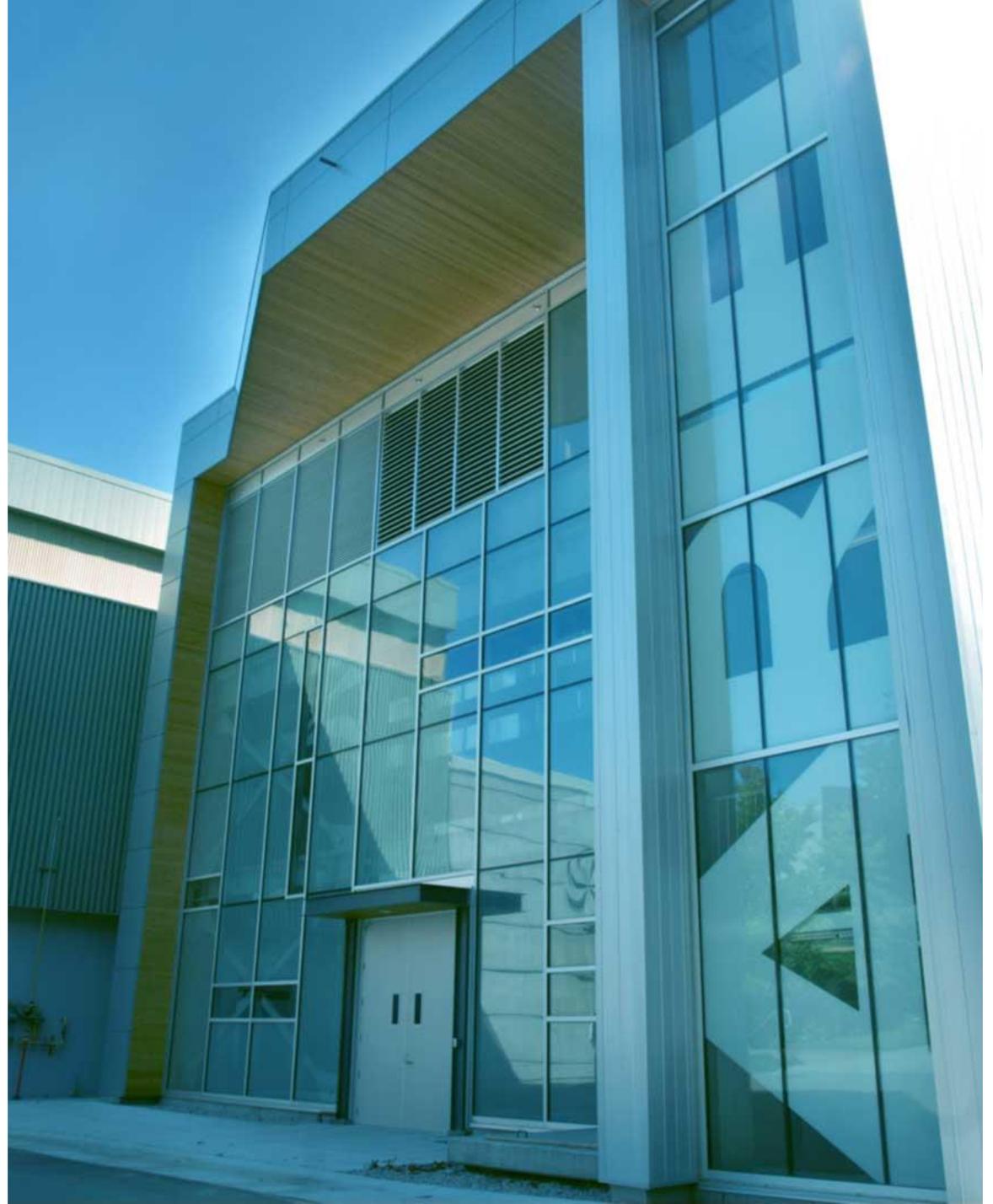


TRIUMF e-linac technical issues

Friedhelm Ames

ERW workshop May 10, 2022



Technical issues with caused most of the e-linac down time

- issues at e-gun
 - High voltage
 - RF
- issues with services
 - Cooling water quality

e-gun

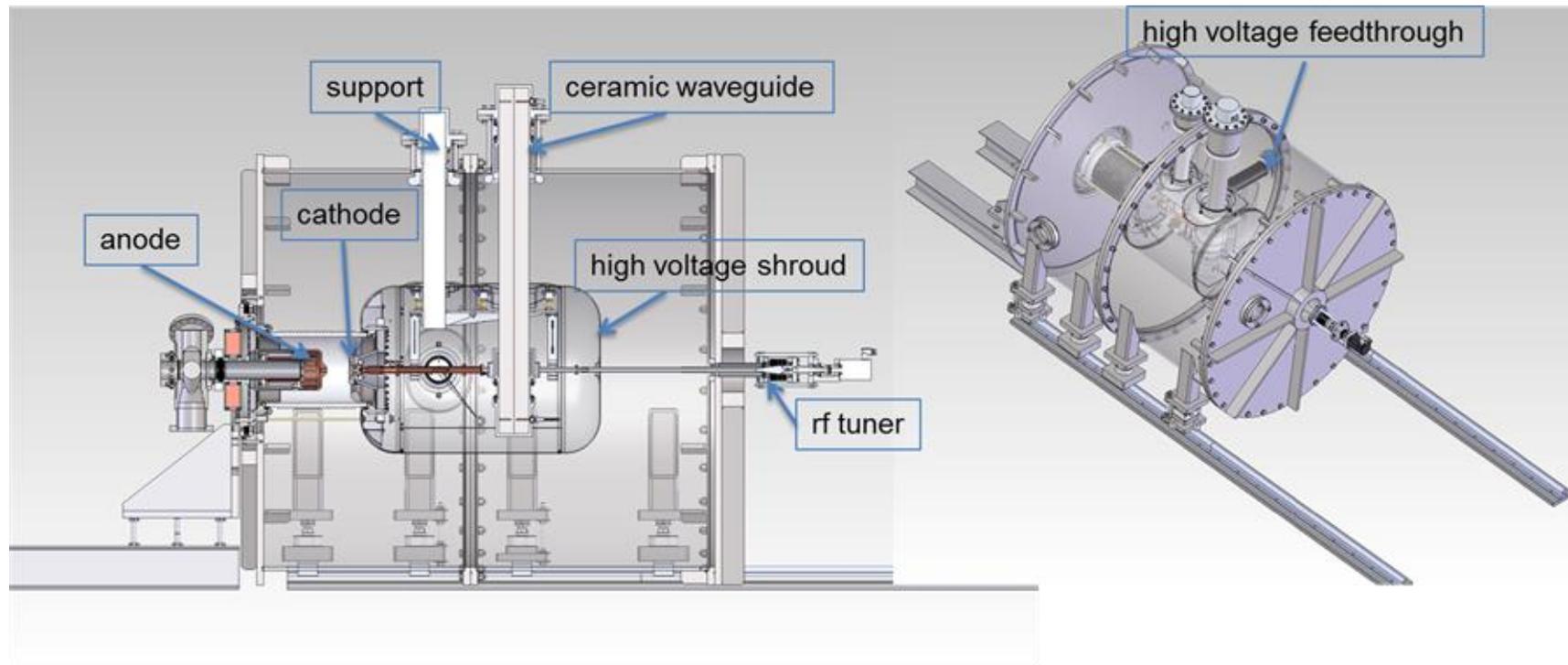
Thermionic source with rf modulation at 650 MHz

Operating voltage 300 kV

Max current 10 mA dc

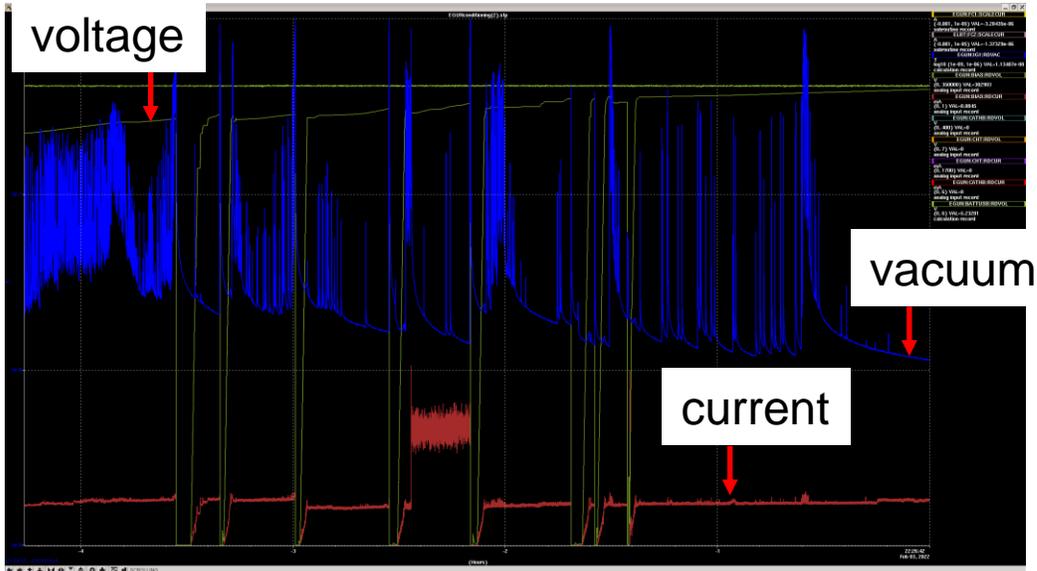
Macro pulsing, typically 100 Hz to 1 kHz with duty factor 0.05% to 100%

Source is operated in SF₆ at 2 bar

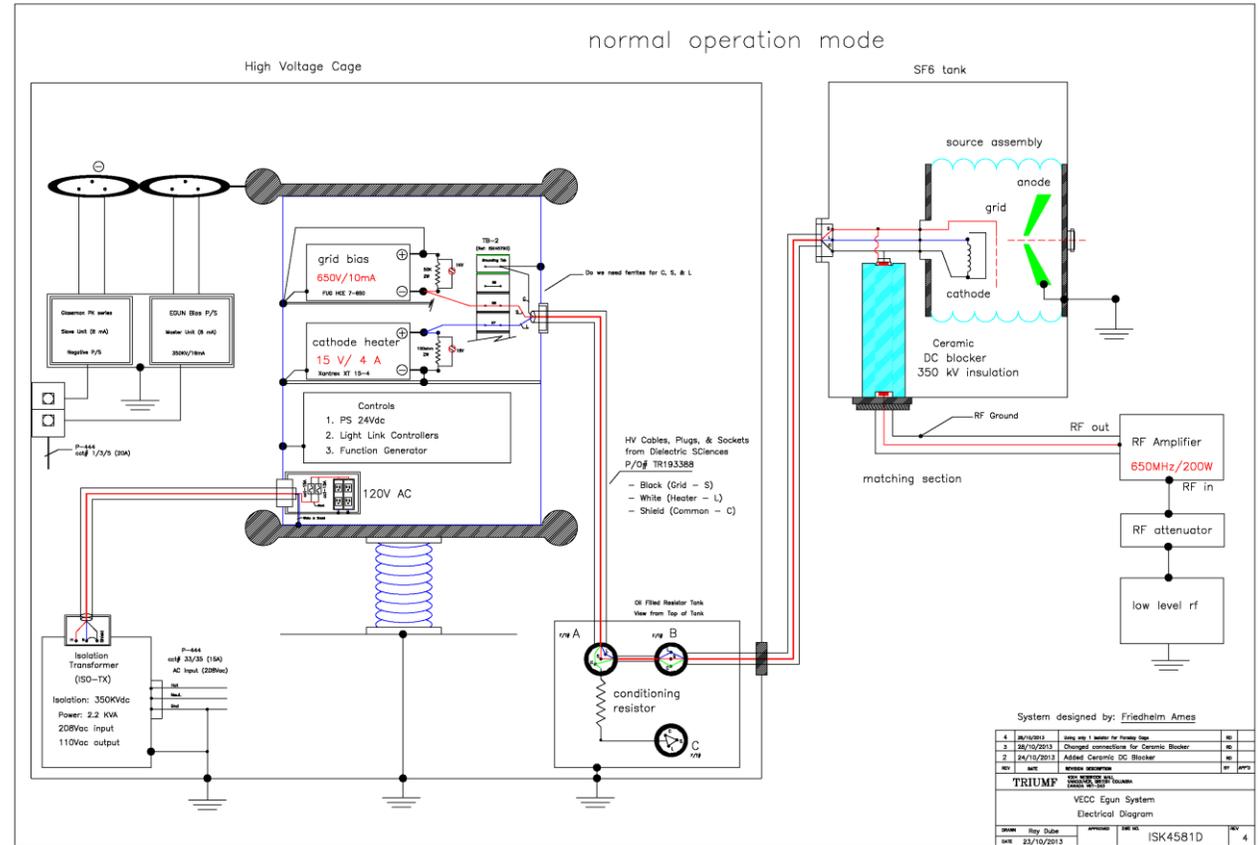


e-gun high voltage

- 2 modes of operation
 - Normal operation
 - Conditioning with inline resistor and power supplies for heater and grid voltage disconnected
- Conditioning up to 320 kV



High voltage conditioning >275 kV



Schematic of e-gun electrical connections

e-gun high voltage

- High voltage power supply in air,
- 2 stacks operating parallel
- Power supplies for cathode heating and grid voltage on high voltage platform
- Ac supply via high voltage oil filled isolation transformer
- Connections with high voltage plugs
- Optional connection via conditioning resistors in oil filled tank



e-gun high voltage issues

- Sparking along high voltage cables
- Tracking inside connectors

- adding isolating sleeves to reduce field strength at cable and connectors
- implementing shorter maintenance intervals for cleaning and greasing of connectors



Sleeve over cable



Tracks on connector plug



Sleeve over receptacle

e-gun high voltage issues

- Break down of high voltage isolation transformer
Manufacturer unable to supply → replace transformer by generator
preliminary work around: battery on high voltage



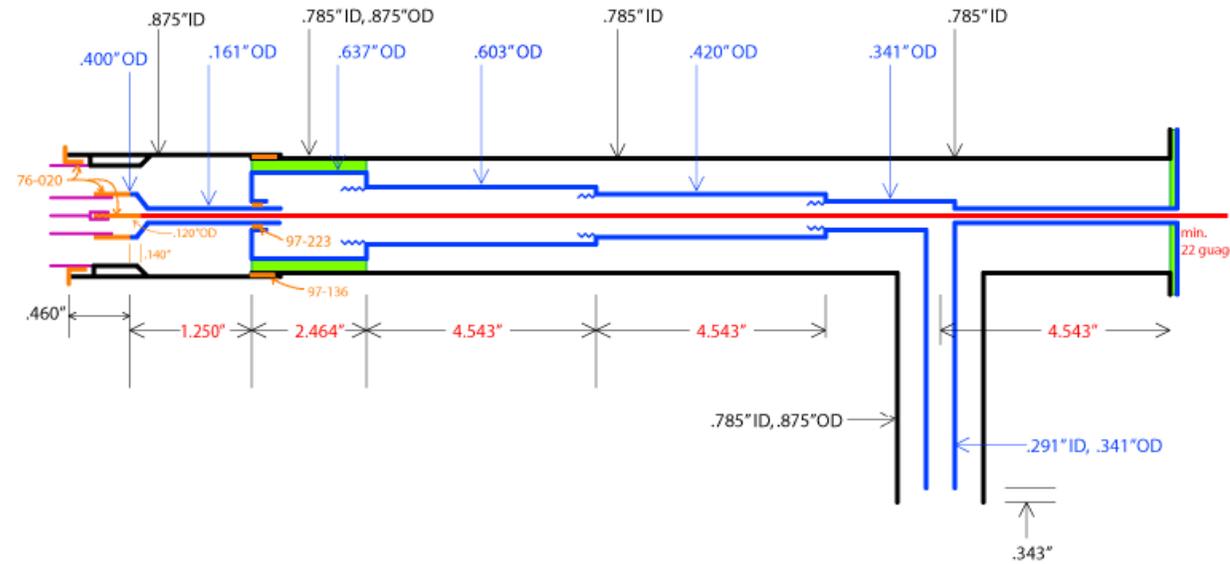
e-gun rf tuner

Coaxial matching section for rf at cathode

- Length can be changed via insulating rod to outside of SF6 tank and stepper motor
- Required resolution < 0.1 mm

Issues:

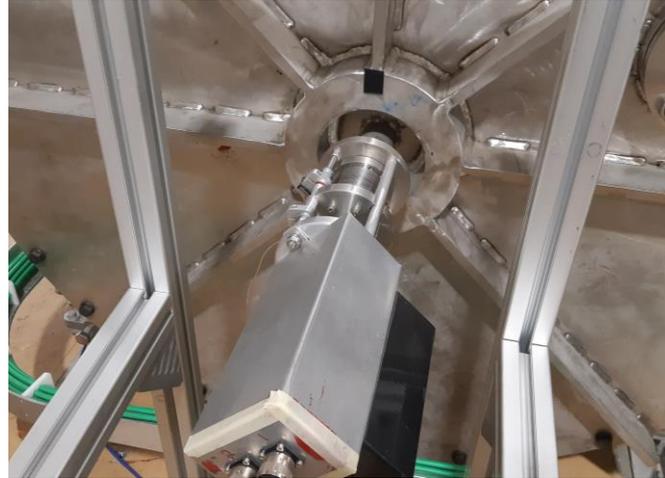
- Mechanical resolution not good enough
- low reproducibility
- Not stable due to thermal sensitivity and bad rf contacts



e-gun rf tuner



Tuner assembly



Tuner motor outside of SF₆ tank



Broken fingerstock
caused short of grid voltage

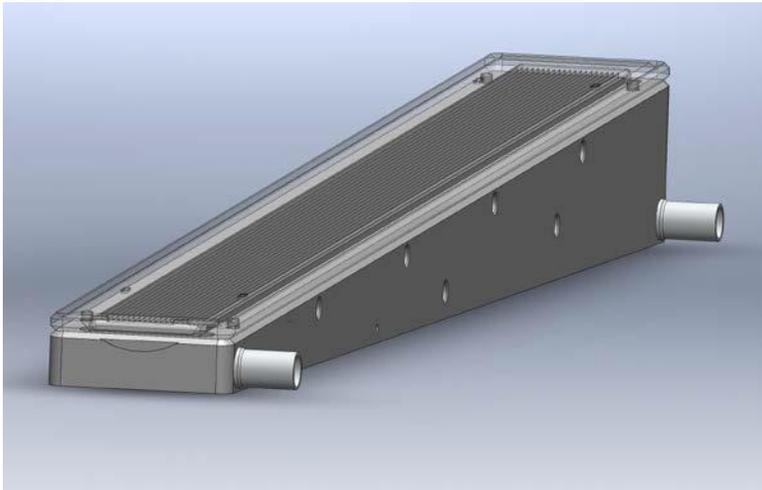
Mitigation: redesign started

- Mechanical movement via hydraulic piston to decouple from SF₆ tank and improve resolution
- New concept: Moving dielectric components in the tuner to avoid rf contacts

Cooling water

Problem particulates in the cooling water

- Clogging of cooling channels at beam dump by resin particles verified by thermal images
- Low water flow at klystron rf window



Model of beam dump



Resin particles in water sample



Part found close to rf window

→ Install more and better filtration

The TRIUMF cyclotron with an up-time >90%

Thank you
Merci

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