



Istituto Nazionale di Fisica Nucleare LABORATORI NAZIONALI DI LEGNARO



Laboratori Nazionali di Legnaro - INFN

# Monte Carlo simulation of DNA damage in soft and bone tissues using Geant4-DNA

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#### In the last meeting...



#### Image of cells (LNCaPs)

**Development of a geometric model** 

Simulations with Geant4

Determination of absorbed dose and of survival fraction in a colture irradiated with Ag-111





#### Results (1)





 S-value distribution similar to a lognormal



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#### **Results (1)**





Time [hours]



#### Results (2)



Average surviving fraction as a function of the **uptake** and of the **applied activity** 





#### In this meeting...



Therapy simulations with Geant4-DNA with Lu-177 in collaboration with Brescia's hospital



Differences between the absorbed dose in bone cancer cells (osteosarcoma cells) and soft tissues cancer cells (e.g. epatocellular carcinoma cells)



#### **DNA damages**





# **SSB**: single break on a DNA strand

 DSB: two breaks on opposite strands that were simultaneously induced within the distance d<sub>DSB</sub>



#### The molecularDNA example



- Geant4 is being extended with processes for the modeling of biological damage induced by ionising radiation at the DNA scale
- GEANTA-DNA A SIMULATION TOOLKIT



 molecularDNA allows easy simulation of radiation-induced
 DNA damage with flexible geometries and well
 defined damage parameters



#### **Parameters of the simulations**



- ✓ human\_cell\_chromosomes.mac
  ✓ <sup>177</sup>Lu
- ✓ Source: **membrane**, target: **nucleus**

- Two environments: water and compact bone
- ✓ Ellipsoidal cells made of water (14 x 3.5 x 14 µm)





#### **Number of events**



Analysis of result stability with increasing events

Analysis of result stability with increasing events





#### **Absorbed dose**





Dose vs Number of Events

Considering same cell dimensions the absorbed dose is nearly the same





## **Dimensions of the cells**



	Osteosarcoma	Epatocellular carcinoma
Cell size	10 – 19 μm	10 — 15 μm
Nucleus size	5.7 — 15 μm	2 – 6 µm





**Results** 



#### Dose comparison



With 10<sup>5</sup> events there's a greater dose absorption in bone cancer cells compared to soft tissue cancer cells





**Errors on DSBs** 







#### **Results: repair model**







#### Next step: a biophysical model



#### **Biophysical model** aimed at monitoring a **cell population** during a radiopharmaceutical treatment







Optimizing the parameters at play, it will predict the **surviving fraction** 



# **Conclusions: future goals**



 ✓ Comparison of the results of the geometric model with <u>experimental data</u> from the next experiment in May/June



DNA damage and the clonogenic survival of LNCaP cells treated with different activities of <sup>111</sup>Ag will be evaluated in vitro for different exposure times.

Validation of the biophysical model





## **Thanks for your attention!**