



Accelerator Production of Mo-99 Using Mo-100*

J. L. McCarter†, J. Harvey, S. M. Burns, M. Brennan,
S. Kelley, T. A. Montenegro, Q. Schiller

NorthStar Medical Radioisotopes, LLC, Beloit, WI,
USA

Presented at IPAC '21 on 24 May 2021 – MOPAB412

* Work supported by DE-NA0001878

† jmccarter@northstarm.com

NorthStar Medical Radioisotopes

- Founded in 2006
- Privately held nuclear medicine technology company
- Headquarters located in Beloit, WI
- More than 200 employees in 4 locations and continuing to grow!
- We produce and ship Mo-99 to U.S. nuclear pharmacies, who rely on our *RadioGenix*[®] System to elute Tc-99m and deliver patient doses to hospitals.



NorthStar Beloit Campus – June 2020

Alliant Energy
Substation

Accelerator
Building

Isotope Processing
Building

Instrument Manufacturing
Building

Office Space and
Production Facility
In Columbia MO

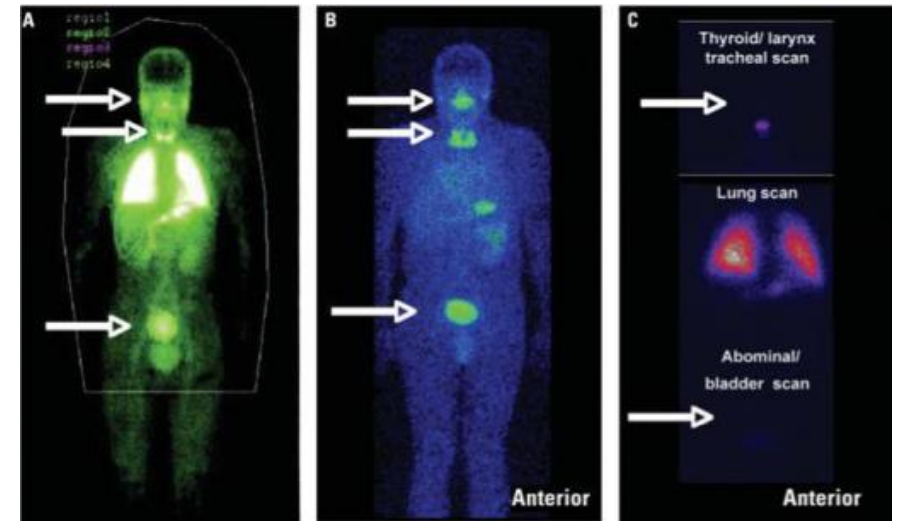
HQ and Administrative
Building

Two R&D facilities in
Madison WI

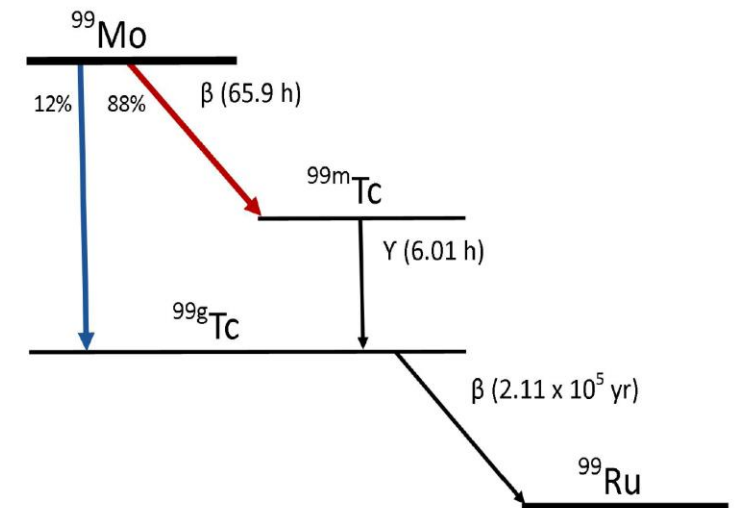
33 Acre Campus with
scope for significant
expansion

Mo-99/Tc-99m Background

- Mo-99 is the parent isotope of Tc-99m
- Tc-99m emits a low-energy gamma ray (140 keV)
- Tc-99m is the most widely used medical radioisotope
 - ~75% of all diagnostic radionuclide based tests
 - Majority used for cardiac stress testing, but also in organ and blood flow abnormalities (amongst others)
 - “Tagged” to a pharmaceutical to target location of interest in body to combine for more than 30 radiopharmaceuticals
 - Early development and use of Tc-99m
 - can be traced to the late 1950’s/early 1960’s
- US market consumes ~50% of worldwide supply
 - ~40,000 procedures each day in the US using Tc-99m



Gamma Camera Images Using TC – 99m



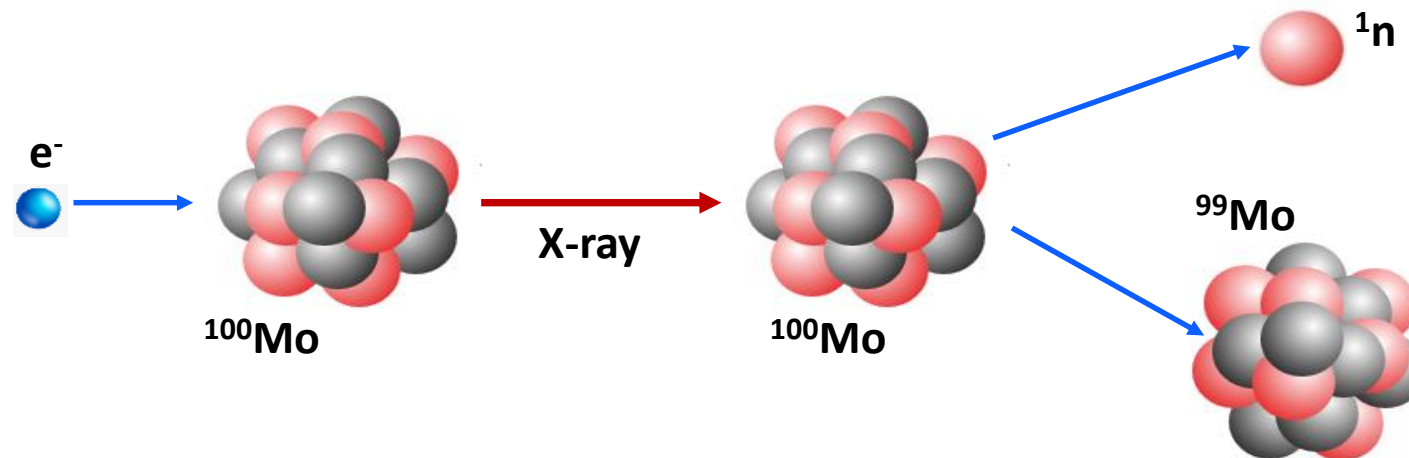
RadioGenix®

- ^{99}Mo source shipped to radiopharmacy
 - > Shipped in source vessel
- ^{99}Mo source installed into *RadioGenix*® System
- *RadioGenix*® separates $^{99\text{m}}\text{Tc}$ from ^{99}Mo source
- *RadioGenix*® elutes $^{99\text{m}}\text{Tc}$ with saline to produce sodium pertechnetate

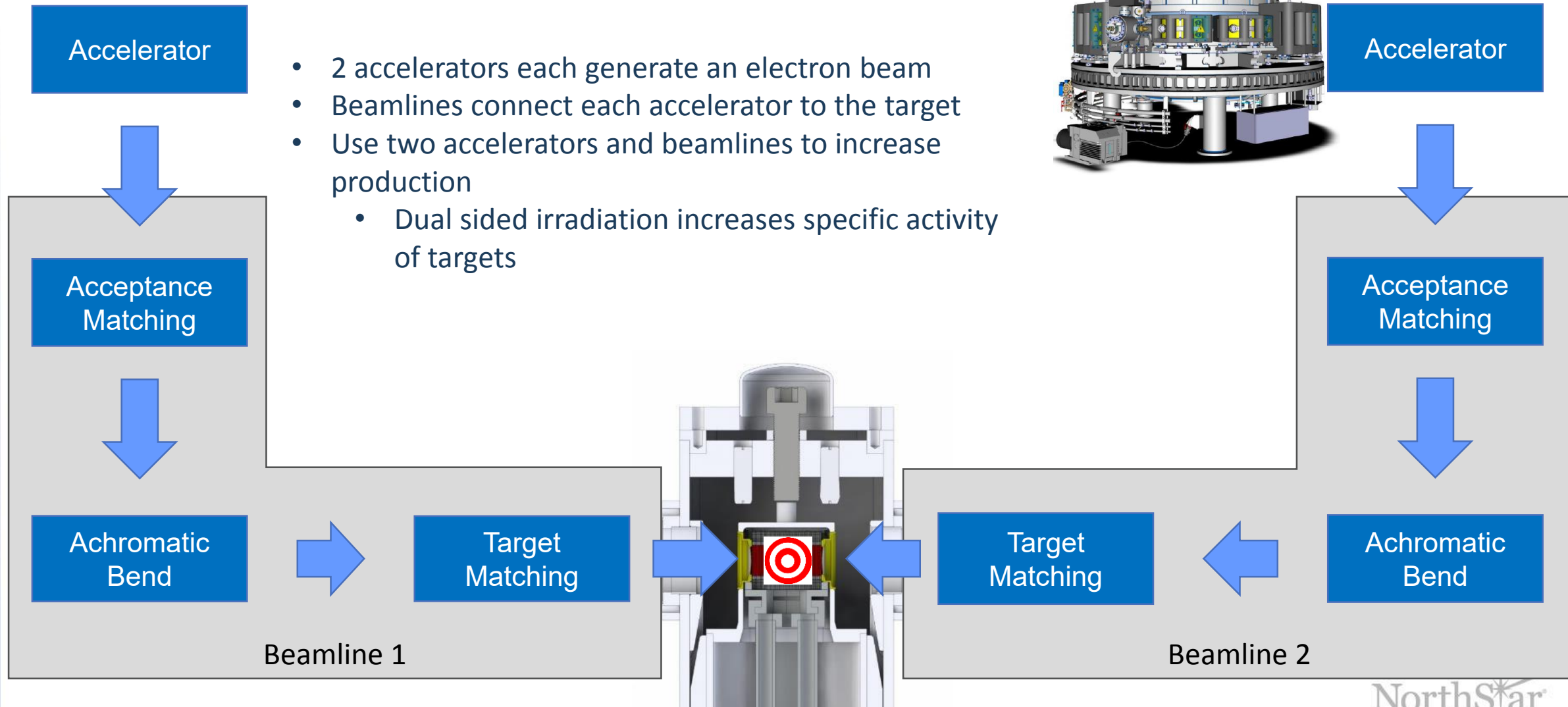


Electron Accelerator Production of Mo-99

- Uses ^{100}Mo as target material (stable, naturally occurring)
 - > Production via (γ, n) process
 - > Accelerator brings an electron to close to the speed of light
 - > This electron hits the ^{100}Mo target
 - > This collision creates X-rays
 - > These X-rays hit other ^{100}Mo atoms
 - > 1 neutron is knocked off, creating ^{99}Mo
- ≤ 19 Ci / source vessel
- Fully vertically integrates NorthStar's production process and provides greater flexibility than a reactor
- Requires unique generator system from fission Mo-99; e.g. NorthStar's *RadioGenix*[®] System



Irradiation Concept



Production Design and Layout

- Accelerators and beamlines

- > 2x IBA TT-300HE Rhodotrons
- > Firsts-of-their-kind
- > 40 MeV
- > 125 kW average power on each



- Vaults

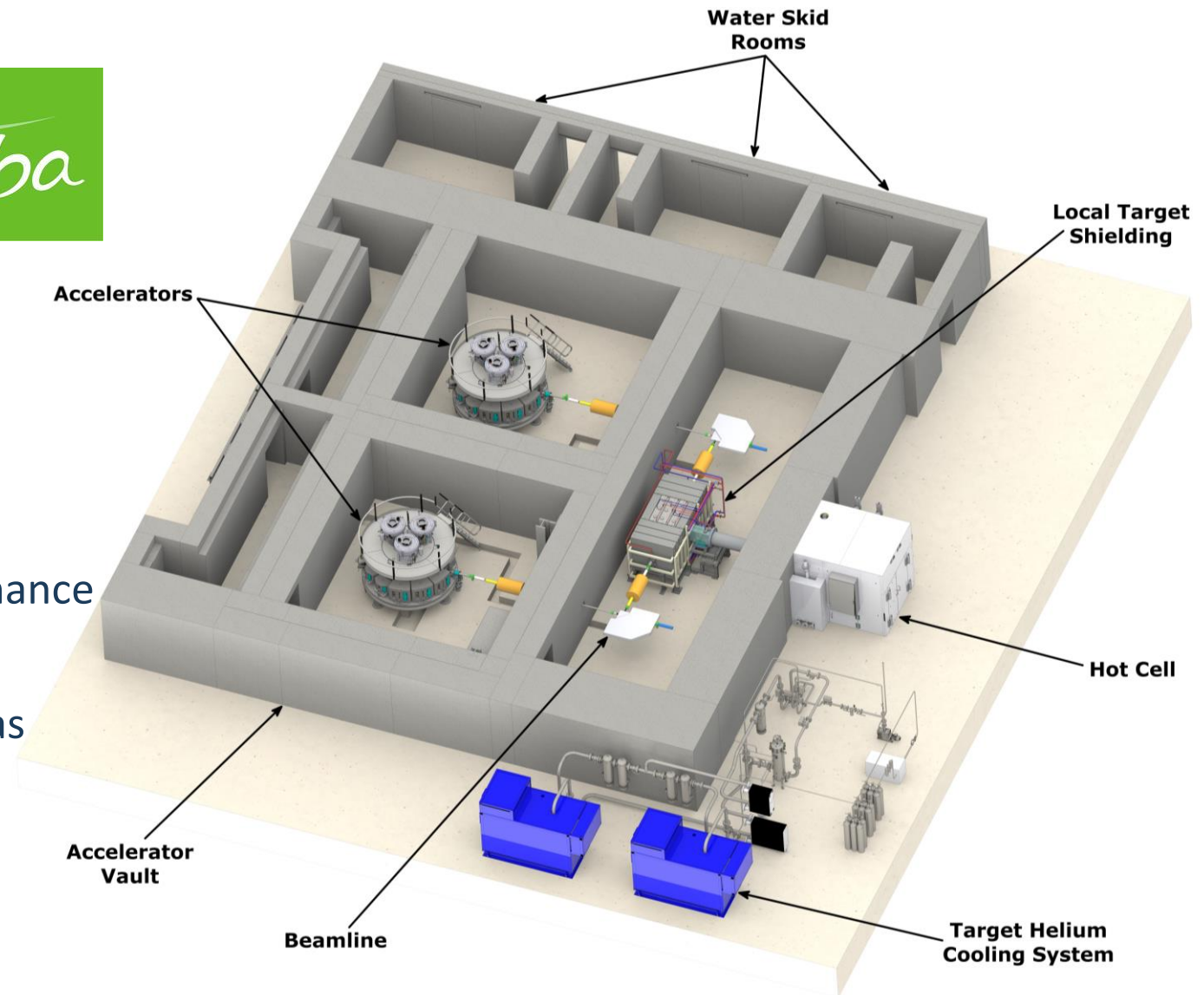
- > Separated to allow for easier maintenance

- Target cooling

- > High velocity, high pressure helium gas

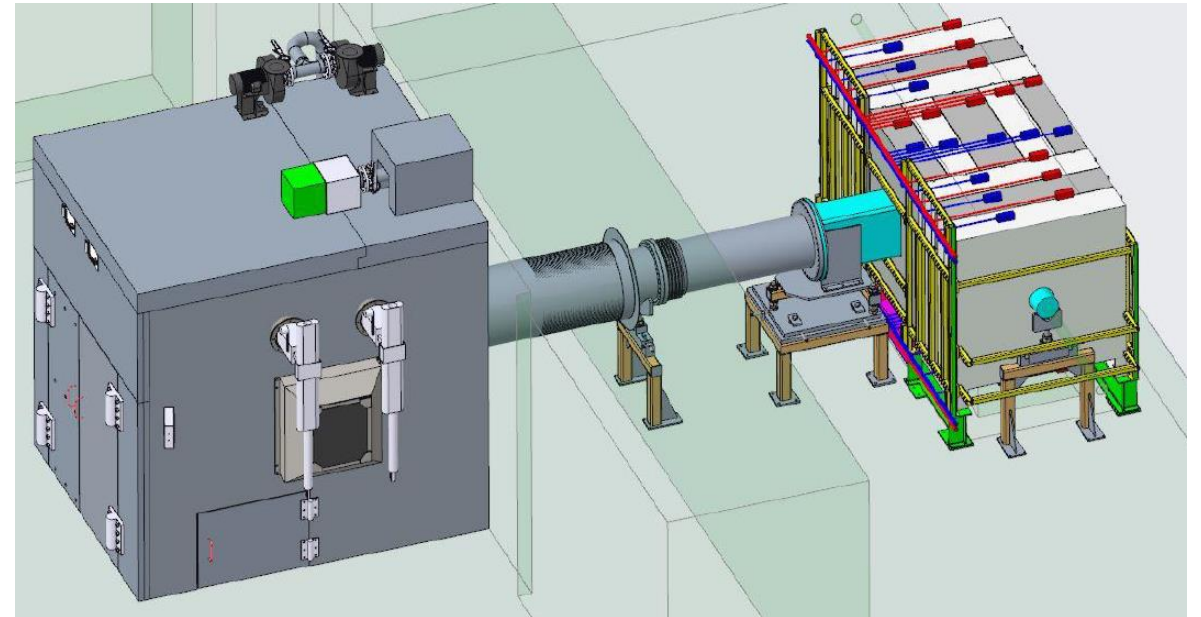
- Target manipulation

- > Steel hot cell and push/pull chain
- > Local shielding around target



Target Manipulation

- Target
 - Stacked sintered disks of ^{100}Mo
 - Physical spacers ensure proper cooling
- Hot Cell
 - Drives target into position using push/pull chain
 - Wall separates hot cell from target vault
- Local Target Shielding
 - Reduced radiation dose to surrounding equipment
 - Modular boxes
 - Concrete and steel
 - Steel and water
 - Water cooled



Project Status

- Building
 - Addressing punchlists
 - Commissioning utilities
- Accelerators and beamlines
 - Accelerator installation in progress
 - Beamline fabrication in progress
- Vaults
 - Completed
- Target manipulation
 - Hot cell and target shielding in final design
 - Fabrication in progress
- Helium cooling
 - Blower installation in progress
 - Process piping installation in progress

