Contribution ID: **183** Type: **Poster**

Examination of systematic uncertainties in the extraction of Fierz interference term within the bSTILED project

The Standard Model (SM) of electroweak interactions has been remarkably successful in describing fundamental particle interactions. However, compelling observational and theoretical indications suggest that it is an incomplete framework, necessitating an extended theoretical formulation. Searches for ***New Physics (NP)*** beyond the SM are actively pursued along three primary frontiers: the high-energy frontier, which probes unexplored energy scales using advanced particle accelerators such as the Large Hadron Collider (LHC); the cosmological frontier, which investigates fundamental questions related to dark matter and the cosmic microwave background; and the high-precision frontier, which employs ultra-sensitive measurements of atomic, nuclear, and particle processes to uncover deviations from SM predictions. Within this precision frontier, the ***extraction of the Fierz interference term (b_F)*** from beta decay experiments serves as a highly sensitive probe for physics beyond the SM. A nonzero value of b_F would indicate the presence of exotic ***scalar or tensor interactions***, providing direct evidence for non-Standard Model weak interactions. However, achieving a precise determination of b_F is experimentally challenging due to statistical and systematic uncertainties that stem from electron back-scattering, detector calibration errors, theoretical modeling approximations, and acquisition system limitations. In this work, we present a comprehensive mitigation strategy for systematic uncertainties affecting the precise extraction of the Fierz interference term. Key aspects include corrections for ***non-linearity in energy calibration, gain and baseline fluctuations, detector response function, light collection effects, acquisition module characteristics, and spectral fitting methodologies***. To enhance the reliability of the analysis, we incorporate ***Geant4-based Monte Carlo simulations***, enabling a refined quantification of systematic uncertainties. Position-dependent variations in optical photon collection have been observed to introduce systematic uncertainties in energy calibration. Imperfect light collection can result in non-uniform energy reconstruction, leading to distortions in the spectral shape. Additionally, reduced light yield can degrade energy resolution, thereby increasing uncertainties in spectral measurements. To mitigate these effects, corrections have been implemented through detailed simulations of light transport to account for collection variations, event-by-event corrections based on optical response maps, and calibration using well-characterized gamma and beta sources to benchmark detector response. These developments significantly improve the robustness of Fierz interference measurements and strengthen their role as a precision test for NP.

Author: RANI, Anjli (LPC CAEN)

Co-authors: LIÉNARD, E. (LPC CAEN); THOMAS, J-C. (GANIL); HAYEN, L. (LPC CAEN); KANAFANI, M. (LPC CAEN); NAVILIAT-CUNCIC, O. (LPC CAEN); GARREAU, R. (LPC CAEN); LEBLOND, S. (CEA / LIST / LNHB); VANLANGENDONCK, S. (KU Leuven); FLÉCHARD, X. (LPC CAEN); MOUGEOT, X. (CEA / LIST / LNHB)

Presenter: RANI, Anjli (LPC CAEN)

Session Classification: Poster session

Track Classification: Fundamental Symmetries and Interactions