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Status of the 152 GeV Candidate at the LHC

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The discovery of a Higgs boson at the LHC consistent with the predictions of the Standard Model (SM) marked a major milestone in particle physics. In this context, the search for new Higgs-like bosons remains at the forefront of efforts to explore physics beyond the SM.

Based on several features observed in the data collected during Run 1 of the LHC, a simplified model was proposed in which a heavy scalar, H, decays into a combination of the SM Higgs boson (h) and a new Higgs-like scalar, S. One implication of this model is the appearance of excesses in lepton production when the decay $S \to WW$ dominates. These excesses, referred to as the multi-lepton anomalies at the LHC, were subsequently identified. They include events with two or more leptons, missing transverse energy, and (b)-jets in the final state. Based on the invariant mass of lepton pairs, the mass of the new scalar is predicted to be $m_S = 150 \pm 5\,\mathrm{GeV}$.

The analysis of $\gamma\gamma$, $Z\gamma$, and WW sideband spectra in Run 2 data confirms the presence of a resonance at $m_S = 152 \pm 1\,\mathrm{GeV}$, with a global significance of 5.3σ. This represents the strongest excess observed at the LHC to date that is consistent with a narrow resonance beyond the SM. These findings strongly motivate further investigation at future high-precision facilities such as the CEPC.

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