# tt threshold update

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With useful input from Marcel Vos and Michele Selvaggi

# Brief recap: goals of this work

- Measurement of top quark properties (mass, width, Yukawa) using tt threshold scan in ee collisions

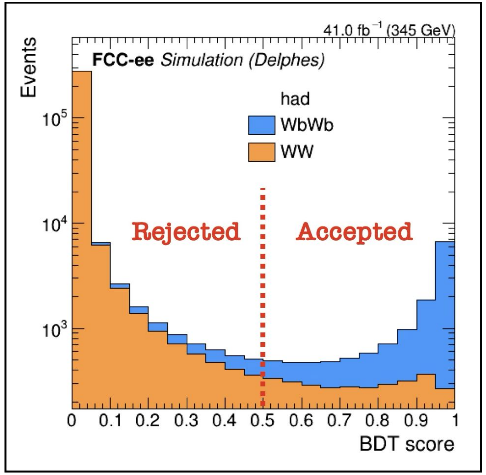
- Measurement of WbWb total rate using detector-level FCC simulation
- Phenomenological analysis of threshold scan

- Comprehensive assessment of systematic uncertainties
    - Experimental (b-tagging, integrated luminosity)
    - Machine-related (beam energy spread & calibration)
    - Theoretical (QCD scale variations)

- Today: update on experimental strategy and machine-related uncertainties

# Brief recap: detector-level studies (from Paris workshop)

- Focus on (semi-) hadronic WbWb (~80% BR)
- BDT-based signal selection
  - Only kinematic variables (leptons, jets, missing momentum)
  - Jet flavour information used as an additional handle

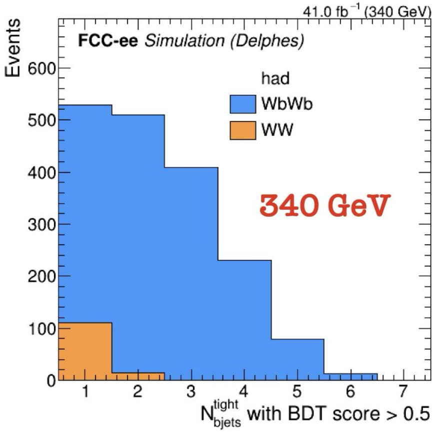


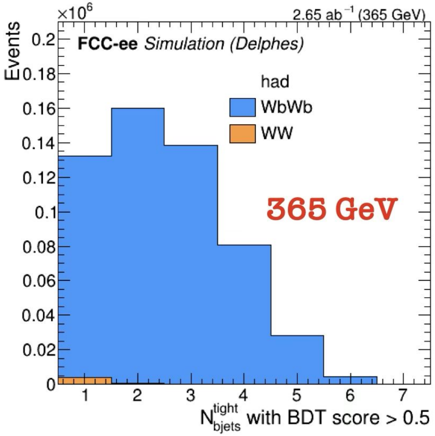

Unexpected b-tagged jet multiplicity, independently of WP

- Tagger optimised for Higgs studies
- May fail due to higher jet multiplicity

New approach: use parameterised b-tagging efficiency with inclusive jet clustering

- Conservatively assume 90% efficiency, 1% uncertainty



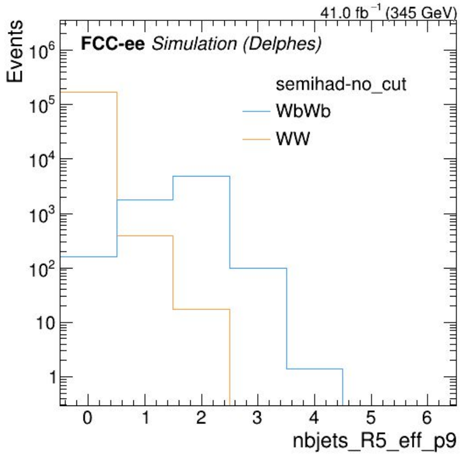



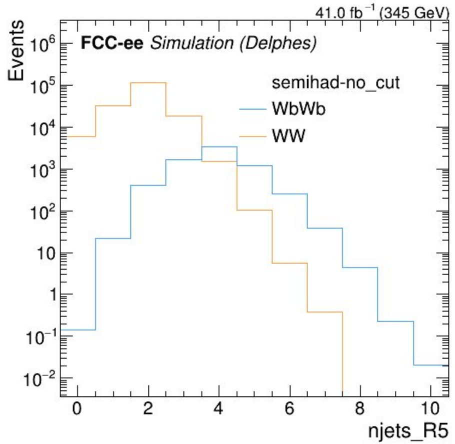
# Multiplicities and new fit strategy

- With this approach we obtain meaningful jet and b-tagged jet distributions for WbWb and WW
- Neglecting mistag rate for now

- Jet and b-tagged jet multiplicities provide good handle on leading WW background

New approach: replace BDT cut with simpler (and more robust) categorisation in number of jets and b-jets



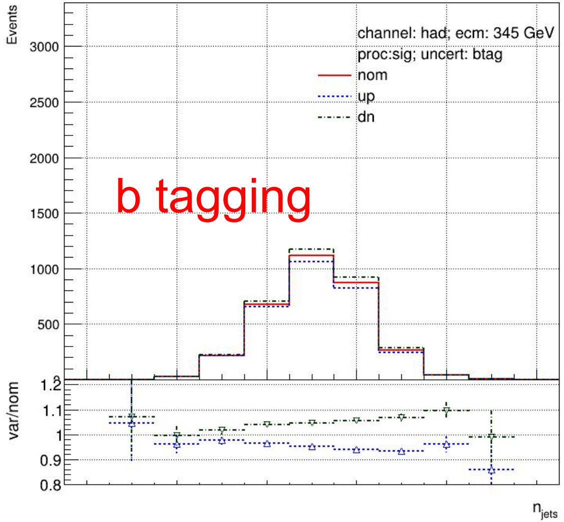
# Systematic uncertainties

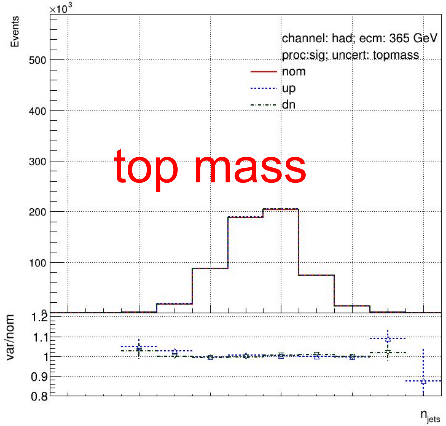
We consider leading effects on

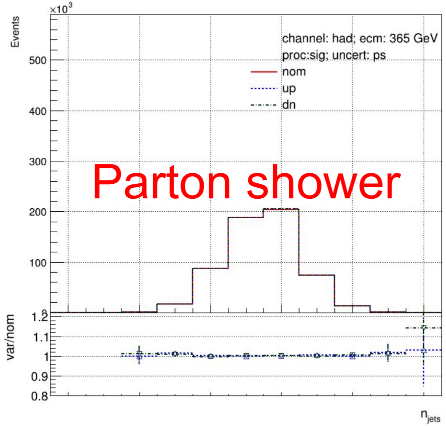
- Normalisation
  - Integrated luminosity: 0.1%

- Shape
  - b-tagging efficiency: 1%
  - Top quark mass: 1 GeV
  - Parton shower: scale variation x2

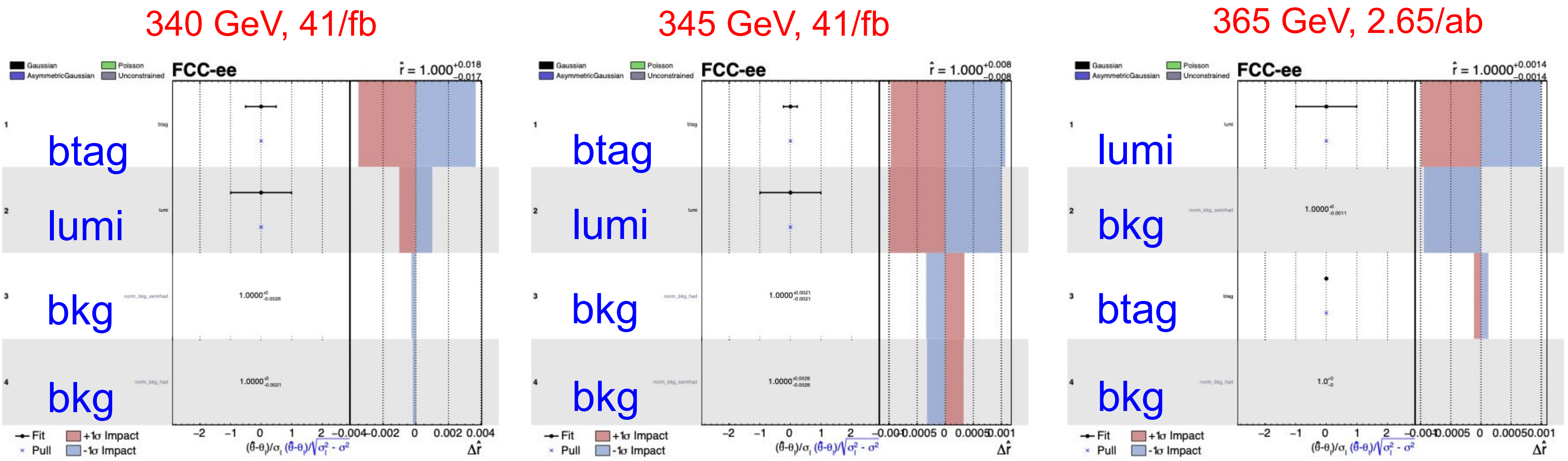
Only b tagging has significant shape effect -> will exclude others for now



# Fit of WbWb total rate




- 340-345: stat dominated. 365: careful assessment of systematics needed
- Strong constraining power on b-tagging efficiency (can be improved with DY)

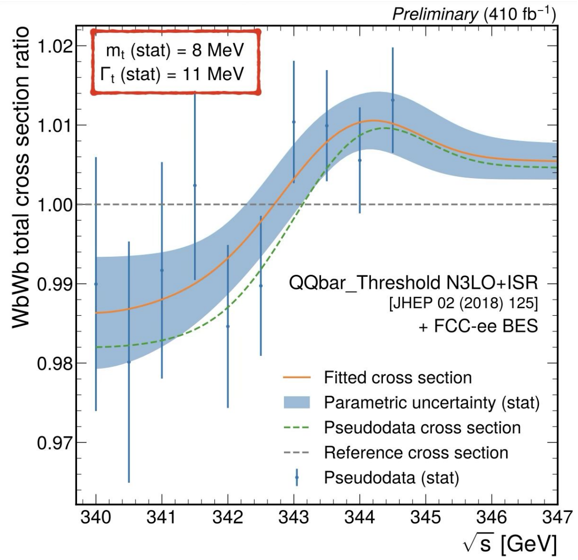
- Backgrounds well under control even without external constraints
- Luminosity uncertainty to be assessed in more detail

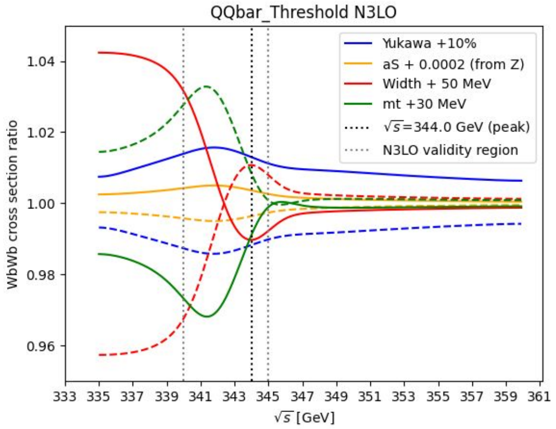
# Measurement of top properties via fit of N3LO calculation

# Quick recap: threshold scan analysis

- 10 equally-spaced points with equal integrated luminosity
- Simultaneous measurement of mass, width, yukawa, with parameterised alphaS
- N3LO prediction convoluted with FCC beam energy spectrum

- 1.7% (stat) determination of top Yukawa using 365 GeV point

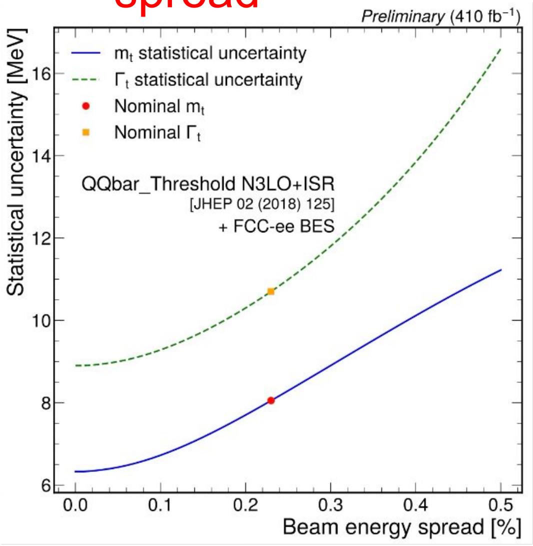


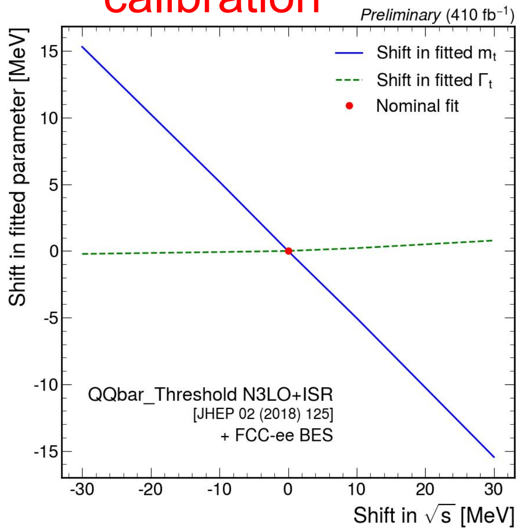
# Beam related uncertainties

- Assess uncertainty in top mass and width as a function of the beam energy spread and calibration

spread




calibration




- Spread: affects width more strongly than the mass
- Calibration: correlated component across energies only affects the mass (trivial relation with 2*mt)
- TODO: assess uncorrelated component of calibration

# Integrated luminosity

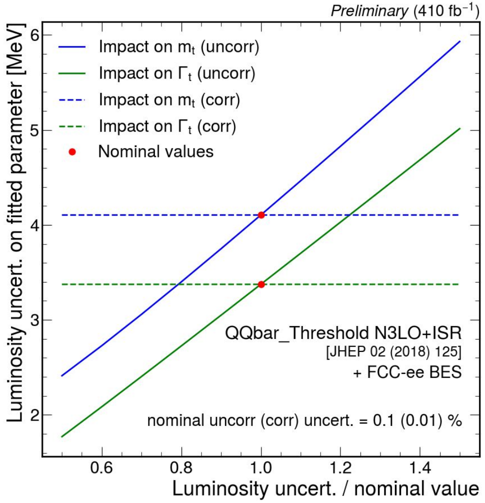
Separate assessment for correlated and uncorrelated components

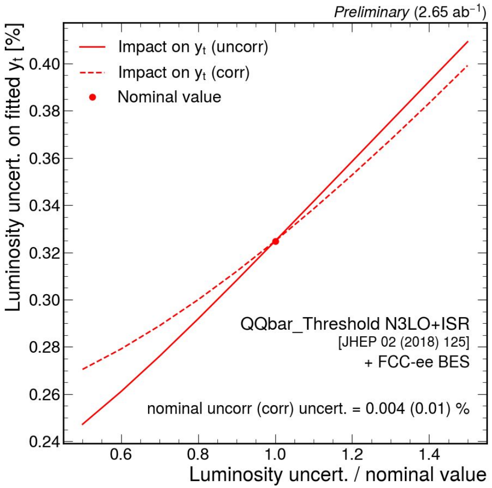
- uncorr: 0.1% for 410/fb, scaled accordingly to 41/fb and 2.65/ab
- correlated: 1E-5

N.B. all numbers are placeholders!

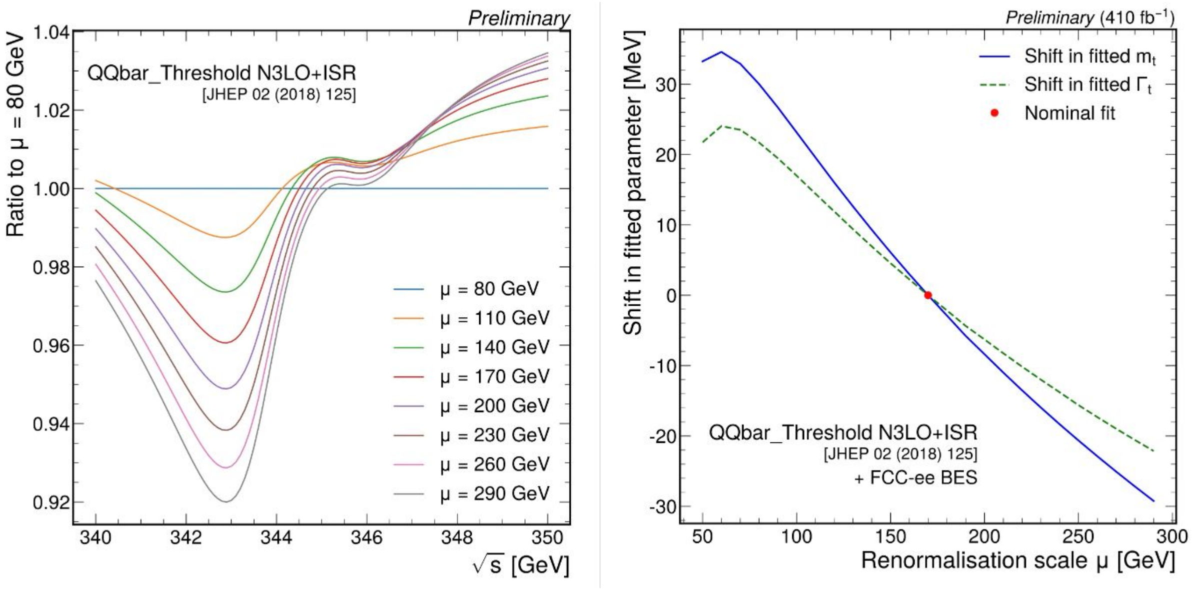
- Effect of varying above assumptions assessed for mass, width, and yukawa

TODO: more accurate assessment of the nominal value of the uncertainty



# The elephant in the room: QCD uncertainties




- 30 (20) MeV on top mass (width)
- Even with N3LO corrections, theory is the dominant uncertainty

# Summary and outlook

- Significant progress towards a comprehensive assessment of uncertainties in the tt threshold scan (experimental, machine-related, theoretical)
- Some numbers are placeholders, but tools are in place for final estimate
  - Uncorrelated component of beam energy calibration still to be assessed
- Aim at finalising the result by the end of the year
- Journal publication in preparation