

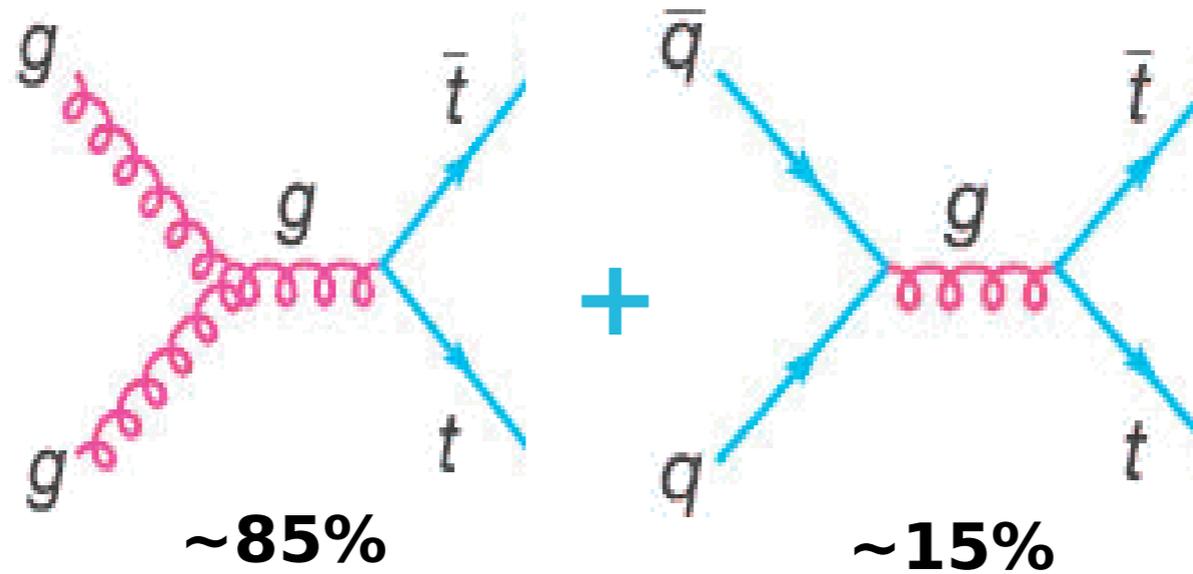
Top Quark physics at the LHC

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Meccanismi di produzione

Processi QCD

↓
Coppie $t\bar{t}$



Tevatron:
 $pp @ 1.96$ TeV
(M. Czakon, et al.
arxiv:1303.6254).

7.16±0.21

LHC pp @ 7
TeV (M. Czakon, et
al. arxiv:1303.6254).

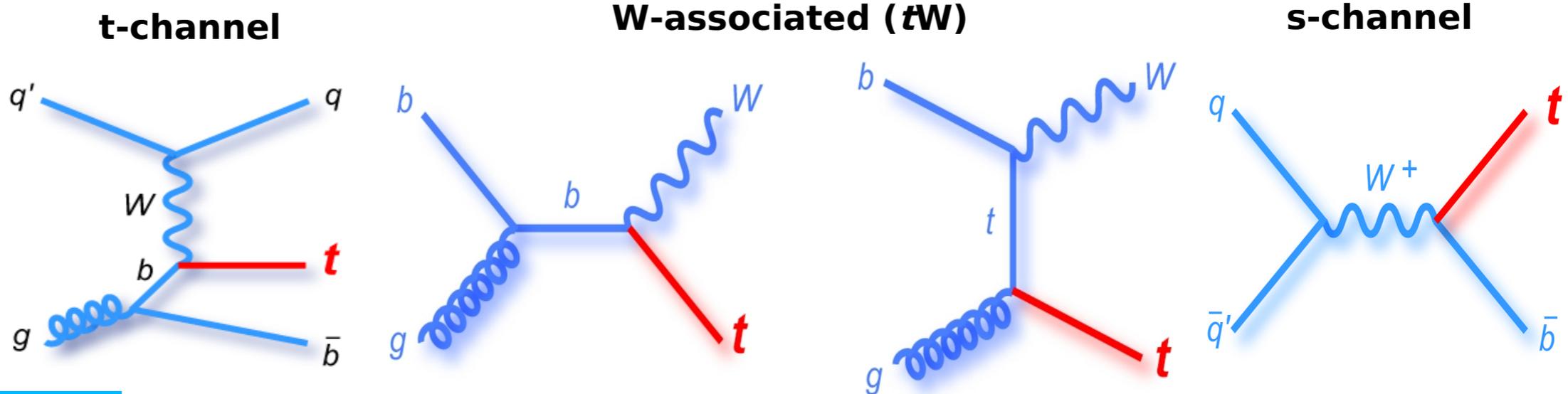
172.0±4.8

LHC pp @ 8
TeV (M. Czakon, et
al. arxiv:1303.6254).

245.8±9.6

Processi EW

↓
top singolo



Tevatron: $pp @ 1.96$ TeV (N. Kidonakis Phys. Rev. D 82, 054018 (2010) and arxiv:0909.0037

2.08±0.12

LHC pp @ 7 TeV (N. Kidonakis Phys. arXiv:1205.3453)

64.6±2.1 pb

LHC pp @ 8 TeV (N. Kidonakis arXiv:1205.3453)

87.1±2.8 pb

0.22±0.08

15.6±1.2

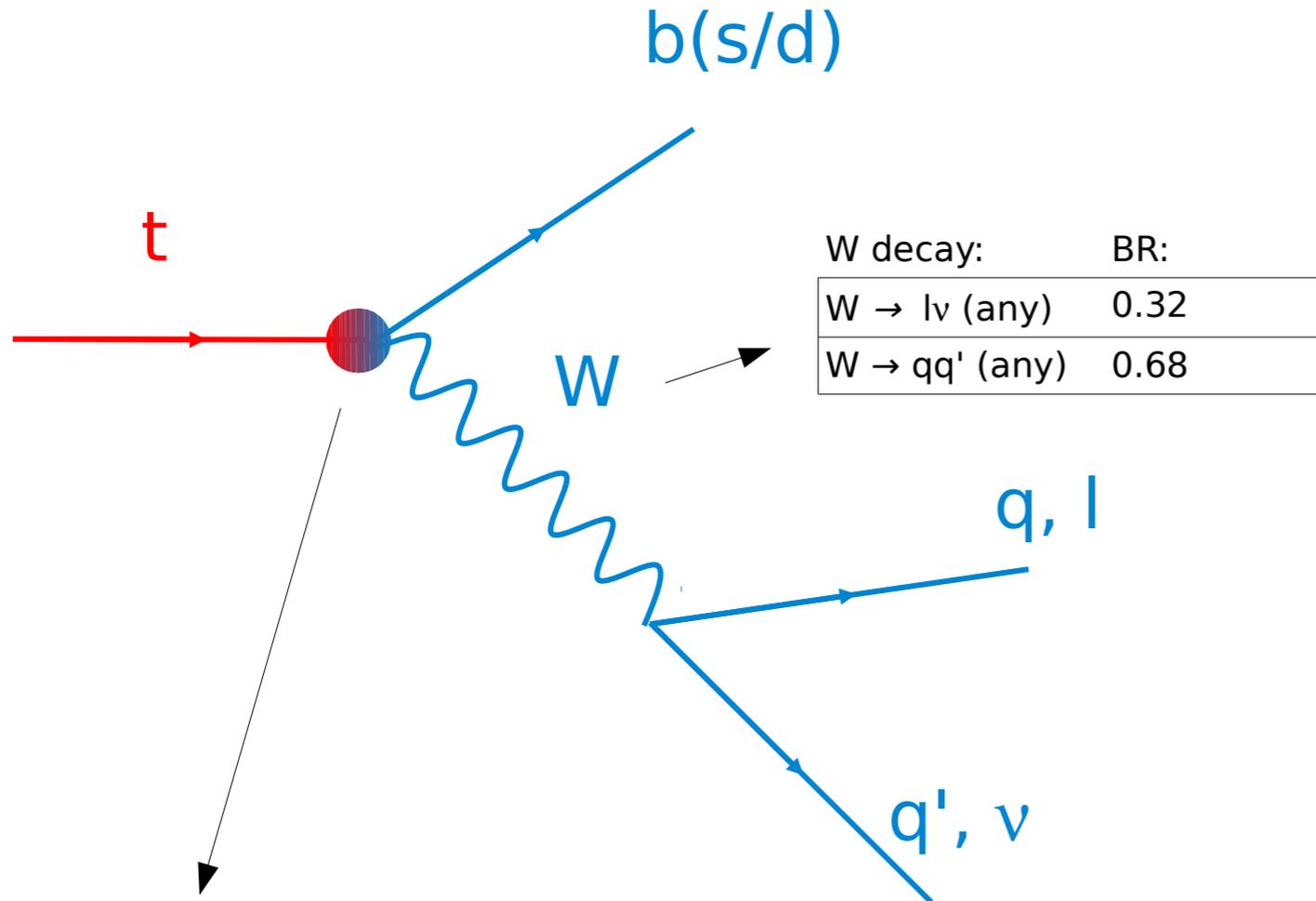
22.2±1.5

1.046±0.058

4.59±0.19

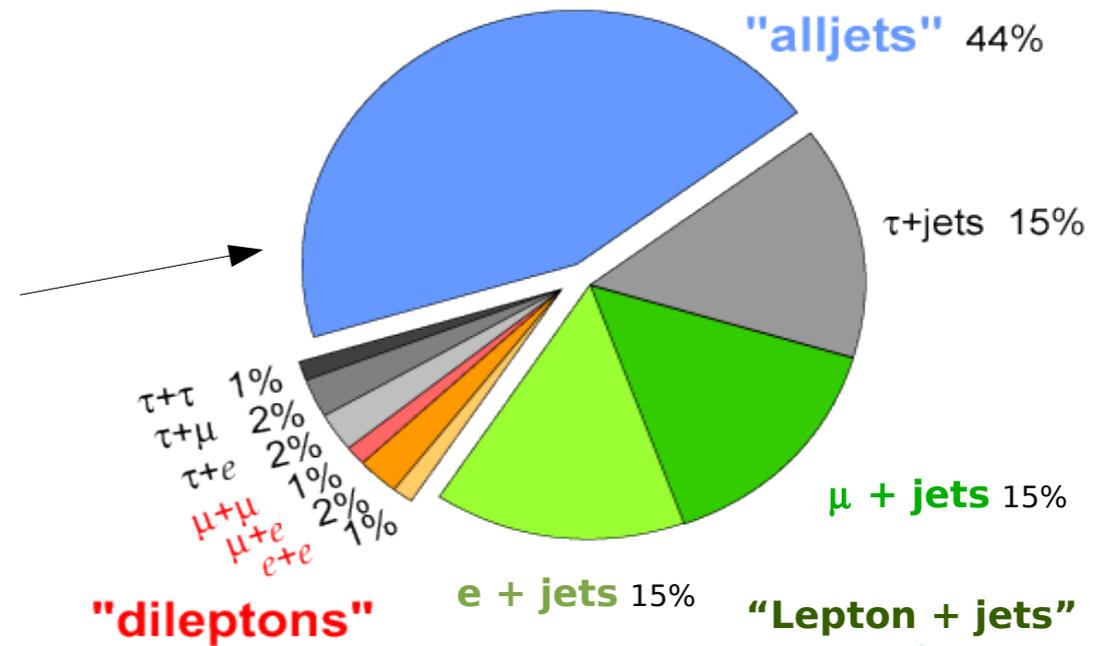
5.55±0.22

Decadimenti



W decay:	BR:
$W \rightarrow l\nu$ (any)	0.32
$W \rightarrow qq'$ (any)	0.68

Top Pair Branching Fractions



$$\frac{-ig}{2\sqrt{2}} \bar{t} \gamma^\mu (1 - \gamma^5) V_{tb} b W_\mu$$

Vertice elettrodebole tWb :

- V-A \rightarrow **polarizzazione** dei prodotti
- Matrice CKM: $|V_{tb}| \sim 1 \rightarrow \Gamma(t \rightarrow b) \gg \Gamma(t \rightarrow s, d)$

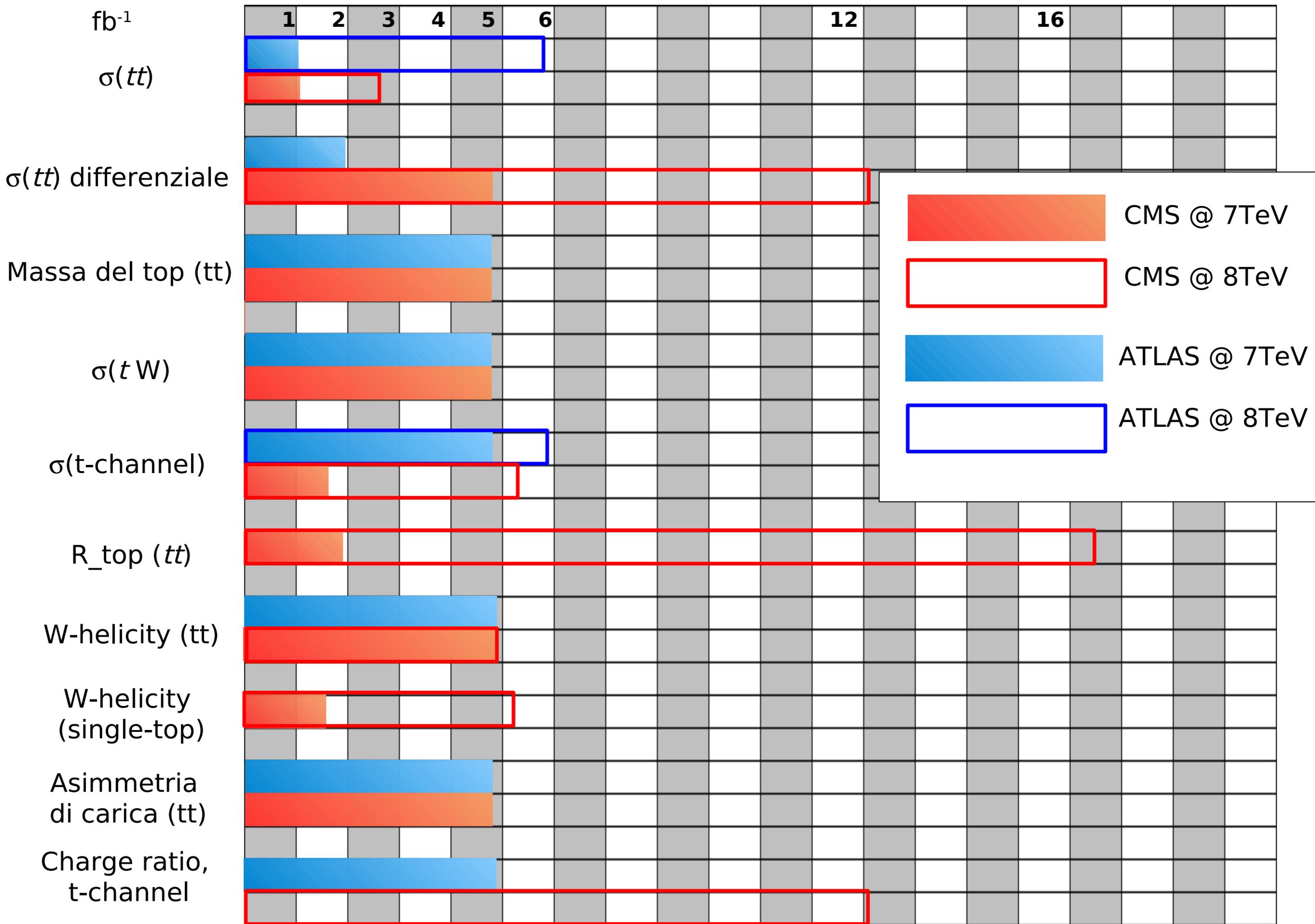
$1/m_t$ production $<$ $1/\Gamma_t$ lifetime $<$ $1/\Lambda$ hadronization $<$ m_t/Λ^2 spin decorrelation

LHC: una Top Factory

- $L \sim 5 \cdot 10^{33}$ interactions / cm^2 / s
- $\sqrt{s} = 8 \text{ TeV}$
 - $\sigma(\text{tt})$: $\sim 200 \text{ pb}$;
 - $\sigma(\text{single-top})$: $\sim 100 \text{ pb}$
- $\epsilon \sim 10\%$
- Rate $\sim 6 \text{ tt}$ e 3 single-tops al minuto!

Perché il top ad LHC?

- **Studio della produzione del top**
 - Misure di **sezione d'urto** di tt e di top singolo: intensità dell'interazione (α_s)
 - Sezioni d'urto **differenziali**: vincoli su sul modeling del segnale
 - **Asimmetrie** nei meccanismi di produzione
 - **Produzione associata** a jets: importante strumento di calibrazione
- **Proprietà del top e dei suoi decadimenti**
 - **Massa del top**: parametro cruciale dello SM, legato a EW symmetry breaking e al bosone di Higgs
 - **Branching ratio** dei decadimenti: misura di V_{tb}
 - Polarizzazione del top e della W: **studio del vertice tWb**
- **Nuova fisica nei canali del top**
 - **Risonanze** in tt e single-top
 - Processi di Flavour Changing Neutral Current



Produzione di quarks top

ATLAS - PAPER

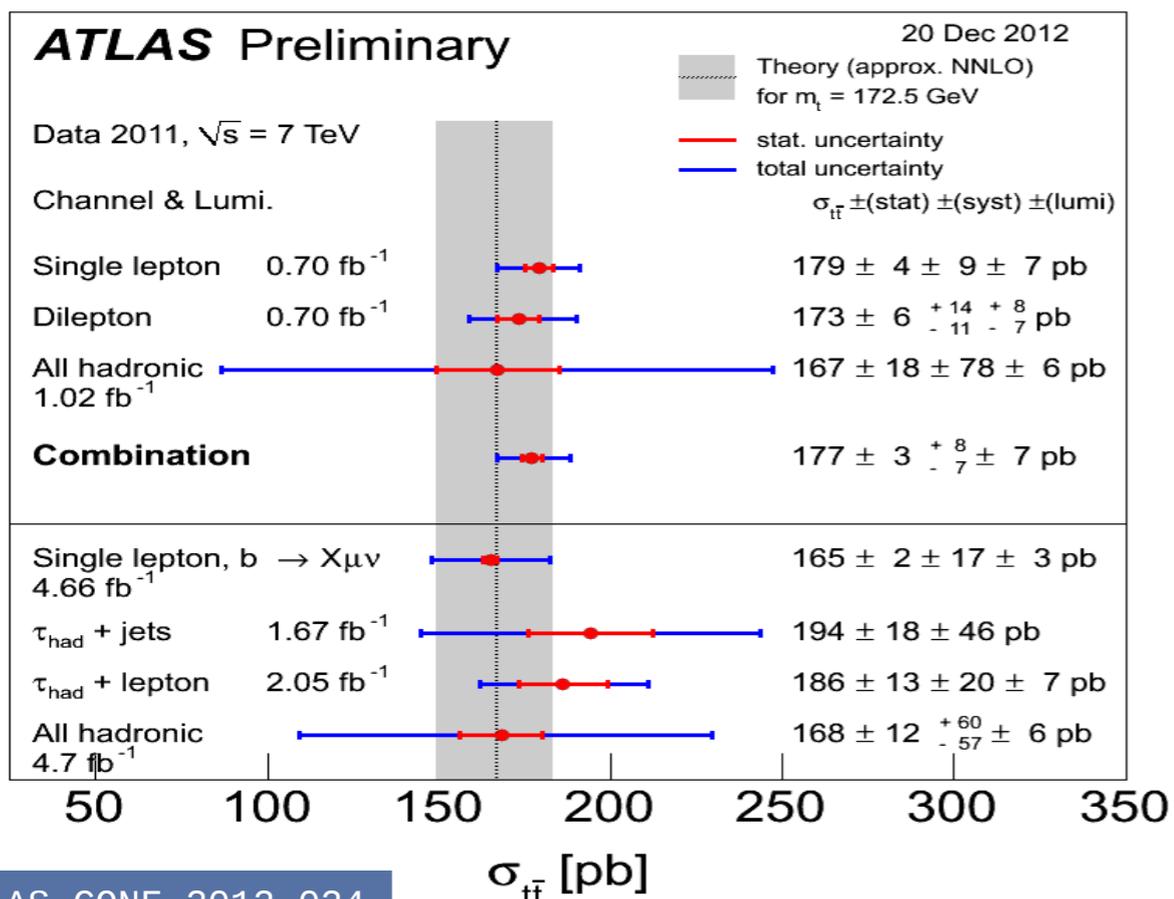
CMS - PAPER

COMBINED

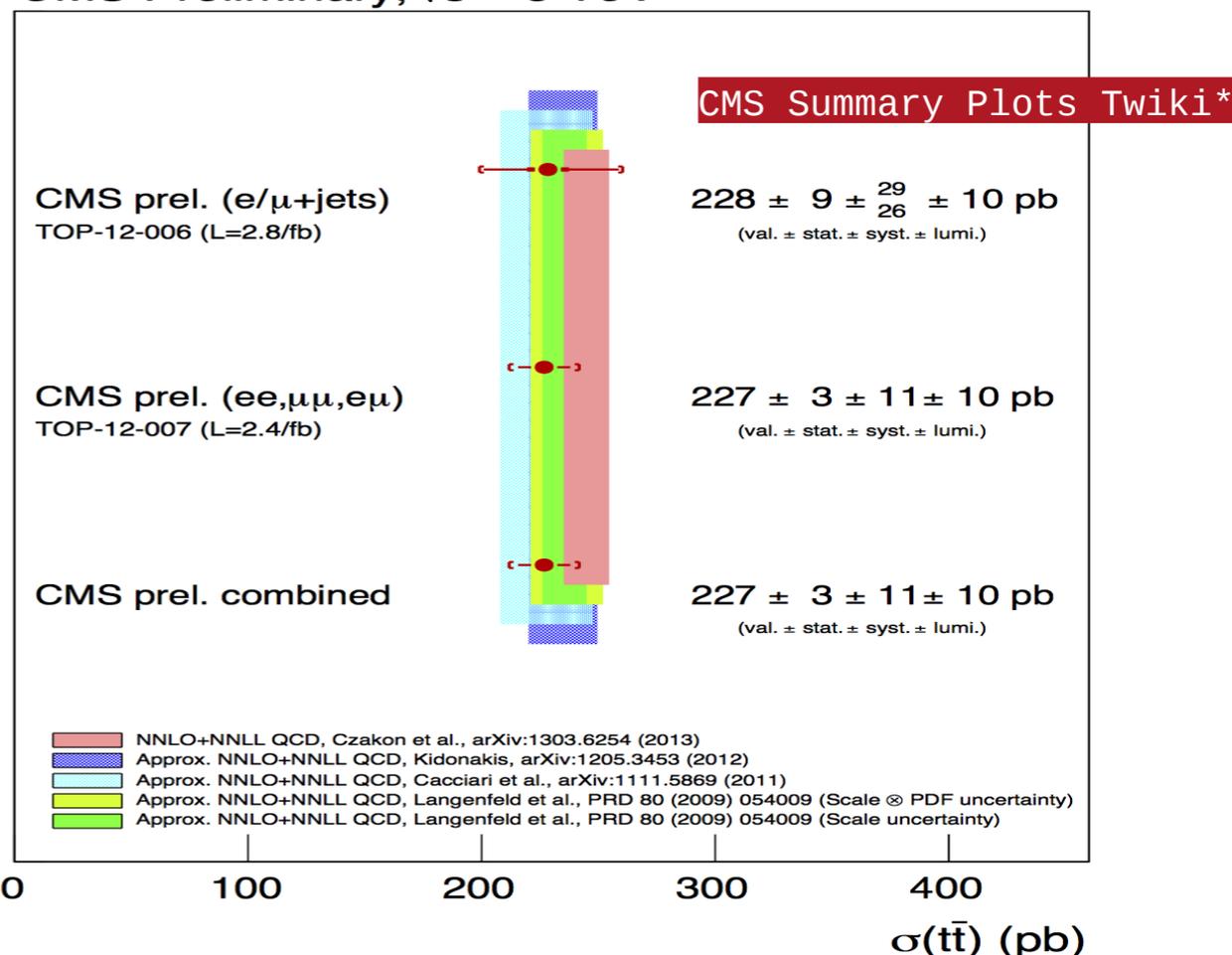
- Sezioni d'urto tt e single top
- Sezioni d'urto differenziali
- Spettri di jet multiplicity
- Asimmetrie nella produzione

Sezione d'urto $t\bar{t}$

- Sezione d'urto $t\bar{t}$: ~ 170 pb @7TeV; ~ 240 pb @8TeV
 - Fondi principali: W/Z + jets, QCD
 - Contributo gg dominante \rightarrow rapporto S/B migliora con l'energia
 - Sensibile sia ad α_s che a m_{top}



CMS Preliminary, $\sqrt{s} = 8$ TeV



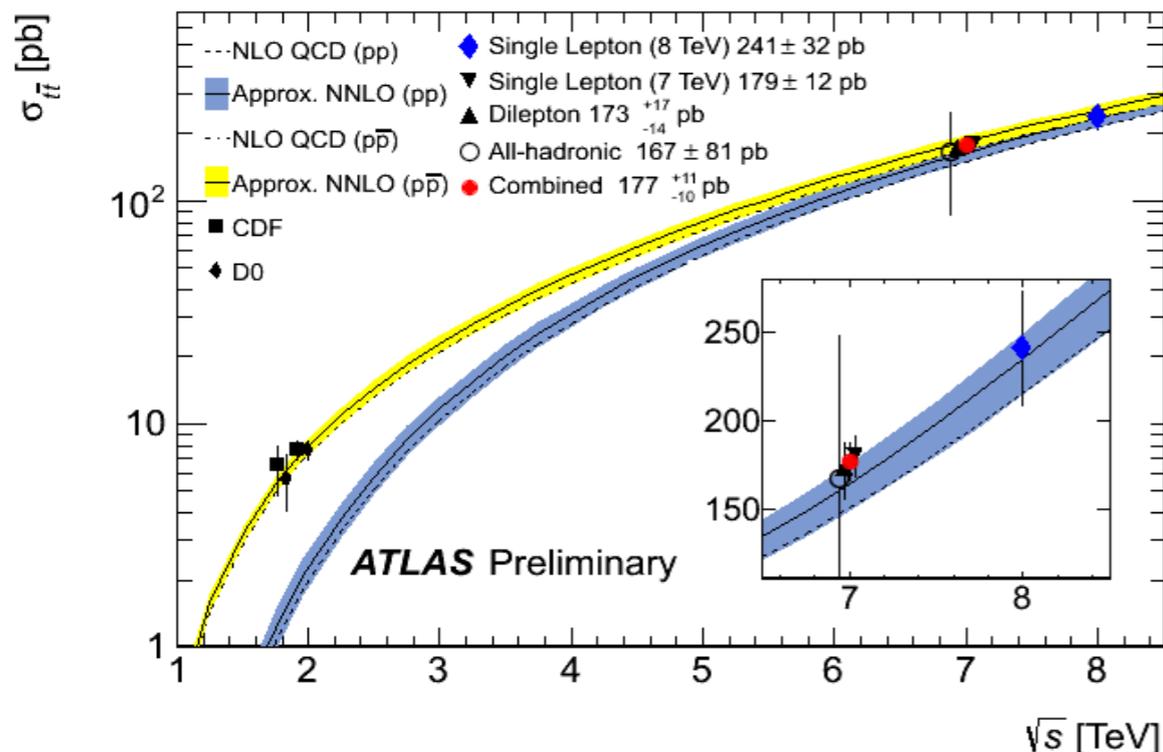
*<https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsTOPSummaryPlots>

ATLAS-CONF-2012-024

- Nuovo regime di misure di precisione:
 - “Riscoperta” avvenuta già coi primi dati a 7 TeV
 - La precisione delle misure attuali è **comparabile a quella delle previsioni teoriche!**

Sezione d'urto tt

PLB(2012)716:142-159



Atlas:

- @7TeV: combinazione delle misure:

$$\sigma(tt, 7\text{TeV}) \mathbf{177^{+11}_{-10} \text{ pb}}$$

ATLAS-CONF-2011-108

- @8TeV leptone + jet: fit cinematico ad un likelihood discriminant

$$\sigma(tt, 8\text{TeV}) \mathbf{241 \pm 32 \text{ pb}}$$

ATLAS-CONF-2012-149

CMS:

- Combinazione delle misure sia per 7 che per 8 TeV

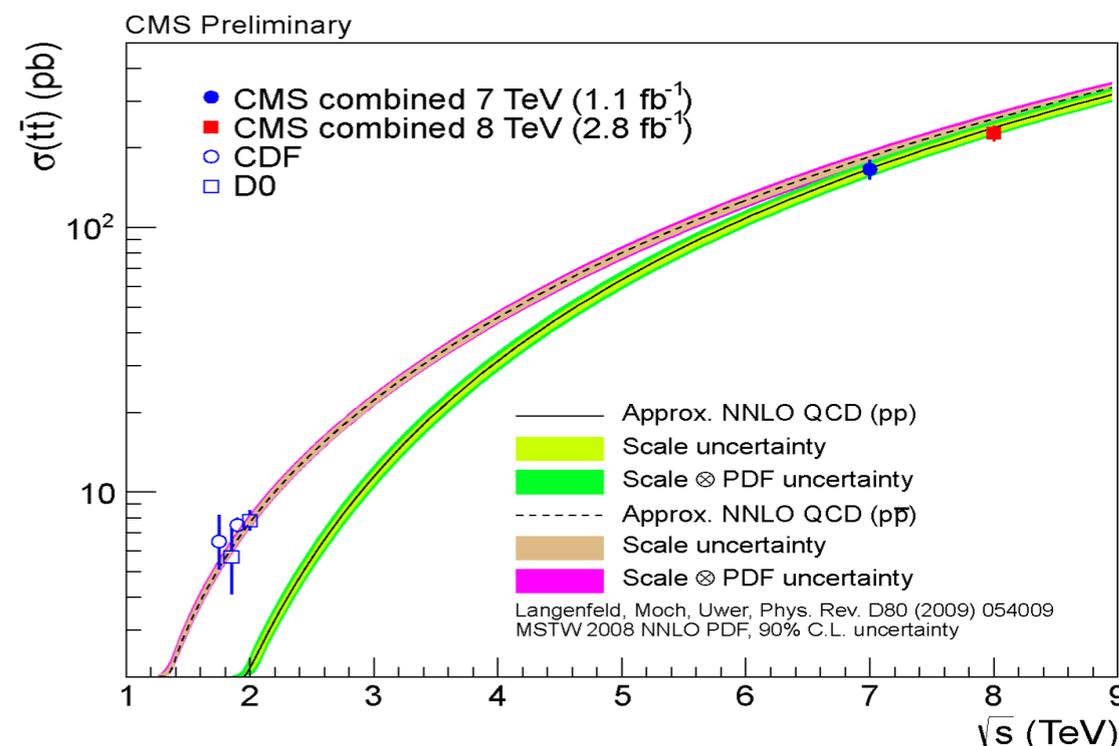
$$\sigma(tt, 7\text{TeV}) \mathbf{166 \pm 13 \text{ pb}}$$

CMS-PAS-TOP-11-024

$$\sigma(tt, 8\text{TeV}) \mathbf{227 \pm 15 \text{ pb}}$$

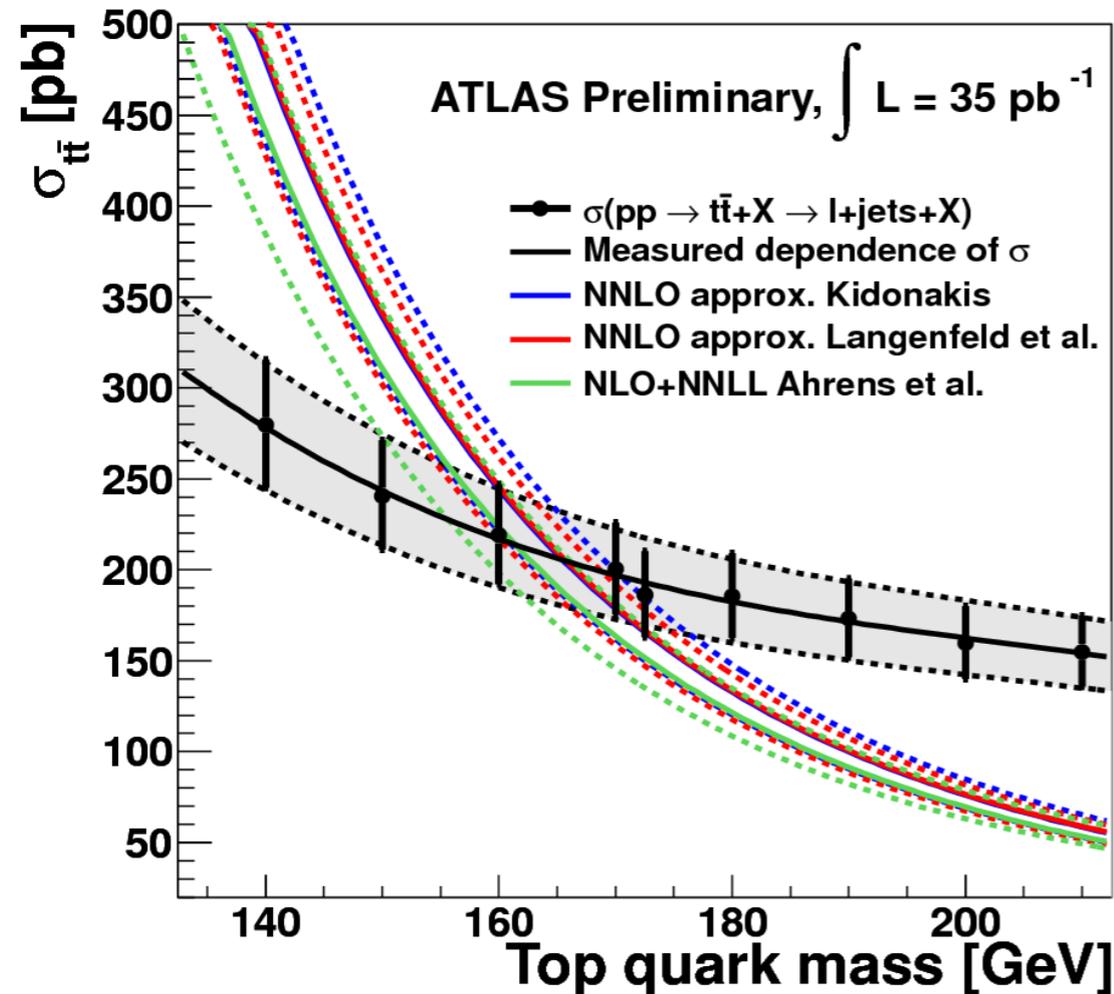
CMS-PAS-TOP-12-006

CMS-PAS-TOP-12-007



Sezione d'urto: vs m_{top} ed α_s

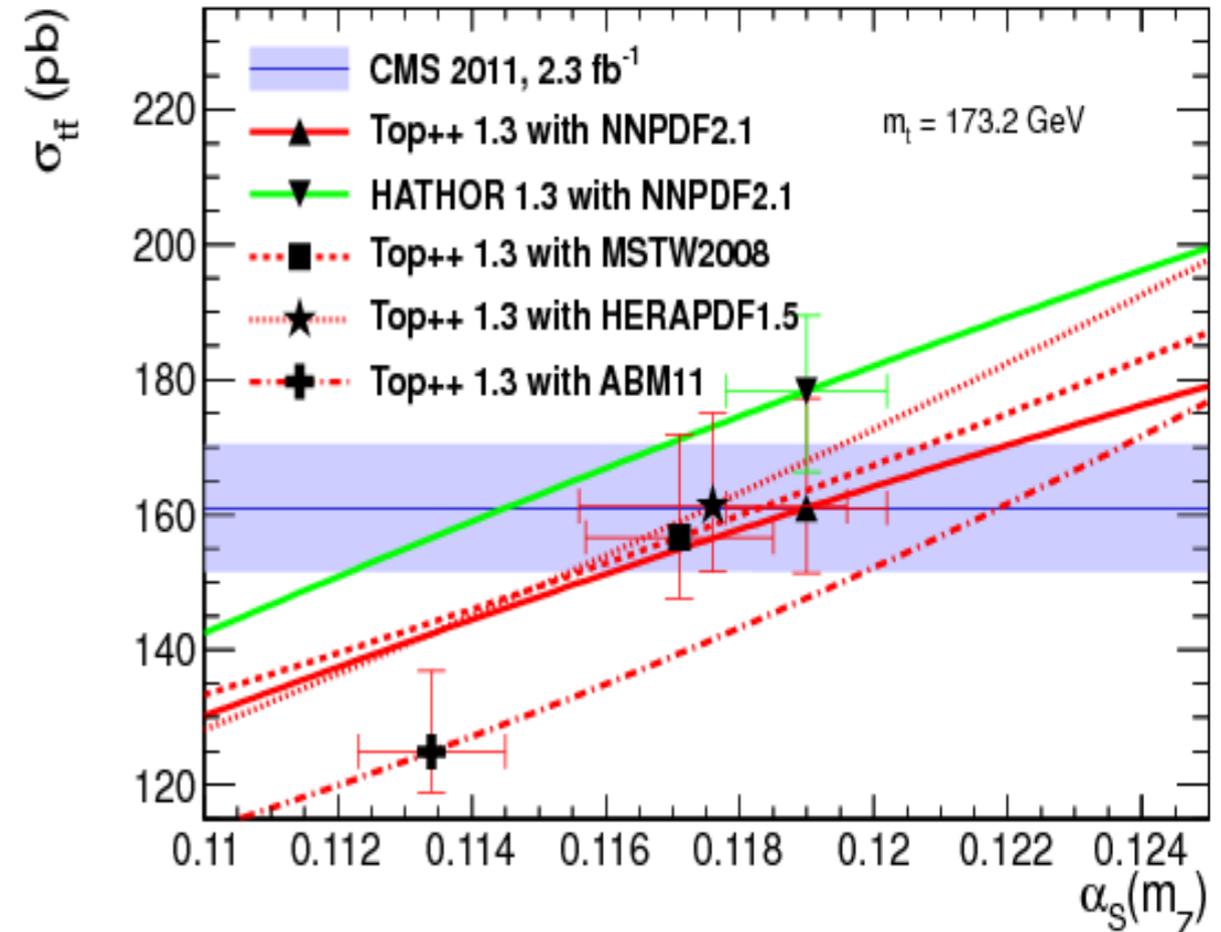
ATL-CONF-2011-054



- Sezione d'urto permette di **misurare direttamente** α_s
- Per porre ulteriori constraints (e.g. scales): studi differenziali e di jet spectra possono fare la differenza!

- Misura di m_{top} da $\sigma(\text{tt})$:
 - **Complementare** alle misure dirette
 - Permette di testare lo schema di rinormalizzazione usato per estrarre la massa

CMS-PAS-TOP-12-022

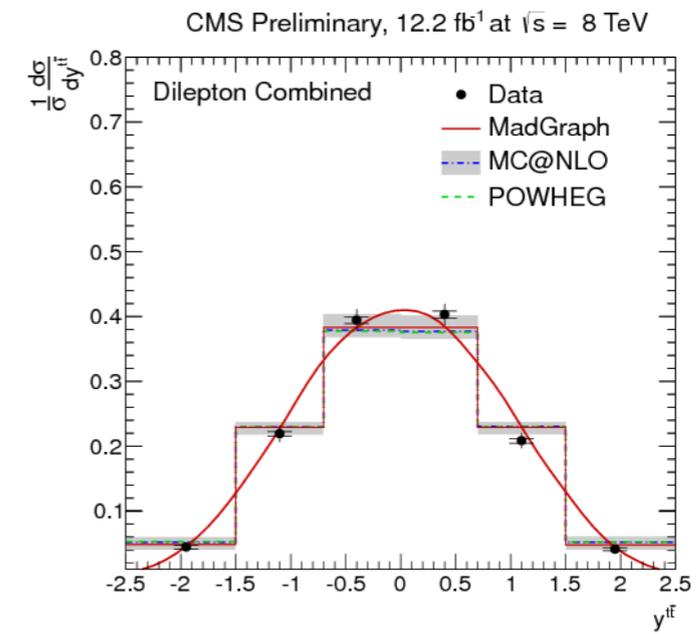
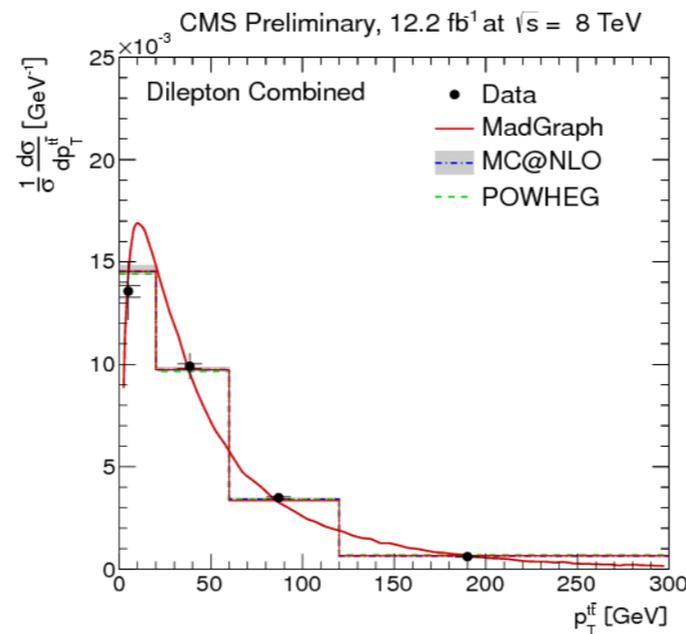
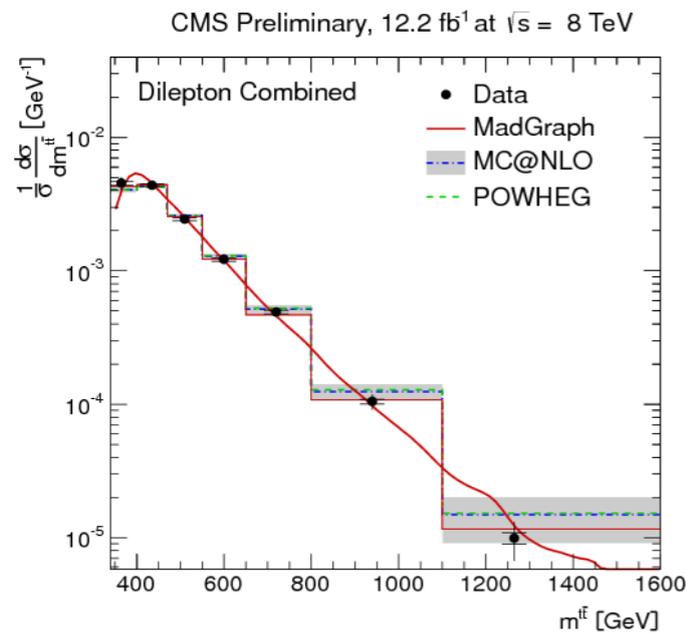
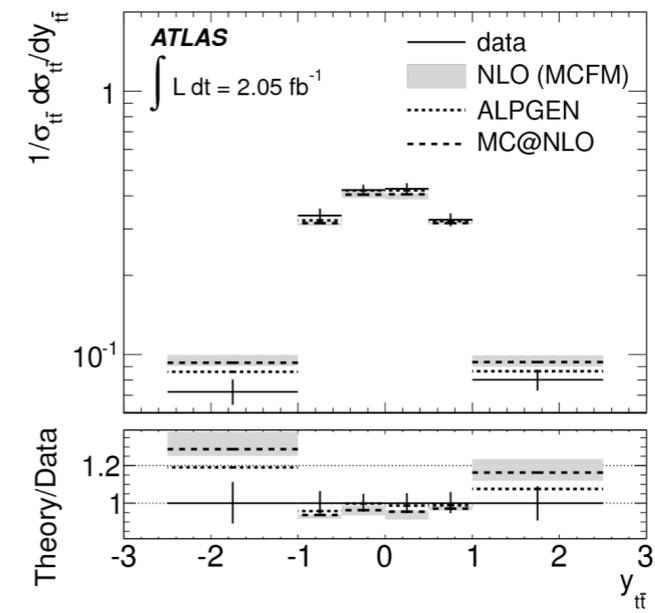
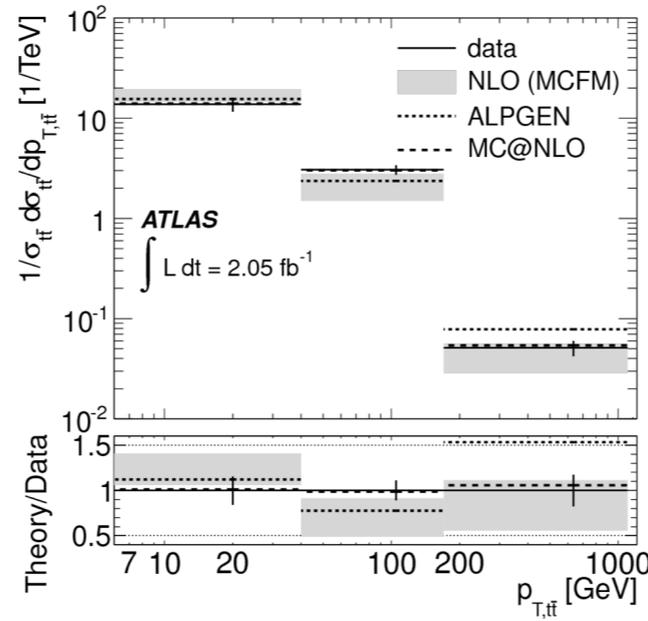
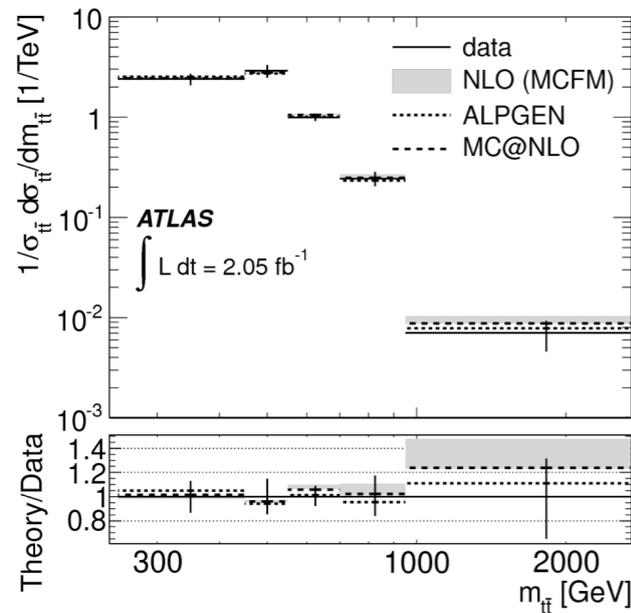


Sezioni d'urto differenziali tt

EPJC(2013)73:2261

CMS-PAS-TOP-12-027

CMS-PAS-TOP-12-028

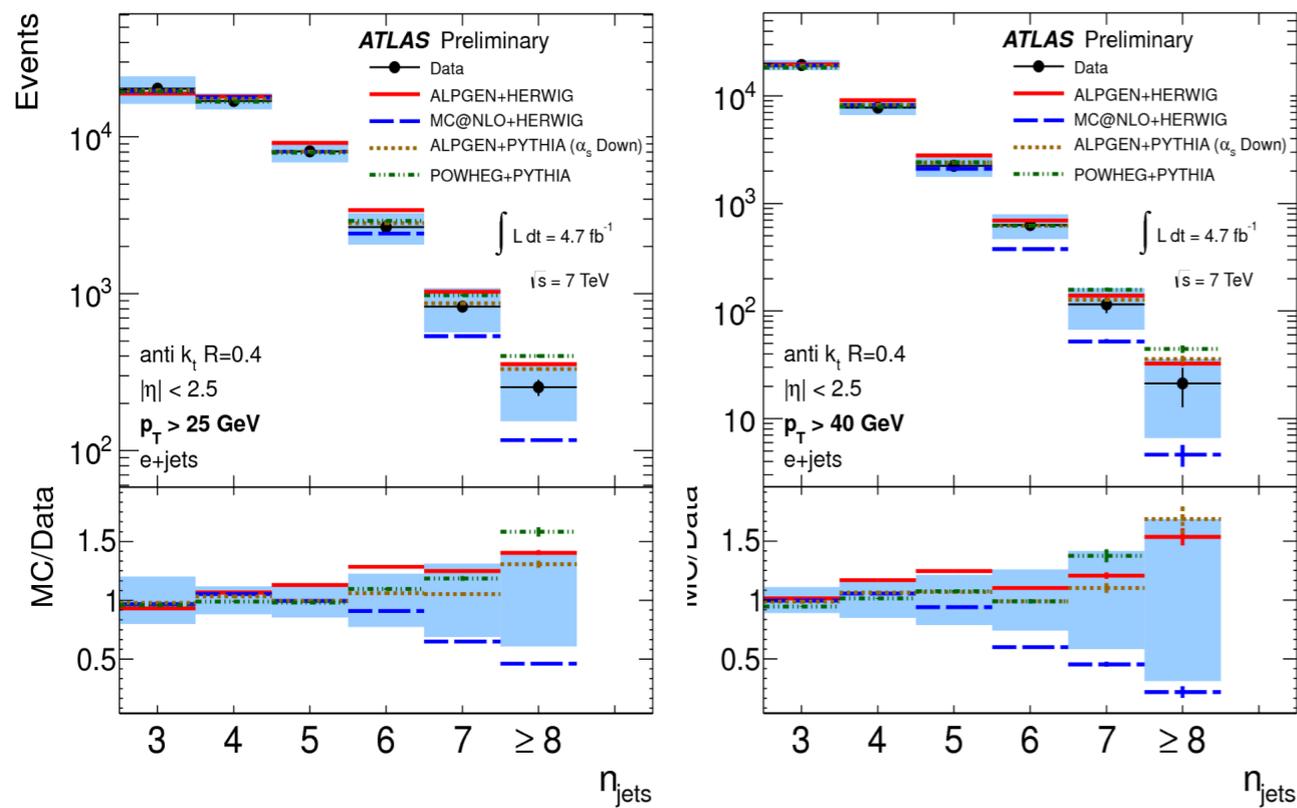


- Attuali misure: mostrano un buon accordo con le previsioni

Produzione associata: molteplicità jet

- MC@NLO too soft, sottostima tt+j al livello M.E. Sia le misure di ATLAS che quelle di CMS danno indicazioni in questa direzione.
- ALPGEN+HERWIG, ALPGEN+PYTHIA α_s down in miglior accordo coi dati - vincolo su ISR/FSR
- MadGraph : vincoli su Q^2 (factorisation scale) e matching scale con PYTHIA

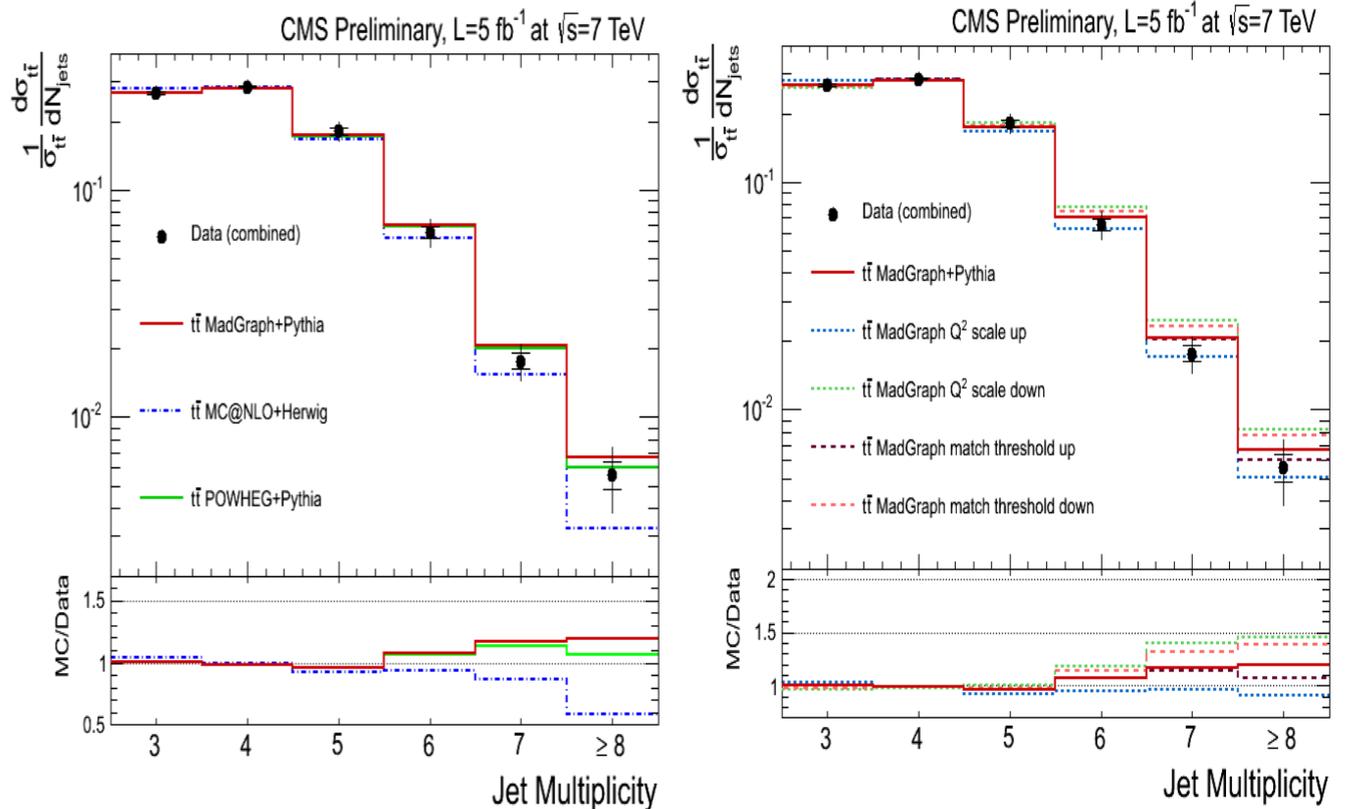
ATL-CONF-2012-155



$p_T > 25$

$p_T > 40$

CMS-PAS-TOP-12-018

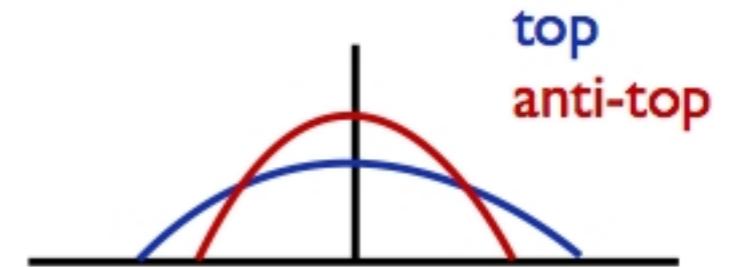
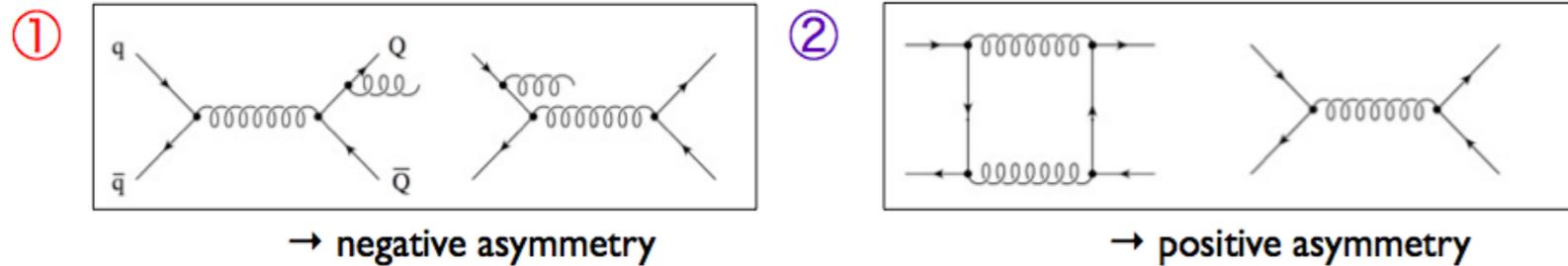


$p_T > 35$

$p_T > 35$

Altre possibilità: studiare la produzione di tt + bb

Asimmetria top/antitop



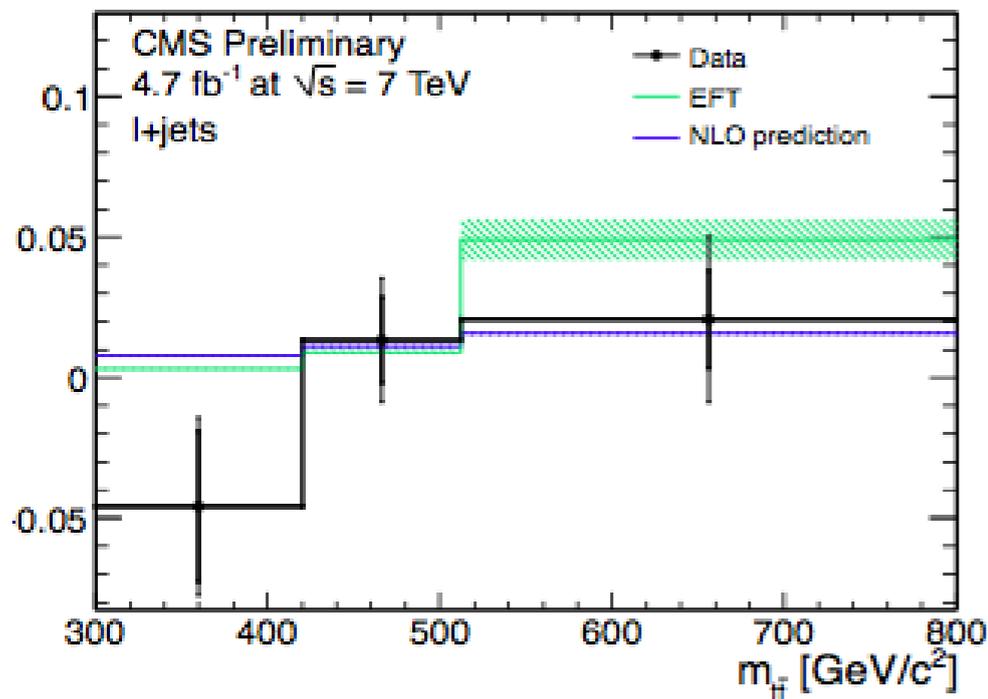
$$\Delta|y| = |y_t| - |y_{\bar{t}}|$$

- Asimmetria forward-backward (A_{FB}) a **Tevatron** → modifica della distribuzione di **rapidità ad LHC (A_C)**

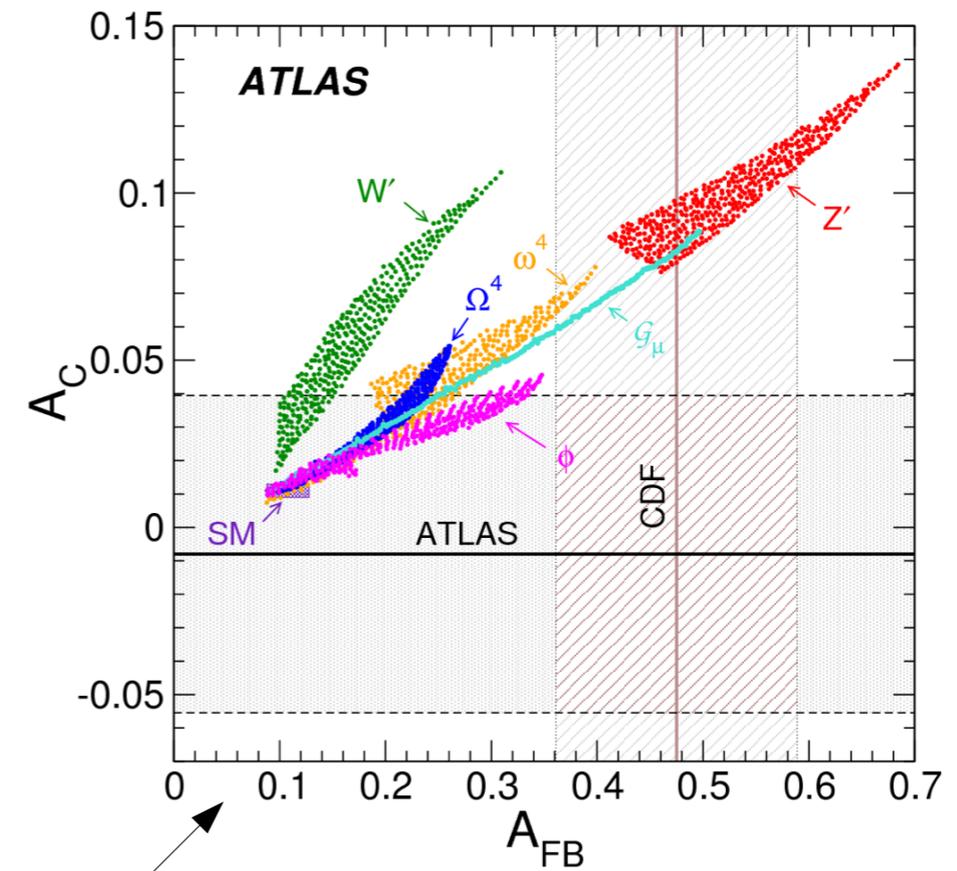
ATL-CONF-2012-057

EPJC72(2012)2039

- Misure inclusive e differenziali



PLB 717(212)129

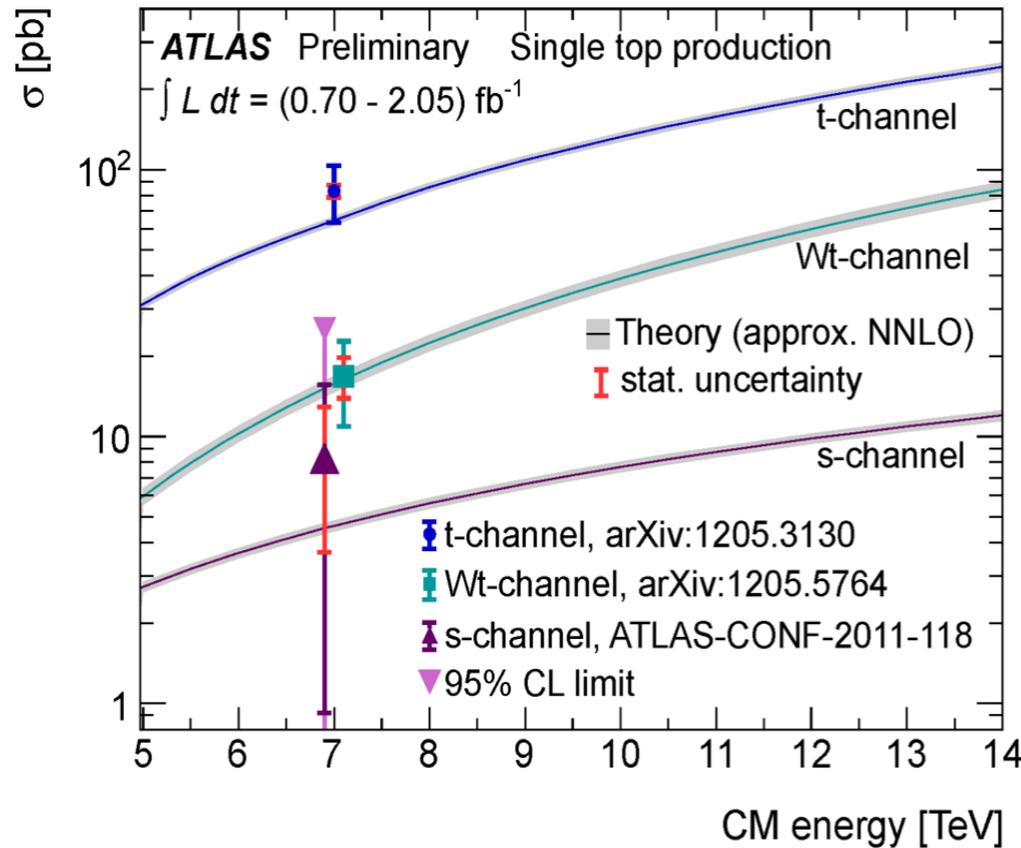


Con taglio in $m(tt) > 450$ GeV

Sezione d'urto di top singolo

PLB(2012)716:142-159

PLB(2012)716:142-159



Canali di produzione **elettrodebole**:

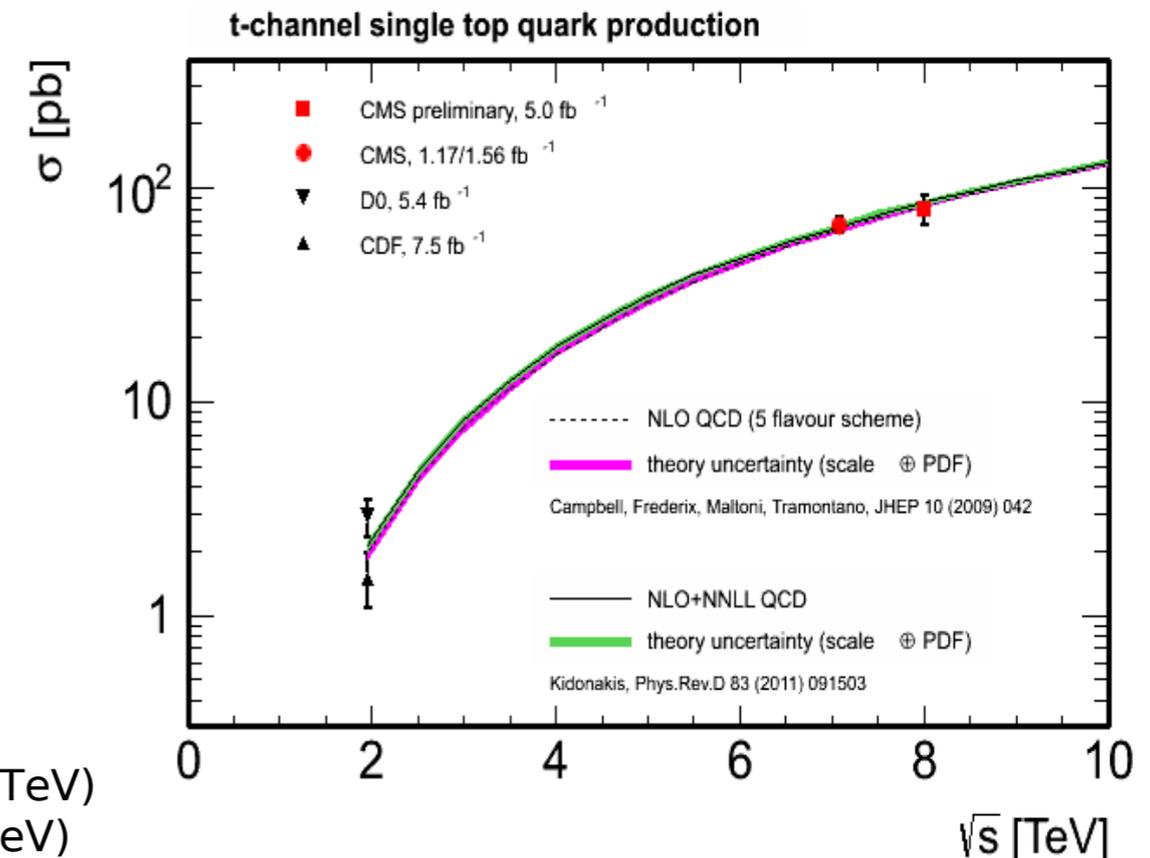
- Tutti i canali permettono misura assoluta di $|V_{tb}|$
- Sensibili a nuova fisica che modifichi il vertice tWb
- **t-channel** canale dominante

JHEP12(2012)035

CMS-PAS-TOP-12-011

PRL110(2013)02203

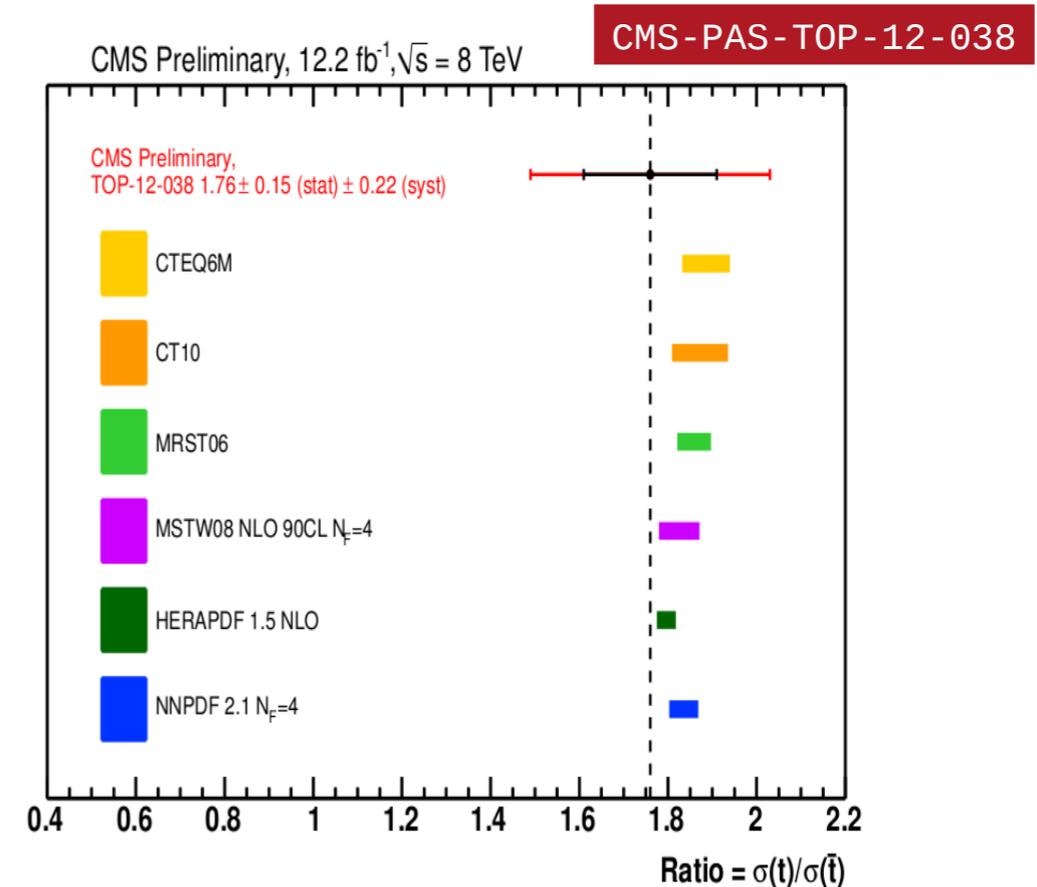
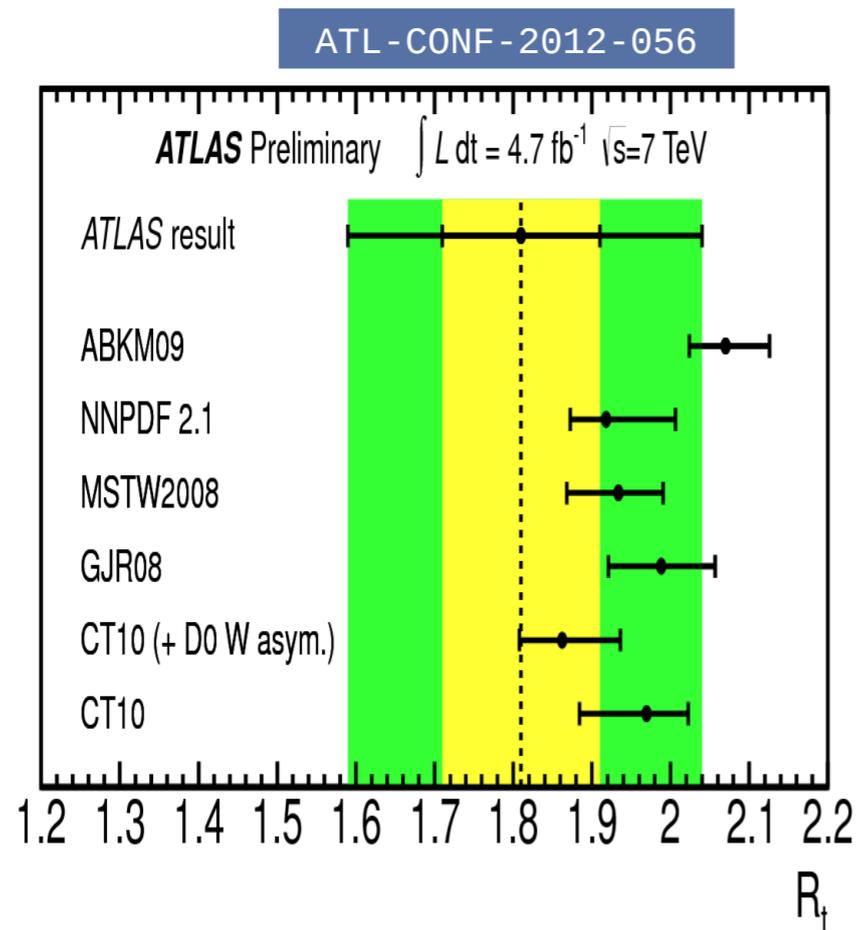
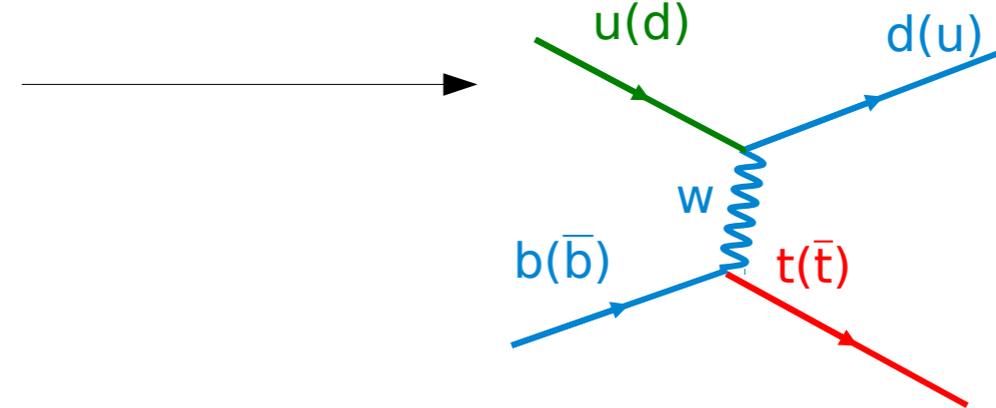
	Atlas 7TeV	CMS 7TeV	Atlas 8TeV	CMS 8TeV
$\sigma(\text{t-chan.})$ [pb]	80 ± 20	67.2 ± 6.1	95 ± 18	80 ± 13
$\sigma(\text{tW-chan.})$ [pb]	17 ± 6	16 ± 5	/	/
$\sigma(\text{s-chan.})$ [pb]	< 26.5	/	/	/



Misura di $|V_{tb}|$ dal **t-channel**: 1.020 ± 0.046 CMS (7TeV)
 1.04 ± 0.10 ATLAS(8TeV)

Rapporto top/antitop: t-channel

- t-channel: quark top eredita il segno della carica dal quark di valenza
- Asimmetria** nella sezione d'urto di top-antitop sensibile alle pdf del protone



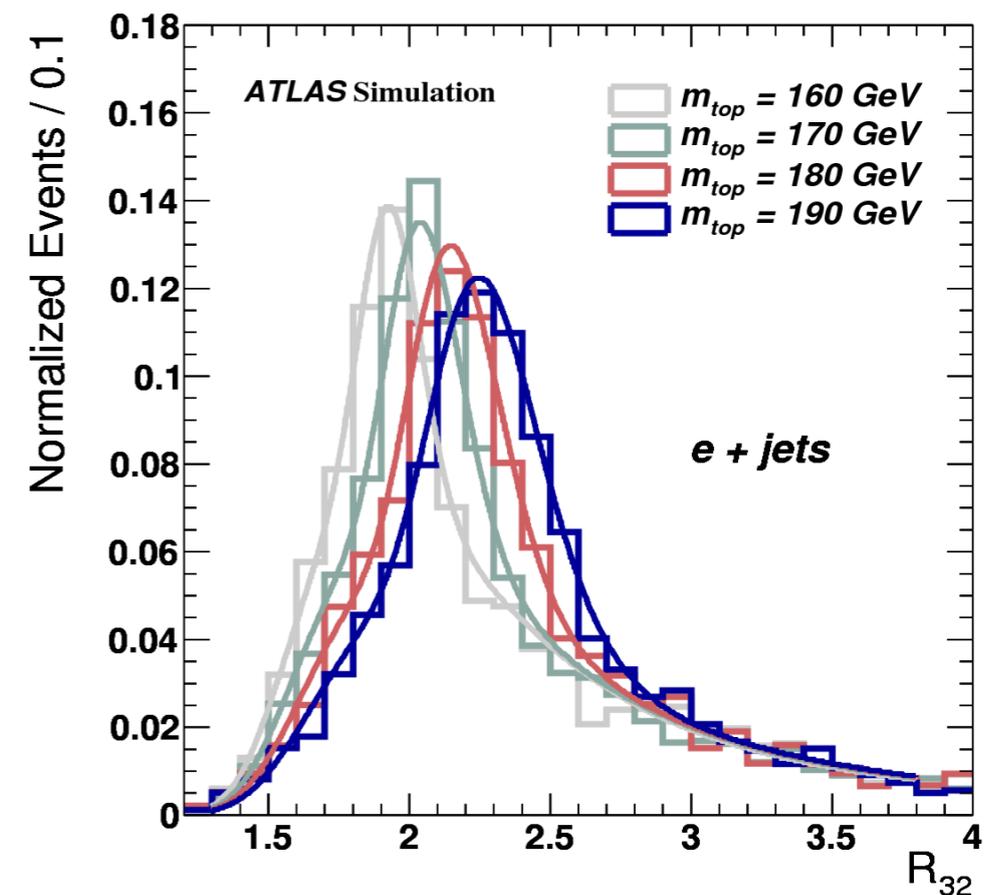
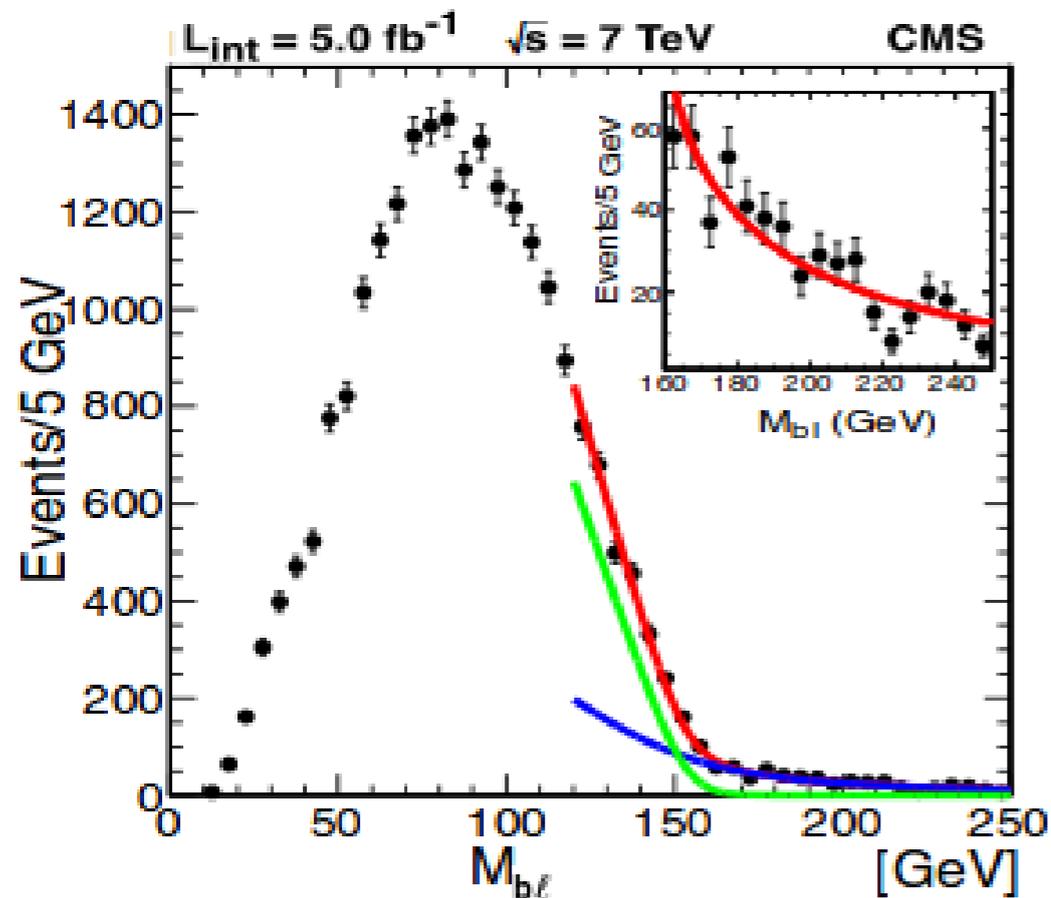
Proprietà del quark top e dei suoi decadimenti

- Massa del top
- Carica elettrica e accoppiamento con fotoni
- Proprietà angolari : polarizzazione di top e W, correlazione di spin
- $B(t \rightarrow Wb)/B(t \rightarrow Wq)$

Metodi per la misura di m_{top}

- **Template fits:** fit ad una o più variabili ricostruite sensibili al valore di m_{top}
- E.g.: fit a $R_{32} = M_3/M_2$ in EPJ C72(2012)2046 →
- $M_3 = m_{top, had}$; $M_2 = m_{w, had}$; rapporto riduce sistematica da JES
- Varianti includono fit che sfruttano constraints cinematici, **e.g. kinematic endpoint method**

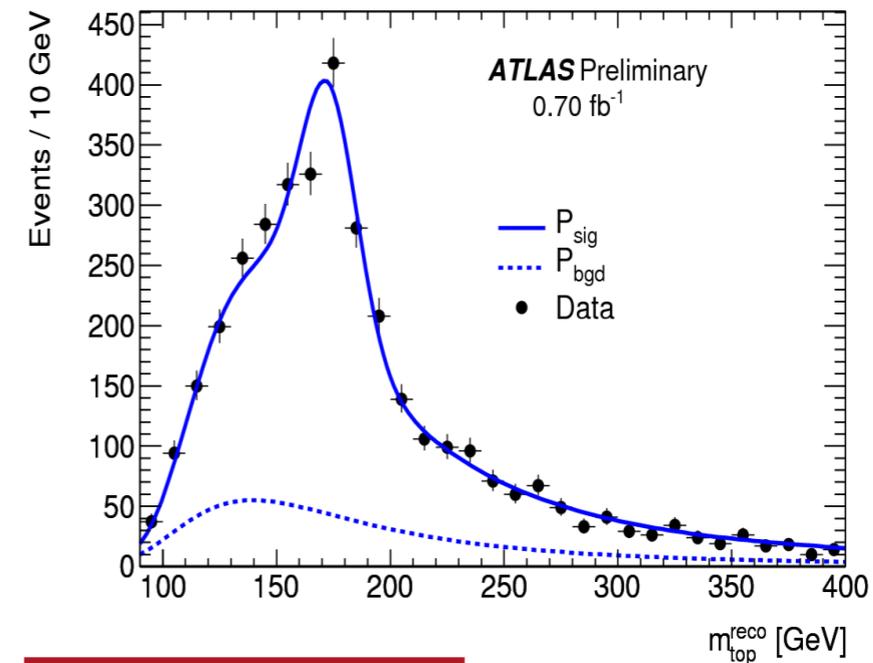
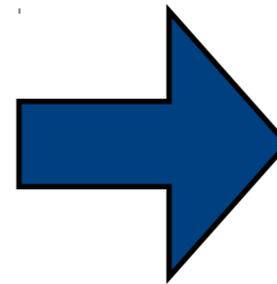
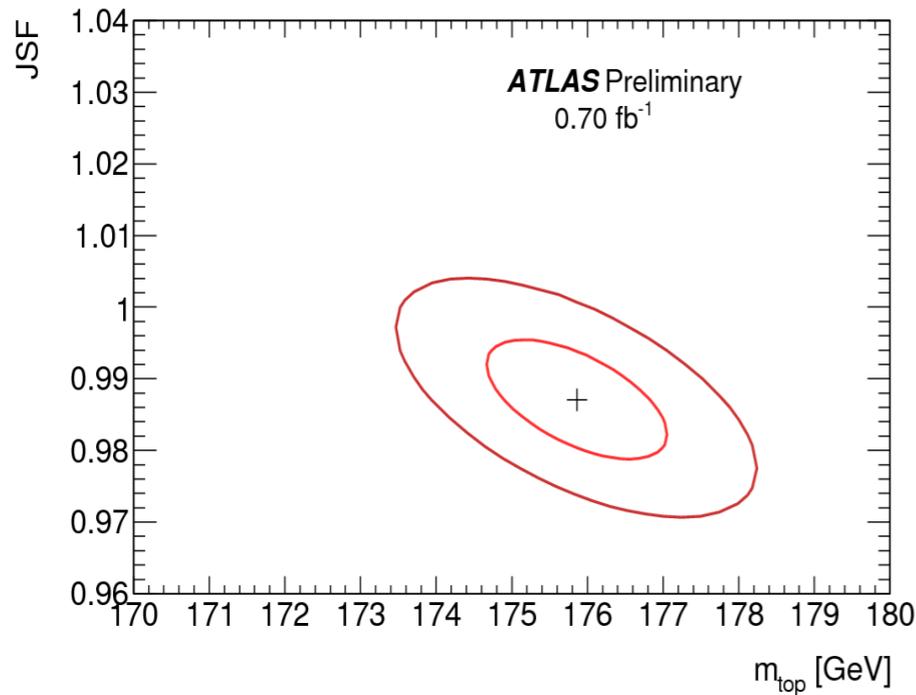
arXiv:1304.5783



- **Analytical Matrix Weighting Technique:** per ricostruire m_{top} in canali dileptonici dove non ci sono sufficienti vincoli cinematici
- Si ricostruisce ogni possibile soluzione analitica per m_{top} in un dato range.
- Si assegna un peso agli eventi in funzione delle pdf e di $P(p_{T,lep} | m_{top})$. Si prende m_{top} che massimizza questo peso.

Massa del top: calibrazione dell'energia dei jets

ATL-CONF-2011-120



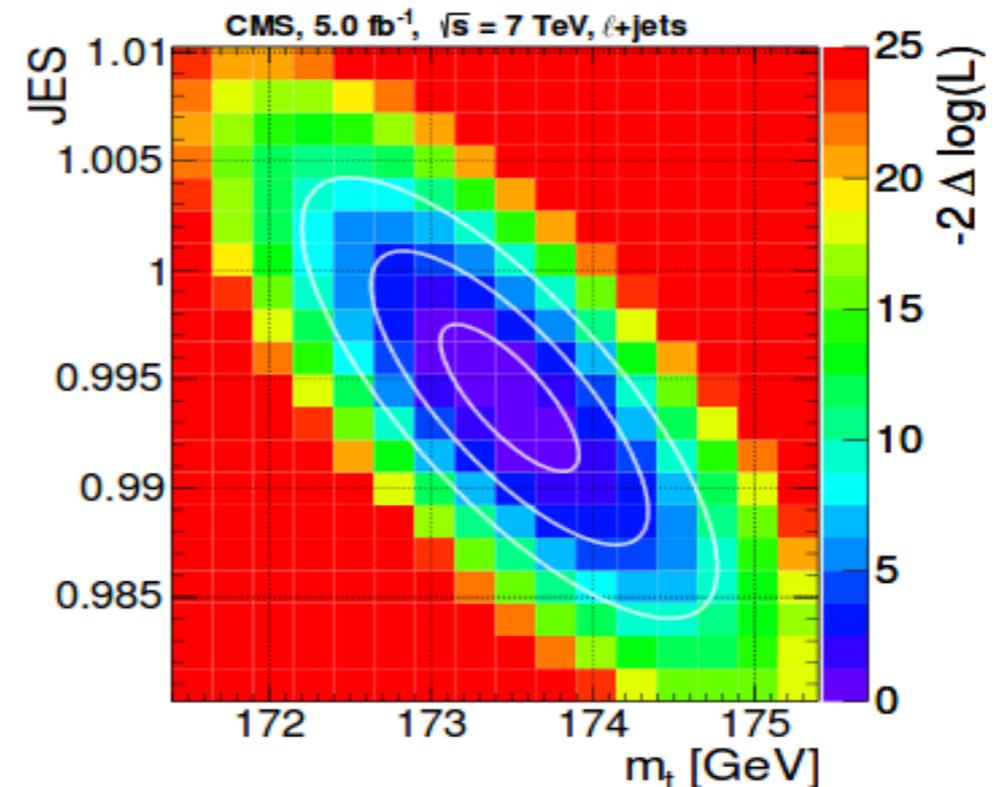
Atlas (2D template fit method) e CMS (ideogram method):

Ricavano in situ l'impatto della scala di calibrazione dei jets (JES, JSF) da un fit simultaneo a m_T e m_W

CMS: $m_{top} = 173.49 \pm 0.43$ (stat) ± 0.98 (syst)

ATLAS: $m_{top} = 174.5 \pm 0.6$ (stat) ± 2.3 (syst)

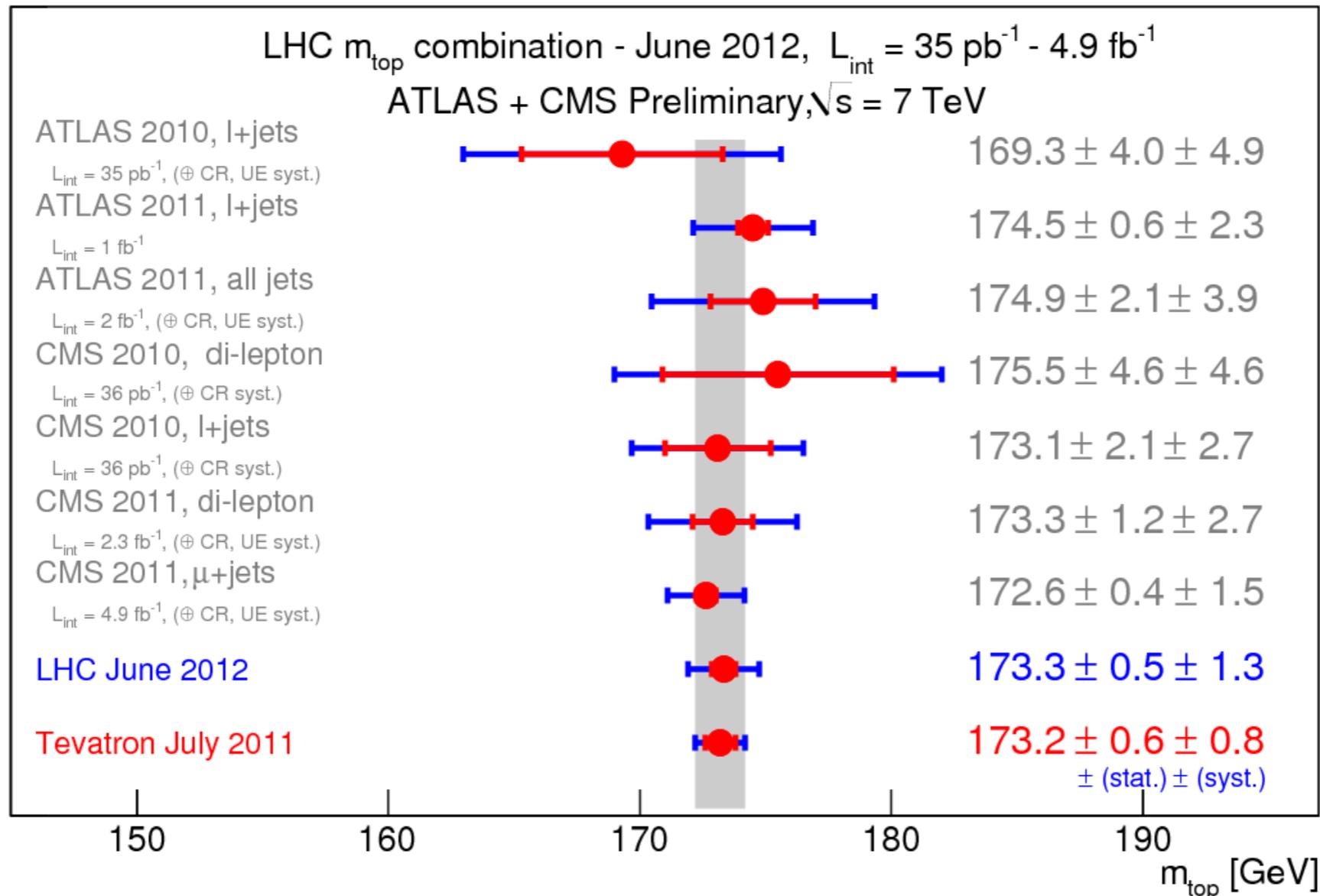
JHEP 12(2012)105



Massa del top: combinazione dei risultati

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CMS-PAS-TOP-12-001

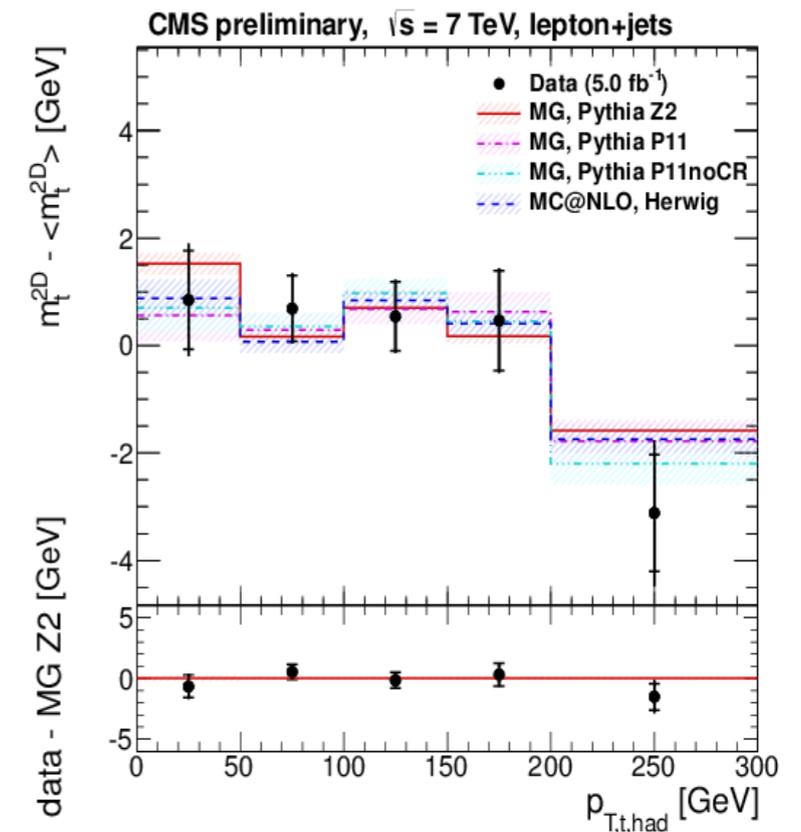
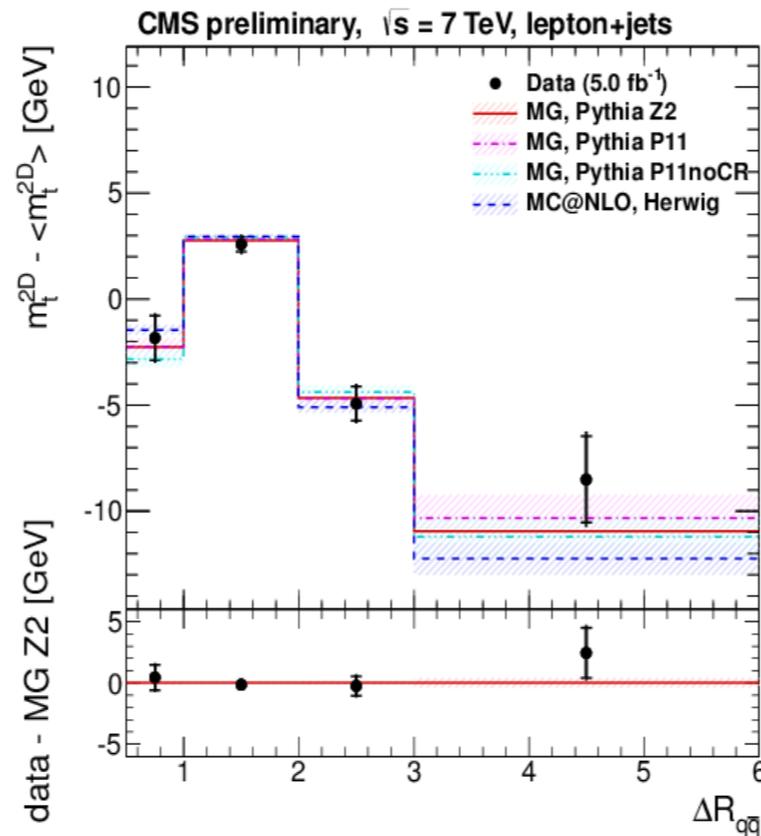
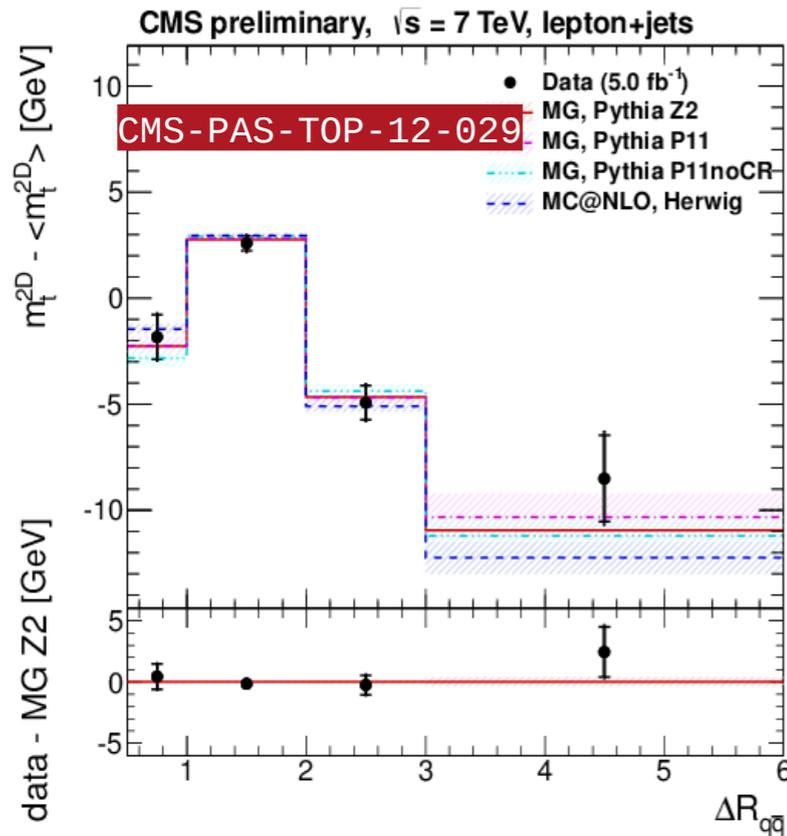


- Numerosi metodi per la misura della massa, combinati tramite **BLUE**
- **Precisione vicina a quella di Tevatron!**
- Combinazione **CMS/Atlas**: obiettivo ultimo, più laborioso ma asintoticamente più preciso!

*<https://twiki.cern.ch/twiki/bin/view/AtlasPublic/CombinedSummaryPlots>

Misura di m_{top} in funzione delle variabili cinematiche

- Possibile testare gli effetti di modeling sulla misura di m_{top}
- misure differenziali del **bias delle variabili m_{top} ricostruite** rispetto alla massa misurata

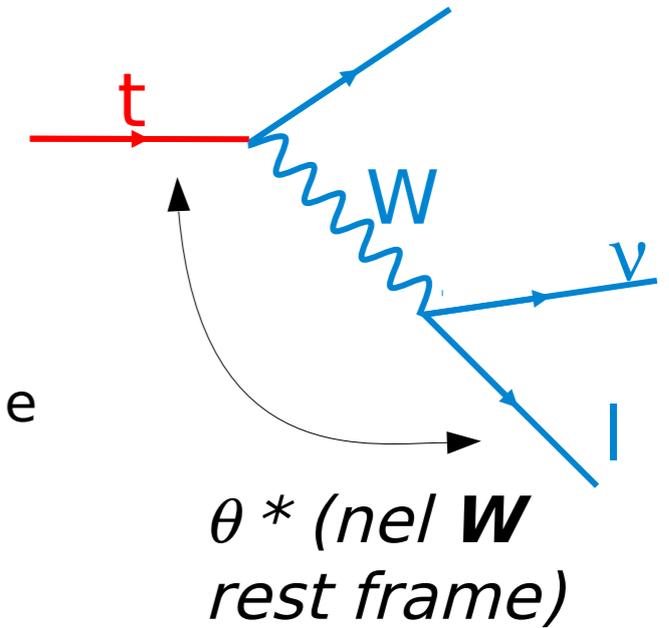


- Possibile studiare diverse variabili sensibili a variazioni di **ISR/FSR**, effetti di **color reconnection...**
- **Ancora nessuna deviazione significativa dalla predizione**

Polarizzazione W: eventi tt e single top

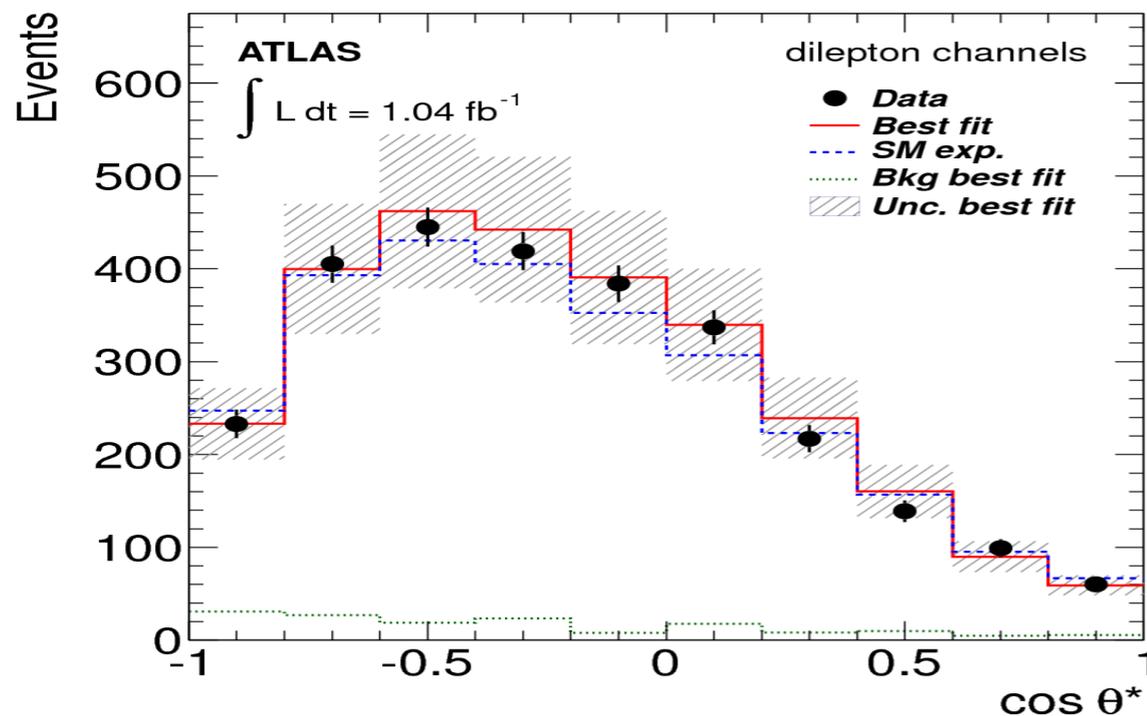
$$\frac{1}{\Gamma} \frac{d\Gamma}{d\cos\theta^*} = \frac{3}{8} (1 + \cos\theta^*)^2 F_R + \frac{3}{8} (1 - \cos\theta^*)^2 F_L + \frac{3}{4} (1 - \cos^2\theta^*) F_0$$

- Struttura **V-A** del decadimento: componenti left (F_L), right (F_R), e longitudinale (F_0) della polarizzazione della W fissate
- Possibile ricavarle da fit negli eventi tt e single-top



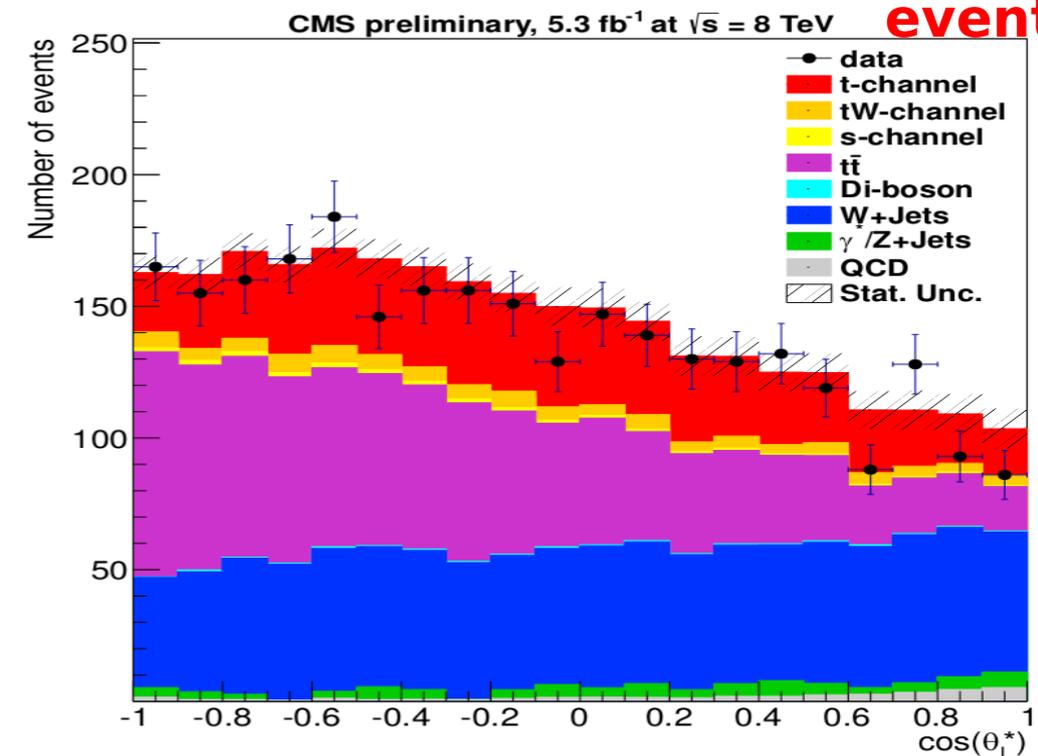
JHEP 1206 (2012) 088

tt events



CMS-PAS-TOP-12-020

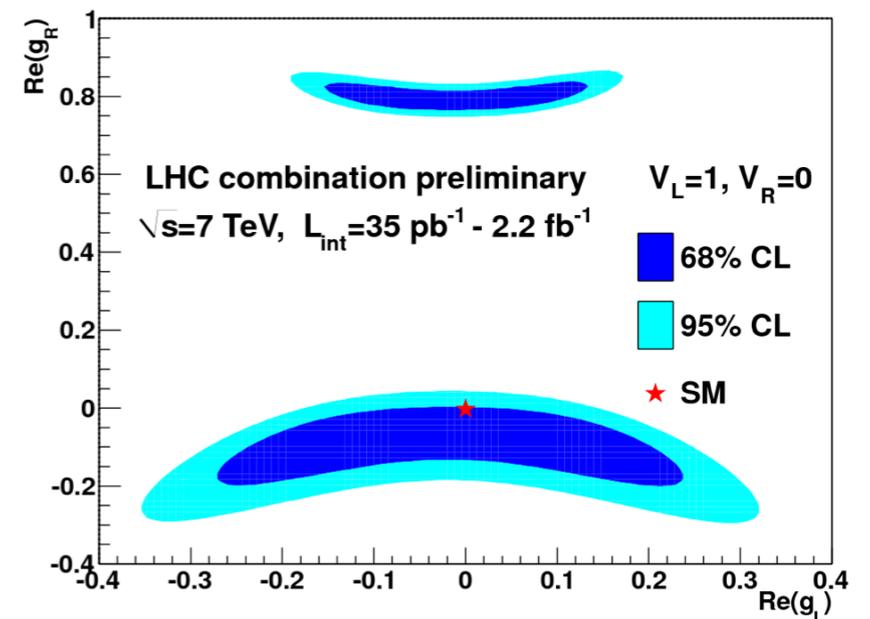
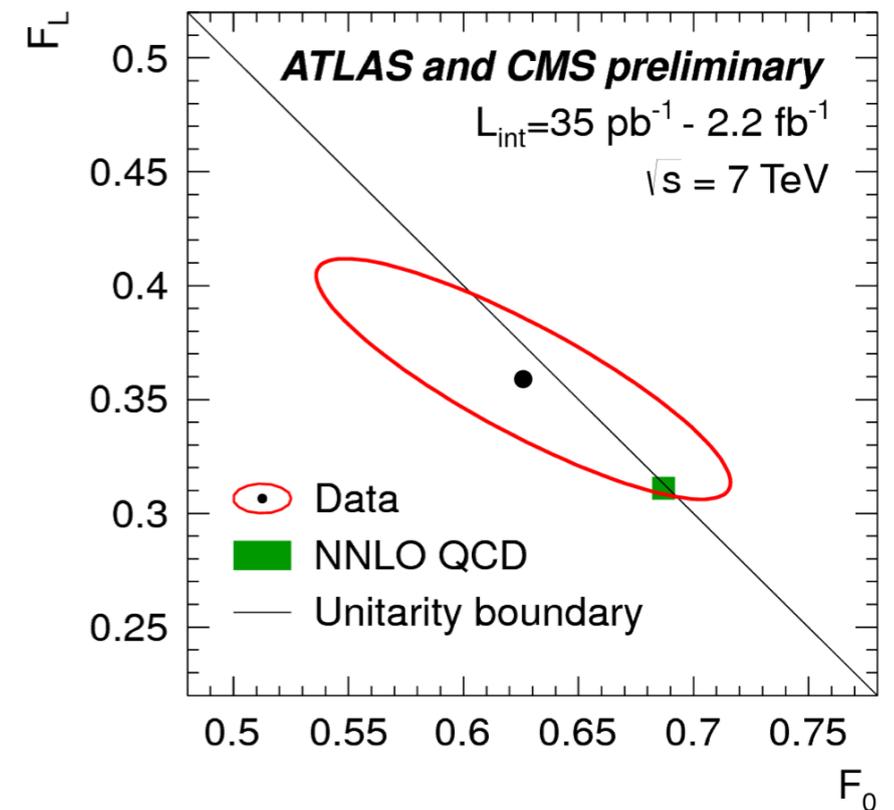
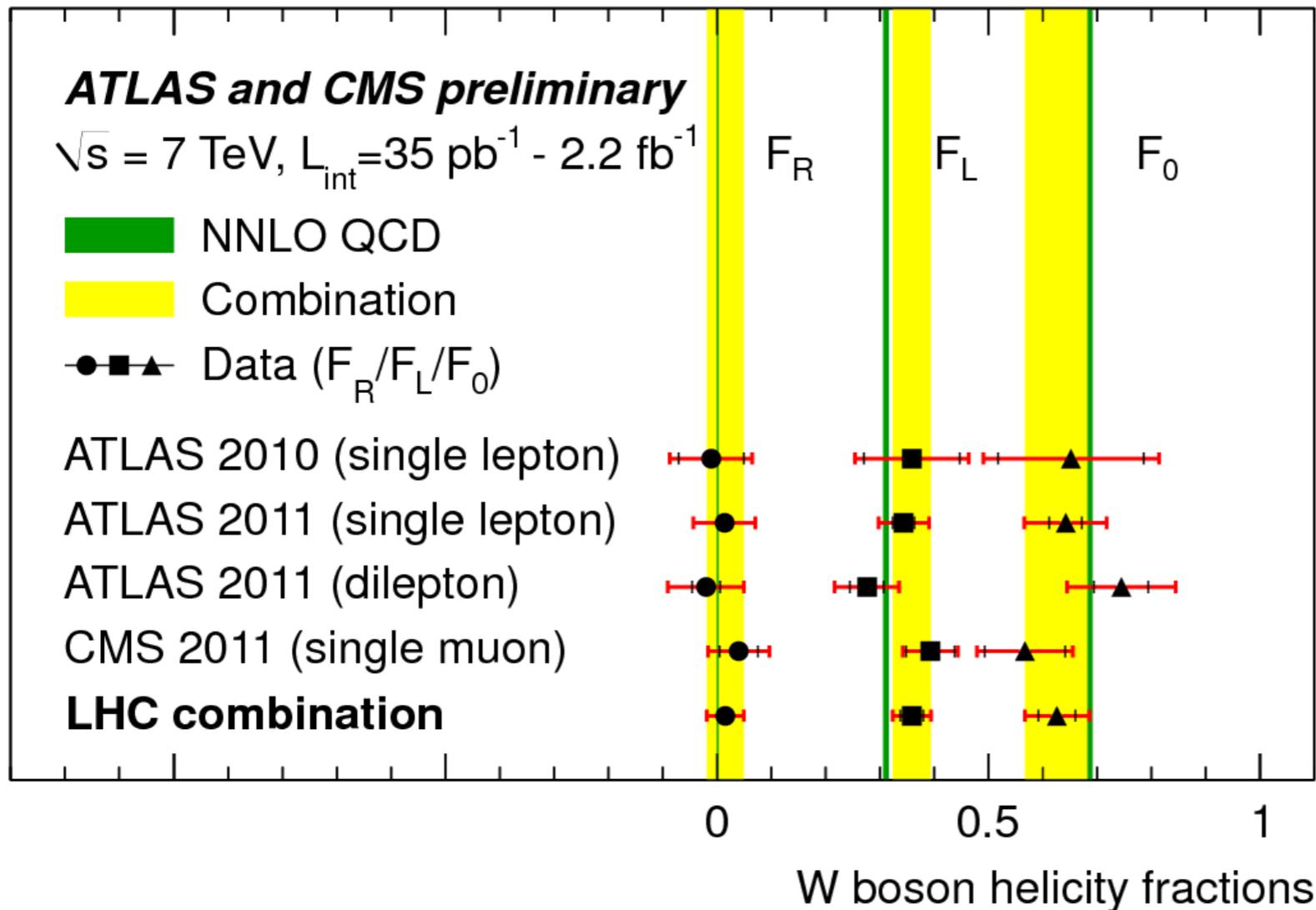
single-top events



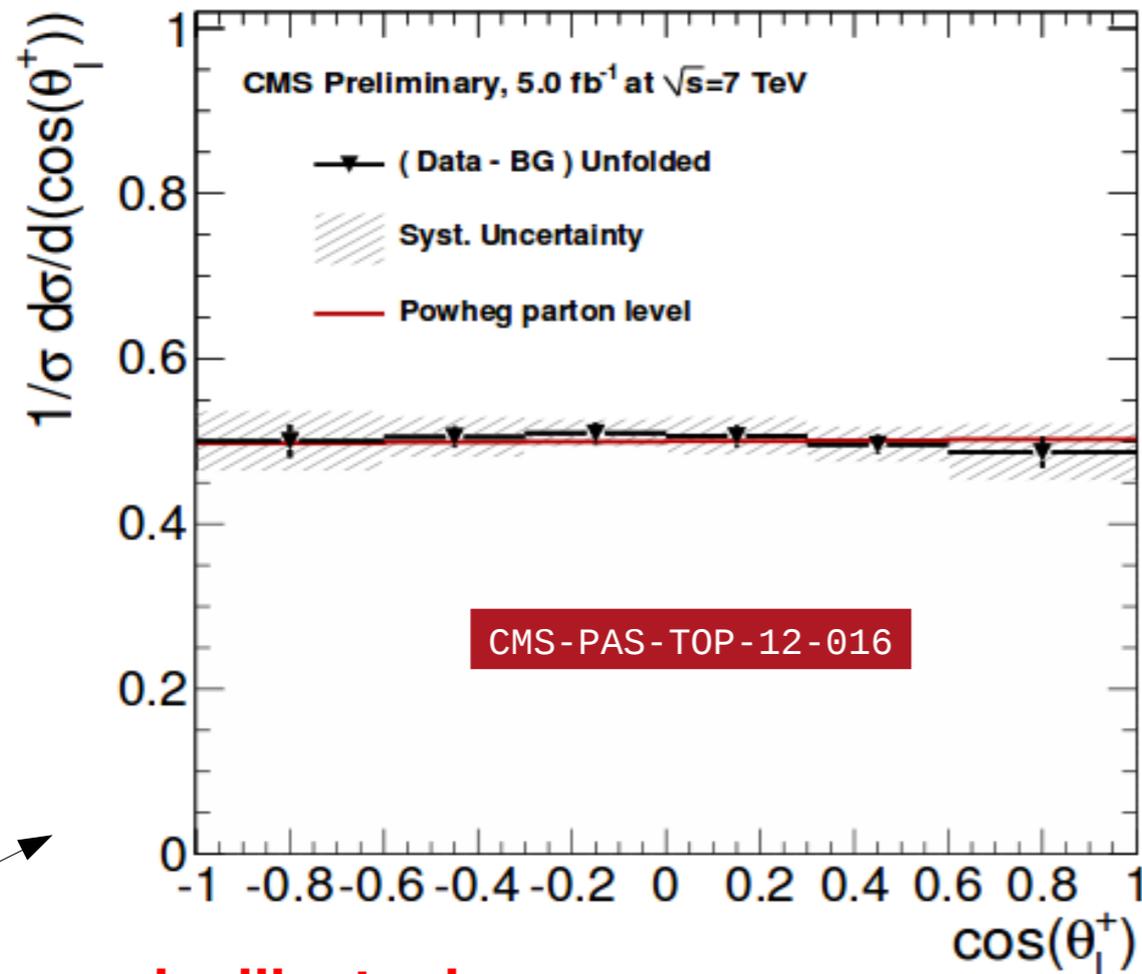
Polarizzazione W: combinazione

ATL-CONF-2013-033

CMS-PAS-TOP-12-025



Polarizzazione del top in eventi tt

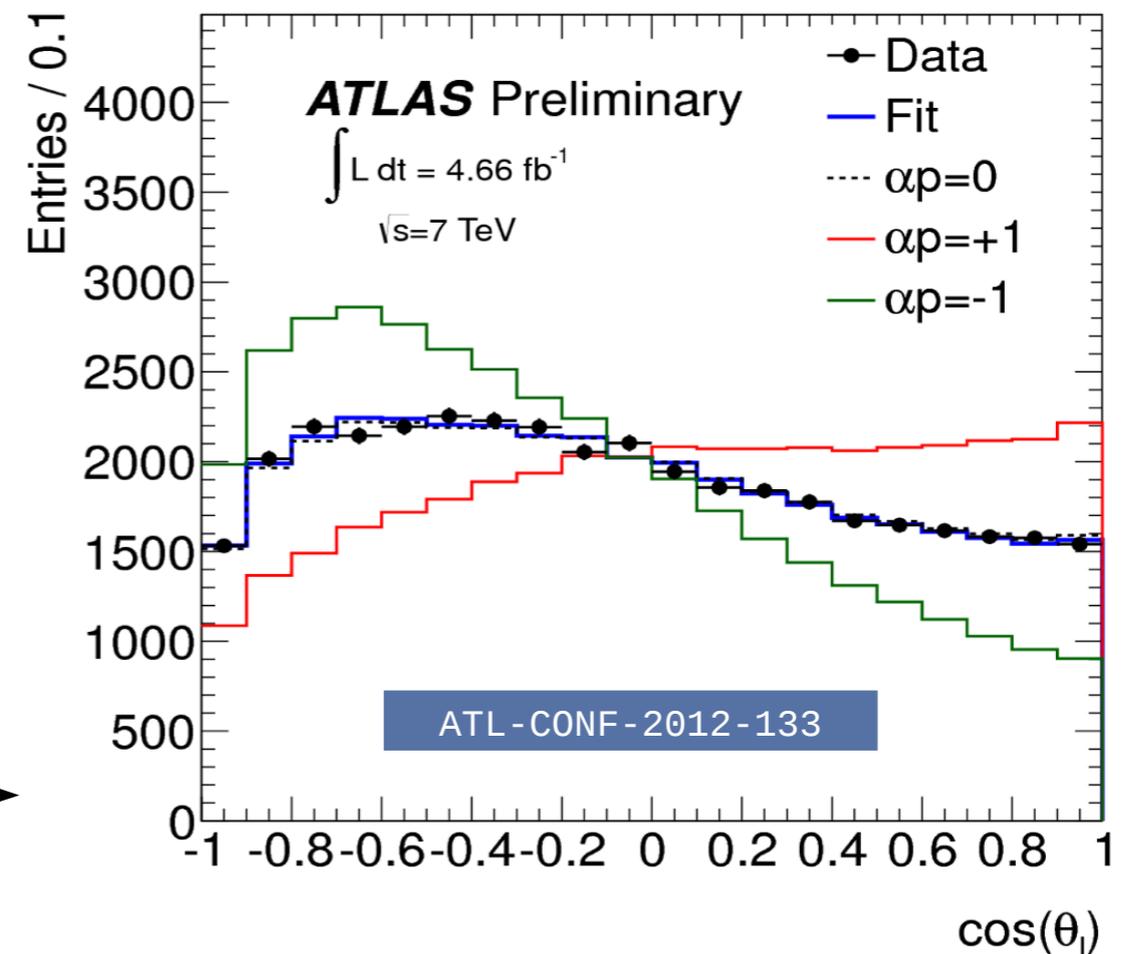
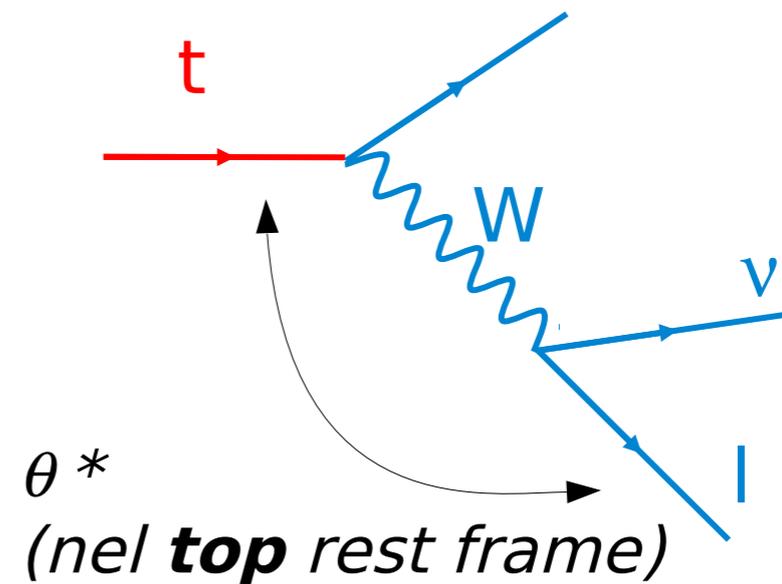


CMS, canale dileptonico:

Sistema tt: si ricostruisce con l'Analytical Matrix Weighting Technique. Si esegue poi l'unfolding della distribuzione risultante

ATLAS, canale semileptonico:

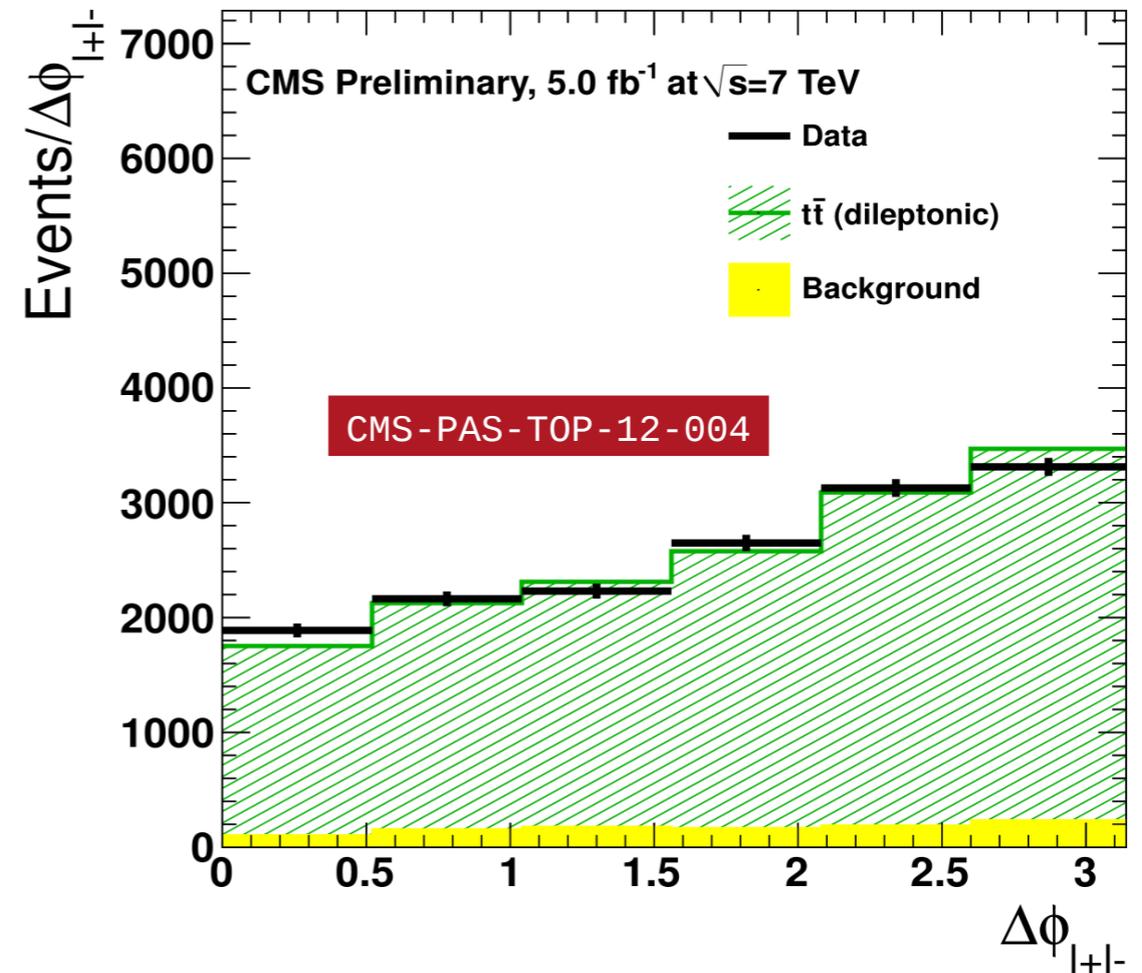
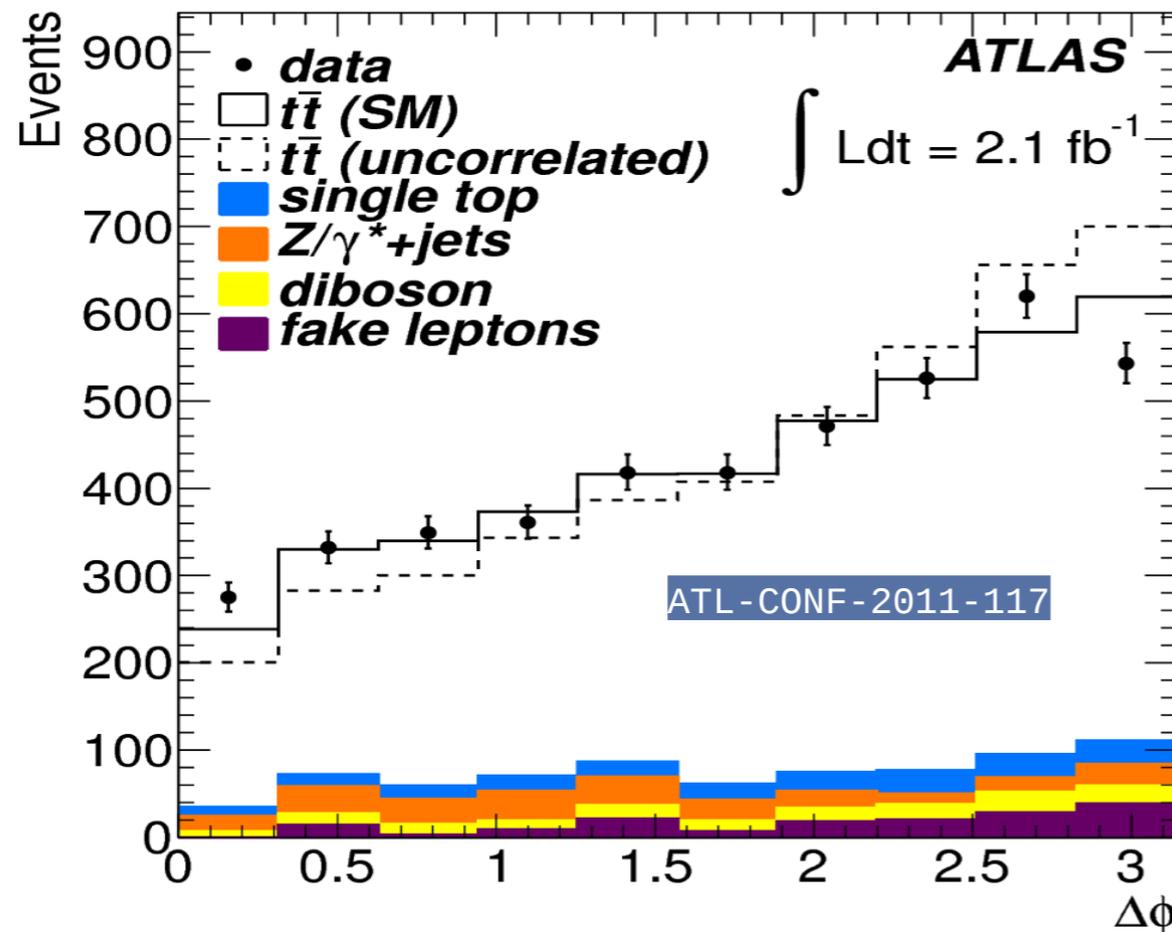
Polarizzazione ricavata da un template fit per ricavare le componenti della polarizzazione



Spin correlation

- Distribuzione angolare dei leptoni nel decadimento di coppie $t\bar{t}$

$$A = \frac{N(\uparrow\uparrow) + N(\downarrow\downarrow) - N(\uparrow\downarrow) - N(\downarrow\uparrow)}{N(\uparrow\uparrow) + N(\downarrow\downarrow) + N(\uparrow\downarrow) + N(\downarrow\uparrow)}$$



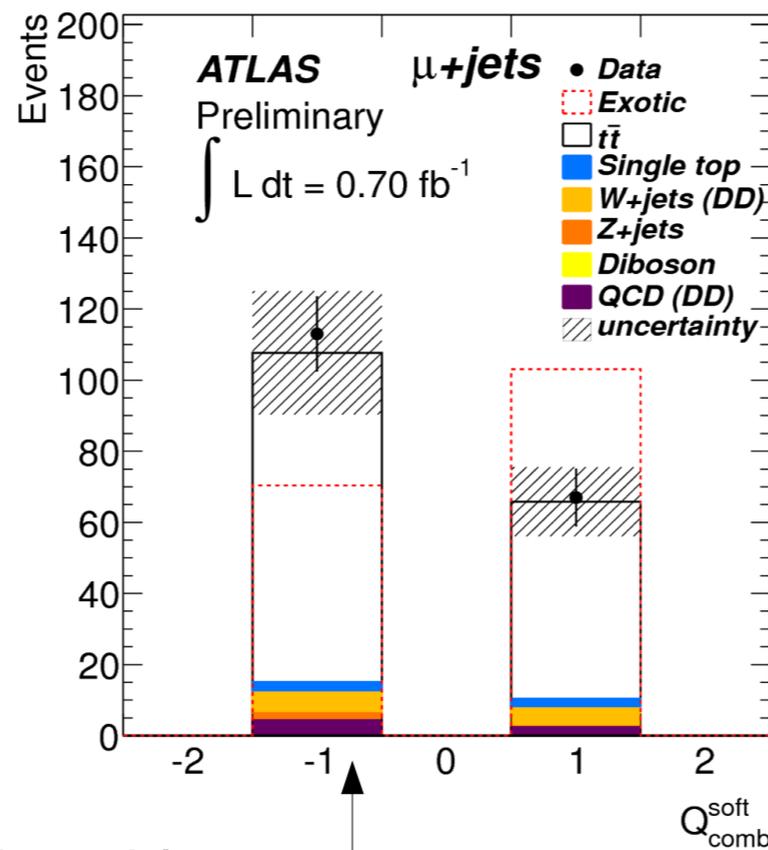
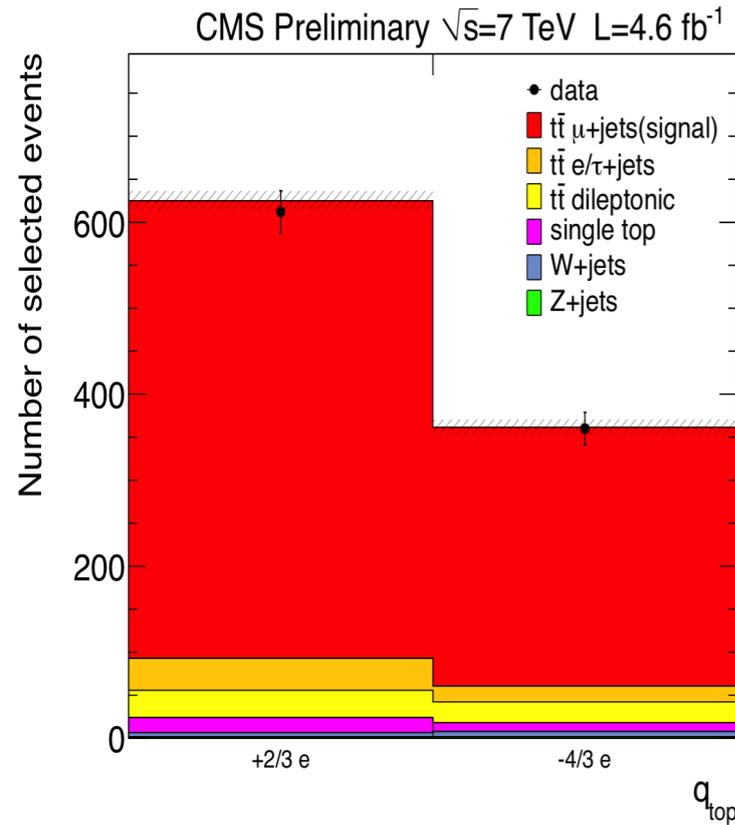
$$A_{\Delta\phi} = \frac{N(\Delta\phi_{l+l-} < \pi/2) - N(\Delta\phi_{l+l-} > \pi/2)}{N(\Delta\phi_{l+l-} < \pi/2) + N(\Delta\phi_{l+l-} > \pi/2)}$$

Variabili sensibili a **charge asymmetry** in eventi $t\bar{t}$

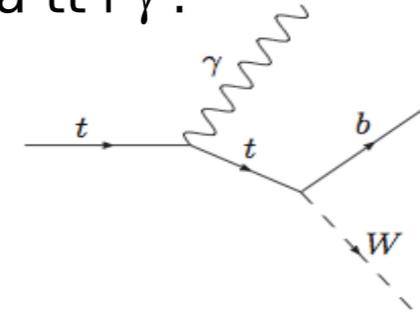
Carica del top

CMS-PAS-TOP-11-031

ATL-CONF-2011-141



Misura dalla sezione d'urto di produzione associata $t\bar{t}+\gamma$:



→ **consistente** con top standard model

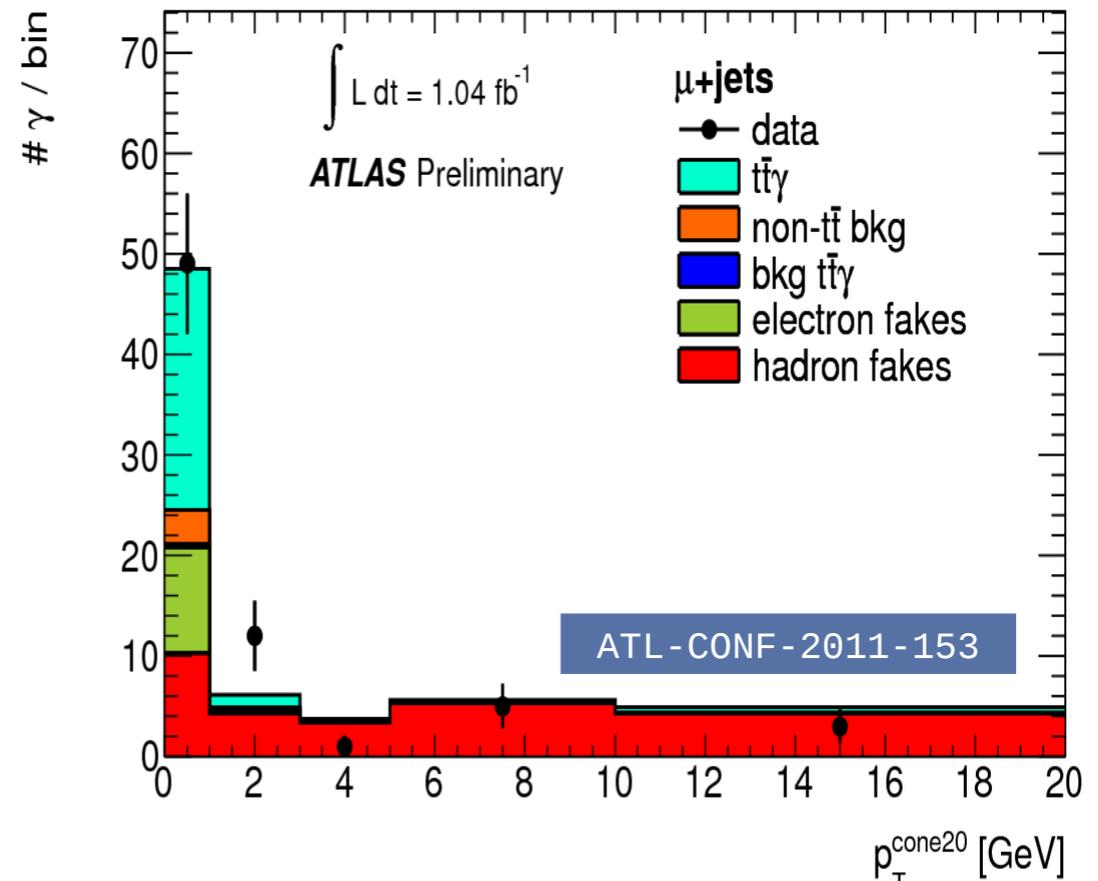
Misura dai decadimenti $t \rightarrow b\ell\nu$:

Metodo 1): misurare **la carica del leptone soft** prodotto jet proveniente dal b, per verificare se il prodotto ha il segno previsto dallo SM

Metodo 2): sommare **le cariche delle particelle** nel b-jet :

$$Q_{bjet} = \frac{\sum_i q_i |\vec{j} \cdot \vec{p}_i|^\kappa}{\sum_i |\vec{j} \cdot \vec{p}_i|^\kappa}$$

Entrambi i metodi escludono a 5 sigma un top esotico a carica -4/3

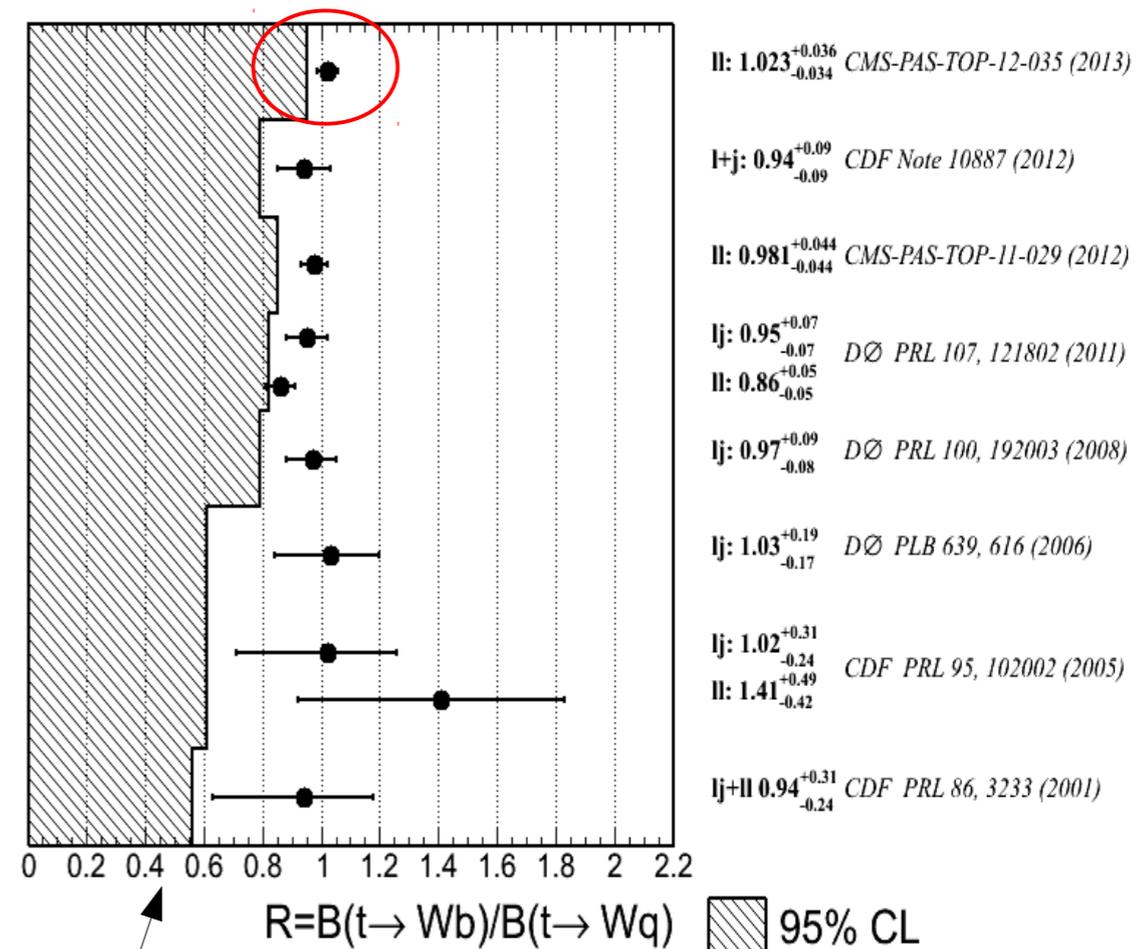
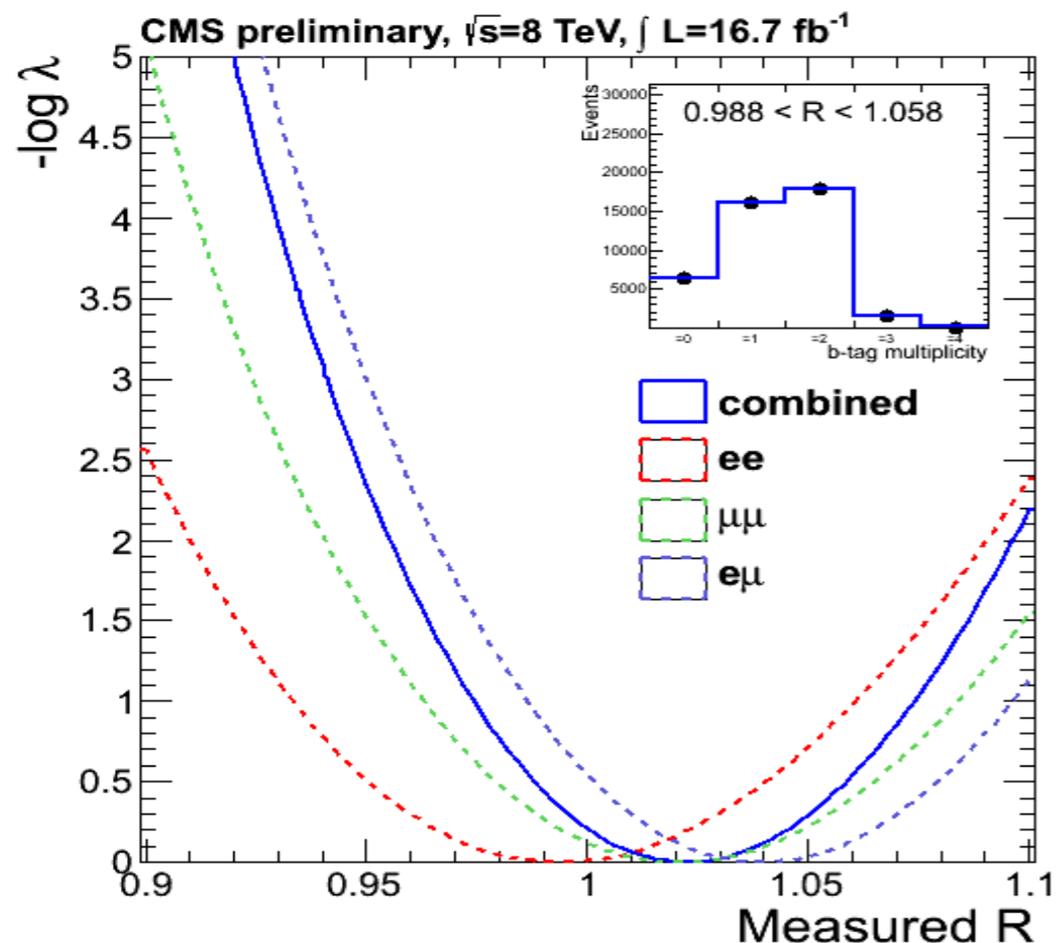


$$\sigma_{t\bar{t}\gamma} \cdot \text{BR} = 2.0 \pm 0.5 (\text{stat.}) \pm 0.7 (\text{syst.}) \pm 0.08 (\text{lumi.}) \text{ pb}$$

Misura di $R=B(t \rightarrow Wb)/(t \rightarrow Wq)$

CMS-PAS-TOP-12-035

- Permette misura di $|V_{tb}|$
- Limite di unitarietà prevede $|V_{tb}|=0.999146^{+0.00021}_{-0.00046}$
- Misura più recente di Tevatron: $|V_{tb}|=0.95 \pm 0.02$
- Likelihood fit allo spettro di jet multiplicity

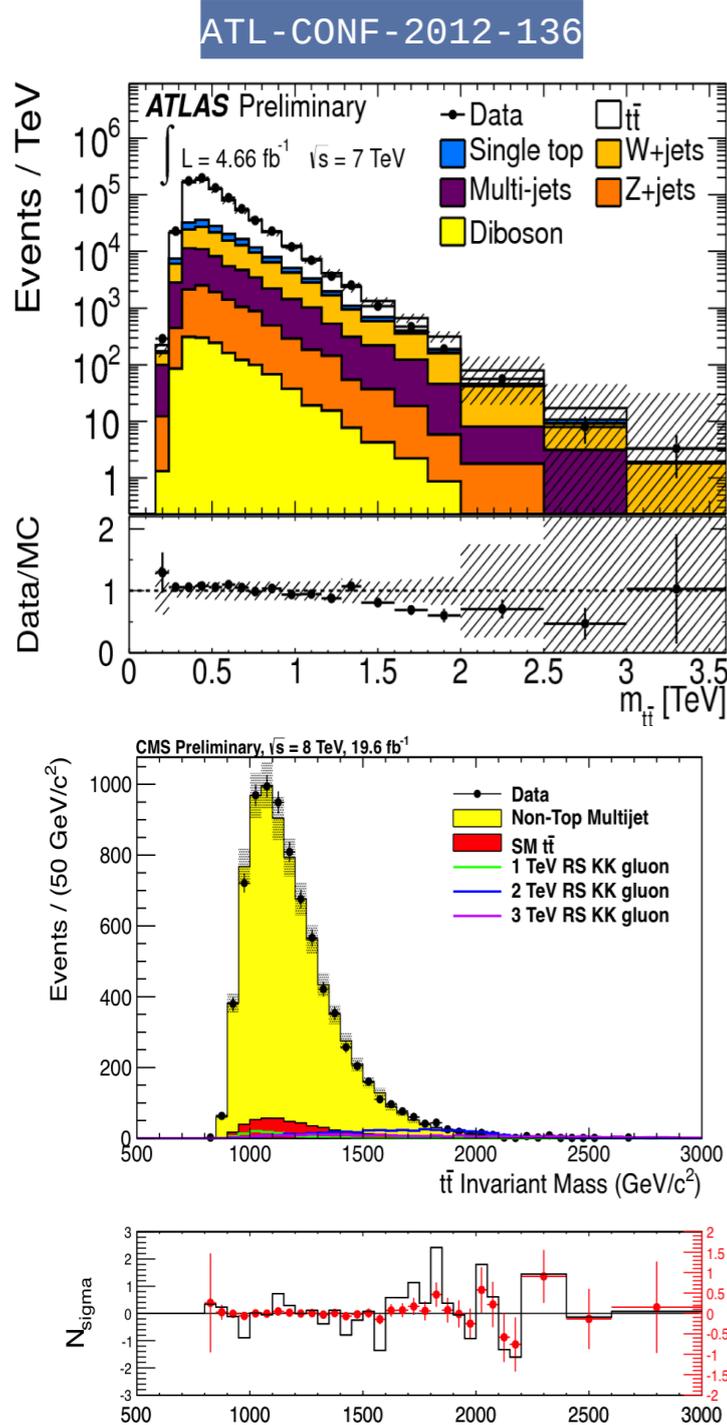


- Misura più precisa up to date
- $R = 1.023^{+0.036}_{-0.034}$**
- $|V_{tb}| = 1.011^{+0.018}_{-0.017}$**
- Lontani dalla precisione del limite di unitarietà nello scenario SM
 - Sensibile a variazioni dovute a fisica bsm.

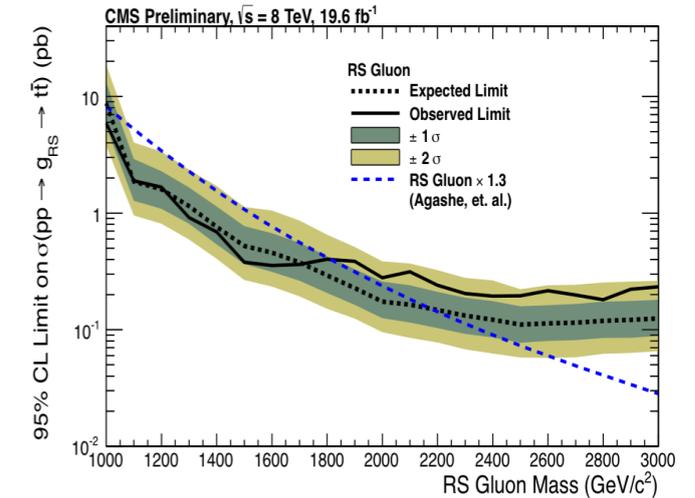
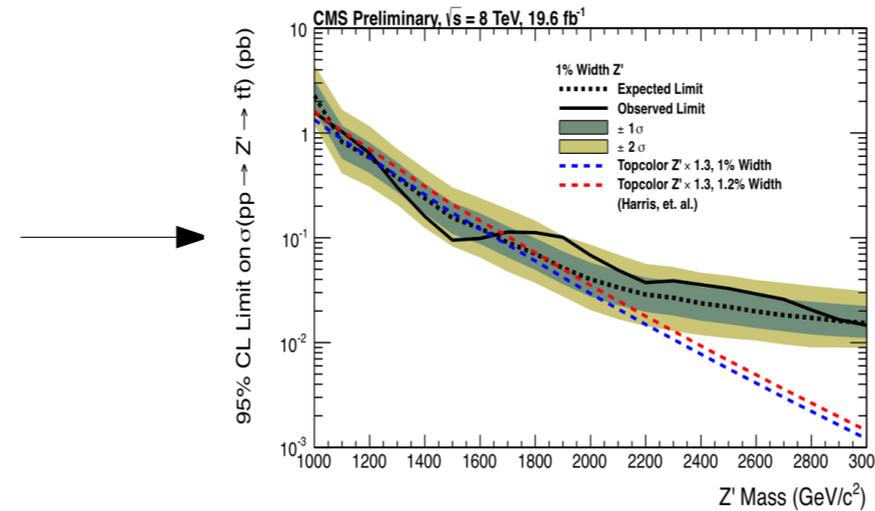
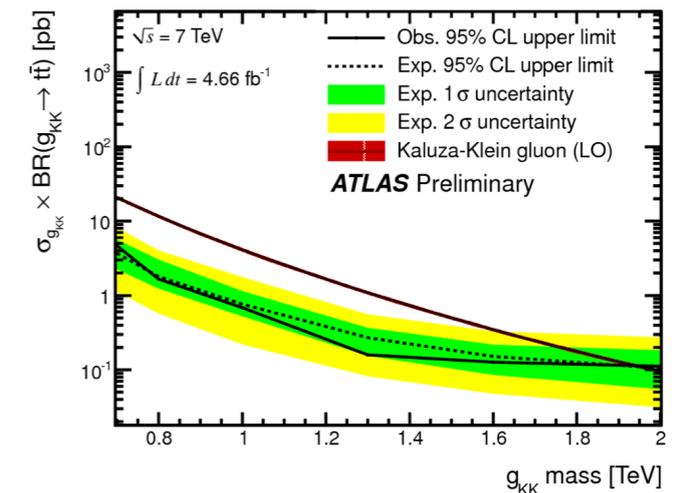
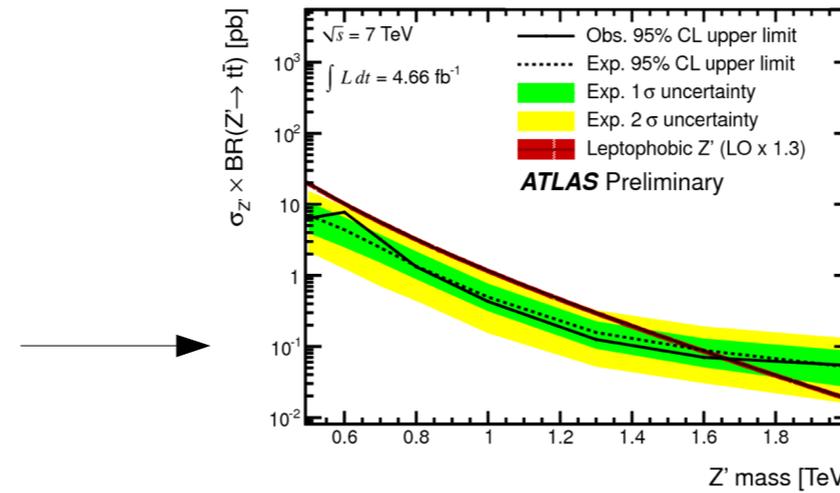
Ricerche dirette di nuova fisica nei canali con quarks top

- Risonanze tt , $tt+j$, $t+b$
- FCNC
- Violazione CP

Risonanze $t\bar{t}$



CMS-PAS-B2G-12-005



- Ricerca di risonanze strette ($\Gamma_{Z'}/m_{Z'} = 1.2\%$) in bosoni Z' e stati eccitati di gluoni in modelli di Kaluza Klein

$m_{Z'} > 2.5 \text{ TeV CMS } (\sigma < 33 \text{ fb});$

$> 1.7 \text{ TeV ATLAS } (\sigma < 0.7 \text{ pb});$

$m_{KK'} > 1.8 \text{ TeV CMS}; > 1.9 \text{ TeV ATLAS};$

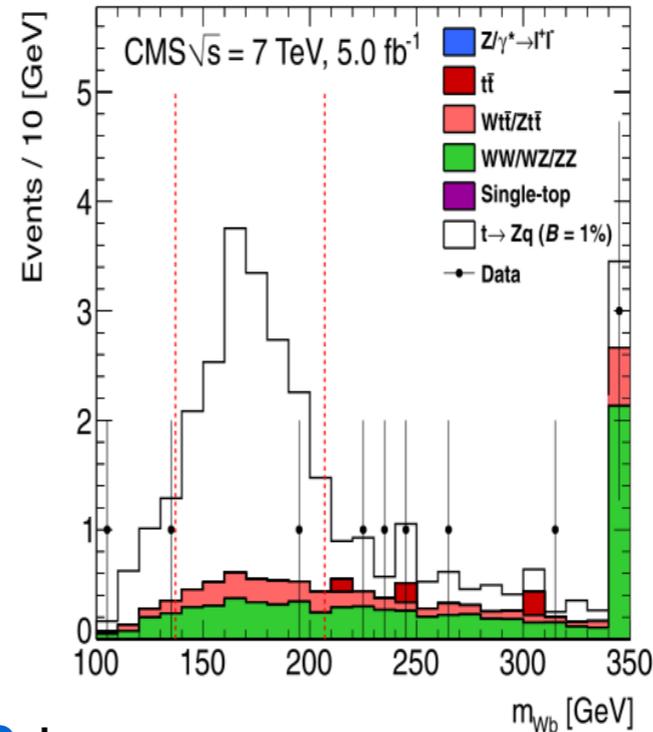
- Altre risonanze in $t\bar{t}$ + jets: legate a possibile anomalia F-B rilevata a Tevatron. Vedi anche: [ATL-CONF-2012-096](#)

Ricerca di Flavour Changing Neutral Currents

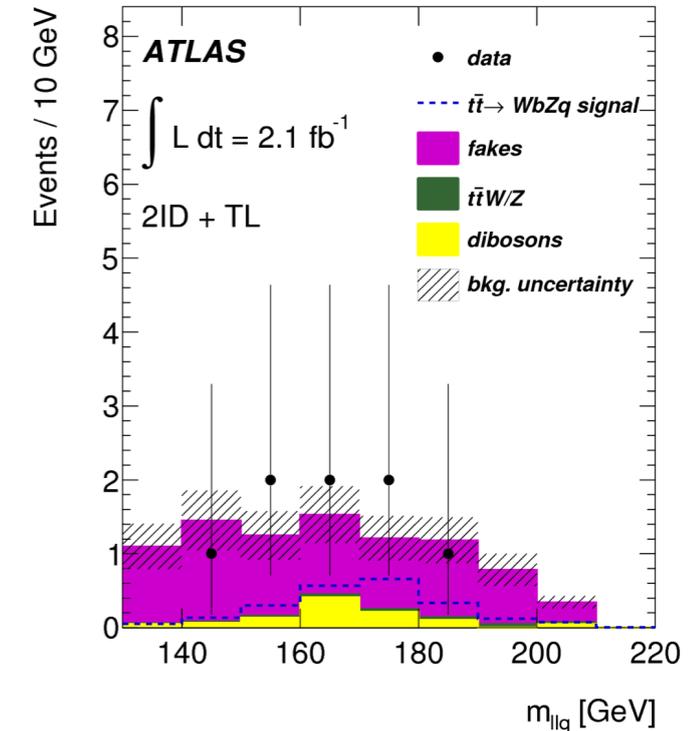
Canale con **3 leptoni carichi** in eventi tt:

- BR(t → qZ) < **0.21% CMS;**
 - BR(t → qZ) < **0.73% ATLAS;**
- @95%CL

PLB718 (2012) 1252

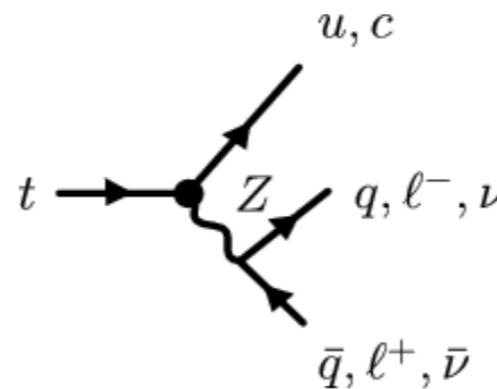


JHEP09(2012)139

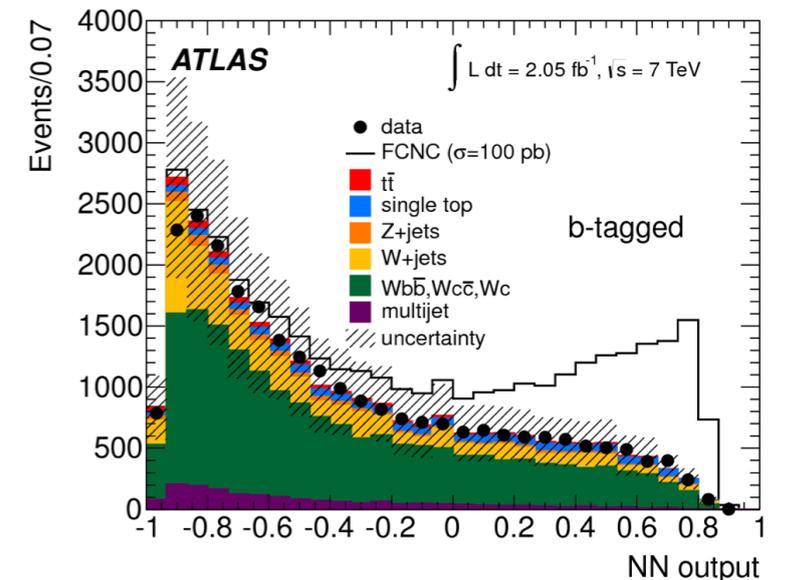


Produzione di FCNC in eventi di **top singolo** :

- $\sigma(qg \rightarrow t) * BR(t \rightarrow bW) < 3.9 \text{ pb}$
 - BR(t → ug) < **5.7 10⁻⁵**
 - BR(t → cg) < **2.7 10⁻⁴**
- @95%CL



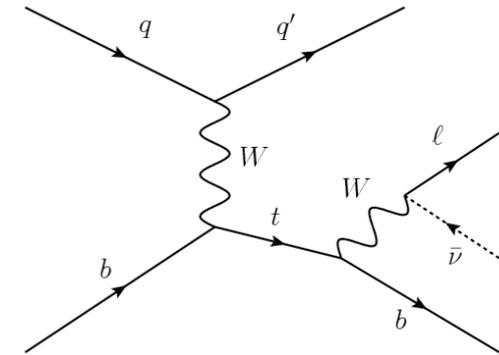
PLB712(2012)351-369



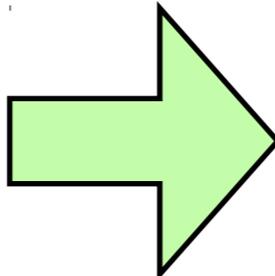
Violazione CP

- Polarizzazione del quark top nel t-channel :

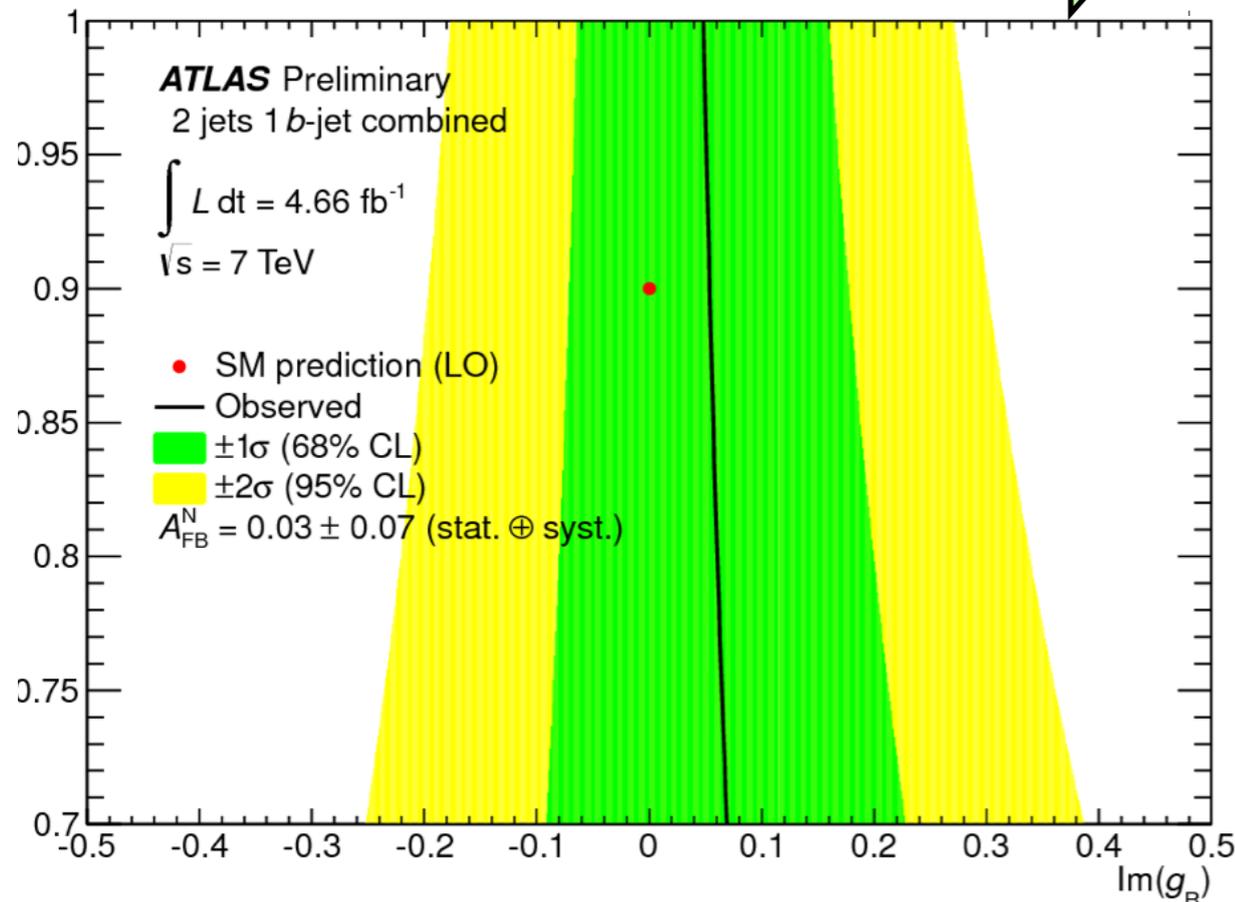
$$\mathcal{L}_{Wtb} = -\frac{g}{\sqrt{2}} \bar{b} \gamma^\mu (V_L P_L + V_R P_R) t W_\mu^- - \frac{g}{\sqrt{2}} \bar{b} \frac{i\sigma^{\mu\nu} q_\nu}{m_W} (g_L P_L + g_R P_R) t W_\mu^- + \text{h.c.}$$



helicity
frame



$$A_z \equiv \frac{N_{\text{evt}}(\cos \theta > z) - N_{\text{evt}}(\cos \theta < z)}{N_{\text{evt}}(\cos \theta > z) + N_{\text{evt}}(\cos \theta < z)}$$



$$A_{\text{FB}}^N = 0.031 \pm 0.065(\text{stat}) \pm 0.030(\text{syst})$$

$$\text{Im}(g_R) \in [-0.20, 0.30] \text{ 95\% CL}$$

ATL-CONF-2013-032

Conclusioni

- **Studio della fisica del top ha raggiunto una fase matura:**

- LHC si è dimostrata anche nei fatti una eccellente top factory, sia per produzione di top via **processi forti** (tt) che per **processi elettrodeboli** (single top)
- Processi di quark top possono essere usati per **misurare i parametri fondamentali** della teoria, nonché le **proprietà del quark top**

- **Misure attuali**

- **Precisione** in molti casi largamente superiore o comunque comparabile a quella di tevatron, spesso comparabile anche a quella delle previsioni teoriche (e.g. per le sezioni d'urto tt).
- **Spettri differenziali** usati per la calibrazione dei modelli (pdf, isr/fsr, schemi di adronizzazione...)
- Permettono di escludere numerosi modelli di fisica **oltre il modello standard**

- **Prospettive future**

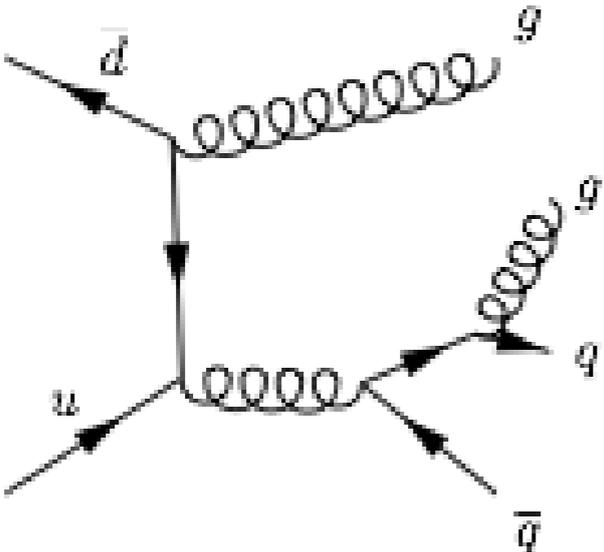
- **Ampio margine di miglioramento** della precisione delle misure attuali (uso di più statistica, miglioramento delle tecniche di analisi, studio di topologie con top boosted...)
- Studio della fisica del top cruciale per il **tuning delle simulazioni**
- **Interazione top-higgs privilegiata**, costituisce praticamente un campo inesplorato!
- La fisica del top fornisce un **“workspace” ideale per la fisica ad LHC**, di cui abbiamo iniziato a malapena a sfruttare le potenzialità!

Grazie!

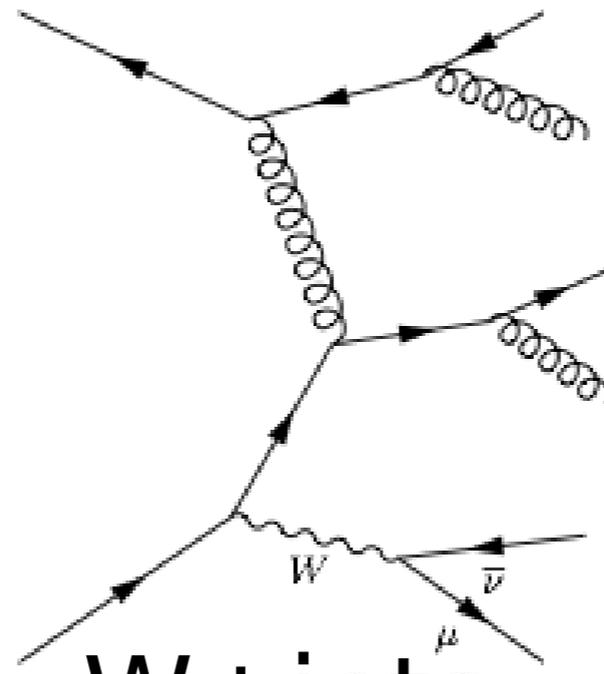
Backup

Backgrounds

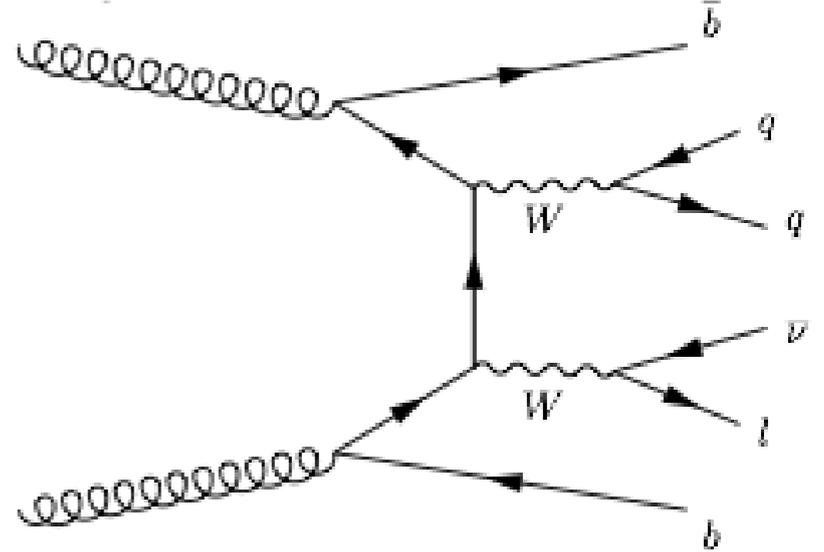
Channel	Topology	Backgrounds
Di-leptonic	2 b-jets + 2l [±] + E _T ^{miss}	WW+jets, Z+jets
Semi-leptonic	2 jets + 2 b-jets + l [±] + E _T ^{miss}	W + jets
Full-hadronic	4 jets + 2 b-jets	QCD Multi-jet



QCD

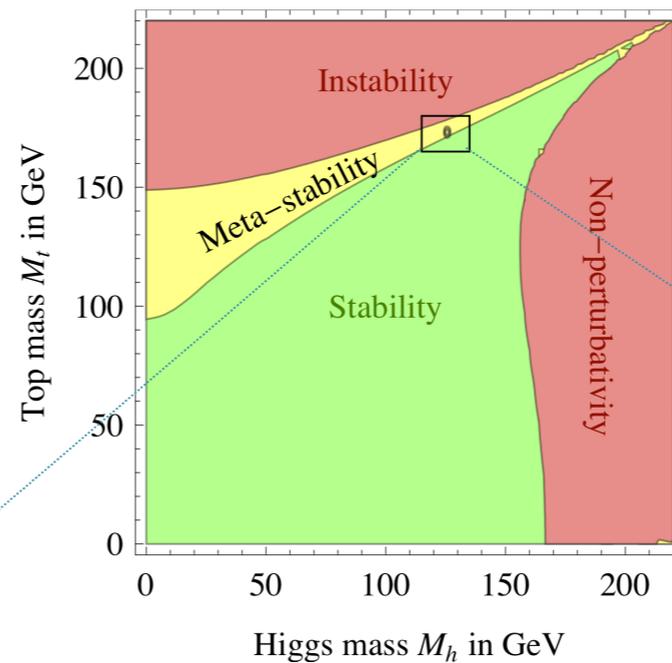
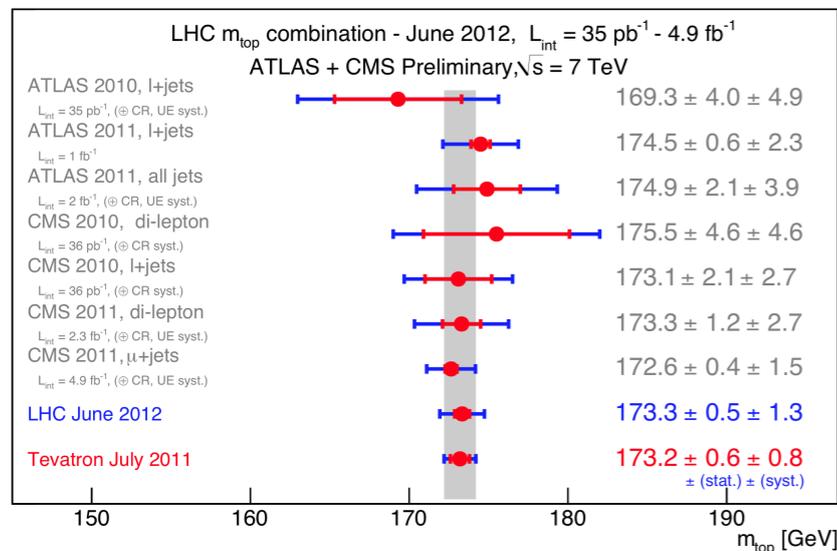


W+jets

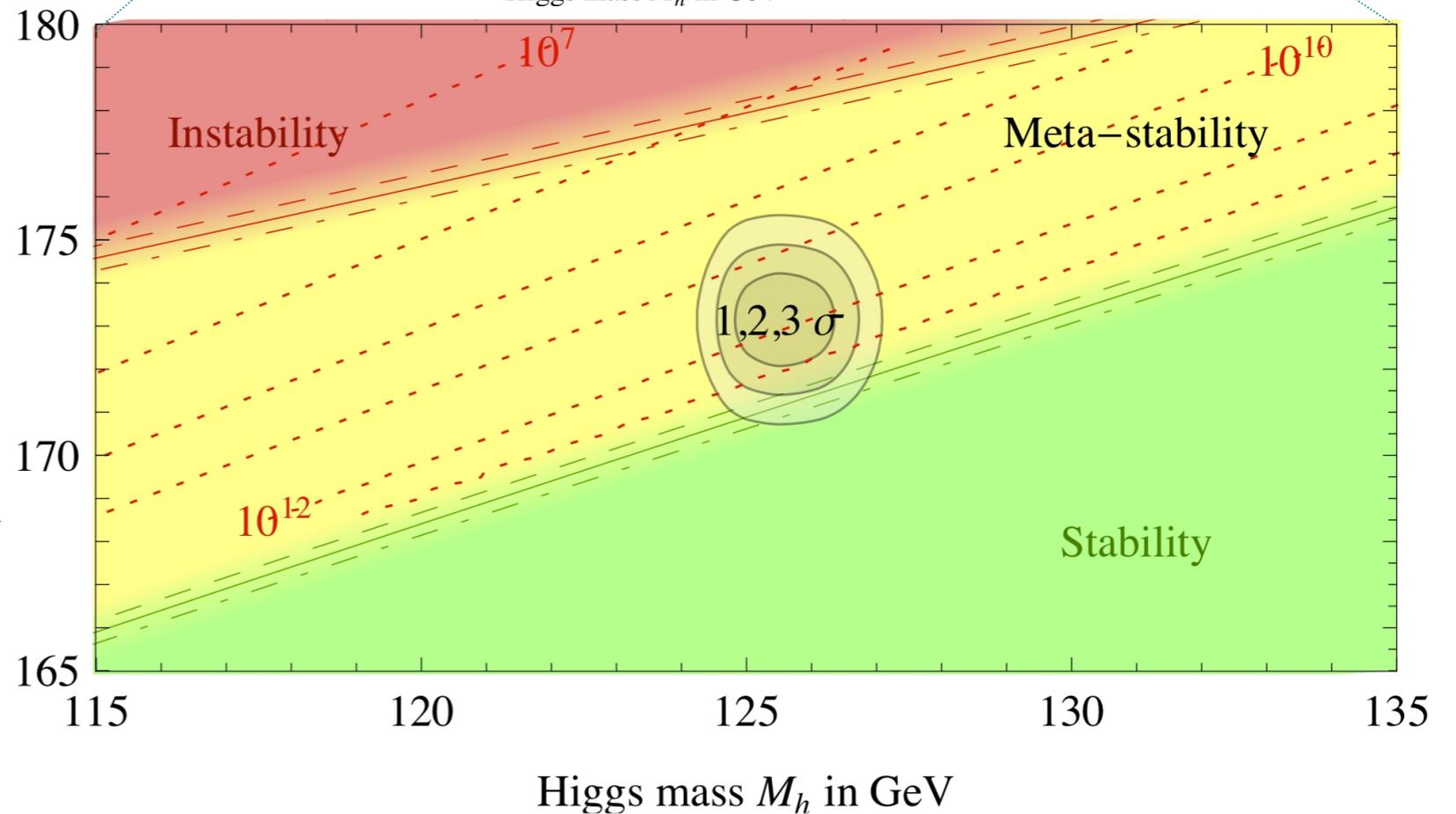
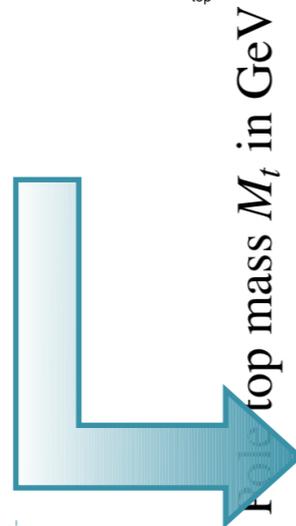


WW+jets

top mass vs higgs mass



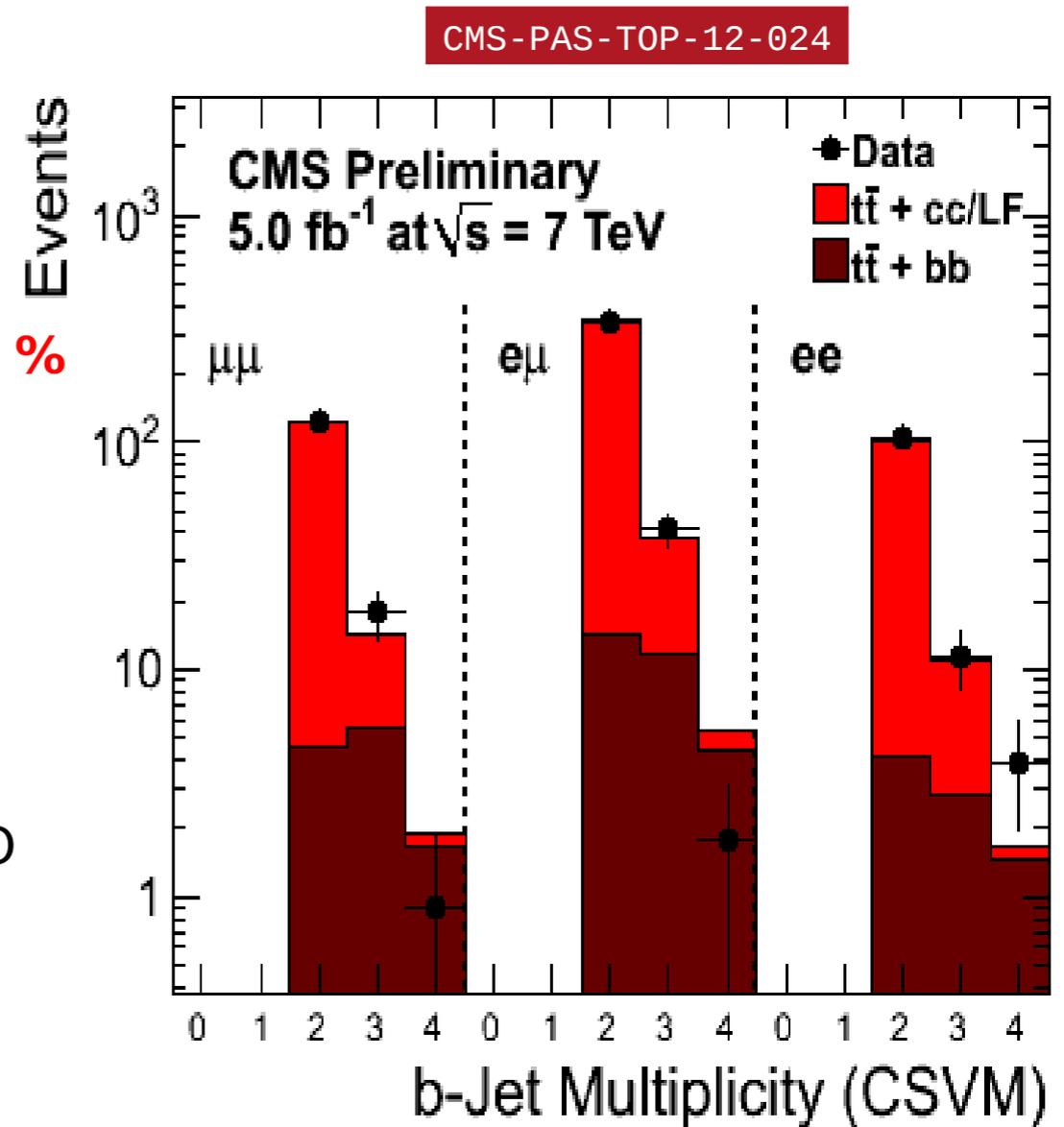
Degrassi et al:
JHEP08(2012)098



Produzione associata tt + bb

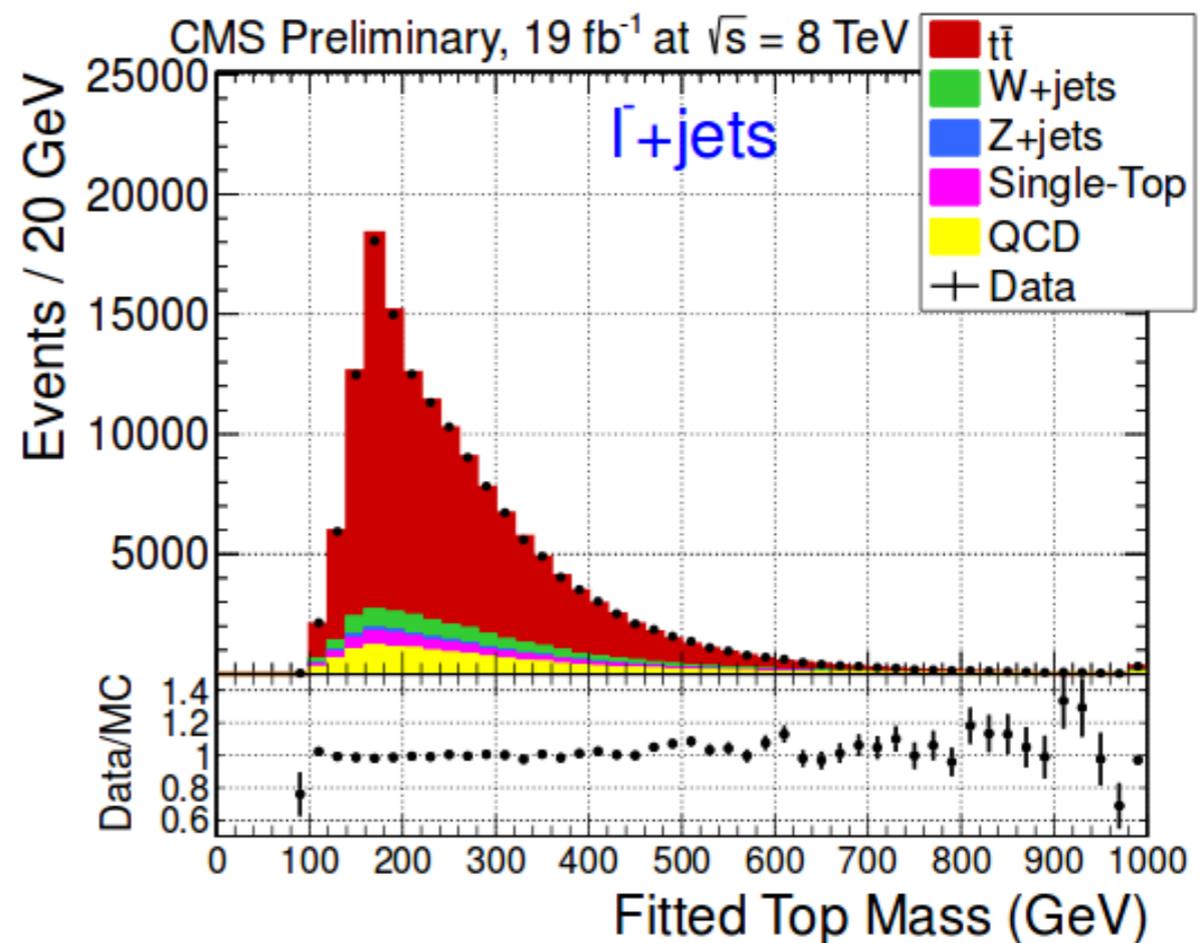
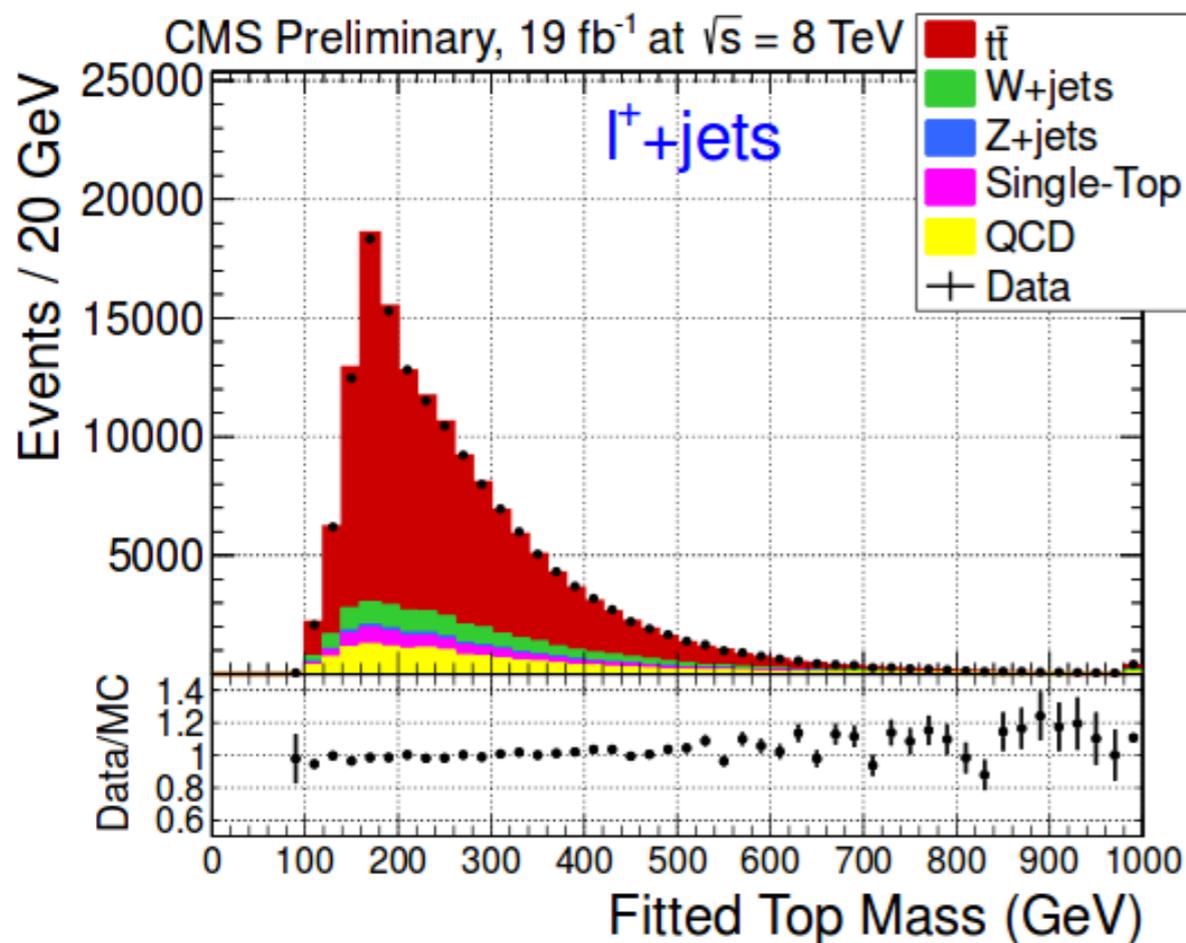
- $\sigma(ttbb)/\sigma(ttjj) \rightarrow$ prima misura (7TeV)
- Fondo per ttH(\rightarrow ttbb)
- Valore misurato :

$$\sigma(ttbb)/\sigma(ttjj) = 3.6 \pm 1.1 \text{ (stat)} \pm 0.9 \text{ (syst)} \%$$
- Previsioni:
 - $\sigma(ttbb)/\sigma(ttjj) = 1.2\%$ (Madgraph)
 - $\sigma(ttbb)/\sigma(ttjj) = 1.3\%$ (POWHEG)
- Non possono essere comparate i calcoli QCD @ NLO (4.7%) a causa della diversa accettazione dei tagli e assenza di correzioni adrone \rightarrow partone



Mass difference top - antitop

CMS-PAS-TOP-12-031



CPT invariance $\rightarrow \Delta m_t = m_t - m_{\bar{t}} = 0$

Misura con 19 fb⁻¹:

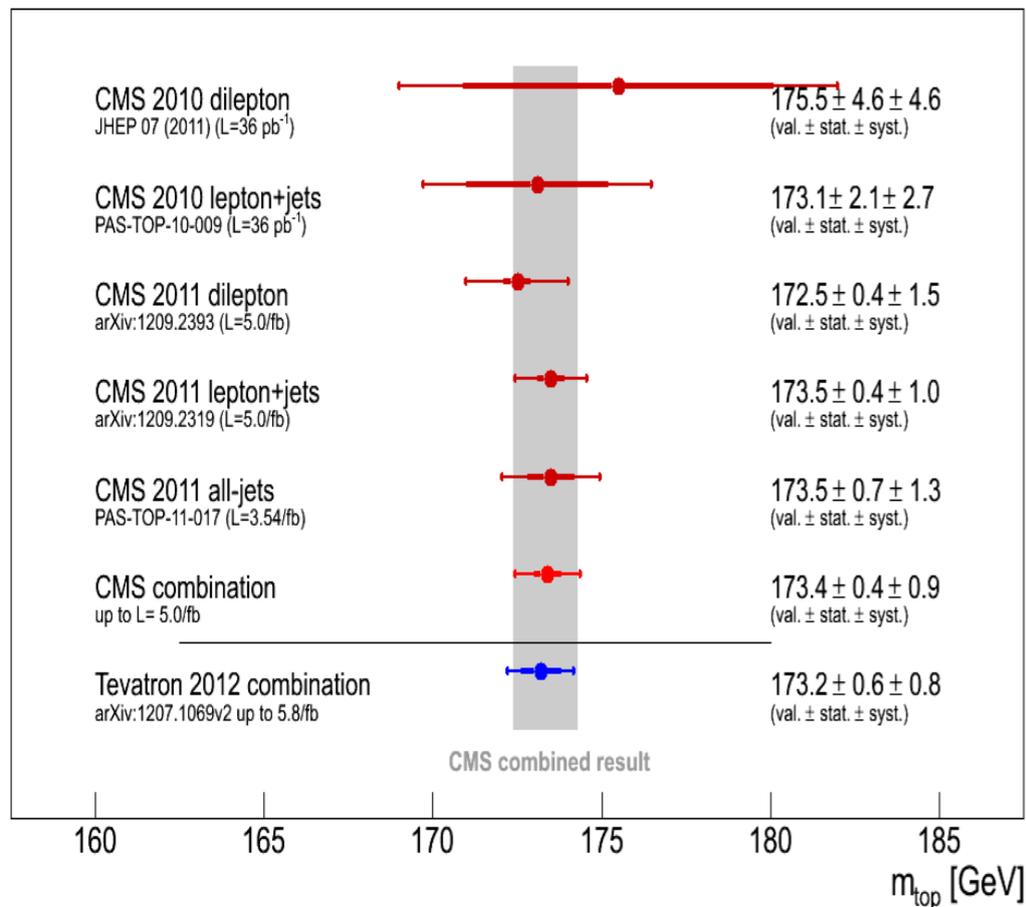
$$\Delta m_t = -272 \pm 196 \text{ (stat.)} \pm 122 \text{ (syst.) MeV}$$

Massa del top: combinazione dei risultati singoli esperimenti

CMS

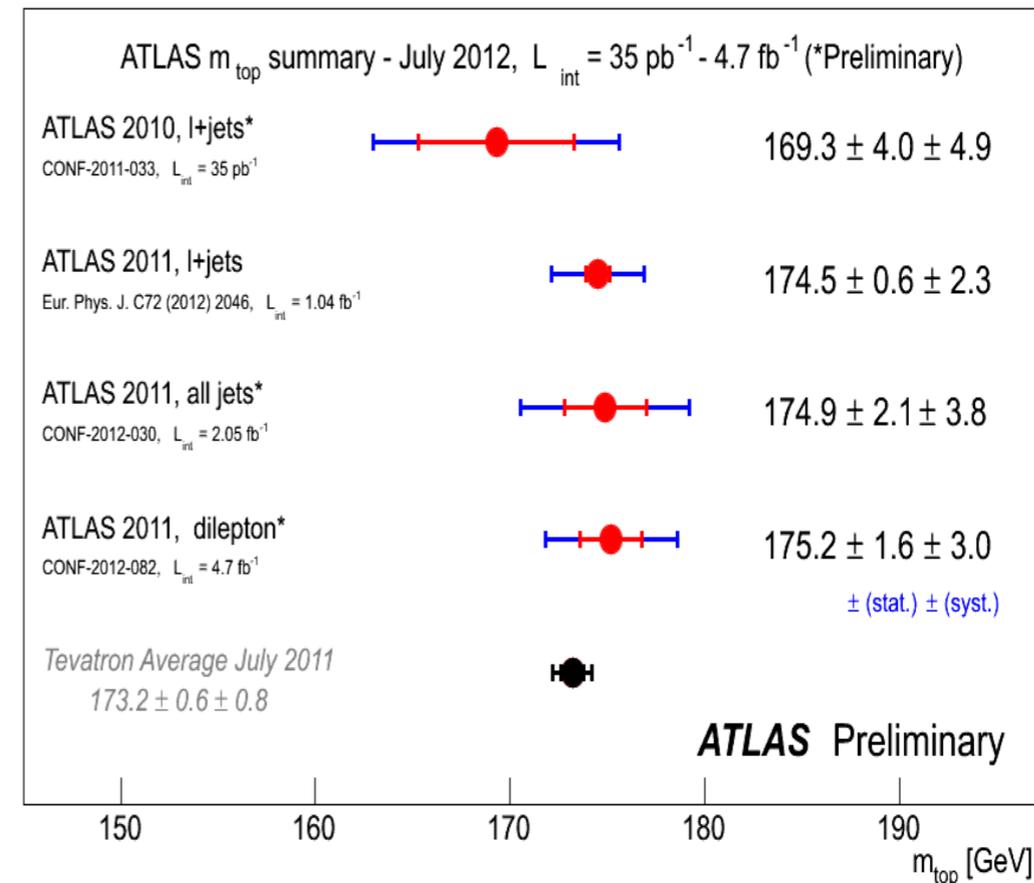
CMS-PAS-TOP-12-018

CMS Preliminary



ATLAS

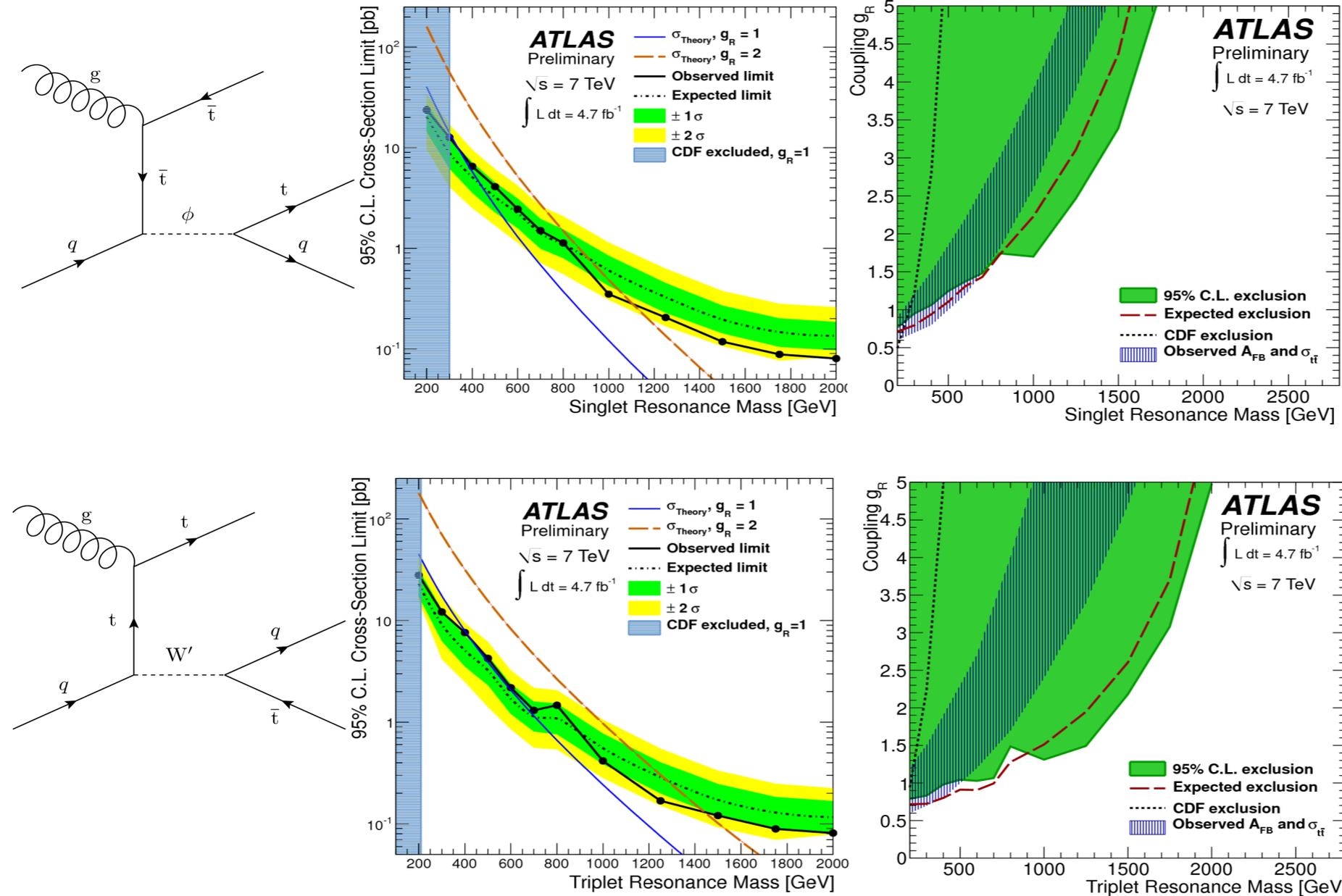
Atlas summary plots twiki*



*<https://twiki.cern.ch/twiki/bin/view/AtlasPublic/CombinedSummaryPlots>

Risonanze $tt + jets$

causa top quark charge asymmetry anomala?



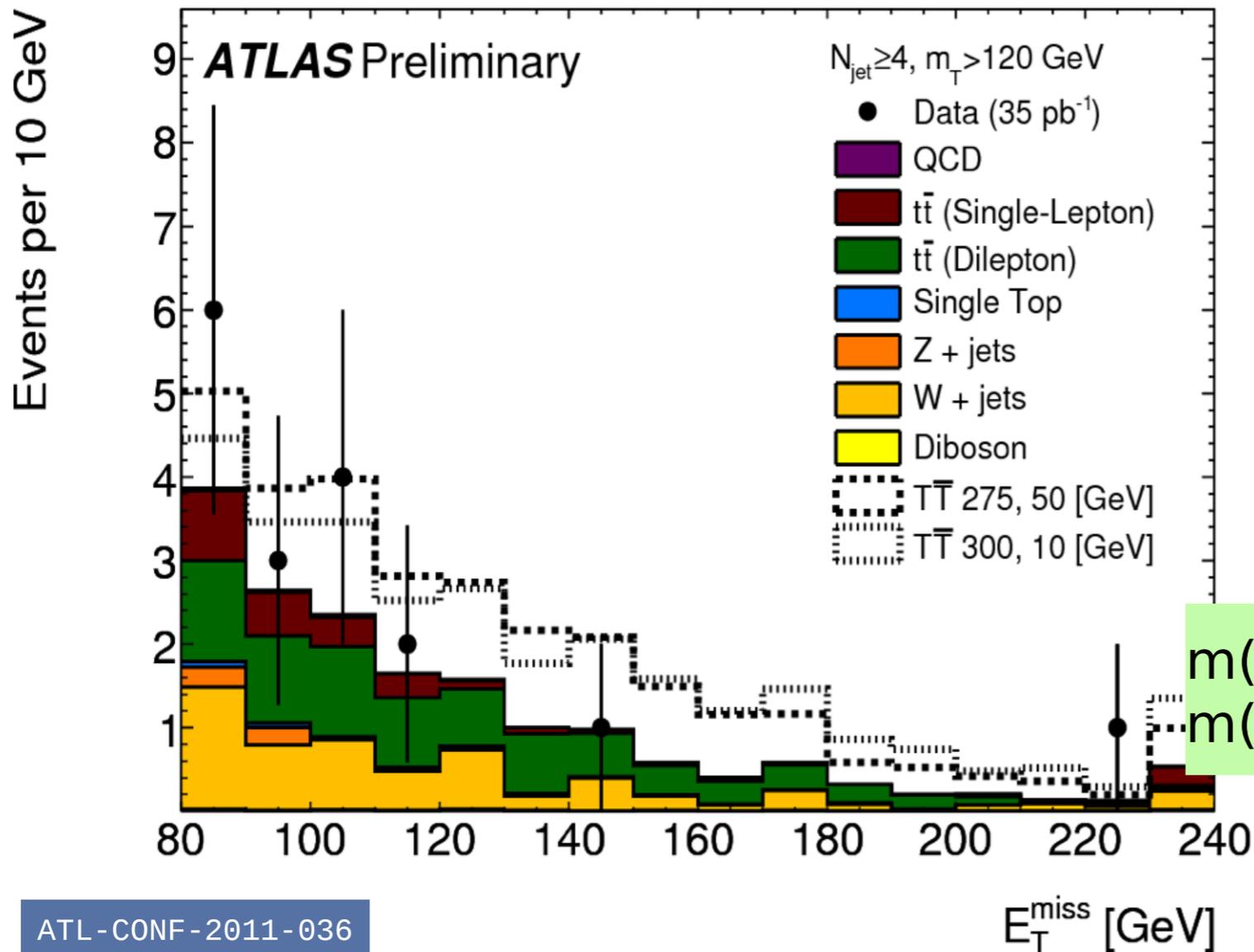
ATL-CONF-2012-096

$m_{W'} > 450 \text{ GeV}$ 95% CL
 $m_\phi > 700 \text{ GeV}$ 95% CL

E_T^{miss} anomala in $t\bar{t}$

particella neutra a^0 sorgente di energia trasversa mancante

particella pesante T simile al quark top: $T \rightarrow t a^0$

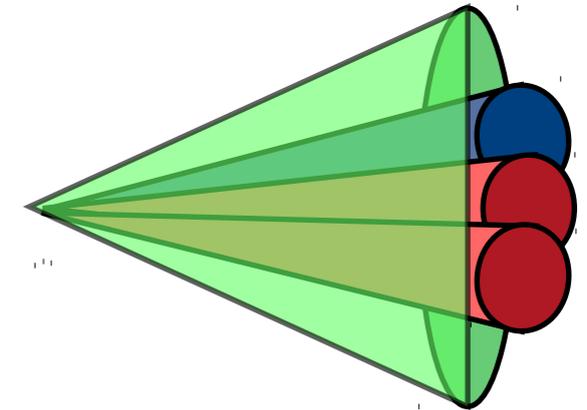
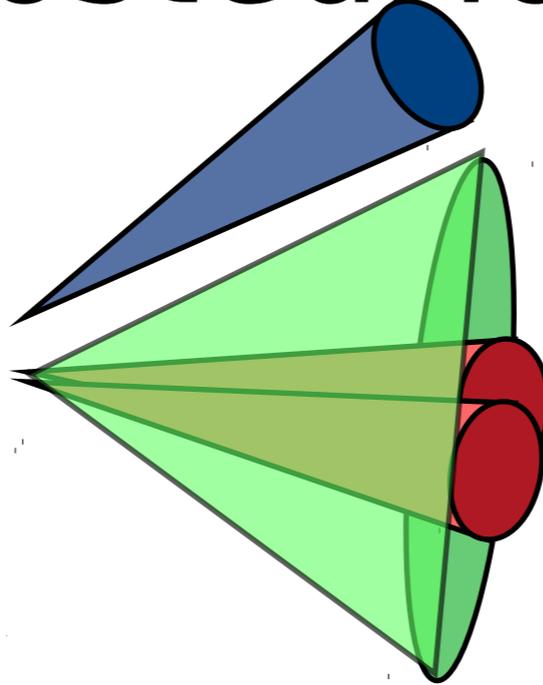
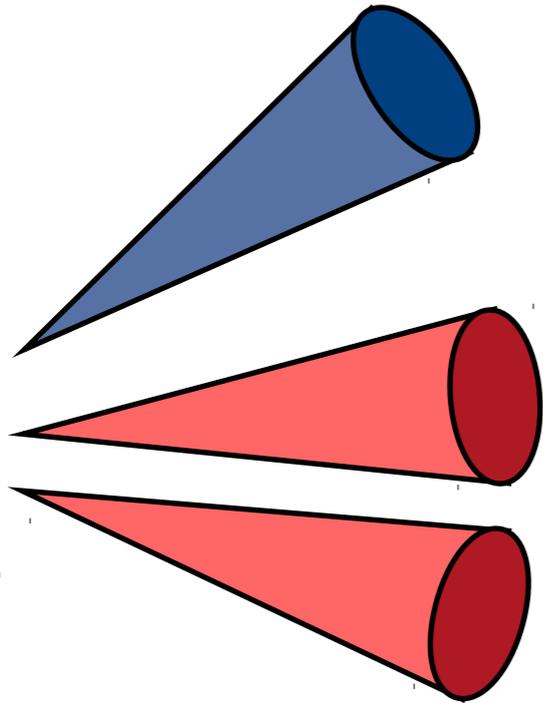


$m(T) > 300 \text{ GeV } a^0 = 10 \text{ GeV } 95\% \text{ CL}$
 $m(T) > 275 \text{ GeV } a^0 = 50 \text{ GeV } 95\% \text{ CL}$

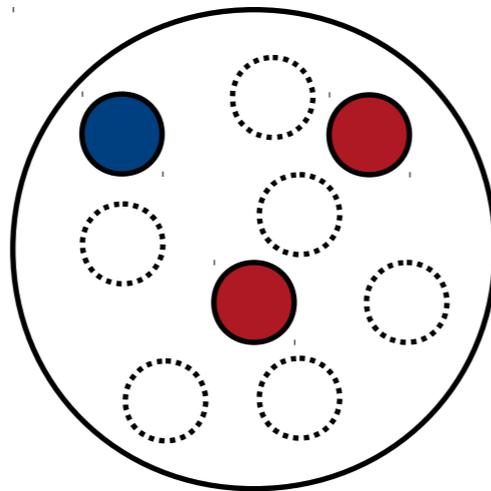
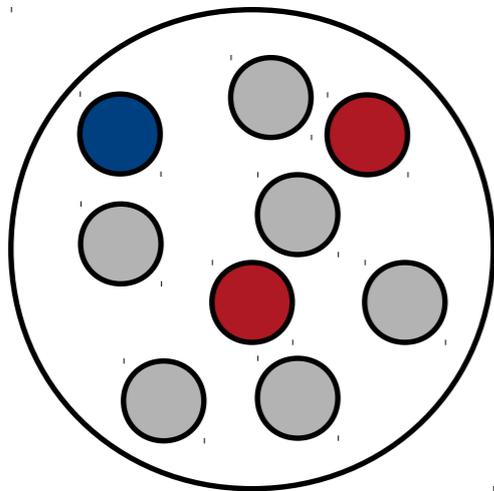
ATL-CONF-2011-036

Boosted Tops

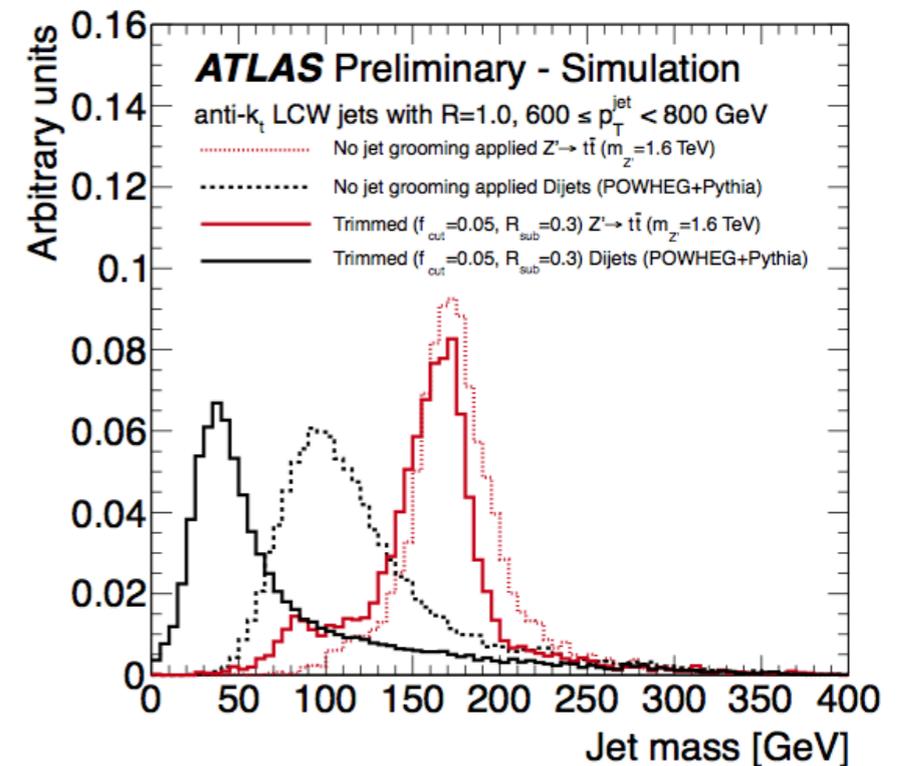
$$\Delta R \sim 2 \frac{M}{p_T}$$



ATL-CONF-2012-096

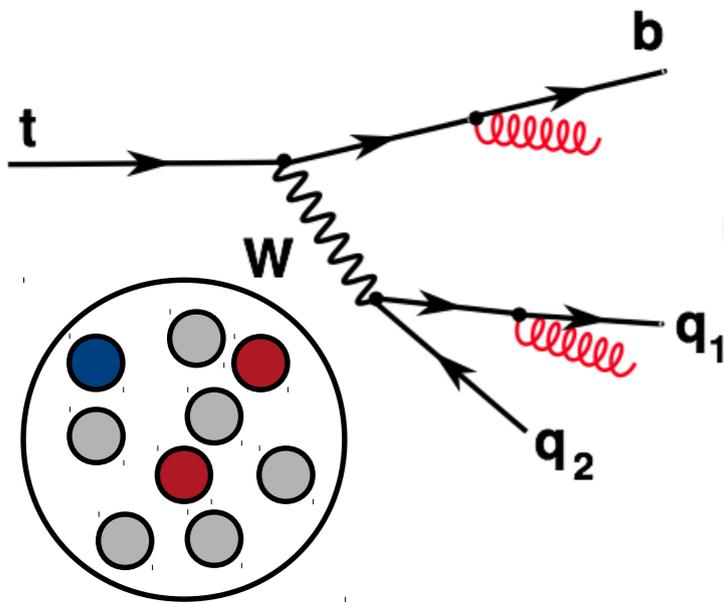


grooming/trimming/pruning =
rimozione cluster bassa
energia/grande distanza
angolare



migliora risoluzione in massa
migliora reiezione fondo QCD

Boosted Tops



before

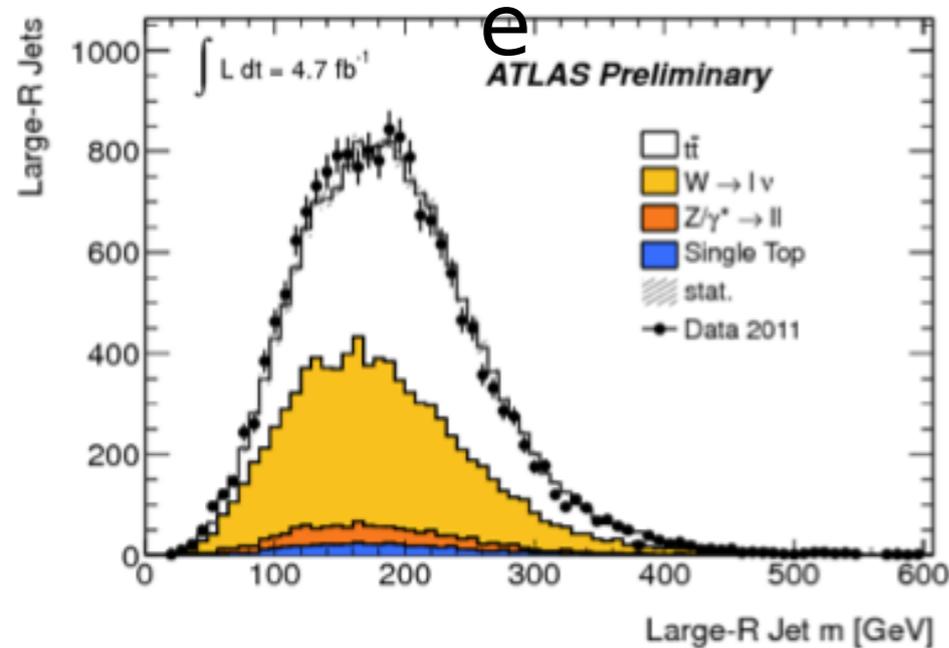
HEPTopTagger, CMS top tagger
Decomposizione e iterazione

- jet mass
- no. of subjets
- min m_{jj}

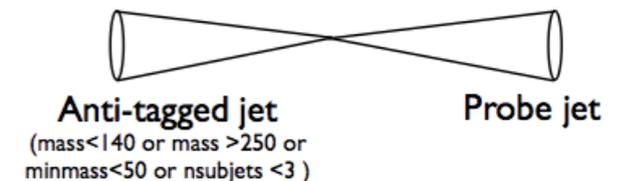
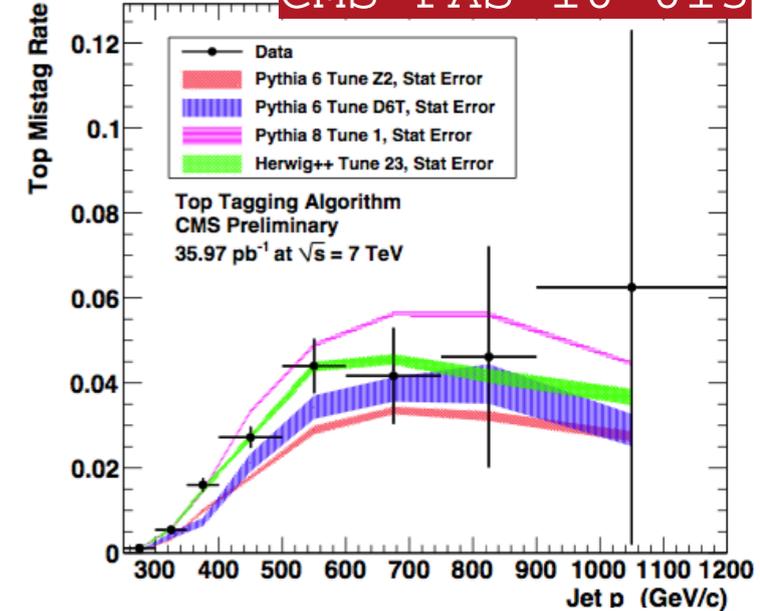
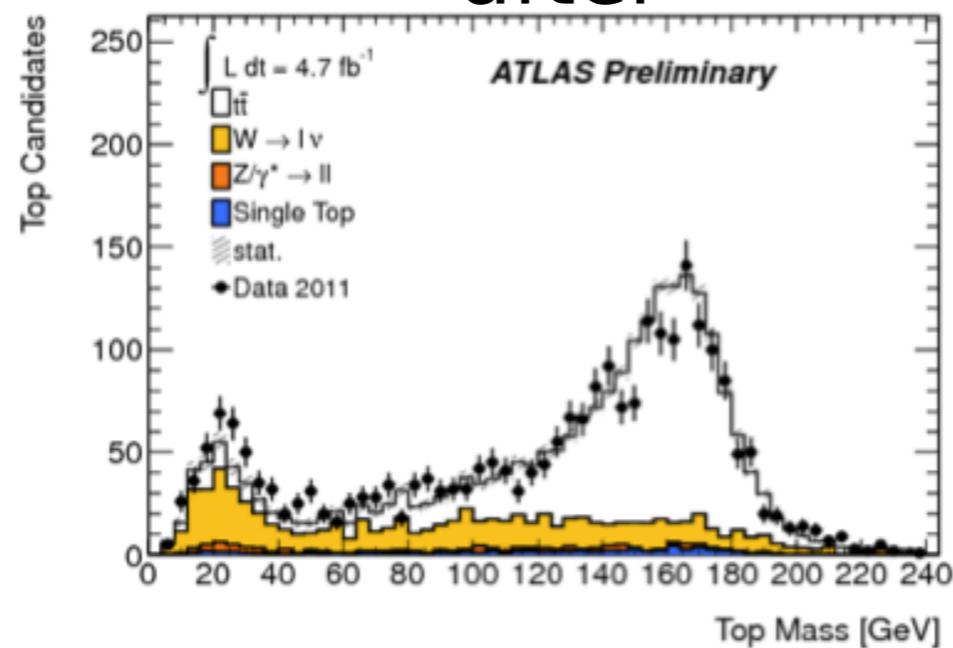
Template Tagging
Associazione partone-cluste

- p_T
- ΔR
- top template da generatore MC

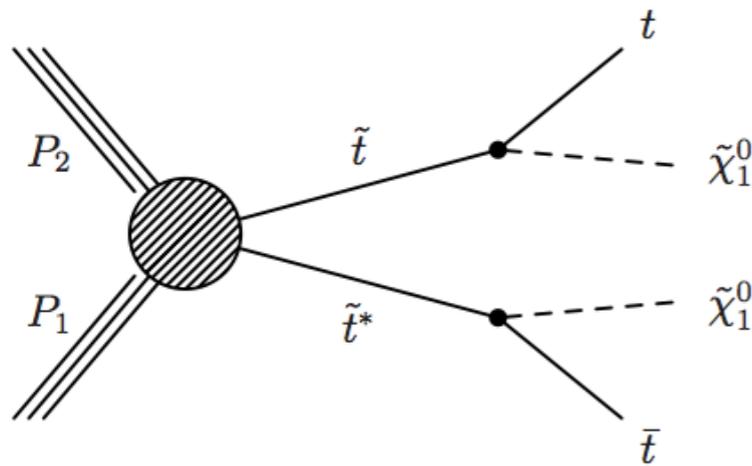
after



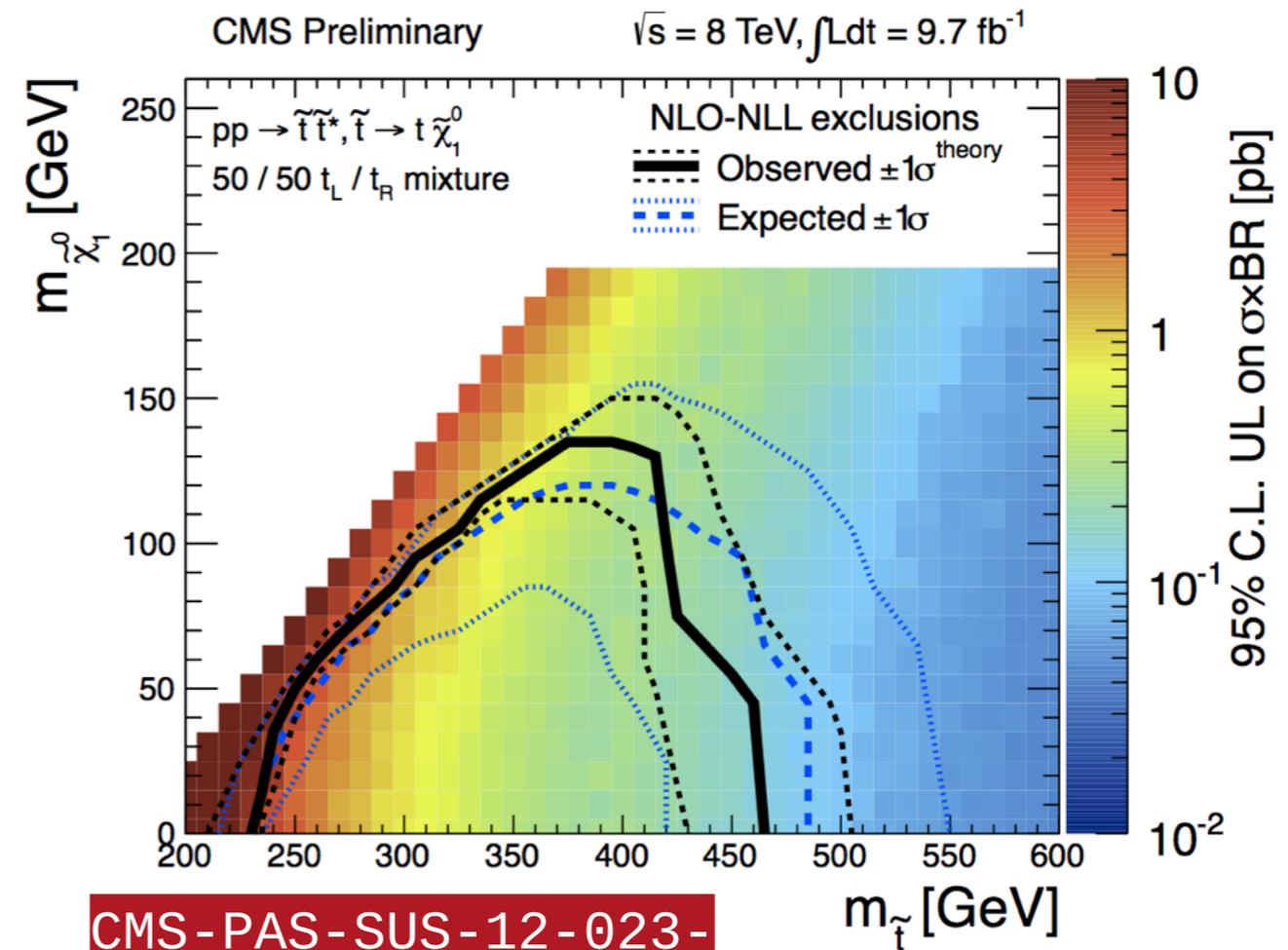
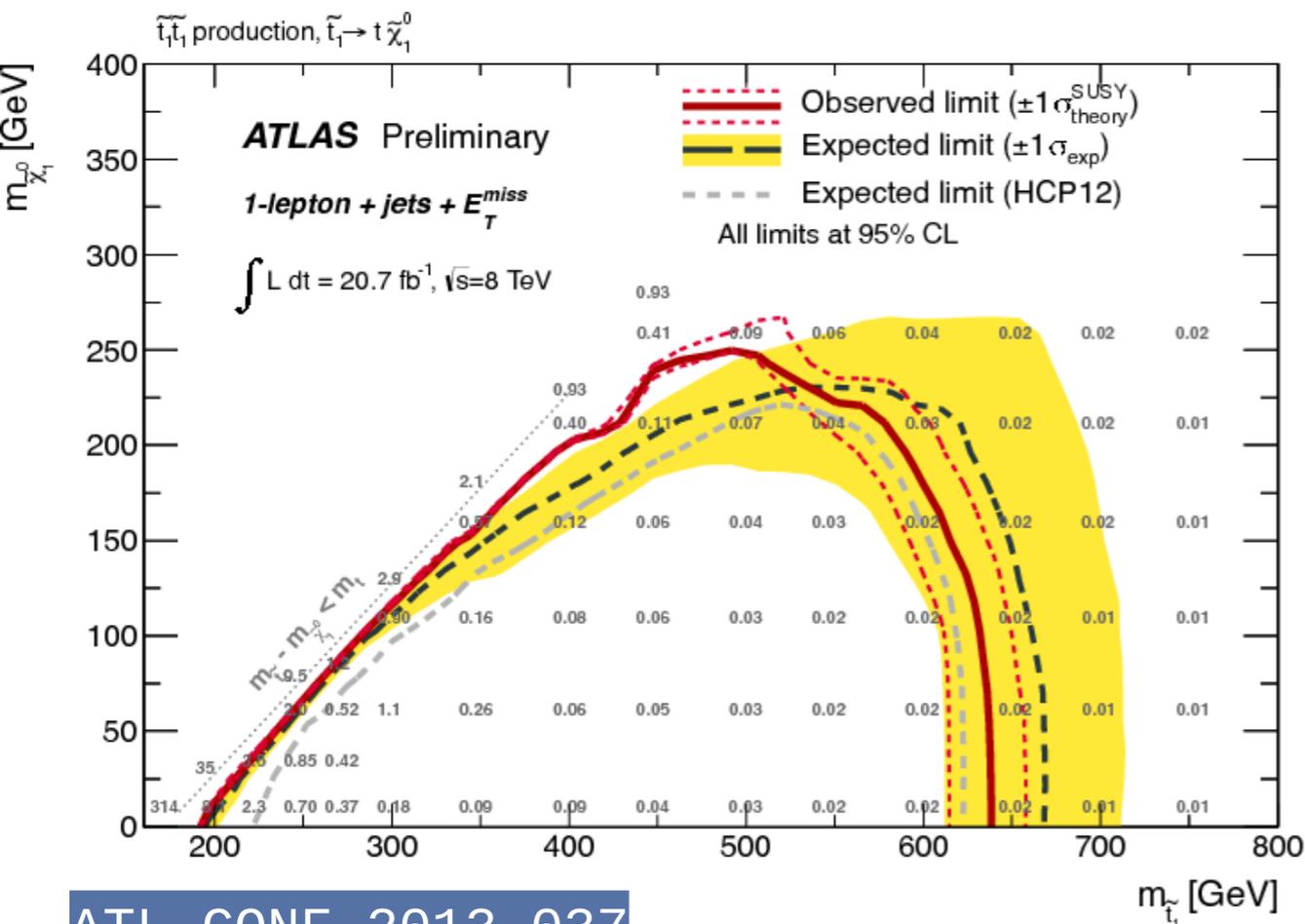
ATLAS-CONF-2012-035



Ricerche di s-top



$m(\tilde{t}) \approx 1 \text{ TeV} \rightarrow \text{top boosted}$



tt xs incl	ATL-CONF-2012-149	ATL-CONF-2012-131	ATL-CONF-2012-0
tt xs diff	EPJC(2013)73:2261		
Mass	ATL-CONF-2012-030	ATL-CONF-2012-120	ATL-CONF-2012-134
t-ch xs	ATL-CONF-2012-132		
s-ch xs	ATL-CONF-2011-118		
tW xs	ATL-CONF-2011-104		
xs(t)/xs(T)	ATL-CONF-2012-056		
W pol	ATL-CONF-2011-037		ATL-CONF-2013-033
tt pol	ATL-CONF-2012-133		
tt spin corr	ATL-CONF-2011-117		
tt resonance	ATL-CONF-2012-136	ATL-CONF-2012-102	ATL-CONF-2011-123
tt+a	ATL-CONF-2011-153		
charge	ATL-CONF-2011-141		
FCNC	JHEP09(2012)139	PLB712(2012)351-369	
Q asymm	ATL-CONF-2012-057	EPJC72(2012)2039	
t-j res	ATL-CONF-2012-096		
b-tagging eff	ATL-CONF-2012-097		
jet mult	ATL-CONF-2012-155	ATL-CONF-2011-142	
CP viol	ATL-CONF-2013-032		

tt xs incl	CMS-PAS-TOP-12-006	CMS-PAS-TOP-12-007	CMS-PAS-TOP-11-024
tt xs diff	CMS-PAS-TOP-12-027	CMS-PAS-TOP-12-028	
tt mass	arXiv:1304.5783	JHEP 12(2012)105	
tt mass diff.	CMS-PAS-TOP-12-029		
t-ch xs incl	JHEP12(2012)035	CMS-PAS-TOP-12-011	
t-ch xs(Q)	CMS-PAS-TOP-12-038		
tW	PRL110(2013)02203		
tt W pol	CMS-PAS-TOP-11-020		
tt, top pol	CMS-PAS-TOP-12-016		
tt spin corr	CMS-PAS-TOP-12-004		
t-ch. W pol	CMS-PAS-TOP-12-020		
tt+jets	CMS-PAS-TOP-12-018		
tt+bb	CMS-PAS-TOP-12-024		
tt Q asym.	PLB 717(212)129		
Δm_t	CMS-PAS-TOP-12-031		
R_tt	CMS-PAS-TOP-12-035		
tt risonanze	JHEP12(2012)015		
FCNC	PLB718(2012)1252		