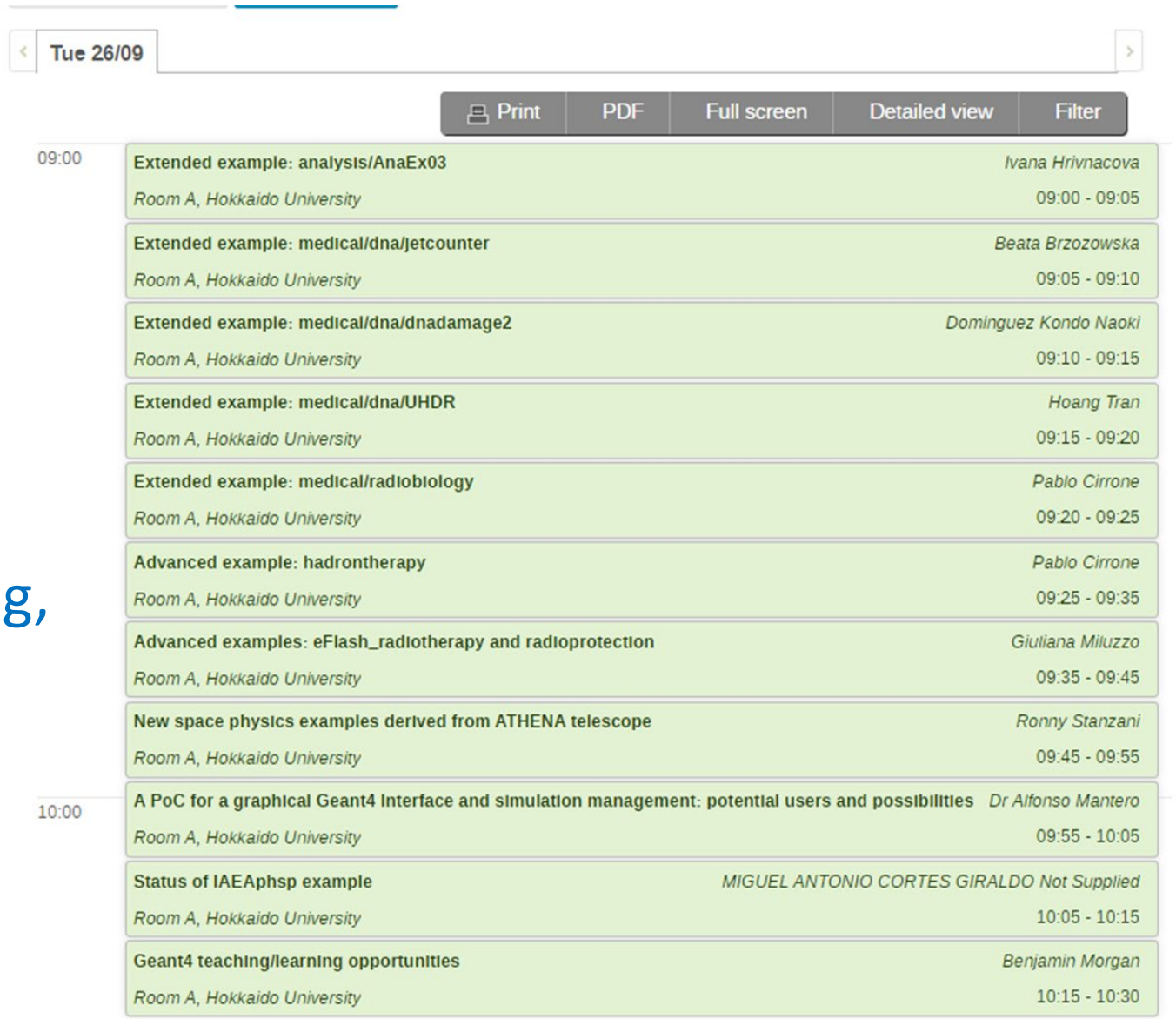
Summary of Parallel 2A: Basic, Extended and Advanced Examples

S. Guatelli and I. Hrivnacova

28th Geant4 Collaboration Meeting,

25-29 September, Sapporo, Japan



New Extended Examples

AnaEx03 *I. Hrivnacova*

- New extended/analysis example to demonstrates usage of analysis **commands for file management** (new since Geant4 11.1), in particular writing histograms and ntuples in a file multiple times
  - `/analysis/openFile`
  - `/analysis/write`
  - `/analysis/closeFile`
- and **commands for histogram [and ntuple] deleting** (new since Geant4 11.2)
  - `/analysis/h1/delete id [keepSetting]`
  - `/analysis/ntuple/delete id [keepSetting]`
  - Deleting ntuples is still to be added

JetCounter

M. Pietrzak, B. Brzozowska, A. Bancer, M. Mietelska, A. Ruciński

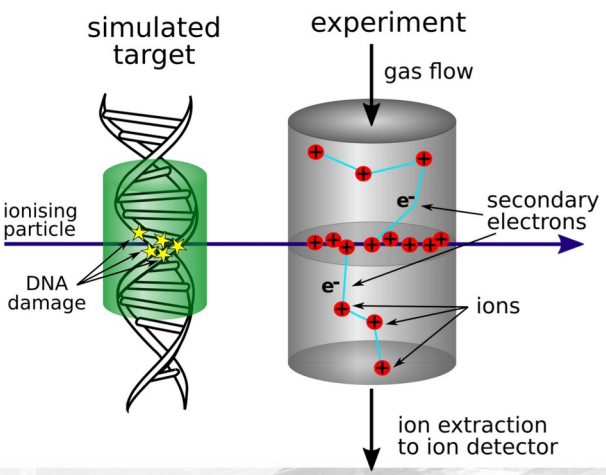
extended/medical/dna

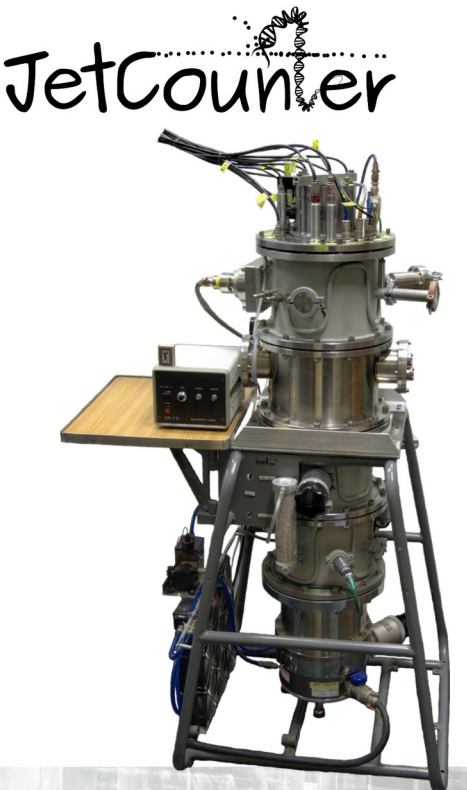
GEANT4-DNA

Jet Counter nanodosemeter

The **extended/medical/dna/jetcounter** example is meant to represent the Jet Counter nanodosimetric setup for measurements with alpha particles.

The Jet Counter device is an experimental model for a nanometric biological target comparable in size to a short segment of a DNA.





UHDR

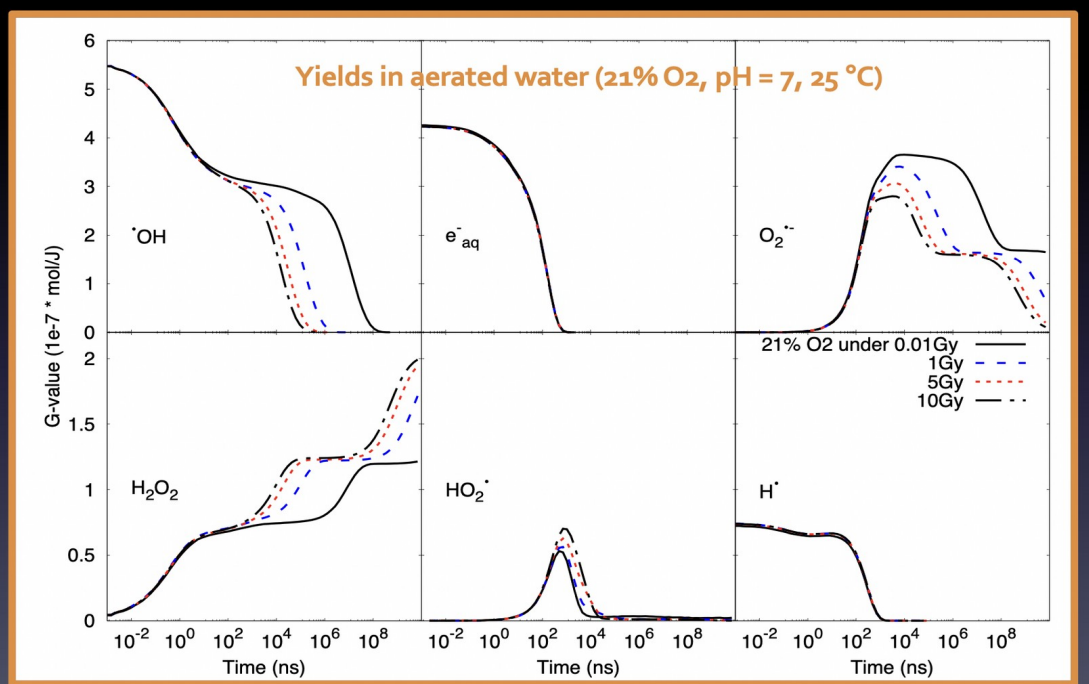
H. Tran

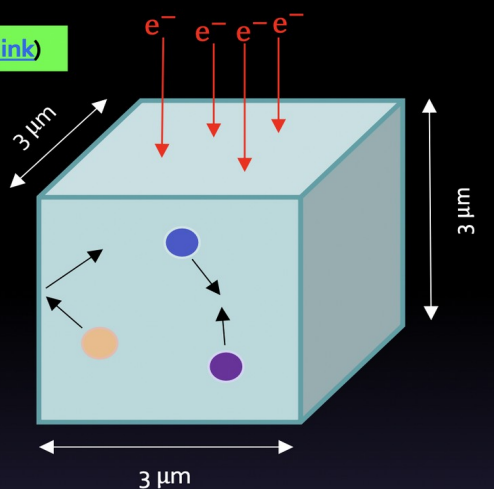
extended/medical/dna

New « UHDR » example

Tran et al., Int. J. Mol. Sci. (2021) 22 (link)

Modelling of ultra-high dose rate (UHDR) electron beams





- Source: 1 MeV electron beam
- Simulation volume: water cube taking into account radiolytic species rebound (closed system)
- Electron irradiation until the total energy deposition reaches 1-10 Gy (UHDR) or ~ 0.01 Gy (conventional)
- Instantaneous pulse (all species are produced simultaneously)
- Extension of the chemical stage beyond the microsecond
- Study the evolution of ROS such as HO2• and O2•- produced by irradiation, pH is considered
- Currently being validated with exp. data

Radiobiology

G.A.P. Cirrone, F. Farrokhi, S. Fattori, L. Pandola, G. Petringa, A. SciutoTran

extended/medical

Radiobiology example offers customisable geometry, advanced physics lists, and comprehensive outputs for dosimetric and biological evaluations.

Radiobiology **future direction**: **Sandbox usage** for testing Machine Learning (ML) post-processing models.

Aim: Improve the accuracy and efficiency of dosimetric and biological predictions.

Integration: Facilitate the implementation of ML algorithms into Geant4's workflow.

In system testing, pubblicazioni in December 2023, a paper is in progress.

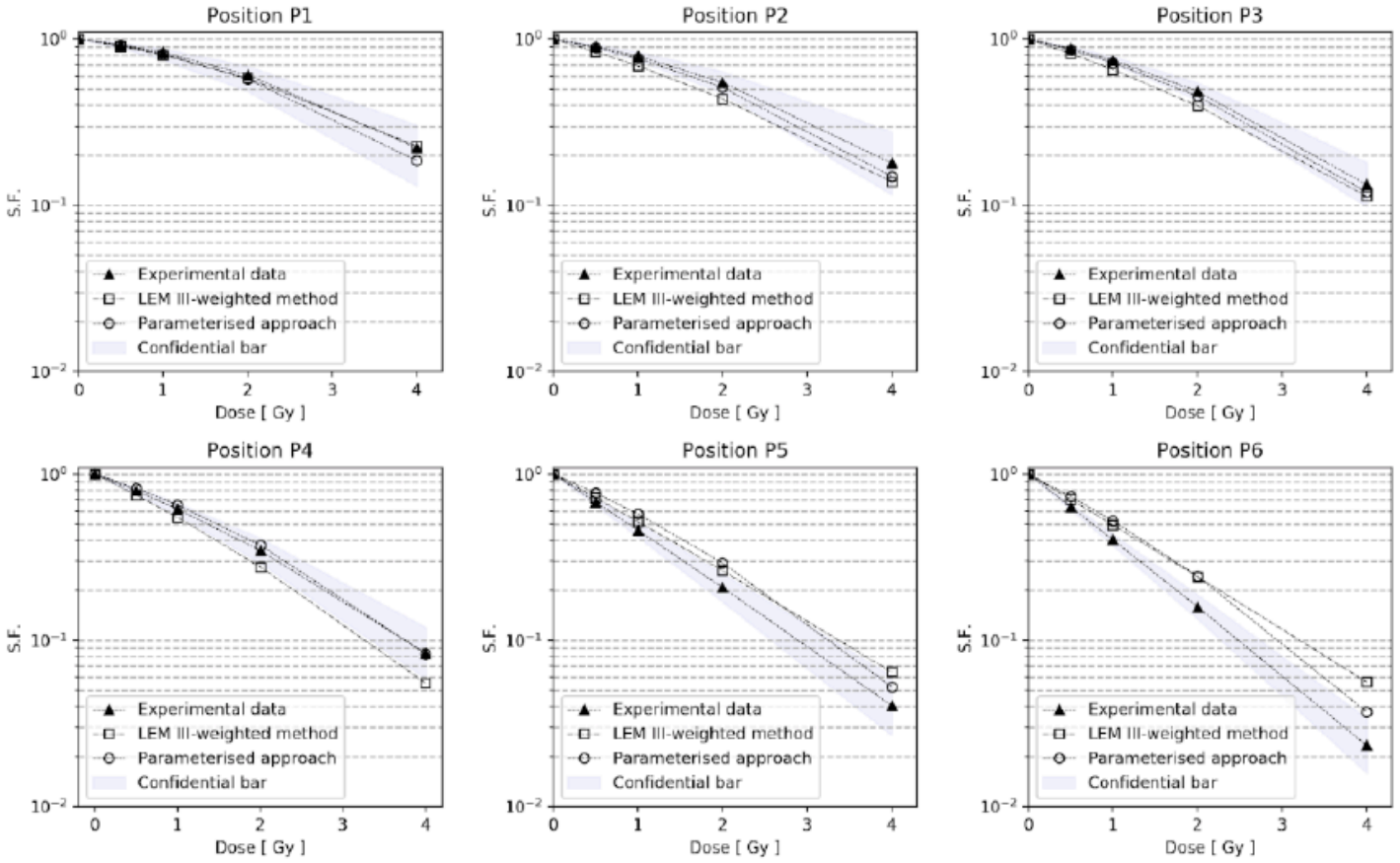
Advanced Examples

Hadrontherapy

Talk by P. Cirrone, LNS, INFN, Italy

Responsible G4 members: G.A.P. Cirrone, L. Pandola, G.Petringa, LNS, Catania, Italy

Computation Method coupling Geant4 to LEM



Physica Medica 58 (2019) 72–80
Contents lists available at ScienceDirect
Physica Medica
journal homepage: www.elsevier.com/locate/ejmp
Original paper

Radiobiological quantities in proton-therapy: Estimation and validation using Geant4-based Monte Carlo simulations

G. Petringa[a,b], F. Romano[a,h], L. Manti[c,d], L. Pandola[a], A. Attili[e], F. Cammarata[a,f], G. Cuttone[a], G. Forte[a,f], L. Manganaro[e], J. Pipek[g], P. Pisciotta[a,b], G. Russo[a,f], G.A.P. Cirrone[a,g,*]

applied sciences
MDPI
Article

Radiobiological Outcomes, Microdosimetric Evaluations and Monte Carlo Predictions in Eye Proton Therapy

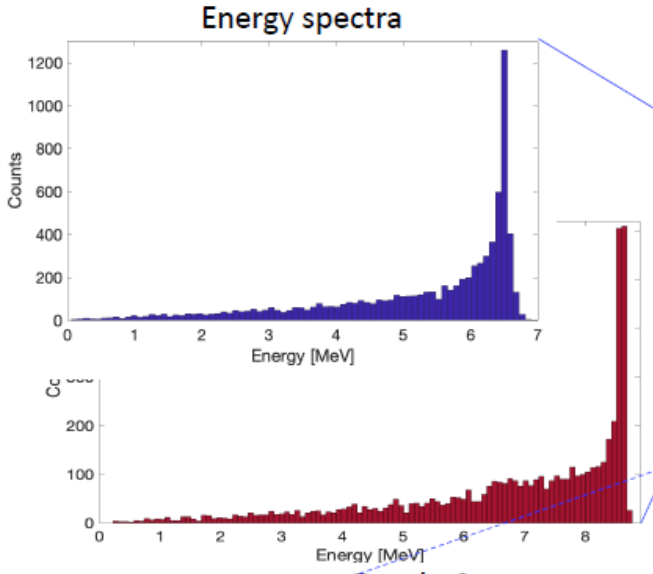
Giada Petringa [1,2,†], Marco Calvaruso [1,3,*], Valeria Conte [4], Pavel Bláha [5], Valentina Bravatà [1,3], Francesco Paolo Cammarata [1,3], Giacomo Cuttone [1,6], Giusi Irma Forte [1,3], Otilija Keta [7], Lorenzo Manti [5,8], Luigi Minafra [1,3], Vladana Petković [7], Ivan Petrović [7], Selene Richiusa [1,3], Aleksandra Ristić Fira [7], Giorgio Russo [1,3] and Giuseppe Antonio Pablo Cirrone [1,6,9,†]

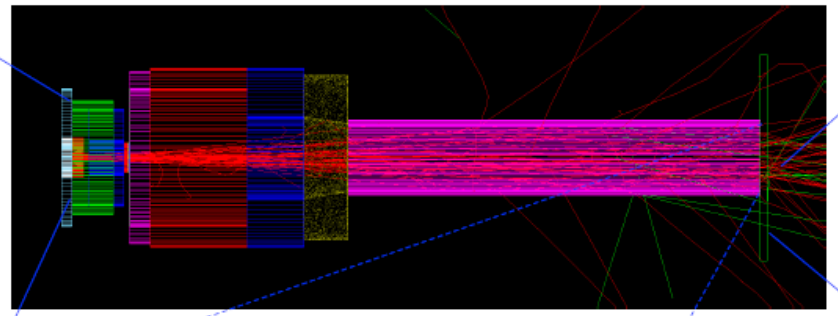
- The code was already successfully validated with clinical proton beams
- A study with ^{12}C is currently ongoing
- The next step is to extend the validation with multiple light ions: ^{4}He and ^{16}O

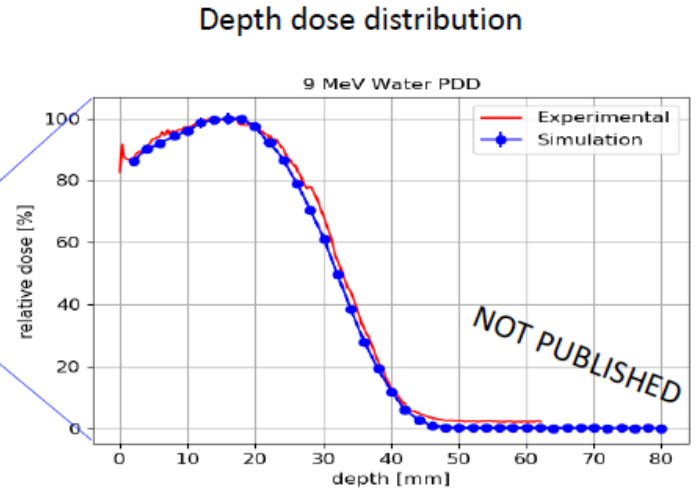
eFLASH_radiotherapy

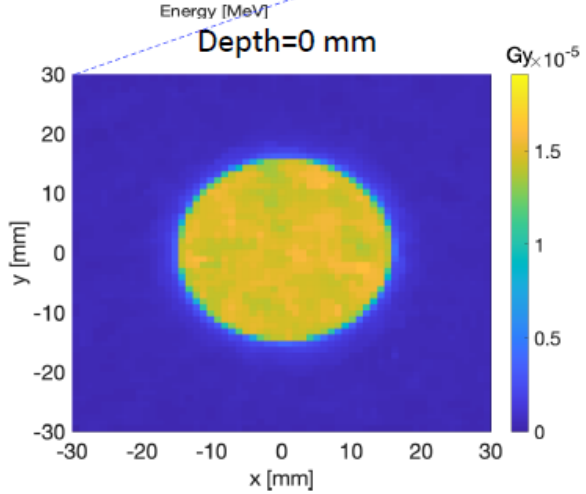
Talk by G. Miluzzo, INFN Catania, Italy

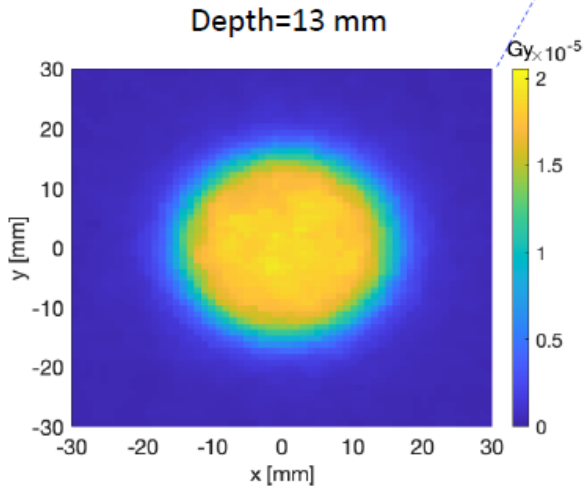
Authors: J. H. Pensavalle (1,2), G. Milluzzo (3) and F. Romano (3)
(1) Azienda Ospedaliera Universitaria Pisa, Pisa, Italy, (2) INFN, Pisa, Italy, (3) INFN, Catania, Italy

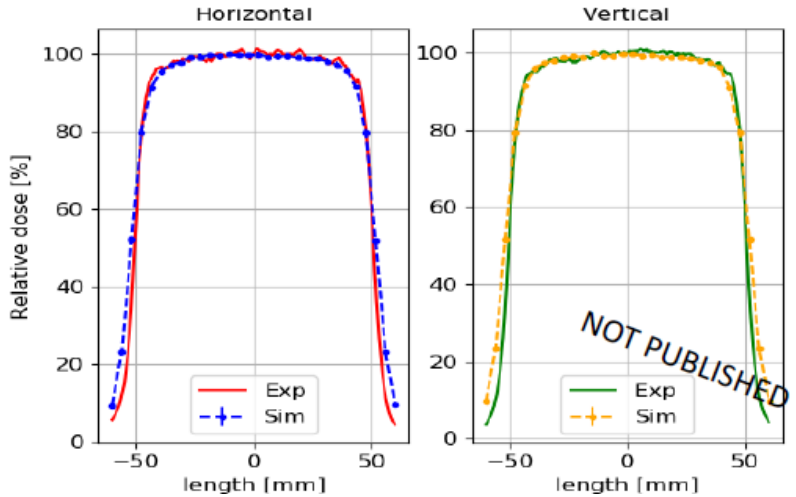












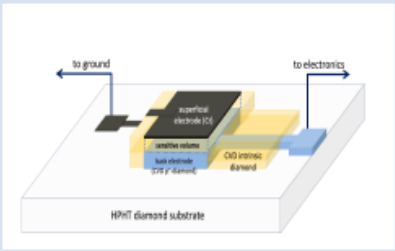
Radioprotection

Talk by G. Miluzzo, INFN Catania, Italy

Responsible G4 members: G. Miluzzo and F. Romano, INFN Catania, Italy
S. Guatelli, UOW, Wollongong, Australia

Microdosimeters

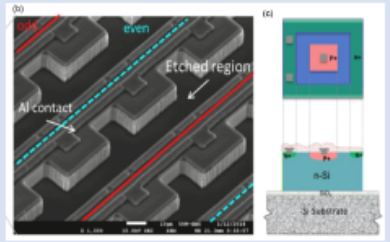
- Semplified diamond microdosimeter developed at the Centre For Medical Radiation Physics, CMRP, University of Wollongong, NSW, Australia IEEE Transactions on Nuclear Science, Vol. 59, pp. 3110-3116, 2012



- ***p-i-n*** junction structure
- **1 to 10 µm thick**
- **Single SV** 10/500 µm diameter (or side)
- Manufacturing by Chemical Vapour Deposition (**CVD**) **growing**
- Possibility to grow **independent detectors** on the **same substrate** with different area or **different thickness**
- ~10-100 keV low energy cut-off
- Well defined SV
- Low CCE regions surrounding SV

Journal of Applied Physics, vol. 118, 2015

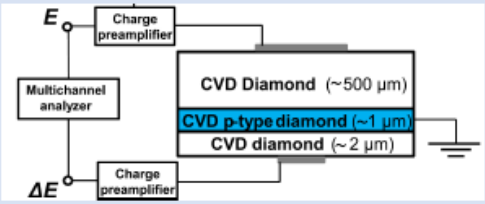
- The microdiamond detector based on the detectors developed by the Research Group of The University of Rome "Tor Vergata". The design



- ***p-n*** junction structure
- **Silicon On Insulator (SOI)** → insulates SV to avoid Field Funnelling effect
- **1-10µm thick**
- Arrays of 10x10 / 100x100 μm^2 SVs
- Manufactured by **etching and ion-implantation**
- Dedicated front-end electronics
- **~1/10 keV low energy cut-off**
- Low CCE regions surrounding SVs / lateral charge collection from outside SV

- Silicon microdosimeters based on the "Bridge" microdosimeter, developed by the Centre For Medical Radiation physics, University of Wollongong (simplified geometry with only four sensitive volumes and the complete design)

- The diamond telescope is based on the detector developed by University of Rome "Tor Vergata".



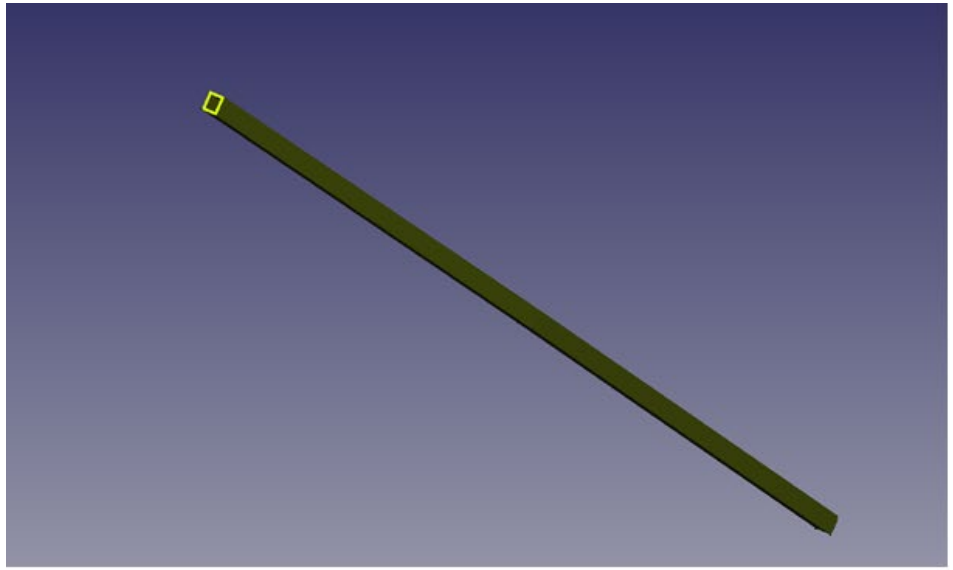
Cesaroni et al., "", Nucl. Instrum. Methods. Phys. Res. A, vol.947, 2019

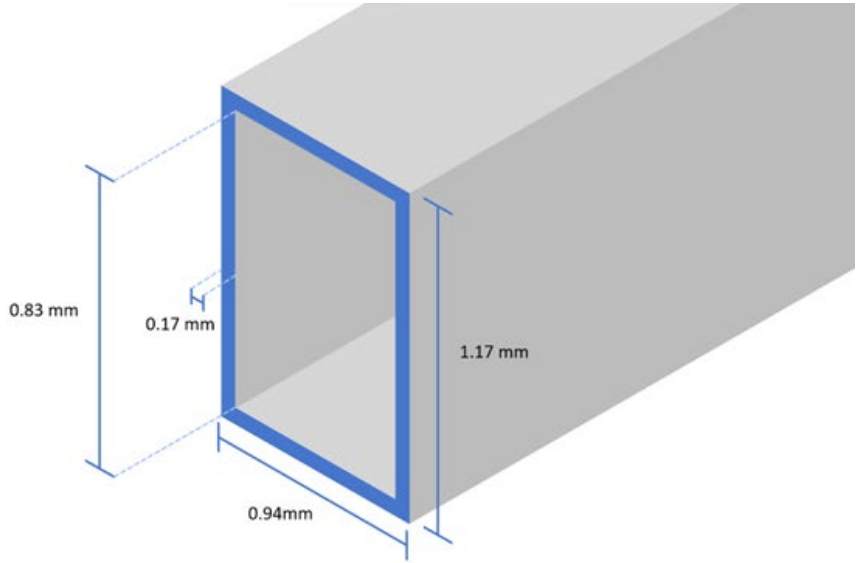
X-ray Silicon Pore Optics

Talk by R. Stanzani, SWHARD s.r.l., Italy

Authors: P. Dondero and R. Stanzani, SWHARD, Italy

- Evaluate the impact of low energy protons scattering on the ATHENA mirror surface and focussing on the XRay detector
- Planar source of 100 keV protons with a cosine-law distribution within a cone of +-1 deg on both Theta and Phi (polar angles from the axis of the detector).
- Use of the Geant4 SS process reflections to evaluate the number of reflections inside the pore and the transmission efficiency



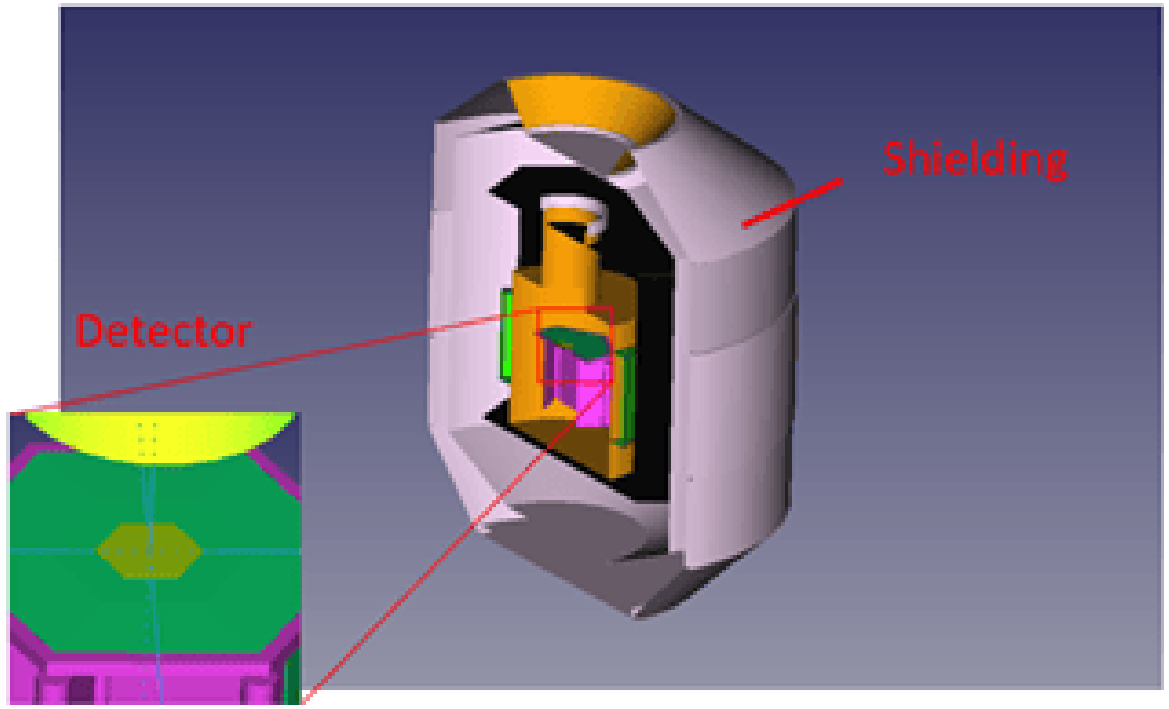


X-RAY TES detector

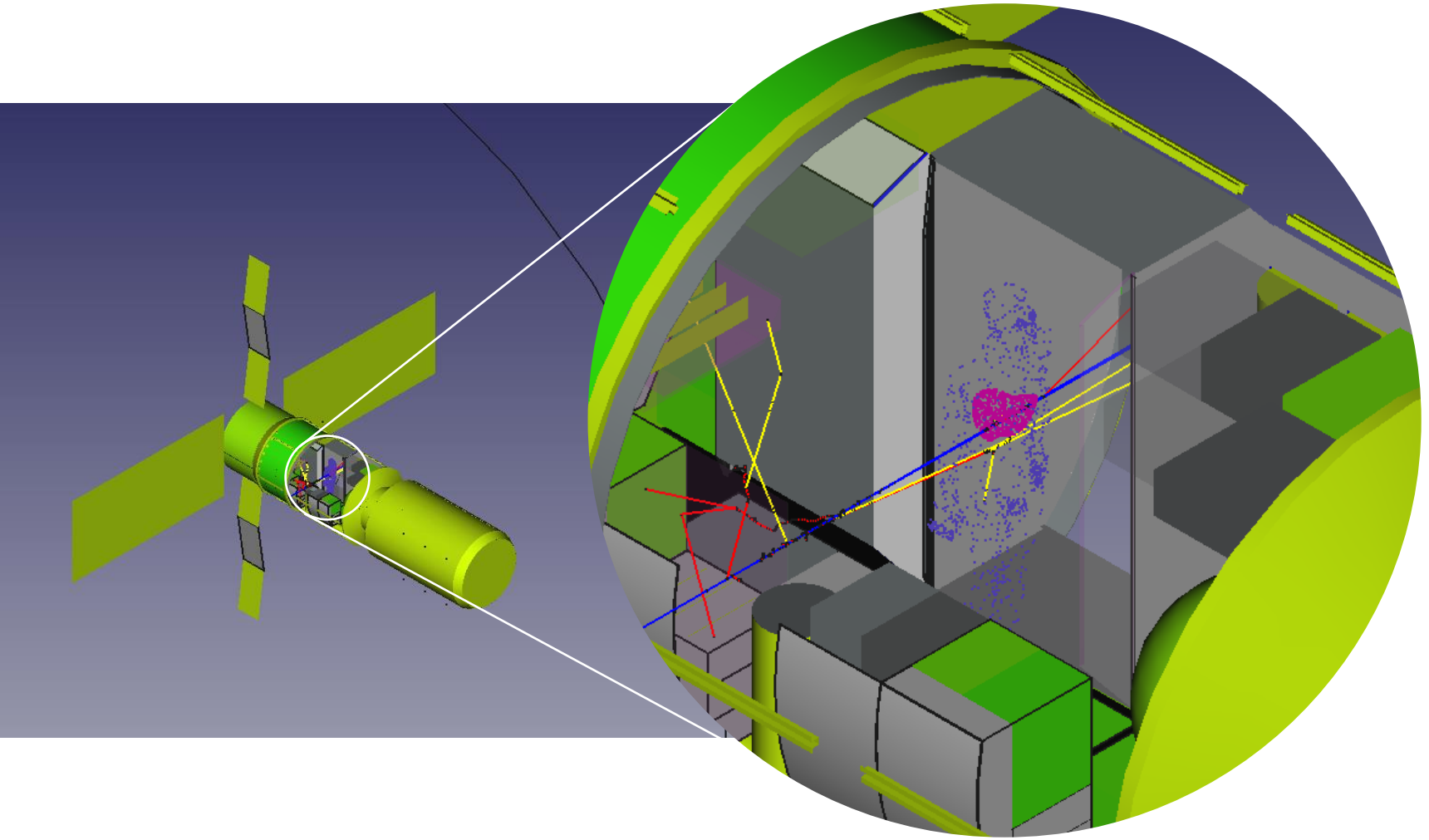
Talk by R. Stanzani, SWHARD s.r.l., Italy

Authors: P. Dondero and R. Stanzani, SWHARD, Italy

- Based on a simplified geometry derived from the X-ray Integral Field Unit (X-IFU), a Transition-edge sensor (TES) composed of ^{317}Bi-pixels
- Geometrical model (in GDML)
- Isotropic source of GCR protons (10MeV -100 GeV)
- Calculate the number of GCR protons reaching the detector



FreeCAD: a potential G4 GUI from a Multi Stage simulation framework



Talk by Alfonso Mantero
Swhard Srl, Genova (Italy)

Facilitates seamless exploration and presentation of results in intricate scenarios by adjusting **visualization** properties, such as color and transparency, for volumes, all while keeping the original geometry file intact.

New example to read IAEA Phase Space Files

Authors: M. Cortés-Giraldo and C. G. Okolinta, University of Sevilla, Spain

Talk by M. A. Cortés-Giraldo, University of Sevilla, Spain

- **IAEAphsp:** Standardized format to use phase-space files produced from different codes.

http://www-nds.iaea.org/phsp

IAEA.org International Atomic Energy Agency

Phase-space database for external beam radiotherapy

IAEA NAPC Nuclear Data Section
IAEA NAHU Dosimetry and Medical Radiation Physics Section

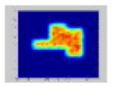
Project Officer: Roberto Capote

Objective: To build a database and disseminate representative phase-space data of accelerators and Co-60 units used in medical radiotherapy by compiling existing data that have been properly validated.

NEWS

Dec 2009: Geant-4 interface to read/write the IAEA format released on December 14, 2009.

How to produce and submit phase-space data: The IAEA phsp format was designed to cover both phase-space files and event generators (see phsp contents). We have implemented the IAEA phsp format in a set of read/write routines (Updated: May 2011, see readme file). Native IAEA phsp format is available in EGSnrc and PENELOPE Monte Carlo codes. Geant4 interface to use the native IAEA phsp format is also available. Once the validated phsp data is produced and documentation is published, you may submit your phsp for review using the upload link here.



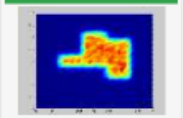
How to download phase-space data: You have to select a phsp data type among Co-60 source, linac electron or linac photon phsps. For photon and electron PHSPs you may download the header first to decide which data you want to retrieve. Once decided you should download the PHSP data from the corresponding sub-directory. Please note that the first time access to the selected subdirectory could be slow.

Both the PHSP data and header should be present for the PHSP data to be accesible !

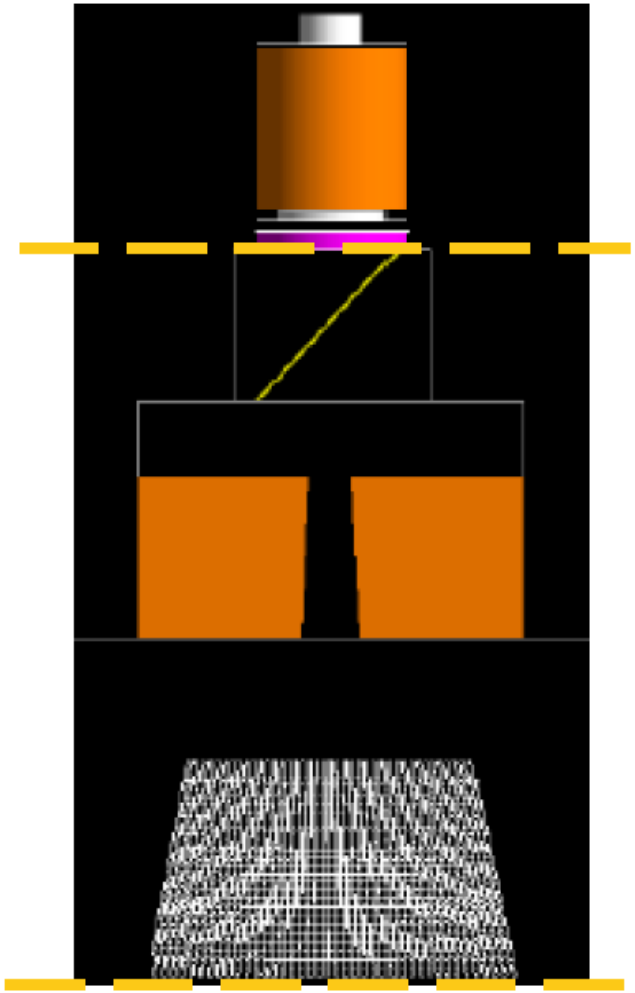
- International Advisory Committee (IAC)
  - R. Jeraj
  - I. Kawrakow
  - C.-M. Ma
  - D.W.O. Rogers
  - F. Sanchez-Doblado
  - J. Sempau
  - J. Seuntjens
  - J.V. Siebers
  - P. Andreo
- Mailing Lists
  - Send mail to all members of the IAC
  - Register to the IAEA PHSP mailing list
- Medical Portal
  - Atomic and nuclear data for medical applications
- IAEA NAPC/NDS
  - Nuclear Data Section
- IAEA NAHU/DMRP

- Tech. Report
  - IAEA-NDS-0484

- PHSP format
  - List of PHSP variables
- PHSP Header
  - How to fill header ...
- PHSP upload
  - Upload files
- PHSP to review
  - Files to review
- PHSP database



1. Co-60 phsps
2. Photon phsps
3. Electron phsps



Talk by B. Morgan, The University of Warwick

Thoughts…

Thoughts on Tutorials and Training for Geant4

- **Is there scope for us to gather our existing courses together into a single syllabus?**
  - *Beginner, Advanced "modules" like CERN?*
  - *"Optional" ones for HEP/Medical/Space?*
- Could it be developed as an open, community project similar to Software Carpentry?
  - ***We** develop it, but **invite contributions** to improve/add, reviewed of course.*
  - *Use Carpentry "teach the teachers" method to expand/maintain pool of tutors*
- Have at least part of the course(s) **online or in suitable format for self-study**

That’s all, thank you