2nd Annual ARDENT Workshop & ARDENT MidTerm Review

Monday, 14 October 2013 - Friday, 18 October 2013

Politecnico di Milano

Book of Abstracts

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Each supervisor from each Institute should briefly present (5 min) their research team and describe their role within the network.

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ARDENT Project Overview

Author: Marco Silari[1]

[1] *CERN*

A presentation by the Coordinator on the Network and the Mid-Term Review Report. The presentation cover scientific, training and networking topics.

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ESR 1 presentation - CERN

Author: Eleni Aza[1]

[1] *CERN*

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ESR 2 presentation - CERN

Author: Erik Frojd[1]

[1] *Mittuniversitetet (SE)*

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ESR 3 presentation - CERN

Author: Silvia Puddu[1]

[1] *CERN*

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ESR 4 presentation - CERN

Author: Stuart Patrick George[1]

[1] *CERN*

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ESR 5 presentation - SL

Author: Jayasimha BAGALKOTE[None]

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ESR 6 presentation - AIT

Author: Andrej Sipaj[None]

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ESR 7 presentation - CTU

Author: Ivan Caicedo[None]

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ESR 8 presentation - CTU

Author: Kevin Loo[None]

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ESR 9 presentation - CTU

Author: Benedikt Ludwig Bergmann[1]

[1] *Czech Technical University (CZ)*

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ESR 10 presentation- IBA

Author: Francesca Bisello[None]

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ESR 11 presentation - IBA

Author: Michele Togno[None]

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ESR 12 presentation - JABLOTRON

Author: Vijayaragavan Viswanathan[None]

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ESR 13 presentation - MIAM

Author: Alvin Sashala Naik[None]

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ESR 14 presentation - POLIMI

Author: Elena Sagia[1]

[1] *National Technical Univ. of Athens (GR)*

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ESR 15 presentation - POLIMI

Author: Christopher Cassell[1]

[1] *P*

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Il programma ARDENT della Unione Europea / The ARDENT European Union project

Author: Marco Silari[1]

[1] *CERN*

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Introductory lecture on microdosimetry

Author: Paolo Colautti[1]

[1] *LNL INFN*

1. The energy transfer points
2. The single-event energy imparted
3. Single-event microdosimetric quantities
4. Multi-event microdosimetric quantities
5. Micro and macro dosimetry
6. From micro-to-macro dosimetry for low and high LET radiations.

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Gas detectors for microdosimetry

Author: Anthony Waker[1]

[1] *UOIT*

FUNDAMENTALS
• Gas ionization
• Charge collection
• Cavity chambers

GAS DETECTORS for MICRODOSIMETRY
• Ionization Chambers
o Variance method
o Recombination Chambers

• Proportional Counters
o Principles of Operation
o Tissue Equivalent Proportional Counters (TEPC)
o TEPC Properties and Applications
o Multi-element TEPCs

o Heterogeneous Counters
o Wall-Less Counters

FUTURE NEEDS and CHALLENGES
• Size and sensitivity
• Neutron-Charge particle discrimination
• Calibration
• Signal Processing

Summary:

Gas detectors remain the most common and the most used of all detector types in experimental microdosimetry. This lecture aims to provide the basis for understanding gas detector operation and to illustrate their application in microdosimetry and radiation measurement science. The discussion will conclude with a review of future needs and current technical challenges.

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Quality assessment of hadrontherapy fields with TEPCs

Author: Paolo Colautti[1]

[1] *LNL INFN*

1. Mini TEPC design and construction
2. Vacuum and gas flow
3. The electronic chain
4. Mini TEPC energy calibration
5. Data processing
6. Therapeutic proton-beam qualities
7. BNCT radiation-field qualities

Training Courses on Experimental Micro- and Nano-dosimetry / 47

Principle of Silicon based microdosimetry

Authors: Andrea Pola[1]; Stefano Agosteo[1]

[1] *Politecnico di Milano*

Silicon detectors are being studied as microdosimeters since they can provide sensitive volumes of micrometric dimensions. They can be applied for assessing single event effects in electronic instrumentation exposed to complex fields around high-energy accelerators or in space missions. When coupled to tissue-equivalent converters, they can be used for measuring the quality of radiation therapy beams or for dosimetry. The use of micrometric volumes avoids the contribution of wall effects to the measured spectra. Further advantages of such detectors are their compactness, cheapness, transportability and a low sensitivity to vibrations. Anyway, the following problems should be solved when a silicon device for microdosimetry: i) the sensitive volume has to be confined in a region of well-known dimensions; ii) the electric noise limits the minimum detectable energy; iii) corrections for tissue-equivalency should be made; iv) corrections for shape equivalency should be made when referring to a spherical simulated site of tissue; v) the angular response should be evaluated carefully; vi) the efficiency of a single detector of micrometric dimensions is very poor and detector arrays should be considered. Several devices are being proposed as silicon microdosimeters, based on different technologies (telescope detectors, silicon on insulator detectors and arrays of cylindrical p-n junctions with internal amplifications), in order to satisfy the issues mentioned above.

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Silicon microdosimetry

Author: Anatoly Rozenfeld[1]

[1] *UOW*

1. Introduction to Solid State microdosimetry
2. Electronic , calibration and sensitivity of Si microdosimeter
   2.1. Comparison of TEPC to Si-microdosimeter
3. Concept and design of Silicon on Insulator (SOI) microdosimeters
   3.1. Three generation of SOI microdosimeters
   3.2.Charge collection in Sensitive Volumes (SV) of SOI microdosimeters

4.Application of SOI microdosimeters
4.1.Radiation protection (Cf-252 and Pu-Be Sources)
4.2.Hadron Therapy
4.2.1.Fast Neutron Therapy (FNT)
4.2.2.Proton Therapy (PT)
4.2.3.Heavy Ion Therapy.(HIT)
4.2.4. LEM vs MKM –SOI microdosimetry experience

1. 3D detector technology-future of Si microdosimetry.
   5.1.Pecularities of charge collection in 3D Si detectors
   5.2.Concept and design of 3D Si microdosimeter.
   5.3.GEANT 4 modeling of 3D microdosimeter (avionics environment, isotopic neutron sources)
2. Other Si microdosimetric structures (DRAM , FGMOSFET etc)
3. Conclusion and tips for thinking on new Si microdosimeters design

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A monolithic silicon telescope for solid state microdosimetry

Author: Andrea Pola[1]

[1] *Politecnico di Milano*

1. The detection system: features, advantages and drawbacks.
2. Microdosimetry of neutron fields: numerical studies and experimental characterizations.
3. Quality assessment of clinical proton beams: microdosimetric characterization and direct comparison with TEPCs.

4. Microdosimetry of carbon beams: preliminary tests.
5. A silicon microdosimeter integrated into a nanodosimeter.

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From microdosimetry to nanodosimetry

Author: Bernd Grosswendt[1]

[1] *PTB (retired)*

Radiation-induced damage to living cells or genes is governed, to the greater part, by the pattern of inelastic interactions of ionizing particles in sub-cellular targets (segments of the DNA, nucleosomes, or segments of the chromosome fibre). In consequence, the effectiveness and quality of ionizing radiation should be defined more in terms of quantities which are directly related to the track structure of ionizing radiation than in terms of macroscopic quantities like absorbed dose and linear energy transfer (LET). At the same time, these quantities should be measurable by physical means.
To tackle this challenge to radiation metrology, a track-structure based concept of radiation damage has been developed assuming that the initial damage to nanometre-sized volumes like the DNA is mainly due to the number of ionizing processes of single particles within a target volume or in its near neighbourhood. This number of particle interactions (the so-called ionization-cluster size) is measurable in gases using single-ion or single-electron counting techniques, and serves as a measure of the degree of radiation damage; the corresponding cluster-size frequency then serves as a measure of the radiation-induced damage probability. Radiation damage is described, therefore, in terms of particle interaction probabilities in nanometric volumes (nanodosimetry) instead of micrometric volumes (microdosimetry). In this way the traditional description of radiation damage in terms of LET and absorbed dose is exchanged by a probabilistic description of cluster-size formation which characterizes the interaction pattern of ionizing radiation in nanometric volumes and, thus, the particles'track structure.
To check the validity of the track-structure-based concept of radiation quality, experimental radiobiological data are compared with nanodosimetric quantities derived from cluster-size frequencies calculated by Monte Carlo simulations for ionizing particles at different radiation qualities assuming nanometre-sized liquid-water targets as substitutes of short segments of the DNA. This comparison shows a clear relation between track-structure-based nanodosimetric quantities and radiobiological data, which can also be expected if ionization-cluster-size frequencies are measured in gaseous target volumes filled, for instance, with molecular nitrogen or propane at low gas pressure.

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THE STARTRACK EXPERIMENT - Nanodosimetric STructure of hAdRon TRACKs

Author: Valeria CONTE[1]

[1] *LNL INFN*

GENERALITIES OF TRACK STRUCTURE

THE EXPERIMENTAL SET UP
- The rational of the experiment
- The measuring procedure

DATA ACQUISITION AND DATA ANALYSIS
- How to handle experimental data

RESULTS
- Some interesting features of the track structure of light ions
- The link to radiobiology

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Microdosimetry with GEM and GEM-PIX

Author: Fabrizio Murtas[1]

[1] *Istituto Nazionale Fisica Nucleare (IT)*

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Practical training on TEPCs

Authors: Davide MORO[1]; Paolo Colautti[1]

[1] *LNL INFN*