

STEAM: The Next Generation Triggers Education Program

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NexTGen
Next Generation Triggers

Overview of the STEAM Program

What is STEAM?

- CERN Software Training, Education, and Advanced Modules

Purpose:

- Equip postgraduate students, Ph.D. scholars, and researchers with cutting-edge software skills
- Focus on algorithms, AI, trigger systems, advanced computing as applied to HEP

Vision:

- Ensure a vibrant future for research by enhancing software proficiency

The team



Felice Pantaleo
Leader of Task 4.2



Vicky Batsari
Graduate (Origin)

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Or on
[Mattermost](#)

Objectives of the STEAM Program

- Develop a year-long educational program:
 - Topical lectures, seminars, dedicated schools
 - Hands-on training courses in software tools and techniques
- Engage professors, researchers and experts, collaborate with universities and industrial partners
- Create opportunities for the exchange program (Task 4.1)

Phases of the Program

- Preparatory Phase (2 years):
 - Establish Program Committee
 - Conduct skills gap analysis
 - Develop course modules and training materials
- Implementation Phase (3 years):
 - Official launch of the STEAM Academy
 - Regular lectures, seminars, and dedicated schools
 - Hands-on sessions and practical experience
 - Continuous assessment and refinement

Growing Network of Schools

45th CERN School of Computing

8 – 21 September 2024
Hamburg, Germany

Thematic School on Machine Learning

13 – 19 October 2024
Split, Croatia

INFN XV
INFN INTERNATIONAL SCHOOL
EFFICIENT SCIENTIFIC COMPUTING
14 - 24 OCTOBER 2024
CEUB - BERTINORO (FC) ITALY

ARCHITECTURES, TOOLS AND METHODOLOGIES FOR DEVELOPING EFFICIENT LARGE SCALE SCIENTIFIC COMPUTING APPLICATIONS

PROGRAM

FUNDAMENTALS OF EFFICIENT PROGRAMMING

- Modern processor architectures
- Tools and methodologies for improving performance
- Efficient use of modern C++
- Managing memory usage

PARALLEL PROGRAMMING FOR SCIENTIFIC APPLICATIONS

- Parallel CPU programming
- Floating-point computation
- GPU programming
- Cluster computing with MPI

LOCATION

CEUB - University Center of Bertinoro

INTERNATIONAL SCIENTIFIC COMMITTEE

F. Giacomini - INFN CNAF (Chair)	V. Innocenti - CERN
A. Bocci - CERN	T. Mutton - Independent Researcher
M. Busamane - HZDR Dresden	A. Pace - CERN
D. Casari - INFN CNAF	F. Panfili - CERN
D. Goll - Bologna Uni. and INFN	

LOCAL ORGANIZING COMMITTEE

D. Goll - Bologna Uni. and INFN (Chair)
D. Bertolotti - INFN Bologna
A. Garofolini - Padova Uni. and INFN
A. Mondocci - INFN Bologna
C. Pellegrino - CNAF

MANAGEMENT COMMITTEE

M. Morandini - INFN Padova (School Director)
R. Stralli - Padova Uni. and INFN (Technical Manager)
R. Chiarotti - INFN Padova (School Administrator)
A. Della Bona - INFN Padova (Communication, SMM, Staff)

REGISTRATION:
esc.inf.it

In partnership with **NextGen** Next Generation Triggers

EDGE MACHINE LEARNING SCHOOL

SMARTHEP
REAL-TIME ANALYSIS FOR SCIENCE AND INDUSTRY

23-27.09.2024
CERN

An event organised by the **SMARTHEP Network** and **Next Generation Triggers**

Organising committee:
Anna Sfyrla (University of Geneva)
Maurizio Pierini (CERN)
Sioni Summers (CERN)
Thea Aarrestad (ETH Zürich)

Lecturers from NVIDIA, AMD/XILINX, IBM Research, GraphCore, hls4ml, HACC and more

This training program is designed to provide participants with knowledge and hands-on experience in the emerging field of Edge Machine Learning, tailored for applications at the LHC.

It includes introductory lectures, tutorials, and seminars covering topics like fast inference on specialised hardware, model compression techniques, and neuromorphic computing. Now open for poster submissions and registration:

indico.cern.ch/e/SMARTHEP-edge-ML

SMARTHEP is funded by the European Union's Horizon 2020 research and innovation programme, call H2020-MSCA-ITN-2020, under Grant Agreement n. 956098

Formation of Committees

STEAM Program Committee:

- Responsible for development and implementation

STEAM Program Advisory Board:

- Provides guidance and strategic recommendations
- Ensure program effectiveness and relevance
- Foster collaboration and avoid redundancy with existing programs

Mandate of the STEAM Program Committee

Development and Implementation:

- Create and execute the STEAM education program
- Organize training events, schools, seminars, hackathons

Curriculum Design:

- Address specialized training needs
- Recommend effective training methodologies

Operational Involvement:

- Coordinate logistics and scheduling
- Facilitate collaboration among NGT Work Packages and Experiments

Collaboration and Engagement:

- Engage experts from CERN openlab industrial partners
- Engage professors from universities

Mandate of the STEAM Program Advisory Board

Program Review and Evaluation:

- Assess curriculum and training methods
- Align program with industry and academia trends

Strategic Recommendations:

- Enhance program based on best practices
- Improve curriculum design and resource utilization

Curriculum Coherence and Gap Analysis:

- Coordinate with existing schools to avoid overlaps
- Identify and fill educational gaps

Quality Assurance and Networking:

- Facilitate external relations and collaborations
- Monitor outcomes and suggest metrics

Skills Gap Analysis - Survey Results

Advanced Training Requests from Task Leaders:

Parallel, High-performance, and High-throughput Computing:

- Parallel programming fundamentals
- Optimization techniques for HPC and HTC
- Heterogeneous architectures (GPUs, FPGAs)
- FPGA programming

C++/Data-intensive applications:

- Efficient memory usage
- Expert-level of C++ and Accelerated Python
- Big data handling
- Data Preparation, tools

Machine Learning and AI:

- Advanced neural networks
- Optimization of neural networks

Skills Gap Analysis - Interviews

Interviews with NGT hired students and graduates:

- Need for FPGA design knowledge
- GPU programming and efficient memory usage
- HPC and HTC communication
- Advanced ML concepts and architectures
- Advanced courses on specific tools (e.g., Performance portability)

Additional Requests for Basic Training:

- Introduction to event reconstruction, behind computing tasks for Computer Scientists
- Introduction to experimental frameworks (e.g. Athena, CMSSW, Gaudi)
- Practical, hands-on hackathons with real problems

Skills Analysis Gap - Three Branches to Cover

The main branches:

- High Throughput/Real-Time Computing
- Data Science, Data Preparation Libraries, Methods, and Tools
- Advanced Neural Networks

Plan:

- Work with committees to determine the best delivery methods
- Develop targeted training modules for each branch



Alpaka Tutorial

By Andrea Bocci

```
Code Blame 229 lines (187 loc) · 9.18 KB Code 55% faster with GitHub Copilot
intro_to_alpaka / alpaka / 05_kernel.c

84 auto in1_d = alpaka::allocAsyncBuf(float, uint32_t(queue, size));
85 auto in2_d = alpaka::allocAsyncBuf(float, uint32_t(queue, size));
86 auto out_d = alpaka::allocAsyncBuf(float, uint32_t(queue, size));
87
88 // copy the input data to the device; the size is known from the buffer objects
89 alpaka::memcpy(queue, in1_d, in1_h);
90 alpaka::memcpy(queue, in2_d, in2_h);
91
92 // fill the output buffer with zeros; the size is known from the buffer objects
93 alpaka::memset(queue, out_d, 0x0);
94
95 // launch the 1 dimensional kernel with scalar size
96 auto div = mappers::divAccID(1, 2);
97 std::cout << "Testing alpaka::getWorkDiv() with scalar indices with a grid of "
98 << alpaka::getWorkDiv(alpaka::Device, alpaka::Blocks(div)) << " blocks x "
99 << alpaka::getWorkDiv(alpaka::Block, alpaka::Threads(div)) << " threads x "
100 << alpaka::getWorkDiv(alpaka::Thread, alpaka::Elements(div)) << " elements...\n";
101 alpaka::execAccID(
102     queue, div, alpaka::getWorkDiv(alpaka::Device, alpaka::Blocks(div)),
103     alpaka::getWorkDiv(alpaka::Block, alpaka::Threads(div)),
104     alpaka::getWorkDiv(alpaka::Thread, alpaka::Elements(div)),
105     alpaka::memcpy(queue, out_d, out_h);
106
107 // wait for all the operations to complete
108 alpaka::wait(queue);
109
110 // check the results
111 for (uint32_t i = 0; i < size; ++i) {
112     float sum = in1_h(i) + in2_h(i);
113 }
```



Basic Trainings



Advanced Seminars

Next Steps and Future Plans

Feedback:

- Your feedback is very valuable for us
- If you have attended a NextGen-sponsored training, a **very short** feedback request form will be sent to you next week

Contributions:

- Seeking additional introductory tutorials and materials for the website
- Contact us if you have content to share

Hackathons:

- Organizing hackathons for 2025

Continuous Training:

- Developing training modules for identified needs
- Continuous collaboration with committees
- Engagement with Industrial Partners and Universities

Conclusions

- The STEAM training program aims to equip all NGT members with essential and advanced skills
- We focus on fostering cross-collaboration and providing continuous learning opportunities
- All NGT members are encouraged to actively participate in the training sessions, workshops, and hackathons

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