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Multi-Threading for Baikal-GVD Core Software Framework

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Baikal-GVD is a gigaton-volume neutrino observatory under construction in Lake Baikal. Its data processing software consists of a core part and a managing part. The former is a set of C++ programs built upon the BARS (Baikal Analysis and Reconstruction Software) framework, which provides a basis for implementing all data processing stages. The Python-based management layer organizes these programs into an executable processing graph, resolving dependencies between them.

The system is designed with three levels of parallelism. First, different detector clusters are processed independently on separate virtual machines (VMs), with a dedicated VM merging their results. Second, each cluster data processing is performed in two sequential workflows: Fast Processing (per-file analysis within 2–13 minutes) and Offline Processing (full-run reprocessing with higher precision, completed within 1–5 hours after a run). Each workflow contains parallel processing sections.

This work focuses on the third level of parallelism: multi-threading within the core BARS framework. The use of multi-threading allows for a sizeable reduction of the algorithms' execution time, which can be particularly beneficial for online data analysis tasks in the context of multi-messenger astronomy.

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