Polarized Injector & Upgrade Schedule

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QWeak Collaboration Meeting
November 06, 2009

Outline

- Inverted Gun & Higher Voltage
- Electron Polarization Reversal
- Fast Helicity Reversal & New Helicity Board
- New QWeak IA Electronics
- Injector Commissioning & Optimization for QWeak

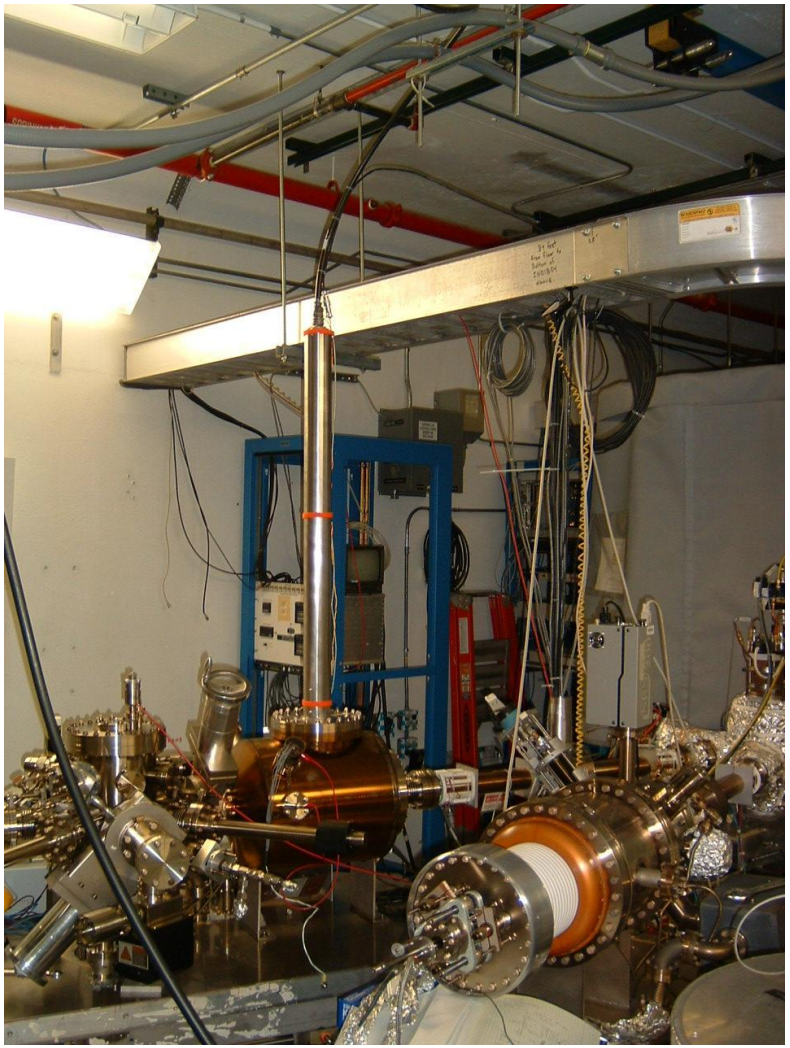
Parity Experiments Requirements

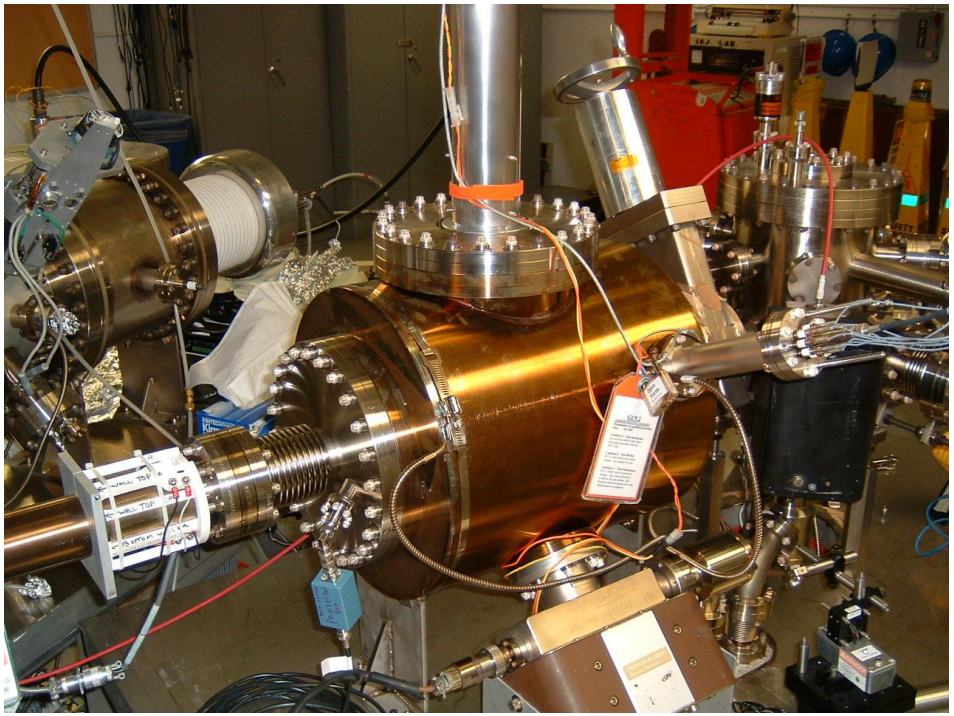
Experiment	Hall	Start	Energy (GeV)	Current (μA)	Target	A_{pv} (ppm)	Maximum Charge Asym (ppm)	Maximum Position Diff (nm)
HAPPEx-III (Achieved)	A	Aug 09	3.484	100	^{1}H (25 cm)	16.9±0.4	0.2±0.1	3±3
PVDIS	A	Oct 09	6.068	100	^{2}H (25 cm)	63±3	1±1	10±10
PREx	A	March 10	1.056	100	^{208}Pb (0.5 mm)	0.500±0.015	0.100±0.010	2±1
QWeak	C	May 10	1.162	180	^{1}H (35 cm)	0.234±0.005	0.100±0.010	2±1

Inverted Gun at CEBAF

- First Inverted Gun (with Stainless Steel electrode) installed at CEBAF, operational since July 23, 2009
- Running at 100 kV. Conditioned to 110 kV
- Lifetime about 75 C at 130 μA average current
  - 2 weeks between spot moves, 2-3 months between heat/activations
- HAPPEx-III, PVDIS, and PREx: 100 kV. QWeak: >100 kV
- Maximum possible Gun Voltage is 150 kV (limited by Safety System and HV Power Supply)


DuPont
Tyvek
DuPont
Tyvek





Inverted Gun at Test Cave & Higher Voltage

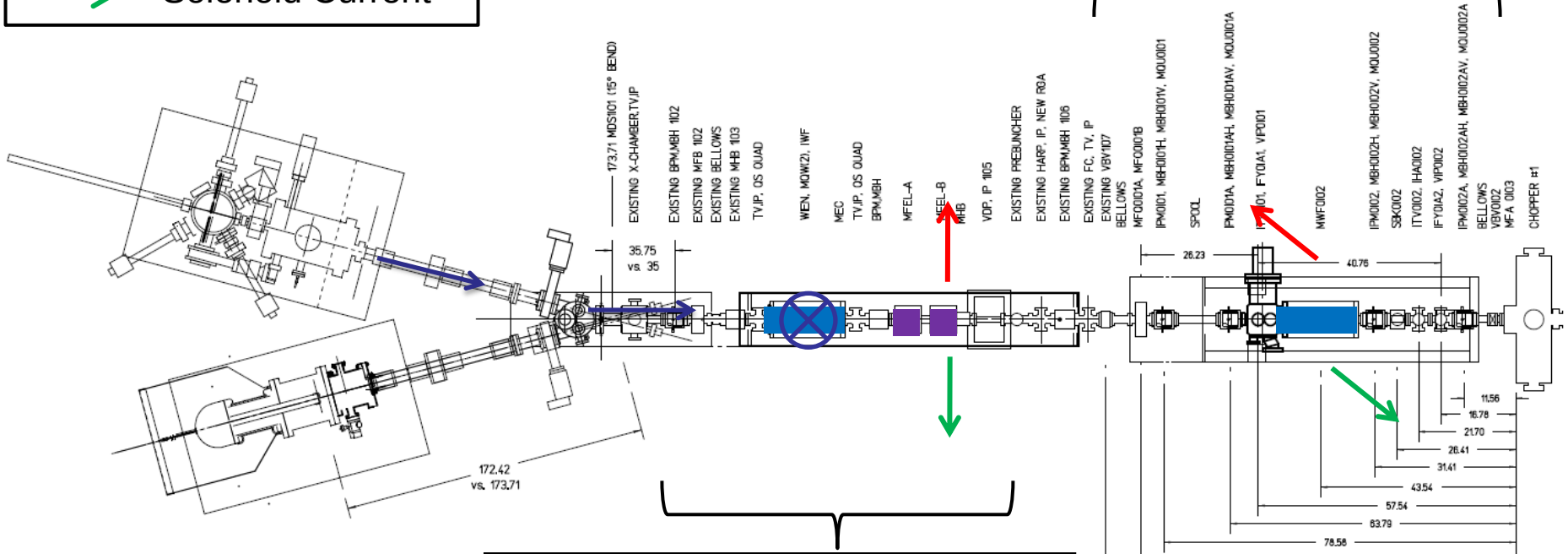
- Second Inverted Gun (with Nb electrode) will be installed at Test Cave by mid November
- Condition to 150 kV by end of November
- Run beam and measure lifetime at >100 kV by Christmas
- Reminder: still need to test the CEBAF injector up to 150 keV for compatibility with higher voltage gun, mainly warm RF: PreBuncher, Chopper, Buncher, Capture.

Injector Test Cave

Electron Polarization Reversal

+ Solenoid Current
- Solenoid Current

"Long. Pol. for Halls"
Horizontal Wien = -90° → +90°



"Spin Flipper"
Vertical Wien = 90°
Two Solenoids 2(+/- 45) = ± 90°

- **Helicity reversal using one Wien Filter and Two Solenoids:**

I. **New optics design with new quadrupoles to maintain constant Injector configuration**

II. **Cancels all helicity-correlated beam asymmetries from laser and photocathode**

III. **Can be used up to maximum Gun Voltage of 140 kV**

IV. **Install in Jan 2010. Commission basic beamline in Feb 2010. Commission reversal at 100 kV at start of PREx**

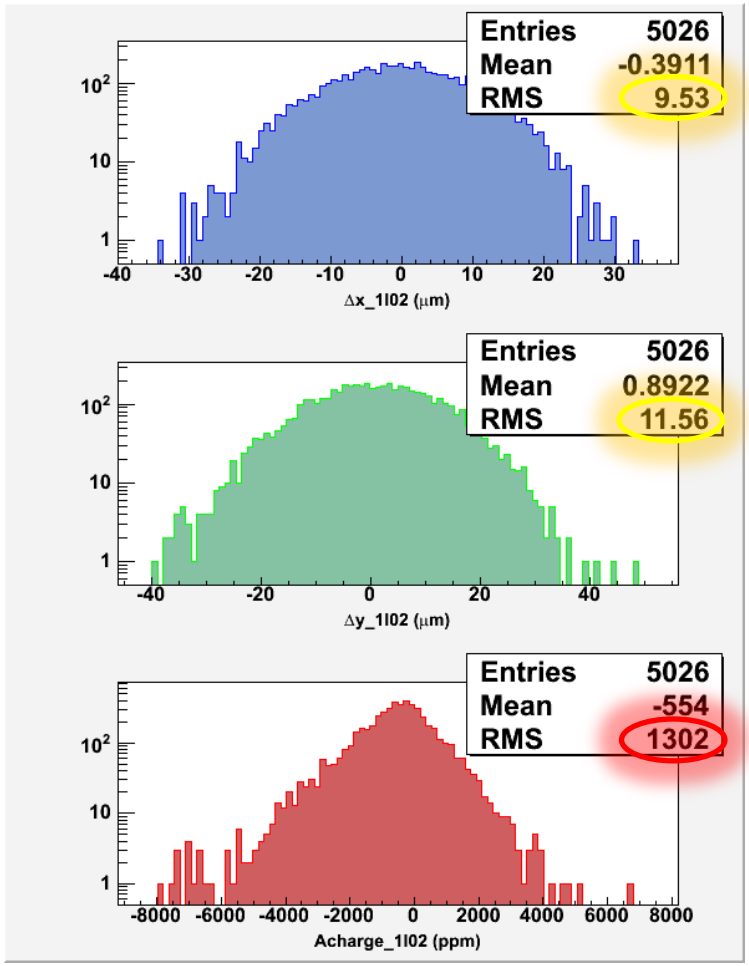
V. **More diagnostic to commission and operate the beamline: 1 new harp, 1 new viewer, new vacuum gauges, new UHV ion supplies and two new BPMs with LINAC IF and S/H cards (Need to add to QWeak DAQ)**

Fast Helicity Reversal

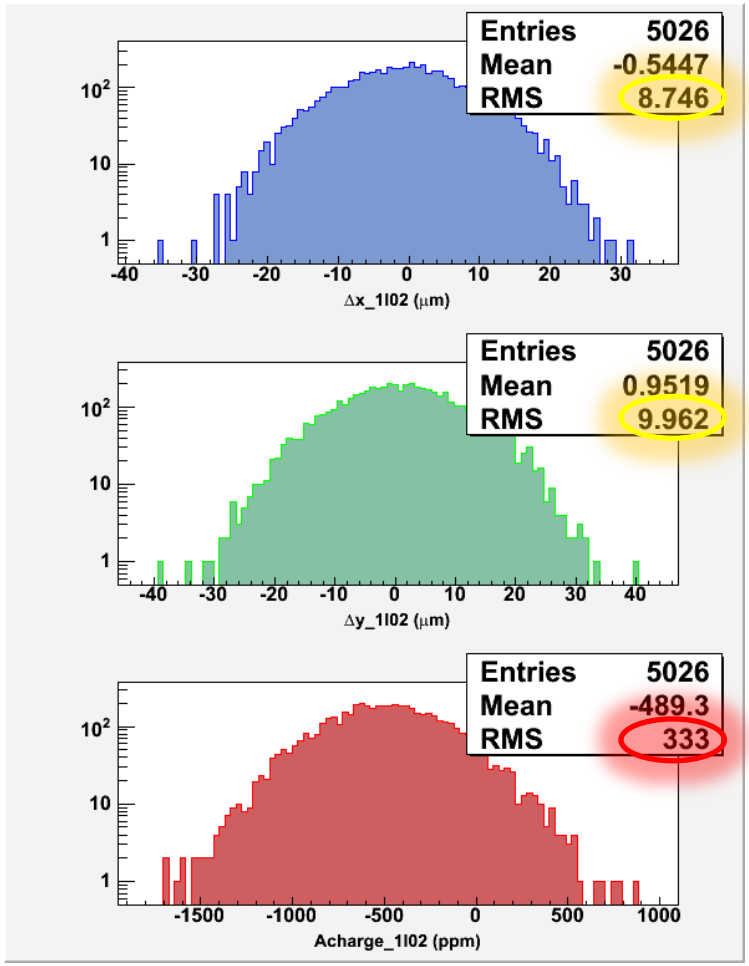
- **Summary of Fast Helicity Reversal Studies:**
  - **Reduces noise on beam current by factor of 4**
  - **Reasonable reduction in beam position noise**
  - **Achieved Pockels Cell T_Settle of 60 μs**
  - **Will reduce noise from QWeak target density fluctuations**

- **Requirements:**

Experiment	Rate	Clock	Pattern
HAPPEx III & PVDIS	30 Hz	Free	Quartet
PREx	240 Hz	Line-Locked	Octet
QWeak (Preliminary)	1 kHz	Free	Quartet



30 Hz, T_Stable = 33.333 ms,
T_Settle = 500 μs



1 kHz, T_Stable = 0.980 ms,
T_Settle = 60 μs

New Helicity Board

- **New Helicity Board installed on Nov 2, 2009**
- **Features:**
  - **Transition to T-Settle will start 1 μs before all other signals**
  - **30-bit Pseudo-random Shift Register**
  - **Patterns: Toggle, Pair, Quartet, Octet**
  - **T-Settle: 10 μs – 1,000 μs**
  - **Clock:**
    I. **Line-Locked: Helicity Reversal of 30 Hz, 120 Hz, or 240 Hz**
    II. **Free: T-Stable of 400 μs – 1,000,000 μs**
- **More Fiber Outputs:**
  - **Real Time Helicity:**
    I. **Standard: Pockels Cell & IAs**
    II. **Complementary: Helicity Magnets**
  - **20 MHz board internal clock**
  - **Two outputs indicate current and previous helicity patterns to QWeak IA**

QWeak New IA Electronics

- Charge Feedback using Intensity Attenuator (IA) with the option to correct for Pockels Cell hysteresis
- Use Fast EPICS to communicate with the IA
- Use 16-bit ADC and 16-bit DAC
- Hardware to be installed in Jan 2010
- Commission during QWeak in May 2010

Injector Commissioning & Optimization

- **Coordinator: Suleiman**
- **Members: Poelker, Grames, Hansknecht, King, Carlini, Paschke, Ramsay**
- **Plan:**

  - **Higher Voltage:**
    I. **Gun: Dec 2009, Test Cave**
    II. **CEBAF Beamline: May 2010**
  - **Electron Polarization Reversal: Commission at 100 kV during PREx, >100 kV in May 2010**
  - **New Helicity Board: Commission during PREx**
    I. **QWeak Pattern: May 2010**
    II. **QWeak Reversal Rate: May 2010**
  - **New IA (Charge Feedback): May 2010 (need analysis support)**