The University of Washington Clinical Cyclotron A Summary of Current Particles and Energies Used in Therapy, Isotope Production, and Clinical Research

Eric Dorman and Robert Emery
University of Washington Medical Center

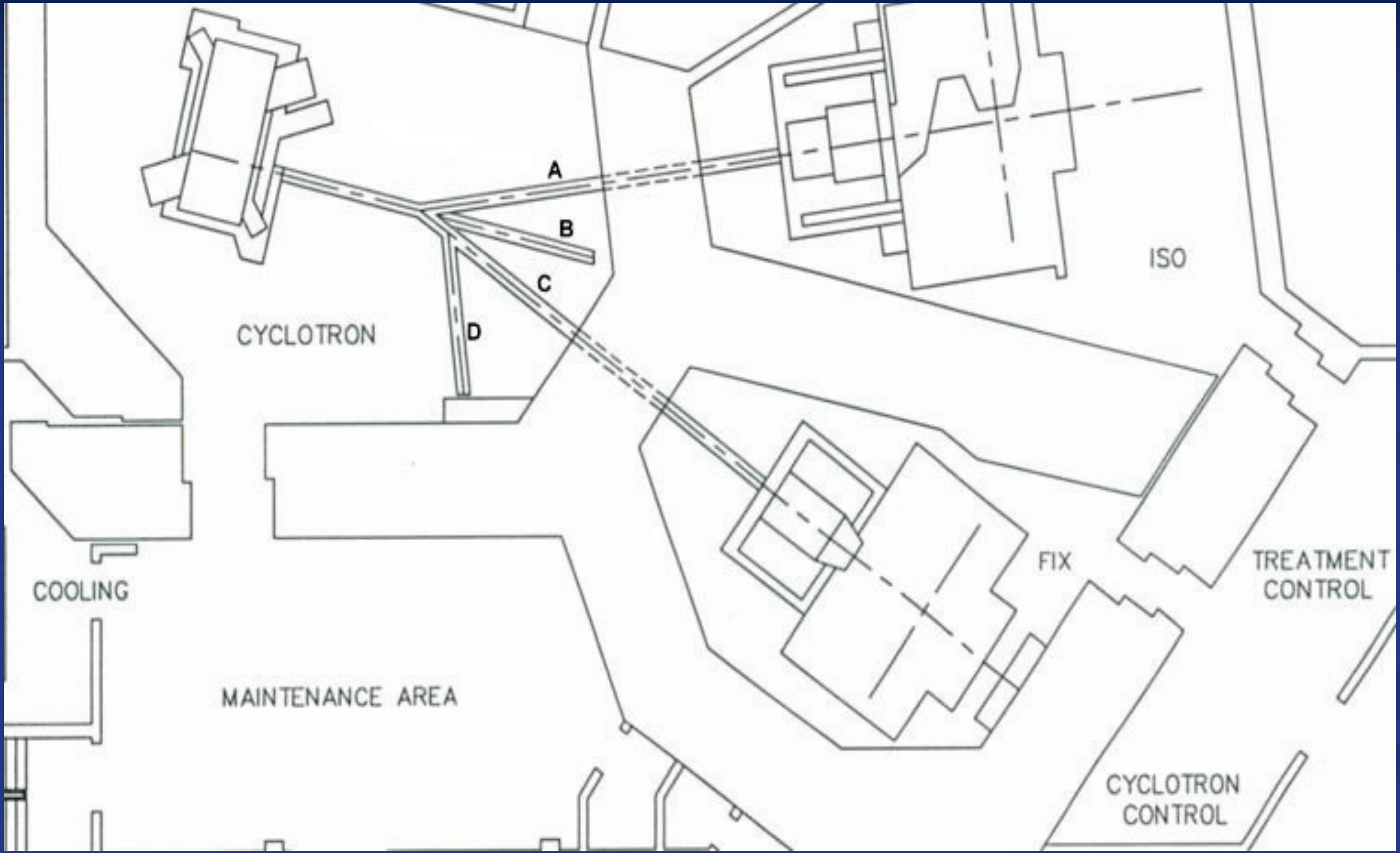
Outline

- History of the Facility
- Facility Layout
- Beams we are currently running
  - Protons
  - Deuterons
  - Alphas

Who We Are

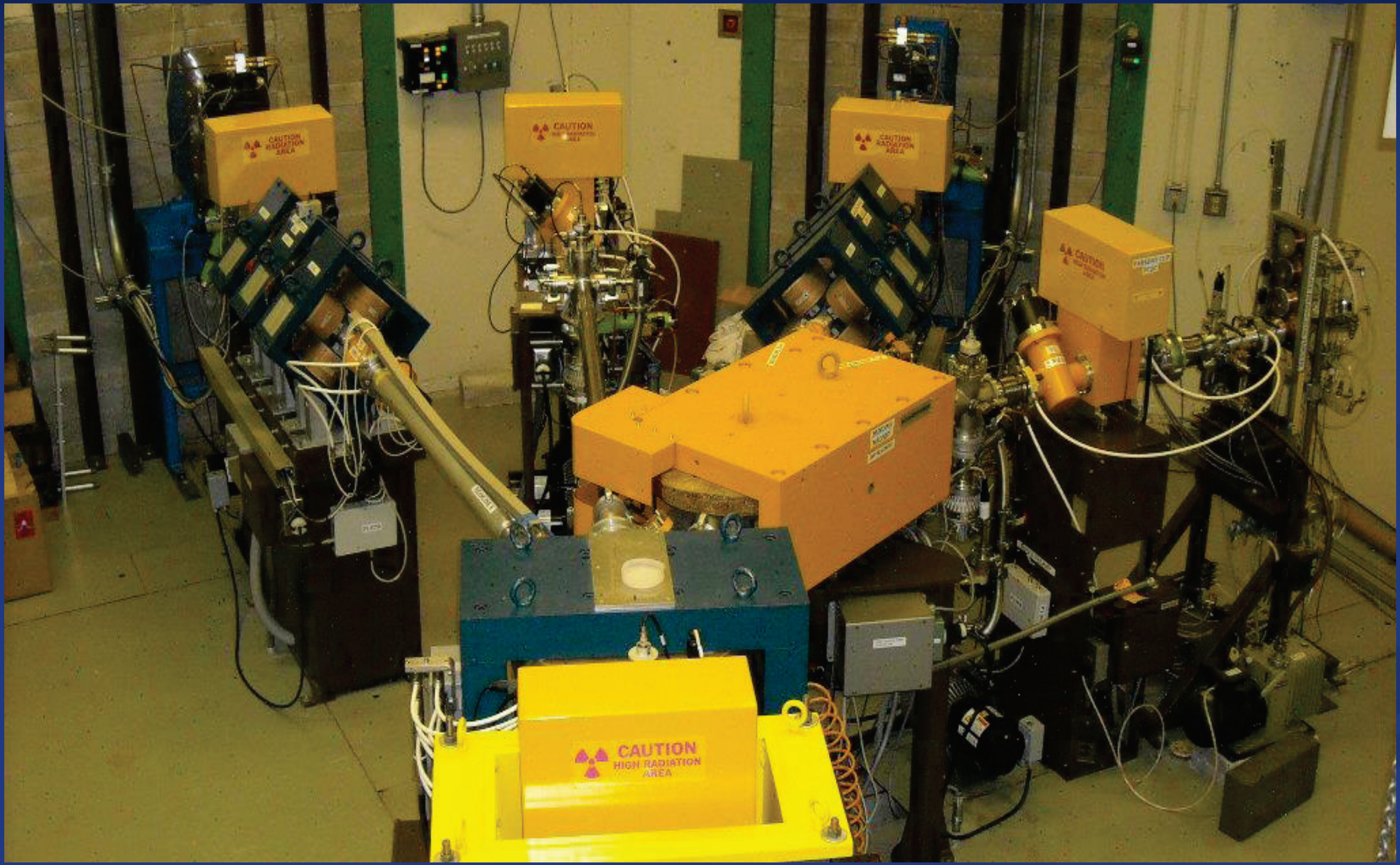
- Clinical Neutron Therapy Program funded by the National Cancer Institute
  - Acquire a neutron generator
  - Acquire the facilities to house the generator and treatment rooms
  - Undertake 6 years of clinical trials
- Scanditronix MC50 Cyclotron
- Multi-Particle / Variable Energy
- Installed in 1983, First patient treated 1984

Facility Schematic

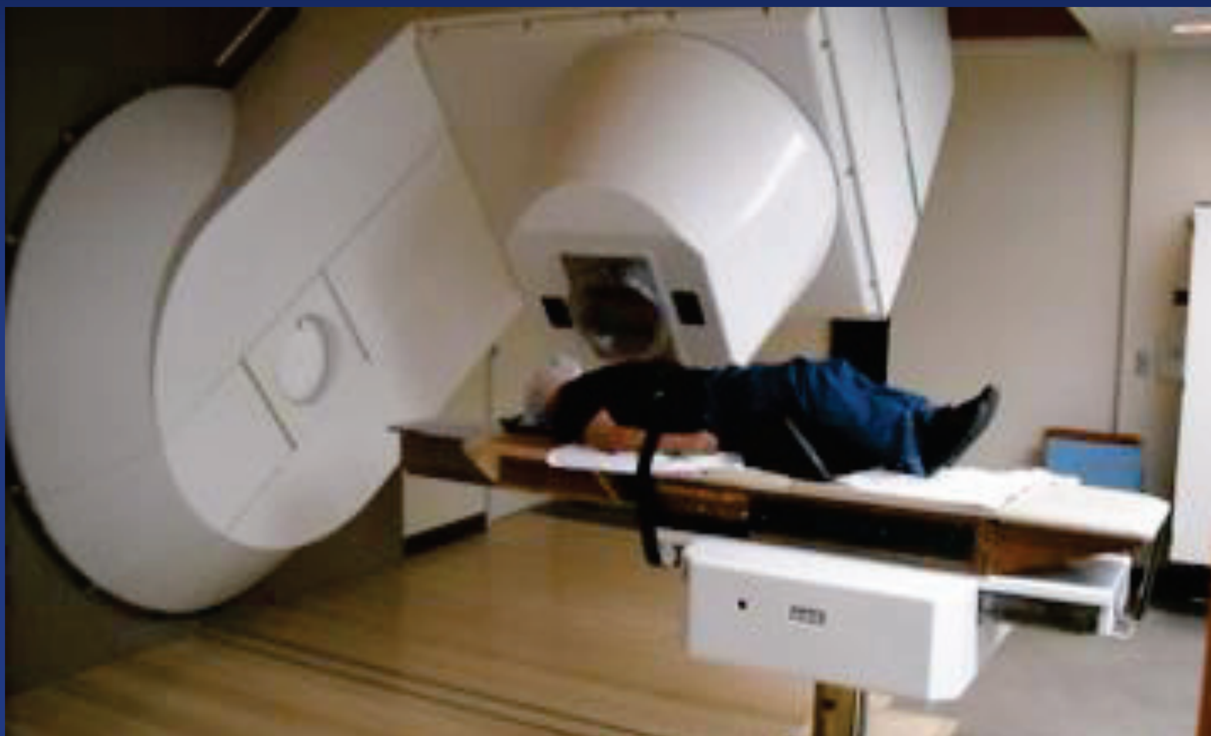


The MC50 Cyclotron

Beam Line Layout



50.5 MeV H^+ 70μA
Fast Neutron Radiotherapy



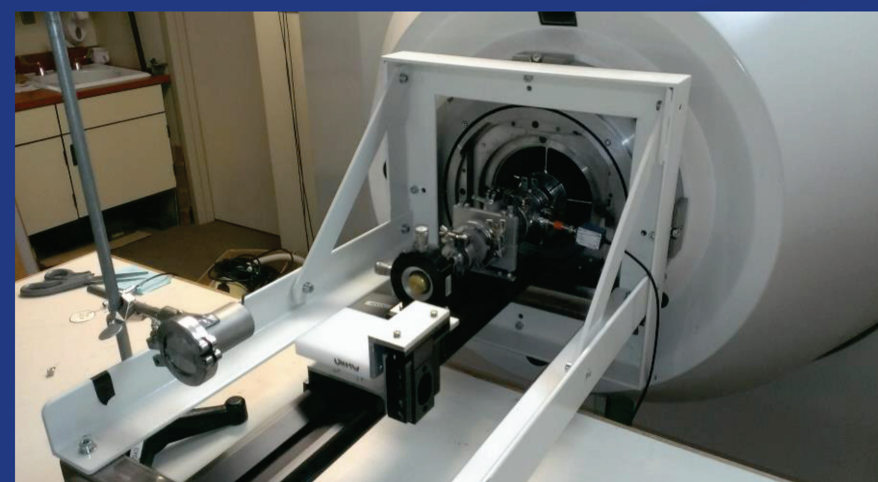
The 50.5 MeV H^+ beam is the original design purpose of the UWCC. Impinging on a Beryllium target housed in the Isocentric gantry, this is the beam that creates the neutron flux for radiotherapy. We originally ran 60μA on target, but internal modifications to the cyclotron were made so that the target current now operates at 70μA. Of the four Isocentric gantries built for neutron therapy, ours is the only one with a multi-leaf collimator.

Beryllium Target

Experimental Beam Research Room

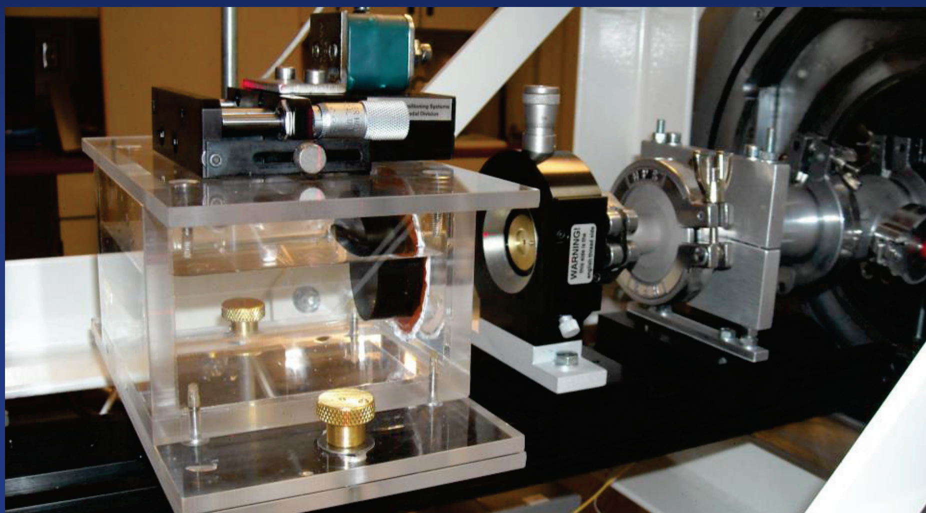
Fixed Beam Neutron Treatment Room

With a new UW (ProCure) Proton Therapy Center opening this year, our Medical Physics team came to us seeking access to a proton beam for various research projects. To accommodate their request, we converted our 2nd neutron therapy room into an Experimental Beam Research Room.

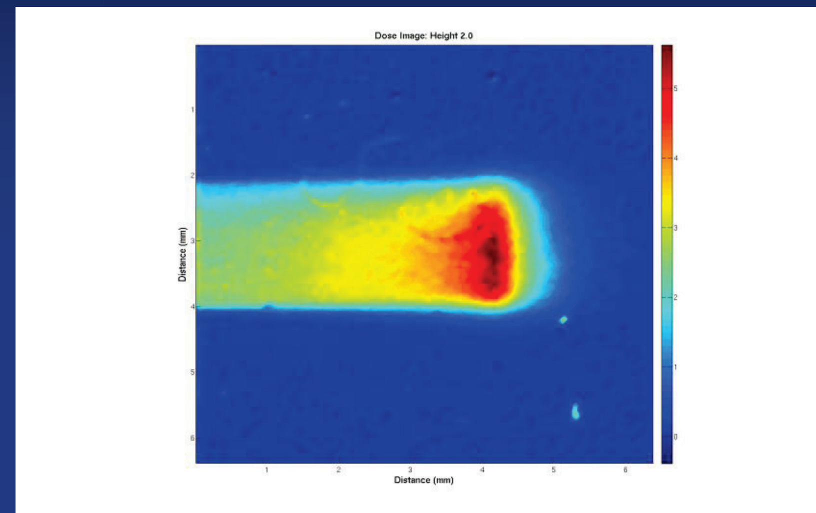


Experimental Beam Research Station

30 and 35 MeV H^+ 3-5 pA
Precision Proton Radiotherapy Platform (PPRP)



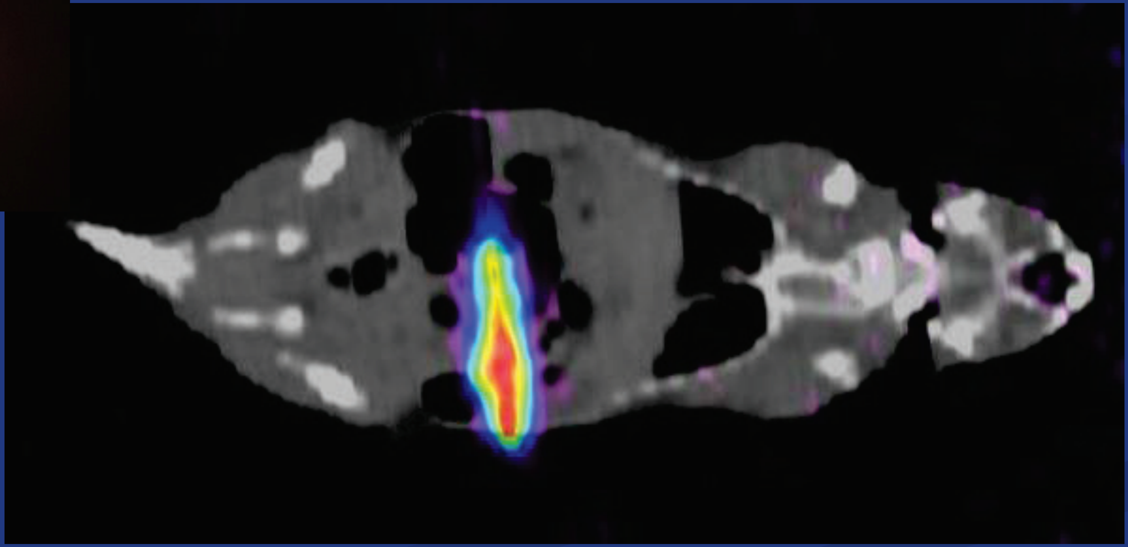
Dr. Ford’s PPRP set up



This is the first project we supported with the Medical Physics group in the Experimental Beam Room.

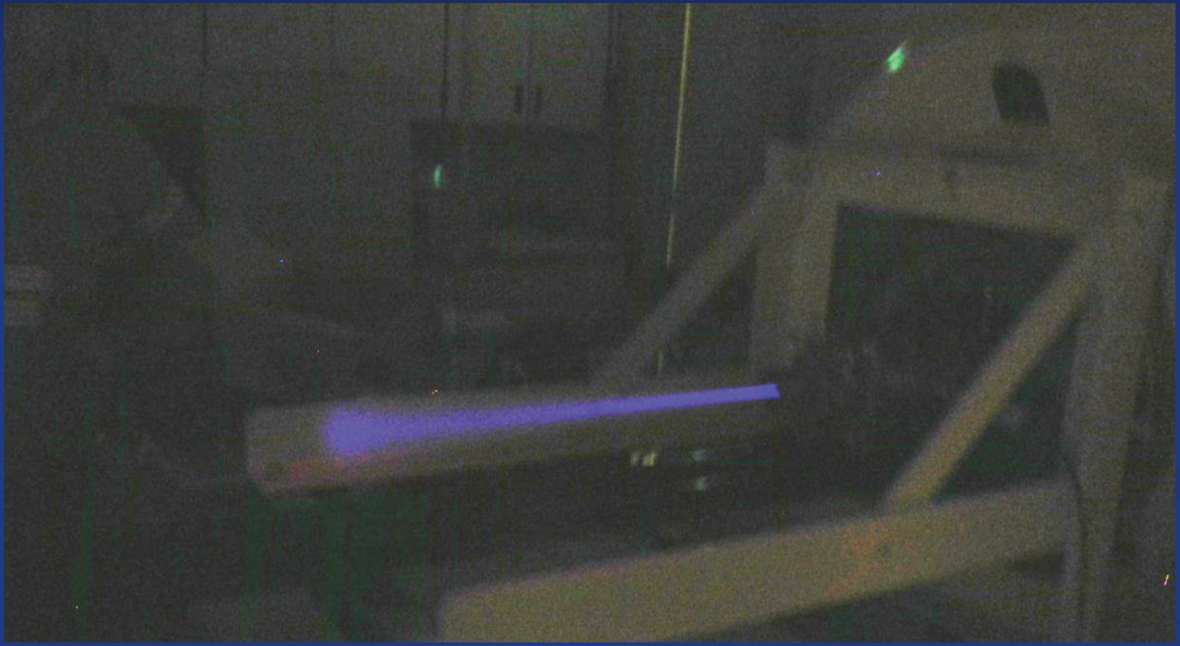
50.5 MeV H^+ 5 pA
Proton Beam Activated PET

Other Medical Physicists requested proton beam time as well, this group is working on verification of delivered dose using proton-induced radioisotopes.



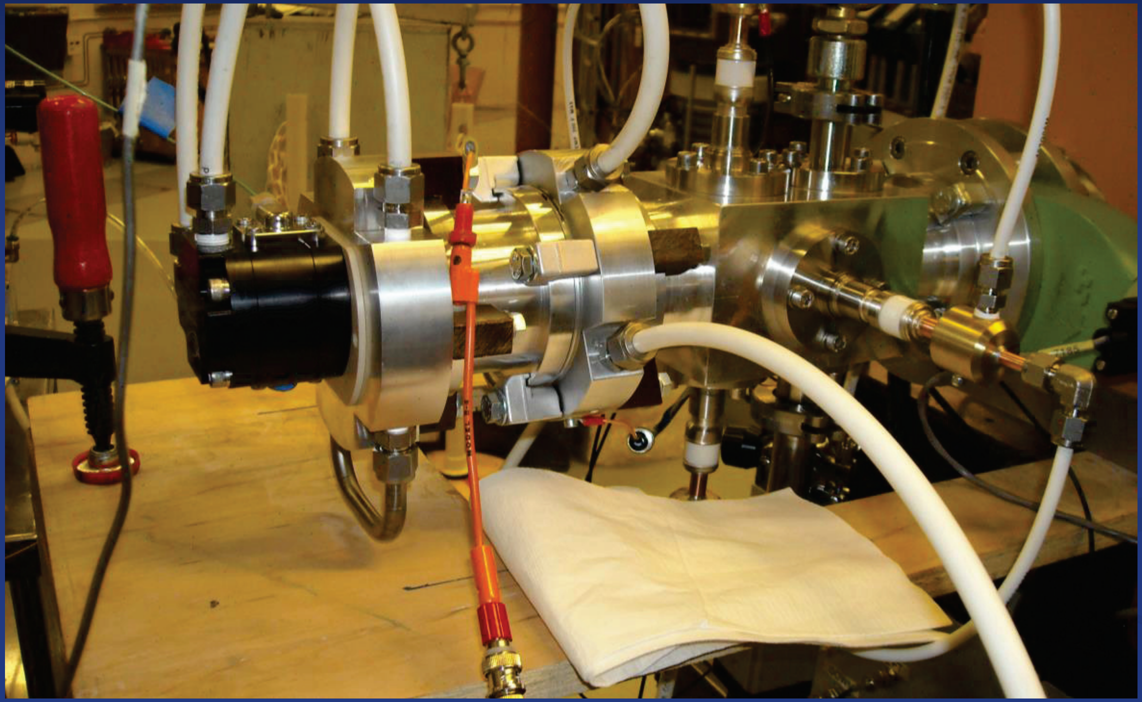
Fused CT/PET image of the Irradiated Mouse

6.8 MeV H_2^+ 300 nA
"Show and Tell"



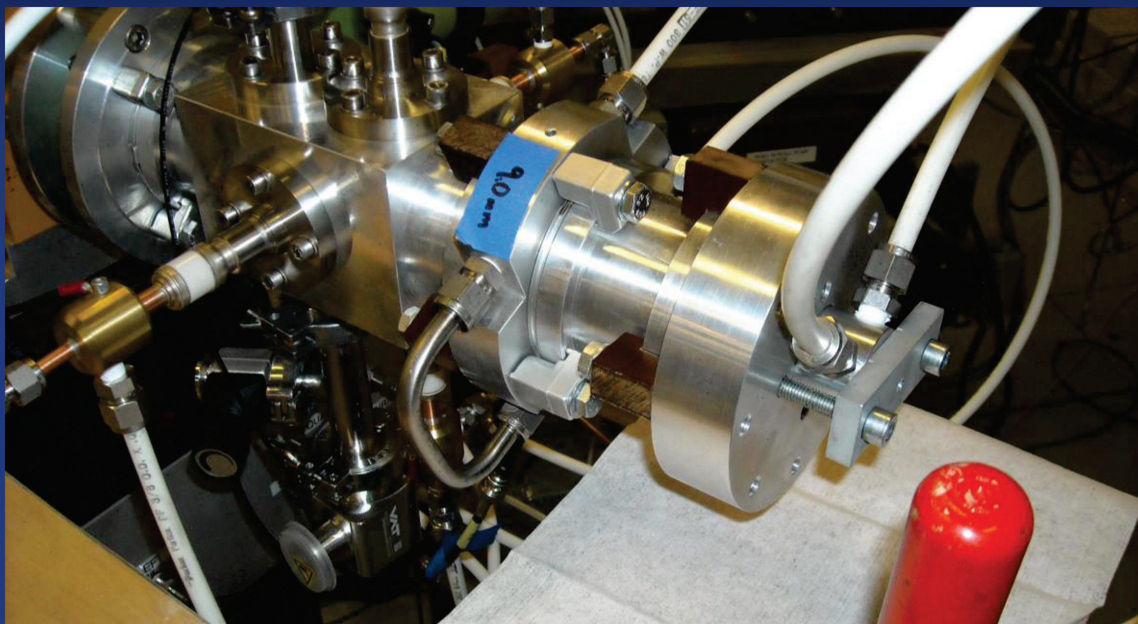
The cyclotron has the capability to produce low energy protons by accelerating H_2^+ molecules. Recently developed and extracted into air, we use this beam as a demonstration of our cyclotron's multiuse capacity.

16, 18, 20, 24 MeV H^+ 20μA
Cyclotron Based Tc-99m Production



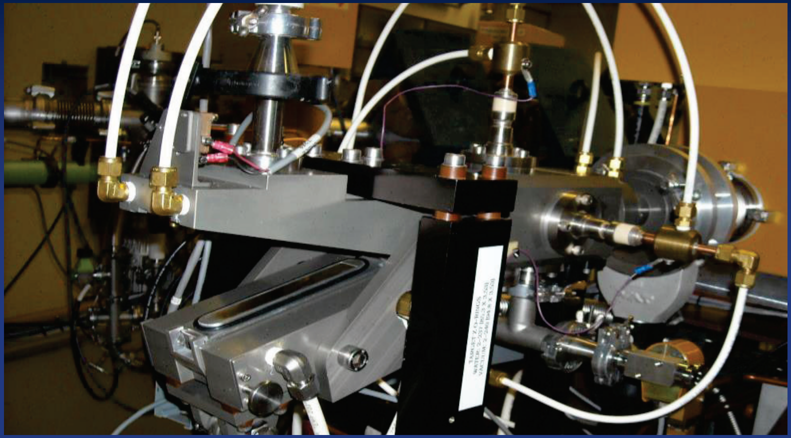
This project was performed on our vault experimental beam line.
We tuned up our lowest H^+ energy, 28 MeV and used graphite degraders to attain each energy required by the researcher.
This was a Proof of Principle experiment, we do not make Tc-99m on a routine basis.

18, 20, 22, 24 MeV D^+ 20μA
Cyclotron Based Rhenium-186 Production

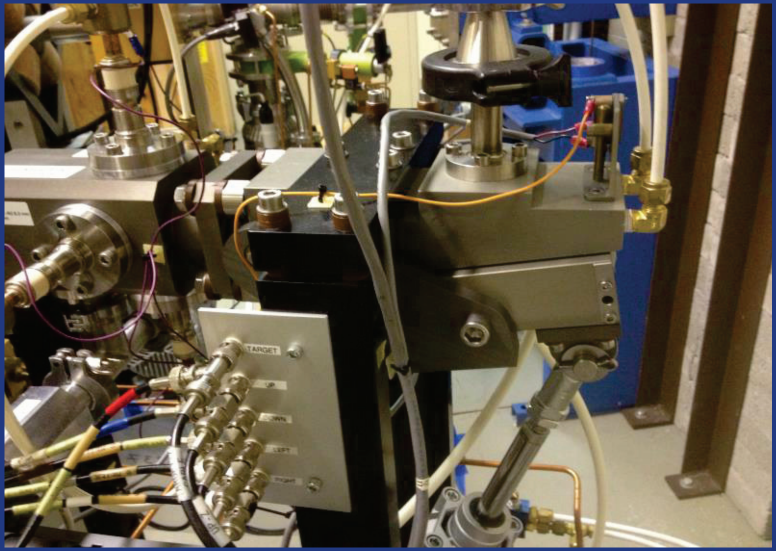


Deuterons were run on the cyclotron during the cyclotron commissioning phase. Only recently have we been running deuterons on a regular basis.
This project is also performed on our vault experimental beam line.
We are currently supporting a yield study with the multiple D^+ energies for the UW Radiochemistry group.

29 MeV He^{2+} 50μA
Cyclotron Based Astatine-211 Production



Isotope Production Station Jaws open



- 1990 – First Alphas extracted, 28 MeV, 1μA
- 1997 – Greater demand for Astatine-211
- Modifications made:
  - Central Region Geometry
  - Ion Source Slit Geometry
  - Ion Source Power Supply
  - Cathode Button Design
  - Beam Line
- 2002 – Dedicated beam line installed at the zero degree port of the Switching Magnet
- Slanted Target Isotope Production Target (TRIUMF designed and manufactured)

We are producing Astatine-211 on a weekly basis. Production runs vary between 1 and 2 hrs., and are done in the morning before patient treatment. Targets are processed in house (8hr half-life) by the UW Radiochemistry group and used at the FHCRC.

47.3 MeV He^{2+} 60μA
Cyclotron Based Tin-117m Production

Top: Bismuth-209 target on Aluminum backing used in the production of Astatine-211
Bottom: Cadmium-116 target on Copper backing used in the production of Tin-117m

Routinely producing Tin-117m on a monthly basis.
Production runs vary between 10-20 hours, and are preformed on a weekend.
Targets are shipped out of house for processing.

Summary

- After 30 years, the cyclotron facility is running well, continuing its mission to treat cancer patients with fast neutron radiotherapy. We are just shy of 3000 patients treated.
- It was important that flexibility was built into the original design requirements -- In the form of a variable energy multi-particle accelerator
- This gave the UWCC many tools in supporting multiple medical research projects, creating a unique hospital based facility.

Founding Fathers of the UWCC

- Peter Wootton
- Tom Griffin, M.D.
- George Laramore, M.D.
- Juri Eenmaa, M.D.
- Ruedi Risler, Ph. D.

Thank you!