

BWXT ITG Canada & TRIUMF Partnership



About BWXT

BWX Technologies, Inc. (BWXT) is a leading supplier of nuclear components and fuel to the U.S. government; provides technical, management and site services to support governments in the operation of complex facilities and environmental remediation activities; and supplies precision manufactured components, services and CANDU® fuel for the commercial nuclear power industry.

Safety is ingrained in our culture. As a guiding principle in all operations, BWXT is committed to the safety of each employee with a vision of zero accidents. We maintain a highly skilled security force that is vital to the safety and security of the facilities where we provide complex operations management.

About BWXT



NUCLEAR OPERATIONS GROUP
(BWXT NOG)



NUCLEAR SERVICES GROUP
(BWXT NSG)



NUCLEAR POWER GROUP
(BWXT NPG)



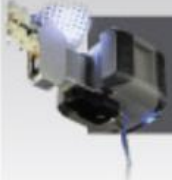
**NUCLEAR
OPERATIONS
GROUP**



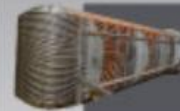
**NUCLEAR
FUEL
SERVICES**



**TECHNICAL
SERVICES
GROUP**



**NUCLEAR
ENERGY
U.S.**



**BWXT
CANADA**



**BWXT
NUCLEAR
ENERGY CANADA**

Objective of the Partnership

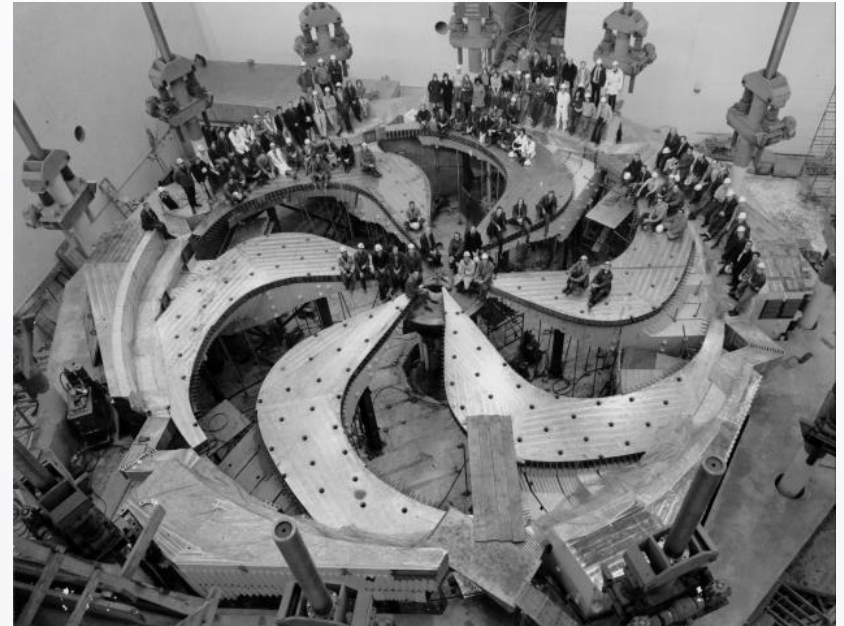
Atomic Energy of Canada Limited (AECL) was to combine its entrepreneurial and business skills as an international supplier of radioisotopes with the unique **TRIUMF** expertise in both cyclotron design and operation. This was to be a new business development for **CANADA** that depended completely on the combined and complimentary skill sets of the two parties.



1978 Technical Support Agreement

Crown corporation **Atomic Energy of Canada Limited (Commercial Products)** and TRIUMF sign a Technical Support Agreement

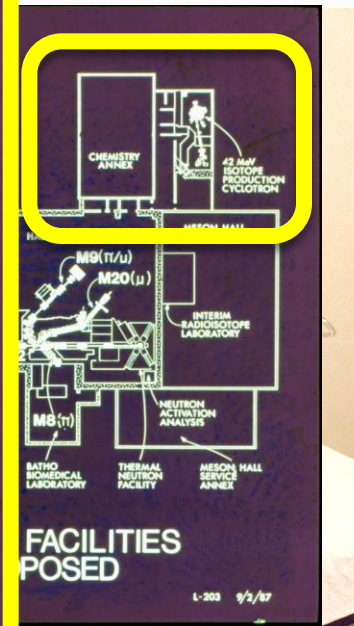
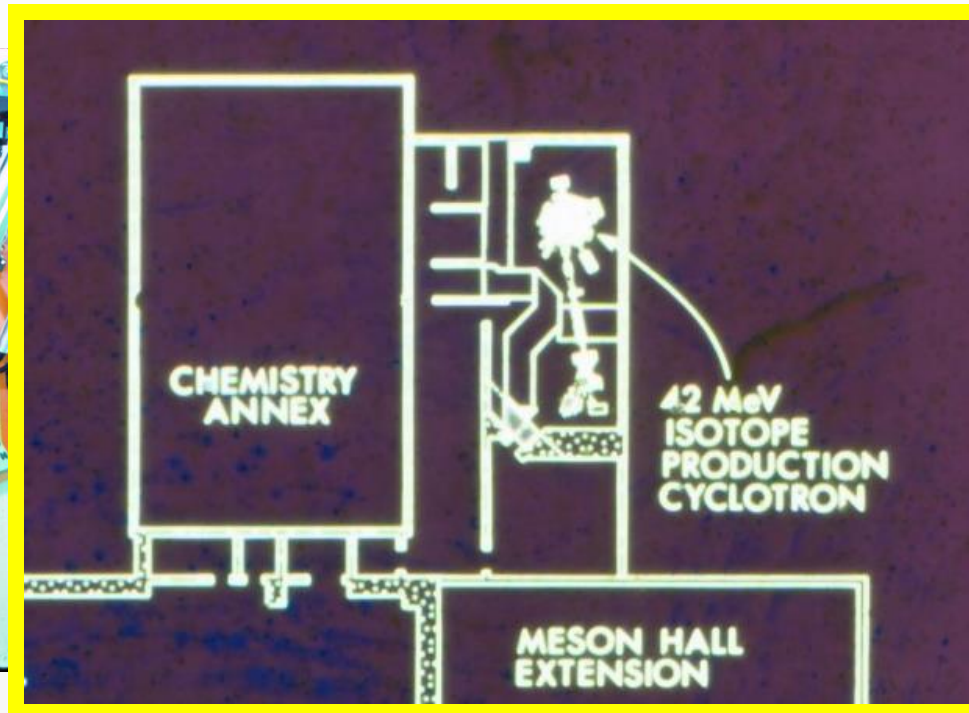
- UBC Lease Agreement
- Use of 500 MeV cyclotron



Late 1970's - Radiochemical Annex (RCA-1) Construction

Construction starts 1977 with **Nordion** occupancy in 1980

- Installation of first set of hot cells Q4 1979
- Radiochemistry development 1980

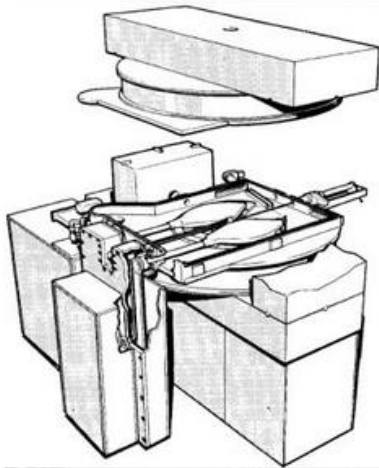


Purchase of the CP42 Cyclotron

AECL identifies **The Cyclotron Corporation (TCC)** of Berkley, CA as the supplier for a cyclotron for Medical Isotope Production.

- Purchase order in 1980 for ~ \$ 2.5 M. Target delivery 1982.
- A TCC CP-42 negative ion cyclotron was selected. Same accelerator had been ordered by Karlsruhe in Germany, Argentina, and by Mallinckrodt and Amersham in the US.

NEW FOR NUCLEAR RESEARCH FROM THE CYCLOTRON CORPORATION



30-INCH AVF CYCLOTRON

■ This new cyclotron produces intense external beams of protons, deuterons, and helium-3 ions, and, with suitable targets, fast and thermal neutrons. These particles can be used for activation analysis, isotope production, low energy nuclear structure research and physics teaching, and for radiation effects and shielding studies. The cyclotron can also be modified for negative ion acceleration and use as an injector to a Tandem Van de Graaff accelerator.

PERFORMANCE

Particle	Proton	Deuteron	Helium-3	Fast Neutron ¹	Thermal Neutron ¹
Energy	15 MeV	7.5 MeV	20 MeV		
Resolution	75 keV	38 keV	100 keV		
Current	50 μ A	50 μ A	50 μ A	2×10^{-7}	5×10^6

Beam Size at Exit Port, 0.5 inch diameter, .050 radian divergence

¹Ba¹³⁵(d,n)Ba¹³⁶: thick target, n/cm²/sec

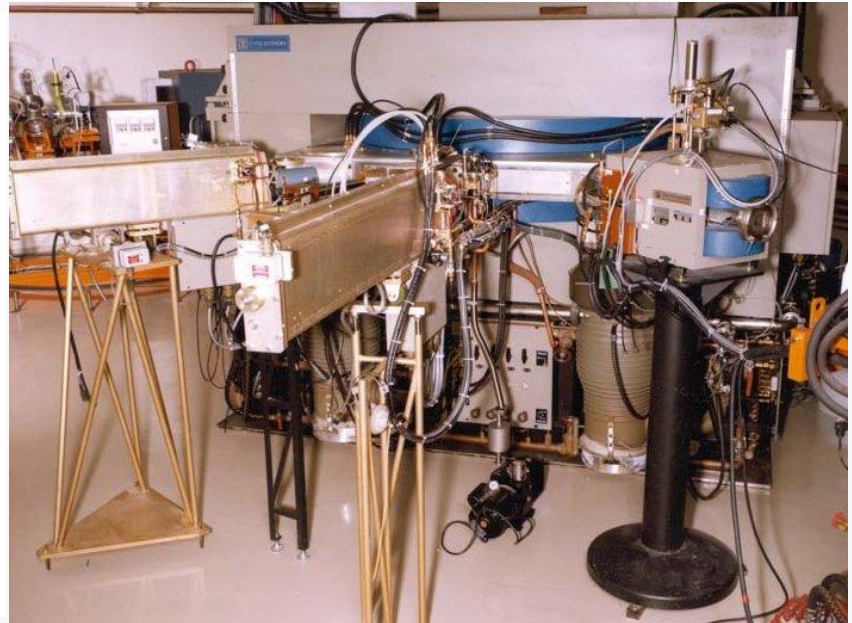
¹With paraffin moderator, n/cm²/sec

FEATURES

■ Compact size for minimum shielding requirements ■ Separable magnet for full access to accelerating region ■ Preset focusing sectors eliminate harmonic coils ■ Solid state, stabilized RF and magnet power supplies ■ Convenient frequency change for protons, deuterons, and helium-3 ■ Recirculating helium-3 recovery system.

For more information, please write or call: **THE CYCLOTRON CORPORATION**

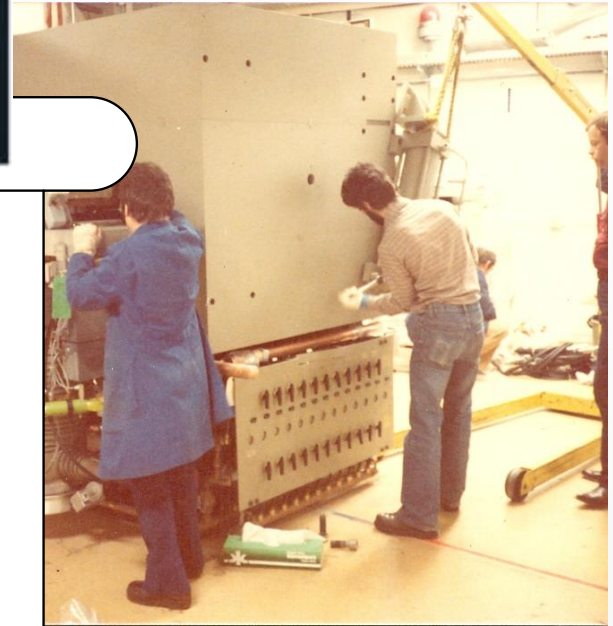
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December 12, 1981, CP42 Arrives ...A Good Day???

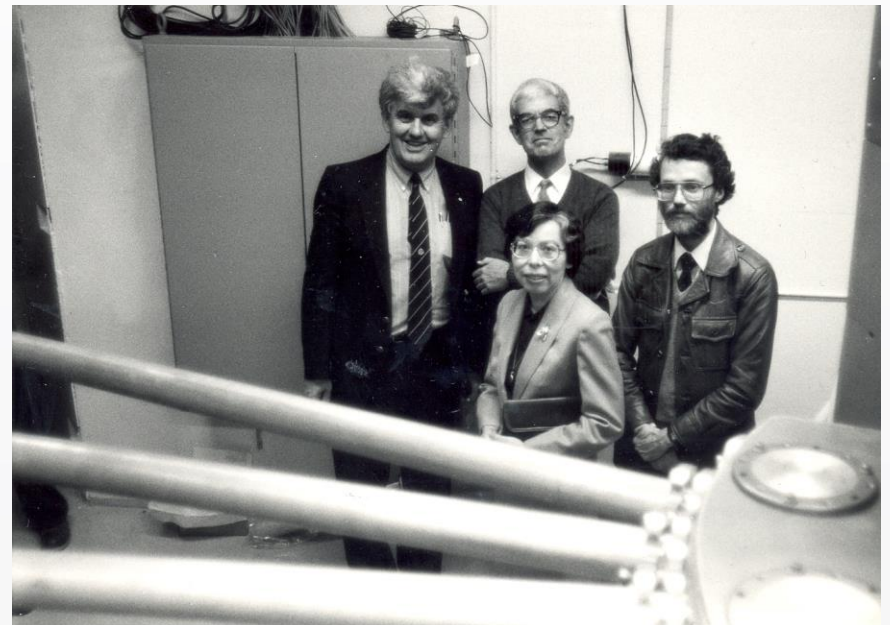
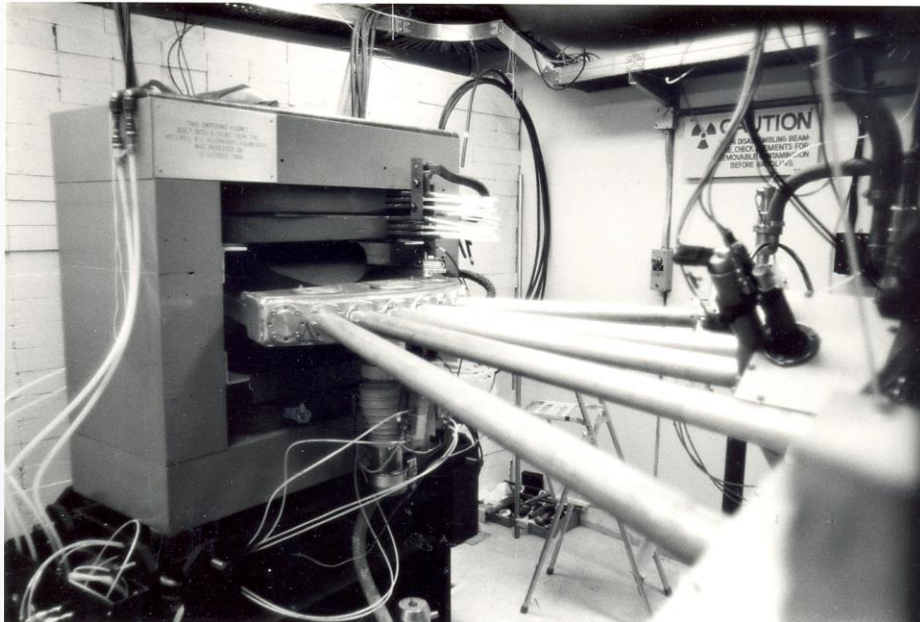


The Atomic Energy of Canada Limited (AECL) receipts still show an increase of 19.81% due to their capital program at TRIUMF continuing. It is expected to come to an end next year, causing the funding to be reduced considerably. The purchase of the 42 MeV Cyclotron (CP42) from The Cyclotron Corporation (TCC) in California has run into some problems. TCC was granted the rejection of the executory contract, related to this CP42, by the Bankruptcy Court of the Northern District of California, U.S.A., under the terms of Chapter 11. Negotiations are underway to arrive at an acceptable settlement. The costs and consequences of these actions are the responsibility of AECL.



Installation and Commissioning of the CP42

Without the support of **The Cyclotron Corporation (TCC)**, **AECL** turns to **TRIUMF** for collaborative support in the installation and commissioning of the new cyclotron.



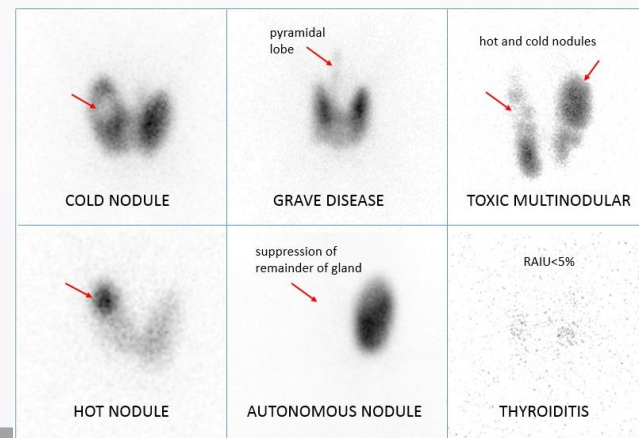
First Beam 1983

- Initial production was mainly Cobalt-57. Industrial use by New England Nuclear (NEN) and DuPont as flood sources and phantoms.
- Started development scale production for Iodine-123 and Thallium-201
- Shared their cyclotron capacity to support **TRIUMF** PET program



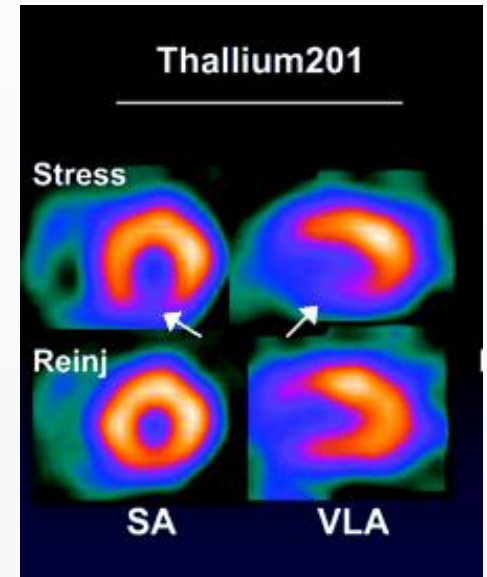
First Commercial Shipment for Nuclear Medicine Use 1984

- Iodine-123 shipped to Denver, Colorado
- Radioisotope was further processed into Iodine-123 Capsules for diagnosis of thyroid cancers



Major contract for Thallium-201, 1986

- DuPont (New England Nuclear)
- Radioisotope was further processed into Thallium-201 Thallous Chloride Sterile Injection for imaging cardiac diseases



Growth in the late 1980's

- 1988, business increased and a need arose for an additional cyclotron
- Erich Vogt promised to put **TRIUMF's** expertise behind EBCO's offer to supply a new cyclotron. Erich also supported the negotiation of a new 30 year agreement with TRIUMF on the same terms, providing a secure commercial footing for **BWXT (then Nordion)** and an opportunity for EBCO to establish itself in the cyclotron business.
- 1989, **BWXT** makes royalty payment to **TRIUMF (\$150K)**

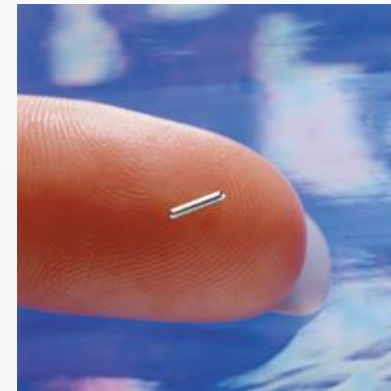
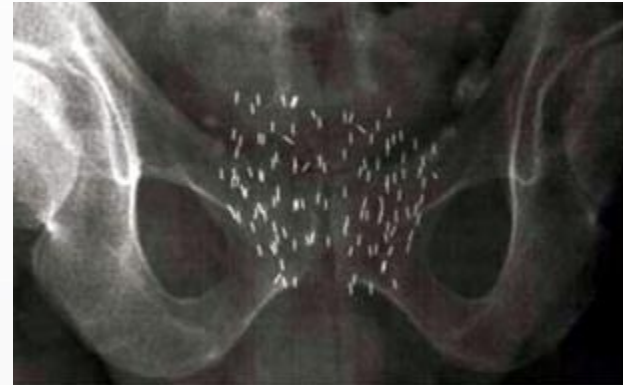
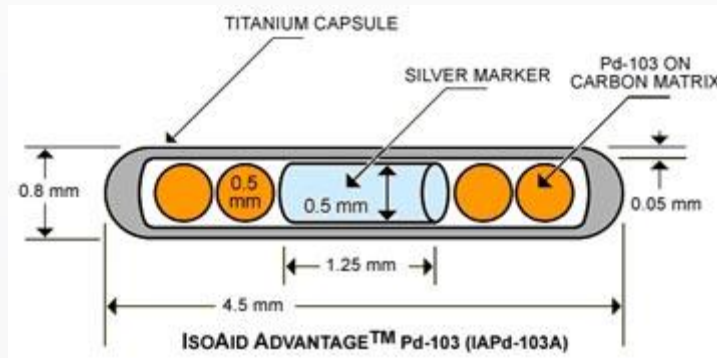
Installation and Commissioning of the TR-30-1 Cyclotron, 1991

- Expansion adds the second Radiochemistry Annex (RCA-2)
- Solid and gas target stations installed



Additional Collaborations and Growth in the 1990's

- 1992, Technology transfer of Strontium-82 process developed by **TRIUMF** to **BWXT**
- 1994, upgrade of the TR-30-1 to operate at 1.2 mA currents
- 1999, introduction of Pd-103 which is used for prostate brachytherapy medical devices



Installation and Commissioning of the TR-30-2 Cyclotron, 2001

- Expansion adds the third Radiochemistry Annex (RCA-3)



Grand Opening TR-30-II – Feb 2003



Left to right in front of the new cyclotron, which was designed by EBCO technologies: The Hon. Colin Hansen, BC Minister of Health Services; Mary Mogford, Director on Board of MDS Inc.; John Rogers, President and CEO of MDS Inc.; Wilf Lewitt, Board Chairman of MDS Inc.; Don Rix, Board Chairman of MDS Metro Lab Services; Jerry Porter, General Manager of Nordion Vancouver.

Partnership

- 2004, **TRIUMF** and **Nordion** collaboration recognized by Natural Sciences and Engineering Research Council of Canada (NSERC). **TRIUMF** and **Nordion** awarded the 2004 Synergy Award for Innovation.
- 2005, **BWXT** supplies every mCi of Iodine-123 used in medical procedures in North America
- 2009, Joint Radiochemistry Research Laboratory MHESA
- The 2010 reactor isotopes shortage. **BWXT**, Vancouver supplies Thallium-201 to meet the needs of the undersupplied cardiac diagnostics market.

Partnership

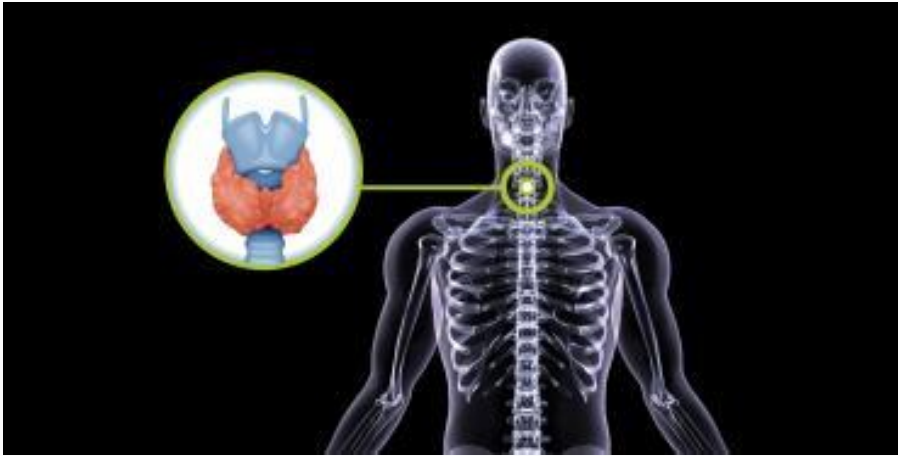
- 2013, celebrated **35 years** of successful partnership
- 2016 Nordion was acquired by Sterigenics
- 2018 Nordion – Medical Isotopes becomes **BWXT - ITG** and partnership continues



Partnership - Royalty



Medical Isotopes - Vancouver



- **Iodine-123** (I-123), used to diagnose thyroid disease
- **Strontium-82** (Sr-82), used to manufacture Rubidium-82 generators, which are used in imaging to diagnose heart disease
- **Palladium-103** (Pd-103), used to treat prostate cancer
- **Indium-111** (In-111), used to diagnose infection and cancer

Tc-99m, Sr-82

I-123

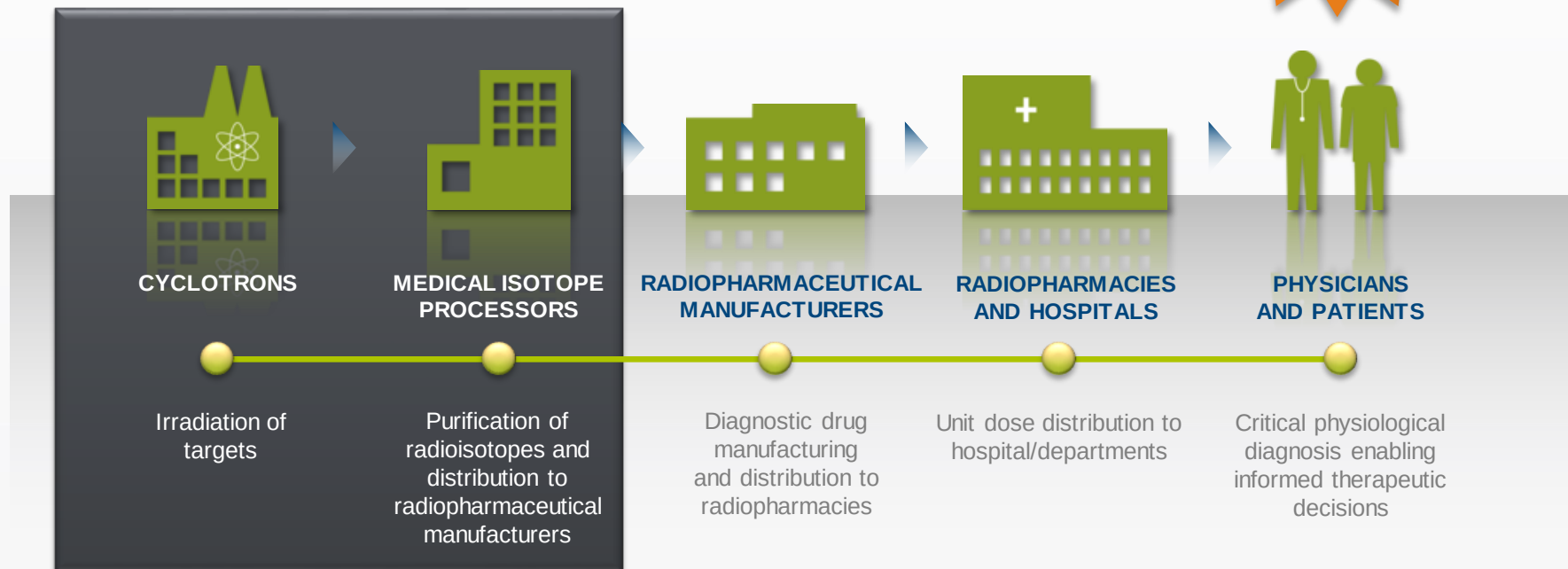
Tc-99m

Tc-99m

Global Healthcare Benefit

- Millions of patients served by products from the **TRIUMF** and **BWXT** partnership
- 150,000 packages shipped worldwide

50
million!



Conclusion

At **BWXT**, we have been collaborating with **TRIUMF's** research and development unit for more than 40 years. This partnership has assured the domestic and global delivery of reliable healthcare solutions and is a powerful example of the kind of success that public and private partnerships can achieve.



1968: "The Great Leap" by Erich Vogt. The ditch was dug to drain the swamp lands where TRIUMF would eventually be built.