



GATE

Simulations of Preclinical and Clinical Scans in Emission Tomography, Transmission Tomography and Radiation Therapy

GATE users meeting

Introduction

IEEE MIC 2016, Strasbourg

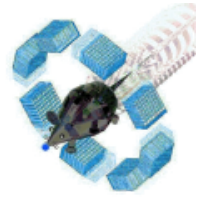
Irène Buvat

IMIV, Inserm – CEA – CNRS – Université Paris Sud

Université Paris Saclay

irene.buvat@u-psud.fr

Program



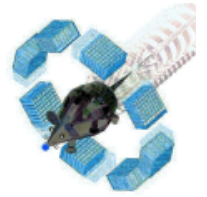
- 12:15 **Quick introduction to GATE**
Irène Buvat, IMIV, Orsay, France
- 12:30 **Optical modeling of scintillation detectors using GATE**
Emilie Roncali, University of California, Davis
- 12:45 **Modeling of hyperthermia therapy and heat diffusion using GATE**
Vesna Cuplov, IMIV, Orsay, France
- 13:00 **Contributing to GATE developments using the Git Hub**
Albertine Dubois, IMNC, Orsay, France
- 13:15 **Using GATE as an educational tool**
Irène Buvat, IMIV, Orsay, France
- 13:30 **Discussion with users / conclusions**

GATE for newcomers



- GATE: Application for Monte Carlo simulations of **Emission Tomography, Transmission Tomography, Optical imaging, Radiation Therapy and Theranostic** based on the general purpose Monte Carlo simulation toolkit **Geant4**
- GATE is an **open source** software **freely available** through registration on the OpenGATE web site
<http://www.opengatecollaboration.org>
- First release of GATE in May 2004
21 releases since that date (about 2 releases each year)
Currently **GATE V7.2**
> 1800 subscribers to the GATE users mailing list (cleaned up every month)

What can GATE be used for?



- Initially (2004) : SPECT and PET simulations

INSTITUTE OF PHYSICS PUBLISHING

PHYSICS IN MEDICINE AND BIOLOGY

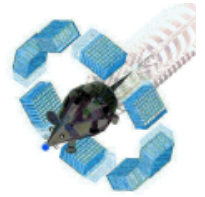
Phys. Med. Biol. **49** (2004) 4543–4561

PII: S0031-9155(04)80763-2

GATE: a simulation toolkit for PET and SPECT

**S Jan¹, G Santin^{2,24}, D Strul^{2,25}, S Staelens³, K Assié⁴, D Autret⁵,
S Avner⁶, R Barbier⁷, M Bardiès⁵, P M Bloomfield⁸, D Brasse⁶,
V Breton⁹, P Bruyndonckx¹⁰, I Buvat⁴, A F Chatziioannou¹¹, Y Choi¹²,
Y H Chung¹², C Comtat¹, D Donnarieix^{9,13}, L Ferrer⁵, S J Glick¹⁴,
C J Groiselle¹⁴, D Guez¹⁵, P-F Honore¹⁵, S Kerhoas-Cavata¹⁵,
A S Kirov¹⁶, V Kohli¹¹, M Koole³, M Krieguer¹⁰, D J van der Laan¹⁷,
F Lamare¹⁸, G Largeron⁷, C Lartizien¹⁹, D Lazaro⁹, M C Maas¹⁷,
L Maigne⁹, F Mayet²⁰, F Melot²⁰, C Merheb¹⁵, E Pennacchio⁷, J Perez²¹,
U Pietrzyk²¹, F R Rannou^{11,22}, M Rey², D R Schaart¹⁷, C R Schmidtlein¹⁶,
L Simon^{2,26}, T Y Song¹², J-M Vieira², D Visvikis¹⁸, R Van de Walle³,
E Wieërs^{10,23} and C Morel²**

What can GATE be used for?



- Then (2011), CT simulations, Radiation Therapy scenarios and Dosimetry

IOP PUBLISHING

PHYSICS IN MEDICINE AND BIOLOGY

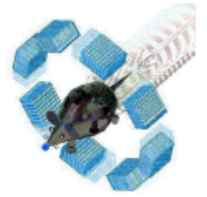
Phys. Med. Biol. **56** (2011) 881–901

[doi:10.1088/0031-9155/56/4/001](https://doi.org/10.1088/0031-9155/56/4/001)

GATE V6: a major enhancement of the GATE simulation platform enabling modelling of CT and radiotherapy


S Jan¹, D Benoit², E Becheva¹, T Carlier^{3,4}, F Cassol⁵, P Descourt⁶,
T Frisson⁷, L Grevillot⁷, L Guigues⁷, L Maigne⁸, C Morel⁵, Y Perrot⁸,
N Rehfeld², D Sarrut⁷, D R Schaart⁹, S Stute², U Pietrzyk¹⁰, D Visvikis⁶,
N Zahra⁷ and I Buvat²

What can GATE be used for?



- Then (2011), CT simulations, Radiation Therapy scenarios and Dosimetry



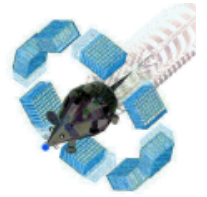
- A review of the use and potential of the GATE Monte Carlo simulation code for radiation therapy and dosimetry applications  CrossMark

David Sarrut^{1,a)}, Manuel Bardiès², Nicolas Bousson³, Nicolas Freud⁴, Sébastien Jan⁵, Jean-Michel Létang⁶, George Loudos⁷, Lydia Maigne⁸, Sara Marcatili⁹, Thibault Mauxion⁹, Panagiotis Papadimitroulas¹⁰, Yann Perrot¹¹, Uwe Pietrzyk¹², Charlotte Robert¹³, Dennis R. Schaart¹⁴, Dimitris Visvikis¹⁵ and Irène Buvat¹⁶



Download PDF

What can GATE be used for?



- Recently (2014): Optical imaging

Journal of Biomedical Optics 19(2), 026004 (February 2014)

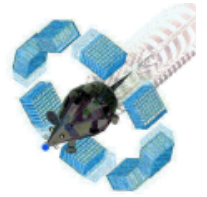
Extension of the GATE Monte-Carlo simulation package to model bioluminescence and fluorescence imaging

Vesna Cuplov,^a Irène Buvat,^b Frédéric Pain,^b and Sébastien Jan^{a,*}

^aService Hospitalier Frédéric Joliot, Commissariat à l'Energie Atomique, 91401 Orsay, France

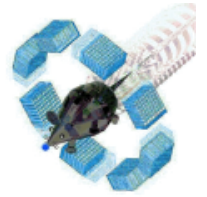
^bLaboratoire Imagerie et Modélisation en Neurobiologie et Cancérologie, UMR 8165 CNRS—Université Paris 7—Université Paris 11, France

What can GATE be used for?



- GATE is currently **the only opensource Monte Carlo simulation code** supporting the integrated modeling of imaging and therapy for **theranostic applications**
- Enhancing the features enabling theranostic modeling is currently a **main axis of development in GATE**

What can GATE be used for?



- GATE can also be used for teaching and helping students understand the physics behind imaging or radiation therapy



Zeitschrift für Medizinische Physik

Volume 23, Issue 1, February 2013, Pages 65–70



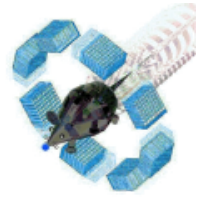
TECHNISCHE MITTEILUNG

EduGATE – basic examples for educative purpose using the GATE simulation platform

EduGATE – einfache lehrreiche Beispiele zum Zweck der Ausbildung basierend auf der GATE Simulationsplattform

Uwe Pietrzyk^{1, 2},  , Abdelhamid Zakhnini^{2, 3}, Markus Axer^{1, 2}, Sophie Sauerzapf^{2, 4}, Didier Benoit⁵, Michaela Gaens¹

GATE is a collaborative effort

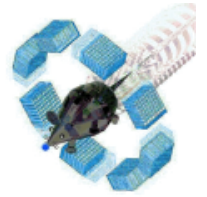


■ Developed by the OpenGATE collaboration (19 labs)

- IMIV Inserm/CEA/CNRS, Orsay, Irène Buvat (**spokesperson**), Sébastien Jan (**techn coordinator**)
- IMNC CNRS, Orsay, Albertine Dubois (**GATE engineer**)
- U1101 Inserm, LaTIM, CHU Morvan, Brest, Dimitris Visvikis
- U892 Inserm, CHU Nantes, Ludovic Ferrer
- UMR 1037 Inserm/UPS Toulouse, Manuel Bardiès
- LPC Clermont-Ferrand CNRS, Lydia Maigne
- CREATIS Inserm/CNRS, Lyon, David Sarrut
- Centre de Physique des Particules de Marseille CNRS, Marseille, Christian Morel
- Institut Pluridisciplinaire Hubert Curien CNRS, Strasbourg, Ziad El Bitar
- Subatech CNRS, Nantes, Jean-Pierre Cussonneau
- NIM group, BIOSIM, National Technical University of Athens, George Loudos, Greece
- Forschungszentrum-Juelich, Uwe Pietrzyk, Germany
- Delft University of Technology, Dennis Schaart, The Netherlands
- MOCAMMED, Medical University of Vienna, Dietmar Georg, Austria
- MedAustron, Wiener Neustadt, Loïc Grevillot, Austria
- Uppsala University, David Boersma, Sweden,
- Memorial Sloan-Kettering Cancer Center, New York, Assen Kirov
- University of California Davis, Davis, Emilie Roncali
- Sungkyunkwan University School of Medicine, Seoul, Yong Choi

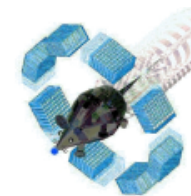
■ **Any of you can easily contribute to the development of the code thanks to the Git Hub system**

Role of the collaboration members



- To **upgrade GATE** so as to follow the Geant4 releases
- To **add and test new functionalities** in GATE
- To **answer users' requests** on the gate-user mailing lists
- To **help organize training** sessions and users' meetings
- To write and maintain the **documentation**
- To **publish articles** demonstrating the usefulness of GATE
- To discuss and **agree on future orientations** of GATE
- To find **funding** for GATE

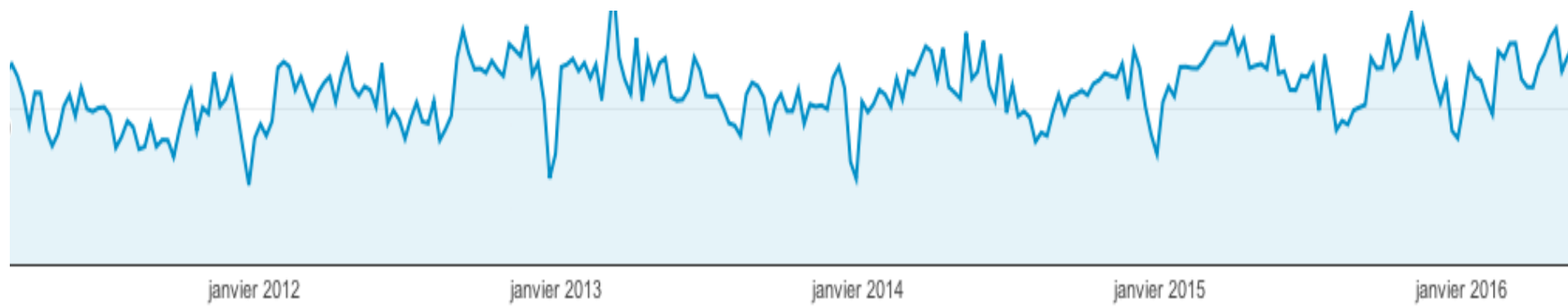
GATE by numbers



Feb 2011

June 2016

Visits per week



66,632 unique visitors

729,605 page views

35.3% new visitors

244 GATE V7.2 download

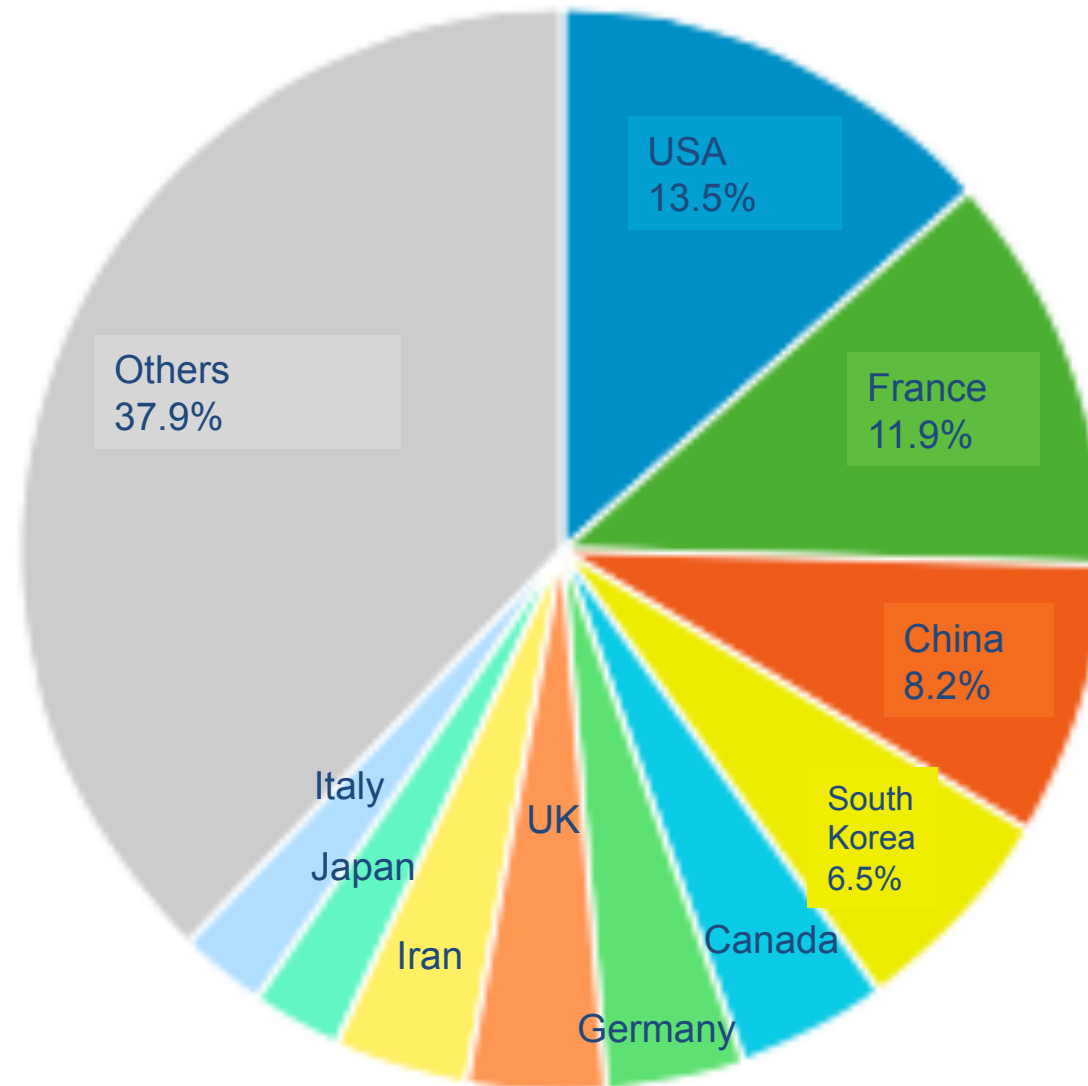
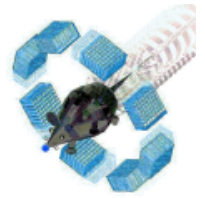
1034 GATE V7.1 download

933 GATE V7.0 download

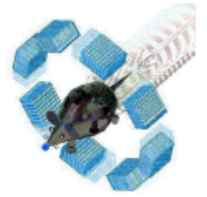
1638 vGATE 2.1 downloads, 2051 vGATE 3.0 downloads

1111 EduGATE 2011 downloads, 337 EduGATE 2014 downloads

Where do GATE users come from?

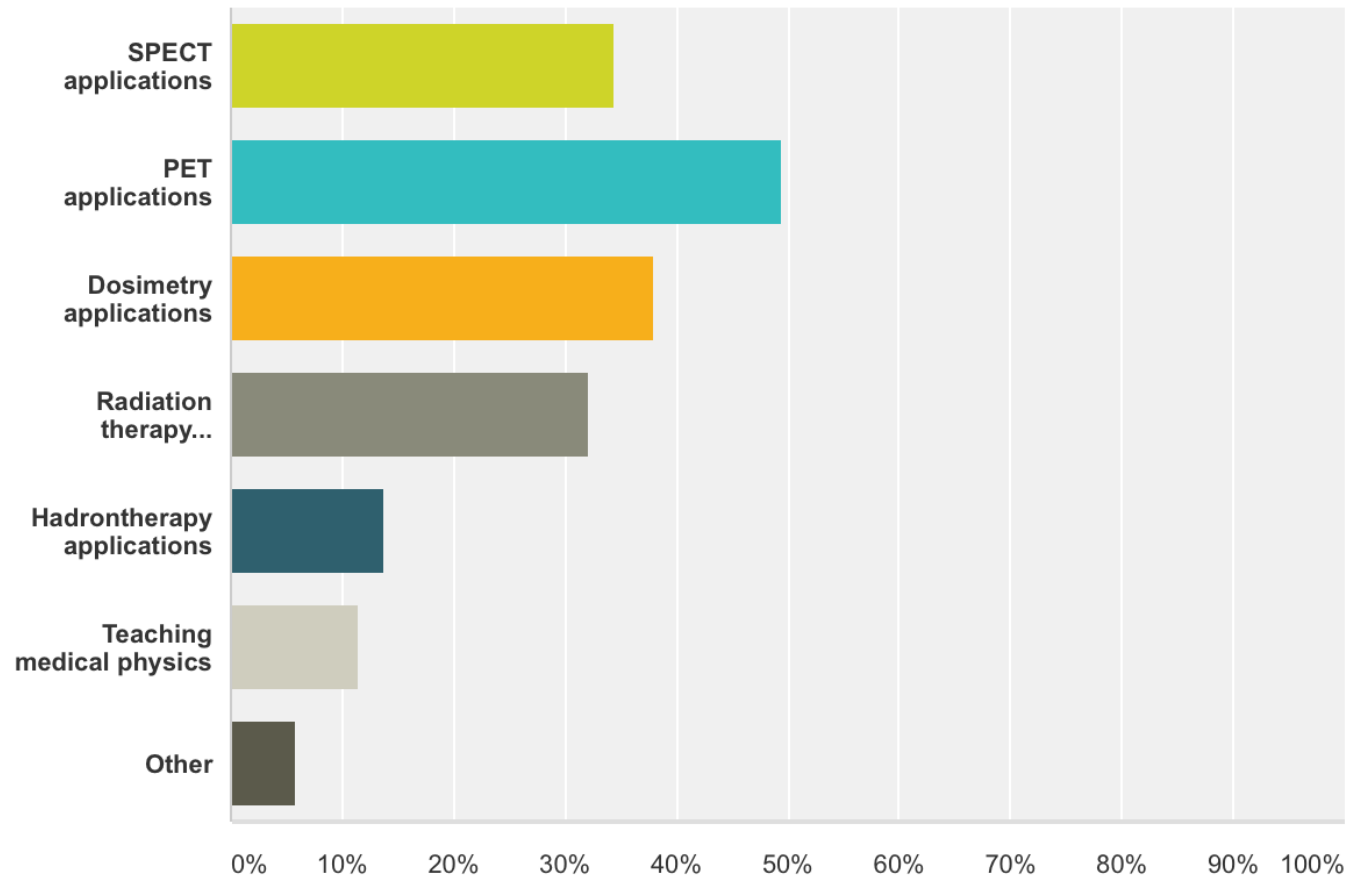


What we learnt from a user survey

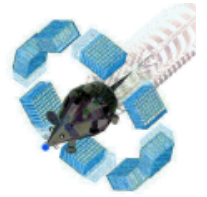


95% of GATE users
7% of GATE developers

Do you use GATE for



What we learnt from a user survey



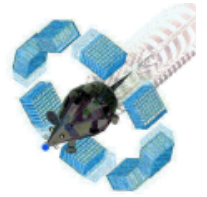
24% of users are taking advantage of the GPU options

First importance priorities for the users are:

- Improved user support (59%): would you prefer a forum or stick with the mailing list?
- Additional GPU modules for Radiation Therapy applications (43%)
- Variance reduction techniques for SPECT (32%)
- Improvement of currently available GPU modules (32%)

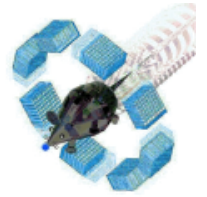
**Please give us your expectations at the end
of the workshop**

Latest news

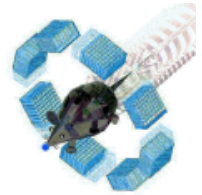


- A new release GATE V8.0 will be available Spring 2017, including:
 - A new PET coincidence sorter of GATE
Strydhorst and Buvat, Phys Med Biol 61: N522-N531, 2016
already available in the Git Hub
 - New “source” to speed-up the ^{90}Y bremsstrahlung photon production – PET imaging applications
Strydhorst et al, Med Phys 43:5320, 2016
already available in the Git Hub
 - Thermotherapy modeling
Cuplov et al, submitted, see presentation
 - A DICOM reader by Dubois et al
- Training material is on line
- List of GATE-related articles produced by the collaboration are listed by topic on the Web site

Later on



- End of 2017
 - Improvement of fixed forced detection for X-ray imaging (CREATIS group in Lyon)
 - New optical module (see Roncali's presentation)
 - Hybrid navigator supporting a combination of voxelized and analytical phantom descriptions (analytical objects can be inserted within a voxelized phantom) (LATIM group in Brest)
 - Additional hybrid options (combining MC and analytical simulations), eg analytical model of the SiPM response (CPPM group in Marseilles and others)



GATE

Simulations of Preclinical and Clinical Scans in Emission Tomography, Transmission Tomography and Radiation Therapy

[Home](#)[Download ▾](#)[Documentation ▾](#)[Collaborative Wiki](#)[Mailing-list](#)[Training ▾](#)[Publications](#)[Meetings](#)[Opportunities](#)[Awards](#)[About GATE ▾](#)

User login

Username *

Password *

[Create new account](#)

[Request new password](#)

[Log in](#)

PMB Citations Prize

Members of the OpenGATE collaboration have won the Physics in Medicine & Biology Citations Prize twice, in 2009 for their paper 'GATE: a simulation toolkit for PET and SPECT' and in 2015 for their paper 'GATE V6: a major enhancement of the GATE simulation platform enabling modelling of CT and radiotherapy'.



Forewords

GATE is an advanced opensource software developed by the international OpenGATE collaboration and dedicated to numerical simulations in medical imaging and radiotherapy. It currently supports simulations of Emission Tomography (Positron Emission Tomography - PET and Single Photon Emission Computed Tomography - SPECT), Computed Tomography (CT), Optical Imaging (Bioluminescence and Fluorescence) and Radiotherapy experiments. Using an easy-to-learn macro mechanism to configure simple or highly sophisticated experimental settings, GATE now plays a key role in the design of new medical imaging devices, in the optimization of acquisition protocols and in the development and assessment of image reconstruction algorithms and correction techniques. It can also be used for dose calculation in radiotherapy experiments.

If you are interested in contributing to GATE, here are a few tips regarding what you can do to be part of this collaborative effort:

● [Reply to the mailing list](#)

● [Contribute to the documentation](#): ask for a [login/password](#) and then modify the [documentation on the wiki](#)

● [Report bugs](#)

GATE project is now publicly available on [GitHub](#). So, any people identified as a GATE contributor on GitHub can create, assign and close an [issue](#)

● [Add/modify the source code or fix bugs](#)

○ Start by copying the GATE public repository from GitHub

`git clone https://github.com/OpenGATE/Gate.git`

○ Create a specific branch on your repository copy and commit your modifications in that branch

○ Create your own copy (fork) of GATE public repository inside your GitHub account so as to be able to push your branch onto this copy

○ Once your code is ok,

1. Create a [pull-request](#) from your Gate repository to the official Gate repository

2. Provide an example that tests your new feature

3. If you implemented a new feature, have the associated documentation ready

4. Inform these three people from the collaboration (S. Jan, D.Sarrut and A. Dubois) who will then get in touch with you to integrate your changes in the official repository.

● Interested in a long term participation? Why not join the collaboration? Read some [documentation](#) about the collaboration and [contact us](#)

Shortcuts



[Subscribe to GATE-users mailing-list](#)



[Request account on GATE collaborative wiki](#)

GitHub

[Access to GATE project on GitHub](#)



SurveyMonkey®

[GATE users survey](#)

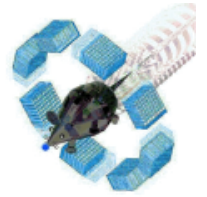


[Download](#)

PMB 60th anniversary collection

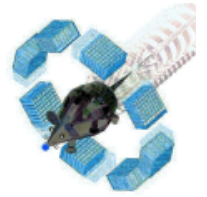
To commemorate 60 years of PMB, the Editorial Board and International Advisory Boards of the journal have selected just 25 of the thousands of

Our supports



Dimitris Visvikis, Suleman Surti, and Tony Lavietaes
... and you !

Program



- 12:15 **Quick introduction to GATE**
Irène Buvat, IMIV, Orsay, France
- 12:30 **Optical modeling of scintillation detectors using GATE**
Emilie Roncali, University of California, Davis
- 12:45 **Modeling of hyperthermia therapy and heat diffusion using GATE**
Vesna Cuplov, IMIV, Orsay, France
- 13:00 **Contributing to GATE developments using the Git Hub**
Albertine Dubois, IMNC, Orsay, France
- 13:15 **Using GATE as an educational tool**
Irène Buvat, IMIV, Orsay, France
- 13:30 **Discussion with users / conclusions**