



The Belgian expertise in nuclear science and technology applications for healthcare



Rad4Med.be in a nutshell

As a non-profit network, **Rad4Med.be** promotes medical applications of nuclear science and technology by creating awareness about the use of radioactivity and nuclear radiation in healthcare and by improving their visibility. This provides interested parties a network of competences available in Belgium and, when requested, helps them to find the correct sources of information or partners.

To achieve its aim, SCK CEN, the Belgian Nuclear Research Centre, BioWin, the Health cluster of Wallonia, IRE, the Institute for Radioelements, and IBA, Ion Beam Applications, have created **Rad4Med.be**.

Today, the network consists of some 80 members: companies, hospitals and clinical departments, research and education centres, associations...

Rad4Med.be is supported by SCK CEN, IRE, IBA and the Belgian Federal Government.

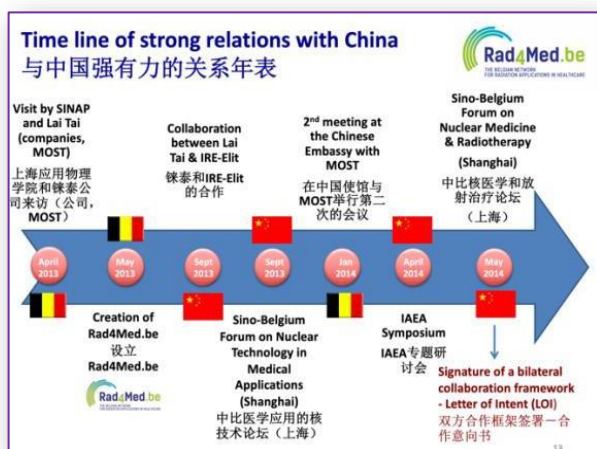
Rad4Med.be presented the Belgian assets and know-how in the field during Royal State Visits, Belgian Princely Economic Missions, and at congresses & symposia world-wide. **Rad4Med.be** provided as such support to the Government, the International Atomic Energy Agency and other national or international counterparts.



Rad4Med.be booth at EANM



Rad4Med.be symposium at IAEA



Royal State visit to China



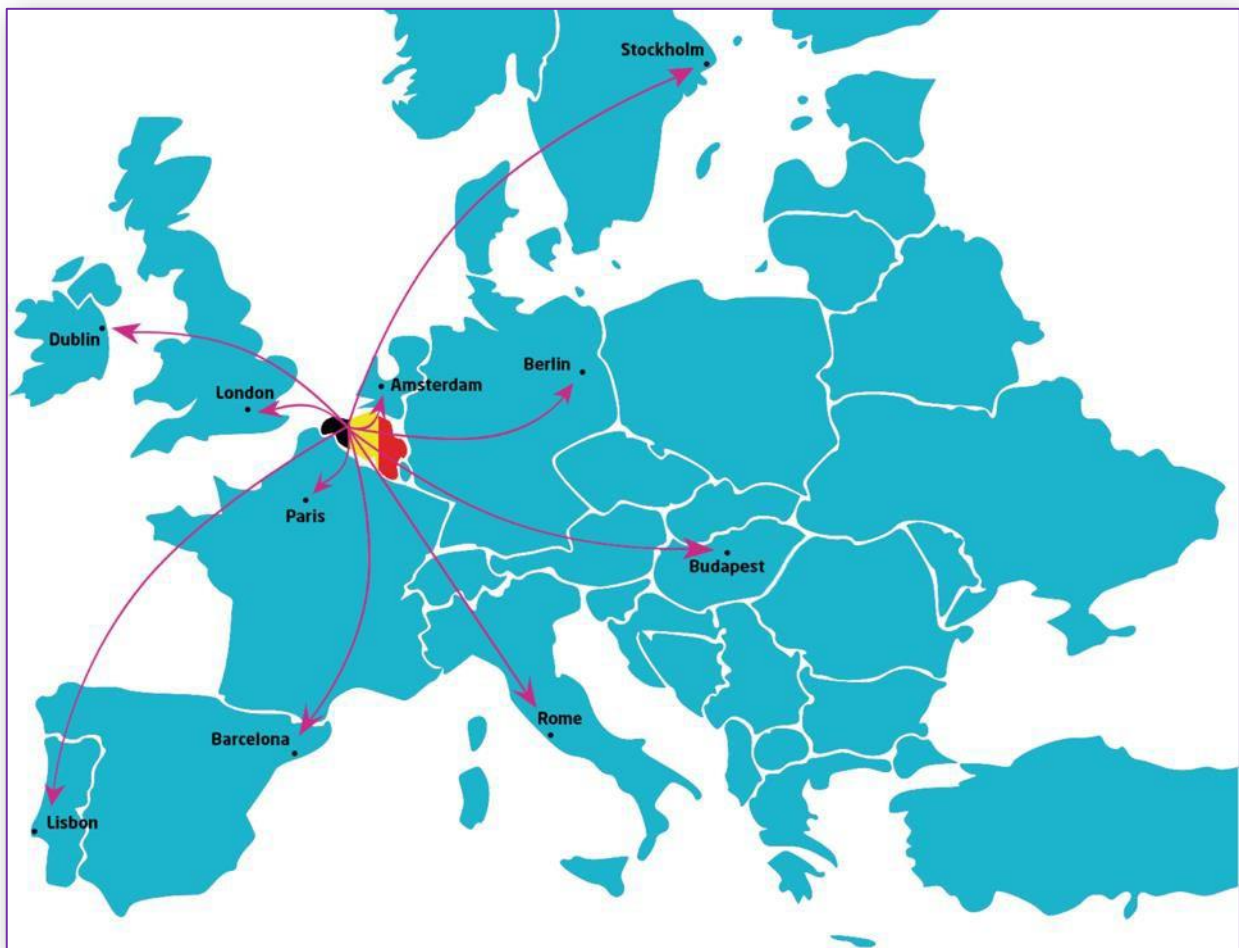
Princely economic mission to Korea

Belgium, a country at the very heart of Europe

Belgium, ideally located between Northern and Southern Europe, is neighbour to France, Germany, Luxembourg and the Netherlands.

Its small size allows for rapid internal communications thanks to its efficient motorway and railroad system. The high-speed train lines spanning the country place its major cities (Antwerp, Brussels, Charleroi, Ghent, Liège, Namur,...) within a 2-hour journey to Paris, London, Amsterdam or Frankfurt. The 5 major airports, including the Brussels international airport, put most European destinations within reach in less than two hours. The ports of Antwerp, Ghent and Zeebrugge, to name only those, are gateways for heavy equipment.

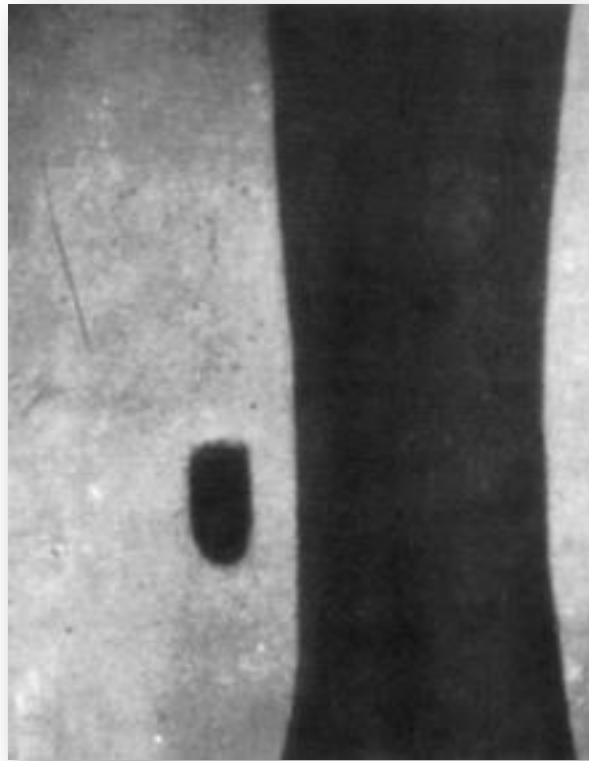
The location and excellent communication ways to the rest of Europe and the World allow for a very efficient and streamlined supply chain for medical radioisotopes or equipment.



The Belgian historical expertise in medical applications of ionising radiation¹

Belgium is a world leader in medical applications of ionising radiation. This leadership has been achieved thanks to the creativity and the innovations by hundreds of scientists, clinicians and engineers who built on the very strong foundations provided by the pioneers in the field.

At the end of the 19th and beginning of the 20th century, Belgium being one of the richest countries per habitant in the world was very much oriented towards scientific discoveries and technological developments. As an example, in April 1896, only five months after the discovery of X-rays by Roentgen, the Belgian army had X-ray equipment installed to improve medical diagnosis.



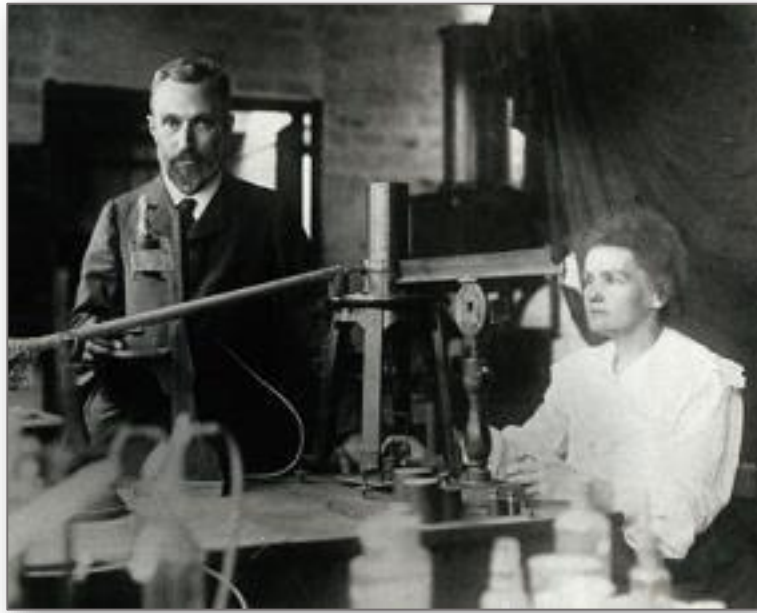
Leg of Belgian soldier, 1896²

In March 1896, Henri Becquerel discovered rays of unknown nature. Shortly afterwards, Marie and Pierre Curie would explain the origin of the rays and coin the term radioactivity.

Marie and Pierre Curie discovered the existence of radium in 1898 and successfully isolated radium salts in 1902. On year later, they shared the Nobel prize in physics with Henri Becquerel. The potential of radium for therapeutic uses was realised soon afterwards when both Becquerel and Pierre Curie experienced skin lesions after having been exposed to radium.

¹ Frank Deconinck, 2023

² 100 years of radiology in Belgium, Belgian Museum of Radiology, ISBN 90-802575-1-6



Pierre and Marie Curie-Skłodowska, 1904(?)³

In Belgium, already in 1900, Prof. Jules De Nobele of (R)UGent was using X-rays to treat Lupus by X- rays and in 1904 Prof Adrien Bayet of ULBruxelles initiated treatment by radium.



Jules De Nobele⁴ and Adrien Bayet⁵

³ https://fr.wikipedia.org/wiki/Fichier:Pierre_and_Marie_Curie.jpg

⁴ Personal communication

⁵ https://fr.wikipedia.org/wiki/Adrien_Bayet#/media/Fichier:Portrait_de_Adrien_Bayet.jpg

Les physiciens se réunissant ce jour sur le sol
 hospitalier de la Belgique grâce à la noble initiative
 d'Ernest Solvay se penchaient avant d'entamer la
 discussion de problèmes actuels d'atomistique et de
 mécanique, de priés leur Mgrs et d'après accepter
 l'expression du profond respect de

H. A. Lorentz, Leiden
~~F. G. ...~~
 Louis Poincaré
 E. Rutherford
 A. Sommerfeld
 Martin Knudsen

M. Curie
 A. Einstein
 F. A. Lindemann
 E. H. Rans
 H. de Broglie
 O. Rans
 J. Hasenöhel
 W. Wien
 J. Hartog

Henrich Rubens
 G. Barken
 Nimitz

Message to H.M. King Albert by attendants of the First Solvay Conference, 1911⁶

During World War I, Marie Curie and her daughter Irène would spend a several weeks in Belgium, training Belgian nurses and doctors in radiography.



Marie and Irène Curie, Hoogstade, 1915⁷

Thanks to the exploitation of the Shinkolobwe mine, the "Union Minière du Haut Katanga" had a near monopoly on radium supply between World War I and II. Until the end of the World War II, radium was the principal source of nuclear radiation for therapy, either for local brachytherapy or for external beam therapy.

⁶ Fondation Universitaire/Universitaire Stichting

⁷ Roseline Debaille, http://www.1914-1918.be/marie_curie.php

The Belgian Red Cross founded the Belgian Radium Institute in 1923 and in 1931, the Sino-Belgian Radium Institute was created in Shanghai, now the Fudan University Shanghai Cancer Centre, the major cancer specialty hospital in China.



Sino-Belgian Radium Institute, 1931⁸

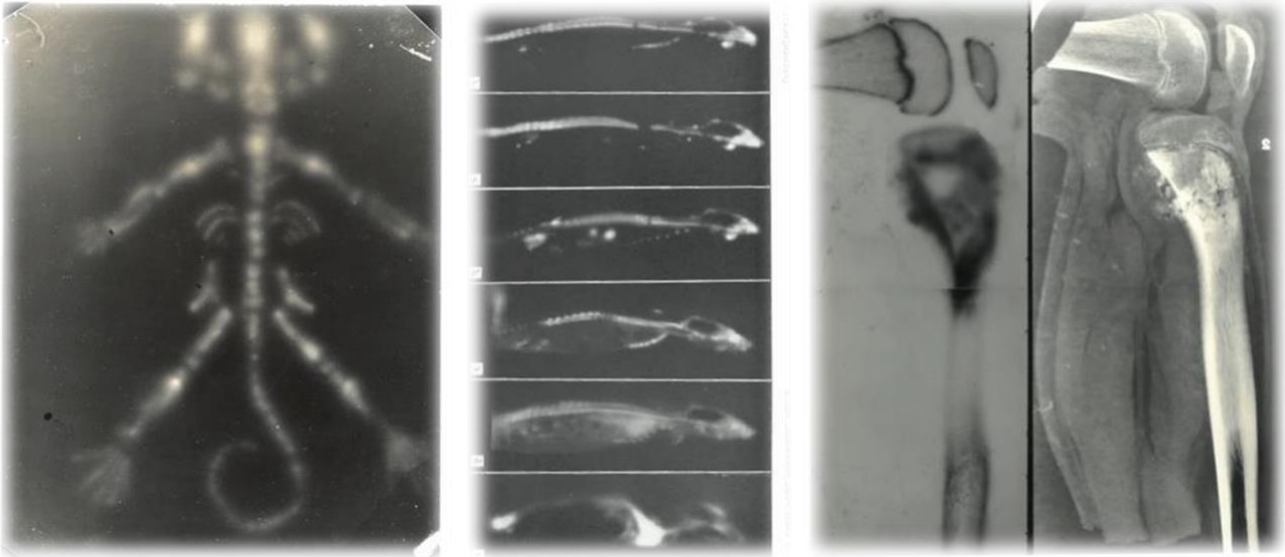
The universities of Ghent, Brussels, Leuven/Louvain and Liège all received a significant amount of radium for medical use through the Belgian “University Foundation”. At Leuven university, in 1928, Prof. Joseph Maisin founded the “Institut du Cancer” with a dedicated therapeutic X-ray source as well as with the then most powerful “radium bomb” world-wide.

As opposed to clinical nuclear medicine, which only strongly developed after World War II once artificial radioisotopes became available, new radiotherapeutic technologies and procedures were continuously developed and applied during the entire interbellum. Radium-based interstitial brachytherapy was refined and X-ray tubes for röntgenotherapy, delivering voltages up to a few hundred kV, became available allowing deep cancers to be treated. In 1939, the Bordet Institute⁹ was founded with the fight against cancer as its mission.

Also in 1939, a freshly graduated MD from ULB, Charles Pecher, moved to Berkeley to work with the inventor of the cyclotron, Ernest Lawrence, and his brother John Lawrence. MD. Pecher wanted to develop a cure for the pain caused by bone metastasis using one of the newly discovered radioisotopes. In 1940-41, he demonstrated that ⁸⁹Sr (Strontium-89) is taken up by the bone, that the uptake dynamics were optimal for therapy, and he performed the first successful therapies with ⁸⁹Sr. If it hadn't been for the fact that his work was classified as very secret – due to the link between Strontium and nuclear weapons research and therefore only rediscovered a few years ago – he would have been considered one of the great pioneers in nuclear medicine.

⁸ https://en.wikipedia.org/wiki/Shanghai_Cancer_Center ; <https://www.shine.cn/feature/art-culture/2010238298/>

⁹ Named after Jules Bordet (1870-1961), Nobel Medicine 1919.



First bone scan, first dynamic study, first therapy with ^{89}Sr , 1940-1941¹⁰

Nuclear medicine was introduced in most Belgian university hospitals in the late 40's, early 50's. This was also the period when the Belgian Nuclear Research Centre SCK CEN was created (1952).

In radiation oncology, ^{60}Co (Cobalt-60) produced in nuclear reactors replaced radium for teletherapy from the fifties on. The University of Liège pioneered by replacing its radium bomb by a ^{60}Co bomb and Julien Garsou introduced medical physics. Zénon Bacq (ULiège and ULB) and Joseph Maisin collaborated on radiobiology research, soon joined by a strong research team at SCK CEN.



Joseph Maisin¹¹



Belgian radiation oncology pioneers
Zénon Bacq¹²



Suzanne Simon¹³

With its research reactors BR1 and BR2, SCK CEN performed uranium target irradiation to produce a variety of medical isotopes, and its spin-off, the Institute for Radioelements, IRE, took care of their separation and purification. Belgium then (and is still doing so today) started providing medical radioisotopes on a regular basis to nuclear medical centres in Europe and worldwide.

¹⁰ Charles Pecher (1913-1941) et le strontium radioactif Sr-89, Evelyne Cerf-Pecher, ISBN 978-2-931008-24-9. Link to download a free pdf of the book: <https://rad4med.be/wp-content/uploads/2023/07/Charles-Pecher-1913-1941-et-le-strontium-Evelyne-Cerf-Pecher.pdf>

¹¹ <https://sites.uclouvain.be/md-histoire/maisinJ/ilmaisin.htm>

¹² https://fr.wikipedia.org/wiki/Z%C3%A9non_Bacq

¹³ <https://docplayer.fr/6236691-70-ans-centre-integre-de-lutte-contre-le-cancer-de-1939-a-nos-jours.html>



BR2 research reactor at SCK CEN¹⁴



Remote handling of isotopes at IRE¹⁵

Dedicated transport was set up and gave rise to specialised companies. The major Belgian universities developed training in radiochemistry, radiopharmacy and nuclear medicine as a subspecialty to internal medicine.

By 1975-1980, the entire value chain, from production of isotopes up to clinical research and practice was operational. Already in the 80's, more than 100 nuclear medicine departments were active in the country.

The Belgian Society of Nuclear Medicine (BSNM, now called 'BELNUC') was founded in 1978 by physicians who had previously been involved in an extended partnership with radiation therapy and radiology. The first president was Michel De Roo from KULeuven.

¹⁴ <https://www.sckcen.be/en>

¹⁵ <https://www.ire.eu/>



Belgian nuclear medicine pioneers

G.Merchie, Ulg; M.De Visscher, UCLouvain; M.Van Vaerenbergh, UGent; M.De Roo, KULeuven; A.Ermans, ULB; M.Jonckheer, VUB

The European Society for Radiotherapy and Oncology, ESTRO, was founded in 1980 to establish radiation oncology as an independent specialty uniting all disciplines involved: clinical, physics, biology and technology. The Belgian founder was Emmanuel van der Schueren.

Until then, there was no specifically Belgian association in the field of radiation oncology. This led to the creation of ABRO-BVRO, now called BeSTRO. It is the scientific organisation of radiation oncology in Belgium, open to radiation oncologists, radiation physicists, radiobiologists, biomedical and radiation therapists.



Yves Jongen at IBA¹⁶

Up to the mid-eighties, only reactor produced isotopes were routinely available in Belgium. The first Belgian cyclotron was built in 1947 at the university of Leuven/Louvain. As researcher with extensive experience in cyclotron technology, Yves Jongen went to work at Berkeley and upon his return created IBA in 1986.

¹⁶ <https://www.camsoc.be/events/2020-01-18-iba/>

Soon, all Belgian universities would be equipped with cyclotrons which would open the door to the introduction of Positron Emission Tomography, PET, mainly with ^{18}F (Fluor-18). By the year 2000, Belgium hosted the highest density per capita of nuclear medicine departments, cyclotrons and SPECT or PET cameras in the world.

Linear accelerators became standard equipment in the Belgian radiation oncology departments. The interuniversity "Particle" proton therapy centre in Leuven welcomed its first patients in 2020.

Belgium is worldleader in medical isotope supply, cyclotron-based applications and installations for proton therapy. All nuclear medicine and radiation oncology departments now have strong interdisciplinary teams to ensure an optimal treatment for the patients.

Belgium, a world leader in nuclear science and technology for healthcare

The early interest of the country in nuclear activities, focused at a very early stage on healthcare applications, brought Belgium to a very high level of development in isotope production, labelling techniques, radiopharmacy, dosimetry and clinical applications, not to mention supporting activities such as specialised transport or education and training.

By the end of the 90's, alongside Germany, Belgium became not only the leading European country but also the country worldwide with one of the highest densities of nuclear medicine equipment per capita. This translated into a very high density of medical physicists, chemist, pharmacists, and nuclear physicians. With the presence of the SCK CEN, the Belgian Nuclear Research centre, and IRE, the Institute for Radioelements, Belgium became one of the two major producers of radionuclides for radiopharmaceuticals worldwide, in particular of ^{99}Mo (Molybdenum-99), mother isotope of $^{99\text{m}}\text{Tc}$ (Technetium-99m).

Today, only two reactors in the world, among them the powerful research reactor BR2 from SCK CEN in Mol, can produce this radioisotope in quantities required for the world demand. On a yearly basis, SCK CEN produces one third of the radioisotopes used worldwide for diagnostics and treatments of cancers. IRE, one of the two major locations worldwide for ^{99}Mo processing, supplies the isotope to generator manufacturers. IRE itself produces the top-of-the-line Galli-Eo ^{68}Ga (Gallium-68) generator. More than 95% of IRE's production is exported. Together, when required, SCK CEN and IRE can assure 100% of the ^{99}Mo world needs.

Over the past decade new cancer therapies based on alpha or beta emitting radioisotopes have shown highly convincing results and Belgian centres are involved in various clinical trials with potential high future impacts.

Each year, medical radioisotopes produced in Belgium allow more than 10 million patients to benefit from the most advanced nuclear medicine procedures.

IBA is the world leading company in cyclotron-based applications. More than 250 cyclotrons for radiopharma production have been installed by IBA in nuclear medicine departments worldwide.

Accelerator based techniques, and in particular proton therapy, have rapidly evolved over the past few years. In proton therapy too, IBA is today the leading company in the world.

Belgium is a global leader in all links required for the clinical practice in nuclear medicine and for the applications of nuclear science and technology in healthcare worldwide. From the production and refinement of radioisotopes over transport, generator production, labelling and radiopharmaceuticals, imaging equipment, pre-clinical and clinical studies to daily practice, Belgium excels in all steps of the value chain. A dedicated staff in university laboratories and research centres ensure a strong expertise for educational aspects.

Belgium, and Brussels in particular, is also host to major agencies and associations, both national and international.

Radiation applications in healthcare: *Some fact and figures...*¹⁷

Belgium is one of the major worldwide actors producing radioisotopes, radiopharmaceuticals and nuclear medical equipment:

Major supply chain for radioisotopes

- The BR2 has the largest irradiation capacity for ⁹⁹Mo/^{99m}Tc production worldwide and is the second ⁹⁹Mo producer on yearly basis.
- The BR2 reactor of SCK CEN is one of the 2 most flexible and powerful research reactors in the world, able to satisfy 100% of the worldwide demand of ⁹⁹Mo when required.
- IRE is one of the 2 major processing facilities in the world for ⁹⁹Mo separation and purification.
- Both SCK CEN and IRE also produce other radioisotopes for medical applications.
- Yearly, Belgium coordinates 35.000 transports of radionuclides for medical applications

High density of nuclear medical imaging equipment for clinical use

- 160 SPECT/CT Gamma cameras: 15 per million inhabitants
- 33 PET/CT cameras: 3 per million inhabitants
- 136 (N)MRI cameras: 12 per million inhabitants
- 8 cyclotrons (7 for production of radioisotopes and 1 for proton therapy) in Belgium

High density nuclear medicine specialists

- ± 350 nuclear medicine specialists: 30 per million inhabitants
- ± 5000 direct or indirect jobs

An integrated supply and value chain in Belgium

International organisations such as the IAEA, research institutes, pharmaceutical industries as well as investors from different countries are increasingly interested in medical applications of nuclear science and technology. The Belgian experts in the field are joining their expertise to propose the products, equipment, logistics, training, know-how and services the country can offer.

Our research reactor and cyclotrons produce, at large scale and under GMP conditions, a wide spectrum of radionuclides and will produce many new ones in the future. Full turnkey systems for the manufacturing of radiopharmaceuticals (PET, SPECT and theranostic applications) are present in the country.

Belgium not only hosts the number one company worldwide with respect to the development and the manufacturing of cyclotrons, but in proton therapy as well. These activities are obviously also performed under GMP conditions and are fully in line with ALARP regulations.

In its different renowned universities and associated healthcare centres, Belgium provides the full spectra of services in diagnostics, therapeutics and imaging, including (pre)clinical research activities as well as all the associated expertise in medical physics and nuclear chemistry.

Complementary services linking all these partners should not be forgotten. With their expertise linked to transport, nuclear safety, waste management or engineering, they complete the value chain.

¹⁷ Data for 2023, <https://www.health.belgium.be/en/node/33209>

Thanks to their training centres and their study programs, Belgian industries and universities provide a full range of education and training at every stage, creating an integrated value chain of utmost interest for any partner looking for a global approach.

The fully integrated value chain is represented and solutions for almost all requests concerning the use of radioactivity in healthcare can be addressed and answered in Belgium: the **Rad4Med.be** network has been created to gather this knowledge, expertise, and the stakeholders involved in the field.

Belgian expertise in medical applications of nuclear science and technology

Irradiation, purification, isotope supply

Already a century ago, Belgium was strongly involved in medical isotope production due to its stocks of uranium ore from former Belgian Congo. This involvement in nuclear physics and radionuclide production eventually led to the creation of the Belgian Nuclear Research Centre (SCK CEN) in 1952. It is one of the two major worldwide producers of Mo-99 through irradiation of Uranium targets in its BR2 research reactor. The BR2 reactor now uses Low Enriched Uranium targets and fuel in order to avoid proliferation risks.

The processing of bulk radionuclides and the manufacturing of radiopharmaceuticals is part of the expertise of the National Institute for Radioelements (IRE), founded in 1971 as a spin-off of SCK CEN. With these two large R&D and production centres, Belgium became one of the few countries in the world able to process and supply industrial scale amounts of medical radionuclides such as Mo-99 and I-131. IRE and SCK CEN have a joined forces to produce significant quantities of non-carrier added Lu-177 for targeted radionuclide therapy.

The first Belgian cyclotron was built in 1947 at the university of Leuven/Louvain. With the creation of IBA (Ion Beam Applications) in 1986 as a spin-off of the UCL Cyclotron Research Center, Belgium entered in the field of cyclotrons manufacturing and is now the largest producer of radiopharmacy and proton therapy equipment in the world. IBA thereby opened the way to the widespread local supply of short-lived radionuclides for positron emission tomography (PET), such as F-18. IBA and SCK CEN are major partners in PanTera for the industrial production of Ac-225.

IBA (Ion Beam Applications S.A.) is the world leader in particle accelerator technology. The company is the leading supplier of equipment and services in the field of proton therapy, considered to be the most advanced form of radiation therapy available today. IBA is also a leading player in the fields of industrial sterilization, radiopharmaceuticals and dosimetry. The company, based in Louvain-la-Neuve, Belgium, employs approximately 1,600 people worldwide. IBA is a certified B Corporation (B Corp) meeting the highest standards of verified social and environmental performance. IBA is listed on the pan-European stock exchange EURONEXT (IBA: Reuters IBAB.BR and Bloomberg IBAB.BB).

<https://www.iba-worldwide.com/>
info@iba-group.com

IRE, the Institute for Radioelements, is a public utility foundation, whose main activity is the production of radioisotopes for diagnostic and therapeutic applications in the field of nuclear medicine. IRE is the world leader in the production of Molybdenum-99. In addition to its production activities, the IRE contributes to the protection and monitoring of the environment through its services of measuring radioactivity in various samples, radiological characterisation of waste and contaminated elements and consultancy and technical assistance in the radiological and nuclear fields.

<https://www.ire.eu/>
<https://www.linkedin.com/company/ire---elit/>
info@ire.eu

PanTera is a joint venture between IBA (Ion Beam Applications S.A.), the world leader in particle accelerator technology, and the Belgian Nuclear Research Centre SCK CEN, world leader in reactor produced medical radioisotopes. PanTera's goal is to use the combined knowledge and expertise of IBA and SCK CEN, as well as the access they provide to the appropriate technology (Rhodotron electron accelerator) and materials (high purity radium-226 starting material), to secure the large-scale production of actinium-225 (Ac-225). This radioisotope is one of the most promising alpha-emitting radioisotopes to fight cancers and is the topic of >20 ongoing clinical trials for >10 different cancers. To support these clinical trials, PanTera has also secured an Early Supply of Ac-225 through a collaboration agreement with TerraPower Isotopes (TPI). Through this collaboration, PanTera will be able to supply already from 2024 onward over 30mCi of Ac-225 per week to support the development of radiotheranostic drugs.

<http://www.pantera-life.com>

<https://www.linkedin.com/company/pantera-life>

info@pantera-life.com

SCK CEN, the Belgian Nuclear Research Centre, is a foundation of public utility. With laboratories in Mol, Louvain-la-Neuve and a registered office in Brussels, it is one of the largest research centres in Belgium. Over 900 people work on the development of peaceful applications of nuclear science and technology. SCK CEN mission mirrors societal needs in the field of climate change, circular economy and fight against cancer through important nuclear innovative applications to contribute to a world in which these and future generations can live safely and in good health.

<https://www.sckcen.be/en>

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Transport

The transport companies play the important role of interconnecting the successive links in the medical radioisotope value chain from irradiation and refinement to the end-users or hospitals. The transport of radioactive materials requires the respect of challenging safety (radioprotection...) and security (physical protection, terrorism...) procedures. When medical isotopes are involved, an extra challenge is added: time. Indeed, due to the sometimes very short half-life of medical isotopes (Tc-99m: 6h; F-18: 110 min), transport can be a race against time. Every minute lost may impact patient care. It is essential therefore to establish streamlined administrative procedures with authorities and customs at national and international levels. Among the companies, some are more specialized in bulk transport of irradiated or refined products, others for the delivery of generators or labelled radiopharmaceuticals to the end users.

Debrouwer daily transports radioactive isotopes and raw materials that are destined for the use in medical and industrial applications every day. It is licensed for more than 35 years to execute Class 7-transport. Over that period of time, Debrouwer developed a comprehensive expertise in this exceptional specialisation, working under strict supervision and control of the Federal Agency for Nuclear Control.

<http://www.transport-debrouwer.be/en/transport/class-7>

<https://www.linkedin.com/company/transport-van-caudenberg-debrouwer/>

info@dbvcb.be

Fiege Healthcare is a European logistics service provider specializing in the storage and distribution of healthcare products with over 15 sites in five countries.

In Benelux Fiege Healthcare started off with the distribution of radioactive materials (ADR class 7) for Nuclear Medicine over 20 years ago. Today, Fiege transports radioactive sources by road on a daily base (24/7) to e.g. hospitals, institutions, and airports.

<https://www.fiege.com/en/logistics/industries/healthcare>

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ISI, Isotopes Services International, is specialized in international distribution of short lifetime products for the radiopharmaceutical market. ISI is proud to be part of the Radiopharma Logistics Group

<https://isotopes.be/en/>

<https://www.radiopharmalogistics.com/en/> <https://www.linkedin.com/company/isi---isotopes-services-international/>

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TRANSRAD is a logistics company specialised in the nuclear and radioactive field at a worldwide level. Transrad has its own fleet of vehicles and organizes transports of radioactive and nuclear material (by land, sea and air) thanks to a wide portfolio of permits. Next to its transport capacities, Transrad also has a storage capacity, an own fleet of packages and a wide range of additional services such as permit applications, package approval, feasibility studies, on-site industrial operators services, etc....

<https://www.transrad.be/en/>

<https://www.linkedin.com/company/sa-transrad-nv/>

info@transrad.be

WIS, World Infinity Services, is dedicated to the worldwide transport and logistics of radioactive materials and radiopharmaceutical products. WIS is focused on providing a safe and secure, compliant and high-quality customer experience. They perform feasibility studies in terms of regulation, transport- and packaging permits. With their dedicated partners we provide worldwide door-to-door logistics, airfreight and charter services.

<https://be-wis.com/> <https://www.linkedin.com/company/world-infinity-services/>

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Generator production

Some short-lived isotopes are decay products (= daughter isotopes) of parent isotopes with a much longer half-life. Examples are Mo-99 with a half-life $T_{1/2}$ of 66h, which decays into Tc- 99m ($T_{1/2}$ = 6h) and Ge-68 ($T_{1/2}$ = 271 days), decaying into Ga-68 ($T_{1/2}$ = 68 min). Generators contain the parent isotopes. They are delivered to the hospitals and are chemically eluted (a.k.a. "milked") when required to obtain the daughter isotope for clinical use.

IRE-ELIT is world leader for the production of the Ge/Ga generator, used in positron emission tomography. IRE-Elit develops, produces and commercializes new, ready to use solutions for diagnostic and therapeutic agents in nuclear medicine such as Galli Ad and Galli Eo, the pharmaceutical grade $^{68}\text{Ge}/^{68}\text{Ga}$ generators.

<https://www.ire.eu/nos-activite/ire-elit> <https://www.linkedin.com/company/ire---elit/>

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Radiochemistry, radiopharmacy, radiobiology, medical physics

Administering radioactive products to a patient requires full respect of pharmaceutical and nuclear safety regulations, among others concerning purity, sterility, and radiation dose. The first two relate to Good Manufacturing Practice (GMP) which describes the minimum standards that manufacturers must meet in the production and/or labelling processes. The third one concerns the correct measure of the radioactivity and the dose calculation.

Comparable to constraints in the transport sector, time is a major challenge in this link of the supply chain as the half-life of some medical isotopes is so short that all manipulations, such as labelling and QA procedures, affect the final amount of the radiopharmaceutical available for clinical use.

Most of the companies cited, started as spin-offs of Belgian universities and have grown into leaders in their respective fields. A common characteristic of the companies is their creativity and fast response to new developments, inherited from their academic origins.

ABSCINT focuses on the development of radiolabelled single domain antibodies for whole body molecular imaging applications, to be used for the diagnosis of disease, for molecular characterisation of a disease, for monitoring treatment response and for detection of disease recurrence. The company has two clinical stage products: one in oncology and one in cardiovascular disease.

<https://absclnt.com/>

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ELYSIA is a spin-off from the Cyclotron Research Centre of the University of Liège. It designs, manufactures, sells, and installs instruments used for the measurement of radioactivity and quality control activities.

<https://www.elysia-raytest.com/en/> <https://www.linkedin.com/company/elysia-s-a-/>

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Full Life Technologies is a fully integrated global radiopharmaceutical company with operations in Europe, the United States, and China. We seek to own the entire value chain for radiopharmaceutical research & development, production & commercialization in order to deliver clinical impact for patients. The company plans to attack core issues affecting radiopharmaceuticals today through innovative research that targets the treatments of tomorrow.

<https://www.full-life.com/>

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IBA is also a worldwide key leader in the supply of equipment for GMP radiopharmaceuticals production centres and offers a wide range of radiochemistry solutions designed to be highly productive and reliable for the everyday tracer needs, as well as customizable and flexible for research purposes.

<https://www.iba-radiopharmasolutions.com>

<https://www.linkedin.com/company/iba-radiopharma-solutions/c>

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Nucleis is a radiopharmaceutical company which proposes and manufactures Radiopharmaceutical Drugs for Diagnostic and Therapy Monitoring. Nucleis is a spin-off from the University of Liège (Cyclotron Research Centre - Belgium) created to outsource the GMP manufacturing and distribution of PET (*Positron Emission Tomography) radiopharmaceutical drugs.

<https://nucleis.eu/>

<https://www.linkedin.com/company/nucleis-radiopharmaceuticals/about/> info@nucleis.eu

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ORA supplies fully automated PET radiopharmaceutical synthesizers (radiochemistry modules) for use in the production of sterile injectable PET drug products. The synthesizers are specifically designed and constructed to meet current industry standards and user requirements with its potential future needs also in mind. The robust hardware and advanced software capabilities provide the means to create an unlimited number of individualized radiotracer synthesis applications.

<https://www.oraneptis.com/about/>

<https://www.linkedin.com/company/ora---optimized-radiochemical-applications/?originalSubdomain=be>

questanswered@radiochem.eu

PRECIRIX is a clinical-stage biotechnology company dedicated to improving the lives of cancer patients by developing novel targeted radiopharmaceuticals using camelid single domain antibody fragments.

<https://www.precirix.com/> <https://www.linkedin.com/company/camel-ids/>

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SCANNIX is specialised in the development and sales of nuclear spectroscopy equipment and radioprotection systems. Scannix offers a wide range of measurement devices in order to maintain safety of staff, assess the health of nuclear facilities and safeguard the public and the environment.

<https://www.scannix.com/>
[https://www.linkedin.com/company/scannix-solutions/
info@scannix.com](https://www.linkedin.com/company/scannix-solutions/info@scannix.com)

SCK CEN-NURA contributes to the development of the next-generation radiopharmaceuticals. More specifically, NURA performs game-changing research into radiopharmaceuticals for treating different types of cancer in cooperation with clinical and industrial partners. NURA also performs fundamental as well as applied preclinical research in the field of radiopharmacy, radiobiology and dosimetry. It includes a Hot Animal Facility and a Central Radiochemical Facility.

<https://www.sckcen.be/en/our-scientific-projects/nura> [https://www.linkedin.com/company/sckcen/
koen.hasaers@sckcen.be](https://www.linkedin.com/company/sckcen/koen.hasaers@sckcen.be)

Telix is a global, commercial-stage biopharmaceutical company focused on the development of diagnostic and therapeutic ('theranostic') radiopharmaceuticals. With more than 20 clinical trials underway worldwide (including partnered investigator-led studies), Telix's core pipeline aims to address significant unmet medical needs in prostate, kidney, brain, and blood cancers as well as a range of hard to treat immunologic and rare diseases. Telix's lead product for prostate imaging Illuccix® has been approved in Australia, Canada, and the United States.

<https://telixpharma.com/about/> [https://www.linkedin.com/company/telix-innovations/
info@telixpharma.com](https://www.linkedin.com/company/telix-innovations/info@telixpharma.com)

TRASIS strives to help the medical community gain easier and faster access to new radiolabeled therapeutic and diagnostic substances. To this end, we design, manufacture, sell and support high-performance synthesizers, quality control instruments, dose preparation equipment, shielding and accessories. We also develop customized synthesis methods and instruments. GMP Part I and Part II certified, we produce and supply active pharmaceutical ingredients (APIs Precursors) and support our customers in their regulatory processes. Our proven radiopharmaceutical expertise, combined with our high-end instruments, enables us to provide fully integrated solutions for efficient radiotracer production and a faster transition from drug development to market authorization.

<https://www.trasis.com/en/>
[https://www.linkedin.com/company/trasis/
info@trasis.com](https://www.linkedin.com/company/trasis/info@trasis.com)

Dedicated hard- and software

Belgian universities, hospitals, research institutes and companies have a long tradition in nuclear medical imaging, image processing and/or image management.

From the early seventies on, state of the art nuclear medicine departments in university hospitals in Belgium acquired computers for image acquisition, thereby opening the research fields of digital image processing, including tomographic reconstructions, and image management, including communication between departments or hospitals, "PACS".

A major factor which allowed the nuclear medicine expertise to be build up was not only the production of reactor based radioisotopes at the SCK CEN BR2 reactor, the isotope separation and purification installations at IRE or the creation of IBA, but also the very high density of specific nuclear medical imaging equipment and specialised infrastructure in radiochemistry and radiopharmacy departments, complying with GMP standards. As it is the case for the Belgian expertise in radiochemistry and related fields, most of the cited companies started as spin-offs of Belgian universities and inherited their academic creativity and flexibility.

CYRPA develops non-invasive lasers used for patient-positioning in radiotherapy. Precise patient positioning is essential for a successful radiotherapy treatment. CYRPA's R&D team constantly develops new products in order to meet customers' needs.

<https://www.cyrpa.com/en/home> [https://www.linkedin.com/company/cyrpa-international/
info@cyrpa.com](https://www.linkedin.com/company/cyrpa-international/info@cyrpa.com)

INFINITY is the pre-clinical core imaging facility of Ghent University providing multi- modality imaging services to departments of Ghent University, Ghent University Hospital, Flanders Institute for Biotechnology (VIB) and the industry. The lab houses a wide range of state-of-the-art pre-clinical imaging devices for non-invasive in-vivo imaging of laboratory animals. The following imaging technologies are available: positron emission tomography (PET), single photon emission computed tomography (SPECT), computed tomography (CT), magnetic resonance imaging (MRI), ultrasound (US), and optical imaging (bioluminescence and fluorescence imaging). Next to these imaging modalities, INFINITY also houses a micro-irradiator for small animal precision image-guided radiotherapy.

<https://www.crig.ugent.be/en/infinity>
Infinity@UGent.be

Intuitim provides medical imaging centres with tailored software and services for storage, communication and data management of medical images and health data.

<http://intuitim.com/en/homepage-eng/>
<https://www.linkedin.com/company/intuitim/>
info@intuitim.com

Nuclivision is a Ghent-based MedTech start-up, active in the field of nuclear medicine and Artificial Intelligence (AI). Their mission is to make nuclear medicine safer, more cost- effective, and more efficient for both patients and clinicians. Nuclivision is currently in the product development phase, marketing an innovative medical software device for PET image enhancement. The technology Nuclivision is pioneering has the potential to revolutionize the management of positron emission tomography (PET) scans, which are critical in diagnosing, treating, and monitoring cancer, Parkinson's, and inflammatory diseases. By potentially reducing the amount of time and radioactive tracer dosage needed during PET scan acquisition, their product promises to deliver enhanced efficiencies.

<https://www.nuclivision.com/>
<https://www.linkedin.com/company/nuclivision/?originalSubdomain=be>
info@nuclivision.com

Molecubes provides molecular imaging solutions enabling an easy and flexible approach for in vivo scanning of lab animals: CT, SPECT and PET. The main application is imaging of biological processes in oncology, neurology, cardiology and inflammation.

<https://www.molecubes.com/>
<https://www.linkedin.com/company/molecubes-nv/>
info@molecubes.com

Orthanc is an ecosystem for medical imaging that is released as free and open-source software.

<https://www.orthanc-server.com/>
sebastien.jodogne@uclouvain.be

Radiomics is a next generation Liège-based imaging research organization focusing on AI powered healthcare, with a unique expertise in Radiomics, Deep Learning & Federated Learning applied to oncology and other therapeutic areas. Through our proprietary advanced image analysis technology, we support biopharma and medical device companies in their research development by unraveling the gold mine of hidden data information embedded in standard medical images.

www.radiomics.bio
<https://www.linkedin.com/company/radiomics-bio/?originalSubdomain=be>
info@radiomics.bio

Telemis is a healthcare IT company specialized in PACS/MACS (Picture/Multimedia Archiving & Communication System), Digital Pathology and Healthcare Business Intelligence solutions. Our solutions allow healthcare institutions (hospitals, clinics, etc.), private practices and OEM partners to manage digital imaging

and healthcare data more efficiently. While they move to a more efficient environment and reduce cost, Telemis helps them to provide patients with a better quality of care.

<https://www.telemis.com/>

<https://www.linkedin.com/company/telemis/>

info@telemis.com

Vortal is the company which, since 2004, has been manufacturing TYPE A packages in Belgium, intended for the transport of radioactive products. Vortal is the supplier of the main manufacturers in the field of radiopharmaceuticals.

www.vortal.pro

info@vortal.pro

XEOS wants to tackle the limitations of today's available imaging techniques applied in surgical oncology, by leveraging the power of molecular imaging intra-operatively. Founded in 2019 in Ghent, Belgium, XEOS is an expert in specimen imaging, and focuses on enhancing the predictability of surgery-based treatments, through innovations in intraoperative imaging. Xeos' vision is to be a global technology and knowledge leader that provides surgeons, pathologists and other healthcare professionals absolute surgical confidence, and giving their patients instant peace of mind. The company has a strong track record of in-house PET & CT design. XEOS is an ISO 13485 certified company.

<https://www.xeos.care/>

info@xeos.care

Education and training

The expertise available in universities, companies, research and clinical centres, is shared through different academic and industrial training programs.

The Belgian universities, all part of the worldwide top in the international rankings, offer standard educational programs that can last from a few days to several years and provide certificates up to high-level university grades. The universities have strong links with university hospitals and radiopharmacies providing the perfect educational environment. Most of them, as well as SCK CEN, have open positions for doctoral education and post-doctoral research programs in the field.

Training programs, oriented to different target groups, covering aspects of radioactivity in healthcare such as basic notions of GMP, nuclear safety, clinical trials, transport regulation ... are also offered.

Industries are more oriented towards very specific technical programs related to their equipment and can provide on-site training.

Bordet Institute is an integrated, multidisciplinary centre, unique in Belgium, which enjoys an international reputation. The hospital is devoted entirely to patients affected by cancer. For more than 75 years, their teams have been offering patients leading-edge diagnostic and therapeutic strategies in the prevention, screening and active treatment of all types of cancer. The Jules Bordet Institute also carries out important research activities which every year lead to major discoveries, as well as providing high-level, specialised university training.

<https://www.bordet.be/en>

<https://www.linkedin.com/company/institut-jules-bordet/>

CMMI, Center for Microscopy and Molecular Imaging, is a cutting-edge preclinical imaging facility founded by researchers and academics of the Université Libre de Bruxelles and the Université de Mons which welcomes students for training or internship. They are also co-organizing two-days training on microscopy.

Their platform is established on the Biopark Charleroi Brussels South with the financial support of the European Union and the Walloon Region.

<http://www.cmmi.be/>

<https://www.linkedin.com/company/cmmi---the-center-for-microscopy-and-molecular-imaging/>

info@cmmi.be

Mirion developed and offers a broad array of standard training courses on topics ranging from radiation detection fundamentals to the expert use of Mirion Technologies most sophisticated products. Custom courses include development of learning objectives, presentation materials, and course examinations designed to meet your specific needs.

<https://www.canberra.com/cbns/training/default.html>

https://www.canberra.com/cbns/contact/contact_general.html

ISIB, Institut Supérieur Industriel de Bruxelles. The engineering department of HE2B offers education in six industrial engineering degrees, including a unique Nuclear and Medical Physics degree. The research department has expertise in the field of protection against ionising radiation, the recycling of raw materials, ISO certification of measurement methods... The department also provides training for experts in radiation protection as well as services for private companies.

<https://www.he2b.be>

<https://irisib.be/departements/departement-nucleaire/>

<https://www.linkedin.com/school/isib---institut-sup%C3%A9rieur-industriel-de-bruxelles/>
isib@he2b.be

KU Leuven is dedicated to education and research in nearly all fields. Its fifteen faculties offer classes and degree-granting academic programmes, whilst research activities are organised by departments and research groups. These faculties and departments are clustered into three thematic groups: Humanities and Social Sciences, Science, Engineering and Technology (SET), and Biomedical Sciences. Each of these groups sponsors its own doctoral school for organising and awarding doctoral degrees. KU Leuven boasts thirteen campuses, spread across 10 cities in Flanders.

<https://www.kuleuven.be/english/kuleuven/index.html>

https://www.linkedin.com/school/ku_leuven/

<https://www.kuleuven.be/english/contact>

SCK CEN Academy for Nuclear Science and Technology coordinates all education and training activities of the Belgian Nuclear Research Centre. It relies on 70 years of expertise and experience in the fields of nuclear science and technology, innovative research and the availability of large and unique nuclear facilities. The SCK CEN Academy is an important partner for nuclear education and training in Belgium as well as at international level.

<https://www.sckcen.be/en/academy> <https://www.linkedin.com/company/sckcen/>
academy@sckcen.be

UAntwerpen is a young, dynamic and forward-thinking university, integrating the assets of its historical roots with the ambition to contribute positively to society. UAntwerpen develops, provides access to and disseminates scientific knowledge through research, teaching and academic service to the community and accomplishes these tasks in a spirit of academic freedom and responsibility. The University of Antwerp espouses active pluralism. In that spirit, critical research and teaching, reflection and debate on scientific, social, philosophical and ethical questions are stimulated.

<https://www.uantwerpen.be/en/> <https://www.linkedin.com/school/university-of-antwerp/>
decanaat.fbd@uantwerpen.be

UCLouvain provides higher education programmes to regular students and to professionals and develops high-level research activities, both in close collaboration with socio-economic and cultural sectors and by hosting researchers and students from around the world. UCL is highly placed in international rankings. It is also a pioneer in the creation of massive open online courses.

<https://uclouvain.be/en/study/rdivinfos>

<https://www.linkedin.com/school/uclouvain/>

<https://uclouvain.be/en/study/inscriptions/contacts.html>

UGent is a top 100 university and one of the major universities in Belgium, founded in 1817. Its 11 faculties

offer a wide range of courses and conduct in-depth research within a wide range of scientific domains. UGent is a pluralistic university that is open to all students, regardless of their ideological, political, cultural or social background. 'Dare to think'.

<https://www.ugent.be/en>

<https://www.linkedin.com/school/ghent-university/international@ugent.be>

UHasselt is an independent university which is regionally anchored and has a pronounced international orientation. The university stands for excellence in education, top research in spearhead fields and active engagement in innovation and entrepreneurship. The overall objective is to combine academic excellence with economic and social relevance. Hasselt University targets students with attractive undergraduate, graduate and PhD programmes which are research-led and characterised by a high academic level and the integration of lifelong employability skills. The programmes, among which a master in nuclear technology, are supported by a range of innovative and effective teaching/learning forms.

<https://www.uhasselt.be/en>

<https://www.linkedin.com/company/hasselt-university/research@uhasselt.be>

ULB, Université libre de Bruxelles, is a multicultural university with one third of students and researchers from abroad. Just like the city of Brussels itself, one of the world's most cosmopolitan cities, international relations is a daily reality for the Université libre de Bruxelles. Six Nobel Prizes, two Abel prizes, one Fields Medal, three Wolf Prizes, are further evidence of the University's longstanding tradition of excellence.

<https://www.ulb.be/en>

<https://www.linkedin.com/school/universite-libre-de-bruxelles/> <https://www.ulb.be/en/aid-services-and-support/venseignement@ulb.be>

ULiège, the only complete public university in the Belgian French-speaking community, prides itself on its pluralistic vision and on its pursuit of excellence in teaching, research, and innovation. It is a member of the Wallonia-Europe University Academy (together with Gembloux Agricultural University).

https://www.uliege.be/cms/c_8699436/en/uliege

<https://www.linkedin.com/school/university-of-liege/>

https://www.uliege.be/cms/c_11961789/en/general-contacts

UMONS is ideally located in the heart of Europe. The University of Mons (UMONS) offers a wide variety of courses in an enriching environment, as well as close teacher- student relationships. Research at UMONS is carried out by some 1000 researchers within 10 research institutes, all of which is supported by the Department for Research Support and Technology Transfer. Each Institute brings together the skills of experienced researchers, post-docs and PhD students from several UMONS faculties. Thereby, our researchers are provided with increased visibility among international organizations and donors. With its research excellence UMONS contributes to the socio-economic development of the entire region.

<https://web.umons.ac.be/en/missions/research;>

[https://www.instagram.com/umons/;](https://www.instagram.com/umons/)

<https://www.facebook.com/UniversiteMons/>

<https://twitter.com/UMONS>

sophie.laurent@umons.ac.be

UNamur puts meaning and a focus on the human person as the guiding principles. You will be trained to take responsibility. The commitment of the professors to their teaching role is a priority. The research institutes bring together and interweave various skills around a global topic. This way of functioning favours transdisciplinary collaboration and original approaches for research as well as for teaching.

<https://www.unamur.be/>

<https://www.linkedin.com/school/unamur/>

info.etudes@unamur.be

VUB, Vrije Universiteit Brussel, is an internationally oriented university in Brussels, the heart of Europe. Through tailor-made high quality research and education, VUB contributes in an active and committed way to a better society for tomorrow. VUB is linked to the world from within the international capital Brussels. A never-ending quest for knowledge, insights and enlightenment form the golden thread in all VUB does in education, research and social commitment.

<https://www.vub.be/en>

<https://www.linkedin.com/school/vrije-universiteit-brussel/>

OnderwijsStudentenadministratie@vub.be

Academic research, clinical trials and patient care

Academic research related to health care, whether it is fundamental, preclinical, or clinical, is an essential activity of all Belgian universities and university-based hospitals. Next to better and innovative patient care, this also leads to the creation of spin-offs or to close collaborations with leading industries.

Due to the high level of expertise combined with state-of-the-art equipment in public and private R&D centres, Belgium currently has among the highest number of phase 1 clinical trials and, in particular, clinical trials on radiopharmaceuticals, per capita in Europe.

Bordet Institute

Nuclear medicine <https://www.bordet.be/en/nuclear-medicine>

secrmednuc@bordet.be

Radiopharmacy - Brussels Imaging Pharmacy

zena.wimana@bordet.be

Radiotherapy <https://www.bordet.be/en/radiotherapy>

secretariatradiotherapie@bordet.be

SCK CEN Nuclear Medical Applications Institute <https://www.sckcen.be/en/expertises/exploring-nuclear-medicine> <https://www.linkedin.com/company/sckcen/>

koen.hasaers@sckcen.be

UZLeuven - KULeuven

Nuclear medicine <https://gbiomed.kuleuven.be/english/research/50000677/50000683>

koen.vanlaere@uzleuven.be

Radiopharmacy

guy.bormans@kuleuven.be

Radiopharmacy GMP facility

kim.serdons@uzleuven.be

Radiotherapy <https://www.kuleuven.be/kankerinstituut/en/research/radiotherapy>

Karin.Haustermans@uzleuven.be

UZAntwerpen - UAntwerpen

Iridium radiotherapy network <https://iridiumnetwerk.be/nl/home/> <https://www.uza.be/english>

vrage@uza.be

Molecular Imaging Center Antwerp, MICA, UAntwerpen <https://www.uantwerpen.be/en/research-groups/mica/>

steven.staelens@uantwerpen.be

UCL Saint-Luc – UCLouvain

Nuclear medicine <https://www.saintluc.be/fr/service/service-de-medecine-nucleaire-consultations>

renaud.lhommel@uclouvain.be

Radiopharmacy

radiopharmacie@saintluc.uclouvain.be

Institut Roi Albert Ii (Ira 2) - Adult and Paediatric oncology <https://www.institutroiAlbertdeux.be/fr>

Radiotherapy <https://www.saintluc.be/fr/radiotherapie-oncologique-presentation>
MIRO - UCLouvain/IREC (UCLouvain/ Institut de recherche expérimentale et clinique (IREC)/ Pôle d'imagerie moléculaire, radiothérapie et oncologie (MIRO)) <https://uclouvain.be/fr/instituts-recherche/irec/miro>

UZGent - UGent

Nuclear medicine <https://www.uzgent.be/nucleaire-geneeskunde> nucleaire.geneeskunde@uzgent.be
Radiopharmacy FilipX.DeVos@UGent.be
Radiotherapy <https://www.uzgent.be/patient/zoek-een-arts-of-dienst/radiotherapie-oncologie>
info@uzgent.be

CHU Liège - ULiège

Nuclear medicine https://www.chuliege.be/jcms/c2_16987029/en/medecine-nucleaire-et-imagerie-oncologique/accueil
mednuc@chuliege.be
Radiopharmacy
rhustinx@uliege.be
Radiotherapy https://www.chuliege.be/jcms/c2_17331837/fr/recherche-par-service-specialise?serviceId=17&cid=c2_16987535
radiotherapie@chuliege.be
GIGA-Cyclotron - ULiège https://www.gigacyclotron.uliege.be/cms/c_4221332/en/gigacyclotron
methods.crc.giga@uliege.be

UNamur

LARN, Laboratoire d'Analyse par Reaction Nucléaire <https://www.unamur.be/sciences/physique/ur/larn>
stephane.lucas@unamur.be

ULB Erasme

Nuclear medicine <https://www.erasme.ulb.ac.be/fr/services-de-soins/imagerie/medecine-nucleaire>
SecMed.MedNuc@erasme.ulb.ac.be
Radiopharmacy - Brussels Imaging Pharmacy
zena.wimana@bordet.be

UZBrussel - VUB <https://www.uzbrussel.be/web/international/>

Nuclear medicine
tony.lahoutte@uzbrussel.be
Radiopharmacy - Brussels Imaging Pharmacy
vicky.caveliers@uzbrussel.be
Radiotherapy <https://www.uzbrussel.be/web/radiotherapie/in-het-uz-brussel> , radiotherapie@uzbrussel.be
MITH, Molecular Imaging and Therapy, VUB mith.research.vub.be
mith@vub.be

Supporting activities

The actual medical applications of nuclear science and technology not only rely on the global supply chain from production to delivery, but also require external services and consultancy. To set up a nuclear medicine or radiotherapy department, one must rely on engineers and architects. Strategic intelligence and market advice require external support. Procedures for nuclear and non-nuclear safety of workers and patients must be implemented and regularly controlled. Physical protection and security against aggressions require particular and confidential competences within well-defined legal frameworks.

The listed companies provide this wide spectrum of services.

AgwA technics is the technical spin-off of AgwA architecture. AgwA technics specializes in the integration of complex industrial processes and machinery in buildings. It provides independent follow-up of work site and

of the third-party contractors, engineers to anticipate and minimize the risk of expensive errors. Over the past years, AgwA technics has developed a stable relationship with IBA's protontherapy centers in Europe, Russia, India and Japan.

<http://www.agwa.be>
info@agwa.be

BelV, subsidiary to the FANC (Federal Agency for Nuclear Control), is in charge of the regulatory controls and safety assessments in the main nuclear installations in Belgium.

<https://www.belv.be/index.php/en/>
stephane.palmaerts@belv.be

Be.Sure is a certified radiation protection organisation, active on Belgian territory and abroad, with the mission of ensuring the radiation protection of workers, the public and the environment. The furnished services are education, study of new installations, follow-up of the installations, control on site, help to workers, RPO and responsible, waste characterisation, decommissioning of installations.

<http://besurerp.be/>
info@besurerp.be

CMMI, Center for Microscopy and Molecular Imaging, is a cutting-edge preclinical imaging facility founded by researchers and academics of the Université libre de Bruxelles and the Université de Mons which provides services for academic and industrial partners. Their multidisciplinary team offers a wide range of services, ranging from sub-cellular microscopy to in vivo animal imaging.

Their platform is established on the Biopark Charleroi Brussels South with the financial support of the European Union and the Walloon Region.

<http://www.cmmi.be/>
<https://www.linkedin.com/company/cmmi--the-center-for-microscopy-and-molecular-imaging/>
info@cmmi.be

CYCLADE brings together the expertise and synergies of five Belgian companies (IBA, Interboring, IRE, SCK CEN and Transrad) - specialists in dismantling and nuclear medicine - in order to meet the needs of sites wishing to decommission or dismantle an existing accelerator and its associated facilities, including cyclotrons. This consortium is a combination of industrial companies, SMEs and research centres offering a turnkey decommissioning solution from the study phases to the final management of materials.

<https://www.cyclade.be/>

ICMI, the In Vivo Cellular and Molecular Imaging Core Facility at the Vrije Universiteit Brussel is specialised in nuclear and optical imaging of small animals. The lab is equipped with a myriad of state-of-the art multi-modality cameras and *ex vivo* analysis techniques to study tracer biodistribution, pharmacokinetics, dosimetry, and therapeutic efficacy of (radio)pharmaceuticals. The latest addition in the fee-for- services range is the imaging of living cells, while they are in a true and complex environment, using intravital microscopy.

<https://icmi.research.vub.be/>
icmi@vub.be

MEDRAYSIntElI is a team of international experts providing first-rate strategic intelligence in nuclear medicine, radiopharmaceutical, cyclotron, proton therapy and brachytherapy. It offers the most comprehensive set of reports and directories, with over 4,900 pages of unrivalled intelligence covering some of the most exciting healthcare technologies using radiation for diagnosis and treatment. MEDraysintell also offers client-specific intelligence in the field of radiation healthcare, with the upmost knowledge leveraging our extended network of worldwide contacts.

<https://www.medraysintell.com/>
<https://www.linkedin.com/company/medraysintell/>
contact@medraysintell.com

OMEGA RISK is an independent consultancy practice that assists corporations, organisations and institutions in the fields of security, emergency response and related strategic issues. Main fields of expertise include: critical infrastructure protection, terrorism and organised crime, executive protection, emergency response and competitive intelligence issues.

<https://www.linkedin.com/company/omega-risk/>
ydm@omegarisk.be

PM • Risk-Crisis-Change makes individuals, teams and organizations more resilient to manage crisis situations. PM provides consultancy, training and on the job support before, during and after crises. The PM team is specialised in the coordination and execution of crisis strategies that integrate policy priorities, operational actions and strategic communications and constantly underpins practical expertise with applied scientific research.

<https://pm.be/>
<https://www.linkedin.com/company/pm-risk-crisis-change/>
info@pm.be

The Binding Energy (TBE) is an independent nuclear engineering office, unique in the Belgian nuclear sector and active in different European countries. TBE is a scale-up, aiming to innovate based on the existing nuclear knowledge available in Belgium. The company offers project engineering as well as consultancy for nuclear systems design, licensing and safety studies, third party reviews, customised trainings and new nuclear technology business development.

<https://www.thebindingenergy.com/>
<https://www.linkedin.com/company/the-binding-energy/>
wim@thebindingenergy.com

Tractebel is a global engineering company delivering game-changing solutions for a carbon-neutral future. Insights gathered during our more than 150 years of experience in energy, water, infrastructures and nuclear projects combined with local expertise allow us to tackle complex future-oriented projects.

<https://tractebel-engie.com/en>
<https://tractebel-engie.com/en/our-healthcare-solutions>
<https://www.linkedin.com/company/tractebel-engie-group/>
nuclear@tractebel.engie.com

Vincotte offers objective and advisory services in inspection, certification, conformity assessment and training, striving every day to create a safer and more efficient society.

<https://www.vincotte.be/en/>
<https://www.vincotte.be/fr/radioprotection-controlatom/contact>

Agencies and associations

Belgium hosts several very active Belgian and international agencies, associations and learned societies in, or essential for the field. This not only demonstrates that the expertise is present in Belgium, but also that it is structured and available.

The agencies, associations, learned societies, and **Rad4Med.be** in particular, can bring additional support to any local or foreign entity, private or public, that is seeking help in entering the domain of medical applications of nuclear science and technology.

AWEX, the Wallonia Export & Investment Agency, is the public service in Wallonia in charge both of attracting foreign investment to Wallonia-Belgium and to stimulate foreign trade by assisting the companies established in our region in their export endeavours. It constitutes a one-stop shop for all foreign companies interested in locating to Wallonia or expanding their existing activities and is the complete partner for all Walloon companies wishing to develop overseas.

<https://www.awex.be/en>

<https://www.linkedin.com/company/wallonia-export-investment-agency/?originalSubdomain=be>
<http://www.investinwallonia.be/key-sectors/life-sciences>
lifesciences@awex.be

The Belgian Foreign Trade Agency provides support to the three Belgian Regions and Federal government in promoting foreign trade. The Agency organises joint economic missions linked to an initiative by one or several of the Regions or at the request of the Federal Government.

https://www.abh-ace.be/en_secretariat@abh-ace.be
https://be.linkedin.com/company/abh-ace_secretariat@abh-ace.be

The Belgian Hospital Physicists Association is a Belgian organisation of scientists who want to ensure accurate and safe use of technology and ionizing radiation in medical procedures such as radiology, nuclear medicine and radiation therapy. Hospital physicists are generally known as medical physicists and are uniquely qualified to link the medical doctor to the patient through the responsible use of technology in both diagnosing and treating people. The main responsibility of the hospital physicist is to assure that the radiation prescribed to the patient is delivered accurately and safely.

<https://www.bhpa.eu/>
https://www.linkedin.com/company/bhpa/about_alain.sottiaux@chu-charleroi.be

The Belgian Nuclear Forum, groups companies and institutions that are committed to the use of nuclear technology. The Belgian Nuclear Forum is dedicated to provide information on this technology.

<https://www.forumnucleaire.be> <https://www.nuclearforum.be/>
info@nuclearforum.be

Belnuc is the learned society for all professionals who are primarily concerned with nuclear medicine. As the national society of a small country, Belnuc often serves as a first step for young members to achieve recognition at the European or world level.

<https://www.belnuc.be/>
office@belnuc.be

BeSTRO (Belgian Society for Radiotherapy and Oncology) is the scientific organization of radiation oncology in Belgium. The purpose of the association is to promote the practice and development of radiotherapy and oncology in the broadest sense, as well as to establish a fruitful dialogue with other clinical disciplines that can contribute in an important way to the successful treatment of patients. To this end, BeSTRO organizes training courses and continuing education, but the organization also participates in the development of national guidelines on oncological treatment and promotes scientific studies within radiation oncology.

www.bestro.be
info@bestro.be

BHTC, Belgian Hadron Therapy Foundation, groups all Belgian centres active in the field of hadron therapy.

<https://bhtc.sckcen.be/> sarah.baatout@sckcen.be

BioWin is the Health Cluster of Wallonia, Belgium. It is the regional reference holder for all stakeholders in innovative R&I projects in health biotechnology and medical technologies, whether they are companies, research centers or universities. It also aims to promote Wallonia internationally as a world-class life sciences environment for academic, clinical and industrial research.

<https://biowin.org/>
<https://www.linkedin.com/company/biowin/contact@biowin.org>

BRAVO is the Belgian Radiation Oncology Awareness and Visibility Organization. The Belgian radiation oncology providers (physicians, medical physicist, nursing staff) team up with the medical industry that offers

the tools and systems to provide high-quality radiation therapy treatments to patients with cancer. Within BRAVO, they create better awareness of radiation-oncology as a very safe and very modern treatment method of cancer. The main aim of this cooperation is to spread this message among patients, medical colleagues, politicians and press.

<https://bravo-radiotherapie.be/en>

<https://bravo-radiotherapie.be/en/contact>

Brussels LifeTech is the public Brussels HealthTech cluster. It aims at facilitating and stimulating the attractivity and success of high potential HealthTech solutions with a focus on social and environmental impact. Its goal is to accelerate the availability of innovative healthcare solutions at the service of patients' wellbeing and professionals' needs by promoting collaborations and synergies between entrepreneurs, researchers, makers, practitioners and industries.

<https://lifetechbrussels.com/>

lifetech@hub.brussels

BVS-ABR, the Belgian Society for Radiation Protection is the learned society interested in the protection against the risks of ionising radiation. The association is member of the International Radiation Protection Association, IRPA.

<https://www.bvsabr.be/>

office@bvsabr.be

ECPC, the European Cancer Patient Coalition, works for a Europe of equality, where all European cancer patients have timely and affordable access to the best treatment and care available, throughout their life regardless: nationality/the country they were born in; where they live; their education; sex; age; social background.

ECPC works to ensure that the scope of the entire cancer care pathway effectively includes prevention, treatment, survivorship and palliative care.

<https://ecpc.org/>

info@ecpc.org

ECSA, the European Corporate Security Association, is the professional association of managers in charge of security, resilience and anticipation at public & private corporations and institutions, active in Europe. Their mission is to inform, educate and connect the security communities. Their vision is to be the trusted catalyst in enhancing security, resilience & anticipation.

<https://www.ecsa-eu.org/>

secretariat@ecsa-eu.org

EITA is a non-profit association, founded by European logistics companies, trained, licensed and highly sophisticated in transport and handling of radioactive isotopes, mainly used for medical purpose and / or research.

<http://www.eita.org/>

info@eita.org

Embassy of Belgium in Vienna - Permanent Representation to the UN & IAEA.

The Belgian embassy in Vienna represents Belgium at the International Atomic Energy Agency.

<https://diplomatie.belgium.be/en/embassies-and-consulates>

Vienna@diplobel.fed.be

EORTC, the European Organisation for Research and Treatment of Cancer, is a pioneer in promoting multi-disciplinary cancer clinical research and pan-European collaboration and links a network of more than 2.500 clinicians and scientists in more than 300 hospitals in over 30 countries. Founded in 1962, the EORTC encompasses all aspects of cancer clinical research, from translational research and new drug development to large phase III clinical trials and meta-analyses.

<https://www.eortc.org/> <https://www.eortc.org/contact/?related=General>

denis.lacombe@eortc.be

FANC-AFCN, the Federal Agency for Nuclear Control promotes the effective protection of the general public, workers and the environment against the hazards of ionising radiation.

<https://fanc.fgov.be/nl> <https://afcn.fgov.be/fr>
meldpunt@fanc.fgov.be
pointcontact@fanc.fgov.be

FIT, Flanders Investment & Trade, is the key point of contact for international business in Flanders.

<https://welcome.flandersinvestmentandtrade.com/en>
info@fitagency.be

hub.brussels works with entrepreneurs based in Brussels and elsewhere and with our partners to create a modern urban economy that lives up to its social and environmental values and to bring out the best in Brussels in terms of innovation, internationalisation and socio-economic impact.

<https://hub.brussels/en/>
<https://hub.brussels/en/complete-list-of-economic-and-commercial-attaches/>
info@hub.brussels

Kom op tegen Kanker is a non-governmental organisation, pioneer and point of contact in the fight against cancer in the Flemish Community.

<https://www.komoptegenkanker.be/>
info@komoptegenkanker.be

LiEU Network brings together the knowledge transfer services of the six universities of the Fédération Wallonie-Bruxelles. LiEU is a unique gateway to all the skills of universities that connects researchers and private or public partners in order to stimulate collaboration.

<https://reseaulieu.be/en/>
contact@reseaulieu.be

ONDRAF/NIRAS, the Belgian Agency for Radioactive Waste and Enriched Fissile Materials, manages all radioactive waste in Belgium. That waste is generated in nuclear power plants, research institutes, hospitals, laboratories and in the industry. By identifying, transporting, processing, storing and disposing of the waste, ONDRAF/NIRAS protects the population and the environment from the risks caused by radioactive waste. The waste is monitored in every step of the process by an extensive control system.

<https://www.niras.be/>
<https://www.ondraf.be/>
info@nirond.be

Nuclear Medicine Europe is an industry association representing the majority of radiopharmaceutical & imaging equipment companies in the field of Nuclear Medicine in Europe. Based in Brussels, the association has several working groups focused on the main challenges the nuclear medicine field is facing, such as the security of supply, transport of radiopharmaceuticals, or regulatory affairs. The association is a key partner with European Institutions and works hand in hand with the Euratom Supply Agency through the European Observatory on the Supply of Medical Radioisotopes.

<https://nuclearmedicineeurope.eu/>
admin@nmeu.org

Oncidium foundation: Pioneering a Future of Hope for Cancer Patients.

Oncidium foundation envisions a world where everyone affected by cancer has access to cutting-edge radioligand therapy. With a global network of over 70 ambassadors, the nonprofit focuses on three key pillars: Access: Initiating the RLT-Connect Platform to enhance global access and finance treatment for needy cancer patients, especially in low- and middle-income countries.

Education: Addressing awareness gaps by offering a range of educational materials tailored for patients, oncologists, and the nuclear medicine community.

Hope: Serving as a driving force in the fight against cancer through pioneering research initiatives to broaden access to innovative therapies, fostering hope for those affected by this severe illness.

<https://www.oncidiumfoundation.org/>

[https://www.oncidiumfoundation.org/contact/
contact@oncidium-life.org](https://www.oncidiumfoundation.org/contact/contact@oncidium-life.org)

Rad4Med.be is a non-profit network. It aims at promoting medical applications of nuclear science and technology by creating awareness about the use of radioactivity in healthcare and improving its visibility. It provides interested parties a network of competences available in Belgium and, when requested, helps find the correct sources of information or partners.

<https://www.linkedin.com/company/rad4med-be/>

<http://rad4med.be/>

contact@rad4med.be

Stichting tegen Kanker – Fondation contre le Cancer. The Foundation against Cancer funds the work of many researchers at Belgian universities, provides information, social assistance and support to people with cancer and their families and contributes to prevention and detection through the wide dissemination of scientifically validated information.

<https://www.kanker.be/>,

<https://www.cancer.be/>

<https://www.kanker.be/contactformulier>

<https://www.cancer.be/formulaire-de-contact>

brussel@stichtingtegenkanker.be

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The Belgian expertise in nuclear science and technology applications for healthcare

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contact@rad4med.be