



SCCVD DIAMOND MEMBRANE RADIATION DETECTORS FOR RADIOBIOLOGICAL APPLICATIONS

6th ADAMAS Workshop, Zagreb 27/11/2017 | Pomorski Michal





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An ultra-thin diamond membrane as a transmission particle detector and vacuum window for external microbeams

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It took some time for experimental realization in radiobiology.....

Cell micro-irradiation with MeV protons counted by an ultra-thin diamond membrane

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INTRO

... going to be published in December APL 2017...



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Localized molecular damage in cells with focused / collimated radiation (lasers, UV microspots, X-rays, charged-particles - protons, a, HI)



Study of radiation effects at sub-cellular level:

- \rightarrow Visualization of the cellular/molecular response
 - \rightarrow Dynamical study of the cellular response
 - ightarrow DNA damage and repair kinetics

Information on:

oncogenic transformation, micronuclei formation, genetic instability low dose effects, micro-tracks models → hadron therapy models











AIFIRA FACILITY

Beamlines @ AIFIRA





3.5 MV Singletron accelerator (HVEE)
Ions: p, d and a-particles; E<3.5MeV
2 microbeam lines - 1 dedicated to cells



PIXIE wine dating



Radiobiology micro-beam line @ AIFIRA Facility, CENBG, Bordeaux



Micro-beam Focusing ~1μm (fwhm) Electrostatic scanning: -high throughput (<100μs) - few mm² scan -geometrical patterns Fluorescence microscopy:

Targeting the cells
 Observing early cellular response (time lapse)



List CEALECH EXTERNAL MICROBEAMS

... Precise information about the dose (or number of ions) is required ...

- statistics: $N \rightarrow error sqrt(N)$, ok for 1000 ions
 - \rightarrow impossible for single particle irrad.

• thin transmission detectors (thin plastic scintillators, thin semi-conductors, gas detectors) *those are too thick for MeV a-particles ...*



300 nm BNCD membrane SEE yield spectra BNCD membrane 1 BNCD membrane 2 SIN.

BNCD diamond membrane detector based on secondary electron emission (SEE):

100% efficient for a-particles microbeam, but not for protons.....

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Solution for p: Solid-state 'active' vacuum window ionization chamber



RADIOBIOLOGY – MEMBRANES PERFORMANCE





Instrumentation aux limites 2016

Active solid-state ionization chamber vacuum window for low energy ion counting (non-electronic grade scCVD)

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- mechanical robustness
- radiation hard, compact, no maintenance
- VIS transparency (dark field microscopy)

2.8 µm scCVD membrane with ITO electrical contacts as active VIS transparent vacuum window





vacuum tight scCVD membrane detector





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MEMBRANES PERFORMANCE

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External 3 MeV p beam properties after 2 and 3μ m diamond active window @ 100 μ m distance







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The U2OS cells expressing fluorescence from XRCC1-GFP (single strand DNA breaks repair), 3min after p irradiation



Exactly 100 protons per irradiation point, delivery steered by the scCVD diamond membrane detector

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A 100% efficient (protons) active vacuum window for radiobiological studies. Allows perfect dosimetry during irradiation of living cells.

Detectors installed at AFIRA for routine irradiations

Outlook:

- single protons irradiations of C. elegance
- collaboration with the community members



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