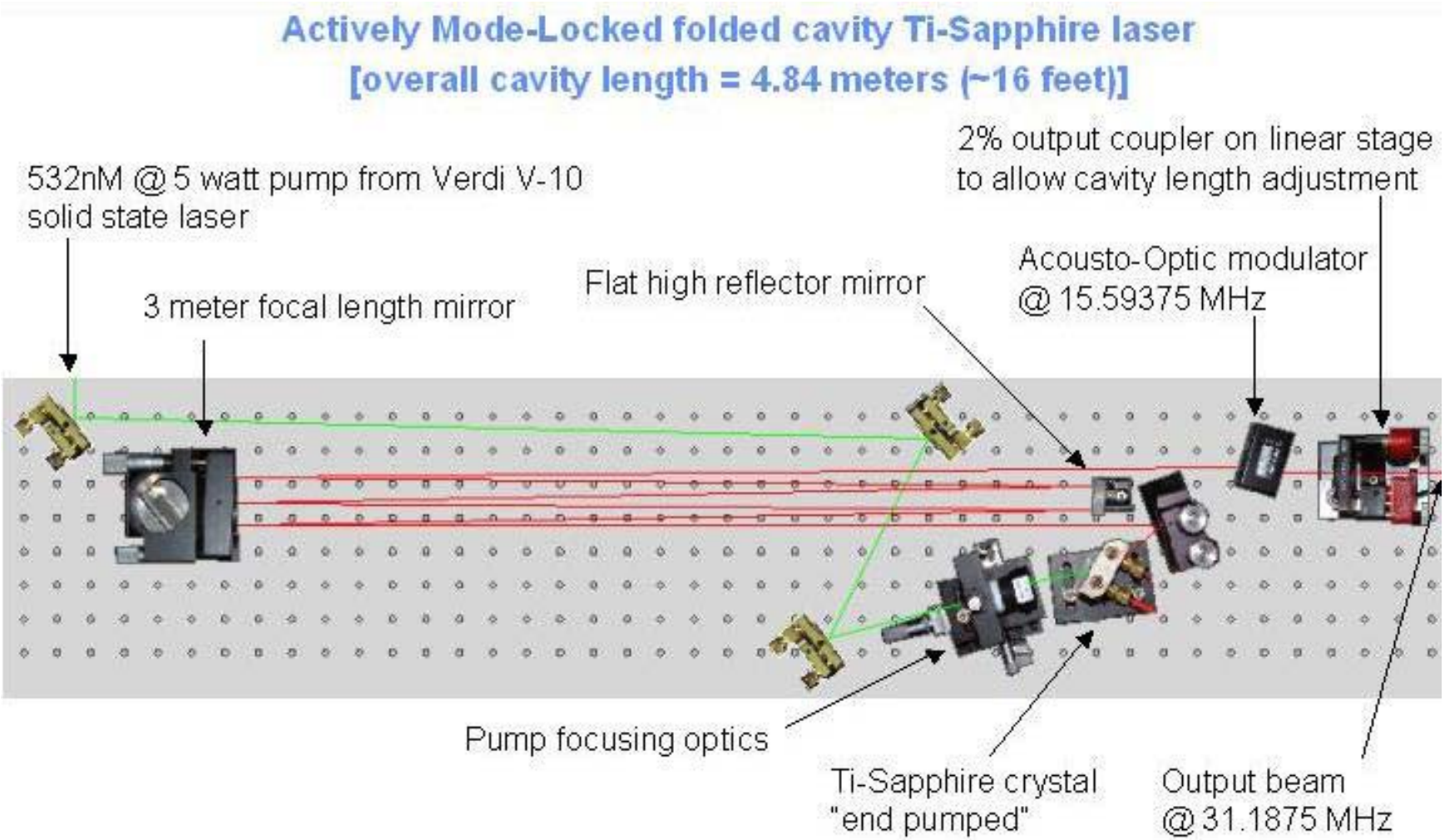
# G0 Laser Status

# Parity Controls

# Injector Diagnostics

G0 Collaboration Mtg
Jefferson Lab
August 16, 2002

# Installed new AOM homebuilt laser



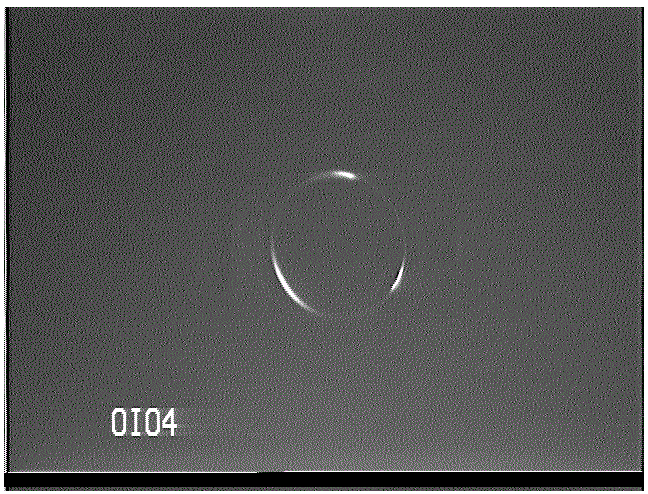
# Homebuilt laser results

Reminder: the new AOM provides better pulse-picking, i.e., better extinction ratio for mode-locking.

Found that by using a "cleaner" RF source the optical pulses shortened from ~260 ps to about ~ 180 ps fwhm.

Installed the improved homebuilt G0 laser with new AOM and better RF source on August 8th.

The new optical pulse-mode generator is working spendidly; this is the system using a Pockels cell and fast high voltage switching supply from Lasermetrics.



# Homebuilt beam results - August 8th

Quickly delivered 12 μA beam to FC2 with better than 50% transmission, an improvement over tests with past lasers.

Found that we would lose G0 beam shortly after the gun when exceeding 50 μA from gun. We could not determine where or why the beam vanished.

Delivered > 20 μA to FC1, but were limited to ~ 17 μA at FC2 because of BLM trips at aperture A3.

Bleedthrough/leakage very small (not measurable) with this laser.

Electron bunch grows dramatically with increasing G0 beam current.

| Current (μA) | Bunchlength (ps) |
|---|---|
| 2 | 181 |
| 5 | 227 |
| 10 | 272 |
| 16 | 318 |
| 31 | 409 |
| >46 | Double pulse |

# Homebuilt beam results - August 9th

Harp scans with G0 beam at varying beam intensity were taken in the 100keV region to provide data on beam "disappearance" > 50μA.

QE vs beam current with diode and G0 lasers were measured.

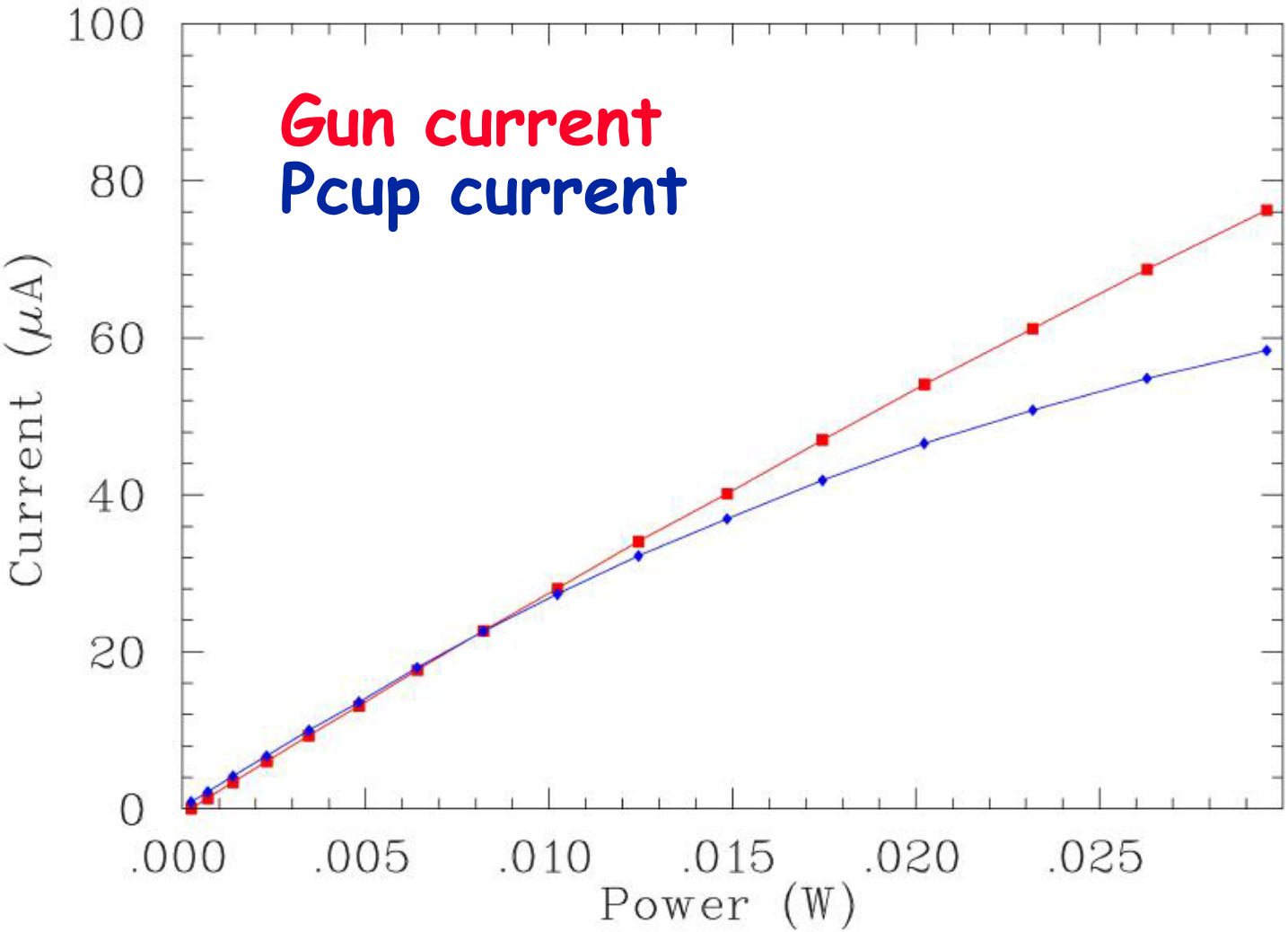
Performed 30 Hz "noise" measurement.

At the end of the second day, using nominal setting we delivered (with the use of the prebuncher):

- 11μA to in line dump with 80% transmission,
- 17μA to in line dump with 38% transmission, without BLM trips.

The above measurements were performed with an injector that was capable for delivering >100 μA of diode beam.

# QE ok, yet beam loss onset appears

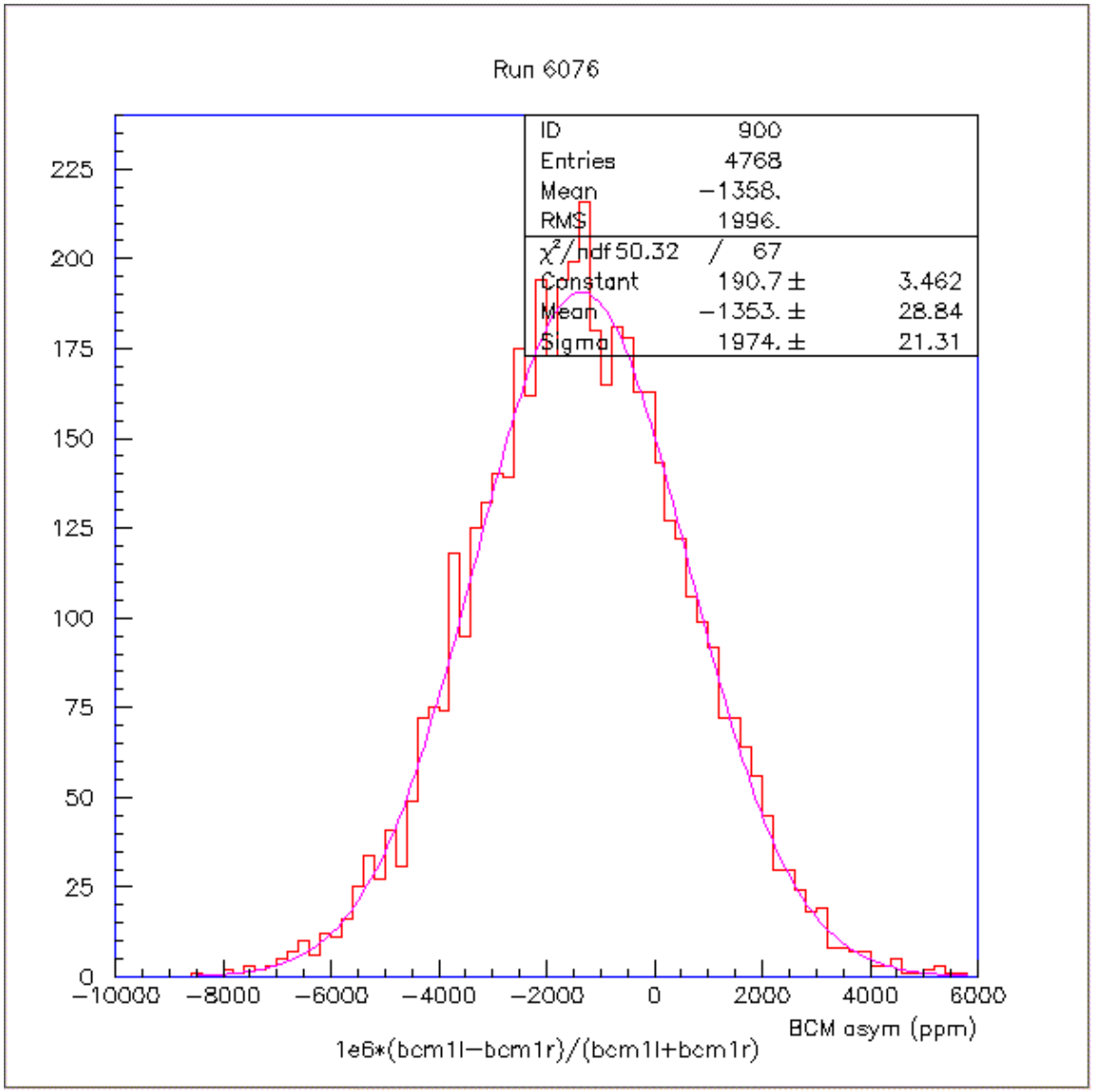


# 30 Hz Noise Measurement

I = 10μA at

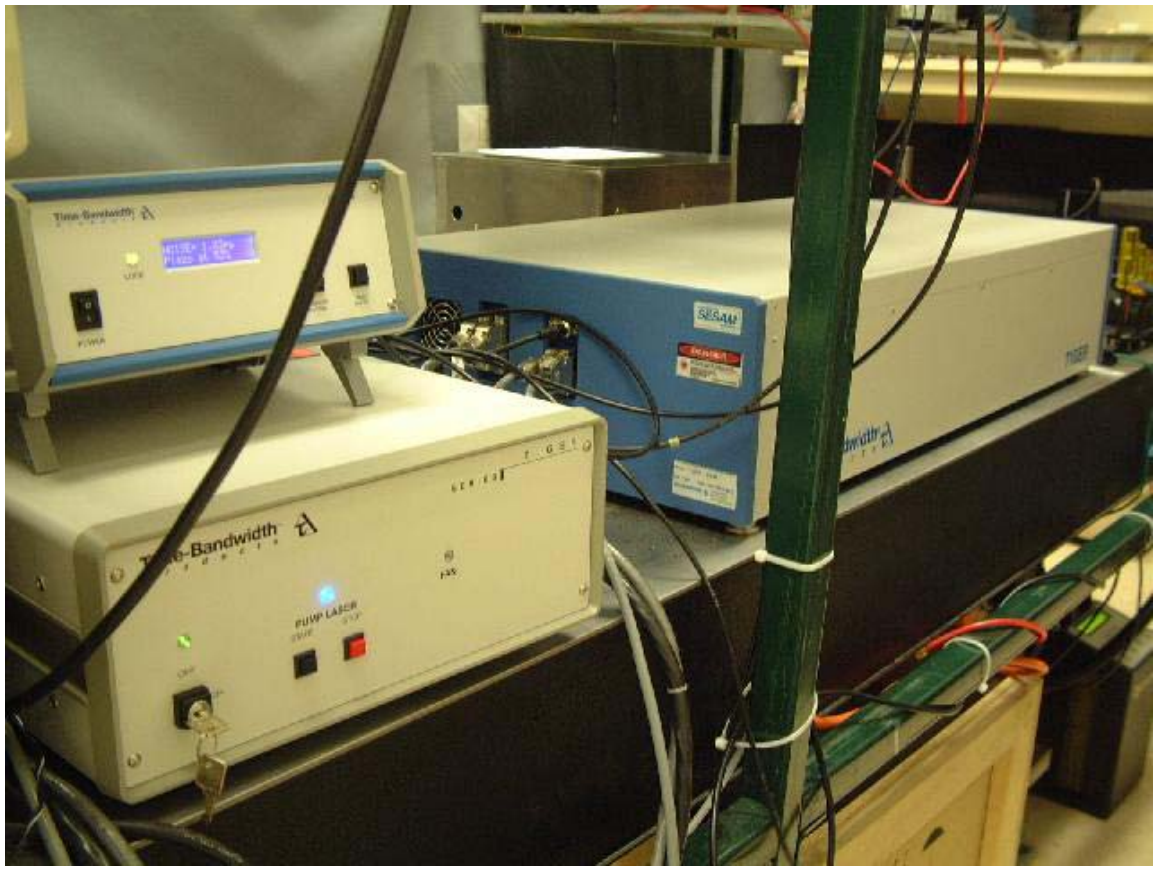
5 MeV BCM

σ < 0.2%



# Time-Bandwidth Laser

The TIGER laser arrived Wednesday and was unboxed...

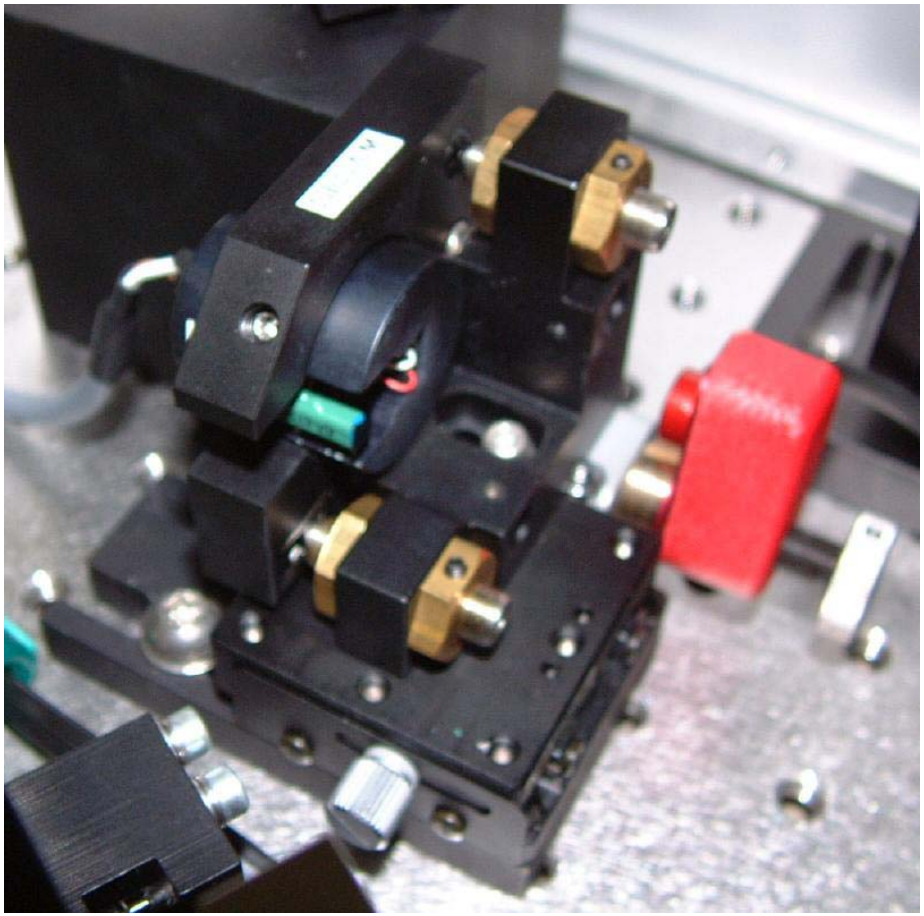


# Time-Bandwidth Laser

Thursday, with the Time Bandwidth designer the system was connected, turned on and began pulsing…

# Time-Bandwidth Laser

Passive mode-locking is achieved using SESAM technology and a PLL to the reference 31.1875 MHz RF source.



# Time-Bandwidth Laser Performance

Measured > 300 mW at 840 nm; tunable from 770-860 nm.

Measured pulse width ~ 70 ps fwhm.

Etalons for 15 ps, 33 ps, 50 ps, and 70 ps received.

Phase jitter measured < 700 fs.


Laser has met spec.
Training and testing in progress.

# Parity controls overview

3 hall operation means our laser configuration has constraints

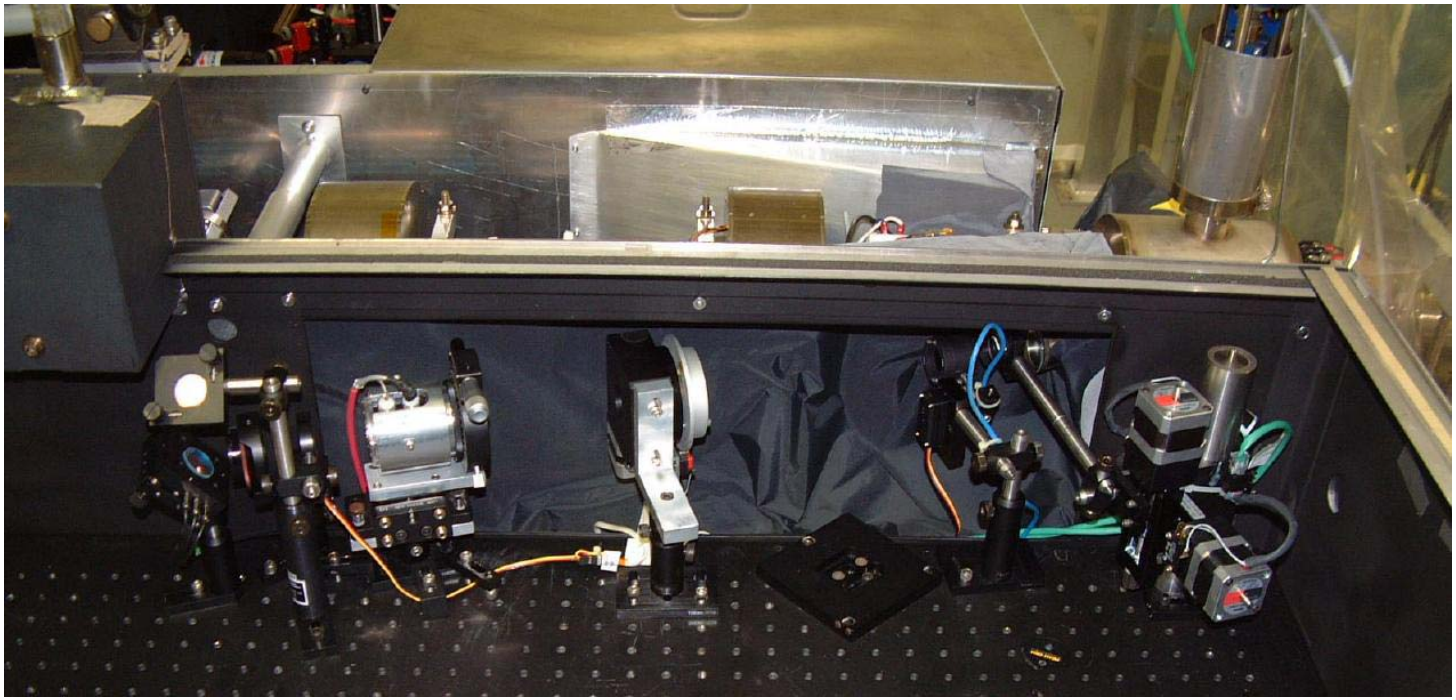
Independent intensity control for each end station. This mean additionally providing parity quality intensity and position devices for both G0 and HAPPEx2.

Hall B continues running a diode laser and TACO intensity feedback.

Independent position feedback for the parity Halls (A&C).

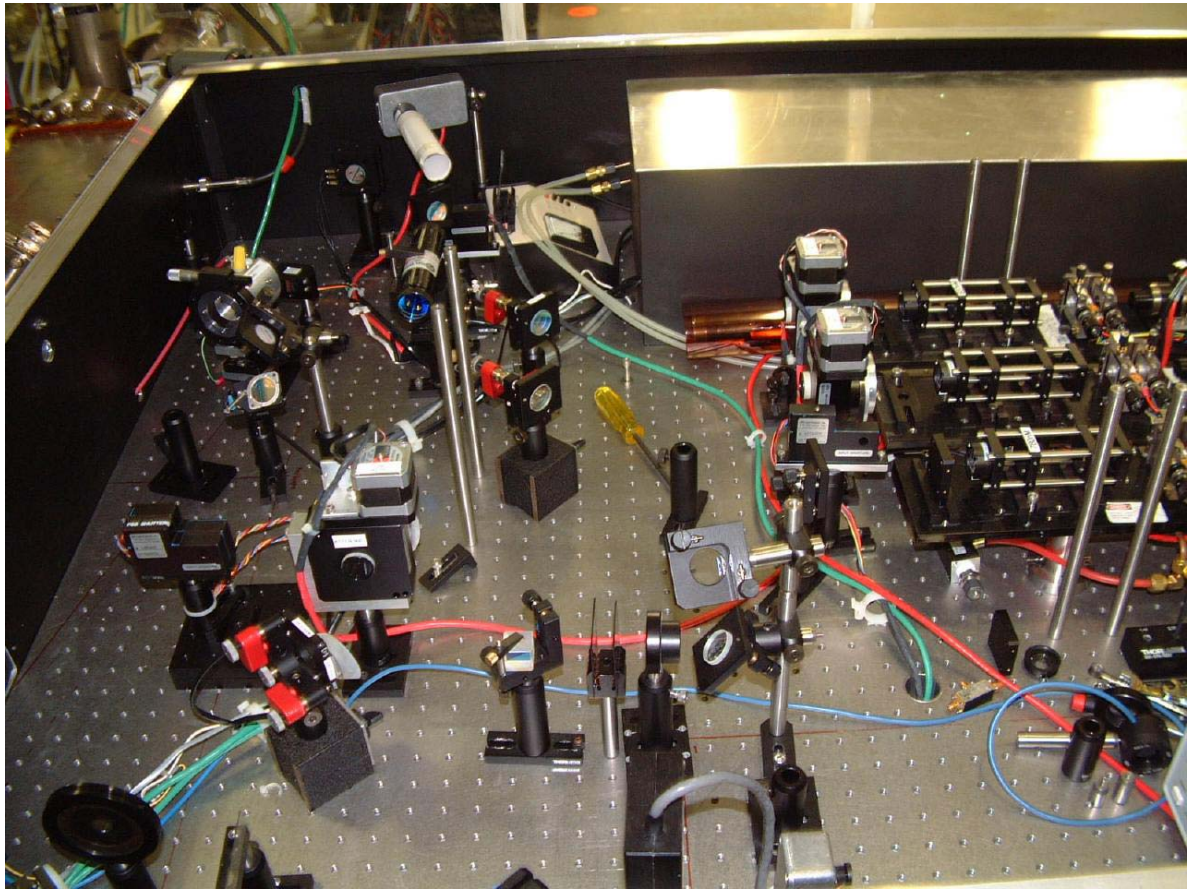
Asymmetry Lock Server provides G0 access to control parity devices

# Parity devices common to all lasers



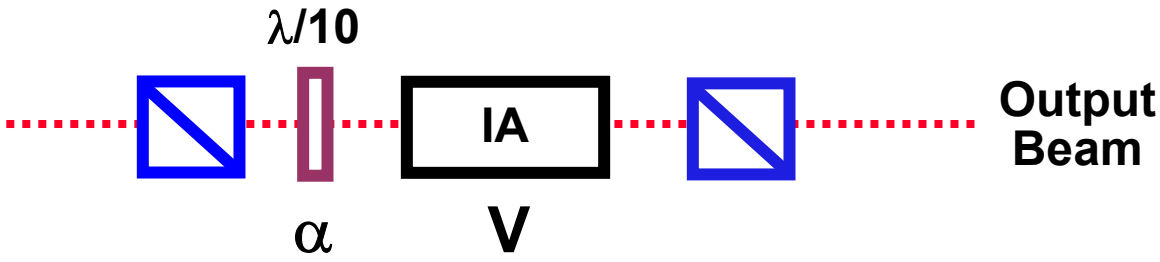
- PZT X/Y kinematic mount
- Insertable l/2 waveplate for systematic helicity reversal
- 20 mm l/4 waveplate Pockels cell for CP and PITA
- Rotatable l/2 waveplate

# Parity devices independent to a laser

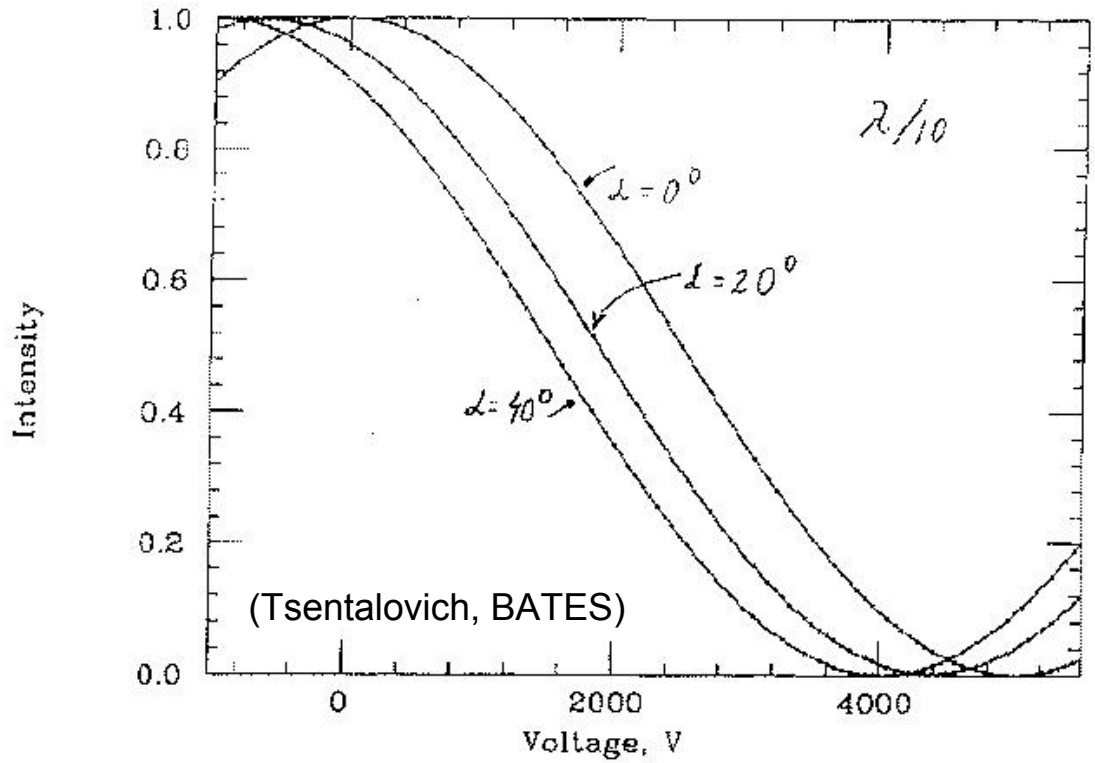


- Independent intensity control using 10 mm LV IA Pockels cell
- Independent position control using pico-PZT kinematic mount

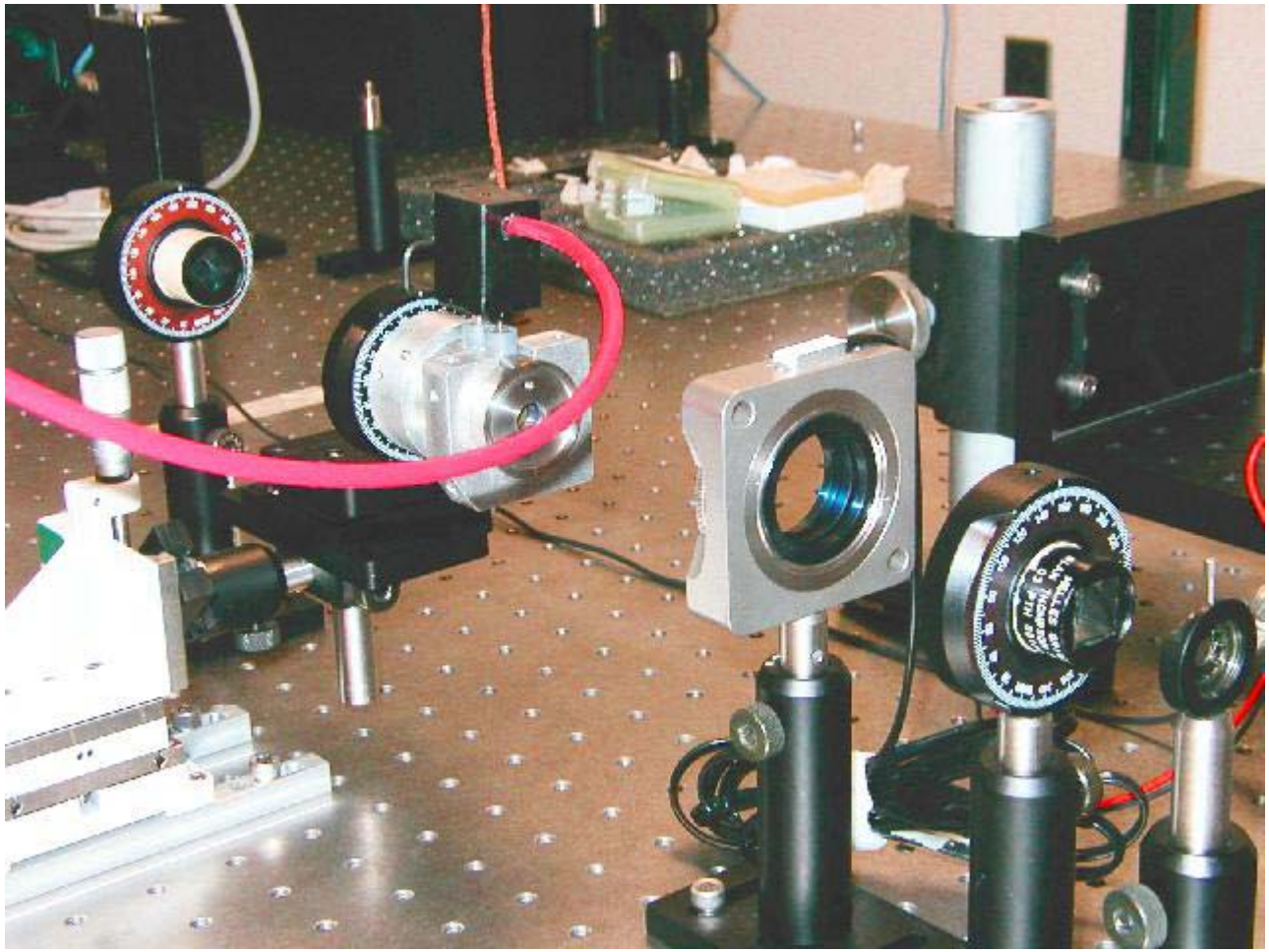
# Independent intensity control



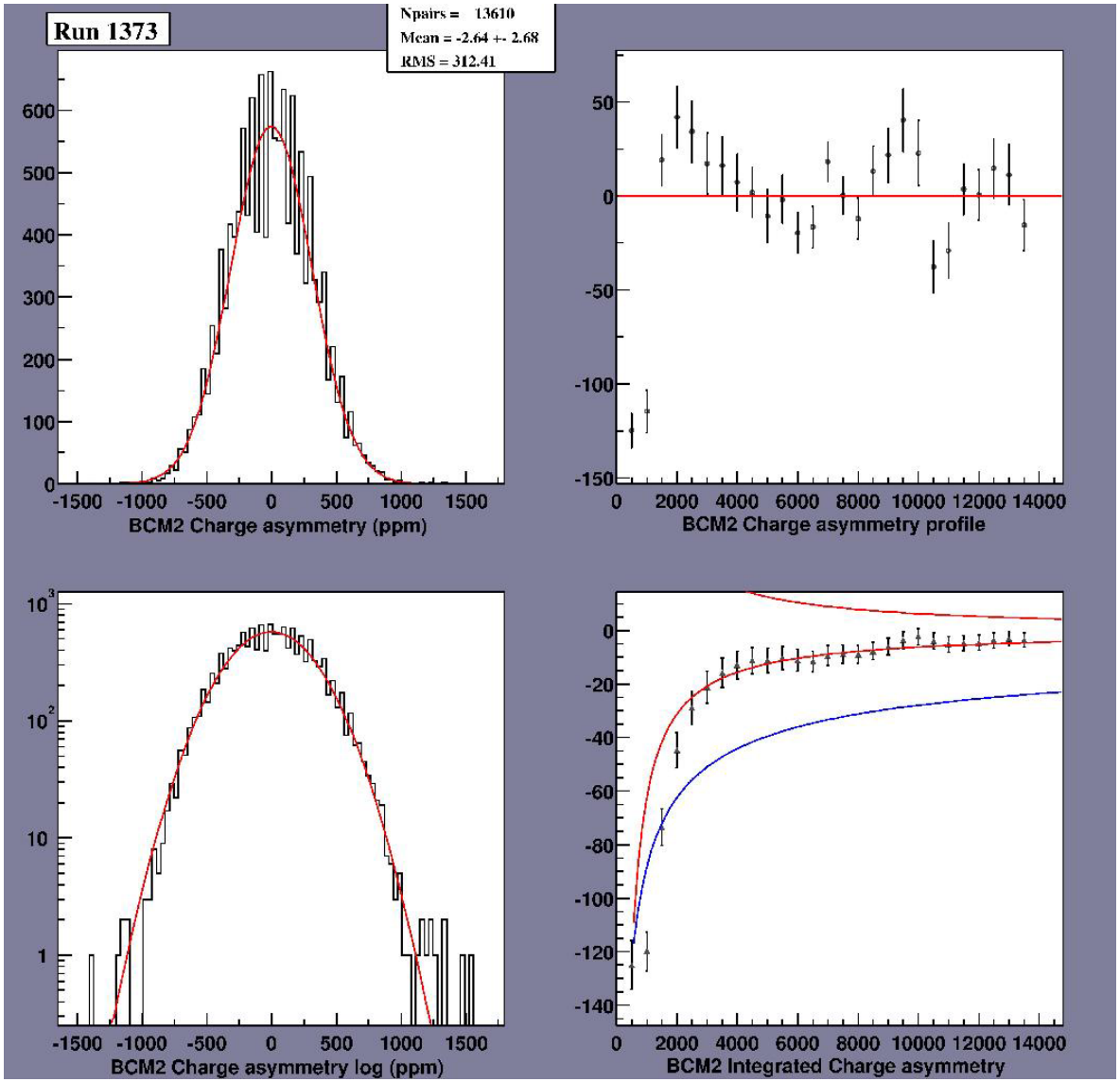

- Follows laser directly
- Stable slope ~300 ppm/V
- Low cell voltage
- Low insertion loss
- Compact footprint



# IA bench test



# IA beam test (Hall A)



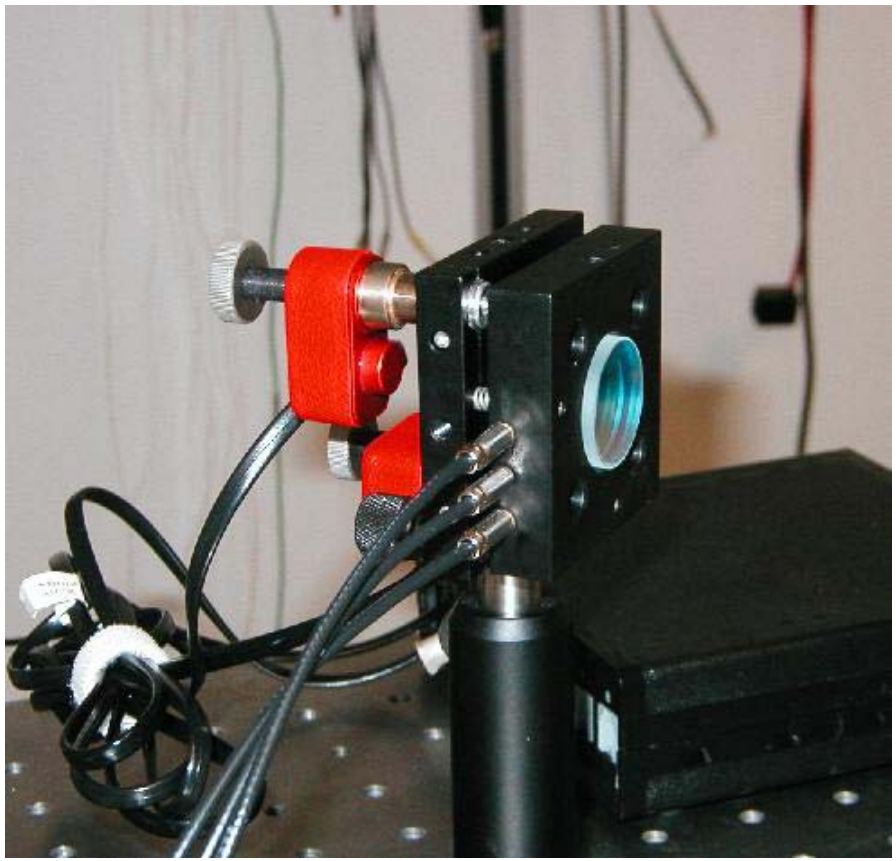
# Independent position control

We use a mirror mounted to a kinematic stage with PZT stacks for laser deflection.

The common mirror is ~10 cm upstream of the Pockels cell.

To achieve independent postion control we retrofit a picomotor controlled mirror with a PZT kinematic mount.

This doubles the moment arm to the cathode, but also increases the distance (100 cm) to the Pockels cell.



# Issues regarding position feedback

HC motion at injector apertures produce charge asymmetry.

- Original aperture set produced $Q_{asym}$~ 300-400 ppm/volt.
- 2x aperture set reduced to this to < 40 ppm/volt.
- A 3x+ aperture set exists and hasn't yet been tested.

HC motion on the cathode QE surface produces charge asymmetry.

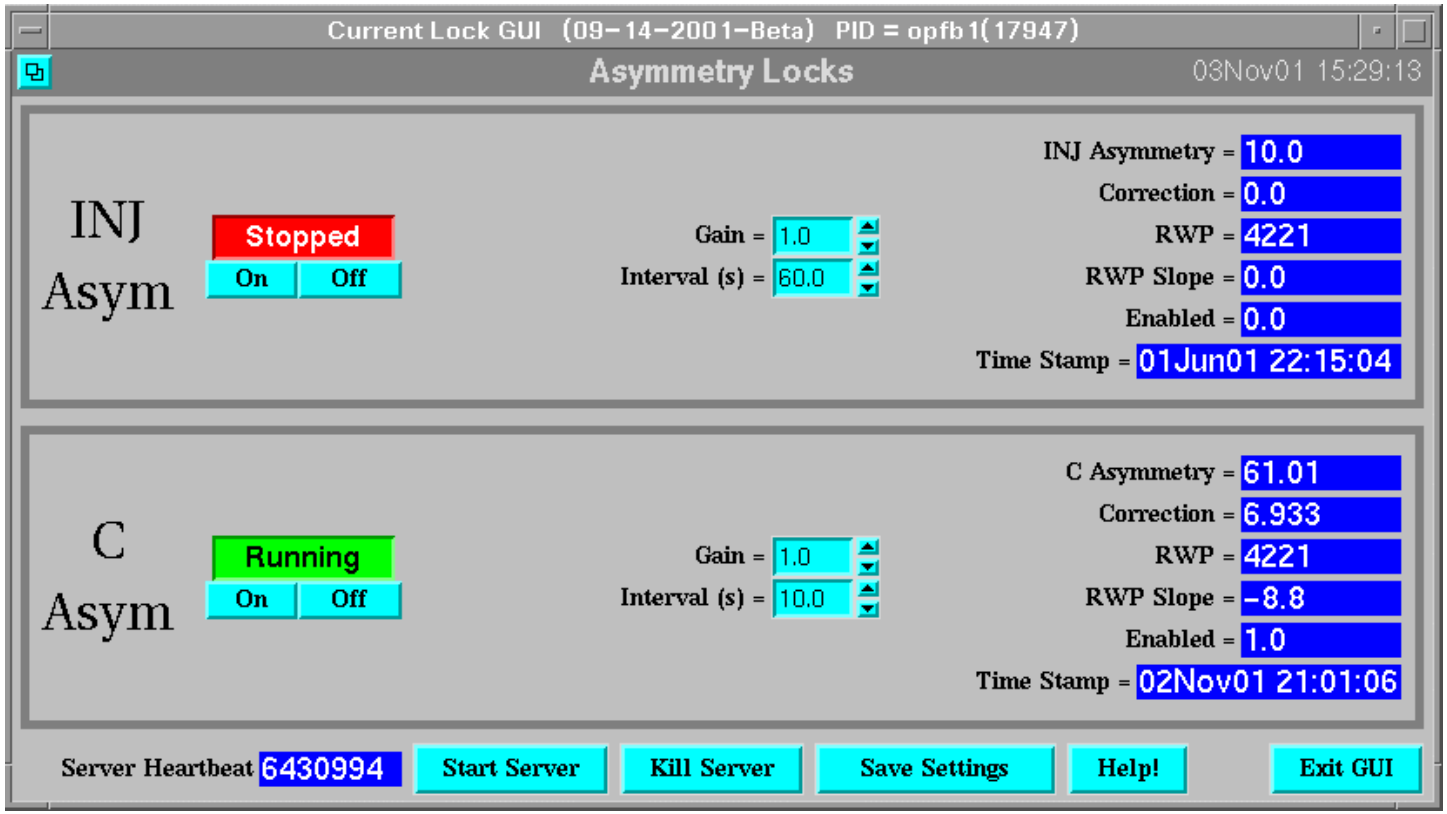
- A clean measurement to determine contribution from cathode QE surface vs. apertures remains to be tested soon (next week?).

PZT kinematic mount is not perfect.

- Recent bench tests using 10V modulation shows no cross-talk at the orthogonal stack, but about 0.1% cross-talk at the coupled stack.
- Test also shows ~0.5% ringing for 5 msec at each stack.
- Better news is PZT feedback probably requires <1 Volt.

HAPPEx2 is considering the possibility of employing HC magnets.

# Asymmetry Lock Server




- ALS provides G0 access via EPICS to control parity devices
- Good track record and is being improved for User readback

# Injector beam monitors

## BPM's

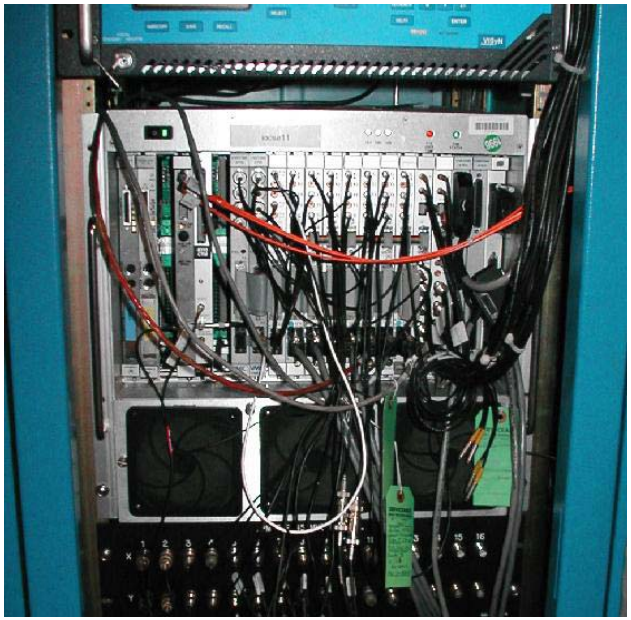
| # | Energy | Quality |
|---|---|---|
| 1 | 100 keV | Prior to any apertures |
| 3 | 100 keV | Between Wien & A1 |
| 1 | 100 keV | Between A1 & A2 |
| 1 | 100 keV | After chopper |
| 3 | 5 MeV | After all apertures |

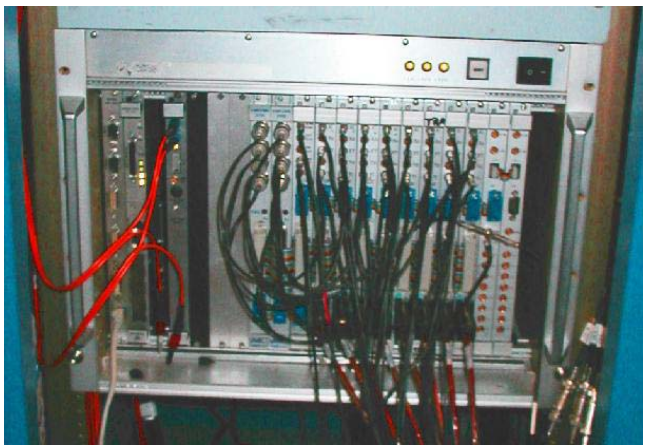
## BCM's

| # | Energy | Quality |
|---|---|---|
| 1 | 5 MeV | After all apertures |

## S/H's

| # | Energy | Quality |
|---|---|---|
| 6 | 100 keV | Temporary |
| 3 | 100 keV | Permanent |
| 3 | 5 MeV | Permanent |





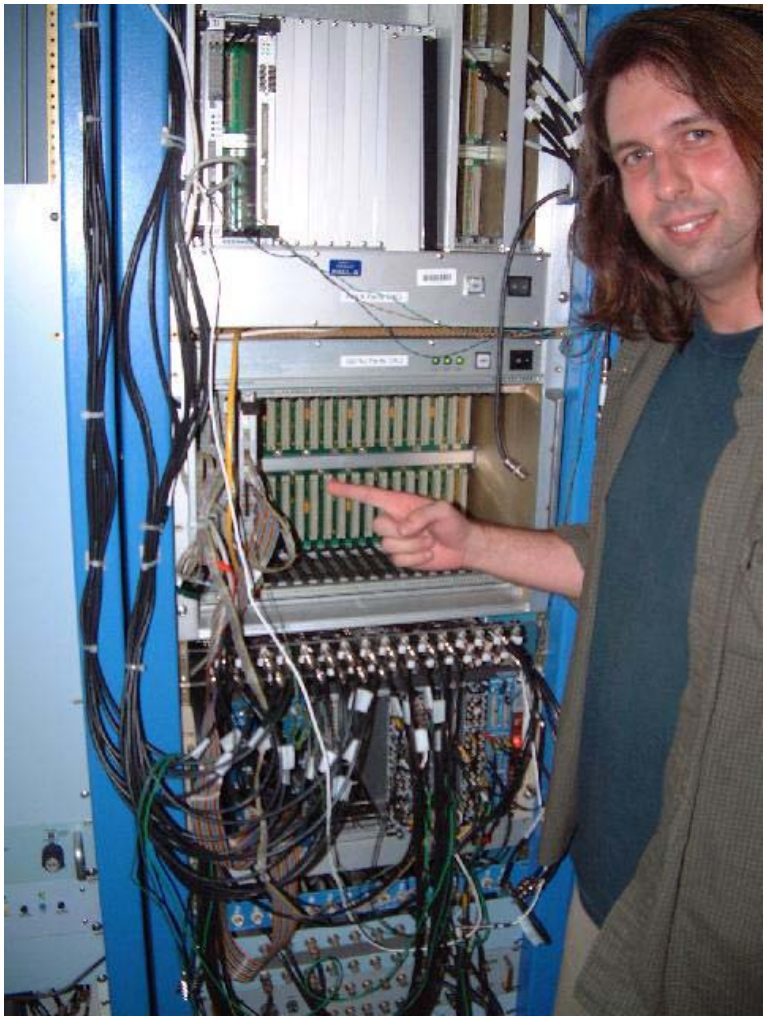
# Injector DAQ

32 channel scaler based DAQ
Triumf V/F's
BPM's = 4 channels
BCM = 1 channel

Improve laser setup
EES recently ran cables from tunnel to DAQ to analyze photodiode signals from tunnel.

Jeff Secrest & Sue Witherspoon
Upgrade DAQ to Ops IOC w/ PowerPC
Implement EPICS analysis output
Improve data storage

HAPPEx2 ADC DAQ
Located in same crate
Analyzes mostly same signals
Redundancy/debugging



# Injector beam monitoring

Because injector diagnostics see all 3 beams HC measurement and feedback is presently limited.

A drawing board idea for independent capability:

- Requires a beam intensity modulation (~1 kHz)
- RF VME boards with DSP to use lock-in technique
- Project has Operations support
- Initial test using the injector BCM before 2003

# Timeline & Conclusions

We are in the midst of reaching many important G0 milestones. We are making progress both on the laser front, beam transport front, and parity front.

Next week we will:

- complete injector parity controls installation
- prepare an injector setup for G0 beam
- perform injector parity measurements
- deliver that beam to Hall C

Now, Mark can tell us what he's planning and hoping for...