



SCHOOL ON RADIATION
TECHNOLOGIES 2017

Network for Innovation in Nuclear Applications





What is the School on Radiation Technologies?

The WNU School on Radiation Technologies (RT School) is a two-week programme aimed at future leaders in the radiation and radioisotope field. It is open to companies, governments, research institutions and regulatory authorities expected to play key roles in the field.

The programme aims at:

- Providing selected participants with broad understanding and new horizons in the area of radioisotopes and radiation technologies
- Familiarising participants with the main issues encountered by practitioners in the field
- Providing opportunities for participants to develop a worldwide network of contacts of unique value to their current and long-term careers

The RT School receives technical support from the International Atomic Energy Agency and the World Council on Isotopes. Previous RT Schools have been run in cooperation with Australian Nuclear Science and Technology Organisation (ANSTO) and with the Association of Imaging Producers and Equipment Suppliers (AIPES).

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Introduction

The aim of the Network for Innovation in Nuclear Applications (NINA) is for fellows, participating in teams, to intensely investigate important issues in the radiation technologies area and bring new and fresh light to them. This module takes place at the end of the WNU School of Radiation Technologies and it is a project where each team presents an innovative approach to selected issues. Each topic was guided by mentors.

The fellows knew that time management was crucial and they took full advantage of the strength of their team by considering new ideas from all members of the group!

Each NINA created a piece of work of high quality that took numerous forms. Fellows get to choose.

Every fellow got motivated to learn and brought their ideas and experience to the table. Every one of them needed to be persistent, enthusiastic and hardworking.

This publication shows a summary of the projects produced by each NINA.

NINA 1 | Install or not a research reactor or accelerator to produce radioisotopes

Abstract

Cancer and cardiovascular diseases are and will continue to be the leading causes of death all over the world. Steady and reliable supply of radioisotopes can tremendously help early diagnosis and treatment of these diseases. Developing countries suffer the most due to a lack of life-saving radioisotopes and corresponding infrastructure. There are numerous strategies for producing isotopes for medical applications, but the main two ways are using nuclear reactors and particle accelerators (primarily proton cyclotrons). Both types of installations require significant investments, both manpower and financial. In this paper we will outline the main issues for both types of radioisotopes production facilities and provide guidance for countries interested in such installations.

Nuclear Science Advisory Committee for Medical Radioisotope Production

Goal

To encourage development of new installations for medical radioisotopes production in low- and middle-income countries.

How to fight cancer in low- and middle-income countries with radioisotopes?

Strategy for low-income countries:

- Low energy cyclotron for radioisotope production (for example F-18)
- Import radioisotopes and develop infrastructure?

Strategy for middle-income countries:

- Low or high energy cyclotron for several radioisotope production (for example F-18)
- Research reactor for production of additional isotopes (for example Mo-99, I-131, Ir-192)



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Vin Zyl de Villiers	President
Ngô Szeewoon	Chair, Industrial Application
Timothy Payne	Chair, Environmental Applications
Richard Braun	Chair, Medical Applications
Carole R. Chantley	Chair, Publication
Hani Beer	Chair, Education and Training
Woo-Guon Song	Director of Secretariat



Romania's ICN radioisotopes production capability - Focus on Iridium

Madalina Stanculescu
Institute for Nuclear Research Romania

Institute for Nuclear Research (ICN) Romania has as principal task maintaining and developing the scientific and technological support for the national nuclear energy program, vital component in ensuring the sustainable, clean and safe energy citizens.

Romania's nuclear energy program for safe and competitive operation of Cernavoda nuclear power plant, ensuring the medium and long term of Cernavoda advanced reactors, the safe storage and management of radioactive waste.

The institute ensures the operation, development and use of the infrastructure required to support research and development programs, sustained international cooperation, promotes the development and application of nuclear technologies in medicine, agriculture.

MEDICAL ISOTOPE PRODUCTION IN LOW- AND MIDDLE-INCOME COUNTRIES: ISSUES AND SUGGESTIONS

Maitre A., Harianto R., Hong T., Perini E., Qin X., Rodriguez M., Santos N. O., Skopchenko M., Guo Y.

ABSTRACT

Cancer and cardiovascular diseases are and will continue to be the leading causes of death all over the world. Steady and reliable supply of radioisotopes can tremendously help early diagnosis and treatment of these diseases. Developing countries suffer the most due to a lack of life-saving radioisotopes and corresponding infrastructure.

There are numerous strategies for producing isotopes for medical applications, but the main two ways are using nuclear reactors and particle accelerators (primarily proton cyclotrons). Both types of installations require significant investments, both manpower and financial. In this paper we will outline the main issues for the both types of radioisotope production facilities and provide guidance for countries interested in such installations.

NINA 2 | An insight on potential overregulation

Background

Some applications require a license from several governmental agencies, for example, nuclear regulatory body, health authority, environmental agency, agriculture and commodities control, etc. The process can be very long and costly for the radiation facility, the capital investment is very high in the beginning, for example for industrial irradiators, without an assurance that all the operational licenses will be issued in due time. This is a very sensitive issue. Due to the over-enthusiasm to be 'very safe' the regulations could be so stringent that it would be impractical to follow. A holistic approach will be needed to balance between the 'safety' and 'benefit', with awareness of the consequences on the public health of regulatory delayed decisions.

Globion Corporation

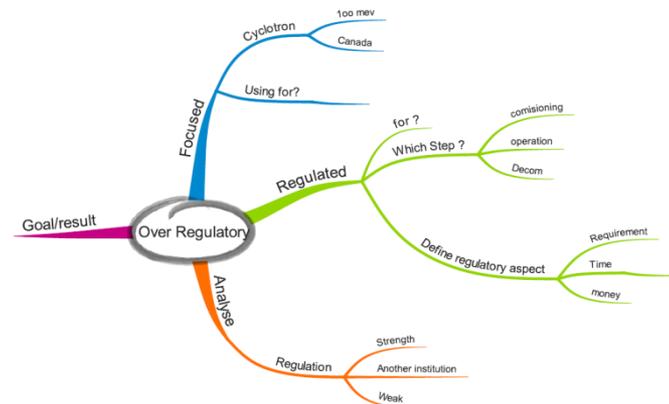
Globion Corporation

Challenging technologies,
producing radioisotopes,
saving lives

We care.



Production of radioisotopes with proton accelerator



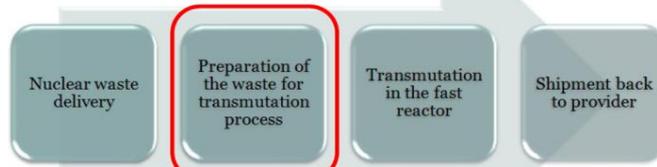
Proposal

- Amend the Class II Nuclear Facilities and Prescribed Equipment Regulations to include proton accelerators between 50 MeV and 100 MeV
- This will decrease the regulatory burden not only for facilities such as the one we are proposing, but also for potential proton radiotherapy in hospitals

Market Analysis

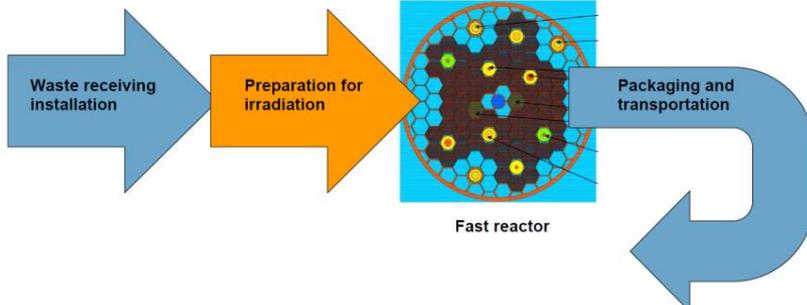
- Healthcare providers in Canada want access to these technologies
- Significant market in Eastern Canada and the United States due to lack of current capacity and high transportation costs
- Construction of a variable beam energy proton accelerator and processing facility in Toronto, Canada

Process steps



Optimize the process for industrial scale

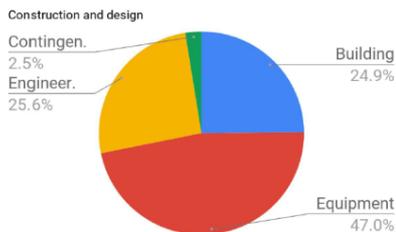
Infrastructure needed



Budget

Investment cost: 760 Millions Euros

Operational cost: 40 Millions Euros /year



revenues	(M Euro)	15 years later
waste treatment	100	1500
costs	(MEuro)	
operational	40	600
investment	760	760
Total		140

NINA 3 | Planning the implementation of a research centre / new facility in the area of radiation technology field

Background

Belgian nuclear research centrum, SCK•CEN, is actively working on designing and building a new multifunctional research installation [1-3]: MYRRHA as in Multi-purpose hybrid Research Reactor for High-tech Applications. MYRRHA is the very first prototype of a nuclear reactor driven by a particle accelerator in the world. Distinctive feature: as an external source of neutrons, this particle accelerator maintains the nuclear fission chain reaction. It is referred to as a subcritical reactor: the core does not contain enough fissile material to spontaneously maintain the chain reaction. This innovative nuclear technology is safe and easy to control. When the particle accelerator is stopped, the chain reaction also stops automatically within a fraction of a second.

Solution ReNuclear

Nuclear waste issues

- Storage costs
- Terrorist attack
- Environmental issues
- Natural disasters
- Proliferation (Pu - 1%)
- 6800 tons/year of spent fuel

ReNuclear

New solutions for nuclear waste treatment and reprocessing

Next step of spent fuel reprocessing

- Reduction of radiotoxicity (HLW);
- Reduction of radioactivity
- Reduce the volume and heat load/reduction of the storage cost

NINA 4 | Planning the start-up of an industrial company in the radiation technology field

Background

Radiation processing technology where materials are exposed to ionising radiation is an additive-free treatment process that can change the chemical, physical and biological properties of a material without inducing radioactivity. Radiation processing of materials using gamma radiation from radioisotope sources, electron beam (EB) accelerators and X-ray sources, has been deployed in many countries for industrial applications as well as exploring additional avenues of potential applications. A large majority of them are used for sterilization of medical products, tissue banking, treatment of food and agricultural products, in polymer based industries (cables, tubes, tapes), tire belt vulcanization, gem stone colouration, and art objects disinfection. The use of this technology is increasing with industrialisation and economic development in several developing countries, and in this context, there is growing interest in the countries for strengthening operational practices and quality management systems in radiation processing plants and many of them are installing new facilities.



Mission

- Provide irradiation services for food safety and security.
- Disinfection of grains, preventing the germination and sprouting and extending the shelf-life.
- Reduce the post-harvest losses – economic value improvement.

FOOD PRESERVATION



Vision

To be a worldwide reference in the application of radiation technology in Agro Industry.



Customers

Companies that stored grains before exportation

Market analysis



Brazilian exportation in 2016 (48,11% of the production)**



Value Grains Wasted...



Multipurpose irradiation facility

E-beam facility (Dynamitron ®5MeV) Application

- From 0.5 to 5 MeV
- Up to 150kW
- Vertical installation
- Up to 30mA
- Grain disinfection
- Food decontamination
- Environmental treatment



NINA 5 | Medical Over Exposure in Breast Cancer Patients Treated with Radiotherapy

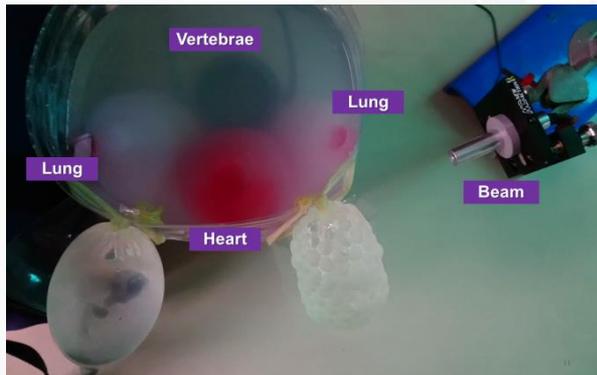
Abstract

Breast cancer (BC) treatment is done usually through radiation beams tangent to thorax to hit affected tissue. Radiotherapy against BC was shown to increase risk of cardiovascular disease on patients. Due to a plethora of anatomical differences between patients, beam alignment to hit cancer tissues, avoiding to strike healthy organs, can be difficult. This work used data from 21 patients to calculate risk of carcinogenesis on lungs, underlining the importance of therapy planning.

Radiotherapy Experiments

Materials and Methods

The analysis was performed using the planning system data of 21 breast radiotherapy patients. An *Elektra Modern Precise* equipment was used in association with the *Pinnacle* treatment planning. The used beam had energy of 6 MeV and the source-to-skin distance was 100 cm. Based on the results of the absorbed dose (D) three different parameters were calculated: Effective Dose (E), the Relative Risk (RR) and the Probability of Causation (PC).



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In collaboration with

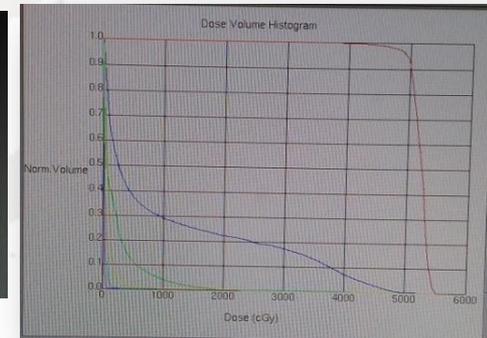
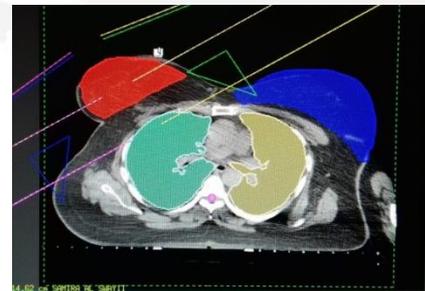


RADIOTHERAPY FOR BREAST CANCER: RISK ANALYSIS

Anderson V. S. Alves¹, Camila Salata², Daniel P. Vieira³, João V. B. Valença¹, Ibrahim Duhaini⁴.

Results and discussion

- Dose volume histogram (DVH) obtained from *Pinnacle* planning system, represented as cumulative, and absolute dose
- Comparison of the doses calculated in the planning system and measured with an anthropomorphic phantom
- Mean dose, Effective dose, RR, and PC values for the Ipsilateral and Contralateral lung



Conclusions

A correlation between the tangential breast treatment and a significant dose to the ipsilateral lung was shown. Thus, it was demonstrated the importance of planning and the correct choice of the angle of beam related to the treated breast. To help the physician and the oncologist, all the BC patients should be accompanied by a cardiologist and a pulmonologist during the treatment.



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World Nuclear University

Tower House
10 Southhampton street
London, United Kingdom
WC2E 7HA

Email

wnu@world-nuclear-university.org

Web

www.world-nuclear-university.org

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