# Abstract

Heavy Neutral Lepton (HNL) is proposed to be the right-handed heavy partner to the left-handed Standard Model (SM) neutrino, motivated by neutrino mass mechanisms. HNLs are hypothesised to be produced from kaon decays in the Booster Neutrino Beam (BNB) and subsequently decay in the Short-Baseline Near Detector (SBND), leaving observable signals for detection. The presented thesis focuses on the HNL channel $N \to \nu\pi^0$ in the mass range of 140-260 MeV, where the neutral pion decays into di-photon showers inside the detector. SBND is a 112 ton liquid argon time projection chamber, which offers an exceptional resolution in calorimetry, spatial and timing. The capability of SBND to search for HNLs is assessed in this thesis, of which the analysis exploits the boosted topology and late arrival features of HNL signals. Two selections of HNLs are presented, with one having more aggressive background rejection than the other. Both have a background rejection $\mathcal{O}(10^{-4})$ while maintaining a signal efficiency of ~ 30%. Moreover, an assessment of sensitivity under the assumption of an improved timing reconstruction is also given. The treatment of statistical and systematic uncertainties is outlined, followed by a limits setting procedure to set upper limits on the coupling $|U_{\mu 4}|^2$ of Majorana HNLs at the 90% confidence level. Three result scenarios are presented, demonstrating the current and potential physics capabilities of SBND.