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Real-Time Tomographic Reconstructions in MARTe with GPU Computation

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Future fusion devices will depend on high throughtput of data for which present CPU capabilities are reaching their limits and GPUs(Graphical Processing Units) are appearing as very promising candidates for such solutions. Integrating GPUs capabilities with the current real-time software frameworks is a challenge that needs adressing. Tomography is a diagnostics which produces high data volumes, while also being one of the more realible diagnostics for a poloidal profile of the plasma density of Tokamaks.

The ISTTOK tokamak is the only worldwide case where tomographic reconstruction is implemented in real-time and integrated with the control system which is built in the MARTe framework, and as such its current hardware configuration is being upgraded to obtain better and more realiable data. The former algorithm and geometry was only able to provide low spatial resolution images in order to meet $100\mu s$ cycle time constraint, but due to the increase of resolution it became necessary to develop a more advanced solution. Simultaneously this solution would also have to be integrated with the MARTe software framework, in a way that mantained its functionality and modularity.

In order to provide high definition images, GPU code was introduced into the computation line. However the code compatibility problem had to be solved, i.e. GPU directives needed to be functional inside the MARTe GAMs (General Acquisition Module). This was achieved by linking a precompiled GPU code to the GAM. GPU reconstruction proved to be very efficient in terms of latency and obtaining high resolution images.

Within the time constrain of $100\mu s$ reconstruction images up to the a resolution of 1600x1600 can be obtained with the new code versus the 15x15 reconstructions with the old code.

This work serves as proof: (i) that GPU computation is viable in real-time applications in fusion science; (ii) that GPU computation can significantly improve the quality of image-based diagnostics; and (iii) that the MARTe framework can improve its functionality with the integration of GPU capabilities.

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