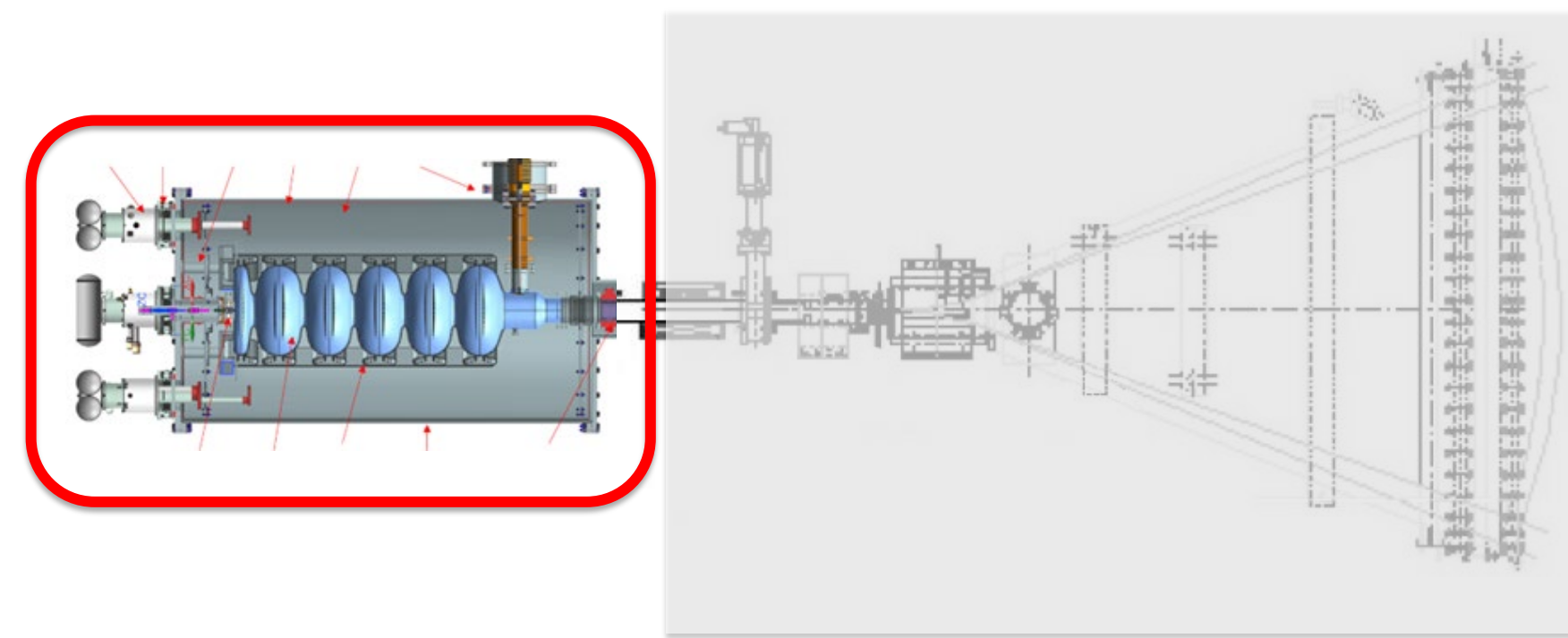


Goals and Objectives

- Demonstrate efficient, high-power, CW electron beams to enable economic x-ray production for medical device sterilization.
- Utilizing: Conduction-cooled superconducting RF (SRF) CW accelerating structures.
- Requirements:
 - 7.5 MeV
 - >200 kW (120 kW/MCi eqv.)



Introduction

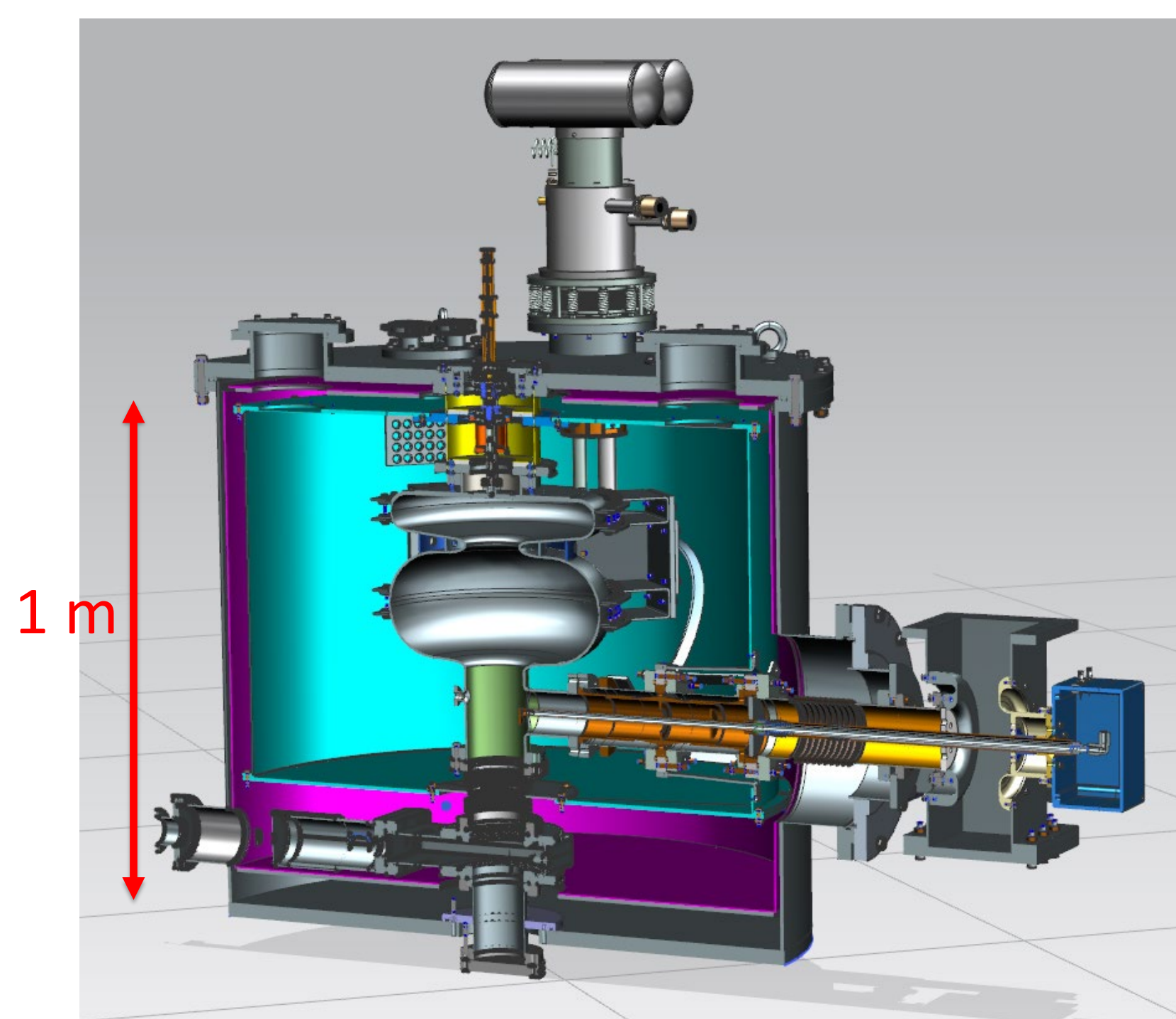
- A large fraction (~45%) of single-use medical devices are sterilized using gamma rays from the decay of cobalt-60.
- The industry has been slow to adopt accelerator- based sources of radiation.
- X-rays provide an almost 1-1 alternative.
- Increased accelerator efficiency is required to compensate for the inefficiency of Bremsstrahlung.
- CW Superconducting RF and efficient RF sources provide the greatest system efficiency.

Methods

- Assemble a 20 kW, 1.6 MeV prototype
- Conduction Cooling w/cryocoolers
 - Eliminates liquid cryogenic system
 - Nb₃Sn coating
 - Puts operating temperature in cryocooler range
 - Integrated electron source
 - Minimizes heat from ambient
 - Low heat-leak RF coupler
 - Minimizes heat from ambient

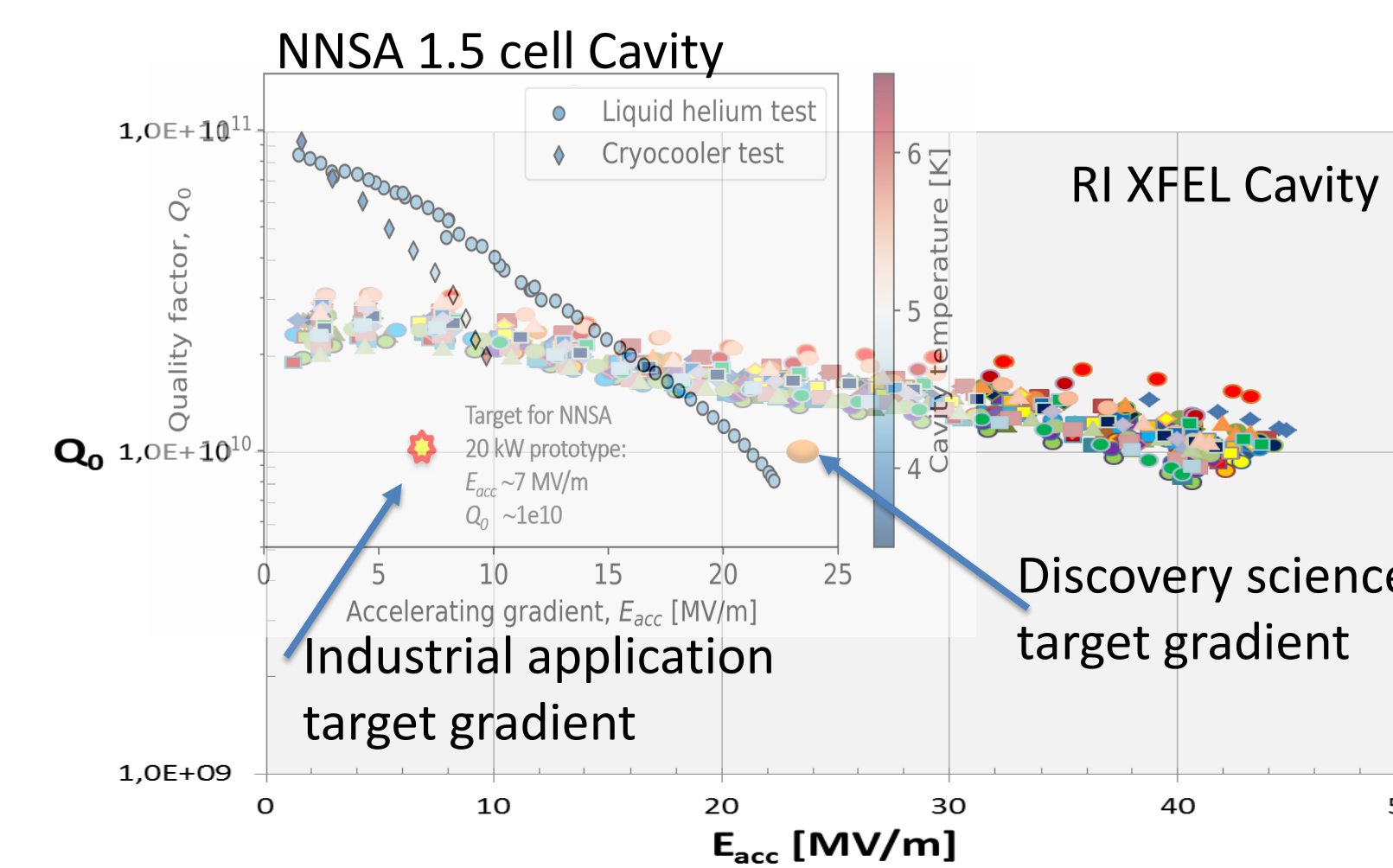
Heat load at ~5 Kelvin	Value [W]
RF dissipation in cavity (with Q ₀ = 1e10)	1.46
Gun static heat leak	0.08
Cathode radiation to cavity (temp = 1373 K)	0.22
Conduction through cavity supports	0.1
Conduction through outlet beam pipe	0.1
Thermal radiation to cavity from thermal shield	0.1
Thermal radiation to cavity through beam pipe window	0.24
Beam loss (1e-6 of 20 kW = 0.02 W)	0.02
Coupler static + dynamic at 20 kW cw	1.0
Total	3.5

- Demonstrate CW operation at 20 kW and within heat budget



Render of complete prototype system.

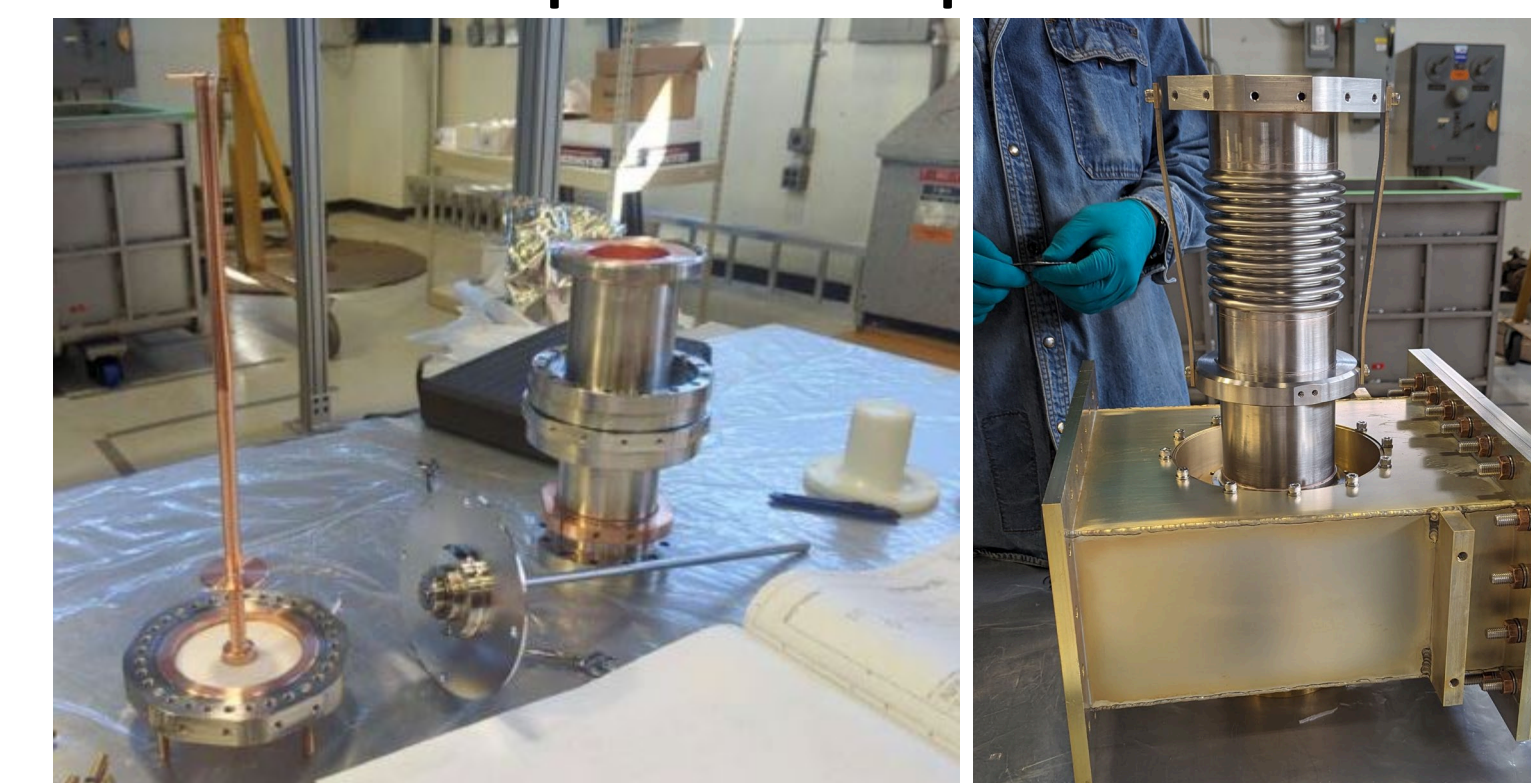
Status



RF Electron Source/Cathode



RF Coupler Components



Next Steps

- Prepare cavity*
- Vertical test stand
 - Surface processing
 - Nb₃Sn coating
 - Vertical test stand
 - Assembly
- Commissioning*
- 1st Beam anticipated Q1 Y25
 - Determine operating parameters
 - RF system
 - Electron source
 - RF coupler tuning
 - CW operation
 - Document performance

Commercialization

Commercialization workshop planned for Q1 of CY25.

Objectives:

- What do users need?
 - Operational constraints
 - Maintenance/service needs
- Integration with other facility systems
- Engage potential manufacturers & system integrators

Commercialization Concerns

Who is best suited to commercialize?

Concerns:

- Capital intensive
 - How to play the fund-raising game
 - NanoGraf – 370,000 miles in one year
- Existing accelerator manufacturers may see this as disruptive to existing product
- Who will fund the necessary developments of transition from prototype to manufacturable item?

CONTACT
Thomas Kroc
630.840.6955
kroc@fnal.gov

This work was produced by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy.

Unclassified