“Search for diboson resonances in hadronic final states in 139 fb−1 of p p collisions at √ s = 13 TeV with the ATLAS detector”

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/HDBS-2018-31/

- This article uses Track-CaloClusters (TCC) jets

Assignments

- Sec1~5
    - Gang, Wei

  Q1: What is minimum-bias?

  Ans: in-elastic scattering events chosen by minimum bias trigger which includes non-diffractive and diffractive processes.

  Q2: How does the D_2 work as described in page 7, the 2nd paragraph?

  Ans: D_2 is built from three-point and two-point energy correlation function, e3 and e2, proposed by 1409.6298. It’s among the most powerful observables for identifying hadronic Boson decay, and verified by ATLAS 1510.05821.

$D_2^{(\beta)} \equiv \frac{e_3^{(\beta)}}{\left(e_2^{(\beta)}\right)^3}$.	$e_2^{(\beta)} = \frac{1}{p_{TJ}^2} \sum_{1<i<j<n_J} p_{Ti} p_{Tj} R_{ij}^{\beta}$, $e_3^{(\beta)} = \frac{1}{p_{TJ}^3} \sum_{1\leq i<j<k\leq n_J} p_{Ti} p_{Tj} p_{Tk} R_{ij}^{\beta} R_{ik}^{\beta} R_{jk}^{\beta}$,

Energy correlation functions, e3_e2, above can explore hard-splitting (R12), Soft and Collinear radiation among a hadronic jets. Their behaviors are quite different for 1-prong and 2-prong jets as depicted in Figure 1 below. D2 shows a clear boundary between 1-prong and 2-prong jets at different boost of the hadronic jets as shown in Figure 3.

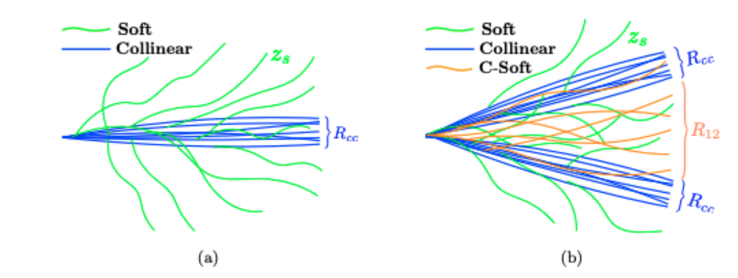

Figure 1: a) 1-prong jet, dominated by collinear (blue) and soft (green) radiation.

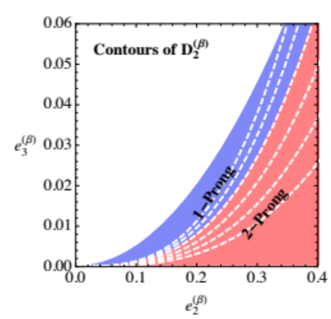

Figure 3. Dashed-line represent different D3 value.

1. What does this mean? these jets are built from a combination of calorimeter and tracker-inputs compatible with the hadronic decay of a boosted W or Z boson in abstract.
   Ans: Typically, a jet at ATLAS is a LCTopo jet (Local Calibrated topological jet). However, the jets studied in this paper use information from both Calorimeter and Tracker.
2. What does this mean? Novel inputs are used for jet finding in introduction, what are the novel inputs
   Ans: Novel Inputs = Track-Calor Clusters
3. What does this mean? Although the analysis primarily relies on jets, reconstruction of lepton candidates is necessary reject events that could bias the SM V+jets studies in Section 6.2
   Ans: Think about what is the possible decay channels of V+jets. Among these events, what do we want to reject, and what do we want to keep for calibration.

4. In 5.1, if combining information from calorimeter and tracking detector is so good, why did not other analysis use this method or are there any other analysis which used the same method?
   Ans: Check performance of TCC jets in Figure 1. Think about Signal to Background ratio required of analysis, and which type of analysis can be benefit from TCC jets.

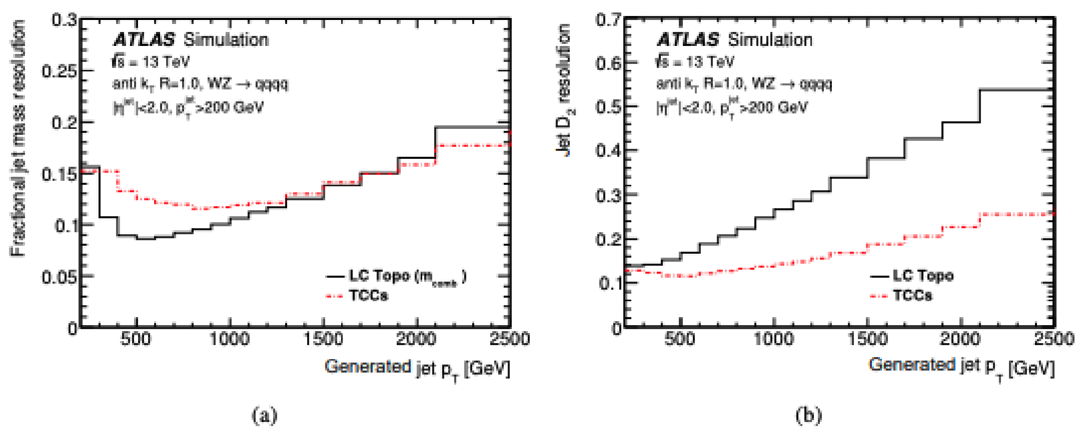

Figure 1: A comparison of (a) the fractional jet mass resolution for jets built from a linear combination of the calorimeter and track-only mass (LCTopo m_{comb}, solid line), and jets built using combined and neutral Track-CaloClusters objects (dashed lines) as a function of Monte Carlo generator-level jet p_T. The fractional jet resolution of the D_2 variable (b) is compared between Track-CaloClusters and pure calorimeter jets. Only the two jets with the highest p_T per event matched to a generated jet from a W or Z boson are shown.

- Sec 6
  - Ke, Haoran

1. p8, selection on A=(pt1-pt2)/(pt1+pt2)<0.15 makes the selection of pt2>200 GeV useless.
   Ans: what is your argument?
   Because pt1> 500 GeV, pT2 will be > 370, which eliminate the pt2>200GeV

2. Q2, p8, sec. 6.1, "A three dimensional...boosted vector boson jets ...", I think the optimization should be based on the di-jet, not single jet, but figure.2 is for one jet.
   Ans: This section is about OBJECT level optimization
3. Q3, p8, sec. 6.1, is the epsilon the average efficiency for W' in the mass range of 0.5 to 10 TeV?
   Ans: THink about statement in p9. "This number, epsilon/(a/2 + √ B), does not rely on a specific signal, but is valid for all signals with similar experimental features. Compared with the often used S/ √ B, that breaks down for small values of B, as is the case here, this measure is more appropriate."
4. Q4, p11, first sentence, how to choose the jet to perform D2 and ntrk selection?
   Ans: Check Sec 6.1
5. Q5, p13, figure 5, the eta of jet is required to be less than 2, why the acceptance times efficiency could be close to 1?
   Ans: Pay attention on which selection criteria with A*Eff close to 1.
6. Q6, p13, figure 5, the relative efficiency for D2 and ntrk is 0.92 from figure. 4, but it is almost one-third from figure. 5.
   Ans: Check definition of S_tag described in 3rd paragraph of Sec 6.2 for Figure 4. Is it the same definition of selection efficiency in Figure 5?

   "This is applied as a scale-factor to the signal MC events, where the uncertainty in it reflects the uncertainty in the W Z-tagging efficiency" => Stag is a scale factor

- Sec 7
    - Wanyun, Alex

1. Q (p13): What is the reasoning behind the parameterisation (1)?
   Ans: Good question.
2. Q(p14, figure 6):How do 'Regions A and C are used to derive a per-event transfer factor from region D to the fit control region'?
   Ans: This is a ABCD background estimate method. Think about relations of yields in each of the ABCD region.
   If two variables are uncorrelated, N_A/N_B = N_C/N_D or A/C = B/D

   The background yield in Region B N_B = (N_A/N_C) * N_D = weight *N_D

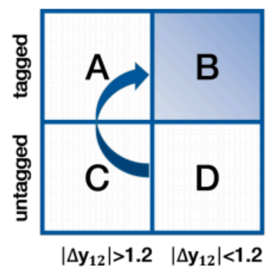

Figure 6: Four orthogonal regions used to build the fit control region for each signal region. A: $|\Delta y_{12}| > 1.2$ with both the jets boson-tagged, B: $|\Delta y_{12}| < 1.2$ with both the jets boson-tagged (this is the nominal signal region), C: $|\Delta y_{12}| > 1.2$ with the event not boson-tagged, D: $|\Delta y_{12}| < 1.2$ with the event not boson-tagged. Regions A and C are used to derive a per-event transfer factor from region D to the fit control region, which is representative of region B. A and C are also signal-depleted due to the $|\Delta y_{12}| > 1.2$ requirement.

3. Q(p14):How 'By applying per-jet weights, for the inverted selections, depending on the jet pT, events of the region D are transformed to resemble region B – the fit CRs' ?
   Ans: This statement is the procedure to use events in control Region D, to build background template in the signal Region B. This procedure requires per-jet weights derived using Control region A and C.

- Sec 8/9/10
    - Min Zhong

1. Q1: p15, the last two paragraphs, why do we use Gaussian smearing event-by-event for jet_pt resolution uncertainty, but study jet_mass scale and resolution uncertainty using boson-tagging efficiency?
   Ans: No. I have different understanding of these two pagraphs.
   It said that jet_Pt and jet_mass scale can affect the boson tagging efficiency.
   In addition to these two systematic effects, they apply boson-tagging efficiency scale factor derived in the Sec 6.2

   They claim the per-event scale factor is 0.85+0.23 −0.21. Because you have two jets per event, and per-jet scale factor derived in Sec 6.2 is 0.92+-0.04.

2. Q2: p16, para3, why will the uncertainties in the behaviour of the PDFs at high Q^2 values potentially have a large effect on the signal acceptance?
Ans: See uncertainty of PDF at high Mx 1510.03865

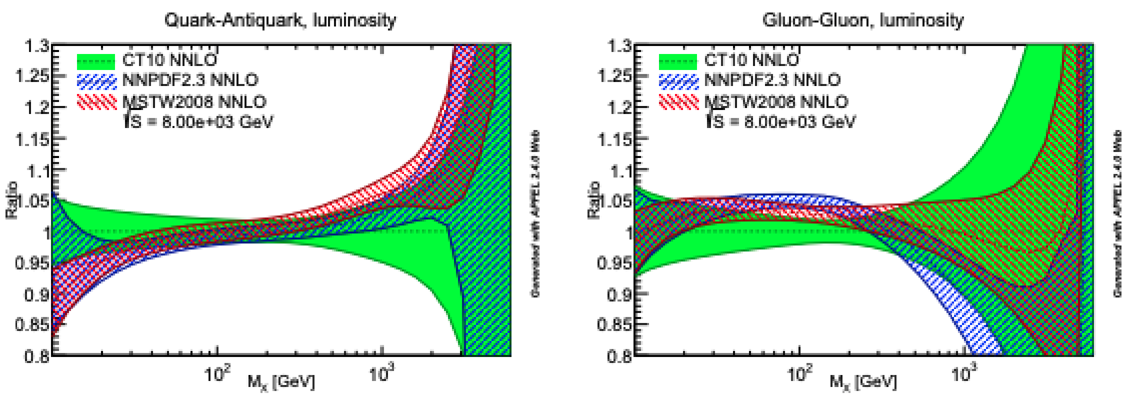

Figure 1: Comparison of the $q\bar{q}$ (left) and gg (right) PDF luminosities at the LHC 8 TeV for CT10, MSTW2008 and NNPDF2.3. Results are shown normalized to the central value of CT10.

3. Q3: P16, para2, simple introduction to trigger efficiency versus dijet invariant mass requirement?

Ans:
In this section, it describes
“The uncertainty from the trigger selection is found to be negligible, as the minimum requirement on the dijet invariant mass of 1.3 TeV guarantees that the trigger is fully efficient”

In Sec 3, the trigger used for this analysis is described as
“Events used in this search satisfied a single-jet trigger requiring at least one jet reconstructed at each trigger level. The final filter in the high-level trigger required a jet to satisfy a high transverse momentum (pT) threshold, pT ≥ 360 GeV (2015), pT ≥ 420 GeV (2016), pT ≥ 440 GeV (2017 and 2018), reconstructed with the anti-kt algorithm [35] and a large radius parameter (R = 1.0).”

Think about what the pT of each vector-boson decayed from a resonance with M>1.3 TeV.

Proposals of the next Journal Club reading:

- Search for squarks and gluinos in final states with same-sign leptons and jets using 139 fb−1 of data collected with the ATLAS detector
  https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/SUSY-2018-09/
- The anti-kt jet clustering algorithm
  https://arxiv.org/pdf/0802.1189.pdf
- Looking inside jets: an introduction to jet substructure and boosted-object phenomenology
  https://arxiv.org/pdf/1901.10342.pdf
- Impact of Alternative Inputs and Jet Grooming on Large-R Jet Performance
  https://cds.cern.ch/record/2644612/files/ATL-COM-PHYS-2018-1484.pdf
- Performance of the ATLAS Inner Detector Track and Vertex Reconstruction in the High Pile-Up LHC Environment
  http://cdsweb.cern.ch/record/1435196/
- Trigger Menu Strategy for Run 2
  https://cds.cern.ch/record/1703730/files/ATL-COM-DAQ-2014-054.pdf
- Observation of electroweak $W^{\pm}Z$ boson pair production in association with two jets in pp collisions at s√=13 TeV with the ATLAS detector
  https://cds.cern.ch/record/2652670