Prototype testing of $^{99}Mo/^{99m}Tc$ generators using (n,γ) ^{99}Mo

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Perma-Fix
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Talking Points

- PESI/PFM novel resin and its application to the production of ^{99}Mo generators
- Past and Current Studies
- Path forward
- Questions

Micro-porous Composite Material (MPCM)

- Preparation of MPCM:
  - MPCM was prepared with or without TiO_2 using addition and condensation polymerization techniques in presence of catalyst
  - One of the key ingredients of MPCM resin is chitosan- a biopolymer

- Reference: US Patent 8,911,695B2

MPCM Characteristics

- MPCM has capacity to absorb up to 700 mg Mo/g MPCM
- MPCM is an acid resistant resin
- Temperatures up to 100 °C do not adversely affect the adsorption capacity of MPCM resin.
- The structure of MPCM has been demonstrated to maintain its integrity when exposed to 50 Mrad Co-60 gamma radiation
- The surface area of MPCM is about 15 m^2/g with a pore volume of 0.012 cc/g
- TG analysis of both MPCM and irradiated MPCM reveals that the decomposition of the resin starts at ~200°C.
- XRD analysis reveals that MPCM is amorphous in nature

Reference: US Patent 8,911,695B2

2014-2018

- Conducted prototypical generator tests at approximately 2 Ci, 4 Ci, and ~6 Ci with natural Mo, and ~6 Ci with 98% enriched ^{98}Mo
- Awarded $2.8 MM grant from EU (STRATEGMED Biotechnet)
- All tests successfully loaded ^{99}Mo onto the MPCM in a column
- All tests demonstrated 70 to 80+% ^{99m}Tc yield
- Elutions were accomplished with pumps or evacuated vials
- No detectable degradation to the resin or eluate

Progress to Date

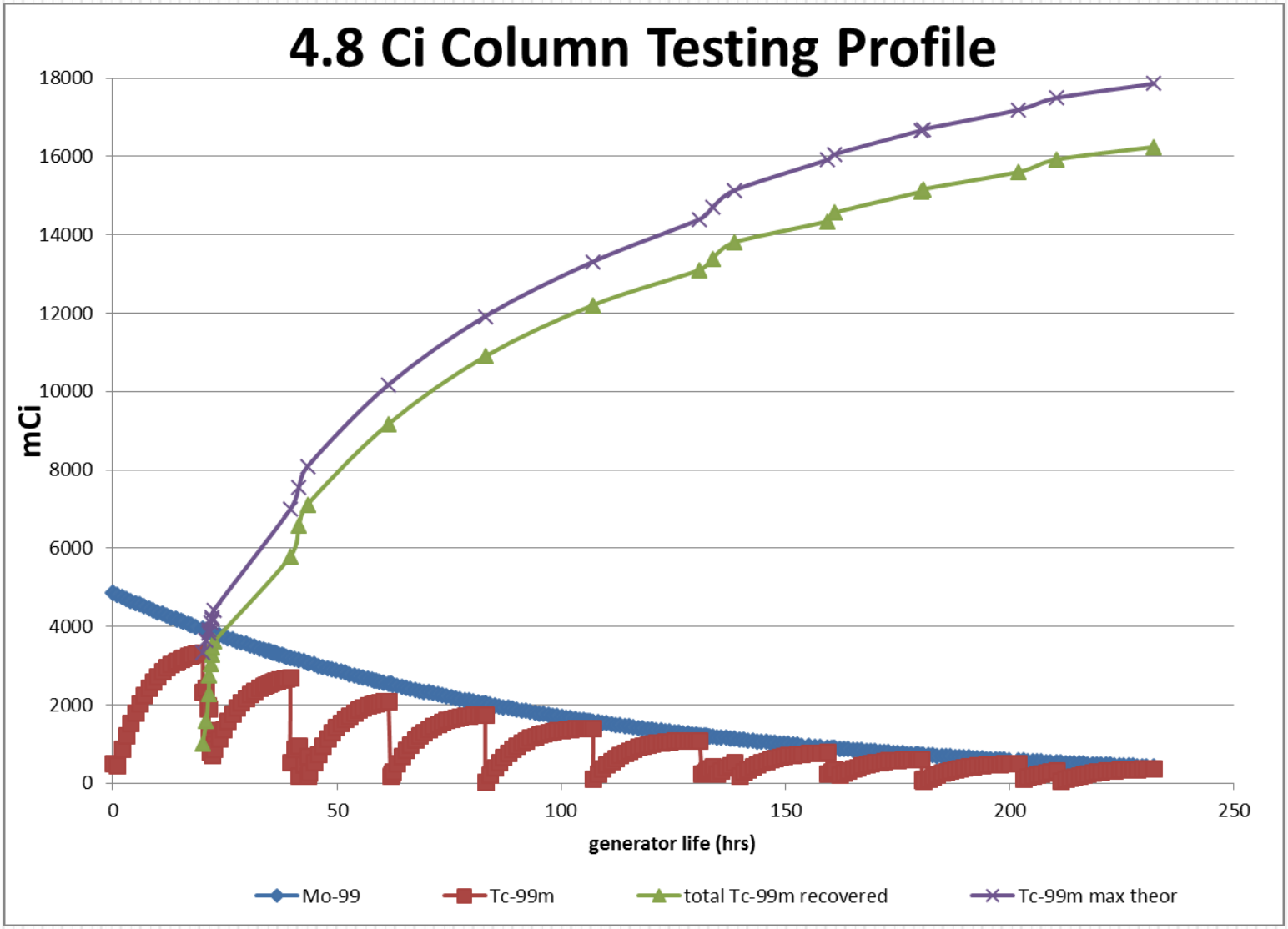
- Resin Development- accomplished
  - Resin preparation and conditioning
  - Radiation tolerance limit of the resin was conducted up to 75 MRad using e-beam
- Mo specifications- accomplished
  - Mo target material specifications and testing (POLATOM)
  - Demonstration of 2, 4, ~6 Ci generators with Mo-natural and Mo-enriched.
    - confirmed that the MPCM resin could withstand higher levels of radiation, while providing clinically useful doses of Tc-99m.

Progress to Date, cont'd

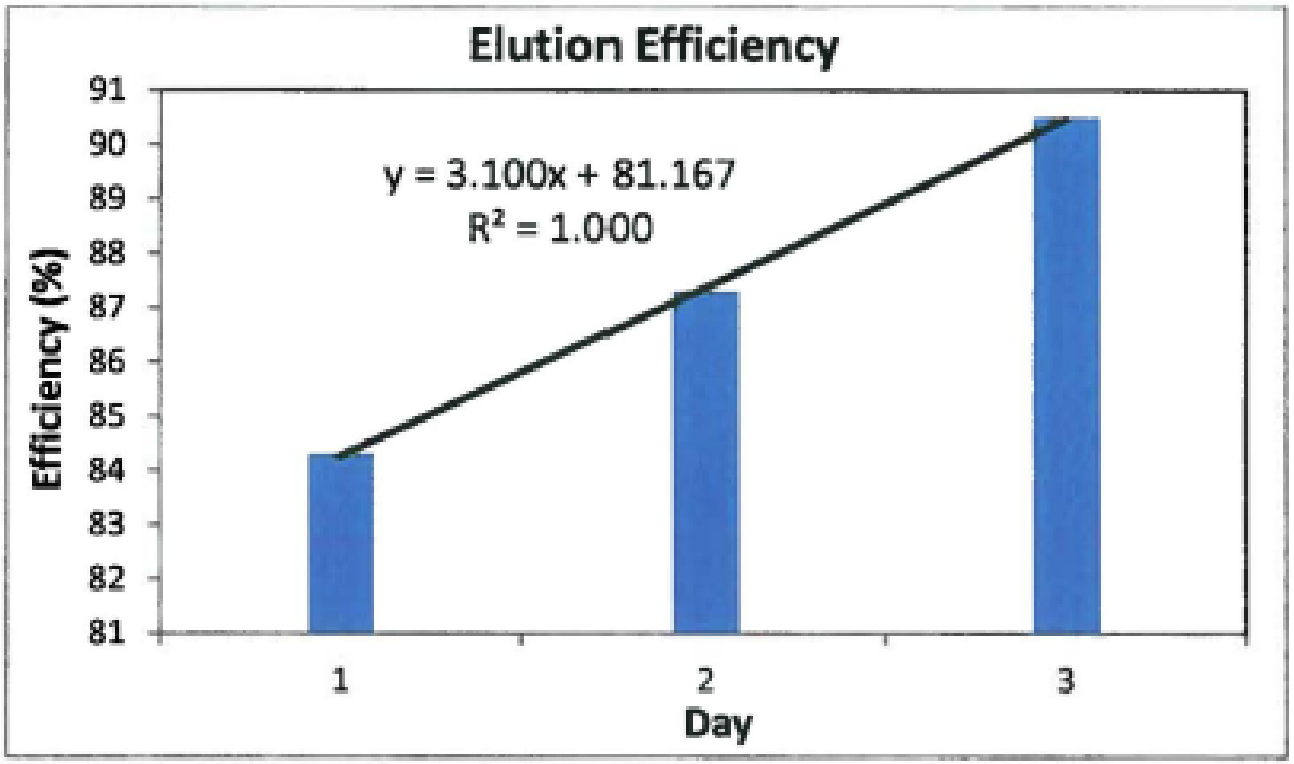
The National Centre for Research and Development

- Currently
  - Demonstration of a ~1Ci functional prototype generator completed under STRATEGMED program
  - Extensive testing of eluents
    - FDA and US and European Pharmacopeia specifications
    - Biological testing (in vivo and in vitro)
    - Radiochemical and radionuclidic purities
- Extensive Testing of compounding kits
  - Warsaw Medical University
  - Ongoing testing with Sestamibi, Ceretec, and MAG3 test kits to ensure reliable reproducible results

Typical Elution Profile of ^{99}Mo Prototype Generators



Typical Elution Profile of ~1Ci ^{99}Mo Prototype Generators



MURR

^{99}Mo Prototype Generators

Eluant Quality Parameter	Typical Value
Radiochemical Purity	> 95%
Radionuclidic Purity	< 0.15 µCi ^{99}Mo/mCi ^{99m}Tc
Other gamma emitting radionuclides	< 0.5 µCi /mCi ^{99m}Tc
Aluminum	< 10 µg/mL
Clarity	Clear
pH	4.5 - 7.5

Final Design Goal

- 1-10 Ci (n,γ) ^{99}Mo generator comparable in size to fission ^{99}Mo generator
- Column Bed Volume: 2.5 – 16 mL
- Elution process similar to conventional HEU/LEU generator
- Eluate solution compatible with all kits
- Elution elapsed time < 10 minutes using evacuated vials
- Competitive price
- 1 - 4 Ci ^{99}Mo /g MPCM in column
- Natural Mo and enriched ^{98}Mo can be used as targets

Path Forward

- Memorandum of Understanding with ENEA (Italian Nuclear Agency)
  - 2018 – Finalize design and construct 0.5 – 2 Ci prototype
  - 2019 – Prototype testing
    - cGMP Production line design
    - Initiate discussions with AIFA
  - 2020 – AIFA accreditation
  - 2021 – Provide 0.5 – 2 Ci generators to Italy and East European market
- 2018-2020 – Develop 6 – 10 Ci generator for US FDA application

Questions?

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