HAPPEX Source Configuration Plan

Lisa Kaufman

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Summary of Laser Room and Injector Studies

Laser Room Studies

- Birefringence gradients and steering from Pockels cells are significant sources of position differences

Injector Beam Studies

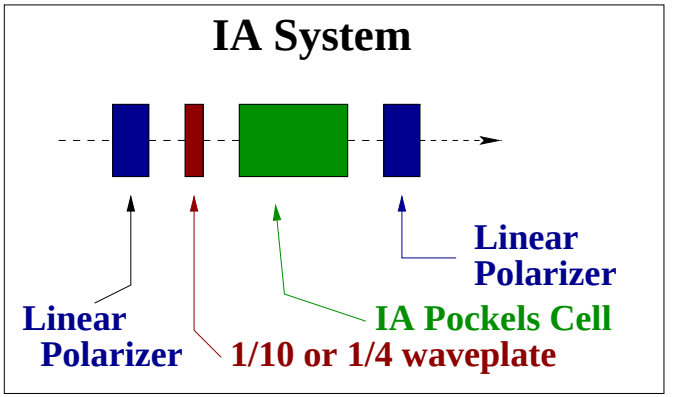
- Steering and vacuum window effects are small
- Cathode gradients are small
- Phase gradients of Pockels cell are large
- IA cell induces position differences ≤ 0.5 nm/ppm

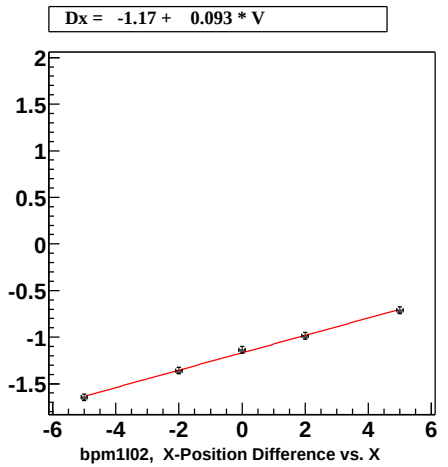
Results depend on quality of optics and their alignment!

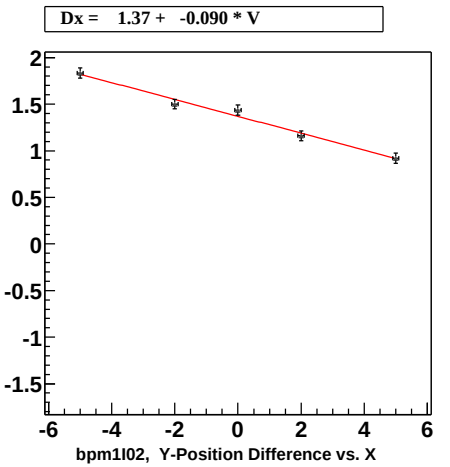
Laser Table Optics

- IA system
- Insertable half-wave plate (IHWP)
- CP Pockels cell
- Rotatable half-wave plate (RHWP)
- Vacuum window
- Cathode

Intensity Attenuator (IA) System







Position Differences (μm) vs. IA setpoint

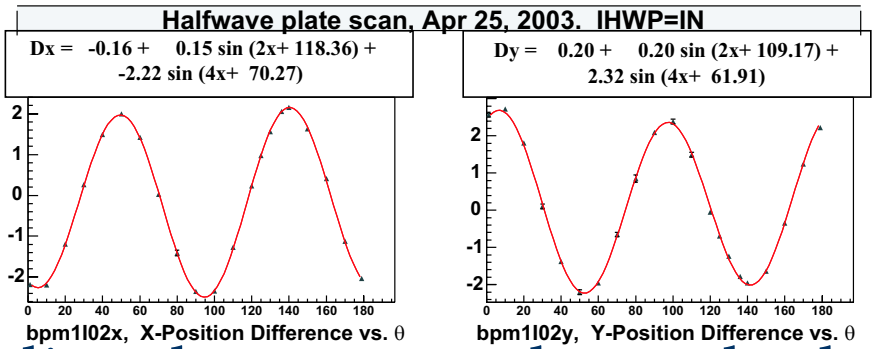
$$\frac{dA_Q}{dV} \sim 190\,\frac{\text{ppm}}{\text{V}};\ \frac{d(\Delta x)}{dV} = 90\,\frac{\text{nm}}{\text{V}} \Rightarrow 0.5\,\frac{\text{nm}}{\text{ppm}}$$

IA Alignment

- Careful alignment of IA system is necessary in order to reduce position differences induced when correcting A_Q
- Dynamic range of IA system is determined with IA waveplate angle
- Study of IA induced position differences and IA alignment will be done in laser room

Circular Polarizer (CP) Pockels Cell

- Injector studies' RHWP scans imply that PC birefringence gradients are large compared to vacuum window gradients and PC steering



- Injector studies also suggest that cathode gradients are small compared to PC gradients
- Using Arwen ⇒ position differences from PC birefringence gradients are half as large as those from PC steering

CP Pockels Cell Alignment

- Align PC using isogyre and crossed polarizers to insure good alignment along optic axis (pitch and yaw)
- Use spinning linear polarizer (SLP) to set roll and quarter-wave voltages such that
  $\mathrm{DoLP} \leq 2.5\ \% \implies \mathrm{DoCP} \geq 99.97\ \%$
- Iterative x and y translation scans in order to find geometric center of cell in order to reduce position differences due to steering
- Measure birefringence gradient around center of PC

Imaging Lens(es)

- Imaging reduces the effective lever arm from the PC to the cathode reducing PC steering effects
- Install lens(es) such that:
  - Spotsize on cathode $\sim 450\ \mu$m
  - Small beamspot through vacuum window
  - All lenses must be placed within first 60 cm after PC

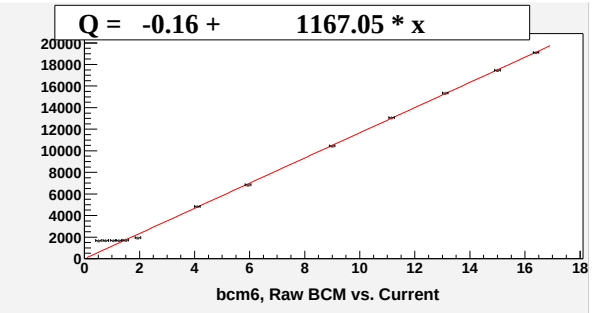
Injector Beam Tests

- BCM and BPM pedestal calibration
- Transmission through injector
- IA calibration
- RHWP setpoints for both IHWP states

BCM and BPM Pedestal Calibration

Current calibration

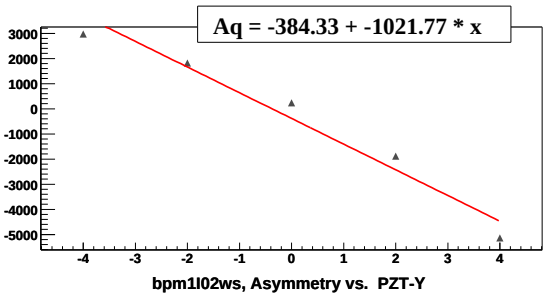
- Take data at several different beam currents
- Measure beam current using EPICS readback of Faraday cup #2

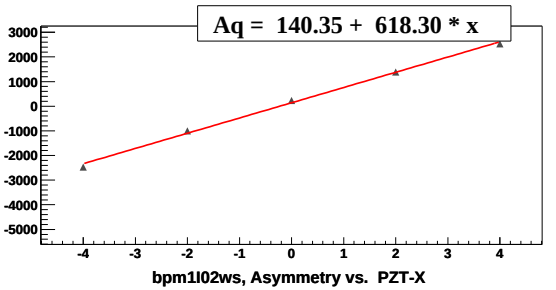


- Intercept of linear fit for current > 4 μA determines effective pedestal for monitor

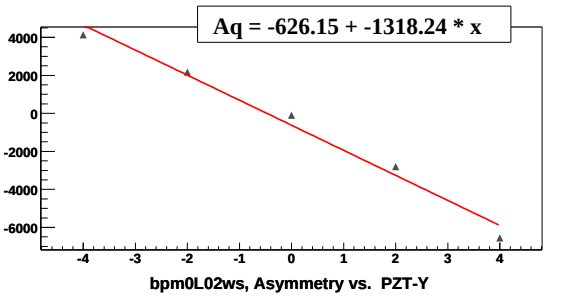
Transmission through Injector

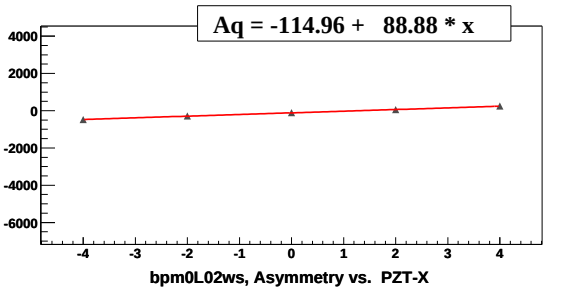
Helicity-correlated A_Q for PZT X and Y scans





100 keV injector region



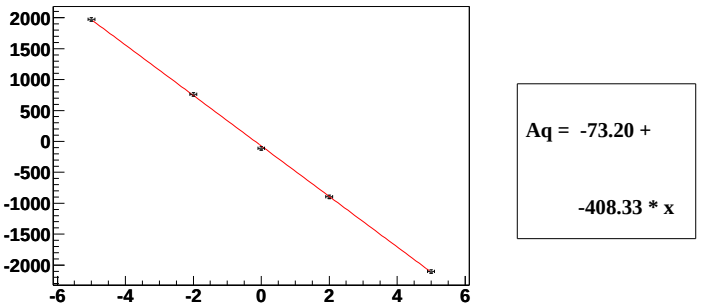


5 MeV injector region

Transmission through the injector needs to be high such that helicity-correlated parameters are not affected!

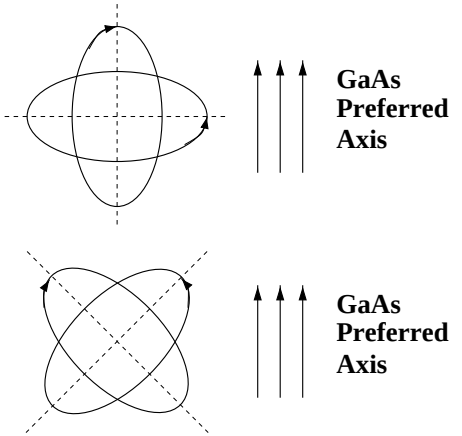
IA Calibration

- Measure A_Q as a function of IA voltage
- Measure position differences induced by IA system
- Tune IA slope with rotation of waveplate



Criteria for RHWP Setpoints

Residual linear polarization interacting with GaAs preferred axis.



- Small A_Q in each IHWP state
- Small but not negligible PITA slope
- Small position differences in each IHWP state
- Small average position differences after IHWP cancellation

Choosing RHWP Setpoints

- PITA scan to measure proportionality between PITA slope and outer A_Q peak separation
- RHWP scans for each IHWP state
- Determine PITA slope at each RHWP angle
- RHWP scans for each IHWP state zeroing A_Q at every angle
- After choosing RHWP setpoints:
  - Verify PITA slope small
  - Set PC voltages to zero A_Q
  - Verify position difference sensitivity

How long will it take?

Laser Table Optics Setup

- 2 shifts during maintenance period
- procedures practiced in laser room

Injector Beam Tests

- test plan to be written and submitted
- 2 shifts of beam studies expected
- source setup results from April beam studies available as HAPPEX tech note

Polarized Source Group - Thank you!