Practical work

M2 – NPAC – 2023/2024

SORBONNE UNIVERSITÉ
Université Paris Cité
université PARIS-SACLAY

List of proposed Practical Works*

CEA-Saclay (max. 6 teams**)

- Neutron – Gamma Discrimination (2 teams)
- Measuring the shape of the nucleus (1 team)
- Muon lifetime measurement (2 teams)
- Muon tomography using Micromegas Detector (1 team)

(*presented by M. Vandebrouck*)

IJCLab-Orsay (max. 9 teams)

- Study of the Compton Effect (2 teams)
- Gamma-ray Spectroscopy (1 team)
- Muon lifetime measurement (3 teams)
- Cosmic-rays Study (1 team)
- Study of the decay of Positronium (2 teams)

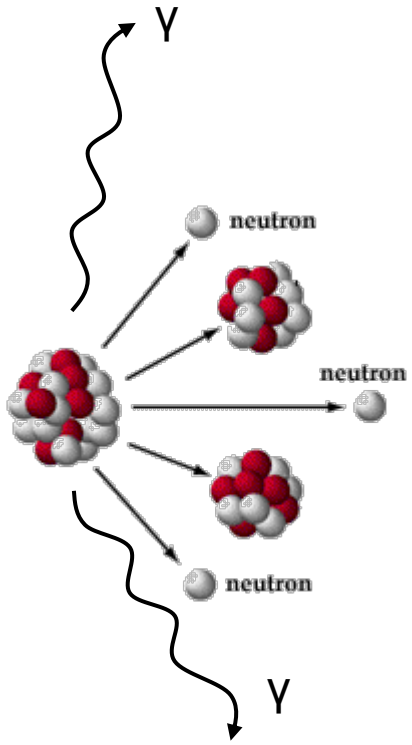
(*presented by I. Matea*)

* *the Practical Work description can be found on the NPAC web page*

** *1 team is composed by 2 or 3 students*

Neutron-Gamma Discrimination (2 teams)

Spontaneous fission source:
Emission of fission fragments,
gammas and neutrons



Aim: discriminate neutrons from gammas

Two complementary techniques:
- Time Of Flight (TOF)
- Pulse Shape Discrimination (PSD)

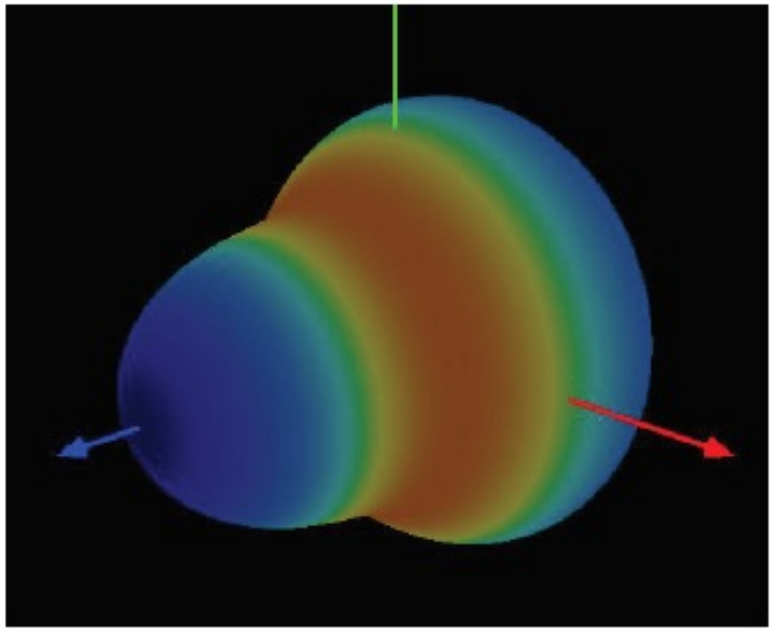
Tools: scintillators + PMT
- Inorganic: NaI(Tl); BaF_2
- Plastics: NE213
- Organic liquid doped with Gd/Hf

Data acquisition and analysis
- DAQ card: MATACQ (signal sampling)
- Analysis: Python or ROOT tools

Supervisor: **Eric BERTHOUMIEUX**

How can we measure the shape of a nucleus ? (1 team)

By measuring the rotational band properties of ^{152}Sm, one can characterize the shape of the nucleus and deduce its axial deformation parameter



Aim: determine the shape of a nucleus

Technique:

Gamma and electron spectroscopy

Tools: LaBr (fast timing detector) + Ge + Si

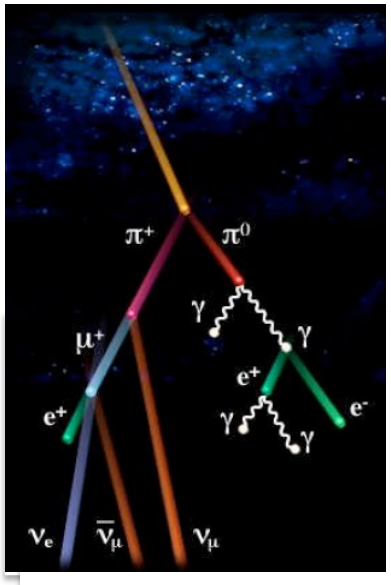
Data acquisition and analysis

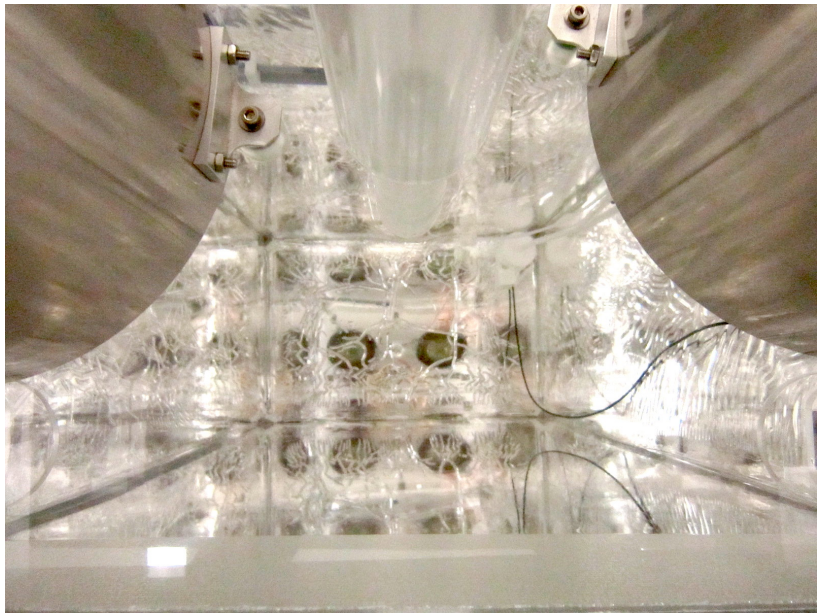
- DAQ card: FASTER
- Analysis: Python or ROOT tools

Supervisor: Pierre MORFOUACE

Muon lifetime measurement (1 team)

1. Using STEREO demonstrator





Aim: measure muon lifetime

Technique:
Using Cherenkov effect in a water tank

Tools: 2 (recent!) PMT from STEREO demonstrator

Data acquisition and analysis
- DAQ card: digital electronics
- Analysis: Python or ROOT tools

Supervisor: Boris Tuchming

Muon lifetime measurement (1 team)

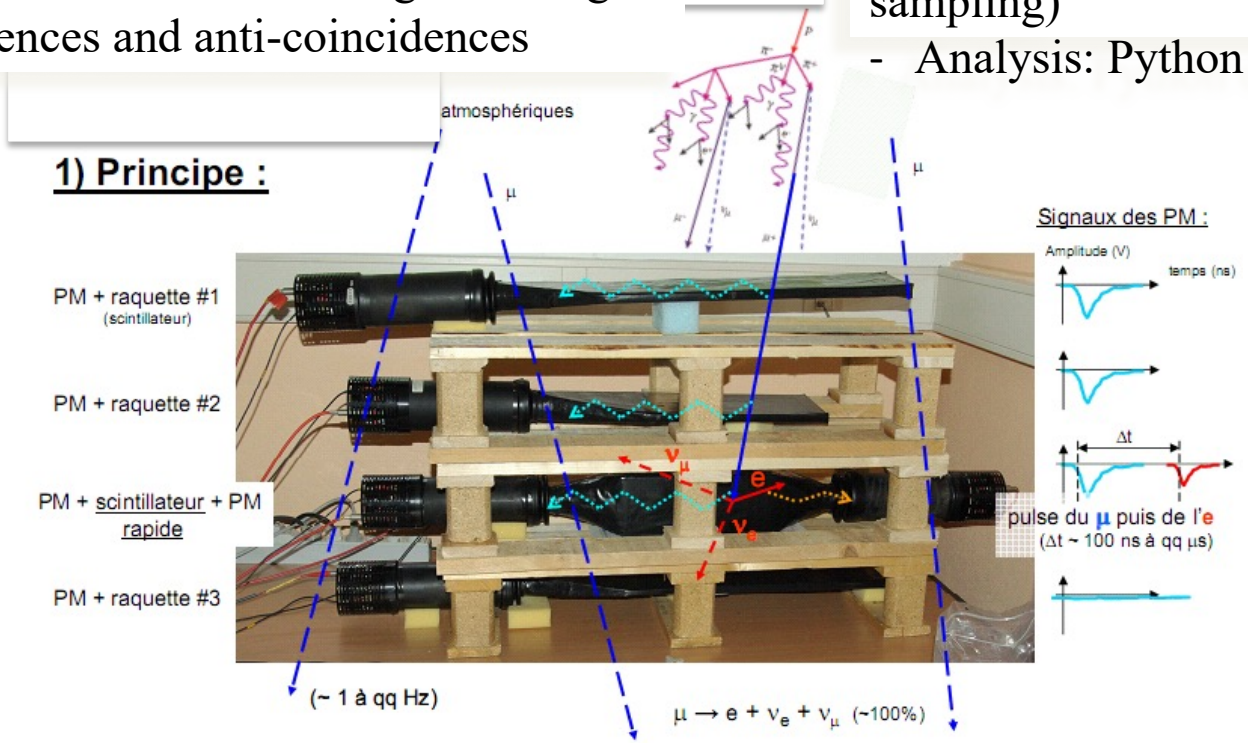
2. Using Organic scintillators

Aim: measure muon lifetime

Technique:
Isolate muon and electron signals using coincidences and anti-coincidences

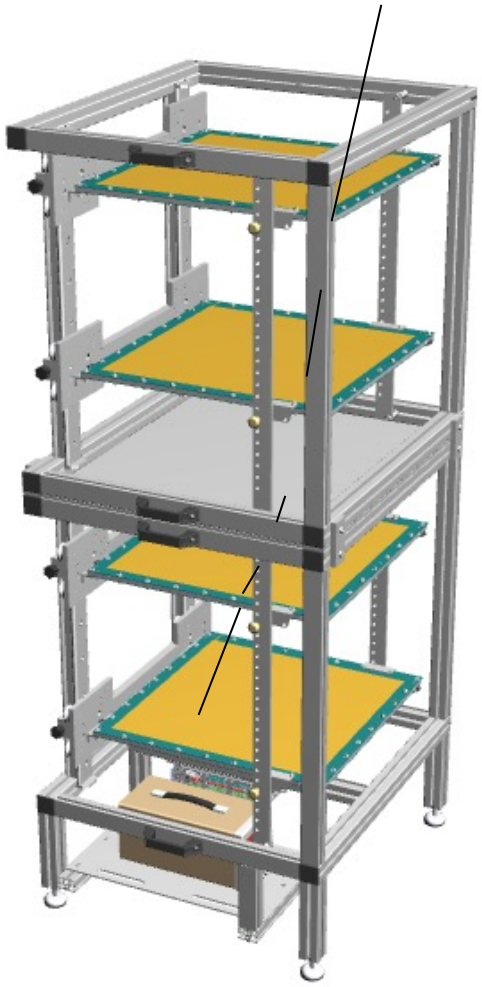
Tools: plastics scintillators + PMT

Data acquisition and analysis:
- DAQ card: MATACQ (signal sampling)
- Analysis: Python or ROOT tools



Supervisor: Boris Tuchming

Muon Tomography using Micromegas (1 team)

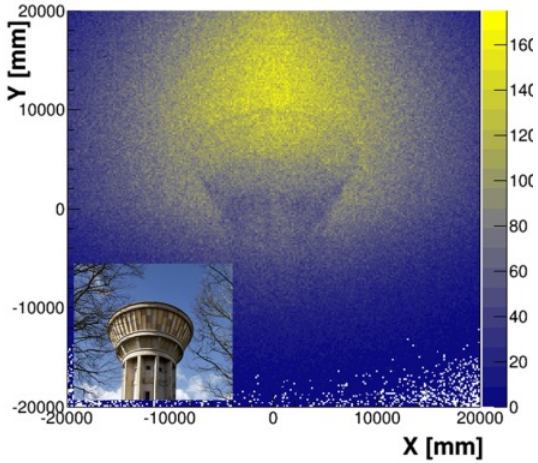


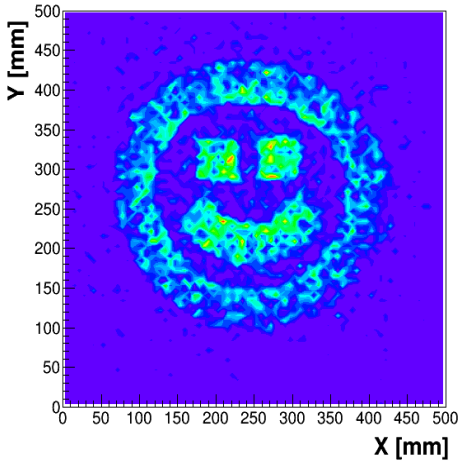
Aim: perform tomography

Technique:
Assembly and characterization of a tomographic bench

Tools: Micromegas gaseous detectors

Data acquisition and analysis
- DAQ card: digital electronics
- Analysis: ROOT tools





Supervisor: **Maxence Vandenbroucke**

RDV Wednesday September 6th 8:50 am
CEA Saclay - Orme des Merisiers Entrance

Bus 9 from RER B Le Guichet.
Stop at “Orme des Merisiers”

Remarks:
- ID
- Cash for the canteen if possible

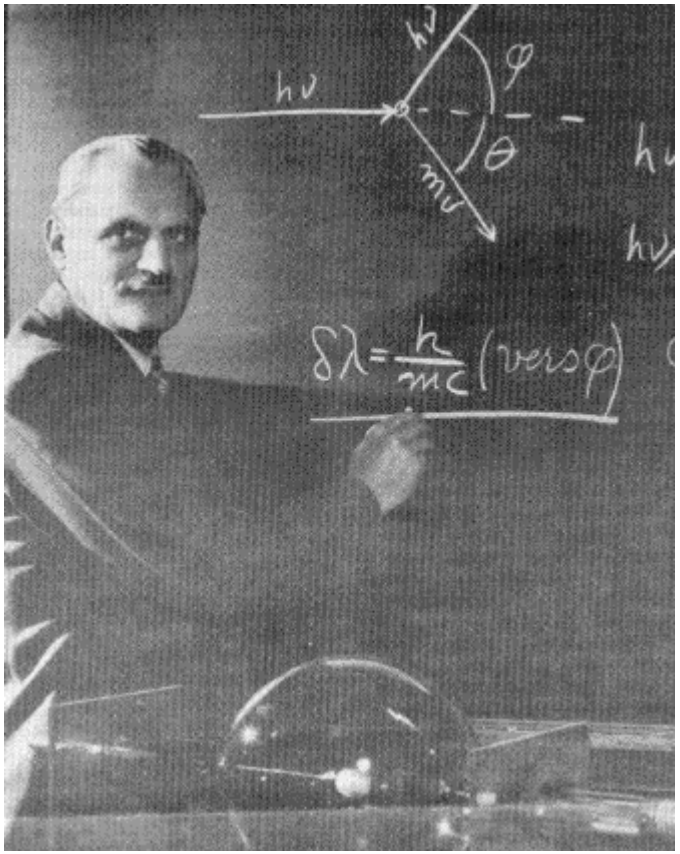
Study of the Compton effect (2 teams)

Goal:
study the Compton effect, by measuring the energy of the scattered photon, its angular dependency, and its differential cross section.

Method: coincidence measurements between incident and scattered gamma and scattered electron.

Material: NaI(Tl) scintilators – NIM electronics – FASTER daq.

Data analysis: Python or ROOT tools.



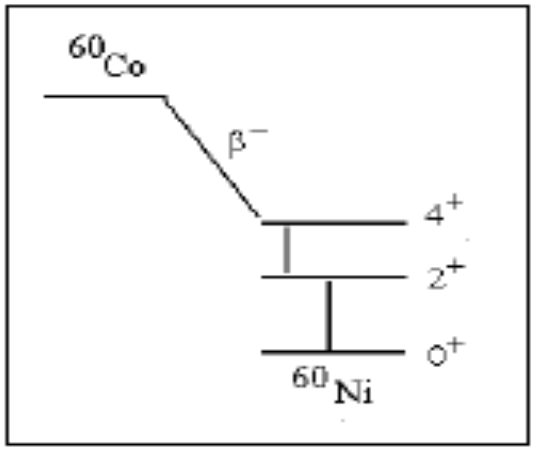
Location: IJCLab Orsay
Supervisor: M. Charles

Gamma-ray Spectroscopy (1 team)

Goal:

Start Lab Work in Nuclear Physics

Study of gamma decay of different standard sources.
Angular correlation measurements for ^{60}Co.



Method: gamma-gamma measurements.

Material: NaI(Tl) scintilators and Silicon Semiconductor detectors – NIM electronics – FASTER daq.

Data analysis: Python or ROOT tools.

Location: IJCLab Orsay
Supervisor: I. Matea

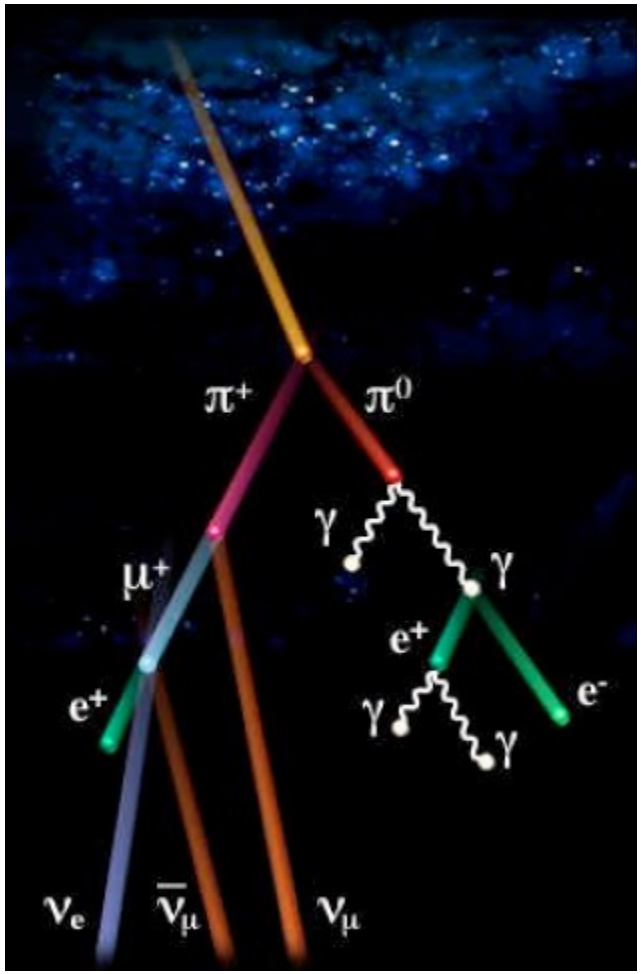
Muon lifetime measurement (3 teams)

Goal:
Muon lifetime measurement.

Method: muon and electron detection.

Material: liquid scintilators – NIM electronics – FASTER daq.

Data analysis: Python or ROOT tools.



Location: IJCLab Orsay
Supervisors: E. Capocasa/M. Bomben

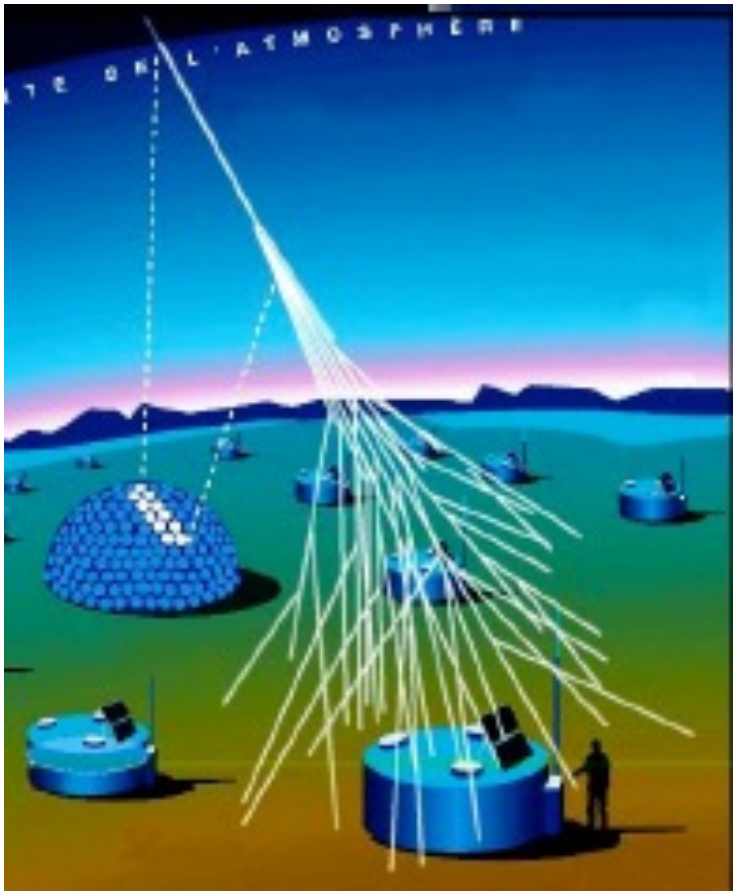
Cosmic Rays Study (1 team)

Goal:
Measure the angular distribution of muons at the surface of the Earth.

Method: muon detection.

Material: plastic scintilators – NIM electronics – FASTER daq.

Data analysis: Python or ROOT tools and Monte Carlo simulations and programming.

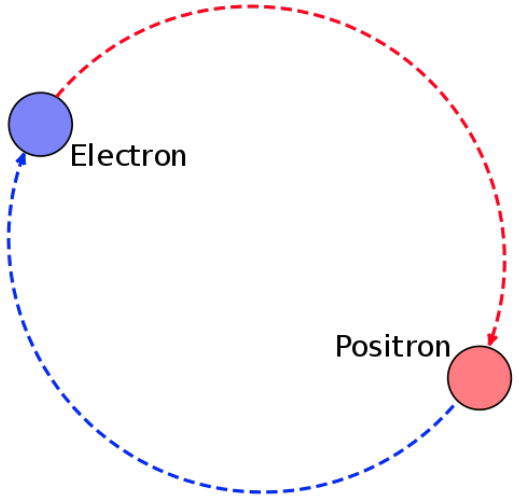


Better to have previous knowledge about MC simulation tools !

Location: IJCLab Orsay
Supervisor: E. Capocasa

Positronium decay (2 teams)

Goal:
Study the decay of different states of positronium: ortho and para positronium.



Method:
coincidence measurements.

Material:
NaI(Tl) detectors – NIM electronics – FASTER daq.

Data analysis: Python or ROOT tools.

Location: IJCLab Orsay
Supervisor: I. Matea

On the examination rules and more …

The aim of the laboratory work is to build one or more experiments using the available equipments to carry out a pre-defined physics measurement.

Five criteria are used in the final evaluation of the student laboratory work:

- autonomy and dynamism during the practical work (4 points)
- scientific interest for the subject (4 points)
- practical work logbook (2 points)
- the report (6 points)
- oral examination (10 minutes/team) (4 points)

You can find the template for the article on the NPAC web page

The template SHOULD NOT be modified. Limited to 4 pages.

Important dates:

- Week of 11th Sep. – free presentation of the subject by the students
- 13th Oct. – send the report to the supervisor(s) + I. Matea and M. Vandebrouck
- 8th November – oral examination

Organisation informations

The lecture on Security and Radioprotection is **mandatory**
(~1h following this presentation)

TL choice – Tomorrow morning (please read the TL booklet on the web)
Start at 10h00

Also tomorrow morning:

- logbook presentation/distribution
- discussion about writing the report (more details last week of the TL)

Miscellaneous:

- TL : french or english for interaction with supervisors, for article (abstract in english)
- in case of absence : inform your direct supervisor
- library NPAC : code A5991
- if needed : IJCLab Library also

Schedule CEA : 9h-12h, 13h-17h // **IJCLab** : 9h-12h, 13h30-17h30