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Rescuing VBF Higgs Invisible Events with Novel Vertex Selection

Tuesday, April 21, 2020 9:35 PM (10 minutes)

ATLAS event reconstruction requires the identification and selection of a hard-scatter (HS) primary vertex among the multiple interaction vertices reconstructed in each event. In Run 3, the HS vertex candidate is selected based on the largest sum of squared transverse momenta over the associated tracks. While this method works very well in events containing hard physics objects within the tracker acceptance, it suffers from low efficiency in final states containing forward and/or low p_T jets, such as in the case of VBF Higgs to invisible (VBF H$\rightarrow$ZZ(*)$\rightarrow$4ν), where the correct primary vertex is chosen correctly only 80% of the time.

In order to overcome this challenge and improve the signal acceptance for VBF Higgs invisible events, we introduce two novel ideas. First, we propose a new vertex selection algorithm that combines tracking with calorimeter jet information to overcome the challenge of events with low p_T jets. This new algorithm improves the vertex selection efficiency by 9%. Second, to address the case of events containing forward jets outside the tracking acceptance, we introduce the concept of vertex confidence. We classify events as high/low confidence based on the amount of track p_T associated to hard jets. Events in which the majority of the total jet p_T is outside the η acceptance of the tracker are classified as low vertex confidence events and no vertex is chosen for this category. For VBF Higgs invisible events, we find that 80% of the events are classified as high confidence, and the new algorithm selects the correct primary vertex 97% of the time for these events. The remaining 20% of the events are classified as low confidence VBF events events, for which no attempt is made to assign a HS vertex even though there is still a VBF jet signature.

In LHC Run-4, where the upgraded ATLAS Inner Tracker (ITk) provides an extended acceptance of $|\eta| < 4$, the new vertex selection algorithm improves upon the current selection technique by 9% by addressing the challenges of vertex selection under HL-LHC conditions.

Consider for young scientist forum (Student or postdoc speaker)

Yes

Second most appropriate track (if necessary)

Advanced usage of tracks

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