CMS Heterogeneous Pixel Track Reconstruction using SYCL

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SYCL – Motivation.

More and more data are being produced, and experiments become increasingly complex.

Algorithms are required to be validated.
- Simulations can take minutes per event (High Lumi Conditions).

Reproducibility and productivity are essential to this validation.

Need to be able to run reconstruction code on cheapest HW without duplicating code.
SYCL

Write code once!

Compile and run on different devices.

Target Intel, NVIDIA, AMD GPUs
CPUs, FPGAs…

Different Supercomputers

• • • • Other devices
Pixel Track Reconstruction
Porting the Clustering Algorithm.

Andrea Bocci et al., *Heterogeneous reconstruction of tracks and primary vertices with the CMS pixel tracker*, 2020, arXiv: 2008.13461
Results

• Successfully developed the SYCL implementation of clustering algorithm
• SYCL allows to run the same code on both CPU or GPU or both in hybrid configuration
• GPU has 1.4x speedup w.r.t. CPU
• All different configurations with the same code!

Relative Throughput

On CMS Run 3 conditions
Summary

• Learned how to program with SYCL – through a real-world application!

• Understood the structure of HEP reconstruction software

• Interesting discoveries through Intel meetings – bugs
  -- Special thanks to Igor Vorobtsov and Klaus-Dieter Oertel from the Intel team!

• Worked amongst an amazing student team (Juan Jose Olivera Loyola, Aurora Perego and Luca Ferragina).
Sources.


https://github.com/cms-patatrack/pixeltrack-standalone


https://developer.codeplay.com/products/computecpp/ce/1.1.0/guides/sycl-for-cuda-developers/migration

https://codimd.web.cern.ch/79K6te6tQvSbUuH_F9hKjQ?view

https://info.ornl.gov/sites/publications/Files/Pub176145.pdf

https://indico.cern.ch/event/742793/contributions/3274390/attachments/1821674/2979847/20190402_Felice_CTD.pdf

https://indico.cern.ch/event/773049/contributions/3474336/attachments/1940557/3217478/Heterogeneous_online_reconstruction_at_CMS.pdf

Git repo (dev branch) : https://github.com/AuroraPerego/pixeltrack-standalone/tree/dev
Thank you for this amazing experience!