



An essential element of health care

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When people think about nuclear power, they think about the electricity that powers their daily lives. In addition to producing enough carbon-free electricity to power one third of the homes, businesses and hospitals in Ontario, Bruce Power contributes to the world's health care system through its decades of isotope production, a legacy it continues to build upon.

Bruce Power's isotopes are used every day — in the global fight against cancer, to keep our hospitals clean and safe, combat disease, and sterilize food against pathogens.

As we look to the future, innovations in medical isotopes are providing a pathway for researchers and health care professionals to improve lives through targeted cancer therapies. These ground-breaking therapies use the power of medical isotopes to improve patient outcomes, by offering treatments tailored to the individual's unique diagnosis.

Medical isotopes are providing a foundation to advance research in cancer treatments and procedures to help save lives.

Bruce Power is proud of the role it plays in powering medical innovation. Together, scientists, researchers, doctors and the nuclear industry are focused on working to build a better tomorrow.

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Isotope i·so·tope | ɪˈsəʊltəp

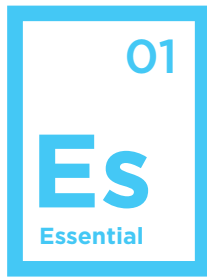
noun

- 1 any of two or more species of atoms of a chemical element with the same atomic number and nearly identical chemical behaviour but with differing atomic mass or mass number and different physical properties.

There are both stable and non-stable isotopes. Non-stable isotopes, or radioisotopes, exhibit radioactive decay, emitting radiation to transform to the element's more stable form. Each isotope has a unique half-life, which is the time it takes for half of the atoms to undergo radioactive decay, ranging from nanoseconds to hundreds of thousands of years. These unique characteristics make radioisotopes useful in a variety of applications, from medicine, to food preservation, to powering batteries for space exploration.

“We’re extremely proud of Bruce Power’s positive impacts on millions of people worldwide. Aside from providing clean, carbon-free electricity for Ontario families and businesses, we also supply medical isotopes internationally. Together, we are powering innovation which allows us to help power our province and keep Canada at the forefront in the supply of life-saving medical isotopes.”

Mike Rencheck, President & CEO, Bruce Power

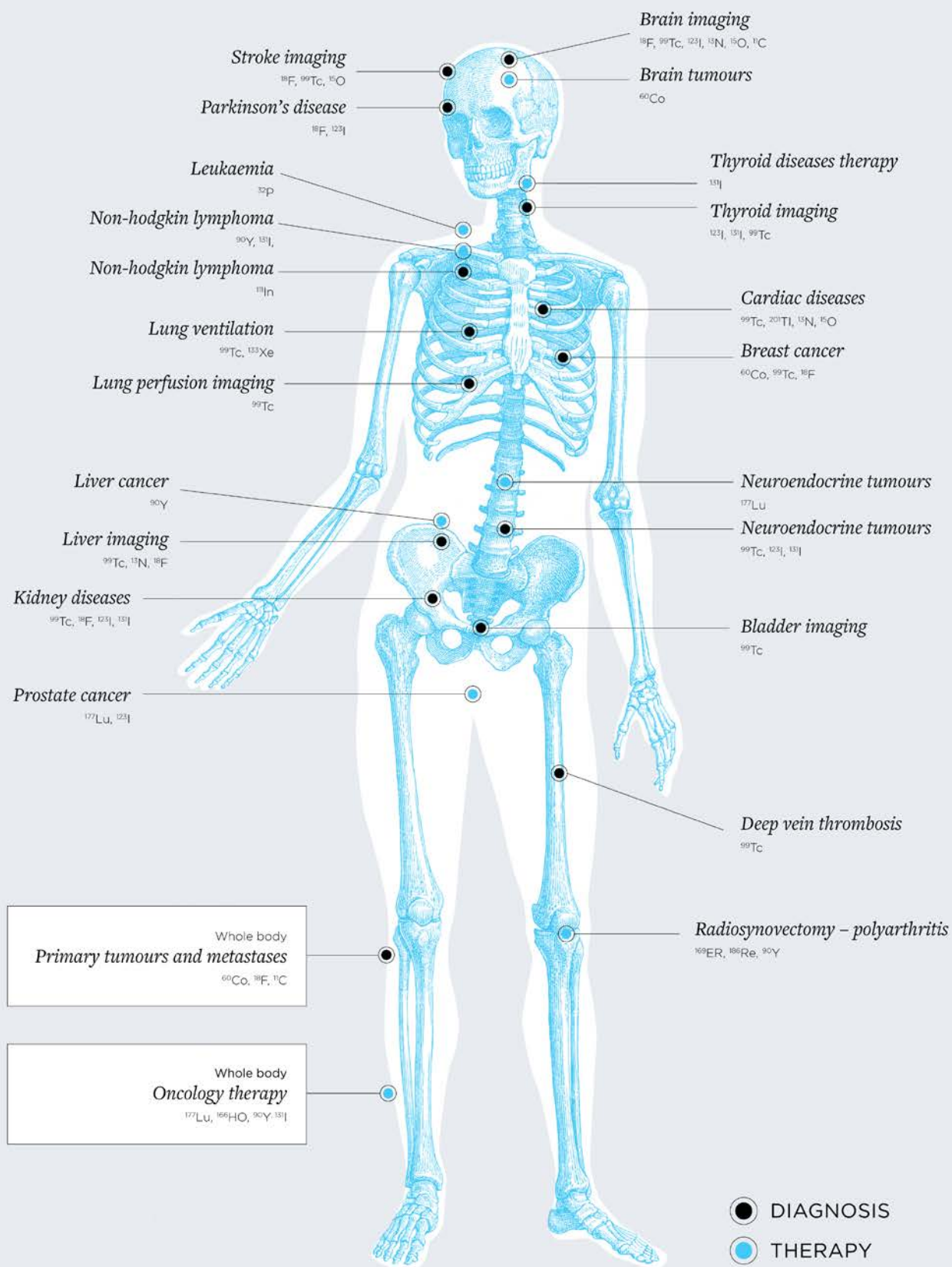


Medical isotopes

The nuclear industry plays an important role in the fight against cancer through the production of medical isotopes. For more than 50 years, Canada has been a global leader in the research, development and production of medical isotopes.

Medical isotopes are the cornerstone of a rapidly expanding field of nuclear medicine. Medical isotopes are used for diagnostic purposes in oncology, cardiology and neurology. Therapeutic applications for isotopes, particularly as a treatment for cancer, are a quickly growing area of nuclear medicine.

Worldwide, over 40 million nuclear medicine procedures are performed each year¹, with approximately 36 million for diagnostic nuclear medicine and four million for therapy. This number is expected to grow as demand for these powerful medical tools is harnessed and treatments are developed for an expanding list of cancers.

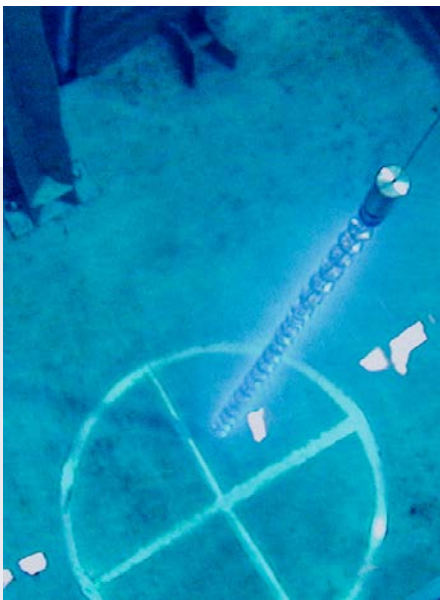


Source: Association of Imaging Producers and Equipment Suppliers



History of isotopes at Bruce Power

Bruce Power has been a global leader in the production of medical isotopes for over 35 years, beginning with production of cobalt-60 in the four Bruce B units, an isotope used worldwide to keep hospitals clean and safe and in the fight against cancer.



1986

First harvest of cobalt-60 at Bruce Power

Used to sterilize medical devices such as sutures, gloves and syringes.

2019

First harvest of medical-grade cobalt-60 at Bruce Power

Used worldwide in cancer treatment and radiation therapy for complex brain conditions.

July 2019

Bruce Power announces partnership with Kinectrics and Framatome

to develop an Isotope Production System (IPS) for use in Bruce Power reactors.

In 2022, Bruce Power took another leap forward in its isotope program, expanding capabilities to supply cancer-fighting isotopes to the world market through the installation of a first-of-a-kind Isotope Production System (IPS) for the production of a short-lived isotope, lutetium-177. This innovation was made possible through partnerships with Isogen (a Kinectrics and Framatome company), which designed and manufactured the IPS and with ITM, which processes and distributes medical isotopes.

As we look to the future, the unique design of the IPS offers flexibility in function, opening the door to a wide range of research and development in the Canadian isotope landscape.

Bruce Power is crucial to the world isotope supply, helping make Canada a global leader in the production of medical isotopes used in the sterilization of medical equipment and in the diagnosis and treatment of certain forms of cancer, here at home and around the world.



2022
Installation of IPS In
Bruce Power's Unit 7

Lutetium-177 is the first medical isotope produced using the IPS, used to treat neuroendocrine tumours and has applications for prostate and breast cancer treatments.

2022
Bruce Power becomes the first
commercial nuclear reactor in the
world to produce lutetium-177.

2022
MOU with Boston Scientific
to explore the production of
yttrium-90.



Cobalt-60

For more than 35 years, Bruce Power has been a consistent, reliable source of cobalt-60 which is an isotope that emits gamma rays essential to the medical community.

Cobalt-60 is an isotope used to sterilize over 40 per cent of the world's single-use medical equipment through gamma irradiation, a process which sterilizes equipment more quickly and in larger volumes than other forms of sterilization. Each harvest of cobalt-60 from Bruce Power sterilizes billions of single-use medical devices. Demand for cobalt-60 continues to grow to meet demand from the world's health care sector for syringes, gloves, surgical gowns and masks.

Gamma irradiation from cobalt-60 has applications that go beyond the medical industry, and is used in a wide range of industrial and commercial settings to safeguard our health. Cobalt-60 is used in the sterilization of pharmaceuticals, and to disinfect food and consumer products. From spices and cosmetics, to the elimination of invasive insects on tropical produce and the treatment of microorganisms such as salmonella on meat, gamma irradiation from cobalt-60 keeps consumer products safe without the need of exposure to chemical treatments which may leave traces and residue behind.

Bruce Power is one of only a small number of global producers of medical-grade cobalt-60, used in radiation therapy in the treatment of complex cancers and conditions through non-invasive procedures like the Leksell Gamma Knife®, and the GammaPod. Leksell Gamma Knife® is used for the non-invasive treatment of complex brain cancers, and delivers a single, high dose of radiation with a high degree of accuracy. This technology, which is growing in popularity, is used in over 360 hospitals worldwide, including six in Canada. Medical-grade cobalt-60 can also be used for the treatment of breast cancer through the GammaPod, a treatment which offers shorter treatment plans with high efficiency.

Decades of Partnership

Bruce Power has a long-standing partnership to supply cobalt-60 to Ottawa-based Nordion, a leading provider worldwide of medical isotopes and gamma irradiation technologies used for the prevention, diagnosis and treatment of disease and infection. Nordion supplies cobalt-60 products to more than 40 countries around the world, and is committed to safeguarding global health care.



Gamma Knife® Radiosurgery

Leksell Gamma Knife® radiosurgery is a type of radiation therapy used to treat tumours and other abnormalities in the brain.

In Gamma Knife® radiosurgery, specialized equipment focuses close to 200 tiny beams of radiation on a tumour or other target. Although each beam has very little effect on the healthy tissue it passes through, a strong dose of radiation is delivered to the site where all the beams meet.

The precision of Gamma Knife® radiosurgery results in minimal damage to healthy tissues surrounding the target. In some cases, radiosurgery may have a lower risk of side effects compared with other types of radiation therapy. Radiosurgery is usually a one-time therapy completed in a single day.

Skutterudite



Mining

Cobalt-59 can be found in minerals such as the crystal shown below (CoAs₃)



Manufacturer

Plant manufactures cobalt-59 pellets and slugs



Manufacturer

Plant inserts pellets and slugs into adjusters, which are delivered to reactors.

Cobalt-60 production process

Cobalt-59 adjustor rods are irradiated for up to 24 months, when the resulting cobalt-60 can be harvested during planned reactor outages.

Nuclear Reactors

Adjusters are installed in the reactor core where cobalt-59 is irradiated to become cobalt-60.

During a planned maintenance outage, it is harvested and stored in the secondary fuel bay (right).



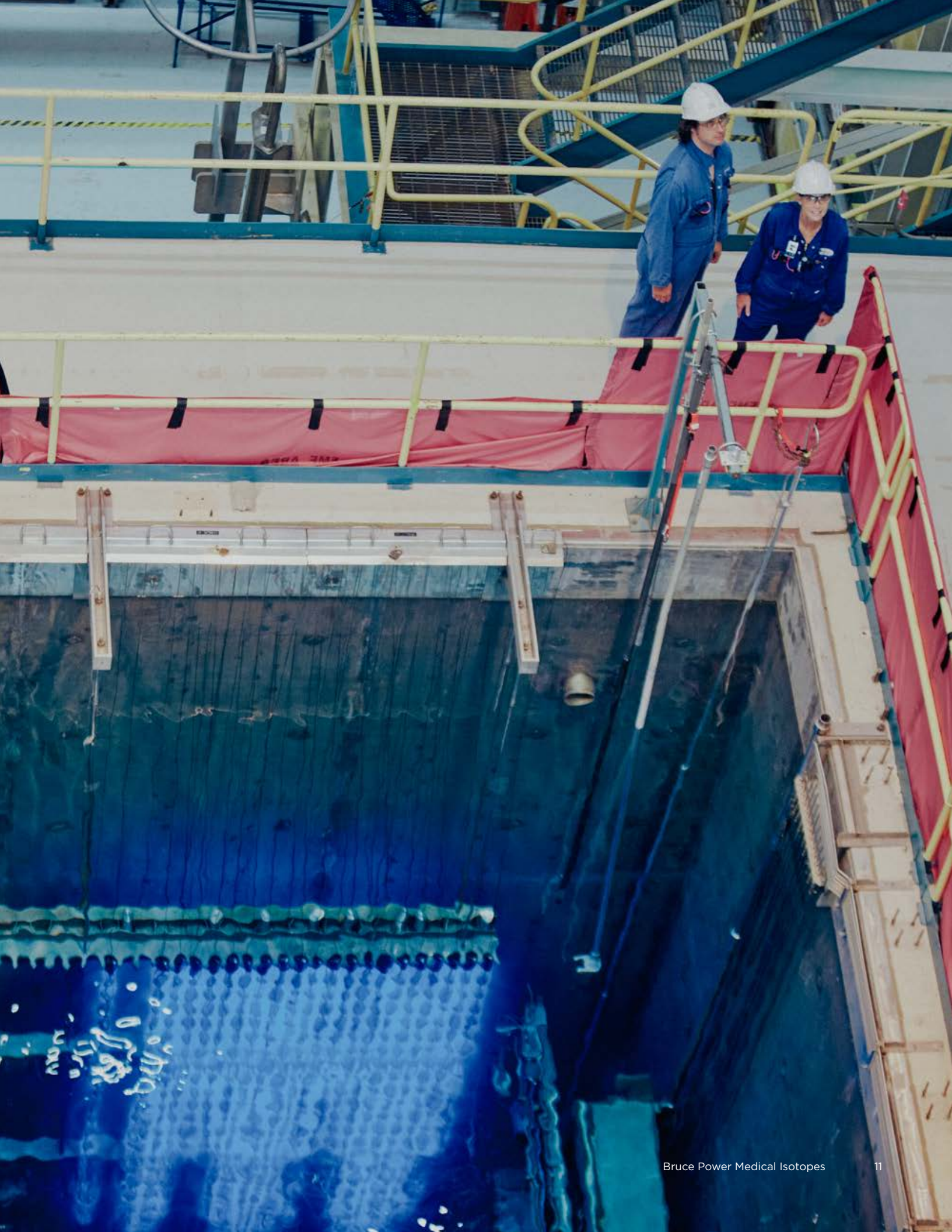
The cobalt-60 is removed from the fuel bay and shipped to the processing facility.

Isotope Processors

At the facility, the cobalt-60 is processed into sources for industrial or medical use.

Global Distribution

The sources are shipped globally.





Lutetium-177

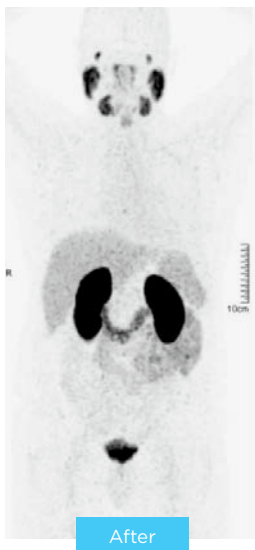
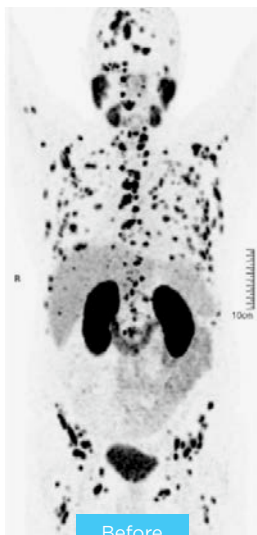
Bruce Power is the first commercial nuclear power reactor in the world to produce lutetium-177, a short-lived medical isotope, using a first-of-a-kind Isotope Production System (IPS).

Lutetium-177 produced at Bruce Power will be used in precision oncology for targeted therapy of a growing number of cancers, including neuroendocrine tumors and prostate cancer. Lutetium-177 treatments are designed to deploy nuclear medicine that precisely targets malignant cells while sparing surrounding healthy tissues.

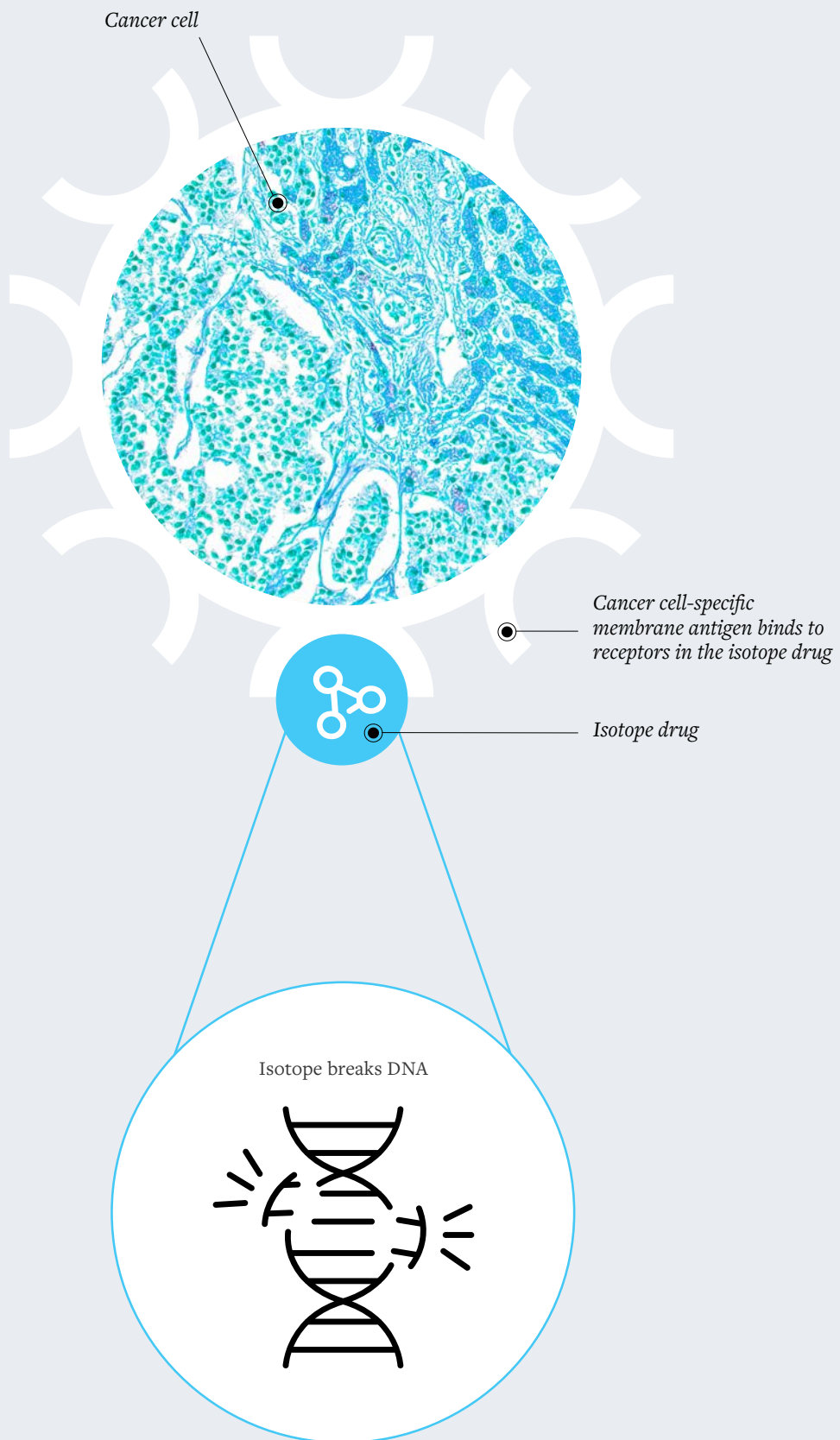
Bruce Power's lutetium-177 is sent to ITM Isotope Technologies Munich SE (ITM) in Germany for processing to yield high-quality, pharmaceutical-grade no-carrier-added lutetium-177 (n.c.a. lutetium-177). ITM is a supplier of n.c.a. lutetium-177 to health care facilities around the world, and the isotope has been successfully used in various clinical and commercial radiopharmaceutical cancer treatments.

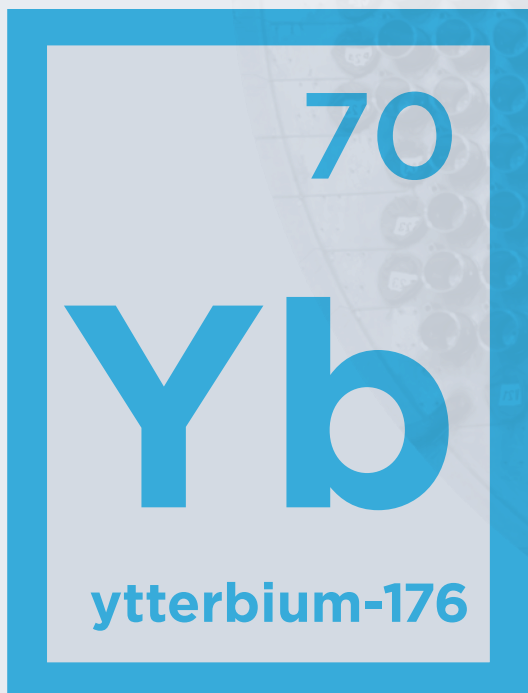
This advancement in isotope production further cements Bruce Power as a worldwide leader in the production of medical isotopes, and matures Canada's status as a leader among the international medical isotope community.

Lutetium-177 has unique properties which make it increasingly popular in nuclear medicine for therapeutic cancer treatments. Lutetium-177 emits sufficient gamma radiation for imaging, while its beta radiation allows for the therapeutic treatment of tumours. In combination with a targeting agent, a treatment known as "theranostics" allows for targeted treatments designed for maximum effectiveness. This can help reduce the severity of side effects when compared to chemotherapy or radiation therapy.



*Cancer treatment
with lutetium-177²*





Germany-based ITM sends ampules of ytterbium-176 to Isogen

Lutetium-177 production process

Ytterbium-176 is irradiated to become ytterbium-177 and decays to lutetium-177 in the Isotope Production System in Bruce Power's Unit 7, allowing for the full production cycle to complete while the unit is online.

The targets are loaded into the nuclear core and irradiated to lutetium-177

Isogen encases ampules in target carriers, which are shipped to Bruce Power



Actual size

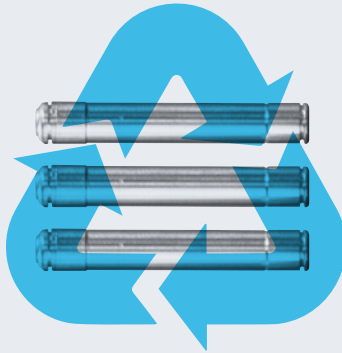


Targets are extracted from the core and packaged for transportation



Packages are transported to ITM in Germany for processing

Recovered recycled target material is decayed for use in a subsequent irradiation



Pharmaceutical-grade lutetium-177 is shipped to customers across the world to treat patients

ITM processes targets into highly pure, pharmaceutical-grade, no-carrier-added lutetium-177





Isotope Production System

The installation of a groundbreaking Isotope Production System (IPS) was completed at Bruce Power in 2022, and commercial production of lutetium-177 began later that year, making Unit 7 the first commercial power reactor in the world capable of producing short-lived medical isotopes.

Commercial production of lutetium-177 is the culmination of a multi-year project among a dynamic, international partnership which began in 2019. This ambitious timeline will help meet growing demand from doctors and cancer patients around the world.

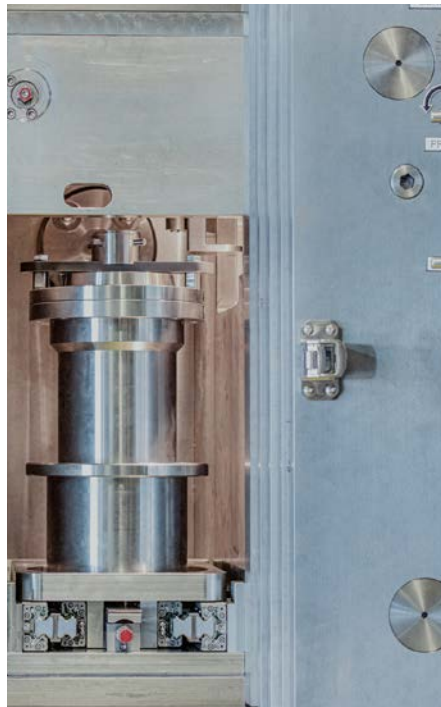
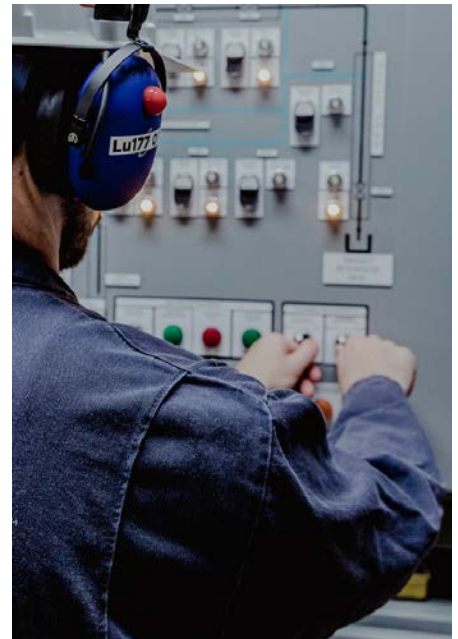
The IPS is a game-changer in the global medical isotope supply chain, providing unprecedented capacity for isotope

production within existing Bruce Power nuclear infrastructure. Historically, most medical isotopes are produced in smaller research reactors with non-continual operation. Bruce Power's continual operations 24 hours a day, seven days a week means a consistent supply of cancer-fighting isotopes, in a much larger production capacity than traditional research reactors are able to supply.

An Innovative Partnership

Bruce Power worked with a unique group of domestic and international partners to bring the Isotope Production System to commercial service.

Isogen is a joint venture between Framatome and Kinectrics whose mission is to enable the use of CANDU reactors to produce the medical isotopes needed to treat and diagnose patients with serious diseases worldwide.



ITM Isotope Technologies Munich SE (ITM) is a Germany-based radiopharmaceutical biotech company that specializes in cancer treatment and provides the source material for isotope creation. ITM is responsible for isotope processing and distributing the final product.

Gamzook'aamin aakoziwin (*We are fighting the sickness together*) A Bruce Power and Saugeen Ojibway Nation (SON) partnership; SON is an equity investor and partner to jointly market isotopes in support of the global fight against cancer.

2019 partnership signing with Greg Nadjiwon, Chief of Chippewas of Nawash Unceded First Nation; Lester Anoquot, Chief of Saugeen First Nation; and Mike Rencheck, President & CEO Bruce Power



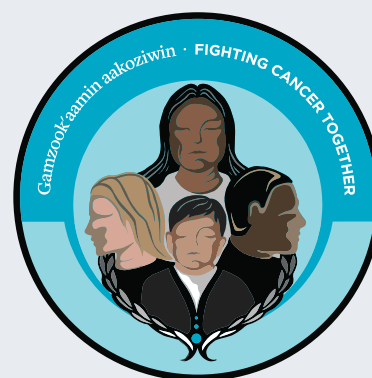
Gamzook'aamin aakoziwin

Bruce Power's site lies within the traditional Treaty Territory of the Saugeen Ojibway Nation (SON). SON is comprised of two communities, the Chippewas of Nawash Unceded First Nation and the Chippewas of Saugeen First Nation. The SON people are Anishinaabek People of the Great Lakes Region. SON describes both the Territory (lands and waters) and the People who have lived with and protected the Territory since time immemorial.

Conrad Ritchie, Chief of Saugeen First Nation at the 2022 MOU signing with Boston Scientific to explore the feasibility of producing cancer-fighting yttrium-90



2022 event to announce Ontario as an isotope innovation hub. Participating in the event were (from left) Mike Rencheck, President & CEO, Bruce Power; Veronica Smith, Chief of Chippewas of Nawash Unceded First Nation; Premier Doug Ford; and Hon. Todd Smith, Ontario Minister of Energy.



Logo design by SON
artist Emily Kewageshig

Bruce Power is committed to working toward true reconciliation and building partnerships that offer real and tangible benefits for Indigenous communities.

Bruce Power has partnered with SON in an historic collaboration to market medical isotopes. The partnership, named “Gamzook’aamin aakoziiwin,” which translates to “We are teaming up on the sickness,” includes an equity stake for SON and a revenue-sharing program that provides a direct benefit to the community, for the marketing of current and new isotopes produced through the IPS.

The Gamzook’aamin aakoziiwin partnership supports the global fight against cancer while creating new, meaningful economic opportunities within SON Territory. It is a demonstration of Bruce Power’s recognition that the next 50 years of Bruce Power operation in SON Territory must be different than the past 50 years as we move forward, fighting cancer together.

“We are proud to be a part of this innovative project, which will have a positive impact worldwide on the health care community. Working together through this partnership, we are playing a leadership role in the fight against cancer and continuing to increase access to isotopes that are critical to innovative treatment and diagnosis of cancer.”

Chief Veronica Smith, Chippewas of Nawash Unceded First Nation.

110.00 mm

C

120kV, 200mAs

SC 350.0 mm

SW 5.00 mm

Z 1.21

R



10 cm

P

C1 61

W1 338

“We are pleased to have the support of Bruce Power to expand our network of reliable supply chain channels, which enables us to continue to help more patients around the world in their fight against liver cancer through precise and effective Y-90 therapy.”

Peter Pattison, President, Interventional Oncology & Embolization, Peripheral Interventions, Boston Scientific



Powering Medical Innovation

The Isotope Production System is designed to be capable of producing a wide variety of isotopes. While the IPS installed in Bruce Power’s Unit 7 will be used in an exclusive agreement to supply lutetium-177, the same or very similar systems may be installed on other units at Bruce Power, allowing for additional nuclear substances or isotopes as global market demands dictate.

Bruce Power and Isogen have partnered with Boston Scientific to investigate the potential for the production of yttrium-90 (Y-90), an innovative internal radiation therapy treatment used for liver cancer.

TheraSphere™ Y-90 Glass Microspheres, manufactured by Boston Scientific, are a targeted liver cancer therapy consisting of millions of microscopic, irradiated yttrium-90 glass microspheres used to treat hepatic malignancies.

As we look toward the future, the possibilities for the IPS to serve the world’s medical community with cancer-fighting isotopes is vast, positioning Ontario as a global leader in the production of medical isotopes and ensuring Canada is at the forefront of isotope research, development and innovation.



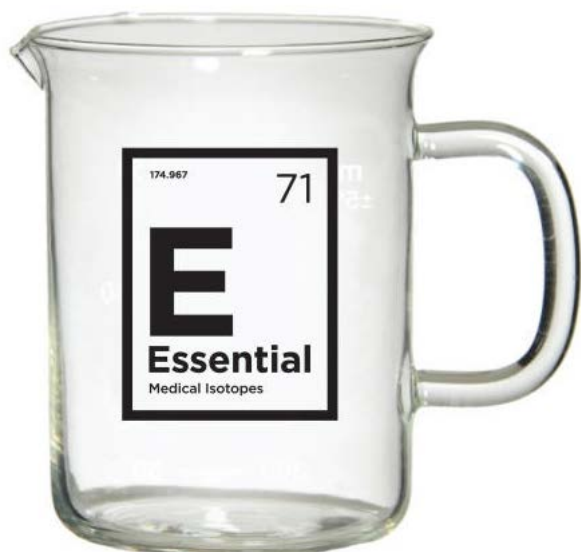
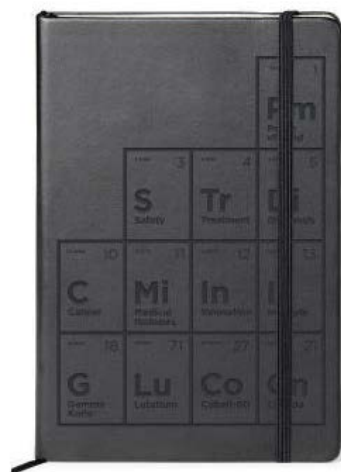
*TheraSphere™ Y-90
Glass Microspheres,
manufactured by
Boston Scientific*



Things you'll use. Periodically.

With every item purchased, \$1 will go to both the Pediatric Oncology Group of Ontario and Brain Tumour Foundation of Canada to support their important work.

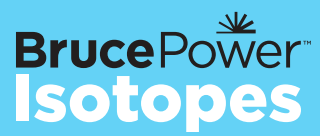
Visit isotopemerch.com to purchase.





References

- 1 Canadian Nuclear Association — cna.ca
- 2 How clinical imaging can assess cancer biology — Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Theranostic-in-oncology-with-PSMA-177-Lu-PSMA-radioligand-therapy-in-a-67-year-old-man_fig6_331518755 [accessed 10 Jan, 2023]



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