LHC JET SUBSTRUCTURE MEASUREMENT GOALS

LHC Electroweak Working Group Meeting

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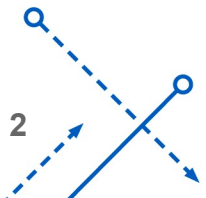
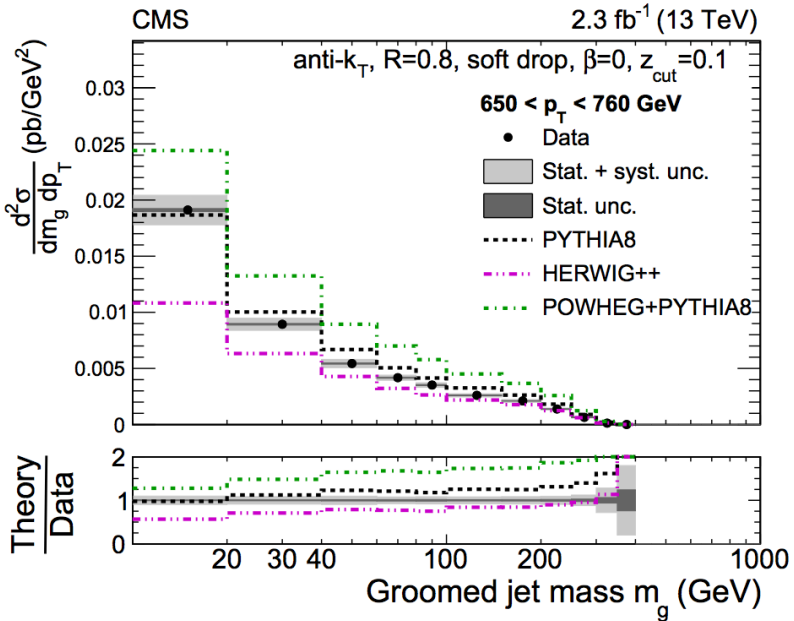
Introduction

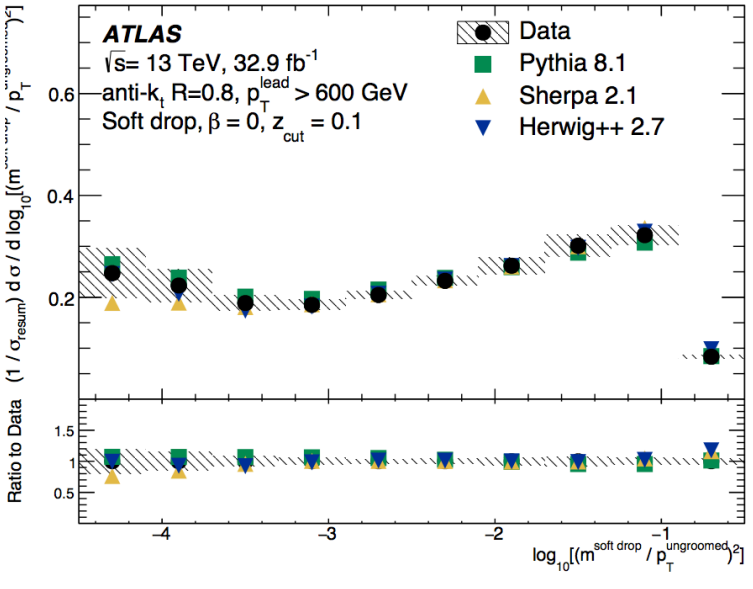
- **Informal chat on February 13 about common goals for LHC jet substructure measurements**
- **Representatives from ATLAS, CMS, LHCb, theory**
- **Aim: allow for better comparison of measurements across experiments**
  - What is measured
  - How it is presented
    - e.g. common binning schemes
  - Systematic uncertainties



Jet Mass

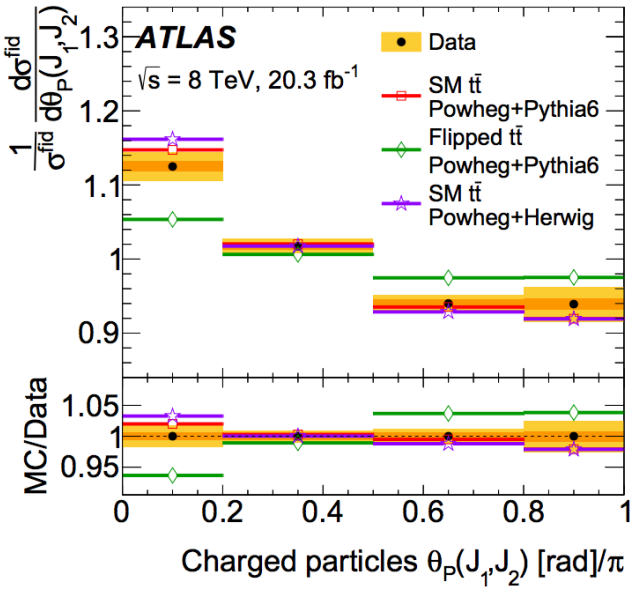
- **Current measurements:**
  - CMS: jet mass, binned in p_T, dijets at 13 TeV
    - In progress: jet mass and ρ vs p_T, Z+jets at 13 TeV
  - ATLAS: jet ρ, inclusive in pT, dijets at 13 TeV
  - Both use softdrop mass
- **Proposal for common setup:**
  - Measure ρ in bins of ungroomed jet p_T
  - One inclusive jet p_T bin above 300 GeV
  - Common softdrop grooming parameters

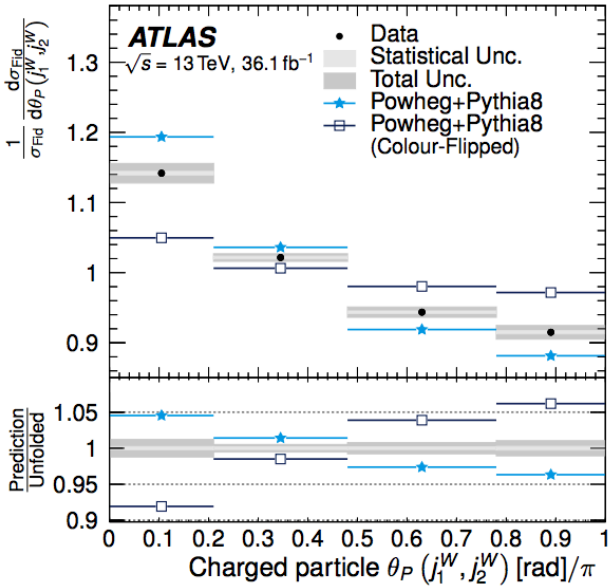




Jet Pull

- **Jet pull vector gives information about color flow within a jet**
- **Current measurements:**
  - ATLAS at 8 TeV, 13 TeV - significant data/MC differences
- **Would be interesting for CMS to measure, too**
- **In progress:** theory paper on IRC safe pull angle related observable
  - Would be interesting to have a dedicated discussion in a future meeting



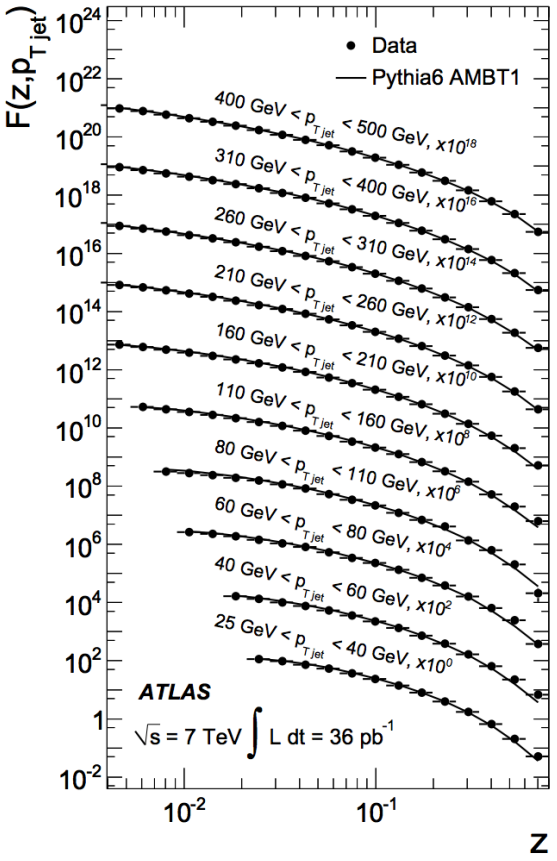


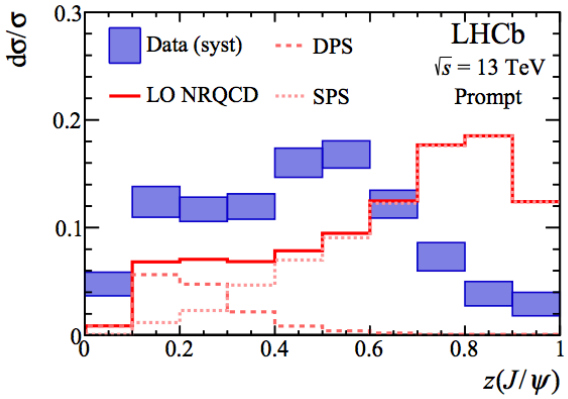
Jet Fragmentation Function

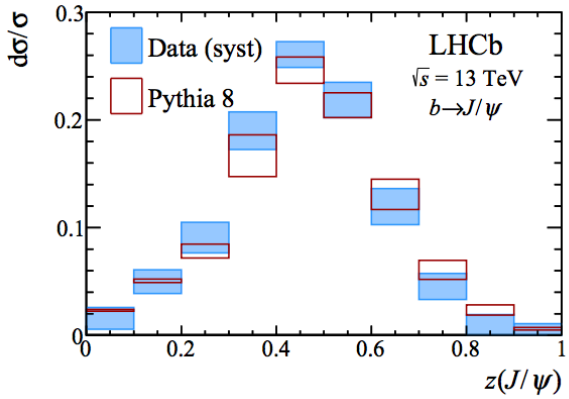
- **Current measurements:**
  - ATLAS measurement for inclusive fragmentation
  - ATLAS HI comparison
  - Run 2 LHCb J/Ψ
- **Proposal for common setup:**
  - Fragmentation function definitions vary:

$$z = \frac{p_{track} \cdot p_{jet}}{p_{jet} \cdot p_{jet}} \qquad z = \frac{p_{T,track}}{p_{T,jet}}$$

  - Proposal: at least use the definition on the right

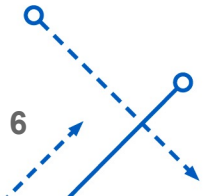






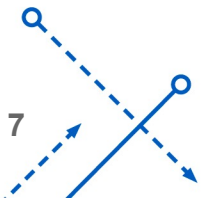
Systematic Uncertainties

- **Types of jets:**
  - CMS - particle flow
  - ATLAS - (mostly) calorimeter jets
- **Main jet-related uncertainties:** jet mass and energy scale and resolution
  - **CMS** - JMS and JMR uncertainty is derived from W mass
    - CMS-TOP-17-013 has extensive measurements of substructure variables with track efficiency-derived uncertainties
      - Cross-checked internally with jet mass from W bosons, comparable
  - **ATLAS** - establish uncertainties on calorimeter inputs directly using p/E with matched tracks for cluster energy and resolution, efficiency, models of split/merging
    - Can be applied to all substructure variables
    - Automatically get correlations between JMS and JES
      - Otherwise, often treated as uncorrelated
    - Can something similar be done in particle flow?
- **To do:** vary parton shower scale
- **Generators:**
  - Pythia8 is the main generator for everyone
  - Alternative generator:
    - ATLAS often uses SHERPA - better than HERWIG++
    - Both CMS and ATLAS moving to HERWIG7

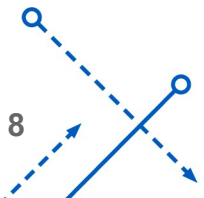


Summary

- **Interesting discussion of common goals for LHC jet substructure measurements**
  - Goal: better comparison (not combination) of measurements across experiments
  - Link to summary on TWiki
- **Focus on jet mass, jet pull, and jet fragmentation function**
- **Important to have at least one common variable definition and inclusive binning**
- **Common (as common as possible) jet-related systematic definitions still a work in progress**
- **People from ALICE are welcome to join!**
- **Plan for communicating and sustaining these goals to/ within larger LHC community?**

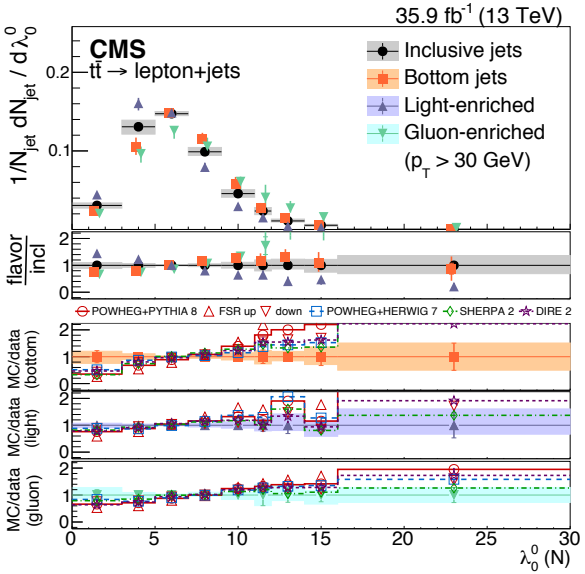


Additional Material

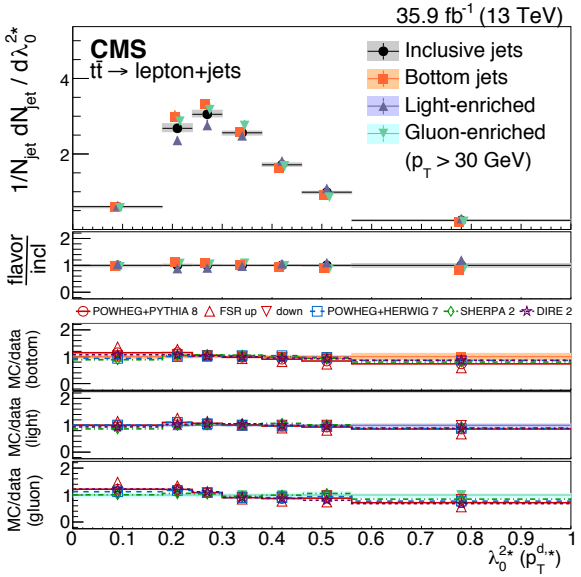


CMS-TOP-17-013

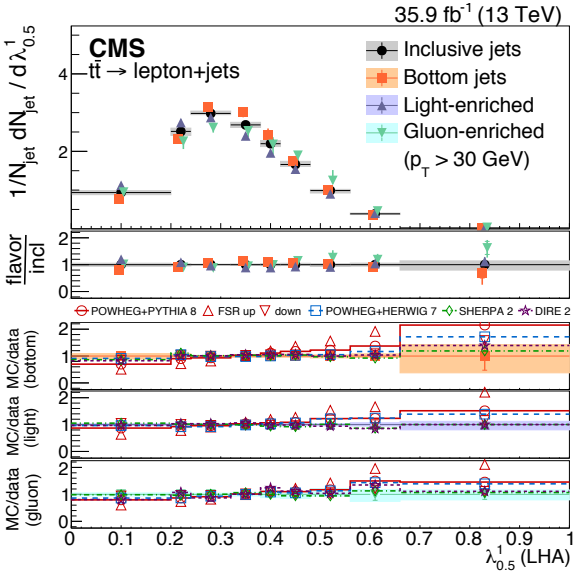
Charged Multiplicity



Scaled p_T Dispersion



Les Houches Angularity



Energy Correlation Ratio $C_3^{(1)}$