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Clustering in the Heterogeneous Reconstruction Chain of the CMS HGCAL Detector

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We present a decisive milestone in the challenging event reconstruction of the CMS High Granularity Calorimeter (HGCAL): the deployment to the official CMS software of the GPU version of the clustering algorithm (CLUE). The direct GPU linkage of CLUE to the preceding energy deposits calibration step is thus made possible, avoiding data transfers between host and device, further extending the heterogeneous chain of HGCAL's reconstruction framework. In addition to various changes and improvements in the management of device memory, new recursive device kernels are added. The latter efficiently navigate through the hit-level information provided by CLUE, calculating the position and energy of the clusters, which are then stored in a cluster-level condensed format. Data conversions from GPU to CPU are included, using structures of arrays, to facilitate the validation of the algorithms and increase the flexibility of the reconstruction chain. For the first time in HGCAL, conditions data (in this case the position of detector elements) are deployed to and filled directly in the GPU and made available on demand at any stage of the heterogeneous reconstruction. This is achieved via a new geometry ordering scheme where a strong correlation between physical and memory locations is present. This scheme is successfully tested with the GPU CLUE version here reported, but is expected to come with a broad range of applicability, and be used by future heterogeneous developments in CMS. Finally, the performance of the combined calibration and clustering algorithms on GPU is assessed and compared to its CPU counterpart.

Speaker time zone

No preference

References

Alves B, Bocci A, Kortelainen M, Pantaleo F, Rovere M. Heterogeneous techniques for rescaling energy deposits in the CMS Phase-2 endcap calorimeter. EPJ Web Conf. 2021;251:04017. doi:10.1051/epjconf/202125104017

Significance

This work covers a new and much-needed contribution to the heterogeneous reconstruction in CMS, essential for the upcoming High-Luminosity LHC. It introduces multiple new steps in the HGCAL CMS reconstruction:

- first time the clustering algorithm is deployed to the official CMS software
- first time conditions data are used (and filled) by GPU algorithms
- first time two reconstruction steps are linked directly in the GPU and their combined performance is assessed
- first time the energy and positions of clusters are calculated in the GPU

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