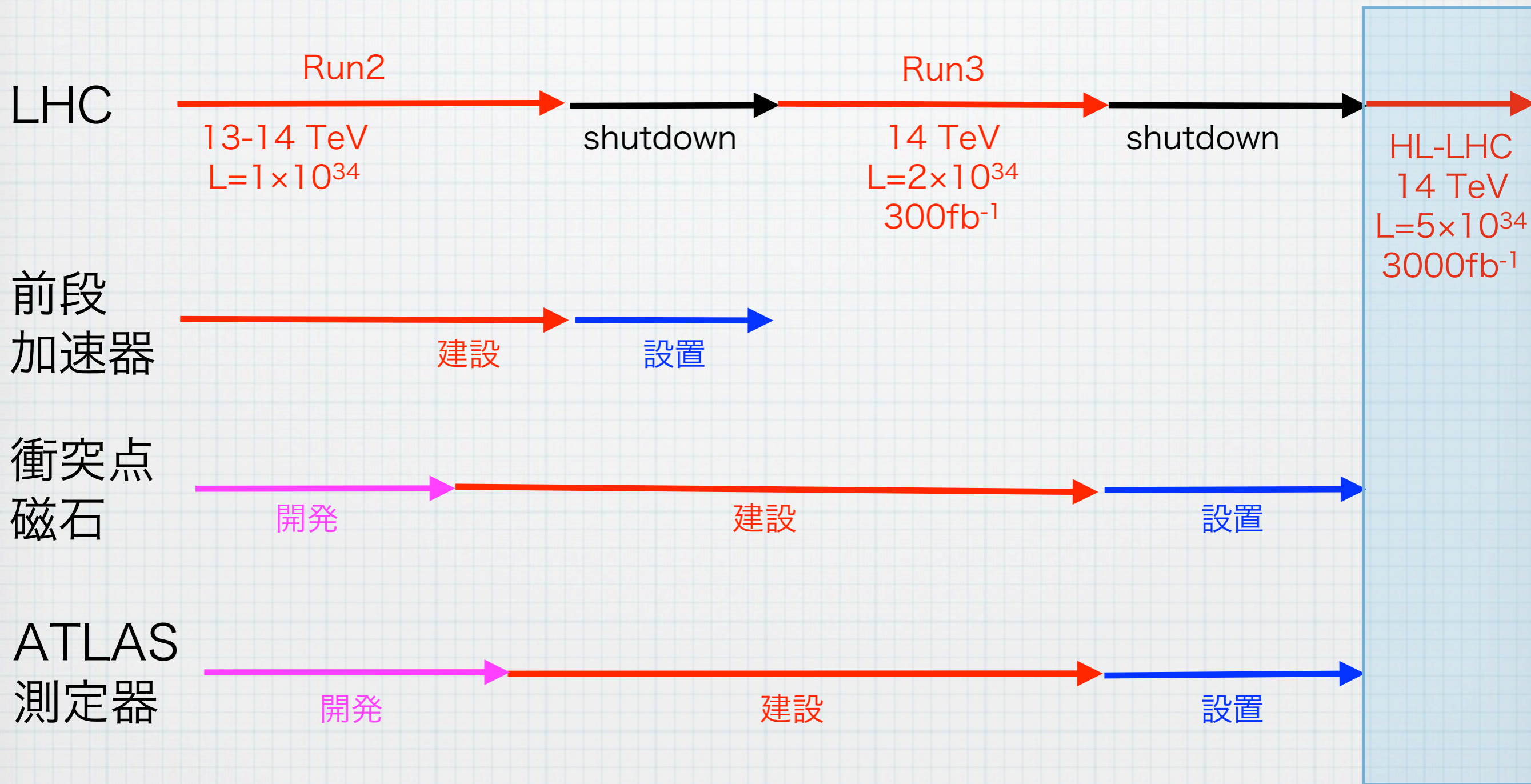
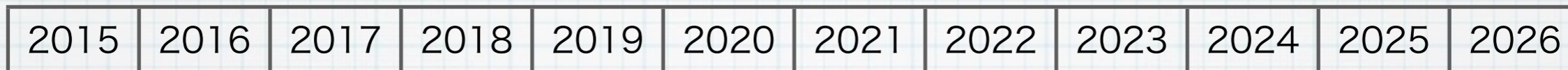


LHC Run2 ATLAS (とCMS) 報告

花垣和則 (KEK/大阪大学)

スケジュール

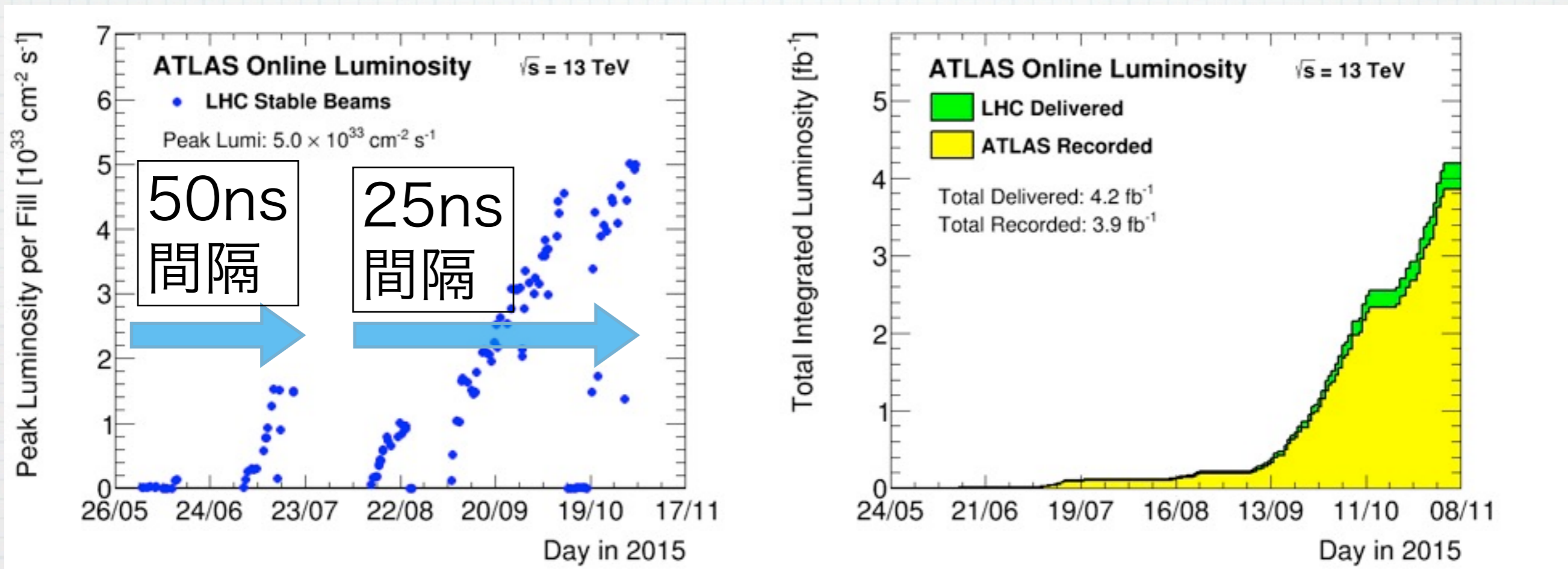


LHC パラメータ

	目標値(*)	現状
ビームエネルギー	7TeV	6.5TeV
ルミノシティ	$1.3E34\text{cm}^{-2}\text{s}^{-1}$	$0.5E34\text{cm}^{-2}\text{s}^{-1}$
陽子数/バンチ	$1.15E+11$	$1.15E+11$
バンチ数/ビーム	2808	2232
バンチ間隔	25ns	25ns
β^*	40cm	80cm

(*)設計値よりもアグレッシブなものあり

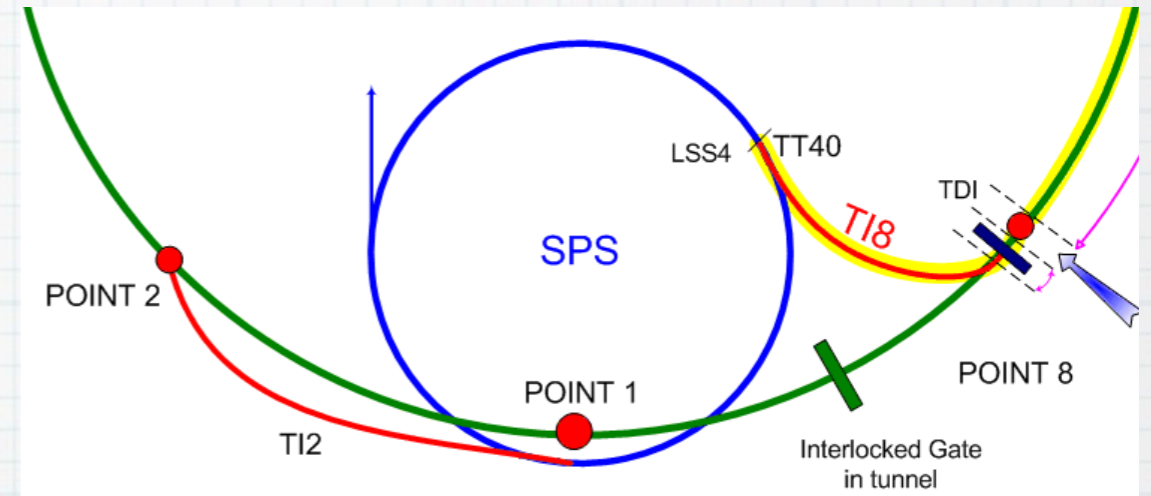
Run2 これまで



- ❖ Peak luminosity $5.0 \times 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$
- ❖ Integrated luminosity 4.2 fb^{-1} (3.9 fb^{-1} recorded)

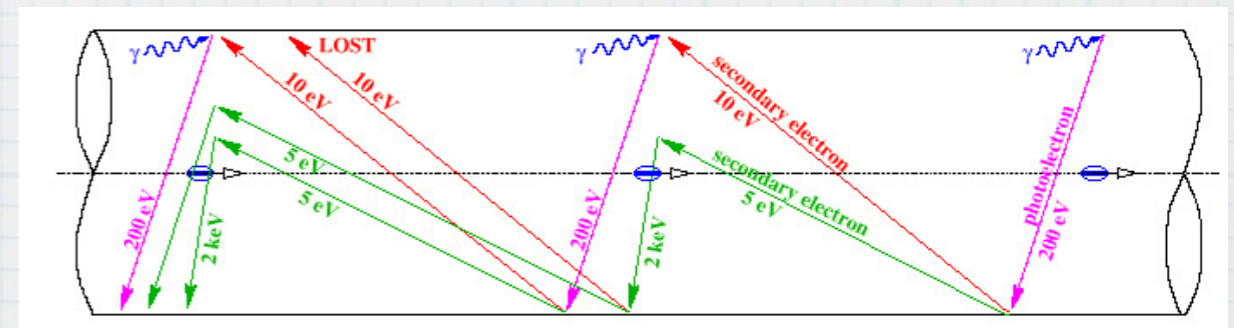
LHC課題

- ❖ ビーム入射時のコリメータ
 - ▶ 高温に耐えられない
 - ▶ 入射バンチ数に制限
⇒ 年末に交換

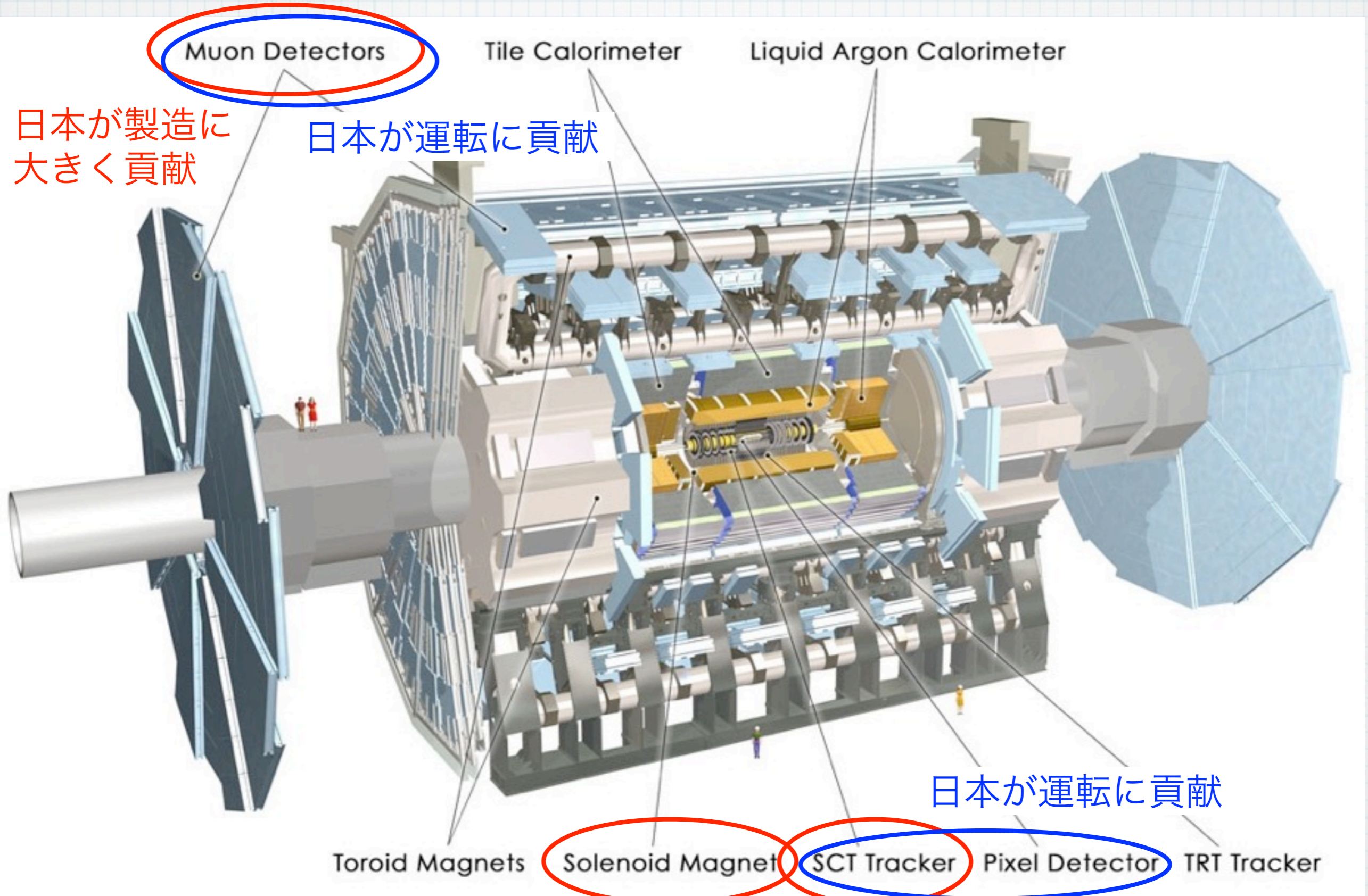


- ❖ Un-identified Falling Objects (UFO)
 - ▶ 「何か」が落ちてきて、ビームが散乱
 - ▶ ビームロス → ビームロスモニターが作動

- ❖ 電子雲：25ns間隔で顕著
 - ▶ Beam scrubbing



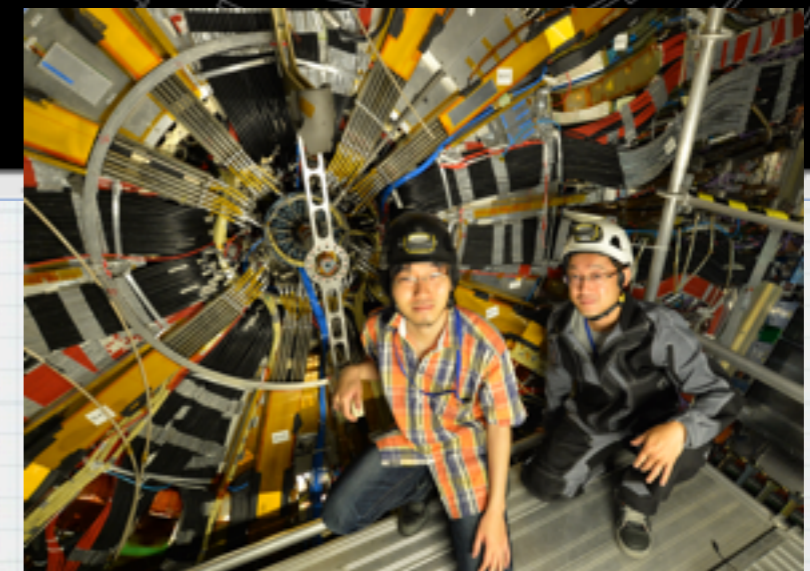
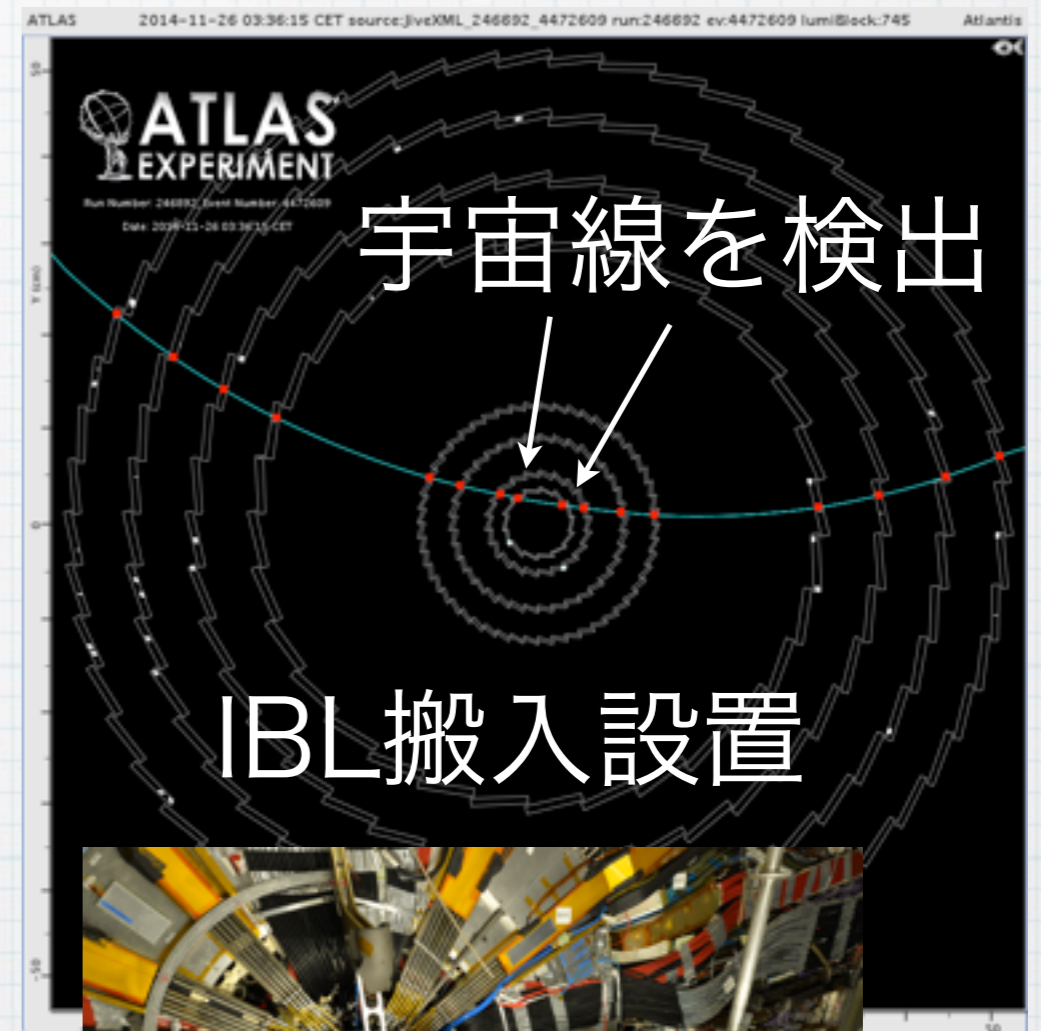
ATLAS検出器



ATLAS検出器の様々な整備・改善

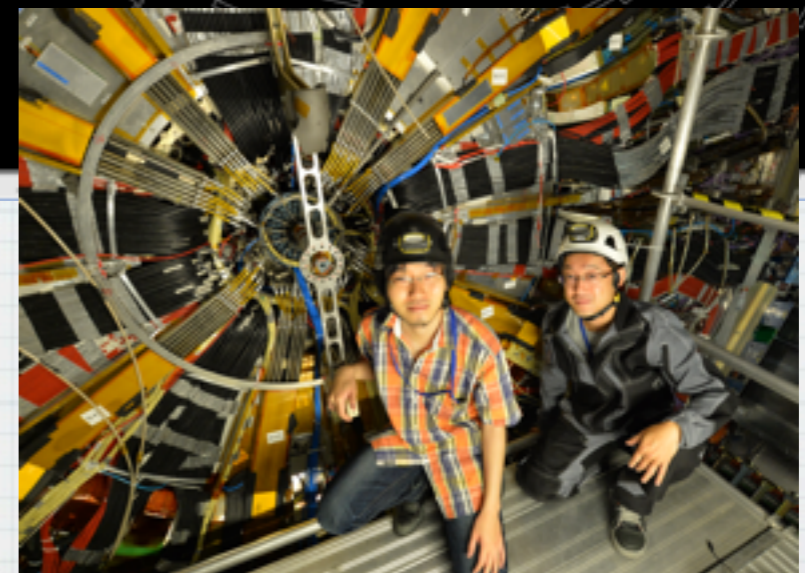
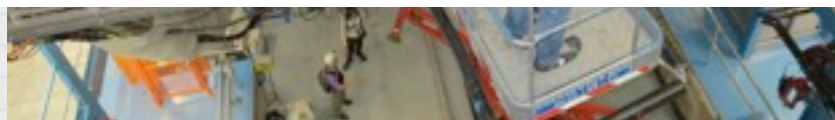
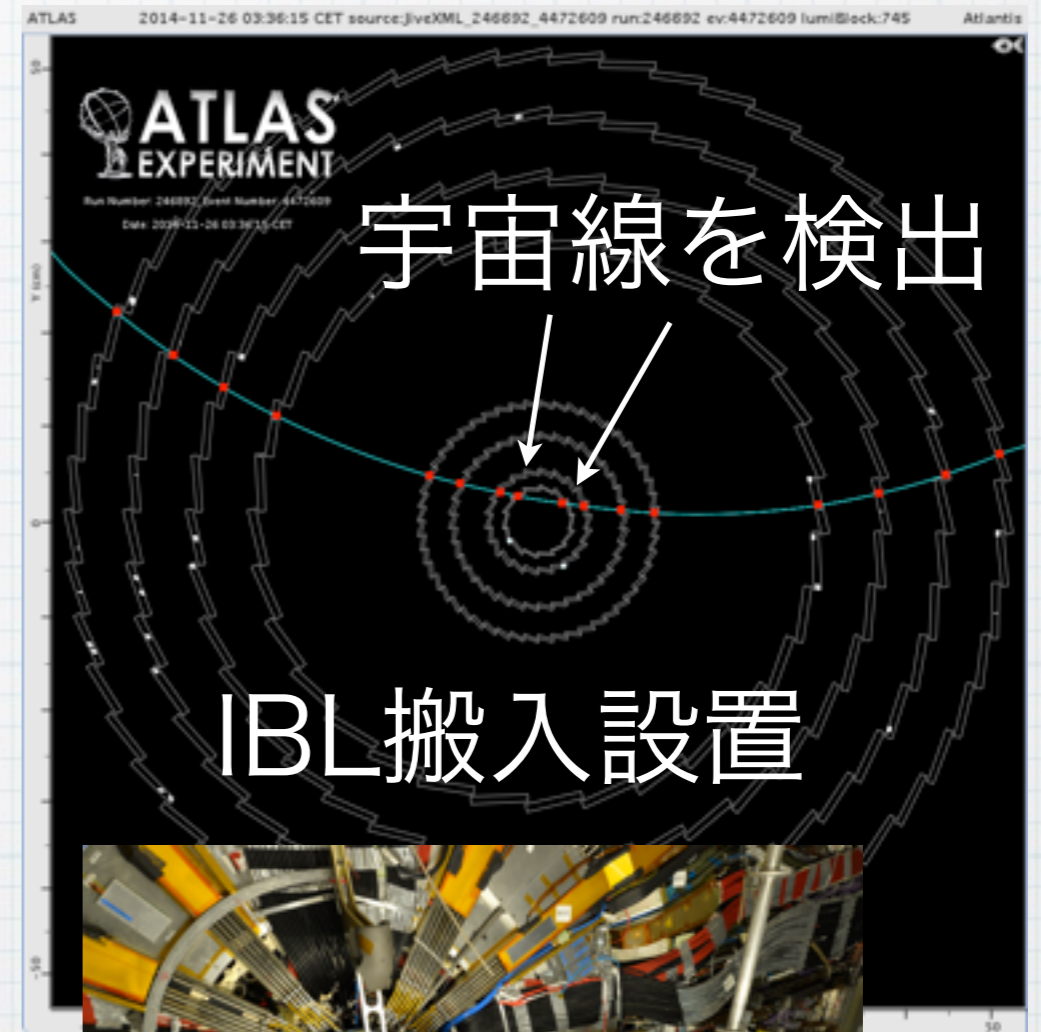
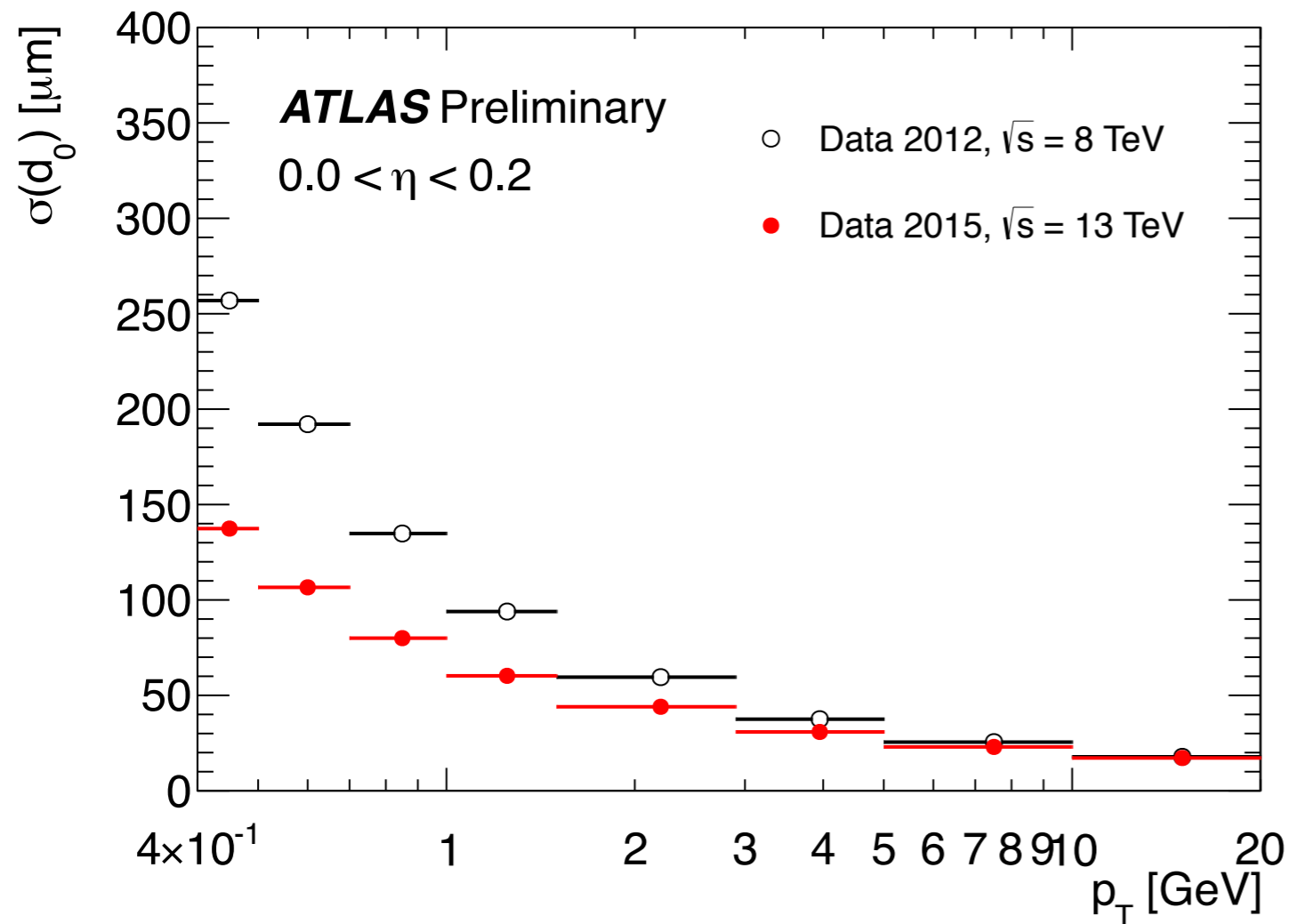
- ❖ 飛跡検出器最内層にピクセルを一層 (IBL) 追加
- ❖ その他様々な整備作業

TGC作業

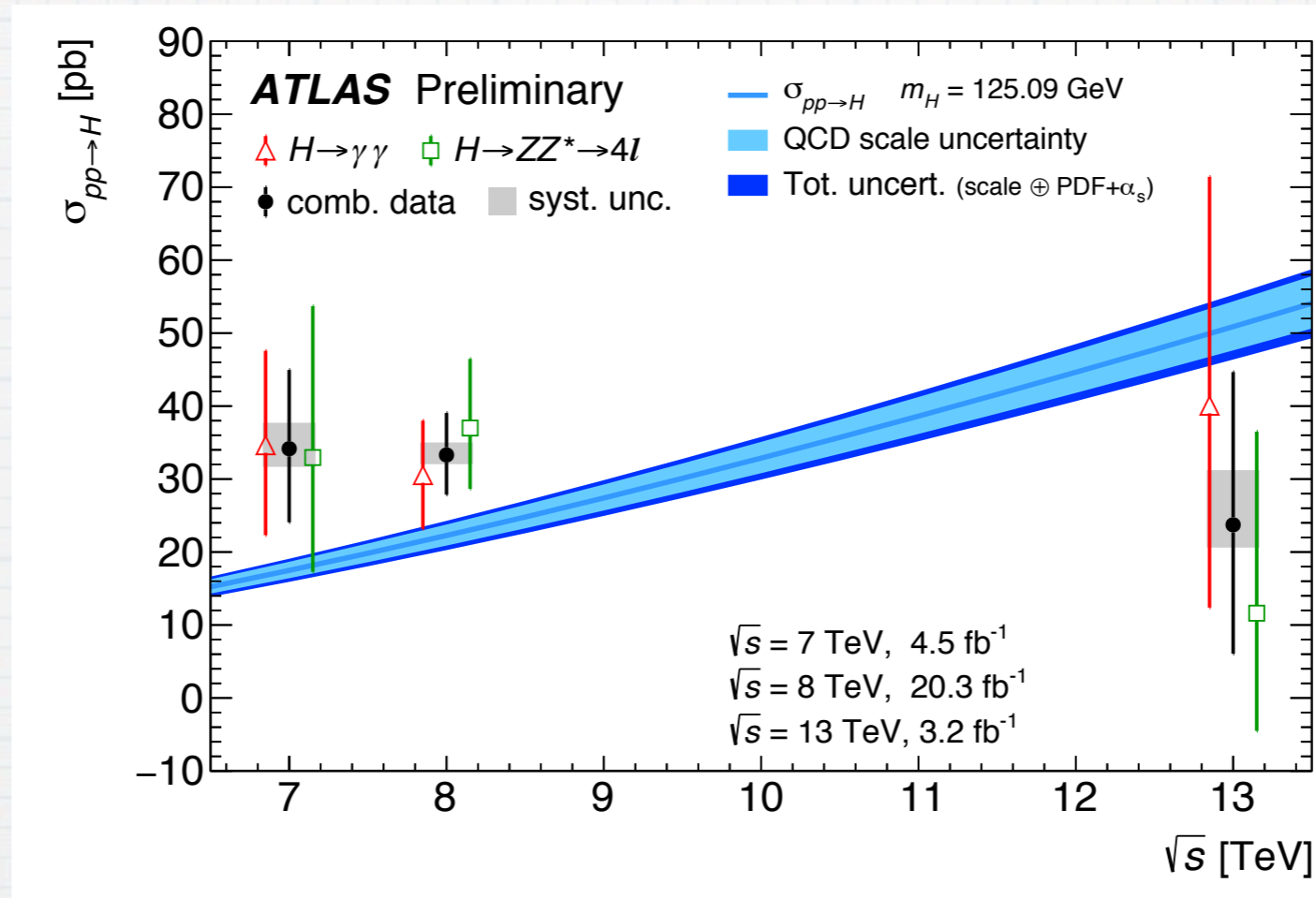


ATLAS検出器の様々な整備・改善

- ❖ 飛跡検出器最内層にピクセルを一層 (IBL) 追加
- ❖ その他様々な整備作業



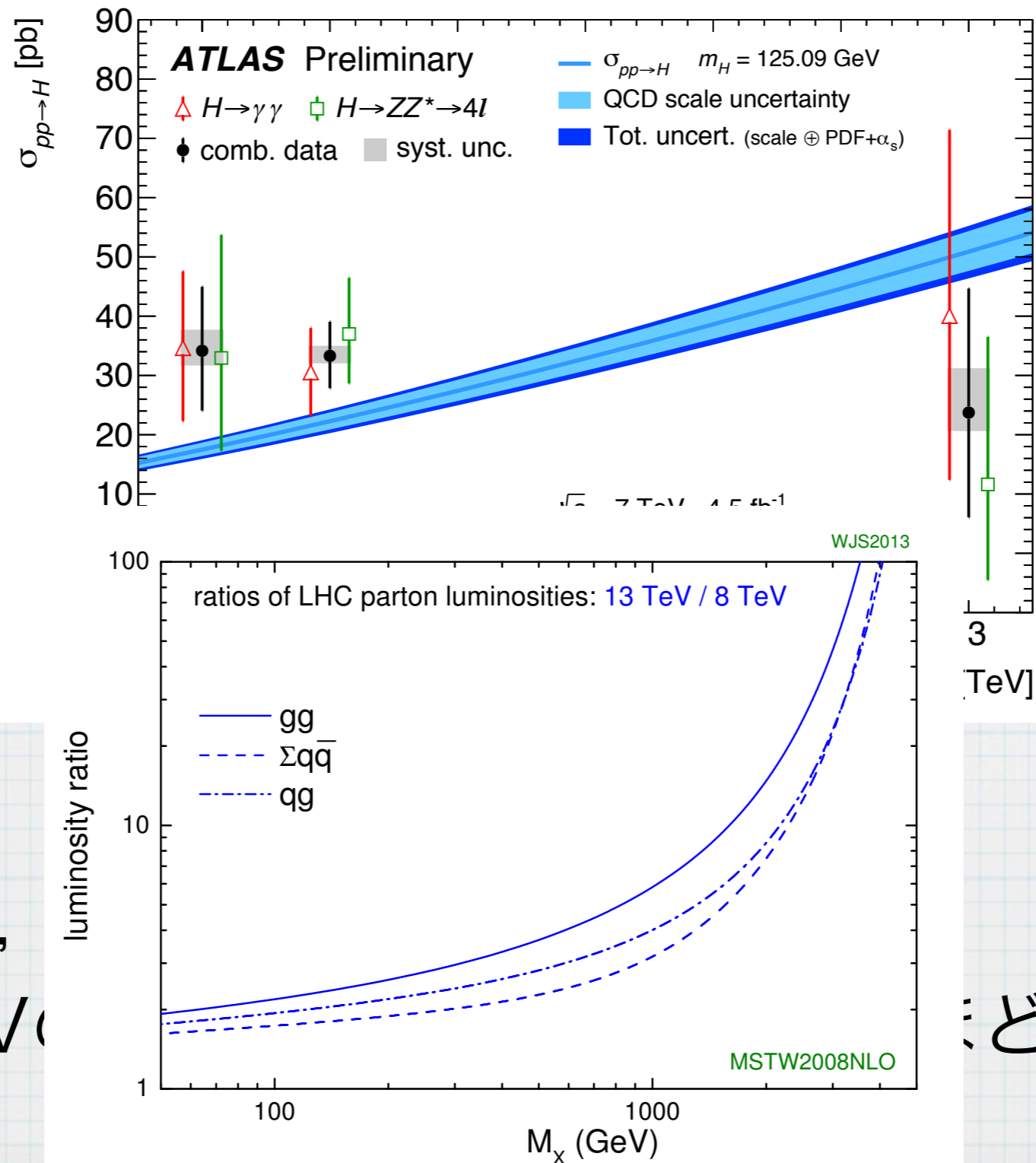
Higgs



❖ $H \rightarrow \gamma\gamma$, $H \rightarrow ZZ$ で新たな結果

▶ 13TeVの恩恵は重い未知粒子探索ほどではない

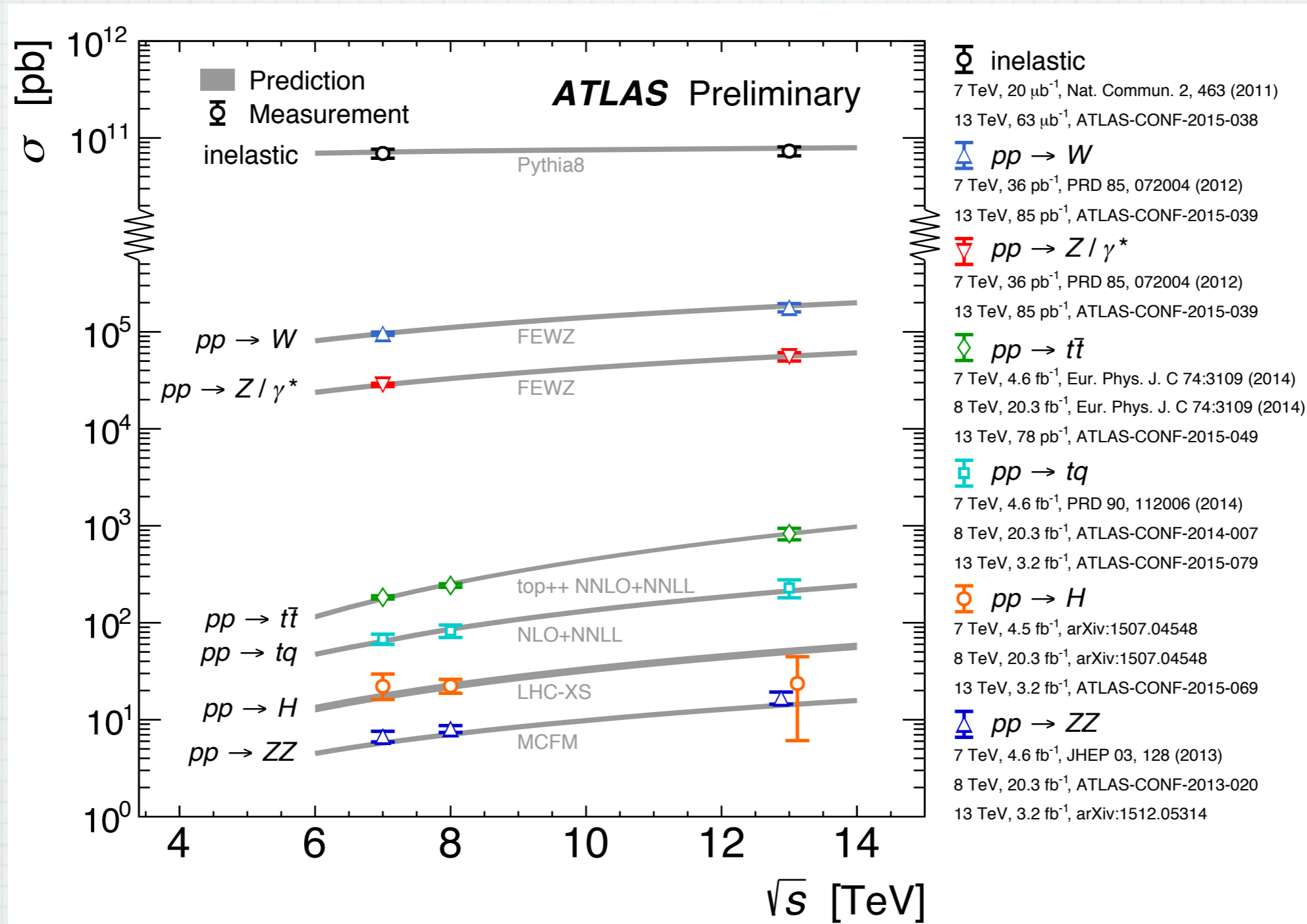
Higgs



❖ $H \rightarrow \gamma\gamma$,
 ▶ 13TeV

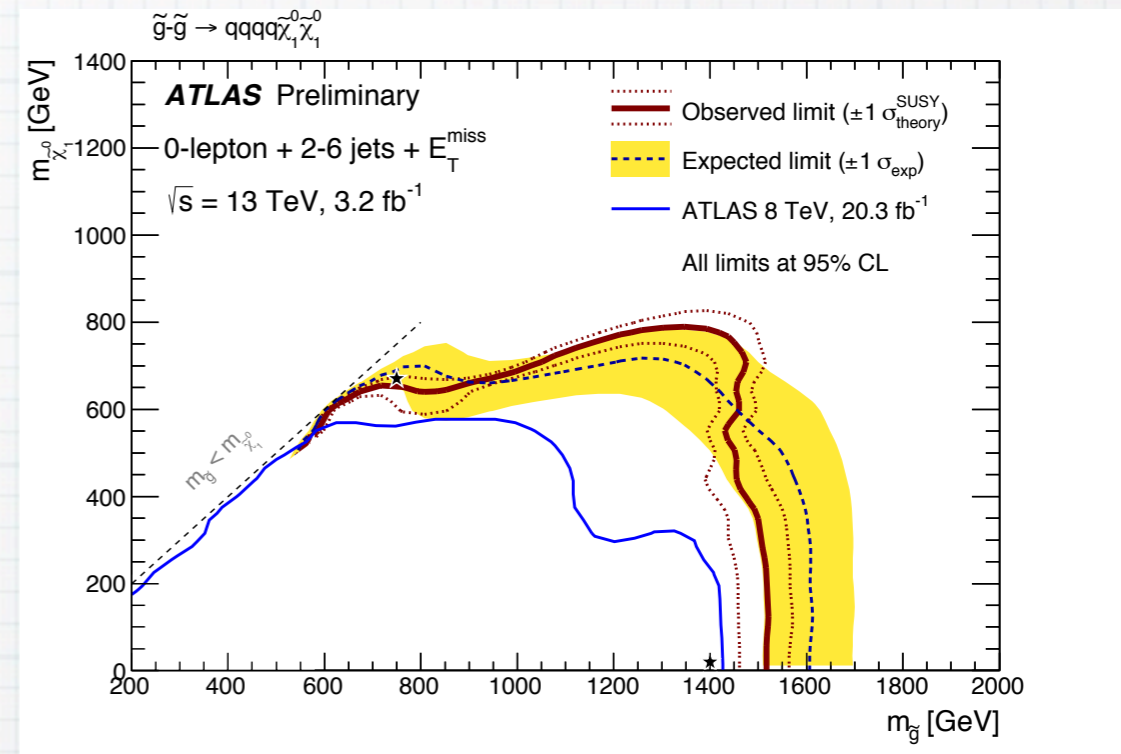
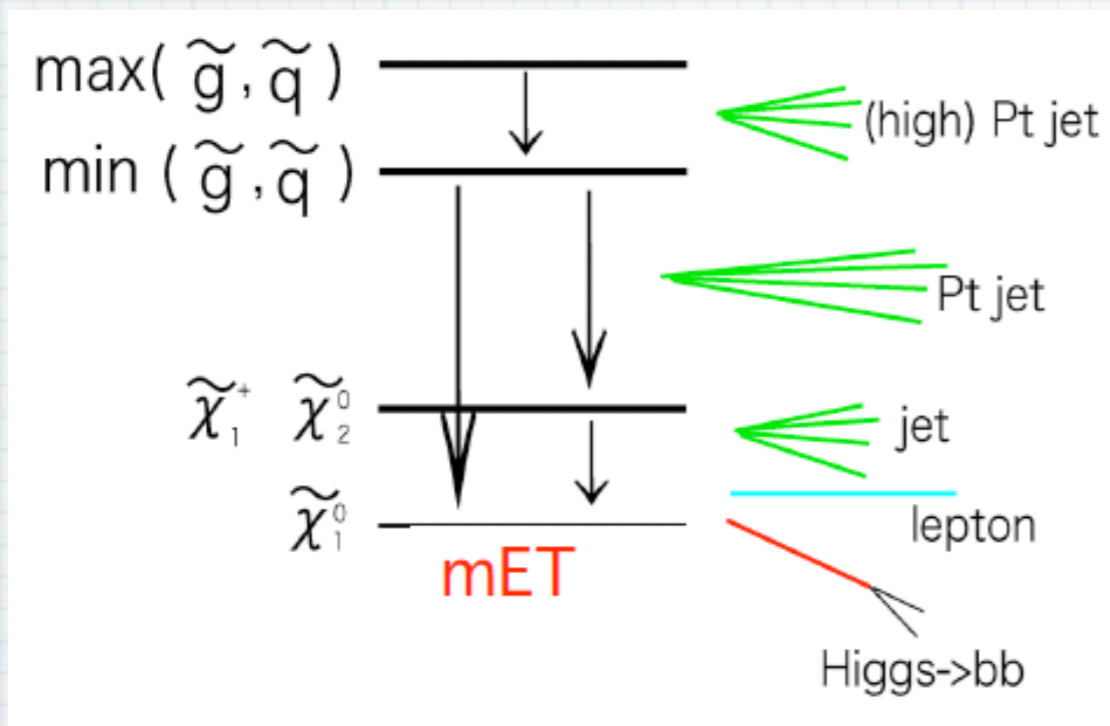
どではない

生成断面積まとめ

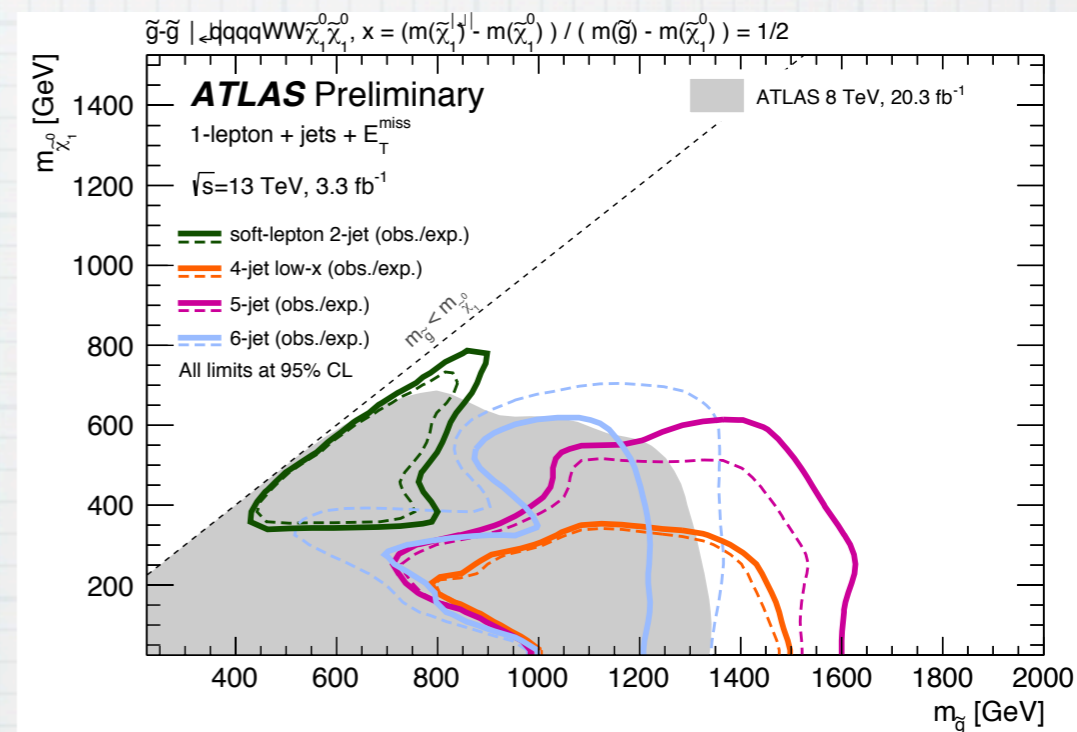


❖ 標準模型13TeVも適用範囲内

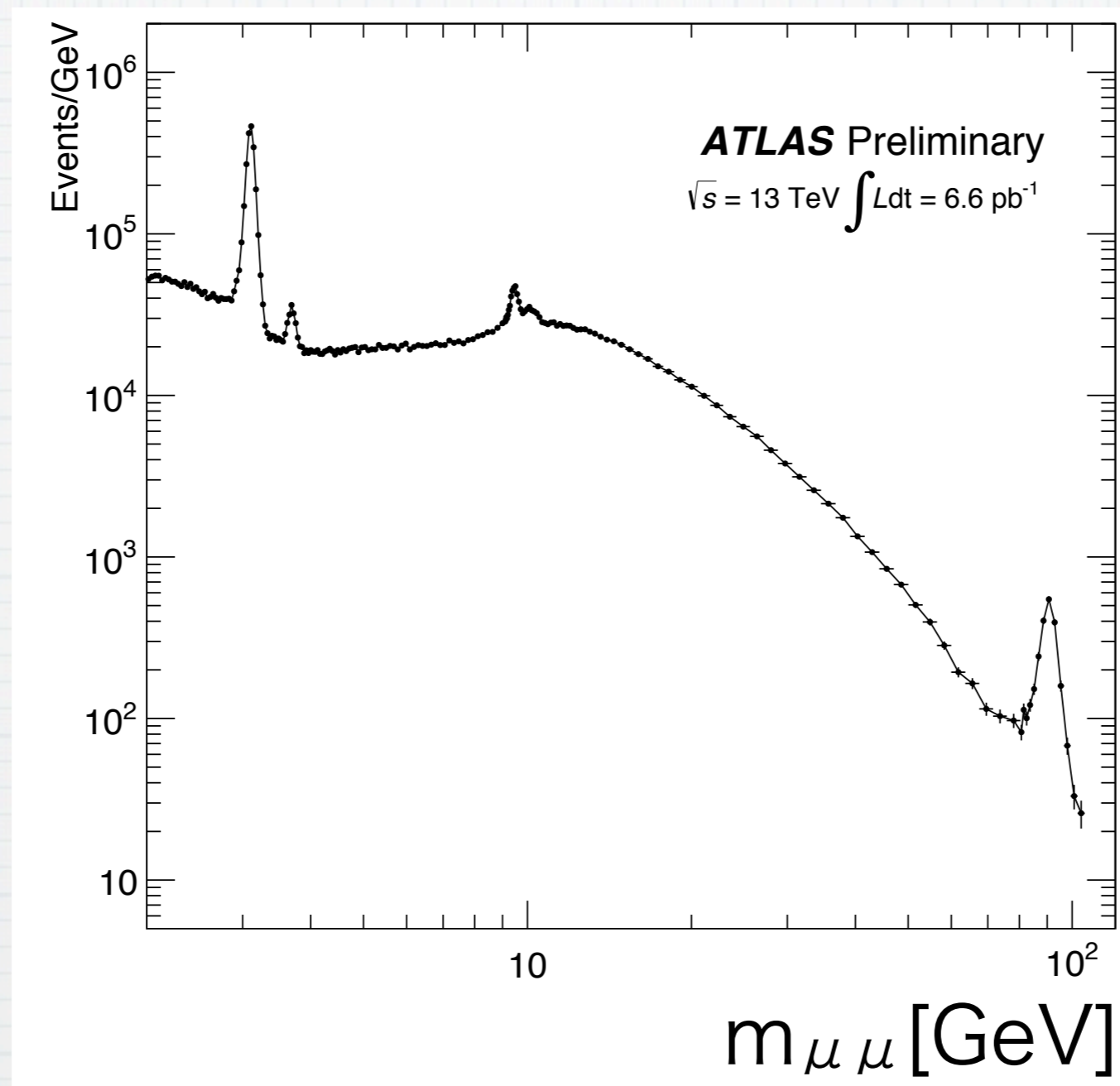
SUSY探索



- ❖ Strong productionでは8TeVの探索感度を超える
- ❖ Weak productionの結果はまだ
 - ▶ 統計が必要

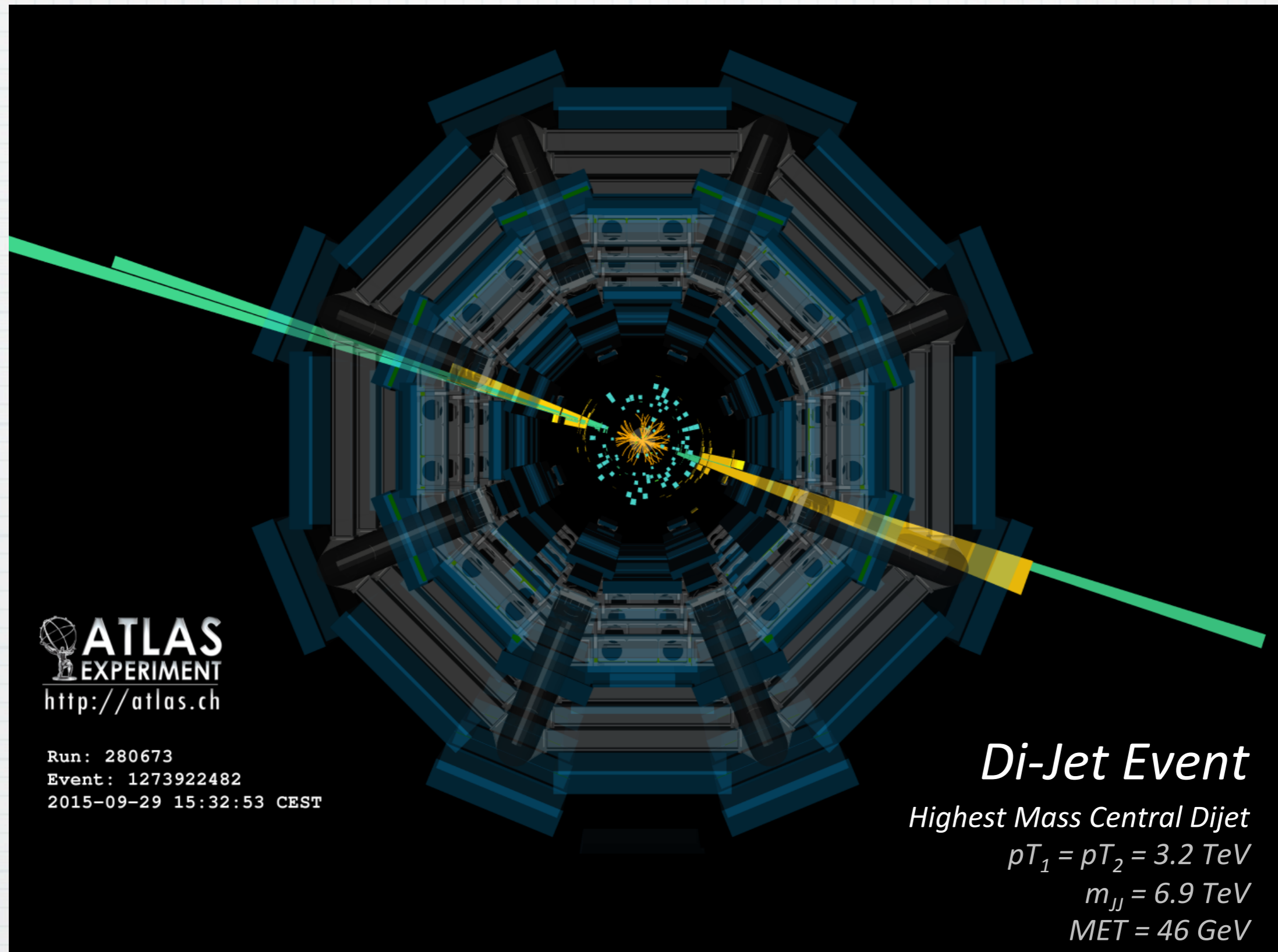


Resonance Search

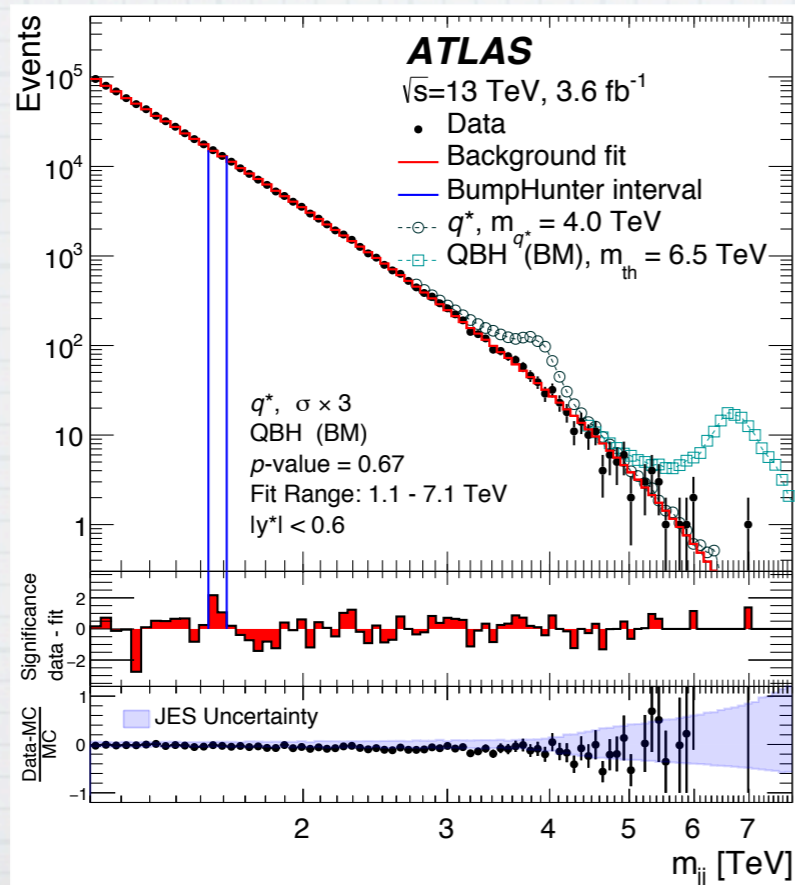
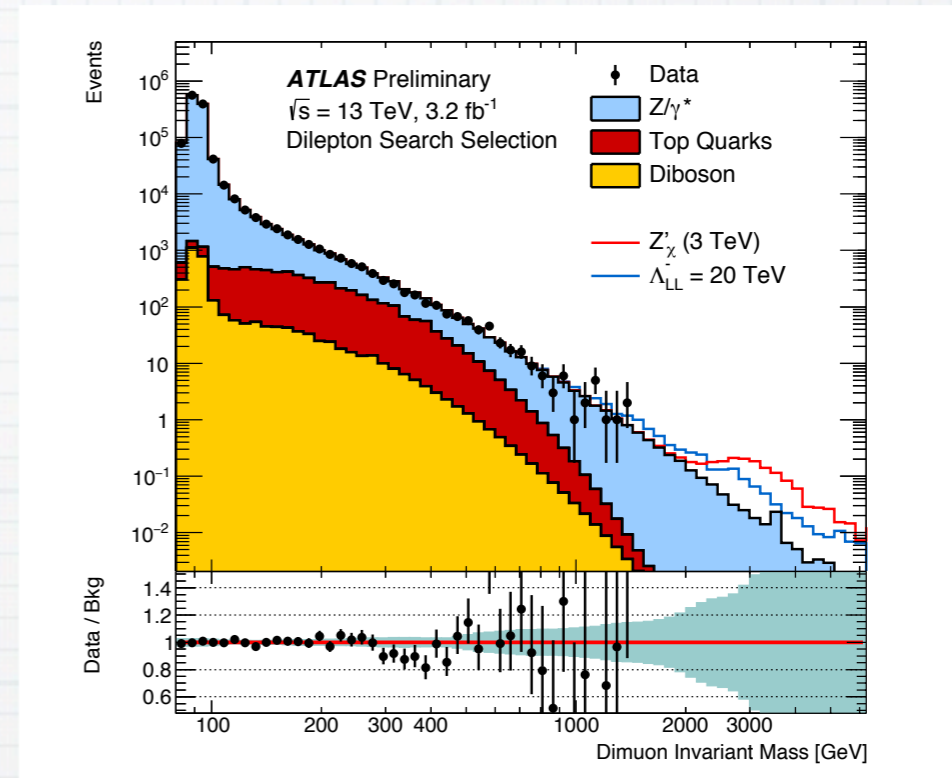
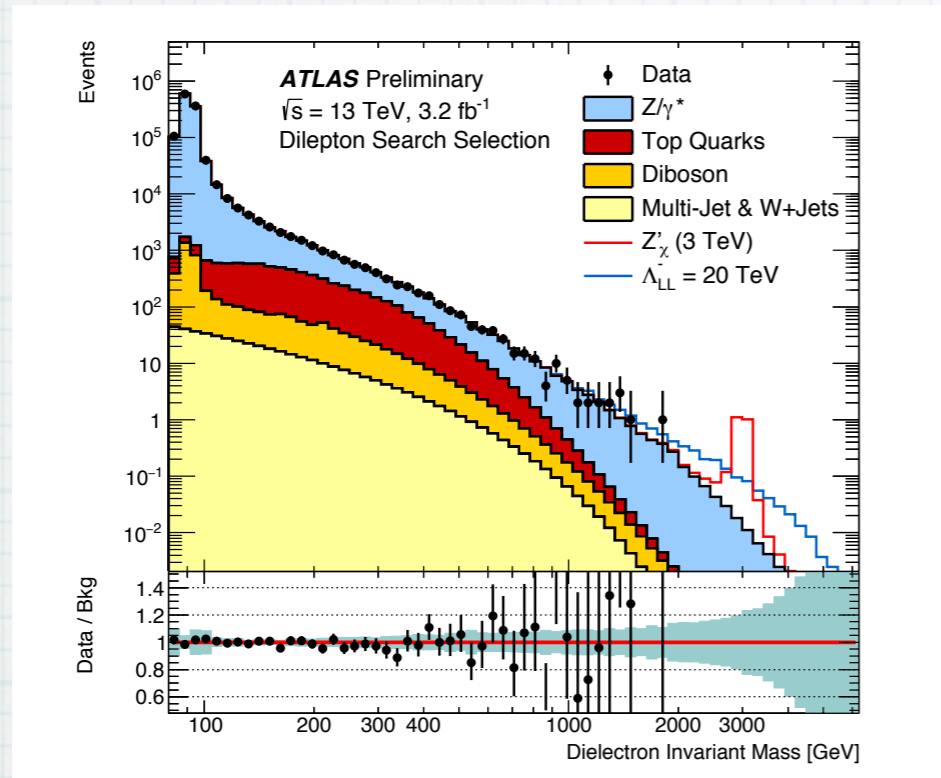


- ❖ 模型に無依存
- ❖ エネルギーフロンティア実験の王道

LHC the energy frontier machine

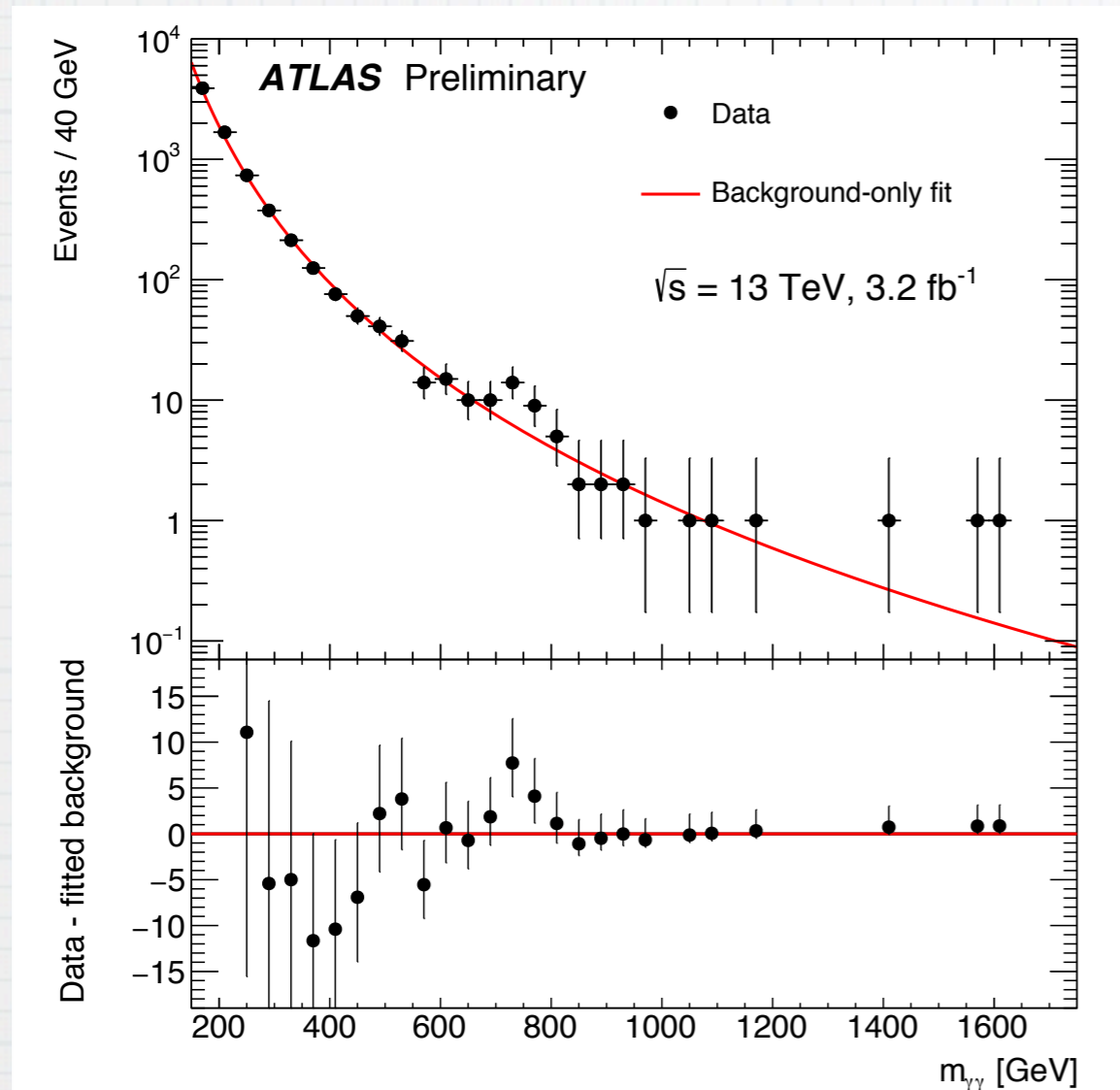


Dilepton, Dijet

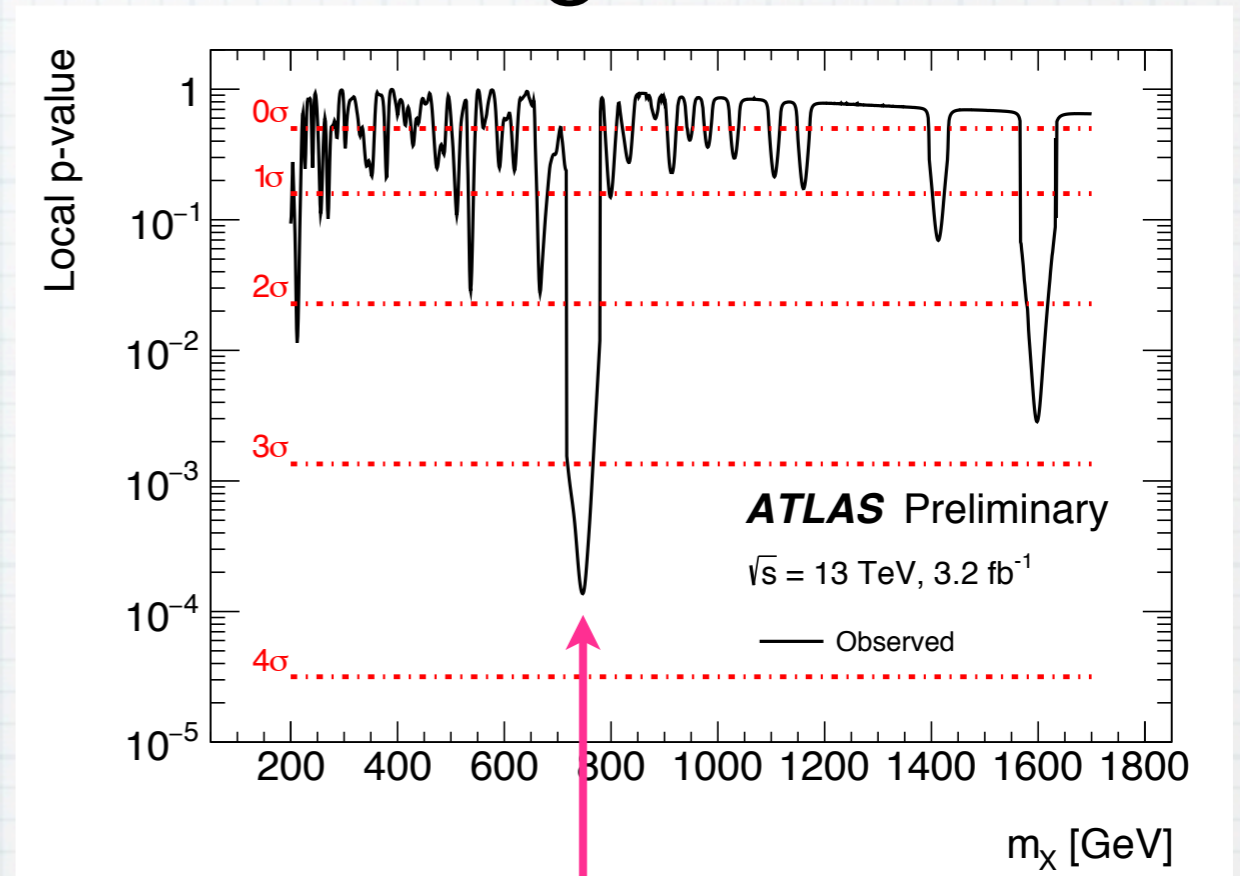


- ❖ $m_{Z'} < 3.4 \text{ TeV}$ を棄却
(2.9 TeV @ Run1)
- ❖ $m_{W'} < 4.1 \text{ TeV}$ を棄却
(3.2 TeV @ Run1)

Diphoton



local significance



750GeV

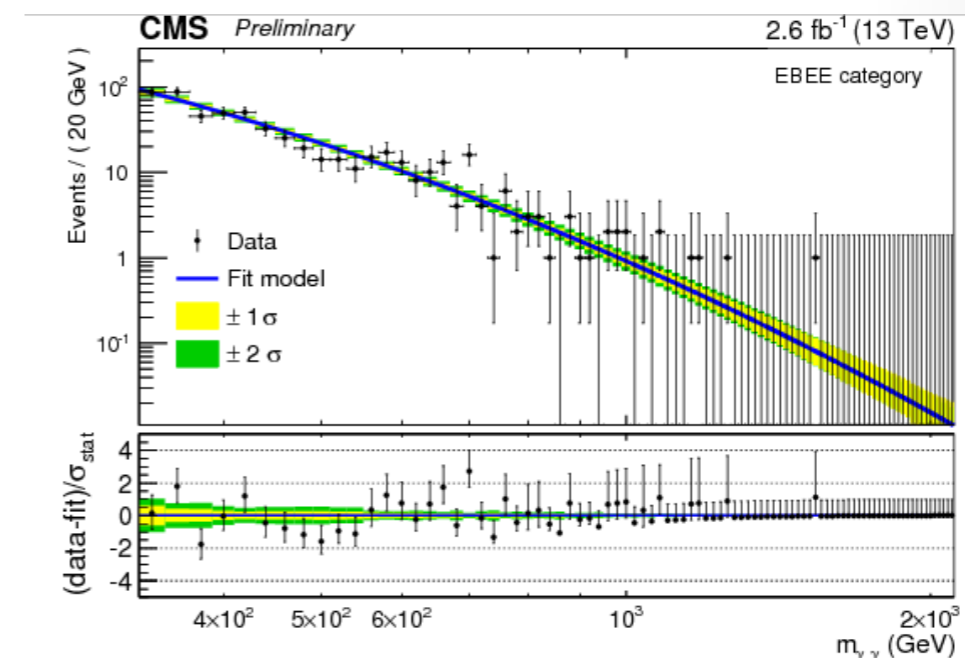
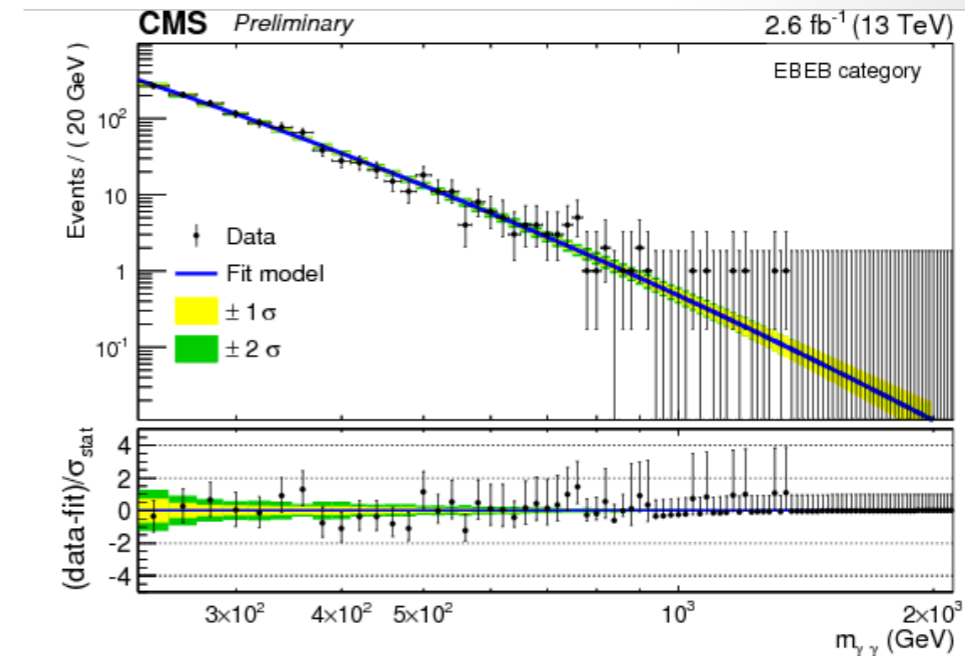
- ❖ 幅0の仮定 : global significance 2.0σ
- ❖ 有限の幅を仮定 : global significance 2.3σ
(フィットの結果, 幅は約45GeV)

Diphoton @ CMS

EXO-15-004

Search for diphoton resonances

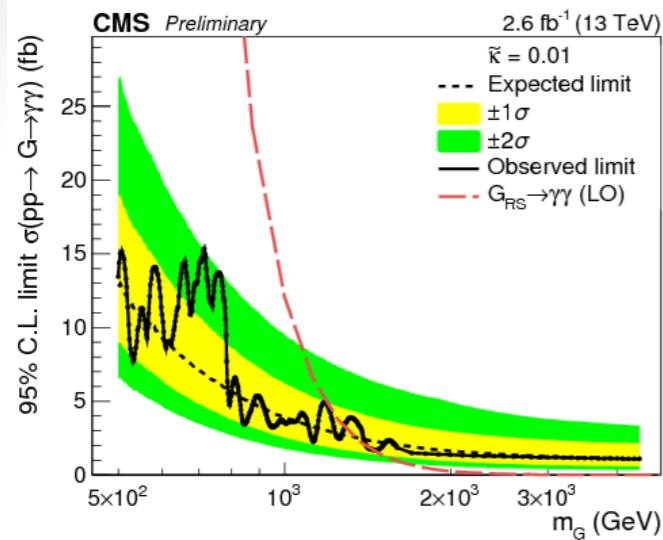
- Two categories: **barrel-barrel (EBEB)**, **barrel-endcap (EBEE)**
- $p_T(\gamma) > 75$ GeV, $I_{ch} < 5$ GeV (in 0.3 cone around photon direction)
- Efficiency, scale and resolution calibrated on $Z \rightarrow ee$ and high-mass DY events
- Search for RS graviton with three assumptions on coupling: $\tilde{\kappa} = 0.01$ (narrow), 0.1, 0.2 (wide)
- **Blind analysis, no changes have been made to the analysis since unblinding data in the signal region**



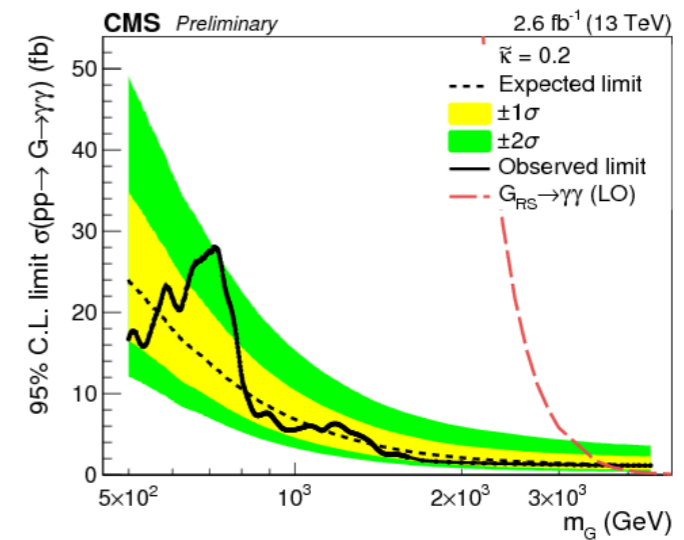
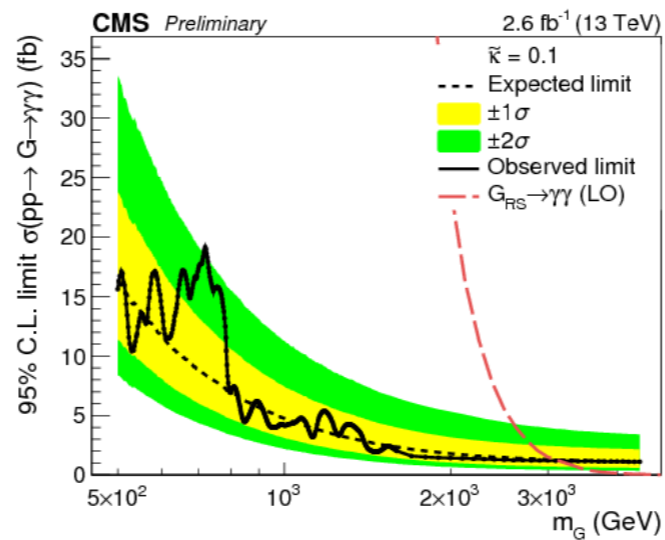
Diphoton @CMS

EXO-15-004

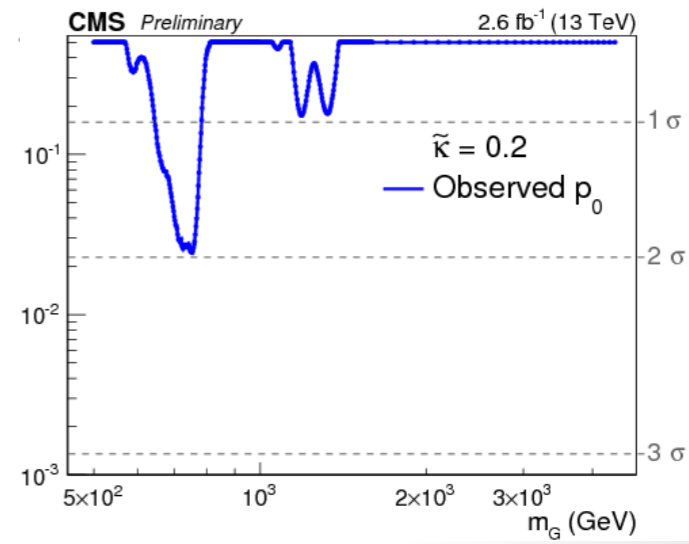
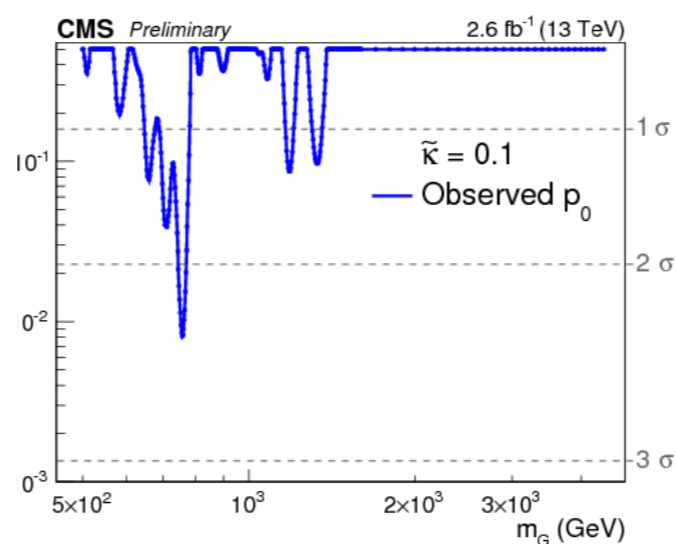
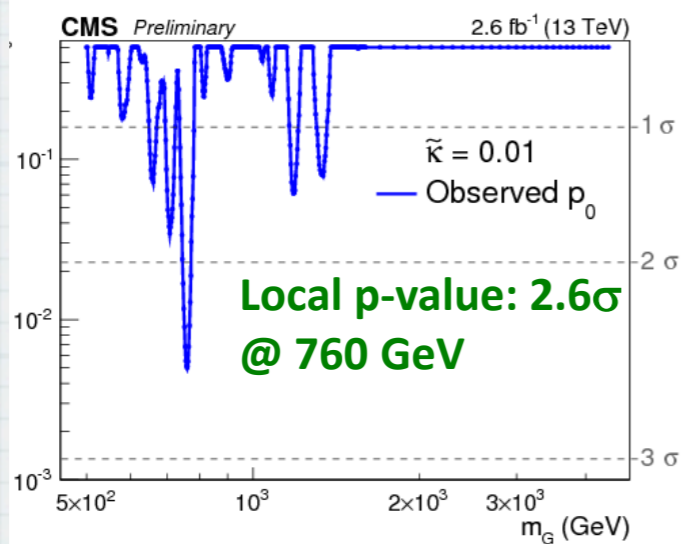
Combined limits and p-values



Narrow Width



Wide (6%) Width



Including LEE (0.5 - 4.5 TeV; narrow width), **global p-value < 1.2σ**

公式コメント

- ❖ CERNで行なわれているATLASおよびCMS実験グループは、すでに知られている物理過程から期待されるのとはわずかに違う事象を観測しているが、それに対して非常に慎重な姿勢を取っている。なんらかの重い粒子が2つの光子に崩壊したと仮定して、2つの光子を含む事象を調査すると、どちらの実験グループも、750から760GeVの質量領域にほんの少しの事象数の過剰がある。LHCのラン1で収集したデータに対して同じ解析を行ったところ、統計の範囲内で、標準模型による期待値からの有意な乖離はなかった。これまでに収集したわずかなデータからは、それらの事象の他の性質に関しては、すでに知られている物理過程と一致している。それでも、どちらの実験グループも同じような統計のふらつきを観測しているため、注目が集まっている。しかしながら、それぞれの実験グループが、この類の分布を山ほど研究していることから、最もありうる説明は、偶然の一致であり、両実験グループはこの結果を必要以上に深読みすることをしないように慎重になっている。この件をさらにハッキリさせるにはより多くのデータが必要で、2016年には実験グループがさらにたくさんのデータを収集することを期待している。

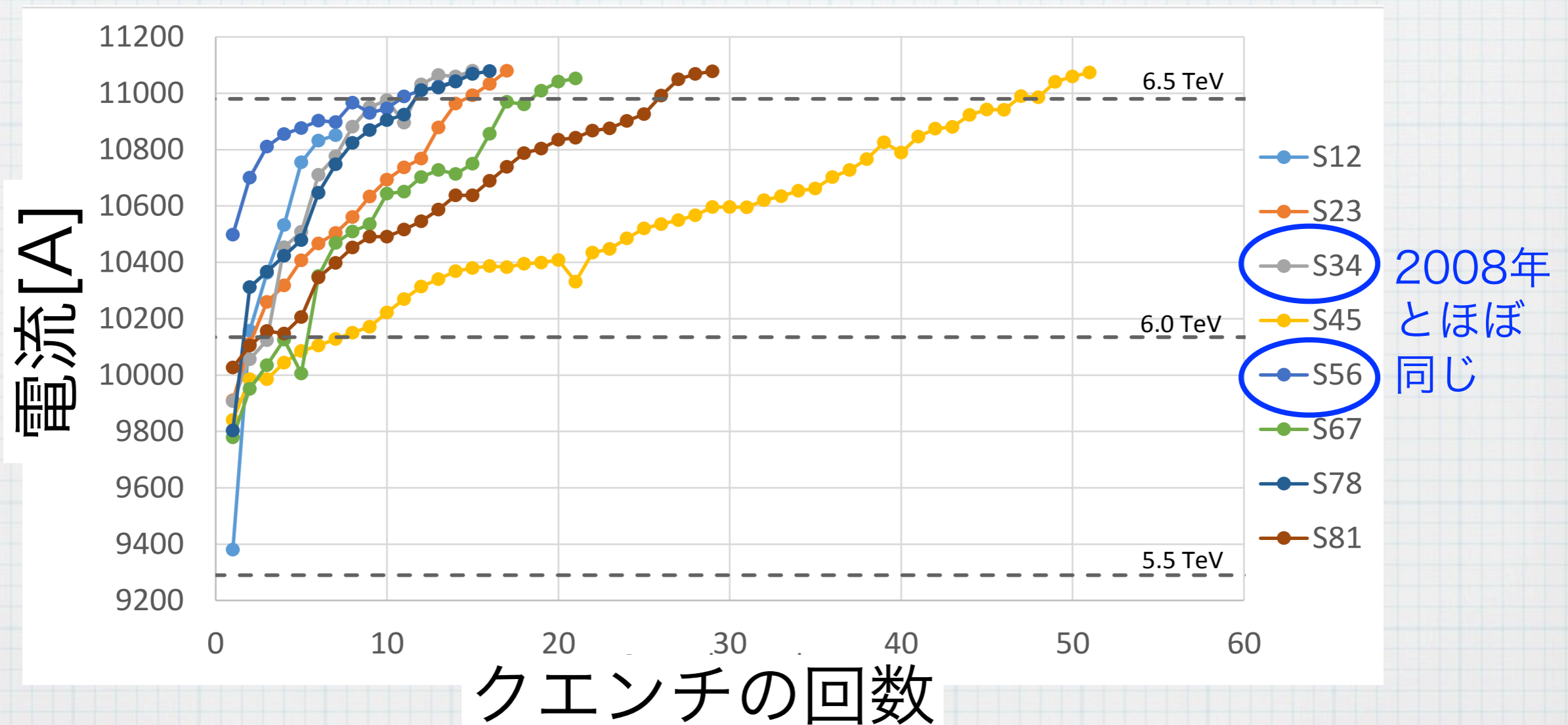
結論

- ❖ Run2 ($\sqrt{s}=13\text{TeV}$) は順調な立ち上がり
 - ▶ LHC, ATLASともに改善

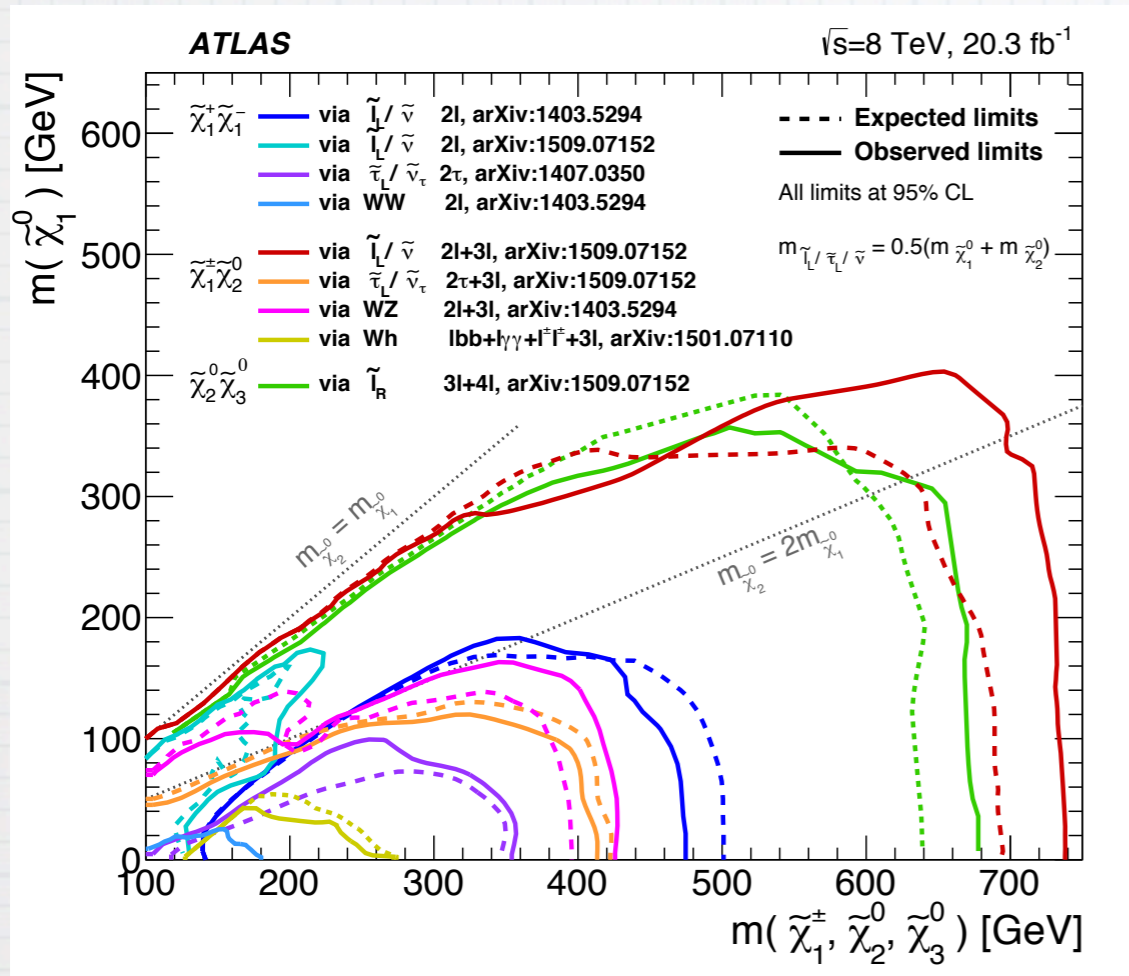
backup

双極子電磁石

- ❖ In-situでのクエンチトレーニング
(1回クエンチすると回復するのに～8時間)
- ❖ 2回クエンチはわずか、3回は1台だけ



SUSY探索@Run1



ATLAS SUSY Searches* - 95% CL Lower Limits
 Status: July 2015

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

Model	e, μ, τ, γ	Jets	E_T^{miss}	$[\mathcal{L} d\Gamma[\text{fb}^{-1}]$	Mass limit	$\sqrt{s} = 7 \text{ TeV}$	$\sqrt{s} = 8 \text{ TeV}$	Reference	
Inclusive Searches	MSUGRA/CMSSM	0-3 e, μ /1-2 τ	2-10 jets/3 b	Yes	20.3		1.8 TeV	1507.05525	
	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow \tilde{q}\tilde{\chi}_1^0$	0	2-6 jets	Yes	20.3	850 GeV		1405.7875	
	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow \tilde{q}\tilde{\chi}_1^0$ (compressed)	mono-jet	1-3 jets	Yes	20.3	100-440 GeV		1507.05525	
	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow \tilde{q}(\ell\ell)$	2 e, μ (off-Z)	2 jets	Yes	20.3	780 GeV		1503.03290	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow \tilde{g}\tilde{\chi}_1^0$	0	2-6 jets	Yes	20.3		1.33 TeV	1405.7875	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow \tilde{g}\tilde{\chi}_1^0$	0-1 e, μ	2-6 jets	Yes	20		1.26 TeV	1507.05525	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow \tilde{g}(\ell\ell)$	2 e, μ	0-3 jets	Yes	20		1.32 TeV	1501.03555	
	GMSB (\tilde{l} NLSP)	1-2 $\tau + 0-1 \ell$	0-2 jets	Yes	20.3		1.6 TeV	1407.0603	
	GGM (bino NLSP)	2 γ	-	Yes	20.3		1.29 TeV	1507.05493	
	GGM (higgsino-bino NLSP)	γ	1 b	Yes	20.3		1.3 TeV	1507.05493	
3^{rd} gen. \tilde{g} med.	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow \tilde{g}\tilde{\chi}_1^0$	0	3 b	Yes	20.1		1.25 TeV	1407.0600	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow \tilde{g}\tilde{\chi}_1^0$	0	7-10 jets	Yes	20.3		1.1 TeV	1308.1841	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow \tilde{g}\tilde{\chi}_1^0$	0-1 e, μ	3 b	Yes	20.1		1.34 TeV	1407.0600	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow \tilde{g}\tilde{\chi}_1^0$	0-1 e, μ	3 b	Yes	20.1		1.3 TeV	1407.0600	
	3^{rd} gen. squarks direct production	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow \tilde{t}_1\tilde{\chi}_1^0$	0	2 b	Yes	20.1	100-620 GeV		1308.2631
		$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow \tilde{t}_1\tilde{\chi}_1^0$	2 e, μ (SS)	0-3 b	Yes	20.3	275-440 GeV		1404.2500
		$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow \tilde{t}_1\tilde{\chi}_1^0$	1-2 e, μ	1-2 b	Yes	4.7/20.3	110-167 GeV		1209.2102, 1407.0583
		$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow W\tilde{b}\tilde{\chi}_1^0$ or $\tilde{t}_1\tilde{\chi}_1^0$	0-2 e, μ	0-2 jets/1-2 b	Yes	20.3	90-191 GeV		1506.0816
		$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow \tilde{t}_1\tilde{\chi}_1^0$	0	mono-jet/-tag	Yes	20.3	210-700 GeV		1407.0608
		$\tilde{t}_1\tilde{t}_1$ (natural GMSB)	2 e, μ (Z)	1 b	Yes	20.3	90-240 GeV		1403.5222
$\tilde{t}_2\tilde{t}_2, \tilde{t}_2 \rightarrow \tilde{t}_1 + Z$		3 e, μ (Z)	1 b	Yes	20.3	150-580 GeV		1403.5222	
EW direct	$\tilde{l}_L\tilde{l}_L, \tilde{l} \rightarrow \tilde{l}\tilde{\chi}_1^0$	2 e, μ	0	Yes	20.3	90-325 GeV		1403.5294	
	$\tilde{l}_L\tilde{l}_L, \tilde{l} \rightarrow \tilde{l}\tilde{\chi}_1^0$	2 e, μ (SS)	0	Yes	20.3	140-465 GeV		1403.5294	
	$\tilde{l}_L\tilde{l}_L, \tilde{l} \rightarrow \tilde{l}\tilde{\chi}_1^0$	2 τ	-	Yes	20.3	100-350 GeV		1407.0350	
	$\tilde{l}_L\tilde{l}_L, \tilde{l} \rightarrow \tilde{l}\tilde{\chi}_1^0$	3 e, μ	0	Yes	20.3		700 GeV	1402.7029	
	$\tilde{l}_L\tilde{l}_L, \tilde{l} \rightarrow \tilde{l}\tilde{\chi}_1^0$	2-3 e, μ	0-2 jets	Yes	20.3		420 GeV	1403.5294, 1402.7029	
	$\tilde{l}_L\tilde{l}_L, \tilde{l} \rightarrow \tilde{l}\tilde{\chi}_1^0$	e, μ, γ	0-2 b	Yes	20.3	250 GeV		1501.07110	
	$\tilde{l}_L\tilde{l}_L, \tilde{l} \rightarrow \tilde{l}\tilde{\chi}_1^0$	4 e, μ	0	Yes	20.3		620 GeV	1405.5086	
	GGM (wino NLSP) weak prod.	1 $e, \mu + \gamma$	-	Yes	20.3	124-361 GeV		1507.05493	
	Long-lived particles	Direct $\tilde{\chi}_1^\pm \tilde{\chi}_1^\mp$ prod., long-lived $\tilde{\chi}_1^\pm$	Disapp. trk	1 jet	Yes	20.3	270 GeV		1310.3675
		Direct $\tilde{\chi}_1^\pm \tilde{\chi}_1^\mp$ prod., long-lived $\tilde{\chi}_1^\pm$	dE/dx trk	-	Yes	18.4	482 GeV		1506.05332
Stable, stopped \tilde{g} R-hadron		0	1-5 jets	Yes	27.9	832 GeV		1310.6584	
Stable \tilde{g} R-hadron		trk	-	-	19.1		1.27 TeV	1411.6795	
GMSB, stable $\tilde{\tau}, \tilde{\chi}_1^\pm \rightarrow \tilde{\tau}(\tilde{e}, \tilde{\mu}) + \tau(e, \mu)$		1-2 μ	-	-	19.1	537 GeV		1411.6795	
GMSB, $\tilde{\chi}_1^\pm \rightarrow \gamma\tilde{G}$, long-lived $\tilde{\chi}_1^\pm$		2 γ	-	Yes	20.3	435 GeV		1409.5542	
$\tilde{g}\tilde{g}, \tilde{\chi}_1^\pm \rightarrow e\tilde{\nu}/e\tilde{\nu}/\mu\tilde{\nu}$		displ. $e\tilde{\nu}/e\tilde{\nu}/\mu\tilde{\nu}$	-	-	20.3		1.0 TeV	1504.05162	
GGM $\tilde{g}\tilde{g}, \tilde{\chi}_1^\pm \rightarrow Z\tilde{G}$		displ. vtx + jets	-	-	20.3		1.0 TeV	1504.05162	
RPV		LFV $p\bar{p} \rightarrow \tilde{\nu}_e + X, \tilde{\nu}_e \rightarrow e\mu/\tau\mu/\mu\tau$	$e\mu, \tau\mu, \mu\tau$	-	-	20.3		1.7 TeV	1503.04930
		Bilinear RPV CMSSM	2 e, μ (SS)	0-3 b	Yes	20.3		1.35 TeV	1404.2500
	$\tilde{\chi}_1^\pm \tilde{\chi}_1^\mp, \tilde{\chi}_1^\pm \rightarrow W\tilde{\chi}_1^0, \tilde{\chi}_1^\pm \rightarrow e\tilde{\nu}_e, e\tilde{\nu}_\mu$	4 e, μ	-	Yes	20.3		750 GeV	1405.5086	
	$\tilde{\chi}_1^\pm \tilde{\chi}_1^\mp, \tilde{\chi}_1^\pm \rightarrow W\tilde{\chi}_1^0, \tilde{\chi}_1^\pm \rightarrow \tau\tilde{\nu}_\tau, e\tilde{\nu}_e$	3 $e, \mu + \tau$	-	Yes	20.3	450 GeV		1405.5086	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}$	0	6-7 jets	-	20.3		917 GeV	1502.05686	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}$	0	6-7 jets	-	20.3		870 GeV	1502.05686	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}$	2 e, μ (SS)	0-3 b	Yes	20.3		850 GeV	1404.250	
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow b\tilde{s}$	0	2 jets + 2 b	-	20.3	100-308 GeV		ATLAS-CONF-2015-026	
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow b\tilde{t}$	2 e, μ	2 b	-	20.3		0.4-1.0 TeV	ATLAS-CONF-2015-015	
	Other	Scalar charm, $\tilde{c} \rightarrow c\tilde{\chi}_1^0$	0	2 c	Yes	20.3	490 GeV		1501.01325

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.