PEPITES

an Ultra-thin monitor for charged particle beams

By : Sara Boumaiza / Supervisor : Christophe Thiebaux

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FUN FACTS ABOUT ME ! SECTION :

My Journey:

Background:

- Bachelor degree in radiation physics
- Master degree in medical physics
- Research work on thin films

Current occupation:

- Student at Paris Physics Master program at Université Paris Cité

Goal:

- Research work in the development of diagnosis and therapy methods and equipment for cancer treatment

PEPITES

an Ultra-thin monitor for charged particle beams

My work :

analysis of the data collected during the first tests of PEPITES with therapeutic carbon ion beams at CNAO, to evaluate the response of the detector and its performance at several energies of the beam.

TABLE OF CONTENTS

00 | SMALL DETOUR

• **Radiotherapy**:

Cancer treatment via external radiation beams targeted at the patient

• **Types of beams used :**

- X-rays
- gamma rays
- electron beams
- proton beams
- carbon ion beams

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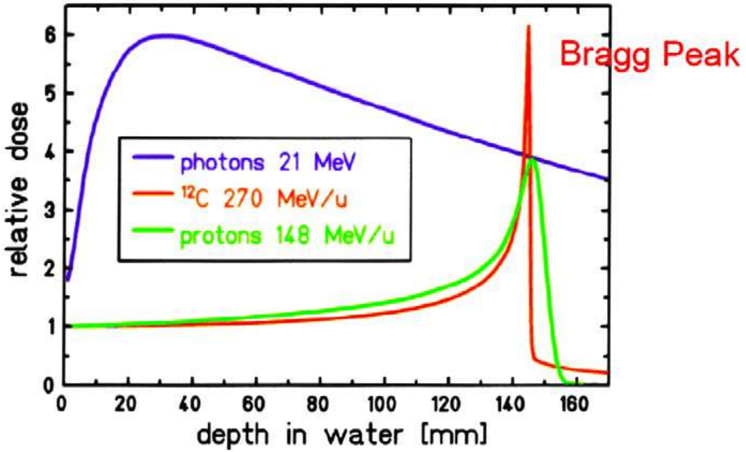
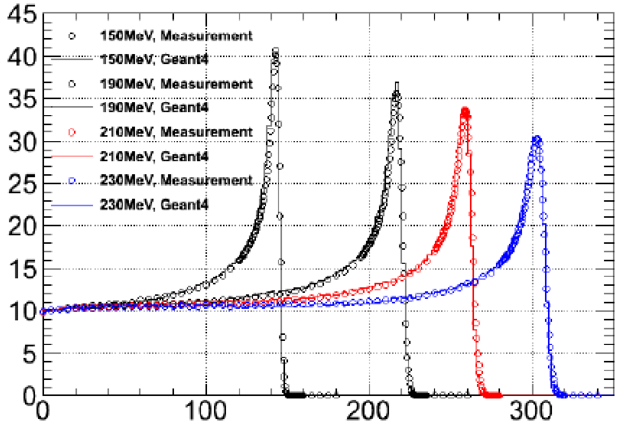
• **Hadrontherapy**:

A therapy method that consists of the use of hadrons (protons, carbon) as beams for cancer treatment





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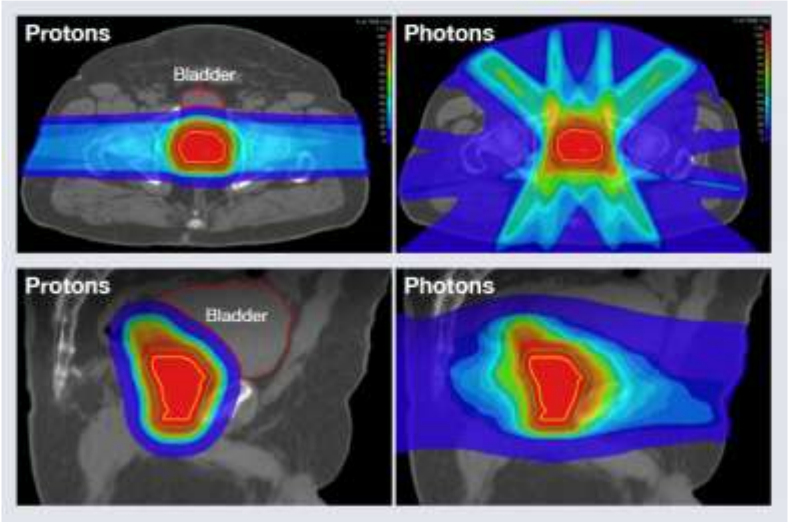
•Advantages of hadrons vs photons:

- ➢ Less dose to healthy tissue
- ➢ More effective against tumors resistant to X-rays
- ➢ Precise allowing higher dose delivery



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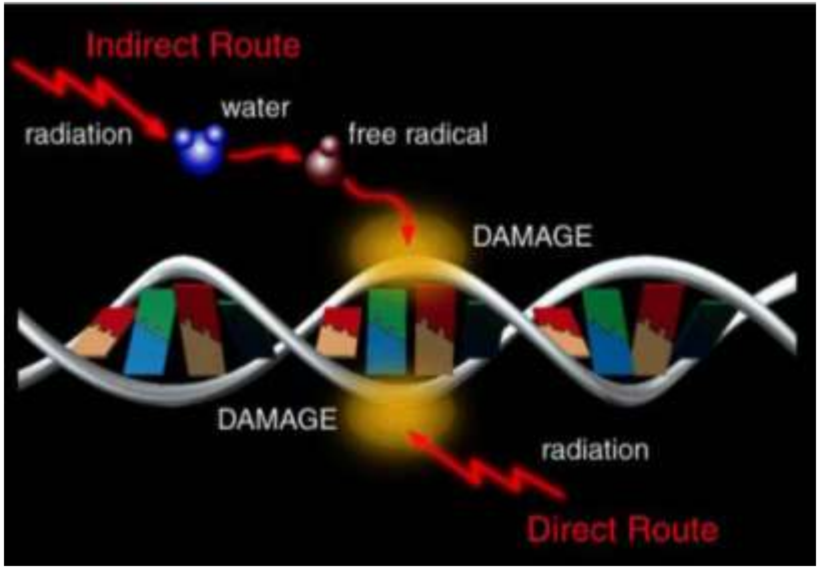
•**Killing Mechanisms:**

Directly through the damage of DNA or indirectly through the creation of free radicals (HO)



01

WHAT IS PEPITES ?

01 | WHAT IS PEPITES ?

•**Objective**:

Obtain a monitor used with mid-energy charged particle accelerators to continiously measure beam parameters

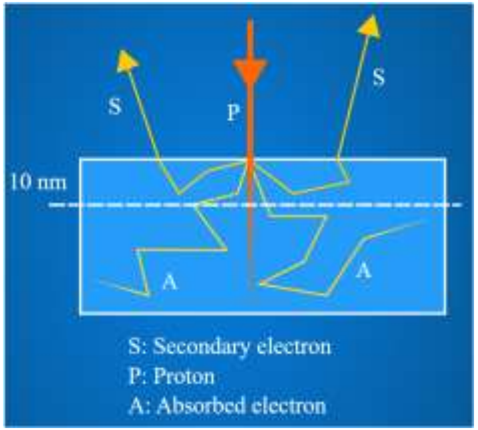
⟶ An ultra-thin profiler with minimum beam perturbation and high radiation resistency

•**Technology**:

Use thin film techniques for detector construction and low noise electronics for readout.

•**Principle**:

Signal generated by secondary electron emission (SEE), which is a surface phenomena that needs very little matter



02

HOW IS IT BUILT ?

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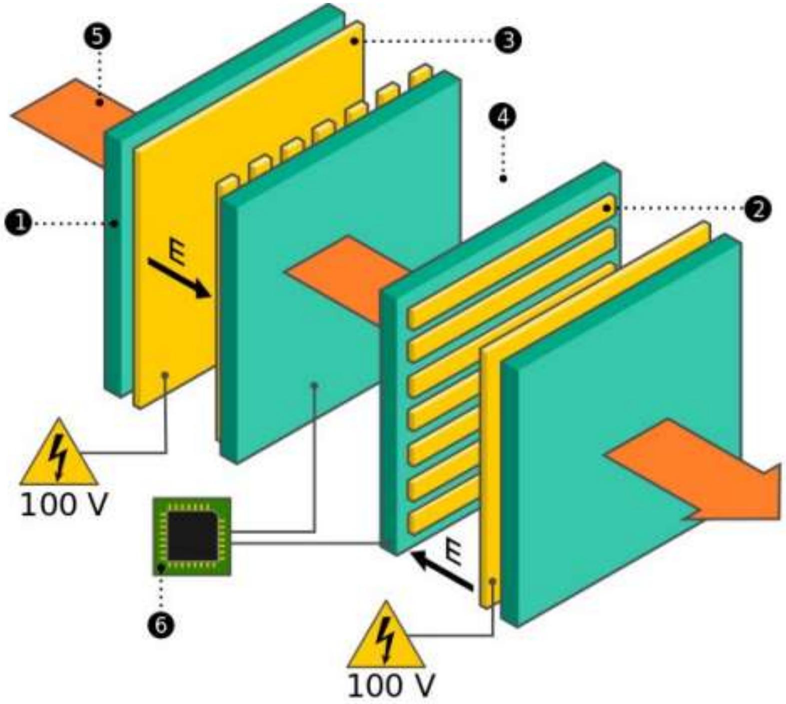
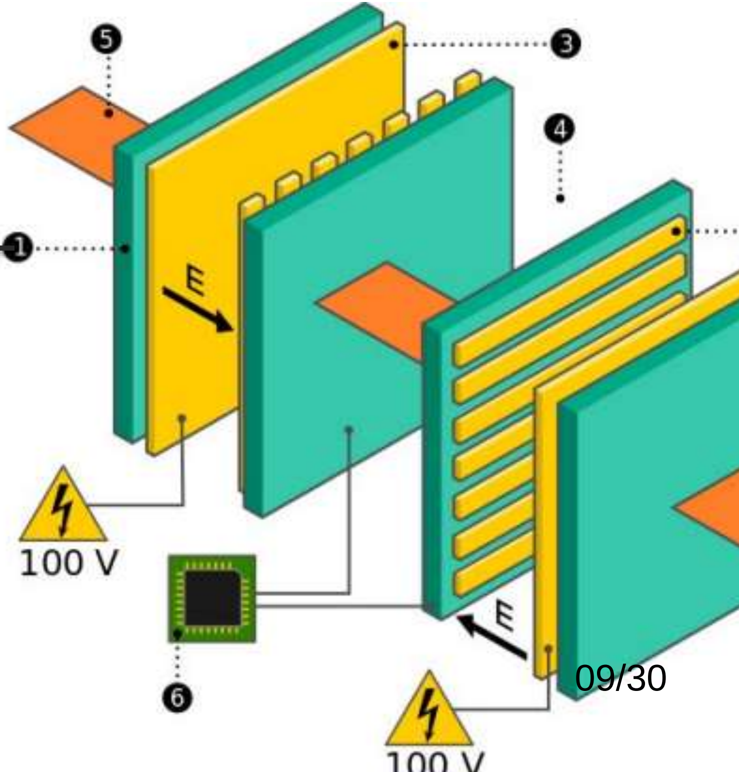


02 | HOW IS IT BUILT ?

CP1 polyimide substrate :

Excellent radiations resistance

Ultra thin (1,5 µm)



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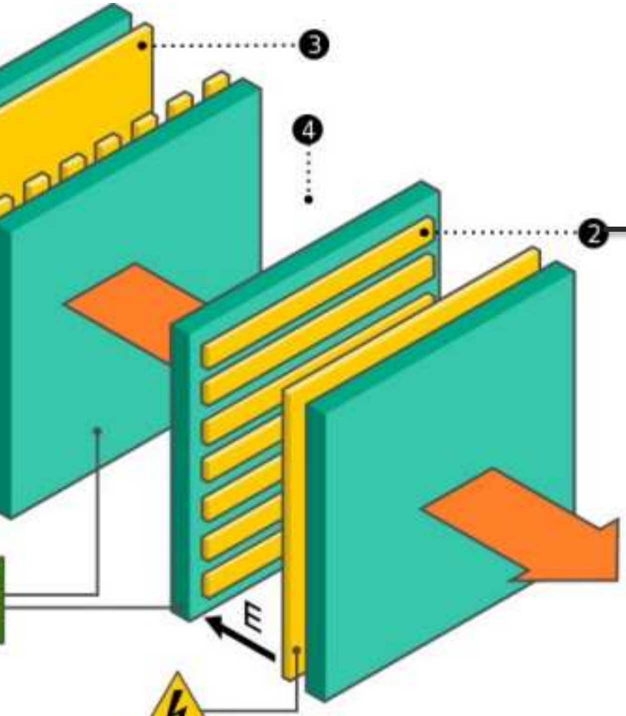
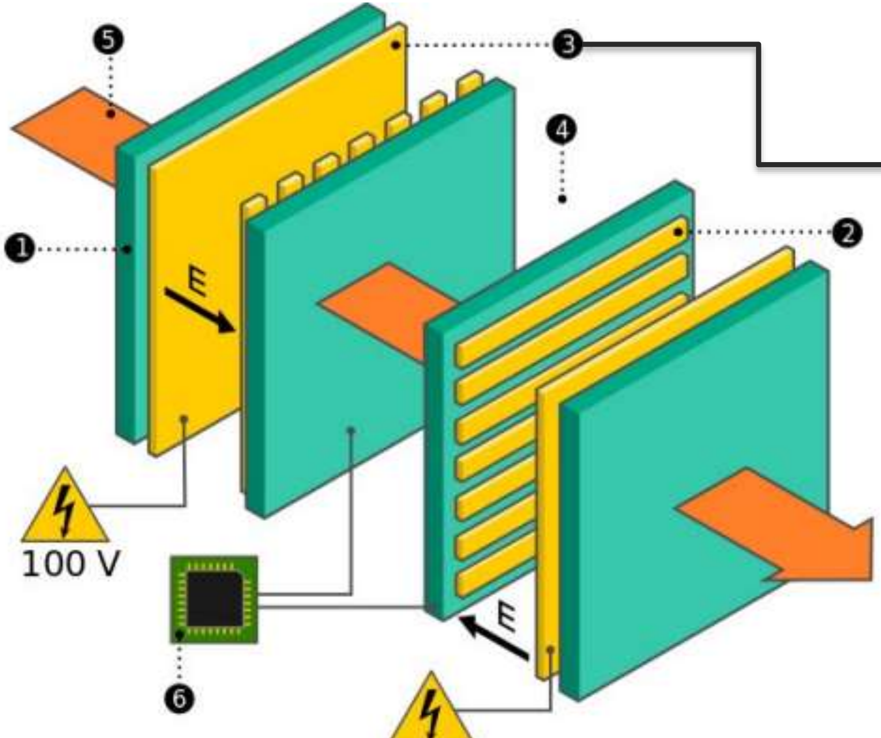


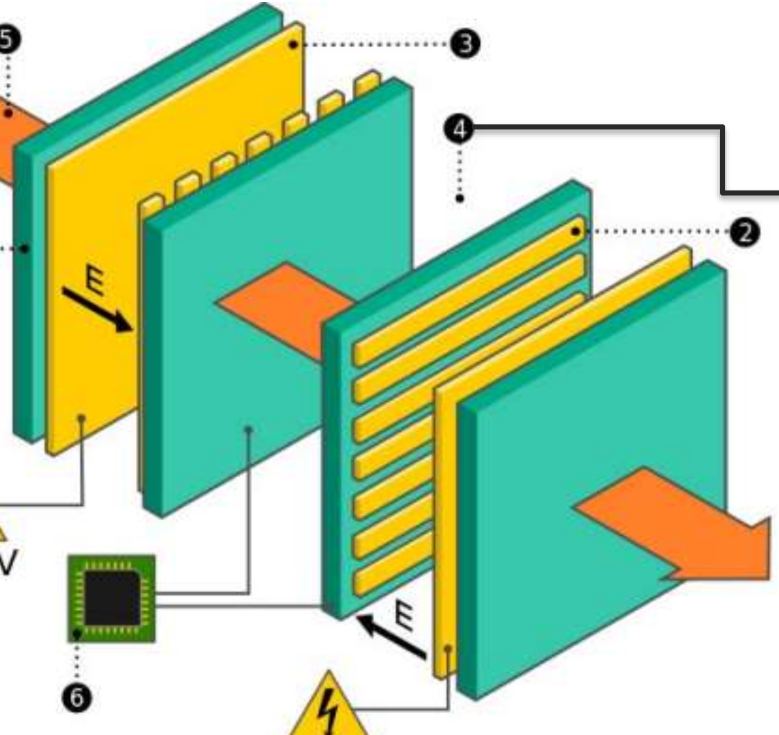
32 horizontal (vertical) gold strips of length 70 mm, width 1.85 mm, and thickness 50 nm representing the cathodes. The strips emit the secondary electrons. The signal (current from each strip) provide the horizontal (vertical) profile

02 | HOW IS IT BUILT ?



A 70 x 70 mm square thin film of thickness 50 nm representing the anode that collects the SEE .

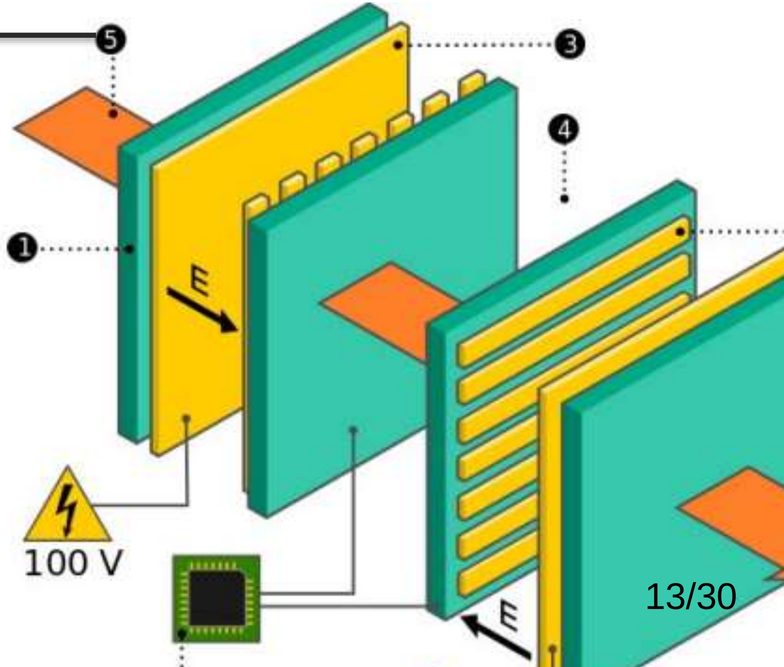
02 | HOW IS IT BUILT ?



The process is done in vacuum insuring the integrity of the signal

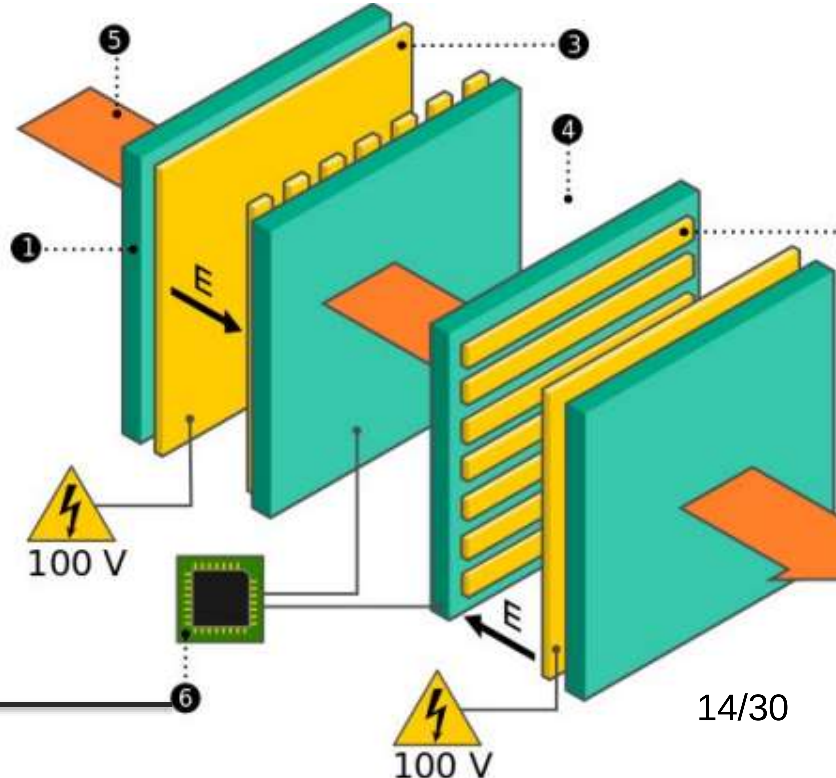
02 | HOW IS IT BUILT ?

A beam of energy ranging from 10 MeV to 100 MeV will penetrate the profiler and create SEE .



02 | HOW IS IT BUILT ?

The readout is done by a low-noise and high dynamic Application Specific Integrated Circuit (ASIC) developed at CEA



03

WHERE IS IT USED ?

03 | WHERE IS IT USED ?

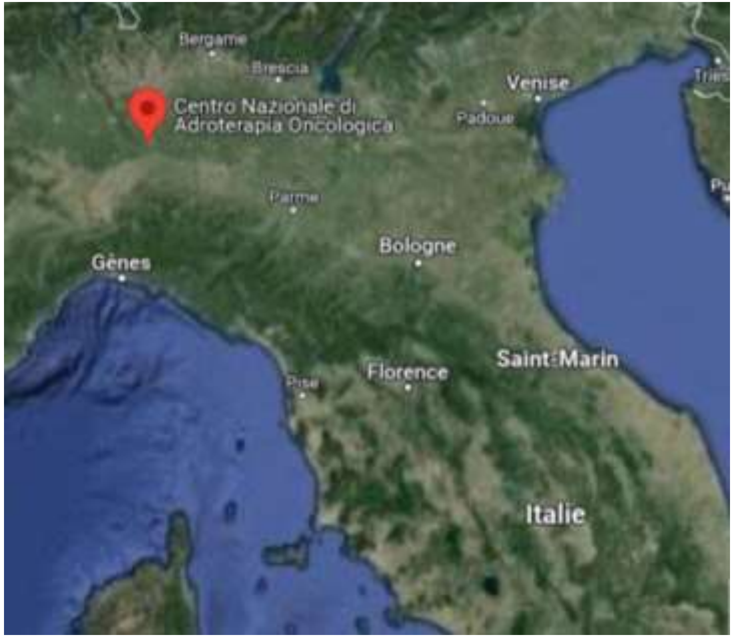
ARRONAX Nantes :

first profiler installed for permenent use

03 | WHERE IS IT USED ?

CNAO : first collaboration between CNAO and LLR to develop a monitor

CNAO :
national center for hadrontherapy
and oncology, Pavia, Italy



04 | WHAT DID WE OBTAIN ?

Electronic read-out

Beam route

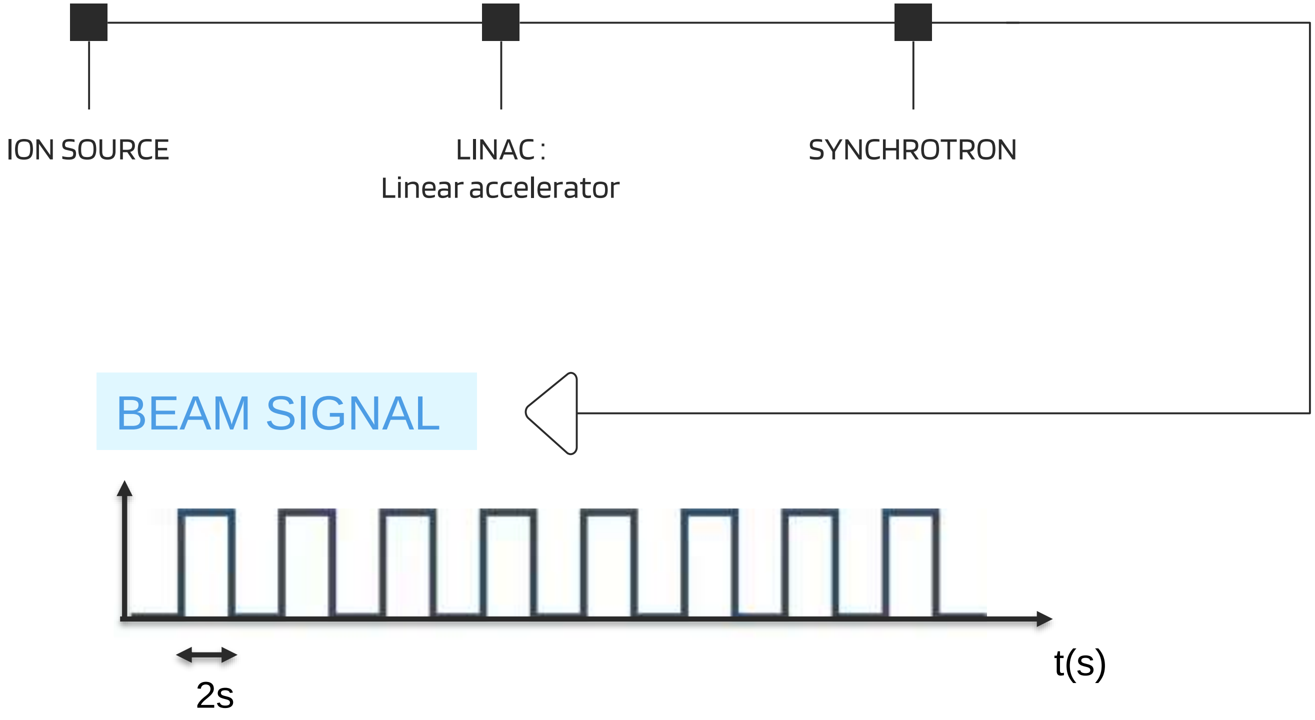
Vacuum chamber

Vacuum pumps

04

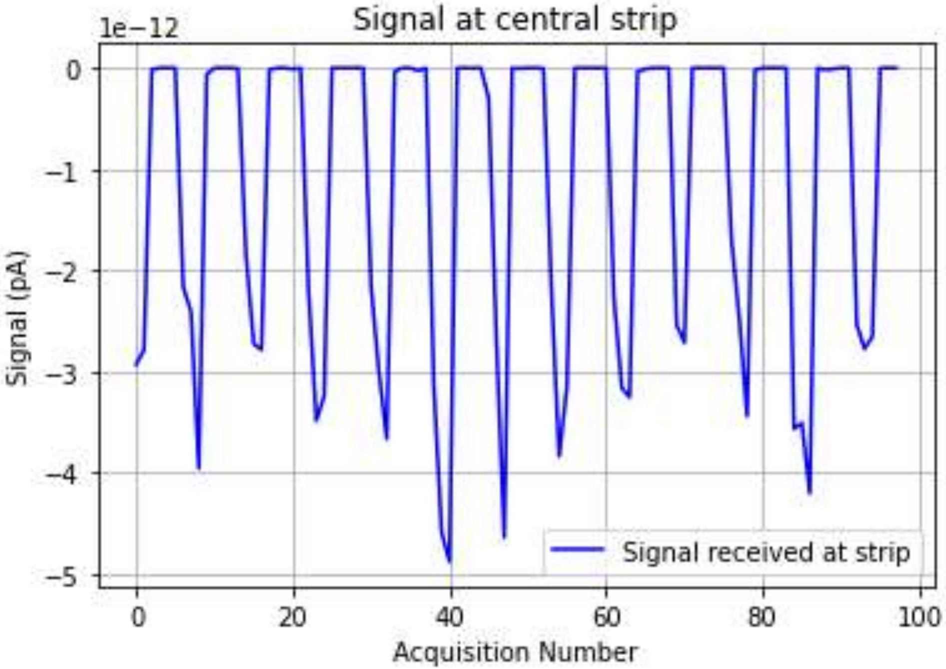
WHAT DID WE MEASURE ?

03 | WHERE IS IT USED?



04 | WHAT DO WE OBTAIN ?

- Total measurement time : 500 s
- Pulse duration : 2 s
- Number of measurements : 200
- Every 200 mesurements gives one aquisition



05

HOW WE TREAT IT ?

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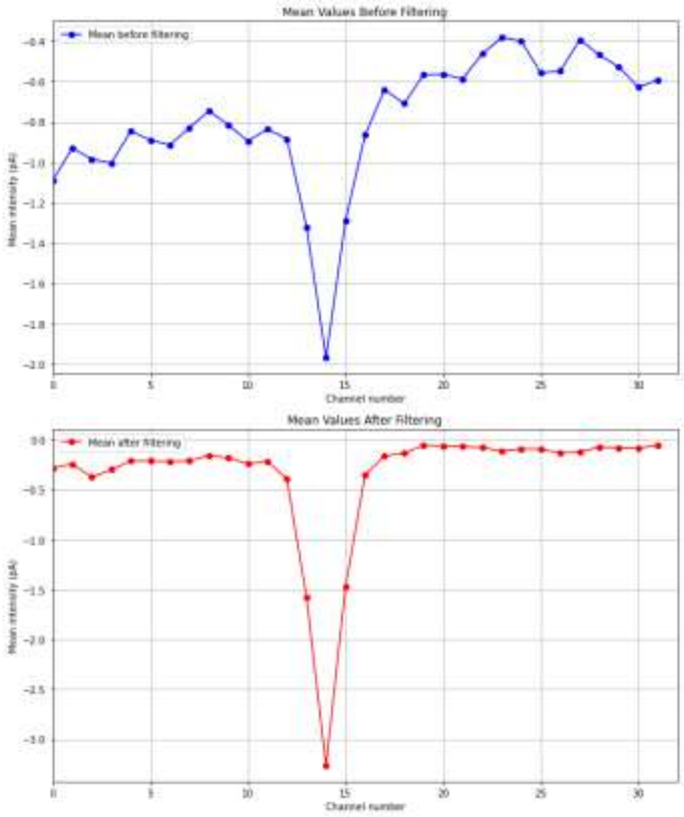
For each channel :

1. Background noise substraction
2. Data extracting
3. Mean calculation

The following data represent the measurements on a 115 MeV Carbon beam :



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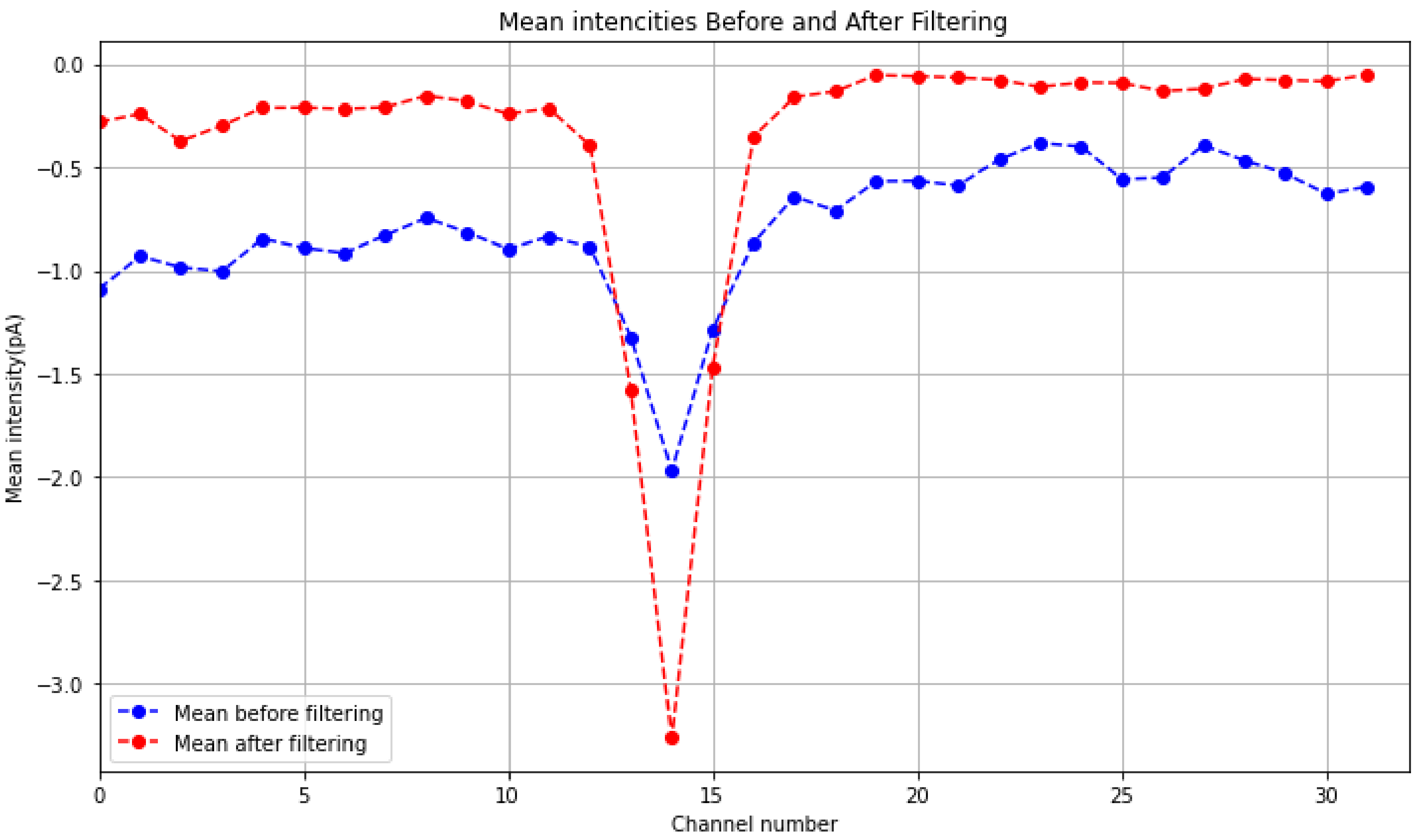
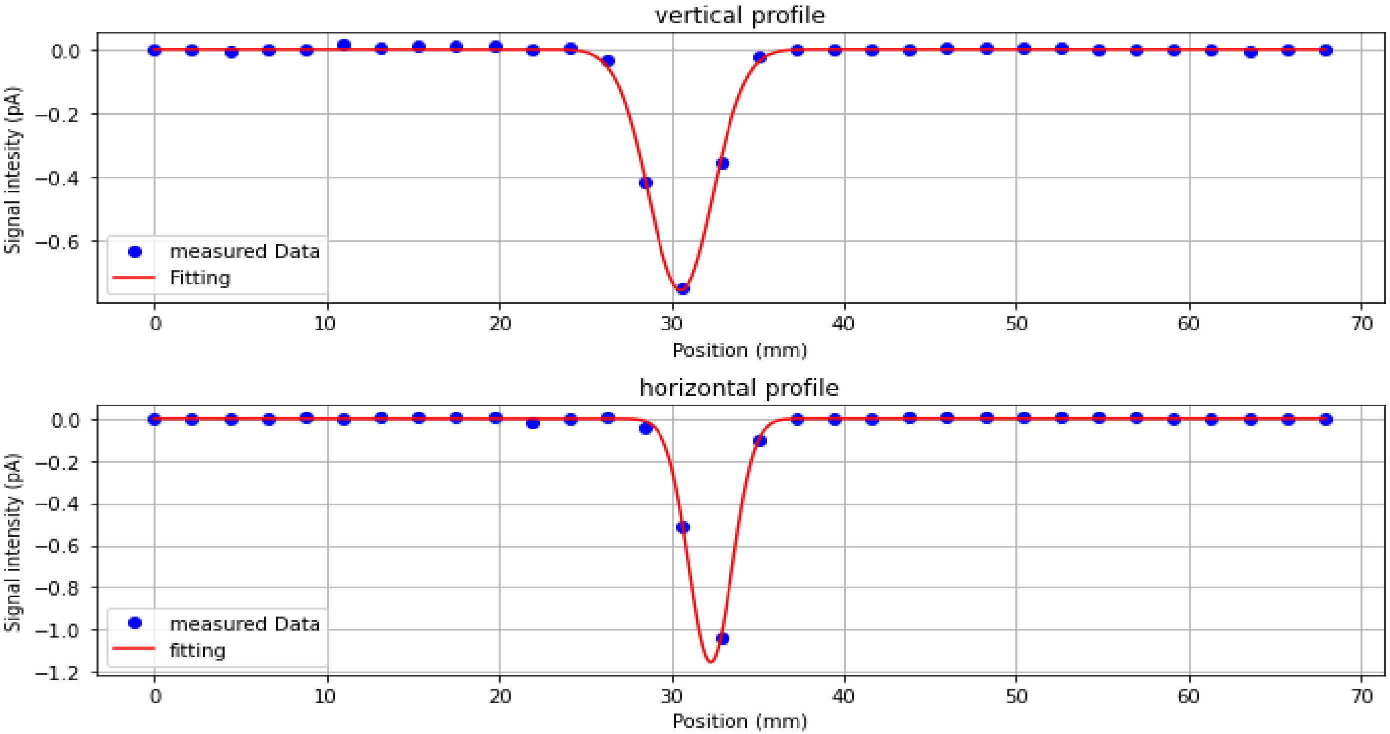


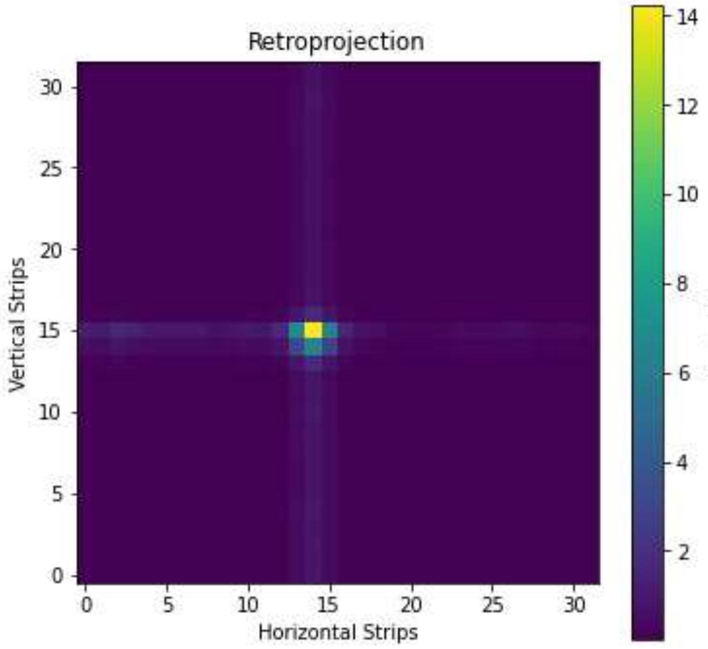
05 | HOW WE TREAT IT ?

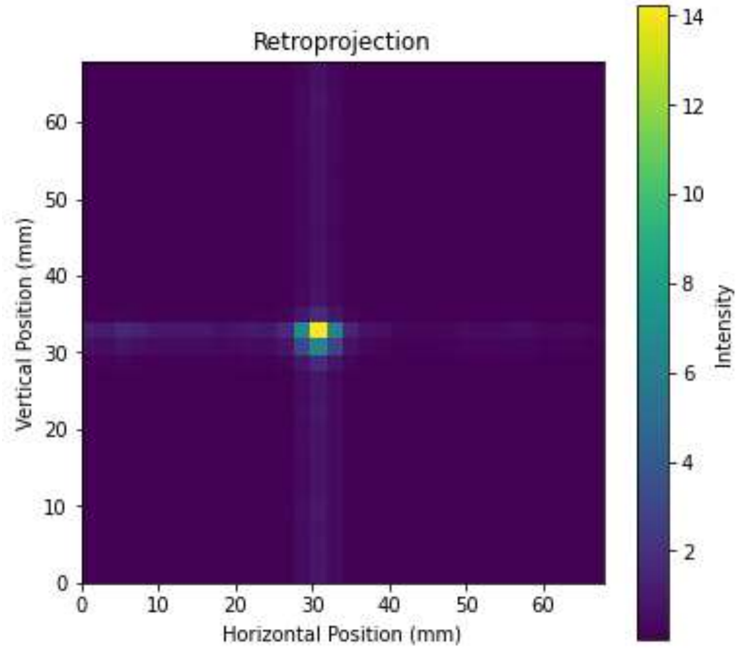
The data is fitted to a Gaussian representing the profiles



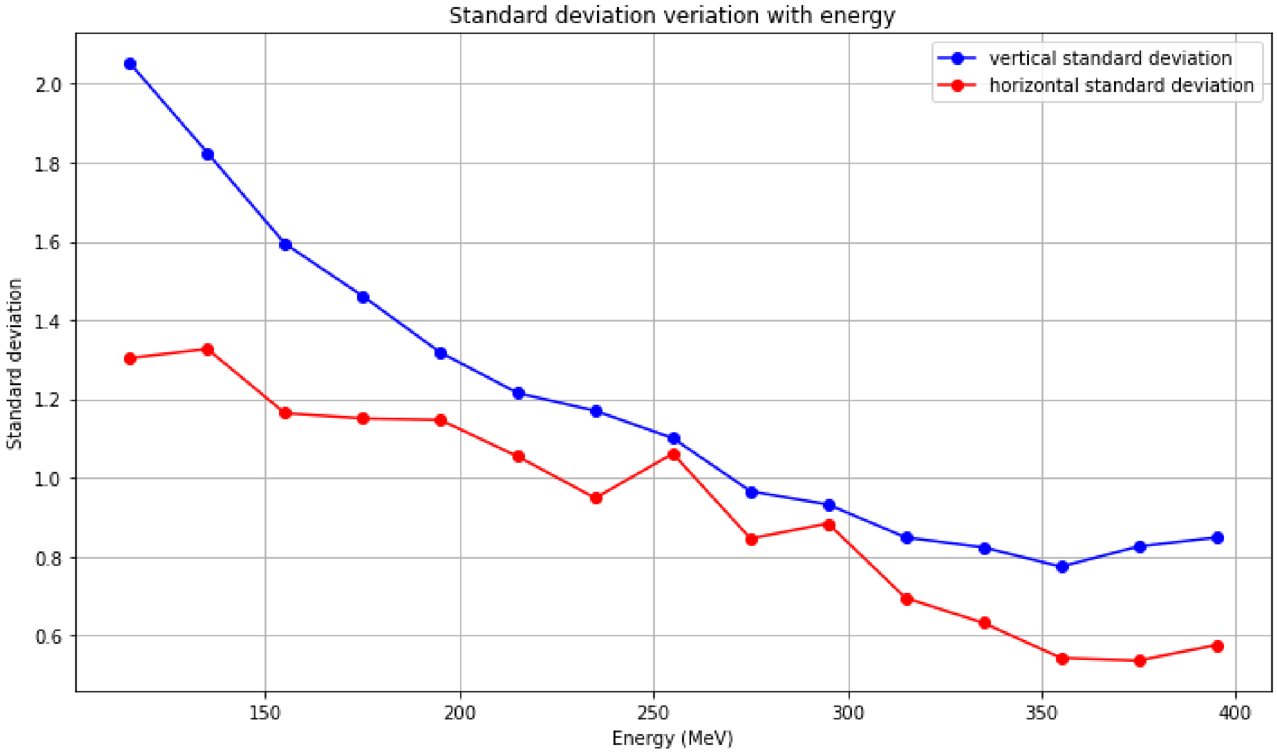
05 HOW WE TREAT IT ?

We obtain a precise representation of our beam in space





05 | HOW WE TREAT IT ?



Conclusion :

I successfully analyzed the first measurements carried out with a carbon ion beam on PEPITES:

- The data showed a good agreament with the signal caracteristics
- I obtained a precise visualization of my beam in space
- I showed the increase in precision when the energy increases

06

WHERE WILL IT GO ?

06 | WHERE WILL IT GO ?

- Comparision with CNAO profiler measurements
- Data acquisition with external trigger

The aim is to obtain a fully functionning Ultra-thin monitor for charged particle beams for clinical use

THANK YOU