

Abstract

This thesis presents a comprehensive study of two custom-designed ASICs developed for high-energy physics experiments: ToASt, part of the PANDA project, and CLEOPATRA, within the HASPIDE project. The main goal was to evaluate their performance, reliability, and radiation tolerance, providing a detailed understanding of their behavior and guidance for future developments.

The work begins with an introduction to the scientific background and the experimental context, describing the PANDA and HASPIDE experiments, followed by a discussion of the silicon sensors employed in both systems, highlighting their design and operational principles. Building on this foundation, the characteristics and architecture of the ASICs under study are presented, emphasizing the key features that determine their performance.

A detailed characterization of ToASt was then carried out, including calibration, noise evaluation, Single Event Upset (SEU) tests, and Total Ionizing Dose (TID) studies. Calibration significantly reduced the gain spread and Time-over-Threshold (ToT) offset, while parameter optimization further enhanced uniformity and predictability across all boards. Noise measurements indicated slightly higher values compared to the first prototype, though ongoing optimization is expected to improve these results. SEU tests demonstrated a reduction in upsets relative to the previous version, confirming the effectiveness of the implemented triple redundancy. TID studies revealed increases in current consumption in both digital and analog sections, with the annealing phase allowing partial or complete recovery depending on the irradiation conditions.

CLEOPATRA was also characterized to evaluate the response of the new design. These measurements provided insights into the device behavior under operational conditions and identified areas requiring improvement, which are being addressed in the development of a second CLEOPATRA version.

Throughout the thesis, each set of results is presented in the context of the experimen-

tal methods and setups used, culminating in a discussion of the findings, comparison of the ASIC versions, and an outline of perspectives for future work. This approach ensures a coherent narrative linking the scientific context, experimental techniques, and performance evaluation.

Overall, the thesis delivers a thorough assessment of both ASICs, establishing a robust methodology for future characterizations. The results contribute valuable insights for optimizing high-performance front-end electronics, supporting the development of increasingly reliable and precise detector systems for high-energy physics experiments.