Motivation

- To determine which set of particles forms a jet, one needs to use a jet algorithm. Here we described the one used in our analysis - the k \(_t\) algorithm, but it is worth noting that there are others.

  - List all the particles in the event and find all the distances \(d_{i,j}\) and self-distances, \(d_i\), defined below:
    \[
    d_{i,j} = \min(p_{t,i}, p_{t,j}) \Delta R_{i,j}^2; \quad d_i = p_{t,i}^2
    \]
    With \(\Delta R_{i,j} = (\Phi_{i} - \Phi_{j})^2 + (\eta_{i} - \eta_{j})^2\)
  - Find the minimum of all \(d_{i,j}\); if the minimum is some \(d_{i,j}\), sum the 4-momenta of particles \(i\) and \(j\) and go back to the first step;
  - If the minimum is some \(d_i\), promote particle \(i\) to a jet and remove it from the list;
  - Repeat until all particles are promoted to jets.

- Sometimes, the contents of a jet are very collimated, due to the boosted parent. In these cases one needs to analyse the substructure of a jet before being able to distinguish the particles that could have originated it. Here we described the method of Mass Drop, used in our analysis:
  - Cluster all particles using the \(k_t\) algorithm;
  - Keep only the jets that satisfy \(p_{t,\text{jet}} > p_{t,\text{cut}}\). And define \(j\) as the jet with higher \(p_t\) in the event;
  - Go back to the last recombination step of \(j\) and define \(j_1\) (the more massive) and \(j_2\) as the parents. If all the following conditions are met, the jet is tagged as a W-jet:
    \[
    M_{j_1} < m_W, \quad d_{j_1,j_2} > y^2 m_W^2 \quad \text{and} \quad |M_j - M_W| < \Delta M_W
    \]
  - If one of these conditions is not met, redefine \(j_2\) as \(j\) and repeat the process until the jet is tagged as a W, otherwise it will not be a W-jet and the event will not be a signal.

- If 2 W-jets are found and they reconstruct the Z mass, the event is tagged as a signal event!

ACKNOWLEDGMENTS:

- The Standard Model of Particle Physics has being tested for many decades now and so far its predictions are in great agreement with experiment.
- Despite this huge success, there are reasons to believe that the SM is not the final theory in High Energy Physics, for example: the hierarchy problem, dark matter, neutrino masses and others.
- One of the Beyond SM proposals is models with extra spatial dimensions. These models are capable of explaining some problems of the SM and have other attractive features such as explaining why gravity is so weak.
- These models predict the existence of new heavy resonances, in particular new vector bosons that couple mainly to the heavy sector of the SM, i.e. the top quark, the Higgs and the EW bosons.

- In this work, we studied the LHC potential for observing the neutral EW boson, commonly know as \(Z'\).
- In particular, we studied the channel:
  \[pp \rightarrow Z' \rightarrow WW \rightarrow \text{jets}\]
- Due to confinement, quarks and gluons are not observed as free particles in nature. When produced, they hadronize originating a shower of new particles, which are collectively called a Jet, like the figure.
- This channel suffers with massive QCD background, since the final state is purely hadronic, that is the reason why we tried to do the analysis using techniques of Jet Substructure.

CONCLUSIONS

- Using the procedure briefly described here, we concluded that the LHC has a great potential of finding a new neutral EW resonance. The results are shown in the table below.
- The algorithm described here is a very useful tool not only for this particular search, but any other heavy particle.
- It is still need to study the effects of
  - Pile-Up or Multiple Events. Also the calorimeter effects.