

# GATE-RTion

## SCOPE AND OBJECTIVES

The OpenGATE collaboration is willing to help clinical users setting-up GATE into the clinics for pencil beam scanning proton and light ion beam therapy.

The GATE-RTion project has 3 objectives:

1. Providing a stable and long term GATE release, called GATE-RTion, having all necessary features for dosimetric applications in Light Ion Beam Therapy facilities equipped with the Pencil Beam Scanning delivery technique.
2. Providing a collection of tools necessary for the clinical users to interface GATE with the clinical environment
3. Developing guidelines for clinical users on how to implement GATE into the clinical routine using the provided tools

The GateRTion release of Gate is used as the dose engine in IDEAL, a clinical tool for independent dose calculation that is currently in development at [EBG MedAustron GmbH](https://www.medastron.at/) in collaboration with [ACMIT GmbH](http://www.acmit.at/) (both in Wiener Neustadt, Austria) and the [Medical University of Vienna](https://www.meduniwien.ac.at/hp/radonc/). These R&D activities are funded within the scope of the Austrian [COMET](https://www.ffg.at/en/comet-competence-centers-excellent-technologies) - Competence Centers for Excellent Technologies program and funded by the federal government (BMVIT and BMDW) and the governments of Lower Austria and Tyrol.

## RESOURCES

- First release of GATE-RTion, validated for proton therapy: [GATE-RTion 1.0](https://github.com/OpenGATE/Gate/tree/GateRTion)
- Build and install instructions are [the same as for Gate release 8.1](http://wiki.opengatecollaboration.org/index.php/Installation_Guide_V8.1#GATE_compilation_and_installation)
- The [Open-ReGate platform](https://public.kitware.com/open-regate/index.php/Main_Page) (Open Resources for GATE Monte Carlo simulations) will be used to share and document all necessary Tools, including guidelines.
- Validation tests for GATE-RTion are included in the [GateContrib](https://github.com/OpenGATE/GateContrib) collection of examples and benchmarks.

## RECOMMENDATIONS

- In the GATE-RTion 1.0 release we have configured the `CMakeLists.txt` file in such a way that you can only build it with [Geant4 version 10.03.p03](http://cern.ch/geant4-data/releases/geant4.10.03.p03.tar.gz)(<http://cern.ch/geant4-data/releases/geant4.10.03.p03.tar.gz>); for comparison of validation results between different clinics it is important that we use the same physics.
- We did not hard-code the physics builder. Please only use `QBBC_EMZ` or `QGSP_BIC_EMZ` with GateRTion.
- We don't think the simulation results depend much on the ROOT version, but still it would be good if you could stick to a relatively recent version of ROOT 6.
- After successful installation, please run the [validation tests!](https://github.com/OpenGATE/GateContrib/tree/master/GATE-RTion)(<https://github.com/OpenGATE/GateContrib/tree/master/GATE-RTion>)
- Ask questions and/or share your success stories on the [gate-users mailing list](http://lists.opengatecollaboration.org/mailman/listinfo/gate-users)(<http://lists.opengatecollaboration.org/mailman/listinfo/gate-users>).

## KEY CONTRIBUTIONS

### • Modeling of Scanned Ion Beam Delivery Systems

- Elia A. et al., *A reference Monte Carlo beam model of the MedAustron proton horizontal fixed beam line using GATE/Geant4*, submitted to Med. Phys.
- E. Almhagen et al., *A beam model for focused proton pencil beams*, [Physica Medica 52 \(2018\), p. 27-32](https://www.sciencedirect.com/science/article/pii/S1120179718304885)(<https://www.sciencedirect.com/science/article/pii/S1120179718304885>) (in press)
- Grevillot L. et al., *A Monte Carlo pencil beam scanning model for proton treatment plan simulation using GATE/GEANT4*, [Phys Med Biol. 56\(16\) \(2011\), p. 5203-19](https://doi.org/10.1088/0031-9155/56/16/008)(<https://doi.org/10.1088/0031-9155/56/16/008>)

### • Validation papers

- A.F. Resch et al.: *Validation of electromagnetic and nuclear scattering models in GATE/Geant4 for proton therapy*, [Med Phys. 2019 March 14 \(Epub ahead of print\)](https://doi.org/10.1002/mp.13472)(<https://doi.org/10.1002/mp.13472>)
- Hermann Fuchs et al., *Evaluation of GATE/Geant4 multiple Coulomb scattering algorithms for a 160 MeV proton beam*, [NIM B410 \(2017\), p. 122-126](https://doi.org/10.1016/j.nimb.2017.08.006)(<https://doi.org/10.1016/j.nimb.2017.08.006>)

### • TPS evaluations

- Jatinder Saini et al., *Dosimetric evaluation of a commercial proton spot scanning Monte-Carlo dose algorithm: comparisons against measurements and simulations*, [Phys. Med. Biol. 62\(19\) \(2017\), p. 7659](https://doi.org/10.1088/1361-6560/aa82a5)(<https://doi.org/10.1088/1361-6560/aa82a5>)
- Grevillot L. et al., *GATE as a GEANT4-based Monte Carlo platform for the evaluation of proton pencil beam scanning treatment plans*, [Phys Med Biol. 57\(13\) \(2012\): p. 4223-44](https://doi.org/10.1088/0031-9155/57/13/4223)(<https://doi.org/10.1088/0031-9155/57/13/4223>)

### • Original contributions to support the development of dosimetry and imaging applications

- Heide Meißner et al., *Towards offline PET monitoring of proton therapy at MedAustron*, [Z. Med. Phys. in press \(2018\), p. tbd](https://doi.org/10.1016/j.zemedi.2018.05.003)(<https://doi.org/10.1016/j.zemedi.2018.05.003>)

- Fatima Padilla-Cabal et al., *A pencil beam algorithm for magnetic resonance image-guided proton therapy*, Medical Physics **45 (5)** (2018), p. 2195-2204(<https://doi.org/10.1016/j.zemedi.2018.05.003>)
- H.E.S. Pettersen et al., *Proton tracking in a high-granularity Digital Tracking Calorimeter for proton CT purposes*, NIM A **860**(2017), p. 51-61(<https://doi.org/10.1016/j.nima.2017.02.007>)
- F. Marsolat et al., *Analytical linear energy transfer model including secondary particles: calculations along the central axis of the proton pencil beam*, Phys. Med. Biol. **61(2)** (2016), p. 740-757(<https://doi.org/10.1088/0031-9155/61/2/740>)
- Charlotte Robert et al., *PET-based dose delivery verification in proton therapy: a GATE based simulation study of five PET system designs in clinical conditions*, Phys. Med. Biol. **58(19)** (2013), p. 6867-6885(<https://doi.org/10.1088/0031-9155/58/19/6867>)
- C. Robert et al., *Distributions of secondary particles in proton and carbon-ion therapy: a comparison between GATE /Geant4 and FLUKA Monte Carlo codes*, Phys. Med. Biol. **58(9)** (2013), p. 2879-2899(<https://doi.org/10.1088/0031-9155/58/9/2879>)
- Hermann Fuchs et al., *A pencil beam algorithm for helium ion beam therapy*, Medical Physics **39(11)** (2012), p. 6726-6737(<https://doi.org/10.1118/1.4757578>)
- Ströbele J. et al., *Comparison of basic features of proton and helium ion pencil beams in water using GATE*, Z. Med. Phys. **22(3)** (2012), p. 170-8(<https://doi.org/10.1016/j.zemedi.2011.12.001>)

## Twitter Thread

[Tweets by Gate](https://twitter.com/OpenGATE_MC?ref_src=twsrc%5Etfw)([https://twitter.com/OpenGATE\\_MC?ref\\_src=twsrc%5Etfw](https://twitter.com/OpenGATE_MC?ref_src=twsrc%5Etfw))

<https://gate.uca.fr/download/gate-rtion>(<https://gate.uca.fr/download/gate-rtion>)