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Jefferson Laboratory

Parity Collaboration Meeting
April 17, 2009



Thomas Jefferson National Accelerator Facility

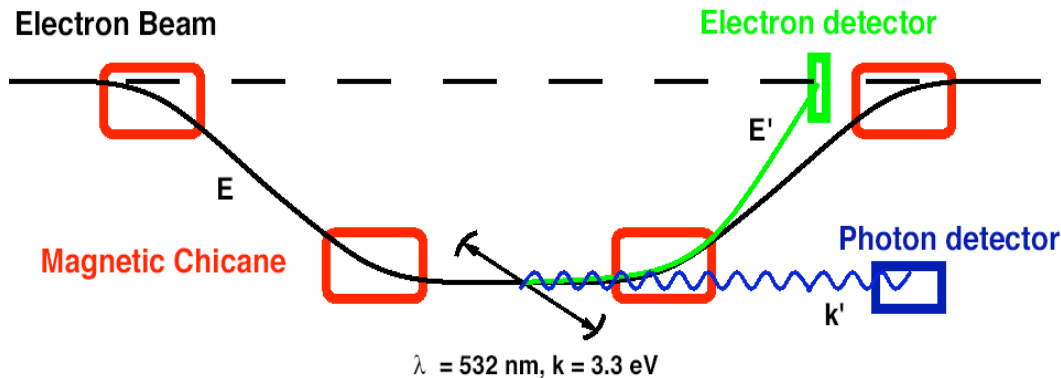
The Hall A Compton Polarimeter Upgrade

Goal:

Provide 1% beam polarimetry from 1 to 11 GeV.

High precision Parity violating experiments are feasible with this upgrade

Scope:



New Electron Detector

- High resolution silicon microstrips to improve systematic errors
- Movable in dispersive plane for wide energy coverage

New Photon Detector

- Large single crystal GSO calorimeter
- Integrating FADC for improved accuracy
- Preserve counting abilities

High Power Green Fabry-Perot Cavity

Twice the Analyzing power of present IR cavity

➔ Increased in Figure-of-Merit

Participating Institutions: Jefferson Lab, Syracuse, Clermont-Ferrand, Carnegie-Mellon, Saclay, UVA, Duke, &M



IR Cavity Upgrade

- **Present IR Cavity has been decaying in Power**
 - Power had fallen to about 400 W
 - This is due to aging of cavity mirrors as well as falling drive laser pump power
 - Below 300 Watts this cavity will not provide satisfactory Compton signal over beam background
- **Laser Head Swap**
 - Replace old 200 mW IR laser head with 700 mW backup laser
 - Align, mode-match and lock the new head
 - Should have up to 1.4kW cavity power, essentially back to initial power of the cavity
- **Thanks to Cates et.al, the laser head swap is successful**
 - New laser locked (~ 1kW) using Saclay electronics
 - Old laser being decommissioned



Electron Detector

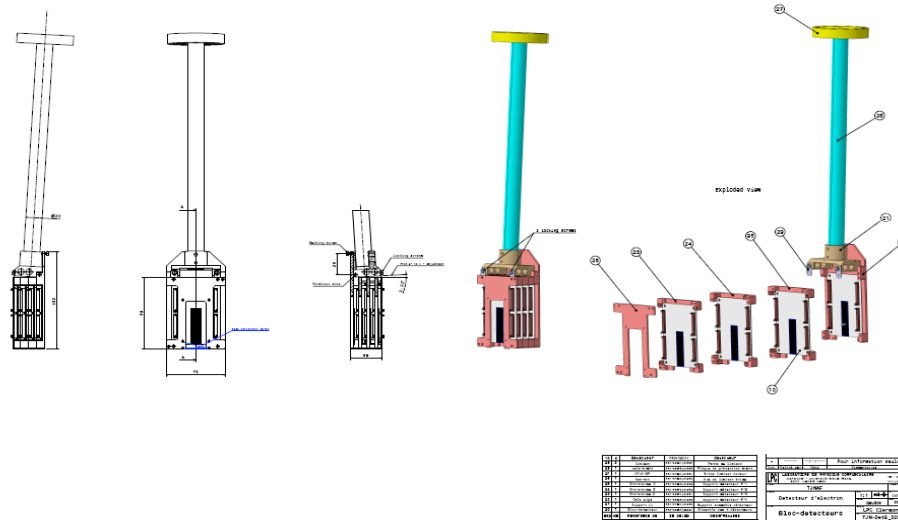
LPC Clermont-Ferrand

- **Goal**

- Stand-alone Asymmetry measurement with improved tracking resolution
- Provide absolute energy calibration for photon detector

- **Scope**

- 768 ch 240 μm pitch silicon μstrips
- 4 Planes, 192 strips/plane, 1 cm spacing between planes
- 120 mm Vertical motion to allow coverage of Compton edge from 0.8-11 GeV
- New custom front-end, FPGA trigger module (ETROC)
- New DAQ and Analysis Software



Electron Detector Status

- **Status**

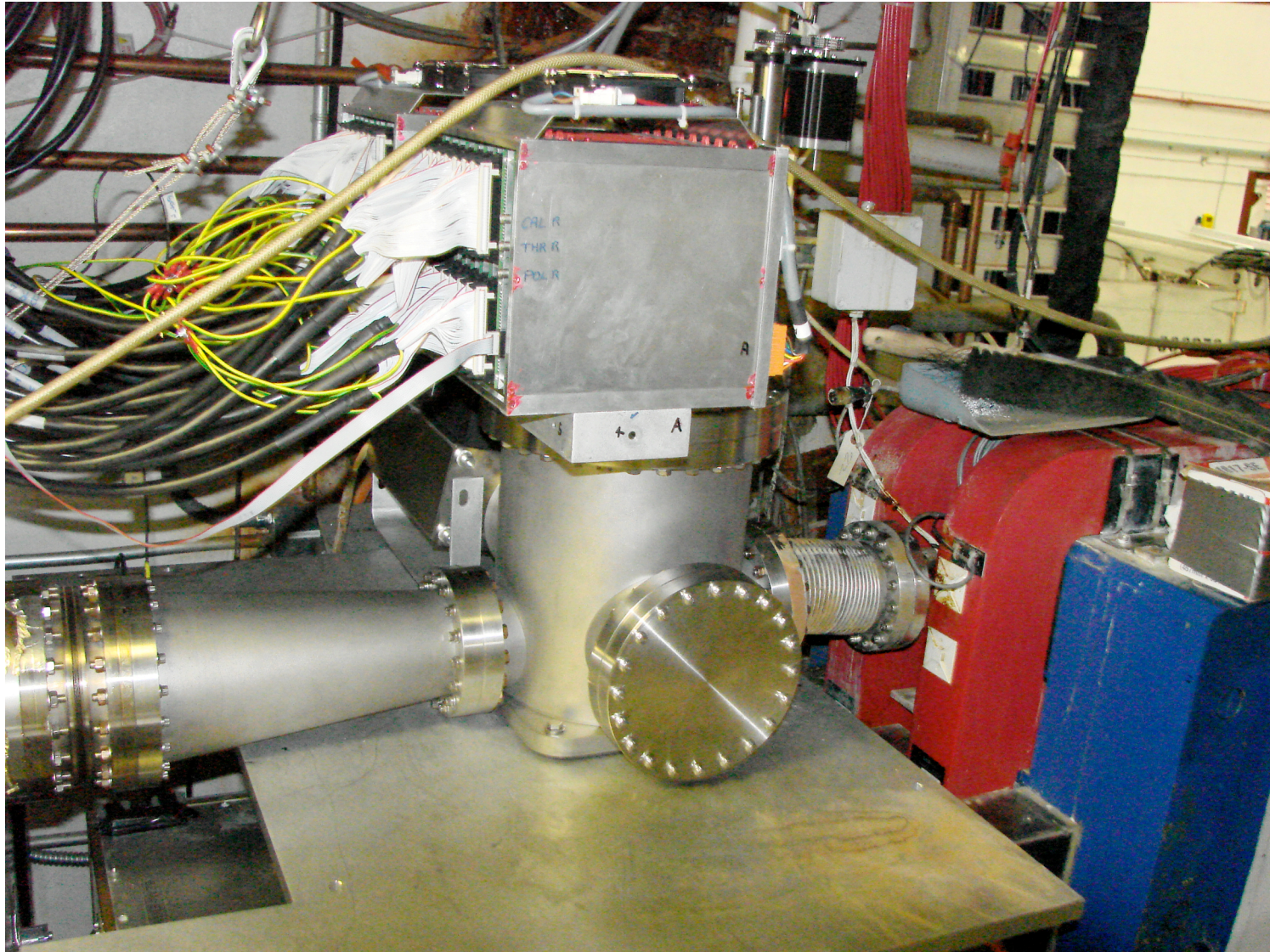
- Delivered to the Lab Aug 08
- Installation, alignment, survey completed October 08
- Control systems, safety interlocks completed Nov 08
- DAQ readout completed Feb 09
- Electron-photon coincidence trigger to be implemented

- **Commissioning (Alex)**

- Detector commissioning facing difficulties
- March Beam tests failed to produce a Compton spectrum
- Systematic checkout in progress
- Background shield and visual beam monitor added
- Further beam tests scheduled

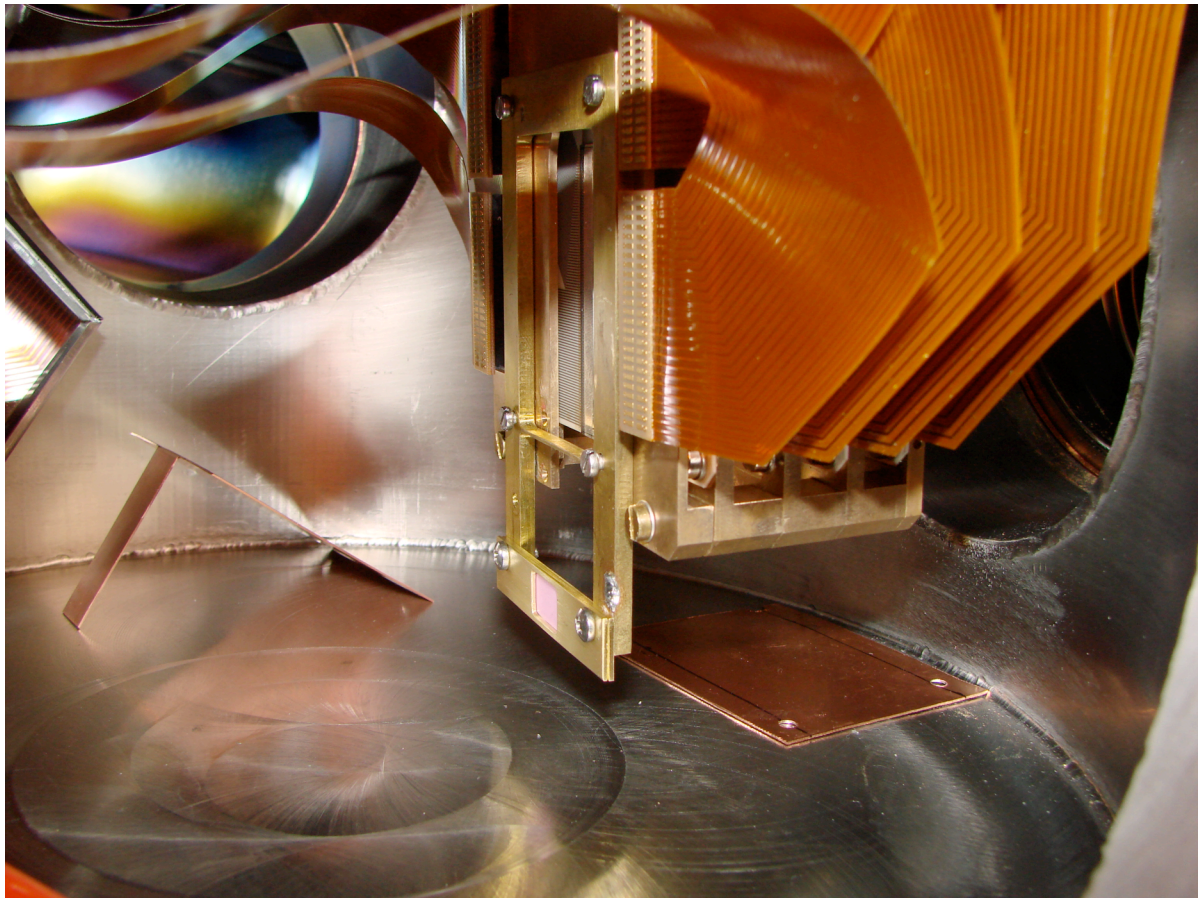


Installed e-detector in Hall A



E-detector in vacuum Chamber

- **E-detector chamber opened up for rad source checkout**
- **Synchrotron radiation shielding added**
- **Visual beam position monitor installed**



Photon Detector

Carnegie-Mellon University

- Calorimeter

- Single crystal GSO, $6\phi \times 15$ cm cylinder, Single PMT
- High light output, fast decay time (less than 60 ns)
- Can do triggered counting as well as integration.
- GSO Crystal (Hitachi) under commissioning tests
- Mechanical support in design

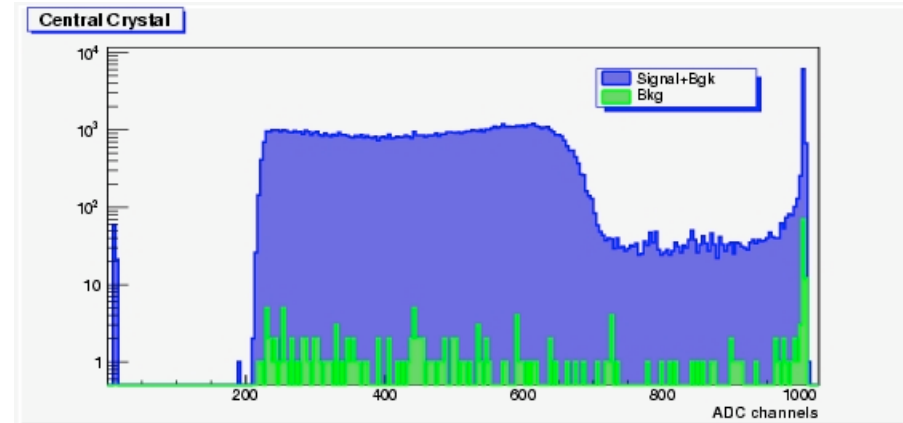
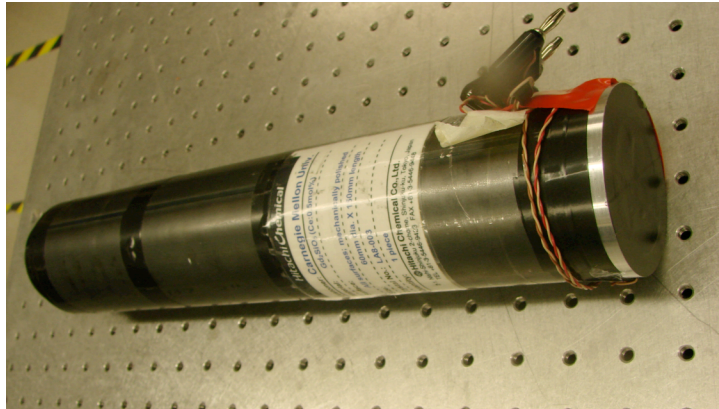
- Integrating DAQ

- Required for 1% polarimetry @1Gev
- New Flash ADC's in commissioning

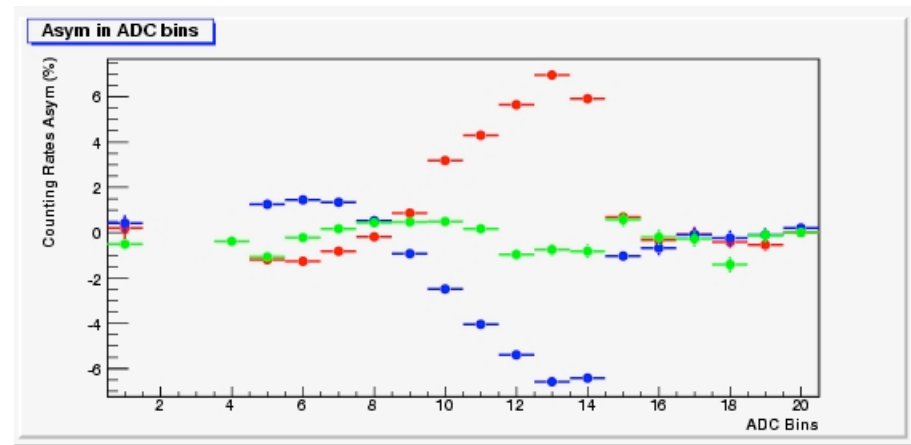


GSO Calorimeter

- First Spectrum and Asymmetry with counting DAQ



- $E_e = 5.9 \text{ GeV}$
- $E_\gamma = 0.2 - 0.8 \text{ GeV}$
- $P_{\text{cav}} = 450 \text{ W}$



Green Fabry-Perot Cavity

Jefferson Lab, Syracuse U

- **Specification**

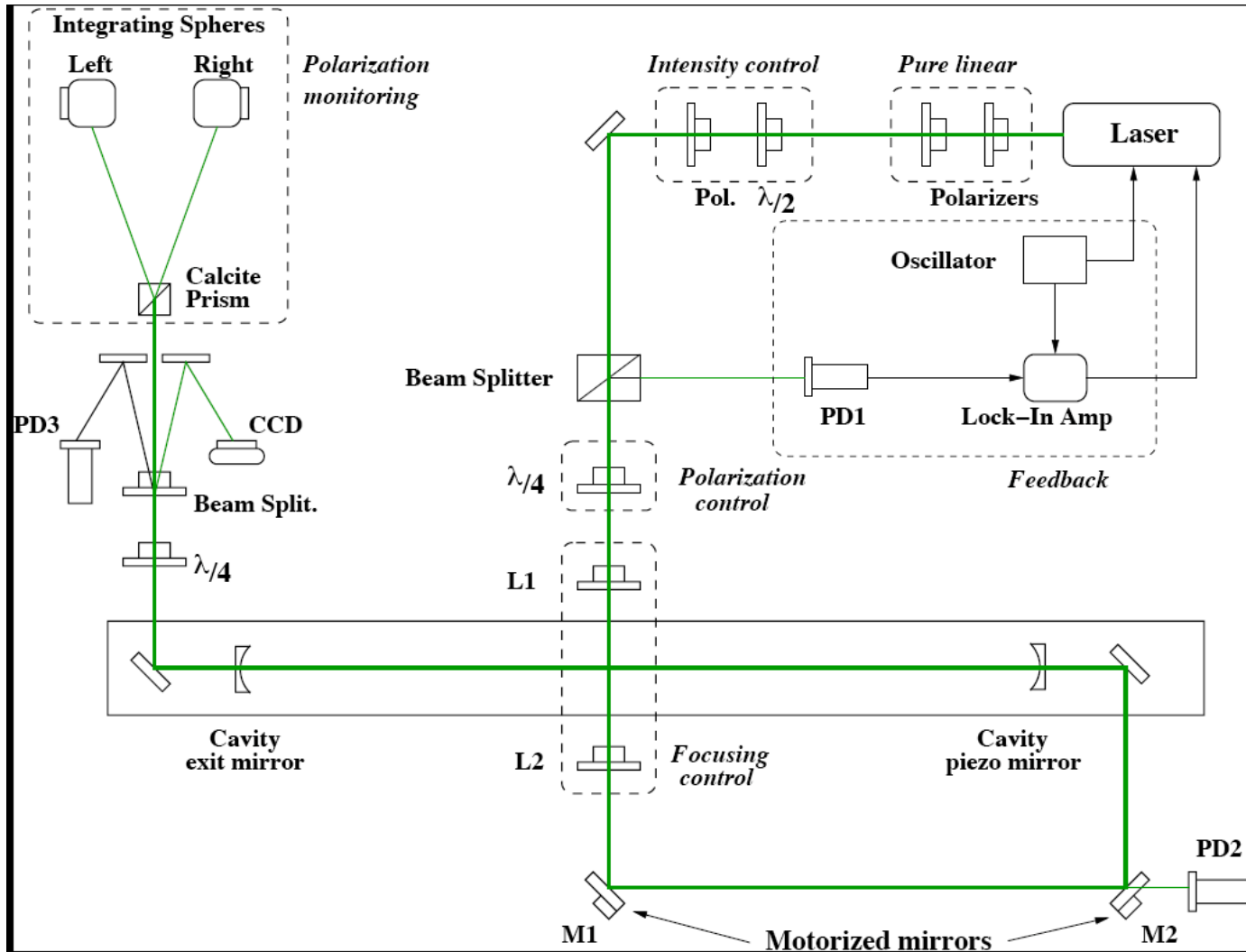
- Intra-cavity power 1.5 kW
- Time structure CW
- Wavelength 532 nm
- Mode TEM₀₀
- Waist size (σ) 65 μm

- **Solution**

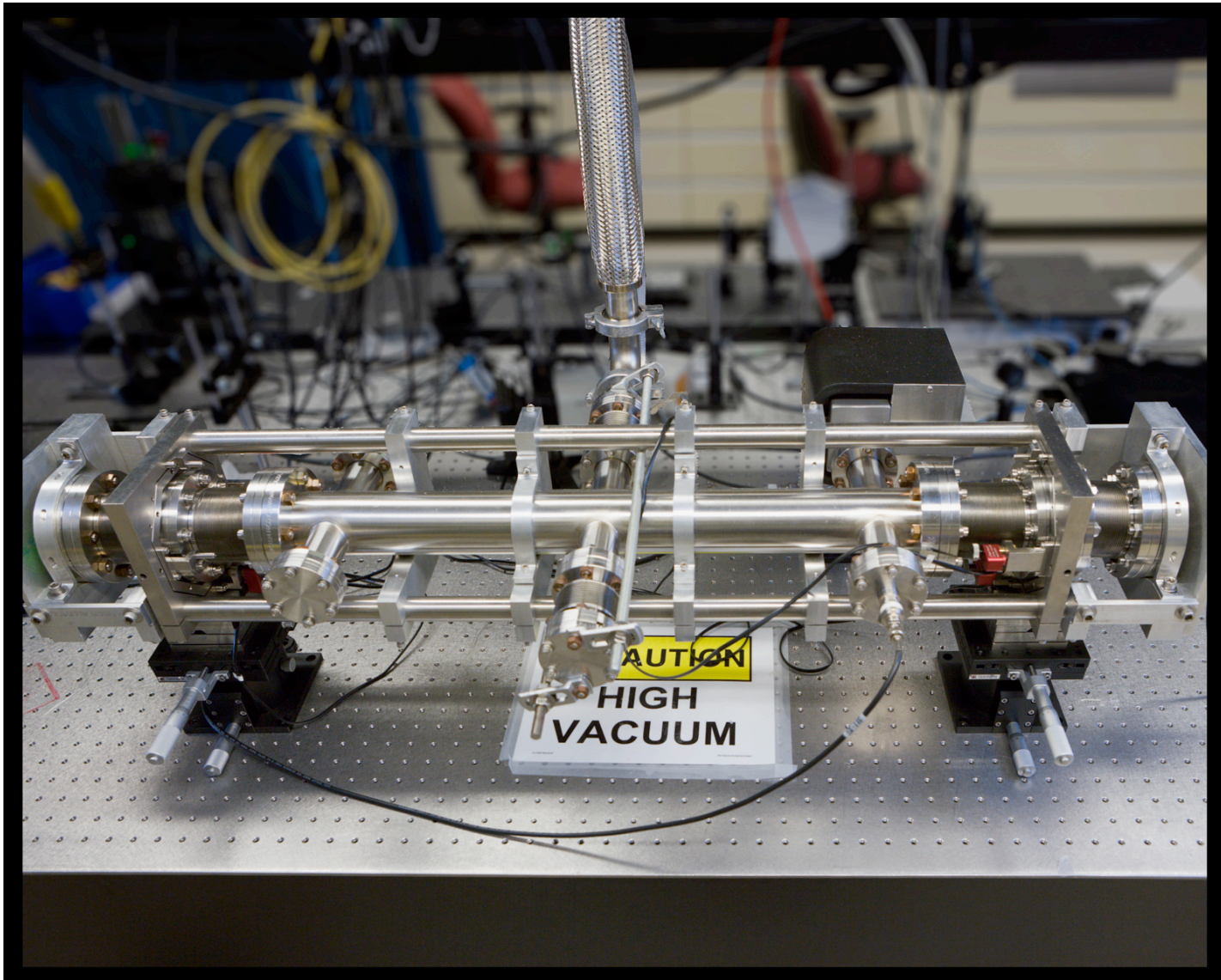
- IR seed laser + Ytterbium Fiber Amplifier + PPLN doubler -> FP Cavity
- PDH Feedback to seed laser for TEM₀₀ mode lock



Optical Setup



Cavity in the Compton Lab



Photograph: Alan Gavalya

Green Cavity Progress

- **Mechanical**

- Invar cavity with adjustable off axis gimbal mirror mounts
- Long term mechanical stability - excellent
- Ultra high vacuum capability demonstrated
- Cavity mount for beam line installation in design

- **Optical**

- New low loss mirrors from General Optics (GSI) perform!
- 180 +/- 20 W cavity power obtained with GSI-240 mirror and 100 mW Prometheus Green laser (Innolight)
- 3 Watts green power achieved with PPLN and fiber amplified IR pump seeded by Prometheus IR beam
- Successful lock acquired with amplified green beam
 - => **Up to 30x boost to cavity power**

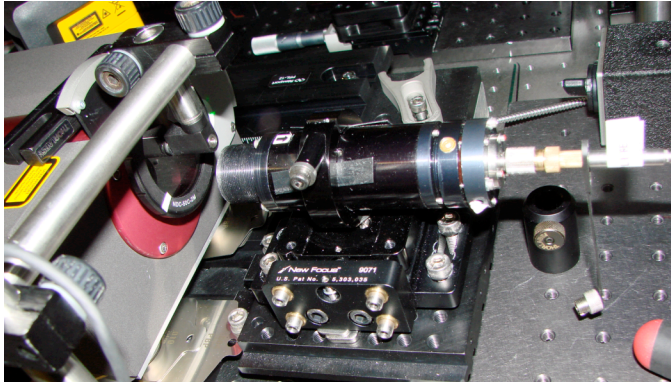
- **Electronics**

- Home-made cavity lock electronics design finalized.
- Previously observed oscillations in lock resolved
- Robust cavity locks achieved
- Final lock box in fabrication

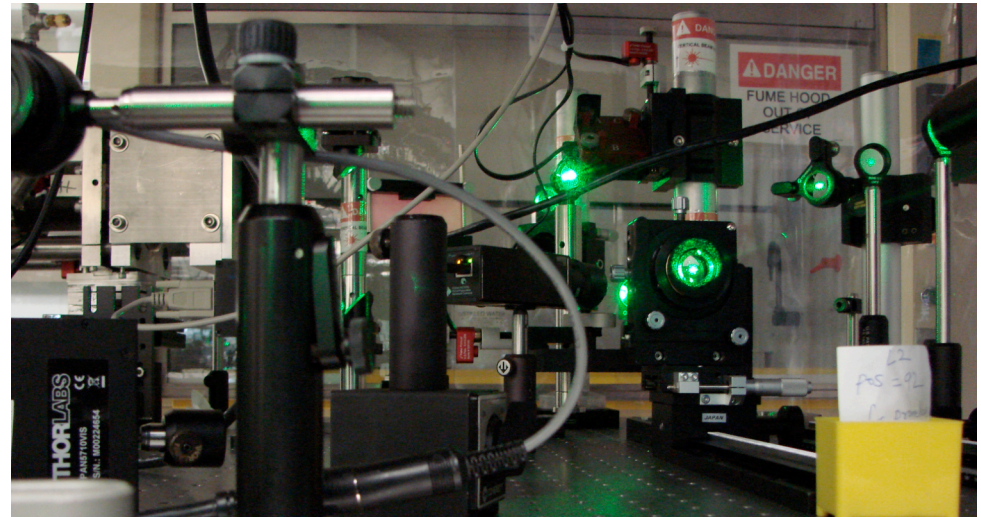
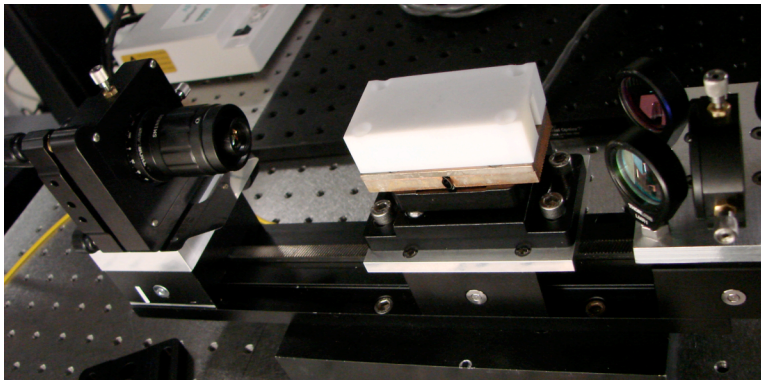


Optical setup with Amplified beam

- Prometheus IR Seed 10 mW, 1064 nm, 1kHz Line coupled to singlemode fiber, Amplified with IPG Ytterbium doped Fiber Amplifier



- Amplified IR beam Pumps PPLN Crystal producing .2 - 3W Green

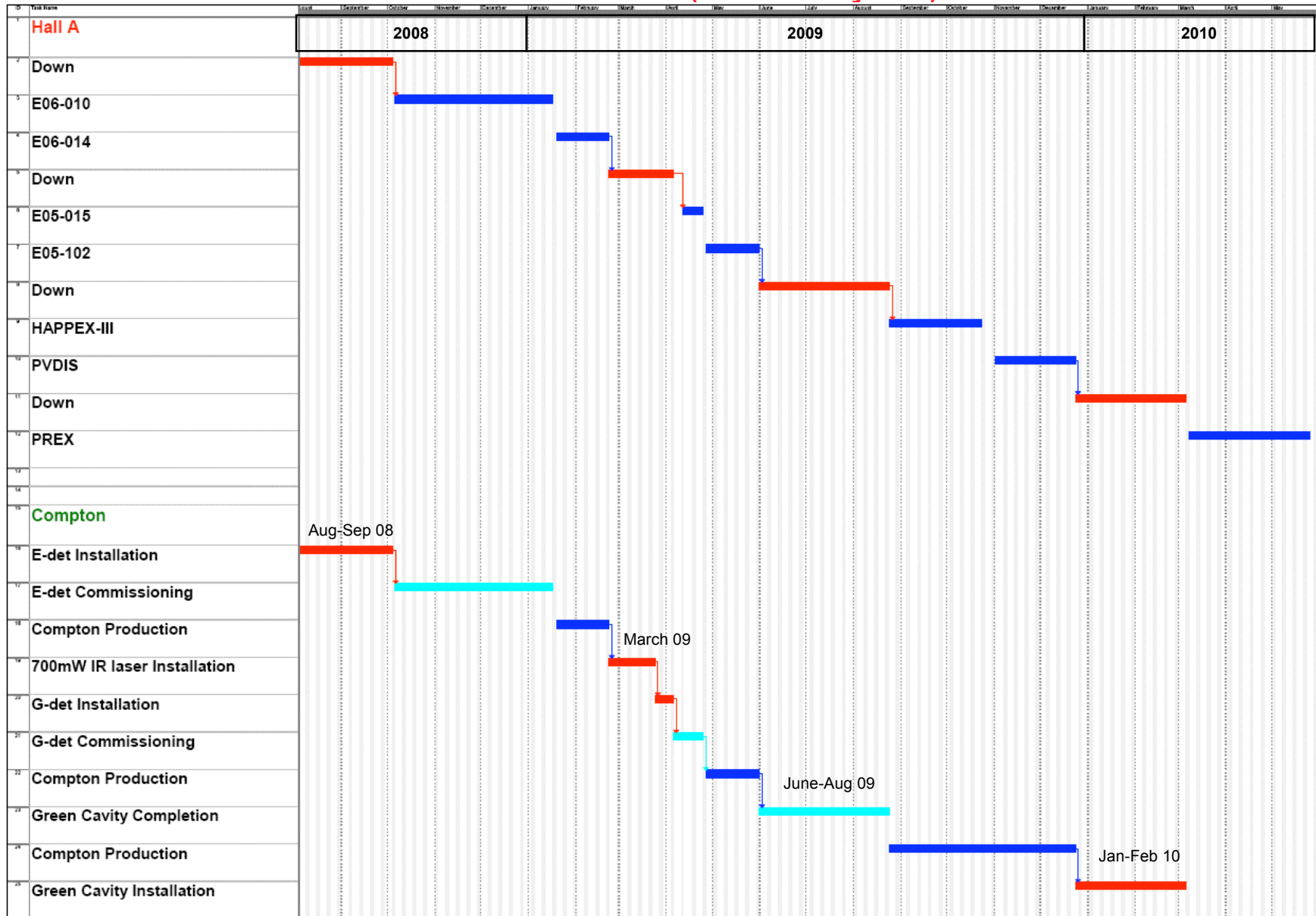


**First Lock Acquisition!
IR Laser -> Fiber Amp -> PPLN
-> Green FP Cavity**

(December 22, 2008, S Nanda)



Schedule (as of July 08)



Conclusion

- **IR cavity power boosted by 3x with new 700 mW Lightwave laser**
 - Will provide comfortable Compton signal/background margin for Happex III and PVDIS
- **Electron detector facing commissioning difficulties**
 - Stay tuned for further developments
- **GSO Photon detector commissioning successful, ahead of schedule**
- **Green FP cavity**
 - The new GSI-240 mirrors meet our objective
 - Locking electronics prototype validated, awaiting finished box
 - Cavity power of 180 W with .1W Prometheus green laser achieved
 - Lock acquisition with fiber amplification and PPLN successful
 - **Final design frozen:**
 - IR seed + Fiber amplifier + PPLN doubler -> FP Cavity
(Innolight) (IPG) (Home made) (GSI-240 mirrors/Invar Cavity)
 - KiloWatts level Intra-cavity power is feasible
- **Jan '10 installation of green cavity on track**

