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iactsim: a CUDA-accelerated Python simulation framework for Imaging Atmospheric Cherenkov Telescopes

In the last decade, Graphic Processing Units (GPUs) have become a standard component of High Performance Computing systems and are now ubiquitous in consumer-grade hardware. Their massive parallel architecture offers significantly higher computing throughput and energy efficiency than traditional CPU-based solutions. In the context of Imaging Atmospheric Cherenkov Telescopes (IACTs), large-scale Monte Carlo simulations of Extensive Air Showers are fundamental for data analysis. The telescopes' response to the Cherenkov light produced by such showers must also be carefully simulated. The most time-consuming tasks of an IACT response simulation are the optical ray-tracing and the camera electronics response. Although with a certain diverging degree, both tasks can be divided into independent sub-tasks (single photon propagation and single pixel response), making them highly suitable for GPU acceleration. In this contribution we present "iactsim": a CUDA-accelerated IACT Python simulation framework. The framework is designed to accelerate the aforementioned computationally intensive tasks, with the additional aim of providing a flexible and user- and developer-friendly collection of tools for IACT performance studies. These tools are intended to facilitate and accelerate instrument design studies and data analysis. Although the framework is still in its early development phase, we present a real-world case study simulating the ASTRI dual-mirror optical system and its Silicon Photo-Multiplier based Cherenkov camera. This is done to demonstrate the framework capabilities and validate its performance.

Collaboration(s)

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