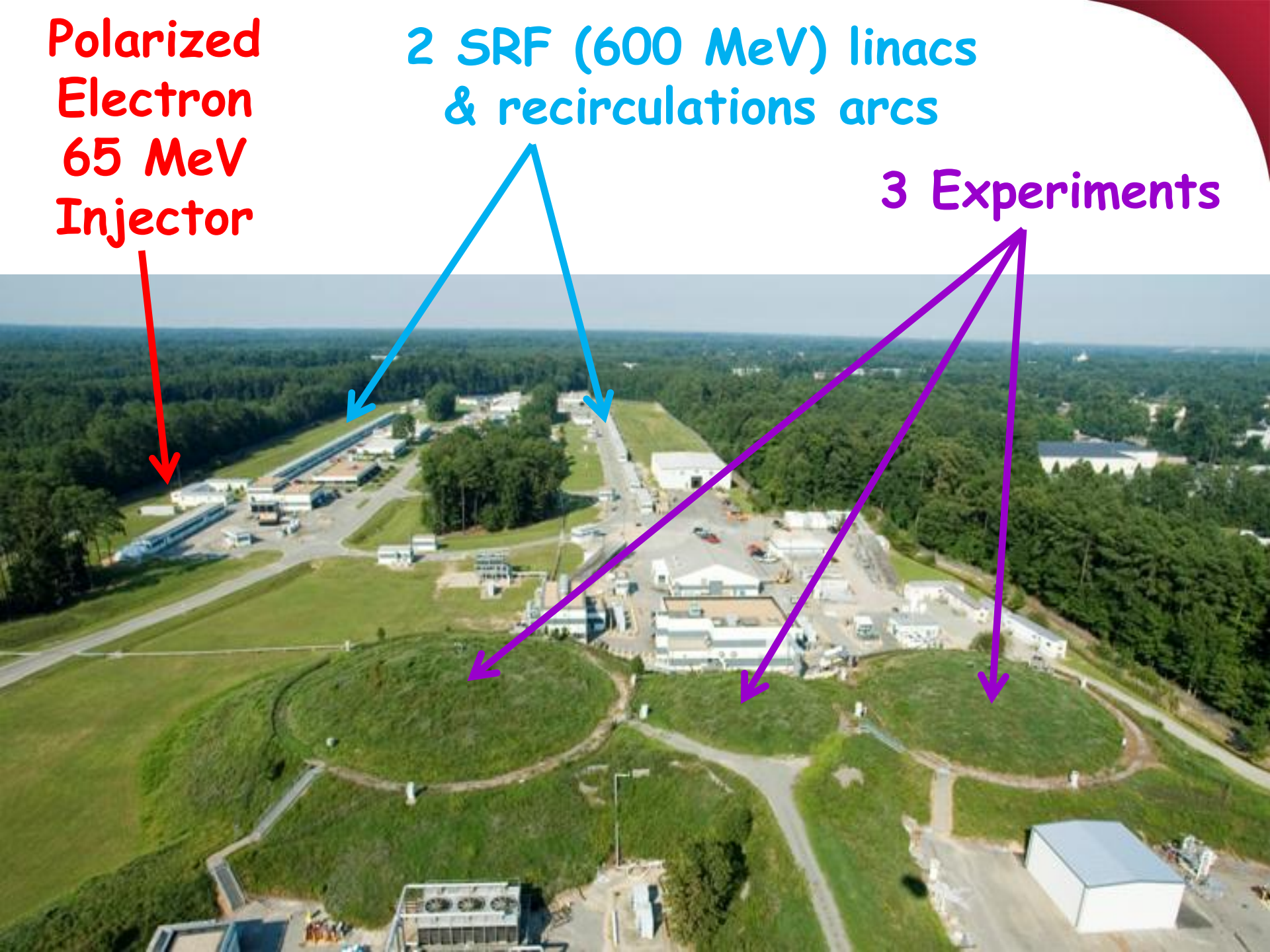
Overview of CEBAF Electron Injector

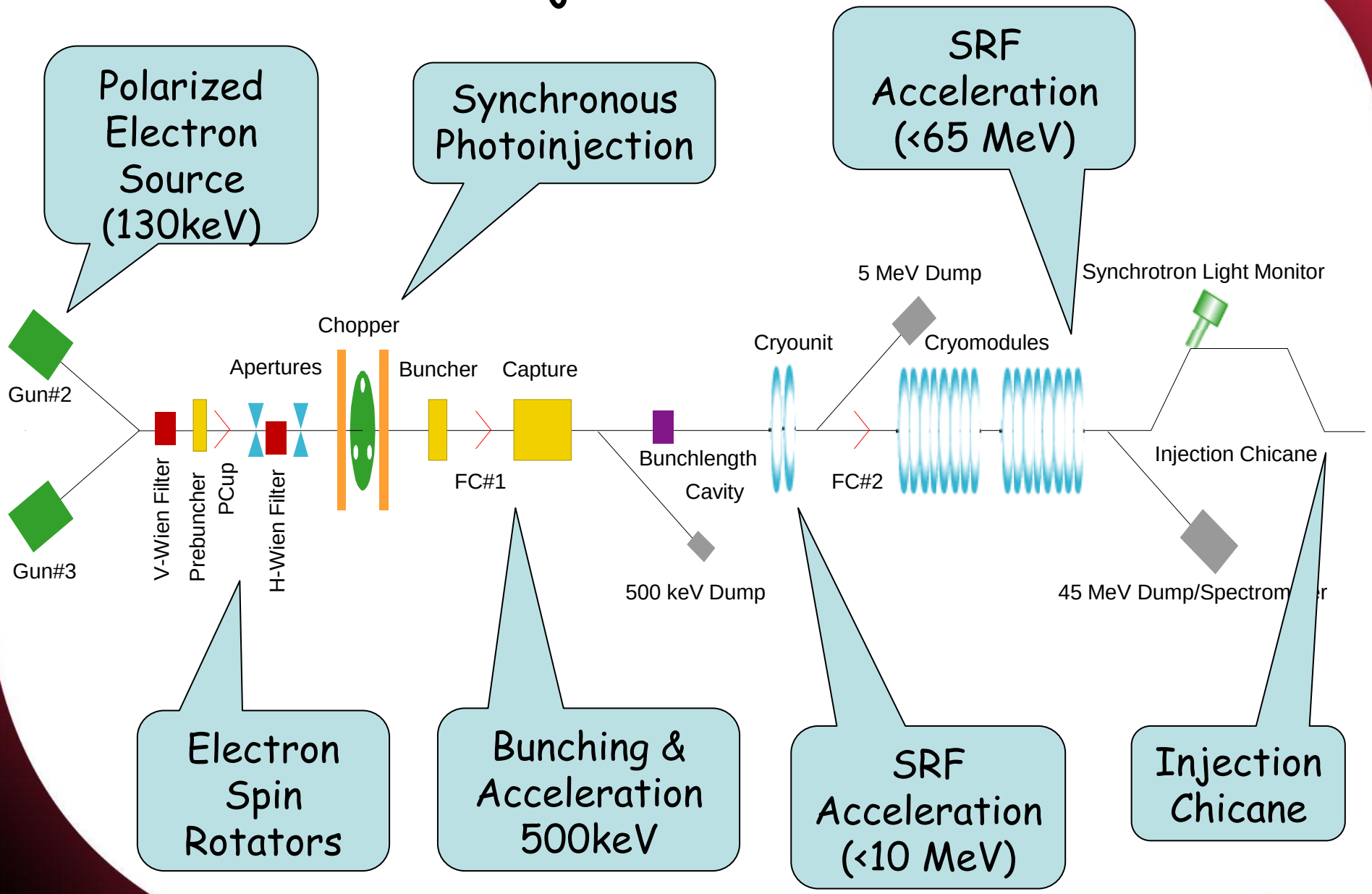
Joe Grames
(and many others whose slides I've stolen)

PEPPo Collaboration Meeting
November 8, 2010

- **Injector overview for "Newbies" and Users alike**
- **Polarized Electron Source: a critical piece of this puzzle**
- **The "5 MeV Region" => A good place to stage PEPPo ?**
- **Some "Bells & Whistles" that we might find useful**


Polarized
Electron
65 MeV
Injector
2 SRF (600 MeV) linacs
& recirculations arcs
3 Experiments

Polarized Electron Injector

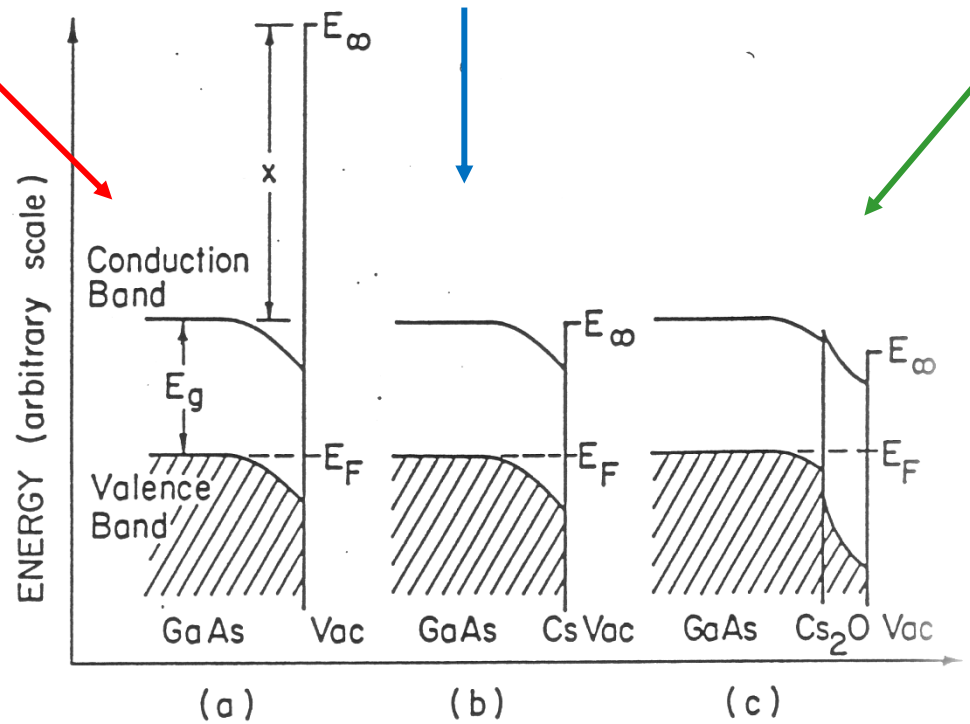


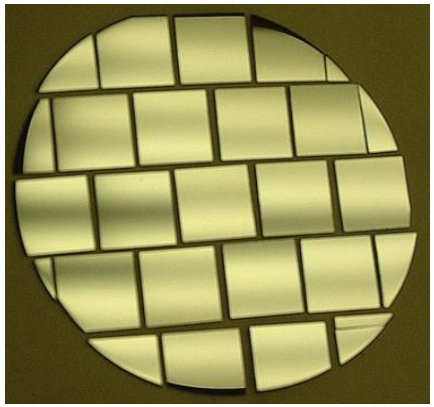
Photoemission from GaAs

Bare GaAs surface;
Large work function.
No electrons

Alkalai (Cs) reduces
work function.
Some electrons.

Cesium + Oxidant (O or NF3)
"Negative Electron Affinity".
Many electrons

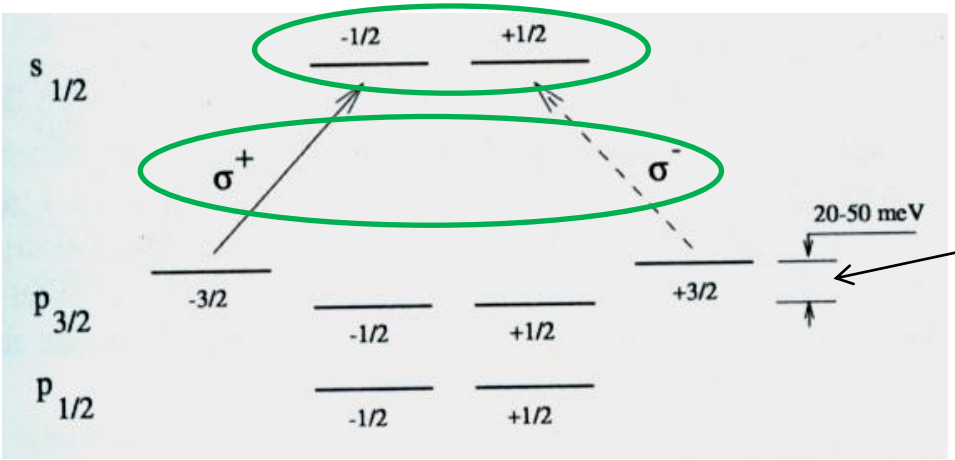


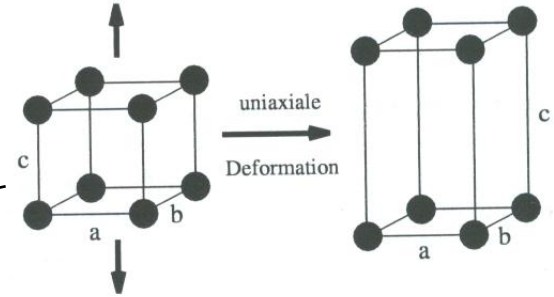


$E_a > 0$ $E_a \approx 0$ $E_a < 0$

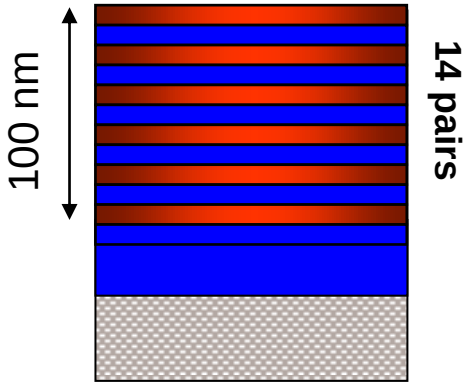
"Activate" GaAs photocathodes by applying about one mono-layer of cesium and oxygen to surface, which must be very clean……

Polarization from GaAs

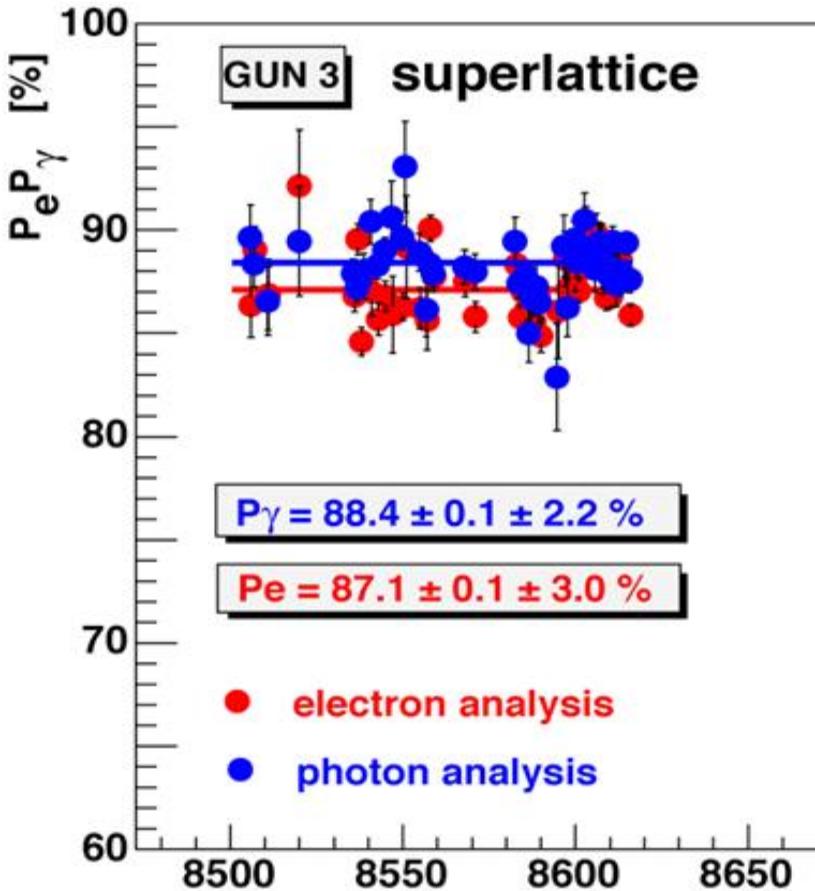




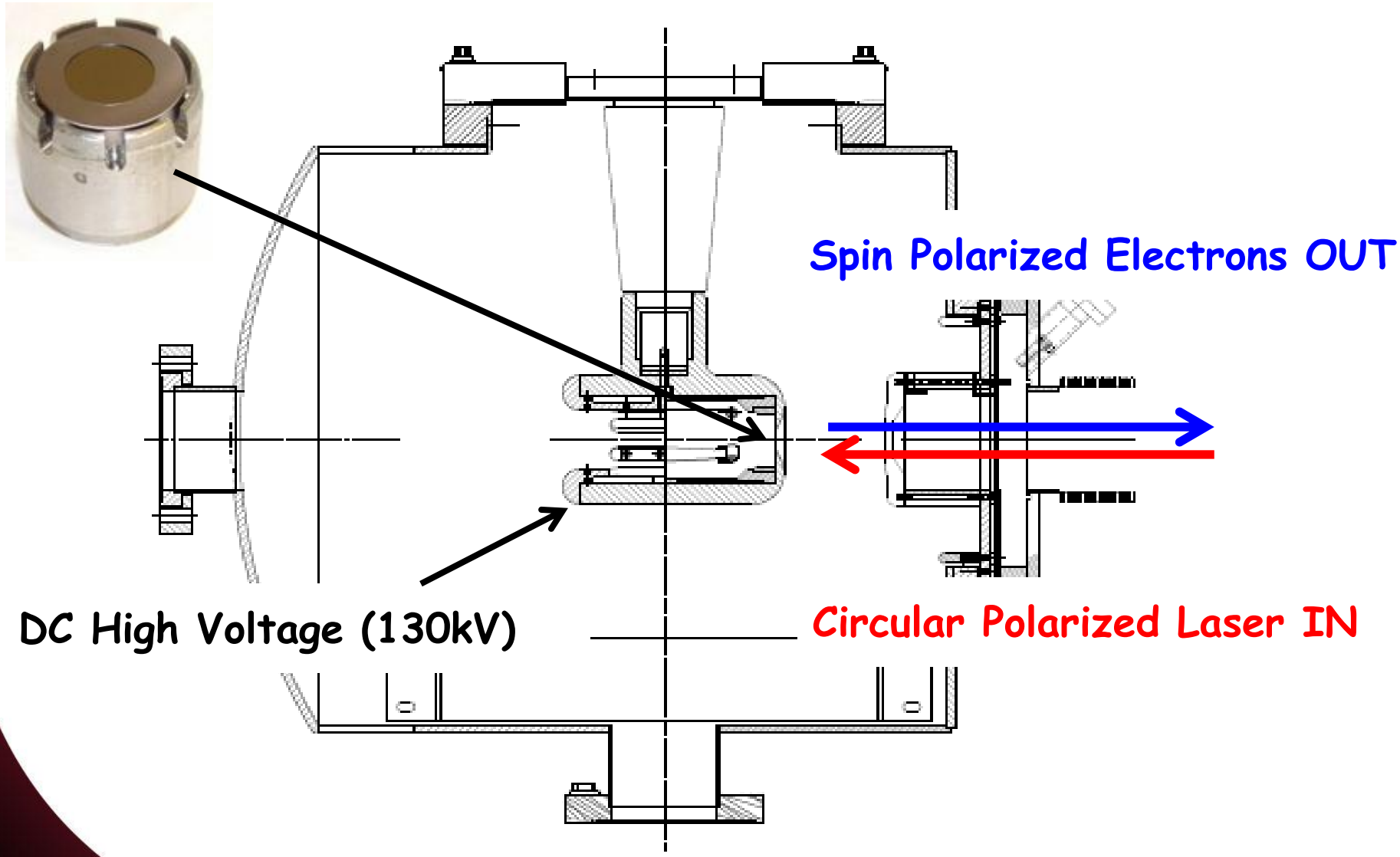
Layers of GaAs
on GaAsP



No strain relaxation
QE = 1%, 6uA/mW
Pol > 80% @ 780 nm



High-P GaAs Photogun



DC HV Inverted Photogun (2009)….

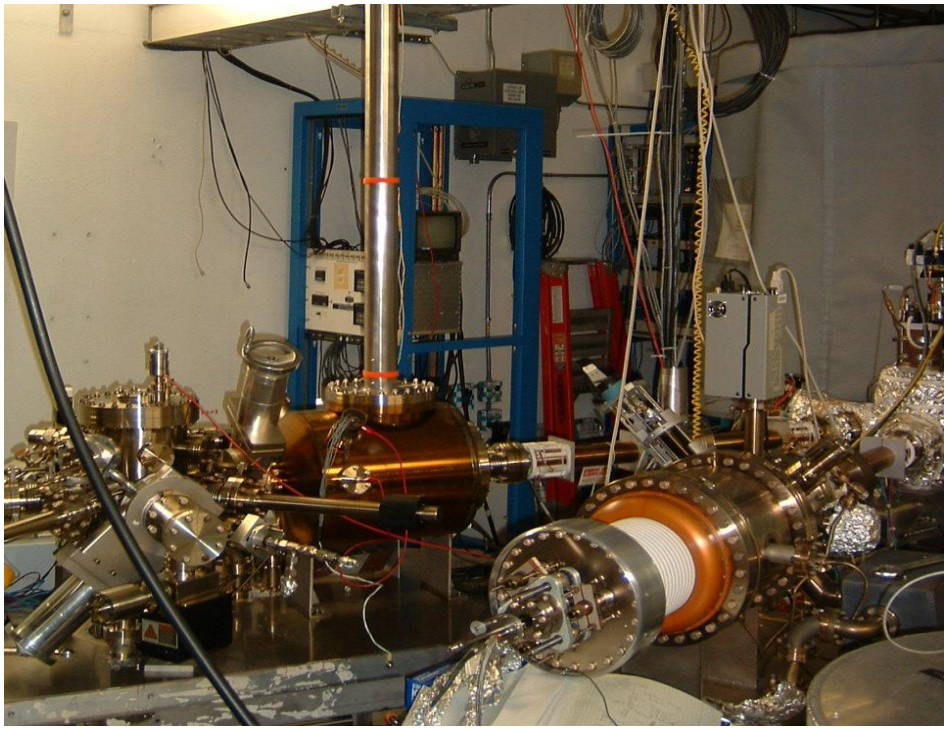
PHYSICAL REVIEW SPECIAL TOPICS - ACCELERATORS AND BEAMS **13**, 010101 (2010)

Load-locked dc high voltage GaAs photogun with an inverted-geometry ceramic insulator

P. A. Adderley, J. Clark, J. Grames, J. Hansknecht, K. Surles-Law, D. Machie, M. Poelker,*
M. L. Stutzman, and R. Suleiman

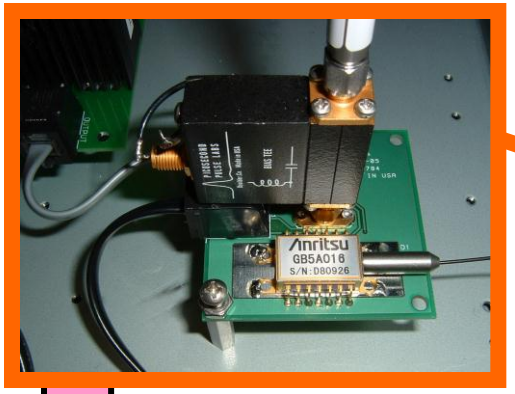
Thomas Jefferson National Accelerator Facility, Newport News, Virginia 23606, USA
(Received 24 November 2009; published 26 January 2010)

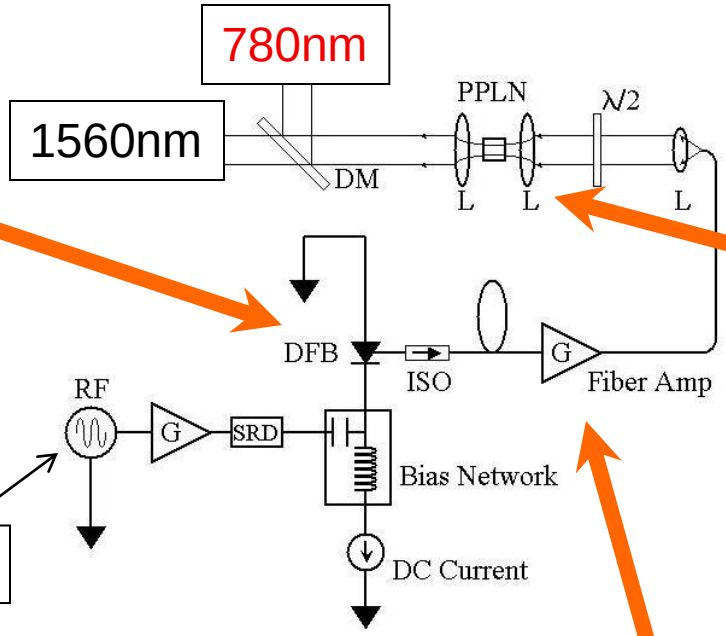
A new dc high voltage spin-polarized photoelectron gun has been constructed that employs a compact inverted-geometry ceramic insulator. Photogun performance at 100 kV bias voltage is summarized.



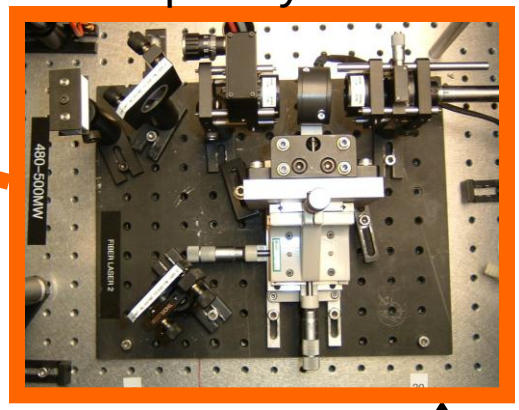
Fiber-Based Drive Laser

Gain-switched seed



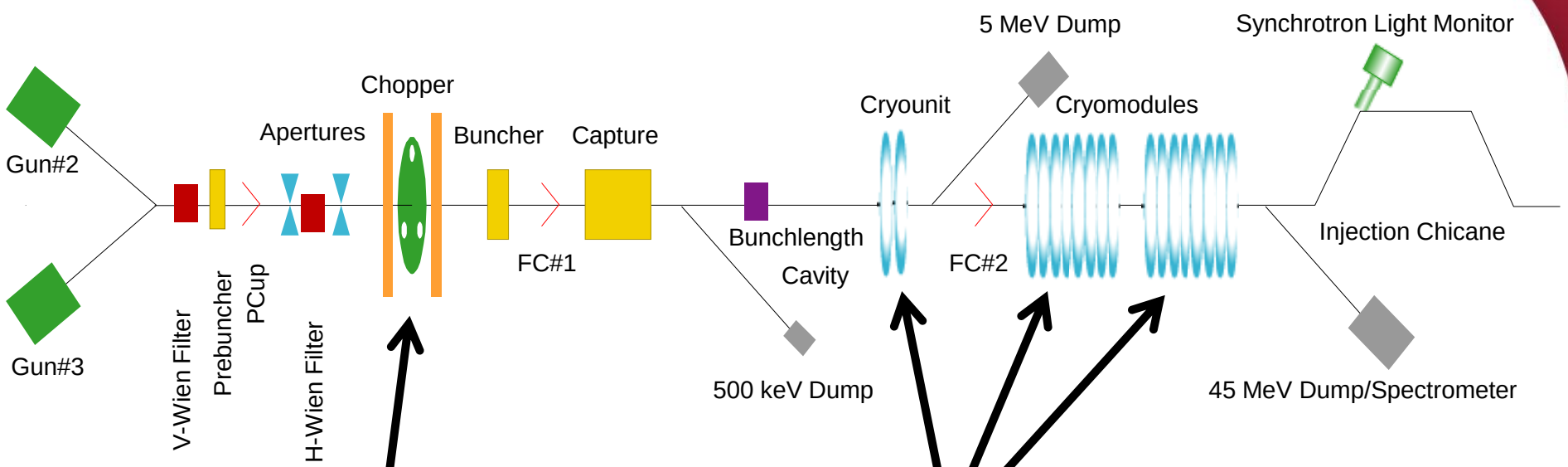


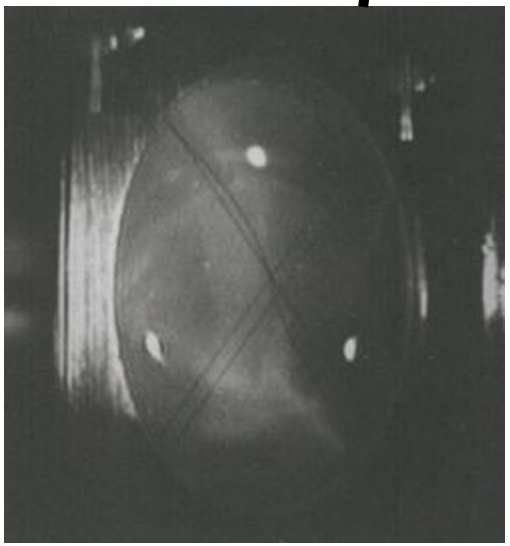
Frequency-doubler

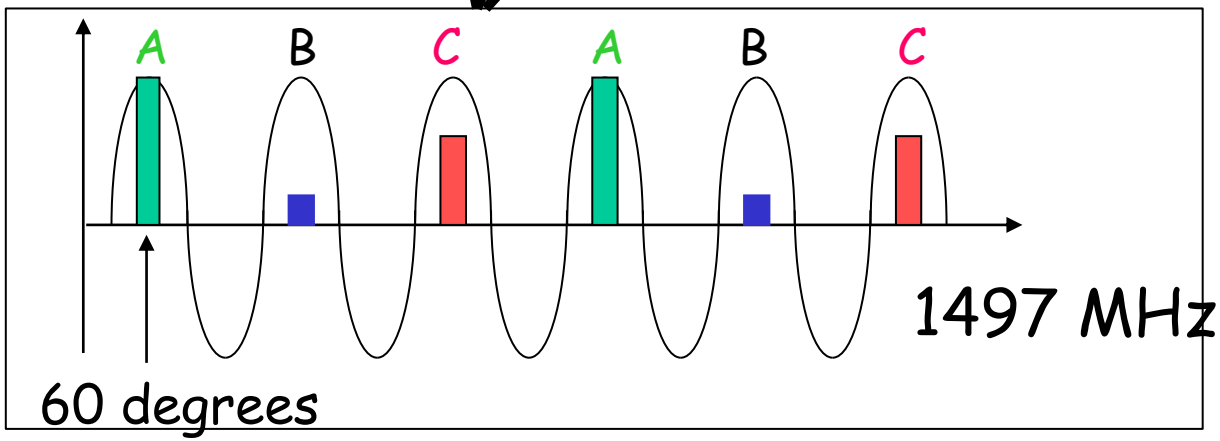


ErYb-doped fiber amplifier

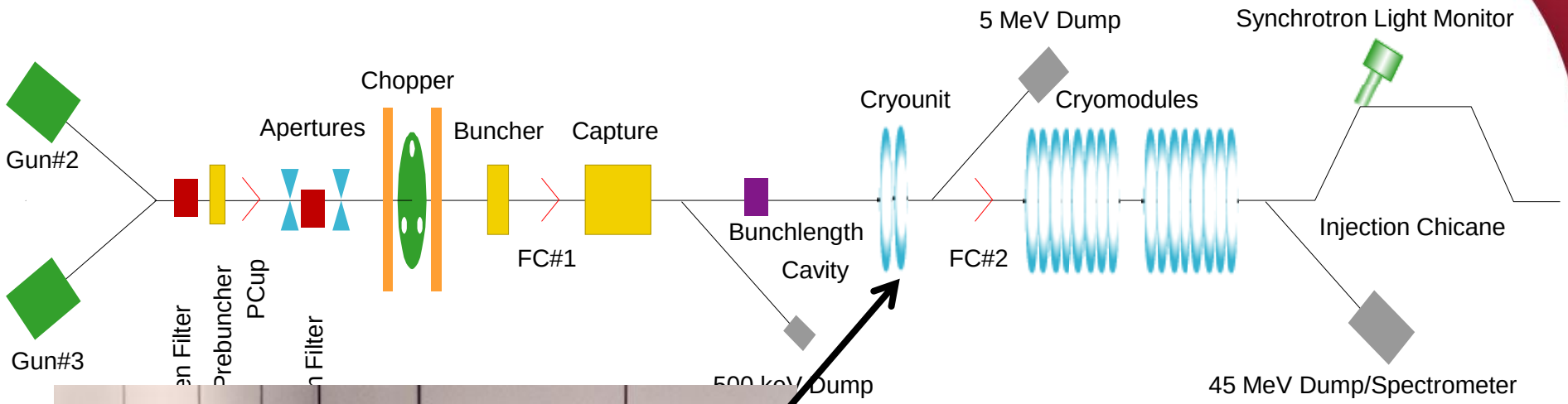
Synchronous Photoinjection







The "5 MeV" Injector

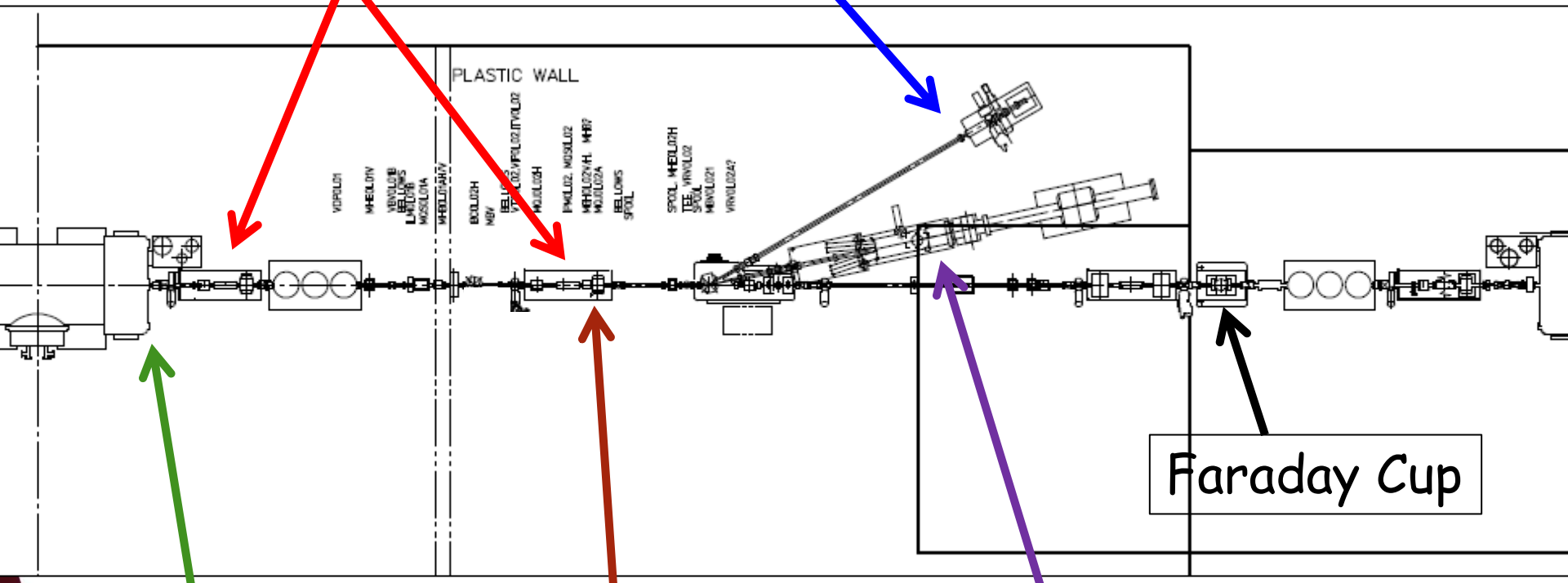


Beam Parameter	Values
Energy	<10 MeV
Average Current	<200 μA
Repetition Rate	499MHz (or sub)
Energy Spread	<20 keV
Bunch Length	< 1 ps
Norm. Emittance	~1 micron
Beam Size (typ.)	~0.50 mm

5 MeV region has good diagnostics…

Beam position monitors

Spectrometer
(momentum & energy spread)



Faraday Cup

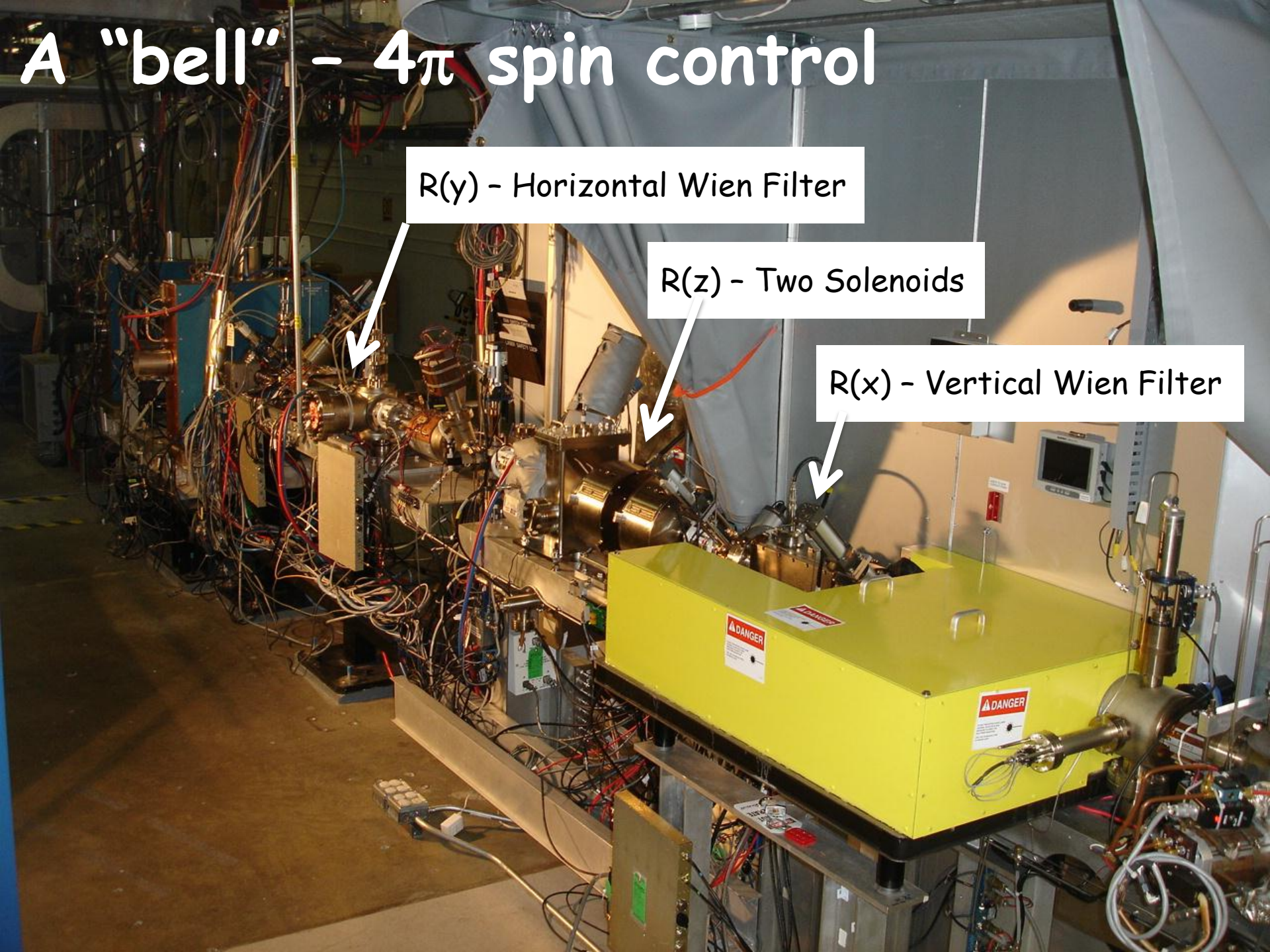
SRF (<10 MeV)

Beam current cavity

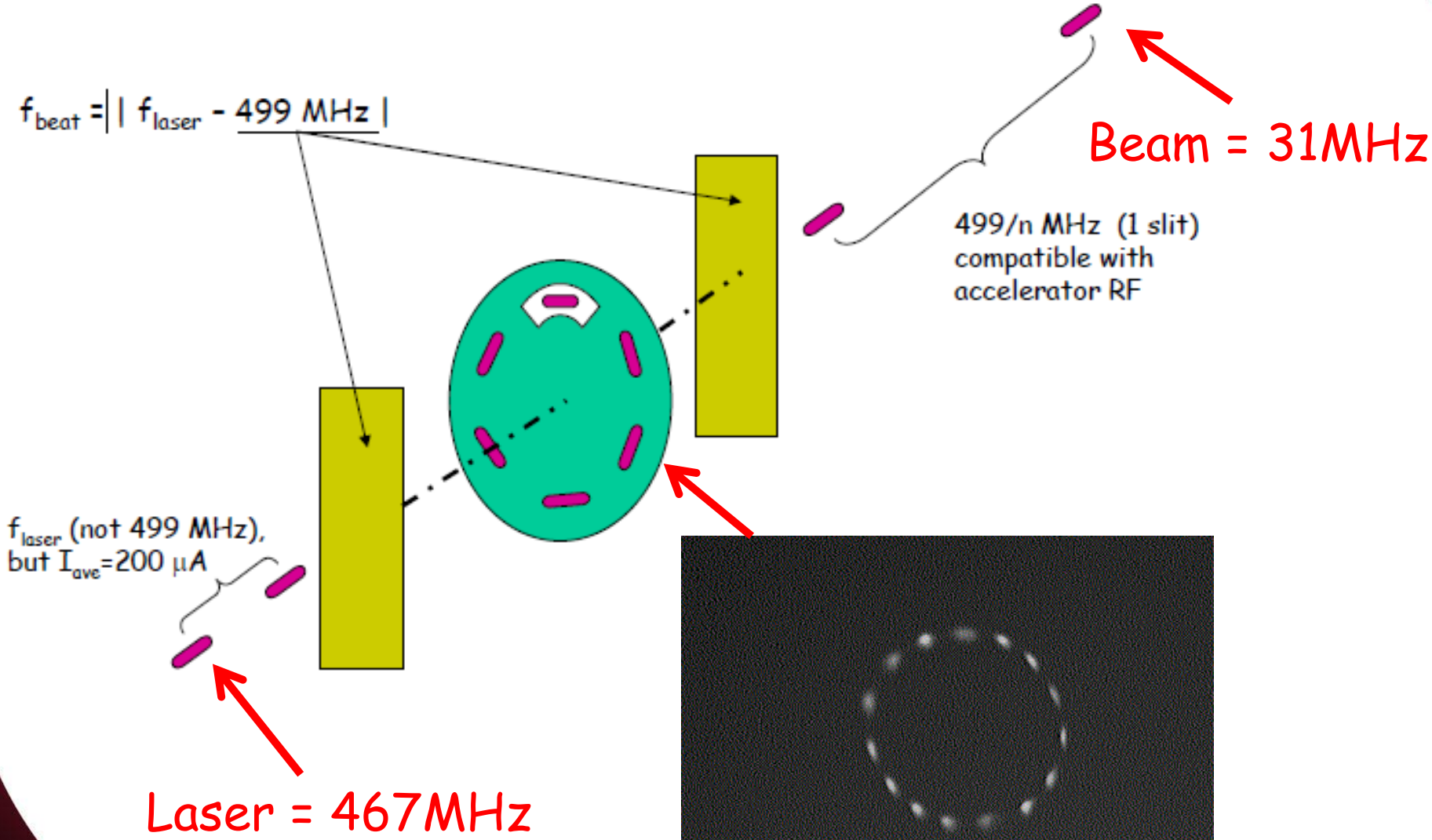
Mott electron polarimeter
(precision <2%, Px & Py)

…and you can't beat the floor space !

A "bell" – 4π spin control



A "whistle" - Beat Frequency Modulator (BFM)



So, test e- to e+ production at "5 MeV"?

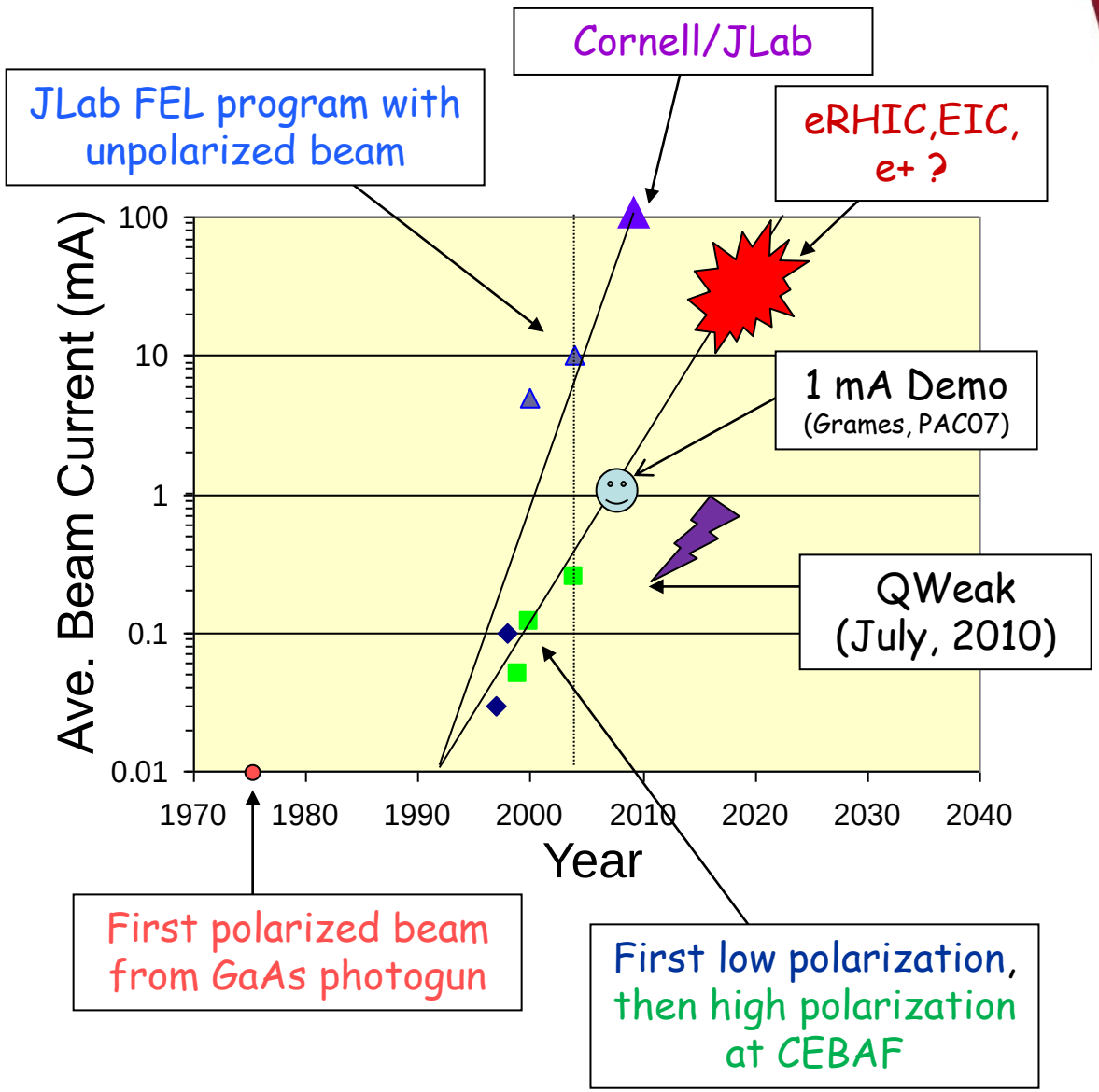
Yield ~0.01%
Collection ~10%

Not encouraging:
100μA => ~1 nA

But, many e- *is* encouraging:
10mA => ~100nA
(good for CEBAF)

Small Energy Footprint
Small Radiation Footprint

And higher energy even more tantalizing…



Summary

- CEBAF polarized electron injector is an ideal place to test the PEPPo concept in the <10MeV energy range

- Advances in polarized electron sources make the idea of using the PEPPo concept to produce polarized positrons *not* unthinkable. ☺

- Jonathan has to "show off" his experiment concept, and then I'll discuss how we might implement this at CEBAF.