

### **Scoring excerpt 1: track averaged LET**

```
s:Sc/ScoringCylinder3cmLET_t/Quantity = "ProtonLET"  
s:Sc/ScoringCylinder3cmLET_t/Component = "ScoringCylinder3cm"  
b:Sc/ScoringCylinder3cmLET_t/OutputToConsole = "FALSE"  
s:Sc/ScoringCylinder3cmLET_t/WeightBy = "track"
```

### **Scoring excerpt 2: using a phase space from TOPAS to run TOPAS nBio simulations of an FNTD**

```
i:Ts/NumberOfThreads = 1
```

```
b:Ts/PauseBeforeInit = "false"  
b:Ts/PauseBeforeSequence = "false"  
b:Ts/PauseBeforeQuit = "false"  
Ts/ShowHistoryCountAtInterval = 10
```

```
s:So/Default/Type = "PhaseSpace"  
s:So/Default/Component = "World"  
b:So/Default/PhaseSpaceIncludeEmptyHistories = "False"  
i:So/Default/PhaseSpaceMultipleUse = 1  
b:So/Default/PhaseSpaceIgnoreXPos = "true"  
b:So/Default/PhaseSpaceIgnoreYPos = "true"  
b:So/Default/PhaseSpaceIgnoreZPos = "true"
```

```
Ge/World/HLX = 200000 nm  
Ge/World/HLY = 200000 nm  
Ge/World/HLZ = 400005 nm
```

```
b:Ge/World/Invisible = "TRUE"  
Ge/World/Material = "Air"
```

```
s:Ma/G4_WATER_Mod/CloneFromMaterial = "G4_WATER"  
d:Ma/G4_WATER_Mod/CloneWithDensity = 3.07908 g/cm3 # WEPL at 15 MeV
```

```
# Phantom
```

```
s:Ge/Phantom/Parent="World"  
s:Ge/Phantom/Type="TsBox"  
s:Ge/Phantom/Material="G4_WATER_Mod"  
d:Ge/Phantom/HLX=10000.0 nm  
d:Ge/Phantom/HLY=10000.0 nm  
d:Ge/Phantom/HLZ=20000.0 nm  
d:Ge/Phantom/TransX=0. nm  
d:Ge/Phantom/TransY=0. nm  
d:Ge/Phantom/TransZ=20001. nm
```

```
s:Ge/target/Parent="Phantom"  
s:Ge/target/Type="TsBox"  
s:Ge/target/Material="G4_WATER_MOD"
```

d:Ge/target/HLX=10000.0 nm  
d:Ge/target/HLY=10000.0 nm  
d:Ge/target/HLZ=10000.0 nm  
d:Ge/target/TransX=0. nm  
d:Ge/target/TransY=0. nm  
d:Ge/target/TransZ=0. nm  
s:Ge/Target/AssignToRegionNamed = "target"

s:Sc/FNTD/Quantity = "FNTD"  
s:Sc/FNTD/Component = "target"  
s:Sc/FNTD/IfOutputFileAlreadyExists = "Overwrite"  
s:Sc/FNTD/OutputType = "binary" # "csv", "binary", "Root", "Xml" or "DICOM"  
s:Sc/FNTD/OutputFile = "FNTD"

s:Sc/PhyDose/Quantity = "DoseToMedium"  
s:Sc/PhyDose/Component = "target"  
s:Sc/PhyDose/IfOutputFileAlreadyExists = "Overwrite"  
s:Sc/PhyDose/OutputType = "binary" # "csv", "binary", "Root", "Xml" or "DICOM"  
s:Sc/PhyDose/OutputFile = "Dose"

s:Sc/LET/Quantity = "ProtonLET"  
s:Sc/LET/Component = "target"  
s:Sc/LET/IfOutputFileAlreadyExists = "Overwrite"  
s:Sc/LET/OutputType = "binary" # "csv", "binary", "Root", "Xml" or "DICOM"  
s:Sc/LET/OutputFile = "LET"

sv:Ph/Default/Modules = 7 "g4em-lowep" "g4h-phy\_QGSP\_BIC\_HP" "g4decay"  
"g4ion-binarycascade" "g4h-elastic\_HP" "g4stopping" "g4radioactivedecay"

d:CutForAllParticles = 1. nm

**Additional data for nominal, unshifted FNTD depths**

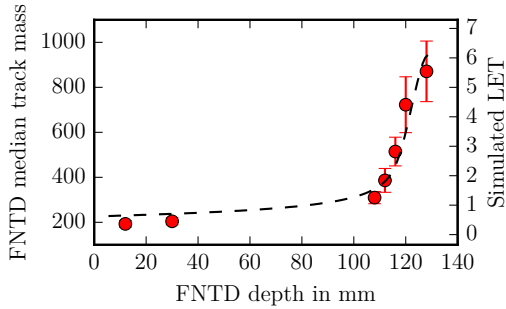


Figure 1: Overlay of data for track-averaged LET values at nominal FNTD positions, plus FNTD median track IB values

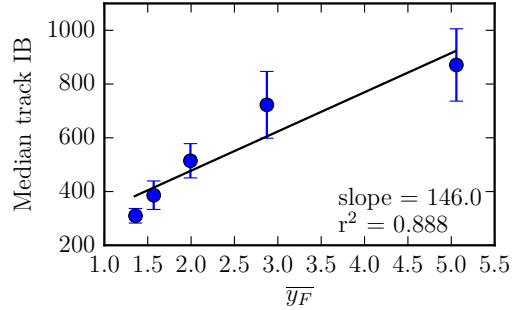


Figure 2: Correlation between FNTD median track IB and  $\bar{y}_F$  scored at the nominal FNTD positions

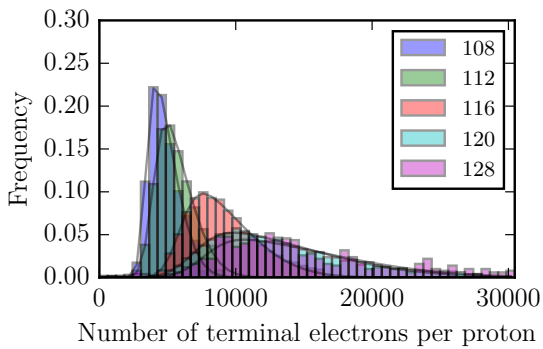


Figure 3: Simulated stochastic data for the number of terminal electrons per proton, scored at the nominal FNTD positions

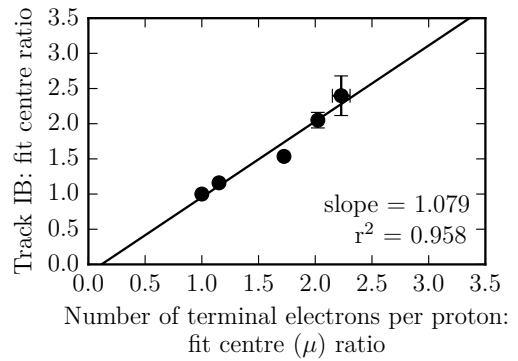


Figure 4: Simulated versus experimental correlation of the skewed Gaussian fit centres, nominal FNTD positions

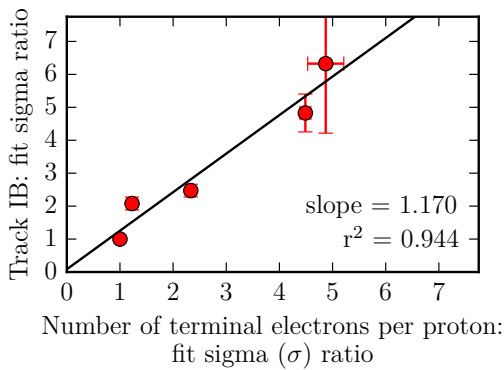


Figure 5: Simulated versus experimental correlation of the skewed Gaussian fit sigmas, nominal FNTD positions