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Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
ICSC Centro Nazionale di Ricerca in HPC, Big Data and Quantum Computing

Porting Code to GPU Platforms - UC2.2.4

Status

Adriano Di Florio

WP2 Bi-weekly Meeting - 22/07/2025

The flagship

- A link to the [full flagship document](). The KPIs status [in (X) the thresholds].

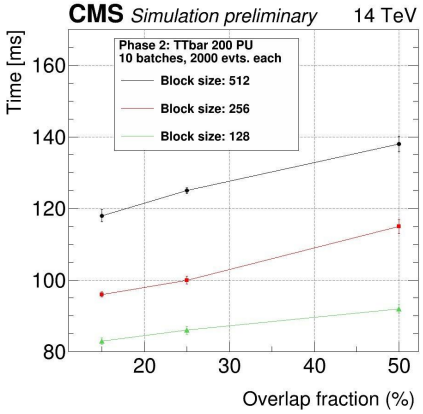
	Description	
KPI2.2.4.1	At least XX offline algorithm ported to GPU (most probably an LHC algorithm)	2 (1)
KPI2.2.4.2	At least YY online algorithm ported to GPU (most probably an LHC algorithm)	2 (1)
KPI2.2.4.3	**Preparation of a test infrastructure able to test codes on heterogeneous systems. At least ZZ architectures to be supported (eventually, AMD, nVIDIA, CPU)**	**3 (3)**
KPI2.2.4.4	**Organize at least KK events to introduce students and collaborators to heterogeneous computing and train them to the usage of portability tools (joint with WP4).**	**3 (3)**

- We are in the **third (and final period).**
- The integration in the software frameworks always happened in parallel.
- The validation is in place (a small updated today).

- Third Period (ICSC month 32-36)
  - ✅ Integration with the software framework of the experiments.
  - ✅ Setup of the simulation production campaigns for the cross-platform validation campaign.
  - ✅ Documentation of the software developed and integrated in the experiment stacks.
  - 🚧 Deliverables (MS10):
    - 🚧 Report demonstrating the KPIs

KPI 2.2.4.1 - Online Reconstruction

	Description	
KPI2.2.4.1	At least XX offline algorithm ported to GPU (most probably an LHC algorithm)	2 (1)

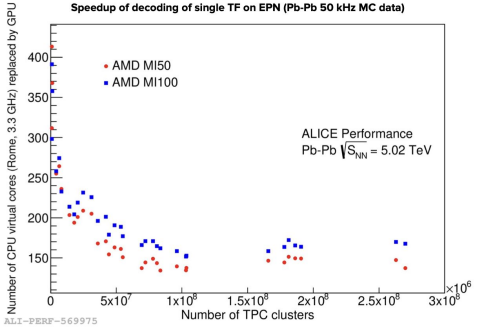


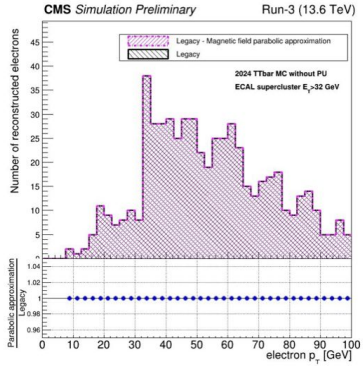
- What goes in this KPI ?
  - CMS Primary Vertex Reconstruction on GPU [CDS] (could actually contribute also to 2.2.4.1);
  - CMS Strip Particle Reconstruction on GPU [to be integrated in CMSSW, will have a contribution at ACAT25].
  - Multi-Objective Optimization Tool for CMS GPU Algorithms Optimization [CDS] [CHEP24]

KPI 2.2.4.2 - Online Reconstruction

	Description	
KPI2.2.4.2	At least YY online algorithm ported to GPU (most probably an LHC algorithm)	4 (1)

- What goes in this KPI?
  - ALICE ITS clustering in Alpaka [contribution from Leo];
  - ALICE data decompression for asynchronous reconstruction [CHEP24];
  - CMS Electron Seeding on GPU [CDS][CHEP24] (could contribute also to 2.2.4.1);
  - CMS Pixel Tracks Reconstruction in Alpaka [CMSSW-PRs] [CDS]



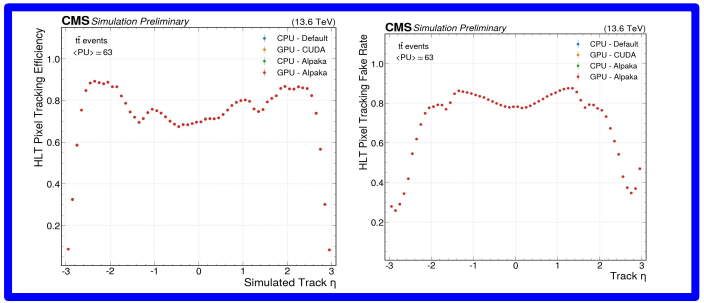


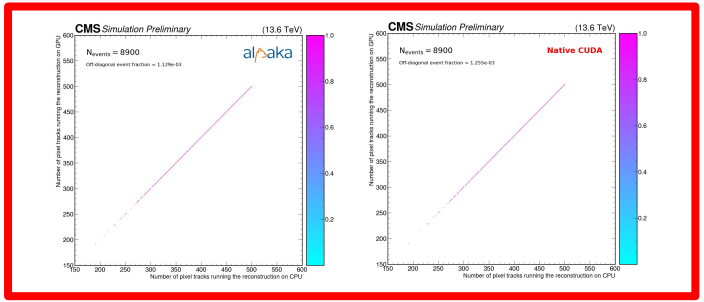
KPI 2.2.4.3 - Validation and Infrastructure

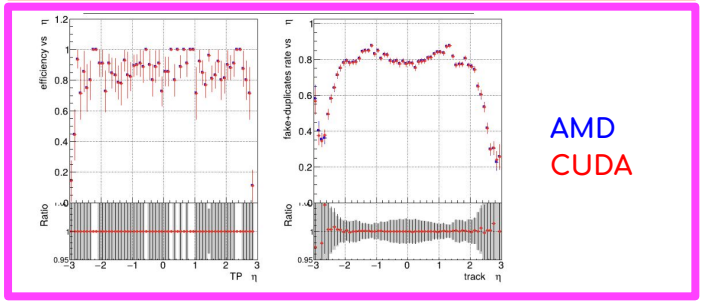
	Description	
KPI2.2.4.3	**Preparation of a test infrastructure able to test codes on heterogeneous systems. At least ZZ architectures to be supported (eventually, AMD, nVIDIA, CPU)**	**3 (3)**

Validation infrastructure

- working validation infrastructure, tested also on *pledged resources*;
- validate the usage of Alpaka by CMS from 2024 datataking; pixel tracks performance as metrics [see CDS];
    - **Validation 1:**
        - Running on the same RAW events.
        - Four setups
            - pre-Alpaka migration on CPU/GPU (native CUDA);
            - Alpaka on CPU/GPU;
        - perfect match
    - **Validation 2:**
        - running the Alpaka (and CUDA) GPU and CPU reconstruction in the same job and for each event;
        - compare GPU and CPU quantities event by event;
        - same intrinsic fluctuations in Alpaka and native CUDA.
- **Tested AMD resources at CNAF for an additional architecture.**
    - Validation type 1: locally tested (AMD vs CUDA)->3 architectures.
    - Tested access to resources also from CMS centra submission infrastructure ✅







AMD
CUDA

KPI 2.2.4.4 - Events

	Description	
KPI2.2.4.4	Organize at least KK events to introduce students and collaborators to heterogeneous computing and train them to the usage of portability tools (joint with WP4).	~3 (3)

- What goes in this KPI?
  - "First course about the porting on GPUs of code and algorithms"
    - https://agenda.infn.it/event/35808/
  - 16th CMS Patatrack Hackathon.
    - Not directly organized by the CN. But served as a follow up for many of the activities in the flagship.
  - "Second course on porting on code and algorithms on GPU"
    - https://agenda.infn.it/event/46681/

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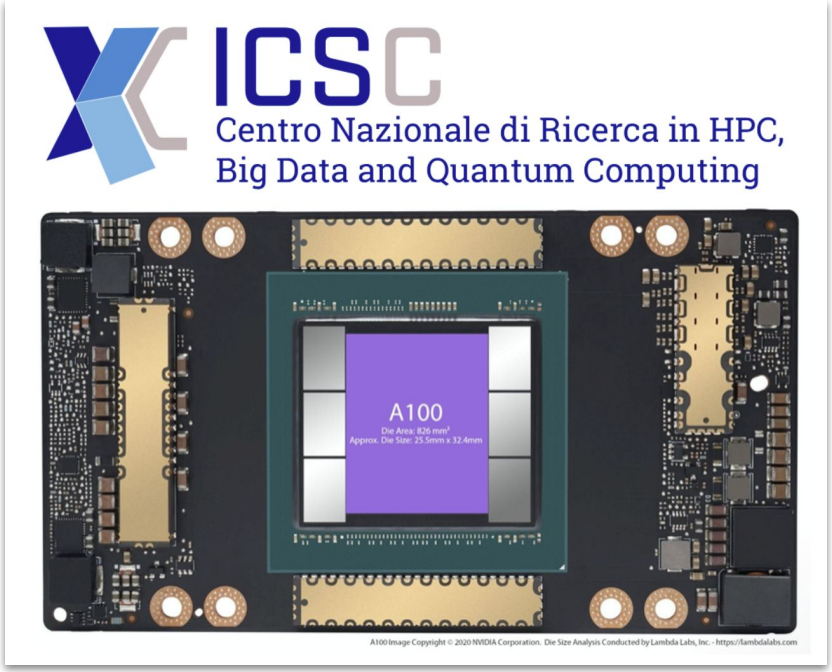

- ~30 participants (~20 in person in Bologna)
- Program:
  - General introduction to GPU programming with CUDA.
  - Performance portability with Alpaka.
  - Optuna for Hyperparameters optimization.

Summary

- **Flagship is an good shape.**
- **All the KPIs fulfilled.**
    - Thanks to WP4 also the latest event have been organized.
- **The last missing piece is the final report for MS10 (in progress).**

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(questions?)