Heavy Quarks in SHERPA

Frank Krauss

Institute for Particle Physics Phenomenology
Durham University

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1. what the talk is about
2. comparing the schemes implemented in SHERPA
3. off-topic: mass effects in loop–induced processes ($gg \to H$)
4. summary

motivation & introduction

motivation: issues with heavy quarks

- many processes with b quarks as part of signal/background
  - prominent example: $t\bar{t}H_{\to b\bar{b}}$
- various schemes on different levels
  - matrix element (ME) level: massive vs. massless,
    but constraint: no NLO with massive initial state quarks (yet)
  - parton shower (PS): explicit mass vs. dead-cone
  - PDFs: fixed vs. varying flavour number schemes
- how are results comparable?
- for this talk: what is available in SHERPA

schemes for heavy quark production in SHERPA

- use b quarks as example

(probably similar for c, but not yet checked)

- schemes implemented in SHERPA (results below):
  - **4FS**: MC@NLO with massive b's in FS, no b's in IS,
  - **5FS^0**: MEPS@NLO & MEPS@LO with massless b's in IS & FS
  - **5FS^m**: MEPS@LO with massive b's in IS & FS

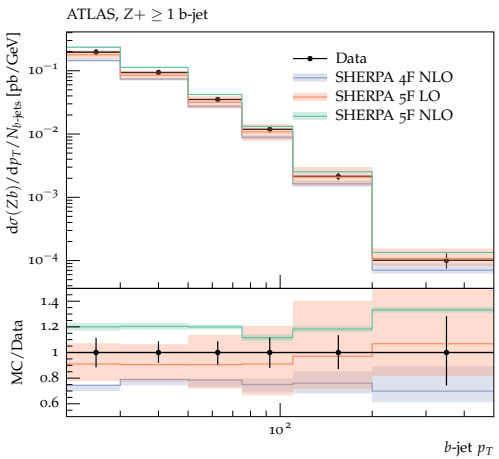
(soft/collinear divergent CS shower kernels include masses, kinematics consistently massive)

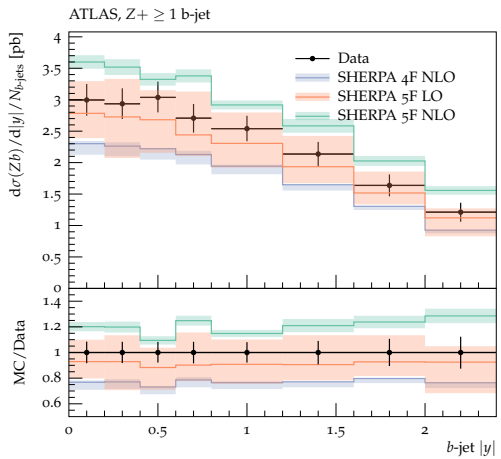
- PDFs: standard 4 & 5 flavour PDFs (usually VFS-types)
- hadronization: SHERPA version of cluster model
- hadron decays: own hadron decay model, a few dozen form factors & MEs

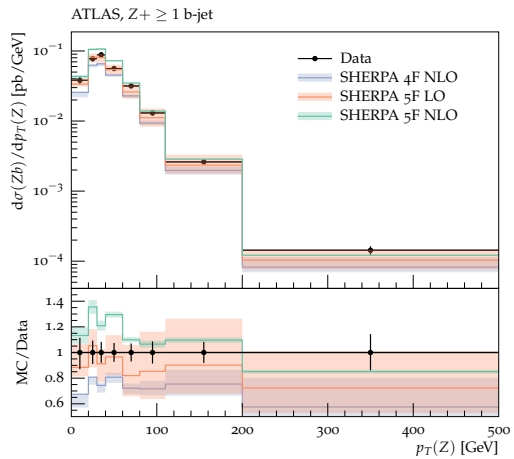
comparison of schemes

comparison: $Z + b$

- $Z + b$ production, ATLAS

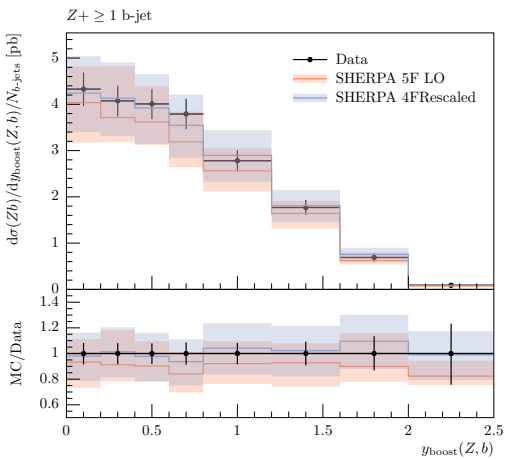


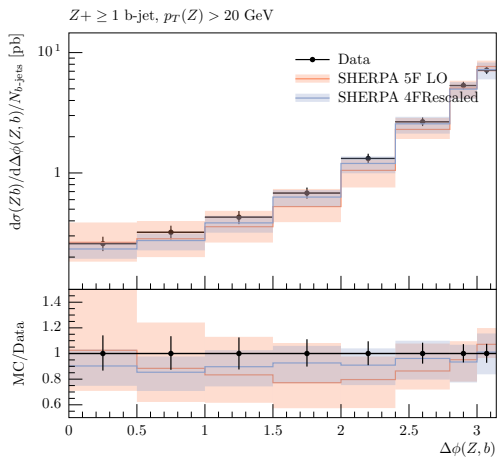


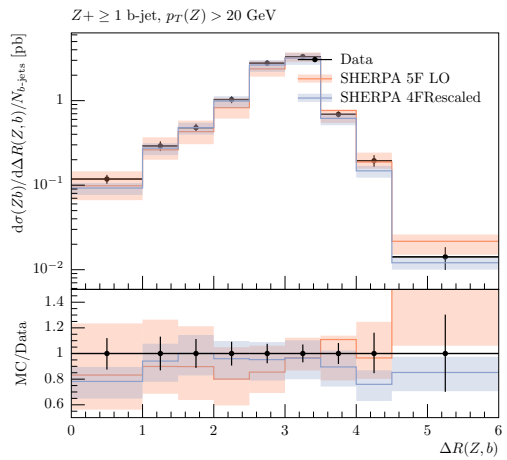


comparison: $Z + b$

- $Z + b$ production, ATLAS, after rescaling

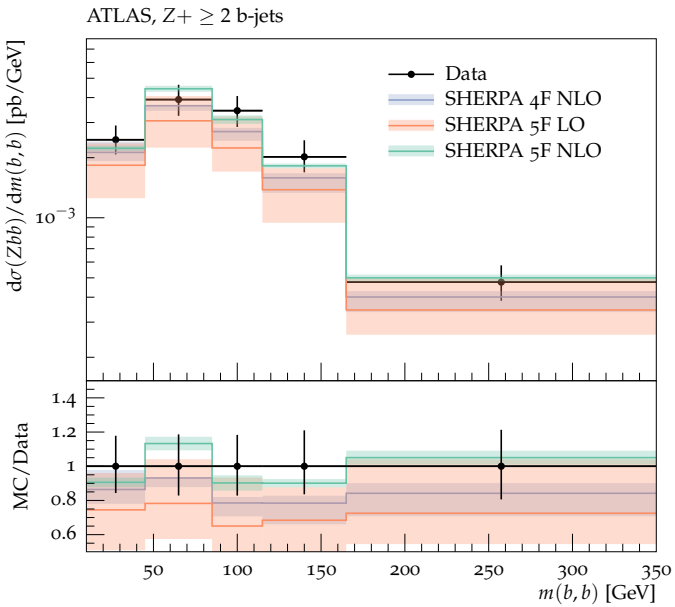


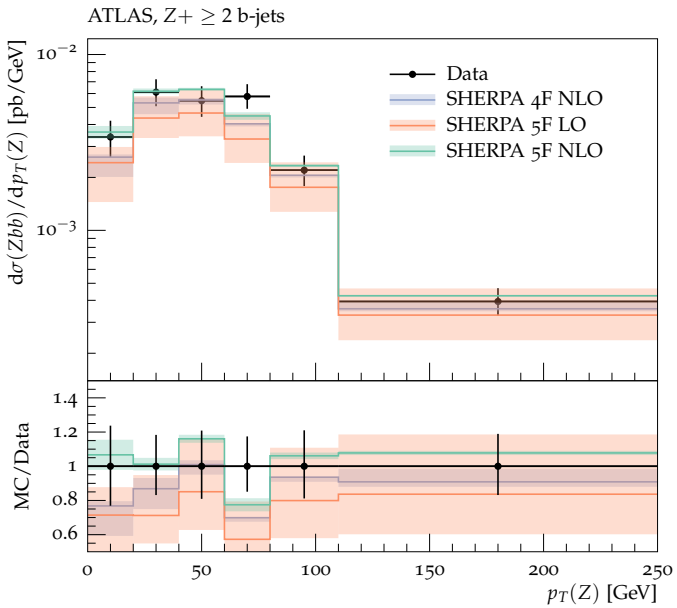




comparison: $Z + b\bar{b}$

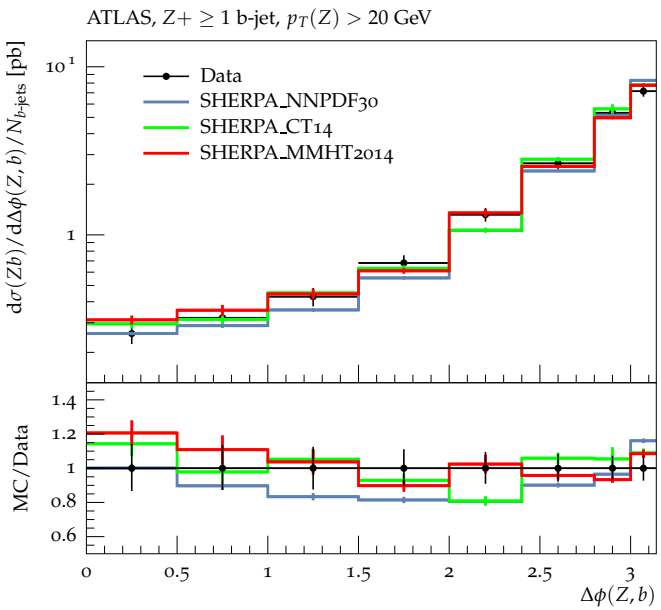
- $Z + b\bar{b}$ production, ATLAS

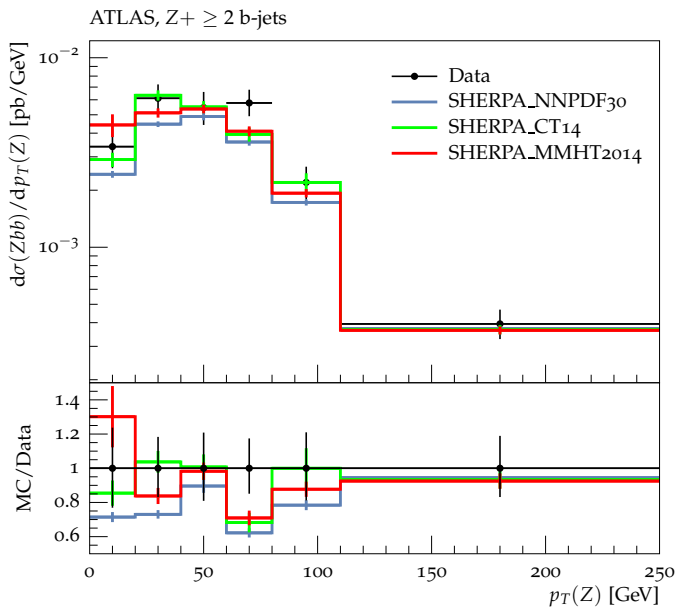




comparison: $Z + b\bar{b}$

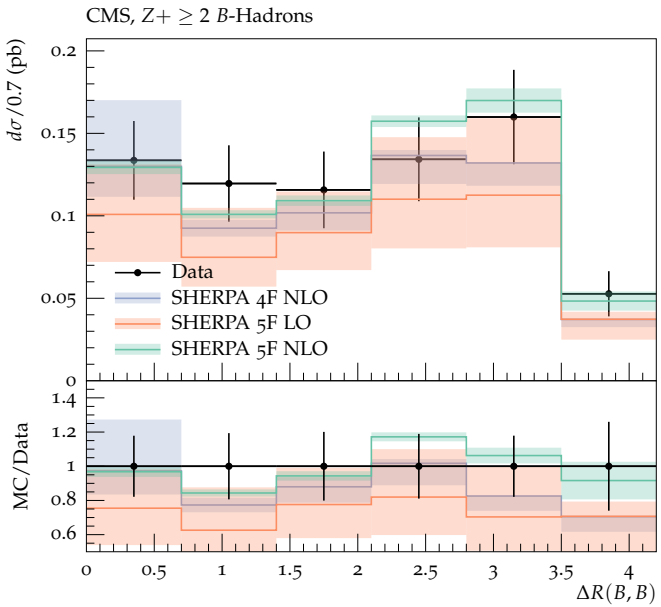
- $Z + b\bar{b}$ production, ATLAS, impact of PDFs

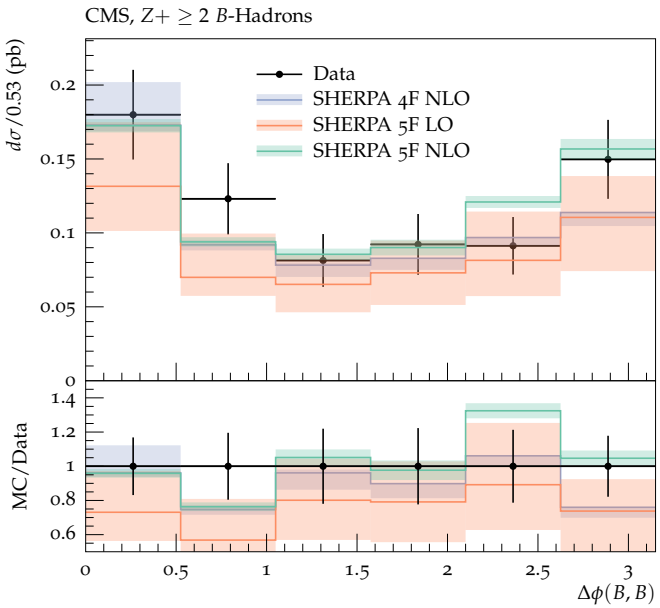




comparison: $Z + b\bar{b}$

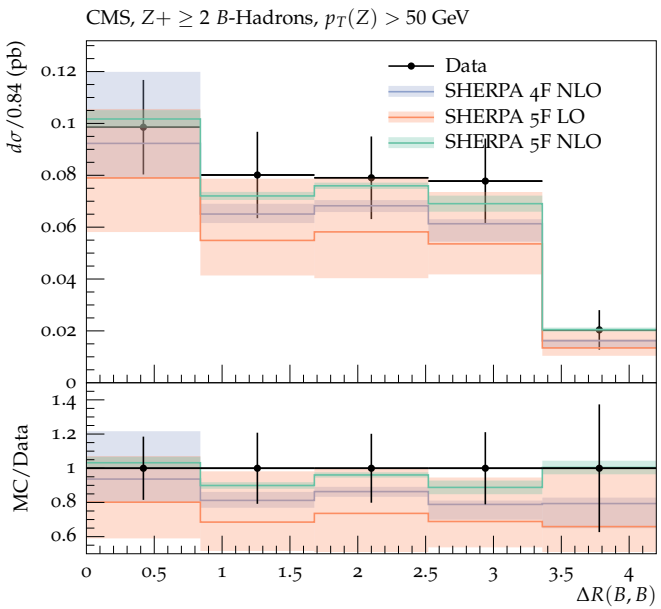
- $Z + BB$ production, CMS: look at B hadrons

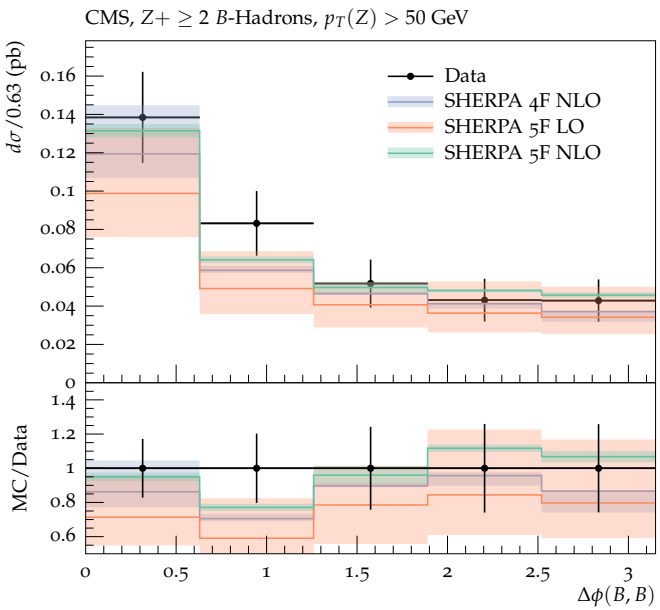




comparison: $Z + b\bar{b}$

- $Z + b\bar{b}$ production, ATLAS, impact of PDFs

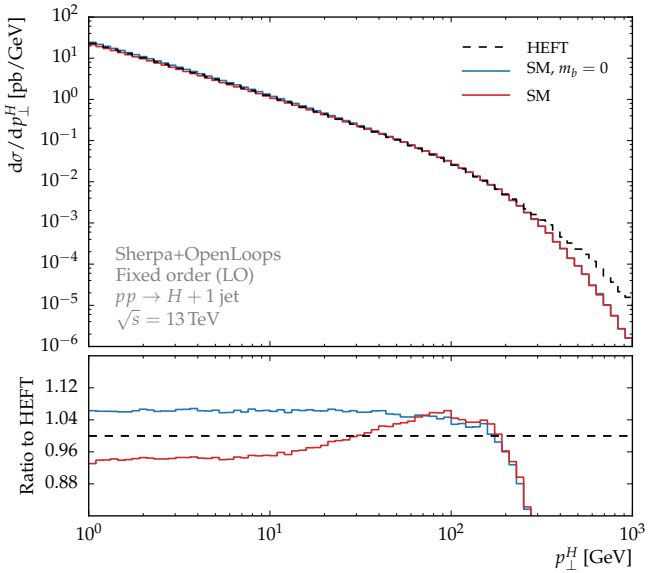


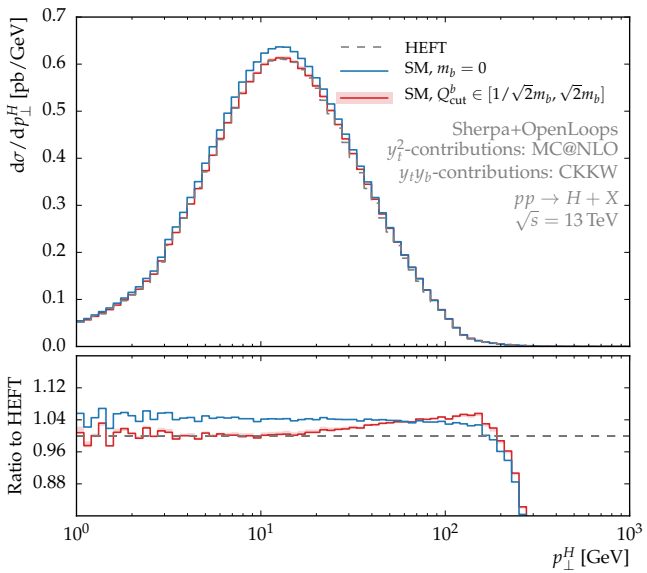


off-topic: mass effects in loop–induced processes

comparison: $Z + b\bar{b}$

- $Z + b\bar{b}$ production, ATLAS, impact of PDFs





summary

comparison: $Z + b\bar{b}$

- different schemes in SHERPA in moderately good agreement and in ok agreement with $Z + b(\bar{b})$ data from ATLAS & CMS
  - for Zb: MEPS@NLO too high, MC@NLO too low (each about 20%)
  - for Zbb: agreement much better
  - for MC@NLO: leading b's naively come from ME
    ignoring fragmentation component apparently problematic for Zb
    may have to add $Zj+\{b$ from fragmentation$\}$ "by hand"
- issue in $W + b$: too large xsecs
  - potential problem in MEPS@NLO with b in IS:
    double counting of $g \to bb$ component in PDF and ME
  - must subtract from calculation ($\to$ work in progress)
  - hope: will also cure overshoot of MEPS@NLO in Zb