HEAVY ION TRACK STRUCTURE BY GEANT4: AN APPLICATION FOR THE SPACE RADIOBIOLOGY

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INTRODUCTION

❖ Relativistic heavy ions of high charge and energy (HZE) in galactic cosmic rays (GCR) are the important contributors to space radiation risk because they cannot be shielded completely and their relative biological effectiveness (RBE) is very high.

❖ To understand these risks, Monte Carlo track structure simulations by radiation transport codes are widely used in radiation biology to provide information on energy deposition and production of radiolytic species that damage cellular structures.

❖ Many Monte Carlo codes are available for simulation of track structure at the molecular scale: Geant4, PARTRACK, TRIOL, NOREC, RITRACKS,...

METHOD

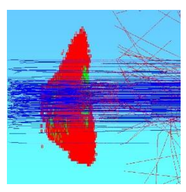
We use Geant4 toolkit:

❖ simulation of interactions of radiation with biological systems at the cellular and DNA level

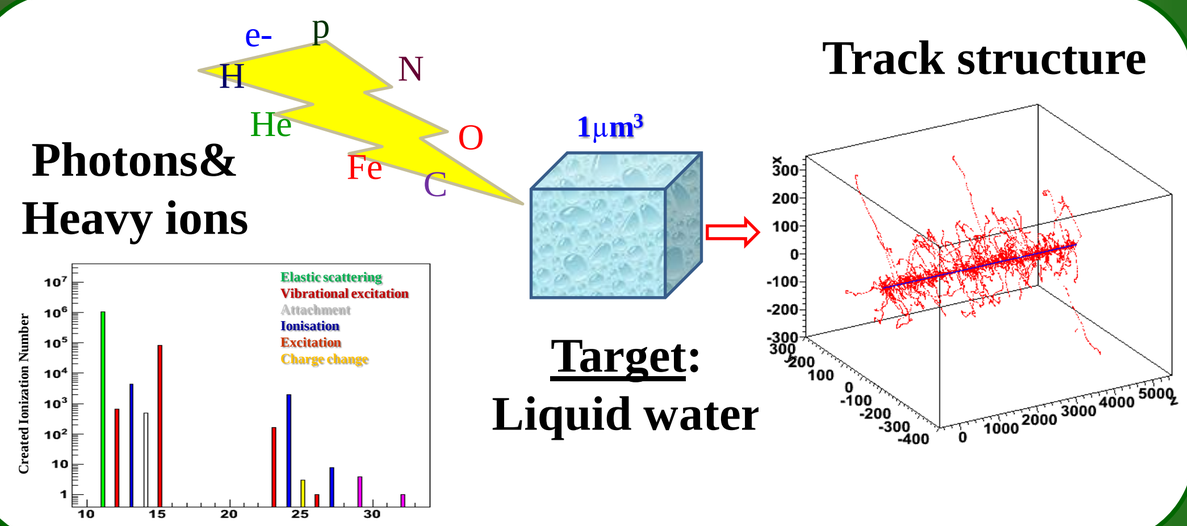
❖ modern toolkit

❖ quickly updating by users and developers of 80 countries

Geant4. 9.5+p01-release (March, 2012)

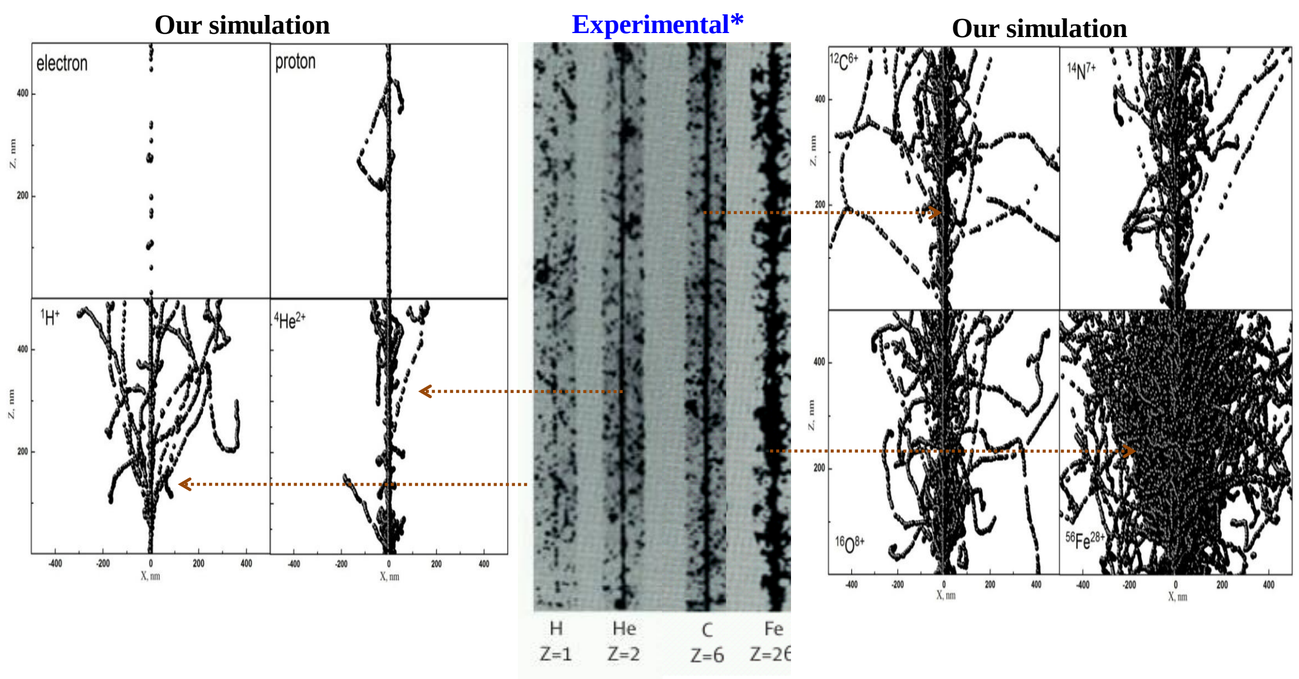


Geant 4



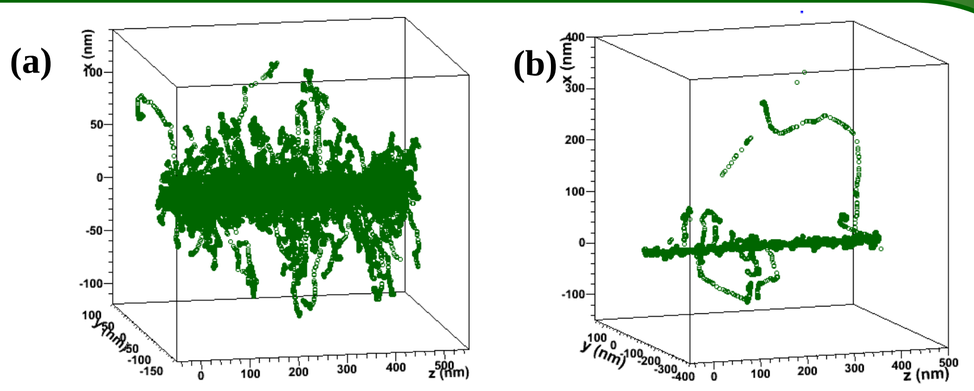
RESULTS

Better <----------Biological knowledge----------> Poor

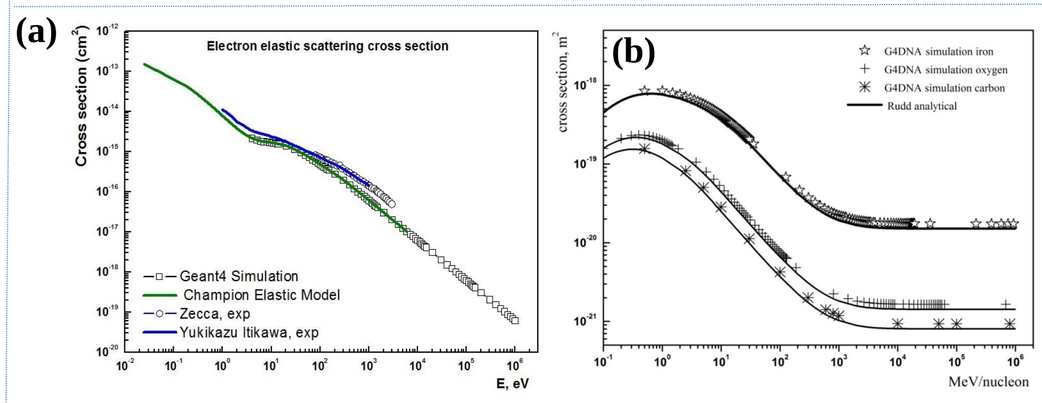


2D track structures of e^-, p, H, He and C, O, N, Fe ion in liquid water with initial energy 10 MeV/n

*F.A. Cucinotta, M. Durante. *Cancer risk from exposure to galactic cosmic rays: implications for space exploration by human beings*. Lancet Oncol. 2006. V. 7. P. 431-435.



3D track structures of iron ions with initial energy of 1 MeV/n (a) and 1 GeV/n (b)



Cross section of electrons for elastic scattering (a) and iron, oxygen and carbon for ionization (b)

CONCLUSION

❖ We have simulated the tracks of e^-, He, C, N, O and Fe ions in liquid water by Geant4 and calculated the cross sections of ionization for these particles.

❖ Our results show the increasing of ionization density when the particle charge (Z) increases.

❖Some cross sections for e^-, He, C, O and Fe calculated by Geant4 were compared to analytical and experimental data**.

**Yukikazu Itikawa J. Phys. Chem. Ref. Data, Vol. 34, No. 1, 2005

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