



UNIVERSITY  
OF WOLLONGONG  
AUSTRALIA

University of Wollongong  
Research Online

---

Faculty of Engineering and Information Sciences -  
Papers: Part A

Faculty of Engineering and Information Sciences

---

2015

# 3D bridge microdosimeter: Charge collection study and application to RBE studies in $^{12}\text{C}$ radiation therapy

Linh T. Tran

*University of Wollongong, tltran@uow.edu.au*

Dale A. Prokopovich

*Australian Nuclear Science and Technology Organisation, dalep@uow.edu.au*

Susanna Guatelli

*University of Wollongong, susanna@uow.edu.au*

Marco Petasecca

*University of Wollongong, marcop@uow.edu.au*

Michael L. F Lerch

*University of Wollongong, mlerch@uow.edu.au*

*See next page for additional authors*

---

## Publication Details

Tran, L. T., Prokopovich, D. A., Guatelli, S., Petasecca, M., Lerch, M. L F., Reinhard, M. I. & Rosenfeld, A. B. (2015). 3D bridge microdosimeter: Charge collection study and application to RBE studies in  $^{12}\text{C}$  radiation therapy. *Journal and Proceedings of the Royal Society of New South Wales*, 148 (455-456), 44-51.

Research Online is the open access institutional repository for the University of Wollongong. For further information contact the UOW Library: [research-pubs@uow.edu.au](mailto:research-pubs@uow.edu.au)

---

# 3D bridge microdosimeter: Charge collection study and application to RBE studies in $^{12}\text{C}$ radiation therapy

## Abstract

Radiotherapy using heavy ion beam such as Carbon-ion has the advantage for the treatment of deep-seated tumour over conventional radiotherapy with X-rays due to an enhanced dose deposition in the Bragg peak (BP) at the end of the ion range. The highest dose can be deposited in the tumour with much lower doses to the surrounding healthy tissue. The Relative Biological Effectiveness (RBE) of a carbon-ion radiotherapy beam greatly depends on a depth of the target volume in the body and the nuclear fragmentation process that increases close to the BP or spread out BP (SOBP) as well as neutrons. It is important to understand the RBE of the heavy ions in hadron therapy applications in order to deliver correct dose. Microdosimetry is extremely useful technique, used for RBE study in unknown mixed radiation fields typical of hadron therapy. Conventional detectors for microdosimetry consist of tissue equivalent proportional counters (TEPC) which have advantages of a spherical sensitive volume and tissue equivalency through use of a tissue equivalent gas. However, TEPC has several limitations such as high voltage operation, large size of assembly, which reduces spatial resolution and introduces wall effects, and an inability to simulate multiple cells. A new silicon microdosimeter with 3D sensitive volumes (SVs) has been proposed to overcome the shortcomings of the conventional TEPC. The new microdosimeter is called "bridge" microdosimeter as it has thin Si bridges between the SVs to support the Al tracks over the SVs. The charge collection study of the new device and its application for RBE determination in  $^{12}\text{C}$  radiation therapy at the Heavy Ion Medical Accelerator in Chiba (HIMAC), Japan is presented. This work presented the first RBE10 derivation in a  $^{12}\text{C}$  ion therapeutic beam using a high spatial resolution silicon microdosimeter and demonstrated a simple and fast method for Quality Assurance in charge particle therapy.

## Keywords

application, rbe, studies, sup, 12, c, collection, radiation, study, therapy, charge, microdosimeter, bridge, 3d

## Disciplines

Engineering | Science and Technology Studies

## Publication Details

Tran, L. T., Prokopovich, D. A., Guatelli, S., Petasecca, M., Lerch, M. L F., Reinhard, M. I. & Rosenfeld, A. B. (2015). 3D bridge microdosimeter: Charge collection study and application to RBE studies in  $^{12}\text{C}$  radiation therapy. *Journal and Proceedings of the Royal Society of New South Wales*, 148 (455-456), 44-51.

## Authors

Linh T. Tran, Dale A. Prokopovich, Susanna Guatelli, Marco Petasecca, Michael L. F. Lerch, Mark I. Reinhard, and Anatoly B. Rosenfeld

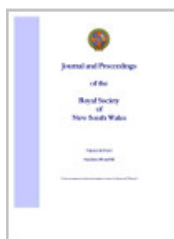


LOGOUT

Simple Search Advanced Search Browse Publications

searching Humanities &amp; Social Sciences Collection CHANGE DATABASES

Search

Limit Search:  This Issue  This Publication  AnywhereCLEAR  
SEARCH[BACK TO TABLE OF  
CONTENTS](#)

Peer Reviewed

Full content available

[More information](#)  
about this publication

## 3D bridge microdosimeter: Charge collection study and application to RBE studies in 12C radiation therapy

**Journal and Proceedings of the Royal Society of New South Wales  
Volume 148 Issue 455/456 (2015)**

**Tran, Linh T<sup>1</sup>; Prokopovich, Dale A<sup>2</sup>; Guatelli, Susanna<sup>3</sup>; Petasecca, Marco<sup>4</sup>; Lerch, Michael LF<sup>5</sup>; Reinhard, Mark I<sup>6</sup>; Rosenfeld, Anatoly B<sup>7</sup>**

**Abstract:** Radiotherapy using heavy ion beam such as Carbon-ion has the advantage for the treatment of deep-seated tumour over conventional radiotherapy with X-rays due to an enhanced dose deposition in the Bragg peak (BP) at the end of the ion range. The highest dose can be deposited in the tumour with much lower doses to the surrounding healthy tissue. The Relative Biological Effectiveness (RBE) of a carbon-ion radiotherapy beam greatly depends on a depth of the target volume in the body and the nuclear fragmentation process that increases close to the BP or spread out BP (SOBP) as well as neutrons. It is important to understand the RBE of the heavy ions in hadron therapy applications in order to deliver correct dose.

Microdosimetry is extremely useful technique, used for RBE study in unknown mixed radiation fields typical of hadron therapy. Conventional detectors for microdosimetry consist of tissue equivalent proportional counters (TEPC) which have advantages of a spherical sensitive volume and tissue equivalency through use of a tissue equivalent gas. However, TEPC has several limitations such as high voltage operation, large size of assembly, which reduces spatial resolution and introduces wall effects, and an inability to simulate multiple cells.

A new silicon microdosimeter with 3D sensitive volumes (SVs) has been proposed to overcome the shortcomings of the conventional TEPC. The new microdosimeter is called "bridge" microdosimeter as it has thin Si bridges between the SVs to support the AI tracks over the SVs. The charge collection study of the new device and its application for RBE determination in 12C radiation therapy at the Heavy Ion Medical Accelerator in Chiba (HIMAC), Japan is presented.

This work presented the first RBE10 derivation in a 12C ion therapeutic beam using a high spatial resolution silicon microdosimeter and demonstrated a simple and fast method for Quality Assurance in charge particle therapy.

FULL TEXT PDF (474KB)

**To cite this article:** Tran, Linh T; Prokopovich, Dale A; Guatelli, Susanna; Petasecca, Marco; Lerch, Michael LF; Reinhard, Mark I and Rosenfeld, Anatoly B. 3D bridge microdosimeter: Charge collection study and application to RBE studies in 12C radiation therapy [online]. Journal and Proceedings of the Royal Society of New South Wales, Vol. 148, No. 455/456, 2015: 44-51. Availability: <http://search.informit.com.au.ezproxy.uow.edu.au/documentSummary;dn=287417712073466>; ISSN: 0035-9173. [cited 31 Aug 15].

**Personal Author:**

**Tran, Linh T; Prokopovich, Dale A; Guatelli, Susanna; Petasecca, Marco; Lerch, Michael LF; Reinhard, Mark I; Rosenfeld, Anatoly B;**

**Source:**

Journal and Proceedings of the Royal Society of New South Wales, Vol. 148, No. 455/456, 2015: 44-51

**Document Type:**

Journal Article

**ISSN:**

0035-9173

**Subject:**

**Radiotherapy; Cancer--Chemotherapy; Relative biological effectiveness (Radiobiology); Microdosimetry--Mathematical models;**

**Peer Reviewed:**

Yes

**Affiliation:**

- (1) Centre for Medical Radiation Physics, School of Physics, University of Wollongong, NSW 2522, Australia, email: [titran@uow.edu.au](mailto:titran@uow.edu.au)
- (2) Australian Nuclear Science and Technology Organisation, Lucas Heights, NSW 2234, Australia
- (3) Centre for Medical Radiation Physics, School of Physics, University of Wollongong, NSW 2522, Australia
- (4) Centre for Medical Radiation Physics, School of Physics, University of Wollongong, NSW 2522, Australia
- (5) Centre for Medical Radiation Physics, School of Physics, University of Wollongong, NSW 2522, Australia
- (6) Australian Nuclear Science and Technology Organisation, Lucas Heights, NSW 2234, Australia
- (7) Centre for Medical Radiation Physics, School of Physics, University of Wollongong, NSW 2522, Australia

Database: HUMANITIES & SOCIAL SCIENCES COLLECTION