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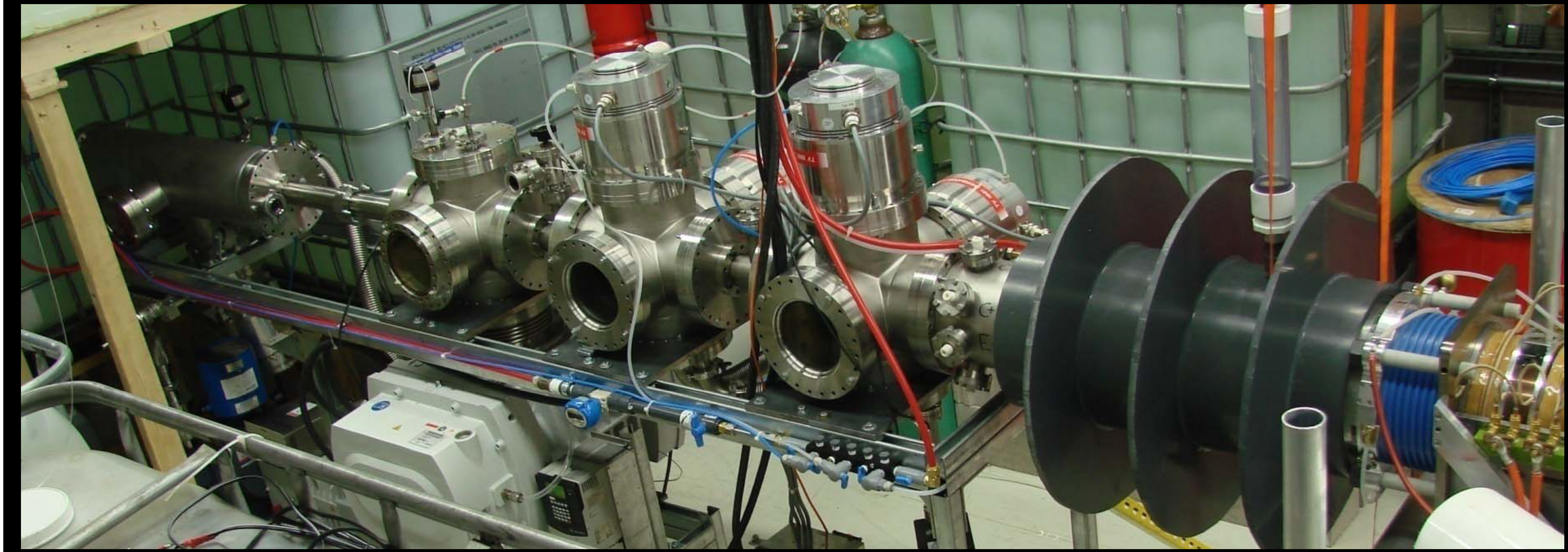

Mo-99 Production with a Subcritical Assmebly

May 1, 2011

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SHINE Medical Technologies

Introduction to SHINE Medical Technologies
Health. Illuminated.

- SHINE Medical Technologies™ is dedicated to being the world leader in safe, clean, affordable production of medical tracers and cancer treatment elements.
- Highest priority is safely delivering a highly reliable, high-quality supply of the medical ingredients required by nearly 100,000 patients each day
- Created by partnership of multiple entities and technology from Phoenix Nuclear Labs, LLC

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Key Collaboration Partners

- Morgridge Institute for Research
- U.S. Department of Energy
- Phoenix Nuclear Labs, LLC
- Los Alamos National Laboratory
- Argonne National Laboratory
- University of Wisconsin

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Technology Overview

- Technology has two key aspects
  - Primary neutrons created by high output D-T source
  - Neutrons enter a subcritical LEU solution creating medical isotopes
- D-T accelerator advantages
  - Demonstrated technology at high yield
  - Efficient and inexpensive
  - We know how to make them
- Subcritical aqueous system advantages
  - Small, bounded power changes in response to void and temperature
  - No possibility of control system "chasing" an instability
  - Cannot become critical after fill procedure completed
  - Easy separation, very low waste production
  - Minimal decay heat after shutdown; less than a hair dryer

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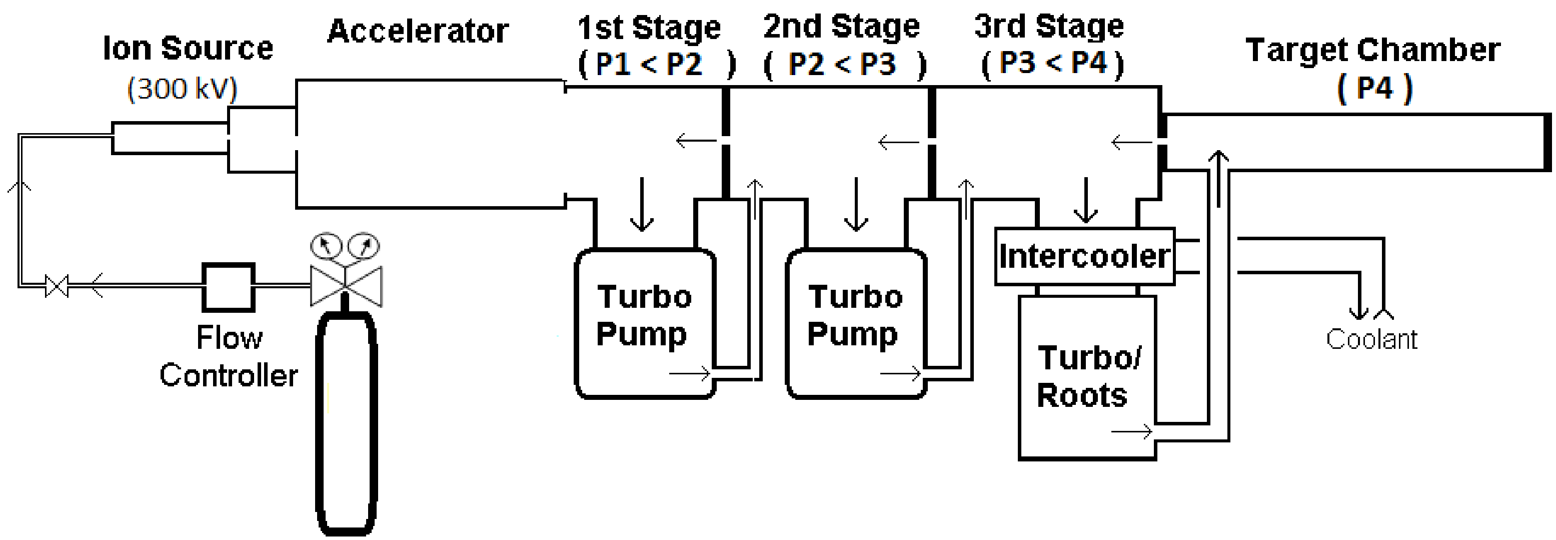
D-T Driver is Based on Demonstrated Technology



- Neutrons are made by reactions between deuterium and tritium atoms
  - Deuterium gas flows into ion source, is ionized by microwaves
  - Simple DC accelerator pushes ions toward target chamber (300 keV)
  - Accelerated deuterons strike tritium gas in target chamber, creating neutrons
  - Proof of high efficiency and yield already demonstrated (> 2×10^{9} n/s per watt)
  - High energy neutrons allow for (n,2n) multiplication on beryllium or other multiplier

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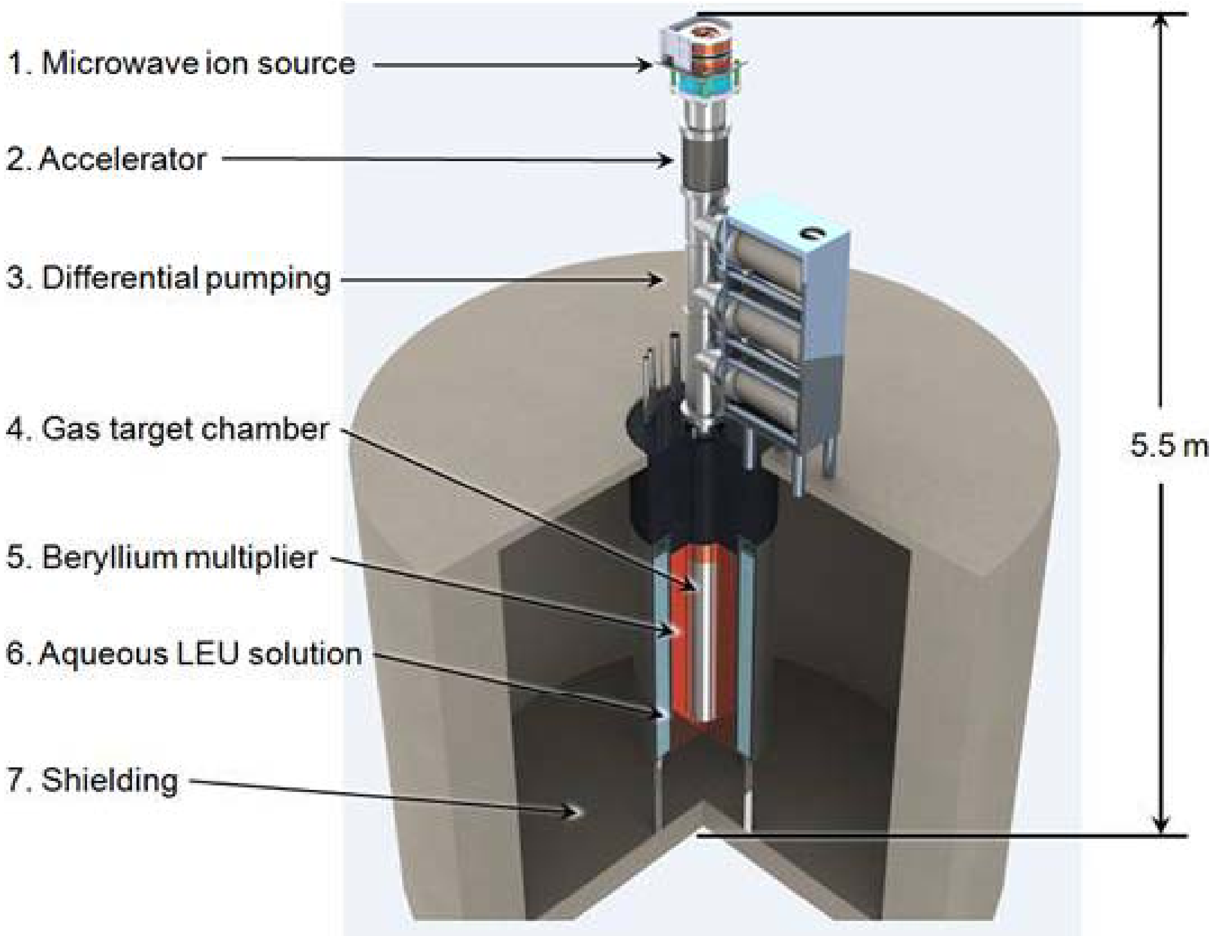
Aqueous Target Generates Medical Isotopes



- D-T source in center
- Neutron multiplier
- Annular geometry
- LEU solution
- No active control elements

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System Specifications

- Neutron source strength: several 10^{13} n/s
- Strength after (n,2n) multiplication: few 10^{14} n/s
- Accelerator power consumption: 30 kW wall power
- LEU target solution
- Thermal fission power: ~ 100 kW per device
- ^{99}Mo production rate after losses: 500 6-day Ci / wk
- Production facility to have 6 units
  - Redundancy
  - Flexible production schedule to meet market need

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Recent Progress-Accelerator

- Ion injection system: complete, demonstrated at 40% above design specification
- Demonstration of production level beam voltage and current in driver prototype: complete
- Design of production model accelerator: complete
- Build of production model accelerator: in progress
- Next step: reliability testing of production model accelerator (will begin mid-2012)

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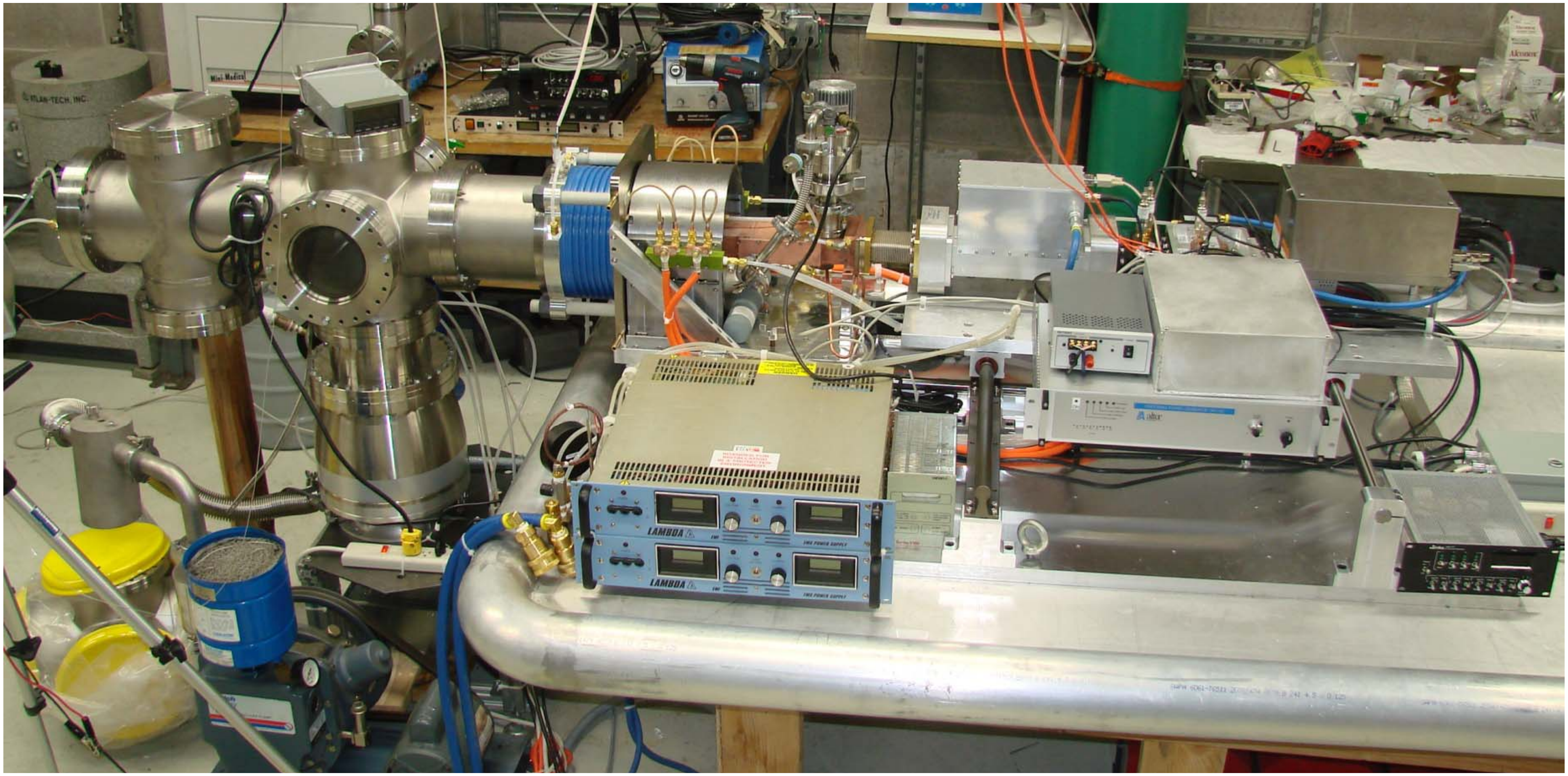
Ion Injector (NNSA phase IA supported)



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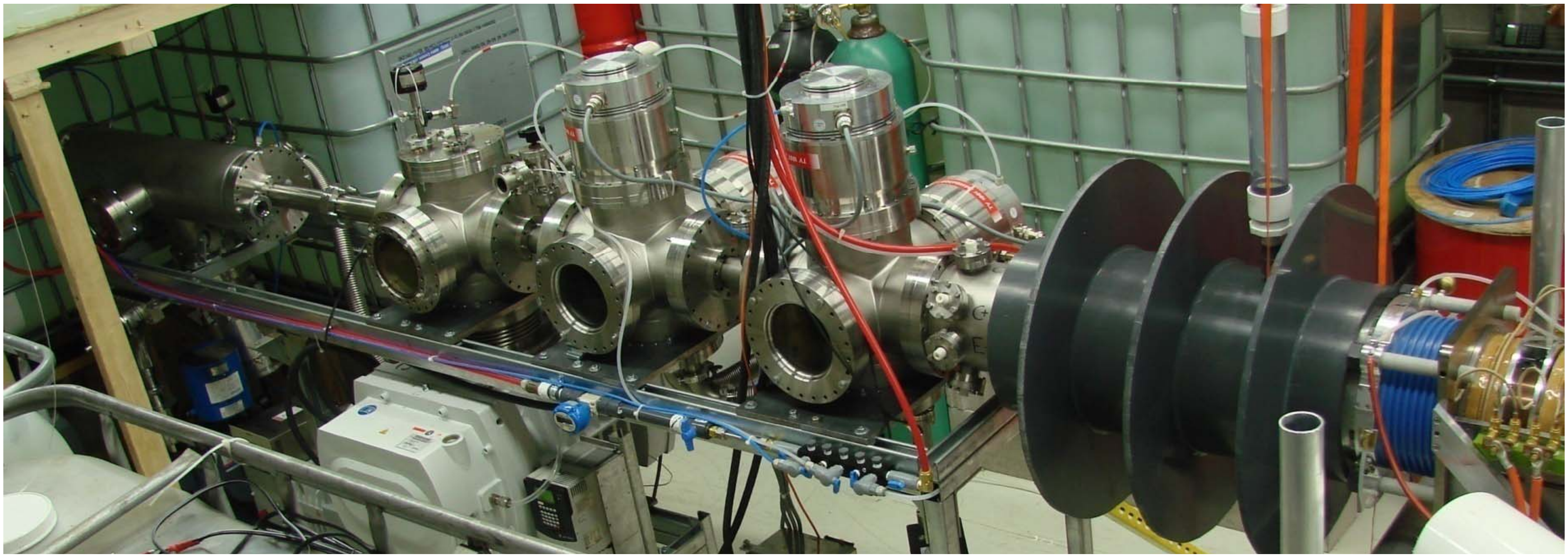
Ion Injector Demo (NNSA phase 1A supported)

Demonstration Accelerator



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Accelerator Beam Video

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Recent Progress-Subcritical System (Support from NNSA/LANL/ANL)

- Geometric optimization nearly complete (neutronic)
- Workable cooling system developed, optimization in progress
- Chemical separation techniques under development, preliminary experimental results encouraging for SHINE solution chemistry
- Off-gas system design underway
- Detailed safety basis calculations underway

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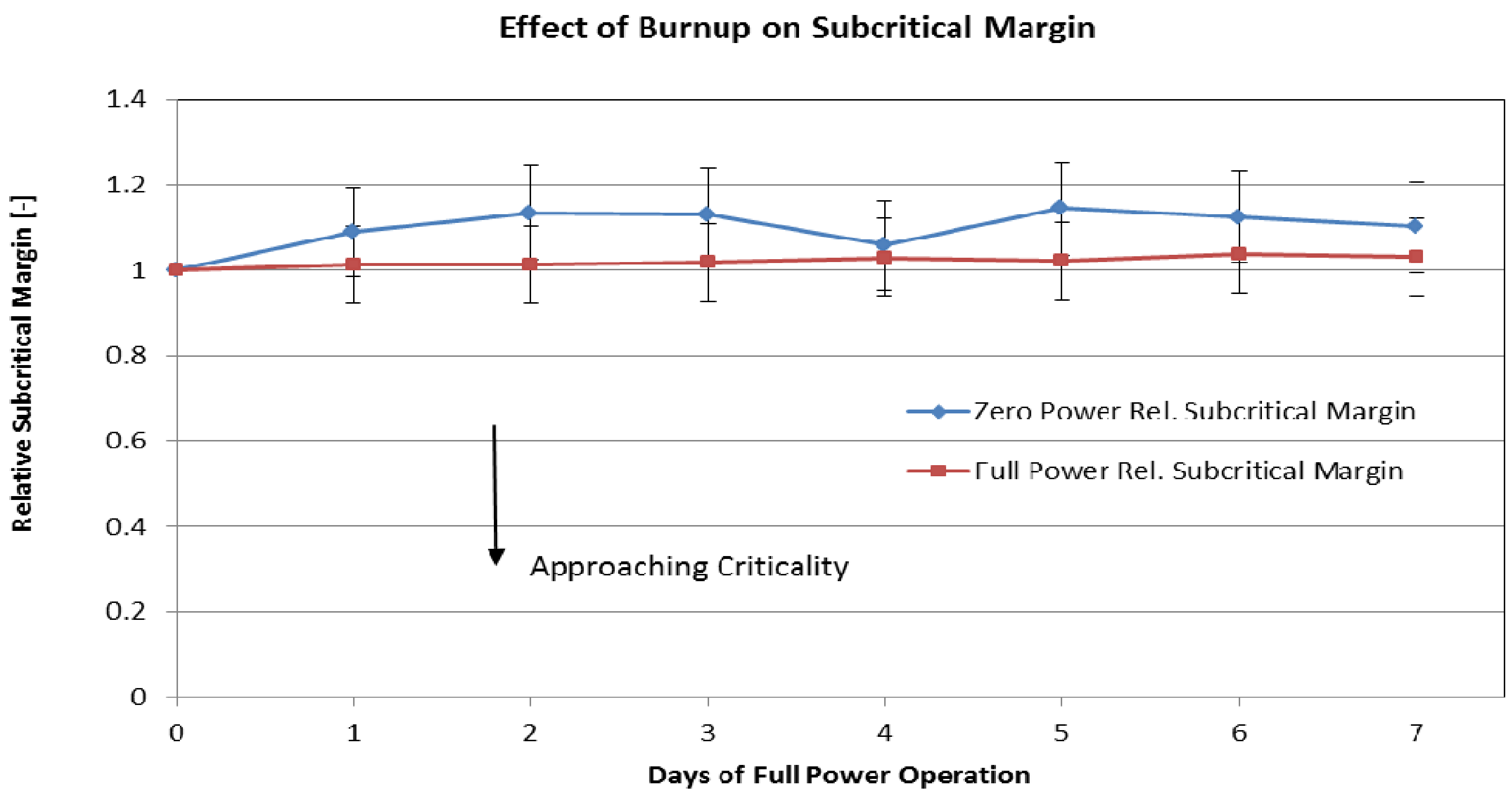
Relative Subcritical Margin Stays Relatively Constant with 1 Week Irradiation



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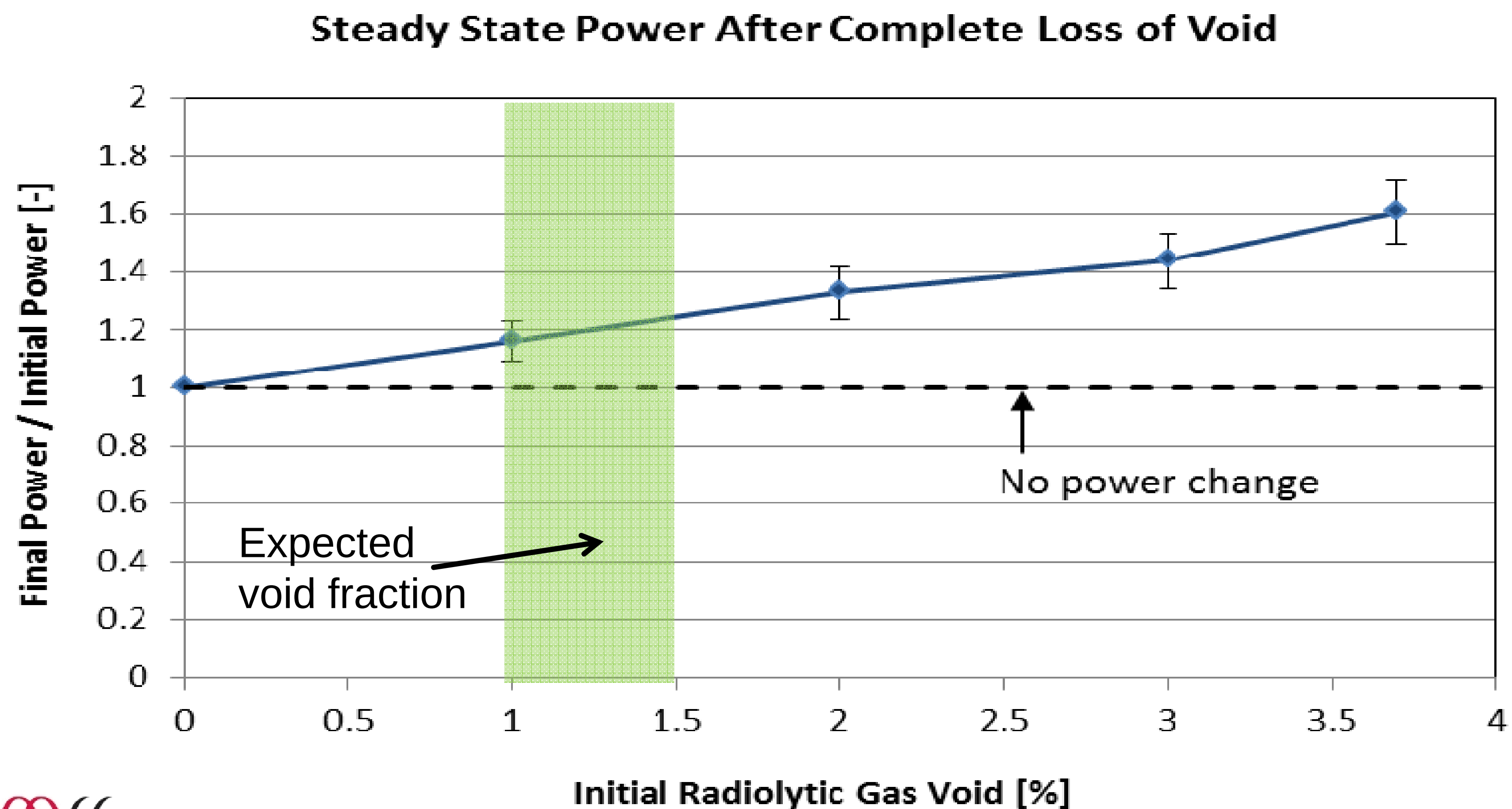
Complete Void Collapse Scenario Shows Small, Bounded Power Change



Facility Progress

- Three sites under consideration, site characterization underway
- Facility pre-conceptual design complete
- Conceptual PFD's nearly complete
- SDD development in progress
- Waste handling / packaging system in development, expect 1 m^3 packaged waste annually—can be contact handled after 3 years
- Working with PNNL to minimize plant emissions

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Thank You!

Dr. Gregory Piefer
SHINE Medical Technologies, Inc.

www.SHINEmed.com
Greg.p@shinemed.com