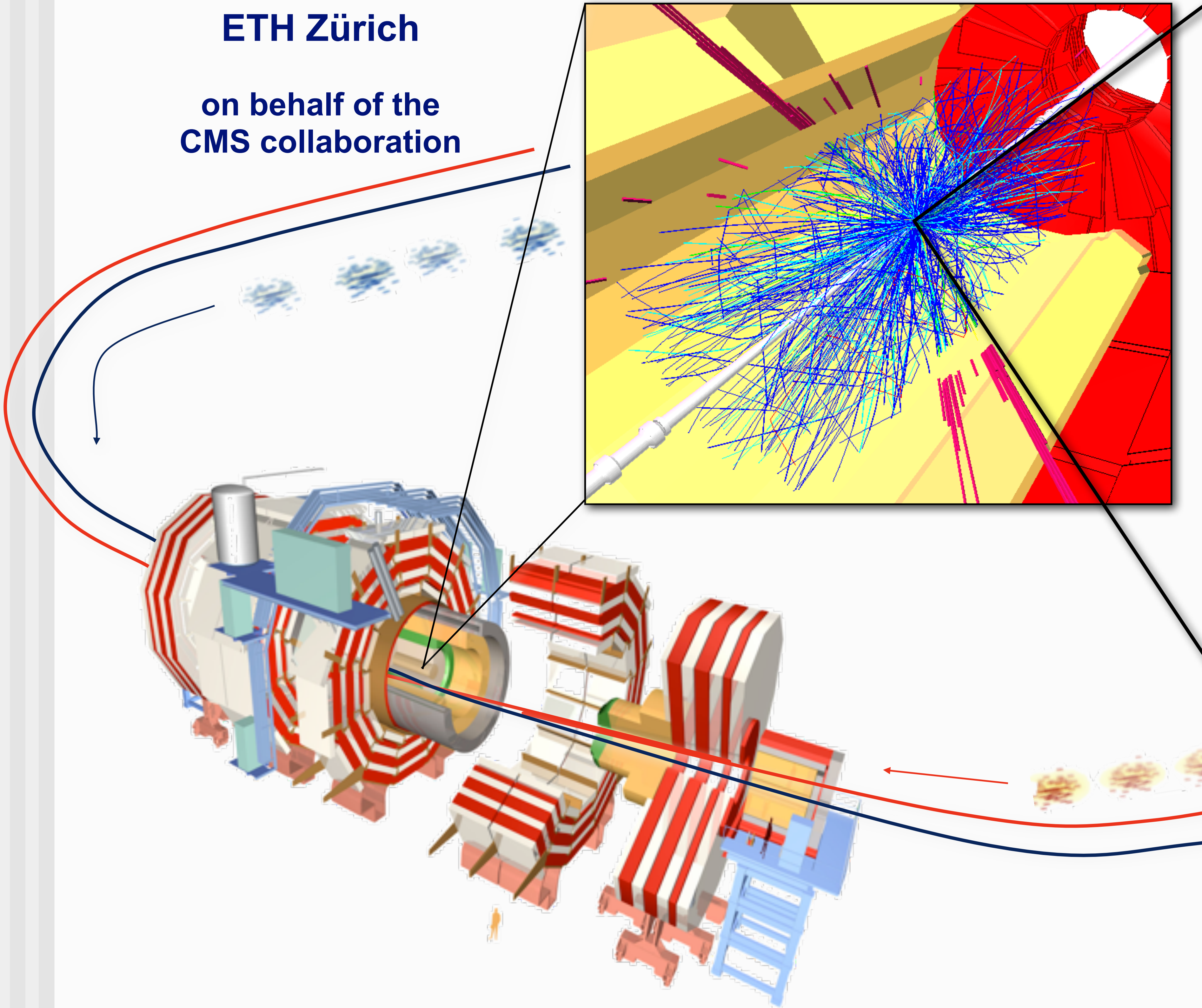
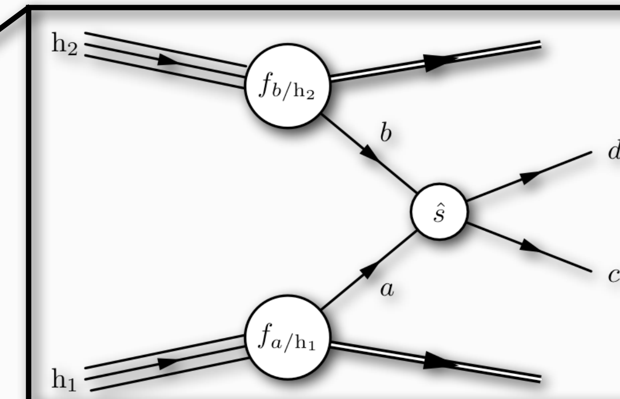
CMS Status Report

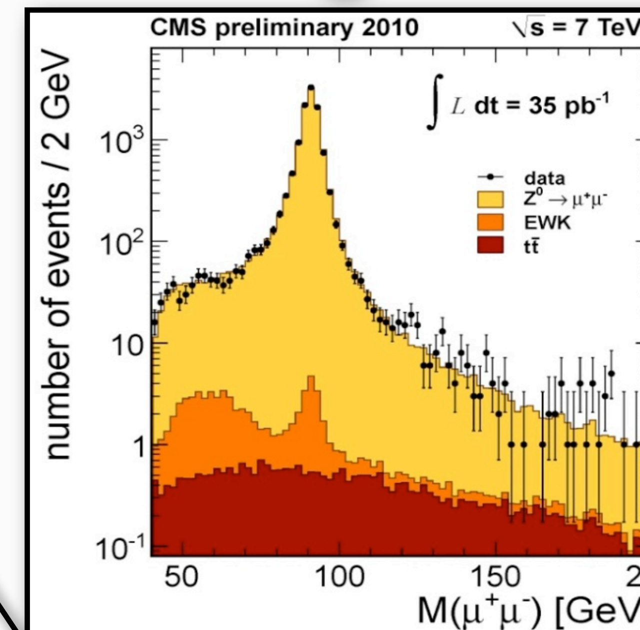
Günther Dissertori

ETH Zürich

on behalf of the CMS collaboration



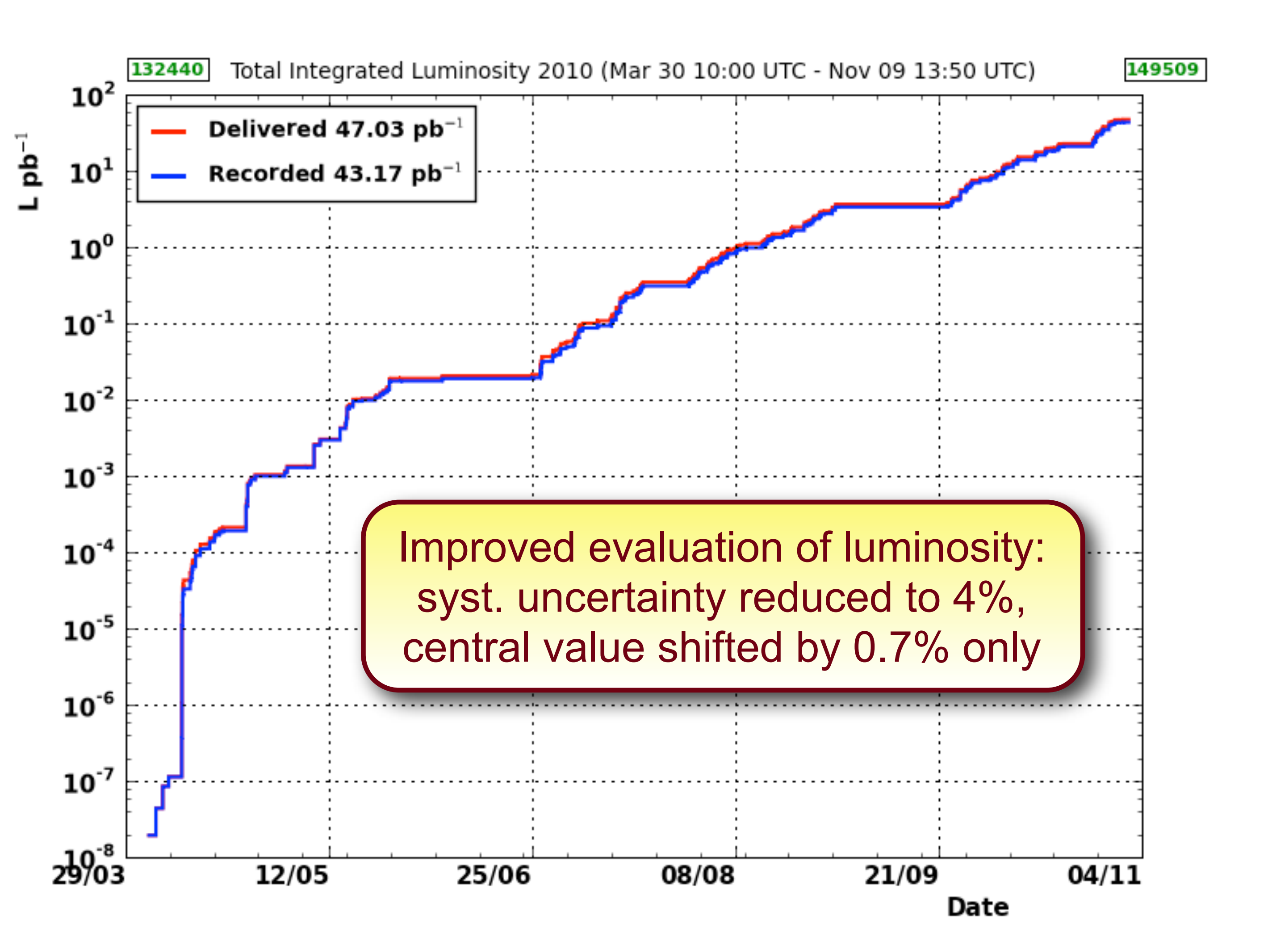




LHCC Open Session
March 23, 2011

Outline

- Introduction
  - Shutdown activities
  - Commissioning, current status
- **Selected** Physics results
  - Heavy Ions
  - Jet Production
  - "Heavy Quark" production
  - Vector Boson production
  - Higgs searches
  - Searches for Supersymmetry
  - Exotic signatures
  - Conclusions



Reliable operations with **47 pb^{-1}** delivered by LHC
CMS recorded **43 pb^{-1}**. Overall data taking larger than **92%**
~85% recorded with all subdetectors in perfect conditions.
All subdetectors have **at least 98%** of all channels operational!

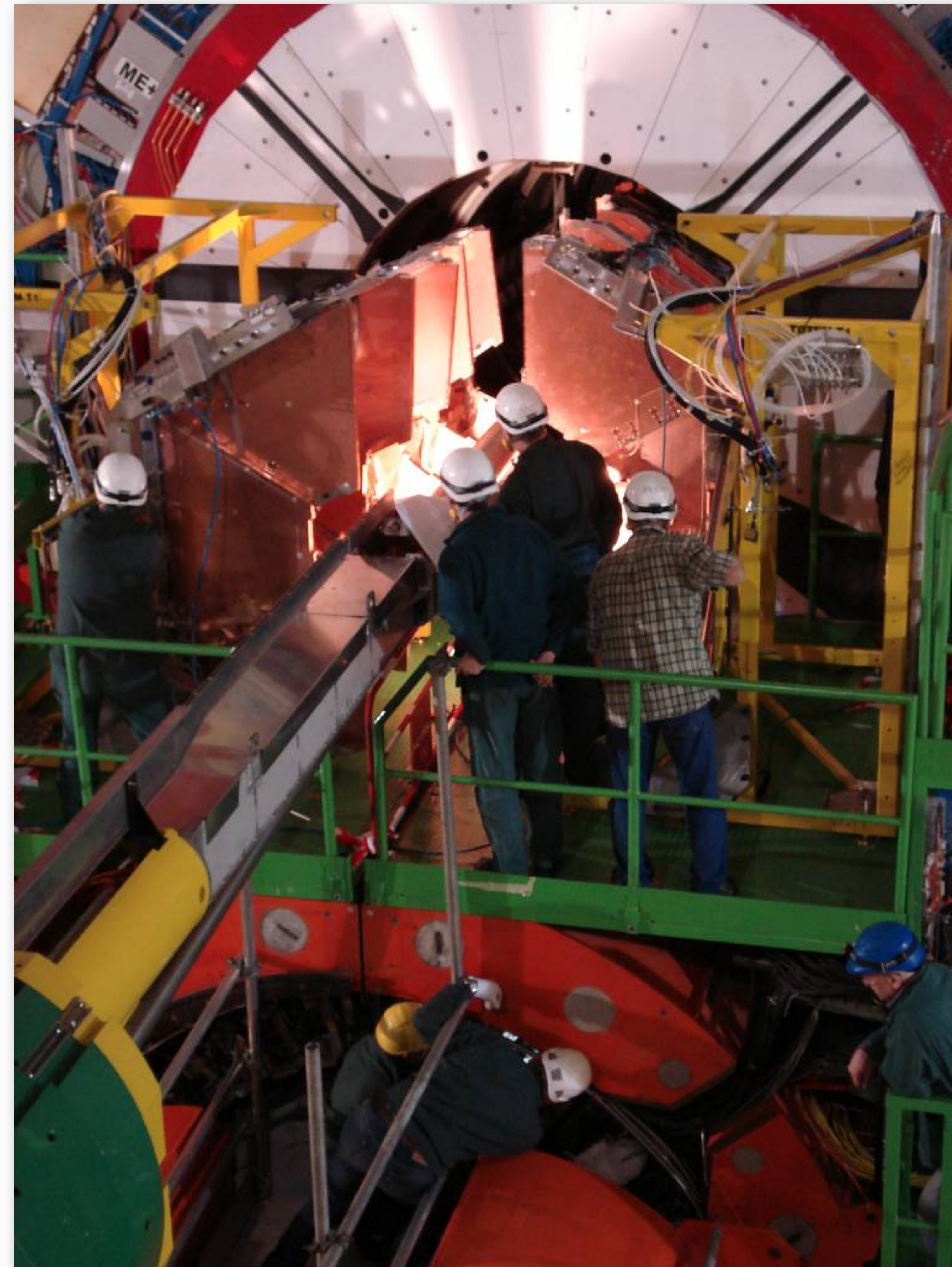
- **Note 1 : Most of the results shown based on full 2010 statistics**
- **Note 2 :** Take-Home messages highlighted in this manner

Extended Technical Stop 2010-2011

- A long list of tasks, successfully carried out, such as
  - **Installation of TOTEM T1 telescope on both ends**
  - **Filter farm cooling upgrade**

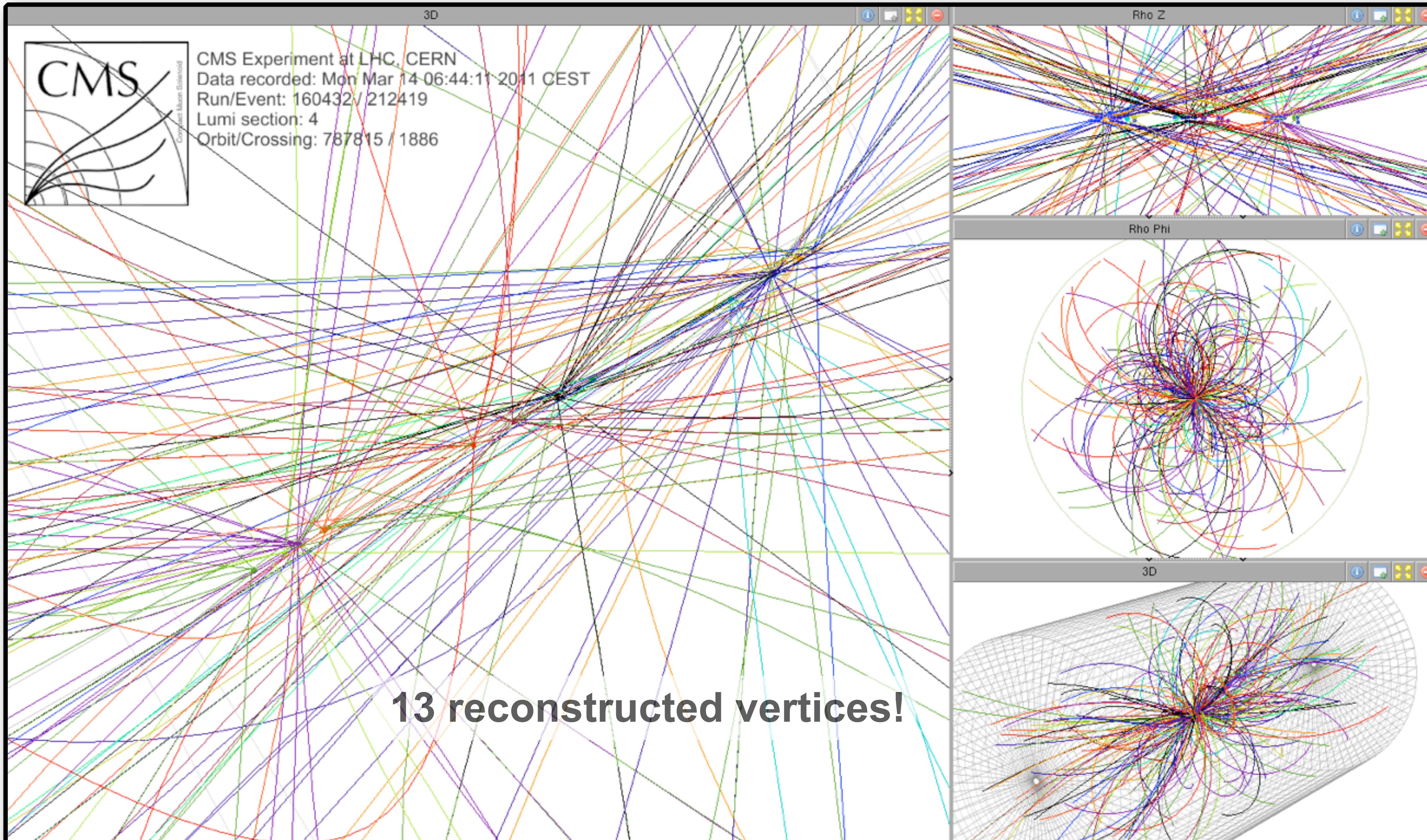
- 21 Jan: All services restored
- 28 Jan: CMS closed, started to pump-down.
- 10 Feb: Pump-down complete.
- B field 0T ➔ 1T ➔ 0T ➔ 3.8T
- **18 Feb: Ready for beam (on schedule)**

- commissioning started with cosmics
- taking collision data since March 13
- ~12 (10) pb^{-1} delivered (recorded) so far



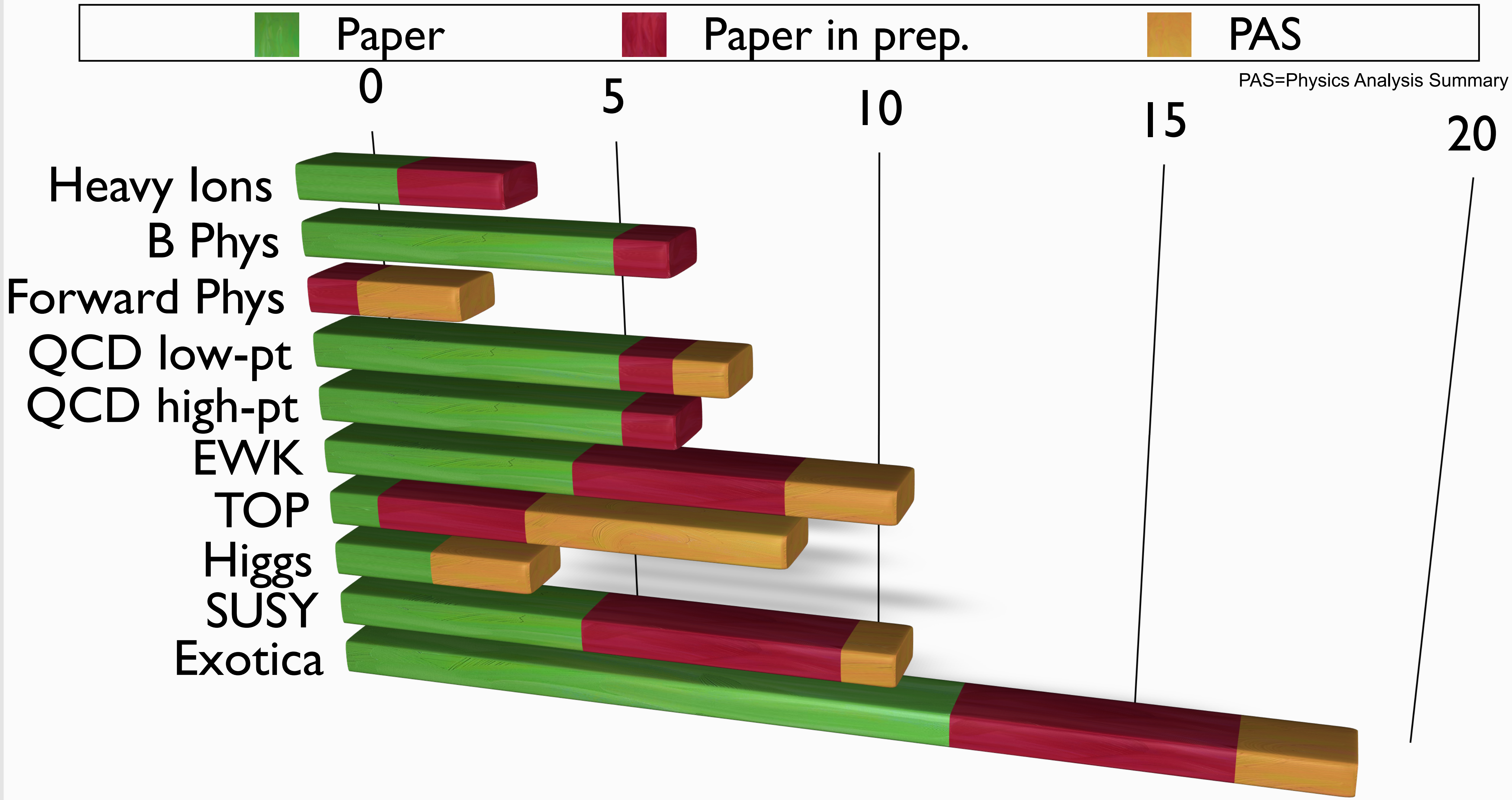
Installation of 2'nd T1 telescope

New events coming in...



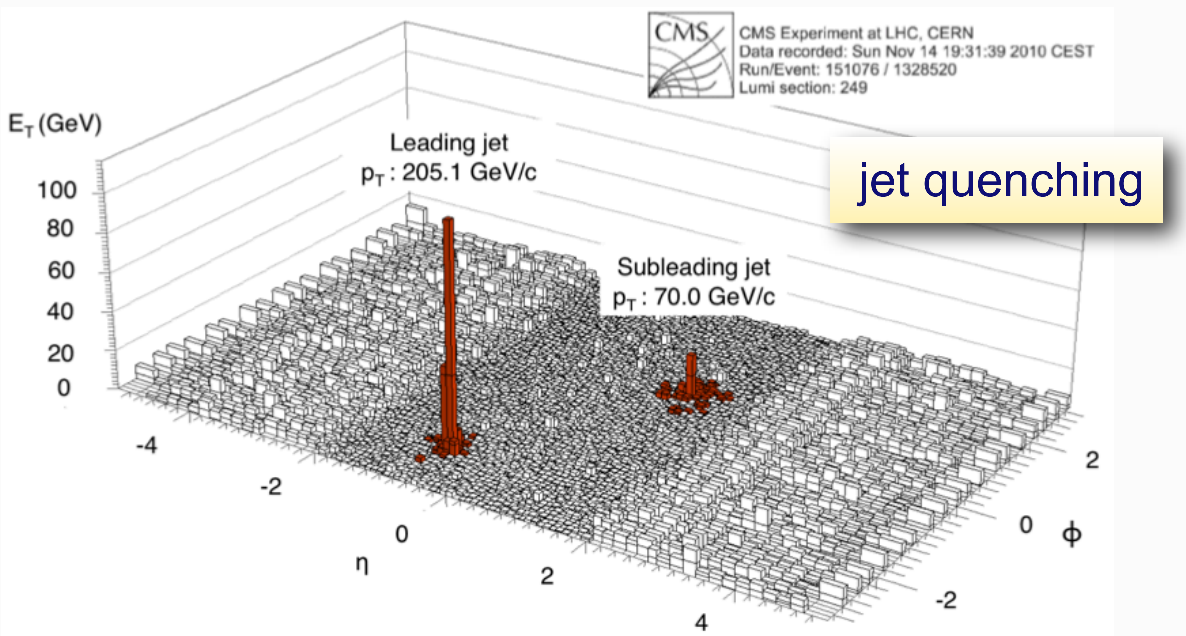
The new challenge: Pile-Up!
CMS is prepared for it on all fronts: Trigger, Reconstruction, Analysis, Computing

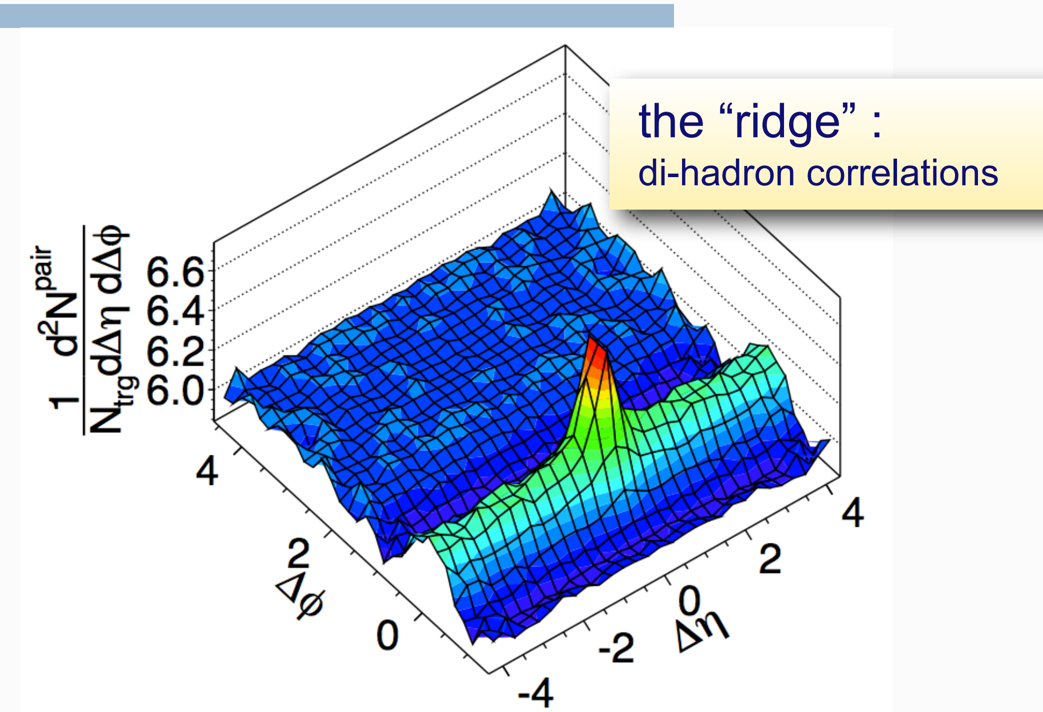
List of physics analyses so far



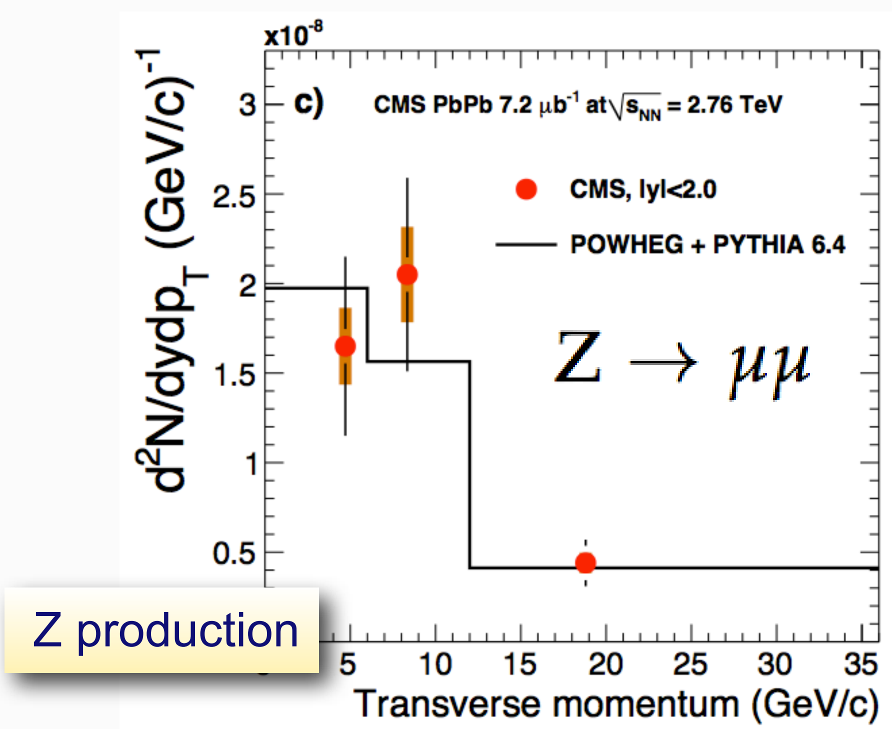
In total : **83** physics analyses, based on 2010 data, approved so far
45 papers completed (published, submitted, or close to submission)
23 papers in preparation
24 analyses to be approved soon

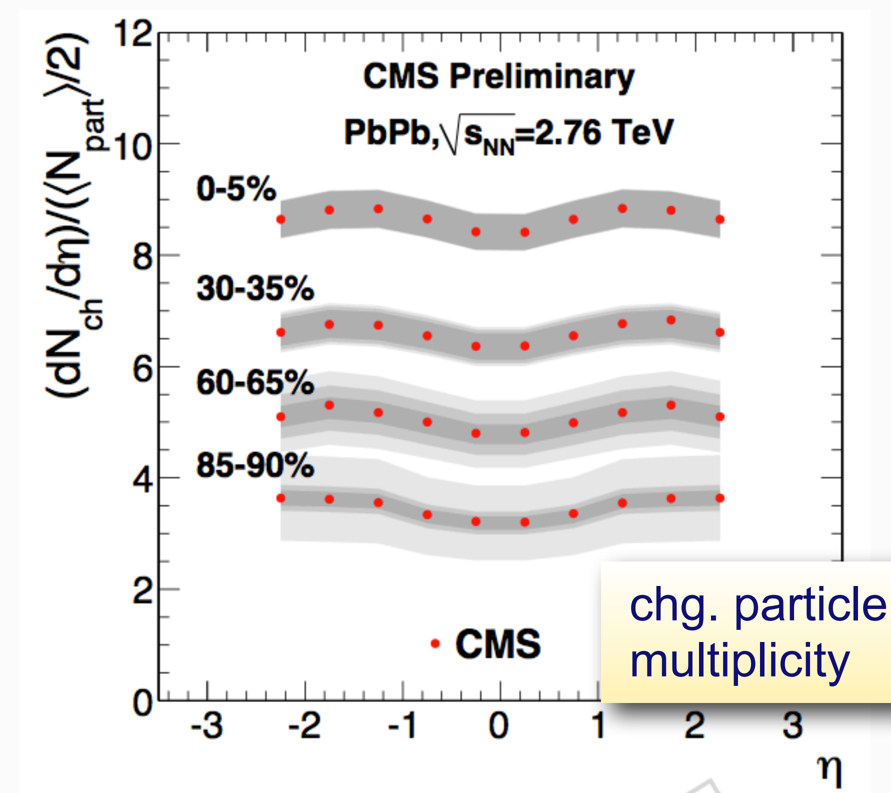
https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResults





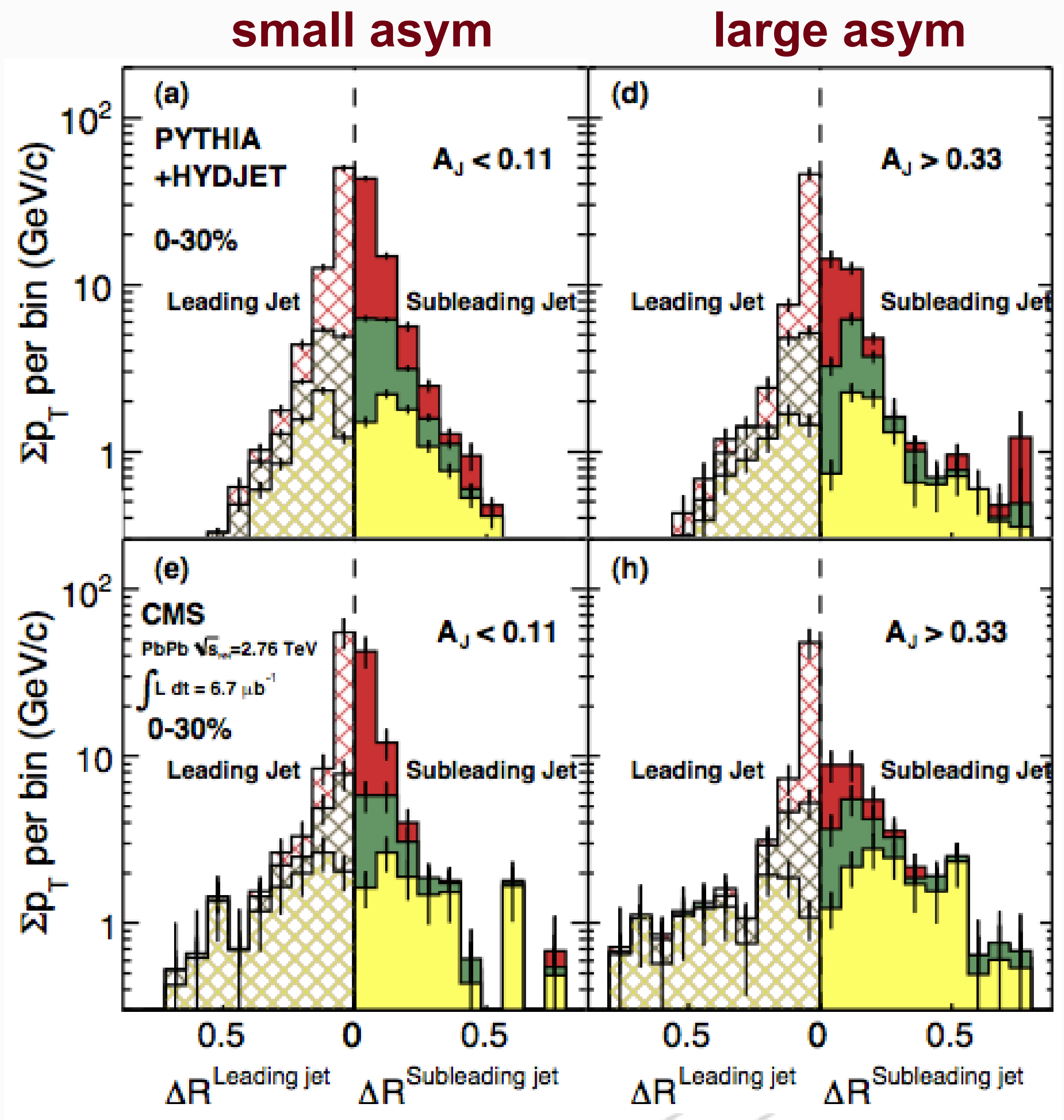
Heavy Ion Physics





Jet Quenching

arXiv:1102.1957 ; CMS-HIN-10-004 ; CERN-PH-EP-2011-001. Submitted to Physical Review C

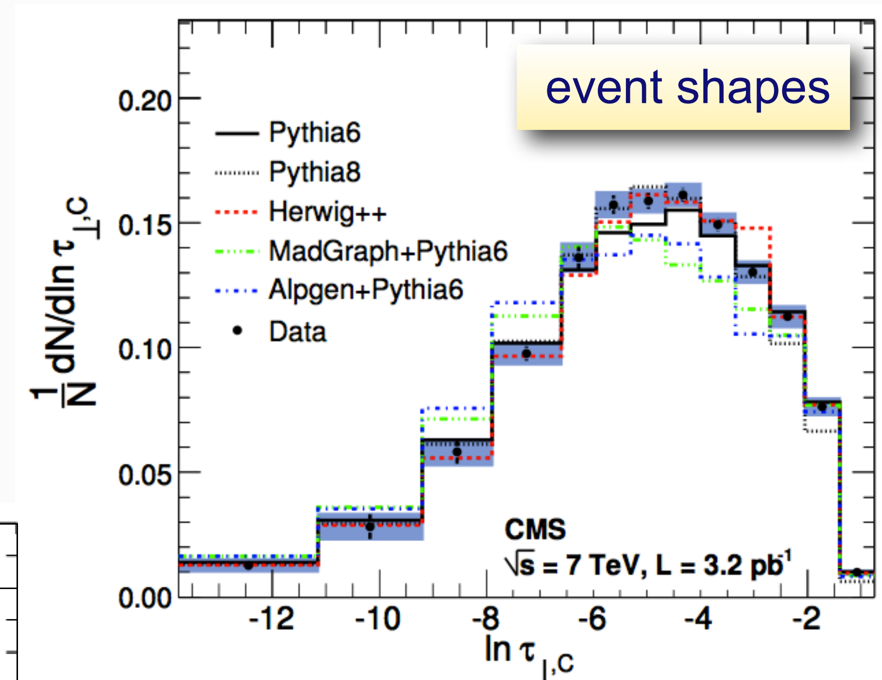


- The phenomenon of jet quenching in Heavy-Ion collisions is now described in detail and well understood.
- The di-jet momentum balance is fully recovered if we consider the low p_T tracks distributed over a wider angular range wrt the jet axis.

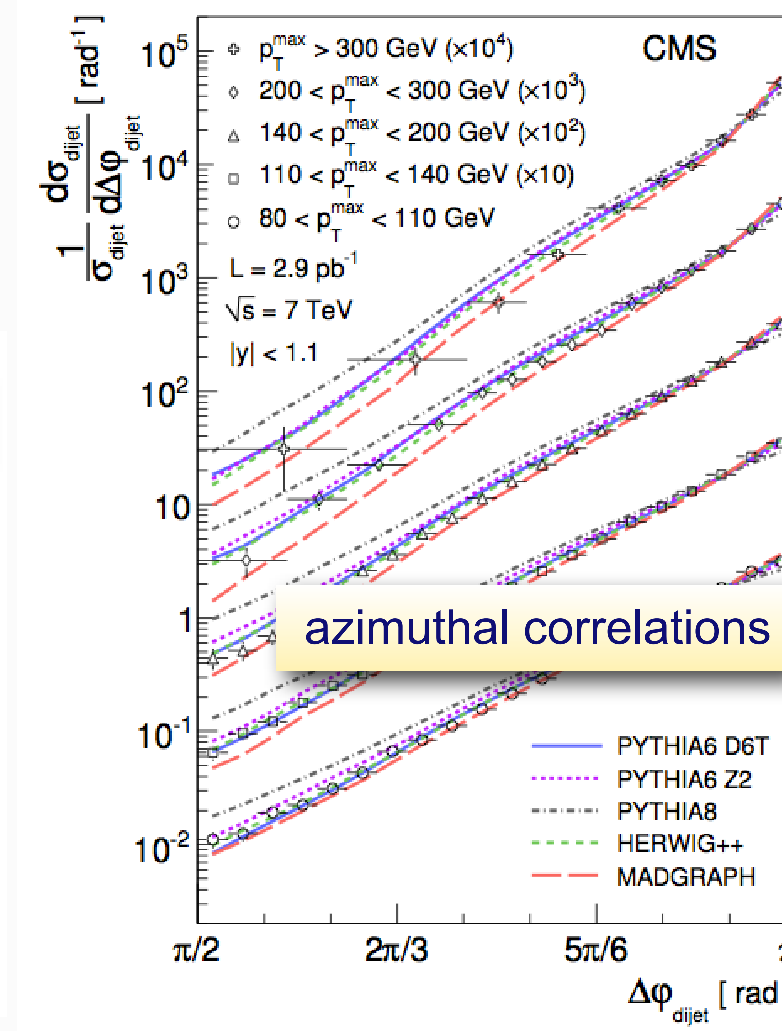
The studies of Heavy-Ion collisions have already gone well beyond the mere observations of new effects!

Production of Jets

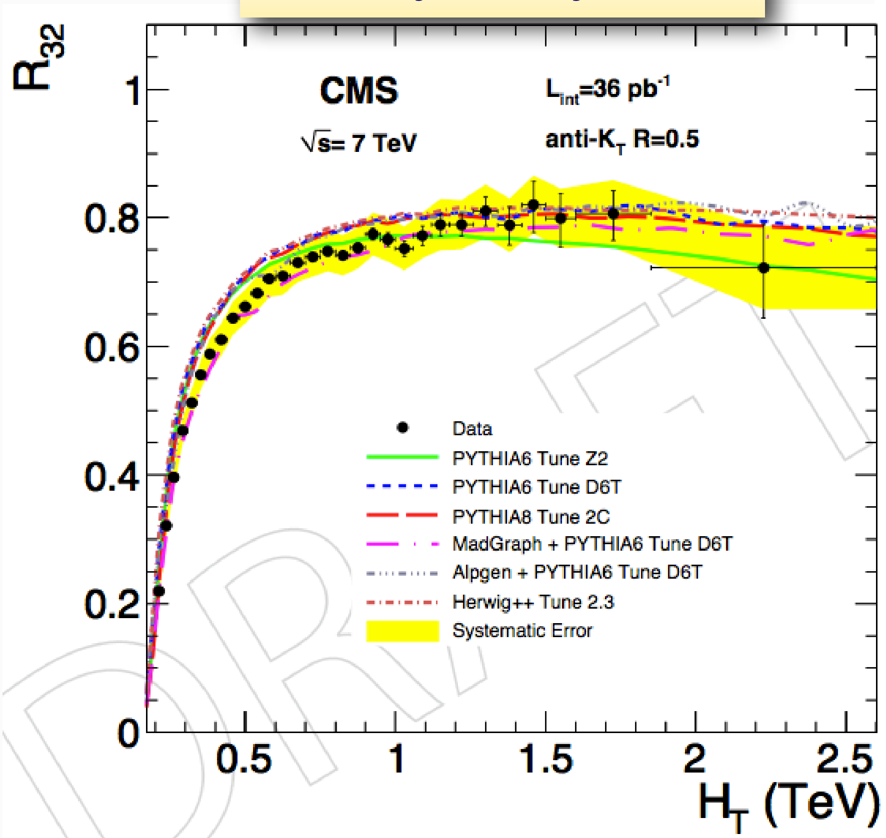
event shapes



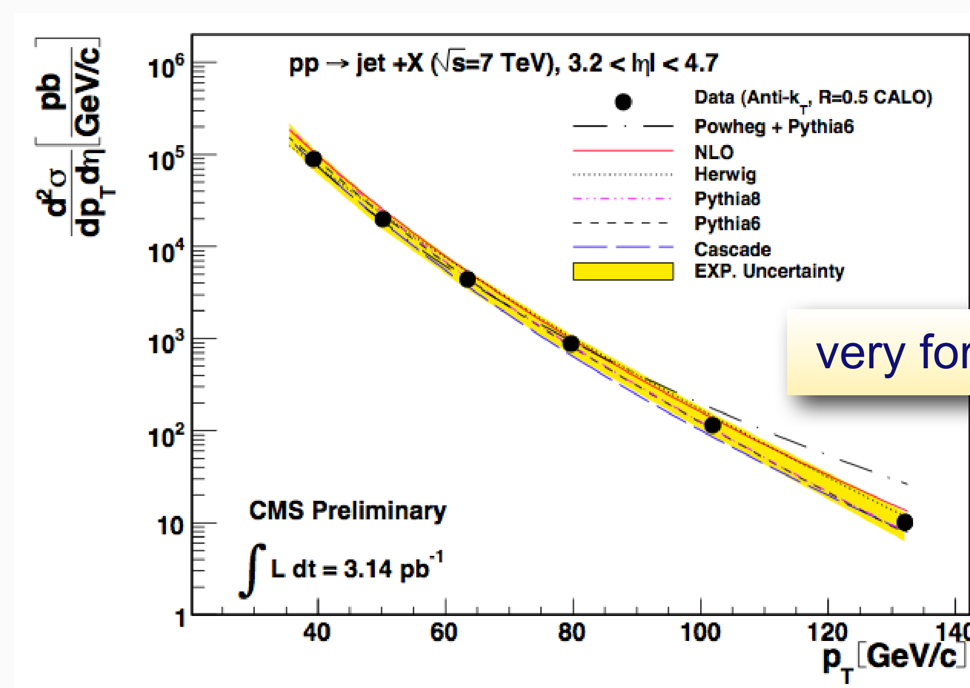
azimuthal correlations



ratio 3-jets / 2-jets rate

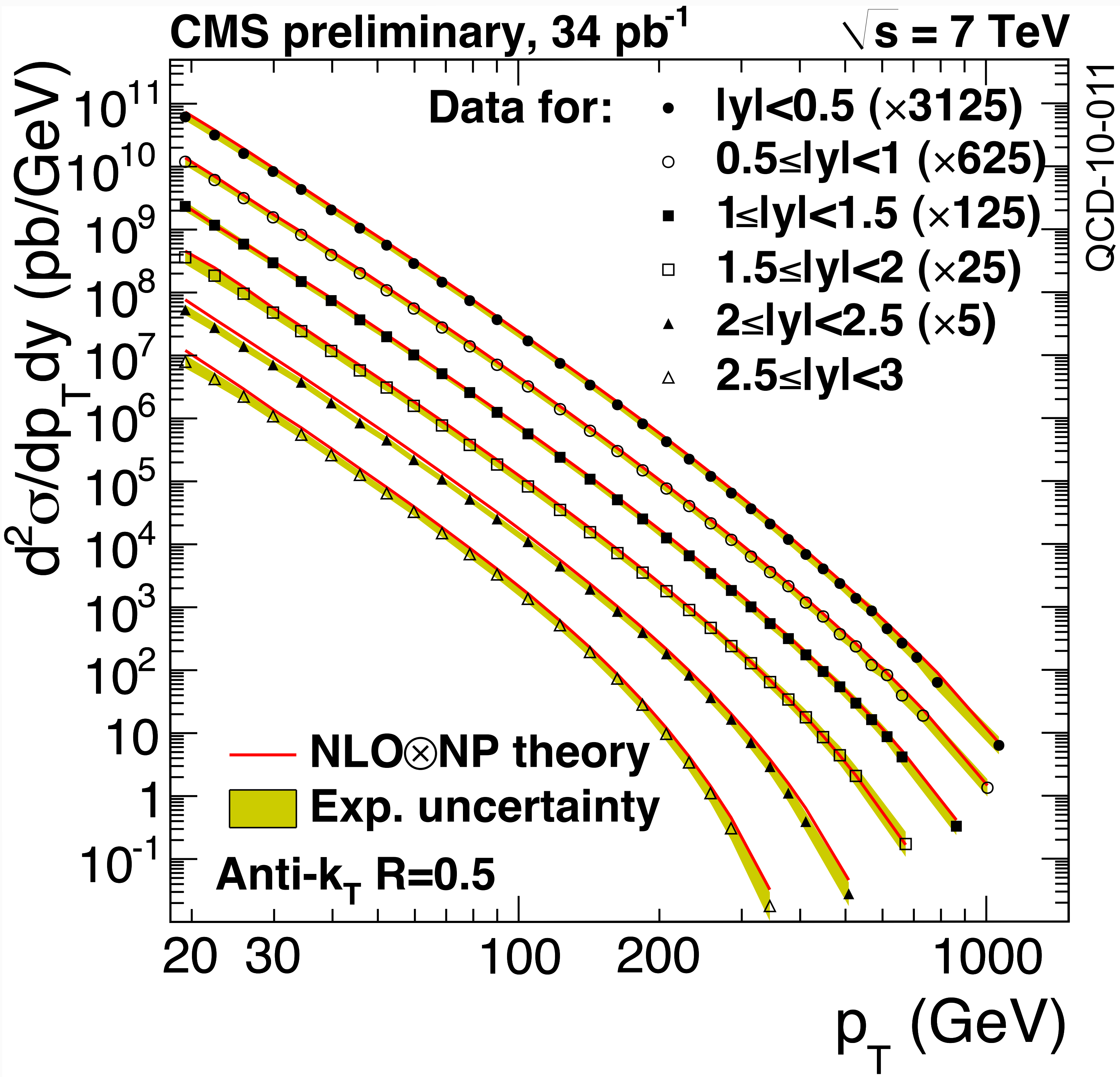


very forward jets



Inclusive jet cross section

- From p_T=18 GeV to p_T~1 TeV!
- Extending to very low p_T thanks to Particle Flow
- JES uncertainties: ~3-5 %
- Corrected to particle level
- Inclusive jet p_T spectra are in **good agreement with NLO QCD**
- Consistent results obtained using calo-jets



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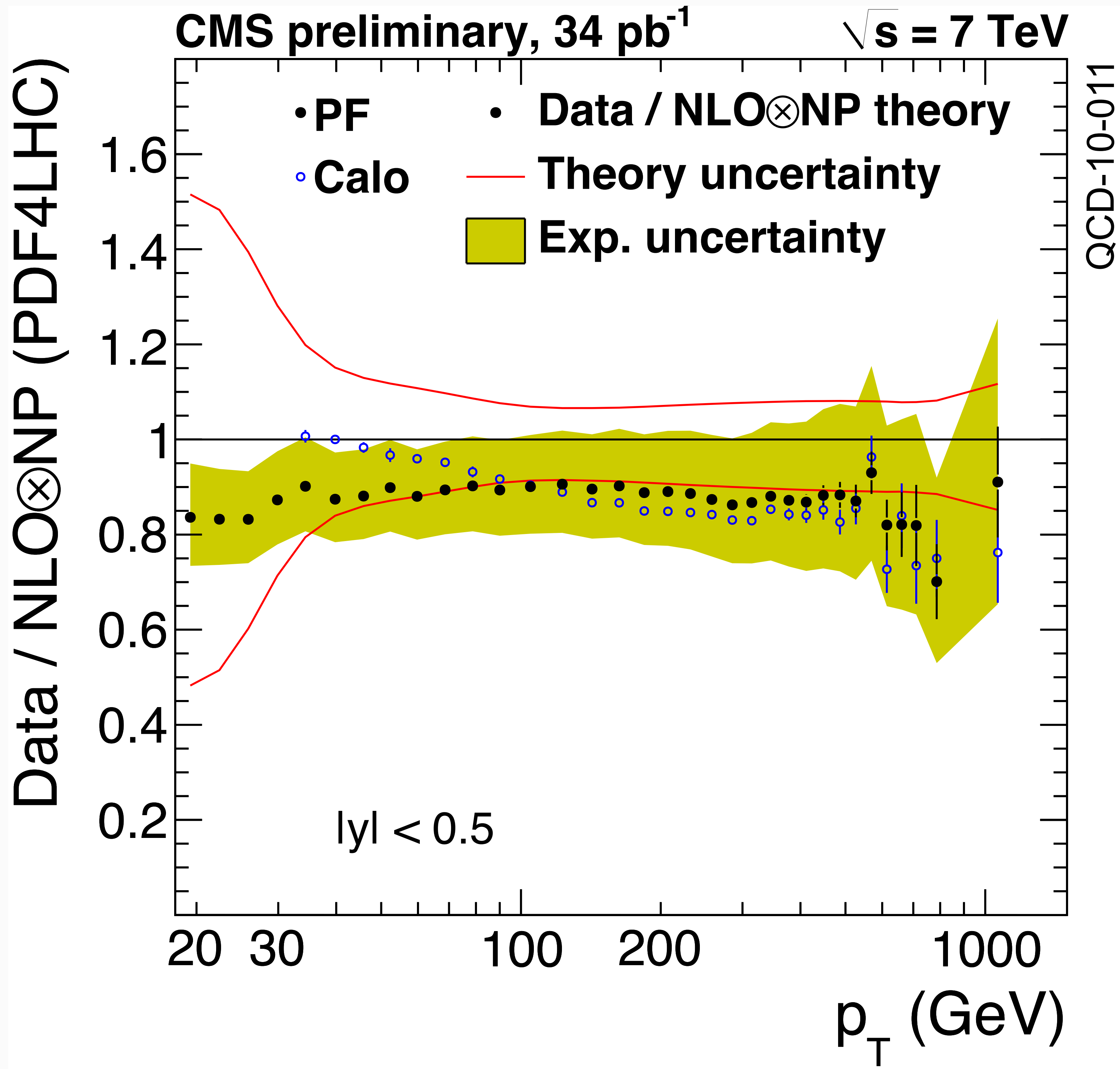
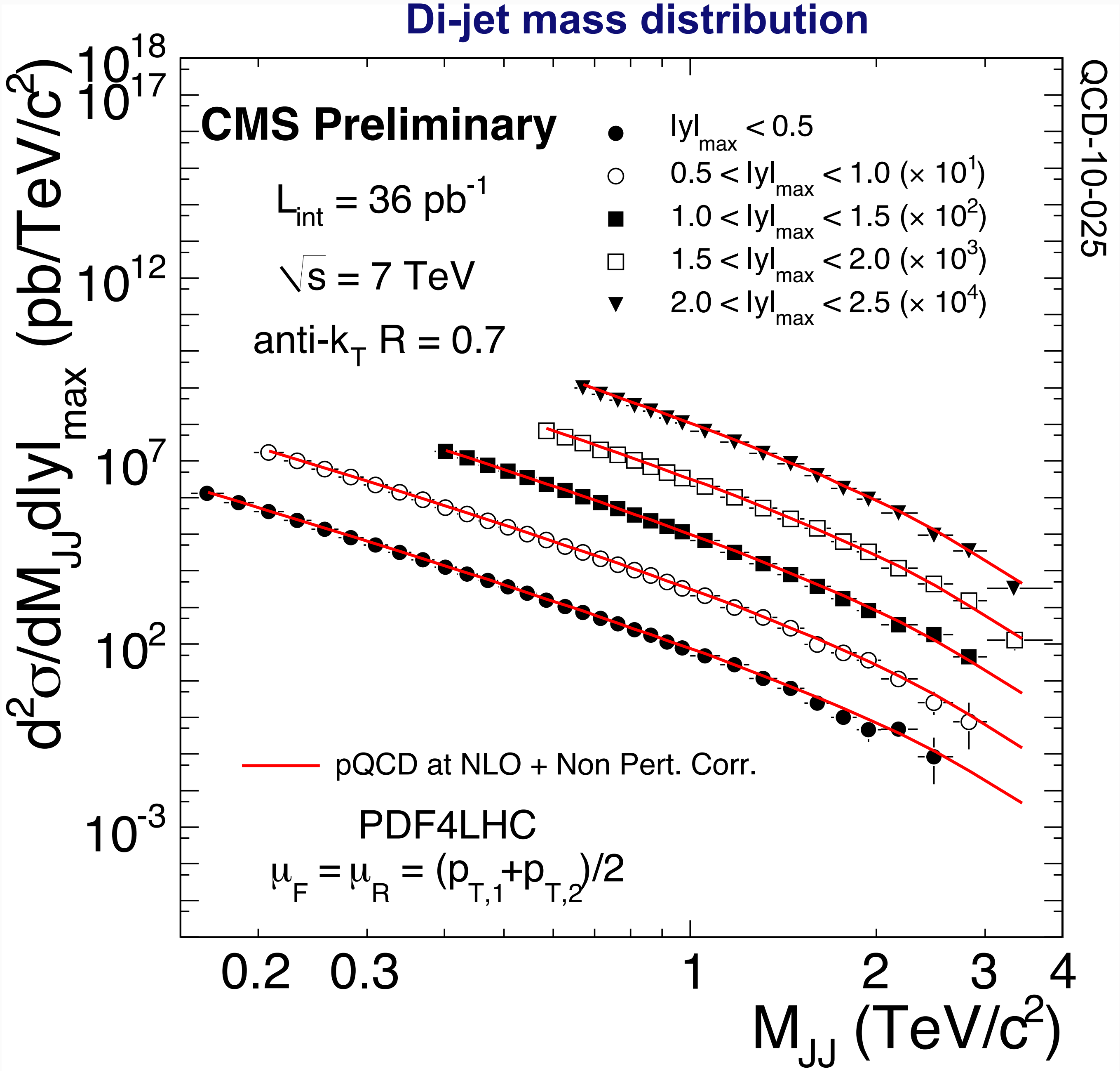


Further jet distributions



Further jet distributions

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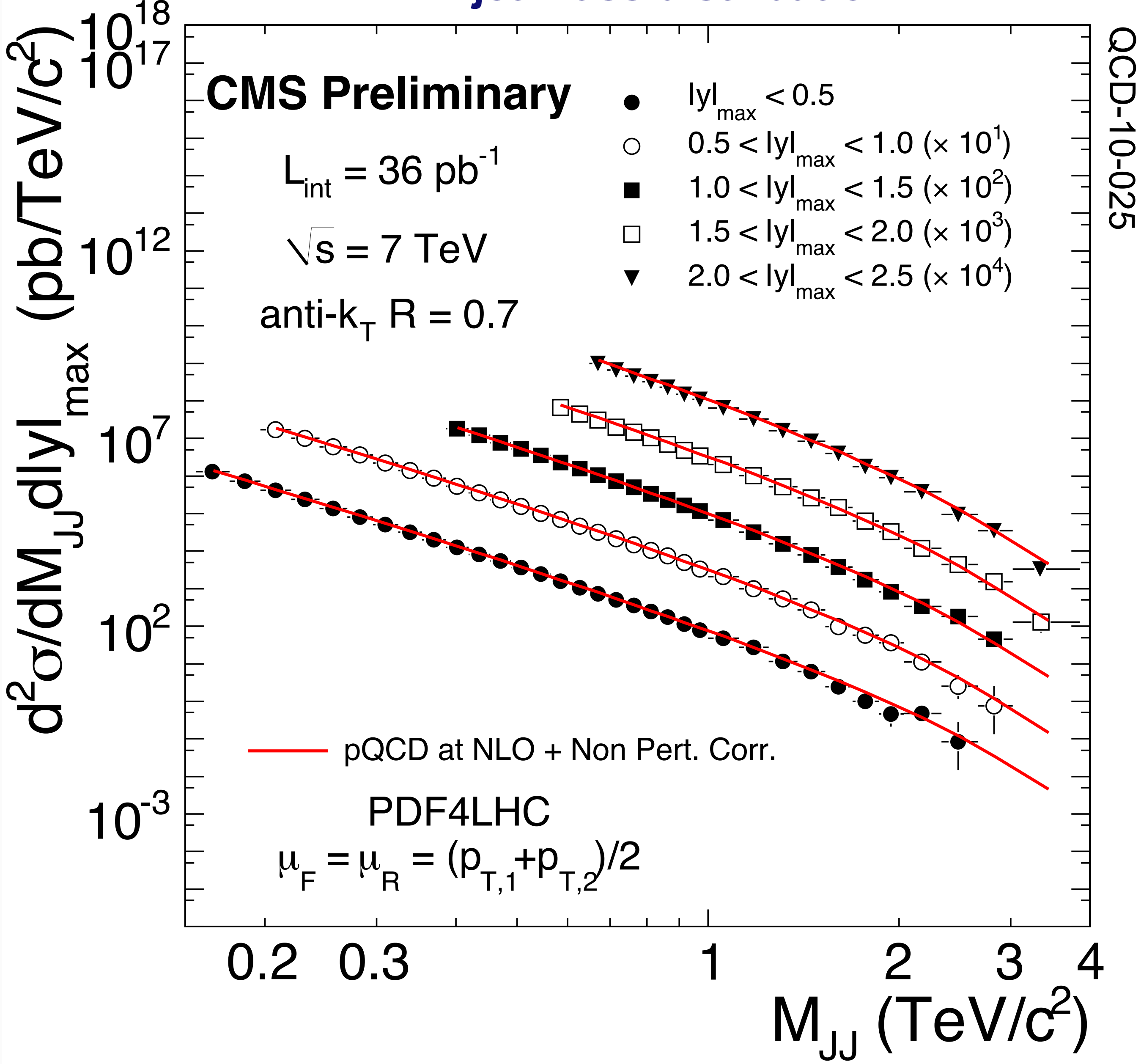
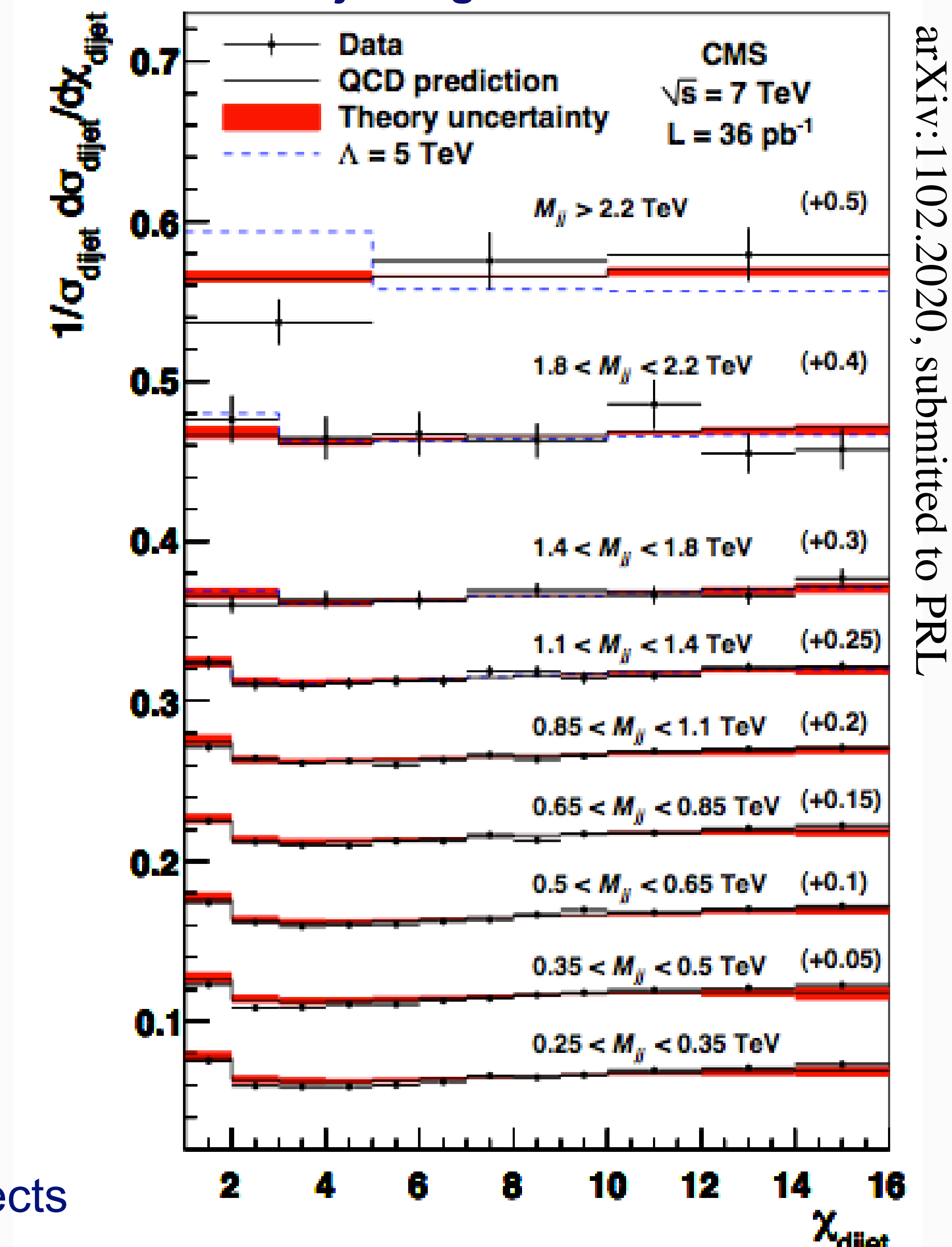
Di-jet mass distribution



Di-jet angular correlations



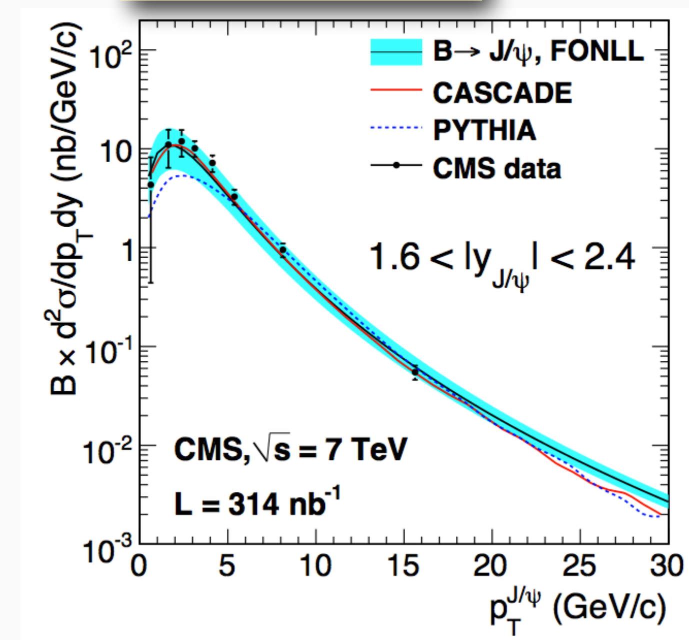
- All distributions unfolded/corrected for detector effects

Achieved excellent understanding of jet production, over very wide phase space. Start to constrain Monte Carlo models.

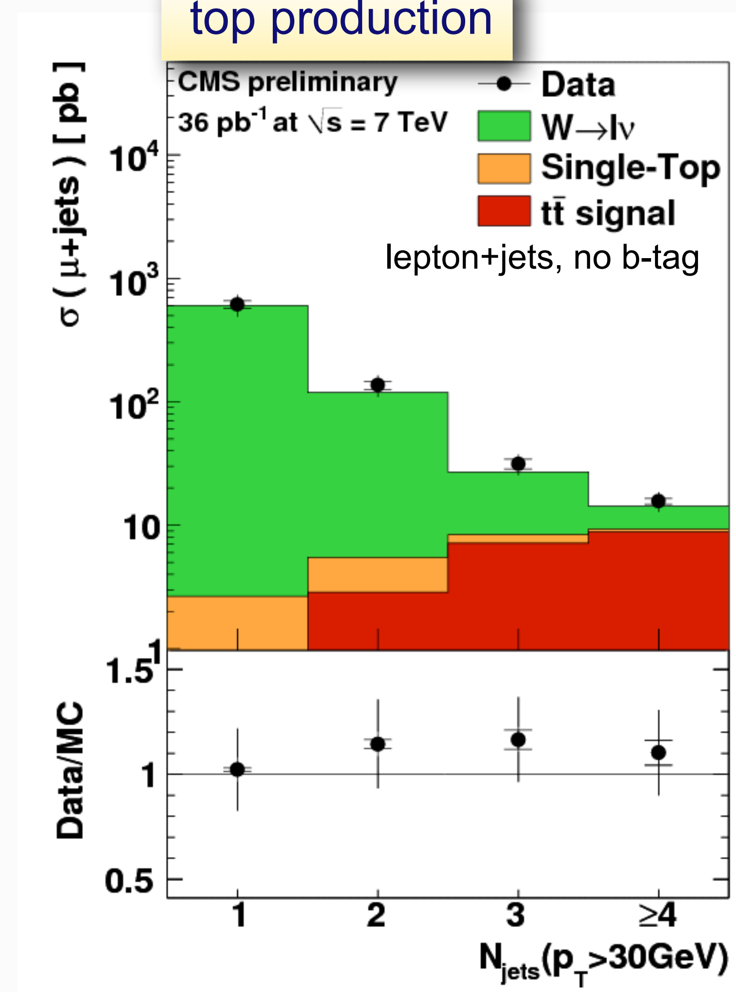
Production of "heavy" quarks:

s → Quarkonia → b → top

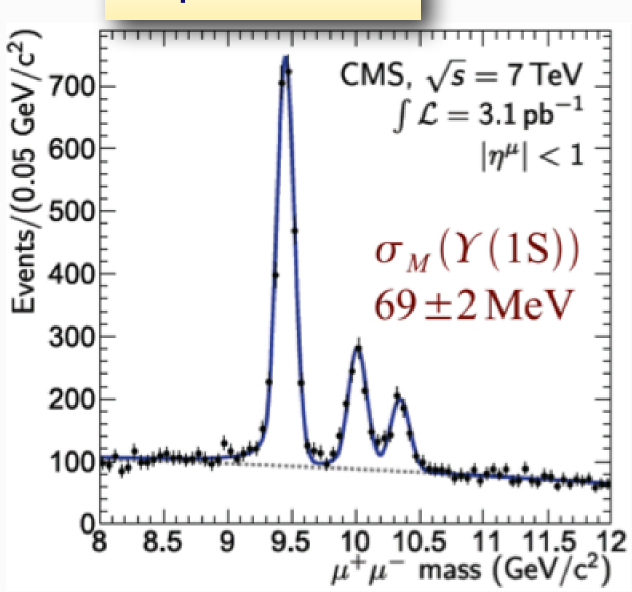
J/Ψ production



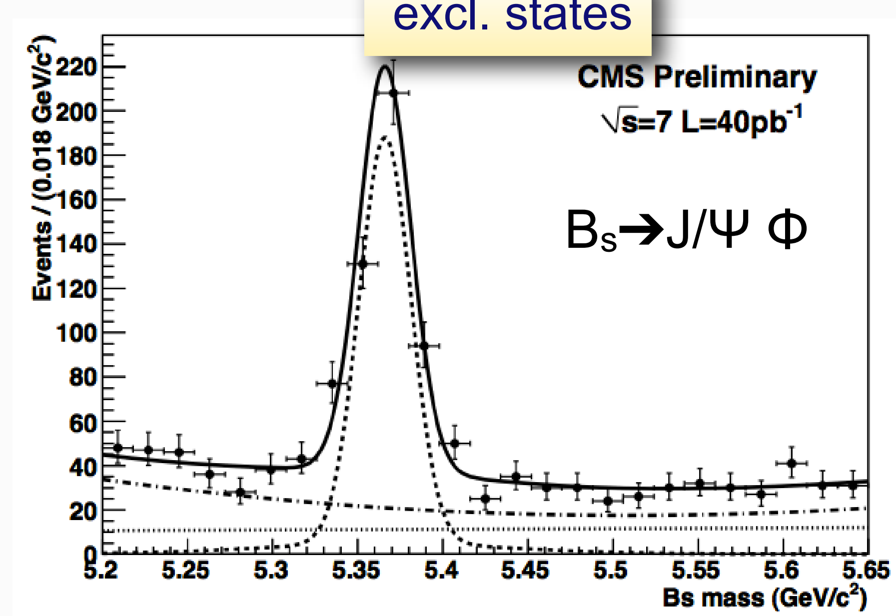
top production



Y production

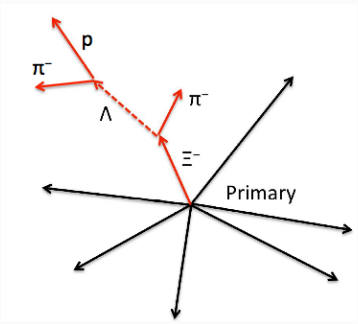


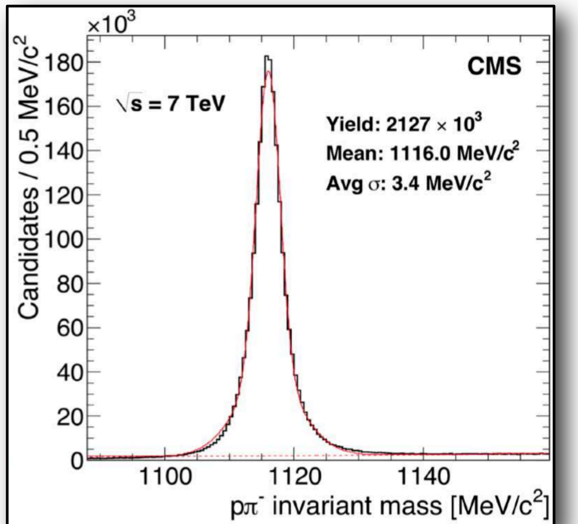
excl. states



Strangeness Production

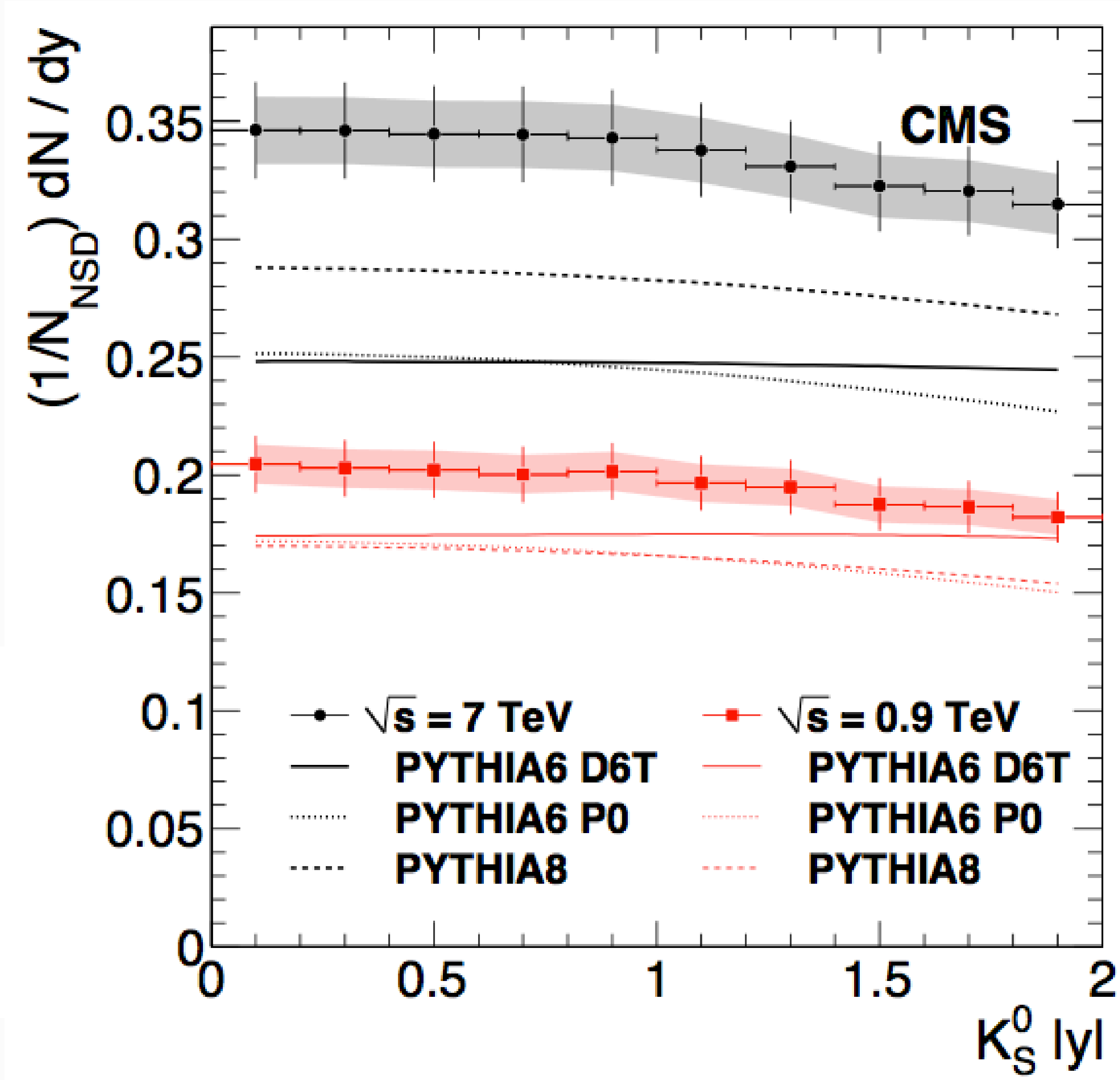
- Reconstruction of K_S, Λ, Ξ^-





Particle	$\left[\frac{\frac{dN}{dy}\|_{y\approx0}(\text{MCD6T})}{\frac{dN}{dy}\|_{y\approx0}(\text{Data})}\right]$ $\sqrt{s} = 0.9$ TeV	$\sqrt{s} = 7$ TeV
K^0_S	$0.852 \pm 0.005 \pm 0.061$	$0.717 \pm 0.001 \pm 0.052$
Λ	$0.606 \pm 0.007 \pm 0.070$	$0.514 \pm 0.003 \pm 0.059$
Ξ^-	$0.477 \pm 0.021 \pm 0.064$	$0.373 \pm 0.010 \pm 0.050$

arXiv:1102.4282 ; submitted to JHEP



Striking diff. Data-MC, increases with strangeness content

b/B : differential cross sections

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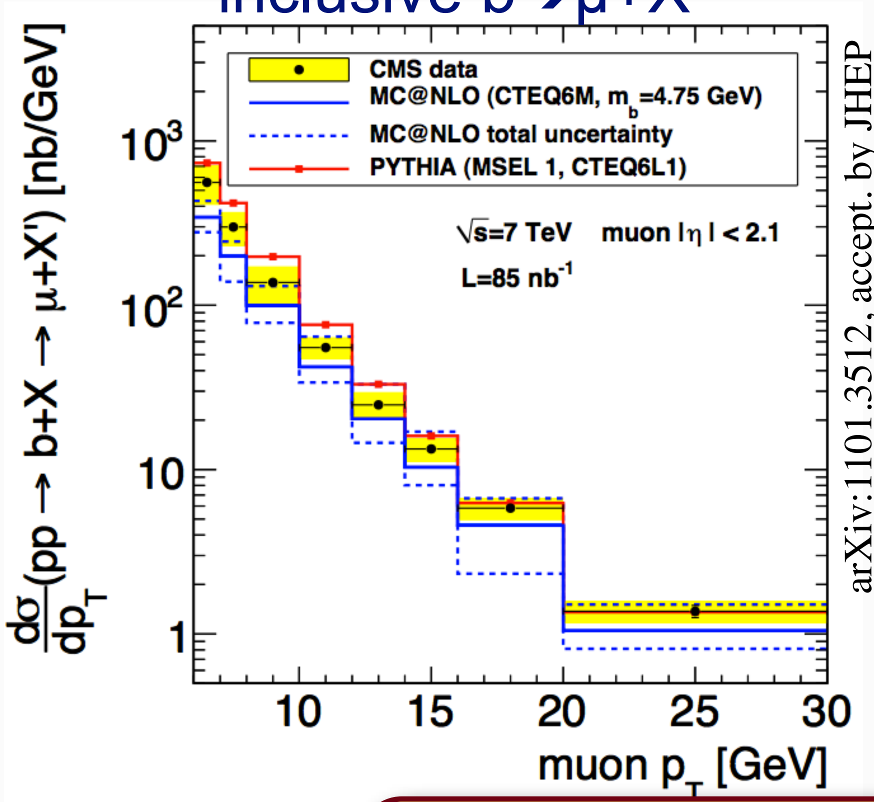
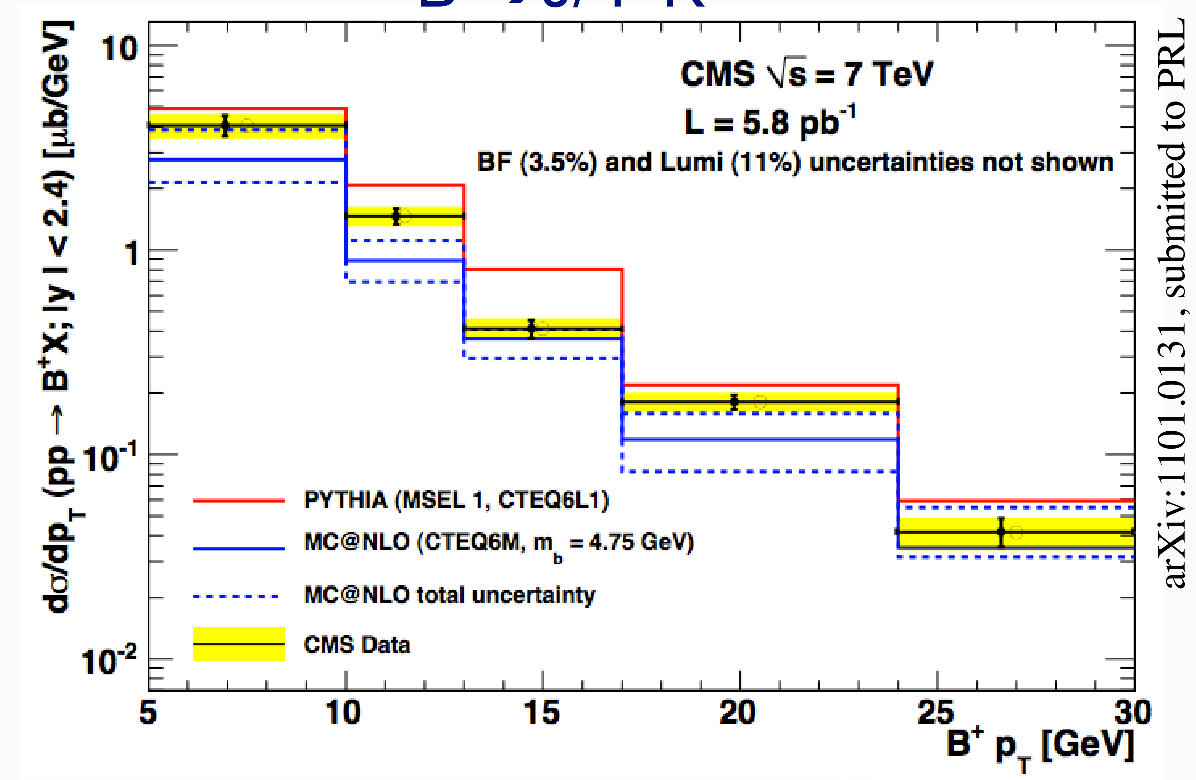
inclusive b→μ+X

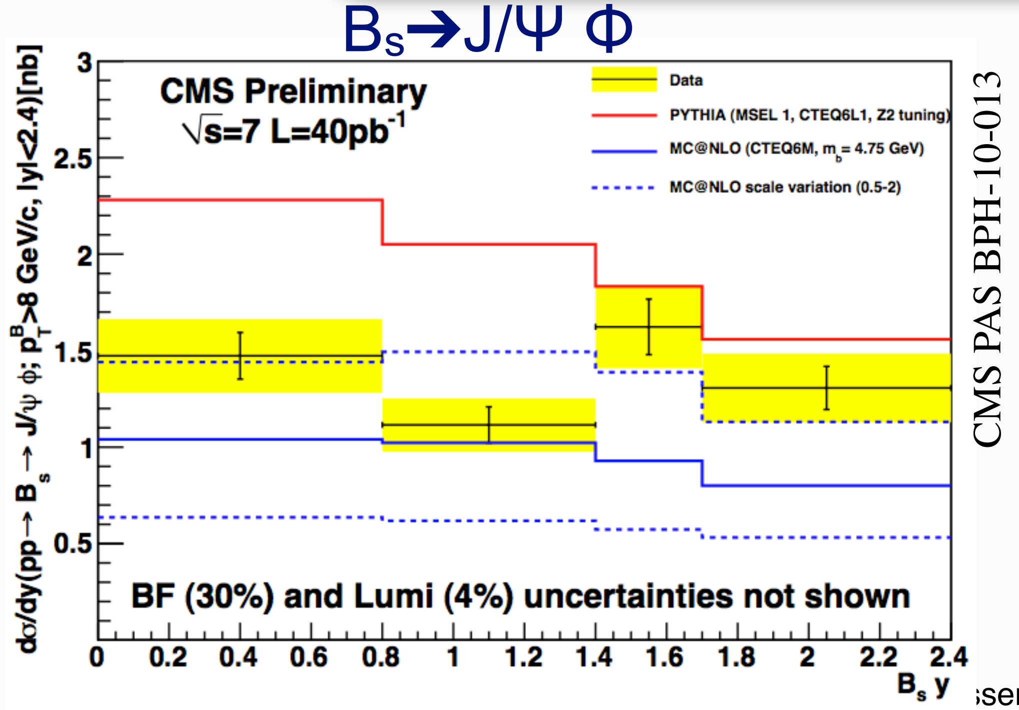


B⁺→J/Ψ K⁺

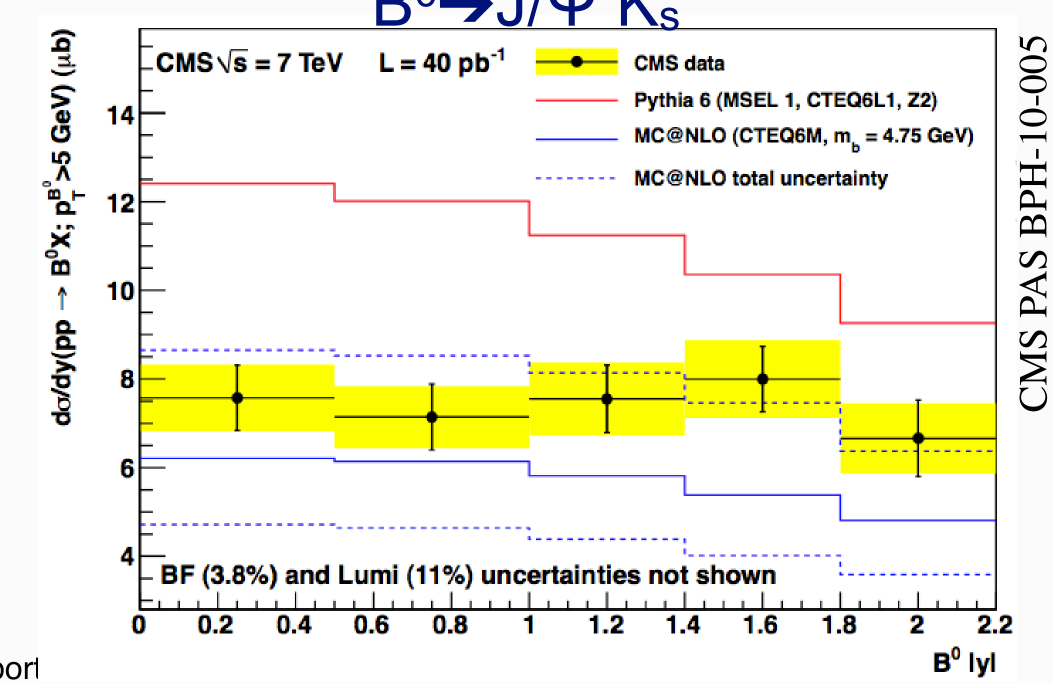


Extensive studies of b/B production. Consistent picture in all channels:
Data between predictions of MC@NLO and Pythia;
differences in shape, both for p_T and rapidity distributions.

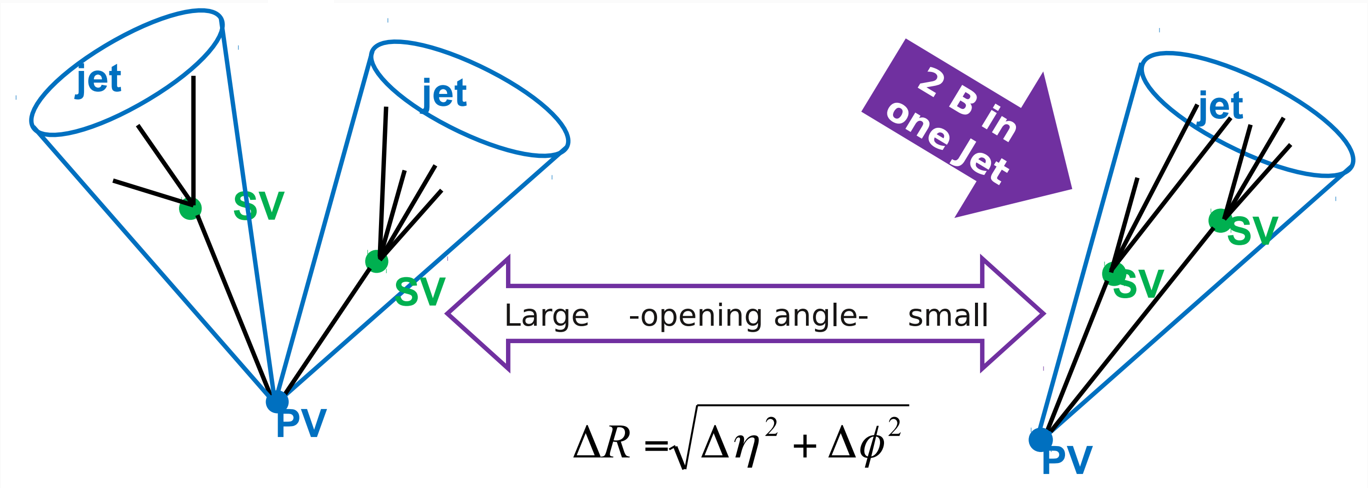
B_s→J/Ψ Φ



B^0→J/Ψ K_s

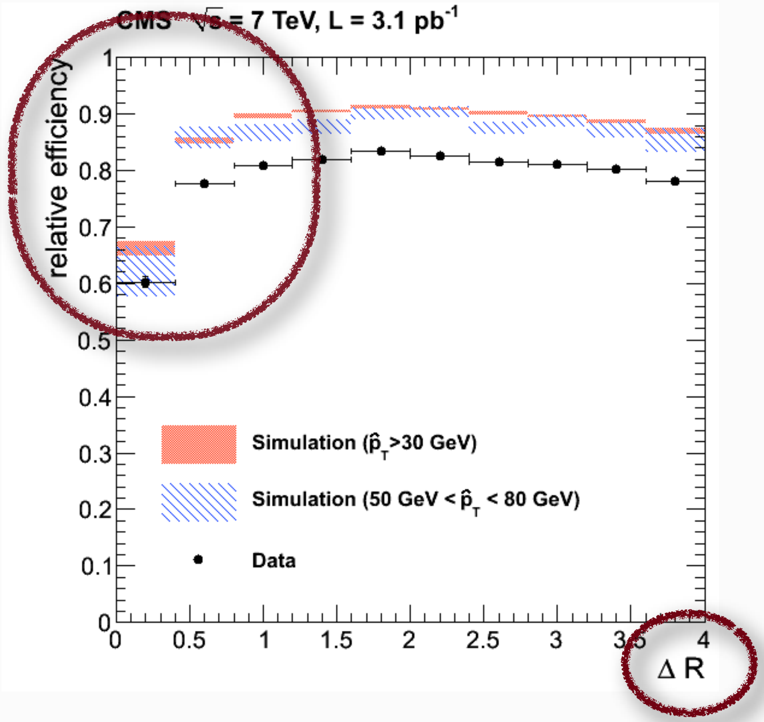


B-hadron angular correlations



$$\Delta R = \sqrt{\Delta\eta^2 + \Delta\phi^2}$$

New: Secondary vertex finder seeded with high IP tracks, jet independent



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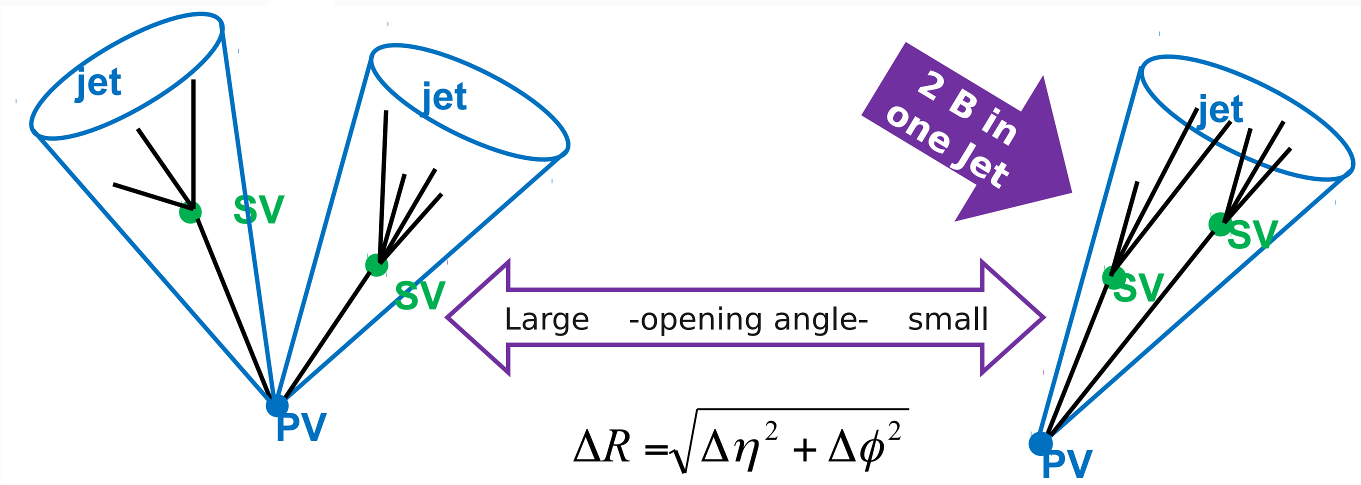

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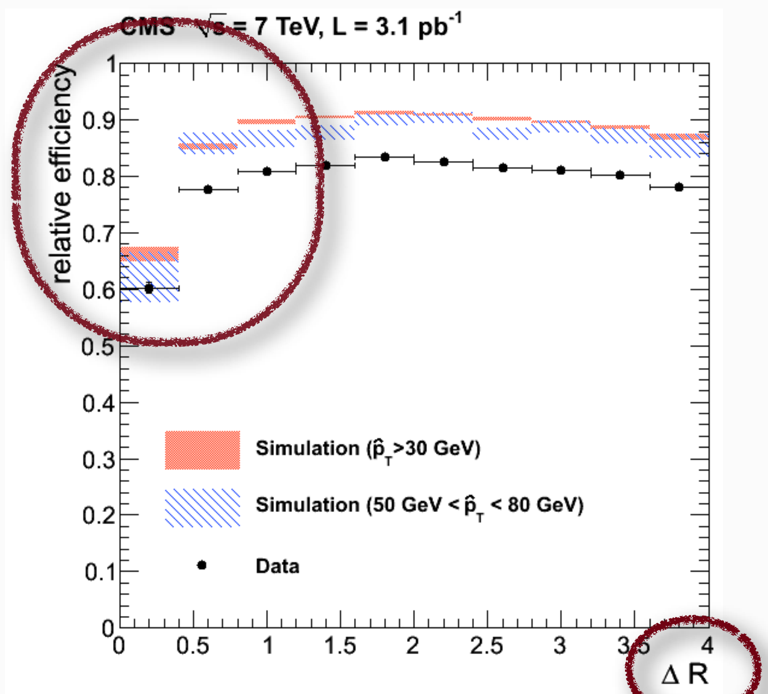

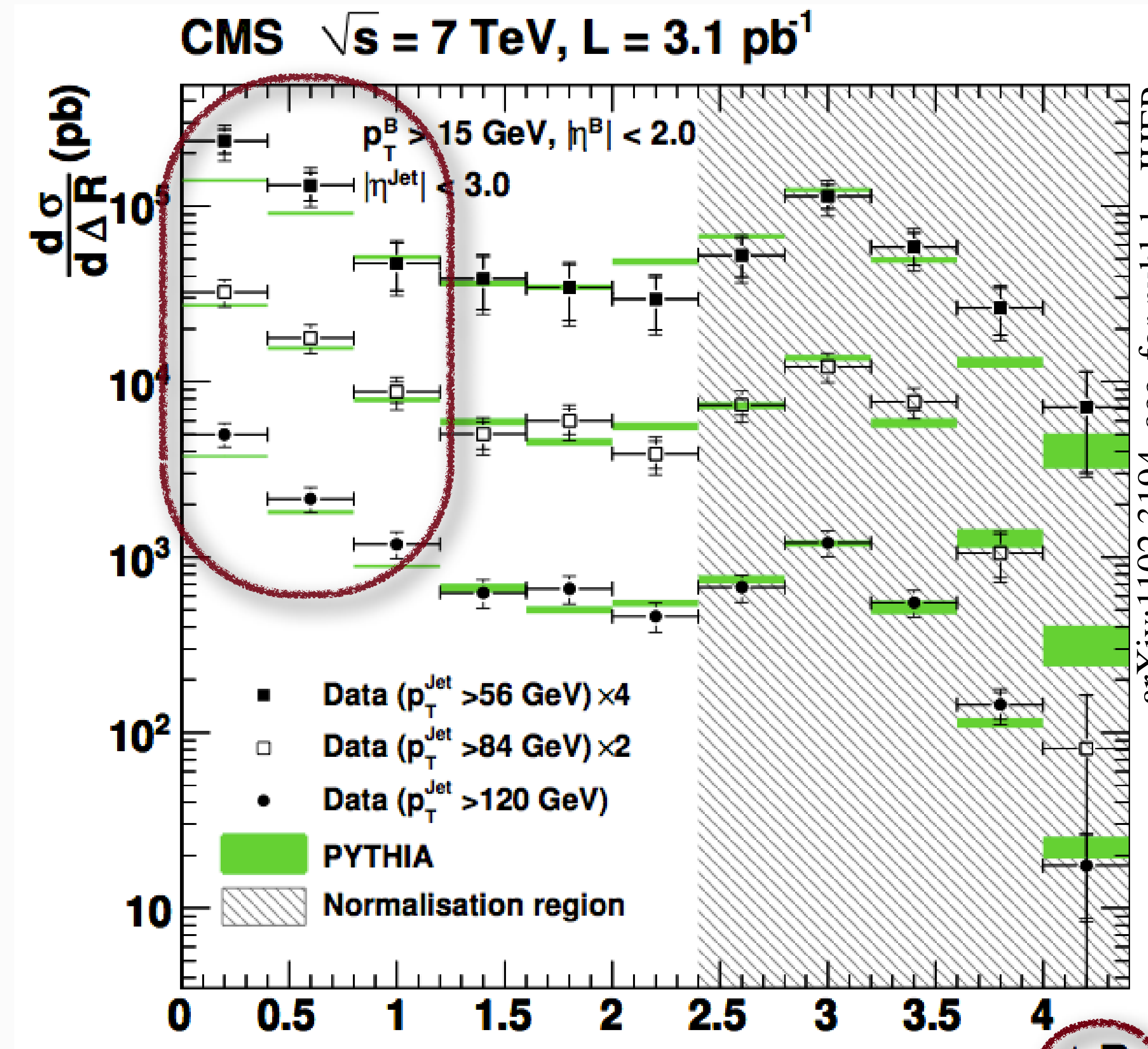

MC normalized to shaded region for shape comparison in the collinear BB region

- Sizable fraction of total BB cross section from collinear B-hadron pairs
- Fraction of collinear BB production increases with leading jet p_T

Extremely important groundwork for upcoming searches with (boosted) bb final states.
In particular: low-mass Higgs!

TOP Cross section

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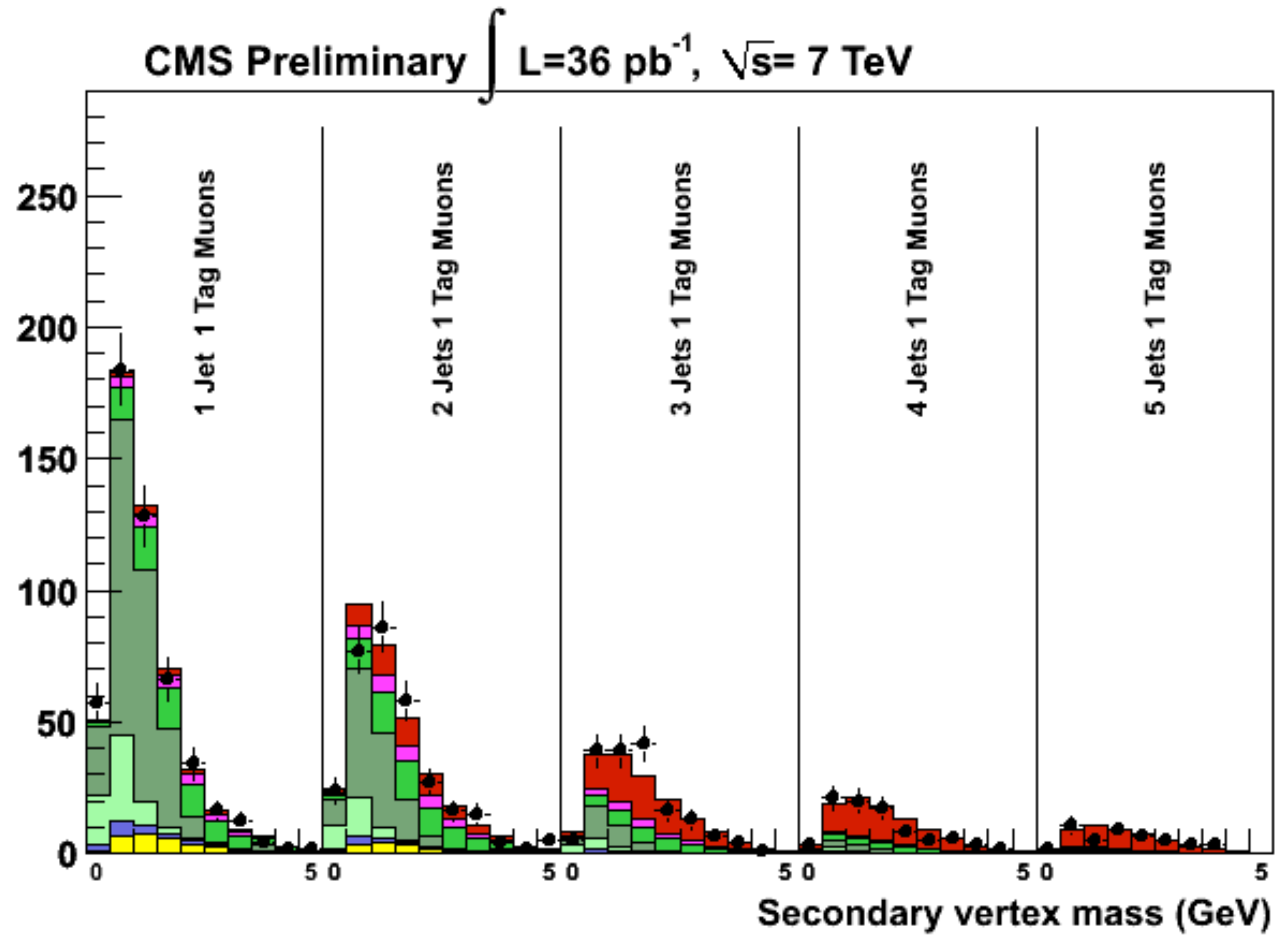
New Analysis: Lepton+jets, b-tagged

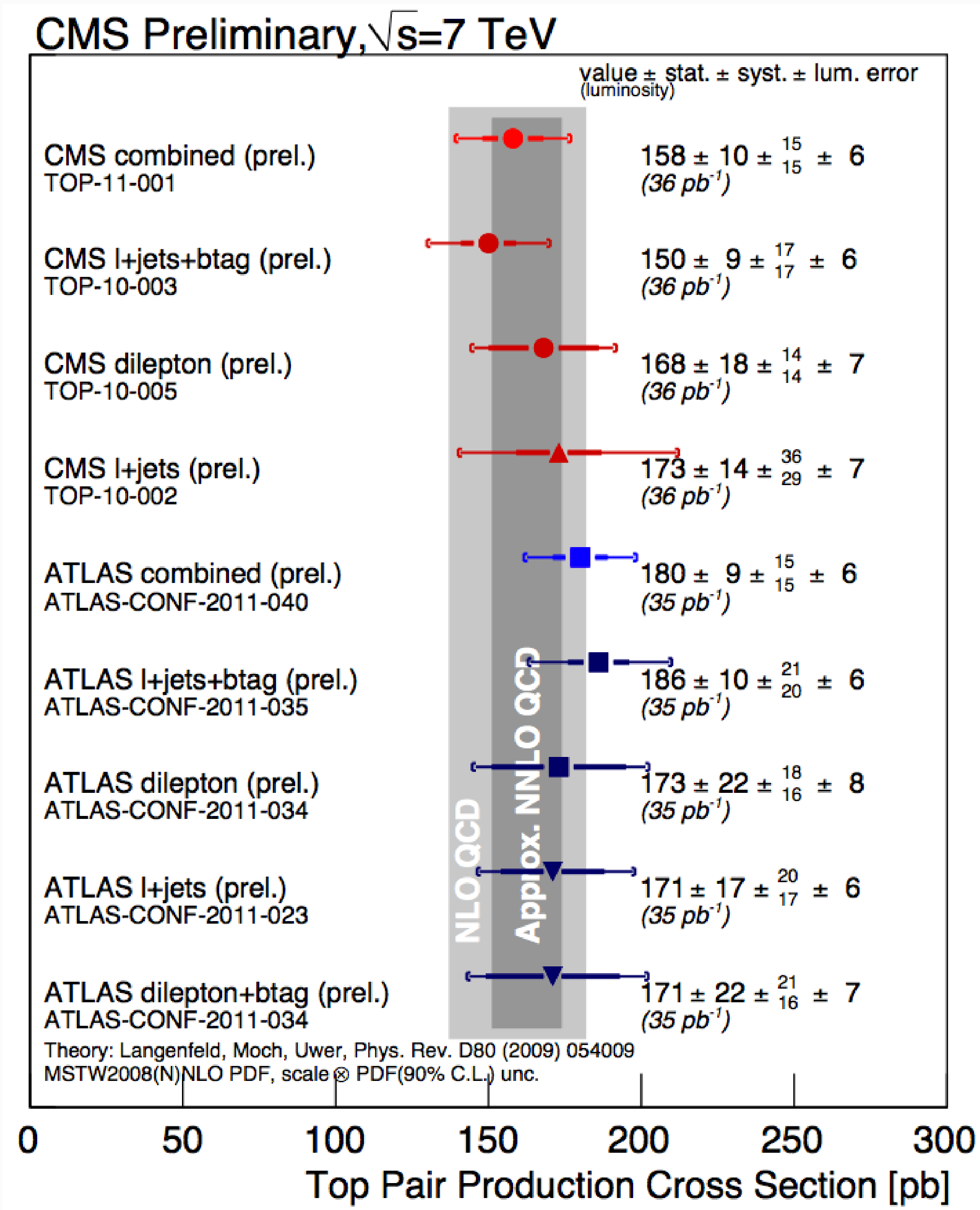
- divide sample into distinct categories: Nr. jets, Nr. of b-tags, electrons, muons
- fit the secondary vertex mass distribution, using templates, simultaneously in all categories
- let also data/MC scale factors (JES, b-tag eff, W+j Q^2-scale) float in the fit
- **Result**:
  - top cross section, with overall **11% syst. uncert.**
  - scale factors consistent with 1, within the fit error

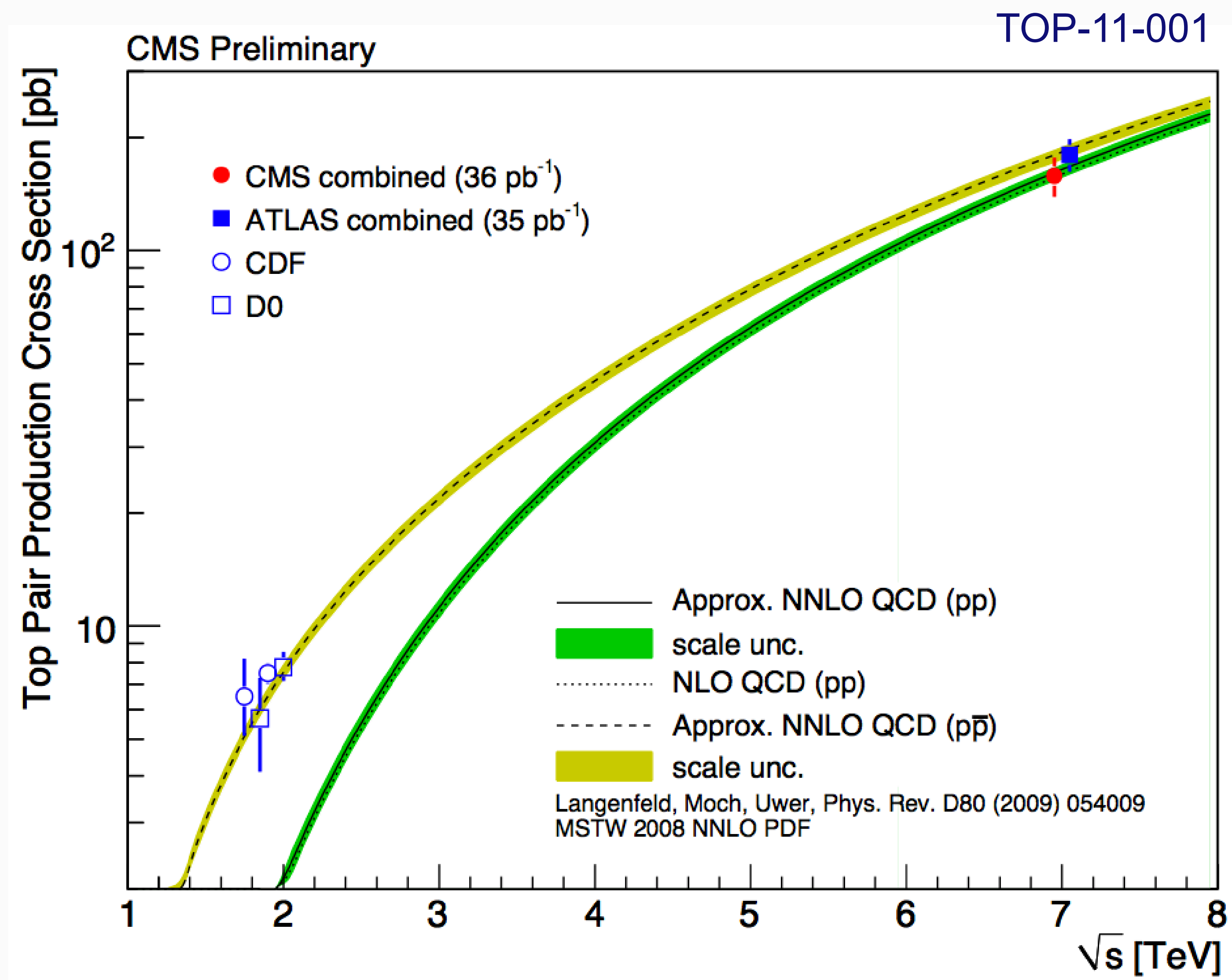


Source	Uncertainty (%)
Systematic uncertainties	
Lepton ID/reco/trigger	3
Unclustered E_T^{miss} resolution	< 1
$t\bar{t}$+ Jets Q^2-scale	2
ISR/FSR	2
ME to PS matching	2
PDF	3.4
Profile likelihood parameters	
Jet energy scale and resolution	7.0
b tag efficiency	7.5
W+Jets Q^2-scale	9.1
Combined	11.6

A fantastic proof of the excellent understanding of all relevant physics objects, and of their outstanding MC description

Top cross section and mass





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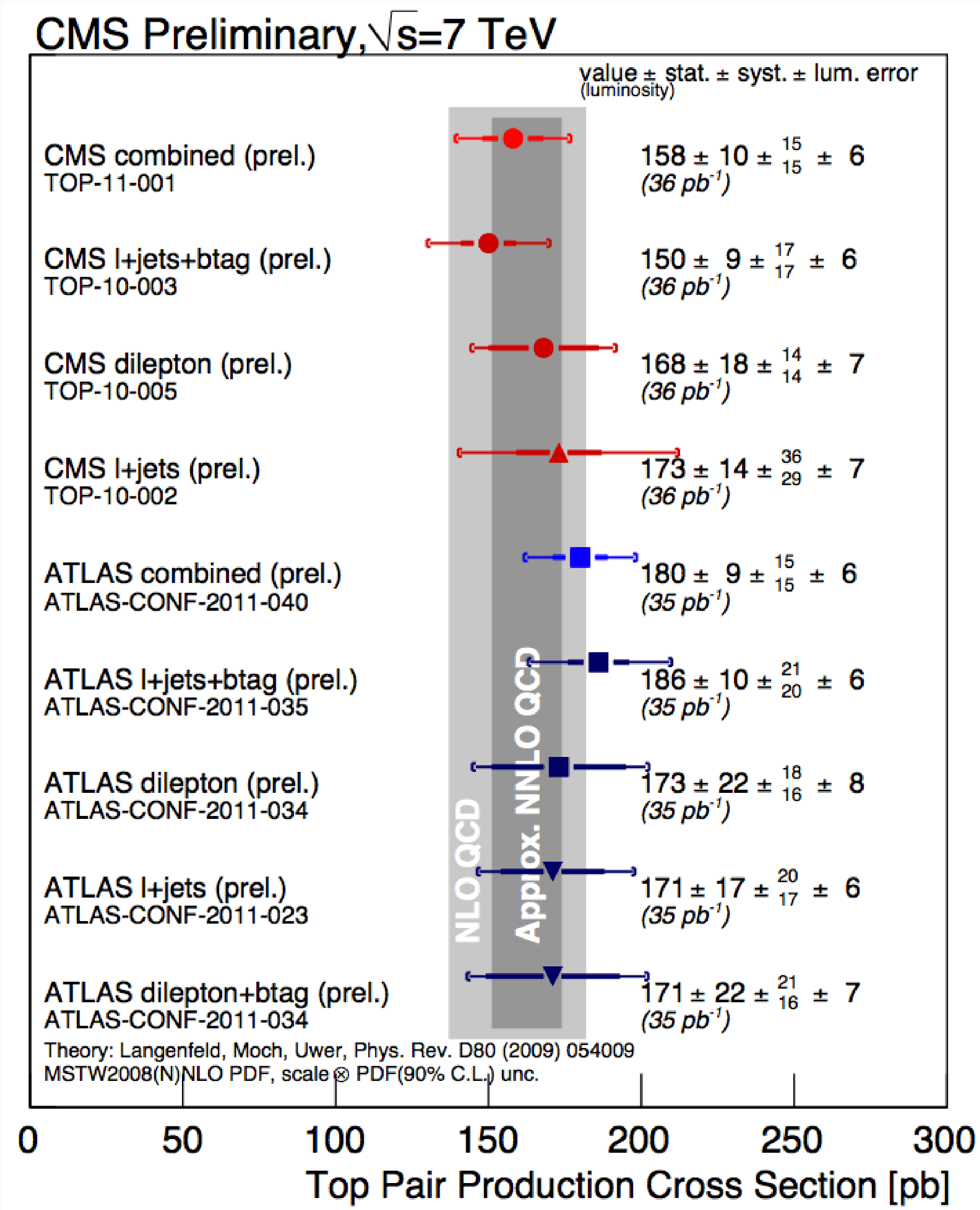
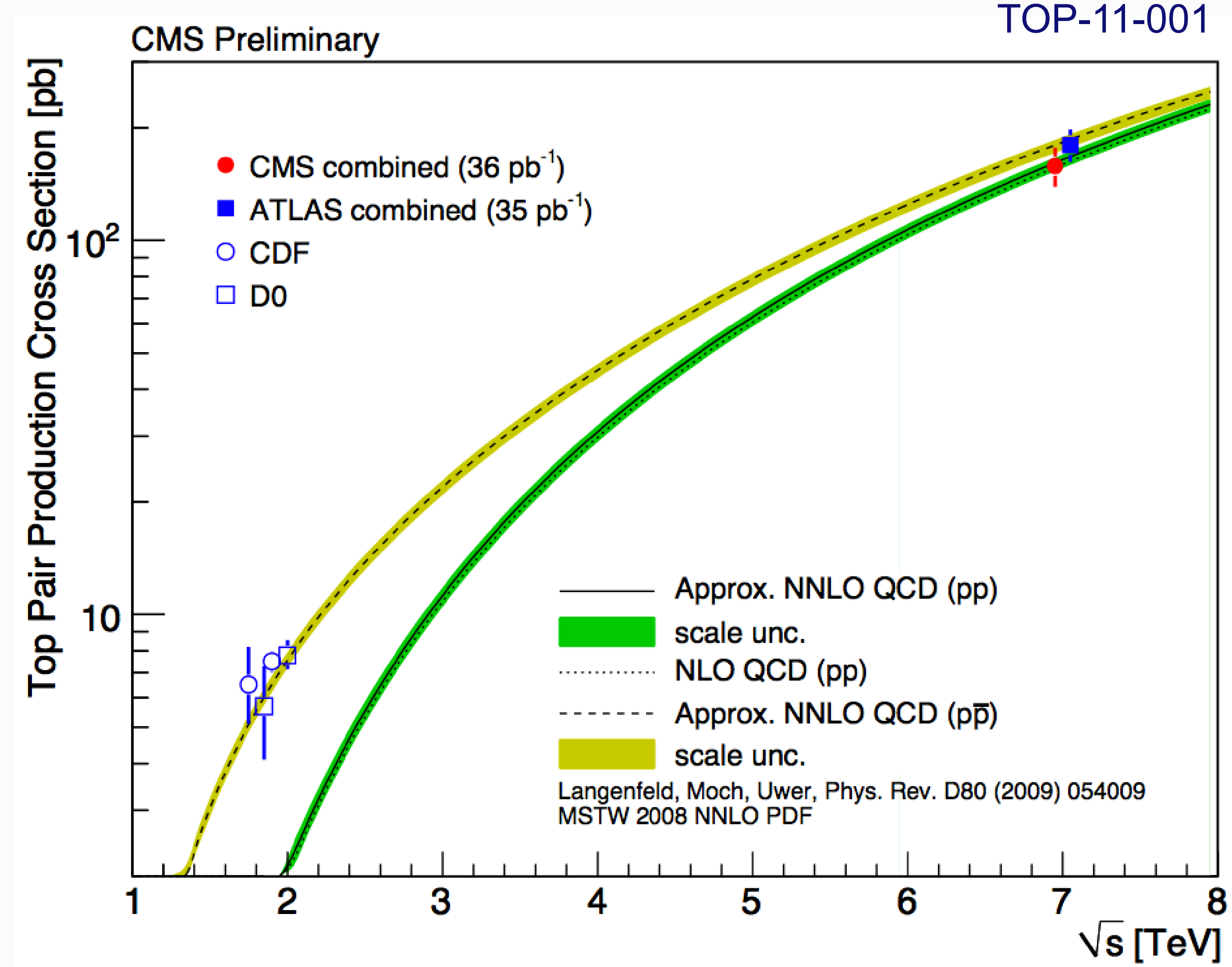


TOP-11-001



TOP mass: dilepton

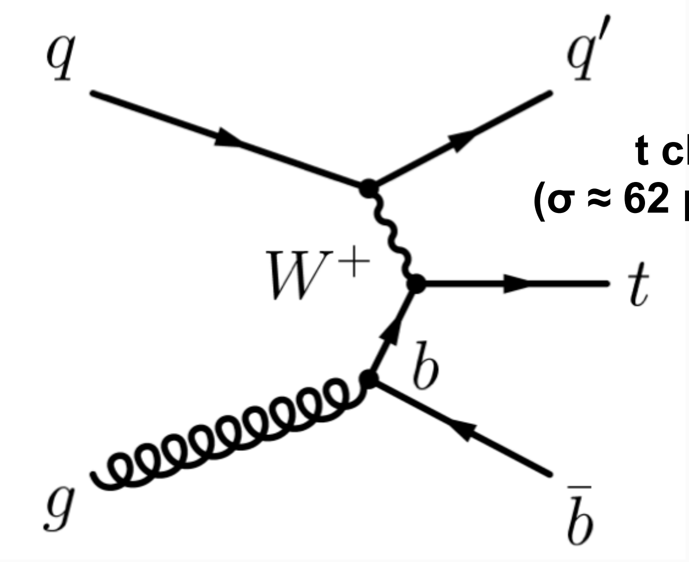
TOP-10-006

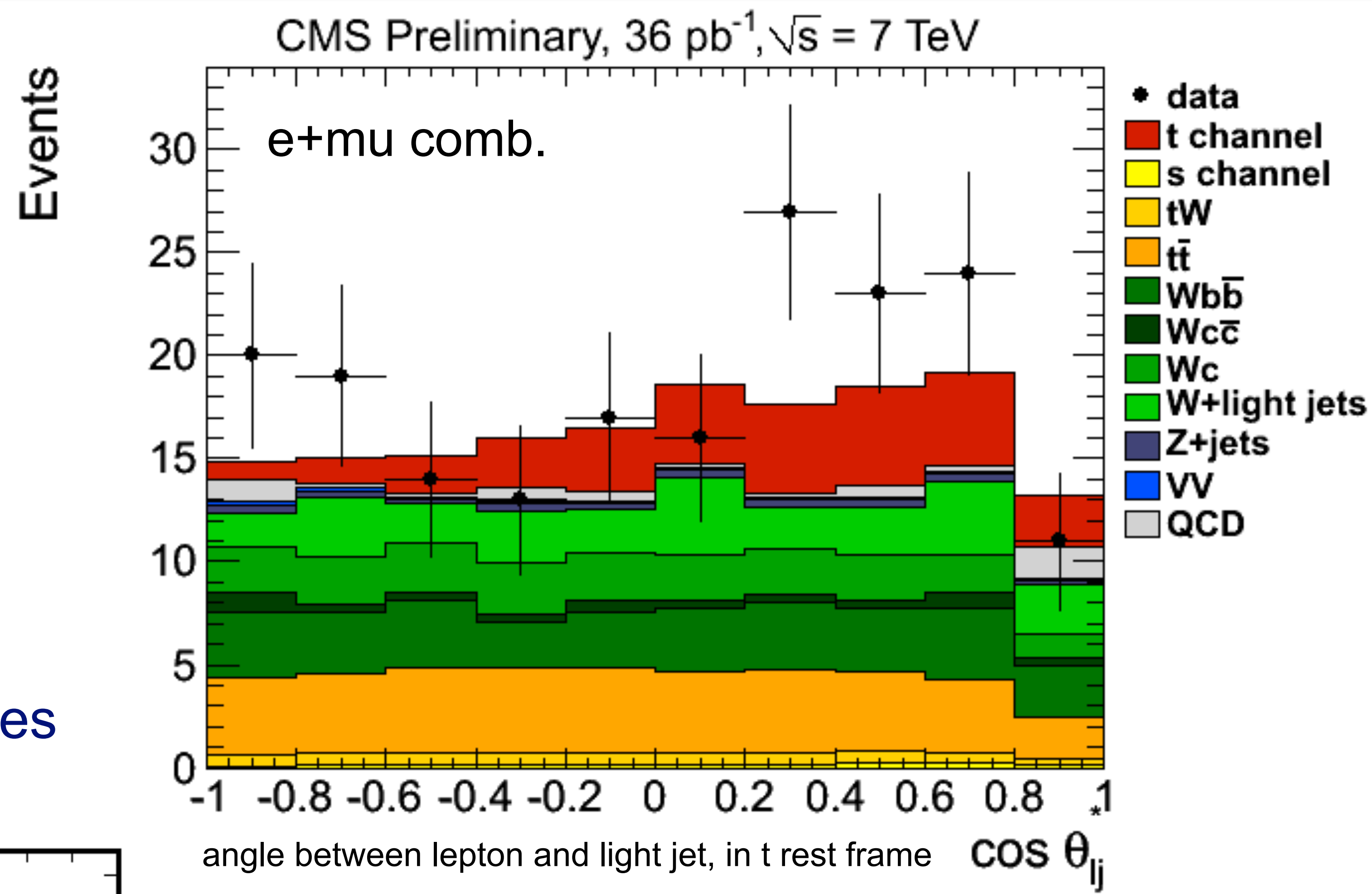
Method	Measured m_{top} (in GeV/c^2)	Weight
AMWT	$175.8 \pm 4.9(stat) \pm 4.5(syst)$	0.65
KINb	$174.8 \pm 5.5(stat)^{+4.5}_{-5.0}(syst)$	0.35
combined	$175.5 \pm 4.6(stat) \pm 4.6(syst)$	χ^2/dof=0.040 (p-value=0.84)

Syst. uncertainty dominated by:
JES (3.1 GeV)
b-JES (2.5 GeV)

Single top production

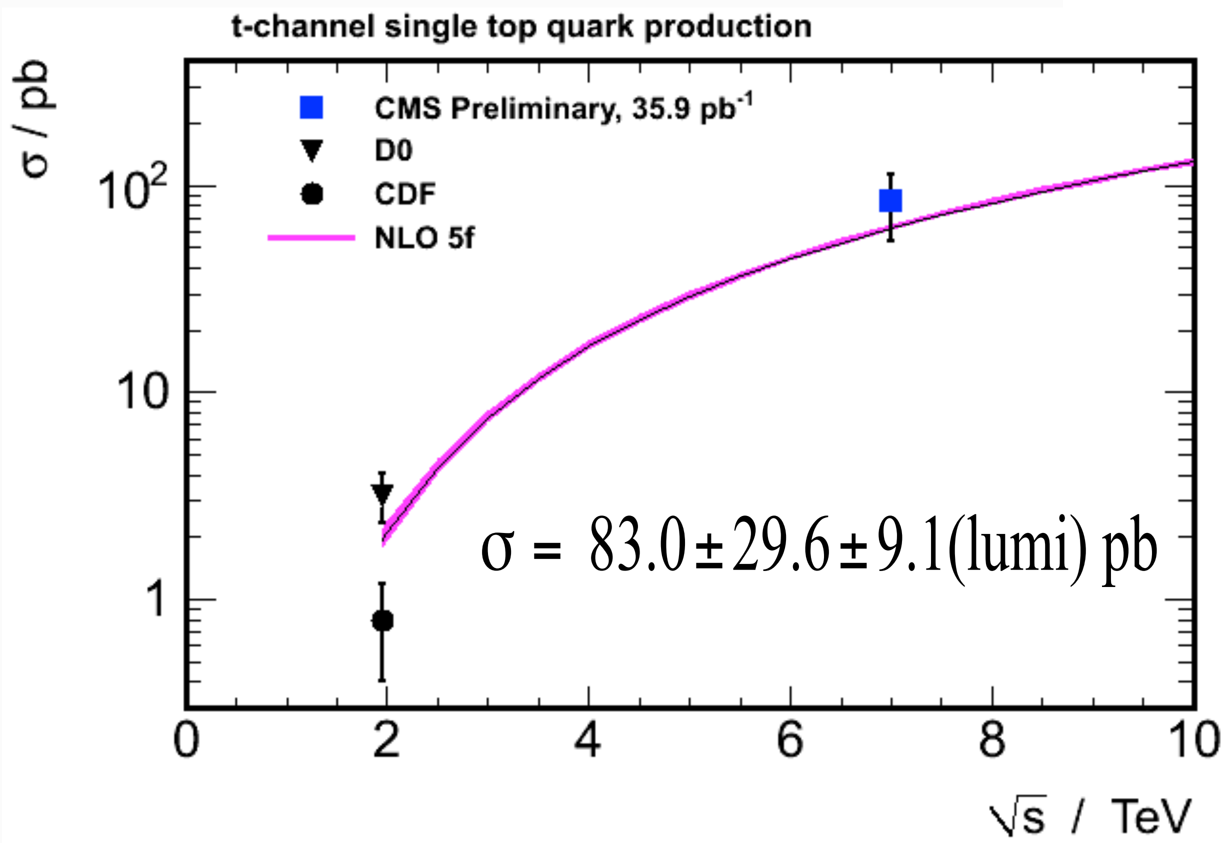
TOP-10-008





Two methods employed:

- Cut based using angular info
- BDT, based on kinematic observables

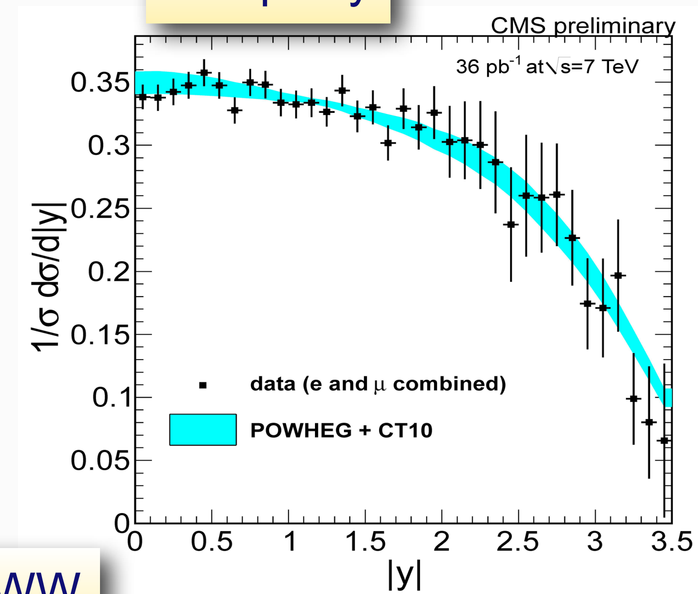


An example of finding **tiny** signals with leptons, MET, b-tag & jets

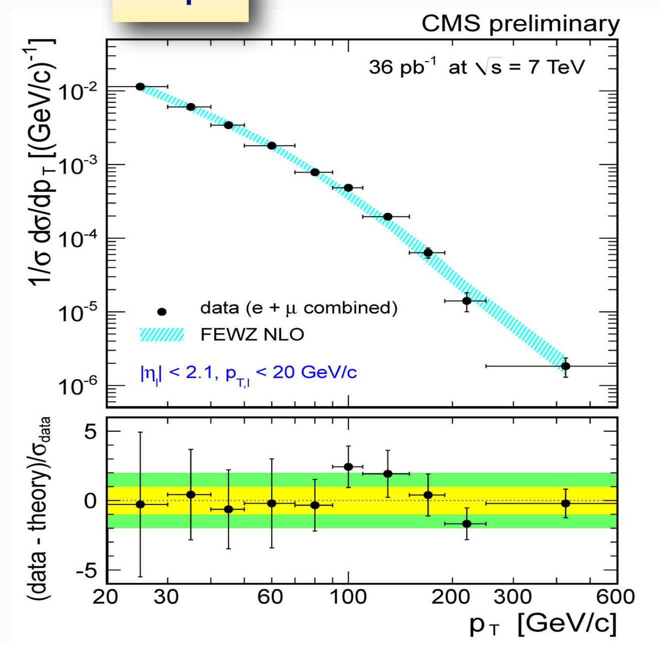
Showing the readiness for challenging searches such as low-mass Higgs

Production of Vector Bosons

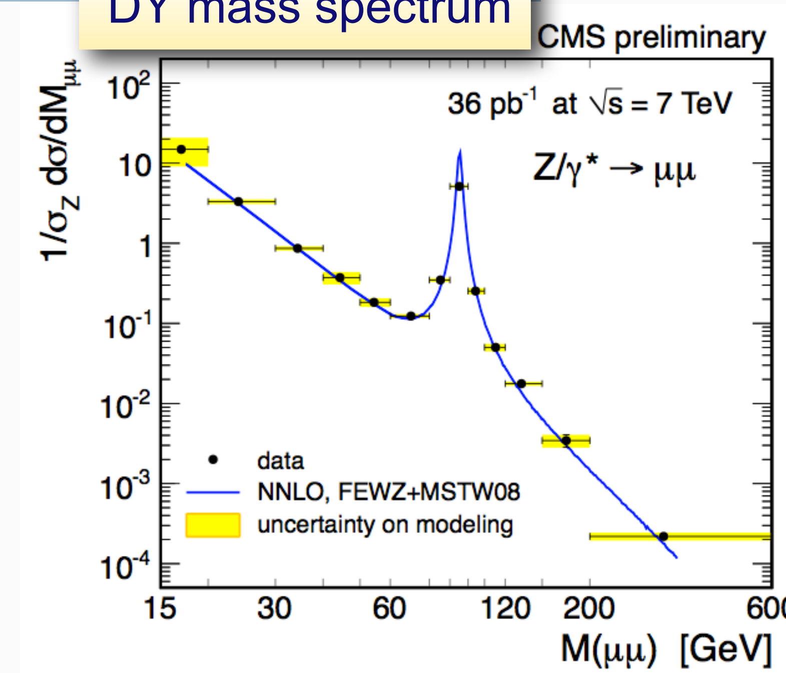
Z rapidity



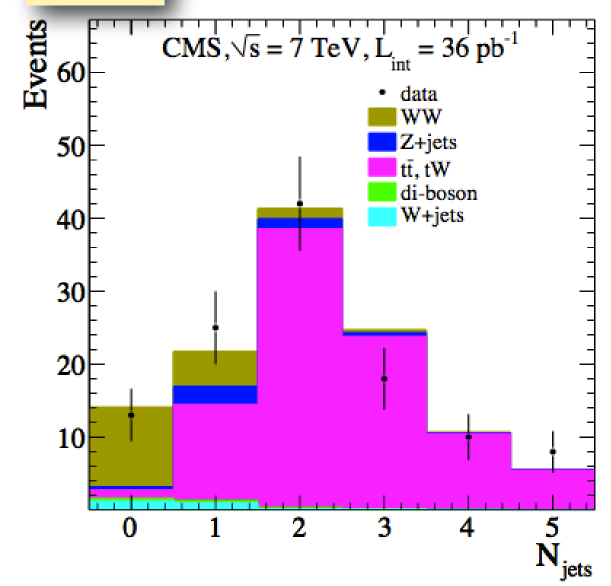
Z pT



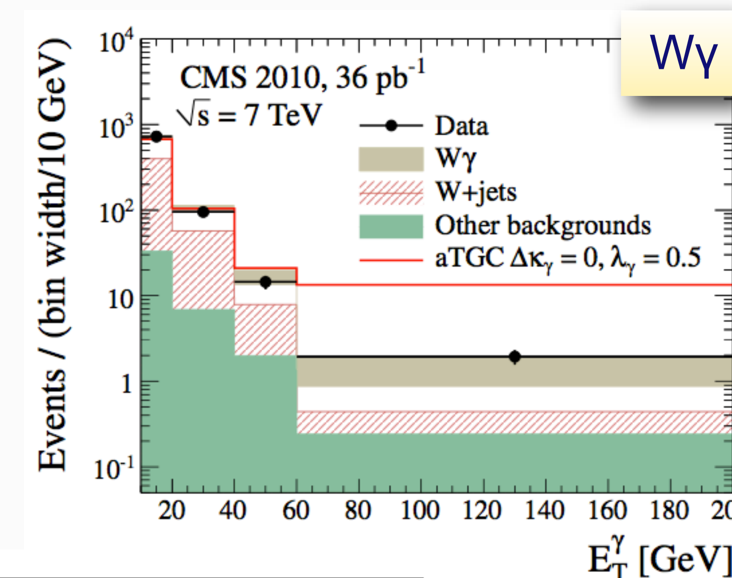
DY mass spectrum



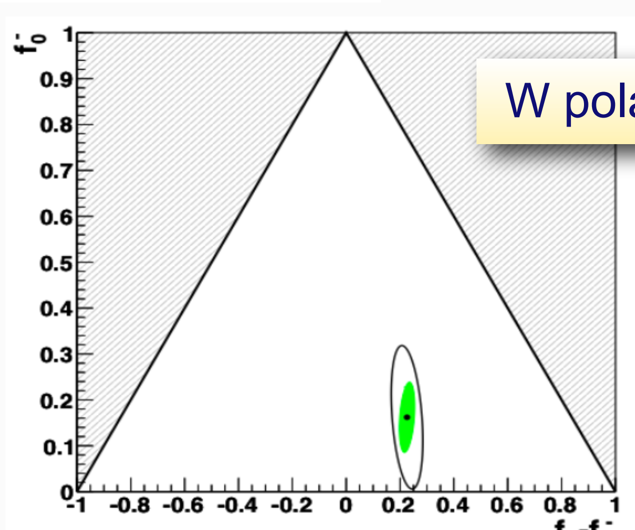
WW



Wγ

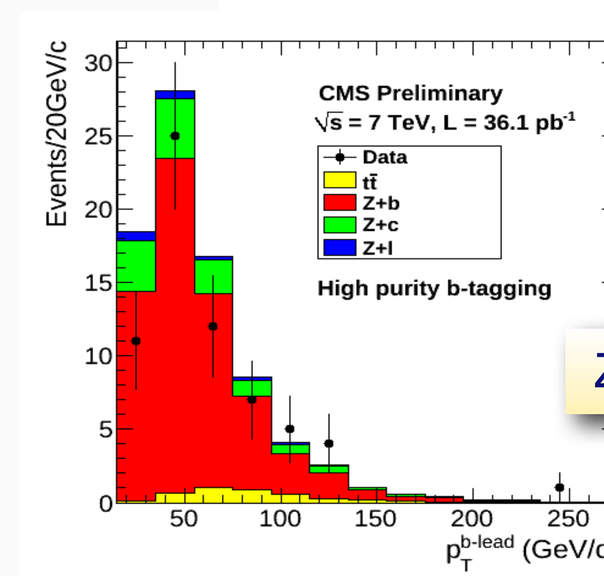


W polarization

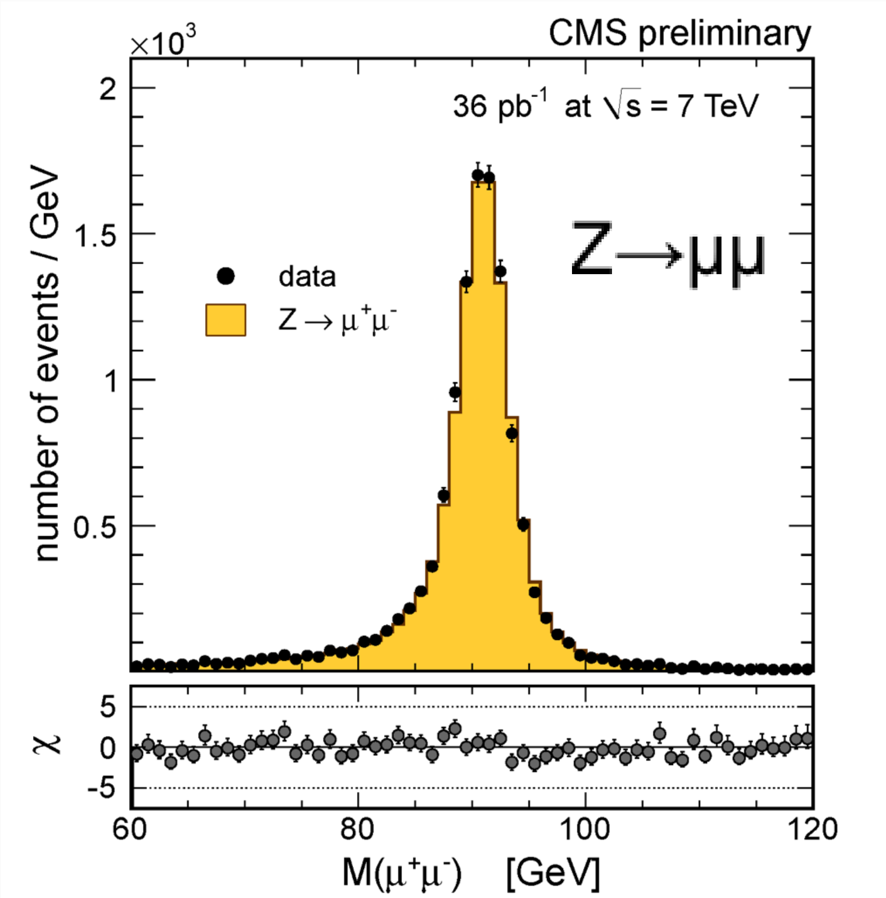


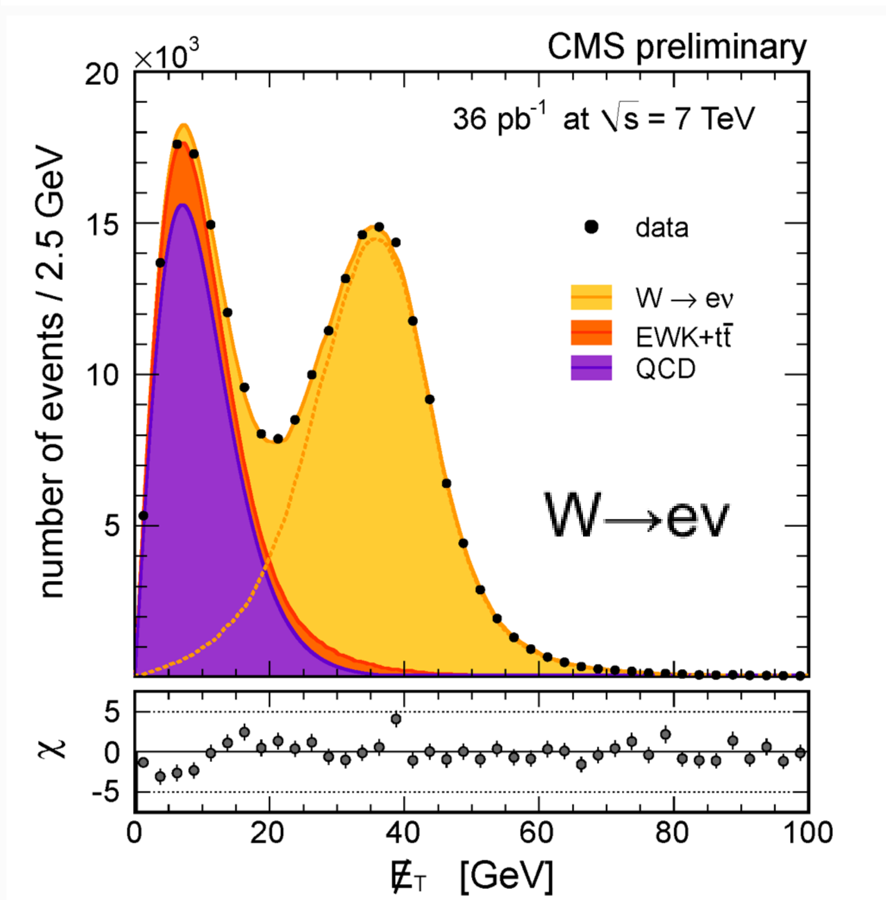
see also recent talk by
- P.C. Harris, Moriond EWK-11

Zb



Inclusive W and Z production





- 3 pb^{-1} results published,JHEP01(2011)080
- new prelim. results for 36 pb^{-1}
- Z important tool : data-driven methods for controlling lepton eff, scale, resolution, E_{Tmiss} (hadronic recoil).
- In general excellent data-MC agreement

Inclusive W and Z production

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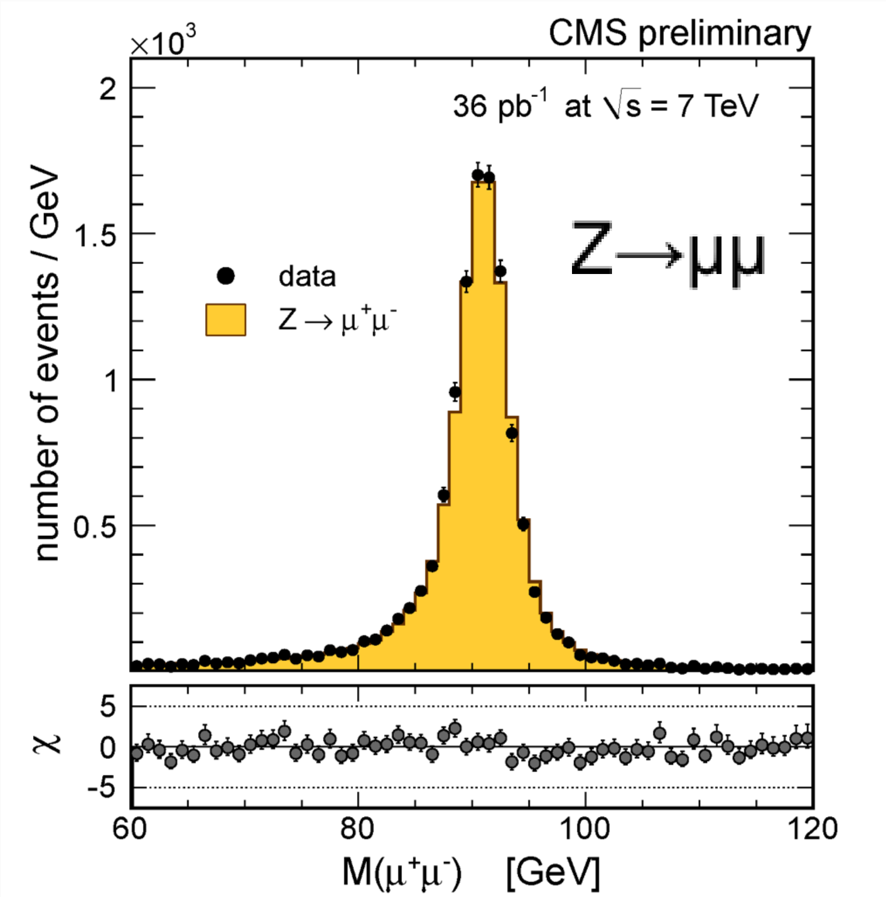

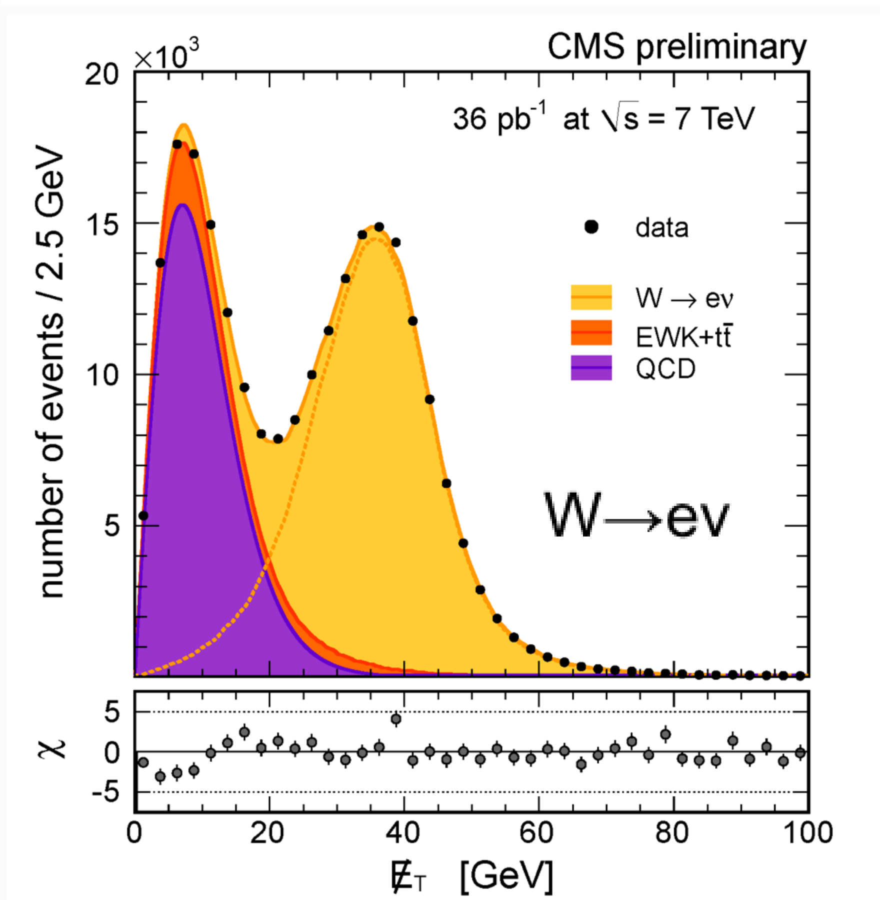

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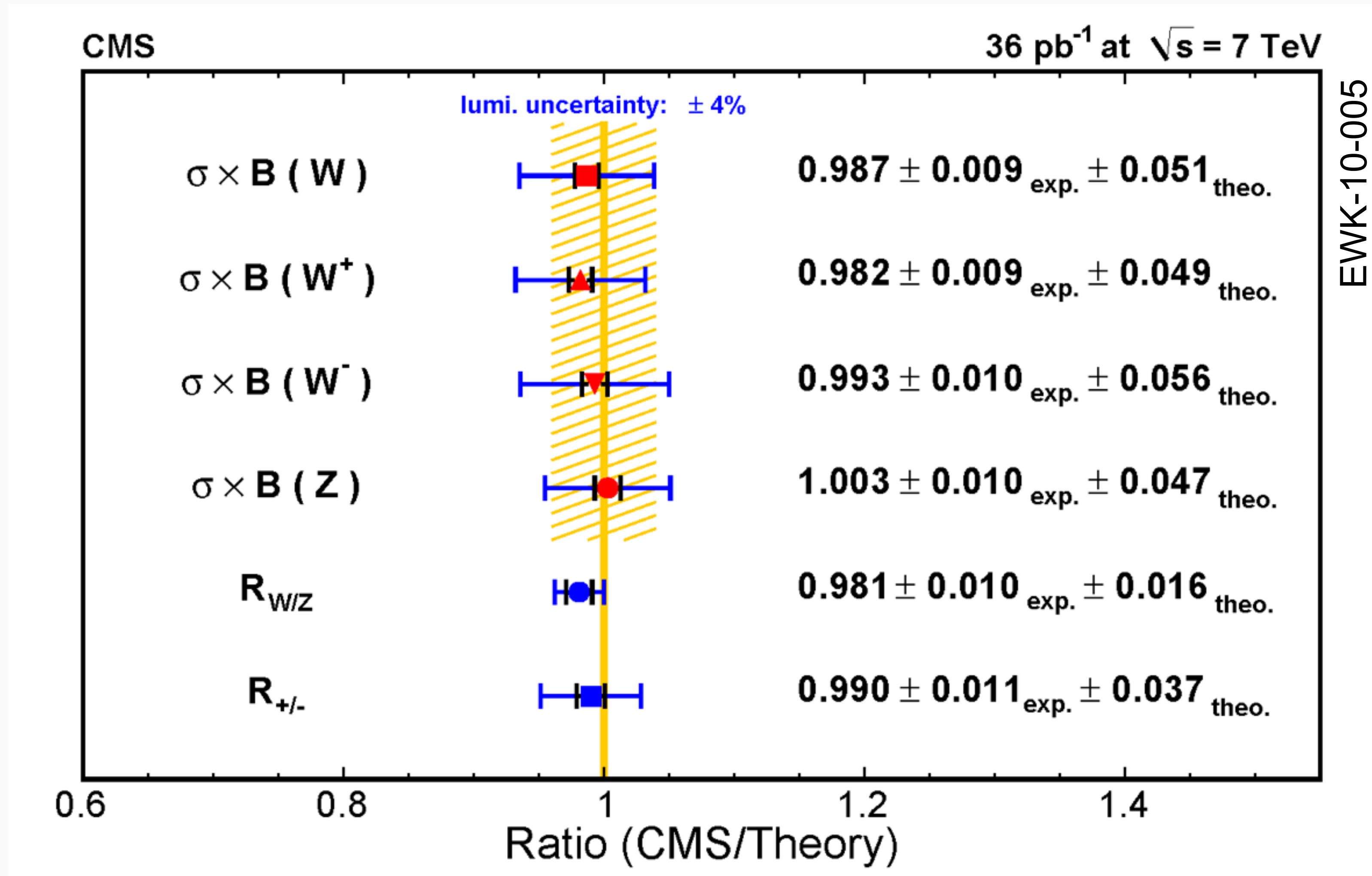
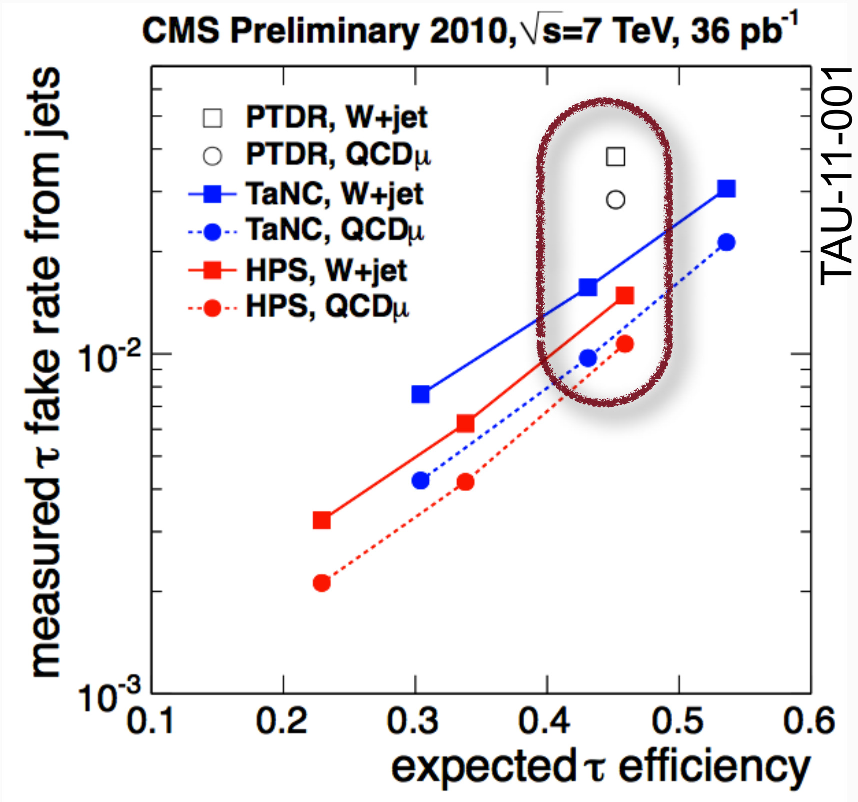
- Z important tool : data-driven methods for controlling lepton eff, scale, resolution, E_{Tmiss} (hadronic recoil).
- In general excellent data-MC agreement



Amazing precision reached (~1% experimental !)
Start to put important constraints on theory (NNLO, PDFs)

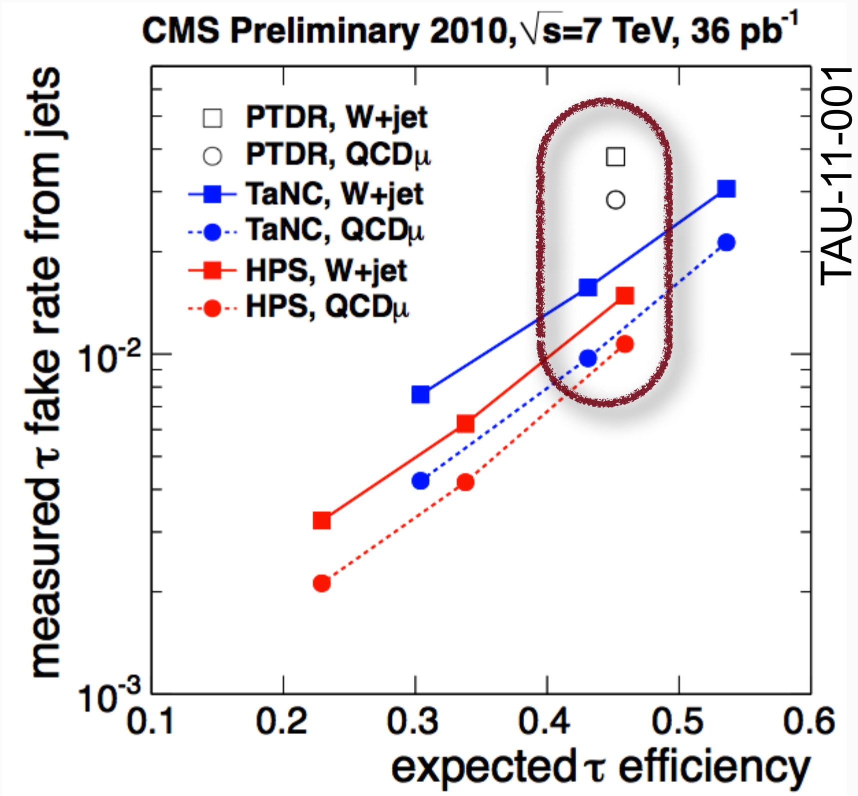
τ performance and Z→ττ



- **Improvement in CMS Tau Identification Performance**
- due to reconstruction of individual decay modes (vector meson resonances), **based on Particle Flow**
- for same efficiency, fake rate reduced by factor of 3
- **for the Z analysis included:** mu+had, e+had, e+mu, mu+mu (~55% of total BR)
- had-tau eff. constrained by ratio lept/semi-lept channels

0.94 ± 0.09

τ performance and Z→ττ



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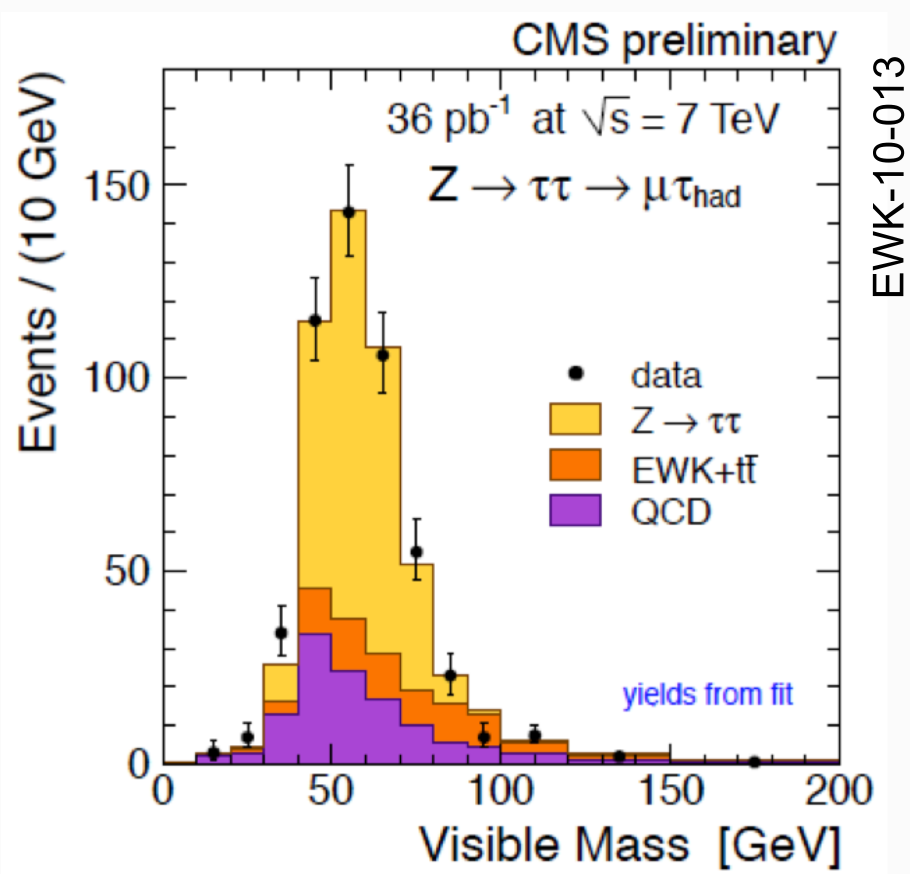
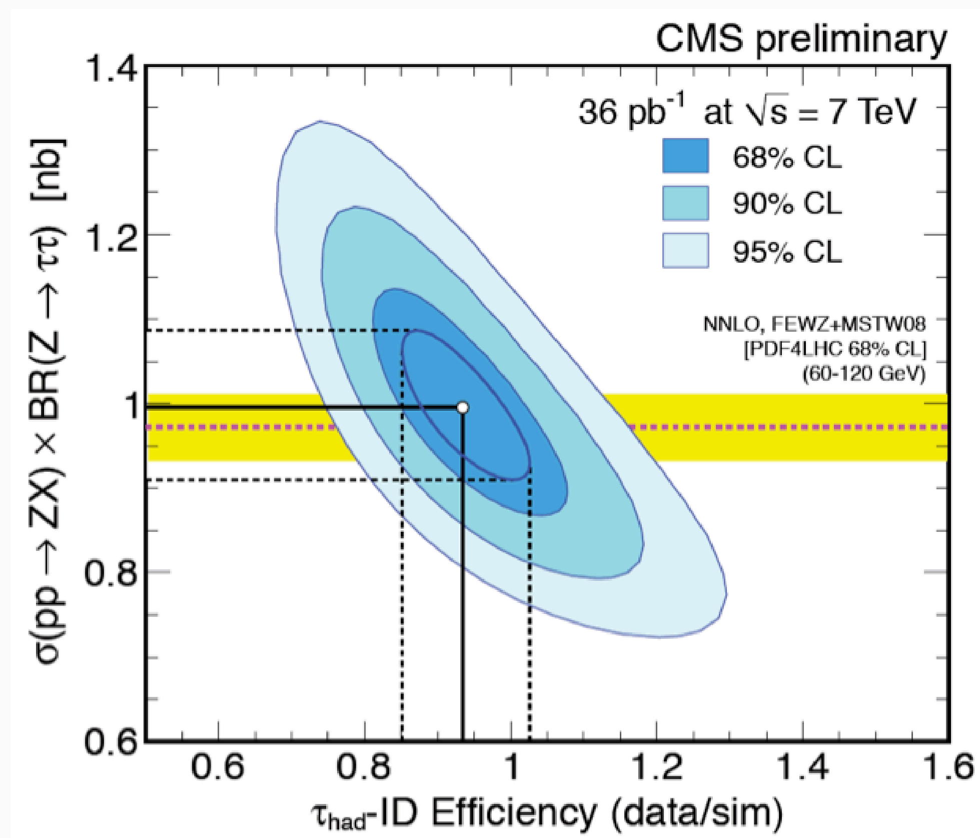
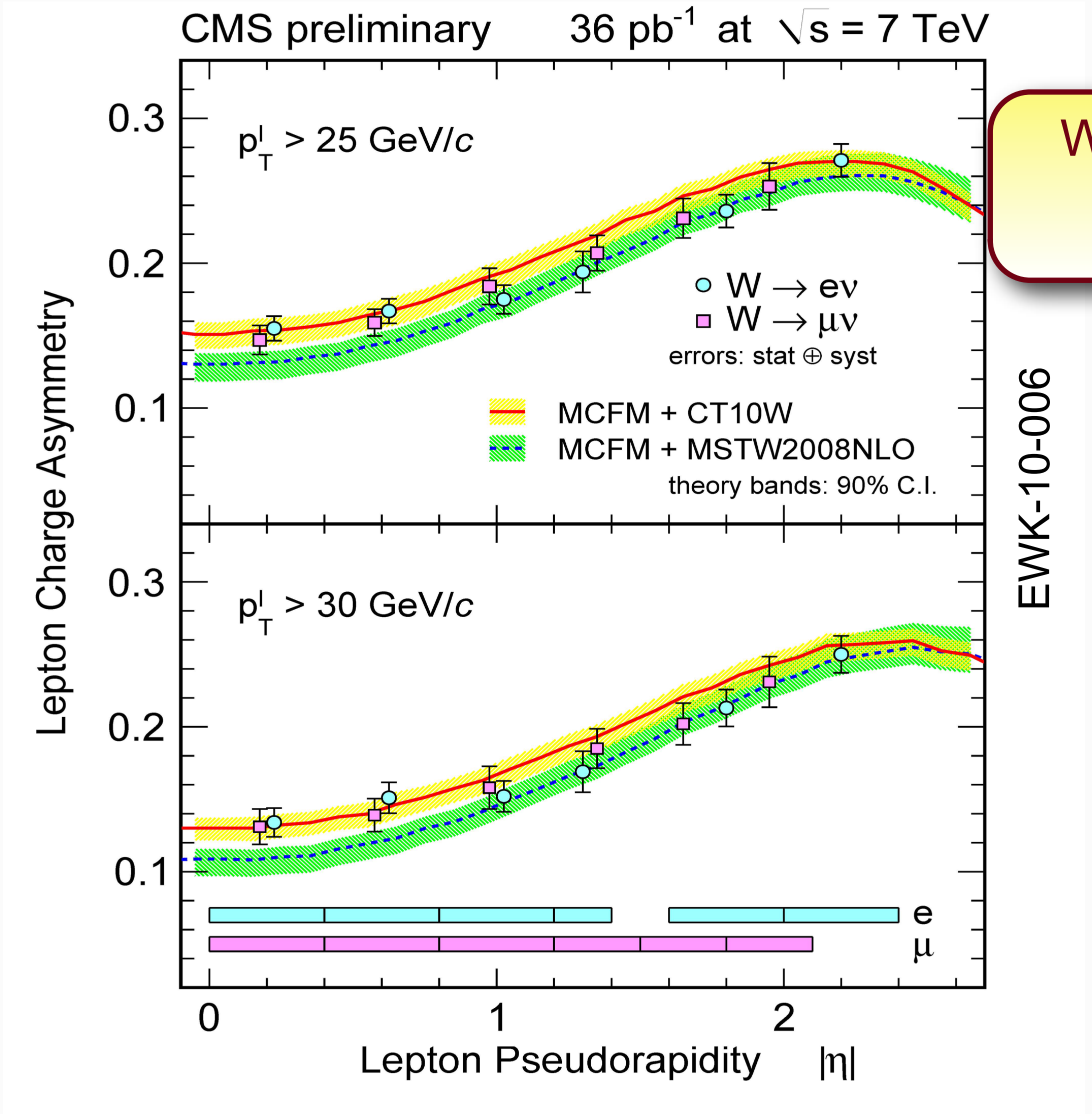




0.94 ± 0.09

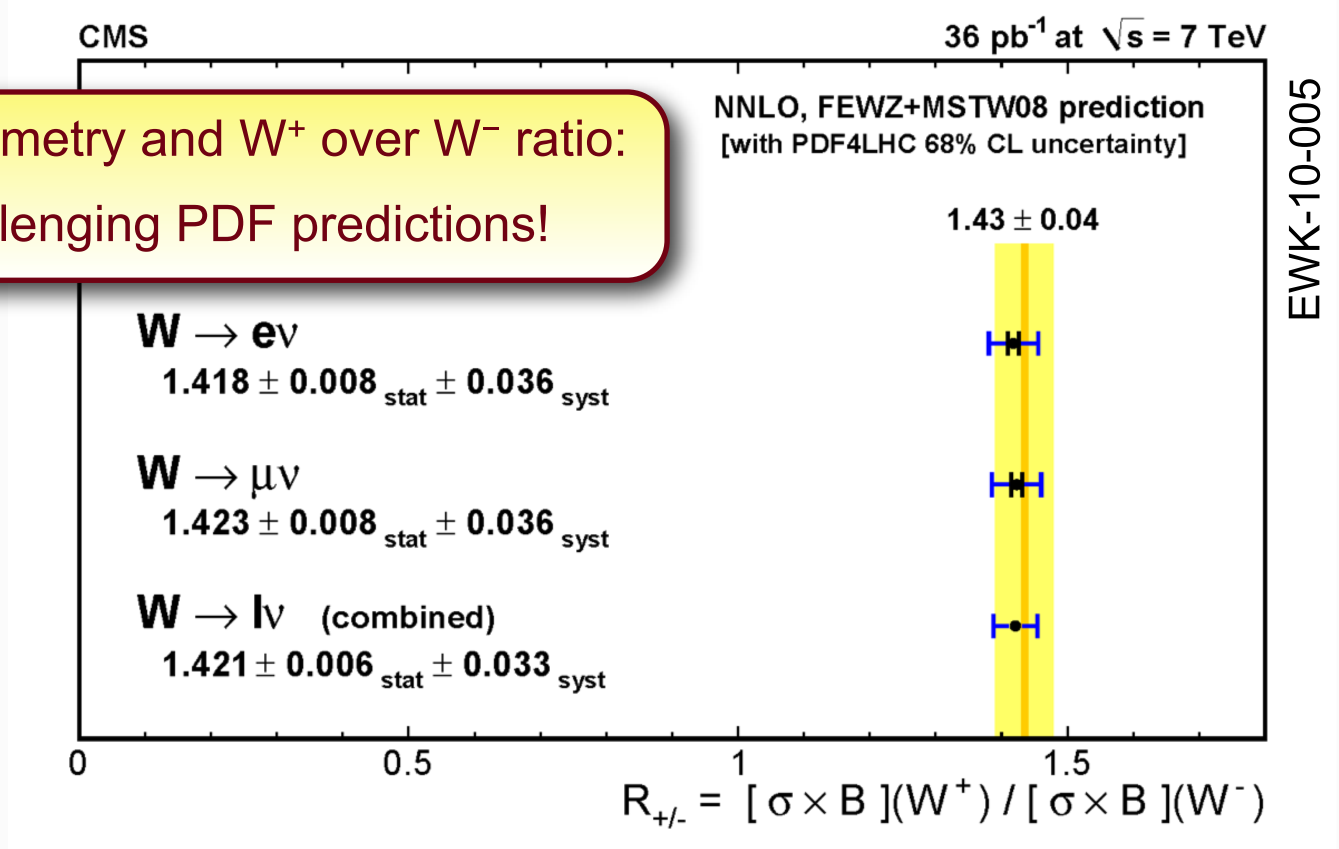
Tau established as an important tool for many analyses, in the SM sector and new physics searches

W properties, constraining PDFs



W asymmetry and W⁺ over W⁻ ratio:

Challenging PDF predictions!



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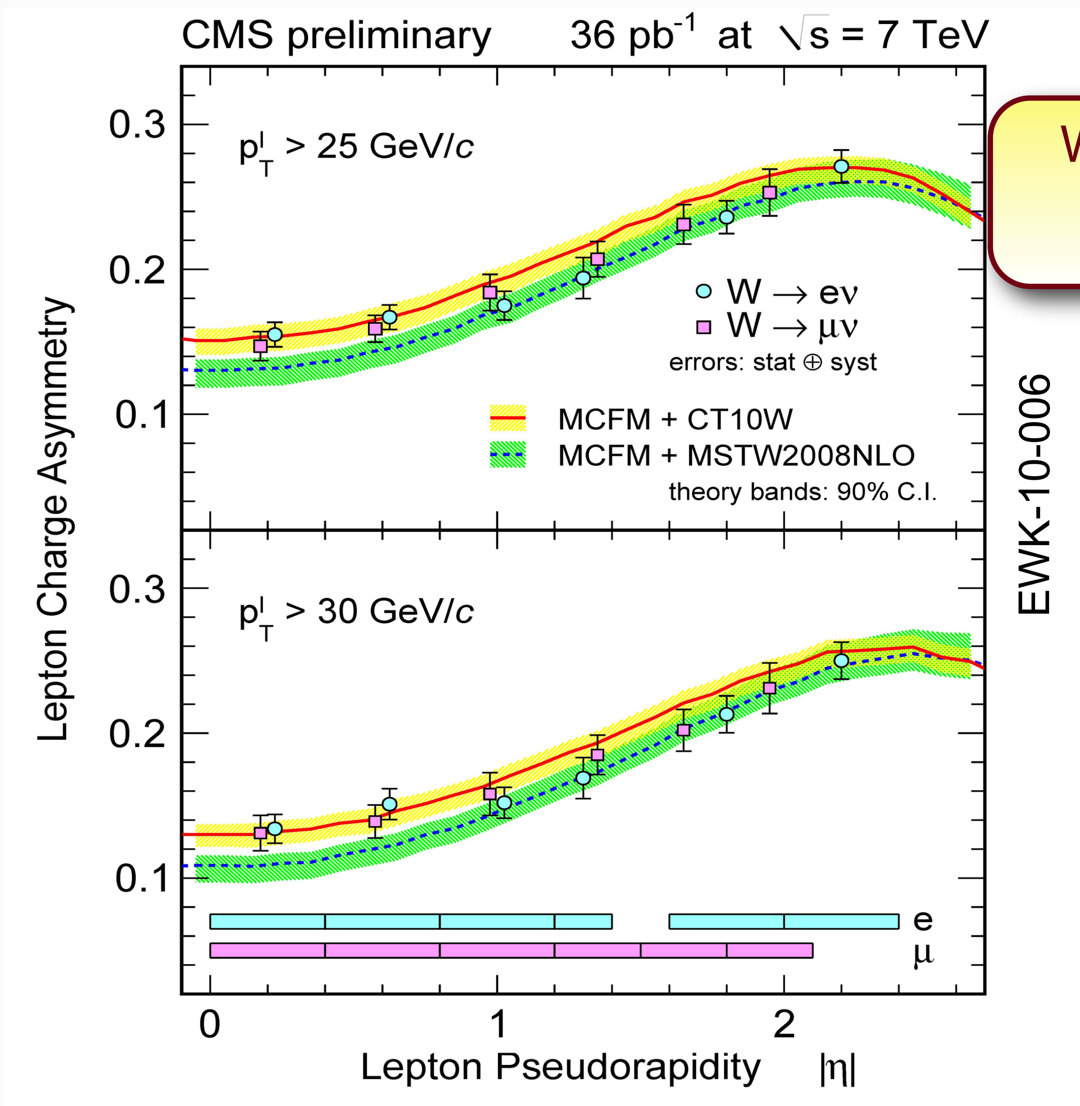

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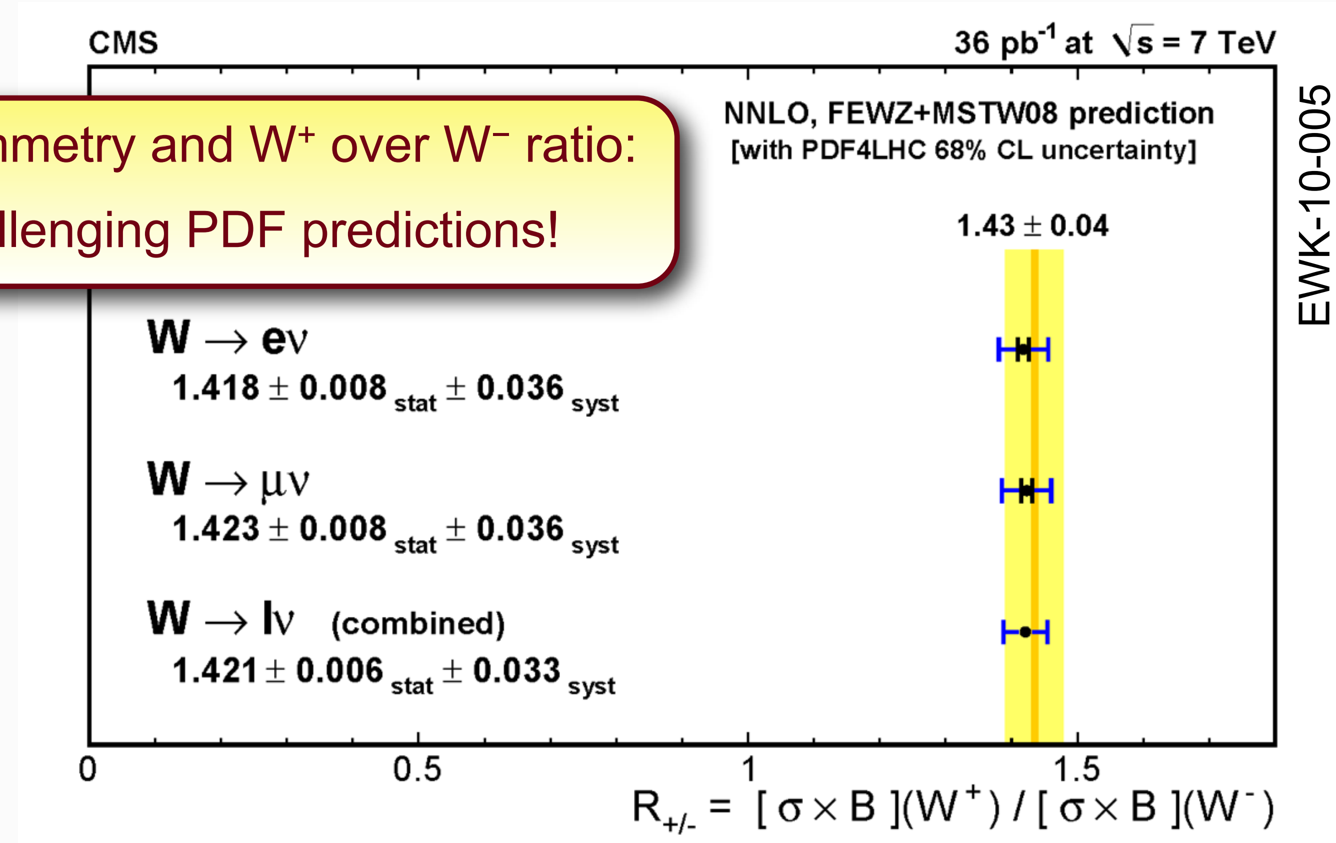
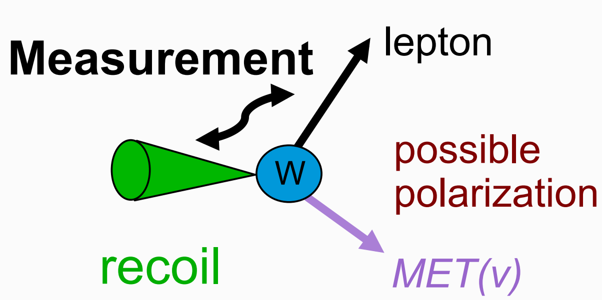
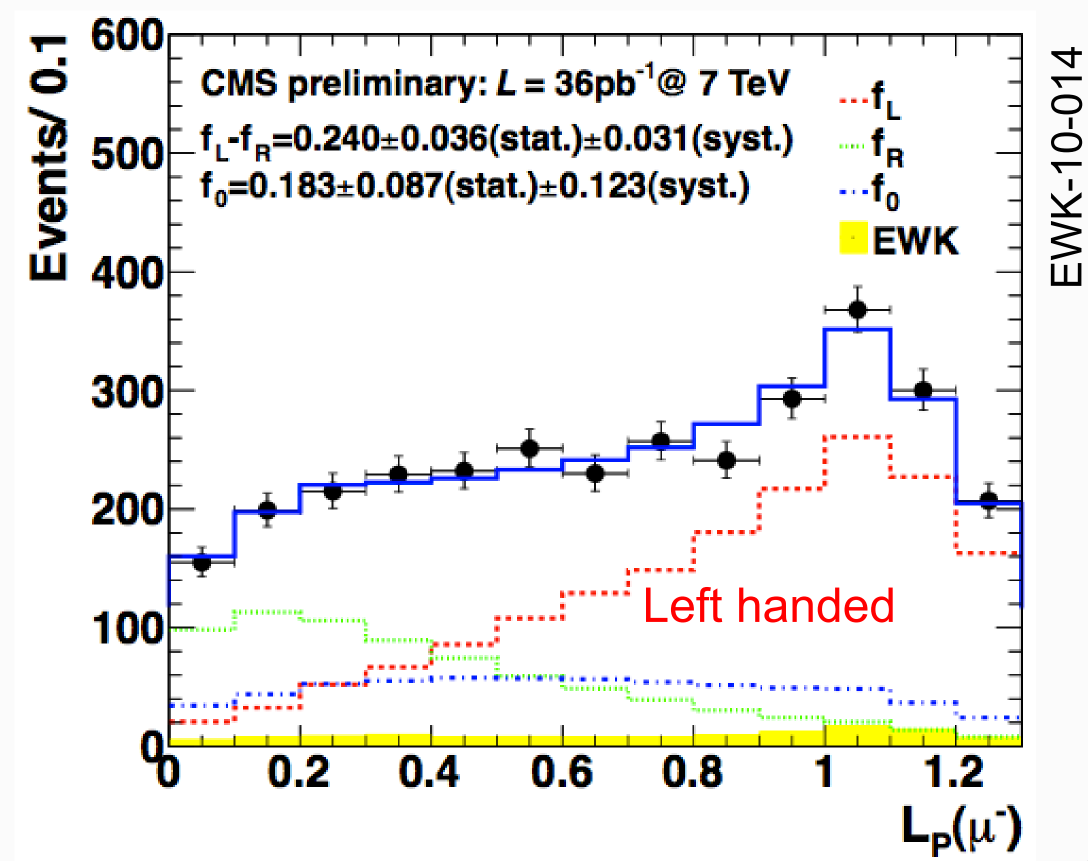




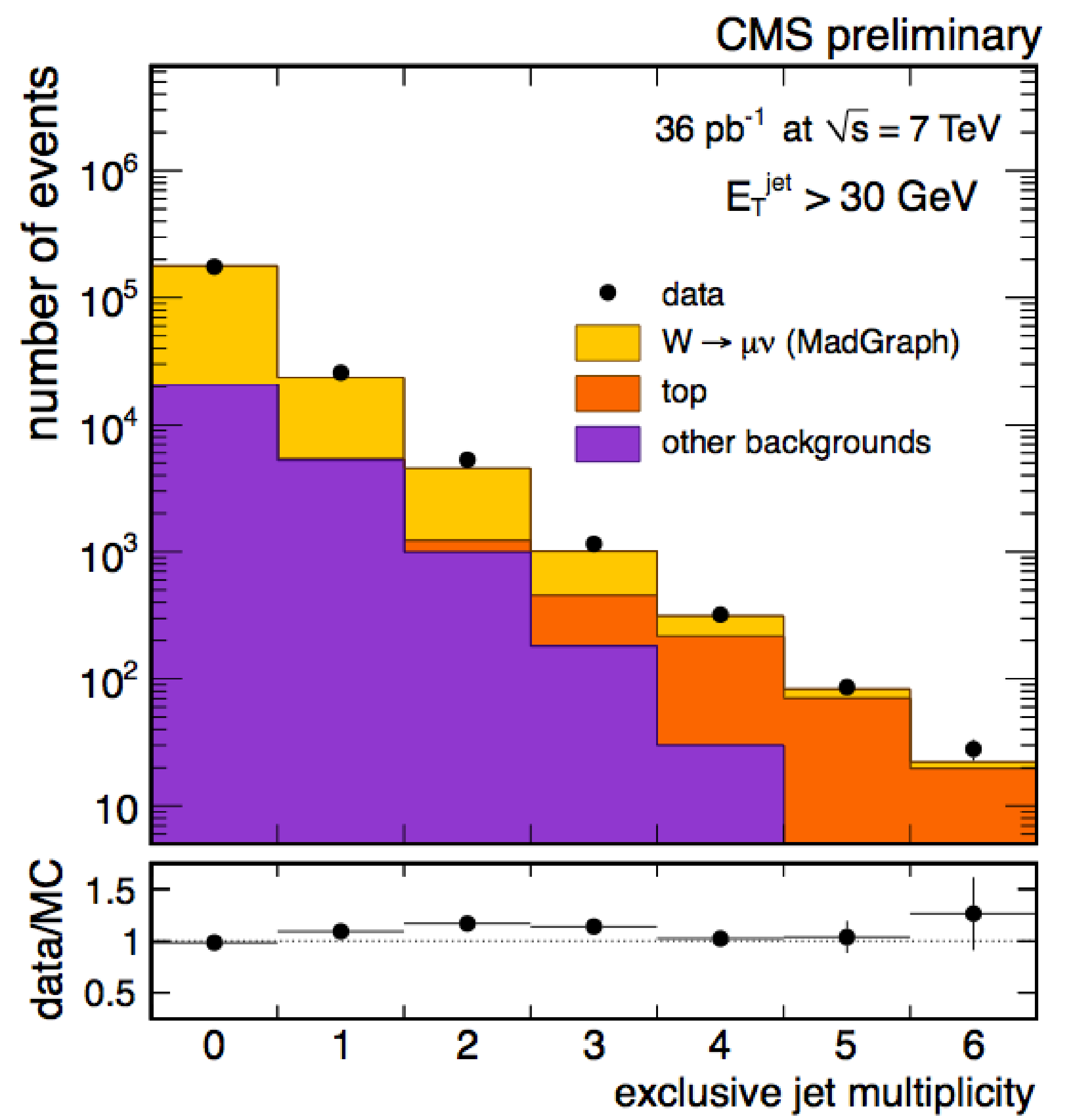
$$LP = \frac{\vec{p}_T(\ell) \cdot \vec{p}_T(W)}{|\vec{p}_T(W)|^2}$$

$$p_T(W) > 50\,\mathrm{GeV}$$



First measurement of W polarization: both W⁺ and W⁻ preferred left-handed

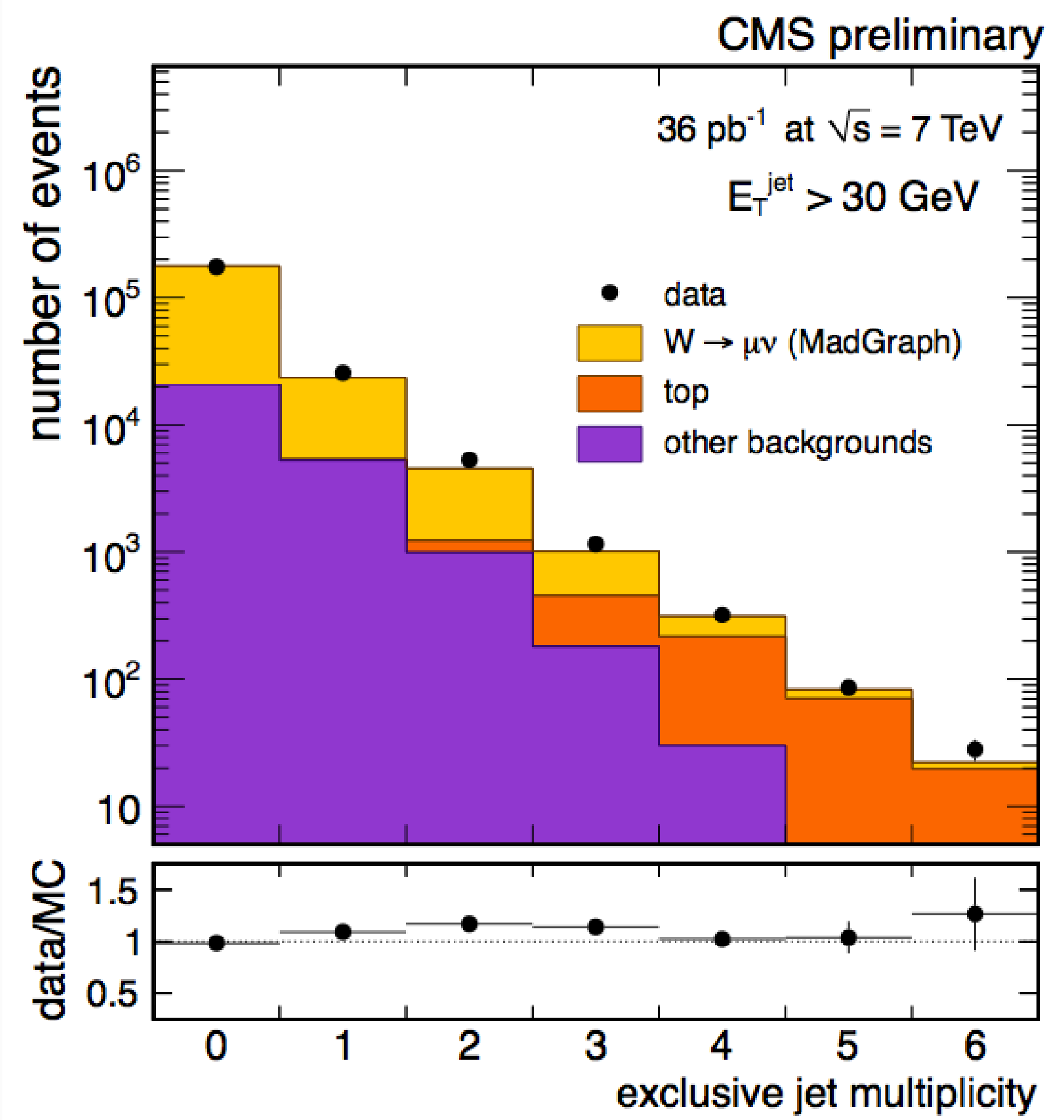
W/Z+jets

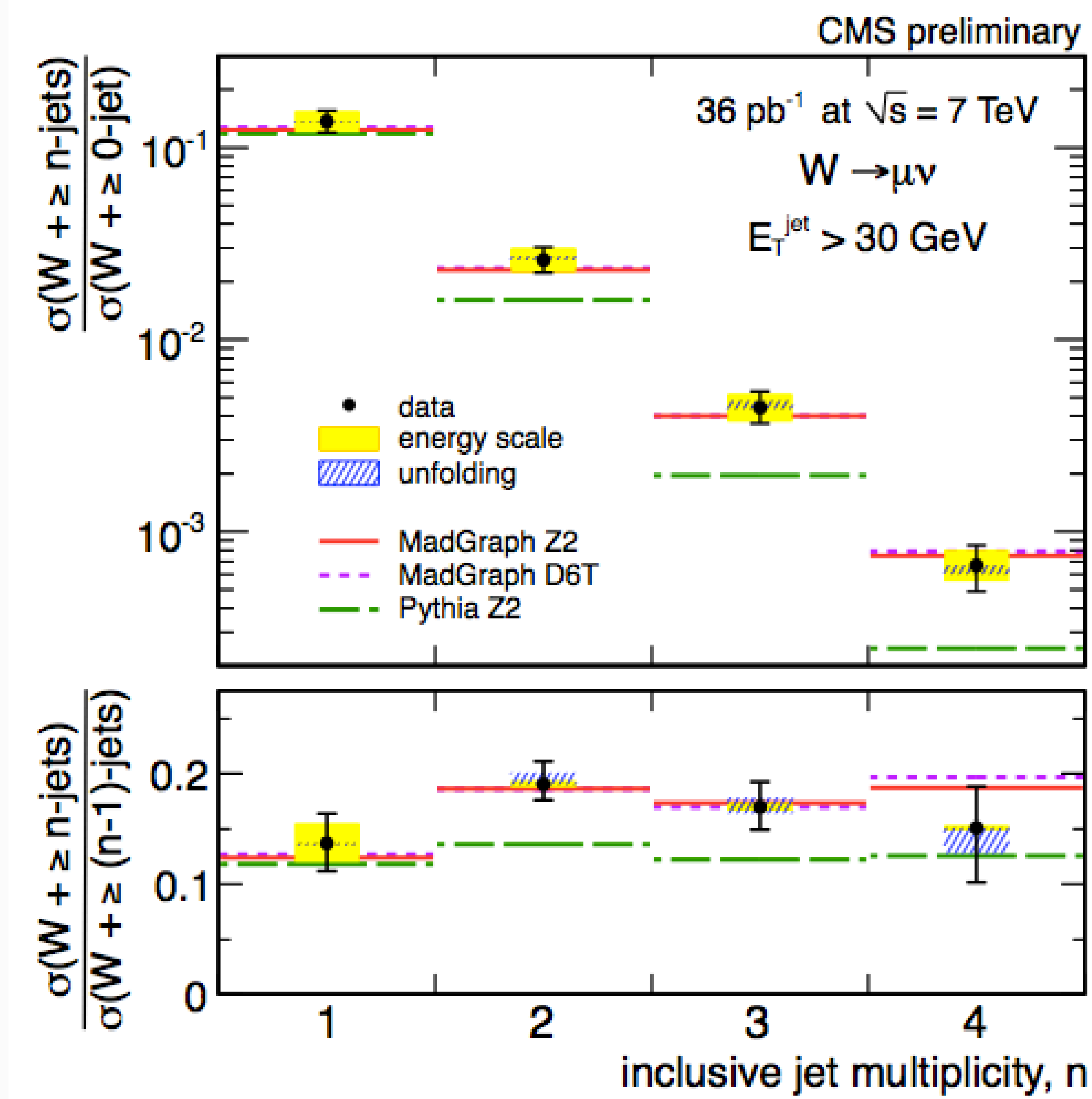


- **simultaneous** extraction of W signal and top background
  - 2D fit to M_T and N_{bjets} distributions
- final distributions: **unfolded to particle level**
- presented for experimental lepton and jet acceptance, eg. p_{Tjet} > 30 GeV

W/Z+jets

EWK-10-005





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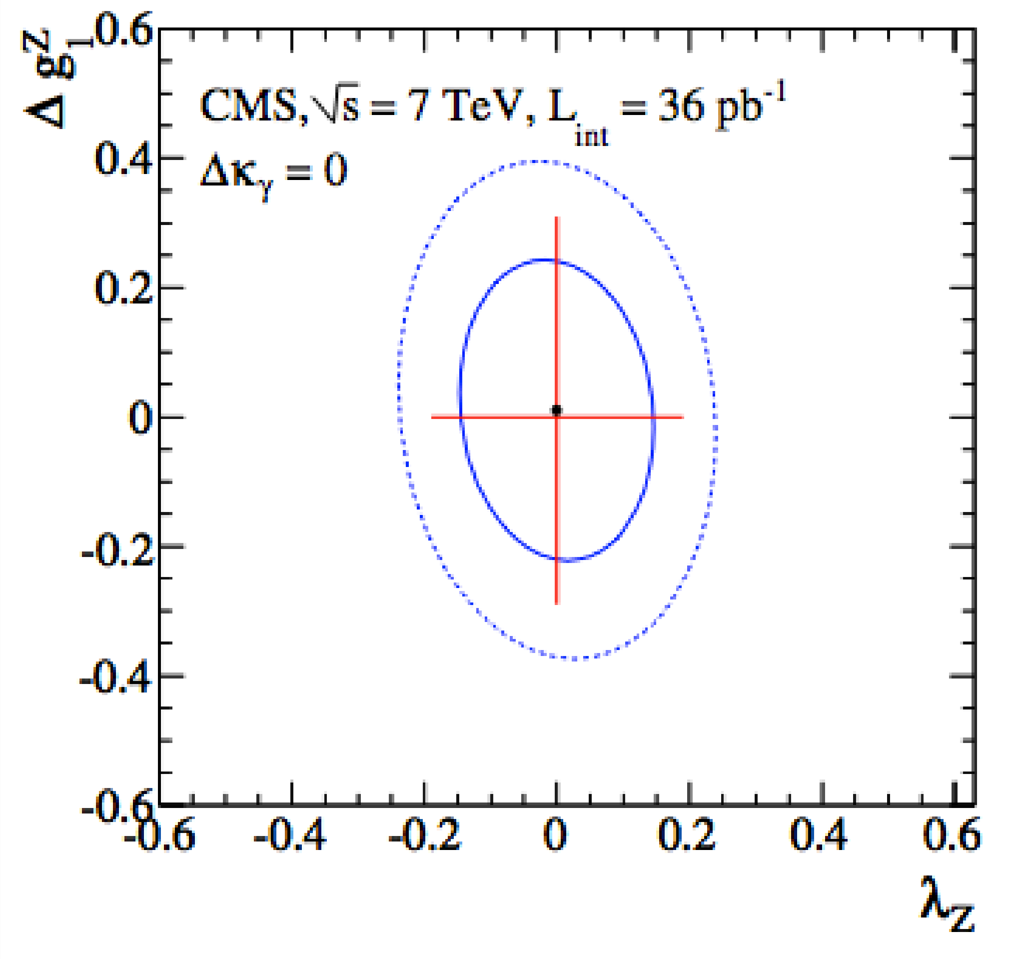
  - 2D fit to M_T and N_{bjets} distributions
- final distributions: **unfolded to particle level**
- presented for experimental lepton and jet acceptance, eg. p_{Tjet} > 30 GeV

Excellent agreement with ME+PS matched Monte Carlo model.

Also tested: Berends-Giele scaling

Di-Boson Production

- **WW** (arXiv:1102.5429, subm. to PLB)
- same pre-selection as for HWW search, including a jet veto
- WW cross section and WW/W ratio in agreement with SM exp.
- limits on TGC from fit to leading lepton p_T
  - consistent with LEP results and similar sensitivity as Tevatron



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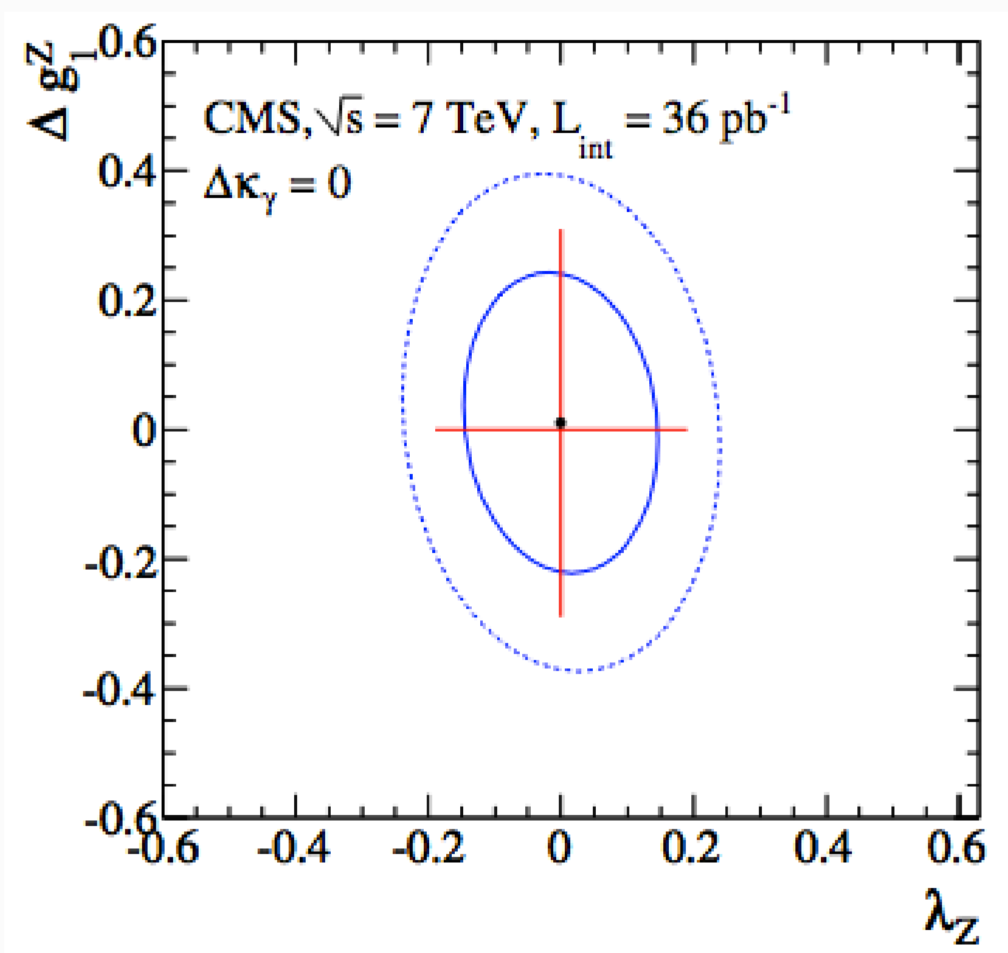
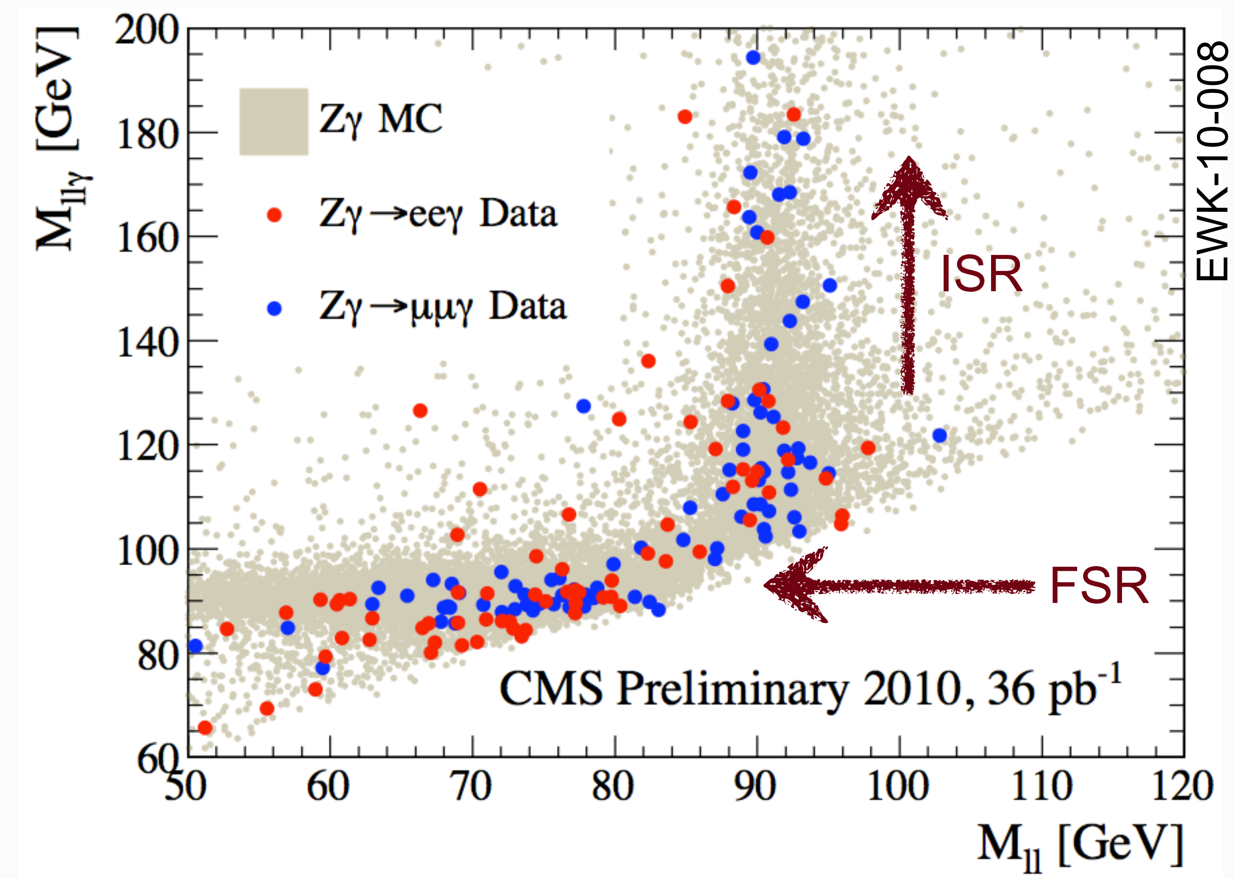
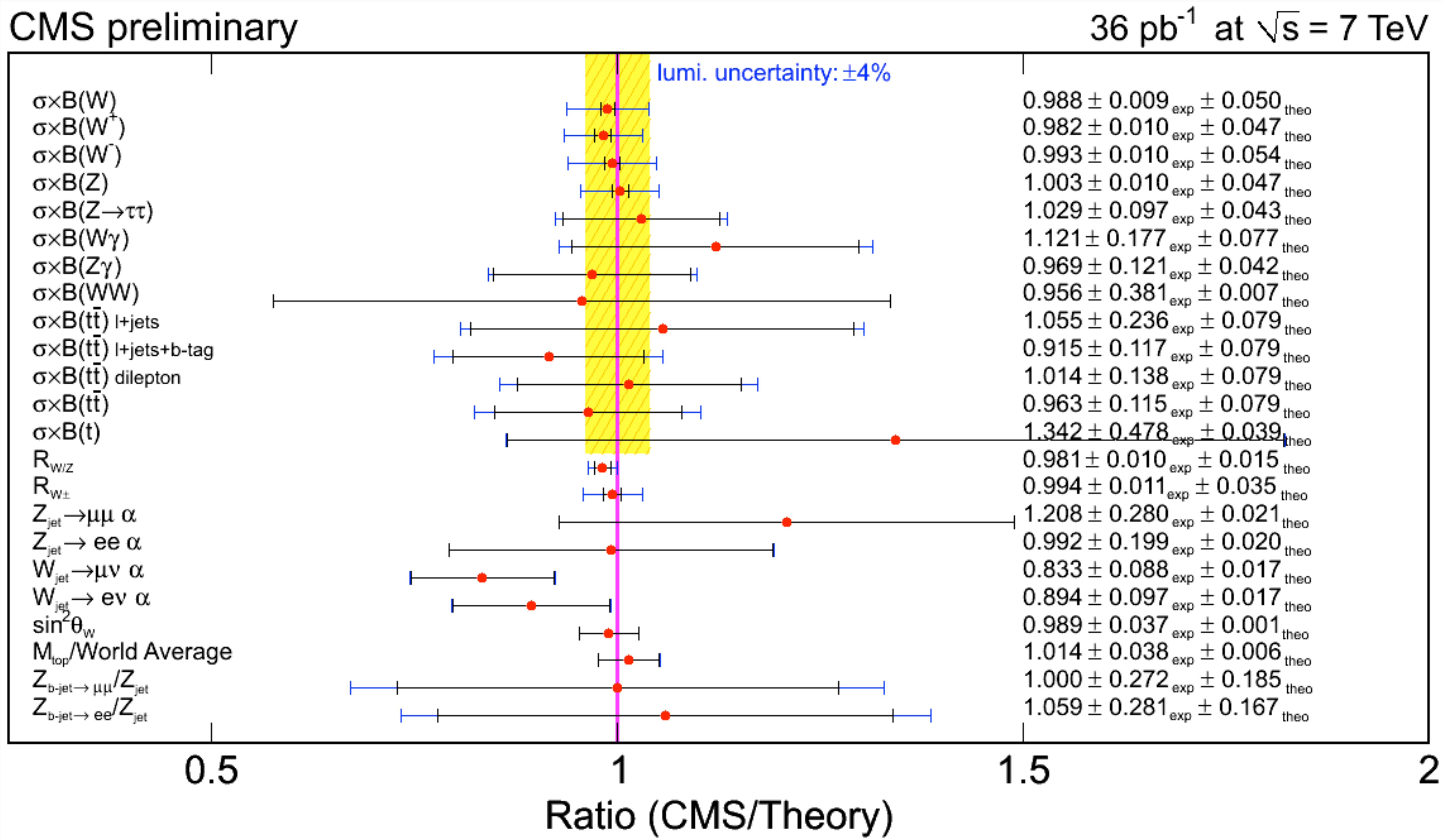


- **Wγ and Zγ**
- cross sections measured for $E_{T\gamma}$> 10 GeV and dR(lept,γ)> 0.7
- cross sections in agreement with SM predictions
- first limits on WWγ,ZZγ,Zγγ TGC at 7 TeV



Measurements of Di-Boson production established.
First limits on TGCs
Groundwork for HWW search!

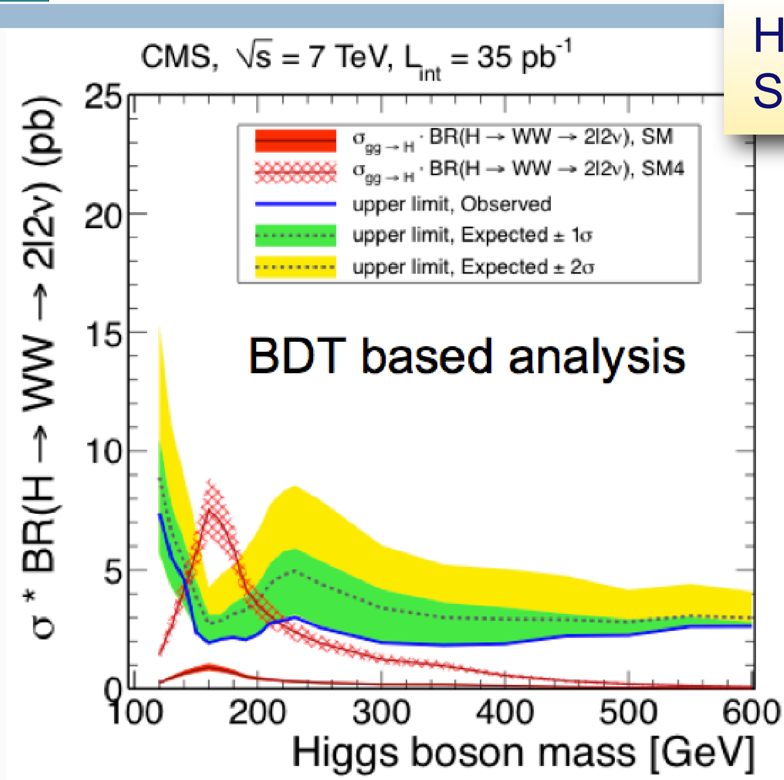
Summary of SM measurements



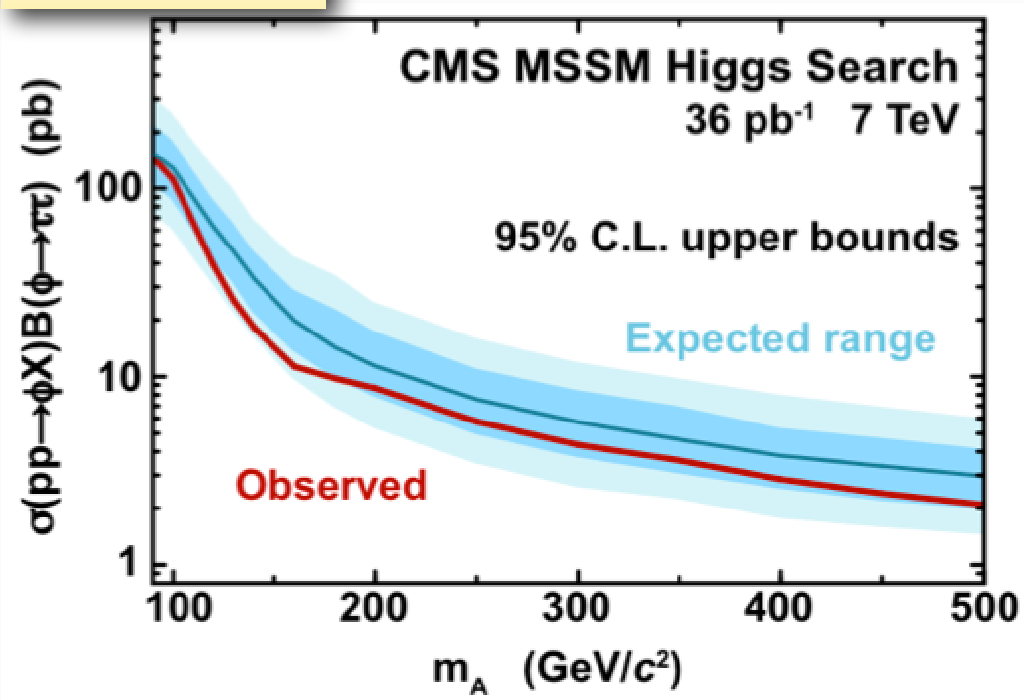
from P.C.Harris, Moriond EWK 2011

Higgs searches

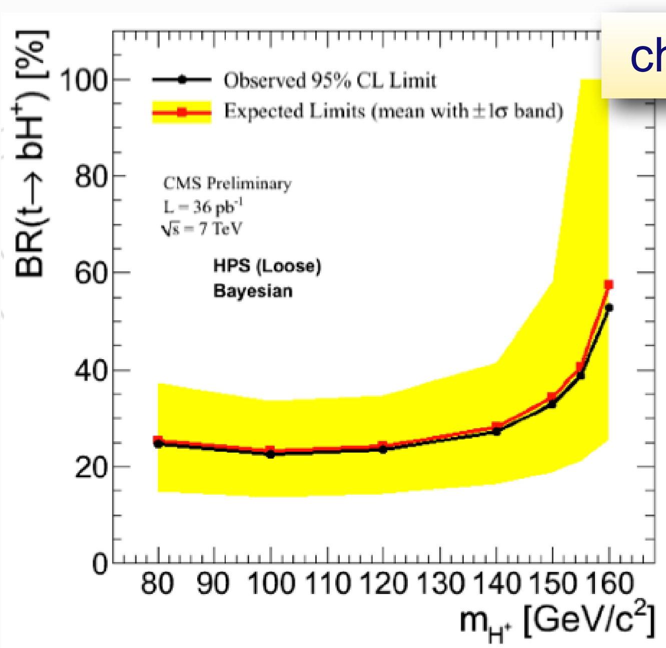
HWW
SM and SM4



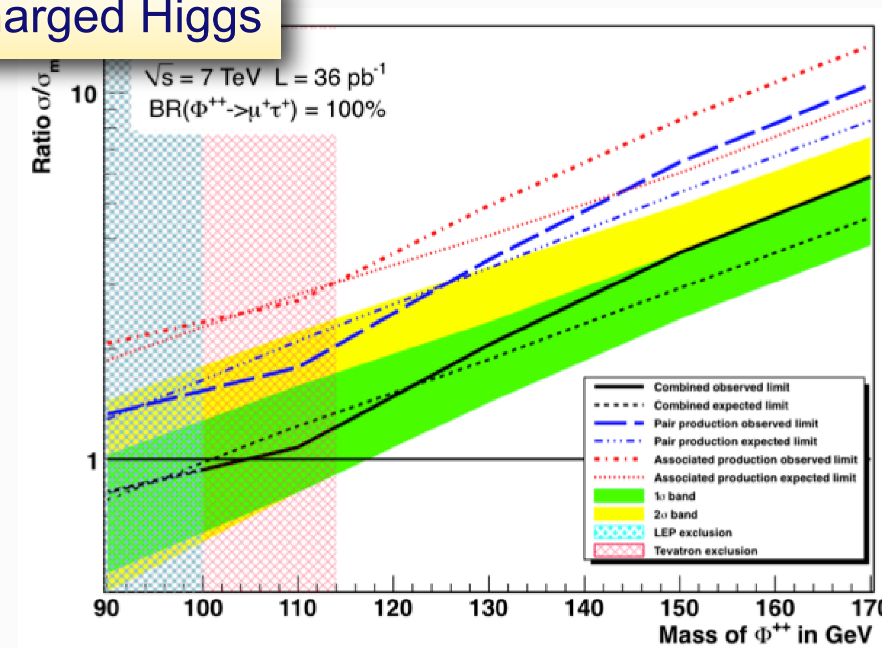
MSSM H→ττ



charged Higgs



doubly charged Higgs



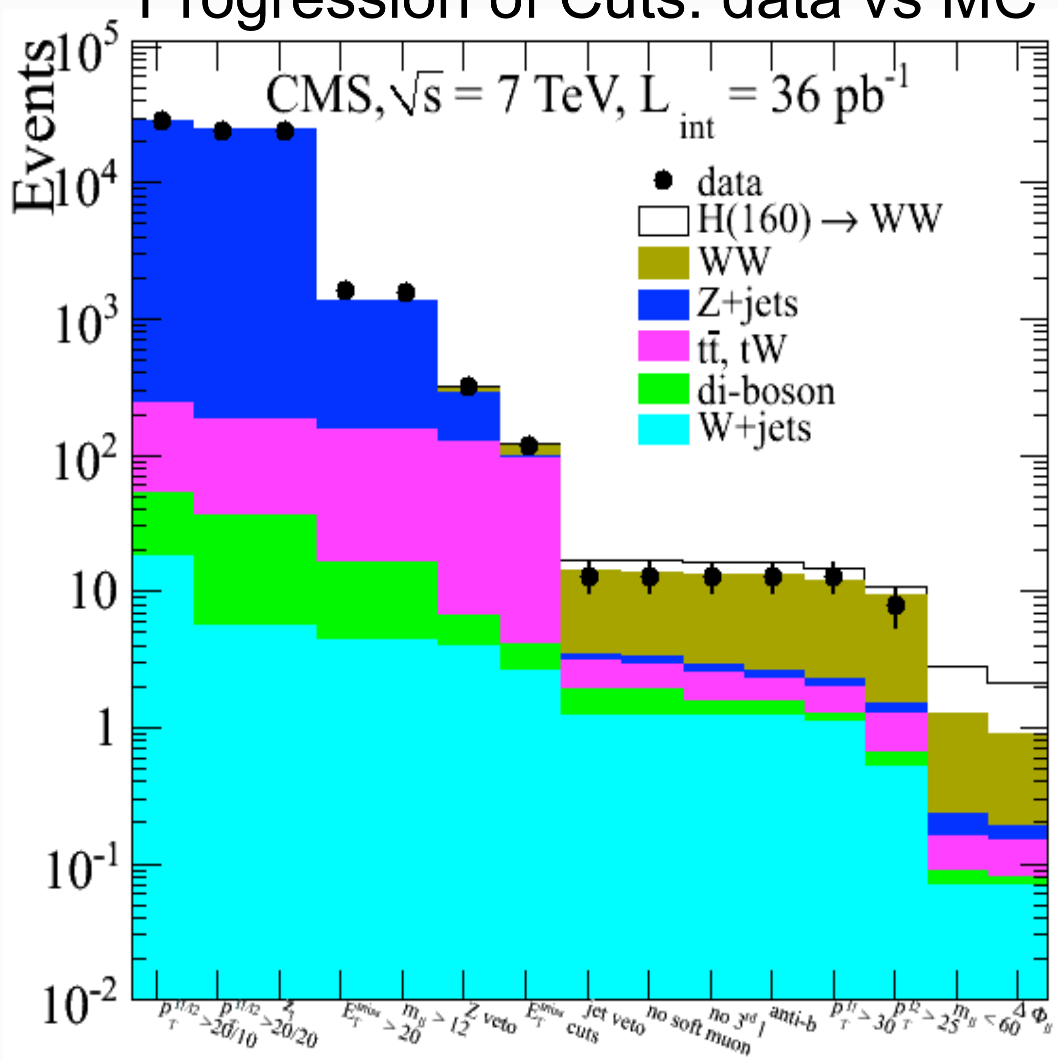
see also recent talks by
- C. Veelken, Moriond EWK-11
- V. Sharma, Moriond EWK-11
- A. Tapper, CERN Seminar, March 15

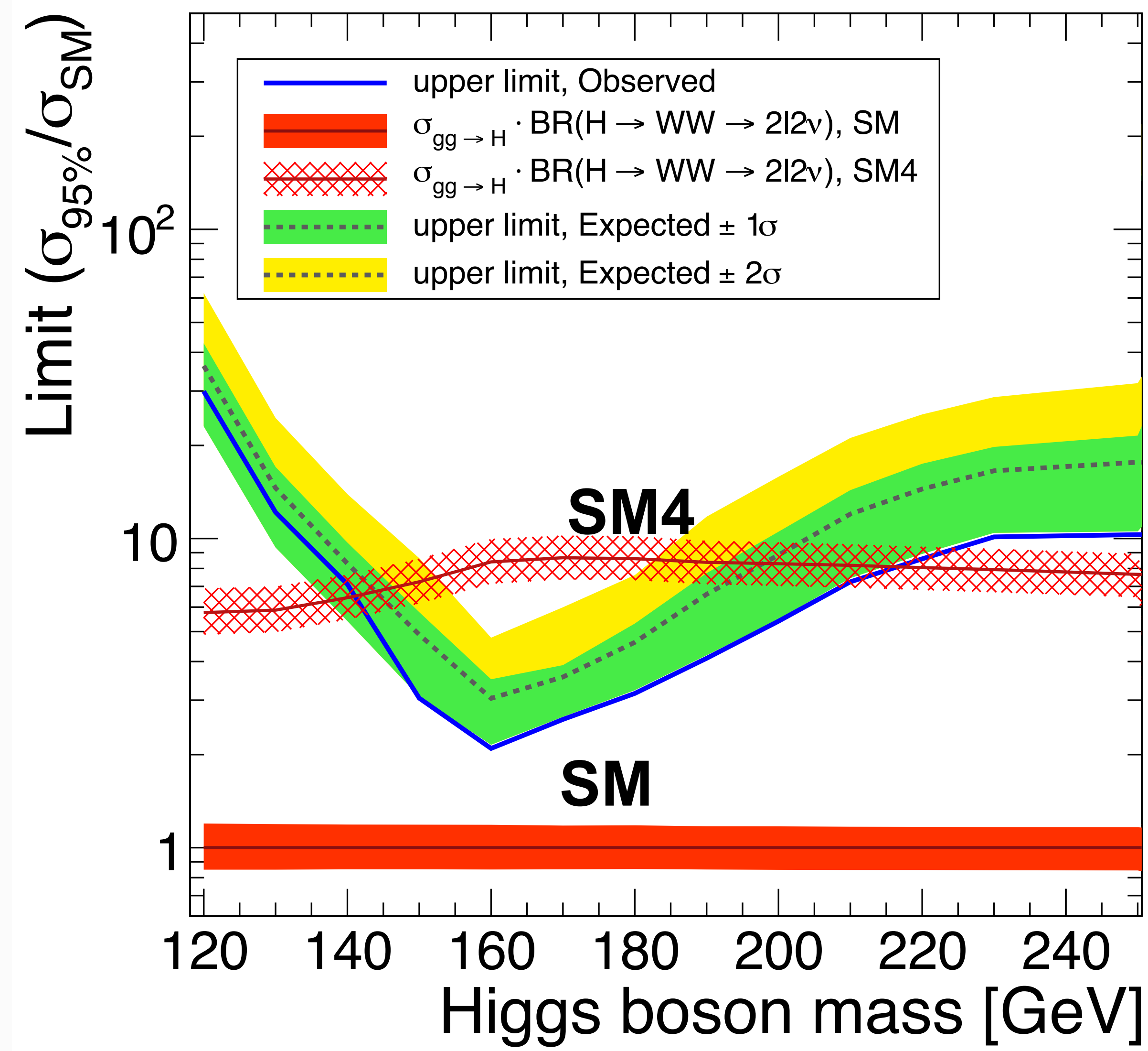
H→WW→2l 2ν

(arXiv:1102.5429, subm. to PLB)

- same pre-selection as for WW analysis, including a jet veto
- Then : 2 analyses
  - cut-based (lepton ΔΦ, lepton mom.)
  - Boosted Decision Tree with 15% higher eff. for same bkgnd

Progression of Cuts: data vs MC





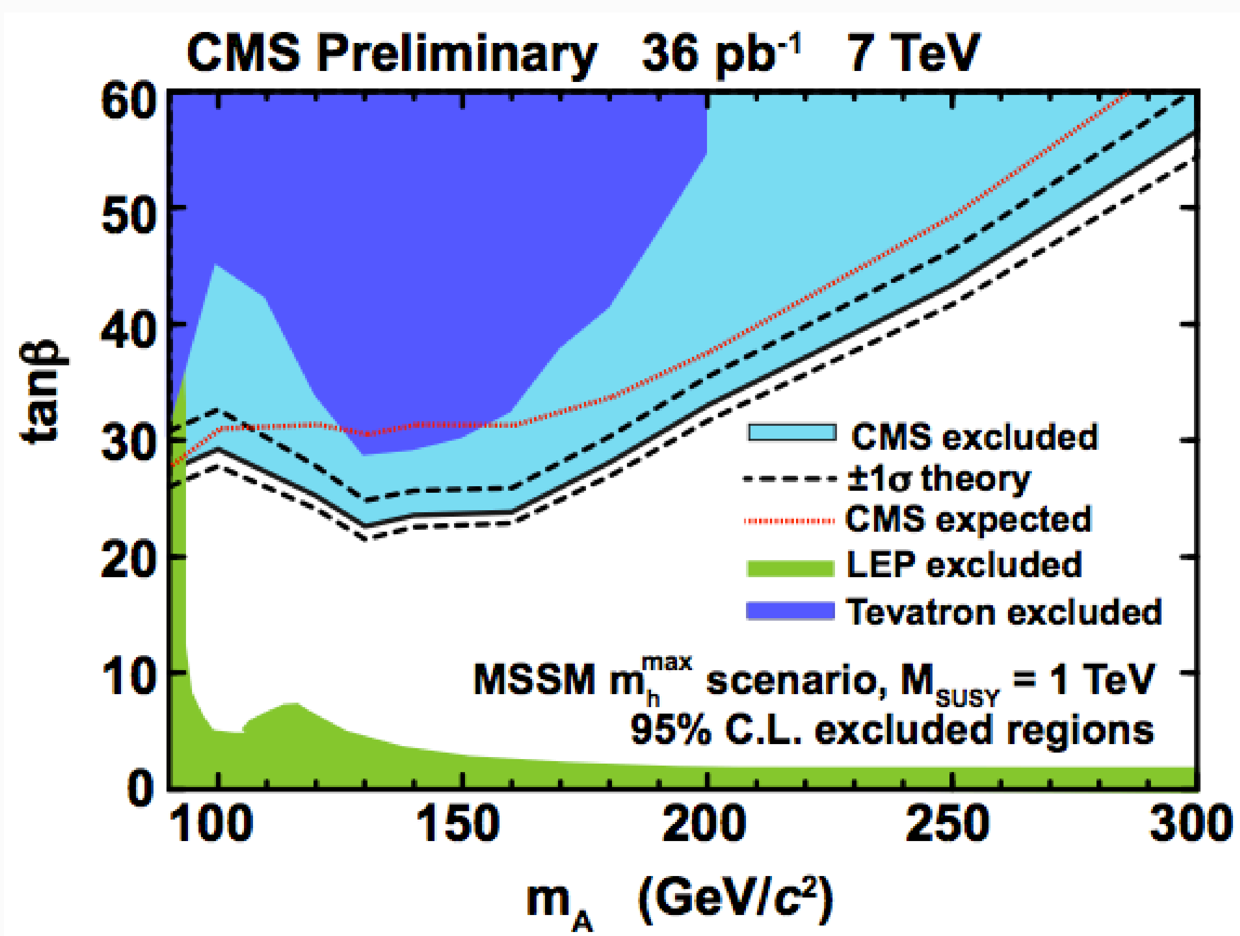
95% CL Limit for MH=160 GeV	CMS (Bayesian)
Expected	3 x SM
Observed	2.1x SM

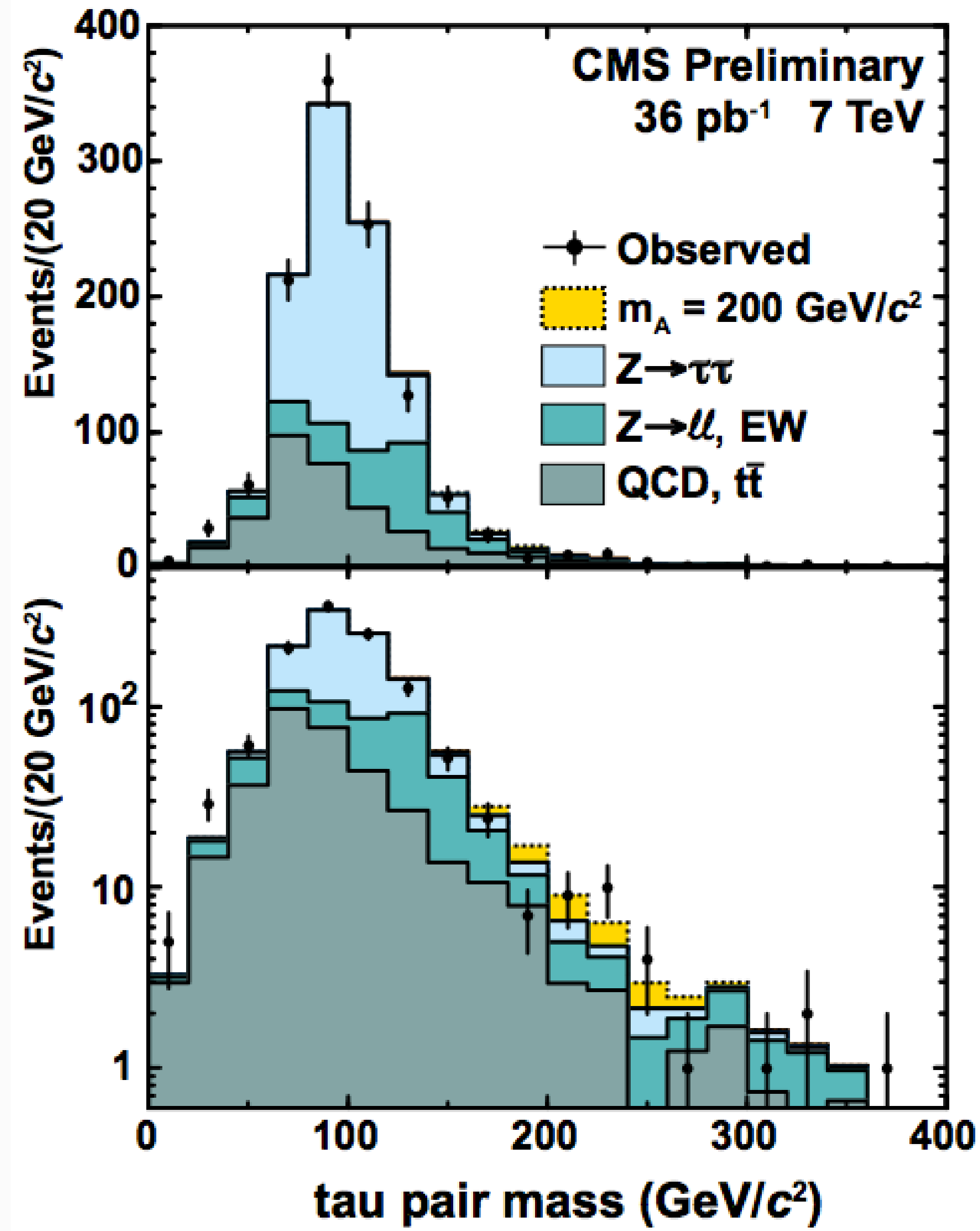
SM-like Higgs in 4-gen model excluded for ($144 < M_H < 207$) GeV

H→ττ

HIG-10-002

- Channels used: e-mu, e-had, mu-had
- improved mass reconstruction (better resolution) using likelihood, based on tau decay kinematics of visible decay products and E_{Tmiss}
- first limits on MSSM Higgs production, already improving on the Tevatron results

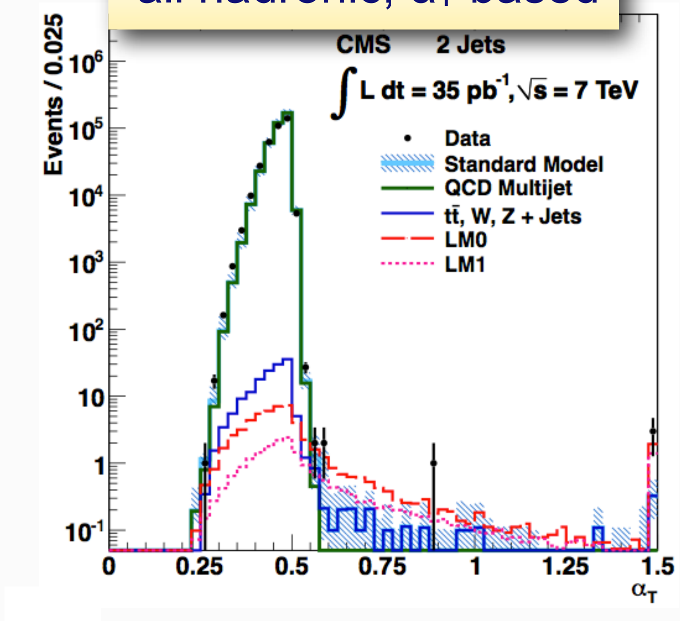




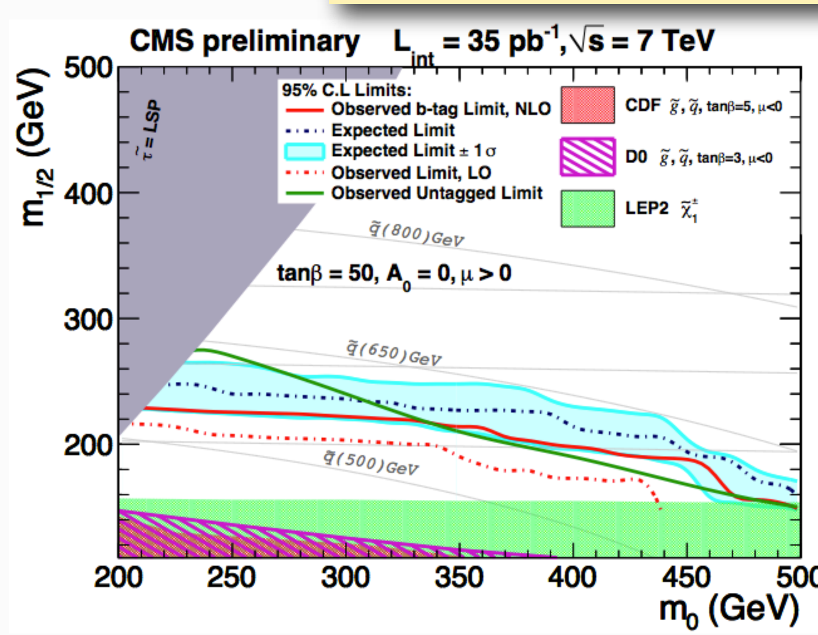
The hunt for MSSM Higgs(es) is open.
Tau channel will play prominent role.

ETH Institute for Particle Physics

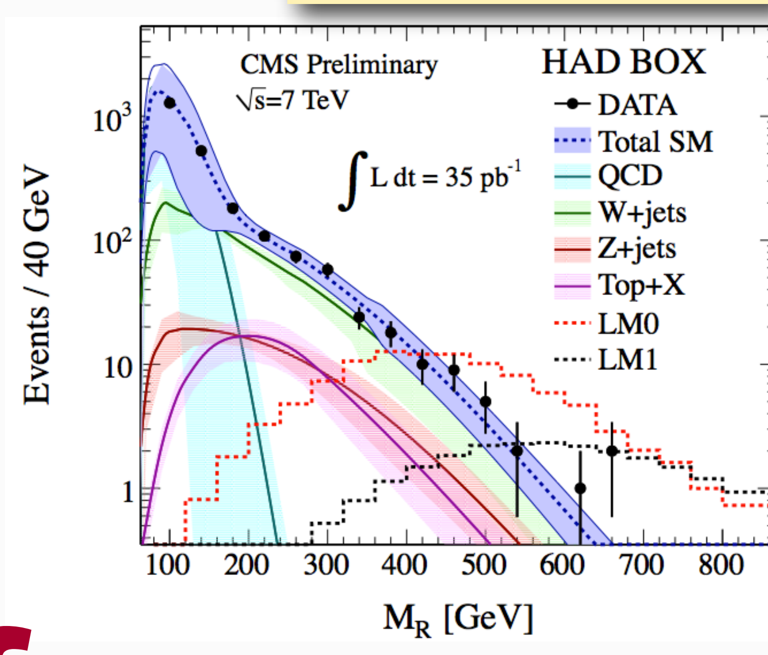
all hadronic, α_T based



all hadronic, α_T + b-tag



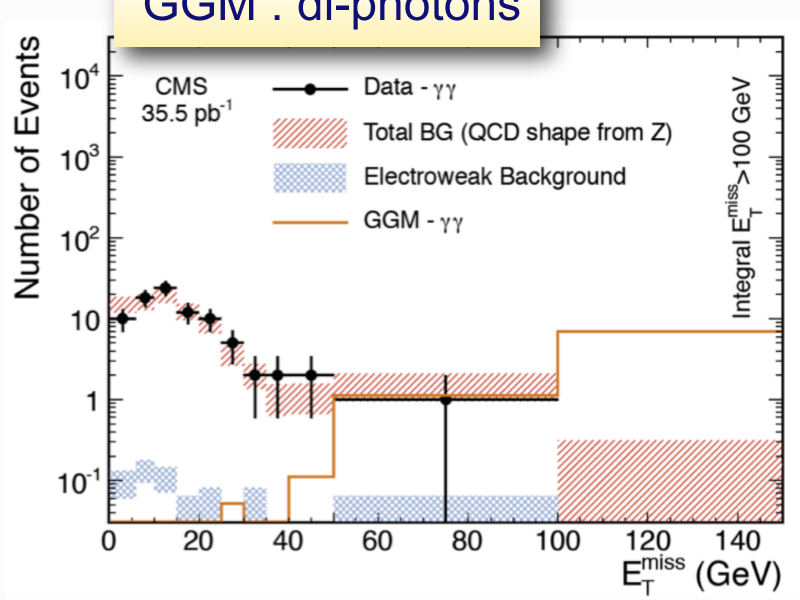
"The Razor" analysis



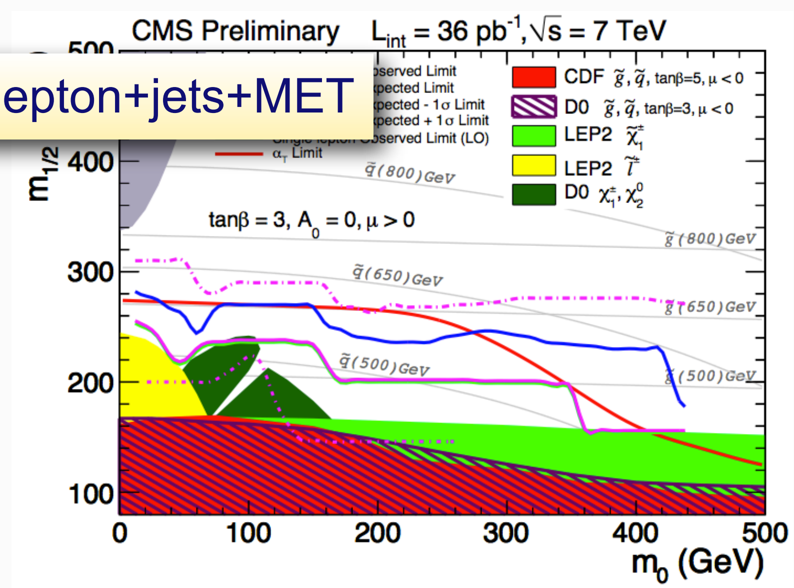
see also talks by
- C. Bernet, Moriond EWK-11
- A. Tapper, CERN, March 15

Searches for Supersymmetry

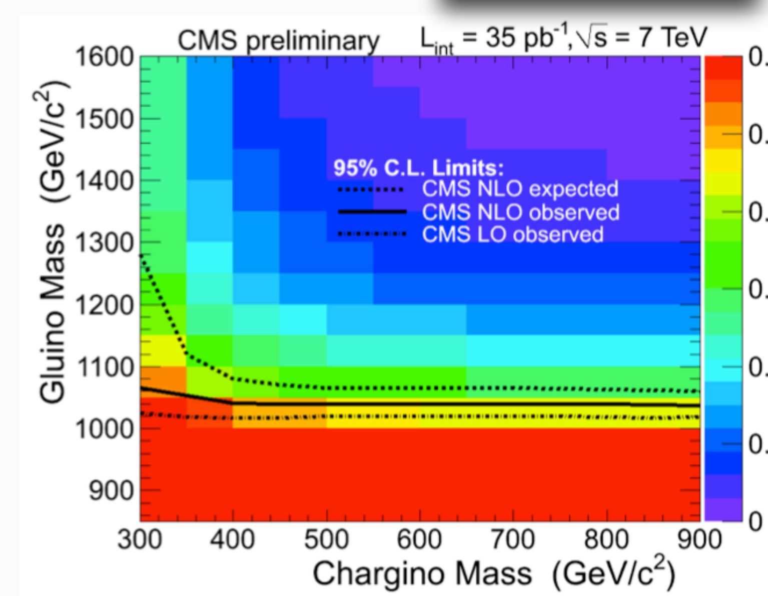
GGM : di-photons



lepton+jets+MET



multi-leptons



The strategy

0-leptons	1-lepton	OSDL	SSDL	≥3 leptons	2-photons	γ+lepton
Jets + MET	Single lepton + Jets + MET	Opposite-sign di-lepton + jets + MET	Same-sign di-lepton + jets + MET	Multi-lepton	Di-photon + jet + MET	Photon + lepton + MET

Large SM backgrounds **Low**

sensitivity to strongly produced SUSY

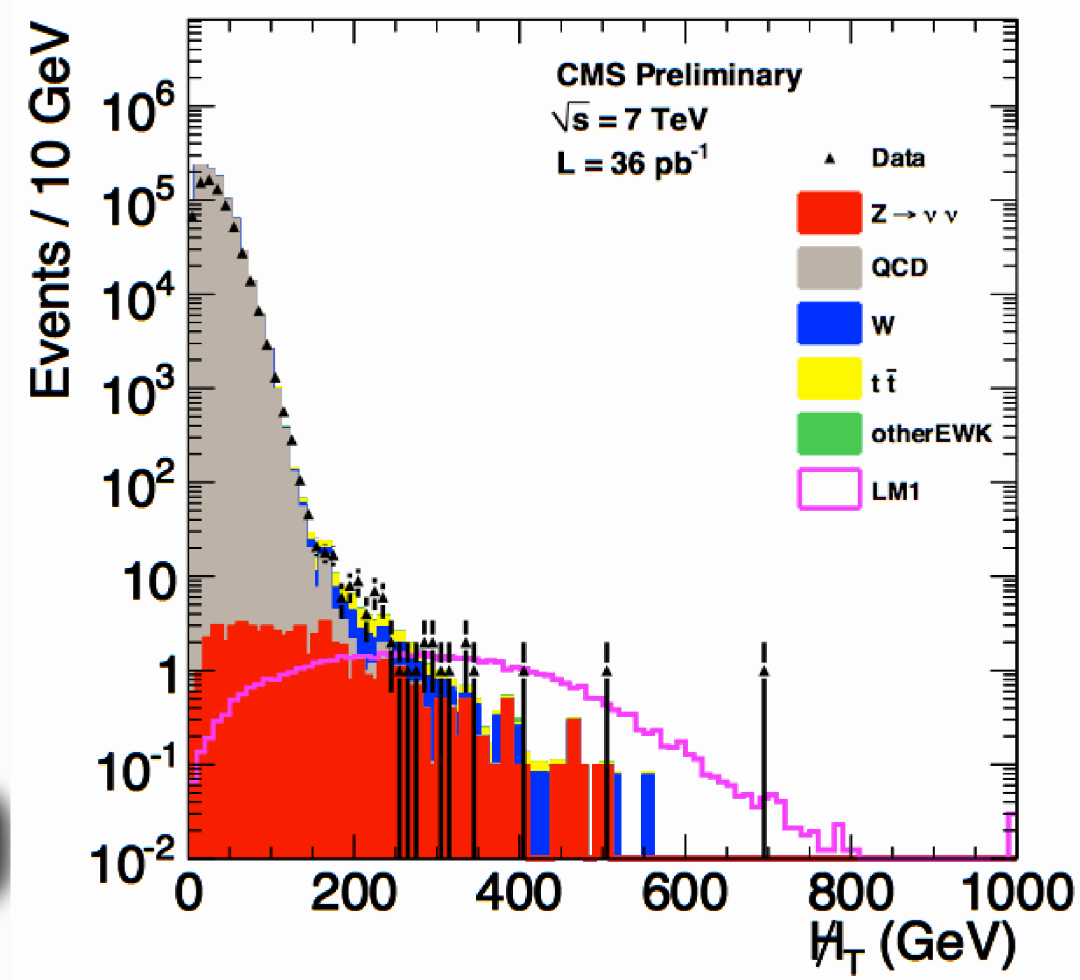
sensitivity to gauge-mediated SUSY

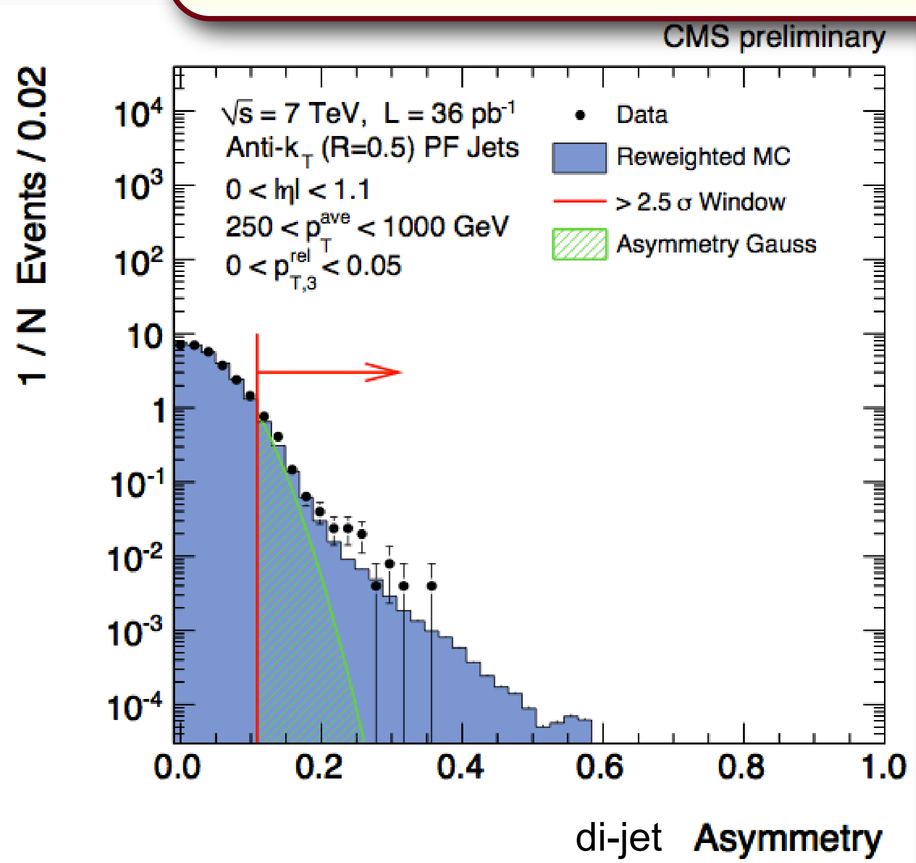
- **Focus on signatures (topologies)**, use different approaches/observables
  - alpha_T, "Razor", HT, MHT, ...
- Established many different **data-driven techniques** to derive backgrounds
  - jet smearing and re-balancing, ABCD, fakeable-object technique to estimate fake lepton rates, generic properties of lepton p_T spectra, generic properties of falling SM spectra
- Different trigger paths (all hadronic HT-based, leptonic)
- Not necessarily optimized for best excl. limits, but sharpened tools for discovery!
- **cross check, cross check, cross check....**

Example: Hadronic search with MET

- Analysis based on understanding the detector response in detail
- Complementary to kinematics- based searches
- Baseline selection
  - At least 3 jets with E_T>50 GeV & |η|<2.5
  - H_T>300 GeV and MHT > 150 GeV
  - Veto isolated electrons and muons
- Backgrounds from
  - Multi-jet QCD, Z(+jets) ➔ νν, W+jets, ttbar
  - **All determined from data-driven techniques**

SUS-10-005

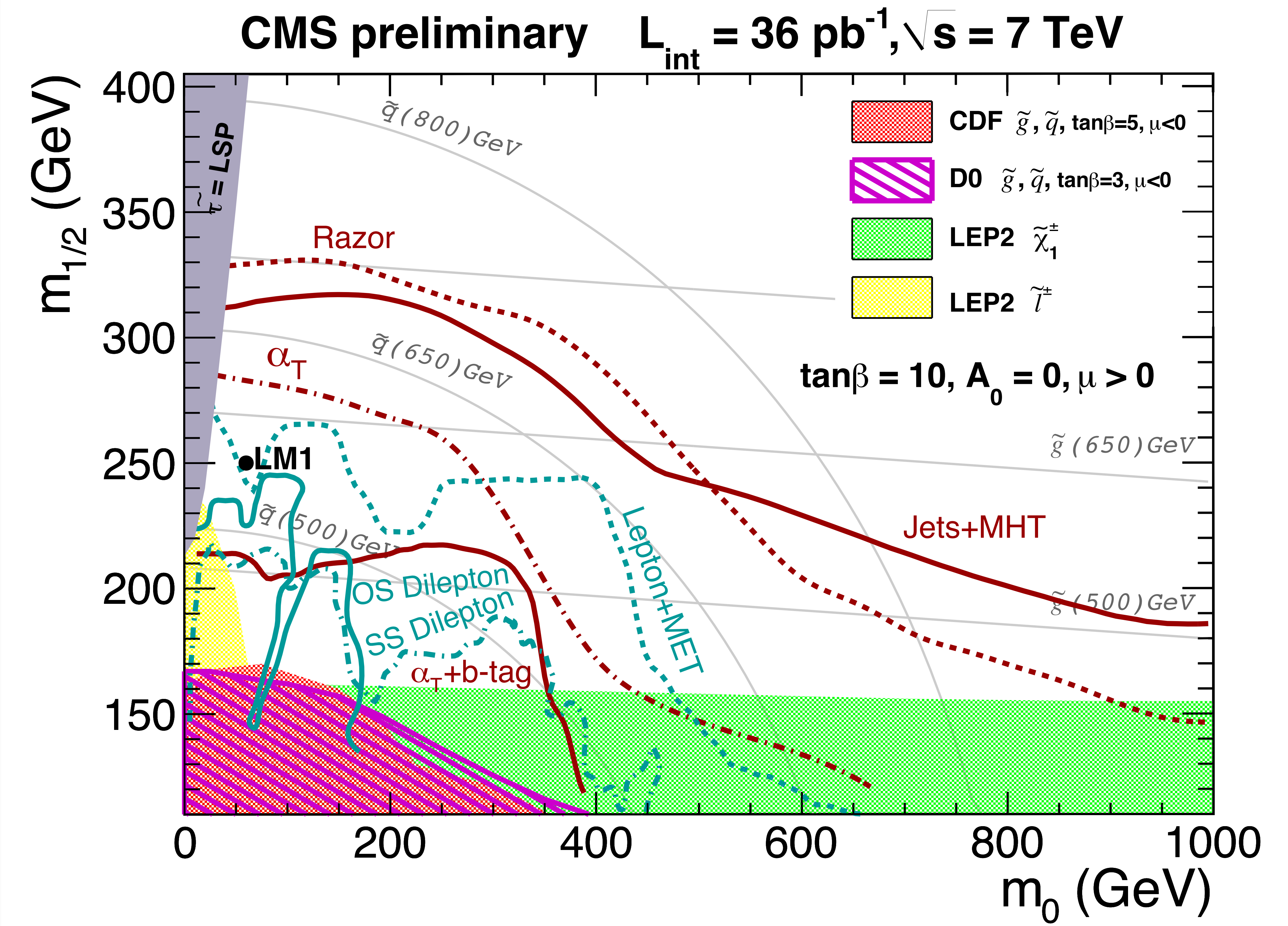




	Predicted	Observed
MHT > 250 GeV	19 ± 3.6	15

	Predicted	Observed
HT > 500 GeV	43.9 ± 6.1	40

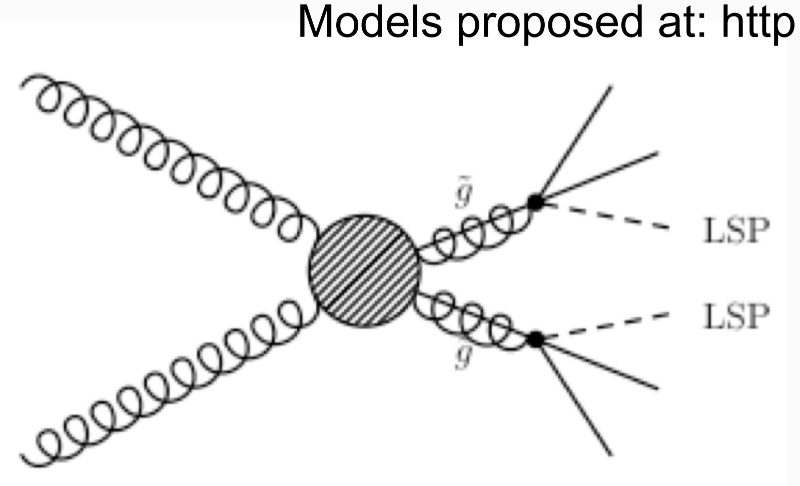
Combined Exclusion plot

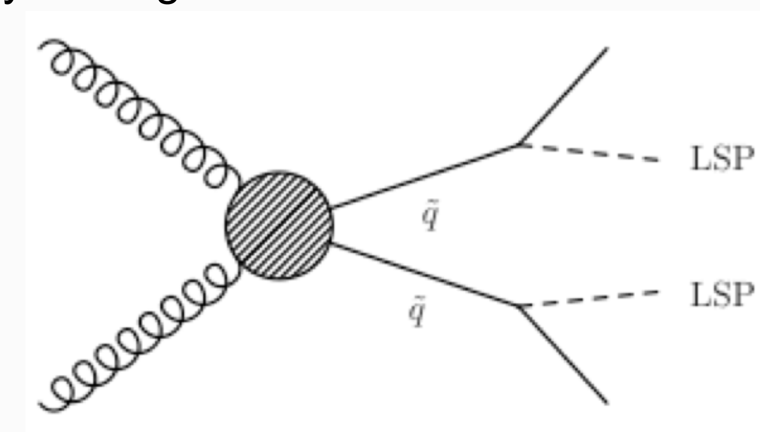


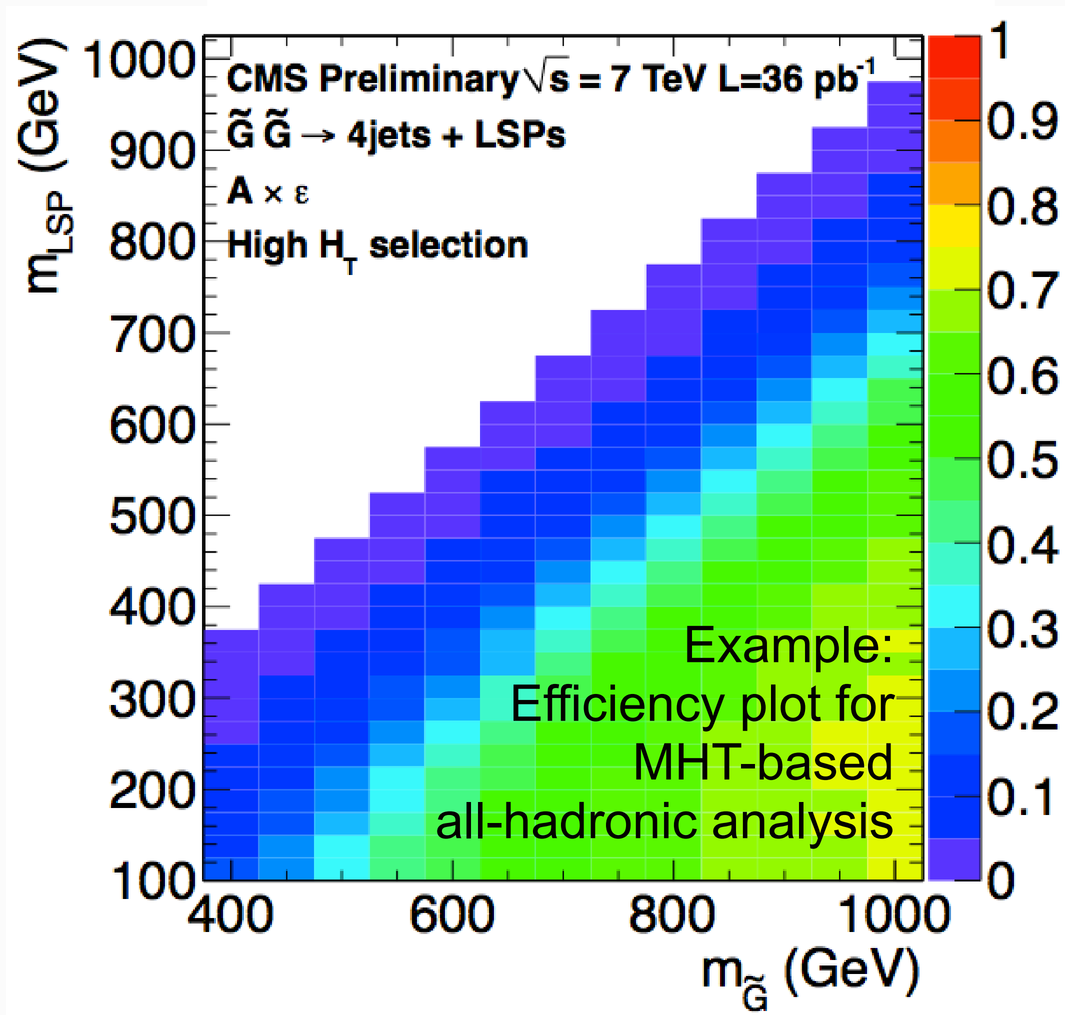
Limits extended well beyond the Tevatron reach

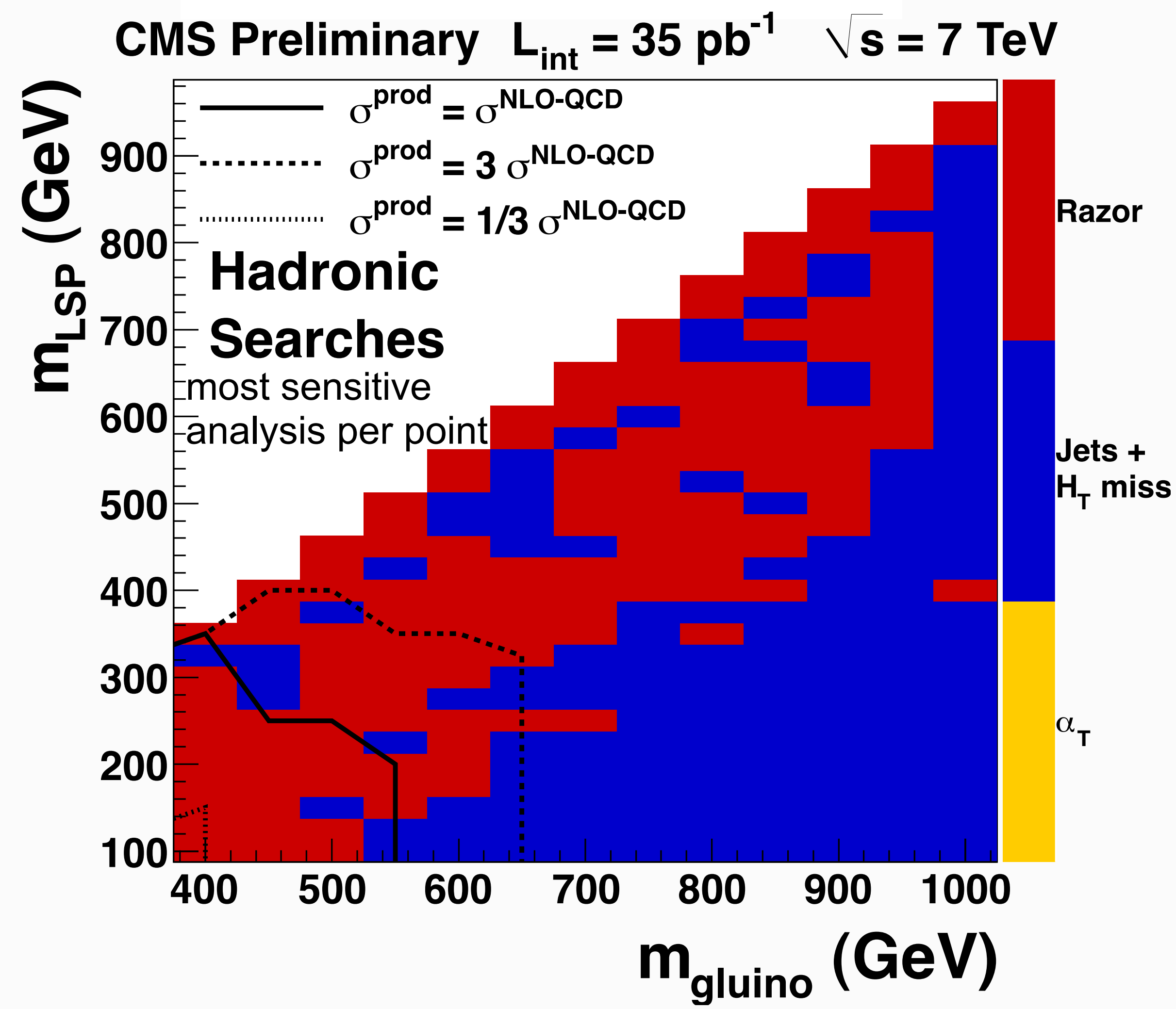
Simplified models

Models proposed at: http://www.lhcnewphysics.org



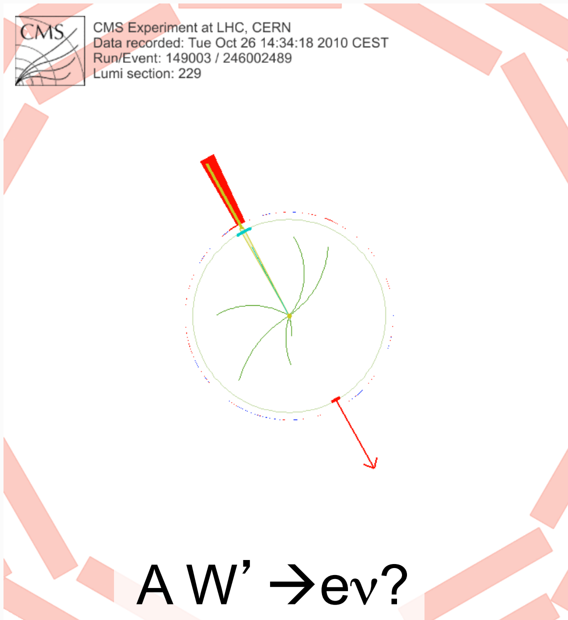




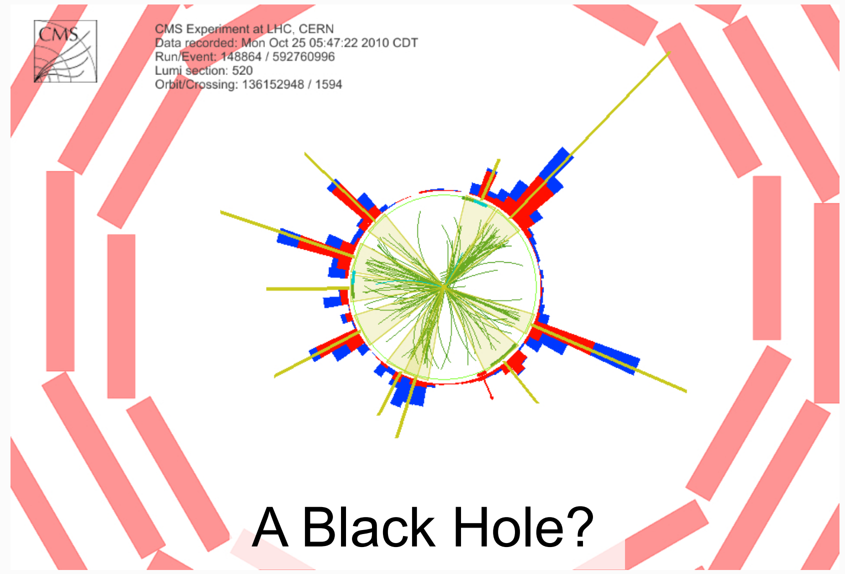


Shows complementarity of hadronic analyses.
CMS will provide these results electronically.
Feedback is welcome.

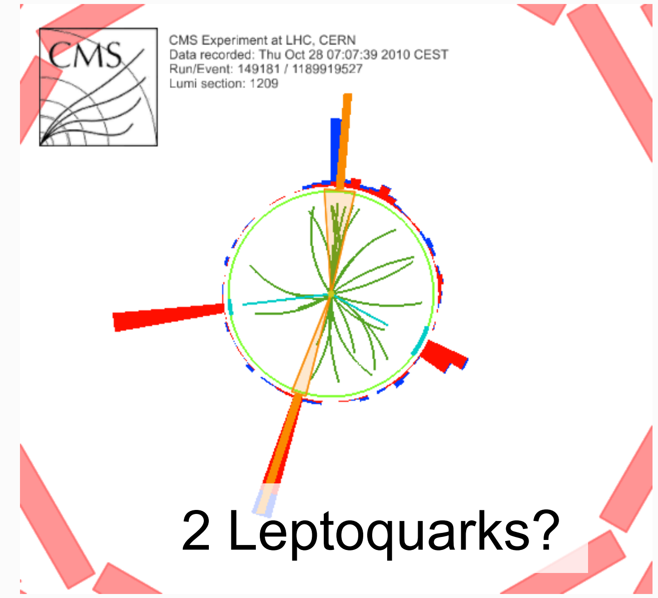
Exotic signatures



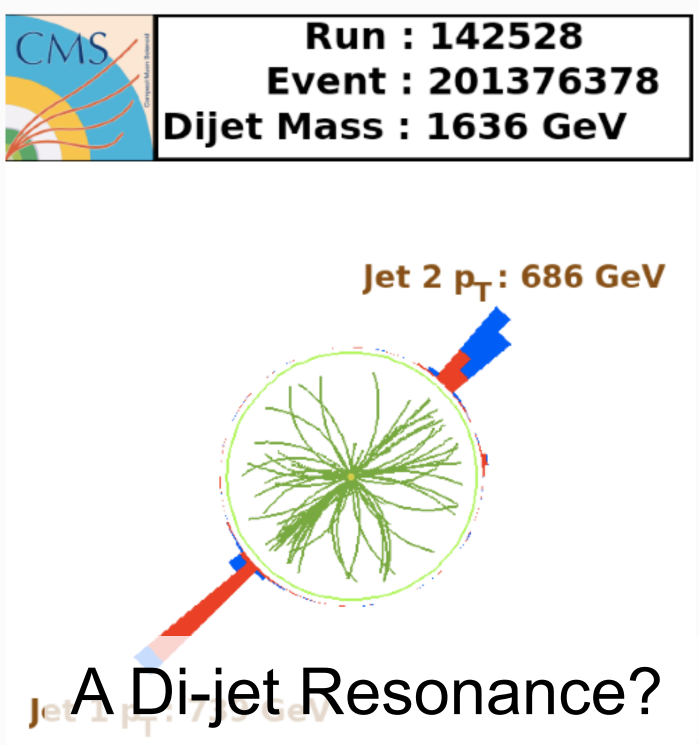
A W' →eν?



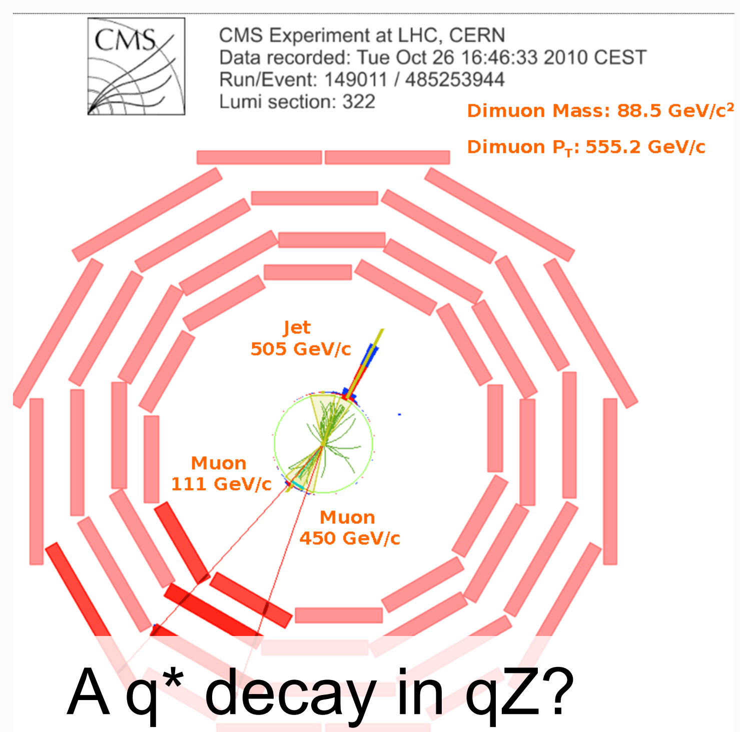
A Black Hole?



2 Leptoquarks?



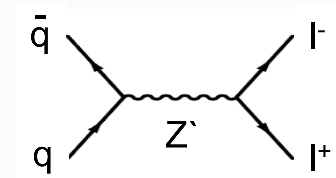
A Di-jet Resonance?

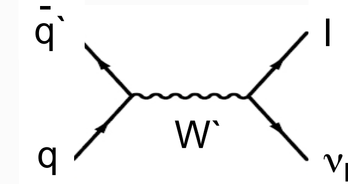


A q* decay in qZ?

see also talk by
F. Santanastasio,
Moriond EWK-11

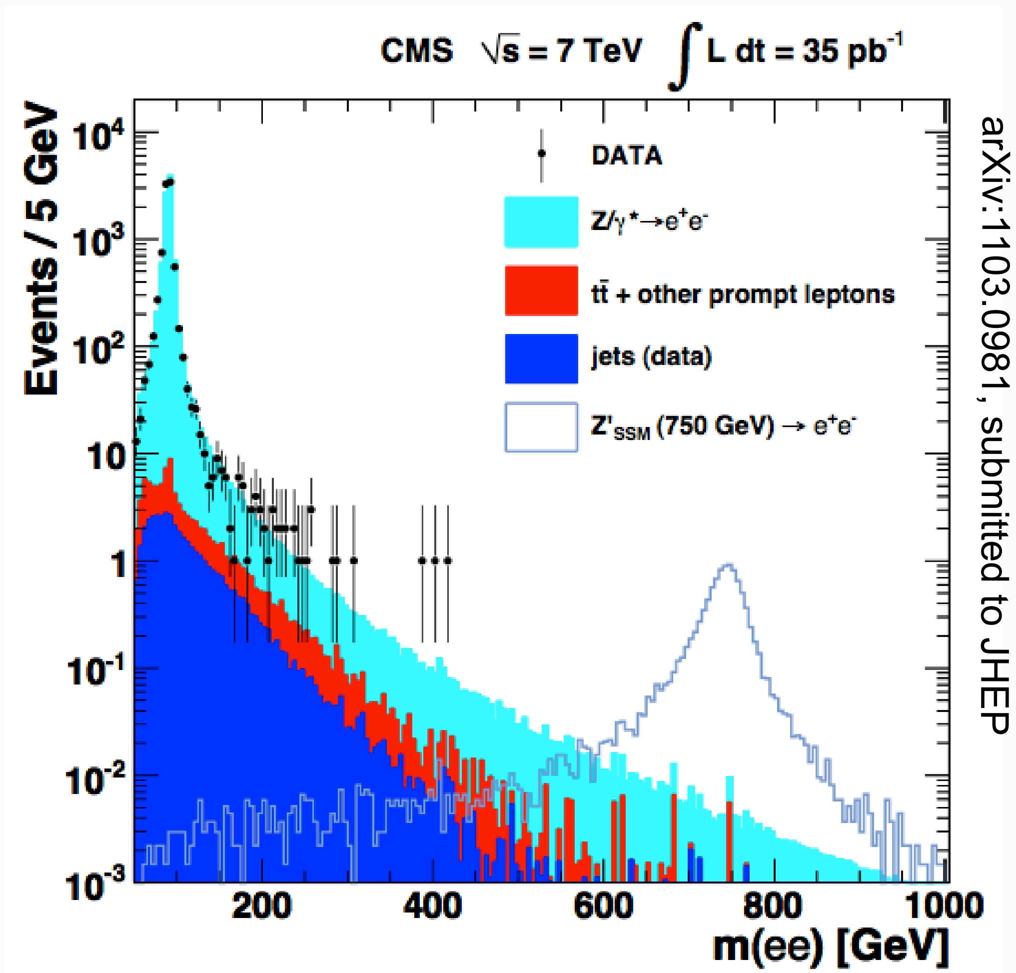
Leptons (+ E_{Tmiss})





Search for heavy resonances decaying to lepton pairs

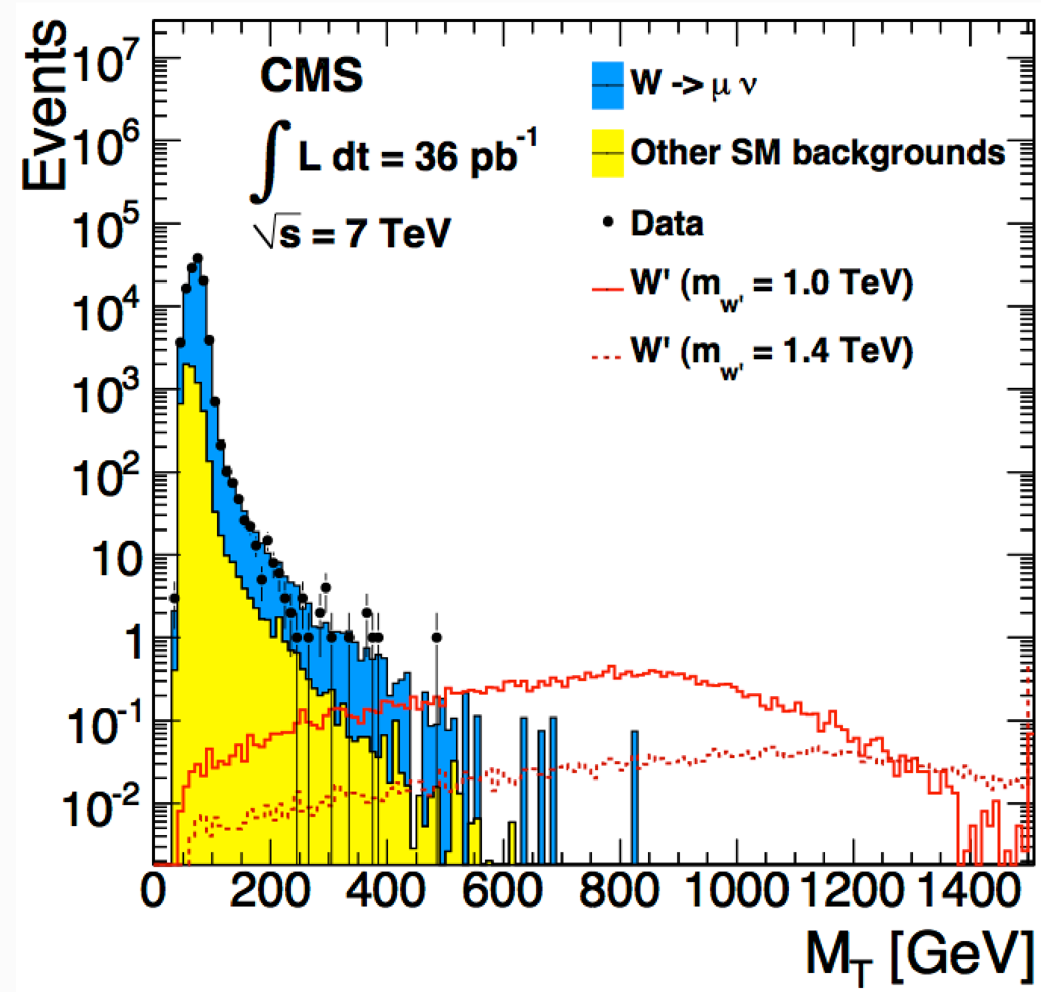
- Bump hunt in M(ee, μμ) spectrum
- no deviations observed



arXiv:1103.0981, submitted to JHEP

Channel	μμ	ee	Combined
Z_{SSM}	1027 GeV	958 GeV	1140 GeV
Z_{ψ}	792 GeV	731 GeV	887 GeV
G_{KK}, $k/M_{Pl} = 0.05$	778 GeV	729 GeV	855 GeV
G_{KK}, $k/M_{Pl} = 0.10$	987 GeV	931 GeV	1079 GeV

- Bump hunt in M_T(lν) spectrum
- no deviations observed



eν arXiv:1012.5945, Accepted by PLB
μν arXiv:1103.0030, Submitted to PLB

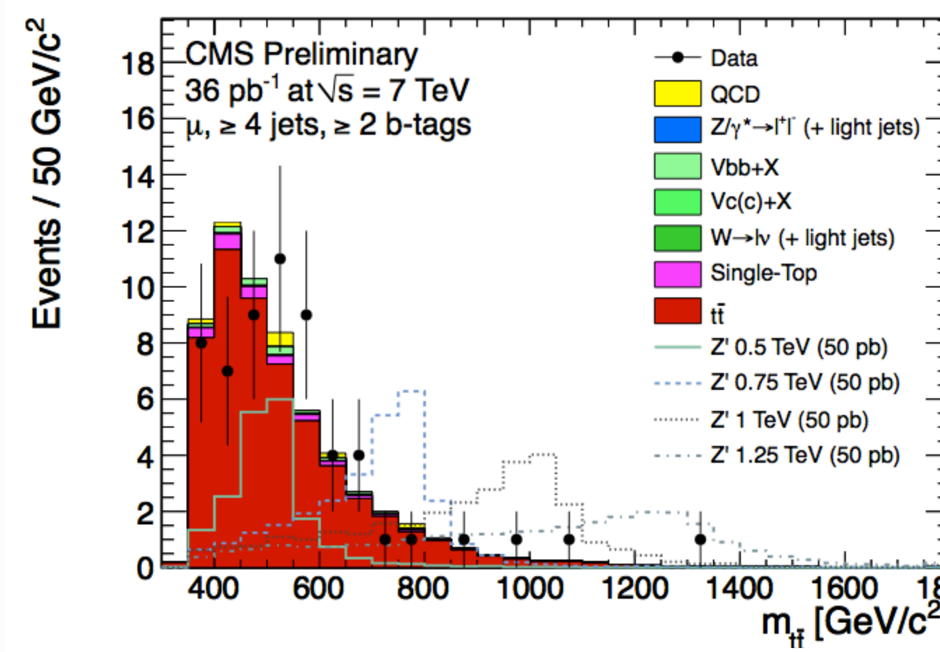
CMS limits (36 pb⁻¹)

eν	1.36 TeV
μν	1.4 TeV
eν+μν	1.58 TeV

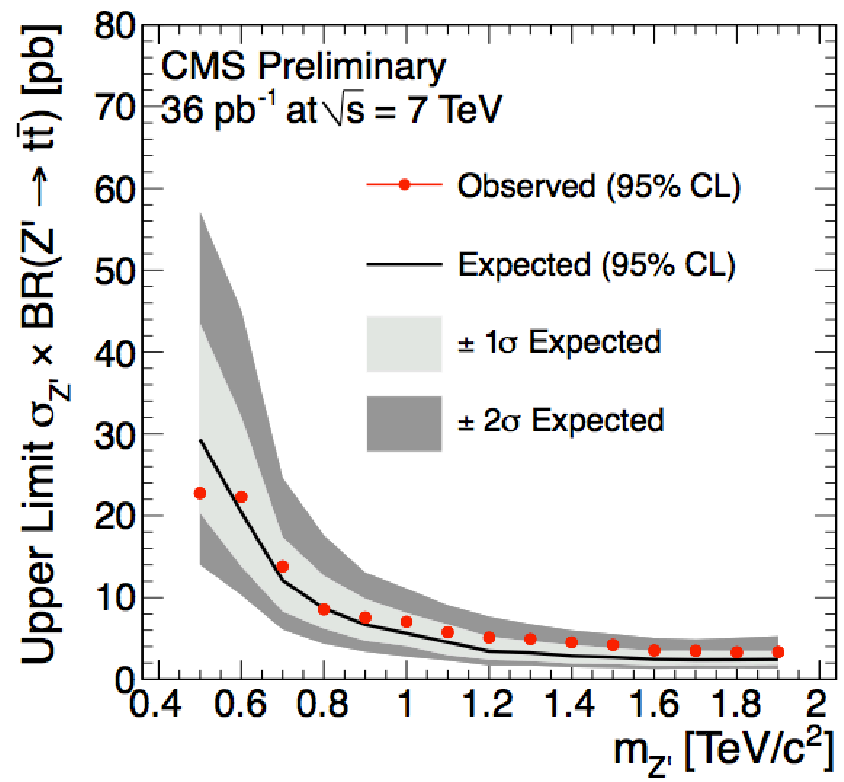
extending published CDF/D0 limits

Photons and Tops in the final state

- **Search for massive neutral bosons**
- Bump hunt in M(ttbar) spectrum
- Lepton+jets channels (el and mu)
- No bump seen in data
- Limits set, competitive with Tevatron



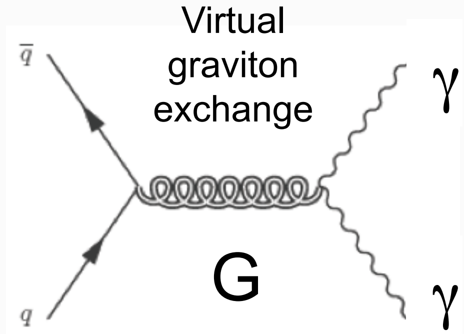
TOP-10-007; EXO-10-023

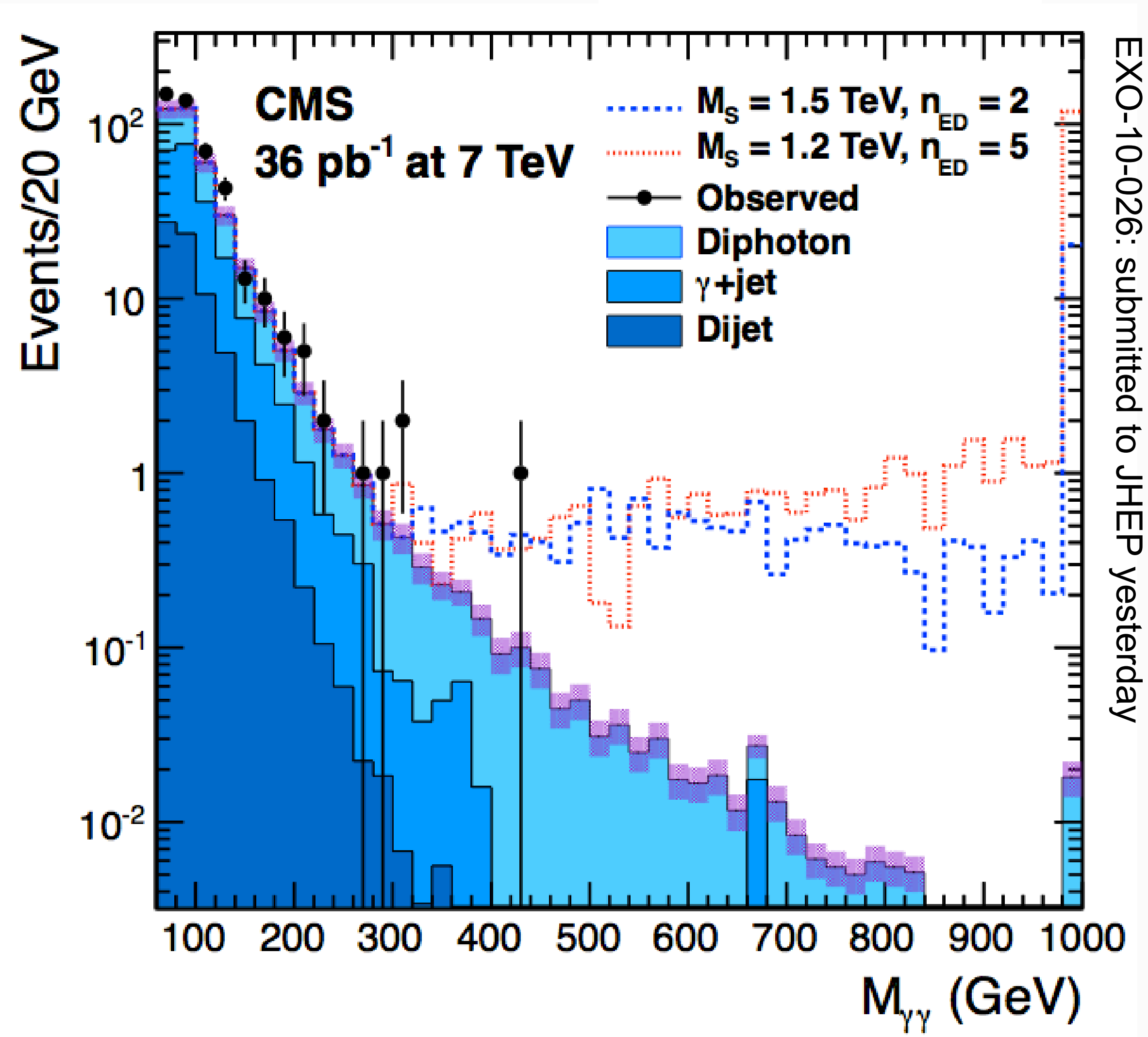


Photons and Tops in the final state

ETH Institute for Particle Physics

Search for LED via





EXO-10-026: submitted to JHEP yesterday

Photons in ECAL barrel, E_T> 30 GeV

Upper limit on σxBR < 0.11 pb for $M_{\gamma\gamma}$>500 GeV

New lower limits on eff. Planck scale of 1.6 - 2.3 TeV !

- **Search for massive neutral bosons**
- Bump hunt in M(ttbar) spectrum
- Lepton+jets channels (el and mu)
- No bump seen in data
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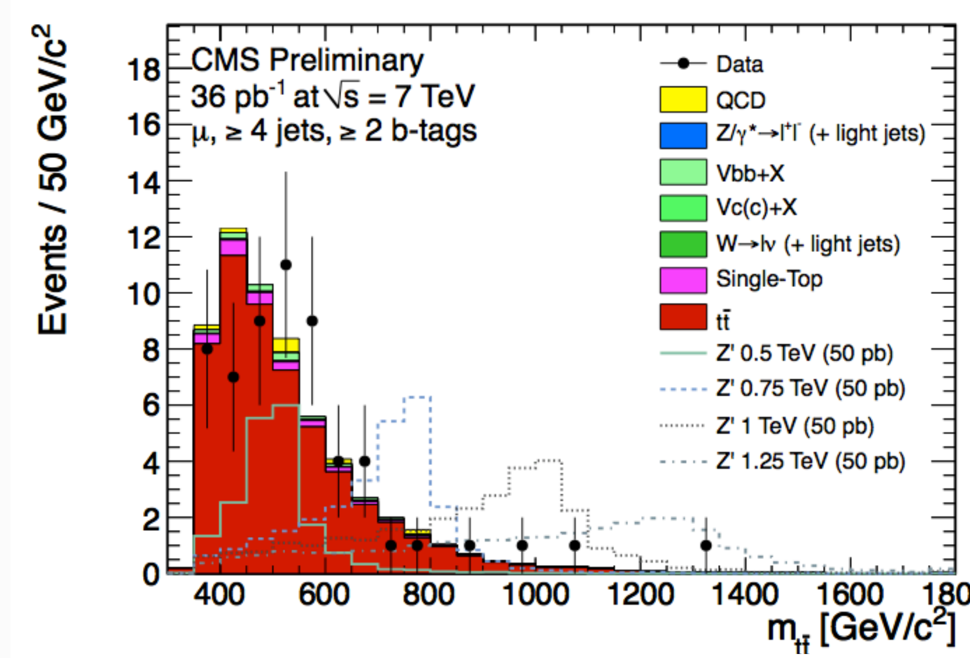
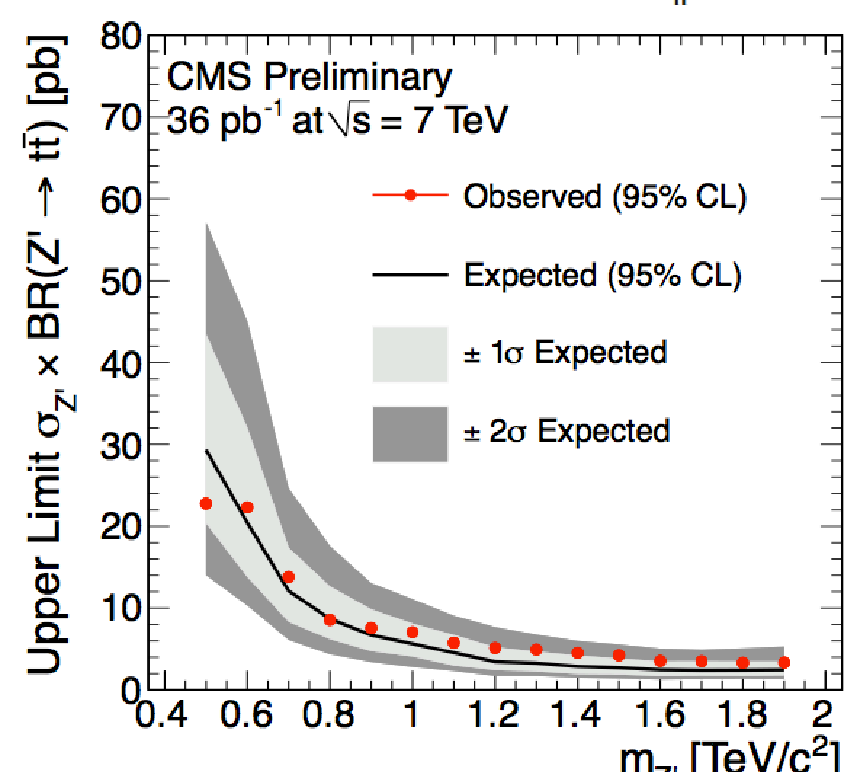
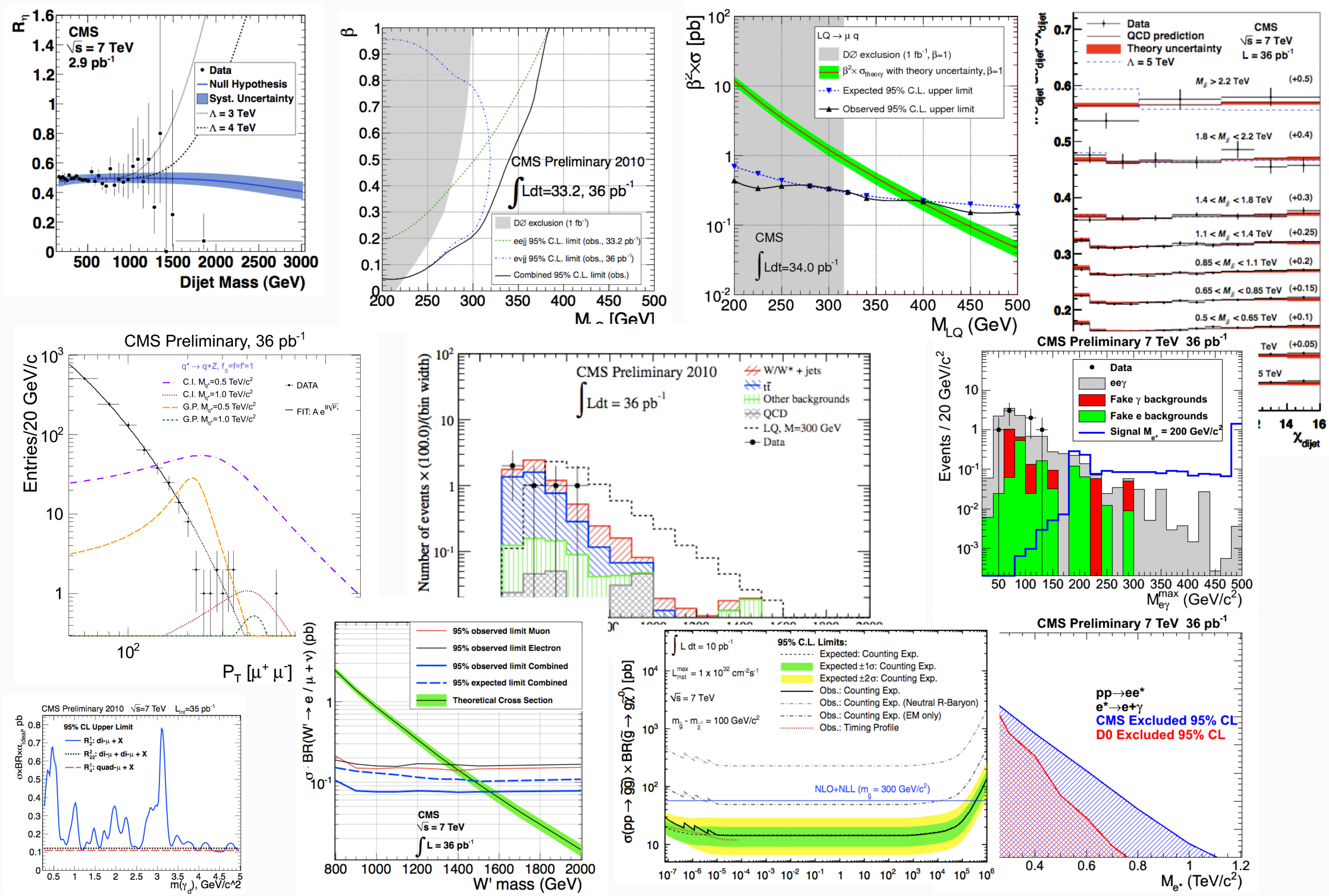


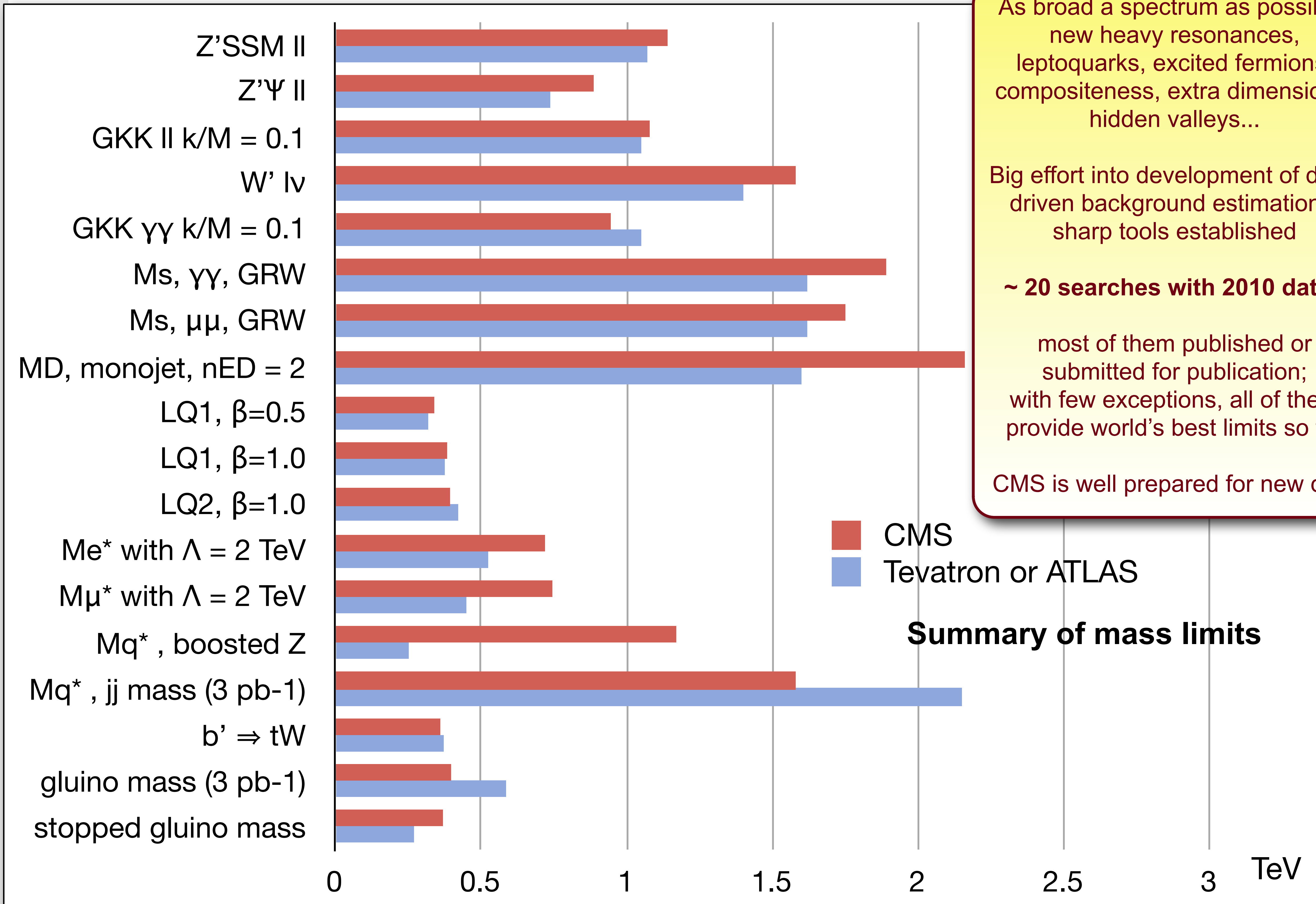
TOP-10-007; EXO-10-023



And many, many more...



And many, many more...



As broad a spectrum as possible: new heavy resonances, leptoquarks, excited fermions, compositeness, extra dimensions, hidden valleys...

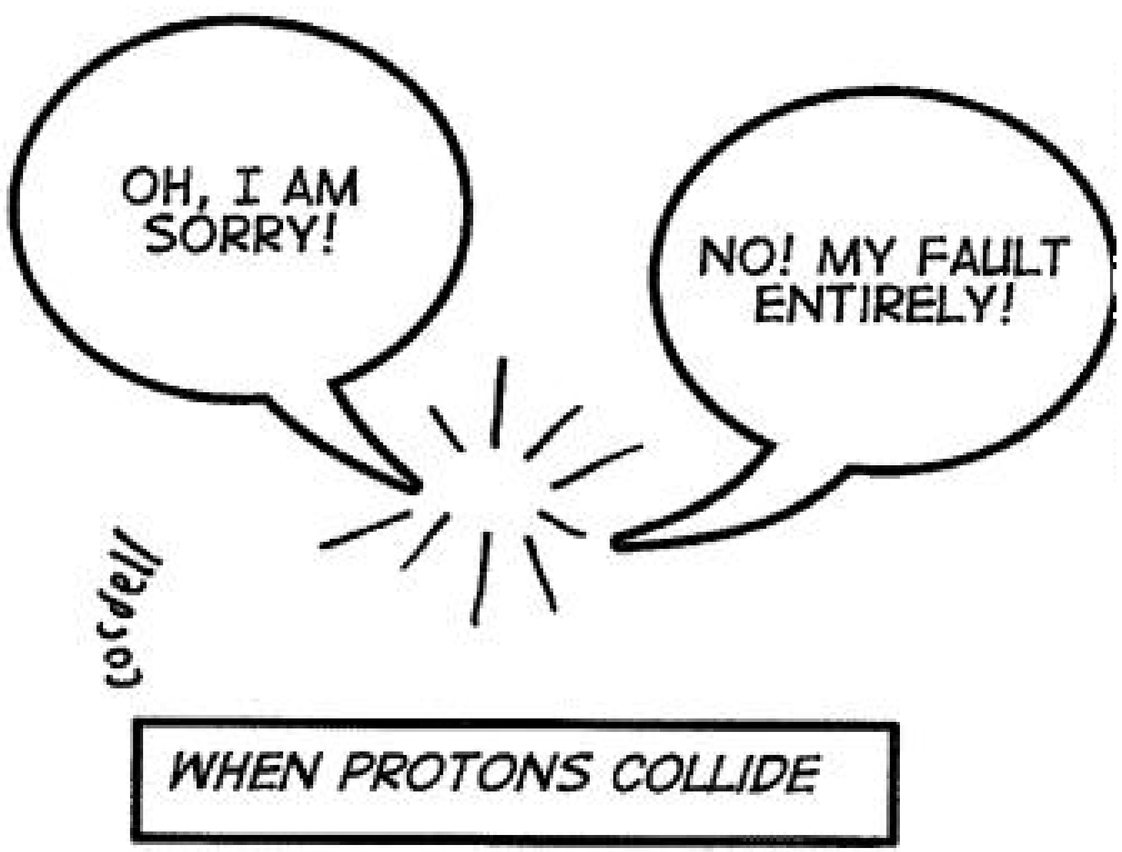
Big effort into development of data-driven background estimations: sharp tools established

~ 20 searches with 2010 data !

most of them published or submitted for publication; with few exceptions, all of them provide world's best limits so far

CMS is well prepared for new data

Conclusions



Summary

- Our sincere thanks go to our colleagues from the machine
  - the excellent LHC performance of last year is extremely promising for the upcoming year(s)
- CMS is in excellent shape
  - the complete chain of operation (from online data taking to final physics plots) has been stress-tested
  - the often better-than-expected performance, and the high motivation of all involved, has allowed for the production of an impressive amount of physics results, on an unseen short time-scale


LHC
few TeV
O(100) GeV

CMS is ready for discoveries

Thanks to...

... all my CMS colleagues who have helped me in preparing this talk!

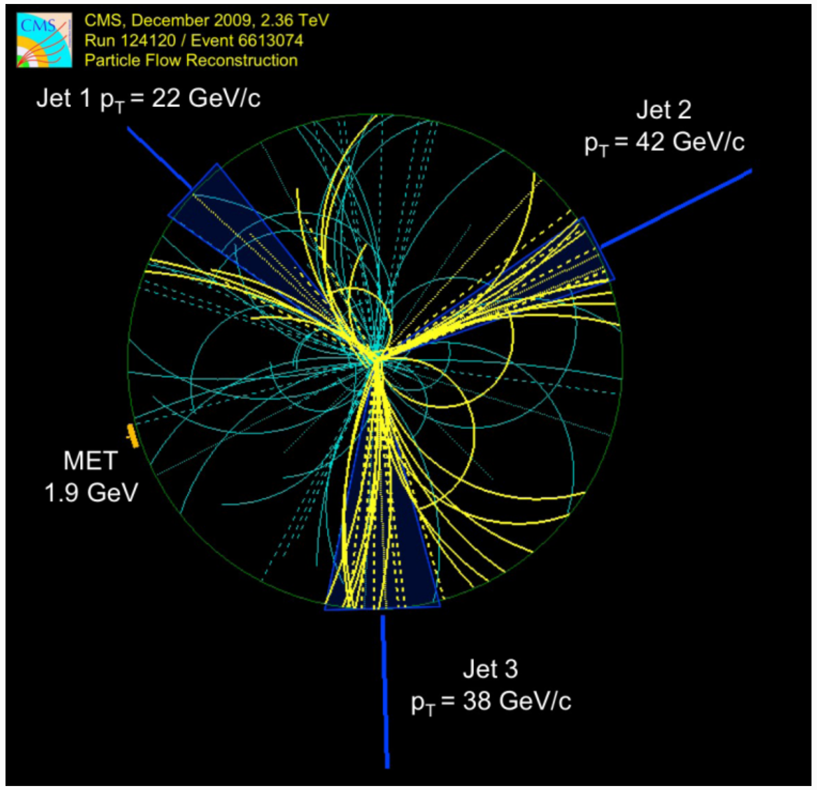
Backup

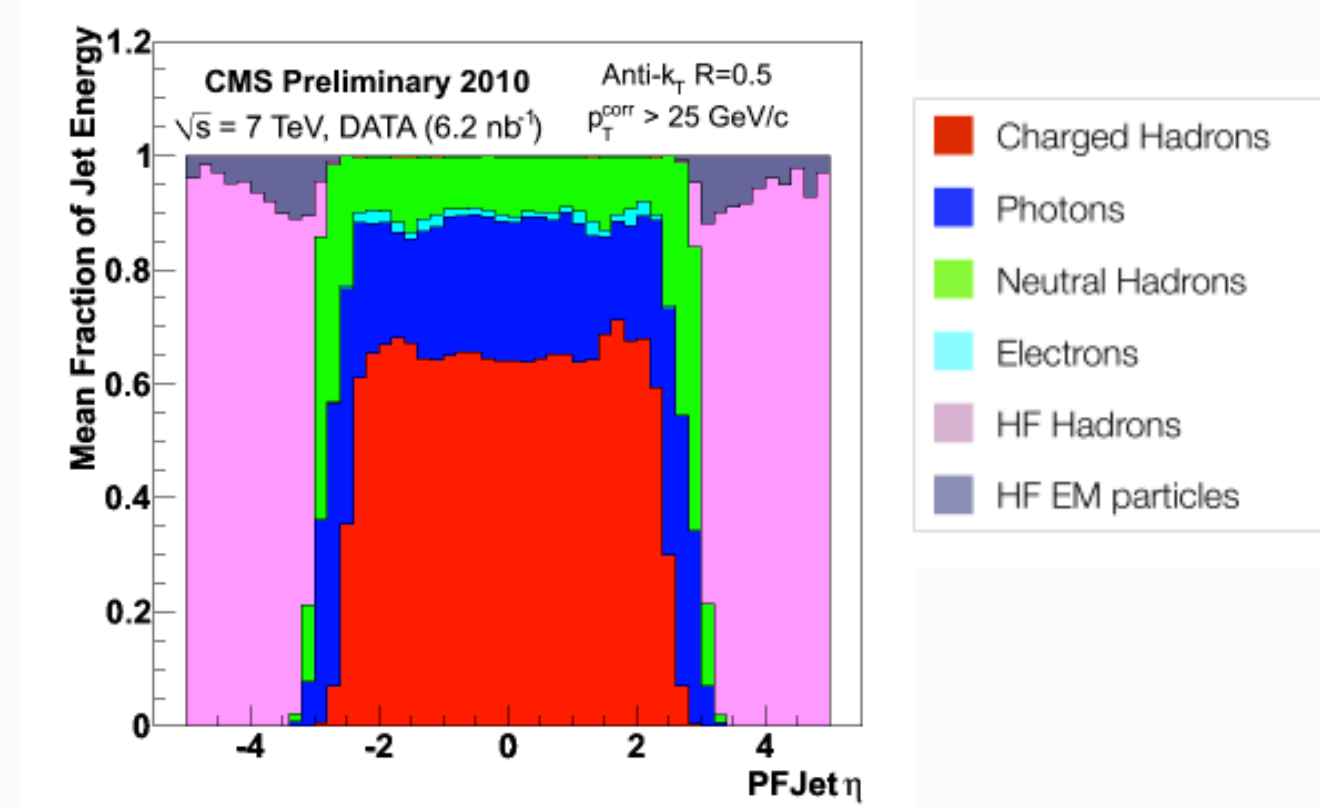
Paper titles

1. Measurement of the Lepton Charge Asymmetry in Inclusive W Production in pp Collisions at sqrt(s) = 7 TeV
2. Search for Physics Beyond the Standard Model in Opposite-sign Dilepton Events in pp Collisions at √s= 7 TeV
3. Search for Resonances in the Dilepton Mass Distribution in pp Collisions at √s= 7 TeV
4. Search for Supersymmetry in pp Collisions at √s= 7 TeV in Events with Two Photons and Missing Transverse Energy
5. Search for a W' boson decaying to a muon and a neutrino in pp collisions at √s= 7 TeV
6. Study of Z boson production in PbPb collisions at √sNN= 2.76 TeV
7. Measurement of W+W–Production and Search for the Higgs Boson in pp Collisions at √s= 7 TeV
8. Search for Heavy Bottom-like Fourth Generation Quark in tW Final State at CMS in pp Collisions at √s=7TeV.
9. Strange Particle Production in pp collisions at √s= 0.9 and 7 TeV
10. Measurement of BB Angular Correlations based on Secondary Vertex Reconstruction at √s=7TeV in CMS
11. Measurement of Dijet Angular Distributions and Search for Quark Compositeness in pp collisions at √s=7TeV
12. Observation and studies of jet quenching in PbPb collisions $\sqrt{S_{NN}}$= 2.76 TeV
13. First Measurement of Hadronic Event Shapes in pp collisions at √s=7TeV
14. Dijet Azimuthal Decorrelations in pp Collisions at √s=7TeV
15. Measurement of Bose–Einstein Correlations in pp Collisions
16. Inclusive b-hadron production cross section with muons in pp collisions
17. Search for Heavy Stable Charged Particles in pp collisions
18. Search for Supersymmetry in pp Collisions at 7 TeV in Events with Jets and Missing Transverse Energy
19. Measurement of the B+ Production Cross Section in pp Collisions at √s = 7TeV
20. Search for a heavy gauge boson W’ in final states with electrons and large missing ET in pp collisions
21. Upsilon production cross section in pp collisions at √s = 7TeV
22. Search for Pair Production of Second-Generation Scalar Leptoquarks in pp Collisions at √s= *7TeV*
23. Search for Pair Production of First-Generation Scalar Leptoquarks in pp Collisions at √s= *7TeV*
24. Search for Microscopic Black Hole Signatures at the Large Hadron
25. Measurements of Inclusive W and Z Cross Sections in pp Collisions at √s *= 7TeV*
26. Measurement of the Isolated Prompt Photon Production Cross Section in pp Collisions at √s= 7TeV
27. Search for Stopped Gluinos in pp collisions at √s= *7TeV*
28. Charged particle multiplicities in pp interactions at √s= 0.9, 2.36, and 7 TeV
29. Prompt and non-prompt J/ production in pp collisions at √s= 7TeV
30. First Measurement of the Cross Section for Top-Quark Pair Production in Proton-Proton Collisions
31. Search for Quark Compositeness with the Dijet Centrality Ratio in pp Collisions at √s= *7 TeV*
32. Search for Dijet Resonances in 7 TeV pp Collisions at √s=7TeV
33. Observation of Long-Range, Near-Side Angular Correlations in Proton-Proton Collisions at the LHC.
34. CMS Tracking Performance Results from Early LHC Operation.
35. First Measurement of the Underlying Event Activity at the LHC with √s *= 0.9 TeV*
36. Transverse-momentum and pseudorapidity distributions of charged hadrons inppcollisions ats√= 7 TeV
37. First Measurement of Bose-Einstein Correlations in pp collisions at √s=0.9 and 2.36 TeV at the LHC
38. Transverse momentum and pseudorapidity distributions of charged hadrons at √s=0.9 and 2.36 TeV

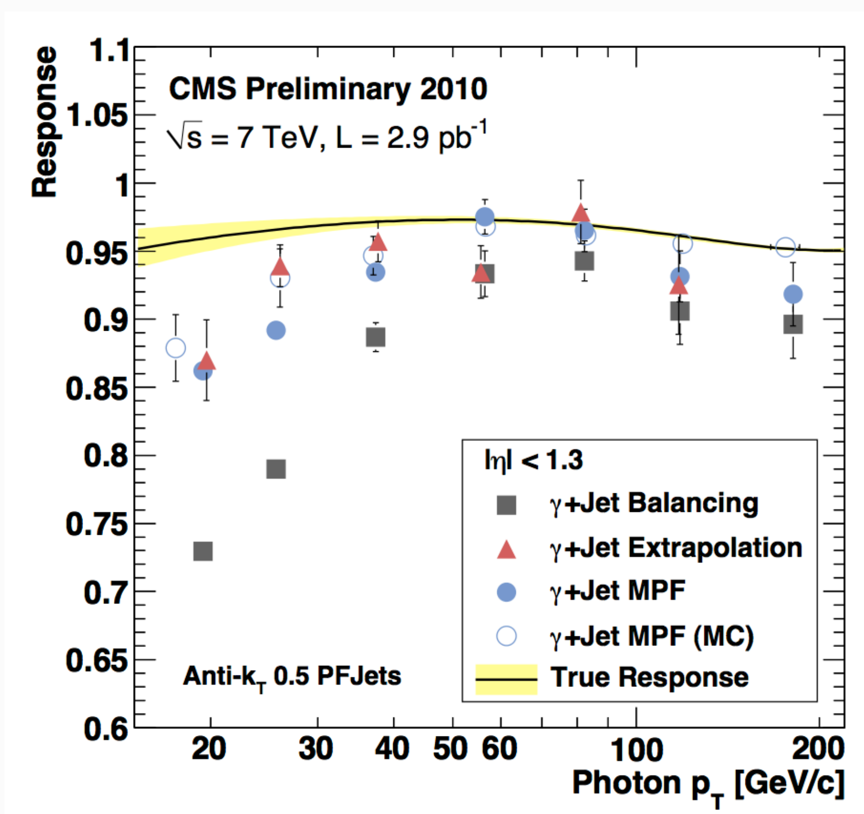
+12 in CWR + many other analyses approved for the Winter Conferences.

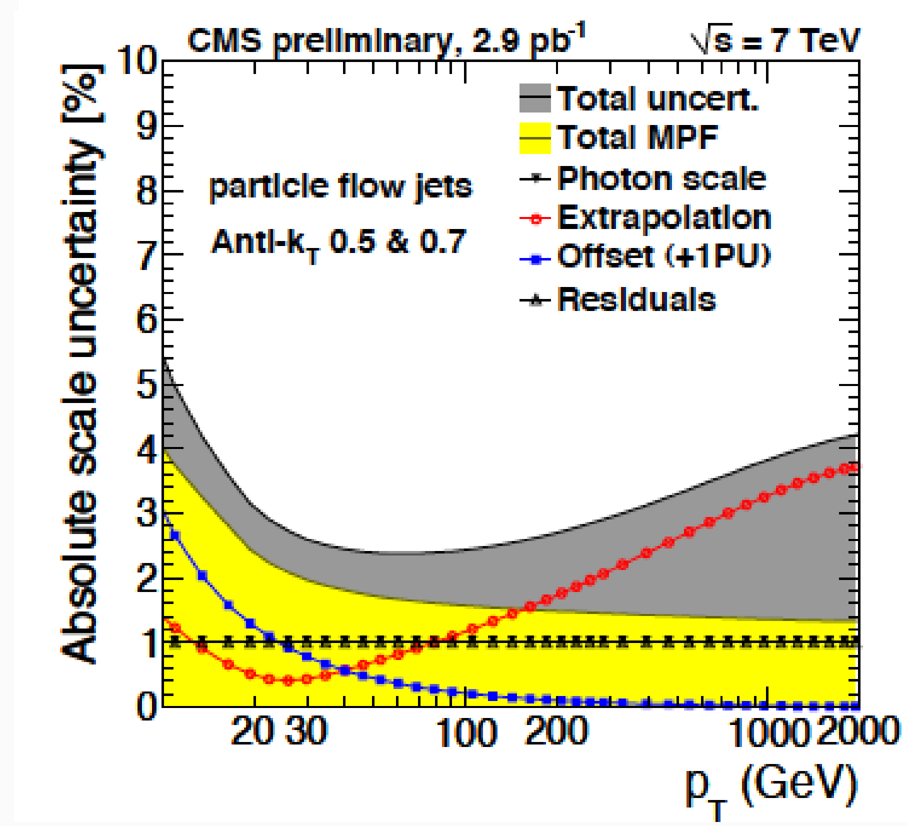
CMS performance: PF jets





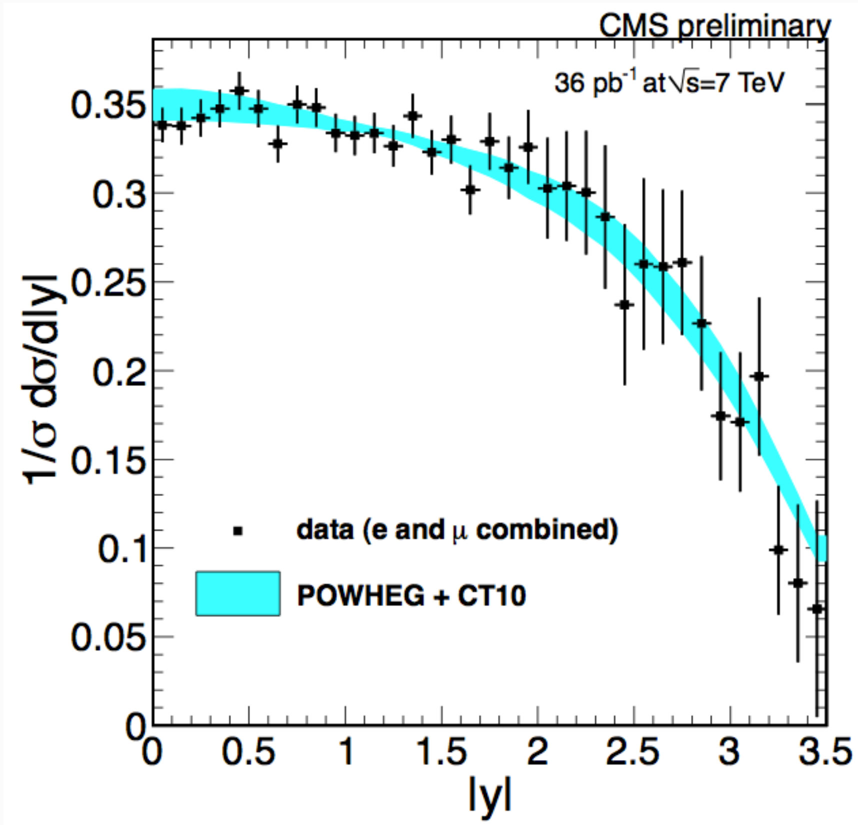
PAS JME-10-010





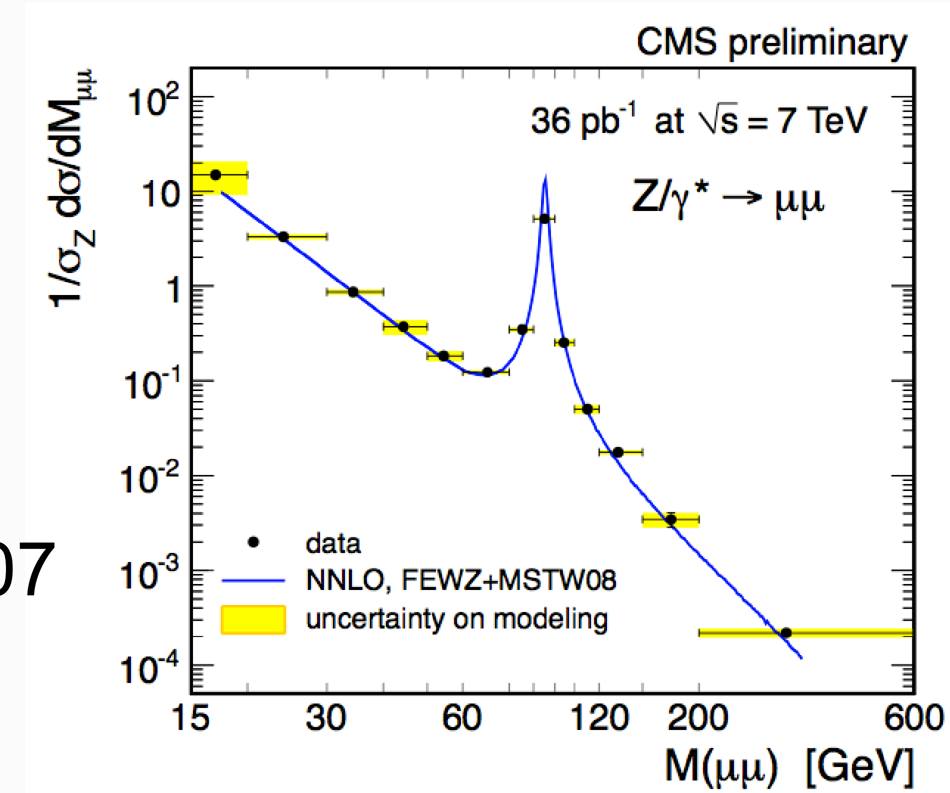
- Jet performance matches simulation very well, PF JEC uncertainties: 3-5 %

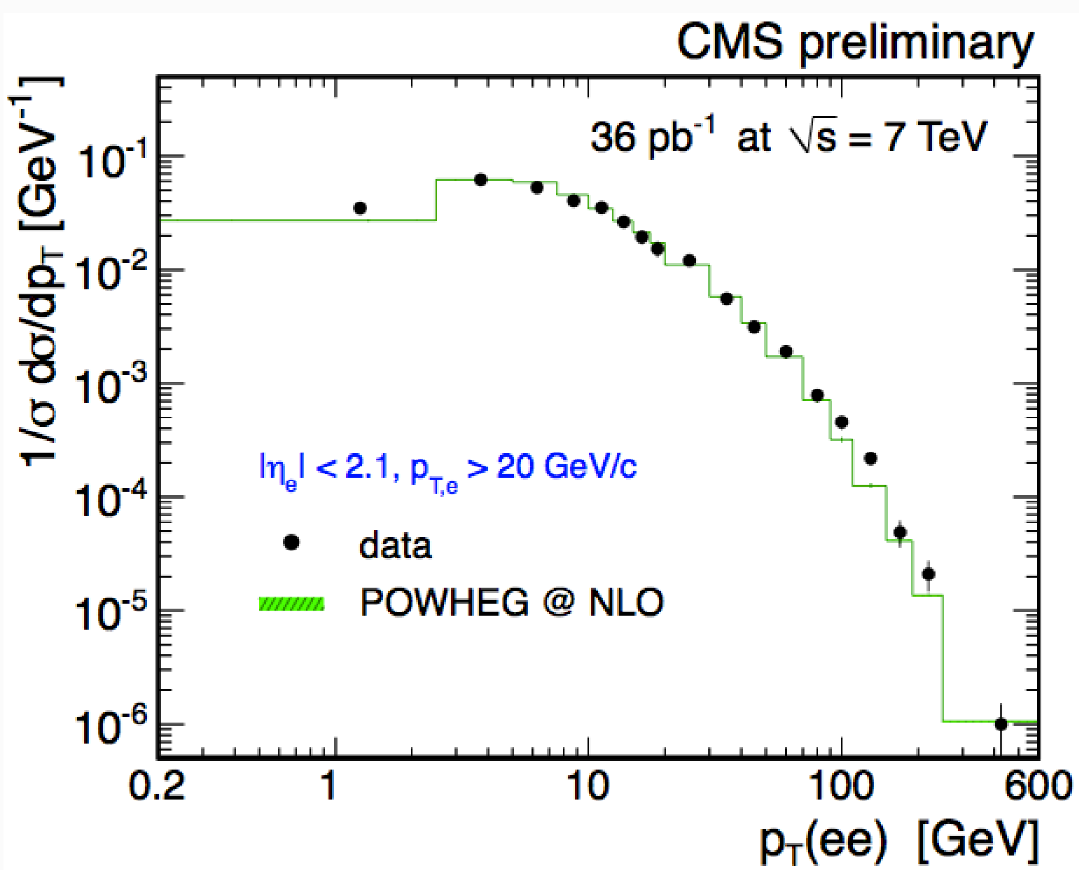
Z production properties

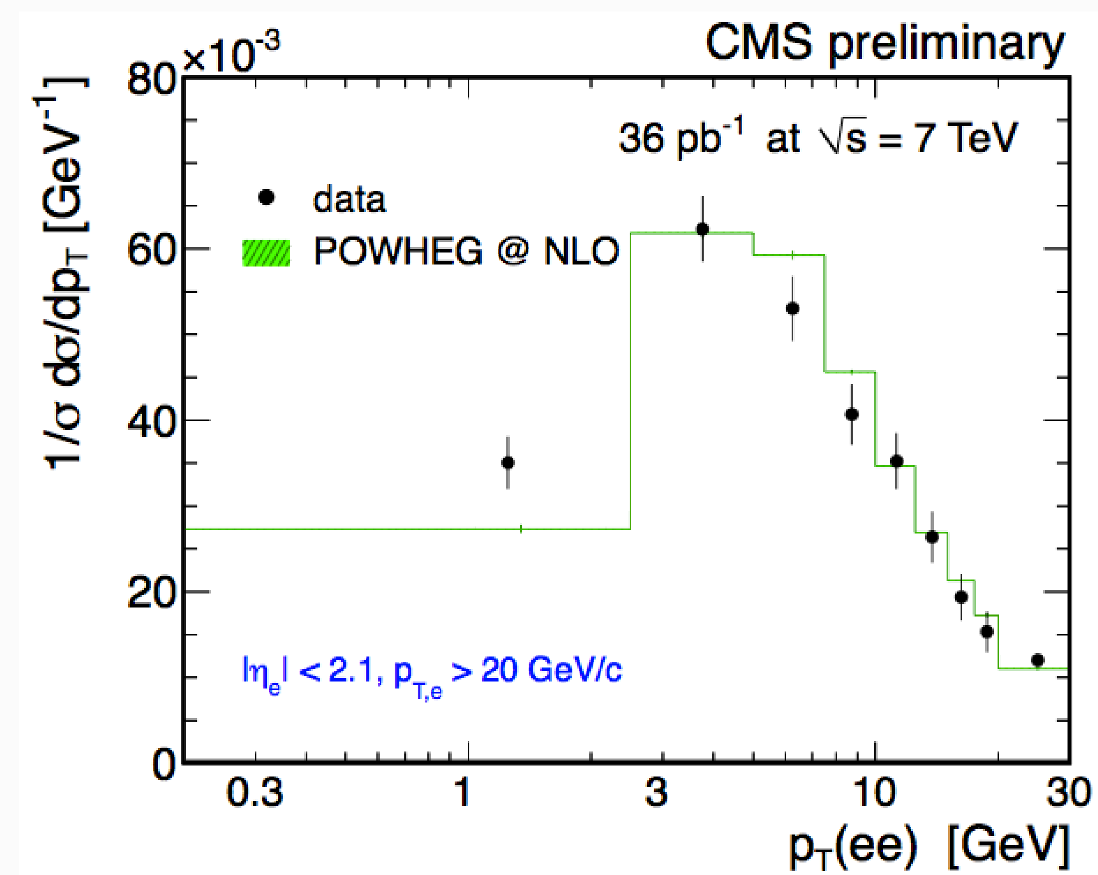


EWK-10-010

EWK-10-007



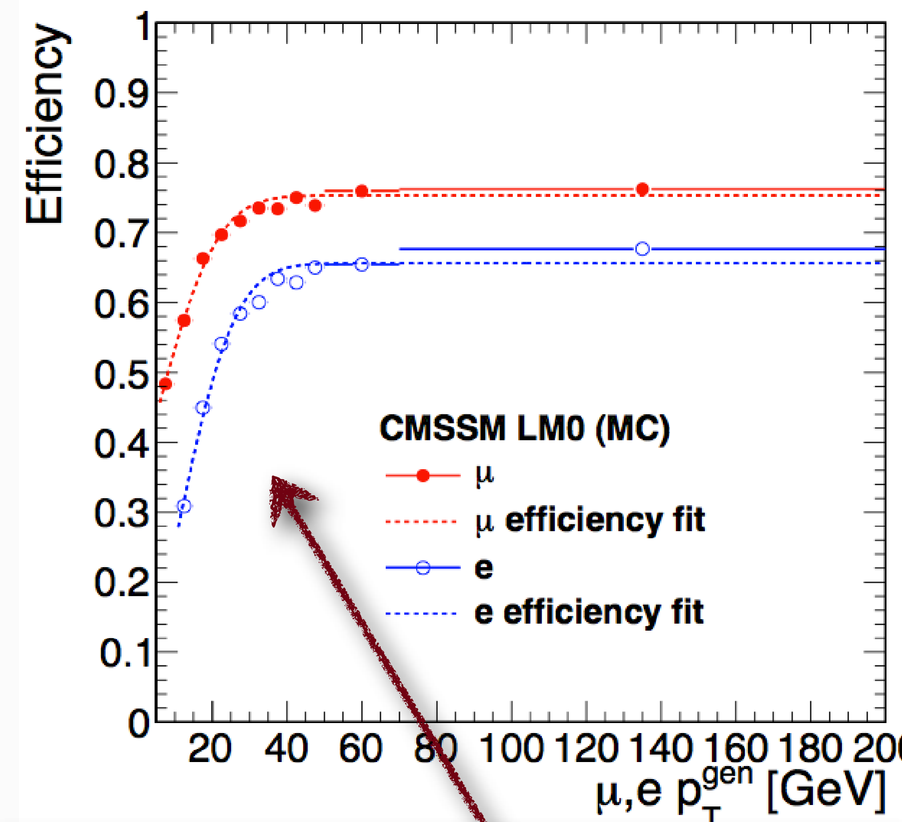




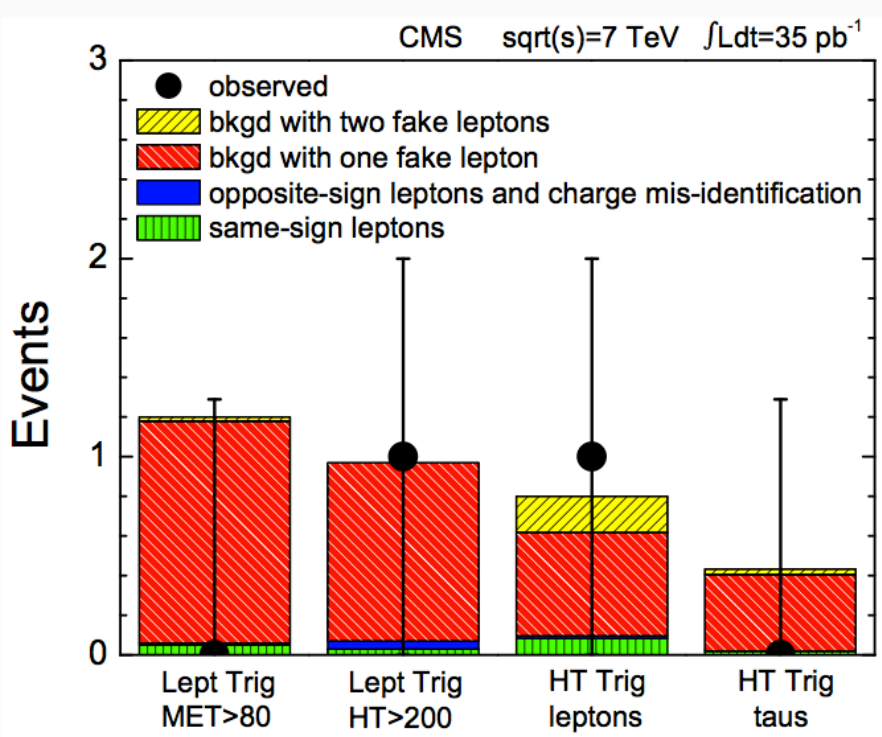
Example SUSY search: same-sign dilepton

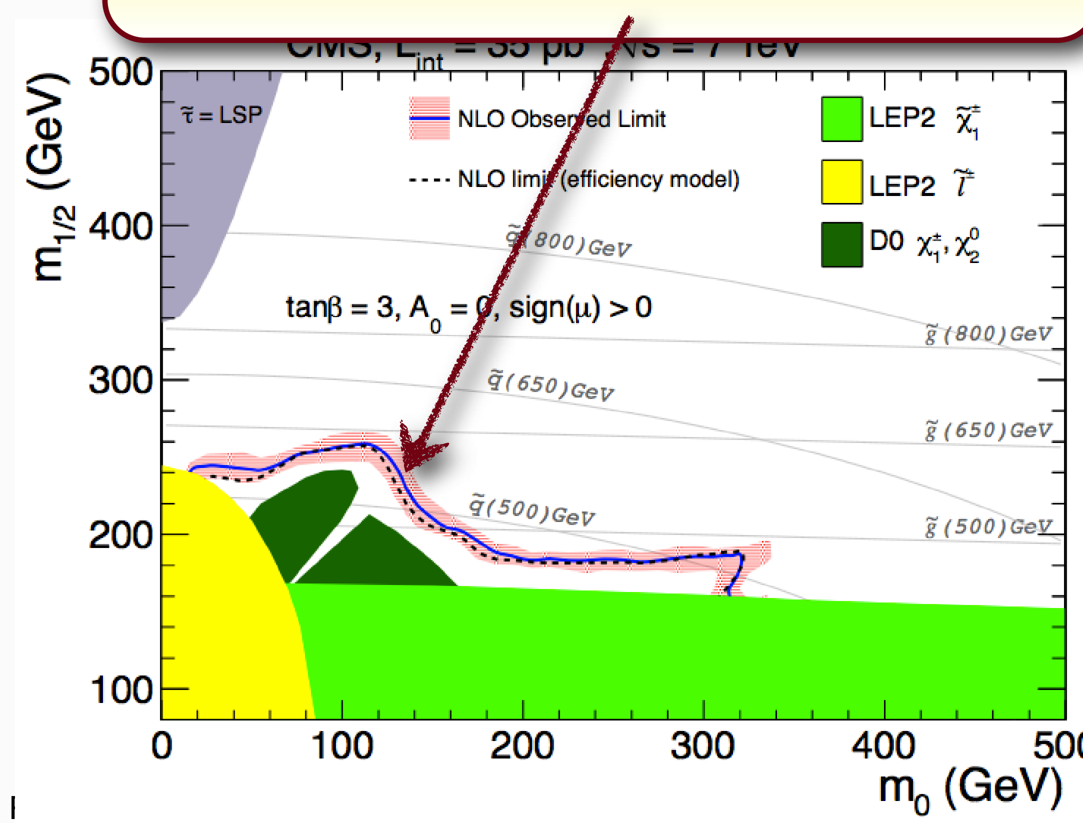
SUS-10-004

- Two different trigger approaches
  - HT or lepton p_T
- Baseline selection:
  - 2 same sign, isolated leptons (e or μ)
  - $p_{T,1}$>20, $p_{T,2}$ > 10 GeV
  - ≥ 2 jets: p_T > 30 GeV, |η|<2.5
  - MET: > 30 GeV (ee and μμ), > 20 GeV (eμ)
- Main background: ttbar (lepton from b)
  - name of the game: jets faking leptons
  - data-driven fake-rate estimations



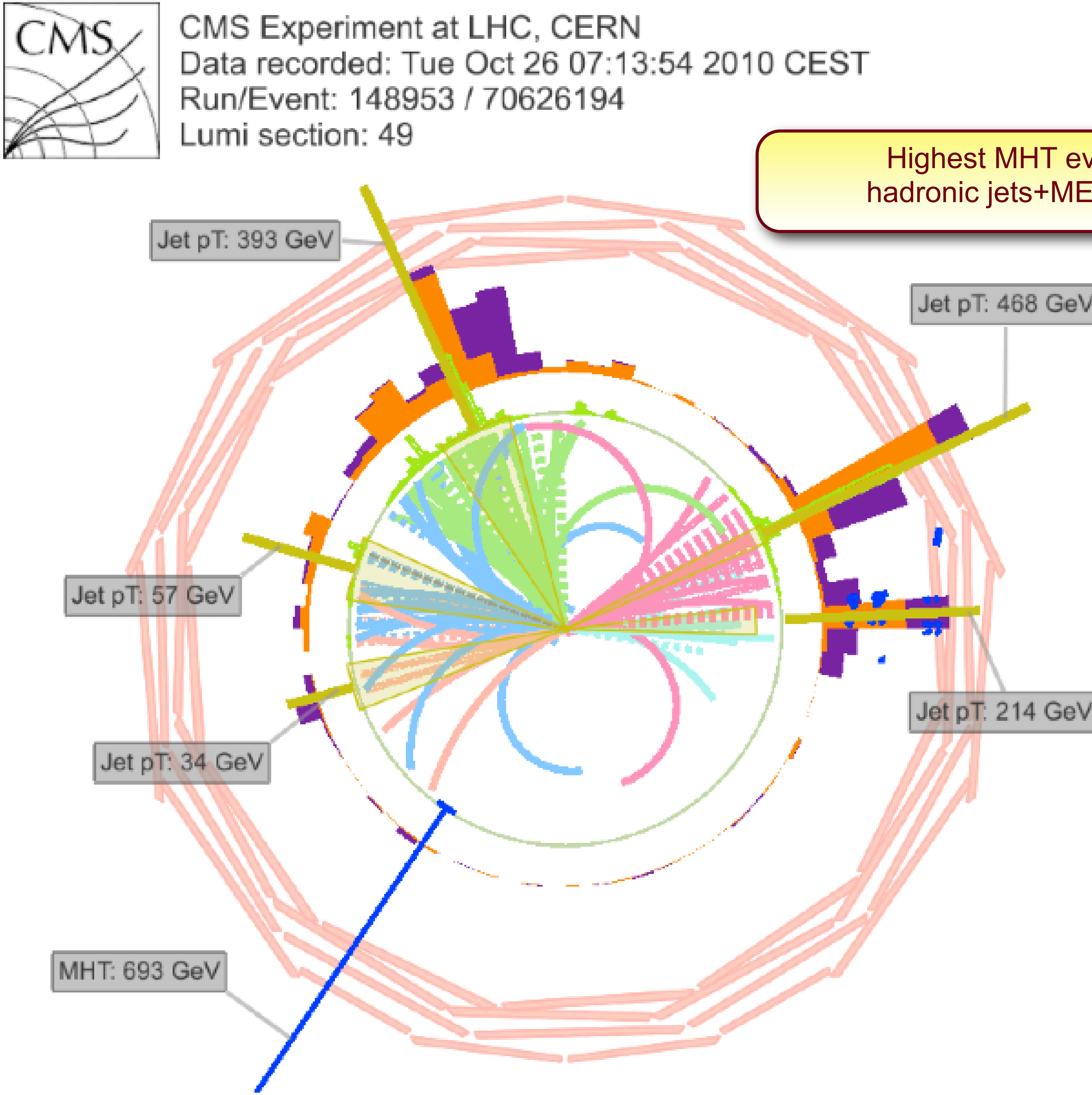
lepton efficiency parametrization agrees with full CMS simulation





Commissioning / Status

- Central DAQ upgraded to 64bit for better performance
- Global data taking started with cosmic data taking for alignment
- Initial collisions have been used to re-commission the detector:
  - Delay scans for timing with LHC beams – pixels and RPCs had moved by ½ bunch crossing with respect to the 2010 run
  - HV scans
  - Verification of trigger timing
- The CMS detector operates with most subdetectors having **over 98% of channels active**
- As the LHC has now started the intensity ramp-up, CMS is collecting data to perform high level validations



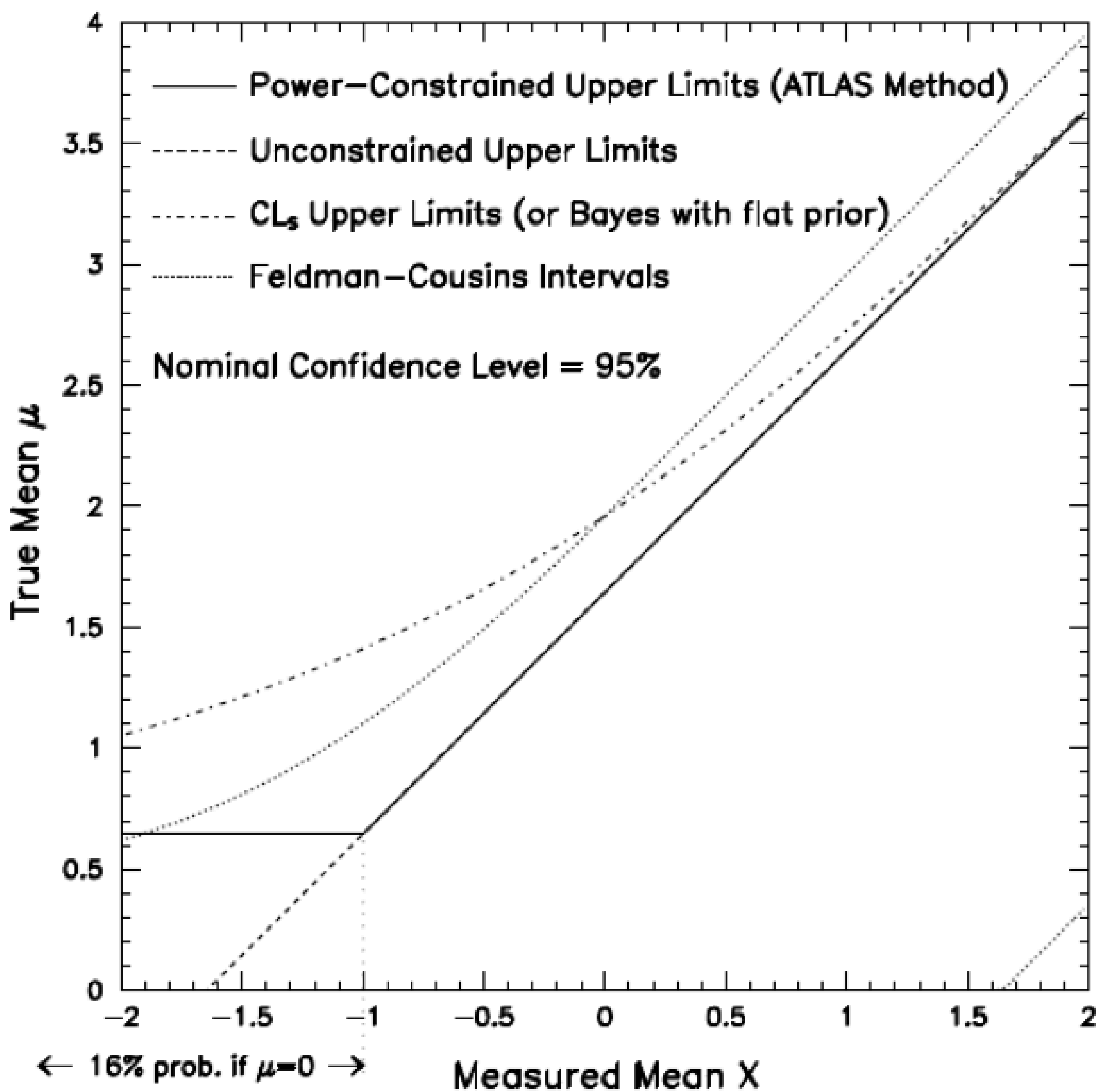
Highest MHT event in all hadronic jets+MET analysis

	Limits in TeV		
	CMS	Best Tevatron	ATLAS
		Heavy Bosons	
Z'_{SSM} ll	1.14	1.071	1.048
Z'_{ψ} ll	0.887		0.738
G_{KK} ll k/M = 0.1	1.079	1.050	
W' lν	1.58	1.10	1.40
G_{KK} γγ k/M = 0.1	0.945	1.050	0.920
		Large Extra Dimensions	
M_s, γγ, GRW	1.89	1.62	
M_s, μμ, GRW	1.75	1.62	
M_D, monojet, n_{ED} = 2	2.16	1.6 (LEP)	
		LeptoQuark	
LQ1, β=0.5	0.340		0.319
LQ1, β=1.0	0.384		0.376
LQ2, β=1.0	0.394		0.422
		Lepton Compositeness	
M_{e^*} with Λ = 2 TeV	0.720	0.525	
M_{μ^*} with Λ = 2 TeV	0.745	0.450	
		Contact Interactions	
M_{q^*} , boosted Z	1.17	0.252 (HERA)	
M_{q^*} , jj mass (3 pb-1)	1.58		2.15
C.I. Λ , jj mass (3 pb-1)	4.0		
C.I. Λ , X analysis	5.6		9.5
		4th Generation	
b' ⇒ tW	0.361	0.372	
		Heavy Stable Charged Particle	
gluino mass (3 pb^{-1})	0.398	0.397	0.586
		Stopped Gluino	
gluino mass	0.370	0.270	

Intervals and Limits for a Physically Bounded μ

- Prototype: measurement x is unbiased Gaussian estimate of μ. (Let σ=1.) What is 95% C.L. Upper Limit (UL)?
- 1986: Six methods for UL surveyed by V. Highland (VH) include U.L. = max(0, x + 1.64) and U.L. = max(0,x) + 1.64.
- RPP 1986: Bayesian: uniform prior on the mean μ for μ≥0, prior prob = 0 for μ<0. (VH's other five not mentioned.)
- 1994,96: 3 ad-hoc frequentist recipes, one using max(x,0).
- 1998: Feldman & Cousins (FC) "Unified Approach" in (Kendall and Stuart) replaces ad hoc frequentist
- 2002: CLS from LEP added to Bayesian and FC.
- CMS Statistics Committee recommends using (at least) one of the three (red) methods in 2002-present PDG RPP.
- ATLAS SC method implies U.L. = max(0, x + 1.64) before power constraint (PC), U.L. = max(-1,x) + 1.64 after PC.

Comparison of ATLAS PCL with the three methods in PDG



(Atlas unconstrained U.L. is zero, not null, for x < -1.64)

ATLAS PCL re-opens discussion on use of diagonal line along with ad hoc constraint, out of favor for many years, not recommended by CMS SC.

CMS and ATLAS SC's are reviewing arguments and what has been learned in 25+ years. Academic statisticians have commented as well.

Just tip of iceberg: Poisson example brings in other issues. Nuisance parameters yet more. Choice of test statistic varies.