4th International Workshop on Top Quark Physics
September 25 - 30, 2011
Sant Feliu de Guixols

Top2011: a summary of the Workshop

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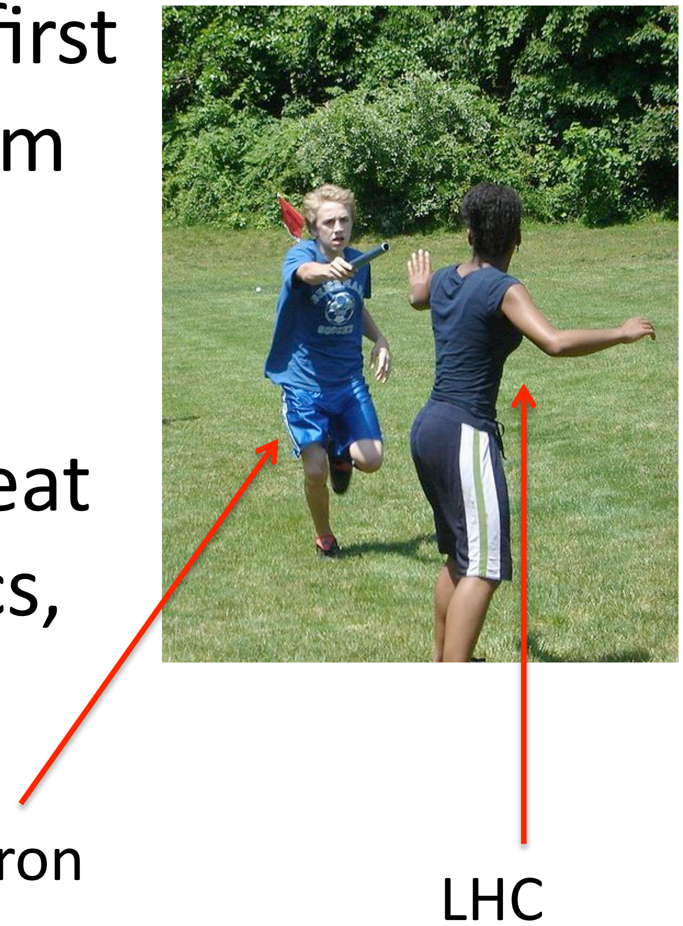
INFN Pisa

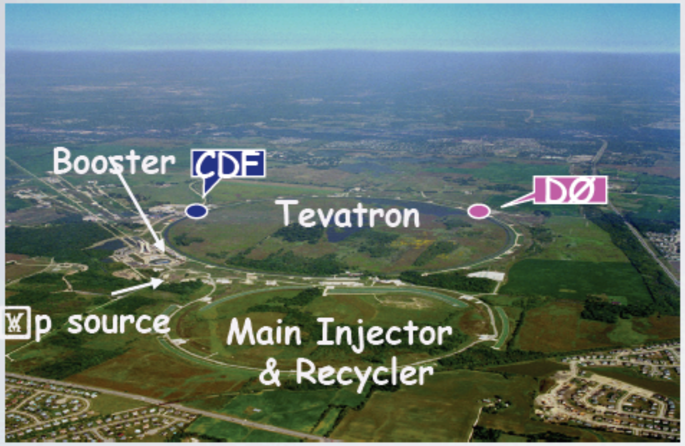
top2011

- After top2006 (Coimbra), top2008 (Elba), top2010 (Brugge), the first workshop with LHC results from top physics !!
- Today the Tevatron closes, we should pay a tribute to this great accelerator (28 years of physics, 10 fb-1 collected) !!

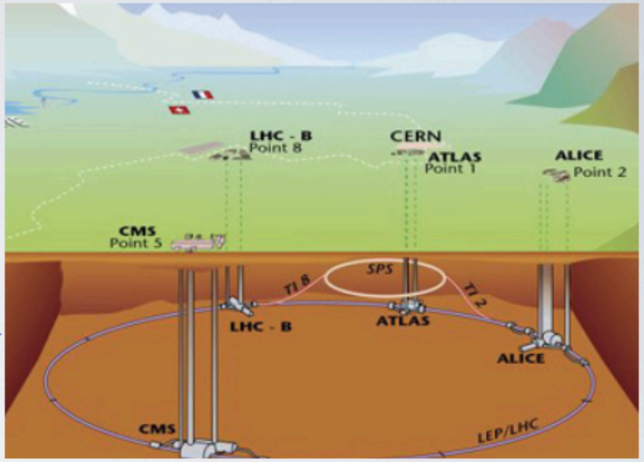


Catastini

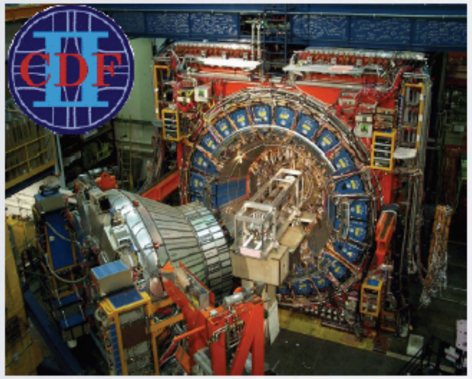
The Machines

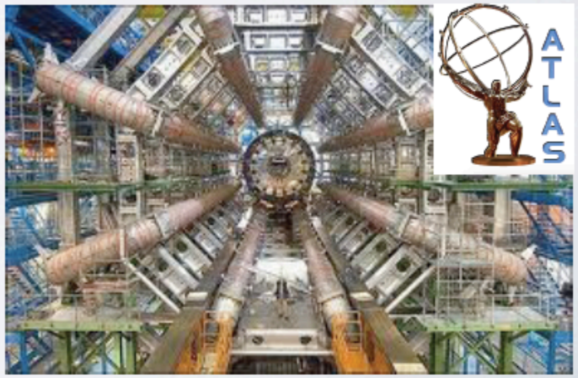


Tevatron
$\sqrt{S}$ = 1.96 TeV
3 decades of Physics !



LHC
Currently $\sqrt{S}$ = 7 TeV
The Future !





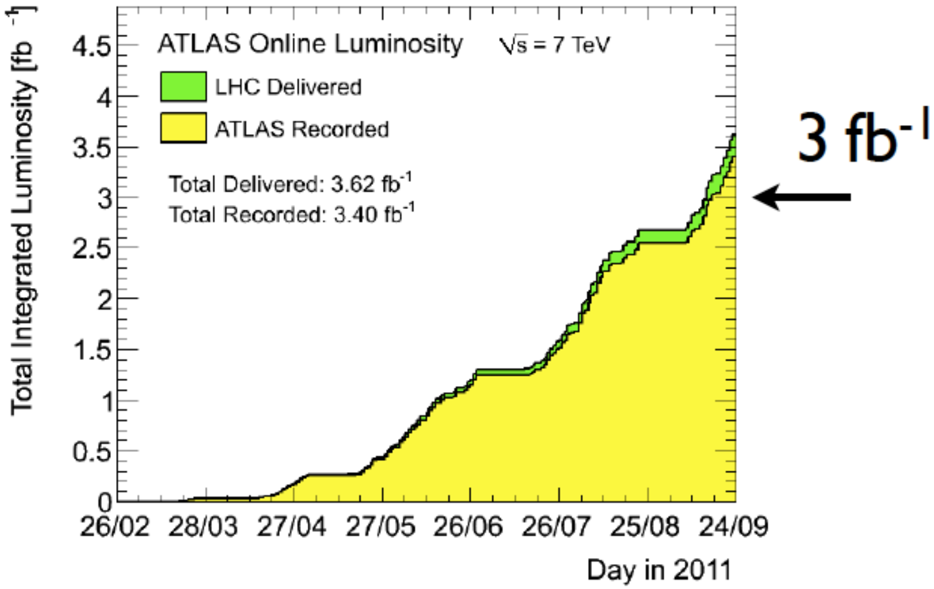
Will discuss results from:

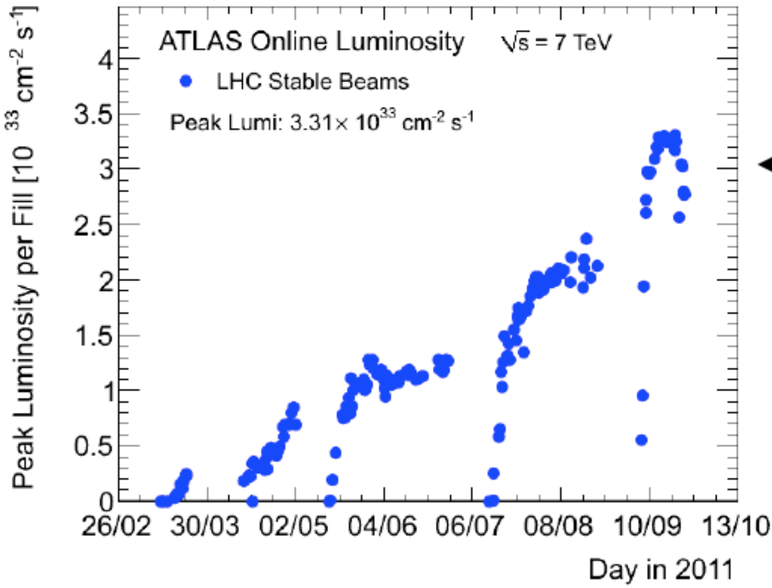
- 2 Colliders
- 4 Experiments

What about the machine that took the baton from Tevatron ?

Fratina

Accumulating data

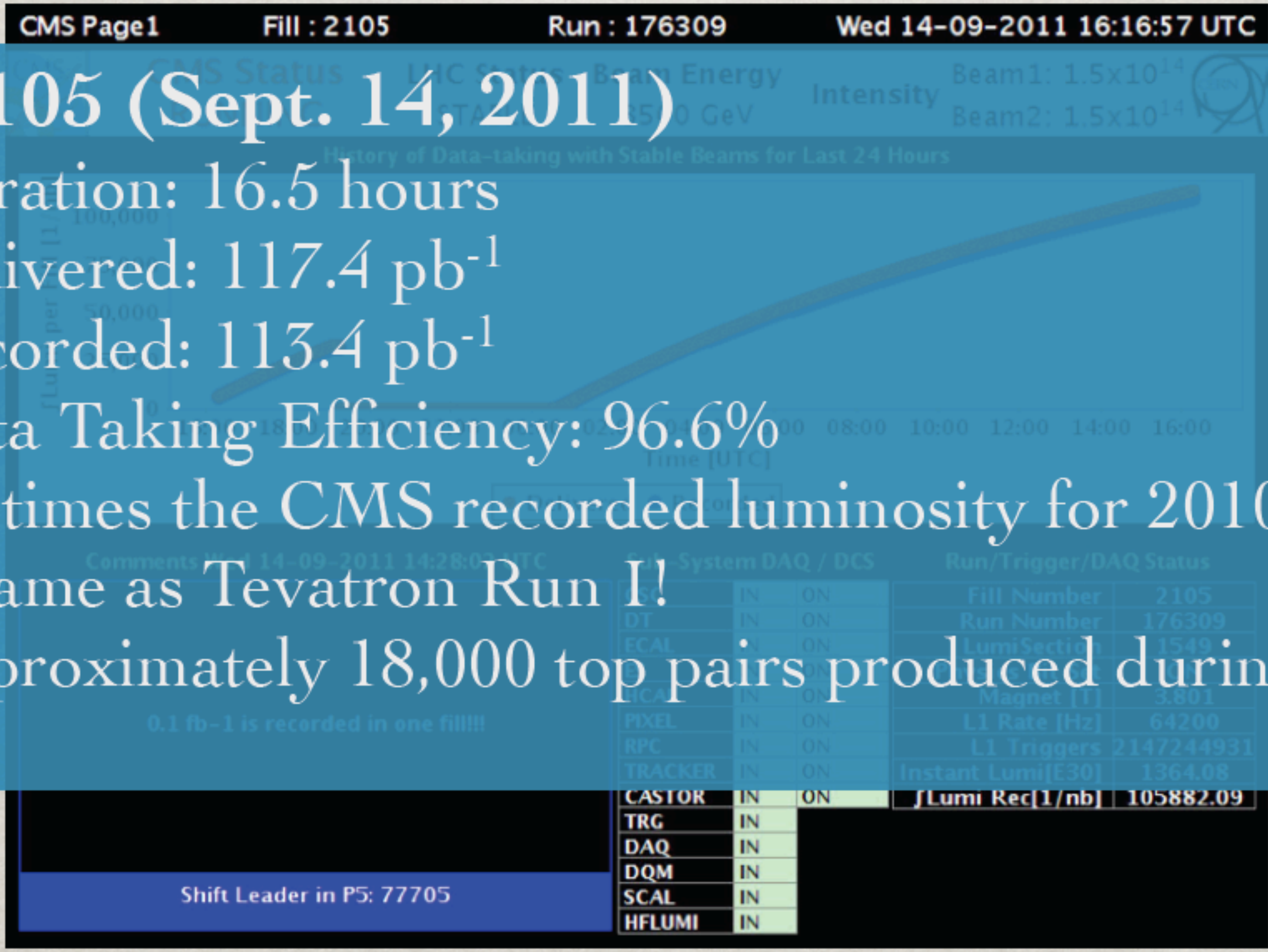




- More than 3 fb^{-1} of data recorded so far
- Great achievement of all detectors, as well as trigger, monitoring, calibration and reconstruction software

Lannon

Record Fill!



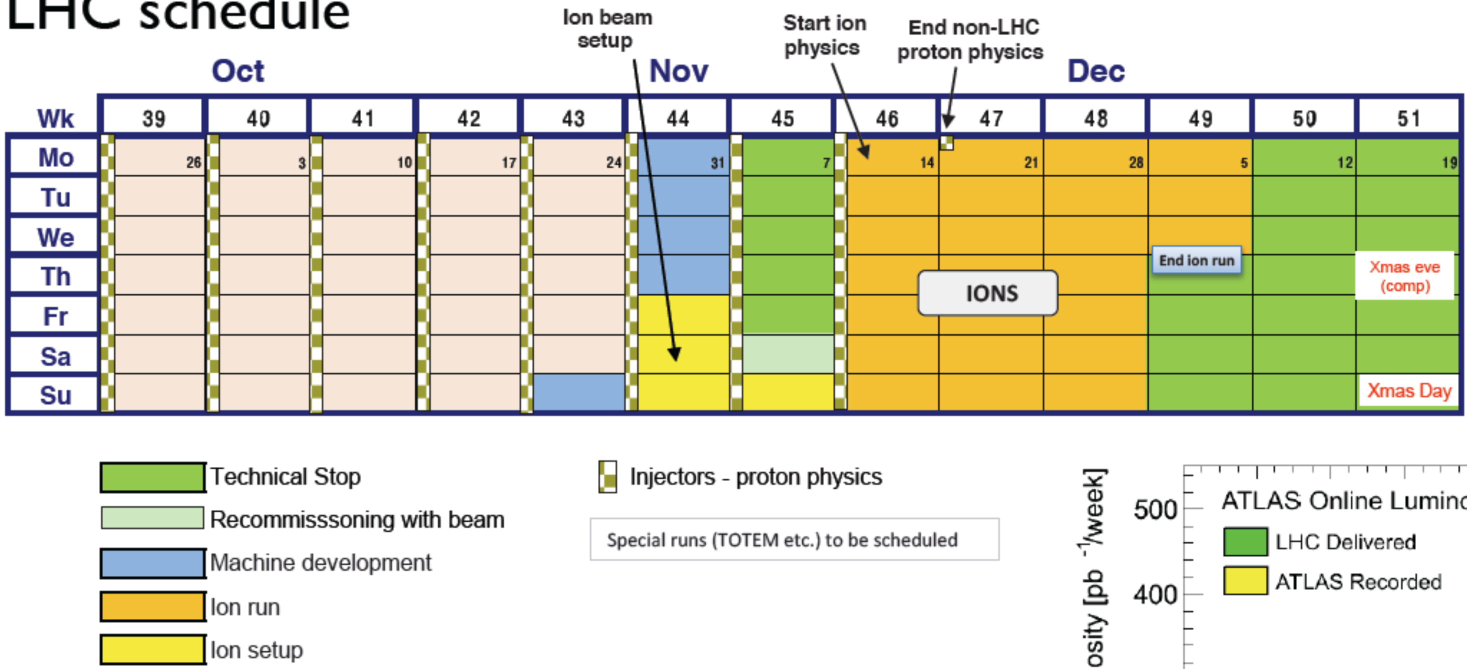
Fill 2105 (Sept. 14, 2011)

- Duration: 16.5 hours
- Delivered: 117.4 pb^{-1}
- Recorded: 113.4 pb^{-1}
- Data Taking Efficiency: 96.6%
- 2.6 times the CMS recorded luminosity for 2010
- ~ Same as Tevatron Run I!
- Approximately 18,000 top pairs produced during this fill!

Fratina

$\int \mathcal{L}\, dt$ in 2011

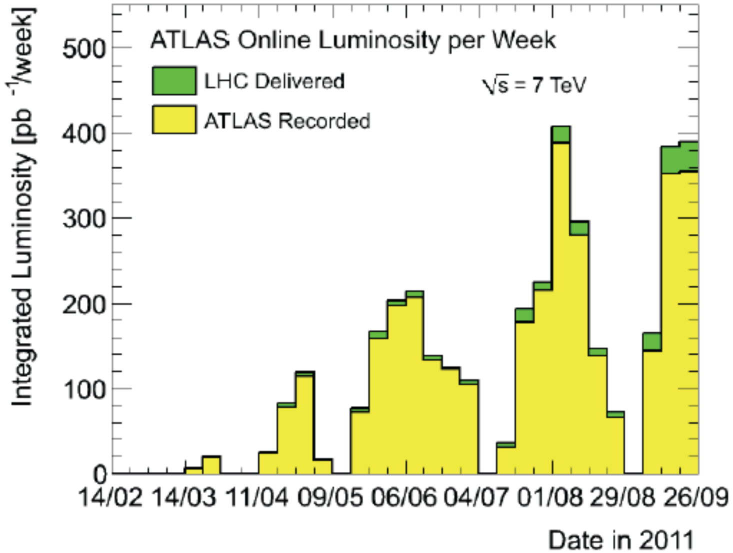
LHC schedule



5 more weeks of running

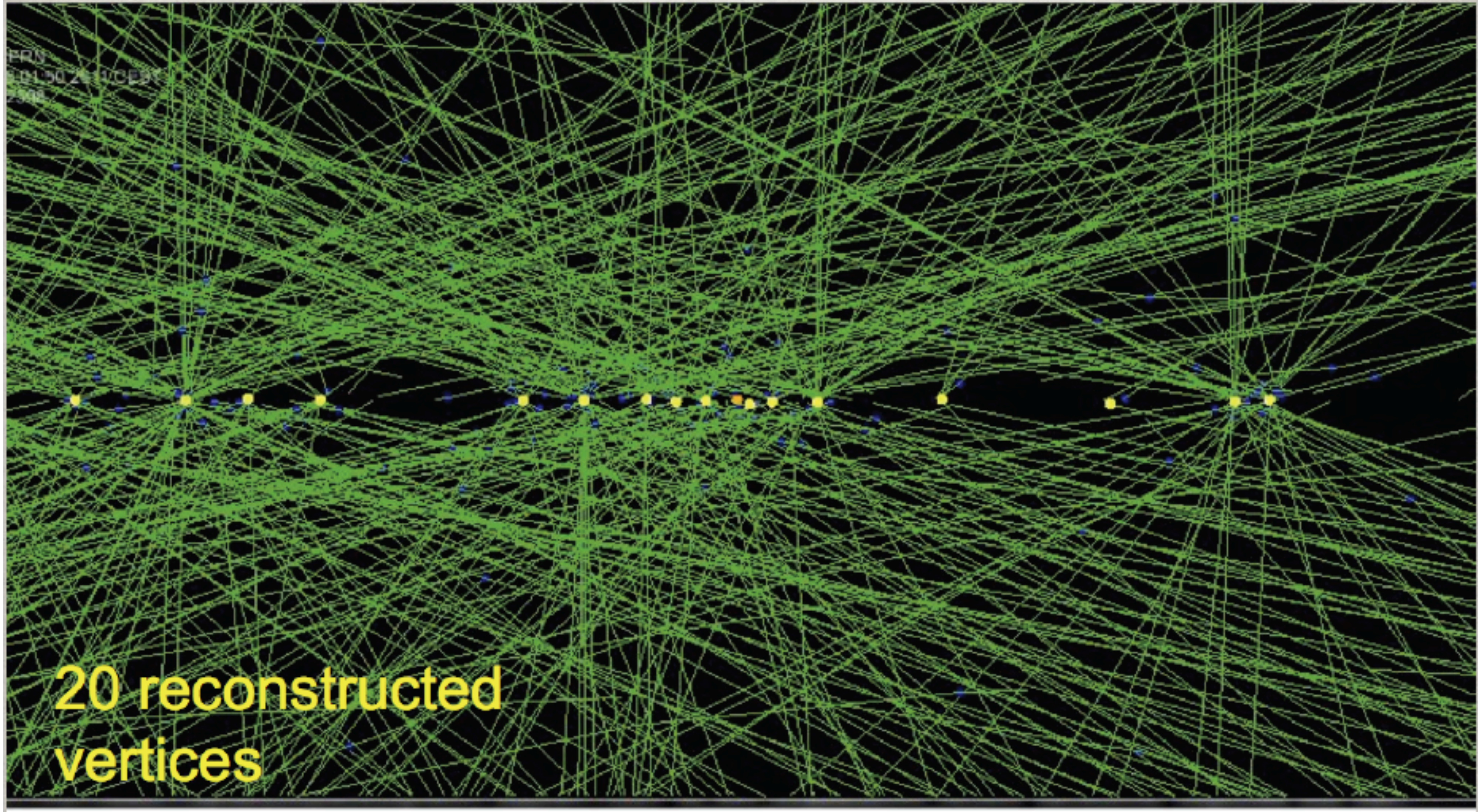
300 - 400 pb^{-1} / week

→ up to ~ 5 fb^{-1} in 2011



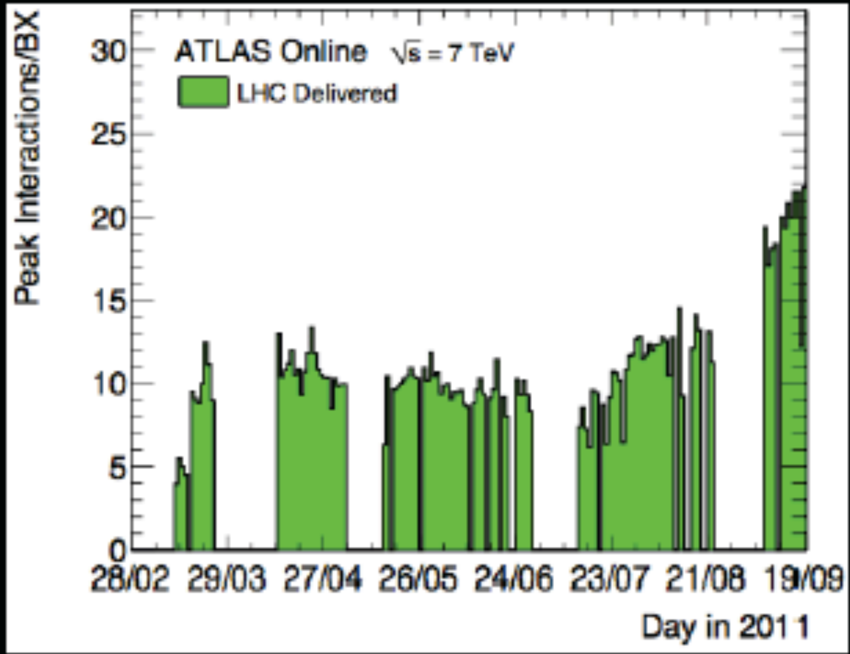
Lannon

Pileup



Future Luminosity Challenges

- Trigger issues:
  - Unprescaled single-lepton triggers no longer possible
  - Future strategies being discussed
- Pileup: Lepton definitions robust except for isolation cuts
  - Tracker isolation much less dependent
- Pileup jets contaminate analyses
  - Future: may veto by requiring consistency with primary vertex
  - Pileup jets not *b*-tagged. *b*-tagging fake-rate calibrations not robust unless pileup jets removed.

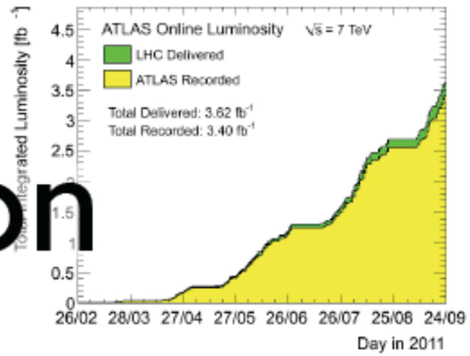


Number of Pileup Interactions Increasing over Time

Garberson

Fratina

Luminosity calibration



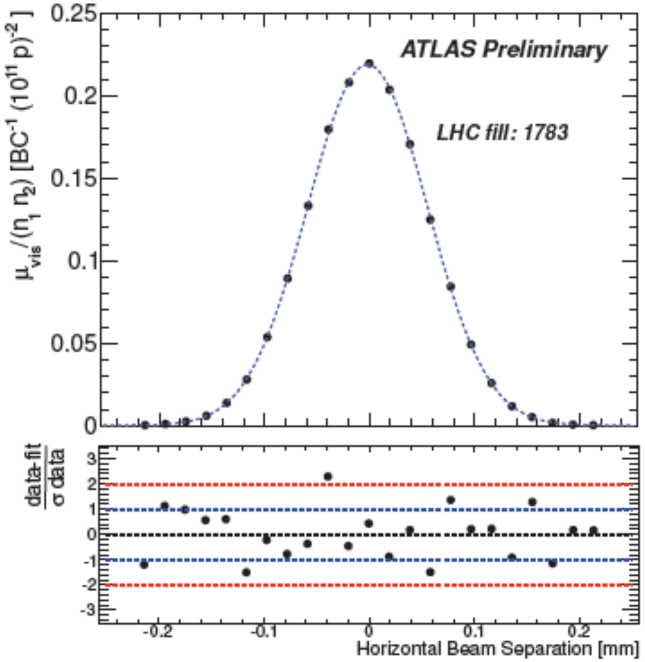
- Luminosity measurement:

μ_{vis}: observable

$$\mathcal{L} = \frac{\mu_{vis} n_b f_r}{\sigma_{vis}}$$

n_b: number of colliding bunches
f_r: machine revolution frequency
σ_{vis}: visible cross-section → needs calibration

- Absolute scale determined from a beam separation scan (also called van der Meer scan):



$$\mathcal{L} = \frac{n_b f_r n_1 n_2}{2\pi \Sigma_x \Sigma_y}$$

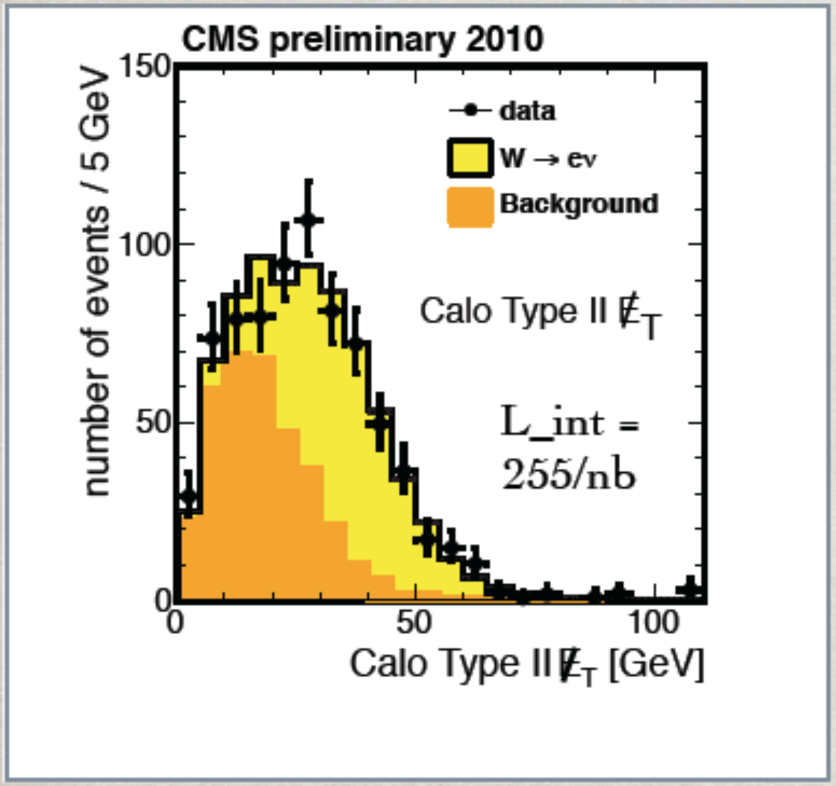
→ external LHC measurement of the charge product

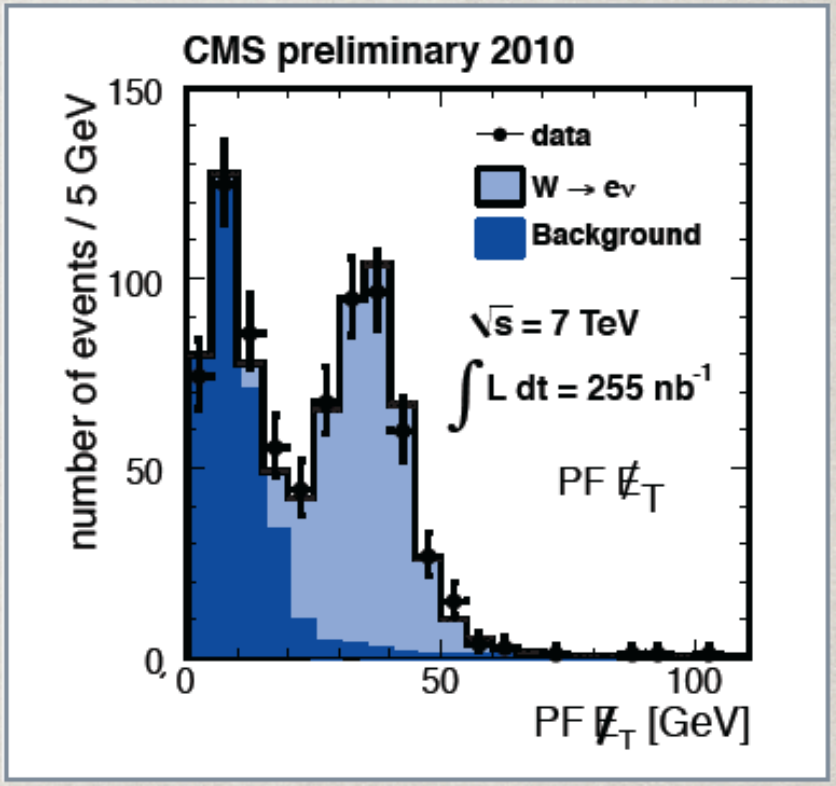
beam profile parameters obtained from the beam separation scan

3.4% uncertainty (compared to 3.7% total) is due to the uncertainty on the absolute luminosity scale

Slaunwhite

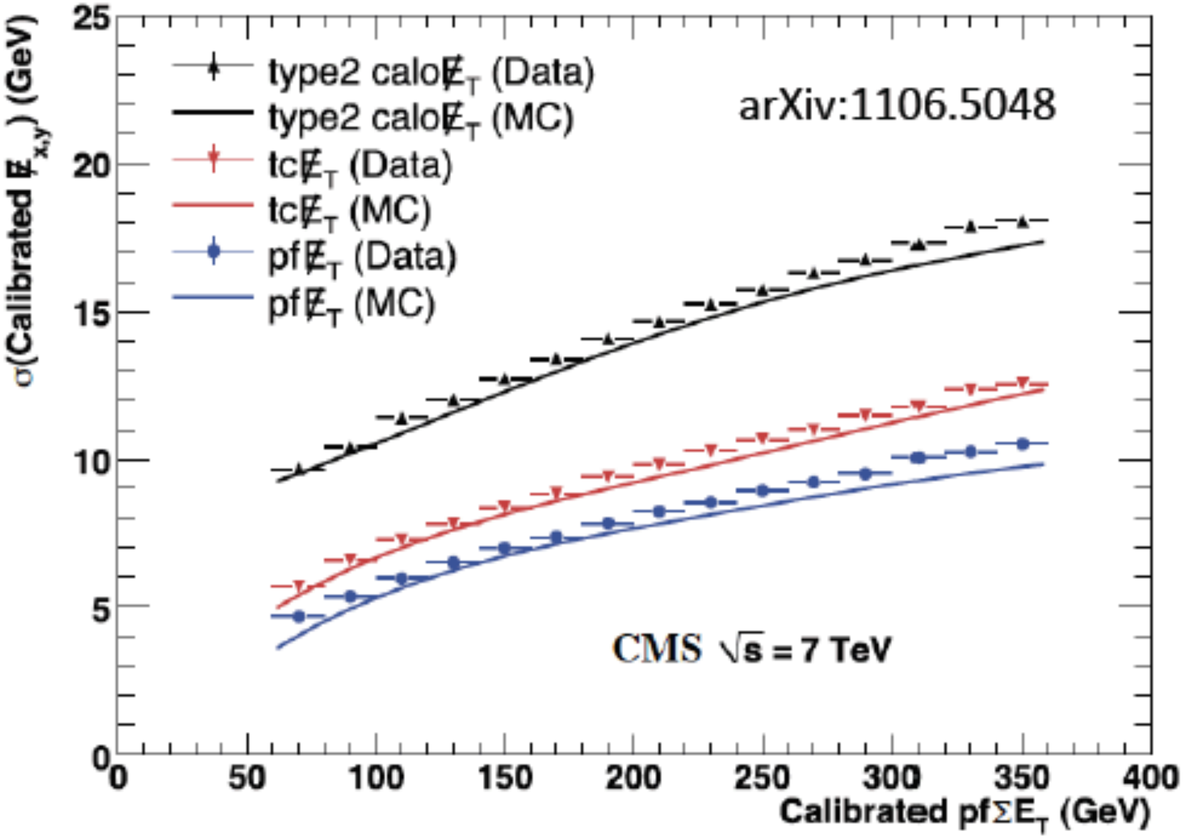
MET Reco: PF vs Calo





- Study of MET in W to e,nu events from early 2010
  - PF improves MET resolution, making W's easier to distinguish from background
  - Impacts on top: QCD estimate & modeling

Impact of the MET algorithm is significant

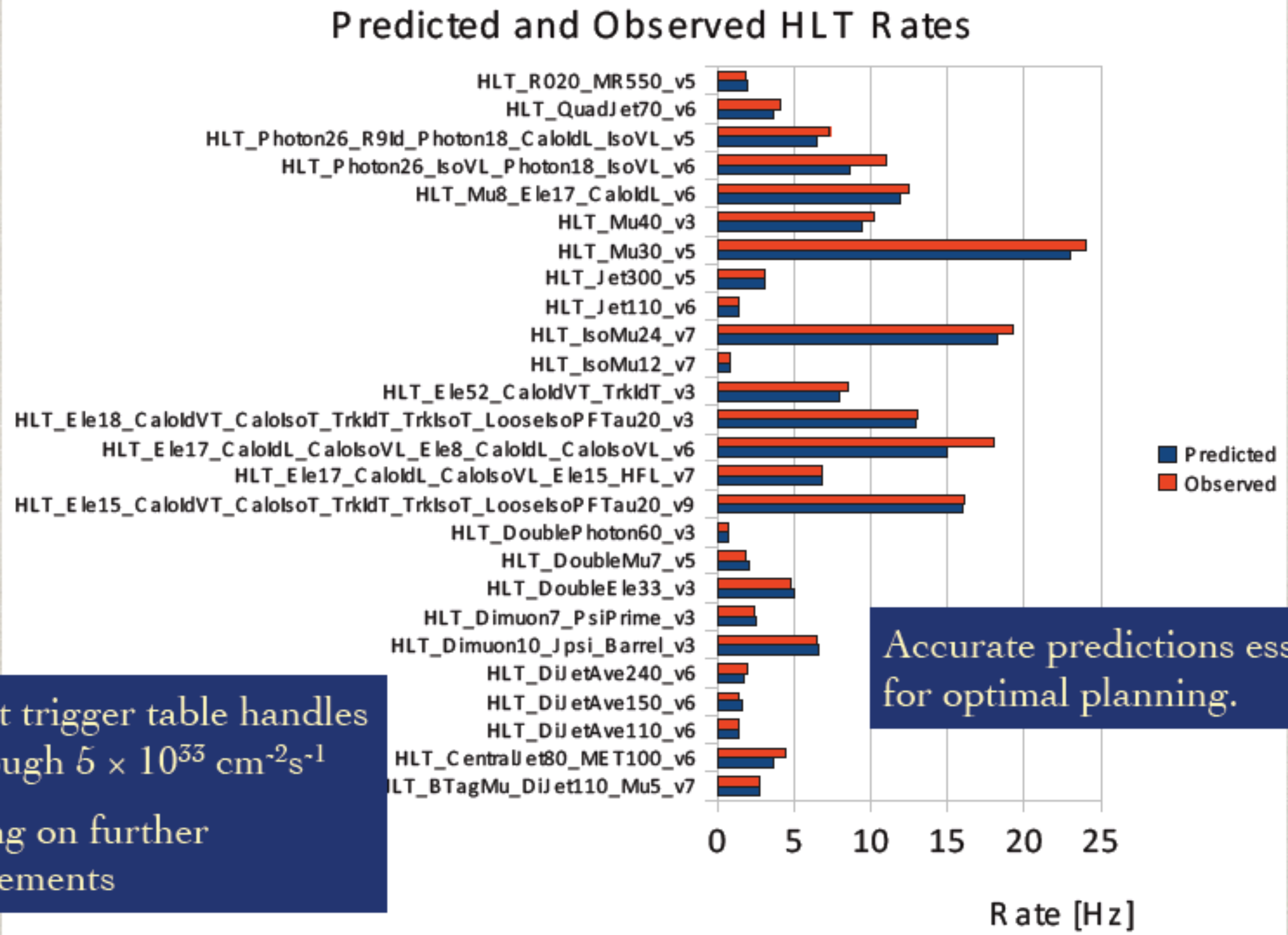


Sjolin

- Measured in multijet events
- Including tracker information improves robustness against instrumental background

Lannon

Trigger Rate Predictions



Accurate predictions essential for optimal planning.

Current trigger table handles up through 5×10^{33} $cm^{-2}s^{-1}$

Working on further improvements

UNIVERSITY OF NOTRE DAME

Backgrounds to top production

(They are also interesting per se)

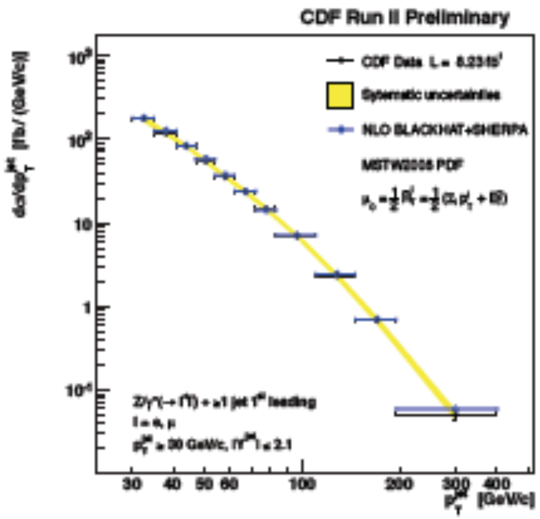
Z+jet Results

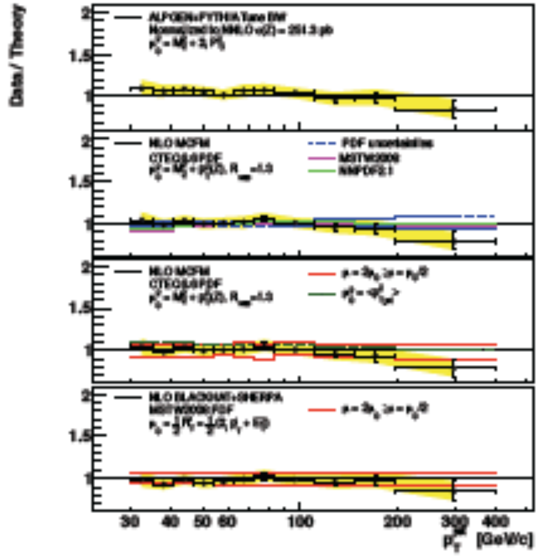
Catastini

Muons and electrons Combined.

- MidPoint algorithm with R=0.7
- Hadron level jets with p_T^{jet} > 30 GeV/c and $|y^{jet}|$ < 2.1
- $\Delta R(l,\text{jet})$ > 0.7
- Theory prediction corrected for non-pQCD effects

Good agreement with NLO pQCD

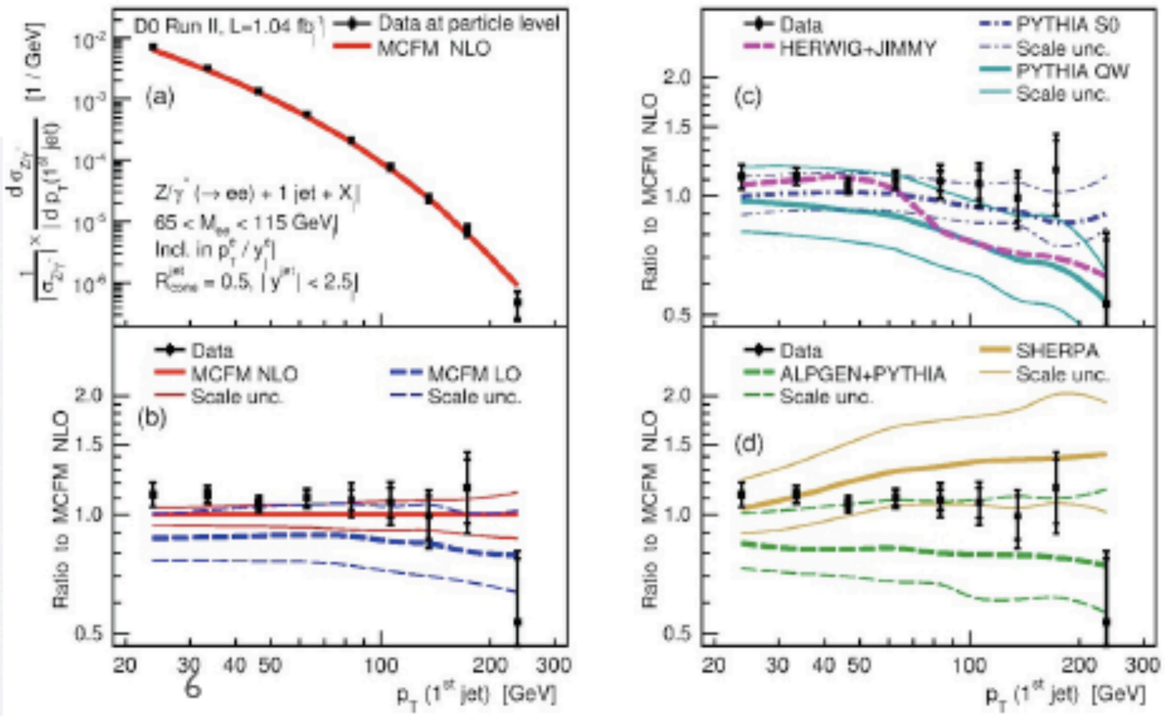




PLB 678, 45 (2009)

- Jets reconstructed with midpoint algorithm with R=0.5, pT > 20 GeV and |η|< 2.5
- Measurements normalized to inclusive Z XS and MCFM prediction corrected for non-pQCD effects

NLO pQCD well described the data. Compared to event generators, ME+PS show reasonable description of shapes but large scale uncertainties



W+c CMS

Catastini

- Select events with muon pT >25GeV/c,η<2.1and at least one jet pT >20GeV/c,η<2.1.
- Require at least one jet tagged with SSVHE algorithm.
- Extract W+c yield by fitting to the SSVHE discriminator with MC templates.
  - Fit extends to negative tags (where SV is in "wrong direction"); helps to constrain the W+l component.
  - tt component checked in control region in data with inverted jet multiplicity cut.

Measure the ratios:

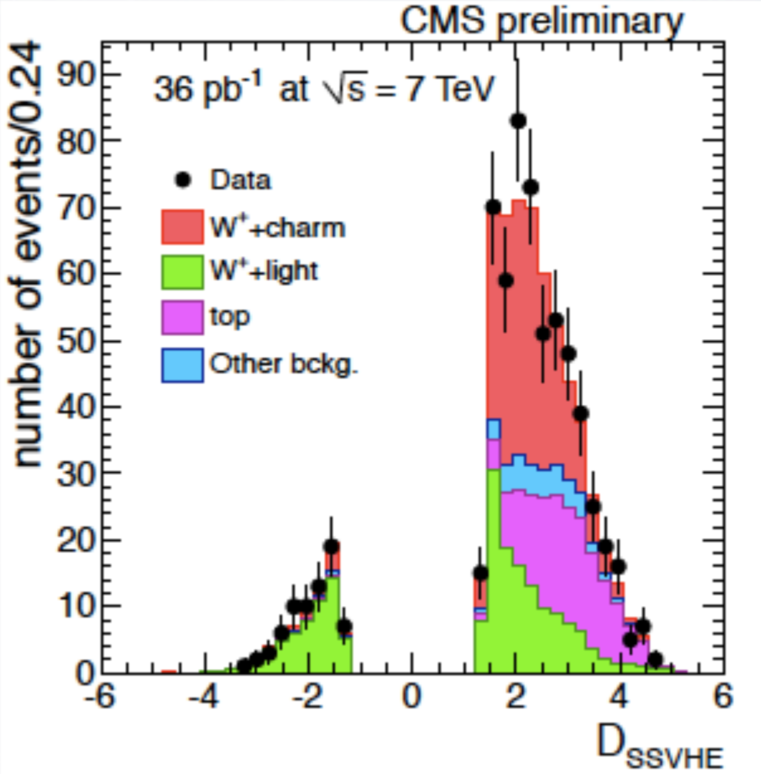
$$R_c^{\pm} = \sigma(W^+c) / \sigma(W^-c)$$
$$R_c = \sigma(W + c) / \sigma(W + j)$$

Results:

$$R_c^{\pm} = 0.92 \pm 0.19\,(stat.) \pm 0.04\,(syst.)$$
$$R_c = 0.143 \pm 0.015\,(stat.) \pm 0.024\,(syst.)$$

In agreement with MCFM predictions at NLO.

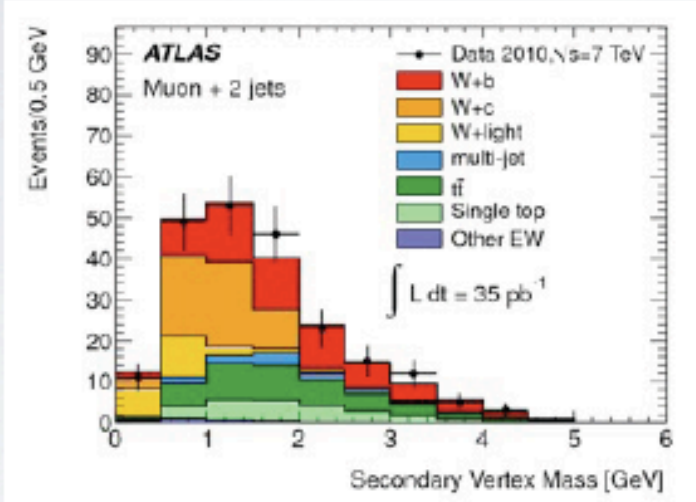
Ratio	MCFM (CT10)	MCFM (MSTW08)	MCFM (NNPDF21)
$R_c^{\pm}$	$0.915^{+0.006}_{-0.006}$	$0.881^{+0.022}_{-0.032}$	0.902 ± 0.008
R_c	$0.125^{+0.013}_{-0.007}$	$0.118^{+0.002}_{-0.002}$	0.103 ± 0.005



W+b ATLAS

Catastini

A maximum likelihood fit to the SV0 mass distribution is used to separate b-jets from c- and light-jets, and extract the flavor fraction on a statistical basis.

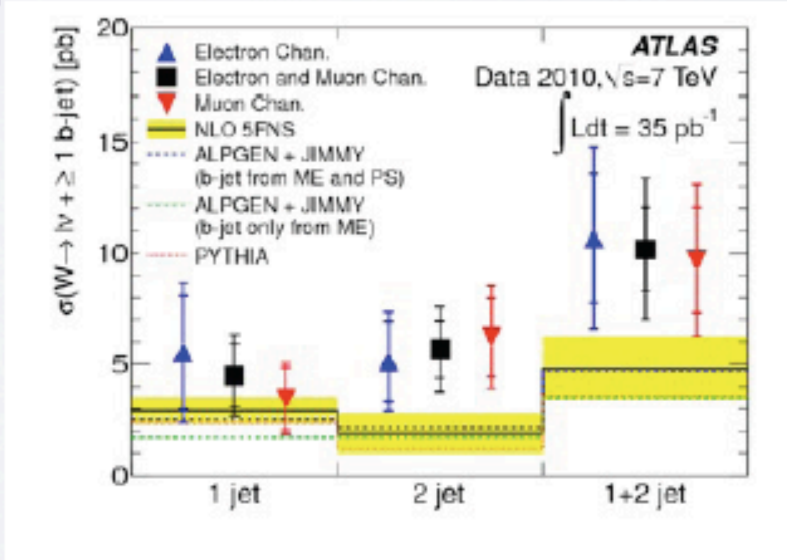


The SV0 b-tagging algorithm is based on requiring a displaced secondary vertex reconstructed within a jet with a decay length significance > 5.85

- SV0 mass template are modeled with MC
- Template systematics: data vs. MC in multi-jet events enriched in light-, c-, and b-jets.
- Event fitted yield is corrected for all detector effects with MC LO matched prediction for Wjet (including heavy flavour) from ALPGEN
  - 1 b-tagged jet
  - 1 or 2 jet
  - Fit each jet bin separately for e and μ

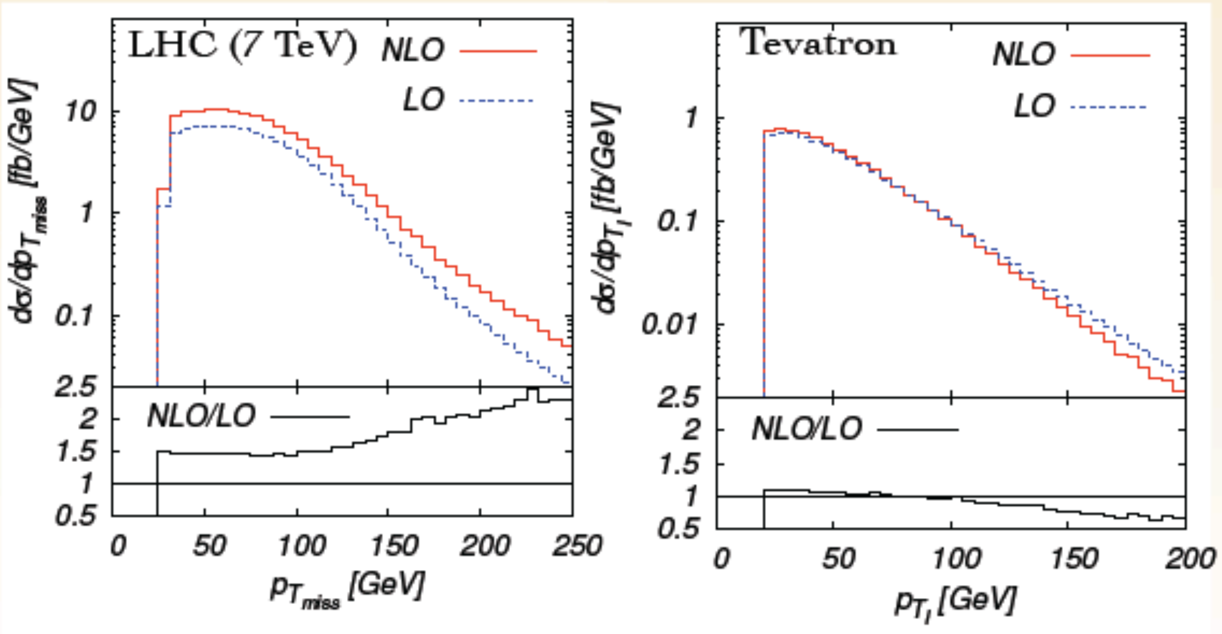
NLO prediction obtained in the 5 flavor number scheme [F. Caola et *al.* arXiv:1107.3714]

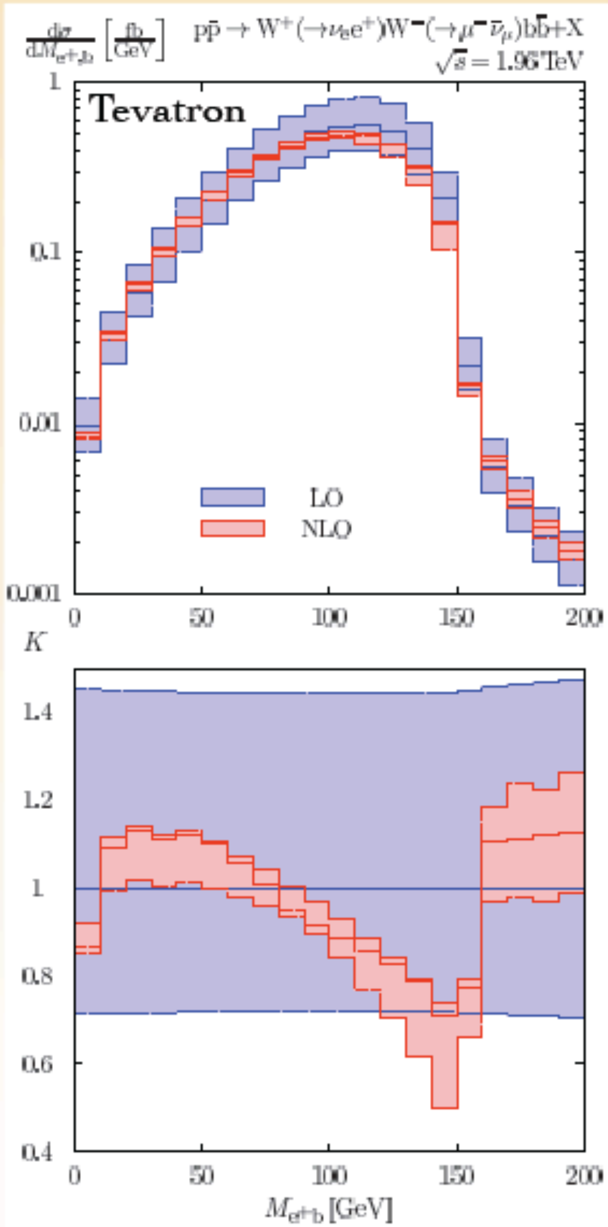
NLO agrees within 1.5 sigma with the measurements



No constant 'K-factor'

- Corrections are small for most observables
- Compared the LO WWbb production, the NLO corrections are **not** an overall change in normalization



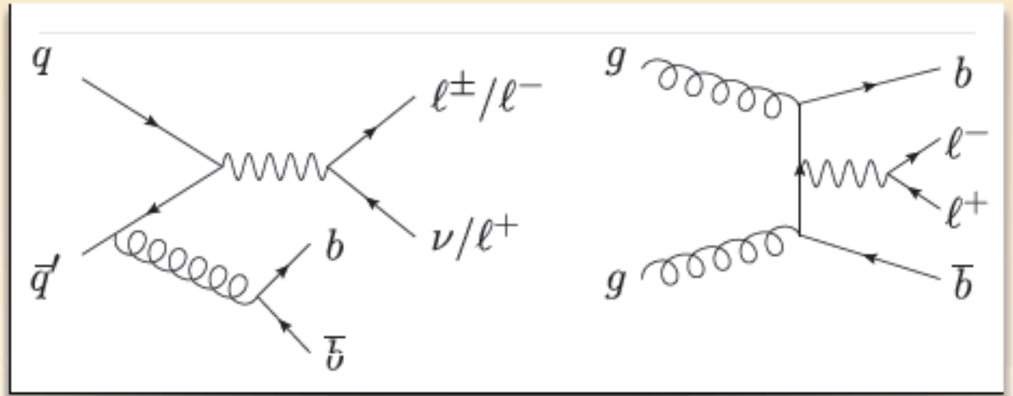


Denner et al.; Bevilacqua et al.

PP → WBB/ZBB WITH aMC@NLO

Frederix

- Background to top pair production and pp → HW/HZ, H → bb
  4 Flavor scheme calculations
  - Massive b quarks
  - No initial state b quarks
  - Born is finite: no generation cuts are needed



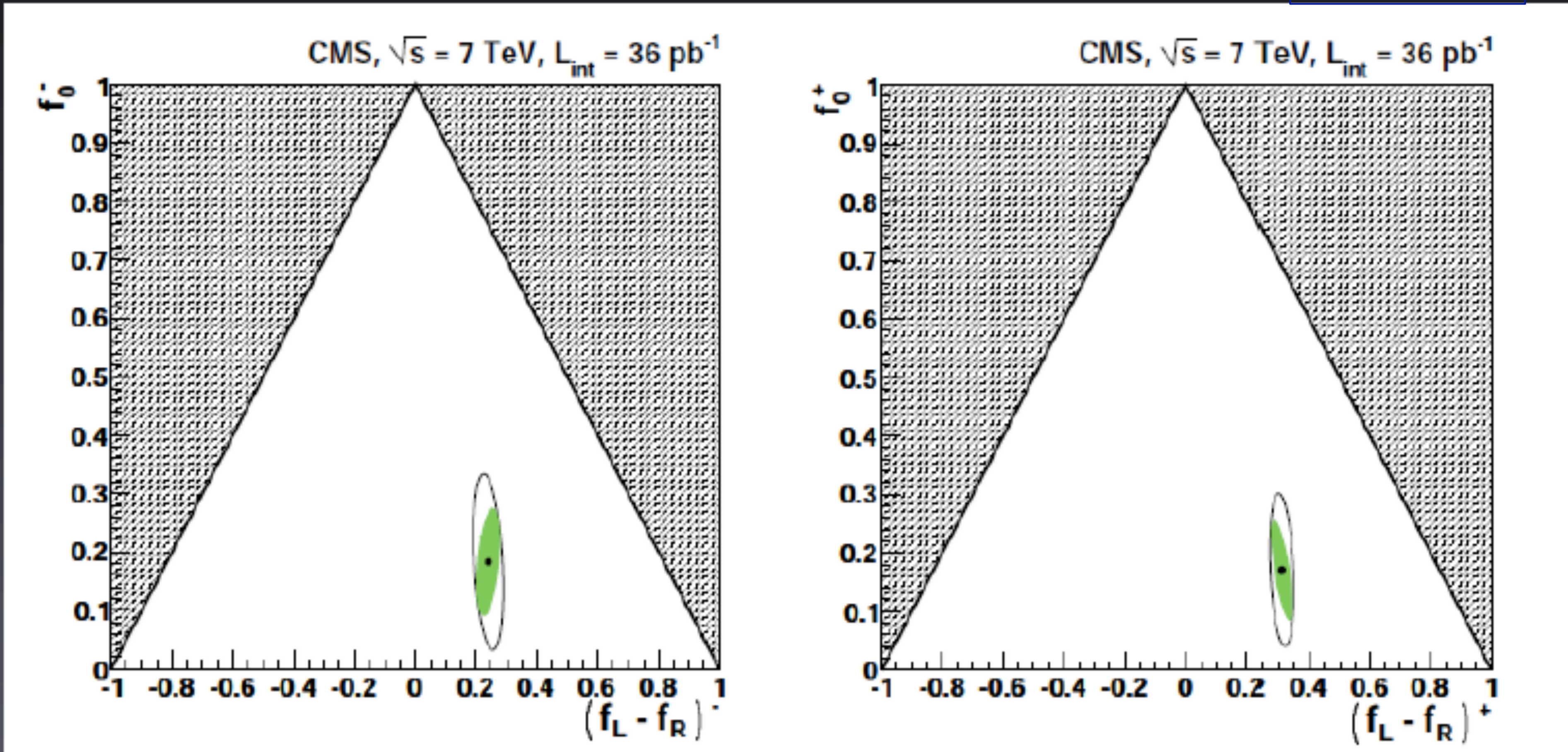
- At LO, Wbb is purely qq induced, while Zbb has also contributions from gg initial states
- Cross sections for Zbb and Wbb are similar at LHC 7 TeV

[RF, Frixione, Hirschi, Maltoni, Pittau & Torrielli, arXiv:1106.6019]

	Cross section (pb)					
	Tevatron $\sqrt{s}$ =1.96 TeV			LHC $\sqrt{s}$ =7 TeV		
	LO	NLO	K factor	LO	NLO	K factor
$\ell\nu b\bar{b}$	4.63	8.04	1.74	19.4	38.9	2.01
$\ell^{+}\ell^{-}b\bar{b}$	0.860	1.509	1.75	9.66	16.1	1.67

Left-handedness measured

Maitre

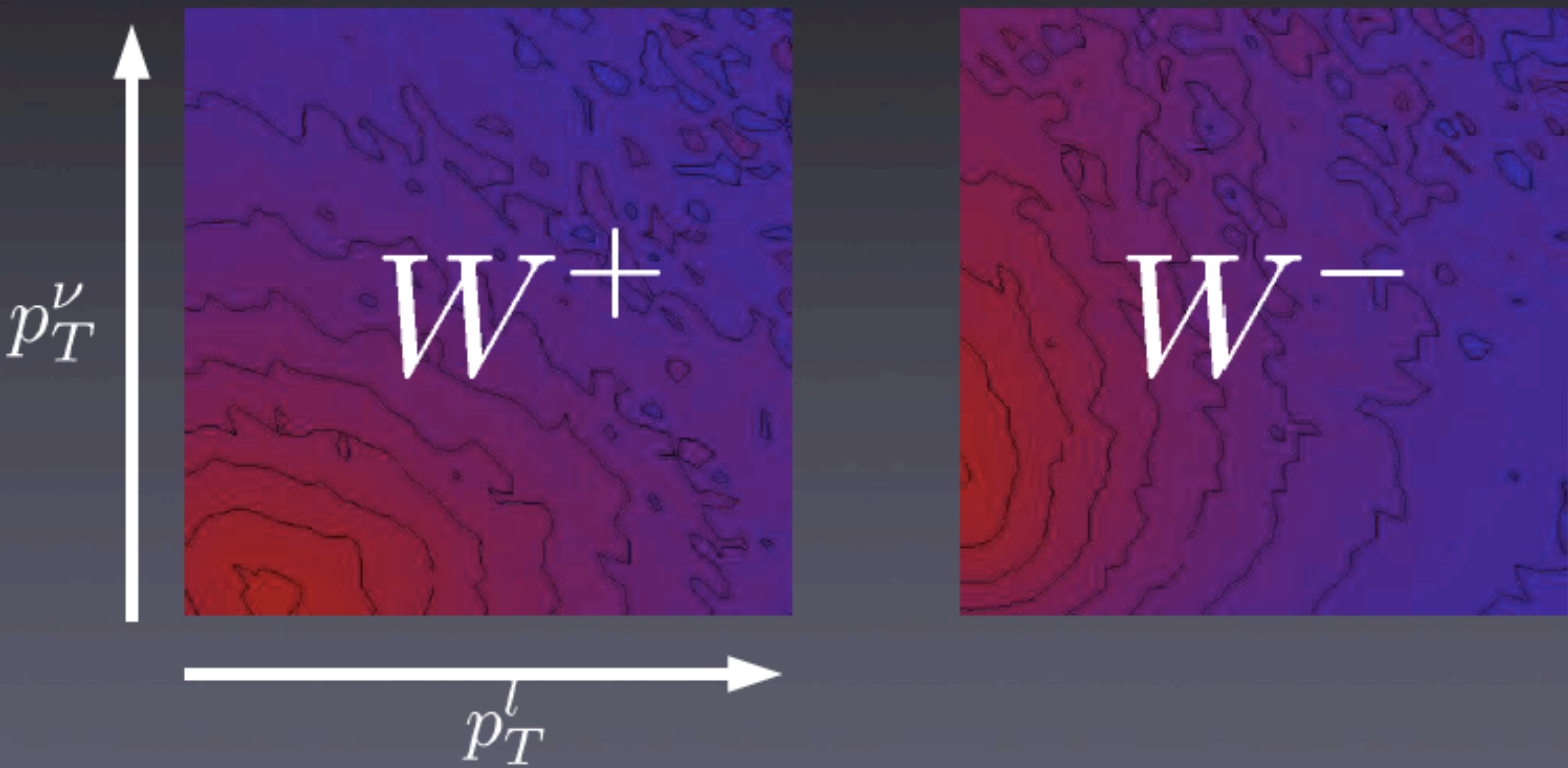


CMS: ArXiv:1104.3829

Prompt *W*s vs *W*s from top decay

Maitre

$$\frac{\frac{d^2\sigma}{dp_T^{\nu}p_T^{l}}(t\bar{t} \to W^{\pm} + 3\text{jets})}{\frac{d^2\sigma}{dp_T^{\nu}p_T^{l}}(W^{\pm} + 3\text{jets})}$$



The ttbar cross section

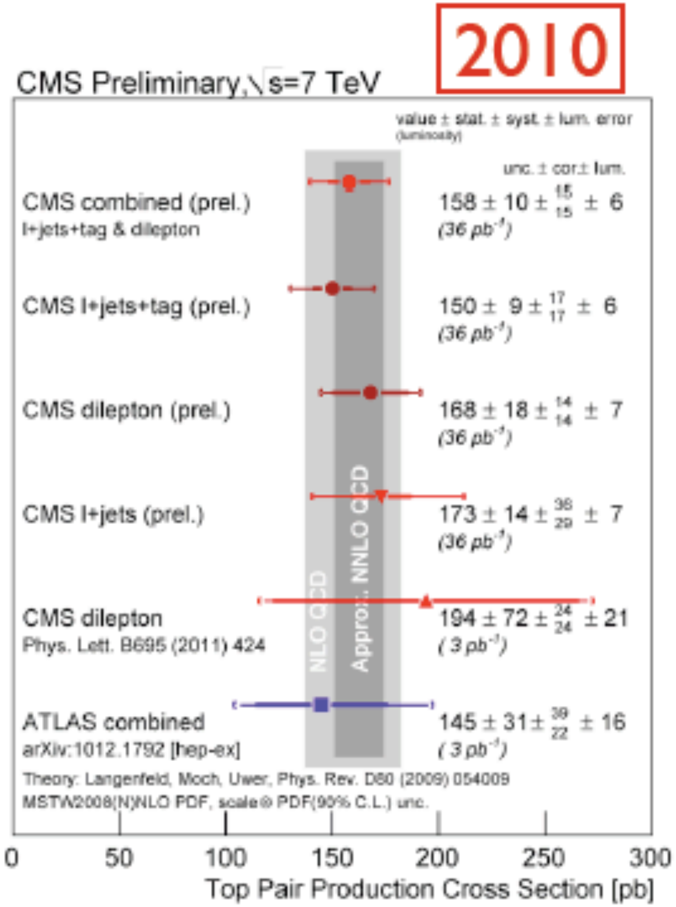
- Already a precise measurement at LHC, precision getting better than 10%

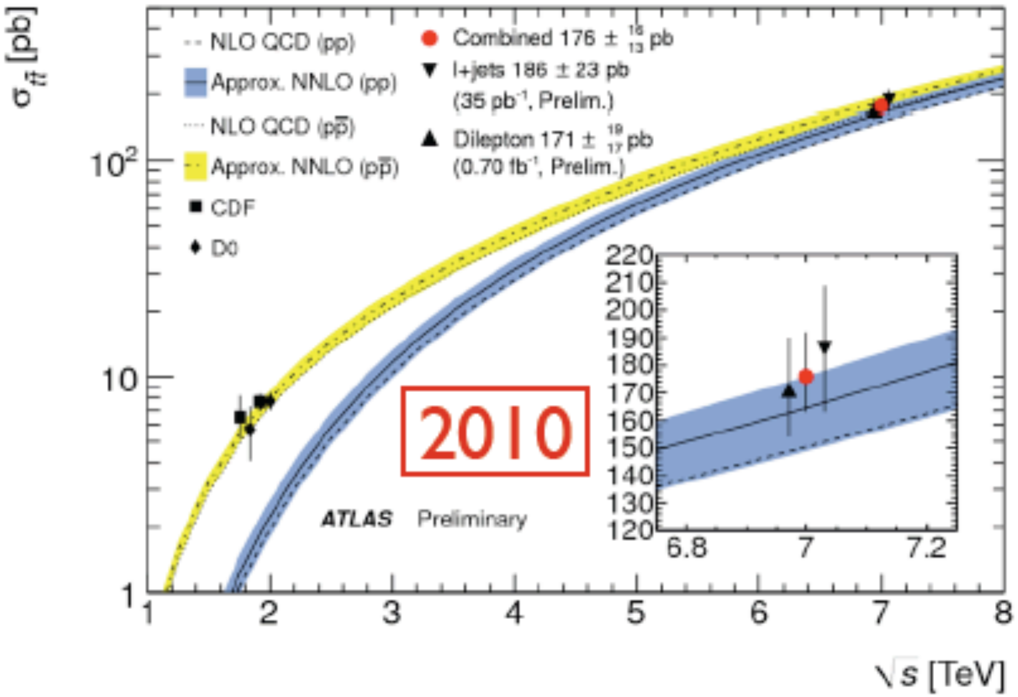
Nadal

Cross-section measurements represent a unique test of perturbative QCD predictions.

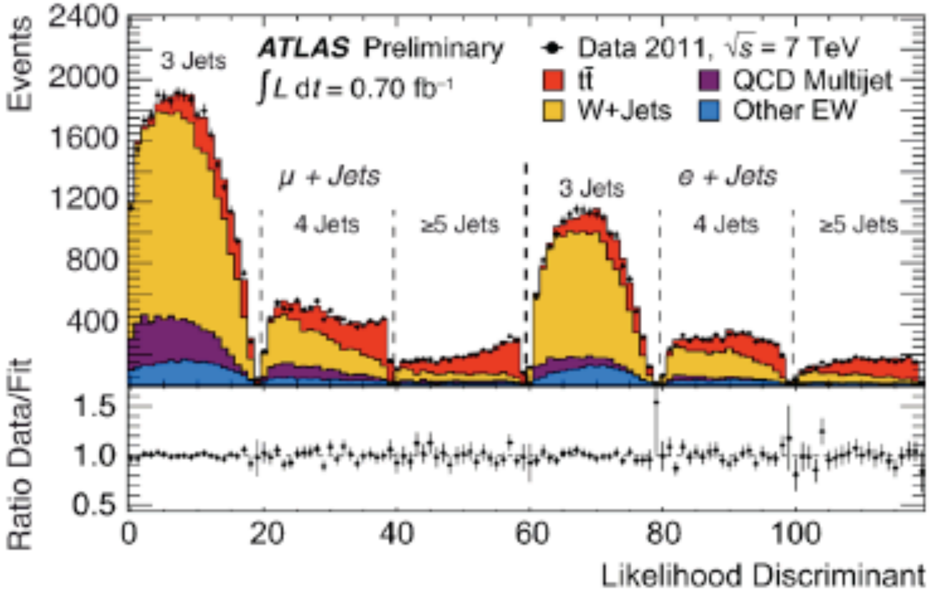
Comparing cross-section measurements in all different channels can give constraints on physics beyond the SM.

Ttbar is a dominant background for several new physics searches such as SUSY.





Single Lepton Untagged Nadal **ATLAS** ***0.7 fb^{-1}***



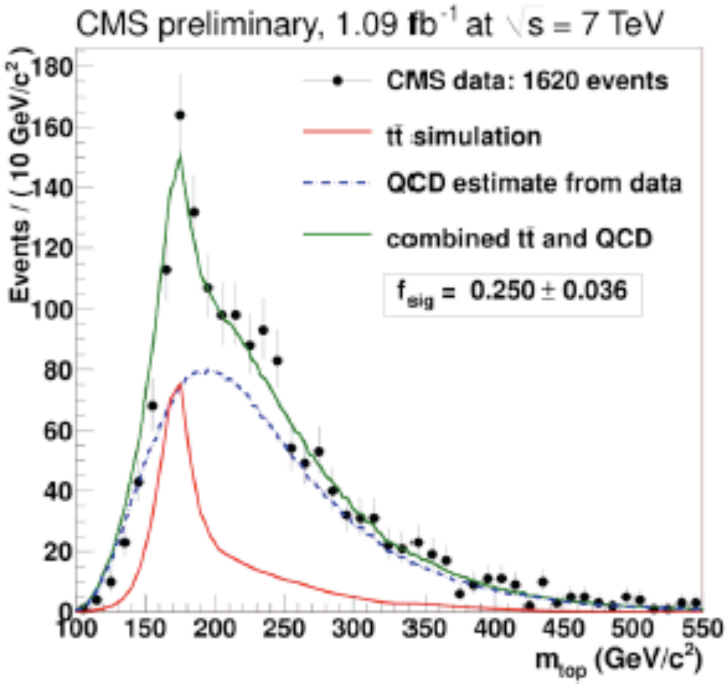
Uncertainty	up (pb)	down (pb)	up (%)	down (%)
Statistical	3.9	−3.9	2.2	−2.2
Detector simulation				
Jets	3.2	−4.3	1.8	−2.4
Muon	4.1	−4.1	2.3	−2.3
Electron	2.7	−3.0	1.5	−1.7
E_T^{miss}	2.0	−1.6	1.1	−0.9
Signal model				
Generator*)	5.4	−5.4	3.0	−3.0
Hadronization*)	0.9	−0.9	0.5	−0.5
ISR/FSR	3.0	−2.3	1.7	−1.3
PDF*)	1.8	−1.8	1.0	−1.0
Background model				
QCD shape*)	0.7	−0.7	0.4	−0.4
W shape*)	0.9	−0.9	0.5	−0.5
Monte Carlo statistics*)	3.2	−3.2	1.8	−1.8
Systematic	9.0	−9.0	5.0	−5.0
Stat. & Syst.	9.8	−9.8	5.4	−5.4
Luminosity	6.6	−6.6	3.7	−3.7
Total	11.8	−11.8	6.6	−6.6

This is the most precise top pair cross-section measurement so far:

$$\sigma_{t\bar{t}} = 179.0^{+7.0}_{-6.0}(stat+syst) \pm 6.6(lumi)pb \qquad \frac{\delta\sigma}{\sigma} \sim 6.6\%$$

Already challenging for theoretical uncertainties!

The cross section is determined from an unbinned maximum likelihood fit to the reconstructed top quark mass.



Source	Relative Uncertainty (%)
B-Tagging	15.7
Jet Energy Scale	13.5
Background	12.2
Q^2 Scale	8.7
Tune	8.1
ISR/FSR	5.6
Top Quark Mass	5.3
Parton Shower Matching	5.2
Jet Energy Resolution	4.8
Trigger	4.5
Pile-Up	0.6
Systematic	29.1
Statistical	14.3
Luminosity	6.0
Total Uncertainty	33.0

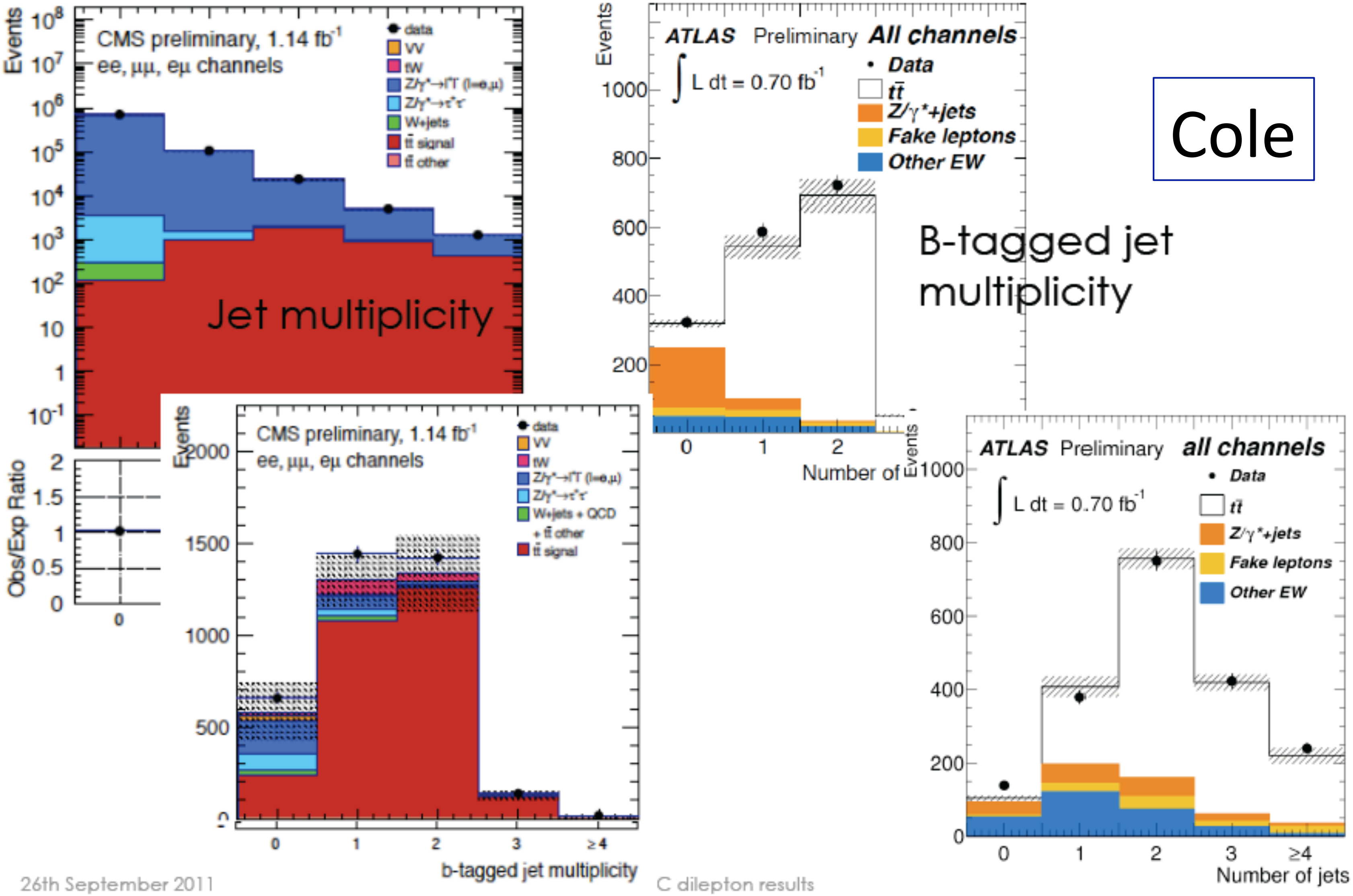
$$\sigma_{t\bar{t}} = \frac{f_{sig} \cdot N}{\epsilon \cdot L_{int}}$$

$$\sigma_{t\bar{t}} = 136 \pm 20\ (\text{stat.}) \pm 40\ (\text{sys.}) \pm 8\ (\text{lumi.})\ \text{pb}$$

$$\frac{\delta\sigma}{\sigma} \sim 33\%$$

Data-MC Comparisons

Cole



C dilepton results

Top-quark pair production in NLO QCD

Experimental accuracy below 10 %

Uwer

→ need to go beyond NLO accuracy

Possible corrections (percent level):

QCD NNLO	Bound state effects	Mixed weak-QCD corrections	finite width
$\sim \alpha_s^4$	$"\sim (\alpha_s^3 \frac{1}{\beta})\beta"$	$\sim \alpha_s^2 \alpha$	Γ_t / m_t

LHC

[Kidonakis, Pecjak '11]

	LHC (7 TeV)
NLO	160^{+20+8}_{-21-9}
Hathor / Aliev et. al. [77]	164^{+3+9}_{-9-9}
Kidonakis [14]	163^{+7+9}_{-5-9}
Ahrens et. al. [69]	156^{+8+8}_{-9-9}

m = 173 GeV

Uwer

scale uncertainty ~5%

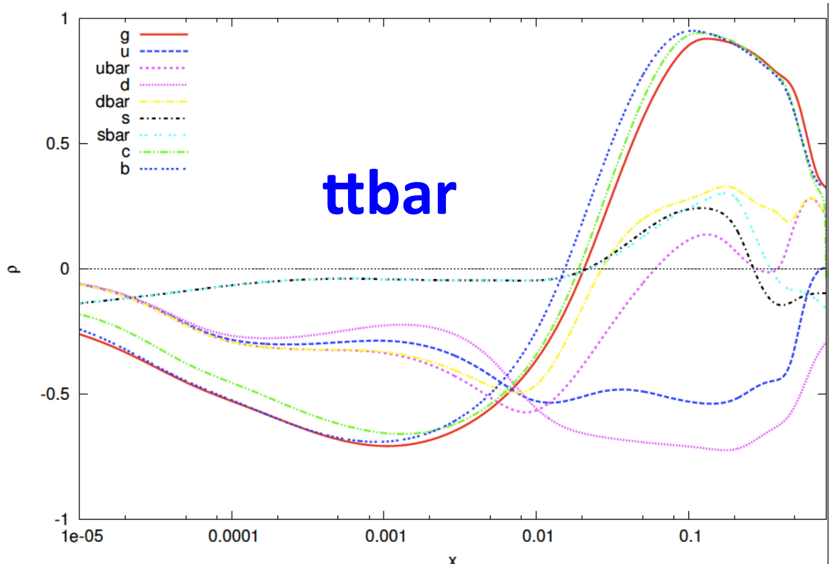
pdf uncertainty ~5%

corrections are small (~2%)
slightly better agreement compared to Tevatron

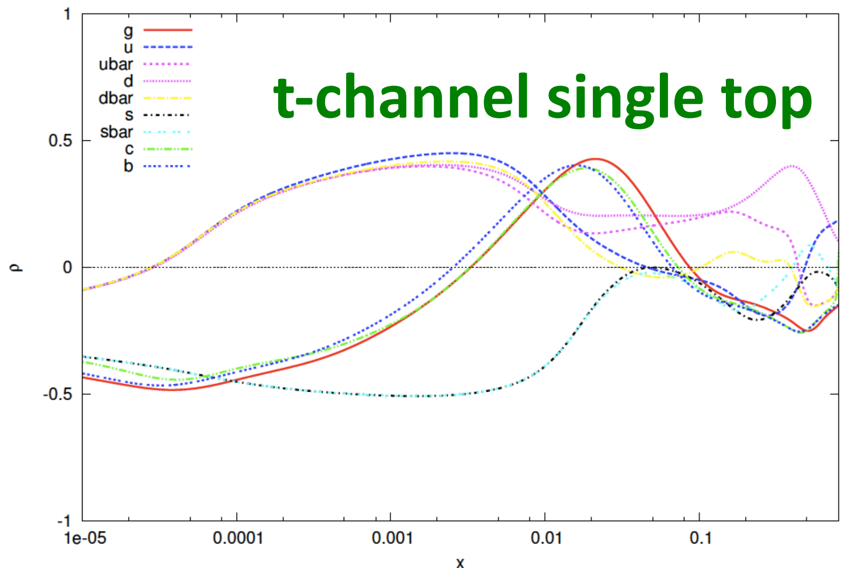
Top cross sections and PDF

- **ttbar** and t-channel **single-top** production are sensitive to PDF in different ways
- Important tools to pin down the **gluon PDF** need a careful study of production versus rapidity

Guffanti and Rojo, top2010



Correlation between ttbar cross section and pdf as a function of x



Correlation between single top cross section and pdf as a function of x

Conclusions

Re

- Amazing progress in the last few years in NLO computations:
  - automation
  - high-multiplicity, e.g. $t\bar{t}+ \leq 2$ jets
- Standard MC generators are well established and invaluable tools, but, for precision studies, use them in association with ME generators (ME+PS), or matching with NLO (NLO+PS).
- with POWHEG and MC@NLO is already possible to study $t\bar{t}$ and single-top with NLO+PS accuracy
- in the last year, several processes relevant for top physics were also added
- and likely many more to come (both NLO codes and matching algorithm are now largely automated).
- possible improvements:
  - simulation of top decays (NLO corrections)
  - ME+NLO+PS: getting the best of NLO+PS and ME+PS

[Hamilton-Nason, Hoeche & al., 2010]

Apologies for topics not discussed, or that I forgot to mention.

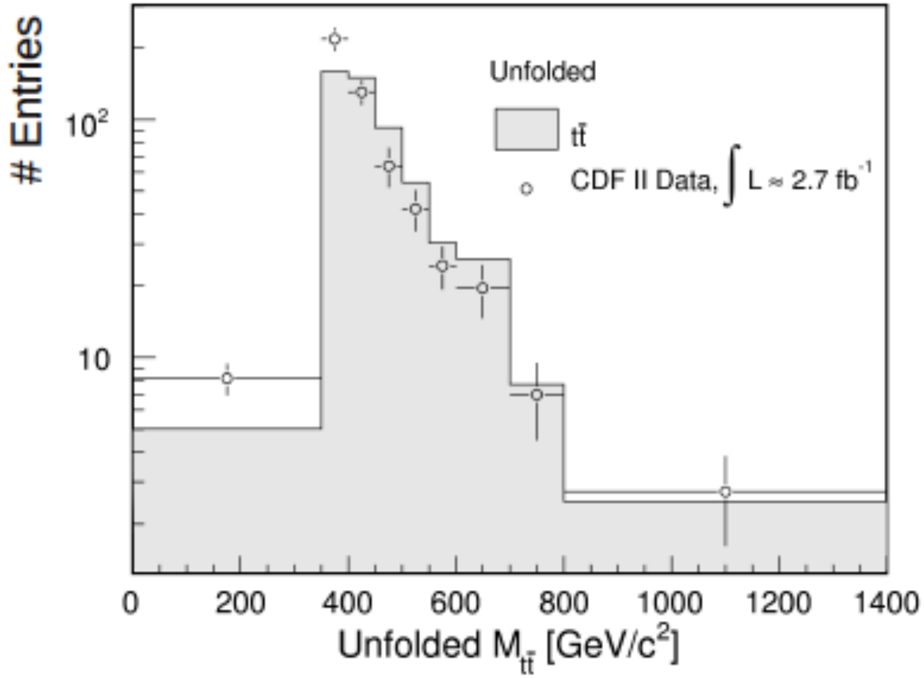
Differential cross sections

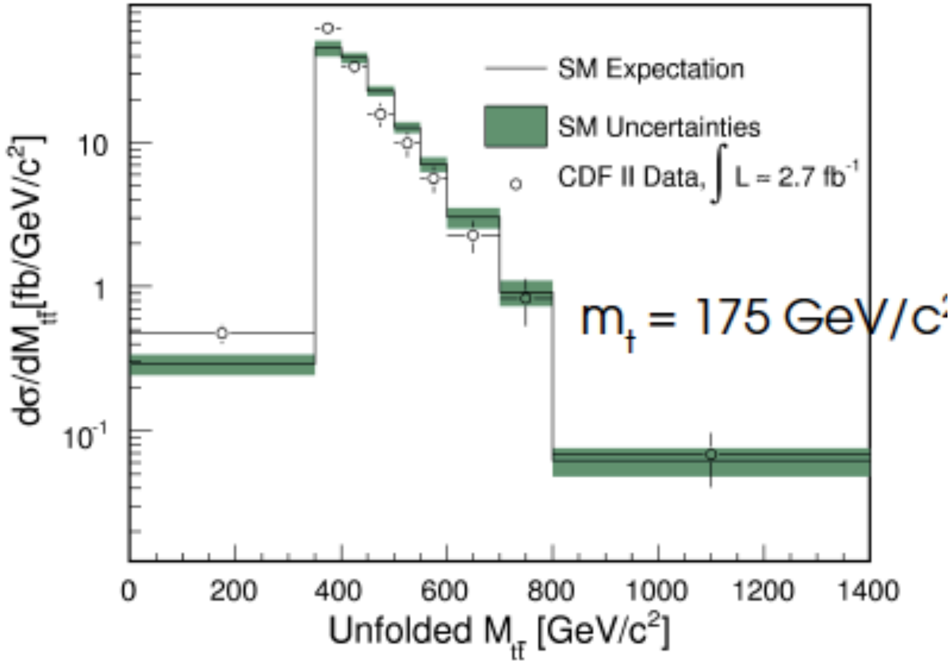
- Tevatron is leaving an important legacy
- Measurement at LHC are starting

Differential cross section

Jung

- Correct for detector effects & finite resolution by regularized unfolding



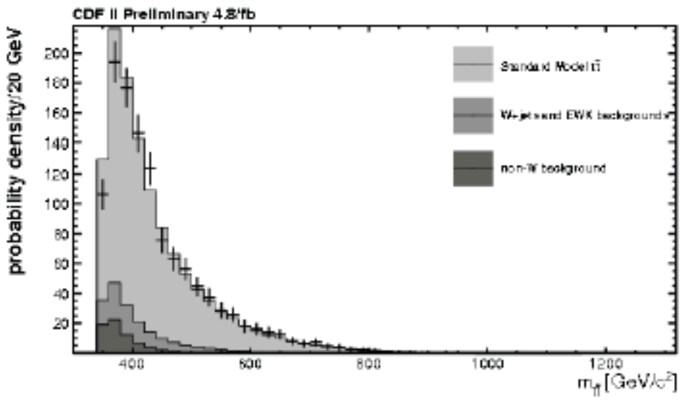


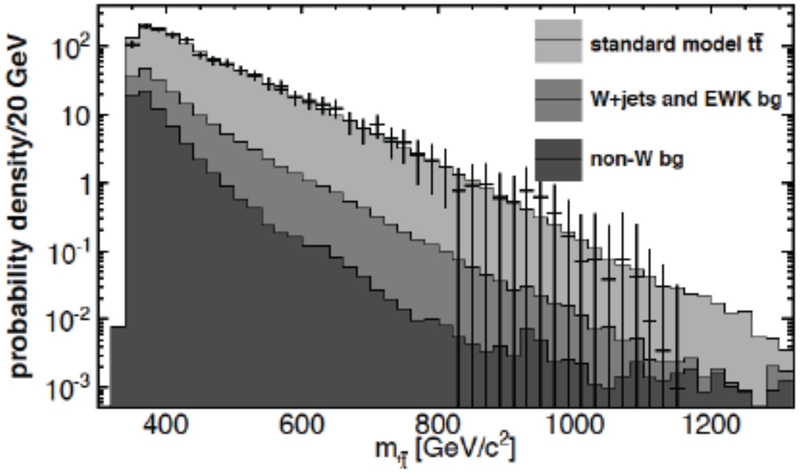
- Dominant systematics: JES 2-8% and at high M($t\bar{t}$) PDF up to 18%
- Integrated cross section: $\sigma = 6.9 \pm 1.0$ (stat.+JES) pb

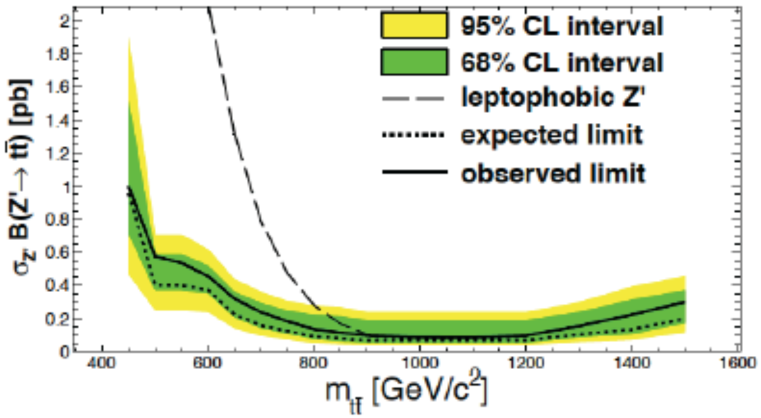
→ Invariant mass distribution of the $t\bar{t}$ system is described by SM
28% of pseudo-experiments show larger deviation

Boisvert

Results







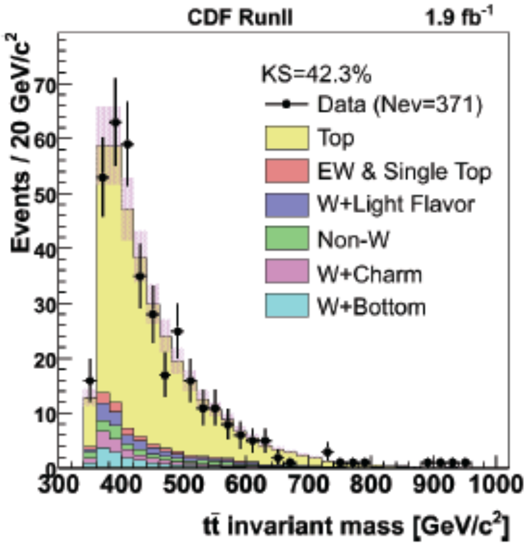
A topcolor leptophobic Z’ is excluded at 95%CL below 900 GeV/c^2

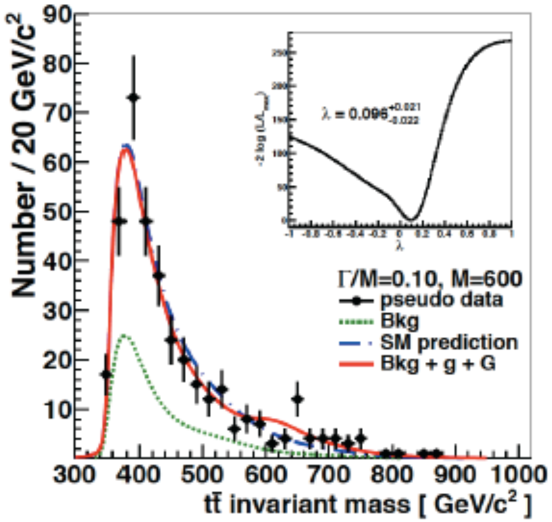
The invariant mass of the ttbar system

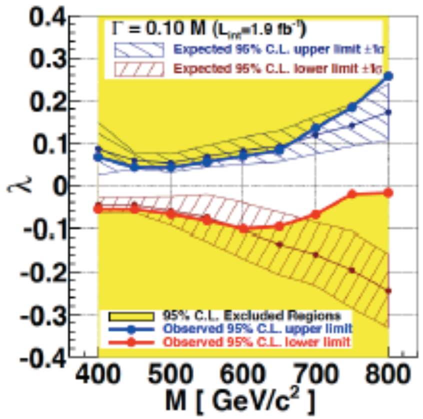
- Already considerable information coming in
- We are learning fast how to treat boosted top

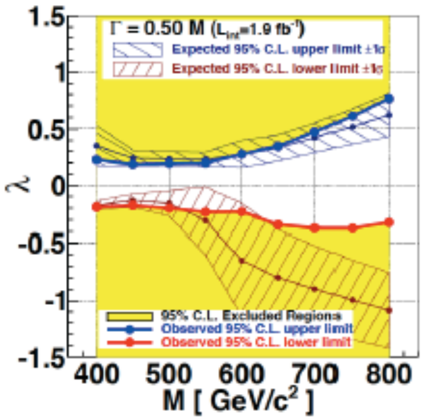
Boisvert

Results



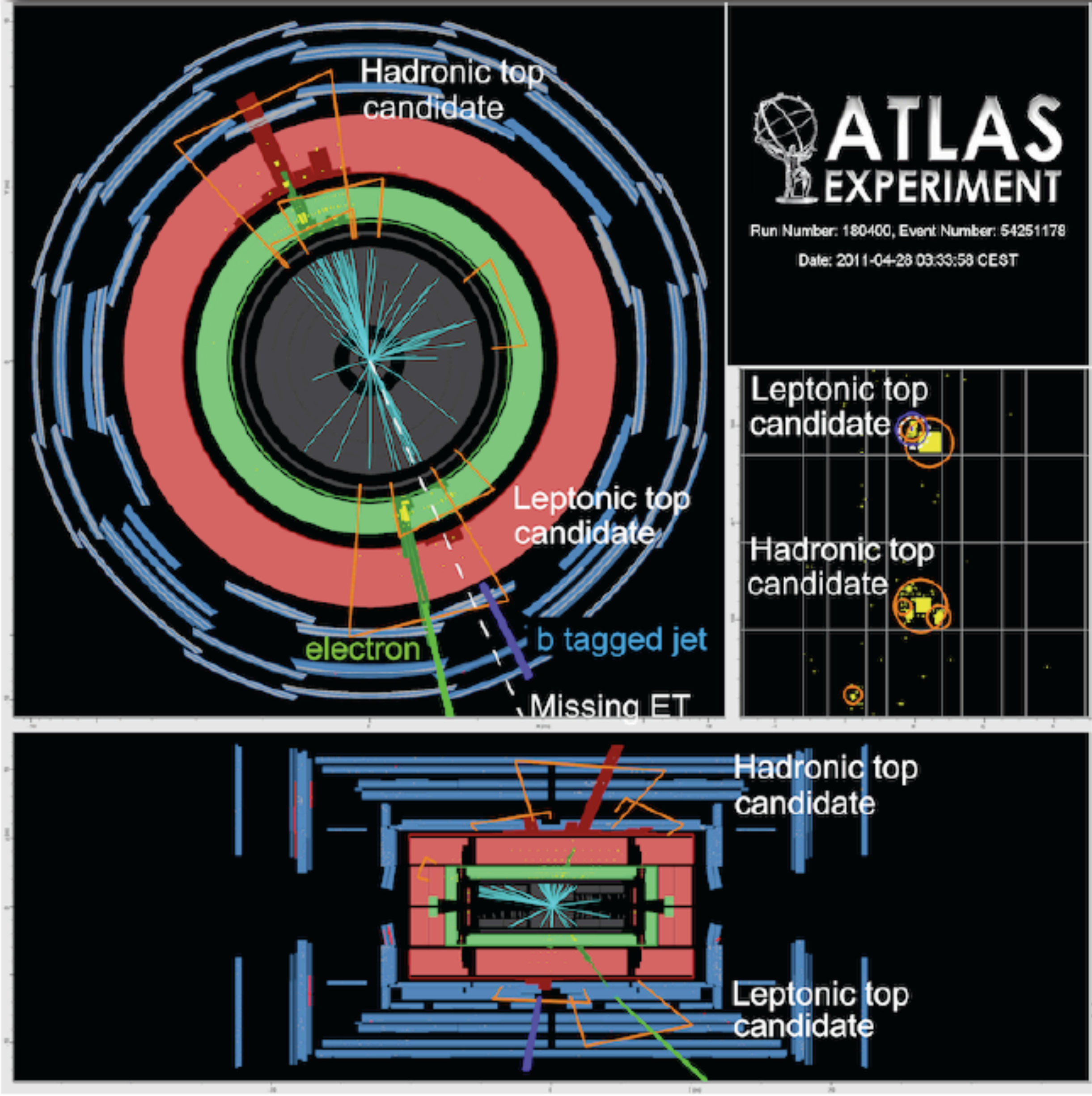






No significant indication of a massive Gluon with |λ|>0.5 is observed

A boosted ATLAS event



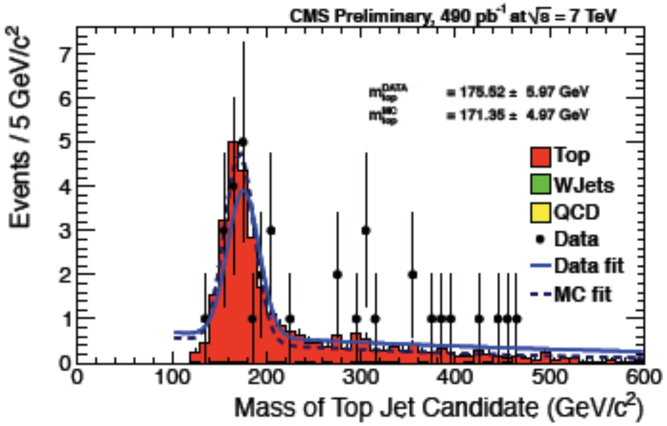
Masetti

Boosted semileptonic ttbar candidate event

Top and W tagging

Top tagging algorithm

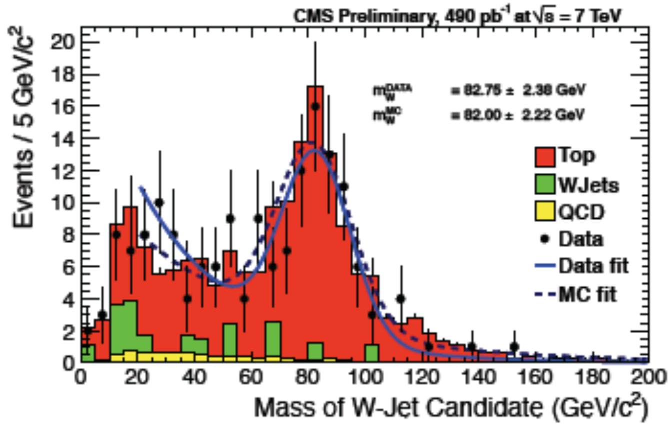
- **Input:**
  - Cambridge-Aachen R=0.8 jets
- **Decomposition:**
  - Two splitting steps
- **Requirements:**
  - Jet mass between 140 and 250 GeV
  - Pairwise mass of the three hardest subjets above 50 GeV



W tagging algorithm

- **Input:**
  - Cambridge-Aachen R=0.8 jets
- **Decomposition:**
  - Jet pruning
- **Requirements:**
  - Pruned jet mass between 60 and 100 GeV
  - Mass drop of hardest subjet < 0.4

Masetti
Bazterra

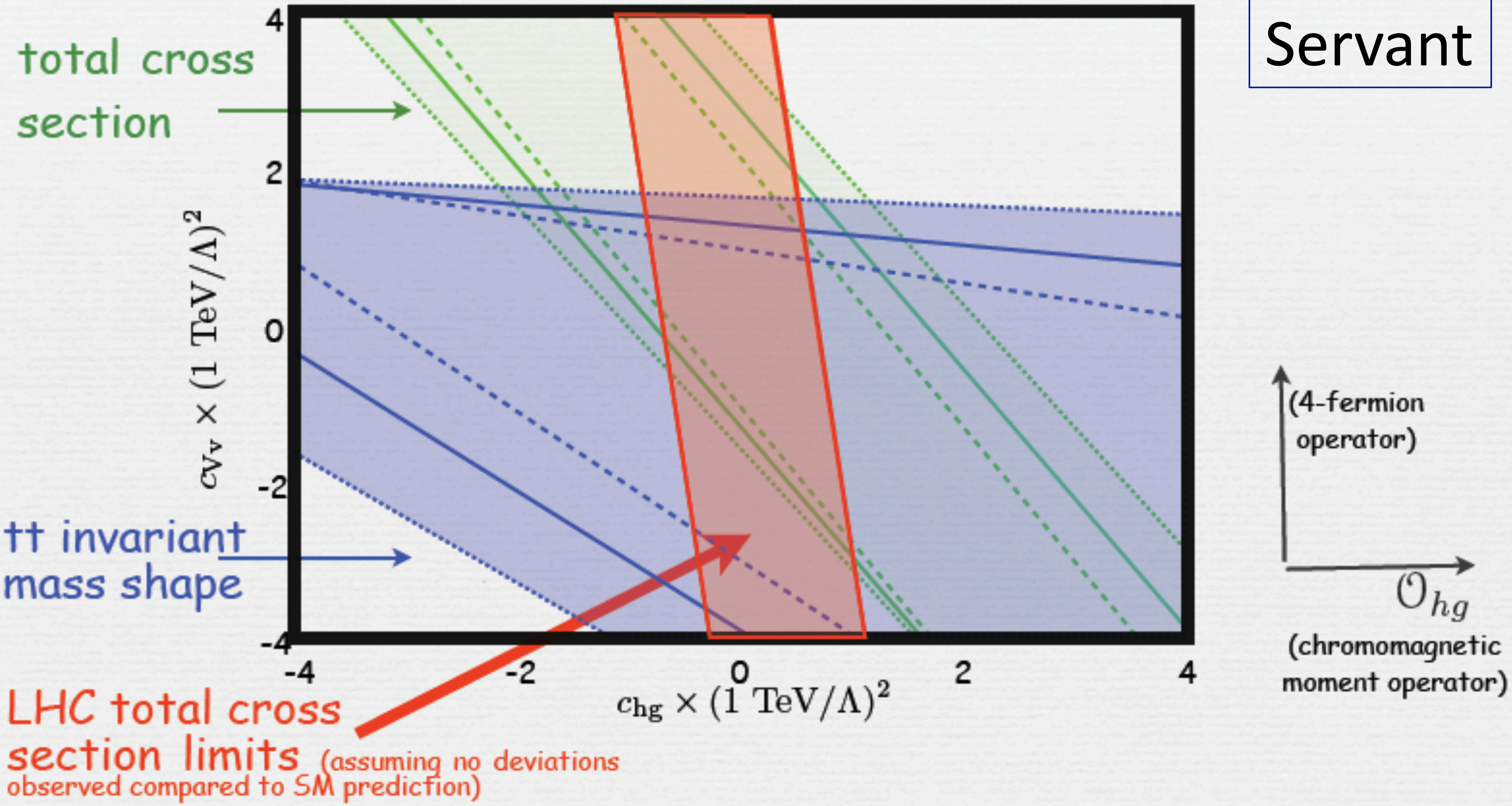


Beyond the observation of a bump

- Comprehensive study of the couplings
- Effective lagrangian approach

The LHC - Tevatron complementarity

- The Tevatron cross section depends on both c_{hg} and c_{Vv} and constrains thus a combination of these parameters.
- At the LHC, the pp -> $t\bar{t}$ total cross section mostly depends on c_{hg} and can be directly used to constrain the allowed range for c_{hg}



Servant

Summary

Non-resonant top philic new physics can be probed using measurements in top pair production at hadron colliders

This model-independent analysis can be performed in terms of 8 operators. Observables depend on different combinations of only 4 parameters:

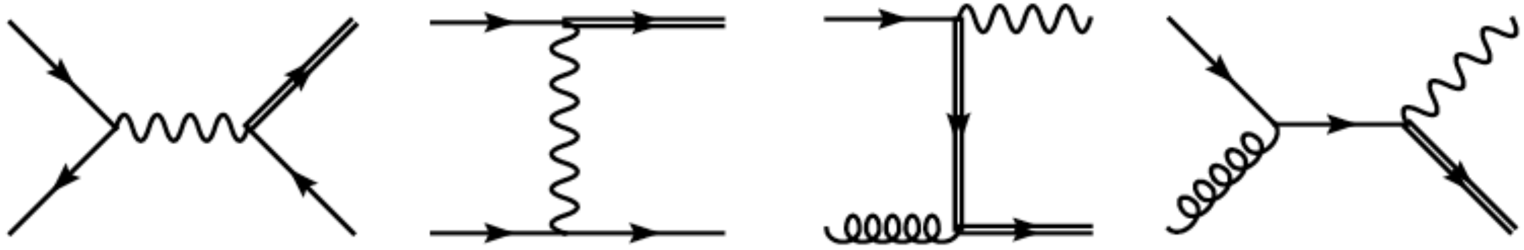
Servant

$\sigma(gg \to t\bar{t}), d\sigma(gg \to t\bar{t})/dt$	$\leftrightarrow$	c_{hg}
$\sigma(q\bar{q} \to t\bar{t})$	$\leftrightarrow$	c_{hg}, c_{Vv}
$d\sigma(q\bar{q} \to t\bar{t})/dm_{tt}$	$\leftrightarrow$	c_{hg}, c_{Vv}
A_{FB}	$\leftrightarrow$	c_{Aa}
spin correlations	$\leftrightarrow$	c_{hg}, c_{Vv}, c_{Av}

Single top

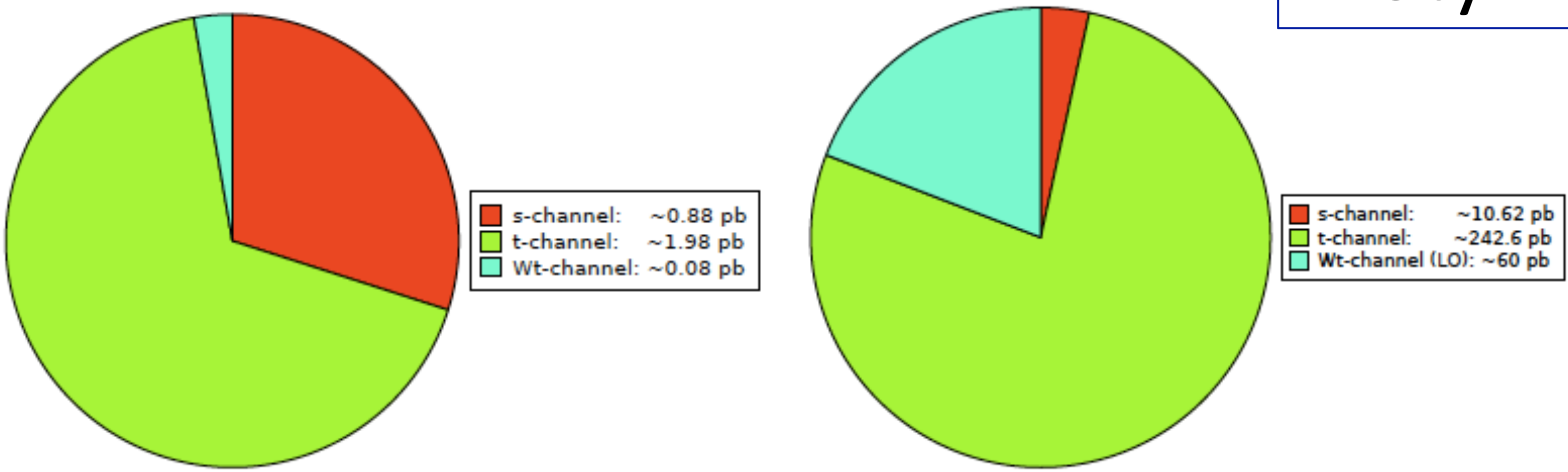
- Legacy from the Tevatron (s channel)
- Quickly in business for the LHC

In the Standard Model there are overall 3 production modes in single top production. Those are depicted here by the corresponding LO diagrams:



(1) (2) (3)

Motylinski



Single top cross section. Tevatron (left) and LHC (right).

Motylinski

The approx. NNLO results yield sizable corrections to the NLO results for the s–channle and the Wt–production:

$(\sigma = \sigma \pm \Delta\mu \pm \Delta PDF)$

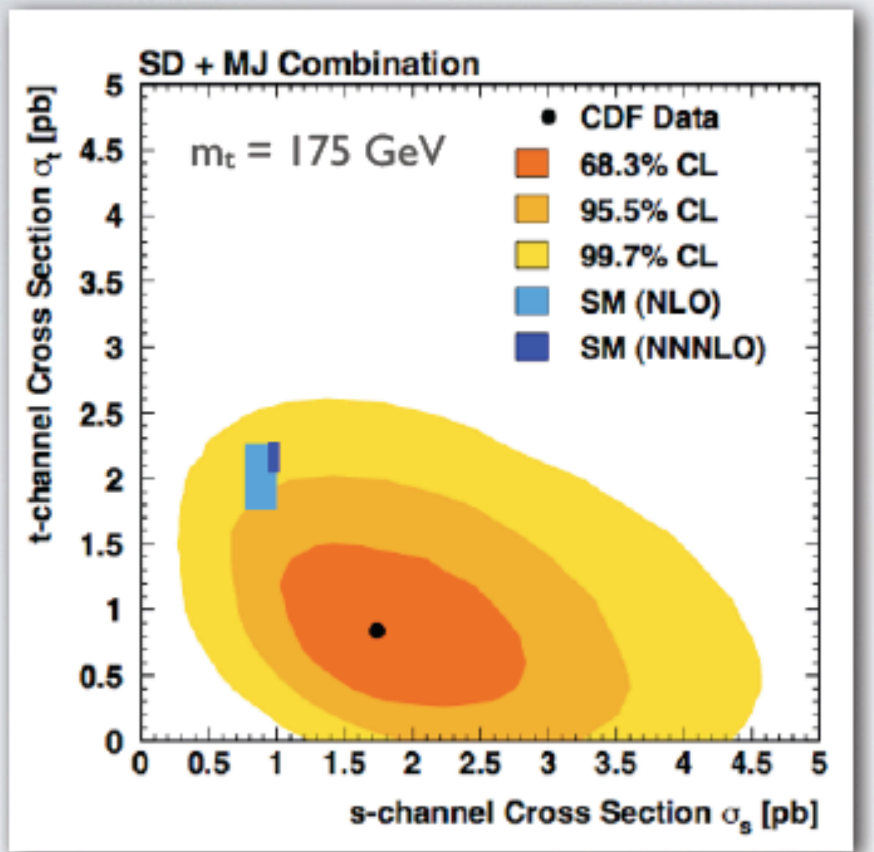
σ (pb)	Tevatron	LHC (7 TeV)	LHC (14 TeV)
s–channel	$0.523^{+0.001+0.03}_{-0.005-0.028}$ (+15%)	$3.17 \pm 0.06^{+0.13}_{-0.10}$ (+13%)	$7.93 \pm 0.14^{+0.31}_{-0.28}$ (+13%)
t–channel	$1.04^{+0.00}_{-0.02} \pm 0.06$ (+4%)	$41.7^{+1.6}_{-0.2} \pm 0.8$(−3%)	$151^{+4}_{-1} \pm 3$ (−3%)
Wt–prod.	omitted	$7.8 \pm 0.2^{+0.5}_{-0.6}$ (+8%)	$41.8 \pm 1.0^{+1.5}_{-2.4}$ (+8%)

Numbers in blue: The enhancement wrt. fixed order NLO cross section.

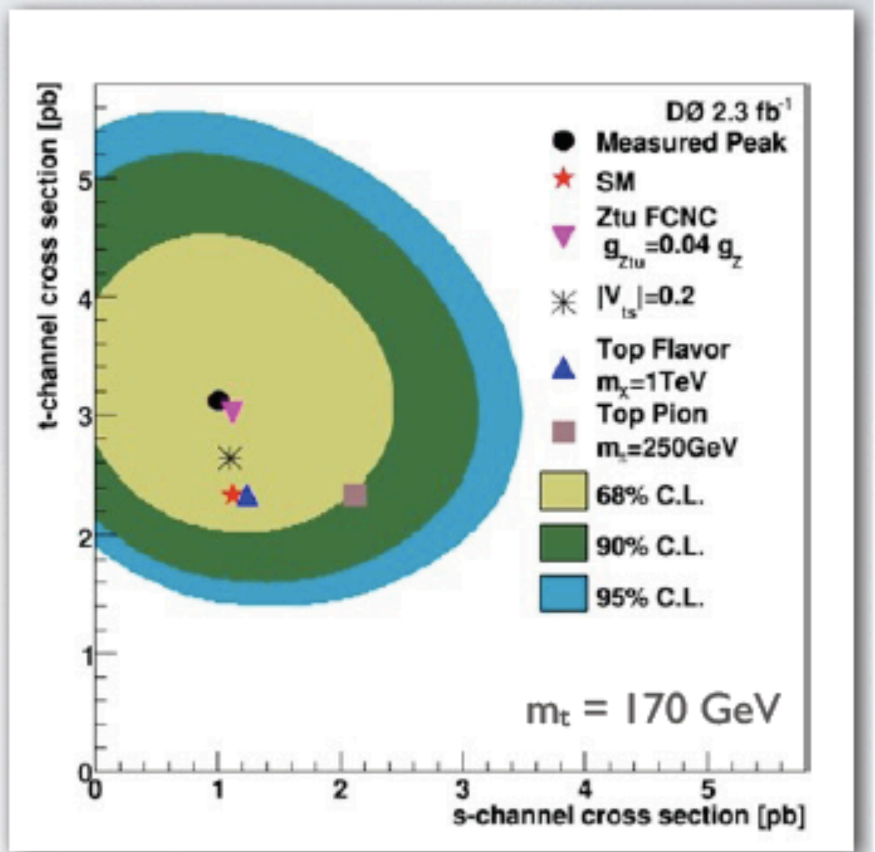
2D measurements (2010)

Gerber

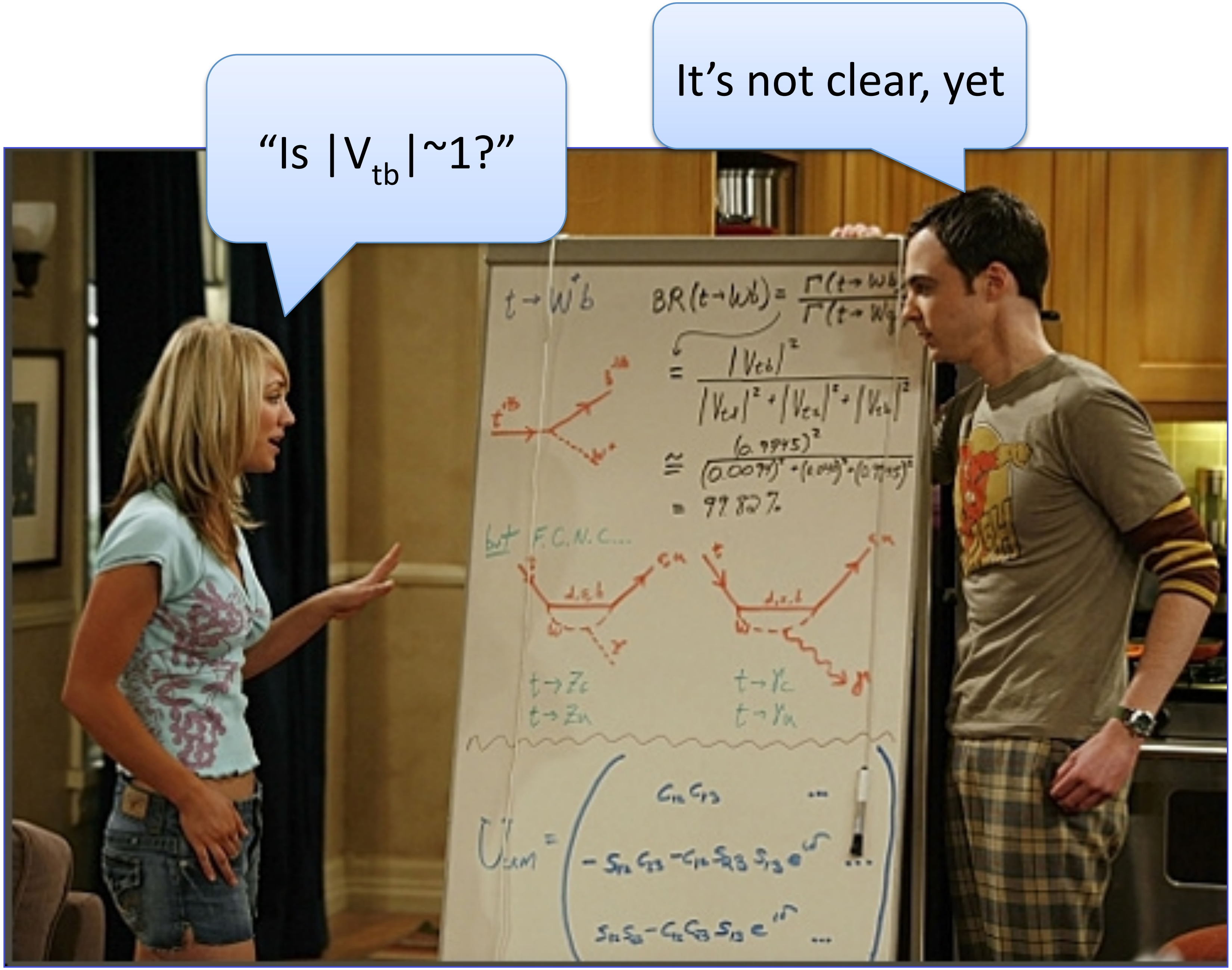
Phys. Rev. D82, 112005 (2010)



PLB 682, 363 (2010)



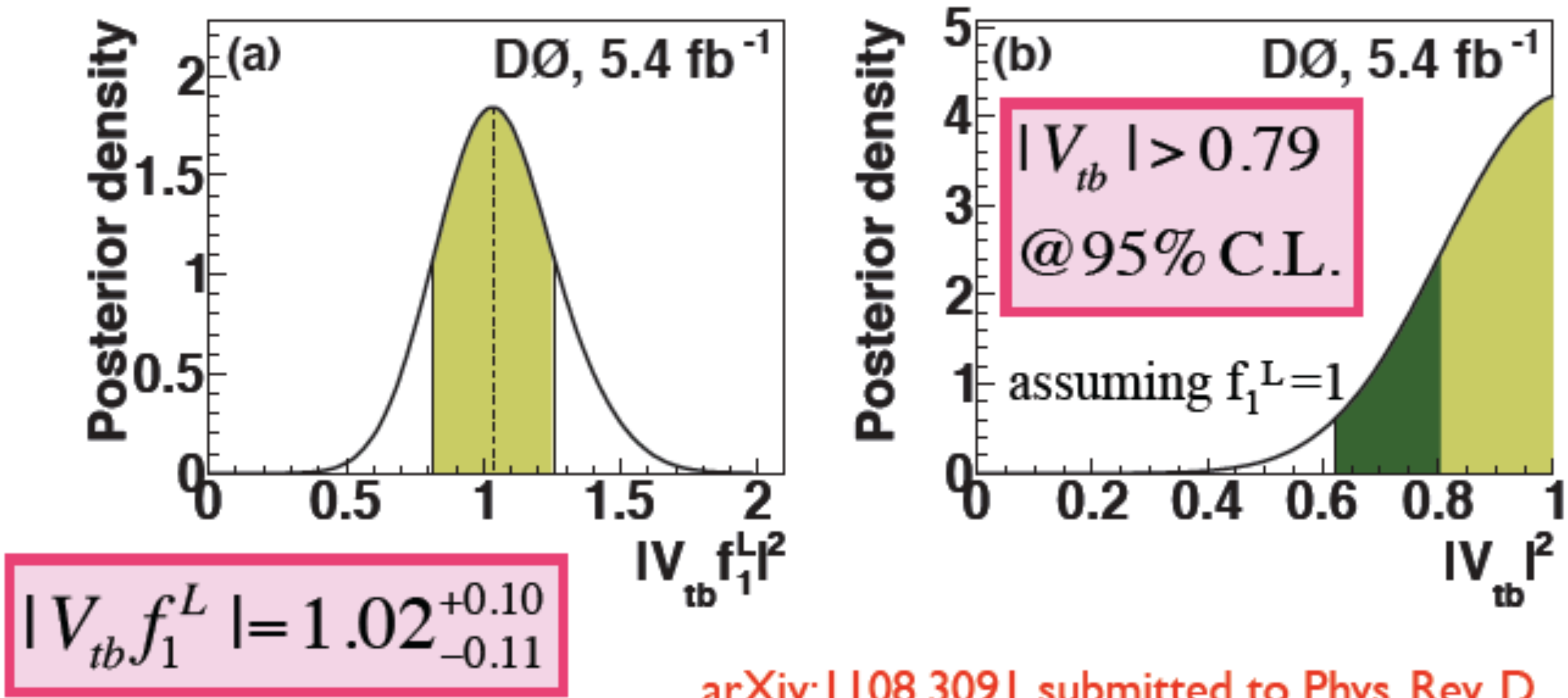
- Simultaneous measurements of s- and t-channel cross sections.
- No standard model cross section is assumed for either of the signals.


"Is $|V_{tb}|$~1?"
It's not clear, yet
t→W⁺b
but F.C.N.C...
t→Zc
t→Zu
t→γc
t→γu

Measurement of $|V_{tb}|$

Gerber

- Use the measurement of the tb+tqb cross section to make a direct measurement of $|V_{tb}|$:
  - Calculate a posterior in $|V_{tb}|^2$ $\quad \sigma(tb, tqb) \propto |V_{tb}|^2$
  - Measure the strength of the V–A

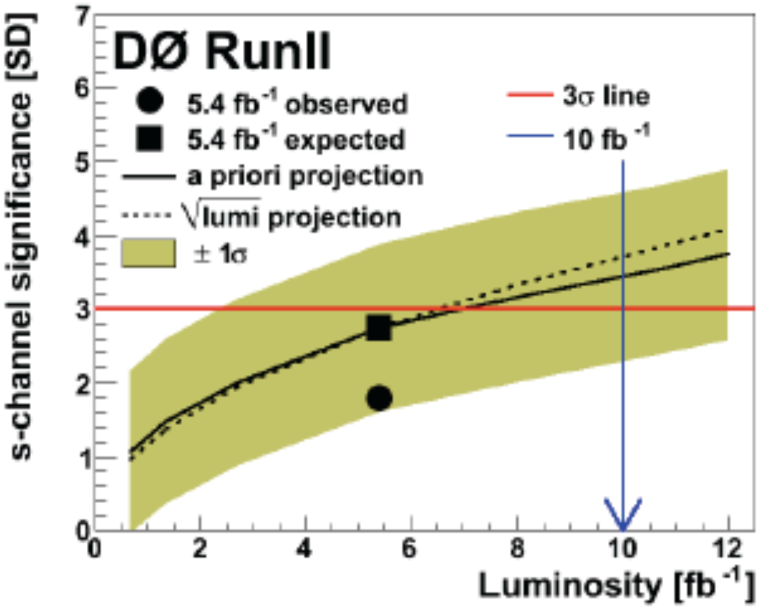


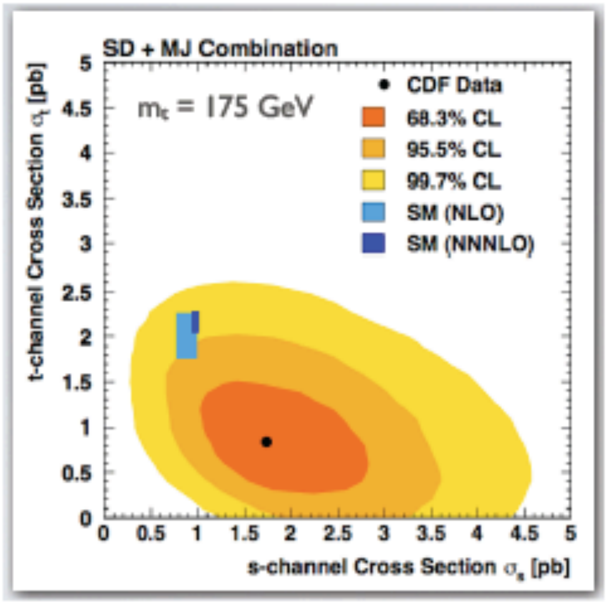
arXiv:1108.3091 submitted to Phys. Rev. D

Conclusions and Plans

Gerber

- Vibrant Single Top Program after 2009 observation
- With half the available luminosity analyzed:
  - New cross section measurements with precision of ~20%
  - Observation of t-channel production
  - Measurements and limits on Vtb
    - No departures from the SM observed
- Going after s-channel with full dataset



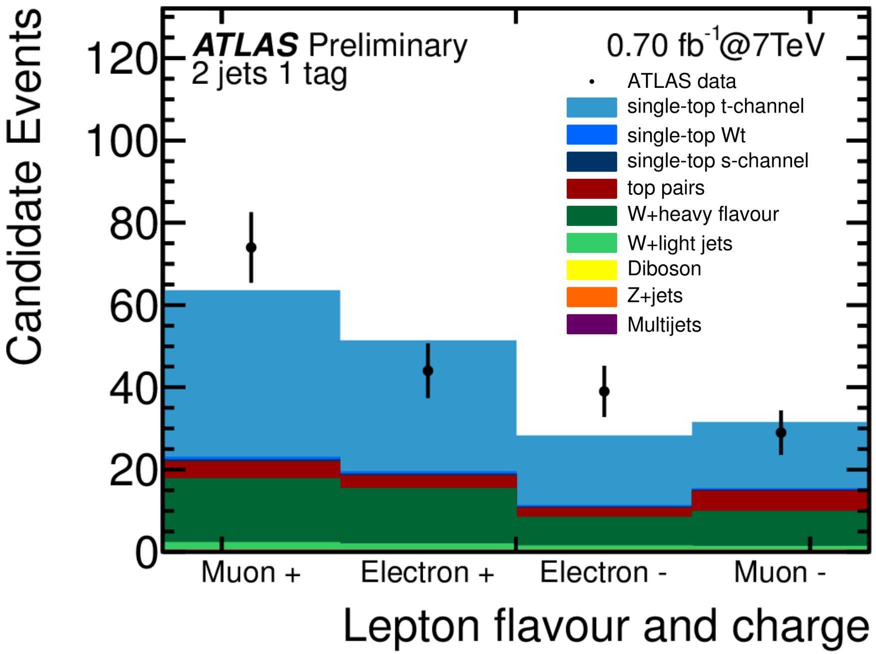


Cut-based analysis at ATLAS

Cut	Value
H_T	> 210 GeV
$M_{l\nu b}$	> 150 GeV & < 190 GeV
$\|\eta(\text{light jet})\|$	> 2.0
$\|\Delta\eta(j_1,j_2)\|$	> 1

- Cuts are optimized including systematics
  ➔ strong reduction of jet energy scale uncertainty
- Counting experiment
- Uses 2 and 3-jet channels
- Separation in channels lepton charge and flavor
  ➔ optimize statistical power
- Statistical method: profile likelihood fit

Wagner



measured cross section:

σ (t-ch) = 90 ± 9 (stat.) $^{+31}_{-20}$ (syst.) pb

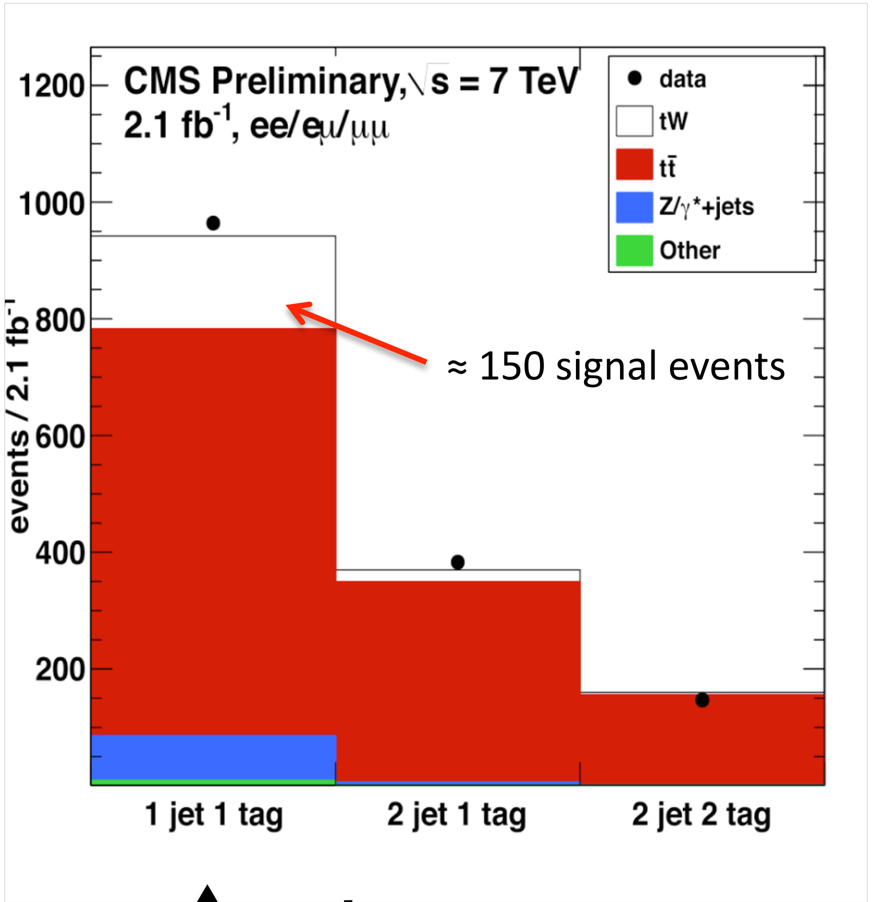
Observed significance 7.6 σ
(expected: 5.4σ)

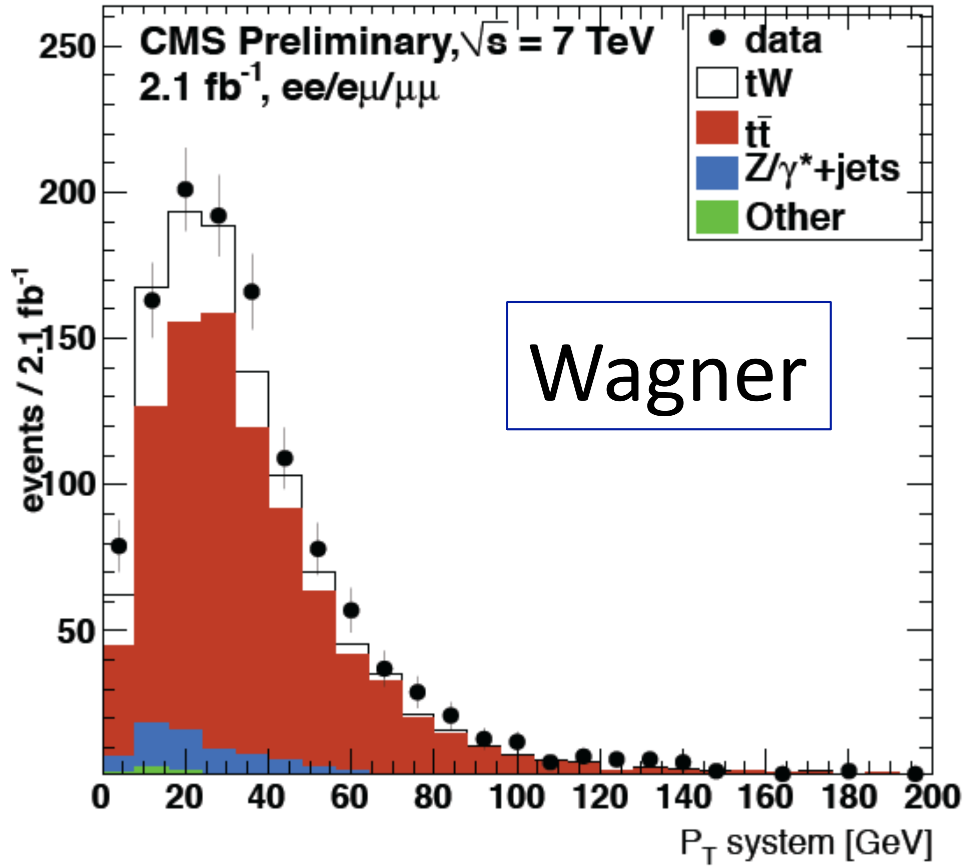
SM: σ_t = 64.2 ± 2.6 pb

Dominating syst. uncertainties:

- B-tagging: +18 / -13%
- ISR / FSR: ± 14%

Top-antitop background and kinematic modeling





signal region

top-antitop sideband region
➔ simultaneous fit

(similar technique in ATLAS)

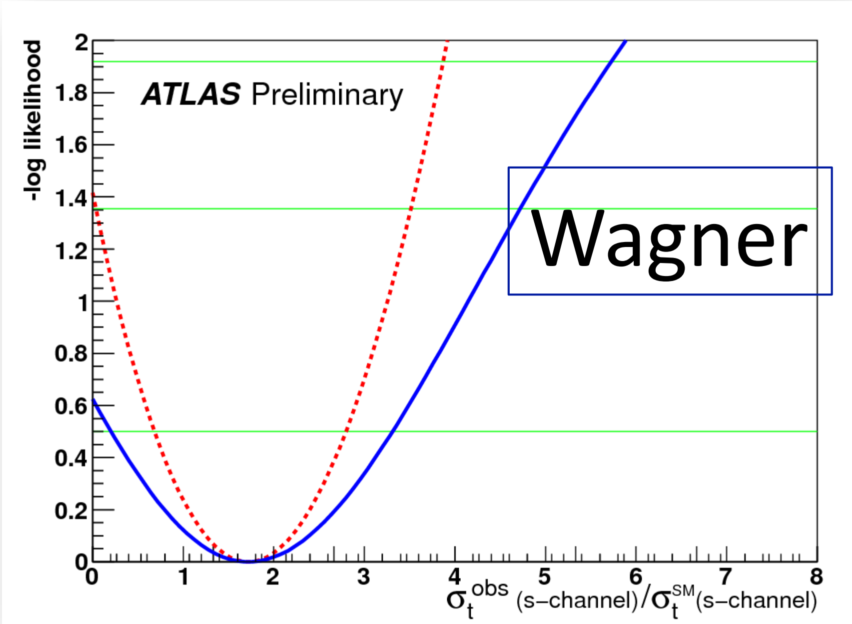
Good agreement with expected jet multiplicity distribution and kinematic distributions.

Limit on s-channel production

Event yield after final selection:

	Final Selection
s-channel	16 ± 6
t-channel	33 ± 13
Wt	5 ± 3
$t\bar{t}$	111 ± 47
W+jets	4 ± 5
Wc+jets	10 ± 8
$Wc\bar{c}$+jets	14 ± 12
$Wb\bar{b}$+jets	70 ± 51
Z+jets	1 ± 1
Diboson	4 ± 1
Multijets	17 ± 10
TOTAL Exp	285 ± 17
$S/\sqrt{B}$	0.98
DATA	296

Statistical analysis: Profile likelihood



Observed limit @ the 95% C.L.:

$\sigma_{\text{s-channel}}$ < 26.5 pb

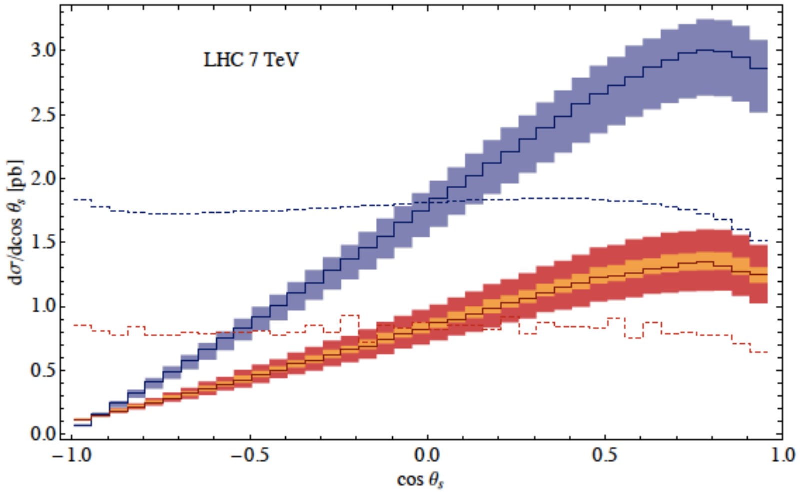
SM: σ_s = 4.6 pb

Polarization and spin correlations

- We already see the polarization from single top !
- First evidence of spin correlations at Tevatron and LHC

Parke

single top: $\cos(\vec{p}^{\,*}_{\rm spec}, \vec{p}^{\,*}_{\ell})$

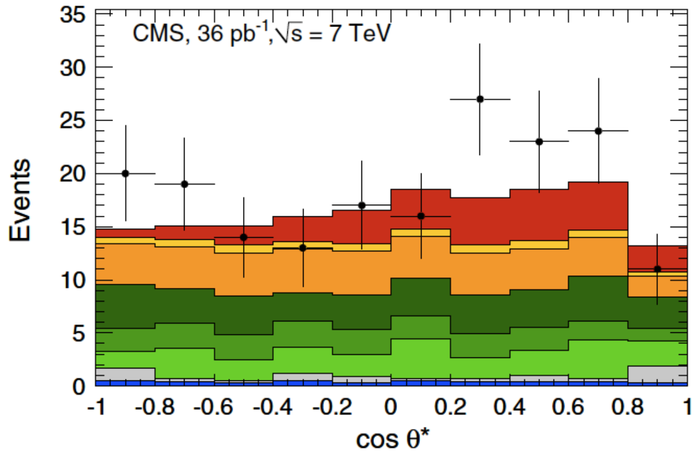


LO

NLO

[Falgari et.al: arXiv:1102.5267]

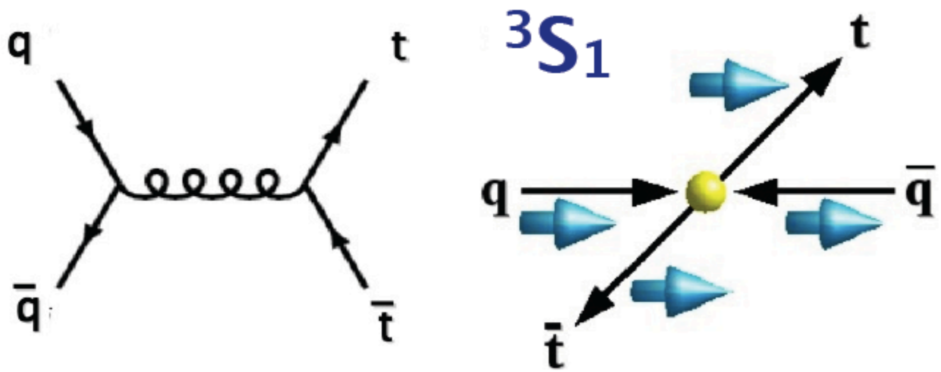
wish list would include $\frac{1}{\sigma_T}\frac{d\sigma}{d\cos\theta_S}$: removes



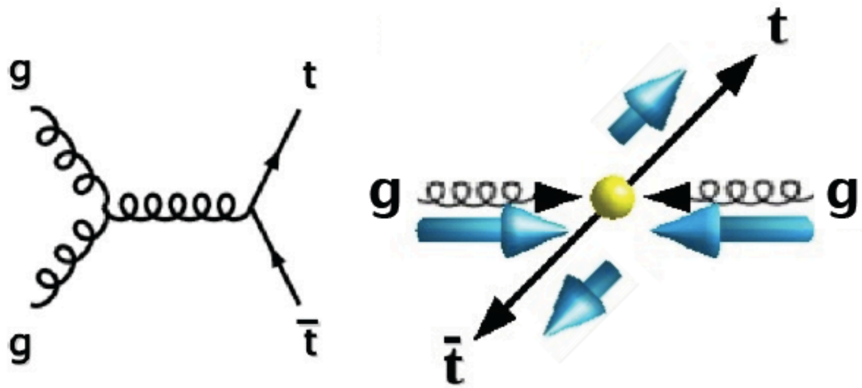
Spin correlation strength

Schwanenberger

$$A = \frac{N_{\uparrow\uparrow} + N_{\downarrow\downarrow} - N_{\uparrow\downarrow} - N_{\downarrow\uparrow}}{N_{\uparrow\uparrow} + N_{\downarrow\downarrow} + N_{\uparrow\downarrow} + N_{\downarrow\uparrow}}$$



Tevatron



LHC

Tevatron

- dominated by $q\bar{q}$ annihilation
- $t\bar{t}$ pairs close to the threshold
- beam axis as spin quantisation axis
  NLO QCD: A = 0.78
- optimised "off−diagonal" basis

LHC

- dominated by gg fusion
- $t\bar{t}$ pairs far off the threshold
- helicity basis as spin quantisation axis
  NLO QCD: A = 0.32
- maximal basis

Bernreuther, Brandenburg, Si, Uwer, Nucl. Phys. B690, 81 (2004)

complementary between Tevatron and LHC

Schwanenberger

- first measurement of spin correlation between top and anti-top quark in dilepton final states at the LHC
- azimuthal angle between charged leptons in laboratory frame

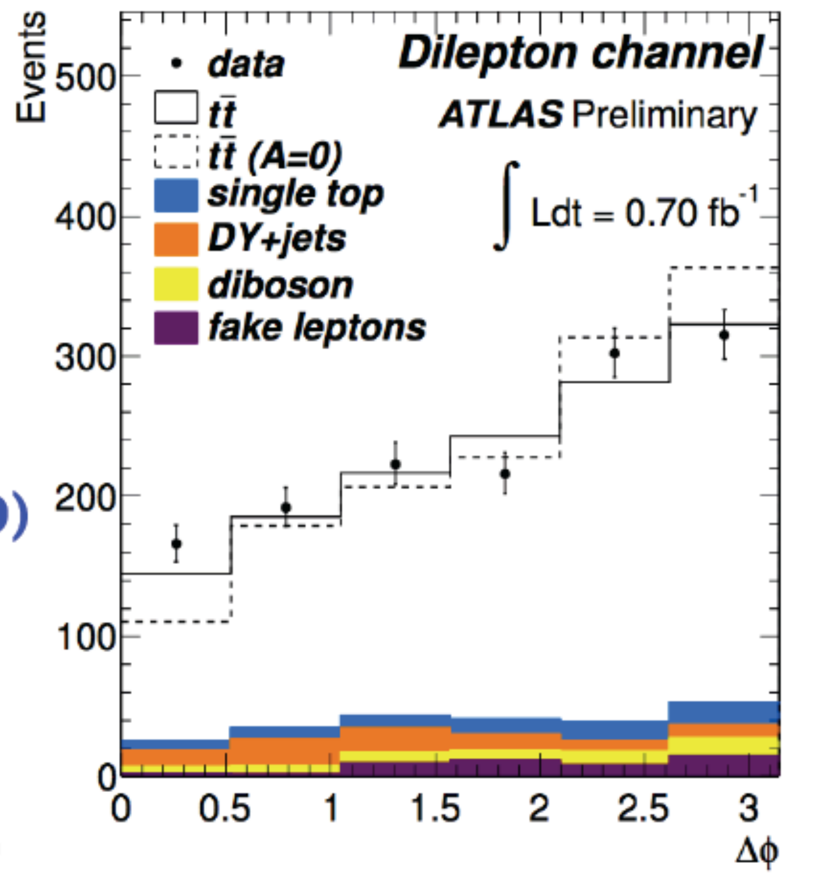
$f^{SM} = 1.06\,^{+0.46}_{-0.34}$ (=1 in NLO QCD)

$A_{helicity} = 0.34\,^{+0.15}_{-0.11}$ (=0.32 in NLO QCD)

comparison with Tevatron:

see talk by Alexander Grohsjean

ATLAS-CONF-2011-117



→ correlation agrees with SM spin 1/2 hypothesis

→ exclude no spin correlation hypothesis ~3σ

W helicity in top decay

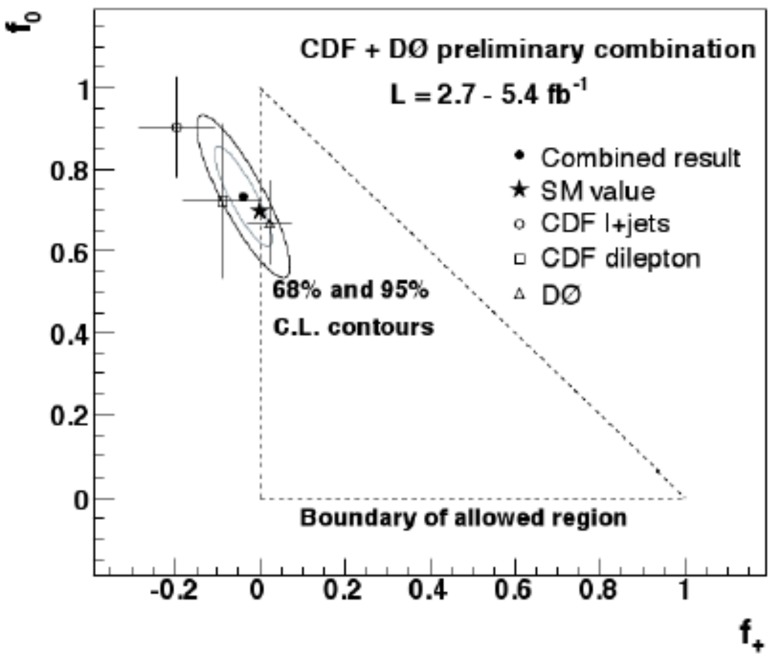
And the Wtb vertex

W helicity measurement - Tevatron combination

Deterre

- Combine the previous measurements using the best linear unbiased estimator (BLUE) (D0 conf note 6231, CDF conf note 10622).

Measurement	s.d. from combined values	Weight for f_0 (%)	Weight for f_+ (%)
CDF ljets f0	1.85	45.2	−15.6
D0 ll+ljets f0	−1.04	49.6	4.7
CDF ll f0	−0.06	5.2	10.9
CDF ljets f+	−2.00	28.9	−3.8
D0 ll+ljets f+	2.17	−13.2	67.8
CDF ll f+	−0.59	−15.8	36.0



Combination result

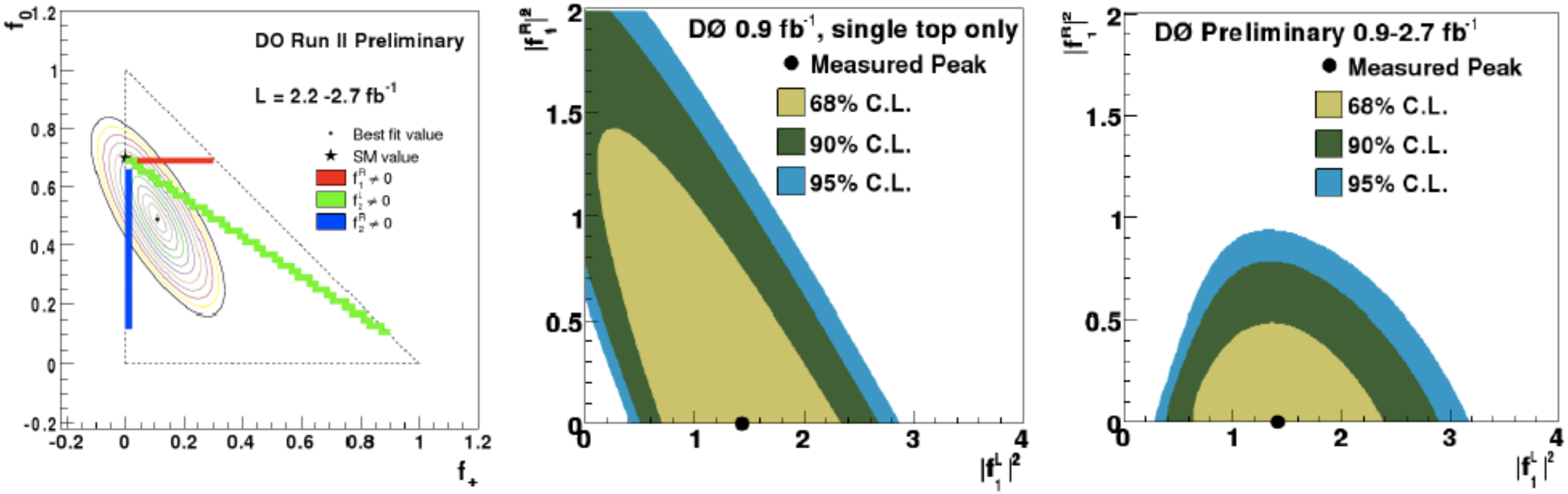
$f_0 = 0.732 \pm 0.063(\text{stat}) \pm 0.052(\text{syst})$

$f_+ = -0.039 \pm 0.034(\text{stat}) \pm 0.030(\text{syst})$

Constraints on anomalous couplings from both W helicity and single-top

Deterre

- W helicity measurement provides constraints on the ratios of the different couplings.
- Last combined limits from D0 with $2.7 fb^{-1}$



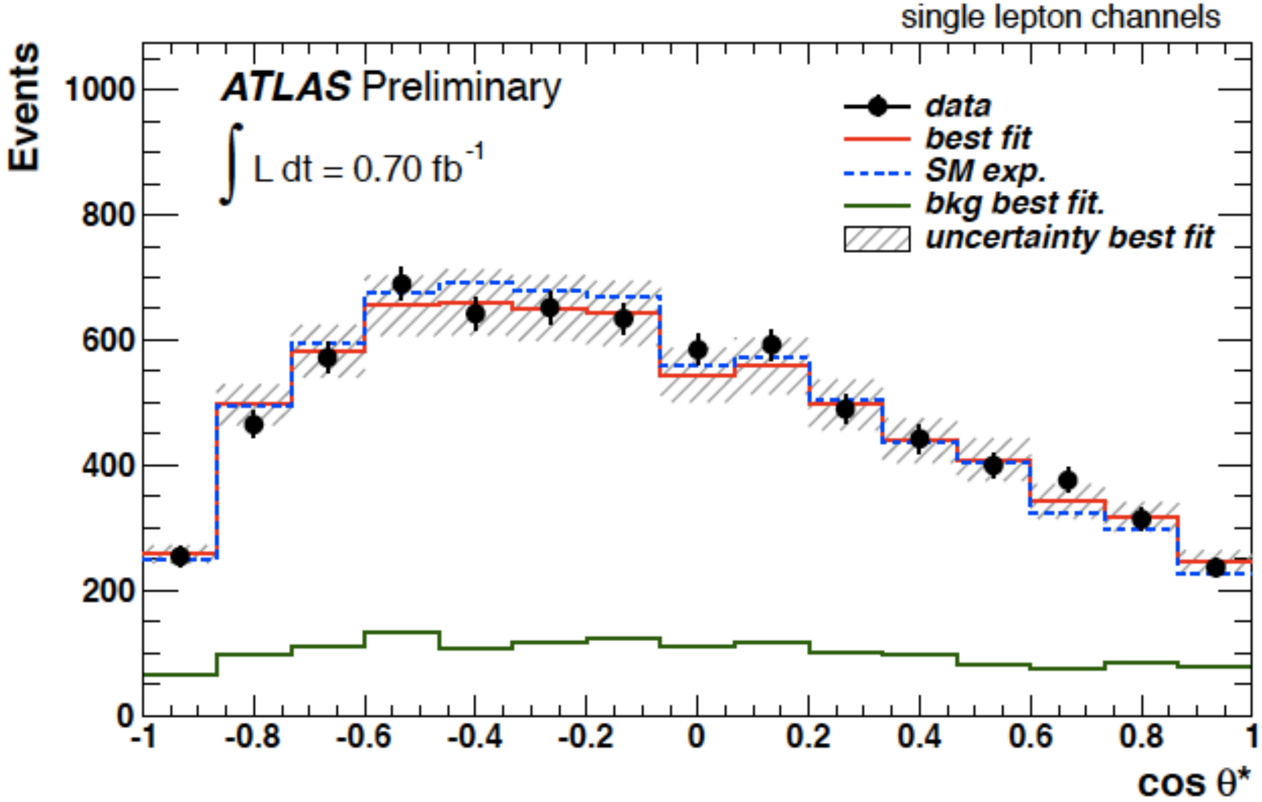
Results - $2.7 fb^{-1}$ (D0 conf note 5838)

Scenario	(L_V, L_T)	(L_V, R_V)	(L_V, R_T)
Limit on $\lvert V_{tb} f_X \rvert^2$	< 0.19	< 0.72	< 0.20

Measuring the W helicity fractions using templates

Castro

- Single lepton channels:

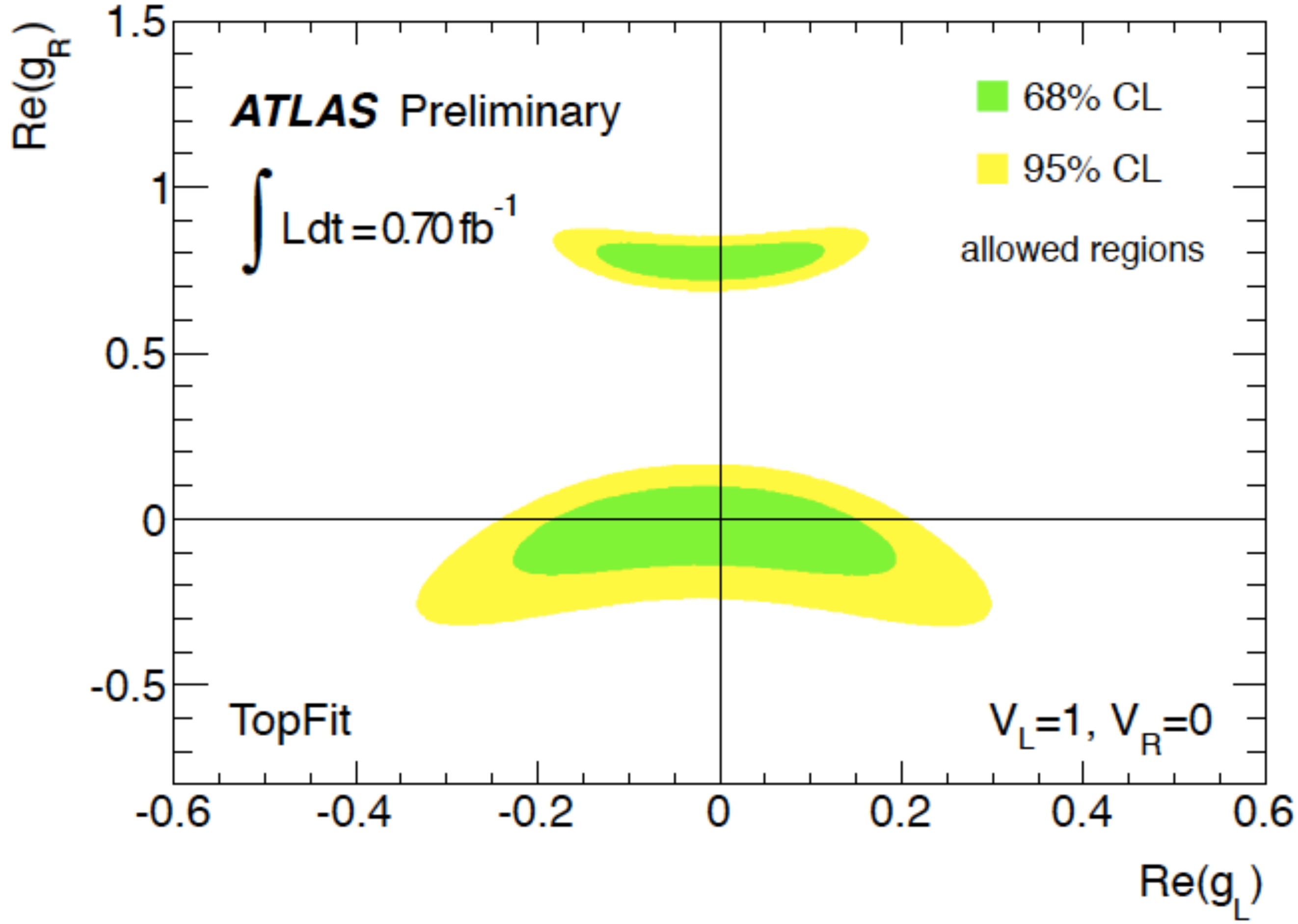


$$F_0 = 0.57 \pm 0.07\,(\mathrm{stat.}) \pm 0.09\,(\mathrm{syst.})$$
$$F_\mathrm{L} = 0.35 \pm 0.04\,(\mathrm{stat.}) \pm 0.04\,(\mathrm{syst.})$$
$$F_\mathrm{R} = 0.09 \pm 0.04\,(\mathrm{stat.}) \pm 0.08\,(\mathrm{syst.})$$

Constraints on *Wtb* vertex

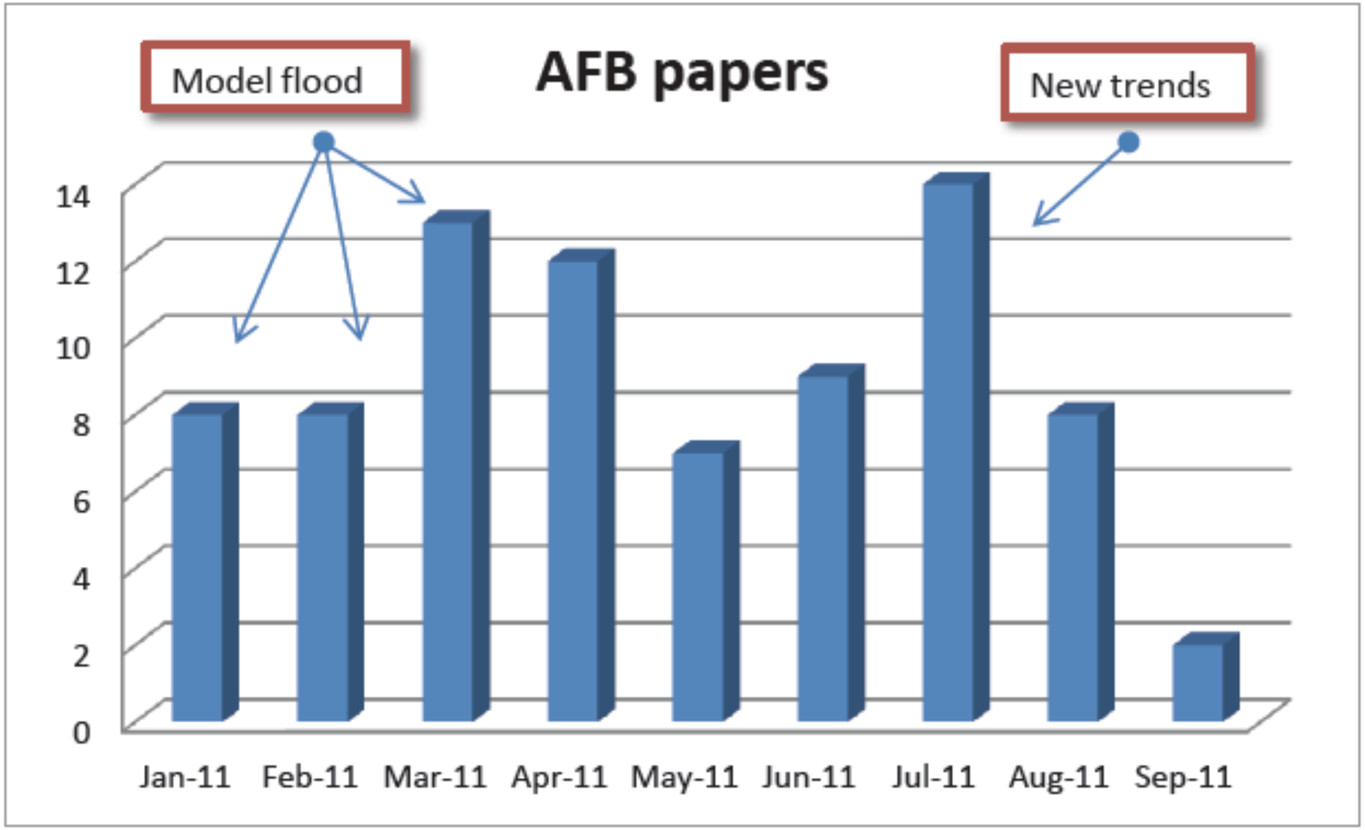
- Considering the dependence of the angular asymmetries with the anomalous couplings, constraints on the *Wtb* anomalous couplings can be set:

Castro

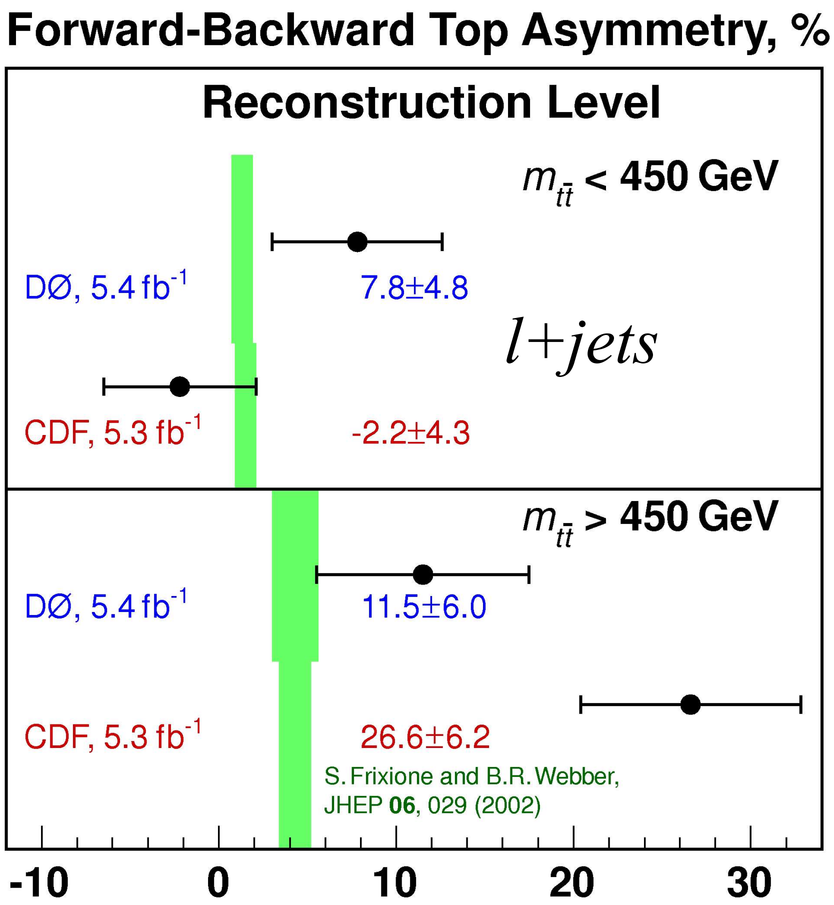


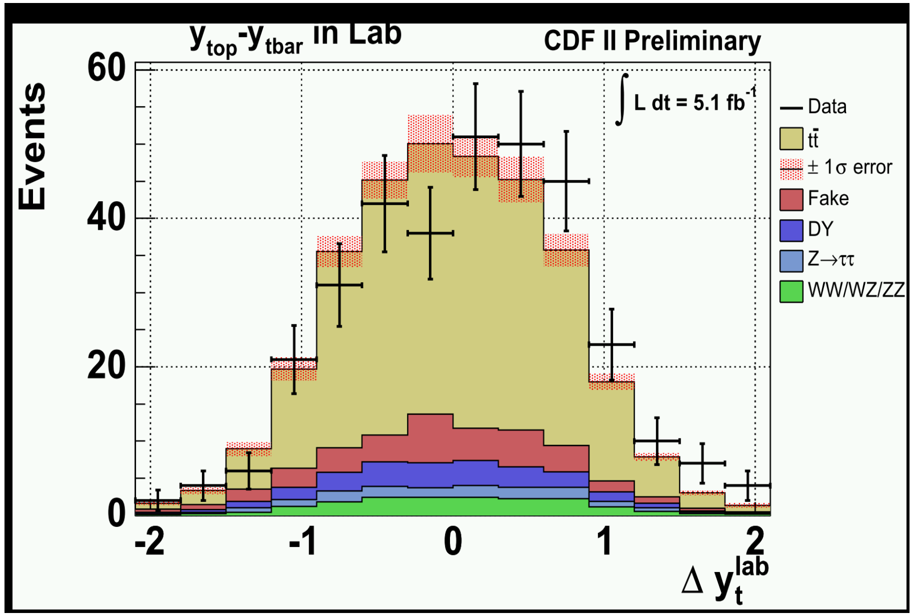
$[\ \rho(A_+, A_-) = 0.12\ ]$

The forward backward asymmetry



A_{FB} at the Tevatron





dileptons

$$A_{FB} = (42 \pm 15\,(\text{stat}) \pm 4\,(\text{syst}))\,\%$$

Important to understand radiation effects and top pair pt modeling

Final Results

Charge Asymmetry at the LHC

Peiffer

ATLAS:

- e+jets: $A_C^y = -0.009 \pm 0.023\,(stat.) \pm 0.032\,(syst.)$
- μ+jets: $A_C^y = -0.028 \pm 0.019\,(stat.) \pm 0.022\,(syst.)$

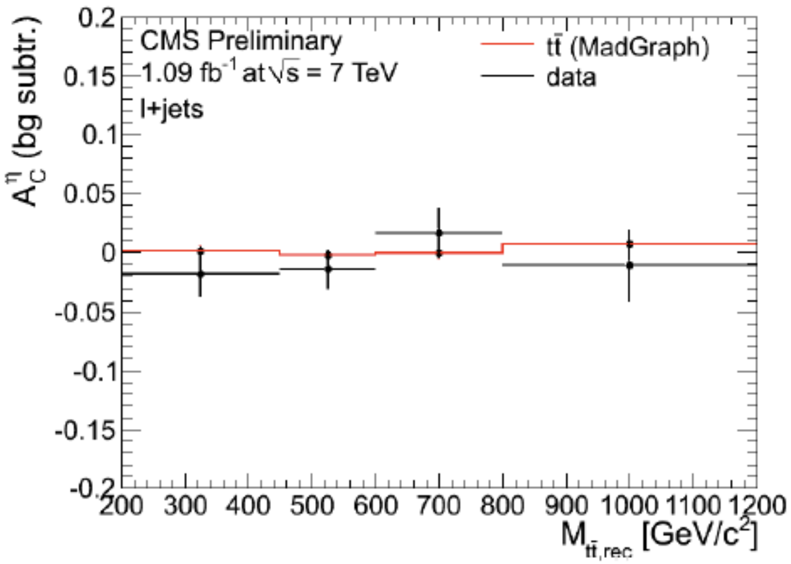
- Combined using BLUE method:

$$A_C^y = -0.024 \pm 0.016\,(stat.) \pm 0.023\,(syst.)$$

CMS:

$$A_C^\eta = -0.016 \pm 0.030\,(stat.)^{+0.010}_{-0.019}\,(syst.)$$

$$A_C^y = -0.013 \pm 0.026\,(stat.)^{+0.026}_{-0.021}\,(syst.)$$

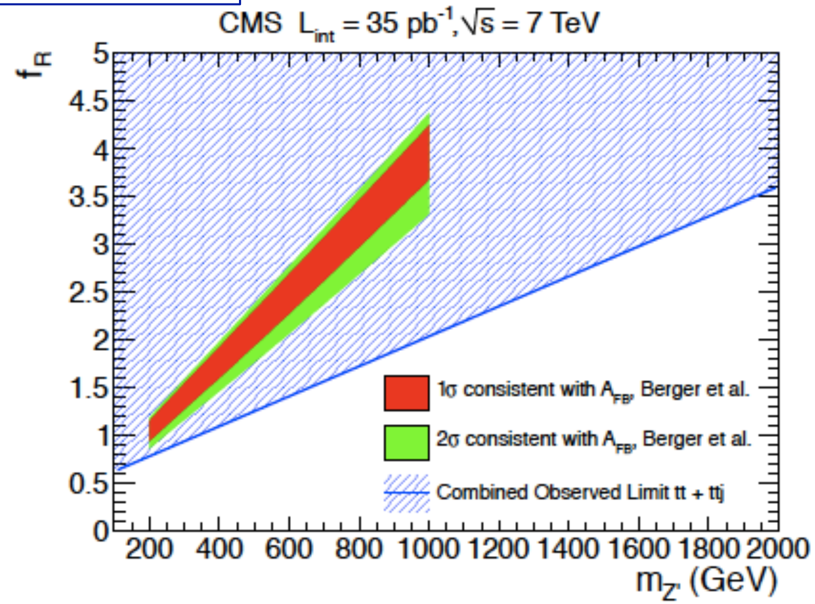


No smoke, no gun: no like-sign tops

Aguilar Saavedra

Blekman

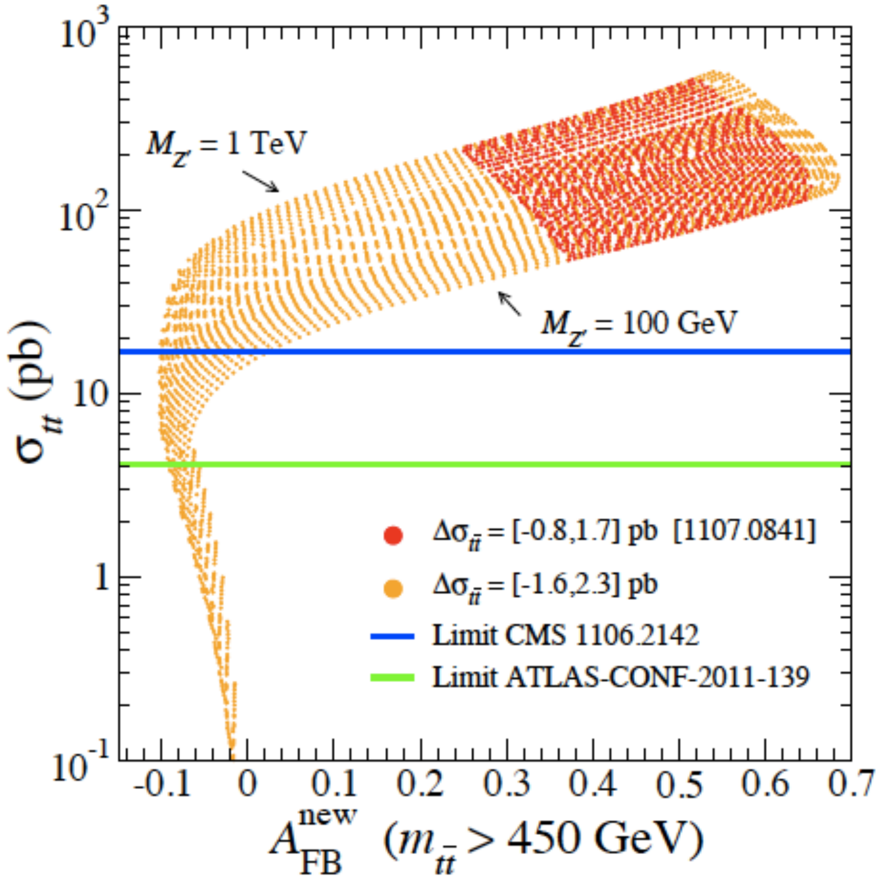
CMS plot 1106.2142



Excludes model parameter region consistent with $\sigma = 7.50 \pm 0.48$ pb, high-mass $A_{FB} = 0.475 \pm 0.114$

What if A_{FB} not so large? (D0)

General exclusion plot



Z' coupling from 0 to $\Delta\sigma = 2.3$ pb

$A_{FB}^{new} > 0$ excluded by ATLAS

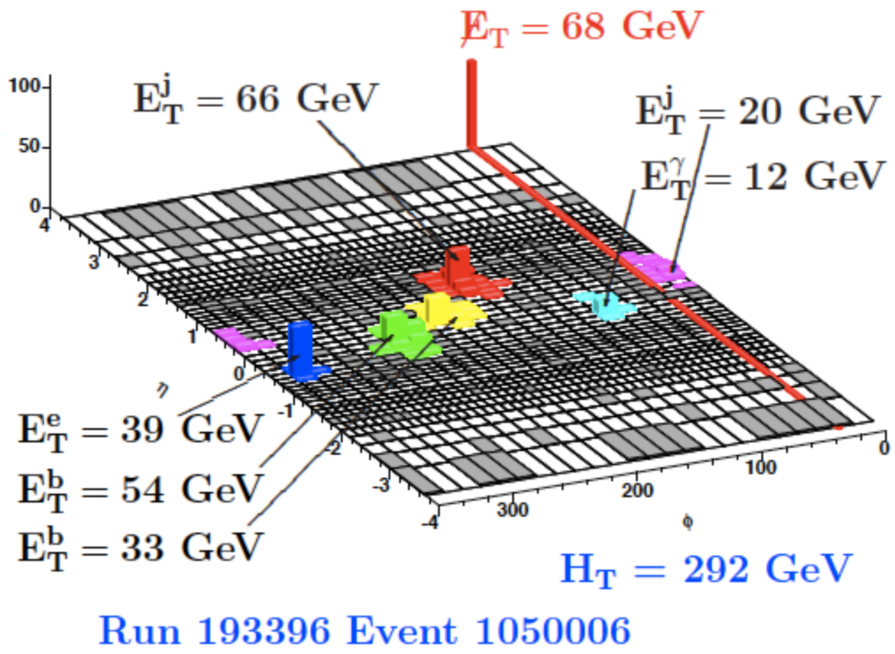
Rare processes

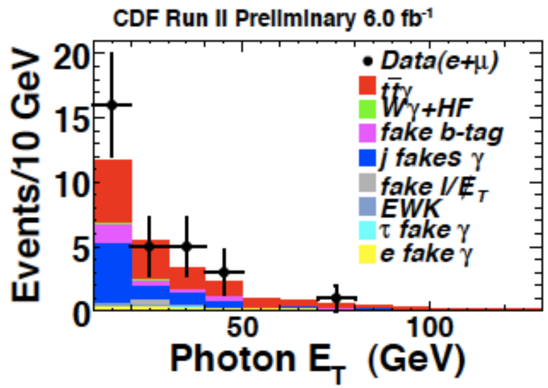
Some are standard, some are less …

Photon Radiation in Top Pair Events (2) CDF $6.0\,\mathrm{fb}^{-1}$

Wicke

A total of 30 candidate events observed





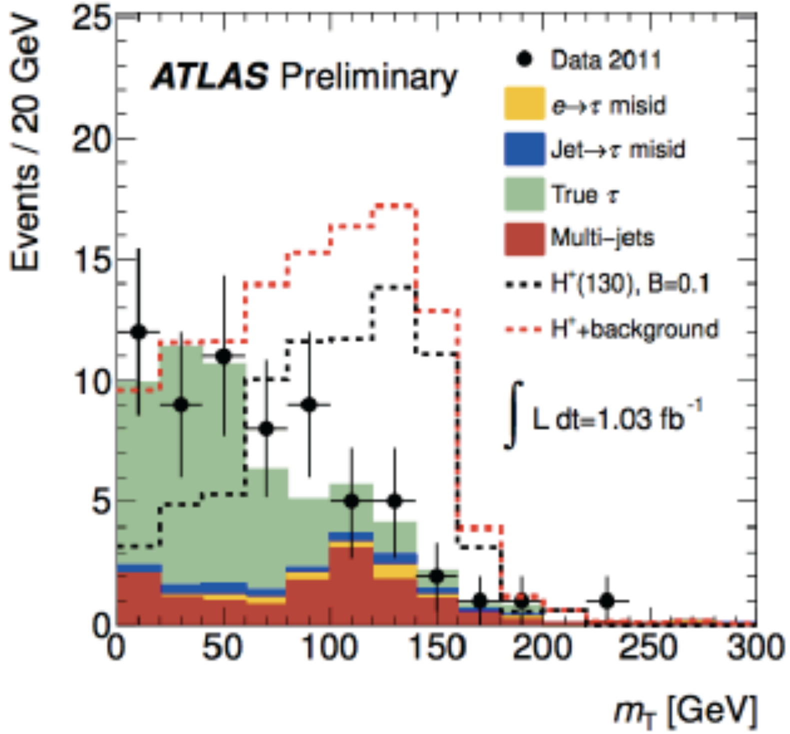
$\sigma_{t\bar{t}\gamma} = 0.18 \pm 0.08$pb SM: 0.17pb (NLO from Madgraph+K-faktor)

p-value: 0.0015 (3.0σ)

McCarn

Charged Higgs Search: $H^+ \rightarrow \tau\ \upsilon$

- The final discriminating variable of the analysis, used in the limit setting process, is **M_T(τ ,MET)**.
  - In the case of the SM background, this is related to the W boson mass
  - In the case of the BSM signal, this is related to the charged Higgs boson mass
- Background contributions in the M_T(τ ,MET) distribution are from data-driven methods



Events From:

	true τ jets	jet $\rightarrow \tau$ mis-id	$e \rightarrow \tau$ mis-id	multi-jet	expected (sum)	data
$m_T > 40$ GeV	21 ± 5	2.4 ± 0.7	1.9 ± 0.2	12 ± 5	37 ± 7	43

Top Quark FCNC - T→tZ

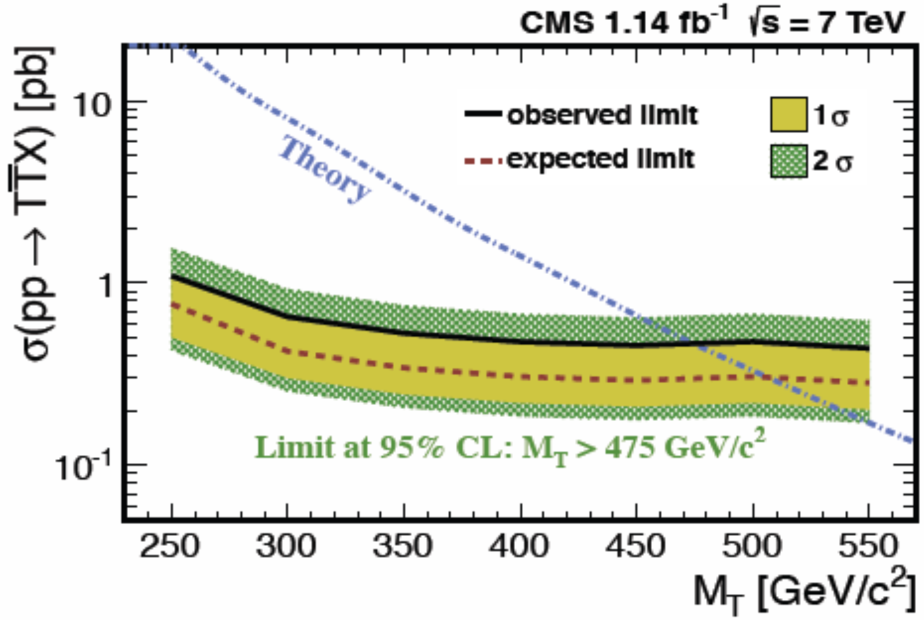
McCarn

- The results are consistent with contributions from SM processes.

arXiv:1109.4985

- The upper limit on the cross section is calculated using a Bayesian method with flat priors and a log-normal model for integration over the nuisance parameters.

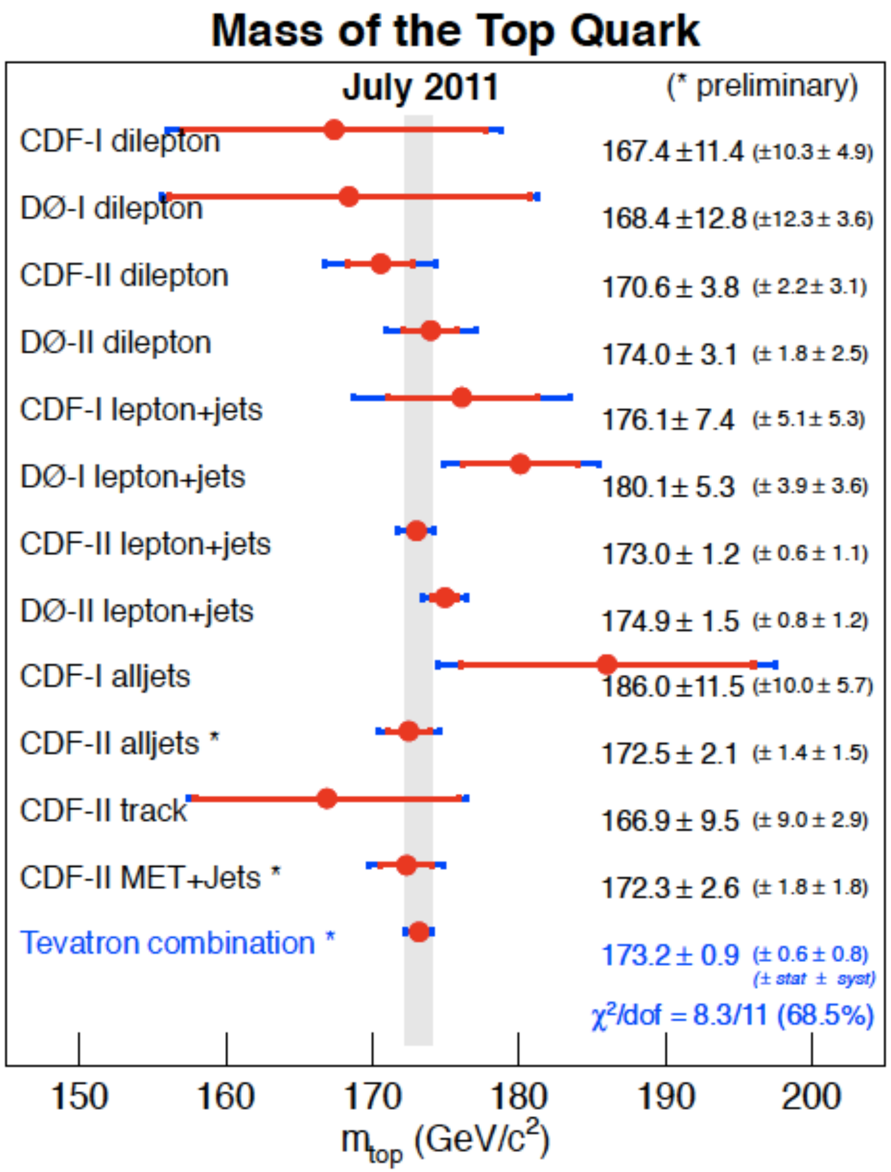
- Comparing the upper limit on the cross section with the NLO calculated cross sections with respect to T mass, a limit of $m_T >$ 475 GeV/c^2 is obtained.

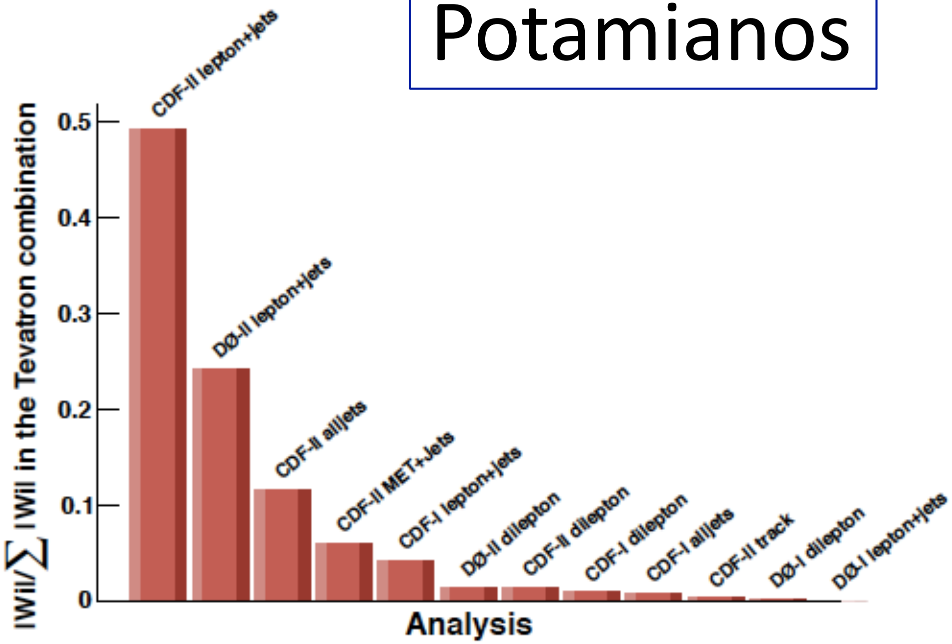


The Top mass

Impressive precision, but what next ?

Potamianos



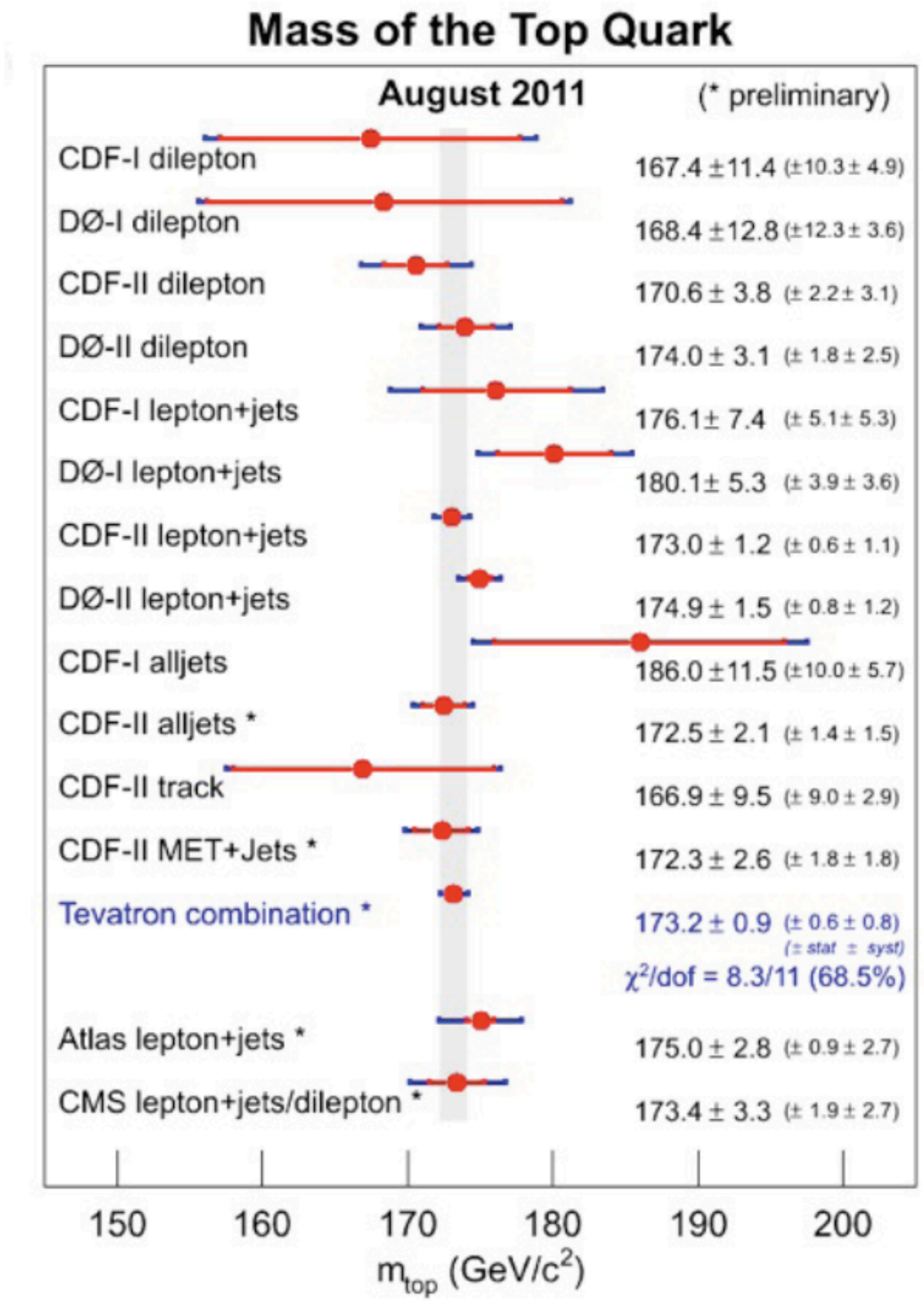


$$m_t = 173.2 \pm 0.6(\text{stat}) \pm 0.8(\text{syst})$$
$$= 173.2 \pm 0.9 \quad \text{GeV}/c^2$$

Combination of 12 measurements.

Uncertainty below 1 GeV/c^2 for the first time!

[arXiv:1107.5255v3 [hep-ex]]

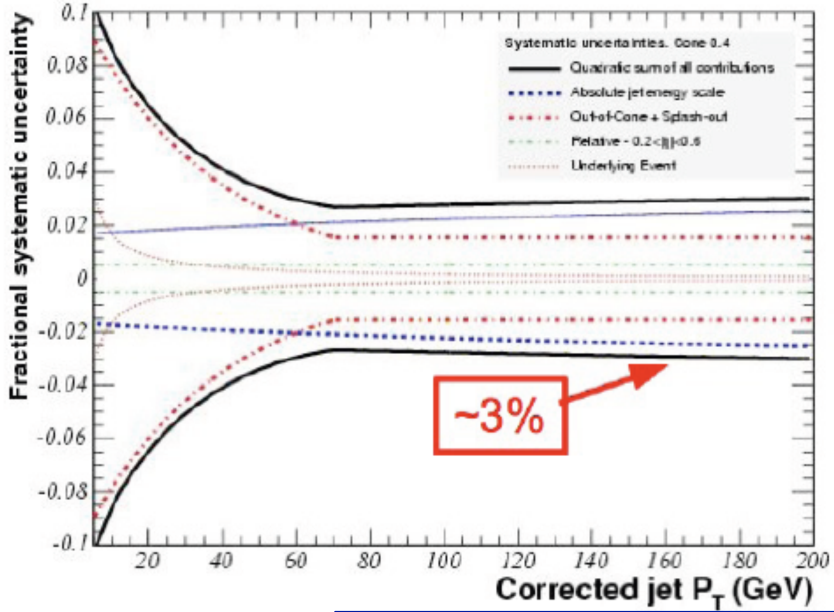


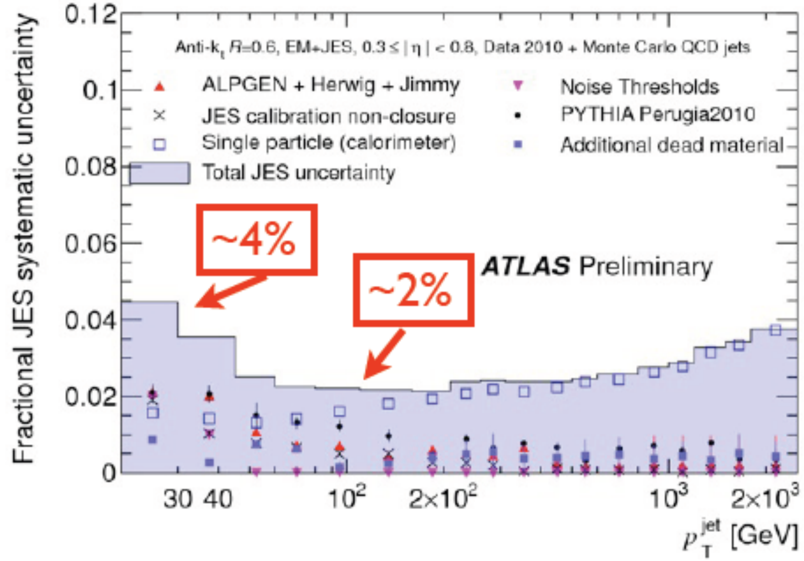
Mass of the Top Quark
August 2011
(* preliminary)
CDF-I dilepton
167.4 ±11.4 (±10.3 ± 4.9)
DØ-I dilepton
168.4 ±12.8 (±12.3 ± 3.6)
CDF-II dilepton
170.6 ± 3.8 (± 2.2 ± 3.1)
DØ-II dilepton
174.0 ± 3.1 (± 1.8 ± 2.5)
CDF-I lepton+jets
176.1 ± 7.4 (± 5.1 ± 5.3)
DØ-I lepton+jets
180.1 ± 5.3 (± 3.9 ± 3.6)
CDF-II lepton+jets
173.0 ± 1.2 (± 0.6 ± 1.1)
DØ-II lepton+jets
174.9 ± 1.5 (± 0.8 ± 1.2)
CDF-I alljets
186.0 ±11.5 (±10.0 ± 5.7)
CDF-II alljets *
172.5 ± 2.1 (± 1.4 ± 1.5)
CDF-II track
166.9 ± 9.5 (± 9.0 ± 2.9)
CDF-II MET+Jets *
172.3 ± 2.6 (± 1.8 ± 1.8)
Tevatron combination *
173.2 ± 0.9 (± 0.6 ± 0.8)
(± stat ± syst)
χ²/dof = 8.3/11 (68.5%)
Atlas lepton+jets *
175.0 ± 2.8 (± 0.9 ± 2.7)
CMS lepton+jets/dilepton *
173.4 ± 3.3 (± 1.9 ± 2.7)
150
160
170
180
190
200
m_top (GeV/c²)

Shabalina

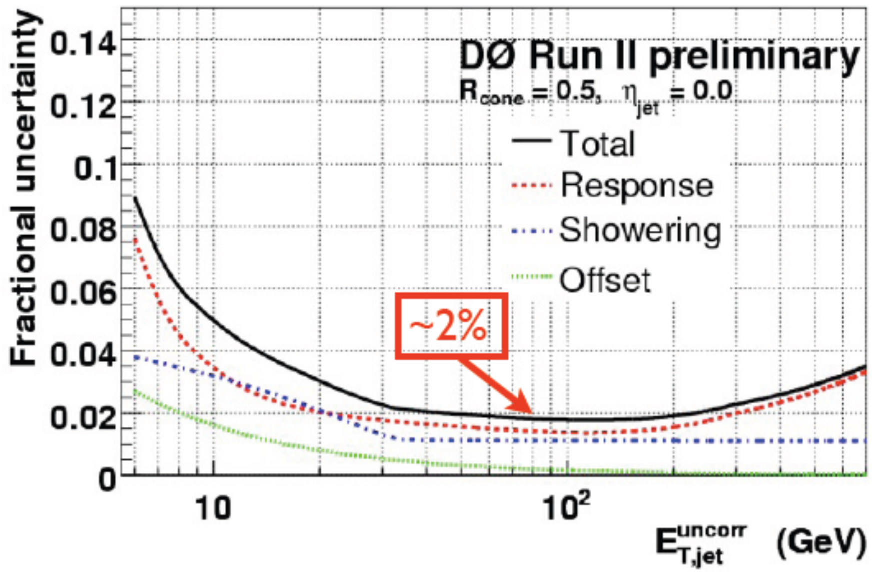
Shabalina

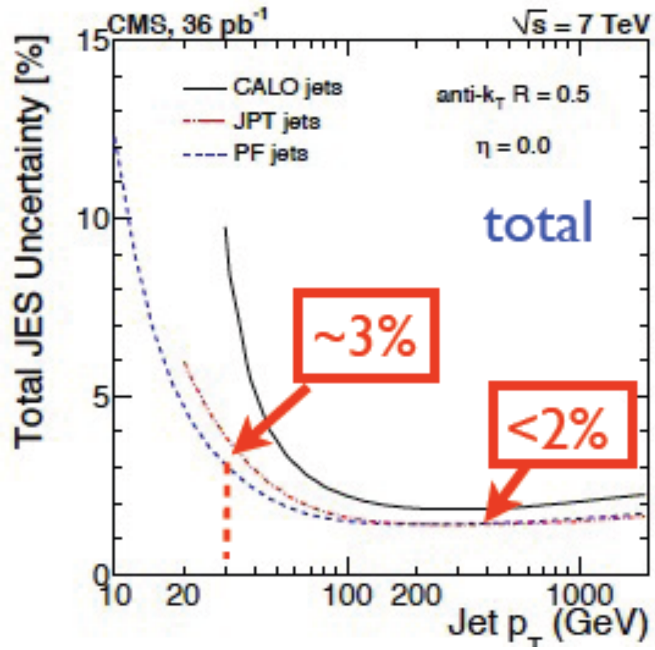
JET Energy Scale and top mass





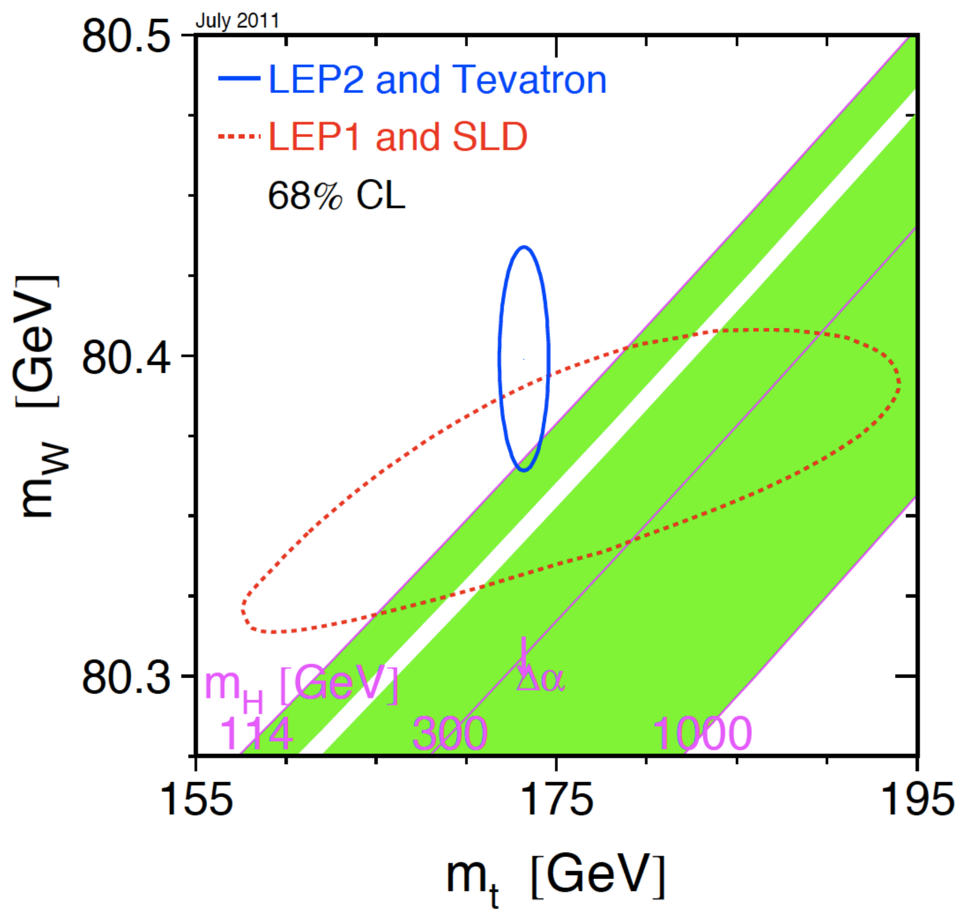
Uncertainty in the top mass due to the JES typically well below 1 GeV





The role of the top mass in 2012

- The usual W-top plot when **the Higgs is discovered** will be seen under a different light
- **Consistency with the Higgs mass: a key test of your Preferred Model**
- Need a precision measurement of the W mass, obviously
- Are we confident about the central value of the top mass and its interpretation ?



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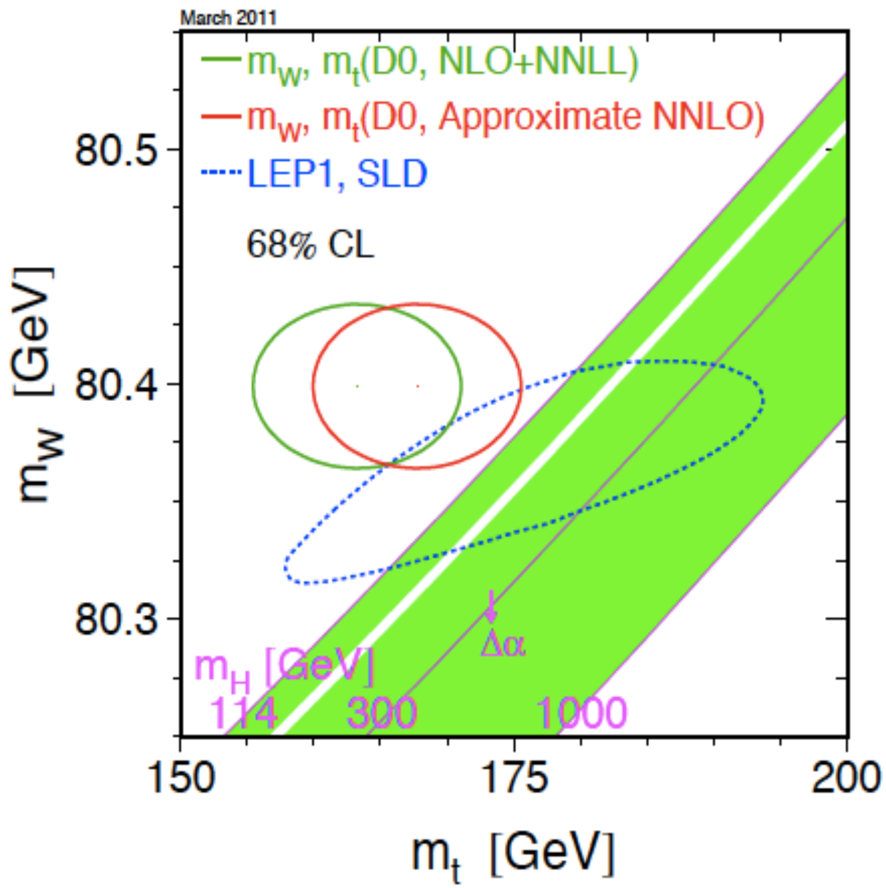
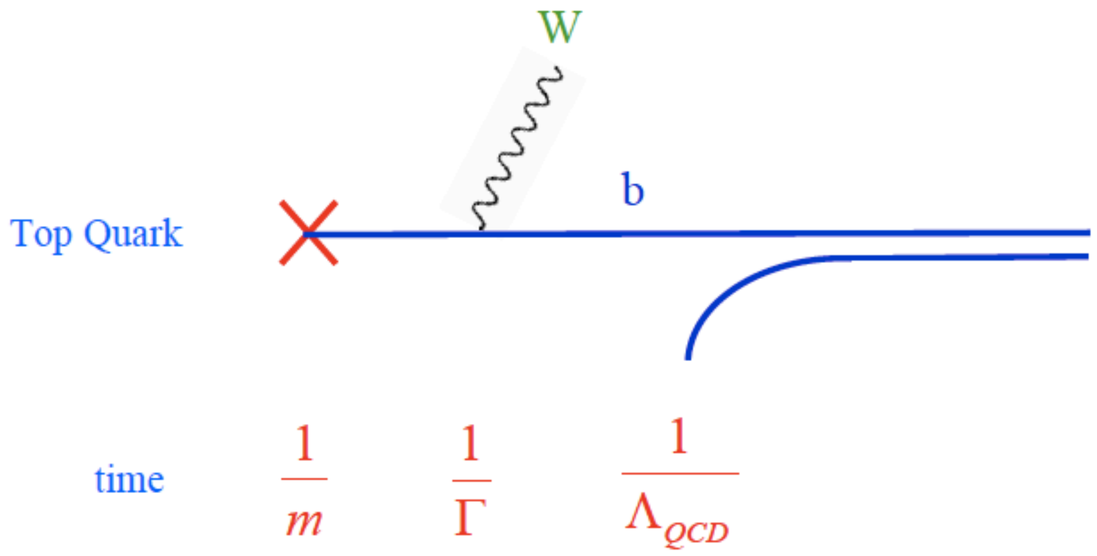


arXiv:1104.2887 **DØ, L=5.3 fb $^{-1}$**

Can we do better ?



- **Colour reconnection deals only with the b jet**

1. b-jet reconstruction less sensitive to reconnection effect, using more the “core of the jet”, less soft particles, etc. as done for WW hadronic reconstruction at LEP ?
2. Make better use of the W information ?
3. Study the top mass as a function of pt ?

A big THANK !

- To Martine, Lluisa, Veronica, Aurelio and the entire Barcelona group !!
- A big thank to all the speakers and to everybody asking questions

top2012 and top2013

- top2012 will be in England in September 2012 (exact location and date to be defined)
- Applications for organizing top2013 are invited (send them before May 2012)