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DEPARTMENT OF
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Coordinator: Prof. Riccardo Paoletti

**Search for resonant double Higgs
production in the $bb\tau\tau$ final state at the
CMS experiment.**

Disciplinary Scientific Sector: FIS/01

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Abstract

This thesis presents a search for resonant Higgs boson pair production via gluon-gluon fusion (HH) and targeting Beyond the Standard Model (BSM) scenarios such as the Warped Extra Dimensions (WED) model which predict resonances, including CP-even scalar particles, that enhance the HH production cross section at specific invariant masses.

The search focuses on the $HH \rightarrow b\bar{b}\tau^+\tau^-$ final state, with the $\tau^+\tau^-$ system studied through three decay channels: $\tau_h\tau_h$ (fully hadronic) and $\tau_h\tau_\ell$ (semileptonic, with $\ell = e/\mu$). This channel balances signal purity with a branching ratio of 7.3%, but poses challenges due to neutrinos in τ decays and background discrimination, requiring advanced reconstruction techniques.

To perform this search, proton-proton collision data at $\sqrt{s} = 13$ TeV collected by the CMS detector during 2016–2018 have been used, for a total integrated luminosity of 137.1 fb^{-1} . A blind analysis approach is employed to avoid biases during the statistical analysis, excluding observed data, and only expected results are reported. Upper limits on the HH production cross section are set as a function of resonance mass and interpreted within the WED framework, offering new insights into potential BSM physics.