IBIC 2022 International Beam Instrumentation Conference

PEPITES

First results of PEPITES a new transparent profiler based on secondary electrons emission for charged particle beams

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Context

Hadrontherapy dose delivery requires continuous and precise measurement of beam properties, intensity, position, and profile with a minimal beam perturbation. PEPITES project has developed a new ultra-thin profiler with a good resistance to radiation and operating in the beam line vacuum of mid-energy (O(100 MeV)) charged particle accelerators

Goals

- Continuous beam monitoring during patient treatment
- Simple operation and long detector lifetime

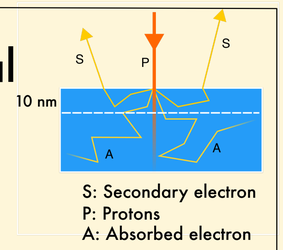
Challenges

Minimum beam perturbation
➠ Material budget < 15 μm WET

Continuous monitoring
➠ Good radioresistance (up to10^8 Gy/year)

Solution

- Secondary Electron Emission (SEE) for signal
  - Surface phenomenon
- Sensitive area
  - 50 nm thick gold strips
    - deposited on 1.5 μm insulating polymer membrane
  - Emits electrons
  - ➠ **Current in each strips : signal**
- Built with thin-film techniques
  - ➠ **Adaptation to the specificities of the beam**



S: Secondary electron
P: Protons
A: Absorbed electron

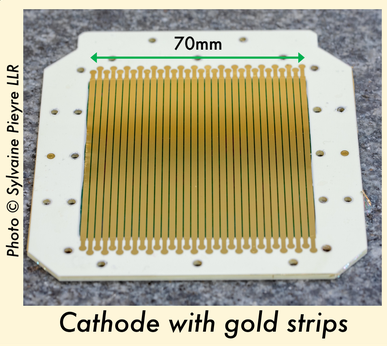
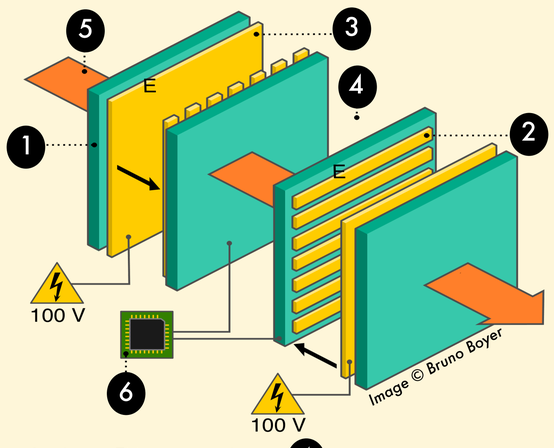


Photo © Sylvaine Pieyre LLR

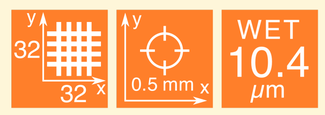
Cathode with gold strips

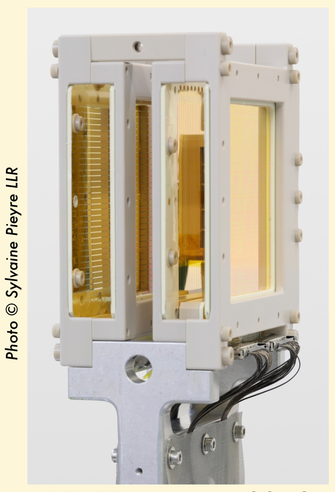
Detector layout



1. Polyimide (CP1™ 1.5 μm)
2. Cathode strips (Au 50 nm)
3. Anode (Au 100 nm)
4. Vacuum
5. Beam
6. Electronique readout

CP1™ : www.nexolvematerials.com





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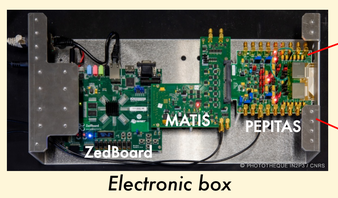
PEPITES sensitive block

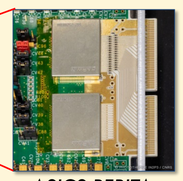
PEPITES @ARRONAX

2022.04 Detector on insertion module
➠ON and OFF beam

Dedicated readout
➠ PEPITA (© CEA)

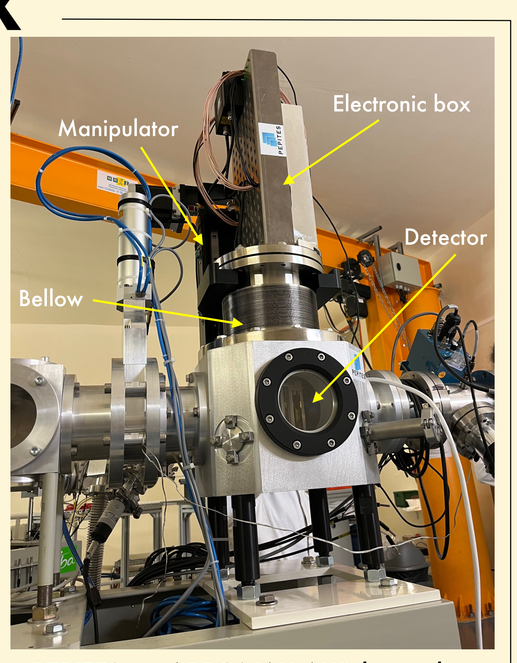


Electronic box



ASICS PEPITA
32 channels femto-ammeter

2022.05 First proton beams !

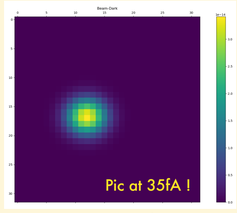


PEPITES on ARRONAX AX3 beam line

Assets

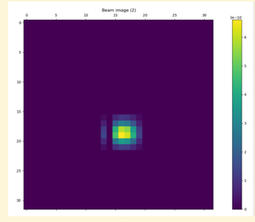
- Membranes in vacuum, free of mechanical constraints
  - ➠ **Less radio induced damages**
- Ultra-thinness reduces heating by the beam
  - ➠ **High beam intensities tolerated**
- Fully working prototype installed at ARRONAX
  - ➠ **Large dynamic range**

Results



I_{beam} = 1 pA

68 MeV proton beam profiles
1 pA < I_{beam} < 20 nA



I_{beam} = 20 nA

- SEE rates : protons of 68 MeV (ARRONAX) and 100-230 MeV (CPO)
- No radiation damages seen up to 10^9Gy

Conclusions and future

- Fully working prototype installed at ARRONAX
  - ➠ **Routine use for feedback**
- Developments to protontherapy
- Good assets for high dose rate
  - ➠ **Towards Flash modalities**

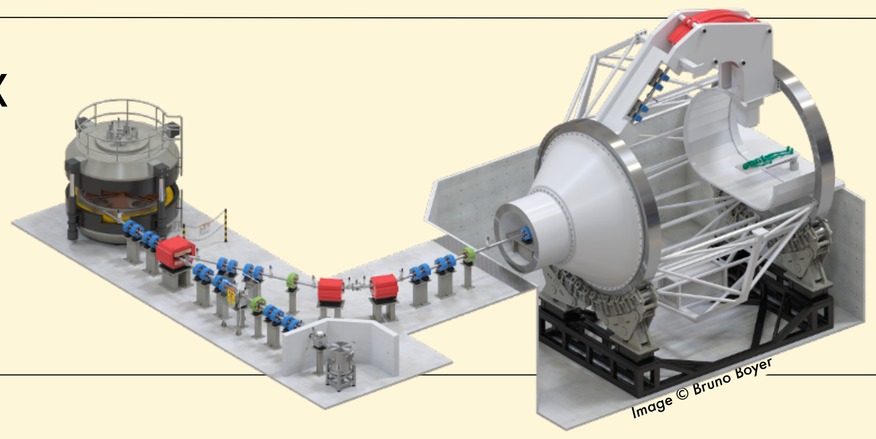


Image © Bruno Boyer

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