

Search for resonances in the mass spectrum of muon pairs produced in association with b quark jets in proton-proton collisions at $\sqrt{s} = 8$ and 13 TeV

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Motivation

previous searches of dimuon resonances with b-jets at 8 TeV data:

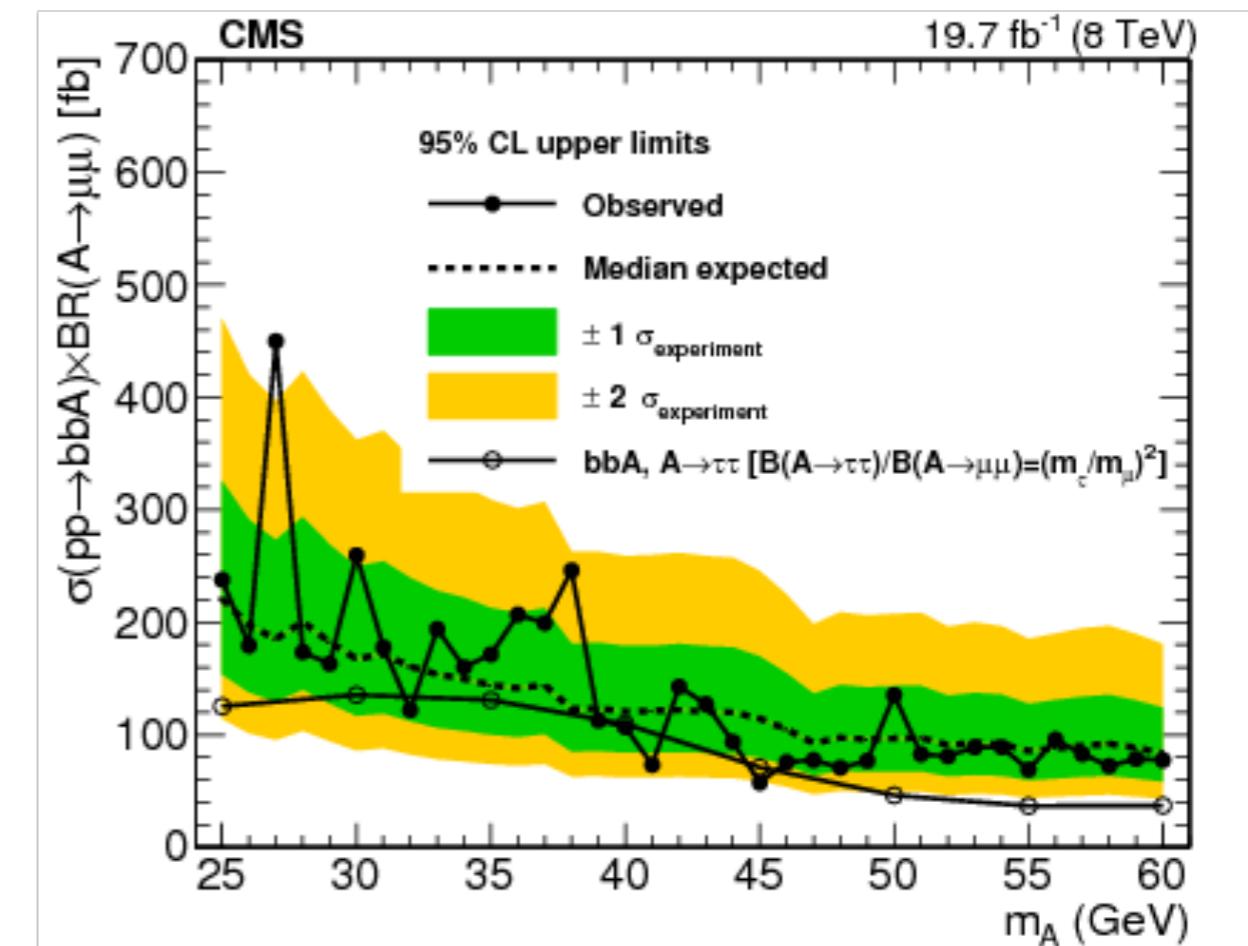
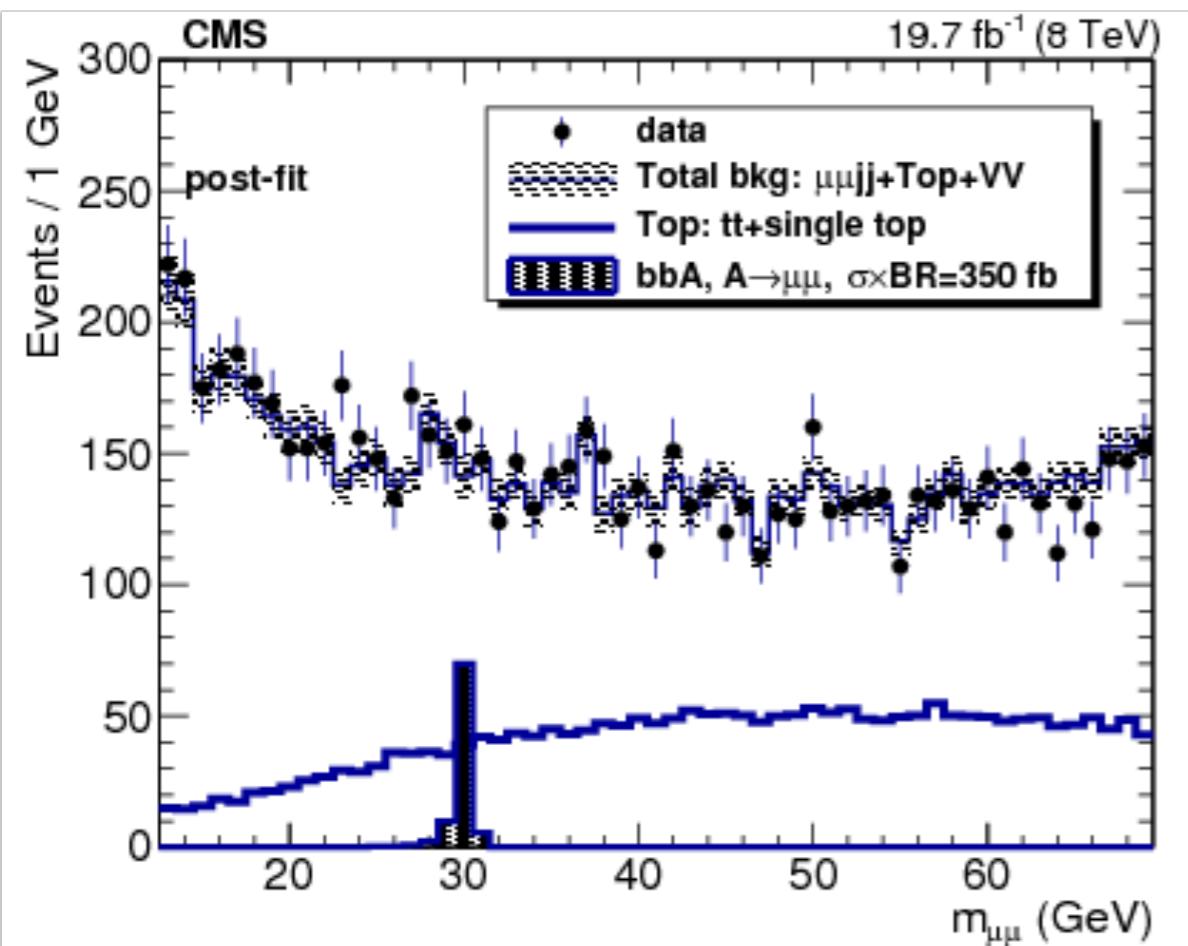
[https://doi.org/10.1007/JHEP11\(2017\)010](https://doi.org/10.1007/JHEP11(2017)010)

2HDM was tested

No signal is observed in the dimuon mass range from 25 to 60 GeV.

selections:

- $p_{\text{t}}^{\mu 1,2} > 25 \text{ GeV}, 5 \text{ GeV}$
- $|\eta_{\mu 1,2}| < 2.1, 2.4$
- $p_{\text{t,b-jet}} > 20 \text{ GeV} \text{ in } |\eta| < 2.4$
- $E_{\text{t,missing}} < 40 \text{ GeV}$

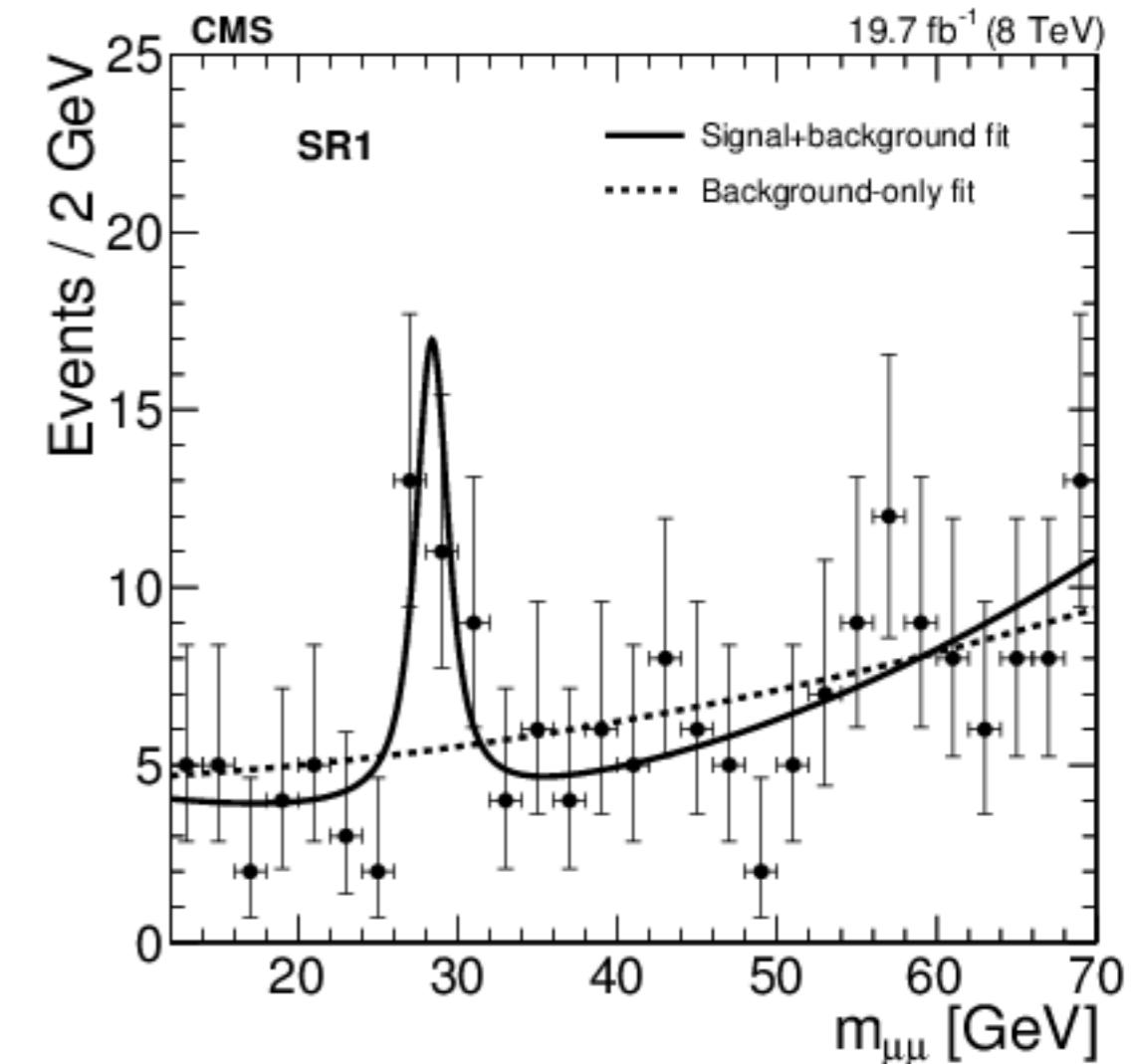
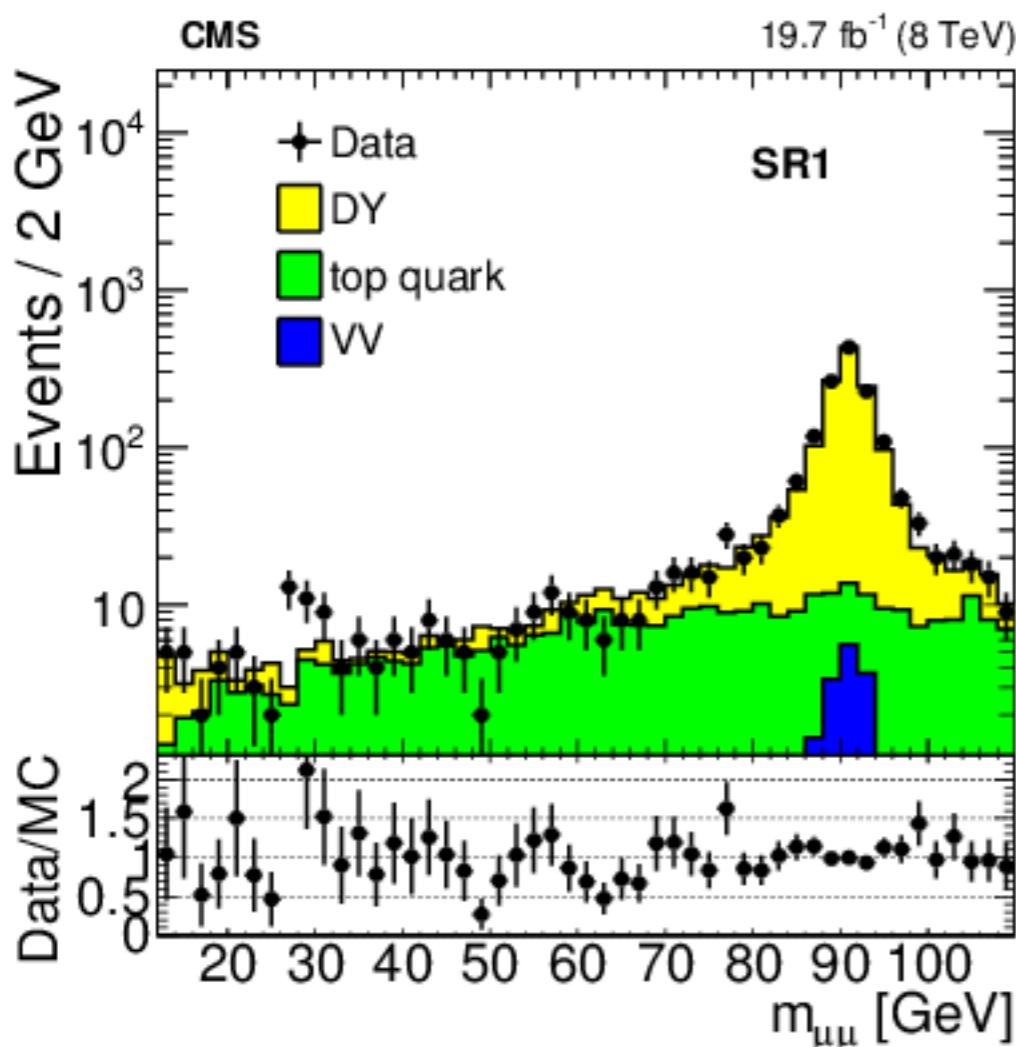


8 TeV results

new selections, boosted $\mu\mu$ - higher $p_{\text{t},\mu}$,
significant events excess at $M_{\mu\mu} \sim 30$ GeV

new selections:

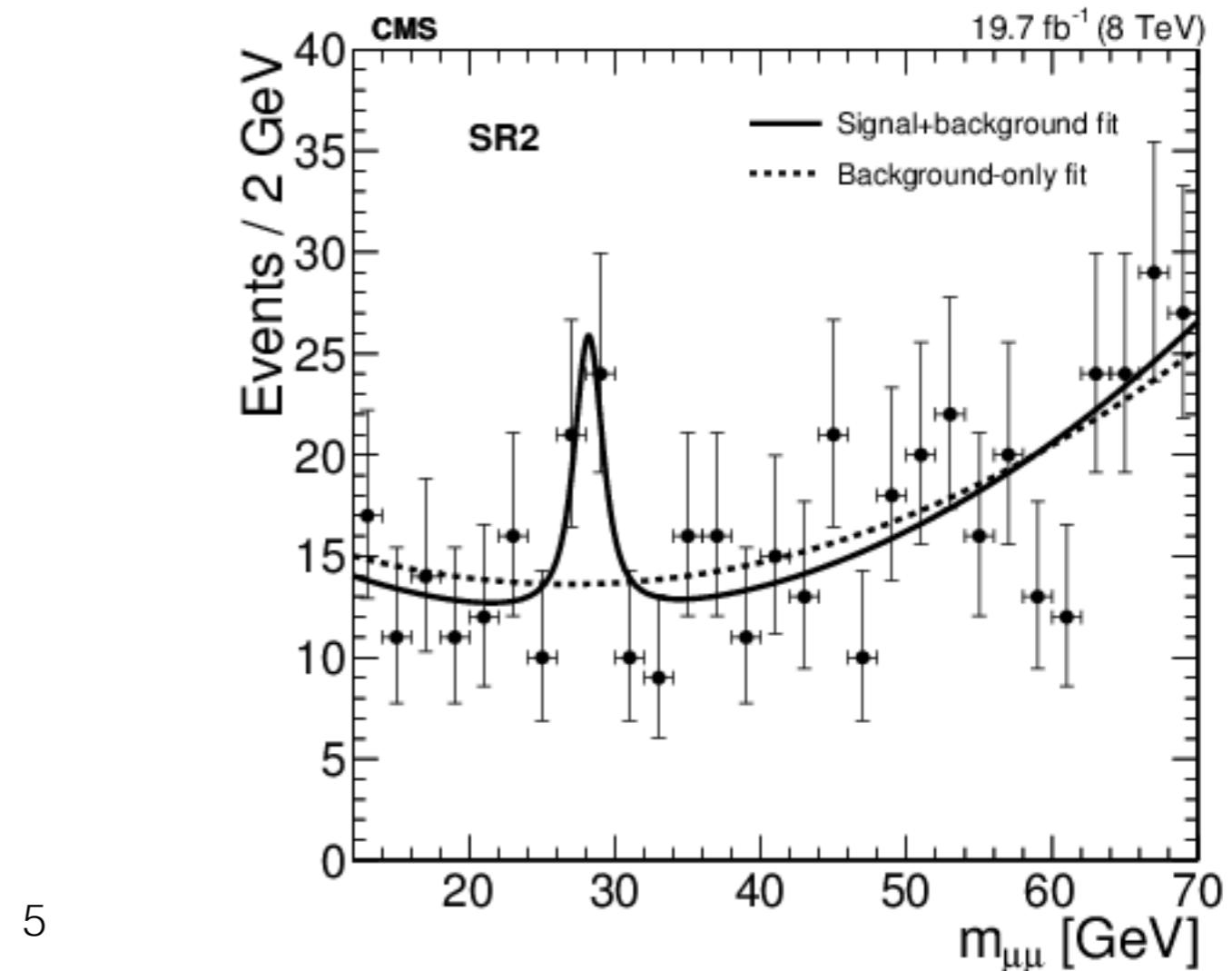
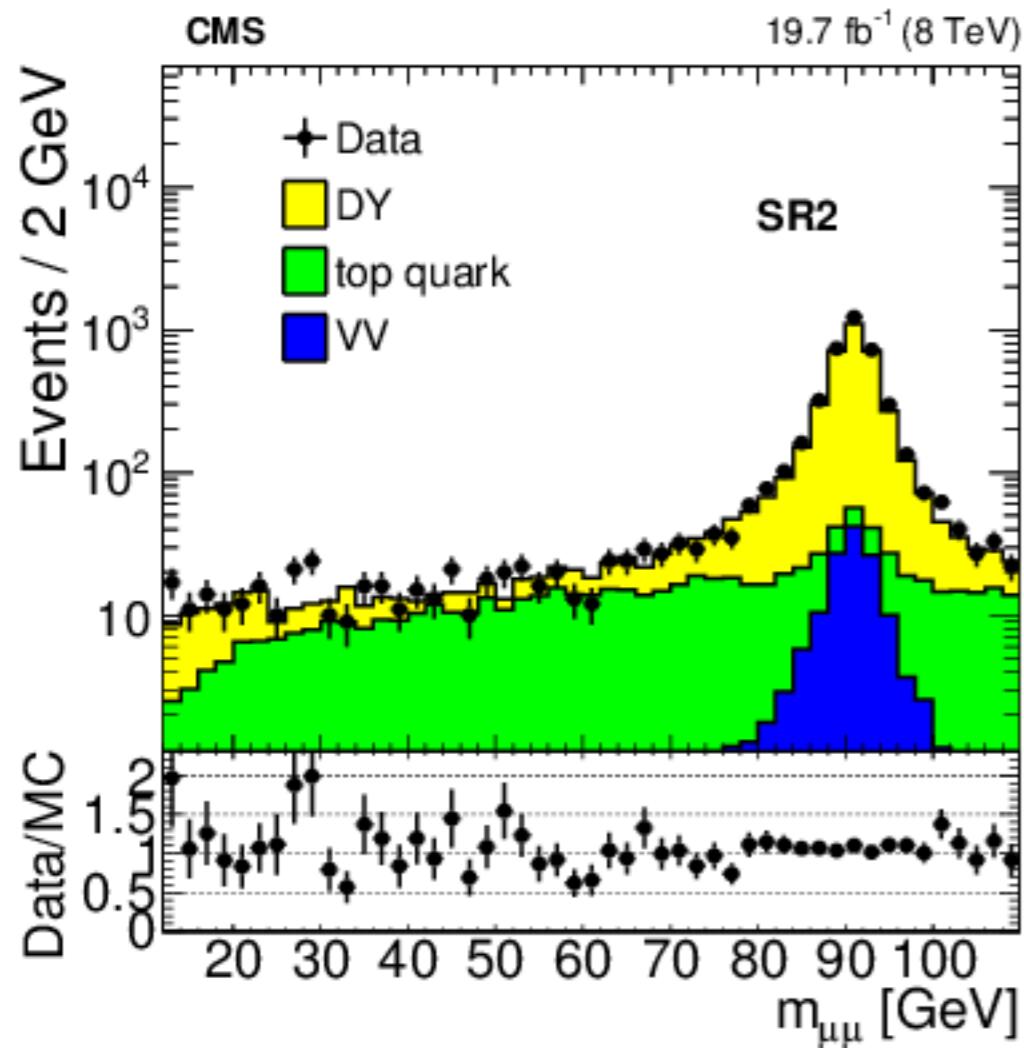
- $p_{\text{t},\mu 1,2} > 25$ GeV
- $|\eta_{\mu 1,2}| < 2.1$
- $p_{\text{t},\text{b-jet}} > 30$ GeV in $|\eta| < 2.4$
- no other jets with $p_{\text{t},\text{jet}} > 30$ GeV in $|\eta| < 2.4$
- at least 1 jet with $p_{\text{t},\text{jet}} > 30$ GeV in $|\eta| > 2.4$



8 TeV results

**alternative
selections:
no intersection with
first signal region**

- $p_{t\mu 1,2} > 25 \text{ GeV}$
- $|\eta_{\mu 1,2}| < 2.1$
- $p_{tj 1,2} > 30 \text{ GeV}$ $|\eta| < 2.4$, at least 1 b-jet
- no other jets with $p_{t\text{jet}} > 30 \text{ GeV}$ in $|\eta| < 2.4$
- no jets jet with $p_{t\text{jet}} > 30 \text{ GeV}$ in $|\eta| > 2.4$
- $E_{t\text{missing}} < 40 \text{ GeV}$
- $\Delta\Phi_{\mu\mu\text{-jj}} > 2.5$



8 TeV results

events excess characteristics

	first signal region	second signal region
mass (GeV)	28.4 ± 0.6	28.2 ± 0.7
width	1.9 ± 1.3	1.9 ± 1.1
Local significance (s.d.)	4.2	2.9
σ_{fid} (fb)	4.1 ± 1.4	4.2 ± 1.7

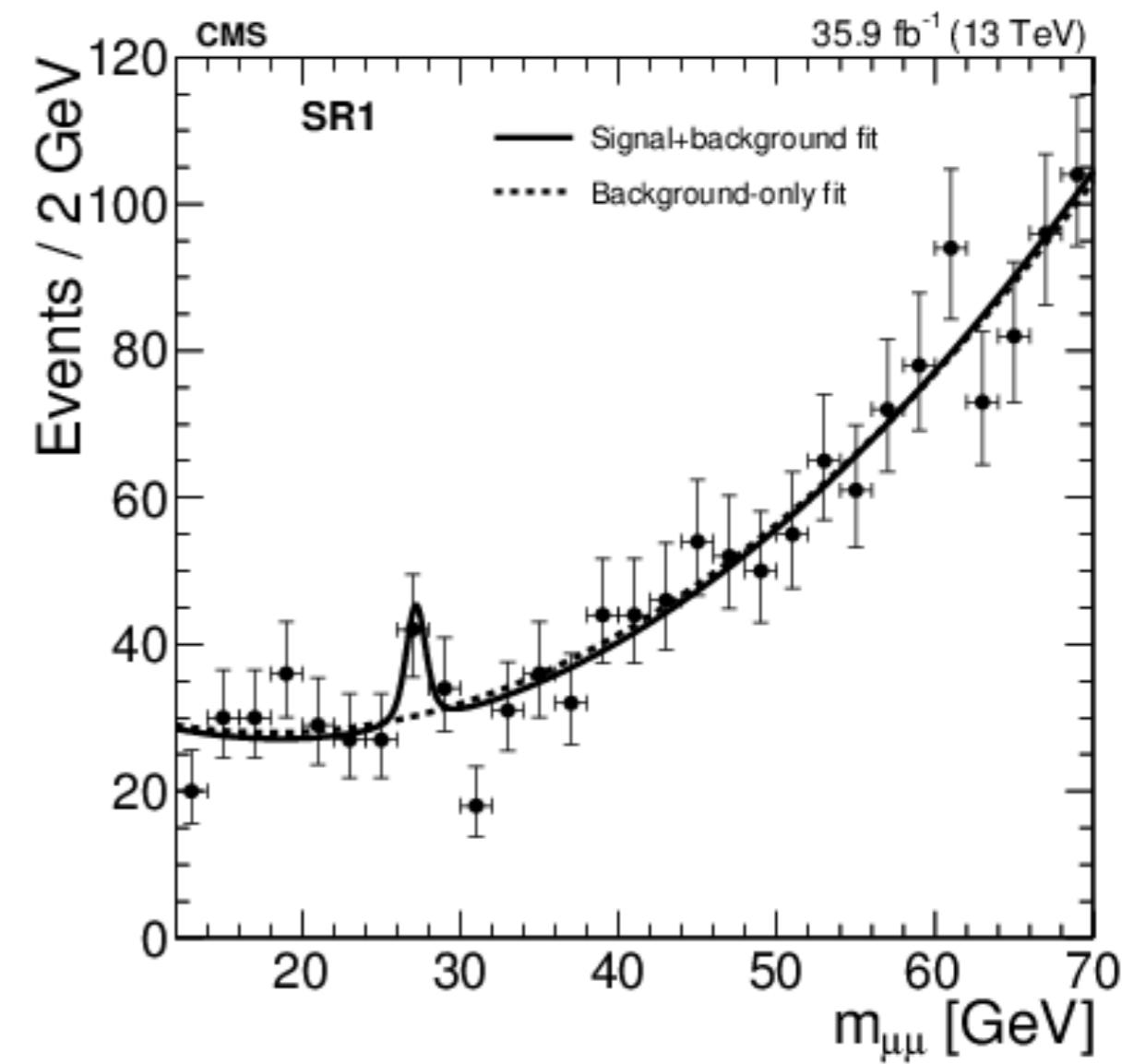
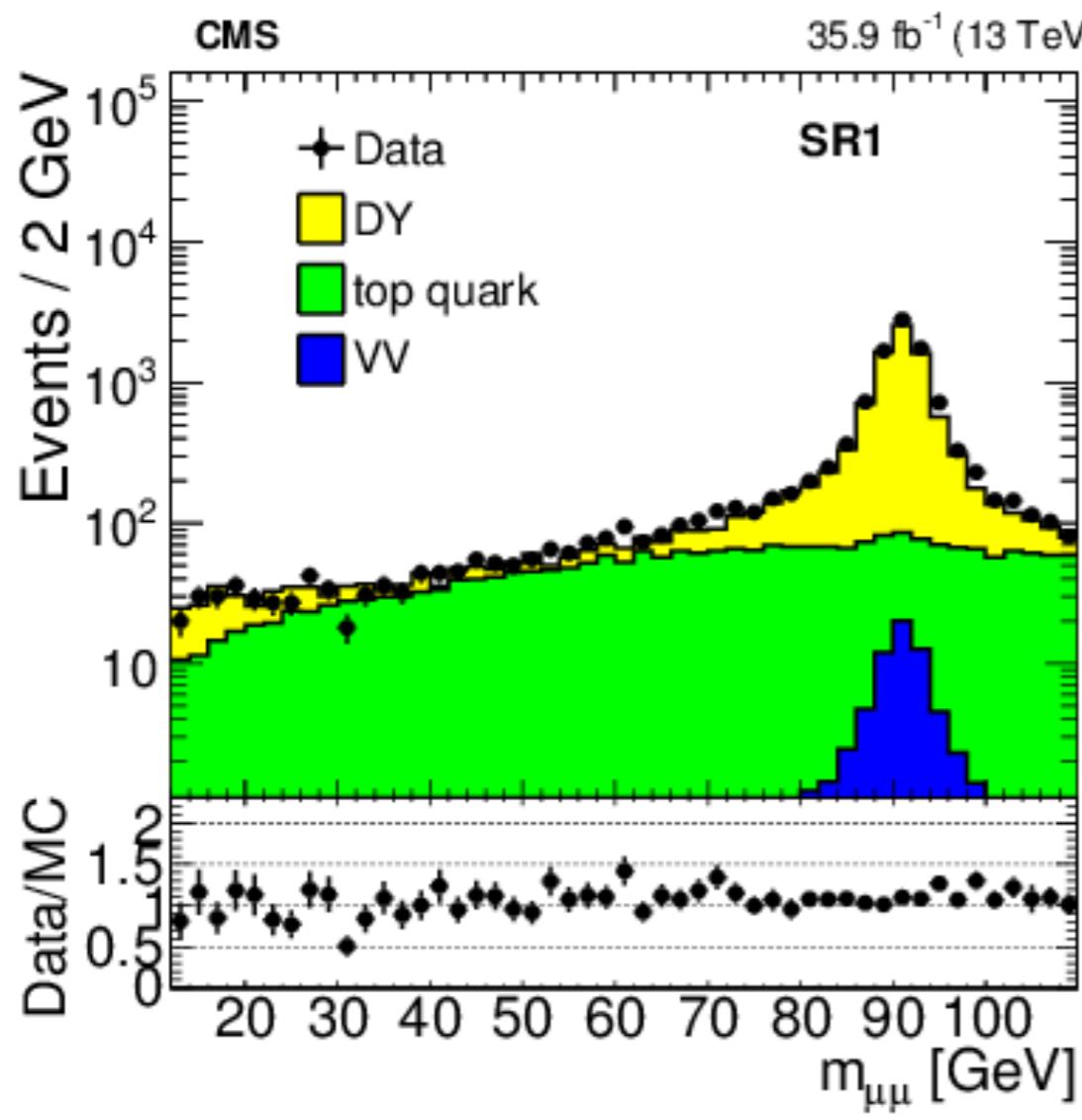
13 TeV results
full 2016 dataset - 35.9 fb-1
same events selections

**difference
between
8 TeV and 13 TeV :**

$\sigma_{\text{Drell-Yan}}$	σ_{tt}	$\frac{13 \text{ TeV}}{8 \text{ TeV}}$
1.4	3.3	
		~ 3
rate of PU jets in the forward region $\eta > 2.4$		

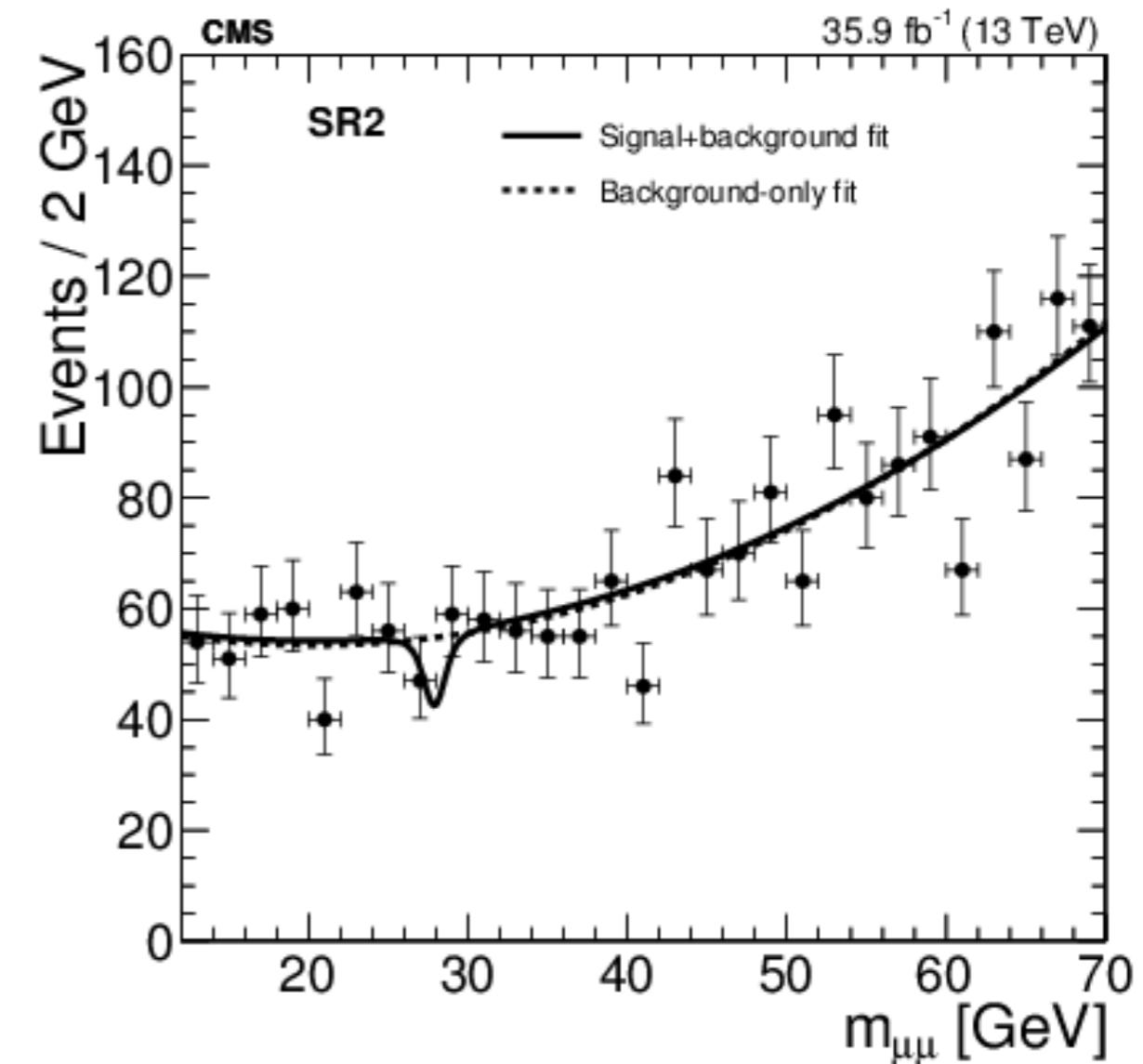
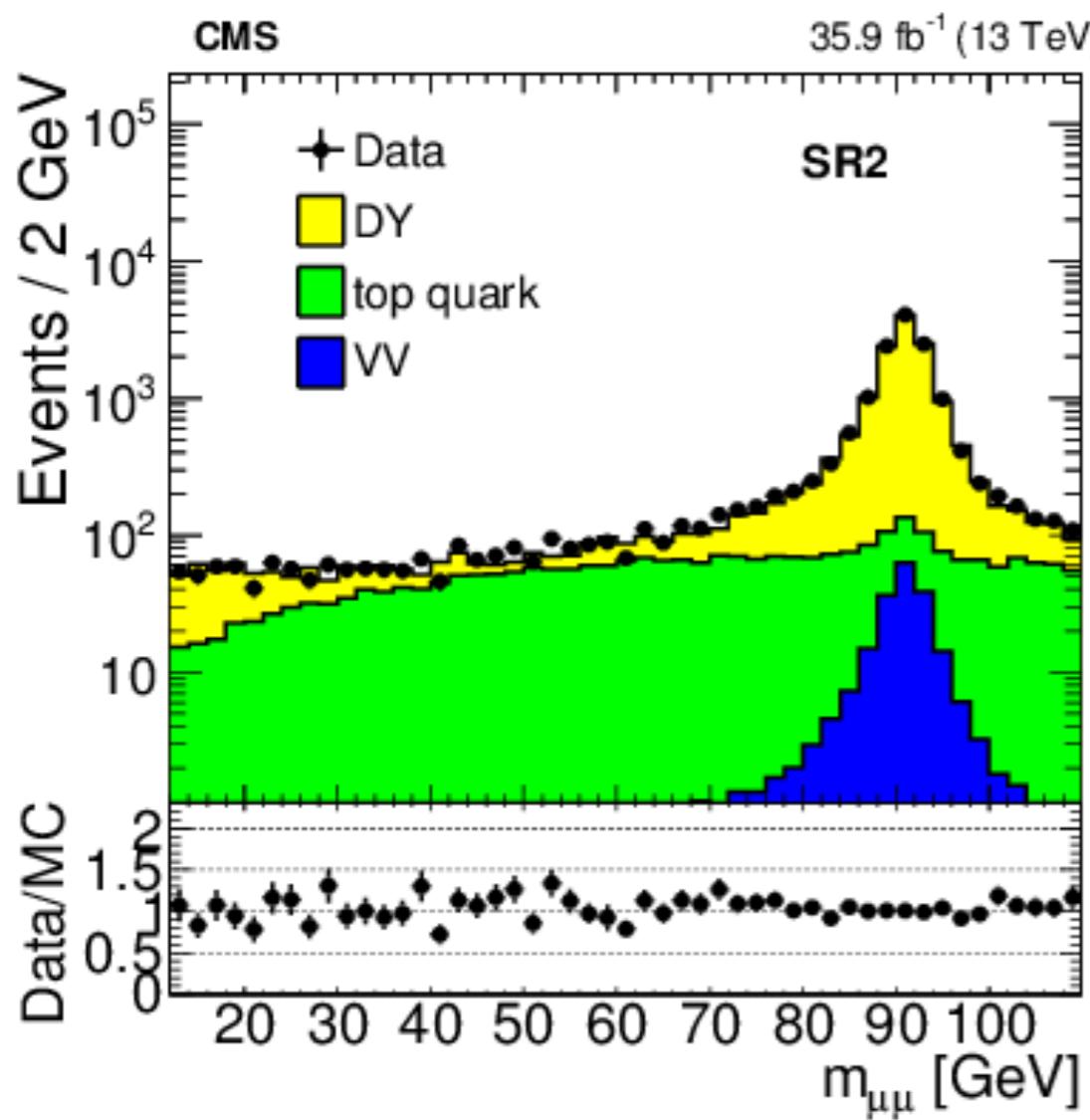
13 TeV results

first signal region: small events excess observed



13 TeV results

second signal region: no event excess observed



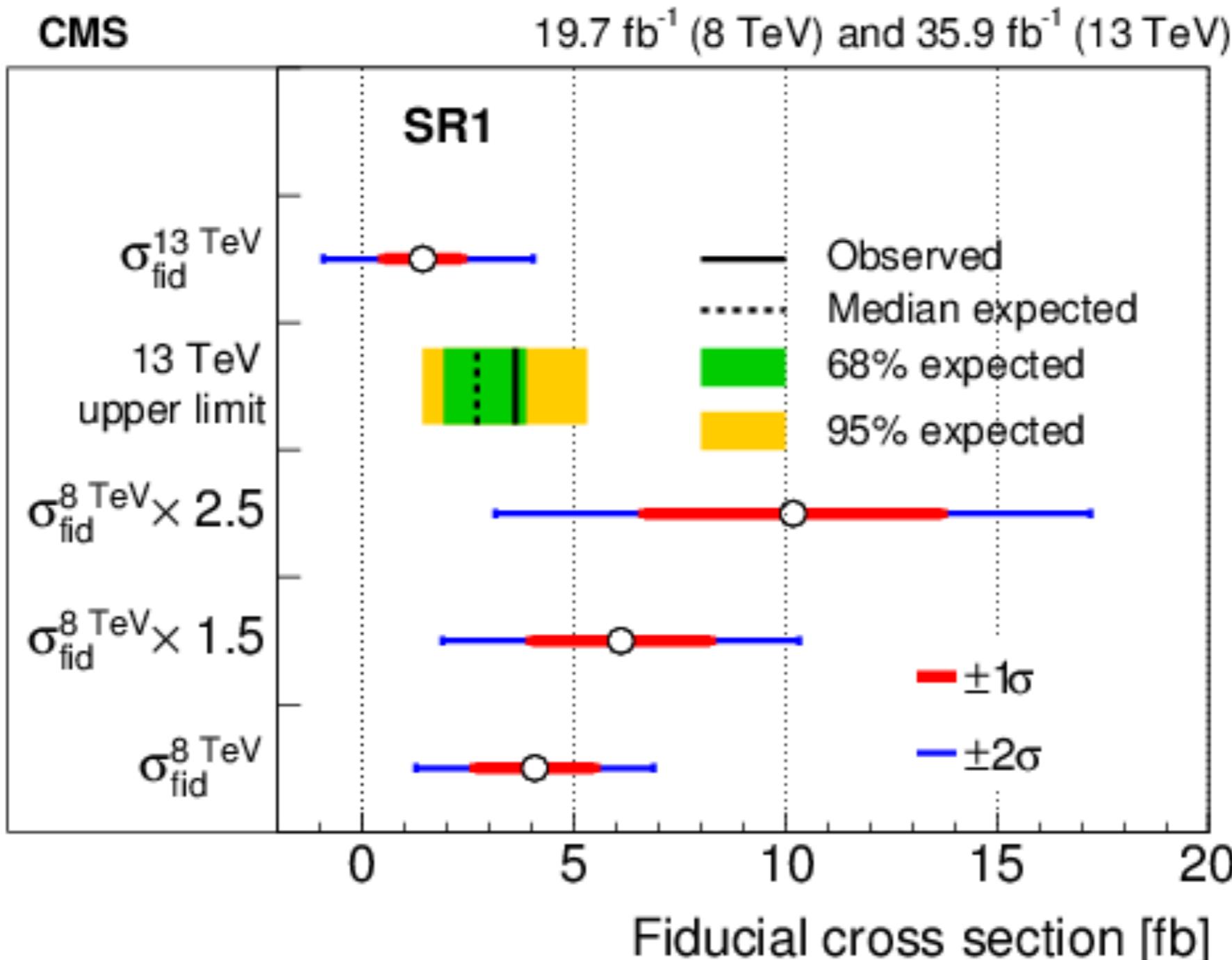
13 TeV results

Summary of 8 and 13 TeV results (2016 data)

	first signal region, 8 TeV	second signal region, 8 TeV	first signal region, 13 TeV	second signal region, 13 TeV
mass (GeV)	28.4 ± 0.6	28.2 ± 0.7	27.2 ± 0.6	-
width (GeV)	1.9 ± 1.3	1.9 ± 1.1	0.7 ± 1.0	-
Local significance (s.d.)	4.2	2.9	2.0	1.4 deficit
σ_{fid} (fb)	4.1 ± 1.4	4.2 ± 1.7	1.4 ± 0.9	-1.5 ± 0.5

13 TeV results

Compatibility of 8 and 13 TeV results



Summary

- Events with $\mu^+\mu^-$ with b-jet and additional jet studied in two independent signal regions.
- Event excess is observed for both signal regions at $\sqrt{s} = 8 \text{ TeV}$, while mild excess in first signal region and negative event yield are seen at $\sqrt{s} = 13 \text{ TeV}$, 2016 data.

backup

CMS detector

CMS DETECTOR

Total weight : 14,000 tonnes
Overall diameter : 15.0 m
Overall length : 28.7 m
Magnetic field : 3.8 T

STEEL RETURN YOKE
12,500 tonnes

SILICON TRACKERS
Pixel (100x150 μm) $\sim 16\text{m}^2 \sim 66\text{M}$ channels
Microstrips (80x180 μm) $\sim 200\text{m}^2 \sim 9.6\text{M}$ channels

SUPERCONDUCTING SOLENOID
Niobium titanium coil carrying $\sim 18,000\text{A}$

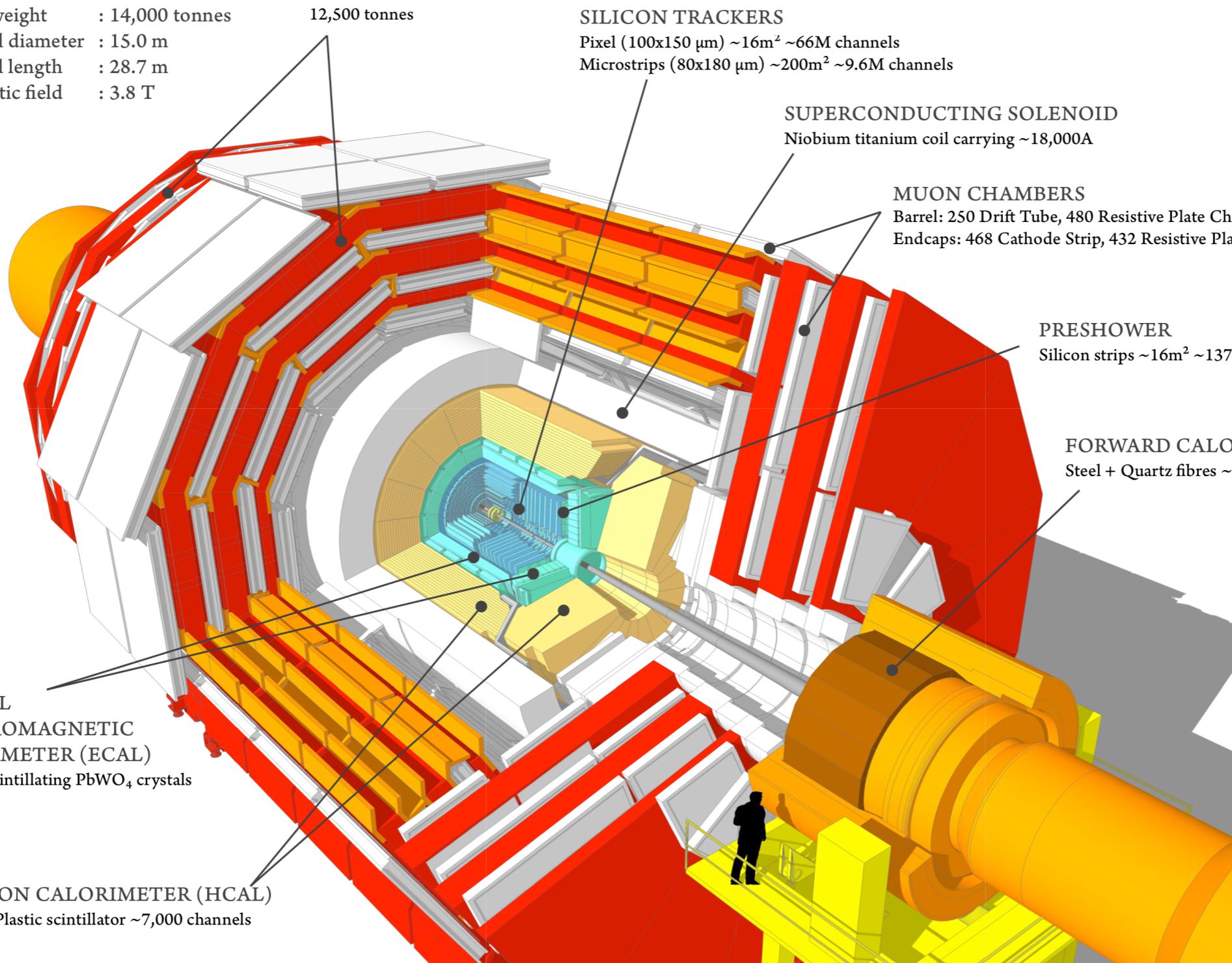
MUON CHAMBERS
Barrel: 250 Drift Tube, 480 Resistive Plate Chambers
Endcaps: 468 Cathode Strip, 432 Resistive Plate Chambers

PRESHOWER
Silicon strips $\sim 16\text{m}^2 \sim 137,000$ channels

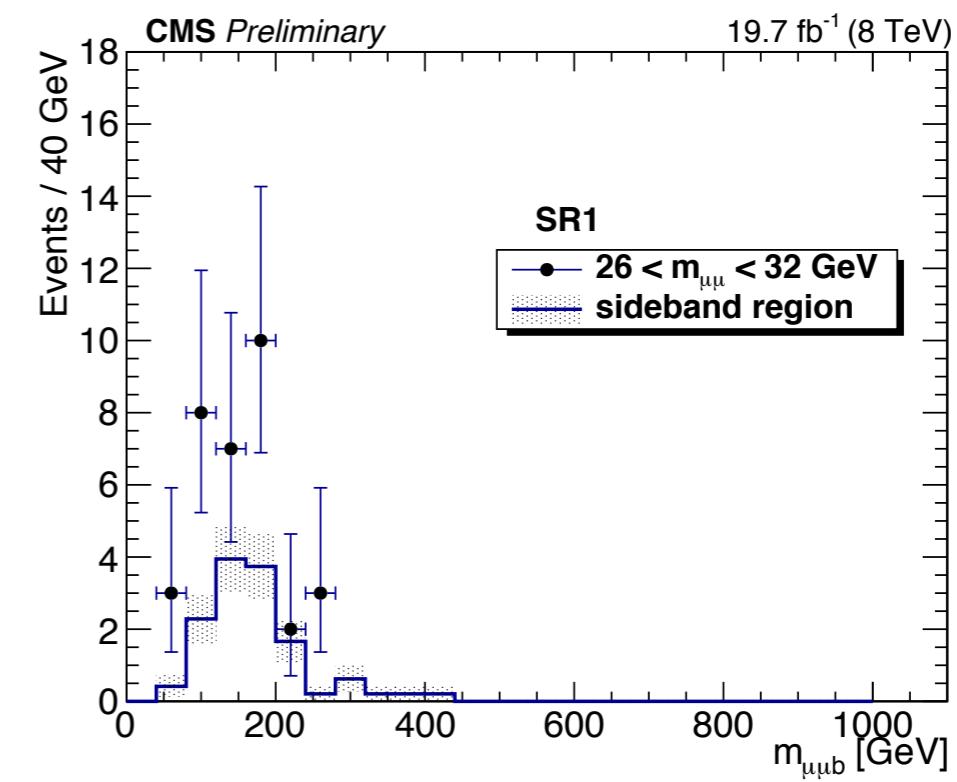
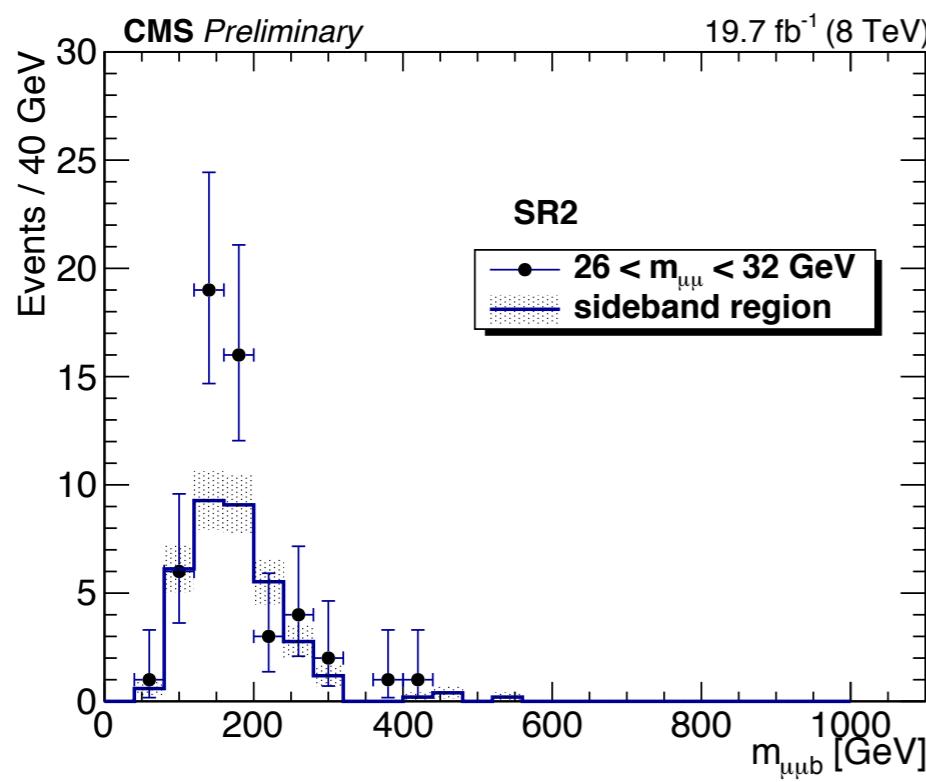
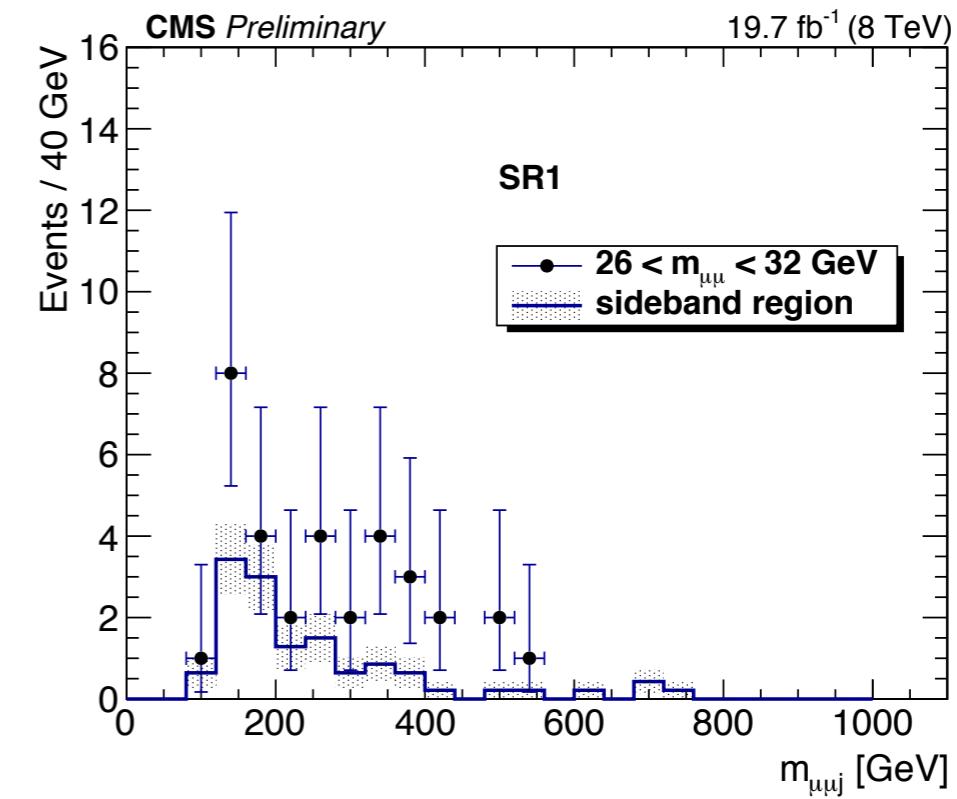
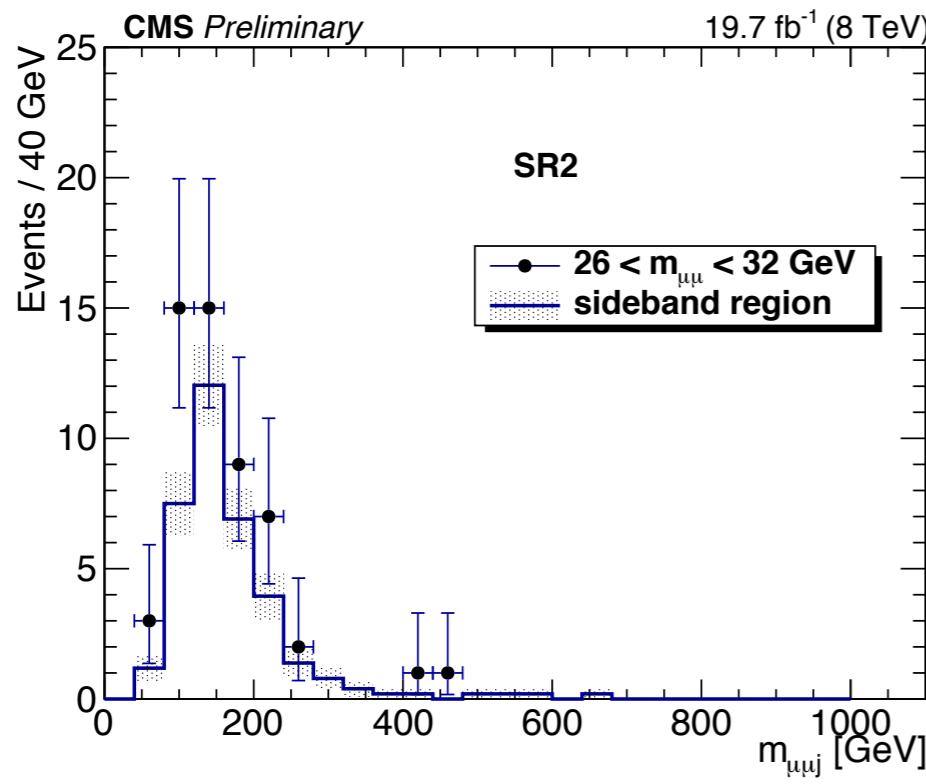
FORWARD CALORIMETER
Steel + Quartz fibres $\sim 2,000$ Channels

CRYSTAL
ELECTROMAGNETIC
CALORIMETER (ECAL)
 $\sim 76,000$ scintillating PbWO_4 crystals

HADRON CALORIMETER (HCAL)
Brass + Plastic scintillator $\sim 7,000$ channels



8 TeV results



13 to 8 TeV ratio of parton luminosity

