The Proceedings of the BOOST 2015 Conference: A Review of Jet Substructure at the Start of LHC Run 2

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Abstract: Is very abstract

1 Introduction

With the advent of collisions at $\sqrt{s} = 13$ TeV, the Large Hadron Collider has once again broken records at the energy frontier. Collisions at these unprecedented energy scales, and even those at the lower LHC runs at $\sqrt{s} = 7$ and 8 TeV, are unlike those at any previous collider because they produce significant numbers of massive particles with large (transverse) momentum. As the opening angles betewen the decay products of these massive particles is inversely proportional to the transverse momentum, these decays are highly collimatted, leading to inefficiencies in *classical* event reconstruction techniques.

The field of *jet substructure* began as an effort to address these inefficiencies: by aiming to reconstruct massive particles in a single, large-radius jet (instead of several overlapping small-radius jets), new techniques were hoped to be able to recover and improve the understanding of these high-energy particles. *Grooming* methods were designed to remove the susceptibility of the large jets to pile-up and underlying event by removing portions of the jets that were measured to be uninteresting; *tagging* methods were designed to exploit the difference in the energy distributions between signal jets from electroweak objects and background jets from QCD multi-jet production. Since its origins in improving searches for the Higgs boson and new physics, the field has expanded also to measurement of the Standard Model: the stucture of jets, exactly the information which jet substructure utilizes, can be utilized as sensitive tests of parton showers, hadronization models, and fundamental QCD properties.

The BOOST conferences have been a series of workshops designed to bring together experts in substructure from both theoretical and experimental communities.

These proceedings are designed to serve as both a summary of the BOOST 2014 and 2015 conferences, and as a review of the status of jet substructure in general. The field has evolved significantly since the last review in the 2012 BOOST report, and our goal is to highlight these developments.

2 Jet Tagging and Resonance Searches

- What taggers have already been commissioned and what is the theoretical understanding of their behavior?
  - Top tagging
    - ATLAS top tagging paper [1]
    - CMS top tagging note [2]
    - Comparisons
      - CMS consider subjet b-tagging, ATLAS considers it a separate selection
  - W/Z tagging
    - ATLAS boson tagging paper (not released), ATLAS W/Z (not released)
    - CMS boson tagging paper [3]
    - Comparisons

  - h Tagging
    * Discussion of boosted b-tagging [4–6]
    * ATLAS h tagging note
    * CMS h tagging note
    * Comparisons

- What updates, changes, and additions are necessary for Run 2?
  - ATLAS [7, 8], CMS [9, 10] pub notes for 13 TeV
- What should be the ultimate goal for W/Z tagging in the long term?
- What are the results of resonance searches incorporating these taggers?
  - Diboson searches on CMS [11, 12], ATLAS [13–15]
  - Dihiggs searches on CMS [16] and ATLAS [17]
  - Ditop searches on CMS [18], ATLAS [19]
  - VLQ (???)

3 Other Searches With Substructure

- What other searches have been performed outside of the typical domain of W/Z/H/t resonances, and what techniques do they use?
  - SUSY Searches (multijet RPV [20]/RPC [21]) with total jet mass
    * Top tagging with 1L stop in previous section?
  - SUSY searches with boosted supersymmetric particles
    * ATLAS stop RPV [22], gluino RPV [23]
    * CMS equivalents?
  - Quark gluon separation
    * ATLAS [24] and CMS [25] comparison of results
    * CMS searches emplying q/g tagging (???)
- What are the prospects for searches with jet substructure in Run 2?

4 Progress in Analytical Calculations

- What is the status and recent theoretical progress in analytic calculations for substructure?
- What has already been done and compared to data?
- What is now available for comparison to data but has yet to be compared?
- What still needs to be calculated and what are the wishes for experimental measurements?

5 Experimental Measurements

- What measurements have been performed already?
  - Cross-section measumements ($d\sigma/dX$)
    - ATLAS [26]/CMS measurements of jet shapes
    - How have these been used?
  - Boosted cross-section measurments ($t\bar{t}$)
    - CMS [27] and ATLAS [28] new results
  - SM properties
    - Pull and color flow: singlet vs octet measurement of W
      - ATLAS measurement [29], CMS use in searches [3, 30]
    - Jet charge, and scale violation [31]
      - Or with cross-section measurements?
- What measurements are being planned for Run 2?
- What measurements are missing and should be performed?

6 Prospects for Super Boosted Objects

- What observables do we know have problems as a function of pT?
  - Issues related to granularity?
- What observables are roughly scale independent?
- What studies have already been done and what performance assessments can be made?
  - Various approaches (Sergei, Gilad, etc.)
- What lessons have been learned about detector requirements?
- What studies are still missing and how can detector simulation be used or incorporated?
  - What should the FCC study groups focus on?
- How can substructure be utilized at lepton colliders?
  - What kind of jet algorithms will be useful?
  - What are the detector performance requirements?

7 Conclusion

8 Acknowledgements

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