# Progress in SCET on b-jet substructure

- This LDRD supported PhD student **Prashant Shrivastava** (Carnegie Mellon), who visited Jun-Aug 2017.

- Collaborating also with DOE EC-funded postdoc **Varun Vaidya**

- *Energy Correlation Functions*
  - *U_i variables shown to be excellent light q-g discriminants*

- e.g.

$$U_1^{(\beta)} = \sum_{1 \leq i < j \leq n_J} z_i z_j \theta_{ij}^{\beta}$$

Moult, Necib, Thaler (2016)

$$U_2^{(\beta)} = \sum_{1 \leq i < j < k \leq n_J} z_i z_j z_k \min\{\theta_{ij}^{\beta}, \theta_{ik}^{\beta}, \theta_{jk}^{\beta}\}$$

$$U_3^{(\beta)} = \sum_{1 \leq i < j < k < l \leq n_J} z_i z_j z_k z_l \min\{\theta_{ij}^{\beta}, \theta_{ik}^{\beta}, \theta_{il}^{\beta}, \theta_{jk}^{\beta}, \theta_{jl}^{\beta}, \theta_{kl}^{\beta}\}$$

- *Jet Grooming:* **Soft Drop:**

Larkoski, Marzani, Soyez, Thaler (2014)

- 0. Start with jet identified with IRC safe jet algorithm (e.g anti-kT)
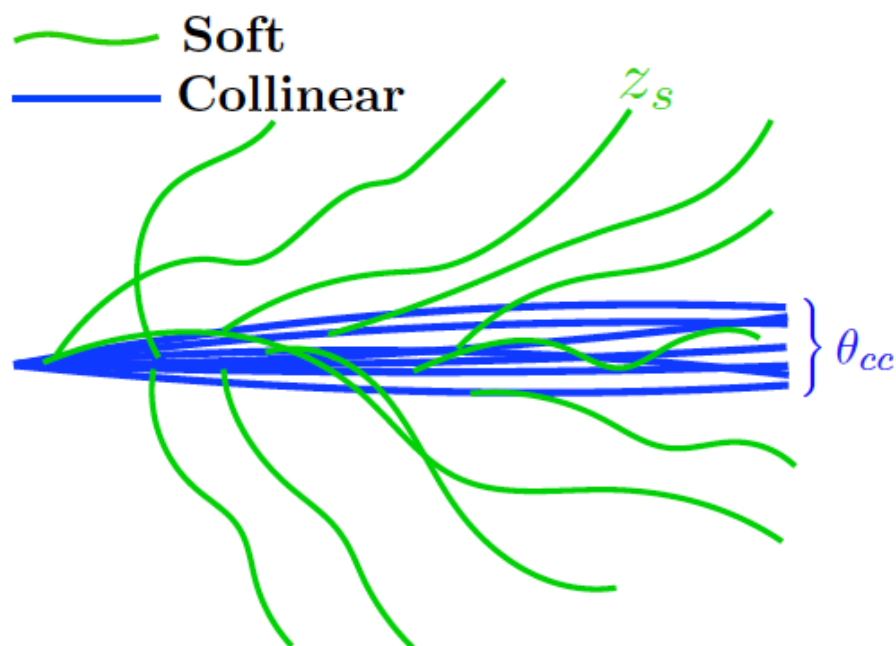
- 1. Recluster jet using C/A algorithm (angular ordered)

- 2. Step through branching history of reclustered jet.

  Check **soft drop** condition:
  $$\frac{\min[p_{Ti}, p_{Tj}]}{p_{Ti} + p_{Tj}} > z_{\text{cut}}$$

  If not satisfied, remove softer of two branches from the jet. Iterate process on harder branch.
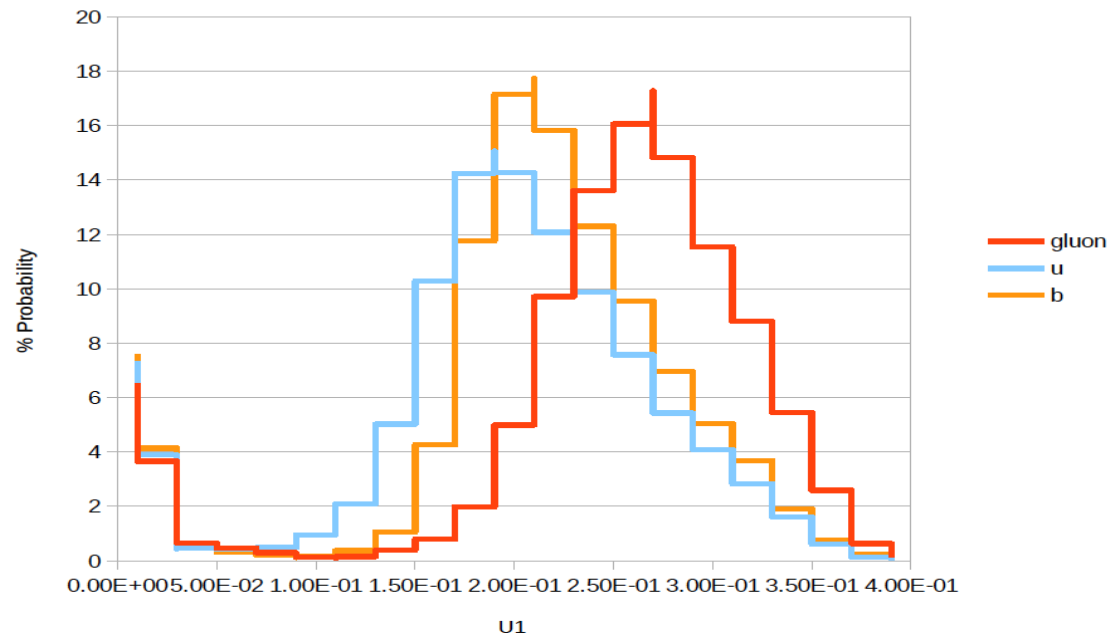
- 3. Terminate once soft drop condition is satisfied.

Light & Heavy Quark Jets and Gluon Jets

$$U_1^{(\beta)} = \sum_{1 \le i < j \le n_J} z_i z_j \theta_{ij}^{\beta}$$

Lee, Shrivastava, Vaidya (in progress)

Ungroomed Jets

pT > 500 GeV, R=0.6, alpha=0.2

Groomed Jets

pT > 500 GeV, R=0.6, alpha=0.2, zcut=0.1, beta=0
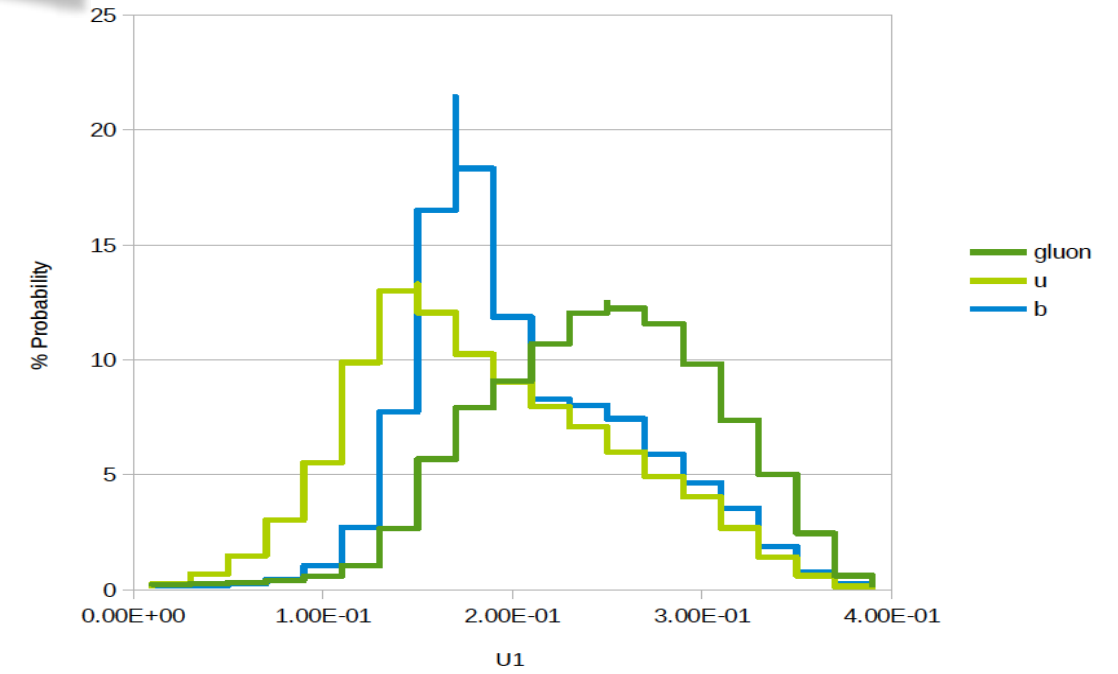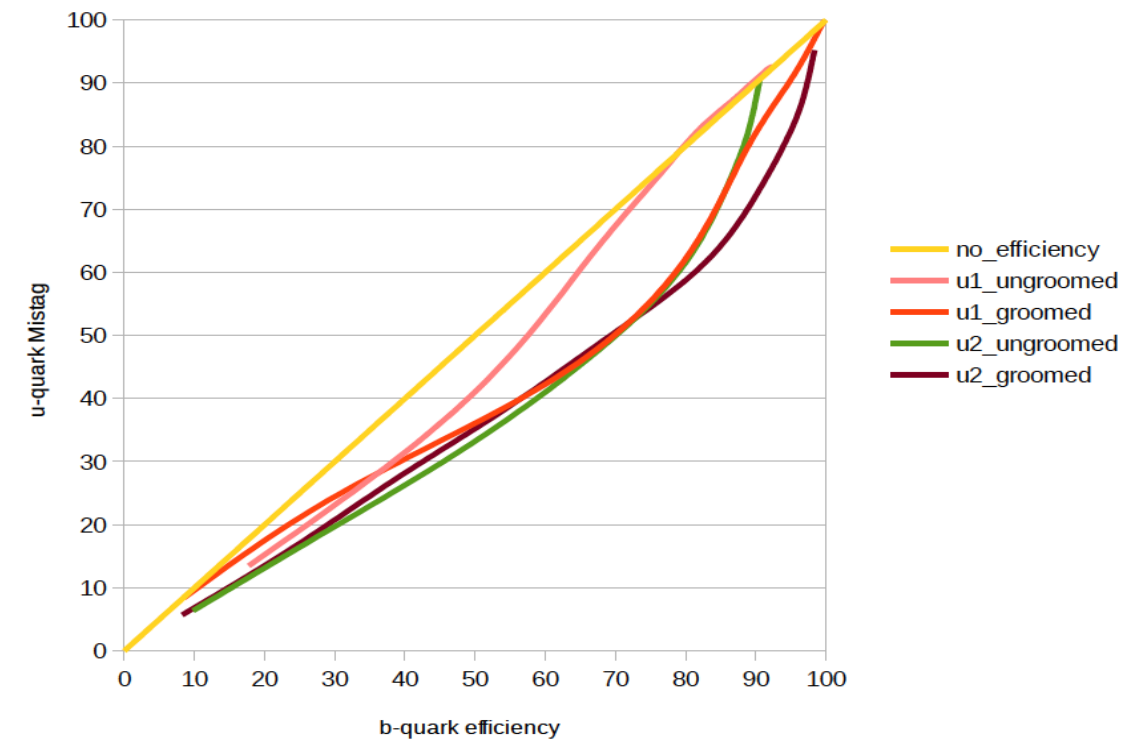
ROC curve with single sided cut

pT > 500 GeV, R=0.6, alpha=0.2, zcut=0.1, beta=0
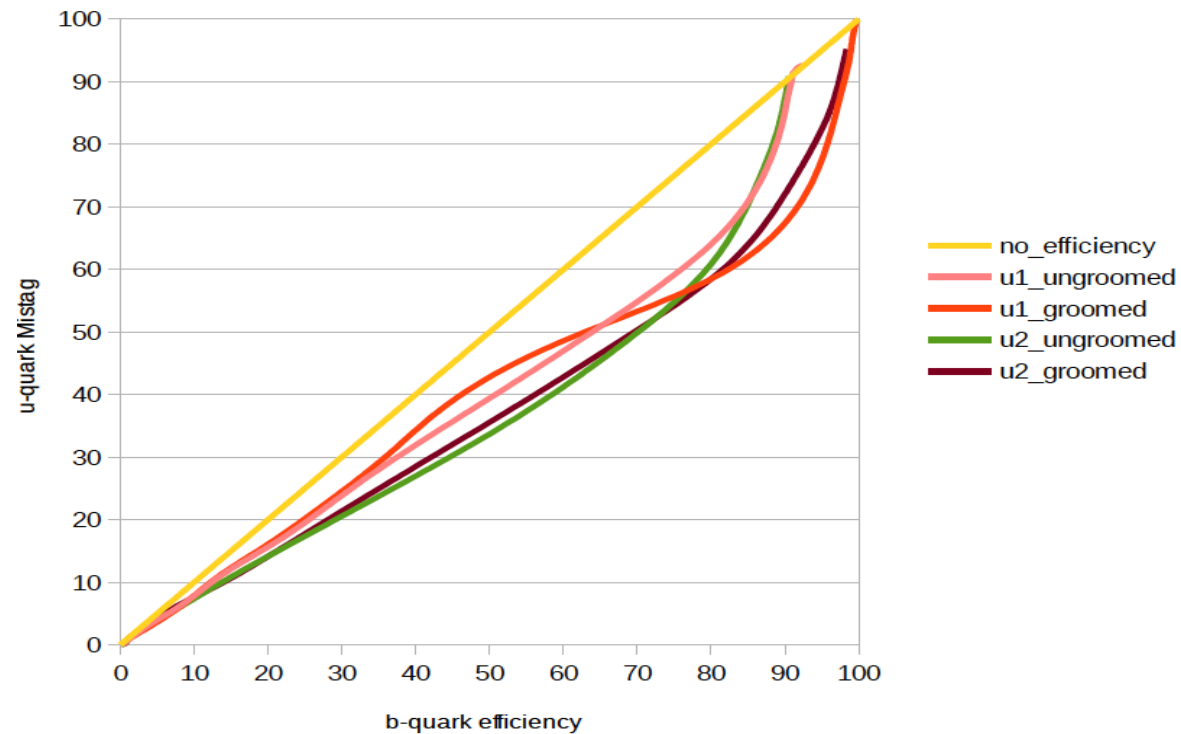
ROC curve with double sided cut

pT > 500 GeV, R=0.6, alpha=0.2, zcut=0.1, beta=0

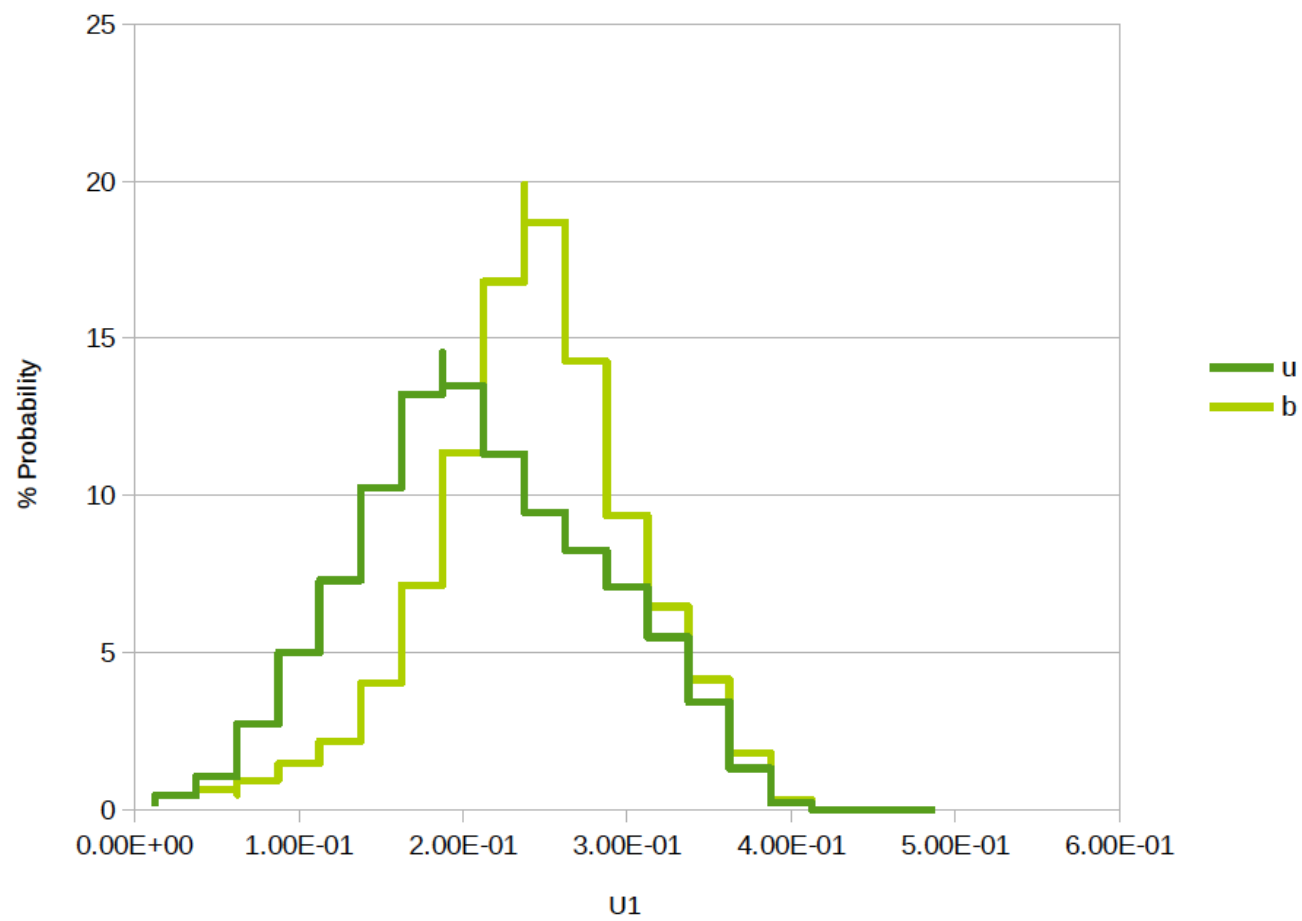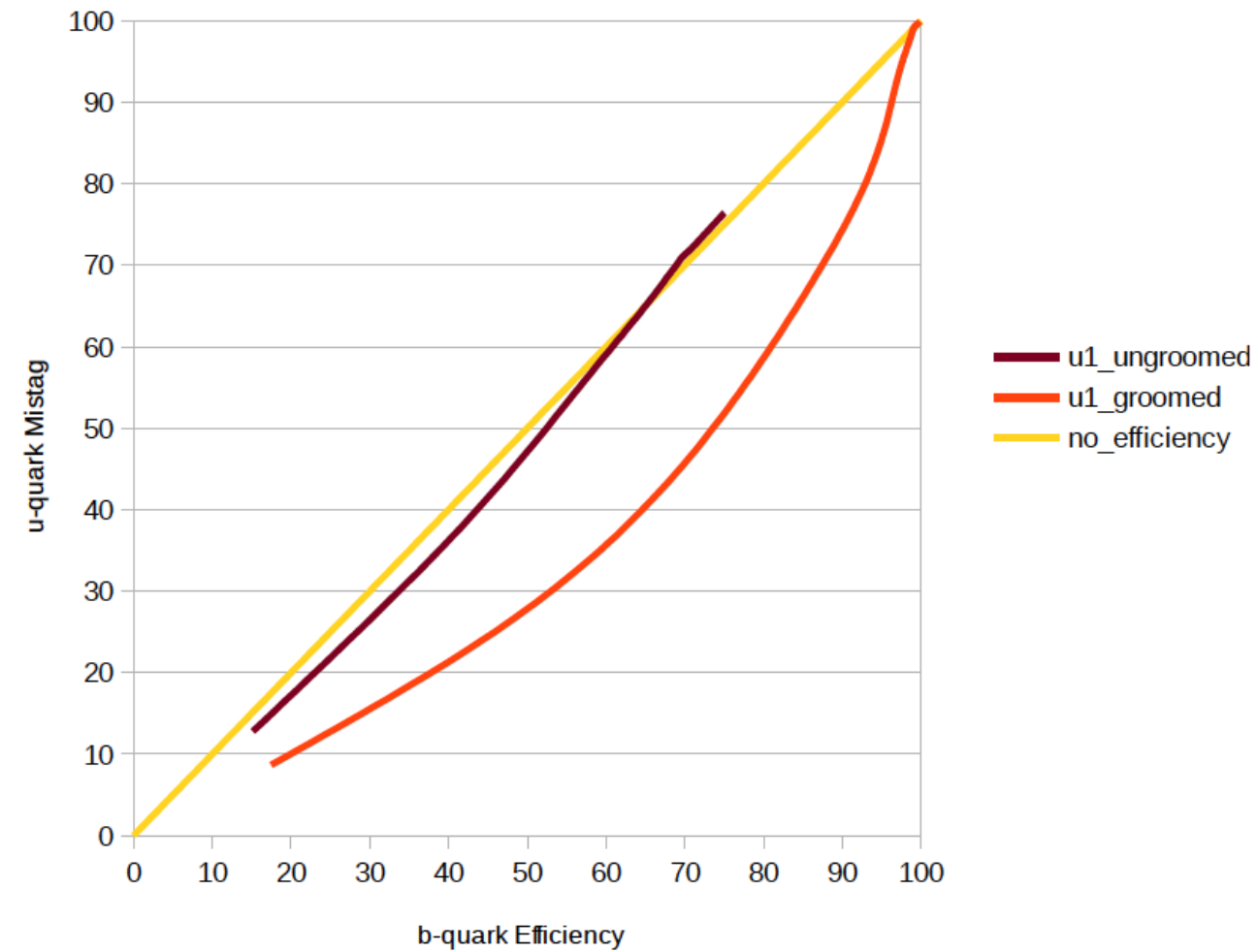# Light vs Heavy Quark Jets

Lee, Shrivastava, Vaidya (in progress)

Groomed Jets

pT > 50 GeV, R=0.6, alpha=0.2, zcut=0.2, beta=0

ROC with double sided cut

pT > 50 GeV, R=0.6, alpha=0.2, zcut=0.2, beta=0

Next steps in FY18

- Complete full QCD fixed-order calculation of groomed and ungroomed U_1 distributions for light parton and heavy quark jets

- Perform factorization and resummation of groomed and ungroomed U_1 distributions in SCET

- Expertise in T-2 on new SCET tools for precision jet shapes, effects of grooming, jet radii, non-global logs (e.g. Lee, JRO D. Neill), and on heavy quarks and quarkonia (e.g. new DOE postdoc Y. Makris): *combine and collaborate*

- *Food for future thought:* The effect of grooming on $U_{i(=3?)}$ for light vs. heavy quark jets may itself be a sensitive probe of quark mass effects, more than U_i itself.

see also Ilten, Rodd, Thaler, Williams (2017)