Laser Room Studies: Position Differences

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Precision of Position Differences

HAPPEX-H

- Run averaged $\Delta x \leq 2\,\text{nm}$
- One day (slug) average $\Delta x < 15\,\text{nm}$

HAPPEX-He

- Run averaged $\Delta x \leq 3\,\text{nm}$
- One day (slug) average $\Delta x < 23\,\text{nm}$

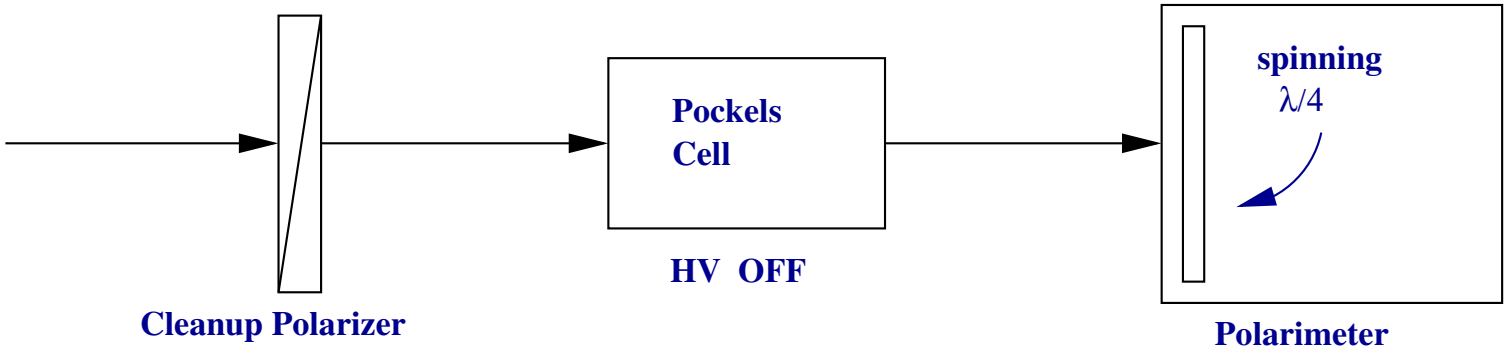
Sources of Position Differences

1. Birefringence gradients of Pockels cells
2. Steering from Pockels cells
3. Cathode gradients
4. IA cell coupling

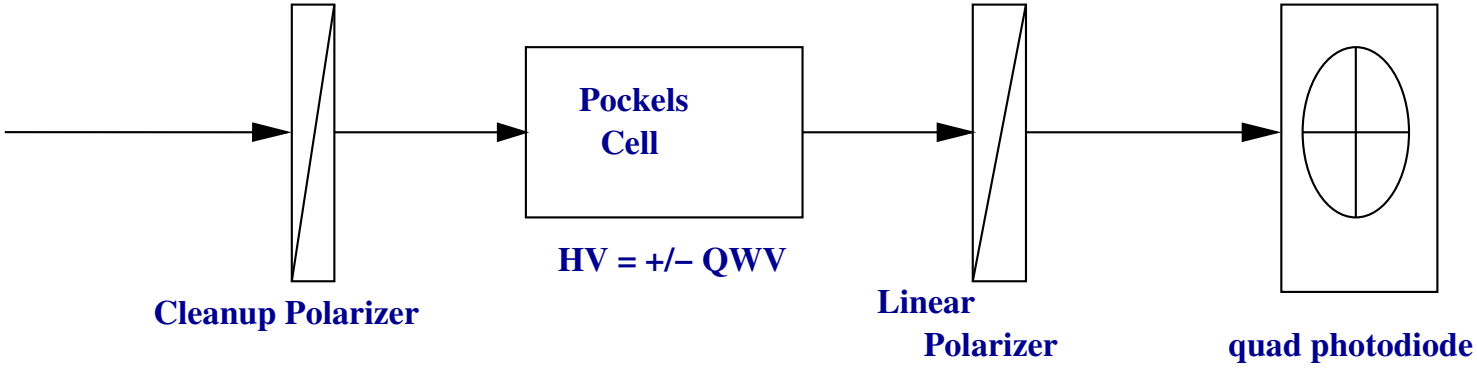
$\Longrightarrow$ Pockels cells are the largest sources of position differences.

Measuring Birefringence Gradients: 2 Methods

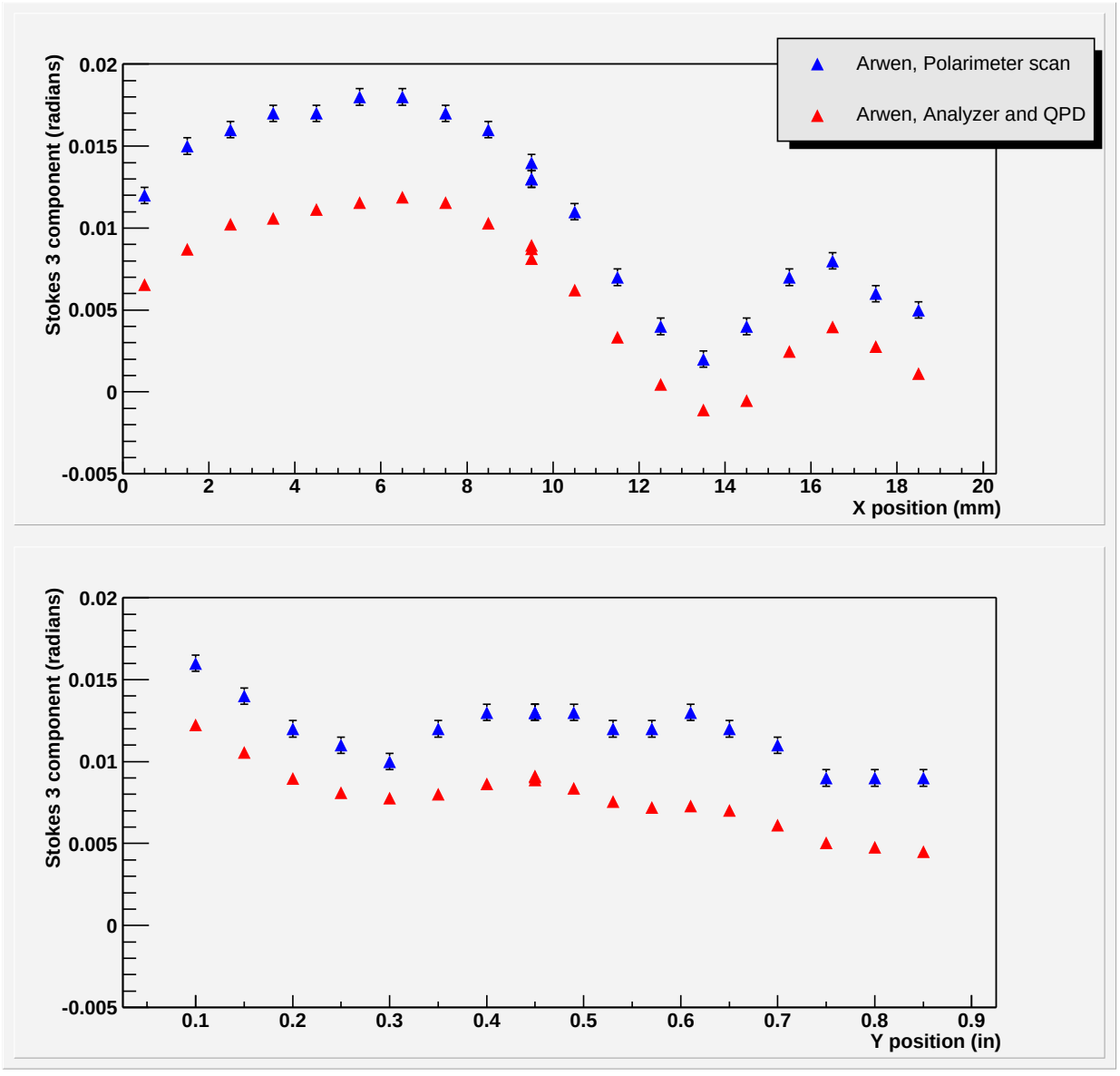
1st method



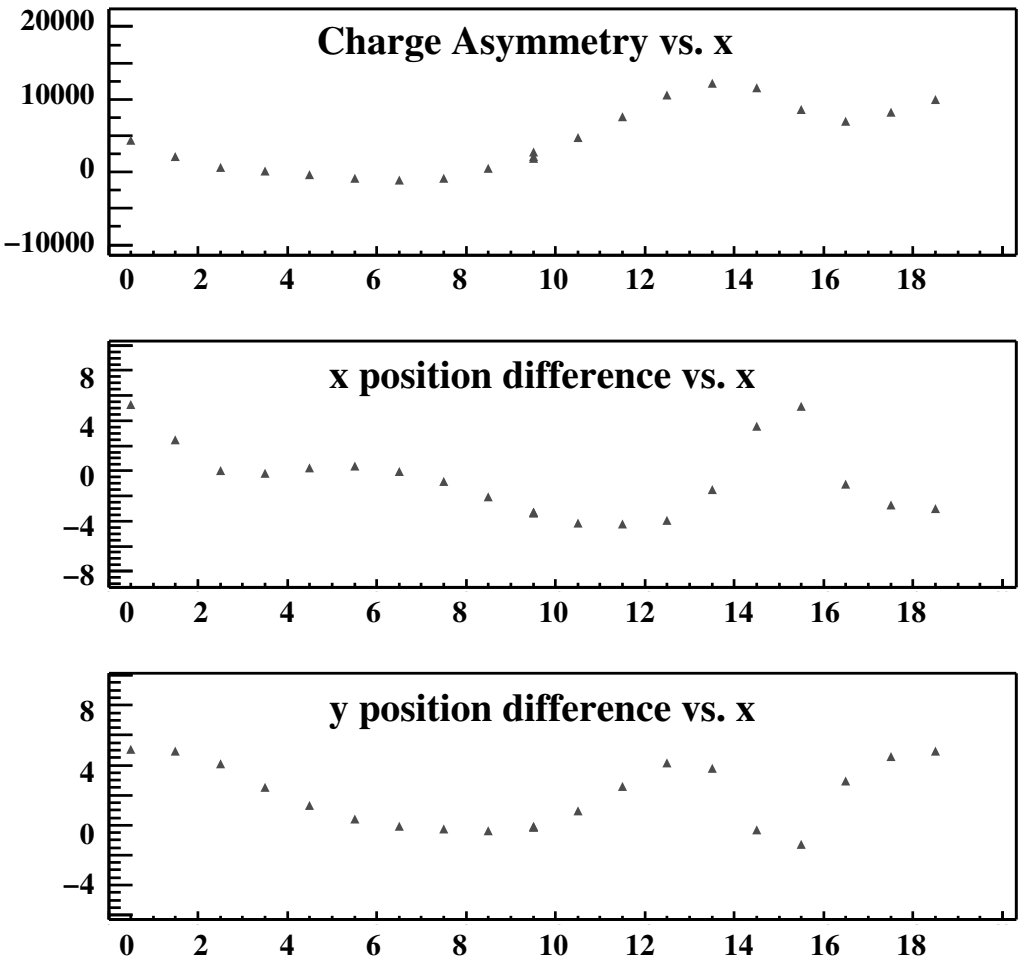
2nd method



Arwen Birefringence Gradient Measurement

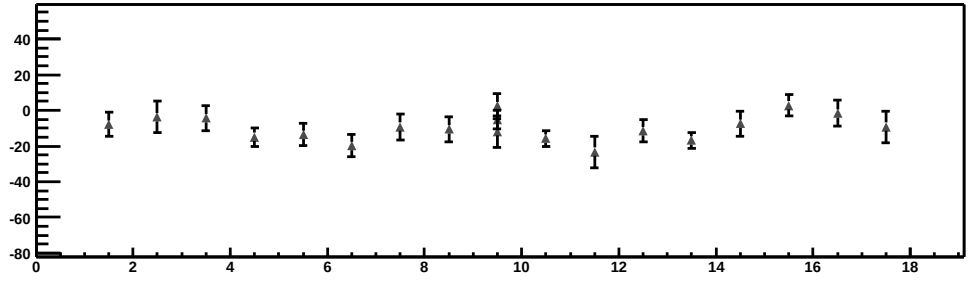


Position Differences due to Birefringence Gradients

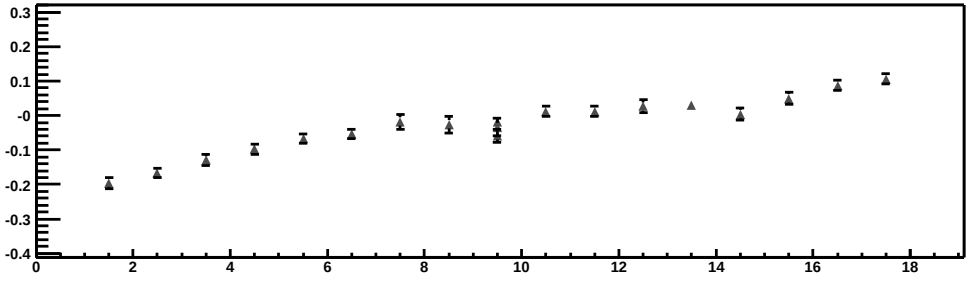


Steering

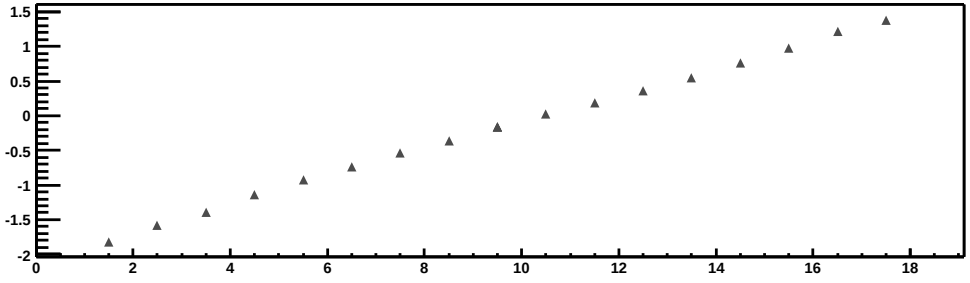
Arwen trans X scan, Ana OUT, Run 1825



qpd1sum, Asymmetry vs. X



qpd1x, X-Position Difference vs. X



qpd1y, Y-Position Difference vs. X

Summary of Pockels Cell Characterization

Pockels Cell	A_Q grad	Δx from grad	Steering
Merry	$\frac{1.6\%}{\text{mm}}$	< 30 μm	< 4 μm
Gimli	$\frac{0.34\%}{\text{mm}}$	N/M	N/M
Arwen	$\frac{0.25\%}{\text{mm}}$	< 6 μm	< 2 μm
TX	$\frac{1.4\%}{\text{mm}}$	< 10 μm	< 1.5 μm

Position Differences Expected in Injector with Arwen

- **Birefringence gradients of Pockels cells**

  Estimate PITA slope $\leq$ 30 ppm/V
  $\Delta x \leq 275$ nm

- **Steering from Pockels cells**

  $\Delta x \leq 300$ nm at lever arm of 1 m
  $\Longrightarrow$ $\Delta x \leq 600$ nm at lever arm of 1.7 m in injector

- **Cathode Gradients**

  $\sim$ 0.5 nm/ppm
  control A_Q contributions $\leq$ 100 ppm $\Longrightarrow$ $\Delta x \leq 50$ nm

- **IA cell coupling**

  $\leq$ 0.5nm/ppm
  control A_Q contributions $\leq$ 100 ppm $\Longrightarrow$ $\Delta x \leq 50$ nm

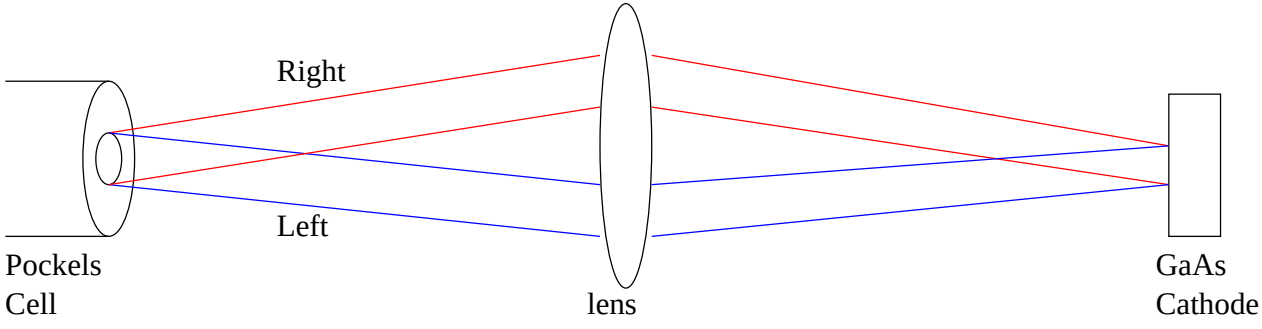
Solutions to Improve Position Differences

- Small PITA slope $\sim$ 5-10 ppm/V

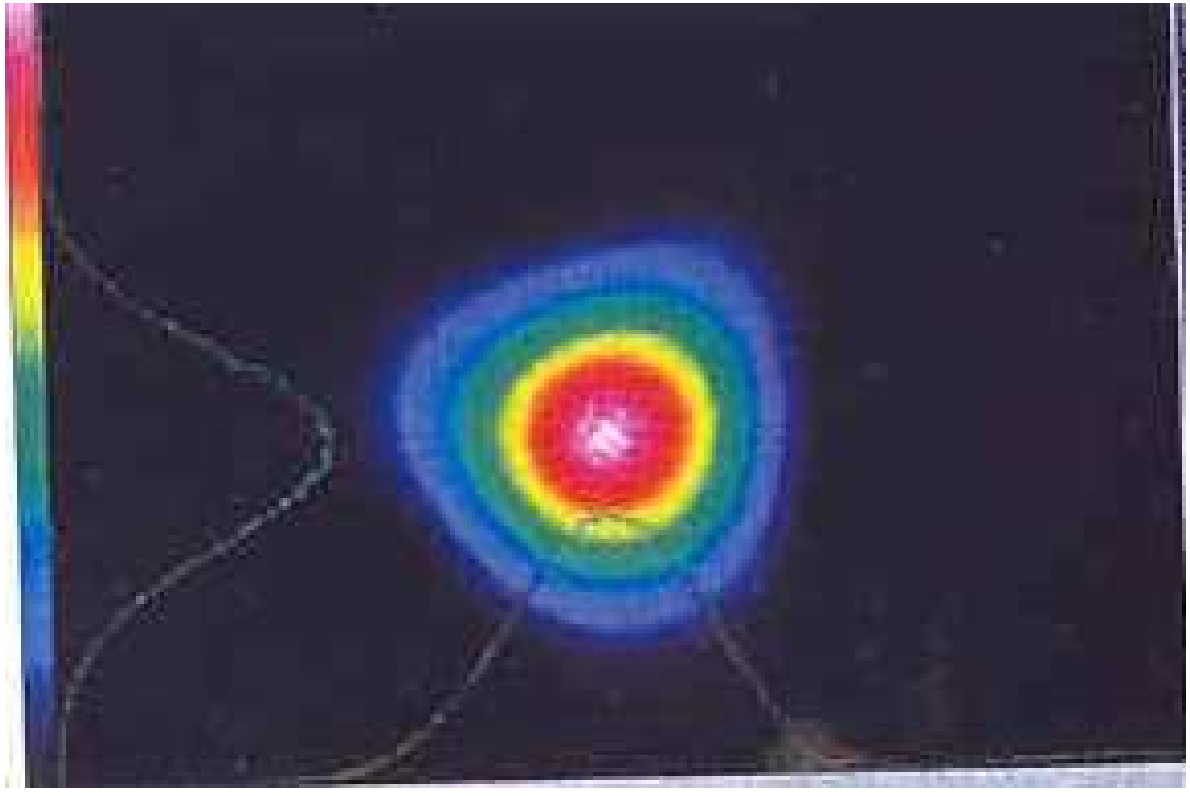
  Improves effects from: PC birefringence gradients & cathode gradients
- Insertable half-wave plate

  Improves steering
- Imaging

  Improves steering



Imaging: Ocelot Beamshape - TEM00 mode



Divergence (mrad)	
X	0.7578
Y	0.4280

Ongoing Work

- Recharacterize Arwen, new cells
- set up imaging
- IA system study
- practice aspects of source configuration
- Two new PC's with identical specs to Arwen have been ordered from Cleveland Crystals