



100 keV DC Gun Test Stand

Intermediate Report: FEA Damage (SRI - 1257E)

December 21, 2005

Simon C. Leemann • Intermediate Report • December 21, 2005

Events Leading to FEA Damage

- SRI-1257E performance increased with conditioning (10Hz, 100ns, Ug<320V)
- At external DC HV of 50kV we reached cathode space charge limitation at Ug=230V; current collected of FC reached ~30mA
- Leak current from hot-deck measured on HV PS decreased to levels < I μA (<3% collected on anode) with conditioning; 80kV stable DC HV condition
- Encountered severe arc at 82kV causing immediate and sustained pressure increase (peak pressure increased by two orders of magnitude) and high levels of leak current (>80% collected on anode); after restart we observed:
 - \rightarrow leak currents started to appear already at 25kV
 - → leak currents caused immediate strong pressure increases
 - \rightarrow leak current levels at 50kV already >120µA (>80% collected on anode)
- After applying gate voltage on FEA with increased leak current levels
 → suddenly zero emission from FEA detected on anode or FC
 → FEA dead; finite ohmic resistance (48kΩ) between gate and tips
- After venting chamber observed severe damage
 - Anode: Au plating chipped off asymmetrically around iris
 - FEA: cracks due to excessive thermal load on gate layer, Au sputters on FEA due to back bombardment

Anode Damage



No Damage Observed on Cathode Electrode





FEA Damage



Possible Reconstruction of Events Leading to Damage

- HV arc at 82kV caused first crater on anode iris (peak field strength region)
 → Increased local field enhancement triggering parasitic FE from gate layer
 - \rightarrow High leak currents to anode
 - \rightarrow Increased desorption of Au plating in the vicinity of the crater
 - \rightarrow Increased emission from FEA to damaged area on anode
- Resulting in
 - \rightarrow High thermal load on gate layer leading to cracks
 - \rightarrow Au back bombardment onto FEA leading to shortcut between gate and tips

"Disaster Management"

- Removal of dead FEA and damaged anode electrode
- FEA will be replaced (with no. 2 of 4)
- Replace anode ASAP with non-plated pure Cu anode as in the original design (Au plating was never foreseen by us, but done by the workshop without further inquiry to avoid oxidation of Cu surface which they believed harmful)
- Re-bake chamber, recondition FEA, step up HV slowly, condition carefully
- No HV operation when increased leak current is collected on anode
- No FEA operation in high leak current condition