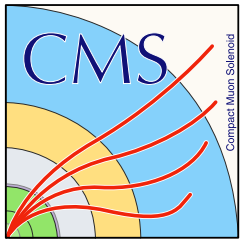

Spåtind 2016 – Nordic Conference on Particle Physics

Dijet Resonance Search at CMS

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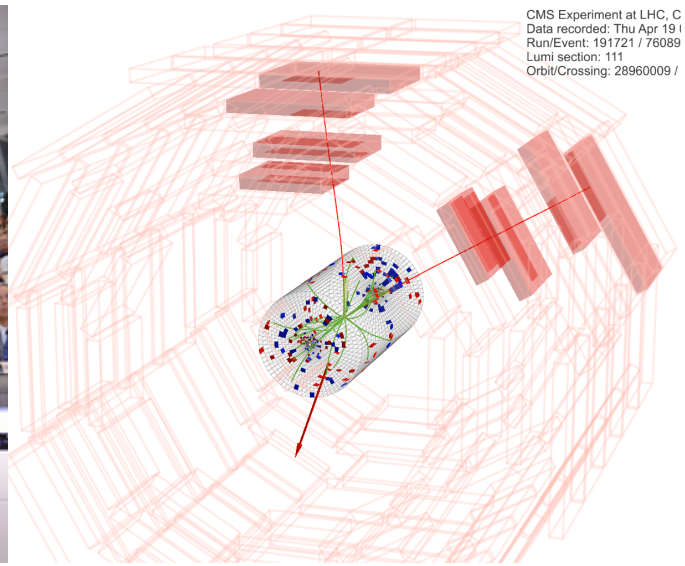
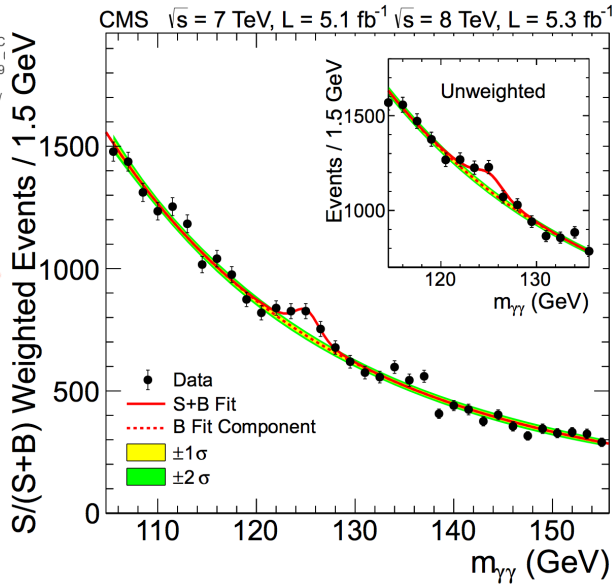
Outline

1. Motivation for new physics searches
2. Jets in CMS Experiment
3. Dijet Resonance Search in CMS
4. 2015 Results
5. Conclusions & Outlook

Higgs found, hooray!

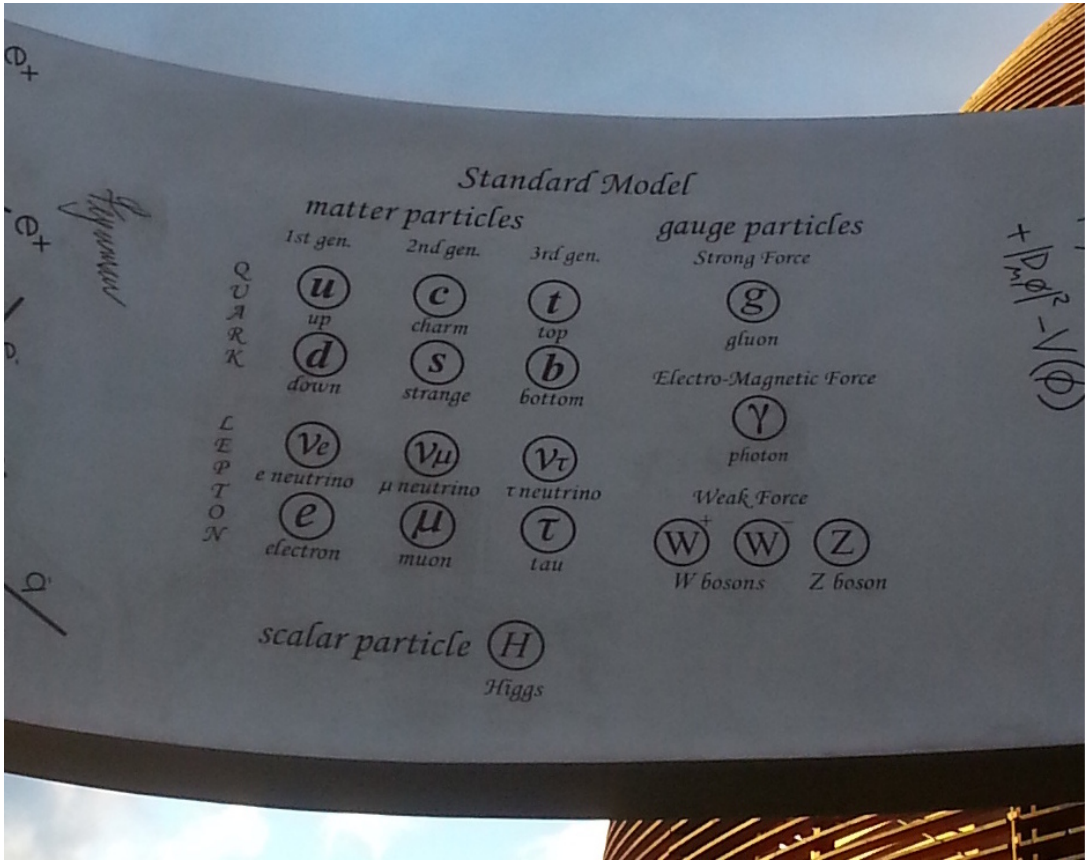
- 'Last piece of Standard Model' found at CERN in 2012
- Studies with 2013 run show no deviance from SM





- **...but SM is far from being the whole picture!**

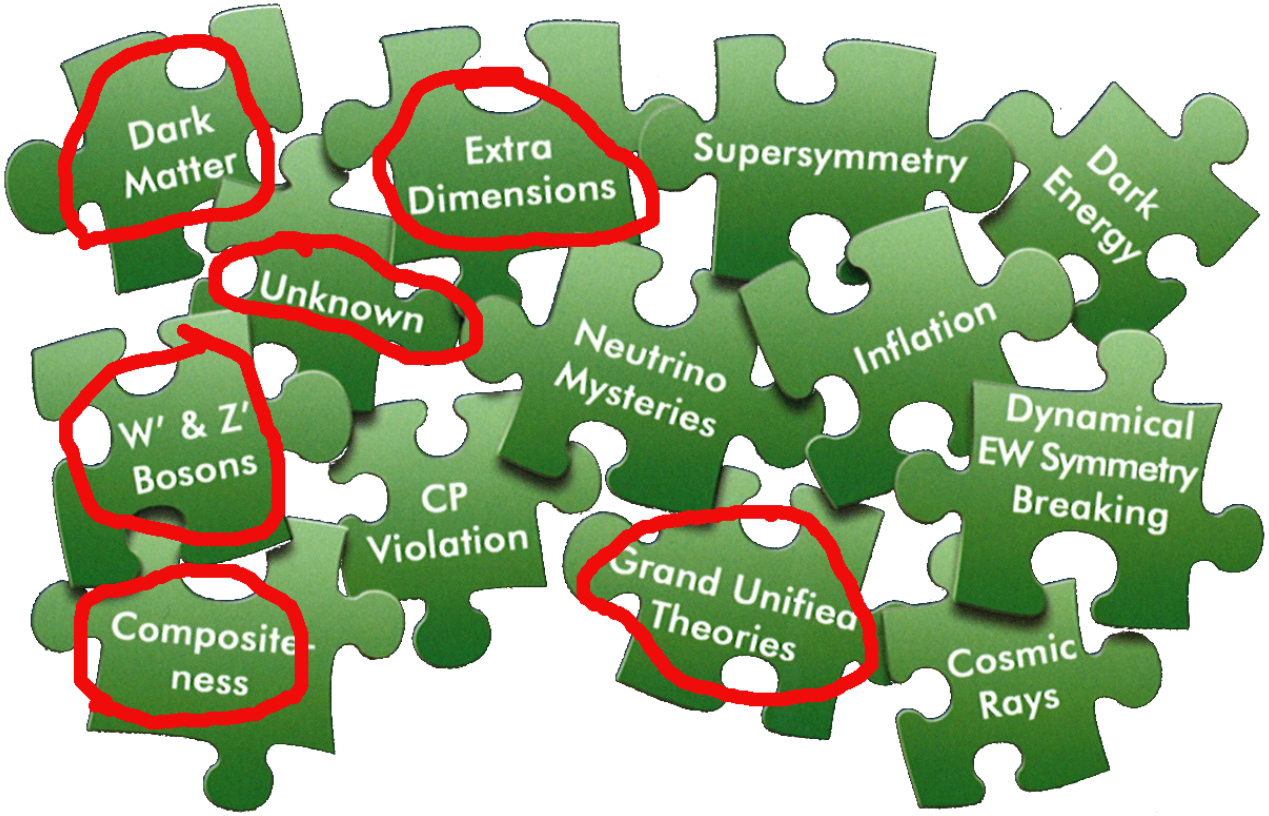
So what else could there be?



+ ?

So what else could there be?

So what else could there be?

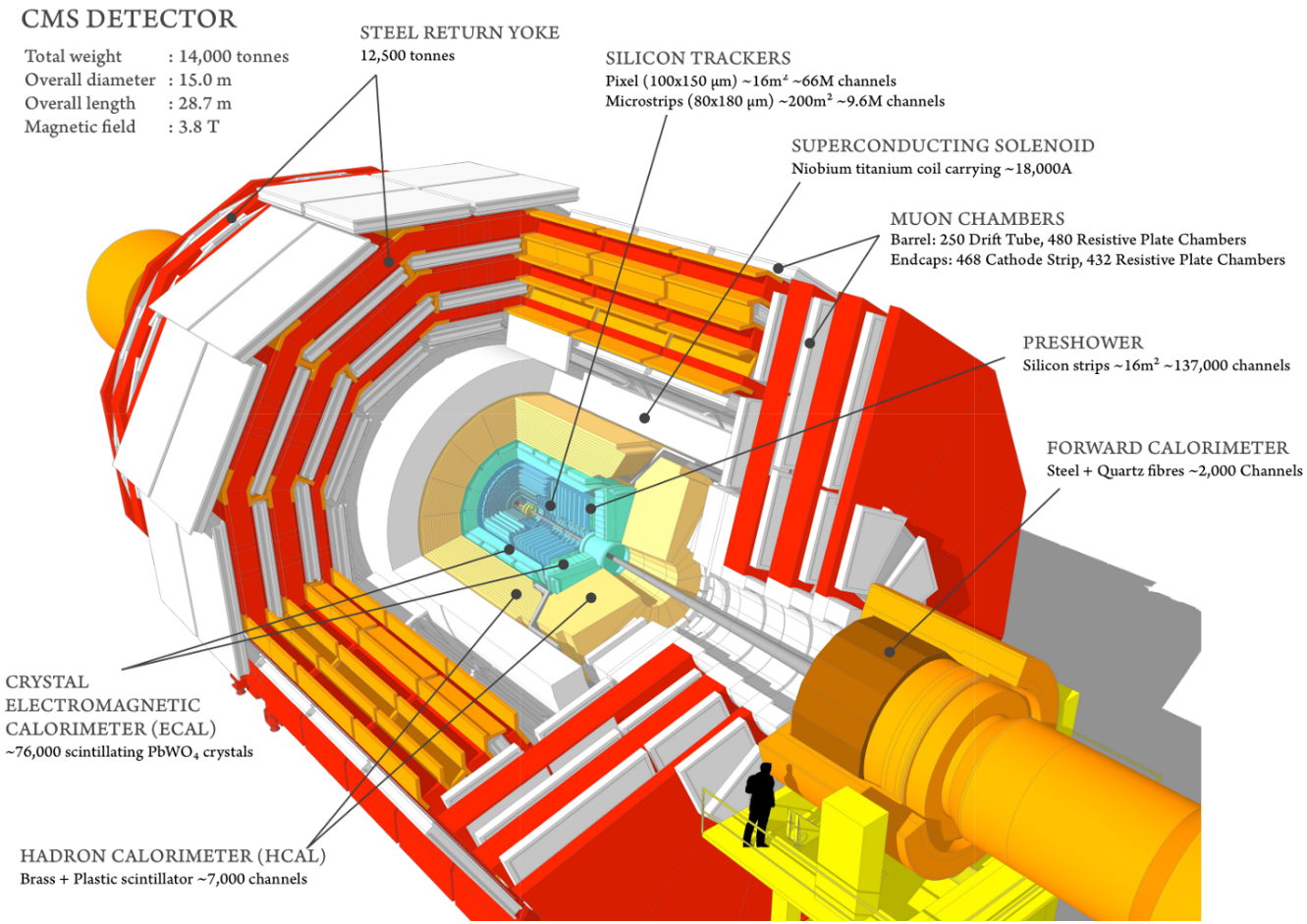


Accessible by dijet resonance search:

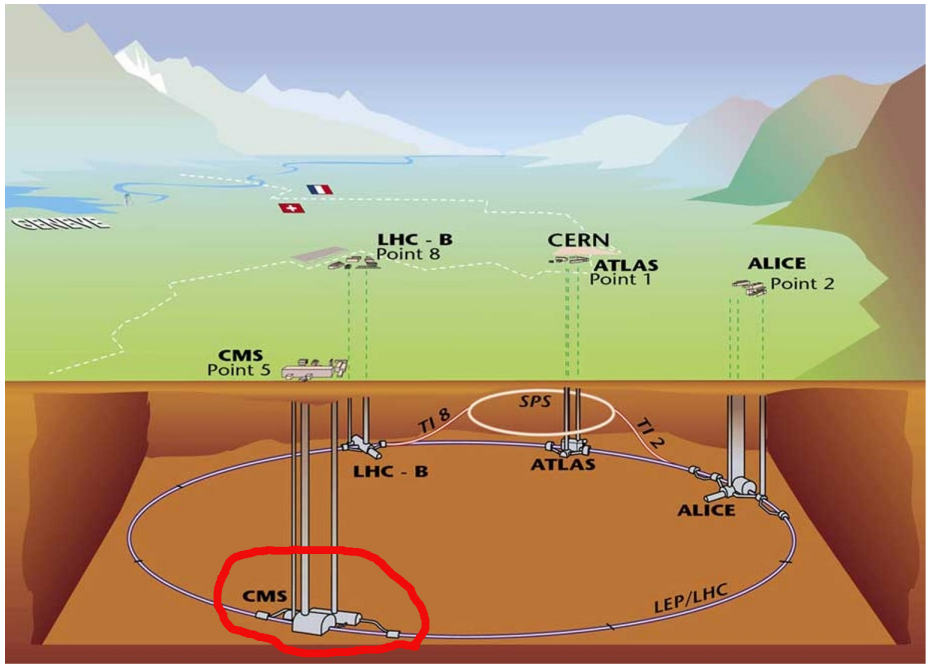
- Excited Quarks
- Scalar Diquarks
- String Resonances
- Z' Bosons
- W' Bosons
- RS Gravitons
- Color Octet Scalars
- Axigluons/Colorons
- (Dark Matter)

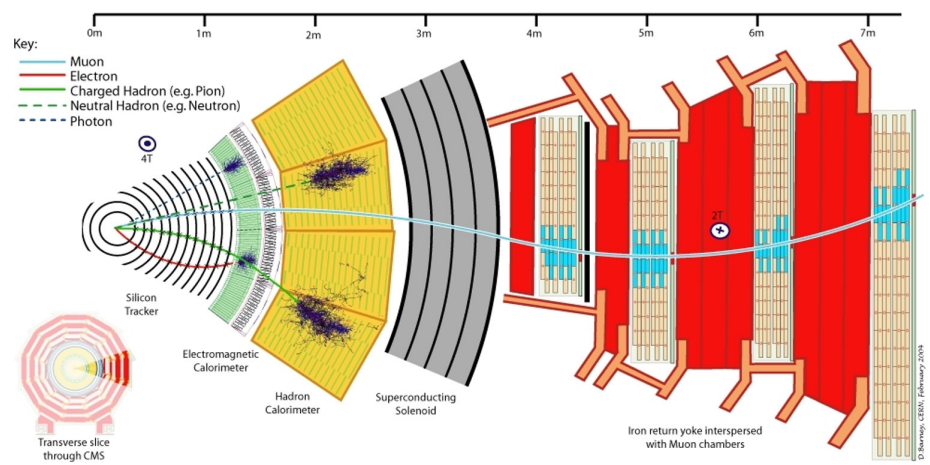
The Compact Muon Solenoid Experiment

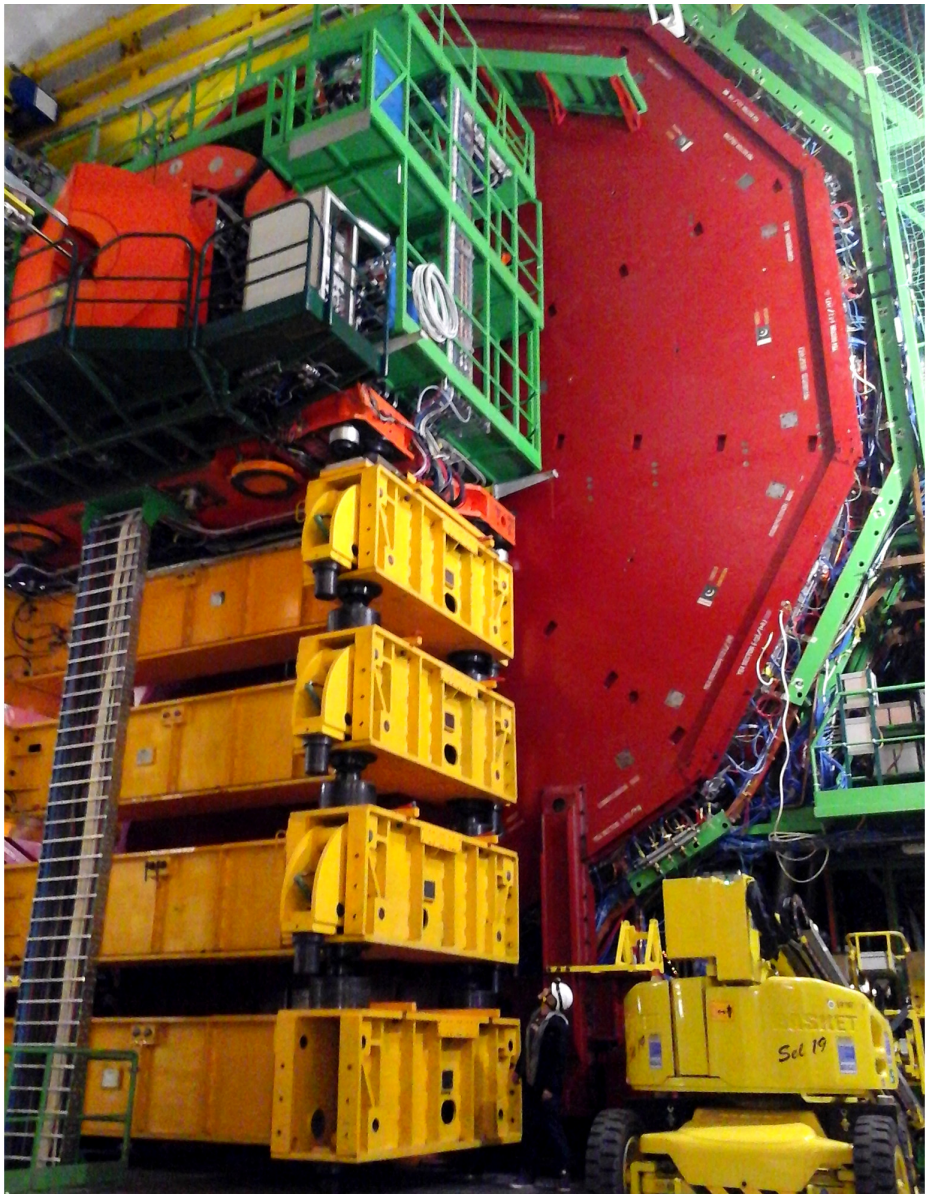
- 15x30m multipurpose experiment
- Accurate muon chambers & ECAL
- 3.8T magnetic field
- Particle Flow evt reco



The Compact Muon Solenoid Experiment

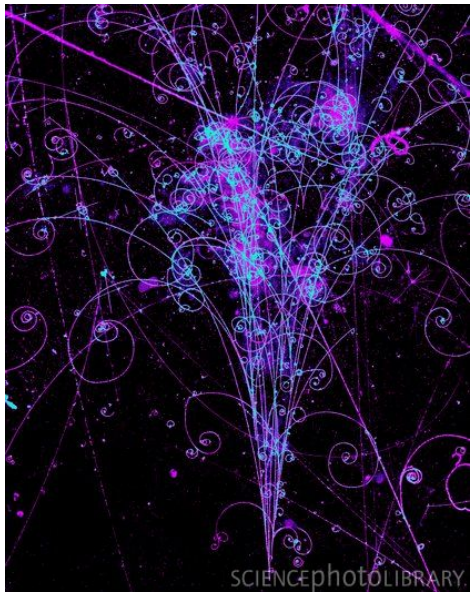


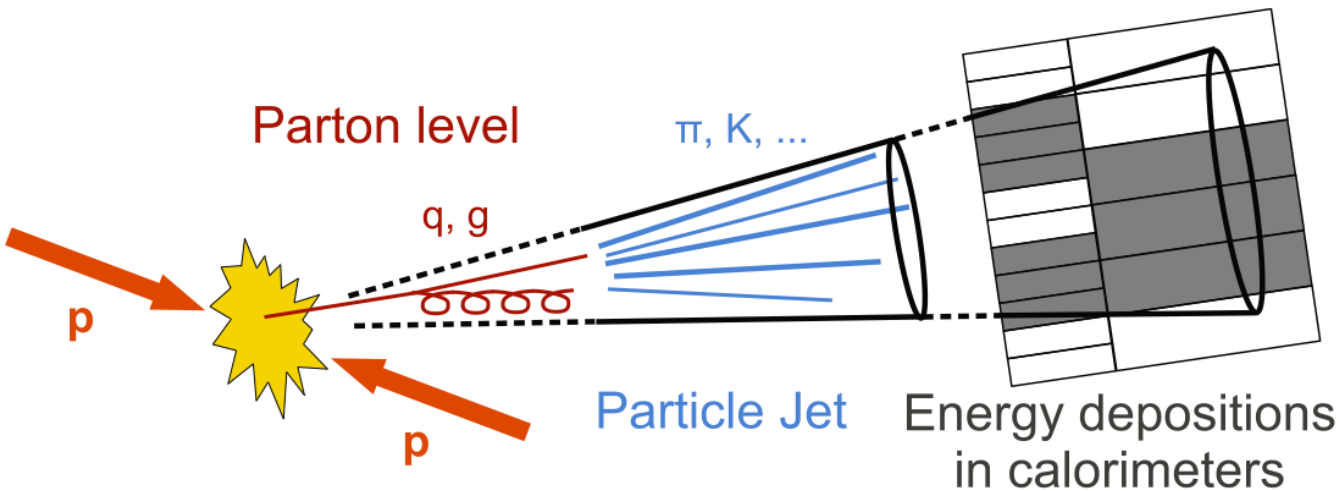




Jets in CMS

- Quarks confined -> hadronization
- Seen as showers of hadrons that we call *jets*
- Individual particles reco'd by Particle Flow
- Tracks clustered to anti-k_T R=0.4 jets
- Elaborate energy calibration needed
- In dijet search re-clustering to R=1.1 WideJets

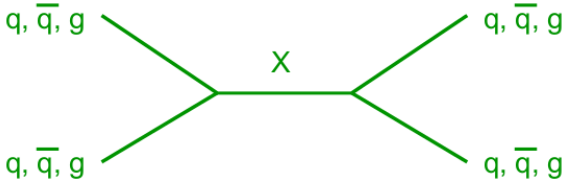




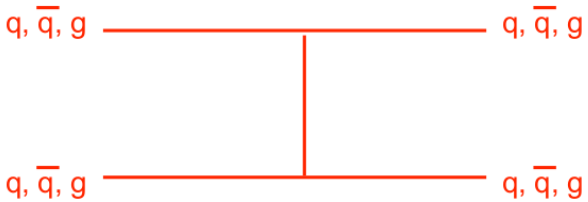
Dijet Resonance Search

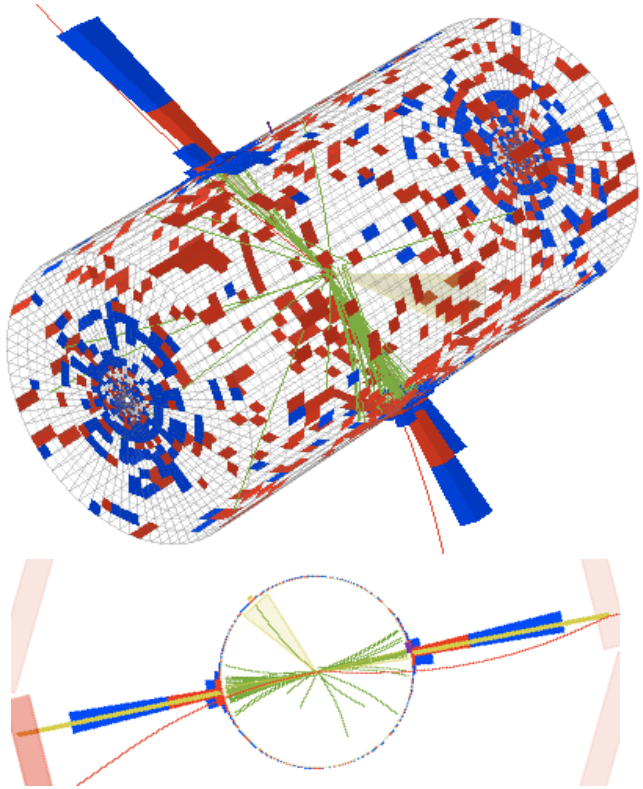
Look at collision events with **dijet topology:**

Resonance Signal



QCD Background

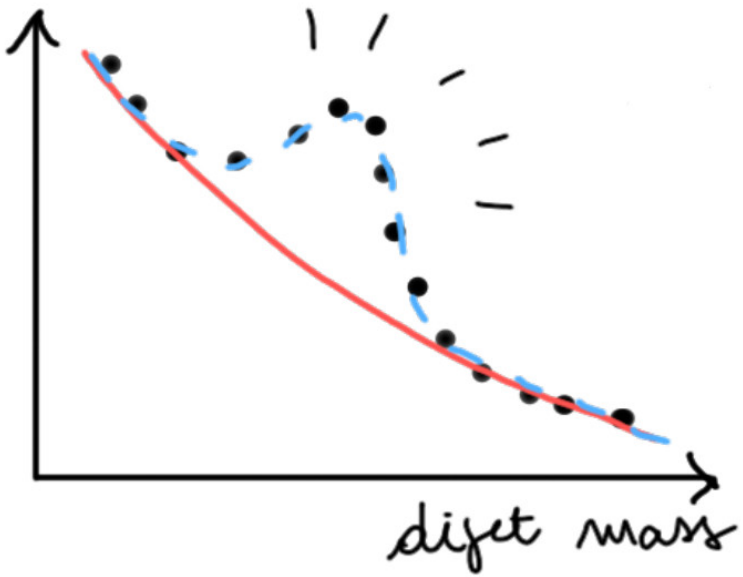




- Use back-to-back events to search for resonances
- Use R=1.1 WideJets to catch FSR
- Use dijets close to xy-plane to reduce QCD bkg ($\Delta\eta$<1.3)

Analysis Strategy

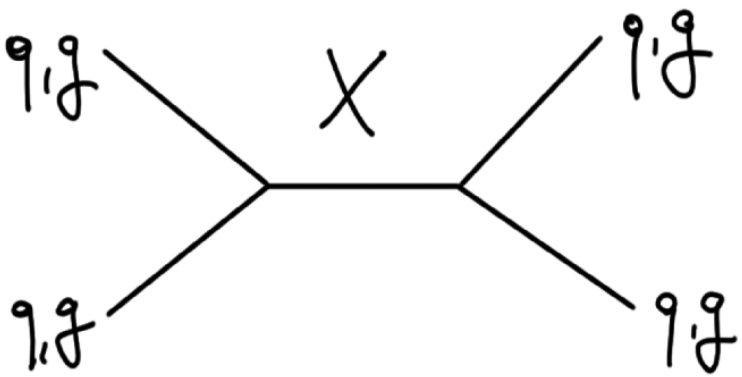
1. Collect invariant mass values of dijet events to histogram
2. Determine where chosen jet trigger is 100% efficient
3. Fit data with QCD-inspired fit
4. Look for excess above the fit

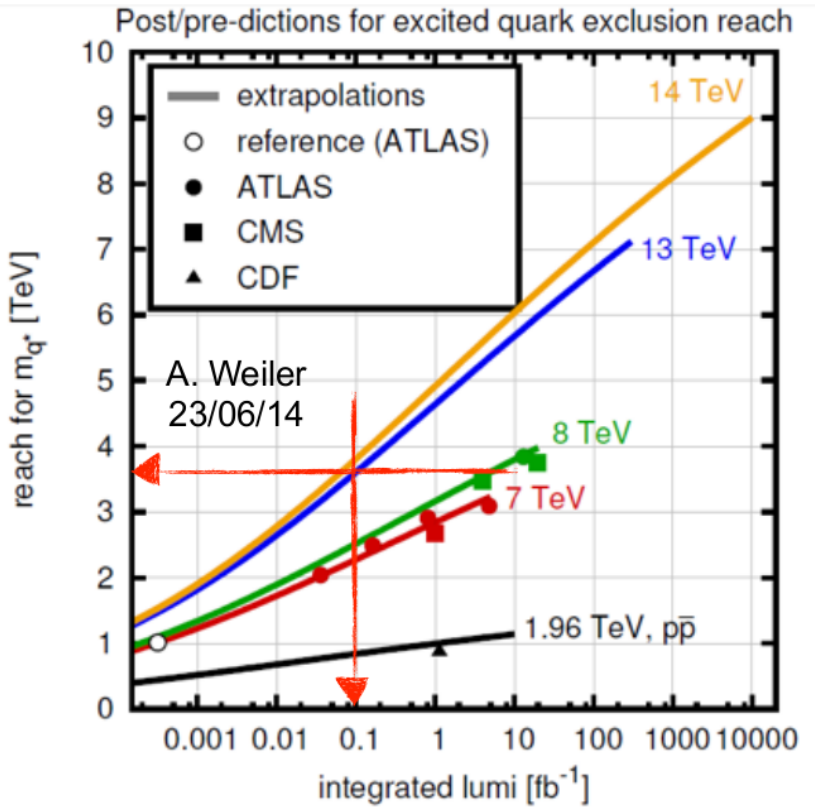


Motivation for Dijet Analysis

- Simple yet powerful
- Exceptional discovery potential
- Access to $\mathcal{O}$(10 TeV) resonances!
- Only 100 pb^{-1} of data equals Run1 q* cross-section

→ **High-priority CMS Early Analysis**





Results

CERN-PH-EP/2015-317
2015/12/04

CMS-EXO-15-001

Search for narrow resonances decaying to dijets in proton-proton collisions at $\sqrt{s} = 13\,\text{TeV}$

The CMS Collaboration*

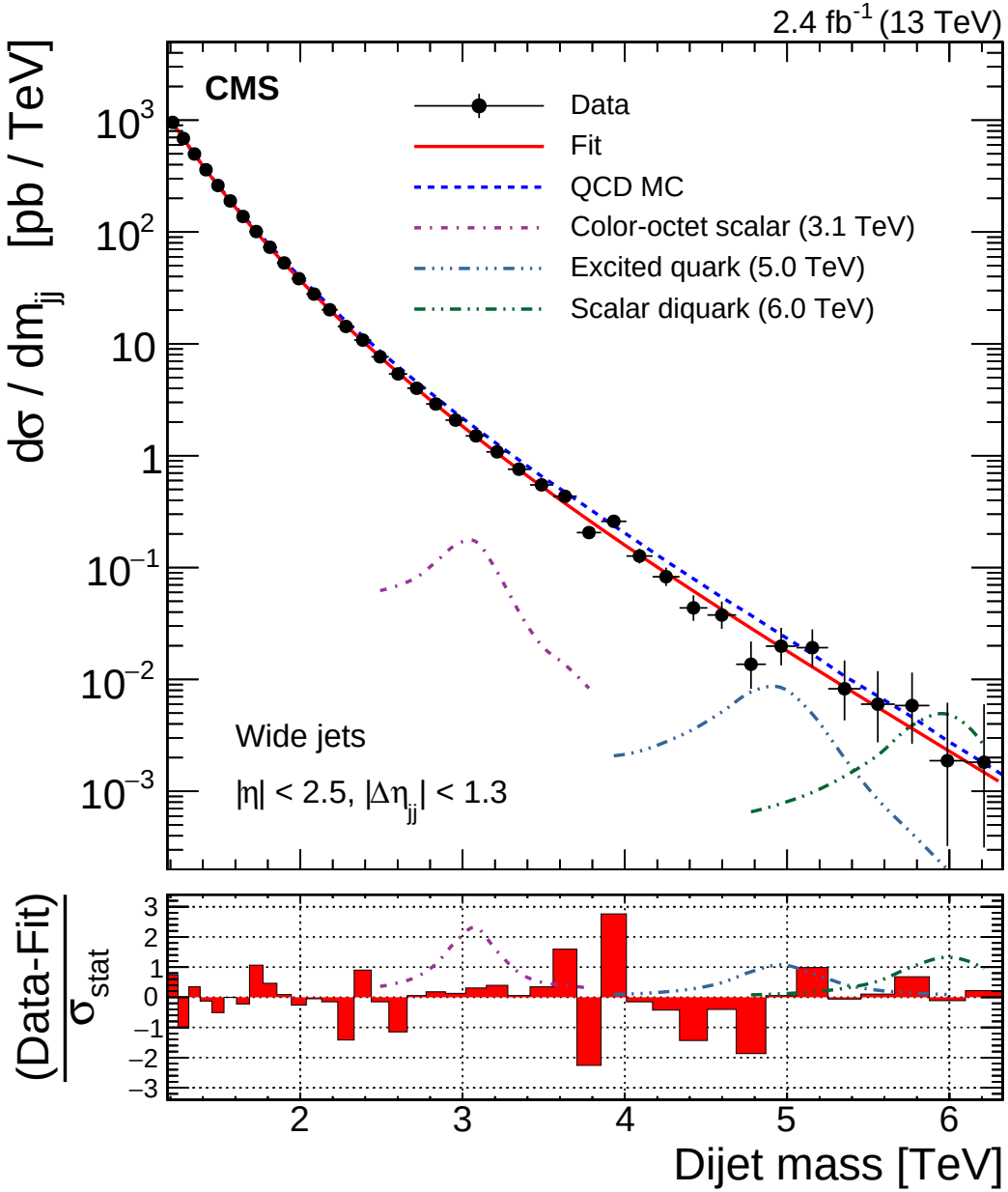
Abstract

A search for narrow resonances in proton-proton collisions at $\sqrt{s} = 13\,\text{TeV}$ is presented. The invariant mass distribution of the two leading jets is measured with the CMS detector using a data set corresponding to an integrated luminosity of $2.4\,\text{fb}^{-1}$. The highest observed dijet mass is 6.1 TeV. The distribution is smooth and no evidence for resonant particles is observed. Upper limits at 95% confidence level are set on the production cross section for narrow resonances with masses above 1.5 TeV. When interpreted in the context of specific models, the limits exclude string resonances with masses below 7.0 TeV, scalar diquarks below 6.0 TeV, axigluons and colorons below 5.1 TeV, excited quarks below 5.0 TeV, color-octet scalars below 3.1 TeV, and W′ bosons below 2.6 TeV. These results significantly extend previously published limits.

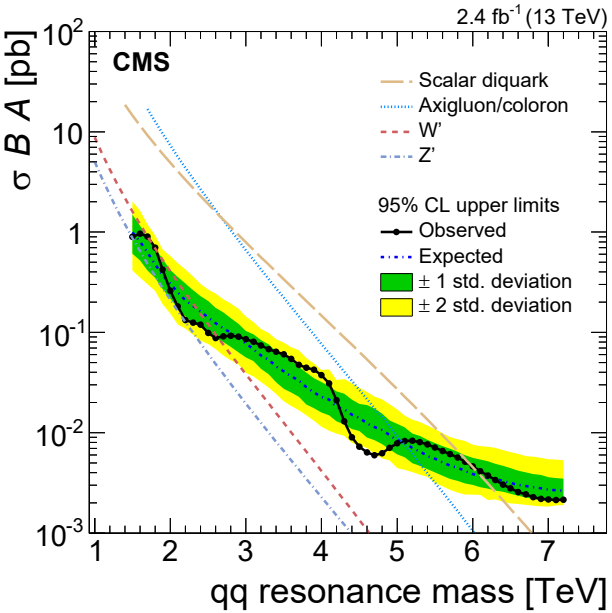
Submitted to Physical Review Letters

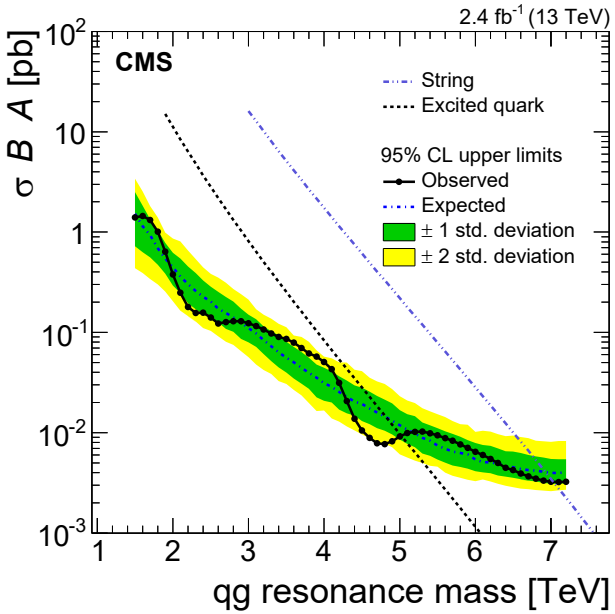
World's 1st public new physics search result at 13 TeV

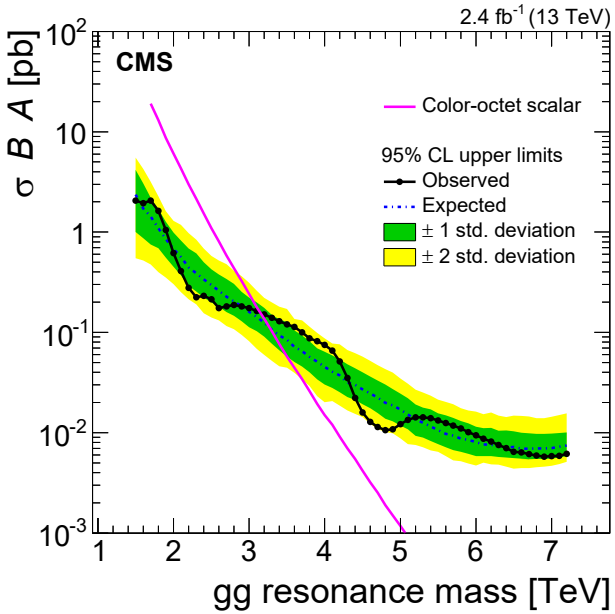
Results


2.4 fb^{-1} (13 TeV)
CMS
Data
Fit
QCD MC
Color-octet scalar (3.1 TeV)
Excited quark (5.0 TeV)
Scalar diquark (6.0 TeV)
Wide jets
$|\eta| < 2.5$, $|\Delta\eta_{jj}| < 1.3$
$d\sigma / dm_{jj}$ [pb / TeV]
$\frac{(Data-Fit)}{\sigma_{stat}}$
Dijet mass [TeV]

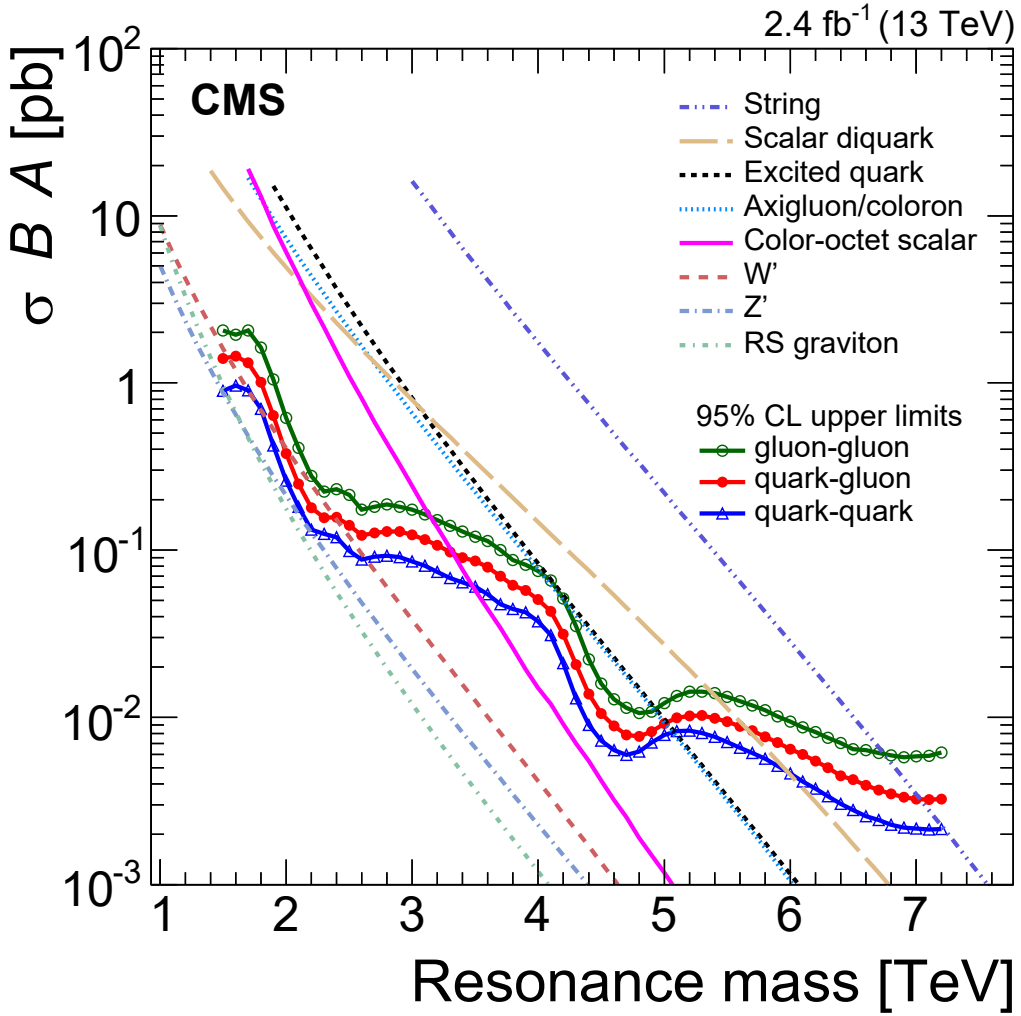
Results


2.4 fb^{-1} (13 TeV)
CMS
Scalar diquark
Axigluon/coloron
W'
Z'
95% CL upper limits
Observed
Expected
± 1 std. deviation
± 2 std. deviation
σ B A [pb]
qq resonance mass [TeV]


2.4 fb^{-1} (13 TeV)
CMS
String
Excited quark
95% CL upper limits
Observed
Expected
± 1 std. deviation
± 2 std. deviation
σ B A [pb]
qg resonance mass [TeV]


2.4 fb^{-1} (13 TeV)
CMS
Color-octet scalar
95% CL upper limits
Observed
Expected
± 1 std. deviation
± 2 std. deviation
σ B A [pb]
gg resonance mass [TeV]

Results


2.4 fb-1 (13 TeV)
CMS
String
Scalar diquark
Excited quark
Axigluon/coloron
Color-octet scalar
W'
Z'
RS graviton
95% CL upper limits
gluon-gluon
quark-gluon
quark-quark
σ B A [pb]
Resonance mass [TeV]

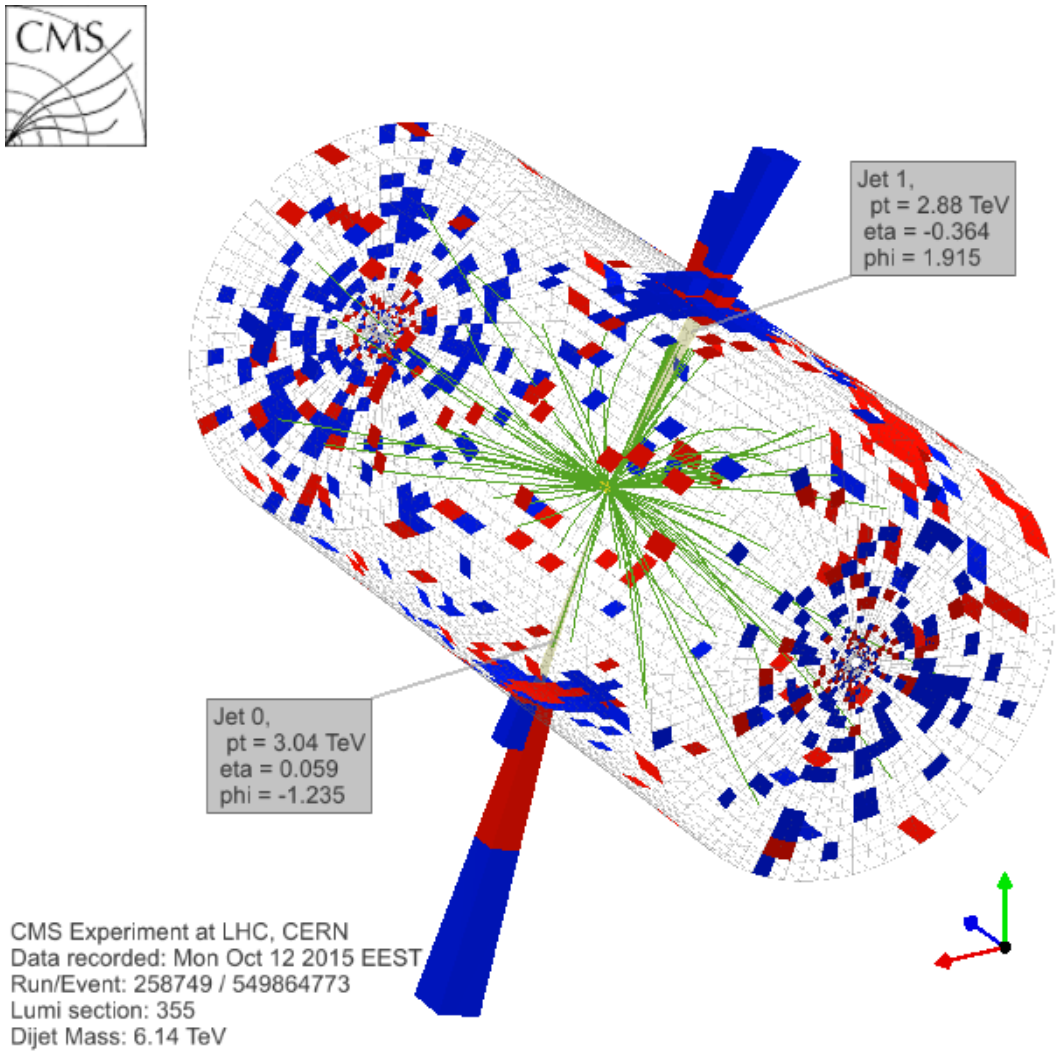
Results

Narrow Resonance Model	Mass Limits (TeV)			
	CMS Run 1 (20 fb^{-1})		CMS Run 2 (2.4 fb^{-1})	
	Observed	Expected	Observed	Expected
String Resonance (S)	5.0	4.9	7.0	6.9
Scalar Diquark (D)	4.7	4.4	6.0	6.1
Axigluon (A) / Coloron (C)	3.7	3.9	5.1	5.1
Excited Quark (q*)	3.5	3.7	5.0	4.8
Color Octet Scalar (S8)	2.7	2.6	3.1	3.3
Heavy W (W')	1.9, 2.0-2.2	2.2	2.6	2.3
Heavy Z (Z')	1.7	1.8	--	--
RS Graviton (G)	1.6	1.3	--	--

Giulia D'imperio

- Run 1 limits exceeded for 6 models
- Atlas Run 2 dijet result has similar limits

6.4 TeV Dijet Event



Conclusions

- Dijets a probe for various BSM phenomena in a simple analysis
- First results show no indications of resonances
- Previous limits significantly exceeded in a world premiere 13 TeV result

Outlook

- More data arriving by summer 2016
- Next data taking will show what's at 1.8 TeV
- Investigations to the 750 GeV region underway