Prepared for submission to JHEP

Measurability and Calculability Working Group Minutes

Jon Walsh

Abstract: Notes from the Boost 2012 working group discussion

Contents

1 Observables 1

2 Why? 2

3 Grooming 3
- 3.1 Input from theorists needed: 3
- 3.2 Observables for groomed jets to measure: 4

4 Jet Mass 4
- 4.1 Samples 4
- 4.2 Aspects 4

5 Global Shapes 5

6 Jet shapes 5

1 Observables

- jet mass
- jet broadening/width/girth/1-subjettiness
- N-subjettiness
- N-jettiness
- splitting scales
- subjet multiplicity
- tracks and multiplicities
- groomed masses
- dipolarity/pull
- planar flow
- angularities
- hadronic event shapes
- jet areas

2 Why?

- find new physics
  - jet mass
  - splitting scales
  - groomed masses
- sensitivity to detector effects
  - jet broadening/width/girth/1-subjettiness
  - subjet and track multiplicity
- test MC
  - N-jettiness
  - groomed masses
  - dipolarity/pull
  - hadronic event shapes
- validate substructure
  - splitting scales
  - subjet multiplicity
  - groomed masses
  - N-subjettiness
- test theory errors
  - N-jettiness
  - jet mass
- test redundancy
  - all variables
- data makes us smarter
- unfolding
  - N-jettiness
  - hadronic event shapes

Test QCD:

- color connections
  - dipolarity/pull
- underlying event
  - groomed masses
  - hadronic event shapes
  - track multiplicities
  - jet area
- resummations
  - jet mass
  - N-jettiness
  - angularities
- NLO/NLL importance
  - N-jettiness
  - jet mass
- factorization
  - jet mass
  - groomed mass

3 Grooming

3.1 Input from theorists needed:

The grooming jet algorithms are going to be fixed soon for the near future by the experimentalists. They need input from the theorists on which grooming algorithms would be useful to measure, and for what signals/channels. Are any grooming algorithms useful to measure on jets outside of jet substructure (for general use)? Are there any important theoretical considerations for the calculability/feasibility of the grooming algorithms? What grooming methods can reasonably be measured in the coming year by each collaboration?

- which removes contamination best?
- which is calculable?

3.2 Observables for groomed jets to measure:

A set of observables would be useful to measure on groomed jets to characterize their sensitivity to underlying event, pileup, and other soft effects. It would be very useful to compare these measures before and after grooming to compare the effects of the grooming algorithm. Of course jet mass before and after grooming is very important to see.

- N-subjettiness
- broadening
- charged tracks

4 Jet Mass

4.1 Samples

The dijet sample is important because it forms such a large background, but EW+jet is useful for high pT EW as it provides a sample of single jet events that can be easily measured.

- Dijets
- Inclusive Jets
- W/Z/photon Jets

4.2 Aspects

There are many aspects of jet mass that can be measured. The 3 that various theorists deemed to be important are listed below, as are a set of subleading jet cuts that are useful to restrict additional jets for theory calculations. It is also important to theorists to see exclusive jet samples with hard cuts on extra jets.

- inclusive
- leading
- subleading
- pT bins
- mass vs. pT *****in the top 3***** - cross section vs. mass for different pT bins
- tracks/clusters/towers
- rapidity dependence
- hT bins

- pileup bins
- mass vs. deltaR to the nearest jet *****in the top 3***** - mass distribution for different kinematic cuts on the multijet final state
- density bins
- jet algorithm parameters (ATLAS - temporary)
- jet algorithms (ATLAS - temporary)
- hard cuts on extra jets
- mass of exclusive jets
- sum of jet masses
- mass vs. mass in dijets *****in the top 3***** - 2D contour plot in mass
- mass vs. broadening measures (width, tracks)
- mass of the jet in single jet events (e.g. EW + jet) *****theoretically important, simpler*****
- **subleading jet vetos:** EW+jet - cut on the pT of the 2nd jet $<$ 20% of the EW pT; dijet - cut on the pT of the 3rd jet $<$ 20% of the dijet pT

5 Global Shapes

Measurements:

- 1-jettiness in EW+jet for pT bins in EW (high and low pT)
- y_{23}: recombination metric scale d_{23} for kT divided by the pTs of the leading jets (for multijet events)
- transverse thrust (for multijet events)

6 Jet shapes

Measurements:

- Jet broadening/1-subjettiness (hadronic definition) $\tau_1 = \frac{1}{p_{T_J}} \sum_{i \in J} \Delta R_{iJ} p_T^i$. Interesting to see mass vs. jet broadening
- General angularities: take ΔR_{iJ}^{2-a} in the above broadening definition. $a = 1$ is broadening, $a = 0$ is jet thrust or quadratic measure.

- 2-subjettiness and 3-subjettiness
- Planar flow
- subjet multiplicity from trimming
- multiplicities of objects in a jet (subjets, charged tracks,...): how fine is the resolution in spatial resolution and energy?
- the distribution in the jet shape $\Psi(r)$, the energy of a jet in a subcone of radius r, for a given r. The average value has already been measured, theorists want to see the distribution that gets averaged for various small r $(0.1 - 0.4)$.