IPPP meets MINERvA:

a neutrino masterclass report

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IPPP meets MINERvA

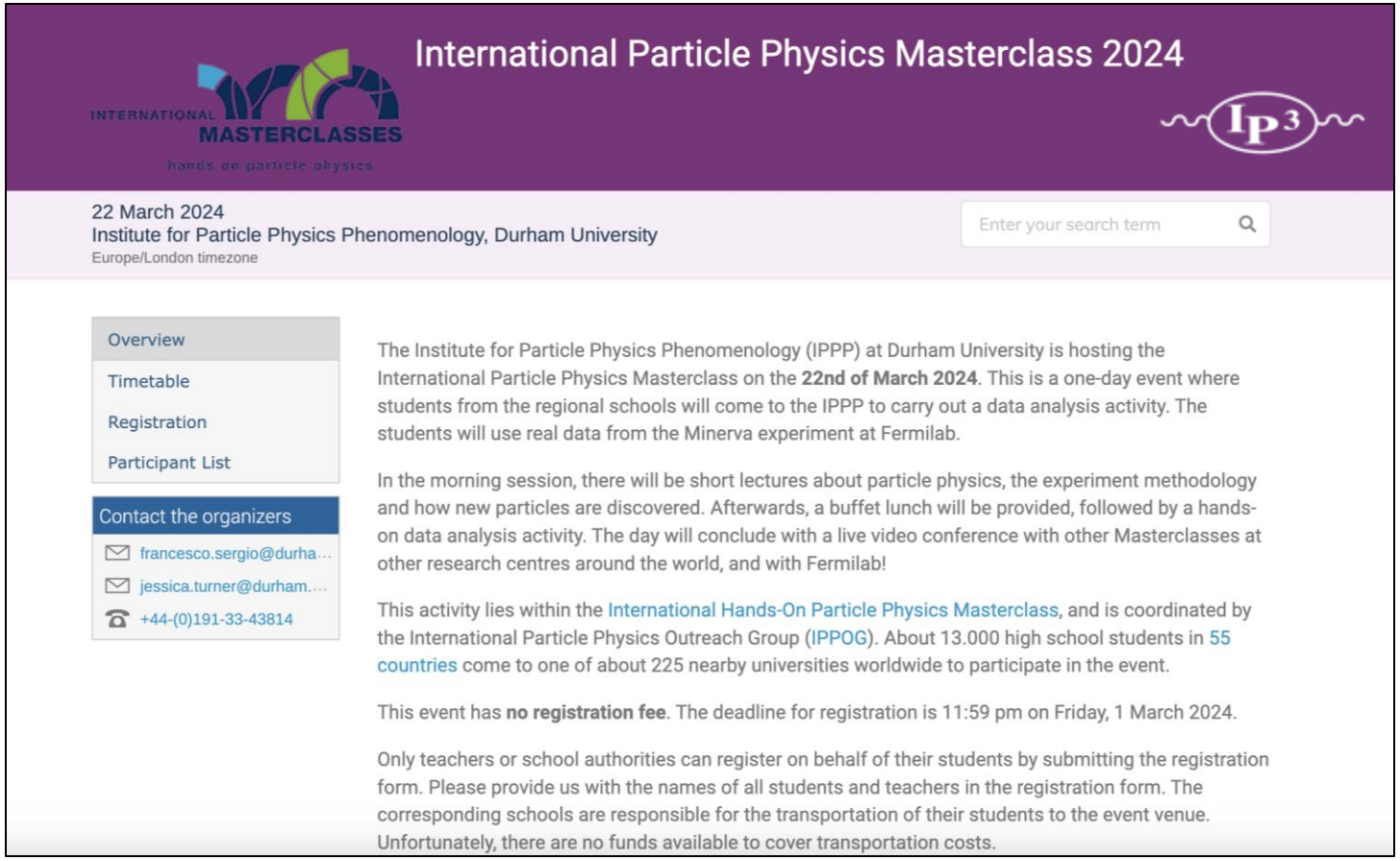
- Who
- What
- Why
- How
- Future

Last 22nd March 2024,

the IPPP hosted its **3rd** particle physics masterclass.

The **first** one after the COVID19 interruption.

We were a new, **inexperienced yet motivated** team.



Oct 15th 2023

Who

Jessica Turner

Assistant professor

(my supervisor)

Hi! Since you are here, we should definitely re-establish the particle physics masterclass here at IPPP!

 ?

Francesco Sergio

Outreach officer

(me)

Don’t you run them in Italy?

Nw, trust me. I know someone in the US who can help us

Spencer Pasero (Fermilab OPE manager)
joined the conversation

A brief recap...

What

1. The IPPOG masterclasses

International Particle
Physics Outreach Group

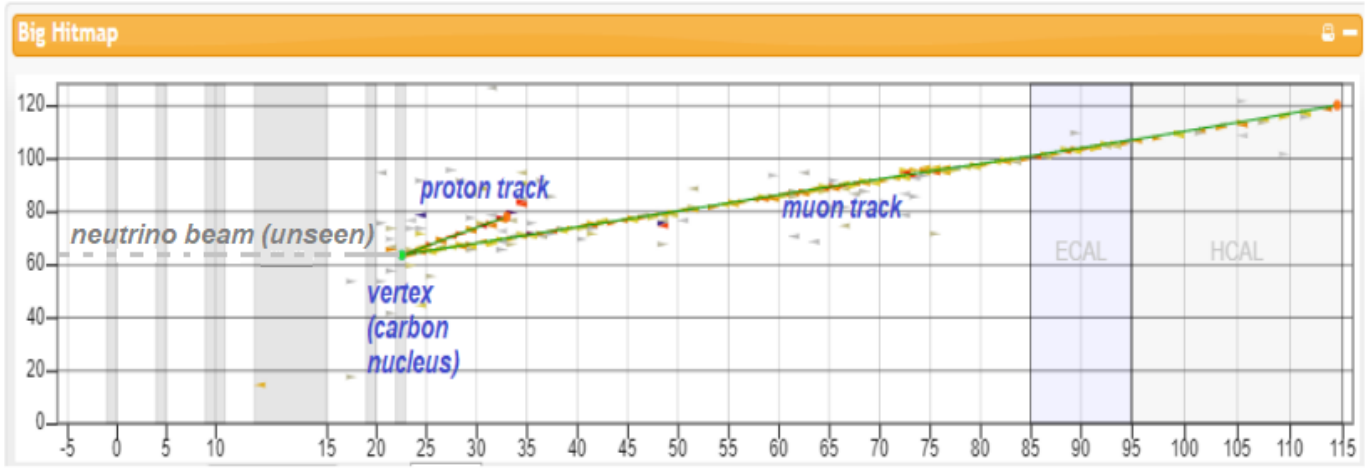
synopsis

One-day event where high school students analyze **real data** from **real experiments** thanks to intuitive software developed by those teams

What

2. MINERvA Masterclass [1] [2]

MINERvA is a neutrino-scattering experiment based at Fermi National Accelerator Laboratory.



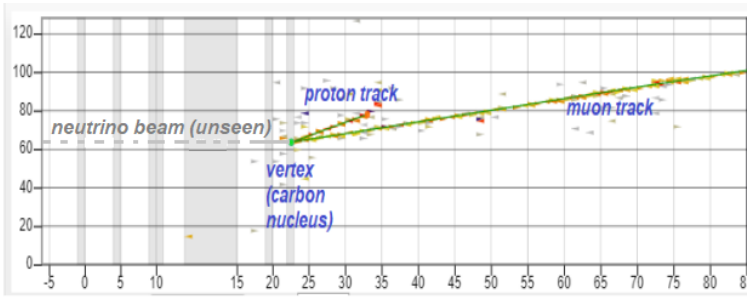
from QuarkNet website

What

2. MINERvA Masterclass

The masterclass consists in analyzing MINERvA events,

one by one: students should long tracks from the noisy ones.



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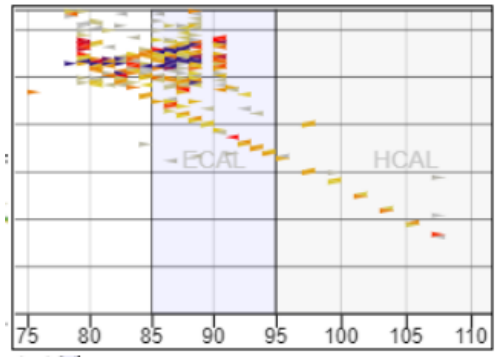


Fermilab

Combining the **p** and μ^- momenta, it is possible to reconstruct the incoming ν beam, thus the Carbon nucleus size

(via Heisenberg principle).

What

2. MINERvA Masterclass

Students operate the data analysis via Arachne Simple,

the dedicated (online) software developed by Fermilab.

Arachne

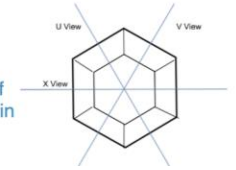
Welcome to Arachne Simple, the MINERvA web event display.

MINERvA

MINERvA is a neutrino scattering experiment which uses the NuMI beamline at Fermilab. MINERvA studies neutrino interactions in support of neutrino oscillation experiments. Simple is a simplified version of the original Arachne used by members of the MINERvA collaboration. It is designed for use by teachers and student.

The Detector

The diagrams at the right shows three directions the detector is viewed from with the z axis pointing out of the detector. The Hit Maps box in Arachne displays the X, U, and V views of the detector. The detector is made of overlapping layers of scintillator, a plastic which absorbs the energy of particles and reemits it in the form of a flash of light. The light deposited in the scintillator is carried through fiberoptic cables to photomultiplier tubes which detect the small flashes of light.



What

3. Masterclass at IPPP

Fermilab

Timetable

- **Morning: Introductory talks**
  a) Particle Physics Card Game [1], [2], [3]
  b) "*What is the Universe made of* ?"
  c) "*Why neutrinos matter*"
  d) "*Neutrino Detection*"
- **Afternoon: Hands-on experience**
  100 students, **2** computer rooms,
  6 teachers, **20** IPPP tutors
- **Farewell with certificates of participation**

Why IP3 choose

- Jessica is a neutrino physicist who worked at Fermilab for years
- I was supposed to collaborate with **Quarknet**, the Fermilab Ed. Group

Spencer Pasero (Fermilab OPE manager and co-organizer of MINERva masterclass) *joined the conversation*

How IP3 planned the masterclass

- NE disadvantaged educational system
- Low % of enrolled students from local areas

Instead of knowledge, our aim was the **student's sense of belonging**:

we wanted them to feel comfortable and confident within the academic environment.

They won't remember what you said, but they will remember how they felt.

How IP3 planned the masterclass

- NE disadvantaged educational system
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"Pressing" state schools to apply

60% of students were from state schools

They won't remember what you said, but they will remember how they felt.

3 scheduled breaks to let students socialize with peers and tutors

How IP3 planned the masterclass

About the registration process,

<u>only teachers could apply.</u>

→

To involve students **regardless** of their level of interest or background in physics.

We attempted to achieve the most diverse background possible:

Lower limit was **Year 9** (15yo)

+

Different types of school

How did the masterclass go?

Thigs that went **well**

- **A lot of students were engaged**
- **We achieved a good diversity in background:**

  ~60% from state schools

  ~10 % from Year 10

  ~ 3 counties

- **No lost student**

Both **lunch** and hands-on session were lively, with many students engaging with IPPP tutors

How did the masterclass go?

challenges we faced

- **Introductory talks must be revised**

a) Talks were too broad

b) Talks did not focus enough on MINERvA

- **The hands-on activity itself suffers of some issues**

c) Repetitive

d) Easy: students spent 45’ to analyze all the tuples (we planned 120’)

future

strategies we will adopt

- **Talks:** less but more detailed concepts
- **Breaks:** to make them more engaging
- **Hands-on activity**

Focus on the physics behind MINERvA experiment:

a) **Not only neutrinos**

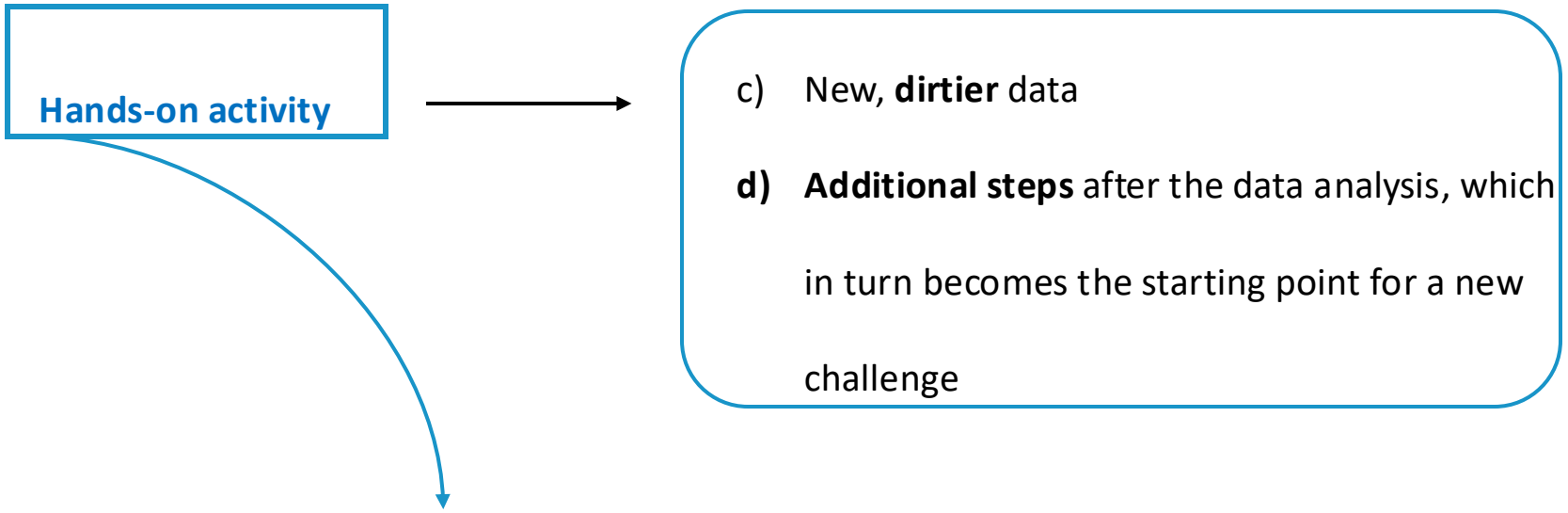
b) Heisenberg principle

c) New, **dirtier** data

d) Additional steps after the data analysis, which in turn becomes the starting point for a new challenge

Future

strategies we will adopt



Further details coming soon …

Thanks for your attention!

Francesco Sergio

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