TOP 2014
Experimental Summary

Christian Schwanenberger

University of Manchester

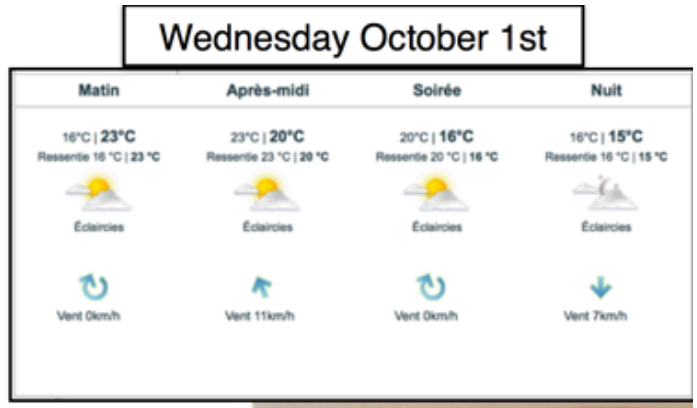
TOP 2014 International Workshop

Cannes, 3 October, 2014

The top quark enthusiasts

⇒ a personal summary

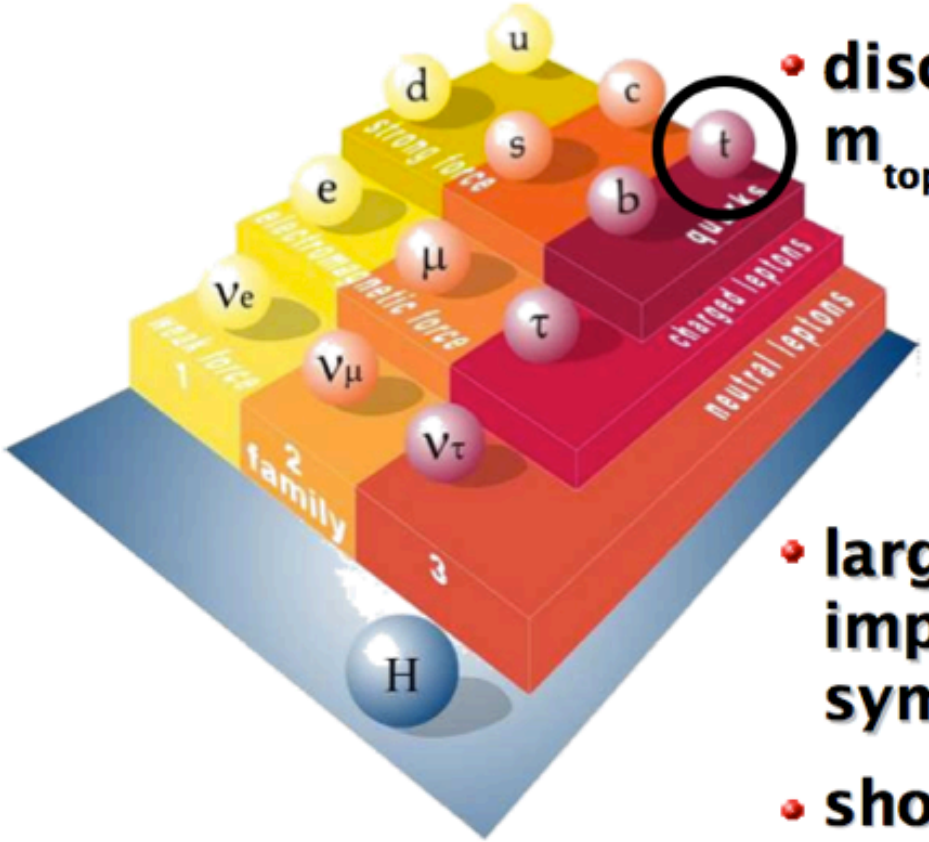
The top quark enthusiasts



40 excellent talks!

⇒ a personal summary

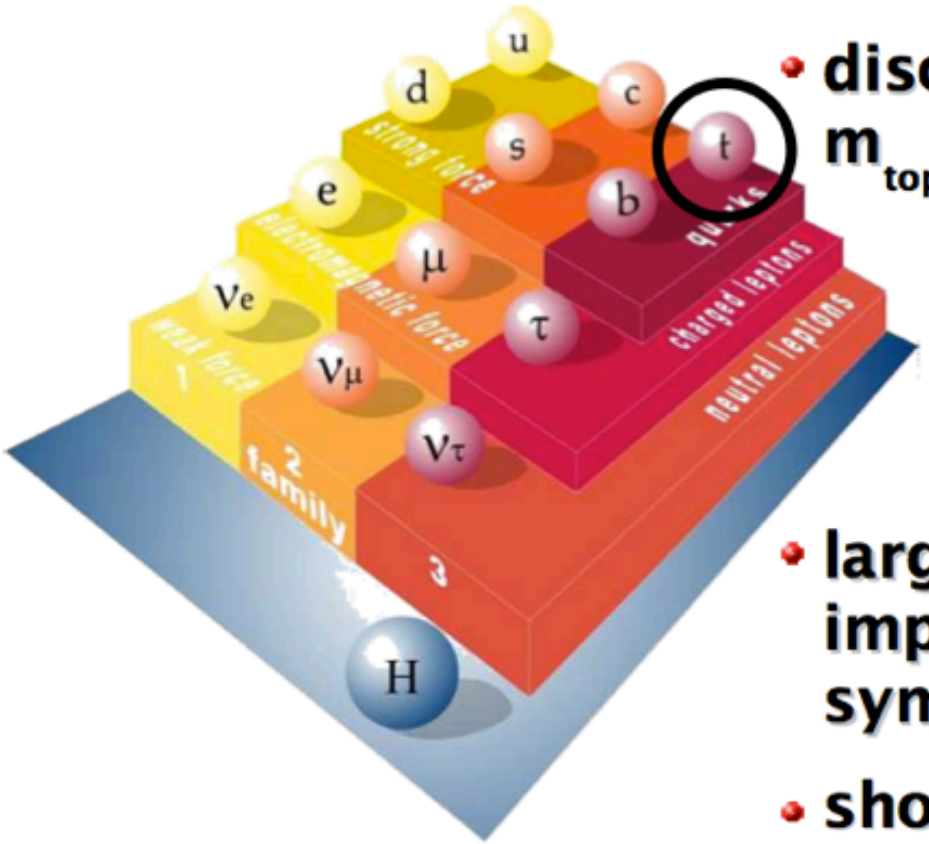
The Top Quark



- needed as isospin partner of bottom quark
- discovered in 1995 by CDF and DØ: m_{top} ~ gold nucleus
- large coupling to Higgs boson ~ 1: important role in electroweak symmetry breaking?
- short lifetime: $\tau \sim 5 \cdot 10^{-25}$s $\ll \Lambda^{-1}_{QCD}$: decays before fragmenting → observe "naked" quark

Is the top quark the particle as predicted by the SM?

The Top Quark



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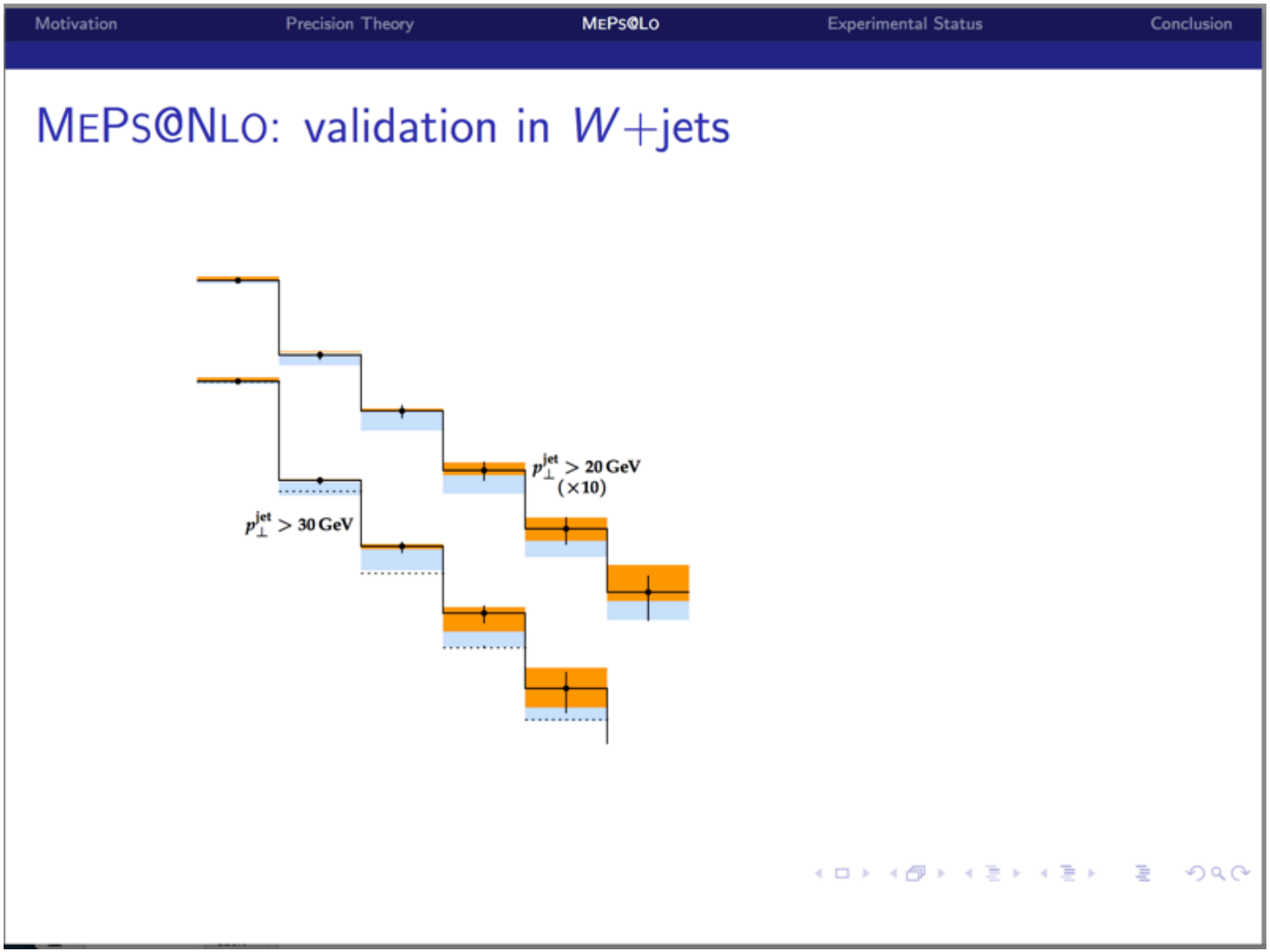
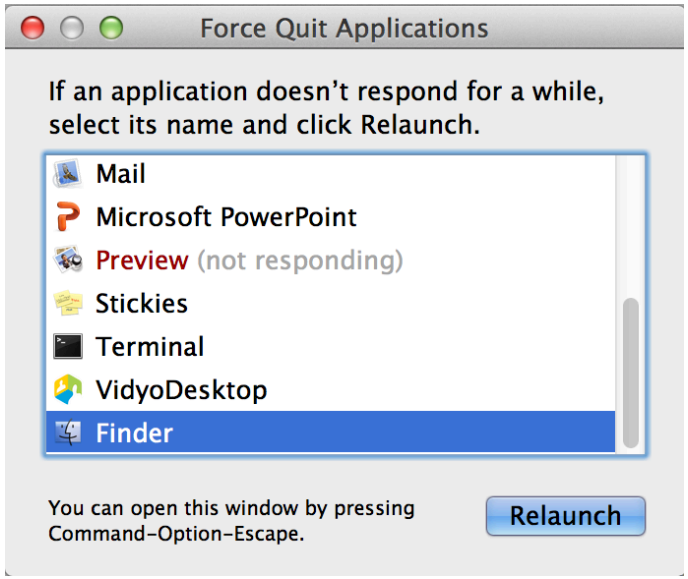
→ precision measurements and searches

Somebody said...

- Tevatron is a bit of a few-numbers experiment

Somebody said...

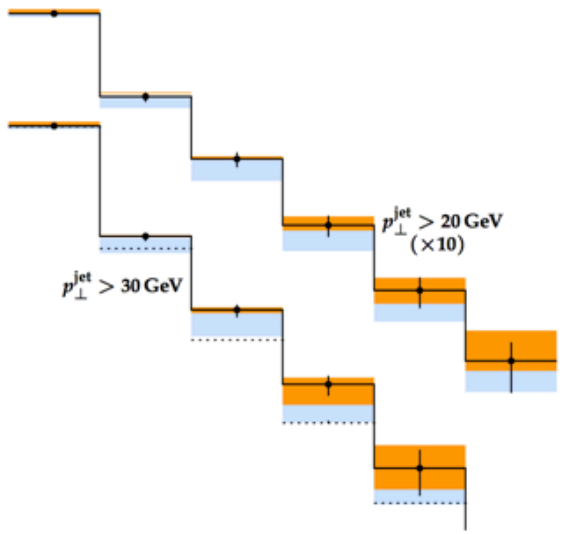




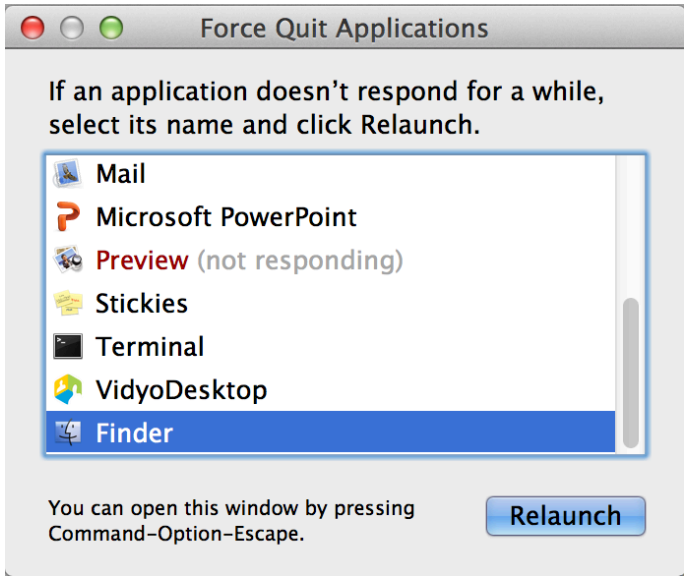
my MAC never makes it to that point though...

Somebody said...

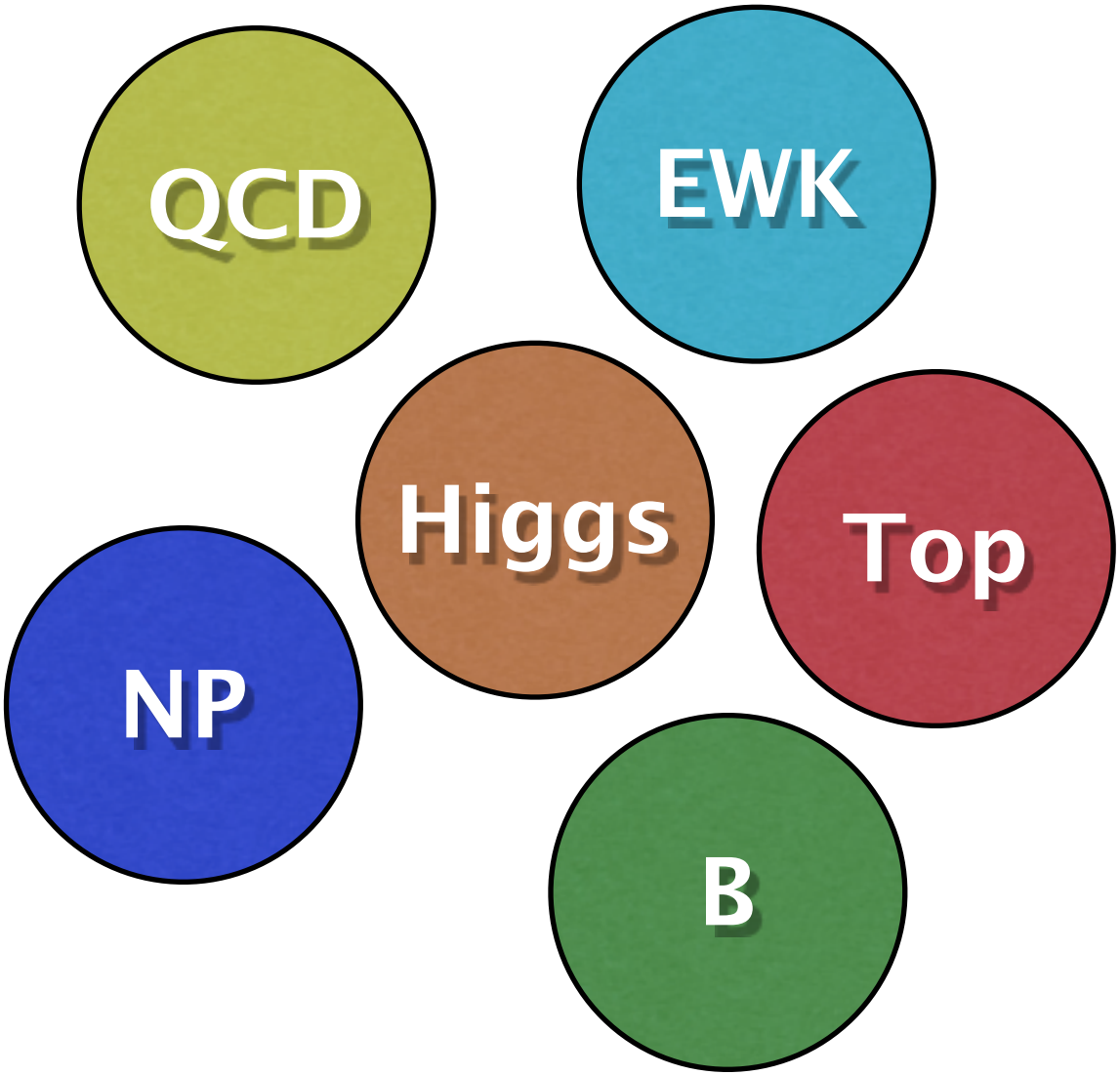
MEPS@NLO: validation in W+jets



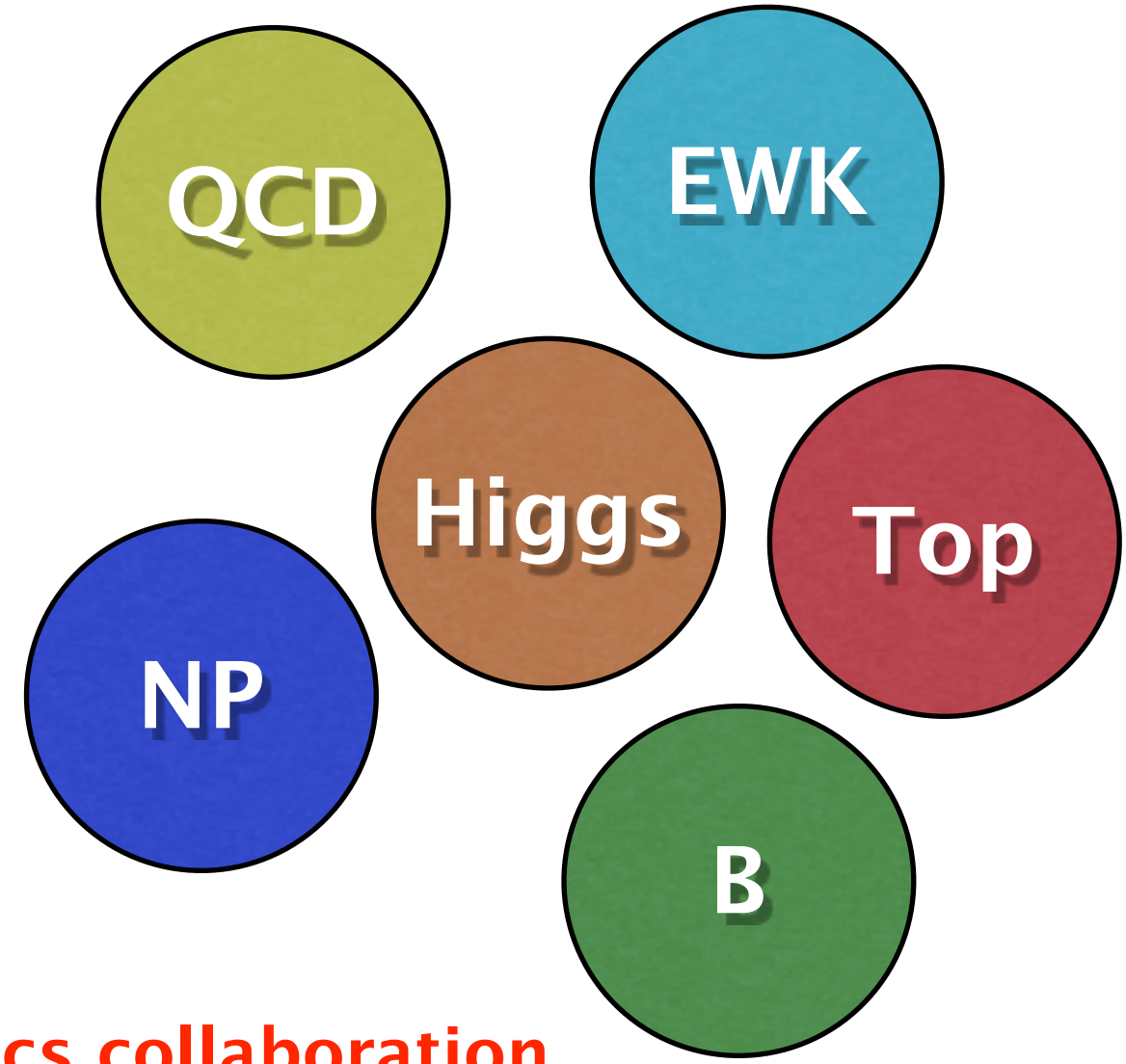
many fun discussions!



Physics Groups: DØ Collaboration

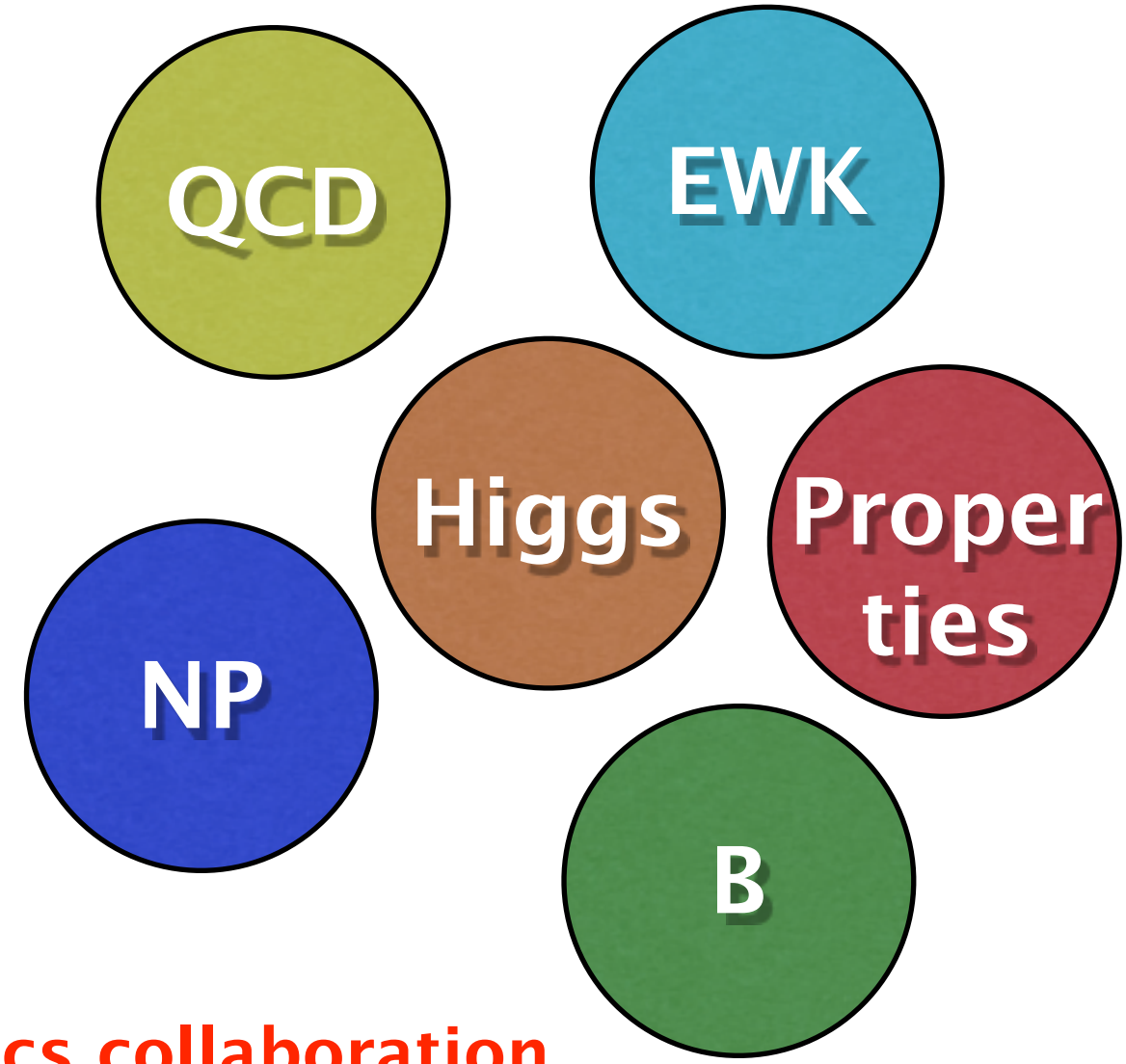


Top Quark Physics Topics



→ top physics collaboration

Top Quark Physics Topics

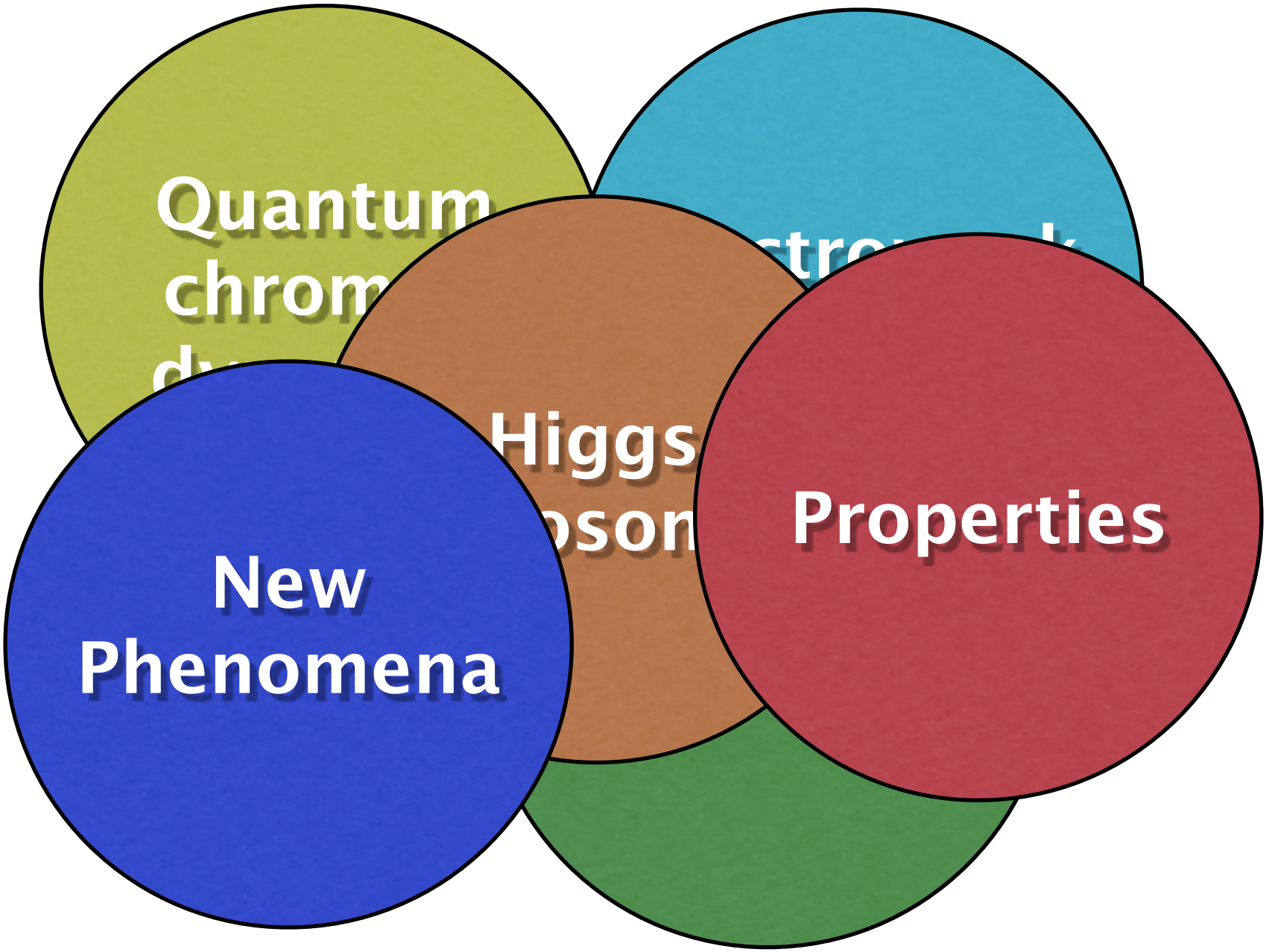


→ top physics collaboration

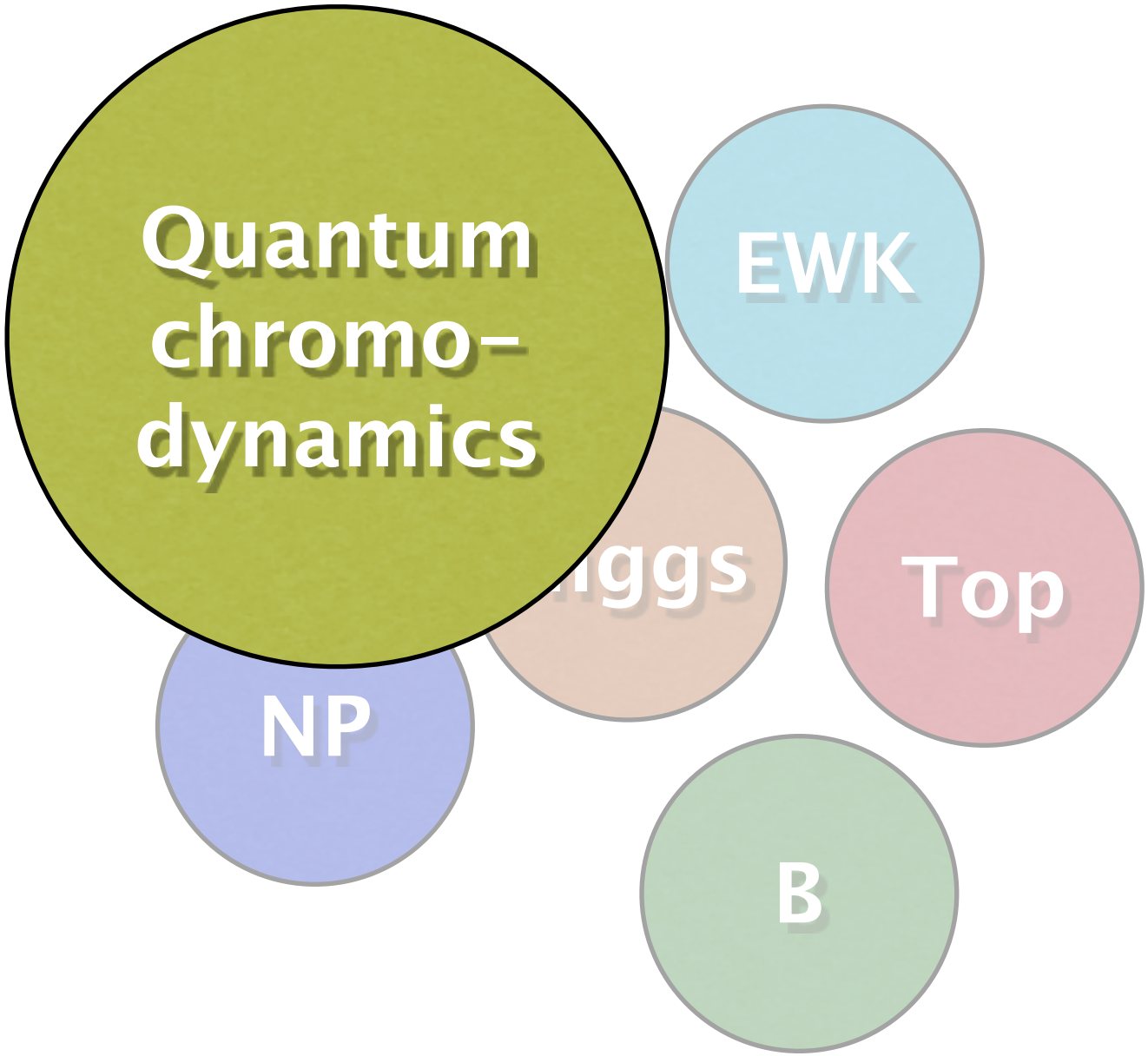
Top Quark Physics Topics

→ top physics collaboration

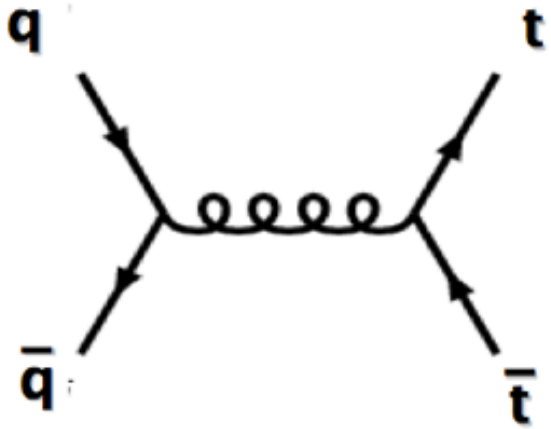
Top Quark Physics Topics



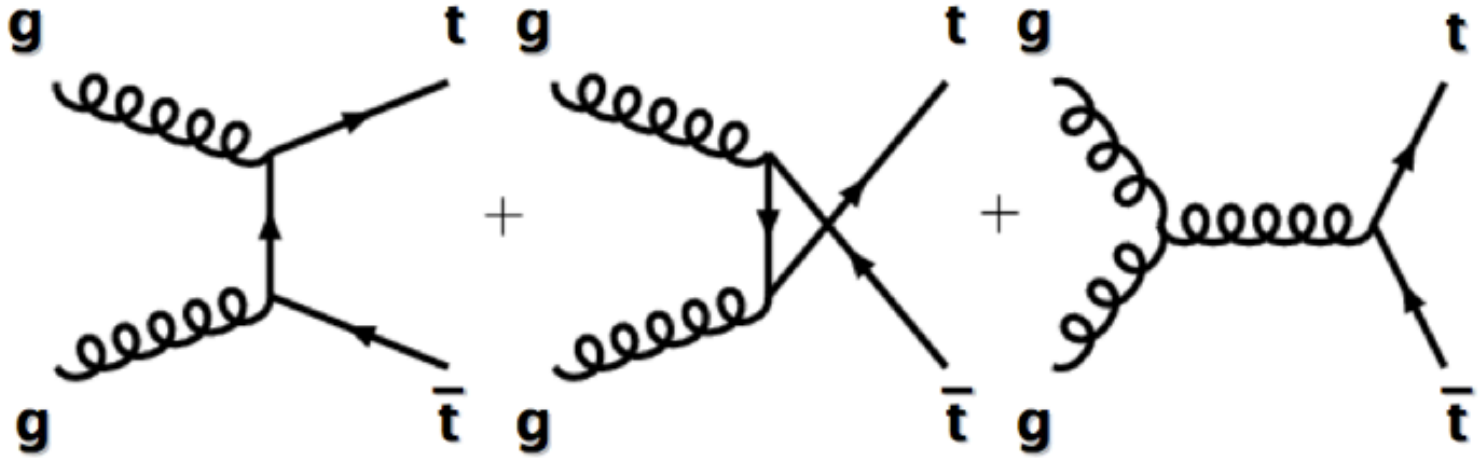
Top Quark Physics Topics



Top Quark Pair Production



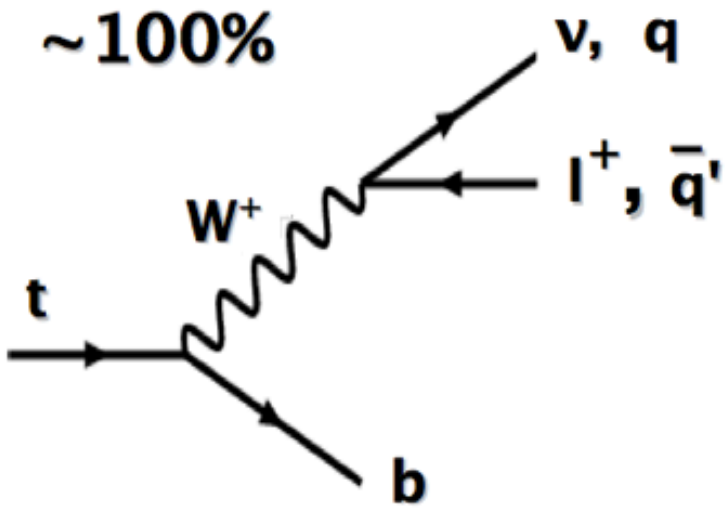
Tevatron (~85%)



LHC (~87%)
(8 TeV)

Top Quark Pair Signatures

top decay:



- high p_T leptons, missing E_T
- jets
- b-jets

τ's 14%

alljets 46%

Top Pair Decay Channels

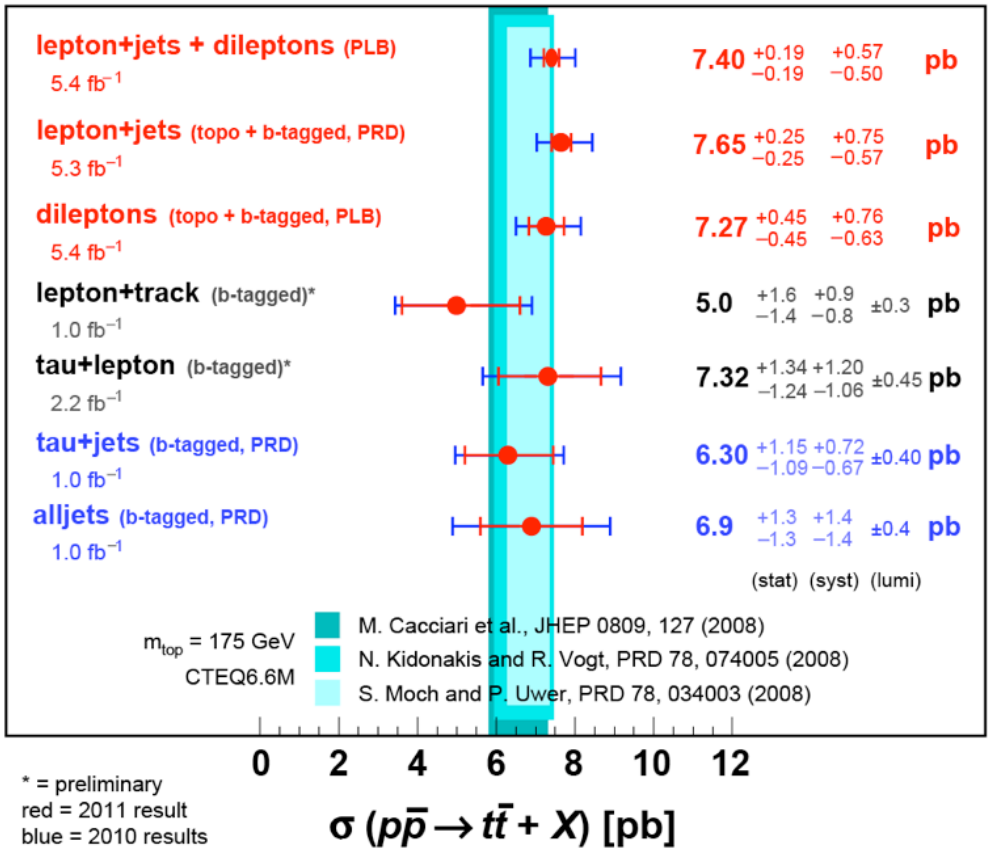
W decay	e^+	μ^+	τ^+	$u\bar{d}$	$c\bar{s}$
e^-	ee	eμ	eτ	electron+jets	
μ^-	eμ	μμ	μτ	muon+jets	
τ^-	eτ	μτ	ττ	tau+jets	
$\bar{u}d$	electron+jets	muon+jets	tau+jets	all-hadronic	
$\bar{c}s$					

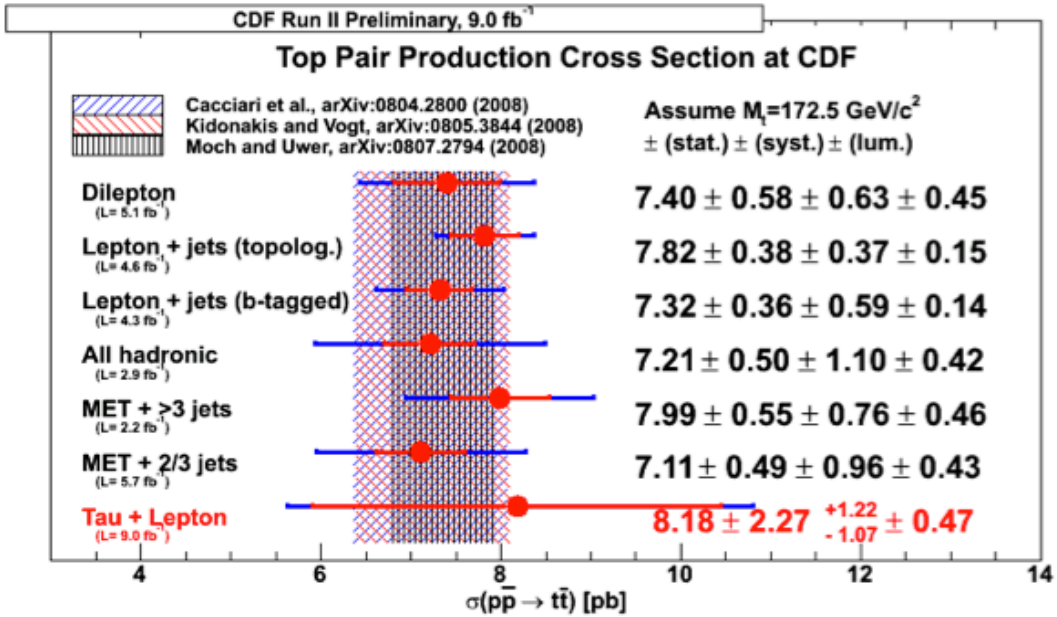
dileptons

dilepton (e/μ) 6%

e/μ+jets 34%

Top Pair Production Cross Section





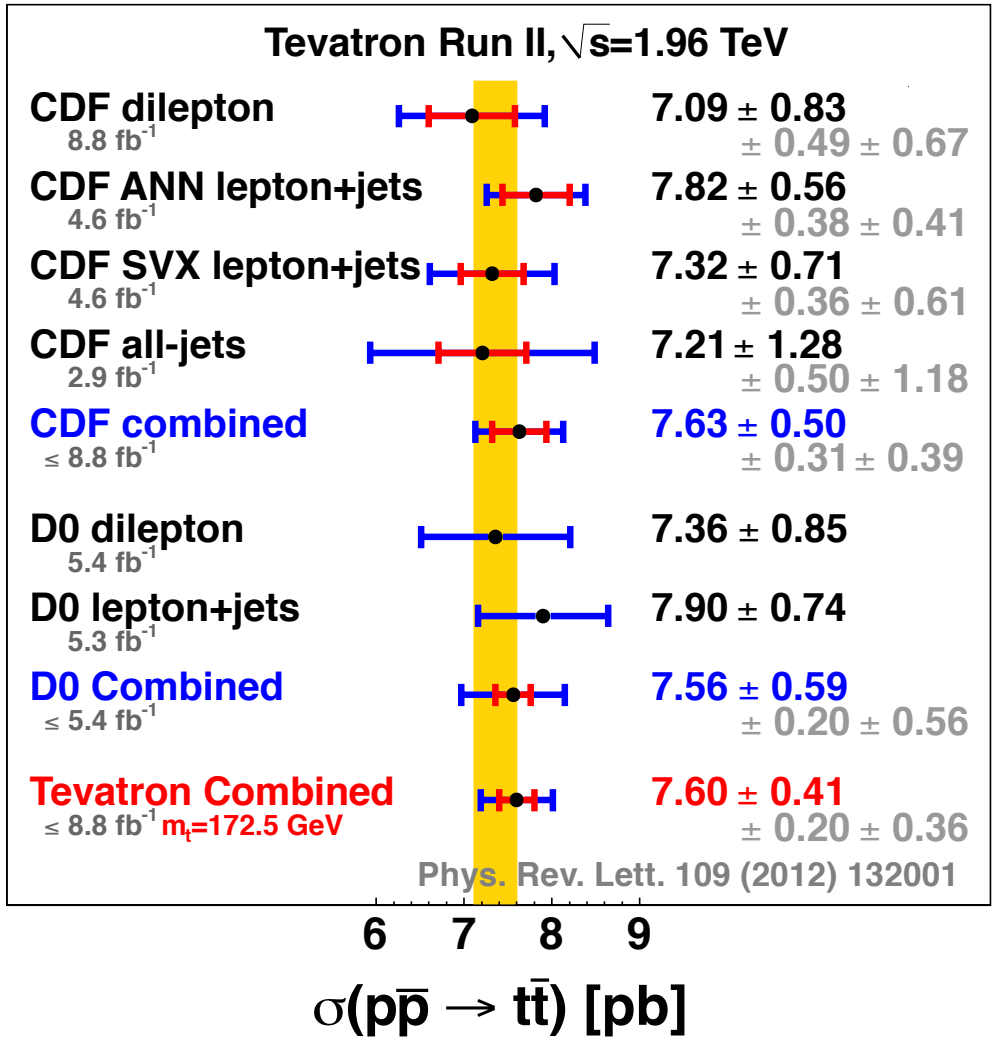
all channels measured except for $\tau_{had}\,\tau_{had}$

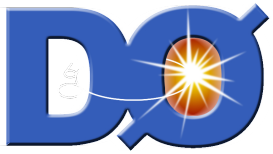
L. Shabalina

→ **good agreement with each other**

Top Pair Production Cross Section

NNLO+NNLL



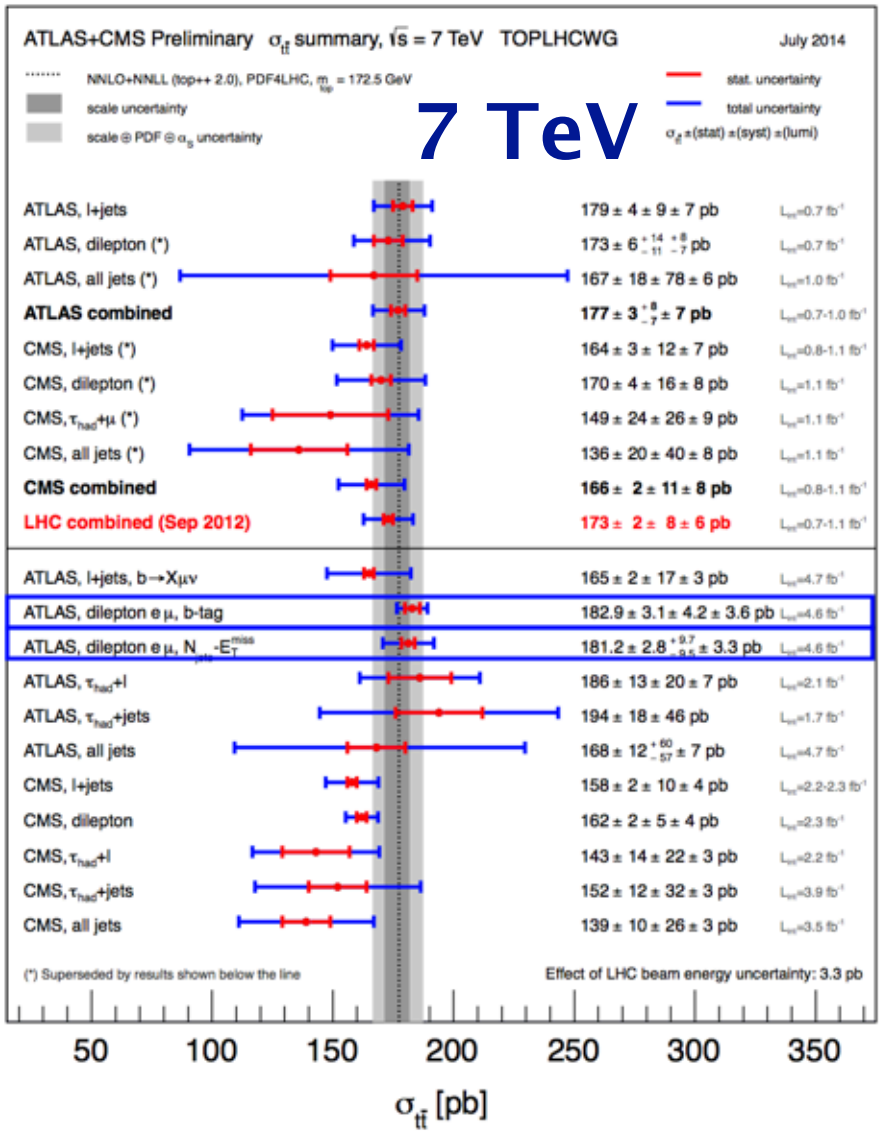


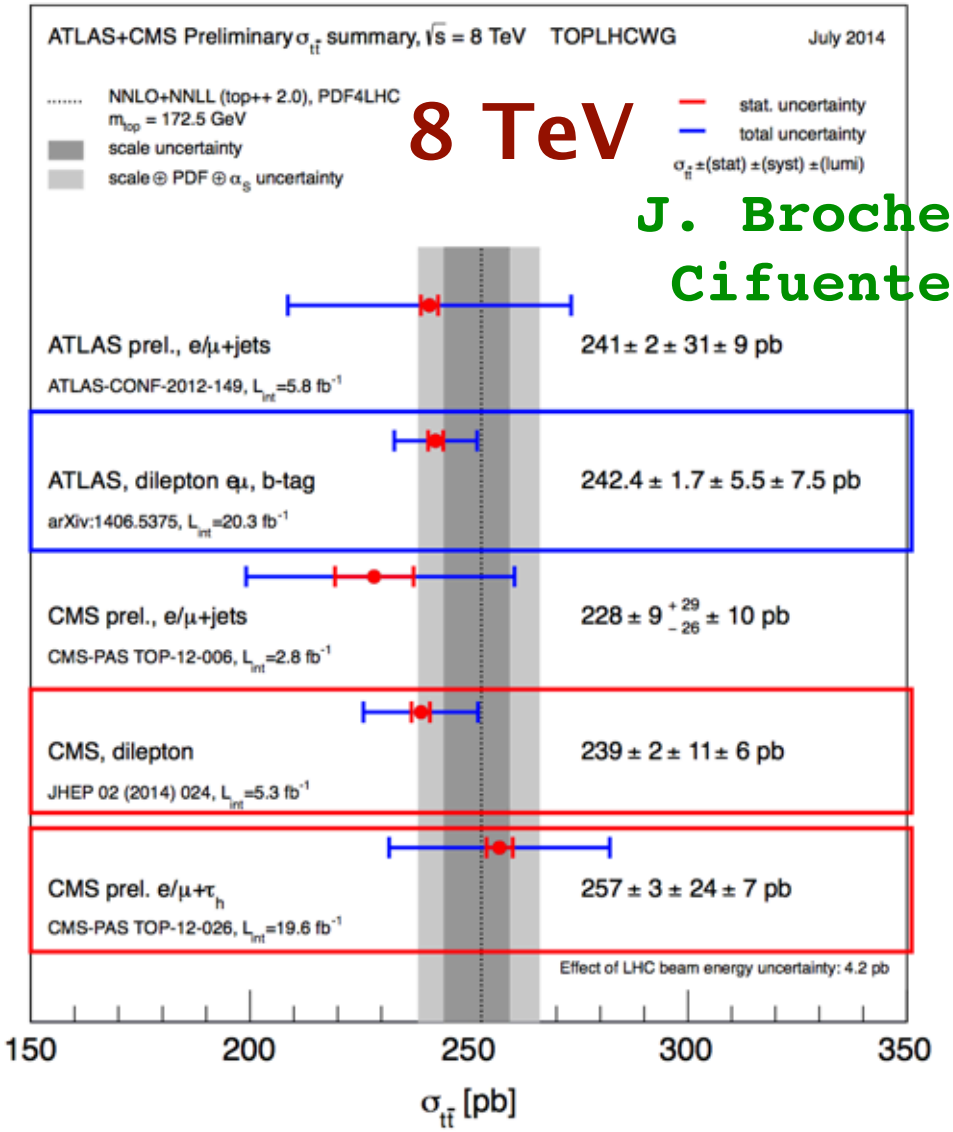
±5.4%

Y. Peters

→ good agreement with NNLO+NNLL

Top pair production cross section



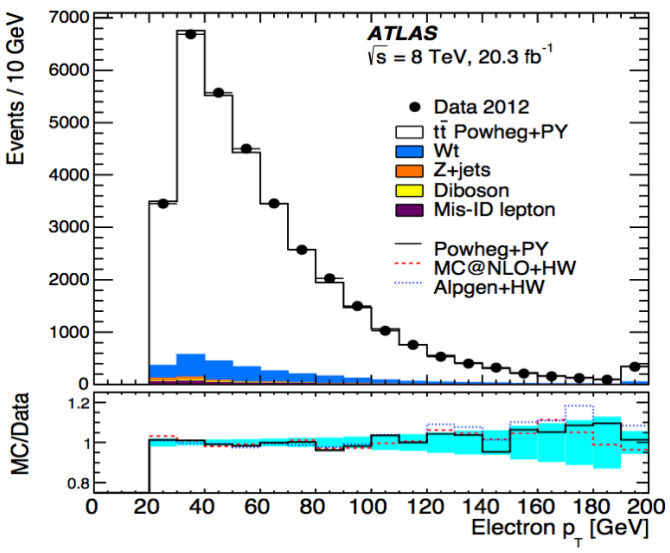


J. Brochero Cifuentes

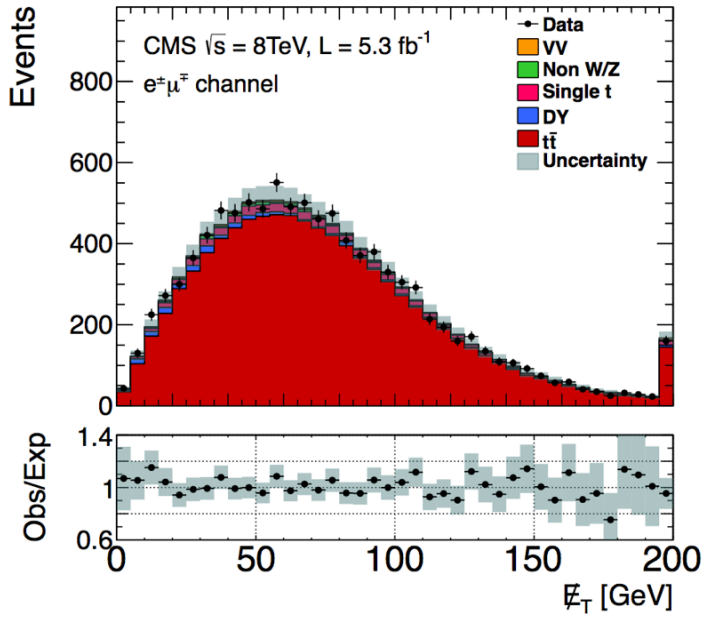
→ (all) channels measured to look for the unexpected

→ no new physics (ratios would enhance sensitivity)

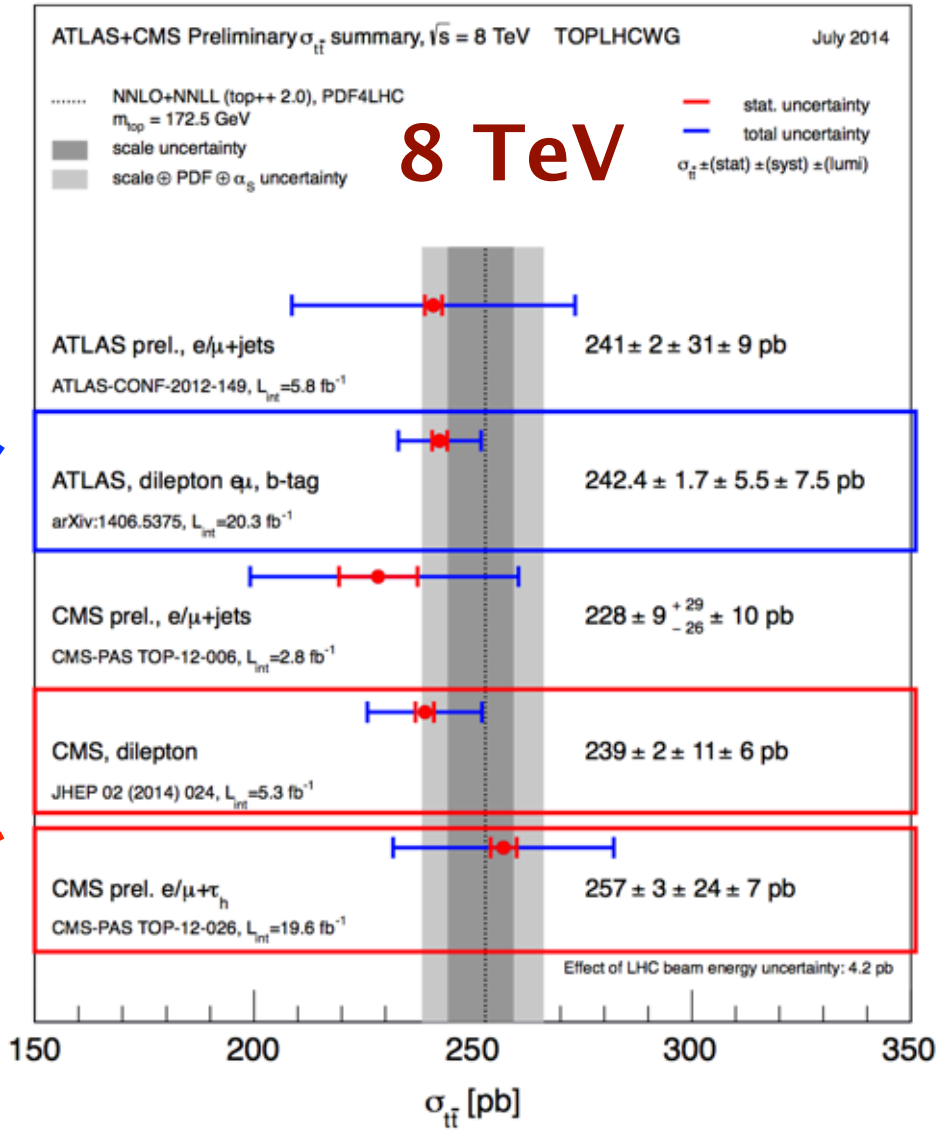
Top pair production cross section



±3.9%

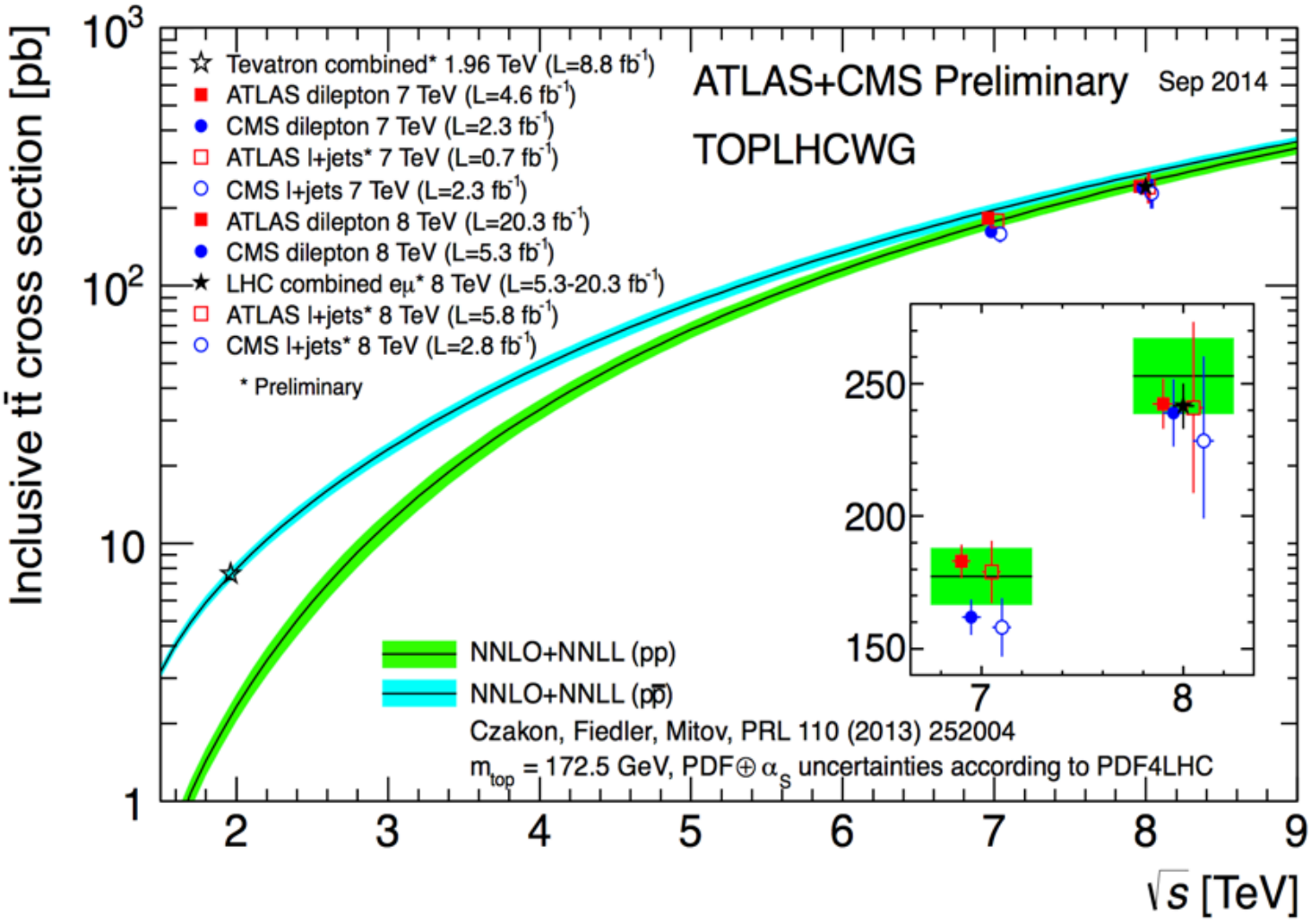


±5.7%



J. Brochero

Top pair production at hadron colliders



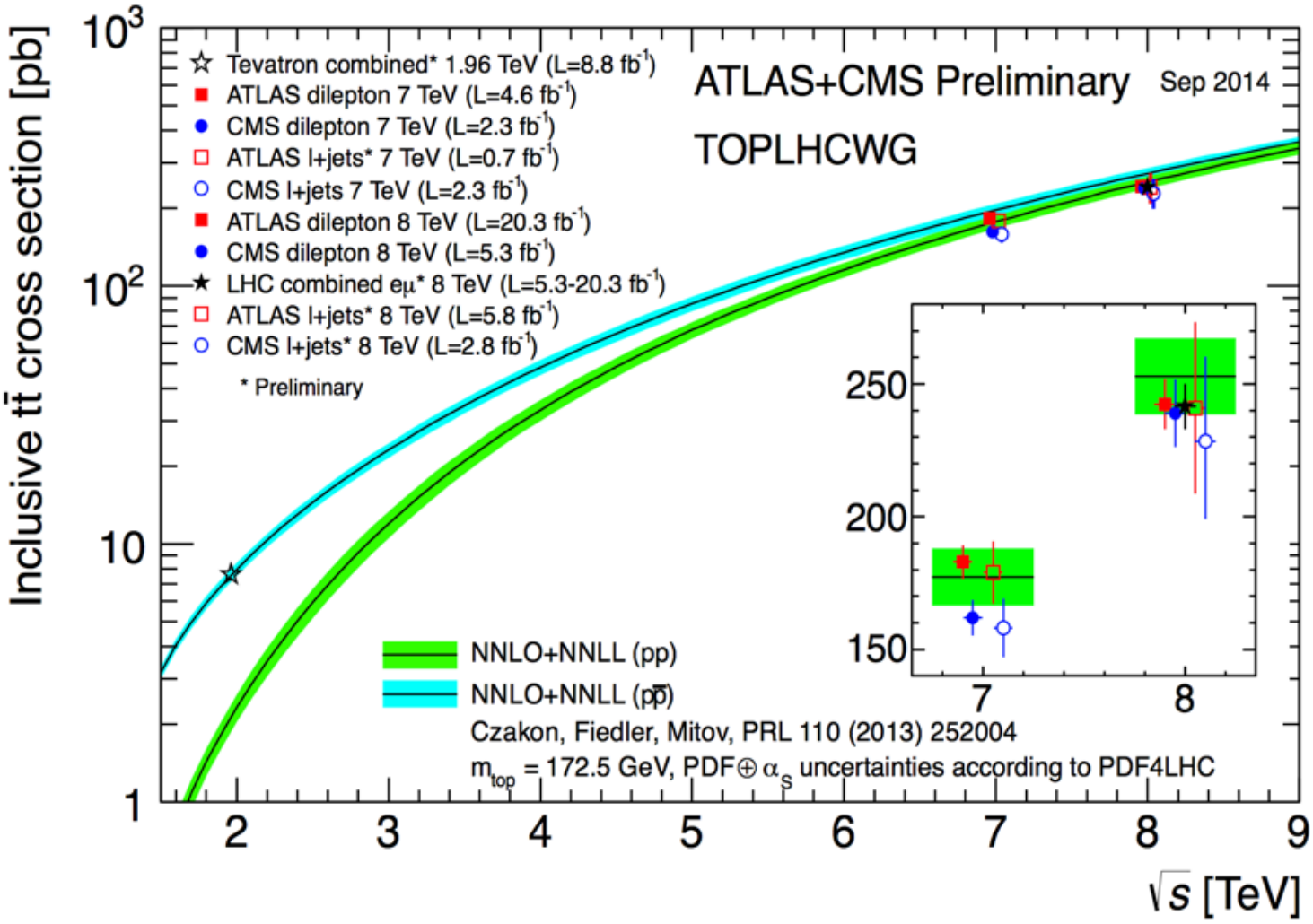
±5.7% (theo)

±3.5% (eμ)

→ **experiments challenge theory again**

Top pair production at hadron colliders

eager to put a point here



±5.7% (theo)

±3.5% (eμ)

→ experiments challenge theory again

Frodo and the ring

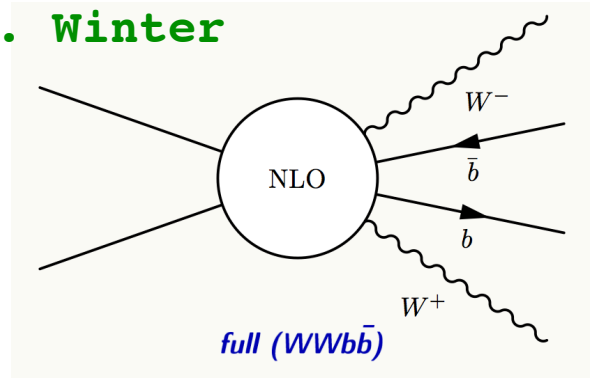
The theorist and the wine

High precision top physics: theory

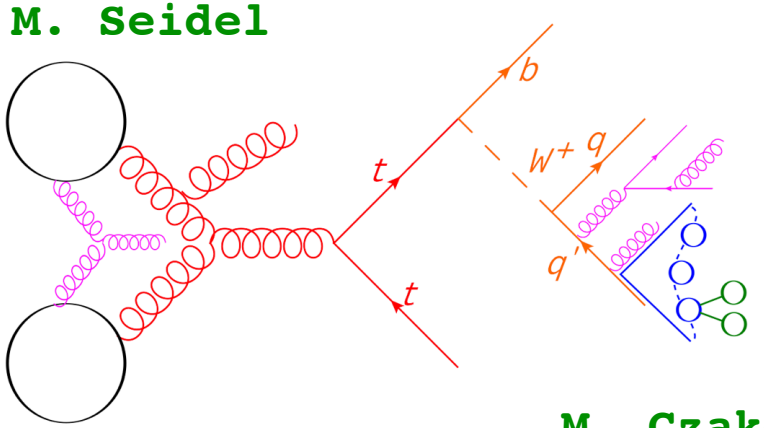
3 "revolutions" in phenomenology:

- NLO+parton shower generators

J. Winter



M. Seidel

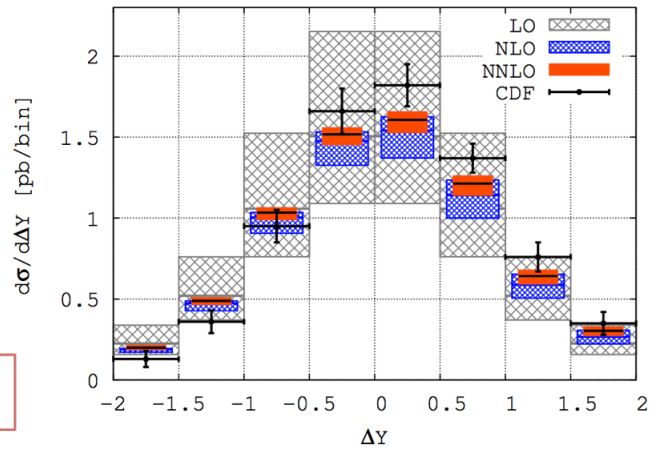


- NLO QCD+multileg LO generators matched with parton showers

soon NLO EW+ multileg S. Pozzorini

- NNLO QCD calculations

M. Czakon



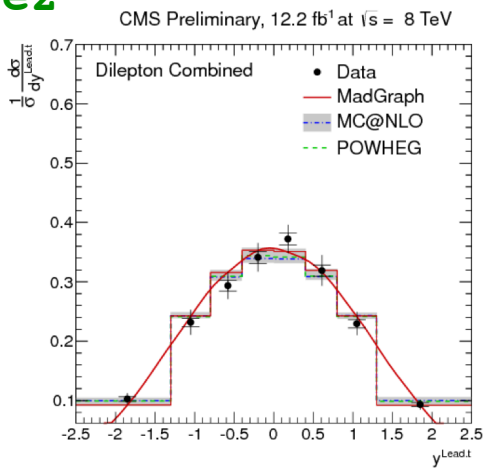
Czakon, Fiedler, Mitov, preliminary

High precision top: experiment

3 "ways to go" in top quark physics:

- unfolded distributions

C. Diez



- fiducial measurements

A. Jafari

With different generators

$$\sigma = \frac{1}{\epsilon_{fid}} . \sigma_{fid}$$

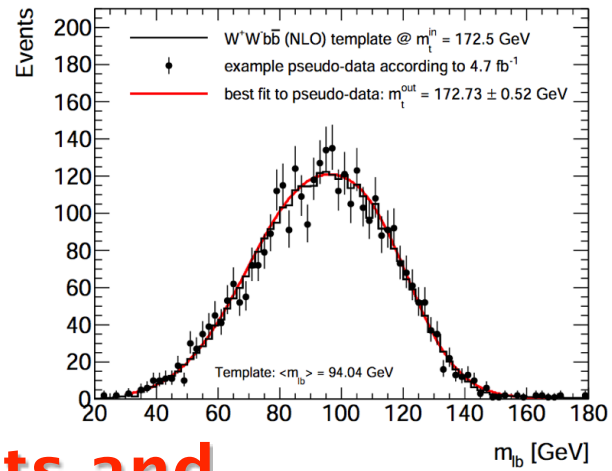
Model-dependence $\gg \delta_{th}$

aMC@NLO + Herwig

$\sigma = 82.6 \pm 1.2(\text{stat.}) \pm 11.4(\text{syst.}) \pm 3.1\ (\text{PDF}) \pm 2.3\ (\text{lumi.})$

- cross sections of final states (e.g. WbW(b) cross sections enriched for double t-resonance, single t-resonance, no-t-resonance

J. Winter

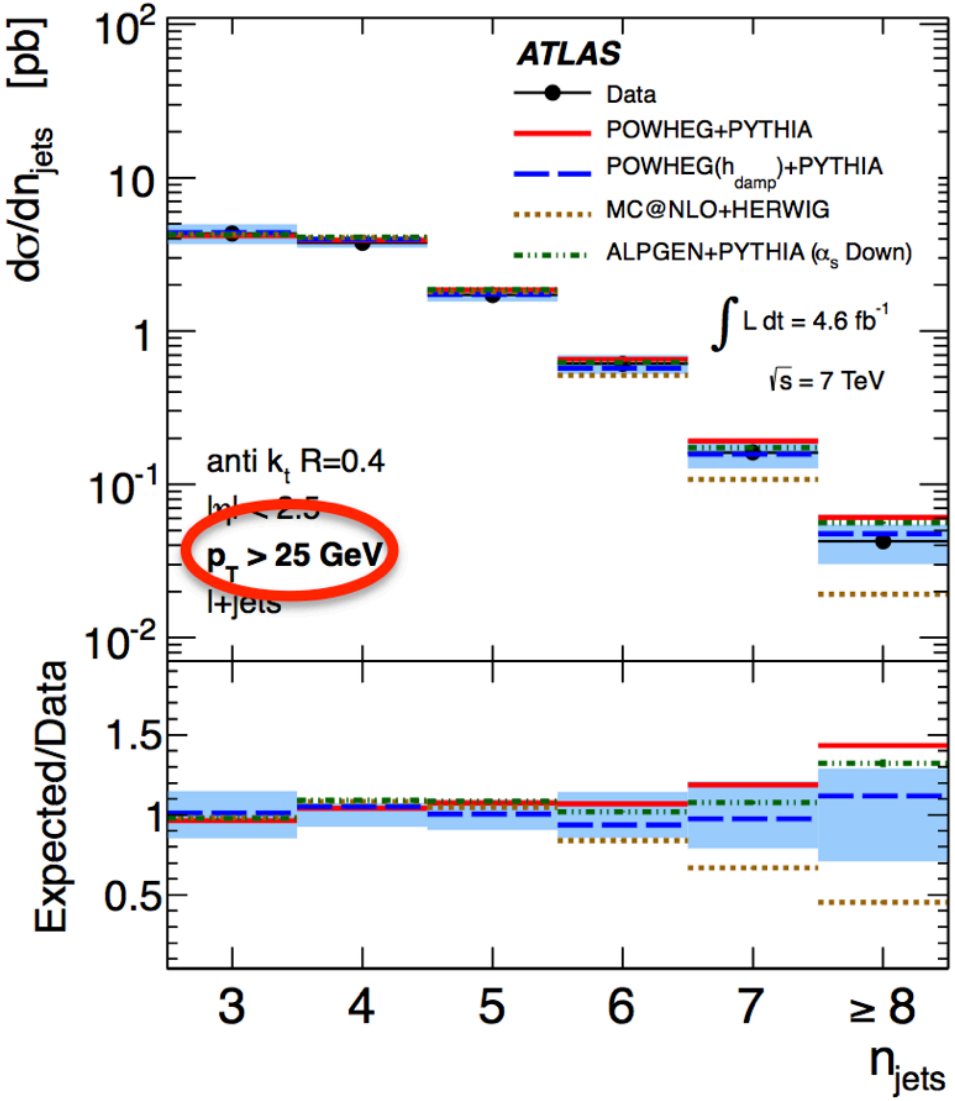


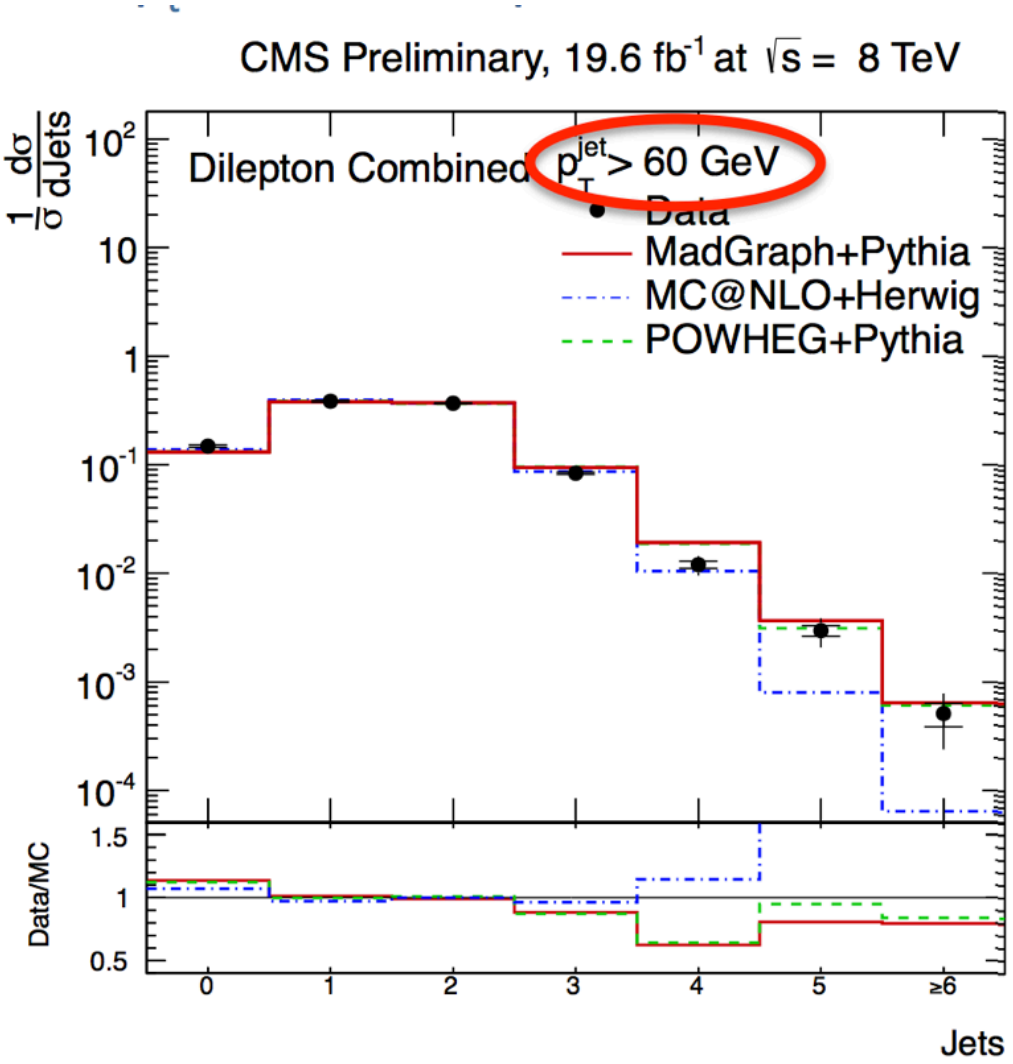
→ usable, understandable for theorists and experimentalists today and in 20 years...

The theorist is happy!

Differential: jet multiplicities

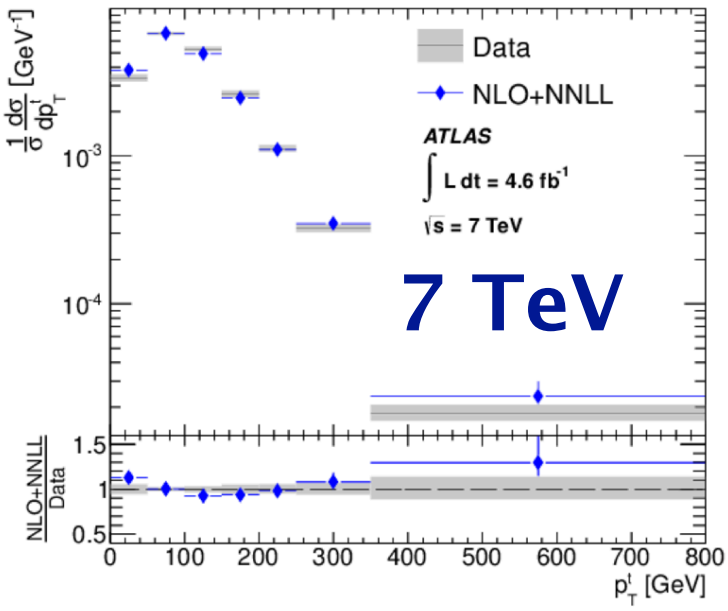
J. Katzy



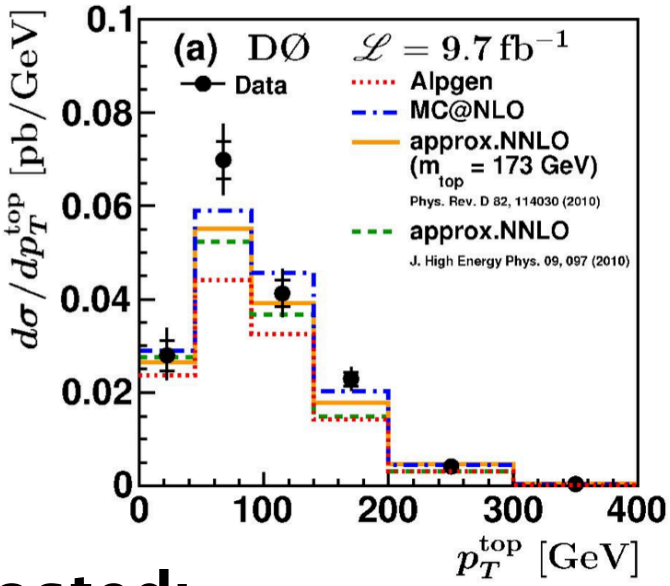


→ large differences between generators: helps to improve

Differential: top p_T

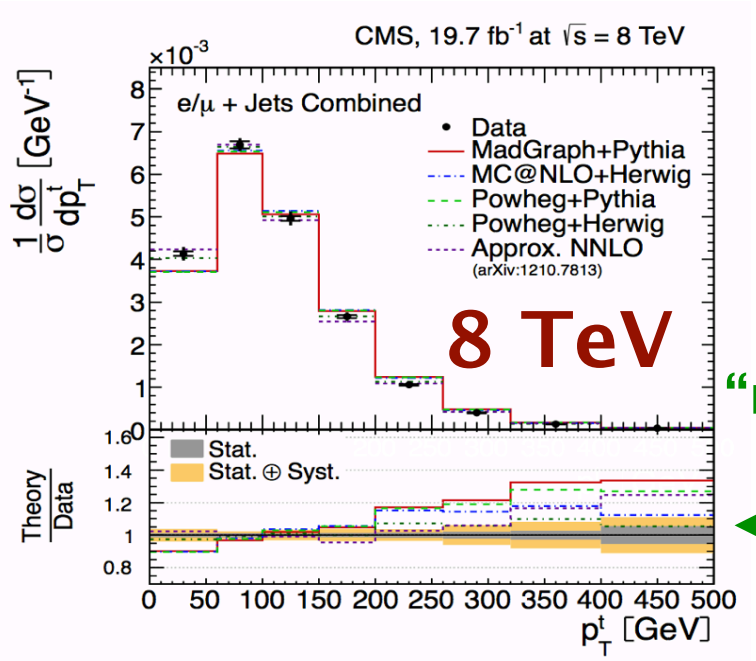


C. Diez

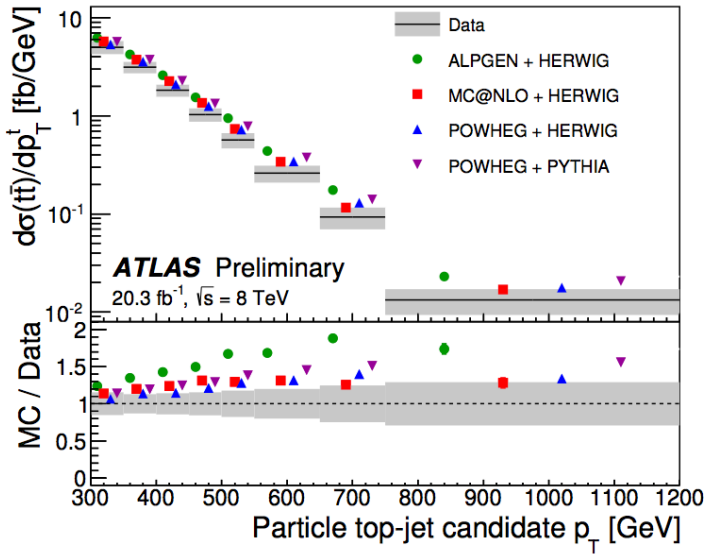


2 TeV

boosted:



Herwig "reshuffling" helps

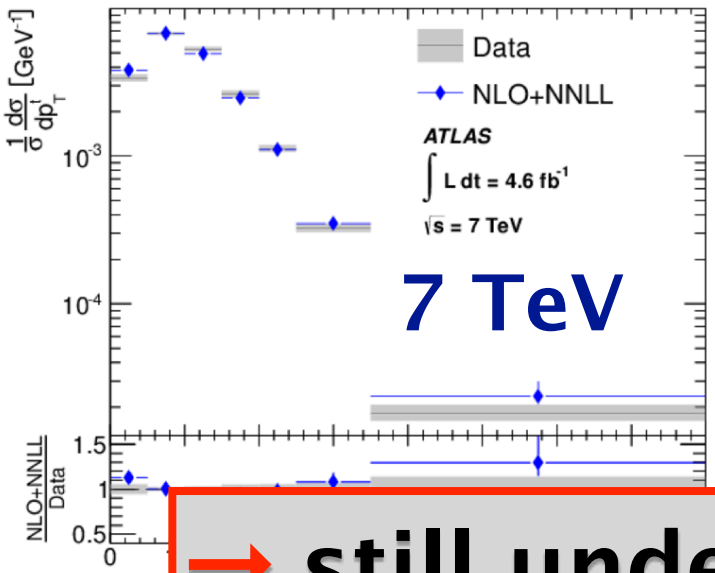


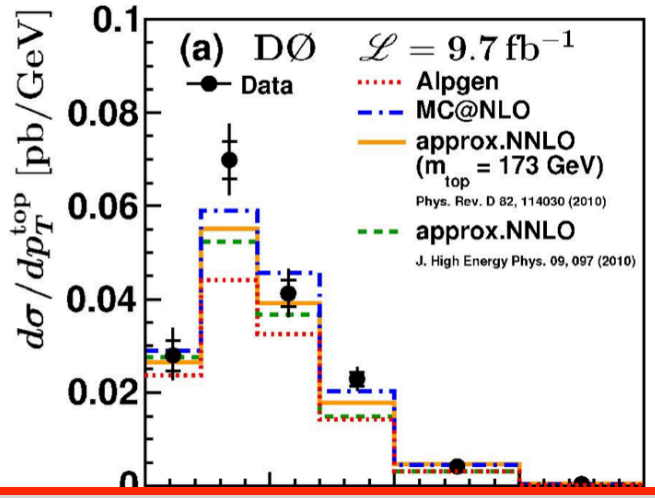
8 TeV

→ still much softer in data

Differential: top p_T

C. Diez

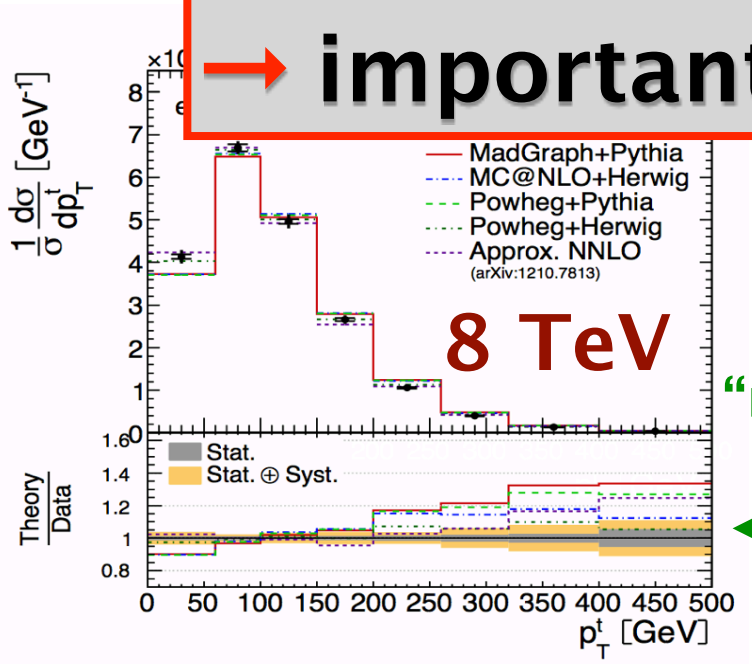




2 TeV

→ still under investigation

→ important info for MC modeling



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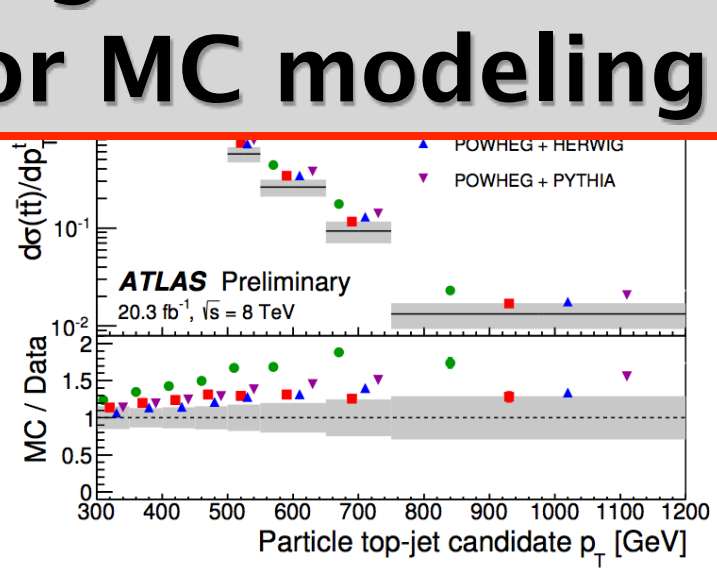
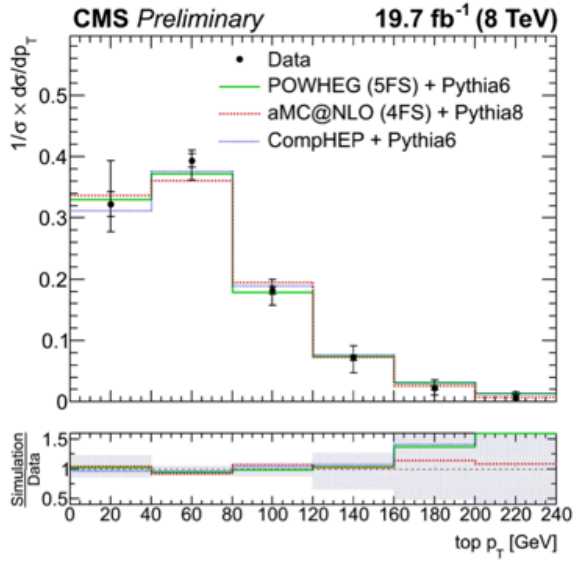


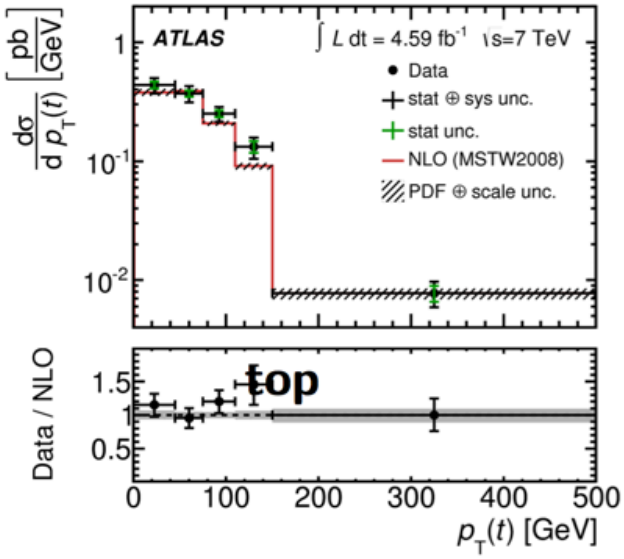
→ still much softer in data

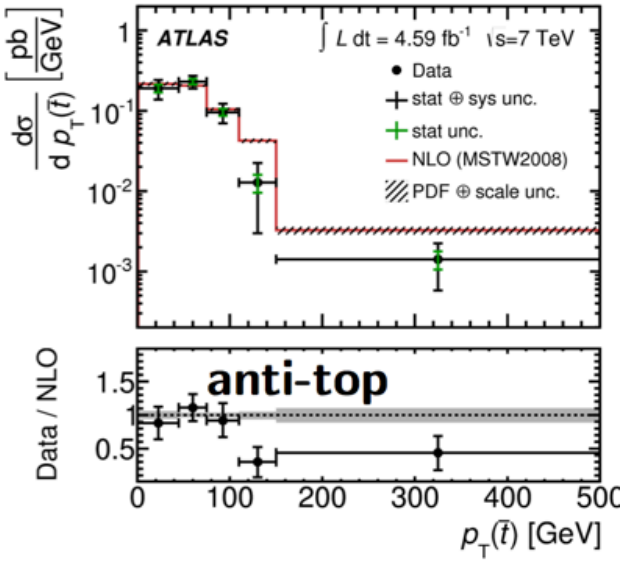
Differential single top: top p_T

C. Diez



8 TeV





7 TeV

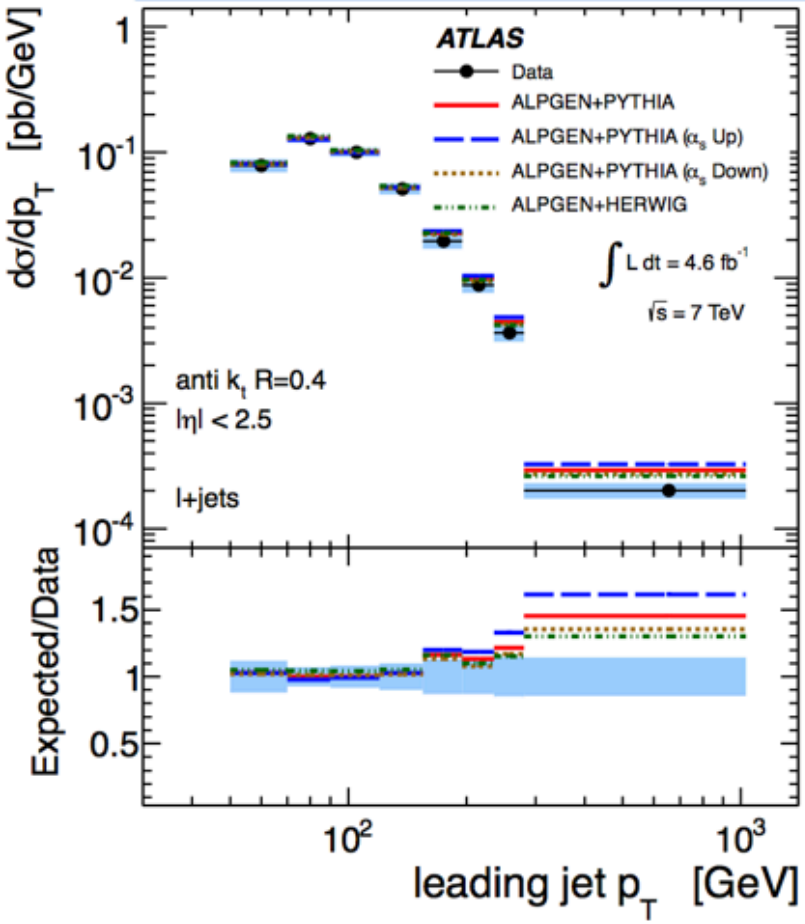
→ good description

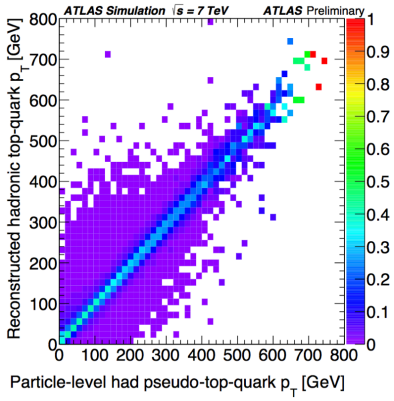
Top decay products: pseudo-top

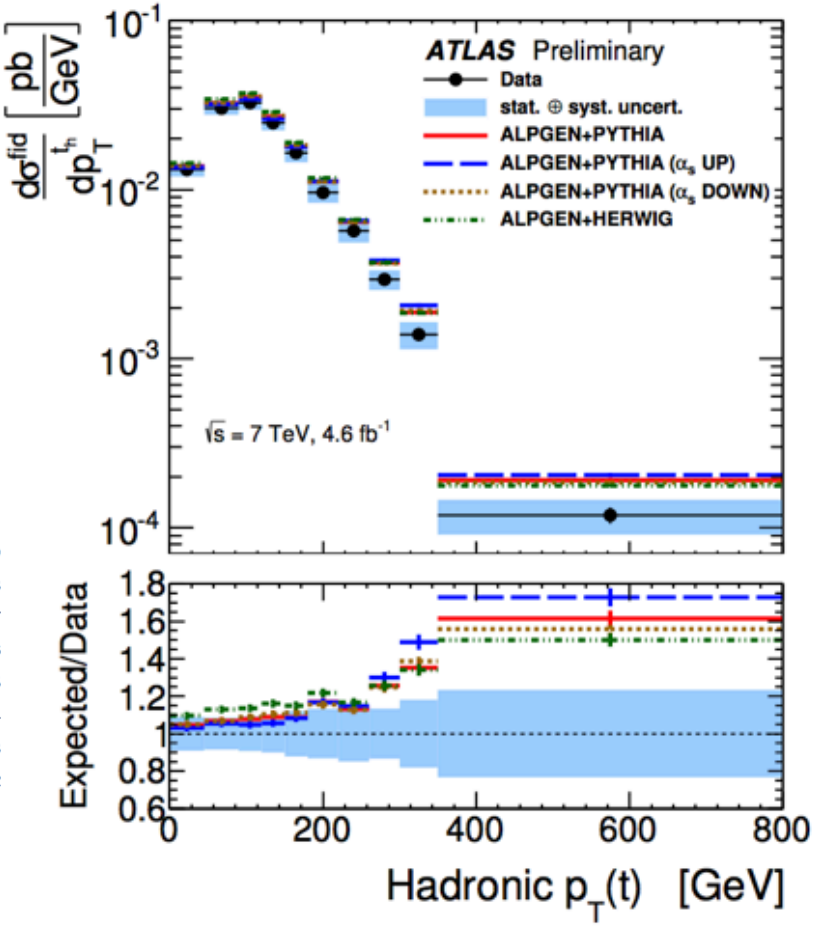
Fiducial phase space:
>=1 b-jet, 1 lepton, >=3 jets,
1st jet p_t>50 GeV, 2nd jet p_t>35 GeV

J. Katzy

Fiducial phase space:
2 b-jets, 1 lepton, >=4 jets



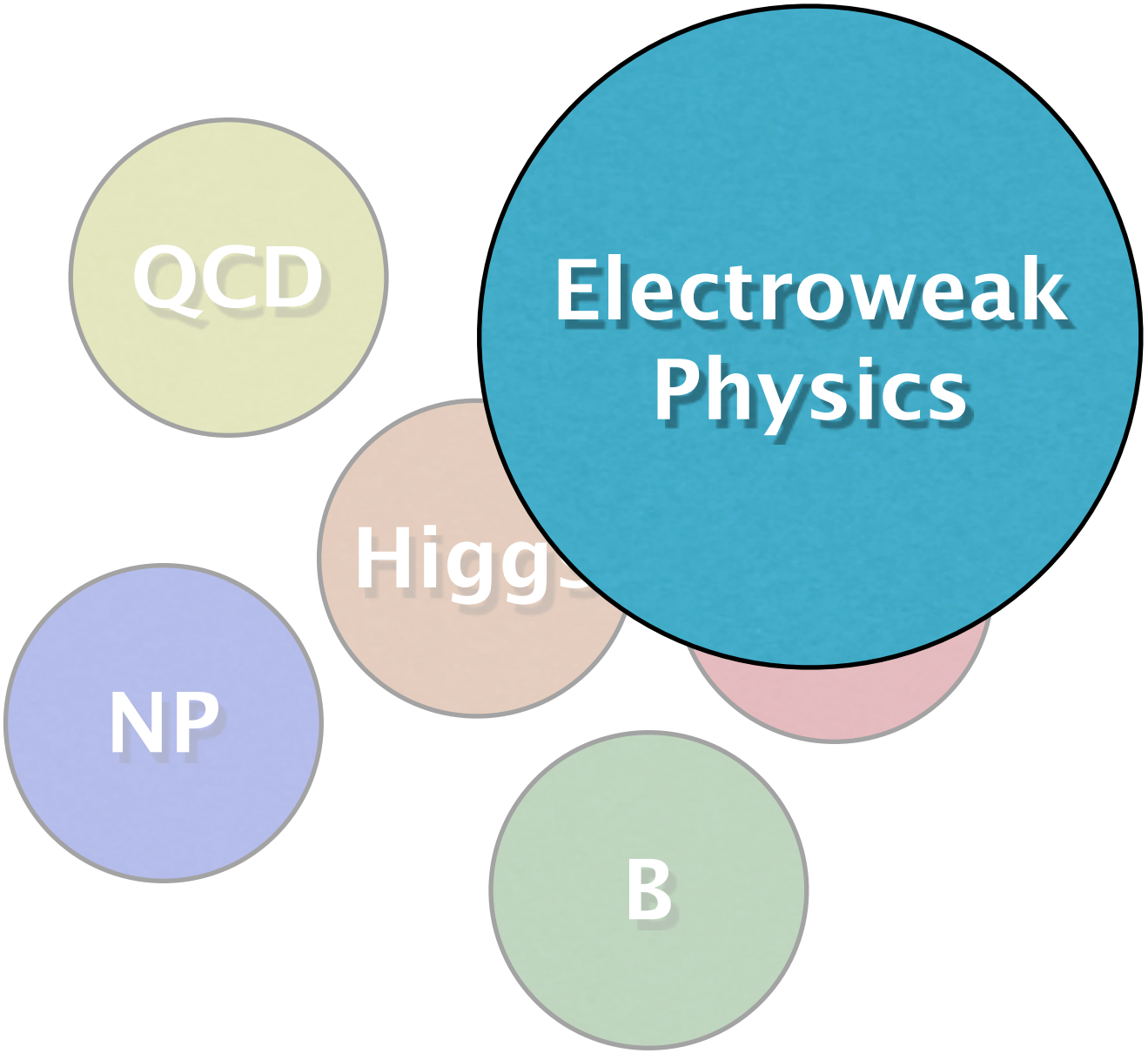




→ reconstruct tops on particle level

→ very valuable for theorists today and in future

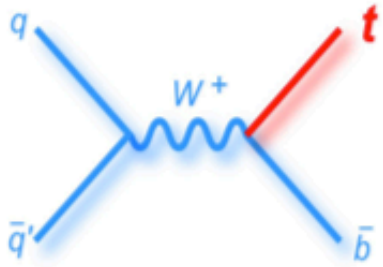
Top Quark Physics Topics

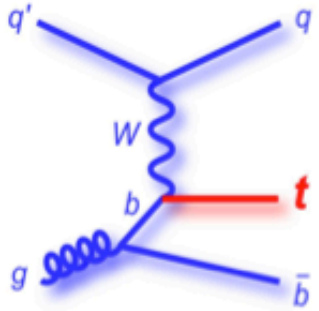


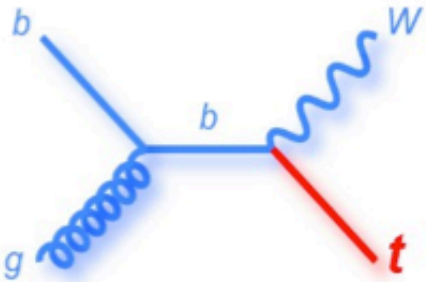
Single Top Quark Production

direct measurement of $|V_{tb}|$

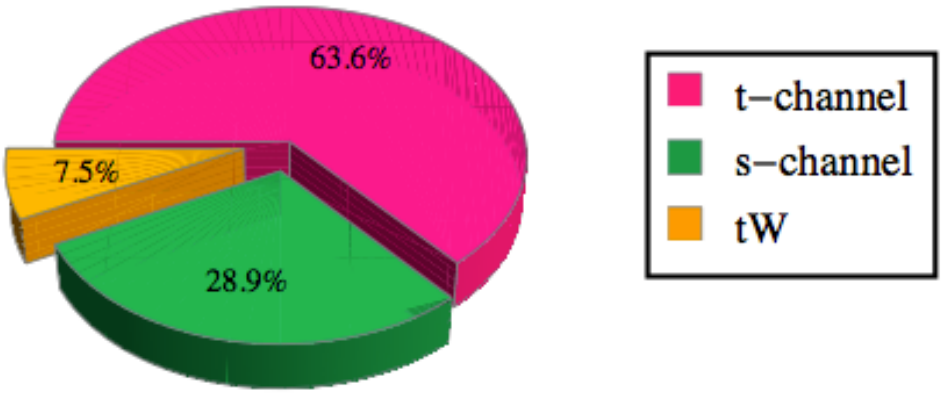
$$V_{CKM} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix}$$



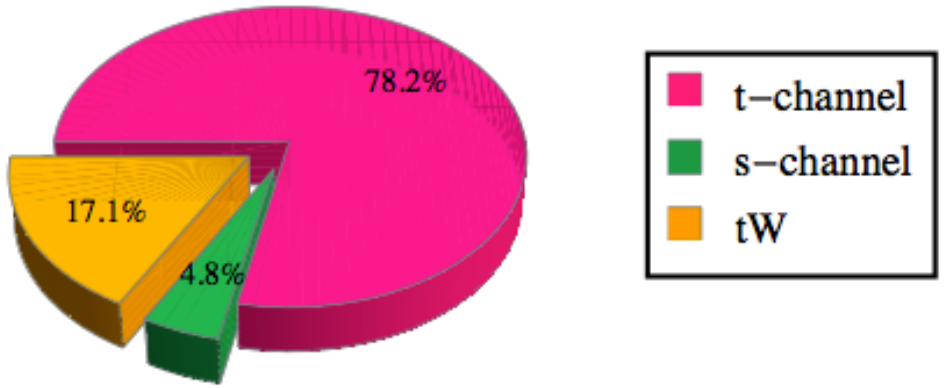




Tevatron



LHC (7 TeV)

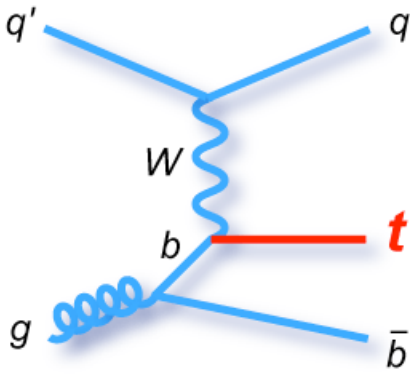


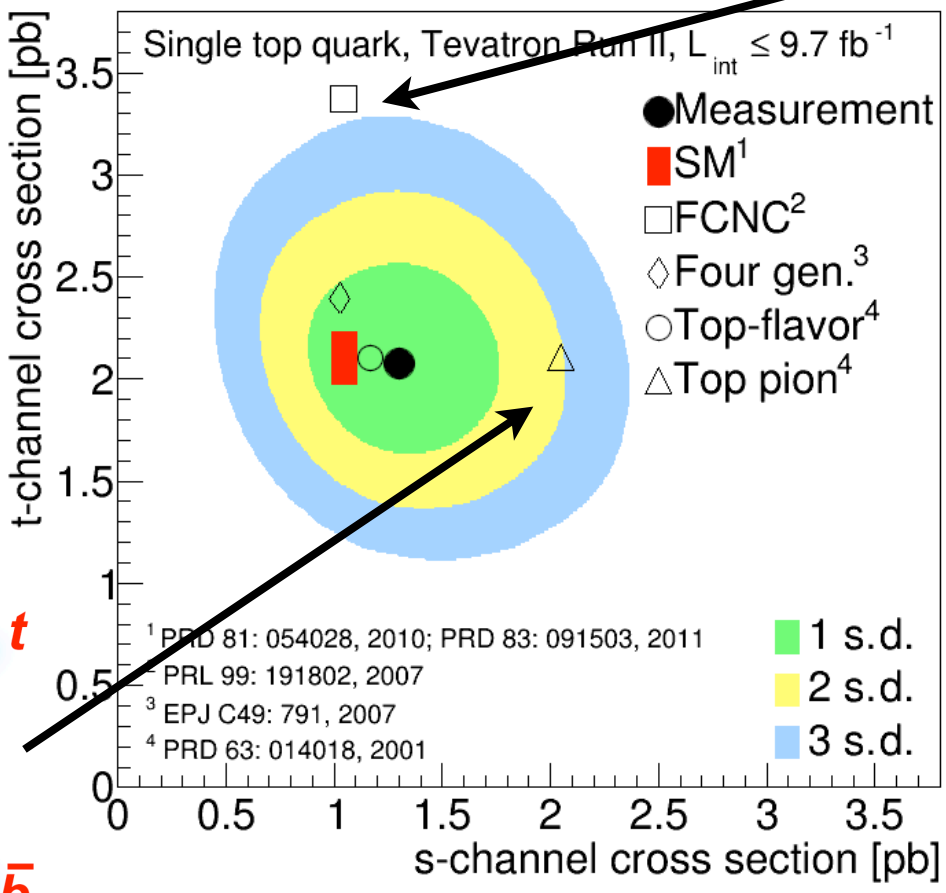
⇒ important to measure all channels separately to search for new physics

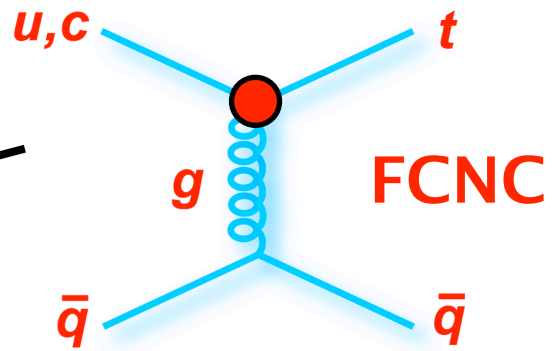
BUT: do not separate Wt in higher orders –an unphysical question!

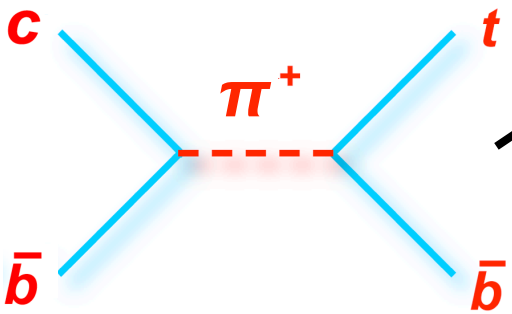
Single Top s- vs. t-channel

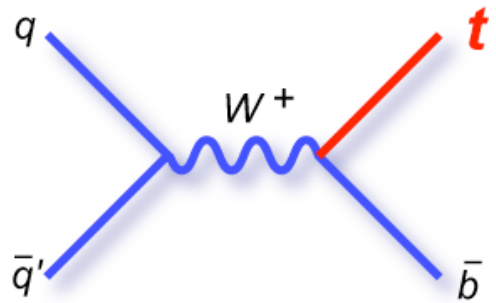
M. Ronzani







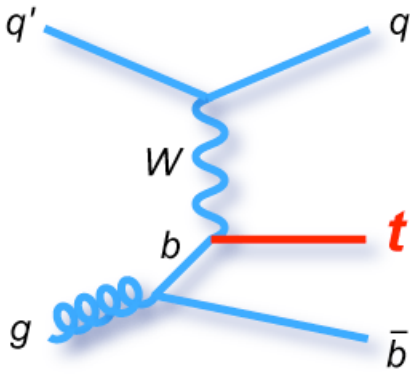




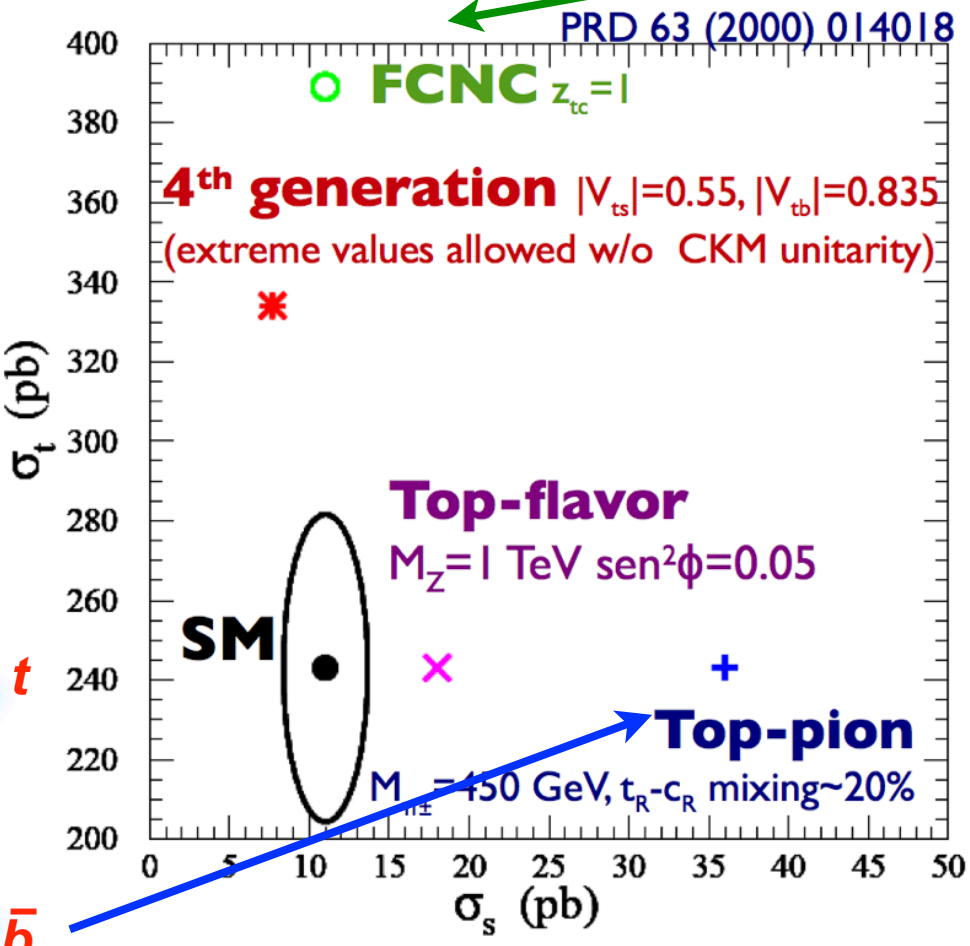
→ observed!

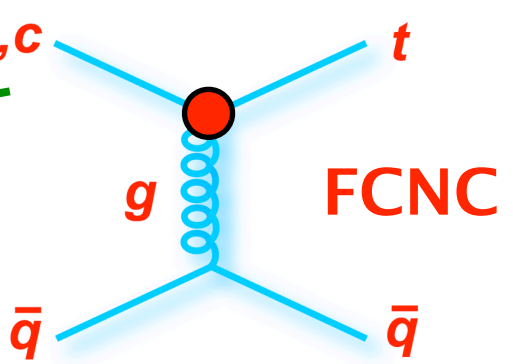
⇒ important to study production channels separately

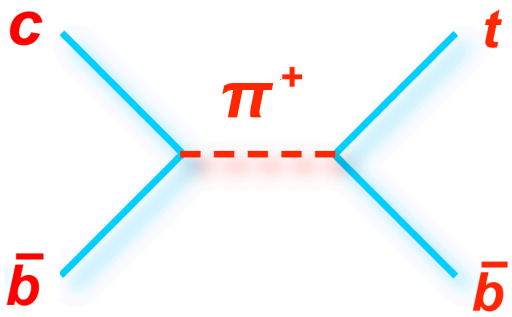
Single Top s- vs. t-channel: Run-II

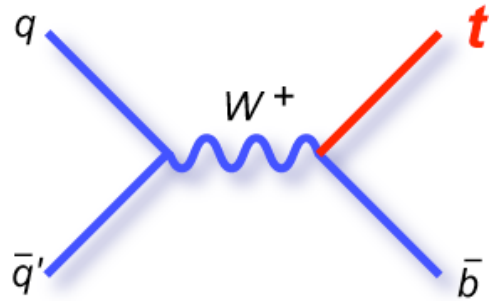


P. Silva







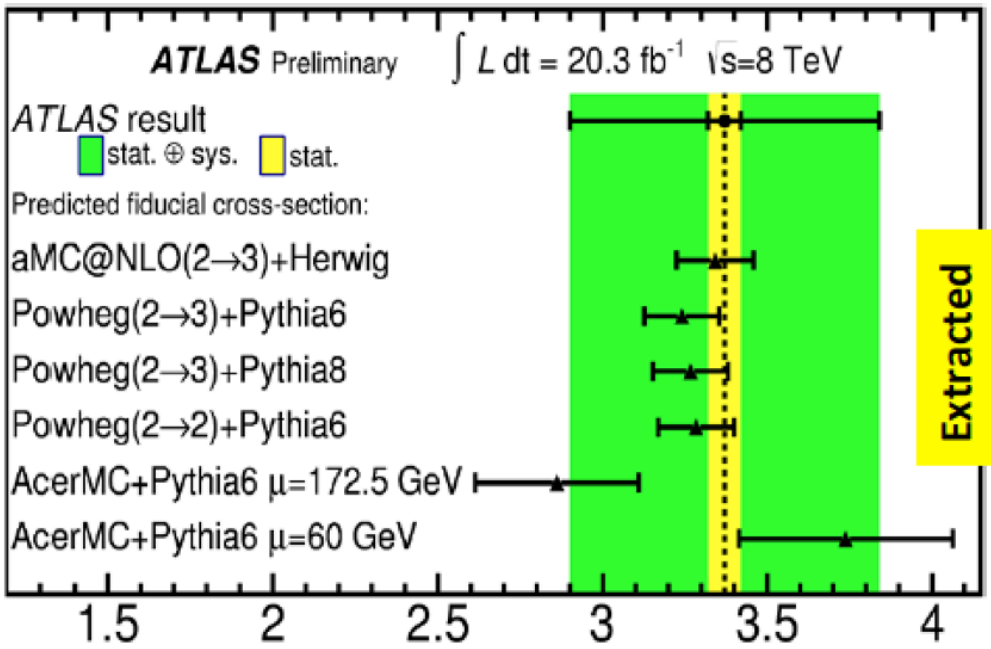


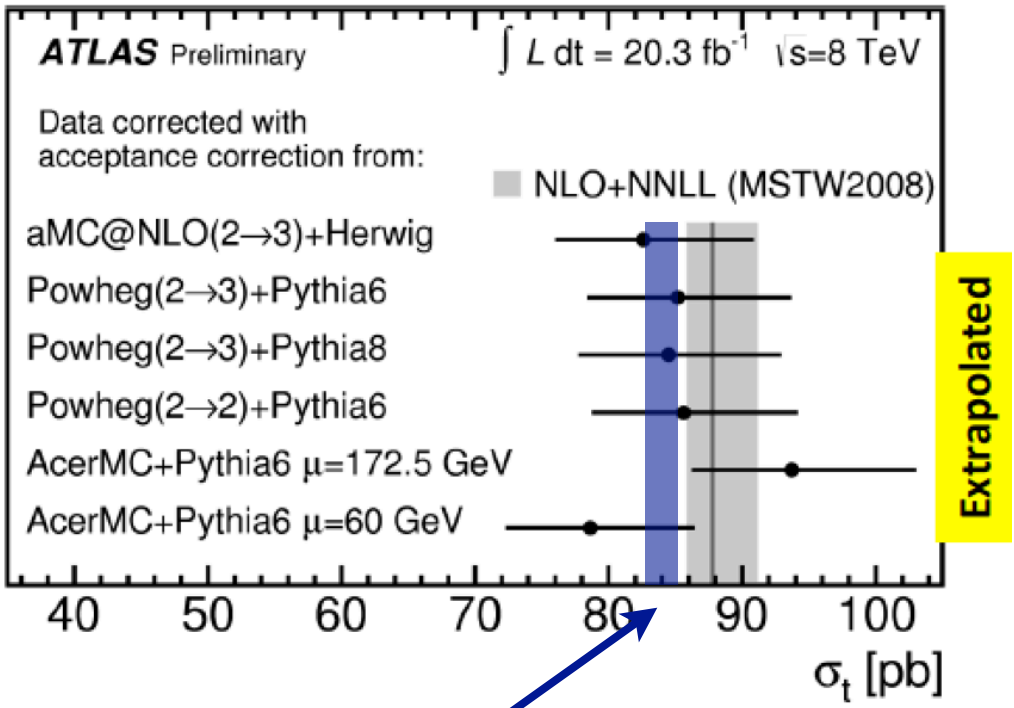
→ observed!

⇒ important to study production channels separately

Fiducial t-channel cross section

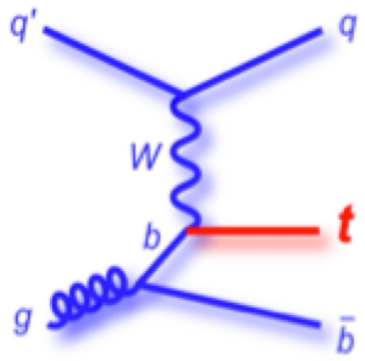
A. Jafari





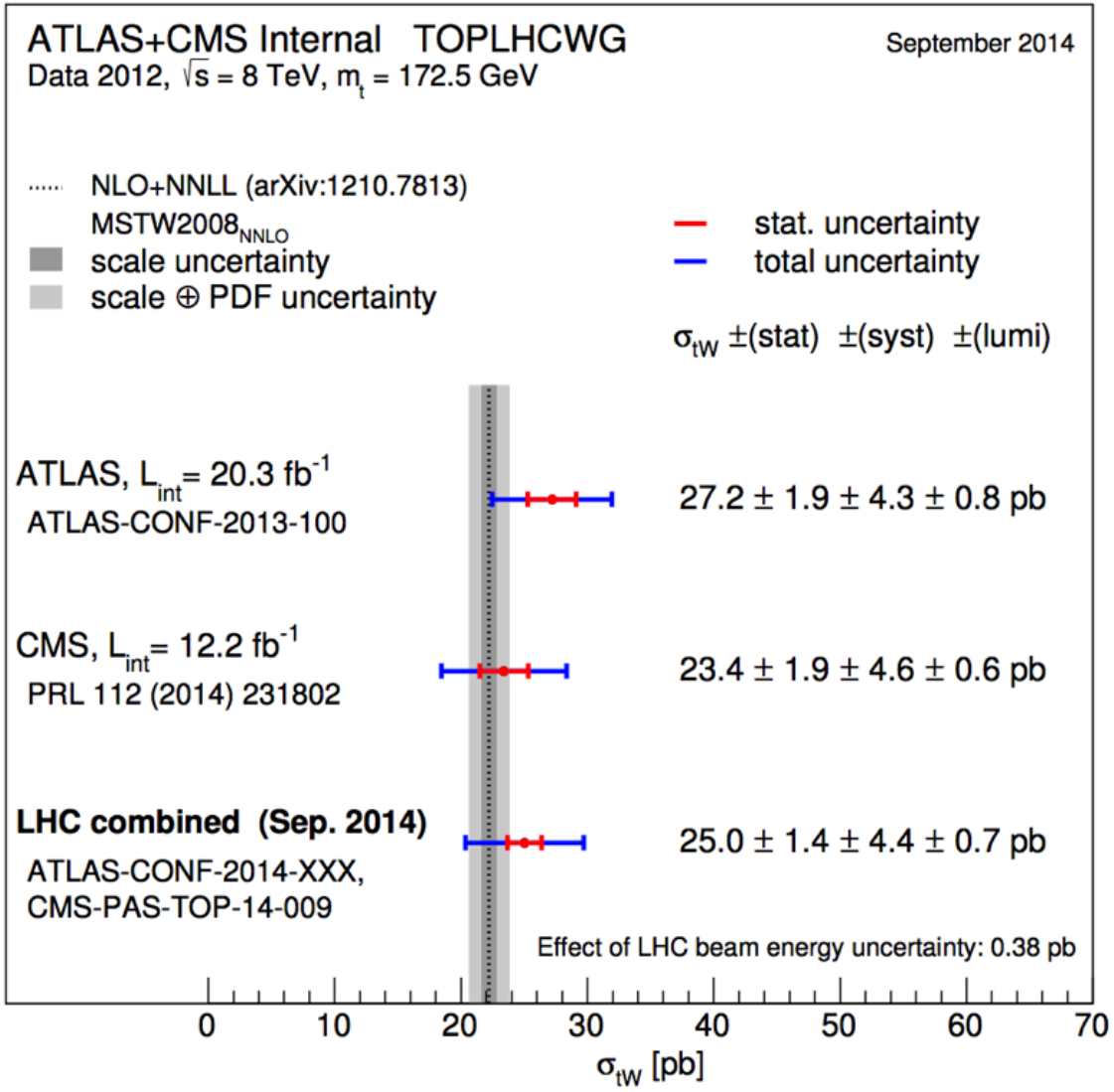
NNLO

F. Caola



→ **good agreement with SM predictions**

Single Top Wt Cross Section

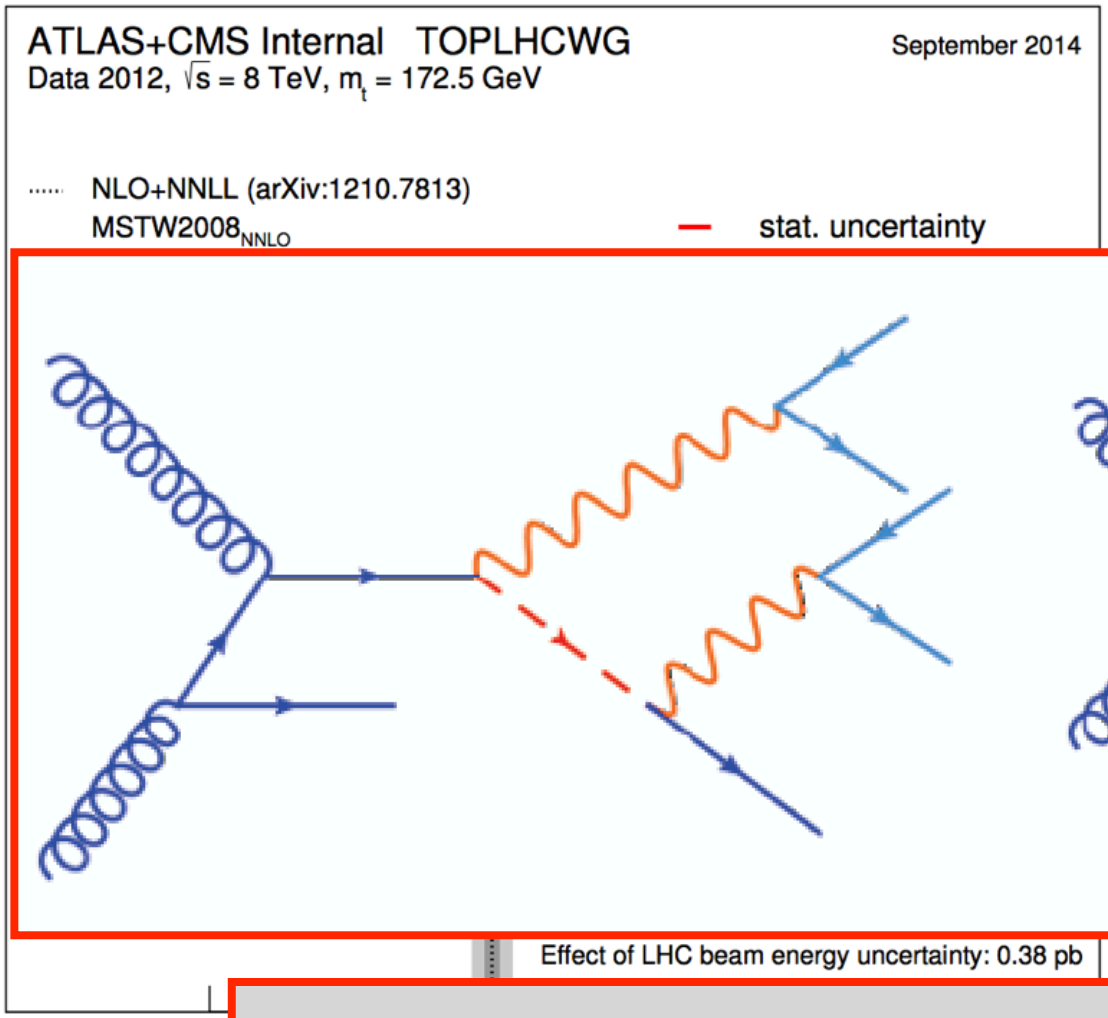


A. Jafari

Source	Uncertainty (%)	Uncertainty (pb)
Data statistics	5.5%	1.4
Simulation statistics	1.8%	0.5
Luminosity	2.7%	0.7
Theory modeling	15.8%	4.0
Background normalization	2.3%	0.6
Jets	5.3%	1.3
Detector modeling	4.9%	1.2
Total systematics (excl. lumi)	17.5%	4.4
Total systematics (incl. lumi)	17.7%	4.4
Total uncertainty	18.6%	4.7

→ observed!

Single Top Quark Cross Section



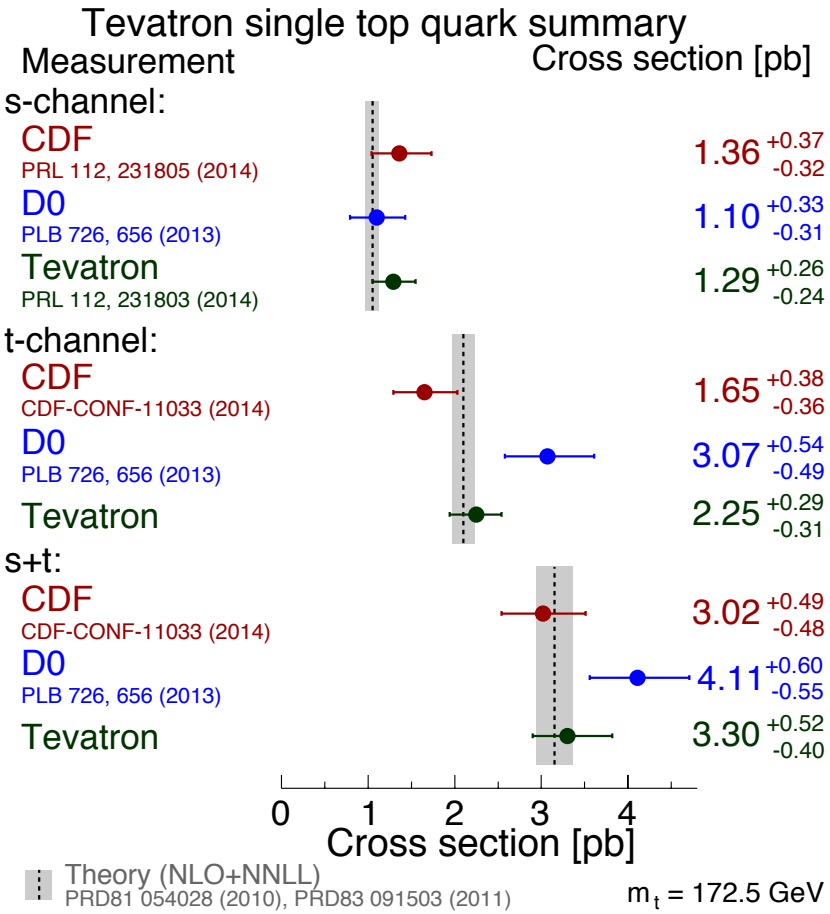
F. Caola

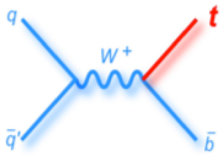
Total systematics (incl. lumi)	17.7%	4.4
	18.6%	4.7

→ **measure WWb cross section**

(single resonant enriched)

Single channel cross sections



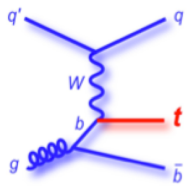


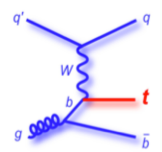
→ observation

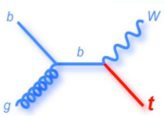
$$V_{CKM} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix}$$

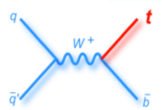
$|V_{tb}| = 0.998 \pm 0.041$ ±4.1%

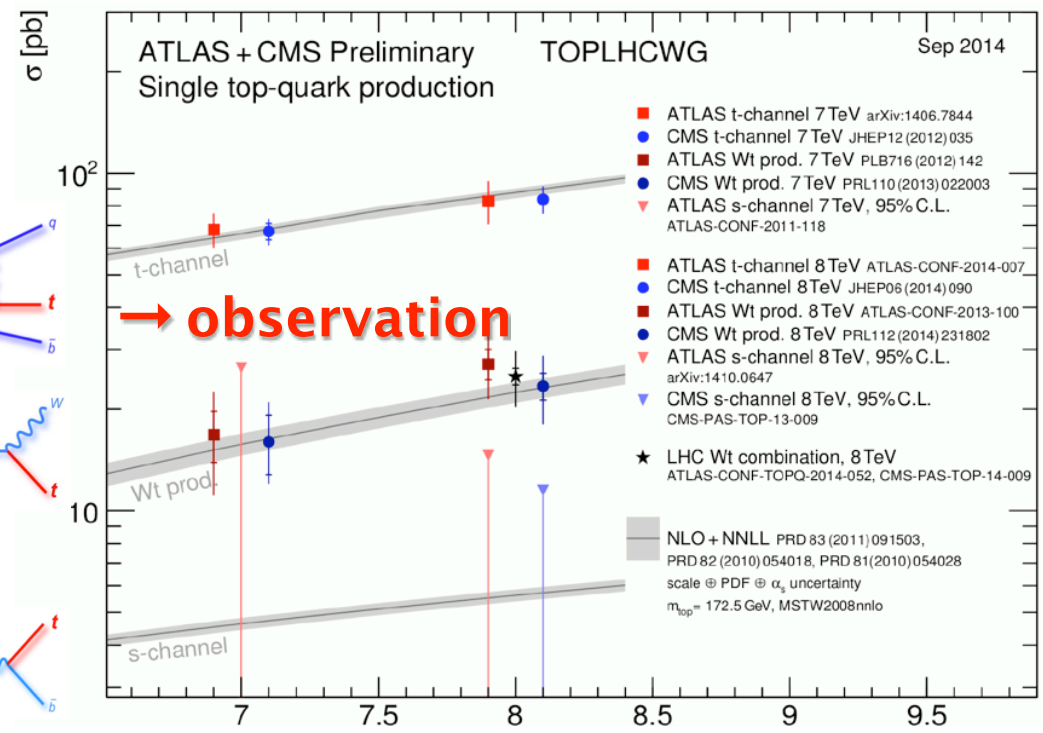
$|V_{tb}| > 0.92$ @ 95%CL











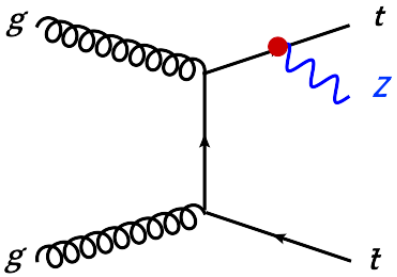
→ observation

this is the final word from the Tevatron!

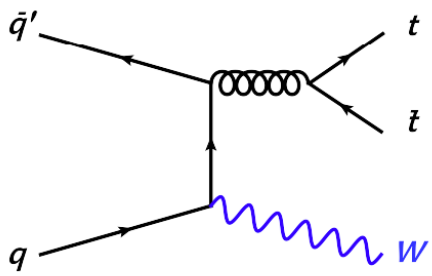
→ all production modes observed!

Search for ttZ and ttW

T.V. Schroeder

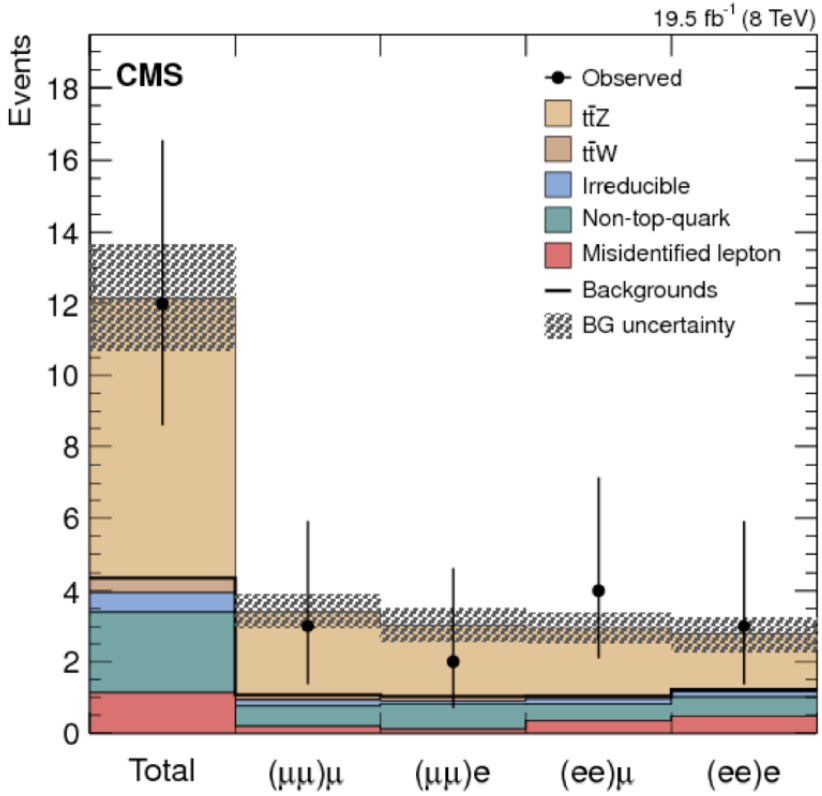


FSR

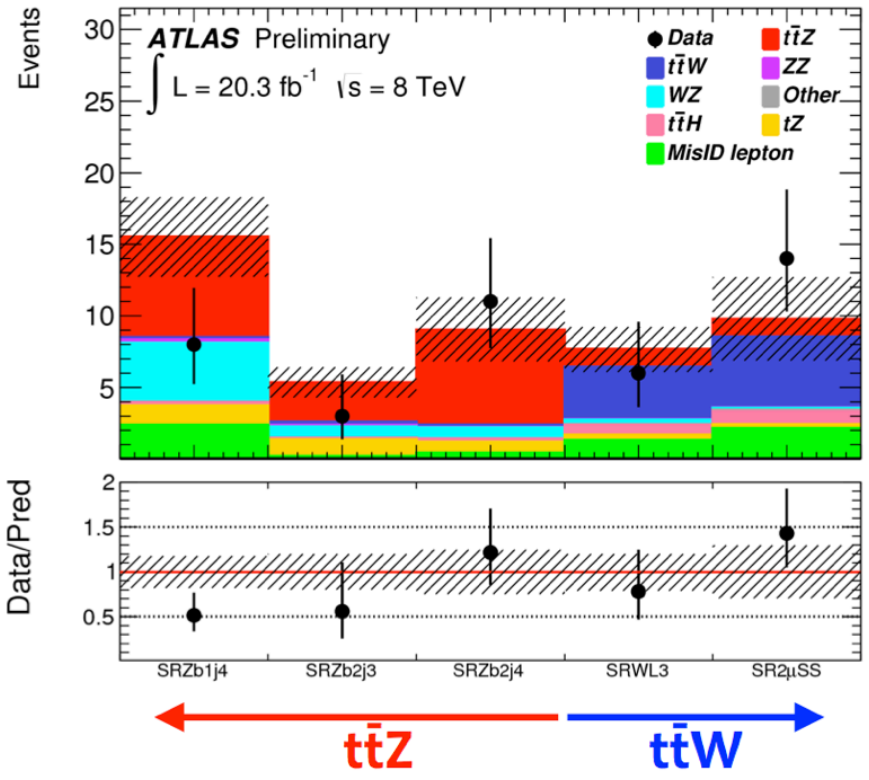


ISR

trilepton:



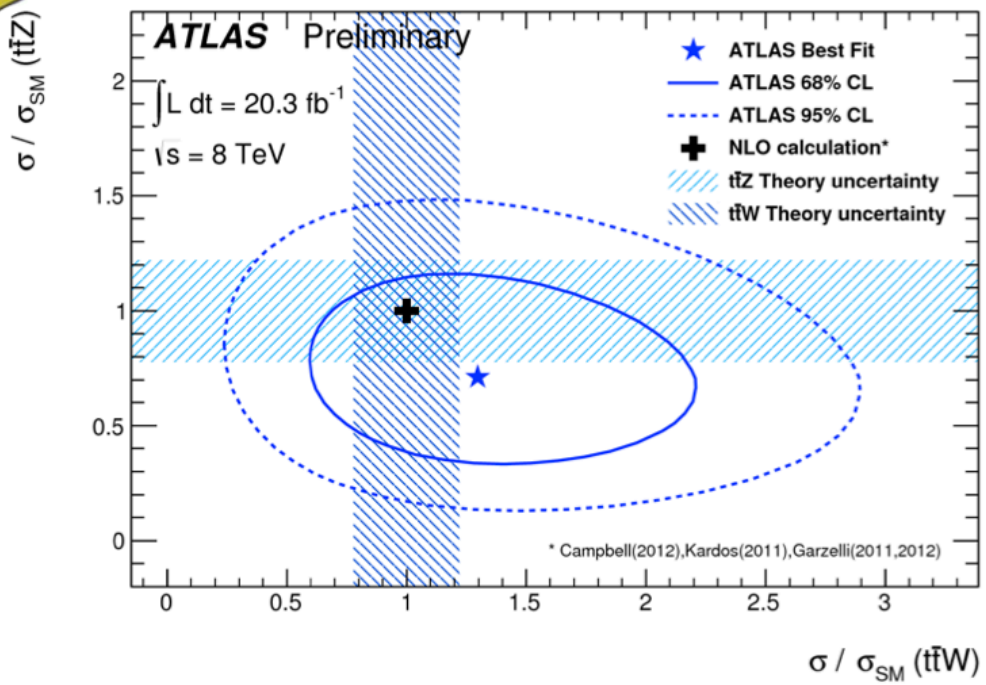
same sign dilepton:



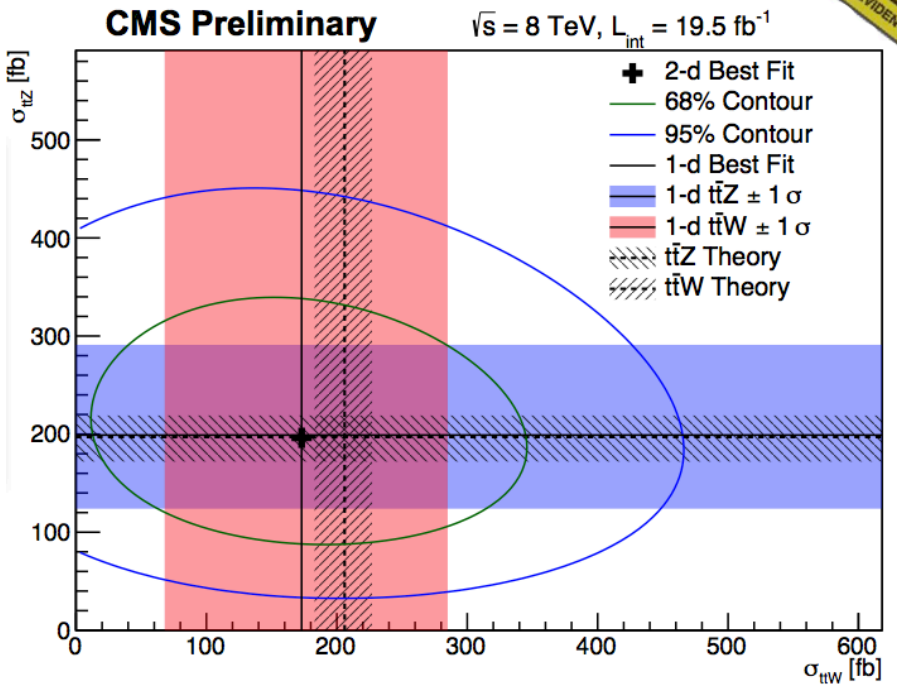
Evidence for ttV production

T.V. Schroeder

Evidence for ttZ and ttW!

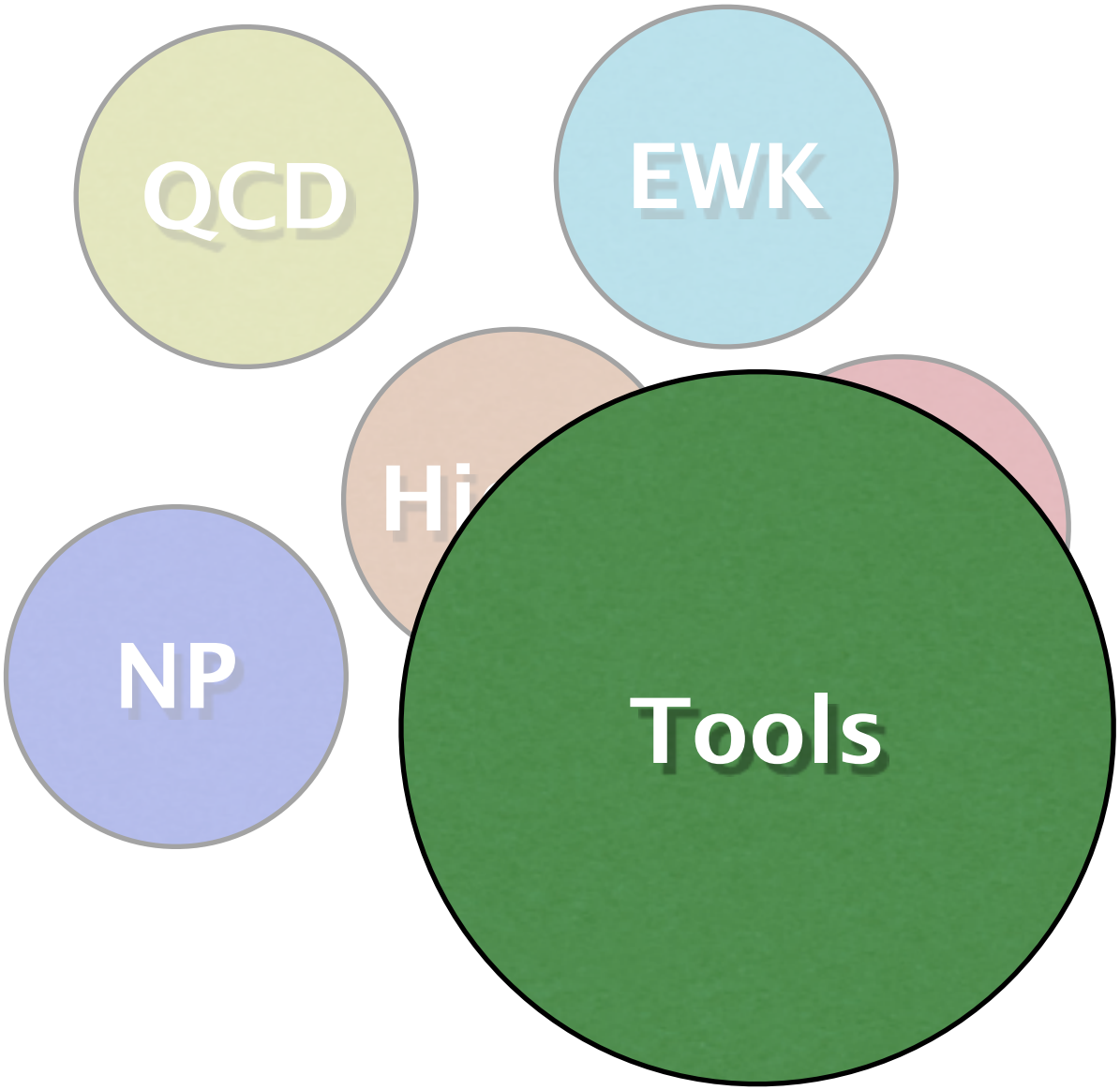


Evidence for ttZ!



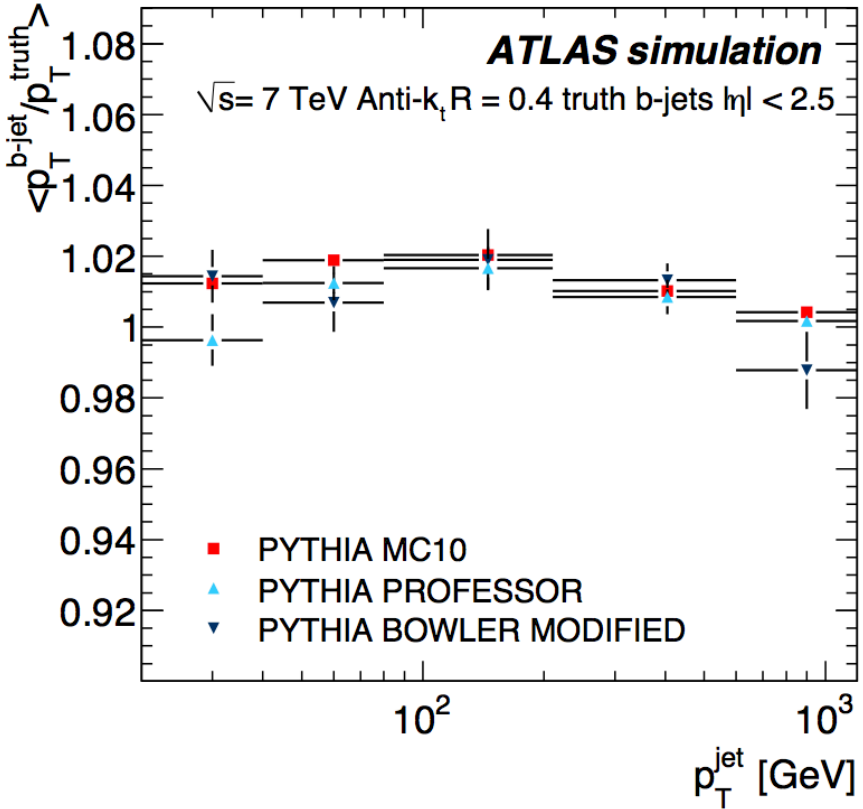
→ in agreement with the SM prediction
(ttγ also in agreement with SM prediction)
→ observation and studies in Run-II

Top Quark Physics Topics

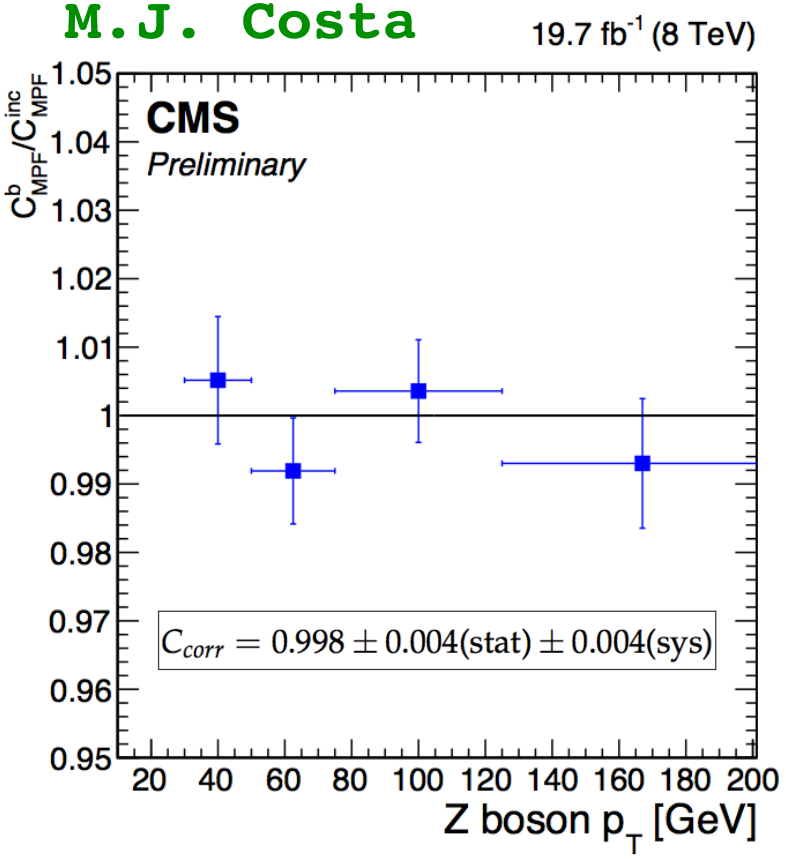


b-JES

M. Seidel



M.J. Costa



Specific b-JES uncertainty evaluated by comparing MC samples with different fragmentations and B-hadron decays, and cross checked using data

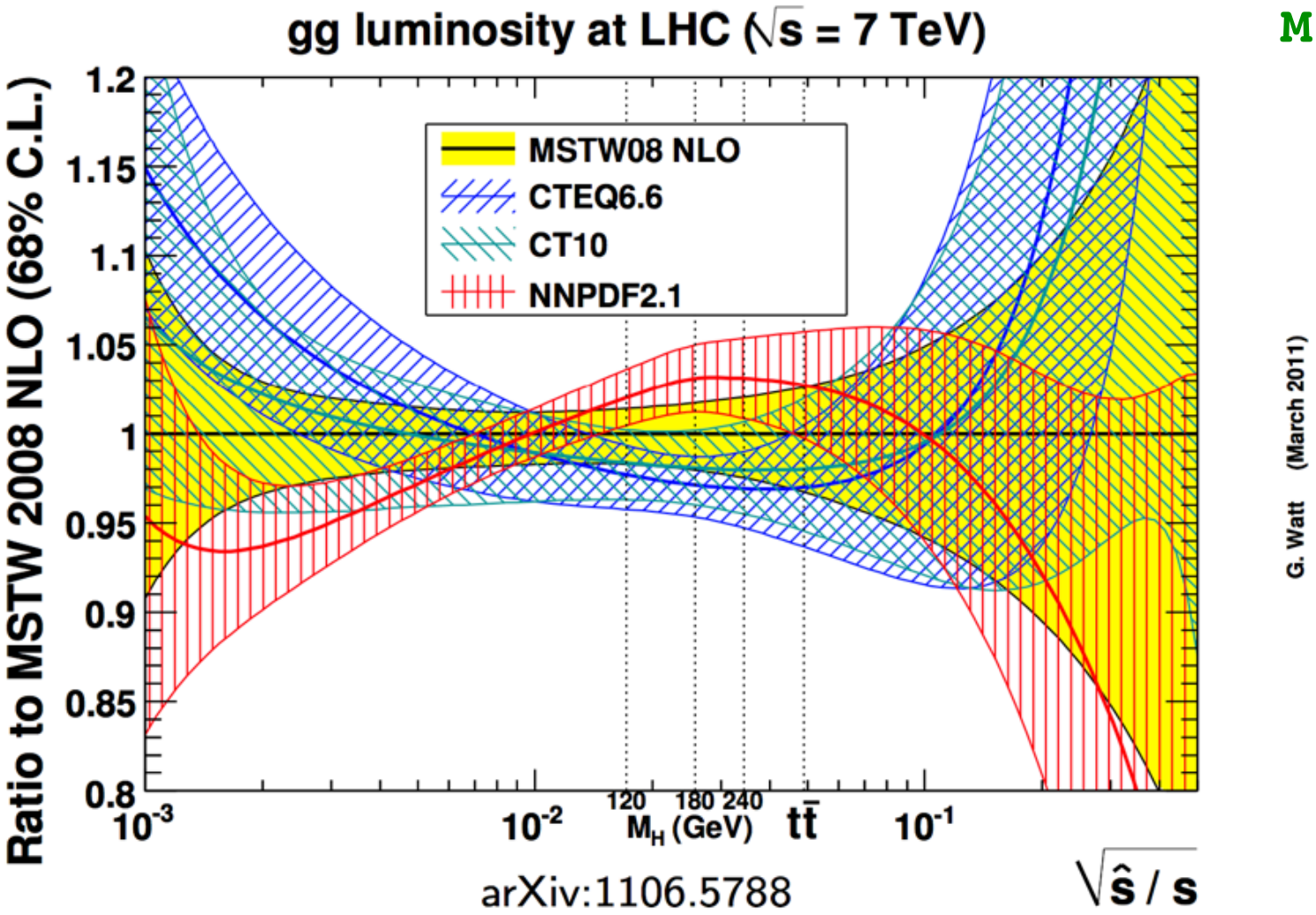
NEW determination of b-jet energy corrections using Z+b events exploiting the p_T balance of the b-jet and Z- boson

→ **used across physics groups**

→ **top group motivated ATLAS-CMS comparisons**

PDF uncertainties

M. Seidel



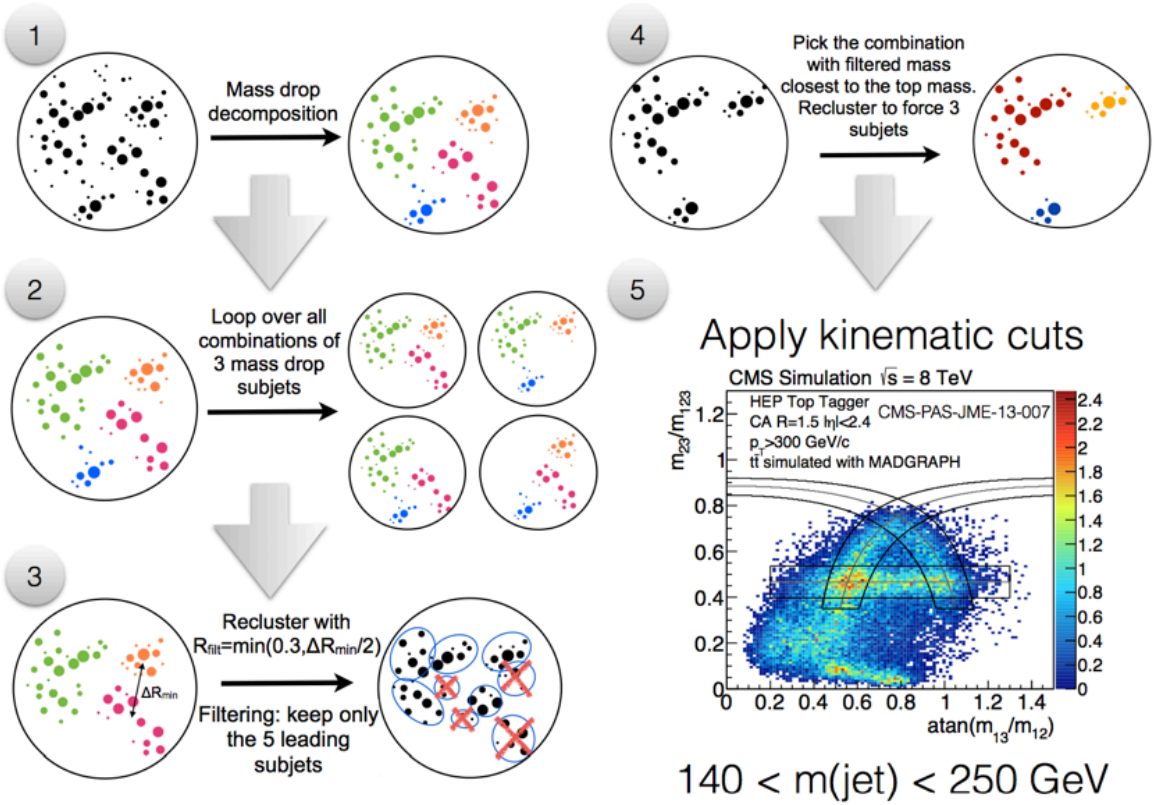
→ let's be complete as possible (LHAPDF?)

→ can we be more efficient

Tools for boosted tops

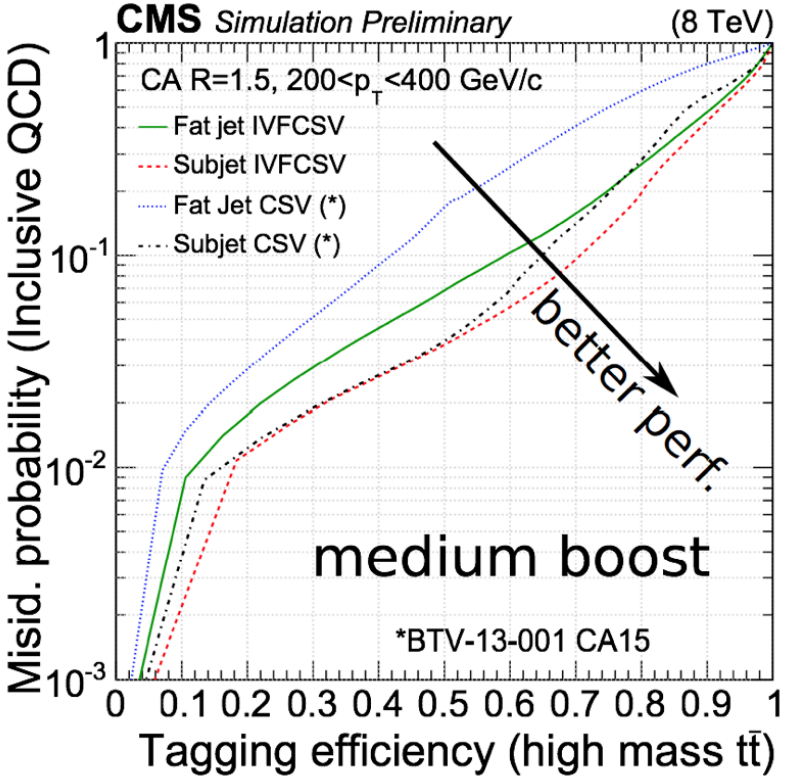
HEP Top Tagger

E. Usai



improvements:

- lhood based b-tagging
- inclusive vertex finder
- ...



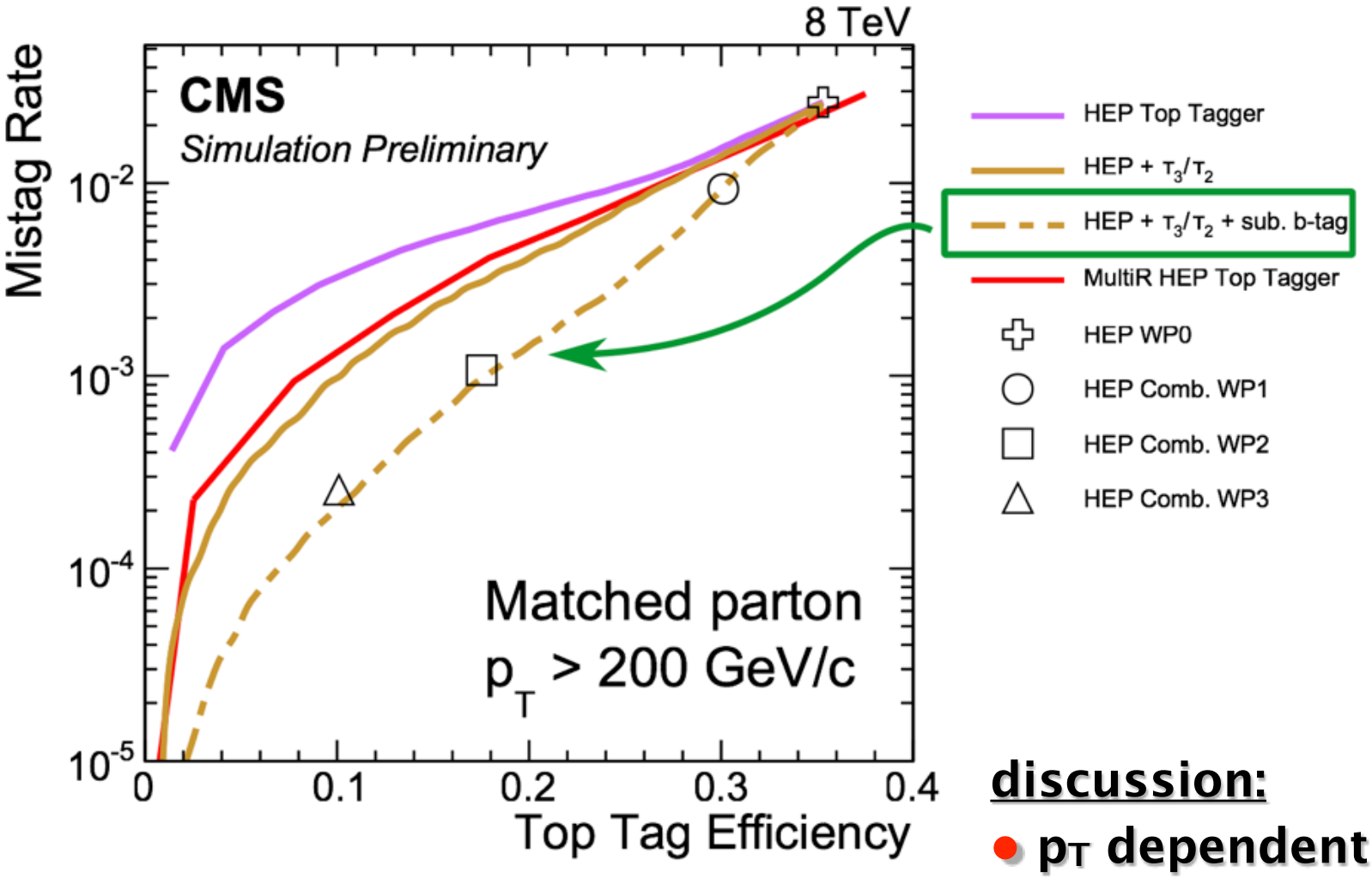
M. Backovic

→ impressive progress moving from R&D to performance testing

→ essential for searches for new phenomena

Top tag efficiency

E. Usai



discussion:

- p_T dependent
- how are uncertainties?
- dependent on MC generator?

LHC combination overview

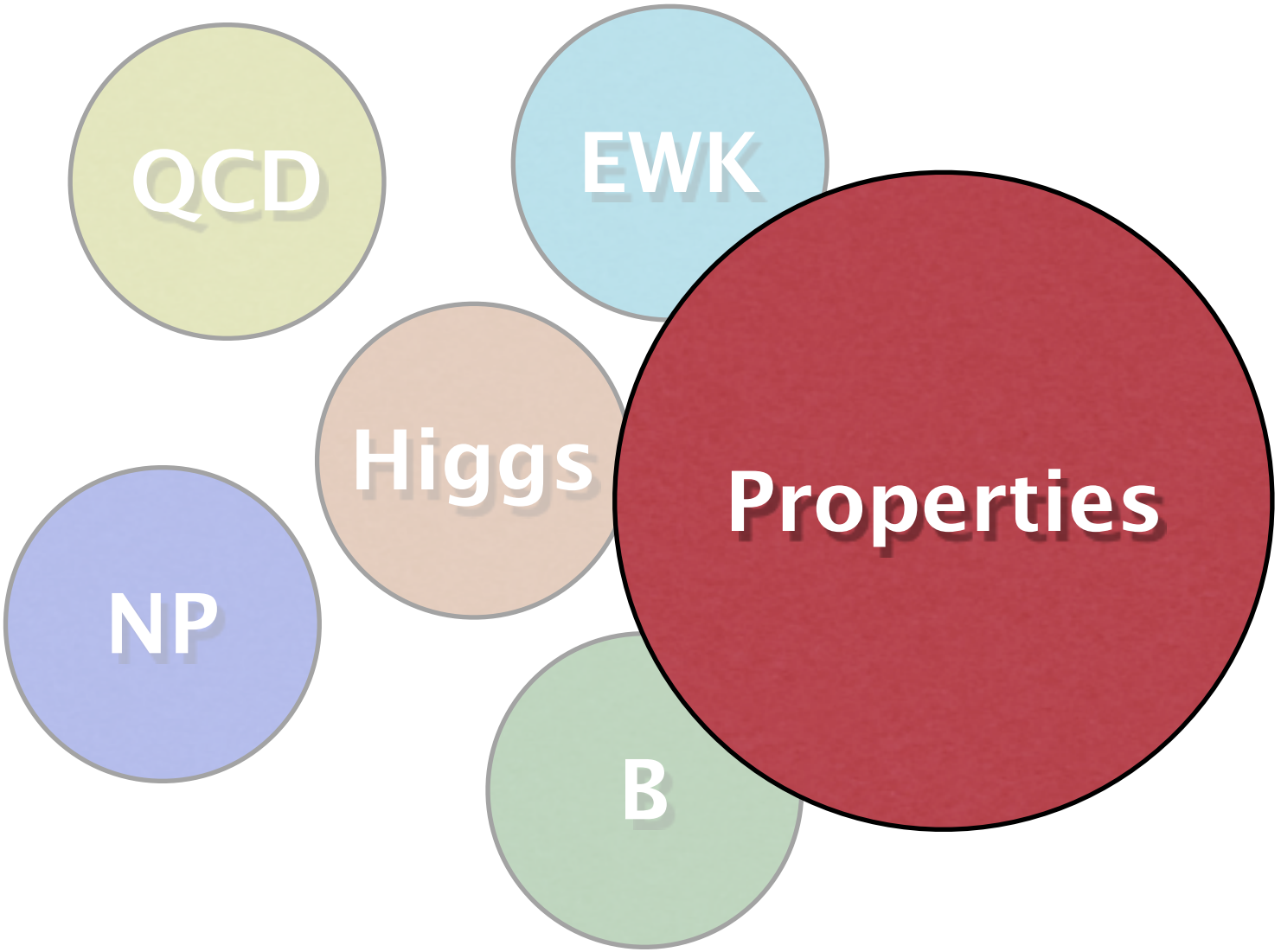
G. Cortiana

Overview (Sept. 2014)	$\sigma(t\bar{t})$ [pb] 7 TeV		$\sigma(t\bar{t})$ [pb] 8 TeV		$\sigma(t)$ 8 TeV [pb] t − ch		$\sigma(t)$ 8 TeV [pb] tW	
value	173.3		241.4		85.3		25.0	
statistics ($\star$)	2.8	$(0.08)^{\circ\circ}$	1.4	$(0.03)^{\times\circ}$	4.1	$(0.11)^{\times\circ}$	1.5	$(0.10)^{\times\circ}$
MC model/ theory	4.9	$(0.23)^{\bullet\bullet}$	4.1	$(0.23)^{\times *}$	7.7	$(0.40)^{\times *}$	4.0	$(0.72)^{\times *}$
Detector model (†)	4.6	$(0.21)^{\bullet\circ}$	2.7	$(0.10)^{\times\circ}$	5.5	$(0.20)^{\times *}$	1.2	$(0.06)^{\times *}$
JES/Jets ($\odot$)	2.1	$(0.04)^{\bullet\circ}$	1.7	$(0.04)^{\times *}$	4.5	$(0.14)^{\times\circ}$	1.3	$(0.08)^{\times\circ}$
Background	2.3	$(0.05)^{**}$	2.3	$(0.07)^{\times *}$	3.2	$(0.07)^{\times *}$	0.6	$(0.02)^{\times\circ}$
Luminosity	6.3	$(0.39)^{\bullet *}$	6.2	$(0.53)^{\times *}$	3.4	$(0.08)^{\times *}$	0.7	$(0.02)^{\times *}$
Total uncertainty	10.1		8.5		12.2		4.7	
Relative unc. [%]	5.8		3.5		14.3		18.8	
Best single meas.	182.9 ± 6.3		242.4 ± 9.5		83.6 ± 7.8		27.2 ± 5.8	
Ref. (ATLAS, CMS)	arXiv 1406.5375		arXiv 1406.5375		JHEP 06 (2014) 090		ATL-CONF 2013-100	

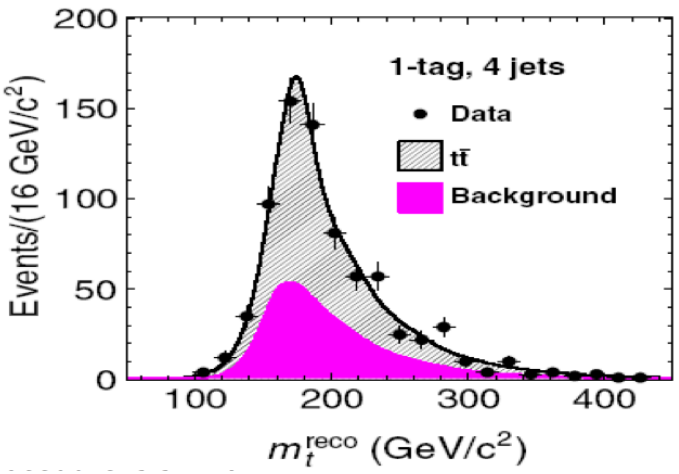
Overview (Sept. 2014)	m_{top} [GeV]		W polarization F_0		W polarization F_L		A_C	
value	173.29		0.626		0.359		0.005	
statistics ($\star$)	0.24	$(0.06)^{\circ\circ}$	0.035	$(0.35)^{\circ\circ}$	0.022	$(0.38)^{\circ\circ}$	0.007	$(0.61)^{\times\circ}$
MC model/ theory	0.59	$(0.38)^{\bullet\bullet}$	0.034	$(0.33)^{\bullet *}$	0.019	$(0.30)^{\bullet *}$	0.002	$(0.07)^{\times *}$
Detector model (†)	0.32	$(0.12)^{\bullet\circ}$	0.020	$(0.11)^{\bullet\circ}$	0.011	$(0.11)^{\bullet\circ}$	0.004	$(0.21)^{\times\circ}$
JES/Jets ($\odot$)	0.61	$(0.42)^{\bullet *}$	0.020	$(0.11)^{\bullet\circ}$	0.012	$(0.12)^{\bullet\circ}$		
Background	0.09	$(0.01)^{**}$	0.019	$(0.10)^{\bullet\circ}$	0.010	$(0.09)^{\bullet\circ}$	0.003	$(0.11)^{\times *}$
Luminosity								
Total uncertainty	0.95		0.059		0.035		0.009	
Relative unc. [%]	0.5		9.5		9.7		181	
Best single meas.	172.22 ± 0.73		0.659 ± 0.027		0.350 ± 0.026		0.006 ± 0.011	
Ref. (ATLAS, CMS)	CMS-PAS-TOP 14-001		CMS-PAS-TOP 13-008		CMS-PAS-TOP 13-008		JHEP 1402 (2014) 107	

→ driving force to agree on systematics, tools and methods

Top Quark Physics Topics



Top mass at the Tevatron

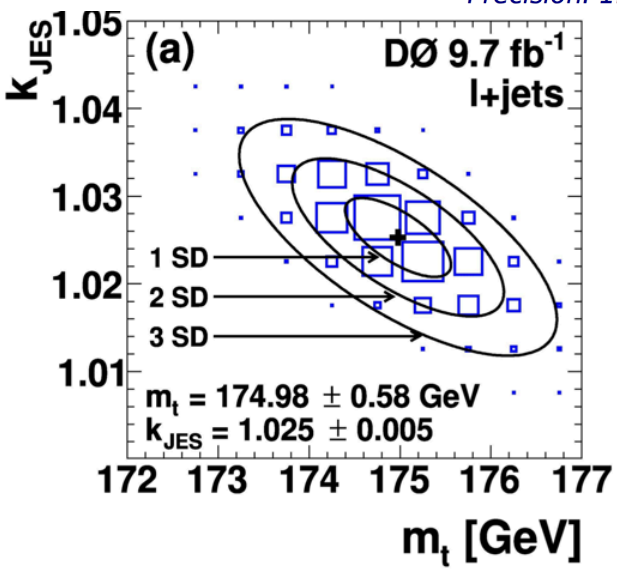


M_{top} = 173.93 ± 1.64 (stat+JES) ± 0.87 (syst) GeV

Precision: 1.1%

V. Sharyy

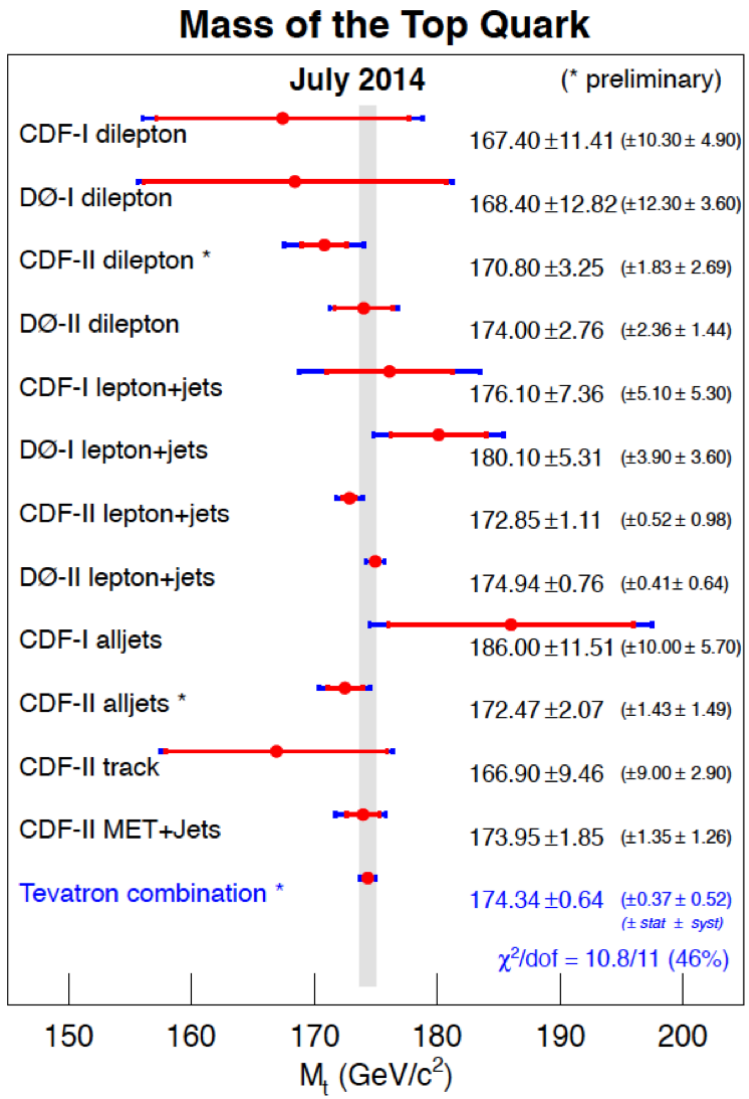
±1.1%



±0.44%

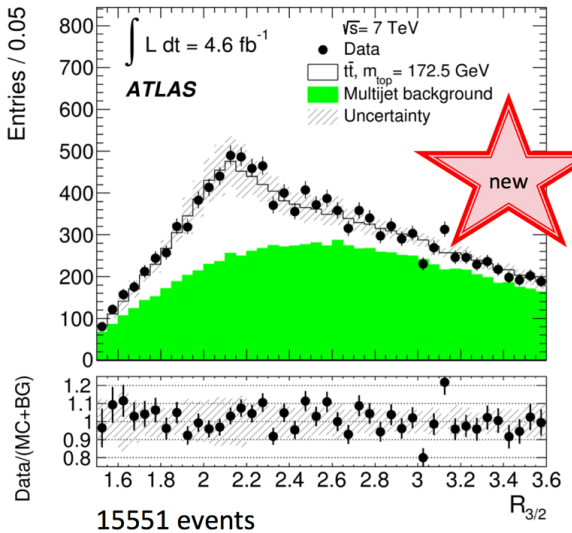
m_{top} = 174.98 ± 0.41(stat) ±0.41(JES) ±0.49(syst) GeV

Precision: 0.44%



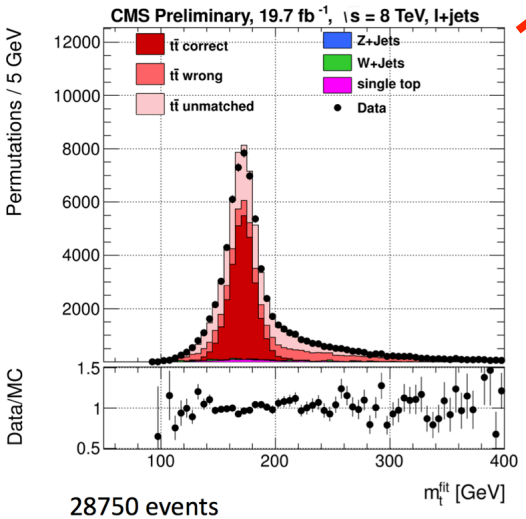
good agreement between all channels…

Top mass at the LHC



15551 events

m_t = 175.1 ± 1.9 GeV (1.06%)

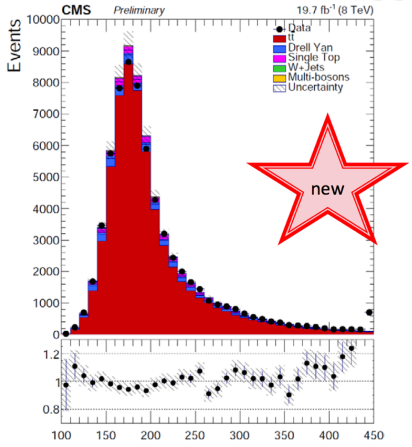


28750 events

m_t = 172.04 ± 0.77 GeV (0.45%)

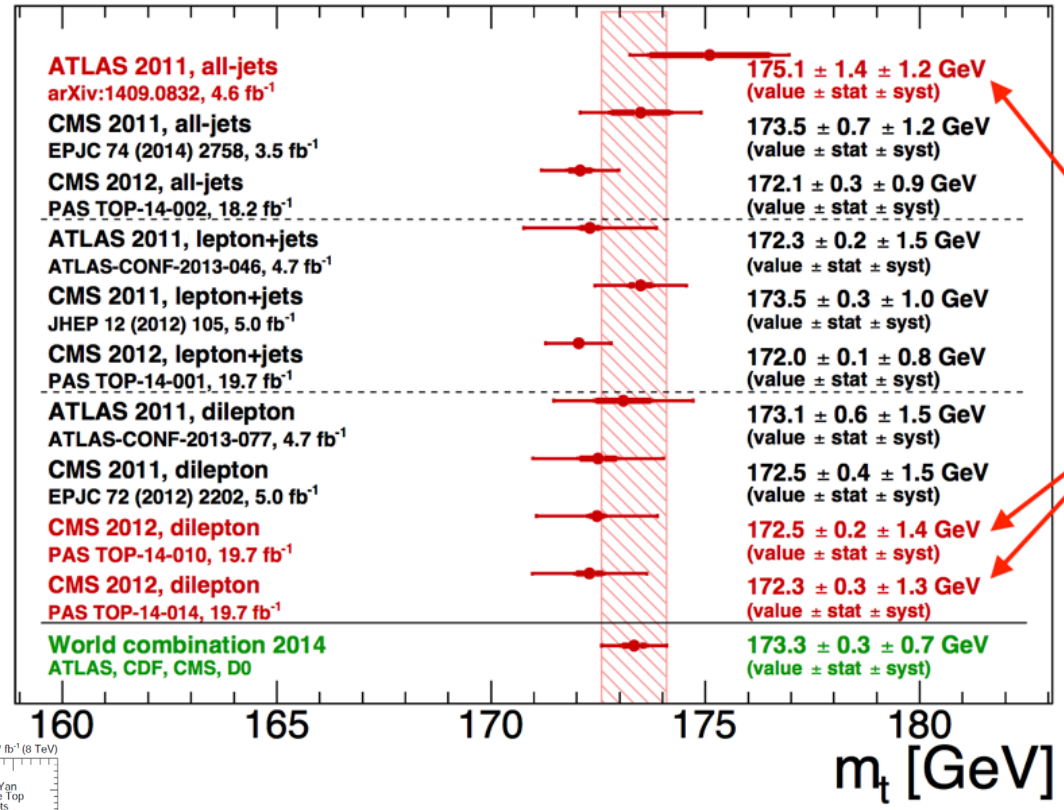
JSF = 1.007 ± 0.012

±0.45%



66092 events

m_t = 172.47 ± 1.41 GeV (0.81%)



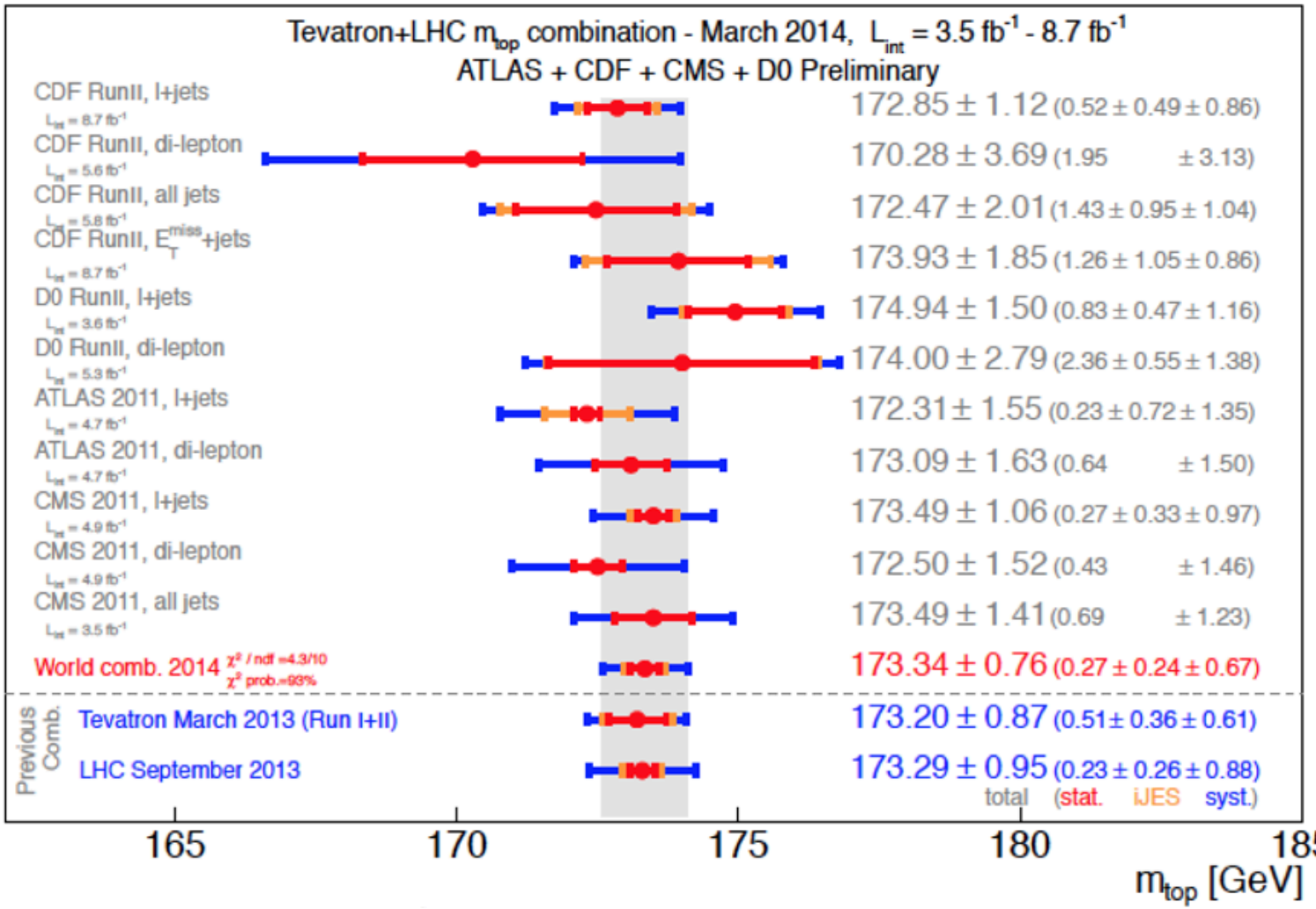
NEW at TOP2014

good agreement between all channels...

E. Schlieckau

Top mass world combination

Y. Peters



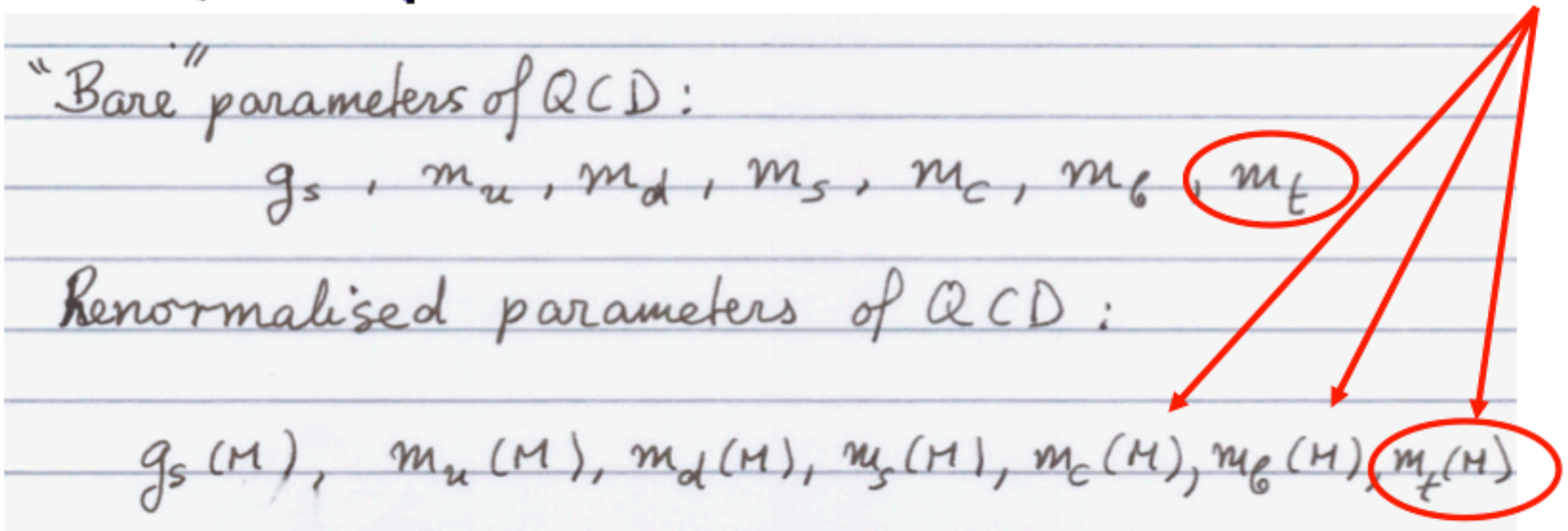
±0.44%

What mass do we measure?

$$\mathcal{L} = \ldots - \bar{\psi} M \psi \left(1 + \frac{H}{v}\right) \ldots$$

m_{top}

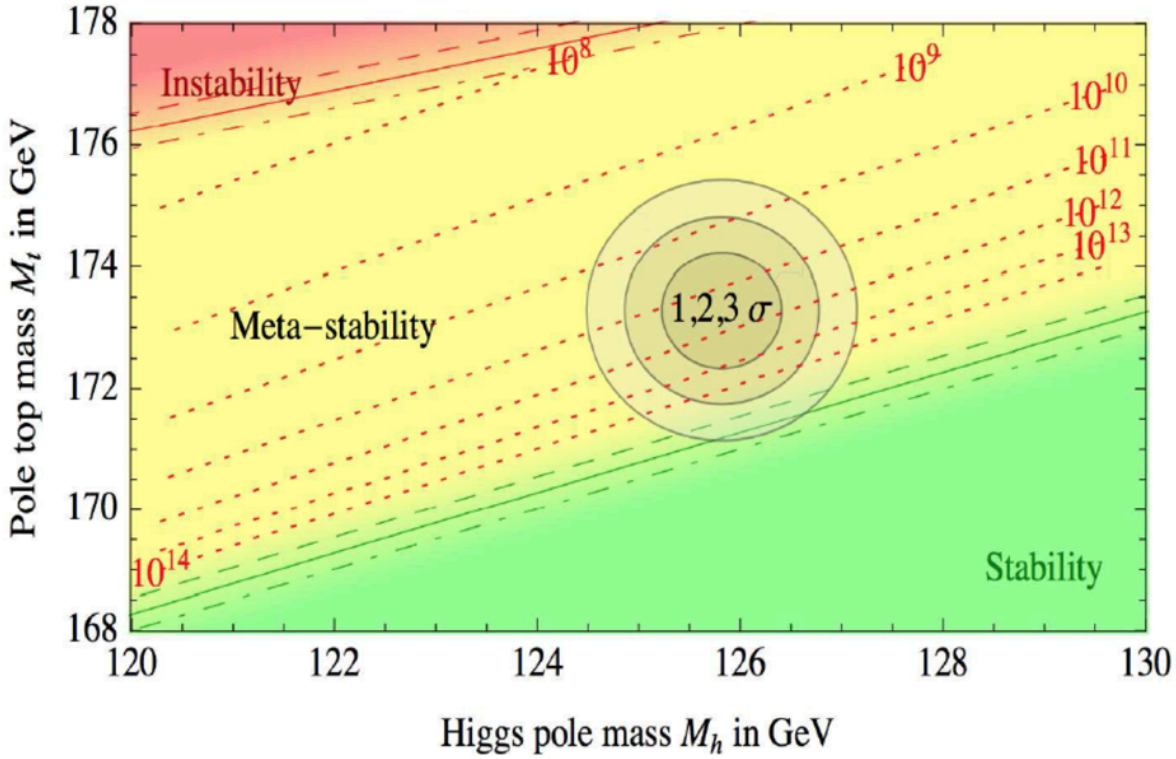
- **LO QCD: free parameter**
- **NLO QCD: dependent on the renormalisation scale M**



the concept of quark mass is convention–dependent!

What mass do we need?

A. Hoang



- we measure the MC mass
- we need the pole mass
- we need to calculate:

Scheme-dependent

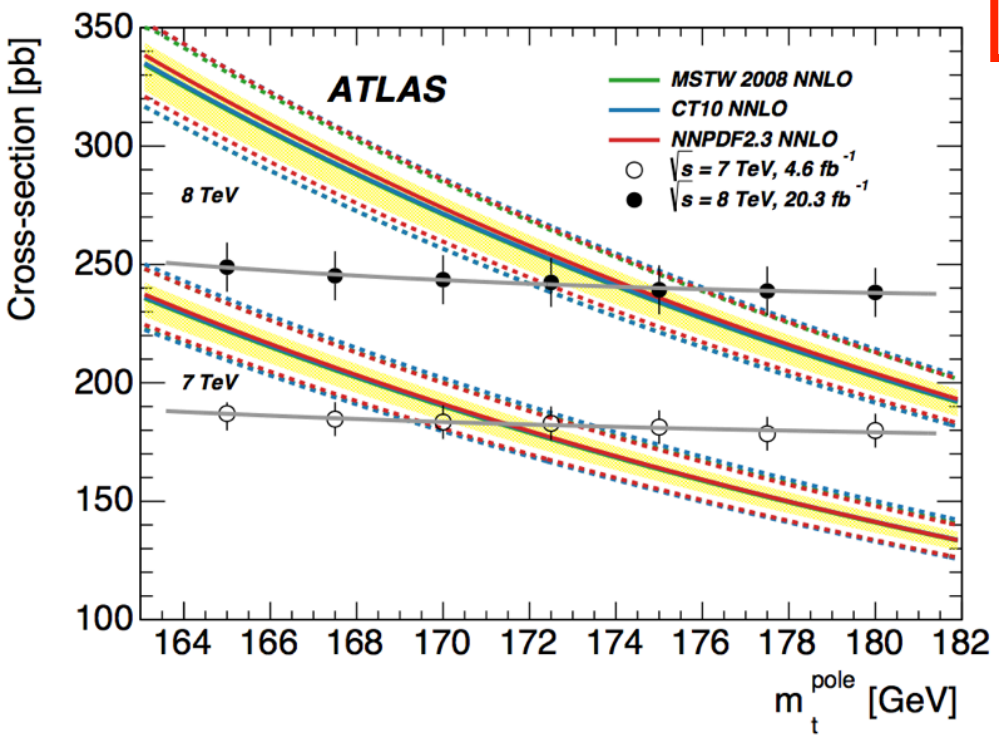
$$m_t^{\rm MC} = m_t^{\rm quark} + \Delta$$

~ O(1 GeV)

e.g. pole mass

- every MC generator mass can can correspond to different pole mass

Top Quark Pole Mass



$$m_t^{\text{pole}} = 172.9^{+2.5}_{-2.6}\,\text{GeV}\ (\sqrt{s} = 7/8\,\text{TeV})$$

→ pole mass unambiguously!

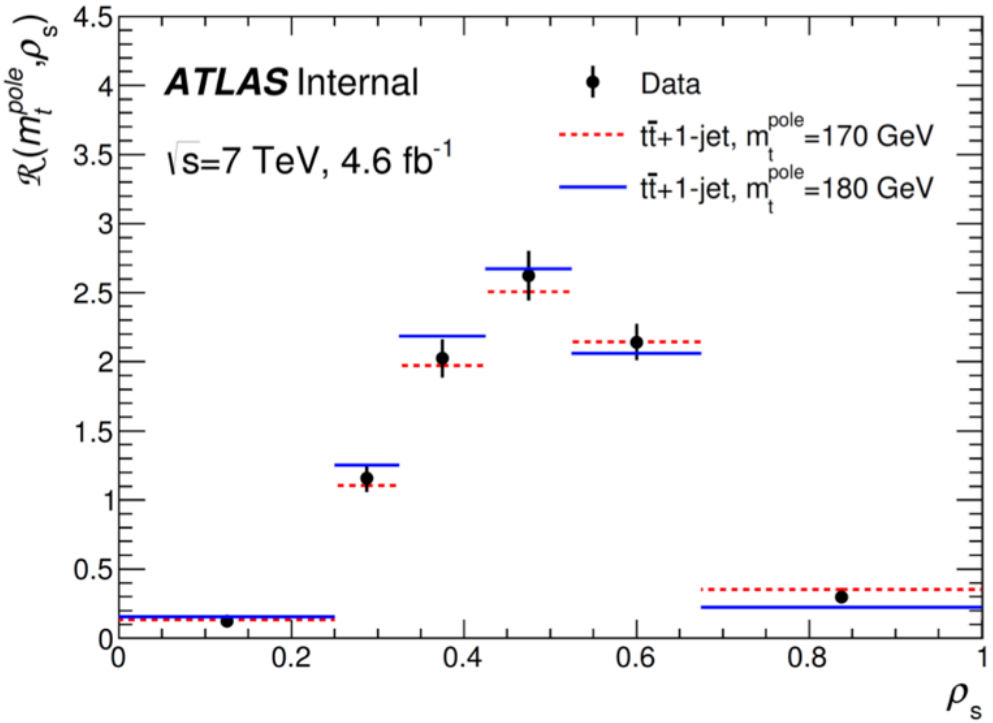
S. Adomeit

many alternative measurements

tt+1jet: differential cross section

$$\mathcal{R}(m_t^{pole}, \rho_s) = \frac{1}{\sigma_{t\bar{t}+1-\text{jet}}} \frac{d\sigma_{t\bar{t}+1-\text{jet}}}{\rho_s}(m_t^{pole}, \rho_s)$$

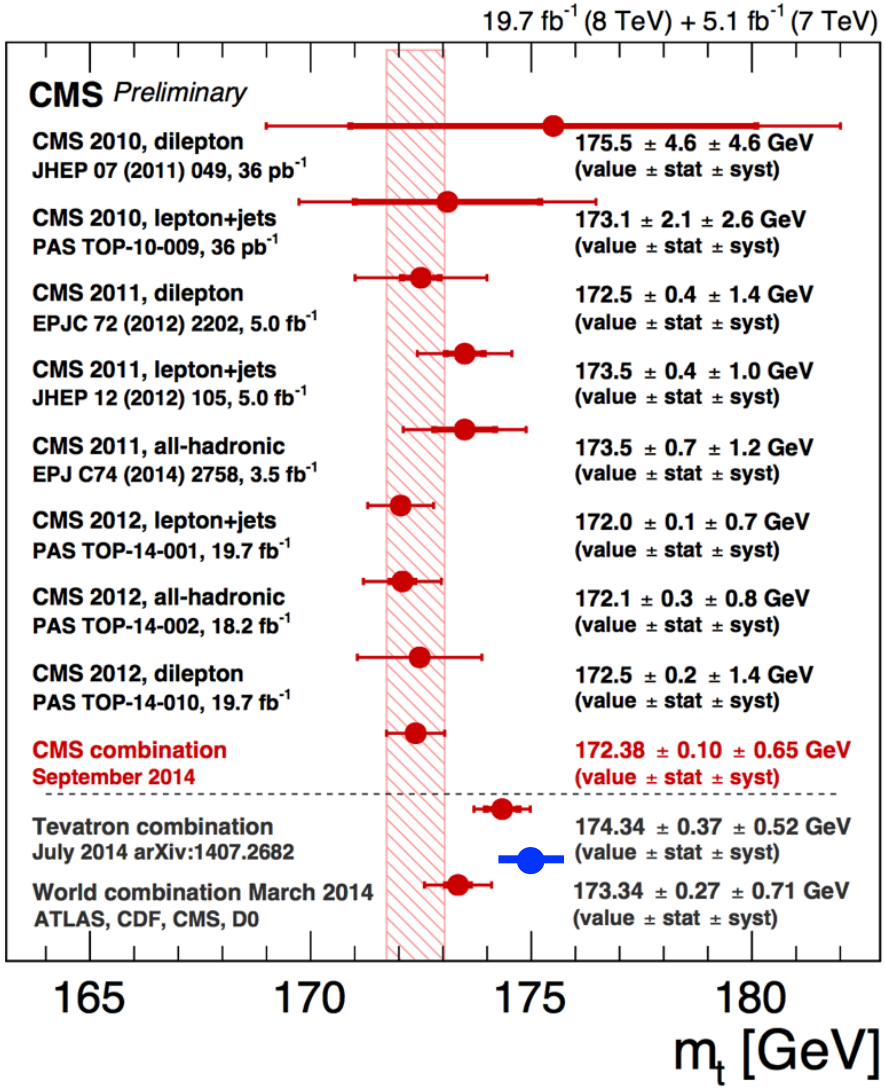
$$\rho_s = \frac{2m_0}{\sqrt{s_{t\bar{t}j}}} \qquad m_0 = 170\ GeV$$



is it really the pole mass?

CMS top mass combination

top mass crisis?



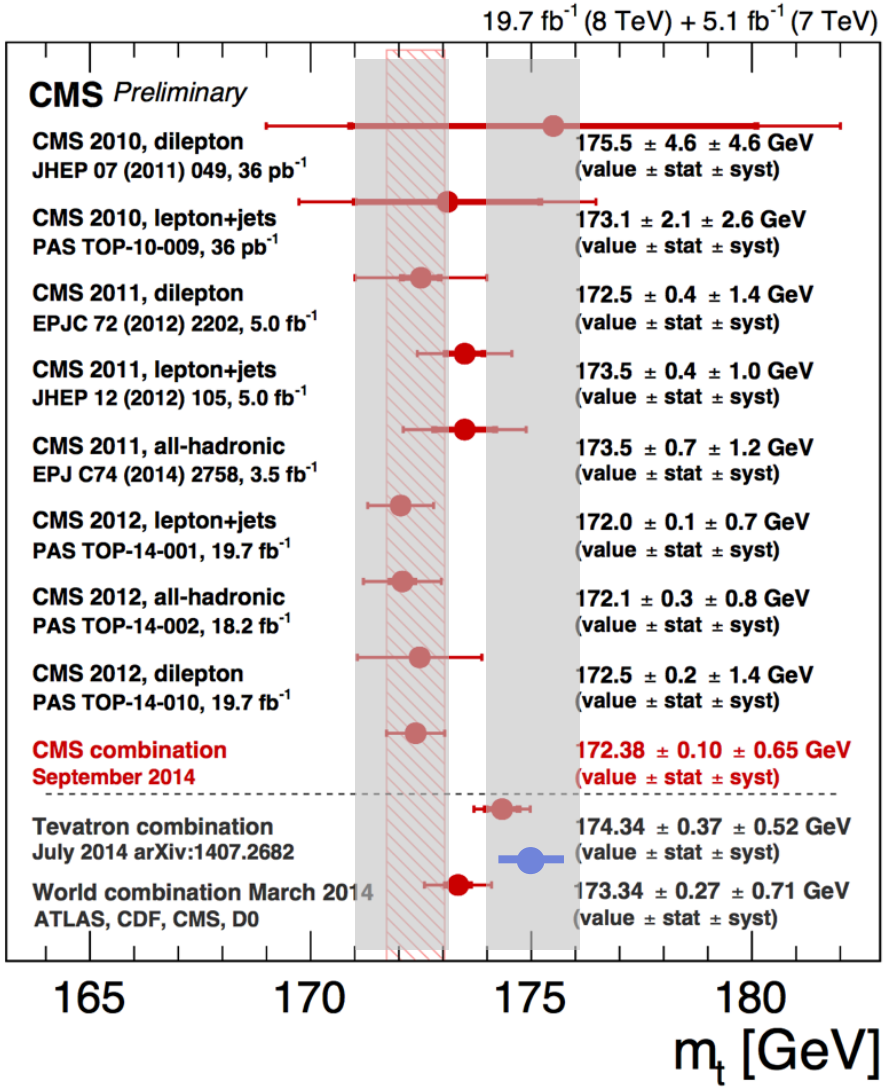
E. Schlieckau

DØ l+jets, 9.7 fb^{-1}

- discussions about JES, b-JES, other systematics
- differences between CMS and D0 to be understood during combination

I am just speculating...

top mass crisis?



E. Schlieckau

DØ l+jets, 9.7 fb^{-1}

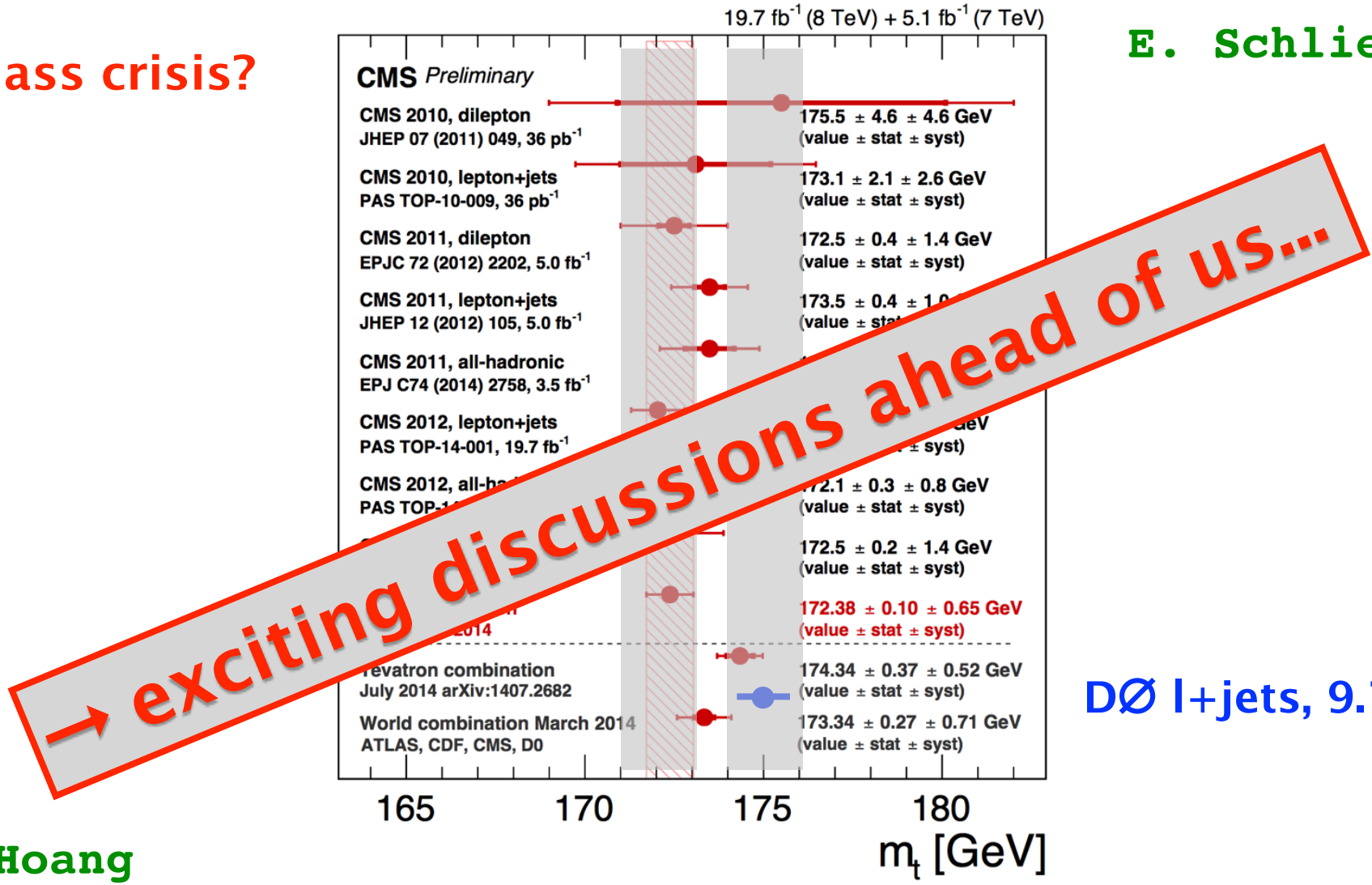
A. Hoang

- each MC mass can shift by up to Δ≈O(1 GeV) to QFT mass
- WbWb off-shell effects: can move $\langle m_{lb} \rangle$ by O(1 GeV)

J. Winter

I am just thinking...

top mass crisis?



→ exciting discussions ahead of us...

E. Schlieckau

DØ l+jets, 9.7 fb^{-1}

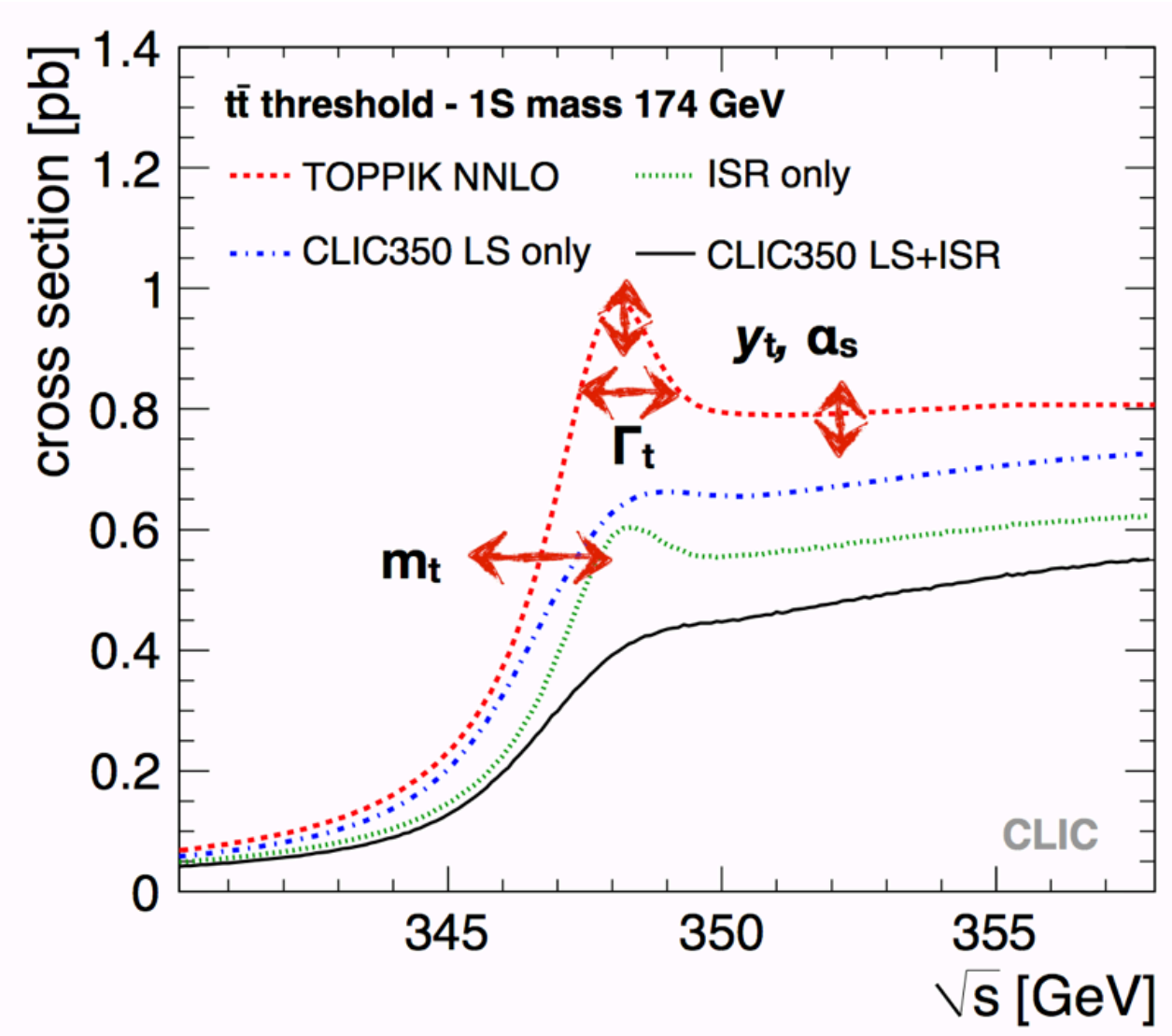
A. Hoang

- each MC mass can shift by up to Δ≈O(1 GeV) to QFT mass
- WbWb off-shell effects: can move <m_{lb}> by O(1 GeV)

J. Winter

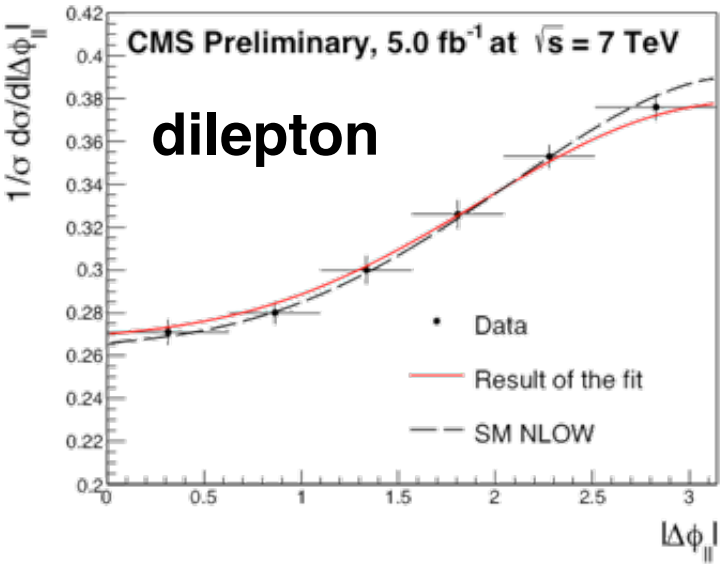
Top mass at ILC

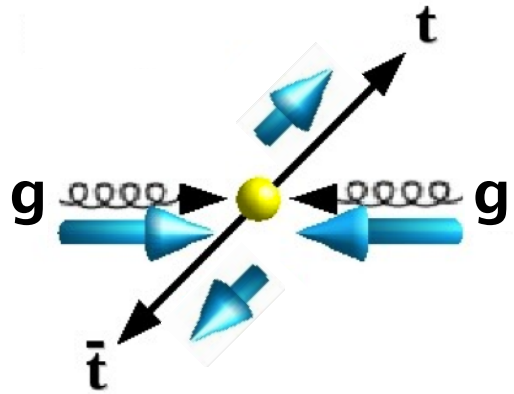
F. Simon



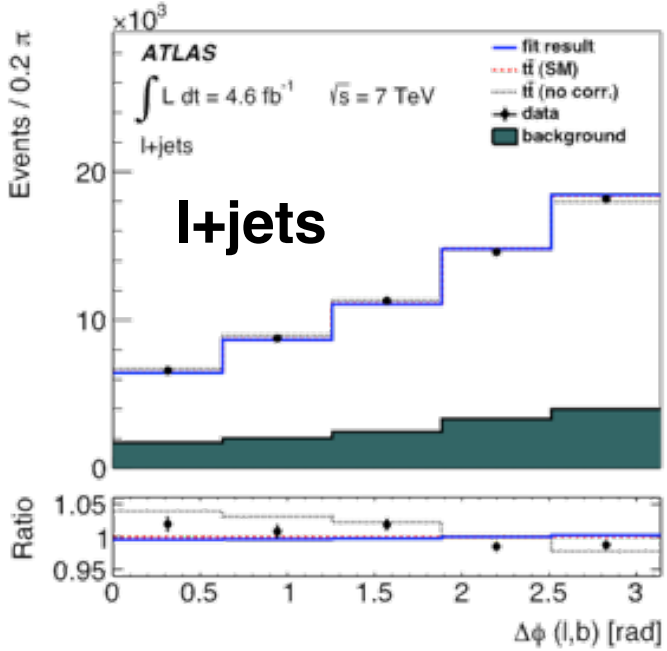
→ well-defined top mass with ~O(100 MeV) uncertainty

Polarisation and Spin Correlation

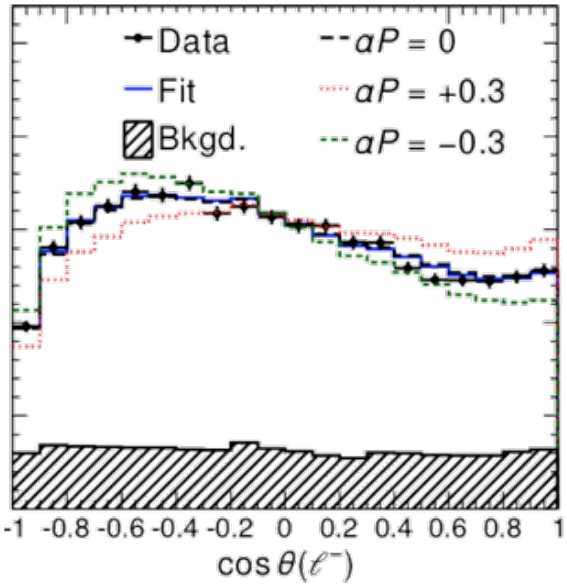




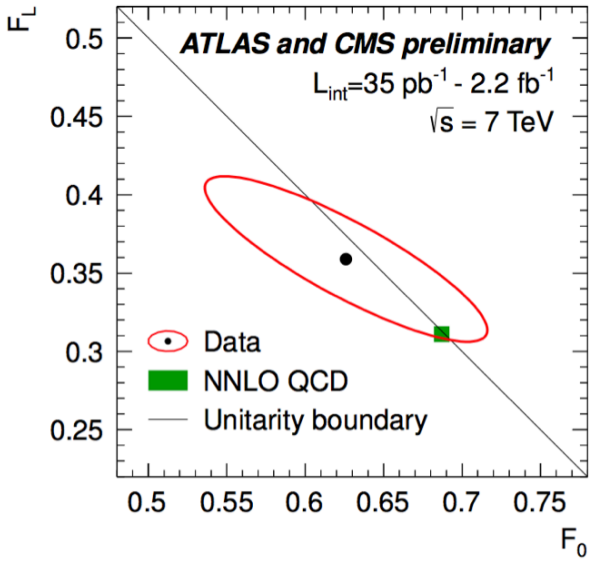
→ spins of tt pairs: correlated as in SM



→ no chromomagnetic dipole moments



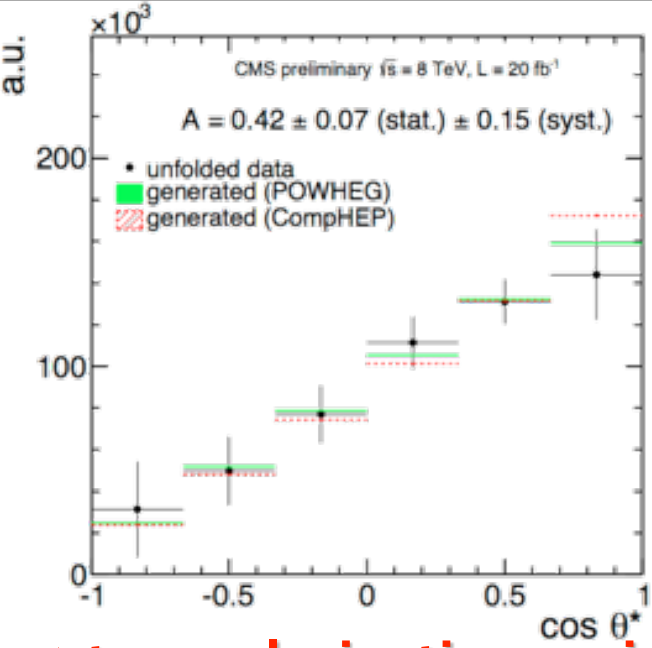
R. Hawkings
G. Cortiana
T.V. Schroeder



→ top quarks unpolarised

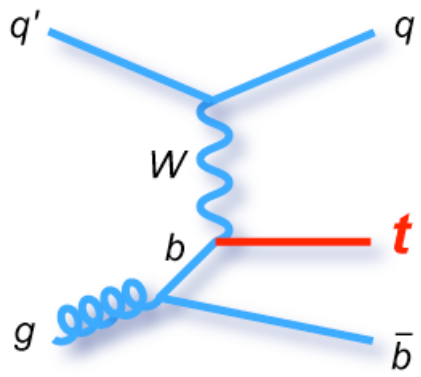
→ W polarisation as in SM

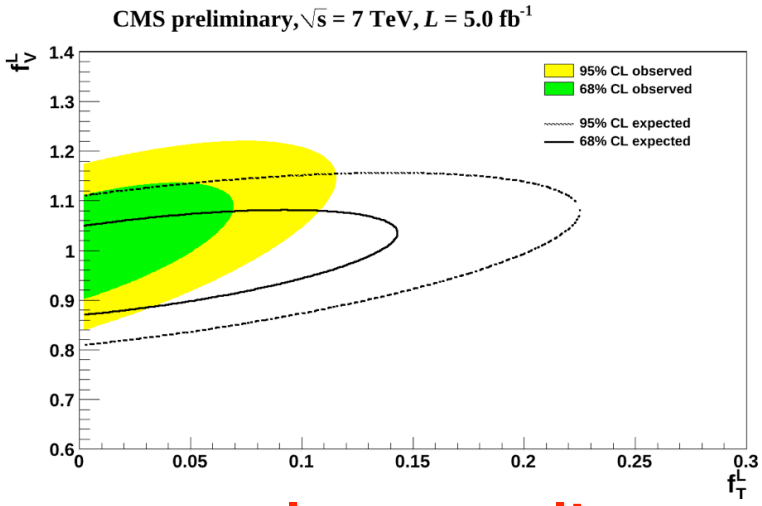
Polarisation and Couplings



→ top polarisation as in SM

A. Jafari



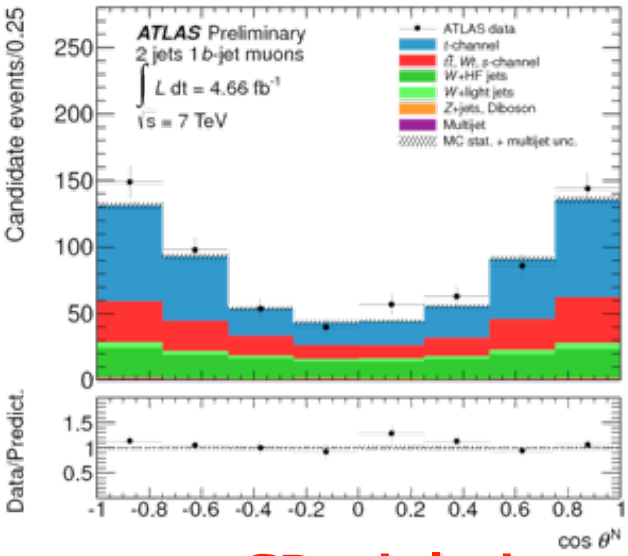


→ no anomalous couplings

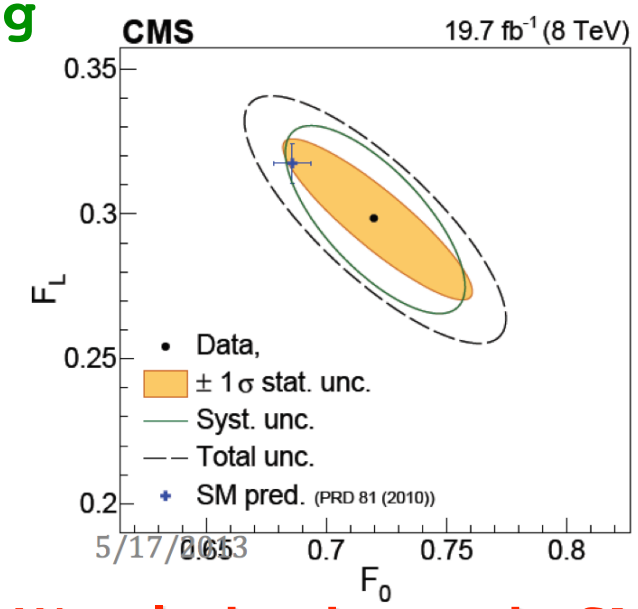
→ global analysis in the future

C. Zhang

no new physics

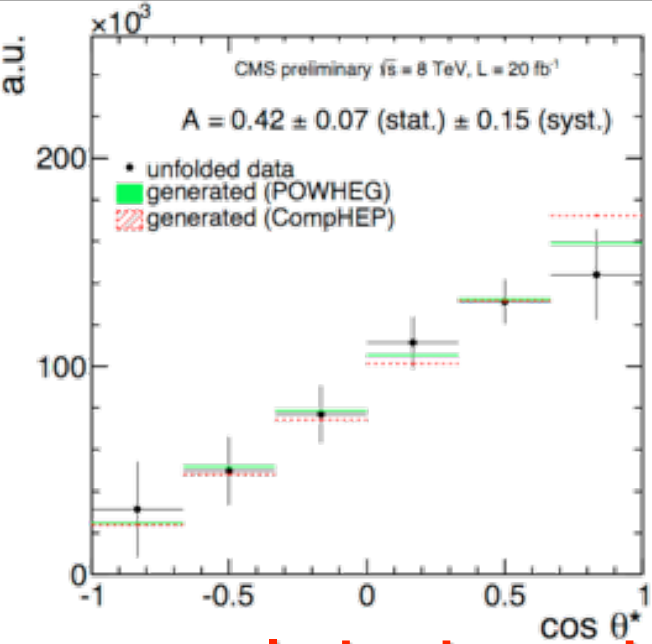


→ no CP-violation



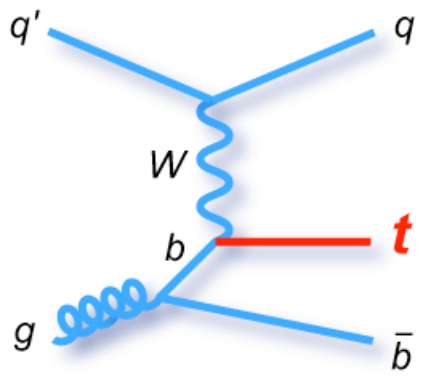
→ W polarisation as in SM

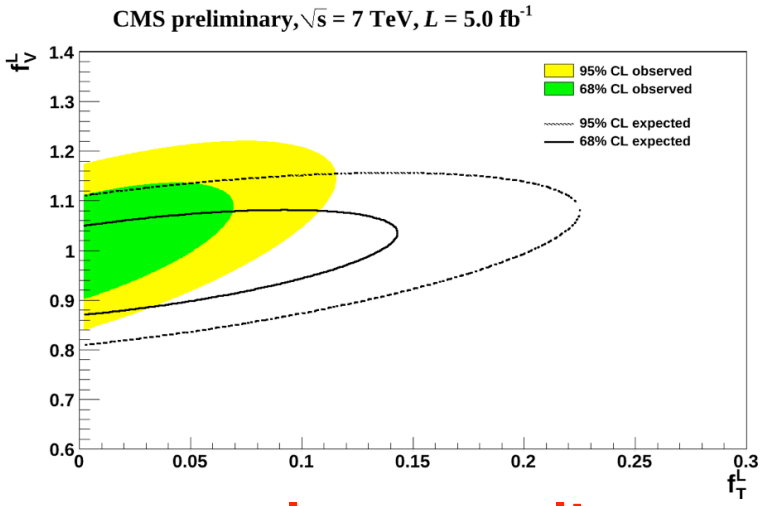
Polarisation and Couplings



→ top polarisation as in SM

A. Jafari

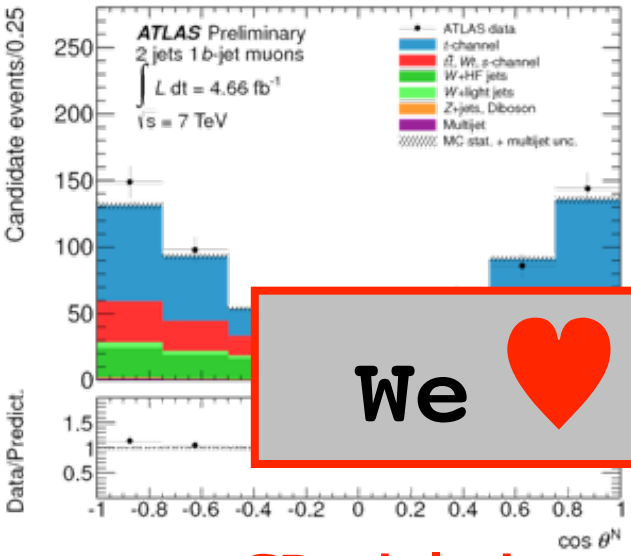




→ no anomalous couplings

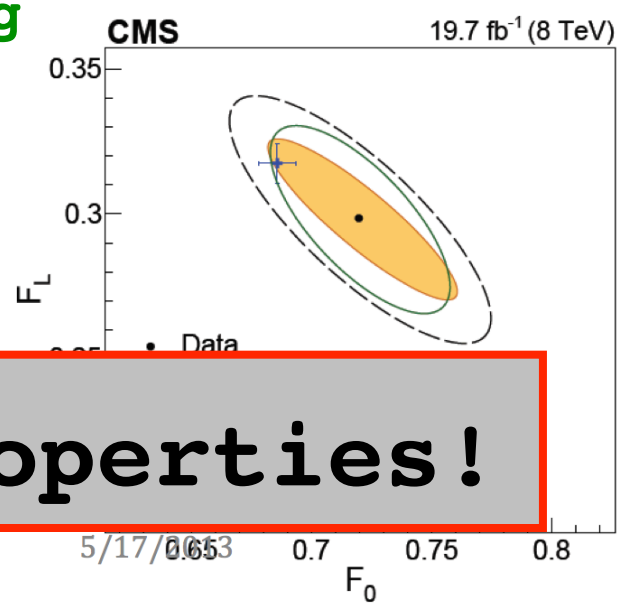
→ global analysis in the future

C. Zhang



→ no CP-violation

no new physics



→ W polarisation as in SM

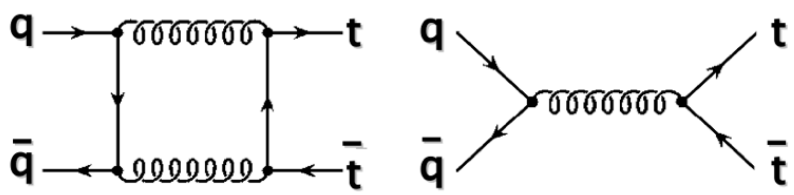
We ♥ single top properties!

Charge Asymmetry

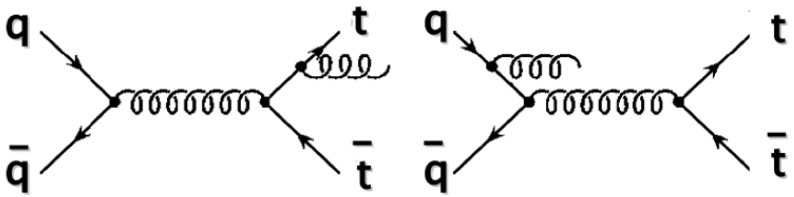
- asymmetry in $O(\alpha_s^3)$

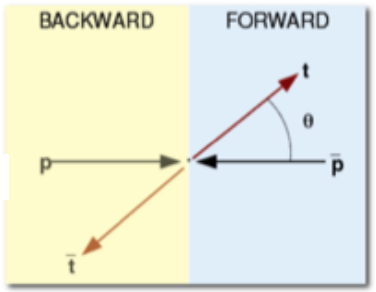
NLO QCD

interference between:



interference between:





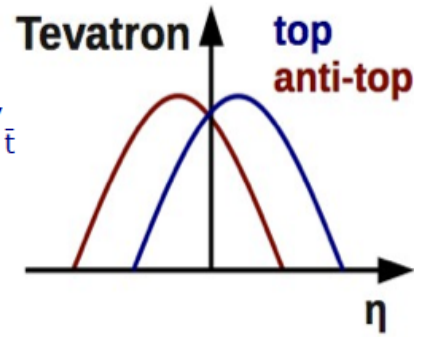
$$A_{fb} = \frac{F - B}{F + B}$$

- complementary to the LHC

Tevatron

$$A_{FB}^{t\bar{t}} = \frac{N(\Delta y > 0) - N(\Delta y < 0)}{N(\Delta y > 0) + N(\Delta y < 0)}$$

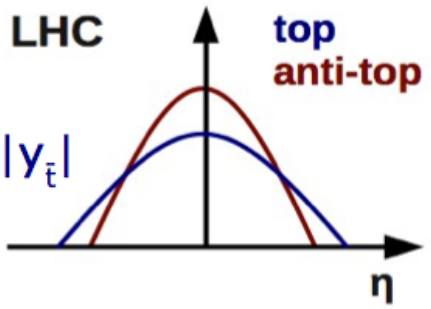
$\Delta y = y_t - y_{\bar{t}}$



LHC

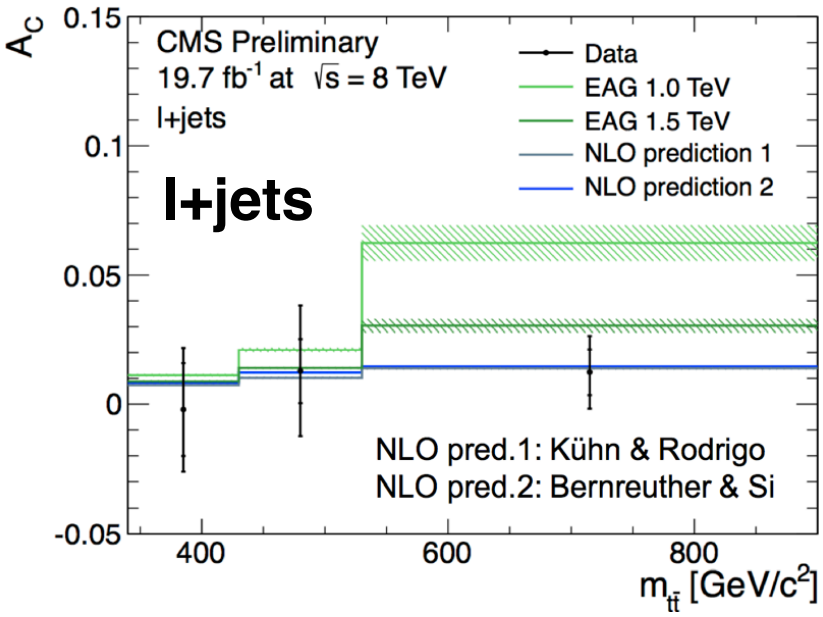
$$A_C = \frac{N(\Delta|y| > 0) - N(\Delta|y| < 0)}{N(\Delta|y| > 0) + N(\Delta|y| < 0)}$$

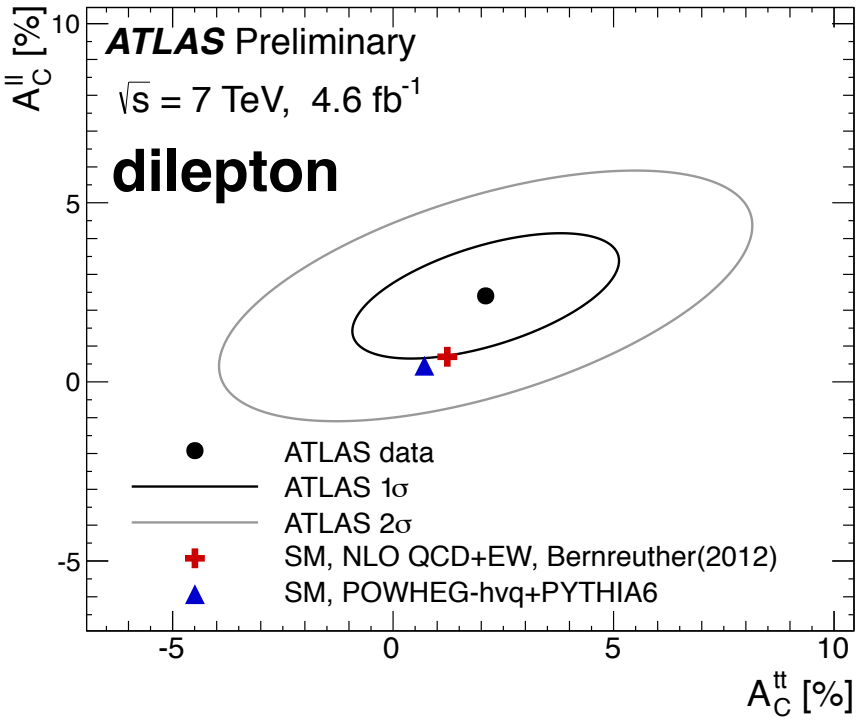
$\Delta|y| = |y_t| - |y_{\bar{t}}|$

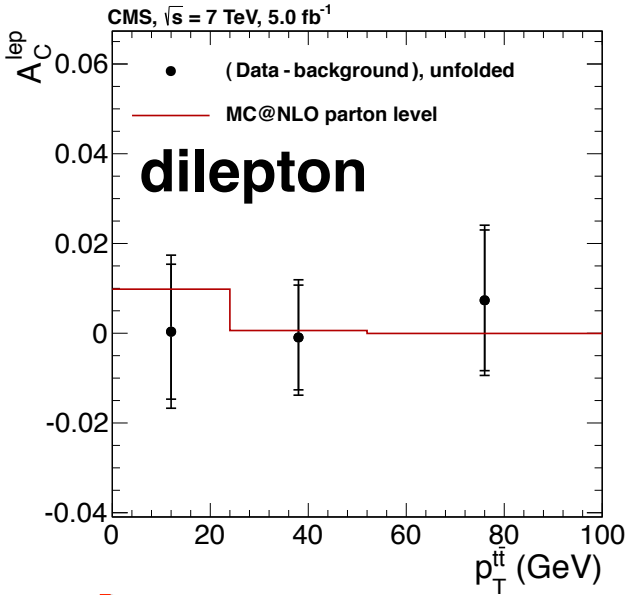


"NLO is LO for asymmetry"

Charge Asymmetry: LHC

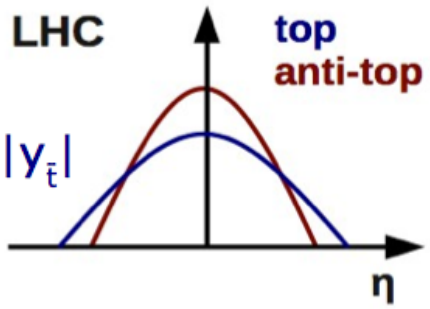






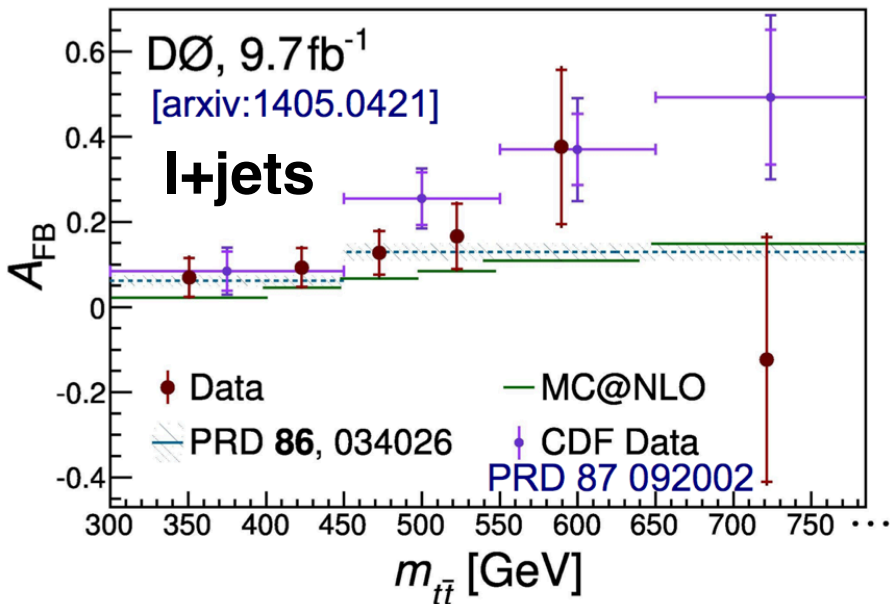
LHC

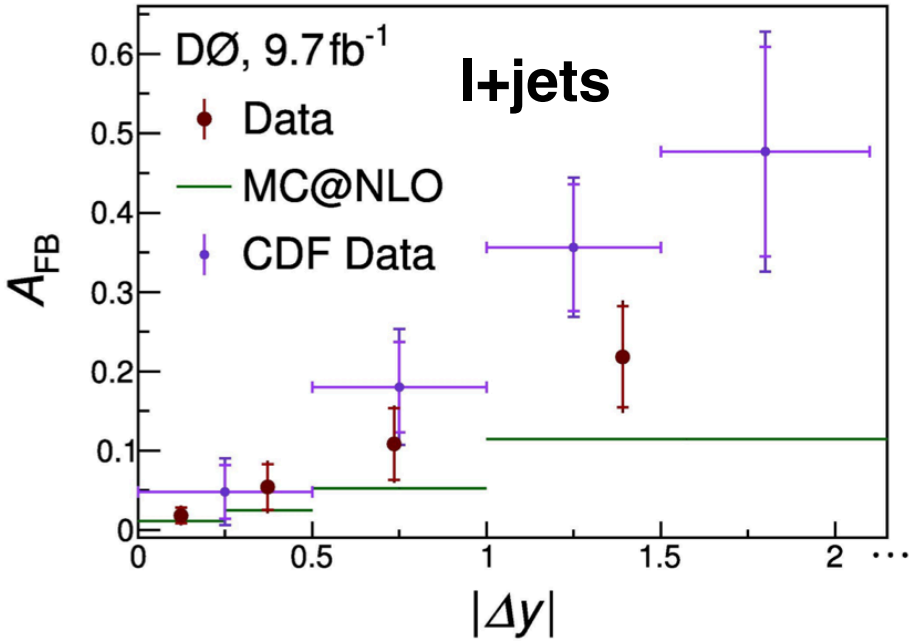
$$A_C = \frac{N(\Delta|y|>0) - N(\Delta|y|<0)}{N(\Delta|y|>0) + N(\Delta|y|<0)}$$



→ good agreement with SM

Charge Asymmetry: Tevatron



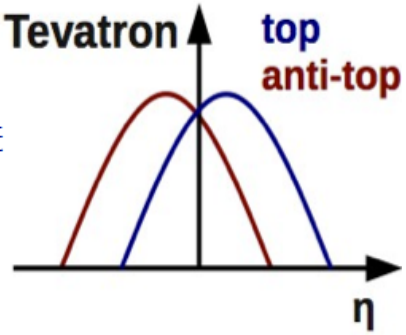


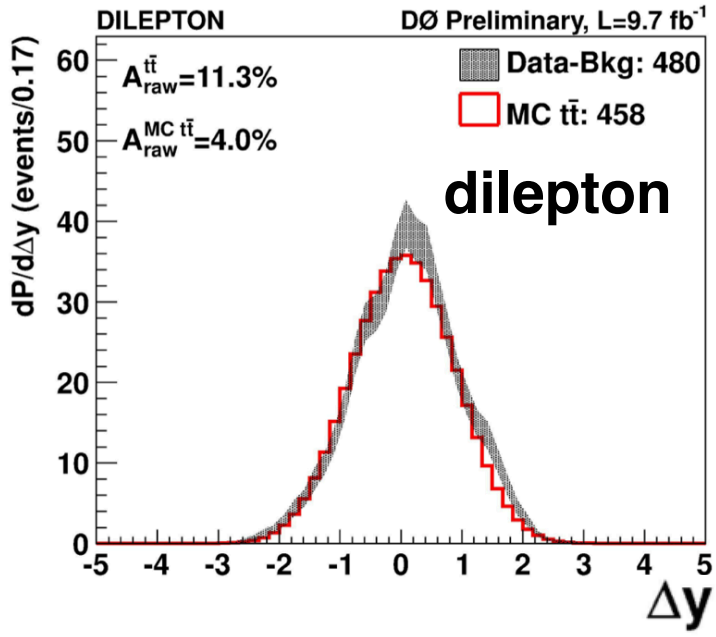
A. Jung

Tevatron

$$A_{FB}^{t\bar{t}} = \frac{N(\Delta y > 0) - N(\Delta y < 0)}{N(\Delta y > 0) + N(\Delta y < 0)}$$

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

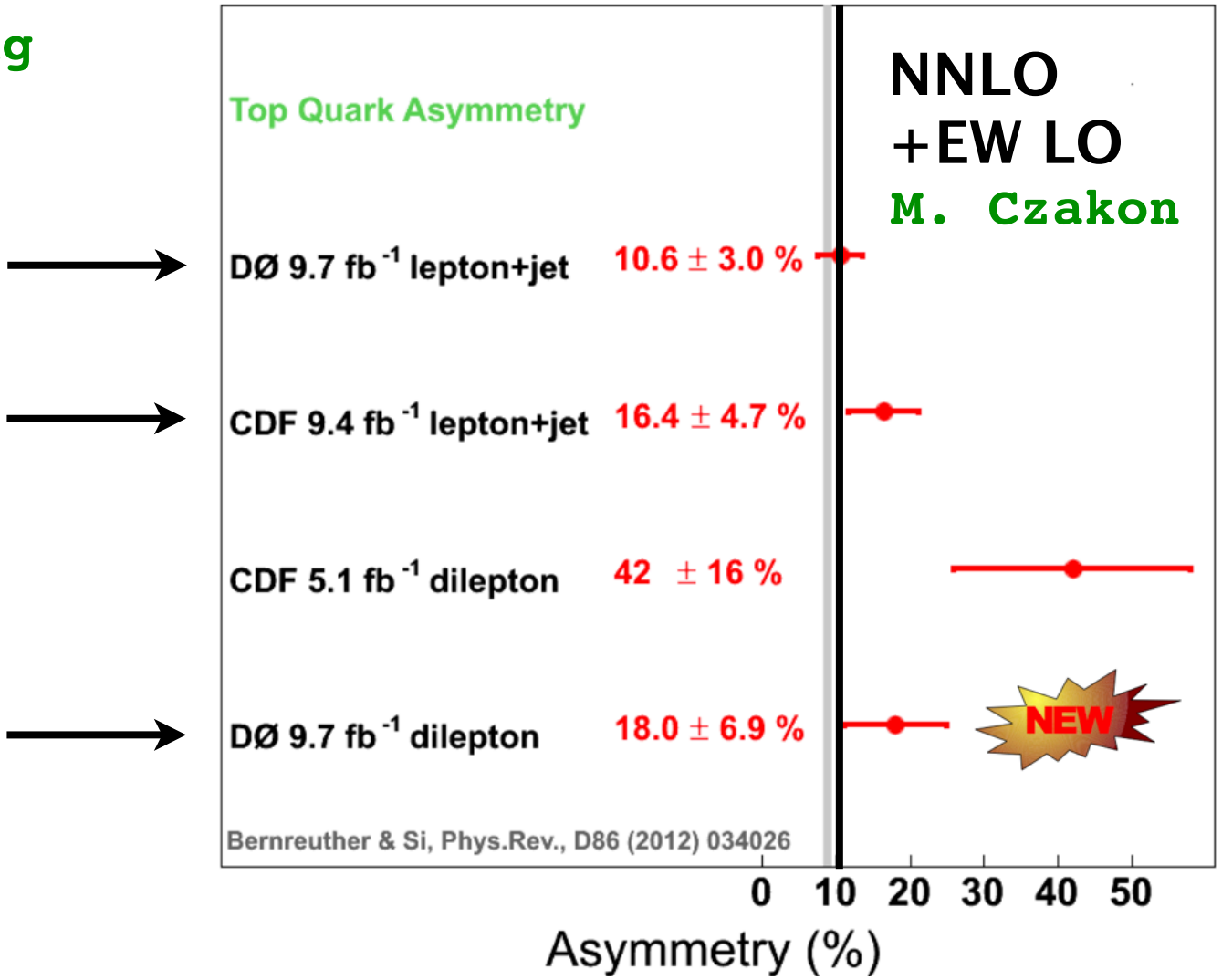




Charge Asymmetry: Tevatron

A. Jung

full dataset

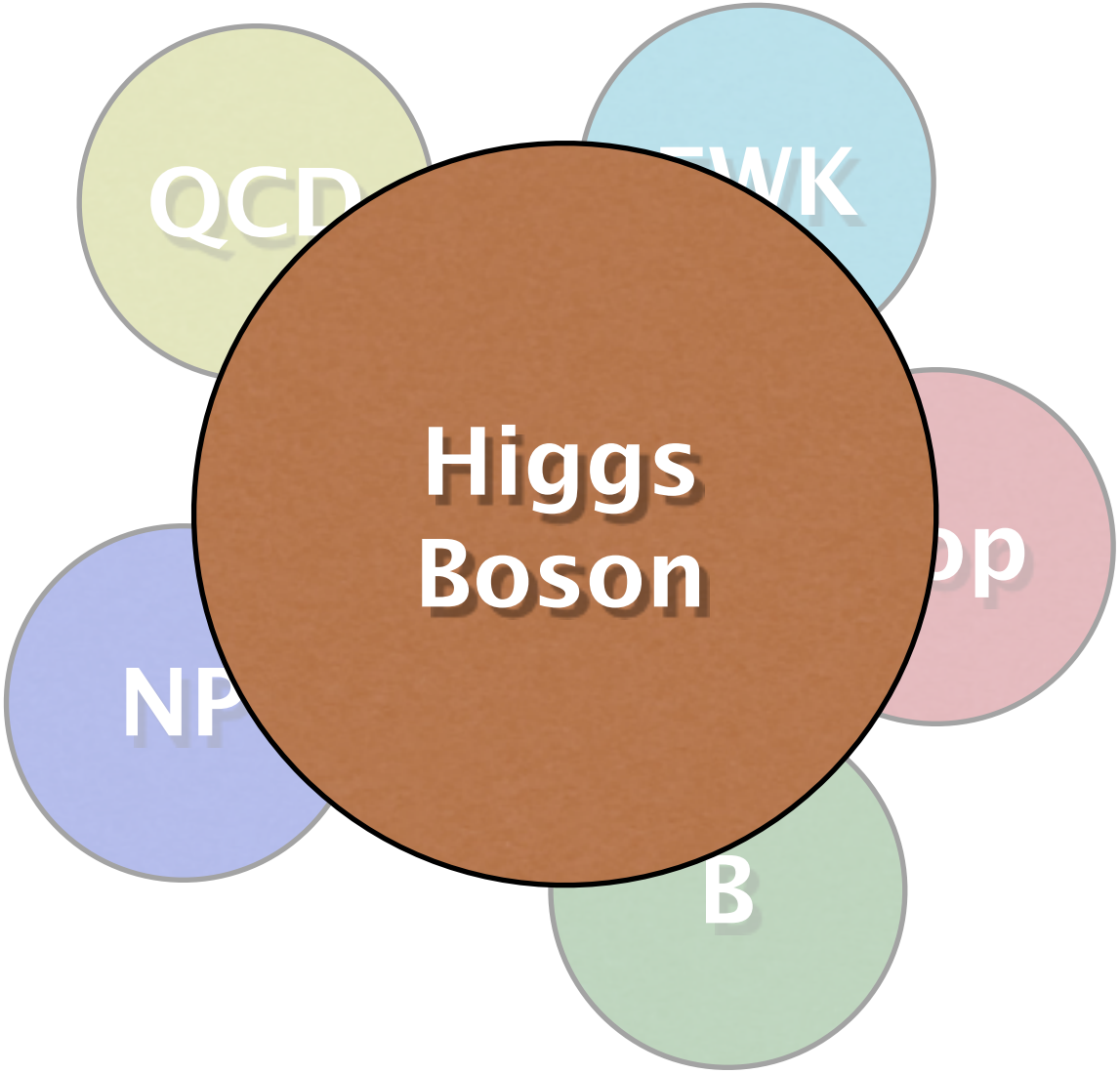


no $b\bar{b}$ asymmetries at Tevatron and LHCb

→ higher order QCD is important!

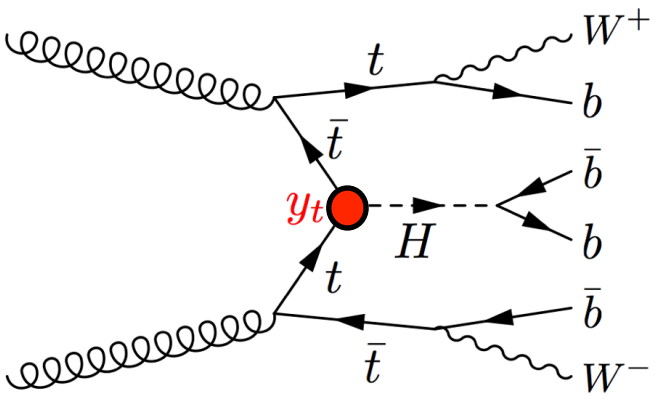
→ high precision measurement is essential

Top Quark Physics Topics

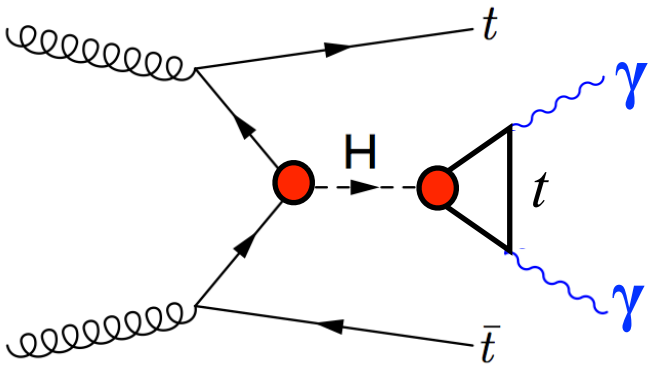


Search for ttH production

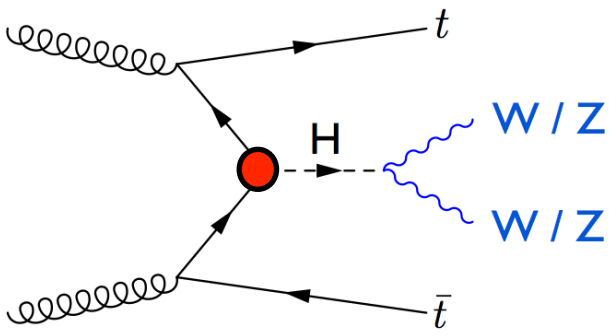
H→bb



H→γγ



H→WW, ZZ



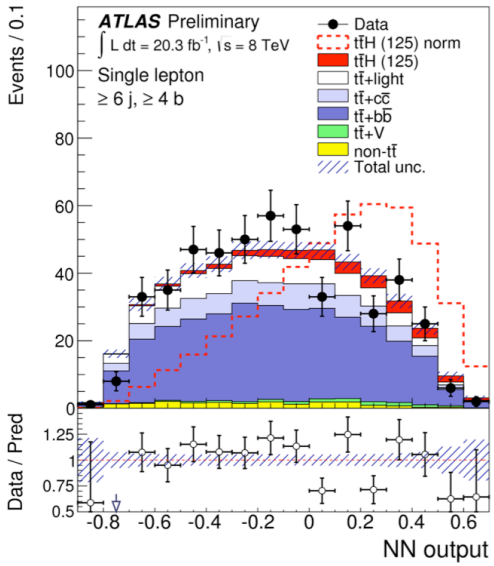
multi-leptons

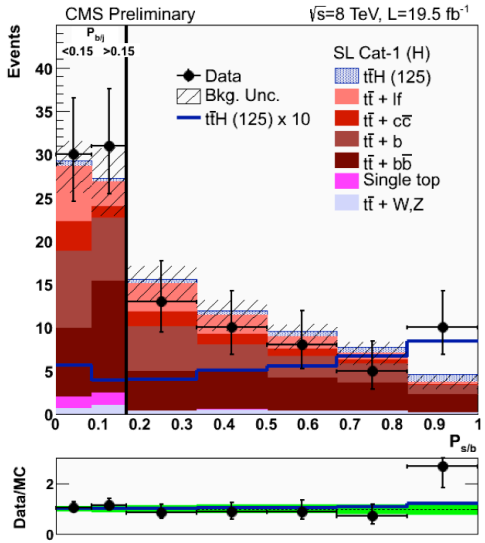
M. Owen

Search for ttH production

H→bb

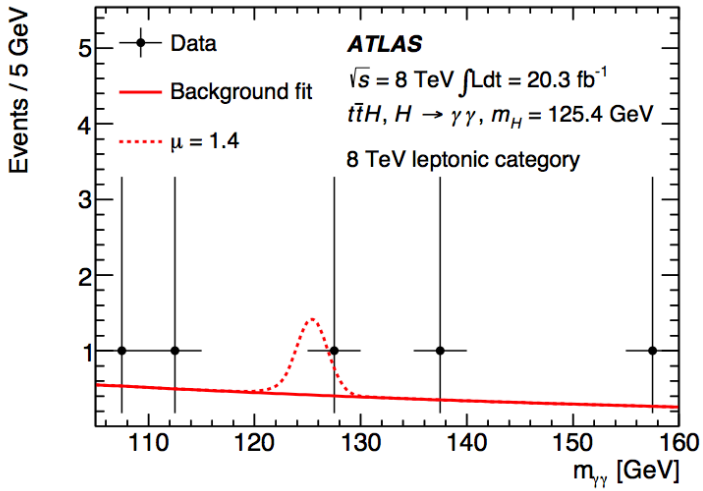
M. Owen

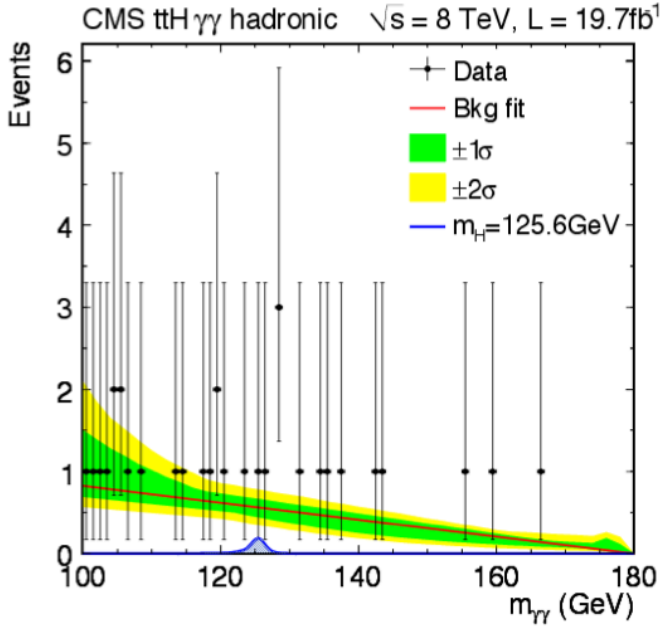




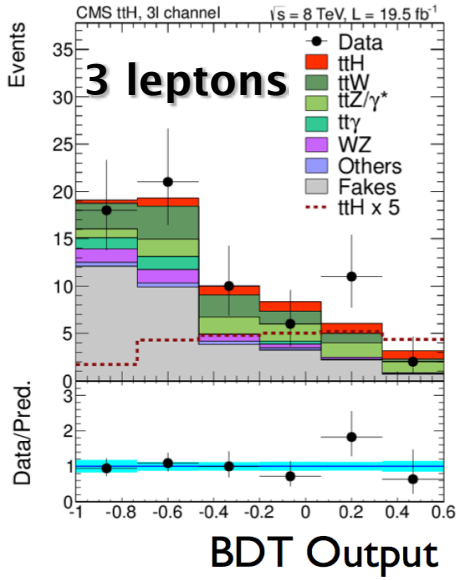
matrix element

H→γγ

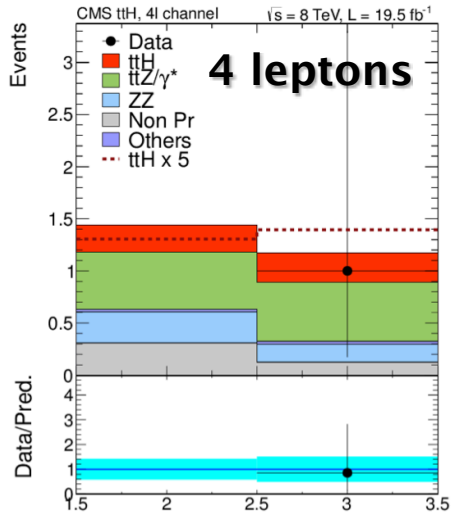




H→WW, ZZ

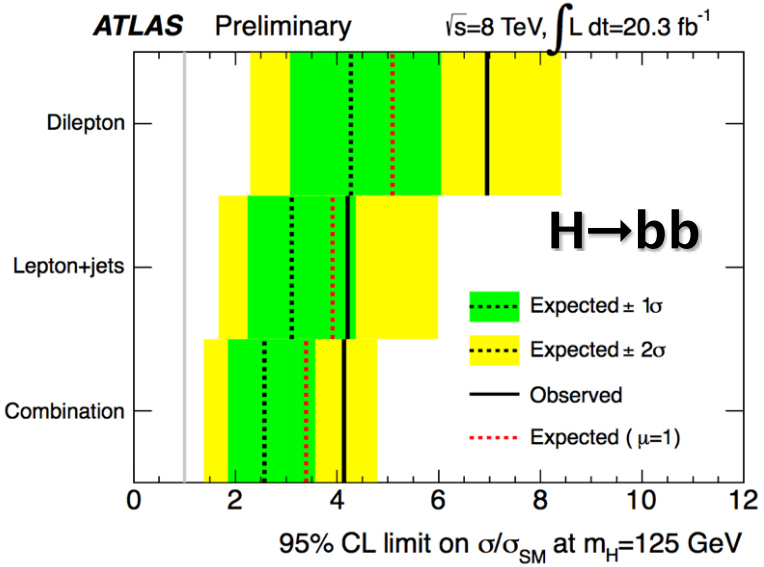


BDT Output

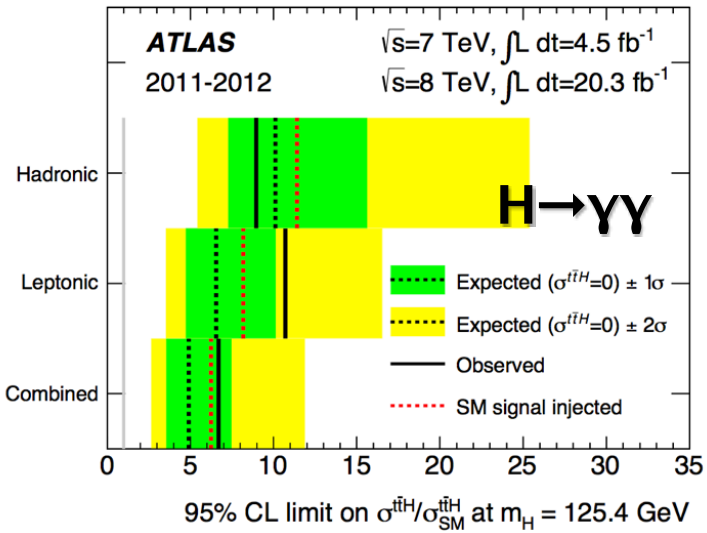


N(jets)

Results in ttH

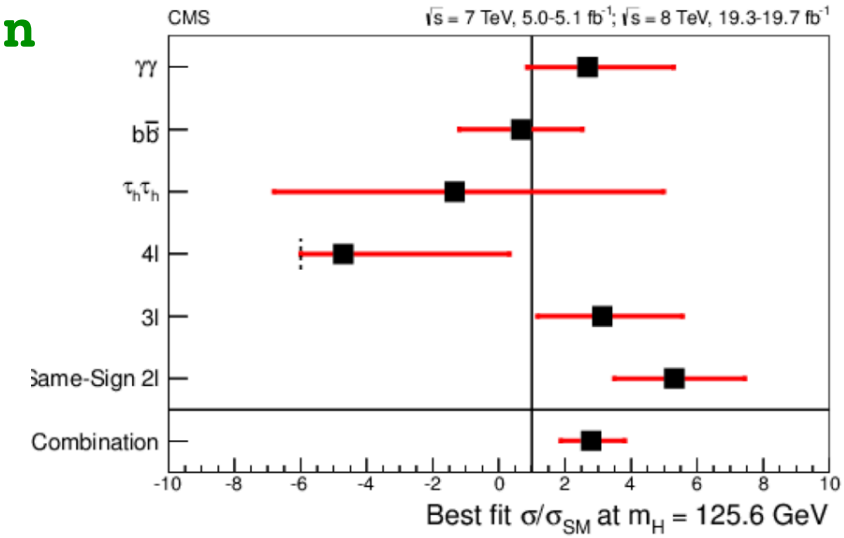


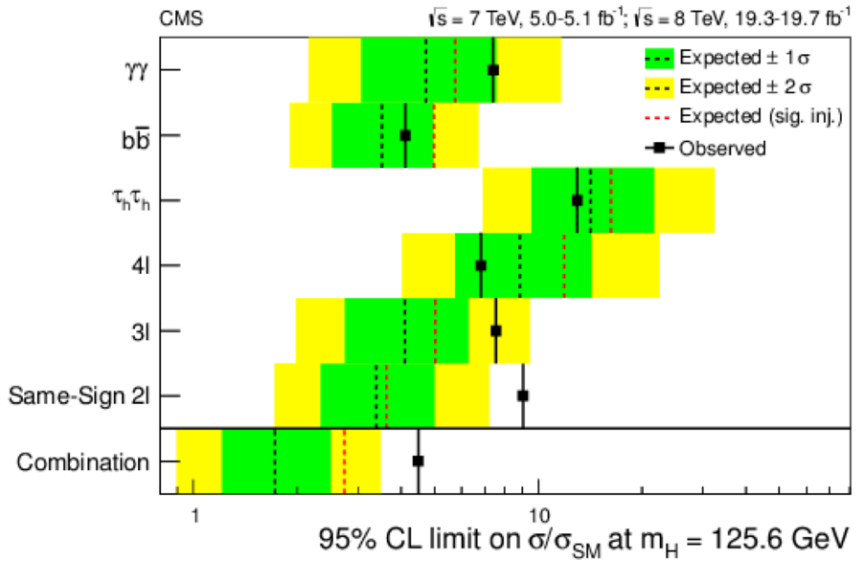
Fitted $\sigma/\sigma_{SM} = 2.9 \pm 2.3$



Fitted signal $\sigma/\sigma_{SM} = 1.4\ ^{+2.2}_{-1.4}$

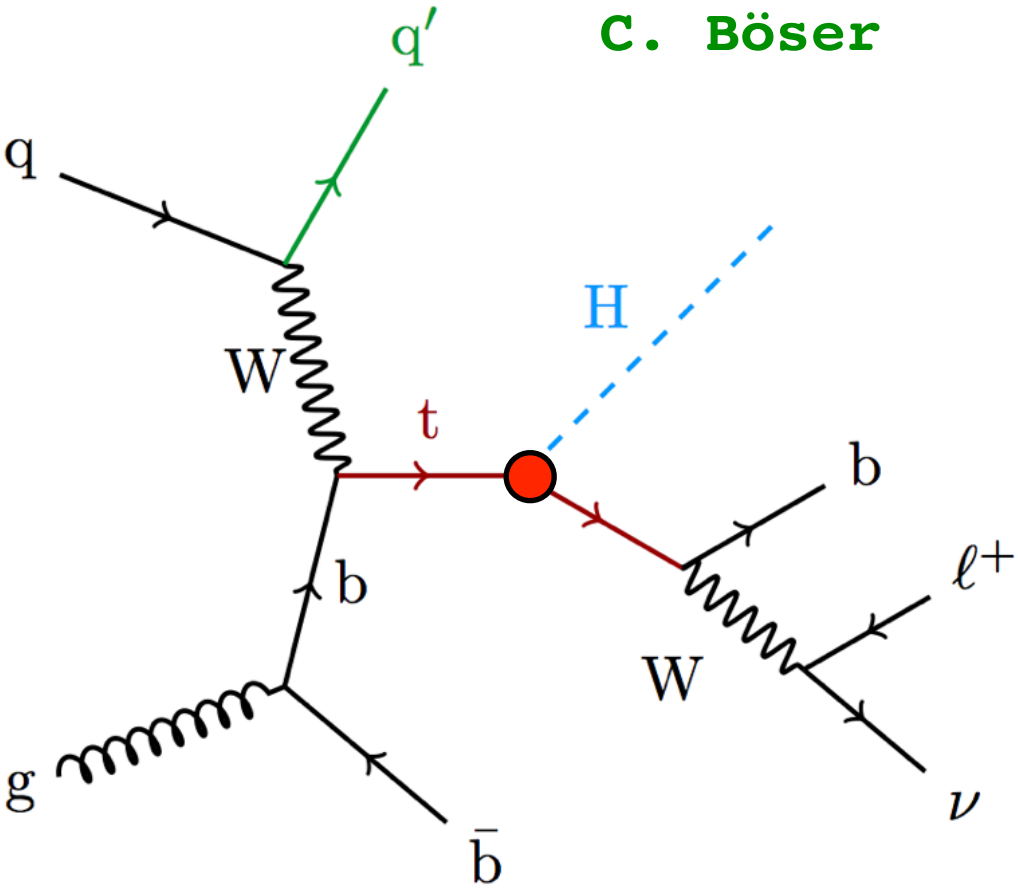
M. Owen





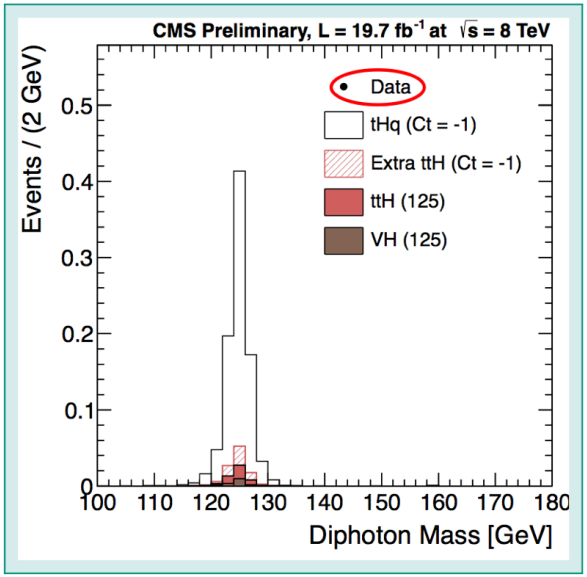
→ observation in Run-II

Search for tHq production



H→γγ

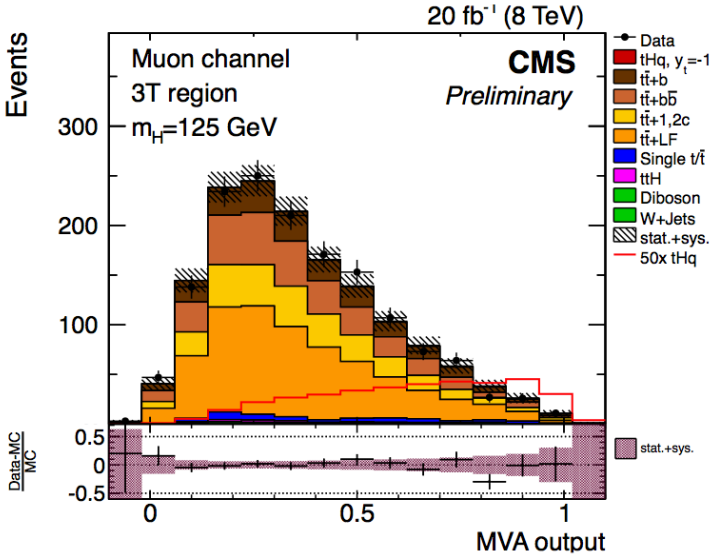
4.1×σ/σ(κt) expected



H→bb

5.1×σ/σ(κt) expected

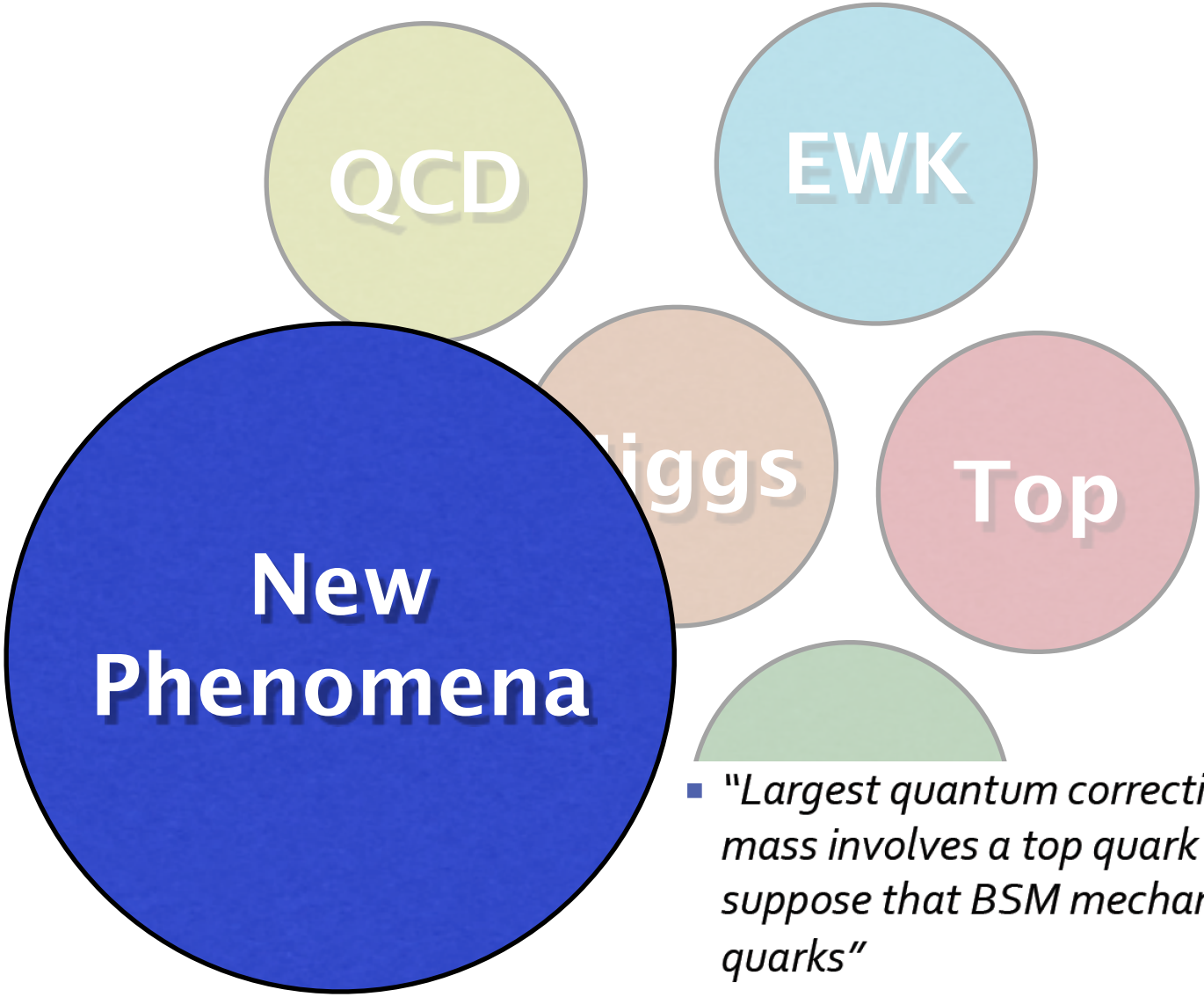
7.6×σ/σ(κt) observed



in case top Yukawa coupling $\kappa_t = y_t/y_t^{SM} = -1$ coupling: cross section can be enhanced by factor 13

→ fun in Run-II

Top Quark Physics Topics

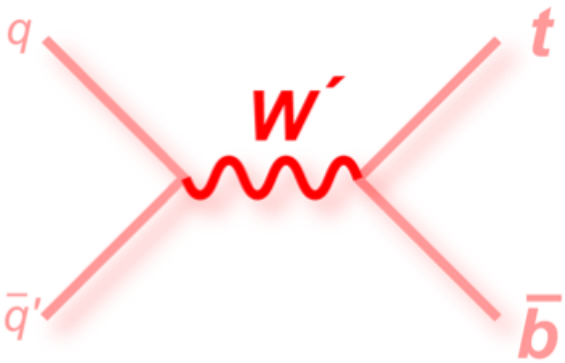


- *"Largest quantum correction to the Higgs boson mass involves a top quark loop, it is natural to suppose that BSM mechanisms involve top quarks"*

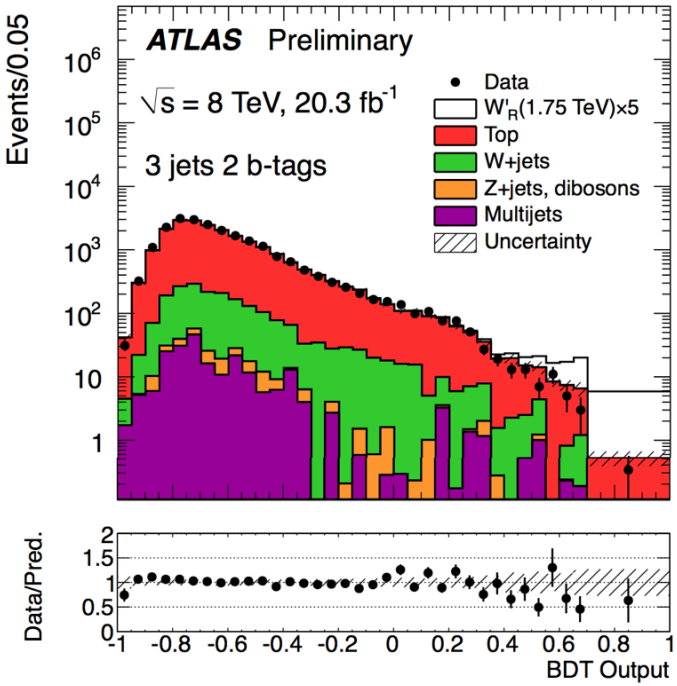
F. Canelli

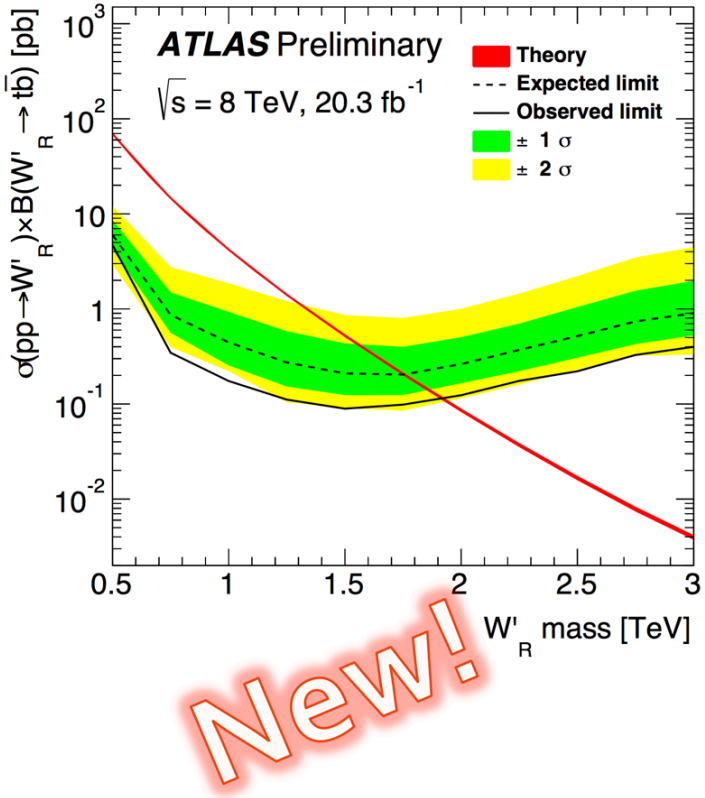
Search for W' production

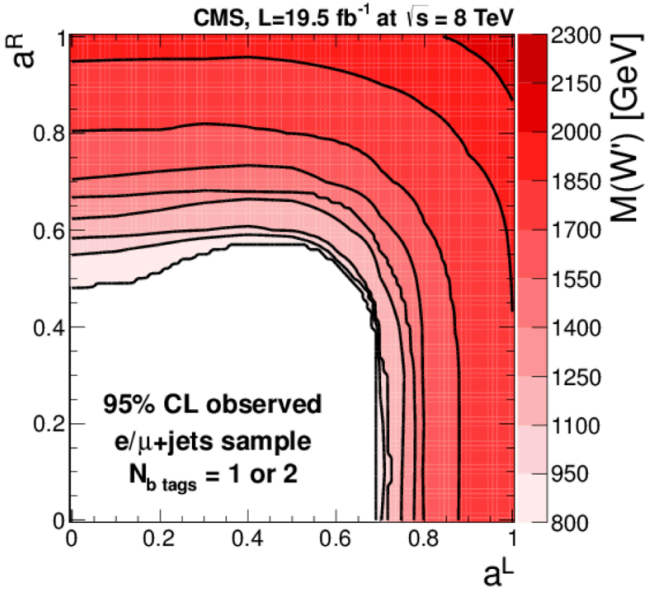
F. Canelli



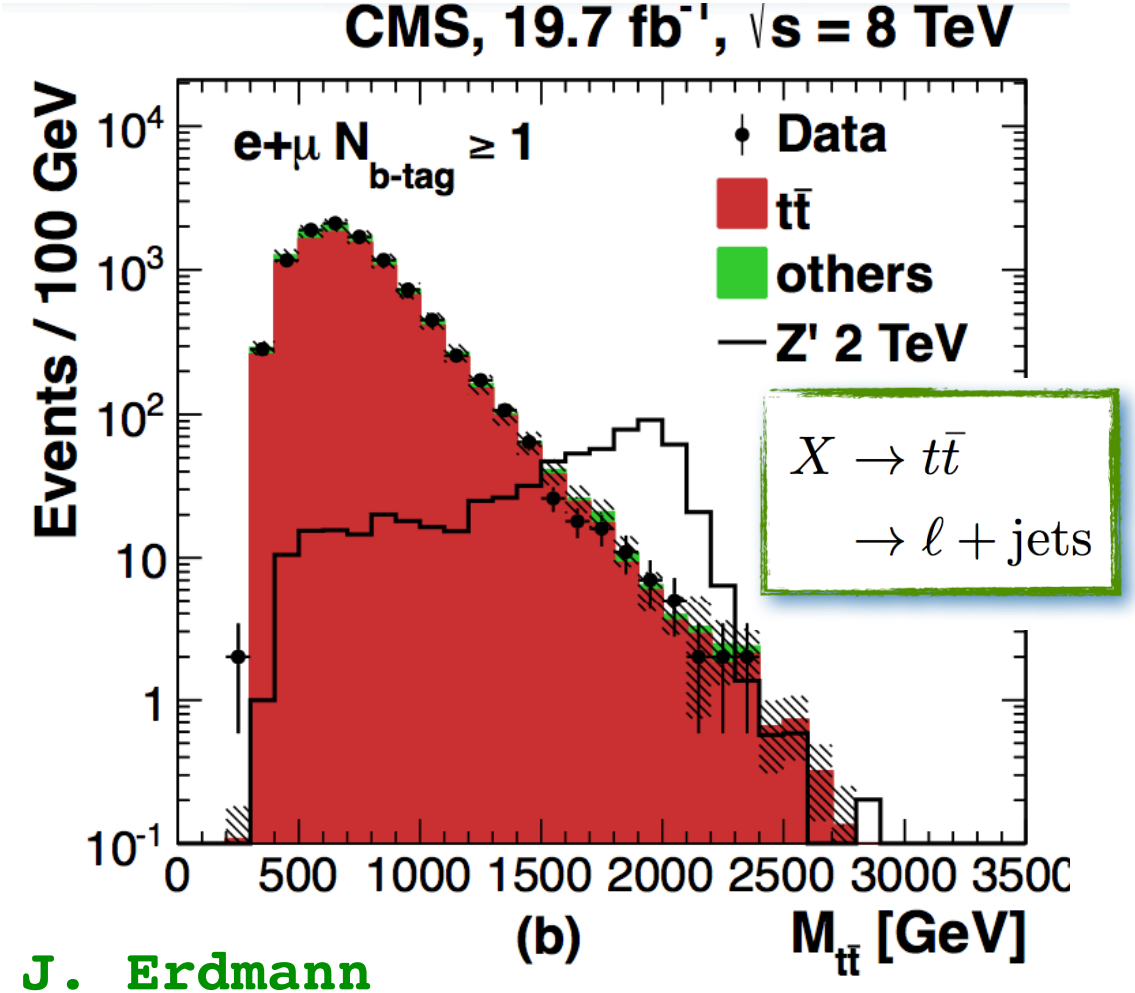
→ **no new physics**

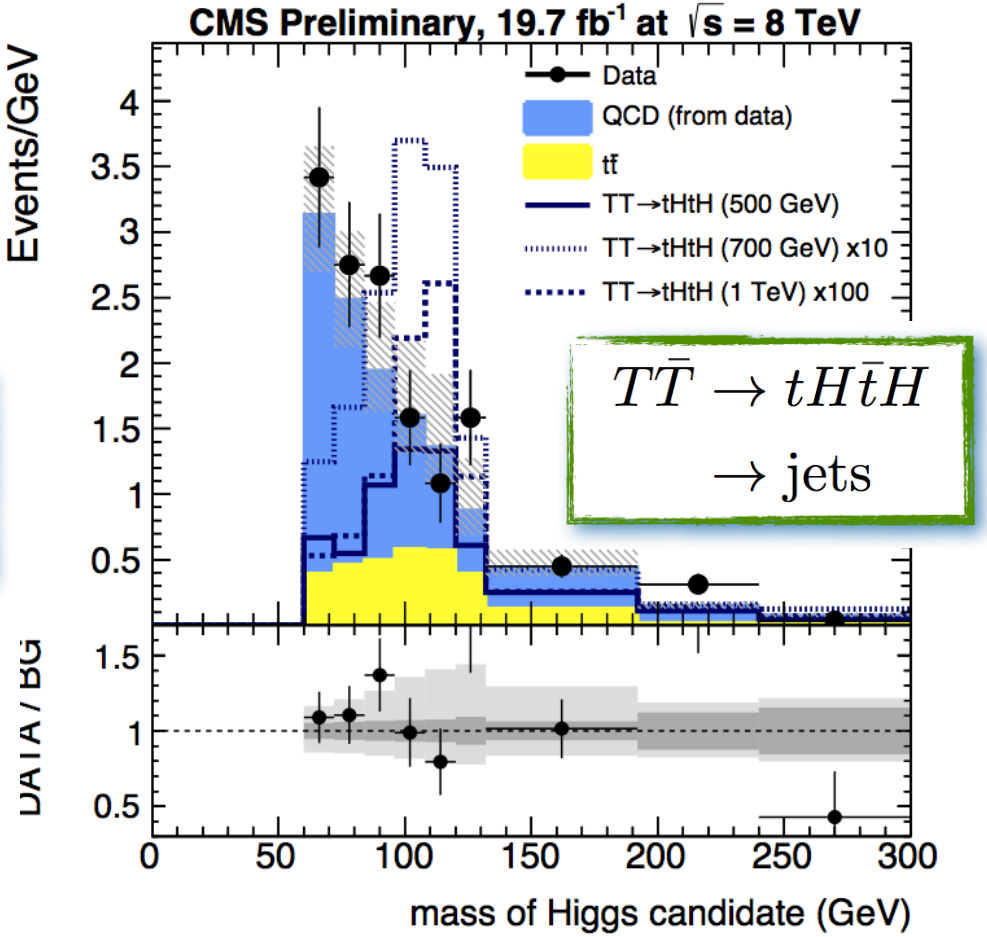






Heavy resonances with boosted tops



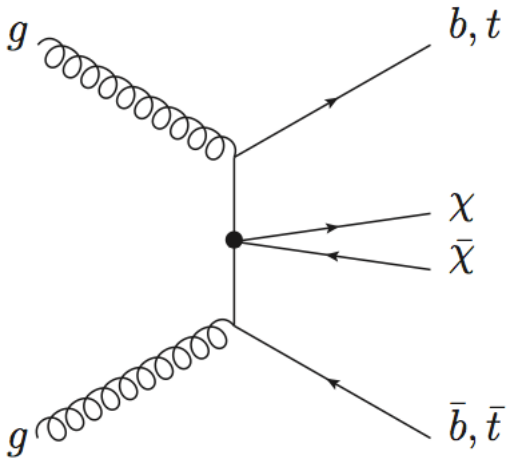


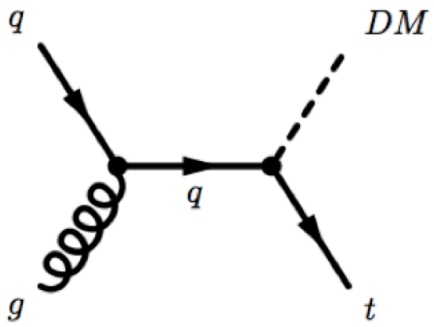
J. Erdmann

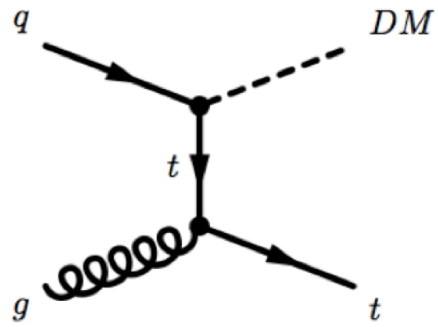
use "boosted reconstruction" top-, Higgs-, subjet-b tagging

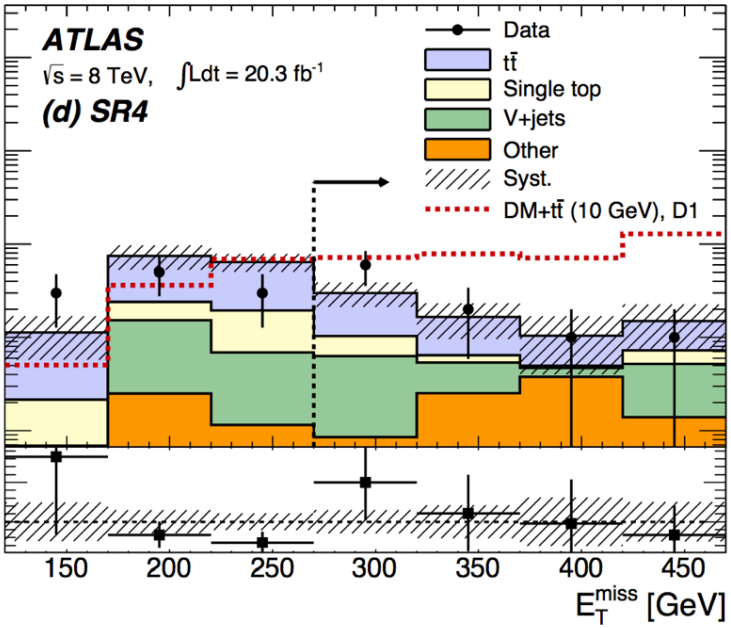
→ essential for discoveries in Run-II!

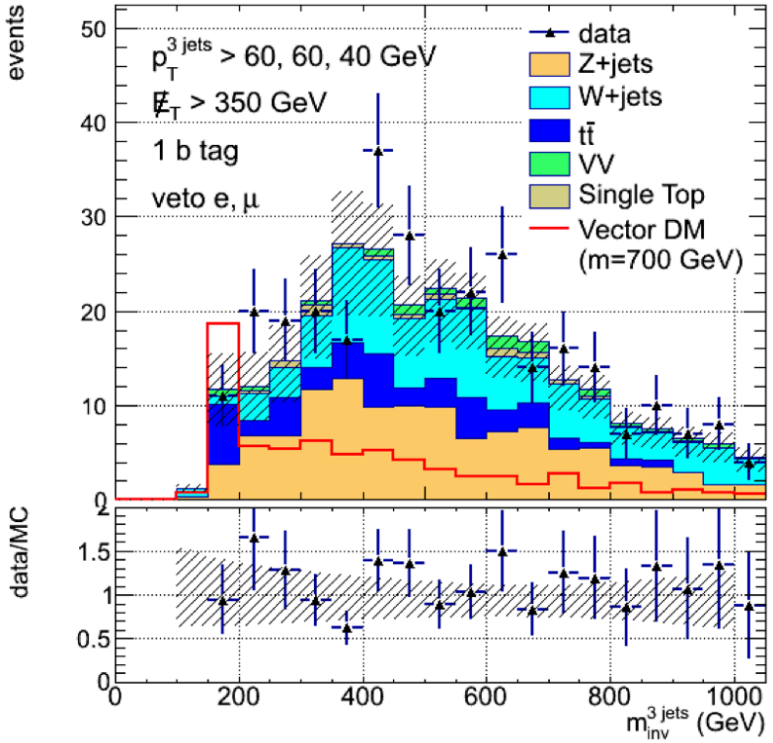
Search for dark matter







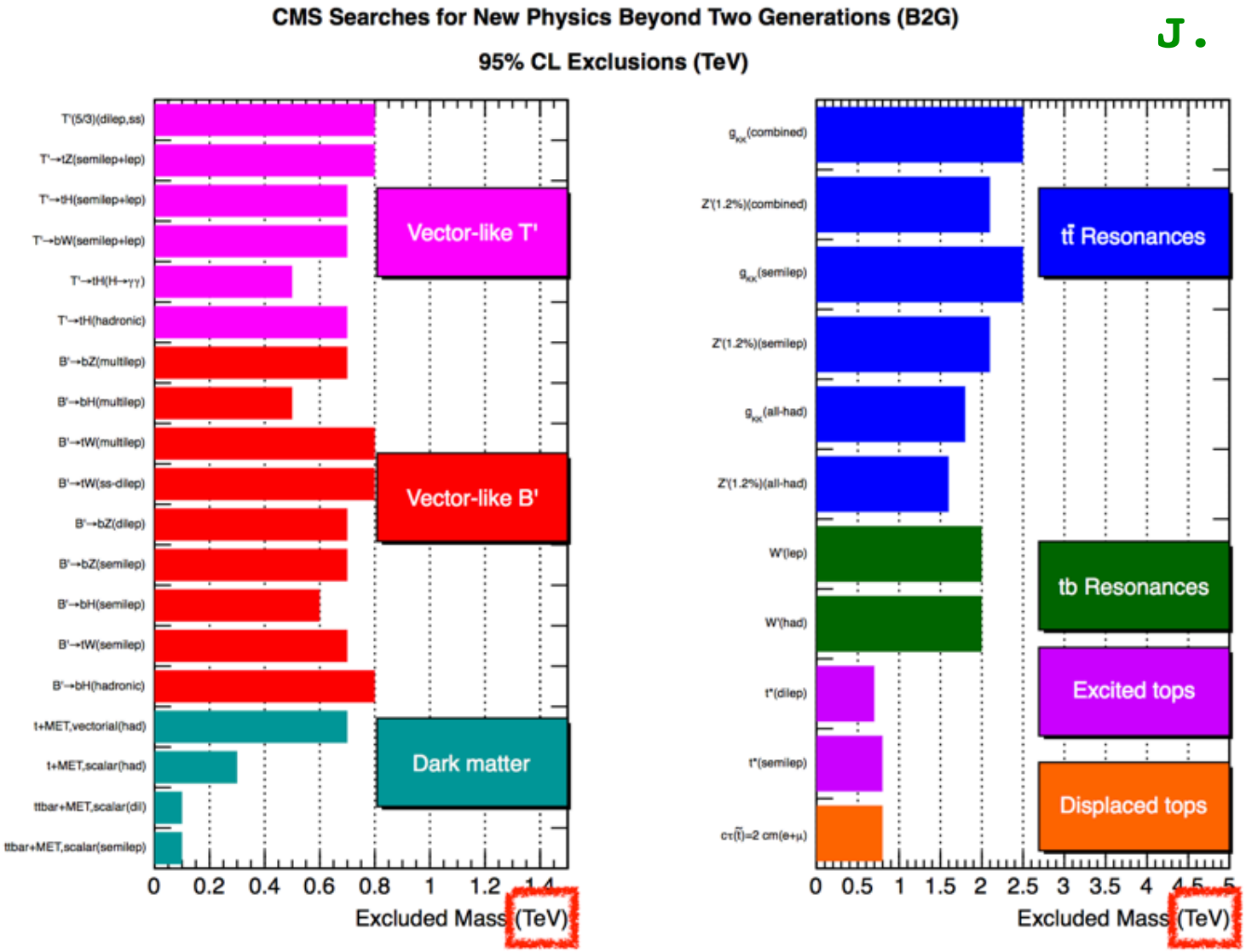




→ **no hint for dark matter**

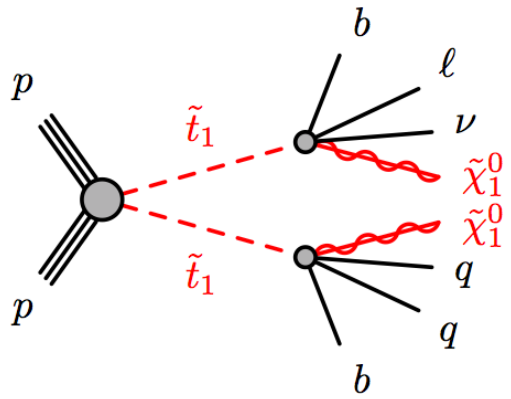
Pushing the TeV scale

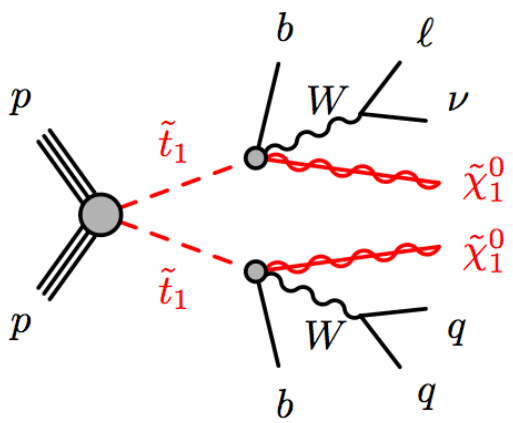
J. Erdmann

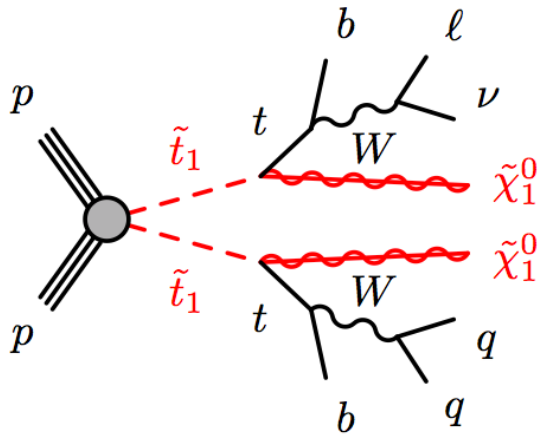


→ lots of opportunities for discovery in Run-II

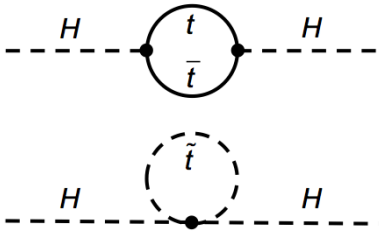
Direct searches for light stop



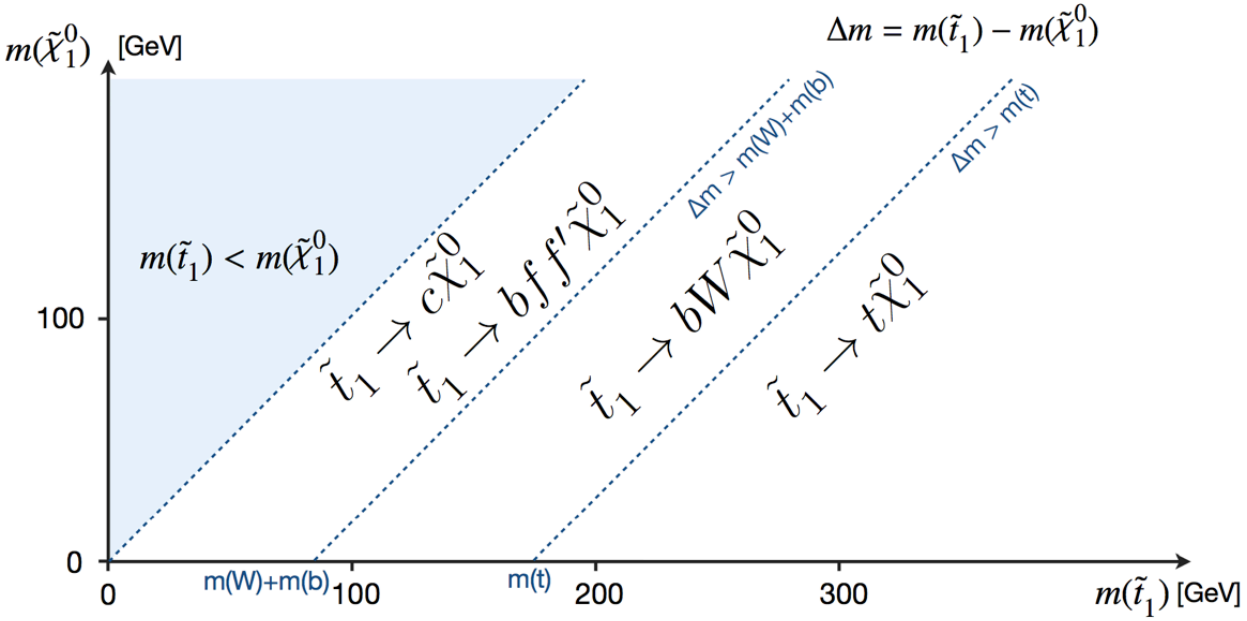




Recall: **Top loop** is the most i
contribution in Higgs virtual corrections:



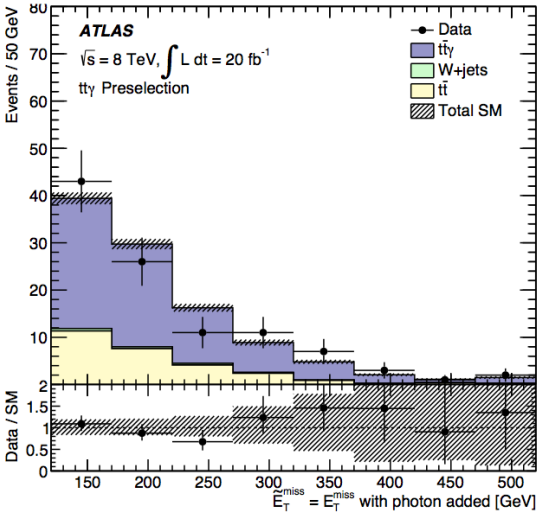
small stop mass is natural

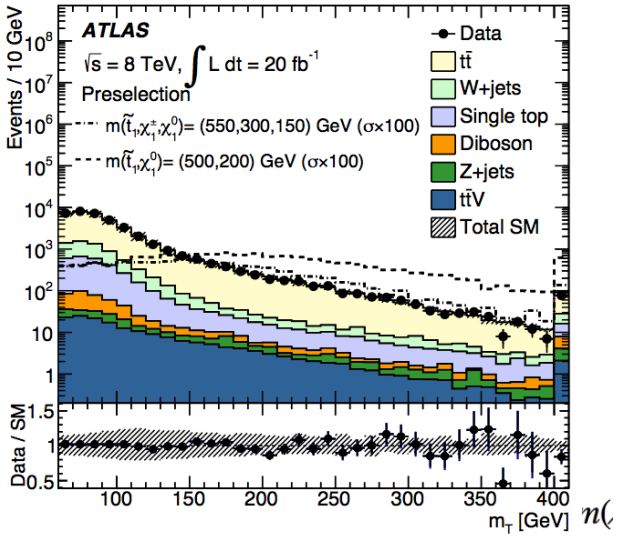


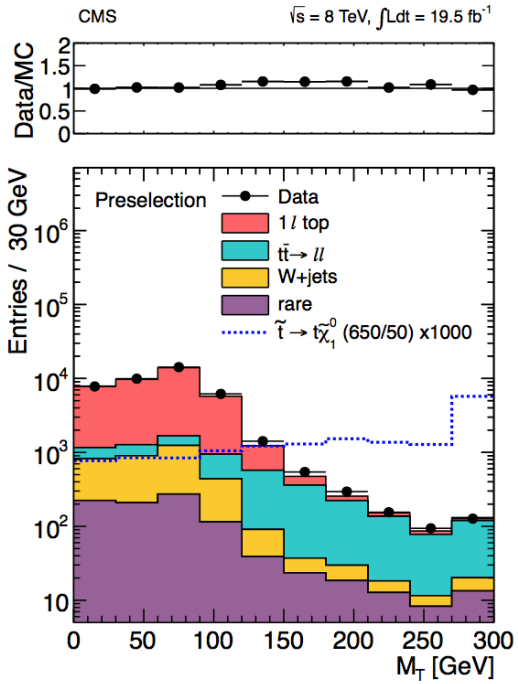
T. Eifert

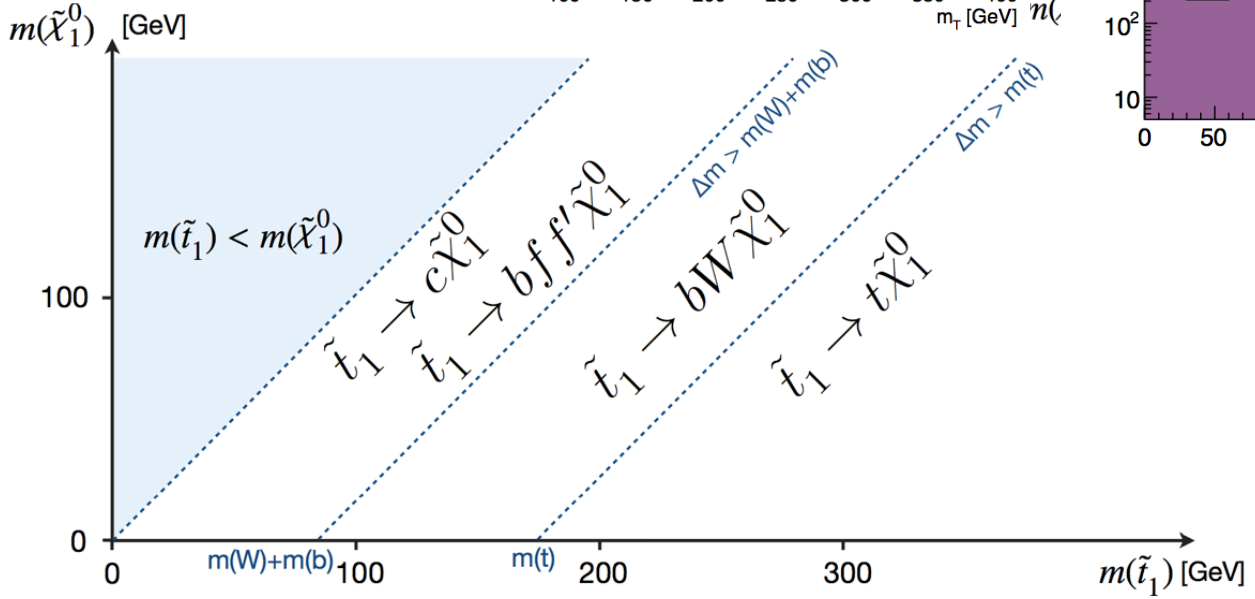
we check every little corner...

Direct stop searches









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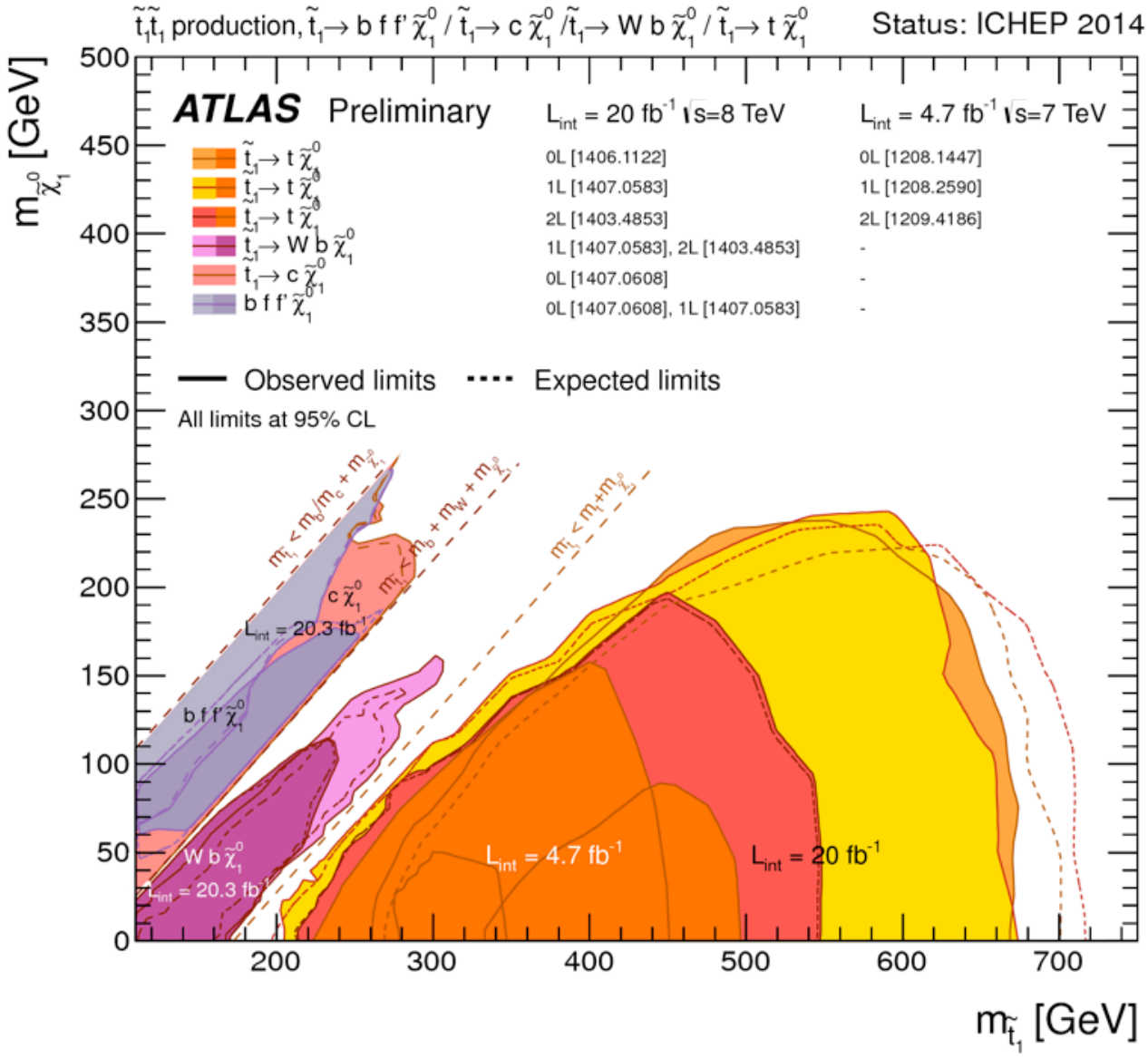
we check every little corner…

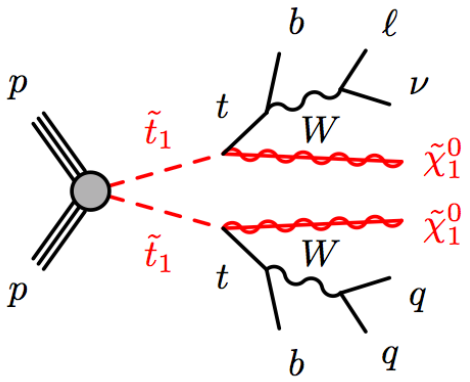
Direct stop searches

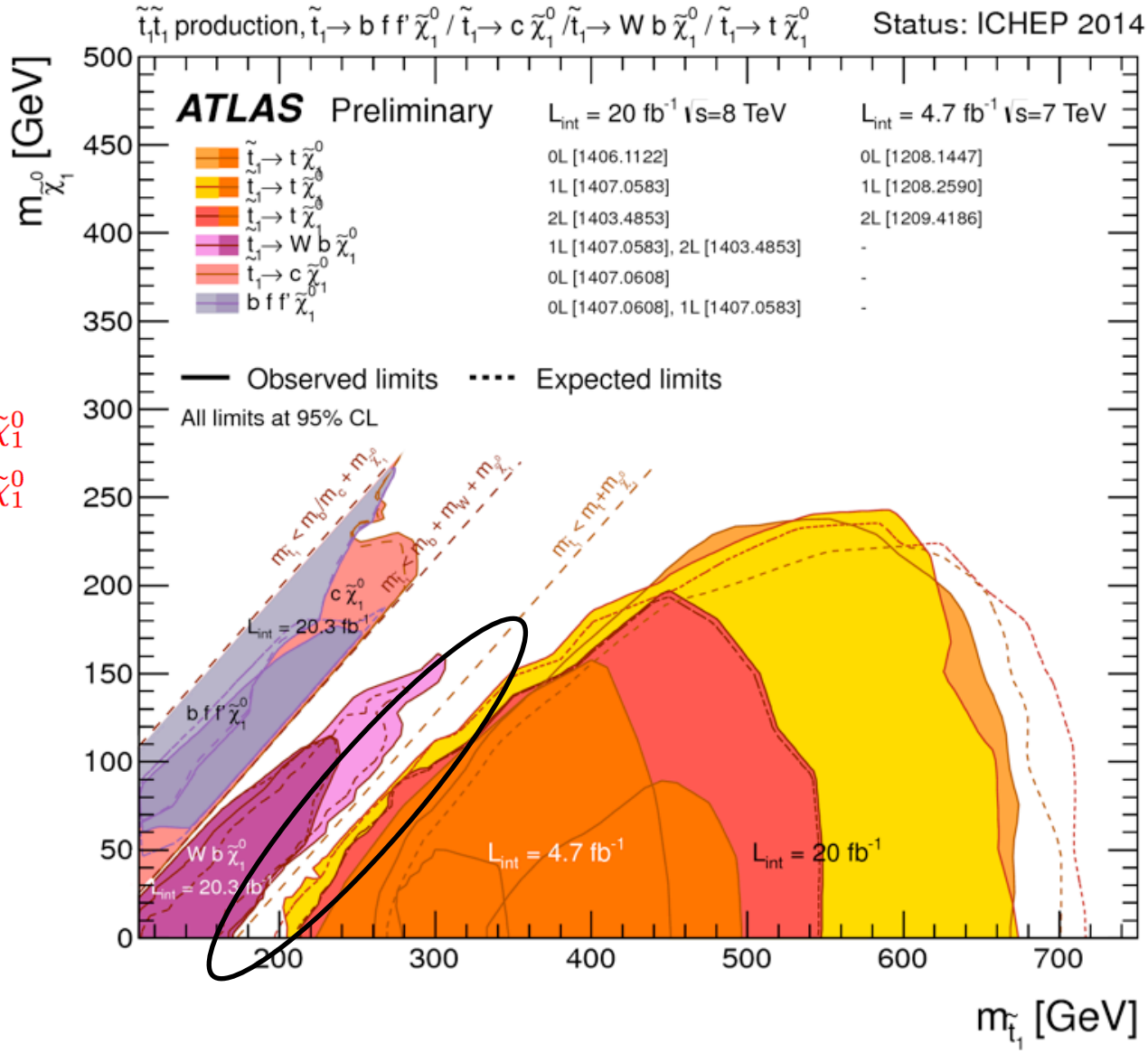


T. Eifert

we check every little corner…

Direct stop searches

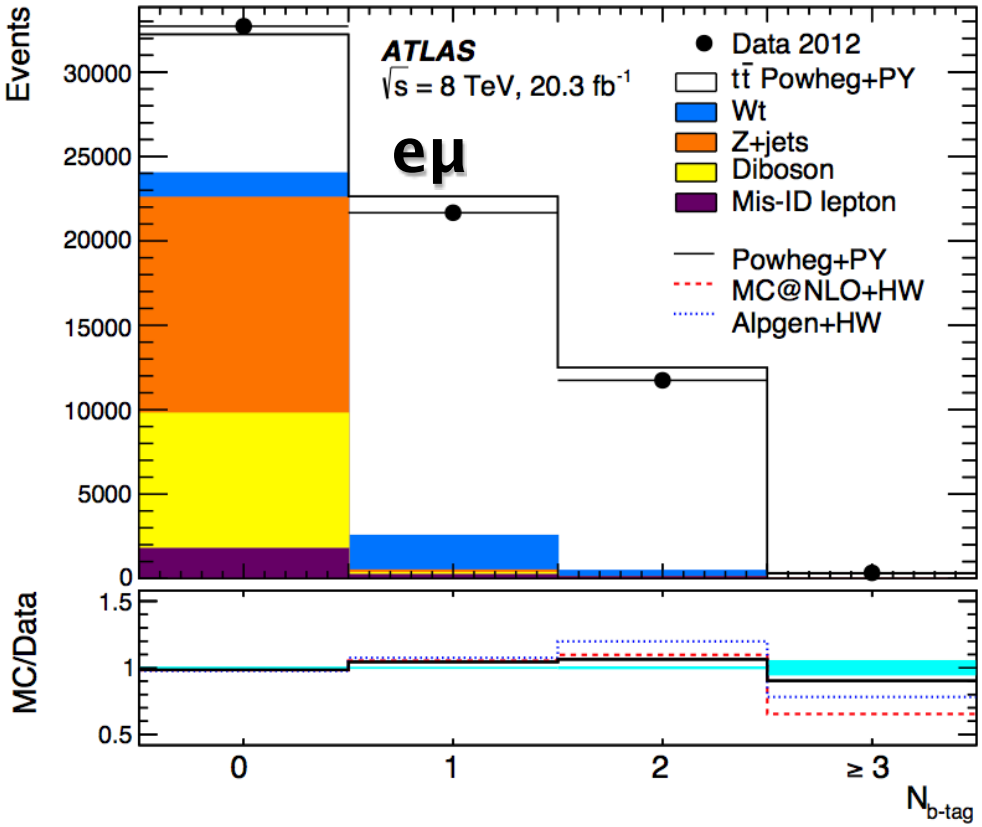


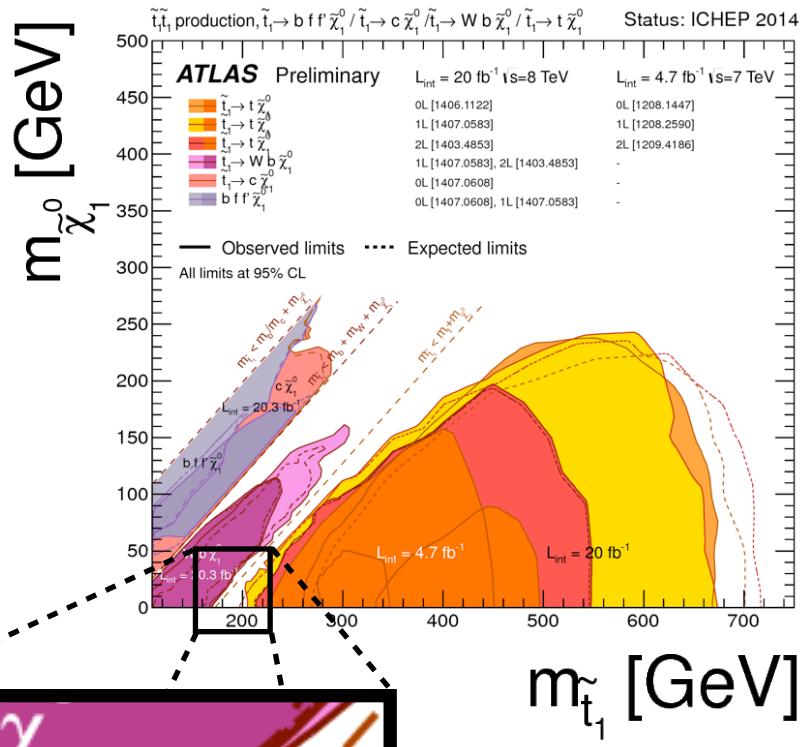


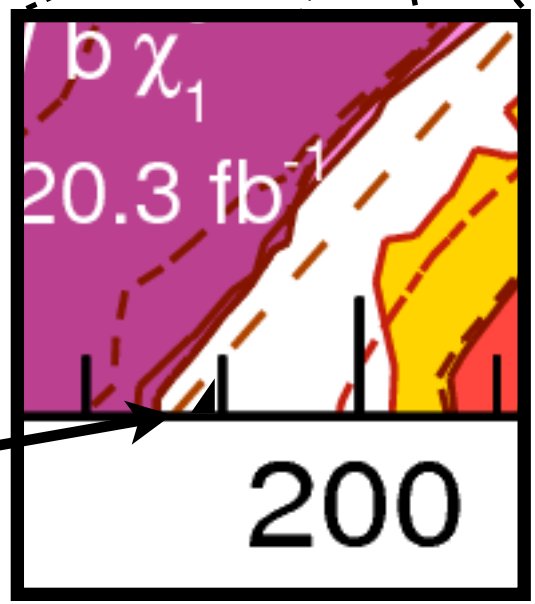
T. Eifert

we check every little corner...

Top precision for stop search



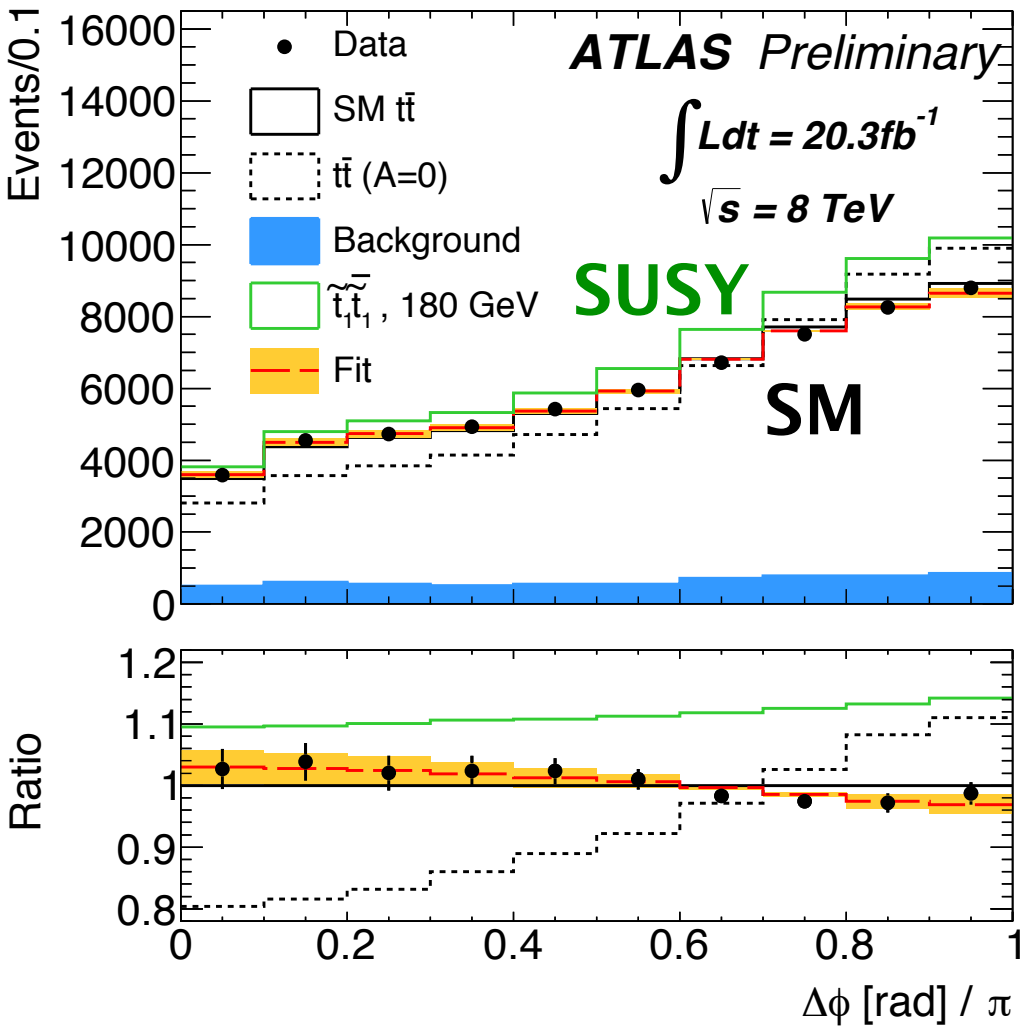


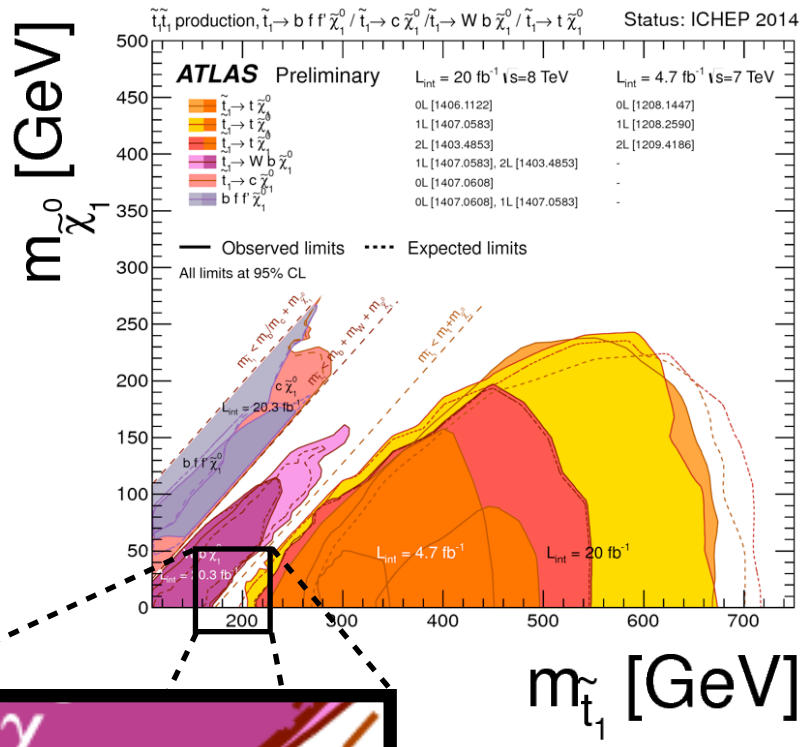


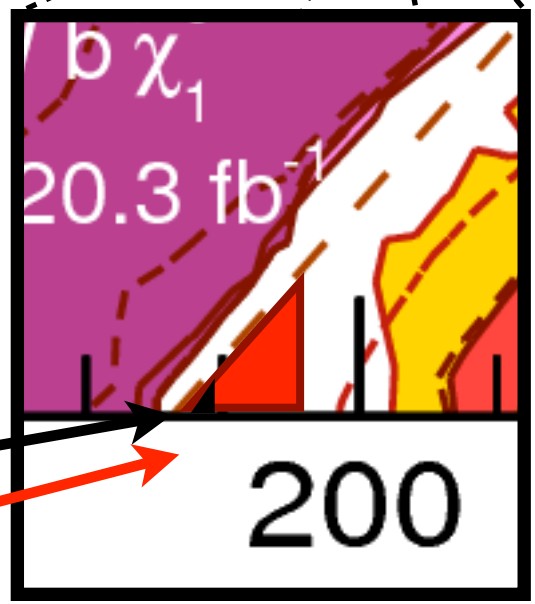
ttbar cross section

T. Eifert

Top precision for stop search







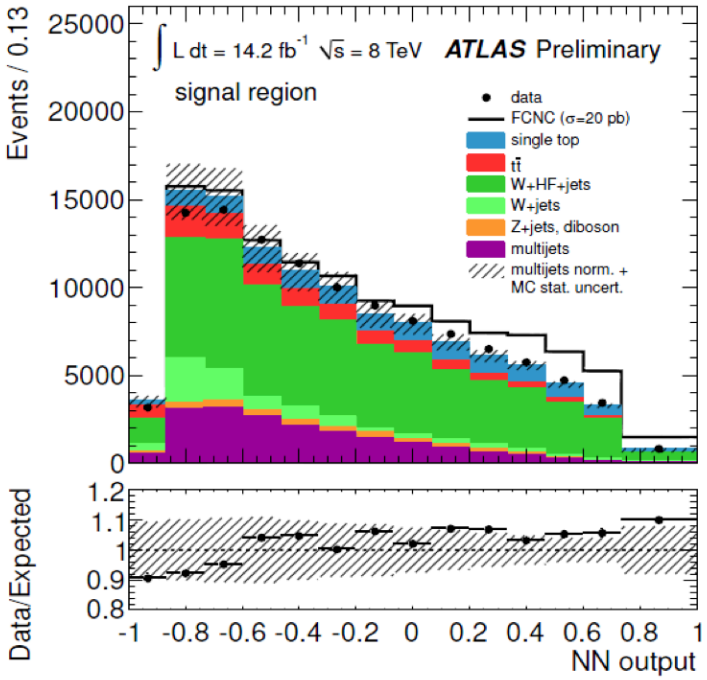
ttbar cross section

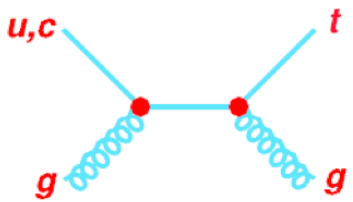
ttbar spin correlation

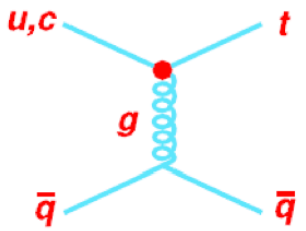
T. Eifert

Search for FCNC

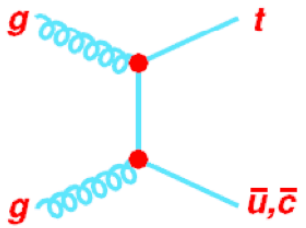
R. Goldouzian

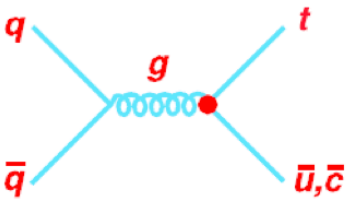


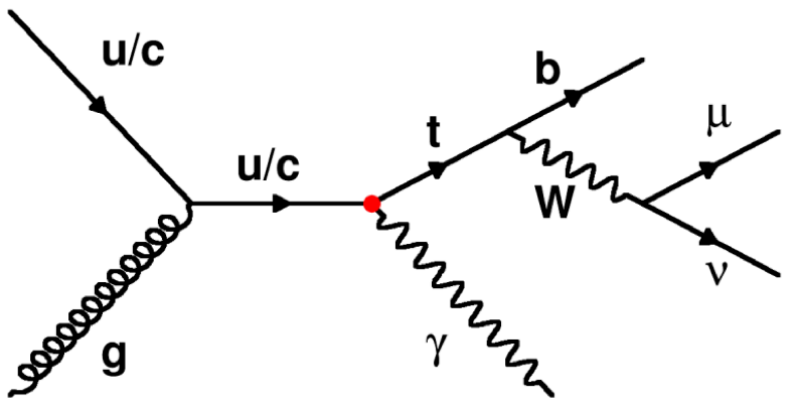


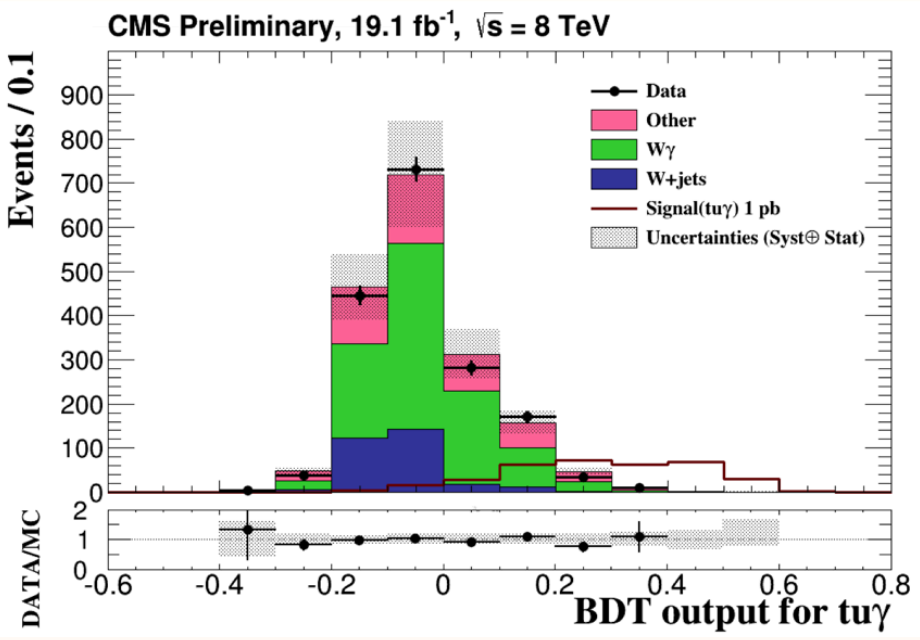


IR divergent?





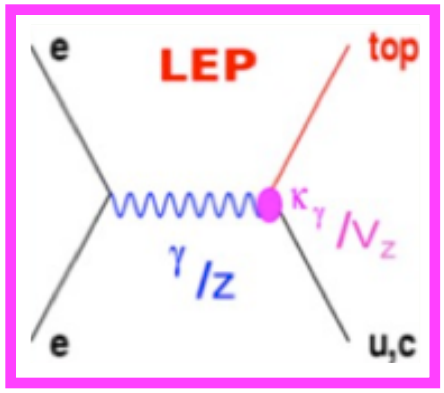


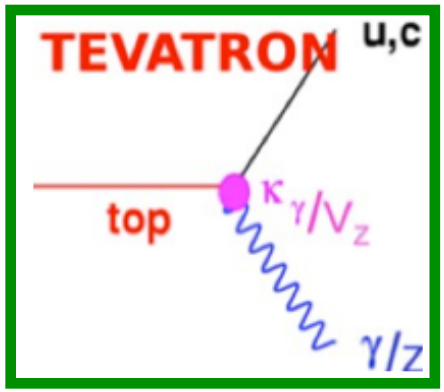


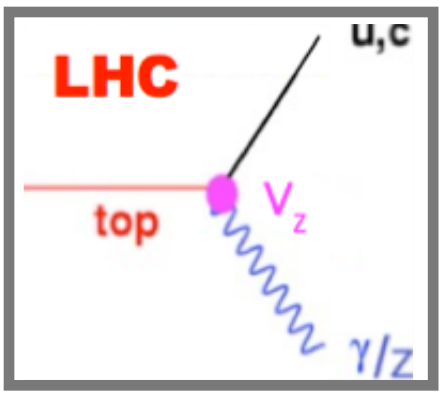
→ no hint for new physics

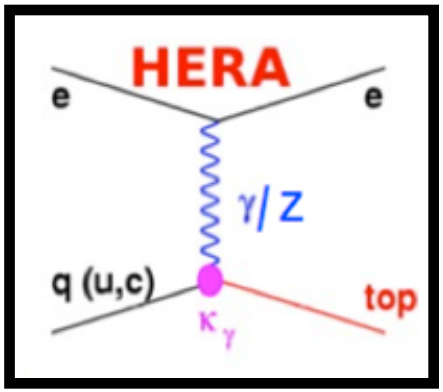
FCNC Top Couplings at

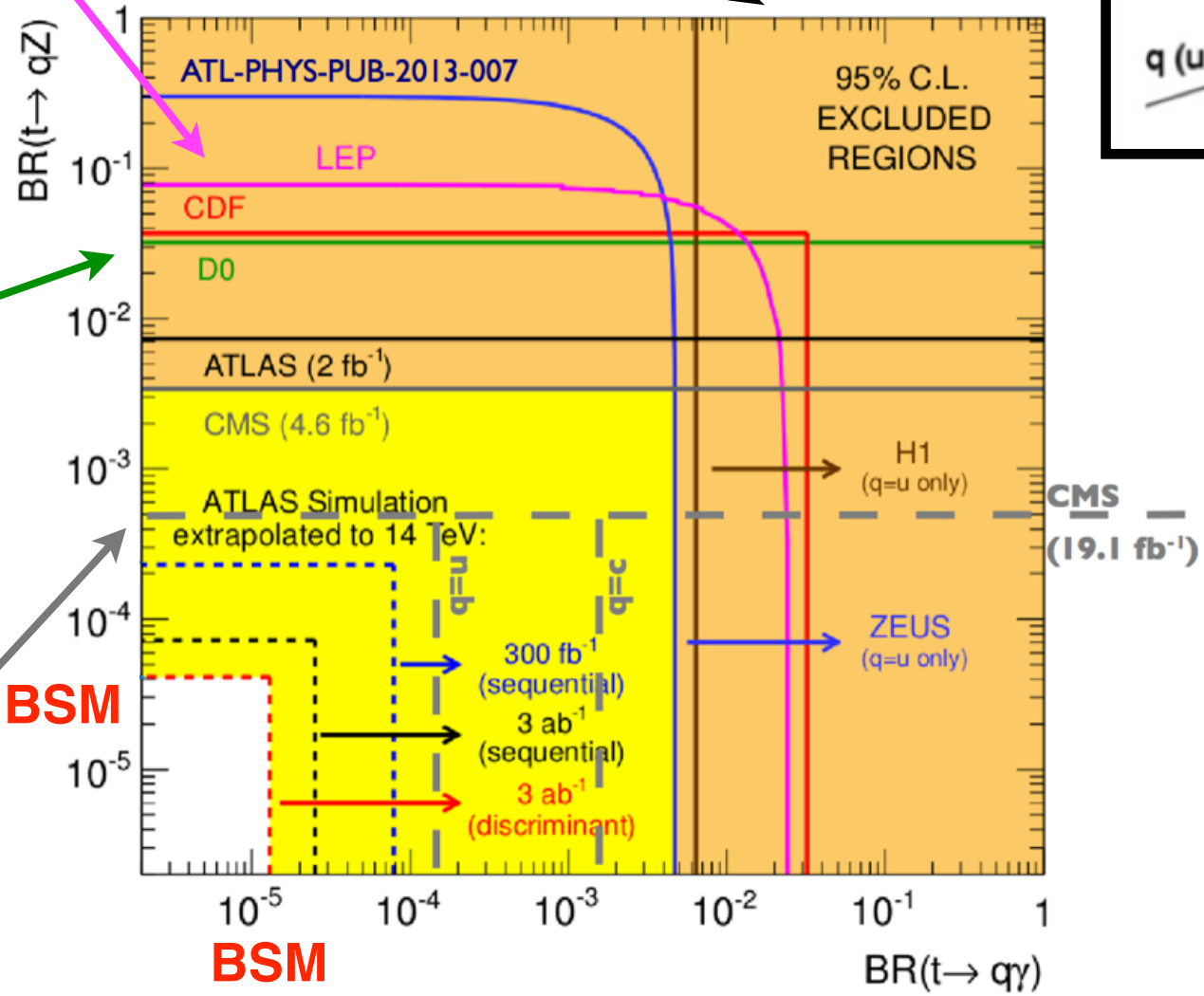
P. Silva











Summary of the summary

- very rich and diverse field of research!
- many exciting highlights at TOP 2014!
- high precision: cross sections, mass, couplings, ...
- high precision tools: NLO+multileg MC, NNLO calculations, ...
- huge development of tools: top-tagging, combinations, b-JES, ...
- measure unfolded and fiducial!
- new processes: s-channel single top, Wt, ttγ, ttZ, ttW, (ttH)
- many properties, also from single top
- top mass crisis?
- sensitive direct searches and by precision measurements

→ observe more SM processes in Run-II, many high precision property/cross section measurements to come, many mass discussion, new physics??

THANK YOU!!!

THANK YOU!!!


Philippe Briet
Sophie Cavata
Jeremy Andrea
Roberto Chierici
Frédéric Déliot
Dominique Pallin