IRISH RADIATION RESEARCH SOCIETY

2017 Scientific Meeting

10th - 11th November

Wexford, Ireland

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Irish Radiation Research Society Annual Scientific Meeting
November 10-11, 2017
Environmental Protection Agency, Wexford
Programme

Friday November 10th	
12.30 – 13.30	Registration and lunch

Friday November 10th Radiation Protection Research	
13.30 – 13.45	Stephen Fennell (Programme Manager of Office of Radiation Protection and Environmental Monitoring, EPA) **Opening Address**
13.45 – 14.30	Keynote Addresses: Dr. Brenda Howard (MBE) **Comparison of remediation after the Chernobyl and Fukushima Daiichi accidents**
14.30 – 15.00	Break and Poster Viewing
15.00 – 15.20	Alison Dowdall (EPA) **Research to Support Ireland National Radon Control Strategy**
15.20 – 15.35	Josh Walsh (DIT Kevin Street) **Assessment of Safecast bGeigie Nano Monitor**
15.35– 15.50.	Kevin Kelleher (EPA) **Updating and Improving K_d datasets for marine systems**
15.50– 16.05	Una O'Connor (St James Hospital) **Radiation Protection Research in Europe via EU Joint Programme (CONCERT):Towards Development of online dosimetry using computational methods (PODIUM)**
16.05 – 16.20	Leo McGuinness (Perkin Elmer) **Case Studies of Radiometric Detection Instruments**
19.00 – 21.00	Dinner, The Yard Restaurant Wexford

Saturday November 11th Translational potential of Radiation cellular damage assessment	
10.00 – 10.20	Hugo Moreira (QUB) **A Radium-223 Monte-Carlo computational model for bone metastatic disease treatment**
10.20 – 10.40	Stephen McMahon (QUB) **Temporal modelling of DNA damage repair and implications for non-targeted effects**
10.40 – 11.10	Break and Poster Viewing
11.10– 11.30	Francisco Guerra Liberal (QUB) **Monte Carlo Evaluation at a sub-cellular scale of Targeted α-particle Therapy**
11.30– 11.50	Heinz Peter Nasheuer (NUIG) **UV-mediated DNA damage compromizes cell cycle-dependent formation of Cdc45-Claspin complexes in human cells.**
11:50– 12:00	Close of IRRS Scientific Meeting
12.00– 12.30	IRRS Annual Meeting (Agenda included in Booklet)
12.30– 13.30	Lunch

Friday November 10th Radiation Protection Research

Professor Brenda Howard MBE

Centre for Ecology & Hydrology
and University of Nottingham

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Brenda Howard is a radioecologist studying environmental radioactivity. She is currently a member of the Committee on Medical Aspects of Radiation in the Environment (COMARE). She has chaired Working groups on modelling and transfer of radionuclides to wildlife under the IAEA EMRAS I and II programmes. She is currently chairing WG 4 of the IAEA MODARIA II (Modelling and Data for Radiological Impact Assessments) programme. WG 4 focuses on addressing Analysis of radioecological data in IAEA TRS publications to identify key radionuclides and associated parameter values for human and wildlife exposure assessment. She was awarded an MBE by Queen Elizabeth for her radioecological work in 2002.

Her career spanning thirty six years as a radioecologist at CEH has focused on understanding factors affecting radionuclide behaviour in the terrestrial environment, radiation protection of the environment and the development and application of countermeasures and remediation strategies. After the Chernobyl accident, she co-ordinated seven EU framework projects, including STRATEGY which produced the first information datasheets for remediation after nuclear accidents. Brenda has currently published more than 150 refereed papers and 20 books. The latter include special issues of journals and contributions to various IAEA documents, notably the chapters on transfer to domestic animals in both TRS 364 and 472 and the environment section of Chernobyl forum report. She recently led the preparation of a TRS on transfer to wildlife, and co-edited TRS 475 on remediation. After the Fukushima Daiichi accident, she assisted response efforts related to contamination of livestock, was technical editor for the off site remediation aspects and is a member of the UNSCEAR FFUP expert group reviewing Fukushima information.

Research to support Ireland's National Radon Control Strategy

Dowdall A.[1,*], Long S.[1] and Fenton D[1]

[1] Office of Radiation Protection and Environmental Monitoring, EPA, Dublin

**Presenter, Scientific Officer, EPA*

Radon is a significant public health hazard in Ireland, accounting for almost 250 lung cancer cases each year (approximately 13% of all lung cancers). Despite much work to tackle this problem since the 1990s, the Government recognised that a national strategy was needed to reduce the risk from radon to people living in Ireland. In 2014, the National Radon Control Strategy (NRCS) was published setting out a broad range of measures aimed at improving radon prevention in new buildings, including radon in property transactions, raising awareness and encouraging action on radon, communication of advice and guidance of radon risks to householders and employers, promoting confidence in radon services in Ireland and addressing radon in workplaces and public buildings.

To support effective delivery of the NRCS, knowledge gaps and areas that required further targeted research were identified. To date, significant progress has been made towards addressing these knowledge gaps and research needs.

A review of radon awareness campaigns from a health psychology perspective has been completed. Work to refine Ireland's radon risk map is underway. Development of seasonal correction factors for workplaces has begun. Studies to determine the optimal radon preventive and remediation techniques and to determine the impact of energy efficient buildings on radon concentrations are currently being carried out.

To measure the effectiveness of the NRCS overtime, a number of key metrics were identified that could be monitored periodically. Surveys to establish baseline metrics for the rate of remediation in Ireland, the geographic national average indoor radon concentration and the population weighted average concentration have been completed.

Assessment of Safecast bGeigie Nano Monitor

Walsh J.[1,*], Kelleher K.[2], Currivan L.[2]

[1] School of Physics, DIT, Kevin Street, Dublin 8.

[2] Environmental Protection Agency, Dublin Campus, Richview, Dublin 14

**Presenter, Graduate student*

The bGeigie Monitor is a radiation sensor developed by the team at Safecast as an affordable and easy to use mobile radiation monitoring device for public use as part of its citizen science project. The bGeigie Monitor is said to measure alpha, beta and gamma radiation accurately to within a 15% uncertainty, as well as the ability for this measured data to be uploaded to a Safecast API website. The objective of this study was to evaluate the bGeigie Monitor's accuracy and reliability in both measuring and recording radiation from alpha, beta and gamma sources.

It was found that the bGeigie Monitor is very accurate in the range of 5-500μSv/hr. Above this dose rate the accuracy of the measurements are not as reliable. The monitor is capable of detecting alpha, beta and gamma radiation. During the assessment of the monitor it was found that it could take up to a minute for the measured dose rate exposed to a source to stabilise. In conclusion, the bGeigie Monitor is fit for the purpose as an easily assembled radiation sensor so the public can accurately measure the levels of radioactive dose in their area and share this monitoring data through the internet.

UPDATING AND IMPROVING K_d DATASETS FOR MARINE SYSTEMS

Bildstein O.[1], Boyer P.[2], Howard B.[3], Kaplan D.[4], Kelleher K.[5*], Kuusito J.[6], Lahdenperä A-M.[7], Vetrov V.[8], Vidal M.[9]

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[6] Posiva Oy, FINLAND

[7] Saanio & Riekkola Oy, FINLAND.

[8] Institute of Global Climate & Ecology, RUSSIAN FEDERATION

[9] Universitat de Barcelona, SPAIN

**Presenter*

The solid-liquid distribution coefficient (K_d) is often used to describe how radionuclides interact with solids and water in ecosystems. The fate of radionuclides in the marine environment are of concern to the public and to workers in the marine environment. The ability of suspended and bed sediment to bind and retain radionuclides, thereby reducing their activity concentrations in seawater and marine organisms, is a key environmental process that needs to be understood and quantified.

In 2004, the International Atomic Energy Agency (IAEA) published revised K_d values for sediment in the marine environment. However, since this publication there has been additional studies on marine K_d values which have identified factors which may affect marine K_d values and which were not addressed at that time, these include sediment grain size, mineralogical properties, salinity and turbidity.

The IAEA's Modelling and Data for Radiological Impact Assessments II (MODARIA II) Programme has undertaken the task of revising and updating the marine K_d values for water sediment interactions to better estimate these values taking into consideration the above-mentioned factors. This will result in an improved understanding of the processes influencing soil sediment interactions in the marine environment and further improve radiological impact modelling for both routine and accidental discharge scenarios.

In addition, this work will also develop a global K_d database for soil, freshwater and marine systems for use in radiological assessment models.

RADIATION PROTECTION RESEARCH IN EUROPE VIA EU JOINT PROGRAMME (CONCERT): TOWARDS DEVELOPMENT OF PERSONAL ONLINE DOSIMETRY USING COMPUTATIONAL METHODS (PODIUM)

O'Connor U.[1,*]

[1] Department of Medical Physics & Bioengineering, St. James's Hospital Dublin

**Presenter, Senior Physicist*

In early 2017, the European Joint Programme CONCERT announced a transnational call for proposals for Radiation Protection Research in Europe. One of the key topics of this call was to strengthen understanding of human health effects from ionising radiation, including improving occupational dosimetry. As such, a consortium of partners from across Europe, including St. James's Hospital, submitted a proposal to develop an online dosimetry system for radiation workers (project acronym PODIUM).

Individual monitoring of workers exposed to external ionizing radiation is required for compliance with legal dose limits. However, large uncertainties still exist in personal dosimetry, especially for neutrons and for inhomogeneous fields. The objective of this project is to improve occupational dosimetry by an innovative approach: the development of an online dosimetry application based on computer simulations without the use of physical dosemeters. Dose quantities will be assessed based on the use of modern technology such as personal tracking devices, flexible individualized phantoms and scanning of workplace geometry. When combined with fast simulation codes, input from fixed radiation monitors and real movements of exposed workers, the aim is to perform personal dosimetry in real-time.

This proposal was accepted for funding by CONCERT in August 2017 and is a 2-year project due for completion in February 2020 (under Horizon 2020). It is an ambitious scientific project and prior to beginning the scientific work, there have been practical challenges accessing the CONCERT funding. A co-funding agreement with a national Program-Owner / Program-Manager (POM) must be in place to participate in CONCERT and the establishment of an Irish POM is on-going at this time. This presentation will give an overview of our experience of the route to EU co-funding, in addition to presenting the type of leading-edge radiation research taking place in hospitals and overall goals of the PODIUM project.

Case Studies of Radiometric Detection Instruments

Mc Guinness L.[1]

[1] Perkin Elmer

**Presenter, Senior Physicist*

A selection of examples of PerkinElmer Radiometric Detection Instruments in use for environmental, research, industrial, and medical fields.

A Radium-223 Monte-Carlo computational model for bone metastatic disease treatment

Moreira H.[1, 2*], Liberal F.[1, 2], McMahon S. J.[1], Prise K.[1]

[1] Centre for Cancer Research and Cell Biology, Queen's University Belfast

[2] Nova University of Lisbon

**Presenter, PhD student*

Alpha particle emitting radionuclides have recently been shown to deliver significant improvements in the care of cancer patients, exemplified by the bone seeking α-emitter radium-223 (^{223}Ra). In clinical trials it was shown to have not only a palliative effect, but also a survival benefit in metastatic castration resistant prostate cancer patients. This has encouraged the use of ^{223}Ra in novel patient treatment trials, one of which is being held in Belfast (ADRRAD). However, despite this effectiveness of $^{223}RaCl_2$ among patients with symptomatic bone metastatic disease, its mechanisms of action are still a major subject of discussion. Computational models add a new perspective to the topic as they can quantitatively investigate the interaction of α-particles with a target in an event-by-event particle tracking basis. There is a pressing need to quantify α-particles effects in pre-clinical and clinical models in order to optimize the next generation of trials using ^{223}Ra.

With that in mind, we have designed a computational model that describes the dynamics of a bone metastasis under $^{223}RaCl_2$ treatment. The model is based on clinical data including injected treatment activity and tissue accumulated doses. We have modelled the radiation effect of ^{223}Ra in a metastatic tumour growth in bone combining Monte-Carlo simulations for dosimetry and Gompertz-based growth models. This model predicts the outcomes of ^{223}Ra treatments at different growth stages of a bone metastasis, allowing the investigation of different assumptions about $^{223}RaCl_2$ treatment. These predictions can be comparable to the current clinical data to improve our understanding of ^{223}Ra activity, allowing for better treatment optimizations for future patients.

Temporal modelling of DNA damage repair and implications for non-targeted effects

McMahon S. J.[1,*], Prise K. M. [1]

[1] Centre for Cancer Research & Cell Biology, Queen's University Belfast

**Presenter*

Background

Non-targeted effects of radiotherapy are associated with elevated levels of DNA damage and genetic stress, and reductions in survival in un-irradiated cells which are cultured with cells exposed to ionising radiation. We have expanded a recently published model of DNA repair to incorporate dose-rate effects, and used it to evaluate whether the reductions in cellular survival can be explained by the increase in background DNA levels.

Materials and Methods

The model used (McMahon et al, Scientific Reports 2016) simulates the repair of DNA damage by modelling the interaction of free double strand break (DSB) ends within the cell nucleus, tracking their misrepair probability as a function of DSB density and type. This model has been expanded to incorporate the production of additional DSBs during prolonged exposures.

To test the model's predictions for non-targeted effects, elevated background DNA damage was modelled as a chronic low dose-rate exposure, and survival calculated for a range of damage rates which was compared to experimental results.

Results

The model accurately reproduces the impact of low direct irradiation dose-rates on cell survival for both repair competent and deficient cells in a range of conditions Gy/hr (R^2=0.88, compared to 0.45 for models without dose rate).

Modelling of non-targeted effects suggests that even using conservative assumptions the observed level of cell death reported experimentally in bystander cells would require significantly higher levels of background DNA damage than reported (e.g. of >10 persistent foci in AG0-1522 cells compared to 3.2 observed).

Conclusions

This work validates a recently published model of DSB repair for protracted radiation exposures. In addition, it indicates that out-of-field effects cannot be explained solely through elevated production of simple DSBs in bystander cells, suggesting the involvement of either more complex damage with high probability of lethality or other signalling-driven death pathways independent of DNA damage.

Monte Carlo Evaluation at a sub-cellular scale of Targeted α-particle Therapy

Liberal F.G.[1,2,*], Moreira H.[1,2], McMahon S.J.[2] and Prise K.M.[2]

[1] Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa

[2] Centre for Cancer Research and Cell Biology, Queen's University Belfast

**Presenter, Graduate student*

Radionuclides have been increasingly used in cancer treatment, with varying degrees of success. α-particles are of particular interest for the treatment of micrometastases. However, the stochastic nature of α-particles poses some challenges for dosimetric studies.

The TOPAS modelling tool was used to simulate the effects of ^{211}At. The deposited dose and number of particle hits were calculated for three different cell models; one spherical model with a central nucleus, other with the nucleus located at the periphery to evaluate the effects of the nucleus eccentricity and lastly an in vitro model of a hemispherical ellipsoid, Fig 1. Cross-fire dose to un-labelled cells was also evaluated as a function of the separation between cells. Lastly, we explored the relationship between the energy deposited in the target and that in nearby marrow for bone targeting.

For nucleus eccentricity, the model shows an increased dose to the nucleus for the eccentric model when the activity is on the membrane or at the medium. This effect deceases when the activity is distributed in the cytoplasm. Interestingly, a similar trend is observed for the comparison between the in-vitro model and concentric model. For cross-fire effects, the dose decreases with distance and for distances equal or greater than 5 μm the sub-cellular localization of the activity in the source cell does not influence the cross-fire dose. Finally, the limited range of the energy deposited is clearly shown in the bone model as significant fractions of adjacent normal marrow components see no α-particle radiation.

As the clinical implementation of α-particles emitters is increasing, this type of study may be useful in interpreting clinical results. Due to its production cost and the capability to produce a stable radiopharmaceutical in addition to our simulations, ^{211}At is an optimal candidate for the application of targeted α therapy.

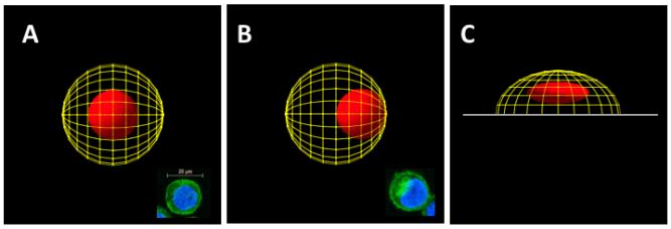

Figure 1: Spherical geometric models generated with TOPAS: (A) Concentric and (B) Eccentric cells (Cell represented in yellow, R_C = 10 μm, nucleus represented in red R_N = 5 μm) (C) *in vitro* attached ellipsoidal cell (Cell represented in yellow, a_C = 10 μm, b_C = 14.142 μm, c_C = 14.142 μm; nucleus represented in red a_N = 2.5 μm, b_N = 7,07 μm, c_N = 7,07 μm).

UV-mediated DNA damage compromizes cell cycle-dependent formation of Cdc45-Claspin complexes in human cells.

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**Presenter*

The replication factor Cdc45 has essential functions in the initiation and elongation steps of eukaryotic DNA replication and plays an important role in the intra-S-phase checkpoint. Its interactions with other replication proteins during the cell cycle and after intra-S-phase checkpoint activation are only partially characterized. Here, we present that the C terminal part of Cdc45 may mediate its interactions with Claspin. The interactions of human Cdc45 with the three replication factors Claspin, replication protein A (RPA) and DNA polymerase δ are maximal during S phase. Following UVC-induced DNA damage, Cdc45-Claspin complex formation is reduced whereas the binding of Cdc45 to RPA is not affected. We also show that treatment of cells with UCN-01, as well as PIKK inhibitors does not rescue the UV-induced destabilisation of Cdc45-Claspin interactions, suggesting that the loss of interaction between Cdc45 and Claspin occurs upstream of ATR activation in the intra-S-phase checkpoint.

Keywords: DNA damage response, intra-S-phase checkpoint, DNA replication, Cdc45, Claspin, Replication Protein A.

Radiochemical analysis of Alpha and Beta Emitters in Irish Drinking Water – Method Validation

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[1]Environmental Protection Agency, Clonskeagh, Dublin 14

**Presenter, Scientific Officer in the EPA*

Radioactivity is present in all waters; the source of this radioactivity can be from natural or man-made sources, natural radioactivity being the leading source which arises from radioactive particles in the earth's crust.

One potential pathway of radioactive substances absorbing into the human body is through ingestion of water, contributing to the overall radioactive dose members of the public receive from ionising radiation. To protect the population and ensuring the risk associated with radioactivity in water is kept as low as reasonably achievable, legislation needs to be introduced to outline what criteria must be met for monitoring and analysing radioactivity in water.

Therefore, the European Council has set out a Directive, 2013/51/EURATOM (EDWD), which has laid down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption. This has been transposed into Irish Law (S.I. 160 of 2016), creating the national surveillance programme for radioactivity in drinking water.

The focus of this work will be on developing methods for the monitoring of water intended for human consumption for Indicative dose (ID) by analysis of samples for natural radionuclide levels. Artificial radioactivity is not of concern in Ireland as there are no known discharges of artificial radioactivity in water catchments in Ireland.

In summary, the surveillance programme involves an initial screening for gross alpha beta activity to determine whether the activities are below levels at which no further action is required. If these values are exceeded, investigation of the concentrations of individual radionuclides is carried out.

The analysis will be carried out in the radiation monitoring section in EPA Ireland, however new methods must be developed and validated to satisfy the EDWD. The following requirements are:

- Rapid analysis, for short turnaround time of results
- Detection Limits are below the legislative requirements.
- Accredited to ISO standards as the laboratory is accredited to ISO 17025

In this work, methods for the screening of gross alpha beta and the analysis of $^{226/228}$Ra and ^{210}Po/^{210}Pb will be described and the results of the work will be displayed.

The Rapid Determination of ^{226}Ra and ^{228}Ra in Drinking Water by Liquid Scintillation Counting – Method Validation

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[1] Environmental Protection Agency, Office of Radiation Protection and Environmental Monitoring, Ireland

* *Presenter, Environmental Chemist in the EPA*

The European Council introduced legislation which laid down the requirements for the protection of health regarding radioactive substances in drinking water. This was transposed into Irish Law as S.I 160 of 2016, European Union (Radioactive Substances in Drinking Water) Regulations 2016. This requires the development of methods to monitor drinking water for naturally occurring radionuclides in Ireland.

Radium is a radioactive element that exists in nature as four known isotopes, all of which are unstable. These isotopes are important as they can easily be absorbed into bones due to having similar properties to other elements from Group II (i.e. calcium) and producing short lived radionuclides of high massic activity.

Radioisotopes ^{226}Ra and ^{228}Ra are significant from a radiological point of view, with relatively long half-lives of 1600 y and 5.75 y respectively. They are formed from ^{238}U and ^{232}Th decay series. ^{226}Ra is an alpha emitter while ^{228}Ra is a pure beta emitter, with the beta energy being very low, making it difficult to measure.

Radium is only present in the environment in trace amounts and cannot be precipitated alone, therefore requiring the addition of a barium carrier prior to separation. Barium co-precipitation is used as a separation method to separate radium from other radionuclides due to their similar chemical properties. The source preparation is achieved by suspending the barium sulphate precipitate in EDTA solution which increases solubility due to complexation of barium and speciation effect.

The work performed describes the process of validating the method ‘A Procedure for the Rapid Determination of ^{226}Ra and ^{228}Ra in Drinking Dater by Liquid Scintillation Counting’ published by the IAEA/AQ/39 in 2014 to meet the following criteria:

- Establish a rapid determination of radium in drinking water.
- Detection limits to meet legislation requirements.
- Accredit the method to ISO 17025 standard.

Efficiency Calibration including True Coincidence Summing Corrections of HPGe Detectors and Analysis of Marine Samples

Orlaith Hamm[1], Claire Keary[1,*], Olwyn Hanley[2] and Máirín O'Colmáin[2]

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[2] Radiation Monitoring Laboratory, Office of Radiological Protection and Environmental Monitoring, Environmental Protection Agency, Dublin.

**Presenter*

Efficiency calibrations were performed for two HPGe detectors using Ortec's GammaVision analysis software; two sample geometries were used, a 250ml tub and a 500ml marinelli beaker. True coincidence summing corrections were applied to the efficiency calibrations for both geometries, and for both detectors, using the EFFTRAN software package.

A number of standard reference materials, supplied by the Environmental Protection Agency's (EPA) Office of Radiological Protection and Environmental Monitoring (ORM), were analysed and interlaboratory comparisons were carried out with measurements produced by the ORM. The ORM use Canberra's Apex Gamma software and Gespecor for true coincidence summing corrections. A number of marine samples were analysed and activities were reported for a number of gamma-emitting radionuclides of interest to the EPA's marine monitoring programme. Interlaboratory comparisons demonstrate the compatibility of WIT's measurements with those produced by the ORM.

Development of Radiation Research Capacity in Ireland

Currivan L. [1,*] and Fennell S.[1]

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**Presenter, Senior Scientific Officer in the EPA*

Ireland's Environmental Protection Agency, EPA, is the national competent authority for the protection of workers, members of the public and the environment against the hazards associate with ionising radiation and has a role in maintaining, growing and building national capacity in radiation science. Evidence indicates that the current capacity nationally in terms of the availability of skilled radiation scientists is insufficient to meet future staffing requirements for EPA in this field. It is acknowledged that a programme to build radiation research in Ireland is a strategic priority for the EPA in its 2016 – 2020 Strategic Plan under the heading "Implement the EPA Research Strategy and leverage national co-funding and EU funding opportunities to help build environmental and radiological protection research capacity in Ireland and improve the dissemination of research outputs". This paper presents a vision and approach towards reinvigoration of radiation research in Ireland to attract the next generation into this field of science.

Optimisation and Application of Monte Carlo Models for self-attenuation corrections in HPGe Gamma Spectrometry

Murphy N.[1,*], Leon Vintro L.[1], Burbidge C. [2] and Currivan L. [2]

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[2)] Office of Radiation Protection and Environmental Monitoring, Environmental Protection Agency, Ireland

**PhD Student of University College Dublin*

The Office of Radiation Protection and Environmental Monitoring (ORM) routinely monitors both natural and artificial radionuclides in a range of samples with high purity germanium (HPGe) detectors. The accurate determination of activity in these samples cannot be achieved without considering the effects of self-attenuation. In this study, we present the implementation of self-attenuation corrections procedures using the GESPECOR software, which is used to compute accurate correction factors by Monte Carlo (MC) simulation. The detector model used to perform the MC calculations has been optimised via an automated program developed in Python that interacts with GESPECOR to establish a set of optimum realistic detector parameters, some of which have been confirmed by CT and X-ray imaging. Three alternative methods have been compared for the determination of the linear attenuation correction factors, which are required as an input for the Monte Carlo calculations. The results obtained highlight the importance of performing self attenuation corrections, particularly at very low photon energies. Linear attenuation coefficients obtained experimentally using transmission measurements for samples of known composition have been found to be in good agreement with those predicted from elemental linear attenuation tables, and confirms the validity of using transmission measurements for the determination of linear attenuation coefficients for environmental samples of unknown composition.

Monitoring radiotherapeutic response in prostate cancer patients using infrared and Raman spectral analysis of blood plasma.

Dinesh K.R.Medipally [1, 2, *], Adrian Maguire [1,2], Ganesh D Sockalingum [3], Valerie Untereiner [4], Jane Byrant [2], John Armstrong [5],Fiona M Lyng [1,2] and Aidan D Meade [1,2].

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Individual patient radiosensitivity is strongly linked to treatment outcome in radiotherapy. There is an unmet clinical need for predictive tests of radiosensitivity and treatment outcome because of a move towards individualised tailoring of treatment for patients. Vibrational spectroscopy is a powerful non-invasive tool that can provide a unique profile of the biochemical content of biological specimens in a label free, non-destructive manner. This study aims to develop methodologies based on Fourier transform infrared (FTIR) and Raman spectroscopy for predicting both patient radiosensitivity and treatment outcome. In the present study, blood samples were acquired prospectively from prostate cancer patients prior to hormonal treatment, prior to radiotherapy, at completion of radiotherapy, 2 months post radiotherapy and 8 months post radiotherapy. Plasma was separated from the whole blood by centrifugation. Infrared and Raman spectra were recorded from the pre and post radiotherapy plasma samples using high throughput (HT)-FTIR and an in house developed HT-Raman spectroscopy method. The spectra were pre-processed and analysed by principal component and linear discriminant analysis. Statistically significant differences were observed between infrared and Raman spectra of pre and post radiotherapy plasma samples and classification could be achieved with high sensitivity and specificity. This study shows the potential of FTIR and Raman spectroscopy as non-invasive tools for monitoring treatment response in prostate cancer patients using blood plasma.

Raman spectroscopy for identification of prostate cancer patients at risk of late radiation toxicity following radiotherapy

Cullen D.*[1,2], Maguire A.[1,2], Bryant J.[1,2], Medipally D.K.[1,2], Armstrong J.[3], Dunne M.[3], Meade A[1,2], Howe O[1,4] and Lyng F.M.[1,2]

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[4] School of Biological Sciences, DIT, Kevin Street, Dublin, Ireland

**Presenter, PhD student*

The success of radiation therapy in tumour control depends on the total dose given but the tolerance of the normal tissues surrounding the tumour limits this dose. It is not known why some patients develop radiation toxicity, and currently, it is impossible to predict before treatment which patients will experience adverse effects as a result of radiotherapy. An assay to predict risk of radiation toxicity would guide the selection of treatment modality to reduce this risk in high risk patients or allow dose escalation in low risk patients to improve tumour control. Individualised cancer treatment would improve quality of life by minimising late radiation toxicity in high risk patients and by improving treatment response in low risk patients. This study aimed to evaluate Raman spectroscopy for identification of cancer patients at risk of late radiation toxicity following radiotherapy. Twenty five prostate cancer patients enrolled on a radiotherapy trial who showed severe late toxicity in follow up and a matched set of seventeen patients who showed no/minimal toxicity in follow up were identified. Blood samples were acquired, cultured and irradiated *in vitro*. In parallel, DNA damage was assessed post-irradiation using the γH2AX assay and G2 chromosomal radiosensitivity assay. Raman spectra were acquired from lymphocytes. Significant differences in spectroscopic profiles were observed between the patient groups.

This event has been supported by the Environmental Protection Agency

EPA-funded environmental research provides essential scientific support for environmental policy development, implementation and broader decision making in Ireland.

EPA Research is built around 3 pillars - Climate, Water and Sustainability

- and the following aims:

Identifying pressures: Providing assessments of current environmental status and future trends to identify pressures on our environment .

Informing policy: Generating evidence, reviewing practices and building models to inform policy development and implementation.

Developing solutions: Generating new approaches and using novel technologies and methods to address environmental challenges, and enabling green economic opportunities.

EPA Research Strategy 2014-2020:

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IRRS AGM Agenda

Irish Radiation Research Society

Meeting Agenda

November 11, 2017

Type of Meeting: **AGM**

Meeting Facilitator: Lorraine Currivan

Apologies: Jonathon Coulter, Laure Marignol, Aidan Meade, Tracy Robson

I. Minutes of AGM 2016

II. Update by Chair

III. Treasurers Report

IV. IRRS website

V. IRRS annual meeting 2018

VI. AOB

Previous IRRS AGM Minutes

Irish Radiation Research Society

AGM

Sat 12th Sept 2016 @13:00-13:10,

Durkan Lecture theatre, Trinity Centre for Health Sciences, St James's Hospital, Trinity College Dublin

MINUTES

1. Apologies – Kevin Prise, Fred Currell
2. Minutes of previous meeting –no minutes taken
3. Chair's communications –

Aidan started by expressing, on behalf of the IRRS, his great sympathies to Bill Morgan's and Wil van der Putten's families, colleagues and friends for the tragic loss of these two eminent radiation researchers.

   a. IRRS 2016
      i. Delegate numbers and IRRS Membership – 56 delegates and we have 62 paid up members
      ii. Sponsorship – thanked all sponsors – can't recall who they were, but received 3200 euros in sponsorship for the meeting
   b. Committee membership – Aidan thanked Fiona Lyng for longstanding commitment to IRRS as she stepped down as past Chair; thanked Lorraine Currivan for taking on role of Chair, with Suneil Jain to take over as Vice Chair. Thanked Laure Marignol for agreeing to take on role as Secretary. New committee members include Stephen Mahon and Niamh Lynam-Lennon.
   c. Links with IRPA and IAMP – in 2015 jointly hosted IRRS/IAPM meeting, 100 attended and has reinvigorated relationship between two societies. Also Fiona Lyng (DIT) and Mark Foley (NUIG) appointed to EPA advisory committee which should strengthen links there.
   d.

4. Treasurer reports – ROI / NI
   a. Paypal membership subscriptions – working well
   b. First Trust Bank account (North) – balance £1000
   c. South – balance 800 euros
   d.
5. IRRS website – this is currently being maintained by Aidan Meade but Niall Murphy agreed to take on role. We discussed setting up a Twitter account and new Secretary to email members to remember to post new papers on twitter page.
6. Next Irish Radiation Research Society meeting 2017 – Lorraine Currivan kindly volunteered to host next meeting at the EPA Wexford. The IRRS should think about a joint meeting with ARR in 2018 as QUB Belfast (Jonny Coulter) will be hosting this meeting.
7. A. O. B – moving forwards, forge relationships with IAPM, Cancer trials Ireland/ICORG
8. Date of next meeting

Final Version accepted 5th October 07

Revised 2017

IRISH RADIATION RESEARCH SOCIETY

DRAFT CONSTITUTION

1. Name of the Institution (hereinafter called "the Society") is "The Irish Radiation Research Society".

2. The Society shall be a voluntary non-profit making body of persons associated for the purposed described below.

3. The objectives for which the Society is established are charitable.

(i) To promote and advance learning and education in the field of radiation protection and radiation research to encompass both ionising and non-ionising radiation.

(ii) To extend, increase and disseminate knowledge of radiation research in the fields of biology, chemistry, physics, medicine and other related disciplines.

(iii) To provide a means whereby those engaged in radiation protection activities on the island of Ireland may communicate more readily with each other and through this process advance radiation protection throughout the Island.

(iv) To affiliate or join in activity with any other charitable body, institution or society whose interests and objects are similar, ancillary or considered to be helpful to the objects of the Society.

(v) To receive and apply donations, subscriptions and funds from persons and organisations designed to promote the objectives aforesaid, or any of them, and to hold funds in trust for same.

(vi) To do all such things as are incidental or the Society may think conducive to the attainment of the above objectives or any of them.

4. Membership

(i) Any person who is concerned, interested or engaged directly or indirectly in the fields of radiation biology, radiation chemistry, radiation physics, radiation oncology, radiography, radiation protection or in any related pursuit or who is able to contribute to the objectives of the Society may be eligible for election to membership of the Society.

(ii) There shall be one class of membership which shall be open to persons of any nationality, except that, in accordance with these general principles, a person may be elected to Honorary Membership on the basis of distinction in his or her field, and/or service to the Society.

(iii) Election to membership and Honorary Membership shall be made by the Committee. The Committee's decision shall be final and no reason need be given. Honorary Membership should not normally exceed 20 persons.

(iv) Any member may resign his or her membership with immediate effect by giving to the Secretary notice in writing to that effect.

5. Subscriptions

(i) The Annual Subscription for members shall be set by the General Meeting on the recommendation of the Committee. The Annual Subscription for students and retired members shall be one half that of ordinary members of the Society.

(ii) Annual subscriptions shall be payable in advance on the 1st April in each year. Whatever time a person applies for election to the membership the full annual subscription will apply for the current year. Provided that if he/she applies for membership after the 1st February in any year the first subscription required will apply from 1st April of that year.

In the event of any person subsequently not being elected under rule 4(i) they shall be entitled to the return of any subscriptions already paid.

(iii) Any member whose subscription is more than two years overdue (and who has been informed of this fact by the Treasurer) shall cease to be a member unless the Committee otherwise decide.

6. Expulsion from Membership

The Committee may expel from the Society any member whose conduct is, in the opinion of the Committee, injurious to the character and interests of the Society or render him / her unfit to be a member of the Society. Before a

member is expelled his / her conduct shall be inquired into by the Committee and he / she shall be given an opportunity to defend him / herself and to justify or explain his / her conduct. If two thirds of the members of the Committee present at the enquiry are of the opinion that the member has been guilty of such conduct and that the member has failed to justify or explain it satisfactorily the Committee may call upon the member to resign; if he/she does not resign, they may be expelled. A member so expelled shall have a right of appeal to members at the next General Meeting and the members present at such a meeting shall decide by a two thirds majority on a secret ballot whether the Committee's decision to expel the member shall be confirmed.

7. General Meeting

(i) A General Meeting of the Society shall take place not less frequently than once in every two years, at such a place as may be determined by the Committee. As far as possible, the General Meeting shall be held in conjunction with a Scientific Meeting at which attendance of members is unrestricted. Fourteen days' notice giving details of time, place, agenda and resolutions shall be given in the case of each General Meeting.

(ii) A quorum for a General Meeting shall not be less than three members of the Committee present with ten members.

8. Special General Meeting

(i) The Committee may, whenever they think fit, convene a Special General Meeting.

(ii) The Secretary shall convene a Special General Meeting forthwith upon the requisition in writing of ten members of the Society stating the purpose for which the meeting is required.

(iii) At least twenty-one days' notice shall be given of a Special General Meeting. The notice shall specify the place, the day and the hour of the meeting and the business to be conducted.

(iv) A quorum at a Special General Meeting shall be twelve members.

9. Scientific Committee

The Committee may arrange Scientific Meetings of the Society at suitable times and places. The arrangements for such meetings shall be made by the Committee or by a local organising committee.

10. Procedure of General Meetings

(i) The Chair of the Committee shall preside as Chair at any General Meeting. If the Chair is not present within fifteen minutes of the time appointed for the meeting, then the Vice Chair will preside. Or, if neither is present and if the numbers present is sufficient to form a quorum, they shall choose a member of the Committee as Chair, or if all members of the Committee present decline to preside, then they may choose any member present to preside.

(ii) The Chairman of the meeting may with the consent of the meeting at which a quorum is present, or if such a meeting so decide, adjourn the meeting from time to time, or from place to place, but no business shall be transacted at such adjourned meeting other than business for which the adjournment took place.

(iii) At all General Meetings any resolution put to the vote shall, unless the Rules otherwise provide, be decided by a show of hands by a majority of the members present in person and entitled to vote; a declaration by the Chair of the meeting that a resolution has been carried or lost shall be conclusive and the Secretary shall make a written note of the decision.

(iv) Every member present shall have one vote and in the event of an equality of votes the Chair shall be entitled to a further or casting vote.

(v) If within half an hour of the time appointed for the holding of a General Meeting a quorum is not present the meeting, if convened on the requisition of members, shall be dissolved. In any other case it shall stand adjourned to such time as the Chairman shall decide.

11. The Committee

(i) The affairs of the Society shall be managed by the Committee which shall be the governing body of the Society and which will act on behalf of the Society within the rules of the Society.

(ii) The Committee will consist of: Chair; Deputy-Chair; Past Chair; Hon. Secretary; Hon. Treasurer; and a minimum of five ordinary members. Office bearers will be elected by the committee from those duly elected to serve on the committee as described in 12 below.

(iii) Only members of the Society shall be eligible to hold office as Committee members.

(iv) A member of the Committee may resign his office at any time by giving notice in writing to the Committee.

(v) Subject to the above-mentioned maximum number, the existing members of the Committee may from time to time appoint any member of the Society to be an additional member of the Committee to fill a casual vacancy. Any member so appointed shall retain his office only until the next Committee elections, at this time he/she shall be eligible for re-election.

12. Election of the Committee

(i) Nomination for any vacancies on the committee will be requested from the membership by the secretary not less than 14 days before each General meeting at which committee elections are required as per regulations 12 (v – viii), Where possible the committee membership should reflect the Institutions in Ireland at which Radiation Science is being conducted.

(ii) Election of the Committee shall take place by ballot at the General Meeting. All attending members of the Society are eligible to vote. Members who wish to may vote by email or in writing. For this pre-meeting vote to be eligible it should be received by the secretary not later than 24 hours before the Meeting and shall be added to those cast personally at the Meeting.

(iii) In giving notice of a General Meeting, the Secretary shall submit a list of the Committee, indicating the number of Committee Meetings each member has attended and distinguishing those eligible for re-election, and shall request nominations for the new Committee.

(iv) Any member shall be entitled to nominate another member for the committee, provided the nominee has consented to stand and is eligible for the office. Nominations shall be seconded by one other member and shall be received in writing (including email) not less than fourteen days before the date of the General Meeting.

(v) All members of the Committee shall be elected for a period of three years, to run from 1st April, provided that:

(vi) The Secretary, the Treasurer and the five ordinary members shall be eligible for re-election provided that they do not serve in those respective offices for more than two consecutive three-year periods unless requested to

by a quorum of the committee.

(vii) The Chair and Deputy-Chair shall serve in these offices for consecutive two-year periods. Normally the Deputy-Chair will succeed the Chair for the following two years and the Chair will remain on the committee for a further two years as Past Chair.

(viii) Any Committee member who has served in one office of the Committee shall be eligible to serve in another office in the next three-year period, provided that he/she does not serve on the Committee for more than three consecutive three-year periods.

(ix) The Society may, by a resolution adopted at a General Meeting, remove any member of the Committee before the expiration of his/her period of office and may appoint another member in his/her place.

13. Procedure at Committee Meetings

(i) The Committee may meet together to undertake business as they think fit. Issues shall be decided by a simple majority of votes. In the case of an equality of votes the Chair shall have a further or casting vote.

(ii) A quorum of the Committee shall be four consisting of three members with at least one officer present. In the absence of the Chairman the Committee shall elect one of their number as Acting Chairman.

(iii) On the request of any three members of the Committee, the Secretary shall at any time summon a meeting of the Committee within twenty-eight days.

(iv) The Committee shall cause proper minutes to be made of the proceedings of all meetings of the Society and of the Committee.

14. Accounts

(i) The Committee shall cause proper books of accounts to be kept with respect to (a) all sums of money received and expended by the Society, (b) all sales and purchases by the Society, (c) all assets and liabilities of the Society.

(ii) At each General Meeting the Committee shall present to the members of the Society an account of income and expenditure since the last General Meeting.

(iii) The Committee shall have the accounts of the Society professionally audited not less than every three years.

15. Winding Up

The Society may only be dissolved by resolution at a General Meeting. There should be agreement by 75% of the members present and this should represent at least 50% of the total paid-up membership. In the event of winding up the assets of the Society, after payment of debts and liabilities, the surplus shall be transferred to a selected charitable institution of a similar nature to the Society.

16. Changes in Rules

The Committee may, at any meeting by a majority of not less than two thirds of the members present and voting (and is an absolute majority of the whole of the Committee) and confirmed at the next General Meeting by a like majority, alter, amend or add to these rules. The change shall be effectual between the resolution of the Committee and the next General Meeting.

17. Notices

Any notice required to be given by these rules shall be given in such a manner as the committee may decide.

Note:
In the unlikely event of the Society becoming bankrupt, the liability of Ordinary members would be limited to the amount of their subscription for the year in question and any arrears which they had not paid, except that the members would be liable for any particular debt which they had specifically authorized the Committee to incur. Apart from this exceptional case, the responsibility would fall upon members of the Committee, whose task it is to manage the affairs of the Society.

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