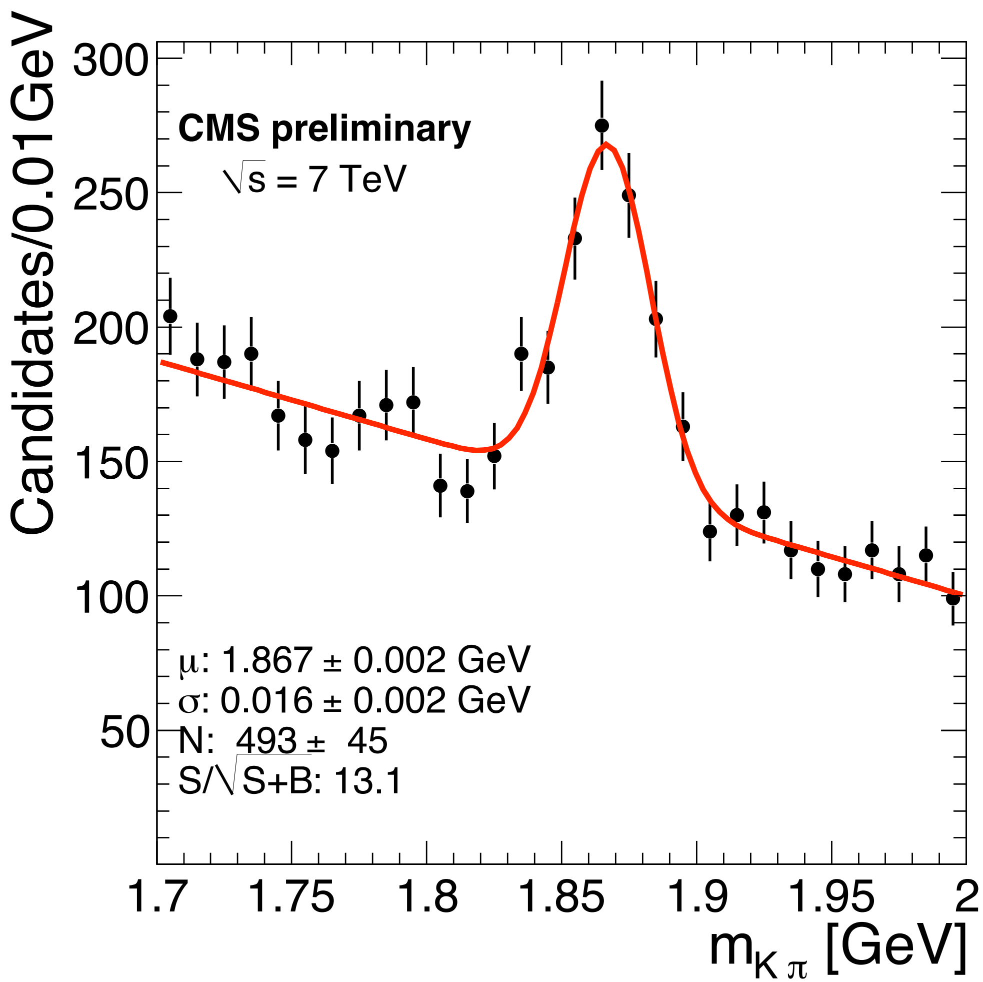
Selection criteria:

pt

$$p_t(K) > 1.25 GeV$$

$$p_t(\pi) > 1.0 GeV$$

$$p_t(D^0) > 3.0 GeV$$



MC expectations

Peak: 1.863±0.002 GeV

Width: 0.014±0.002 GeV

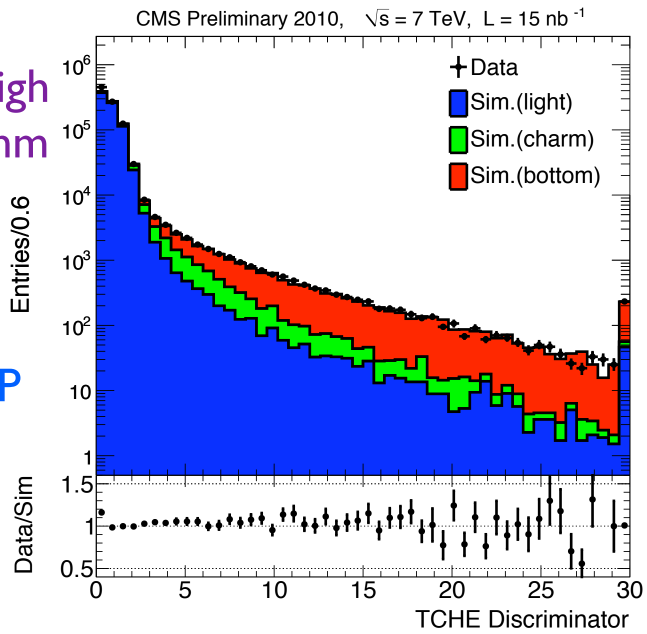
Commissioning of b-jet Identification at 7TeV.

(CMS PAS BTV-10-001)

Tagging discriminators. Comparing data and MC (I)

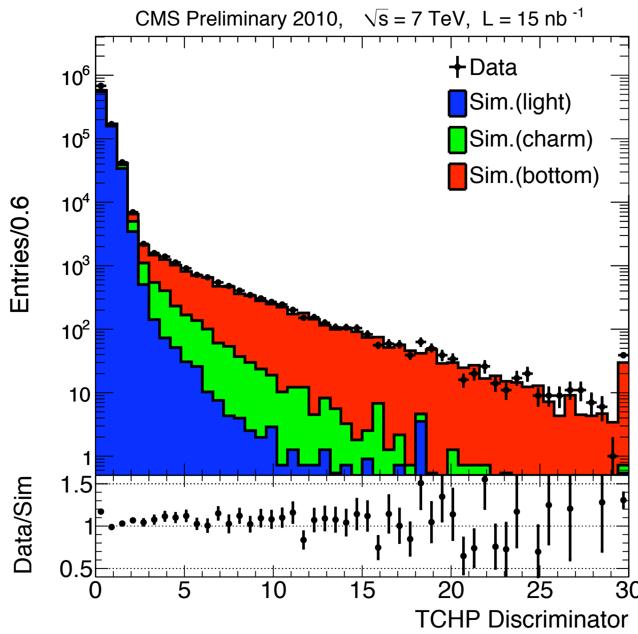
Track counting high efficiency algorithm

Using 2nd track IP significance



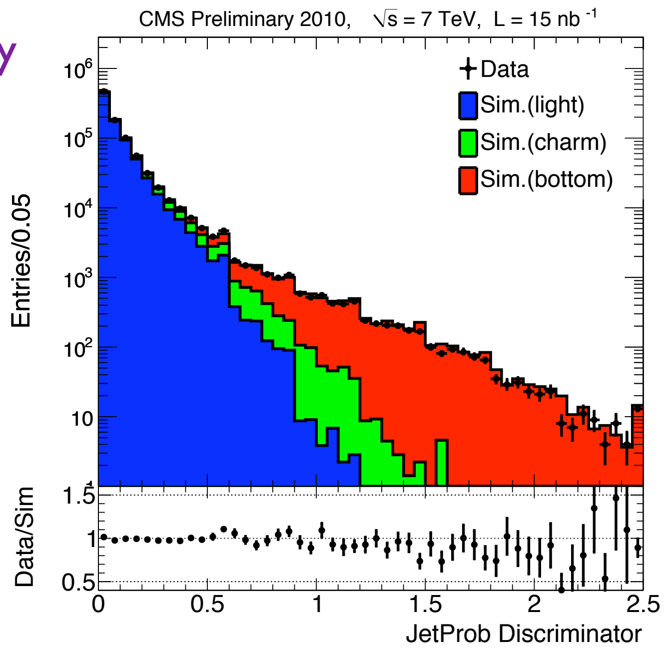
Track counting high purity algorithm

Using 3d track IP significance



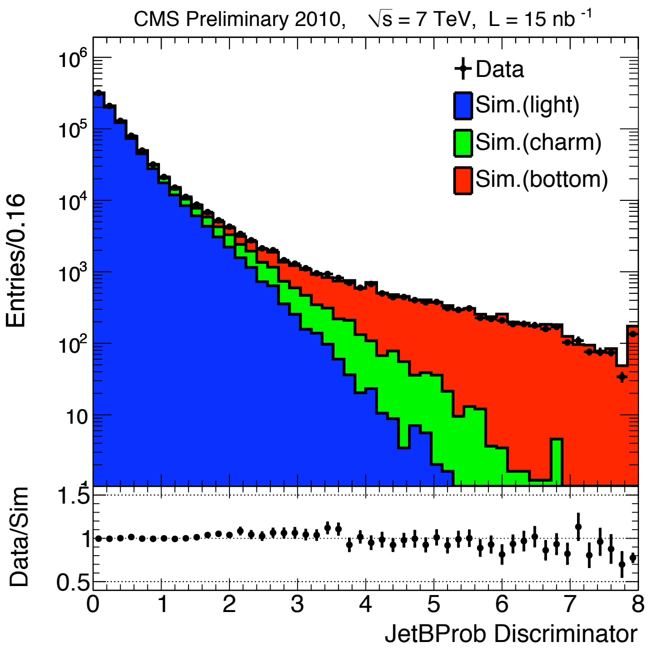
Jet probability

All tracks



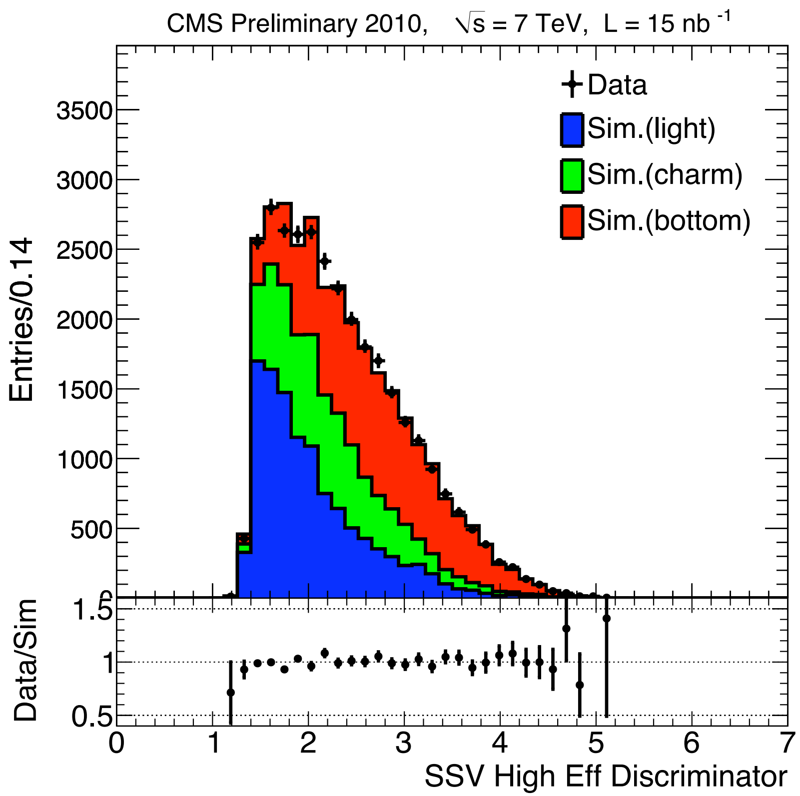
Jet B probability

Four most displaced tracks



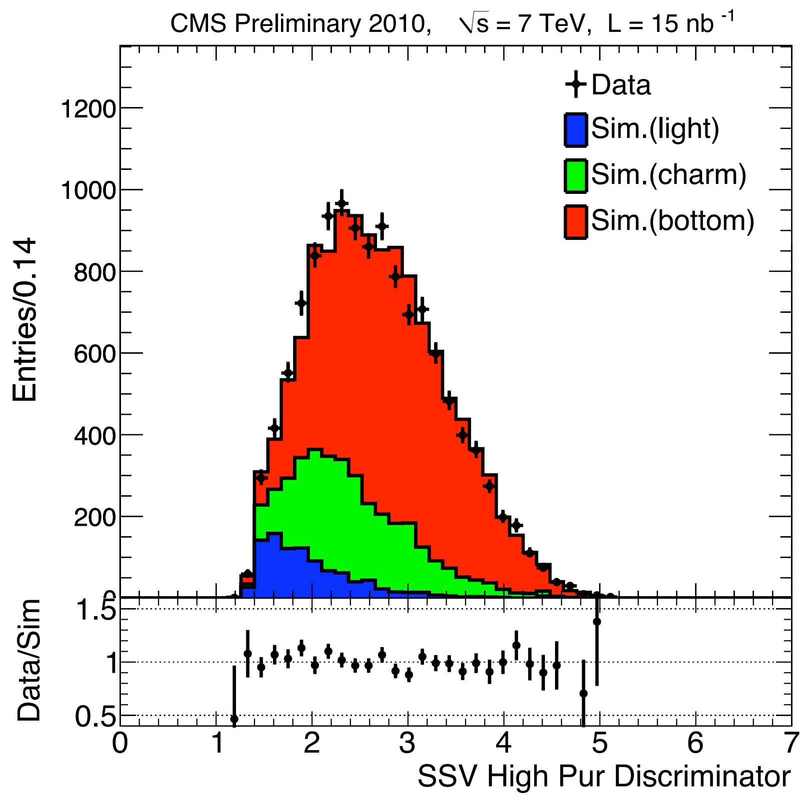
Tagging discriminators. Comparing data and MC (II)

Simple Secondary vertex high efficiency



Minimum number of tracks attached to the vertex $N_{trk} \geq 2$

Simple Secondary vertex high purity



Minimum number of tracks attached to the vertex $N_{trk} \geq 3$

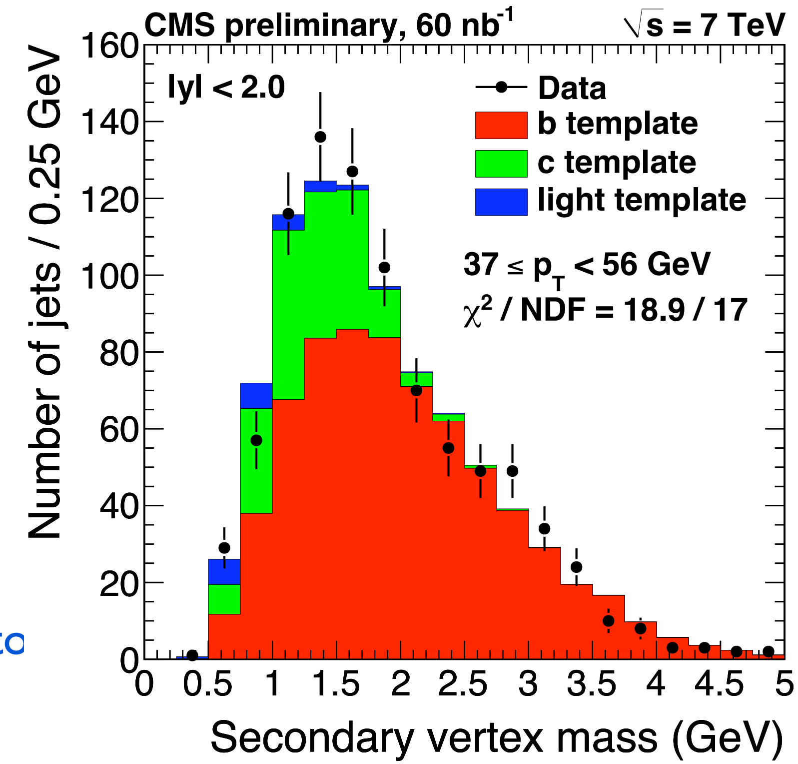
Good agreement between data and MC for all the discriminators!

Inclusive b-jet production in pp collisions at 7 TeV

CMS PAS BPH-10-009

b-tagging - SSVHP;
The SV is fitted with at least 3 charged particle tracks;
10% eff. to tag the light flavor jets;
60% eff. to tag a b-jet at p_t=100 GeV.

b-tagged sample purity estimation



The production cross section:

$$\frac{d^2\sigma_{\mathrm{b-jets}}}{dp_T dy} = \frac{N_{\mathrm{tagged}} f_b C_{\mathrm{smear}}}{\epsilon_{\mathrm{jet}}\epsilon_b \Delta p_T \Delta y \mathcal{L}}$$

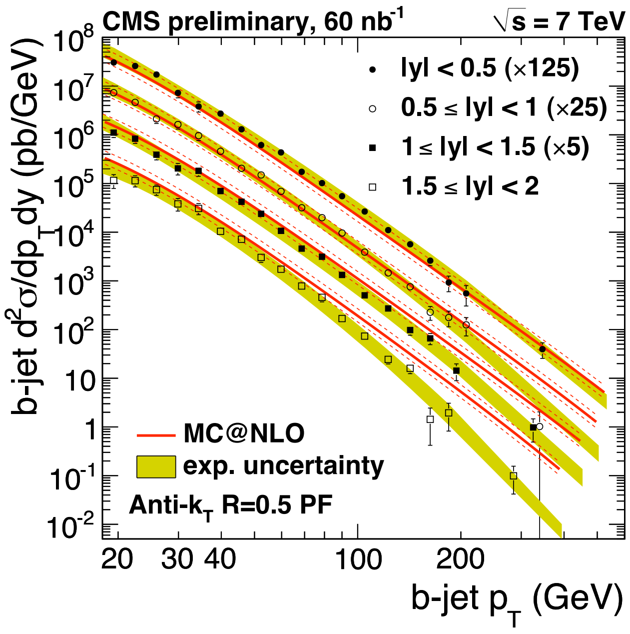
N_{tagged} - number of tagged jets per bin;
Δp_t, ΔY bin widths;
f_b- fraction of tagged jets containing a b-hadron;
e_b- b-jet tagging efficiency;
e_{jet}-jet reconstruction efficiency;
C_{smear}-unfolding correction. Unfolds the measured p_t to particle level

$$f_b = \frac{F_b\epsilon_b}{F_b\epsilon_b + F_c\epsilon_c + F_l\epsilon_l}$$

$e_{l,c}$- mistag rates for LF and Charm

F_b, F_c,F_l- relative fractions of jets

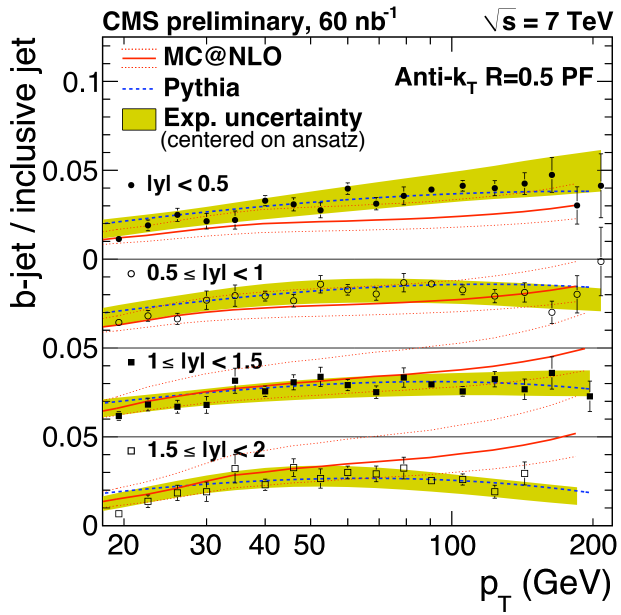
Results



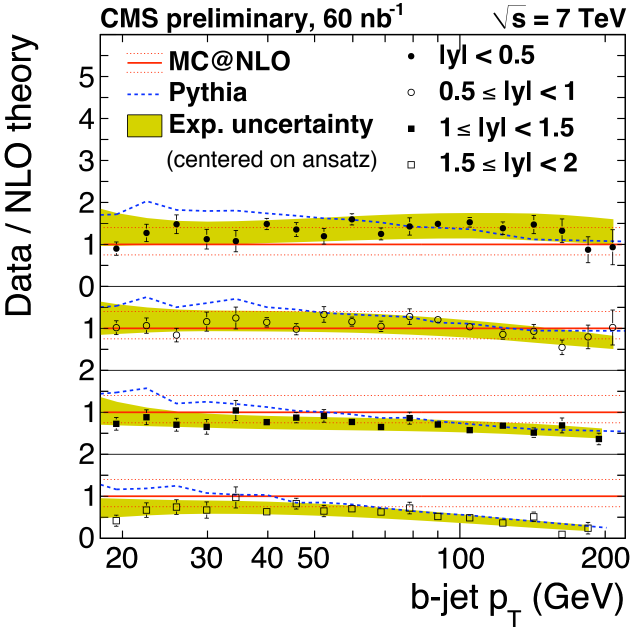
Measured b-jet cross section compared to the MC@NLO (Overlayed)

Good agreement between data and PYTHIA in the jet p_t-range $30<p_t<150$GeV, $|y|<2.0$, with 2% stat, 21% syst.

Reasonable agreement with MC@NLO calculation. and measured b-jet fraction, within 21% syst. Significant shape difference in p_t and y.



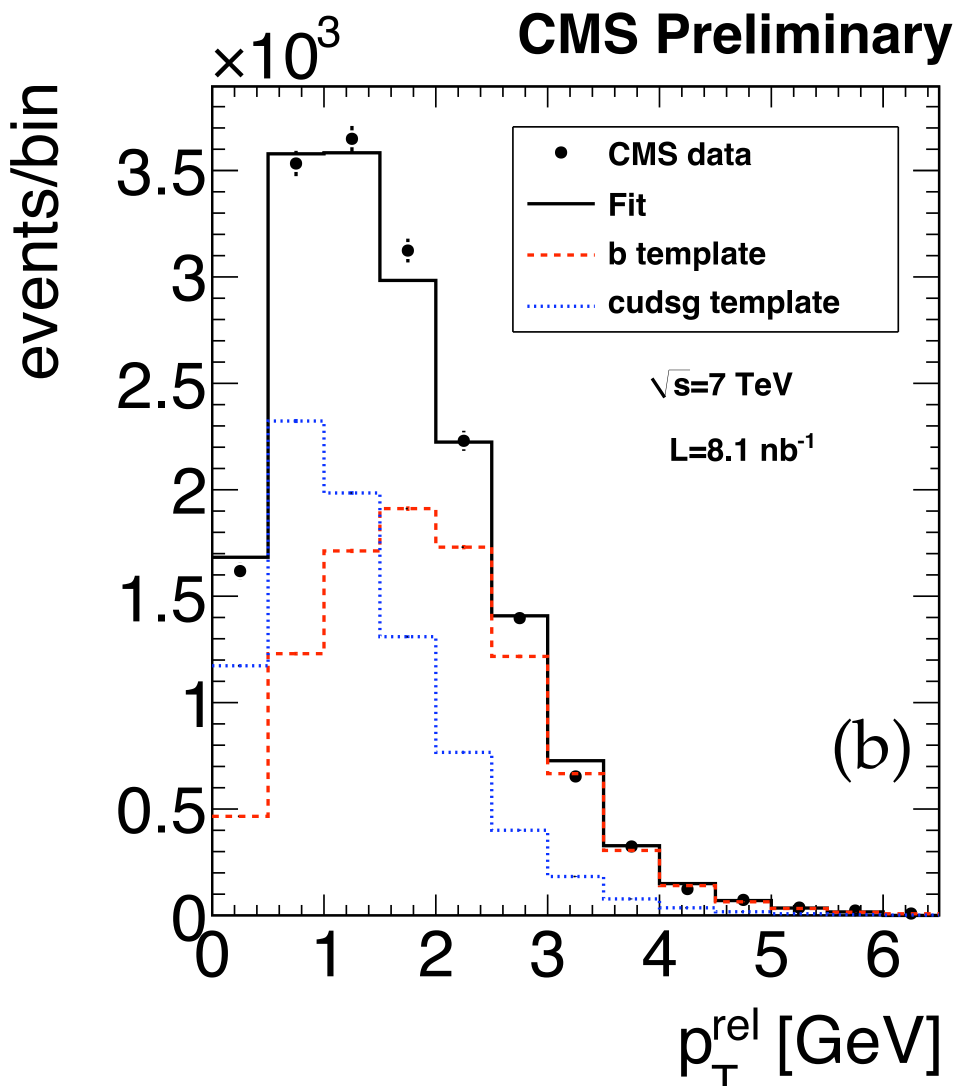
Measured b-jet cross section as a ratio to inclusive jet cross section.



Measured b-jet cross section compared to the MC@NLO (As a ratio)

Open beauty production cross section with muons in pp collisions at 7TeV.

CMS PAS BPH-10-007



$$p_{\perp}^{\mathrm{rel}} = |\vec{p}_{\mu} \times \vec{p}_j| / |\vec{p}_j|$$

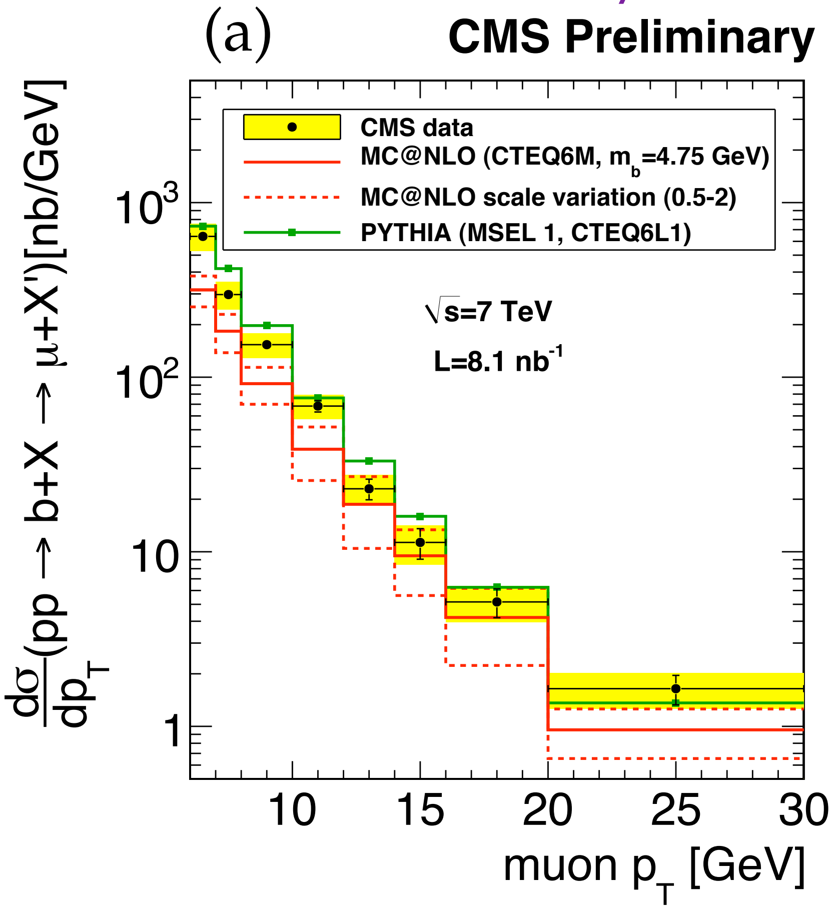
Global muon: combined fit of silicon and muon-chamber hits, belonging to the independent tracker and muon system.

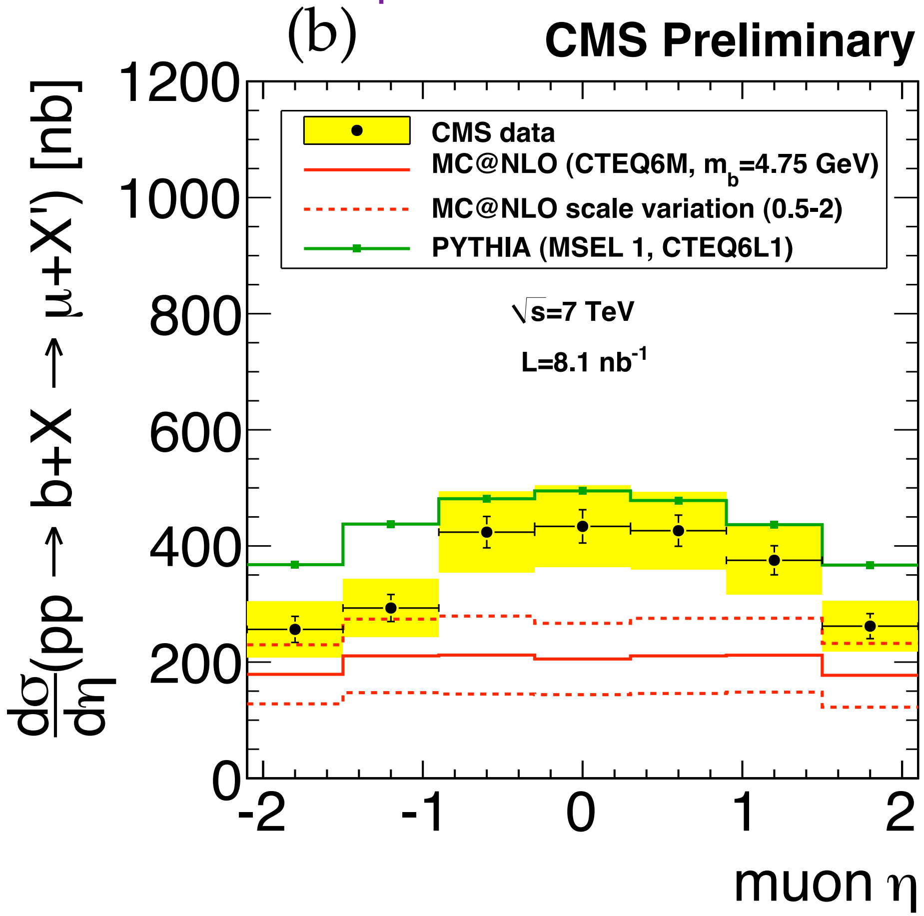
$p_t > 3$ GeV/c

Distribution in data and results of the maximum likelihood fit.
The dashed red and blue lines: *b* and *cudsg*-templates

Differential Cross Section

Yellow bands- syst. and stat. uncertainties added in quadrature





$\frac{d\sigma}{dp_\perp^\mu}(pp \rightarrow b + X \rightarrow \mu + X', |\eta^\mu| < 2.1)$ $\frac{d\sigma}{d\eta^\mu}(pp \rightarrow b + X \rightarrow \mu + X', p_\perp^\mu > 6\,\mathrm{GeV})$

Final Result:

$$\sigma(pp \rightarrow b + X \rightarrow \mu + X', p_\perp^\mu > 6\,\mathrm{GeV}, |\eta^\mu| < 2.1) = (1.48 \pm 0.04_{\mathrm{stat}} \pm 0.22_{\mathrm{syst}} \pm 0.16_{\mathrm{lumi}})\,\mu\mathrm{b}$$

QCD

Hadronic Event Shapes in pp Collisions at 7TeV

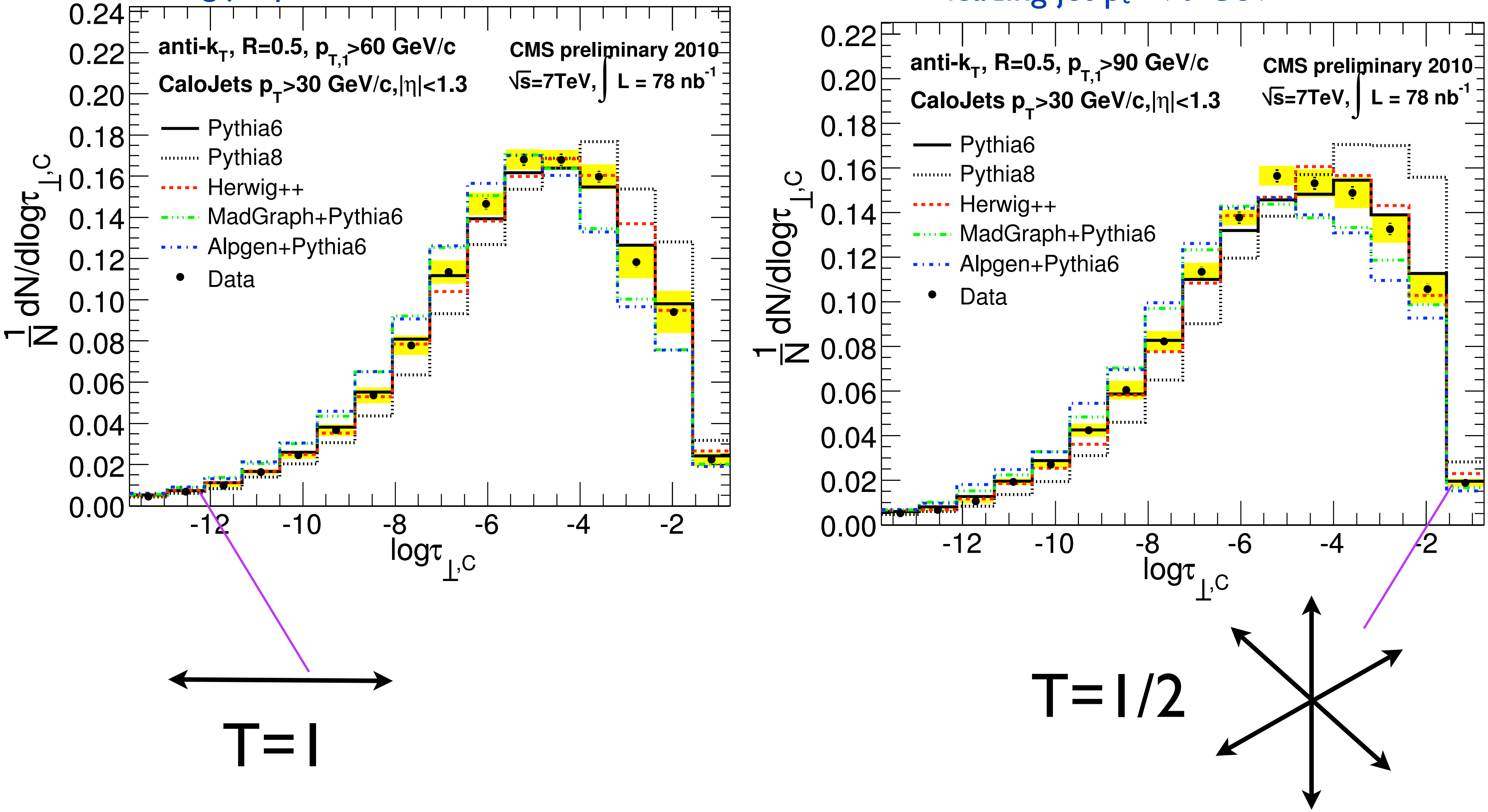
CMS PAS QCD-10-013

$$T_{\perp,\mathcal{C}} \equiv \max_{\vec{n}_T} \frac{\sum_{i\in\mathcal{C}} |\vec{p}_{\perp,i} \cdot \vec{n}_T|}{\sum_{i\in\mathcal{C}} p_{\perp,i}}$$ - central transverse thrust ($|\eta| < 1.3$) $$\tau_{\perp,\mathcal{C}} \equiv 1 - T_{\perp,\mathcal{C}}$$

Yellow bands- syst. and stat. uncertainties added in quadrature

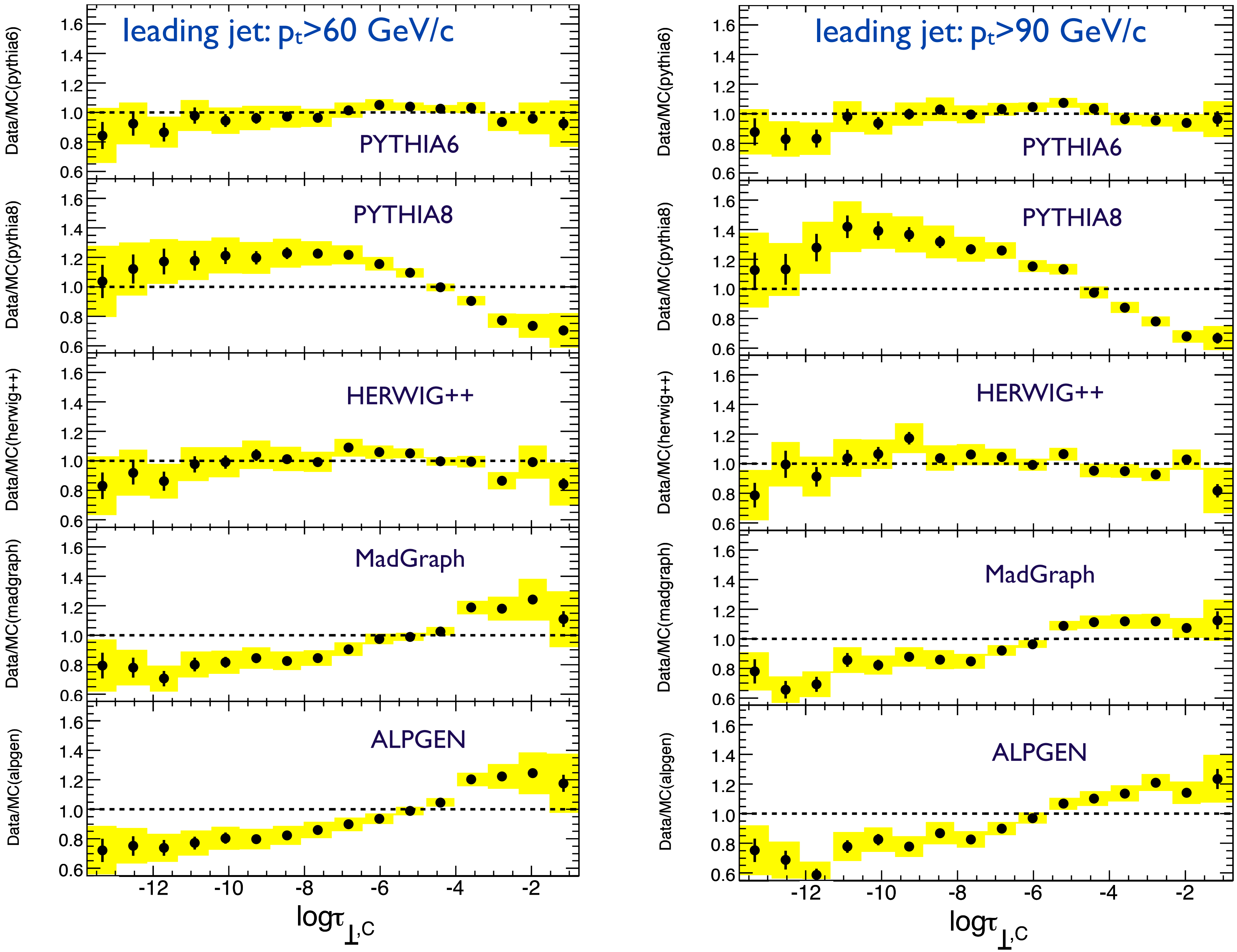
leading jet p_t> 60 GeV

leading jet p_t> 90 GeV



Data/MC

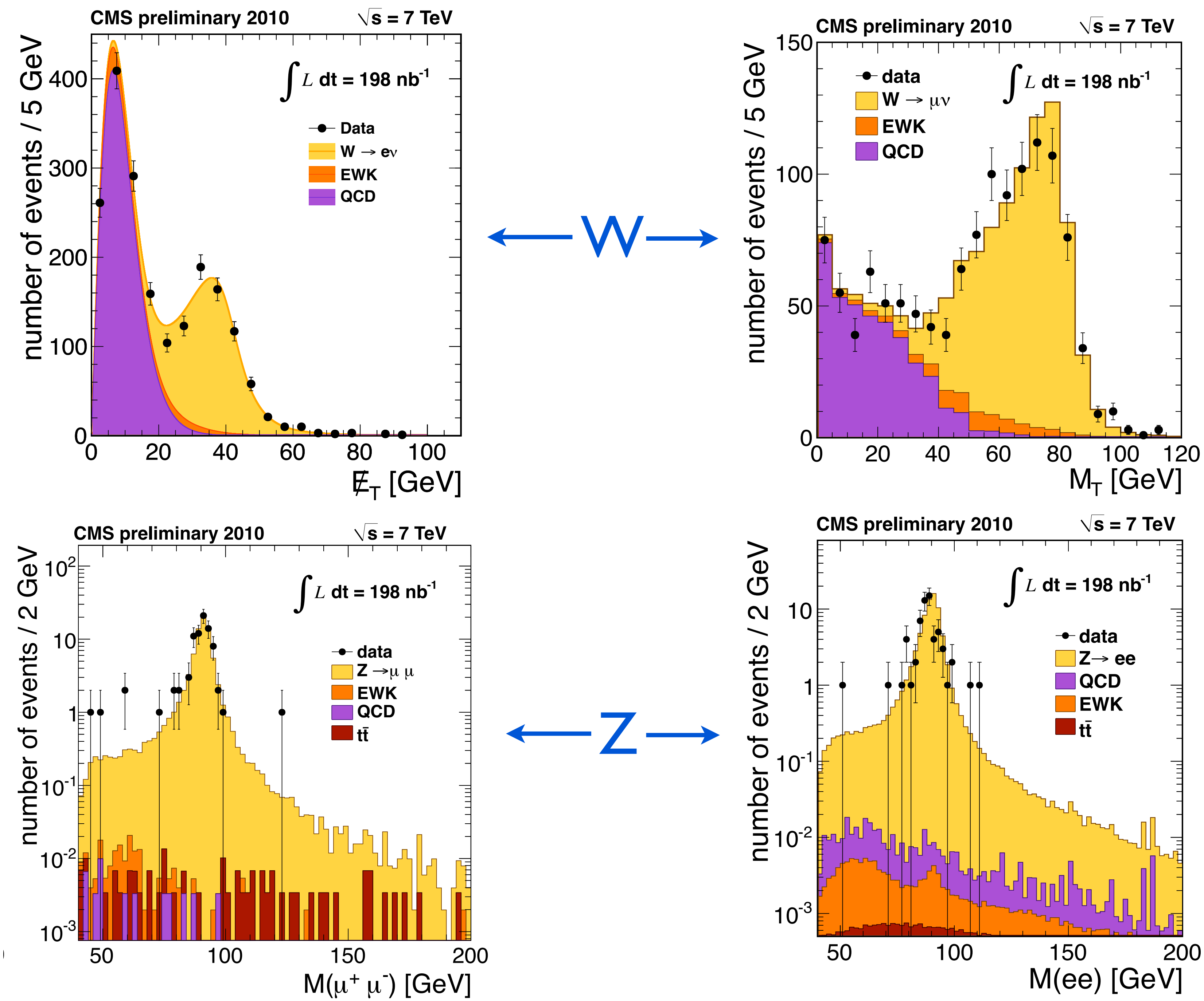
Yellow bands- quadratic sum of syst. and stat. uncertainties



Electroweak Physics

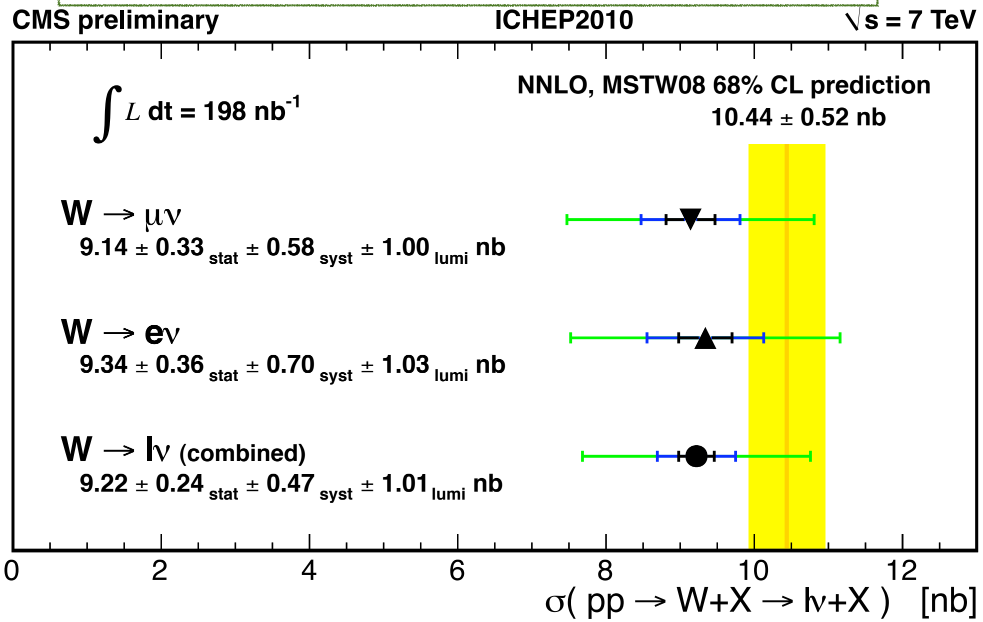
Measurements of Inclusive W and Z Cross sections in pp collisions at 7TeV.

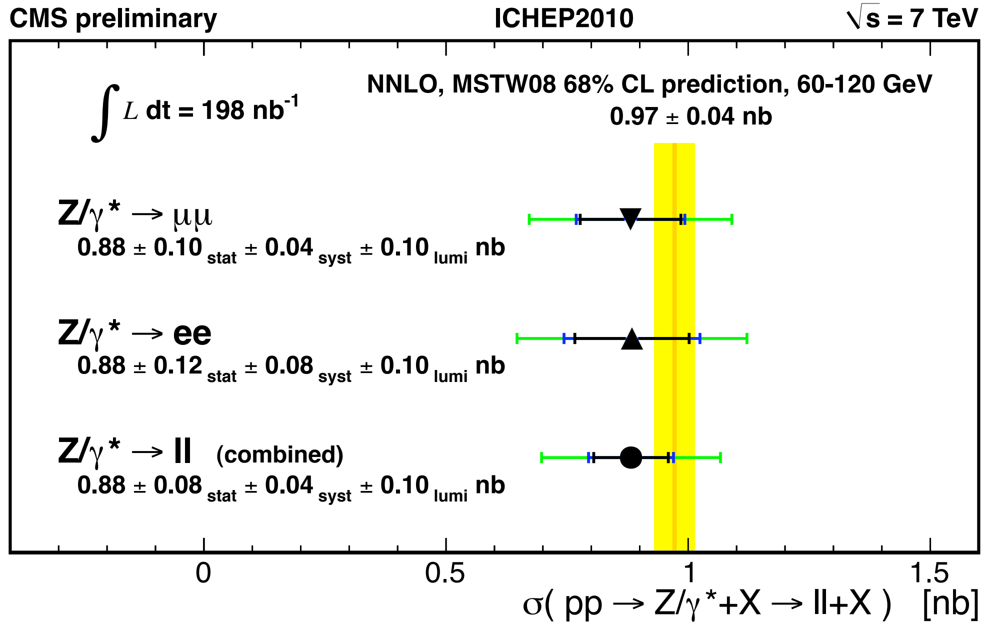
CMS PAS EWK-10-002



Cross section

Results are compatible with Standard Model expectations





SUSY and “Exotic”

Performance of Methods for Data-Driven Background Estimation in SUSY Searches.

1. Suppressing QCD background in SUSY searches with α_T

CMS PAS SUS-10-001

$$\alpha_T \equiv \frac{p_{T2}}{M_T}$$

p_{T2} momentum of the lower momentum jet

$$M_T = \sqrt{2 p_{T1} p_{T2} (1 - \cos\Delta\phi)}$$

For $M_T = 2p_{T1} = 2p_{T2}$ $\alpha_T = 0.5$

If p_t one of the jets is mismeasured $\alpha_T < 0.5$

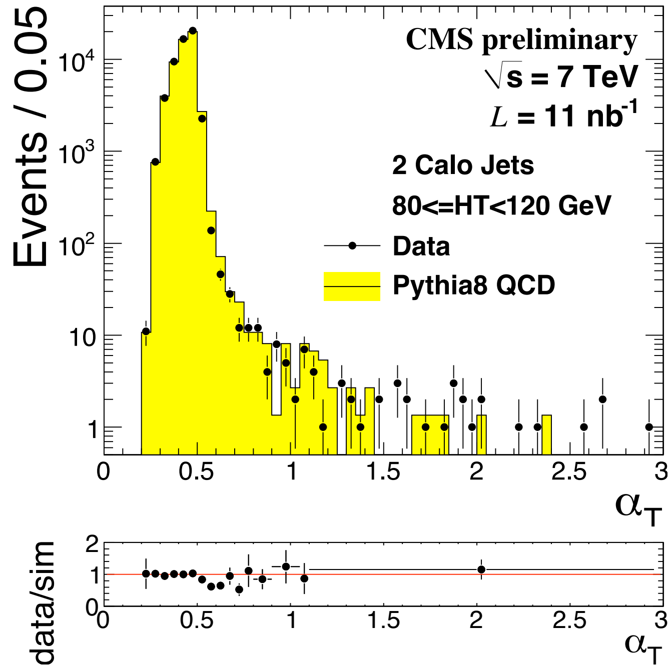
$$H_T = p_{T1} + p_{T2}$$

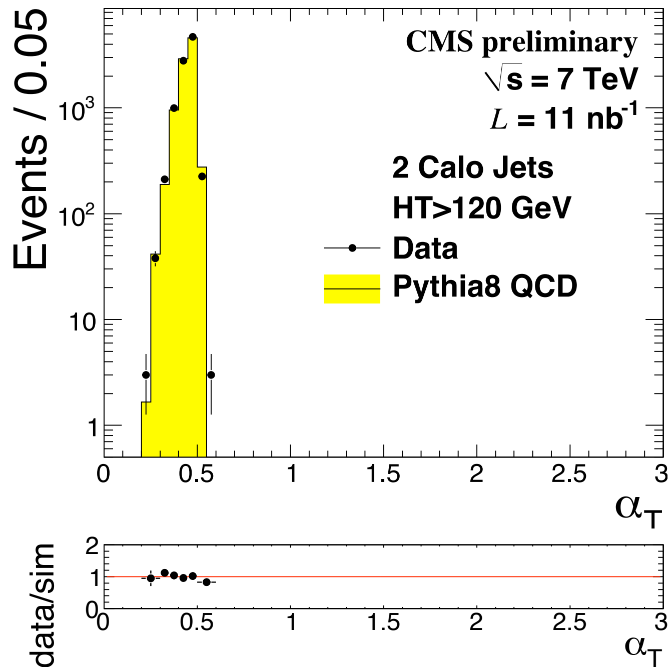
Interest: tail of the distribution above

$$\alpha_T = 0.5$$

The plots demonstrate the reduction of the α_T tail with increase of H_T

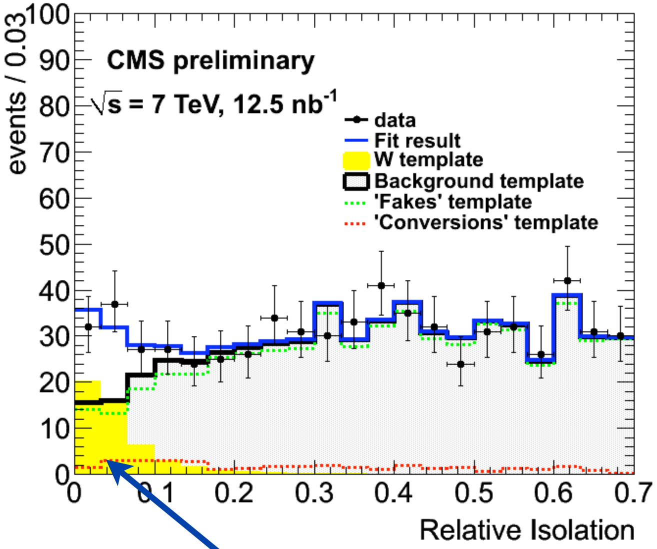
SUSY analysis requirement: H_T>350 GeV



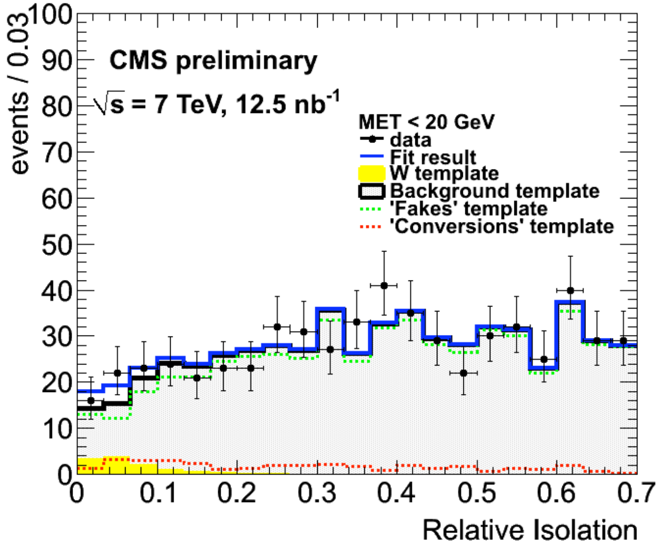


Electron Background prediction

The leptons produced in cascade decay of SUSY particles are usually isolated from the other energy and are well distinct.



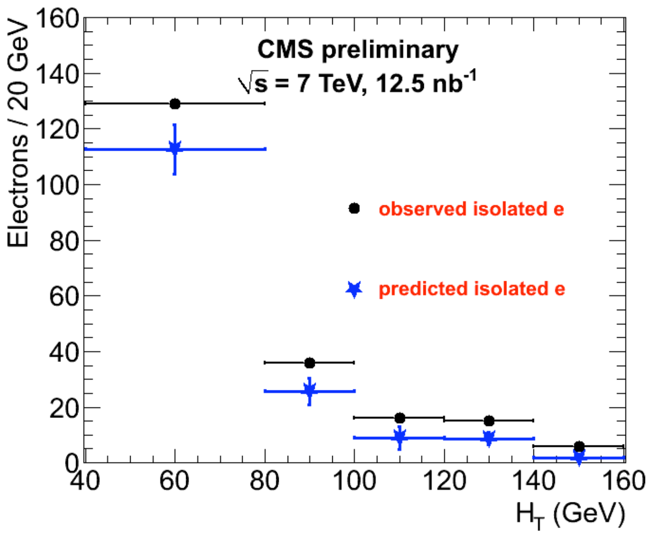
W contamination

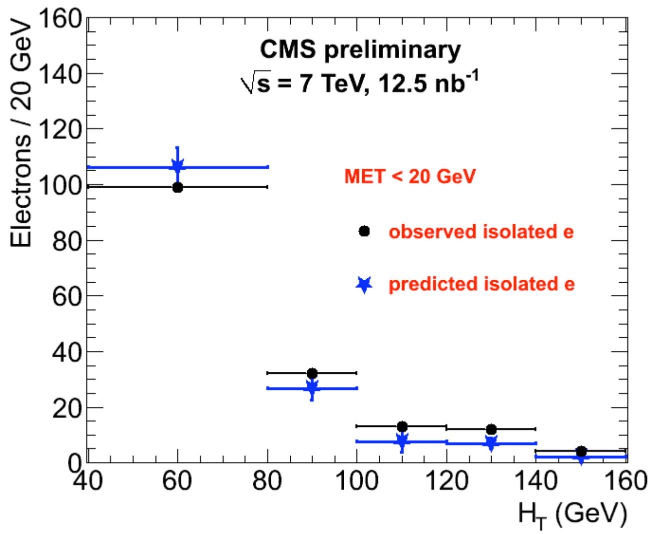


Relative isolation: $\Delta R/p_t$

ΔR=0.3- the radius of the isolation cone around the lepton candidate.

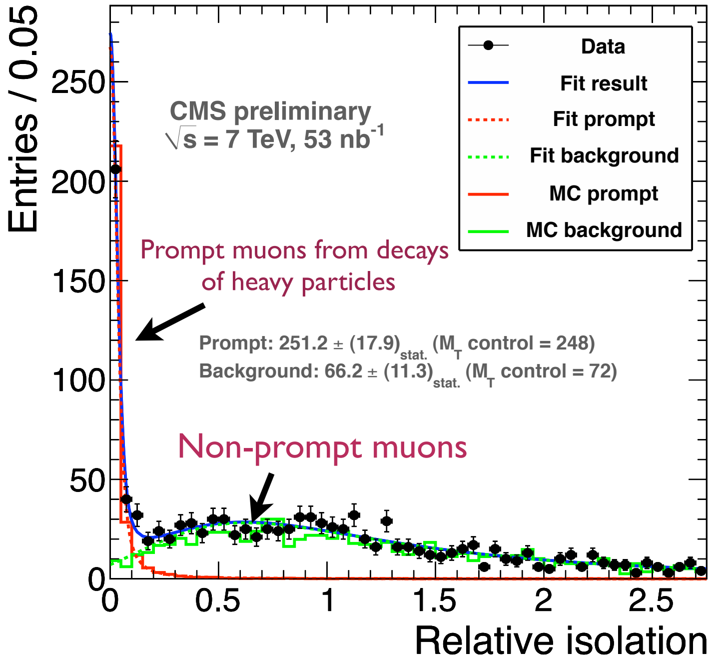
Fits to the distribution of relative isolation of electrons.



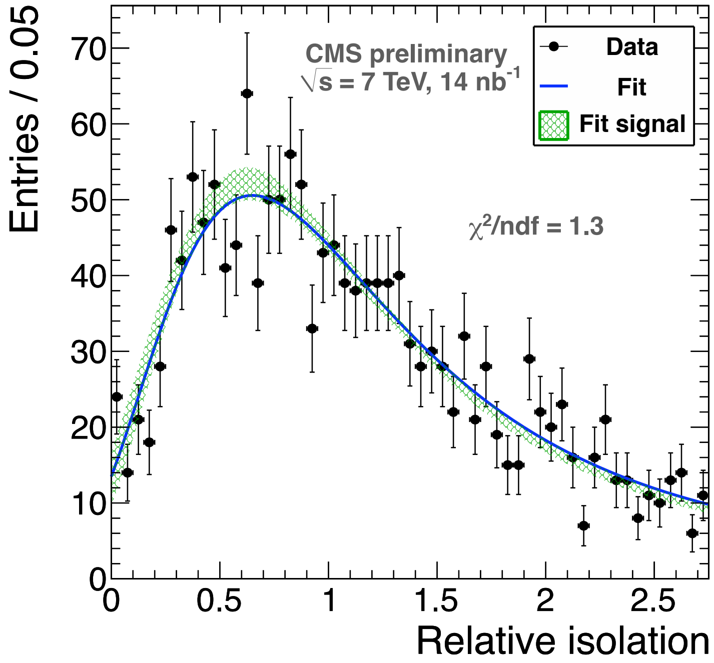


Predicted VS measured number of isolated electrons (relative isolation < 0.3) from background sources.

Muon Background prediction



The distributions of relative muon isolation.
All selected events MET>20 GeV.



Background dominated events,
MET<20GeV, H_t>20GeV

Green band- fit without W rejection
Blue line- fit after W rejection

Search for heavy Stable Charged Particles (HSCP) in pp collisions at 7 TeV.

CMS PAS EXO-10-004

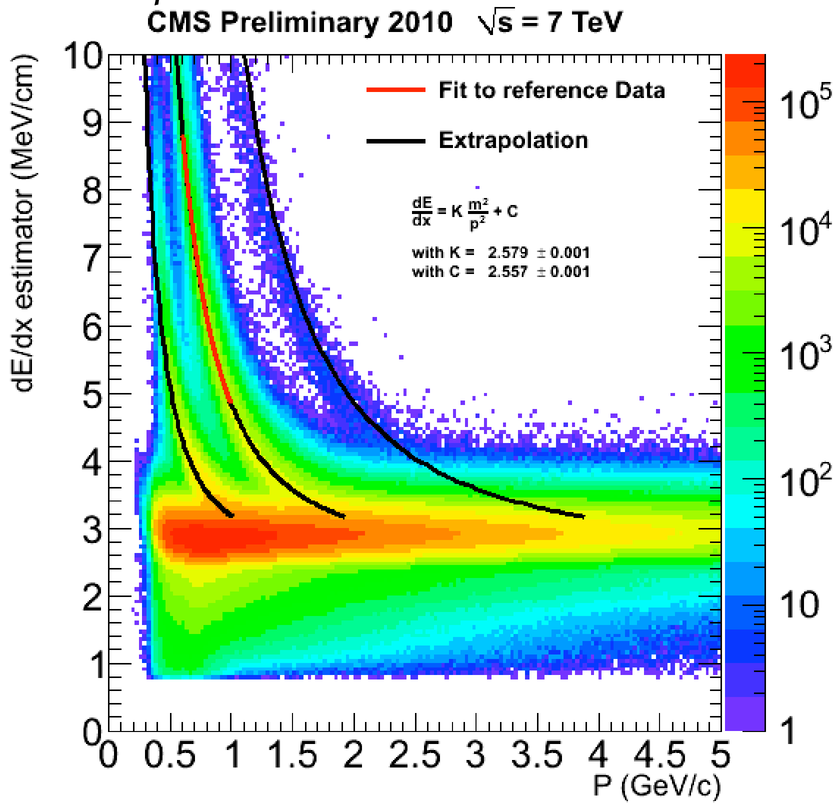
Estimation of the most probable value of dE/dx

$$I_h = \left(\frac{1}{N}\sum_i c_i^k\right)^{1/k} \text{ with } k = -2$$

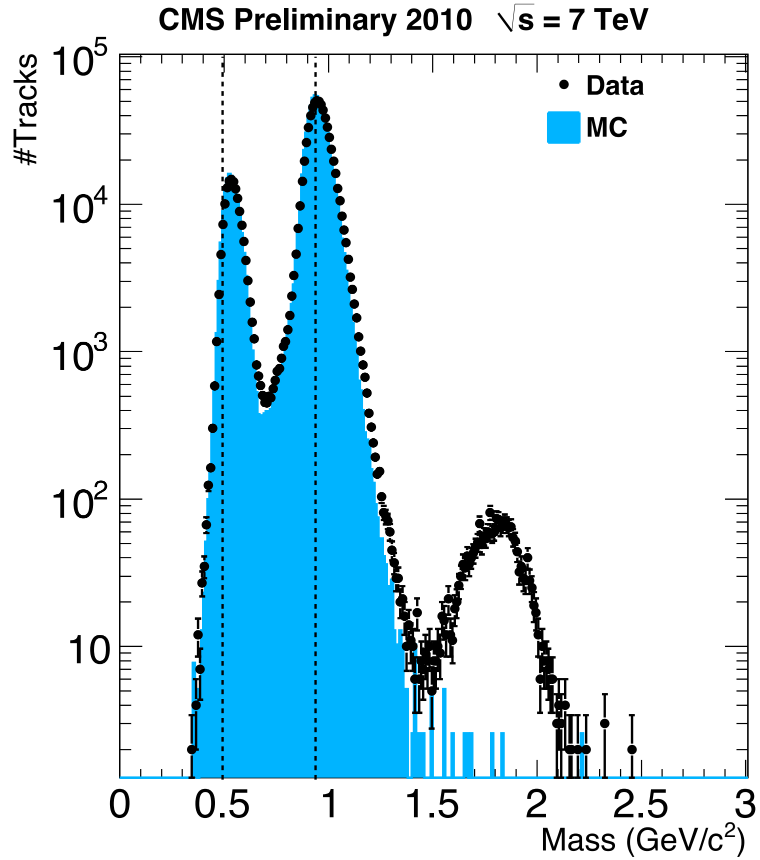
c_i- charge per unit path length for the i-th hit of the track

$$I_h = K\frac{m^2}{p^2} + C$$ For p region below minimum ionization

p_t>7.5GeV/c;
3 hits is Silicon Tracker for dE/dx measurement;
Clean separation:
selection of tracks with high p_t and dE/dx.



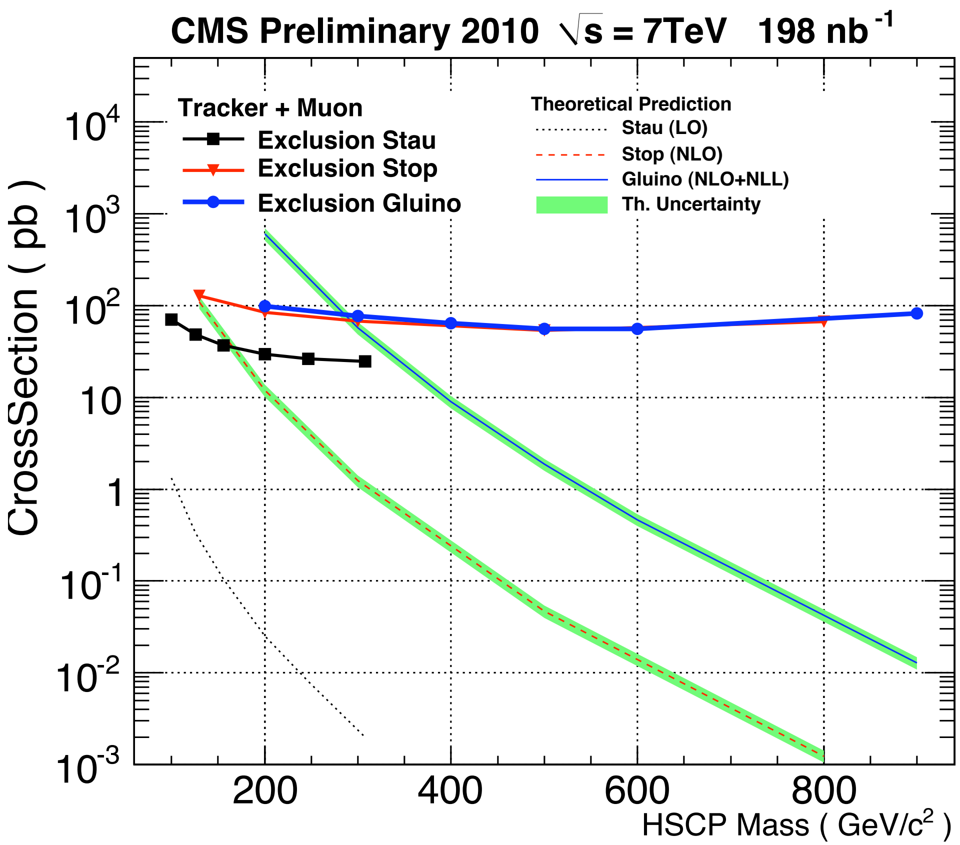
I_h estimator
At least 12 hits in SiStrip
0.7<p<1.5 GeV/c - kaons and protons
p>1.5GeV- deuterons



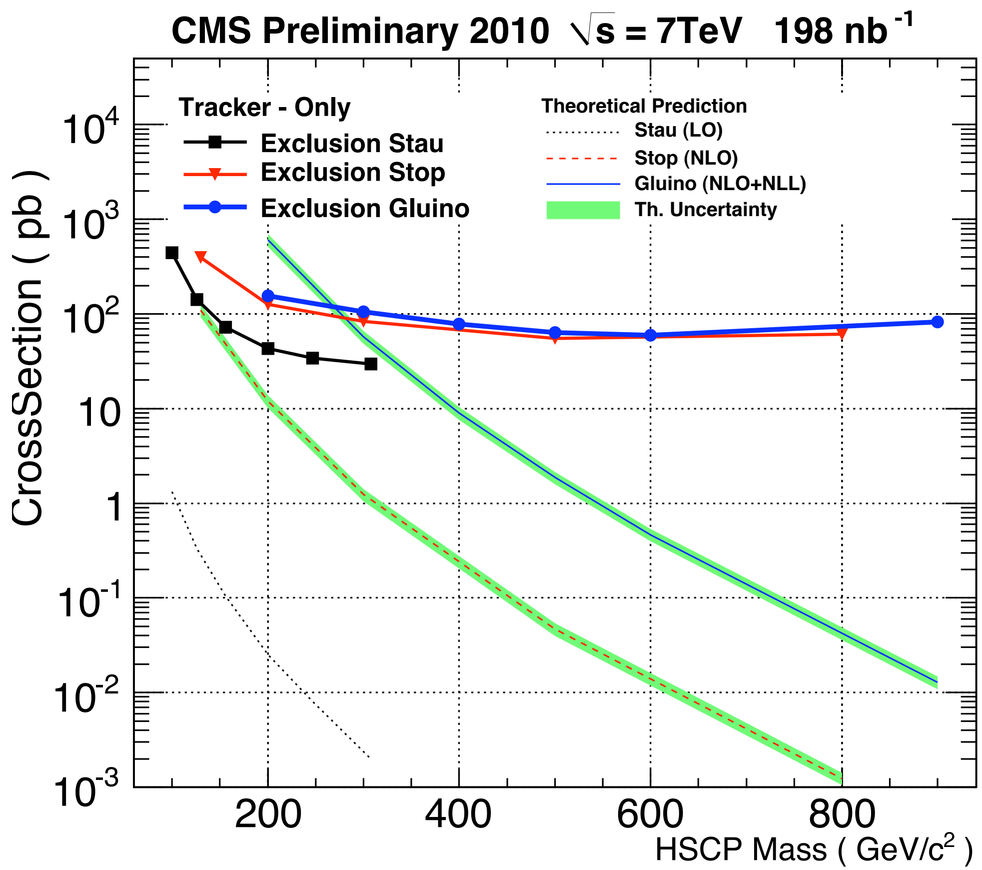
Mass spectrum I_h>5 MeV/cm, p<2.0 MeV/c
(No deuterons in PYTHIA)

Results on the cross section

Observed 95% upper limits on the cross section for production of the different models considered and predicted theoretical cross section.



Tracker+muon candidates



Tracker candidates only

m_{gluino}< 284 GeV/c^2, 95% C.L. , tracer only

m_{gluino}< 271 GeV/c^2, 95% C.L., tracker+muon

Summary

1. First measurement of the J/Ψ production in two rapidity ranges: 1.4<|y|<2.4 and |y|<1.4. $BR(J/\psi \to \mu^+\mu^-) \cdot \sigma(pp \to J/\psi + X) = (289.1 \pm 16.7(\text{stat}) \pm 60.1(\text{syst}))$ nb

2. Good agreement between measurement and MC for the D^0 mass reconstruction. Peak: 1.867±0.002GeV, width: 0.016±0.002 GeV.

3. Several b-tagging algorithms are developed for CMS with the first collisions data at 7 TeV. Good agreement between data and MC.

4. The ratio of b-jet to inclusive jet production is measured. Reasonable agreement between PYTHIA , MC@NLO calculation and measured overall b-jet fraction

5. Preliminary result for the total inclusive b-quark production cross-section

$$\sigma(pp \to b + X \to \mu + X', p_\perp^\mu > 6\,\text{GeV}, |\eta^\mu| < 2.1) = (1.48 \pm 0.04_{\text{stat}} \pm 0.22_{\text{syst}} \pm 0.16_{\text{lumi}})\ \mu\text{b}$$

6. Results on hadronic event shapes. Good agreement between data and MC.

7. W and Z cross sections were measured . No disagreements with SM observed.

$$\sigma_{W \to l\nu} = (9.22 \pm 0.24_{stat} \pm 0.47_{syst} \pm 1.01_{lumi})nb \quad \sigma_{Z/\gamma^* \to ll} = (0.88 \pm 0.08_{stat} \pm 0.04_{syst} \pm 0.10_{lumi})nb$$

8. Studies of the QCD background supression with α_T. Prediction lepton background in SUSY searches.

9. m_{gluino}< 284 GeV/c², 95% C.L. , (tracker only), m_{gluino}< 271 GeV/c², 95% C.L., (tracker+muon)

BACKUP SLIDES

Estimation of the b-tagging efficiency (I)

Relative momentum of muon wrt. the jet (p_t^{rel}) is sensitive to B decays because of high B mass.

Use p_t^{rel} shape to fit fractions (f_b) of b and light+c jets in tagged and anti-tagged jets.

Efficiency calculation:

$$\epsilon_b^{\rm data} = \frac{f_b^{\rm tag} \cdot N_{data}^{\rm tag}}{f_b^{\rm tag} \cdot N_{data}^{\rm tag} + f_b^{\rm untag} \cdot N_{data}^{\rm untag}}$$

f_b^{tag}, f_b^{untag}-fractions of b jets in the data,
N_{data}^{tag} , N_{data}^{untag} - total yields of tagged and untagged jets.

Event Selection:

$p_t > 20$ GeV

Muon Selection:

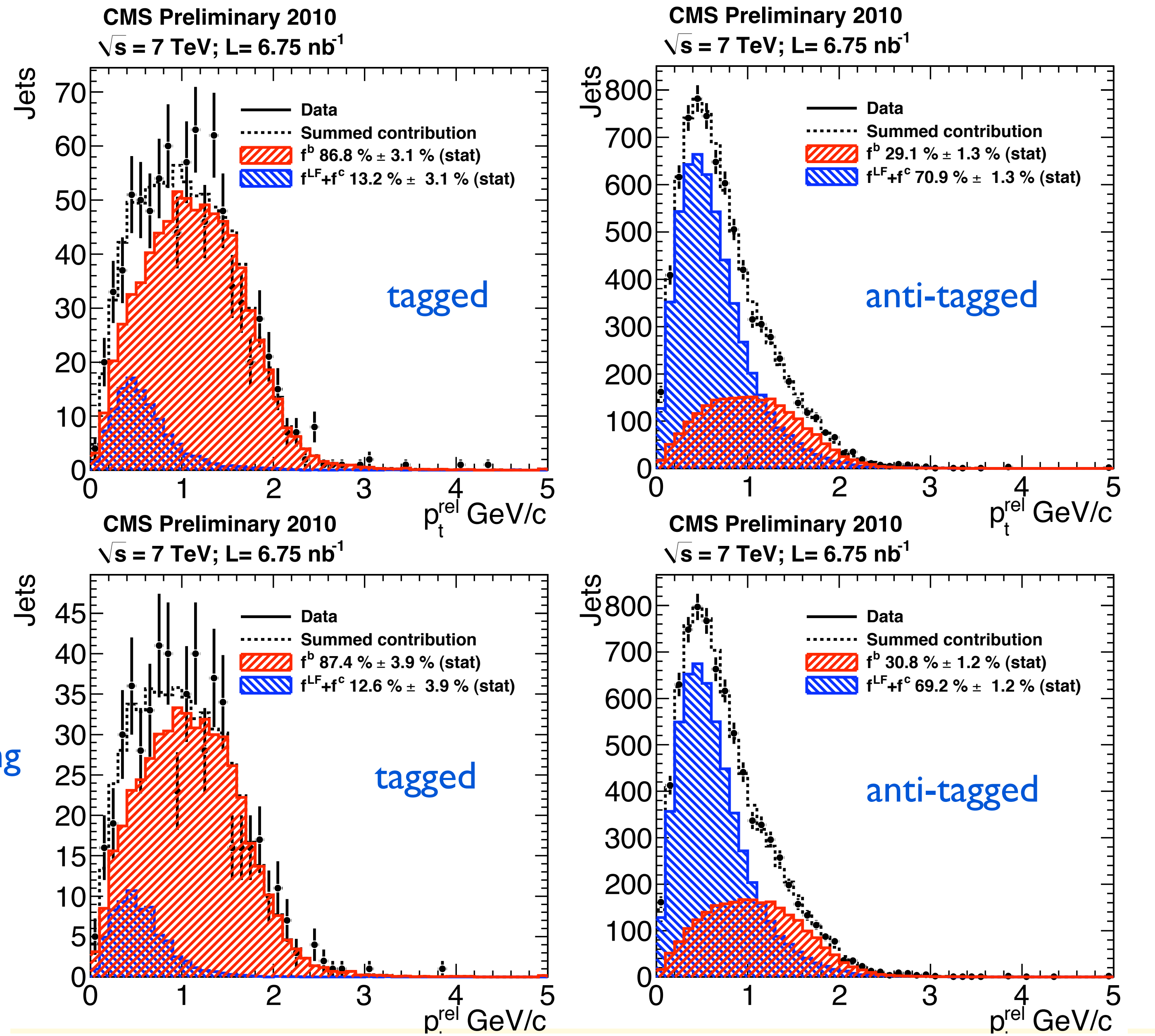
Global muon: combined fit of silicon and muon-chamber hits, belonging to the independent tracker and muon system.

$p_t > 5$ GeV and $| \eta | < 2.4$
$\chi^2 < 10$ for the global track
"high purity" track category
≥ 2 pixel hits and ≥ 12 total hits
expected tracker outer hits < 3

Estimation of the b-tagging efficiency (II)

TCHPM
M- medium
operating point

SSVHPT
T-tight operating
point



Algorithms for the b-jet identification:

1. The "track counting" (TC) approach. Jet is a b-jet if it contains at least N tracks with significance of impact parameter (IP) exceeding S. N=2- TC High Efficiency E; N=3-TC High Purity.
Discriminator: Value S for the Nth track.

2. SSV- based on the reconstruction of at least 1 SV. N_{trk}>=2-"high efficiency" SSVHE, N_{trk} >=3-"high purity" SSVHP.
Discriminator: A monotonic function of the three dimensional flight distance.

3. The jet probability algorithms. Each track is assigned a probability (P_{tr}) to originate at the PV.
Discriminator: built from the set of P_{tr} in the jet

4. Lepton-based tagging algorithms identify b hadrons via their semileptonic decay.
Discriminator: achieved on p_t of the lepton, the IP of the lepton or both.

operating points:

"loose" (L) contamination of light partons: 10%
"medium" (M) contamination of light partons: 1%
"tight" (T) contamination of light partons: 0.1%

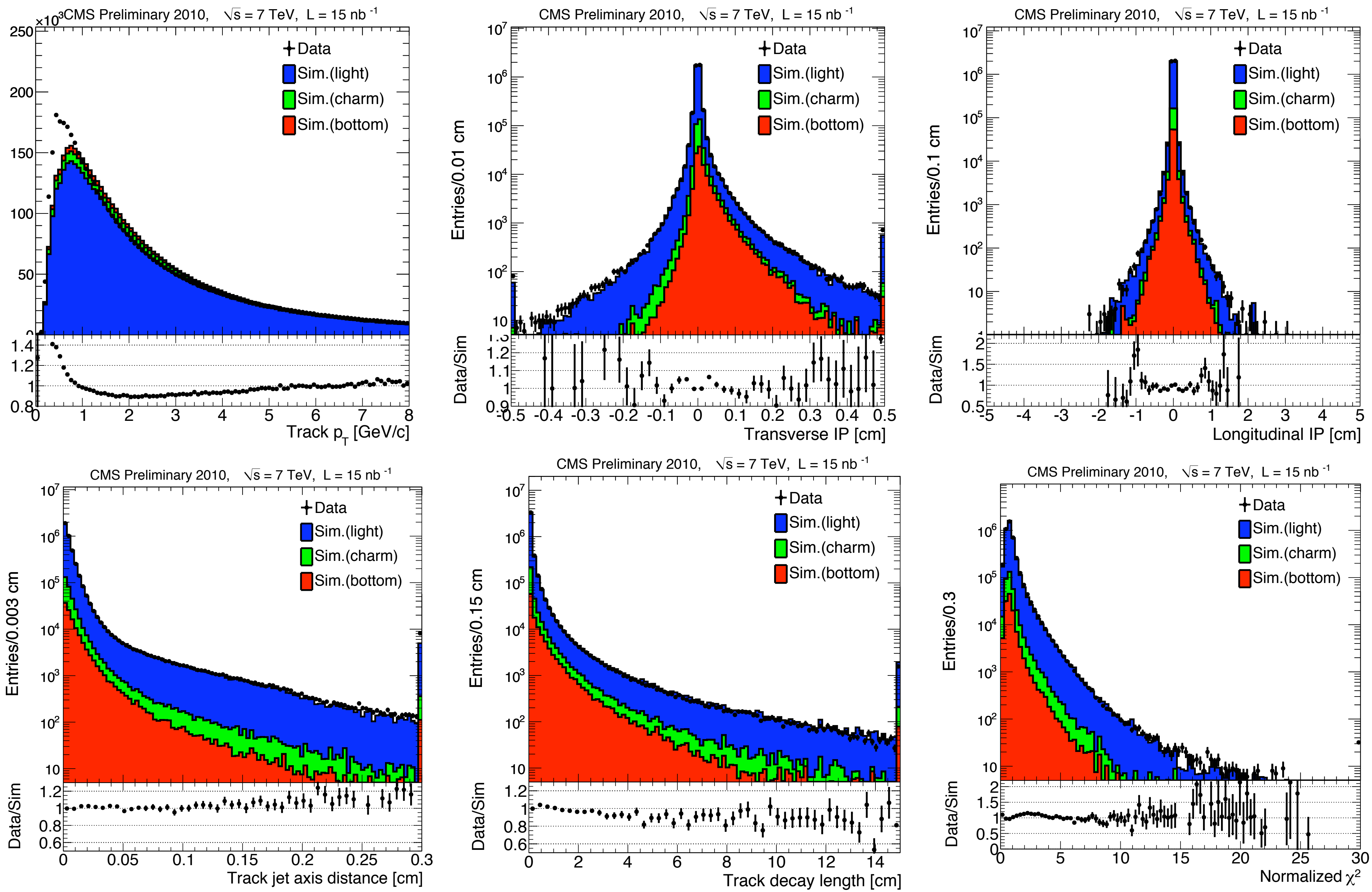
Event Selection:

jet p_t > 30 GeV;
$|\eta|$<2.4;

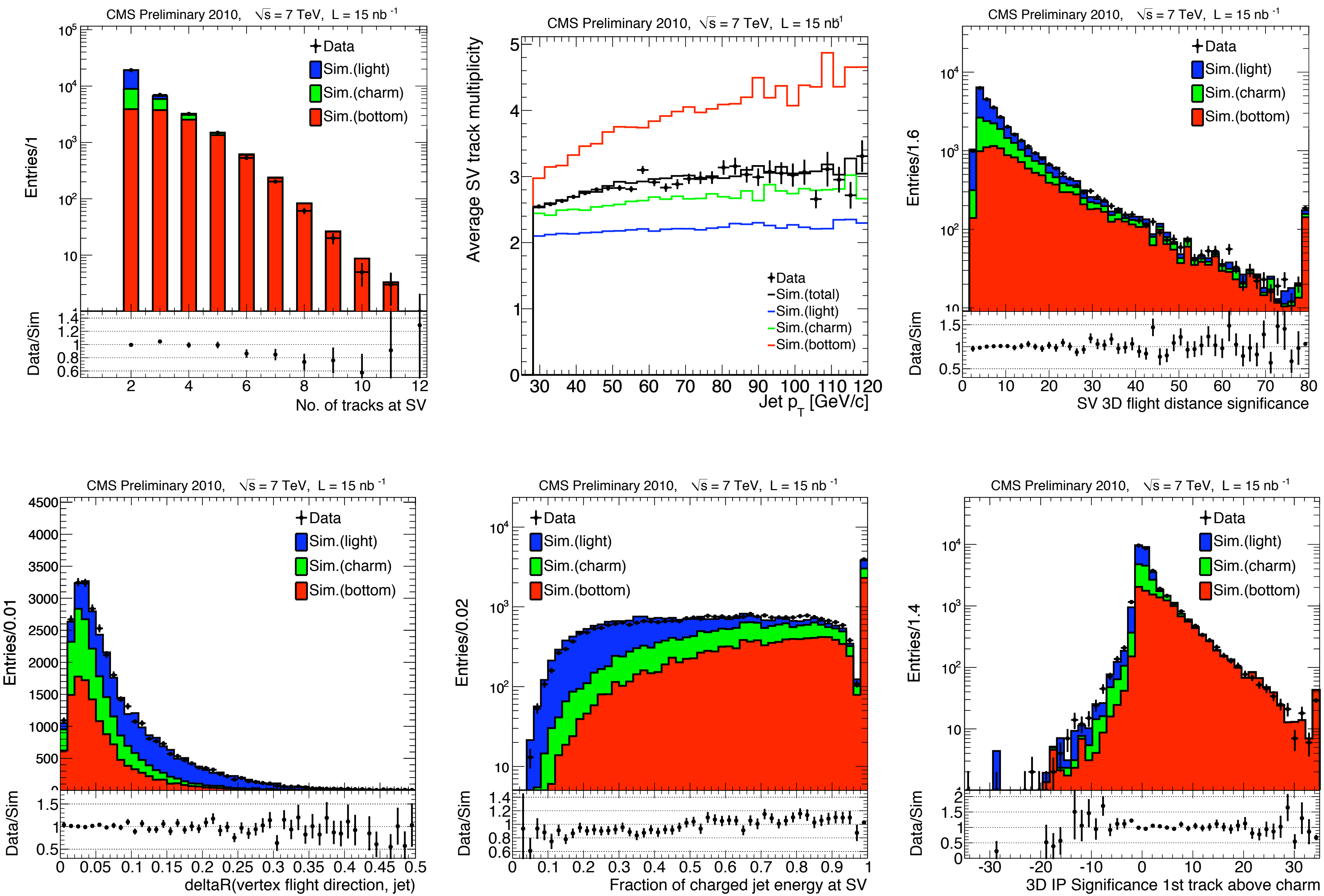
Charged Particle Track quality requirements:

- number of pixel hits ≥ 2
- total number of silicon (pixel + strip) hits ≥ 8
- $\chi^2/ndof$ of the track fit < 5.0
- transverse momentum $p_T > 1.0\,\mathrm{GeV}/c$
- unsigned transverse impact parameter $d_{xy} < 0.2\,\mathrm{cm}$
- unsigned longitudinal impact parameter $d_z < 17\,\mathrm{cm}$
- distance of closest approach to the jet axis < 0.07 cm;
- decay length < 5 cm.

Distribution of track selection variables



Sedondary veriticies



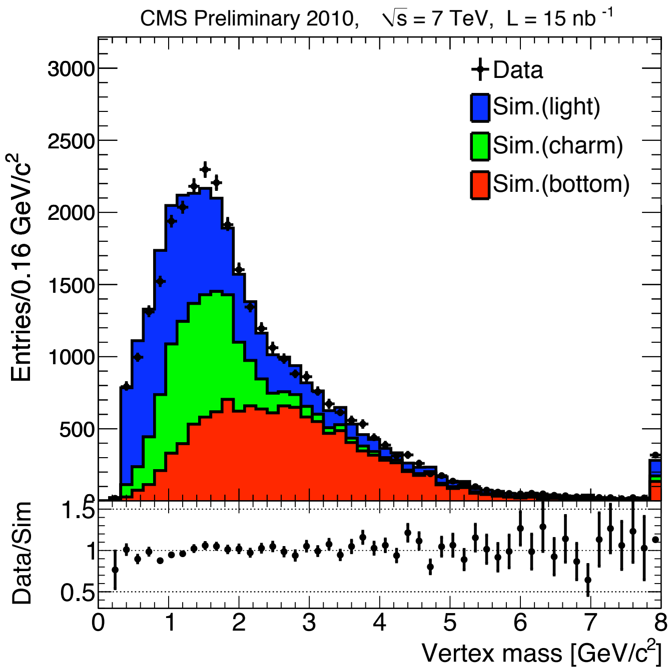
Estimation of the b-tagging efficiency (I)

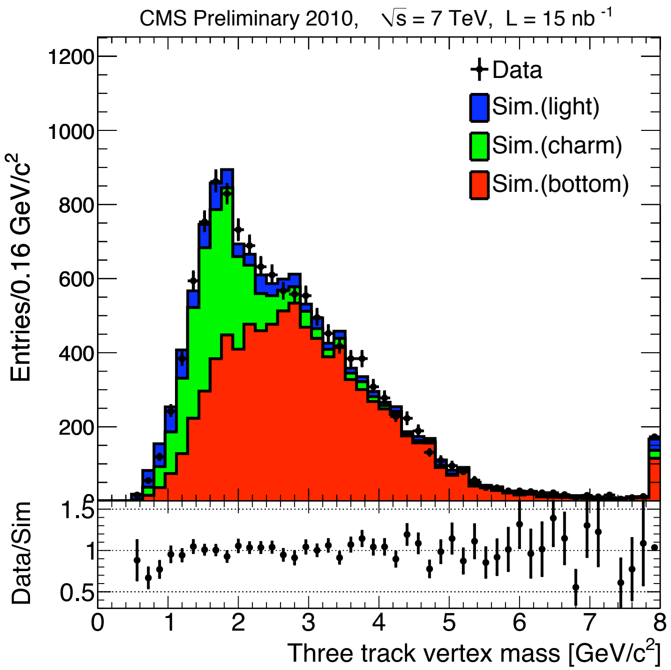
SF_b- scaling factor.
Ratio between data and MC efficiencies.

Tagger+Operating Point	ϵ_b^{data}	ϵ_b^{MC}	SF_b
SSVHPT	0.17 ± 0.01	0.18	0.91 ± 0.06
SSVHEM	0.34 ± 0.01	0.38	0.88 ± 0.03
SSVHET	0.11 ± 0.01	0.12	0.93 ± 0.10
TCHPL	0.34 ± 0.01	0.41	0.84 ± 0.03
TCHPM	0.25 ± 0.01	0.30	0.85 ± 0.04
TCHPT	0.19 ± 0.01	0.21	0.87 ± 0.05
TCHEL	0.50 ± 0.01	0.61	0.83 ± 0.02
TCHEM	0.39 ± 0.01	0.46	0.86 ± 0.02
TCHET	0.13 ± 0.01	0.13	0.97 ± 0.08

Statistical errors only

Vertex Mass

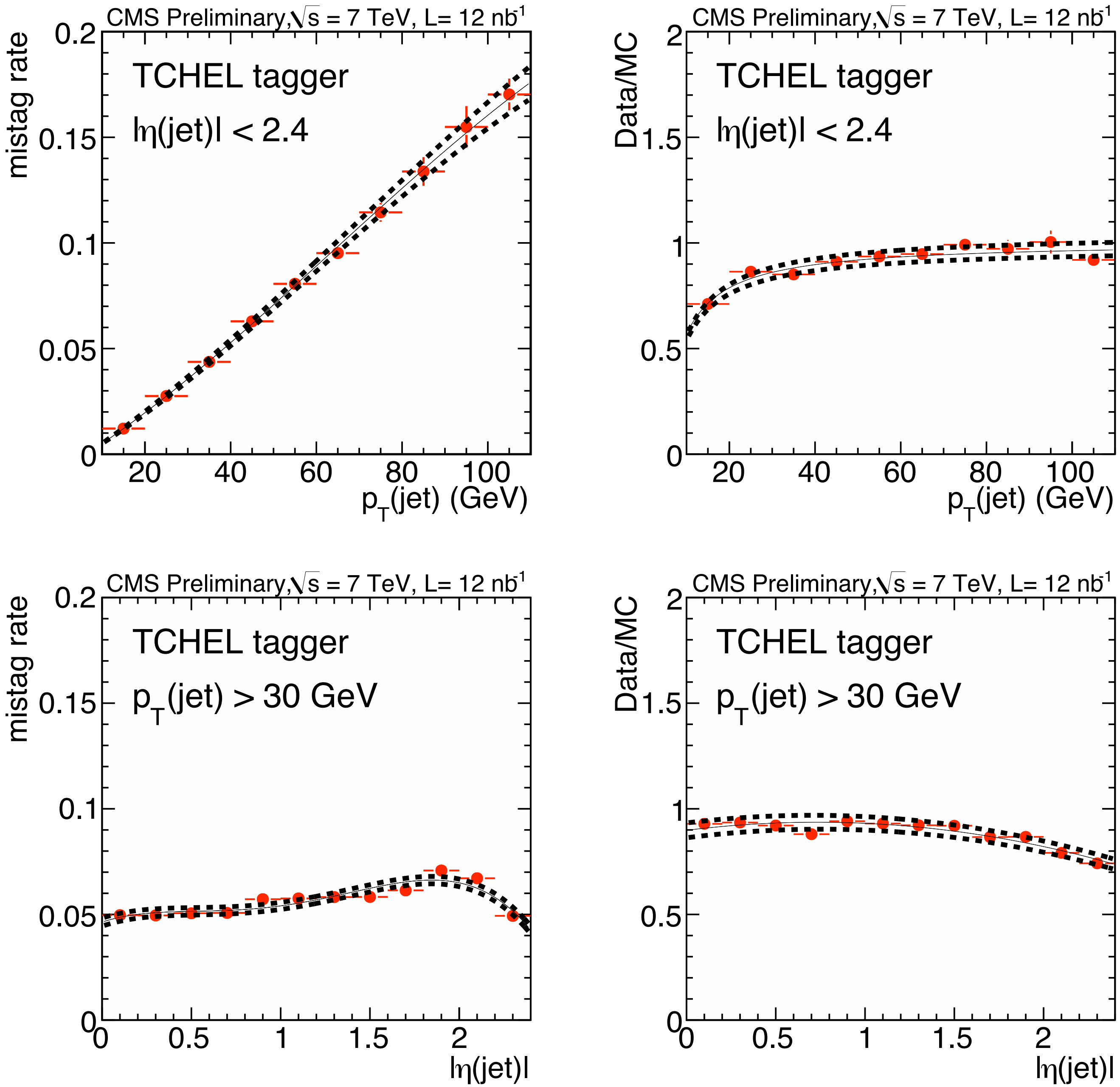




Two or more reconstructed tracks

Three or more reconstructed tracks

Mistag measurements in data (I)



$$\varepsilon_{data}^{mistag} = \varepsilon_{data}^{-} \cdot R_{light}$$

ε_{data}^{-}

Negative tag rate

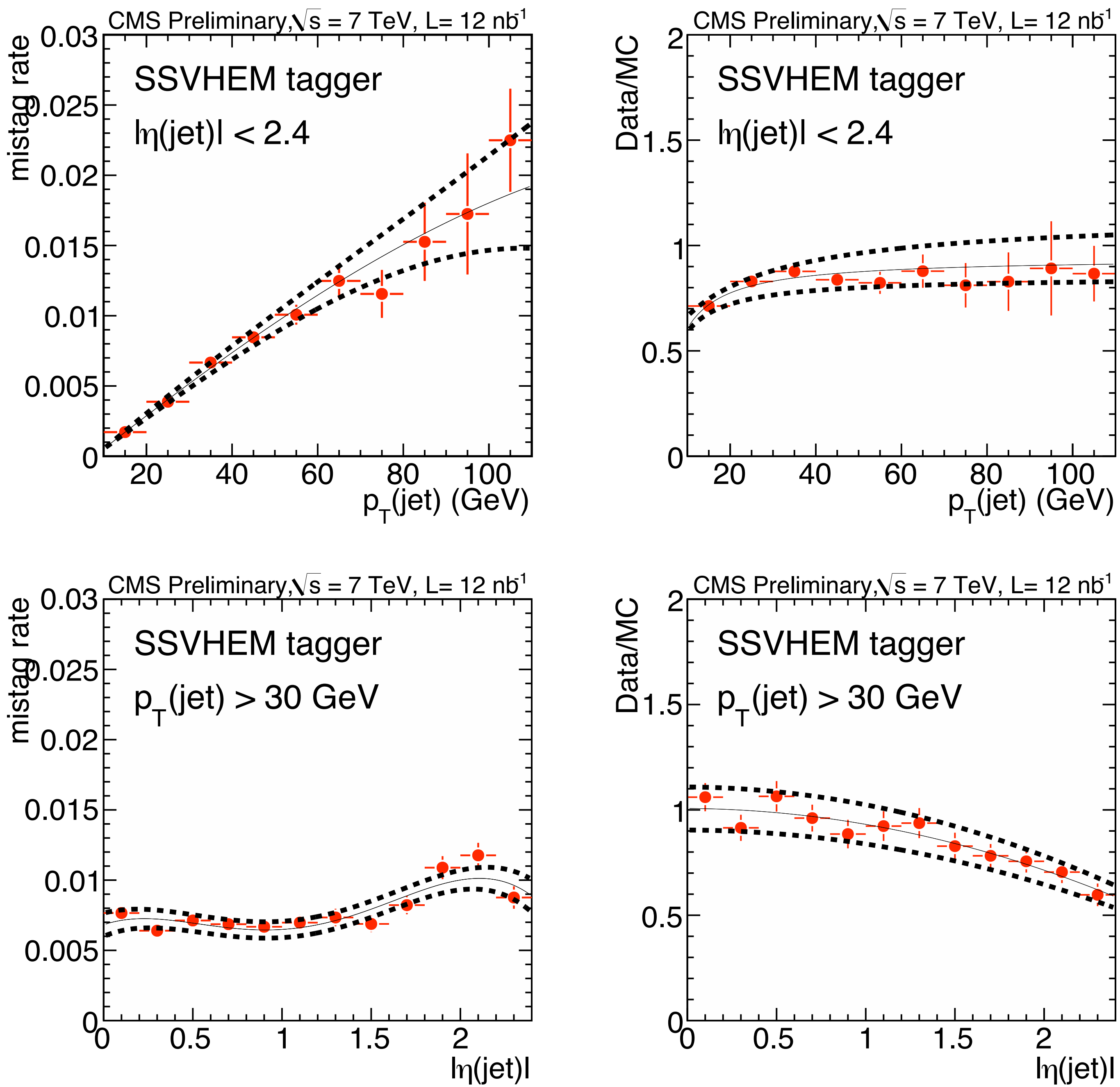
$$R_{light} = \varepsilon_{MC}^{mistag} / \varepsilon_{MC}^{-}$$

mistag rate LF/mistag rate (LF+c+b)

Scale factor:

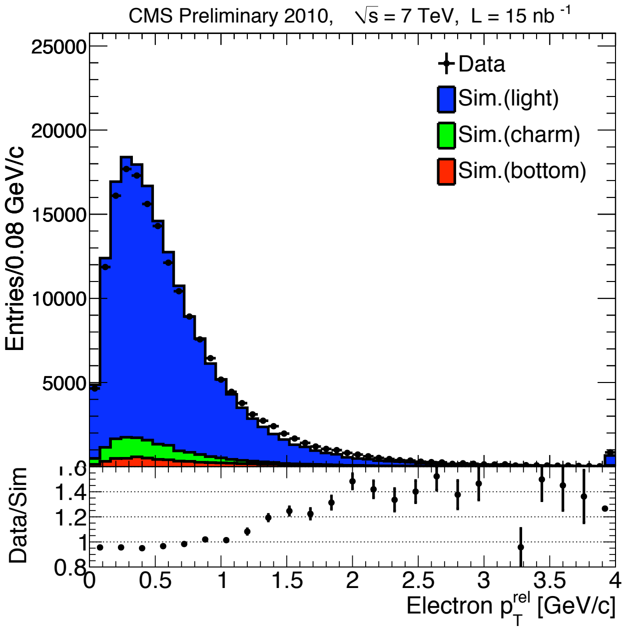
$$SF_{light} = \varepsilon_{data}^{mistag} \; / \; \varepsilon_{MC}^{mistag}$$

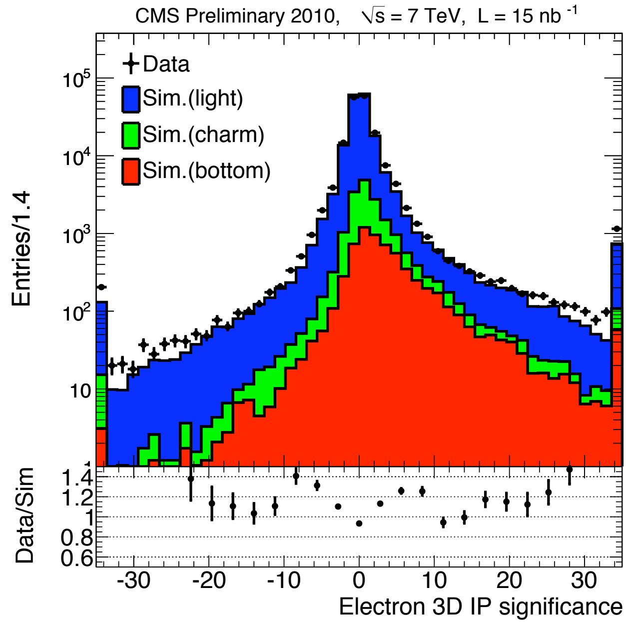
Mistag Measurements in data (II)



The investigation of the kinematics of leptons near jets as candidates for daughters of b-hadron decay.

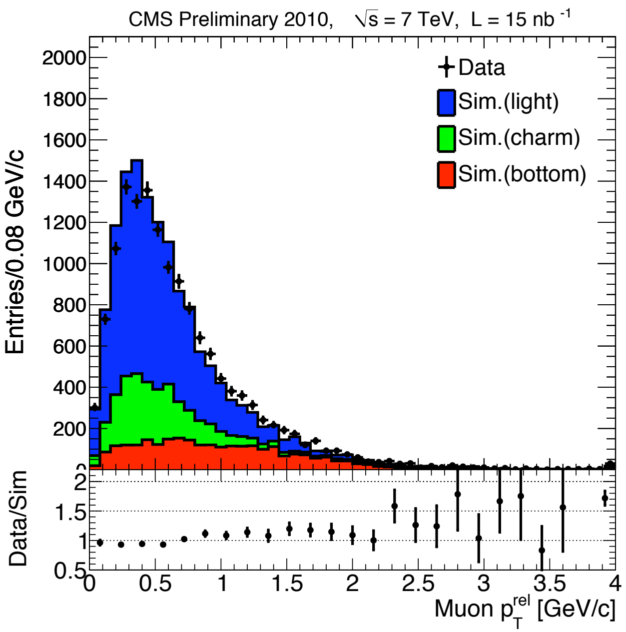
P_t relative to the jet direction for electrons

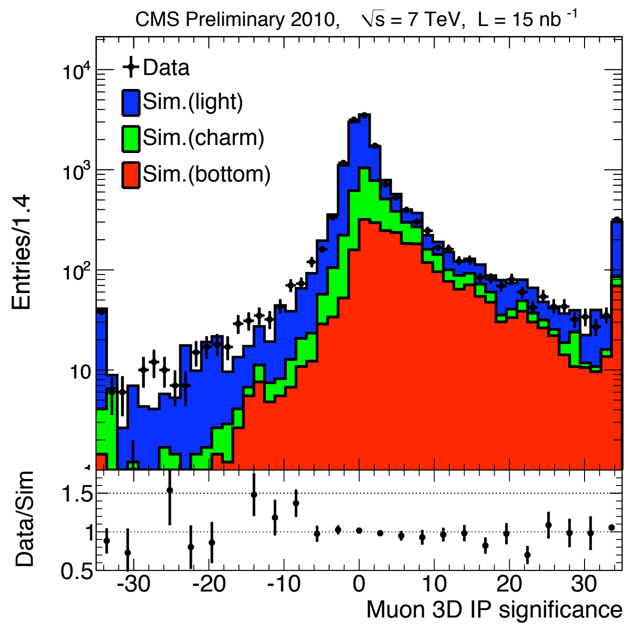




impact parameter significance for electrons

P_t relative to the jet direction for muons

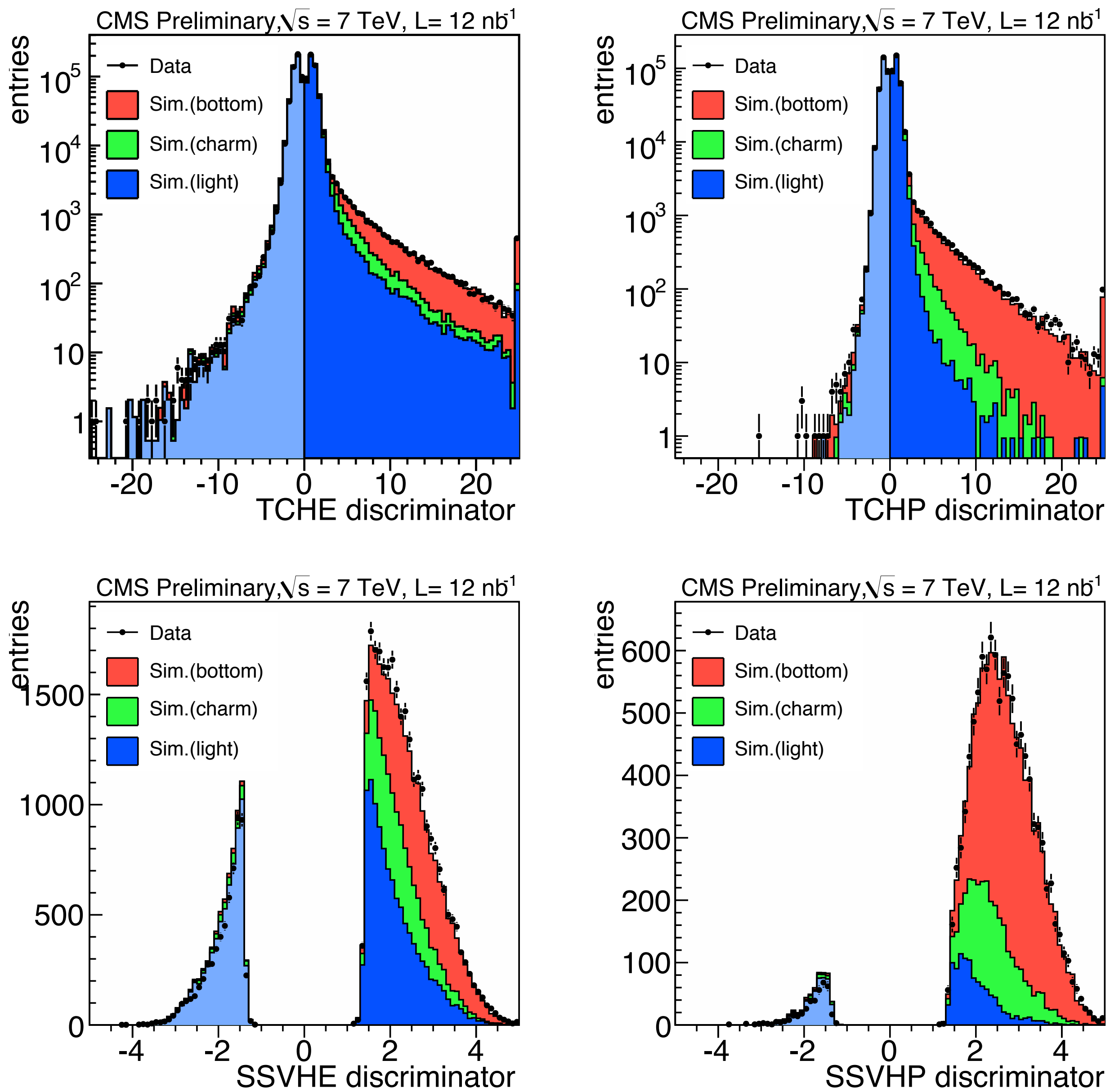




impact parameter significance for muons

Mistag Rate

Evaluated from tracks with negative IP or from SV with negative decay lengths



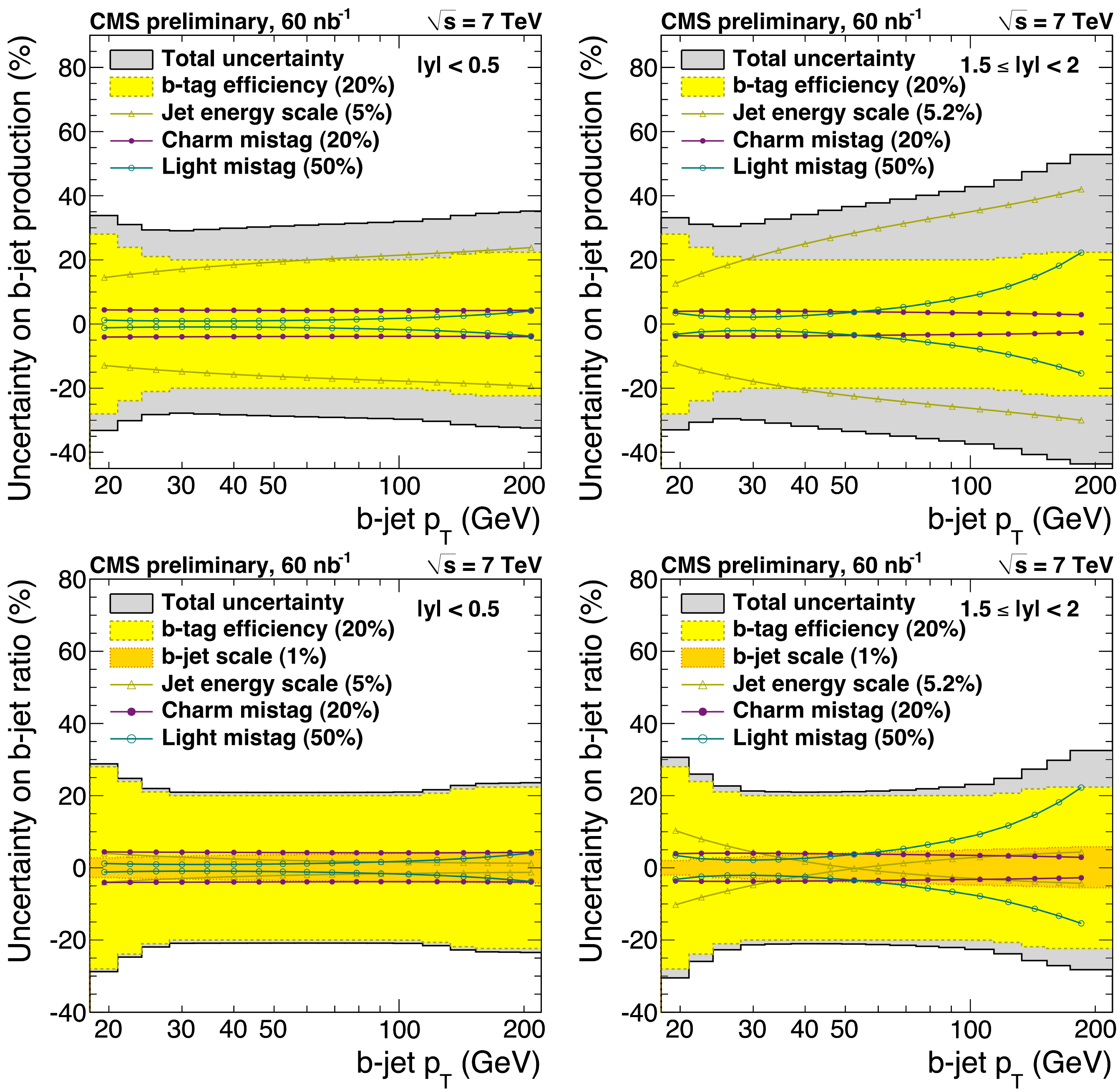
Negative and Positive b-tag discriminators

Mistag Rate (III)

b tagger	mistag rate (data)	scale factor (data/MC)
TCHEL	0.062 ± 0.002	0.91 ± 0.03
TCHEM	0.0074 ± 0.0009	1.0 ± 0.1
TCHPM	0.0041 ± 0.0004	0.9 ± 0.1
SSVHEM	0.0084 ± 0.0006	0.87 ± 0.08
TCHPT	0.0005 ± 0.0003	1.4 ± 1.0
SSVHET	0.0012 ± 0.0003	1.0 ± 0.4
SSVHPT	0.0004 ± 0.0002	0.8 ± 0.4

b-tagging uncertainties estimates

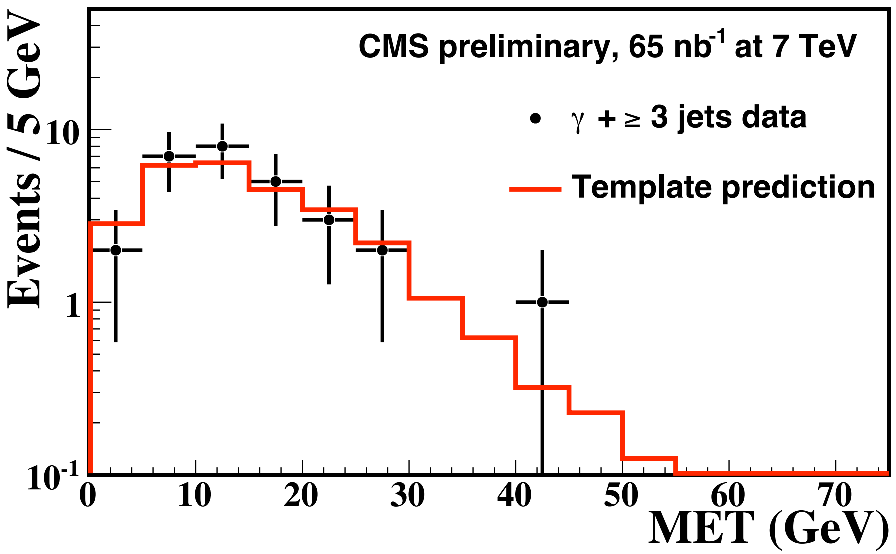
Leading sources of systematic uncertainties for b-jet cross section measurement.



Summary on the systematic uncertanities:

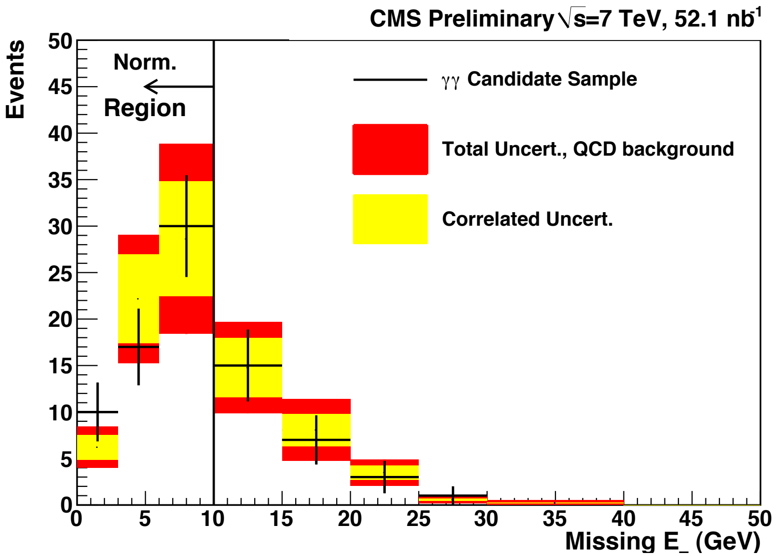
source	uncertainty
Trigger	3–5 %
Muon reconstruction	3 %
Tracking efficiency	2 %
Background template shape uncertainty	1–10 %
Background composition	3–6 %
Production mechanism	2–5 %
Fragmentation	1–4 %
Decay	3 %
MC statistics	1–4 %
Underlying Event	10 %
Luminosity	11 %
total	16–20 %

IV. MET predictions, based on templates, compared to the observed MET in gamma+>=3 jet events.



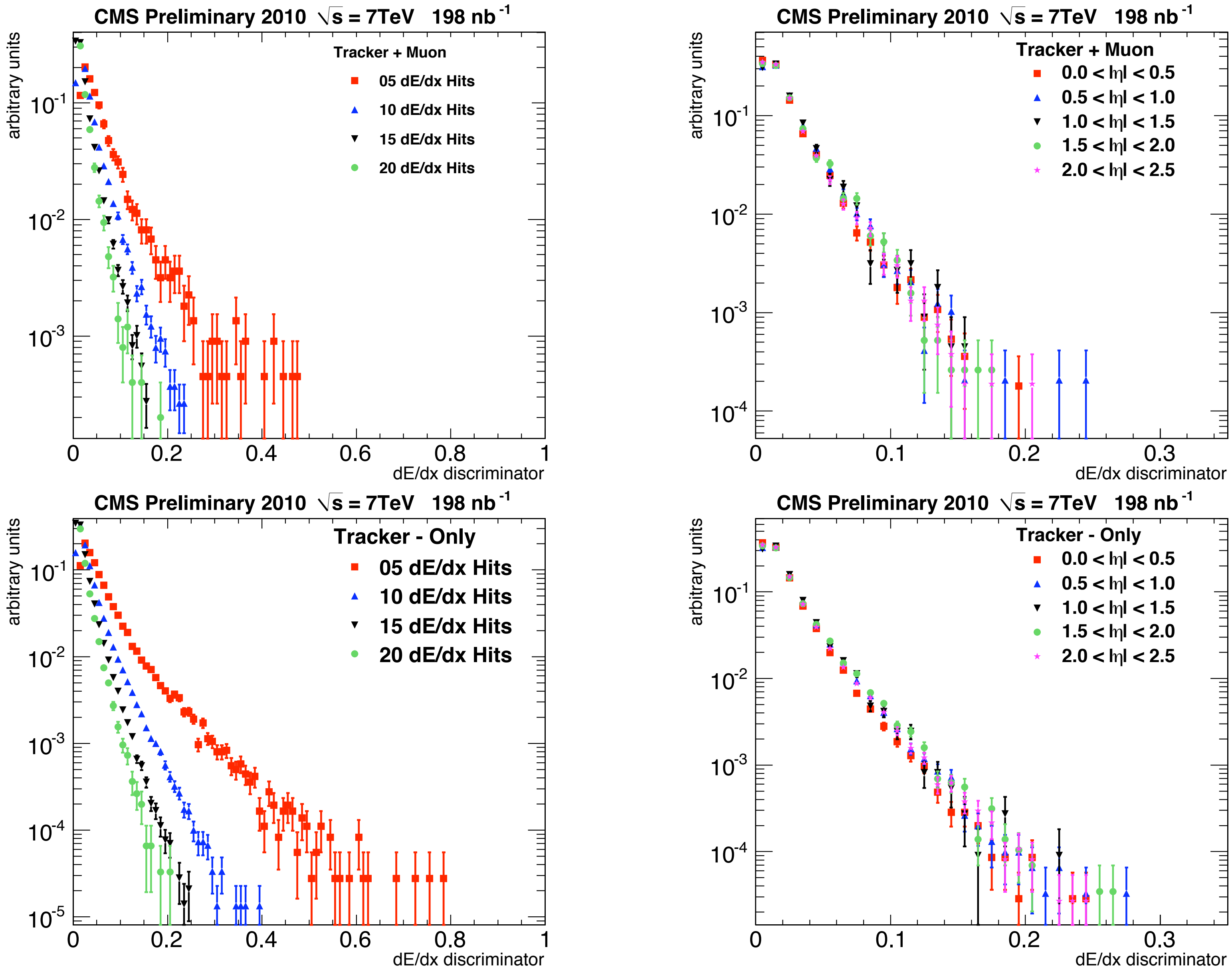
V. Comparison of the di- photon MET distribution with the prediction from a sample with 2 non-isolated photon candidate.

Dominant contribution to MET resolution in di-photon events comes from mis-measurement of the jets recoiling against the di-photon system.



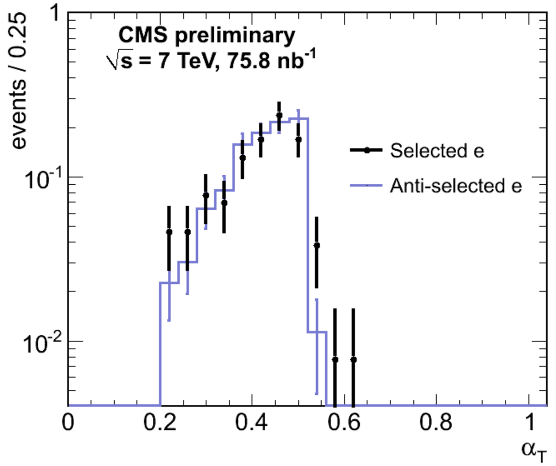
Data distributions of the I_{as} discriminator for tracks with

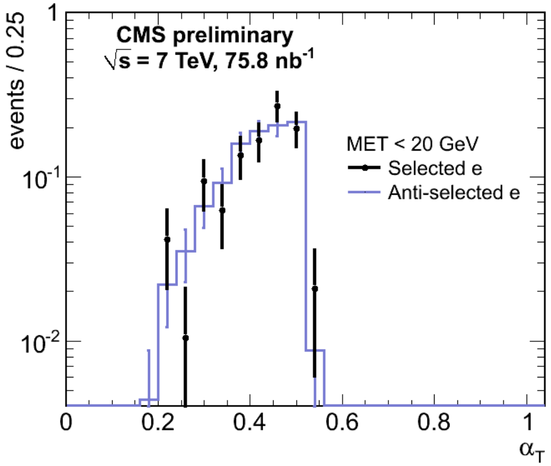
1. different number of dE/dx measurements,
2. 15 dE/dx measurements and different eta regions.



II. Extension to single electron+ jets using α_T

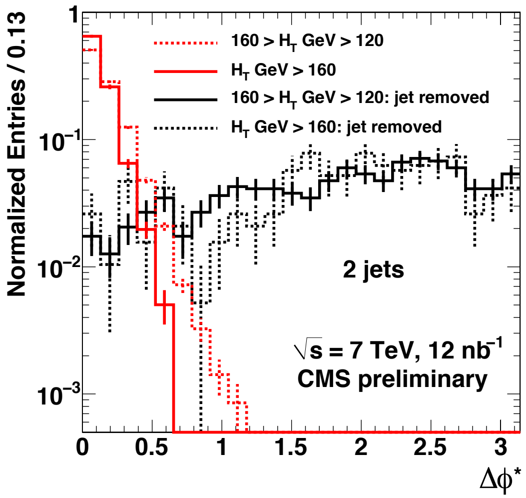
Construction of two pseudo jets out on N-object system,
1 electron and N-1 jets and testing a method of predicting α_T distribution that uses events with "anti-selected" electrons to predict the background of selected electrons.

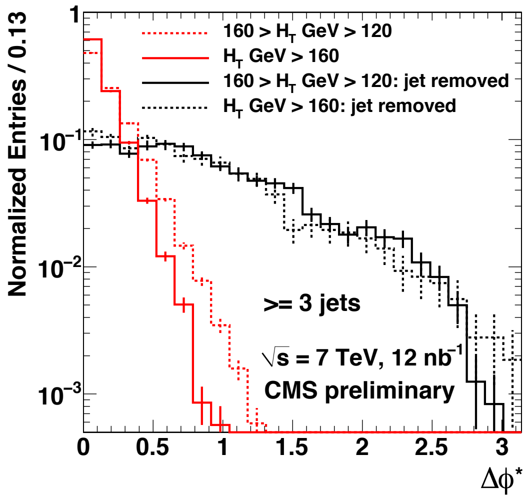




MET<20 GeV to suppress W contaminations

III. Suppressing QCD with $\Delta\phi(\text{jet}, \text{MET})$ cuts $\Delta\phi^* \equiv \min_{\text{jets } k}\left(|\Delta\phi(\vec{p}_k, -\sum_{\text{jets } i \neq k} \vec{p}_i)|\right)$



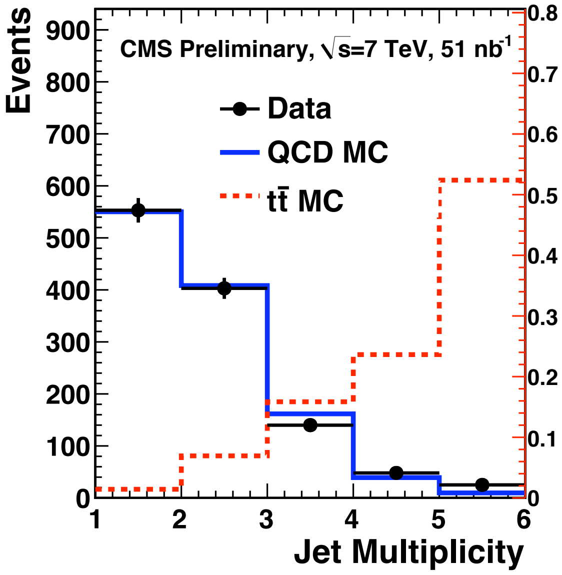


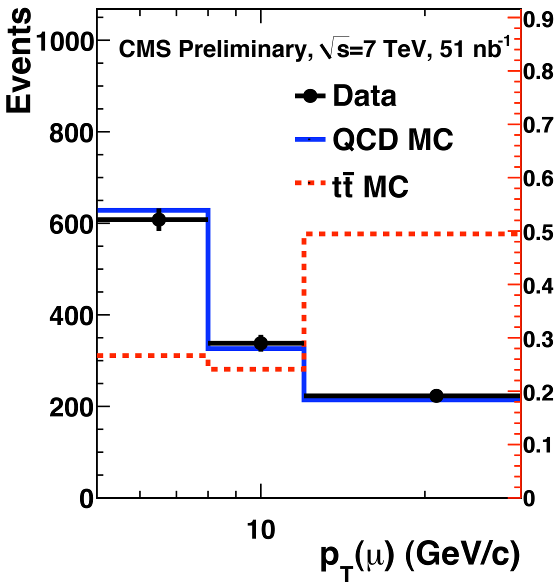
It is expected to become more narrow with increase of H_t.

$$\Delta\phi^* > 0.5$$

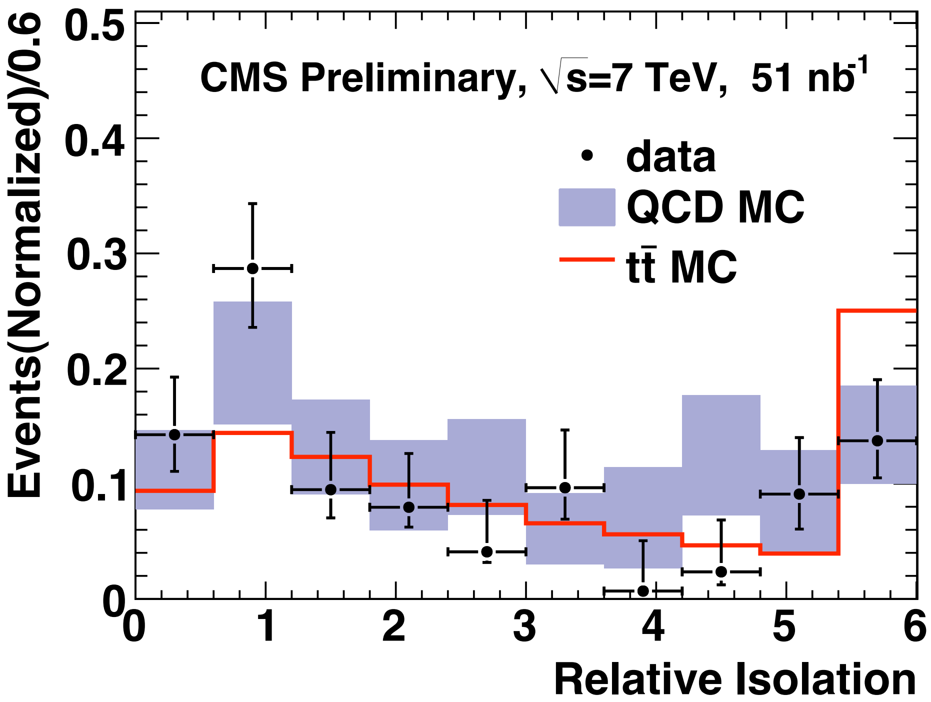
efficiently suppresses the QCD background

VI1.Usage of $b\bar{b}$ events to predict the $t\bar{t}$ background





Comparison of the kinematic quantities in data, QCD Monte Carlo and $t\bar{t}$ Monte Carlo. Significant difference is obserevd.



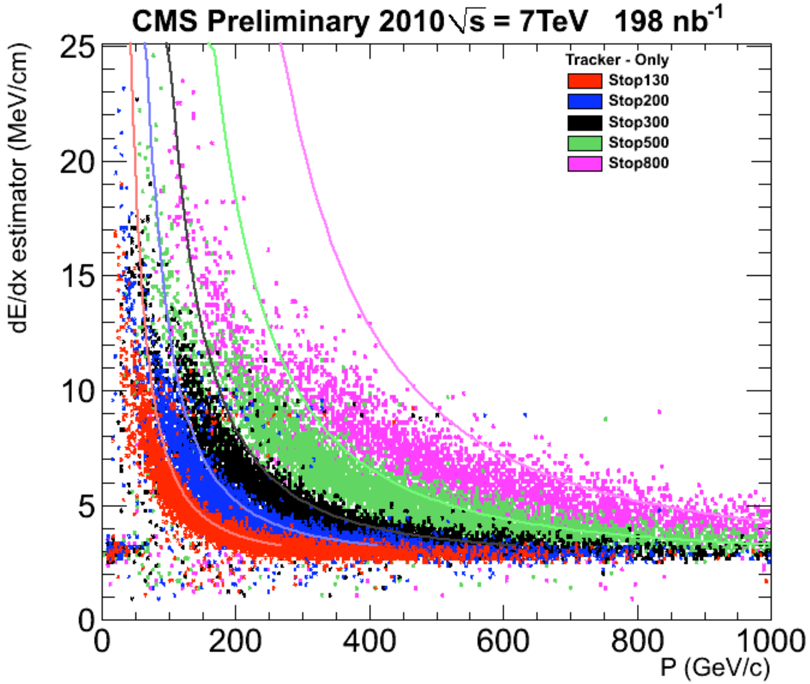
Measured muon isolation distributions.

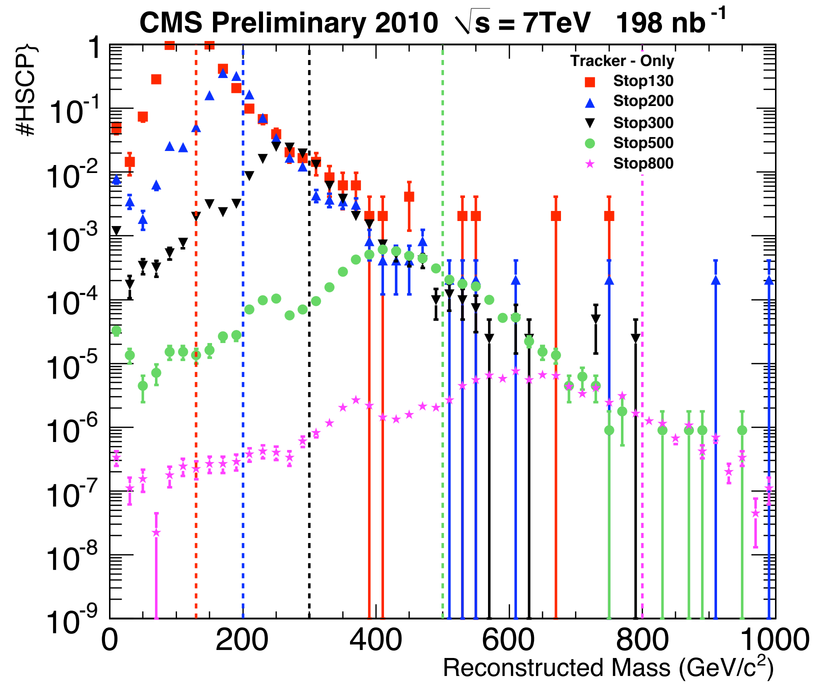
Measurement done with tag-and-probe method:
p_t >5GeV muon trigger,
b-taged jet in TCHP algorithm
(E_t >10GeV, $|\eta|$ <2.4),
global muon in opposite hemisphere
with respect to the b-jet.

Resolution at higher masses

Beta of HSCP lowers, the dE/dx increases => some of charge measurements can be truncated.

Consequence- underestimation of the HSCP mass



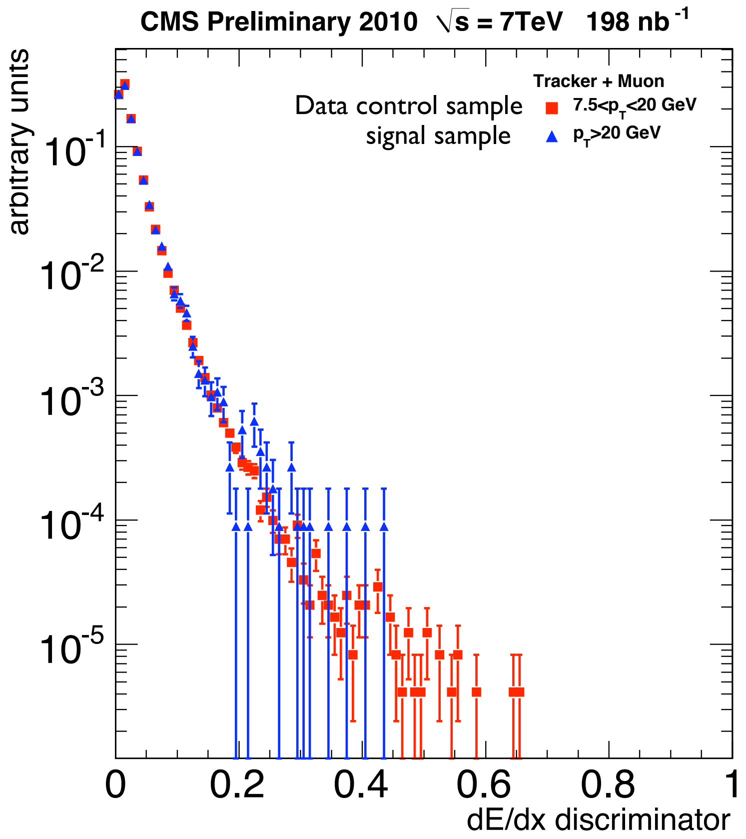


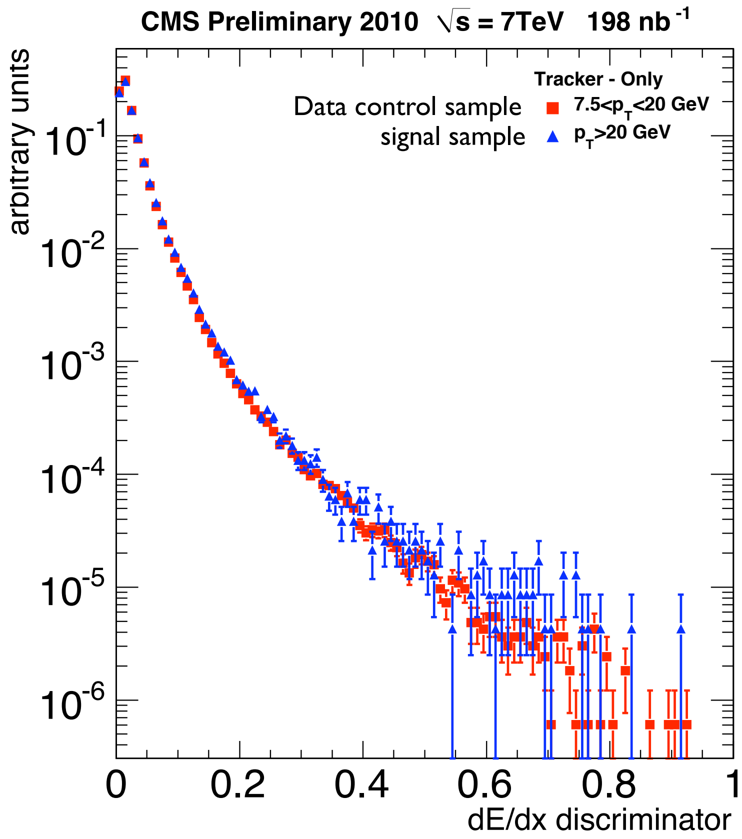
I_h distribution for all tracks in t_l MC sample.
The curves for 5 nominal values of t_l are shown

Reconstructed mass spectra for these tracks.

Background estimation

Performed by investigation of absence of correlation between the p_t dE/dx.





I_{as} distribution for 2 momentum ranges. Good agreement between 2 distributions. Indication that the assumption of lack of correlation gives a good approximation

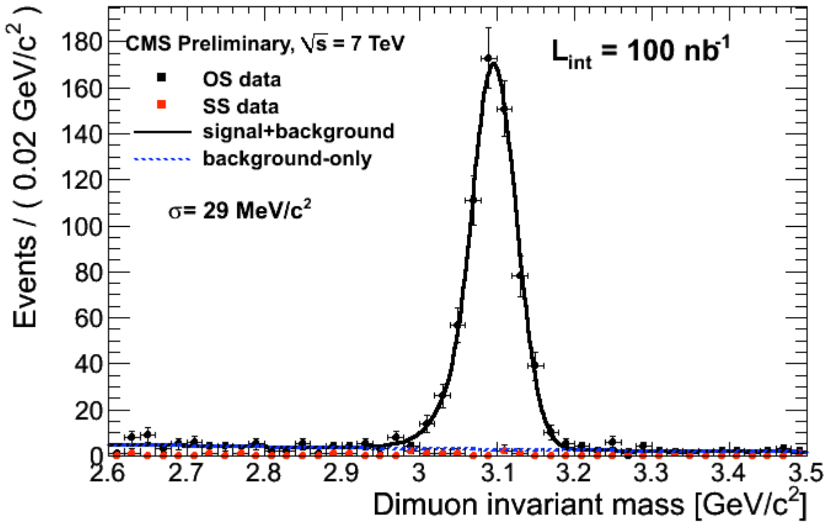
- J/Ψ Promt and non-promt cross section in pp collisions at 7TeV.

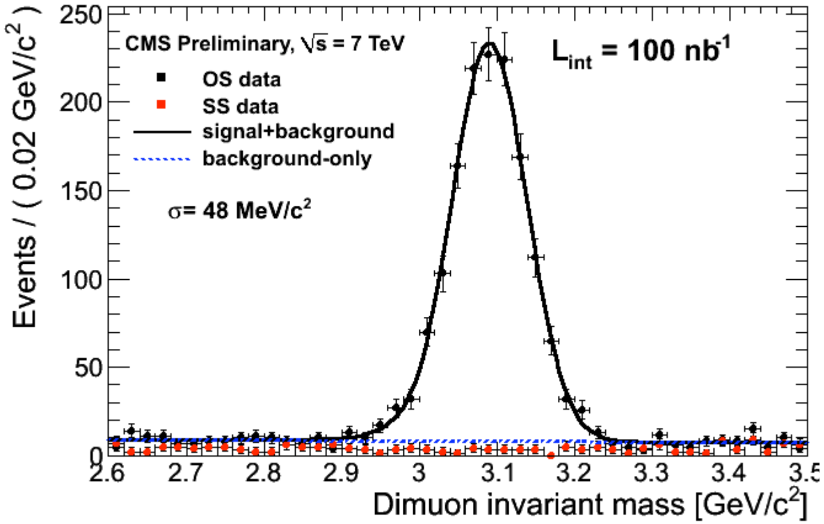
CMS PAS BPH-10-002

Prompt- produced indirectly via decays of heavier states of Charmonium

Non-prompt- produced via decay of b-hadron.

The four- momentum is computed as the vector sum of the two muon momenta.





|y|<1.4 1.4<|y|<2.4

Dimuon invariant mass distributions for Global Muon pairs

Inclusive cross section

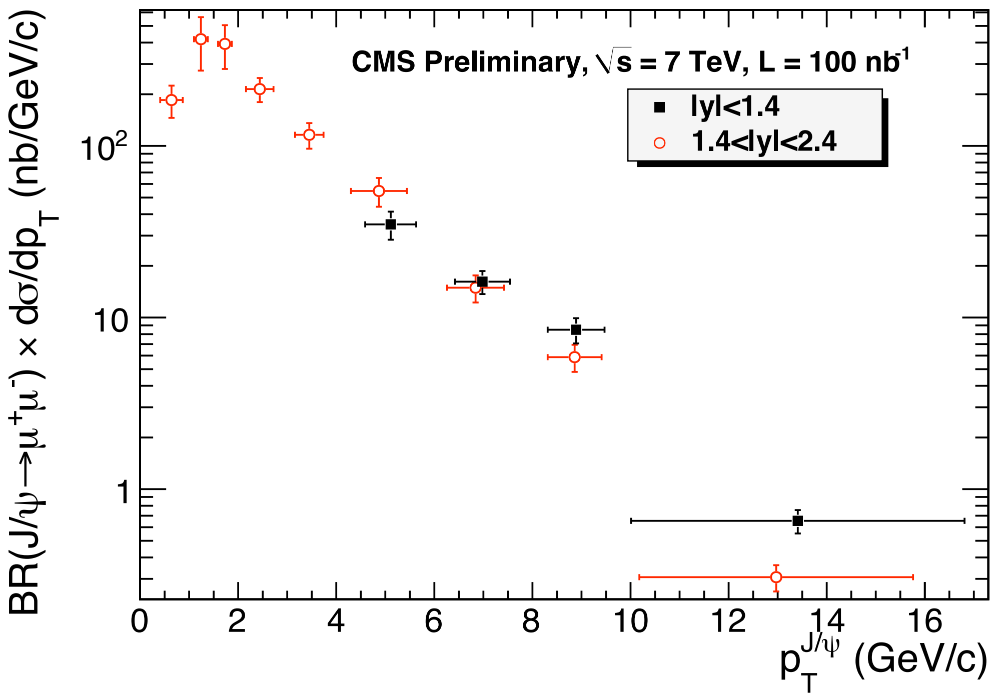
$$\frac{d\sigma}{dp_T}(J/\psi) \cdot \mathrm{BR}(J/\psi \to \mu^+\mu^-) = \frac{N_{\mathrm{corr}}(J/\psi)}{\int L dt \cdot \Delta p_T}$$

$N_{\mathrm{corr}}(J/\psi)$ -The J/ψ yield, corrected for the J/psi selection efficiency, in a given pt bin

$\int L dt$ -Integrated luminosity

Δp_T -Size of the pt bin

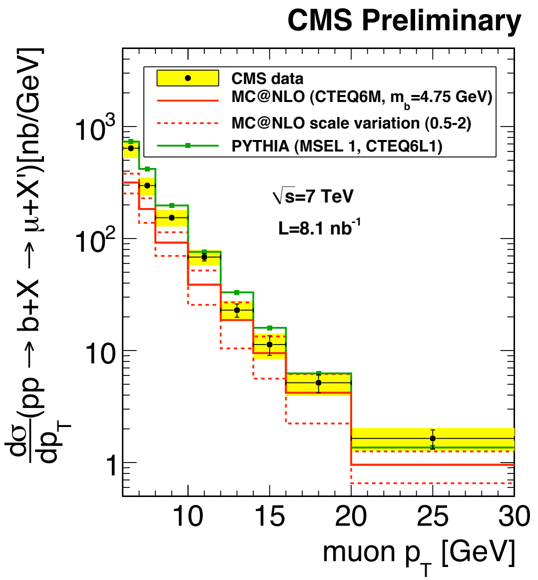
$\mathrm{BR}(J/\psi \to \mu^+\mu^-)$ -Branching ratio (5.88±0.10)%

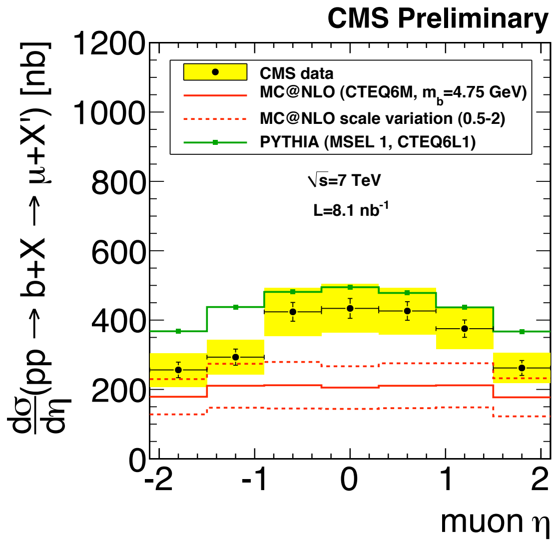


Total Cross Section:

$$BR(J/\psi \to \mu^+\mu^-) \cdot \sigma(pp \to J/\psi + X) = (289.1 \pm 16.7(\mathrm{stat}) \pm 60.1(\mathrm{syst}))\ \mathrm{nb}$$

Differential Cross Section





$$\frac{d\sigma(pp \to b + X \to \mu + X')}{dx}\bigg|_{\text{bin } i} = \frac{N_b^{i,\text{data}}}{\mathcal{L}\,\varepsilon^i\,\Delta x^i},$$

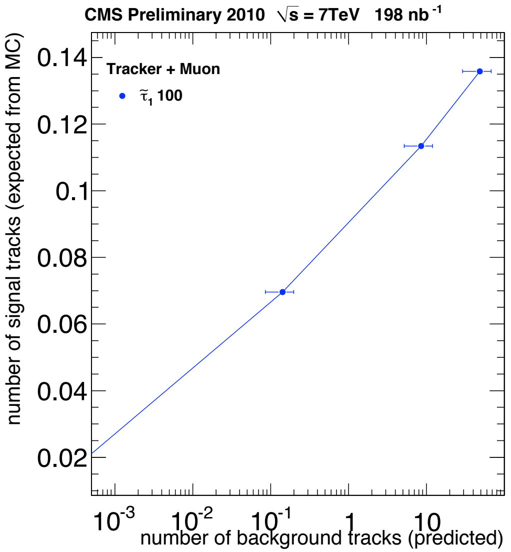
yellow band- quadratic sum of stat. and syst. errors

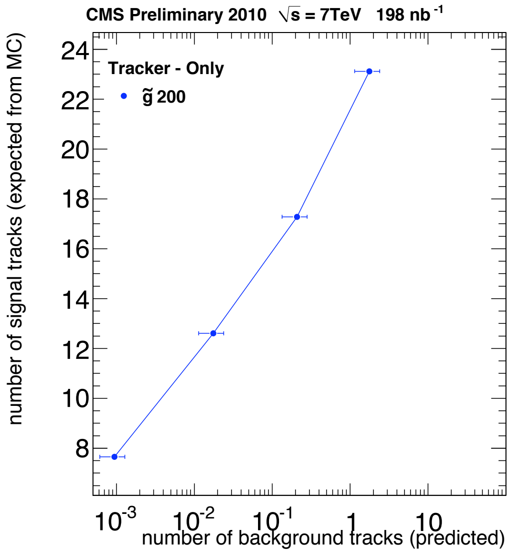
$p_\perp^\mu$	N^b	ε	$d\sigma/dp_T$ [nb/GeV]	stat	sys	lumi
6-7 GeV	2897 ± 140	0.56 ± 0.01	640	5%	15%	11%
7-8 GeV	1479 ± 96	0.61 ± 0.01	297	7%	15%	11%
8-10 GeV	1674 ± 93	0.67 ± 0.01	154	6%	14%	11%
10-12 GeV	771 ± 58	0.69 ± 0.02	68	7%	12%	11%
12-14 GeV	282 ± 38	0.76 ± 0.02	23	14%	13%	11%
14-16 GeV	135 ± 27	0.73 ± 0.04	11	20%	14%	11%
16-20 GeV	131 ± 25	0.78 ± 0.04	5.2	19%	12%	11%
20-30 GeV	102 ± 20	0.77 ± 0.04	1.6	19%	11%	11%

η^μ	N^b	ε	$d\sigma/d\eta$ [nb]	stat	sys	lumi
(-2.1,-1.5)	773 ± 68	0.62 ± 0.02	256	9%	16%	11%
(-1.5,-0.9)	895 ± 71	0.63 ± 0.02	293	8%	15%	11%
(-0.9,-0.3)	1322 ± 84	0.64 ± 0.02	424	6%	15%	11%
(-0.3,0.3)	1240 ± 82	0.59 ± 0.02	434	7%	14%	11%
(0.3,0.9)	1333 ± 84	0.64 ± 0.02	426	6%	14%	11%
(0.9,1.5)	1119 ± 75	0.61 ± 0.02	375	7%	14%	11%
(1.5,2.1)	802 ± 66	0.63 ± 0.02	262	8%	14%	11%

Results (I)

Expected number of signal candidates predicted by MC vs the expected number of background candidates from data driven predictions in search region





Selections used in the analysis

LOOSE	ϵ_{p_T}	p_T^{cut}	ϵ_I	I_{as}^{cut}
Tracker+Muon	$10^{-1.0}$	7.7 - 25.9	$10^{-1.5}$	0.0036 - 0.4521
Tracker only	$10^{-2.0}$	7.9 - 67.4	$10^{-2.0}$	0.0037 - 0.5293

TIGHT	ϵ_{p_T}	p_T^{cut}	ϵ_I	I_{as}^{cut}
Tracker+Muon	$10^{-3.0}$	7.7 - 125.9	$10^{-3.0}$	0.0036 - 0.6526
Tracker only	$10^{-4.0}$	7.9 - 259.0	$10^{-3.5}$	0.0037- 0.8901

ϵ_{p_T} ϵ_I MIP Background efficiency values

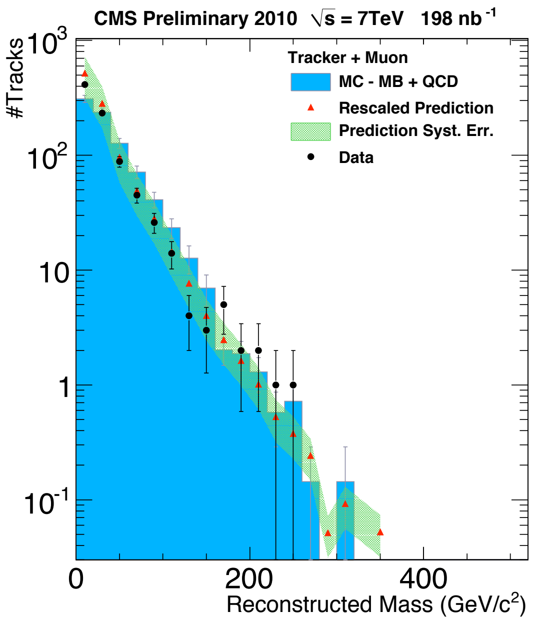
Result for Loose selection

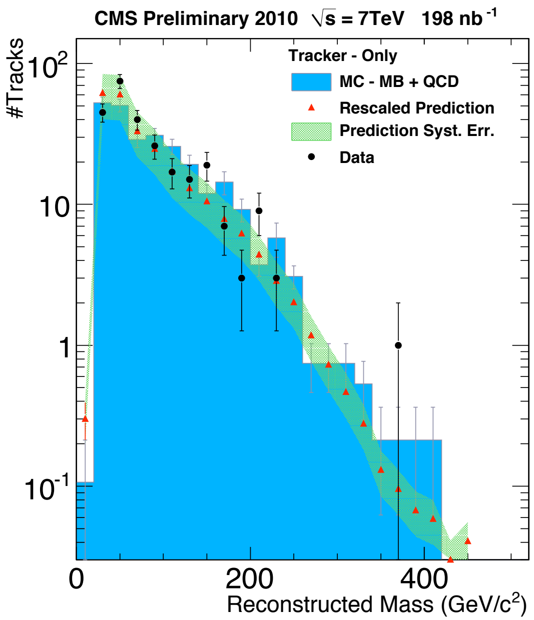
LOOSE	Exp.	Obs.	Exp. in full spectrum	Obs. in full spectrum
Tracker+Muon	82 ± 33	77	1007 ± 200	838
Tracker Only	108 ± 38	122	184 ± 250	260

Result for Tight selection

TIGHT	Exp.	Obs.	Exp. in full spectrum	Obs. in full spectrum
Muon-like	0.153 ± 0.061	0	0.249 ± 0.050	0
Tk-only	0.060 ± 0.021	0	0.060 ± 0.011	0

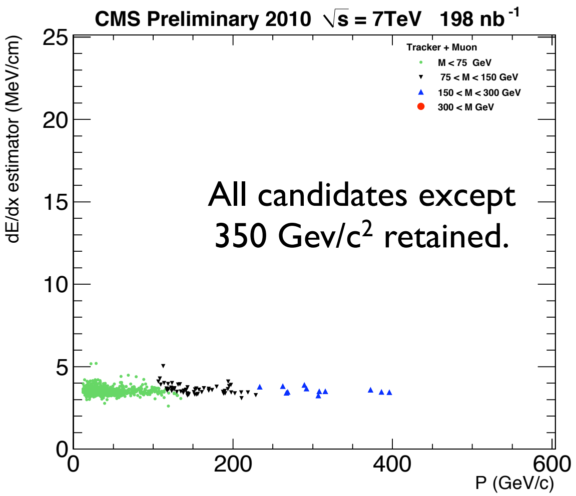
Results II

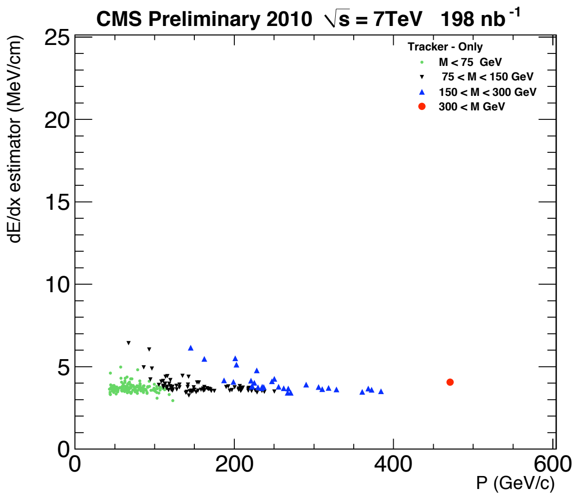




Mass spectra for the loose selection

Red dots: data-driven predictions.



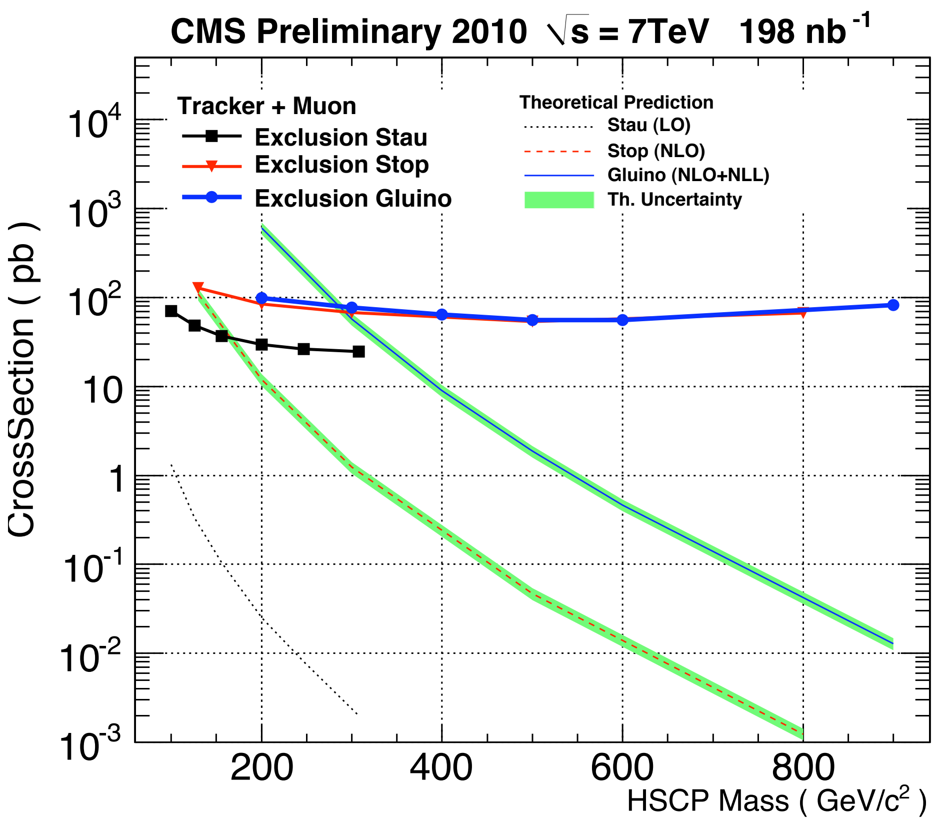


Distribution of the measured p and I_h for all candidates passing the loose selection

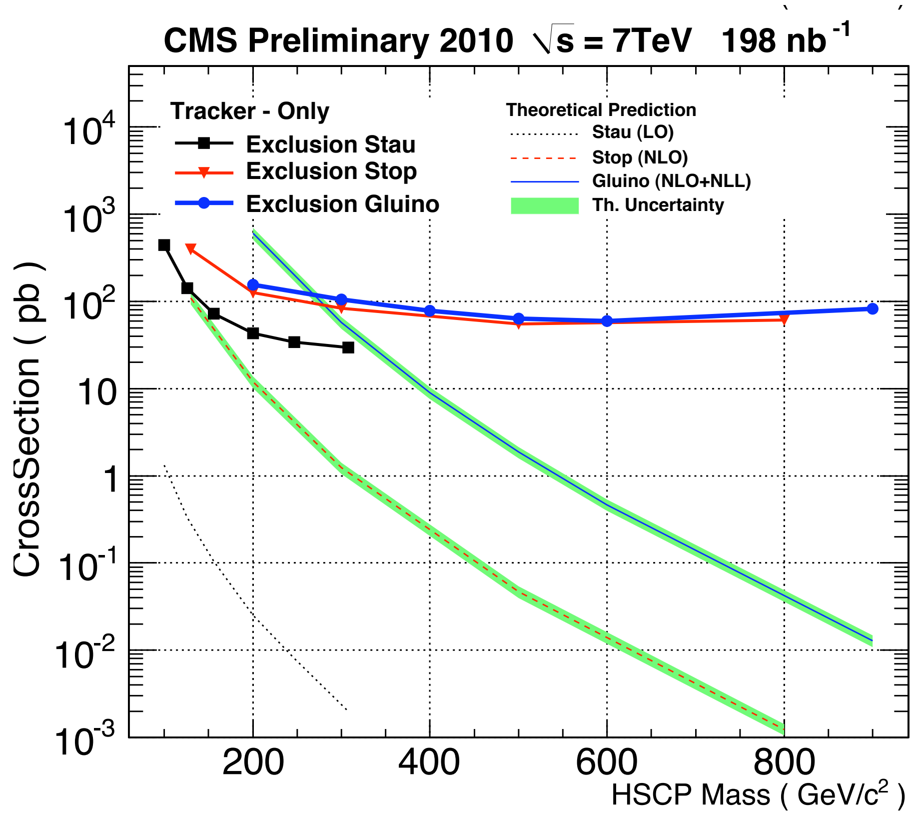
I_h~5 MeV/cm.
Tracks with very few hits with relatively high I_{as} threshold.
Their thresholds are compatible with the MIP background

Results on the cross section

Observed 95% upper limits on the cross section of the different models considered and predicted theoretical cross section.



Muon identification + tracker candidates



Tracker candidates only

Search for heavy Stable Charged Particles (HSCP) in pp collisions at 7 TeV.

Event Selection:

CMS PAS EXO-10-004

p_t>7.5GeV/c;
3 hits is Silicon Tracker for dE/dx measurement;
Clean separation:
selection of tracks with high p_t and dE/dx.

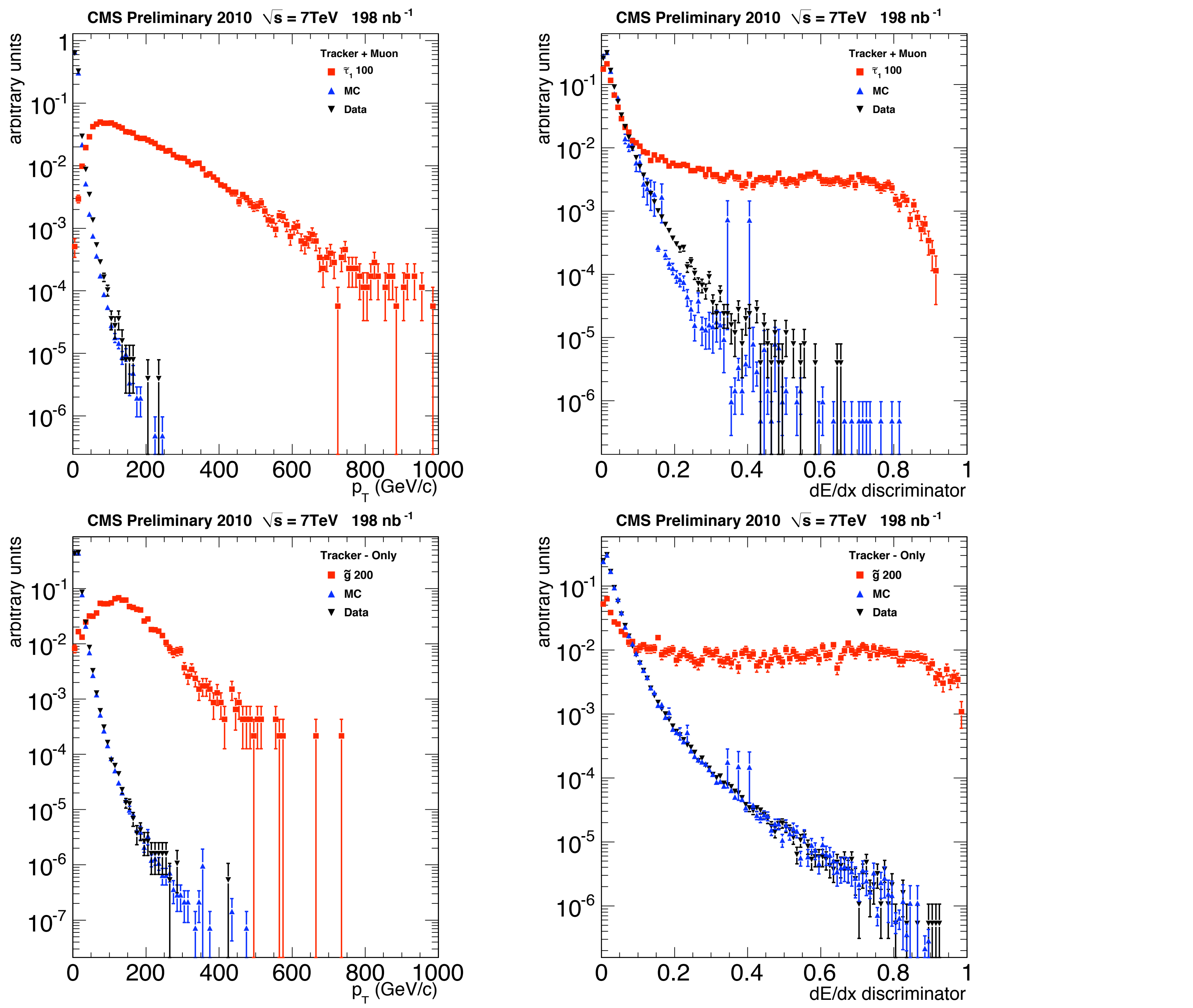
Estimator for selection based on dE/dx

$$I_{as} = \frac{3}{N} \times \left(\frac{1}{12N} + \sum_{i=1}^{N} \left[P_i \times \left(P_i - \frac{2i-1}{2N} \right) \right]^2 \right)$$

N- number of track hits in Silicon Strip;
P_i- probability the MIP will produce a charge $\leq$ the observed one for the observed path length;
Summation is over the number of track hits ordered in terms of increasing $P_{i.}$

Distribution in data, min baias MC and Signal for p_t and I_{as}

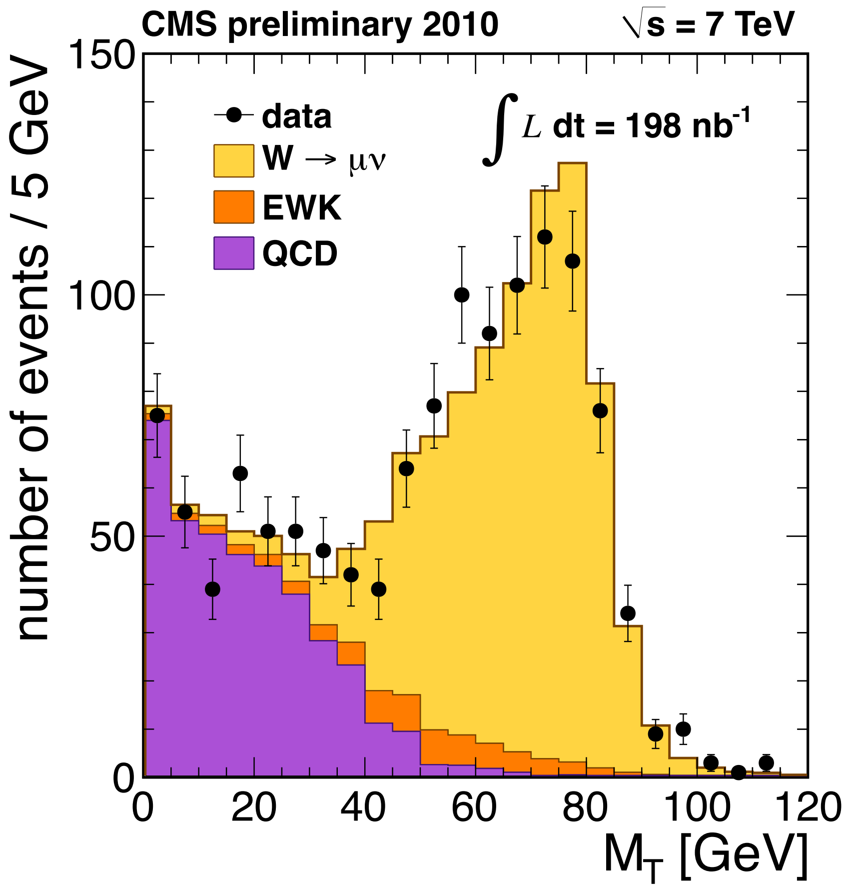
Good agreement between data and MC, strong discriminating power for HSCP signal.

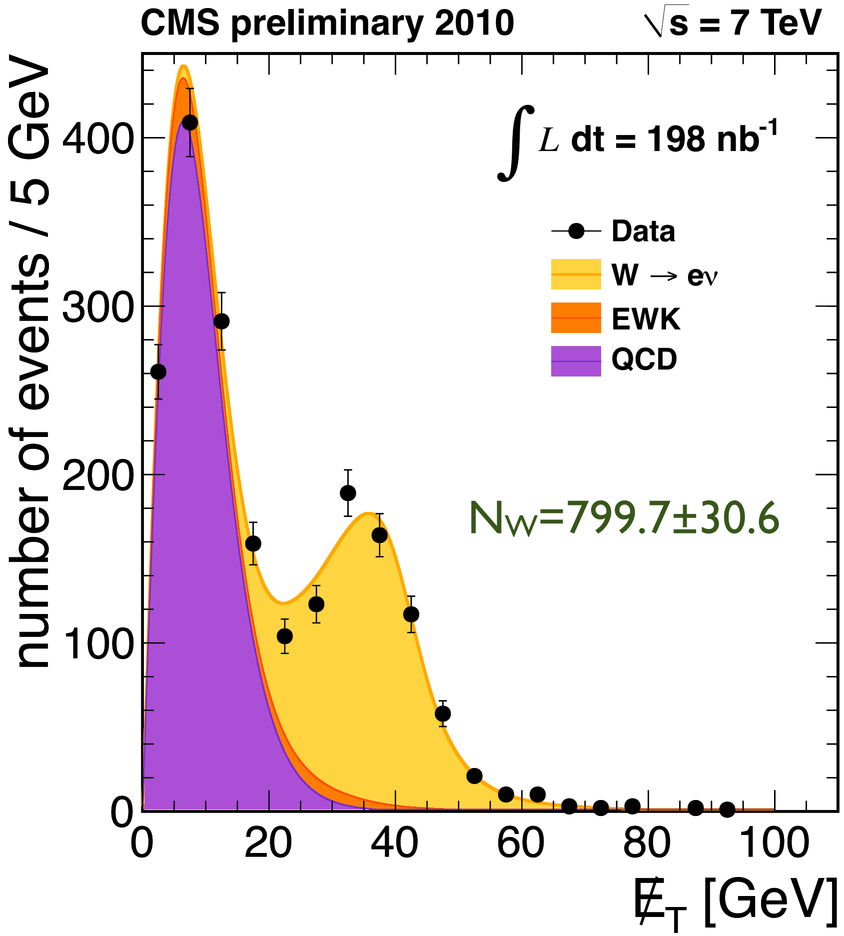


Measurements of Inclusive W and Z Cross sections in pp collisions at 7TeV.

W to leptons

CMS PAS EWK-10-002





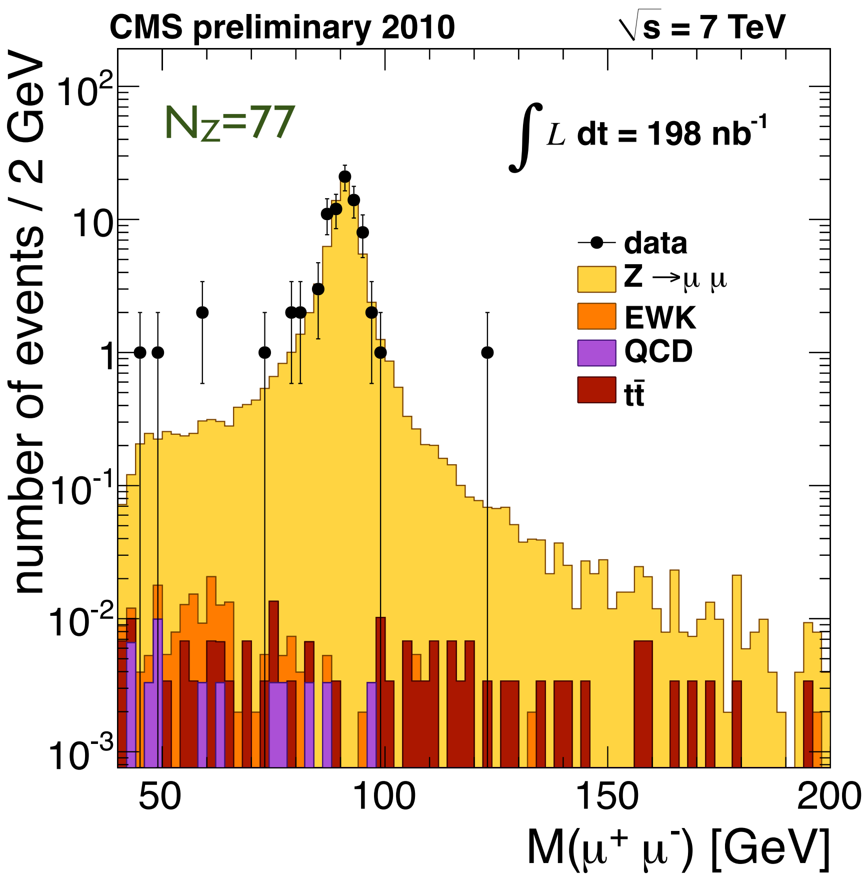
$$M_T = \sqrt{2p_T(\mu)\not{E}_T(1-\cos(\Delta\phi_{\mu,\not{E}_T}))}$$

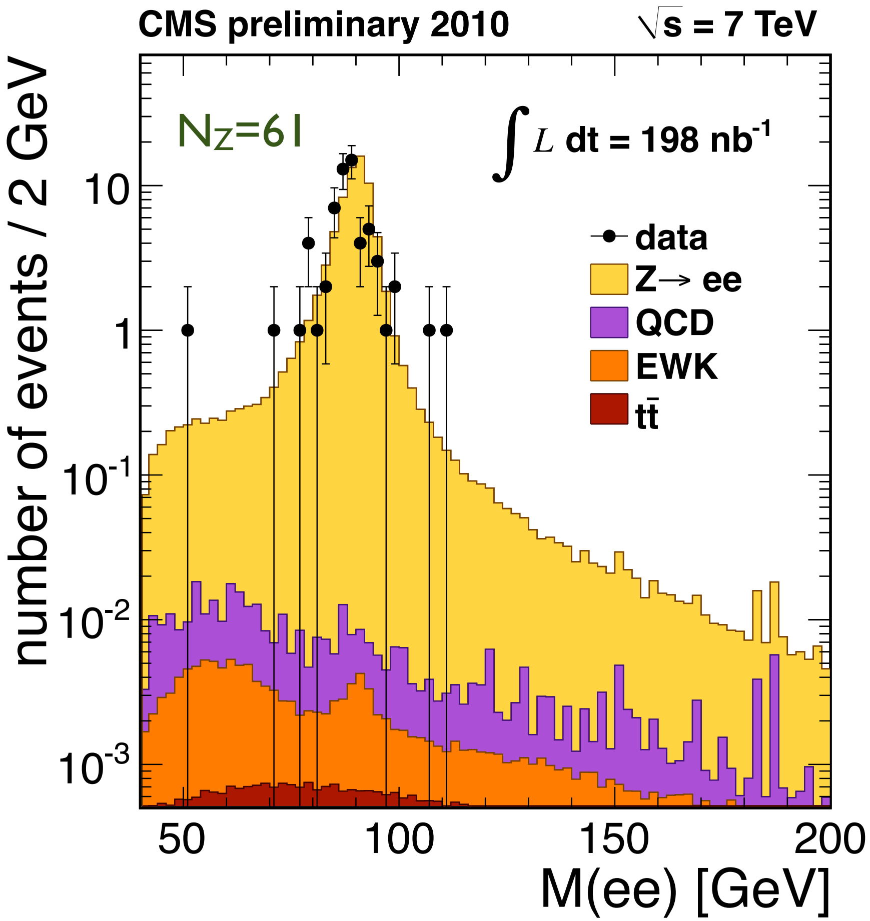
Identified muon with p_t> 20 GeV and $|\eta|<2.1$

One electron with p_t>20 GeV/c

$|\eta|<1.4442$ (EB); $1.566<|\eta|<2.500$ (EE)

Z to leptons


CMS preliminary 2010
$\sqrt{s}$ = 7 TeV
N_Z=77
$\int L\,dt$ = 198 nb^{-1}
data
Z →μ μ
EWK
QCD
$t\bar{t}$
number of events / 2 GeV
M($\mu^+ \mu^-$) [GeV]


CMS preliminary 2010
$\sqrt{s}$ = 7 TeV
N_Z=61
$\int L\,dt$ = 198 nb^{-1}
data
Z→ ee
QCD
EWK
$t\bar{t}$
number of events / 2 GeV
M(ee) [GeV]