Jefferson Lab
Polarized Source

Maud Baylac

International Workshop on Parity Violation
Mainz, Germany
June 5-8, 2002
Three user groups receive simultaneously high polarization beam

- $P_e : 70$ to $80\%$
- $I : \text{up to } 100\, \mu A$

Two guns at injector
- one for production
- one for spare

Presently, both guns operational with long lifetime
Lifetime (1/e)

- Low current (< 100 uA): $T \sim 600 \, \text{C}$
  beam to 3 halls for 3 months with one single activation

- High current (< 200 uA): $T \sim 300 \, \text{C}$
  uninterrupted beam for 3 weeks

- One year with only 3 activations!
Lasers

- **Diode** (gain switched, laser amplifier)
  - easy, low maintenance, reliable
  - low noise ~ 0.1% @ 30 Hz
  - low power < 100 mW
  - DC light => leakage
  - Original vendor SDL quit selling amps
  - Currently testing amps from new vendor Toptica

*used for low current & high polarization experiments*
*high current & low polarization experiments*
Lasers (cont.)

• **Homebuilt TiSap:**
  
  active mode-locking using seed light from gain switched diode laser
  
  high power ~ 300 mW
  
  wavelength adjustable
  
  high maintenance
  
  noisy ~ 1% @ 30 Hz

---

*used for high current & high polarization experiments*
Present setup

future
499 MHz
TiSap
How we manage helicity correlations

✓ **Charge asymmetry**
  - Pockels cell *(circular light and correction)*
  - Rotatable $\lambda/2$-plate *(correction)*
  - Seed laser power modulation *(correction)*

✓ **Position differences**
  - Piezo-driven X/Y mirror *(testing only)*

✓ **Overall systematics**
  - Insertable $\lambda/2$-plate *(systematic reversal)*
Present HC control knobs
# Charge asymmetry results

<table>
<thead>
<tr>
<th>Experiments</th>
<th>Charge asymmetry (ppm) per physics run</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hall B</td>
<td>w/o TACO: &lt; 2000 w/ TACO: &lt; 500</td>
</tr>
<tr>
<td>GEn</td>
<td>TACO: &lt; 1000</td>
</tr>
<tr>
<td>GEp</td>
<td></td>
</tr>
<tr>
<td>GDH</td>
<td>RWP: 300 to 1000</td>
</tr>
<tr>
<td>g2n</td>
<td>RWP: &lt; 50</td>
</tr>
</tbody>
</table>
Managing HC asymmetries for future experiments

- Minimize HC effects on three beams simultaneously
  - independent knobs: TACO
    IA
    PZT

- High current, high polarization experiments require TiSa

Homebuilt lasers have produced noisy beam compared to diode lasers

⇒ improve TiSap lasers
Intensity feedback: IA

Use a low voltage Pockels cell for intensity modulation.

Requirements:
• independent control
• stable & sufficient gain
• low insertion loss
• low cell voltage
• compact footprint

(Tsentalovich, BATES)
New IA cell

- Operated in lab
- \(\frac{d \Delta^Y_i}{d V} \approx 30 \text{ ppm/V}\)
- Installed in tunnel on May 29
- Will be tested on machine in June

Should provide \(\sim 0.1 \text{ ppm level control}\)
Position Feedback

- Mirror on a fast PZT driven stage for HC position control
- Present setup:
  - common mirror ~0.1 m before the PC
  - new mirror for hall A only (May, 27)

Doubles the moment arm to cathode, but also increases distance to the PC to ~1 m

Will be tested in hall A
Could be installed this summer for hall C
G0 experiment

• Time structure
  
  31.2 MHz versus standard 499 MHz

• Modest average current, but high peak current
  
  40 uA @ 31.2 MHz is like transporting 640 uA @ 499 MHz
  
  ie: $8 \times 10^6$ e$^-$/bunch
  
  ⇒ beam optics issues

• Parity quality beam

• Two other halls running simultaneously

  success ⇒ mode-locked TiSa Laser
Latest News

• Homebuilt diode seeded TiSap

• Five-fold cavity : L~ 5m

• Tested in lab: FWHM ~ 150 ps

• Installed in tunnel on May 27

40 uA of beam to end of injector!!
Commercial G0 Laser

• Time-Bandwidth Products (Switzerland), http://www.tbwp.com/

• **TIGER** Laser, with internal pump

• **SESAM** passive mode-locking technique, better than ours?

• Customized

  70 ps pulses
  31 MHZ rep rate
  < 1% amplitude noise RMS
  1 ps timing jitter
  tunable wavelength, centered at 840 nm
  output power ~ 250 mW

• TBWP may build a 499 MHz laser for HAPPEX 2, etc …
Conclusions

✓ Our guns deliver high current beam with long lifetime

✓ 2002-2003: high profile year for parity violation experiments at JLab (HAPPEx 2, G0)

♦ TiSap:
  laser from TBWP may solve noisy beam problem

♦ Helicity Correlated asymmetries:
  independent knobs are being installed & tested

✓ This coming period will help us prepare the future of parity violation at JLab
Outlooks

✓ Research program: QE, Pe always higher

✓ High polarization cathodes with lower, or no analyzing power

✓ Modulation on each beam to provide independent asymmetry measurement at the injector

✓ DC gun:

use cheap “clean” high power DC diode lasers rather than “noisy” TiSap lasers

✓ Kerr cell?