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Neutrino Physics with the SHiP experiment at CERN

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The SHiP Collaboration has proposed a general-purpose experimental facility operating in beam dump mode at the CERN SPS accelerator with the aim of searching for light, long-lived exotic particles of Hidden Sector models. The SHiP experiment incorporates a muon shield based on magnetic sweeping and two complementary apparatuses. The detector immediately downstream of the muon shield is optimised both for recoil signatures of light dark matter scattering and for tau neutrino physics and consists of a spectrometer magnet housing a layered detector system with heavy target plates, emulsion film technology and electronic high precision tracking. The second detector system aims at measuring the visible decays of hidden sector particles to both fully reconstructible final states and to partially reconstructible final states with neutrinos, in a nearly background free environment. Using the high-intensity beam of 400 GeV protons, the experiment is capable of integrating 2×10^{20} protons in five years, which allows probing dark photons, dark scalars and pseudo-scalars, and heavy neutrinos with GeV-scale masses at sensitivities that exceed those of existing and projected experiments. The sensitivity to heavy neutrinos will allow for the first time to probe, in the mass range between the kaon and the charm meson mass, a coupling range for which baryogenesis and active neutrino masses can be explained. The sensitivity to light dark matter reaches well below the elastic scalar Dark Matter relic density limits in the range from a few MeV/c^2 up to $200 \text{ MeV}/c^2$. The tau neutrino deep-inelastic scattering cross-sections will be measured with a statistics a thousand times larger than currently available, with the extraction of the F4 and F5 structure functions, never measured so far, and allow for new tests of lepton non-universality with sensitivity to BSM physics. Following the review of the Technical Proposal, the Collaboration recently submitted to the CERN SPS Committee a Comprehensive Design Study. These studies have resulted in a mature proposal discussed at the European Strategy for Particle Physics Update meeting in Granada. A measurement of charm production with a SHiP-like target interleaved with emulsion-based detectors was performed at SPS during 2019 and will be reported at this conference.

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