Other Results from the LHC Experiments

Yuan CHAO
(National Taiwan University, Taiwan)

PASCOS 2013 in Taipei
2013/11/20-26

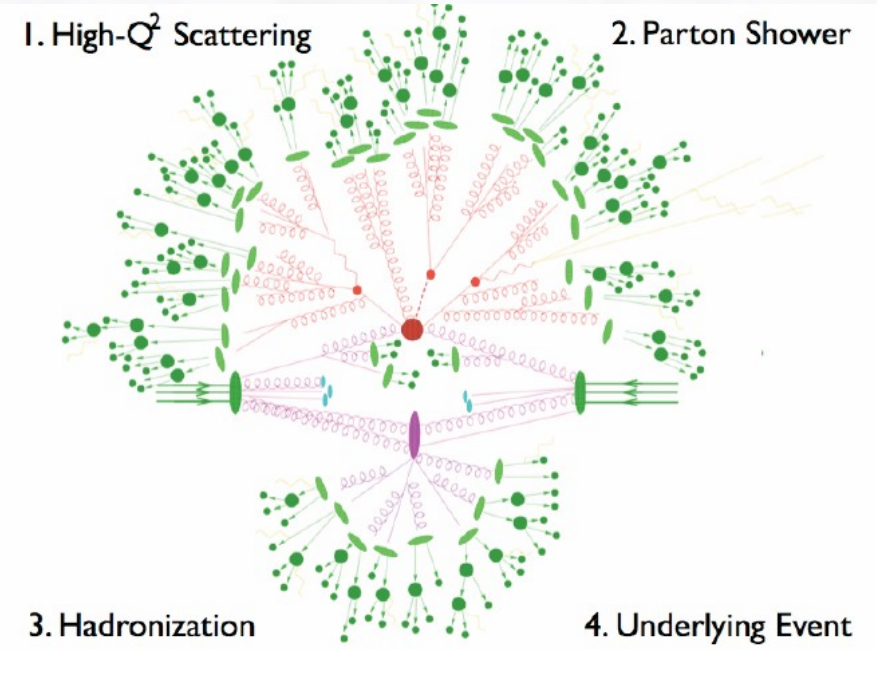
Outlines

- Summary of updated results from LHC
  - Mainly focus on the results of Atlas, CMS and LHCb
  - Other related results are also included
- Try to cover those not in the previous two talks
  - Selected based on my own taste of interests
  - Not overwhelm
- Content outlines
  - QCD forward, small-Q, Jets & Heavy Ion
  - Electroweak
  - Top Quark Physics
  - Flavor physics
- Summary & Prospects

QCD & Jets & HIN

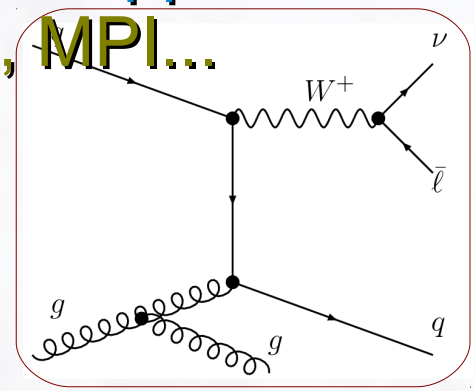
QCD Physics

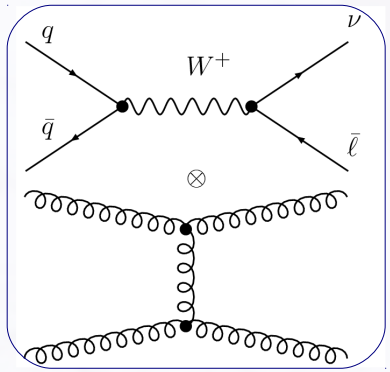
- Complexity – connecting theories and experiments
  - Theoretically hard to predict
  - Challenges on experiments
- QCD process elements
  - Proton structure -- PDF
  - Hard scattering
    - Perturbation theory
  - Parton shower & hadronization
  - Multi-parton interaction (MPI) & underlying event (UE)
- Practical to combine the elements above
  - Factorized & combined
  - Reasonable approximation



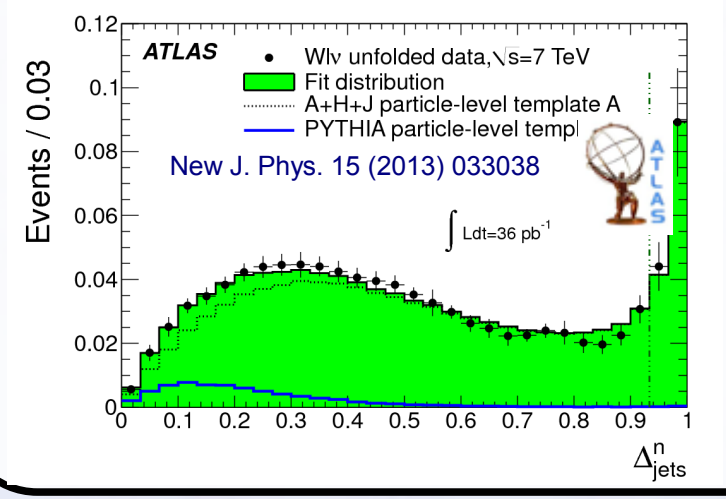
Double-parton Scattering

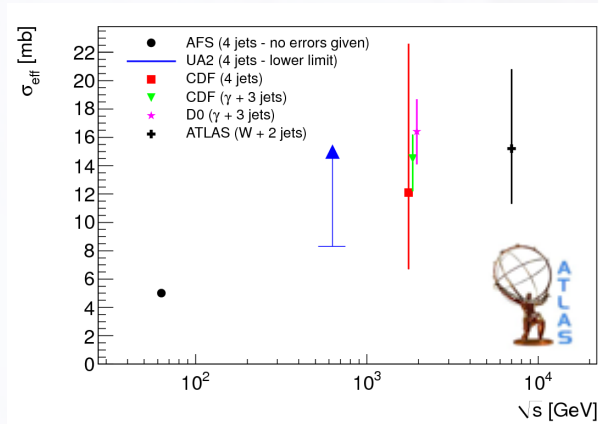
- Two hard interactions from the same pp collision
  - MC relies on approx.: ISR, FSR, MPI...
- Factorized model
  - σ_{eff} to be extracted from exp.
- Looking at W+jj events
  - Δ^{n}_{jets} (pt imbalance) $\frac{|\vec{p}_{T,1}+\vec{p}_{T,2}|}{|\vec{p}_{T,1}|+|\vec{p}_{T,2}|}$
  - ΔS (angle between W, jj)
- Fitting result
  - Compatible with previous studies

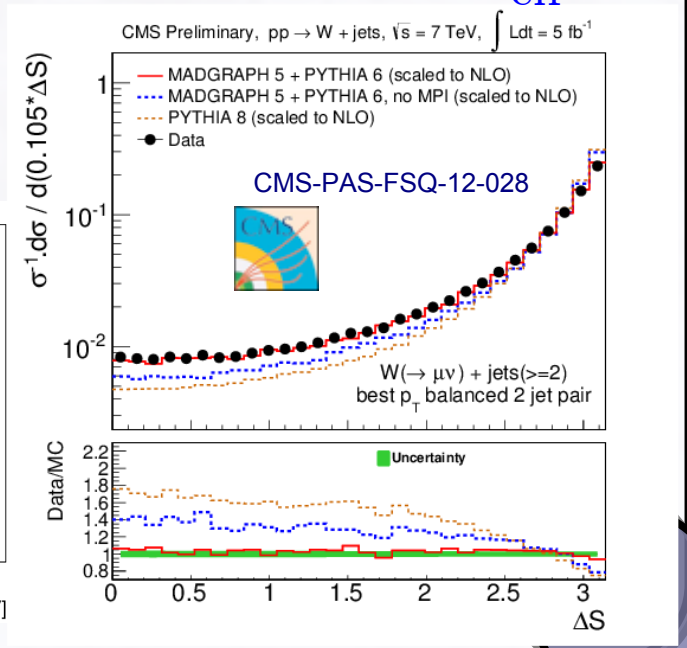




$$d\sigma_{X+Y} = d\sigma^{dir}_{X+Y} + \frac{d\sigma_X \otimes d\sigma_Y}{\sigma_{eff}}$$

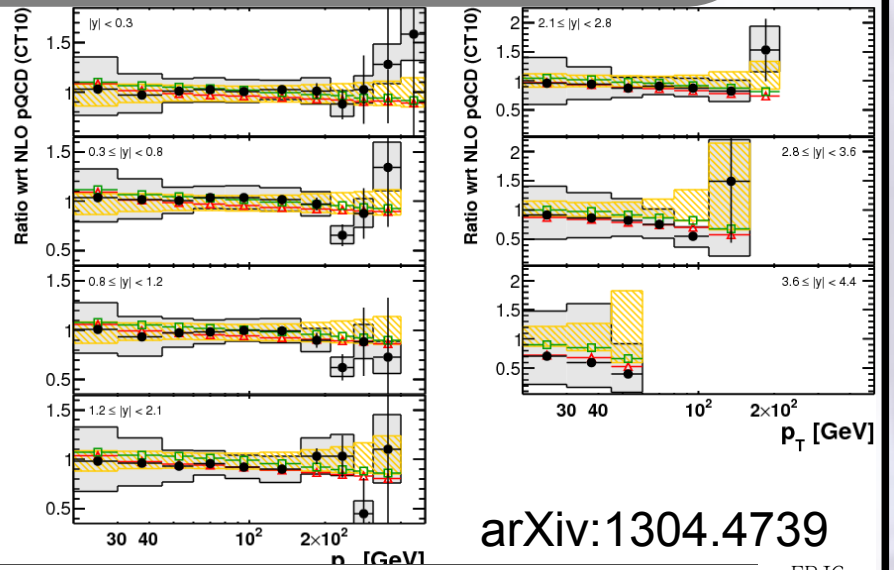






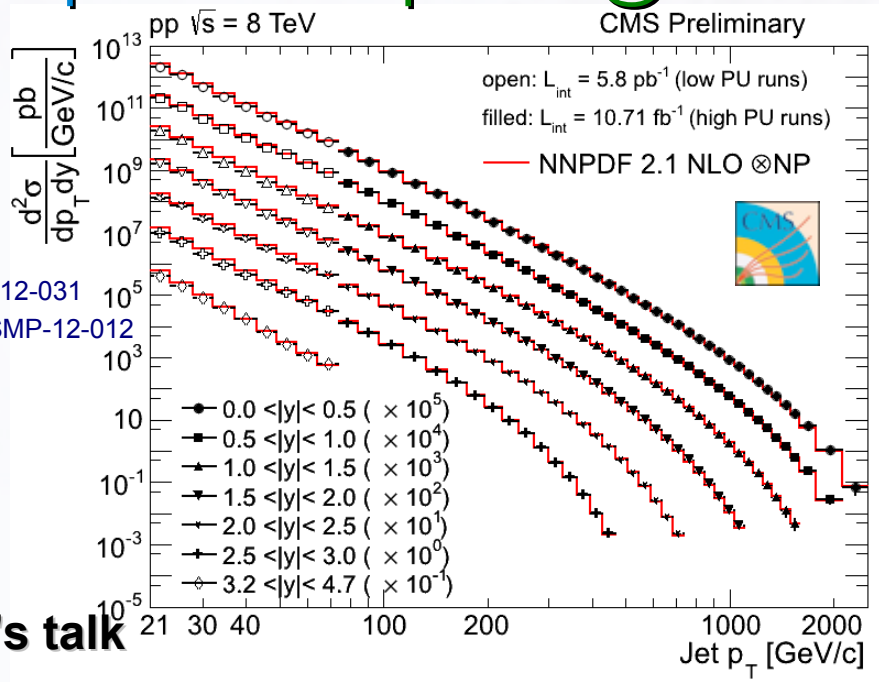
Inclusive Jet Cross Section

- Atlas @ 2.76 TeV & 7 TeV
  - Up to p_T 500 GeV, |y| = 4.4
  - Double ratio $(\text{ratio})_{2.76\text{TeV}}/(\text{ratio})_{7\text{TeV}}$
    - Cancellation of exp. uncertainties
- CMS latest @ 8 TeV
  - Start p_T 20 GeV, to |y|=4.7, low PU
  - Potential constrains to PDF
- Compatible with pQCD @ NLO

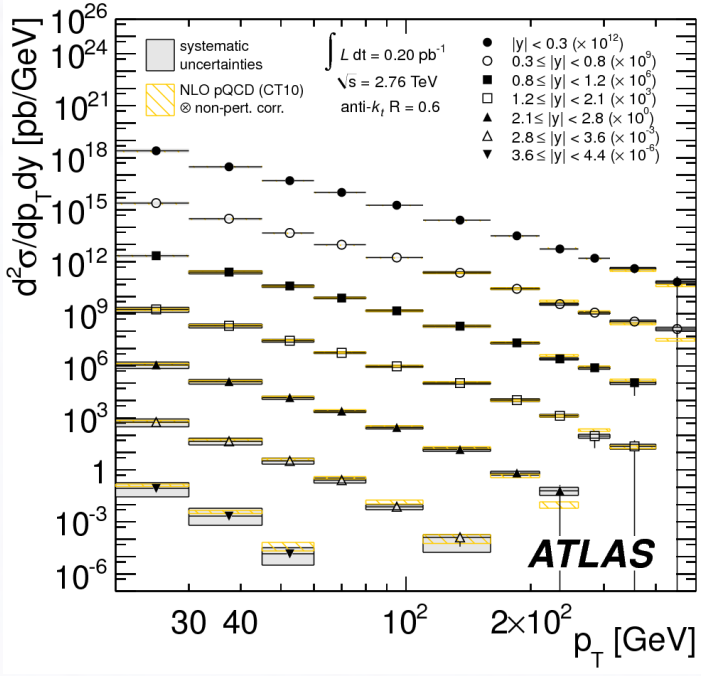


arXiv:1304.4739

EPJC



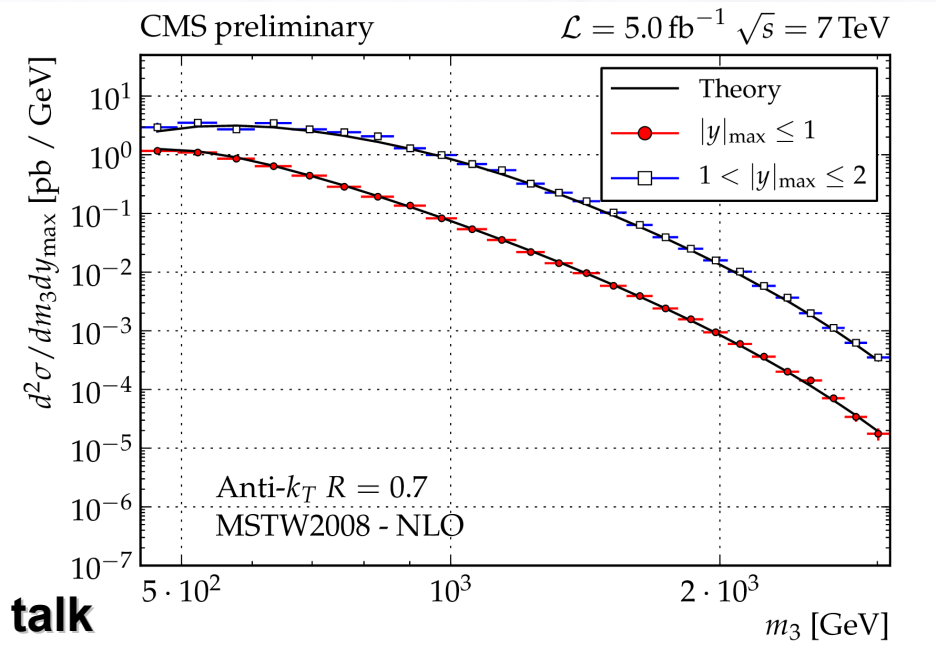
PAS-FSQ-12-031
CMS-PAS-SMP-12-012

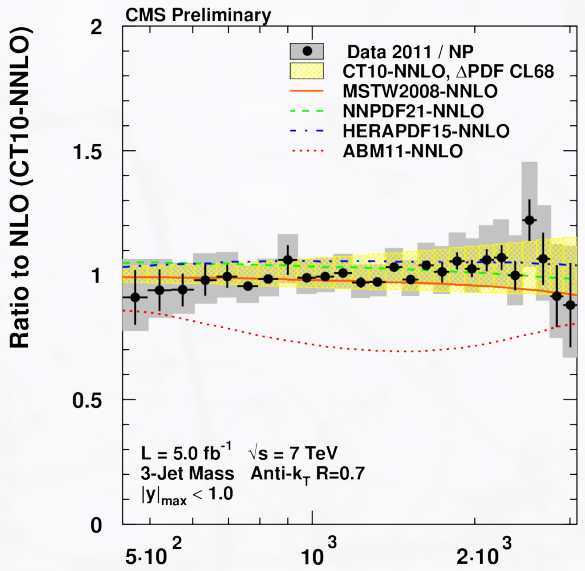


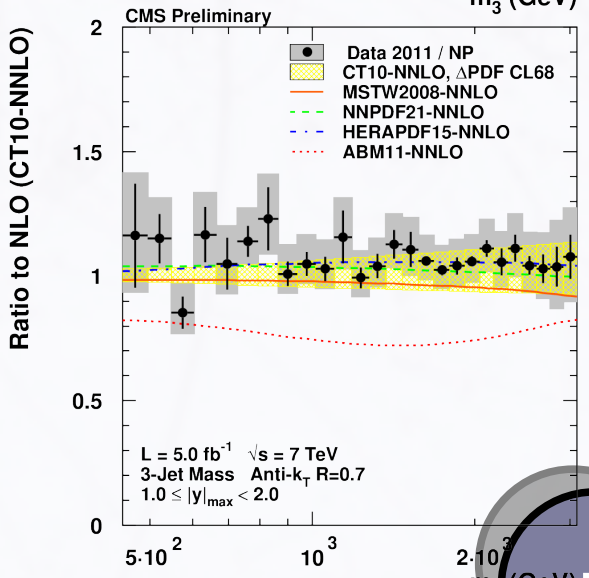
See Mikko's talk

3-jet Invariant Mass

- Measurement of 3-jet inv. mass @ 7 TeV
  - Sensitive to PDFs
  - Sensitive to α_s
- Phase space by the max. of 3 leading jet
  - $|y|_{max} = 2$
  - $m_{3jet} \sim 3$ TeV
- Compatible with pQCD @ NLO







CMS-PAS-SMP-12-027

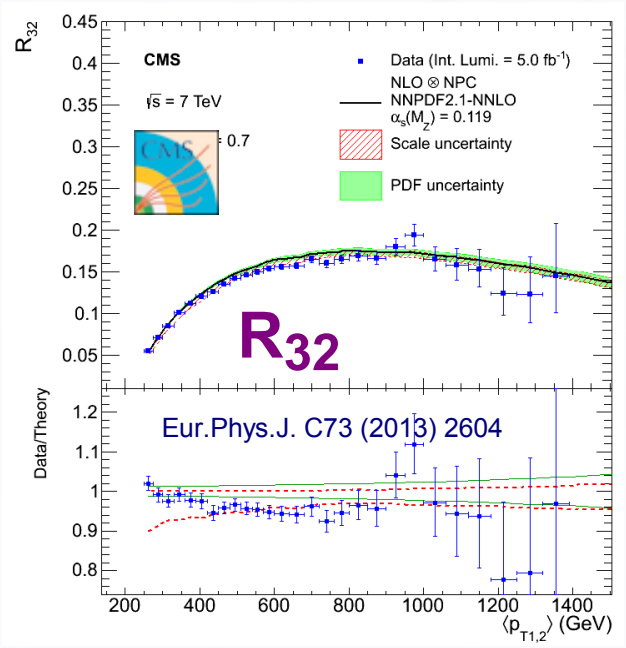
See Mikko's talk

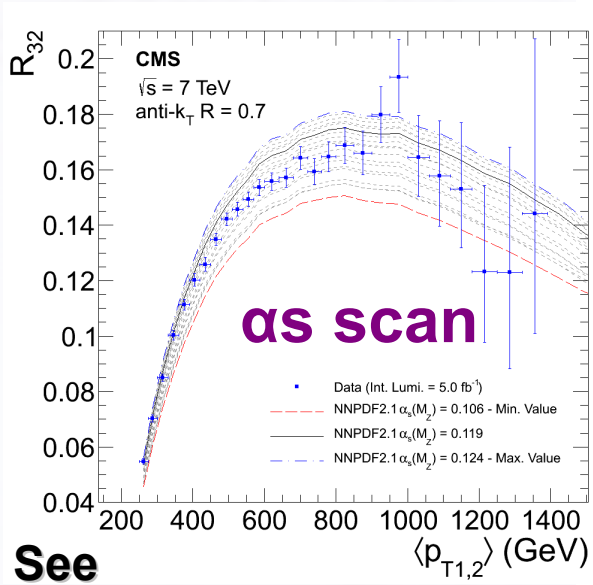
3-jet over 2-jet X-Section Ratio

- Three cross section ratios R_{32} & N_{32}
  - Inclusive 3-jet over 2-jet production
  - Sensitive to α_s
- **Alternative** phase-space options
  - The 3rd p_T cut imposed
  - Different observables
  - Vital to reduce the scale uncertainty

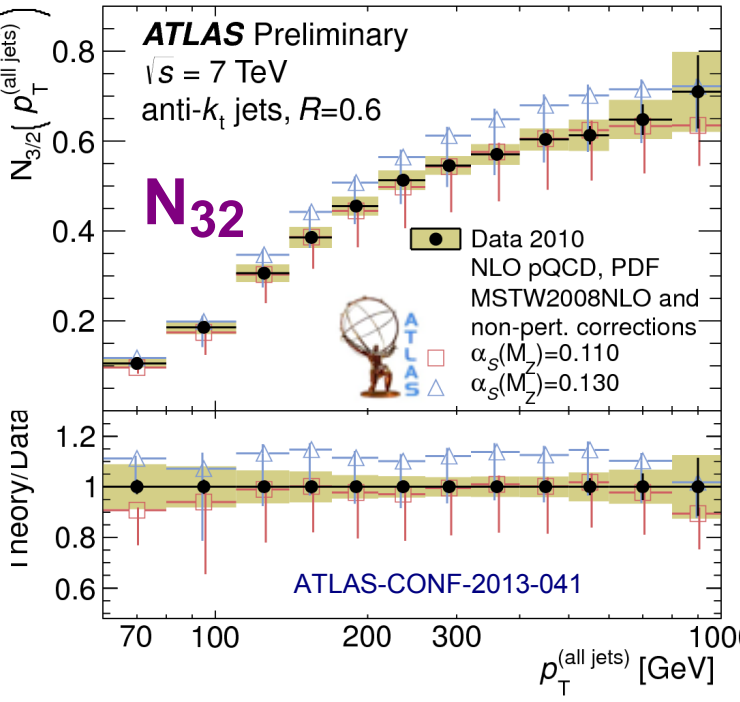
$$R_{3/2} = \sigma_{3\text{-jet}} / \sigma_{2\text{-jet}} = \frac{\sum \; +\ldots}{\sum \; + \; +\ldots}$$

$$N_{3/2}(p_T^{\text{all}}) = \frac{\sum_i^{N_{\text{jet}}} (d\sigma_{N_{\text{jet}}\geq 3}/dp_T^i)}{\sum_i^{N_{\text{jet}}} (d\sigma_{N_{\text{jet}}\geq 2}/dp_T^i)}$$



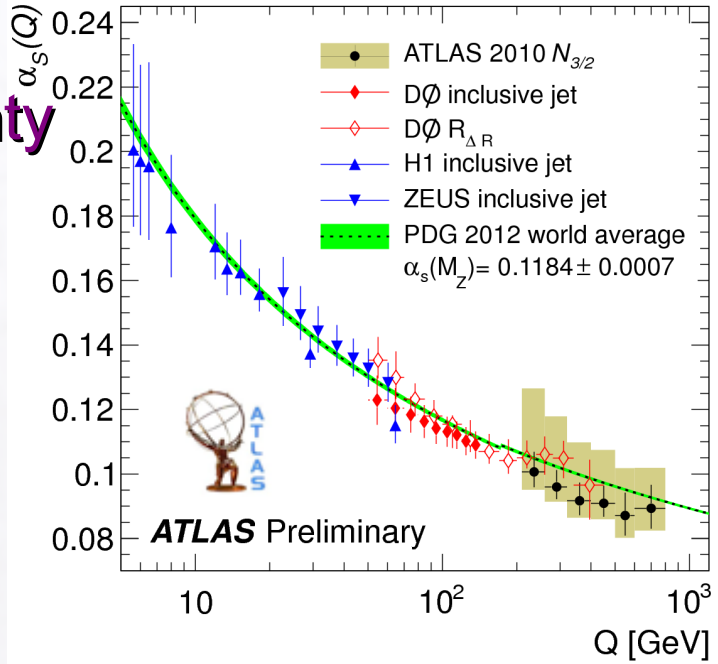


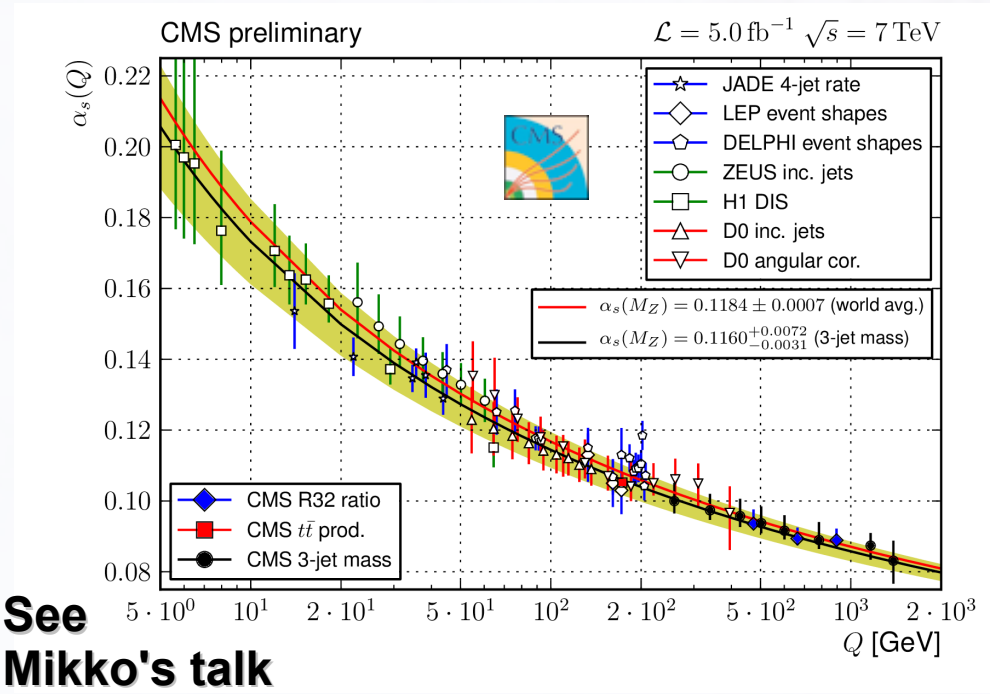
See Mikko's talk



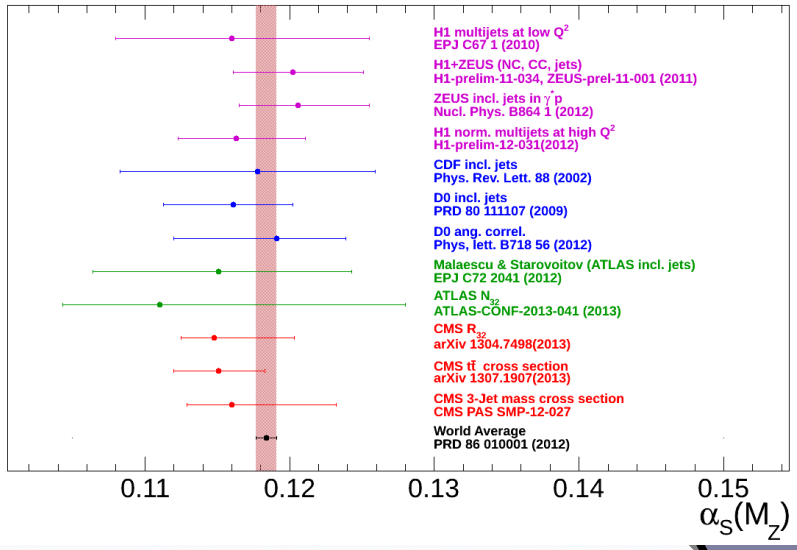
Measurement of αs

- Measurements compatible with world avg.
- Precision dominated by theoretical uncertainty (choice of scale)
  - To improve with **pQCD @ NNLO**
  - **More data** to exploit phase-space regions with small scale uncertainty
- Measurement at scales up to 1.5 TeV





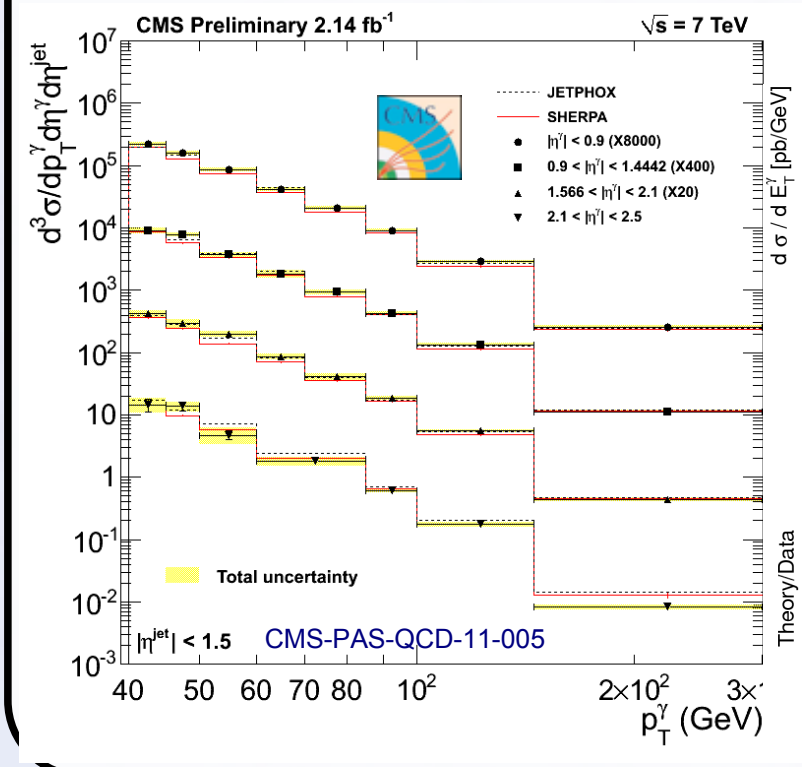
See Mikko's talk

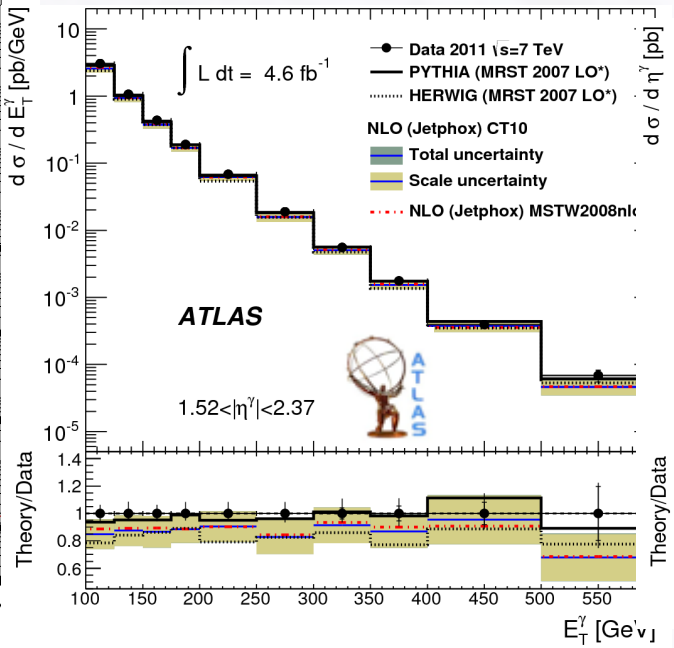


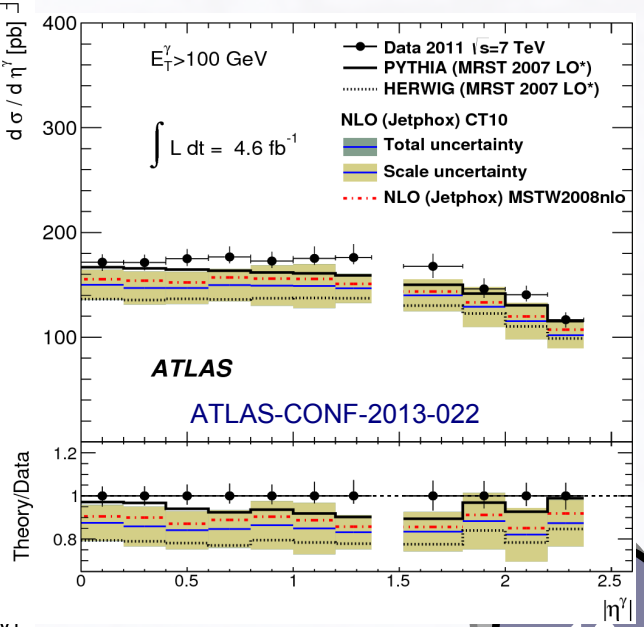
Photon + jets

- Photon production in association with jets at CMS
  - Checked various config. on jet and photon η
  - Additional info on QCD & PDF
- Theory uncertainty dominated by the choice of scale
- Prediction @ NLO agree with data
- Sherpa describes the data well

- Result of Atlas with full 2011 dataset at 7 TeV
  - Extending E_T up to 1 TeV
- Theory uncertainty dominated by the choice of scale
  - Similar or larger than expt. Syst.
- Prediction @ NLO agree with data within uncertainties



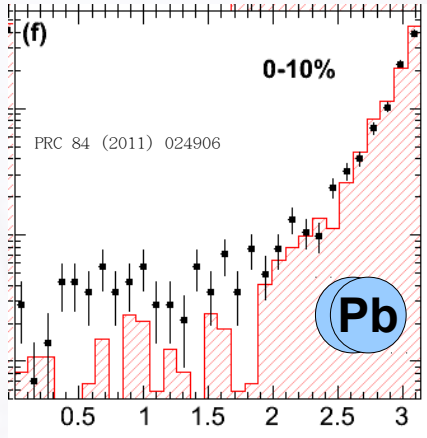


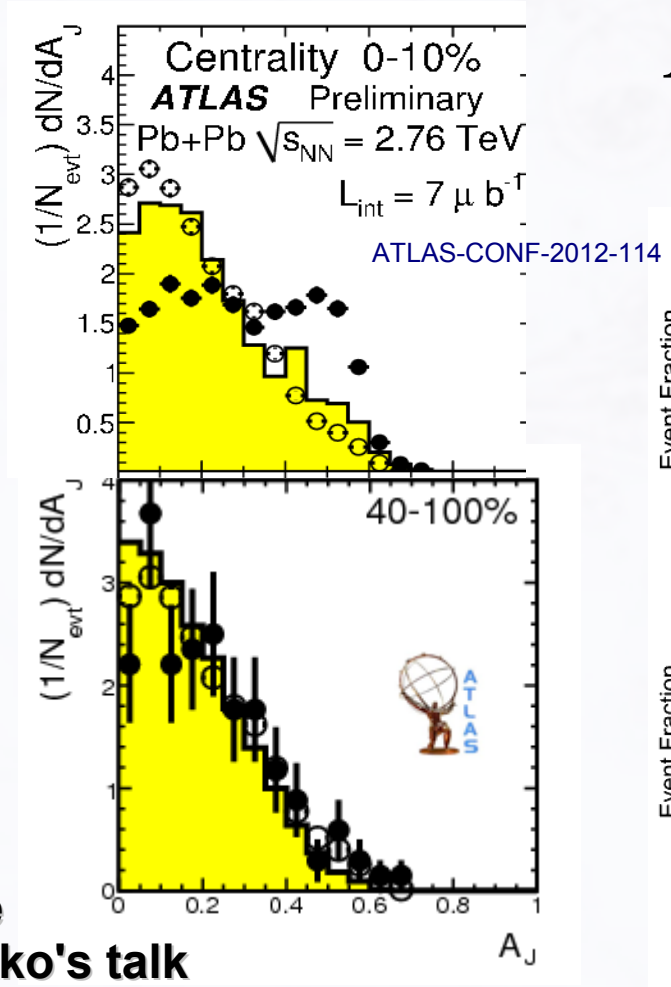


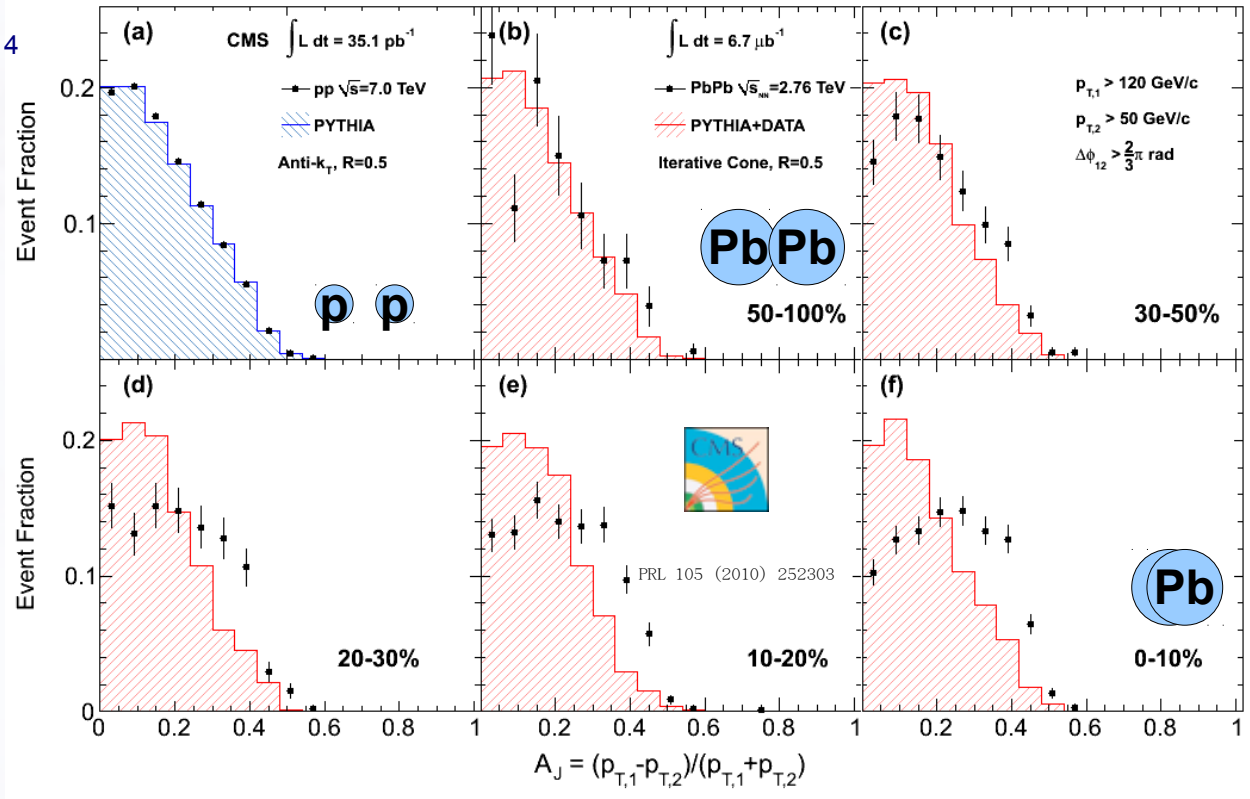
Di-Jet Energy Imbalance

- Parton energy lost as seen in Pb-Pb collisions
  - Still back-to-back in φ

$$A_J = \frac{(p_{T,1} - p_{T,2})}{(p_{T,1} + p_{T,2})}$$



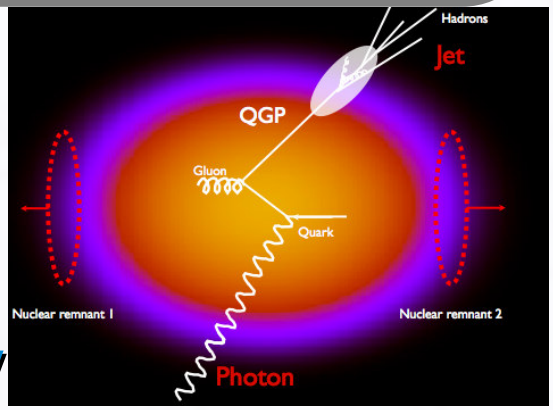




See Mikko's talk

γ-Jet & Z-Jet Pairs

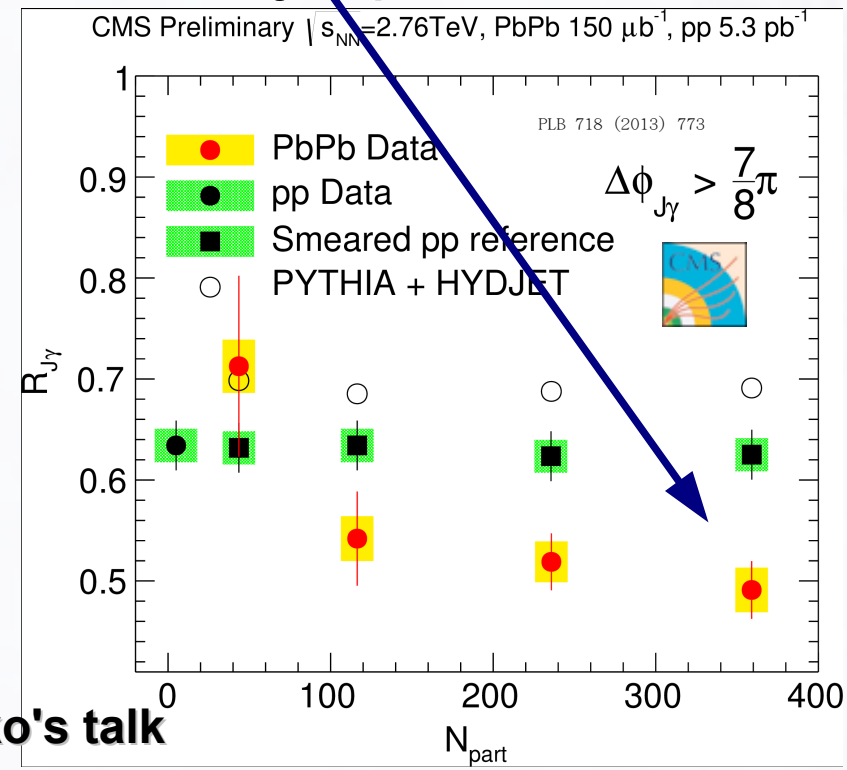
- With photon or Z tag:
  - Providing init. quark direction
  - Providing init. quark p_T

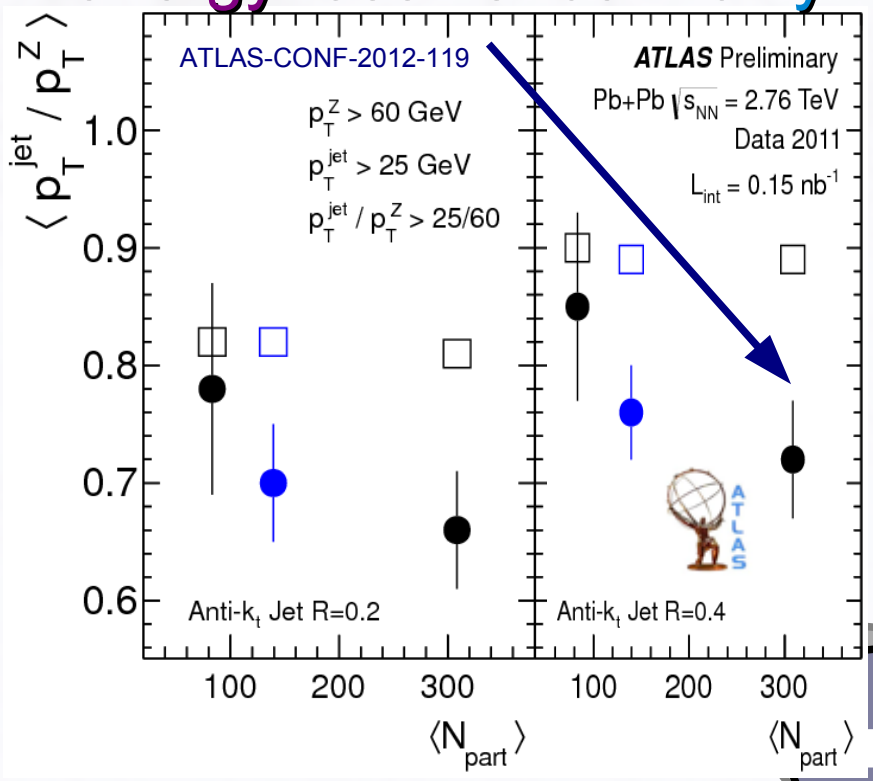


Colorless particles do not lose energy

Less jet partners seen

energy loss vs. centrality





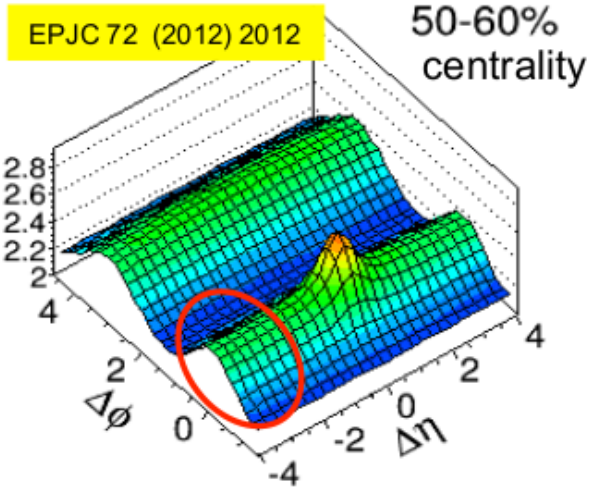
See Mikko's talk

Long-range Corr.: p-p,p-Pb,Pb-Pb

Pb+Pb 2.76 TeV

EPJC 72 (2012) 2012

50-60% centrality

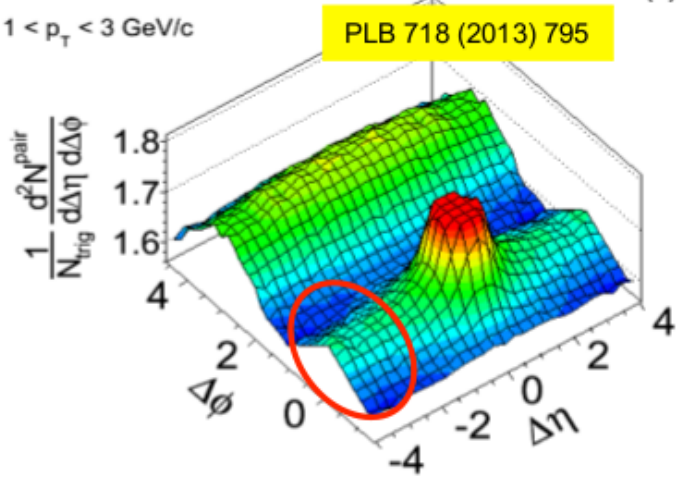


p+Pb 5.02 TeV

CMS pPb $\sqrt{s_{NN}}$ = 5.02 TeV, $N_{trk}^{offline} \geq 110$ (b)

$1 < p_T < 3$ GeV/c

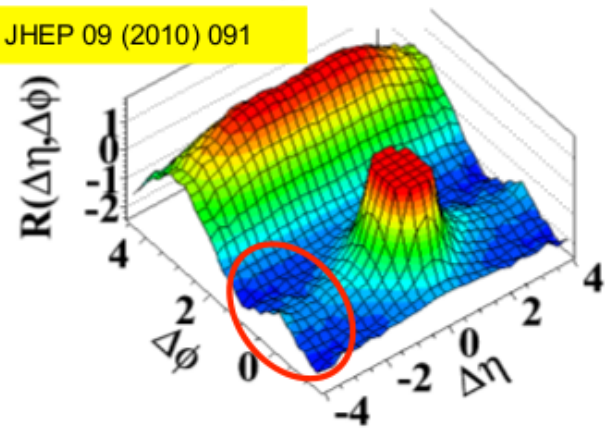
PLB 718 (2013) 795



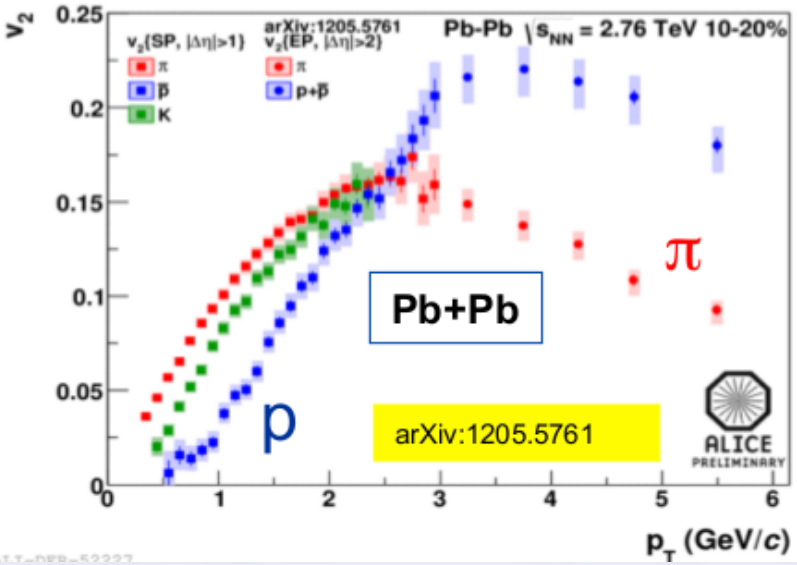
p+p 7 TeV

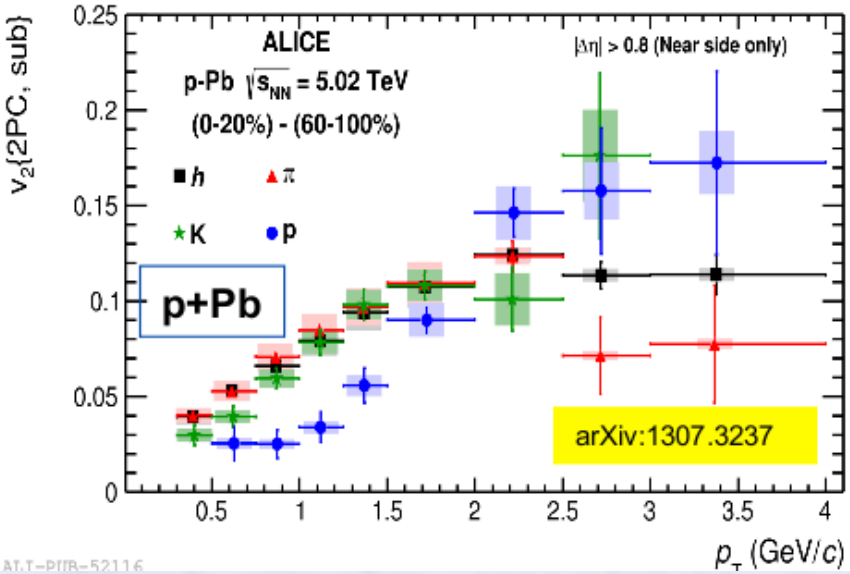
(d) N>110, 1.0GeV/c<p_T<3.0GeV/c

JHEP 09 (2010) 091



Mass ordering of second Fourier-coefficient (v_2):

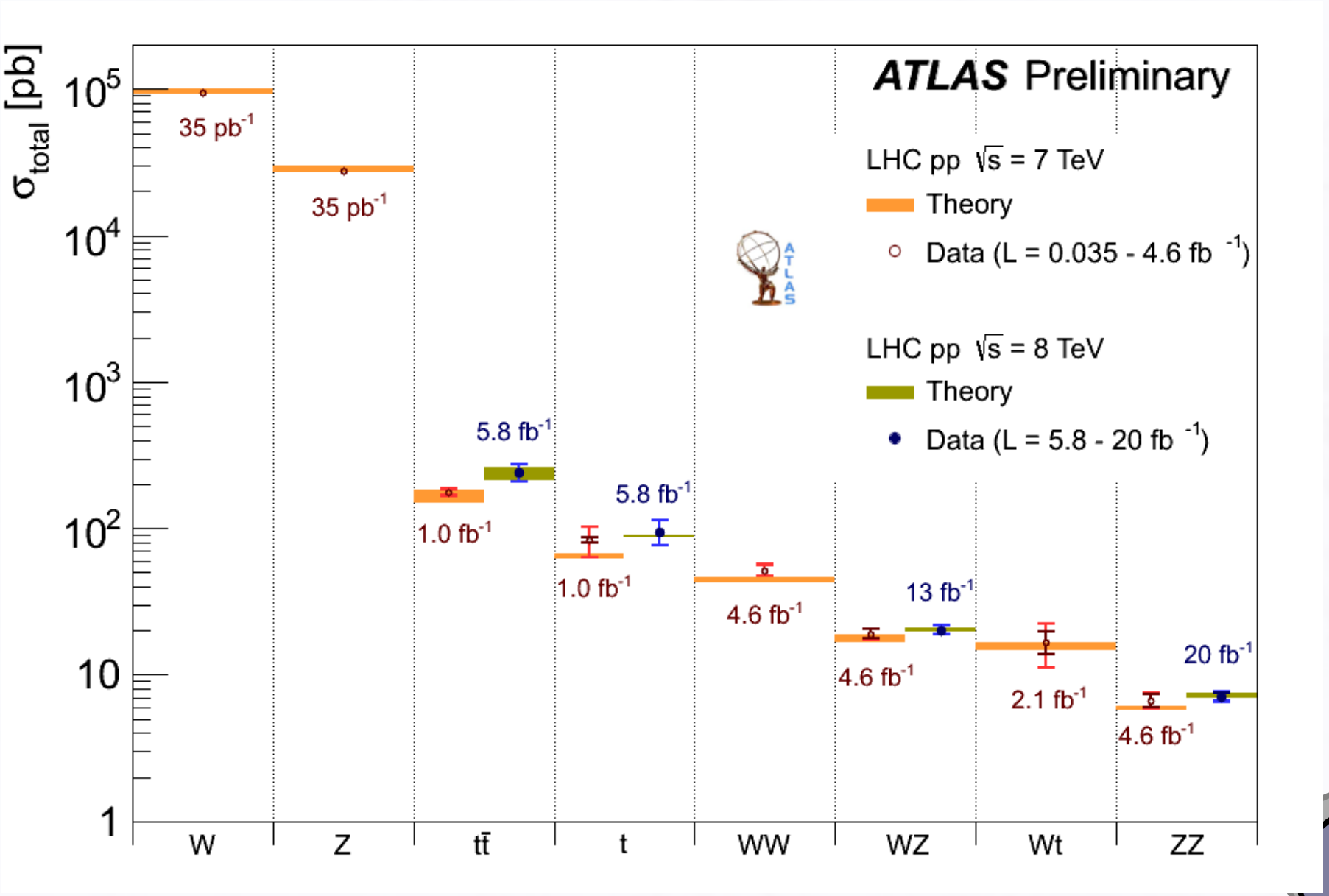




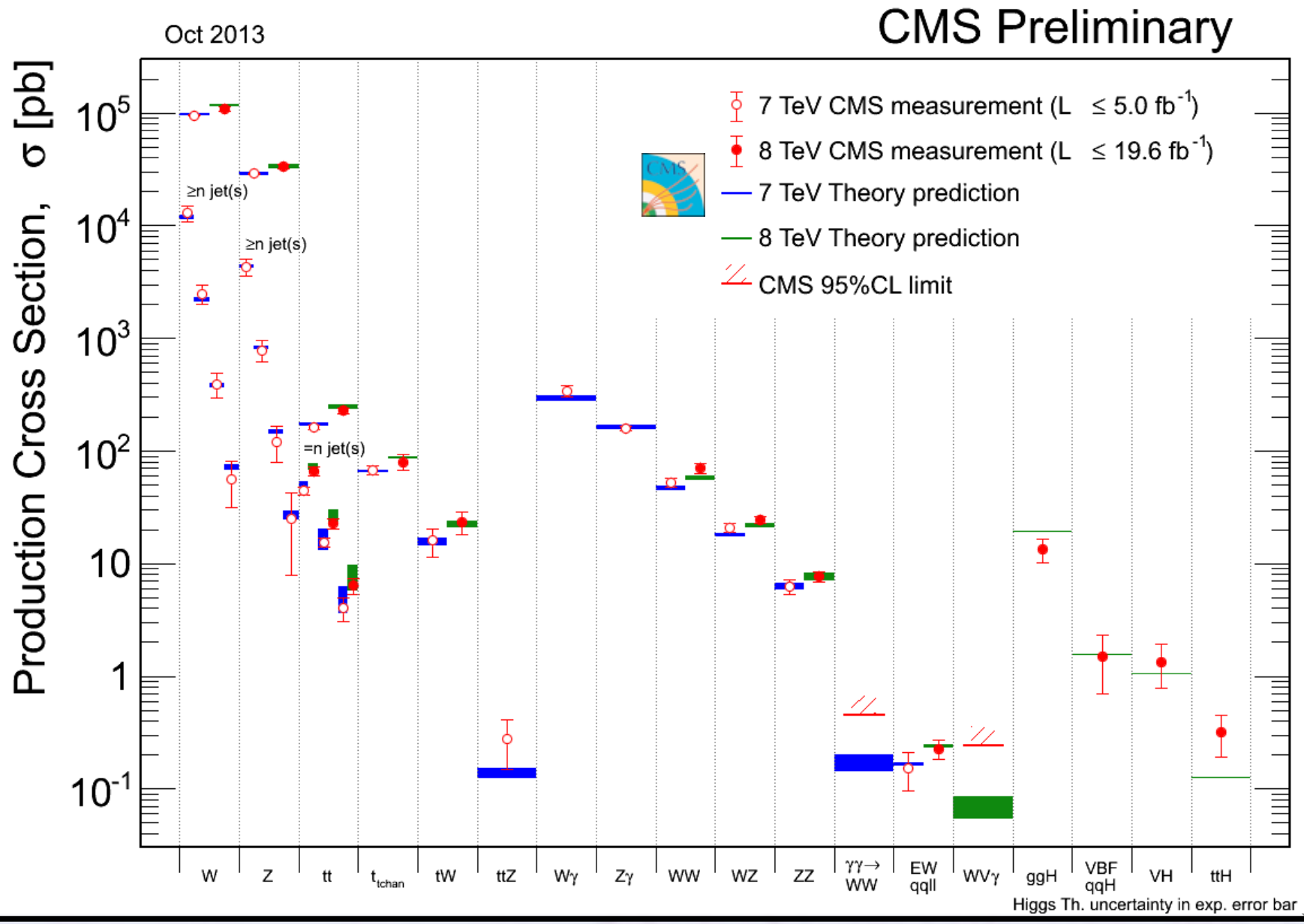
Striking similarities!

Electroweak

Standard Model Cross Sections



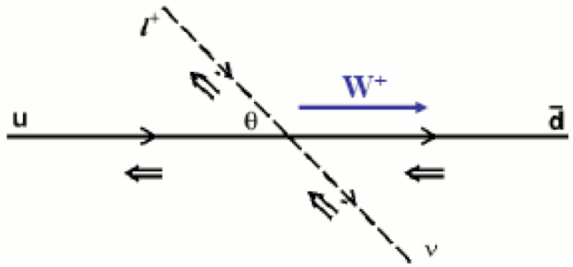
Standard Model Cross Sections

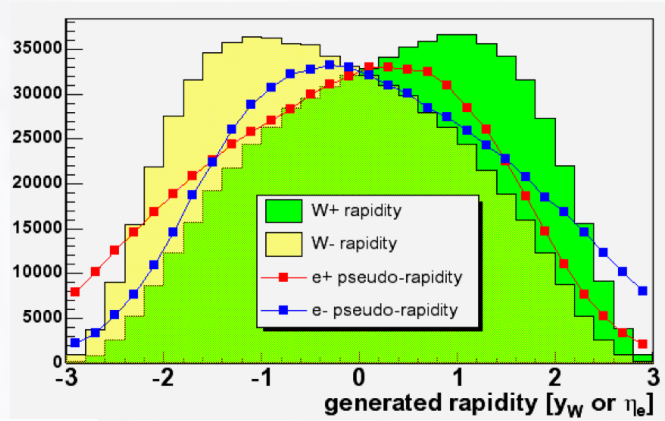


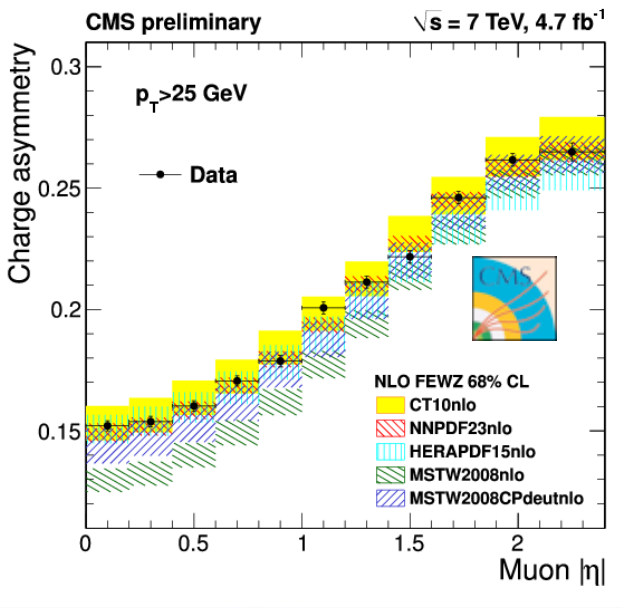
W Charge Asymmetry

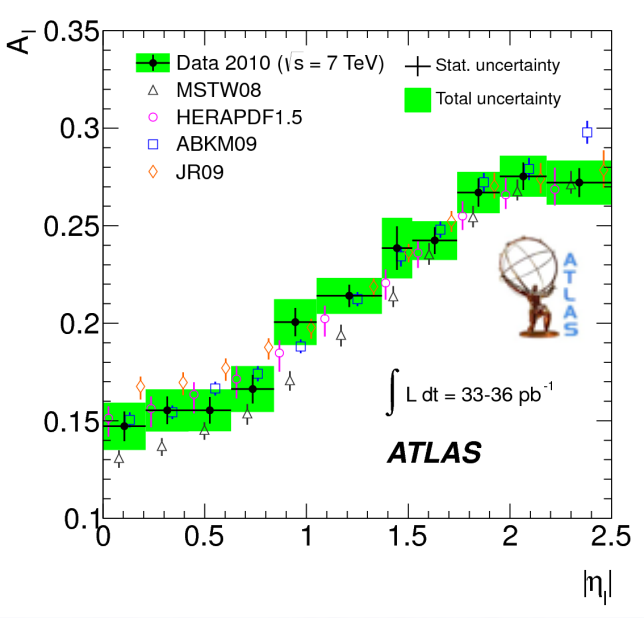
- Tevatron: W mostly produced by valence quark
  - W+ preferentially boosted in proton direction
- Also critical at LHC (p-p)
  - Asym. in valence uud
  - Probes PDFs

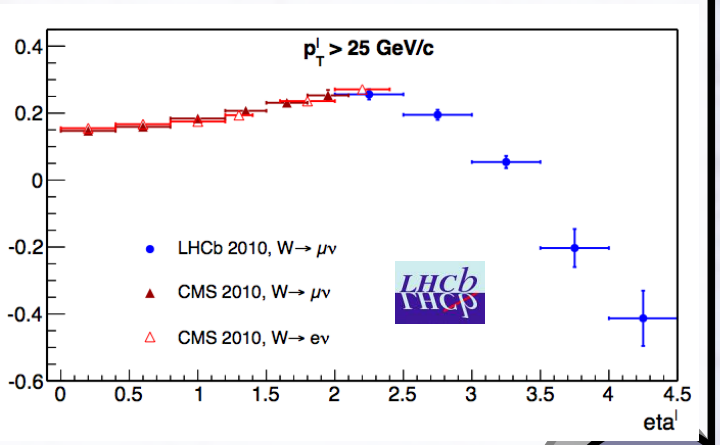
$$A_{FB} = \frac{\sigma_F - \sigma_B}{\sigma_F + \sigma_B}$$





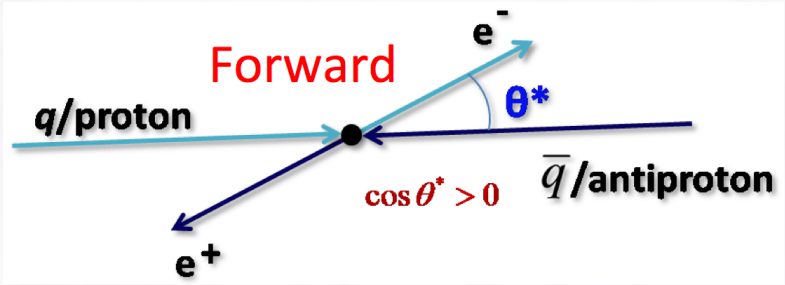


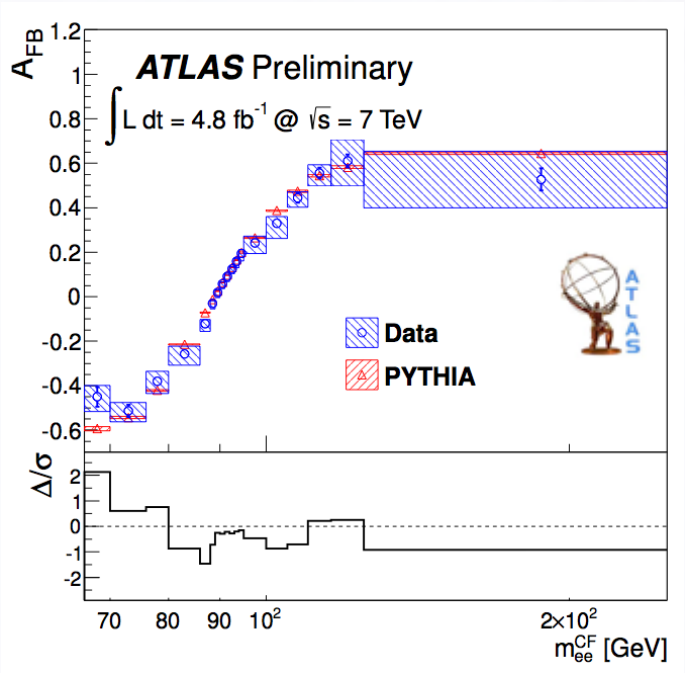


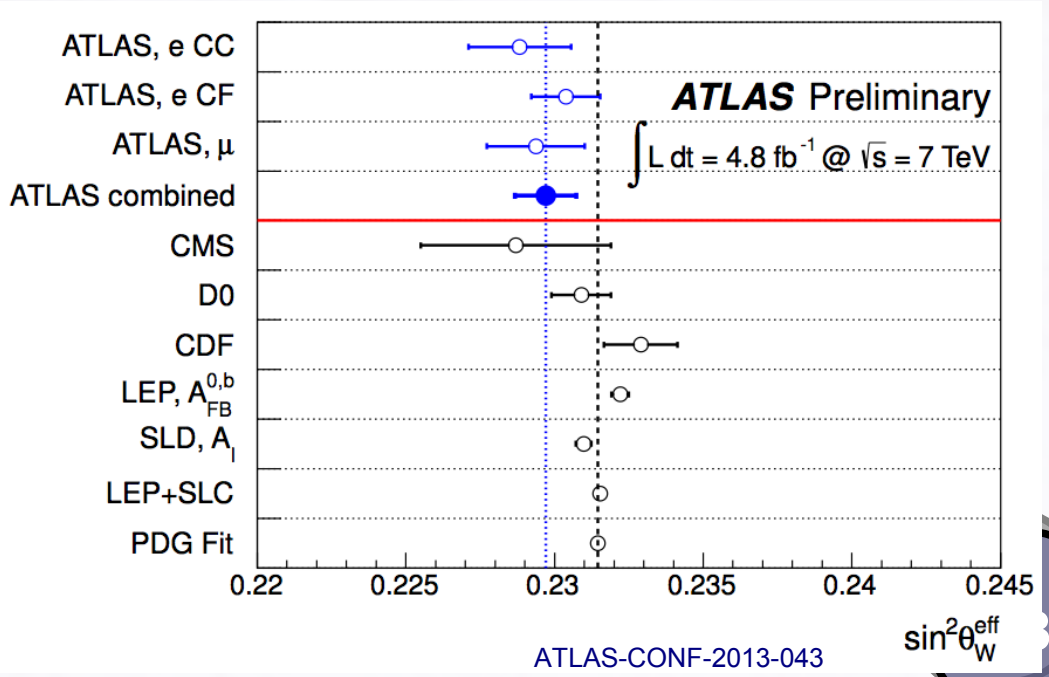


$\sin^2\theta_{eff}$

- The process $q\bar{q} \rightarrow Z/\gamma^* \rightarrow e^+e^-$
  - γ-fermion: V $g_v^f = I_3^f - 2Q_f \sin^2\theta_W$
  - Z-fermion: V+A $g_a^f = I_3^f$
- Forward-backward asymmetry
  - CMS first measurement at LHC PRD 84 112002 (2011), PLB 718 752 (2013)
  - Atlas using both central and forward electrons
  - Syst. uncertainties: data & MC stat., PDF also dominates





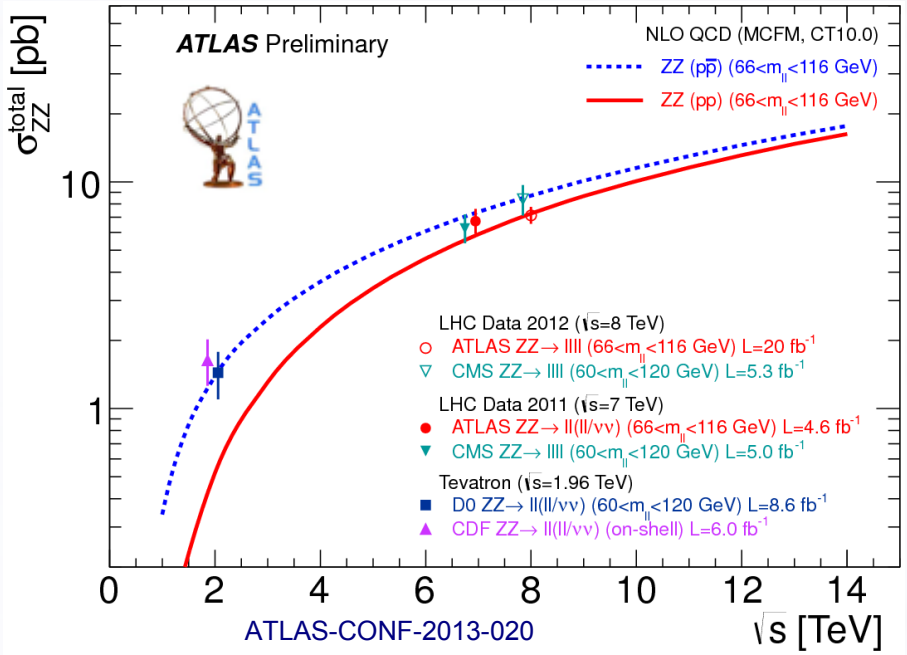


ATLAS-CONF-2013-043

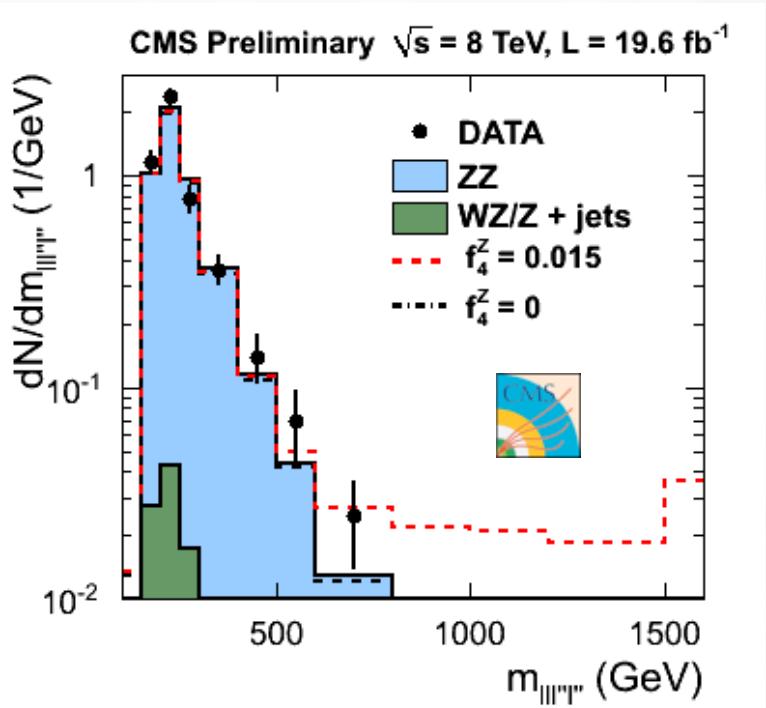
Diboson Production

- ZZ production as example
  - Forbidden at **tree level** in SM
  - One loop level: $O(10^{-4})$
  - In various **SM extension**: up to $O(10^{-3})$
- CMS preliminary

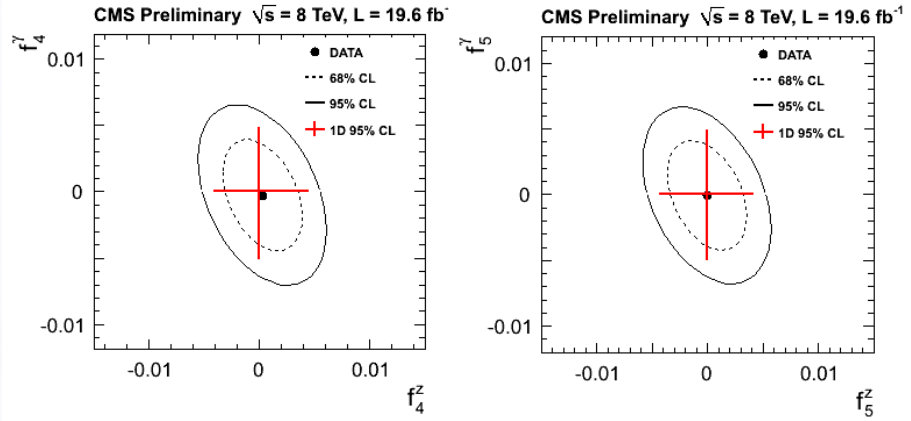
  $\sigma(ZZ)=7.7\pm0.5(stat.)\pm0.5(syst.)$
  $\pm0.4(theo.)\pm0.3(lumi.)$ pb
  - Agree with MCFM prediction



ATLAS-CONF-2013-020



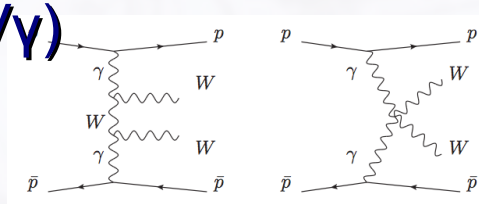
Kinematic distribution for limits on aTGC



CMS-PAS-SMP-13-005

Quartic Gauge Coupling

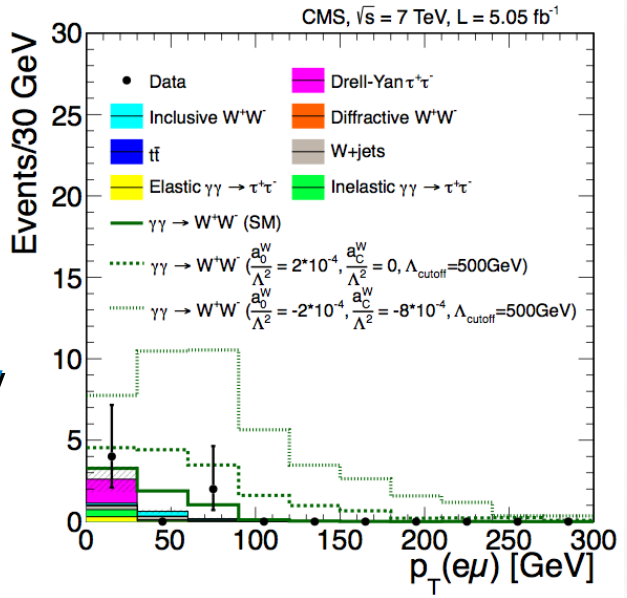
- QGC probed with two processes
  - Photon-initiated processes ($pp \rightarrow \gamma\gamma \rightarrow WW$)
  - Triple boson production ($WV\gamma$)

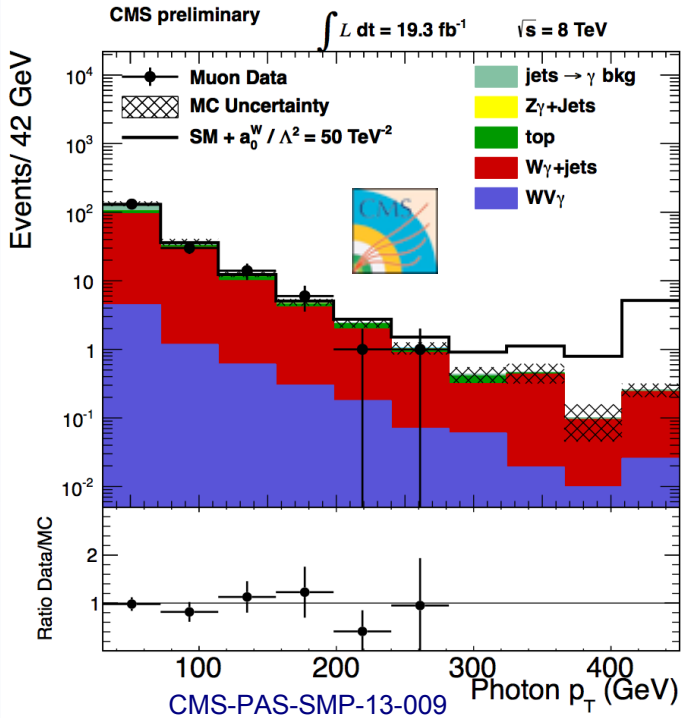


- Measurements

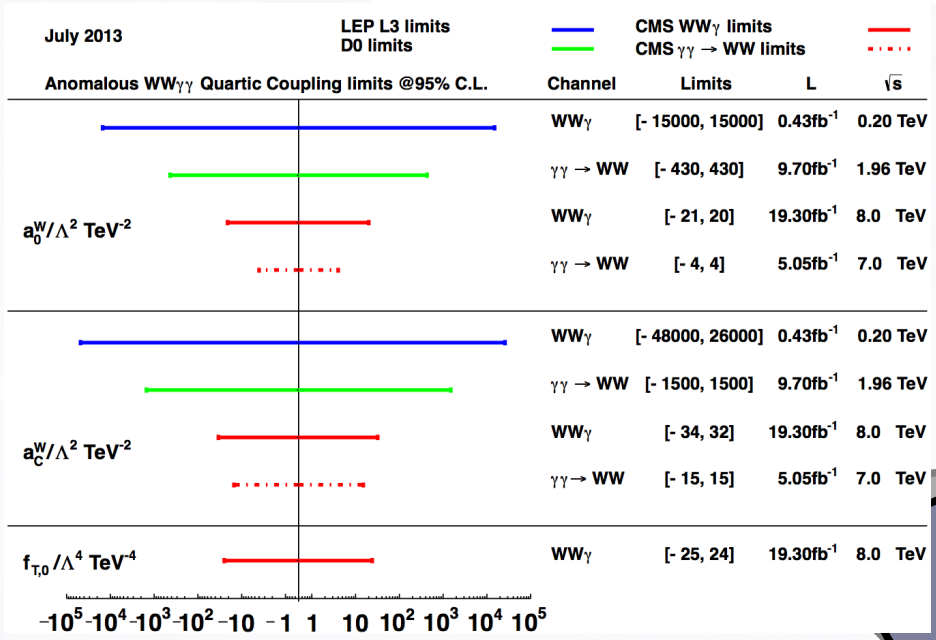
$\sigma(\gamma\gamma \rightarrow WW) < 10.6$ fb – close to SM sensitivity

$\sigma(\gamma\gamma \rightarrow WW) = 2.2\ ^{+3.3}_{-2.0}$ fb – 1σ sig.





CMS-PAS-SMP-13-009



TOP

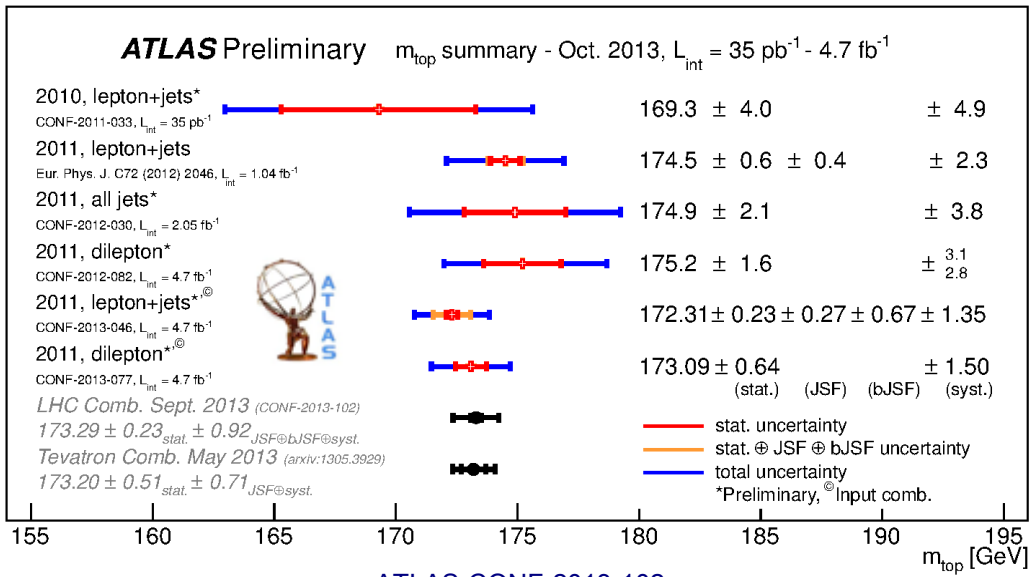
Top Mass

- Top mass measurements
  - Need for **precision** for EWK constraints with Higgs and m_W
  - Mass of a free, non-confined particle
    - Scheme-dependence
    - Non-perturbative effects of order Λ_{QCD}
    - Hadronization effects (Atlas)

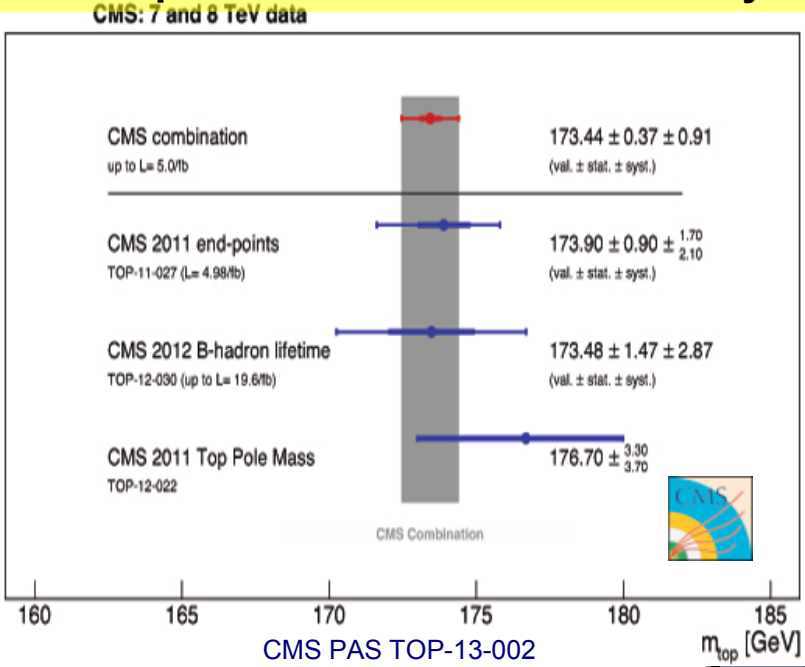
See Eike's talk

Atlas: $m_{top}=172.65\pm0.31_{stat}\pm1.40_{syst}$

CMS: $m_{top}=173.44\pm0.37_{stat}\pm0.91_{syst}$



ATLAS-CONF-2013-102

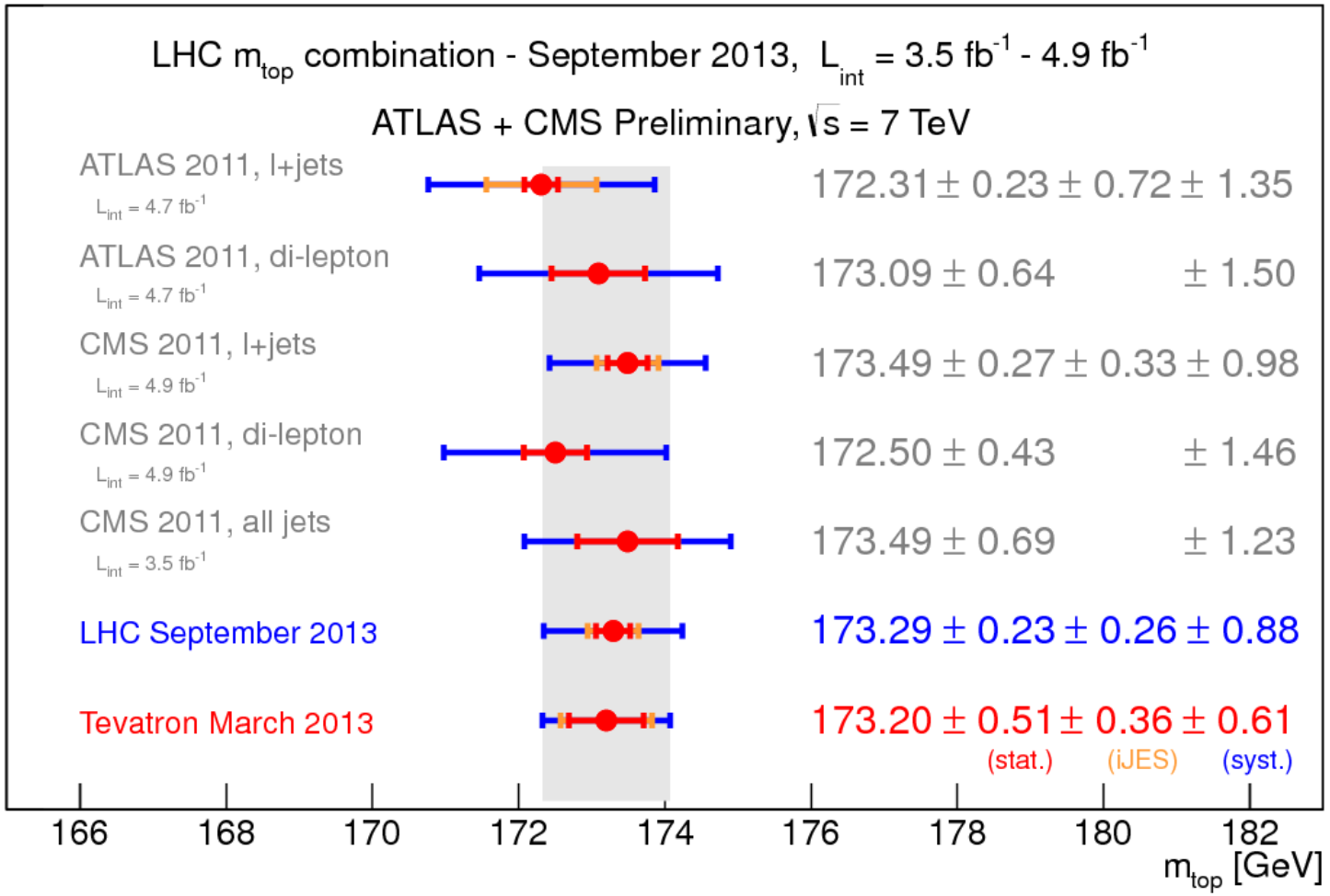


CMS PAS TOP-13-002

Top Mass (cont.)

m_t = 173.20±0.51(stat.)±0.36(JES)±0.61(syst.) GeV

in situ calibration using the W mass constraint



See Eike's talk

Top Mass (cont.)

- Top mass from decay length
  - Using life-time based technique

    $L_{xy} = \gamma_b \beta_B \tau_B \sim 0.4 \cdot m_t / m_B \beta_B \tau_B$
  - First done in CDF

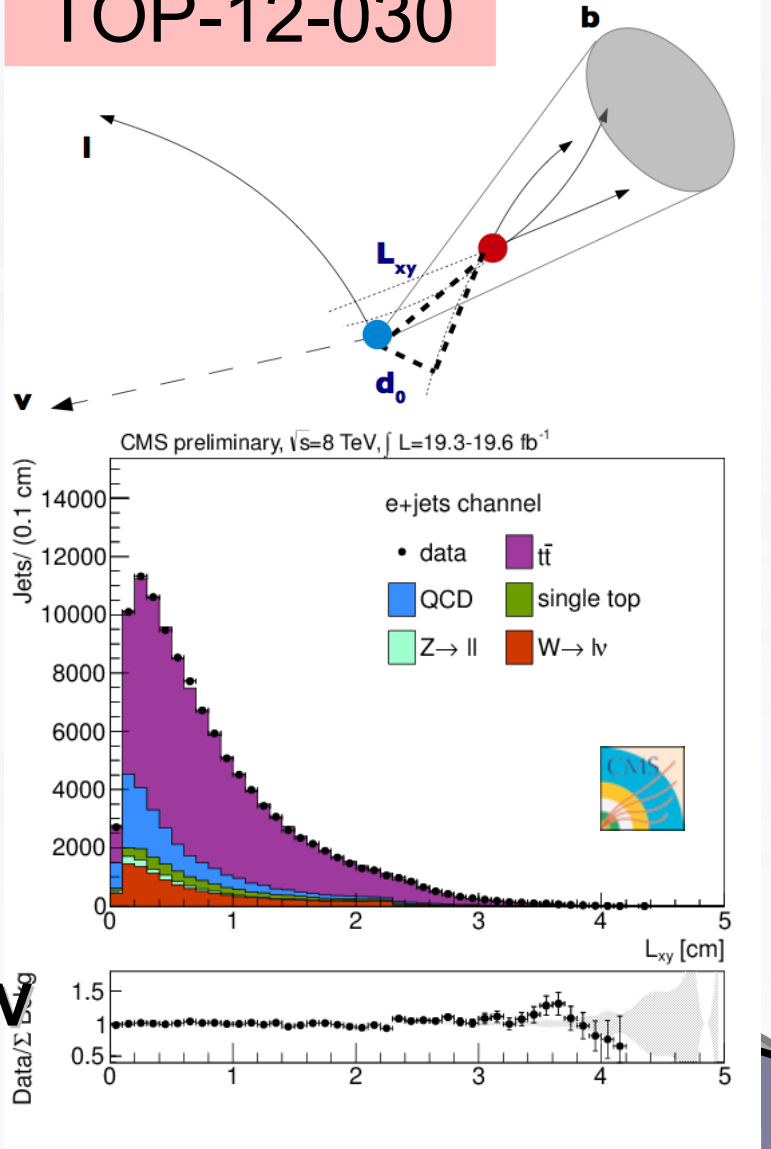
    Phys. Rev. D75, 071102 (2007)
  - Linear mass dept.

    $\Delta L_{xy} / \text{GeV} = 25 - 30 \, \mu m$
- Complementary systematics to traditional measurements (JES)
- Select secondary vertex with largest L_{xy}
- Median L_{xy} is used to extract m_t

m_t = 173.5±1.5(stat.)±1.3(syst.)±2.6($p_T(t)$) GeV

Top quark p_T re-weighting

TOP-12-030



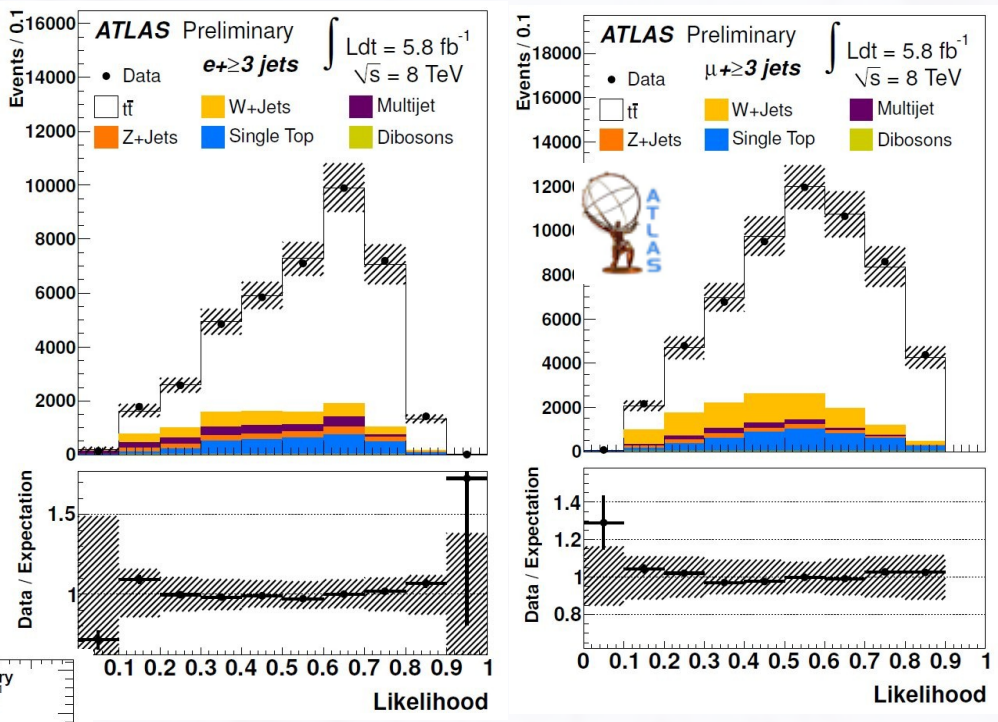
$t\bar{t}$ Cross Section in Atlas

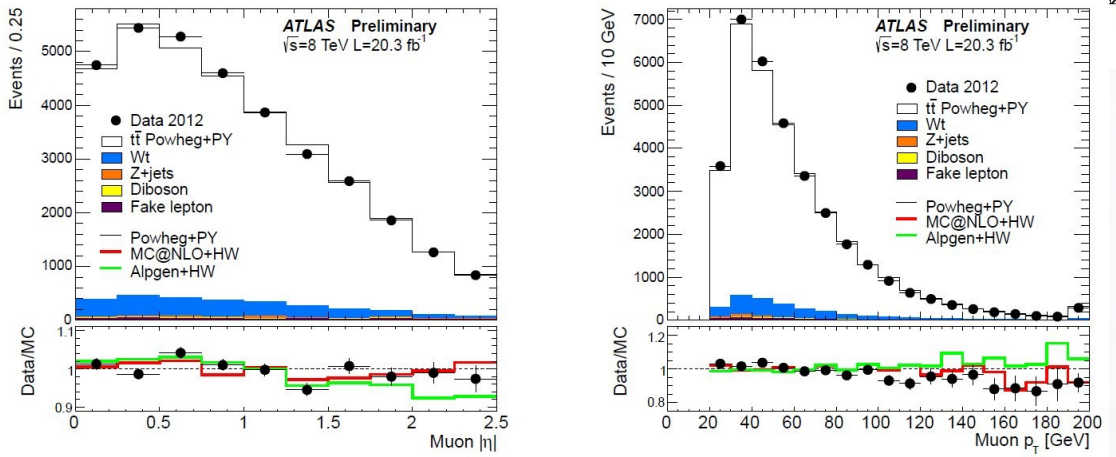
- Di-lepton + jets $t\bar{t}$ events
  - Simultaneous fit on x-sec. and b-taging

$\sigma = 237 \pm 1.7(\text{stat})$
$\pm 7.4(\text{syst}) \pm 4.0(\text{lumi})$ pb

- Lepton + jets $t\bar{t}$ events
  - Kinematic fits with b-taging

$\sigma = 241 \pm 2(\text{stat})$
$\pm 31(\text{syst}) \pm 9(\text{lumi})$ pb





Source	$e+ \geq 3$ jets	$\mu+ \geq 3$ jets	combined
Jet/MET reconstruction, calibration	6.7, -6.3	5.4, -4.6	5.9, -5.2
Lepton trigger, identification and reconstruction	2.4, -2.7	4.7, -4.2	2.7, -2.8
Background normalization and composition	1.9, -2.2	1.6, -1.5	1.8, -1.9
b-tagging efficiency	1.7, -1.3	1.9, -1.1	1.8, -1.2
MC modelling of the signal	±12	±11	±11
Total	±14	±13	±13

- Agree with QCD at NNLO+NNLL $\sigma = 252 \pm 14.5$ pb

$t\bar{t}$ Cross Section in CMS

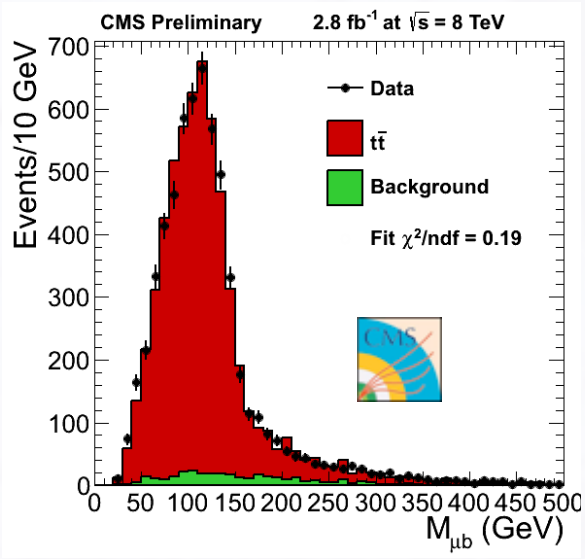
- Di-lepton + jets
  - Luminosity up to **2.4 /fb at 8 TeV**

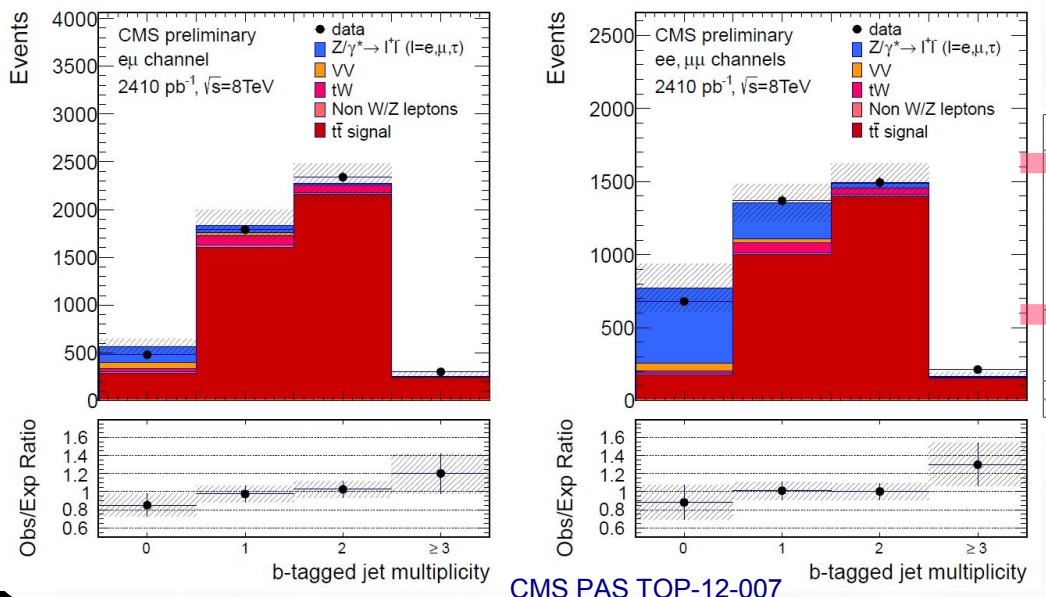
    $\sigma = 227 \pm 3(stat) \pm 11(syst) \pm 10(lumi)$ pb
- Lepton + jets $t\bar{t}$ events
  - Luminosity up to **2.8 /fb at 8 TeV**

    $\sigma = 228.4 \pm 9(stat) \pm 29(syst) \pm 10(lumi)$ pb
- Agree with QCD prediction up to

  Next-to-Next Leading Order

  $\sigma = 245.8 \pm 8.4(scale) \pm 6.4(pdf)$ pb

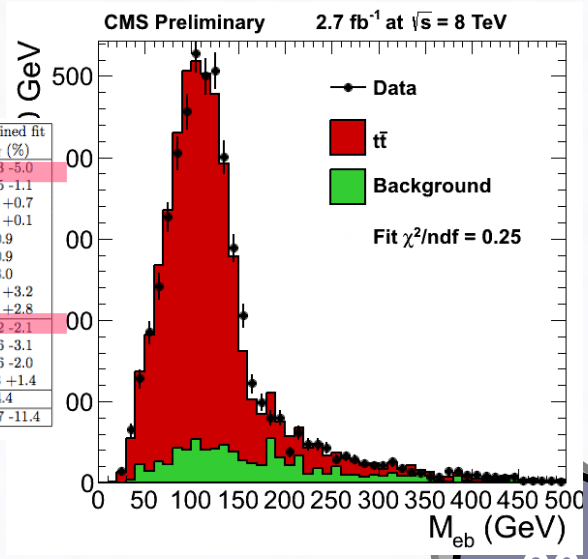




CMS PAS TOP-12-007

Systematic	Combined fit $\delta\sigma_{t\bar{t}}$ (%)
Jet Energy Scale	+4.3 -5.0
Jet Energy Resolution	+0.5 -1.1
Pileup	-0.7 +0.7
Background Composition	-0.1 +0.1
W+Jets template shape from unweighted 7TeV	0.9
Normalisation of data-driven multijet shape	0.9
b tagging efficiency measurement	8.0
Trigger Efficiency	-2.8 +3.2
Lepton selection	-2.4 +2.8
Factorization scale (*)	+6.2 -2.1
ME-PS Matching threshold (*)	+4.6 -3.1
PDF uncertainties (*)	+1.6 -2.0
Top Quark Mass (*)	+0.3 +1.4
Luminosity	4.4
Total	+12.7 -11.4

See Silvia's talk



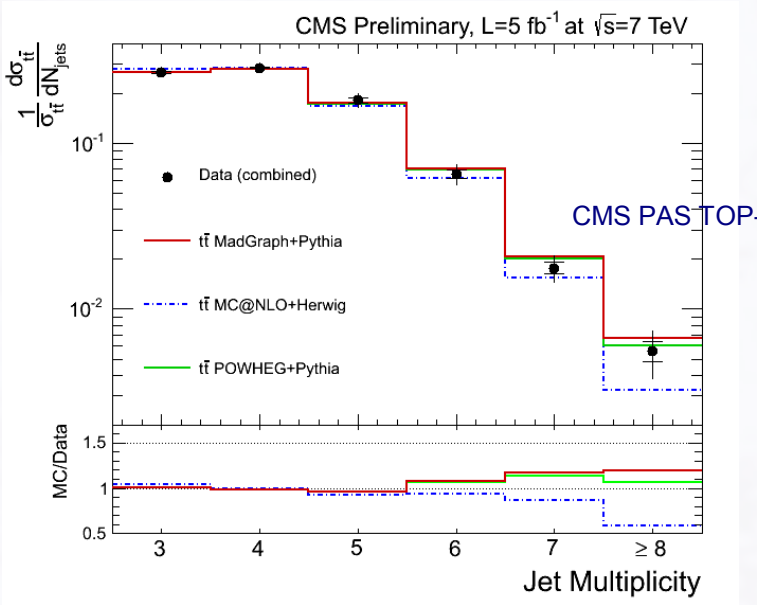
CMS PAS TOP-12-006

$t\bar{t}$ Cross Section in CMS (cont.)

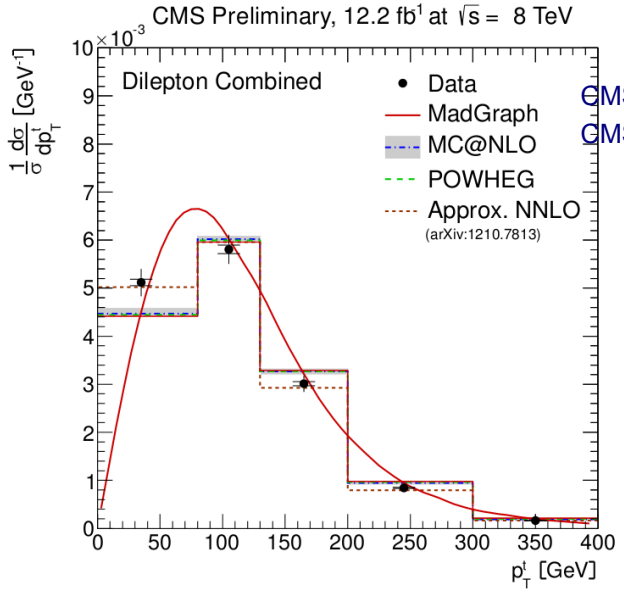
- Jet multiplicity in $t\bar{t}$ events
  - Results with **5/fb at 7 TeV**
  - Di-lepton and lepton + jets
  - Kinematics of additional jets

- Evidence of softness on top p_T
  - **Data/MC** decreasing vs. p_T seen
  - Same tendency at 7 & 8 TeV, across **hadronic & leptonic** ch.

  → pT reweighting



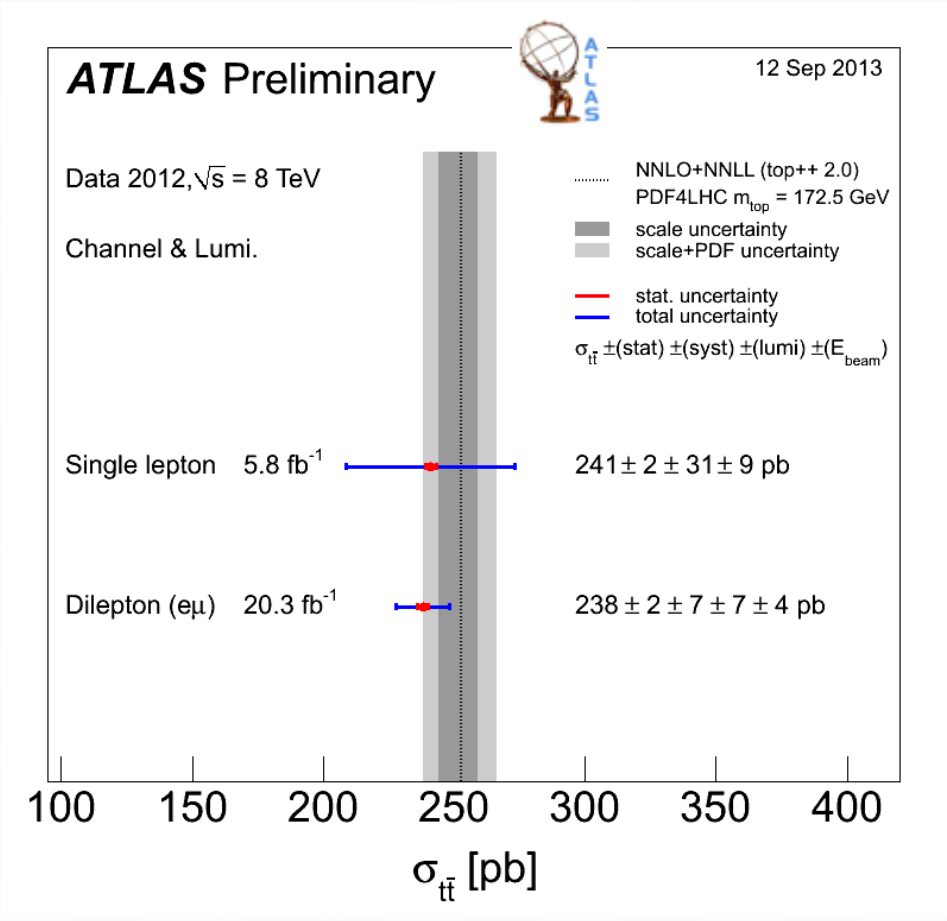
CMS PAS TOP-12-018

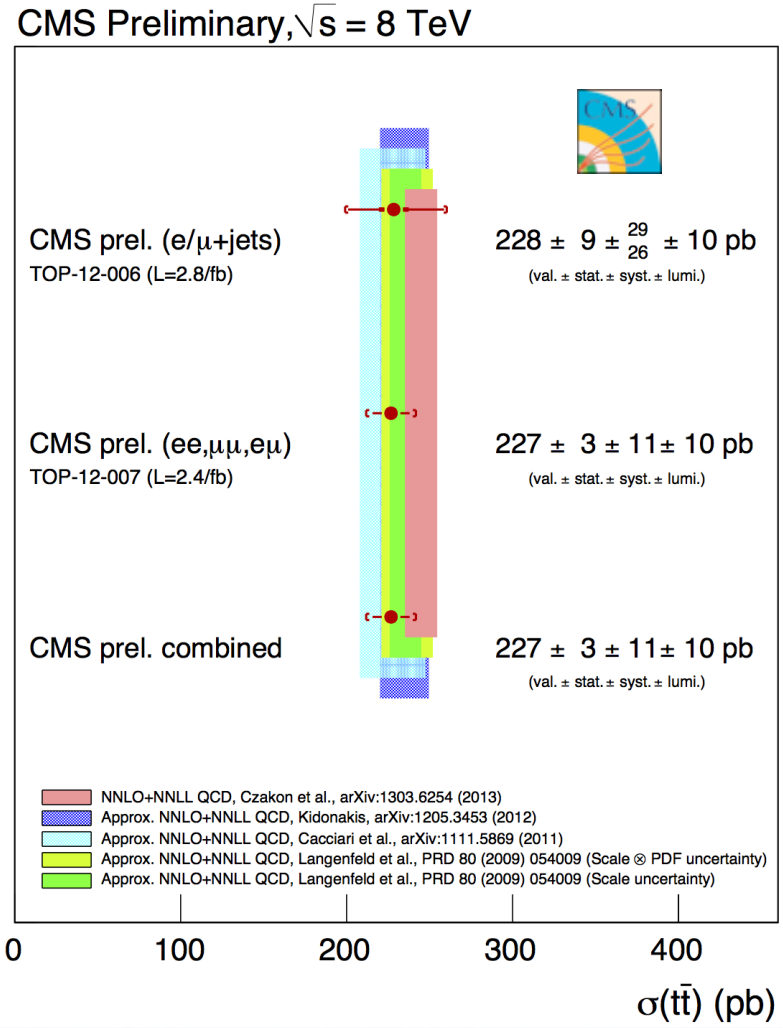


CMS PAS TOP-12-027
CMS PAS TOP-12-028

Cross Section Summary

- To further reduce the uncertainties by combination
  - Major contribution: JES & MC modeling





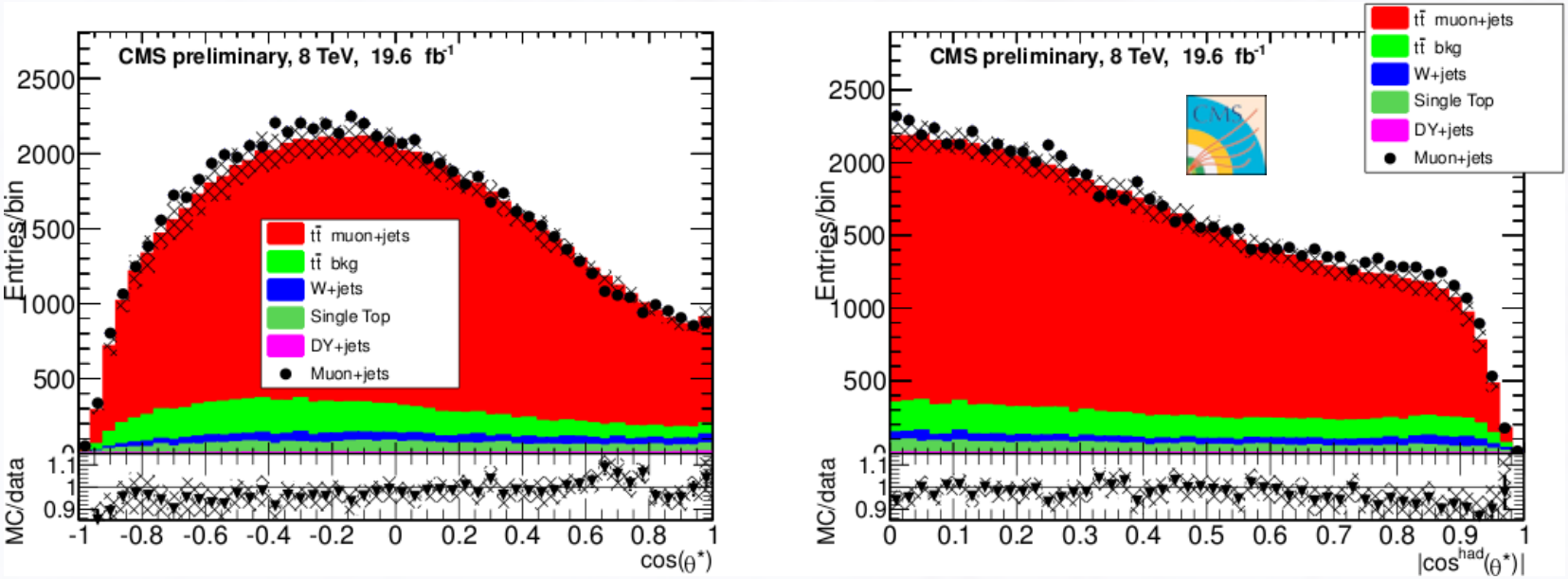
Top Properties – W helicity

- W helicity in top pair events
  - Results of 7 TeV has recently published in JHEP
  - 8 TeV results as CMS PAS TOP-13-008
    → with better precision
  - Agree with SM predictions

JHEP 10 (2013) 167

$$\mathcal{L}(\vec{F}) = \prod_{bin\ i} \frac{N_{\mathrm{MC}}(i;\vec{F})\ N_{\mathrm{data}}(i)}{(N_{\mathrm{data}}(i))!}\ \exp\left(-N_{\mathrm{MC}}(i;\vec{F})\right),$$

Fit to cosθ*



CMS PAS TOP-13-008

F_0=0.659±0.015(stat)±0.023(syst)

F_L=0.350±0.010(stat)±0.024(syst)

F_R=−0.009±0.006(stat)±0.020(syst)

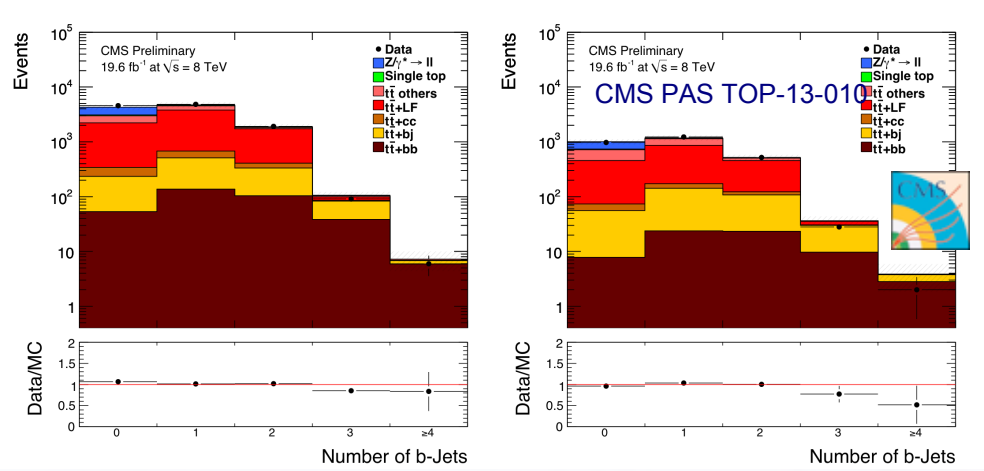
See Oliver's talk

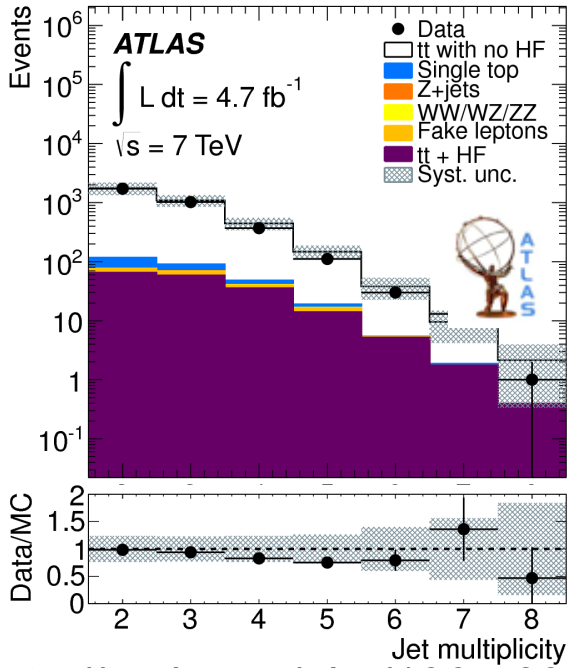
$t\bar{t}$ + bb Cross Section

- First measurement of $t\bar{t}bb$ cross section (bkg. of $t\bar{t}H$)
  - Use **full 2012 data** at 8 TeV on dilepton events in CMS
  - Fit to the CSVT b-tagging output on event >= 4 jets
  - Cross section ratio **corrected** to particle level
  - Results of different min. pT on extra jets given:

    $\sigma(ttbb)/\sigma(tt\,jj) = 2.3 \pm 0.3(stat.) \pm 0.5(syst.)\%$ for min. 20 GeV

    $\sigma(ttbb)/\sigma(tt\,jj) = 2.2 \pm 0.4(stat.) \pm 0.5(syst.)\%$ for min. 40 GeV





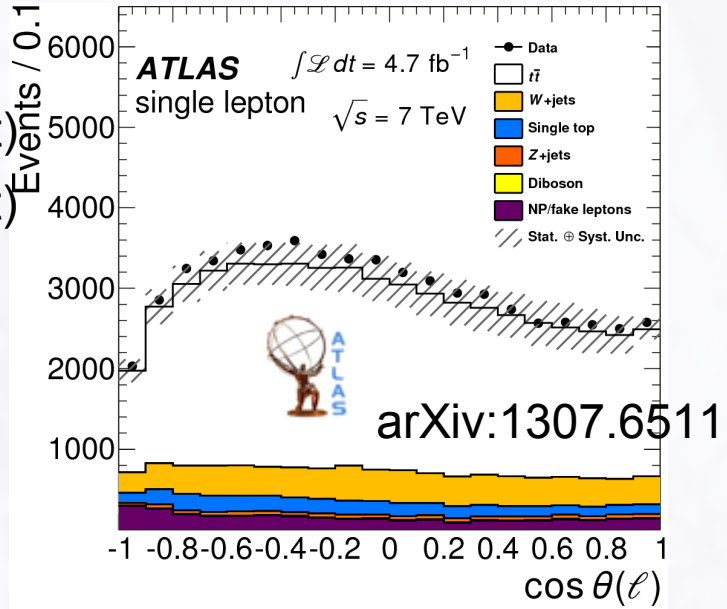
- Atlas on associated **heavy flavor** jets
  - Di-lepton events of **4.7/fb at 7 TeV**
  - $R_{HF} = [7.1 \pm 1.3(stat.)^{+5.3}_{-2.0}\,(syst.)]\ \%$

    vs. **LO QCD** standard model: [3.4±1.1] %

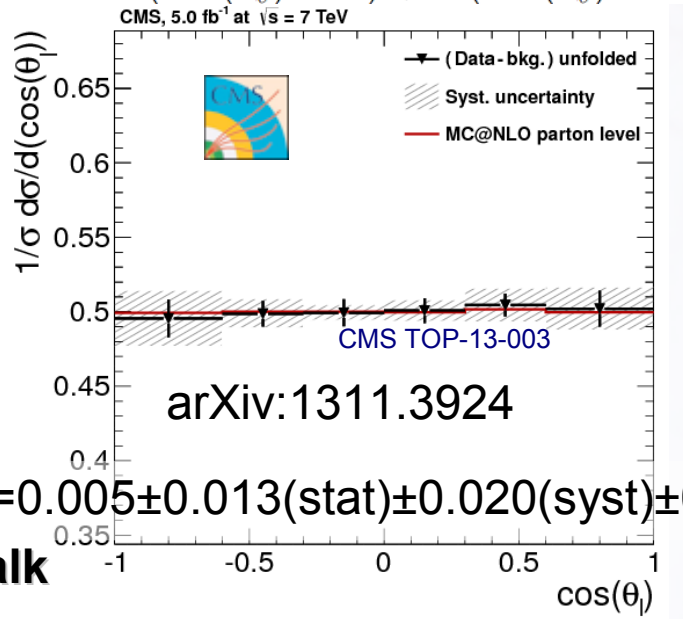
http://arxiv.org/abs/1304.6386

Top-quark Polarization

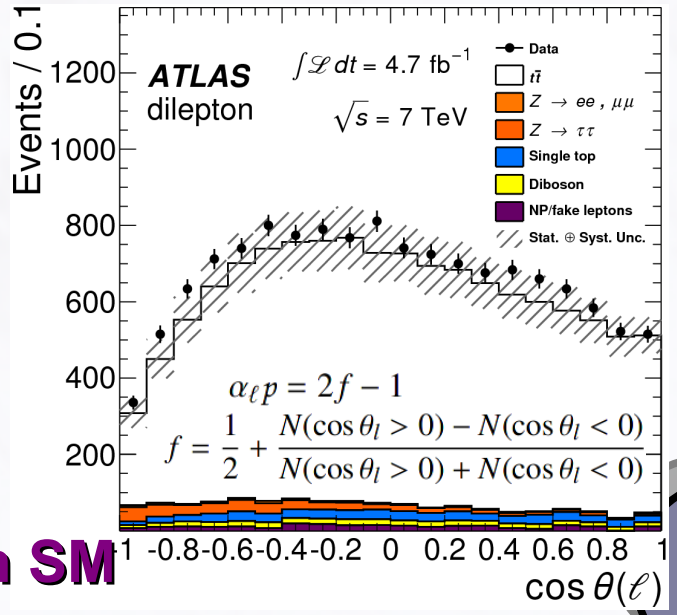
- Atlas at 7 TeV with **template fit**
  - $CP_{conserving}$ $\alpha_l P = -0.035 \pm 0.014(stat) \pm 0.037(syst)$
  - $CP_{violating}$ $\alpha_l P = 0.020 \pm 0.016(stat)^{+0.013}_{-0.017}(syst)$
- CMS preliminary result
  - **Background subtracted, unfolded to parton level** (singular value decomposition)
  - Dilepton with 5/fb at 7 TeV



$$A_P = \frac{N(\cos(\theta_\ell) > 0) - N(\cos(\theta_\ell) < 0)}{N(\cos(\theta_\ell) > 0) + N(\cos(\theta_\ell) < 0)}$$



$A_P = 0.005 \pm 0.013(stat) \pm 0.020(syst) \pm 0.008(pt)$

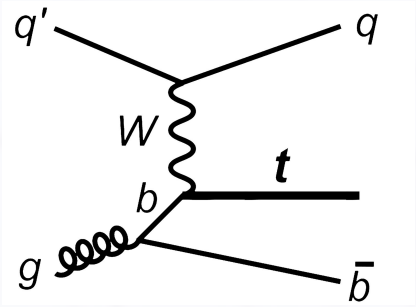


See Oliver's talk

Agree with SM

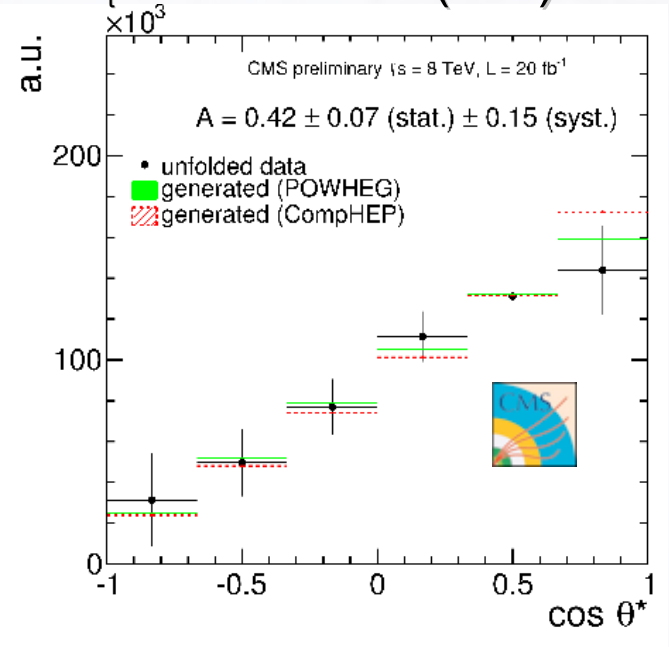
Single Top – Polarization in t-ch.

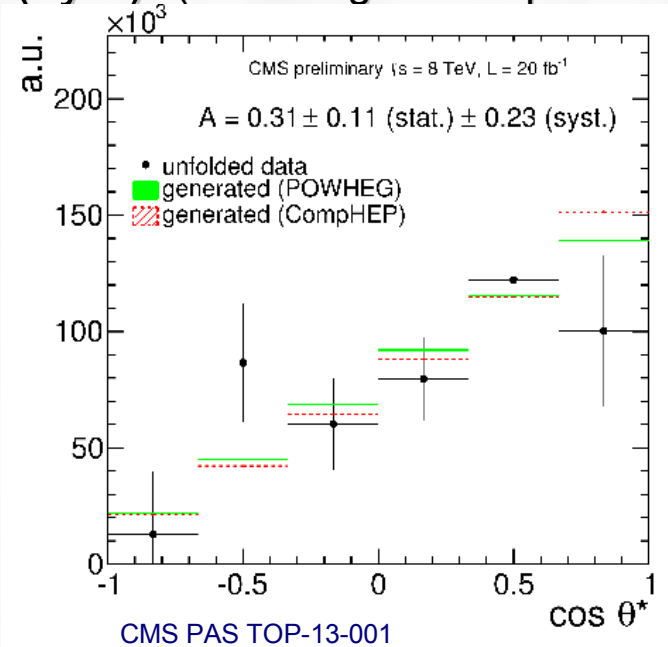
- Top quark polarization in t-channel
  - Using 20/fb data at 8 TeV
  - High purity t-channel event selected
  - Combine e, μ ch. with BLUE technique
  - Unfolded to parton-level distribution
  - First measurement excluding negative or null polarization



A_l = 0.41+-0.06(stat)+-0.16(syst)

P_t = 0.82+-0.12(stat)+-0.32(syst) (assuming 100% spin ana. power)





CMS PAS TOP-13-001

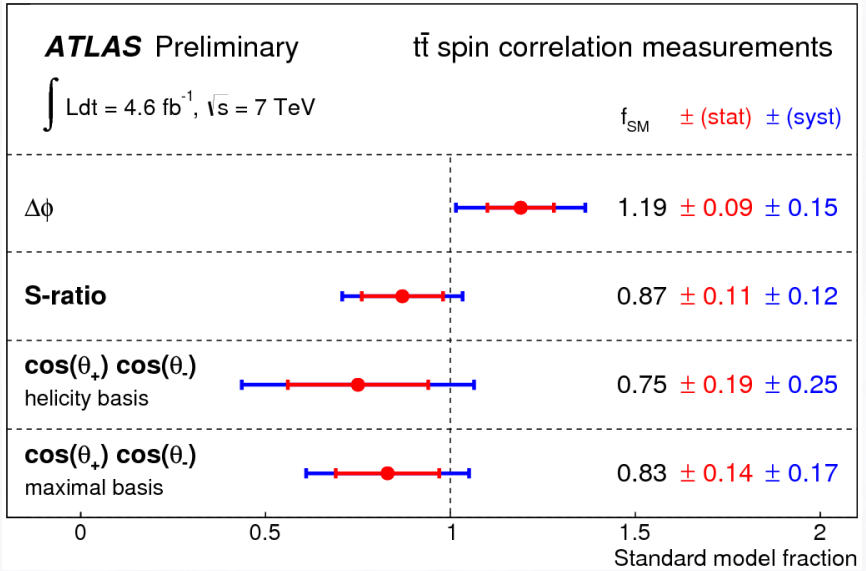
Top Spin Correlation

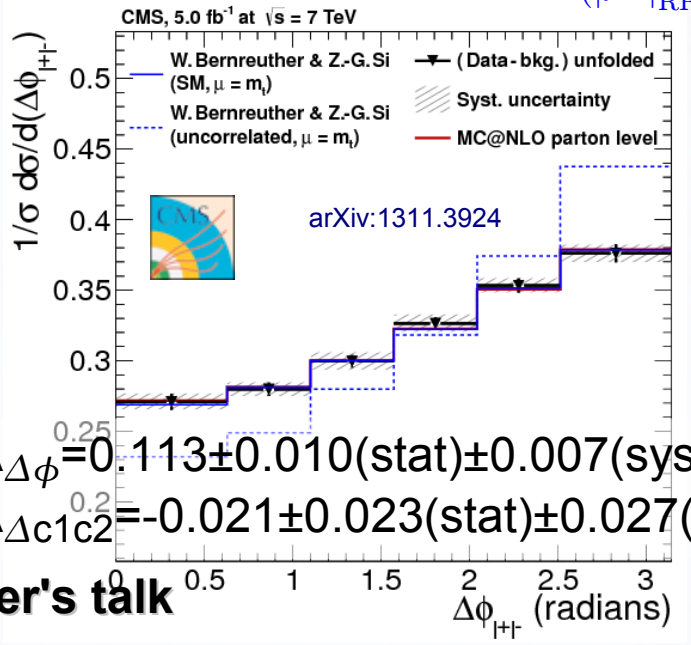
- CMS Preliminary
  - With 5.1/fb data at 7 TeV
  - Unfolded to parton level

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

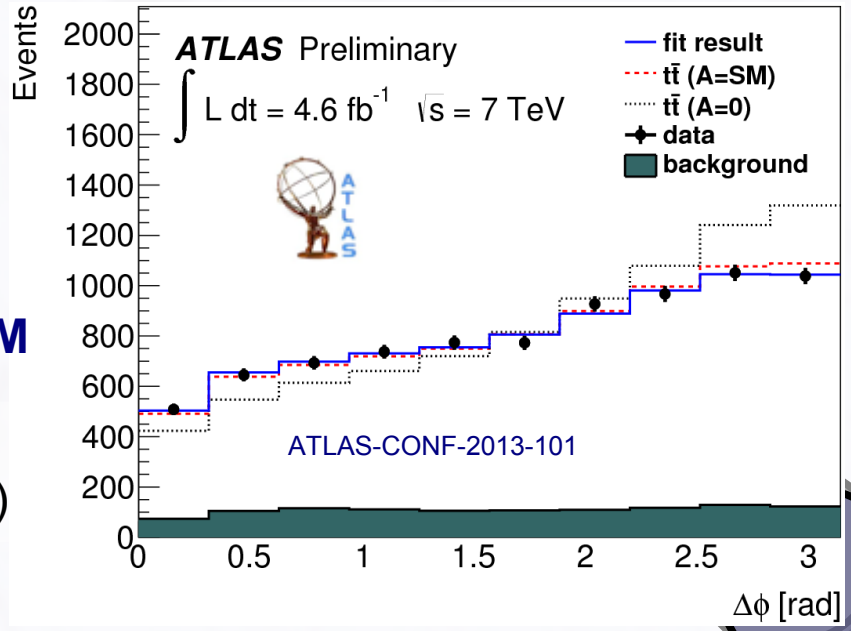
$$A_{c_1c_2} = \frac{N(c_1 \cdot c_2 > 0) - N(c_1 \cdot c_2 < 0)}{N(c_1 \cdot c_2 > 0) + N(c_1 \cdot c_2 < 0)}$$

- Atlas dilepton with 4.7/fb
  - New var. S-ratio: $\mathcal{S} = \frac{(|\mathcal{M}|^2_{RR} + |\mathcal{M}|^2_{LL})_{corr}}{(|\mathcal{M}|^2_{RR} + |\mathcal{M}|^2_{LL})_{uncorr}}$





Agree with SM



$A_{\Delta\phi}$=0.113±0.010(stat)±0.007(syst)±0.012(p_T)

$A_{\Delta c1c2}$=-0.021±0.023(stat)±0.027(syst)±0.010(p_T)

See Oliver's talk

Top FCNC Searches

- Search for top FCNC production and decays
  - Analyses at Atlas and CMS
  - Using trilepton channels

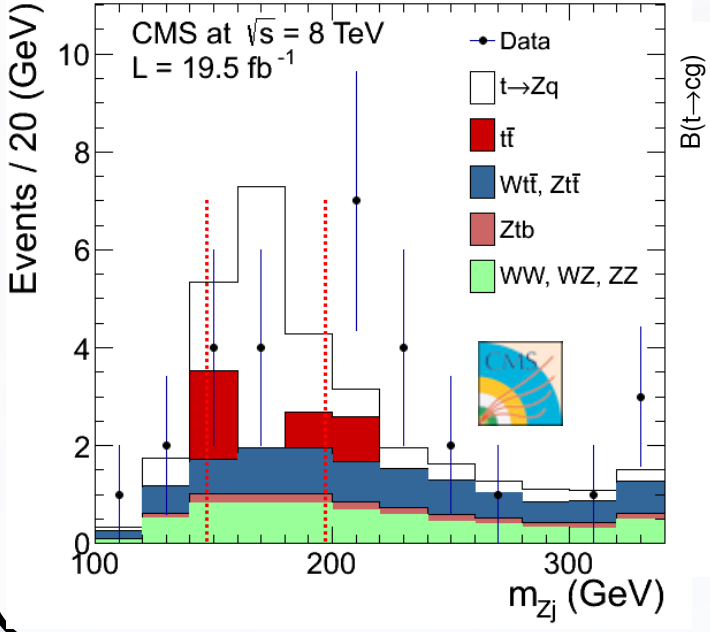
    $t\bar{t} \rightarrow Wb\ Zq \rightarrow bjl^+ l^- l'$
  - CMS: 8 TeV limits with 19.7/fb

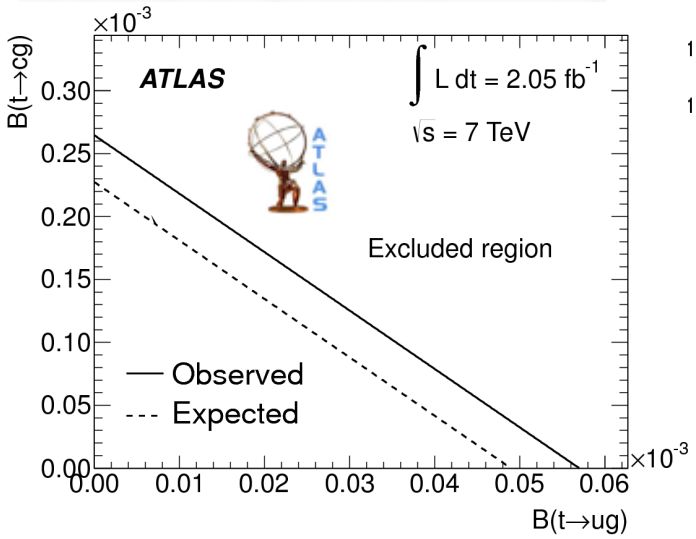
    => BR(t → Zq) < 0.07%
  - FCNC single top at **7TeV**
  - Using trilepton channels
  - Atlas with **2/fb**

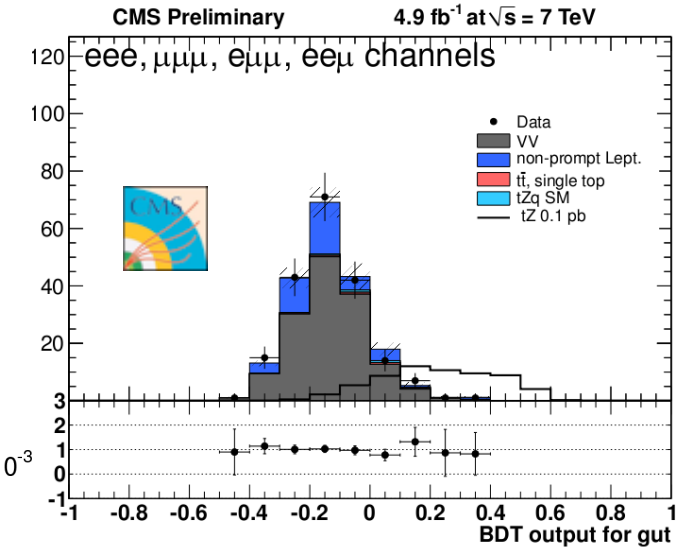
    => BR(t → Zq) < 0.73%
  - CMS with **5/fb**

    B(t→gu)≤0.56%, B(t→gc)≤7.12%,
    B(t→Zu)≤0.51%, B(t→Zc)≤11.40%

See Oliver's talk





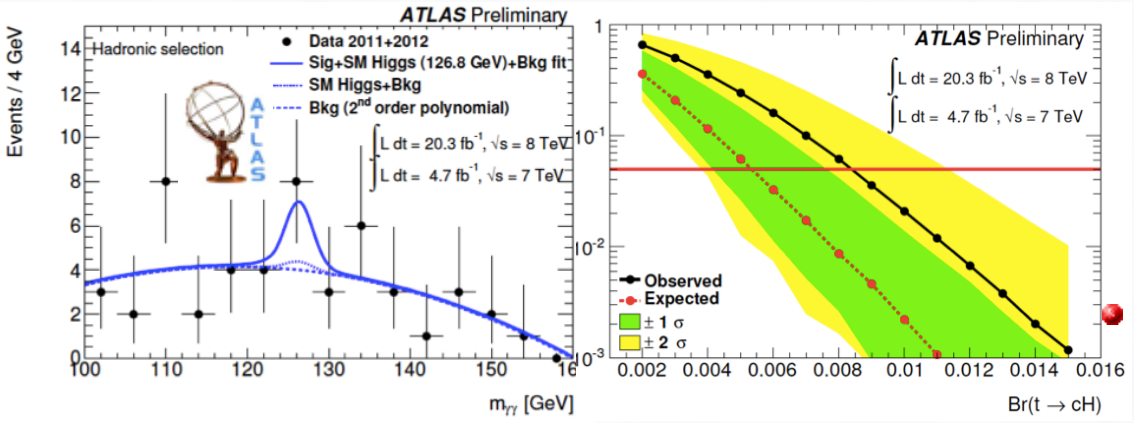


Top FCNH Searches

- Flavor changing neutral higgs decays
  - Highly suppressed in SM $O(10^{-15})$
  - Could be enhanced ex. 2HDM, MSSM... as high as $O(10^{-3})$ ACTA Phys. Pol. B 35 (2004)

	SM	QS	2HDM	FC 2HDM	MSSM	$\not R$ SUSY
$t \to uZ$	8×10^{-17}	1.1×10^{-4}	–	–	2×10^{-6}	3×10^{-5}
$t \to u\gamma$	3.7×10^{-16}	7.5×10^{-9}	–	–	2×10^{-6}	1×10^{-6}
$t \to ug$	3.7×10^{-14}	1.5×10^{-7}	–	–	8×10^{-5}	2×10^{-4}
$t \to uH$	2×10^{-17}	4.1×10^{-5}	5.5×10^{-6}	–	10^{-5}	$\sim 10^{-6}$
$t \to cZ$	1×10^{-14}	1.1×10^{-4}	$\sim 10^{-7}$	$\sim 10^{-10}$	2×10^{-6}	3×10^{-5}
$t \to c\gamma$	4.6×10^{-14}	7.5×10^{-9}	$\sim 10^{-6}$	$\sim 10^{-9}$	2×10^{-6}	1×10^{-6}
$t \to cg$	4.6×10^{-12}	1.5×10^{-7}	$\sim 10^{-4}$	$\sim 10^{-8}$	8×10^{-5}	2×10^{-4}
$t \to cH$	3×10^{-15}	4.1×10^{-5}	1.5×10^{-3}	$\sim 10^{-5}$	10^{-5}	$\sim 10^{-6}$

- Searches in Atlas with 5+20/fb at 7+8 TeV
  - One top in hadronic or leptonic
  - The other top → Higgs(γγ) ATLAS-CONF-2013-081



B(t→cH) < 0.83 % @ 95% CL for m_H=126.8 GeV

→ limit on the coupling: $\lambda_{tcH} = 1.91\sqrt{BR} < 0.17$

- Derive from CMS SUSY search:
  - Re-interpret inclusive multi-lepton search
  - 10 most sensitive channels: PAS-SUS-13-002

OSSF pair	$N_{\tau_{had}}$	E_T^{miss} [GeV]	H_T [GeV]	$N_{b\text{-jets}}$	data	background	signal
below Z	0	50–100	0–200	≥ 1	48	48 ± 23	9.5 ± 2.3
n/a	0	50–100	0–200	≥ 1	29	26 ± 13	5.9 ± 1.3
below Z	0	0–50	0–200	≥ 1	34	42 ± 11	5.9 ± 1.2
n/a	0	0–50	0–200	≥ 1	29	23 ± 10	4.3 ± 1.1
below Z	0	50–100	> 200	≥ 1	10	9.9 ± 3.7	3.0 ± 1.1
below Z	0	0–50	> 200	≥ 1	5	10 ± 2.5	2.8 ± 0.8
below Z	0	50–100	0–200	0	142	125 ± 27	9.7 ± 2.1
n/a	1	0–50	0–200	≥ 1	237	240 ± 113	13.1 ± 2.6
n/a	0	50–100	0–200	0	35	38 ± 15	4.3 ± 1.1
above Z	0	0–50	0–200	≥ 1	17	18 ± 6.7	2.8 ± 0.8

- All signal regions: 3 leptons, no OSSF or an OSSF pair off Z and a b-tag jet

Higgs Decay Mode		obs	exp	1σ range
$h \to WW^*$	(BR = 23.1 %)	1.58 %	1.57 %	(1.02–2.22) %
$h \to \tau\tau$	(BR = 6.15 %)	7.01 %	4.99 %	(3.53–7.74) %
$h \to ZZ^*$	(BR = 2.89 %)	5.31 %	4.11 %	(2.85–6.45) %
combined		1.28 %	1.17 %	(0.85–1.73) %

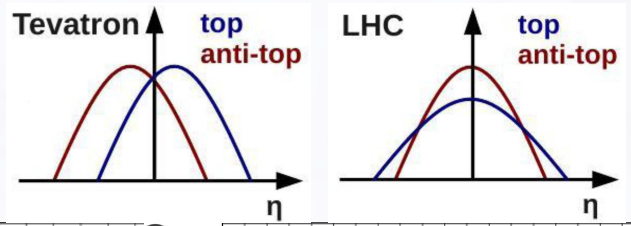
- Complement to H → γγ
  - Limit at 95% C.L. given:

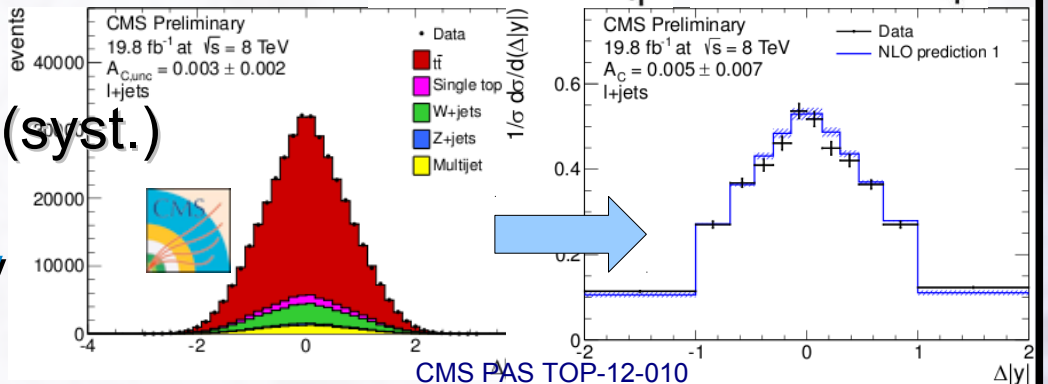
$$\mathcal{B}(t \to ch) < 1.28\%$$

$$\sqrt{|\lambda_{tc}^h|^2 + |\lambda_{ct}^h|^2} < 0.21$$

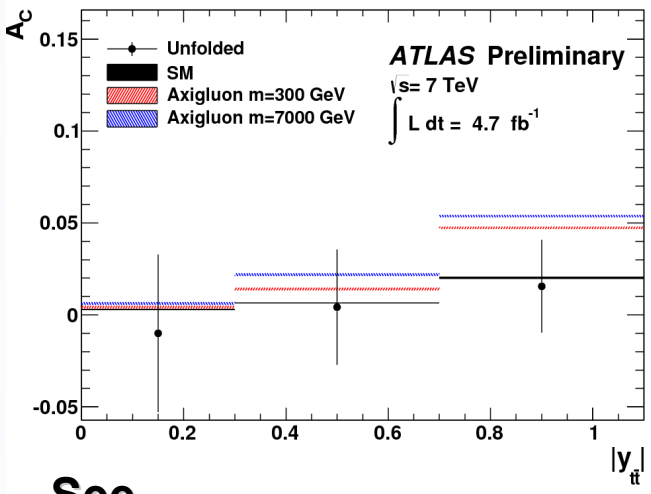
Top Charge Asymmetry

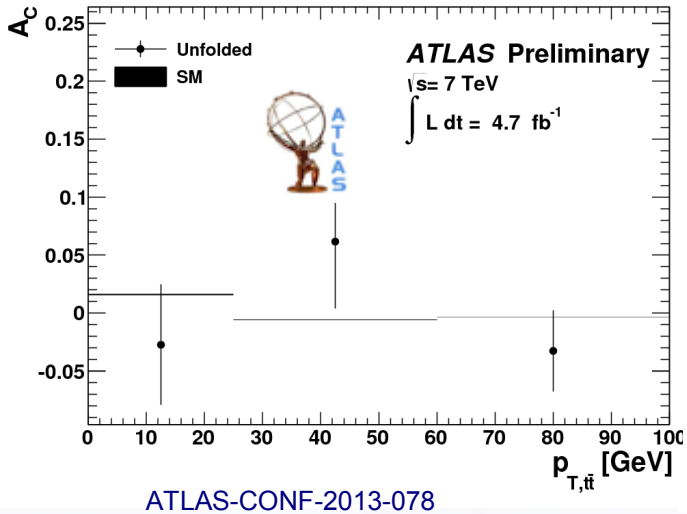
- Charged asymmetry in lepton + jet
  - An 8 TeV update of 7 TeV publication
  - Corrected to parton level
- Measured asymmetry:
  A_C=0.005 ± 0.007 (stat.) ± 0.006 (syst.)
  - No indication of BSM
- Also Atlas results at 7 TeV
  A_C=0.006 ± 0.010 (stat. + syst.)

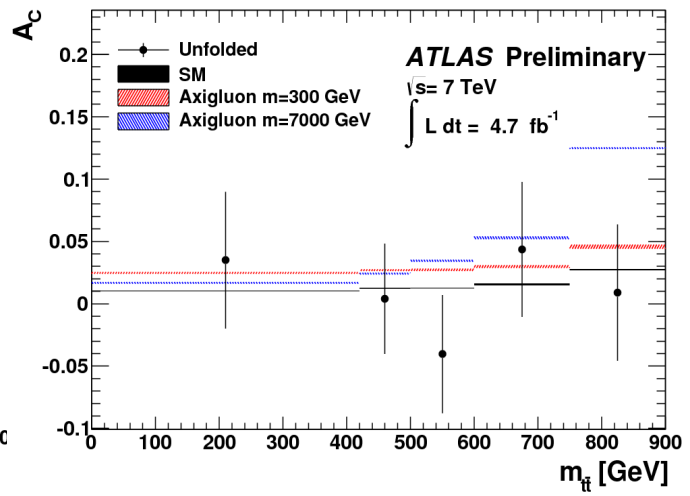




CMS PAS TOP-12-010
CMS PAS TOP-12-033







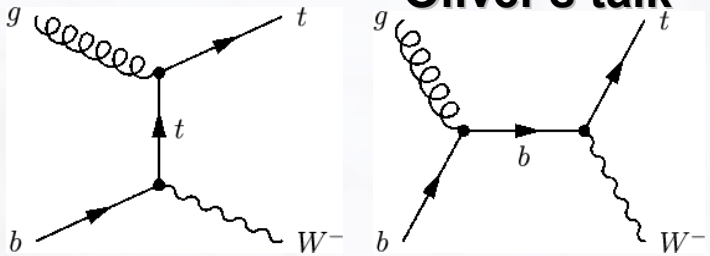
ATLAS-CONF-2013-078

See Oliver's talk

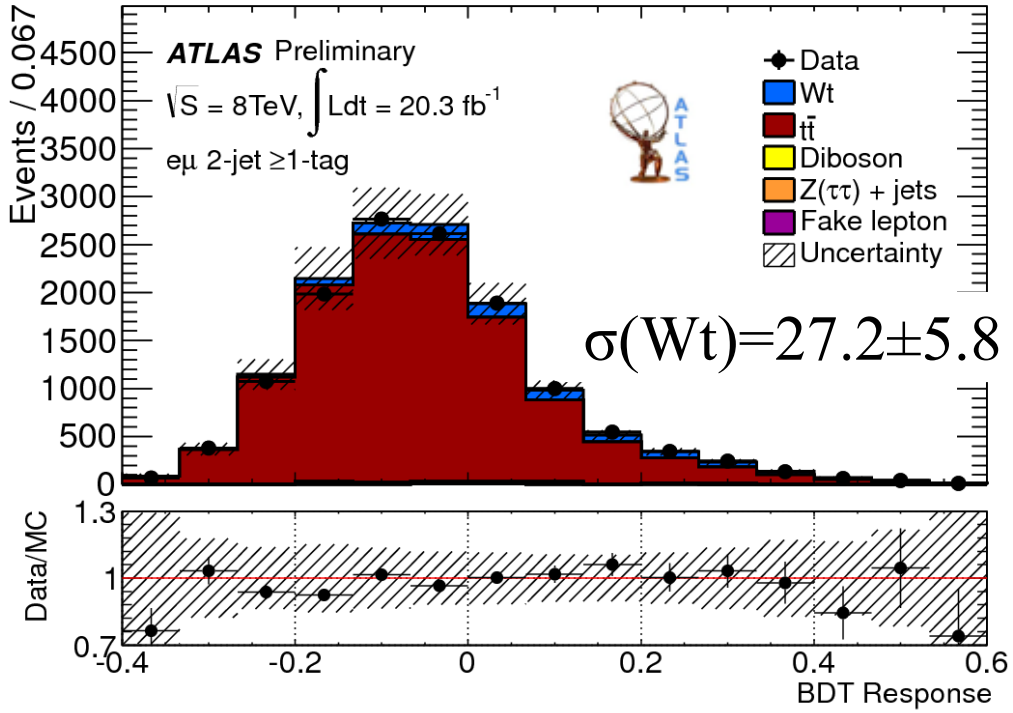
Single Top – Observation tW

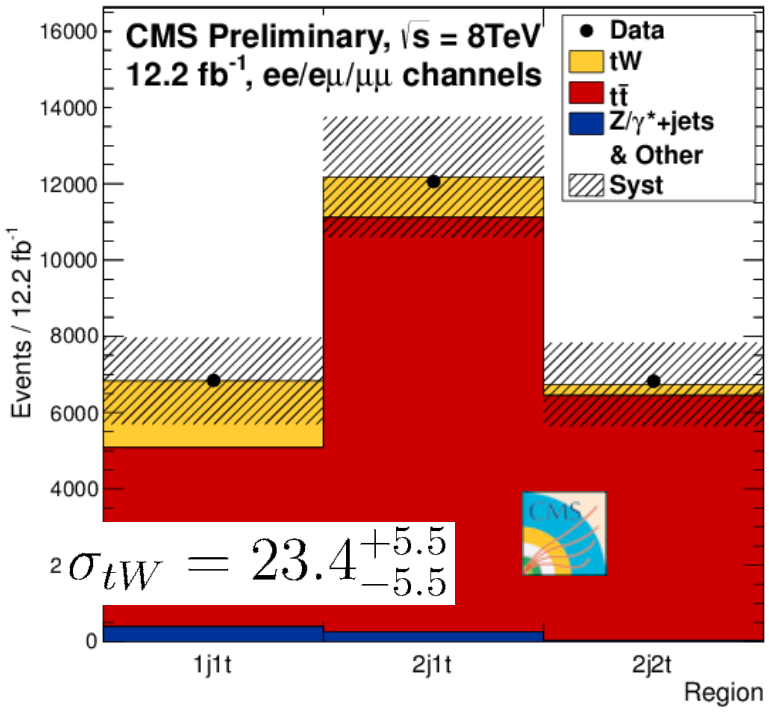
- Single top production in tW channel
  - Using 12.2/fb data at 8 TeV
  - Look for di-lepton + b-jet channels
  - Extract signal with BDT output
    - b-tag eff. constrained in situ
  - First obs. with 6σ (exp. 5.4σ)

See Oliver's talk



$$|V_{tb}| = \sqrt{\frac{\sigma_{tW}}{\sigma_{tW}^{th}}} = 1.03 \pm 0.12(exp.) \pm 0.04(th.)$$

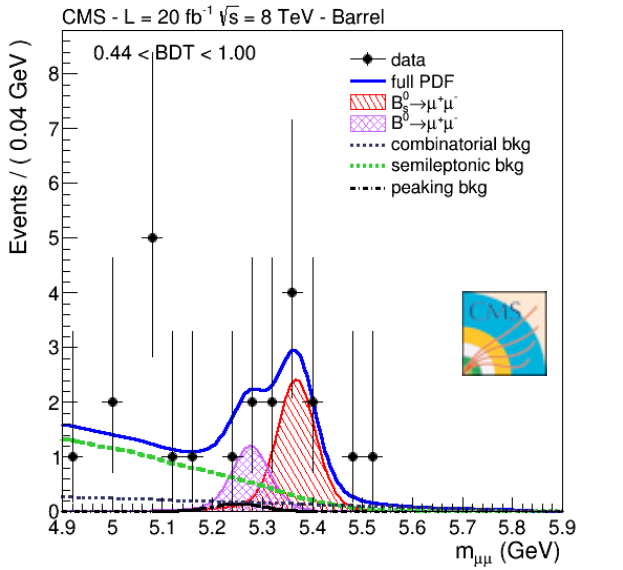


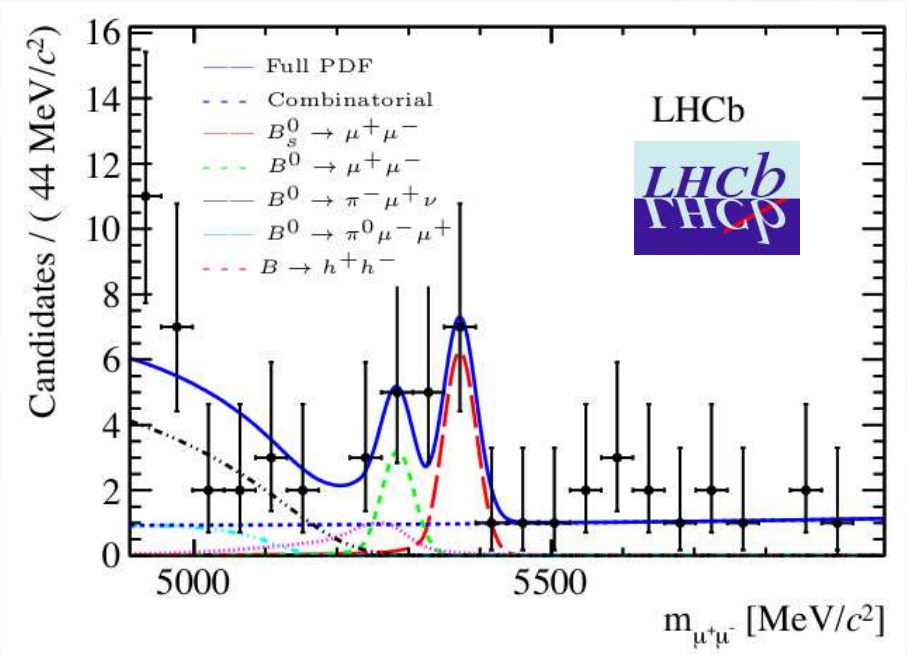


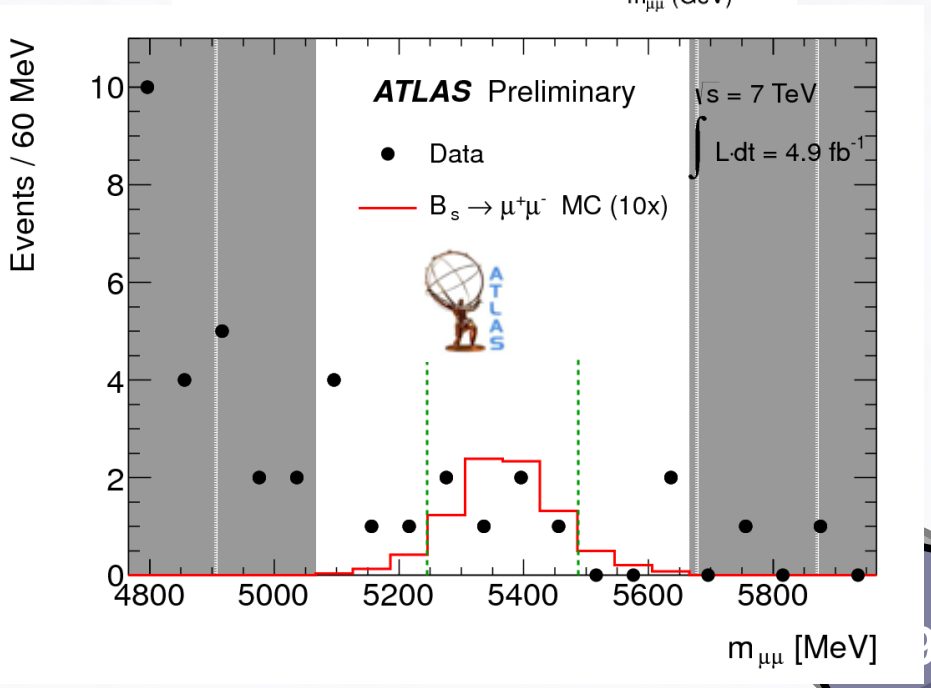
Flavor Physics

Bd → μμ & Bs → μμ

- Highly suppressed channels
  - FCNC channel
  - Probing **BSM**
  - Small theoretical uncertainties

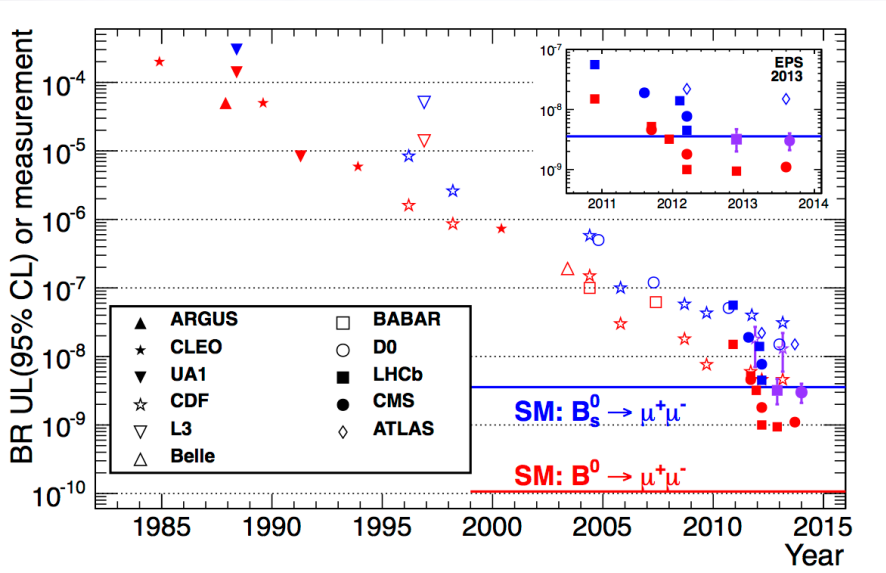


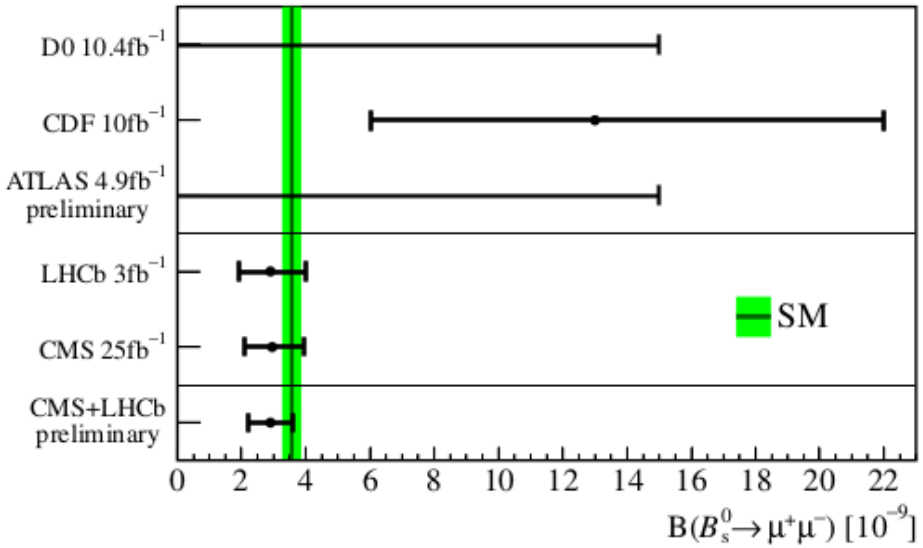


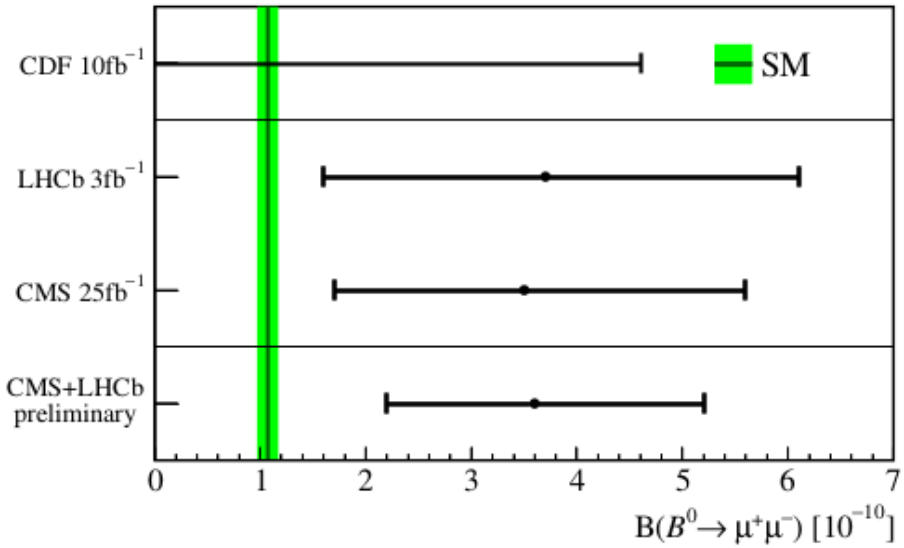


Bd → μμ & Bs → μμ

- Combined results:
  - $B(B_s \rightarrow \mu\mu) = (2.9 \pm 0.7) \times 10^{-9}$
    significance > 5σ
    SM: $(3.6 \pm 0.3) \times 10^{-9}$
  - $B(B_d \rightarrow \mu\mu) = (3.6 \pm 1.6) \times 10^{-10}$
    significance < 3σ
    SM: $(1.1 \pm 0.1) \times 10^{-10}$





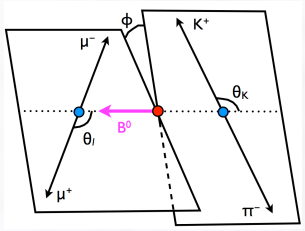


b → s Transitions

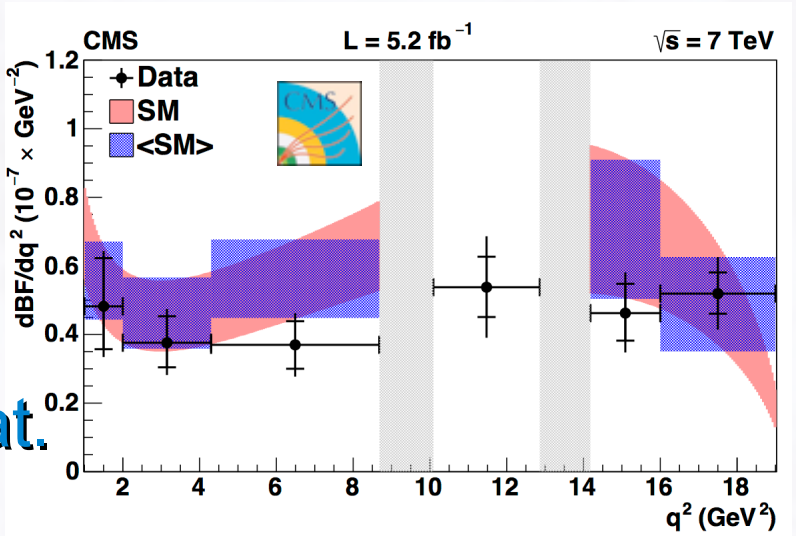
- Angular analysis
  - FCNC, tree suppressed
  - Extracting A_{FB} & F_L

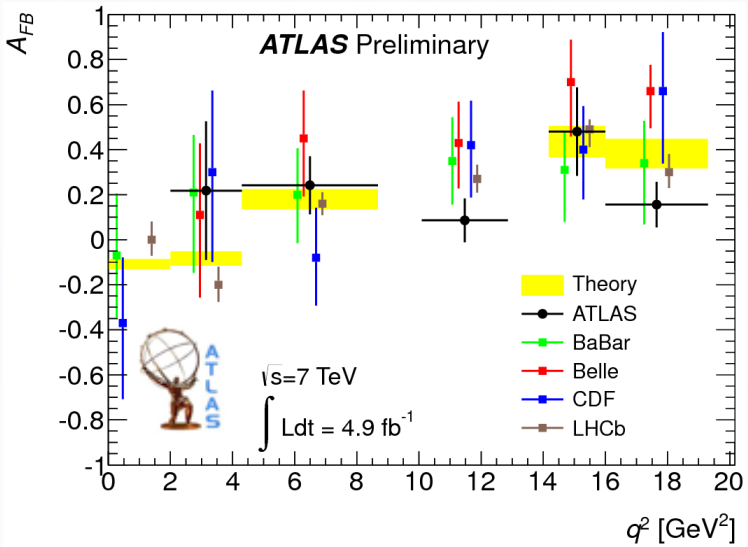
$$A_{FB} \propto -\Re[(2C_7^{eff} + \frac{q^2}{m_b^2} C_9^{eff} C_{10}]$$

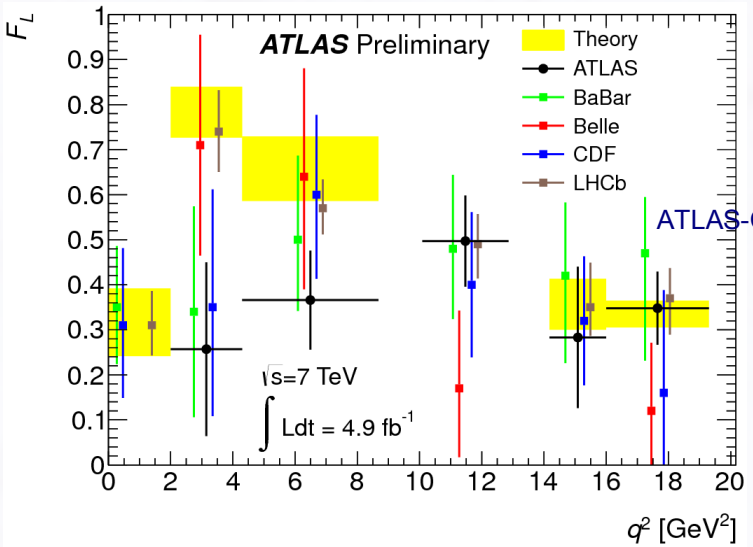
  - Grey region for J/ψ & ψ(2s)
- Latest combined results
  - Uncertainties still dominated by stat.
  - No sign. deviation from SM found



arXiv:1308.3409





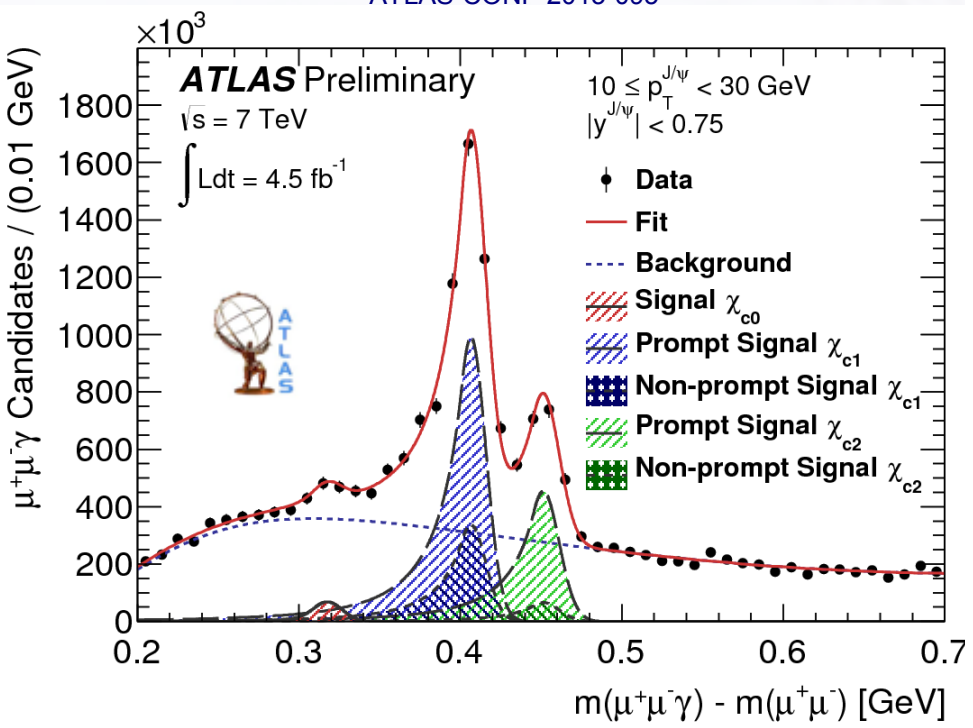


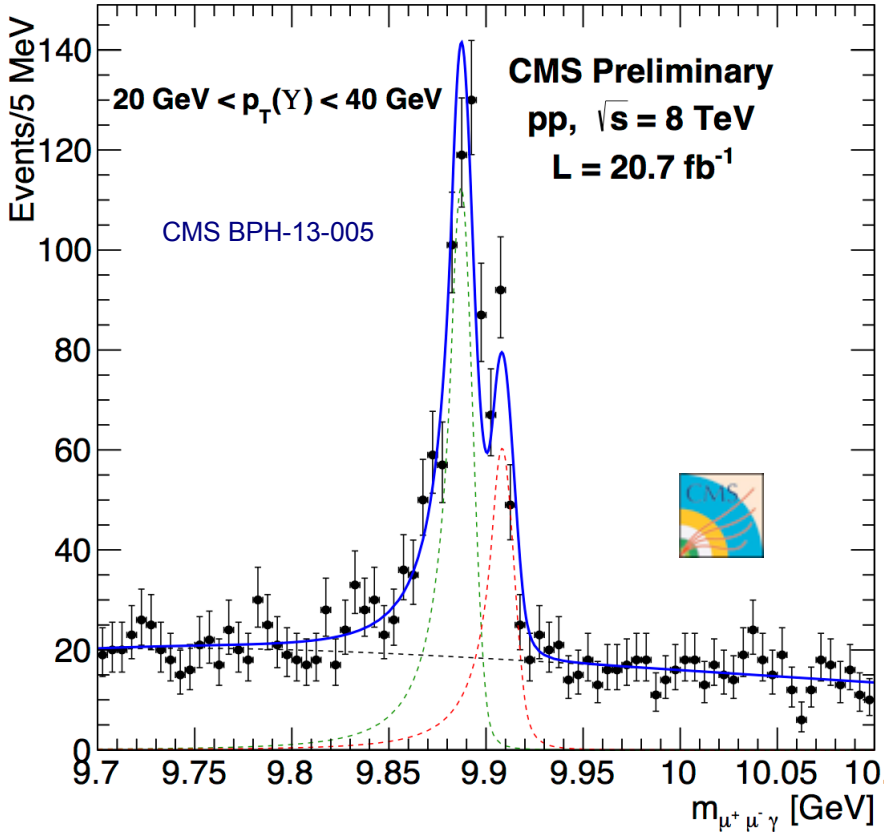
ATLAS-CONF-2013-038

Quarkonia

- Measurements of bottomonium states
  - $X_{c1,2}$ search in Atlas: $\chi_c \rightarrow J/\psi\,\gamma \rightarrow \mu\mu\gamma$ at 7 TeV
  - $X_{b1,2}$ search in CMS: $\chi_b \rightarrow \Upsilon\,\gamma \rightarrow \mu\mu\gamma$ at 8 TeV

ATLAS-CONF-2013-095





Summary

Summary

- LHC provides excellent data for various studies
  - QCD FSQ, Jets & Heavy Ion
  - Standard model physics
  - Top studies
  - Flavour physics
- So far most results agrees with Standard Model
  - To find possible deviation via precision measurements
- New milestone ahead
  - Various new results are coming
  - Still many studies to finish up the full 8 TeV data
  - LHC to be restart in 2015 after LS1
  - Stay tuned for the new results!

以上

Thank YOU!

謝謝

Remercie de Votre Attention