Neptune

Nuclear process-driven Enhancement of Proton Therapy UNravElled

WP1 - Modeling

February, 10 2022

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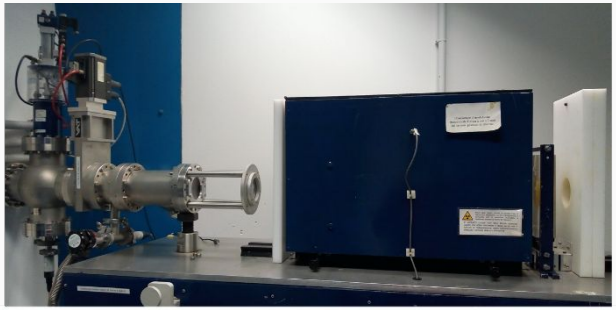
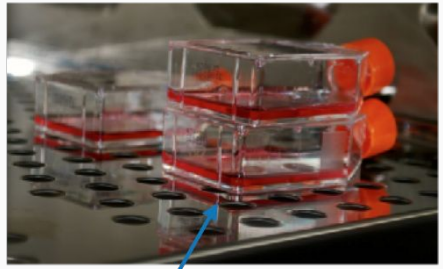
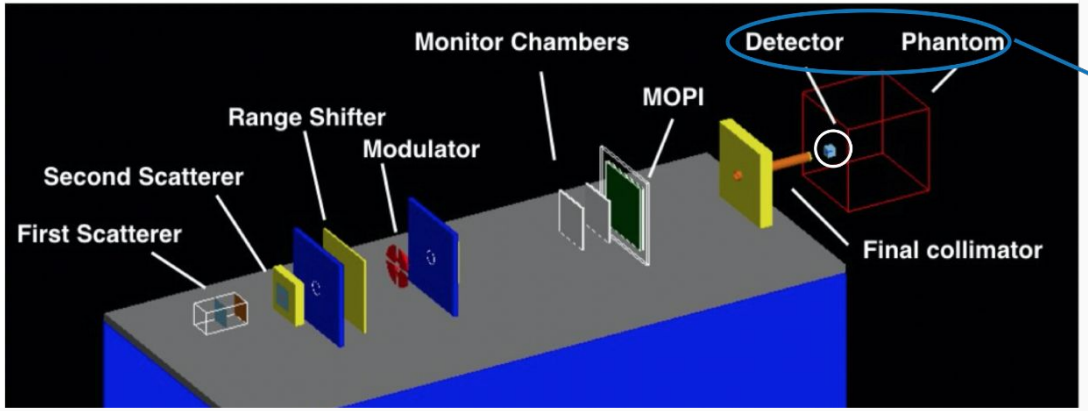
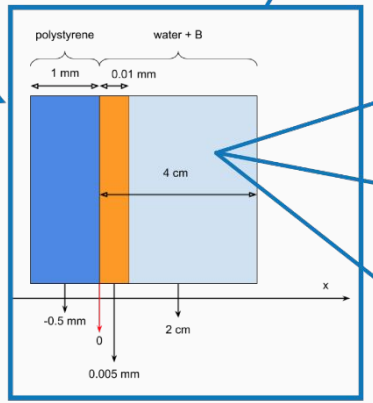
Simulation Implementation

Hadrontherapy Official Geant4 Advanced Example
modelling the CATANA eye proton therapy facility @ LNS-INFN







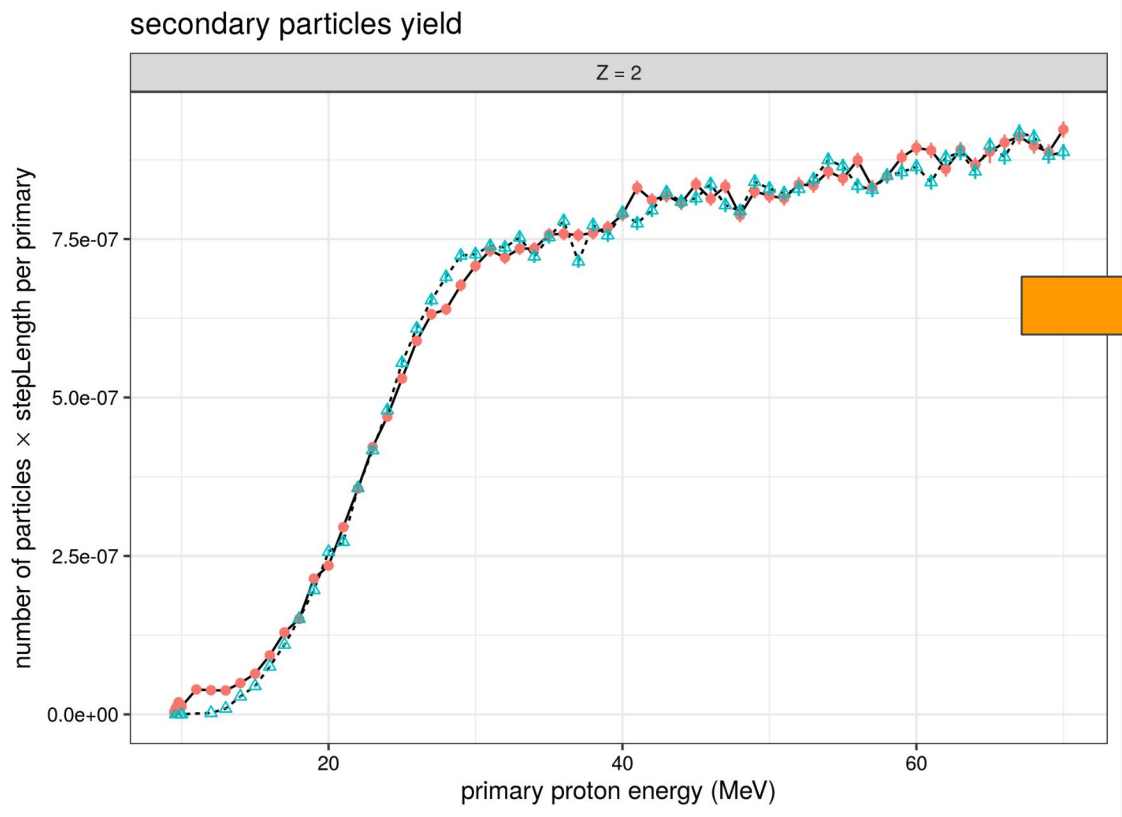


$\rho_{water+B}$ = 1*g/cm^3

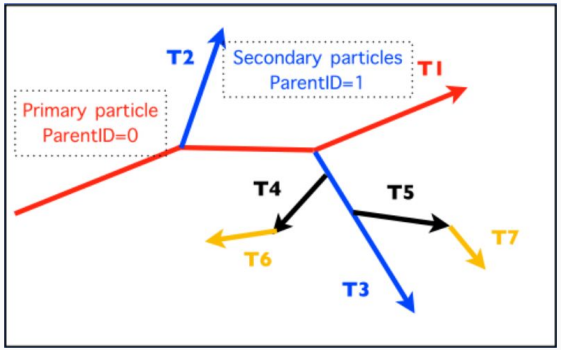
B[%] = 5%

B with natural abundance

New simulations with “target” interactions identification



Simulations with “target” identification



Physics Lists comparison

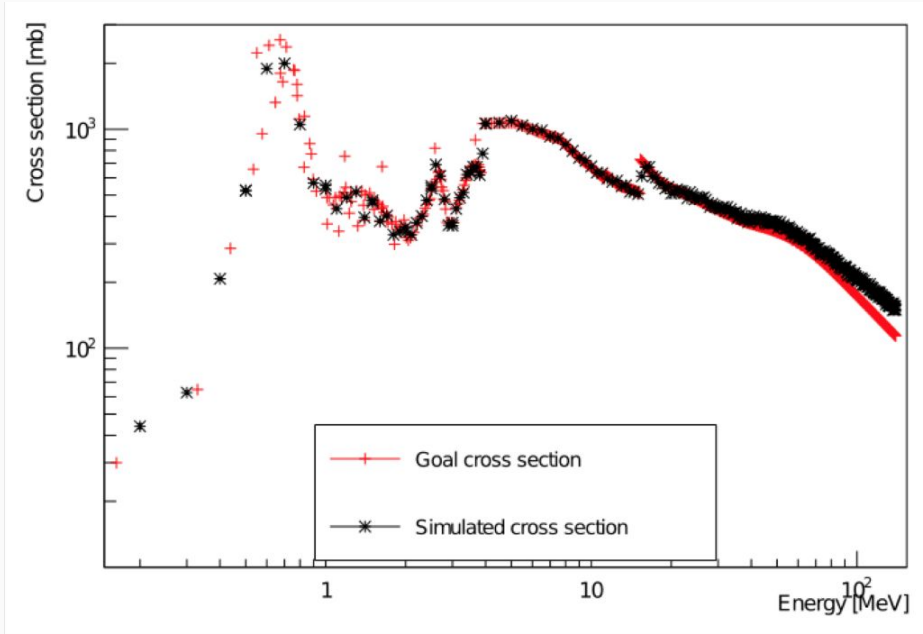
1. **PHP**
   a. G4HadronElasticPhysicsHP
   b. G4HadronPhysicsQGSP_BIC_AllHP
   c. G4IonPhysicsPHP

2. **BIC**
   a. G4HadronElasticPhysics
   b. G4HadronPhysicsQGSP_BIC
   c. G4IonBinaryCascadePhysics

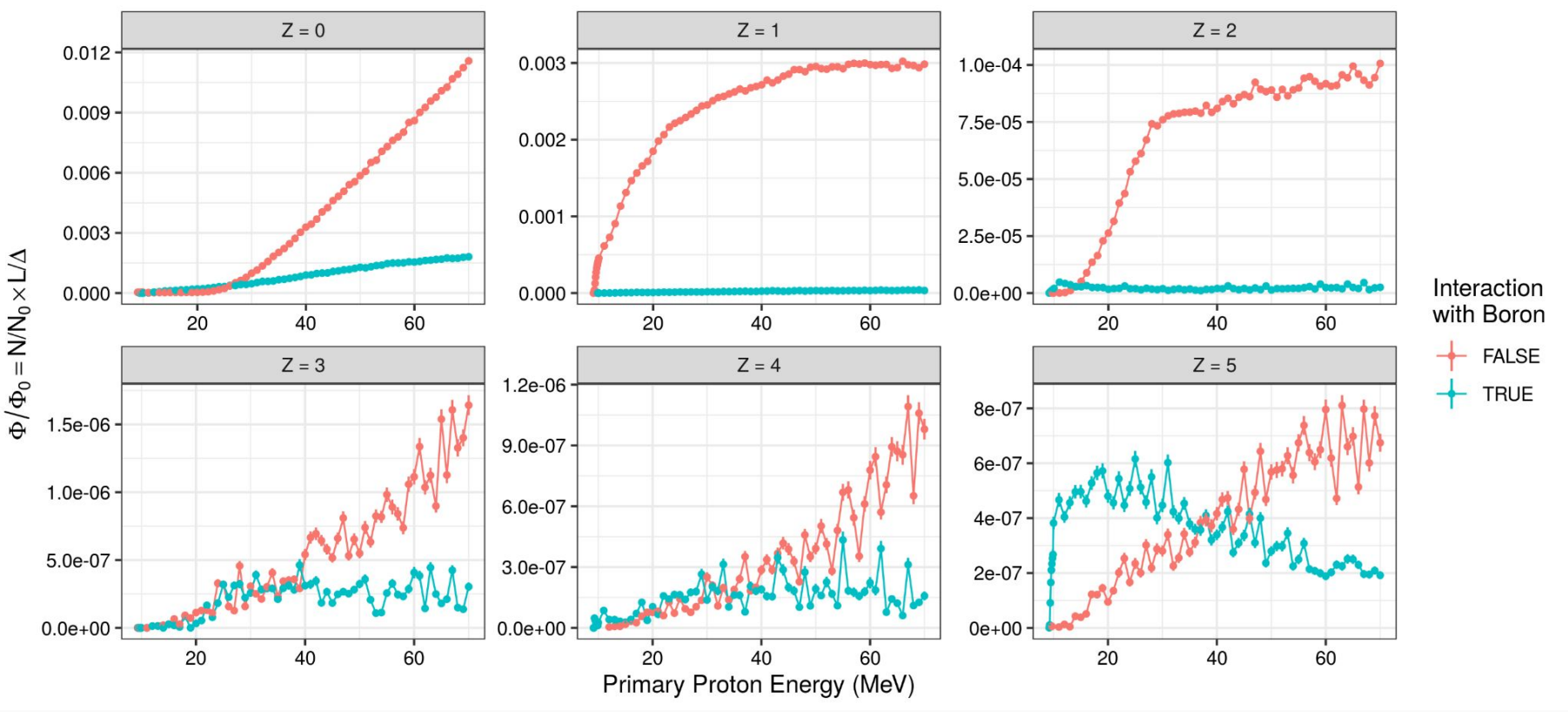
3. **(INCLXX)**
   a. G4HadronElasticPhysics
   b. G4HadronPhysicsINCLXX
   c. G4IonINCLXXPhysics

4. **(QMD)**
   a. G4HadronElasticPhysics
   b. G4IonQMDPhysics

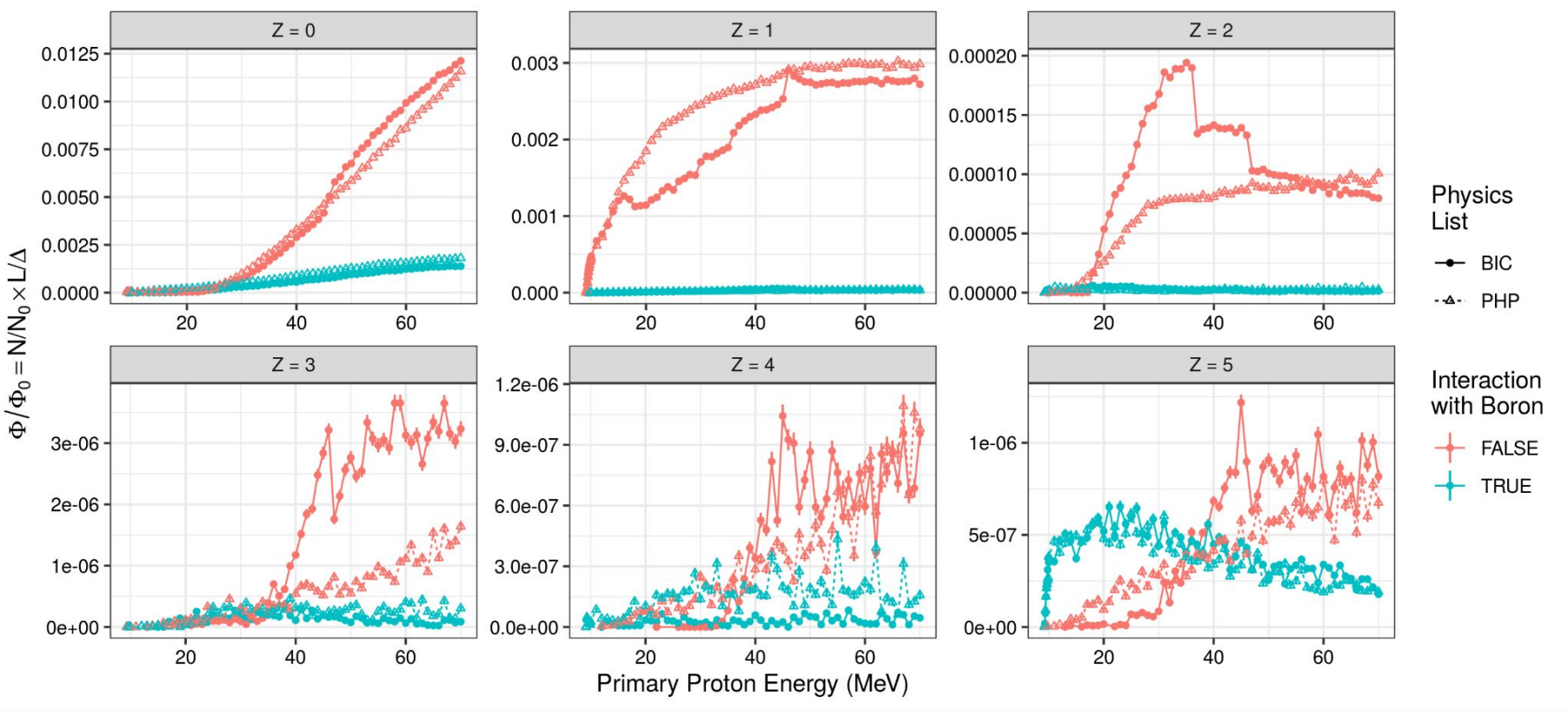
PHP (TENDL + exp. XS for low energy p)



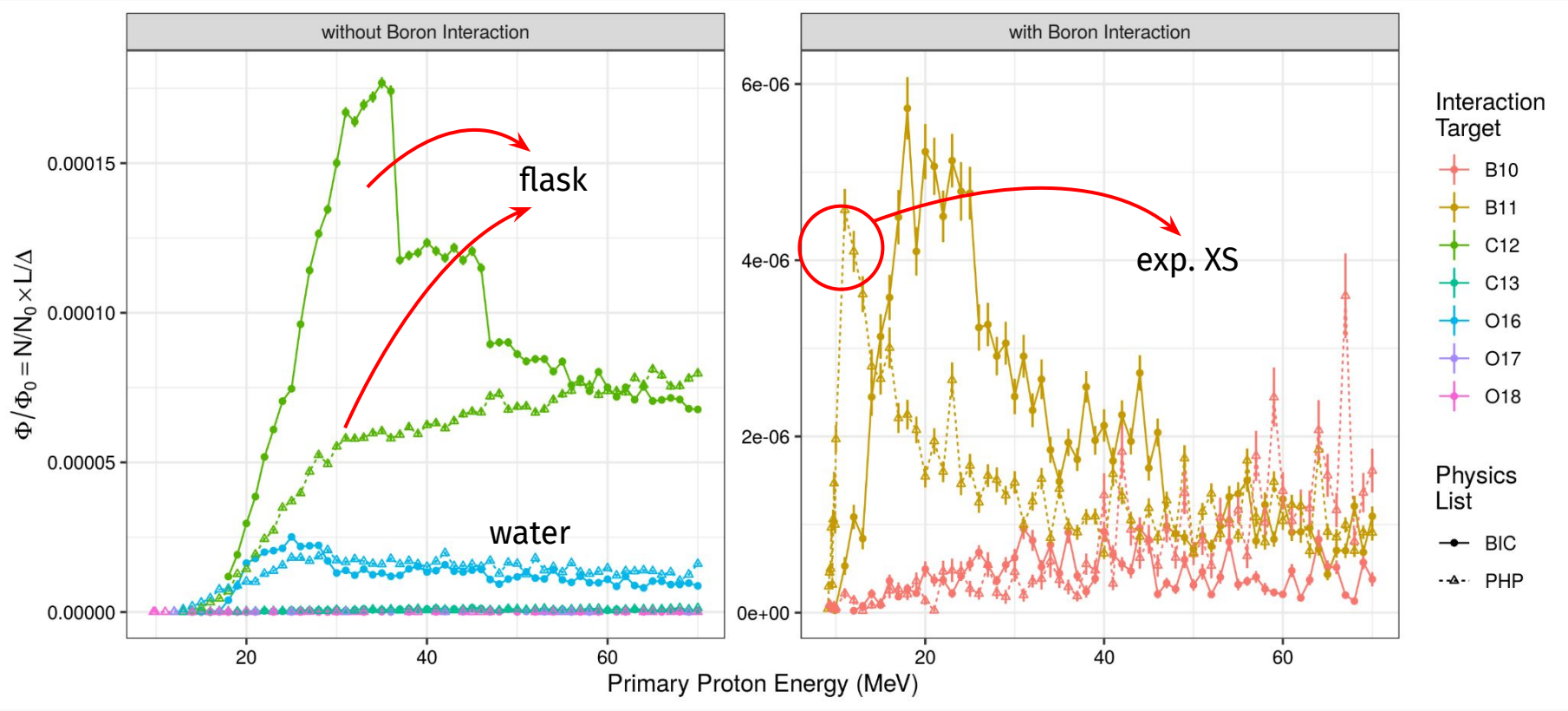
Secondary Particles Yields (PHP physics list)



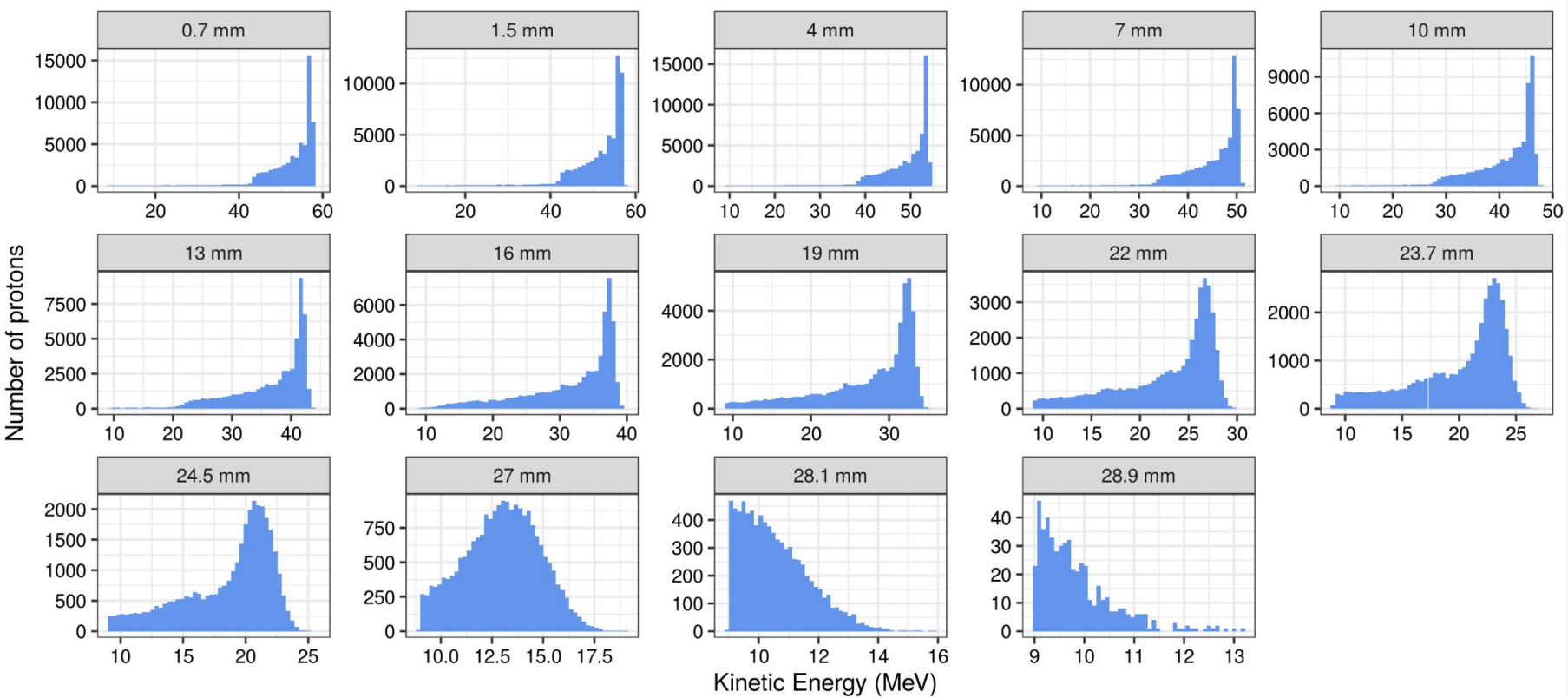
Secondary Particles Yields - Physics Lists comparison (BIC/PHP)



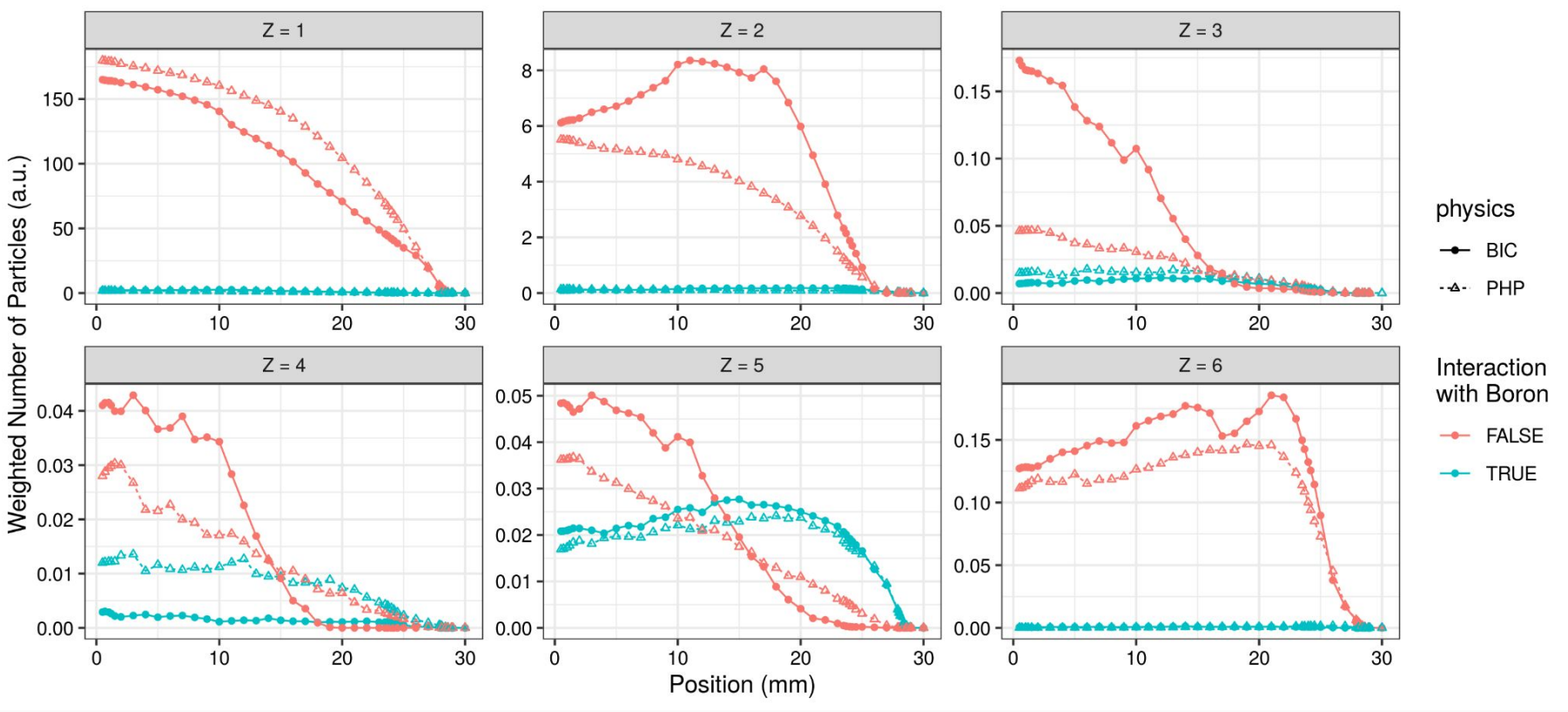
Secondary Particles Yields (Z = 2) - Physics Lists comparison (BIC/PHP)



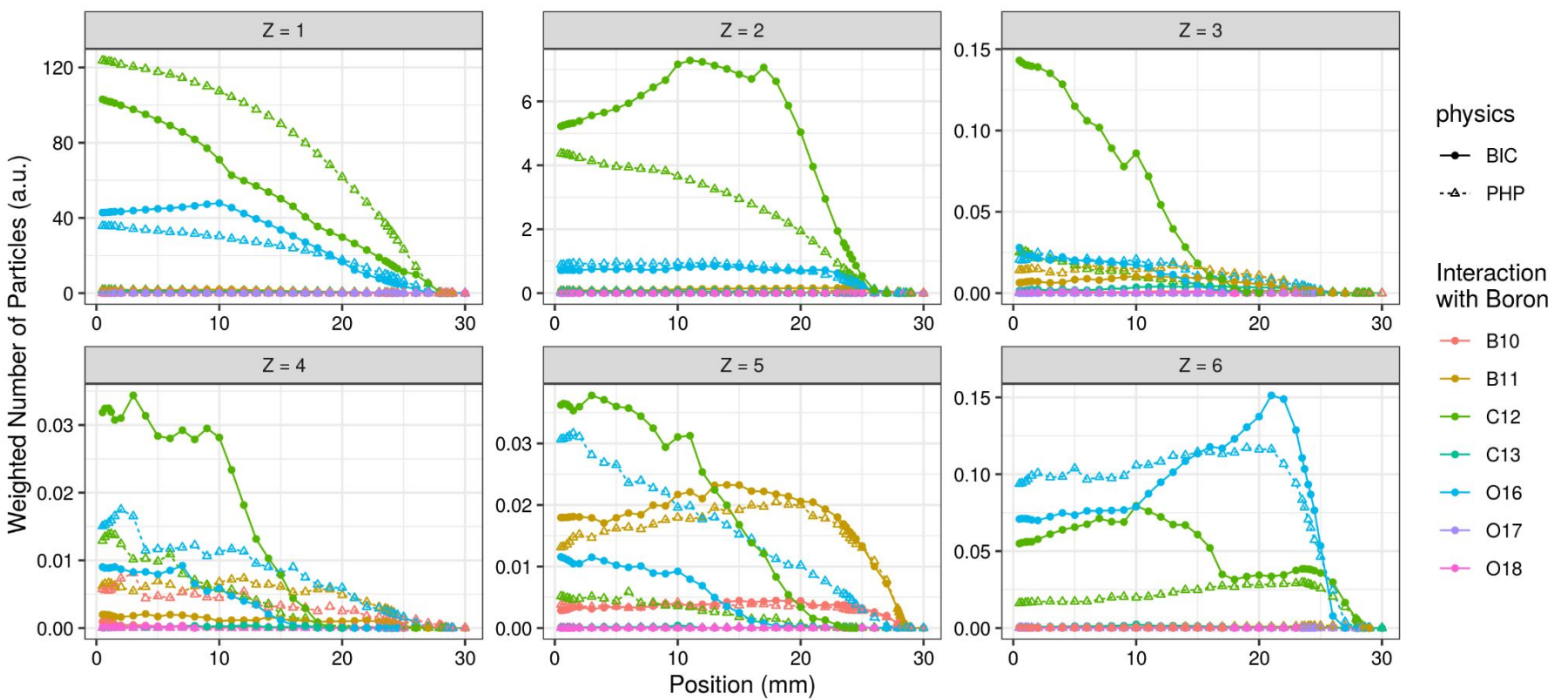
SOBP simulations - Proton PHSP



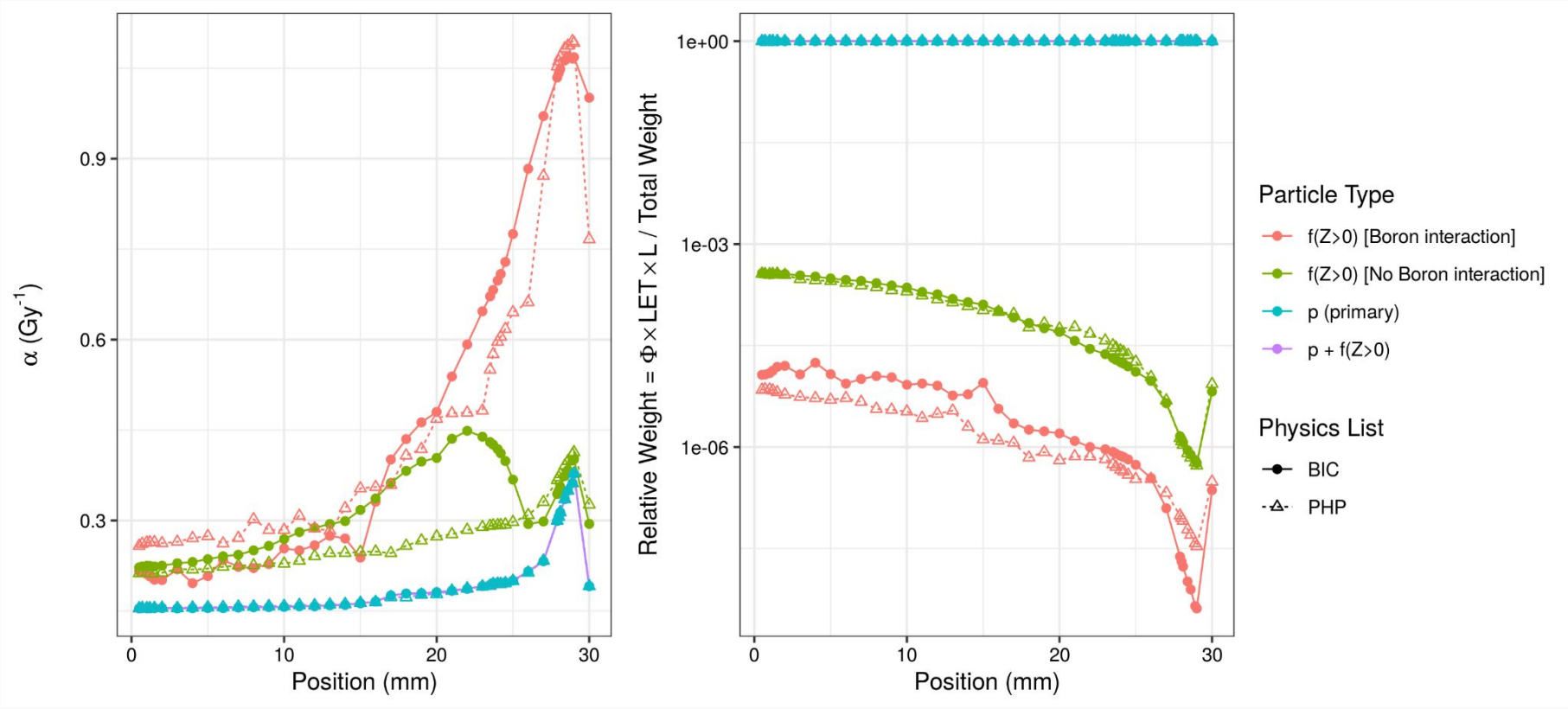
SOBP simulations - Secondary Particles Yields



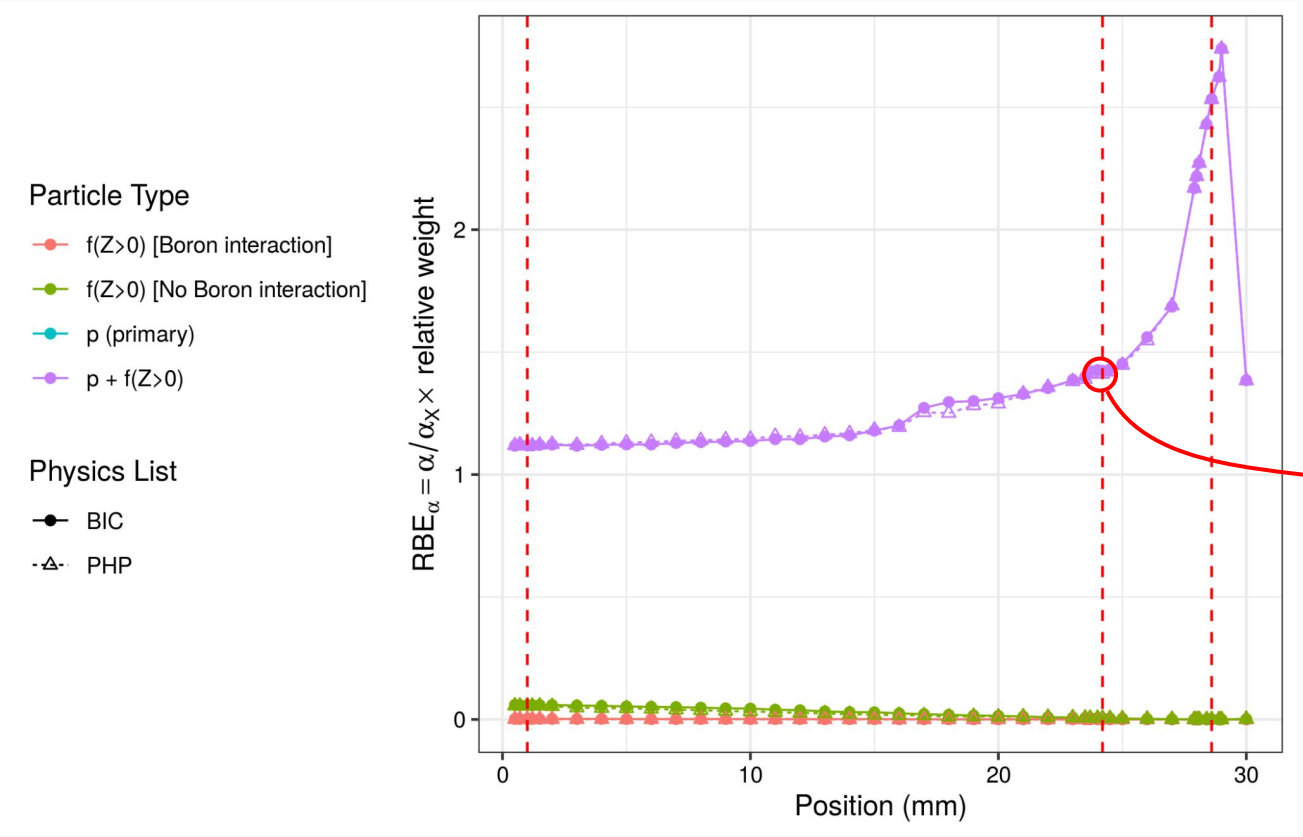
SOBP simulations - Secondary Particles Yields

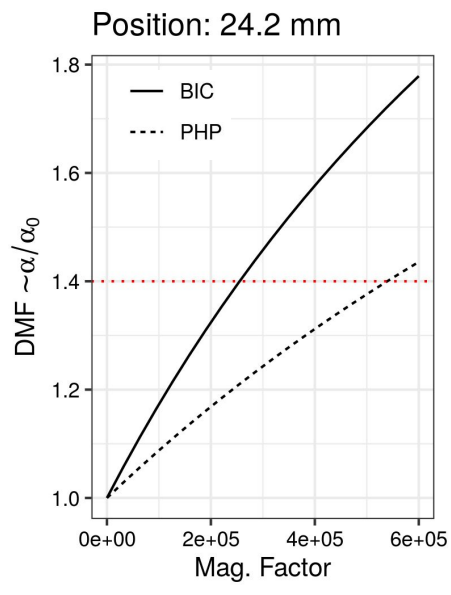


SOBP RB simulations (DU145 + MKM) - α parameter & relative weight



SOBP RB simulations (DU145 + MKM): RBE_{α} = α x relative weight / α_x





Paper in preparation

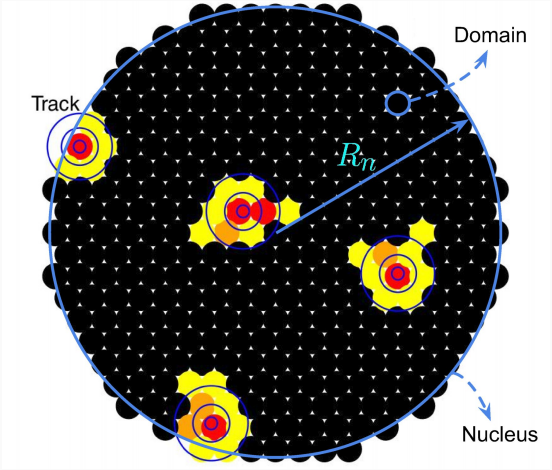
For Sci Rep / Phys Med Biol (?)

Radiation biophysical modeling Investigation on the radiobiological effect observed for proton beam combination with Boron carriers: challenging the nuclear processes driven enhancement hypothesis

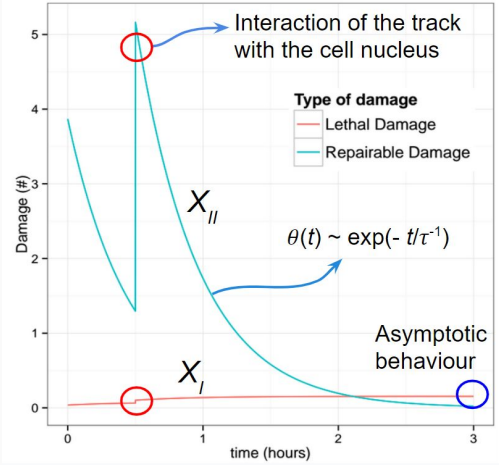
A. Attili, S. Fattori et al.

Spares

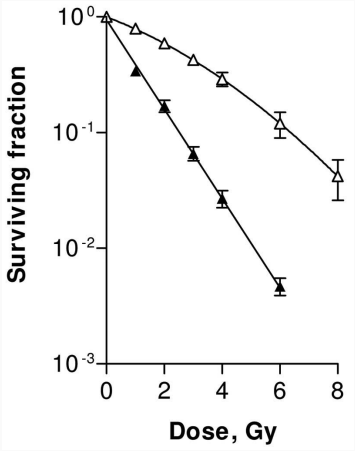
Microdosimetry Kinetic Model (MKM) approach



Multi-track energy deposition pattern in cell nucleus

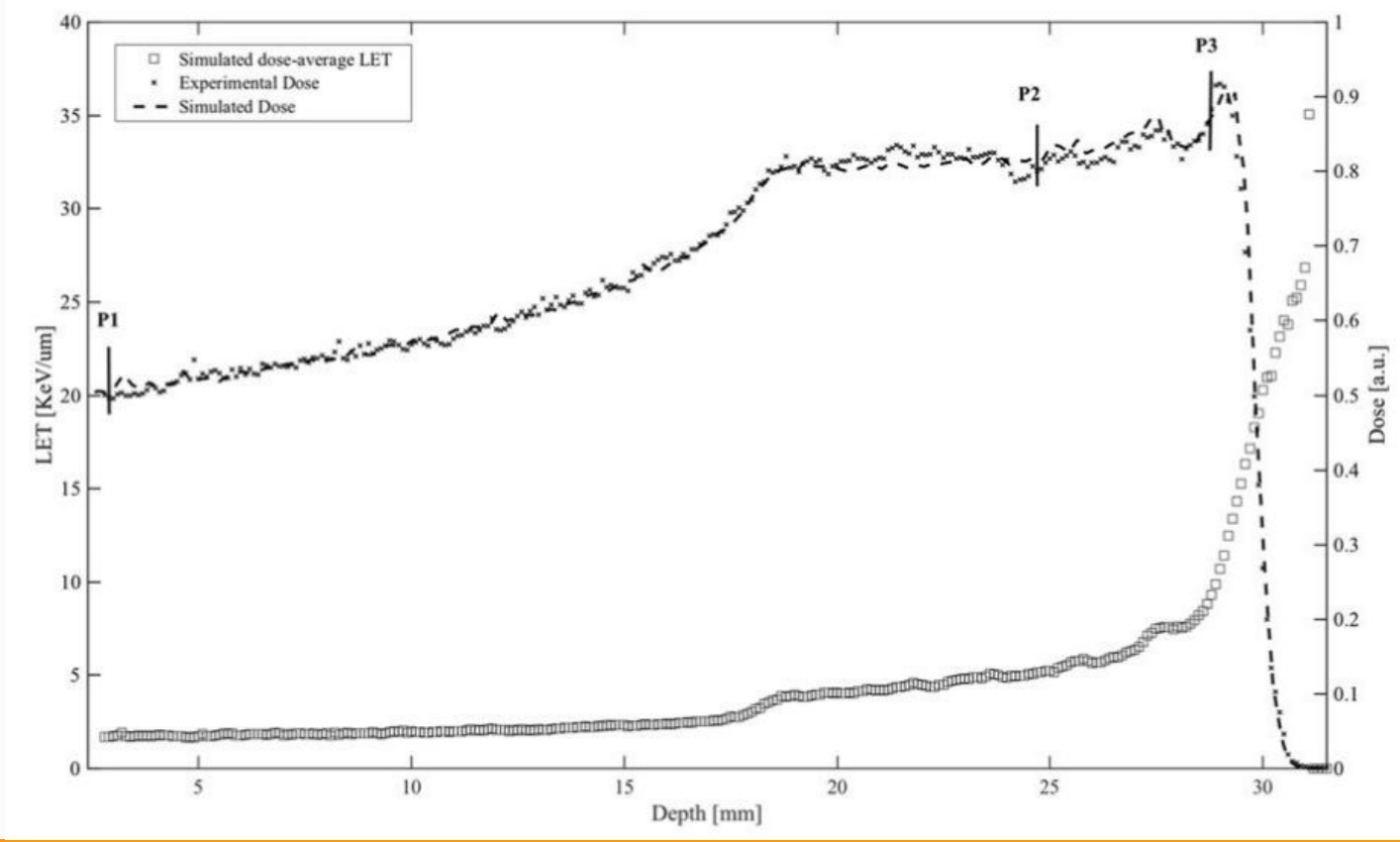


DNA Repair kinetics



(VE Bellinzona, FG Cordoni, M Missiaggia, F Tommasino, E Scifoni, C La Tessa and A Attili (2021) Linking microdosimetric measurements to biological effectiveness in ion beam therapy: a review of theoretical aspects of MKM and other models, Frontiers in Physics, doi: 10.3389/fphy.2020.578492)

SOBP


Simulated dose-average LET
Experimental Dose
Simulated Dose
P1
P2
P3
LET [KeV/um]
Dose [a.u.]
Depth [mm]
0
5
10
15
20
25
30
35
40
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Flask geometry