Latest results from ATLAS and CMS

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Outline

- LHC and ATLAS/CMS status
- Physics Results(*)
  - Higgs
  - SM Physics
  - SUSY and Exotica
- Outlook and Summary

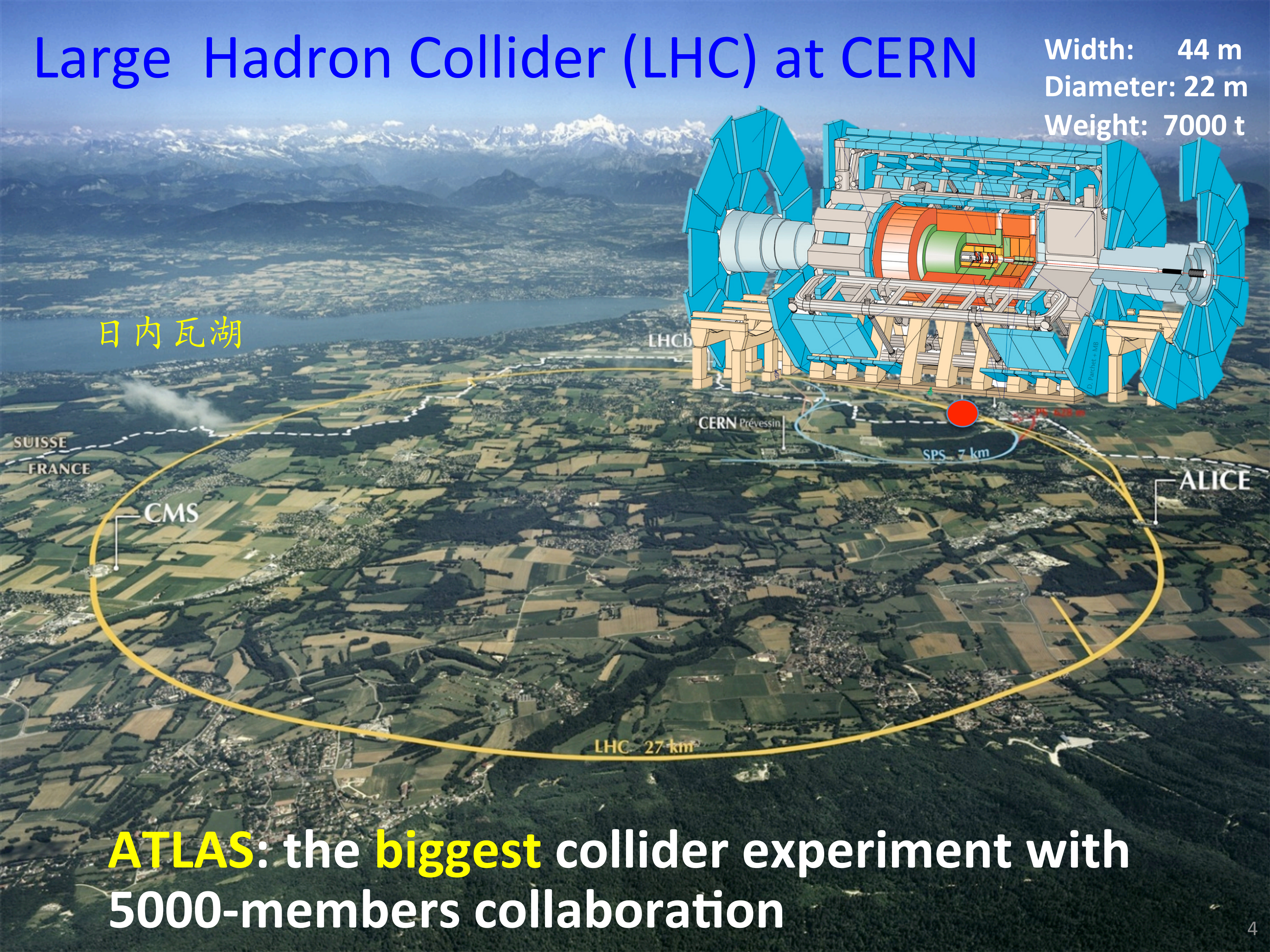
(*)因时间有限，将侧重于最新的物理结果，以及有中国组贡献的重要结果。难免疏漏，敬请见谅！

Large Hadron Collider (LHC) at CERN

周长27km，跨越瑞士法国国境，位于地下100米
世界上最大、能量最高(质心系能量13TeV)、最贵(～44亿美元)的加速器

Large Hadron Collider (LHC) at CERN

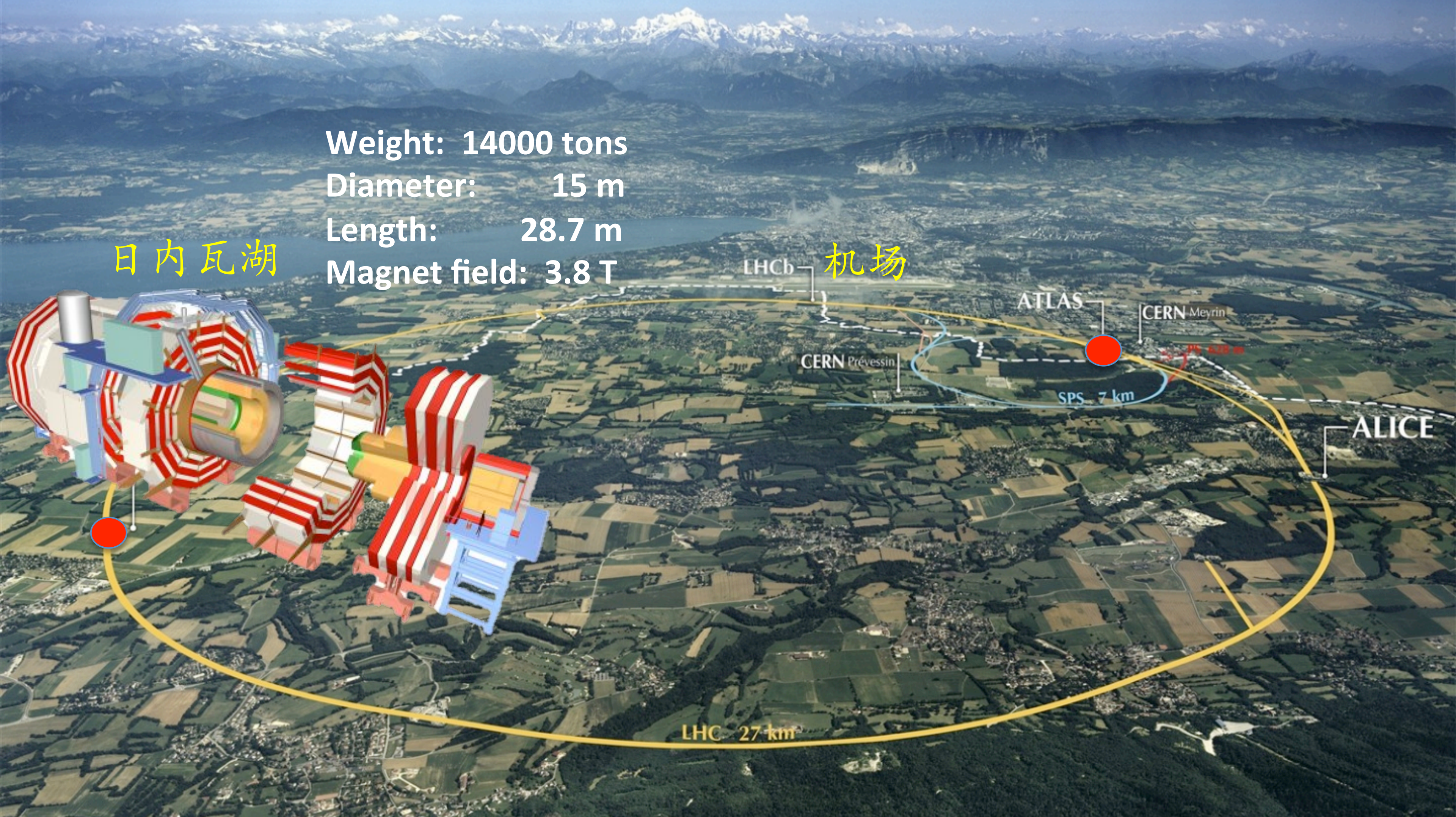
Width: 44 m
Diameter: 22 m
Weight: 7000 t



ATLAS: the biggest collider experiment with 5000-members collaboration

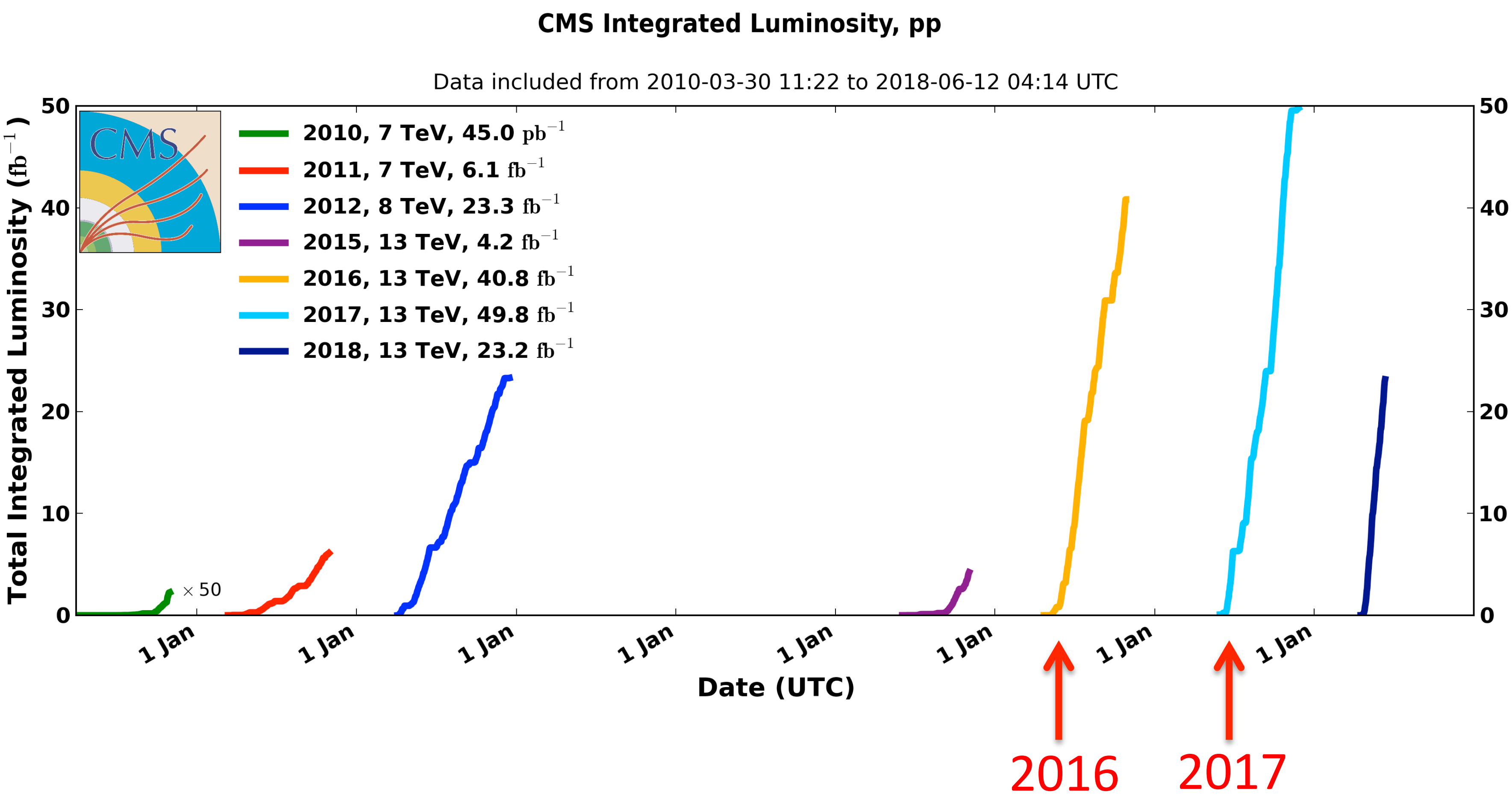
Large Hadron Collider (LHC) at CERN

Weight: 14000 tons
Diameter: 15 m
Length: 28.7 m
Magnet field: 3.8 T



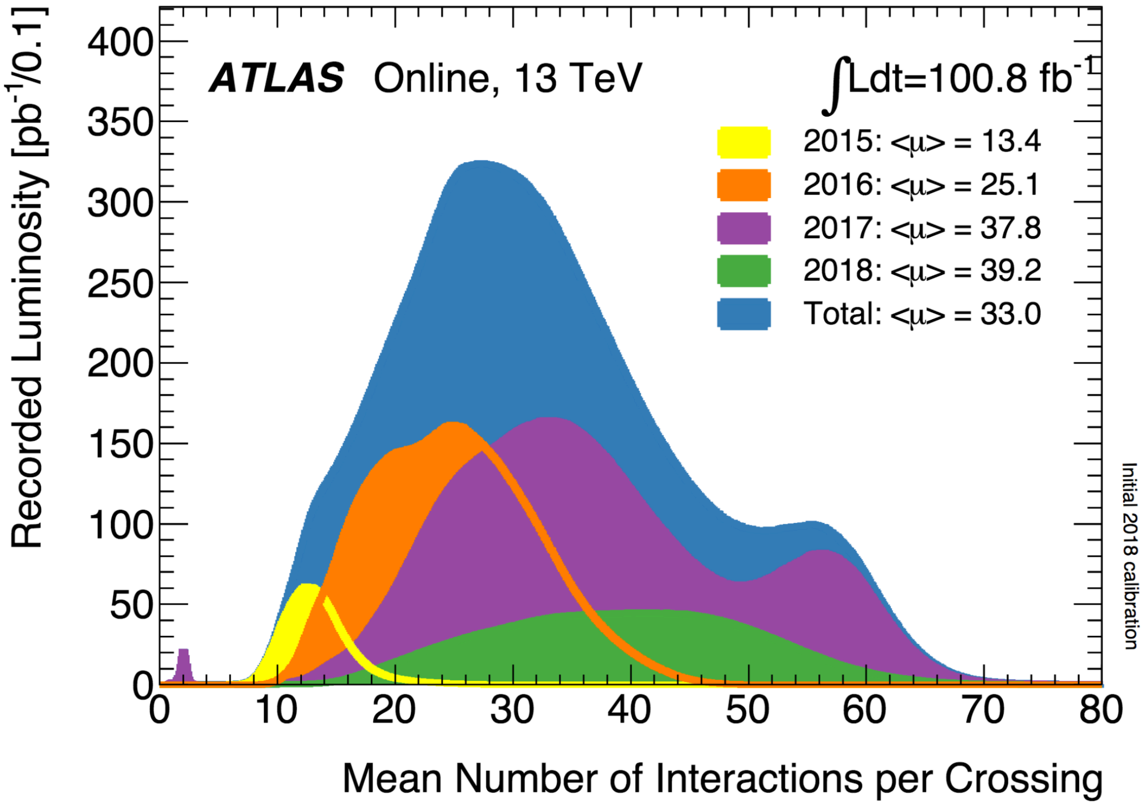
CMS: the heaviest collider experiment with 5000-members collaboration

Run Status

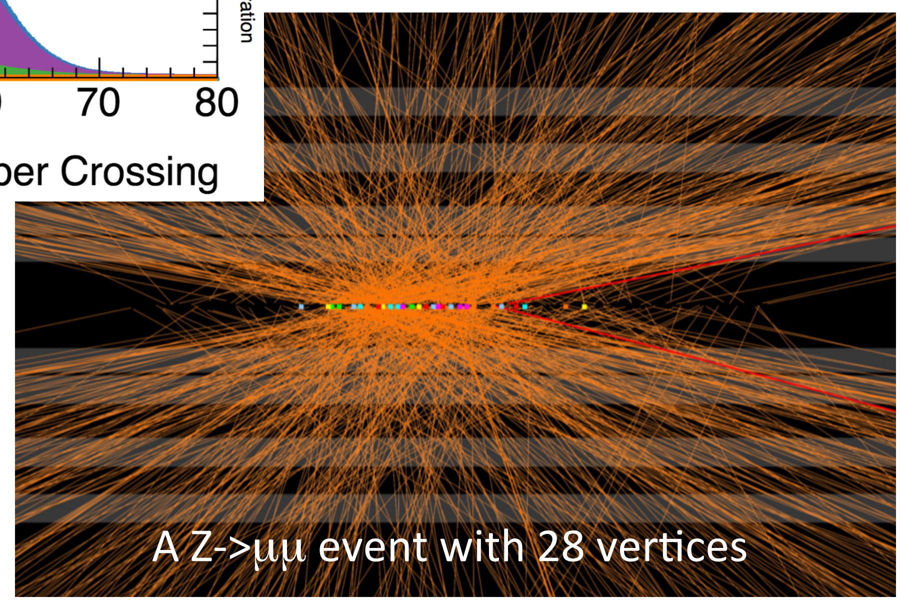


Results shown here mostly based on 2016 w/wo 2017 data

Challenge to the experiments

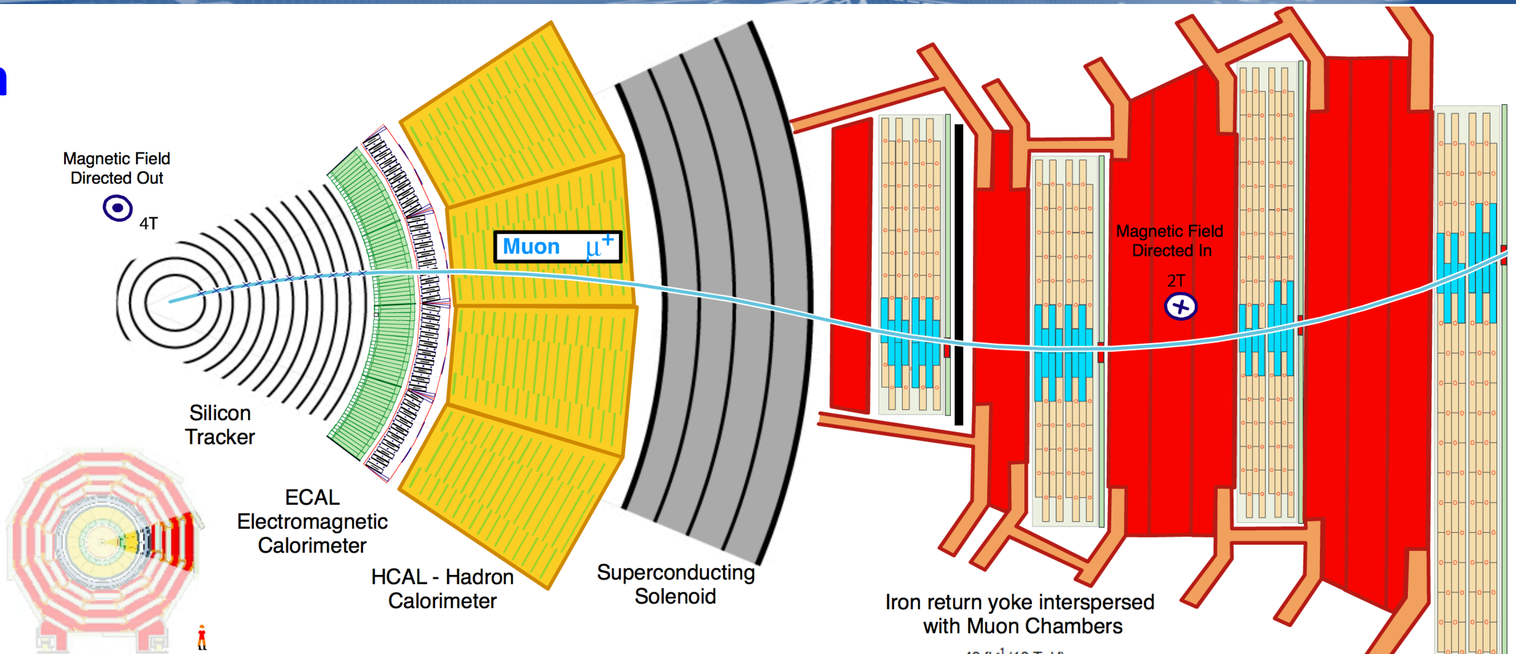


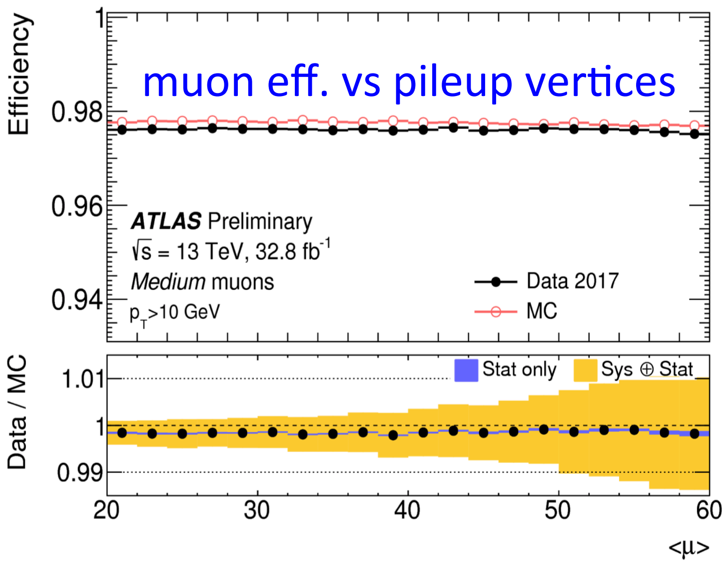
Recorded Inst. Lumi. $=1.5\times10^{34}cm^{-2}s^{-1}$

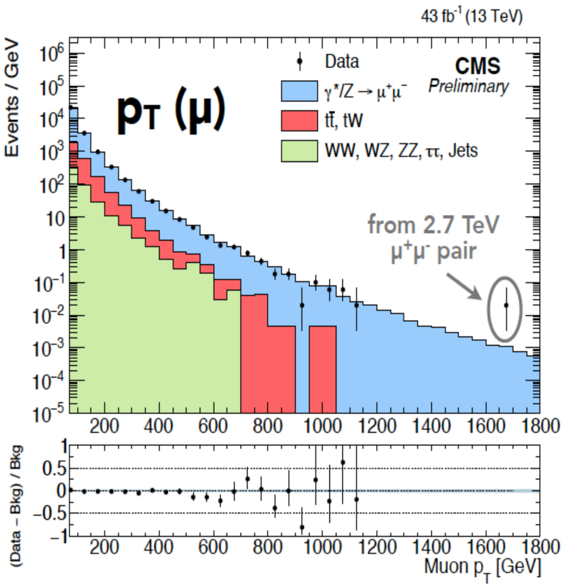


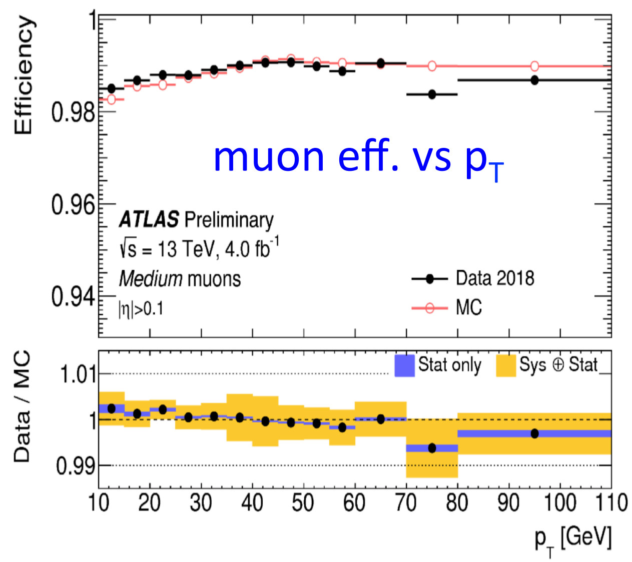
Detector performance

Muon



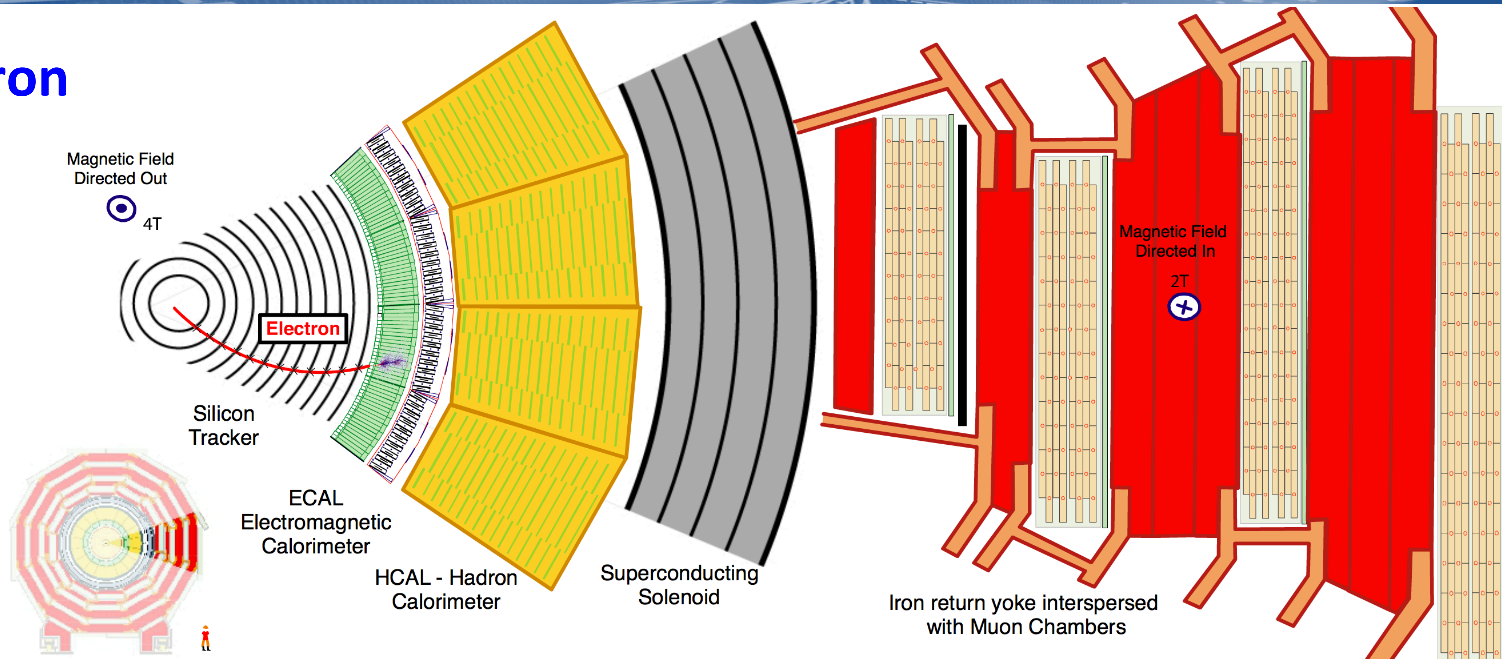


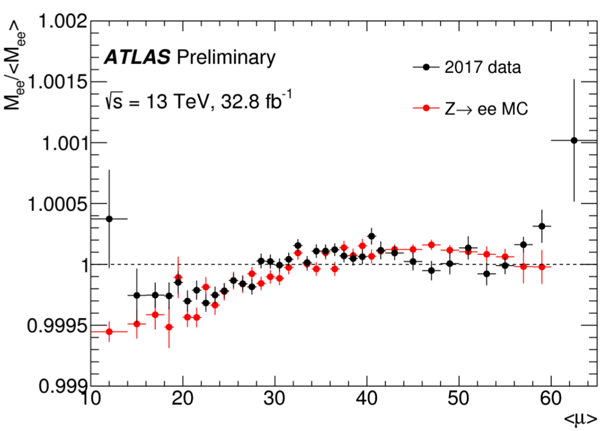




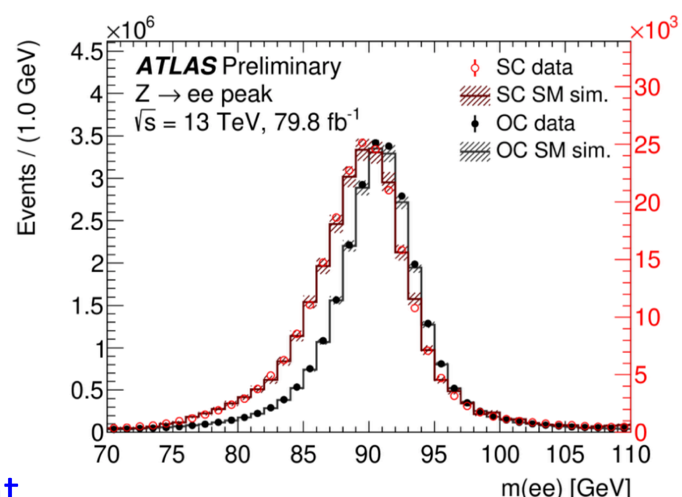
Detector performance

Electron

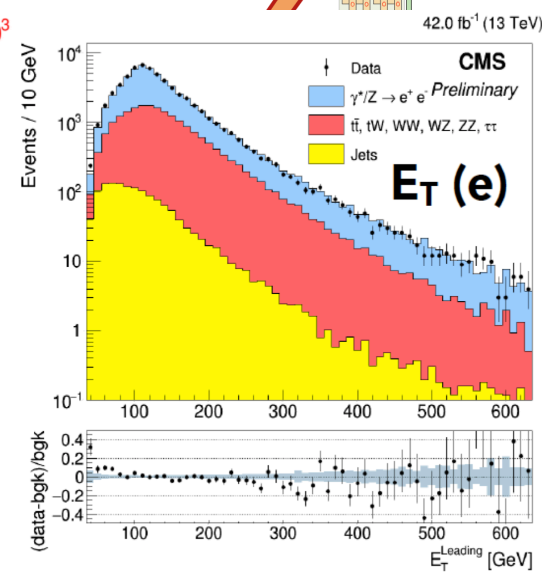




Electron energy response at Z mass vs. pileup vertices

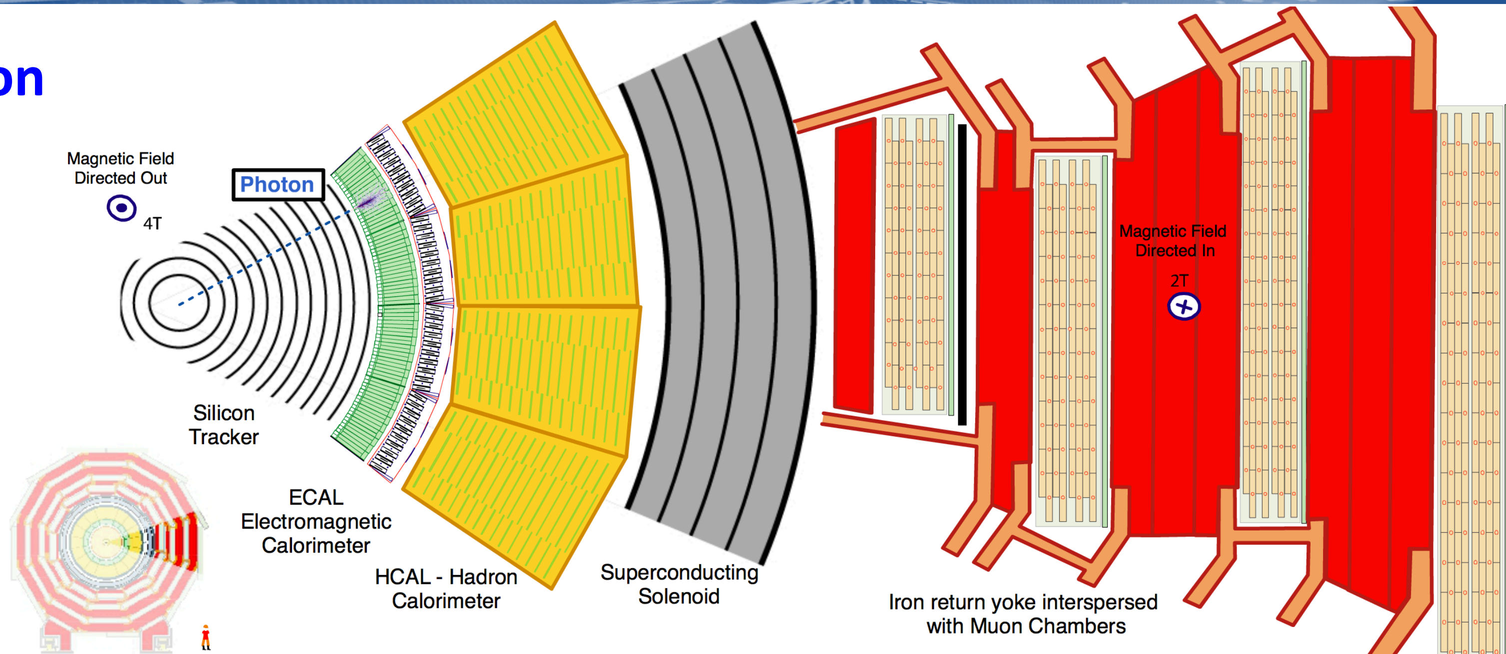


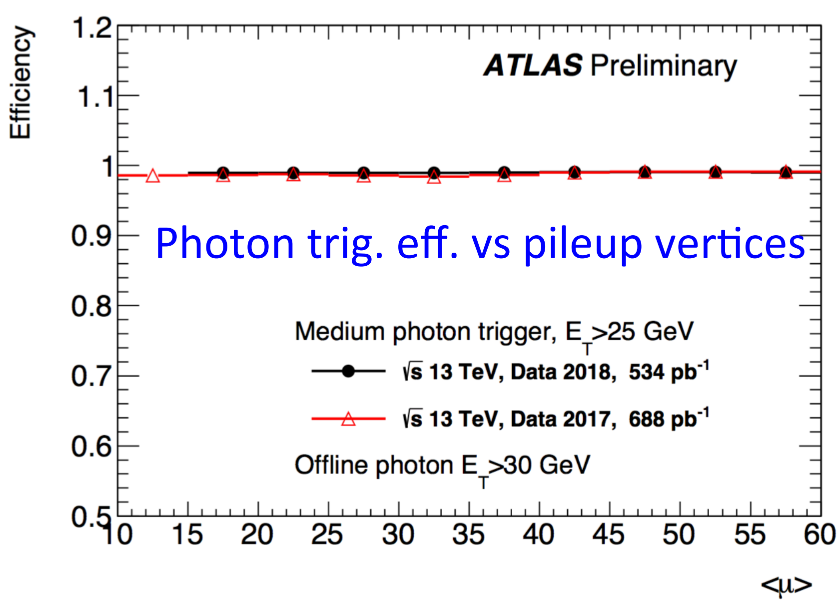
Charge-flip rate from Z events

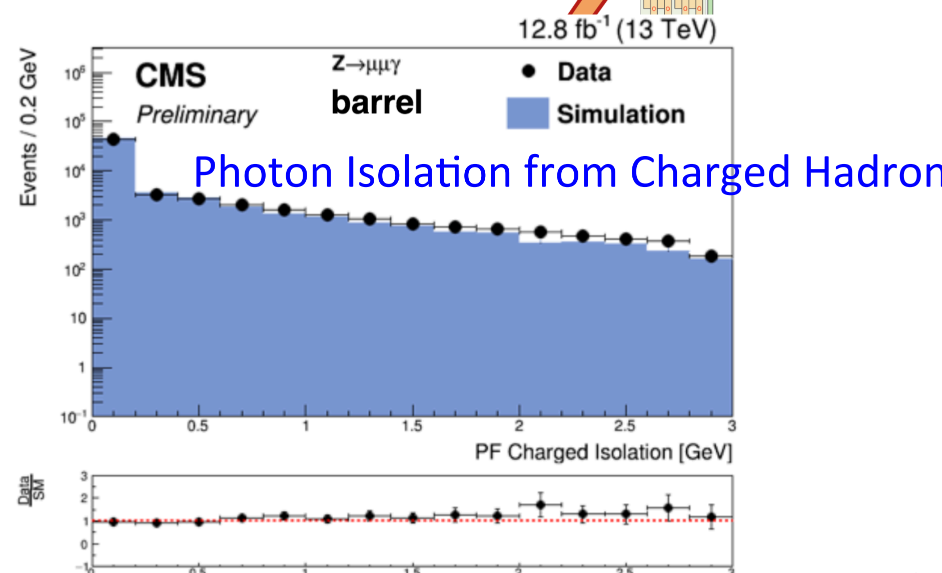


Detector performance

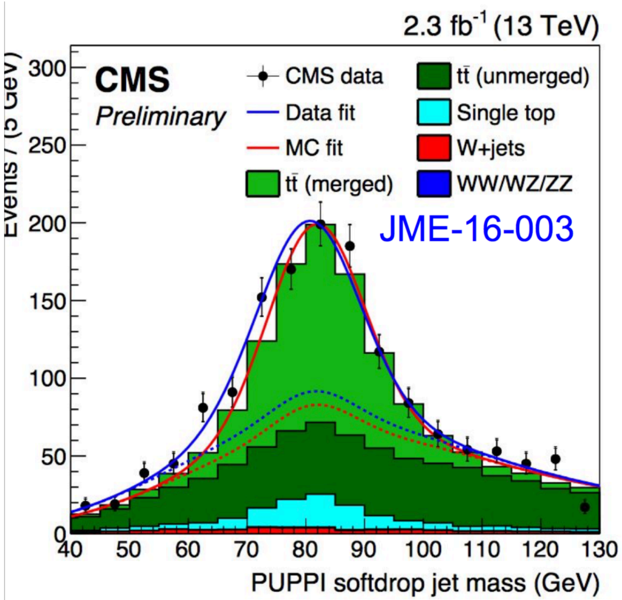
Photon



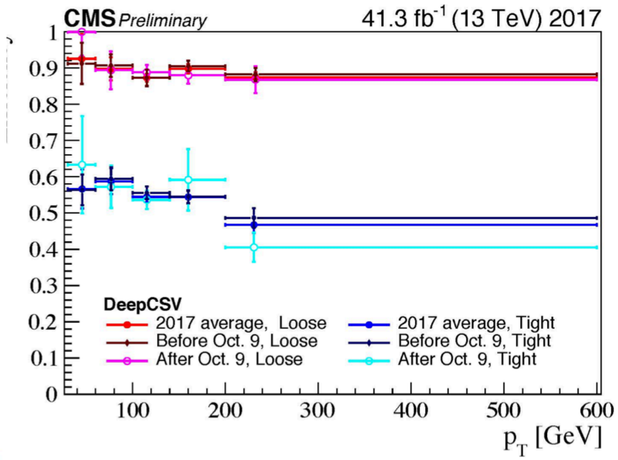




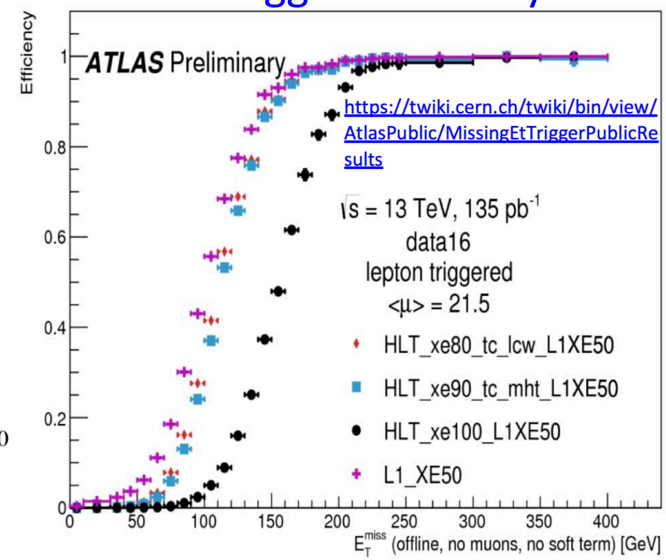
Detector performance

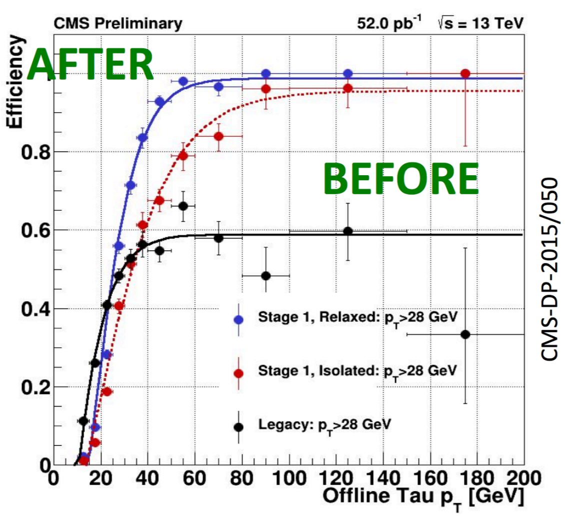


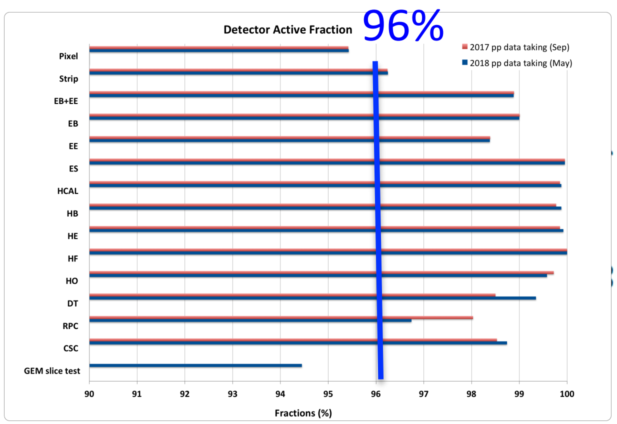
b tagging efficiency



MET trigger efficiency

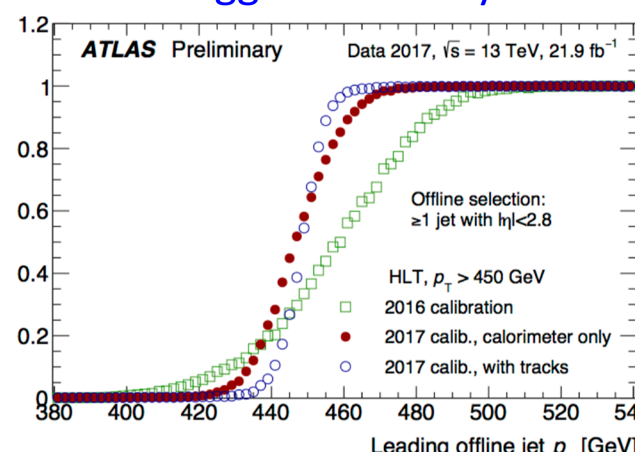






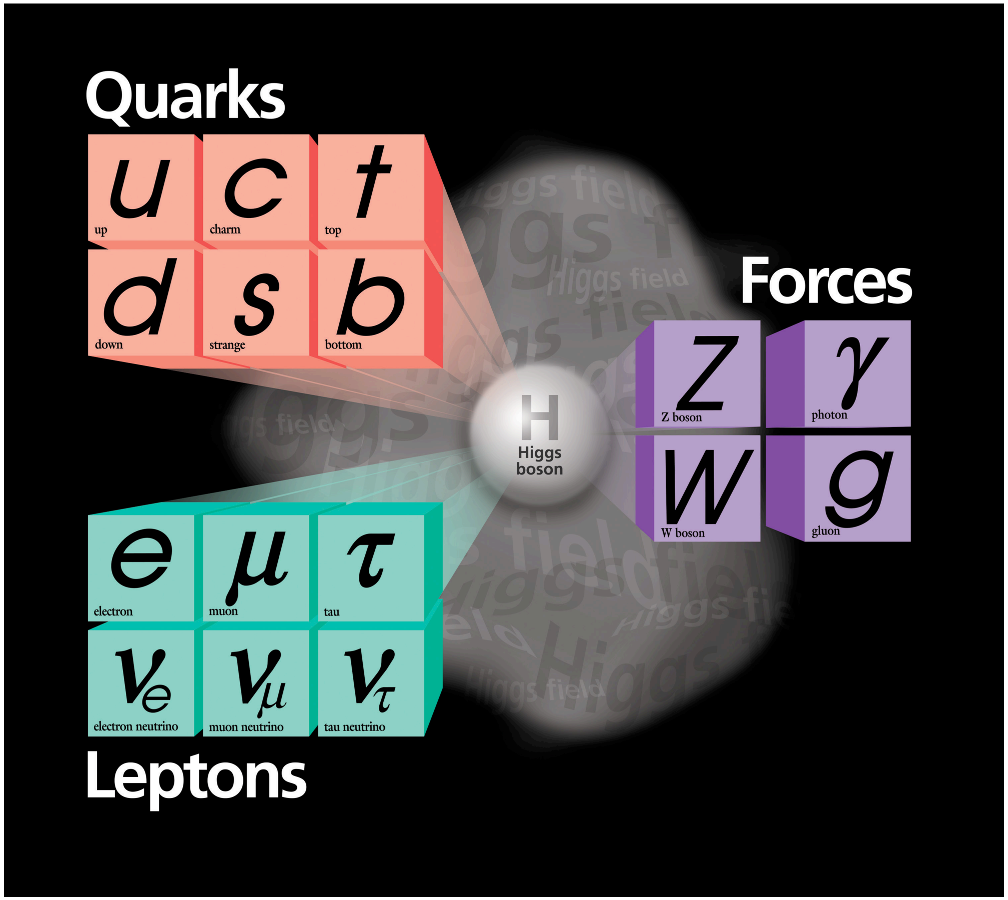
fraction of active channels

Jet trigger efficiency

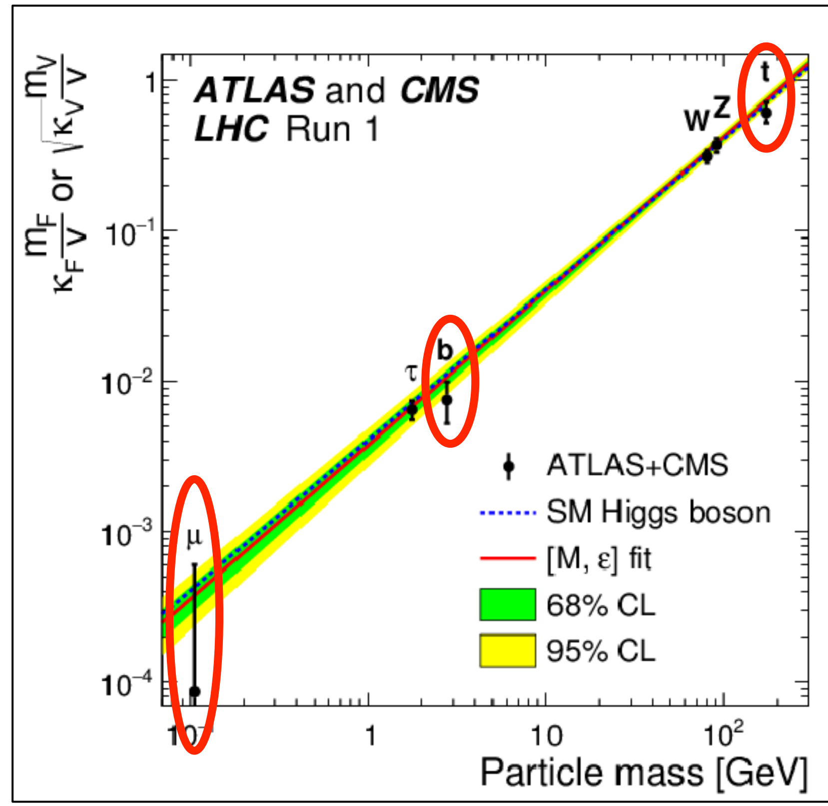


Tau trigger efficiency

- LHC and ATLAS/CMS status
- Physics Results
  - Higgs
  - SM Physics
  - SUSY and Exotica
- Outlook and Summary



Quarks
u
up
c
charm
t
top
d
down
s
strange
b
bottom
Forces
Z
Z boson
γ
photon
W
W boson
g
gluon
H
Higgs boson
e
electron
μ
muon
τ
tau
ν_e
electron neutrino
ν_μ
muon neutrino
ν_τ
tau neutrino
Leptons

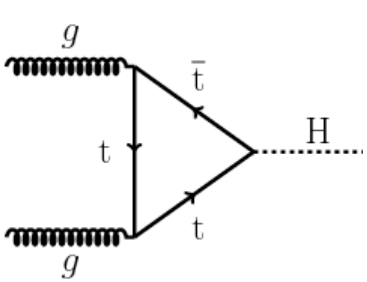


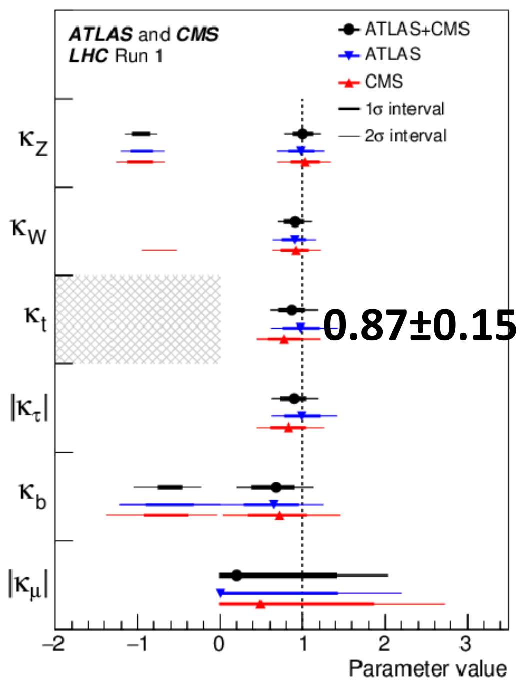
ATLAS and CMS
LHC Run 1
$\kappa_F \frac{m_F}{v}$ or $\sqrt{\kappa_V}\frac{m_V}{v}$
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
1
10
10^2
Particle mass [GeV]
t
W
Z
b
τ
μ
ATLAS+CMS
SM Higgs boson
[M, ε] fit
68% CL
95% CL

$t\bar{t}H$ coupling (two years ago)

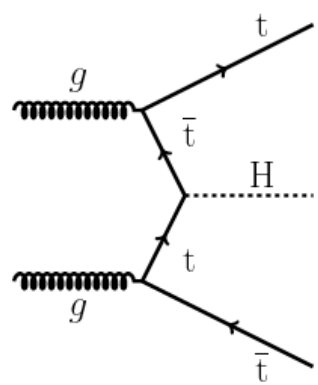
JHEP 08 (2016) 045

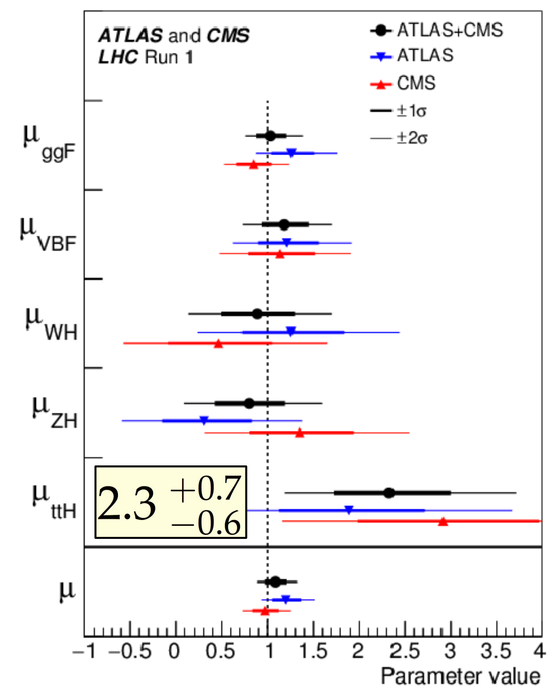
- Indirectly established at Run 1 through the ggH loop process, but model dependent
- The direct ttH coupling was evident, but somewhat higher than expectation





SM structures and no BSM assumed

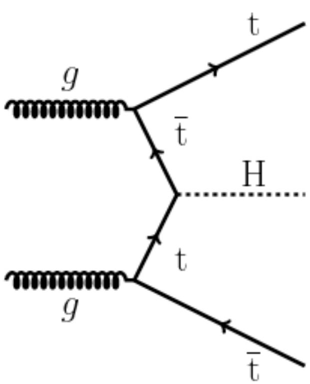


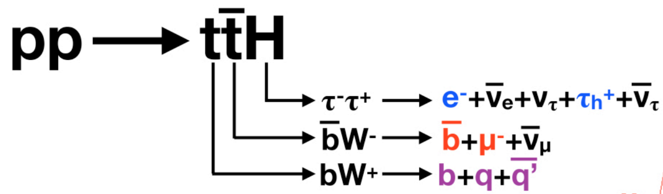


Obs. (exp.) 4.4σ (2.0σ)

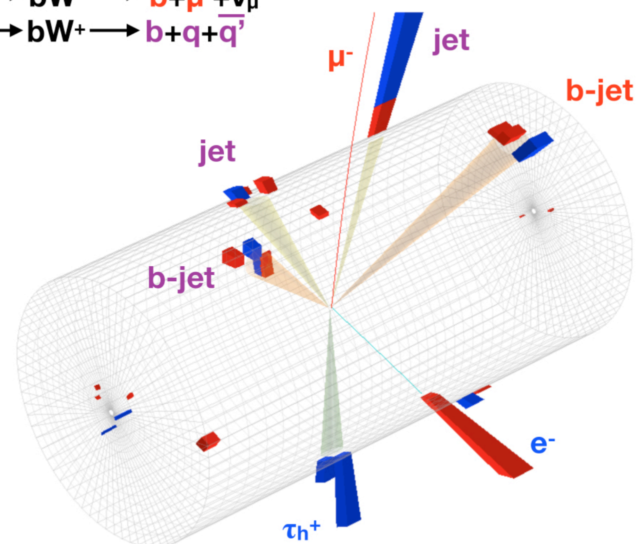
Now we have the $t\bar{t}H$ observation

- >5σ observation of $t\bar{t}H$ from CMS and ATLAS
- Very sophisticated analyses, pushing detector performance very far, many channels, MVAs...





CMS ttH candidate event



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Phys. Rev. Lett. 120, 231801 (2018)

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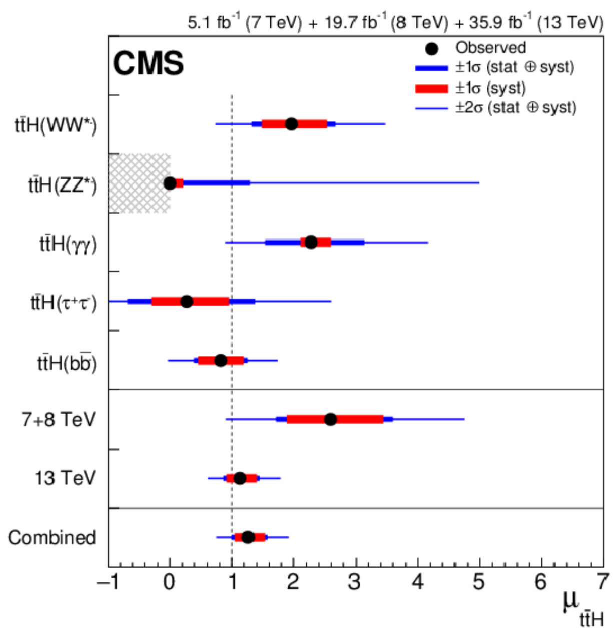
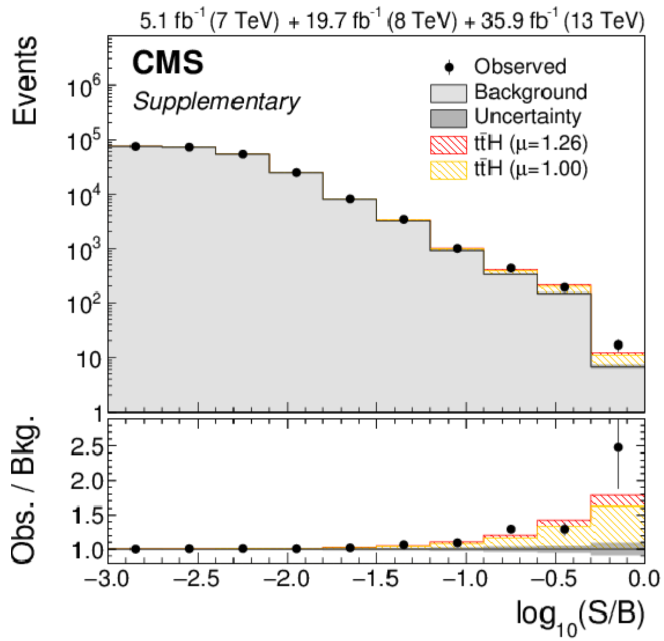
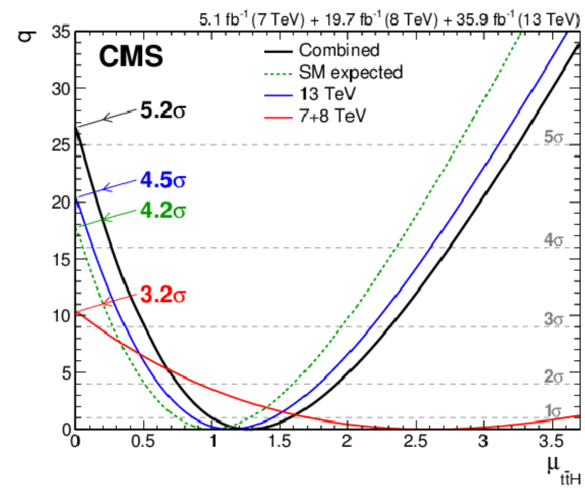




Obs. (exp.) 5.2σ (4.2σ)



$$\mu_{t\bar{t}H} = 1.26^{+0.31}_{-0.26} = 1.26^{+0.16}_{-0.16}(\text{stat}) ^{+0.17}_{-0.15}(\text{exp.}) ^{+0.14}_{-0.13}(\text{bkg. th.}) ^{+0.15}_{-0.07}(\text{sig. th.})$$

参见张华桥报告

Now we have the $t\bar{t}H$ observation

arXiv:1806.00425

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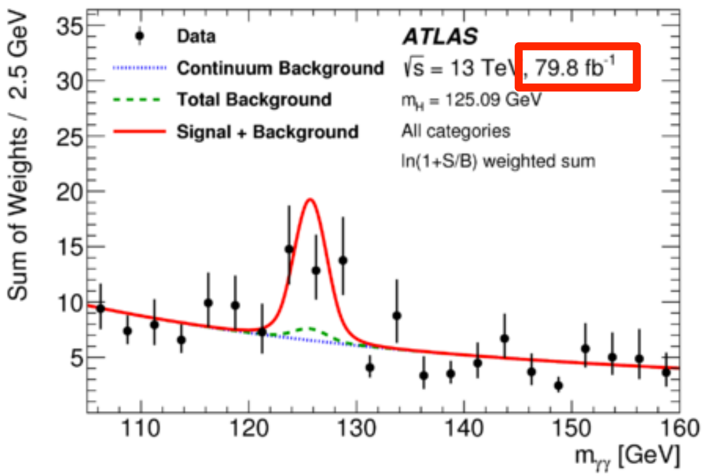
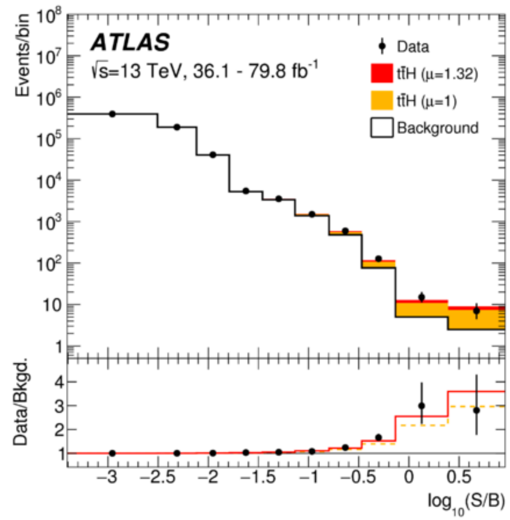
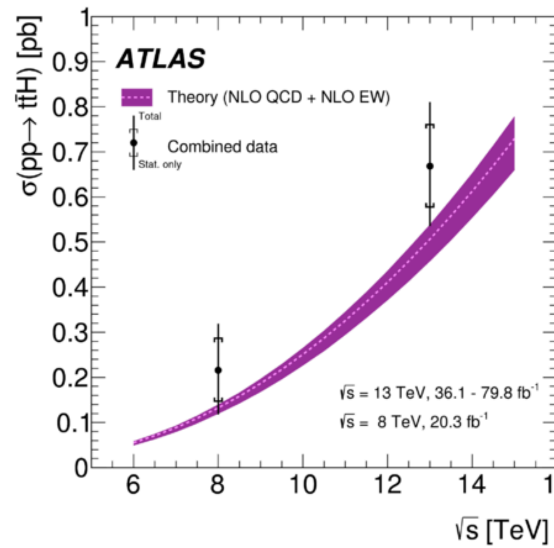
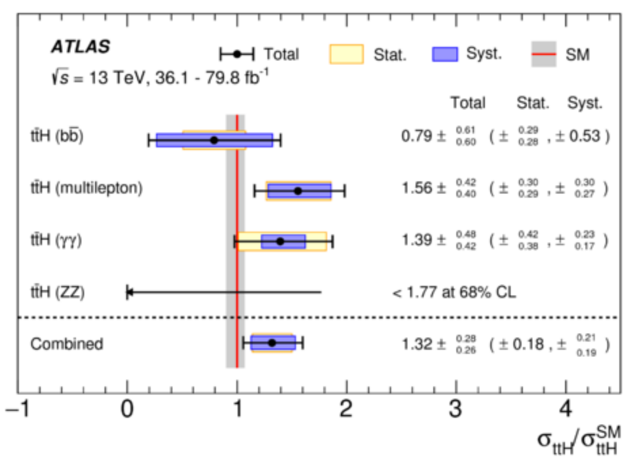
- Very sophisticated analyses, pushing detector performance very far, many channels, MVAs...







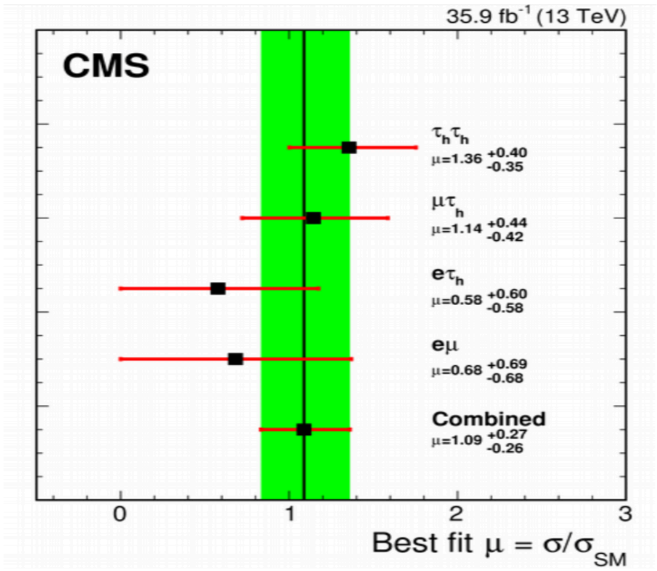


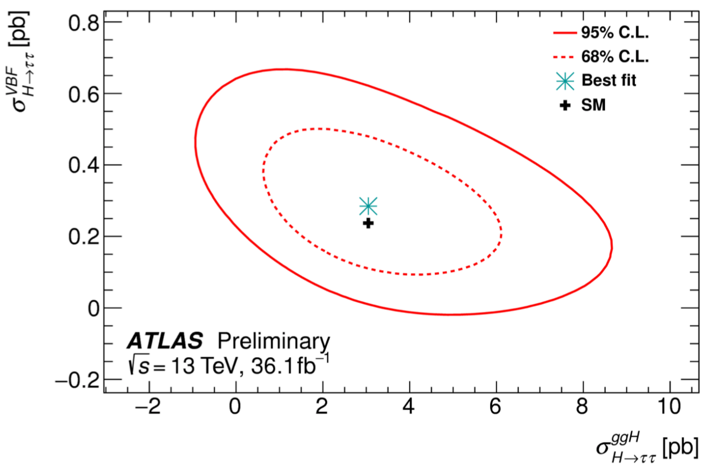
Obs. (exp.) 6.3σ (5.1σ) for Run 1+2

参见马连良报告

H→ττ

- Again complex analyses, systematics have to be under excellent control
- Established by the Run-1 ATLAS+CMS combination: observation at 5.5σ (5.0σ exp.)
- Now complemented by individual CMS and ATLAS 5σ's
  (Run-1+Run-2 / each 36 fb^{-1})
  - CMS 5.9σ (5.9σ)
  - ATLAS 6.4σ (5.4σ)
- Moving to measurements





$$\sigma^{\mathrm{ggH}}_{\mathrm{H}\to\tau\tau} = 3.0 \pm 1.0\,(\mathrm{stat.})^{+1.7}_{-1.3}(\mathrm{syst.})\,\mathrm{pb}$$

$$\sigma^{\mathrm{VBF}}_{\mathrm{H}\to\tau\tau} = 0.28 \pm 0.09\,(\mathrm{stat.})^{+0.11}_{-0.09}(\mathrm{syst.})\,\mathrm{pb}$$

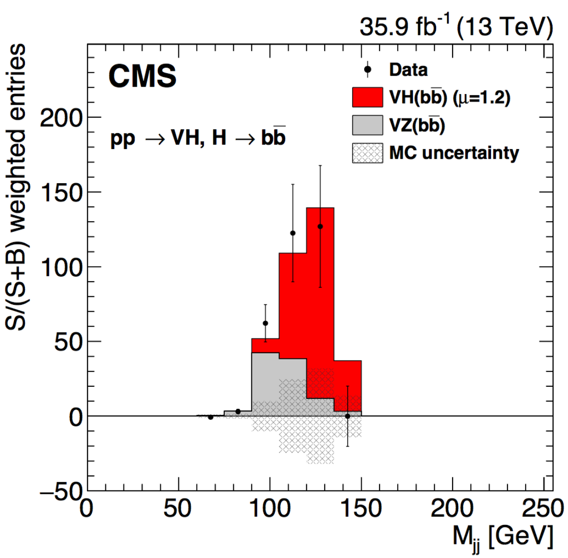
参见张雷、陈新报告

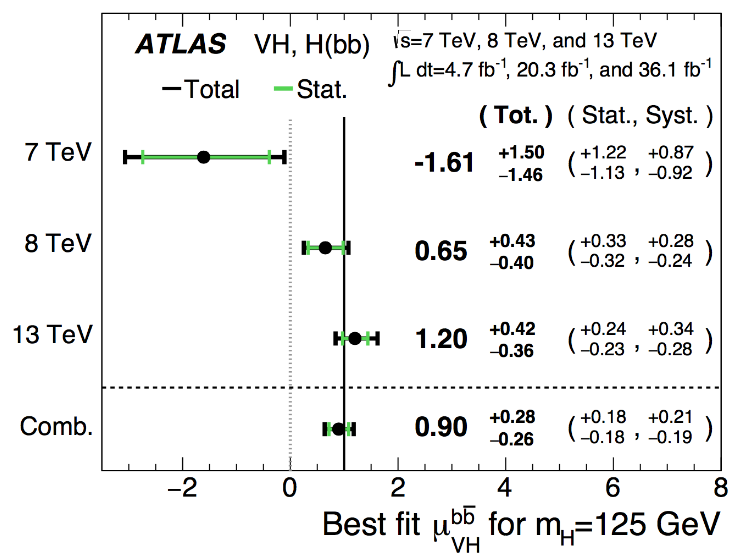
H→b$\bar{b}$

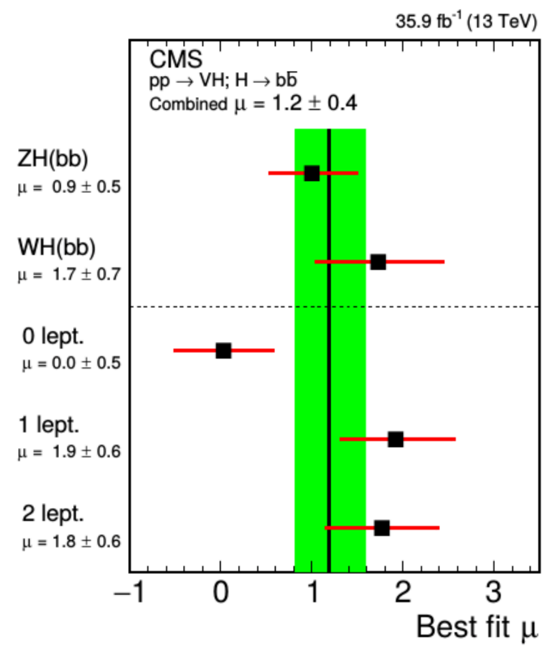
- Also difficult analyses with many tough systematic errors, e.g. (W/Z)+HF backgrounds, b-tagging ...
- Run-1+Run-2 signal strengths:

$$\mu_{VH}^{CMS} = 1.06^{+0.31}_{-0.29} \qquad \mu_{VH}^{ATLAS} = 0.90^{+0.28}_{-0.26}$$

Both correspond to evidence at 3.6-3.8σ





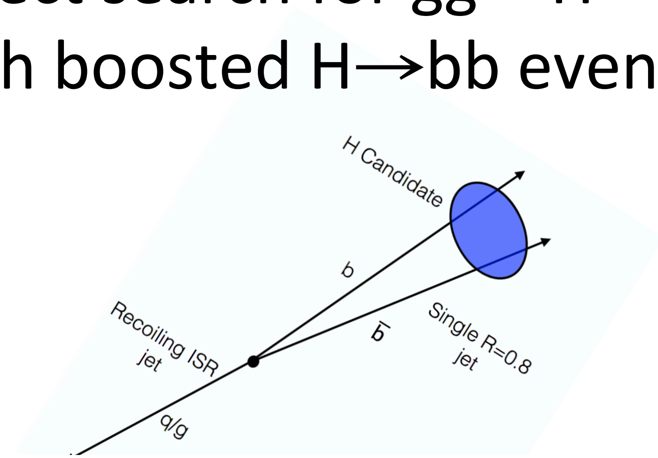


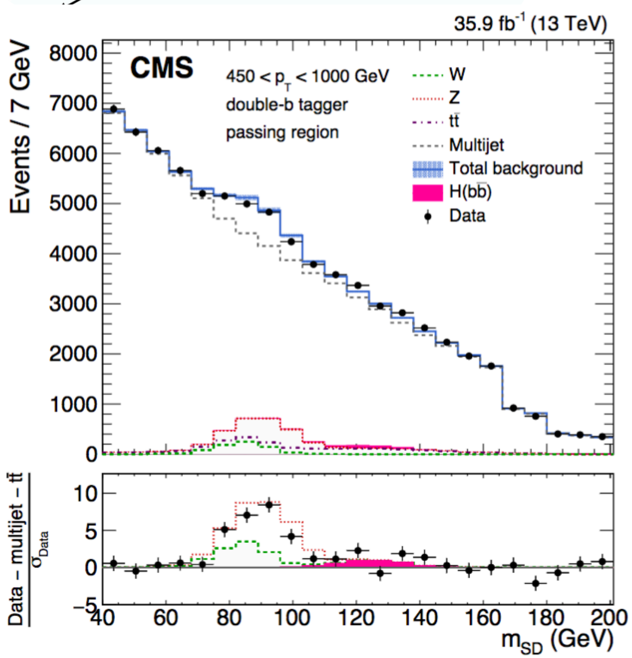
参见张雷、刘衍文、Chikuma Kato报告

$H \to b\bar{b}$: explore new regimes/ideas

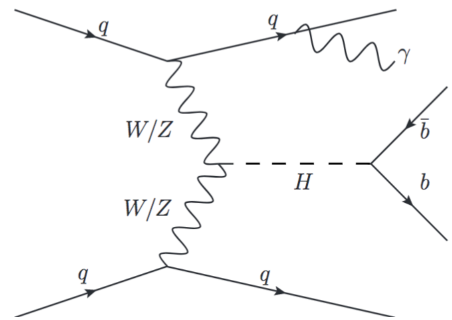
Phys.Rev.Lett. 120 (2018) 071802, CERN-EP-2018-140

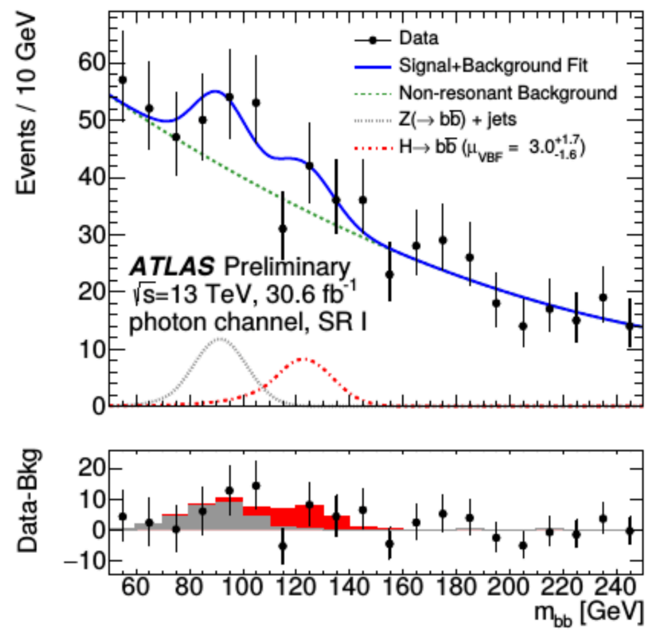
- Direct search for $gg \to H \to bb$ with boosted $H \to bb$ events





- Search for VBF, with an additional high p_T photon



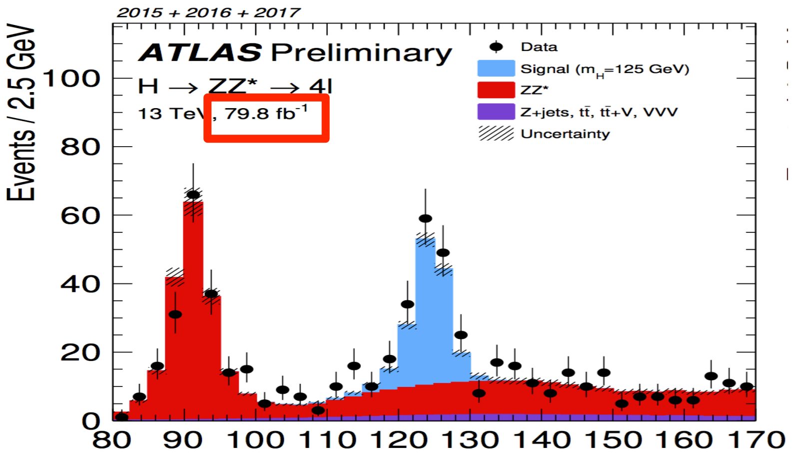


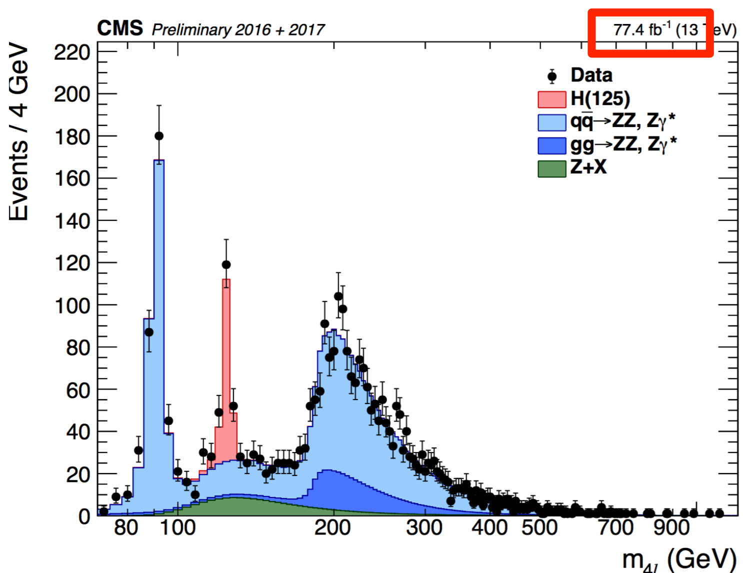
参见石辽珊报告

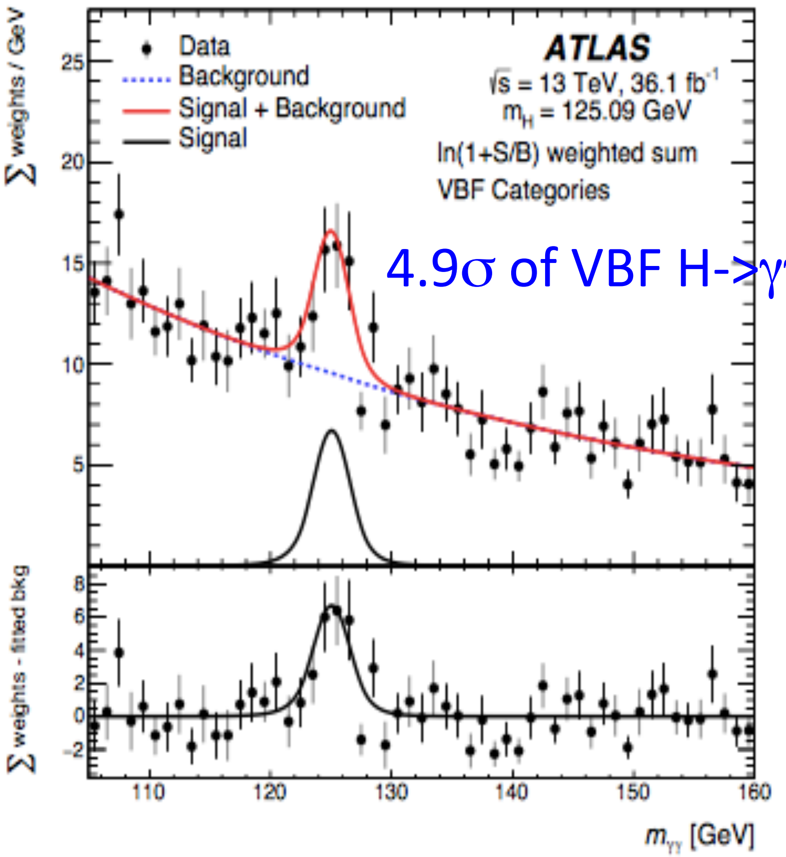
Higgs to bosons – entering precision era

ATLAS-CONF-2018-018, CMS-PAS-HIG-18-001

- Run-2 analyses with 80 fb^{-1} for the first time, higher precision is coming!







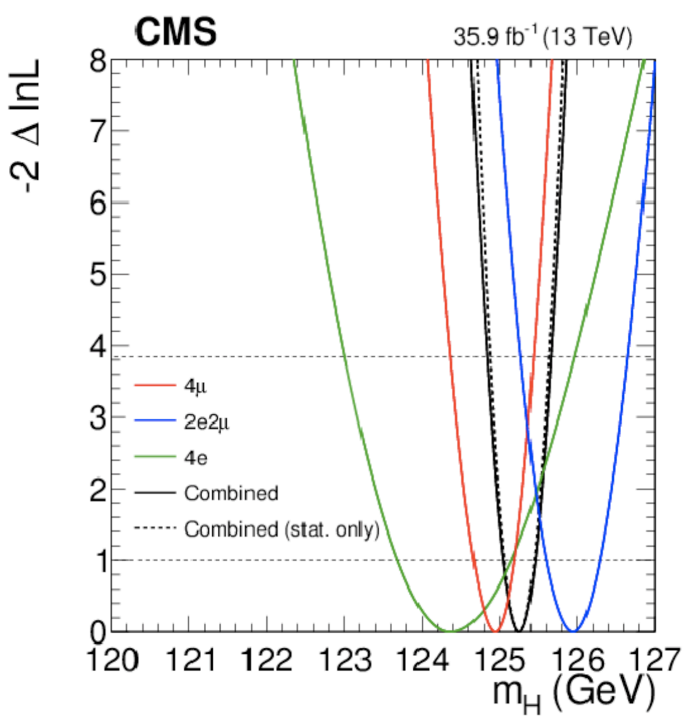
4.9σ of VBF H->γγ

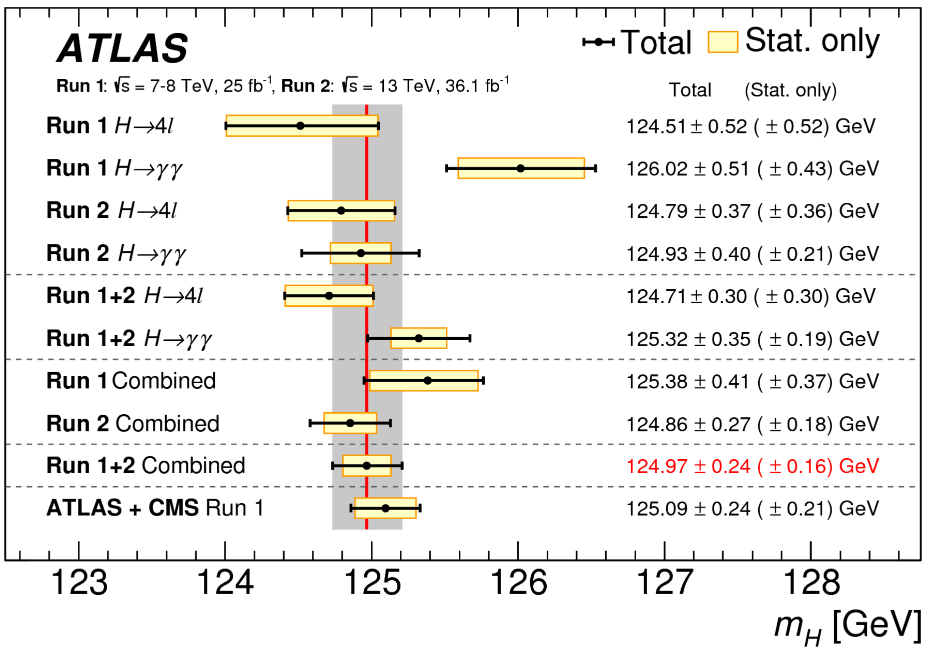
参见陶军全、黄燕萍、方亚泉、Tahir报告

Higgs mass

JHEP 11 (2017) 04, arXiv:1806.00242

- Most precise measurement at the moment comes from CMS H→ZZ→4l mass measurement with 2016 data m_H = 125.26±0.21 GeV
- ATLAS performed the combined measurement of the Run1 and Run2 (2015+2016) H→ZZ→4l and H→**γγ** mass measurements, m_H = 124.97±0.24 GeV

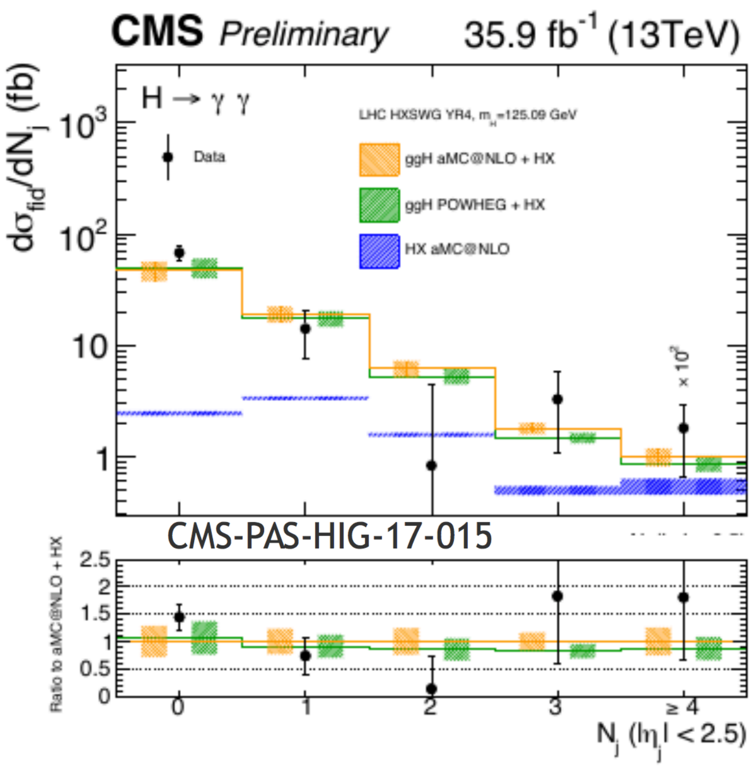


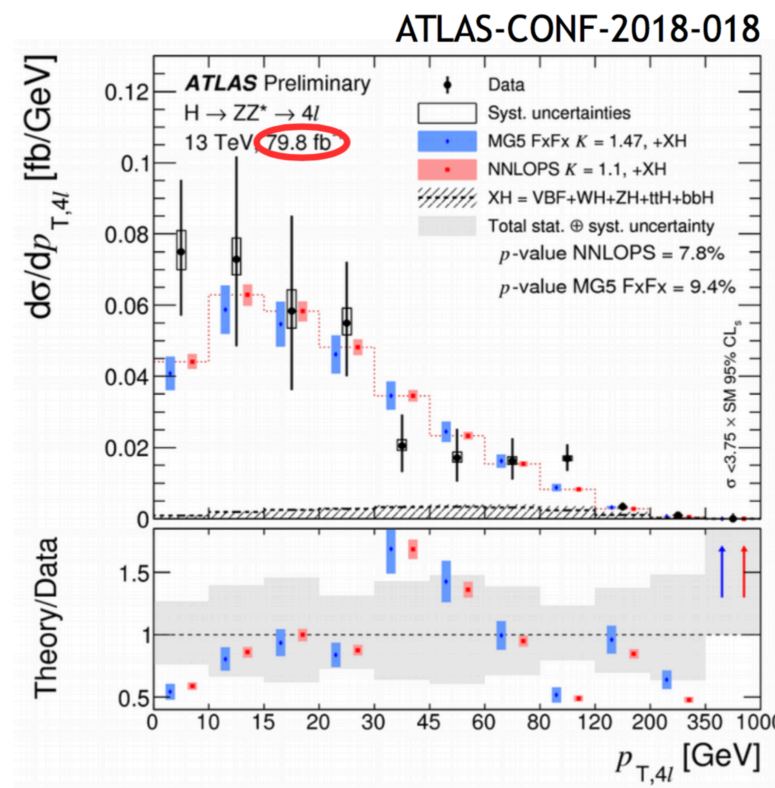


Still limited by statistical uncertainties → impact on coupling ~0.5%

Higgs differential cross sections

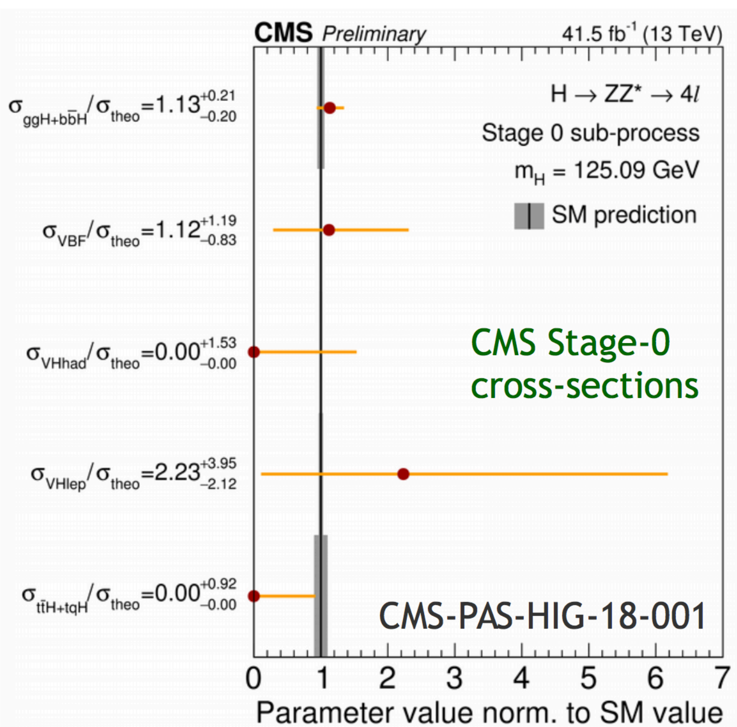
- Measurements of fiducial and differential cross-section distributions made already at Run-1 with low statistics
- Now with more bins and better precision

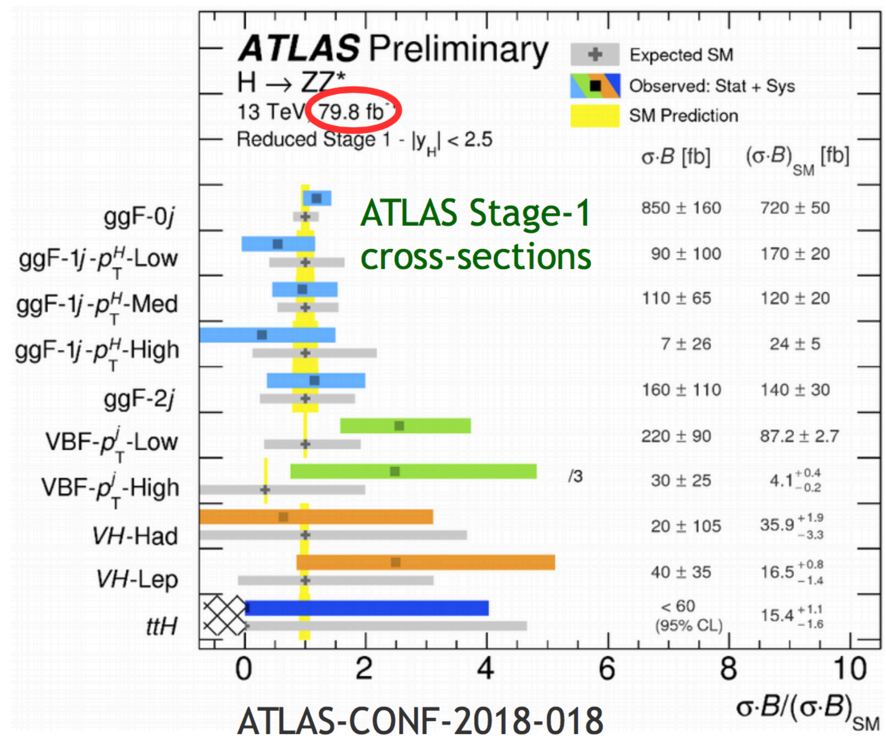




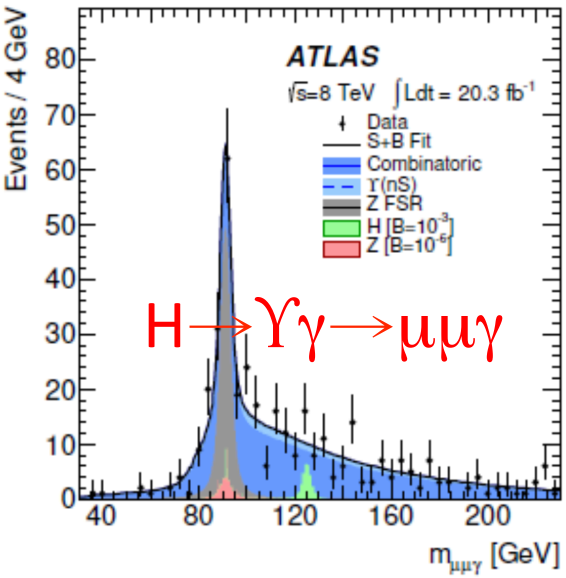
Simplified template cross sections

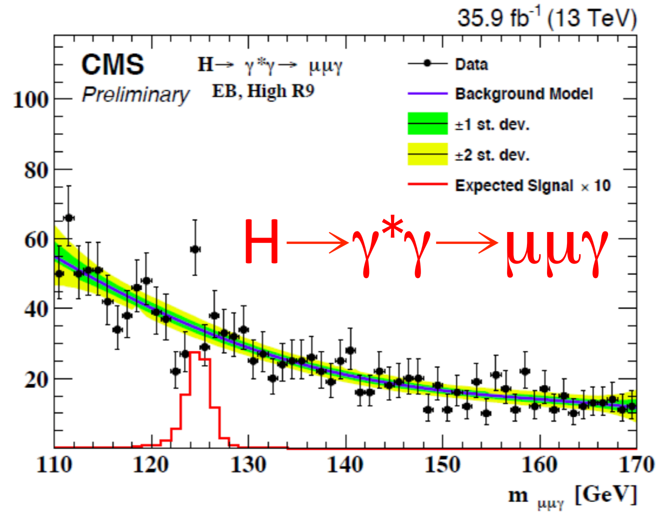
- Simplified template cross-sections (STXS) defined by common effort in LHC Higgs cross-section group
- Finer-grained cross-sections (“Stage-1”) becoming accessible now...
- Using these, and/or individual experimental measurements, EFT fits will allow more detailed SM tests – and perhaps provide hints of BSM structure

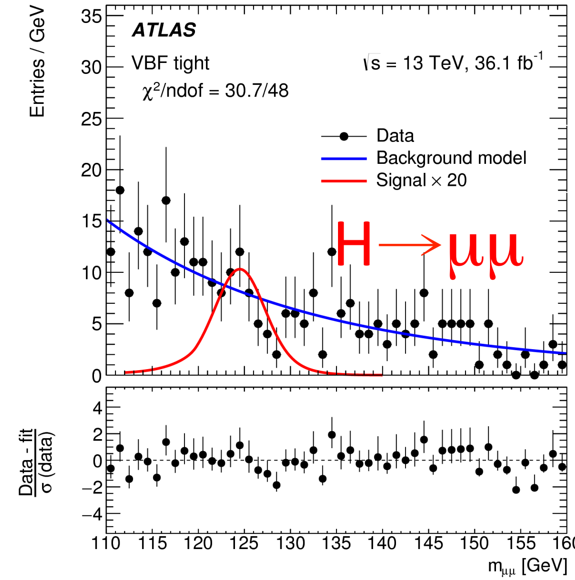


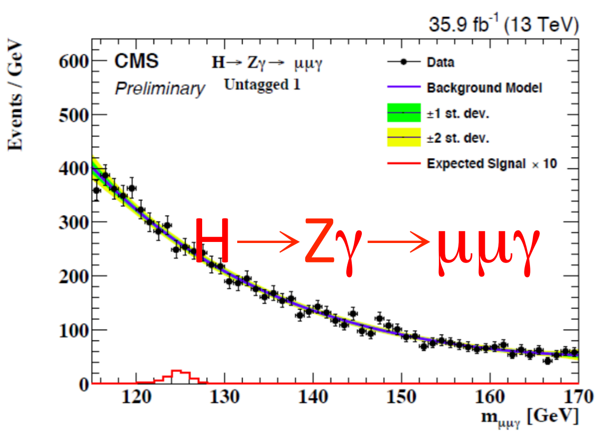


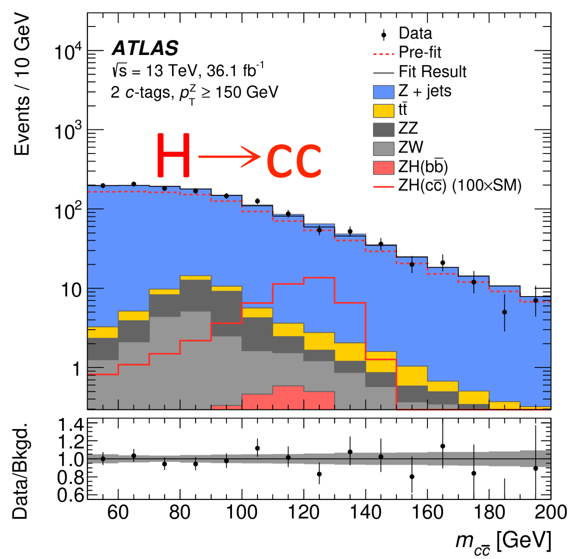
Higgs rare decays

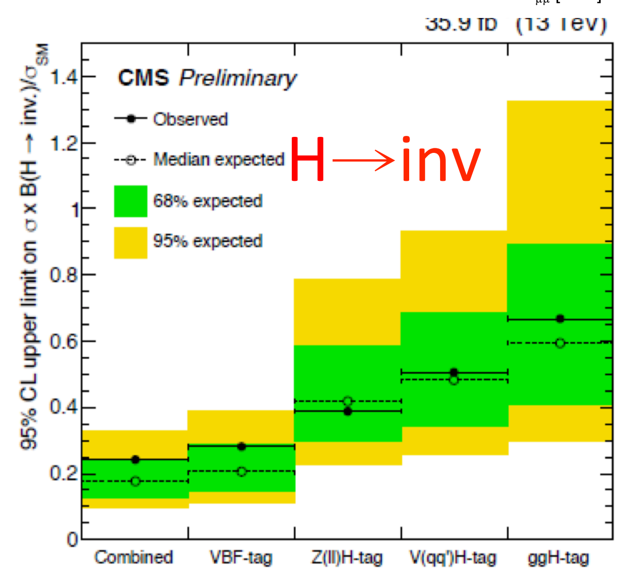












Many studies, all compatible with SM predictions

参见李海峰,刘彦麟报告

Combined Higgs boson couplings

CMS-PAS-HIG-17-031

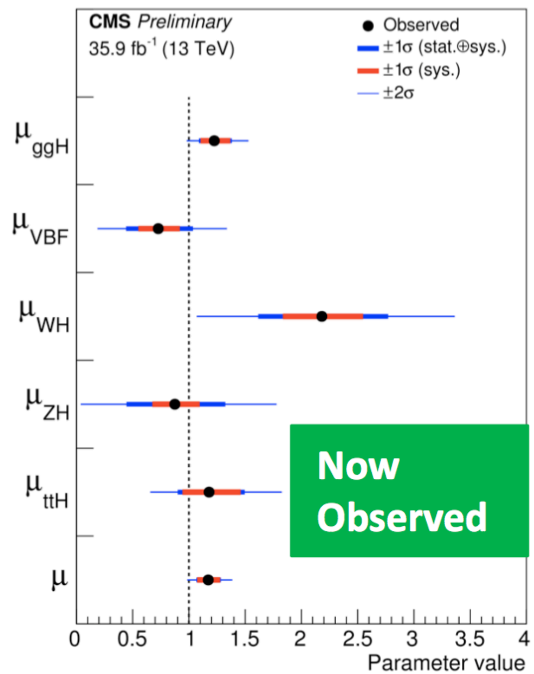
- Overall signal strength compatible with the SM
- Not anymore dominated by statistics, already moving to less inclusive measurements

	ggF	VBF	VH	ttH
H→ZZ→4l	•	•	•	•
H→γγ	•	•	•	•
H→WW	•	•	•	•
H→bb	•		•	•
H→ττ	•	•		•
H→μμ	•	•		
H→inv	•	•	•	

Close to have observed the couplings with all 3rd generation fermions

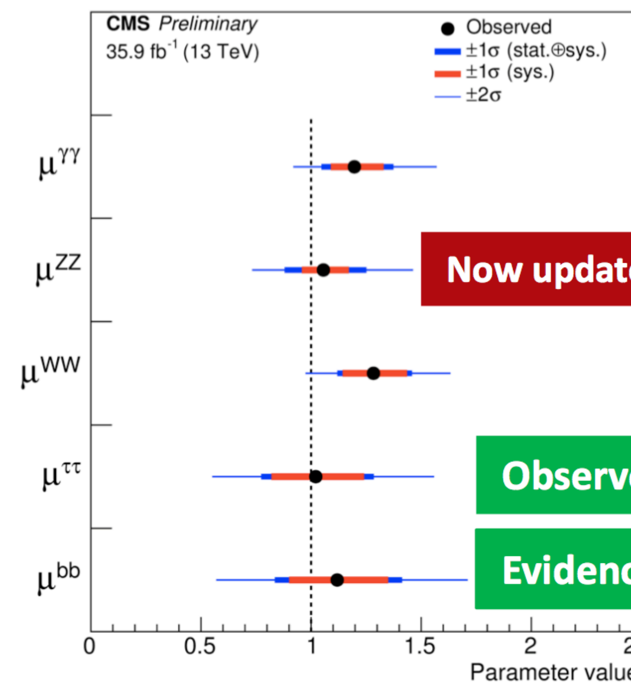
- **One of the targets of LHC Run2**

Per production mode



Now Observed

Per decay mode



Now updated

Observed

Evidence

CMS 13 TeV 2016 combination

$$\mu = 1.17^{+0.10}_{-0.10} = 1.17^{+0.06}_{-0.06}\,(\text{stat.})\,^{+0.06}_{-0.05}\,(\text{sig. th.})\,^{+0.06}_{-0.06}\,(\text{other sys.})$$

- LHC and ATLAS/CMS status
- Physics Results
  - Higgs
  - SM Physics
  - SUSY and Exotica
- Outlook and Summary

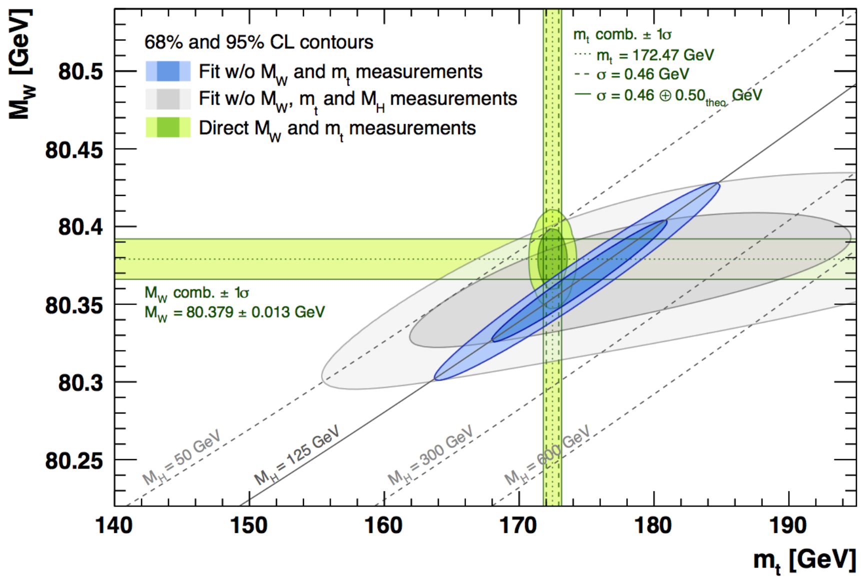
SM measurements: motivation

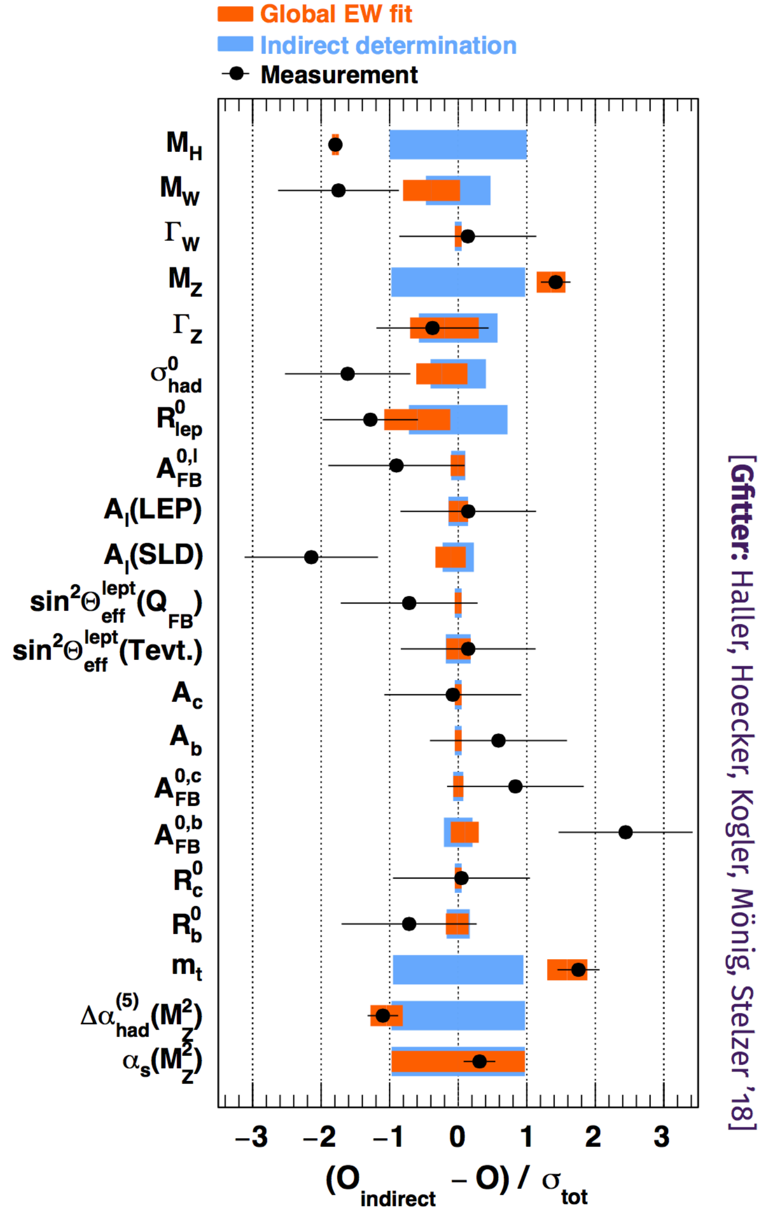
- Self-consistency test of the Standard Model

  → over-constrain the system:

e.g. $\sin^2\theta_W = 1 - M^2_W/M^2_Z$ (@ tree)

- Probe new physics





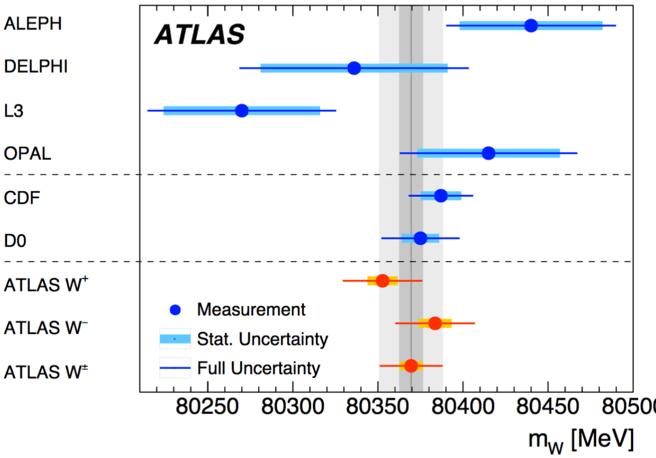
Precision W/top masses

- Self-consistency test of the Standard Model

  → over-constrain the system:

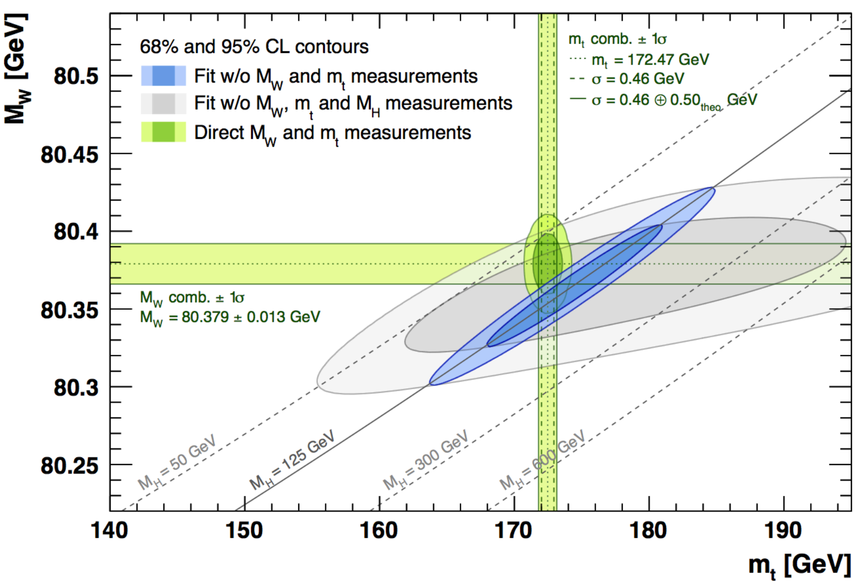
  e.g. $\sin^2\theta_W = 1 - M^2_W/M^2_Z$ (@ tree)

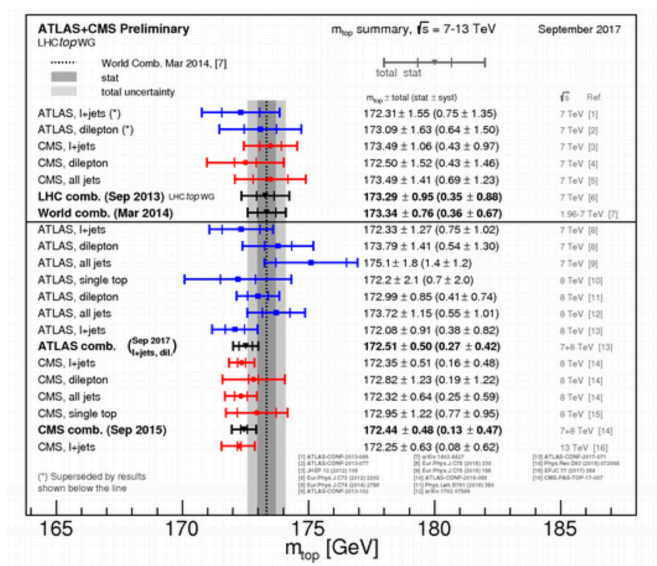
- Probe new physics



±19 MeV m_W from ATLAS

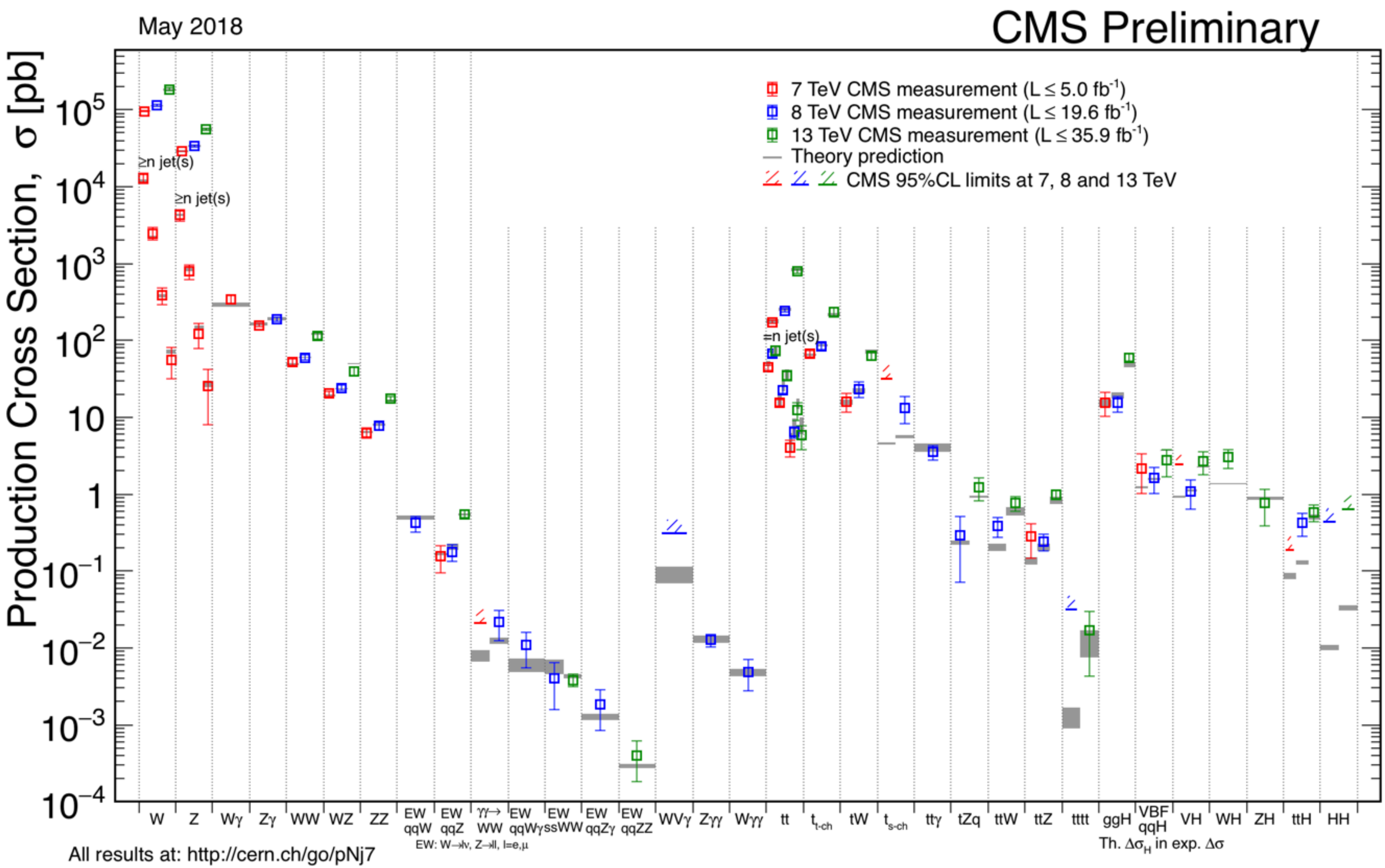
EPJC78 (2018) 110





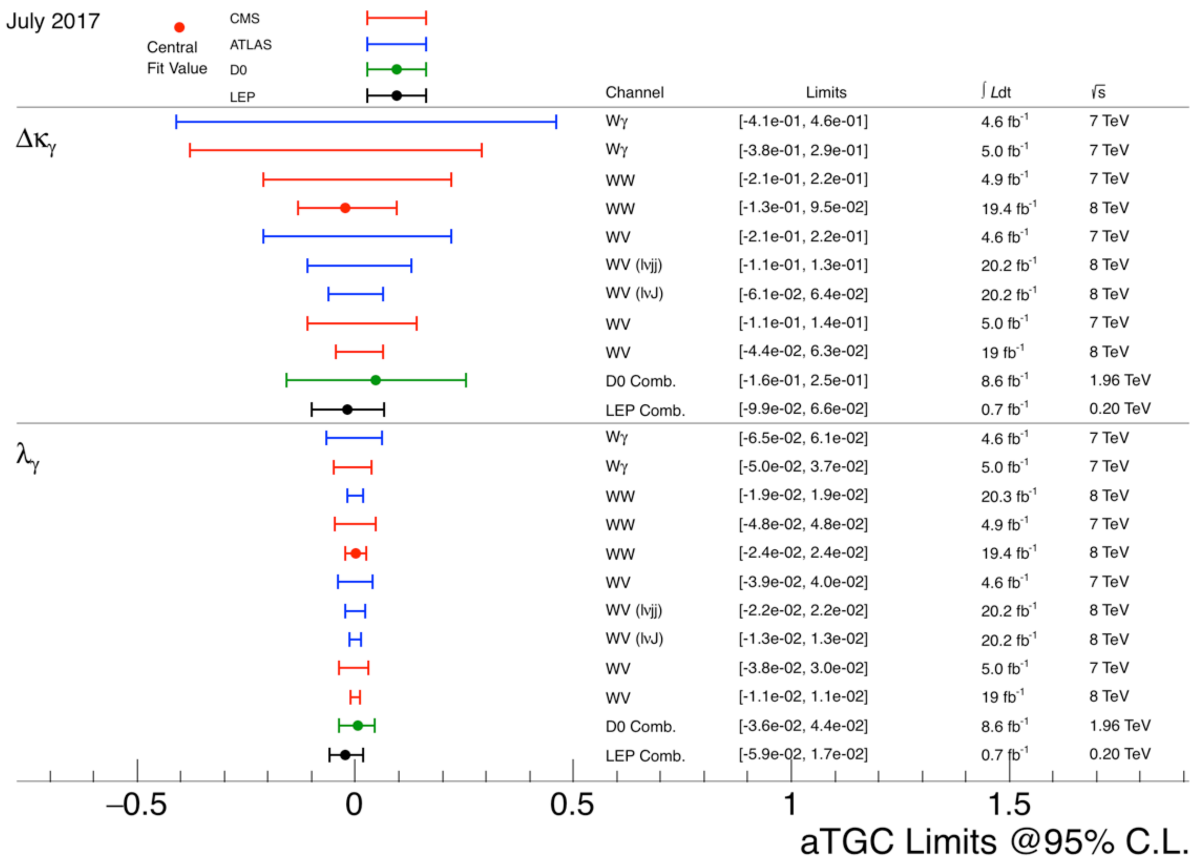
m_{top} error (ATLAS or CMS) from direct reco ~0.5 GeV

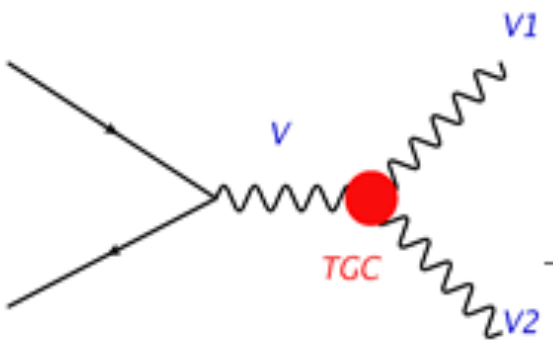
SM production cross section measurements

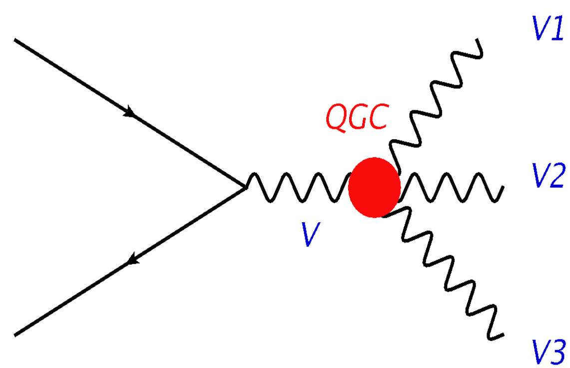


Overall good agreement with SM over 9 orders of magnitude

Probing anomalous TGC/QGC



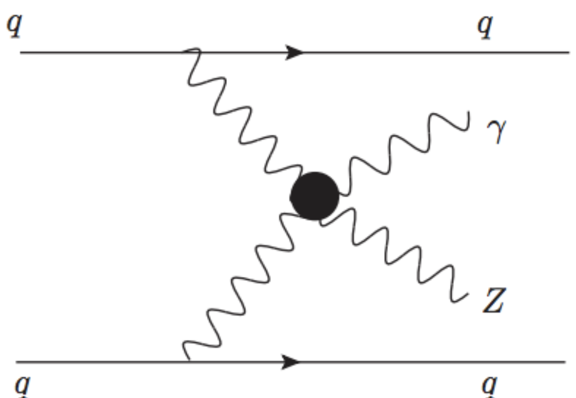




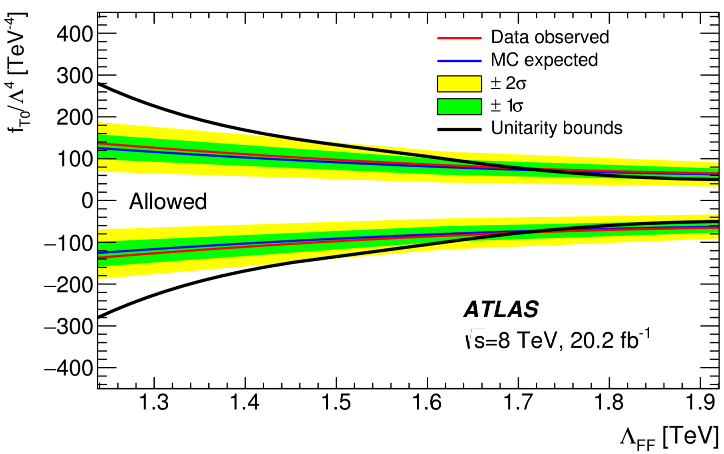
参见李数、 Yatsenko、Chenliang Wang报告

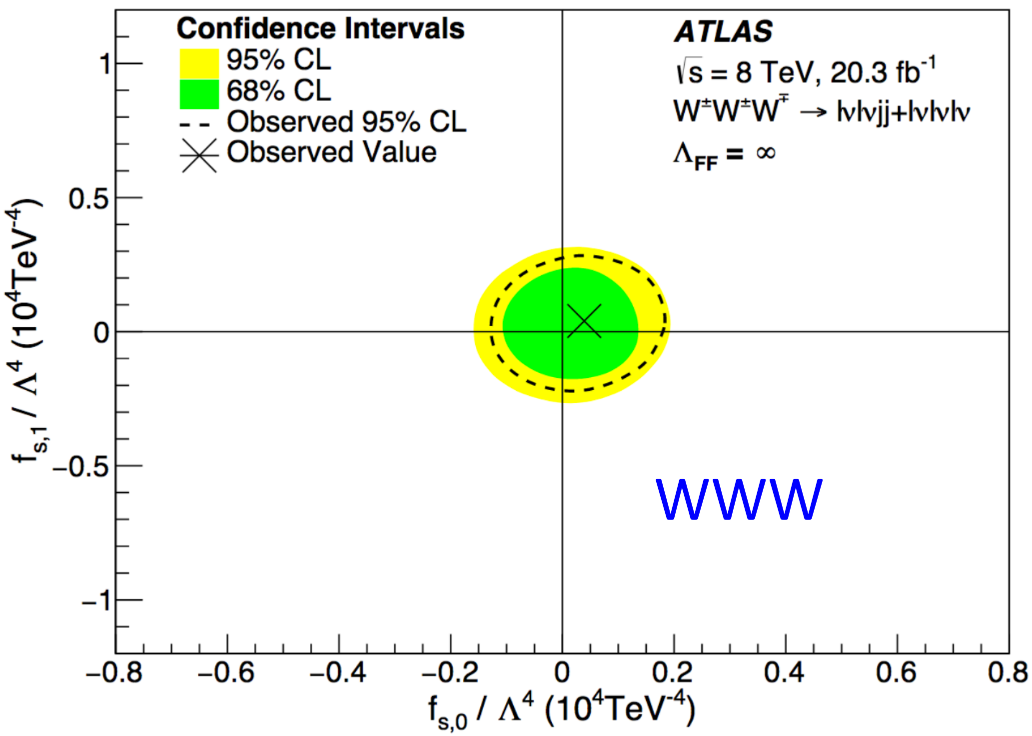
Probing anomalous TGC/QGC

JHEP07(2017)107, EPJC77 (2017) 141



VBS Zγ





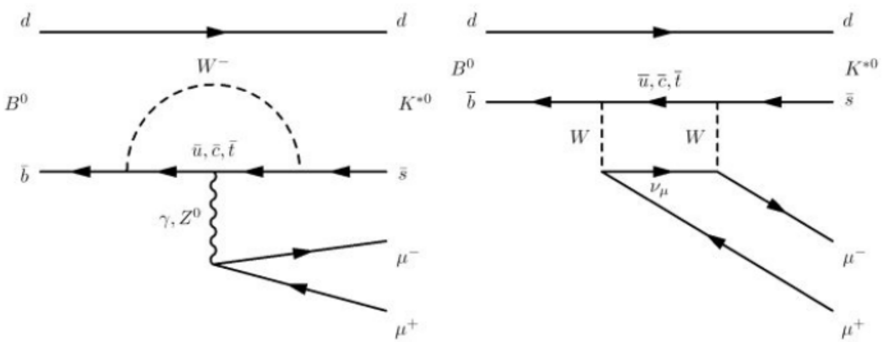
Sensitive to WWZγ, neutral anomalous QGC

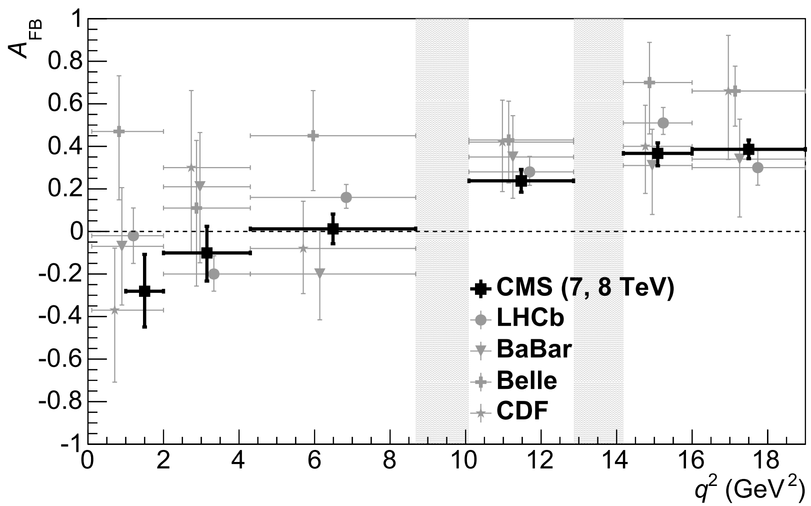
Sensitive to 4-W,HWW anomalous couplings

Heavy flavor

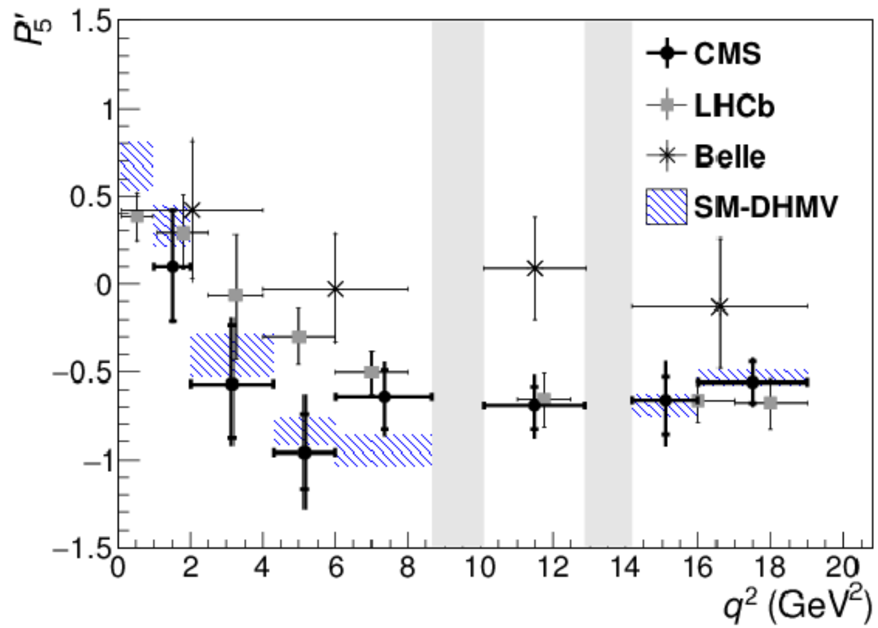
PLB753 (2016) 424, PLB781 (2018) 517

- Angular analyses of flavor-changing neutral current decay $B \to K^{(*)}\mu^+\mu^-$





Forward-backward asymmetry of the muons (A_{FB}) vs. dimuon invariant mass squared (q^2)



P'_5 : a form factor independent observable

参见王大勇报告

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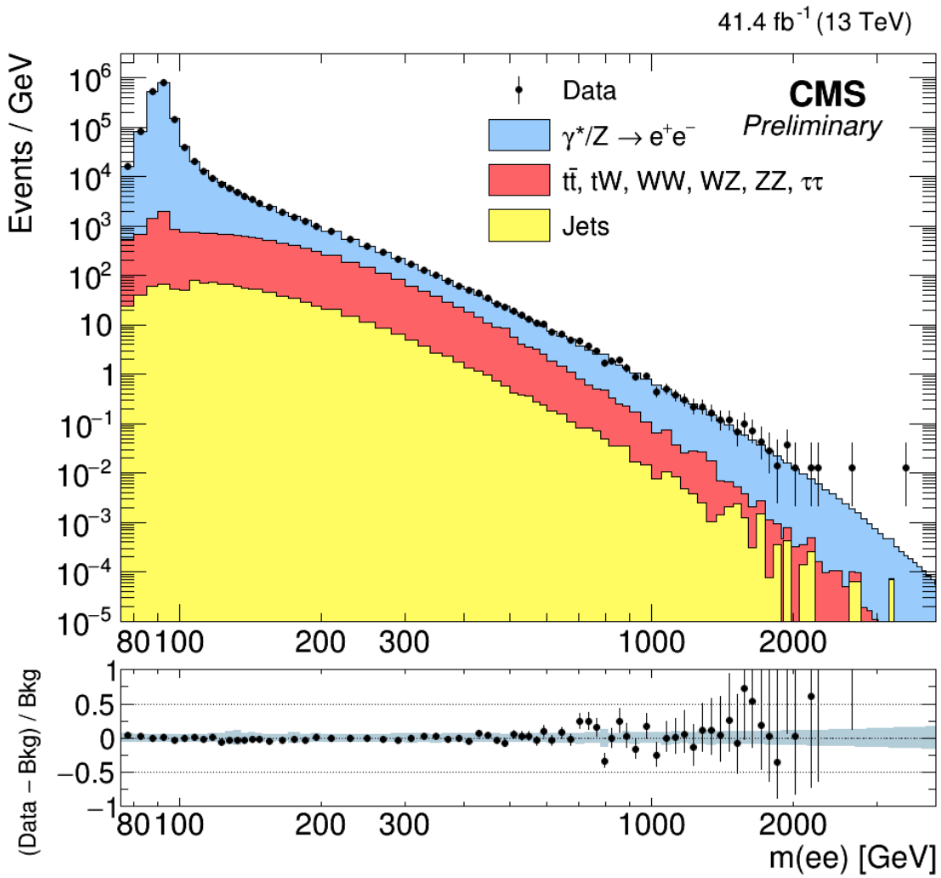
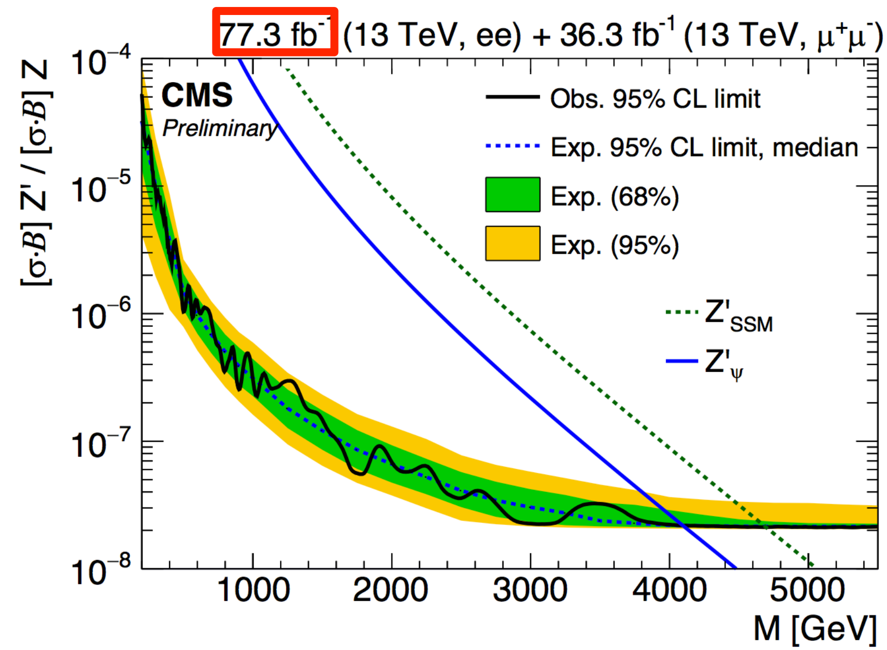
- Outlook and Summary

Search for high-mass di-lepton resonances

CMS-PAS-EXO-18-006

- Limits for high mass searches extending beyond 4 TeV with first 2017 data analyses





Channel	Model	Obs. limit (TeV)	Exp. limit (TeV)
ee (2017)	Z'_{SSM}	4.10	4.15
	Z'_{ψ}	3.35	3.55
ee (2016 and 2017) + $\mu\mu$ (2016)	Z'_{SSM}	4.7	4.7
	Z'_{ψ}	4.1	4.1

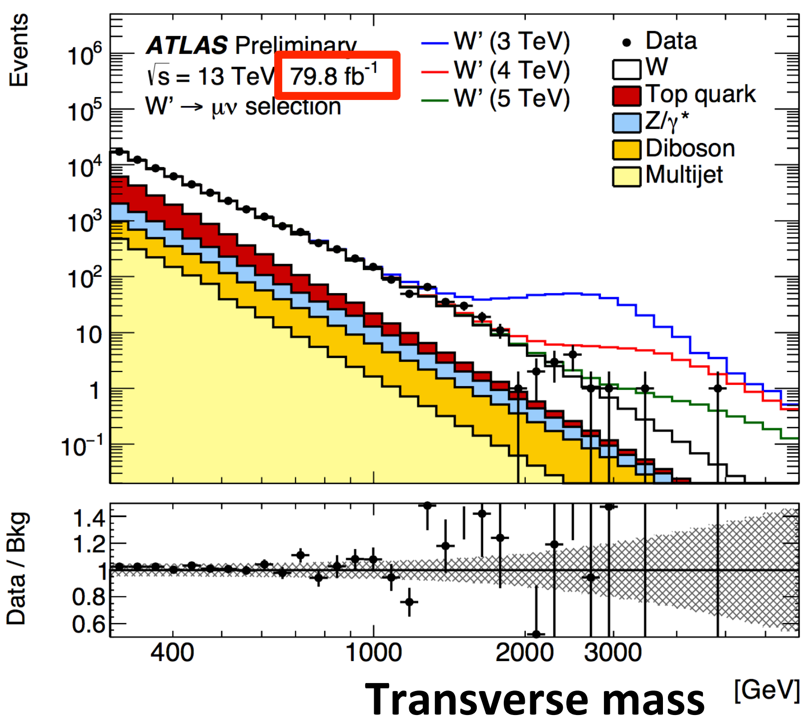
参见高旭阳报告

Resonance search with high p_T lepton

ATLAS-CONF-2018-017, ATLAS-CONF-2018-015

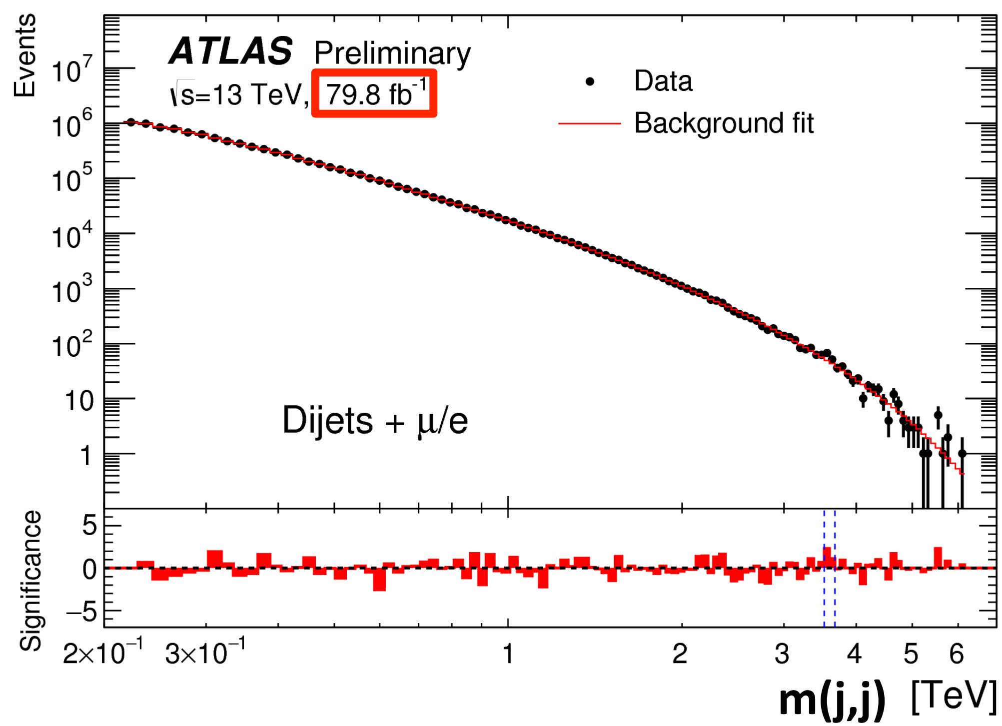
- Limits for high mass searches extending beyond 4 TeV with first 2017 data analyses

W' → e/μ+MET



W' in context of sequential SM excluded up to 5.5 TeV

Di-jet resonance in pp→ W+X

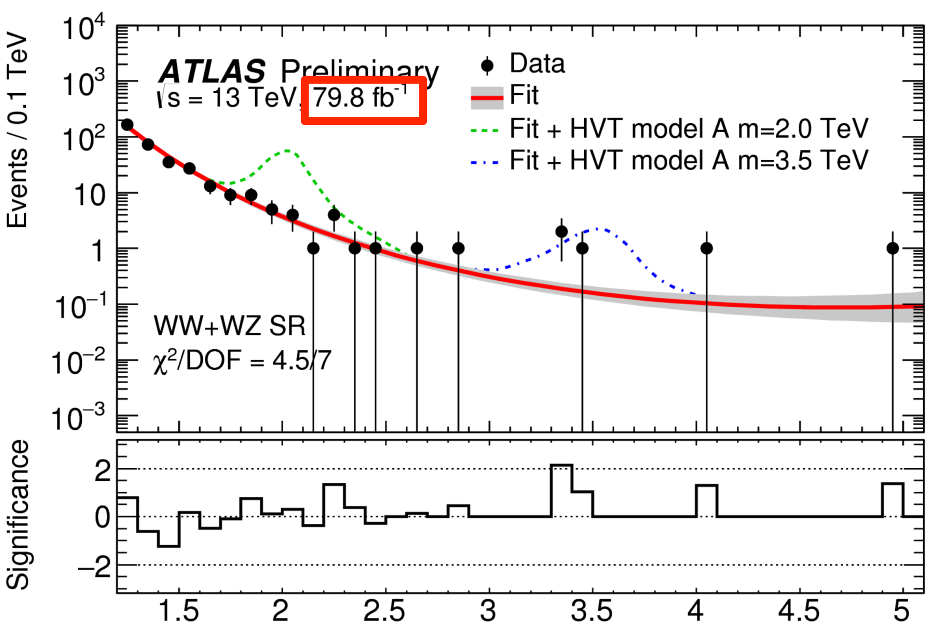


new topology search

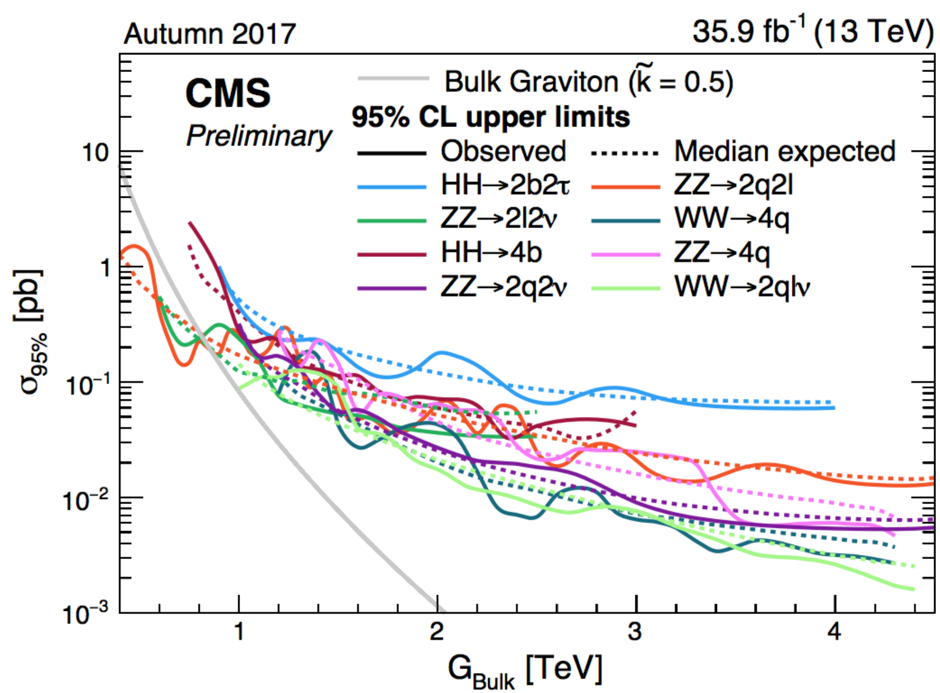
95% CL limit on σ*A*ε:
50 fb-0.1 fb, for masses 0.25-6 TeV

Di-boson resonance searches

- Substructure techniques (for jets, b-tagging) used for maximizing sensitivity to boosted topologies, large mass range
  - Includes using the Higgs as a discovery tool ("Higgs-tagging")



ATLAS-CONF-2018-016 M(JJ) for WW+WZ

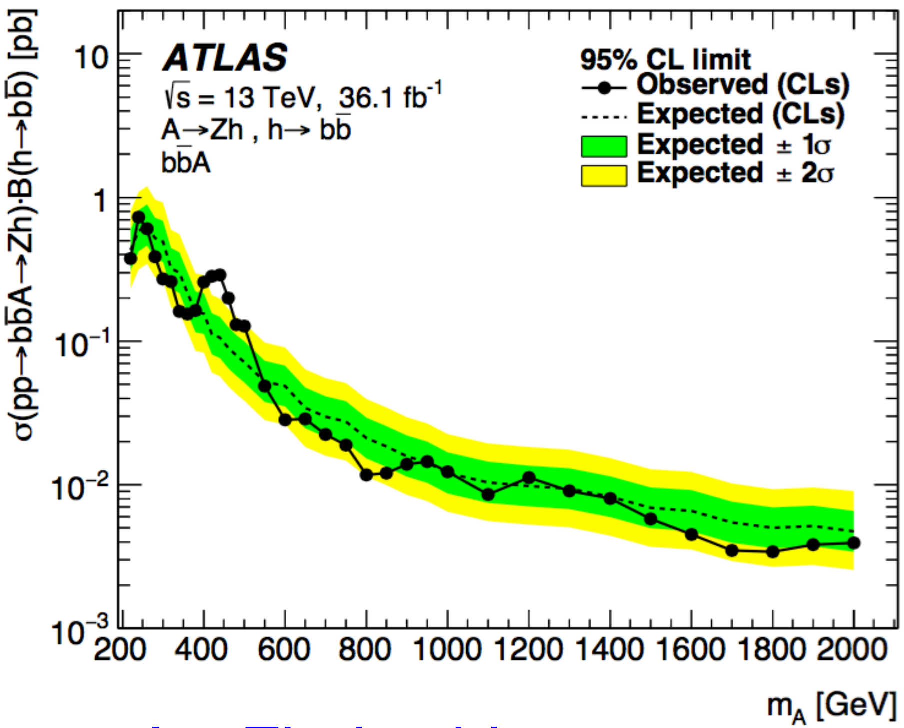


Both experiments have comprehensive di-boson search programs

参见吕旭东、赵永柯、苏琬云报告

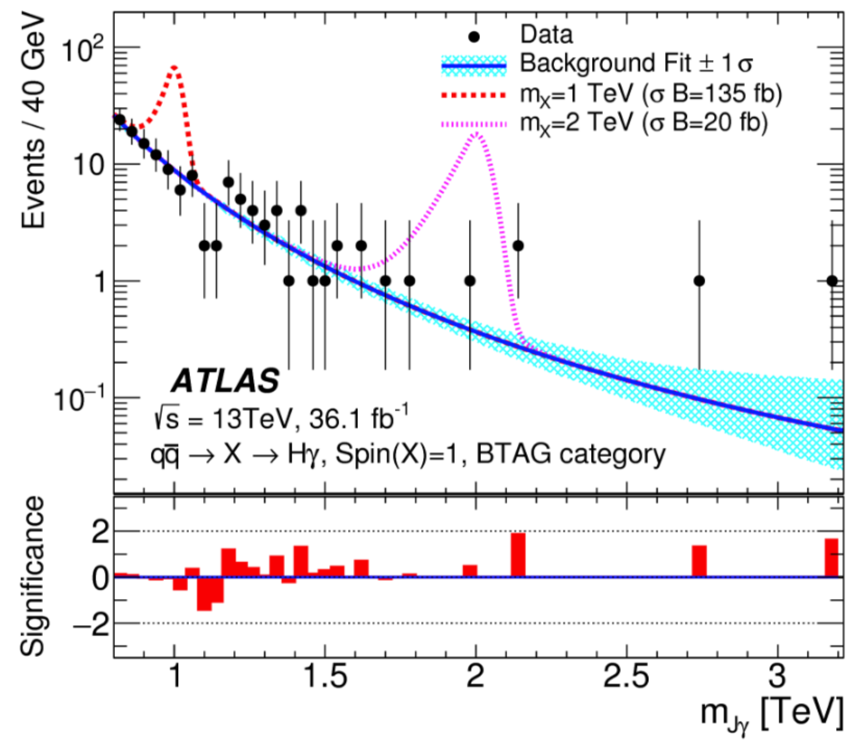
Di-boson resonance searches

JHEP 03 (2018) 174, arXiv:1805.01908



A→Zh, h→bb

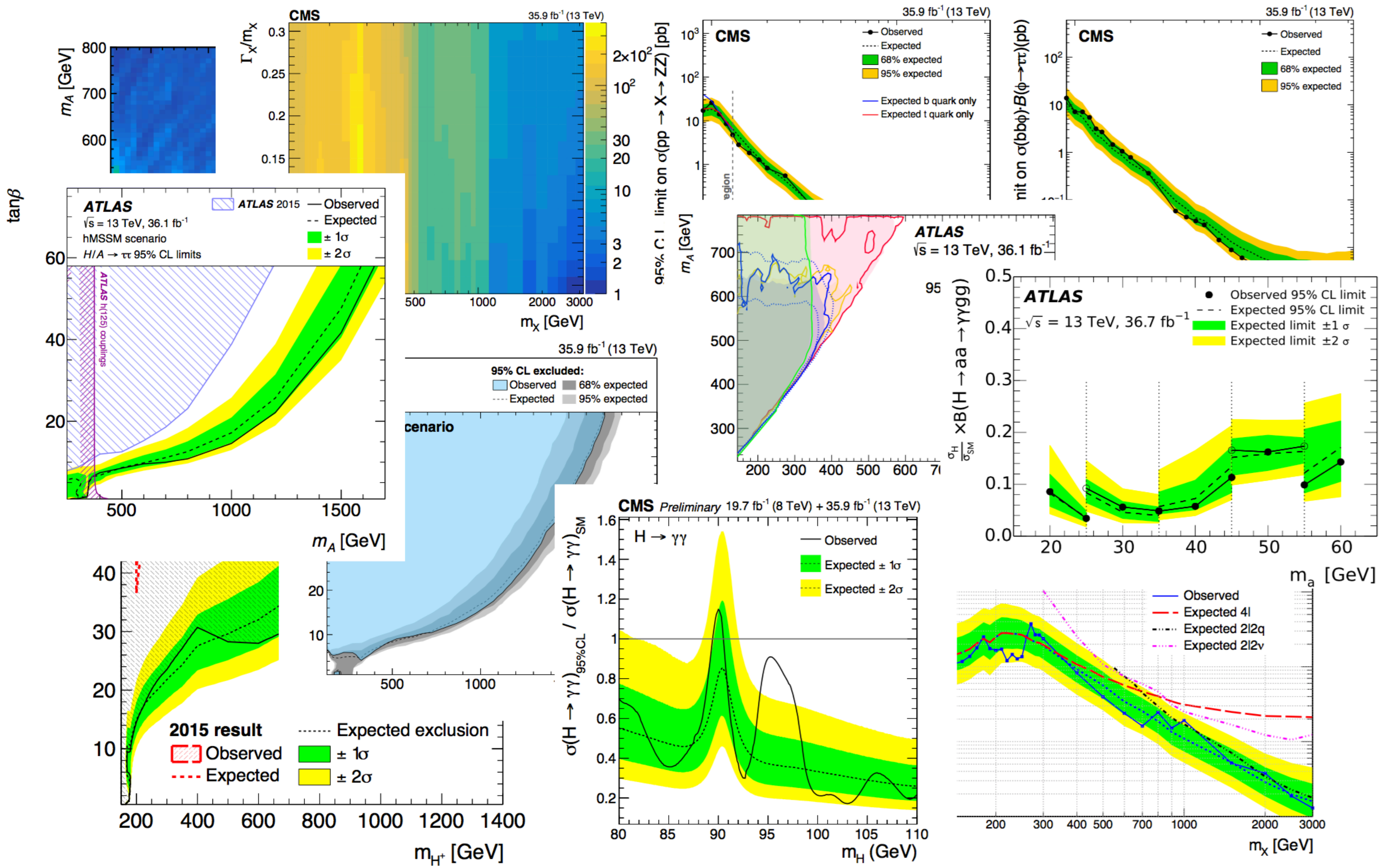
Mild excess around 440 GeV in bbA search (3.6σ local, 2.4σ global)



X→ Higgs + Photon

参见郭军、梁志均、李数报告

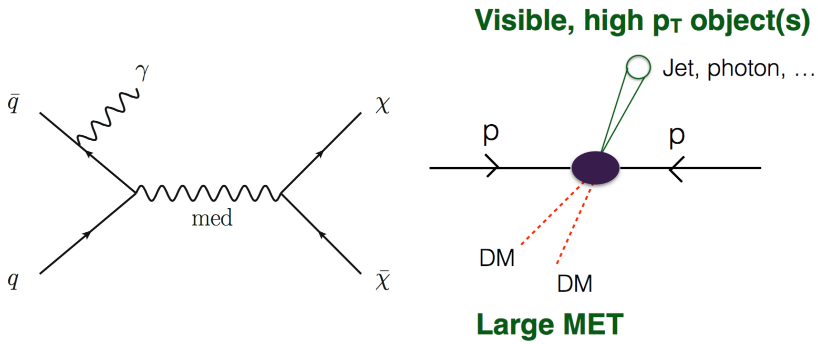
Additional Higgs ?

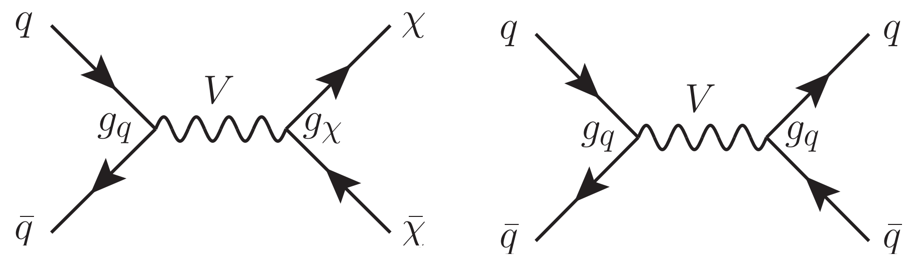


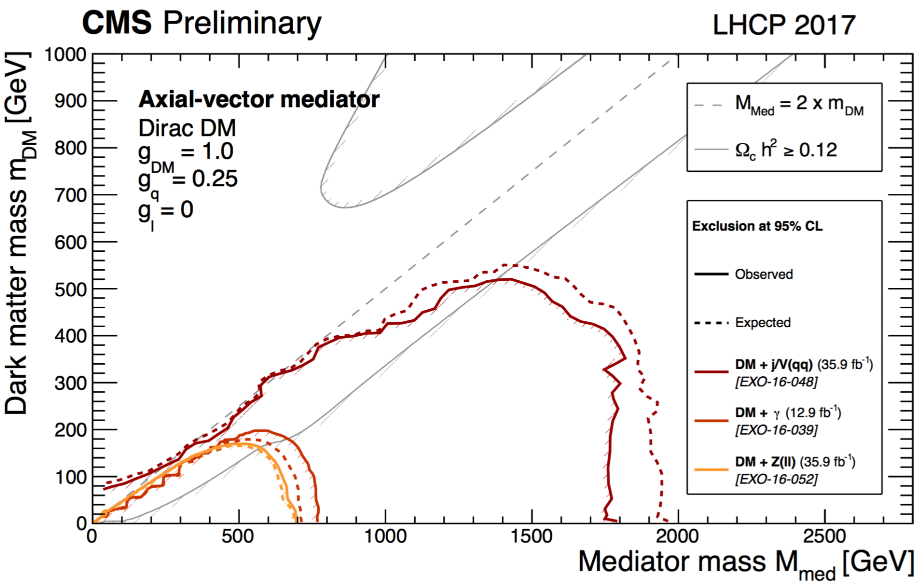
Many searches, no significant excess yet

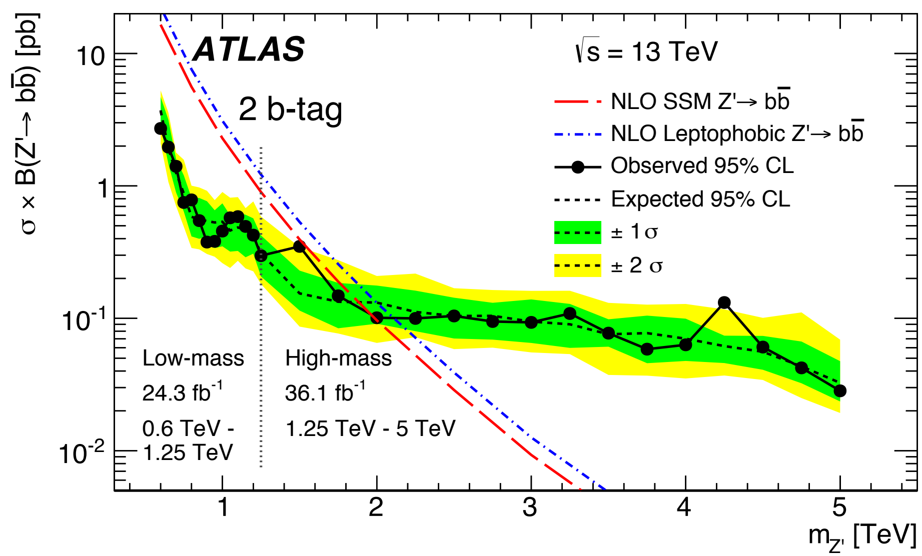
Dark matter searches

arXiv:1805.09299







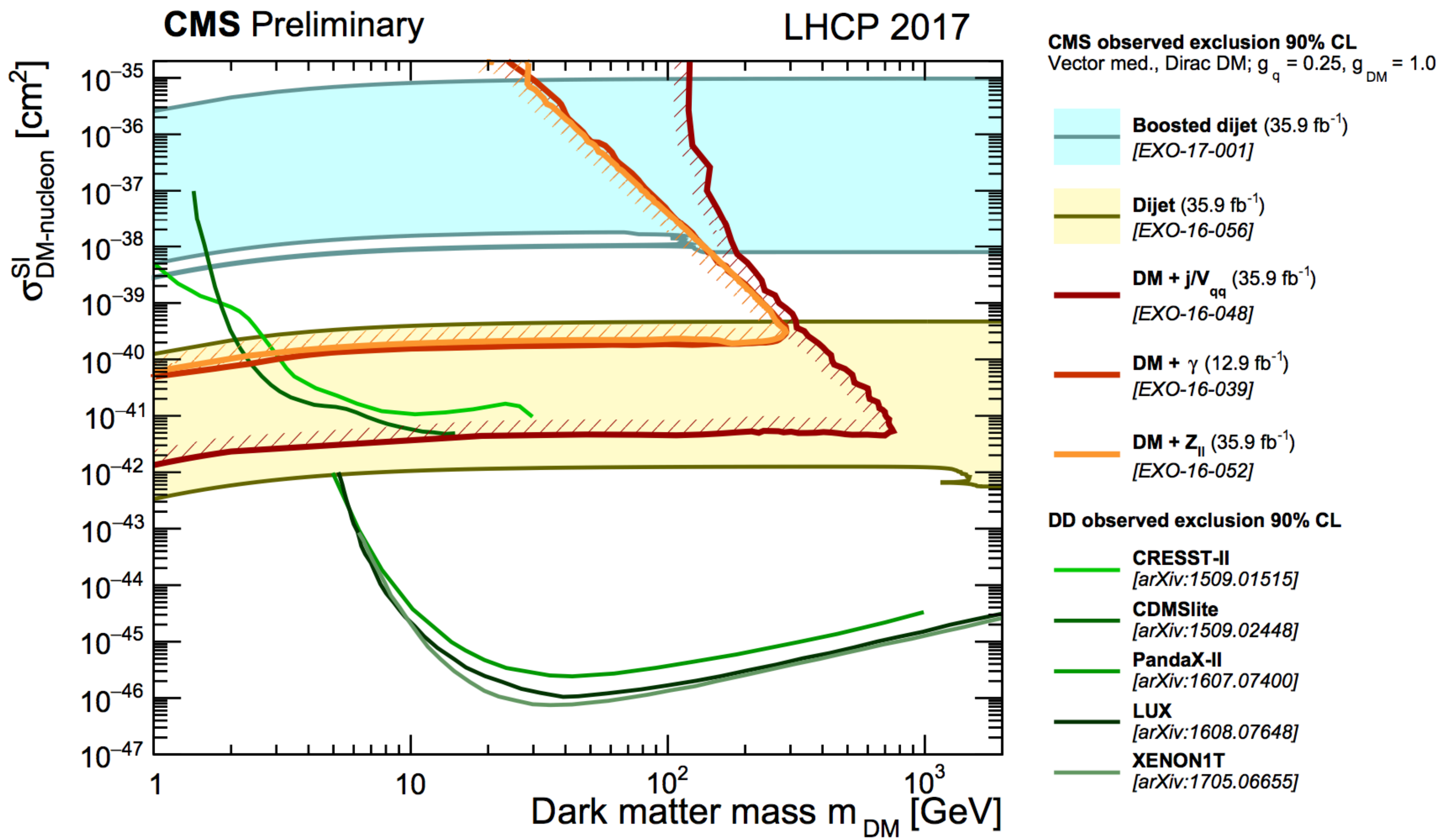


mono-X type search

Constraints from searches looking for visible Z' decays

参见周宁报告

Dark matter searches

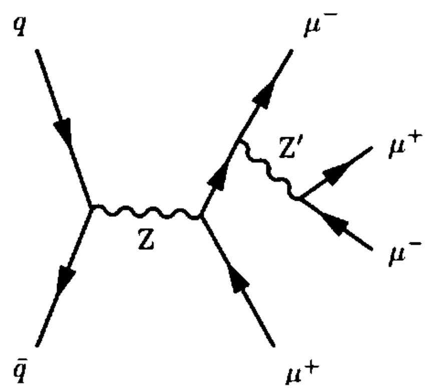


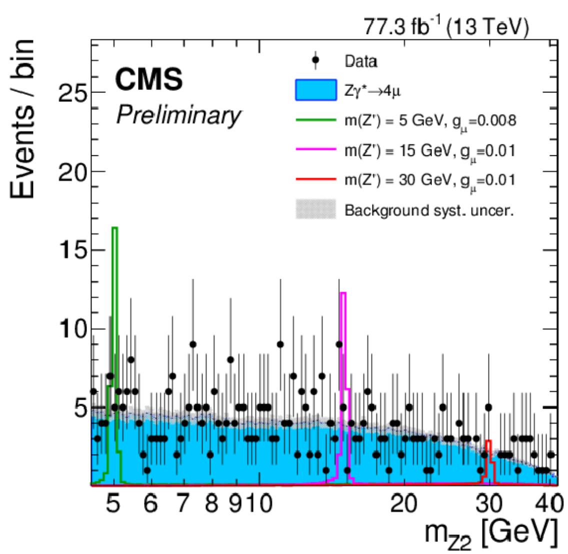
No hints at LHC yet

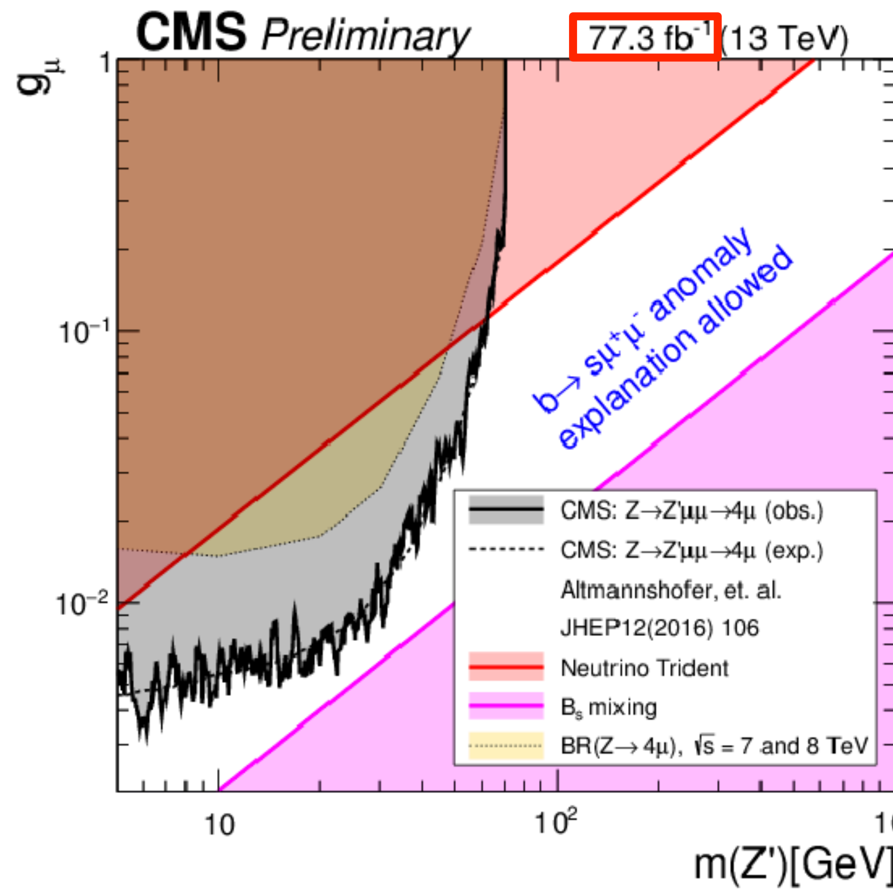
What if Dark Matter doesn't couple to quarks

CMS-PAS-EXO-18-008

- Also motivated by LFU tensions and muon g-2
- Search for an L_μ-L_τ gauge boson: a narrow light Z' decaying in $\mu^+\mu^-$ with $Z \to 4\mu$ events

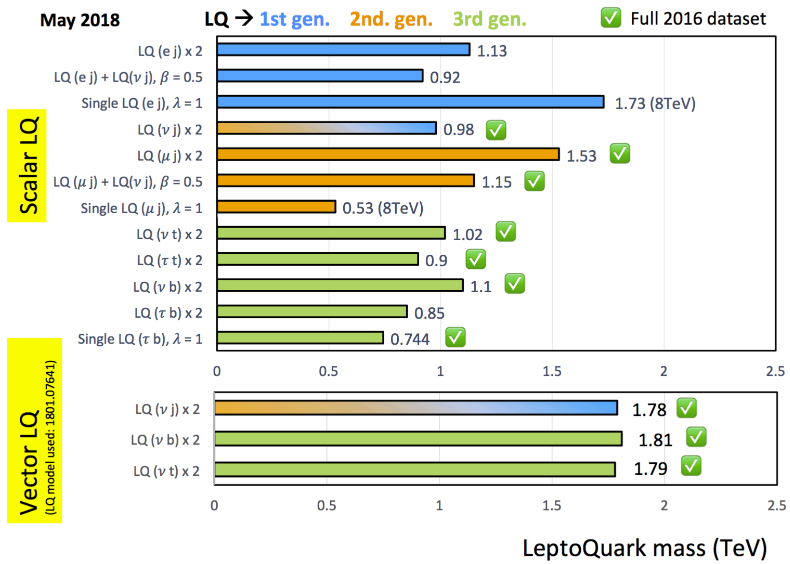


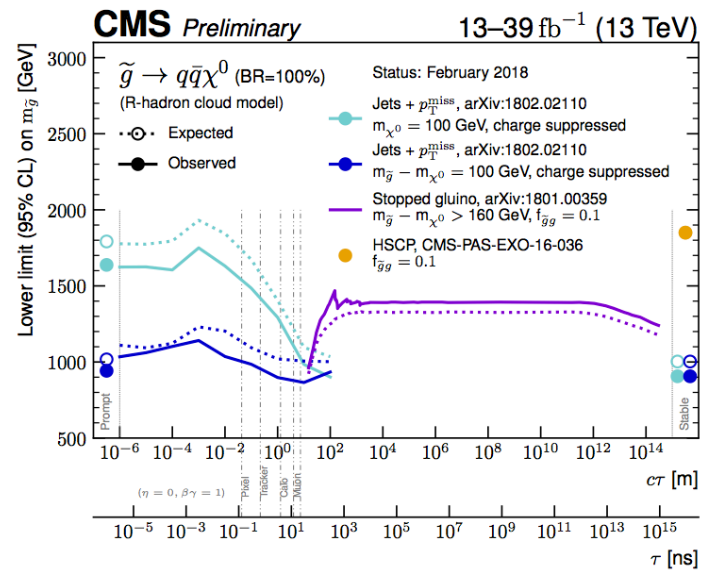


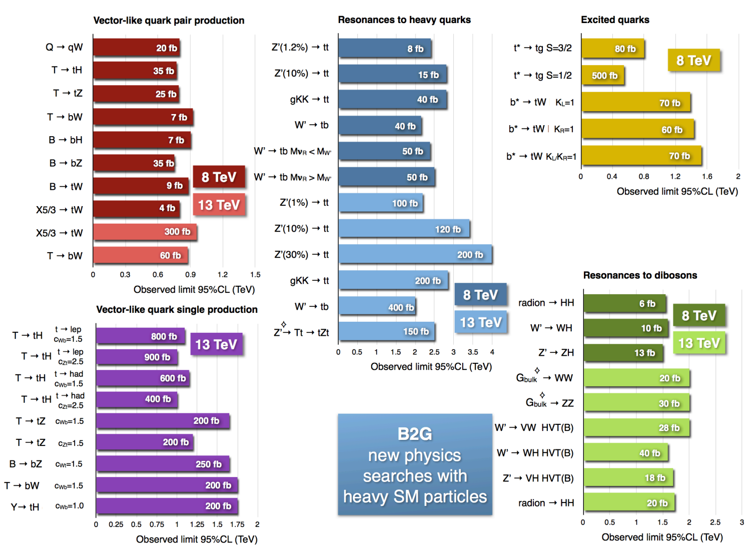


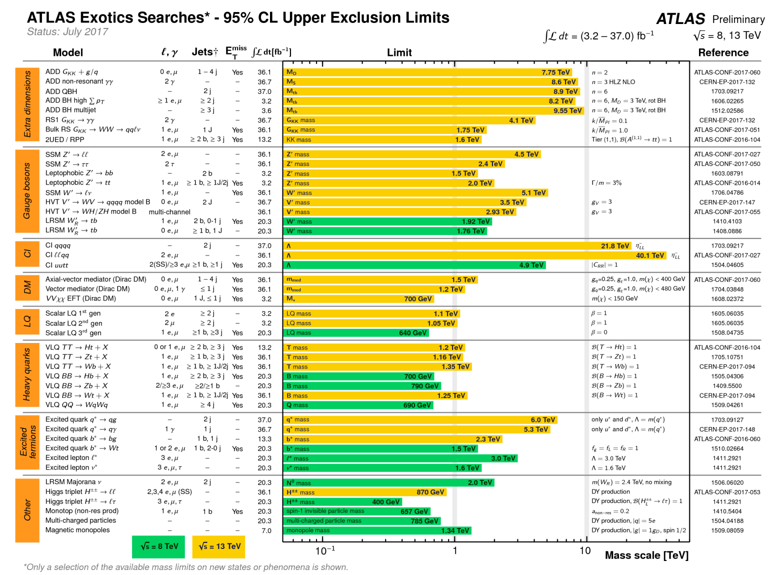
参见Tahir报告

Many other exotica searches









参见Bret、余涛哲、陈晔、袁睿等报告

Searches for SUSY

ATLAS SUSY Searches* - 95% CL Lower Limits

December 2017

ATLAS Preliminary $\sqrt{s}$ = 7, 8, 13 TeV

$\sqrt{s}$ = 7, 8 TeV | $\sqrt{s}$ = 13 TeV

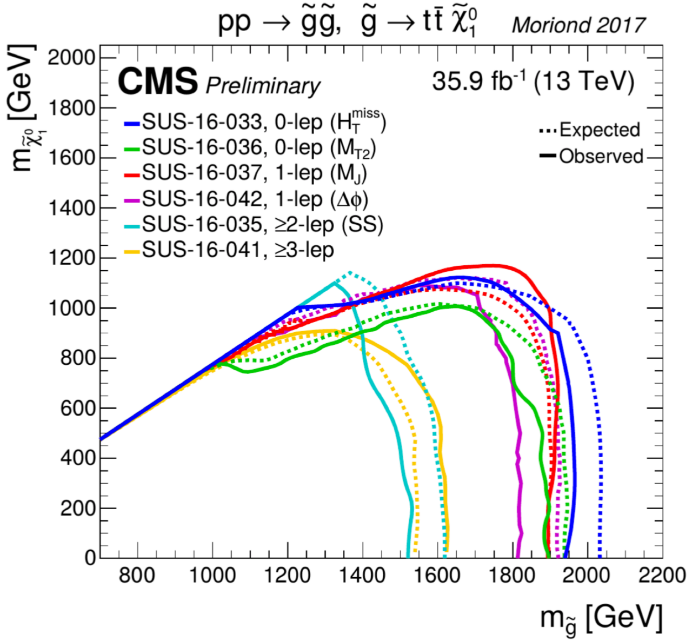
Model	e,μ,τ,γ	Jets	E_T^{miss}	$\int \mathcal{L}\,dt[fb^{-1}]$	Mass limit	Conditions	Reference
$\tilde{q}\tilde{q}, \tilde{q}\to q\tilde{\chi}_1^0$	0	2-6 jets	Yes	36.1	$\tilde{q}$ 1.57 TeV	$m(\tilde{\chi}_1^0)$<200 GeV, m(1st gen. $\tilde{q}$)=m(2nd gen. $\tilde{q}$)	1712.02332
$\tilde{q}\tilde{q}, \tilde{q}\to q\tilde{\chi}_1^0$ (compressed)	mono-jet	1-3 jets	Yes	36.1	$\tilde{q}$ 710 GeV	$m(\tilde{q})-m(\tilde{\chi}_1^0)$<5 GeV	1711.03301
$\tilde{g}\tilde{g}, \tilde{g}\to q\bar{q}\tilde{\chi}_1^0$	0	2-6 jets	Yes	36.1	$\tilde{g}$ 2.02 TeV	$m(\tilde{\chi}_1^0)$<200 GeV	1712.02332
$\tilde{g}\tilde{g}, \tilde{g}\to qq\tilde{\chi}_1^{\pm}\to qqW^{\pm}\tilde{\chi}_1^0$	0	2-6 jets	Yes	36.1	$\tilde{g}$ 2.01 TeV	$m(\tilde{\chi}_1^0)$<200 GeV, $m(\tilde{\chi}^{\pm})=0.5(m(\tilde{\chi}_1^0)+m(\tilde{g}))$	1712.02332
$\tilde{g}\tilde{g}, \tilde{g}\to q\bar{q}(\ell\ell)\tilde{\chi}_1^0$	$ee,\mu\mu$	2 jets	Yes	14.7	$\tilde{g}$ 1.7 TeV	$m(\tilde{\chi}_1^0)$<300 GeV,	1611.05791
$\tilde{g}\tilde{g}, \tilde{g}\to qq(\ell\ell/\nu\nu)\tilde{\chi}_1^0$	3 e,μ	4 jets	-	36.1	$\tilde{g}$ 1.87 TeV	$m(\tilde{\chi}_1^0)$=0 GeV	1706.03731
$\tilde{g}\tilde{g}, \tilde{g}\to qqWZ\tilde{\chi}_1^0$	0	7-11 jets	Yes	36.1	$\tilde{g}$ 1.8 TeV	$m(\tilde{\chi}_1^0)$ <400 GeV	1708.02794
GMSB ($\tilde{\ell}$ NLSP)	1-2 τ + 0-1 ℓ	0-2 jets	Yes	3.2	$\tilde{g}$ 2.0 TeV		1607.05979
GGM (bino NLSP)	2 γ	-	Yes	36.1	$\tilde{g}$ 2.15 TeV	$c\tau$(NLSP)<0.1 mm	ATLAS-CONF-2017-080
GGM (higgsino-bino NLSP)	γ	2 jets	Yes	36.1	$\tilde{g}$ 2.05 TeV	$m(\tilde{\chi}_1^0)$=1700 GeV, $c\tau$(NLSP)<0.1 mm, μ>0	ATLAS-CONF-2017-080
Gravitino LSP	0	mono-jet	Yes	20.3	$F^{1/2}$ scale 865 GeV	$m(\tilde{G})>1.8\times10^{-4}$ eV, $m(\tilde{g})=m(\tilde{q})$=1.5 TeV	1502.01518
$\tilde{g}\tilde{g}, \tilde{g}\to b\bar{b}\tilde{\chi}_1^0$	0	3 b	Yes	36.1	$\tilde{g}$ 1.92 TeV	$m(\tilde{\chi}_1^0)$<600 GeV	1711.01901
$\tilde{g}\tilde{g}, \tilde{g}\to t\bar{t}\tilde{\chi}_1^0$	0-1 e,μ	3 b	Yes	36.1	$\tilde{g}$ 1.97 TeV	$m(\tilde{\chi}_1^0)$<200 GeV	1711.01901
$\tilde{b}_1\tilde{b}_1, \tilde{b}_1\to b\tilde{\chi}_1^0$	0	2 b	Yes	36.1	$\tilde{b}_1$ 950 GeV	$m(\tilde{\chi}_1^0)$<420 GeV	1708.09266
$\tilde{b}_1\tilde{b}_1, \tilde{b}_1\to t\tilde{\chi}_1^{\pm}$	2 e,μ (SS)	1 b	Yes	36.1	$\tilde{b}_1$ 275-700 GeV	$m(\tilde{\chi}_1^0)$<200 GeV, $m(\tilde{\chi}_1^{\pm})=m(\tilde{\chi}_1^0)$+100 GeV	1706.03731
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to b\tilde{\chi}_1^{\pm}$	0-2 e,μ	1-2 b	Yes	4.7/13.3	$\tilde{t}_1$ 117-170 GeV, 200-720 GeV	$m(\tilde{\chi}_1^{\pm})=2m(\tilde{\chi}_1^0)$, $m(\tilde{\chi}_1^0)$=55 GeV	1209.2102, ATLAS-CONF-2016-077
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to Wb\tilde{\chi}_1^0$ or $t\tilde{\chi}_1^0$	0-2 e,μ	0-2 jets/1-2 b	Yes	20.3/36.1	$\tilde{t}_1$ 90-198 GeV, 0.195-1.0 TeV	$m(\tilde{\chi}_1^0)$=1 GeV	1506.08616, 1709.04183, 1711.11520
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to c\tilde{\chi}_1^0$	0	mono-jet	Yes	36.1	$\tilde{t}_1$ 90-430 GeV	$m(\tilde{t}_1)-m(\tilde{\chi}_1^0)$=5 GeV	1711.03301
$\tilde{t}_1\tilde{t}_1$(natural GMSB)	2 e,μ (Z)	1 b	Yes	20.3	$\tilde{t}_1$ 150-600 GeV	$m(\tilde{\chi}_1^0)$>150 GeV	1403.5222
$\tilde{t}_2\tilde{t}_2, \tilde{t}_2\to\tilde{t}_1+Z$	3 e,μ (Z)	1 b	Yes	36.1	$\tilde{t}_2$ 290-790 GeV	$m(\tilde{\chi}_1^0)$=0 GeV	1706.03986
$\tilde{t}_2\tilde{t}_2, \tilde{t}_2\to\tilde{t}_1+h$	1-2 e,μ	4 b	Yes	36.1	$\tilde{t}_2$ 320-880 GeV	$m(\tilde{\chi}_1^0)$=0 GeV	1706.03986
$\tilde{\ell}_{L,R}\tilde{\ell}_{L,R}, \tilde{\ell}\to\ell\tilde{\chi}_1^0$	2 e,μ	0	Yes	36.1	$\tilde{\ell}$ 90-500 GeV	$m(\tilde{\chi}_1^0)$=0	ATLAS-CONF-2017-039
$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to\tilde{\ell}\nu(\ell\tilde{\nu})$	2 e,μ	0	Yes	36.1	$\tilde{\chi}_1^{\pm}$ 750 GeV	$m(\tilde{\chi}_1^0)$=0, $m(\tilde{\ell},\tilde{\nu})=0.5(m(\tilde{\chi}_1^{\pm})+m(\tilde{\chi}_1^0))$	ATLAS-CONF-2017-039
$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}/\tilde{\chi}_2^0, \tilde{\chi}_1^+\to\tilde{\tau}\nu(\tau\tilde{\nu}), \tilde{\chi}_2^0\to\tilde{\tau}\tau(\nu\tilde{\nu})$	2 τ	-	Yes	36.1	$\tilde{\chi}_1^{\pm}$ 760 GeV	$m(\tilde{\chi}_1^0)$=0, $m(\tilde{\tau},\tilde{\nu})=0.5(m(\tilde{\chi}_1^{\pm})+m(\tilde{\chi}_1^0))$	1708.07875
$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0\to\tilde{\ell}_L\nu\tilde{\ell}_L\ell(\tilde{\nu}\nu), \ell\tilde{\nu}\tilde{\ell}_L\ell(\tilde{\nu}\nu)$	3 e,μ	0	Yes	36.1	$\tilde{\chi}_1^{\pm},\tilde{\chi}_2^0$ 1.13 TeV	$m(\tilde{\chi}_1^{\pm})=m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, $m(\tilde{\ell},\tilde{\nu})=0.5(m(\tilde{\chi}_1^{\pm})+m(\tilde{\chi}_1^0))$	ATLAS-CONF-2017-039
$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0\to W\tilde{\chi}_1^0Z\tilde{\chi}_1^0$	2-3 e,μ	0-2 jets	Yes	36.1	$\tilde{\chi}_1^{\pm},\tilde{\chi}_2^0$ 580 GeV	$m(\tilde{\chi}_1^{\pm})=m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, $\tilde{\ell}$ decoupled	ATLAS-CONF-2017-039
$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0\to W\tilde{\chi}_1^0h\tilde{\chi}_1^0, h\to b\bar{b}/WW/\tau\tau/\gamma\gamma$	e,μ,γ	0-2 b	Yes	20.3	$\tilde{\chi}_1^{\pm},\tilde{\chi}_2^0$ 270 GeV	$m(\tilde{\chi}_1^{\pm})=m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, $\tilde{\ell}$ decoupled	1501.07110
$\tilde{\chi}_2^0\tilde{\chi}_3^0, \tilde{\chi}_{2,3}^0\to\tilde{\ell}_R\ell$	4 e,μ	0	Yes	20.3	$\tilde{\chi}_{2,3}^0$ 635 GeV	$m(\tilde{\chi}_2^0)=m(\tilde{\chi}_3^0)$, $m(\tilde{\chi}_1^0)$=0, $m(\tilde{\ell},\tilde{\nu})=0.5(m(\tilde{\chi}_2^0)+m(\tilde{\chi}_1^0))$	1405.5086
GGM (wino NLSP) weak prod., $\tilde{\chi}_1^0\to\gamma\tilde{G}$	1 e,μ + γ	-	Yes	20.3	$\tilde{W}$ 115-370 GeV	$c\tau$<1 mm	1507.05493
GGM (bino NLSP) weak prod., $\tilde{\chi}_1^0\to\gamma\tilde{G}$	2 γ	-	Yes	36.1	$\tilde{W}$ 1.06 TeV	$c\tau$<1 mm	ATLAS-CONF-2017-080
Direct $\tilde{\chi}_1^+\tilde{\chi}_1^-$ prod., long-lived $\tilde{\chi}_1^{\pm}$	Disapp. trk	1 jet	Yes	36.1	$\tilde{\chi}_1^{\pm}$ 460 GeV	$m(\tilde{\chi}_1^{\pm})-m(\tilde{\chi}_1^0)$~160 MeV, $\tau(\tilde{\chi}_1^{\pm})$=0.2 ns	1712.02118
Direct $\tilde{\chi}_1^+\tilde{\chi}_1^-$ prod., long-lived $\tilde{\chi}_1^{\pm}$	dE/dx trk	-	Yes	18.4	$\tilde{\chi}_1^{\pm}$ 495 GeV	$m(\tilde{\chi}_1^{\pm})-m(\tilde{\chi}_1^0)$~160 MeV, $\tau(\tilde{\chi}_1^{\pm})$<15 ns	1506.05332
Stable, stopped $\tilde{g}$ R-hadron	0	1-5 jets	Yes	27.9	$\tilde{g}$ 850 GeV	$m(\tilde{\chi}_1^0)$=100 GeV, 10 μs<$\tau(\tilde{g})$<1000 s	1310.6584
Stable $\tilde{g}$ R-hadron	trk	-	-	3.2	$\tilde{g}$ 1.58 TeV		1606.05129
Metastable $\tilde{g}$ R-hadron	dE/dx trk	-	-	3.2	$\tilde{g}$ 1.57 TeV	$m(\tilde{\chi}_1^0)$=100 GeV, τ>10 ns	1604.04520
Metastable $\tilde{g}$ R-hadron, $\tilde{g}\to qq\tilde{\chi}_1^0$	displ. vtx	-	Yes	32.8	$\tilde{g}$ 2.37 TeV	$\tau(\tilde{g})$=0.17 ns, $m(\tilde{\chi}_1^0)$ = 100 GeV	1710.04901
GMSB, stable $\tilde{\tau}$, $\tilde{\chi}_1^0\to\tilde{\tau}(\tilde{e},\tilde{\mu})+\tau(e,\mu)$	1-2 μ	-	-	19.1	$\tilde{\chi}_1^0$ 537 GeV	10<tanβ<50	1411.6795
GMSB, $\tilde{\chi}_1^0\to\gamma\tilde{G}$, long-lived $\tilde{\chi}_1^0$	2 γ	-	Yes	20.3	$\tilde{\chi}_1^0$ 440 GeV	1<$\tau(\tilde{\chi}_1^0)$<3 ns, SPS8 model	1409.5542
$\tilde{g}\tilde{g}, \tilde{\chi}_1^0\to ee\nu/e\mu\nu/\mu\mu\nu$	displ. $ee/e\mu/\mu\mu$	-	-	20.3	$\tilde{\chi}_1^0$ 1.0 TeV	7 <$c\tau(\tilde{\chi}_1^0)$< 740 mm, $m(\tilde{g})$=1.3 TeV	1504.05162
LFV $pp\to\tilde{\nu}_\tau+X, \tilde{\nu}_\tau\to e\mu/e\tau/\mu\tau$	$e\mu,e\tau,\mu\tau$	-	-	3.2	$\tilde{\nu}_\tau$ 1.9 TeV	λ'_{311}=0.11, $\lambda_{132/133/233}$=0.07	1607.08079
Bilinear RPV CMSSM	2 e,μ (SS)	0-3 b	Yes	20.3	$\tilde{q},\tilde{g}$ 1.45 TeV	$m(\tilde{q})=m(\tilde{g})$, $c\tau_{LSP}$<1 mm	1404.2500
$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to W\tilde{\chi}_1^0, \tilde{\chi}_1^0\to ee\nu, e\mu\nu, \mu\mu\nu$	4 e,μ	-	Yes	13.3	$\tilde{\chi}_1^{\pm}$ 1.14 TeV	$m(\tilde{\chi}_1^0)$>400GeV, $\lambda_{12k}\neq0$ (k = 1, 2)	ATLAS-CONF-2016-075
$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to W\tilde{\chi}_1^0, \tilde{\chi}_1^0\to\tau\tau\nu_e, e\tau\nu_\tau$	3 e,μ + τ	-	Yes	20.3	$\tilde{\chi}_1^{\pm}$ 450 GeV	$m(\tilde{\chi}_1^0)>0.2\times m(\tilde{\chi}_1^{\pm})$, $\lambda_{133}\neq0$	1405.5086
$\tilde{g}\tilde{g}, \tilde{g}\to qq\tilde{\chi}_1^0, \tilde{\chi}_1^0\to qqq$	0	4-5 large-R jets	-	36.1	$\tilde{g}$ 1.875 TeV	$m(\tilde{\chi}_1^0)$=1075 GeV	SUSY-2016-22
$\tilde{g}\tilde{g}, \tilde{g}\to t\bar{t}\tilde{\chi}_1^0, \tilde{\chi}_1^0\to qqq$	1 e,μ	8-10 jets/0-4 b	-	36.1	$\tilde{g}$ 2.1 TeV	$m(\tilde{\chi}_1^0)$= 1 TeV, $\lambda_{112}\neq0$	1704.08493
$\tilde{g}\tilde{g}, \tilde{g}\to\tilde{t}_1t, \tilde{t}_1\to bs$	1 e,μ	8-10 jets/0-4 b	-	36.1	$\tilde{g}$ 1.65 TeV	$m(\tilde{t}_1)$= 1 TeV, $\lambda_{323}\neq0$	1704.08493
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to bs$	0	2 jets + 2 b	-	36.7	$\tilde{t}_1$ 100-470 GeV, 480-610 GeV		1710.07171
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to b\ell$	2 e,μ	2 b	-	36.1	$\tilde{t}_1$ 0.4-1.45 TeV	BR($\tilde{t}_1\to be/\mu$)>20%	1710.05544
Scalar charm, $\tilde{c}\to c\tilde{\chi}_1^0$	0	2 c	Yes	20.3	$\tilde{c}$ 510 GeV	$m(\tilde{\chi}_1^0)$<200 GeV	1501.01325

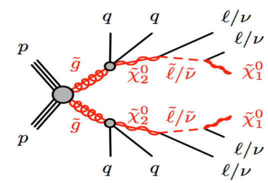
Mass scale [TeV] (axis from 10^{-1} to 1)

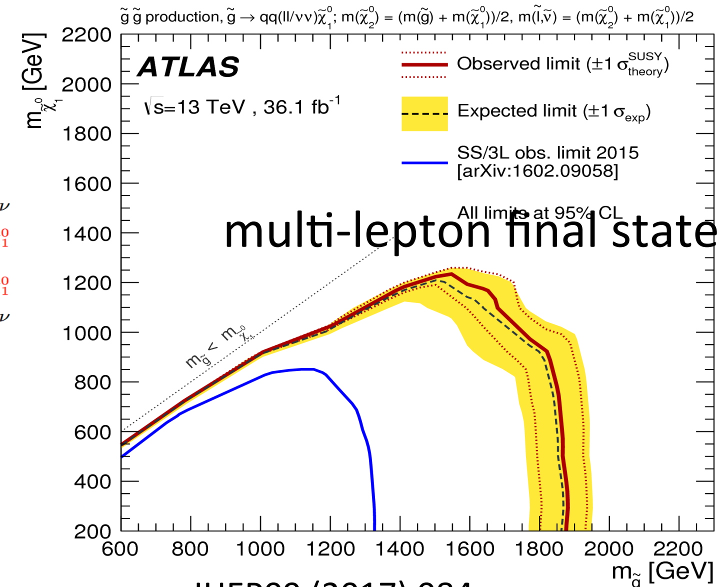
*Only a selection of the available mass limits on new states or phenomena is shown. Many of the limits are based on simplified models, c.f. refs. for the assumptions made.

参见庄胥爱报告

Push hard to full parameter space







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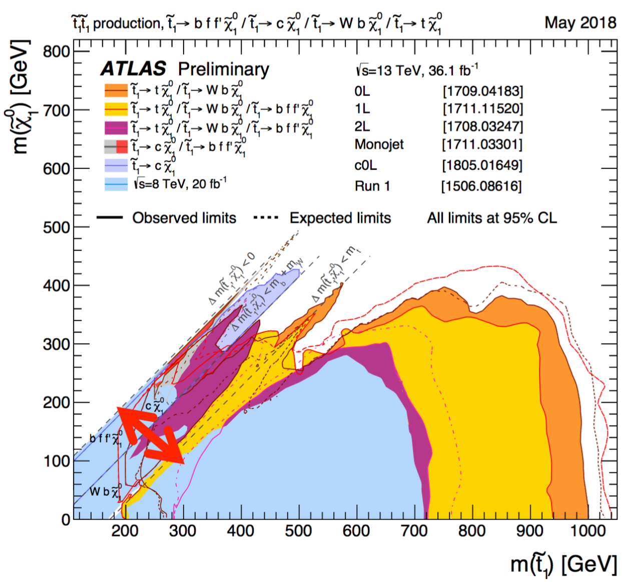

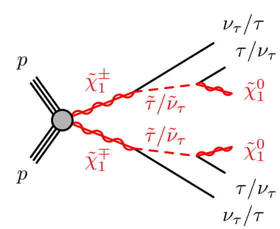

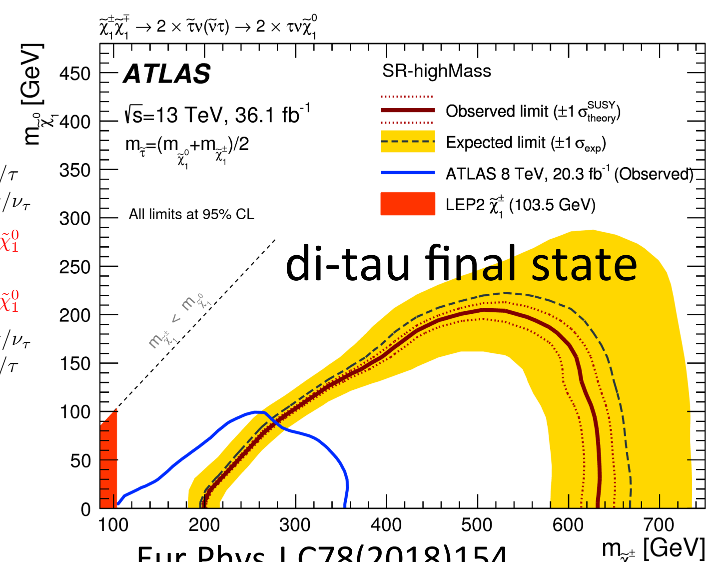

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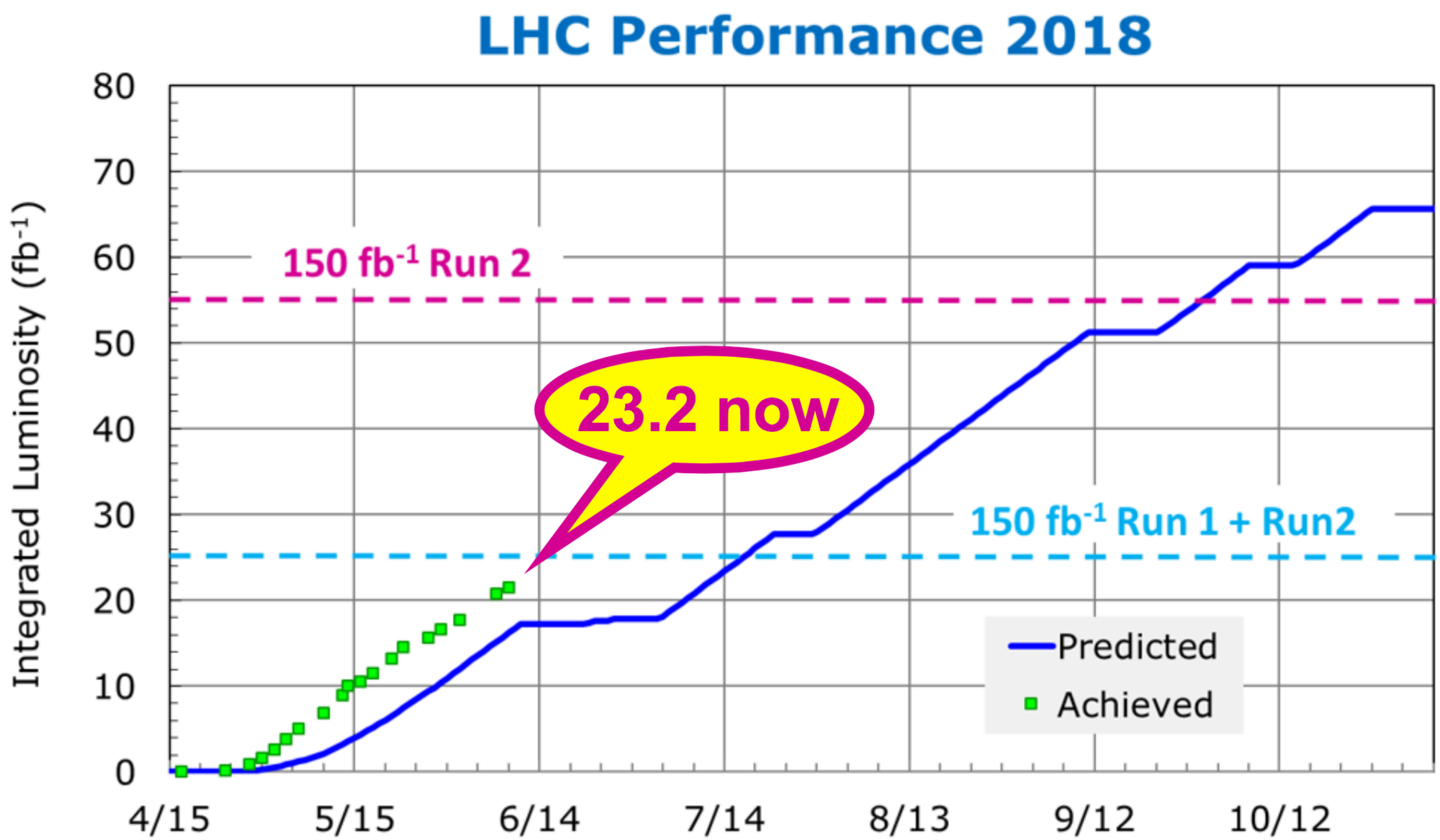
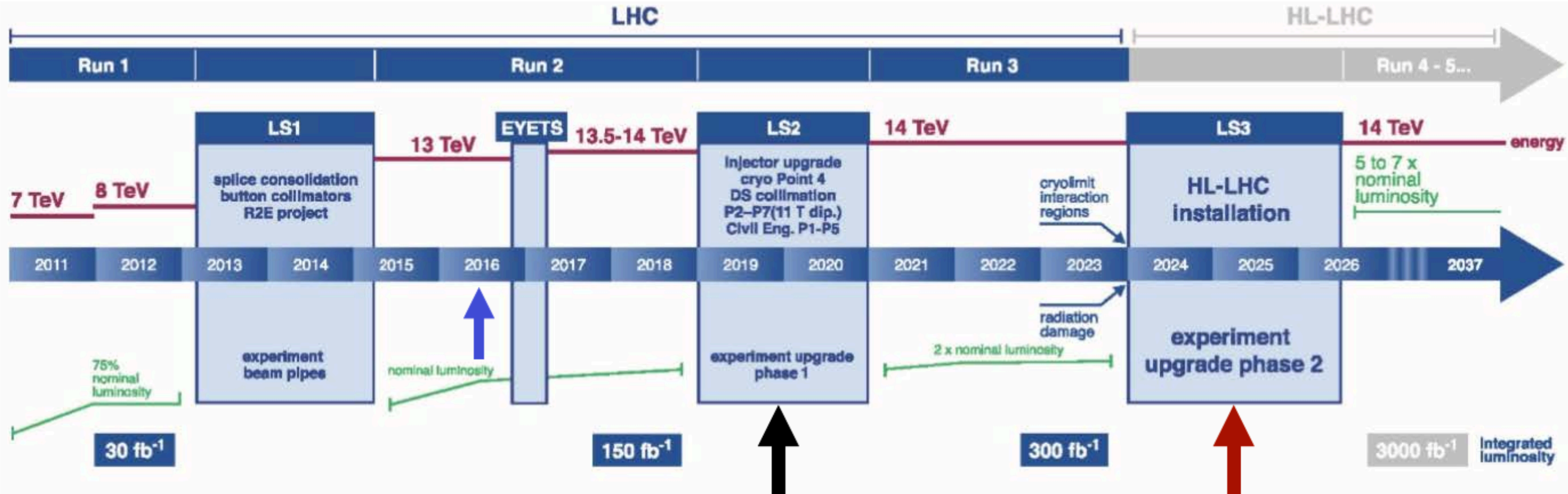
Looking forwards



Almost two weeks ahead schedule

Expect ~150 fb^{-1} (almost double 2016+2017) by the end of 2018

Much more work now devoted to upgrades



LS2 (2019-2020):
- ❑ LHC Injectors Upgrade (LIU)
- ❑ Civil engineering for HL-LHC equipment P1,P5
- ❑ First 11 T dipoles P7; cryogenics in P4
- ❑ Phase-1 upgrade of LHC experiments

LS3 (2024-2026):
- ❑ **HL-LHC installation**
- ❑ Phase-2 upgrade of ATLAS and CMS

Schedule driven by radiation damage to inner triplet (eol: 2023)

Summary

- Approaching a decade after the start, the LHC is now a mature machine, and the detectors are stable, and very well understood
- Direct observation on ttH: it's there at tree-level, and $y_t \approx 1$
- Still no significant deviation/excess from ATLAS/CMS, but only one percent of the full LHC data sample analyzed!
- Completion of Run-2, upgrades and then much more data beyond
- **Let's hope something is still hiding out there**

Don't miss ICHEP for more and exciting resutls!

非常感谢ATLAS和CMS组成员提供大量最新的研究成果。近几年中国组研究队伍和实力显著提升，有许多人担任合作组L2/L3职位，在众多重要物理课题中担任负责人和论文编辑，并在探测器运行、升级上承担越来越多的任务，在合作组中的显示度和作用明显提高！

谢谢大家！

References

- ATLAS
  - https://twiki.cern.ch/twiki/bin/view/AtlasPublic
- CMS
  - http://cms-results.web.cern.ch/cms-results/public-results/publications/