Unbinned fit
in Zy boosted analysis

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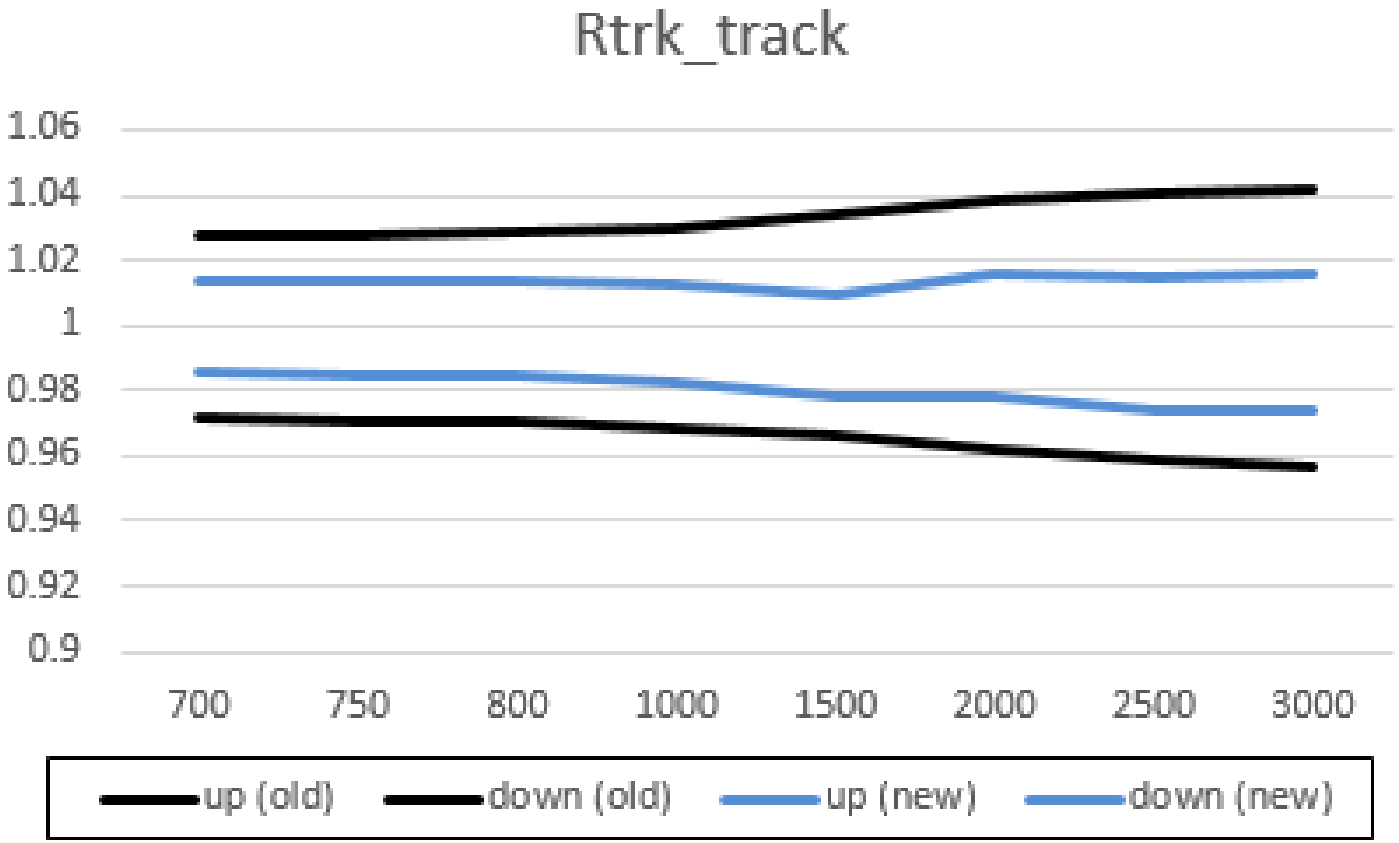
IHEP
2016-05-20

Updates on JES (bug fix)

CxAOD had JES double counted

Fixed JES uncertainties are reduced to half in general

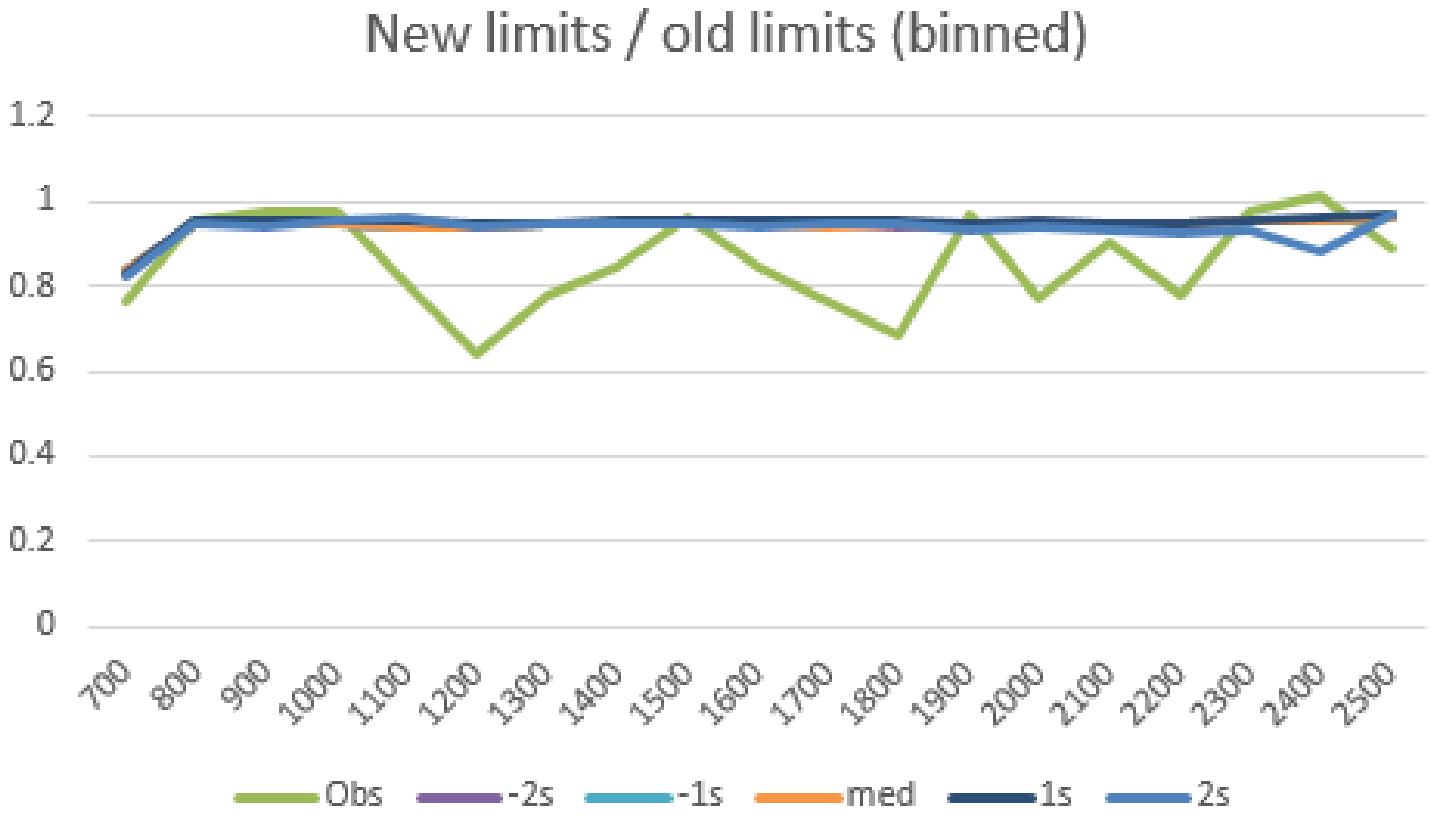


JES impact on CB mu

JES impacts on limits

New limits (with JES bug fixed) decrease a bit in general
Bands are more stable, while OBS is more jumpy because of data

JES nuisance parameters affect CB central value, i.e. where one fits the signal PDF. JES can affects fits a lot when data is few

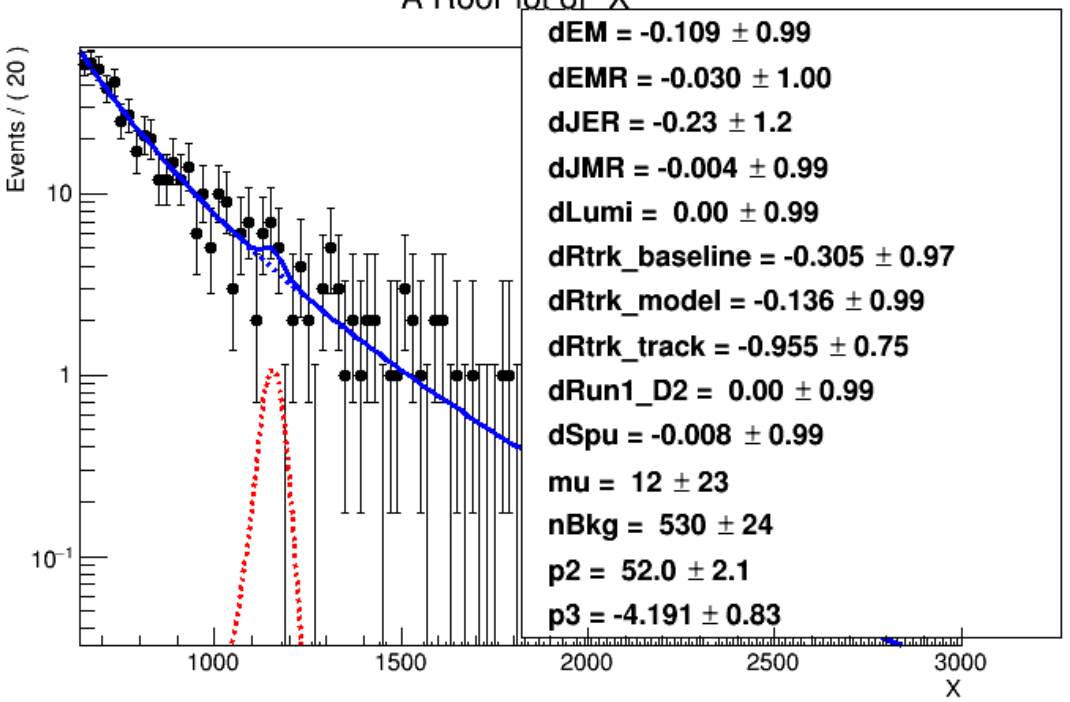


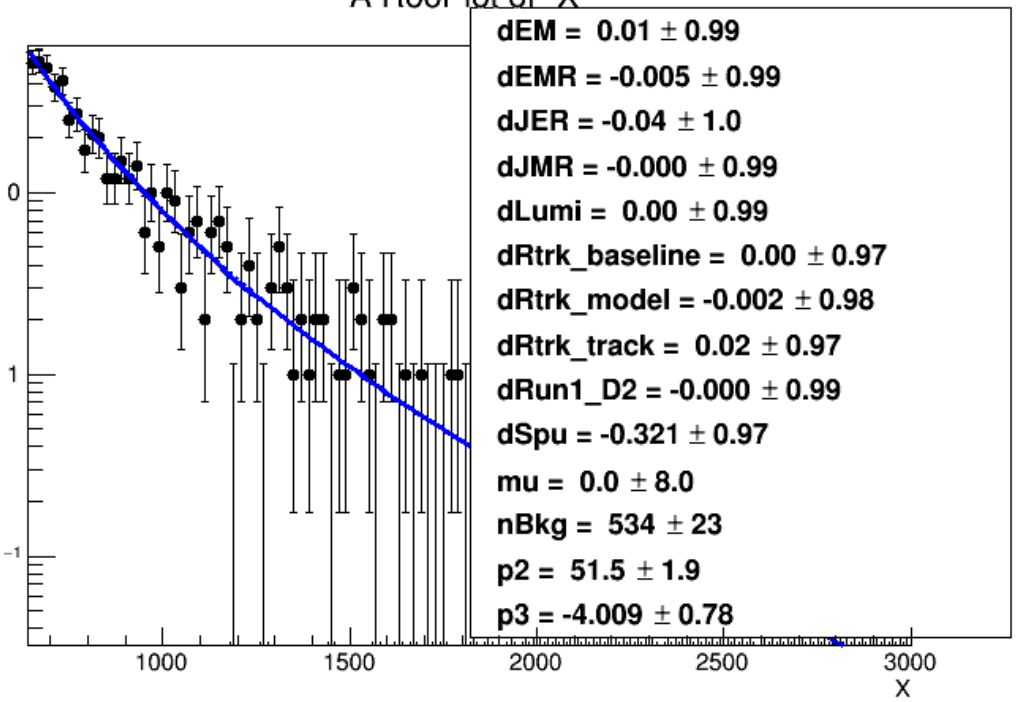
https://docs.google.com/spreadsheets/d/16bAkQkosh-VaUHm4EjDMHm8CgRnGrse_WPoSWh5fFr0/edit#gid=0

JES varies CB mu → OBS limits

To see how JES affects CB mu in fitting to data, I show from the **unbinned** side **how S+B fits to data**, for example @**1200GeV**

Since 1000GeV, JES becomes larger, the relevant impacts on CB mu becomes larger





S+B fit @ 1.2TeV
with double-counted JES
JES varies CB mu strongly
It fits at ~1150GeV effectively
Large signal strength, high limit

S+B fit @ 1.2TeV
with correct JES
JES varies CB mu weakly
It fits at ~1200GeV effectively
Small signal strength, low limit

Compare binned vs unbinned

Many thanks to Enrique, Shu, Zhijun and Evgeny for preparing basic materials and fix the JES bug

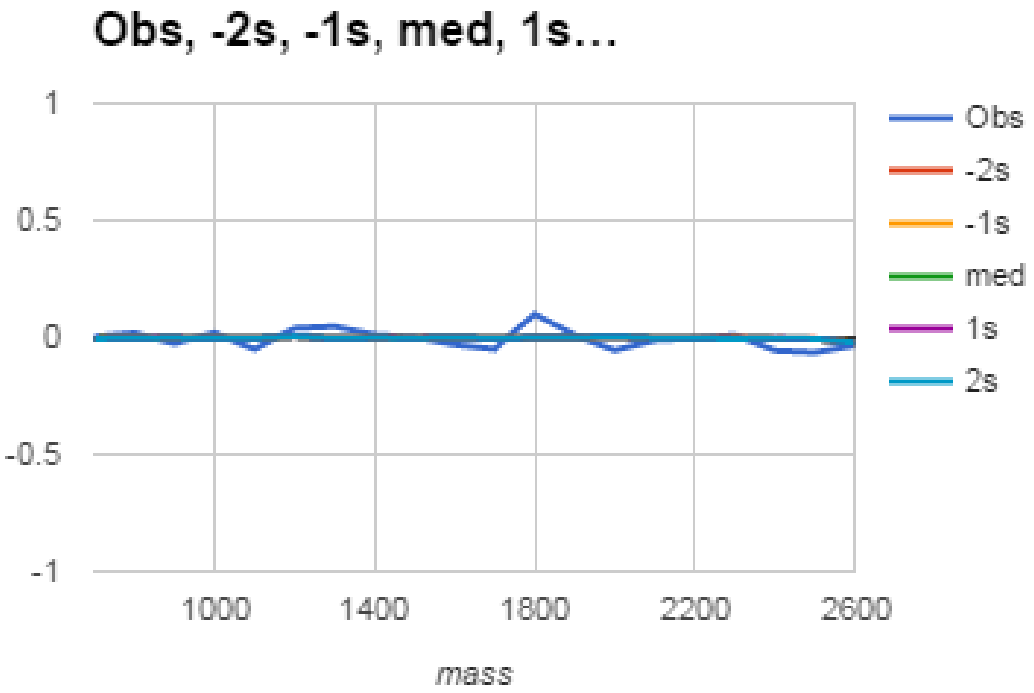
We continue to compare limits with bug fixed in CxAOD (JES was double counted)

We calculate the relative differences between binned and unbinned
(binned – unbinned) / average(binned, unbinned)

All comparisons can be retrieved from
https://docs.google.com/spreadsheets/d/16bAkQkosh-VaUHm4EjDMHm8CgRnGrse_WPoSWh5fFr0/edit#gid=0

Comparisons (no syst)

Without any systemctics
Median+bands agree very well
Only obs fluctuates a bit, but well under 10%

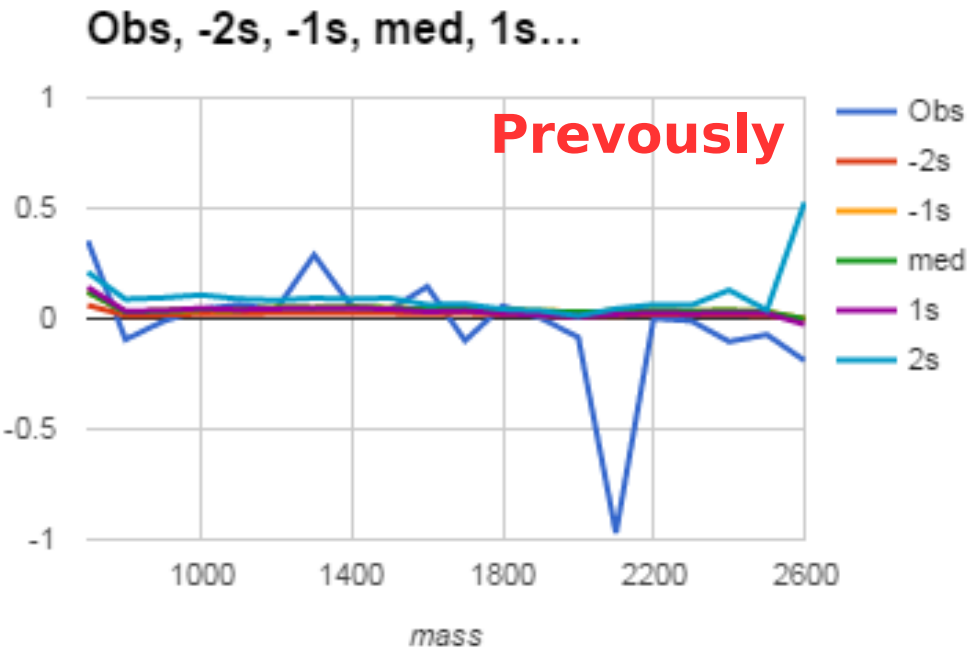


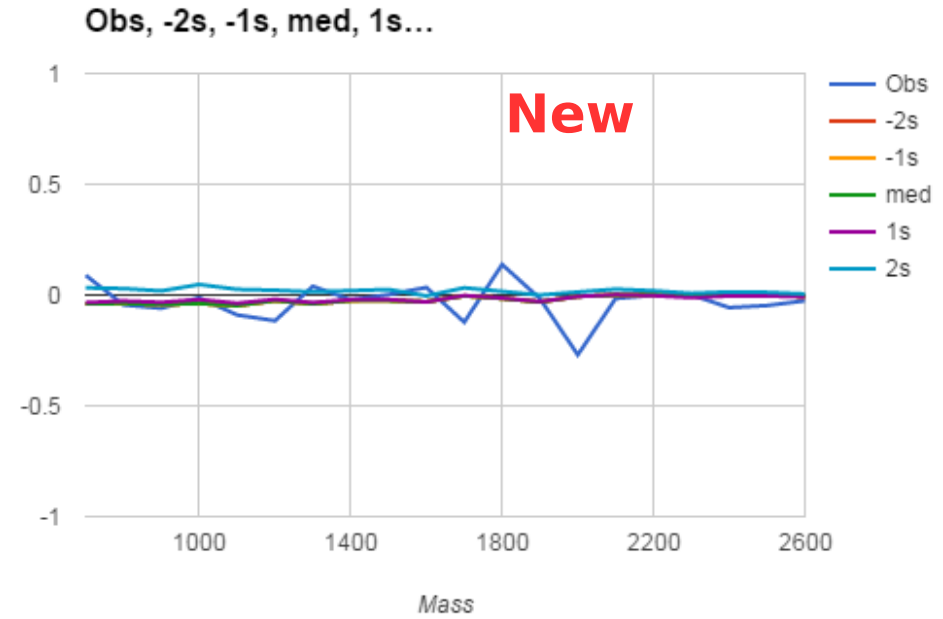
Comparisons (all syst)

Without all systemctics from last time, when the JES was double counted in CxAOD
Big difference @ 2.1TeV

With all systemctics, newly updated with JES bug fixed in CxAOD
They agree well generally

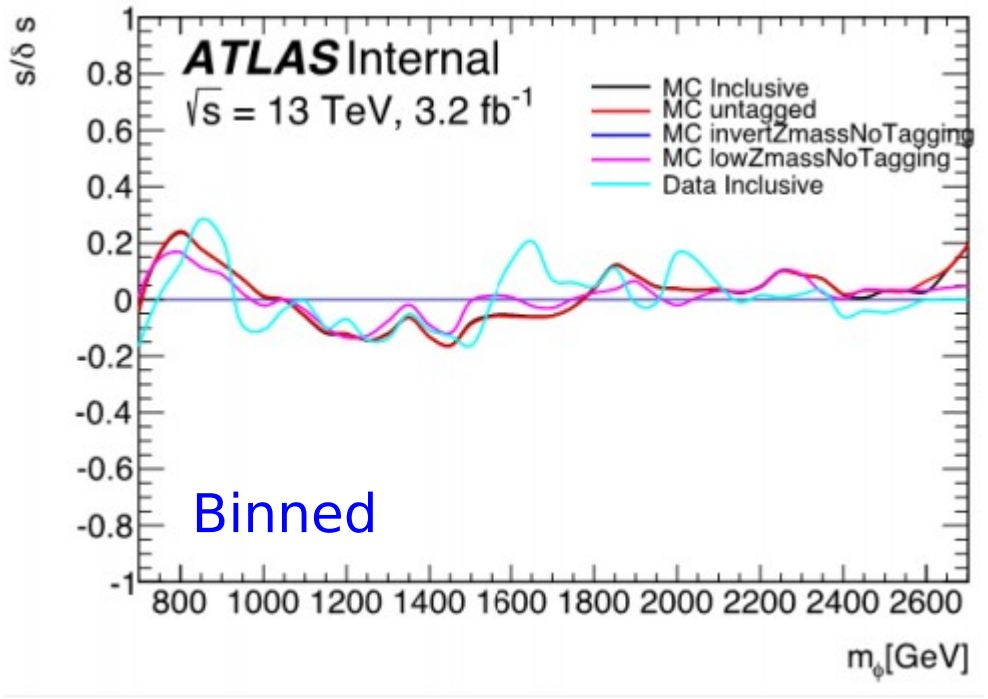
In conclusion, unbinned fit has fully consistent results with binned fit and we can go on with unbinned fit

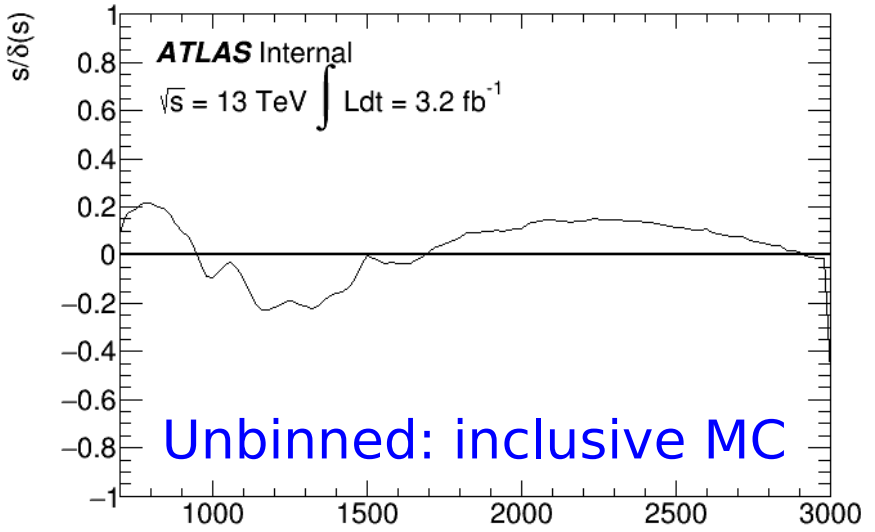


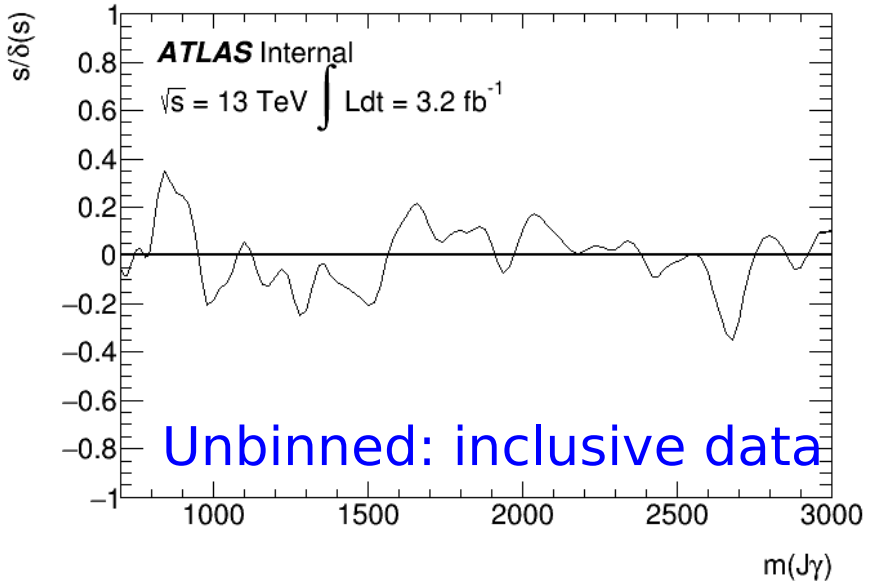


Spurious signal yield

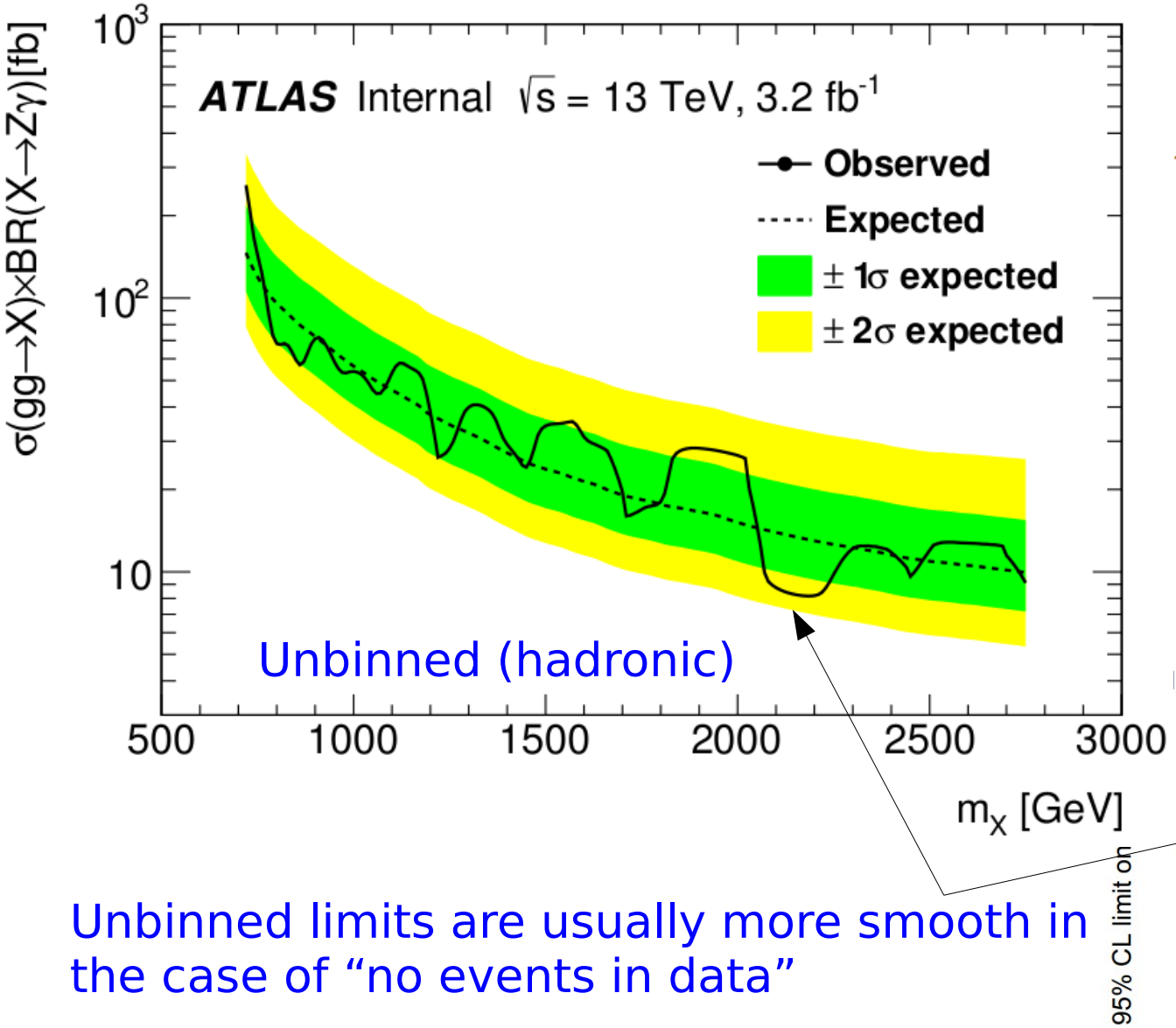
From binned side, 25% of background fluctuation was estimated as the boundary of SS from various samples
From unbinned side, this is double checked. 25% covers SS in general

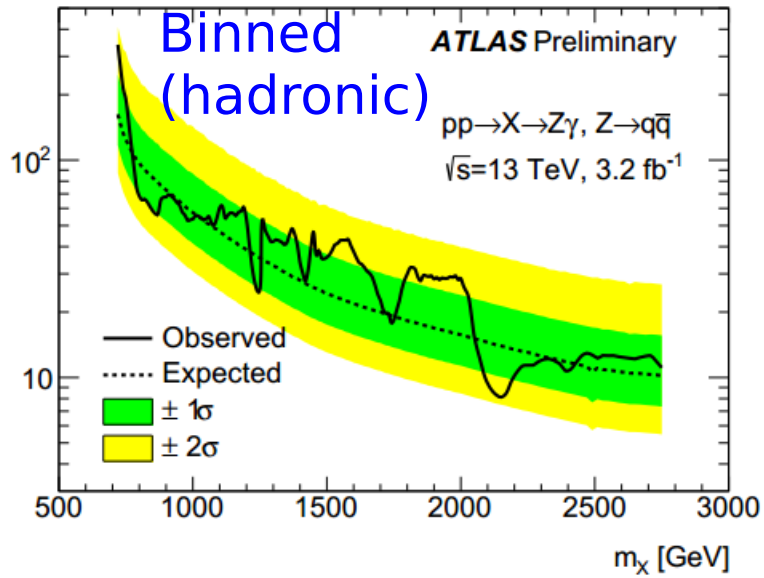


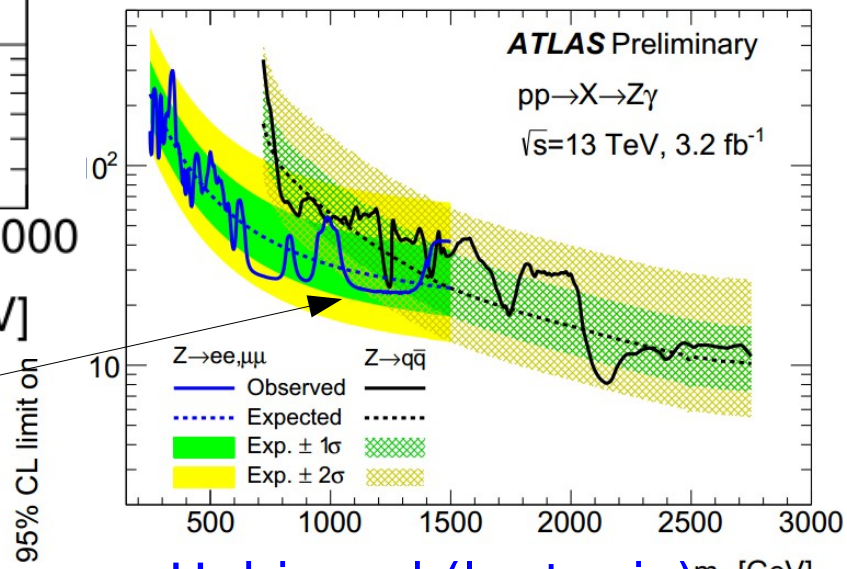




Limit setting (close-to-final)

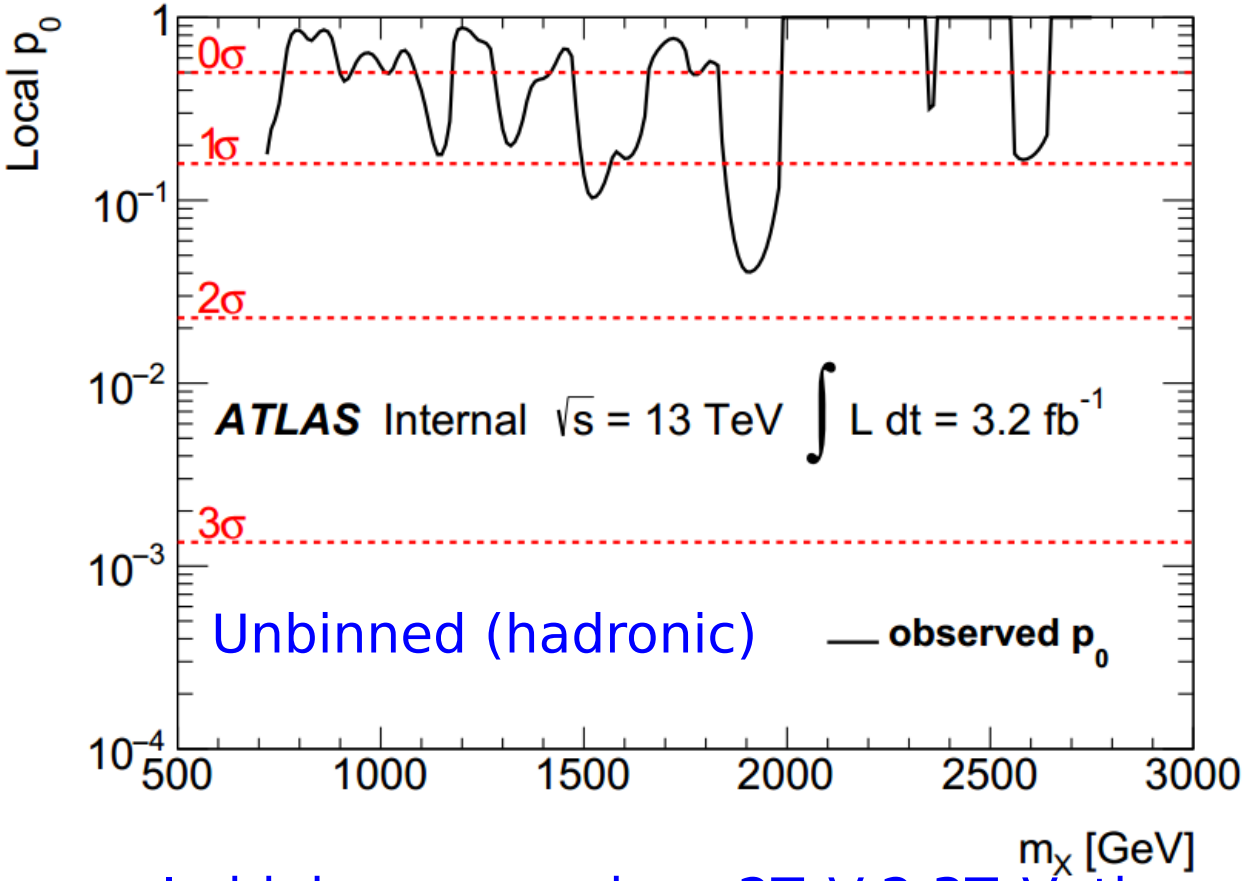




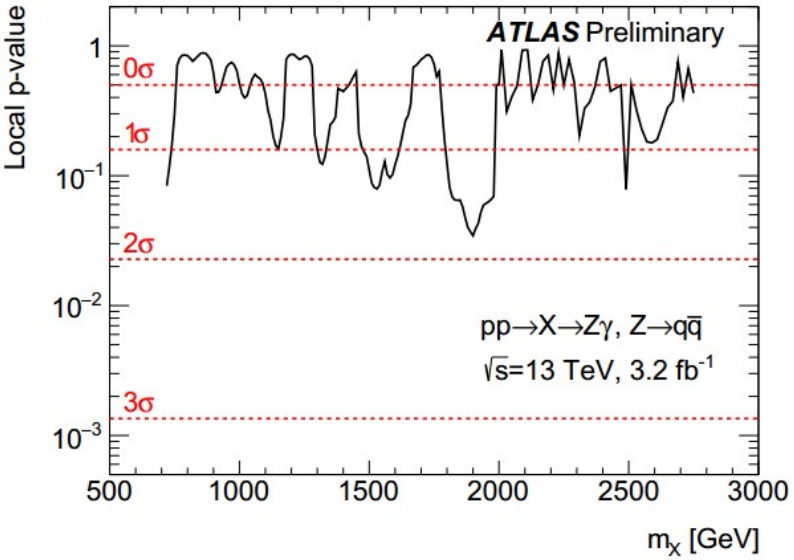


Unbinned limits are usually more smooth in the case of “no events in data”

Local p0 scan



Unbinned (hadronic)

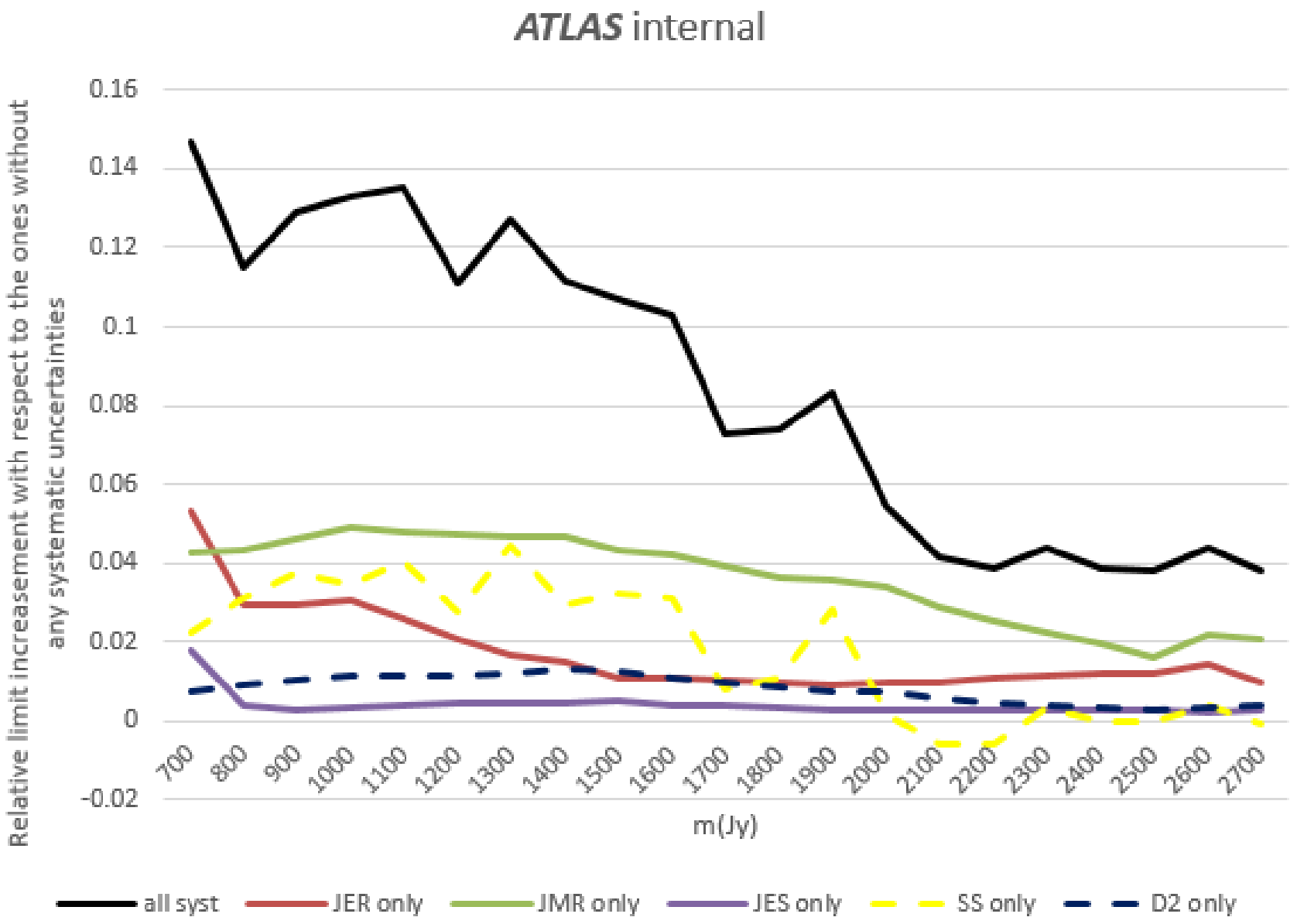


Binned (hadronic)

In high mass such as 2TeV-2.3TeV, there is no data and the fit is actually unsuccessful, under which case p0=1

When no data, S+B is fit to 0, where B is a certain number got from 640-3000 the whole range, but S is got only at the mass point that is scanned. Thus, S+B=0 gives a very negative S, so negative that touching the lower boundary … fit failed. However, p0=1 should be acceptable given strongly negative S

Ranking uncertainties (by limit)



Ranking (numeric)

Uncertainty Source	Mass [GeV] 750	1000	1500	2000	2500	2750
Jet mass resolution	13%	8%	2%	1%	1%	1%
Jet energy resolution	2%	2%	0.3%	0.2%	0.2%	0.1%
Jet energy scale	11%	8%	8%	7%	5%	2%

Previously in INT note (calc with asymptotic formula)

Uncertainty Source	Mass [GeV] 700	1000	1500	2000	2500	2700
Jet mass resolution	4.2%	4.9%	4.5%	3.4%	1.5%	2.0%
Jet energy resolution	5.3%	3.1%	1.2%	0.9%	1.1%	0.9%
Jet energy scale	5.6%	1.0%	0.9%	0.7%	0.5%	0.6%
Run-I D2 scale	0.7%	1.1%	1.2%	2.7%	0.3%	0.4%

Updated last time (calculated with asymptotic limit)
JES bugged
D2 bug at 2TeV

Uncertainty Source	Mass [GeV] 700	1000	1500	2000	2500	2700
Jet mass resolution	4.3%	4.9%	4.3%	3.4%	1.6%	2.1%
Jet energy resolution	5.3%	3.1%	1.1%	1.0%	1.2%	1.0%
Spurious signal	2.2%	3.5%	3.2%	0.1%	0.0%	0.0%
Run-I D2 scale	0.7%	1.1%	1.2%	0.7%	0.3%	0.4%
Jet energy scale	1.7%	0.3%	0.5%	0.2%	0.2%	0.3%

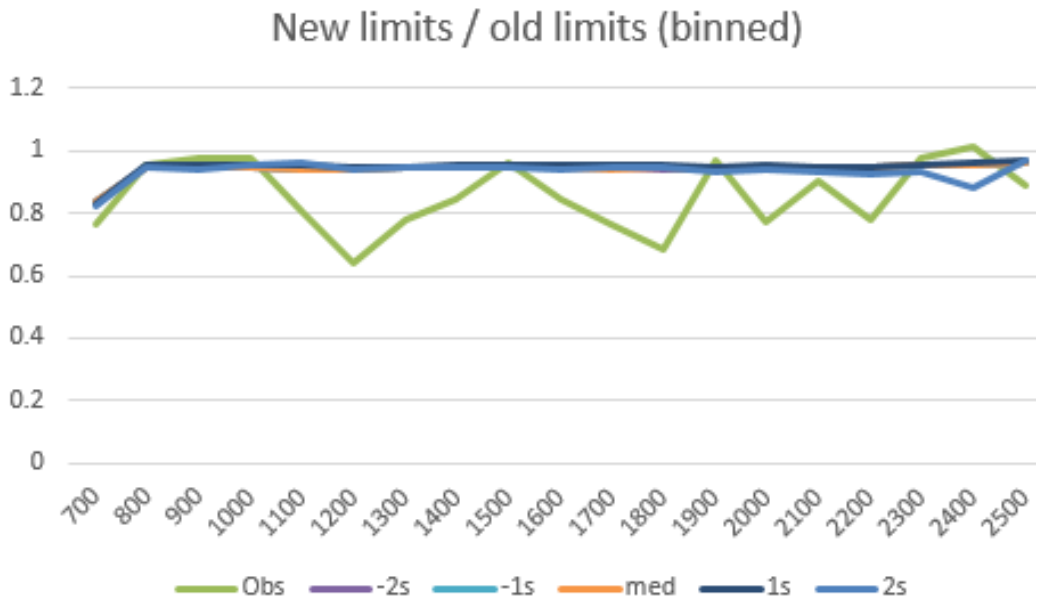
Updated (calculated with asymptotic limit)
JES bug fixed
D2 bug fixed

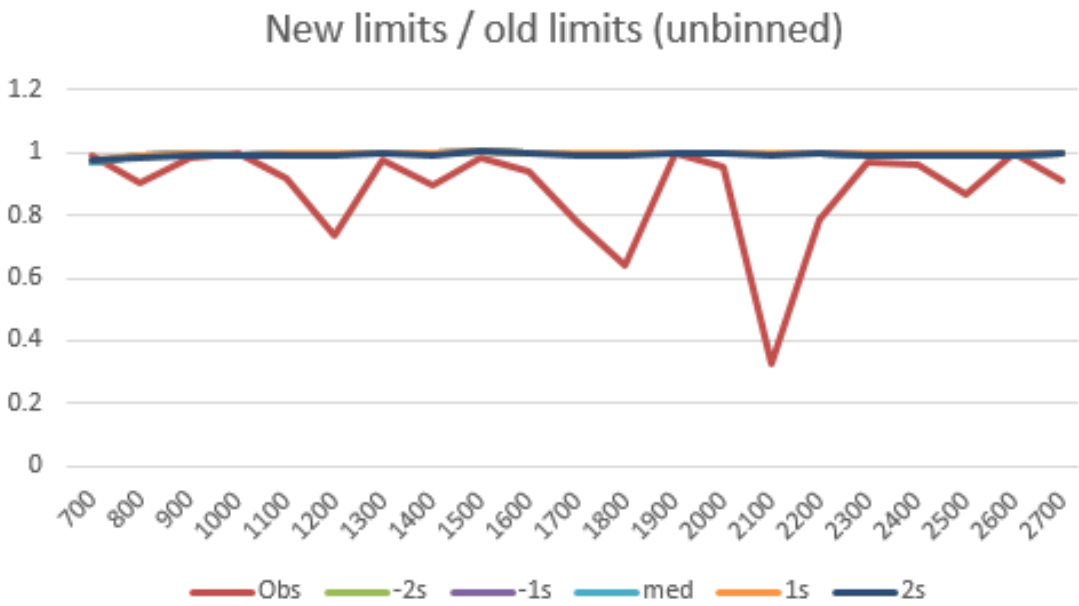
Backup

JES impacts on limits

New limits (with JES bug fixed) decrease a bit in general

JES nuisance parameters affect CB central value, i.e. where one fits the signal PDF. JES can affects fits a lot when data is few





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