# PRÁCTICA DE LABORATORIO CMAM:
# Pulsed beam @ CMAM

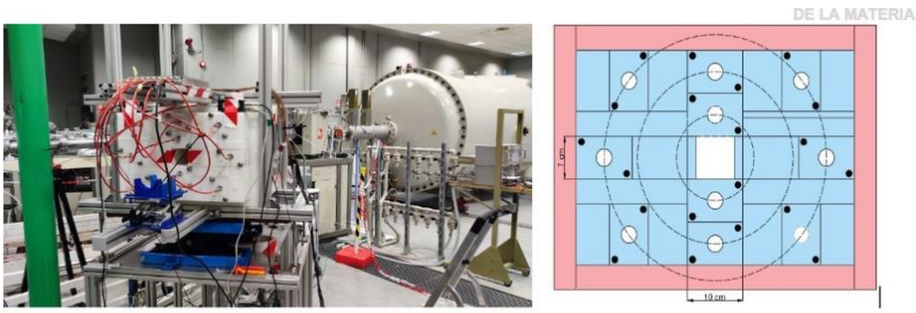
*The objective of this practice is to introduce the student to an accelerator facility. To achieve this objective, it is proposed first to acquire a spectrum standard gamma source with an array of 4 phoswich crystals mounted together. Next, we will do a nuclear reaction using protons accelerated to 2.6 MeV impinging on two different targets $BaF_2$, Au utilizing a motorized target revolver. Thirdly we will pulse the p-beam in kHz and we will change target repeatedly with a frequency of some 30 – 180 seconds.*

## Introduction & background

The study of excited states of nuclei might include the simultaneous detection of several charge particles, neutrons and gamma rays emitted. This puts several constrains on the detection system to be used. For the detectors, high segmentation is often needed to be able to detect several coincident particles, very thin dead layers to reduce the cut-of energy in combination with thin detectors to minimize sensitivity to beta and neutral particles.

For particle mass identification different techniques can be applied; Time of Flight, pulse shape analysis, or detector telescopes. Especially for charged particle energy determination the ΔE-E telescopes is the best choice.

In the case of neutrons things are more complicated. If we want to just know the number of neutrons emitted; we use a long-counter like miniBelen.



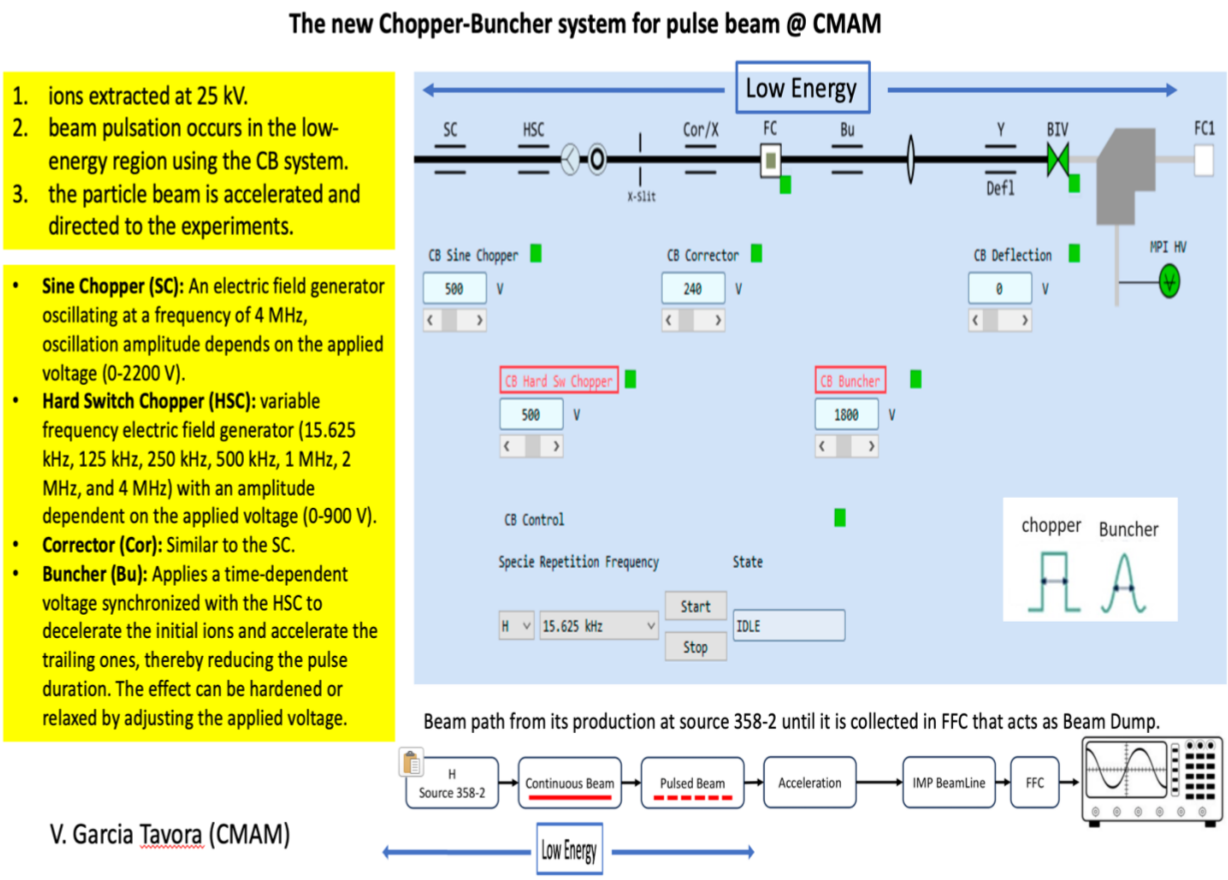

**miniBELEN: modular neutron counter for (alpha,n) reactions**

However, the best method to determining the energy of the neutron emitted is to use the Time-of-Flight technique like MONSTER (liquid scintillator)

What is the Time-of-Flight technique; one measure the time it takes for the particle to pass between to detectors and thus determines the energy the more energy ($E_{kin}$= ½ * $mv^2$) the faster. In the case of beta decay, this is relatively easy, we surround the target with a beta detector (close to 100% efficiency) and use it as START then at some distance 1m (the longer the better) we place the neutron detector and we get a STOP, and so we determine the ΔT and thus the velocity.

(explain why one in reality reverse the START and STOP)

In reactions we have no beta, so we have no start! We need a start signal to relate our ToF with. Using a continuous beam there is no such starting point, so we need a pulsed beam, preferably of a very high frequency, at CMAM we have a newly installed ion-source that delivers pulsed beam from 15kHz up the 4 MHz.



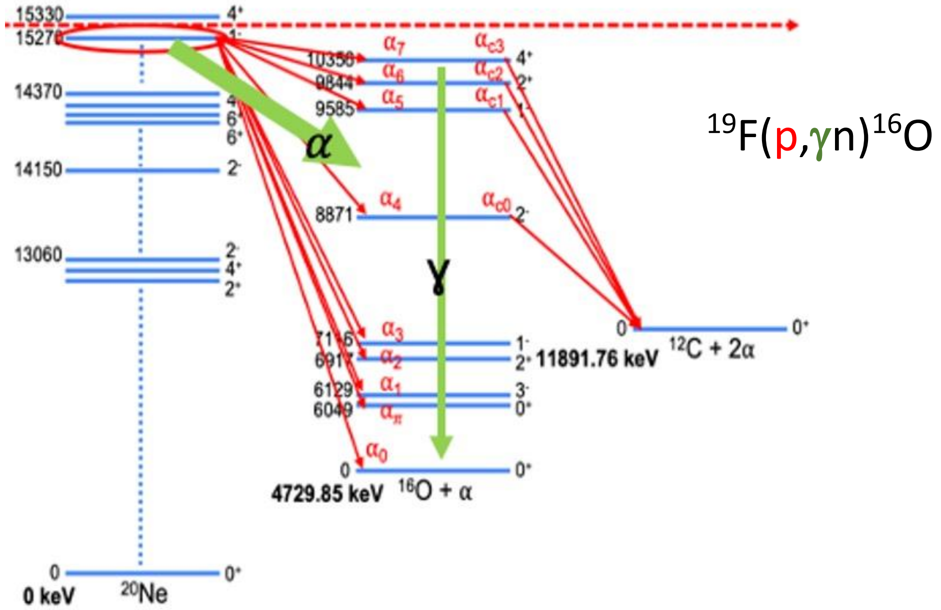

In reaction experiments we usually need to measure with several targets; e.g. to have protons as target we very often use a polyethylene, but this includes a lot of carbon, so we have to run on a C-target also. The target is mounted on a frame and part of beam might hit the frame, so we have to also run part of the experiment on an empty frame. Our reactions of interest are rare so very few good events and we have to clean them from the contaminants, finally we dedicate the same time on measuring background as the real reaction.

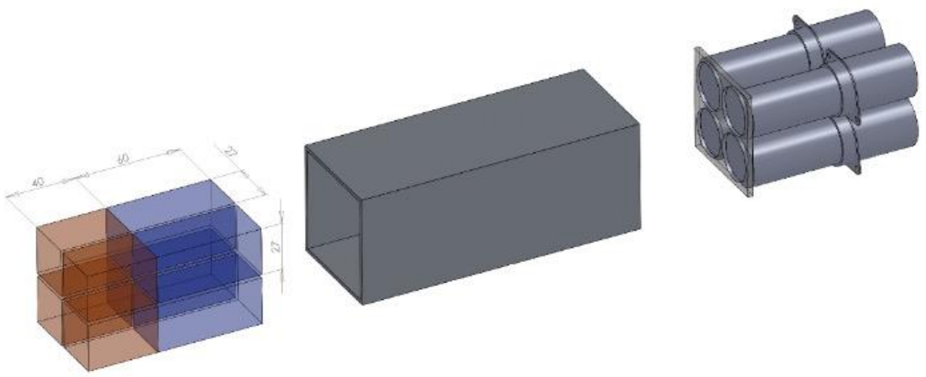
## Experiment

We will in this practice test two things that are crucial for our experiments. First the motorized target wheel, that will make it possible to remotely, without breaking vacuum, to change from one target to another or to change between target and no-target.

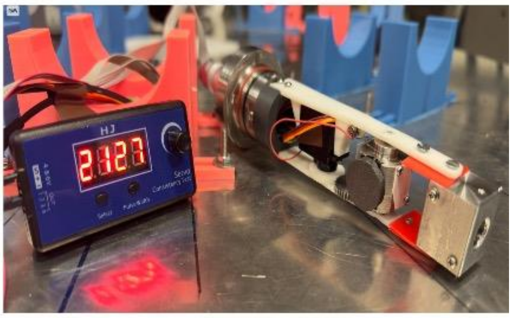
Secondly the pulsed beam structure, here we will only use the kHz pulsing as demonstrator.

To have some data to work with we will study gamma rays from the nuclear reaction $^{19}F(p,\gamma n)^{16}O$, our beam is **p** and the target is $BaF_2$ and we will detect γ using the CEPA4 phoswich array, coupled to a MDPP16 QDC digitizer. We will also have the logic signal from the accelerator pulsing.



CEPA4 Phoswich array; 4x LaBr+LaCl3 crystals within the same can.



The target revolver and its control unit.

## Objectives

The main objective of this exercise is to introduce the student to the work at an accelerator facility, to the technical work involved in preparation of an experiment. To understand the setting up of a simple reaction experiment to test the pulsed beam structure. Discussion point: to understand why the use of pulsed beam

## Materials

- CEPA4 LaBr3/LaCl3 phoswich array
- Radioactive $\gamma$-sources.
- MDPP16 16 ch digitizer QDC.
- Gate generator
- Osciloscopio.
- MVLC Controller.
- MVME Mesytec Adquisición Software.
- Motorized target wheel
- Minicomputer for controlling the target wheel

## Steps

1. Use a radioactive source to calibrate the CEPA4
2. Bias the detector while checking the signals in oscilloscope.
3. Observe the revolver target.
4. Pump to $5x10^{-5}$ mBar
5. Let the accelerated beam into the chamber
6. Start acquisition

7. Adjust the gated spectrum over the gamma-region of interest

## Laboratory Report CMAM

The report from CMAM should include the following:

- Show a diagram and explain the CMAM 5 MV accelerator
- Give some ideas of the different beamline activities at CMAM

- Explain the main characteristics of the CEPA4
- Calibration spectra of the detector.
- Present a diagram of the experimental setup in which the function of each element of the DAQ is described.
- Discuss the Experimental procedure and what is being measured.
- Discuss the target revolver
- Discuss the pulsed beam

## Reports

Reports as well as questions send to:
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