

# Technological challenges for SRF accelerators for waste-water treatment

Reliability, redundancy,  
scalability

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Thursday, April 11, 2019

Jefferson Lab



*CEBAF at JLab: 12 GeV, CW electron accelerator*



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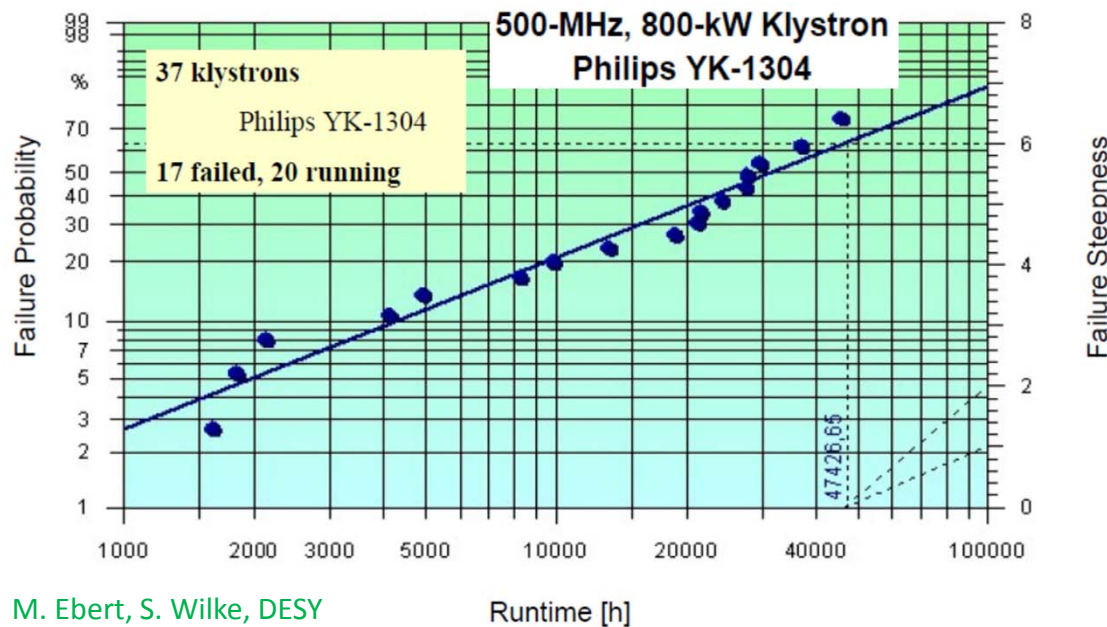


# RF Power Source

- Klytrons



MW-class, 700 MHz CW commercial klystron manufactured by CPI (model VKP-7952)



M. Ebert, S. Wilke, DESY

- 5 kW, 1497 MHz klystrons for CEBAF: average lifetime of 138,000 h

R. Walker, R. Nelson, JLAB

# Cryocoolers

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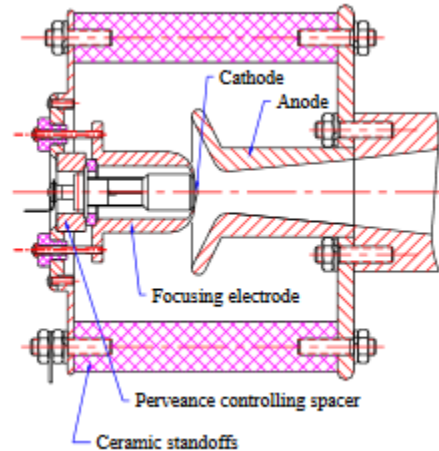


- 1.5 W at 4 K, RDK-415D, Sumitomo Cryogenics of America
- Used in MRI machines at hospitals
- Average lifetime of ~44,000 h
- Recommended maintenance at 10,000 h for cold head, 30,000 h for compressor

# Thermionic gun

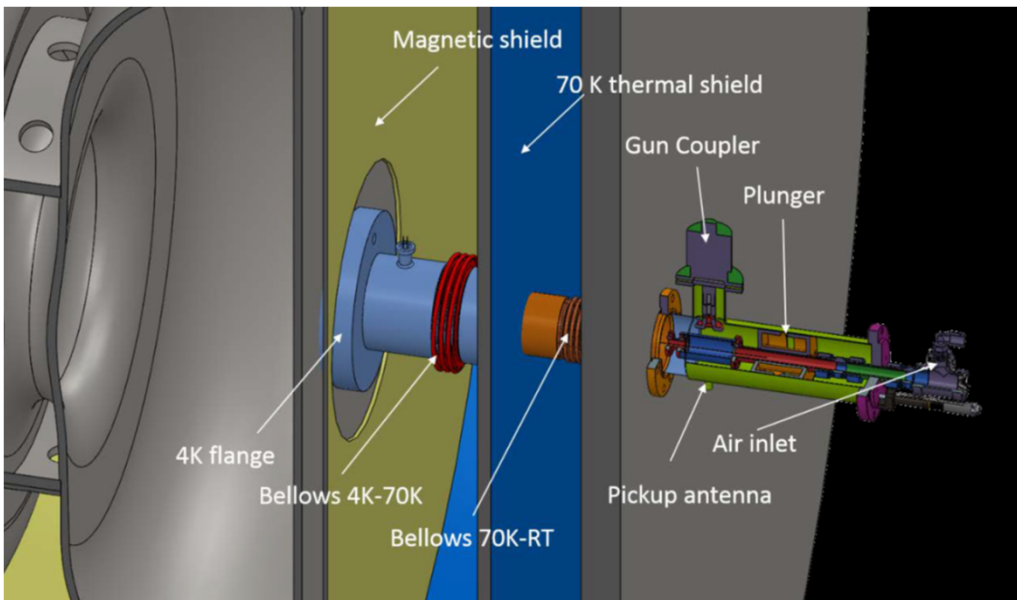


Prototype T-gun for ARIEL at TRIUMF



Schematic of 20 A T-gun for EBIS at RHIC

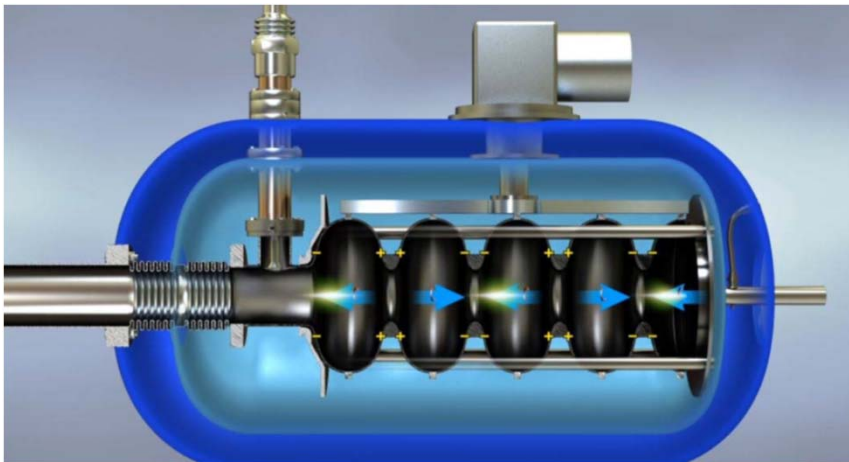
- Estimated average cathode lifetime of  $\sim 40,000$  h at 20 A



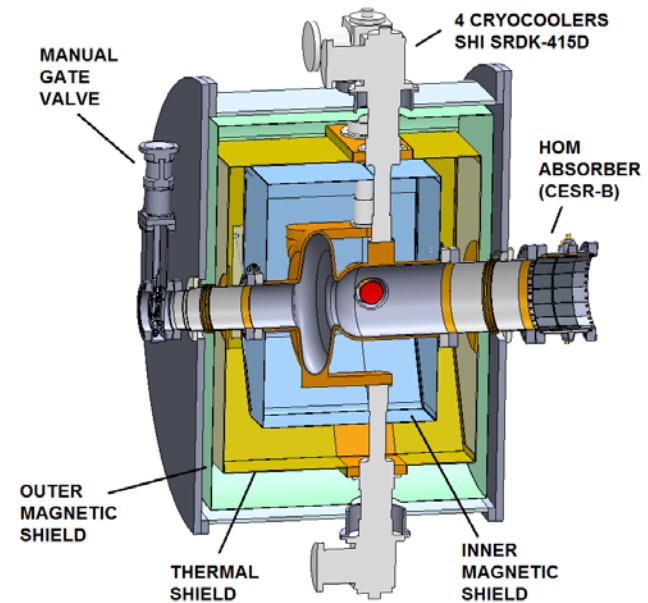
- Integration of electron gun into SRF cavity can be very challenging towards long-term reliability of the cavity

# Conduction-cooled cavity

- Operation of SRF cavity at  $\sim 10$  MV/m with cryocooler(s) needs to be demonstrated



*650 MHz conduction-cooled cavity designed at FNAL*



*750 MHz conduction-cooled cavity designed at JLab*

# Scalability

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- Accelerator designs for 1 MeV, 1 MW and 10 MeV, 1 MW have been produced
- Scaling to 10 MeV, 10 MW would likely require multiple accelerator units operating in parallel.
  - Simply adding more modules of the type a) does not seem practical
  - It may become advantageous to adopt a “traditional” 4 K liquid He refrigerator. Compact, LHe refrigerators capable of ~100 W at 4.5 K are commercially available at competitive cost and long maintenance intervals (~30,000 h)



# Redundancy

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- The 10 MeV, 4x0.25 MW accelerators designed at FNAL includes a 250 kW spare unit.
- For a smaller 1 MeV, 1 MW system, the installation of an additional unit operating at reduced time might be considered, being a “hot spare” and allowing treating temporary increased water flow.
- Maintenance intervals for these accelerator systems should be considered mandatory to maintain lifetime of components.