Measure of the Higgs mass for different impulsion pT(H):

Study of the precision with high luminosity

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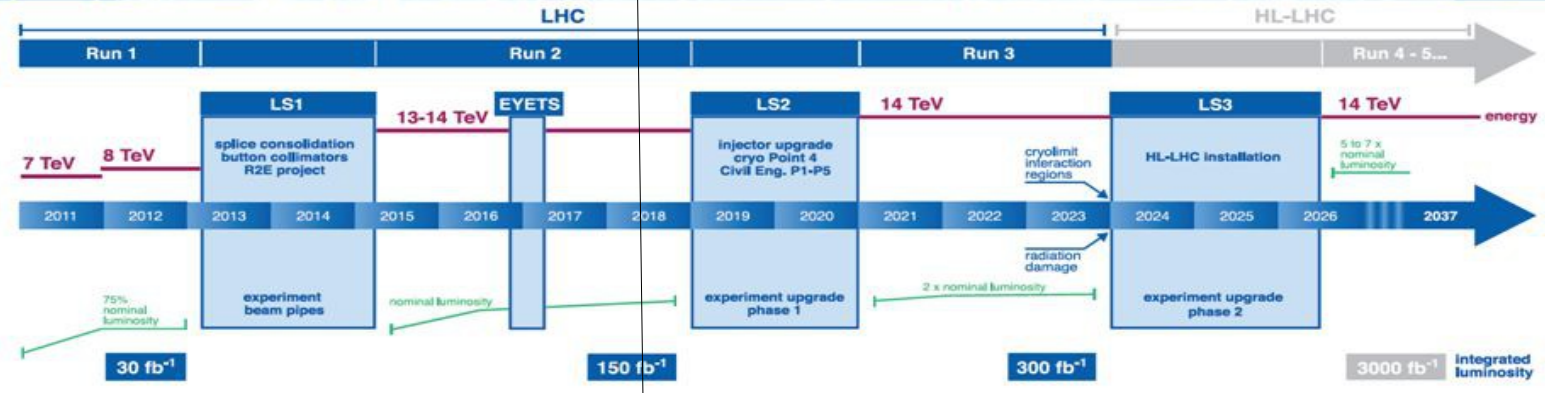
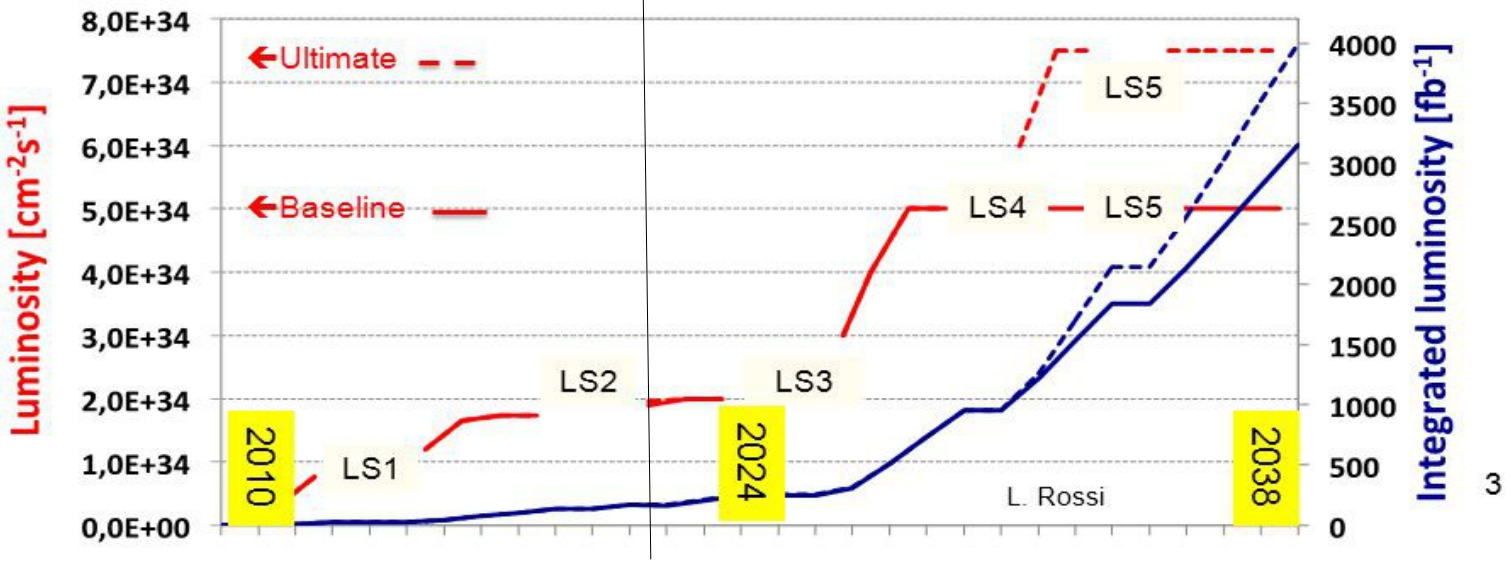
26 June 2018

HL-LHC: planning et luminosité attendue

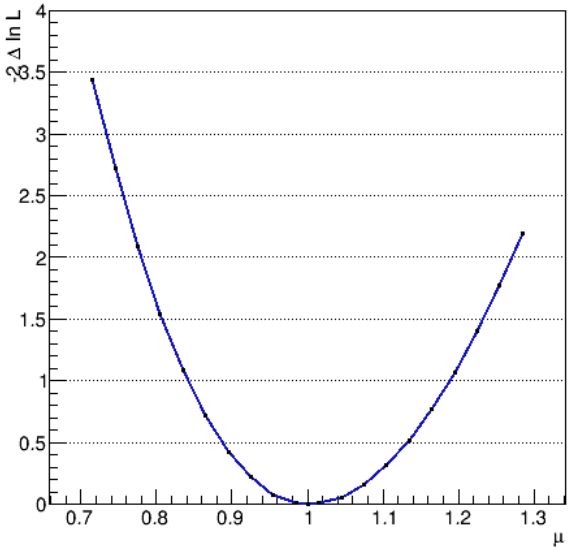




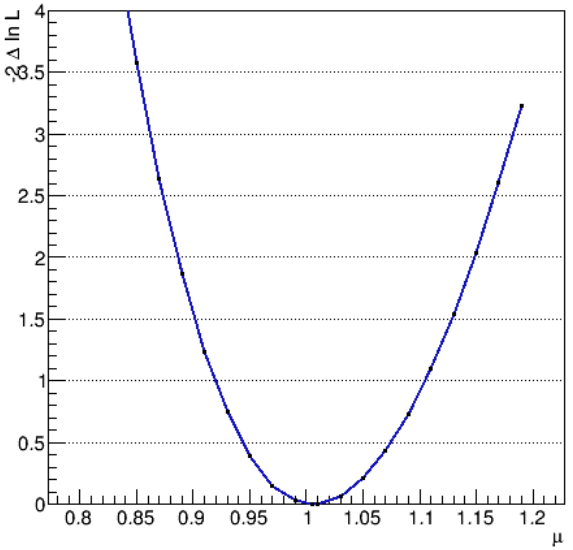
We want to predict the precision on the Higgs mass and the significance as function of pT(H) up to 2038 (end of HL-LHC).

Cross section precision

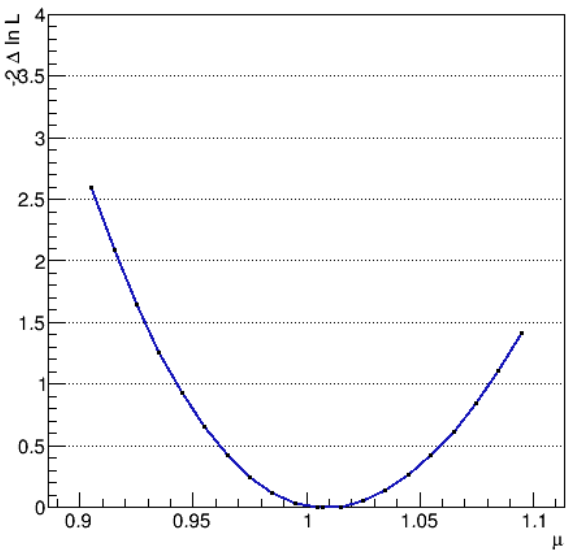
μ Scan



Luminosity 1



Luminosity 10



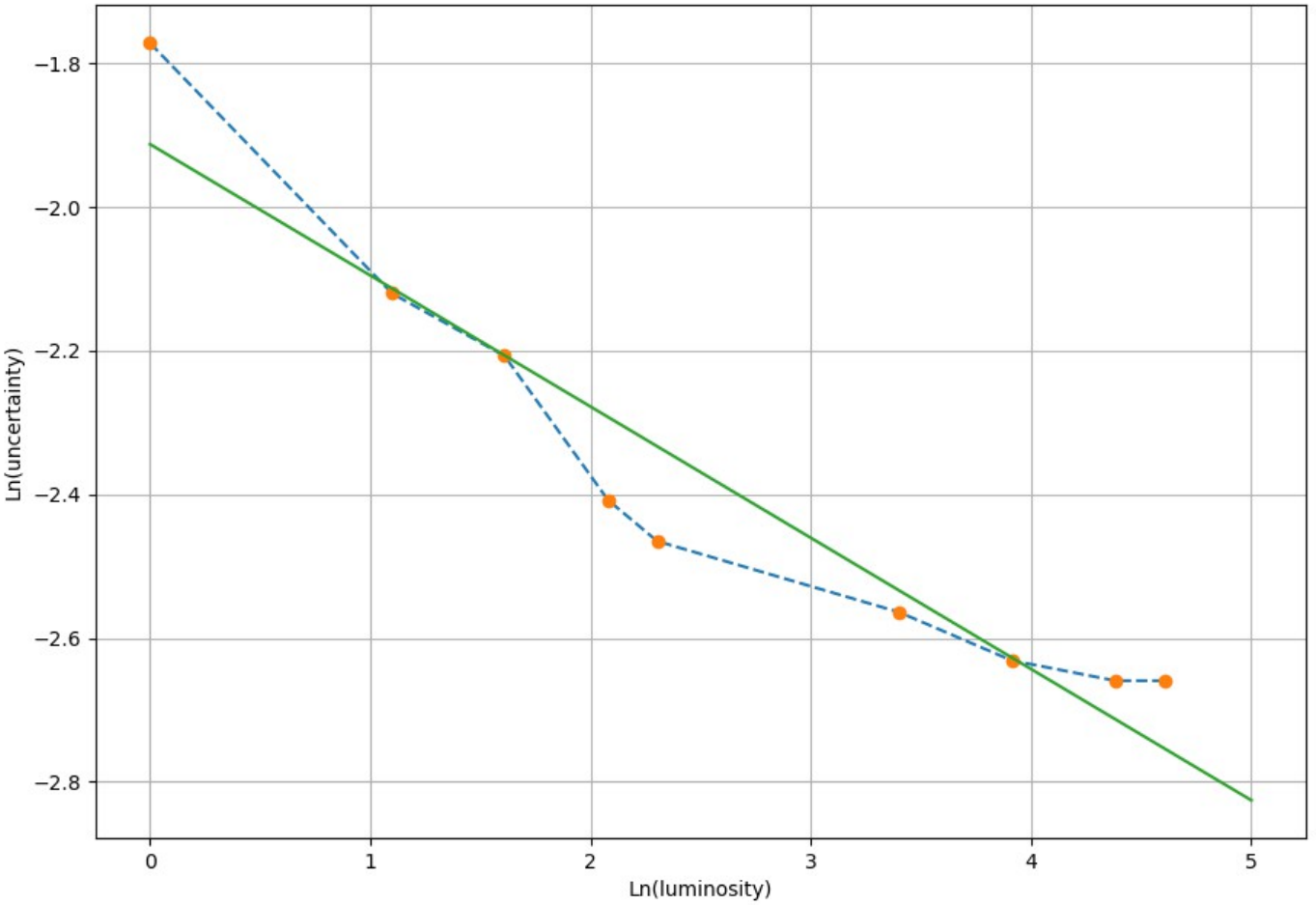
Luminosity 100

Standard Model Higgs boson decaying into γγ, based on 2016 analysis to measure Higgs mass.

Injected signal : μ=1

$$\mu = \frac{\sigma_{obs}}{\sigma_{SM}}$$

Luminosity	1	10	100
Expected precision (1σ)	17%	8,5%	7%

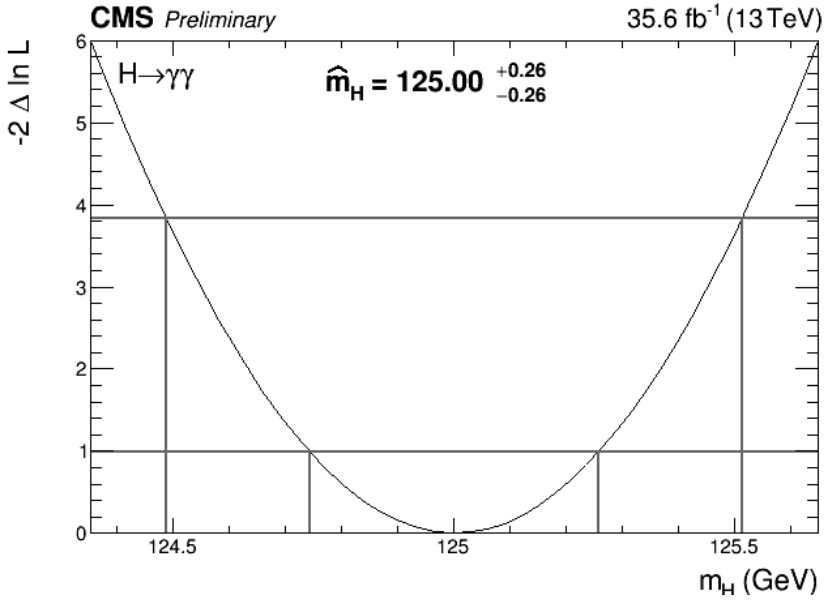


Slope : -0,18

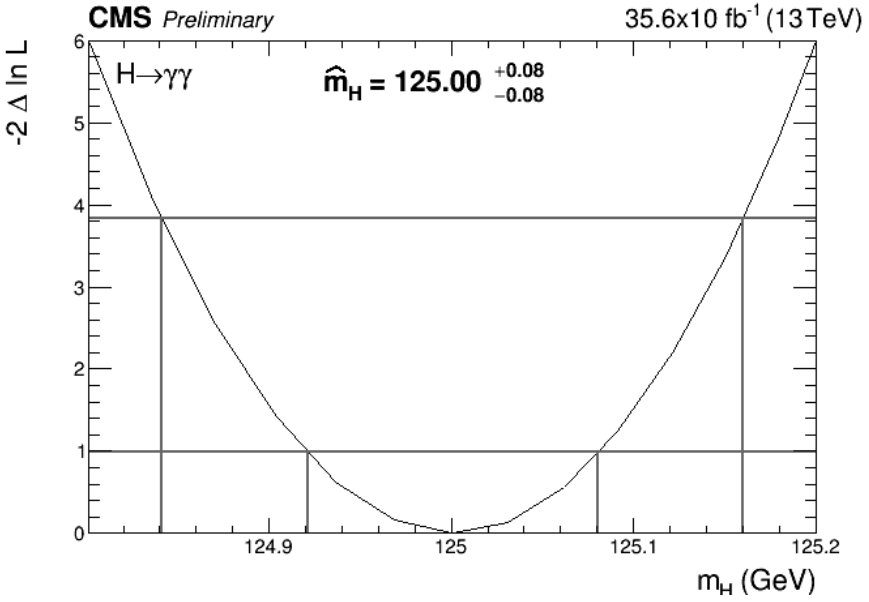
Doesn't follow the scaling : $\sigma \propto \frac{1}{\sqrt{N}}$

Mass precision

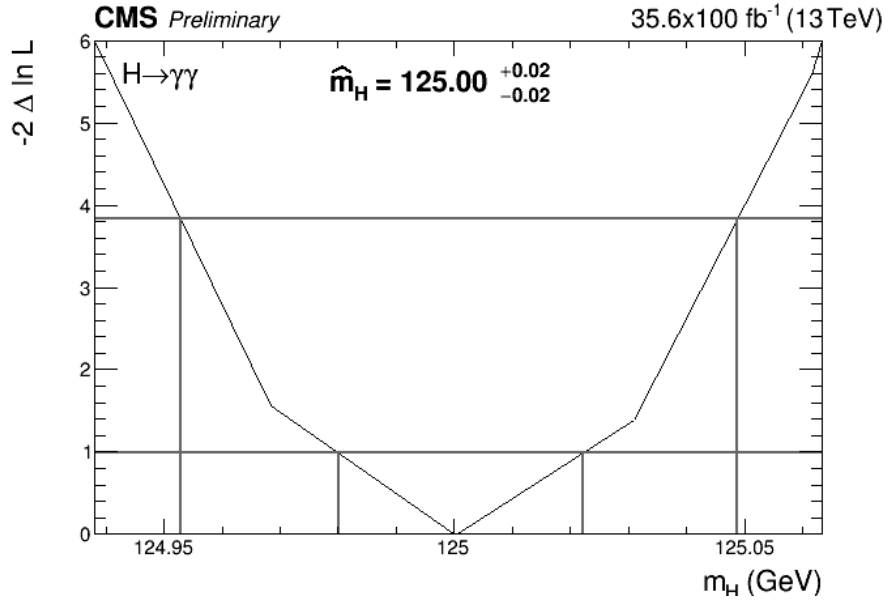
Mass scan (no systematics errors, only statistics)



Luminosity 1



Luminosity 10

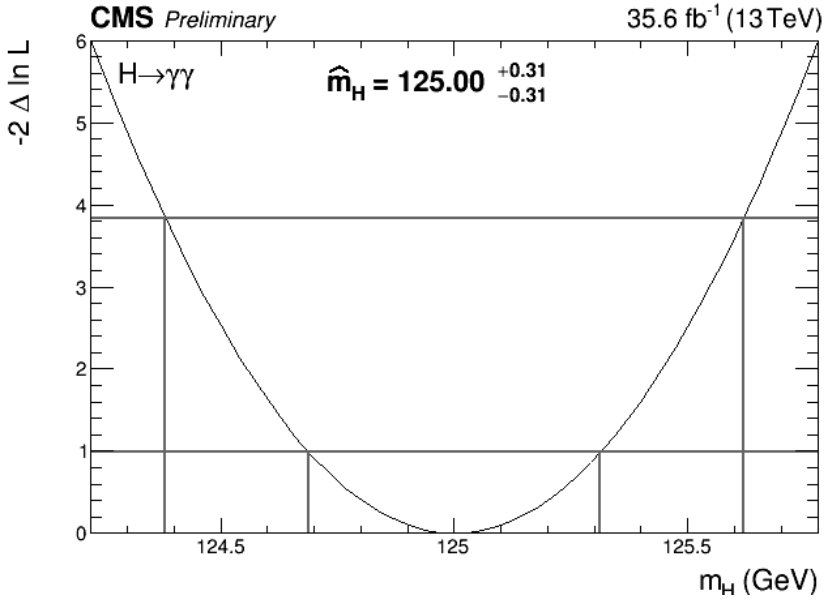


Luminosity 100

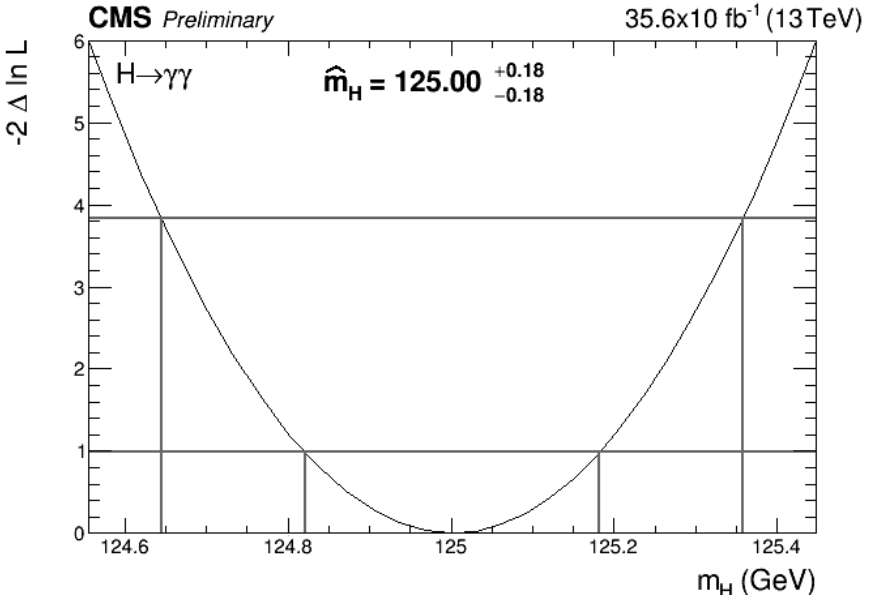
Follows the scaling :

$$\sigma \propto \frac{1}{\sqrt{N}}$$

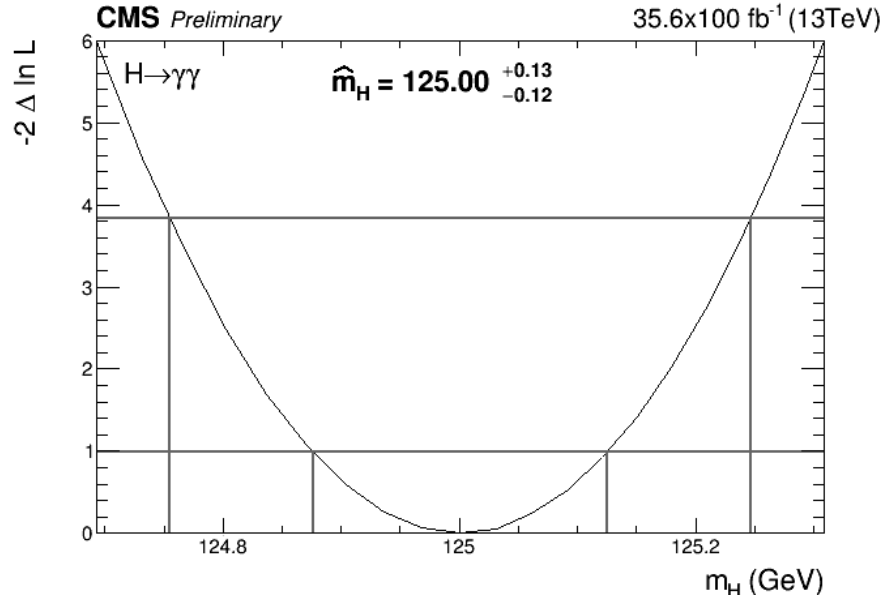
Mass scan (systematics and statistics errors)



Luminosity 1



Luminosity 10



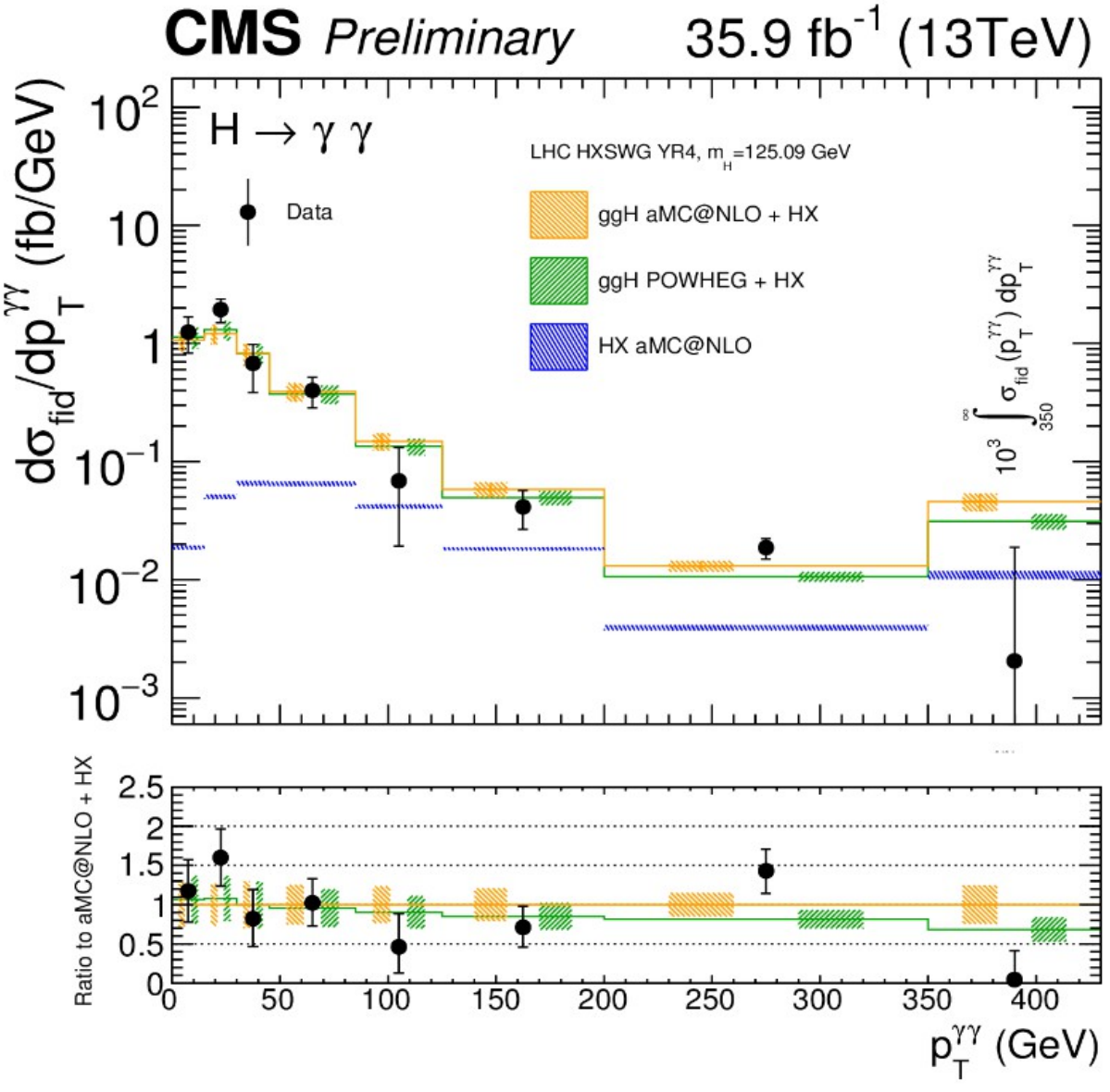
Luminosity 100

Doesn't follow the scaling :

$$\sigma \propto \frac{1}{\sqrt{N}}$$

Significance for pT(H)

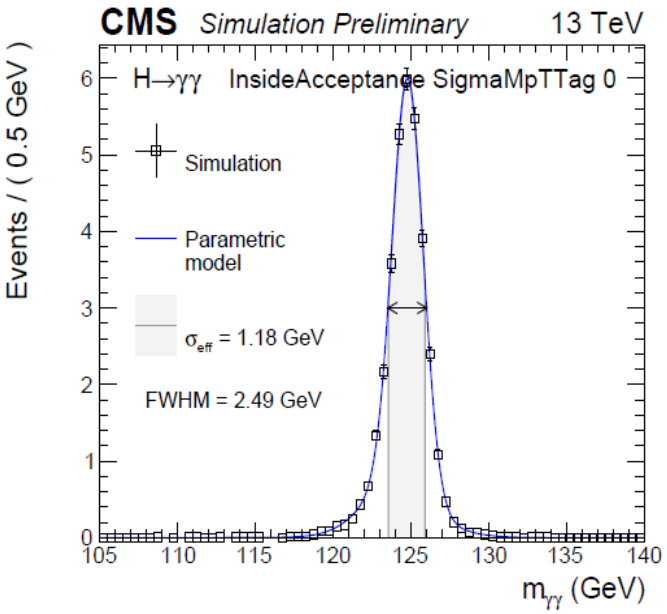
Significance study for different pT(H)



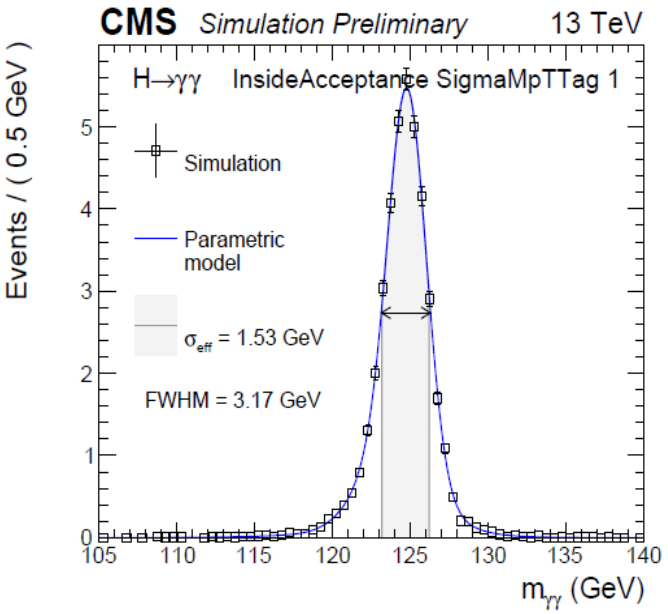
(a) $p_{T,\gamma\gamma}$ differential cross-section

We want to find an expected significance for different impulsion pT, and for each category.

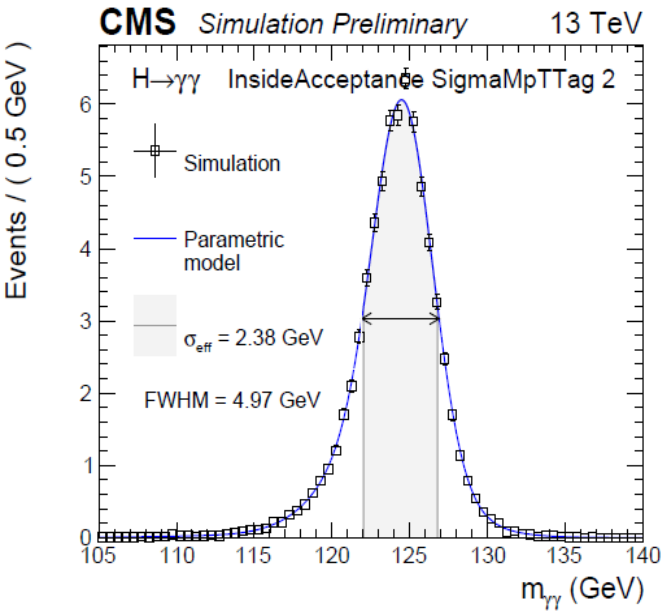
Signal contribution : Integration for each interval of pT(H) and multiply by luminosity



Best mγγ resolution category



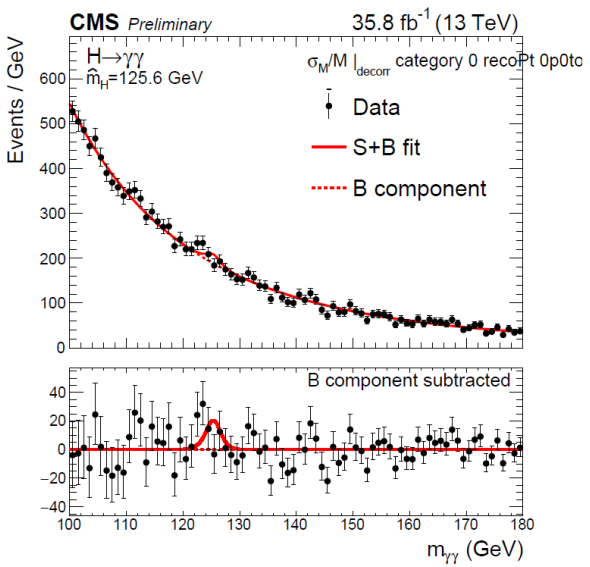
Medium category



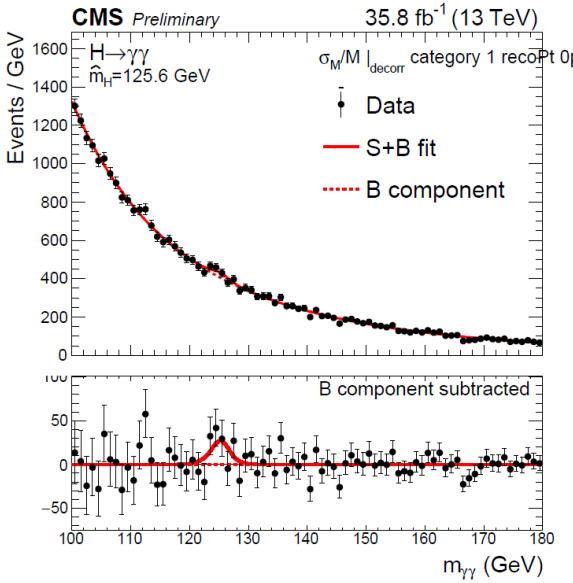
Lowest category

For the Background contribution, 3 categories for mass resolution :
We integrate roughly the background component for each category, and then sum the 3 values.

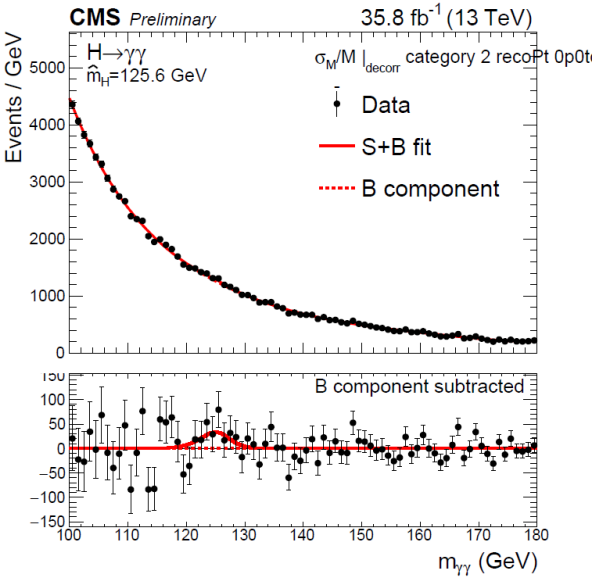
Bin 1 (0 < pT(H) < 15 GeV)



Best category



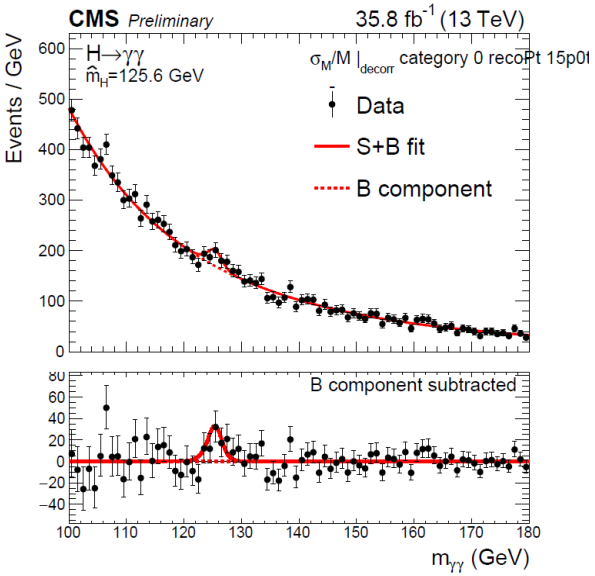
Medium category



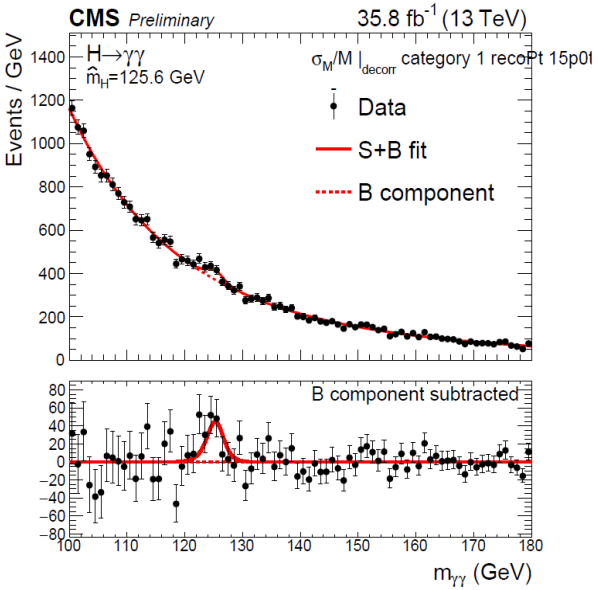
Lowest category

Luminosity (fb^{-1})	36	150 (2018)	300 (2022)	3000
Signal	540	2250	4500	45000
Background	19200	80000	160000	1600000
Significance	3,90	7,95	11,3	35,6

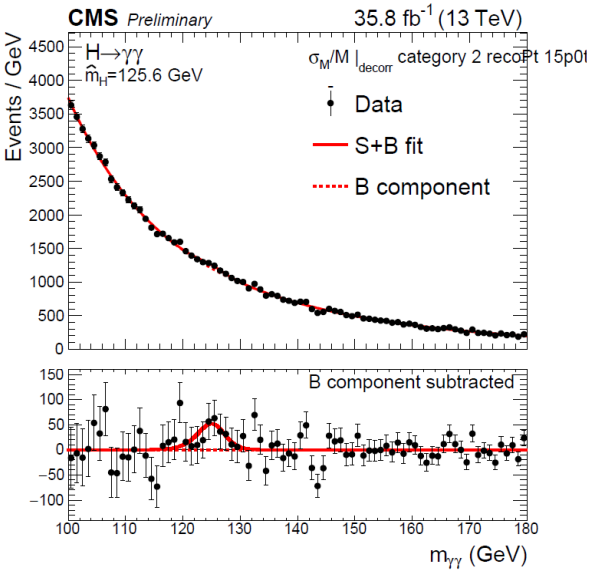
Bin 2 (15 < pT(H) < 30 GeV)



Best category



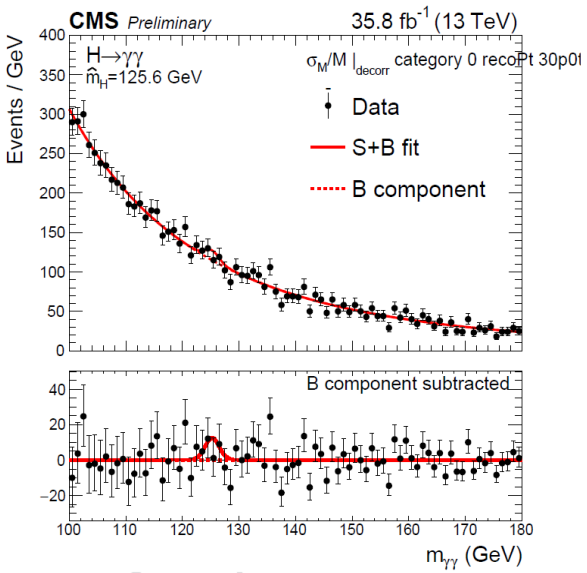
Medium category



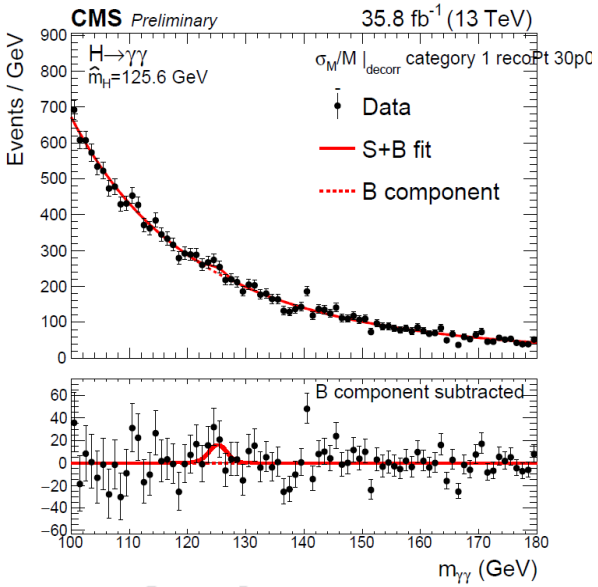
Lowest category

Luminosity (fb^{-1})	36	150	300	3000
Signal	756	3150	6300	63000
Background	19040	80000	160000	1600000
Significance	5,48	11,2	15,8	50,0

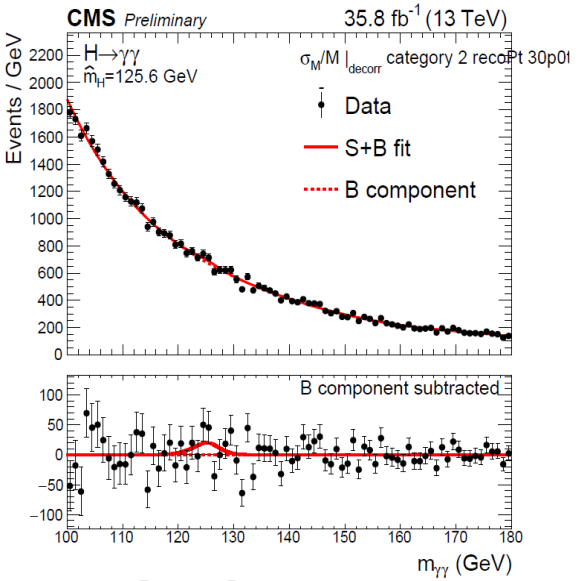
Bin 3 (30 < pT(H) < 45 GeV)



Best category



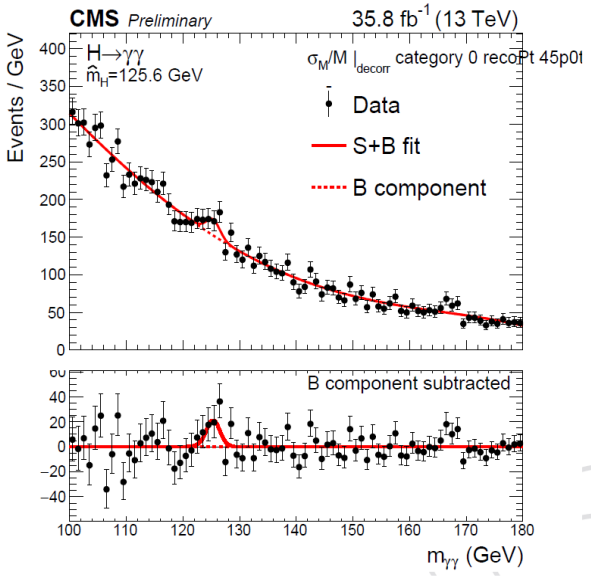
Medium category



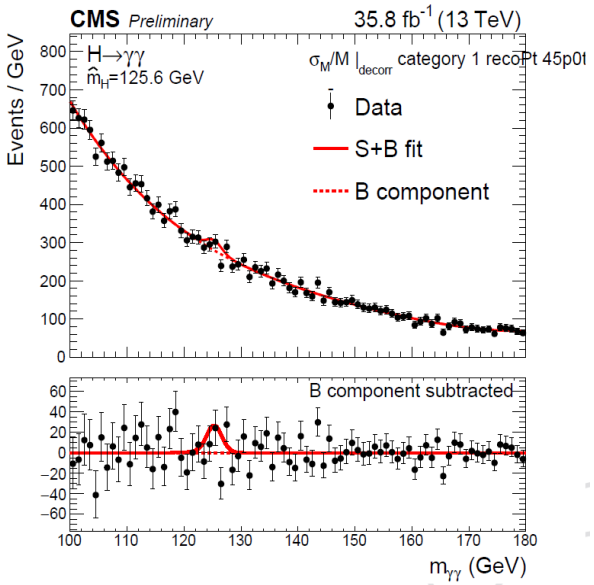
Lowest category

Luminosity (fb^{-1})	36	150	300	3000
Signal	432	1800	3600	36000
Background	9000	38000	75000	7550000
Significance	4,56	9,32	13,2	41,7

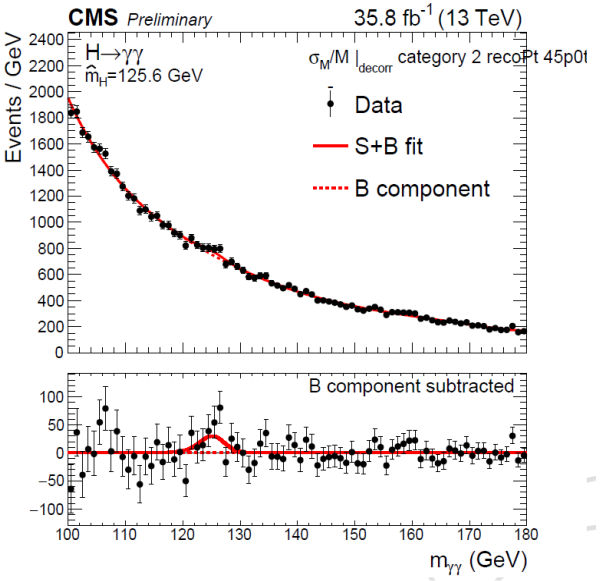
Bin 4 (45 < pT(H) < 85 GeV)



Best category



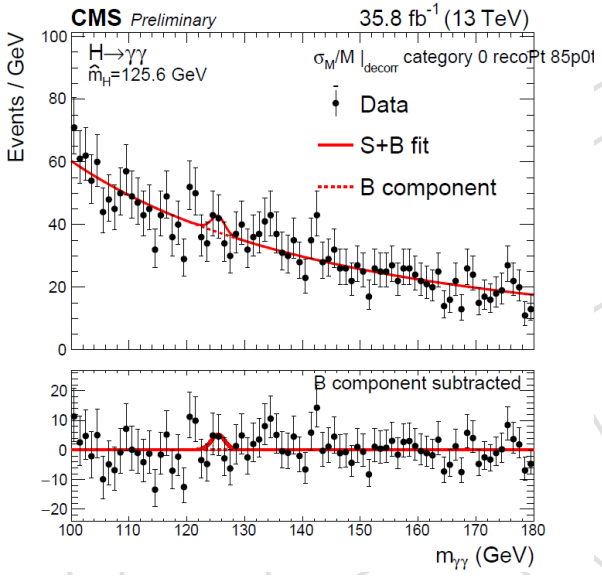
Medium category



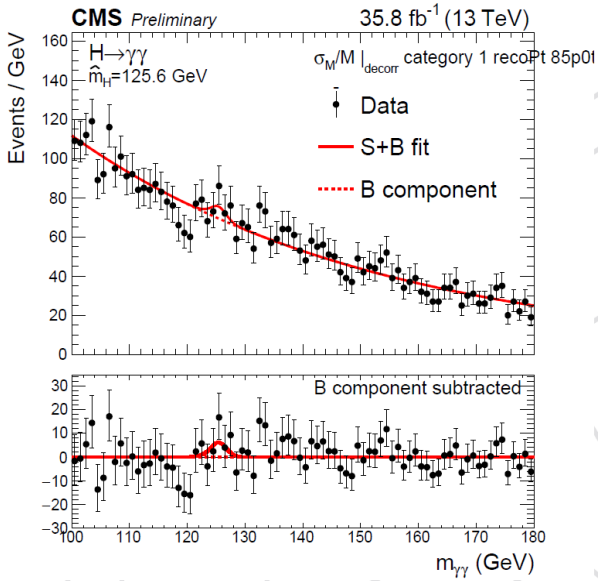
Lowest category

Luminosity (fb^{-1})	36	150	300	3000
Signal	576	2400	4800	48000
Background	10440	43500	87000	870000
Significance	5,64	11,5	16,3	51,5

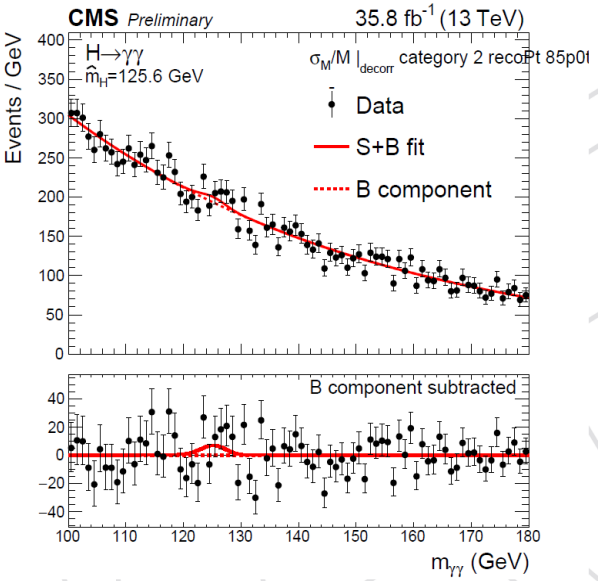
Bin 5 (85 < pT(H) < 125 GeV)



Best category



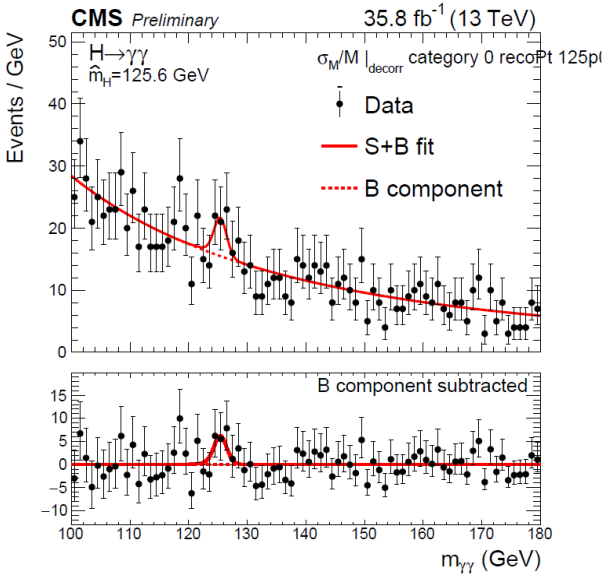
Medium category



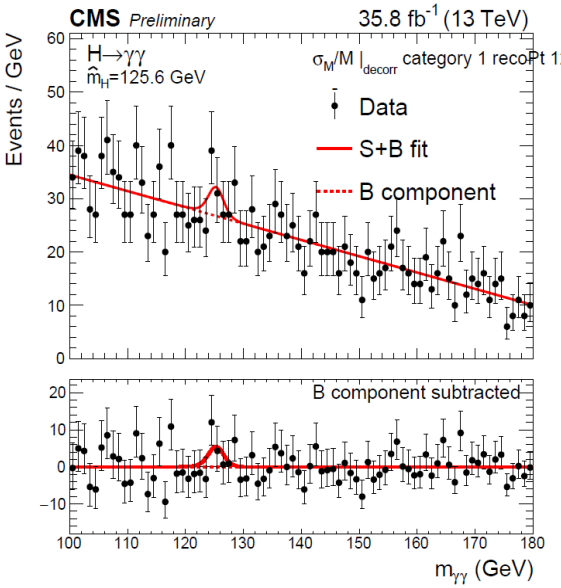
Lowest category

Luminosity (fb^{-1})	36	150	300	3000
Signal	216	900	1800	18000
Background	2840	12000	24000	240000
Significance	4,05	8,27	11,7	37,0

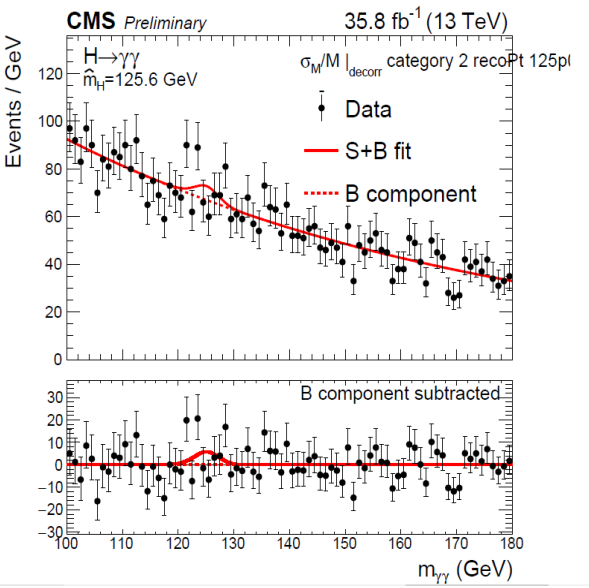
Bin 6 (125 < pT(H) < 200 GeV)



Best category



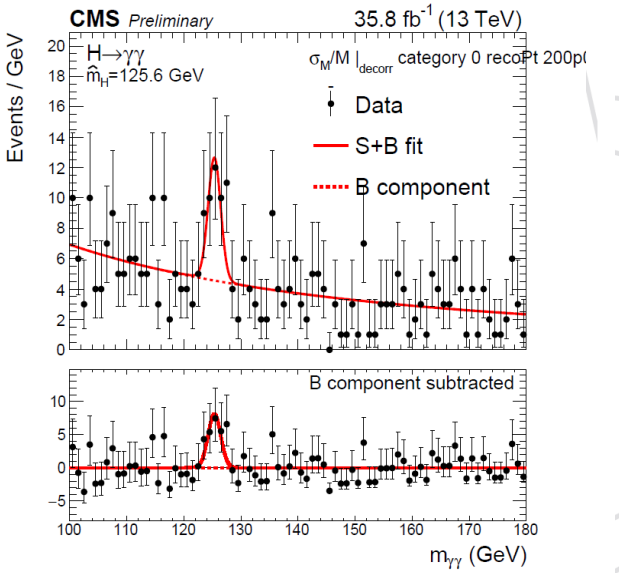
Medium category



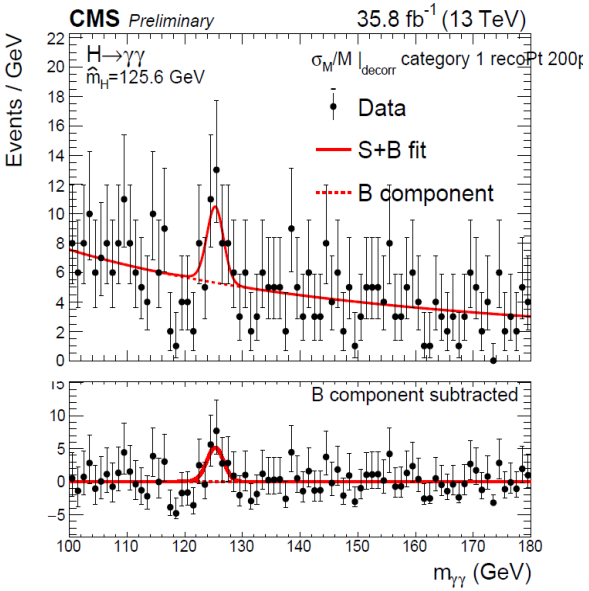
Lowest category

Luminosity (fb^{-1})	36	150	300	3000
Signal	162	675	1350	13500
Background	1108	5000	10000	100000
Significance	4,87	10,0	14,0	44,4

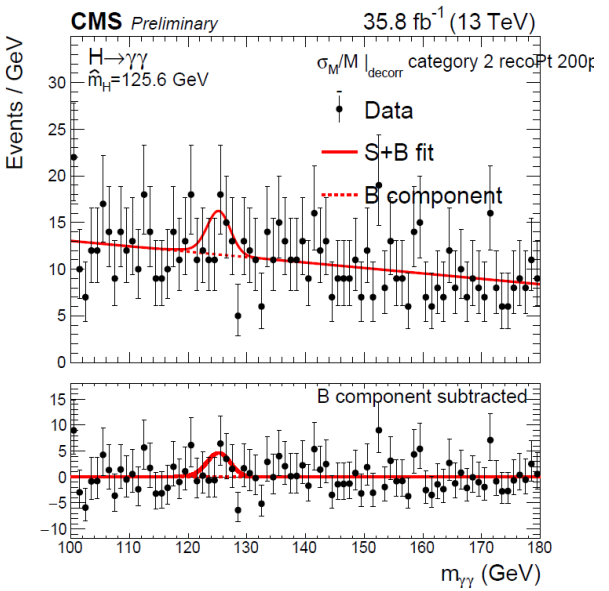
Bin 7 (200 < pT(H) < 350 GeV)



Best category



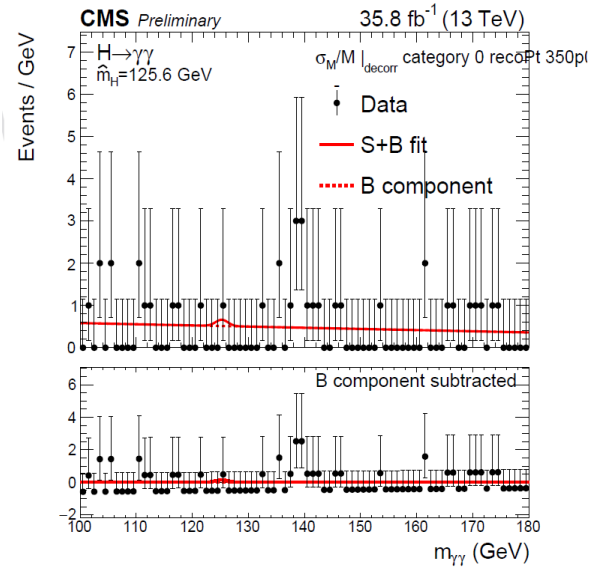
Medium category



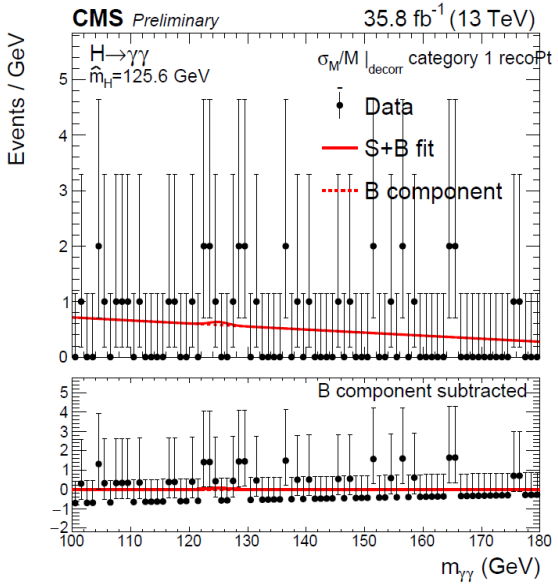
Lowest category

Luminosity (fb^{-1})	36	150	300	3000
Signal	81	340	675	6750
Background	290	1200	2400	24000
Significance	4,76	9,71	13,7	43,4

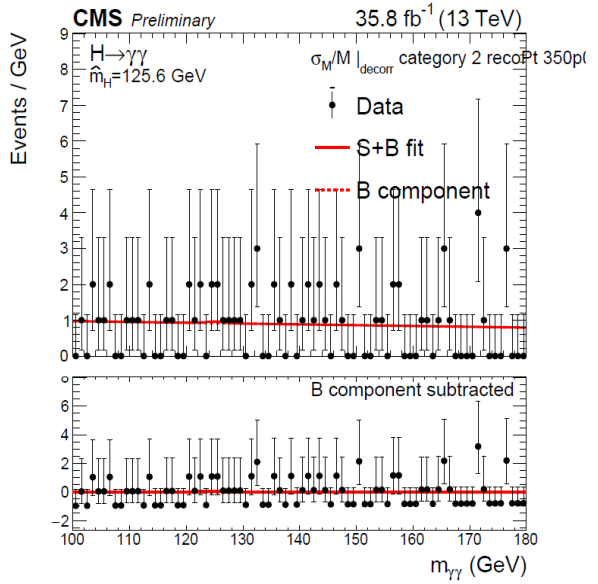
Bin 8 (pT(H) > 350 GeV)



Best category



Medium category



Lowest category

Luminosity (fb^{-1})	36	150	300	3000
Signal	1,26	5,25	10,5	105
Background	17,2	72	143	1430
Significance	0,30	0,62	0,88	2,77

Conclusion

Considering different pT(H), we have a high precision up to pT(H) = 350 GeV