Preparing the Surrounding Background Tagger for Background Suppression in the SHiP experiment

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The SHiP (Search for Hidden Particles) experiment will be installed in a dedicated beam-dump facility at CERN's ECN3 cavern. SHiP will search for long-lived, feebly interacting particles (FIPs) produced when 400 GeV/c protons from the SPS impinge on a heavy-metal target. Over 15 years, SHiP will focus on optimizing the sensitivity for models featuring long-lived FIPs in the GeV/c^2 mass range by suppressing backgrounds induced by the huge flux of neutrinos and muons to negligible levels. A crucial component for this task is the Surrounding Background Tagger (SBT), which surrounds the 50 m helium-filled decay volume. It tags charged particles entering the decay volume from outside and suppresses backgrounds induced by deep inelastic scattering of muons and neutrinos in the helium and the SBT itself. The SBT consists of about 800 cells, each filled with liquid scintillator (LS), read out by two Wavelength Shifting Optical Modules (WOMs). A WOM is a transparent PMMA tube coated with a wavelength-shifting (WLS) dye that absorbs the scintillation photons γ and re-emits photons in the optical range γ'. These secondary photons are then guided to silicon photomultipliers at the tube ends by total internal reflection. About 1600 WOMs will be installed, making reliable production and quality control essential.

My thesis project covers both hardware and physics studies. On the hardware side I will prepare WOM quality-control procedures, take part in upcoming SBT test-beam campaigns at CERN, and contribute to the Technical Design Report (TDR) due in 2027, after which mass production is foreseen. On the physics side, I will study background suppression strategies and analyze benchmark signal processes, such as $N \to \ell + \rho$ and $N \to \tau + \pi$, with the aim of kinematic reconstruction of the hidden particle mass peak and efficient discrimination between signal and background.