Search for a heavy resonance decaying to a pair of vector bosons in the lepton plus merged jet final state at $\sqrt{s}$= 13 TeV

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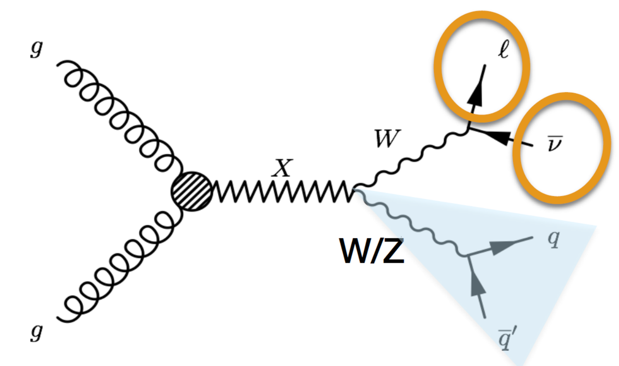
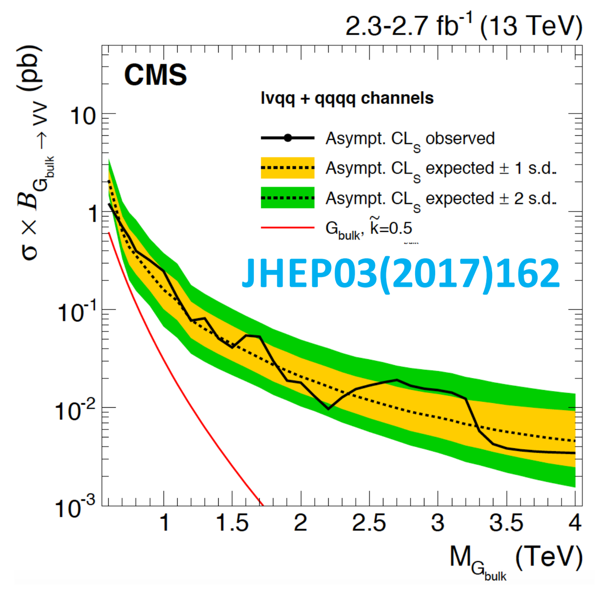
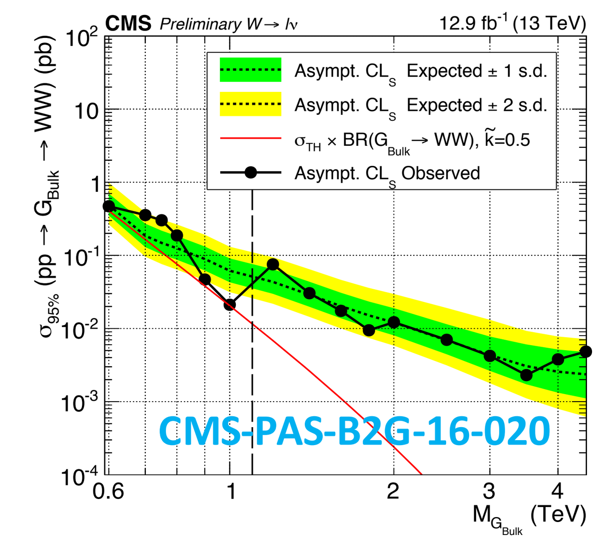
• Introduction

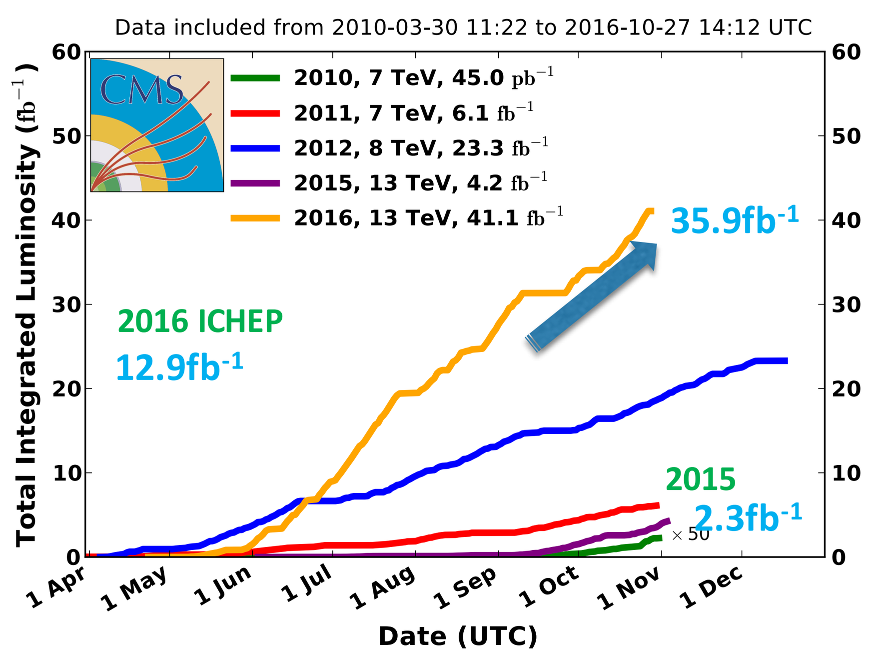
- **2015** data: 2.3/fb, √s=13TeV
- **2016 full year** data: 35.9/fb, √s=13TeV



Channel		Models
EXOTIC Resonance X→ Diboson	WW	Spin-2 Bulk Graviton
	WZ	Spin-1 HVT (charged)



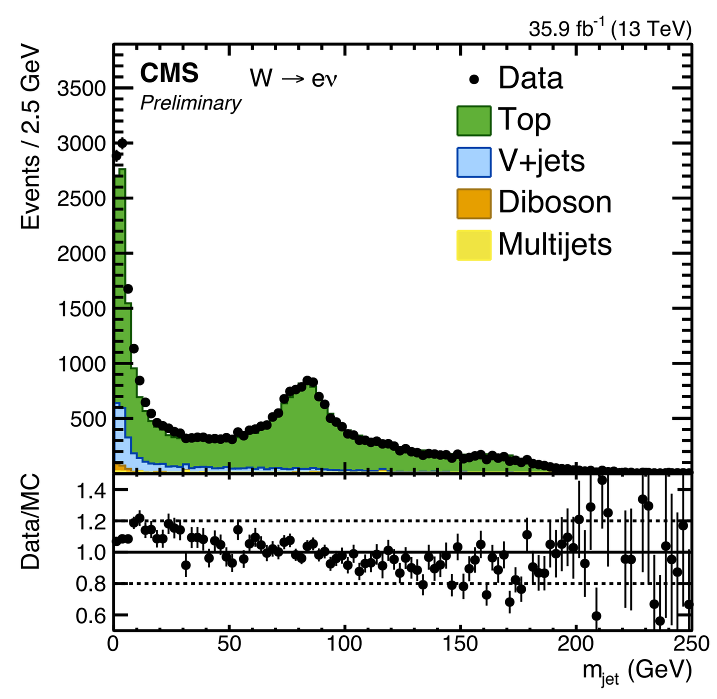


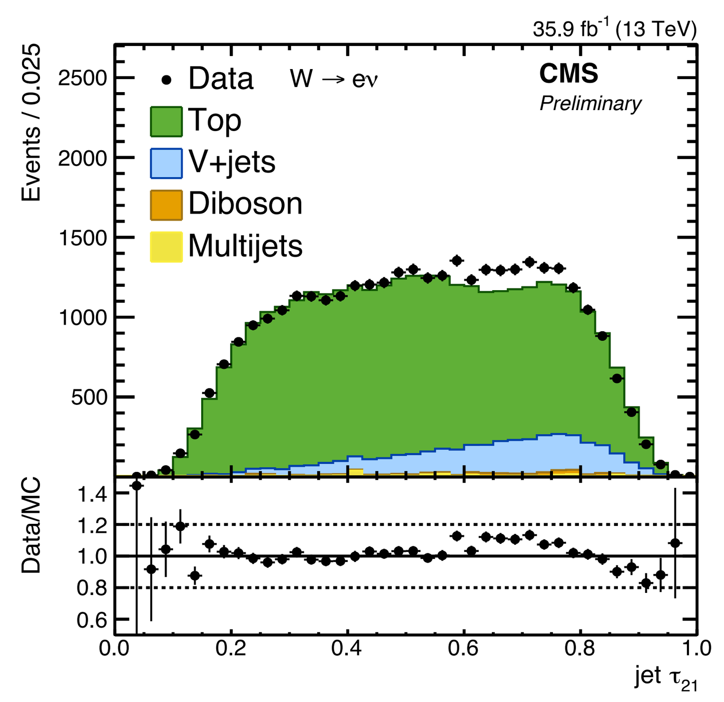


•Samples

- Analysis based on proton-proton collision data at $\sqrt{s}$= 13 TeV collected by the CMS experiment at the CERN Large Hadron Collider during 2016.
- Integrated luminosity: 35.9 fb^{-1}
- Signal: X→ WV → $l\nu qq$, with X = Bulk graviton/W', mass range 1.0~4.5 TeV
- Backgrounds:
  W+jets, dominant one
  TTbar, single top, VW, multijets

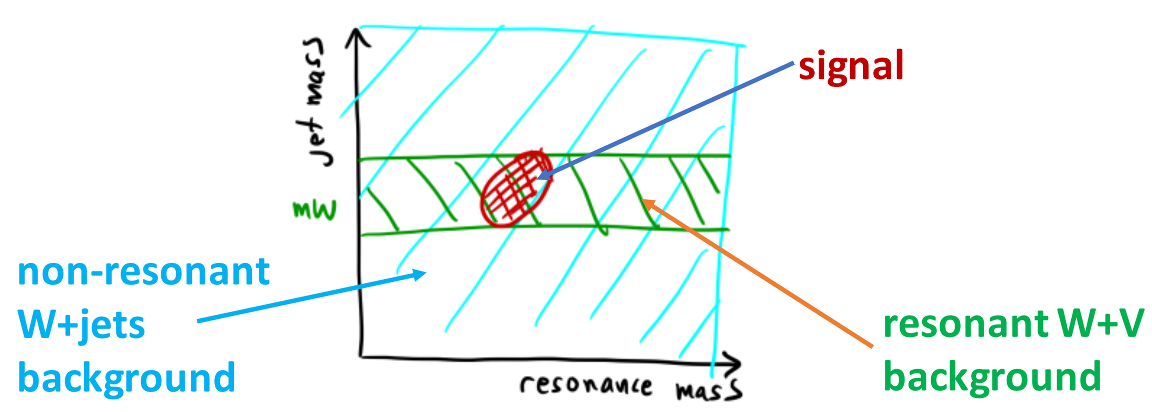
•Data VS MC





•Background estimation: 2D fit

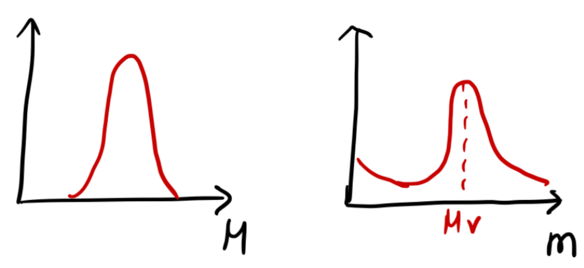
- **New method:** 2D fit in (mWV, mjet) plane - use full V jet mass range: 30 < m_{jet} < 210 GeV
  Make better use of correlations between m_{WV} and m_{jet}
  Much more sideband statistics - use full line-shape of jet mass
  Become less dependent on simulation - learn from data
- Cross check with ***alpha method***:
  sideband: 30 < m_{jet} < 65 GeV, 135 < m_{jet} < 150 GeV (excludes top peak)
  W window: 65 < m_{jet} < 85 GeV, Z window: 85 < m_{jet} < 105 GeV
- 2D fit: distinguish between
  non-resonant W+jets (W(lv)+jets, ttbar with non-W V jet)
  resonant W+V (ttbar, diboson) background processes



•Background estimation:

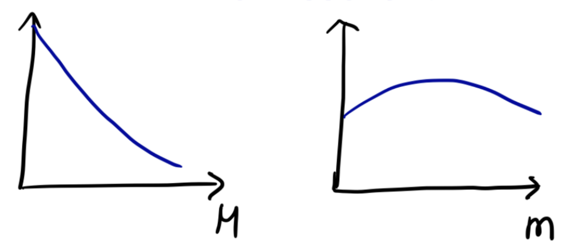
•Signal parametrisation

- **Signal** peaks in both m_{WV} and m_{jet}
- $P_{sig}(m_{WV}, m_{jet}|\theta(M_X)) = P_{WV}(m_{WV}|\theta_1(M_X)) \times P_j(m_{jet}|\theta_2(M_X))$
- Fit both dimensions
  double crystal-ball functions, for LP additional exponential is used for m_{jet} mass tail
- Interpolate using polynomials as a function of the resonance mass hypothesis (M_X)



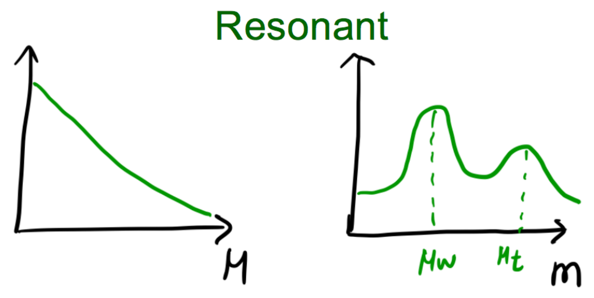
• Non-resonant

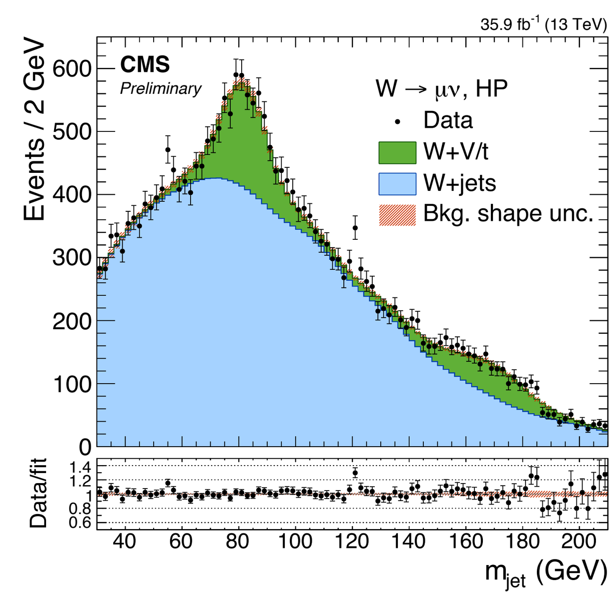
- **W+jets background:**
- Conditional probability of m_{WV} as function of m_{jet}:
- $P_{W+jets}(m_{WV}, m_{jet}) = P_{WV}(m_{WV}|m_{jet}, \theta_1) \times P_j(m_{jet}|\theta_2)$
- P_{WV} templates created using kernel method starting from particle level, clustering as for reconstructed jets
- Determine scale and resolution as function of true jet p_T (encode uncertainties by varying those)
- Populate templates as sums of 2D gaussian templates in bins of m_{jet}
- Smoothen mWV from 2.5 TeV as function of mWV fitting exponential from 2 TeV to avoid empty bins
- $P_j(m_{jet}|\theta_2)$ template created using fitting splines

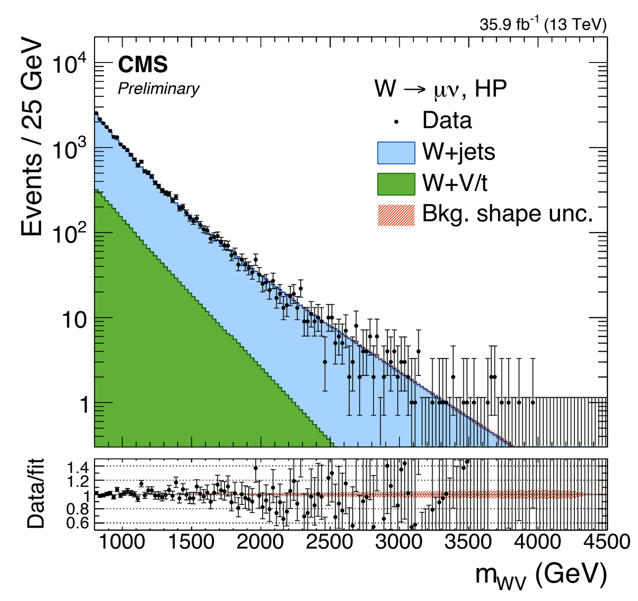


• resonant

- **W+V background:**
- Conditional probability of mWV as function of mjet:
- $P_{W+V}(m_{WV}, m_{jet}|\theta) = P_{WV}(m_{WV}|\theta_1) \times P_j(m_{jet}|\theta_2(m_{WV}))$
- P_{WV} templates created using kernel method as for W+jets (1D)
- Smoothen mWV from 1.2 TeV as function of mWV fitting exponential
- mjet template described by W and top mass peaks - allows to constrain top pT spectrum in data
- **W+jets vs. non-resonant top:** expect shifted distributions for top
- Covered by 3σ scale variations used that are used as uncertainty

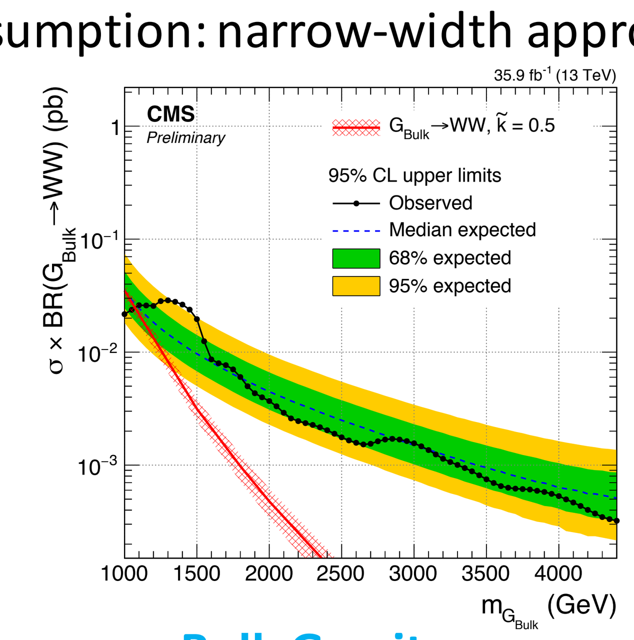




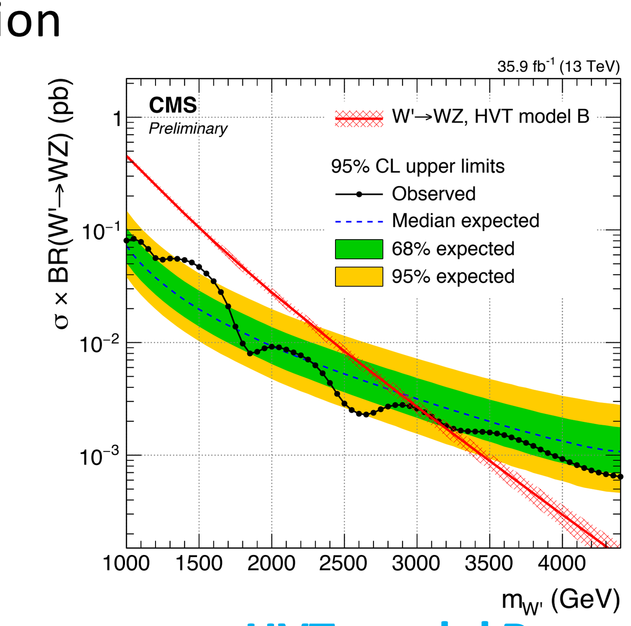


•Statistical interpretation

- Compare M_{WV} distribution observed in data with SM background prediction
- Exclusion limits in the context of bulk graviton model and HVT model B scenario. Combination with another channel (X→ WV)
- Assumption: narrow-width approximation



Bulk Graviton



HVT model B

•Conclusion

- Search for resonances decaying to WW or WZ by 2016 full year data
- No evidence for a signal is found
- Results interpreted as upper limit on the production cross section for bulk graviton and HVT models.

Ref: CMS-PAS-B2G-16-029

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