

A decorative swirl graphic in the top left corner, resembling a stylized 'S' or a spiral galaxy.

First Look on $X \rightarrow SH \rightarrow \gamma\gamma + \textit{leptons}$ Unblinding Results

Kaili Zhang, on behalf of [ATL-COM-PHYS-2021-718](#) team

IHEP

06/14/2023

Status

- [CDS:2779977](#), ver25
- [Glance](#)
- EB meetings
 - Feb. 2nd
 - Sep. 26th
 - Dec 9th
- EB committee:
 - [D'ERAMO, Louis \(Northern Illinois\)](#)
 - [MAZINI, Rachid \(Taipei AS\)](#)
 - [SCHAARSCHMIDT, Jana \(Seattle Washington\)](#)(Chair)
- Unblinding approval passed last week
- Receiving new comment last Sunday, will answer soon;



ATLAS Note
ANA-HDBS-2021-23-INT1
May 13, 2023



Draft version 0.95

1

2 **Search for $X \rightarrow SH$ model in the final states of two**
3 **photons and multiple leptons using 139 fb^{-1} of**
4 **proton-proton collision data at $\sqrt{s} = 13 \text{ TeV}$ recorded**
5 **with the ATLAS detector at the LHC**

6 Yaquan Fang^a, Kaili Zhang^a, Zhijun Liang^a, Bo Liu^a, Xinchou Lou^{a,c}, Xin Shi^a,
7 Qiyu Sha^a, Shuiting Xin^a, Wei-Ming Yao^b, Yesenia Hernandez Jimenez^d, Fangyi
8 Guo^a

9 ^a*Institute of High Energy Physics, Chinese Academy of Sciences, Beijing, China*

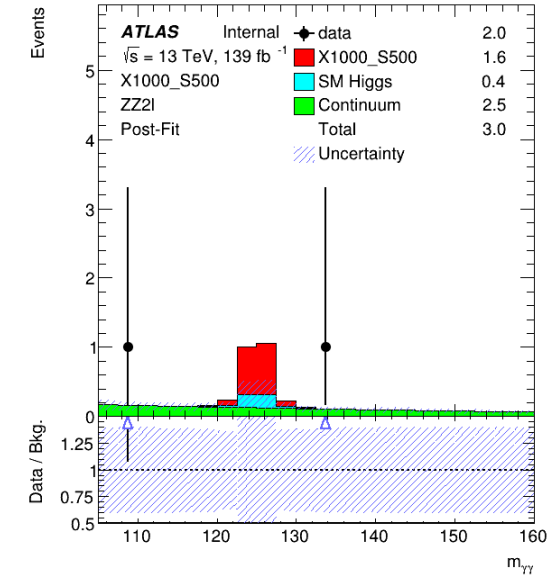
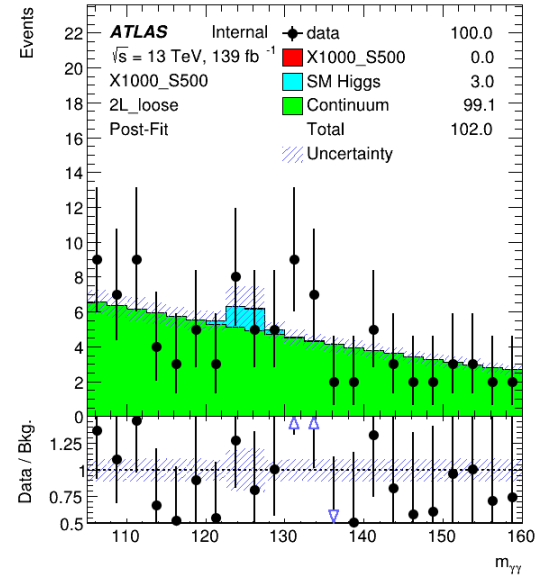
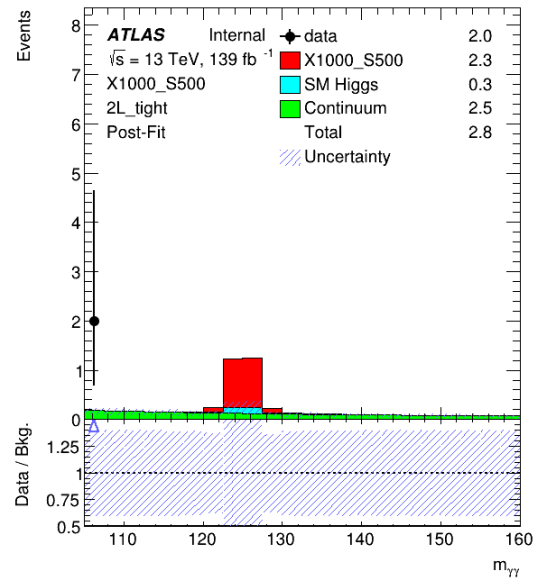
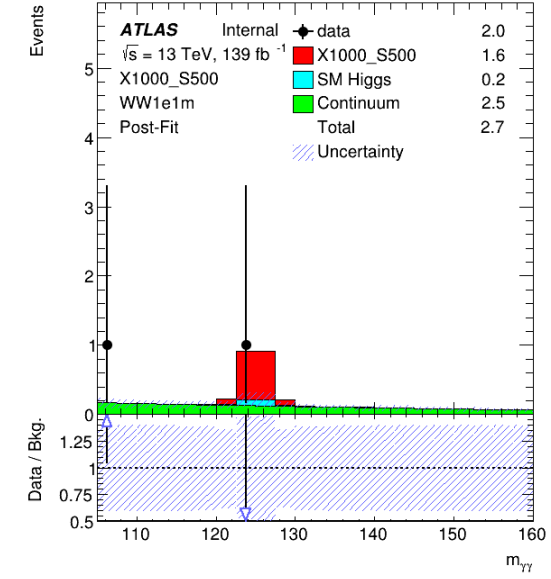
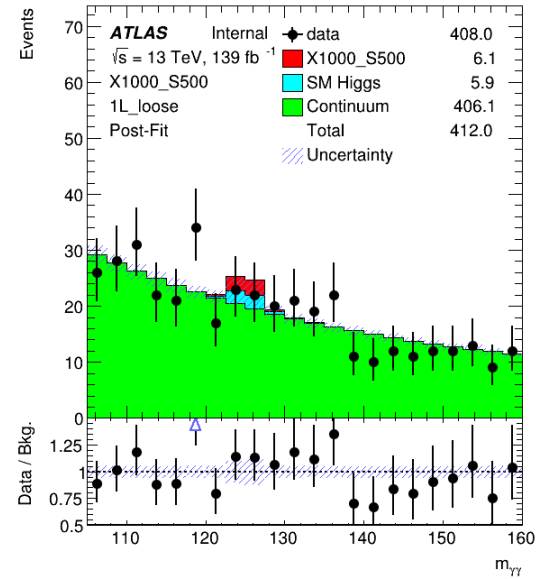
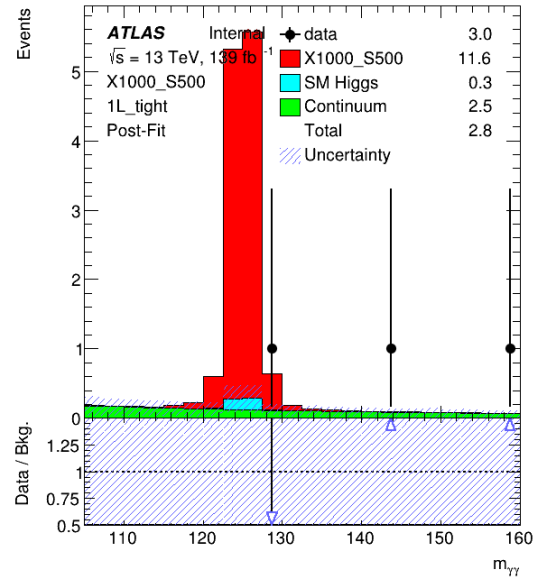
10 ^b*Lawrence Berkeley National Laboratory, USA*

11 ^c*University of Texas at Dallas, USA*

12 ^d*University of Stony Brook University, USA*

13 This note presents a search for a new heavy scalar particle X decaying into a Standard Model
14 Higgs boson and a singlet scalar particle S using 139 fb^{-1} of proton-proton collision data at
15 the centre-of-mass energy of 13 TeV recorded with the ATLAS detector at LHC. The explored
16 X mass range varies from 300 GeV to 1000 GeV, with the corresponding S mass range being
17 from 170 GeV to 500 GeV. This search uses the event signature of two photons from the
18 Higgs boson decay and one or two leptons (e or μ) coming from the process of $S \rightarrow WW/ZZ$.
19 The observed (expected) upper limits at the 95% confidence level on the cross-section for
20 $gg \rightarrow X \rightarrow Sh$ assuming the decay of S following the SM prediction is between X fb (167 fb)
21 and Y fb (710 fb).

Unblinding Asimov Results: X1000S500

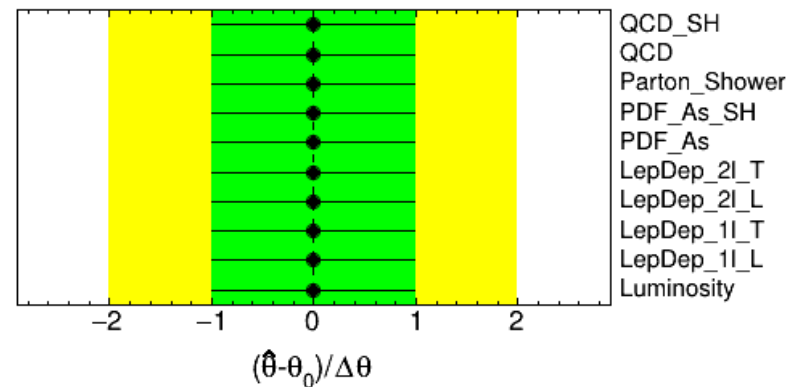


Unblinding Asimov Results: X1000S500

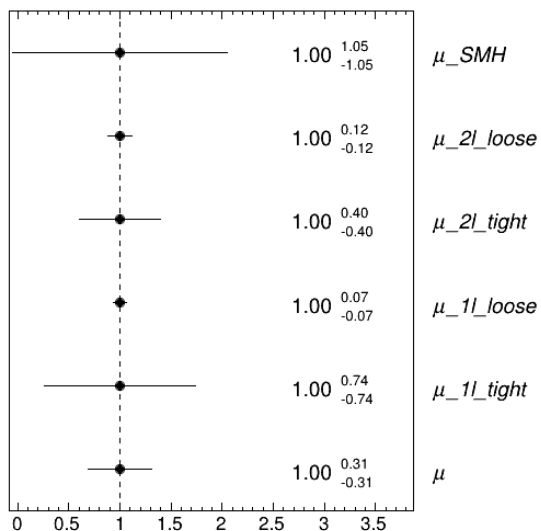
ATLAS Internal

μ	100.0	-5.4	-0.0	-0.0	-0.0	-0.1	-14.4	0.0	-3.8	-40.8	0.0	-11.8	1.7	-7.5	7.5	-32.5
Luminosity	-5.4	100.0	-0.0	-0.0	-0.0	-0.0	0.0	0.0	0.0	0.0	-0.0	-0.0	0.0	0.0	0.0	-1.6
LepDep_1l_L	-0.0	-0.0	100.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-60.9	-0.0	-0.0	-0.0	0.0
LepDep_1l_T	0.0	0.0	0.0	100.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-6.7	0.0	0.0	0.0	0.0	-0.0
LepDep_2l_L	-0.0	-0.0	-0.0	-0.0	100.0	-0.0	-0.0	-0.0	-0.0	-0.0	0.0	-0.0	-45.5	0.0	0.0	0.0
LepDep_2l_T	-0.1	-0.0	-0.0	-0.0	-0.0	100.0	-0.0	-0.0	-0.0	-0.0	-0.0	-2.8	-0.0	0.1	0.0	0.0
PDF_As	-14.4	0.0	0.0	0.0	0.0	0.0	100.0	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.0
PDF_As_SH	0.0	0.0	-0.0	-0.0	-0.0	-0.0	0.0	100.0	-0.0	-0.0	0.0	0.0	0.0	0.0	0.0	-5.5
Parton_Shower	-3.8	0.0	-0.0	-0.0	-0.0	-0.0	0.0	0.0	100.0	-0.0	-0.0	0.0	0.0	0.0	0.0	-1.1
QCD	-40.8	0.0	0.0	0.0	0.0	-0.0	0.0	0.0	0.0	100.0	-0.0	0.0	0.0	0.0	0.0	-0.0
QCD_SH	0.0	0.0	-0.0	-0.0	-0.0	0.0	0.0	-0.0	-0.0	-0.0	100.0	-0.0	0.0	0.0	0.0	-7.1
μ_{1l_tight}	-11.8	-0.0	-0.0	-6.7	-0.0	0.0	-0.0	-0.0	0.0	-0.0	0.0	100.0	-0.1	1.2	-0.9	3.9
μ_{1l_loose}	1.7	0.0	-60.9	0.0	0.0	-0.0	0.0	0.0	0.0	-0.1	100.0	1.1	4.2	-18.0	0.0	-0.0
μ_{2l_tight}	-7.5	0.0	-0.0	0.0	-2.8	0.0	0.0	0.0	0.0	1.2	1.1	100.0	0.8	-3.3	0.0	-0.0
μ_{2l_loose}	7.5	0.0	-0.0	-45.5	-0.0	0.0	0.0	-0.0	-0.0	-0.9	4.2	0.8	100.0	-22.9	0.0	-0.0
μ_{SMH}	-32.5	-1.6	0.0	-0.0	0.0	0.1	-0.0	-5.5	-1.1	0.0	-7.1	3.9	-18.0	-3.3	-22.9	100.0

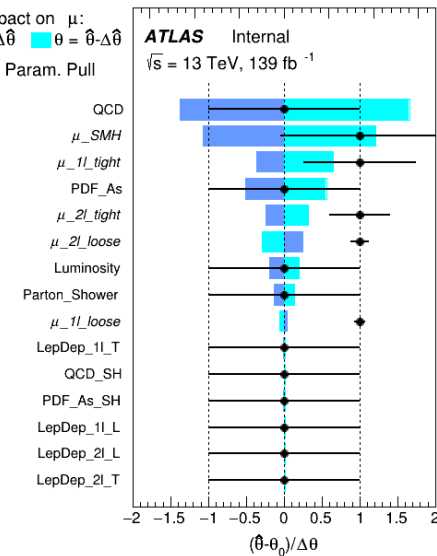
ATLAS Internal



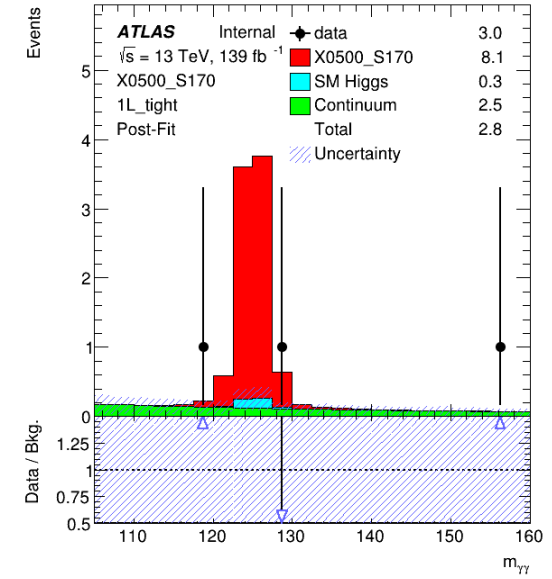
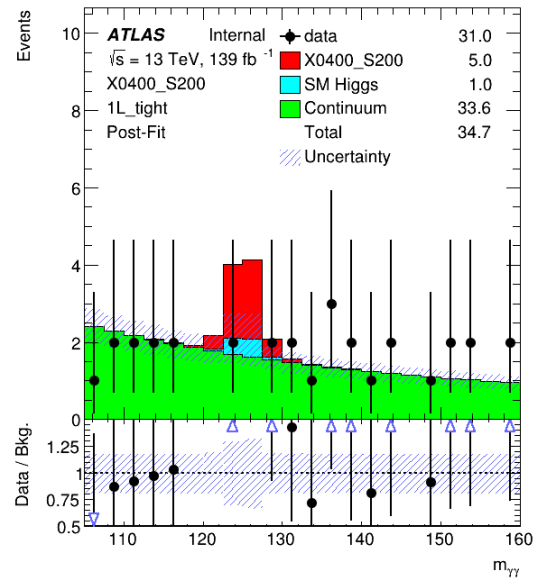
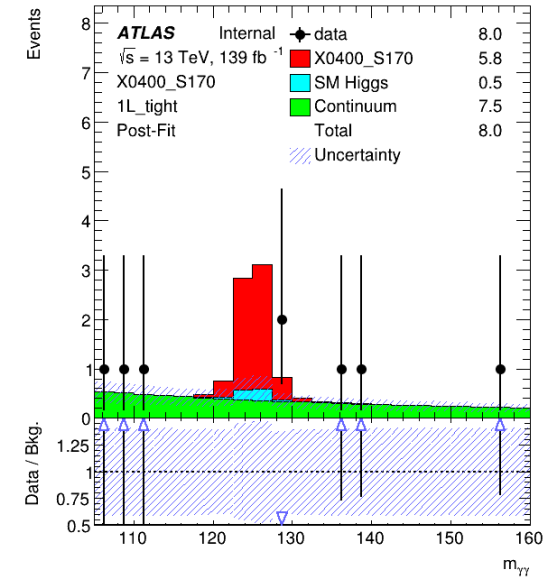
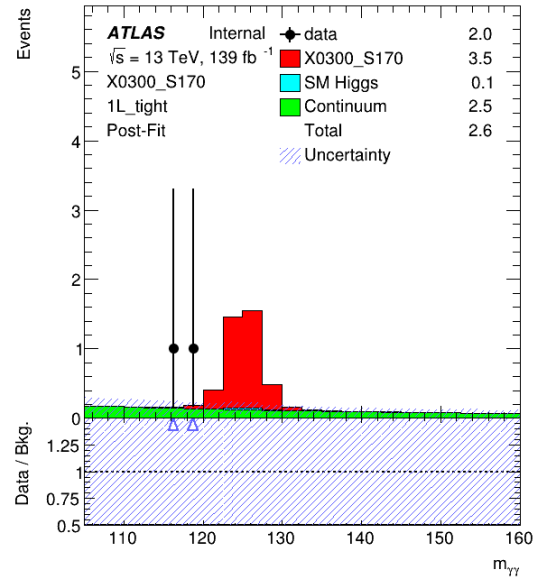
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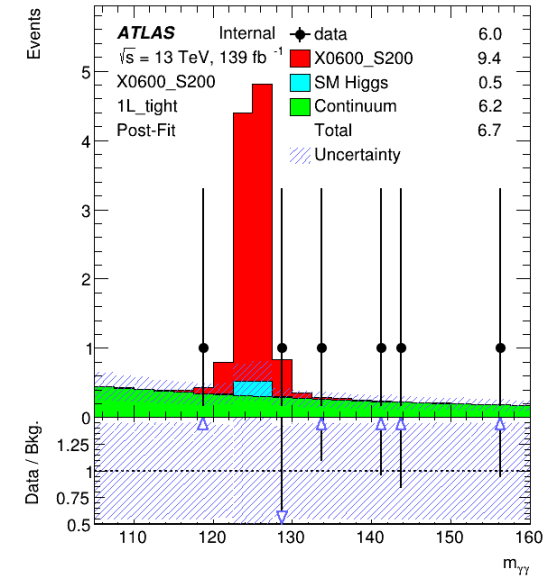
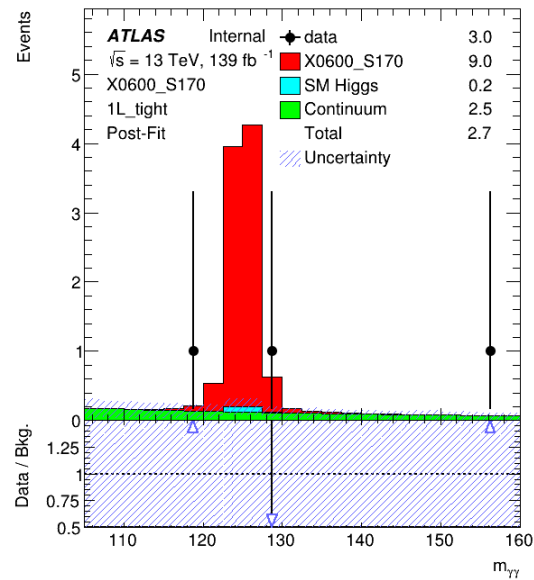
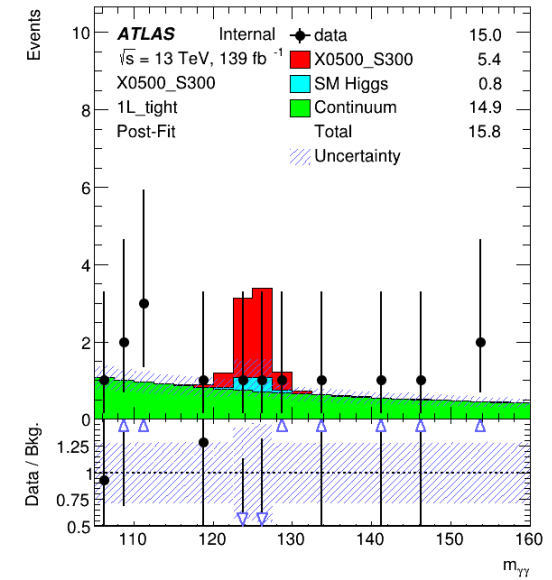
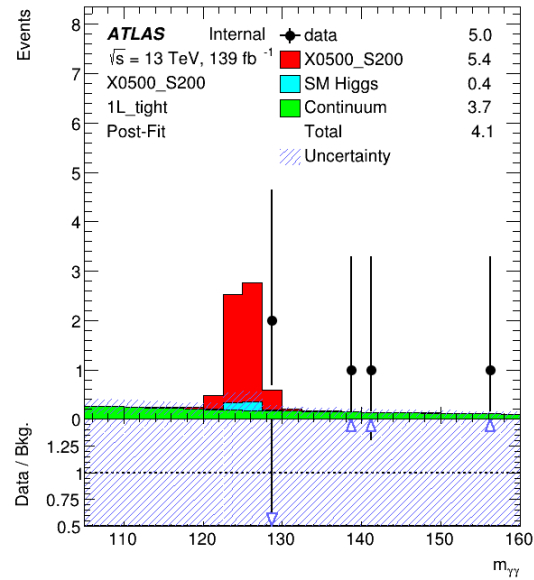
Pre-fit impact on μ :
 $\square \theta = \hat{\theta} + \Delta\theta$ $\square \theta = \hat{\theta} - \Delta\theta$
 Post-fit impact on μ :
 $\square \theta = \hat{\theta} + \Delta\hat{\theta}$ $\square \theta = \hat{\theta} - \Delta\hat{\theta}$
 —•— Nuis. Param. Pull



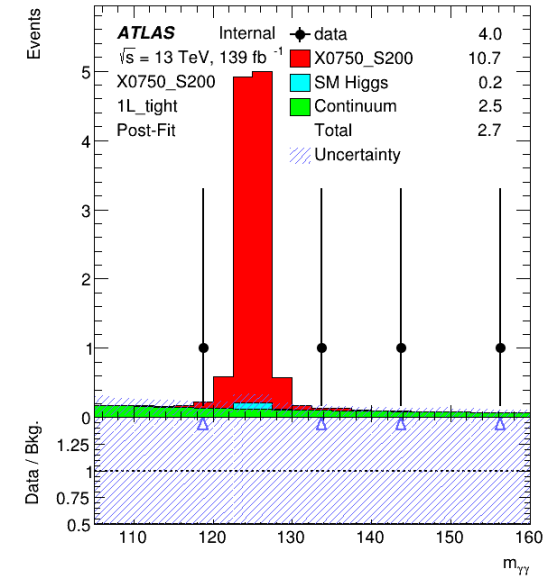
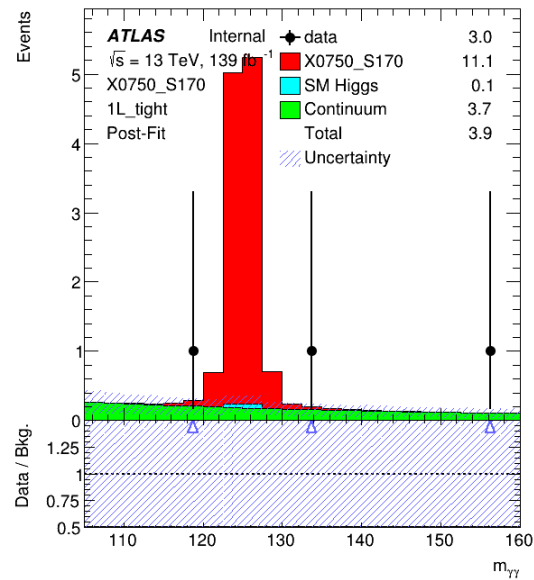
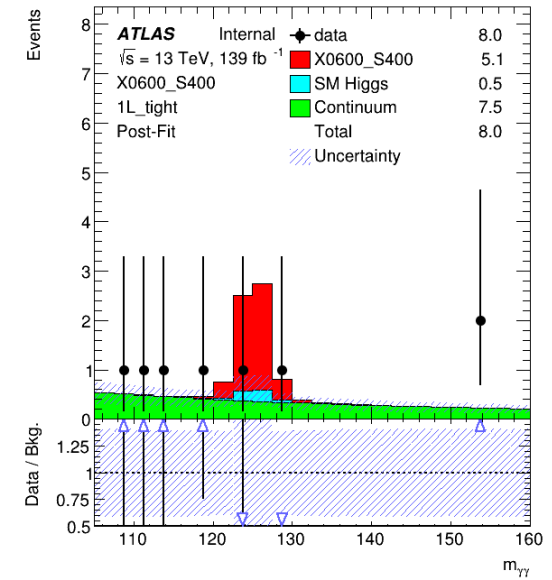
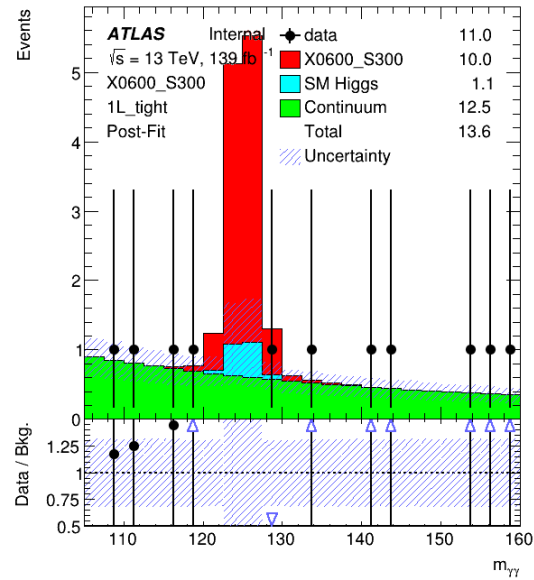
1 lepton tight region: 20 mass points



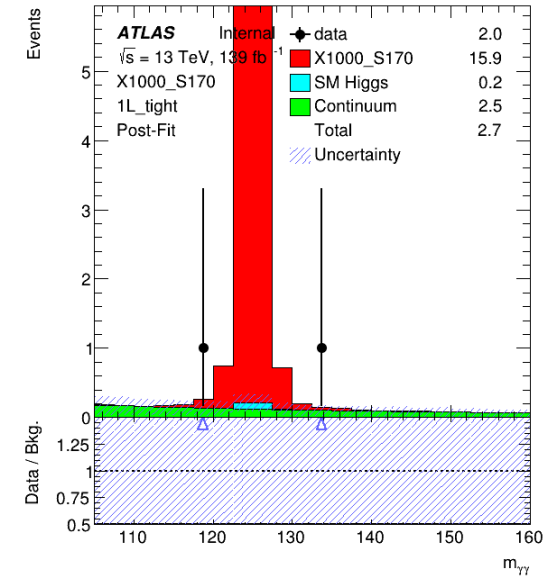
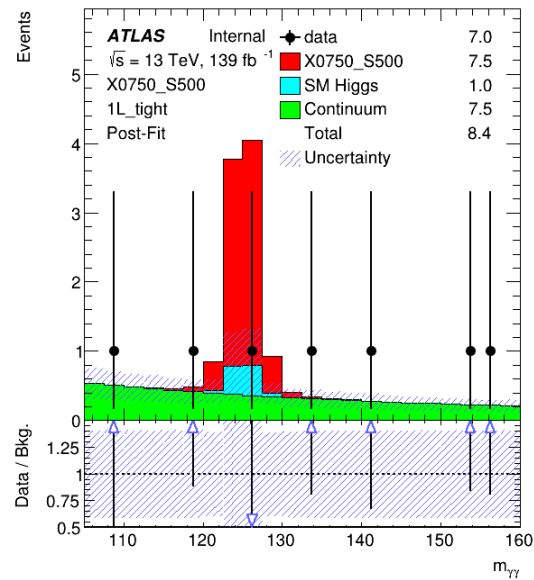
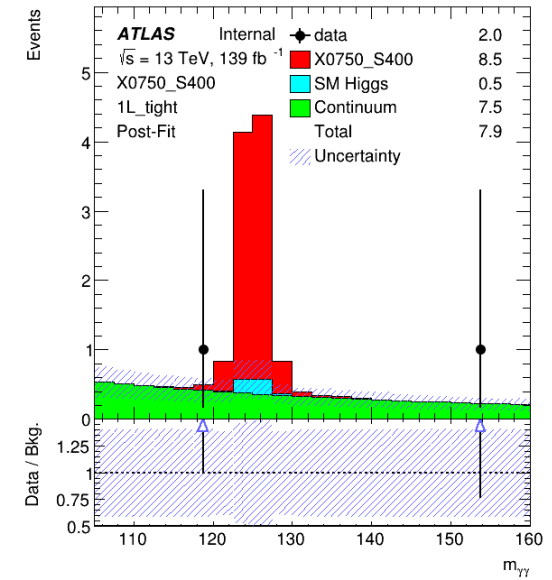
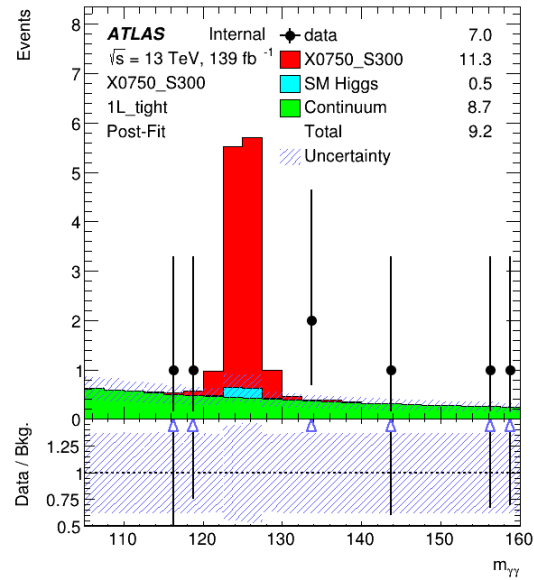
1 lepton tight region



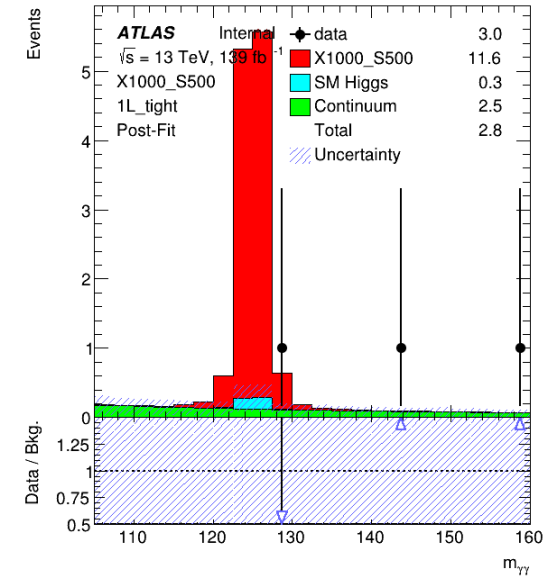
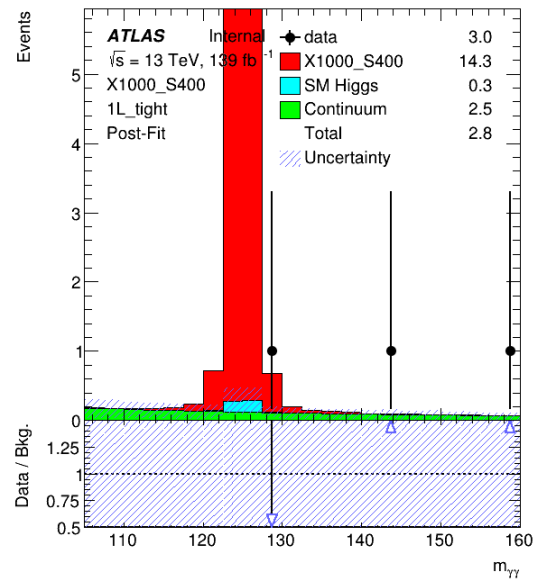
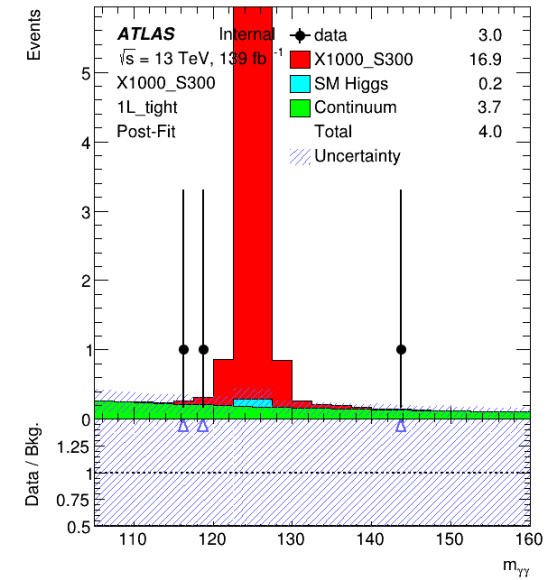
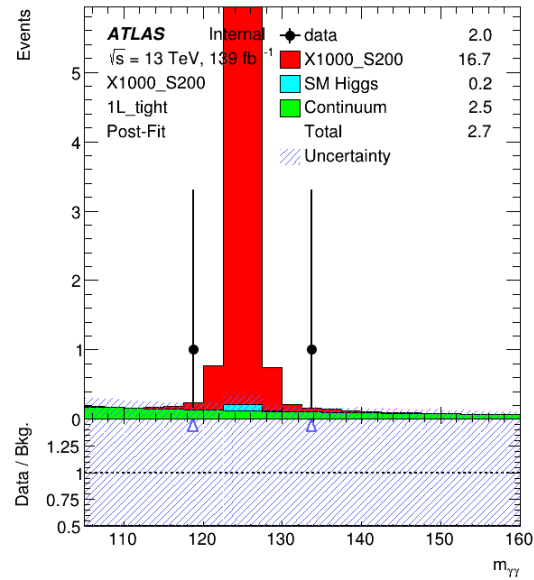
1 lepton tight region



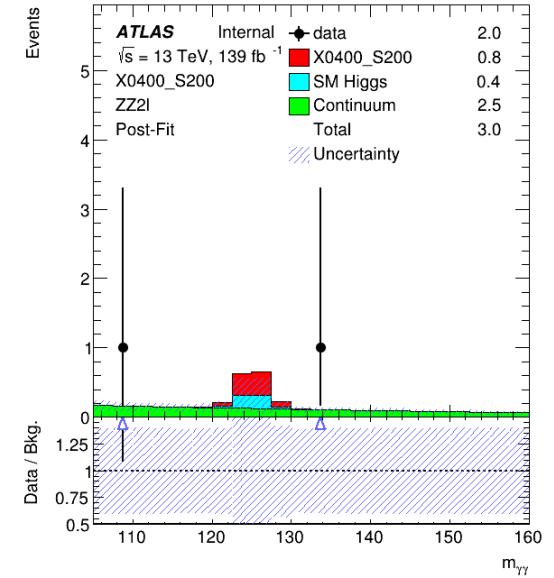
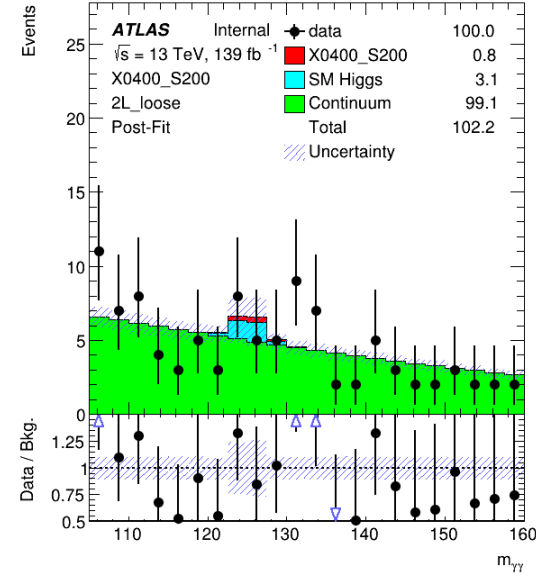
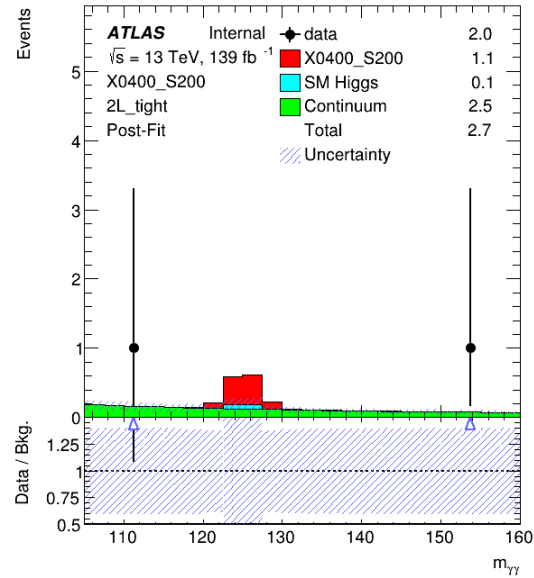
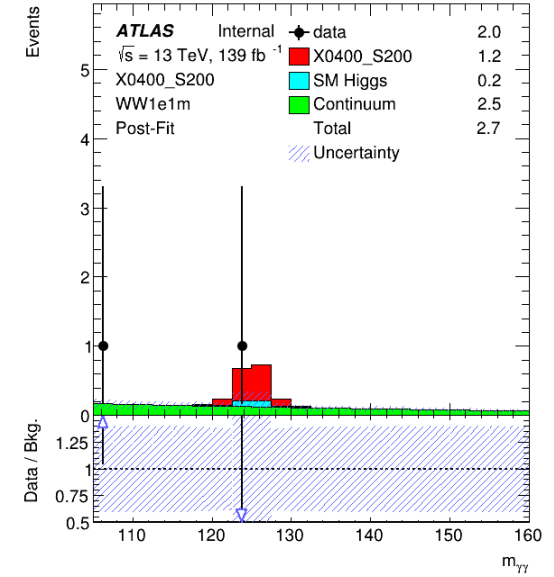
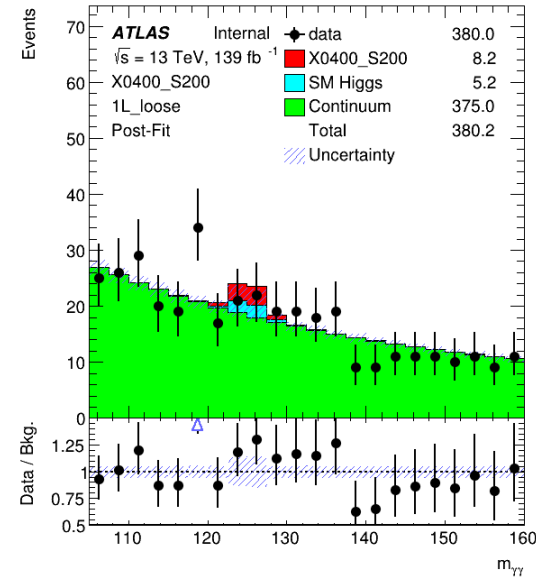
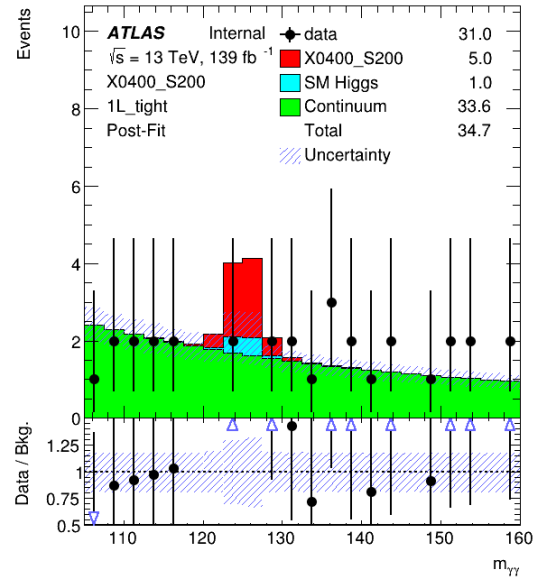
1 lepton tight region



1 lepton tight region

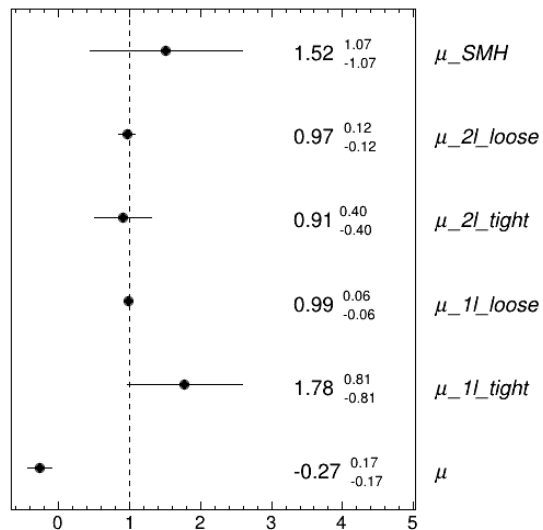


X400S200

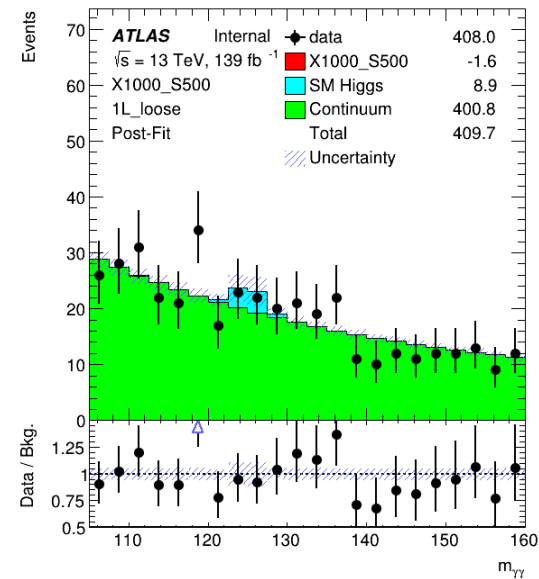
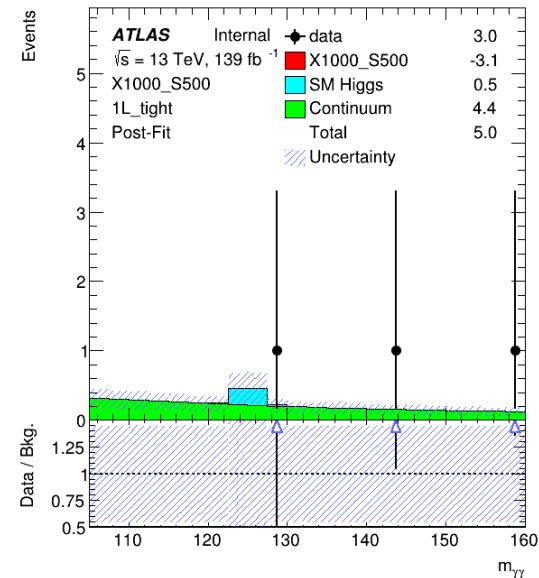
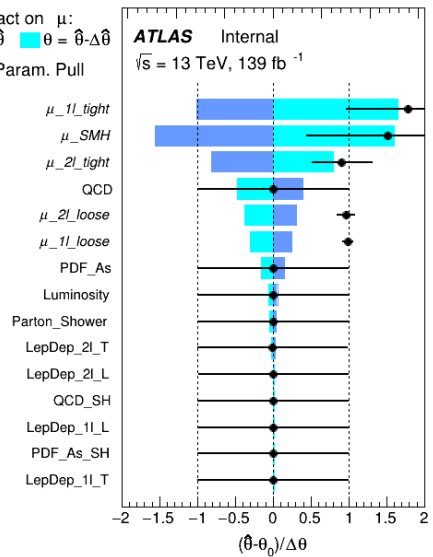


Non-Asimov: X1000S500

ATLAS Internal

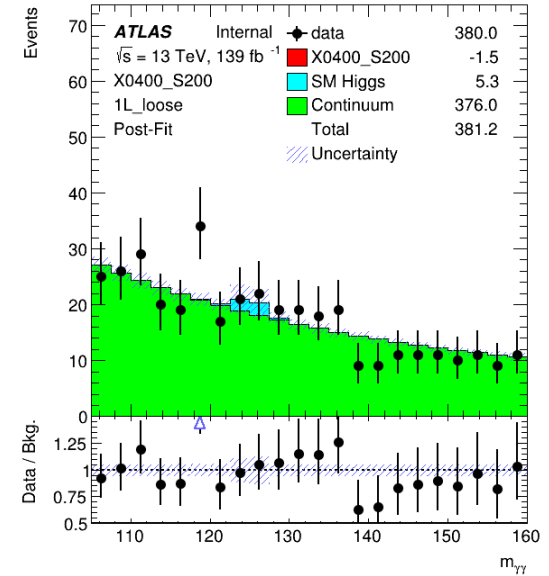
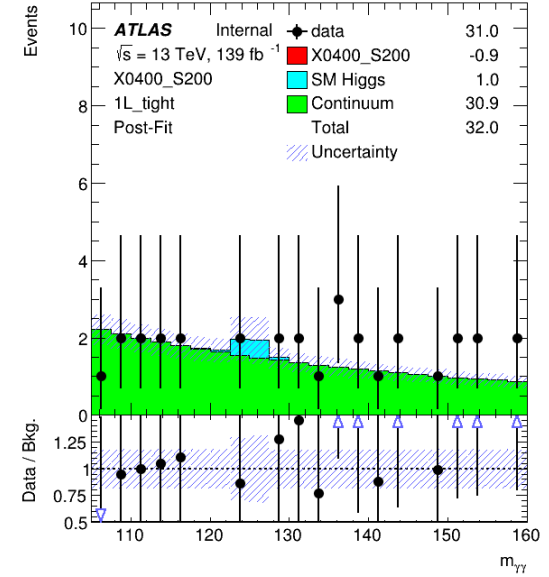
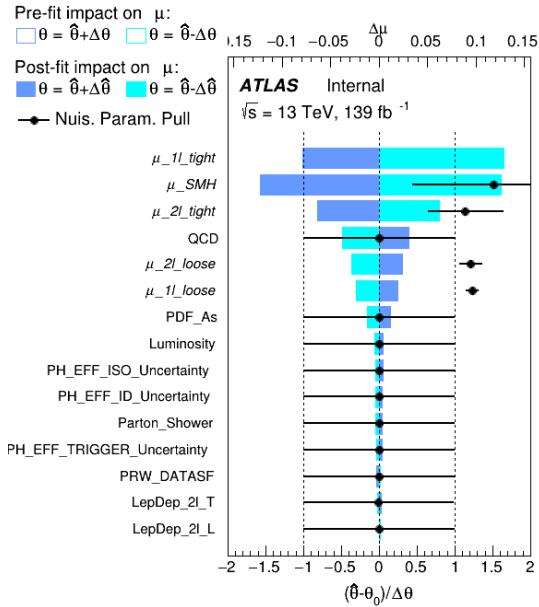
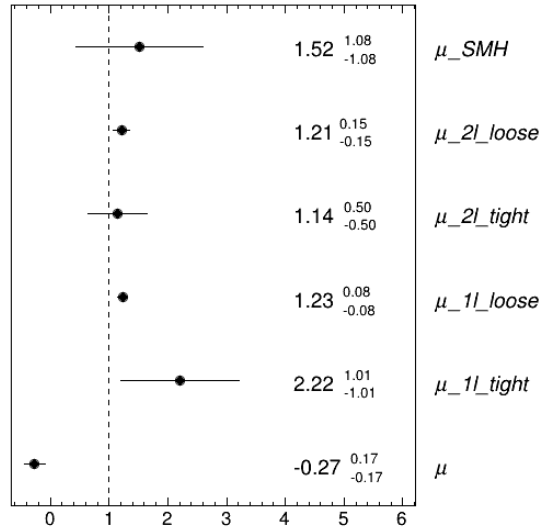


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 — Nuis. Param. Pull

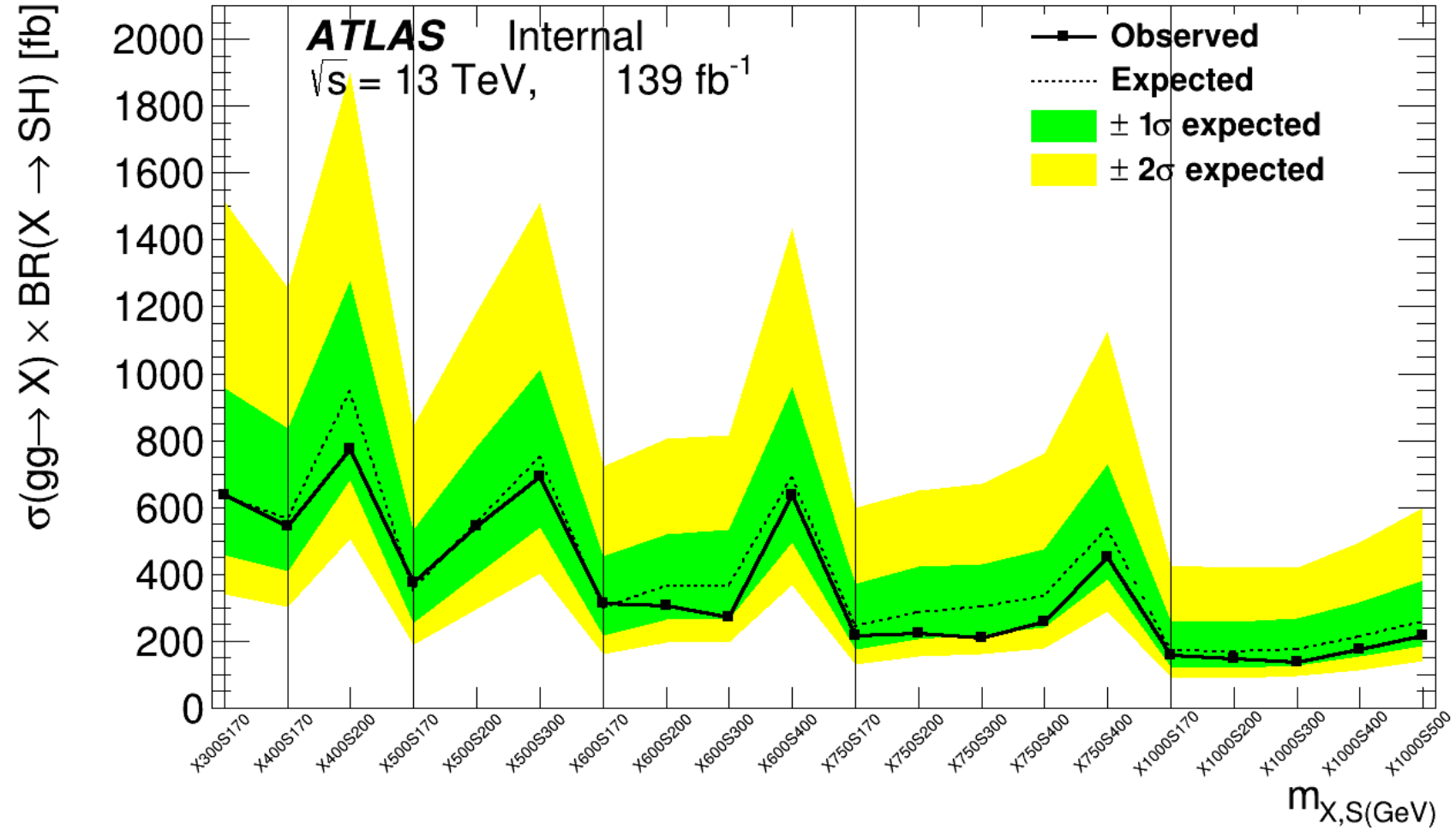


Non-Asimov: X400S200

ATLAS Internal



Limit

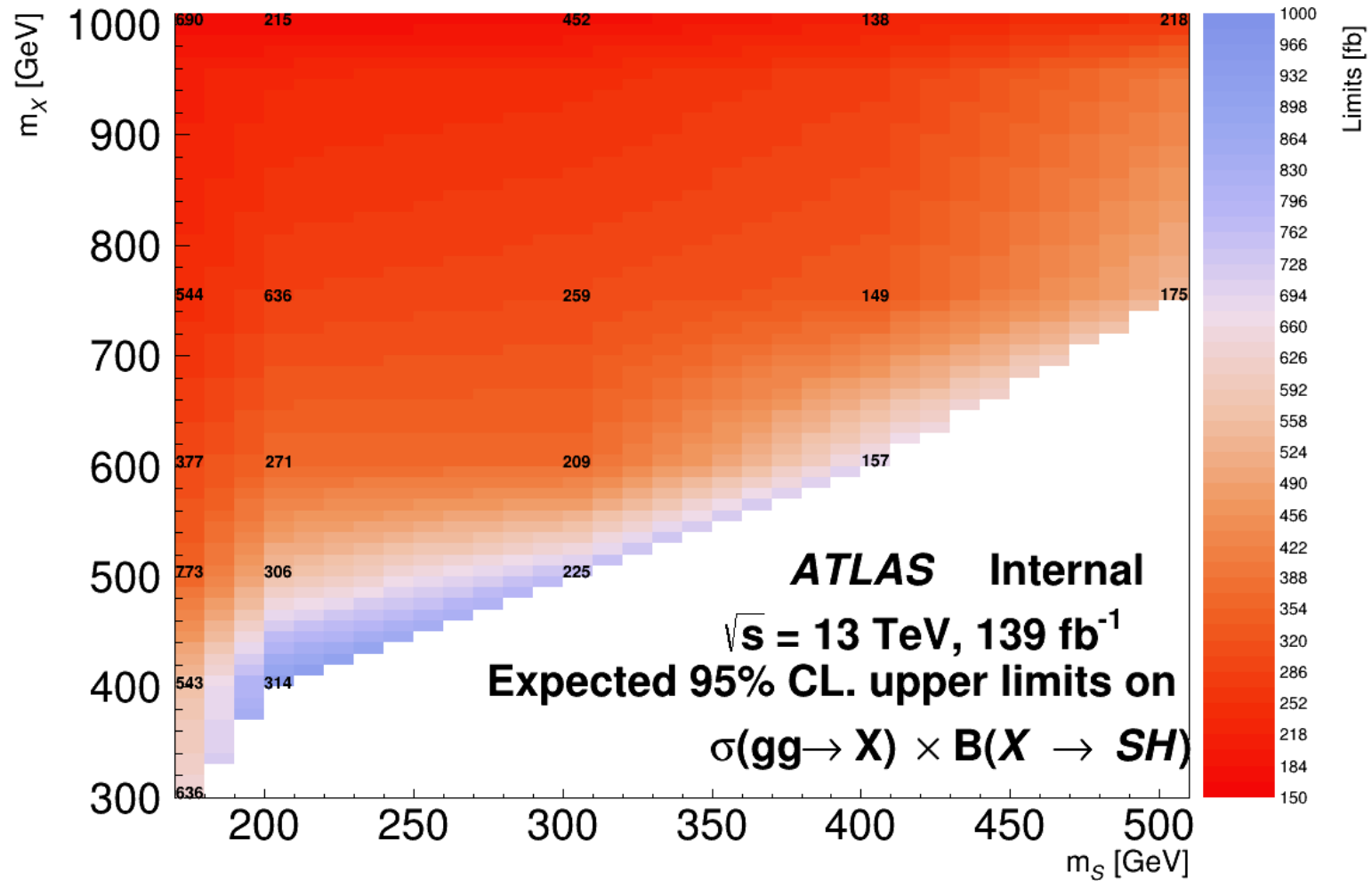


Limit Table



(fb)	X300S170	X400S170	X400S200	X500S170	X500S200	X500S300	X600S170	X600S200	X600S300	X600S400
Exp	634	566	946	354	555	751	299	366	366	688
Obs	636	543	773	377	544	690	314	306	271	636
+1	958	836	1279	534	783	1011	454	519	535	961
+2	1516	1256	1901	843	1183	1513	724	806	817	1437
-1	457	408	682	255	400	541	216	264	264	496
-2	340	304	508	190	298	403	161	196	196	369
	X750S170	X750S200	X750S300	X750S400	X750S500	X1000S170	X1000S200	X1000S300	X1000S400	X1000S500
Exp	244	286	304	336	537	171	169	177	214	260
Obs	215	225	209	259	452	157	149	138	175	218
+1	372	424	430	476	730	262	258	268	318	381
+2	598	651	672	762	1127	426	419	422	497	598
-1	176	206	219	242	387	123	121	127	154	187
-2	131	153	163	180	288	92	90	95	115	139

Interpolation



Summary

- Unblinding results reasonable
- Asimov results, Non-Asimov results checked
- Limits, significance, rankings plots checked
- Will implement in draft this week.