Physics motivation

The nuclear state composed of the $\Lambda$ hyperon and two neutrons, the Ann state, should be unbound [1][2], nevertheless new recent measurements indicate its formation at a mass of $2.993 \text{ GeV}/c^2$ as shown in the plot on the right. The production of a significant amount of baryons and strangeness at LHC energies allows for an increased production of potentially existing exotic QCD bound states. The Ann state can be detected with ALICE via the decay channel $\Lambda nn\rightarrow \pi \tau$ and its observation would crucially contribute to the understanding of exotic nuclear bound states.

Analysis strategy

The main challenge of this analysis is that the signal is not only rare, but it may not even exist. A machine learning (ML) approach has been used to consider all the features of the signal. In particular the Boost Decision Tree (BDT) algorithm within the TMVA package [3] was used. The same analysis procedure was applied at both Pb-Pb collision energies $\sqrt{s_{\text{NN}}}=2.76 \text{ TeV}$ and $\sqrt{s_{\text{NN}}}=5.02 \text{ TeV}$. The particle identification (PID) for tritons was done via TPC $dE/dx$ and Time Of Flight (TOF) measurements. The TOF signal was used in parallel to reject protons and pions below 4 GeV/c and the squared mass determined using the TOF detector was used above 3 GeV/c to have the necessary statistics for the BDT training stage. Only candidates containing antitrinos were considered.