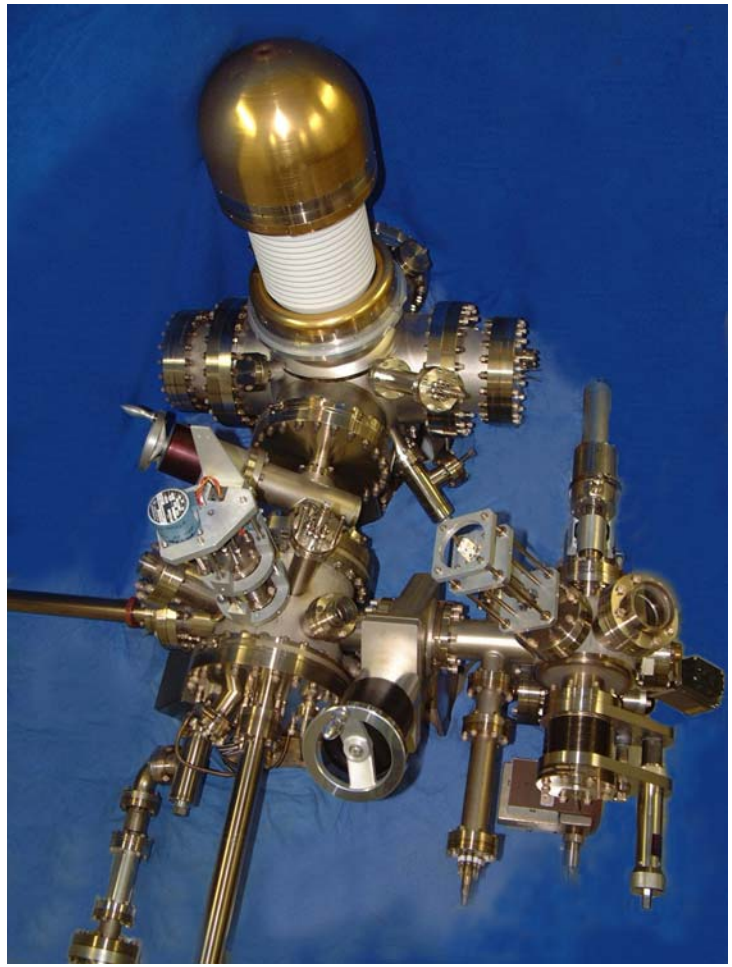
Commissioning of the Jefferson Lab Load-Locked Gun

Marcy L. Stutzman



Jefferson Lab Production Guns

Two Identical Horizontal NEG Guns

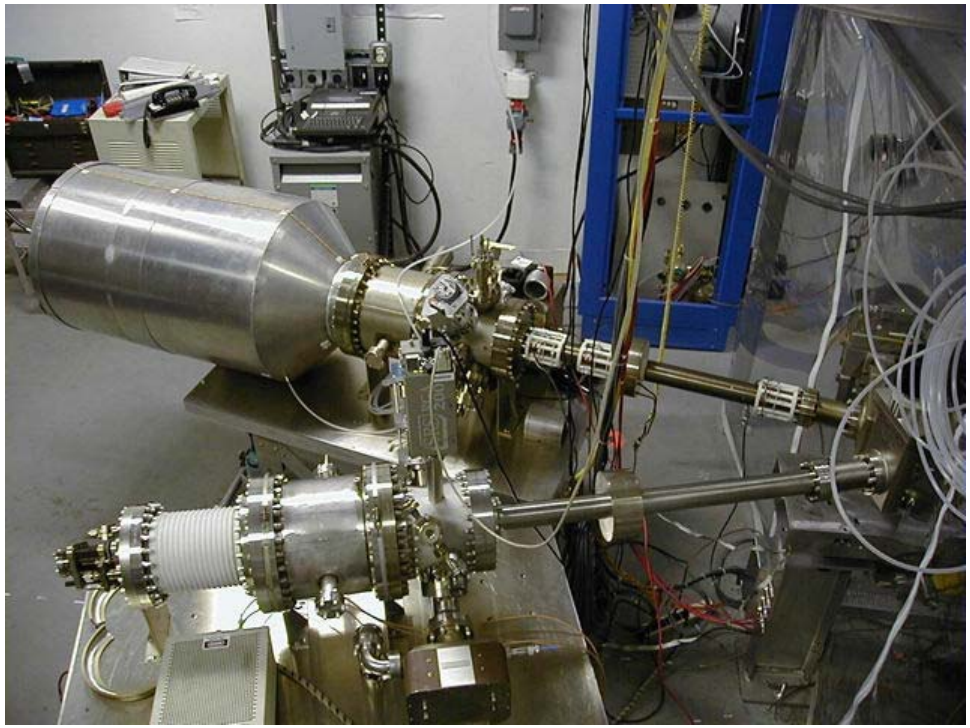
Both have good cathodes
QE ~ 1.6% at 770 nm
0.2% at 842 nm
Polarization ~ 78%

Lifetimes ~ 300 C @ 250 μA
600 C @ 60 μA

Vacuum ~ 5 e^{-12} Torr

Spot moves ~ 2 weeks at 100 μA

Reactivation ~ 2 months at 100 μA



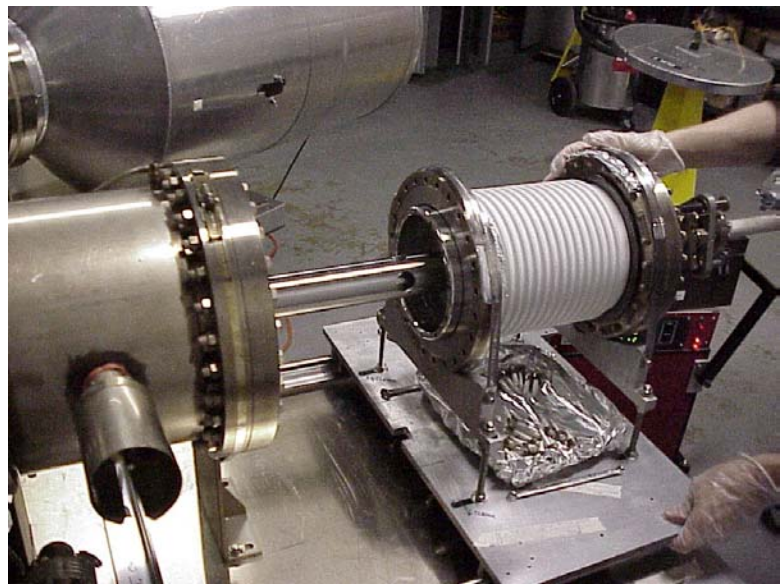
Disadvantages

Cathode Changes

- Full Bakeouts: 3 days downtime
- Only 1-2 times/year with good lifetimes
- Two guns – little lost beamtime

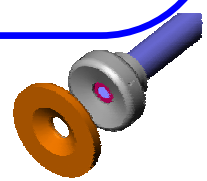
HV breakdowns

- Re-polishing of electrode
- Gun open – extra bakeout, higher pressure
- Cesiation in HV chamber?
  Titanium Electrodes?



Load-Lock Design Goals

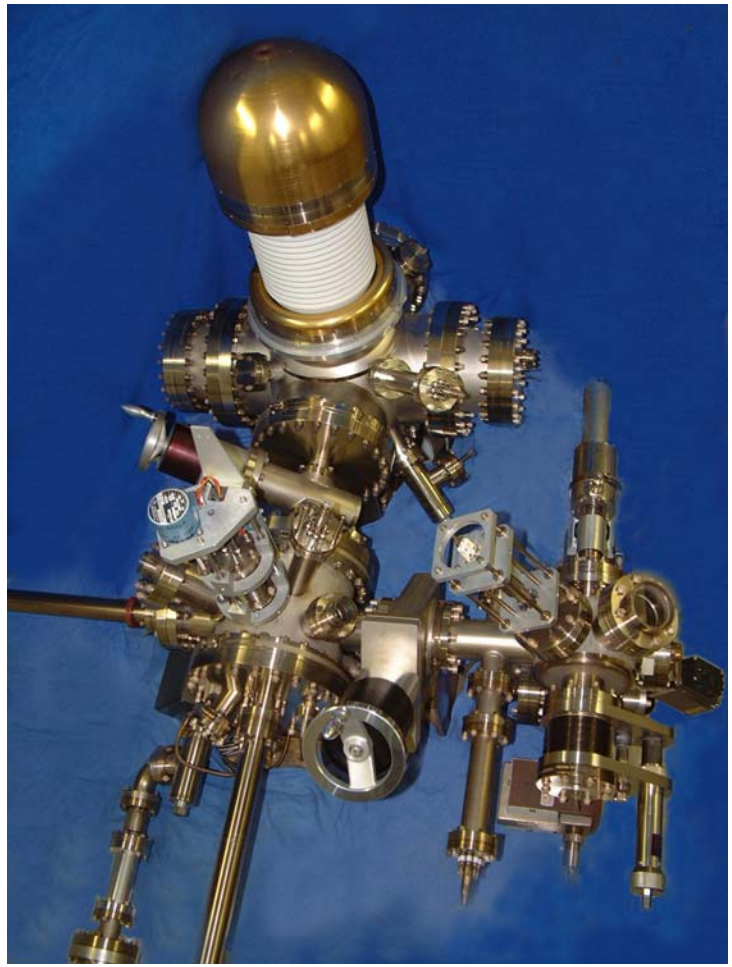
- Installation of cathode from air to HV in less than 8 hours
- Load-lock chamber at ground potential, no moving parts at HV
- Horizontal – compatible with tunnel configuration (15º bend)
- Maintain all good features of current horizontal guns
  - Electrode material
  - Electrostatic optics
  - Excellent vacuum, pumping conductance



Design of the Gun

3 Chambers:

- Load/Heat/Hydrogen Chamber
- Prep Chamber
- High Voltage Chamber



Load/Heat/Hydrogen Chamber

Load through 4½" flange

11 l/s Ion pump
60 l/s Turbo pump
P~1e^{-8} Torr

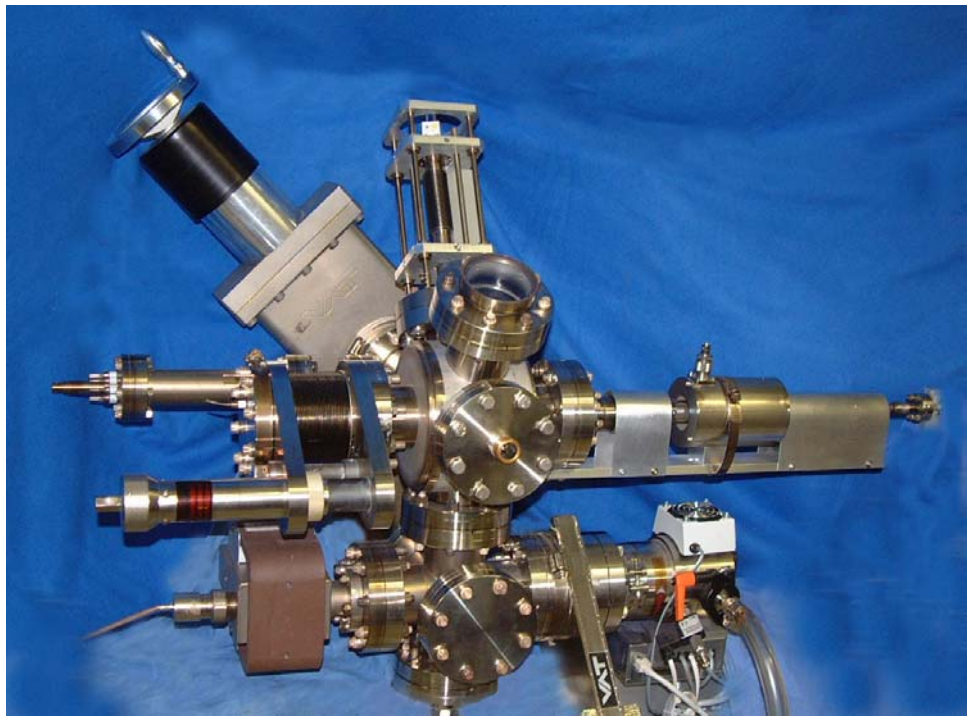
Hydrogen Cleaner

Ceramic Heater

Insertable Thermocouple

Copper Cooling Finger

Residual Gas Analyzer



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Prep Chamber

Two Manipulators

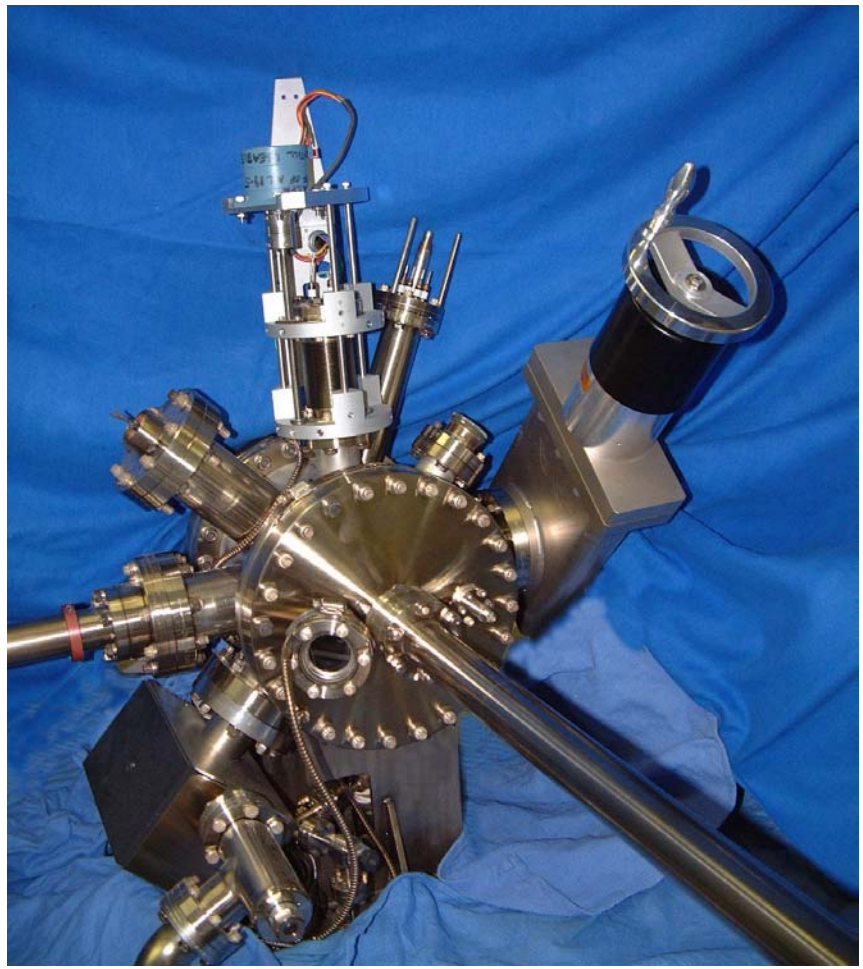
Activate with Cs and NF_3

5 Optical Ports for Puck Transfer
Activation, QE measurement

Ring Anode for Bias

RGA for analysis/leak detection

Pumps: 40 l/s ion pump
GP100 NEG pump
P ~ $1e^{-10}$ Torr



High Voltage Chamber

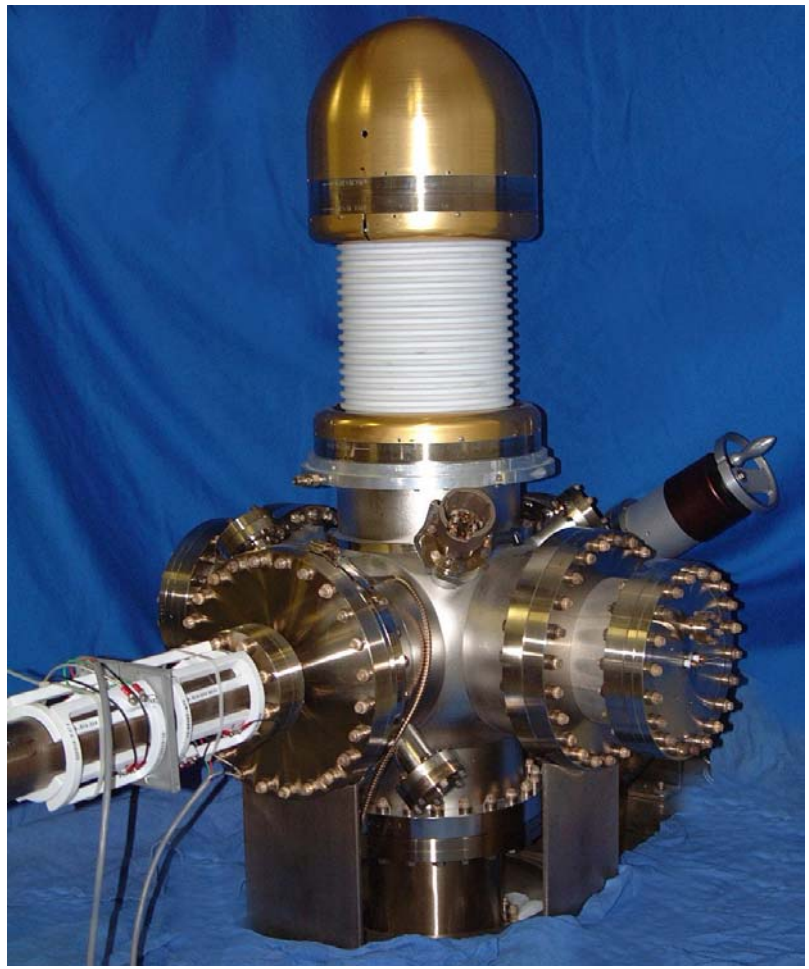
Good conductance to pumps
- 10” 6 way cross, electropolished
- 3x GP500 SAES NEGS
- 220 liter Ion pump

NEG coated beamline, 15º bend

Extractor Gauge – P ~ $9e^{-12}$ Torr

Few Components at HV
- Cathode support, electrode, puck
  - biased –100kV
- Sapphire rollers capture puck

Electrostatic Optics like Production Guns
- 25º cathode electrode geometry
- Titanium electrode
- Same cathode/anode gap



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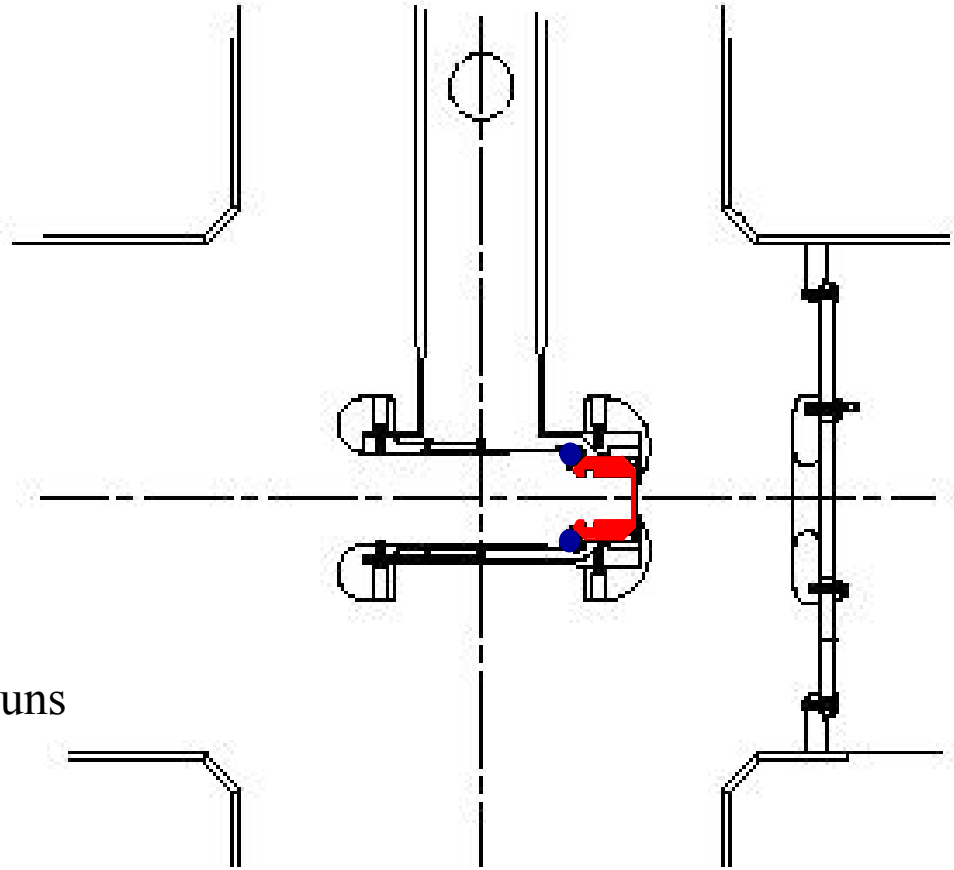
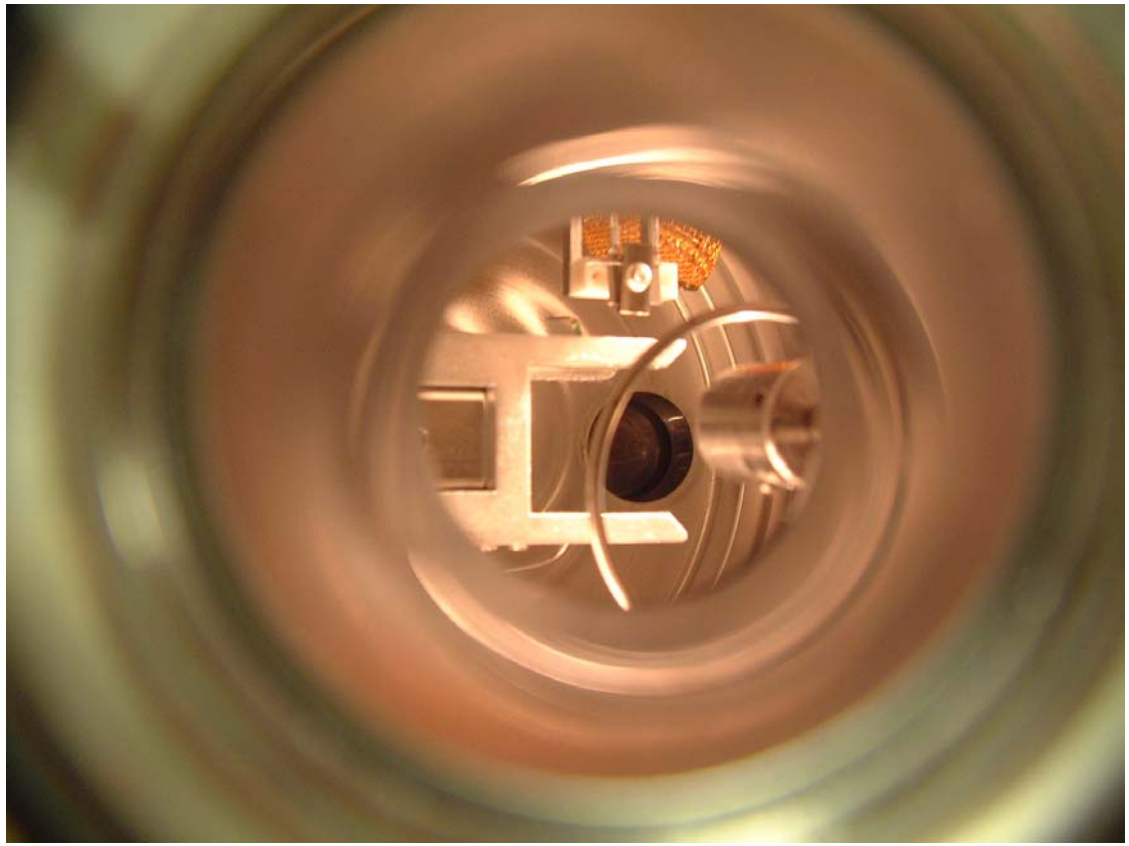


Manipulators

Surface Interface Magnetic Manipulators

Transverse:
- Translational only
- Fingers, springs

Longitudinal:
- Translational and Rotational
- Inserts, wings fit in channel



Puck

Machined Molybdenum
Indium Solder, Tantalum Cup
Hollow back for longitudinal manipulator
Beveled ends for docking/sapphire rollers

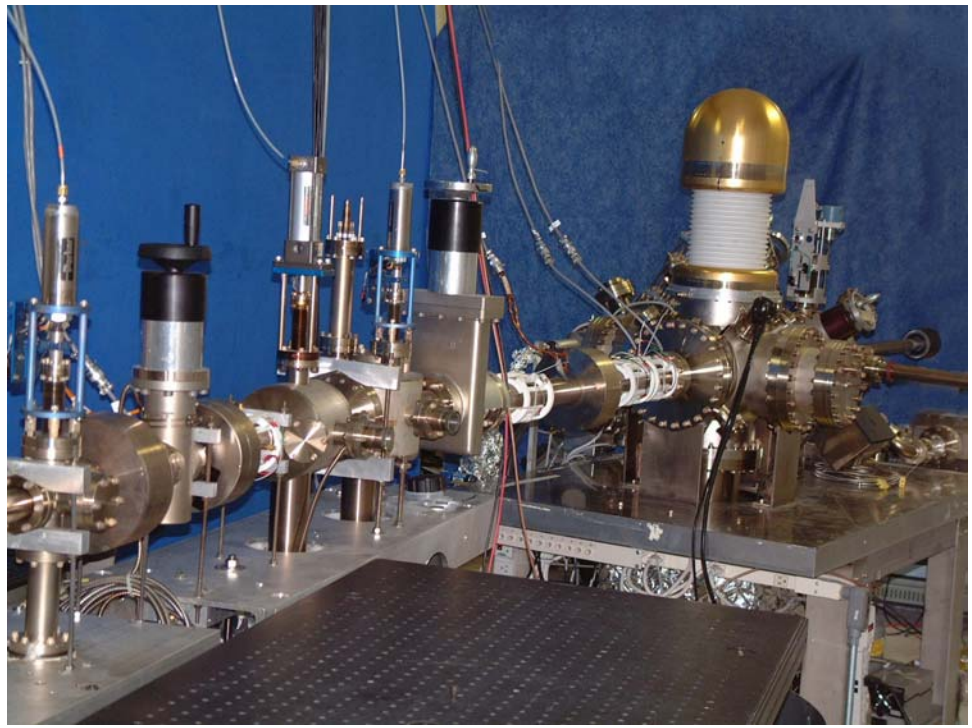
Instrumented Beamline

Same configuration as production beamline

Outfitted with 5 viewers, 2 BPMs, and 1 harp scanner

RF Lasers, BPMs support lifetime, parity experiments

Plans for Wien filter, Mott Polarimeter



Low Voltage Data

Process:

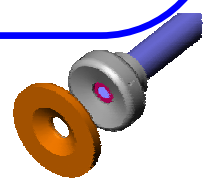
Load Bulk GaAs from air
Heat to 600 ºC, drop to 300 ºC and 10 min. H clean
Heat at 600 ºC for 2 hours, cool to 22 ºC (cooling finger)
Move to Prep chamber and activate with Cs/NF_3

Results:

QE measurements at 100 V ring anode bias:
9.2% QE at 780 nm
6.6% QE at 860 nm
Similar to QE values obtained on baked test chamber!

Total Time from Loading to HV chamber: 7.5 hours

HV chamber holds voltage with minimal leakage current (~100 nA)



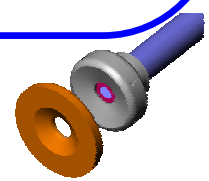
Planned Experiments

Lifetime studies:

- Active area spot size
- Radial position of active area
- Anodization procedure
- Wavelength dependence
- Contaminant species effects

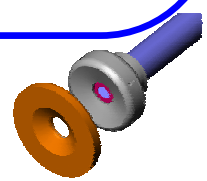
Parity Experiments:

- Helicity correlated position asymmetry
- Helicity correlated charge asymmetry



Conclusions

- New Load-Locked Gun built at Jefferson Lab
- Meets goals of loading, Hydrogen cleaning, activating and taking to HV chamber in less than 8 hours with good QE
- Initial beam tests expected shortly
- Can be used for test stand studies of parameters affecting lifetime, helicity correlated effects
- Can be swapped with horizontal NEG gun for production beam



Acknowledgements

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