# TOPAS-nBio (TOPAS v4.0)

## Regression testing (cf. TOPAS-nBio (TOPAS v4.0))

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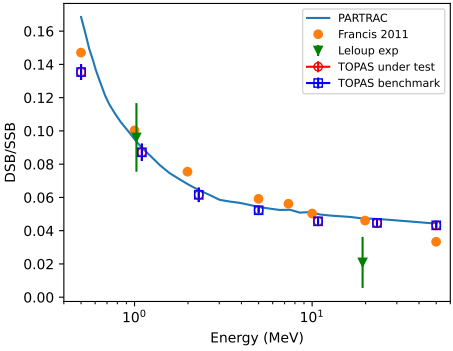
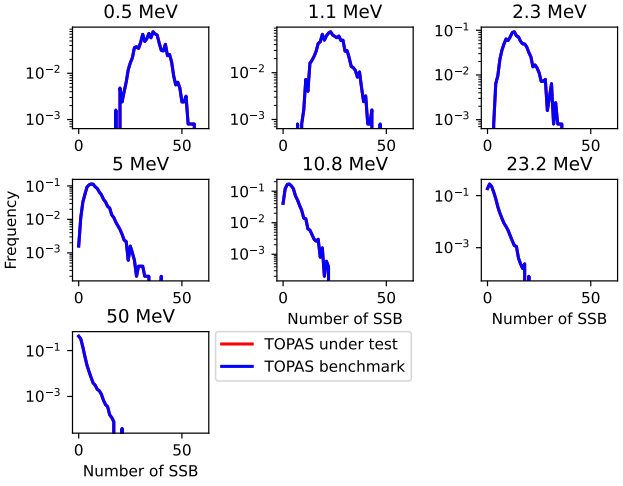
# DBSCAN - TsEmDNAPhysics



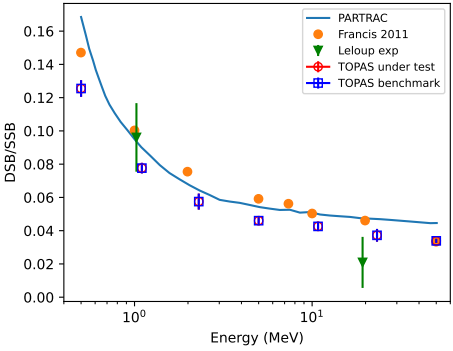

| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 152.0 +/- 0.5 | 152.0 +/- 0.5 |
| Final. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |



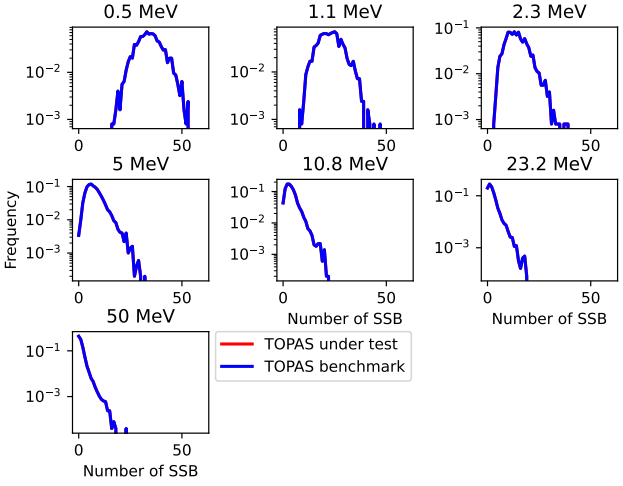


Francis Z, Villagrasa C, Clairand I. Simulation of DNA damage clustering after proton irradiation using an adapted DBSCAN algorithm. *Comput Methods Programs Biomed.* 2011; 101(3):265-270. doi:10.1016/j.cmpb.2010.12.012

# DBSCAN - g4em-dna_opt2



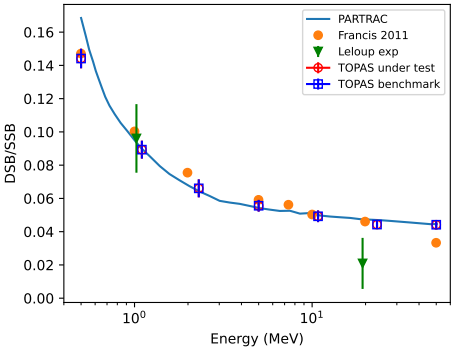

| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 146.1 +/- 1.2 | 146.1 +/- 1.2 |
| Final. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |



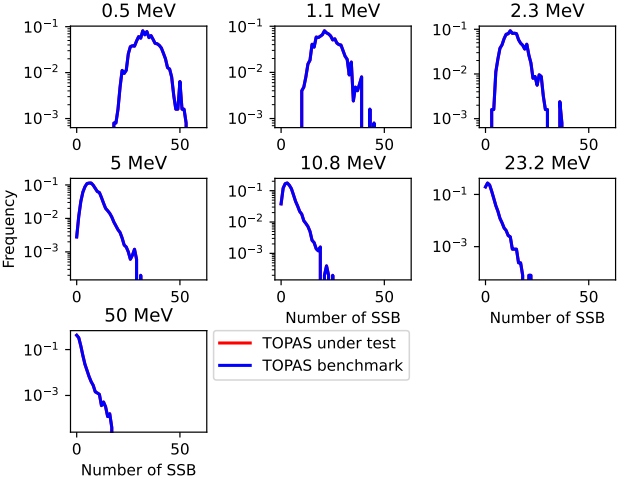


Francis Z, Villagrasa C, Clairand I. Simulation of DNA damage clustering after proton irradiation using an adapted DBSCAN algorithm. *Comput Methods Programs Biomed.* 2011; 101(3):265-270. doi:10.1016/j.cmpb.2010.12.012

# DBSCAN - g4em-dna_opt4



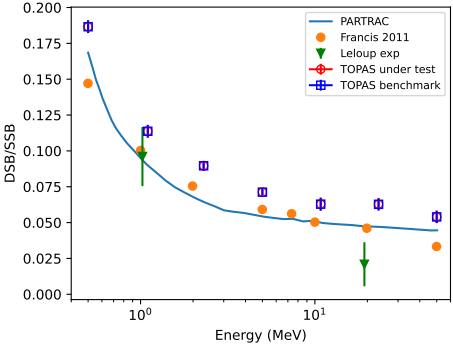

| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 451.3 +/- 0.6 | 451.3 +/- 0.6 |
| Final. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |



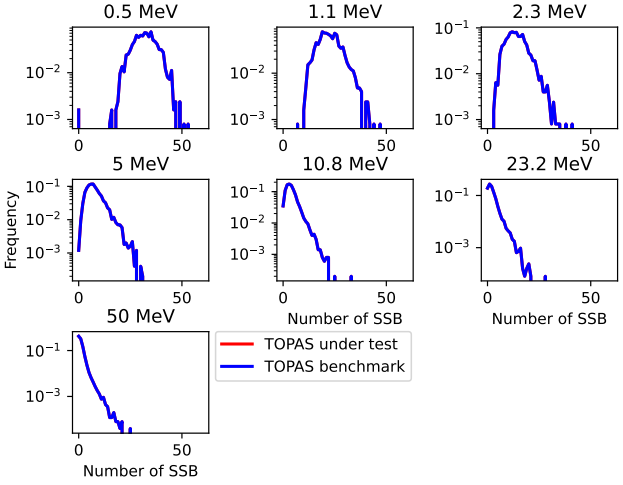


Francis Z, Villagrasa C, Clairand I. Simulation of DNA damage clustering after proton irradiation using an adapted DBSCAN algorithm. *Comput Methods Programs Biomed.* 2011; 101(3):265-270. doi:10.1016/j.cmpb.2010.12.012

# DBSCAN - g4em-dna_opt6



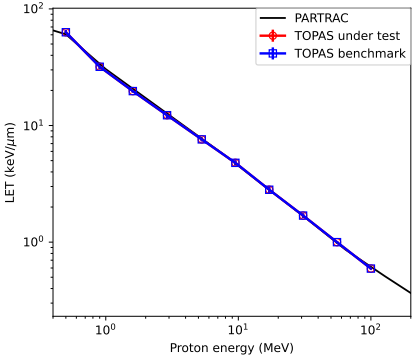

| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 129.1 +/- 0.7 | 129.1 +/- 0.7 |
| Final. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |



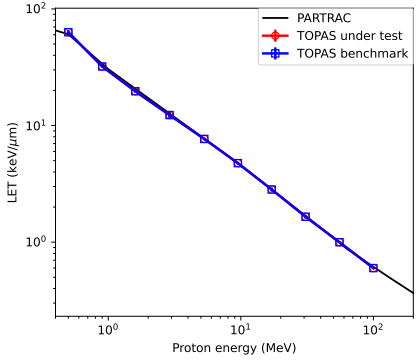


Francis Z, Villagrasa C, Clairand I. Simulation of DNA damage clustering after proton irradiation using an adapted DBSCAN algorithm. *Comput Methods Programs Biomed.* 2011; 101(3):265-270. doi:10.1016/j.cmpb.2010.12.012

# LET I



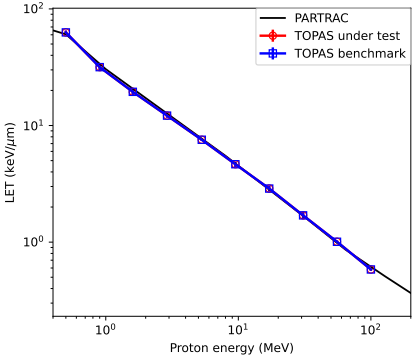

| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 262.7 +/- 0.5 | 262.7 +/- 0.5 |
| Final. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |



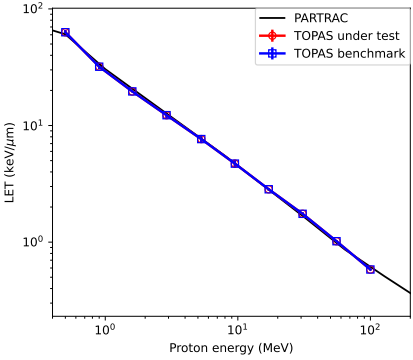

| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 253.1 +/- 1.0 | 253.1 +/- 1.0 |
| Final. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |

- LET as a function of proton energy for TsEmDNAPhysics (left) and g4em-dna_opt2 (right).

# LET II




| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 719.6 +/- 1.8 | 719.6 +/- 1.8 |
| Final. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |

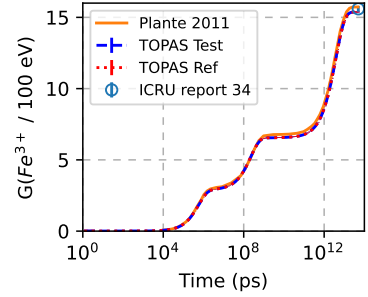


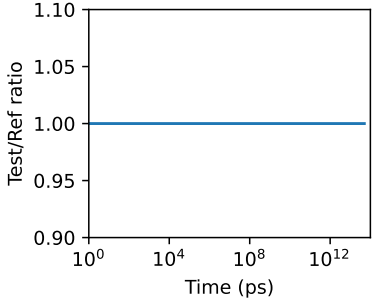

| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 236.4 +/- 1.0 | 236.4 +/- 1.0 |
| Final. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |

- LET as a function of proton energy for g4em-dna_opt4 (left) and g4em-dna_opt6 (right).

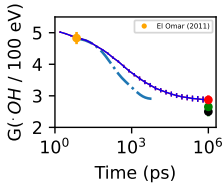
# Fricke: IRT

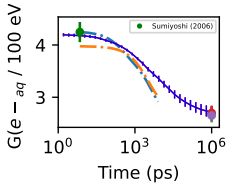
| | TOPAS under test | TOPAS benchmark |
|---|---|---|
| Init. (s) | 0.012 +/- 0.004 | 0.012 +/- 0.004 |
| Exec. (s) | 6.898 +/- 0.685 | 6.898 +/- 0.685 |
| Final. (s) | 0.006 +/- 0.005 | 0.006 +/- 0.005 |
| Value (/100eV) | 15.378 +/- 0.035 | 15.378 +/- 0.035 |

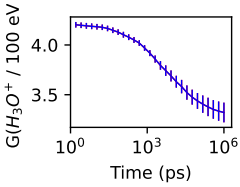


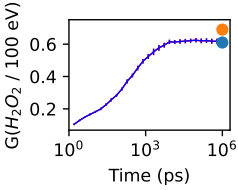



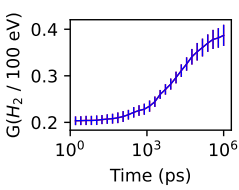
# G-value: step-by-step

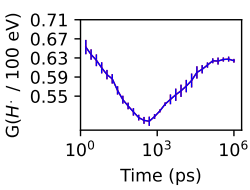


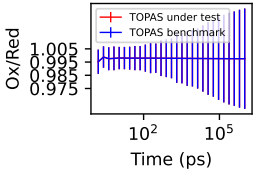



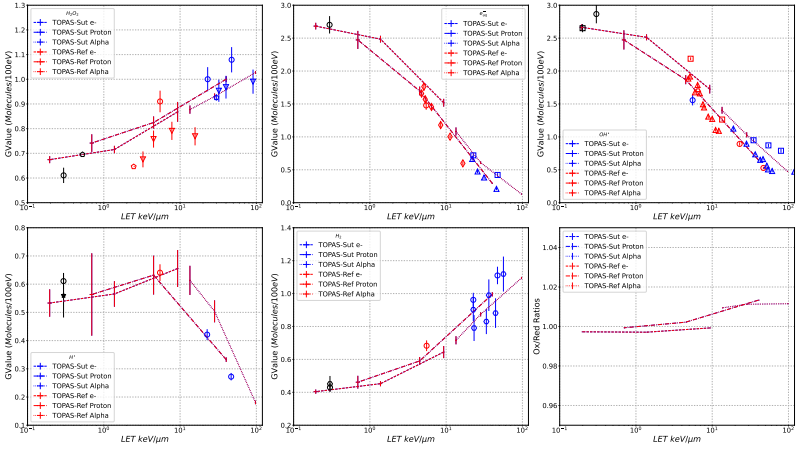



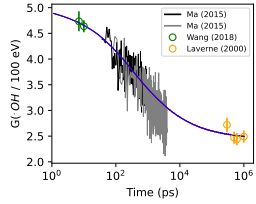

| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 156.0 +/- 54.1 | 156.0 +/- 54.1 |
| Final. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |

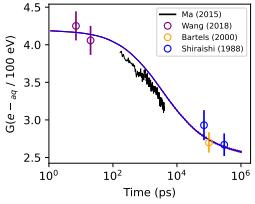
# G-value vs. LET: step-by-step

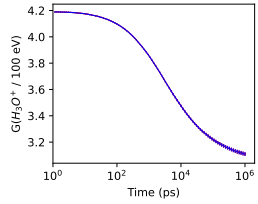


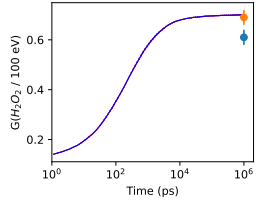

| | TOPAS-Ref | TOPAS-Sut |
|---|---|---|
| Real | 36863.080 +/- 518.497 | 36863.080 +/- 518.497 |
| User | 36844.920 +/- 518.185 | 36844.920 +/- 518.185 |
| Sys | 18.064 +/- 0.323 | 18.064 +/- 0.323 |

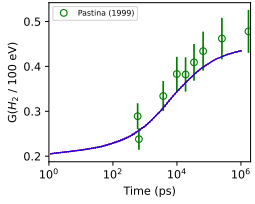
# G-value: IRT

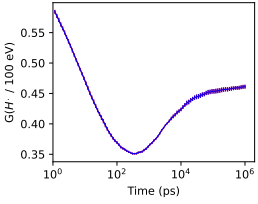


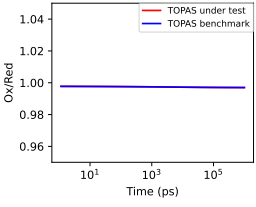



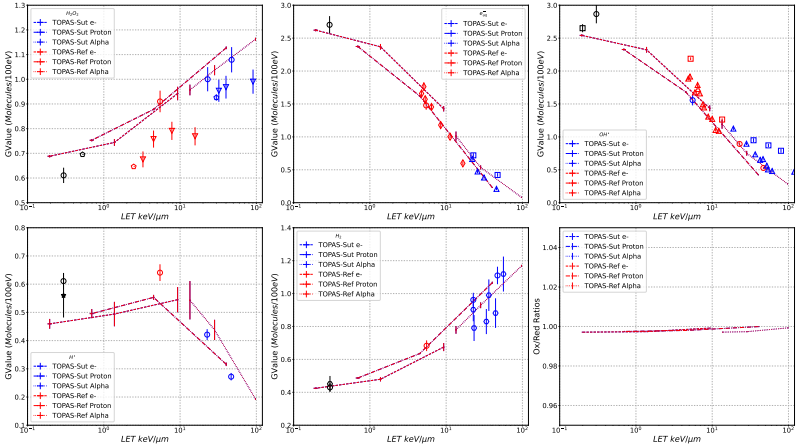



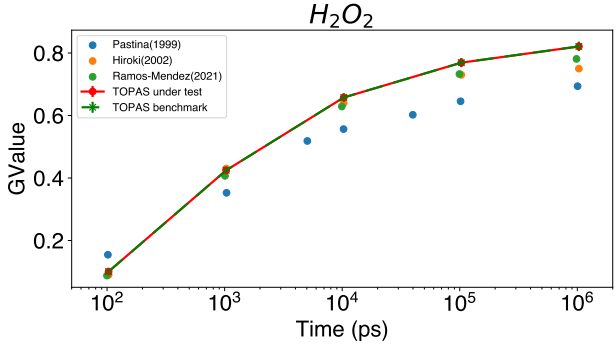

| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.010 +/- 0.000 | 0.010 +/- 0.000 |
| Exec. | 705.132 +/- 4.512 | 705.132 +/- 4.512 |
| Final. | 0.000 +/- 0.000 | 0.000 +/- 0.000 |

# G-value vs. LET: IRT



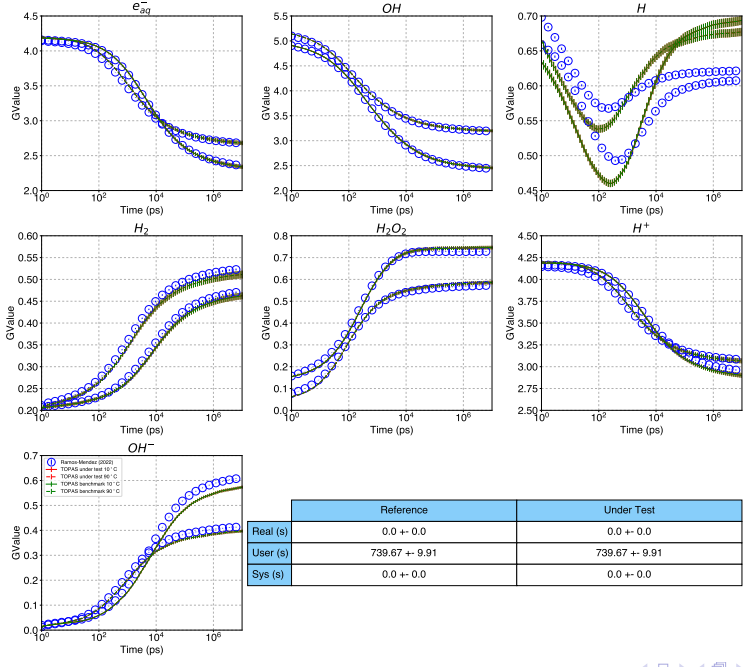

| | TOPAS-Ref | TOPAS-Sut |
|---|---|---|
| Real | 3301.326 +/- 121.620 | 3301.326 +/- 121.620 |
| User | 3274.968 +/- 121.352 | 3274.968 +/- 121.352 |
| Sys | 15.550 +/- 0.260 | 15.550 +/- 0.260 |

# G-value of $H_2O_2$: IRT



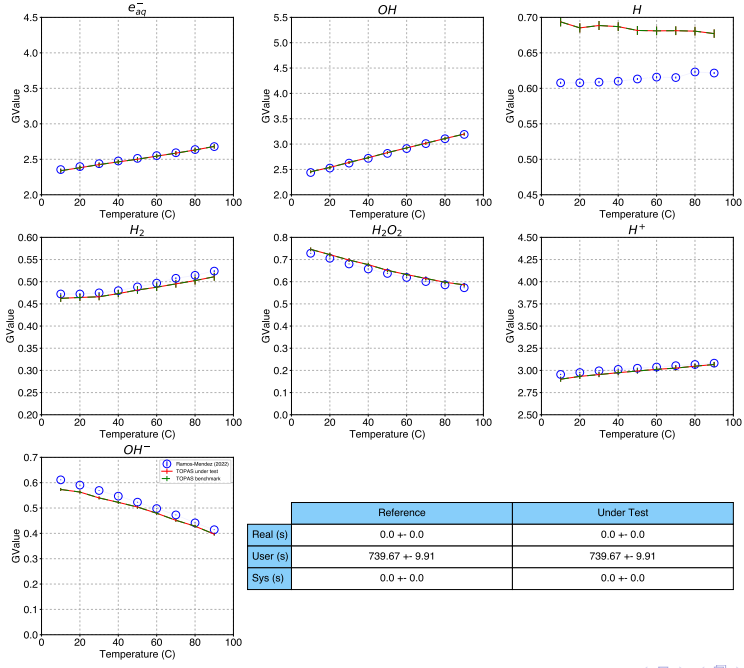

| | Reference | Under Test |
|---|---|---|
| Real (s) | 0.0 +- 0.0 | 0.0 +- 0.0 |
| User (s) | 218.08 +- 1.24 | 218.08 +- 1.24 |
| Sys (s) | 0.0 +- 0.0 | 0.0 +- 0.0 |

# G-value and Temperature I: IRT



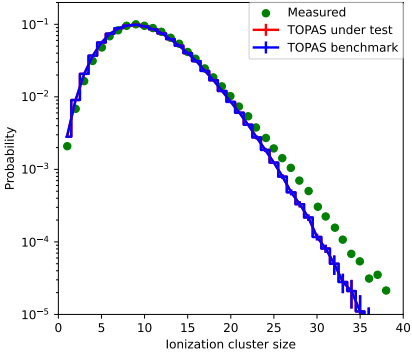

| | Reference | Under Test |
|---|---|---|
| Real (s) | 0.0 +- 0.0 | 0.0 +- 0.0 |
| User (s) | 739.67 +- 9.91 | 739.67 +- 9.91 |
| Sys (s) | 0.0 +- 0.0 | 0.0 +- 0.0 |

# G-value and Temperature II: IRT

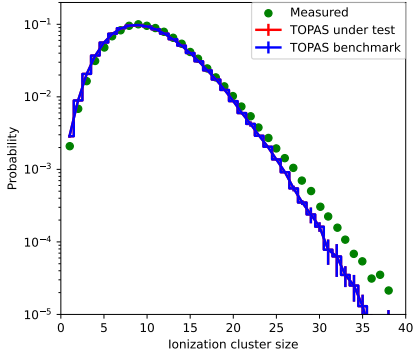



| | Reference | Under Test |
|---|---|---|
| Real (s) | 0.0 +- 0.0 | 0.0 +- 0.0 |
| User (s) | 739.67 +- 9.91 | 739.67 +- 9.91 |
| Sys (s) | 0.0 +- 0.0 | 0.0 +- 0.0 |

# Nanodosimetry I: TsEmDNAPhysics and g4em-dna_opt2



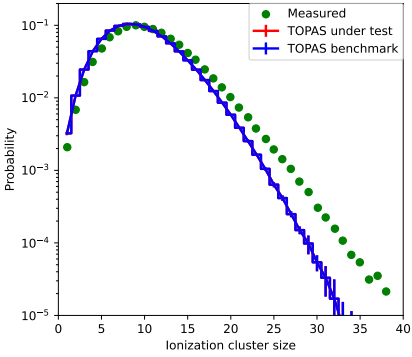

| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 10376.5 +/- 37.9 | 10376.5 +/- 37.9 |
| Final. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |



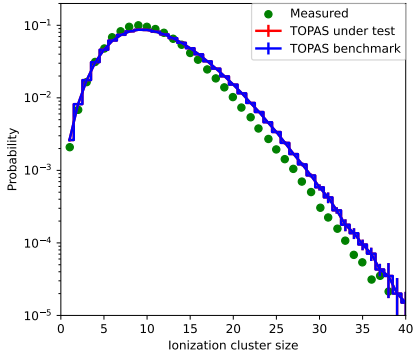

| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 10122.7 +/- 36.3 | 10122.7 +/- 36.3 |
| Final. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |


Conte V, Selva A, Colautti P, et al., Nanodosimetry: Towards a new concept of radiation quality. *Radiat Prot Dosimetry*. 2018;180(1-4):150-156. doi:10.1093/rpd/ncx175

# Nanodosimetry I: g4em-dna_opt4 and g4em-dna_opt6



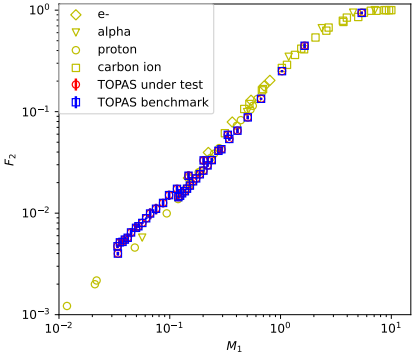

| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 8561.3 +/- 16.4 | 8561.3 +/- 16.4 |
| Final. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |



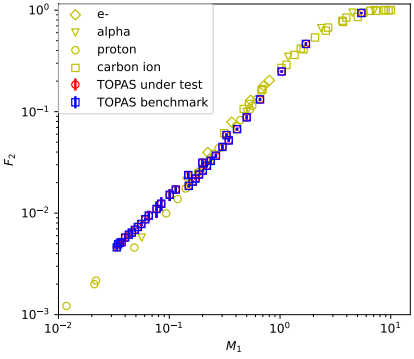

| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 7770.8 +/- 37.7 | 7770.8 +/- 37.7 |
| Final. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |


Conte V, Selva A, Colautti P, et al., Nanodosimetry: Towards a new concept of radiation quality. *Radiat Prot Dosimetry*. 2018;180(1-4):150-156. doi:10.1093/rpd/ncx175

# Nanodosimetry II: TsEmDNAPhysics and g4em-dna_opt2



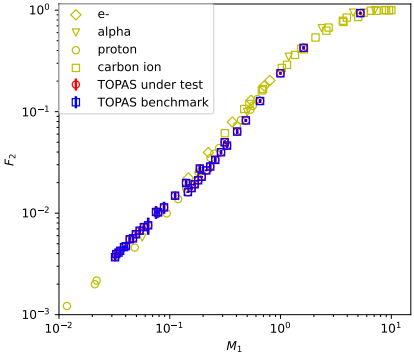

| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 124.7 +/- 0.3 | 124.7 +/- 0.3 |
| Final. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |



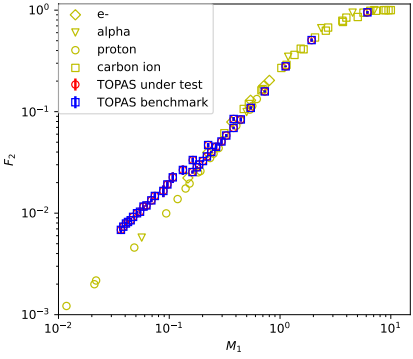

| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 99.2 +/- 0.4 | 99.2 +/- 0.4 |
| Final. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |


Conte V, Selva A, Colautti P, et al., Nanodosimetry: Towards a new concept of radiation quality. *Radiat Prot Dosimetry*. 2018;180(1-4):150-156. doi:10.1093/rpd/ncx175

# Nanodosimetry II: g4em-dna_opt4 and g4em-dna_opt6



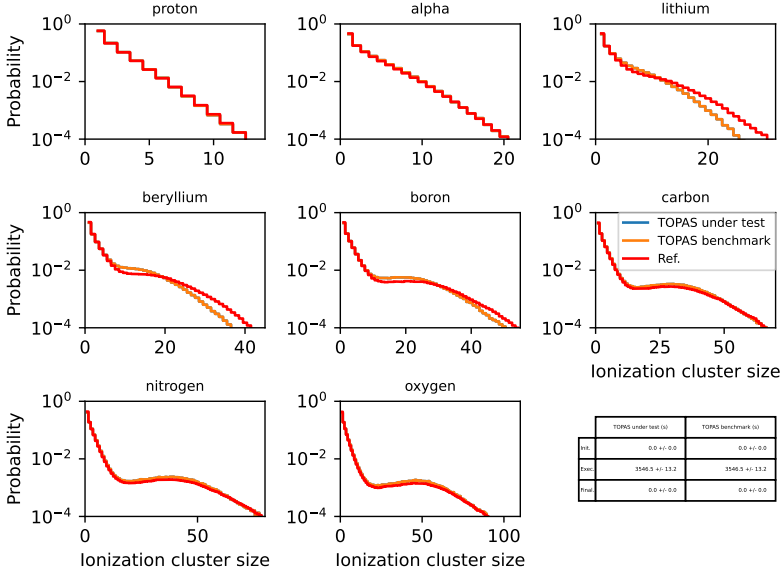

| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 1414.8 +/- 1.6 | 1414.8 +/- 1.6 |
| Final. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |




| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 1033.1 +/- 0.6 | 1033.1 +/- 0.6 |
| Final. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |


Conte V, Selva A, Colautti P, et al., Nanodosimetry: Towards a new concept of radiation quality. *Radiat Prot Dosimetry*. 2018;180(1-4):150-156. doi:10.1093/rpd/ncx175

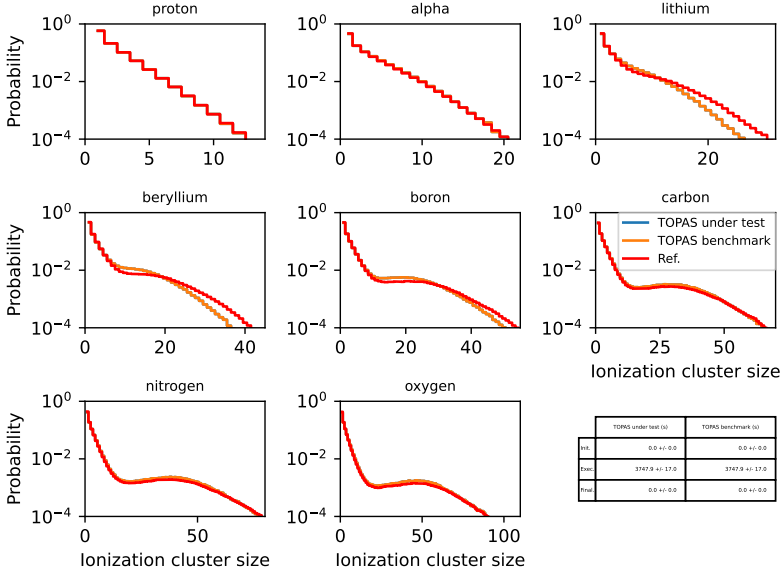
# Nanodosimetry III: TsEmDNAPhysics




| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 3546.5 +/- 13.2 | 3546.5 +/- 13.2 |
| Final | 0.0 +/- 0.0 | 0.0 +/- 0.0 |


- Ramos-Méndez J, Burigo LN, Schulte R, Chuang C, Faddegon B. Fast calculation of nanodosimetric quantities in treatment planning of proton and ion therapy. *Phys Med Biol*. 2018;63(23):235015. doi:10.1088/1361-6560/aaeeee

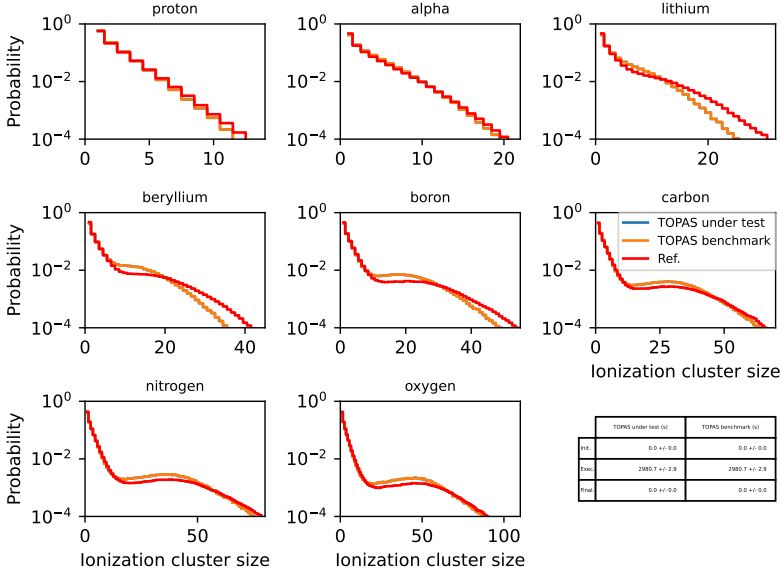
# Nanodosimetry III: g4em-dna_opt2




| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 3747.9 +/- 17.0 | 3747.9 +/- 17.0 |
| Final | 0.0 +/- 0.0 | 0.0 +/- 0.0 |

- Ramos-Méndez J, Burigo LN, Schulte R, Chuang C, Faddegon B. Fast calculation of nanodosimetric quantities in treatment planning of proton and ion therapy. *Phys Med Biol*. 2018;63(23):235015. doi:10.1088/1361-6560/aaeeee

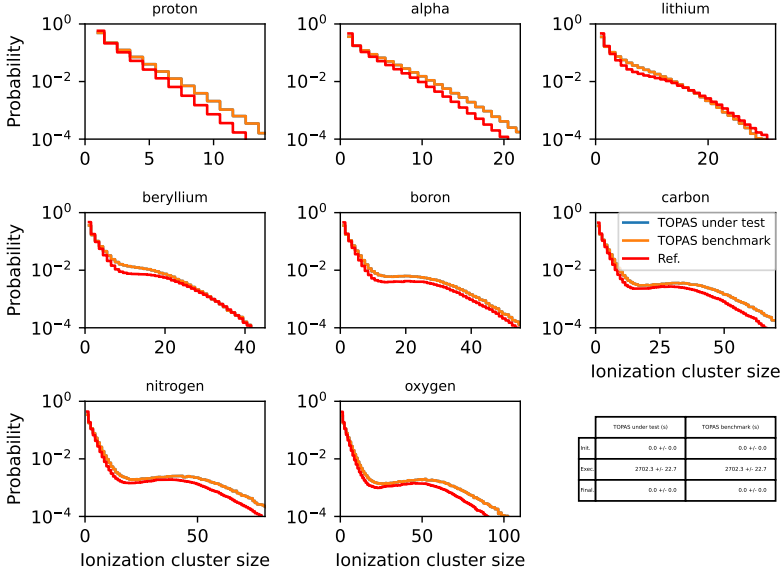
# Nanodosimetry III: g4em-dna_opt4




| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec | 2980.7 +/- 2.9 | 2980.7 +/- 2.9 |
| Final | 0.0 +/- 0.0 | 0.0 +/- 0.0 |

- Ramos-Méndez J, Burigo LN, Schulte R, Chuang C, Faddegon B. Fast calculation of nanodosimetric quantities in treatment planning of proton and ion therapy. *Phys Med Biol*. 2018;63(23):235015. doi:10.1088/1361-6560/aaeeee

# Nanodosimetry III: g4em-dna_opt6




| | TOPAS under test (s) | TOPAS benchmark (s) |
|---|---|---|
| Init. | 0.0 +/- 0.0 | 0.0 +/- 0.0 |
| Exec. | 2702.3 +/- 22.7 | 2702.3 +/- 22.7 |
| Final | 0.0 +/- 0.0 | 0.0 +/- 0.0 |

- Ramos-Méndez J, Burigo LN, Schulte R, Chuang C, Faddegon B. Fast calculation of nanodosimetric quantities in treatment planning of proton and ion therapy. *Phys Med Biol*. 2018;63(23):235015. doi:10.1088/1361-6560/aaeeee