A new transparent beam profiler based on secondary electrons emission for hadrontherapy charged particles 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 aims at developing a new ultra-thin profiler with a good resistance to radiation and operating in the beam line vacuum.

Goal

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

Challenges

- Minimum beam perturbation
 - Material budget < 15µm WET

- Continuous monitoring
 - Good radioresistance (up to 10⁸ Gy/year)

Solution

- Secondary Electron Emission (SEE) for signal
 - Surface phenomenon
- Sensitive area
 - 50 nm gold strips
 - deposited on 1.5 µm polymeric membrane
- Built with thin-film techniques
 - Modular design
 - Adapt patterns to beam specificities
- Operate in beamline vacuum
 - No mechanical constraints

Detector layout

CP1™ : www.nexolvematerials.com

Prototype

- Proof of concept
 - ARRONAX^a
- SEE studies
 - ARRONAX
 - CPO^b
- Hardness studies
 - LSI^c
 - CSNSM^d
 - ARRONAX

^awww.cyclotron-nantes.fr
^bOrsay Protontherapy Center
^cportail.polytechnique.edu/lr/fr
^dwww.csnsm.in2p3.fr

Strips (Au, 50 nm) on 1.5 µm thick CP1™

Results

Irradiation with electrons, protons, gamma sources
no critical damage up to 10⁹ Gy

Measurement of SEE

- ARRONAX protons (30-68 MeV) and alphas
- CPO protons (100-230 MeV)

Future

- mid 2020 Integrated readout chip (CEA)
- end 2020 Install and operate fully working prototype at ARRONAX cyclotron
- 2021 Mature project for PT centers

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