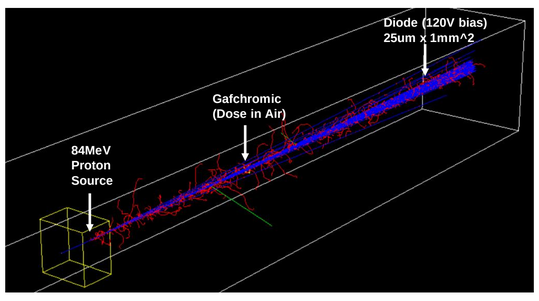
Simulations

Monte Carlo Simulations

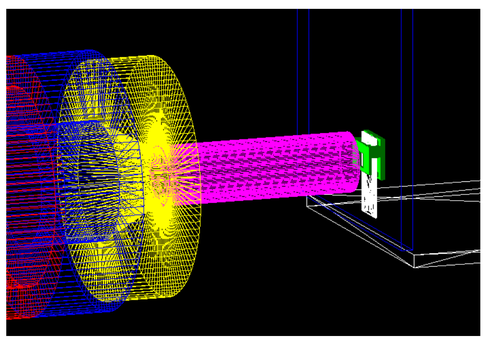
- **Monte Carlo** algorithms used to estimate physical quantities during particle interactions
- Standard approach for radioprotection studies and energy deposition estimation

- **Geant4 libraries** are based on validated data of particle cross-sections
- Allow to study the biological damage on both macro and micro scales.

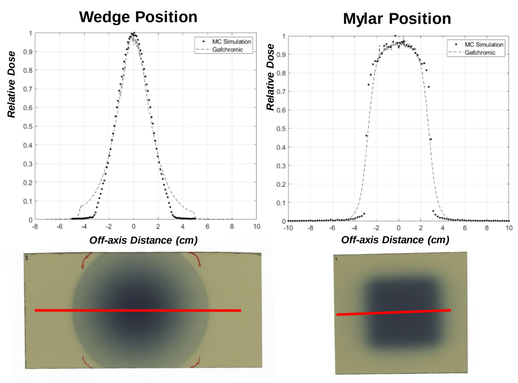


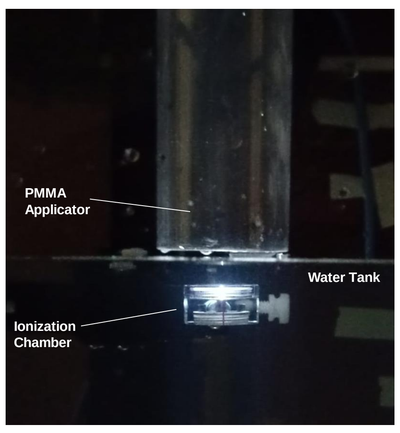
Monte Carlo results are of primary interest since they allow the verification and/or prediction of physical quantities measured during different experimental tests.

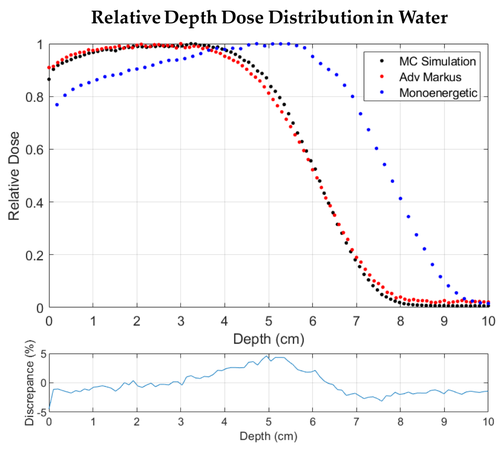
Comparison of dose profiles for electrons of 10 MeV



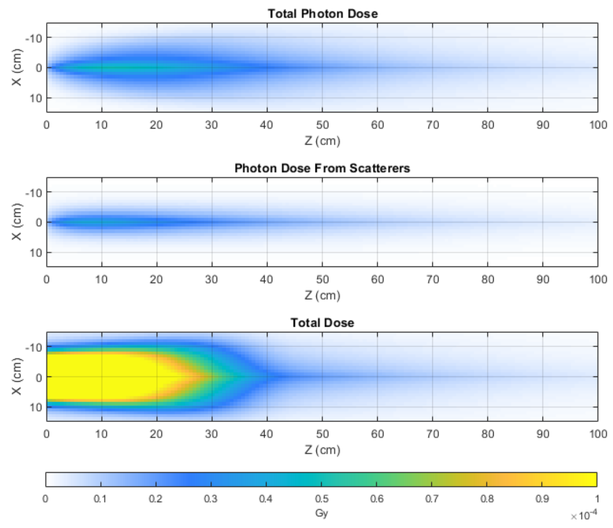
Complex geometries can be simulated to quantify the contribution to the dose of different objects in an experimental setup



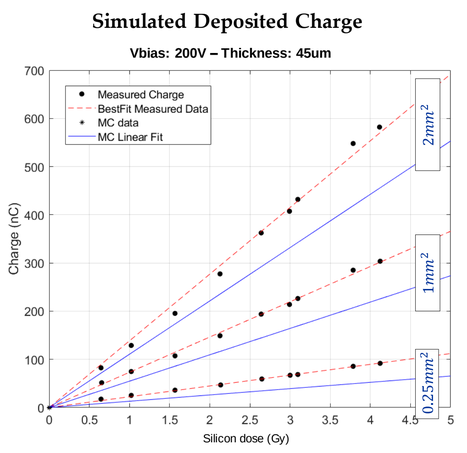


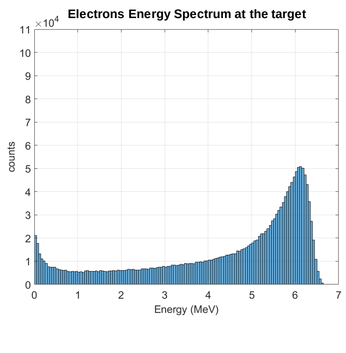


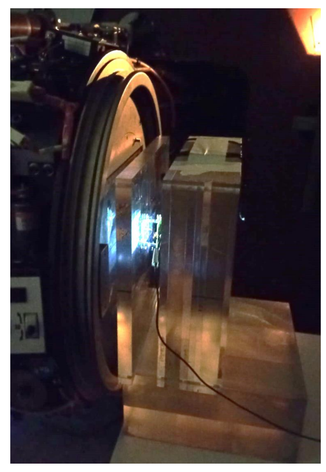
- **TOPAS MC** designed to focus on medical physics applications
- Primary tool used by researchers in medical accelerator facilities.
- Similarly, **AllPix Squared** toolkit can be used to track the deposited charges inside silicon sensors by taking into account charge carriers mobility and diffusion models



Monte Carlo algorithms require significant computing power → Parallel computing resources in collaboration with ReCaS-Bari INFN computing center.





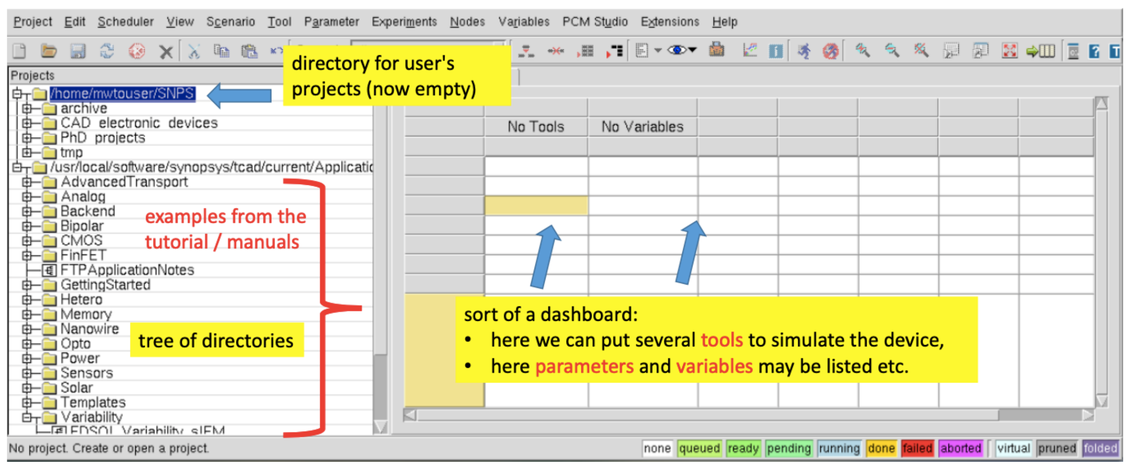


TCAD Sentaurus Synopsys

Sentaurus TCAD SYNOPSYS

Advanced multidimensional device simulator capable of simulating **electrical, thermal, and optical characteristics** of silicon-based and compound semiconductor devices. Sentaurus Device is a new-generation device simulator for designing and optimizing current and future semiconductor devices.

Sentaurus Workbench (SWB)



In the WorkBench (SWB), several tools can be added in sequence

- **SDE**: builds the device geometry; assigns doping concentrations; assign molar fraction (if any)
- **SNMESH**: generates a grid (mesh) for numerical computation (device discretization)

→ step 1: device definition

the device physics is described in this block →

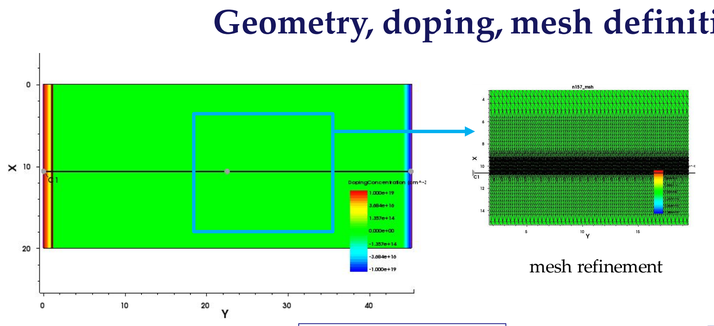
- **SDEVICE**: solves Poisson's and continuity equations (and other transport equations, if any) for given boundary conditions

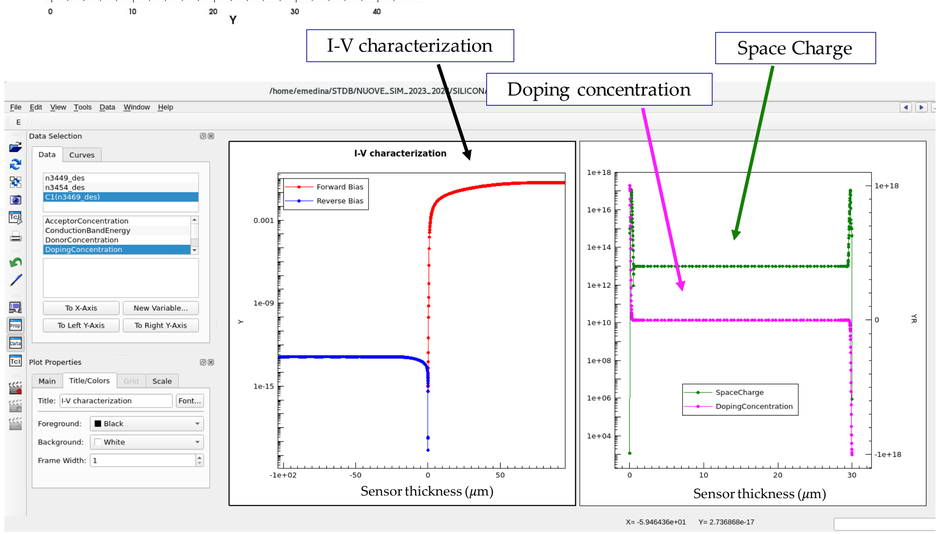
→ step 2 simulation

- **SVISUAL**: post-processing; visualization of results; exporting results (e.g. for further post-processing in Matlab)

→ step 3 results post-processing

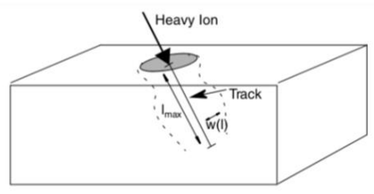
Geometry, doping, mesh definitions

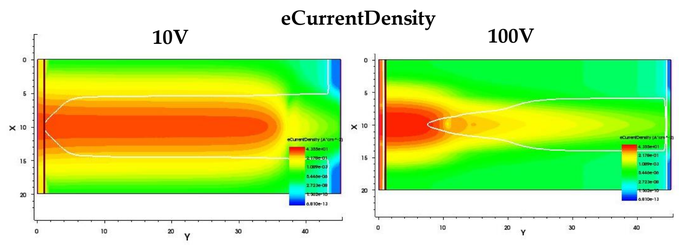


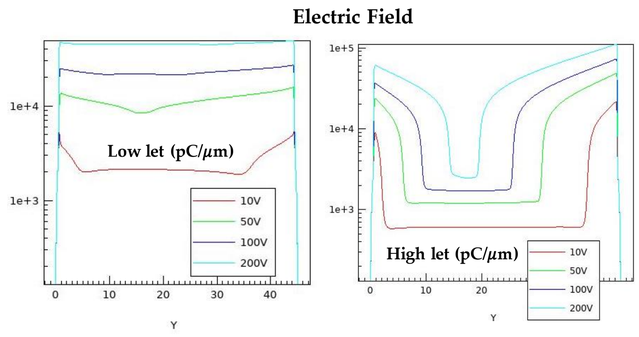


Carrier generation models

- Optical generation
- Gamma radiation
- Alpha particles
- **Heavy Ions**







Output signals study

- Signal generated on the electrods from carriers (electrons and holes)