Validation and testing of the collection chambers for the CERN-MEDICIS project

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MEDICIS project, ISOLDE, CERN

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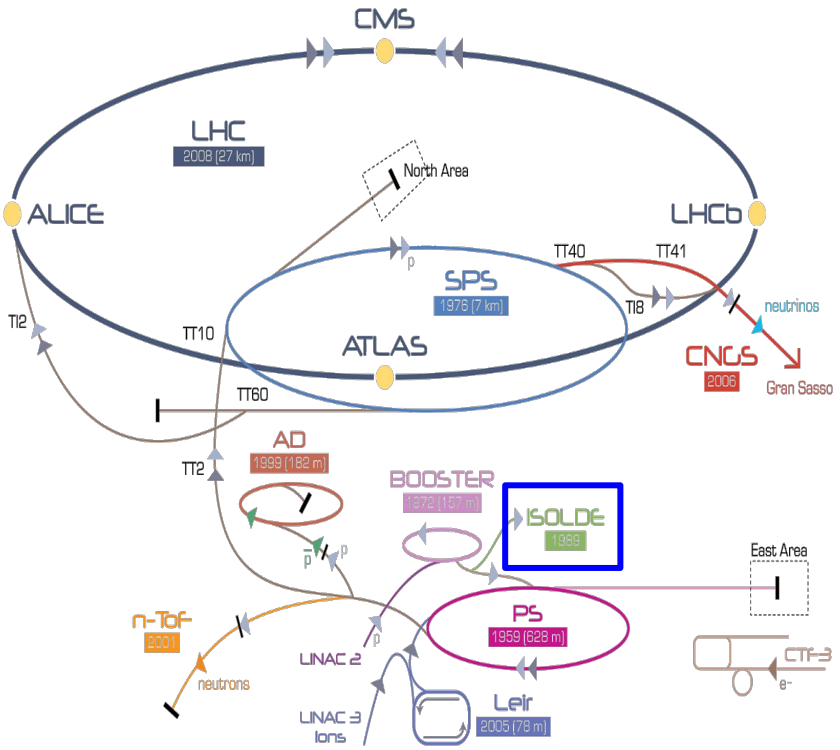
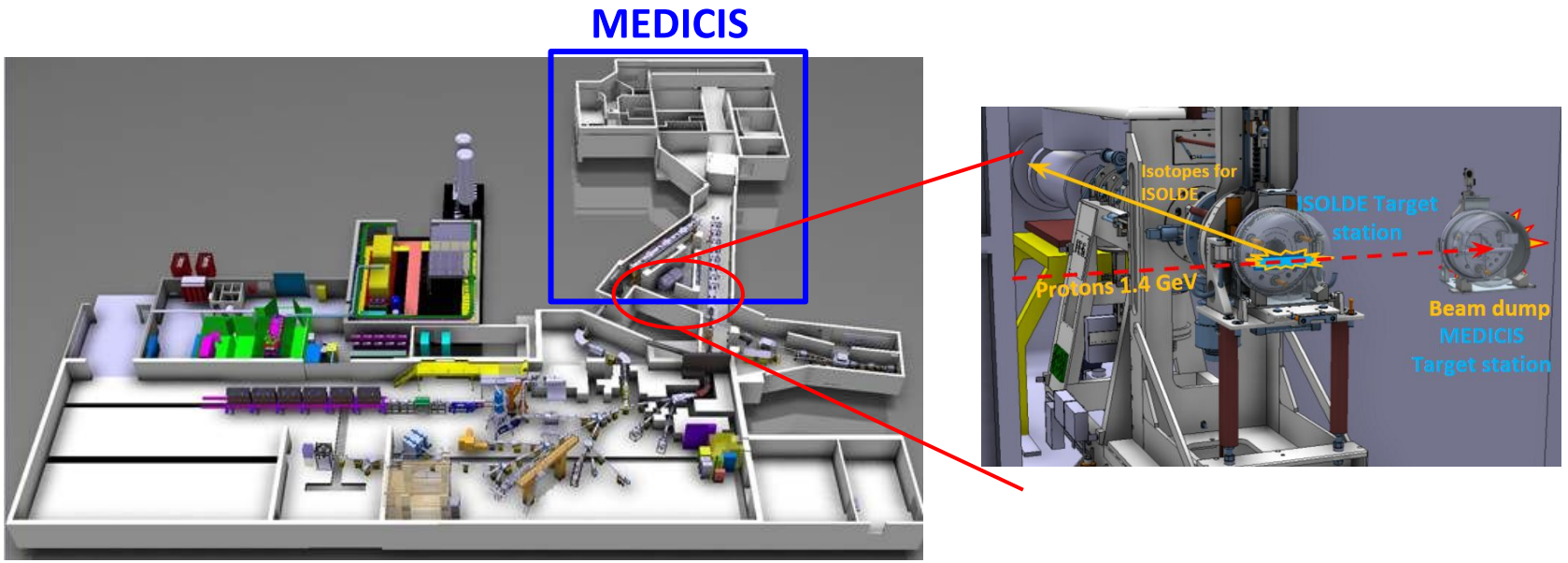
Outline

- MEDICIS facility and the ISOLDE experiment
- Purpose of this work
- Fluka transportation code
- Results
- Future work

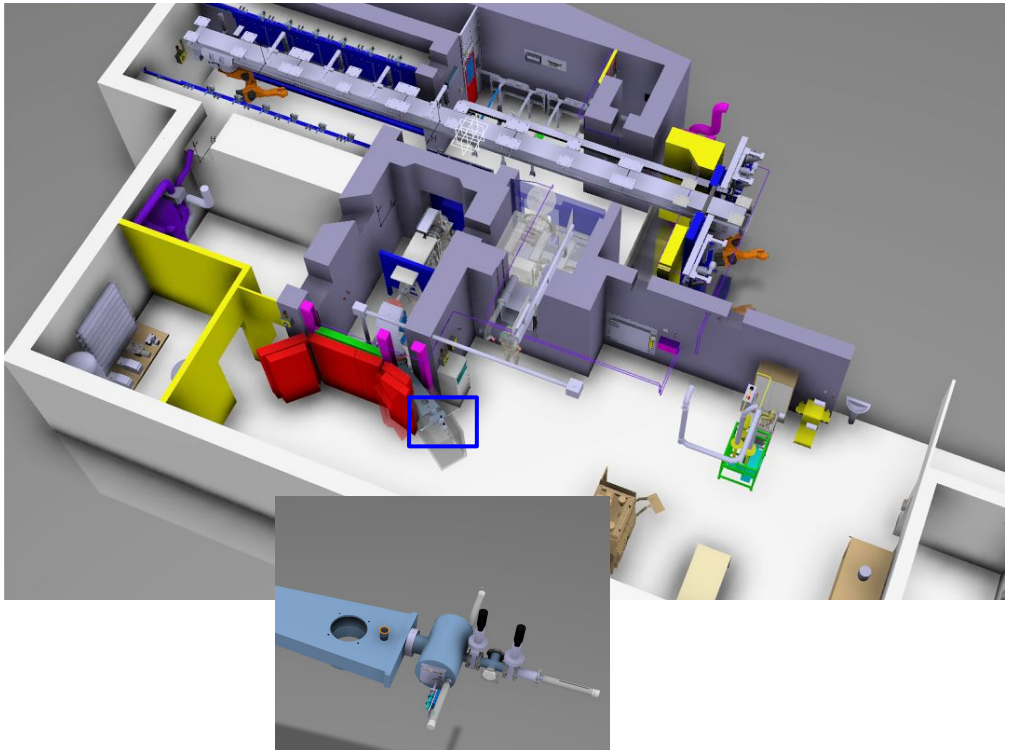


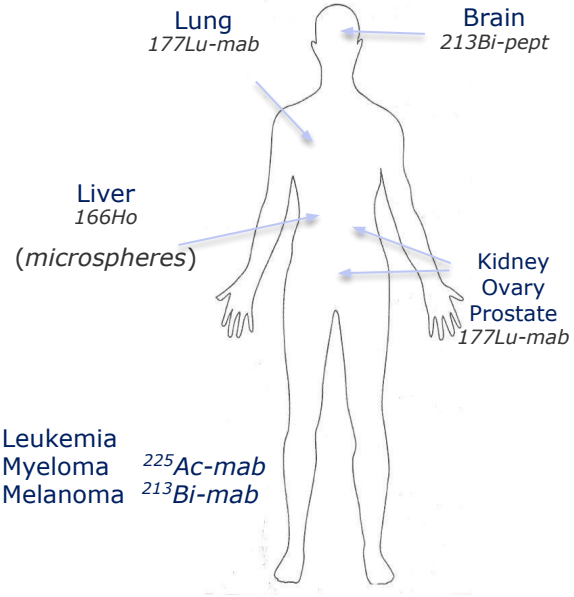
ISOLDE



ISOLDE is a facility dedicated to the production of a large variety of radioactive ion beams for many different experiments in the fields of nuclear and atomic physics, solid-state physics, materials science and life sciences.

MEDICIS facility

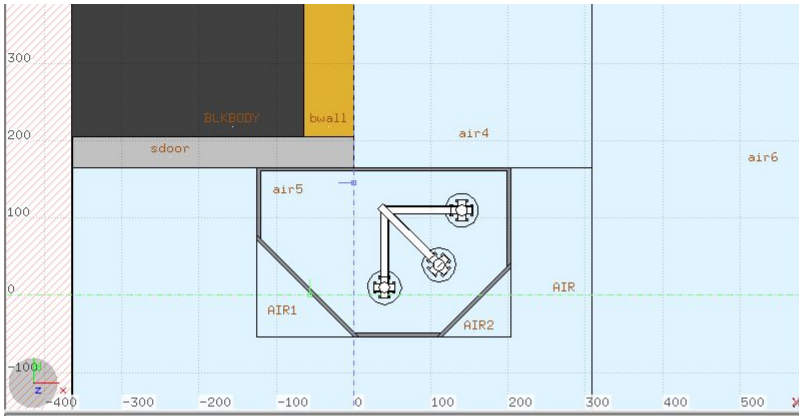




- produce radioisotopes for medical research
- design a collection chamber and transfer system for the radioactive isotopes

Purpose

- To simulate the radiation from collected isotopes and calculate the dose a person may receive by using transport code simulation (Fluka) when the isotope has been collected.



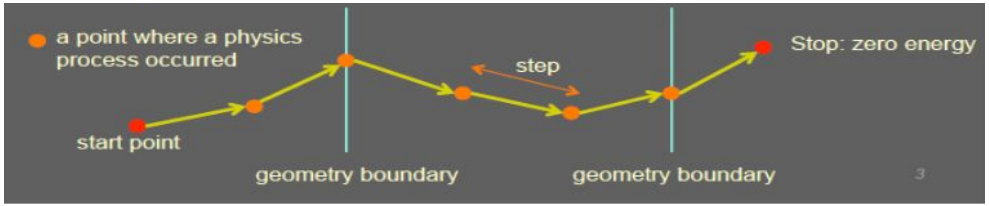
The geometry of chambers

System effected/ Syndrome	Symptoms	Dose
Nervous system CNS or Cerebrovascular Syndrome	Shock, severe nausea, disorientation, seizures, coma	100 Gy
G.I. system Gastrointestinal Syndrome	Nausea, vomiting, diarrhea, dehydration	10 Gy
Blood cells / bone marrow Hematopoietic Syndrome	Chills, fatigue, hemorrhage, ulceration, infections, anemia	3-8 Gy
Skin Erethema	Burning/ infection, sloughing of skin, hair loss	10 Gy
Ovaries/ Testes	Sterility	0.6-0.8 Gy 2-6 Gy

Manjit Dosanjh, Medical Applications-1, July 2016

- Absorption Dose (Gy) = 1 J/kg
- Equivalent Dose (Sv) = D*Q [Q is depend on radiation type]

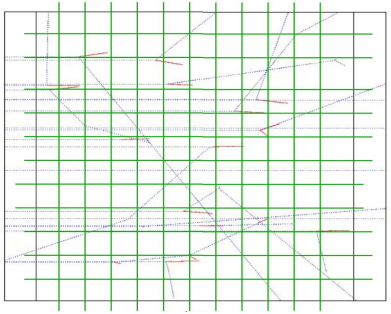
Monte Carlo Radiation Transportation Code



- Total cross section → step length
- Differential & partial cross sections → final state
- Energy deposited (Magnetic and electric fields) → Dose

Dose computation

- Simulate particle histories until all particles have left the grid
- Store the amount of absorbed energy of each particle in each region



Gramma

Conversion	$\gamma \rightarrow e^+ + e^-,\ \mu^+ + \mu^-$
Compton scattering	$\gamma + e^-(atomic) \rightarrow \gamma + e^-(free)$
Photoelectric	$\gamma + material \rightarrow e^-(free)$
Rayleigh scattering	$\gamma + atom \rightarrow \gamma + atom$

Electron, Positron

Bremsstrahlung	$e^- + atom \rightarrow e^- + \gamma$
Ionization	$e^- + atom \rightarrow e^- + ion + e^-$
Positron annihilation	$e^+ + e^- \rightarrow \gamma + \gamma$

Muon

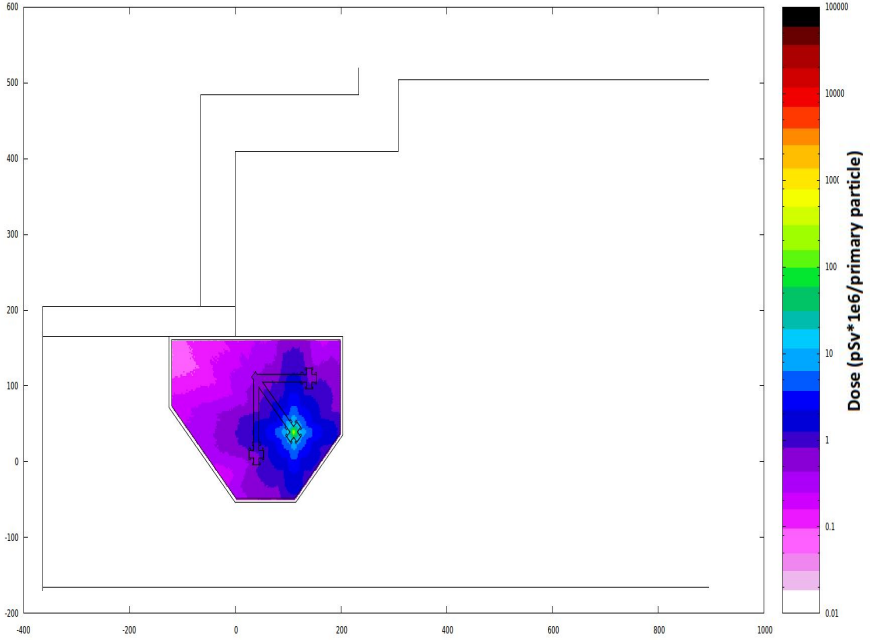
Pair production	$\mu^- + atom \rightarrow \mu^- + e^+ + e^-$
Bremsstrahlung	$\mu^- + atom \rightarrow \mu^- + \gamma$
Ionization	$\mu^- + atom \rightarrow \mu^- + ion + e^-$

Charged hadron, ion

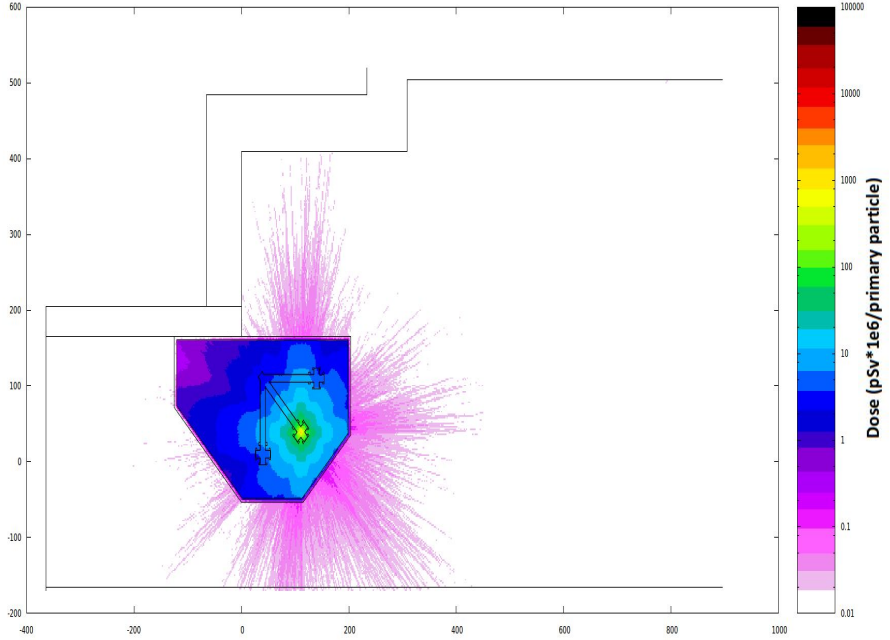
Bremsstrahlung	$h^- + atom \rightarrow h^- + \gamma$
Ionization	$h^- + atom \rightarrow h^- + ion + e^-$

Results

Equivalent Dose of Lu 177

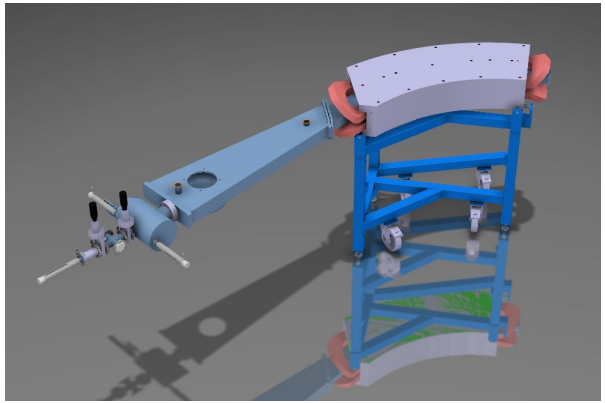


Equivalent Dose of Bi 213

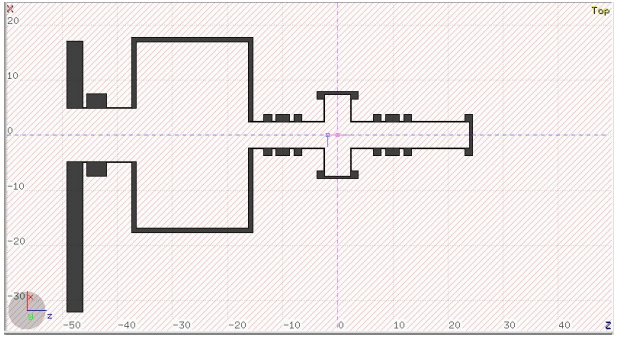


Future work

- make the geometry of the room and the beamline more realistic.
- Instead of using a radioactive point source, I will put the radioactive beam and metal foil from collect the isotope.



Beam line



Chamber

In progress...

Acknowledgement

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