Polarized Injector Status

P. Adderley, J. Clark, J. Grames, J. Hansknecht, M. Poelker, M. Stutzman, R. Suleiman, K. Surles-Law

QWeak Collaboration Meeting
February 1, 2010
Outline

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

- Second Inverted Gun (with Nb electrode) installed at Test Cave by in November 2009
- Conditioned to 150 kV (no vacuum activities, small FE)
- Measured lifetime at 100 kV
- Will measure lifetime at 140 kV this week
- 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.
<table>
<thead>
<tr>
<th>HV (kV)</th>
<th>FE (pA)</th>
<th>Radiation (mR/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>135</td>
<td>-0.1</td>
<td>0.07</td>
</tr>
<tr>
<td>140</td>
<td>-0.6</td>
<td>0.20</td>
</tr>
<tr>
<td>145</td>
<td>-1.4</td>
<td>0.45</td>
</tr>
<tr>
<td>150</td>
<td>-3.1</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Electron Polarization Reversal

- "Spin Flipper"
  - Vertical Wien = 90 deg
  - Two Solenoids = ±90 deg

- "Longitudinal Polarization"
  - Horizontal Wien = {-90 … +90}

From Gun
- FLIP - LEFT
- FLIP - RIGHT
### 4 Most Important Configurations

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Vertical Wien (MWF1I04)</th>
<th>Two Solenoids (MFG1I04A/B)</th>
<th>Horizontal Wien (MWF0I02)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO FLIP (old method)</td>
<td>0 deg</td>
<td>0 deg</td>
<td>+43 deg</td>
</tr>
<tr>
<td>VERTICAL POL</td>
<td>90 deg</td>
<td>0 deg</td>
<td>+0 deg</td>
</tr>
<tr>
<td>FLIP - LEFT</td>
<td>90 deg</td>
<td>-90 deg</td>
<td>-47 deg</td>
</tr>
<tr>
<td>FLIP - RIGHT</td>
<td>90 deg</td>
<td>+90 deg</td>
<td>-47 deg</td>
</tr>
</tbody>
</table>

**Some facts...**

- “Spin Flipping” is accomplished without changing Wien filters
- Vertical Polarization is a “subset” of “Spin Flipper” operation
- “Old Method” achieved by turning Vertical Wien off
- Ability to uniquely define spin in $4\pi$
Functionality of spin controls – operate to 140 keV
January 27, 2010

Region 1 Girder – “Spin Flipper”
January 27, 2010

Region 2 Girder – “A1/A2 + Horizontal Wien Filter”
Fast Helicity Reversal

- **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:
    1. Line-Locked: Helicity Reversal of 30 Hz, 120 Hz, or 240 Hz
    2. Free: T-Stable of 400 µs – 1,000,000 µs
- **More Fiber Outputs:**
  - Real Time Helicity:
    1. Standard: Pockels Cell & IAs
    2. Complementary: Helicity Magnets
  - 20 MHz board internal clock
  - Two outputs indicate current and previous helicity patterns to QWeak IA
<table>
<thead>
<tr>
<th>Experiment</th>
<th>Rate</th>
<th>Clock</th>
<th>Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAPPEx III &amp; PVDIS</td>
<td>30 Hz</td>
<td>Free</td>
<td>Quartet</td>
</tr>
<tr>
<td>PREx (Preliminary)</td>
<td>240 Hz</td>
<td>Line-Locked</td>
<td>Octet</td>
</tr>
<tr>
<td>QWeak (Preliminary)</td>
<td>1 kHz</td>
<td>Free</td>
<td>Quartet</td>
</tr>
</tbody>
</table>
Helicity Control Board

When Configuration is changed please contact Scott Higgins to set new configuration as default

<table>
<thead>
<tr>
<th>CONTROL</th>
<th>MONITOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode</td>
<td>Free Clock</td>
</tr>
<tr>
<td>T-SETTLE Input 1</td>
<td>60 usec</td>
</tr>
<tr>
<td>T-SETTLE Input 2</td>
<td></td>
</tr>
<tr>
<td>T-STABLE Input 1</td>
<td>900 usec</td>
</tr>
<tr>
<td>T-STABLE Input 2</td>
<td></td>
</tr>
<tr>
<td>Helicity Pattern</td>
<td>Quartet</td>
</tr>
<tr>
<td>Reporting Delay</td>
<td>8 windows</td>
</tr>
<tr>
<td>Helicity Board Frequency</td>
<td>1041.67</td>
</tr>
</tbody>
</table>

Hardware Rev: MONTH 12 DAY 11 YEAR 3
User Guide

T_Settle
Pair Sync
Pat Sync
Del Hel
Coupling DC

Tek Trig’d M Pos: 0.000s
CH1 500mV CH2 500mV M 1.00ms CH3 500mV CH4 500mV RefB 1.00V 500.us
990.115Hz

Thomas Jefferson National Accelerator Facility
QWeak New IA Electronics

- Hardware to be installed in Feb 2010
- Commission during QWeak in May 2010
Injectors Commissioning & Optimization

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

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