G. Bagliesi
27/9/2016

Overview of ICHEP 2016

ICHEP2016CHICAGO

38th INTERNATIONAL CONFERENCE ON HIGH ENERGY PHYSICS

AUGUST 3 - 10, 2016

CHICAGO

Very large conference on HEP, huge program...

Wednesday, August 3rd, 2016

16:00 - 19:00	Registration desk open
17:00 - 20:00	Meeting and dinner with parallel session conveners

Thursday, August 4th, 2016

07:00 - 18:00	Registration desk open
09:00 - 19:00	Parallel sessions

Friday, August 5th, 2016

07:00 - 18:00	Registration desk open
08:00 - 19:00	Parallel sessions

Saturday, August 6th, 2016

07:00 - 18:00	Registration desk open
09:00 - 18:00	Parallel sessions
18:00 - 20:00	Poster session with a reception (120')

Monday, August 8th, 2016

07:00 - 18:00	Registration desk open
09:00 - 09:30	Formal Opening (30')
09:30 - 10:50	ICHEP2016 Highlights (80')
11:15 - 12:30	ICHEP2016 Highlights (75')
12:30 - 12:45	1' elevator speeches by 20 young scientists - poster presenters (15')
12:45 - 13:00	Presentation of award from The Science Colaition to US Representative Bill Foster (15')
13:20 - 14:05	Lunch & Learn - What makes a great physics news story (45')
14:15 - 15:45	Neutrinos (90')
16:15 - 17:30	Enabling Technologies (75')
17:30 - 18:30	Future Facilities (60')
18:30 - 20:30	Poster session with a reception (120')

Tuesday, August 9th, 2016

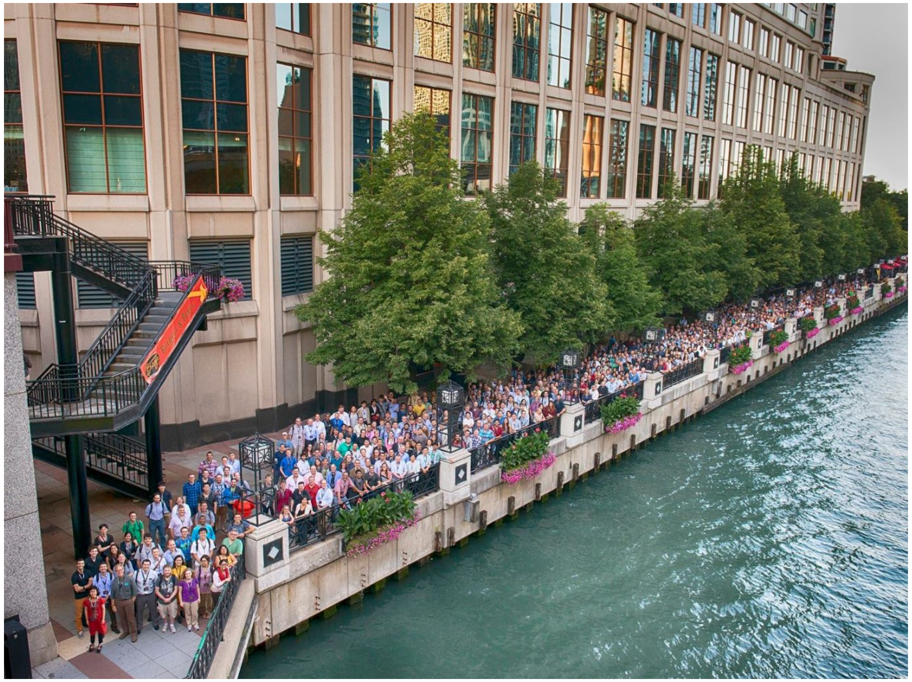
07:00 - 18:00	Registration desk open
09:00 - 10:30	Higgs, Top and Electroweak Physics (90')
11:00 - 12:30	Beyond the Standard Model (90')
12:30 - 12:55	1' elevator speeches by 20 young scientists - poster presenters (25')
13:20 - 14:05	Lunch & Learn - Making science fun and exciting through social media (45')
14:15 - 16:00	Flavor Physics (105')
16:30 - 18:00	LQCD, Formal Theory, Outreach, Diversity (90')
18:30 - 20:00	Public Lecture on Gravitational Waves (90')

Wednesday, August 10th, 2016

08:30 - 09:50	Young Scientists Awards, and IUPAP-C11/ICFA Reports (80')
10:20 - 12:00	Strong Interactions, Hadron Physics & Heavy Ions (100')
12:00 - 12:15	1' elevator speeches by 10 young scientists - poster presenters (15')
12:30 - 13:20	Special Session DOE - PI Meeting (50')
13:30 - 15:35	Dark Matter, Astro-Particle & Cosmology (125')
15:35 - 16:30	Closing (55')

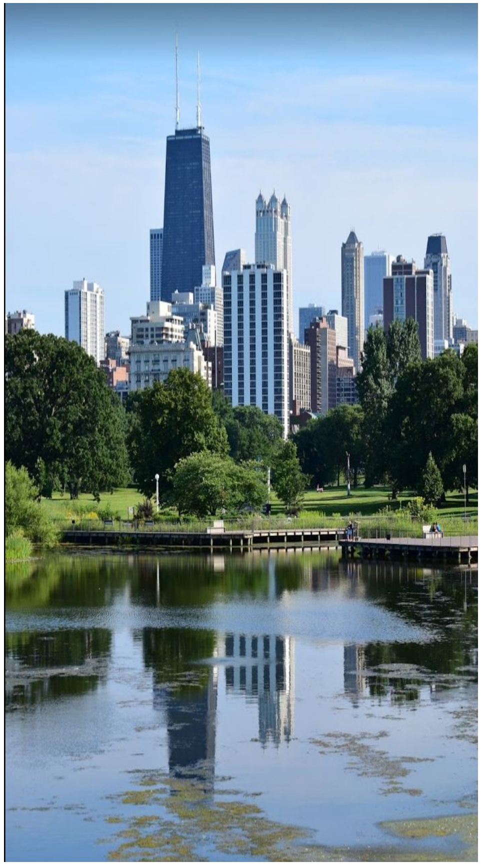
ICHEP in numbers

- 1430 participants from 51 countries
- ~600 parallel talks in ~20 sessions
- ~500 poster presentations
- 40 minutes elevator speeches (new!)
- 64 parallel session conveners
- 40 plenary talks (Mon-Wed)

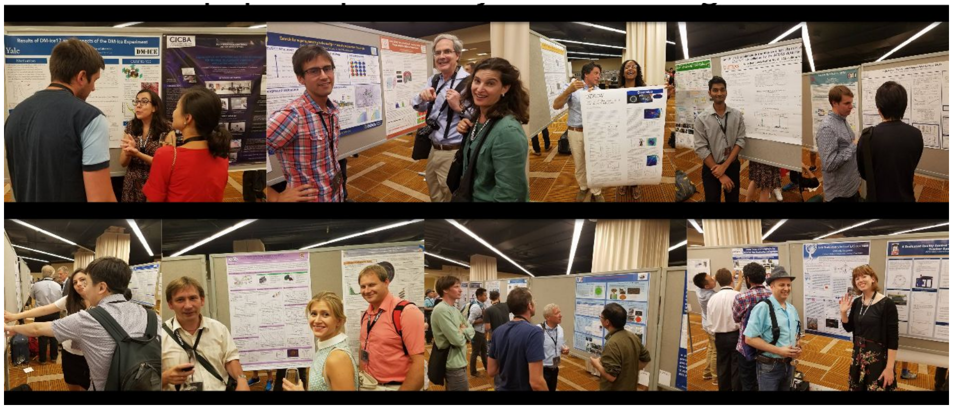


http://indico.cern.ch/event/432527/

Beautiful Chicago... of course!



Posters



- ~500 posters, ~60 judges
- ~20 poster awards to students and postdocs
- 4 mentions for outstanding posters by seniors
- 1 most popular poster by online voting

most popular by online voting

“The design and performance of the ATLAS Inner Detector trigger for Run 2 LHC Collisions at 13 TeV “ **Fabrizio Milano**

outstanding poster contribution by senior researcher

CEPC partial double ring scheme and crab-waist parameters- **DOU WANG (IHEP)**

Summary of the HL-LHC related Civil Engineering studies and the related vibration studies
PAOLO FESSIA (CERN)

GEM*STAR Accelerator-Driven Subcritical System for Improved Safety,
Waste Management, and Plutonium Disposition **RONALD JOHNSON (Muons Inc)**

Maximizing Magnetic Field Uniformity in the 1.45-Tesla Muon g-2 Storage Ring
BRENDAN KIBURG (Fermilab)

1’ elevator talks

(*organized by L. Tompkins, Stanford U. and S. Demers, Yale U.*)

- 106 volunteers from all experiments, outreach, computing, theory

- 40 talks selected (28 first to volunteered, 12 considering balance geographic regions & gender)

IUPAP - C11 young scientist awards

IUPAP International Union of Pure and Applied Physics

C11: PARTICLES AND FIELDS

- *Stefan Hoeche, SLAC, US*
  - For developing high precision Monte Carlo simulations of events at hadronic colliders

- *Liangjian Wen, IHEP, China*
  - For his original contributions to the physics of neutrinos, and in particular, to the discovery of the non-zero neutrino mixing angle θ_{13}

Diversity and Inclusion

- New session devoted to collaborative programs that aim to increase inclusion of developing countries, low-income areas and women into physics
- Presentations from individuals, laboratories, experiments, national programs

09:00	Introductory Remarks	*Zeblon Vilakazi*	*Huron*	09:00 - 09:05
	Ground Rules and Guidelines	*Brian Nord*	*Huron*	09:05 - 09:08
	Project Juno: Advancing Gender Equality In Physics Careers In Higher Education In The UK	*Marcella Bona*		
	A New US-CERN Summer Program on ATLAS Experiment of LHC at CERN for California State University System	*Lauren Alexandra Tompkins et al.*		
	The early career, gender, and diversity actions within the LHCb Collaboration	*Jonas Rademacker et al.*		
	Composition of the ATLAS Collaboration	*Joleen Pater et al.*	*Huron*	09:14 - 09:26
	Creating Inclusive Work Environments -- to break culture-cloning	*Tuva Ora Herenui Richert*	*Huron*	09:26 - 09:38
	Increasing diversity in science	*Maria Isabel Pedraza Morales*	*Huron*	09:38 - 09:50
10:00	Benefits of diverse and interdisciplinary co-creation for HEP - a showcase	*Daniel Dobos*	*Huron*	09:50 - 10:02
	Bridge Programs as an approach to improving diversity in physics	*Brian Beckford*	*Huron*	10:02 - 10:14
	Panel Discussion	*Inclusivity in our work environments*	*Huron*	10:14 - 10:50
	Session of International Outreach and Capacity Development	*Ketevi Adikle Assamagan*	*Huron*	11:10 - 11:22
	Promoting Women in Physics in South Africa	*Kate Shaw et al.*	*Huron*	11:22 - 11:34
	The early career, gender, and diversity actions within the LHCb Collaboration	*Barbara Sciascia et al.*	*Huron*	11:34 - 11:46
	The Masterclass of particle physics and scientific careers from the point of view of male and female students	*Sandra Leone*		
12:00	The Davis-Bacall Scholars Program	*Margaret Norris*	*Huron*	11:57 - 12:08
	Pre-College Science and Engineering for Inner-City Middle School Students	*Kevin Pitts et al.*	*Huron*	12:08 - 12:19
	The Cevale2ve case	*Arturo Sanchez*	*Huron*	12:19 - 12:30
	Panel Discussion	*Providing access to science*	*Huron*	12:30 - 13:00
13:00				


Paula Eerola
Helsinki Institute of Physics, Finland


Rohini Godbole
Institute of Science, Bangalore, India

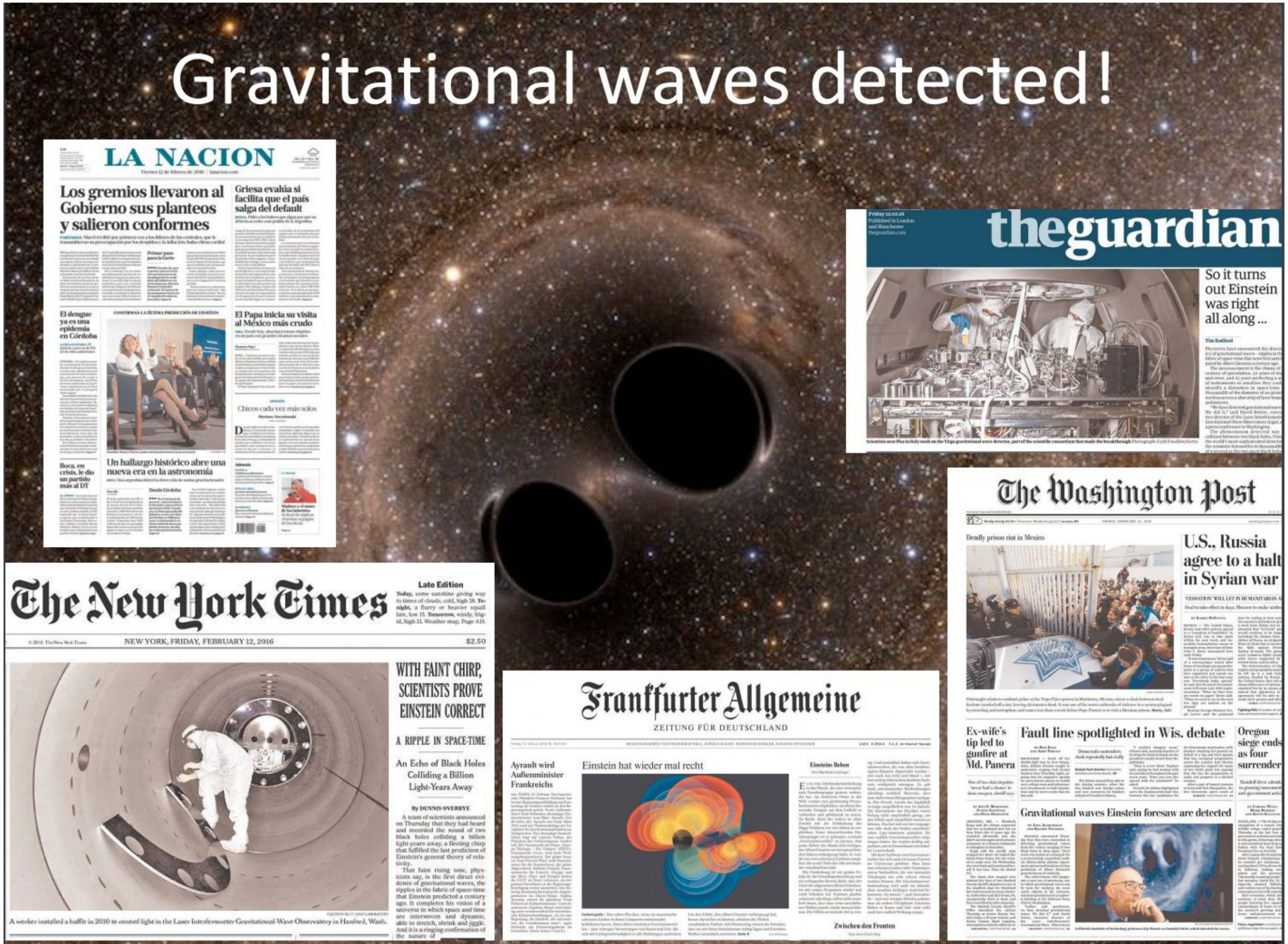

Irais Bautista Guzmán
Benemérita Universidad Autónoma de Puebla, Mexico


Brian Nord
Fermilab, US

Highlight: Gravitational Waves detection

Nergis Mavalvala - MIT plenary talk

LIGO and VIRGO Collaborations

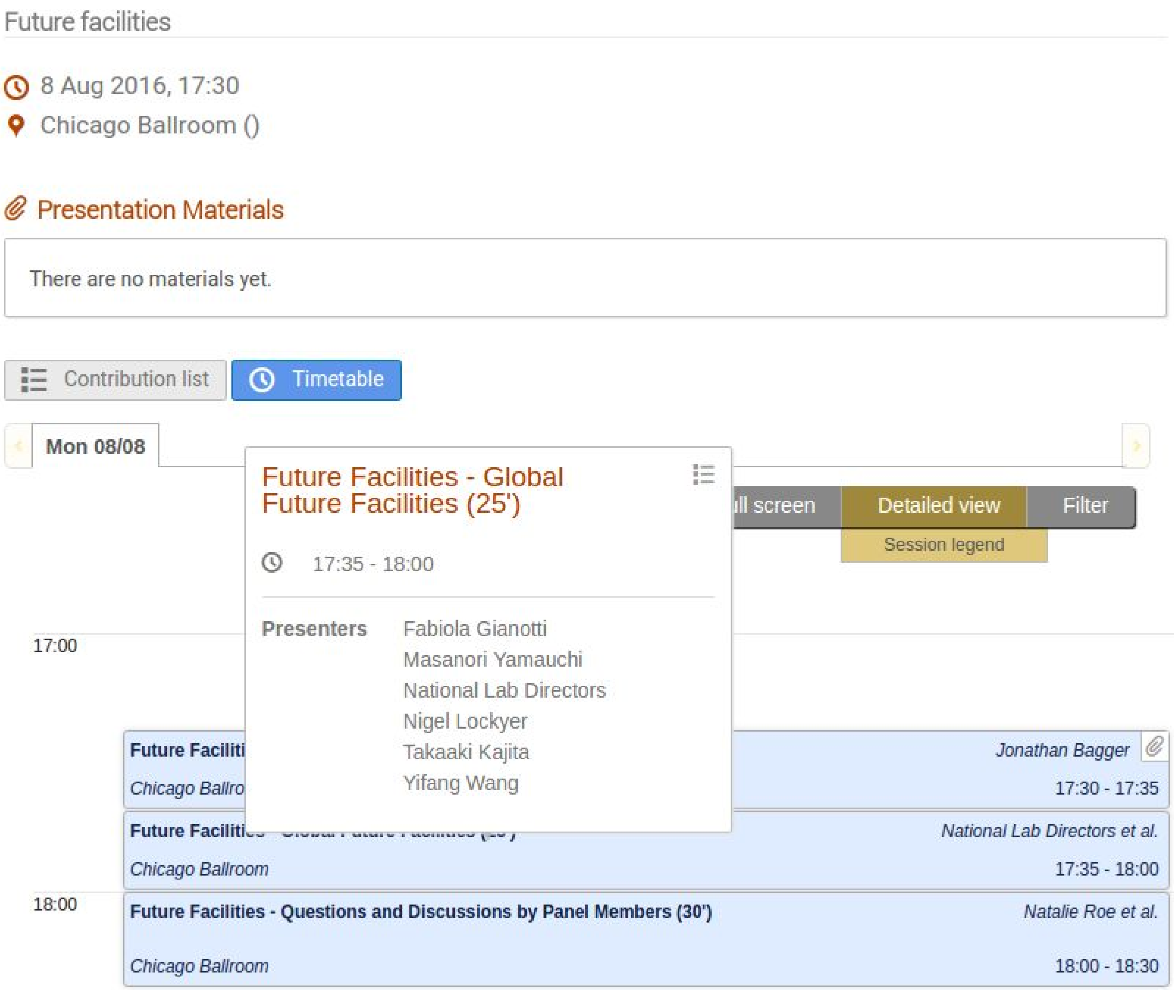


Very interesting parallel sessions on

Astroparticle and Cosmology

Public Lecture held by Barry Barish
On Tuesday

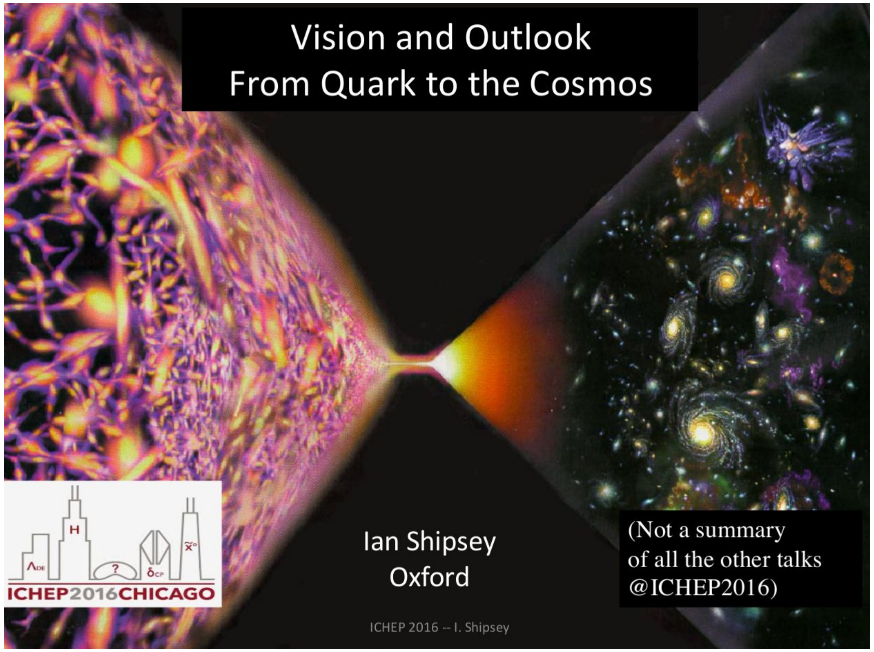
“Future Facilities” session



Roundtable with

F. Gianotti - CERN
M. Yamauchi - KEK
N. Lockyer - FNAL
T. Kajita - ICRR, Tokyo
Y. Wang - JUNO, China

Very inspired conclusive talk by Ian Shipsey



OUTLINE

Particle Physics circa 2016

Physics Aspirations

Essential ingredients of a program

Opportunities for achieving “transformational or paradigm-altering” scientific advances: *great discoveries*.

One field, one voice, one world

ICHEP 2016 -- I. Shipsey

https://dl.dropboxusercontent.com/u/24655052/ICHEP-Vision-Outlook-v4-b.pdf

Atlas & CMS

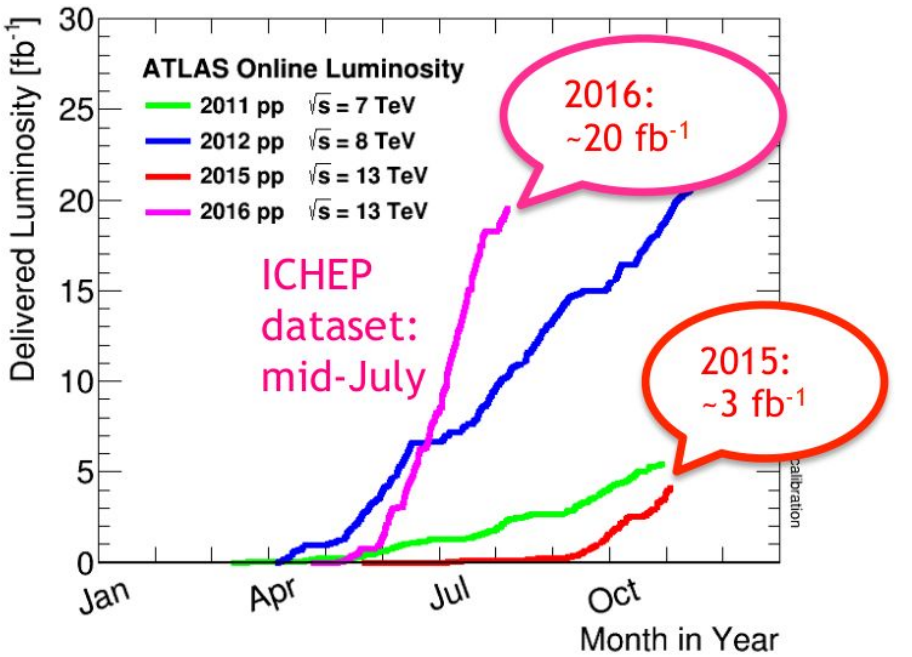
ATLAS and CMS

- Similar Run 2 dataset per experiment for **ICHEP2016**:
  - 2015: ~3 fb^{-1}
  - 2016: ~13 fb^{-1}

- Most analyses in Run 2 follow closely methods and strategies developed during Run 1

- Some new* Run 1 with full dataset, some new results with 2015 dataset, some results only with 2016 dataset, some with 2015+2016 dataset, some combined Run 1+Run 2

*new: presented at ICHEP2016 for the first time



ATLAS: 64 new results, 11 with 2016 Run 2 dataset, 45 with 2015+2016 dataset in Run 2

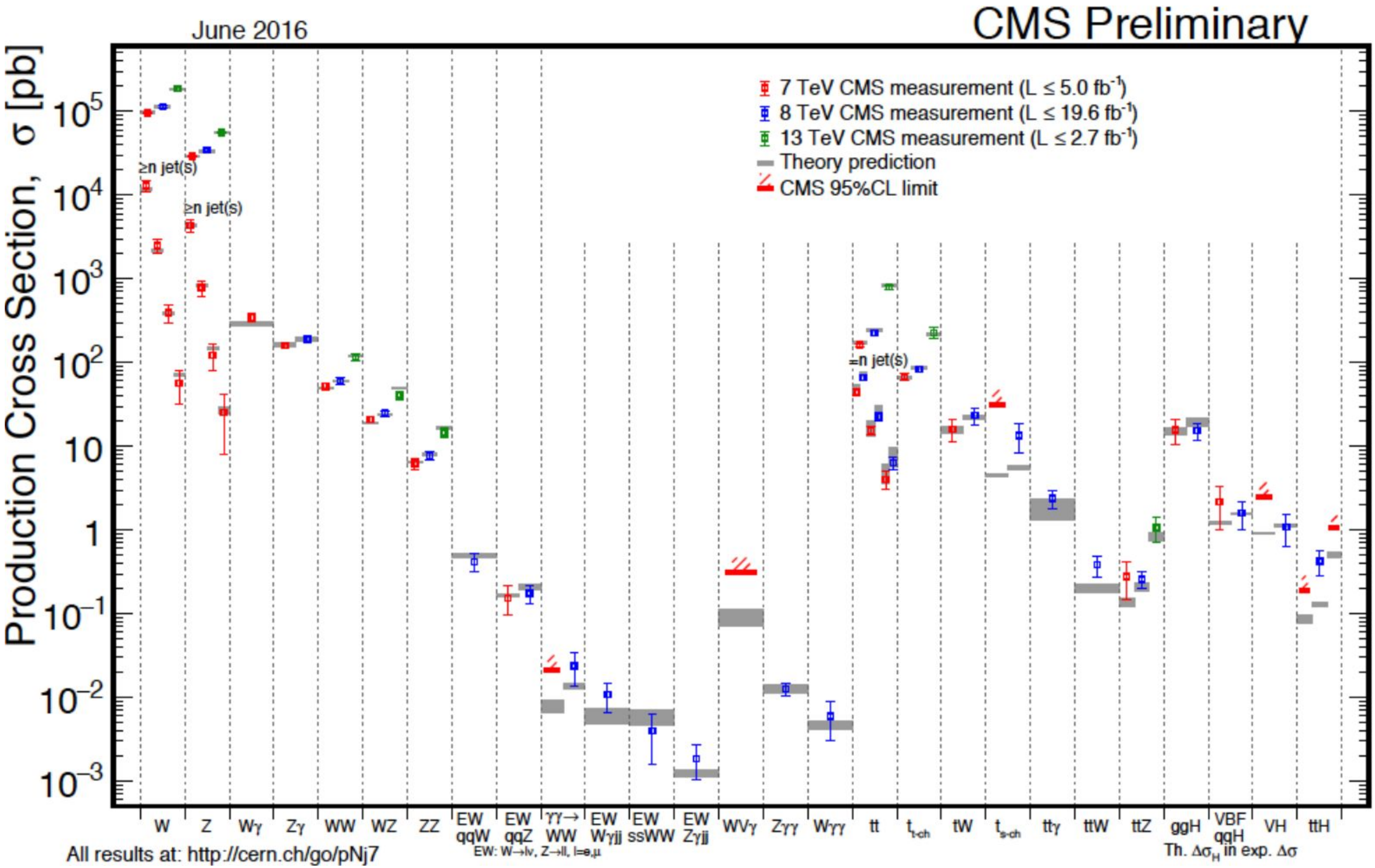
http://cms-results.web.cern.ch/cms-results/public-results/preliminary-results/ICHEP-2016.html

More than 70 new results presented by CMS

Cross section measurements

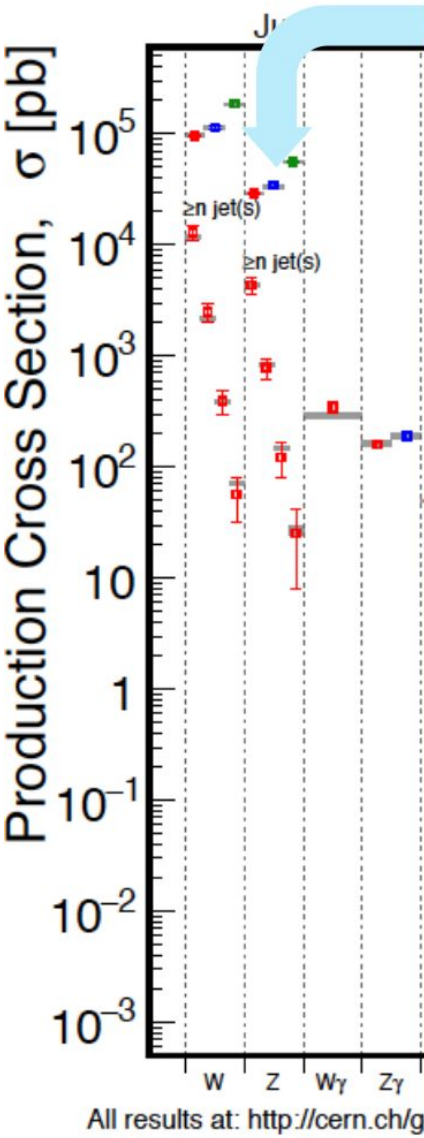
- Many measurements from Run-1 and Run-2
- Better modeling: move to NLO event generators and even some (N)NNLO
- Measuring more complex topologies
- Presented as fiducial and total cross section
- Newer differential cross sections measurements in many SM processes

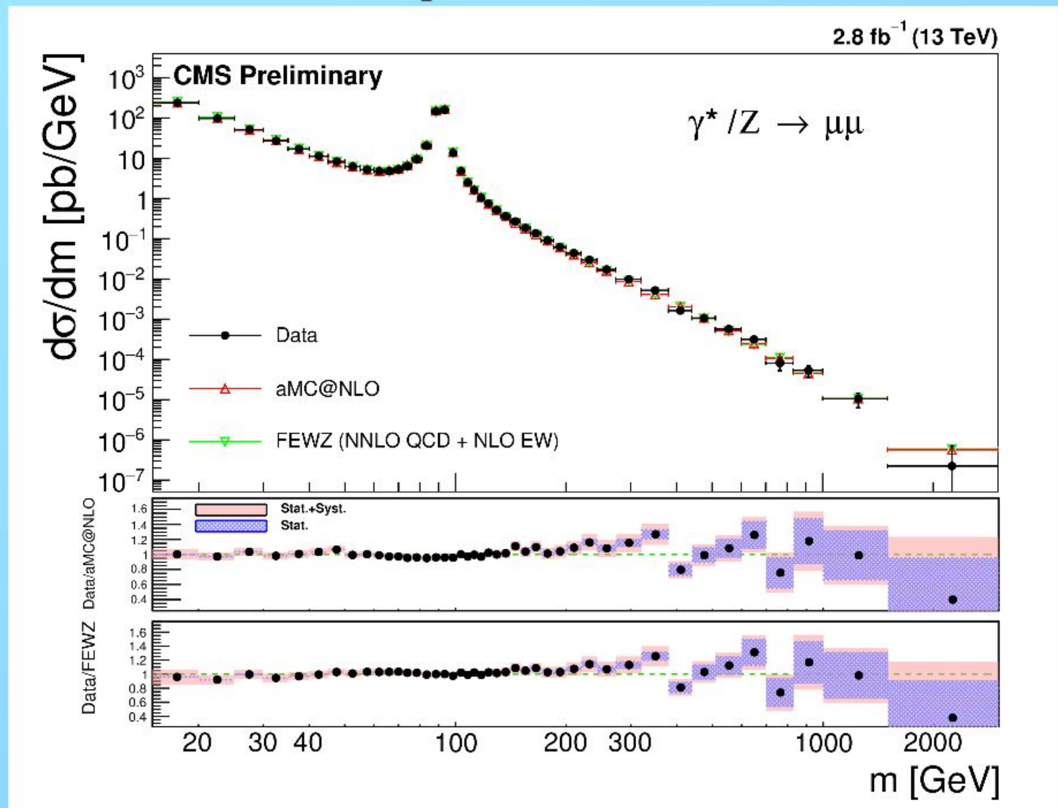
Cross section measurements

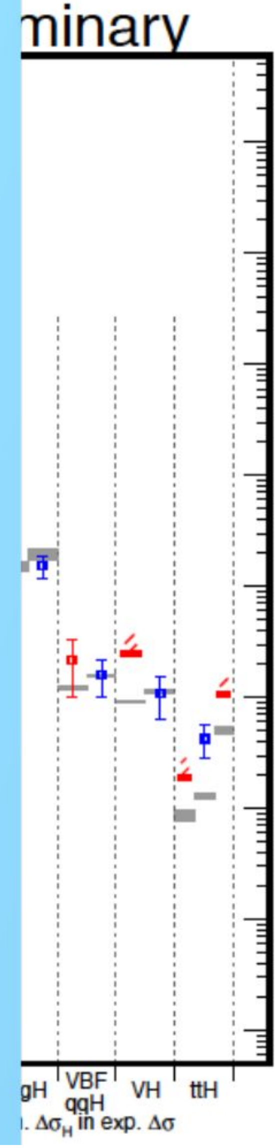


Cross section measurements

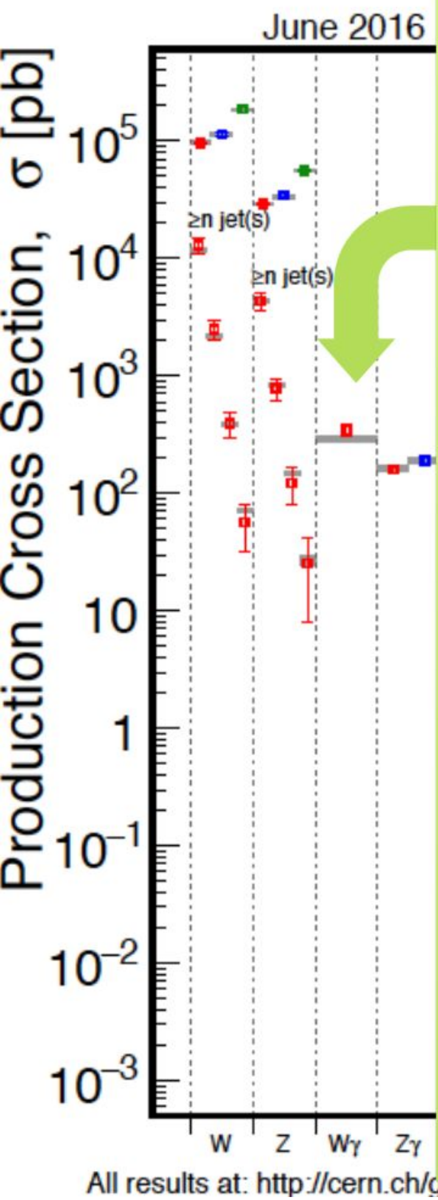
Measurement of the differential Drell-Yan cross section Z(μμ)
CMS, 2.8fb^{-1}, 13 TeV, 2-3% sys. precision; compared NNLO predictions calculated with FEWZ and NLO predictions calculated with aMCatNLO.
[CMS-PAS-SMP-16-009]



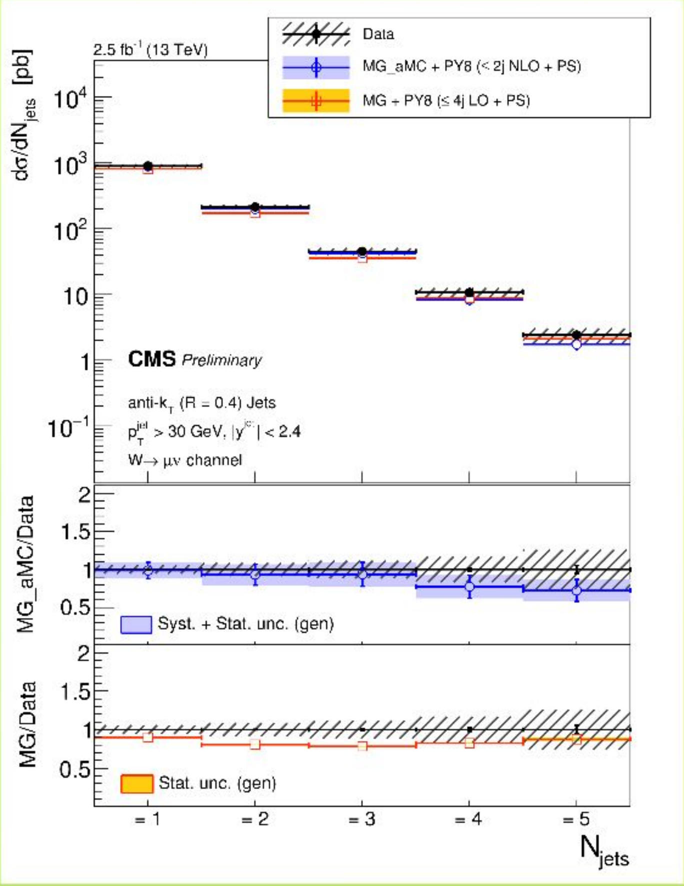


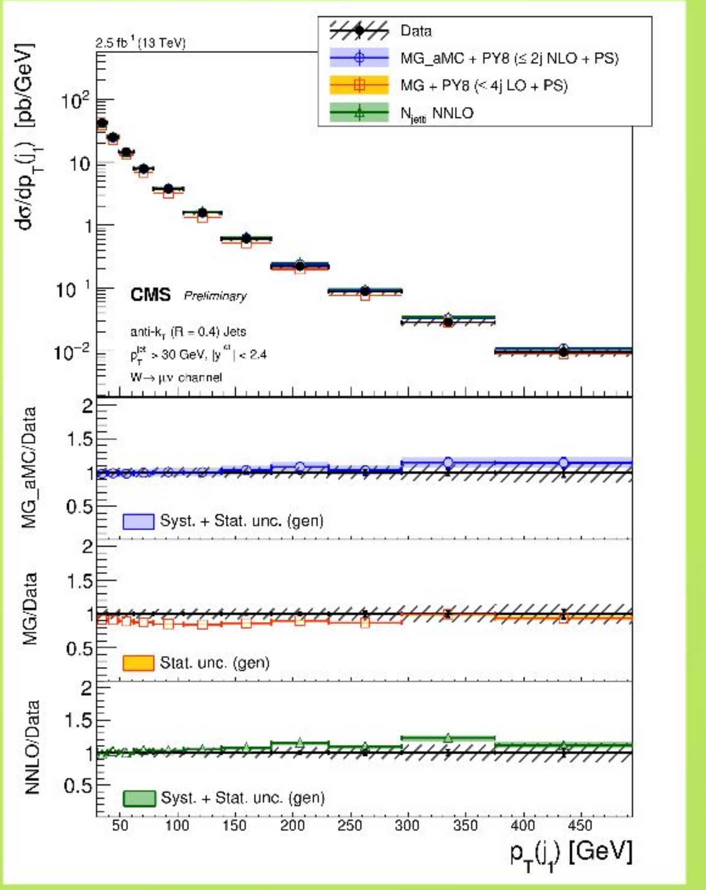


Cross section measurements



Measurement of the differential cross section W(μν)+jets
CMS, 2.5fb^{-1}, 13 TeV, compared with NNLO for one inclusive jet and NLO for all inclusive jet spectra.
[CMS-PAS-SMP-16-005]





Cross section measurements

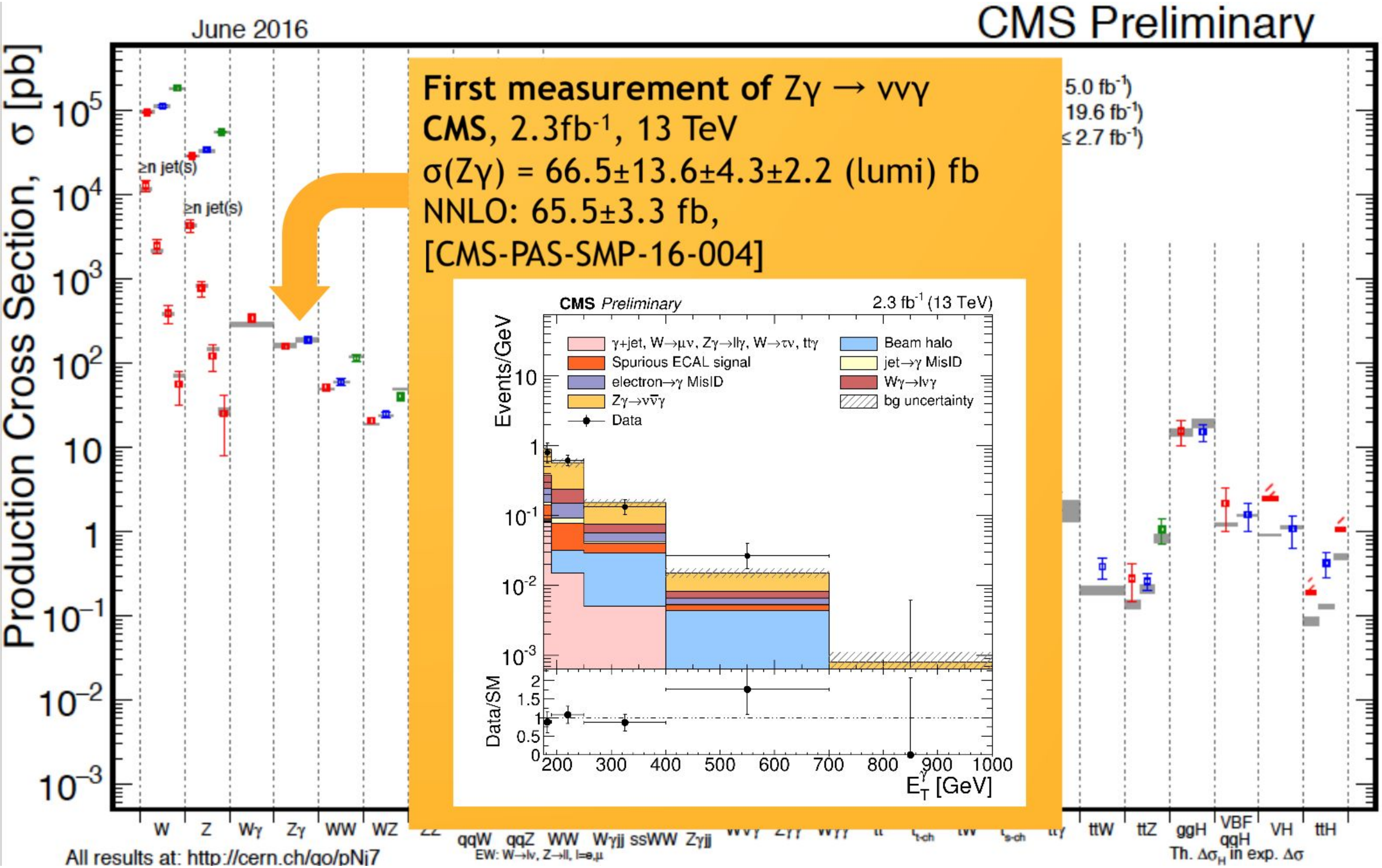
First measurement of Zγ → ννγ

CMS, 2.3fb^{-1}, 13 TeV

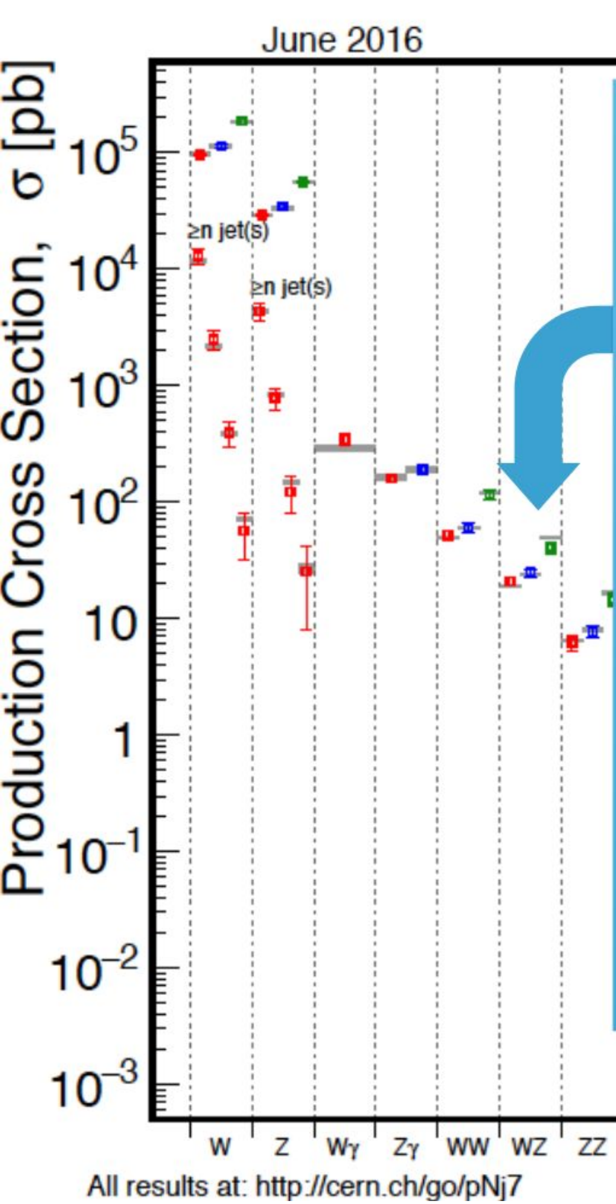
σ(Zγ) = 66.5±13.6±4.3±2.2 (lumi) fb

NNLO: 65.5±3.3 fb,

[CMS-PAS-SMP-16-004]



Cross section measurements



Measurement of WZ→ lνl'l'

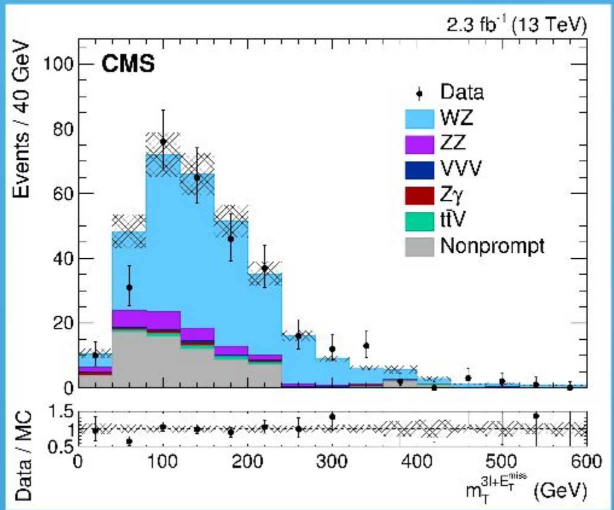
CMS, 2.3fb^{-1}, 13 TeV

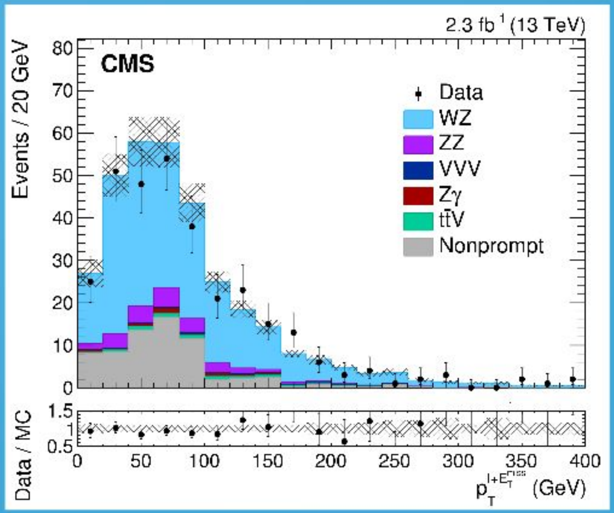
$\sigma(WZ) = 39.9 \pm 3.2(\mathrm{stat})^{+2.9}_{-3.1}(\mathrm{syst}) \pm 0.4(\mathrm{theo}) \pm 1.3(\mathrm{lumi})$ pb

NNLO: $50.0^{+1.1}_{-1.0}$ pb

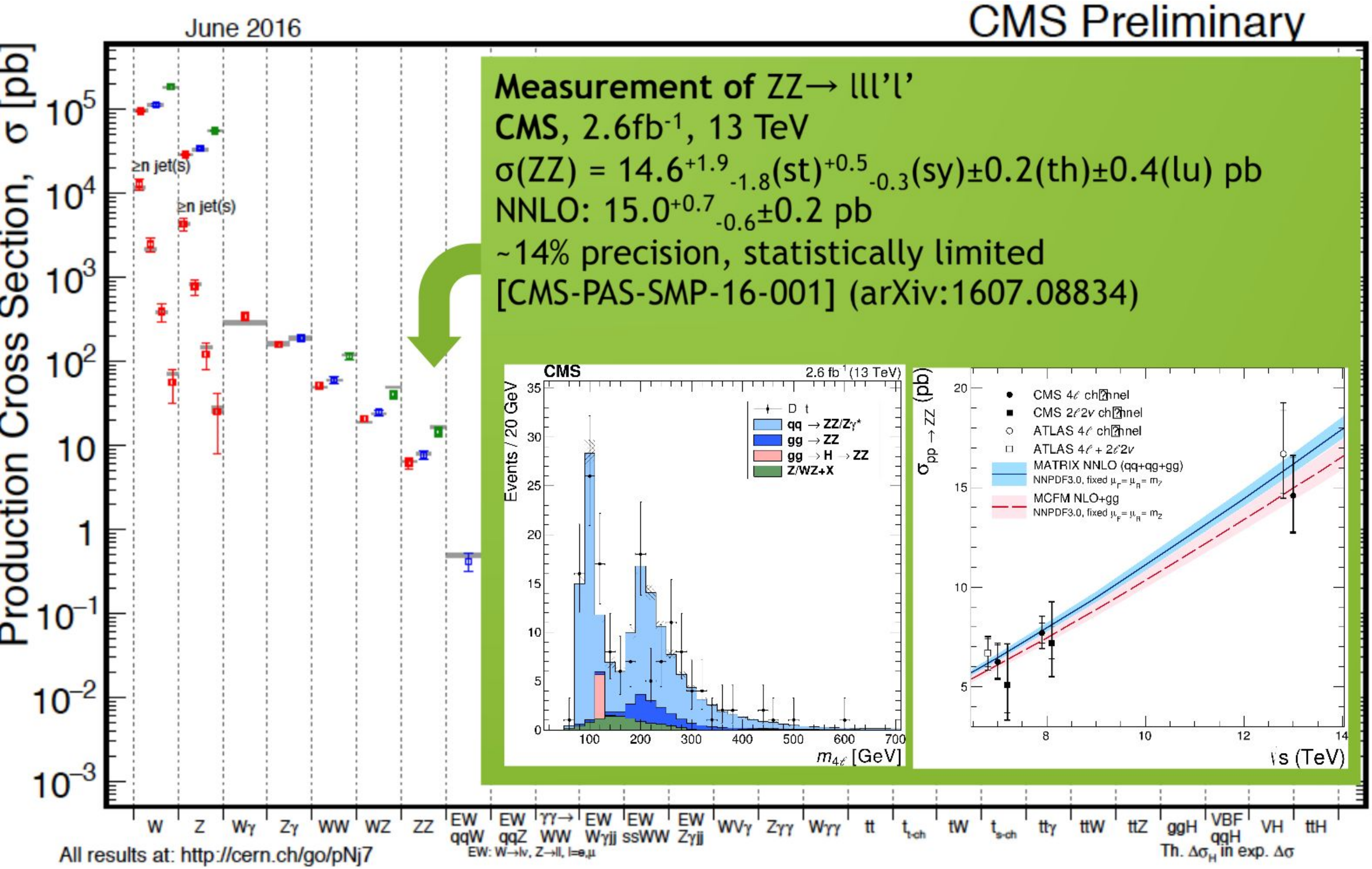
~10% precision. First differential cross sections.

[CMS-PAS-SMP-16-002] (arXiv:1607.06943)





Cross section measurements



Measurement of ZZ→ lll'l'

CMS, 2.6fb^{-1}, 13 TeV

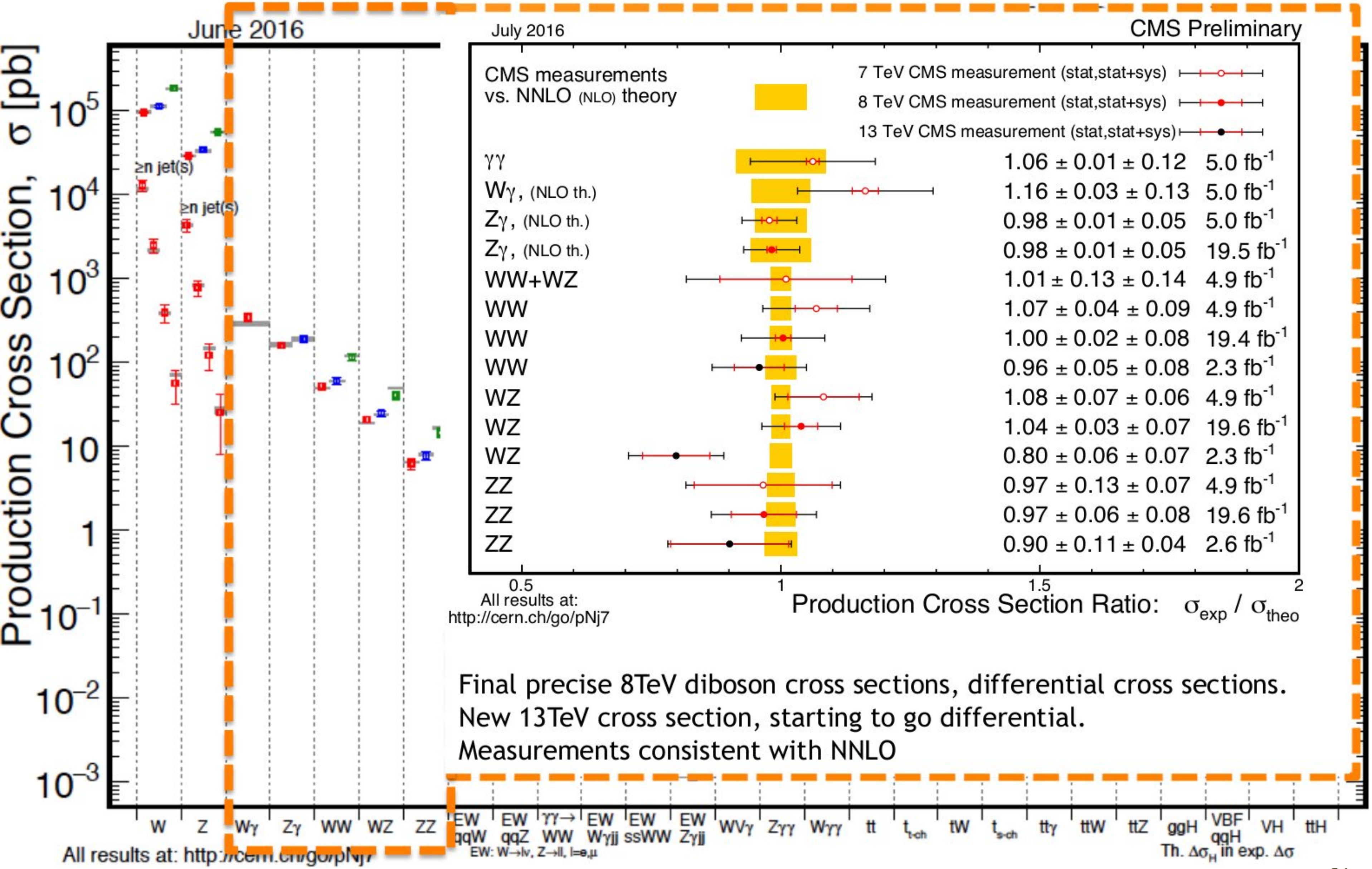
$\sigma(ZZ) = 14.6^{+1.9}_{-1.8}(st)^{+0.5}_{-0.3}(sy) \pm 0.2(th) \pm 0.4(lu)$ pb

NNLO: $15.0^{+0.7}_{-0.6} \pm 0.2$ pb

~14% precision, statistically limited

[CMS-PAS-SMP-16-001] (arXiv:1607.08834)

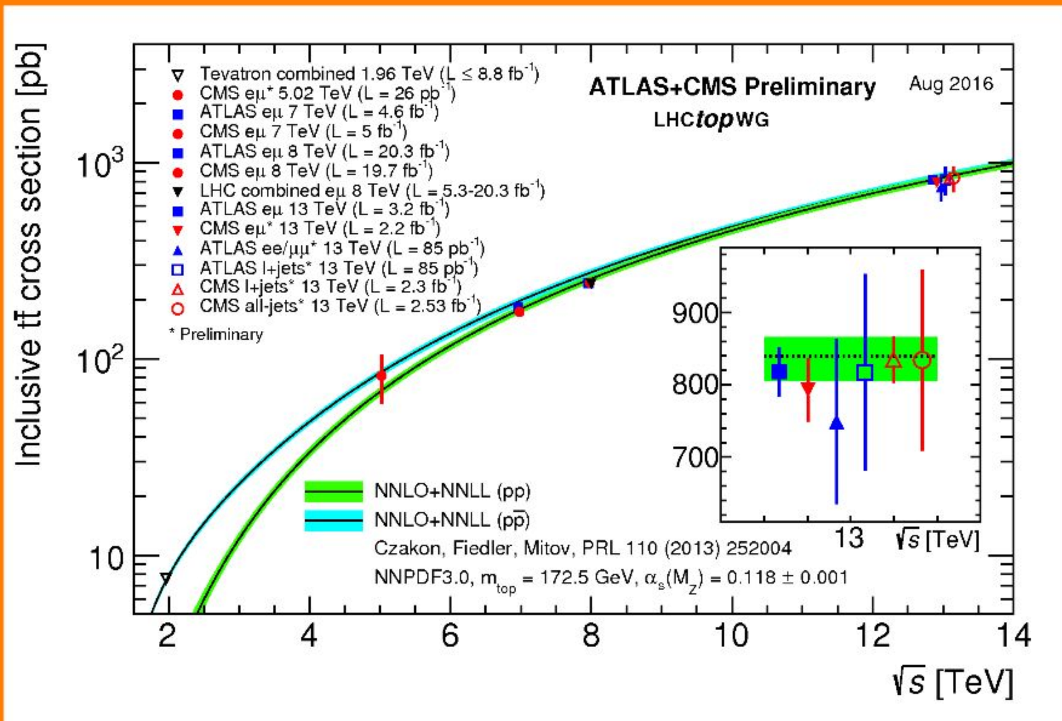
Cross section measurements

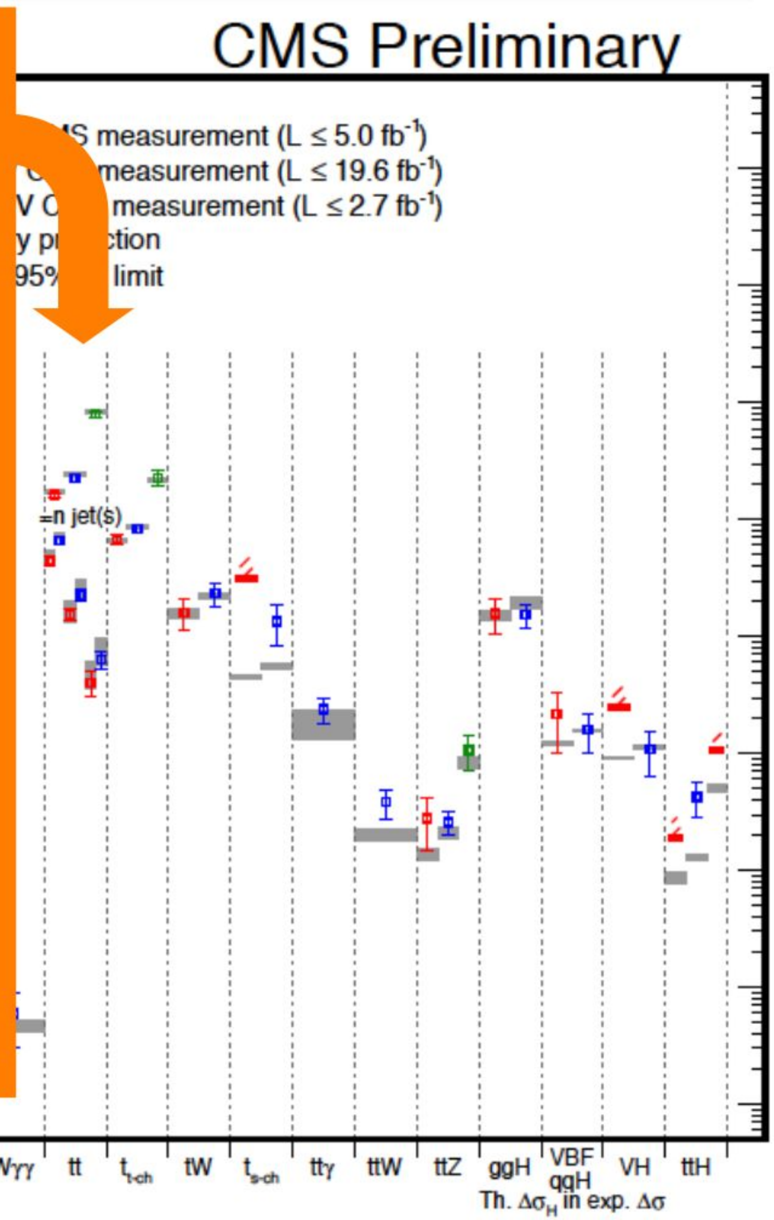


Final precise 8TeV diboson cross sections, differential cross sections.
New 13TeV cross section, starting to go differential.
Measurements consistent with NNLO

Cross section measurements

Top pair cross section:
Added CMS-PAS-TOP-16-006: $2.3 fb^{-1}$, 13TeV, l+jets

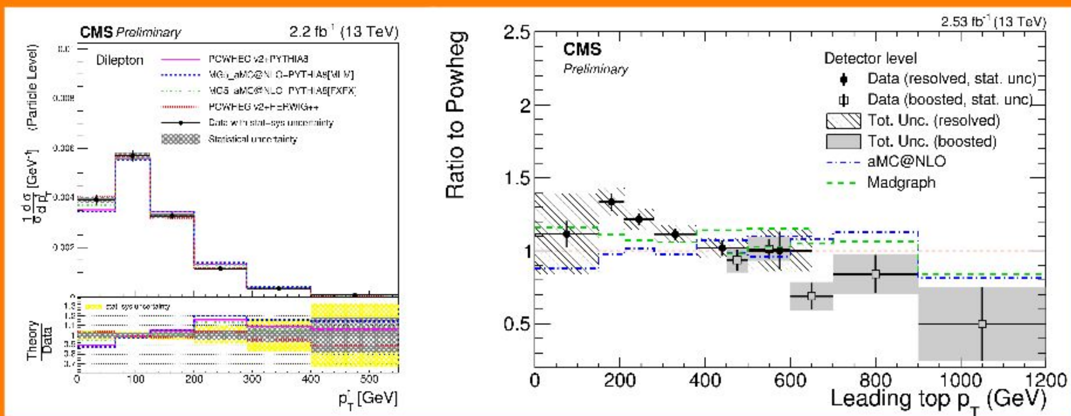




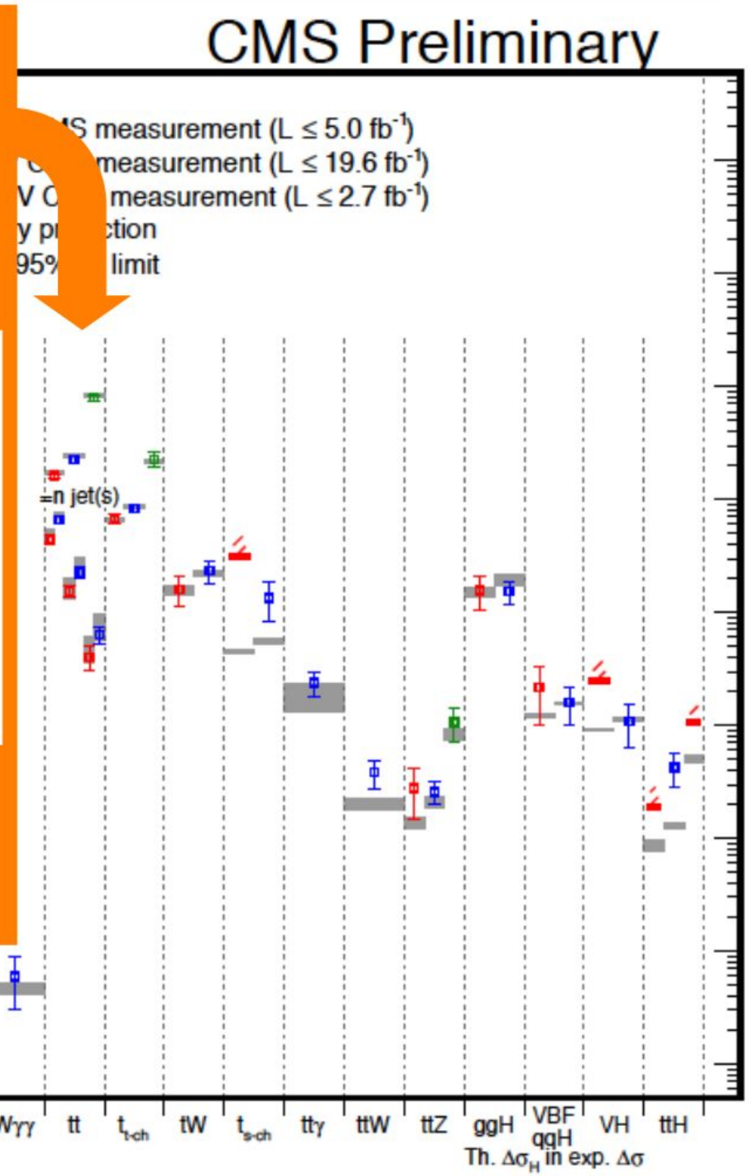
LHC and Tevatron results consistent and in agreement with NNLO+NNLL over a large range of center-of-mass energies

Cross section measurements

Differential tt cross section:
CMS, 2.2fb[-1],13TeV, dilepton channel
[CMS-PAS-TOP-16-007]
Also [CMS-PAS-TOP-16-013]: 2.5fb[-1],13TeV, all-jets (resolved and boosted)



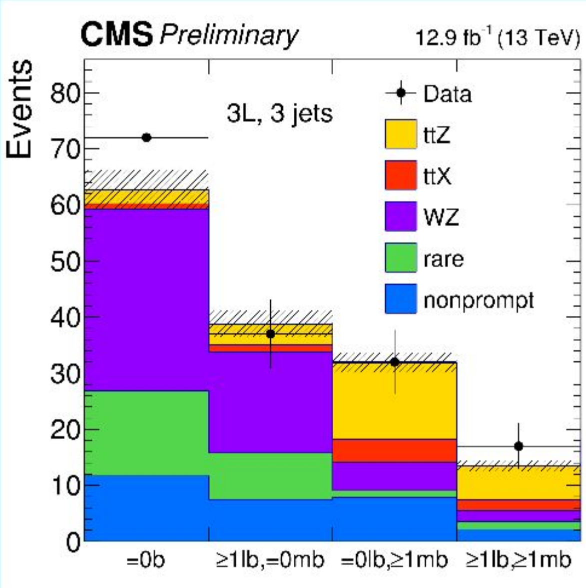
Similar trends as in 8 TeV. Top p_T modeled too hard

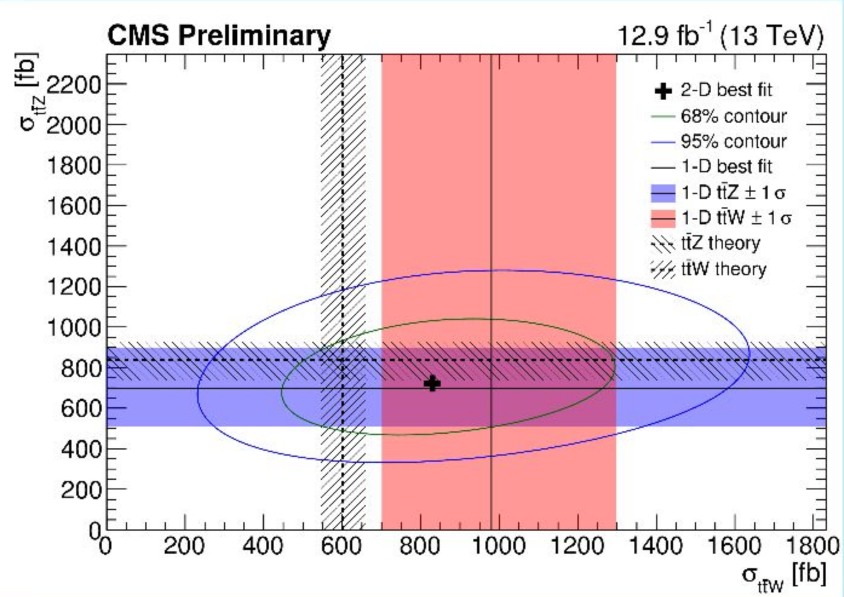


All results at: http://cern.ch/go/pNj7

Cross section measurements

Cross section measurement ttZ and ttW:
CMS, 12.9 fb-1, 13 TeV
Cross section increase 3-4 times from 8 to 13 TeV
[CMS-TOP-16-017]

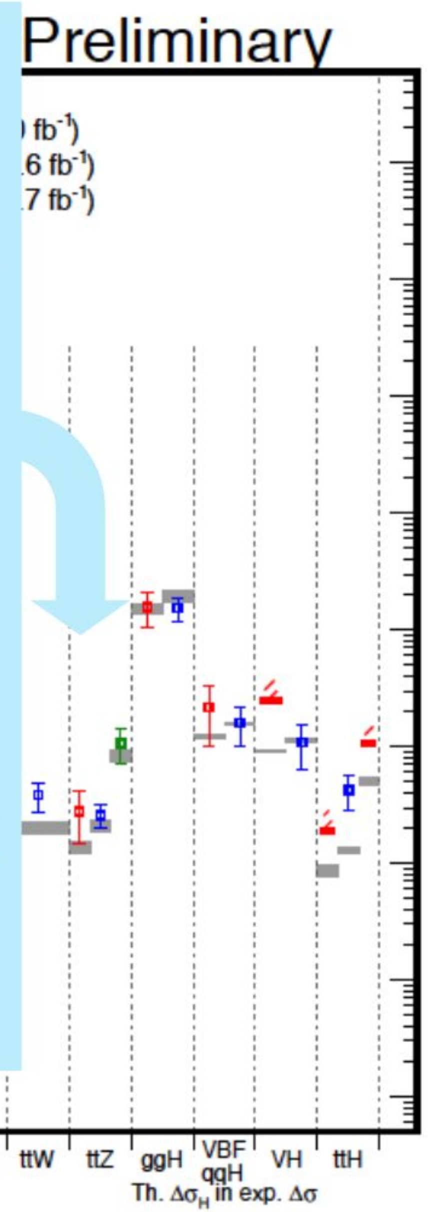




$\sigma(ttW) = 0.98\ ^{+0.23}_{-0.22}\ ^{+0.22}_{-0.18}$ pb

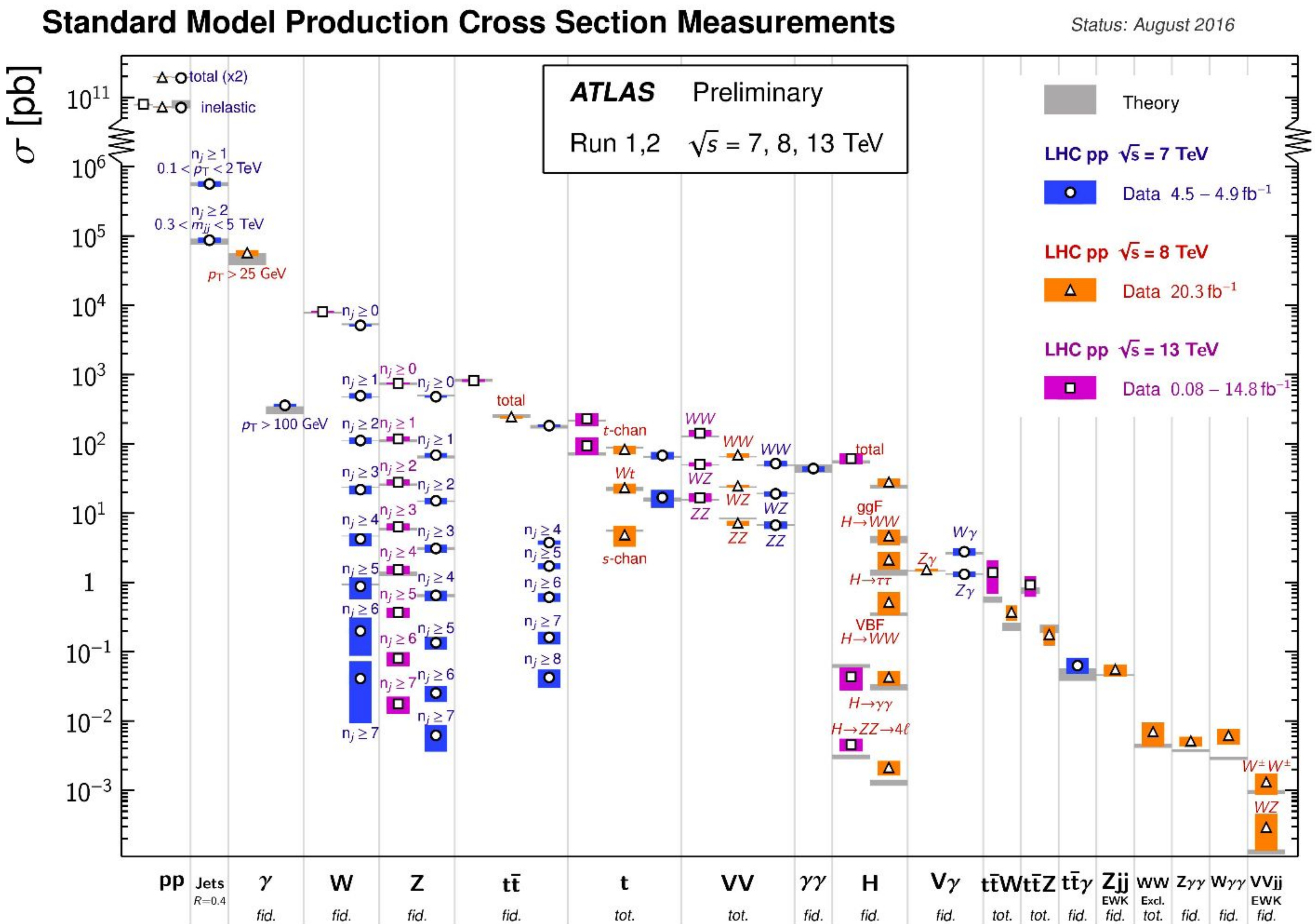
$\sigma(ttZ) = 0.70\ ^{+0.16}_{-0.15}\ ^{+0.14}_{-0.12}$ pb

(→ ttW: 3.9σ, ttZ: 4.6σ)



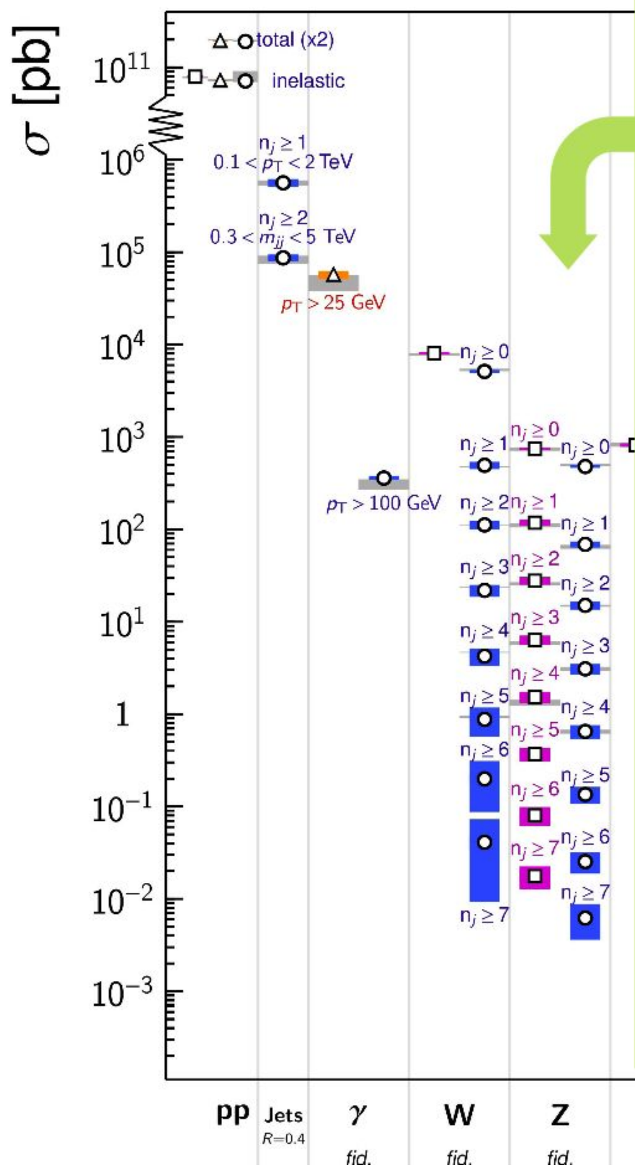
All results at: http://cern.ch/go/pNj7

Cross section measurements

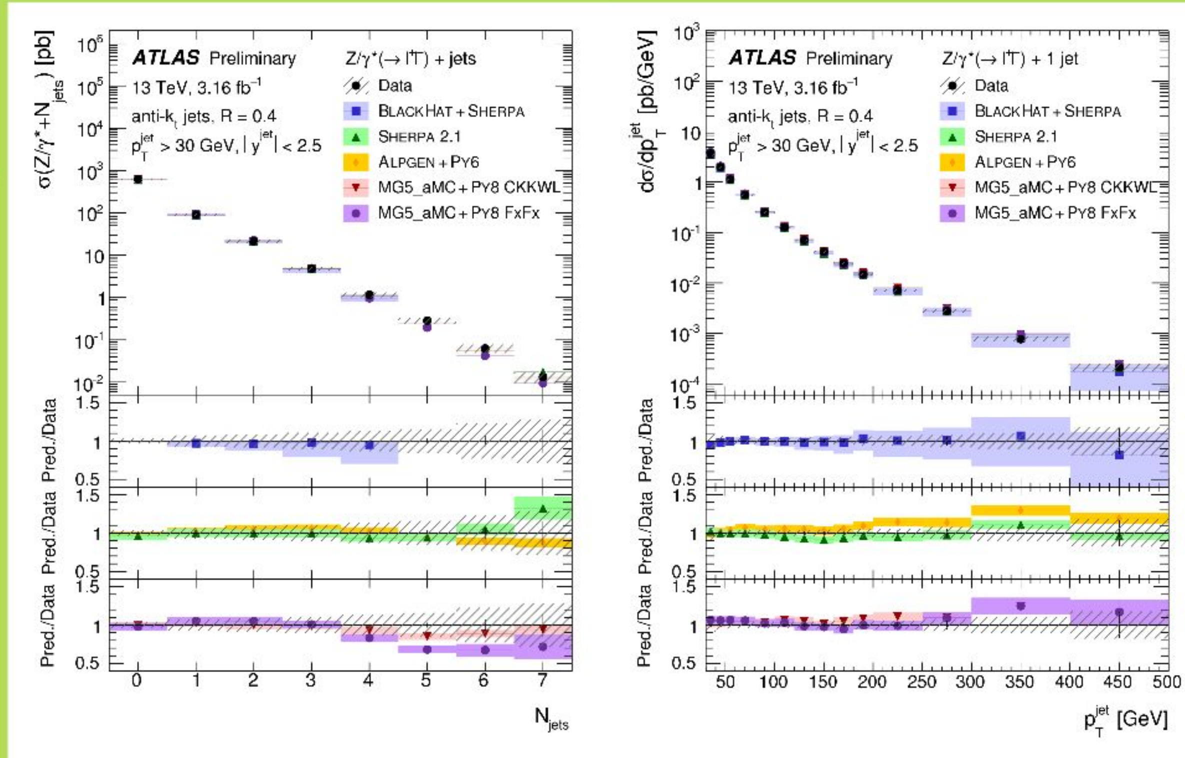
- 

Cross section measurements

- Standard Model Production C



Z+jets differential cross section:
ATLAS, 3.16 fb^{-1}, 13 TeV
Access to high jet multiplicity and test of NLO generators
[ATLAS-CONF-2016-046]



Cross section measurements

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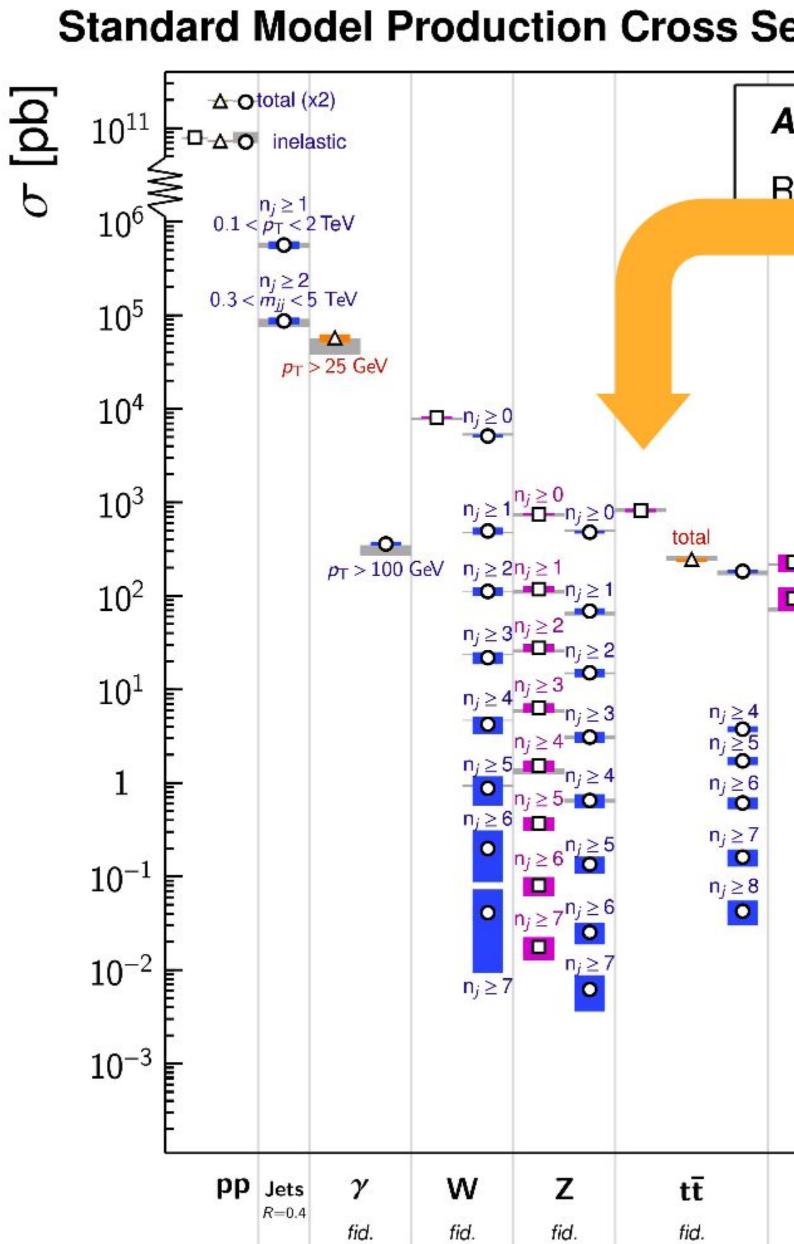
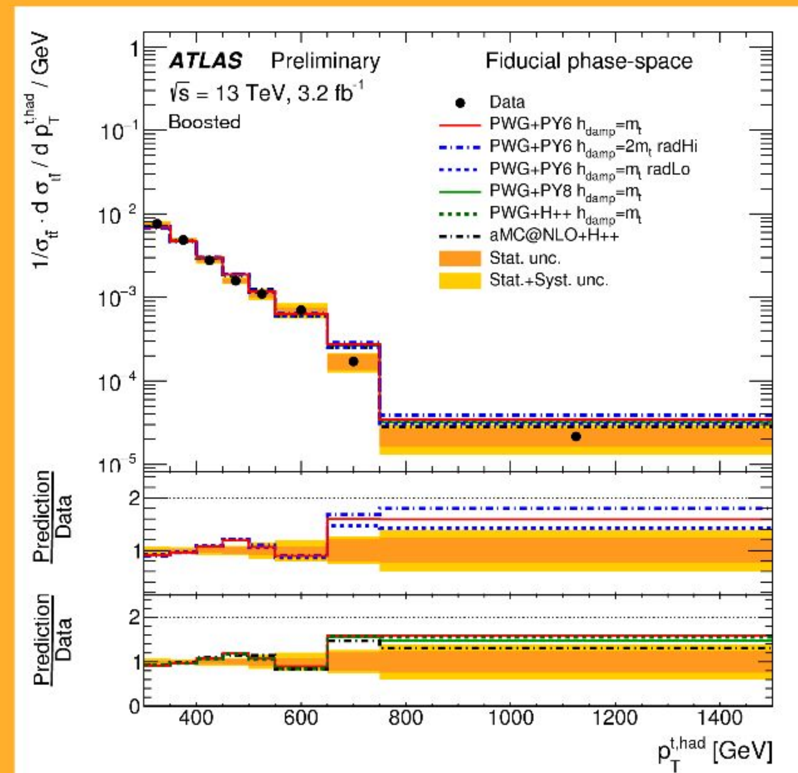


Differential tt cross section (l+jets): ATLAS, 3.2 fb^{-1}, 13TeV

Resolved and boosted.

[ATLAS-CONF-2016-040]



Cross section measurements

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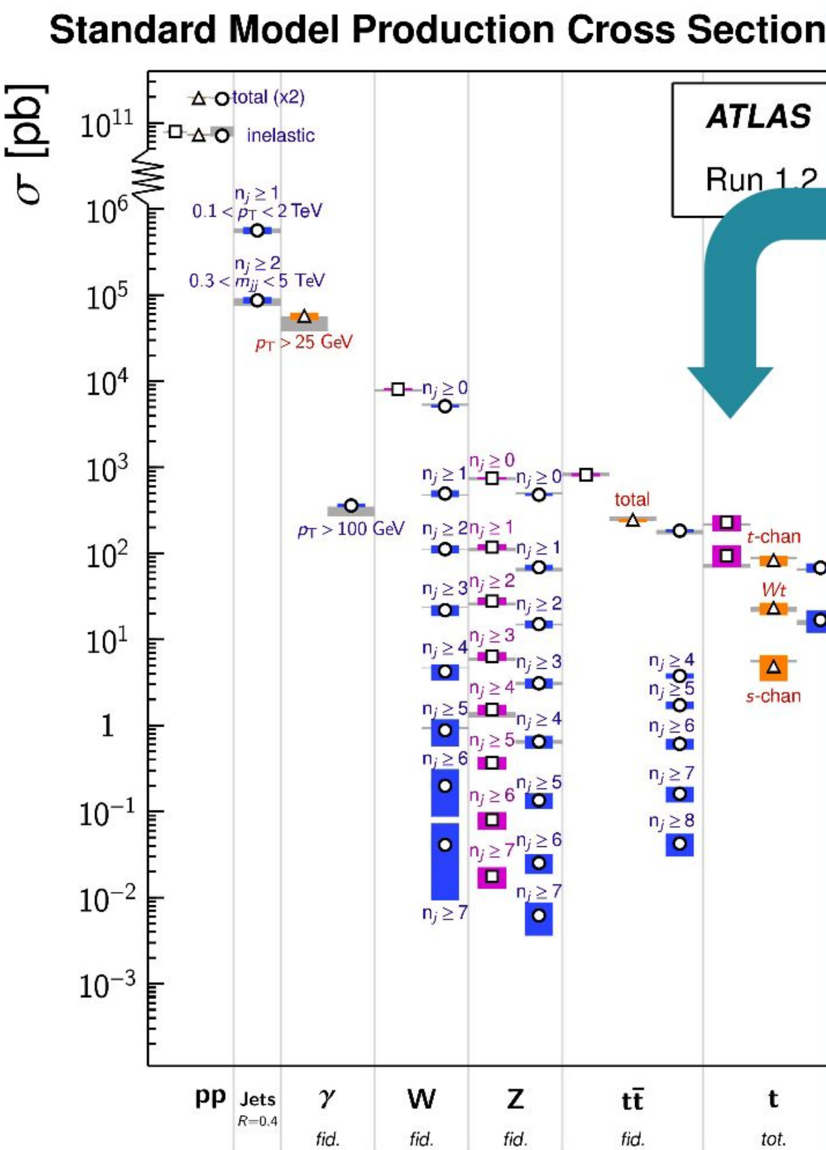
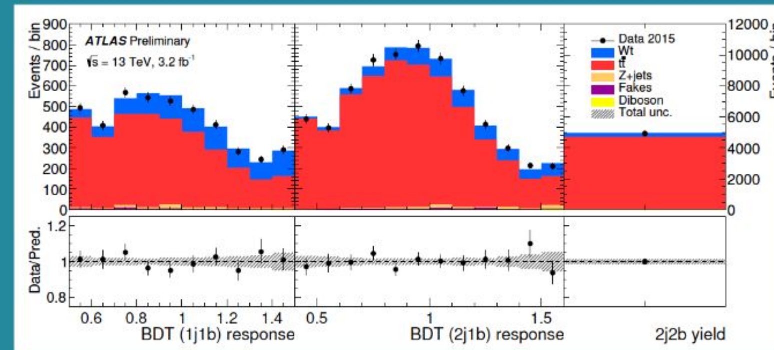
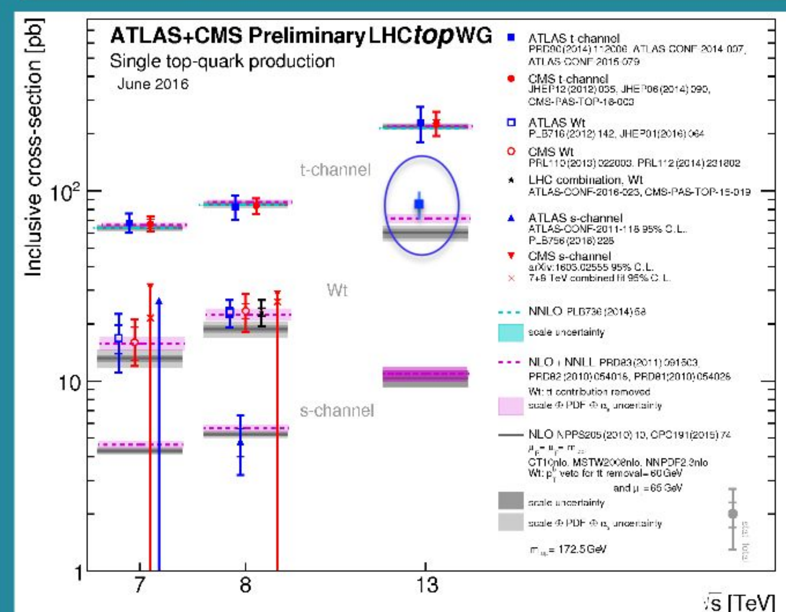


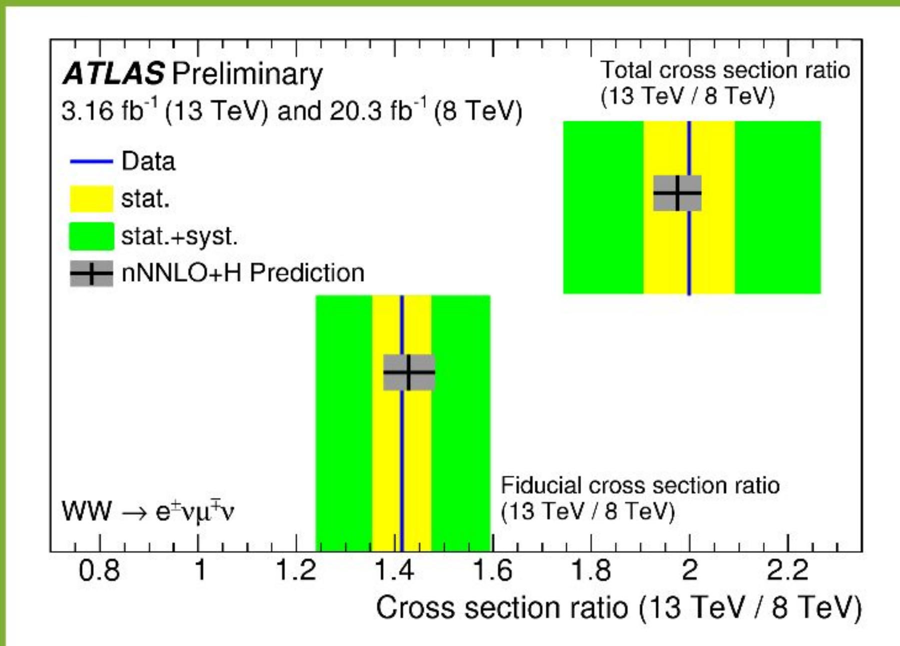
Single top Wt-channel cross section:
ATLAS, 3.2fb^{-1}, 13TeV
$\sigma(Wt) = 94 \pm 10(stat)^{+28}_{-23(syst)}$ pb
[ATLAS-CONF-2016-065]

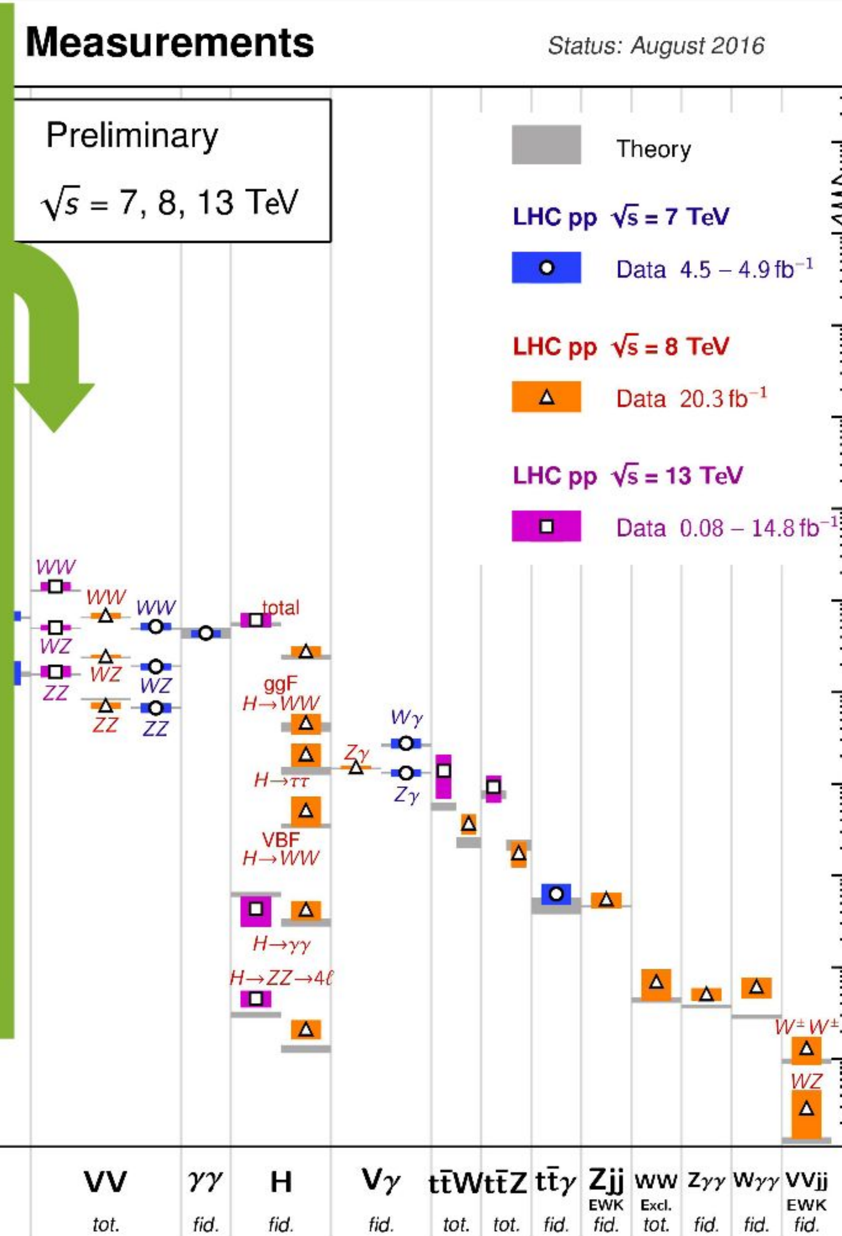




Cross section measurements

WW cross section:
ATLAS, 3.2fb^{-1}, 13TeV, WW (eμ,0 jet)
σ(WW) = 142±5±13±3 pb
NNLO: 128±4 pb
[ATLAS-CONF-2016-090]



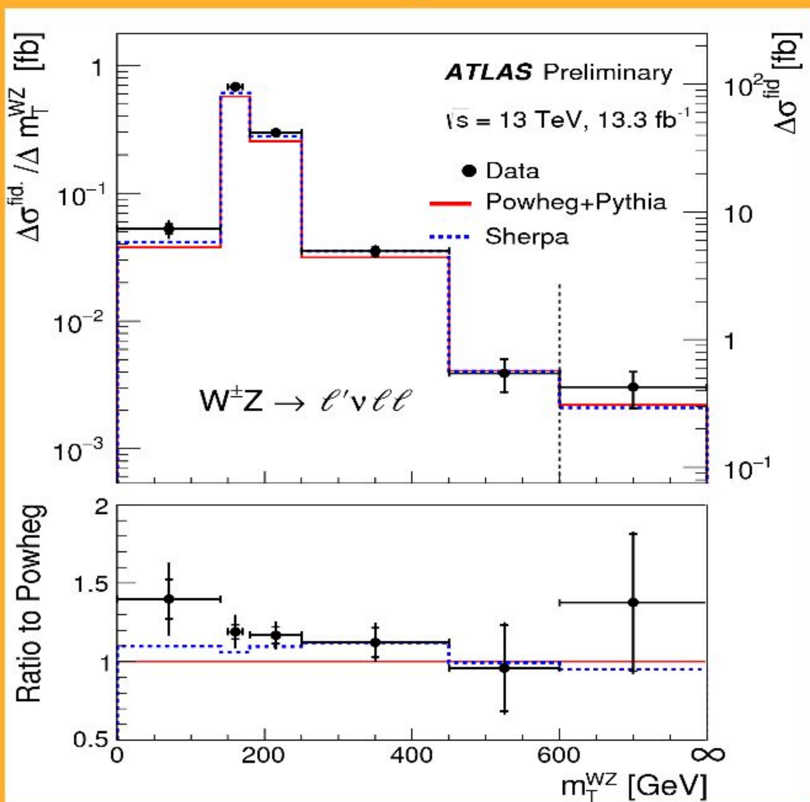


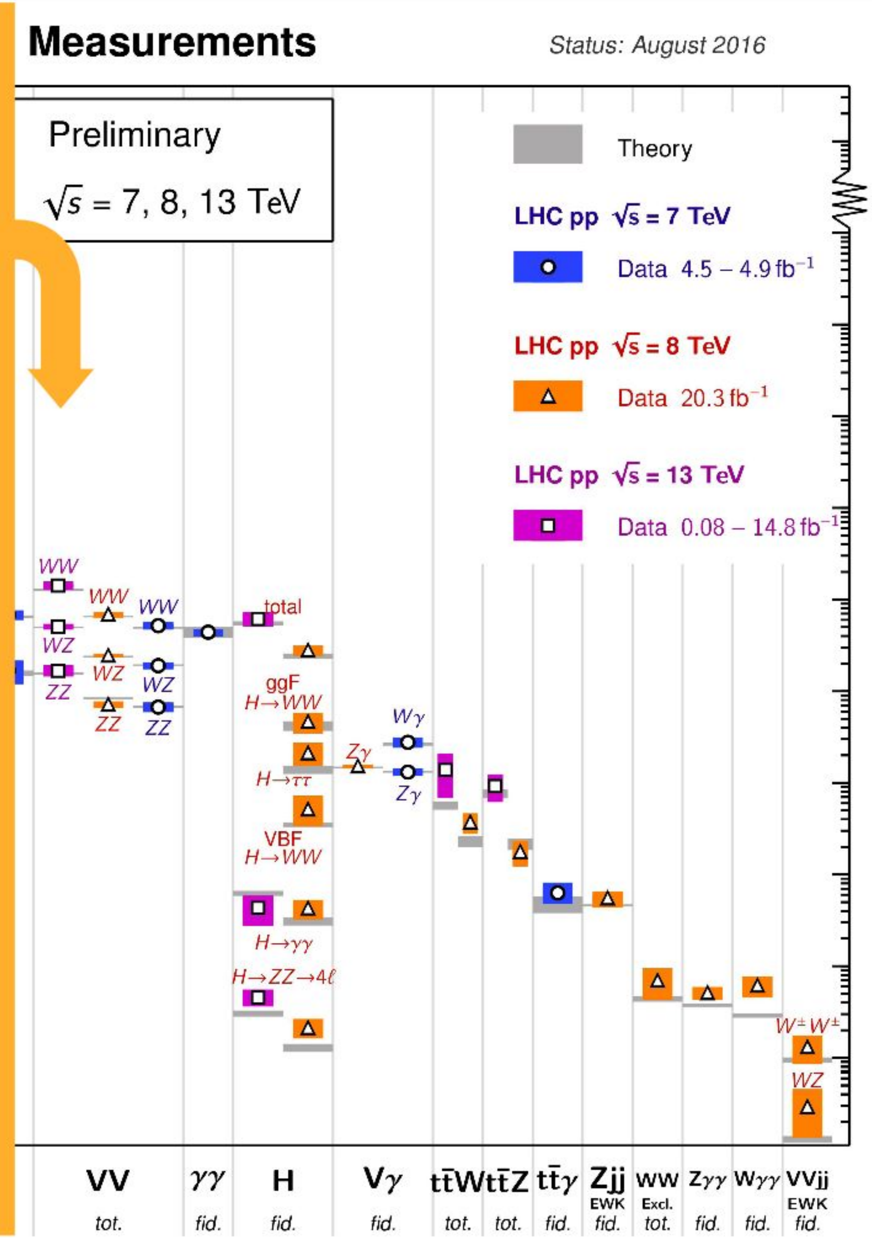
Cross section measurements

Differential WZ cross section (leptonic): ATLAS, 13.3fb^{-1}, 13TeV

With 7-10% precision, first differential cross sections.

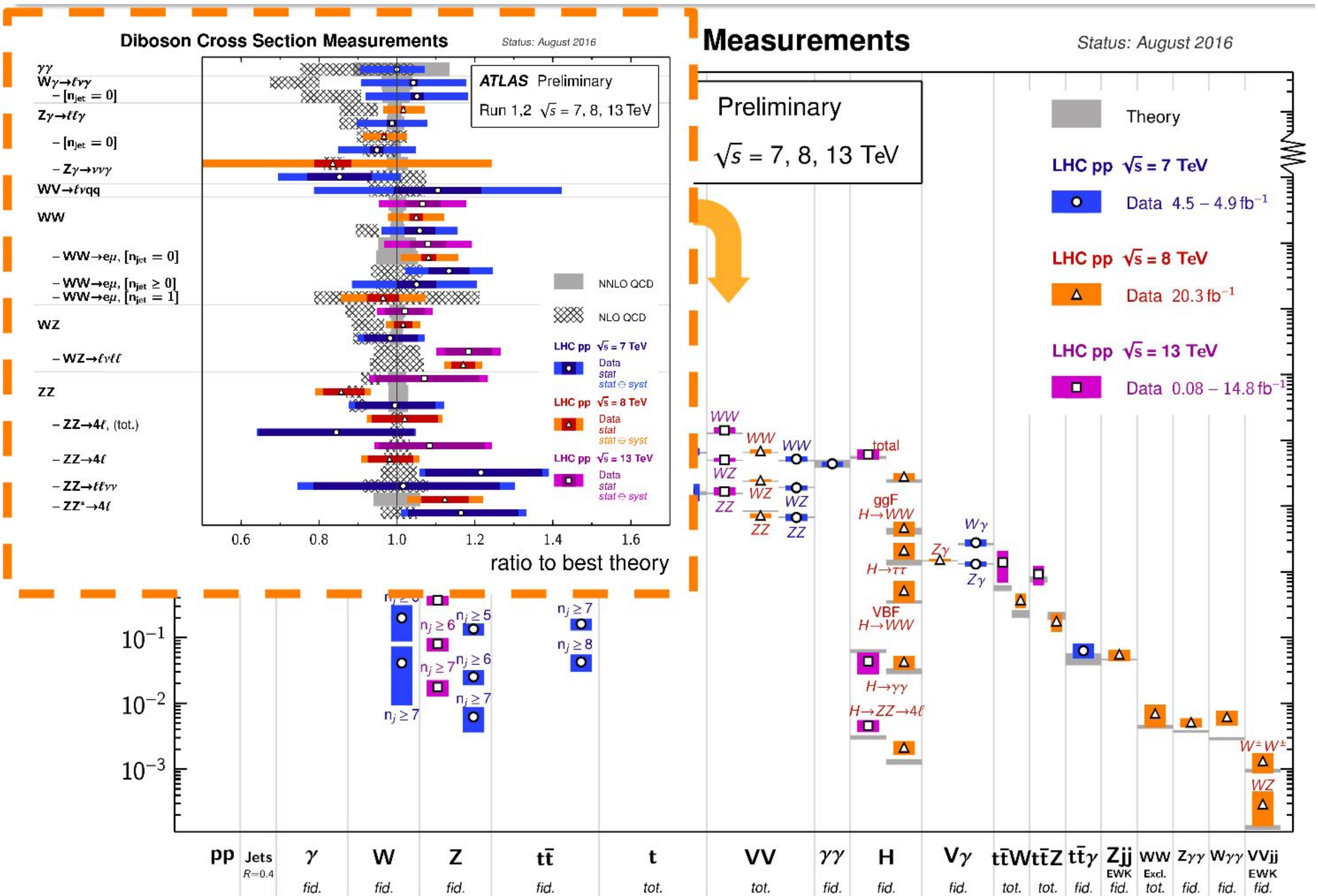
[ATLAS-CONF-2016-043]



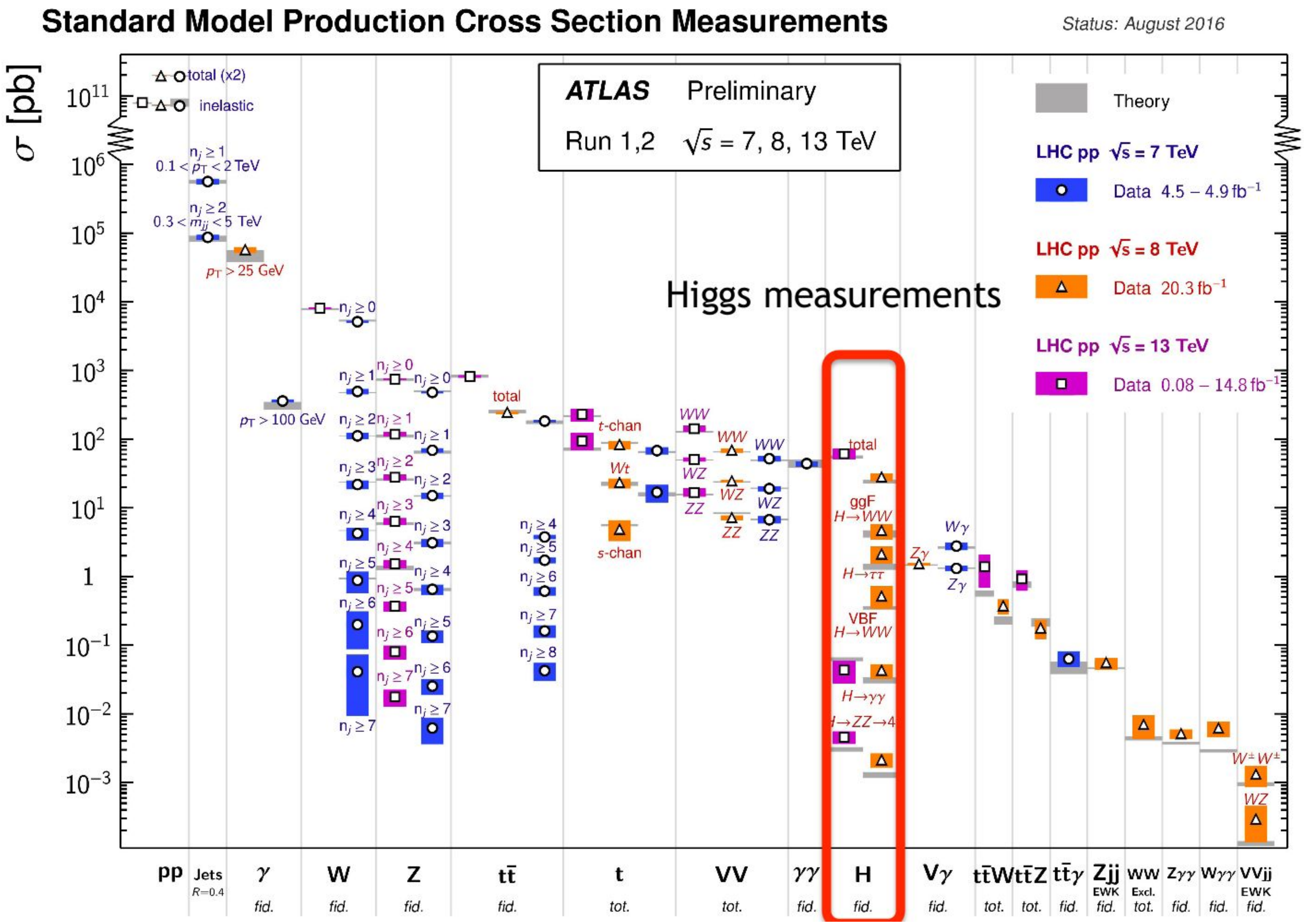


Also most stringent aTGC limits

Cross section measurements



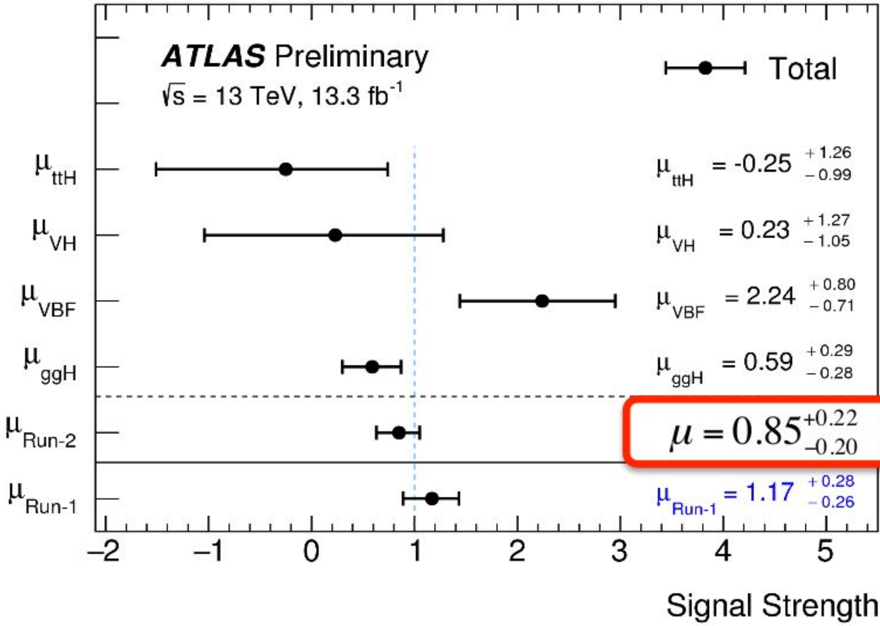
Cross section measurements

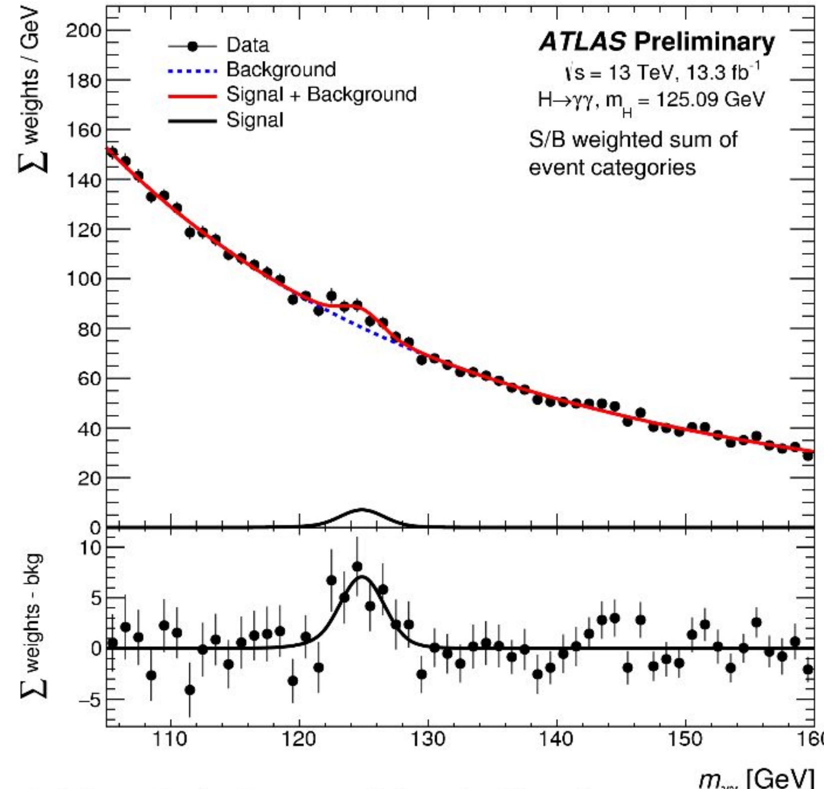
- 

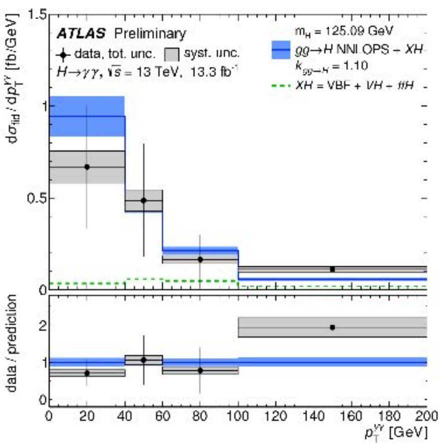
Higgs → $\gamma\gamma$

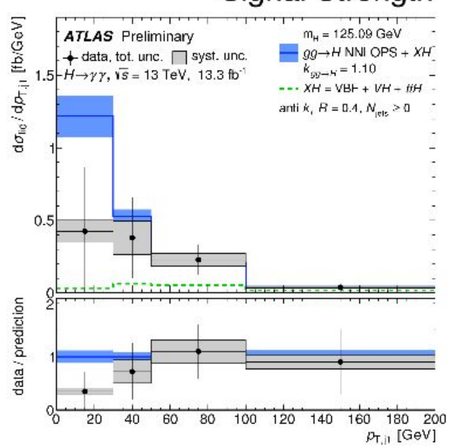
ATLAS -CONF-2016-067

13 TeV	Fiducial σ (fb)	SM prediction (fb)
ATLAS (13.3 fb^{-1})	43.2±14.9(stat)±4.9(syst)	$62.8^{+3.4}_{-4.4}$ (N^{3}LO+XH)



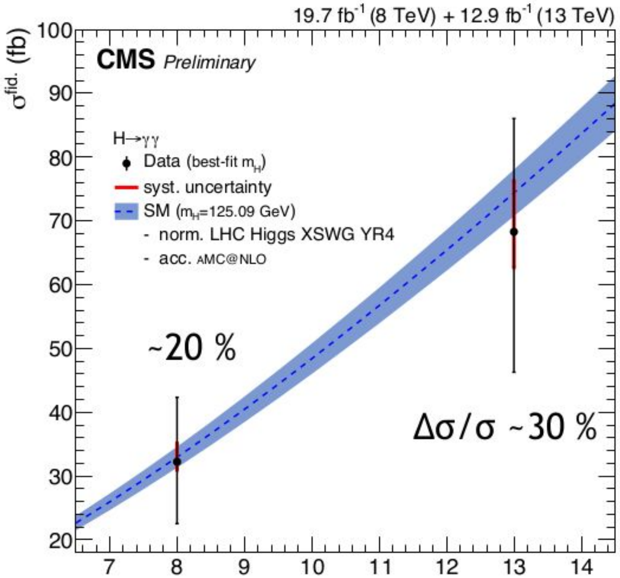


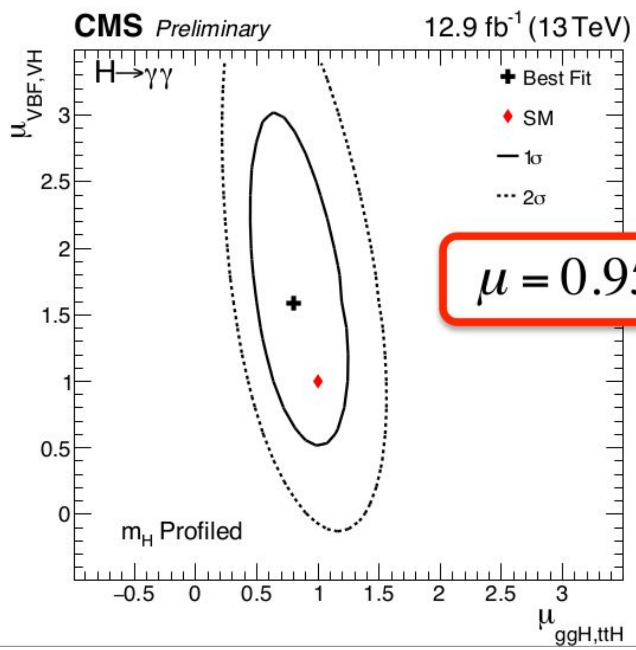




- Achieved similar precision to Run 1
- Measurements compatible with SM
- Results still dominated by statistical uncertainty

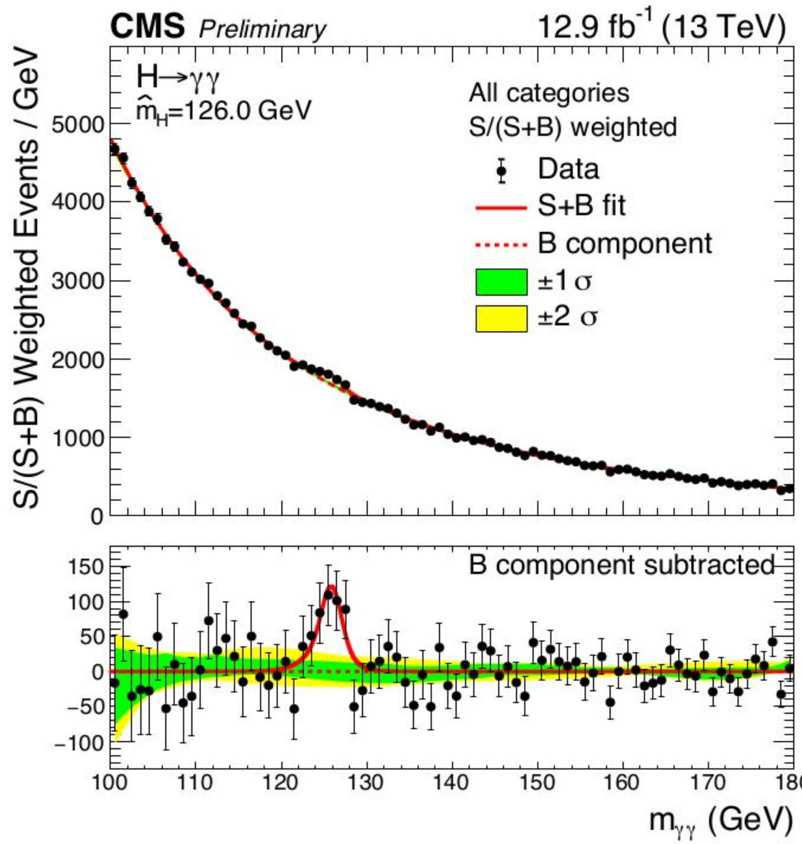
Higgs $\rightarrow \gamma\gamma$





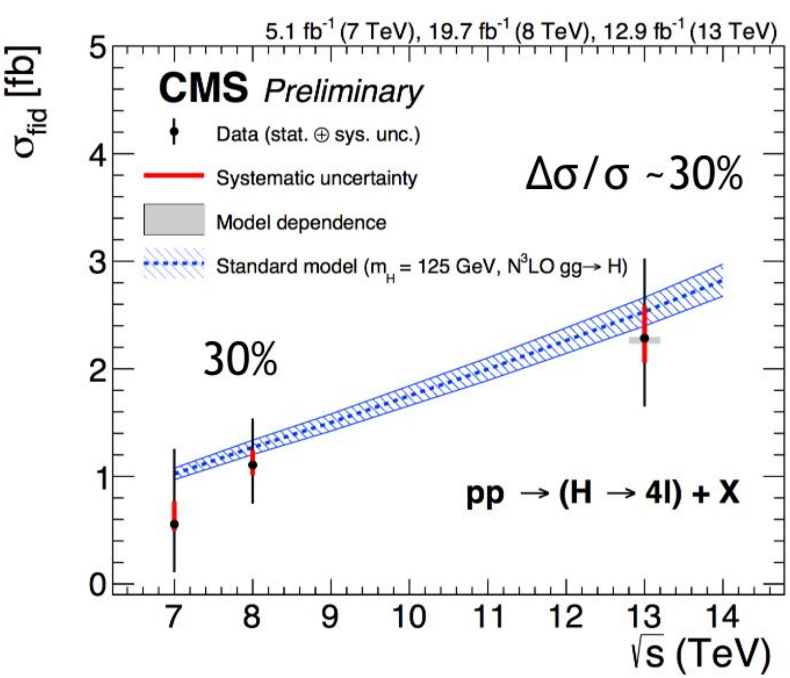
$$\mu = 0.95^{+0.21}_{-0.18}$$

13 TeV	Fiducial σ (fb)	SM prediction (fb)
CMS (12.9 fb^{-1})	69^{+16}_{-22}(stat)$^{+8}_{-6}$(syst)	73.8±3.8

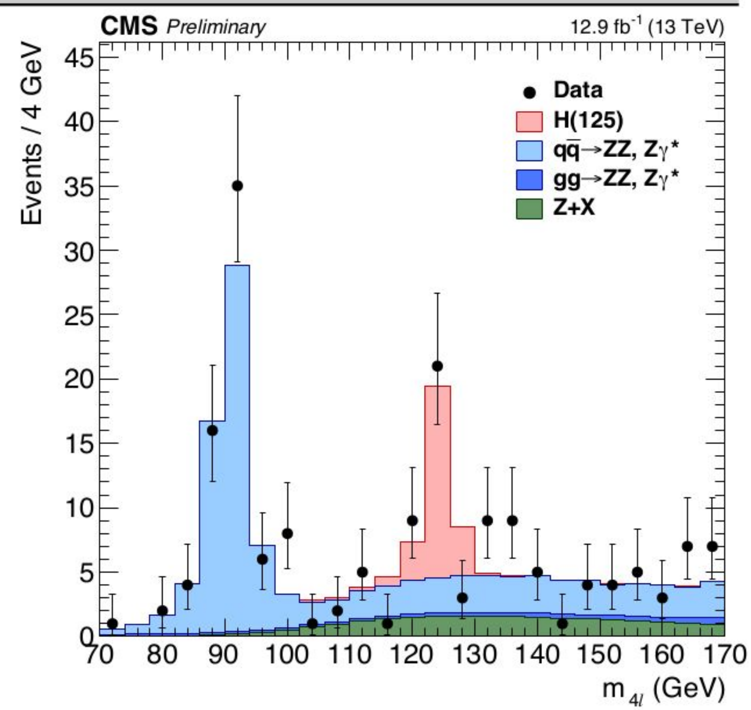


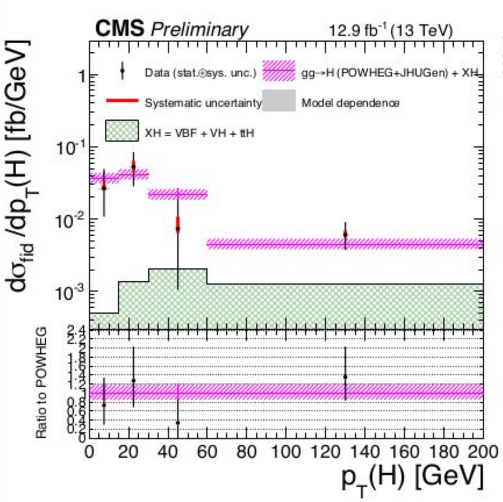
- Achieved similar precision to Run 1
- Measurements compatible with SM
- Results still dominated by statistical uncertainty

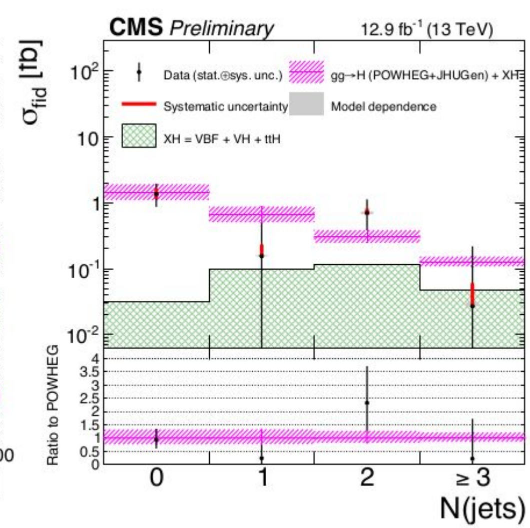
Higgs → ZZ*



13 TeV	Fiducial σ (fb)	SM prediction (fb)
CMS (12.9 fb^{-1})	$2.29^{+0.74}_{-0.64}{}^{+0.30}_{-0.23}$	2.53 ± 0.13



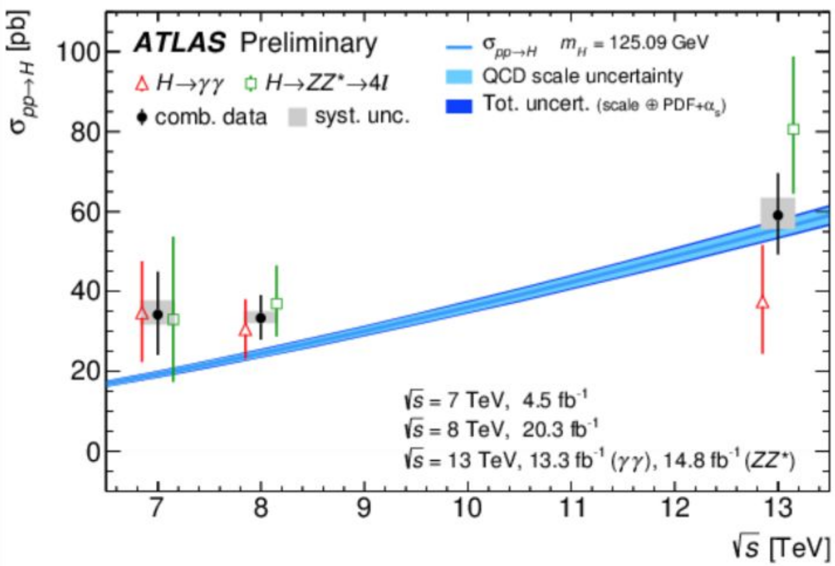


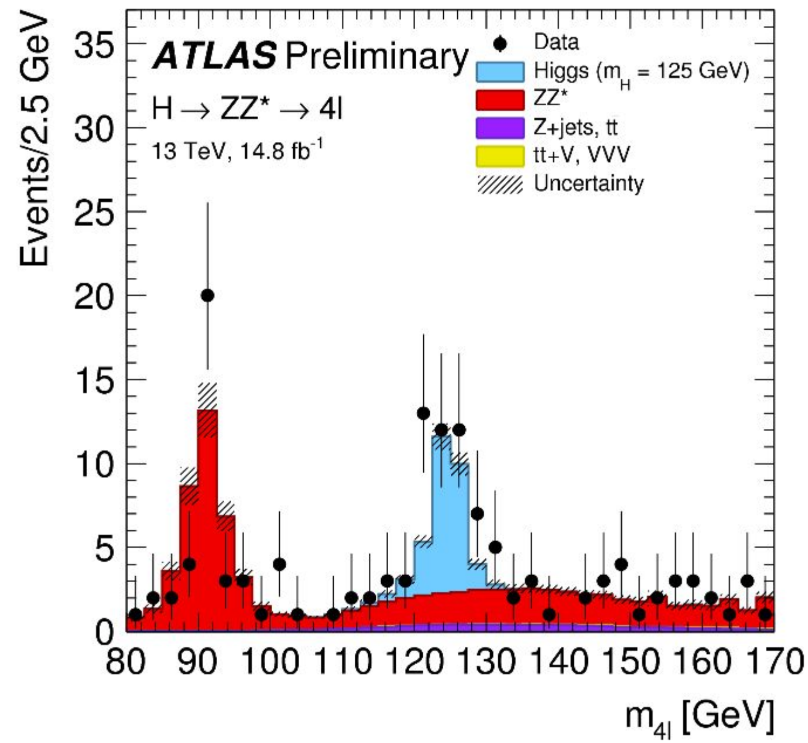


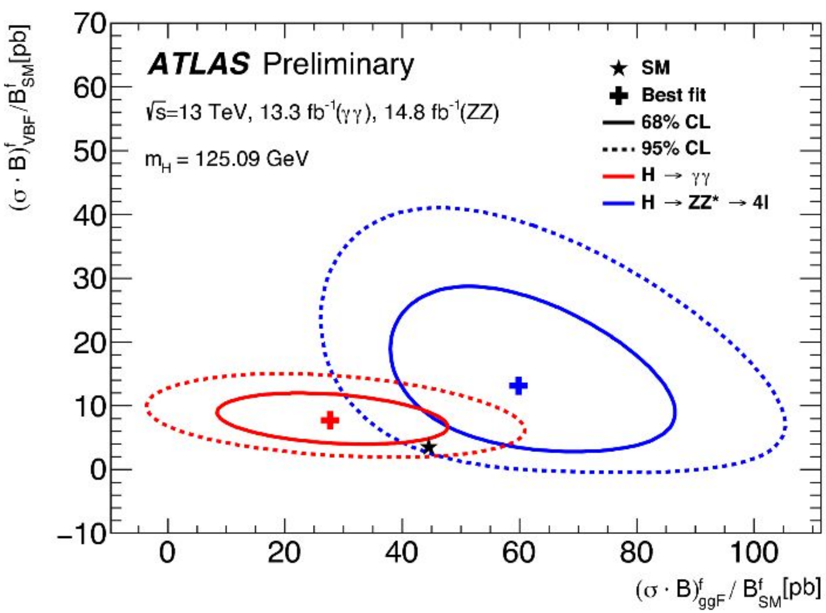
Higgs → ZZ* (+γγ)

ATLAS-CONF-1206-079

13 TeV	Fiducial σ (fb)	SM prediction (fb)
ATLAS (14.8 fb^{-1})	$4.54^{+1.02}_{-0.90}$	$3.07^{+0.21}_{-0.25}$

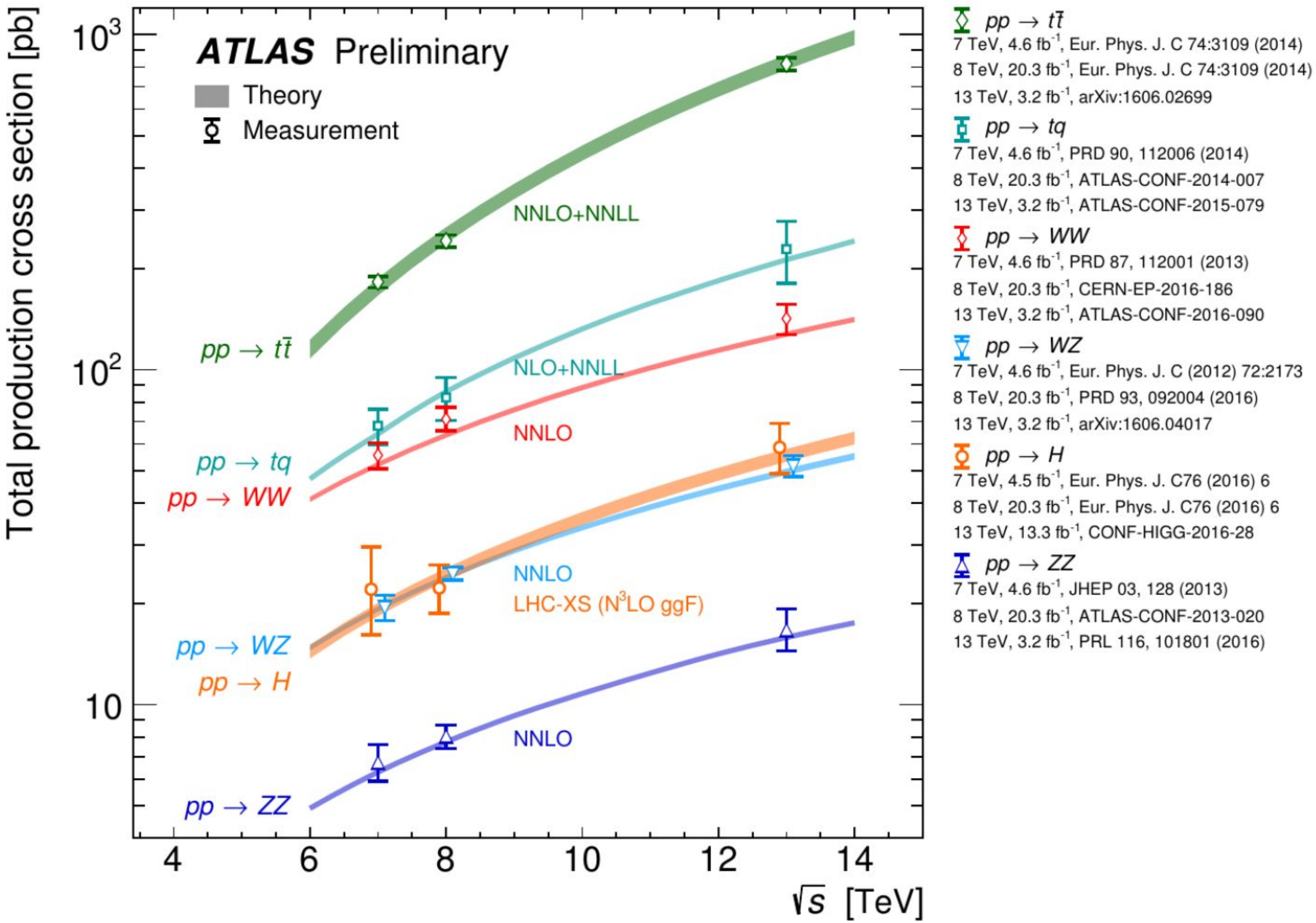






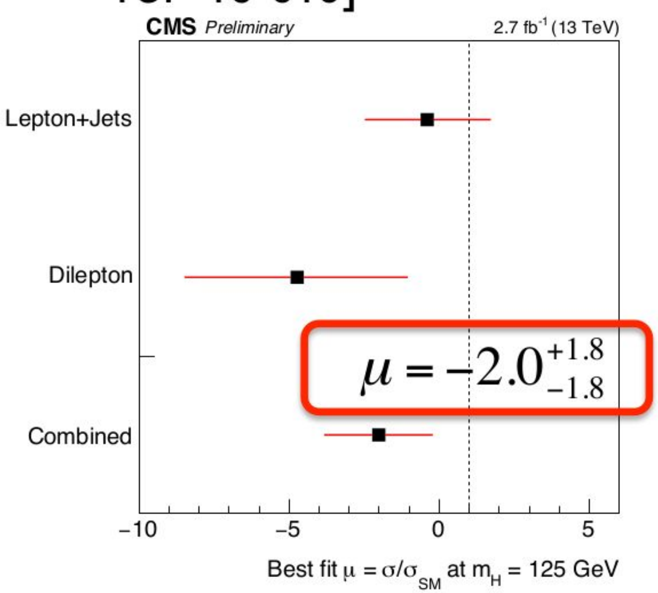
- Combination of ZZ* and γγ: 10σ significance (8.6σ expected)
- Comparable precision to Run 1

SM cross section summary

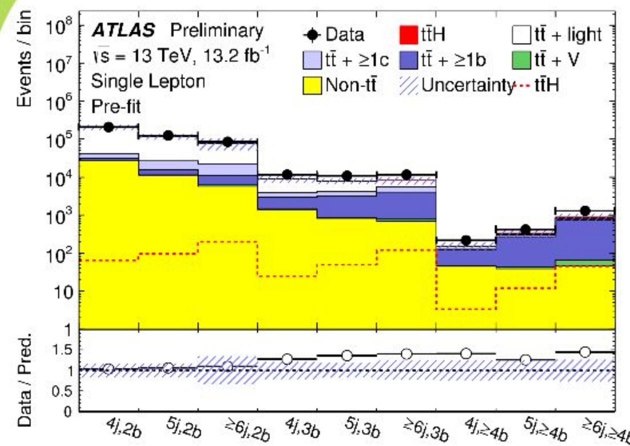
- 

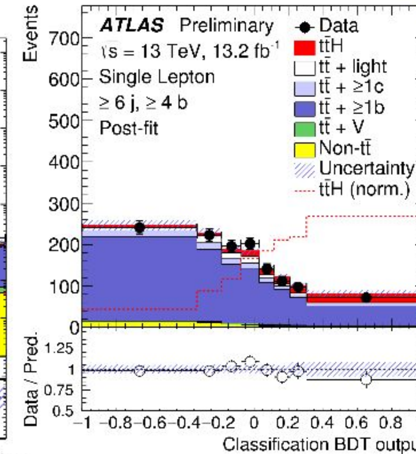
ttH(→bb)

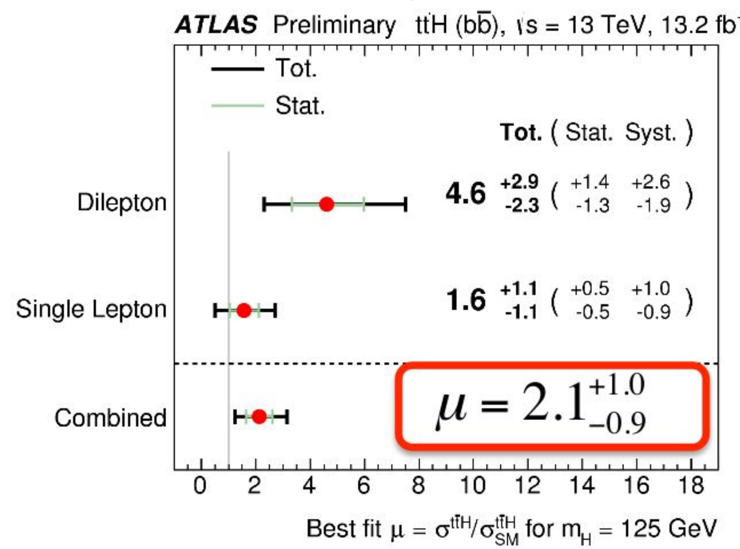
- First result from ATLAS, $13.2 fb^{-1}$, 13 TeV. [ATLAS-CONF-2016-080]
- BDT to reconstruct Higgs and separate signal and background for each category
- Dominated by syst. uncertainty on the background [$\sigma_{ttbb}/\sigma_{ttjj}$, $2.3 fb^{-1}$, 13 TeV; CMS-PAS-TOP-16-010]



[CMS-PAS-HIG-16-004]

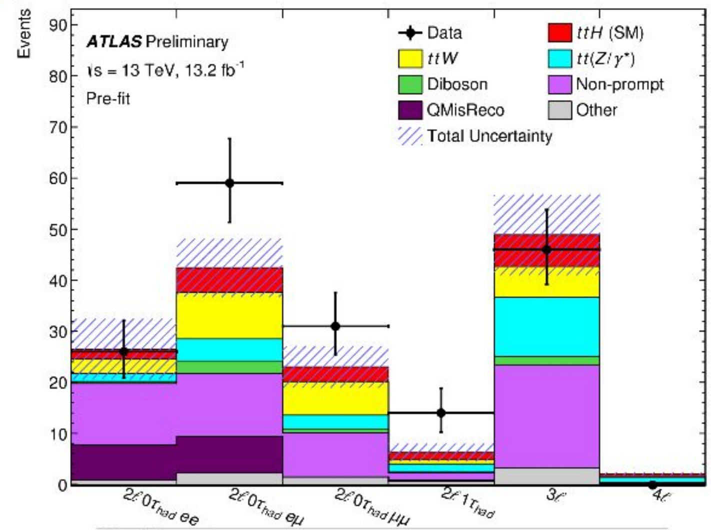


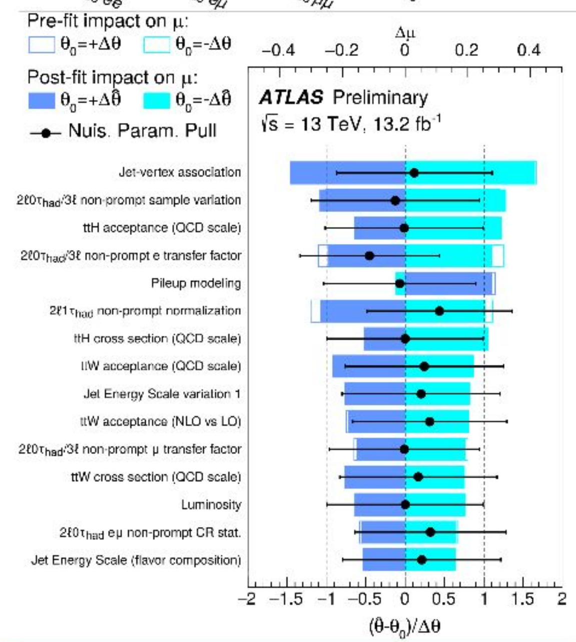


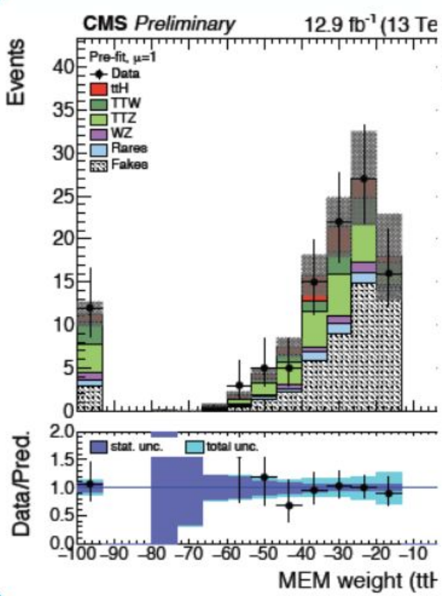


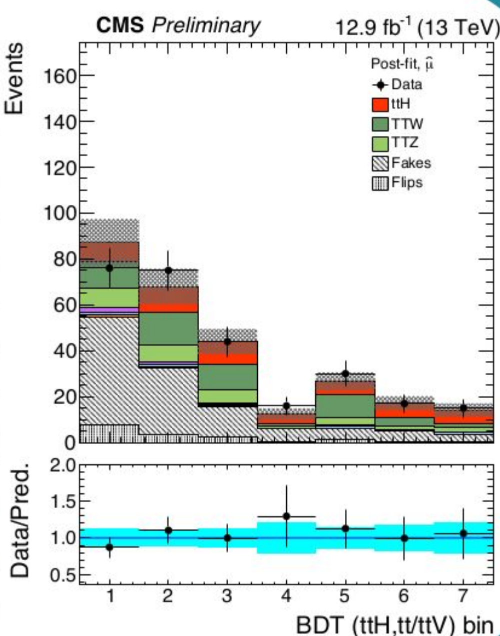
ttH(multileptons)

- New results from both experiments at 13 TeV (full dataset), [CMS-PAS-HI-16-022]; [ATLAS-CONF-2016-058]
  - ATLAS simpler analysis: cut and count analysis in main different category regions
  - CMS BDT based discriminants and now includes matrix element



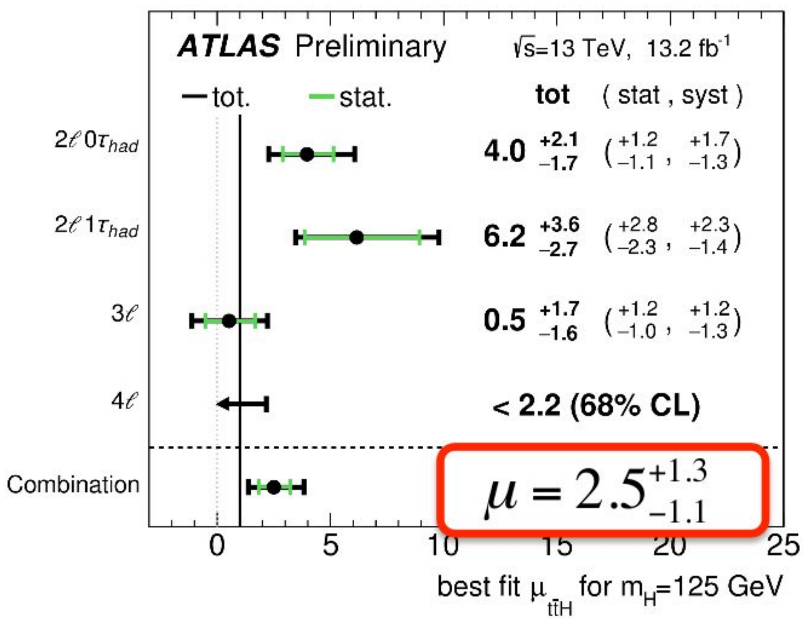


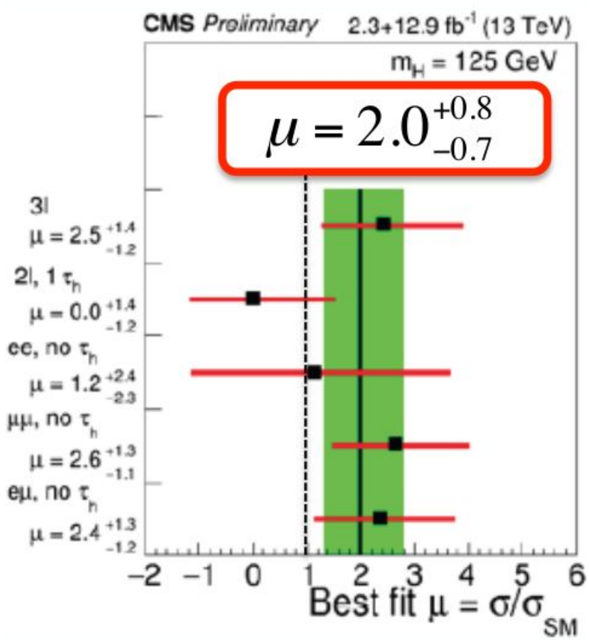




ttH(multileptons)

- **Dominated by the systematic uncertainty on** fake-rate measurements and non-prompt background estimates

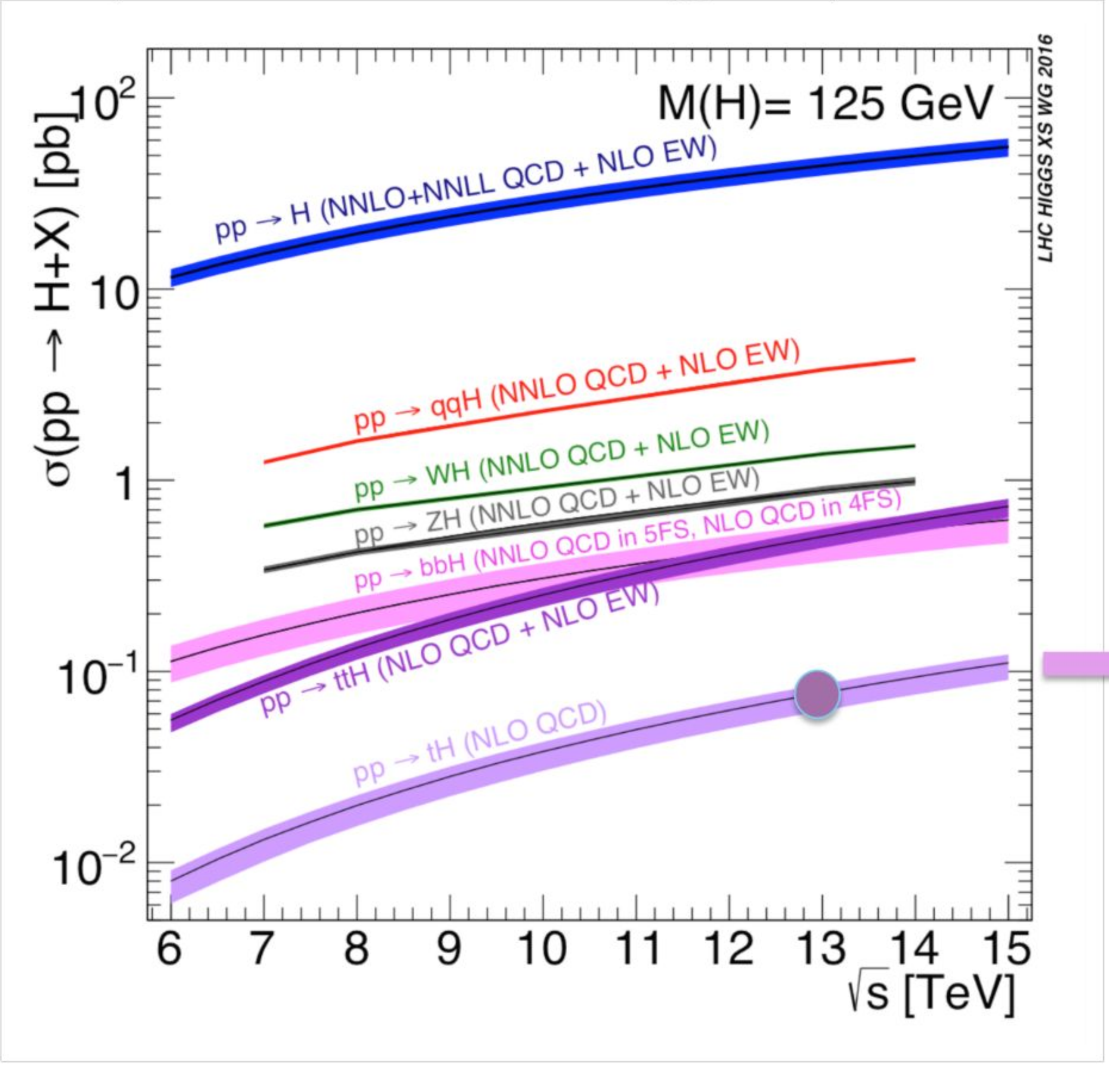


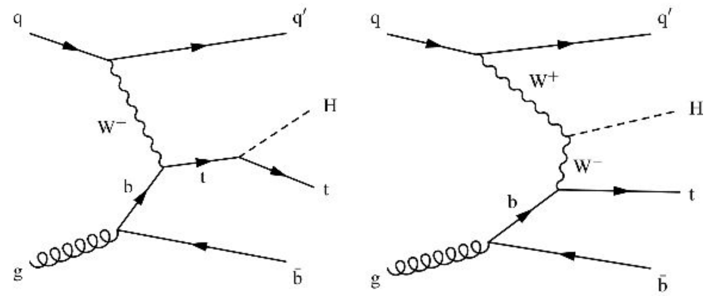


ttH combination $\mu = 1.7^{+0.7}_{-0.8}$ ATLAS-CONF-2016-068

Rare production modes

tH production: smallest Higgs SM production cross section





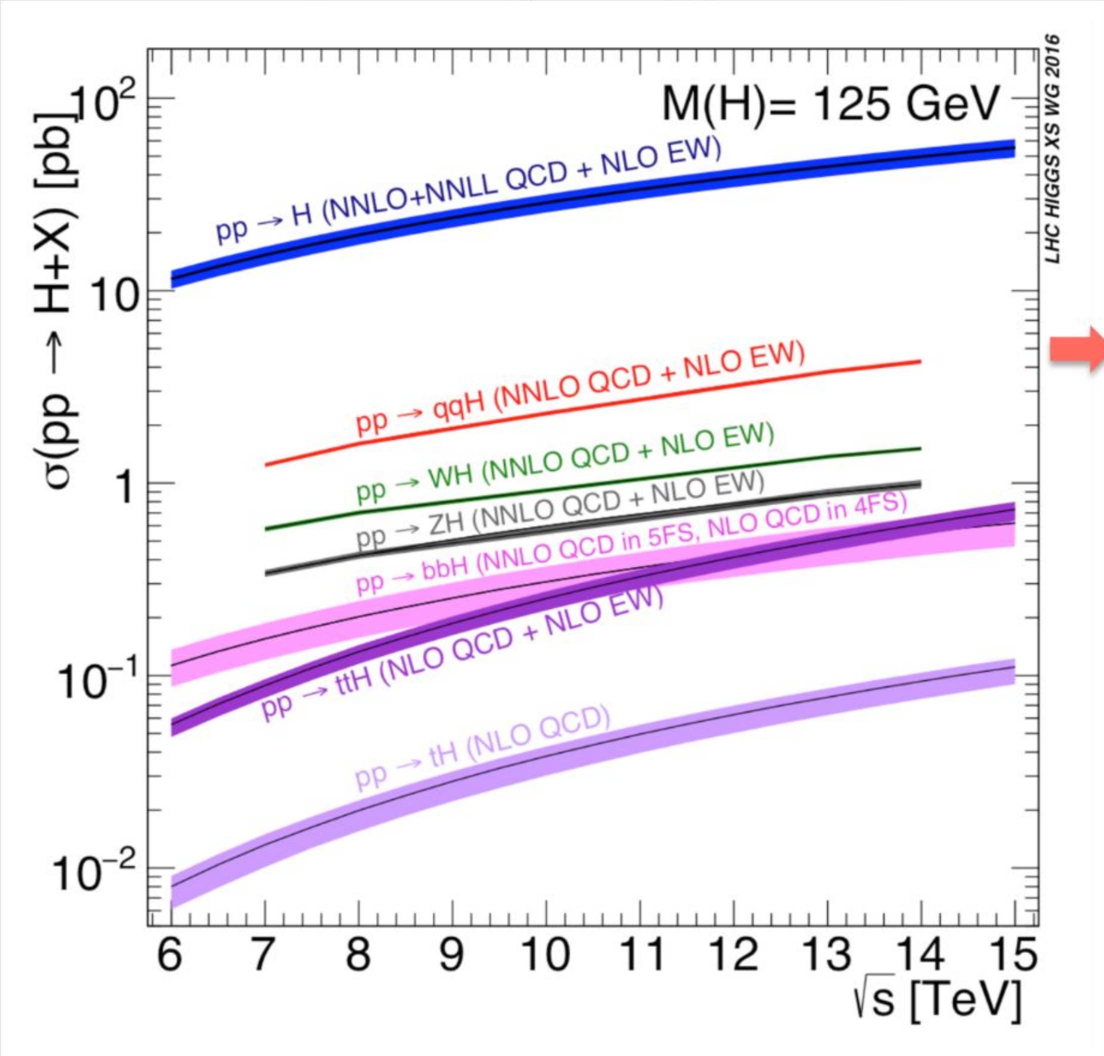
Sensible to the sign of Yukawa coupling y_t

tH(bb)	
CMS	Upper limit x Model (expected)
SM	113.7 (98.6)
ITC	6.0 (6.4)

CMS, 2.3 fb^{-1}, 13 TeV.
[CMS-PAS-HIG-16-019]

Rare decay modes

Establishing coupling of Higgs to b quarks



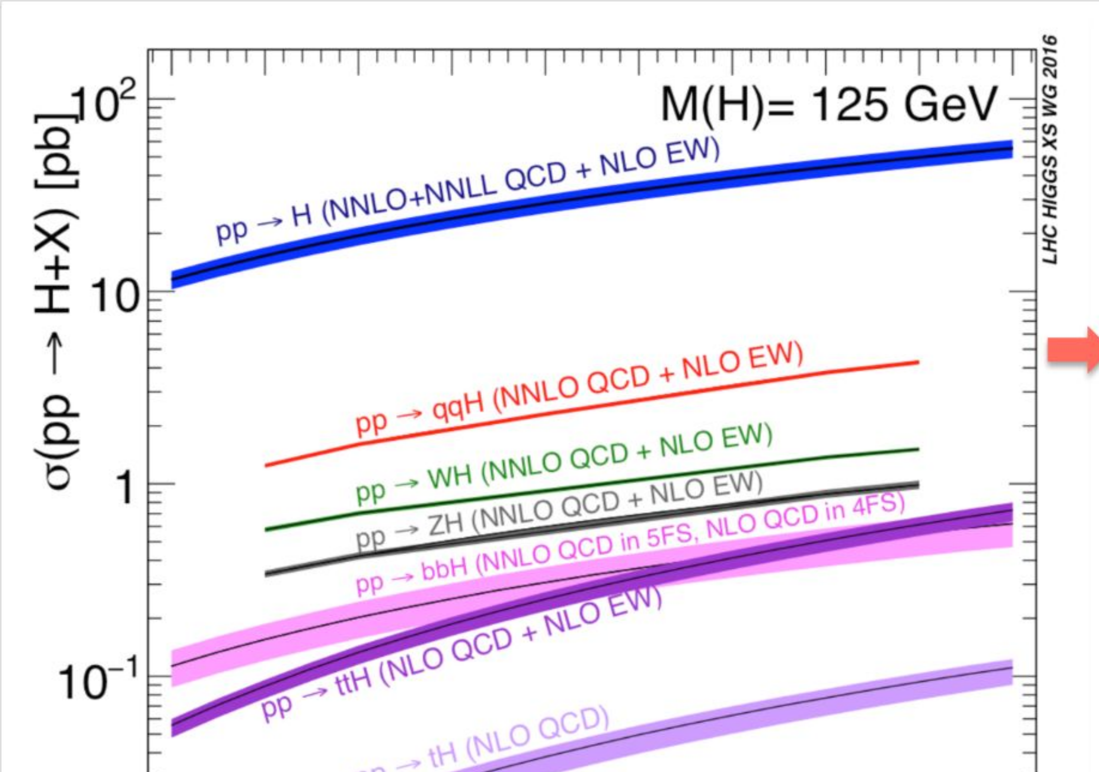
Tagged with forward jets

VBF(bb)		
CMS	Upper limit x SM (expected)	Signal strength μ
Run 1	5.5 (2.5)	$2.8^{+1.6}_{-1.4}$
Run 2	3.4 (2.3)	$1.3^{+1.2}_{-1.1}$

CMS, 2.3 fb^{-1}, 13 TeV.
[CMS-PAS-HIG-16-003]

Rare decay modes

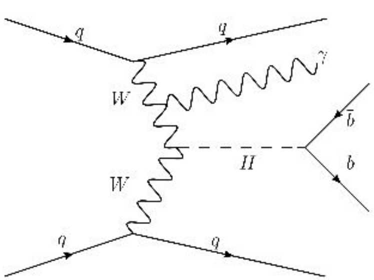
Establishing coupling of Higgs to b quarks



Tagged with forward jets

VBF(bb)		
CMS	Upper limit x SM (expected)	Signal strength μ
Run 1	5.5 (2.5)	$2.8^{+1.6}_{-1.4}$
Run 2	3.4 (2.3)	$1.3^{+1.2}_{-1.1}$

CMS, 2.3 fb^{-1}, 13 TeV.
[CMS-PAS-HIG-16-003]



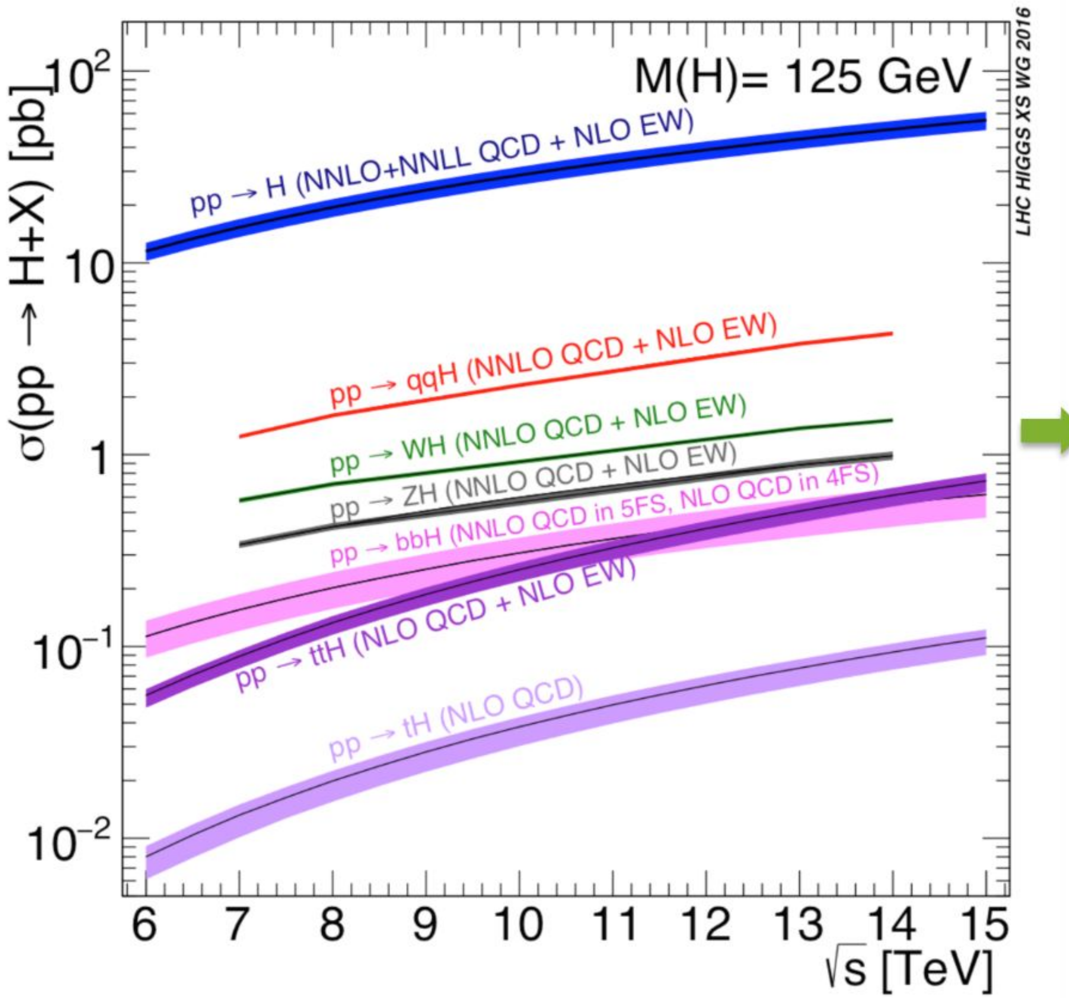
ATLAS result with 12.6 fb^{-1} requiring a high p_T photon to provide a clean signature for efficient triggering.
[ATLAS-CONF-2016-063]

Fit tested on SM

ATLAS	H(→bb) + γj	Z(→bb) + γj
Upper limit at 95% CL	4 x SM (expected 6 x SM)	2 x SM (expected 1.8 x SM)

Rare decay modes

Establishing coupling of Higgs to b quarks



Tagged with lepton/MET

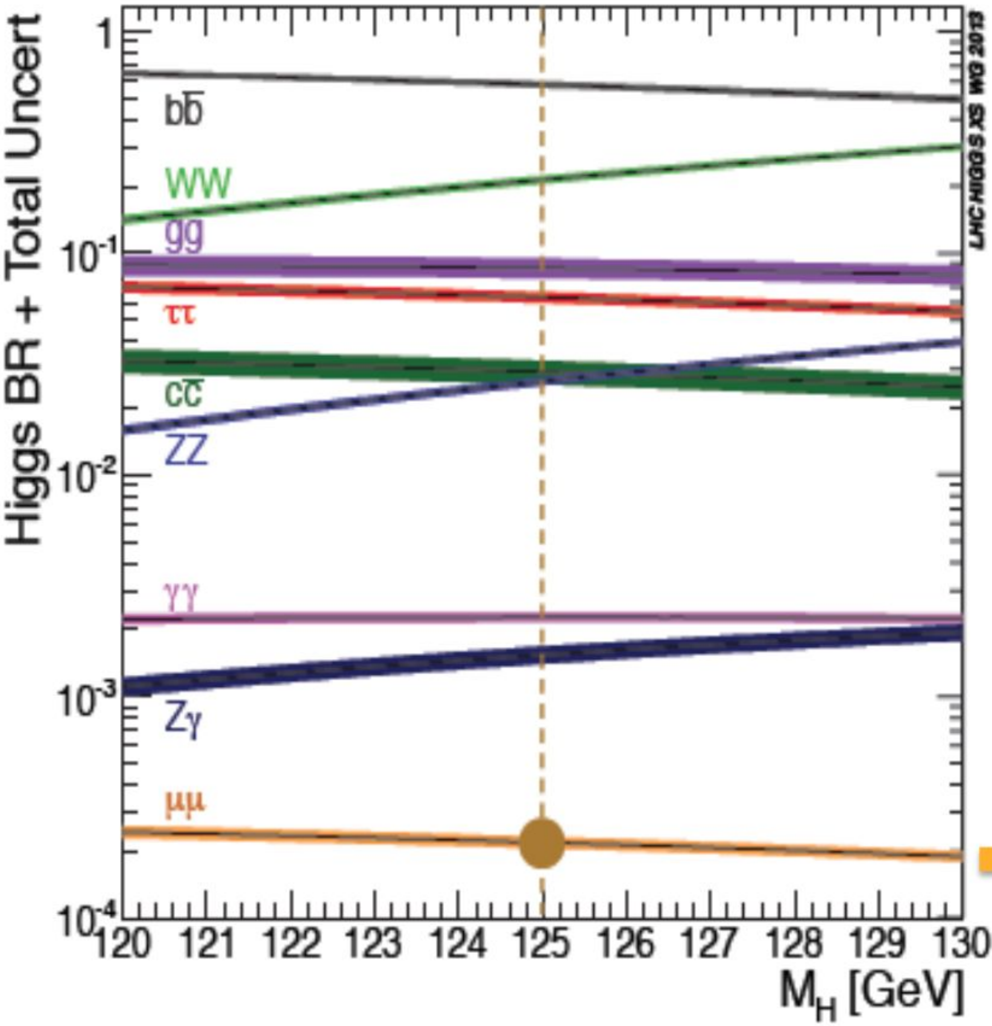
VH(bb)	
	Significance (expected)
ATLAS (13 TeV)	0.4σ (1.94σ)
ATLAS+CMS (8 TeV)	2.6σ (3.7σ)
Tevatron	2.8σ

ATLAS, 13.2 fb^{-1}, 13 TeV.
[ATLAS-CONF-2016-091]

Fit tested on SM

	W(Z)Z(→bb)
Observed μ	$0.91 \pm 0.17(\text{stat})\ ^{+0.32}_{-0.27}(\text{syst})$
Significance	3.0σ (expected 3.2σ)

Rare decay modes



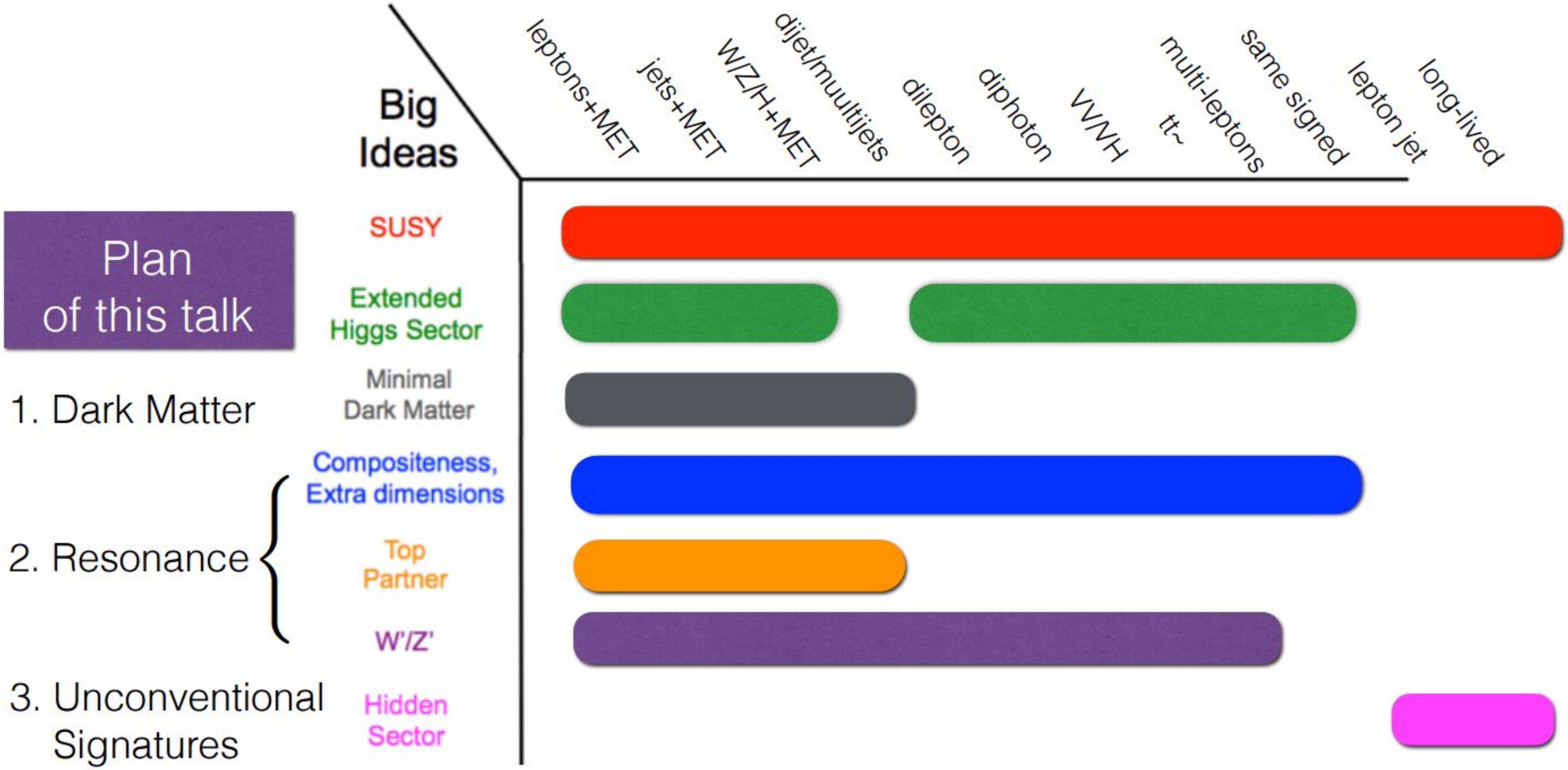
H→μμ	
ATLAS	Upper limit x SM (expected)
Run 1	7.1 (7.2)
Run 2	4.4 (5.5)
Combined Run 1 and Run 2	3.5 (4.5)

ATLAS, 13.2 fb^{-1}, 13 TeV. [ATLAS-CONF-2016-041]

Beyond the SM

- Quite often the same big idea probed by different signatures
  - It's crucial to search all complementary signatures

Shih-Chieh Hsu- Exo Plenary talk



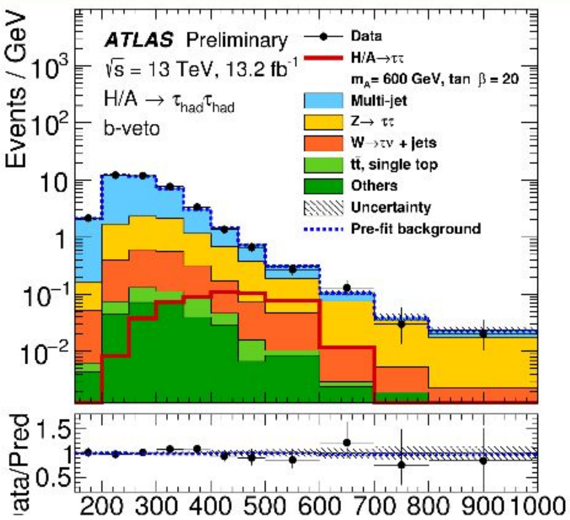
Heavy Higgs Searches @ 13 TeV

Higgs to fermions		
$H \rightarrow \tau\tau$	2.3 fb^{-1} (CMS-PAS-HIG-16-006)*	13.3 fb^{-1} (ATLAS-CONF-2016-085)
$H \rightarrow bb$	2.7 fb^{-1} (CMS-PAS-HIG-16-025)	
Higgs to vector bosons		
$H \rightarrow ZZ \rightarrow 4l$	12.9 fb^{-1} (CMS-PAS-HIG-16-033)	14.8 fb^{-1} (ATLAS-CONF-2016-079)
$H \rightarrow WW \rightarrow l\nu l\nu$	2.3 fb^{-1} (CMS-PAS-HIG-16-023)	13.2 fb^{-1} (ATLAS-CONF-2016-074)
Higgs to Higgs (diHiggs)		
$H \rightarrow hh \rightarrow bbbb$	2.3 fb^{-1} (CMS-PAS-HIG-16-002)*	13.3 fb^{-1} (ATLAS-CONF-2016-049)
$H \rightarrow hh \rightarrow bb\tau\tau$	12.9 fb^{-1} (CMS-PAS-HIG-16-029/028)	
$H \rightarrow hh \rightarrow bbWW$	2.3 fb^{-1}(CMS-PAS-HIG-16-011)*	
$H \rightarrow hh \rightarrow \gamma\gamma WW$*		13.3 fb^{-1} (ATLAS-CONF-2016-071)
$H \rightarrow hh \rightarrow \gamma\gamma bb$		3.2 fb^{-1} (ATLAS-CONF-2016-004)*

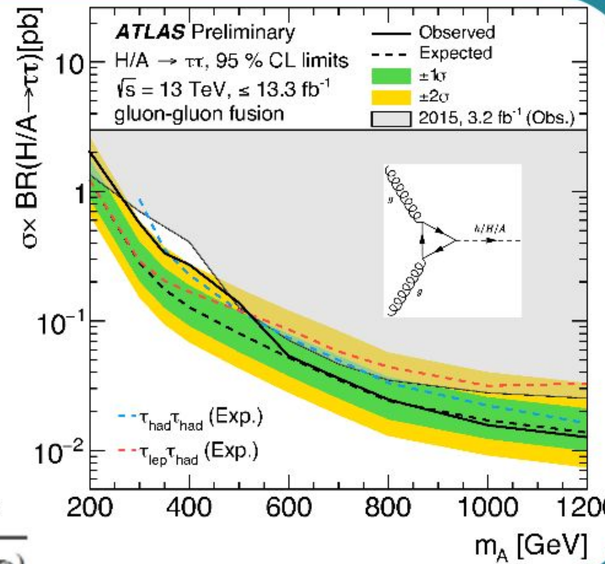
* Previous to ICHEP

Heavy H→fermions

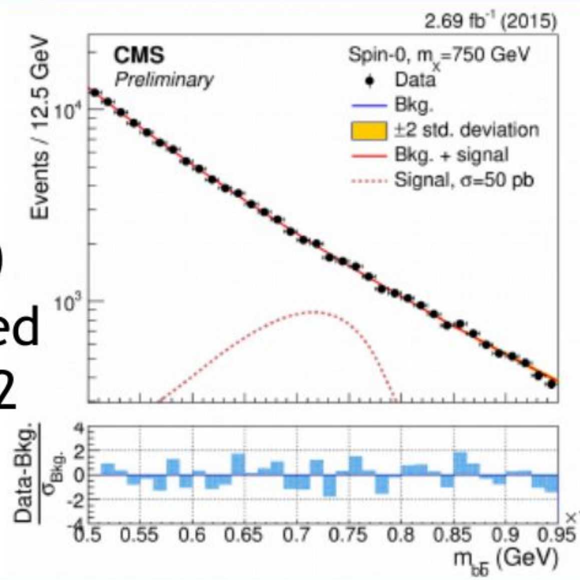
- Higgs→ττ
- New ATLAS analysis includes new triggers and event categories

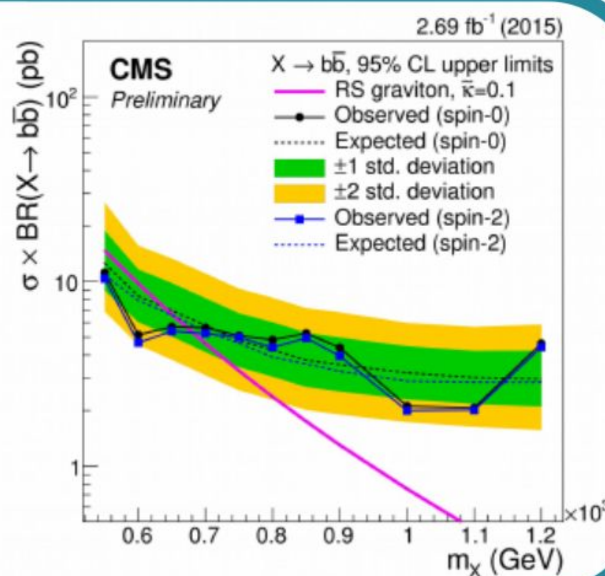


$$m_T^{tot} = \sqrt{m_T^2(E_T^{miss}, \tau_1) + m_T^2(E_T^{miss}, \tau_2) + m_T^2(\tau_1, \tau_2)}.$$



- Higgs→bb
- Two benchmark scenarios: a spin-0 resonance produced in ggF, and a spin-2 RS graviton





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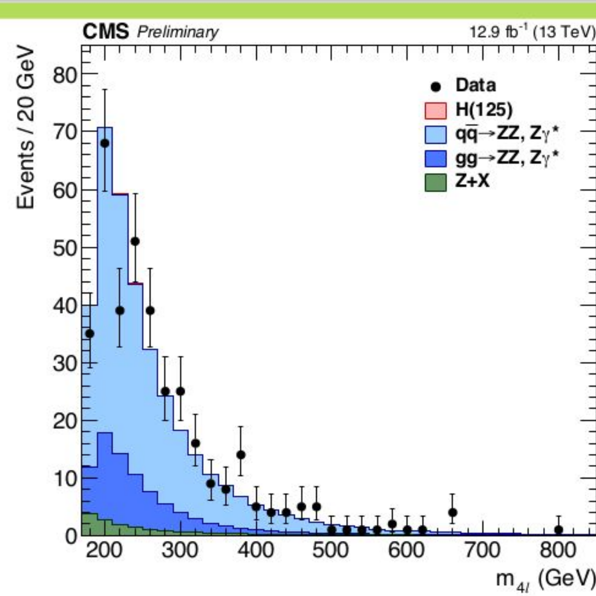
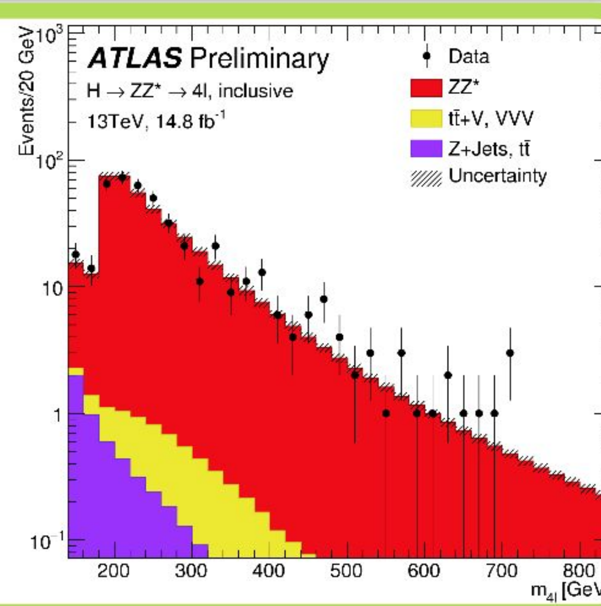
H→ττ	2.3 fb^{-1} (CMS-PAS-HIG-16-006)	13.3 fb^{-1} (ATLAS-CONF-2016-085)
H→bb	2.7 fb^{-1} (CMS-PAS-HIG-16-025)	
Higgs to vector bosons		
H→ZZ→4l	12.9 fb^{-1} (CMS-PAS-HIG-16-033)	14.8 fb^{-1} (ATLAS-CONF-2016-079)
H→WW→lνlν	2.3 fb^{-1} (CMS-PAS-HIG-16-023)	13.2 fb^{-1} (ATLAS-CONF-2016-074)
Higgs to Higgs (diHiggs)		
H→hh→bbbb	2.3 fb^{-1} (CMS-PAS-HIG-16-002)*	13.3 fb^{-1} (ATLAS-CONF-2016-049)
H→hh→bbττ	12.9 fb^{-1} (CMS-PAS-HIG-16-029/028)	
H→hh→bbWW	2.3 fb^{-1}(CMS-PAS-HIG-16-011)*	
H→hh→γγWW*		13.3 fb^{-1} (ATLAS-CONF-2016-071)
H→hh→γγbb		3.2 fb^{-1} (ATLAS-CONF-2016-004)*

* Previous to ICHEP

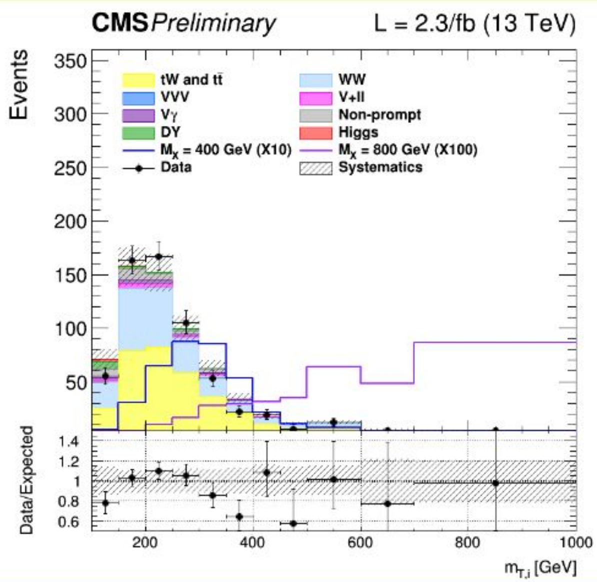
Heavy H→ vector bosons

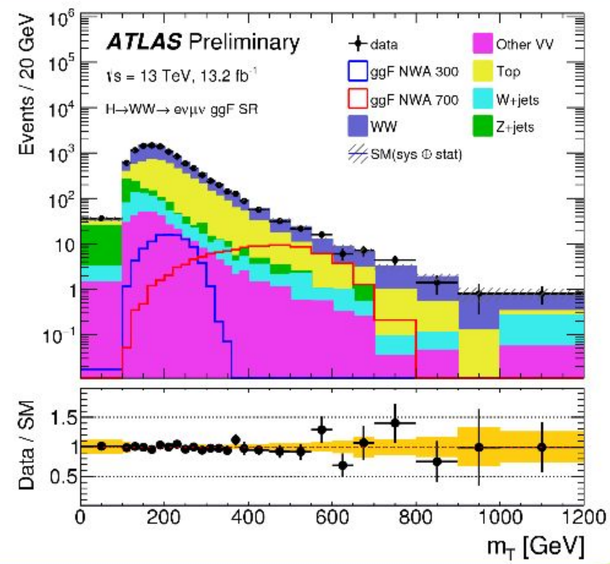
- Heavy H→ZZ
- Fit the m_{4l} distribution





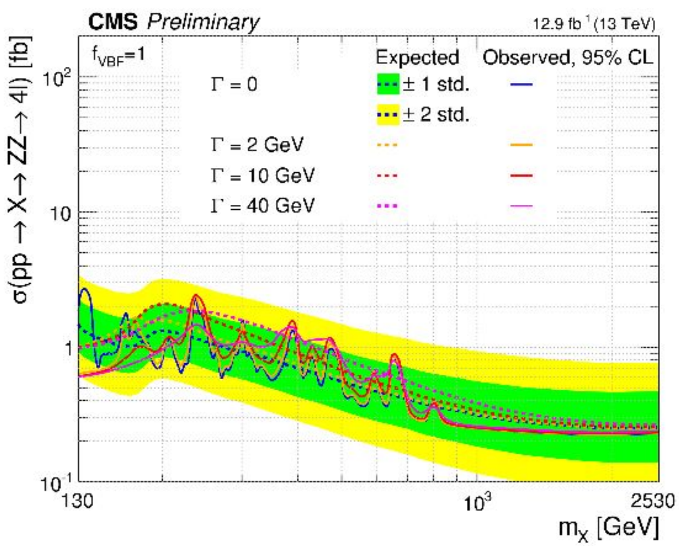
- Heavy H→WW
- Fit to the M_T of the 2 leptons and MET

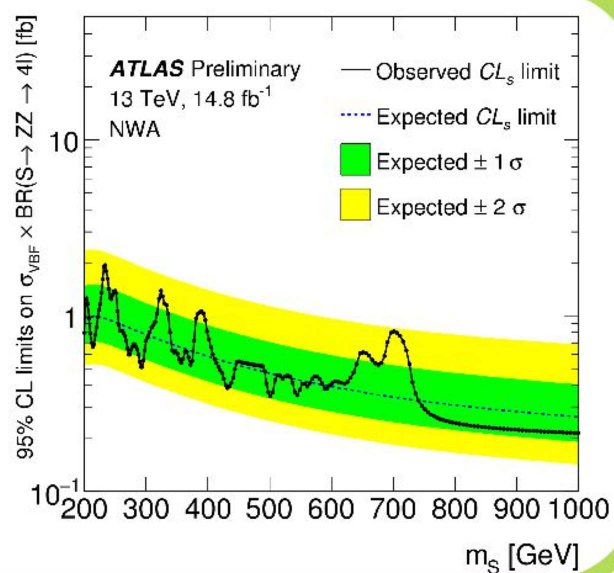




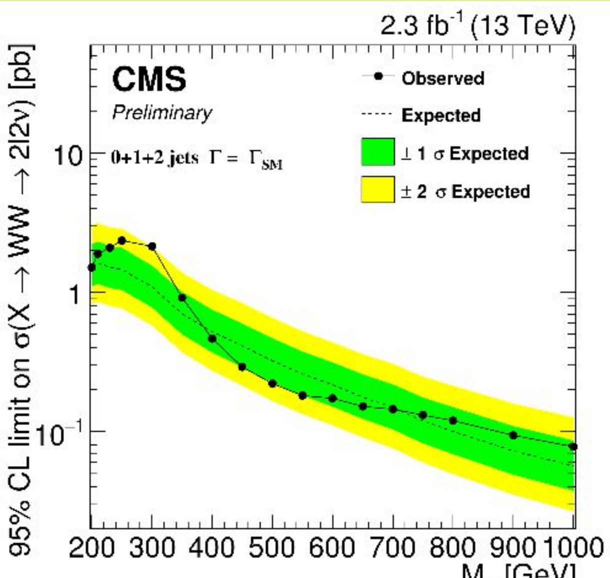
Heavy H→ vector bosons

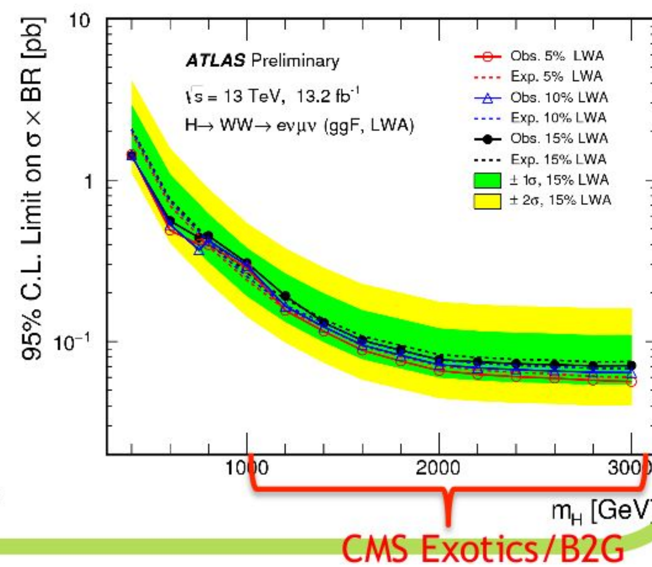
- Heavy H→ZZ
- Limits for different decay width Γ_X assumptions





- Heavy H→WW
- ATLAS: lower limits extended from 600 to 300 GeV. Better limits at low mass than previous combined ones





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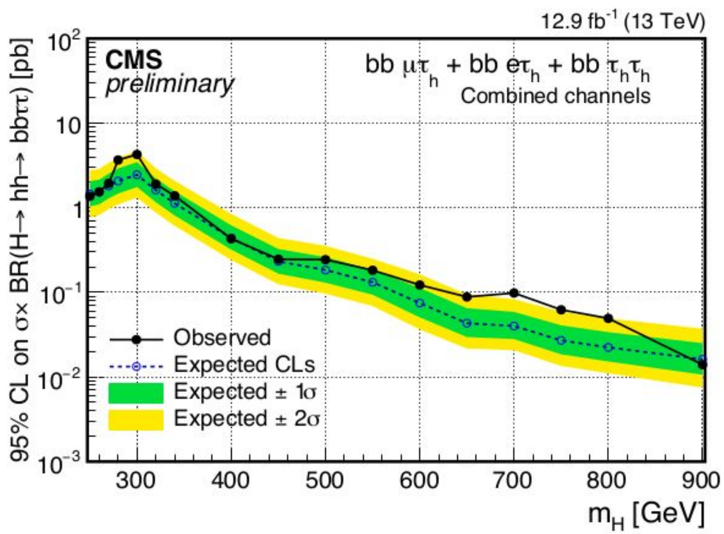
$H \rightarrow hh \rightarrow bb\tau\tau$	12.9 fb^{-1} (CMS-PAS-HIG-16-029/028)	
$H \rightarrow hh \rightarrow bbWW$	2.3 fb^{-1}(CMS-PAS-HIG-16-011)*	
$H \rightarrow hh \rightarrow \gamma\gamma WW^*$		13.3 fb^{-1} (ATLAS-CONF-2016-071)
$H \rightarrow hh \rightarrow \gamma\gamma bb$		3.2 fb^{-1} (ATLAS-CONF-2016-004)*

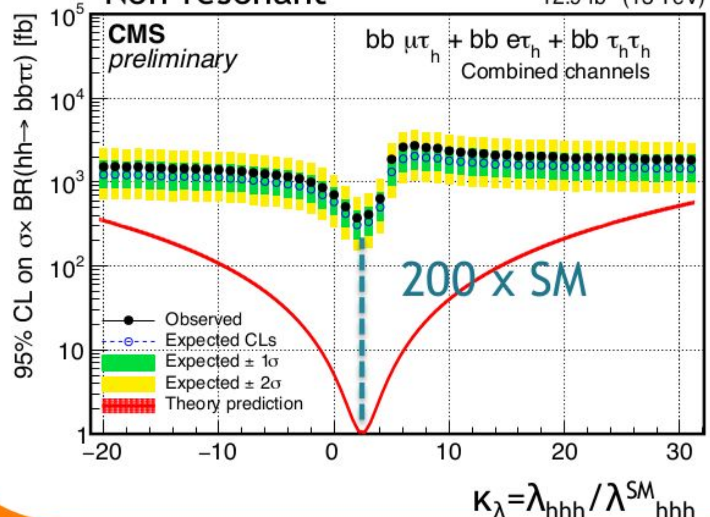
* Previous to ICHEP

Higgs→hh

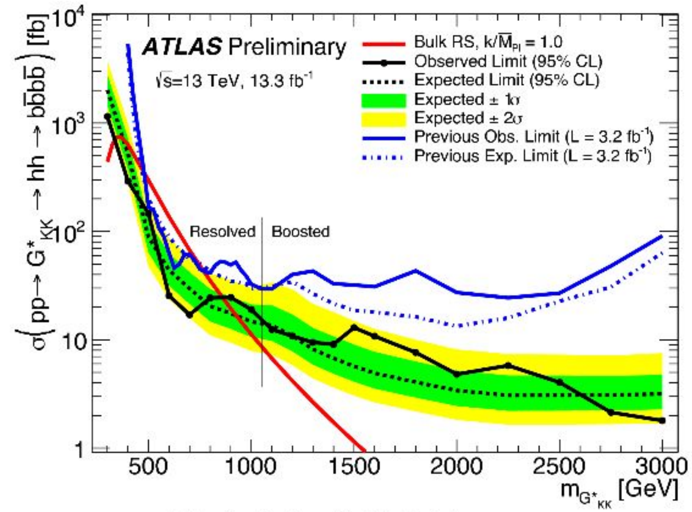
H→hh→bbττ



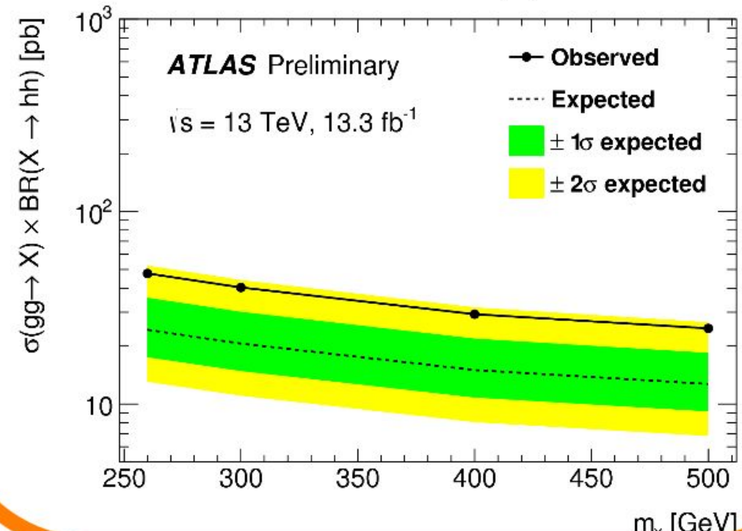
Non-resonant



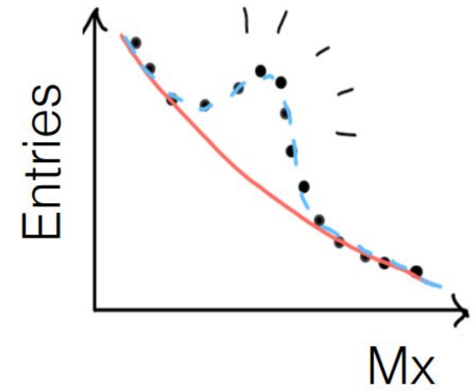
H→hh→bbbb

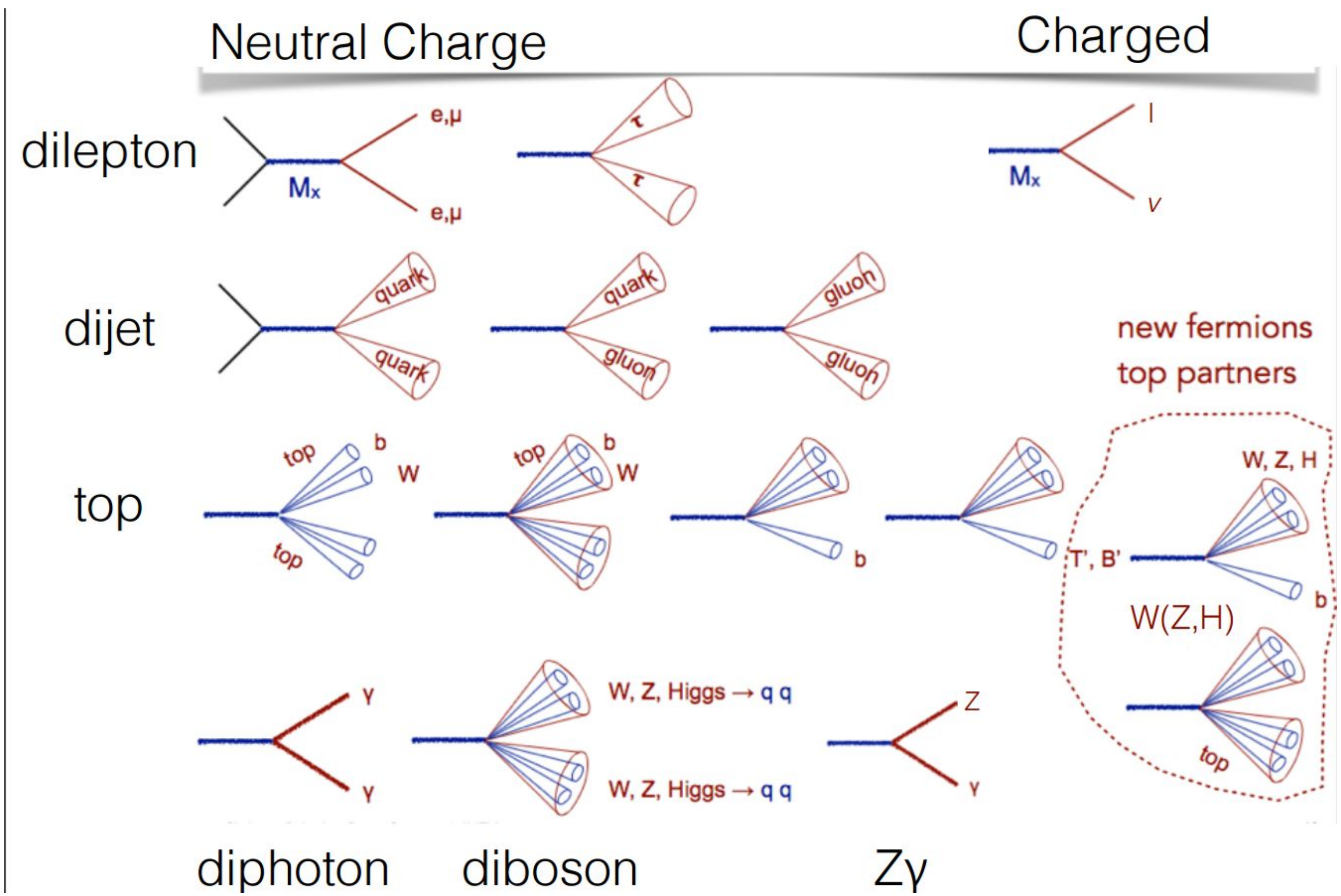


H→hh→WWγγ



Search for resonances

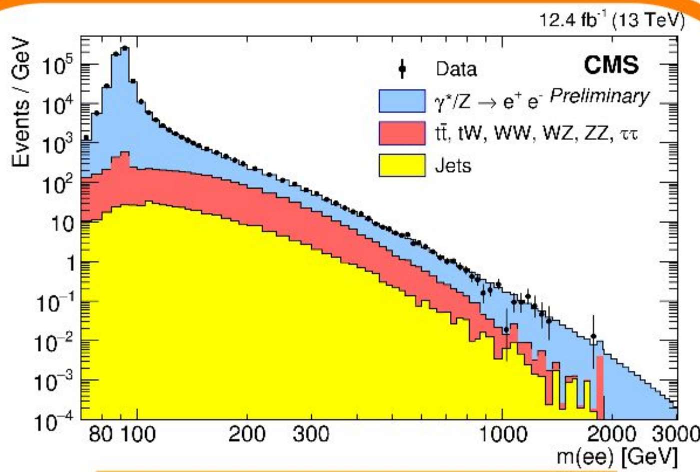




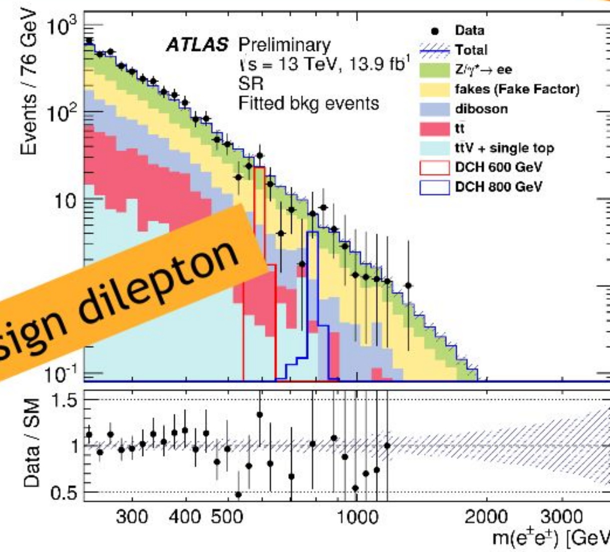
Resonances @ 13 TeV

Resonances		
dilepton	12.4 fb^{-1} (CMS-PAS-EXO-16-031)	13.3 fb^{-1} (ATLAS-CONF-2016-045) 13.9 fb^{-1} (ATLAS-CONF-2016-051)
lepton+ν	2.2 fb^{-1} (CMS-PAS-EXO-15-006)*	13.3 fb^{-1} (ATLAS-CONF-2016-061)
dijet	12.9 fb^{-1} (CMS-PAS-EXO-16-032)	15.7 fb^{-1} (ATLAS-CONF-2016-069) 15.5 fb^{-1} (ATLAS-CONF-2016-070) (w/ γ)
diphoton	12.9 fb^{-1} (CMS-PAS-EXO-16-027)	12.2 fb^{-1} (ATLAS-CONF-2016-059)
tb	12.9 fb^{-1} (CMS-PAS-B2G-16-017)	
Dibosons (with V=W,Z)		
ZZ→llνν	2.3 fb^{-1} (CMS-PAS-HIG-16-001)*	13.3 fb^{-1} (ATLAS-CONF-2016-056)
ZV→llqq	2.7 fb^{-1} (CMS-PAS-B2G-16-010)	13.2 fb^{-1} (ATLAS-CONF-2016-082)
VZ→qqνν		13.2 fb^{-1} (ATLAS-CONF-2016-082)
WV→lνqq	12.9 fb^{-1} (CMS-PAS-B2G-16-020)	13.2 fb^{-1} (ATLAS-CONF-2016-062)
Zγ	12.9 fb^{-1} (CMS-PAS-EXO-16-034)	13.3 fb^{-1} (ATLAS-CONF-2016-044)
Z(qq)γ	12.9 fb^{-1} (CMS-PAS-EXO-16-035)	3.2 fb^{-1} (arXiv:1607.06363)*
VV→qqqq		15.5 fb^{-1} (ATLAS-CONF-2016-055)
VH→qqbb		13.3 fb^{-1} (ATLAS-CONF-2016-083)
Vector like quarks		
Single VLQ→Zt	2.3 fb^{-1} (CMS-PAS-B2G-16-001)	
Single VLQ→Wb	2.3 fb^{-1} (CMS-PAS-B2G-16-006)	3.2 fb^{-1} (ATLAS-CONF-2016-072)

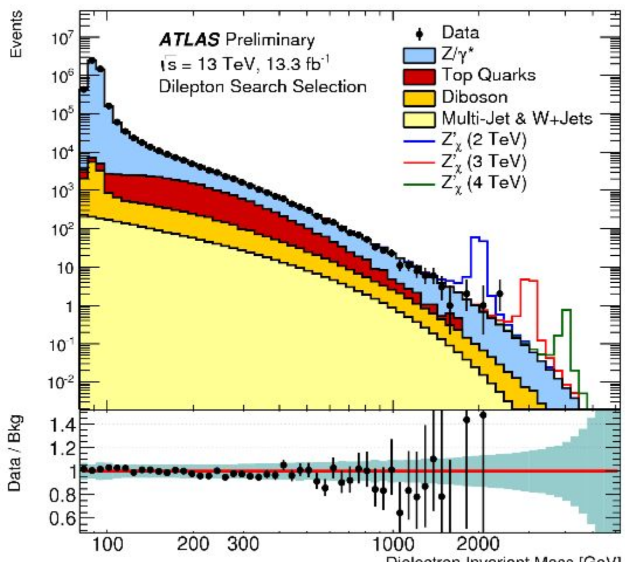
Leptons



Opposite sign dilepton

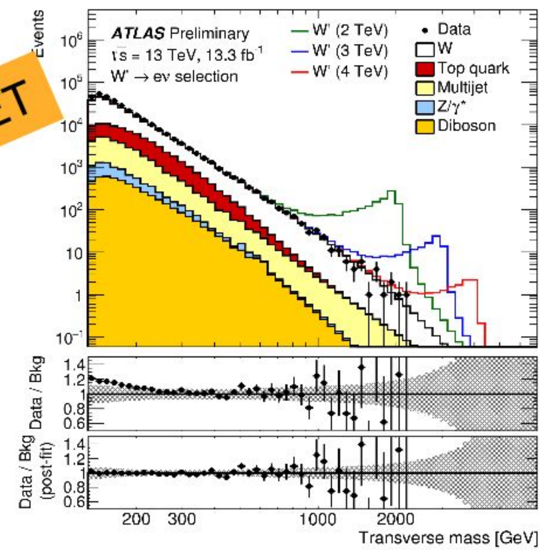


Same sign dilepton



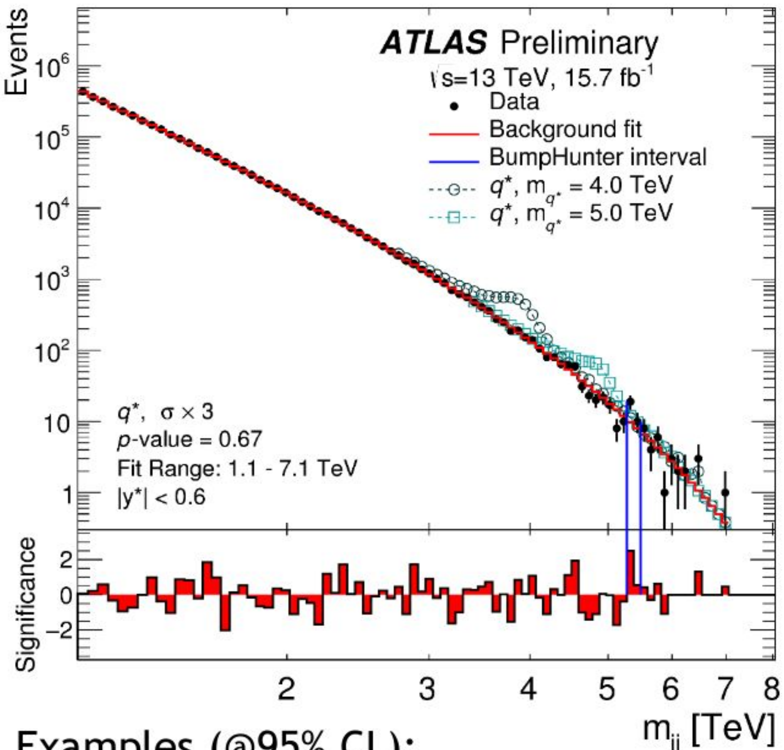
Z'_{SSM} > 4 TeV

Lepton +MET

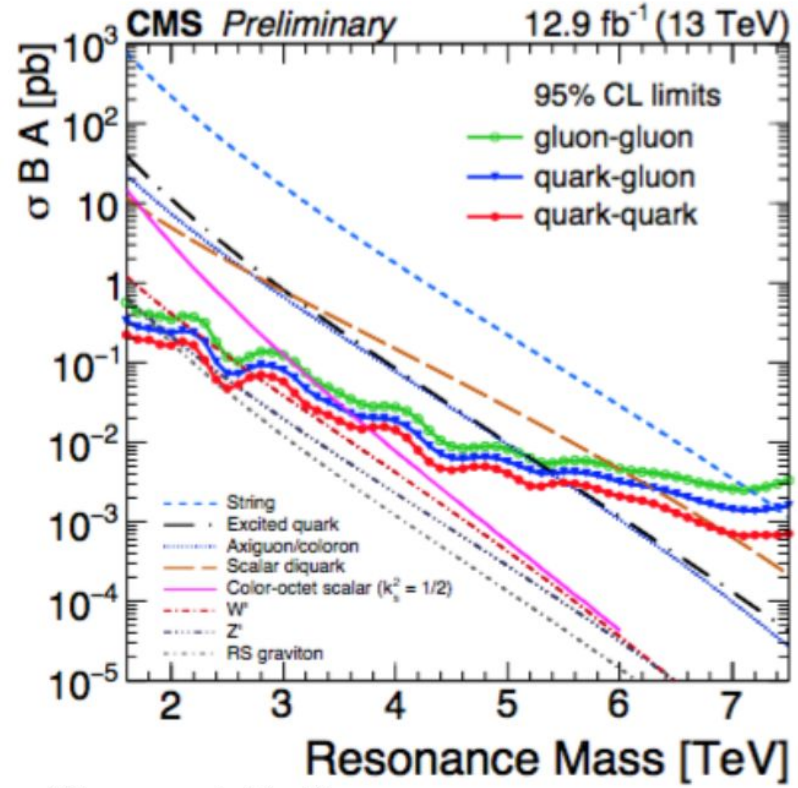


SSM W' > 4.74 TeV

Dijet



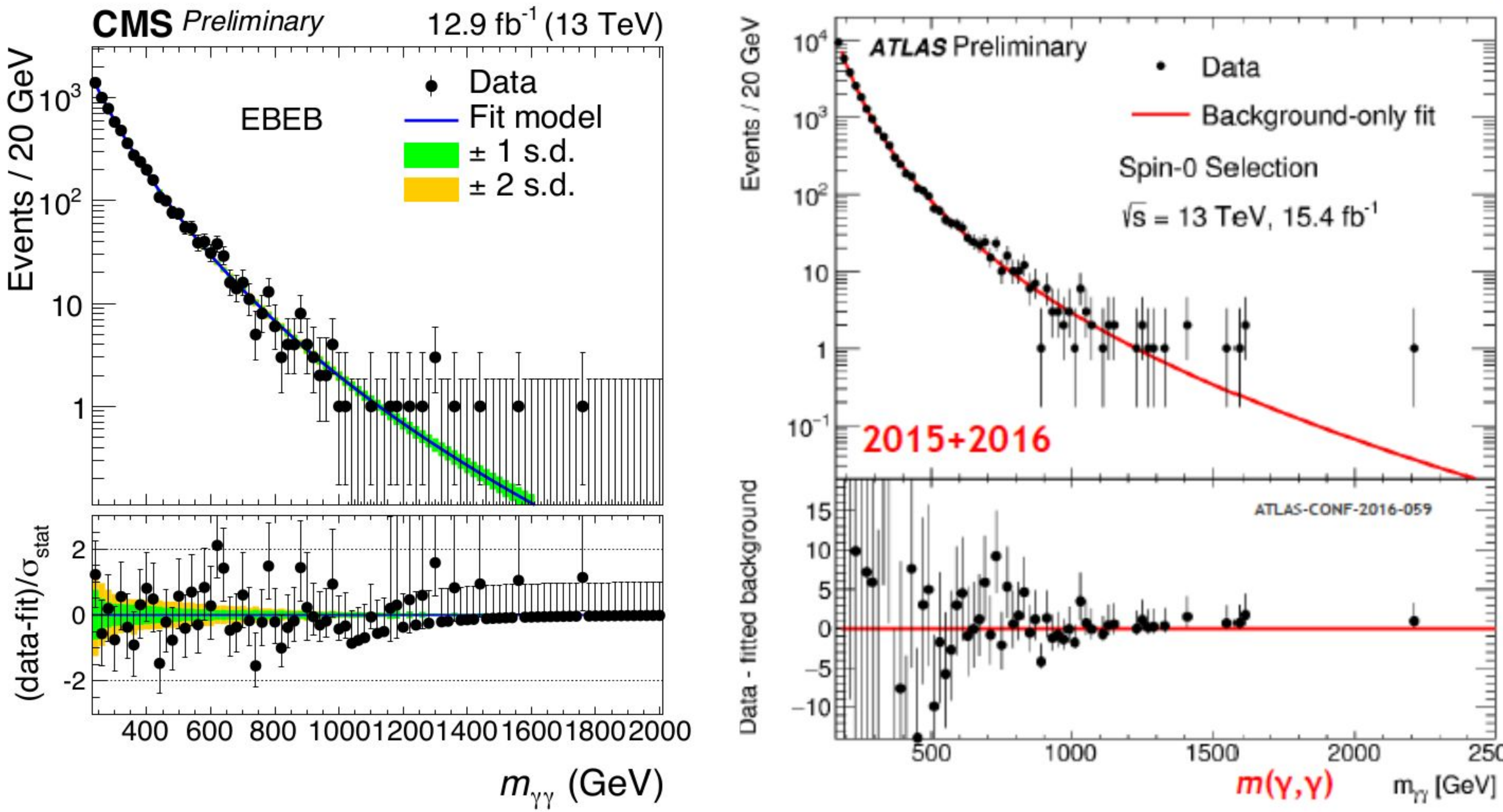
Examples (@95% CL):
m(q*) > 5.6 TeV (ATLAS Run-1: 4.1 TeV)
Z' > 1.5 TeV



Strongest limit:
STRING resonances excluded up to 7.4 TeV

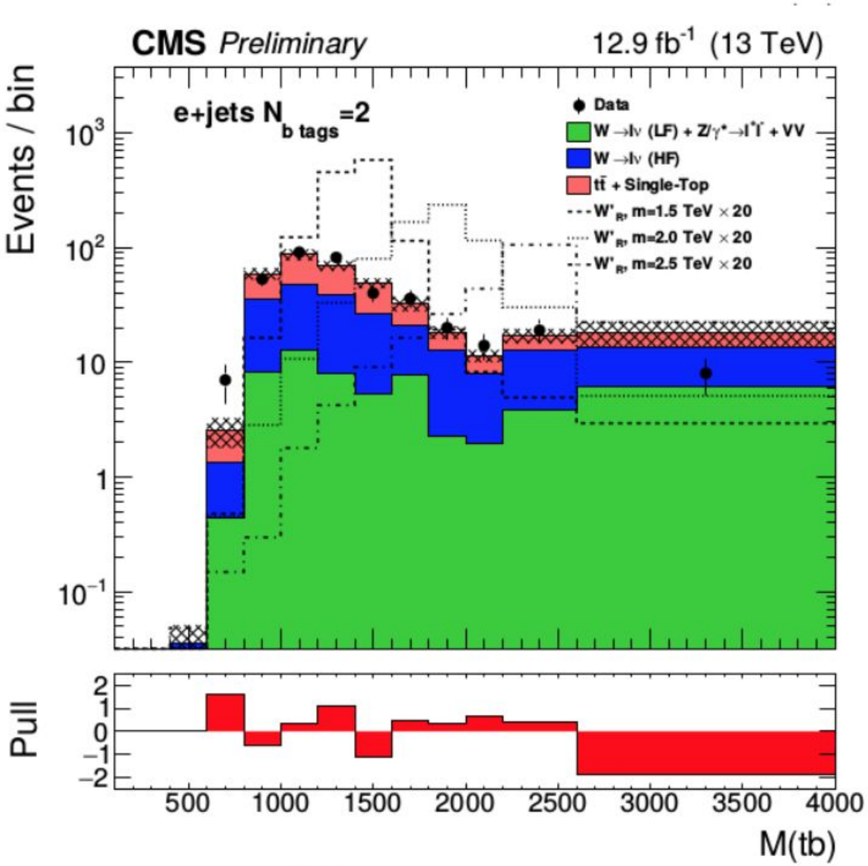
Excess is gone, unfortunately !!

Diphoton

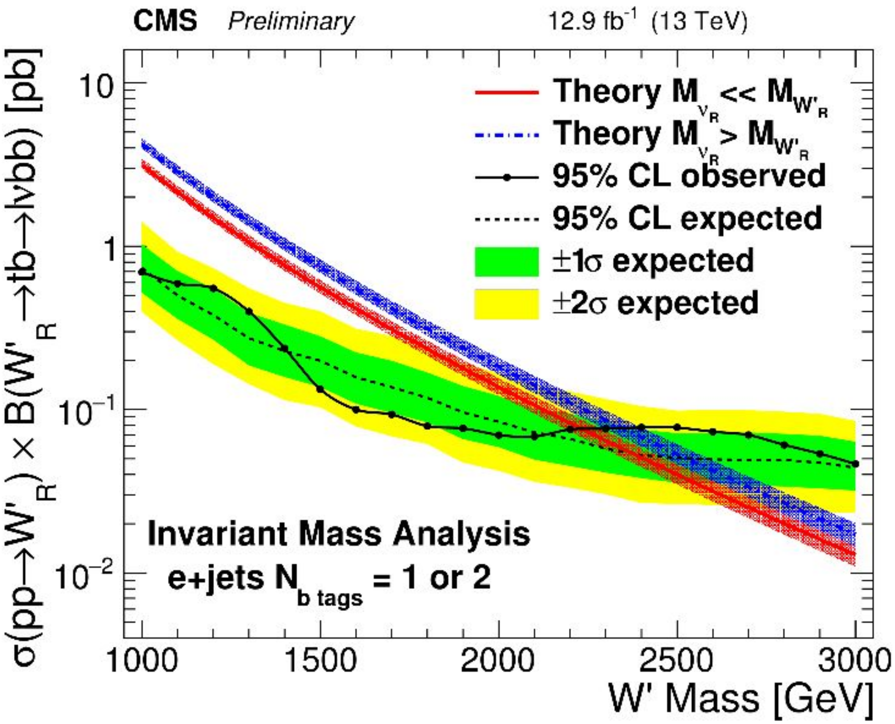


- 2016 analysis: straight reload of 2015 analysis
- 2015 excess not confirmed in 2016 data

W' → tb



CMS Preliminary
12.9 fb-1 (13 TeV)
e+jets N b tags =2
Data
W →lν (LF) + Z/γ*→l+l- + VV
W →lν (HF)
tt̄ + Single-Top
W'R, m=1.5 TeV × 20
W'R, m=2.0 TeV × 20
W'R, m=2.5 TeV × 20
Events / bin
Pull
M(tb)



CMS Preliminary
12.9 fb-1 (13 TeV)
Theory M νR << M W'R
Theory M νR > M W'R
95% CL observed
95% CL expected
±1σ expected
±2σ expected
Invariant Mass Analysis
e+jets N b tags = 1 or 2
σ(pp→W'R) × B(W'R→tb→lνbb) [pb]
W' Mass [GeV]

Resonances @ 13 TeV

Resonances		
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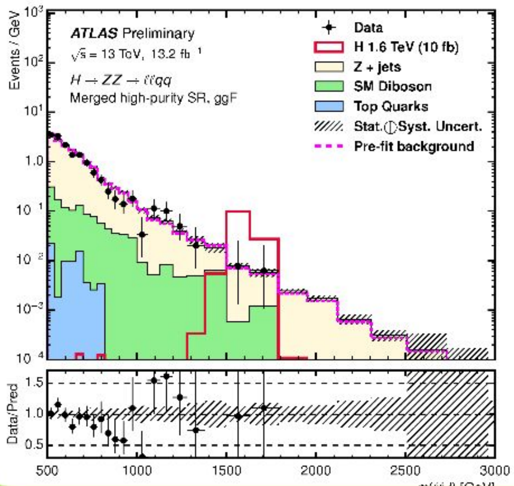
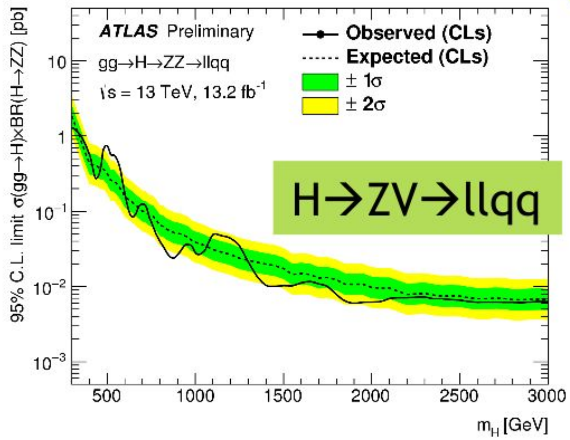
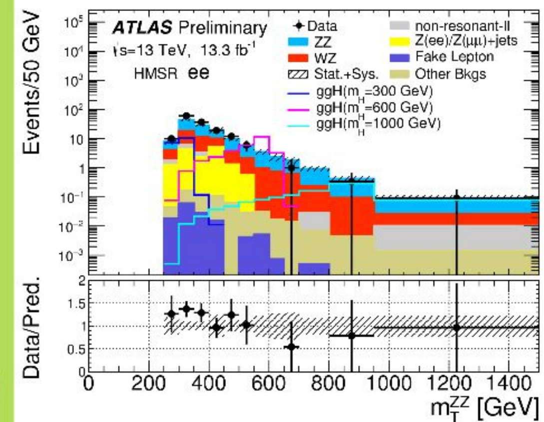
Single VLQ→Wb	2.3 fb^{-1} (CMS-PAS-B2G-16-006)	3.2 fb^{-1} (ATLAS-CONF-2016-072)

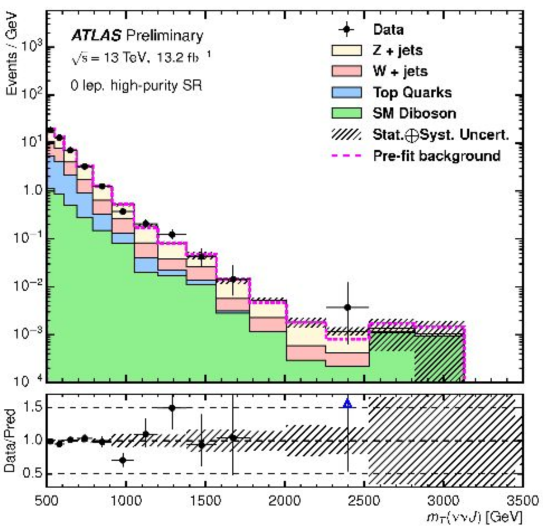
Heavy X→ vector bosons

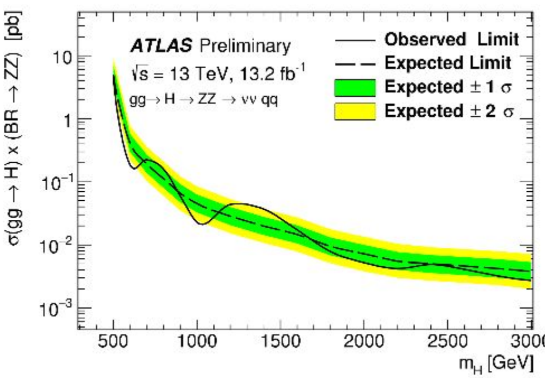
- Also sets limits on HVT W'→ WZ and RS graviton G*→ ZZ



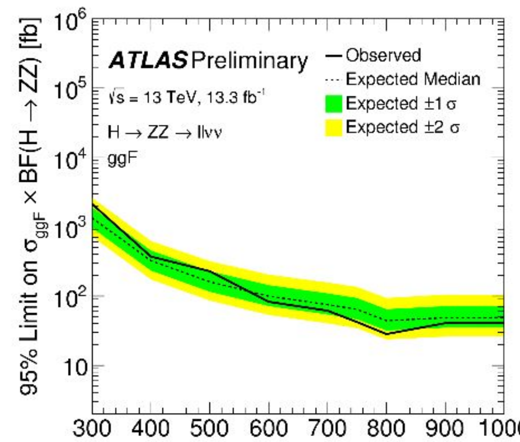








H→ZV→ννqq

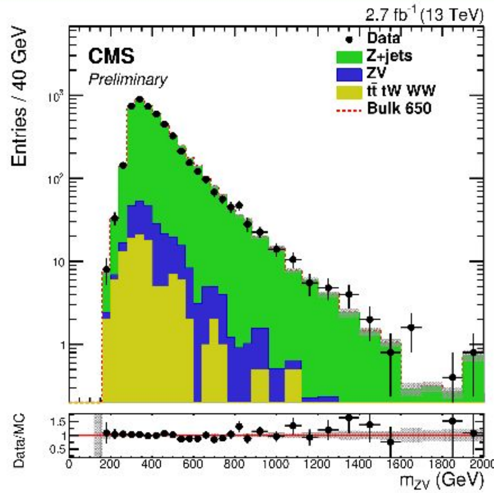


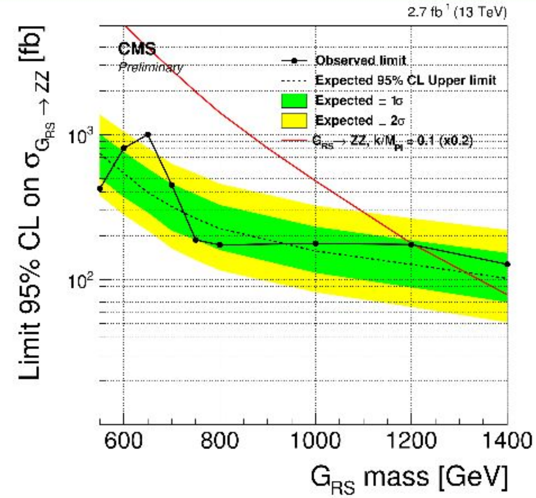
H→ZZ→ννll

Heavy X→ vector bosons

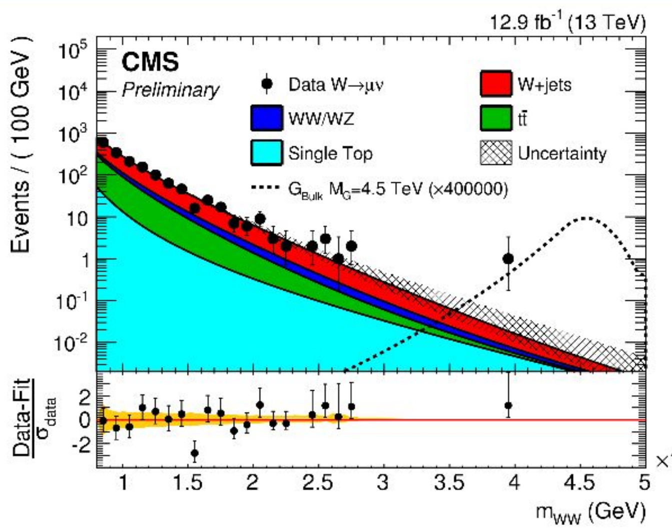
- Sets limits on G_{bulk} and RS graviton, G_{RS}

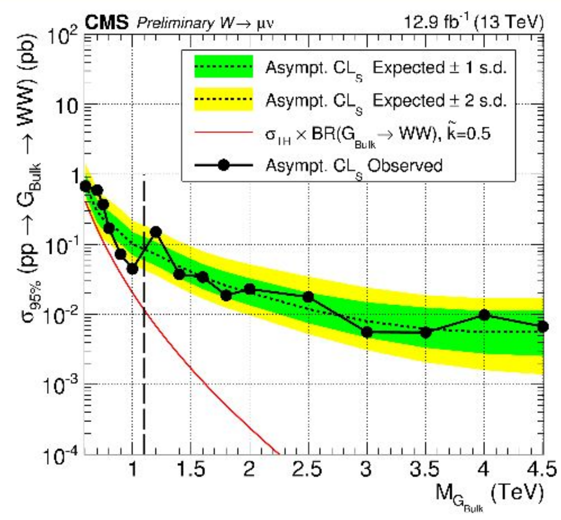
X→ZV→llqq



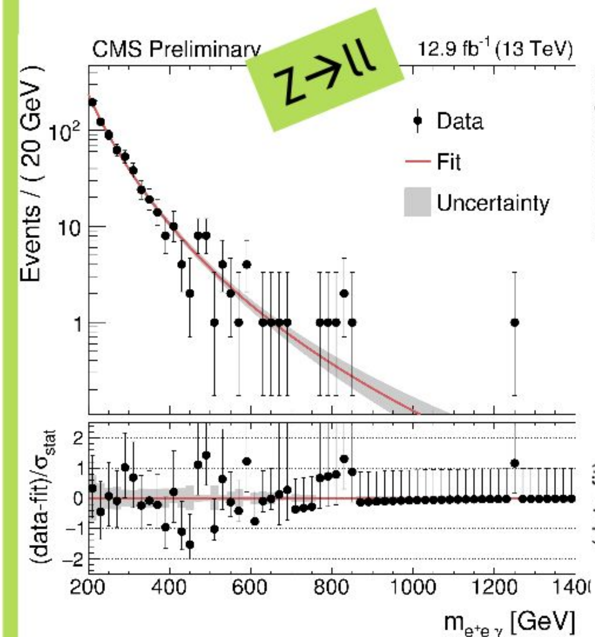


X→WV→lνqq

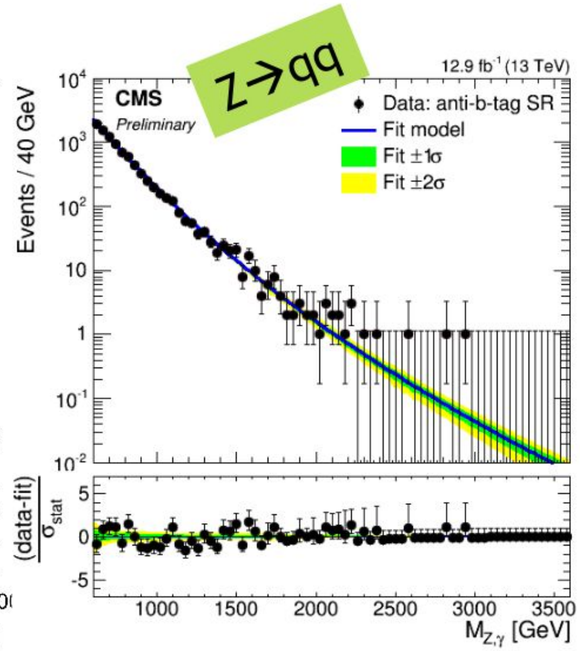




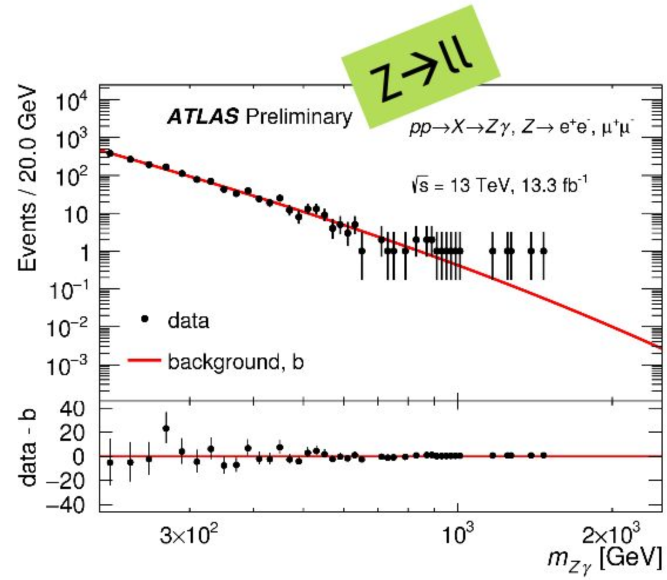
Zγ



CMS Preliminary
Z→ll
12.9 fb-1 (13 TeV)
Data
Fit
Uncertainty
Events / (20 GeV)
(data-fit)/σstat
me+e-γ [GeV]

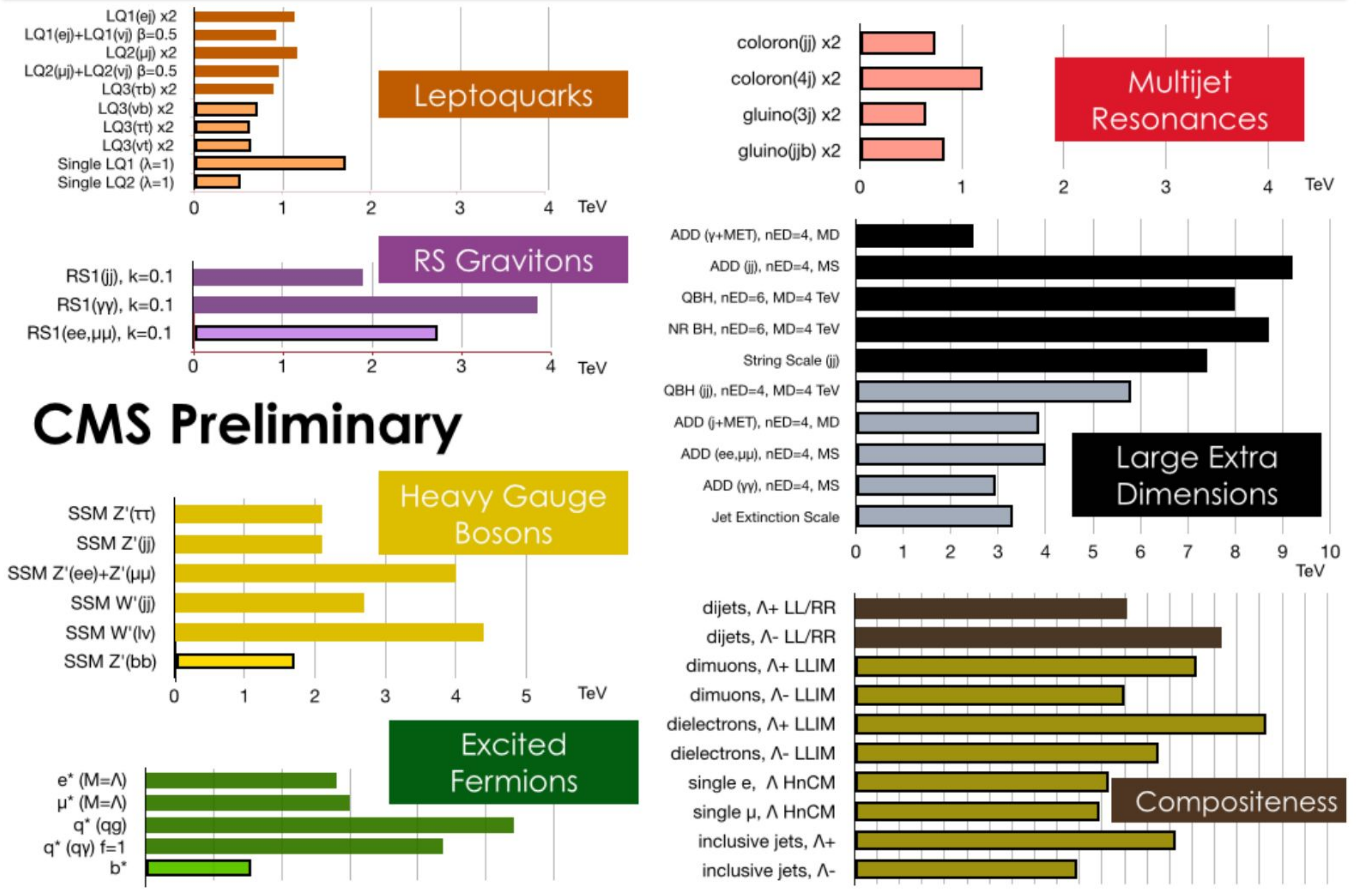


CMS
Preliminary
Z→qq
12.9 fb-1 (13 TeV)
Data: anti-b-tag SR
Fit model
Fit ±1σ
Fit ±2σ
Events / 40 GeV
(data-fit)/σstat
MZ,γ [GeV]



ATLAS Preliminary
Z→ll
pp→X→Zγ, Z→ e+e-, μ+μ-
√s = 13 TeV, 13.3 fb-1
data
background, b
Events / 20.0 GeV
data - b
mZγ [GeV]

Exotic searches



Many searches exceeded Run1 sensitivity

Exotic searches

ATLAS Exotics Searches* - 95% CL Exclusion

Status: August 2016

ATLAS Preliminary

$\int \mathcal{L}\, dt = (3.2 - 20.3)\ \mathrm{fb}^{-1}$

$\sqrt{s} = 8, 13$ TeV

	Model	ℓ, γ	Jets†	E_T^{miss}	$\int \mathcal{L}\, dt [fb^{-1}]$	Limit		Reference
Extra dimensions	ADD $G_{KK} + g/q$	–	≥ 1 j	Yes	3.2	M_D 6.58 TeV	$n = 2$	1604.07773
	ADD non-resonant $\ell\ell$	2 e, μ	–	–	20.3	M_S 4.7 TeV	$n = 3$ HLZ	1407.2410
	ADD QBH $\to \ell q$	1 e, μ	1 j	–	20.3	M_{th} 5.2 TeV	$n = 6$	1311.2006
	ADD QBH	–	2 j	–	15.7	M_{th} 8.7 TeV	$n = 6$	ATLAS-CONF-2016-069
	ADD BH high $\sum p_T$	≥ 1 e, μ	≥ 2 j	–	3.2	M_{th} 8.2 TeV	$n = 6$, $M_D = 3$ TeV, rot BH	1606.02265
	ADD BH multijet	–	≥ 3 j	–	3.6	M_{th} 9.55 TeV	$n = 6$, $M_D = 3$ TeV, rot BH	1512.02586
	RS1 $G_{KK} \to \ell\ell$	2 e, μ	–	–	20.3	G_{KK} mass 2.68 TeV	$k/\overline{M}_{Pl} = 0.1$	1405.4123
	RS1 $G_{KK} \to \gamma\gamma$	2 γ	–	–	3.2	G_{KK} mass 3.2 TeV	$k/\overline{M}_{Pl} = 0.1$	1606.03833
	Bulk RS $G_{KK} \to WW \to qq\ell\nu$	1 e, μ	1 J	Yes	13.2	G_{KK} mass 1.24 TeV	$k/\overline{M}_{Pl} = 1.0$	ATLAS-CONF-2016-062
	Bulk RS $G_{KK} \to HH \to bbbb$	–	4 b	–	13.3	G_{KK} mass 360-860 GeV	$k/\overline{M}_{Pl} = 1.0$	ATLAS-CONF-2016-049
	Bulk RS $g_{KK} \to tt$	1 e, μ	≥ 1 b, ≥ 1J/2j	Yes	20.3	g_{KK} mass 2.2 TeV	BR = 0.925	1505.07018
	2UED / RPP	1 e, μ	≥ 2 b, ≥ 4 j	Yes	3.2	KK mass 1.46 TeV	Tier (1,1), BR$(A^{(1,1)} \to tt) = 1$	ATLAS-CONF-2016-013
Gauge bosons	SSM $Z' \to \ell\ell$	2 e, μ	–	–	13.3	Z' mass 4.05 TeV		ATLAS-CONF-2016-045
	SSM $Z' \to \tau\tau$	2 τ	–	–	19.5	Z' mass 2.02 TeV		1502.07177
	Leptophobic $Z' \to bb$	–	2 b	–	3.2	Z' mass 1.5 TeV		1603.08791
	SSM $W' \to \ell\nu$	1 e, μ	–	Yes	13.3	W' mass 4.74 TeV		ATLAS-CONF-2016-061
	HVT $W' \to WZ \to qq\nu\nu$ model A	0 e, μ	1 J	Yes	13.2	W' mass 2.4 TeV	$g_V = 1$	ATLAS-CONF-2016-082
	HVT $W' \to WZ \to qqqq$ model B	–	2 J	–	15.5	W' mass 3.0 TeV	$g_V = 3$	ATLAS-CONF-2016-055
	HVT $V' \to WH/ZH$ model B	multi-channel			3.2	V' mass 2.31 TeV	$g_V = 3$	1607.05621
	LRSM $W'_R \to tb$	1 e, μ	2 b, 0-1 j	Yes	20.3	W' mass 1.92 TeV		1410.4103
	LRSM $W'_R \to tb$	0 e, μ	≥ 1 b, 1 J	–	20.3	W' mass 1.76 TeV		1408.0886
CI	CI $qqqq$	–	2 j	–	15.7	Λ 19.9 TeV	$\eta_{LL} = -1$	ATLAS-CONF-2016-069
	CI $\ell\ell qq$	2 e, μ	–	–	3.2	Λ 25.2 TeV	$\eta_{LL} = -1$	1607.03669
	CI $uutt$	2(SS)/≥3 e,μ	≥1 b, ≥1 j	Yes	20.3	Λ 4.9 TeV	$\lvert C_{RR}\rvert = 1$	1504.04605
DM	Axial-vector mediator (Dirac DM)	0 e, μ	≥ 1 j	Yes	3.2	m_A 1.0 TeV	g_q=0.25, g_χ=1.0, $m(\chi) < 250$ GeV	1604.07773
	Axial-vector mediator (Dirac DM)	0 e, μ, 1 γ	1 j	Yes	3.2	m_A 710 GeV	g_q=0.25, g_χ=1.0, $m(\chi) < 150$ GeV	1604.01306
	$ZZ_{\chi\chi}$ EFT (Dirac DM)	0 e, μ	1 J, ≤ 1 j	Yes	3.2	M_* 550 GeV	$m(\chi) < 150$ GeV	ATLAS-CONF-2015-080
LQ	Scalar LQ 1st gen	2 e	≥ 2 j	–	3.2	LQ mass 1.1 TeV	$\beta = 1$	1605.06035
	Scalar LQ 2nd gen	2 μ	≥ 2 j	–	3.2	LQ mass 1.05 TeV	$\beta = 1$	1605.06035
	Scalar LQ 3rd gen	1 e, μ	≥1 b, ≥3 j	Yes	20.3	LQ mass 640 GeV	$\beta = 0$	1508.04735
Heavy quarks	VLQ $TT \to Ht + X$	1 e, μ	≥ 2 b, ≥ 3 j	Yes	20.3	T mass 855 GeV	T in (T,B) doublet	1505.04306
	VLQ $YY \to Wb + X$	1 e, μ	≥ 1 b, ≥ 3 j	Yes	20.3	Y mass 770 GeV	Y in (B,Y) doublet	1505.04306
	VLQ $BB \to Hb + X$	1 e, μ	≥ 2 b, ≥ 3 j	Yes	20.3	B mass 735 GeV	isospin singlet	1505.04306
	VLQ $BB \to Zb + X$	2/≥3 e, μ	≥2/≥1 b	–	20.3	B mass 755 GeV	B in (B,Y) doublet	1409.5500
	VLQ $QQ \to WqWq$	1 e, μ	≥ 4 j	Yes	20.3	Q mass 690 GeV		1509.04261
	VLQ $T_{5/3} T_{5/3} \to WtWt$	2(SS)/≥3 e,μ	≥1 b, ≥1 j	Yes	3.2	$T_{5/3}$ mass 990 GeV		ATLAS-CONF-2016-032
Excited fermions	Excited quark $q^* \to q\gamma$	1 γ	1 j	–	3.2	q^* mass 4.4 TeV	only u^* and d^*, $\Lambda = m(q^*)$	1512.05910
	Excited quark $q^* \to qg$	–	2 j	–	15.7	q^* mass 5.6 TeV	only u^* and d^*, $\Lambda = m(q^*)$	ATLAS-CONF-2016-069
	Excited quark $b^* \to bg$	–	1 b, 1 j	–	8.8	b^* mass 2.3 TeV		ATLAS-CONF-2016-060
	Excited quark $b^* \to Wt$	1 or 2 e, μ	1 b, 2-0 j	Yes	20.3	b^* mass 1.5 TeV	$f_g = f_L = f_R = 1$	1510.02664
	Excited lepton ℓ^*	3 e, μ	–	–	20.3	ℓ^* mass 3.0 TeV	$\Lambda = 3.0$ TeV	1411.2921
	Excited lepton ν^*	3 e, μ, τ	–	–	20.3	ν^* mass 1.6 TeV	$\Lambda = 1.6$ TeV	1411.2921
Other	LSTC $a_T \to W\gamma$	1 e, μ, 1 γ	–	Yes	20.3	a_T mass 960 GeV		1407.8150
	LRSM Majorana ν	2 e, μ	2 j	–	20.3	N^0 mass 2.0 TeV	$m(W_R) = 2.4$ TeV, no mixing	1506.06020
	Higgs triplet $H^{\pm\pm} \to ee$	2 e (SS)	–	–	13.9	$H^{\pm\pm}$ mass 570 GeV	DY production, BR$(H_L^{\pm\pm} \to ee)$=1	ATLAS-CONF-2016-051
	Higgs triplet $H^{\pm\pm} \to \ell\tau$	3 e, μ, τ	–	–	20.3	$H^{\pm\pm}$ mass 400 GeV	DY production, BR$(H_L^{\pm\pm} \to \ell\tau)$=1	1411.2921
	Monotop (non-res prod)	1 e, μ	1 b	Yes	20.3	spin-1 invisible particle mass 657 GeV	$a_{non-res} = 0.2$	1410.5404
	Multi-charged particles	–	–	–	20.3	multi-charged particle mass 785 GeV	DY production, $\lvert q\rvert = 5e$	1504.04188
	Magnetic monopoles	–	–	–	7.0	monopole mass 1.34 TeV	DY production, $\lvert g\rvert = 1 g_D$, spin 1/2	1509.08059

$\sqrt{s}$ = 8 TeV | $\sqrt{s}$ = 13 TeV

10^{-1} 1 10 **Mass scale [TeV]**

*Only a selection of the available mass limits on new states or phenomena is shown. Lower bounds are specified only when explicitly not excluded.

†Small-radius (large-radius) jets are denoted by the letter j (J).

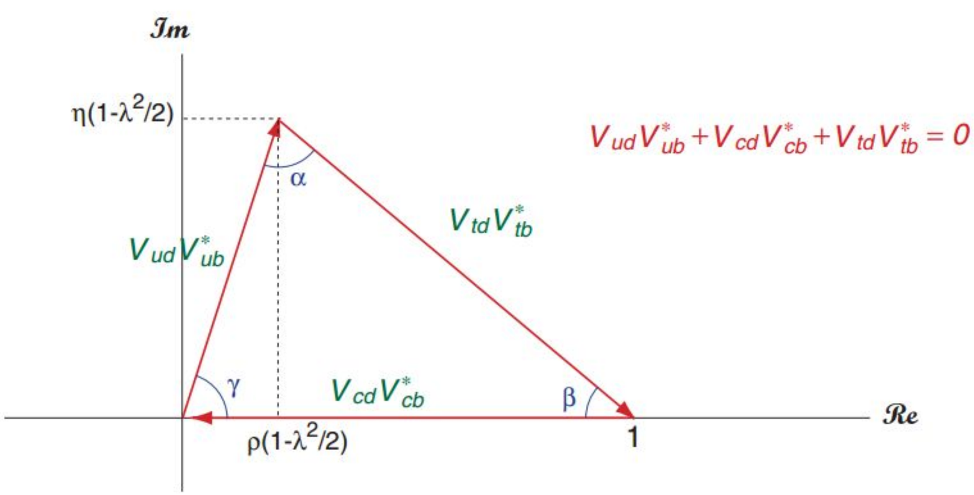
About 50% of the searches updated in Run 2

LHCb

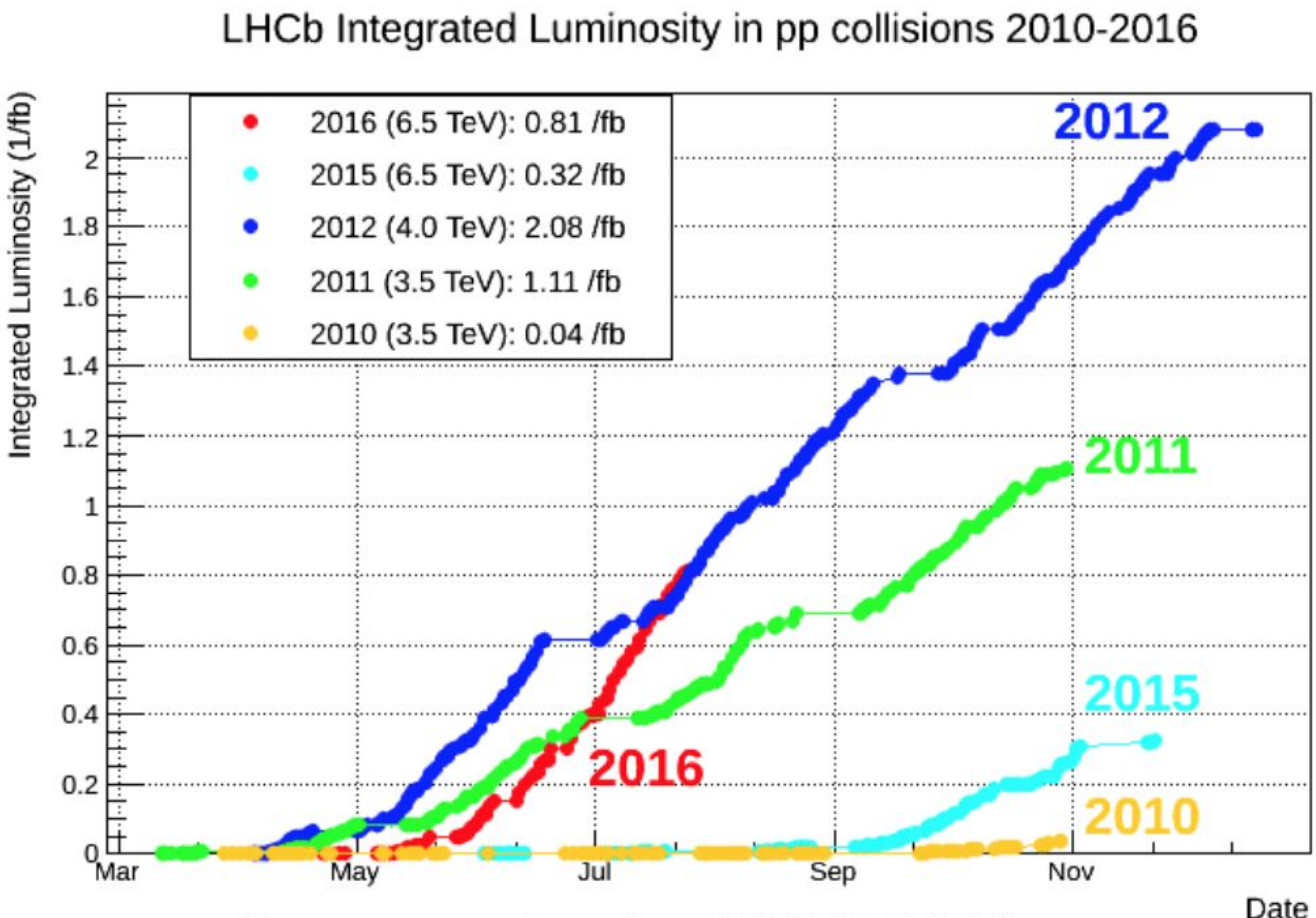
Vincenzo Vagnoni's plenary talk
INFN - Bologna

$$\begin{pmatrix} d' \\ s' \\ b' \end{pmatrix} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \begin{pmatrix} d \\ s \\ b \end{pmatrix} = \hat{V}_{CKM} \begin{pmatrix} d \\ s \\ b \end{pmatrix}$$

$$\begin{pmatrix} 1-\frac{\lambda^2}{2} & \lambda & A\lambda^3(\rho - i\eta + i\eta\frac{\lambda^2}{2}) \\ -\lambda & 1-\frac{\lambda^2}{2} - i\eta A\lambda^4 & A\lambda^2(1+i\eta\lambda^2) \\ A\lambda^3(1-\rho-i\eta) & -A\lambda^2 & 1 \end{pmatrix}$$



LHCb statistics



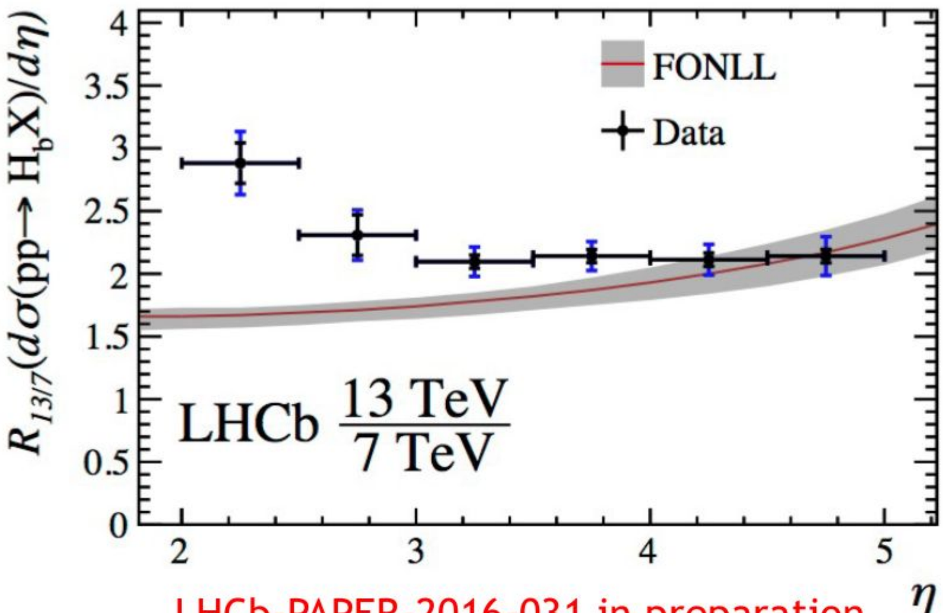
Data samples for ICHEP 2016:

- Run 1 (7+8 TeV): 3 fb^{-1}
- Run 2 (13 TeV): ~1.2 fb^{-1}

New results on flavor anomaly are expected soon

pp⟶bbX cross-section measurement

- Measurement of the cross-section for the process pp→bbX at both 7 and 13 TeV in 2 < η < 5 regions

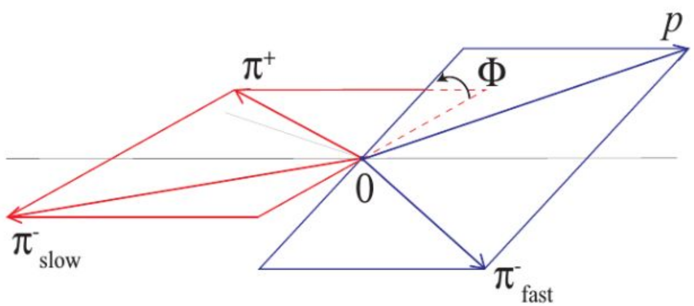


LHCb-PAPER-2016-031 in preparation

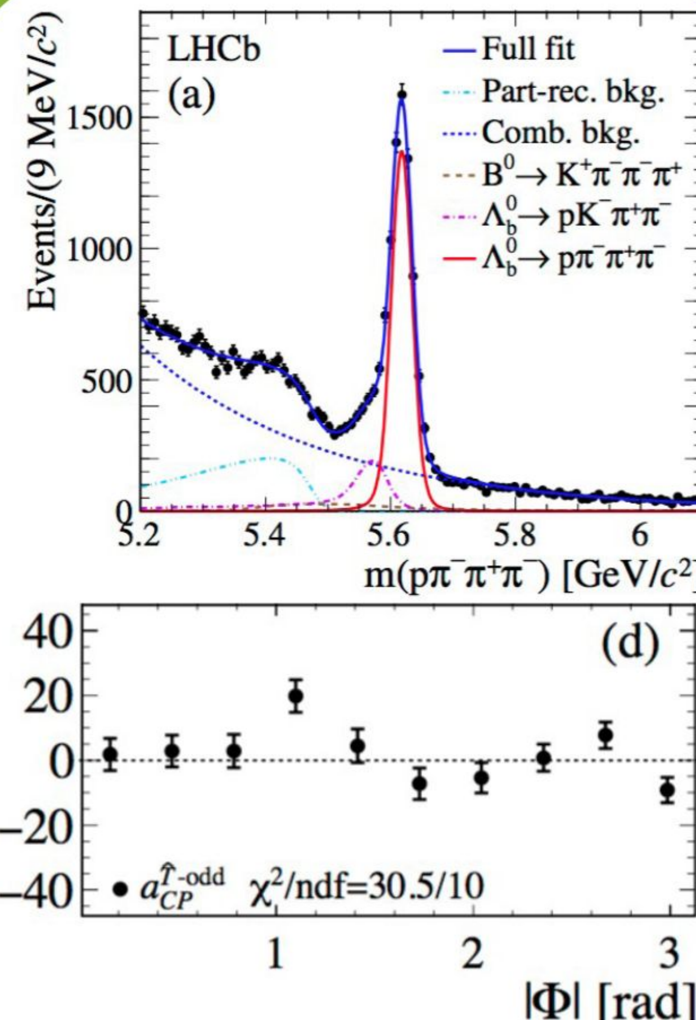
- The ratio of 13 to 7 TeV cross-sections appears to depart from FONLL theory predictions at low η [Cacciari et al., EPJ C75:610]
  - Calls for further theoretical progress
  - Upcoming measurements with exclusive decays will provide further inputs to drive theory developments

Λ_b decays and CP violation

- First evidence of CP violation in the baryon sector
- $\Lambda_b \rightarrow p\pi^-\pi^+\pi^-$
  - Use the relative orientation between the decay planes formed by the $p\pi^-$ and $\pi^+\pi^-$ systems (Φ)

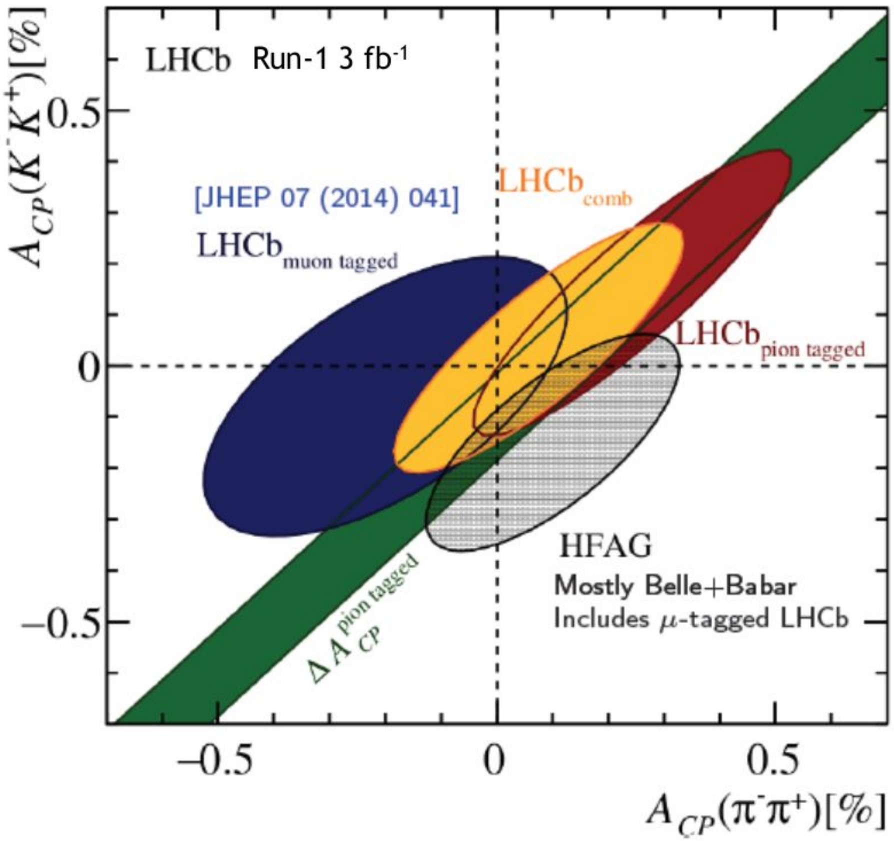


  - Evidence is found for CP violation at the 3.3σ level



LHCb-PAPER-2016-030 in preparation

Charm decays: CP violation ?



LHCb-PAPER-2016-035 (in preparation)

- CP violation expected to be tiny in charm
- Most precise measurement of $A_{CP}(D_0 \rightarrow K^+K^-)$
  - $A_{CP}(K^+K^-) = (0.14 \pm 0.15 \pm 0.10)\%$
- Combined with [PRL 116 (2016) 191601]:
  - Most precise CP violation measurement from a charm meson decay
  - $A_{CP}(K^+K^-) = (0.04 \pm 0.12 \pm 0.10)\%$
  - CP violation below the percent level in D^0 decays

Neutrinos

M. Sanchez's & A. de Gouvea plenary talks

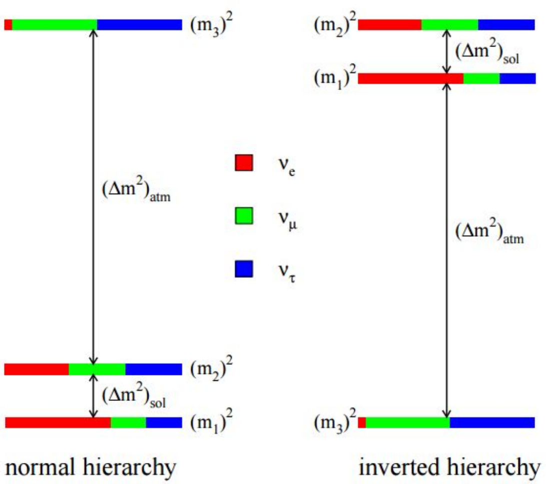
$$\begin{pmatrix} \nu_e \\ \nu_\mu \\ \nu_\tau \end{pmatrix} = \begin{pmatrix} U_{e1} & U_{e2} & U_{e3} \\ U_{\mu 1} & U_{\mu 2} & U_{\mu 3} \\ U_{\tau 1} & U_{e\tau 2} & U_{\tau 3} \end{pmatrix} \begin{pmatrix} \nu_1 \\ \nu_2 \\ \nu_3 \end{pmatrix}$$

Definition of neutrino mass eigenstates (who are ν_1, ν_2, ν_3?):

- $m_1^2 < m_2^2$ — $\Delta m_{13}^2 < 0$ – Inverted Mass Hierarchy
- $m_2^2 - m_1^2 < |m_3^2 - m_{1,2}^2|$ — $\Delta m_{13}^2 > 0$ – Normal Mass Hierarchy

$$\tan^2\theta_{12} \equiv \frac{|U_{e2}|^2}{|U_{e1}|^2}; \quad \tan^2\theta_{23} \equiv \frac{|U_{\mu 3}|^2}{|U_{\tau 3}|^2}; \quad U_{e3} \equiv \sin\theta_{13} e^{-i\delta}$$

Understanding Neutrino Oscillations: Are We There Yet?

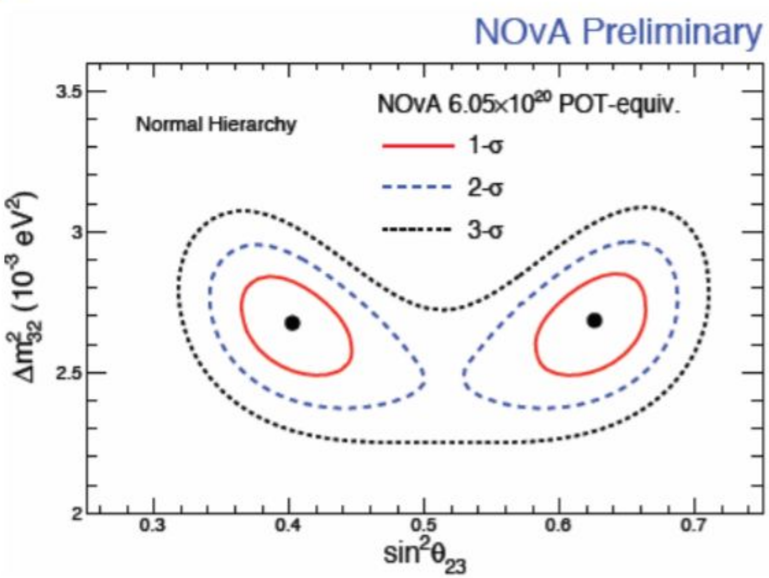


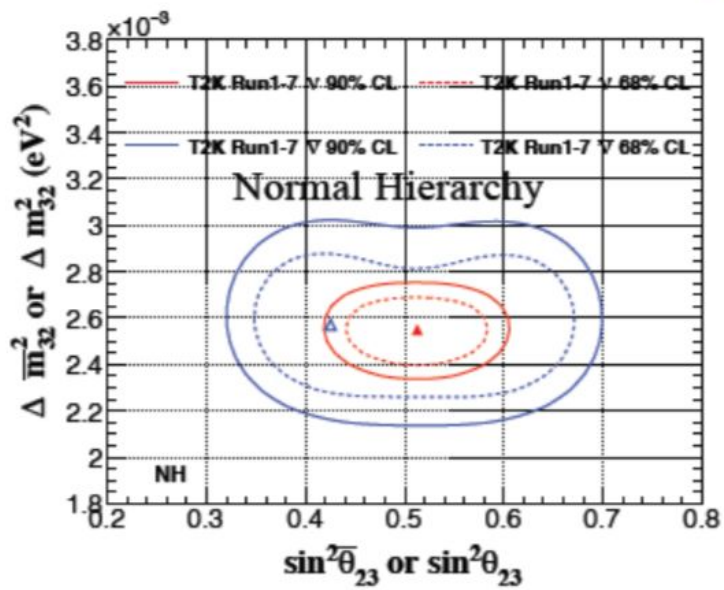
- ~~What is the ν_e component of ν_3?~~ ($\theta_{13} \neq 0$!)
- Is CP-invariance violated in neutrino oscillations? ($\delta \neq 0, \pi$?)
- Is ν_3 mostly ν_μ or ν_τ? ($\theta_{23} > \pi/4$, $\theta_{23} < \pi/4$, or $\theta_{23} = \pi/4$?)
- What is the neutrino mass hierarchy? ($\Delta m_{13}^2 > 0$?)

$\Rightarrow$ All of the above can "only" be addressed with new neutrino oscillation experiments

Muon neutrino disappearance results

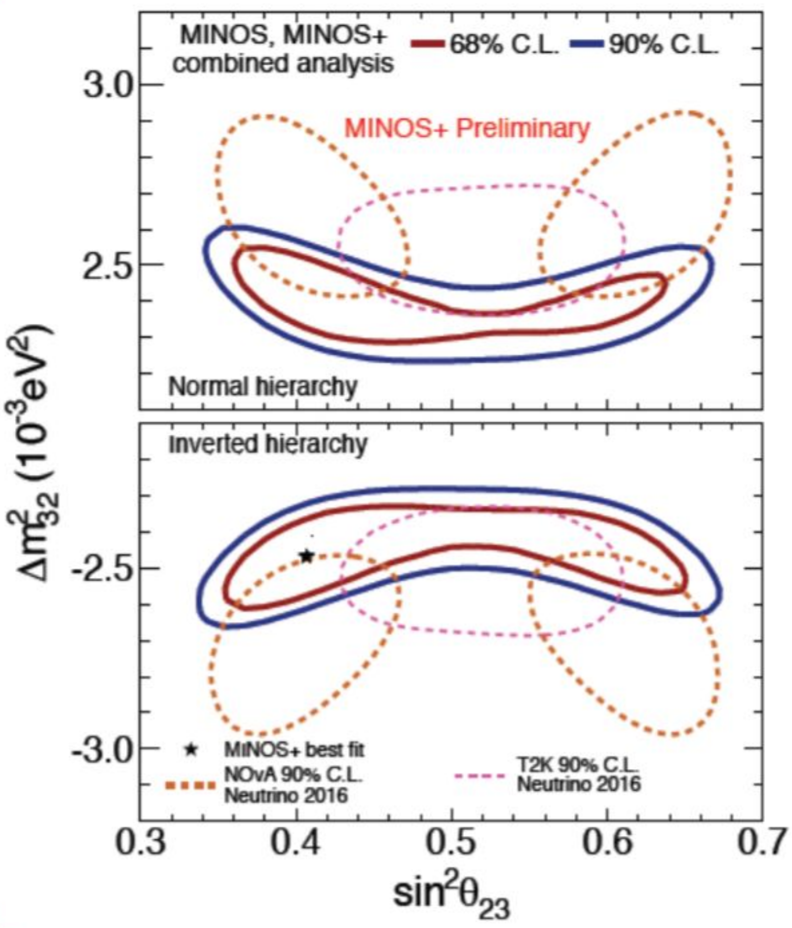
- NOvA observes hints of non maximal mixing
  - Maximal mixing excluded at 2.5σ
- T2K results are consistent with maximal mixing
  - Agrees with previous results from MINOS





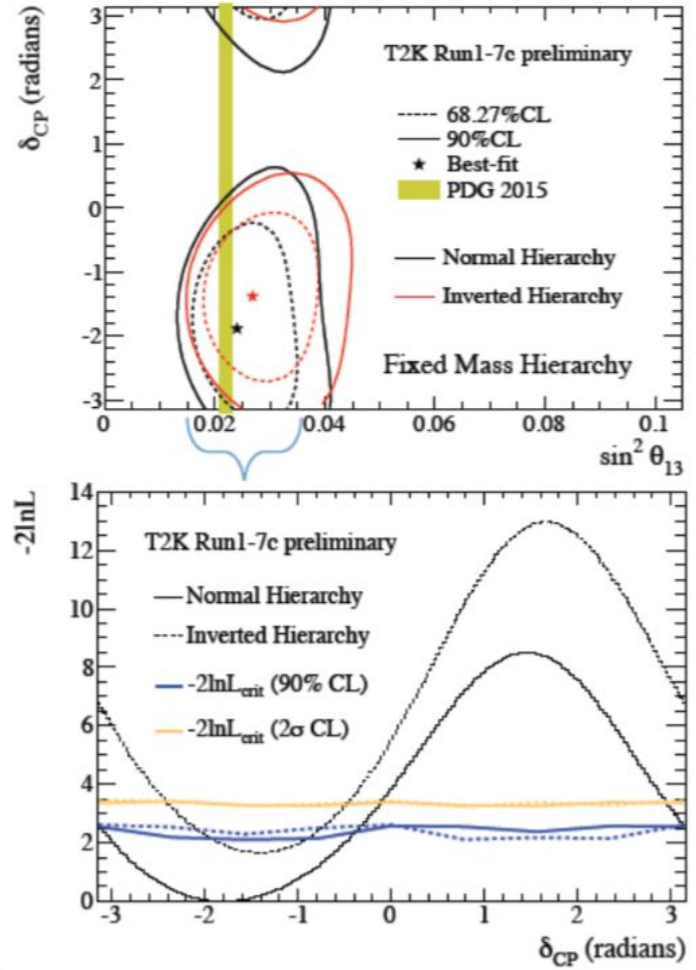
Muon neutrino disappearance results

- Small amount of tension between T2K's maximal and NOvA's non-maximal result
- More data should resolve this



Electron neutrino appearance results

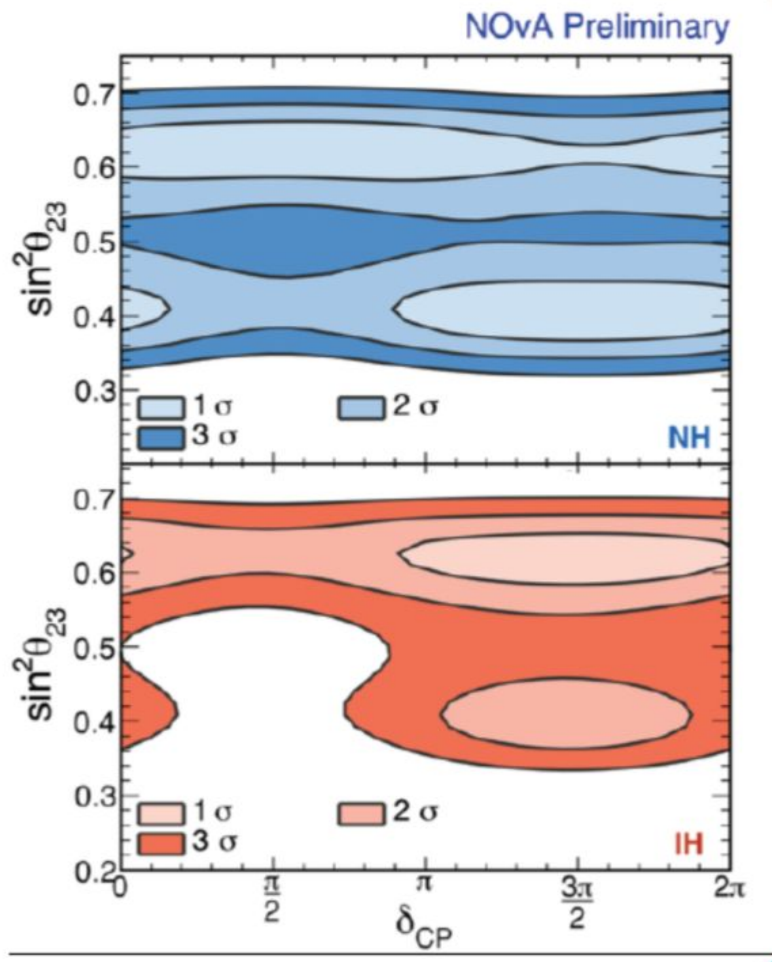
- T2K results consistent with the amount of appearance expected from information in reactors
- Combining with reactor and T2K's own muon neutrino disappearance data
- T2K does not find evidence of CPT
- And at 90% excludes δcp = 0 and π



INFN - Press release:
http://home.infn.it/it/comunicazione/news/1937-t2k-nuovi-risultati-sull-asimmetria-nelle-oscillazioni-dei-neutrini-e-degli-antineutrini-2

Electron neutrino appearance results

- NOvA observed electron neutrino appearance at > 8σ
- Excludes a CP region of inverted hierarchy for the lower octant
- Very small $\chi 2$ difference between IH and NH and both octants

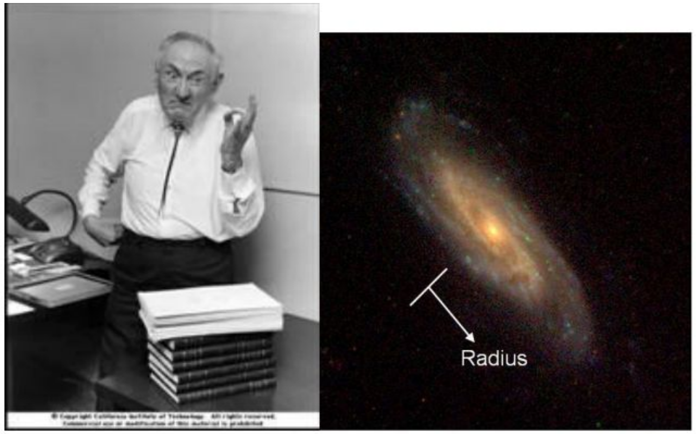


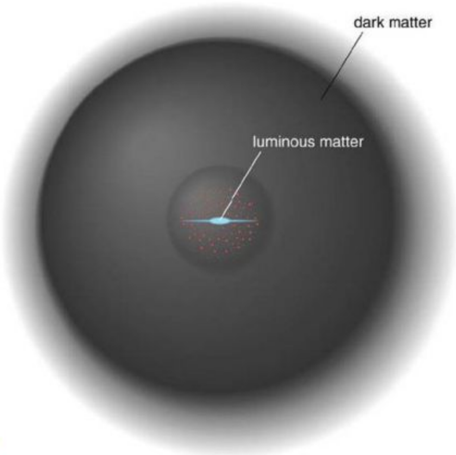
Dark Matter detection

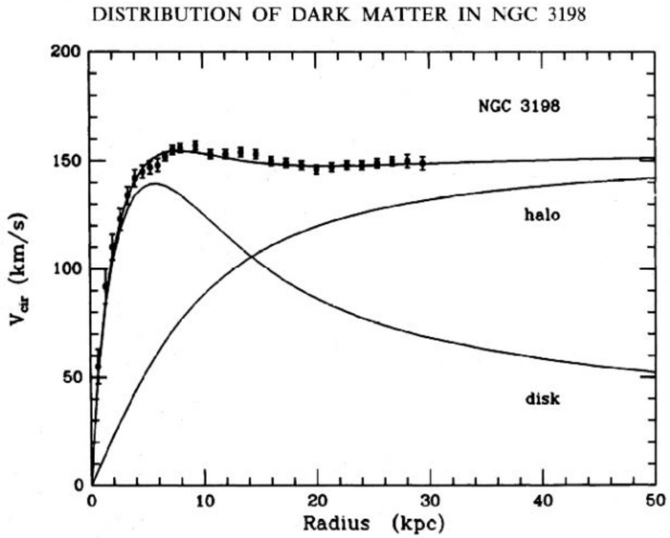
M. Boulay's plenary talk

The Dark Matter Problem

- Rotation curves measure the mass distribution
- Mass density distributed more broadly than visible objects
- Non-luminous halo required to describe rotation curves
- First found in 1933 by Zwicky from Coma Galaxy Cluster analysis

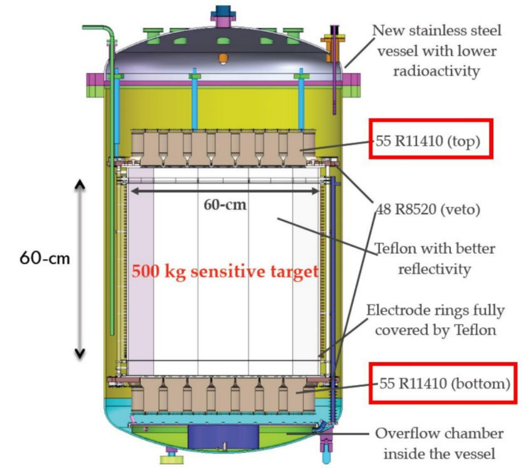






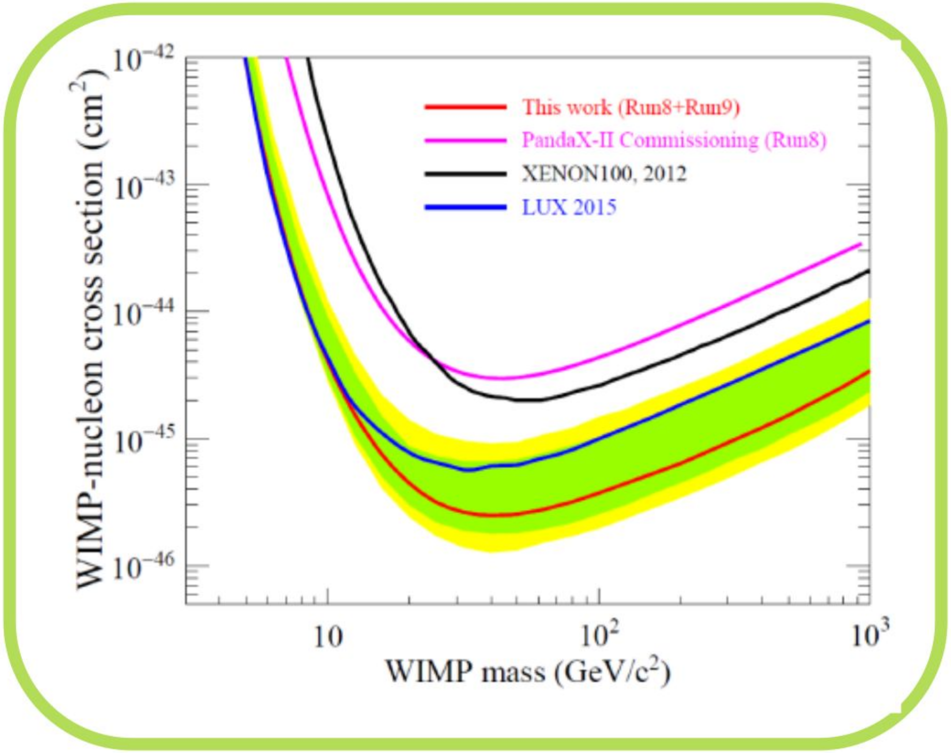
Mark B

Dark matter searches - PANDA-X



CJPL - Sichuan - China

- New results from PANDA-X II (2014-2017)
  - Many experimental improvements
  - Run 8+9 ~100 days exposure
  - A factor of 2 improvement at high mass compared with LUX 2015



Dark matter searches - LUX

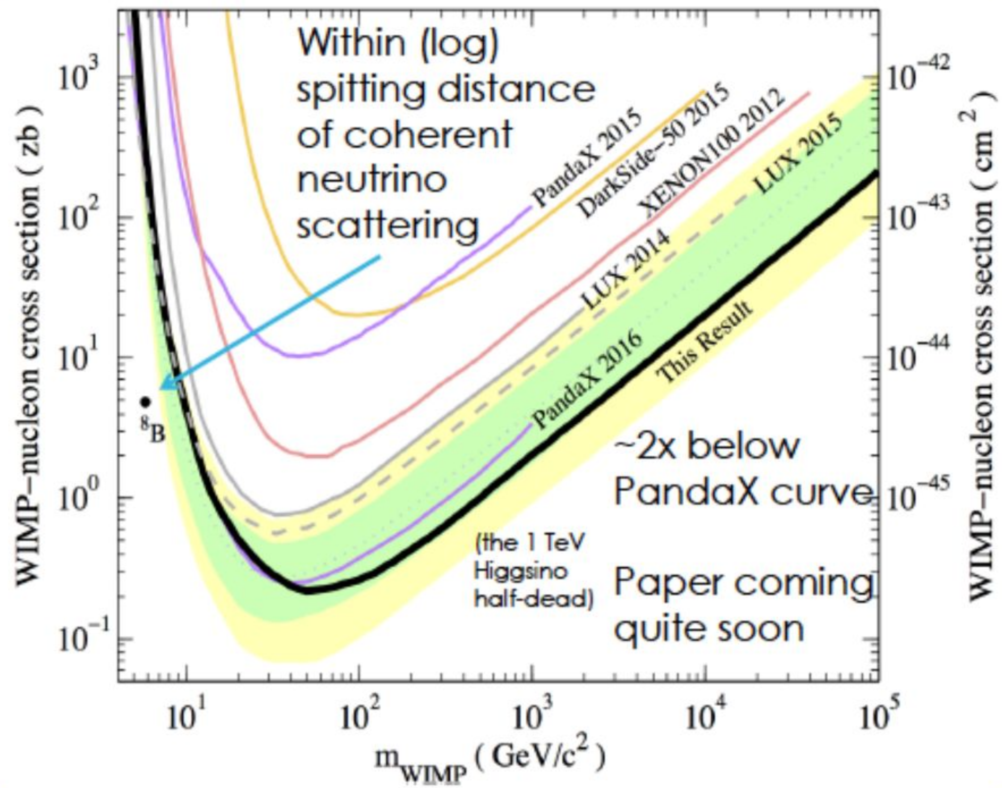
LUX Dark Matter

Welcome to the official website of the Large Underground Xenon dark matter experiment.
Our experiment is a 370 kg liquid xenon time-projection chamber that aims to directly detect galactic dark matter in an underground laboratory 1 mile under the earth, in the Black Hills of South Dakota, USA.

- LUX 2015 re-analysis of 3 months’ worth of data
  - Comparable at low mass but FOUR TIMES better at high mass

- 1 order of magnitude off XENON1T

- Within < 2 orders of LZ projection



Expect new results from XENON-1T and DEAP-3600

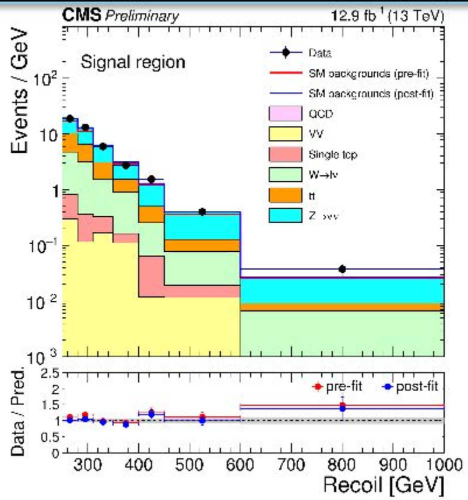
Dark Matter

Dark matter		
Monotop(had)	12.9 fb^{-1} (CMS-PAS-HIG-16-040)	
Jet/V(had)	12.9 fb^{-1} (CMS-PAS-HIG-16-037)	3.2 fb^{-1} (ATLAS-CONF-2016-080)*
γ	12.9 fb^{-1} (CMS-PAS-HIG-16-039)	
Z	12.9 fb^{-1} (CMS-PAS-HIG-16-038) (dil) 2.3 fb^{-1} (CMS-PAS-HIG-16-010) (dil)	13.3 fb^{-1} (ATLAS-CONF-2016-056)(dil)
H	2.3 fb^{-1} (CMS-PAS-HIG-16-012) (bb) 2.3 fb^{-1} (CMS-PAS-HIG-16-011) (γγ)	3.2 fb^{-1} (ATLAS-CONF-2016-019) (bb)* 13.3 fb^{-1} (ATLAS-CONF-2016-087) (γγ)
tt	2.3 fb^{-1} (CMS-PAS-EXO-16-005)	13.2 fb^{-1} (ATLAS-CONF-2016-050) (SUSY-l+jets) 13.3 fb^{-1} (ATLAS-CONF-2016-076) (SUSY- dil) 13.3 fb^{-1} (ATLAS-CONF-2016-077) (SUSY- alljets)
bb	2.17 fb^{-1} (CMS-PAS-B2G-15-007)*	13.3 fb^{-1} (ATLAS-CONF-2016-086)

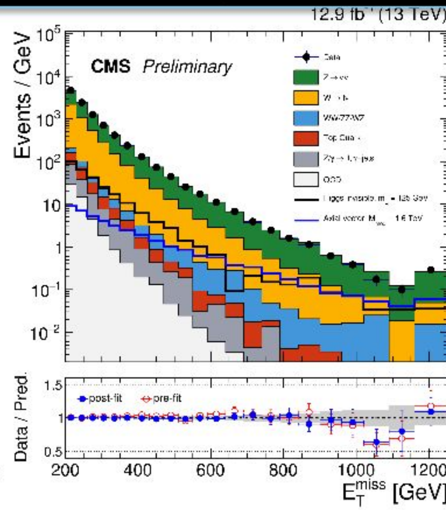
Dark matter

- Search in imbalance transverse spectrum in many topologies

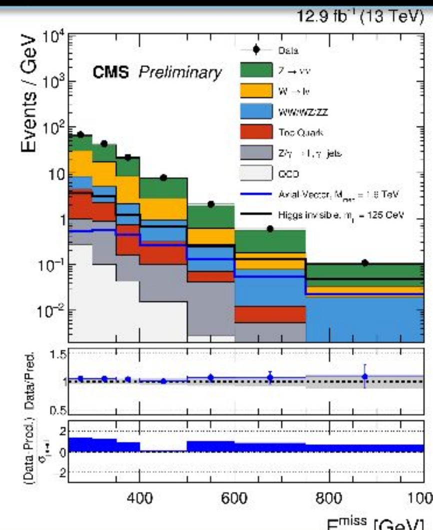
Mono-top(had,boosted)



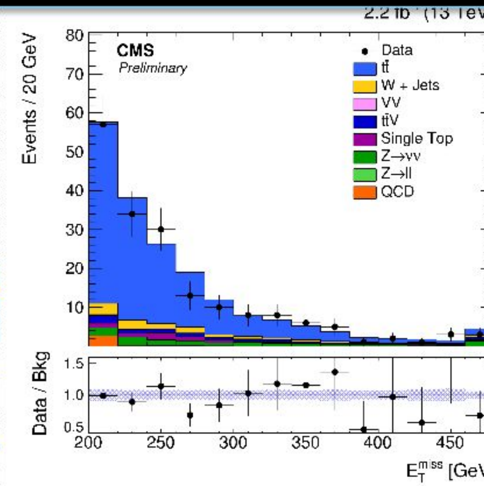
Mono-V(had,boosted)



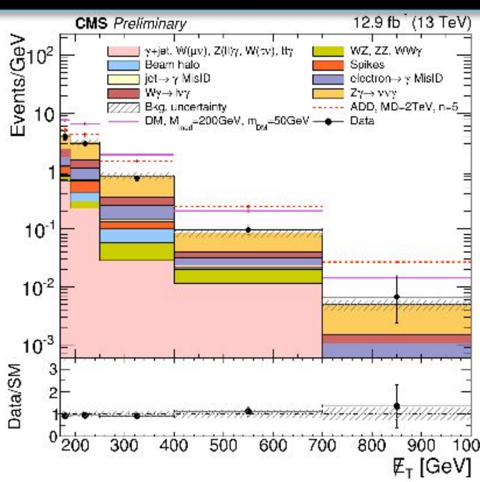
Mono-jet



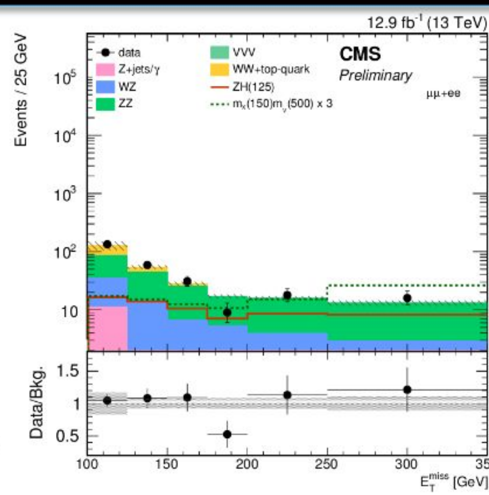
MET+tt



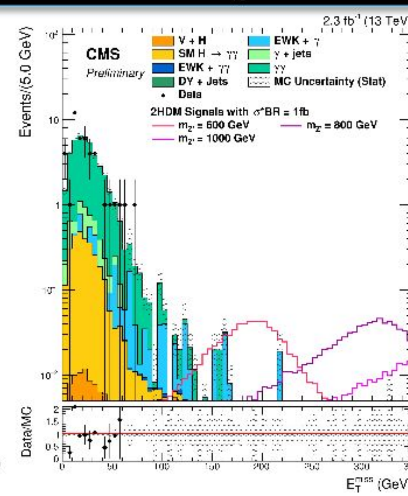
Mono-photon



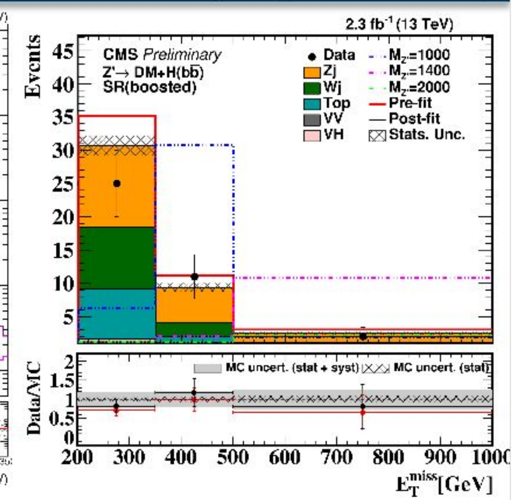
Mono-Z (dilepton)



Mono-H(photons)



Mono-H(bb, boosted)



Conclusions

- Very large and comprehensive conference
- Lot's of new results from LHC experiments
  - High lumi accumulated at 13 TeV in 2016
  - No sign of new physics (unfortunately)
- Very interesting results and exciting perspectives
  - Neutrino physics
  - Gravitational waves
  - Dark matter

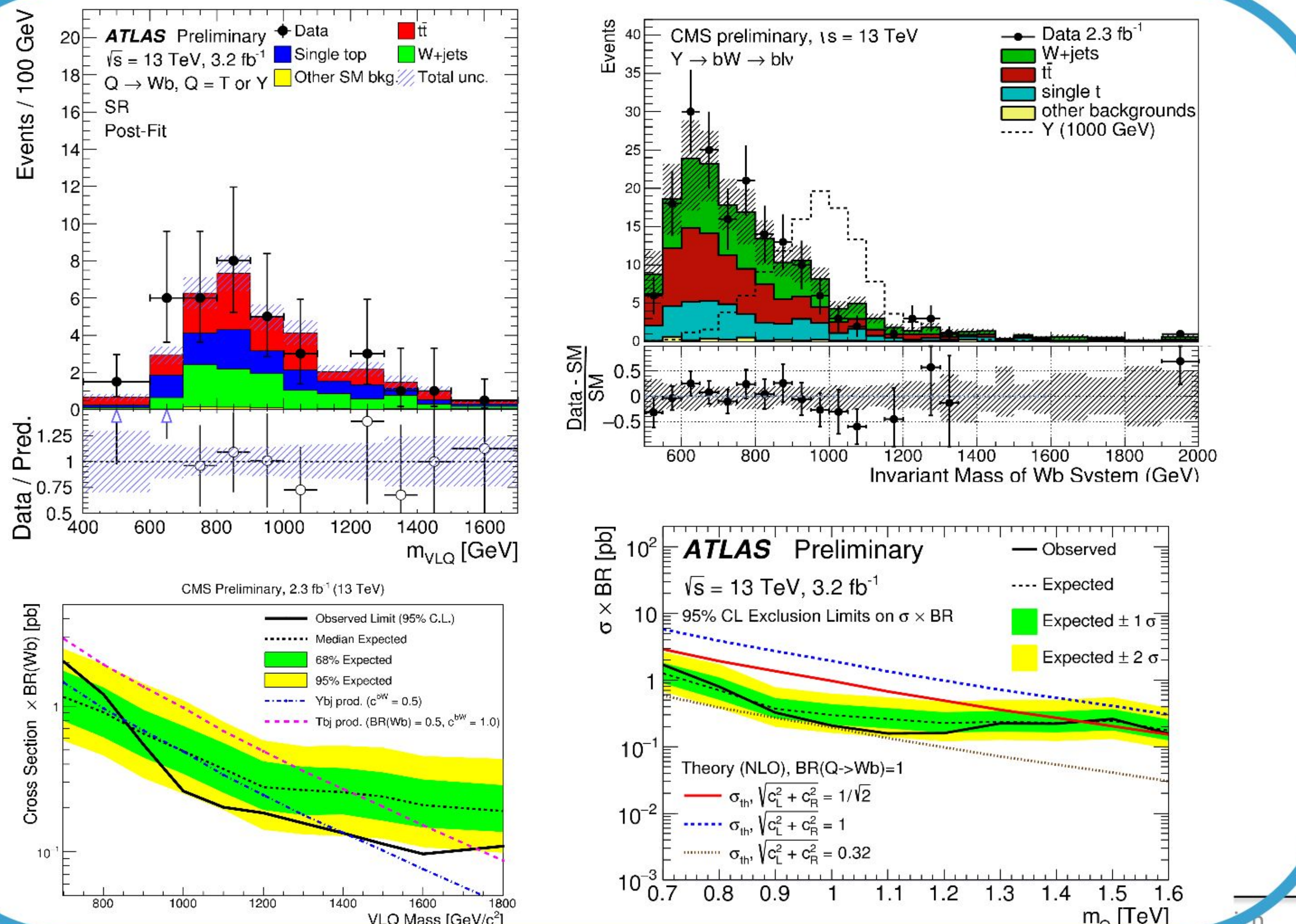
- EPS July 5-12, 2017 Venice, Italy
- ICHEP: July 4-11, Seul 2018, Korea

Backup

Resonances @ 13 TeV

Resonances		
dilepton	12.4 fb^{-1} (CMS-PAS-EXO-16-031)	13.3 fb^{-1} (ATLAS-CONF-2016-045) 13.9 fb^{-1} (ATLAS-CONF-2016-051)
lepton+ν	2.2 fb^{-1} (CMS-PAS-EXO-15-006)*	13.3 fb^{-1} (ATLAS-CONF-2016-061)
dijet	12.9 fb^{-1} (CMS-PAS-EXO-16-032)	12.9 fb^{-1} (ATLAS-CONF-2016-069) 15.5 fb^{-1} (ATLAS-CONF-2016-070)
diphoton	12.9 fb^{-1} (CMS-PAS-EXO-16-027)	12.2 fb^{-1} (ATLAS-CONF-2016-059)
tb	12.9 fb^{-1} (CMS-PAS-B2G-16-017)	
Dibosons (with V=W,Z)		
$ZZ \to ll\nu\nu$	2.3 fb^{-1} (CMS-PAS-HIG-16-001)*	13.3 fb^{-1} (ATLAS-CONF-2016-056)
$ZV \to llqq$	2.7 fb^{-1} (CMS-PAS-B2G-16-010)	13.2 fb^{-1} (ATLAS-CONF-2016-082)
$VZ \to qq\nu\nu$		13.2 fb^{-1} (ATLAS-CONF-2016-082)
$WV \to l\nu qq$	12.9 fb^{-1} (CMS-PAS-B2G-16-020)	13.2 fb^{-1} (ATLAS-CONF-2016-062)
$Z\gamma$	12.9 fb^{-1} (CMS-PAS-EXO-16-034)	13.3 fb^{-1} (ATLAS-CONF-2016-044)
$Z(qq)\gamma$	12.9 fb^{-1} (CMS-PAS-EXO-16-035)	3.2 fb^{-1} (arXiv:1607.06363)*
$VV \to qqqq$		15.5 fb^{-1} (ATLAS-CONF-2016-055)
$VH \to qqbb$		13.3 fb^{-1} (ATLAS-CONF-2016-083)
Vector like quarks		
Single VLQ→Zt	2.3 fb^{-1} (CMS-PAS-B2G-16-001)	
Single VLQ→Wb	2.3 fb^{-1} (CMS-PAS-B2G-16-006)	3.2 fb^{-1} (ATLAS-CONF-2016-072)

VLQ →Wb



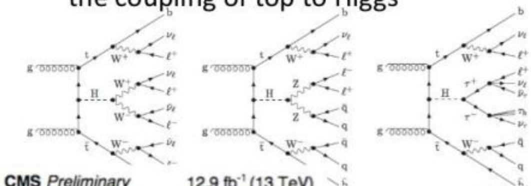
Vector-Like Quark

VLQ - Spin 1/2, colored, charged particles with both left- and right-handed coupling to charged currents.

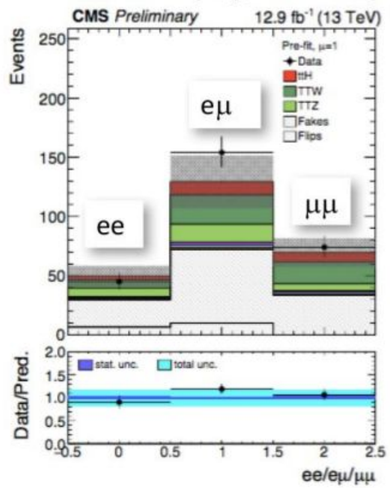
Summer highlights: ttH at 13 TeV

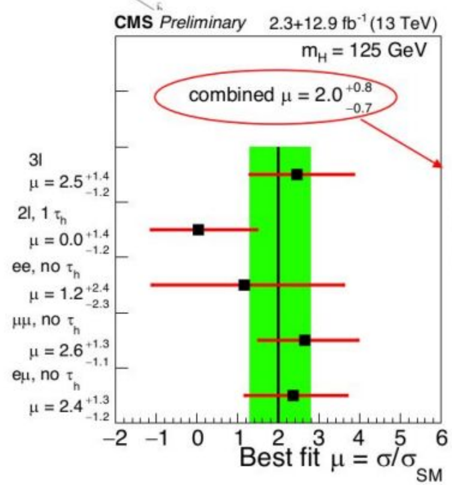
- **Multileptonic channel: HIG-16-022**

Important to study directly
the coupling of top to Higgs



Looking for final states with H decay to ZZ,WW and ττ (yielding events with 2-3 leptons).



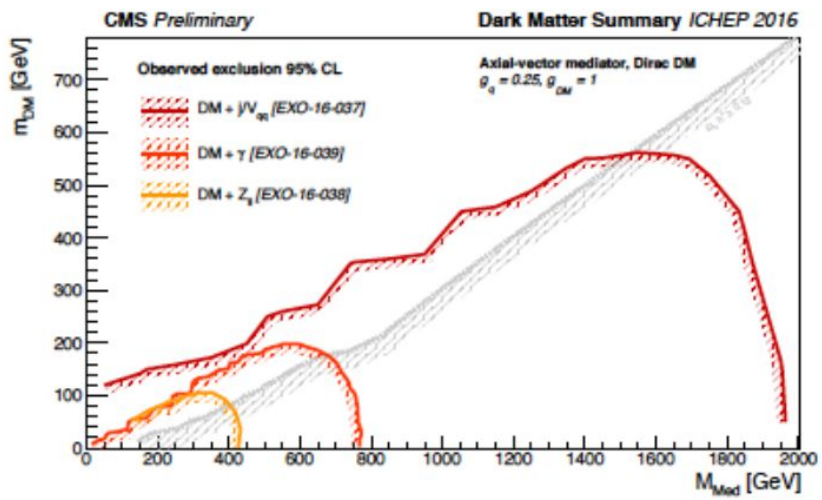


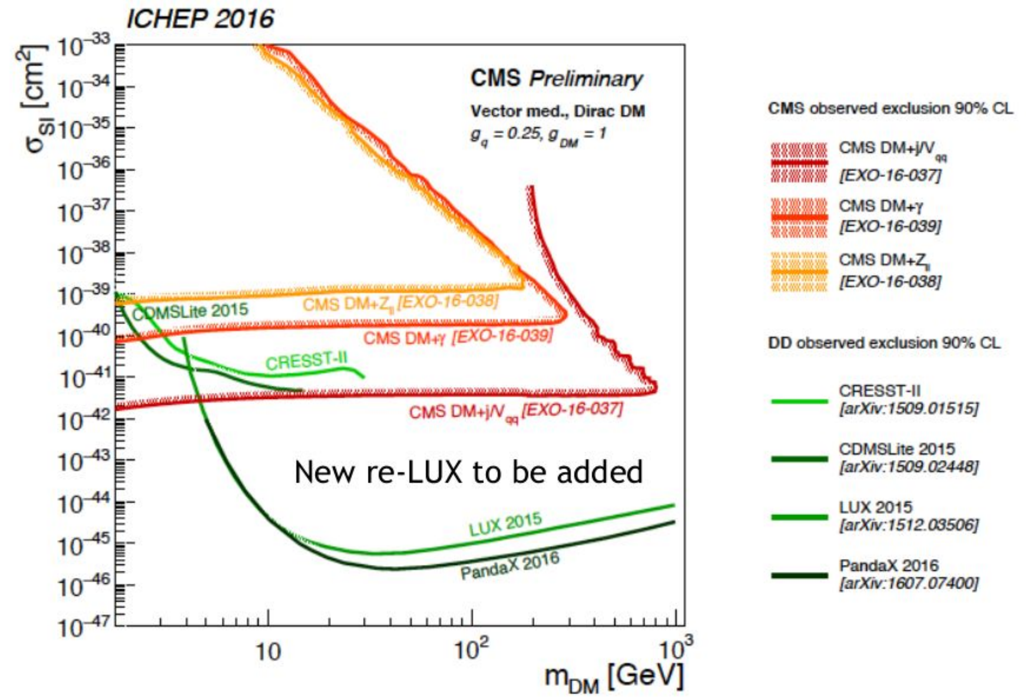
$\mu = 2.0^{+0.8}_{-0.7}$
within statistics, compatible with SM

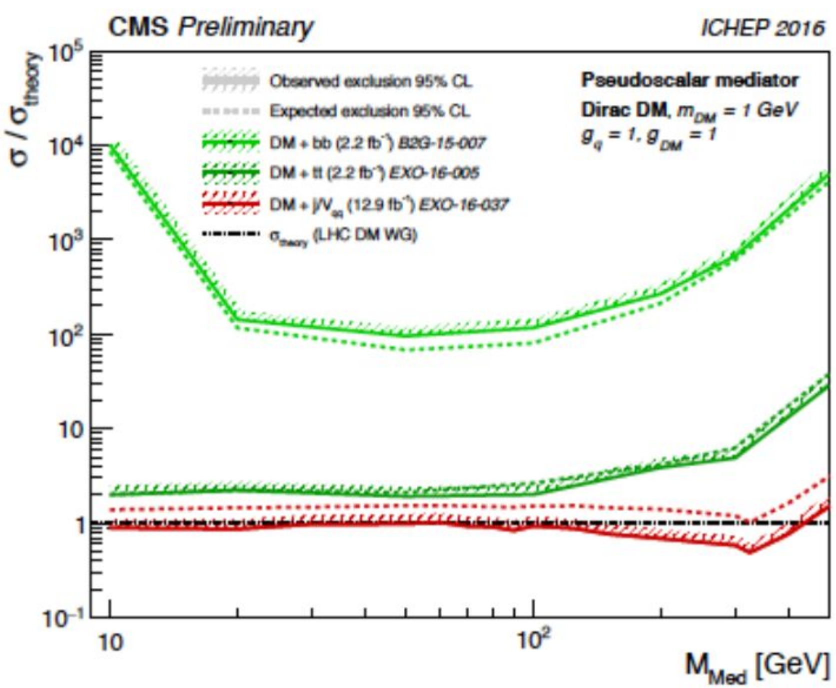
14

- **ATLAS also gets a small excess at 13 TeV (in multileptons and also h->bbbar)**

Dark matter







- A coherent picture of DM
- 20% to factor of 2 improvement in mediator mass or new physic energy scale w.r.t. Moriond ?
- No significant excess observed so far
- DM mass exclusion up to ~550 GeV
- Vector Mediator mass exclusion up to 1.95 TeV
- [CMS-DP-2016-057]