



NAGOYA UNIVERSITY



Kobayashi-Maskawa Institute
for the Origin of Particles and the Universe

Results of LHC-ATLAS

8TeV Run

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Tau-Lepton Physics Research Center

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Nagoya University

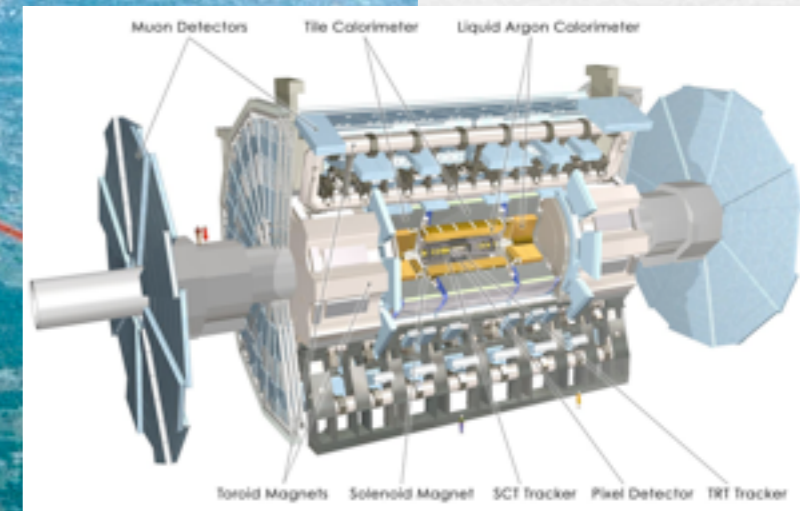


Nagoya University
Tau Lepton Physics Research Center

Contents

LHC experiments

- 2010 : started physics run
- 2011 : physics data ($\sqrt{s}=7$)
- 2012 : physics data ($\sqrt{s}=8$)
- 2012, July : Higgs discovery
- 2013- : upgrade

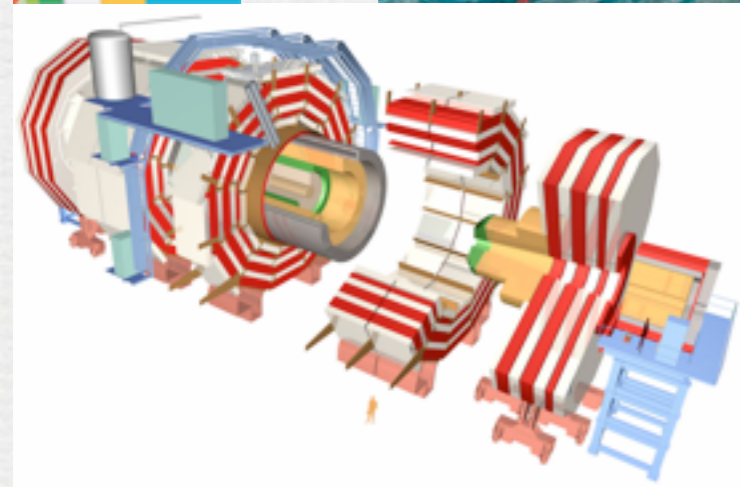
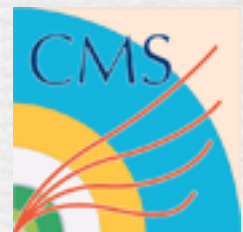


ATLAS

published >270 papers

Today, show a part of them.

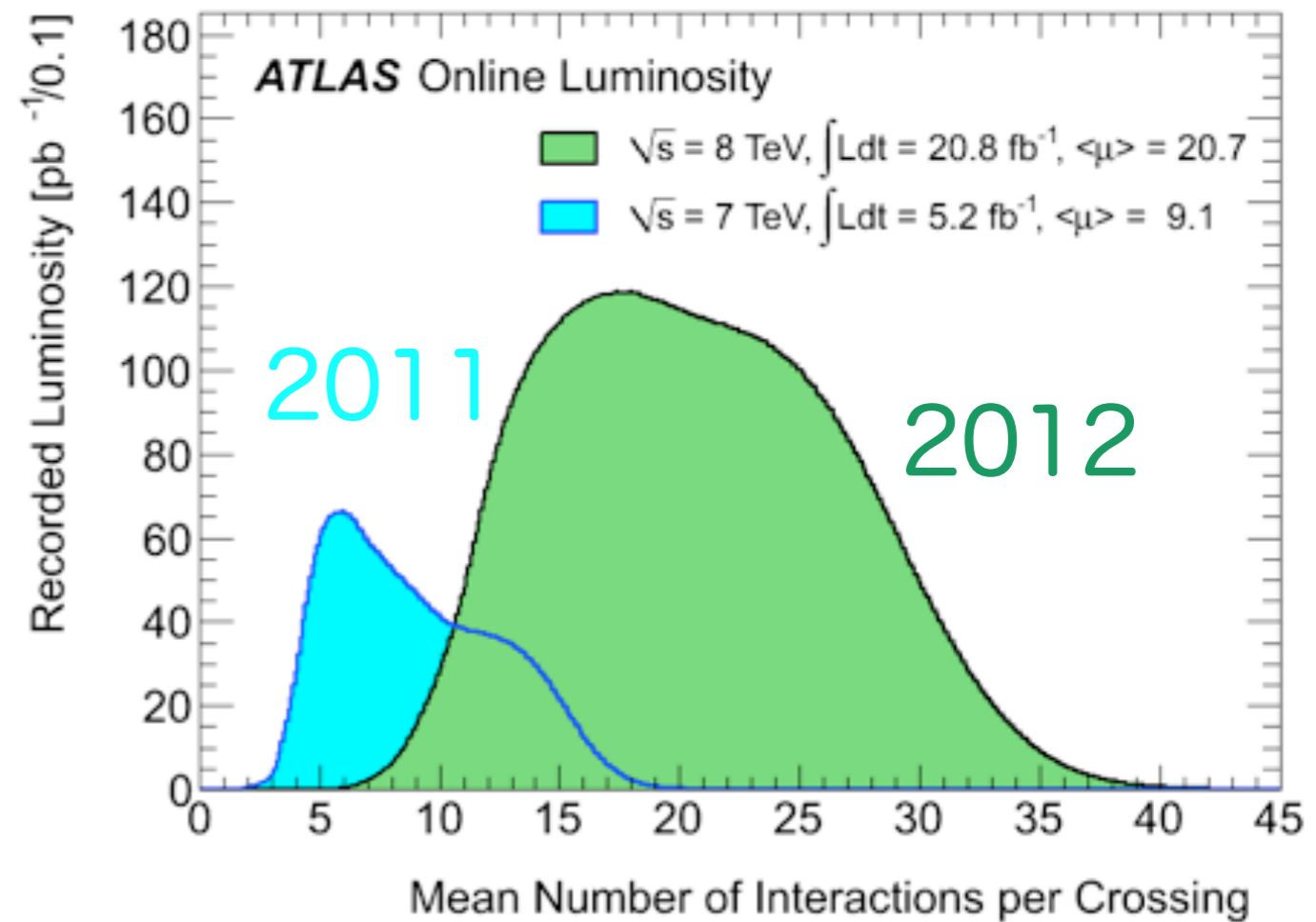
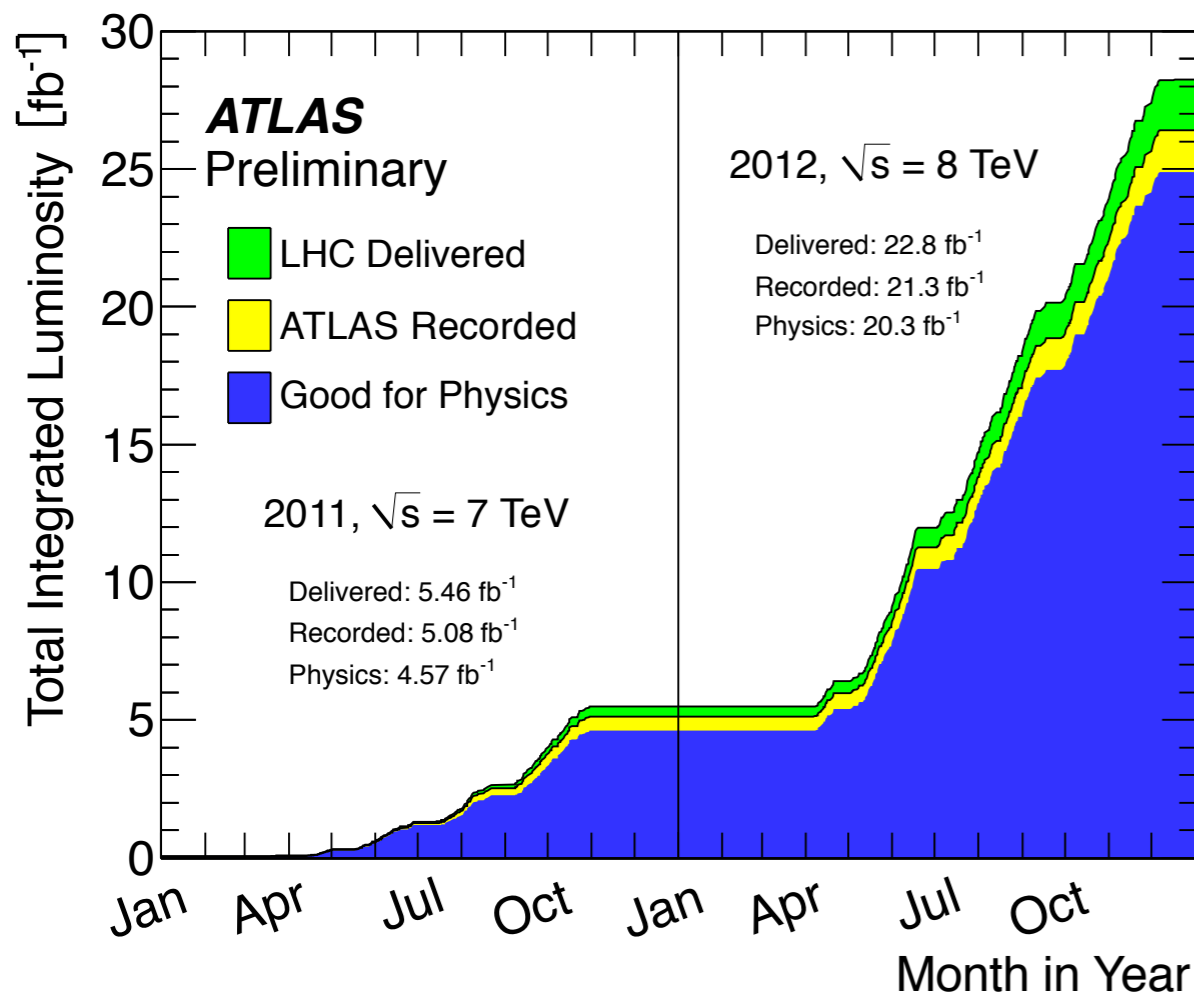
Mainly, Higgs Physics!!



LHC Run I performed very well

2011 : $\sqrt{s}=7\text{TeV}$, $\int L dt = 5\text{fb}^{-1}$, $\langle\mu\rangle=9$

2012 : $\sqrt{s}=8\text{TeV}$, $\int L dt = 21\text{fb}^{-1}$, $\langle\mu\rangle=21$

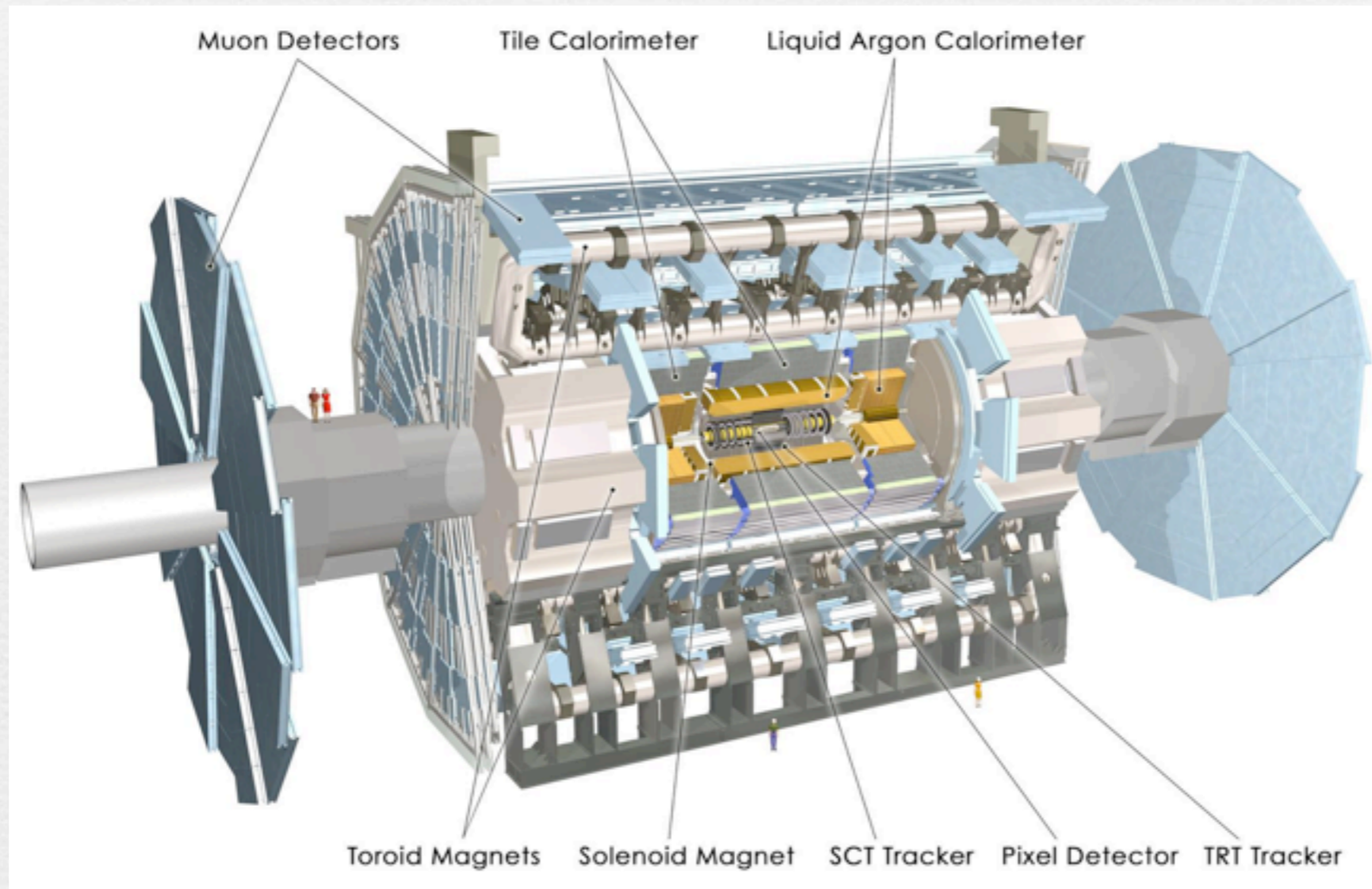


~20 pile-ups!!



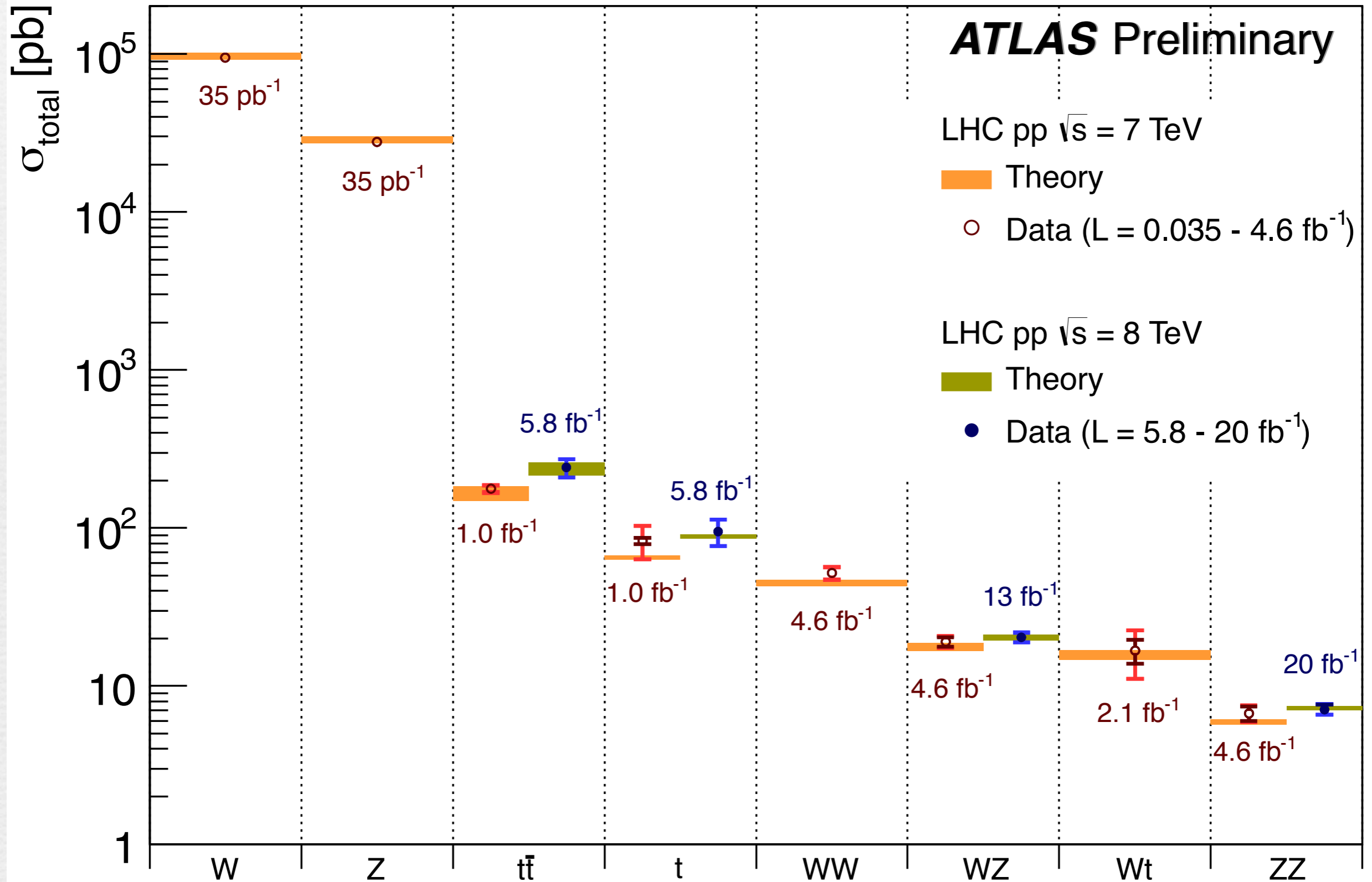
ATLAS detector

The ATLAS detector was designed with discovery of [the Higgs boson
new physics] in mind

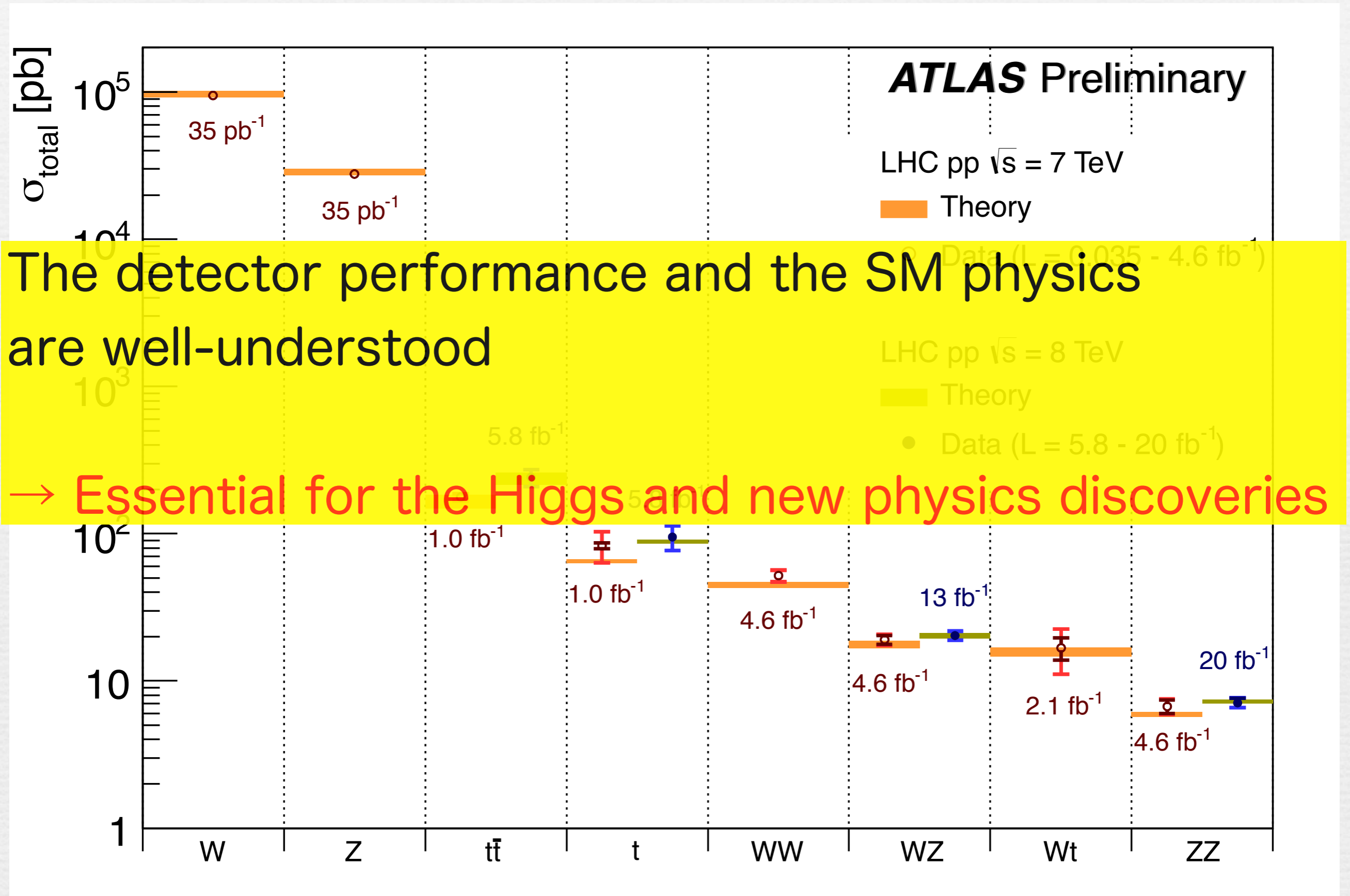


- Precise measurement of the charged tracks by inner detectors
- Identification of electrons and photons against QCD jets
- Excellent calorimeter hermeticity and energy resolution
- Precise muon reconstruction and triggering by muon detectors

Physics towards Higgs discovery



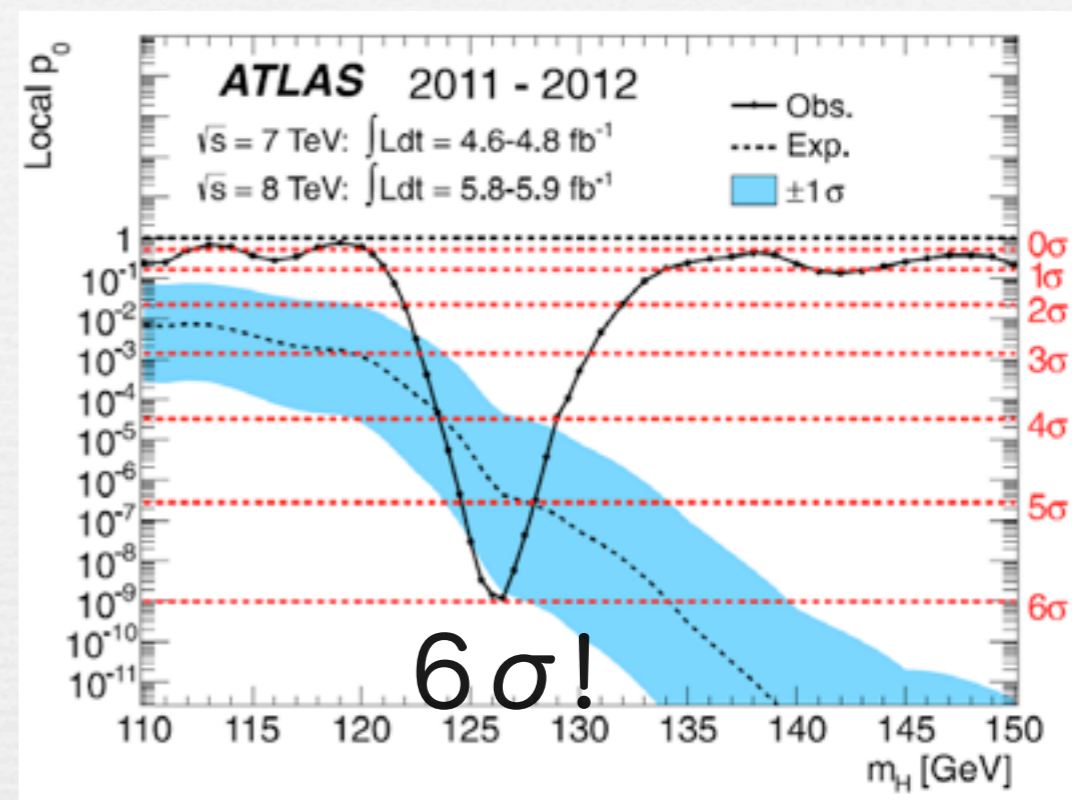
Physics towards Higgs discovery



Higgs discovery

July 2012,

We observed a Higgs-like resonance at $m_H=125.5\text{GeV}$



Since then, we focus our interests on whether :

this resonance is really the Higgs predicted by SM?

there are any signs of physics beyond the SM ?

They are addressed by

Precise measurements on [Higgs property](#)

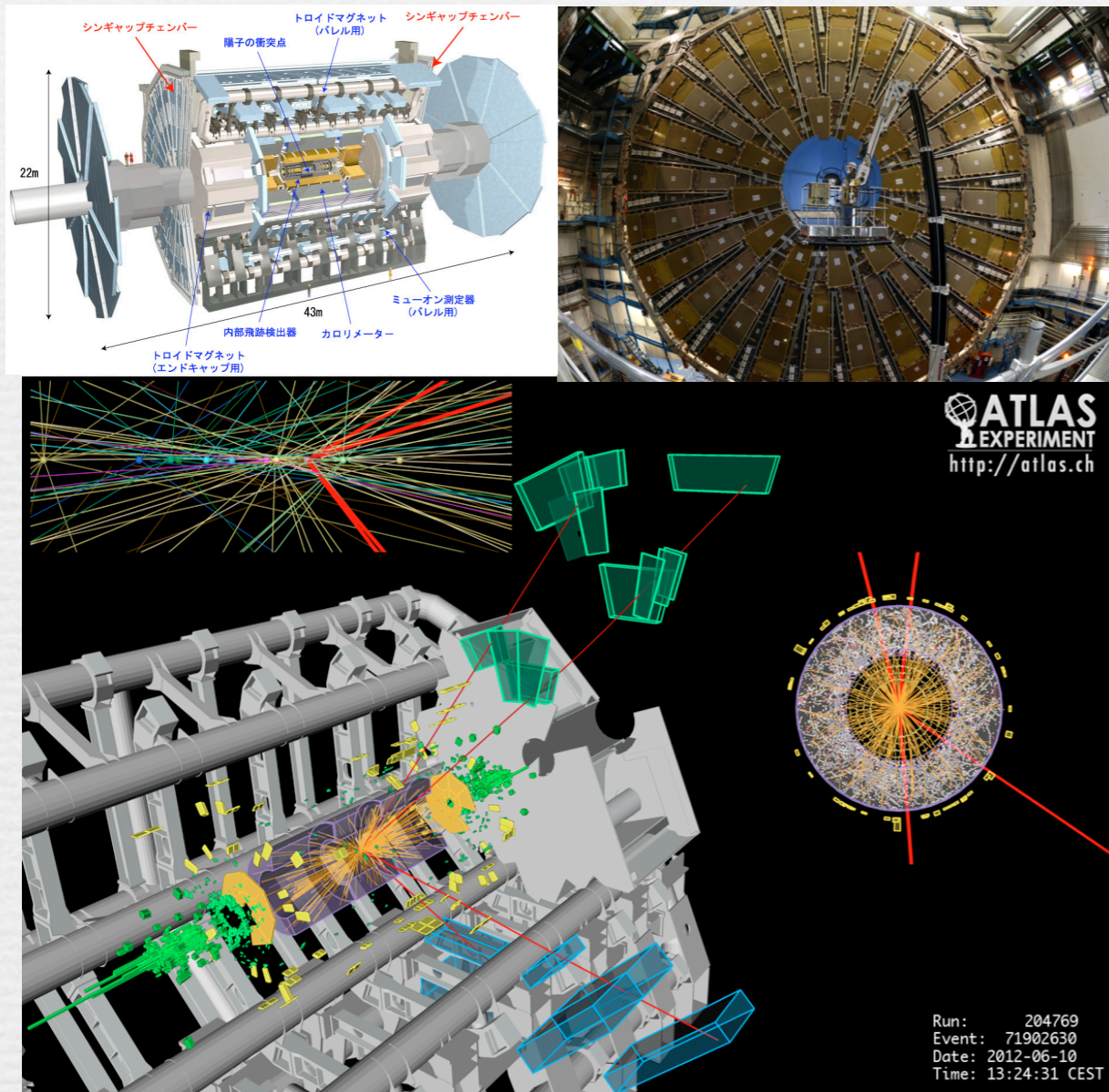
signal strength, couplings and spin-parity

Direct searches for the physics beyond the SM

Nagoya contributions

1. L1 muon trigger system

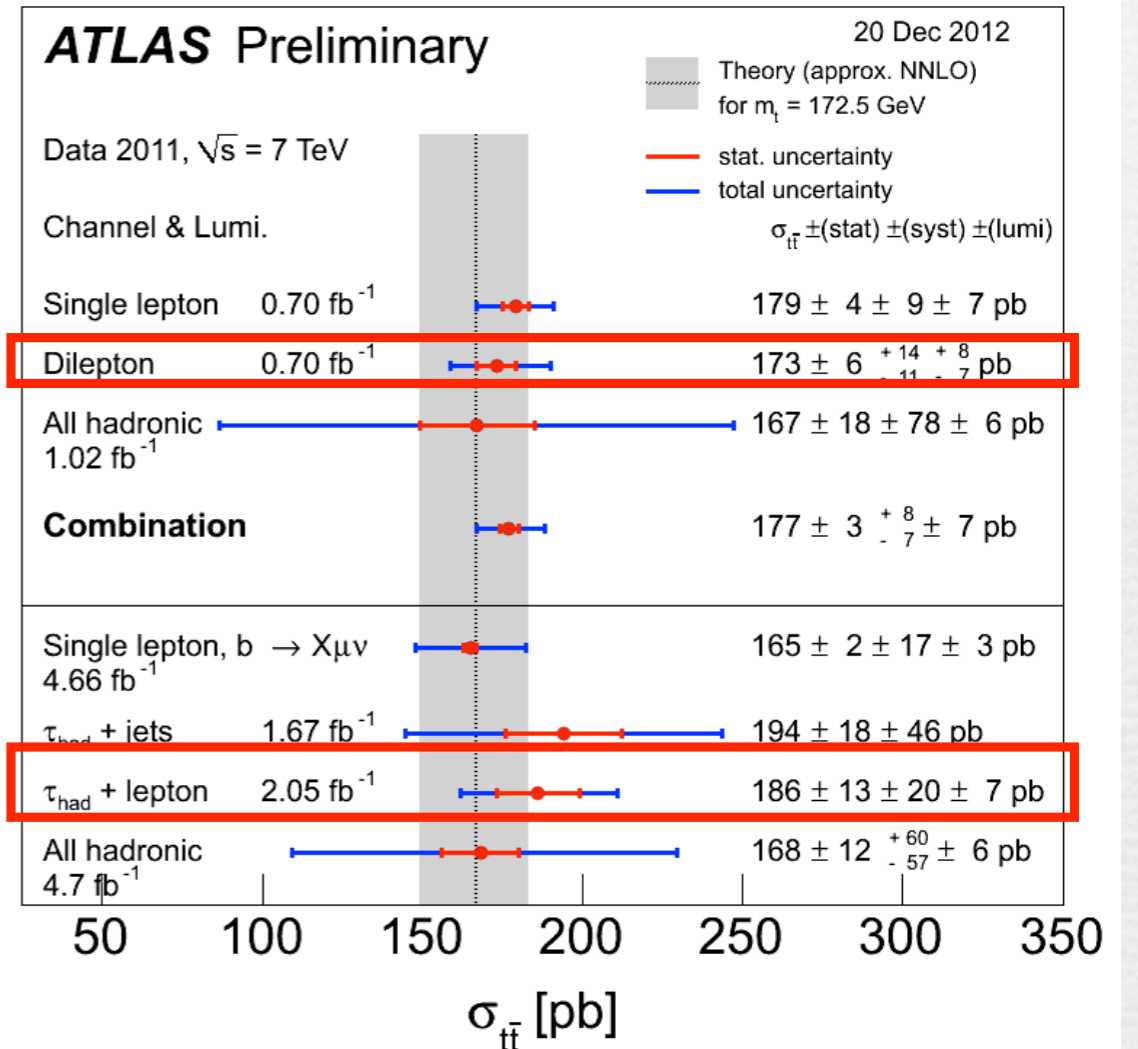
Installation/commissioning/operation



2. Physic analysis

Top quark physics

Higgs, new physics searches



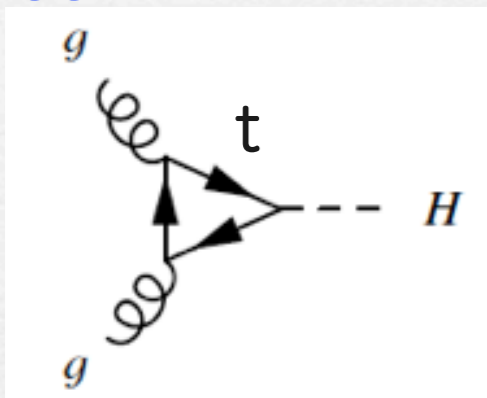
Trying to extend the research area to the Higgs and new physics through top quark productions and decays.

Higgs Physics

Higgs productions and decays

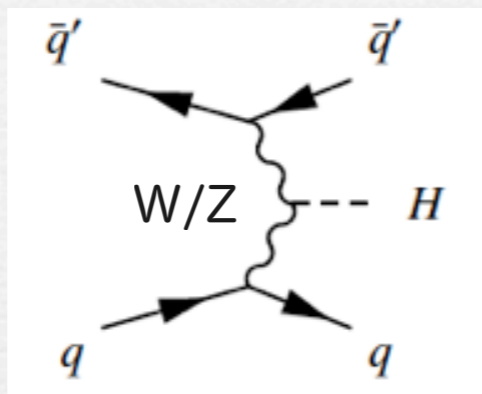
Productions

ggF



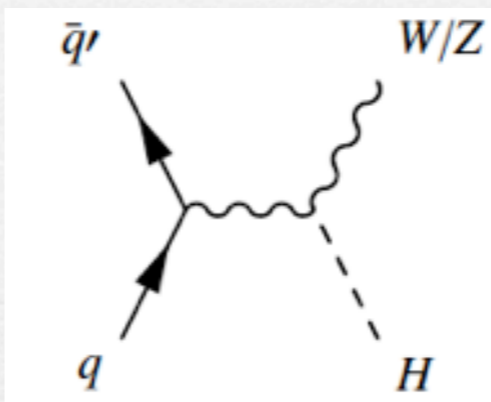
$\sigma = 19 \text{ pb}$

VBF



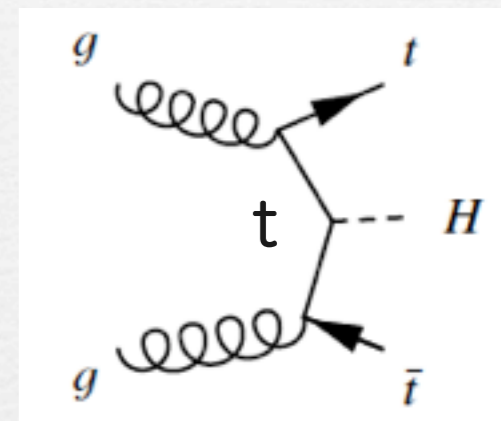
$\sigma = 1.6 \text{ pb}$

VH (V=W or Z)



$\sigma = 0.7 \text{ pb (W)}, 0.4 \text{ pb (Z)}$

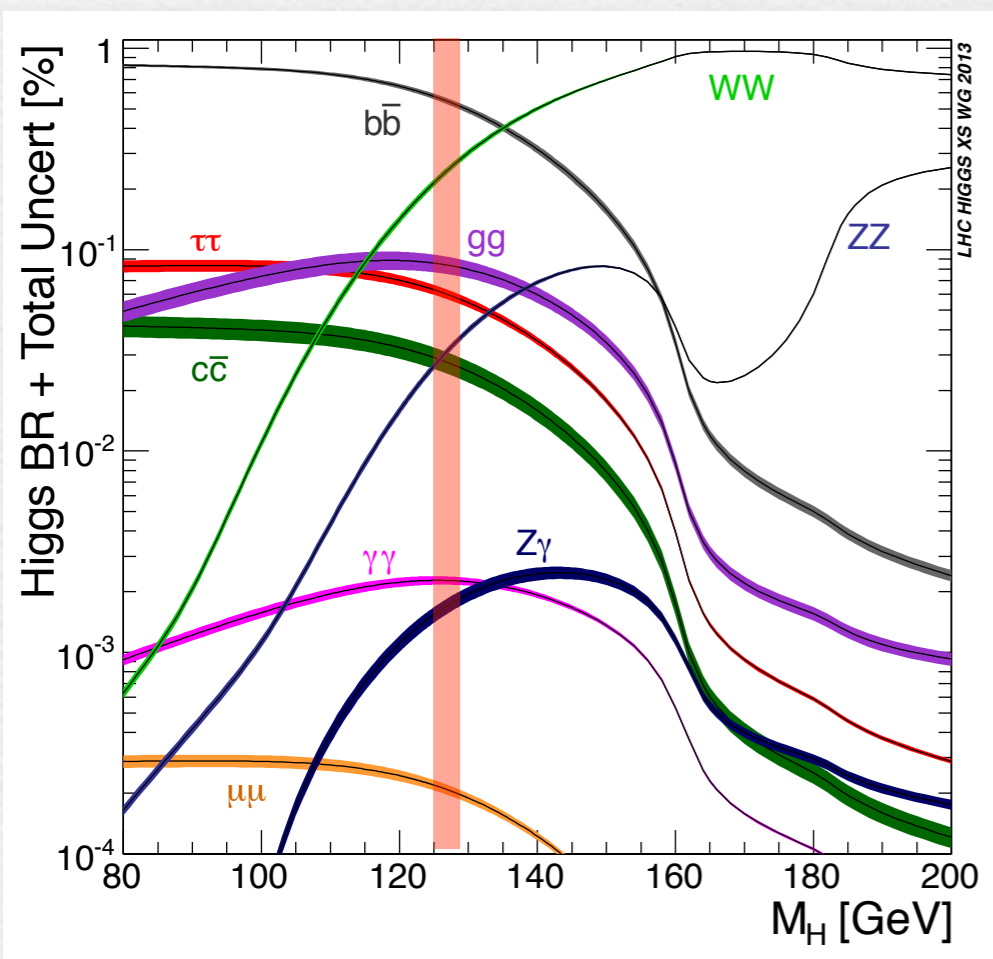
ttH



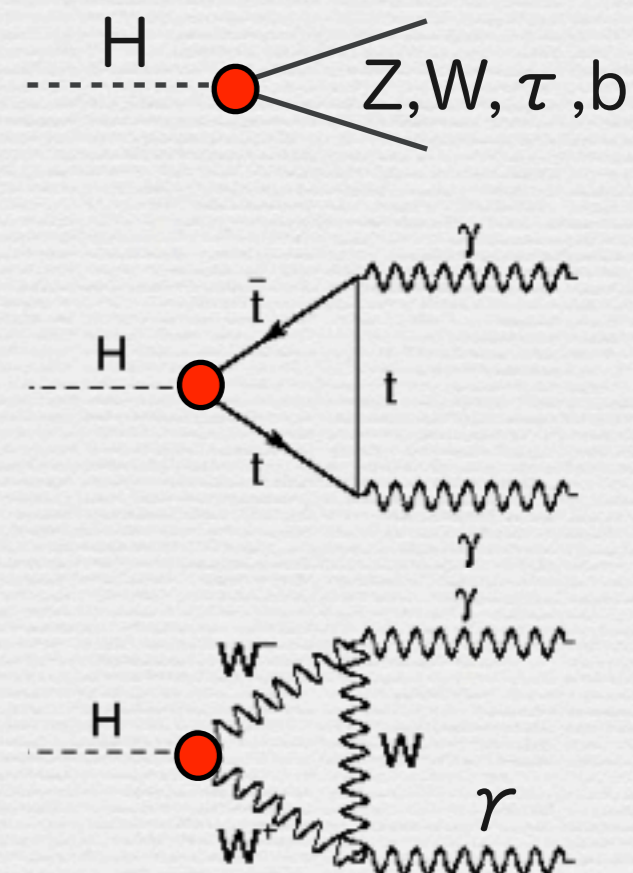
0.13 pb

Decays

Mass of $m_H \sim 125.5 \text{ GeV}$ gives us maximally rich decay modes !!



| $m_H = 125.5 \text{ GeV}$ | BR (%) |
|-------------------------------|--------|
| $H \rightarrow \gamma \gamma$ | 0.23 |
| $H \rightarrow ZZ$ | 2.8 |
| $H \rightarrow WW$ | 22 |
| $H \rightarrow \tau \tau$ | 6.2 |
| $H \rightarrow b b$ | 57 |

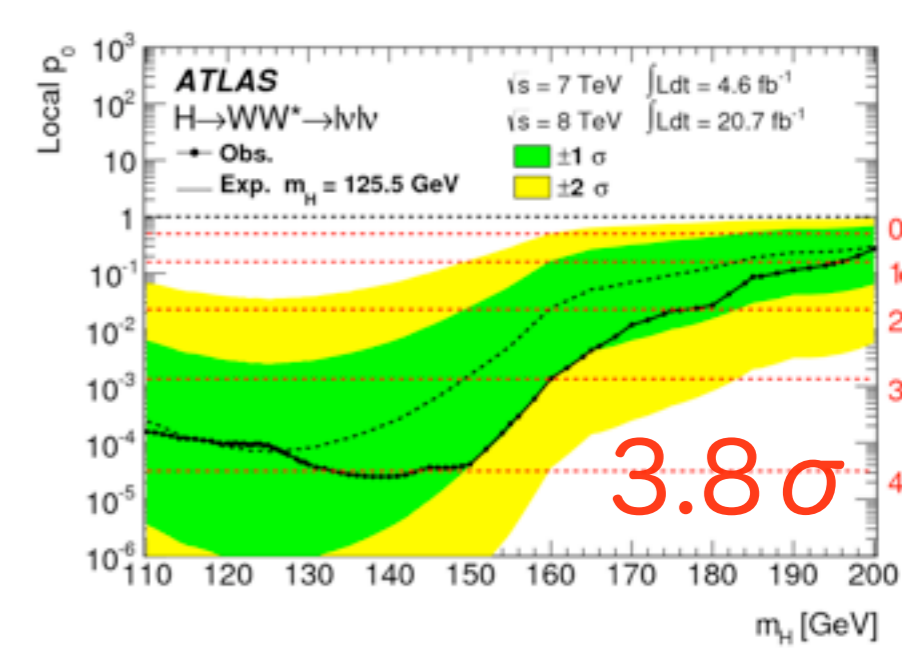
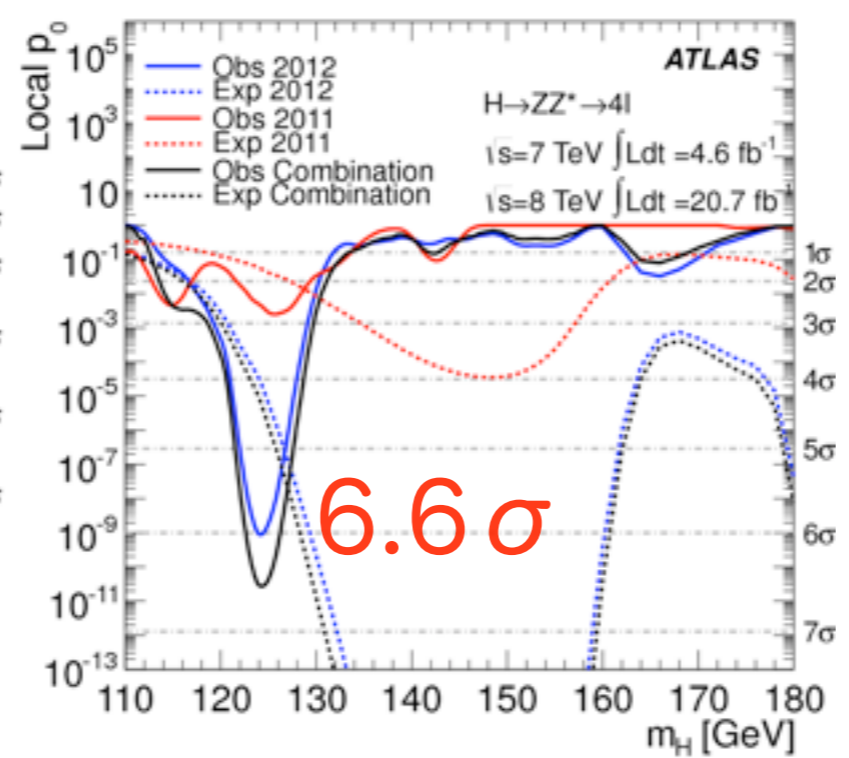
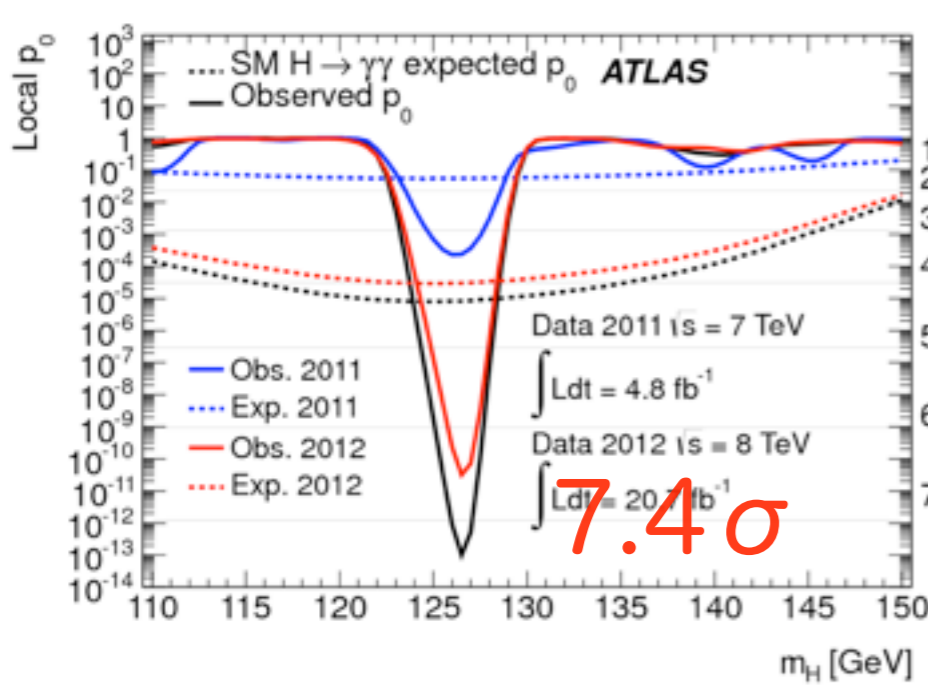
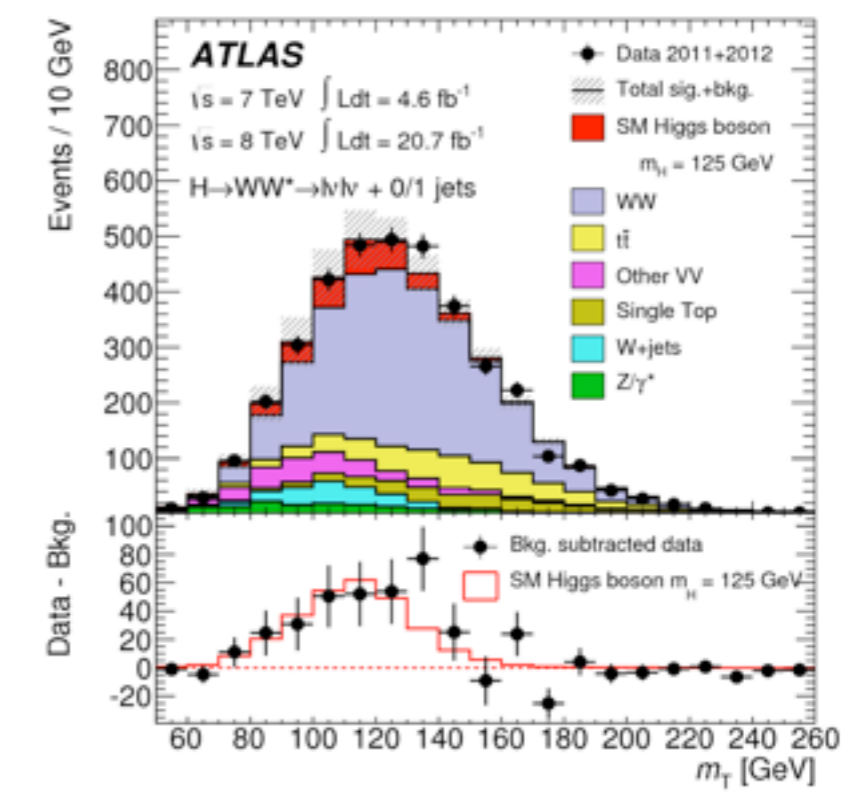
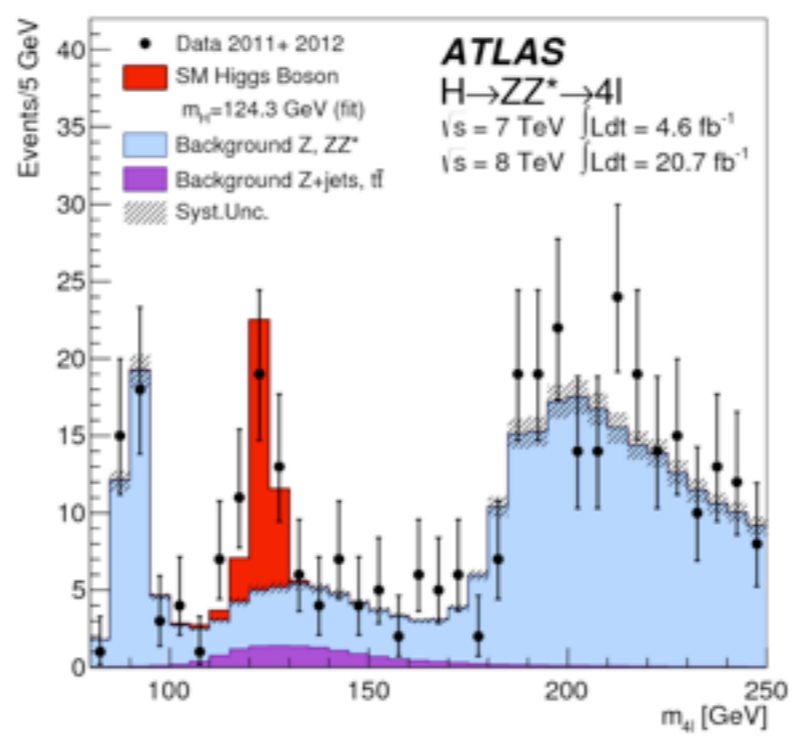
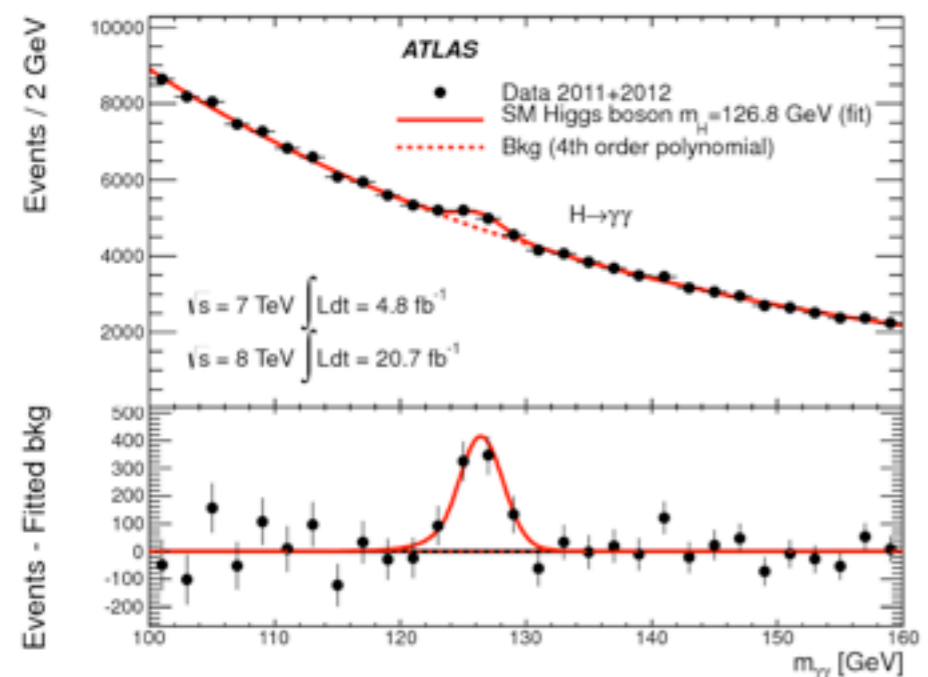


Yields in the discovery channels

$$H \rightarrow \gamma\gamma$$

$$H \rightarrow ZZ$$

$$H \rightarrow WW$$



~450 signal events expected ~15 signal events expected ~180 signal events expected

Signal strength

arXiv:1307.1427

$$\mu = \frac{\sigma \times \text{BR}}{(\sigma \times \text{BR})_{\text{SM}}}$$

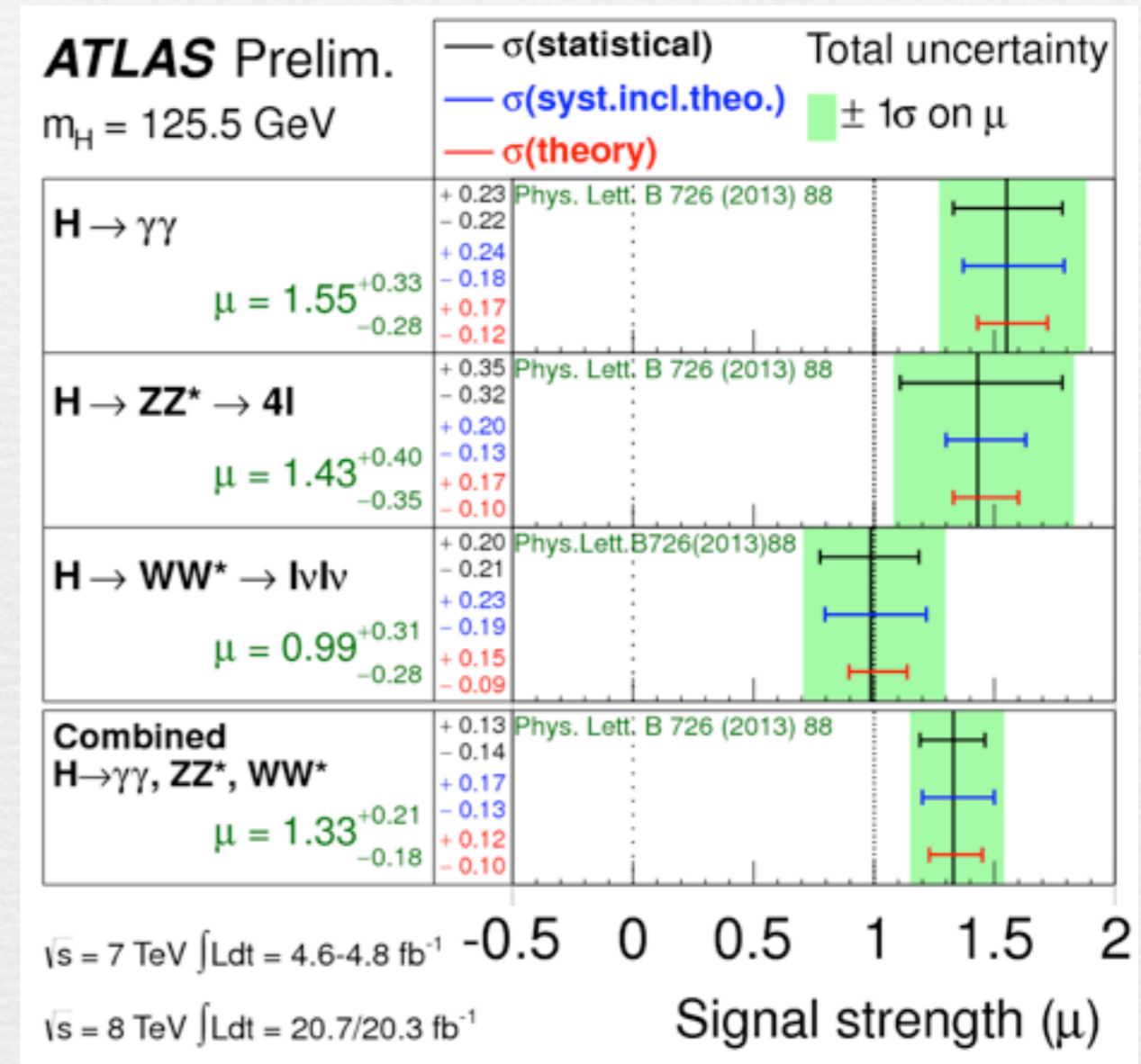
$\mu=1$ (if SM Higgs), $\mu=0$ (if no SM Higgs)

combined ($H \rightarrow \gamma\gamma, ZZ, WW$)

$$\mu = 1.33 \pm 0.14(\text{stat}) \pm 0.15(\text{sys})$$

($m_H=125.5\text{GeV}$)

Result is consistent with the SM prediction with 15% precision.



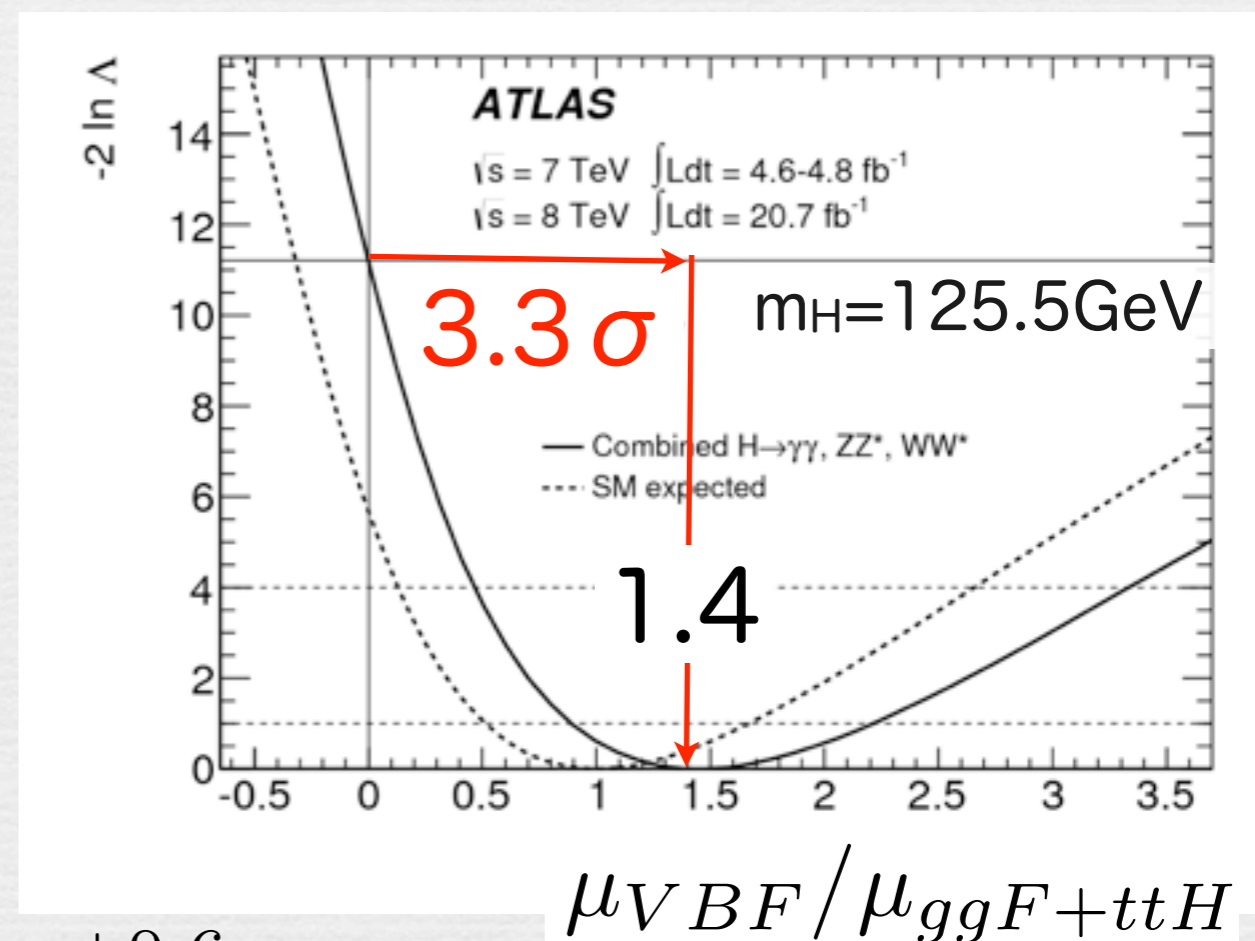
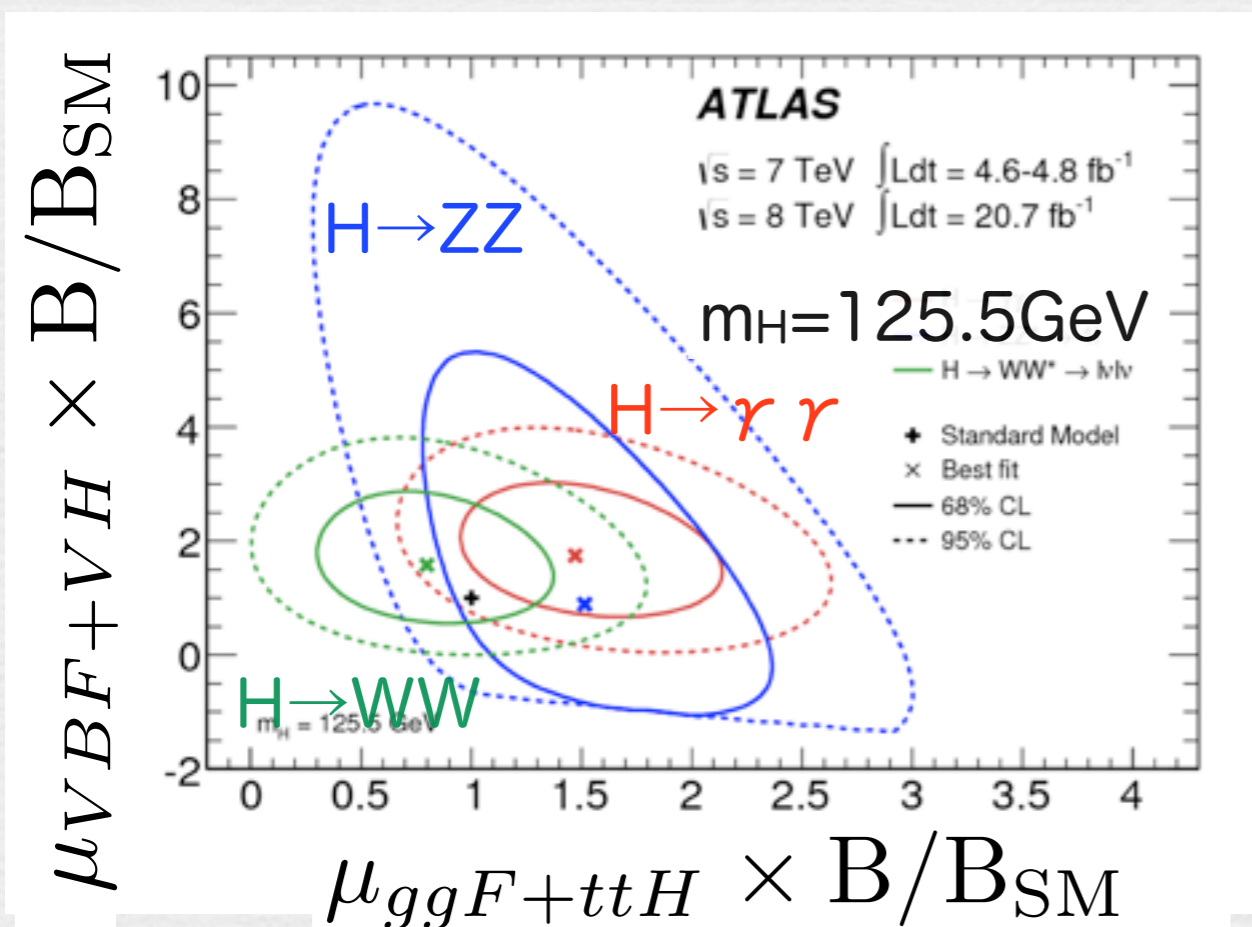
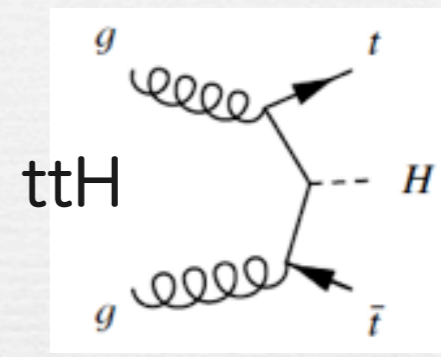
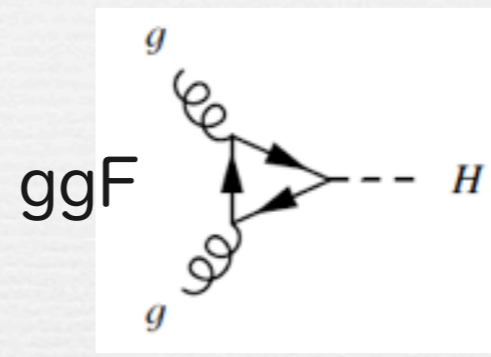
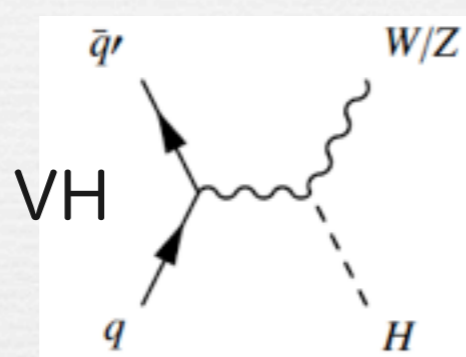
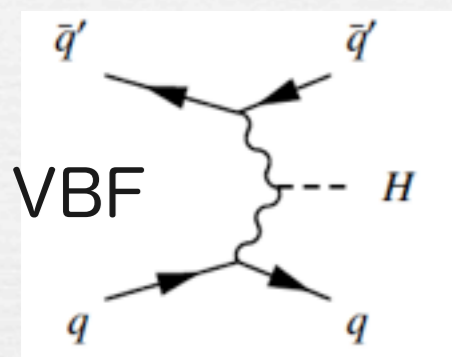
Statistical, systematic and theory (QCD scale, PDF) uncertainties are already comparable.

Evidence for production via VBF

arXiv:1307.1427

Signal strength is categorized by
vector-boson-mediated processes

and gluon-mediated processes



$$\mu_{VBF} / \mu_{ggF+ttH} = 1.4_{-0.3}^{+0.4}(\text{stat})_{-0.4}^{+0.6}(\text{sys})$$

3.3 σ evidence that a fraction of Higgs boson production occurs through VBF

Coupling measurements

In the standard model,

coupling to fermion $g_F^{\text{SM}} = \sqrt{2} \frac{m_F}{v}$ coupling to gauge boson $g_V^{\text{SM}} = 2 \frac{m_V^2}{v}$

SM couplings are tested introducing coupling scale factors κ : $g_i = g_i^{\text{SM}} \times \kappa_i$

The total Higgs boson width is also tested introducing κ_{H^2} : $\Gamma_H = \Gamma_H^{\text{SM}} \times \kappa_{H^2}^2$

$$\sigma \cdot B(i \rightarrow H \rightarrow f) = \frac{\sigma_i \cdot \Gamma_f}{\Gamma_H} \rightarrow \text{signal strength can be written by } \kappa \text{ s}$$

For example, $gg \rightarrow H \rightarrow \gamma\gamma$ process can be written as

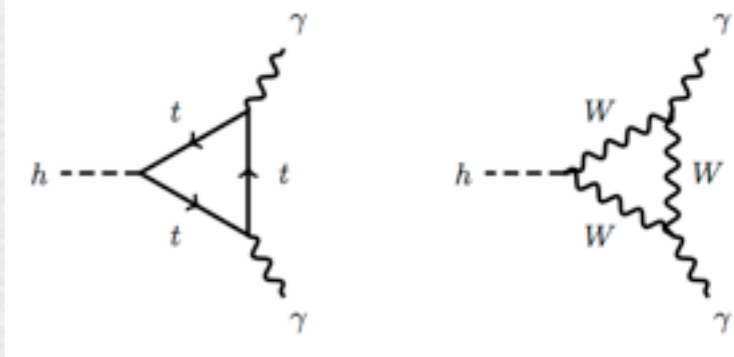
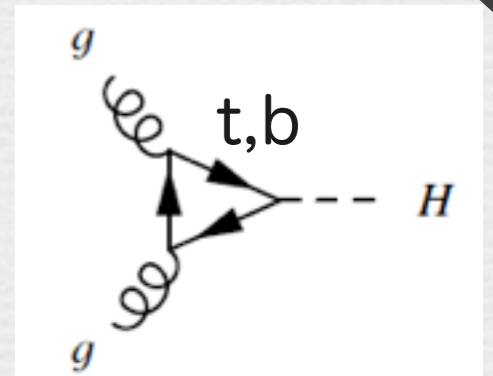
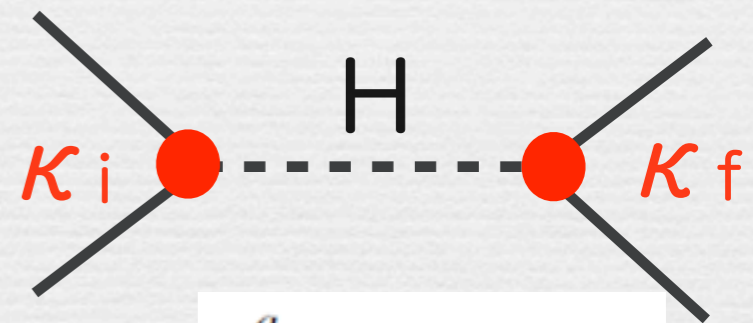
$$\frac{\sigma \cdot B(gg \rightarrow H \rightarrow \gamma\gamma)}{\sigma_{\text{SM}}(gg \rightarrow H) \cdot B_{\text{SM}}(H \rightarrow \gamma\gamma)} = \frac{\kappa_g^2 \cdot \kappa_\gamma^2}{\kappa_H^2}$$

κ_H and effective scale factors κ_γ , κ_g (loop induced processes)

- Expressed as a function of the SM coupling scale factors

$$\kappa_\gamma(\kappa_W, \kappa_t) \quad \kappa_g(\kappa_b, \kappa_t) \quad \kappa_H(\kappa_b, \kappa_W, \kappa_Z, \dots)$$

- Treated as free parameters to test BSM contributions

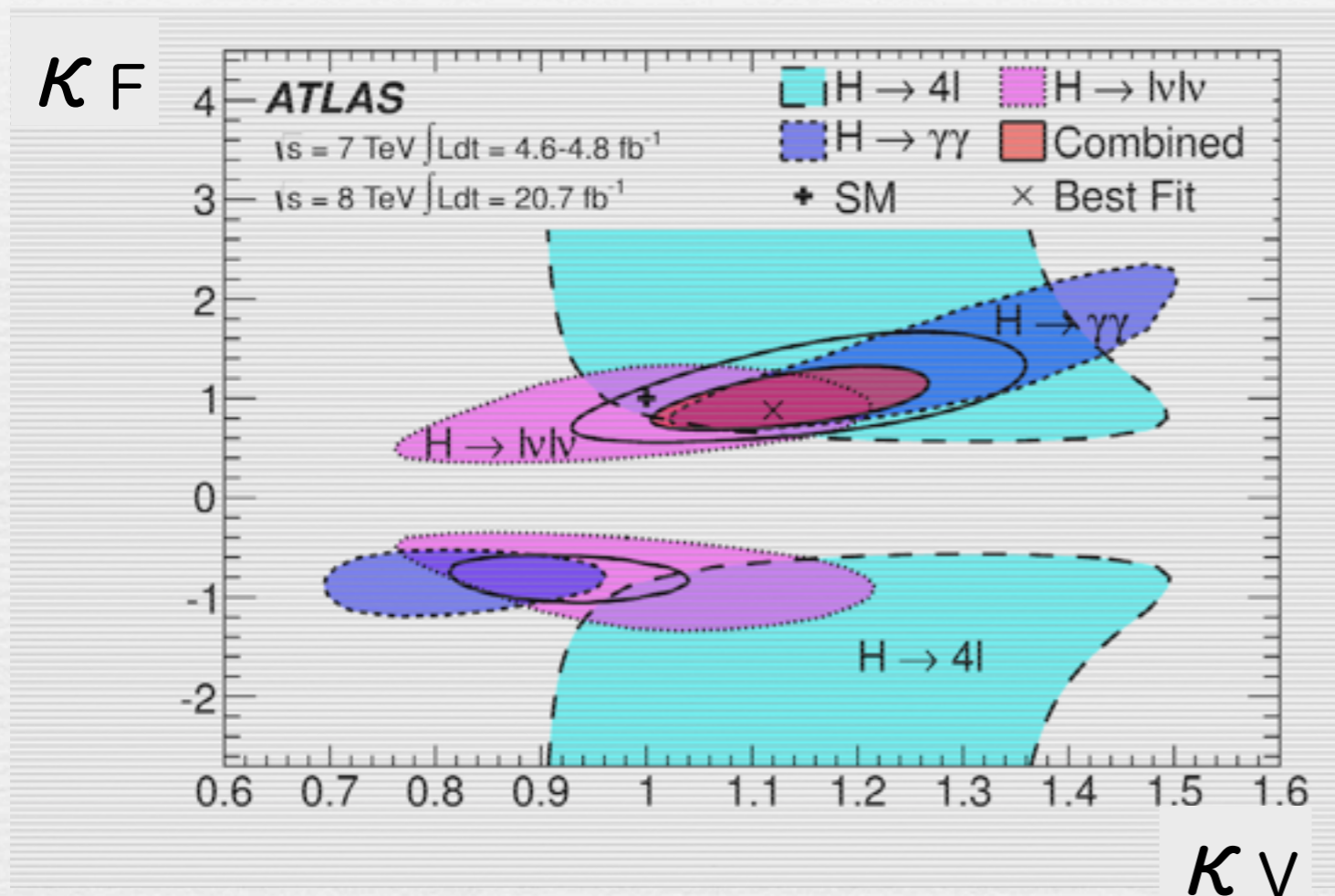


Couplings to fermions and bosons

arXiv:1307.1427

In this analysis, we assume

- One coupling scale factor for fermions $\kappa_F = \kappa_t = \kappa_b = \kappa_\tau = \dots$
- One coupling scale factor for bosons $\kappa_V = \kappa_W = \kappa_Z$
- κ_g , κ_γ , and κ_H depends only on κ_F and $\kappa_V \rightarrow$ No contributions from BSM



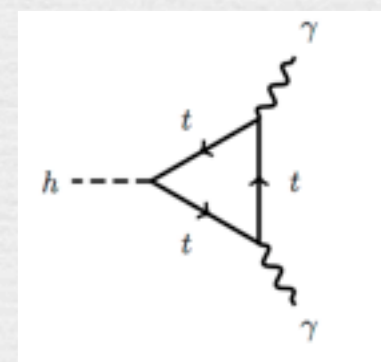
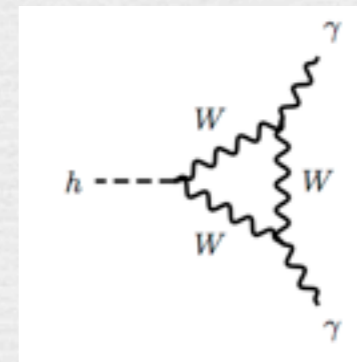
$$\kappa_F \in [0.76, 1.18]$$

$$\kappa_V \in [1.05, 1.22]$$

at 68% C.L.

compatibility of the SM is 12%

$$\kappa_\gamma^2 \simeq |1.26\kappa_V - 0.26\kappa_F|^2$$

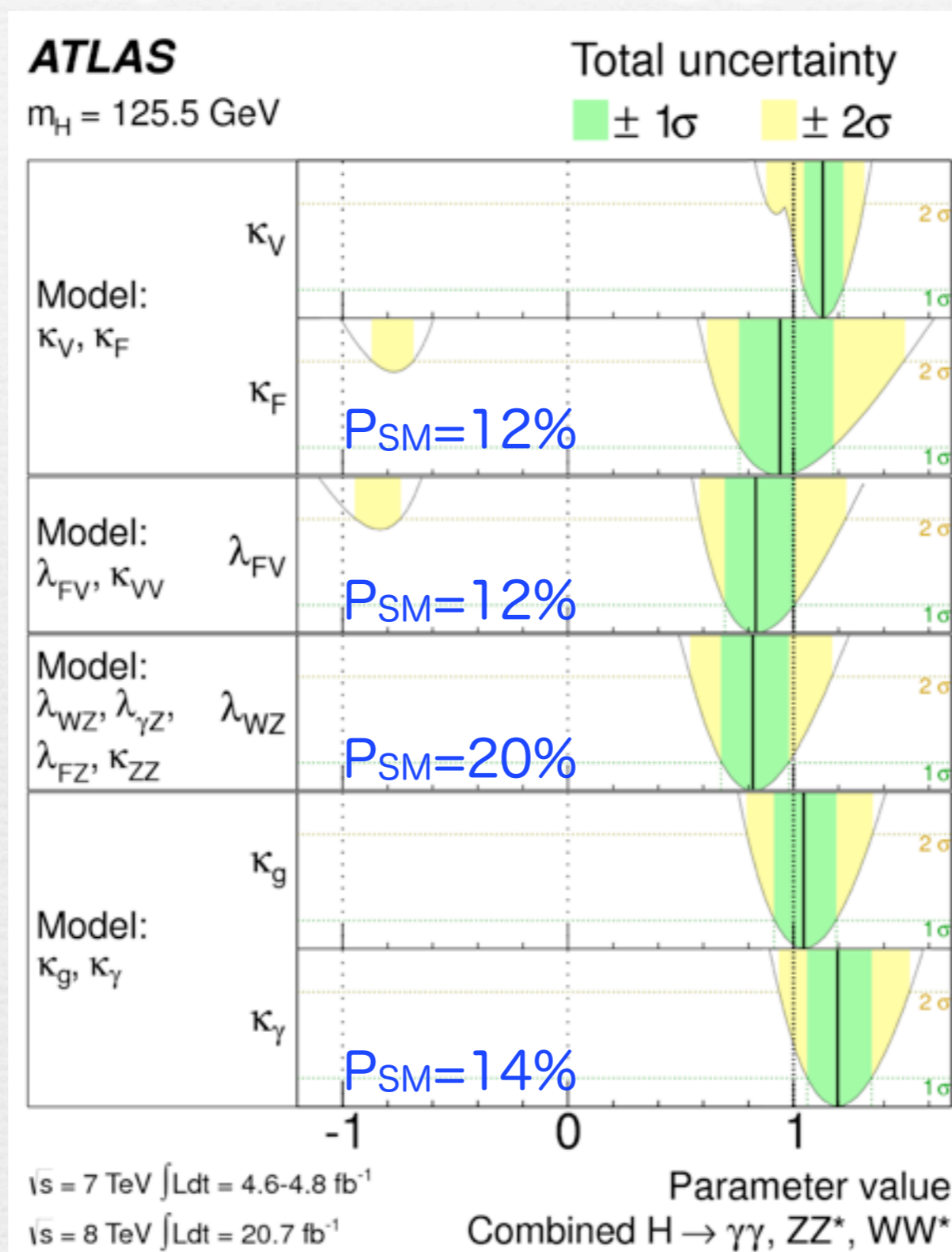


$H \rightarrow \gamma\gamma$ prefers the minimum with positive relative sign

- Thanks to the negative interference between W-boson loop and t-quark loop
- $\kappa_F=0$ is excluded at $>5\sigma \rightarrow$ Indirect evidence of the Higgs-fermion coupling!!

Summary of the Higgs couplings

arXiv:1307.1427



$$= \kappa_V$$

$$= \kappa_F$$

$$= \kappa_F / \kappa_V$$

$$= \kappa_W / \kappa_Z$$

$$= \kappa_g$$

$$= \kappa_\gamma$$

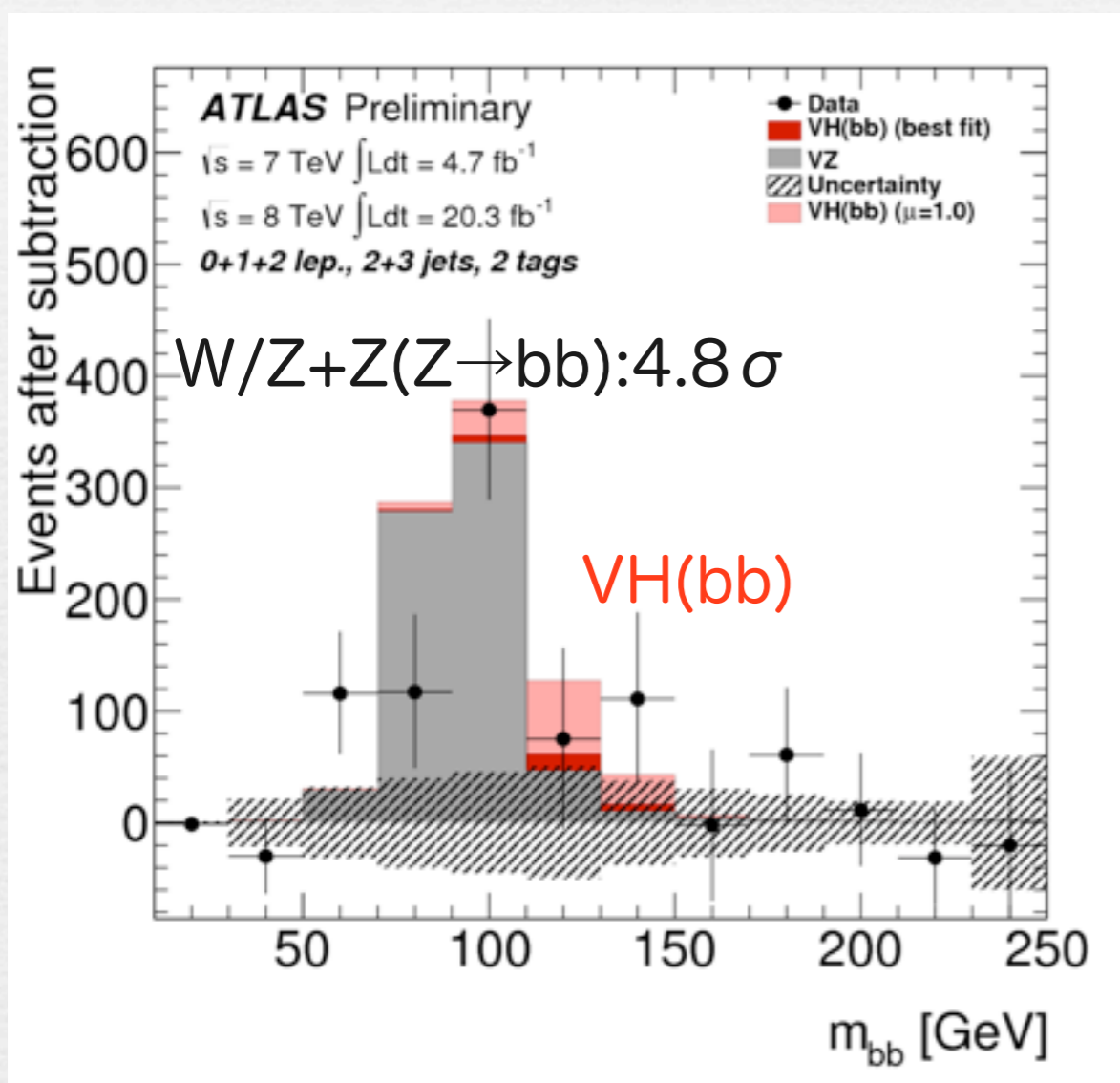
Measurements are compatible with SM Higgs expectations (=1)

Their compatibilities are 12%~20%

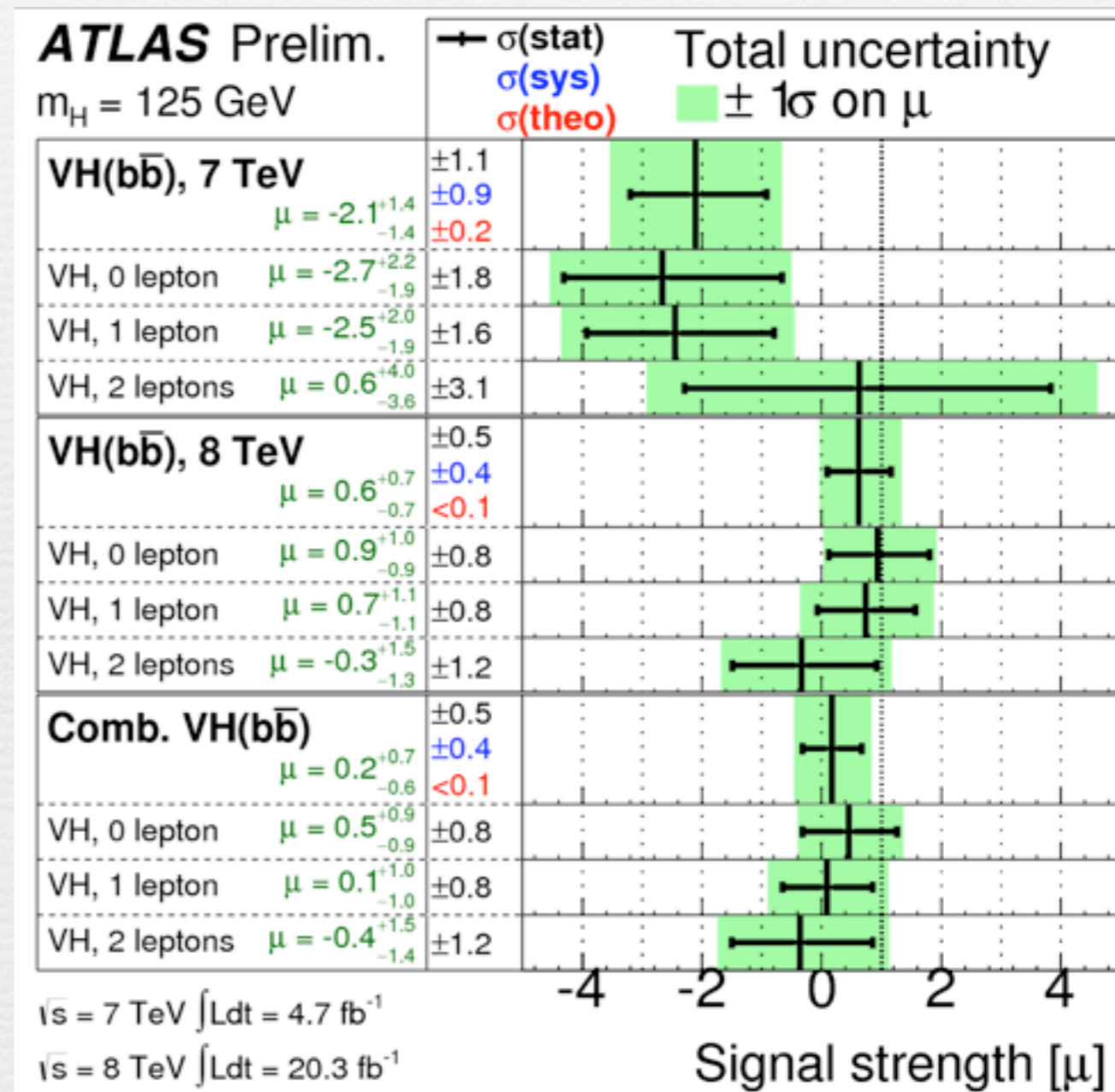
H → bb direct measurement

ATLAS-CONF-2013-079

W/Z+H (H → bb) : 2, 1, 0 (large E_T^{miss})-lepton + 2 b-jets



Best fit $\mu = 0.2^{+0.7}_{-0.6}$



We need more data to obtain evidence of H → bb

$H \rightarrow \tau \tau$ direct measurement

ATLAS-CONF-2013-108

Both hadronic and leptonic τ decays ($\tau_{\text{had}}, \tau_{\text{lep}}$) are used

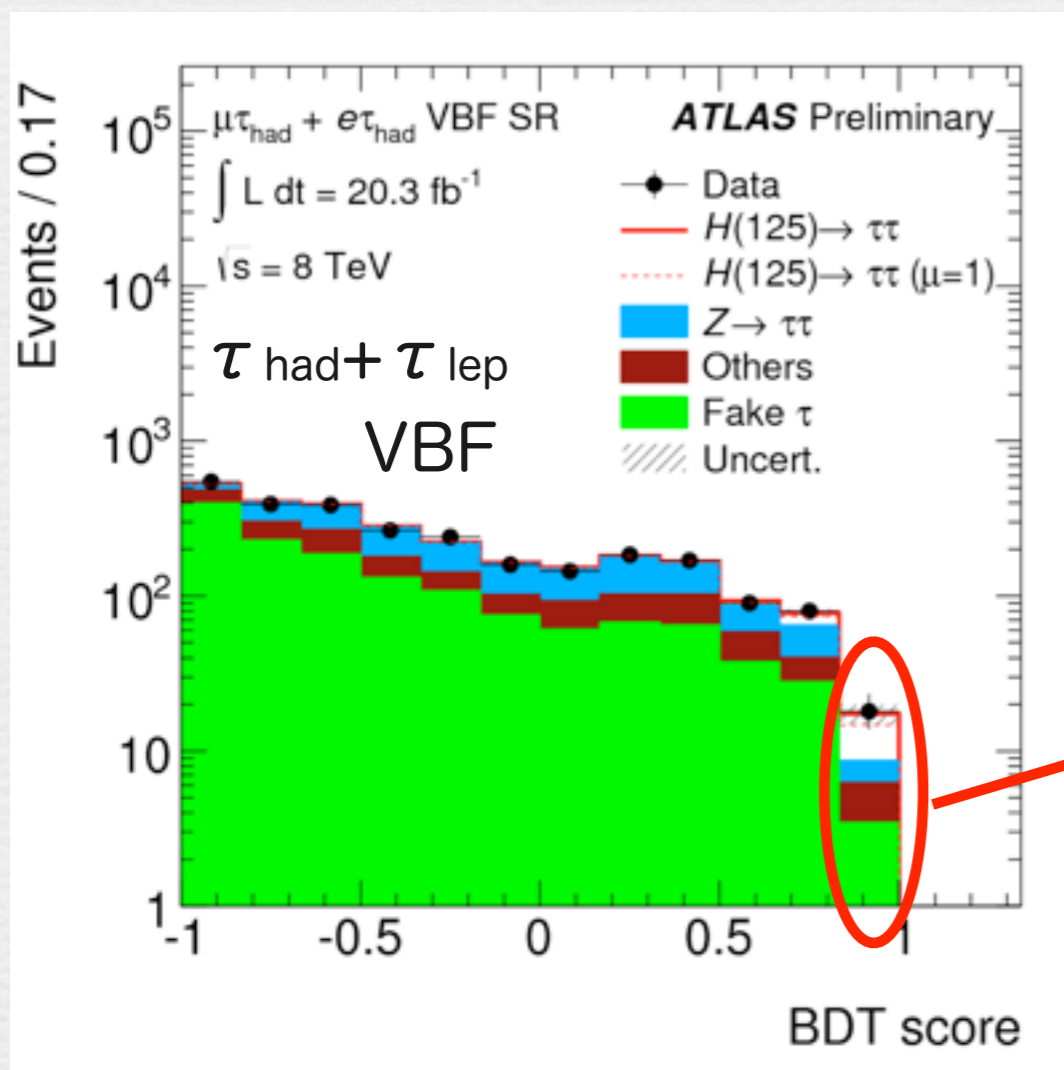
Events are categorized by “VBF” and “Boosted”

$\tau \tau$ + di-jets with large η

$\tau \tau$ with large $p_{T^{\tau \tau}}$

Signals are extracted from the fit of the BDT score dist.

BDT (boosted decision tree) : multivariate analysis based on $E_{T^{\text{miss}}}$, $m_{\tau \tau}$,



Number of events in highest BDT score bin

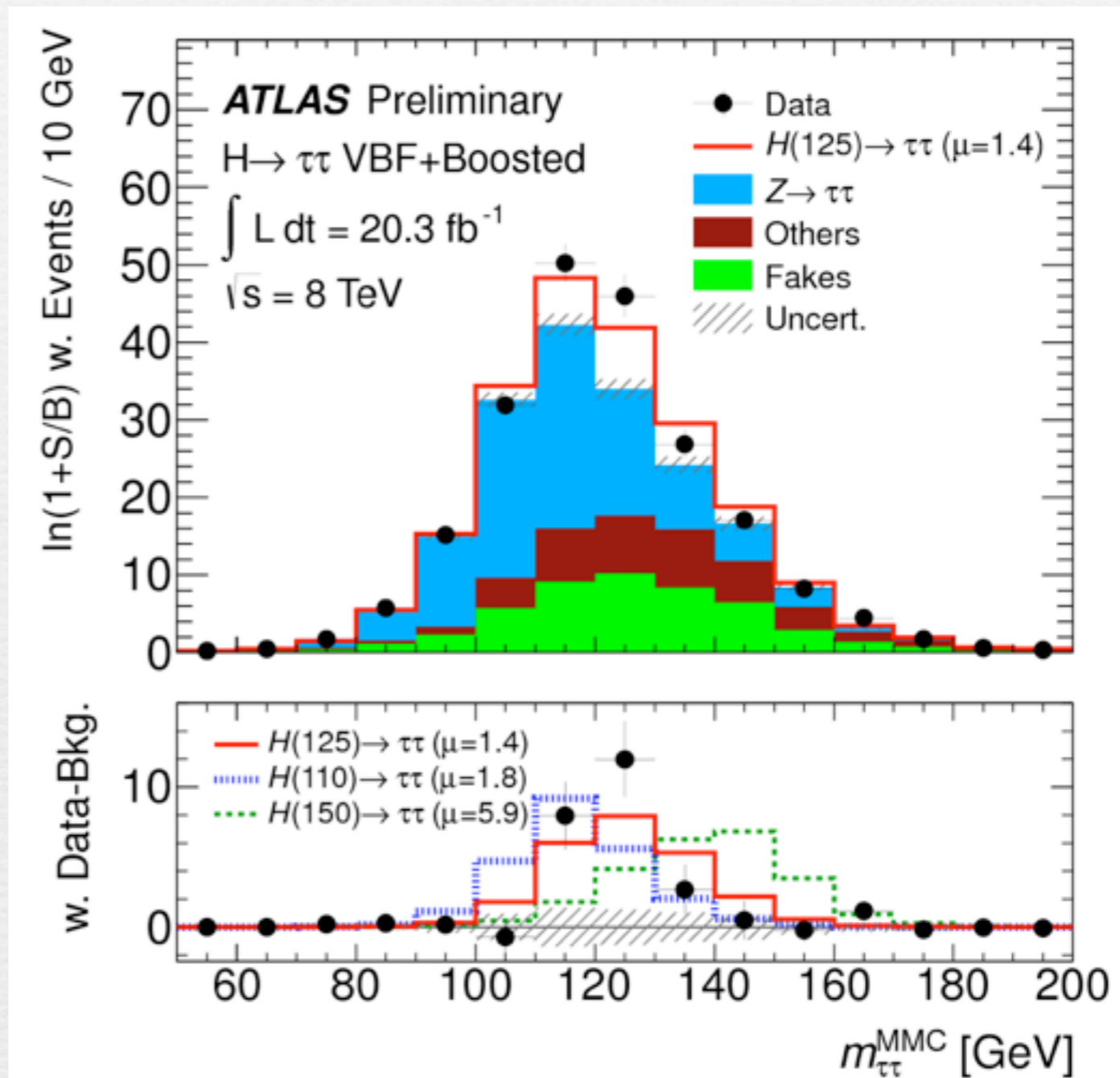
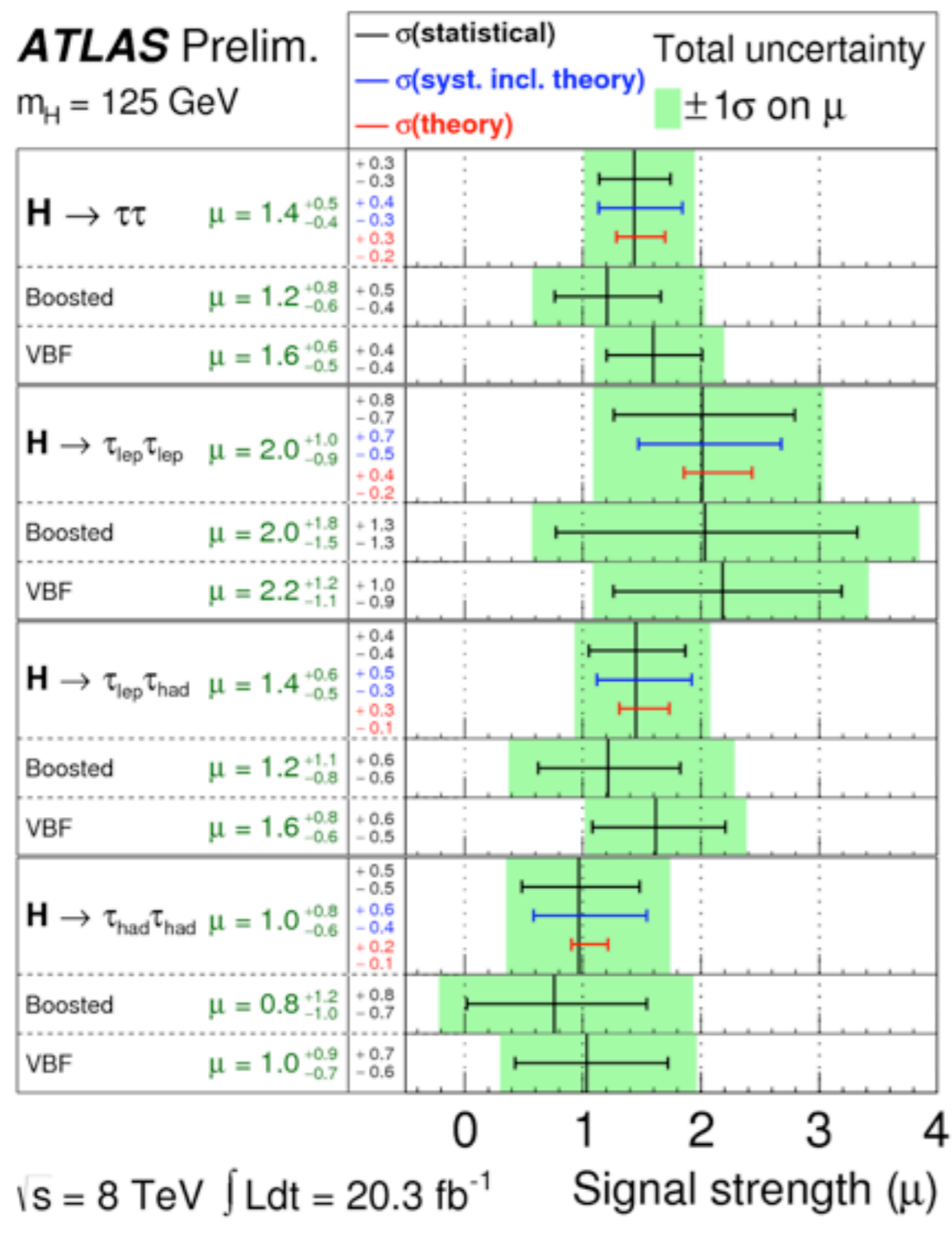
| VBF | Lep-lep | Lep-had | Had-had |
|--------|----------------|---------------|----------------|
| Signal | 5.7 ± 1.7 | 8.7 ± 2.5 | 8.8 ± 2.2 |
| Bckg | 13.5 ± 2.4 | 8.7 ± 2.4 | 11.8 ± 2.6 |
| Data | 19 | 18 | 19 |

| Boosted | Lep-lep | Lep-had | Had-had |
|---------|----------------|---------------|----------------|
| Signal | 2.6 ± 1.7 | 8.0 ± 2.5 | 3.6 ± 1.1 |
| Bckg | 20.2 ± 1.8 | 32 ± 4 | 11.2 ± 1.9 |
| Data | 20 | 34 | 15 |

bkg-like \longleftrightarrow signal-like

$H \rightarrow \tau \tau$ direct measurement

ATLAS-CONF-2013-108



combined $\mu = 1.4^{+0.5}_{-0.4}$

Observed significance corresponds to 4.1σ

Expected significance corresponds to 3.2σ

Spin-parity measurements

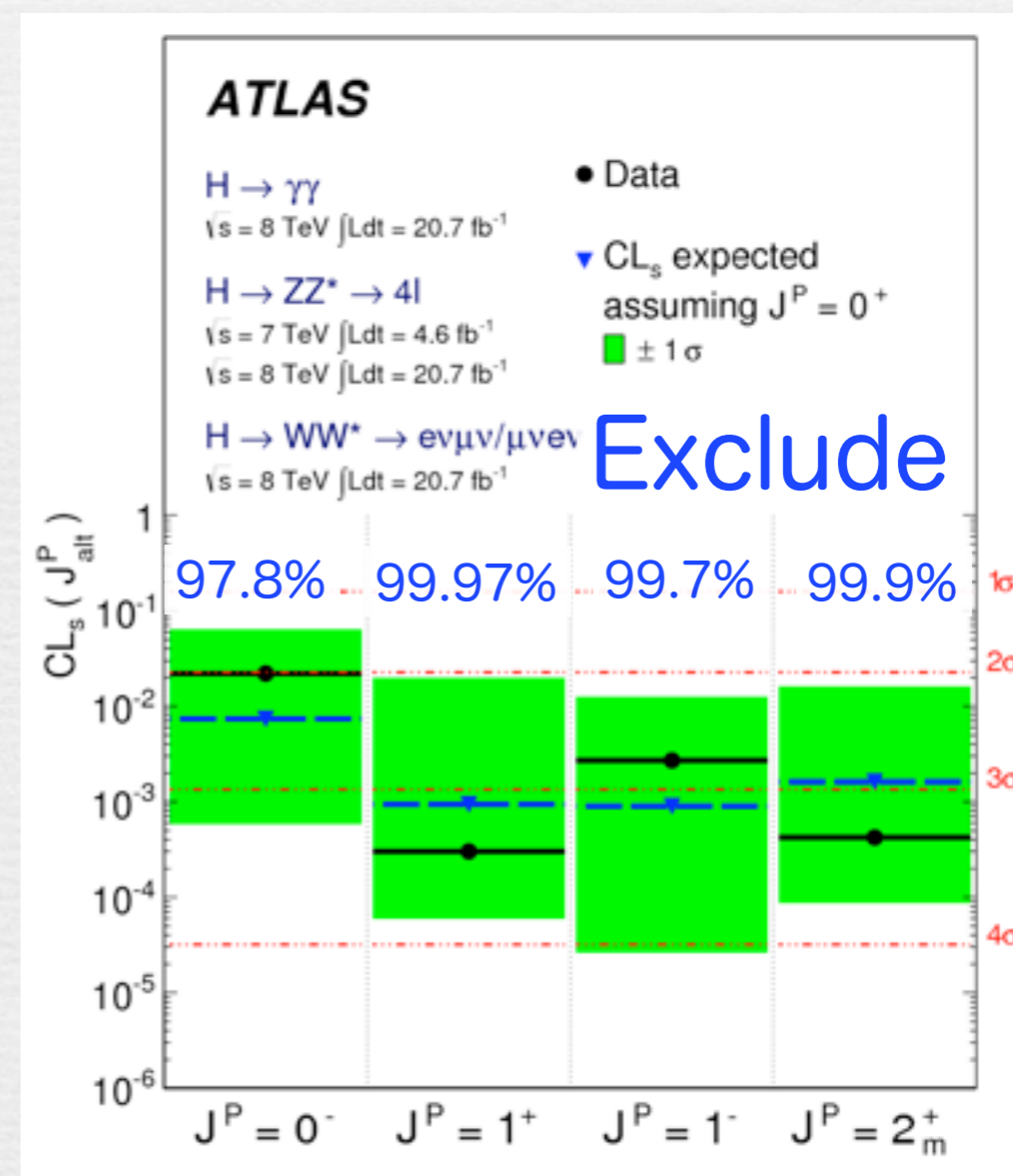
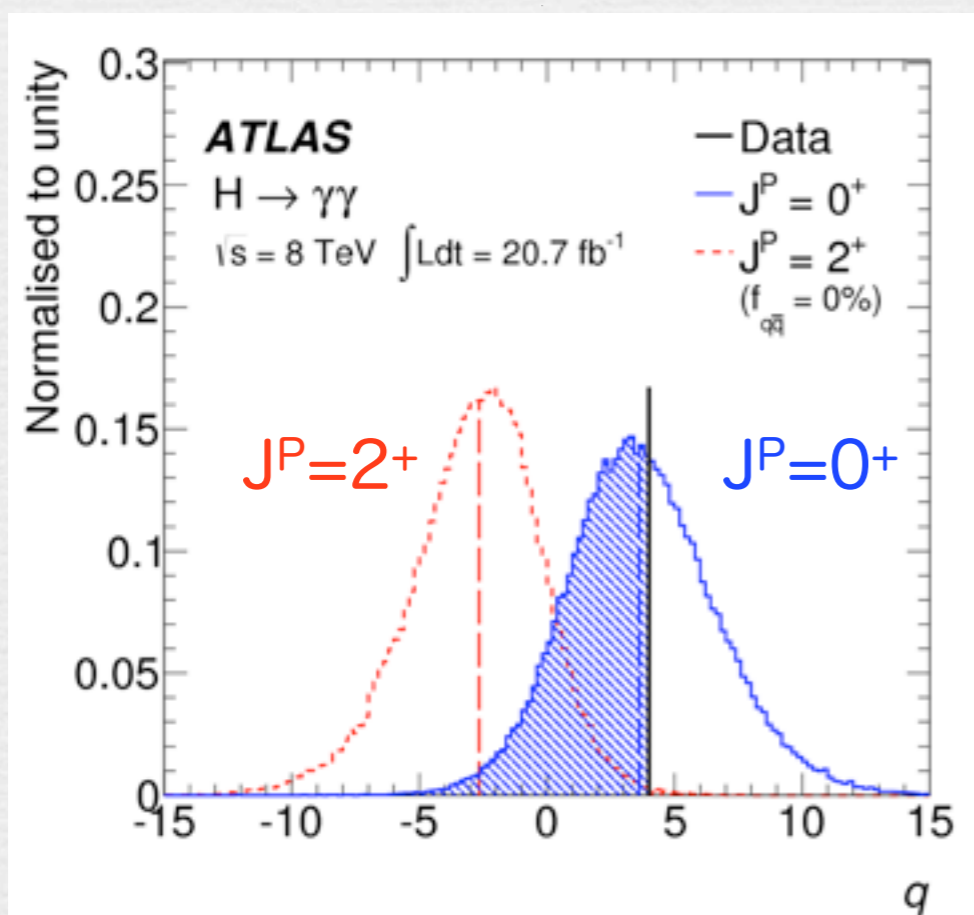
arXiv:1307.1432

Spin-Parity $J^P=0^-, 1^+, 1^-, 2^+$ are tested against SM ($J^P=0^+$)

Existence of $H \rightarrow \gamma \gamma$ rules out $J=1$ (Landau-Yang theorem)

Kinematics and angular distributions of the decay products sensitive to spin-parity measurement

Log likelihood ratio $q = \log \frac{L(J^P = 0^+)}{L(J^P = 2^+)}$



2^+ are excluded at 99.9% CL

$J^P=0^-, 1^+, 1^-$ and 2^+ are excluded at $> 97.8\%$ CL

New physics searches

New physics has not been observed yet

We start excluding the large area of the parameter space of the new physics (ex. SUSY)

SUSY exclusion

ATLAS SUSY Searches* - 95% CL Lower Limits

Status: SUSY 2013

ATLAS Preliminary

$\int \mathcal{L} dt = (4.6 - 22.9) \text{ fb}^{-1}$ $\sqrt{s} = 7, 8 \text{ TeV}$

| Model | e, μ, τ, γ | Jets | E_T^{miss} | $\int \mathcal{L} dt [\text{fb}^{-1}]$ | Mass limit | Reference | |
|---|---|--|---------------------|--|-------------------------|---|---|
| Inclusive Searches | MSUGRA/CMSSM | 0 | 2-6 jets | Yes | 20.3 | \tilde{q}, \tilde{g} 1.7 TeV | $m(\tilde{q})=m(\tilde{g})$ ATLAS-CONF-2013-047 |
| | MSUGRA/CMSSM | 1 e, μ | 3-6 jets | Yes | 20.3 | \tilde{g} 1.2 TeV | any $m(\tilde{q})$ ATLAS-CONF-2013-062 |
| | MSUGRA/CMSSM | 0 | 7-10 jets | Yes | 20.3 | \tilde{g} 1.1 TeV | any $m(\tilde{q})$ 1308.1841 |
| | $\tilde{q}\tilde{q}, \tilde{q} \rightarrow q\tilde{\chi}_1^0$ | 0 | 2-6 jets | Yes | 20.3 | \tilde{q} 740 GeV | $m(\tilde{\chi}_1^0)=0 \text{ GeV}$ ATLAS-CONF-2013-047 |
| | $\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}\tilde{\chi}_1^0$ | 0 | 2-6 jets | Yes | 20.3 | \tilde{g} 1.3 TeV | $m(\tilde{\chi}_1^0)=0 \text{ GeV}$ ATLAS-CONF-2013-047 |
| | $\tilde{g}\tilde{g}, \tilde{g} \rightarrow qq\tilde{\chi}_1^0 \rightarrow qqW^{\pm}\tilde{\chi}_1^0$ | 1 e, μ | 3-6 jets | Yes | 20.3 | \tilde{g} 1.18 TeV | $m(\tilde{\chi}_1^0)<200 \text{ GeV}, m(\tilde{\tau}^{\pm})=0.5(m(\tilde{\chi}_1^0)+m(\tilde{g}))$ ATLAS-CONF-2013-062 |
| | $\tilde{g}\tilde{g}, \tilde{g} \rightarrow qq(\ell\ell/\nu\nu/\nu\nu)\tilde{\chi}_1^0$ | 2 e, μ | 0-3 jets | - | 20.3 | \tilde{g} 1.12 TeV | $m(\tilde{\chi}_1^0)=0 \text{ GeV}$ ATLAS-CONF-2013-089 |
| | GMSB (\tilde{l} NLSP) | 2 e, μ | 2-4 jets | Yes | 4.7 | \tilde{g} 1.24 TeV | $\tan\beta < 15$ 1208.4688 |
| | GMSB (\tilde{l} NLSP) | 1-2 τ | 0-2 jets | Yes | 20.7 | \tilde{g} 1.4 TeV | $\tan\beta > 18$ ATLAS-CONF-2013-026 |
| | GGM (bino NLSP) | 2 γ | - | Yes | 4.8 | \tilde{g} 1.07 TeV | $m(\tilde{\chi}_1^0)>50 \text{ GeV}$ 1209.0753 |
| | GGM (wino NLSP) | 1 $e, \mu + \gamma$ | - | Yes | 4.8 | \tilde{g} 619 GeV | $m(\tilde{\chi}_1^0)>50 \text{ GeV}$ ATLAS-CONF-2012-144 |
| | GGM (higgsino-bino NLSP) | γ | 1 b | Yes | 4.8 | \tilde{g} 900 GeV | $m(\tilde{\chi}_1^0)>220 \text{ GeV}$ 1211.1167 |
| GGM (higgsino NLSP) | 2 $e, \mu (Z)$ | 0-3 jets | Yes | 5.8 | \tilde{g} 690 GeV | $m(\tilde{H})>200 \text{ GeV}$ ATLAS-CONF-2012-152 | |
| Gravitino LSP | 0 | mono-jet | Yes | 10.5 | $F^{1/2}$ scale 645 GeV | $m(\tilde{g})>10^{-4} \text{ eV}$ ATLAS-CONF-2012-147 | |
| 3rd gen. \tilde{g} med. | $\tilde{g} \rightarrow b\tilde{b}\tilde{\chi}_1^0$ | 0 | 3 b | Yes | 20.1 | \tilde{g} 1.2 TeV | $m(\tilde{\chi}_1^0)<600 \text{ GeV}$ ATLAS-CONF-2013-061 |
| | $\tilde{g} \rightarrow t\tilde{t}\tilde{\chi}_1^0$ | 0 | 7-10 jets | Yes | 20.3 | \tilde{g} 1.1 TeV | $m(\tilde{\chi}_1^0)<350 \text{ GeV}$ 1308.1841 |
| | $\tilde{g} \rightarrow t\tilde{t}\tilde{\chi}_1^0$ | 0-1 e, μ | 3 b | Yes | 20.1 | \tilde{g} 1.34 TeV | $m(\tilde{\chi}_1^0)<400 \text{ GeV}$ ATLAS-CONF-2013-061 |
| | $\tilde{g} \rightarrow b\tilde{t}\tilde{\chi}_1^0$ | 0-1 e, μ | 3 b | Yes | 20.1 | \tilde{g} 1.3 TeV | $m(\tilde{\chi}_1^0)<300 \text{ GeV}$ ATLAS-CONF-2013-061 |
| 3rd gen. squarks direct production | $\tilde{b}_1\tilde{b}_1, \tilde{b}_1 \rightarrow b\tilde{\chi}_1^0$ | 0 | 2 b | Yes | 20.1 | \tilde{b}_1 100-620 GeV | $m(\tilde{\chi}_1^0)<90 \text{ GeV}$ 1308.2631 |
| | $\tilde{b}_1\tilde{b}_1, \tilde{b}_1 \rightarrow t\tilde{\chi}_1^0$ | 2 $e, \mu (SS)$ | 0-3 b | Yes | 20.7 | \tilde{b}_1 275-430 GeV | $m(\tilde{\chi}_1^0)=2 m(\tilde{\tau}_1^0)$ ATLAS-CONF-2013-007 |
| | $\tilde{t}_1\tilde{t}_1$ (light), $\tilde{t}_1 \rightarrow b\tilde{\chi}_1^0$ | 1-2 e, μ | 1-2 b | Yes | 4.7 | \tilde{t}_1 110-167 GeV | $m(\tilde{\chi}_1^0)=55 \text{ GeV}$ 1208.4305, 1209.2102 |
| | $\tilde{t}_1\tilde{t}_1$ (light), $\tilde{t}_1 \rightarrow Wb\tilde{\chi}_1^0$ | 2 e, μ | 0-2 jets | Yes | 20.3 | \tilde{t}_1 130-220 GeV | $m(\tilde{\chi}_1^0)=m(\tilde{\tau}_1^0)-m(W)-50 \text{ GeV}, m(\tilde{t}_1)<m(\tilde{\chi}_1^0)$ ATLAS-CONF-2013-048 |
| | $\tilde{t}_1\tilde{t}_1$ (medium), $\tilde{t}_1 \rightarrow t\tilde{\chi}_1^0$ | 2 e, μ | 2 jets | Yes | 20.3 | \tilde{t}_1 225-525 GeV | $m(\tilde{\chi}_1^0)=0 \text{ GeV}$ ATLAS-CONF-2013-065 |
| | $\tilde{t}_1\tilde{t}_1$ (medium), $\tilde{t}_1 \rightarrow b\tilde{\chi}_1^0$ | 0 | 2 b | Yes | 20.1 | \tilde{t}_1 150-580 GeV | $m(\tilde{\chi}_1^0)<200 \text{ GeV}, m(\tilde{\tau}_1^0)-m(\tilde{\chi}_1^0)=5 \text{ GeV}$ 1308.2631 |
| | $\tilde{t}_1\tilde{t}_1$ (heavy), $\tilde{t}_1 \rightarrow t\tilde{\chi}_1^0$ | 1 e, μ | 1 b | Yes | 20.7 | \tilde{t}_1 200-610 GeV | $m(\tilde{\chi}_1^0)=0 \text{ GeV}$ ATLAS-CONF-2013-037 |
| | $\tilde{t}_1\tilde{t}_1$ (heavy), $\tilde{t}_1 \rightarrow t\tilde{\chi}_1^0$ | 0 | 2 b | Yes | 20.5 | \tilde{t}_1 320-660 GeV | $m(\tilde{\chi}_1^0)=0 \text{ GeV}$ ATLAS-CONF-2013-024 |
| | $\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow c\tilde{\chi}_1^0$ | 0 | mono-jet/c-tag | Yes | 20.3 | \tilde{t}_1 90-200 GeV | $m(\tilde{t}_1)-m(\tilde{\chi}_1^0)<85 \text{ GeV}$ ATLAS-CONF-2013-068 |
| | $\tilde{t}_1\tilde{t}_1$ (natural GMSB) | 2 $e, \mu (Z)$ | 1 b | Yes | 20.7 | \tilde{t}_1 500 GeV | $m(\tilde{\chi}_1^0)>150 \text{ GeV}$ ATLAS-CONF-2013-025 |
| | $\tilde{t}_2\tilde{t}_2, \tilde{t}_2 \rightarrow \tilde{t}_1 + Z$ | 3 $e, \mu (Z)$ | 1 b | Yes | 20.7 | \tilde{t}_2 271-520 GeV | $m(\tilde{t}_1)=m(\tilde{\chi}_1^0)+180 \text{ GeV}$ ATLAS-CONF-2013-025 |
| | EW direct | $\tilde{L}_R\tilde{L}_R, \tilde{L} \rightarrow \ell\tilde{\chi}_1^0$ | 2 e, μ | 0 | Yes | 20.3 | \tilde{l} 85-315 GeV |
| $\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+ \rightarrow \tilde{\nu}(\ell\tilde{\nu})$ | | 2 e, μ | 0 | Yes | 20.3 | $\tilde{\chi}_1^{\pm}$ 125-450 GeV | $m(\tilde{\chi}_1^0)=0 \text{ GeV}, m(\tilde{\nu}, \tilde{\nu})=0.5(m(\tilde{\chi}_1^+)+m(\tilde{\chi}_1^-))$ ATLAS-CONF-2013-049 |
| $\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+ \rightarrow \tilde{\nu}(\tau\tilde{\nu})$ | | 2 τ | - | Yes | 20.7 | $\tilde{\chi}_1^{\pm}$ 180-330 GeV | $m(\tilde{\chi}_1^0)=0 \text{ GeV}, m(\tilde{\nu}, \tilde{\nu})=0.5(m(\tilde{\chi}_1^+)+m(\tilde{\chi}_1^-))$ ATLAS-CONF-2013-028 |
| $\tilde{\chi}_1^+\tilde{\chi}_2^0 \rightarrow \tilde{\ell}_i\tilde{\nu}(\ell(\tilde{\nu}), \ell\tilde{\nu}_L(\tilde{\nu}))$ | | 3 e, μ | 0 | Yes | 20.7 | $\tilde{\chi}_1^+, \tilde{\chi}_2^0$ 600 GeV | $m(\tilde{\chi}_1^0)=m(\tilde{\chi}_2^0), m(\tilde{\chi}_1^0)=0, m(\tilde{\ell}, \tilde{\nu})=0.5(m(\tilde{\chi}_1^+)+m(\tilde{\chi}_2^0))$ ATLAS-CONF-2013-035 |
| $\tilde{\chi}_1^+\tilde{\chi}_2^0 \rightarrow W\tilde{\chi}_1^0 Z\tilde{\chi}_1^0$ | | 3 e, μ | 0 | Yes | 20.7 | $\tilde{\chi}_1^+, \tilde{\chi}_2^0$ 315 GeV | $m(\tilde{\chi}_1^0)=m(\tilde{\chi}_2^0), m(\tilde{\chi}_1^0)=0, \text{ sleptons decoupled}$ ATLAS-CONF-2013-035 |
| $\tilde{\chi}_1^+\tilde{\chi}_2^0 \rightarrow W\tilde{\chi}_1^0 h\tilde{\chi}_1^0$ | | 1 e, μ | 2 b | Yes | 20.3 | $\tilde{\chi}_1^+, \tilde{\chi}_2^0$ 285 GeV | $m(\tilde{\chi}_1^0)=m(\tilde{\chi}_2^0), m(\tilde{\chi}_1^0)=0, \text{ sleptons decoupled}$ ATLAS-CONF-2013-093 |
| Long-lived particles | Direct $\tilde{\chi}_1^+\tilde{\chi}_1^-$ prod., long-lived $\tilde{\chi}_1^{\pm}$ | Disapp. trk | 1 jet | Yes | 20.3 | $\tilde{\chi}_1^{\pm}$ 270 GeV | $m(\tilde{\chi}_1^+)-m(\tilde{\chi}_1^-)=160 \text{ MeV}, \tau(\tilde{\chi}_1^{\pm})=0.2 \text{ ns}$ ATLAS-CONF-2013-069 |
| | Stable, stopped \tilde{g} R-hadron | 0 | 1-5 jets | Yes | 22.9 | \tilde{g} 832 GeV | $m(\tilde{\chi}_1^0)=100 \text{ GeV}, 10 \mu\text{s} < \tau(\tilde{g}) < 1000 \text{ s}$ ATLAS-CONF-2013-057 |
| | GMSB, stable $\tilde{\tau}, \tilde{\chi}_1^0 \rightarrow \tilde{\tau}(\tilde{e}, \tilde{\mu}) + \tau(e, \mu)$ | 1-2 μ | - | - | 15.9 | $\tilde{\chi}_1^0$ 475 GeV | $10 < \tan\beta < 50$ ATLAS-CONF-2013-058 |
| | GMSB, $\tilde{\chi}_1^0 \rightarrow \gamma\tilde{G}$, long-lived $\tilde{\chi}_1^0$ | 2 γ | - | Yes | 4.7 | $\tilde{\chi}_1^0$ 230 GeV | $0.4 < \tau(\tilde{\chi}_1^0) < 2 \text{ ns}$ 1304.6310 |
| $\tilde{q}\tilde{q}, \tilde{\chi}_1^0 \rightarrow qq\mu$ (RPV) | 1 μ , displ. vtx | - | - | 20.3 | \tilde{q} 1.0 TeV | $1.5 < c\tau < 156 \text{ mm}, \text{BR}(\mu)=1, m(\tilde{\chi}_1^0)=108 \text{ GeV}$ ATLAS-CONF-2013-092 | |
| RPV | LFV $pp \rightarrow \tilde{\nu}_\tau + X, \tilde{\nu}_\tau \rightarrow e + \mu$ | 2 e, μ | - | - | 4.6 | $\tilde{\nu}_\tau$ 1.61 TeV | $\lambda'_{311}=0.10, \lambda'_{132}=0.05$ 1212.1272 |
| | LFV $pp \rightarrow \tilde{\nu}_\tau + X, \tilde{\nu}_\tau \rightarrow e(\mu) + \tau$ | 1 $e, \mu + \tau$ | - | - | 4.6 | $\tilde{\nu}_\tau$ 1.1 TeV | $\lambda'_{311}=0.10, \lambda'_{1(2)33}=0.05$ 1212.1272 |
| | Bilinear RPV CMSSM | 1 e, μ | 7 jets | Yes | 4.7 | \tilde{q}, \tilde{g} 1.2 TeV | $m(\tilde{q})=m(\tilde{g}), c\tau_{150} < 1 \text{ mm}$ ATLAS-CONF-2012-140 |
| | $\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+ \rightarrow W\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow ee\tilde{\nu}_\mu, e\mu\tilde{\nu}_e$ | 4 e, μ | - | Yes | 20.7 | $\tilde{\chi}_1^{\pm}$ 760 GeV | $m(\tilde{\chi}_1^0)>300 \text{ GeV}, \lambda'_{121}>0$ ATLAS-CONF-2013-036 |
| | $\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+ \rightarrow W\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow \tau\tilde{\nu}_e, e\tau\tilde{\nu}_\tau$ | 3 $e, \mu + \tau$ | - | Yes | 20.7 | $\tilde{\chi}_1^{\pm}$ 350 GeV | $m(\tilde{\chi}_1^0)>80 \text{ GeV}, \lambda'_{133}>0$ ATLAS-CONF-2013-036 |
| | $\tilde{g} \rightarrow qq\tilde{q}$ | 0 | 6-7 jets | - | 20.3 | \tilde{g} 916 GeV | $\text{BR}(\tau)=\text{BR}(b)=\text{BR}(c)=0\%$ ATLAS-CONF-2013-091 |
| $\tilde{g} \rightarrow \tilde{t}_1 t, \tilde{t}_1 \rightarrow b\tilde{s}$ | 2 $e, \mu (SS)$ | 0-3 b | Yes | 20.7 | \tilde{g} 880 GeV | ATLAS-CONF-2013-007 | |
| Other | Scalar gluon pair, $\text{sgluon} \rightarrow q\tilde{q}$ | 0 | 4 jets | - | 4.6 | sgluon 100-287 GeV | incl. limit from 1110.2693 1210.4826 |
| | Scalar gluon pair, $\text{sgluon} \rightarrow t\tilde{t}$ | 2 $e, \mu (SS)$ | 1 b | Yes | 14.3 | sgluon 800 GeV | ATLAS-CONF-2013-051 |
| | WIMP interaction (D5, Dirac χ) | 0 | mono-jet | Yes | 10.5 | M^* scale 704 GeV | $m(\chi)<60 \text{ GeV}, \text{limit of } <687 \text{ GeV for D8}$ ATLAS-CONF-2012-147 |

$\sqrt{s} = 7 \text{ TeV}$ full data
 $\sqrt{s} = 8 \text{ TeV}$ partial data
 $\sqrt{s} = 8 \text{ TeV}$ full data

10⁻¹ 1 Mass scale [TeV]

*Only a selection of the available mass limits on new states or phenomena is shown. All limits quoted are observed minus 1 σ theoretical signal cross section uncertainty.

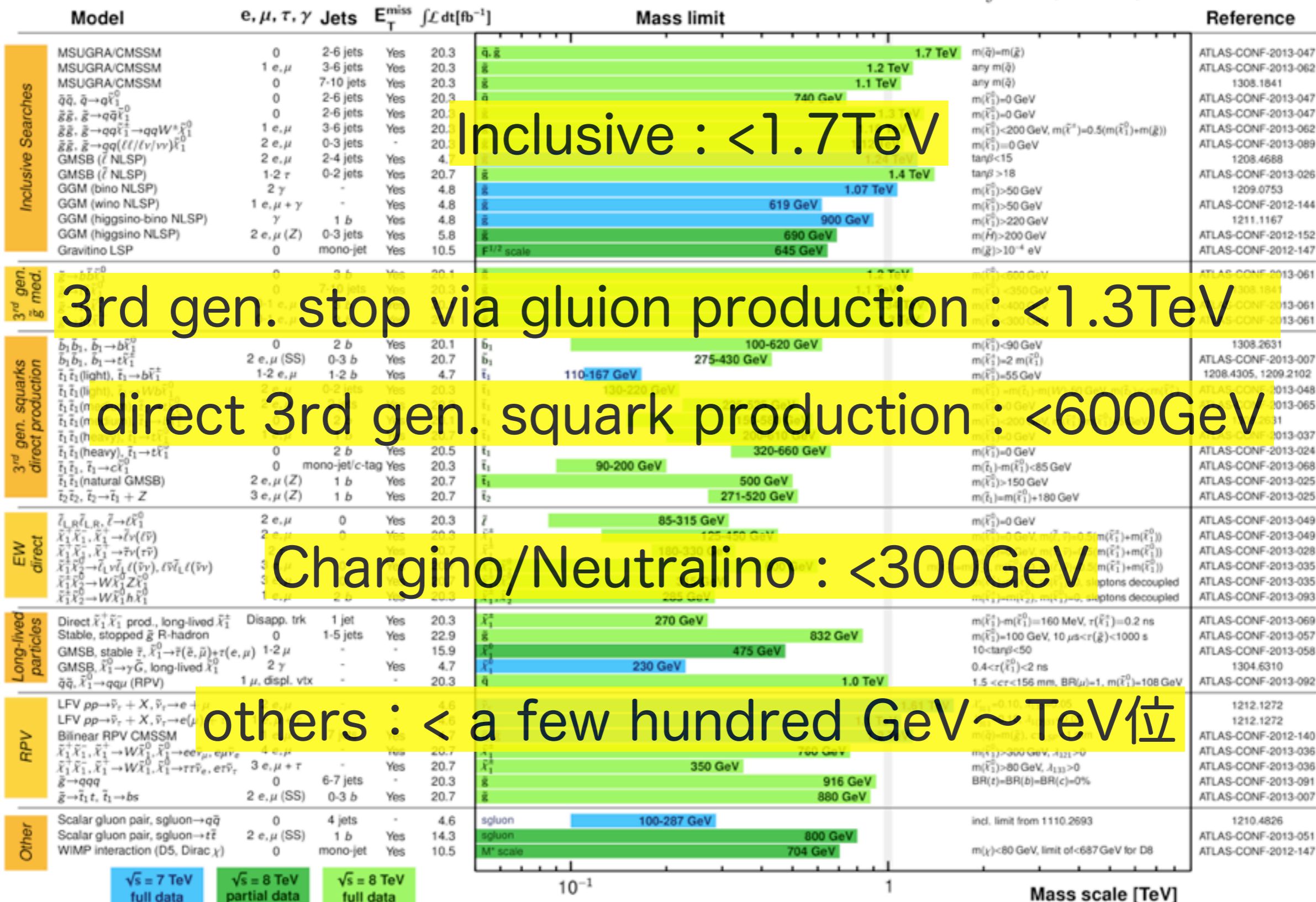
SUSY exclusion

ATLAS SUSY Searches* - 95% CL Lower Limits

Status: SUSY 2013

ATLAS Preliminary

$\int \mathcal{L} dt = (4.6 - 22.9) \text{ fb}^{-1}$ $\sqrt{s} = 7, 8 \text{ TeV}$



Inclusive : <1.7TeV

3rd gen. stop via gluon production : <1.3TeV

direct 3rd gen. squark production : <600GeV

Chargino/Neutralino : <300GeV

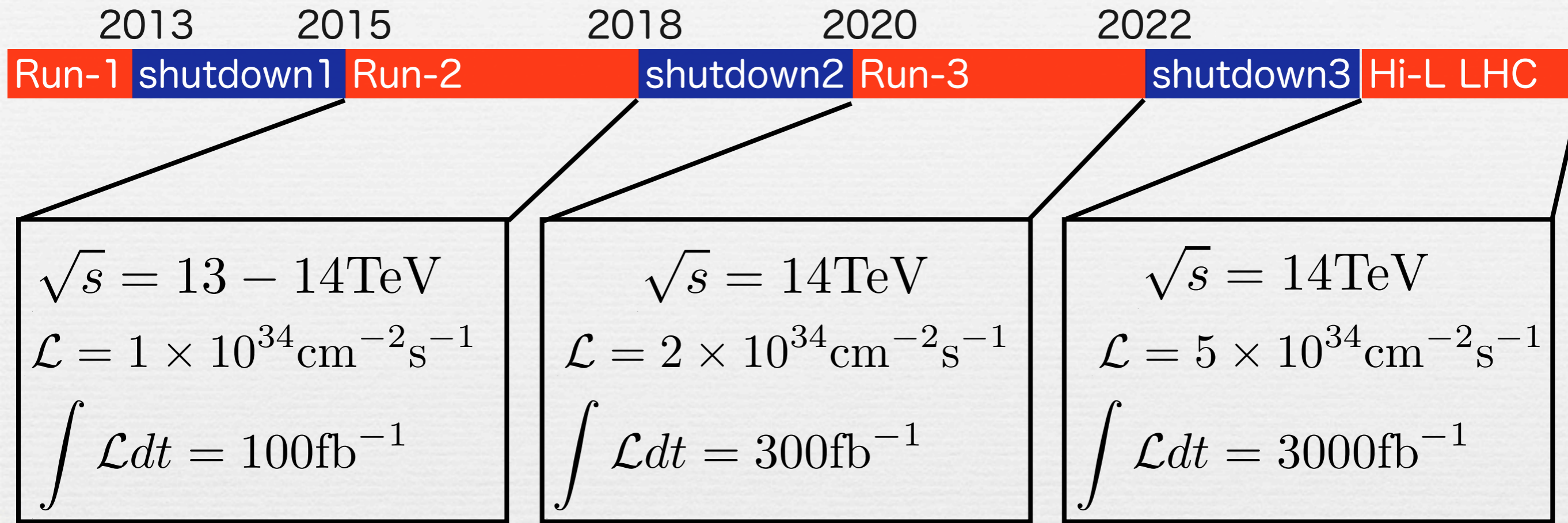
others : < a few hundred GeV ~ TeV位

$\sqrt{s} = 7 \text{ TeV}$ full data
 $\sqrt{s} = 8 \text{ TeV}$ partial data
 $\sqrt{s} = 8 \text{ TeV}$ full data

Mass scale [TeV]

*Only a selection of the available mass limits on new states or phenomena is shown. All limits quoted are observed minus 1 σ theoretical signal cross section uncertainty.

Prospects of LHC upgrades



The 14TeV run (Run 2) will start 2015.

Two other shutdowns after Run-2 are scheduled

Luminosity improvements will be achieved

To discover new physics beyond the SM

To measure the Higgs property precisely

Conclusion

LHC-Run I ends with great success.

- SM physics has been precisely measured and understood.
- A Higgs-like resonance at 125.5 GeV has been discovered.
 - All measured properties are compatible with SM Higgs boson, so far
- The large area of the new physics parameter space has been excluded.

Nagoya-ATLAS group contributes greatly to :

- detector installation/commissioning/operation
- physics analysis (in particular top quark physics)

Enlarge our group activity, towards 14 TeV LHC-Run !!