

Mini-workshop on opportunities to reveal New Physics with
feebly-interacting particles and ultra-rare decays in experiments with
extracted SPS beams at the CERN North Area

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Physics at a high-intensity kaon beam facility at the CERN SPS

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Precision measurements of the branching ratios (BRs) for rare kaon decays can provide unique constraints on CKM unitarity and may reveal the existence of new physics. Building upon a CERN tradition of ground-breaking experiments in kaon physics, including, most recently, NA62's successful application of the in-flight technique to measure $\text{BR}(K^+ \rightarrow \pi^+ \nu \bar{\nu})$, we envision a comprehensive program for the study of the rare decay modes of both K^+ and K_L mesons, to be carried out with high-intensity kaon beams from the CERN SPS in multiple phases starting in LHC Run 3 (2026), including both an experiment to measure $\text{BR}(K^+ \rightarrow \pi^+ \nu \bar{\nu})$ at the 5% level and an experiment to measure $\text{BR}(K_L \rightarrow \pi^0 \nu \bar{\nu})$ at the 20% level. The detectors could also be reconfigured to allow measurements of K_L decays with charged particles, such as $K_L \rightarrow \pi^0 \ell^+ \ell^-$. In addition, the availability of high-intensity proton and kaon beams and detectors with redundant PID systems and precise timing will allow for a wide range of searches for rare phenomena beyond the kaon sector, including dark sector particles produced in kaon and pion decays or in interactions in the experiment's target or beam dump.

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