

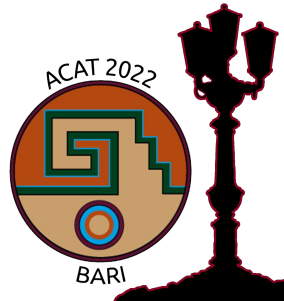
# Track 1 Summary

Raquel Pezoa (UV), Michael Poat (BNL),  
Marica Antonacci (INFN), Maria Girone (CERN)

**ACAT 2022 -- “AI meets Reality”**

24 - 28 October 2022

Bari, Italy



ACAT Track 1

**“Computer Technologies for Physics  
Research”**

# Track 1 Conveners

Raquel Pezoa



Michael Poat



Marica Antonacci



Maria Girone





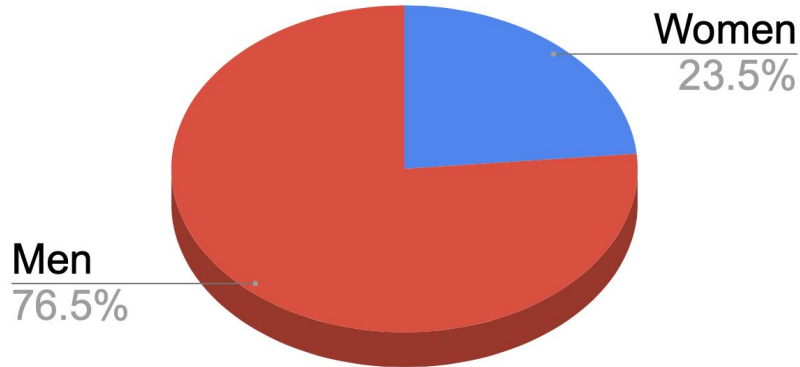
# Statistics

# Statistics

- ~120 Abstracts → 34 talks
- 8 parallel sessions



Day	Monday	Tuesday	Wednesday	Thursday
1st Session	5	4	3	5
2nd Session	4	4	5	4









# Infrastructure



# Infrastructure

## Some Examples

- Construction of the new datacenter to be completed for the HL-LHC
- Datacenters with heterogeneous resources (CPUs, GPUs)



**New data center CNAF in Bologna**

### What we have: ReCaS GPU Cluster

#### Hardware Facility:

- Nodes: 10
- GPUs: 38 (V100 and A100 Nvidia GPU)
- Cores: 1755
- RAM: 13.7 TB
- Local Storage: 55 TB (SSD/HDD)
- Parallel File System: ReCaS storage based on IBM GPFS (3800TB)
- Bandwidth between nodes: 10 Gbps

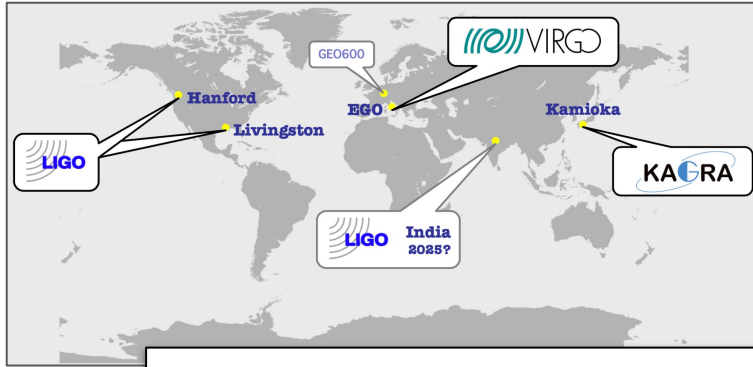


**A GPU-based HPC cluster at ReCaS-Bari**

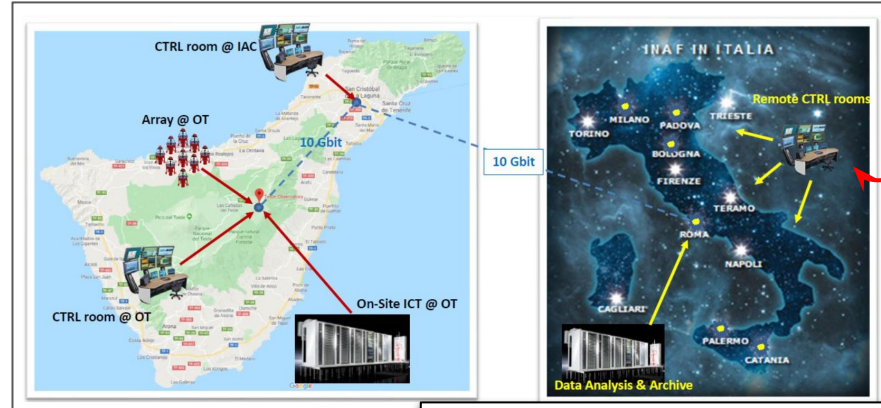
# Infrastructure

## Some Examples

- Heterogeneous resources → important efforts to **design and build a common computing infrastructure.**



**LIGO, VIRGO and KAGRA  
Gravitational-wave**



**ASTRI Mini-array, gamma ray  
experiment**

*guidelines  
for the  
Software  
Quality*

Common architecture and shared resources → to prepare for growing computing demand and increasingly exploit distributed computing resources.

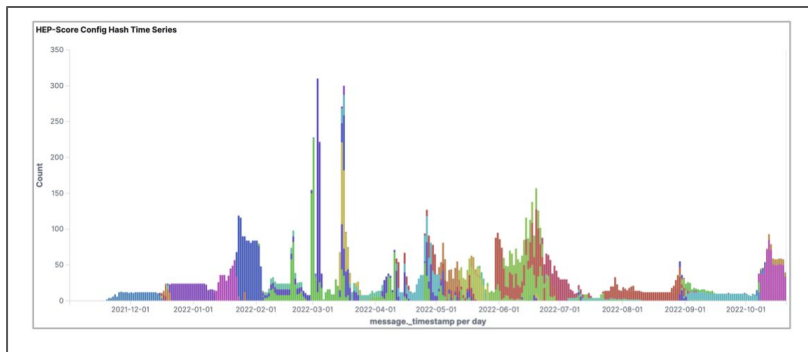


# Advanced Programming

# Advanced Programming

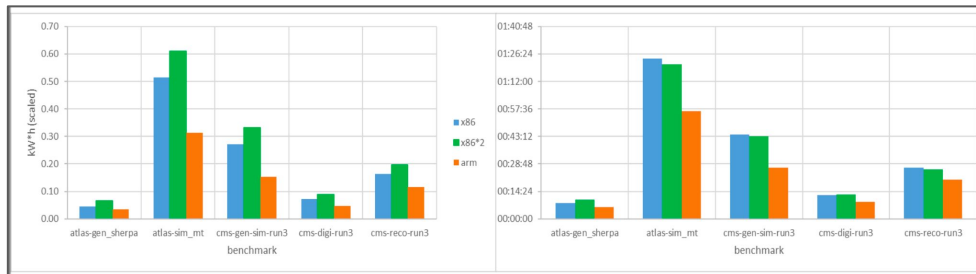
## Some Examples

- HEPscore



**HEPscore is a CPU benchmark, based on HEP applications, extending to heterogeneous resources**

- HEPscore & power consumption

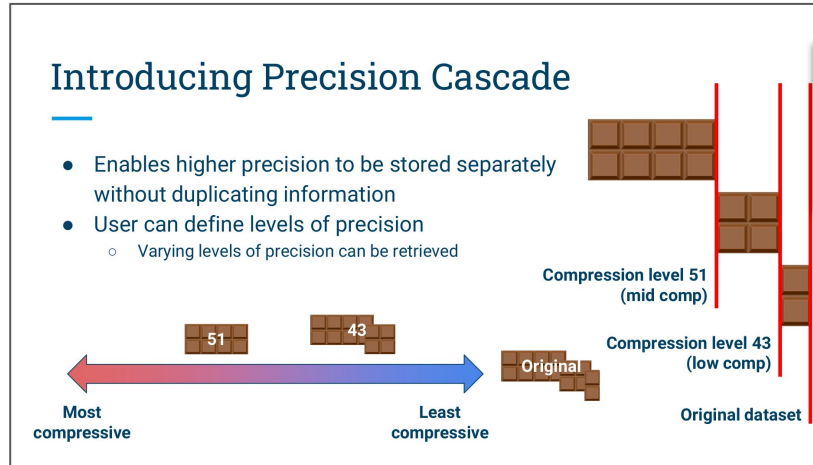


**arm vs x86 → arm ~20% quicker and used ~35% less power per HEP task than x86**

# Advanced Programming

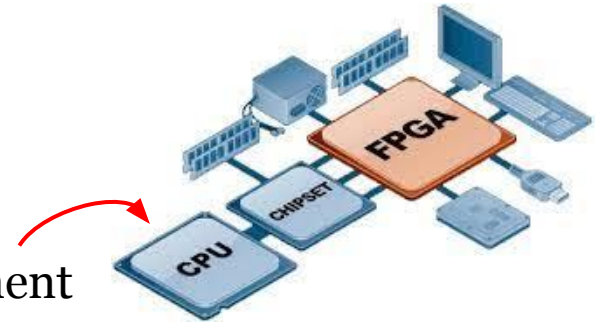
## Some Examples

- Data storage is expensive! → compression algorithms



**Enables higher precision to be stored separately without duplicating information**

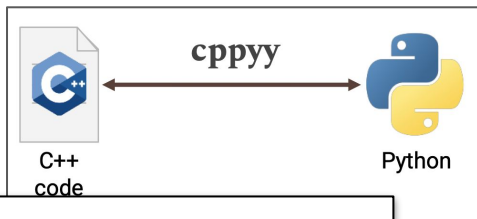
- Zstandard library → LHAASO cosmic ray experiment



# Advanced Programming

## Some Examples

- Programming languages → C++ and Python, a number of tools!



**Automatic Bindings  
Generators**

```
#include "awkward/LayoutBuilder.h"

enum Field : std::size_t {x, y};

UserDefinedMap fields_map({
    {Field::x, "x"},
    {Field::y, "y"}});

RecordBuilder<
    RecordField<Field::x, NumpyBuilder<double>>,
    RecordField<Field::y, ListOffsetBuilder<int64_t,
        NumpyBuilder<int32_t>>>
> builder;

builder.set_field_names(fields_map);

auto& x_builder = builder.field<Field::x>();
auto& y_builder = builder.field<Field::y>();
```

Constructing a Layout Builder from variadic templates!

**Awkward**



**C++ library → data structure abstraction  
layer**



**Portability**

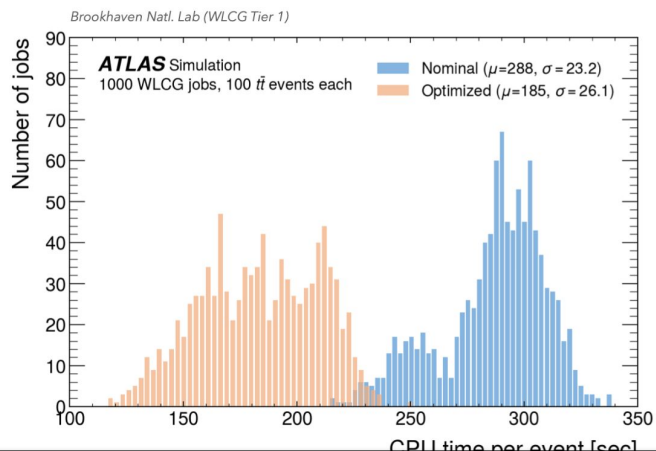


# Optimization

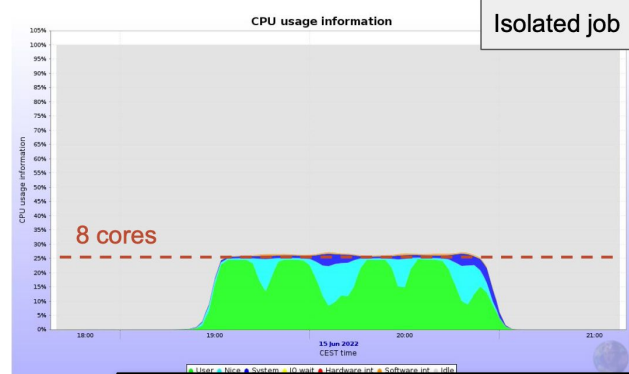
# Optimization

## Some Examples

- There is a need: make efficient use of computing resources:

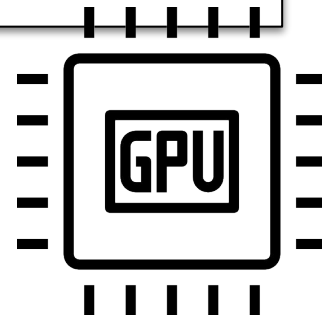


**Geant4 optimizations: 36% CPU speedup, 56% higher throughput, ATLAS**

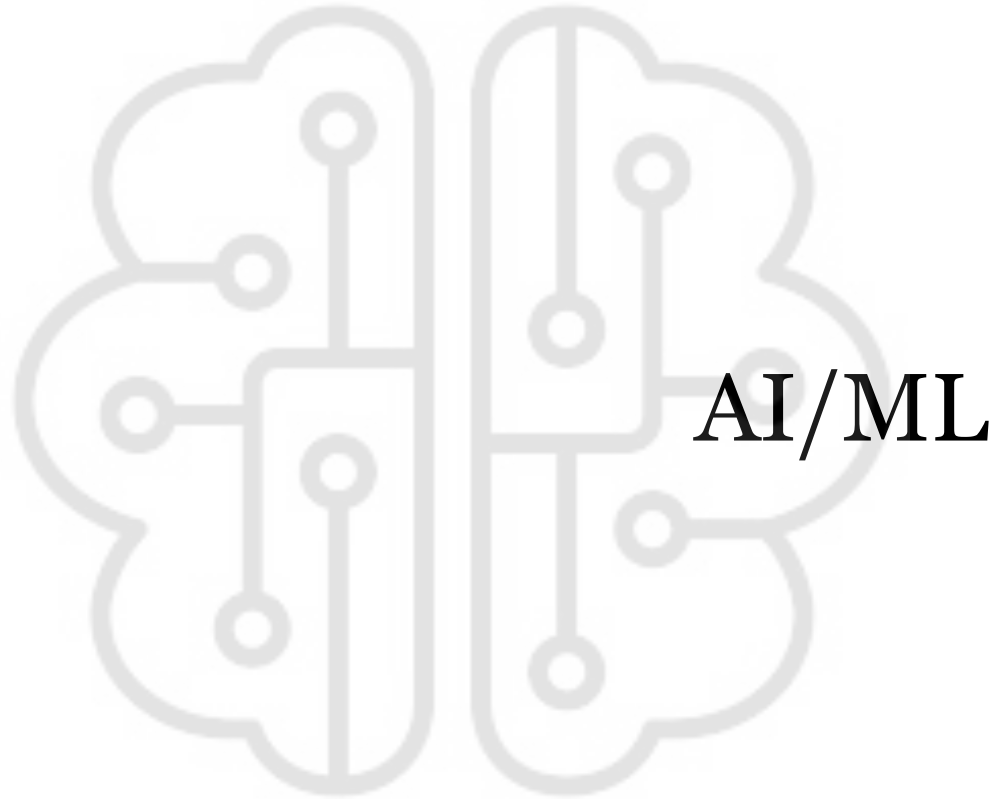


**Optimal CPU-level resources allocation, ALICE**

**GPU acceleration of MC simulations in medicine**



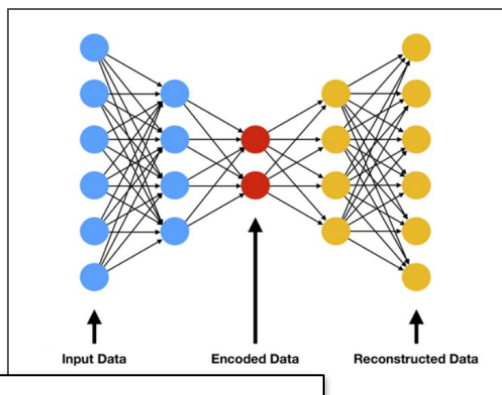




# Some examples: Artificial Neural Networks

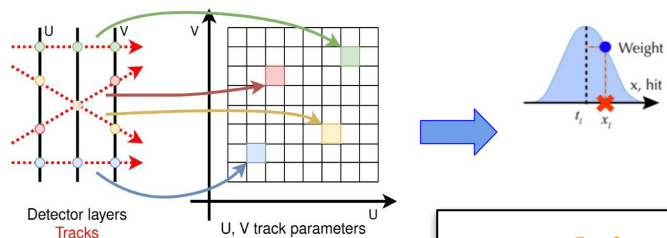
## Some Examples

- ML methods



**Monitoring of Resistive Plate Chambers (RPCs) using ML approaches, CMS**

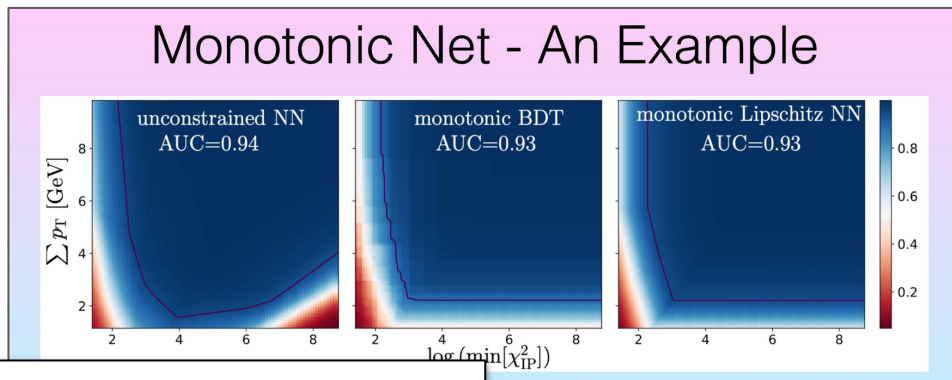
## The “artificial retina” architecture



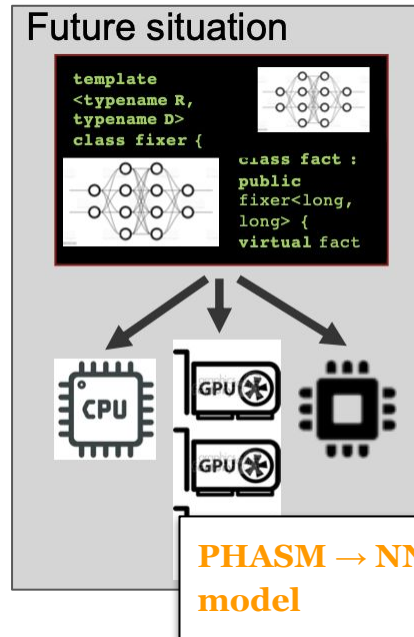
**For real-time tracking on FPGAs to reconstruct tracks**

# Some examples: Artificial Neural Networks

- ML methods



**Topological Trigger LHCb  
uses innovative  
algorithms based on ML**



## To finalize

- Track 1 had a lot of high-quality contributions
- We highlighted 4 different main topics, but of course they overlap
- The growing computing demands an efficient use the resources.

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- We highlighted 4 different main topics, but of course they overlap
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Thanks for your attention!

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