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## *Inside the Mod-Anode Tank*

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U.S. Department  
of Energy

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# ***UVC PURPOSE – To Power and Control a Thompson Klystron #TH 2089***

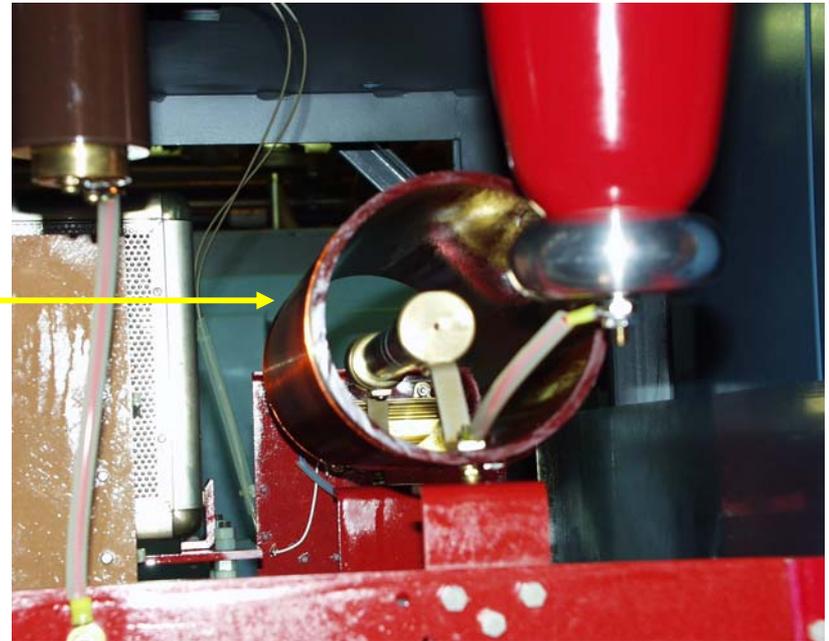
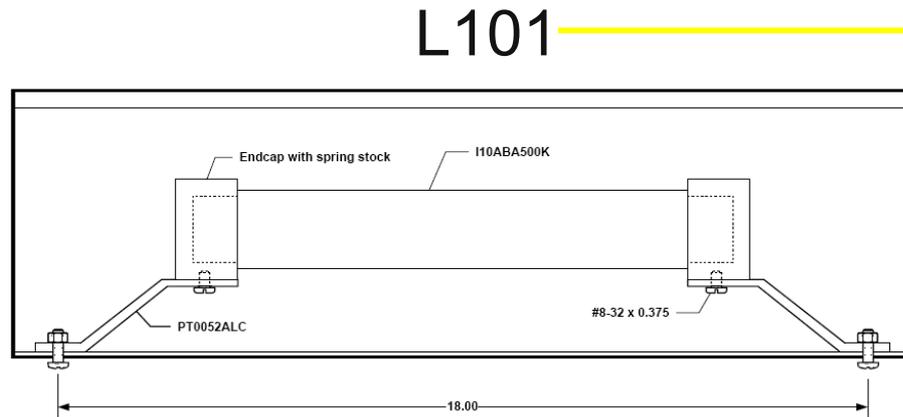
## ***MOD-ANODE TANKS FUNCTION:***

- Modulate Anode
  1. Voltage : 0 – (+)80kV, relative to Cathode
  2. Current : 0 – 10mAdc
  3. Regulation : Voltage, 0.5%or 425V
  4. Rise Time : 100uSeconds
  5. Fall Time : 100uSeconds
  
- Klystron interface – One CB2077 converted to three Pantak cables.
  1. Filament
  2. Cathode / Filament
  3. Anode
  
- Provide isolated klystron filament power.

# INPUT CIRCUIT

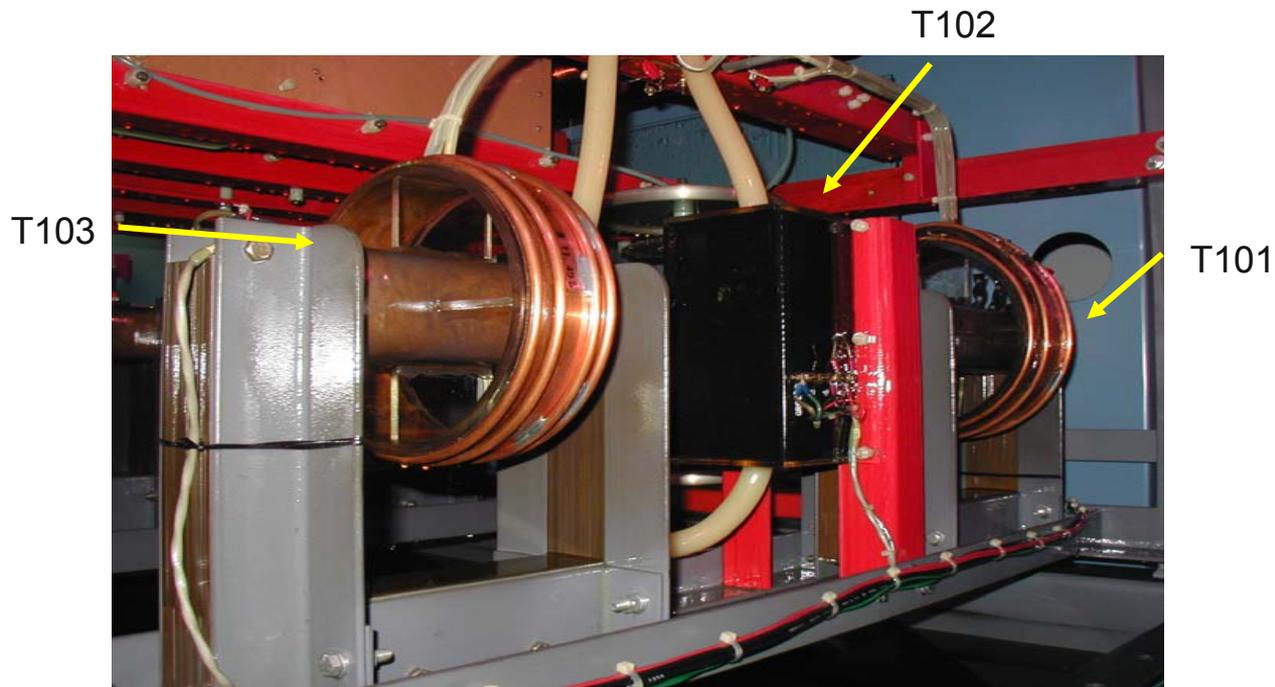
## ■ “Excellent Coil and Resistor”

1. L101 - 1000uH coil with parallel 50Ω resistor.
2. Purpose – suppress in rush current,  $V=L \cdot di/dt$ .



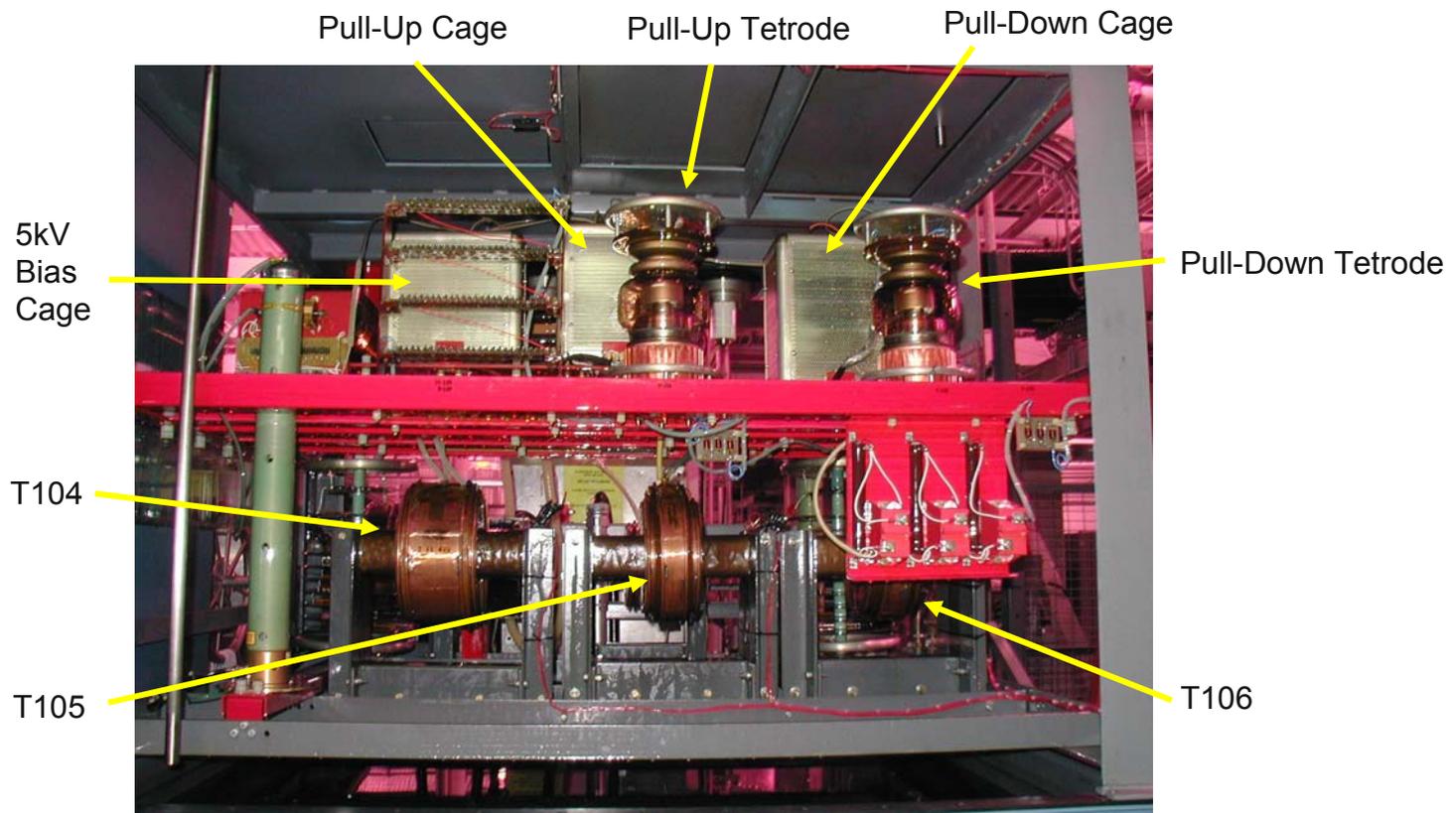
## FILAMENT HEATER

- Isolation transformer T101
  1. Provide 25Vac and 25Aac
  2. Direct connection to the klystron filament
- T102 – Current transducer.
- T103 – Voltage potential transformer.



# BIAS CIRCUIT

- T104 – 120Vac:3500Vac
- 5kV Supply Cage – Full wave rectification circuit =  $3500\text{Vrms} \times \sqrt{2}$
- 1. Produces 100mA with 50k $\Omega$  load.
- Fixed voltage rides up and down with the cathode voltage.



## **PULL-UP CIRCUIT**

- Refers to “pulling up” to cathode. Note, polarity was disregarded when defined.
- Functions as a 15mA current source and must conduct 15mA with 80kV drop.
- During cathode rise, anode fall and cathode fall, circuit is at minimum impedance for charging and discharging the anode capacity.  
$$I = C \Delta V / \Delta t = 10E-9 \times (10E5 / 10E-4) = 1A$$
- Components:
  1. T105 – Feeds Pull-Up Cage 120Vac and 360Vac, and filament 7.5Vac @ 35Aac.
  2. Pull-Up Cage – Creates +1000V Screen and -400V Grid Bias
  3. TH5188 Thomson Tetrode
    - a) *Anode voltage : 120kV, immersed in oil*
    - b) *Anode dissipation : 10kW*
    - c) *Filament power : 7.5V at 35A*
    - d) *Grid bias : -400V.*
    - e) *Screen voltage : 1000V*
    - f) *Screen dissipation : 200W*

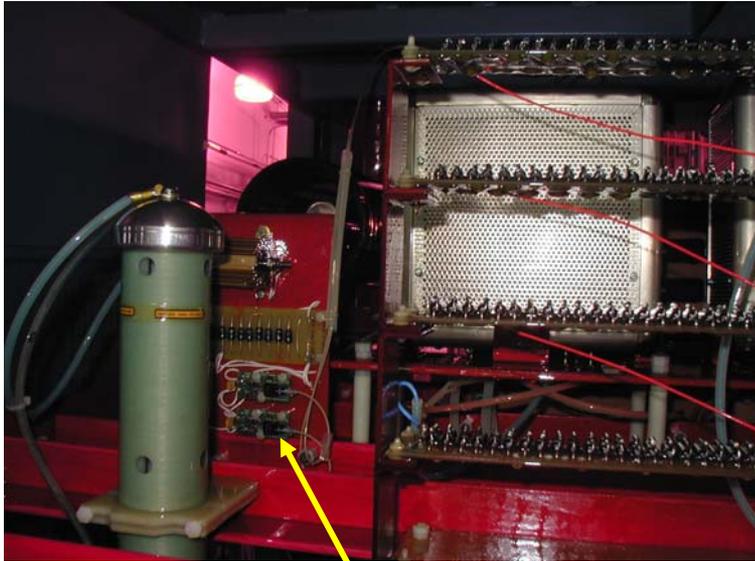
## ***PULL\_DOWN CIRCUIT***

- Refers to “pulling down” to ground. Note : polarity was disregarded when defined.
- Functions as a variable resistor = adjustable voltage divider. Allows anode to move from bias voltage; negative with respect to ground, to 80kV positive of the cathode. Positive movement depends on cathode to ground voltage.
- Holds off 95kV while conducting 25 milliamperes.
- Shuts off during cathode rise and anode fall, and regulates during anode rise.
- Components:
  1. T106 – Feeds Pull-Down Cage 120Vac and 240Vac, and filament 7.5Vac @ 35Aac.
  2. Pull Down Cage – Creates 680V and 500V grid bias (adjustable).
  3. TH5188 Thomson Tetrode - same characteristics as Pull-Up except:
    - a. Highest dissipation requirement, 2375Watts.
    - b. Grid bias normal operation, -150V to -200V.
    - c. Grid bias at anode rise is -50V.
    - d. Grid bias at cutoff is -500V.

## FAULTS VIA FIBER

- Interlocks – Prevent high voltage power supply from powering on and if it is on, an opening of the interlock will power the supply to an off state.
  1. 5kV Bias Ready – voltage must be present. *LL102*.
  2. Pull-Up Tube Ready – screen voltage and filament current must be present. *LL104*.
  3. Pull-Down Tube Ready – screen voltage and bias voltage must be present. *LL106*.
  
- Over-currents Fast – fixed fast circuit used to detect klystron arcing.
  1. Cathode Over Current Fixed – R101 in series with the cathode input senses current in excess of 38A. *LL101* and *LL114*.
  2. Anode Over Current Fixed – in series with anode output and senses current in excess of 1.2A. *LL110* and *LL112*.
  3. Anode Over Current Adjust – Bergoz transformer.

## FAULTS VIA FIBER cont.



Cathode Over Current



Anode Over Current

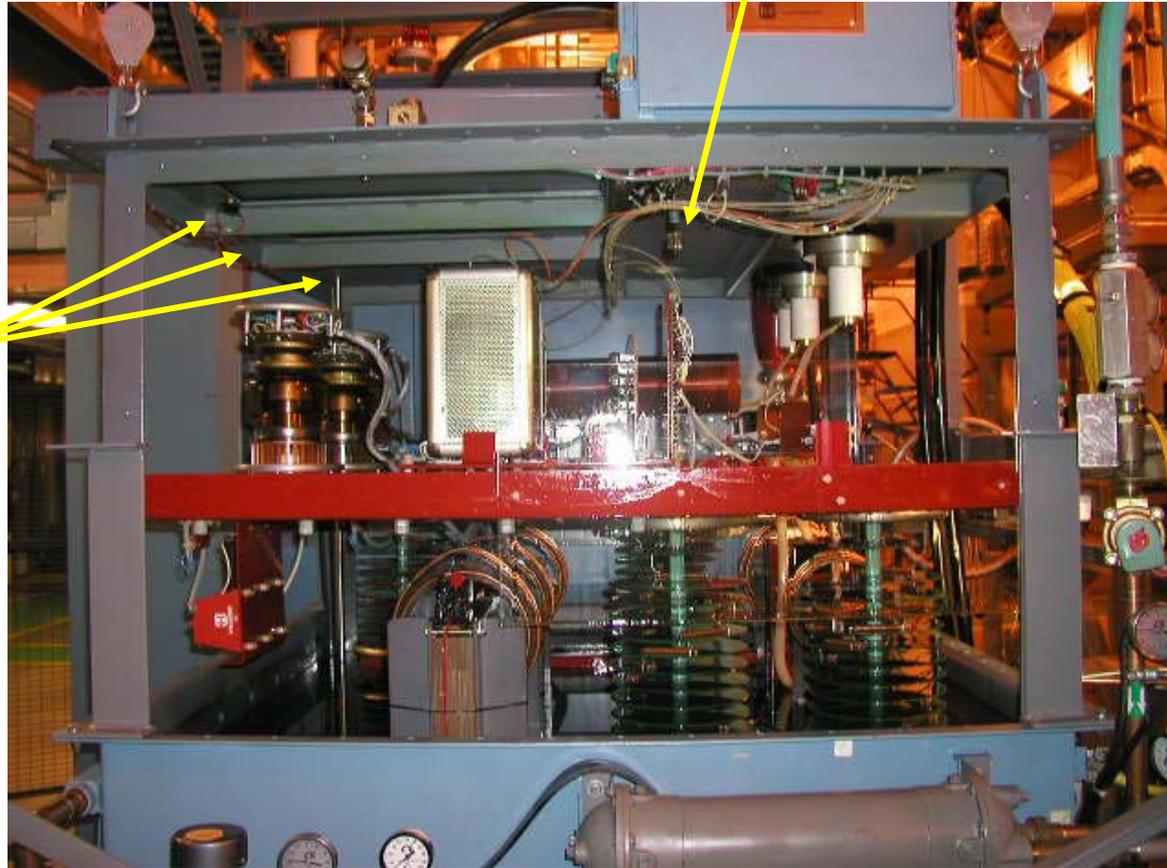
# INTERLOCKS



Pressure Relief

Oil Level

Access

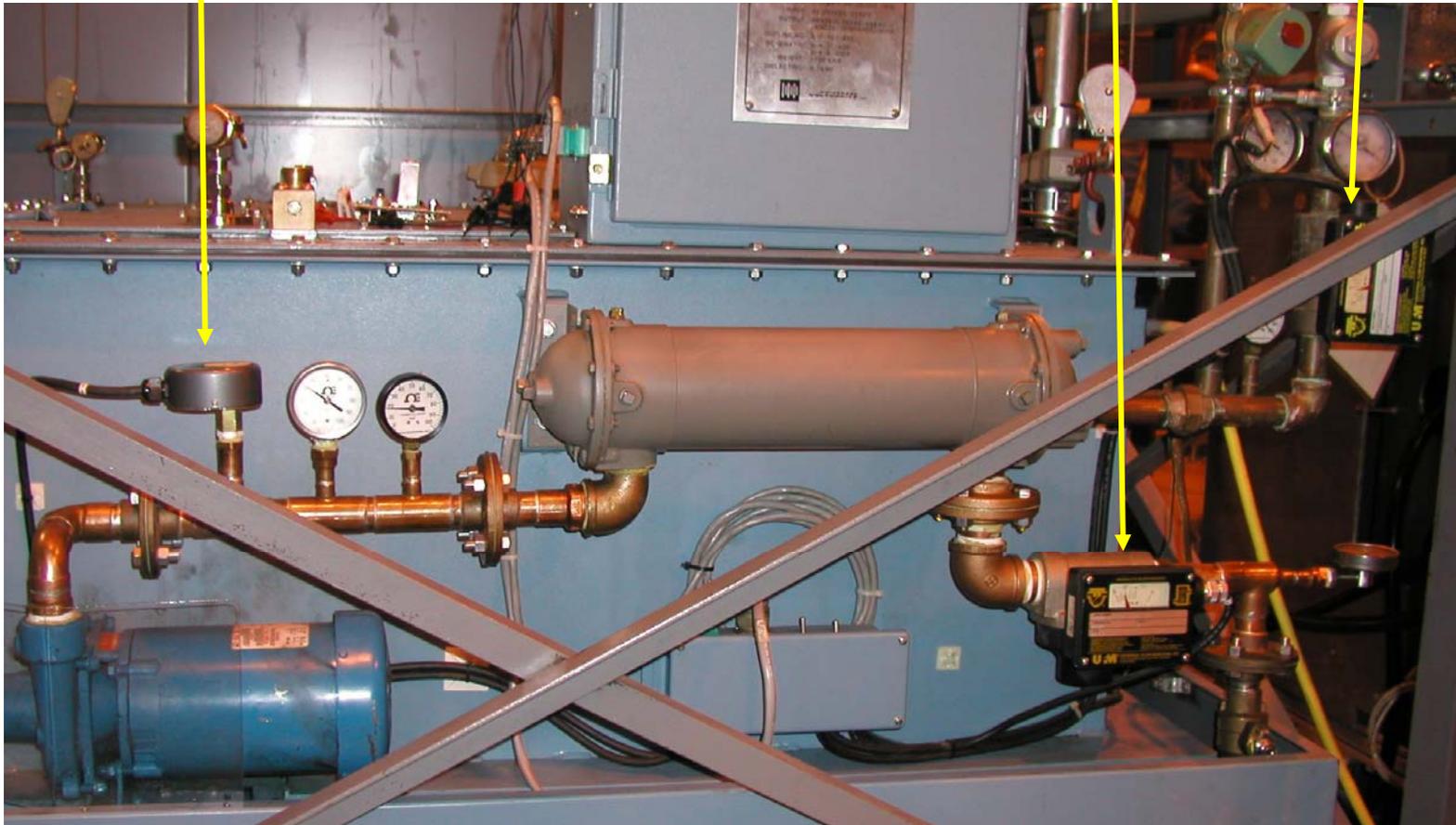


# INTERLOCKS cont.

Oil Temperature

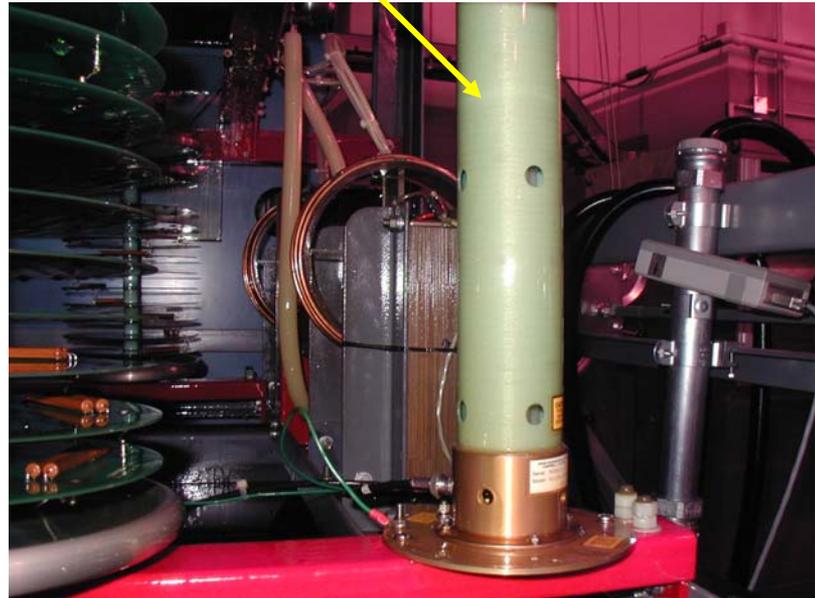
Oil Flow

Water Flow



## DIVIDERS

- Four High Voltage Dividers – separate dividers for viewing and feedback.
- 1. R103 – Cathode viewing front panel
- 2. R104 – Was cathode feedback now monitor, cathode feedback now inside crowbar cabinet. Ross Engineering product.
- 3. R105 – Anode regulator feedback. Ross Engineering product.
- 4. R106 – Anode viewing.



# ***TROUBLESHOOTING THE “BLUE BOX” – PAST FAULTS DISCUSSION***

- Mod-anode off, yet beam current increases with increasing cathode voltage.
  - Ready circuit will not clear to allow cathode voltage power.
  - Filament voltage readback is zero yet AC current is verified.
  - Cathode voltage at 50kV yet, mod-anode is on yet no klystron beam current is produced.
  - System trips on “Filament UI” fault condition.
  - Beam current drops out intermittently and mod-anode voltage drops. Note, when powering the mod-anode control off the on, beam current returns.
1. RF2
  2. RF5
- 5kV bias circuit breaker trips with increasing beam current production.