

# Polarized Electron Source Operation (Gun to FC1)

Ops Group Meeting  
October 20 & 27, 2010

Why a higher voltage gun ?

Recent high voltage issues

- Possible mechanism
- Vacuum activity => HVPS ramp rate
- Orbit changes => Injector Steering

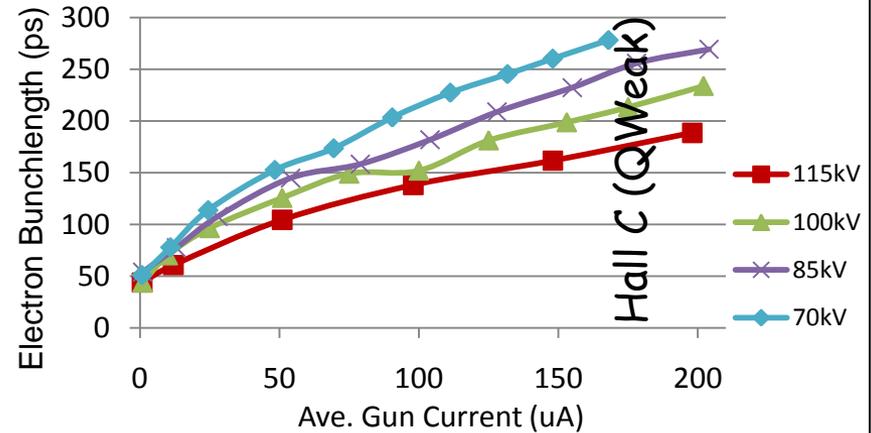
FYI - laser/prebuncher phasing, then & now

# Why a higher voltage gun?

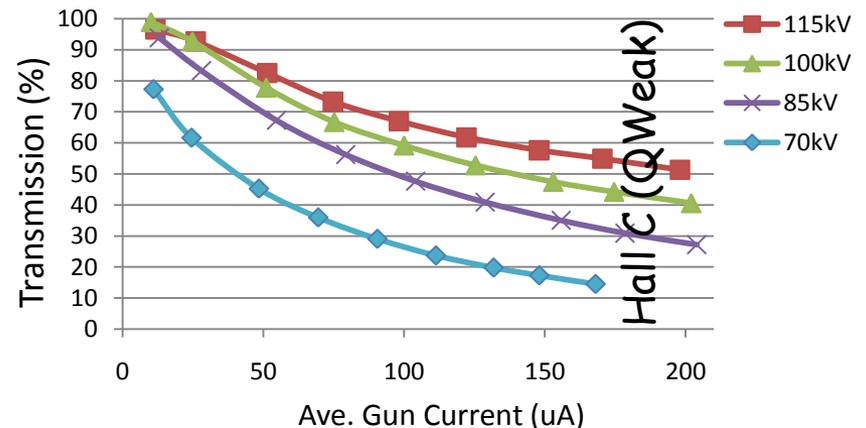
## Measurements at CEBAF/JLab

- Higher voltage means higher beam energy ( $\text{kV} \times e = \text{keV}$ )
- Higher beam energy means more relativistic (closer to “c”)
- More relativistic means electrons repel one another less (important for high current)
- Less repulsion means “stiffer” beam – retain small beam size and short bunch length (better transmission)

### Electron Bunchlength vs Gun Voltage

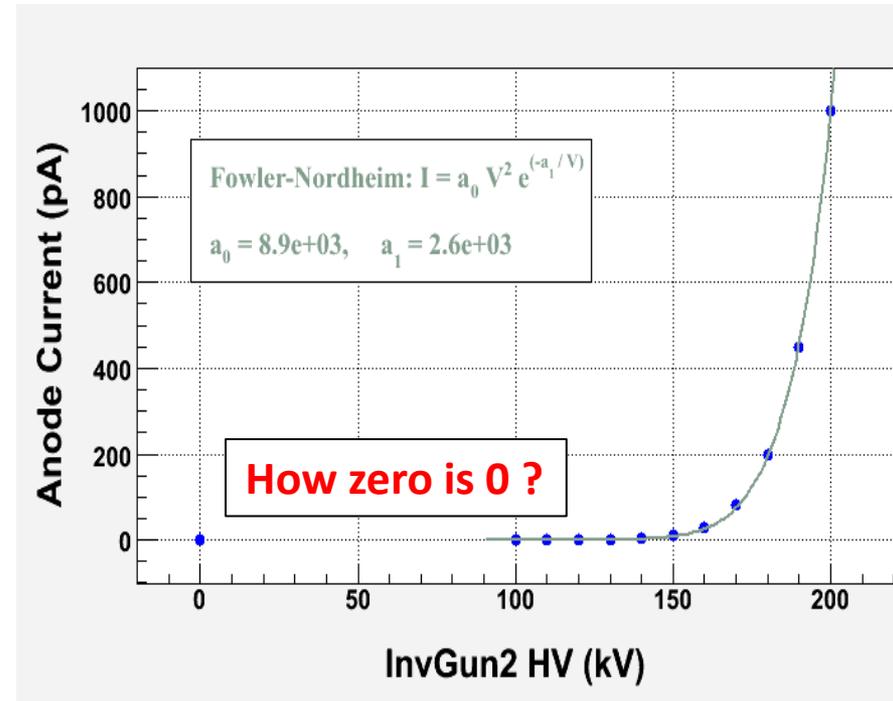
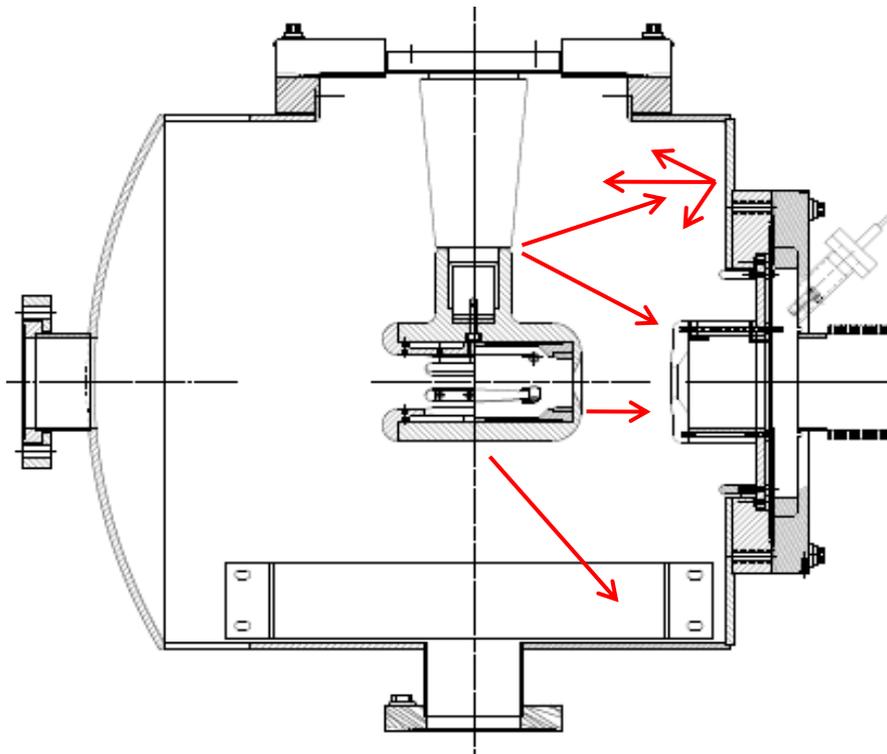


### Transmission vs Gun Voltage



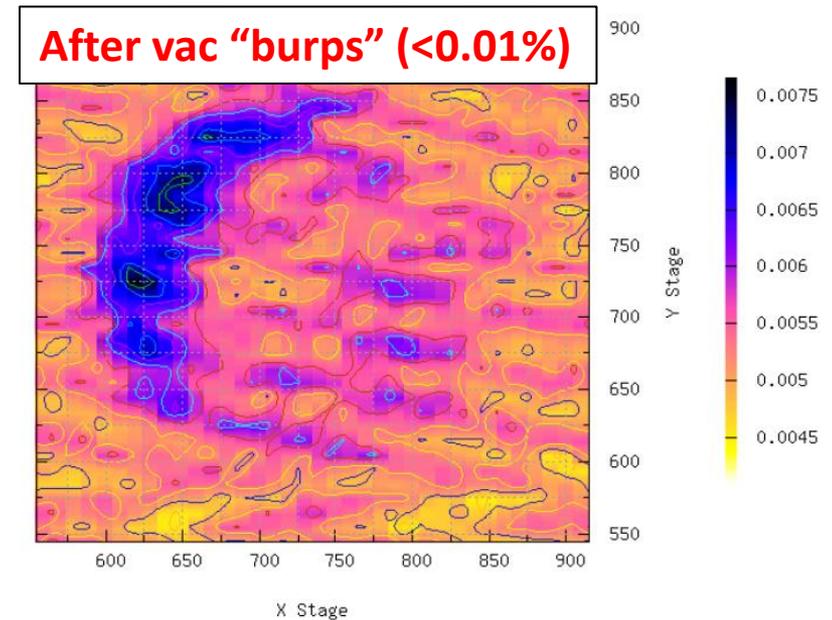
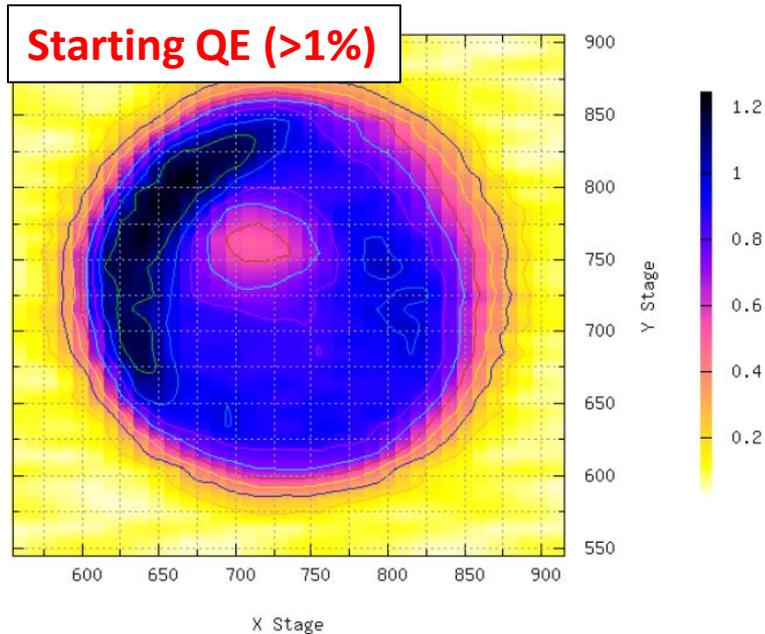
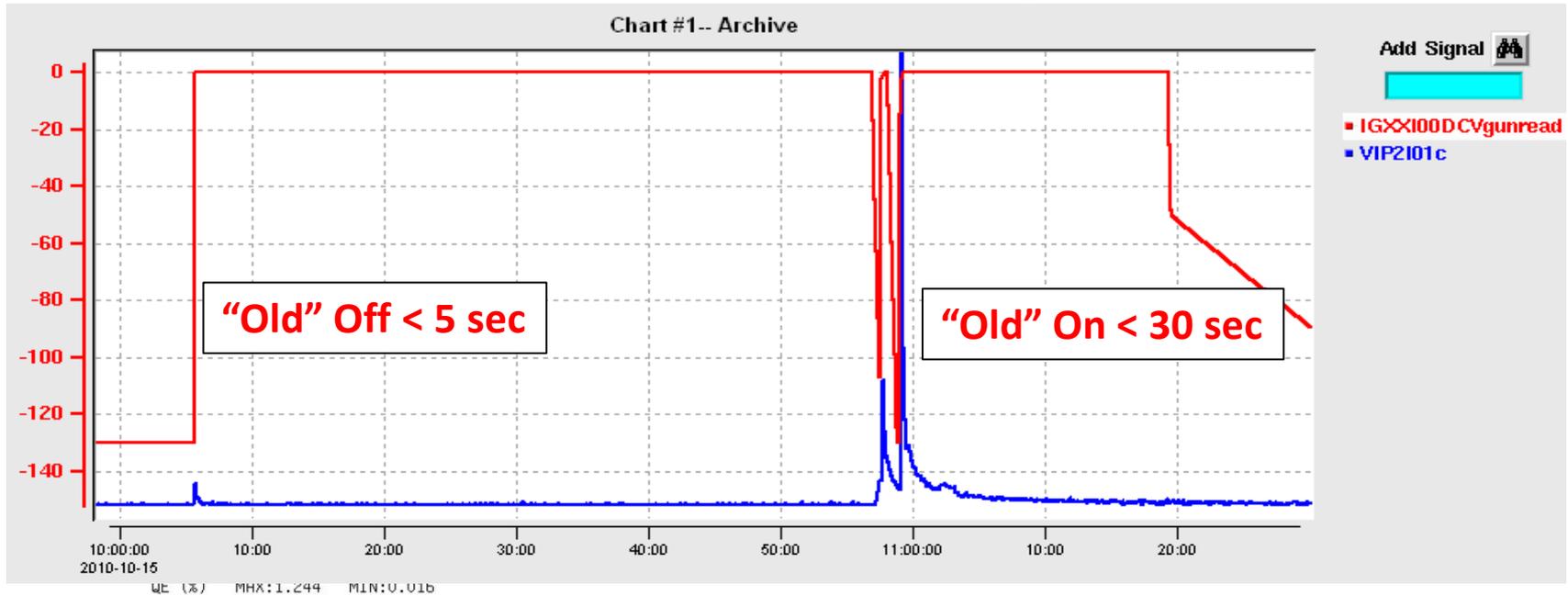
# Recent HV issues - possible mechanism

- High voltages generate high electric fields ( $E = V/d$ )
- Local electric fields are by design (geometry) and “intrinsic” (material, finish, contaminants).



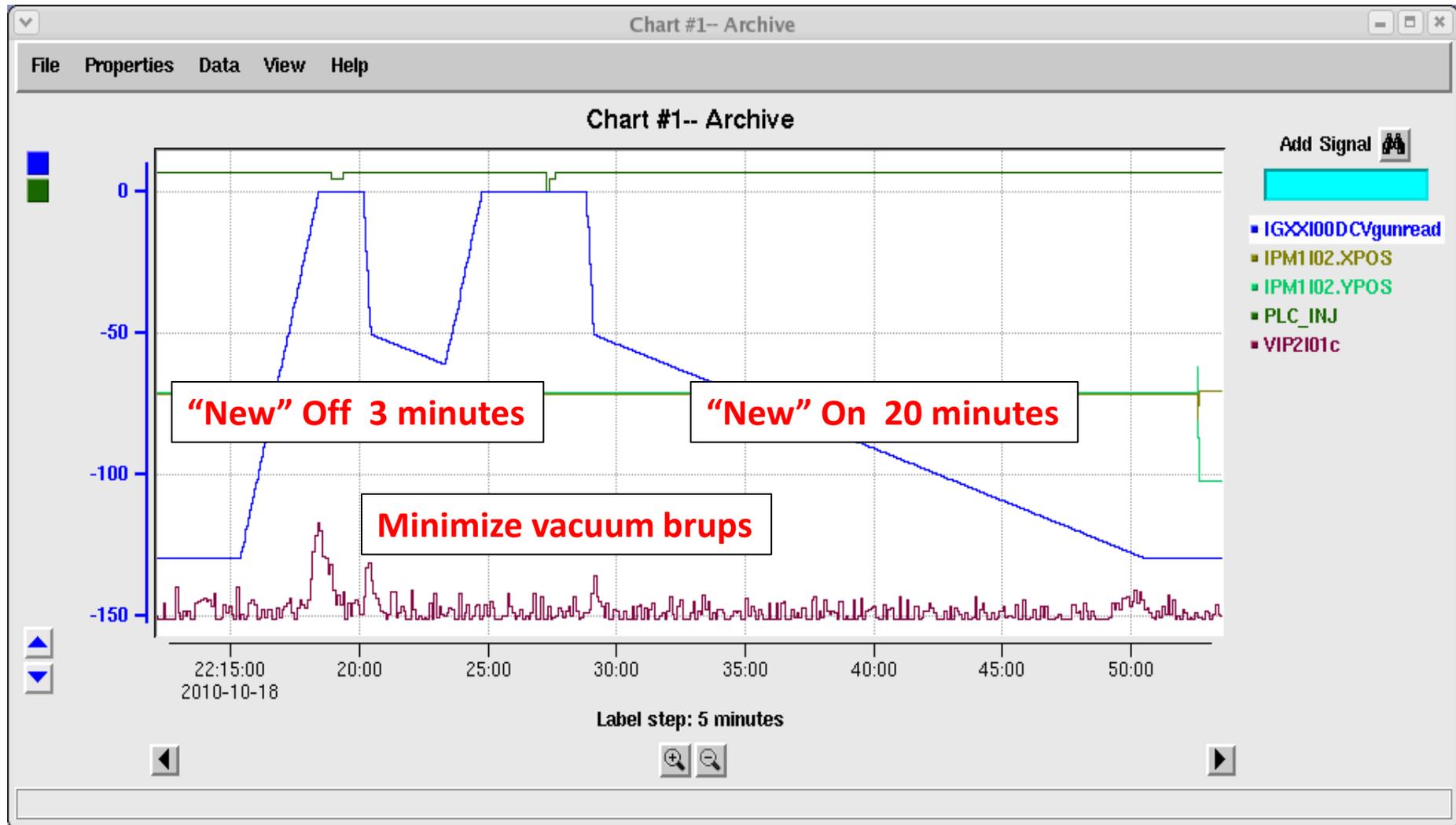
- “Field Emission” occurs when electrons are stripped from material by high electric fields
- These uncontrolled electrons generate secondary e-, photons, desorb gas, charge non-metals

# HV related vacuum activity => kills QE



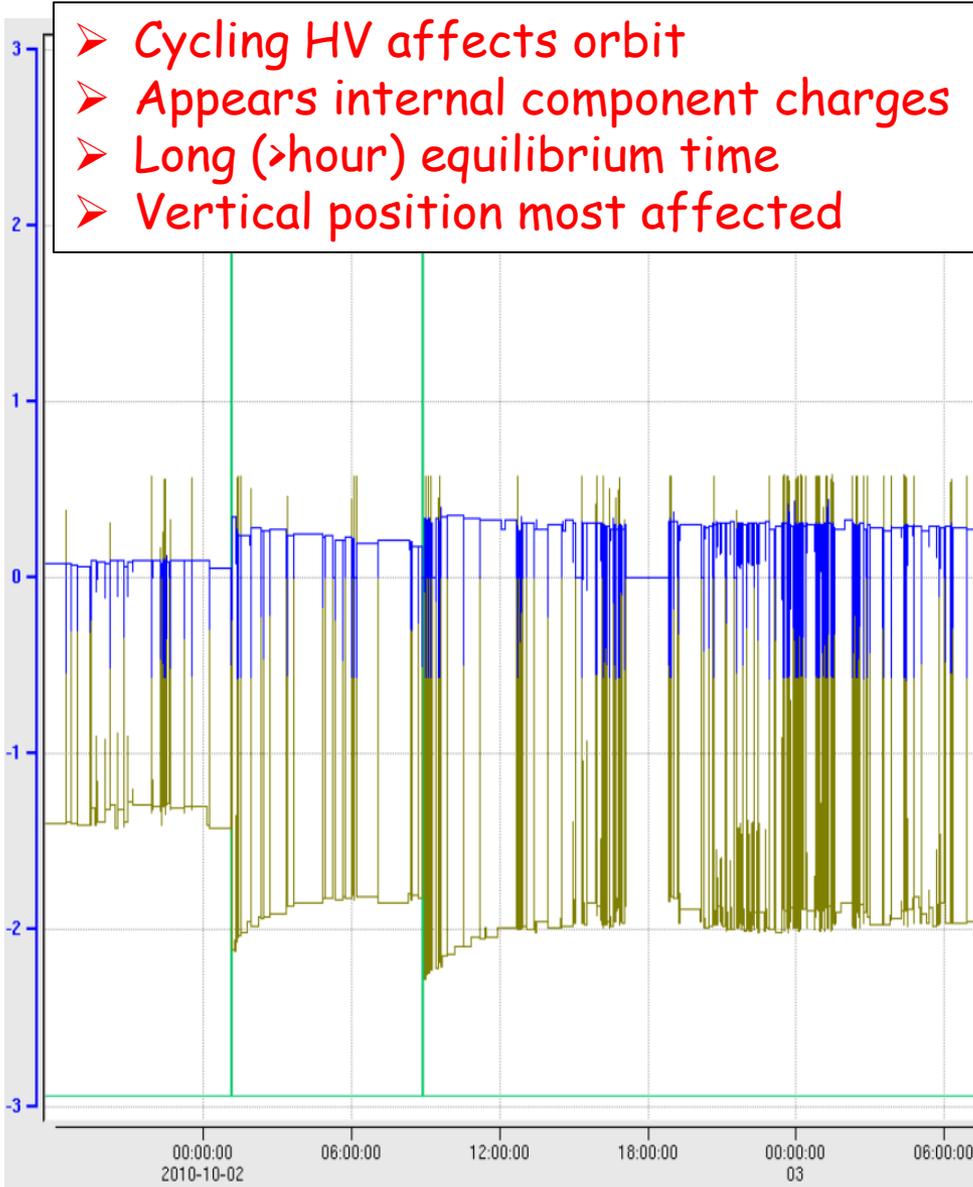
# Slow HV ramp rates => minimize vacuum activity

- Longer Off and On HVPS ramp rates
- Allow HVPS to entirely ramp down before changing PSS state
- Reminder – Gun HV *requires* Beam Permit

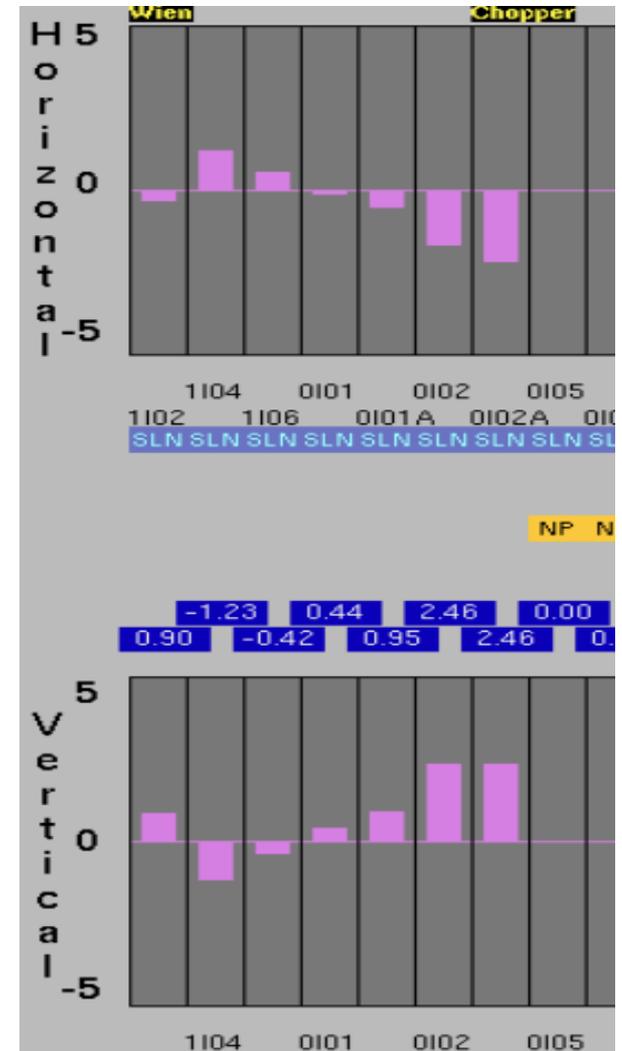


# Irreproducible orbits => offset & drift

- Cycling HV affects orbit
- Appears internal component charges
- Long (>hour) equilibrium time
- Vertical position most affected



- Orbit changes from first BPM
- Loss on A1/A2 is typical



# Injector AutoSteer => Corrects Orbit

- Use "Spot Move"
1. Initialize
  2. Save Setup
  3. Pick Orbit (REL)
  4. Steer
  5. (Restore Setup?)

Edm Screens Help Make POLOG

**Injector Currents**

	A1	A2	MS	FC1
Orig	0.021978	0.021978	0.029304	0.014652
Current	0.021978	0.021978	0.029304	0.014652

Grab Intercepts

**Ready**

**Detailed Status (Most recent at top)**

All injector SOFS match STANDARD.sof.snap  
 Signals for Hspin have been saved  
 Signals for Flip have been saved  
 Signals for Vspin have been saved  
 Signals for Spot have been saved  
 Connecting to All Signals

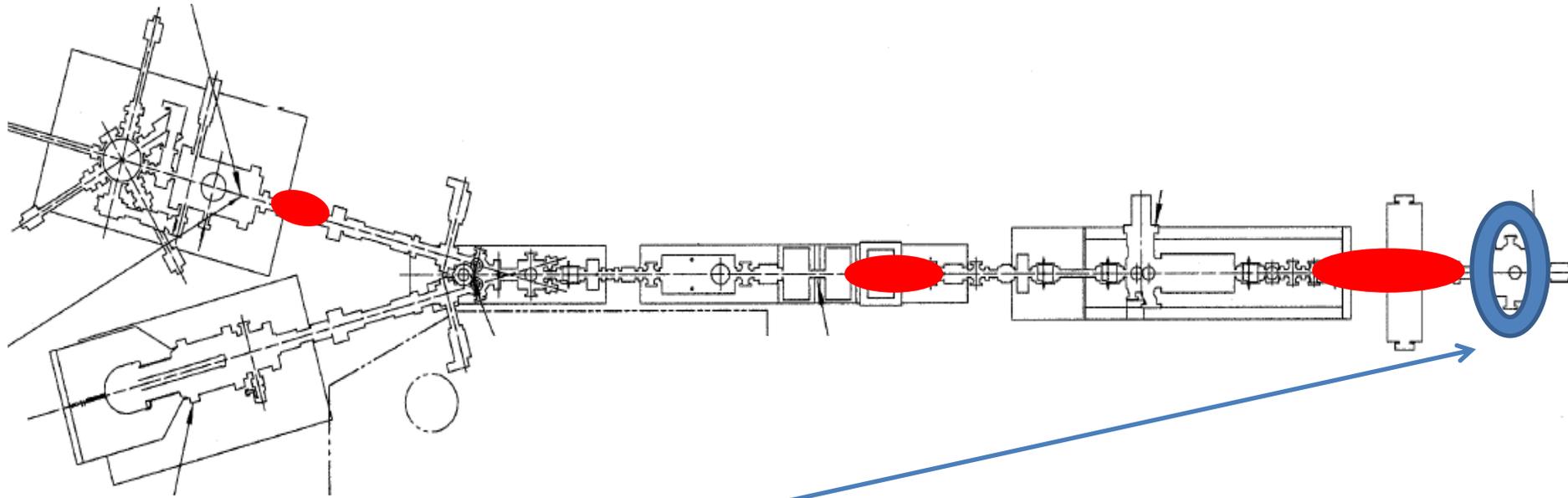
Quit

## Typical adjustments are small.

### Steering Mods Only Modifications

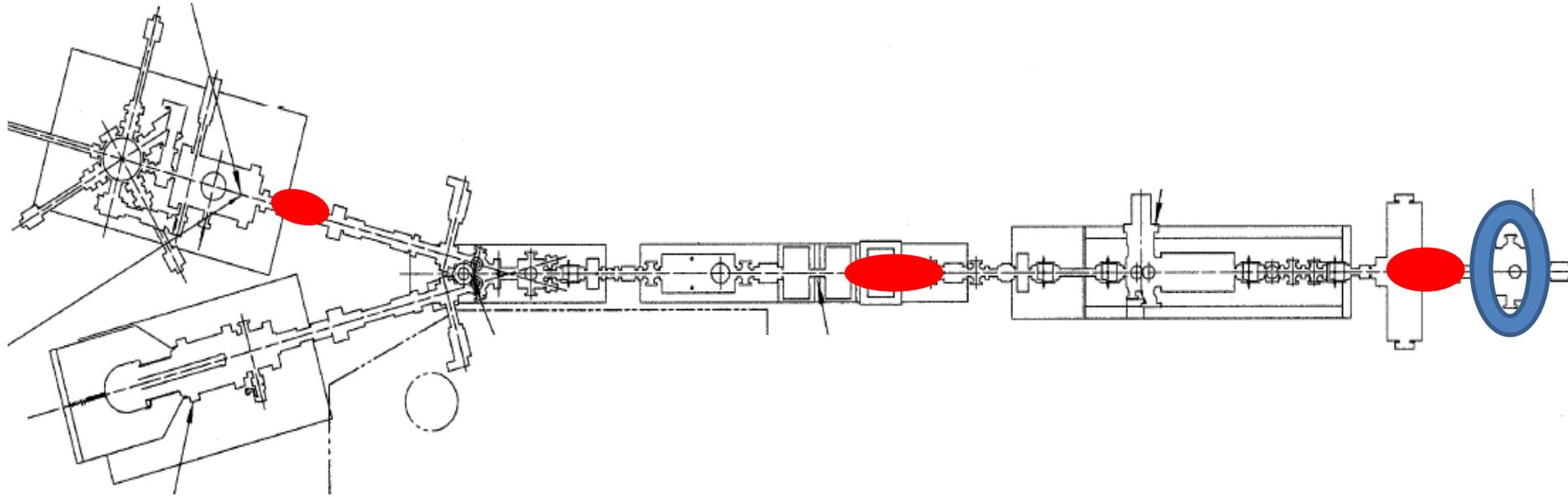
	Old Value	New Value
MBH2I01H	7.9359	7.7659
MBH2I01V	56.0370	54.0270
MBH1I02H	0.6381	0.1281
MBH1I02V	-3.1069	-1.5869
MBH1I04H	-8.6300	-8.6199
MBH1I04V	-4.0279	-4.1079

# FYI - phasing the laser (electron bunch)

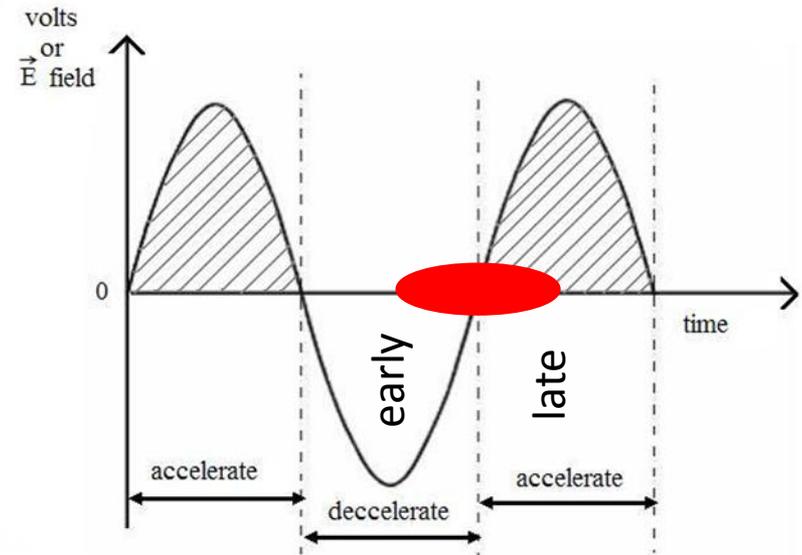


- The **chopper** “opens” for 110 ps at 499MHz (every 2 ns)
- **Electron bunches** travel from the gun to the chopper in about 30 nanoseconds (say, 5 meters divided by  $>0.5c$ )
- The laser phase determines *when* to make the electron bunch
- The bunch (high current) does grow, longer than 110 ps window (remember “space charge” from first slides)

# FYI - phasing the prebuncher

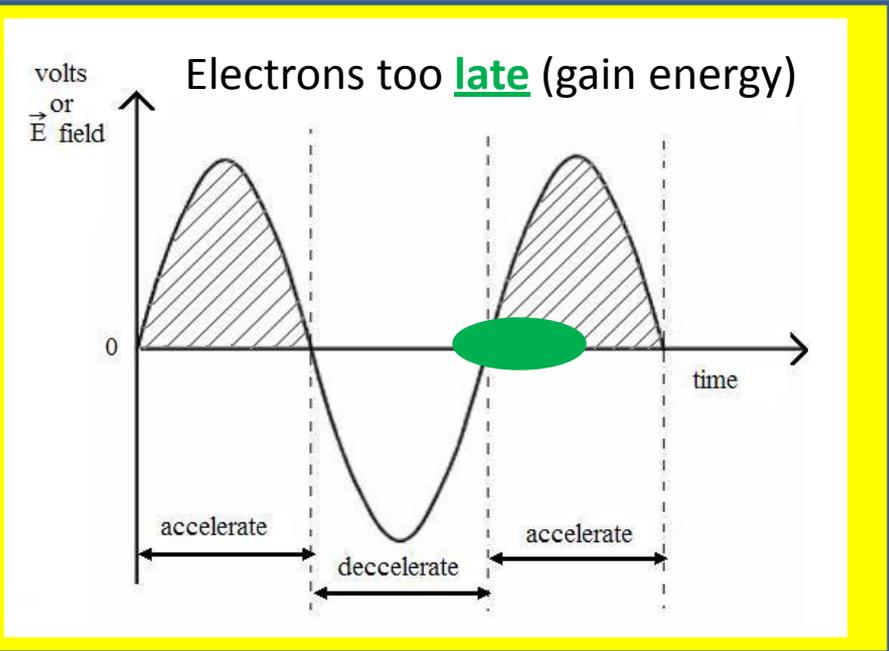
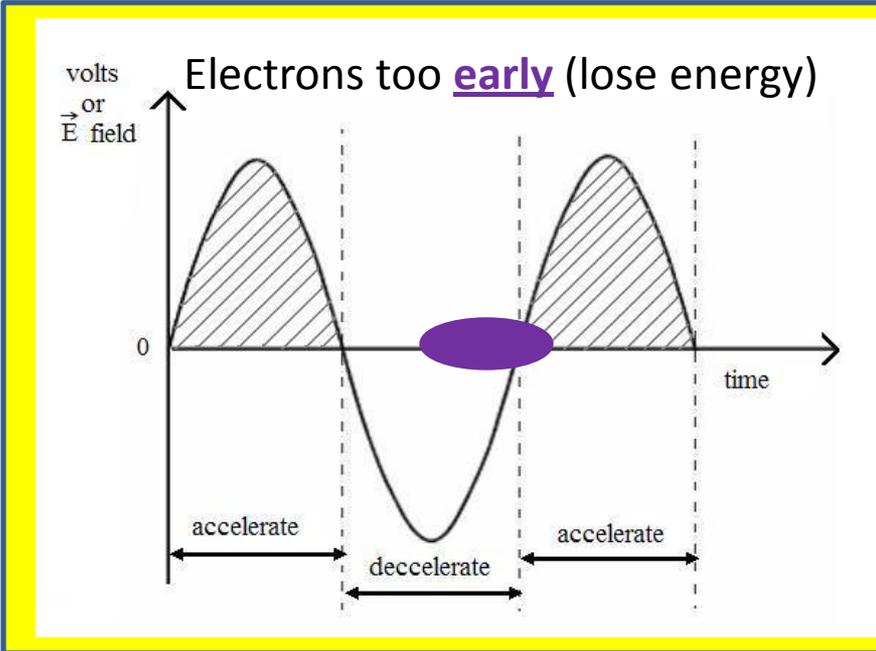
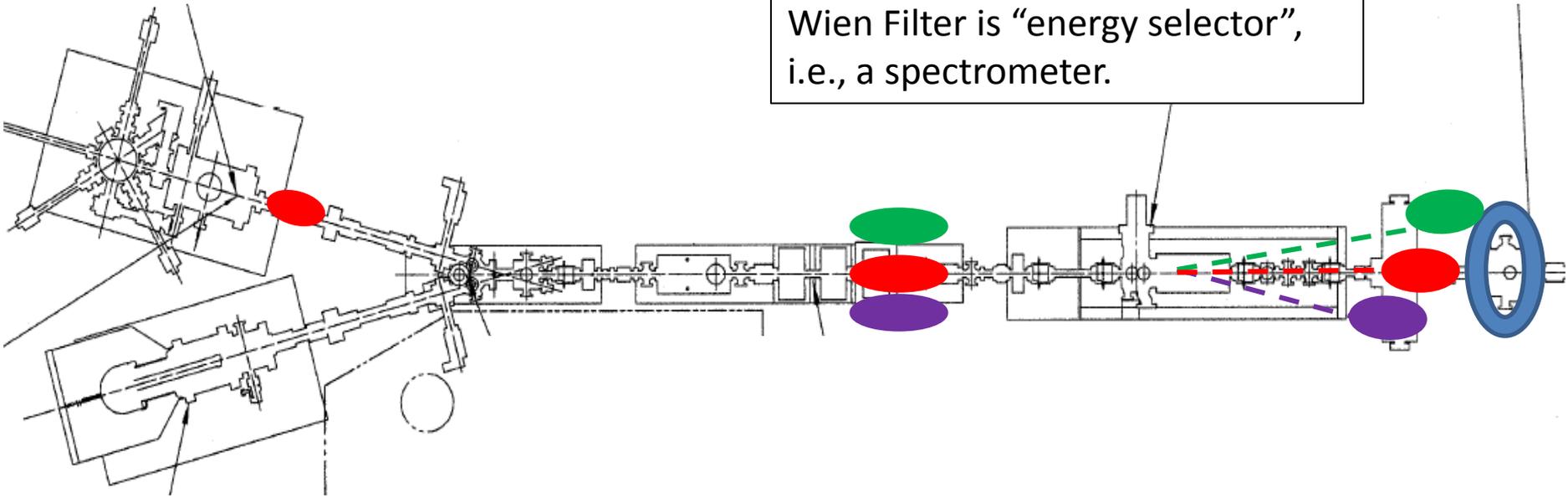


- Drift bunching – slow the early electron, speed the late electron and “center” electron unaffected
- RF Cavity imparts energy (speed)
- Prebuncher phase is set for “zero-crossing”, i.e., set by bunch arrival



# FYI - *misphasing* the laser/prebuncher

Wien Filter is "energy selector",  
i.e., a spectrometer.



# Summary

- A higher voltage gun (>100kV) is good for CEBAF, particularly high current and parity violation experiments like QWeak. An even higher voltage (200kV) gun is planned.
- The present HV issues are puzzling and require more attention than usual. The Injector Steering script generally works well and should be used to correct orbit shifts associated with gun HV off/on. Turning the gun HV off/on now takes about 25 minutes and is hoped to eliminate catastrophic QE loss.
- The laser is phased to the chopper (prebuncher OFF). The prebuncher is then phased to the laser. The H-Wien filter is sensitive to prebuncher changing beam energy. I view this as a "good" thing, improving functionality from the Gun to FC1. However, it is now less of a "tweakers paradise".