Polarized electron source update

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Laser System

- Slow progress at SLAC due to limited resources (both manpower and M&S)
- Plan is still to complete laser system and generate a polarized electron beam
- Intention is to draw resources from other laser groups at SLAC
- Investment in new pump laser still optional
- Meeting at Jlab on 04/20 to discuss integration of laser system and gun developed by Matt Poelker at Jlab

Laser System SBIR with KM Labs

- Expecting completion of the project in ~ 4 months.
- Also trouble with pump lasers for Regen Amplifier
- Reduced scope of the project:
  - **Max repetition rate 1.5 MHz instead of 3 MHz**
- Lessons learned from project:
  - **Use 2x50W MOPA doubled Nd lasers or fiber-based green lasers to get ~ 100W of pump power**
  - **These option became available only recently**

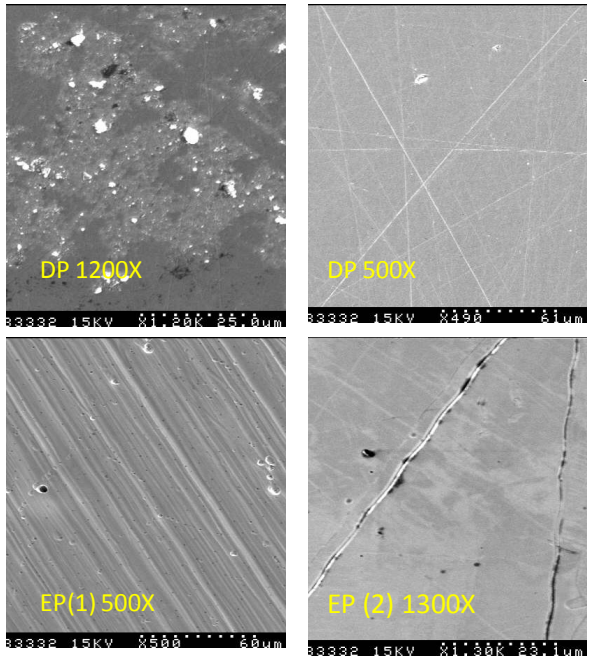
DC Gun R&D at Jlab

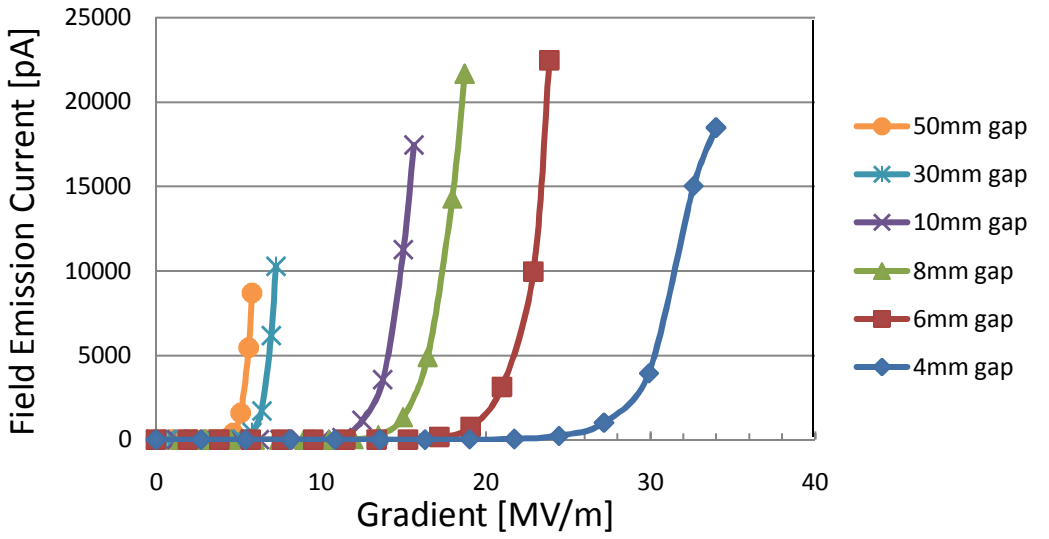
- Most important issue
  → Reduce field emission from electrodes
- Tests of a variety of materials and polishing techniques[1]
  - **Stainless Steel**
    - Diamond paste polishing
    - Electro-polishing
  - **Single Crystal Niobium**
    - Buffer Chemical Polish
    - Diamond Paste Polish

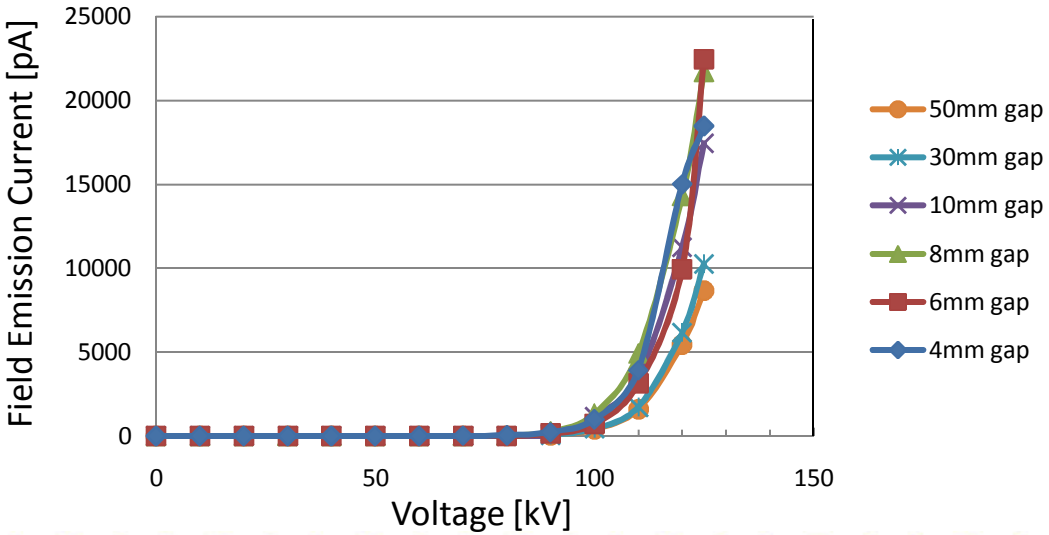
[1] **Work of Ken Surles-Law, Jefferson Lab**

Electro-polished Steel

- Results similar to diamond-paste polishing: limiting gradient 5MV/m
- Considerable time saving
- Perhaps better results if we start with smoother surface





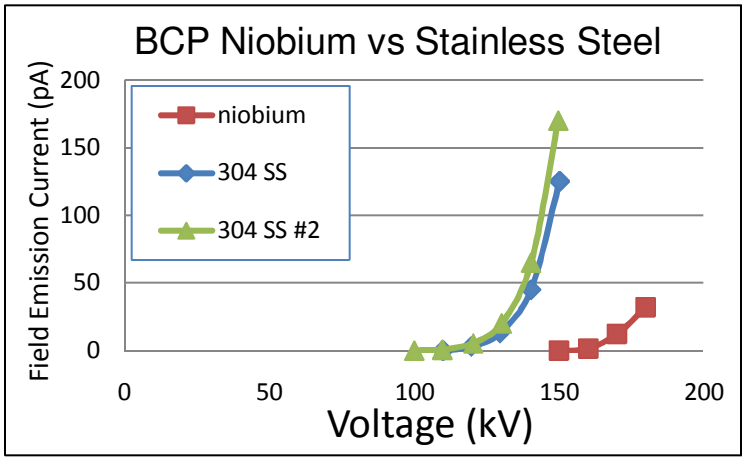


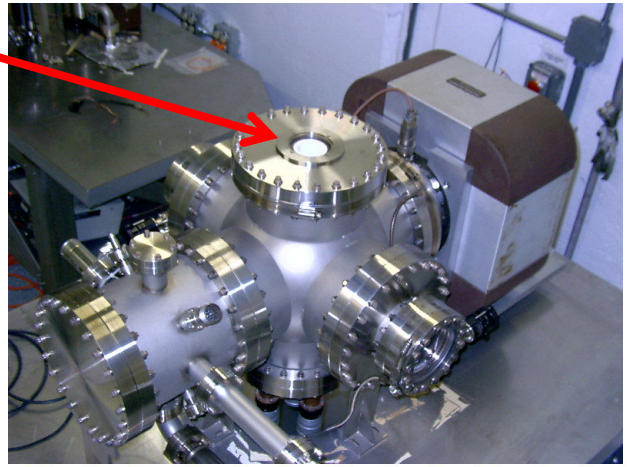
Single Crystal Niobium

- Capable of operation at higher voltage and gradient
- Buffer chemical polish (BCP) much easier than diamond-paste-polish

Conventional geometry: cathode electrode mounted on metal support structure

Replace conventional ceramic insulator with "Inverted" insulator: no SF6 and no HV breakdown outside chamber



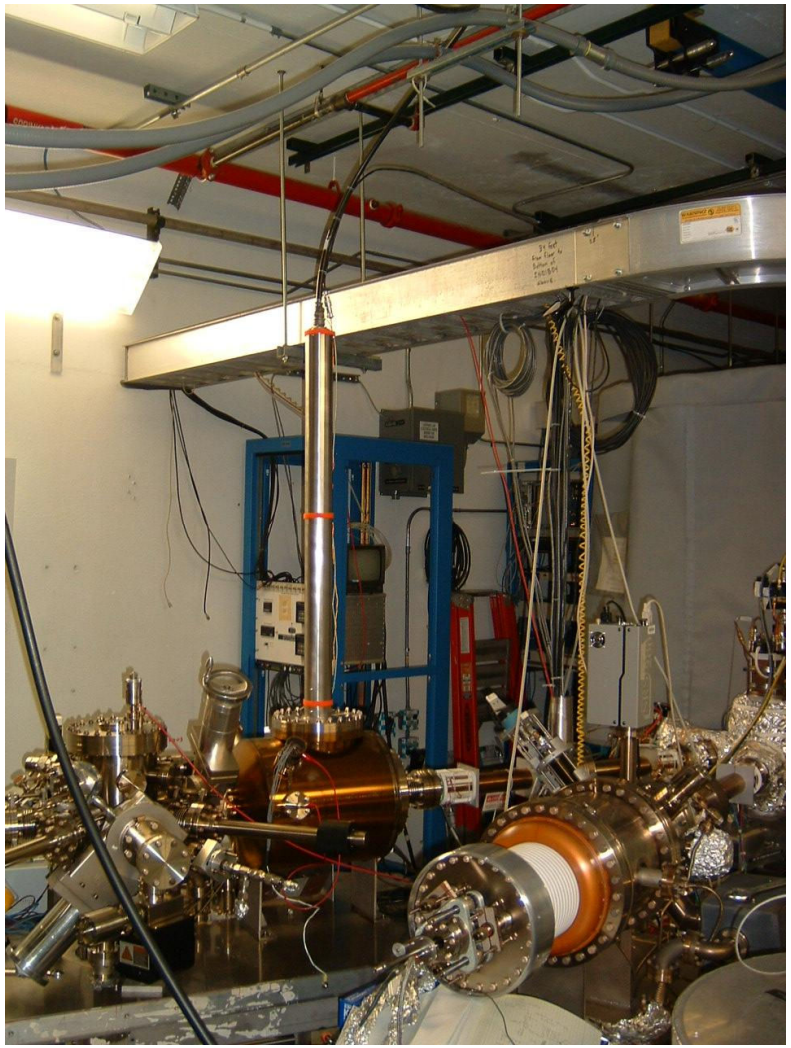


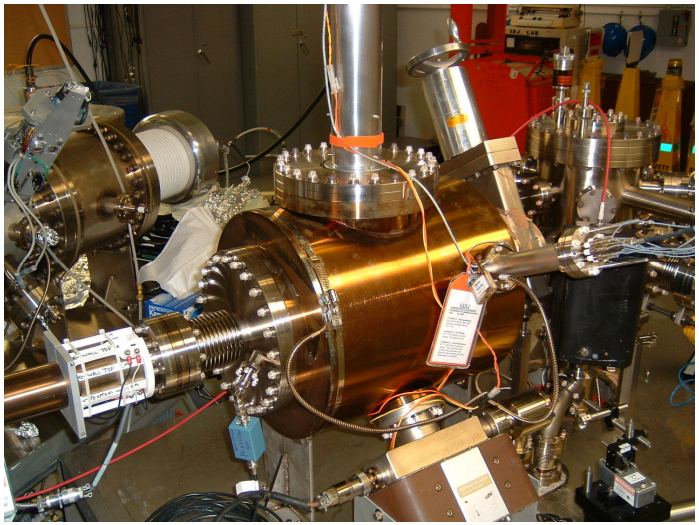
High Temperature Bake to reduce outgassing rate

- As much “thin-wall” material as possible
- 316LN (L= low carbon, N= nitrogen added for hard knife edges)
- Manufactured and electropolished by NorCal
- 400C bakeout for 9 days, under vacuum
- Pumped by oil-free turbo, then added ion pump, while monitoring “effluent” with RGA
- At 9^{th} day, vacuum still improving by ~15% per 24 hours
- RGA shows H2, methane, CO and HCl (from electropolishing)
- Rate of Rise method, with spinning rotor gauge, outgassing rate 10^{-13}TL/scm^2, one order of magnitude improvement
- Vented and remeasured good rate, on test chamber
- Now working to de-gas internal components…

Inverted Gun assembly

CEBAF Gun operation





- Inverted Gun installed at CEBAF, operational since July 23, 2009
- Extractor gauge 2×10^{-12} Torr (raw value)
- Happy at 100kV, conditioned to 110kV, briefly went to 125kV
- Opportunity at CEBAF for operation > 100kV
- Lifetime ~ 70C at 150uA ave. current
- Aggressive commissioning of 2nd InvGun at Test Cave. Under vacuum - with Nb electrode. Ready for beam….

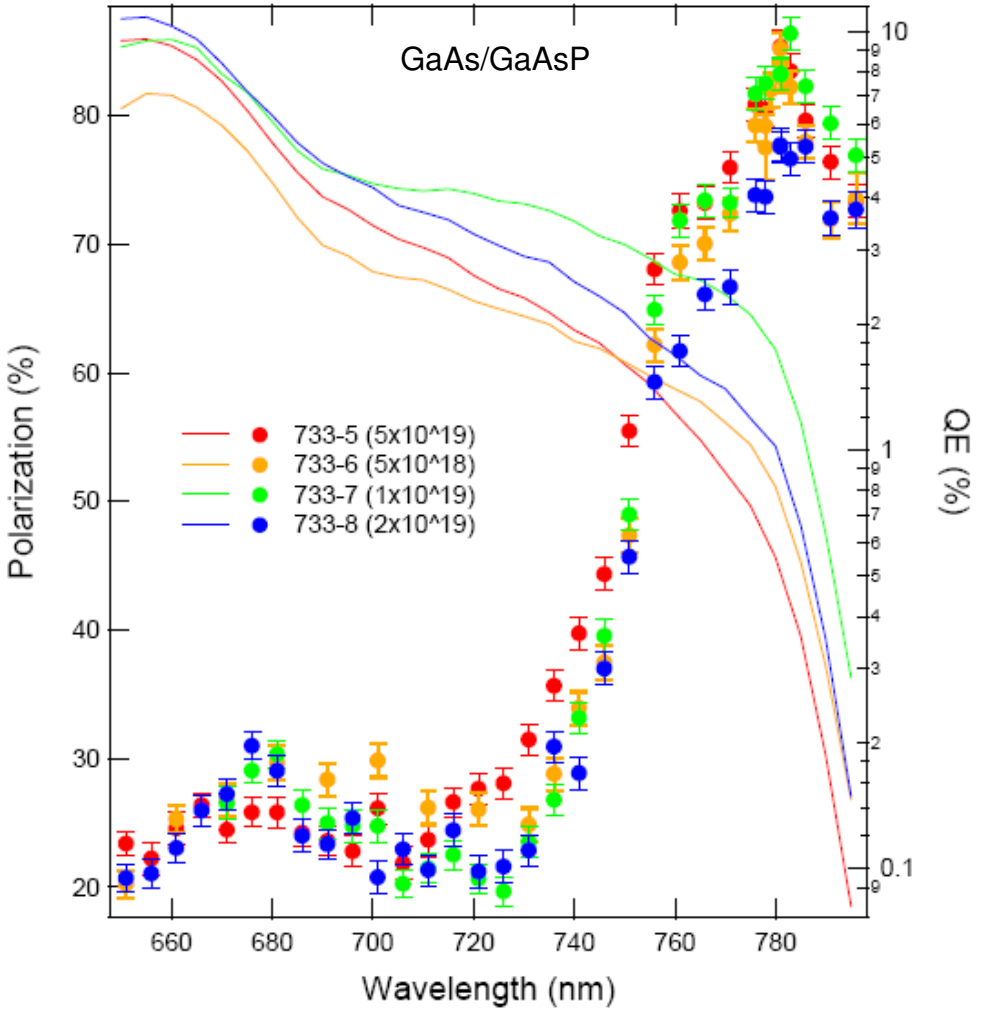
Lessons Learned

- We learned at CEBAF that it is extremely important to manage ALL of the extracted beam
  - **Anodized edge: beam from outside 5 mm active area can hit beampipe walls, degrade vacuum, reduce operating lifetime**
- ILC/CLIC requires large laser beam to reduce current density and overcome space and surface charge problems
- Need a cathode/anode design that ensures uniform emittance across beam profile. A beam that can be easily managed/transported, with *ZERO* beam loss.

Photocathode R&D

- Doping Profile Optimization:
  - **Measure QE/polarization/surface charge limit as a function of doping level on the surface (5e18, 1e19, 2e19, and 5e19):**
  - **5e18 has lower QE but QE of other cases are similar**
  - **Polarization does not strongly depend on the doping level on the surface.**
  - **Measure surface charge limit still pending**

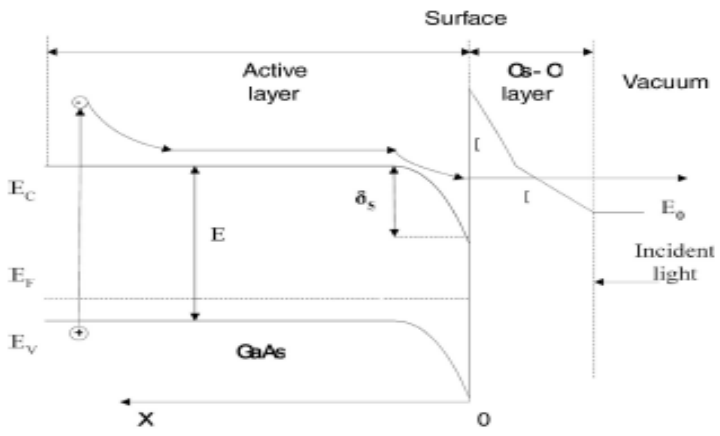
Doping Profile Optimization



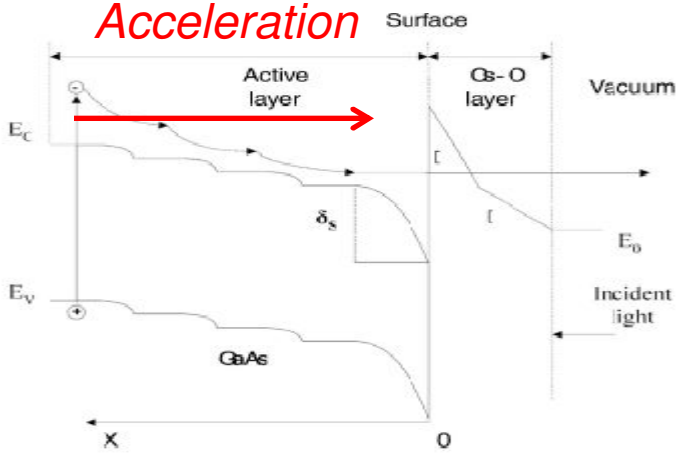
Internal Bias Effect and DBR

- Measurement of the internal bias effect on QE, polarization, and surface charge limit (wafers are delivered: single layer gradient doped AlGaAs)

Constant doping



Gradient doping



- Distributed Bragg Reflector (DBR) development (SBIR pending)