Controlling Aq for A1n

Caryn Palatchi 7/24/2019

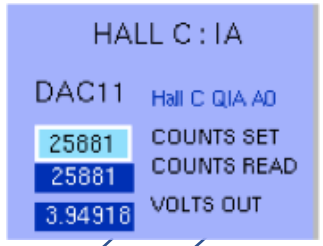
Goal Aq<200ppm

What changes the Aq?

- IA cell setting *** (this is what we'll use for control of Aq)
- IHWP insertion/removal
- RHWP rotation
- Cathode Spot Move
- Clipping e-beam in injector
- Pockels Cell setting/thermals

IA Cell System

40V max

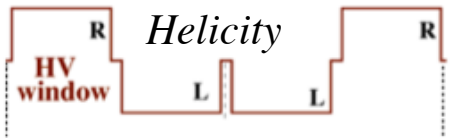


Linearly polarized light

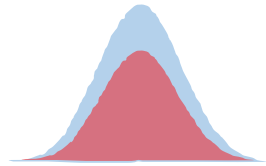
HWP

Polarizer

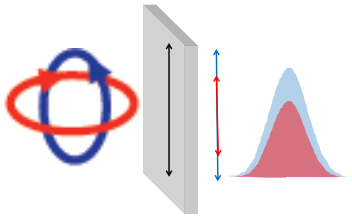
Linearly polarized light



Intensity Asymmetry



Intensity Asymmetry from Laser Polarization Asymmetry



Polarizing element
(i.e. photocathode)

Pockels Cell System

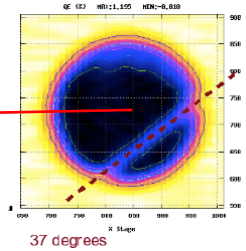
800V max

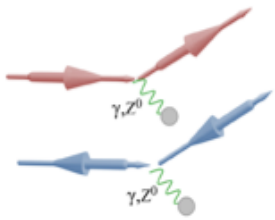
IHWP

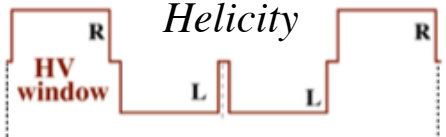
Circularly polarized light

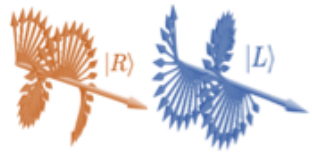
RHWP

Polarizer









Polarized electrons

Procedure for Aq minimization

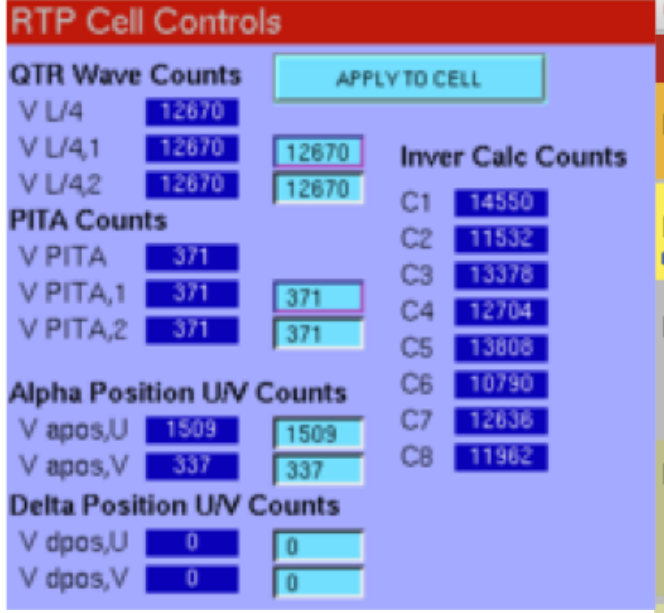
Baseline settings

- Minimize Aq on the laser table
  - *On laser table , find IA settings to minimize Aq for Pockels Cell off*
  - *Get 99.9% DoCP through PC for all 4 lasers for IHWPin/out*
- Minimize Aq in the injector
  - *Rotate RHWP angle so Aq insensitive to polarizing axis of cathode*
  - *Measure Aq for IHWPin/out, rotate cathode to minimize difference in Aq*
  - *Set IA voltages to minimize Aq for IHWPin/out for all 3 lasers with PC off*
  - *Set PC PITA voltages to minimize Aq for IHWPin/out for one laser*
  - *Set IA voltages to minimize Aq for IHWPin/out for all 3 lasers with PC on*
- Minimize Aq in the Hall
  - *Use HallC Aq to feedback on HallC IA cell (can run independently)*
  - *Simultaneously, use HallA Aq to feedback on PC – suppress fluctuations*

All this was done for summer, may have to redo if any cathode changes

Summer

Base Aq control settings



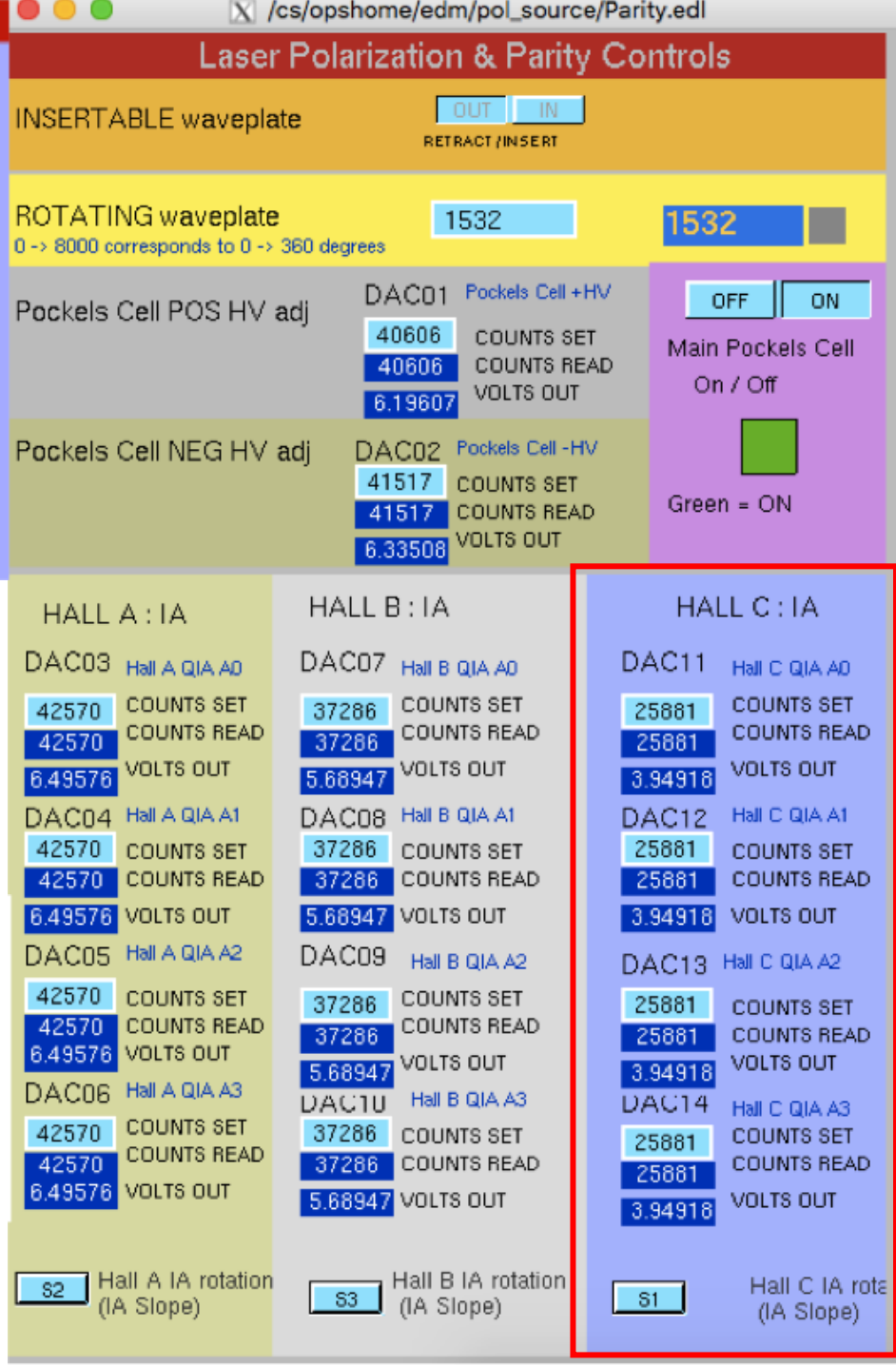


Table 1 - List of the correct settings for Insertable Half Wave Plate (IHWP) IN and OUT / Wien Flip RIGHT and LEFT.

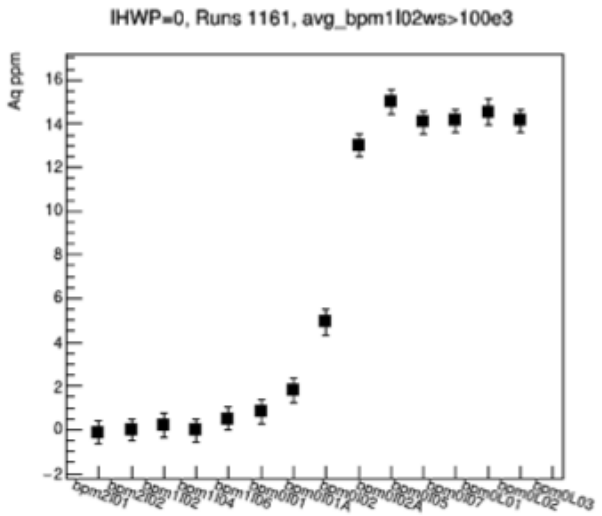
Variable	IHWPout	IHWPout	IHWPin	IHWPin
HallC IA	23000 ± 2000 counts	23000 ± 2000 counts	38000 ± 2000 counts	38000 ± 2000 counts
V PITA	303 ± 1000 counts	303 ± 1000 counts	-970 ± 1000 counts	-970 ± 1000 counts
V L/4	12670	12670	12670	12670
V aposU	1447	1447	768	768
V aposV	163	163	-385	-385
HallA IA	42570	42570	26046	26046
HallB IA	37286	37286	29353	29353

From Baseline injector setting to the Hall

What other factors are there?

Aq

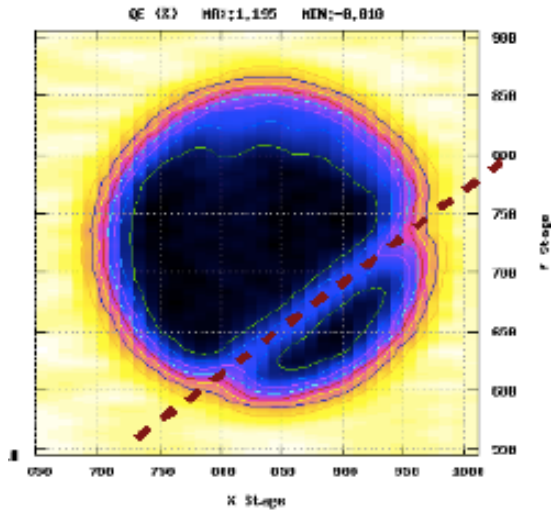
Beam Clipping



Injector bpm

~10-20ppm

Cathode

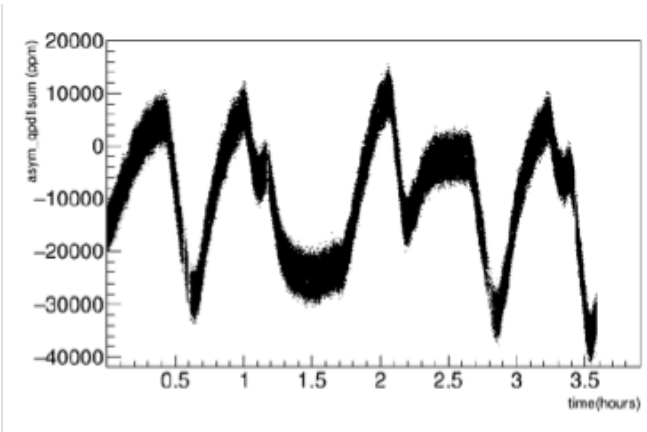


37 degrees

Degradation
Spot moves

~100ppm

Natural dT fluctuations

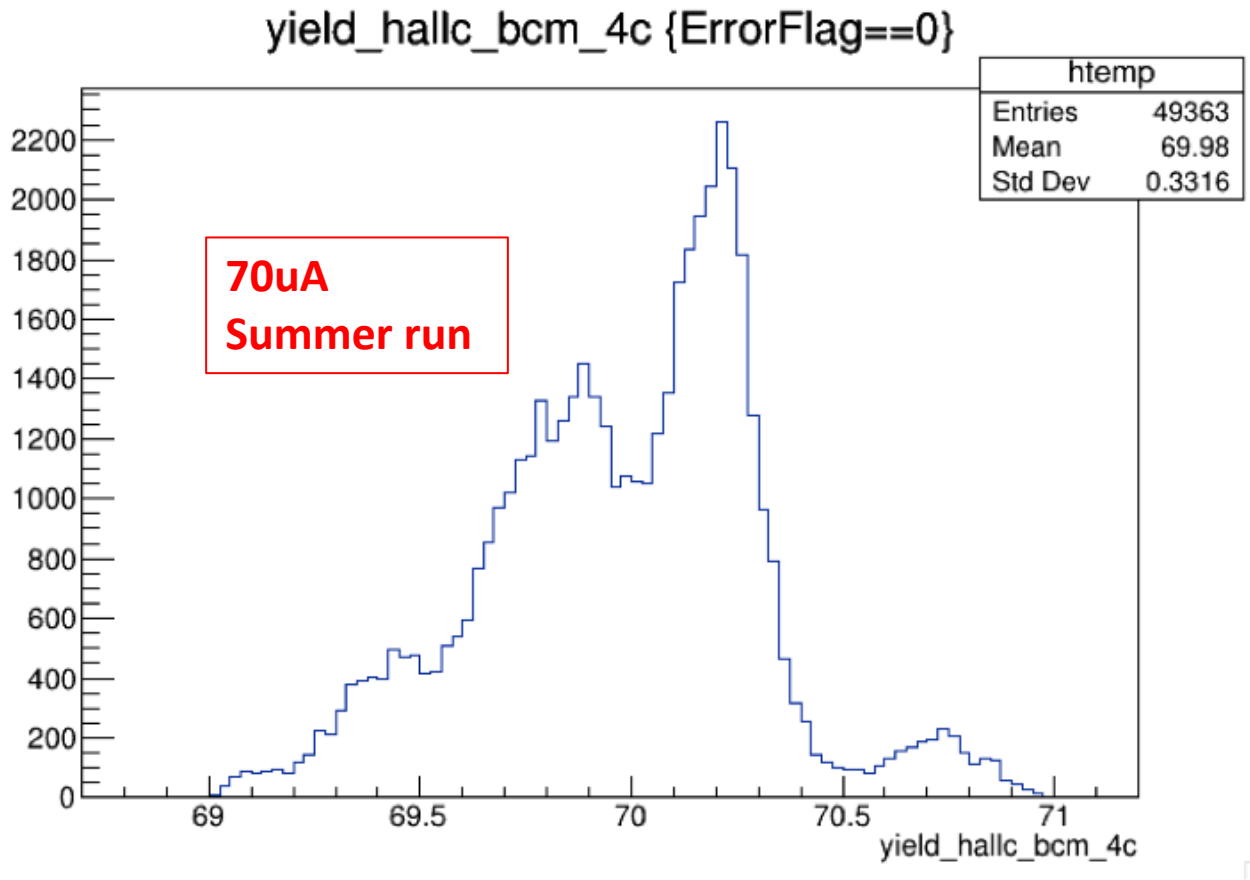


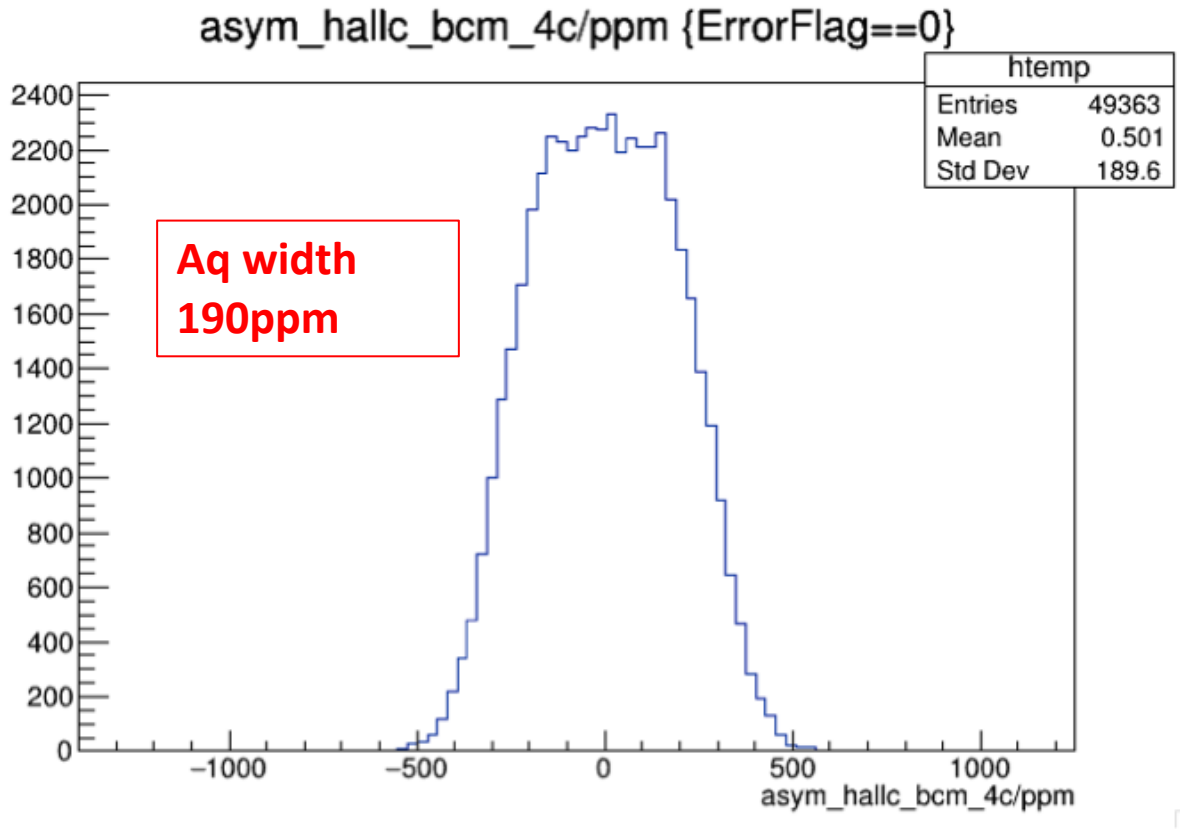
RHWP set to 1deg from S2
6% cathode analyzing power

~30ppm

Monitoring Aq in HallC

HallC BCM “4C” → HallA Counting House → Parity DAQ Qweak ADC

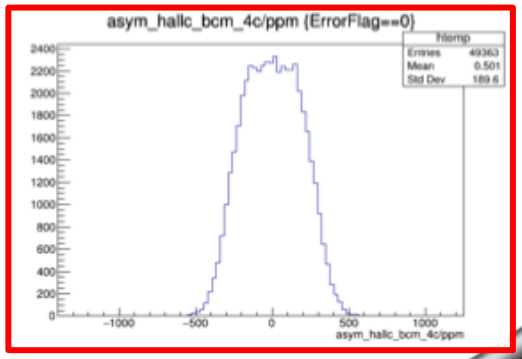


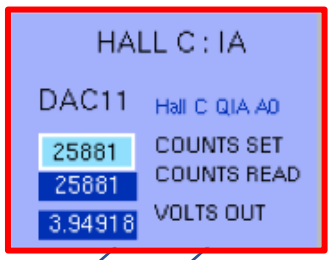


Run3503_hallCAqhist

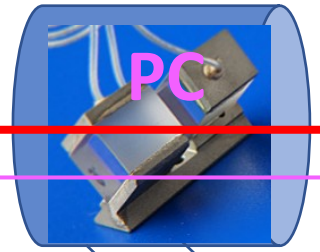
Feedback

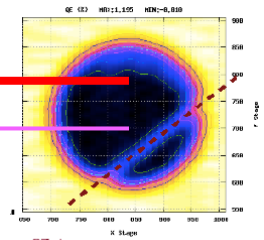
HallC Aq

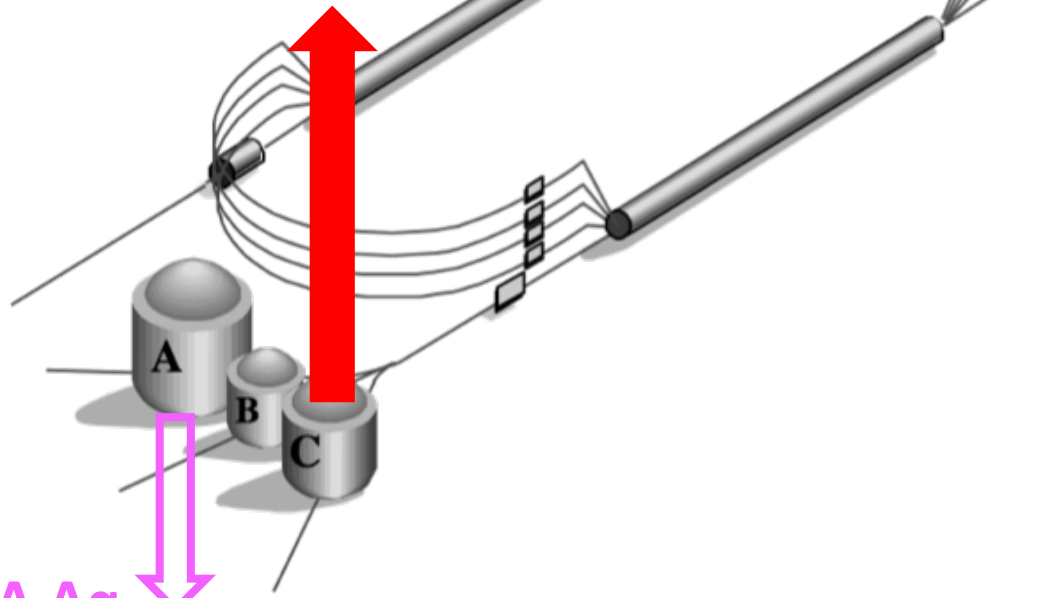




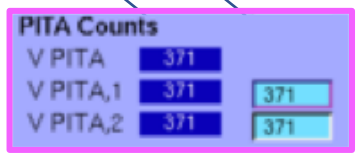
C



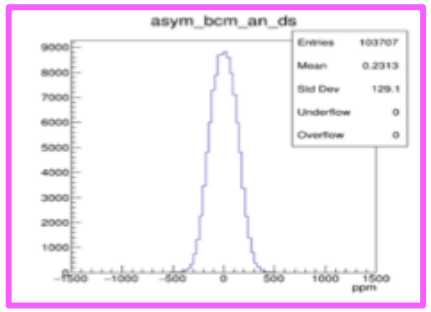




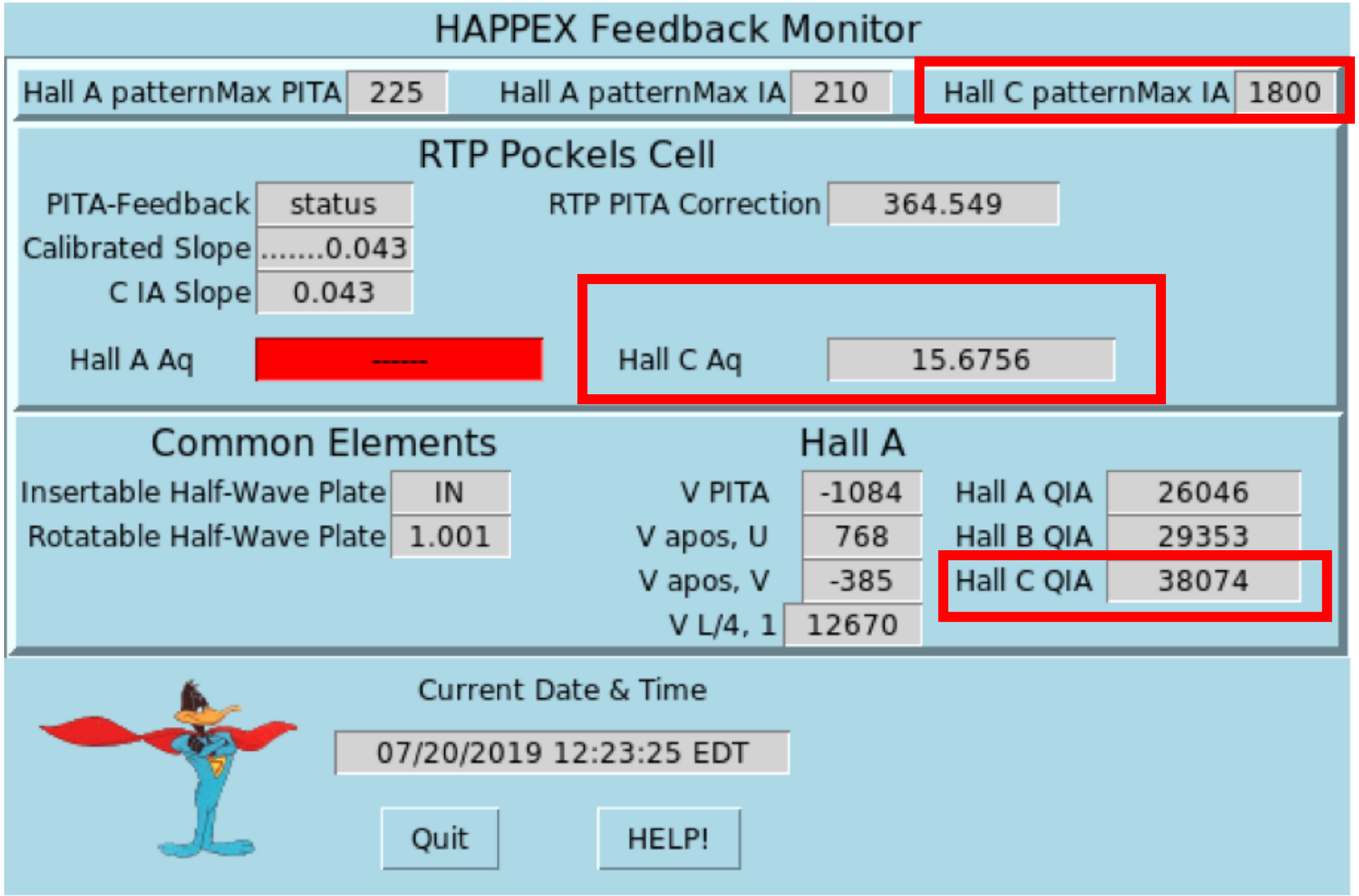
A



HallA Aq



Monitoring Aq – shift crew

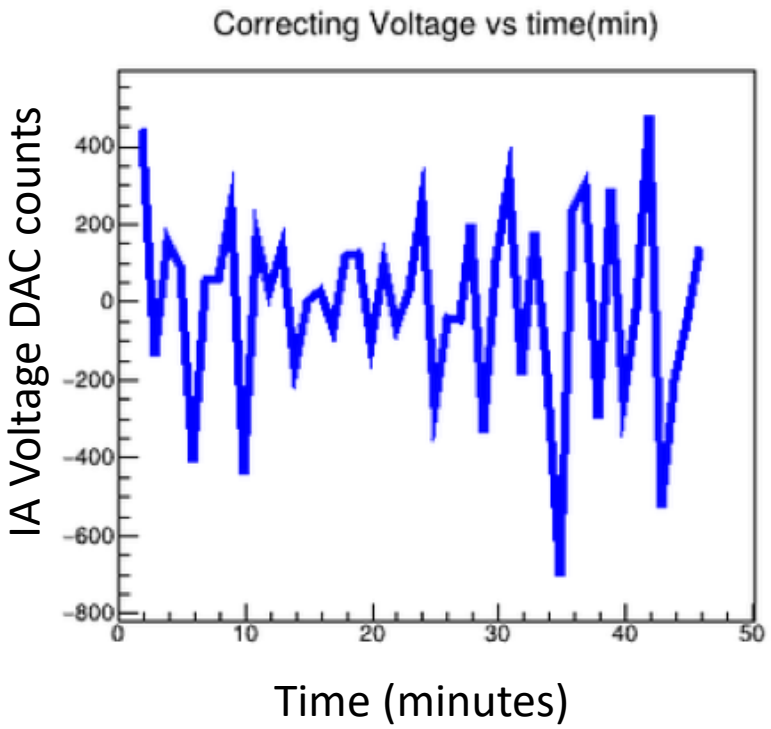


Feedback Interval
(minute-level)

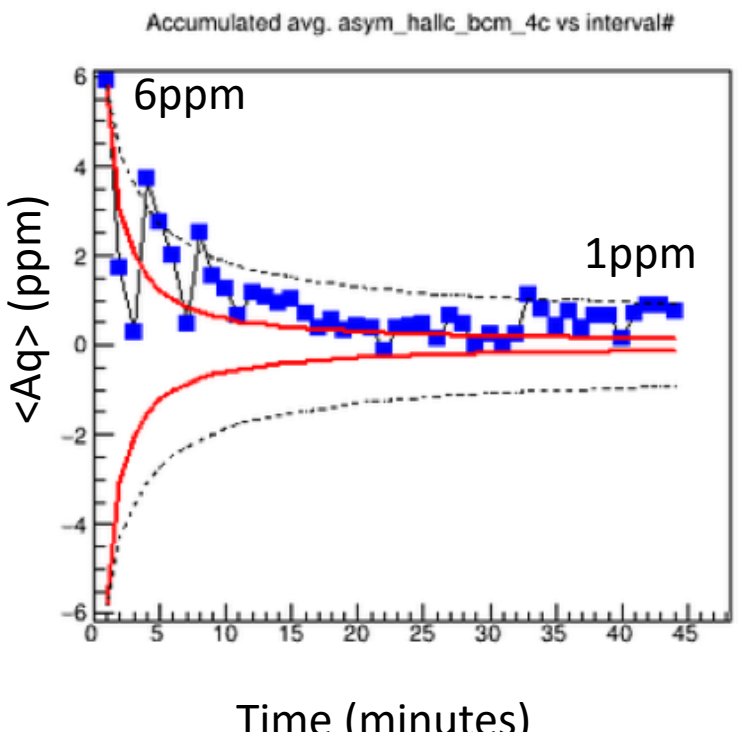
Aq Monitors
(hallc bcm “4c”)

Control Signal
(IA DAC counts)

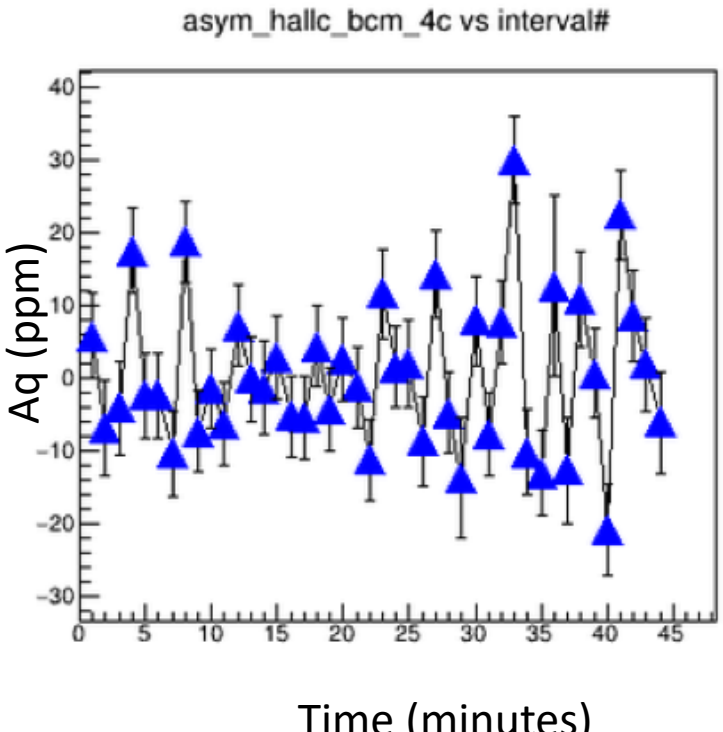
HallC Aq Convergence – 1min intervals



- 0.1ppm/count



- Doing no feedback ~200ppm
- With feedback ~1ppm convergence



- 1min measurements +-30ppm

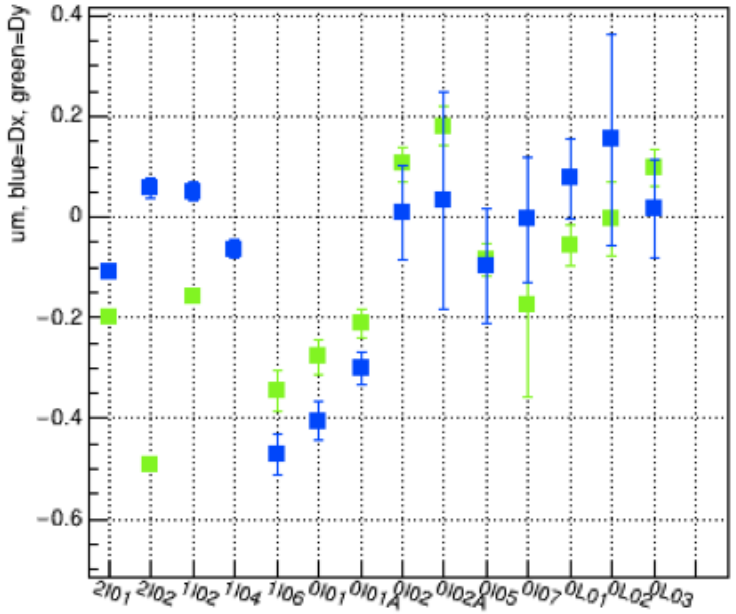
- *1min intervals unnecessarily aggressive, could ease up a bit*

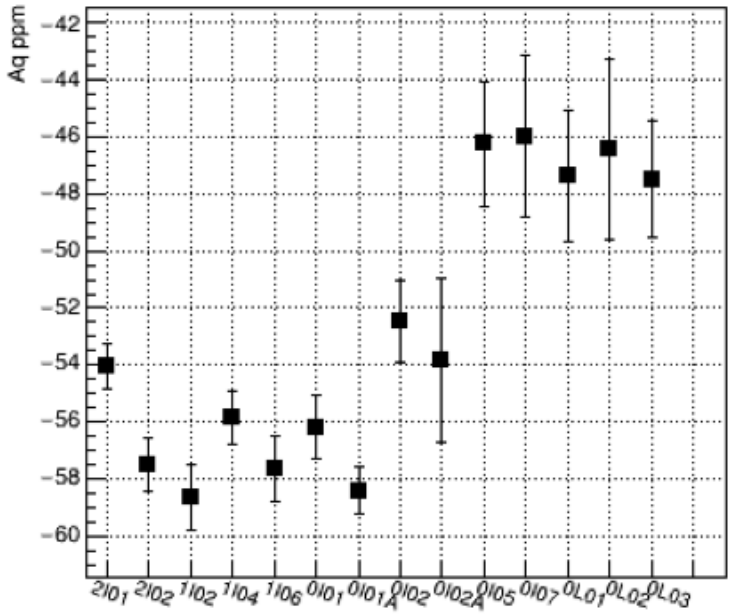
Run3454_IHWP_IN_hallc_bcm_4c.png

Summary

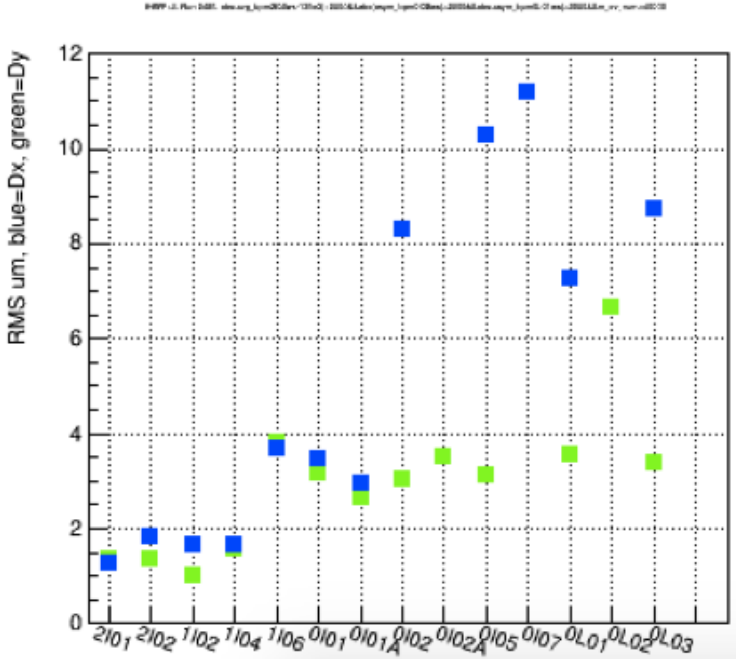
- Aq is controlled with HallC IA cell
- Basic Setup on laser table and injector gives OOM 100ppm
  - IHWPin/out have separate Nominal IA settings
- HallC Aq monitored by Qweak ADC in Parity DAQ
- Feedback presently being performed on HallC IA cell to minimize Aq during summer running
- For Fall, may ease up on aggressiveness on feedback interval

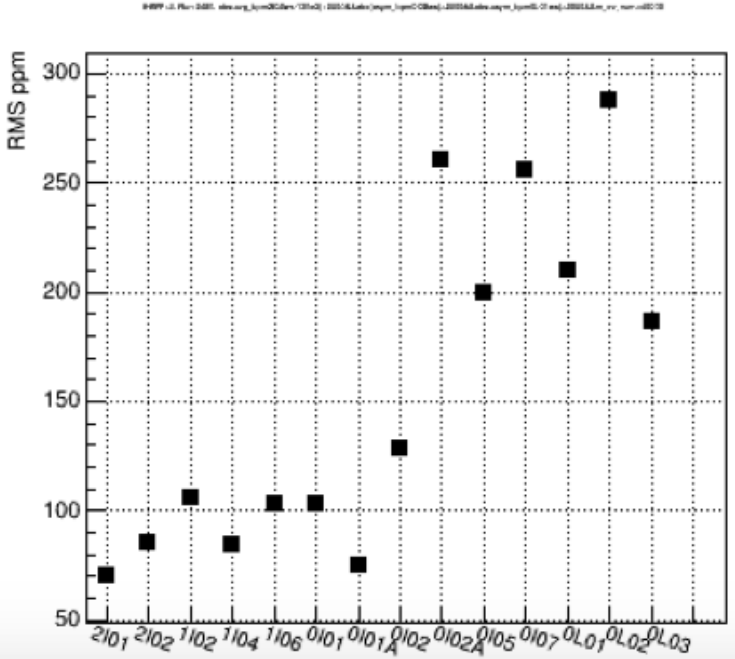
Backup Slides



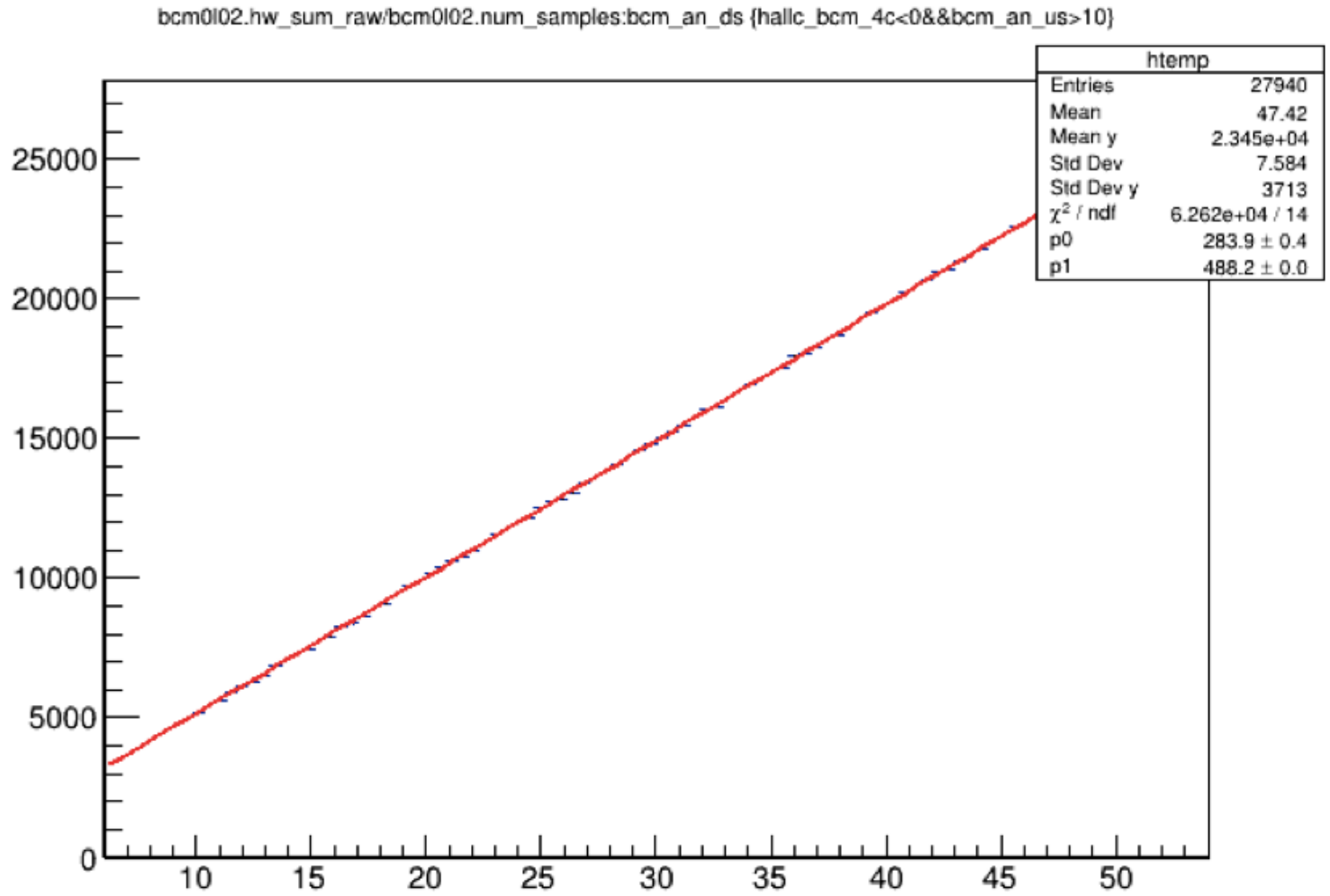


Run2485_HallC93uAgu_76uAFC2_PosDiffs



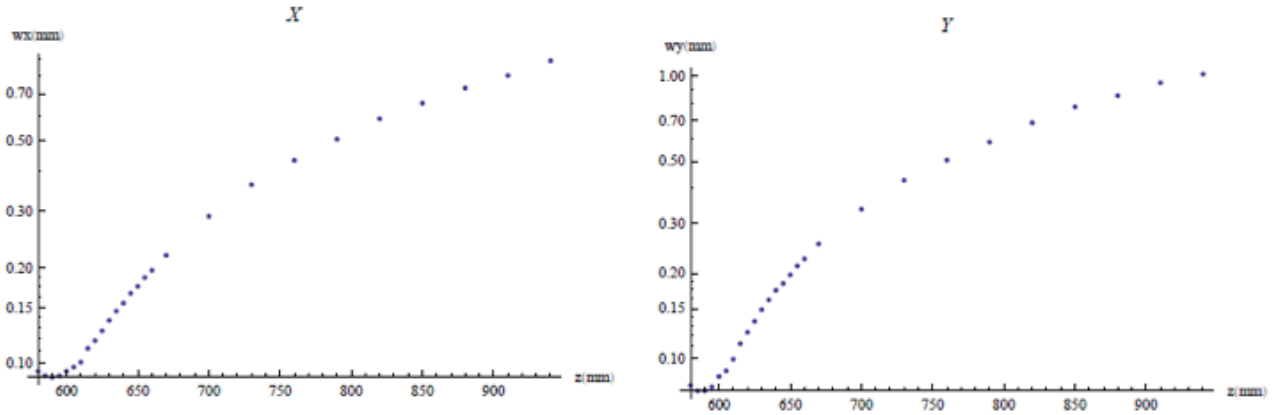


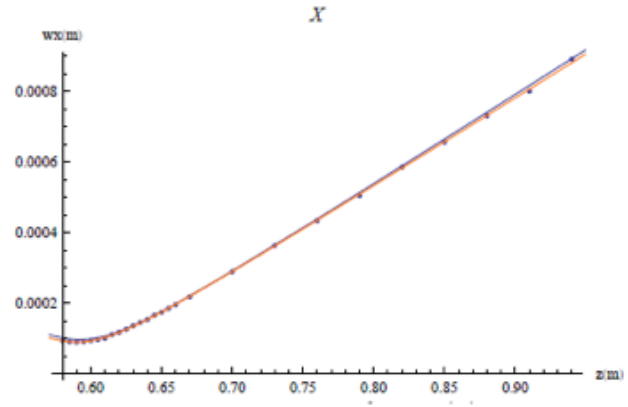
HallC monitor linearity

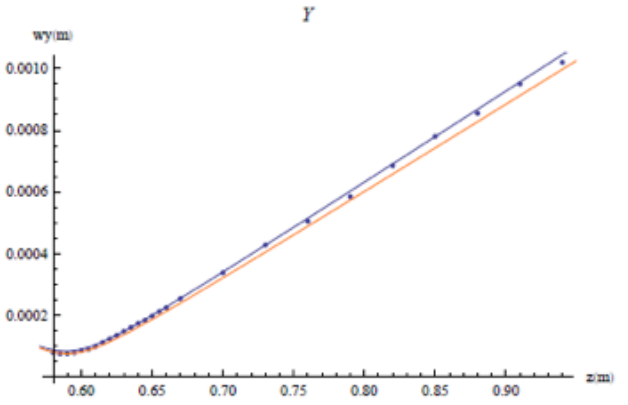


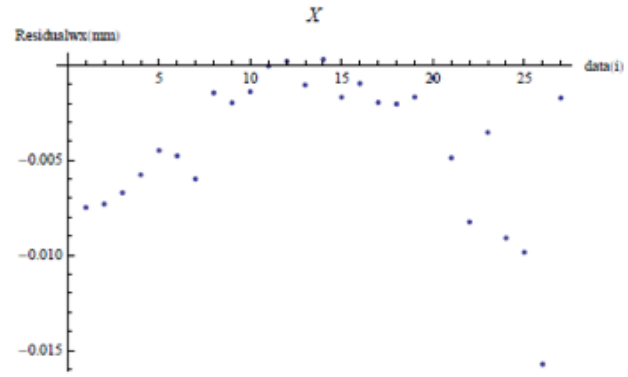
Run3378_hallcofff_bcm0l02calibrationVSbcmands

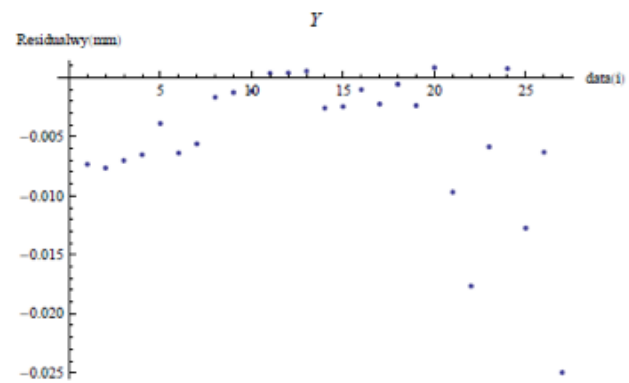
M2fitsHallC.png











	Estimate	Standard Error	t-Statistic	P-Value
M2	1.00101	0.0259885	38.5174	4.30181×10^{-23}
w0	0.0000970309	2.22944×10^{-6}	43.5225	2.38578×10^{-24}
z0	0.59232	0.00126764	467.261	5.01024×10^{-49}

	Estimate	Standard Error	t-Statistic	P-Value
M2	1.00101	0.0450737	22.2082	1.64211×10^{-17}
w0	0.0000834284	3.49299×10^{-6}	23.8845	3.07998×10^{-18}
z0	0.588717	0.00136823	430.276	3.62461×10^{-48}

BeamMic™ 2.11 SP907 #17496560

Source | Beam Display | Capture | Computations | Aperture | Logging | Reports

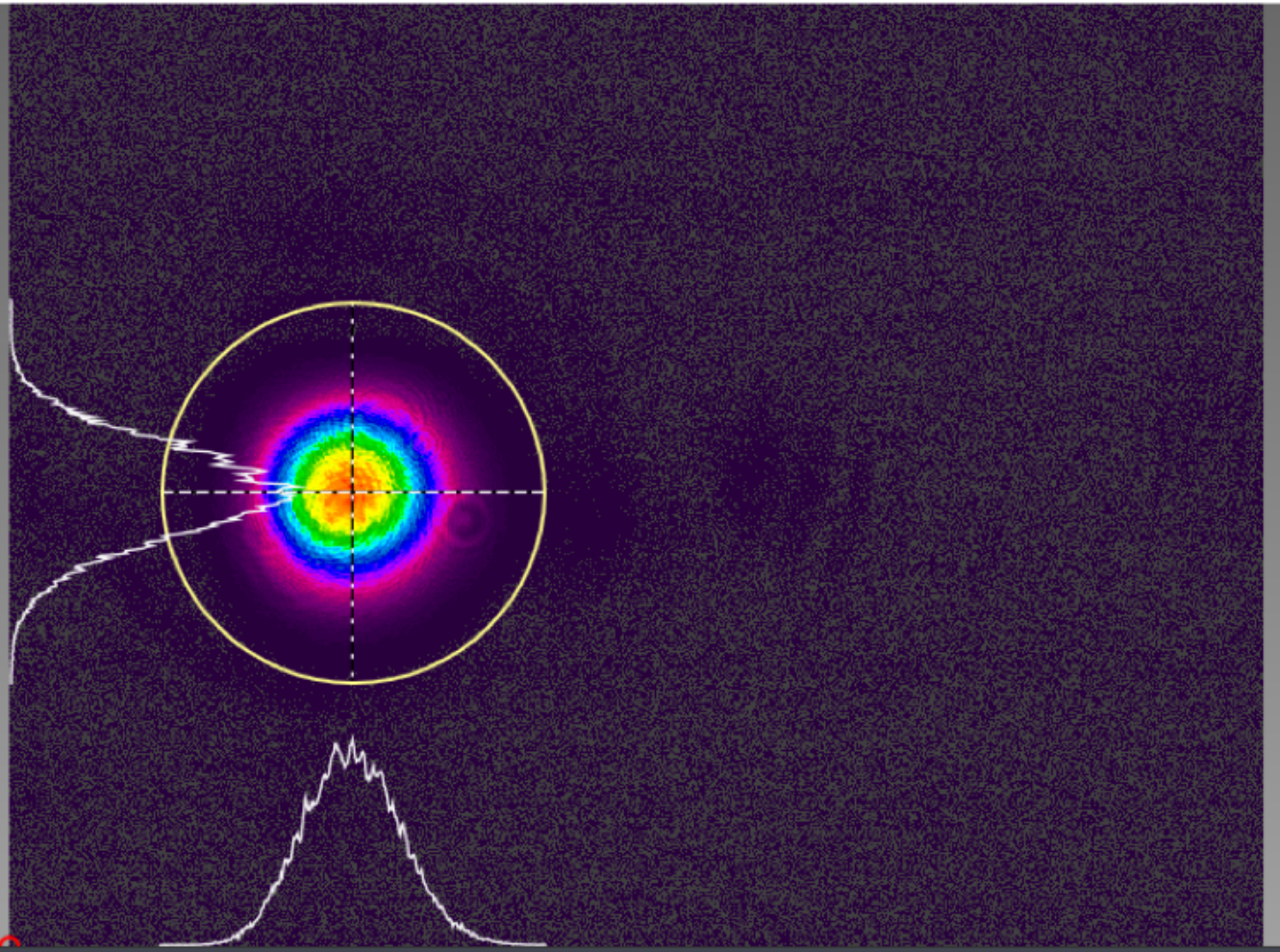
Tools | Power/Energy | Beam Width | Optical Scaling

20190429_HallC11inchesbeforecell_CEin.png

Results

Name	Value	Units
Power/Energy		
Total ISO	29,012,449.04	cnts
Peak ISO	3,790.32	cnts
Min	-5.56	cnts
Spatial		
Centroid X ISO	1.942308e+03	µm
Centroid Y ISO	2.563870e+03	µm
D4σX ISO	1.082e+03	µm
D4σY ISO	1.079e+03	µm
D%pkX	5.978e+02	µm
D%pkY	5.904e+02	µm
Frame Info		

Start Page | 2D Beam Display

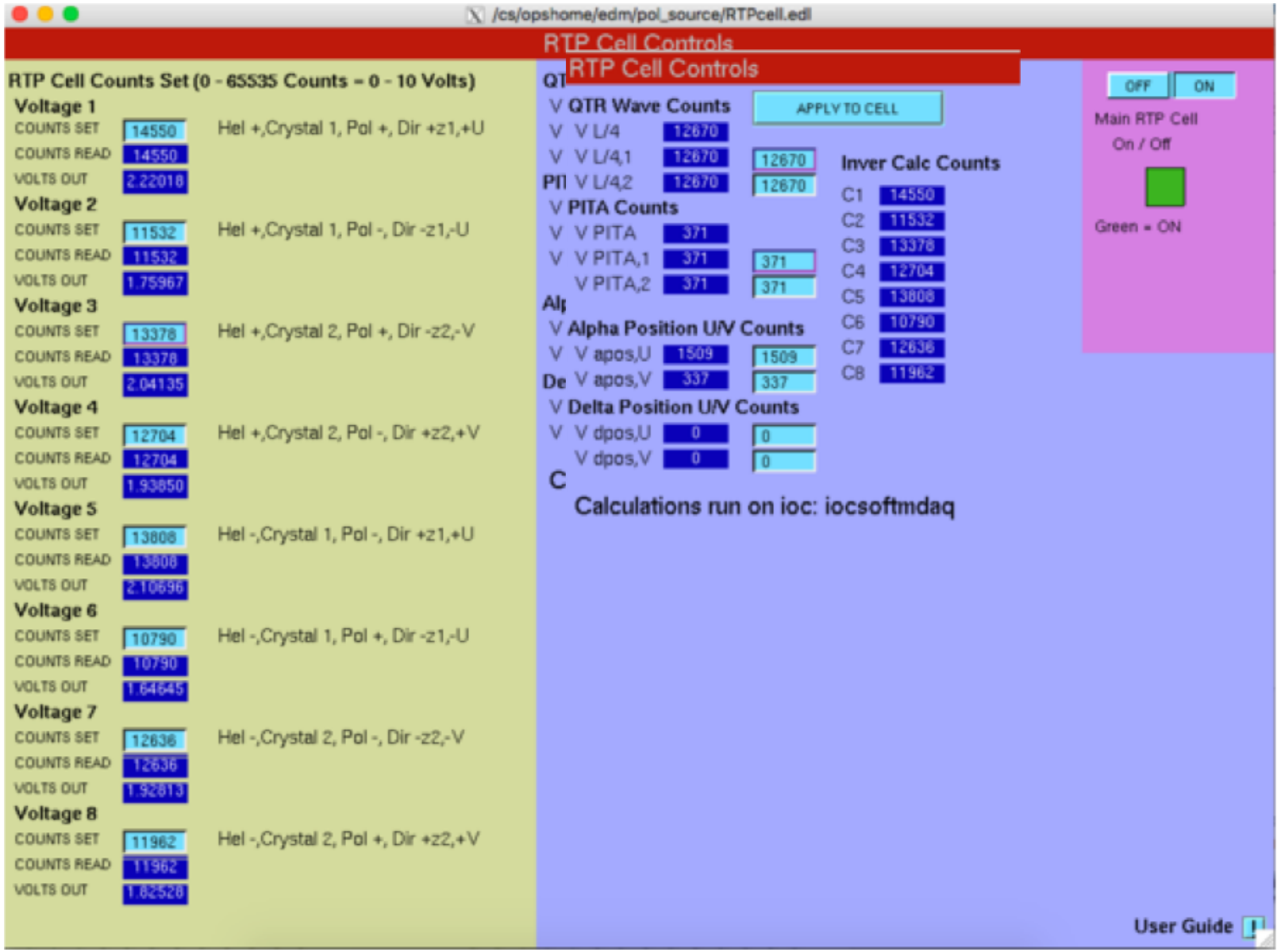


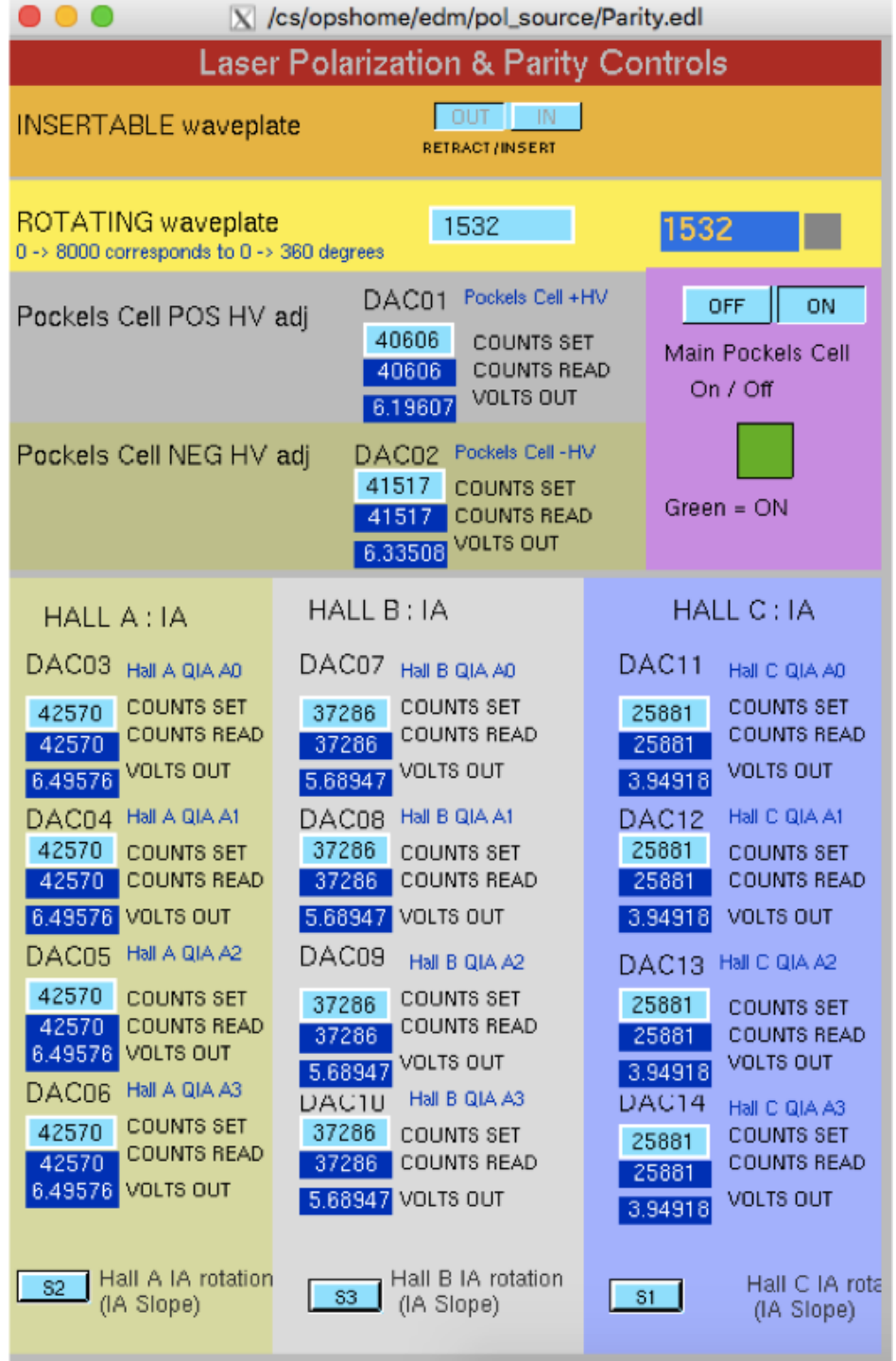
Ready

3,572.09 cnts 2 Hz

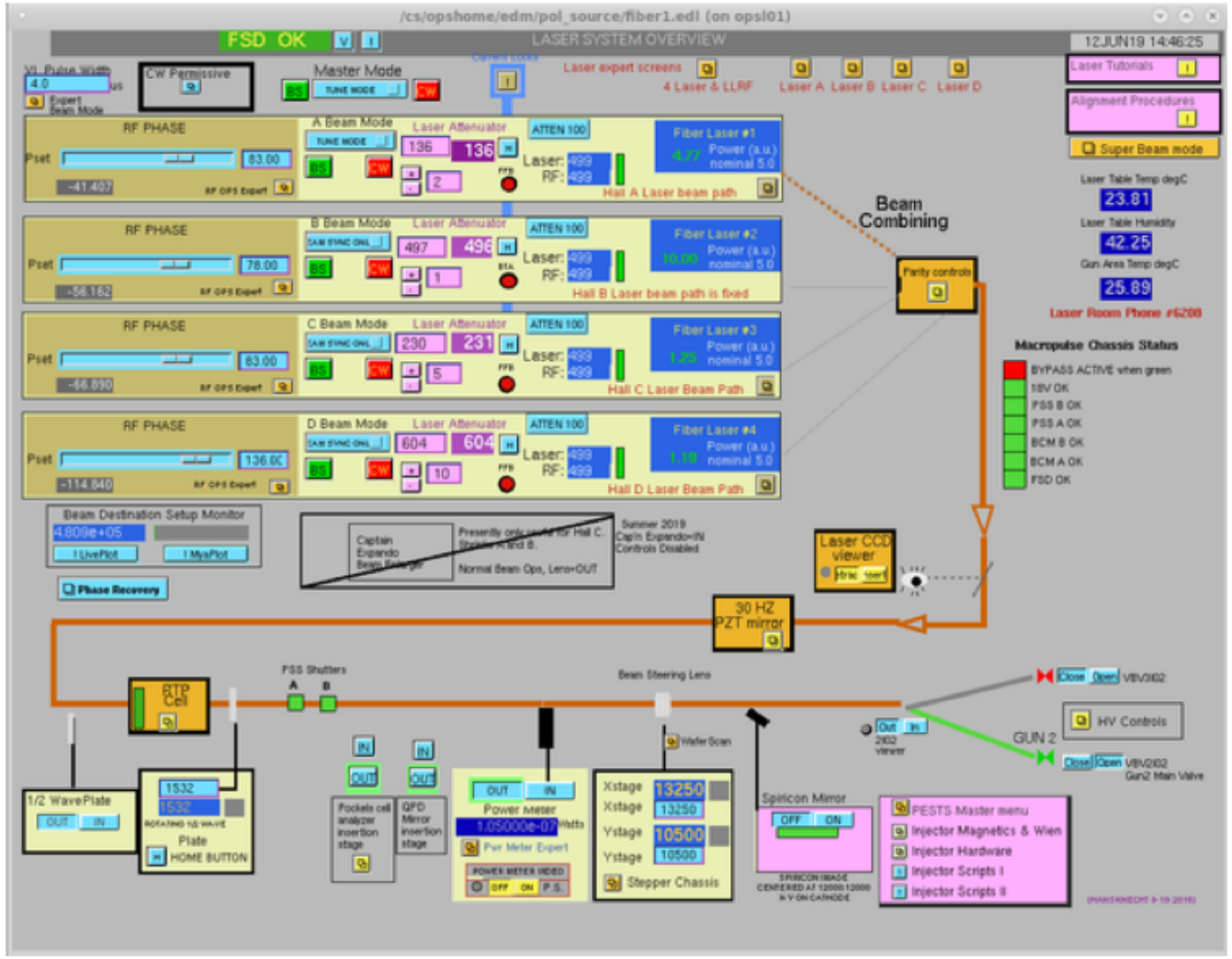
Ask me anything

1:00 AM
4/30/2019


/cs/opshome/edm/pol_source/RTPcell.edl
RTP Cell Controls
RTP Cell Controls
RTP Cell Counts Set (0 - 65535 Counts = 0 - 10 Volts)
Voltage 1
COUNTS SET 14550
COUNTS READ 14550
VOLTS OUT 2.22018
Hel +,Crystal 1, Pol +, Dir +z1,+U
Voltage 2
COUNTS SET 11532
COUNTS READ 11532
VOLTS OUT 1.75967
Hel +,Crystal 1, Pol -, Dir -z1,-U
Voltage 3
COUNTS SET 13378
COUNTS READ 13378
VOLTS OUT 2.04135
Hel +,Crystal 2, Pol +, Dir -z2,-V
Voltage 4
COUNTS SET 12704
COUNTS READ 12704
VOLTS OUT 1.93850
Hel +,Crystal 2, Pol -, Dir +z2,+V
Voltage 5
COUNTS SET 13808
COUNTS READ 13808
VOLTS OUT 2.10696
Hel -,Crystal 1, Pol -, Dir +z1,+U
Voltage 6
COUNTS SET 10790
COUNTS READ 10790
VOLTS OUT 1.64645
Hel -,Crystal 1, Pol +, Dir -z1,-U
Voltage 7
COUNTS SET 12636
COUNTS READ 12636
VOLTS OUT 1.92813
Hel -,Crystal 2, Pol -, Dir -z2,-V
Voltage 8
COUNTS SET 11962
COUNTS READ 11962
VOLTS OUT 1.82528
Hel -,Crystal 2, Pol +, Dir +z2,+V
V QTR Wave Counts
APPLY TO CELL
V V L/4 12670
V V L/4,1 12670 12670
V V L/4,2 12670 12670
V PITA Counts
V V PITA 371
V V PITA,1 371 371
V PITA,2 371 371
V Alpha Position U/V Counts
V V apos,U 1509 1509
V apos,V 337 337
V Delta Position U/V Counts
V V dpos,U 0 0
V dpos,V 0 0
Inver Calc Counts
C1 14550
C2 11532
C3 13378
C4 12704
C5 13808
C6 10790
C7 12636
C8 11962
Calculations run on ioc: iocsoftmdaq
OFF
ON
Main RTP Cell
On / Off
Green = ON
User Guide

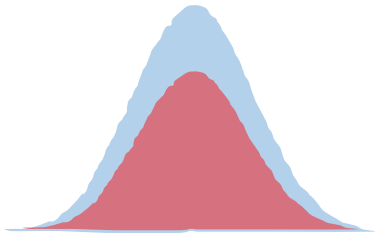

/cs/opshome/edm/pol_source/Parity.edl
Laser Polarization & Parity Controls
INSERTABLE waveplate
OUT
IN
RETRACT/INSERT
ROTATING waveplate
0 -> 8000 corresponds to 0 -> 360 degrees
1532
1532
Pockels Cell POS HV adj
DAC01
Pockels Cell +HV
40606
COUNTS SET
40606
COUNTS READ
6.19607
VOLTS OUT
Pockels Cell NEG HV adj
DAC02
Pockels Cell -HV
41517
COUNTS SET
41517
COUNTS READ
6.33508
VOLTS OUT
OFF
ON
Main Pockels Cell
On / Off
Green = ON
HALL A : IA
DAC03
Hall A QIA A0
42570
COUNTS SET
42570
COUNTS READ
6.49576
VOLTS OUT
DAC04
Hall A QIA A1
42570
COUNTS SET
42570
COUNTS READ
6.49576
VOLTS OUT
DAC05
Hall A QIA A2
42570
COUNTS SET
42570
COUNTS READ
6.49576
VOLTS OUT
DAC06
Hall A QIA A3
42570
COUNTS SET
42570
COUNTS READ
6.49576
VOLTS OUT
S2
Hall A IA rotation
(IA Slope)
HALL B : IA
DAC07
Hall B QIA A0
37286
COUNTS SET
37286
COUNTS READ
5.68947
VOLTS OUT
DAC08
Hall B QIA A1
37286
COUNTS SET
37286
COUNTS READ
5.68947
VOLTS OUT
DAC09
Hall B QIA A2
37286
COUNTS SET
37286
COUNTS READ
5.68947
VOLTS OUT
DAC10
Hall B QIA A3
37286
COUNTS SET
37286
COUNTS READ
5.68947
VOLTS OUT
S3
Hall B IA rotation
(IA Slope)
HALL C : IA
DAC11
Hall C QIA A0
25881
COUNTS SET
25881
COUNTS READ
3.94918
VOLTS OUT
DAC12
Hall C QIA A1
25881
COUNTS SET
25881
COUNTS READ
3.94918
VOLTS OUT
DAC13
Hall C QIA A2
25881
COUNTS SET
25881
COUNTS READ
3.94918
VOLTS OUT
DAC14
Hall C QIA A3
25881
COUNTS SET
25881
COUNTS READ
3.94918
VOLTS OUT
S1
Hall C IA rota
(IA Slope)

Setup – what tools do we use for control?

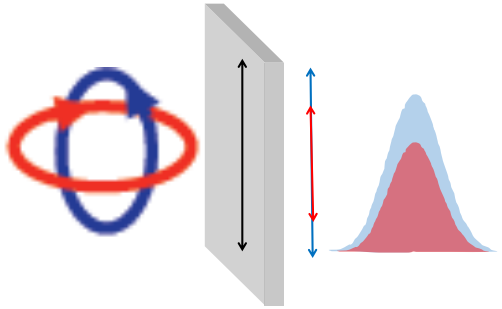


Pockles Cell – Polarization and Intensity

Intensity Asymmetry

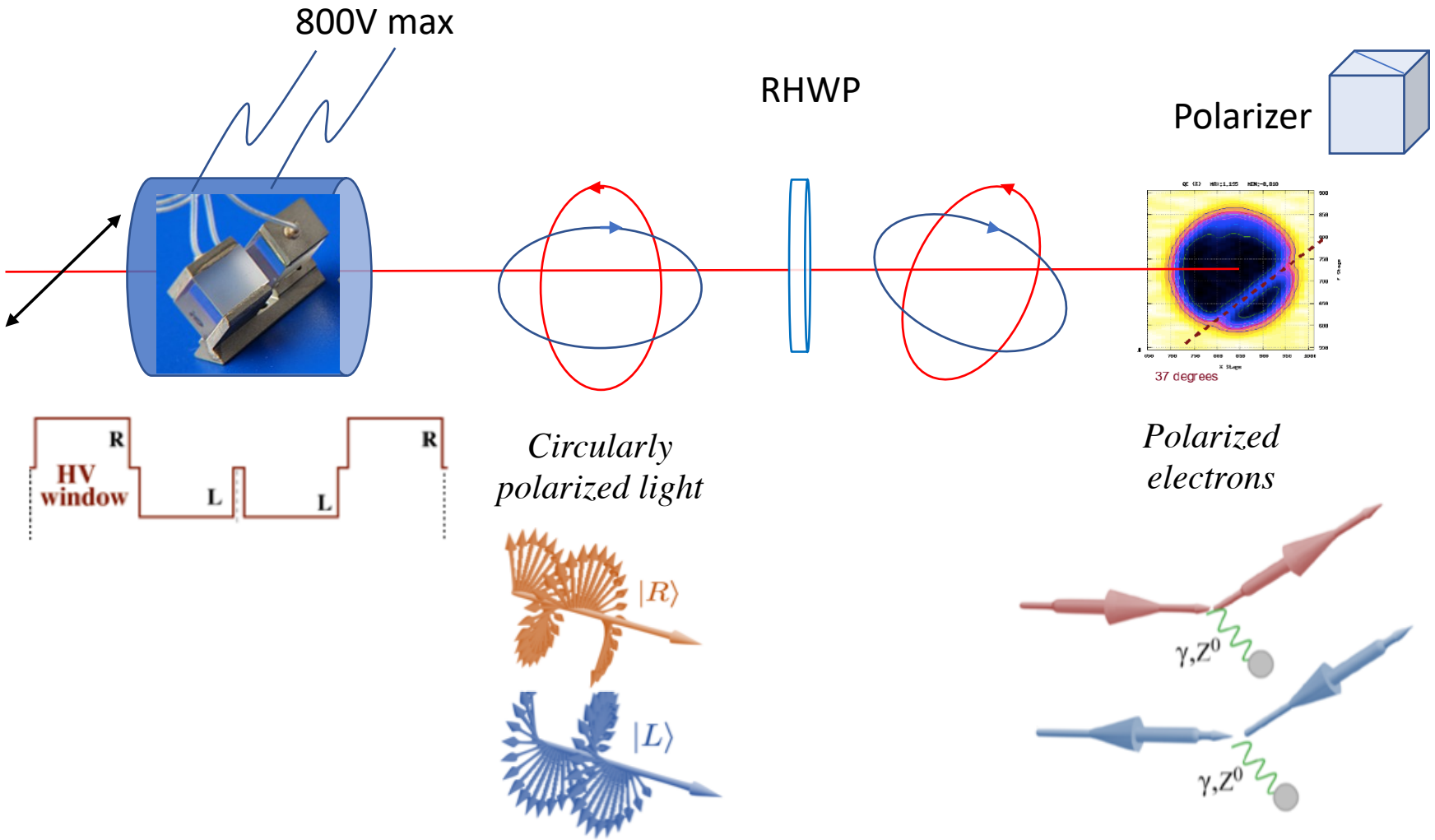


Intensity Asymmetry from Laser Polarization Asymmetry



Polarizing element
(i.e. photocathode)

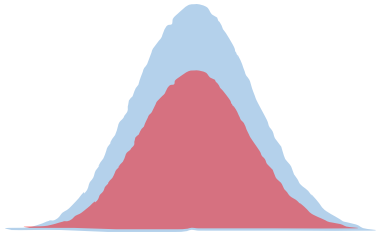
Polarization Asymmetry and Intensity Asymmetry Dependence



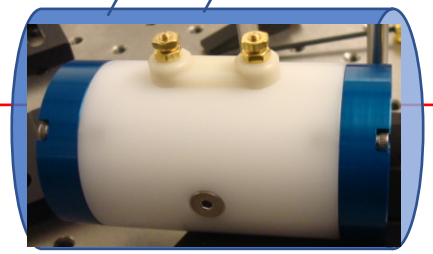
IA Cell – Intensity ONLY

Intensity Asymmetry Independent of Polarization

Intensity Asymmetry

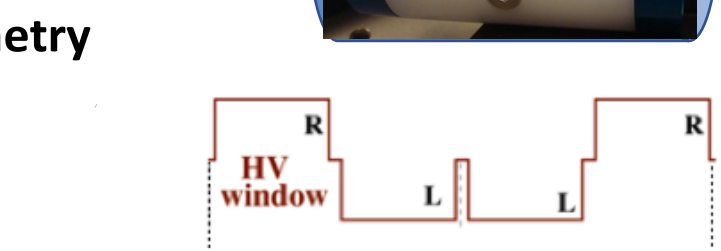


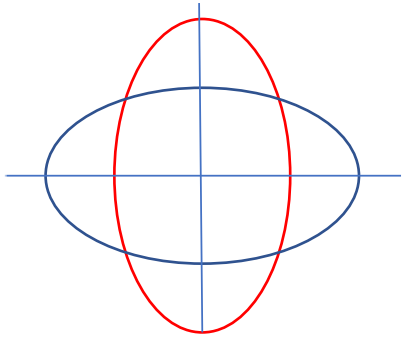
40V max



HWP

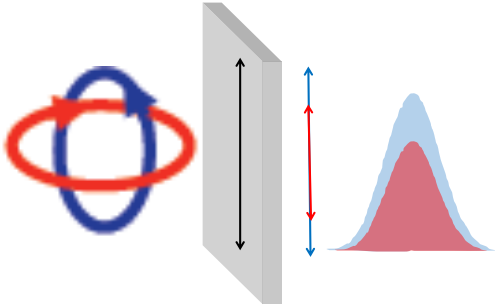
Polarizer





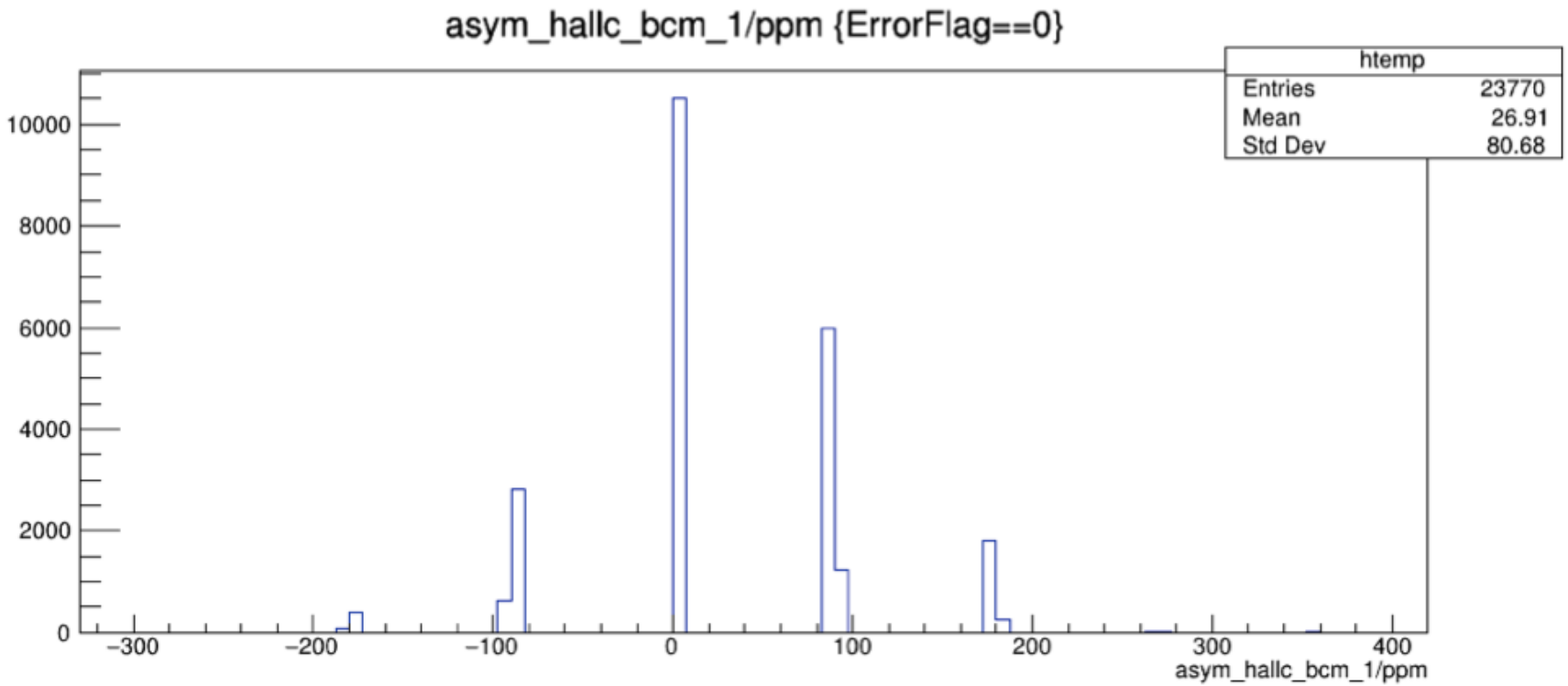
(same polarization)

Intensity Asymmetry from Laser Polarization Asymmetry



Polarizing element
(i.e. photocathode)

TINY bit of DoCP
On top of Linear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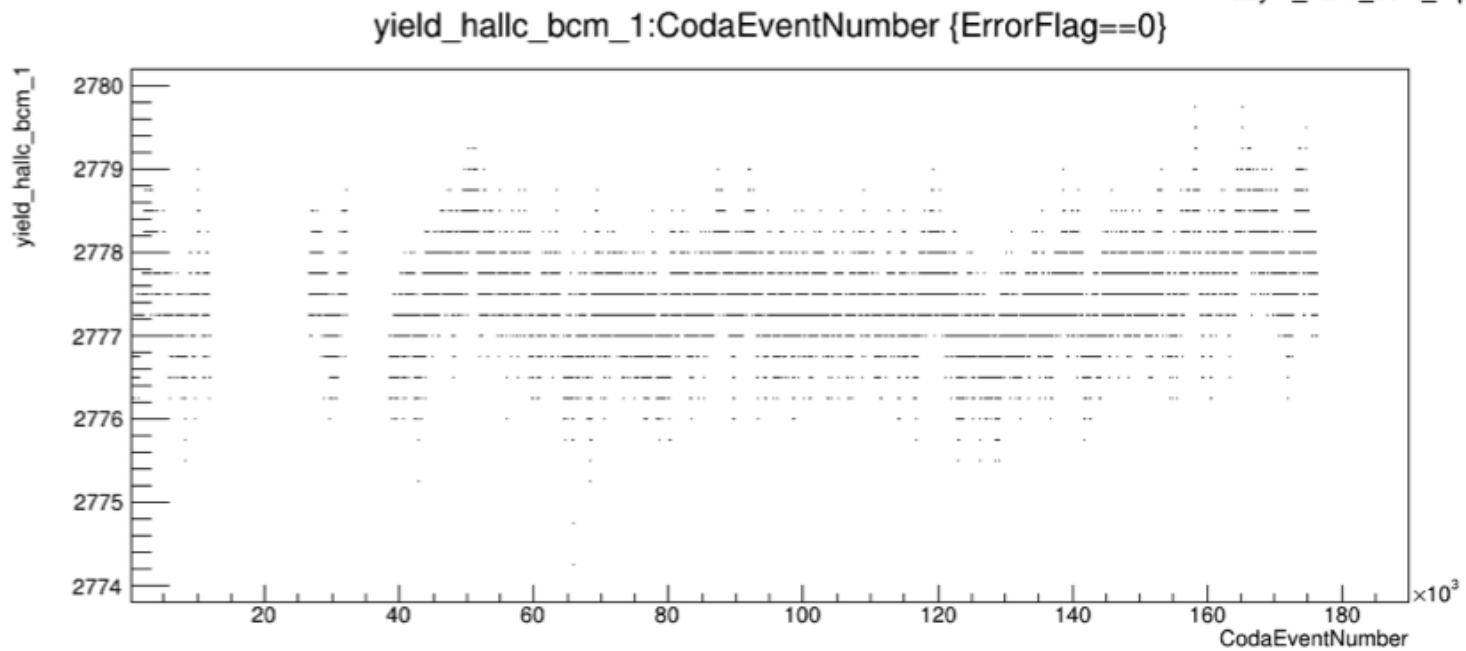
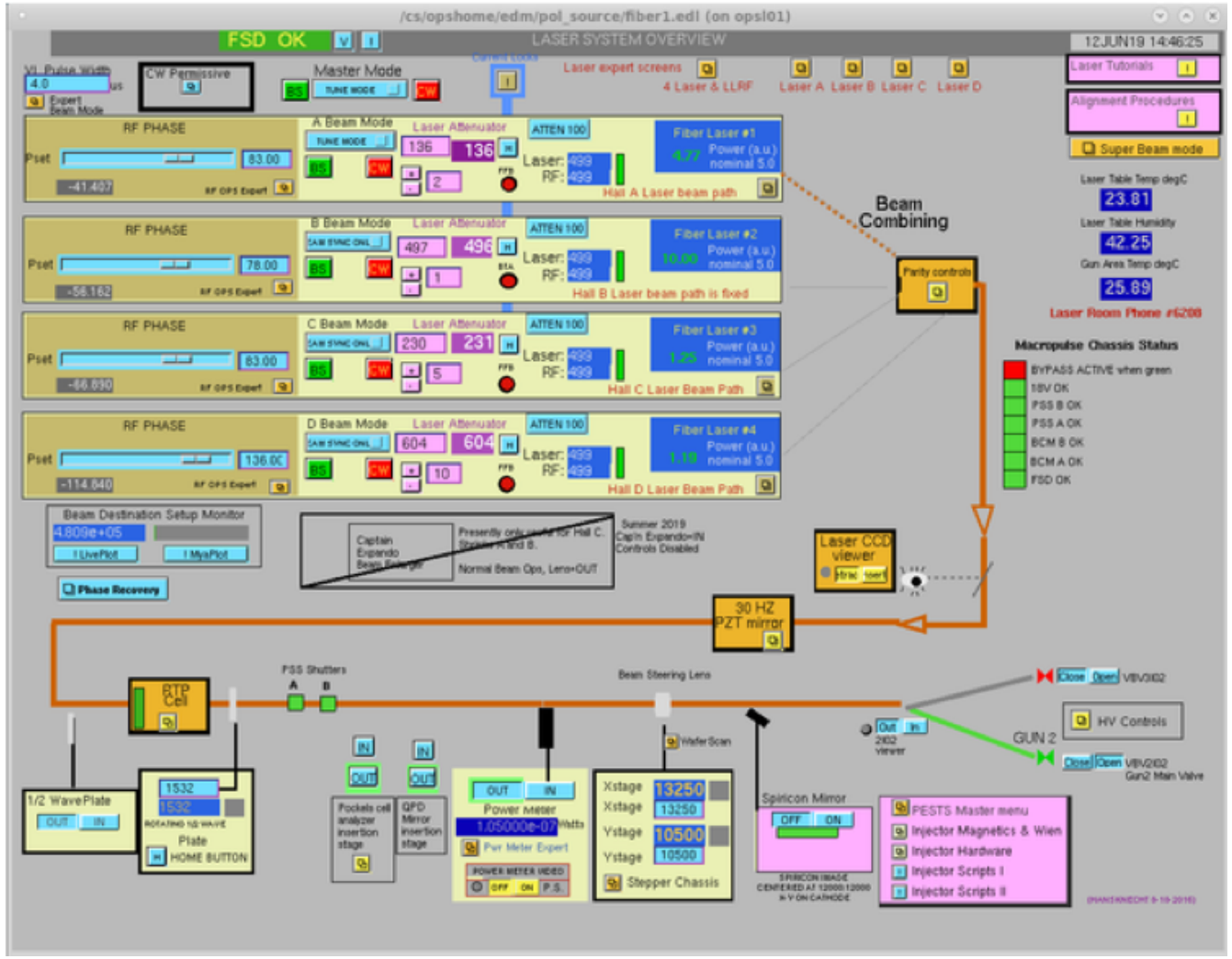
htemp
Entries 23770
Mean 26.91
Std Dev 80.68
10000
8000
6000
4000
2000
0
−300
−200
−100
0
100
200
300
400
asym_hallc_bcm_1/ppm


yield_hallc_bcm_1:CodaEventNumber {ErrorFlag==0}
yield_hallc_bcm_1
2780
2779
2778
2777
2776
2775
2774
20
40
60
80
100
120
140
160
180
×10³
CodaEventNumber

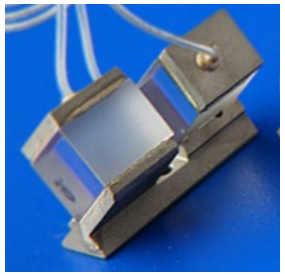
Setup – what tools do we use for control?

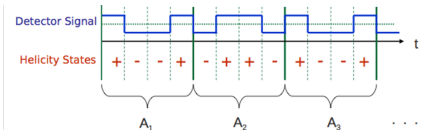


PVES blue print: PREX from Source to Hall

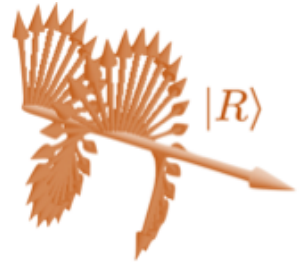
Laser Beam

Pockels Cell (+- HV)



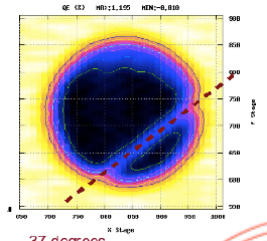


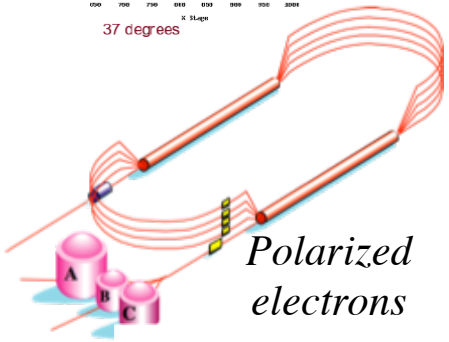
Circularly polarized light



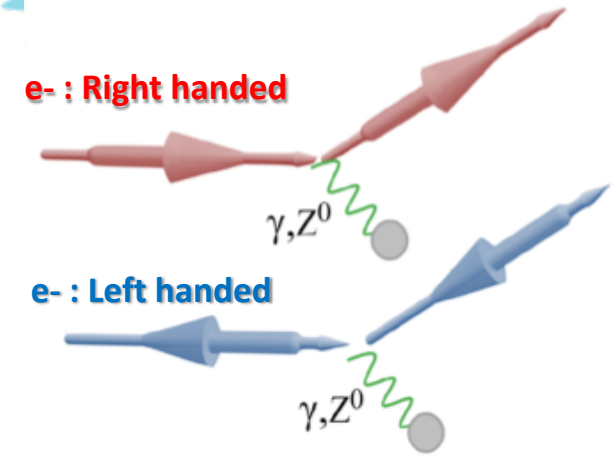
Electron Beam

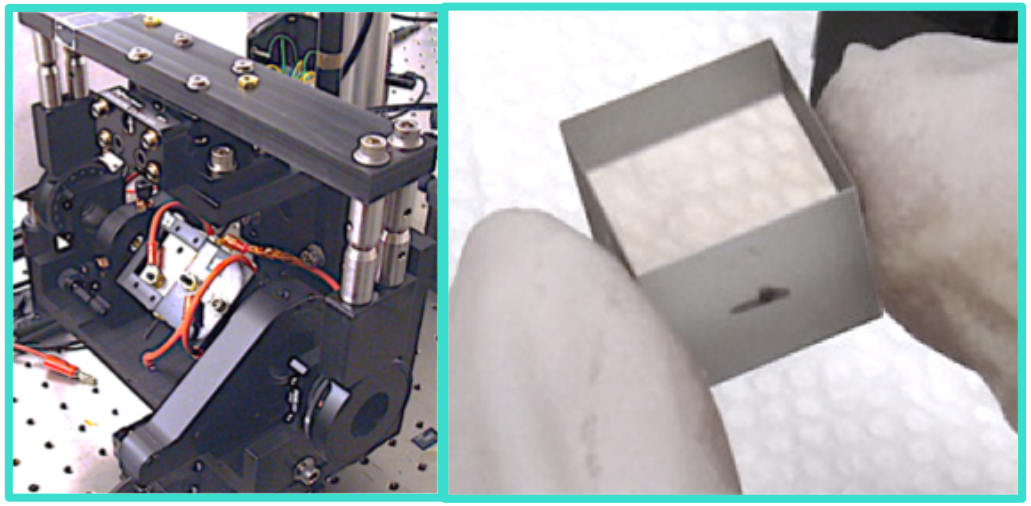
Photocathode (GaAs)



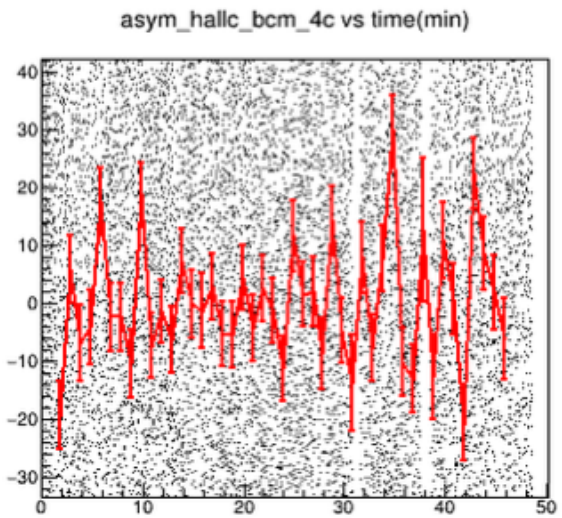


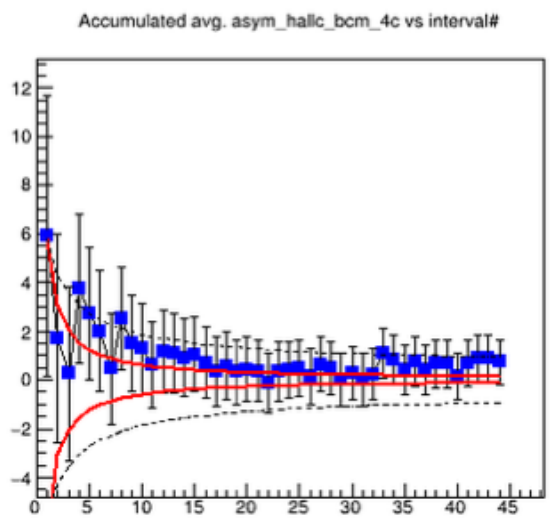
Polarized electrons

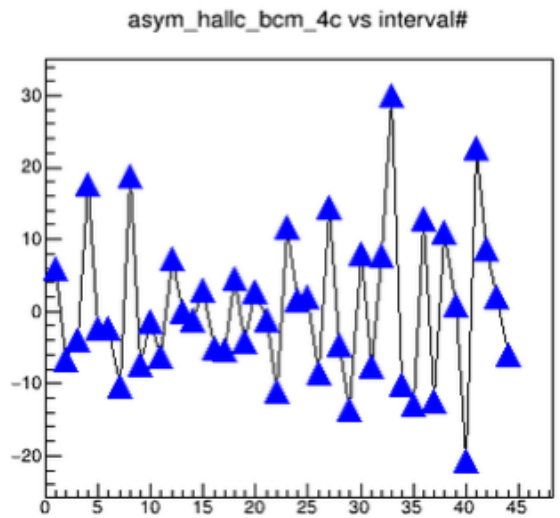


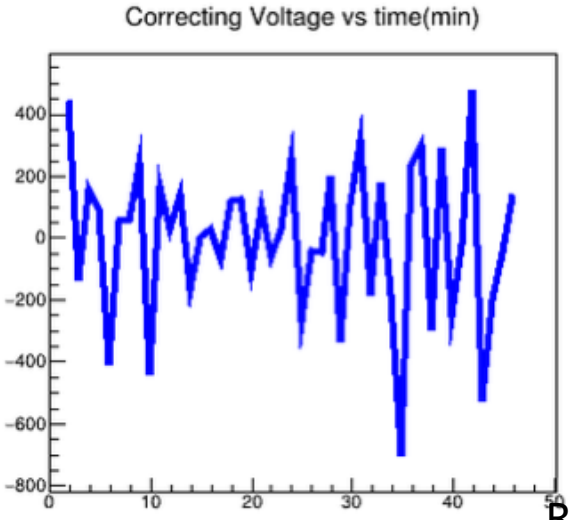


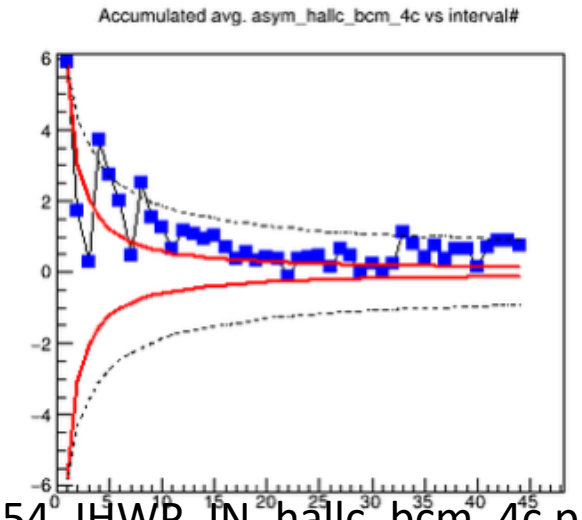
Polarized Beam Source

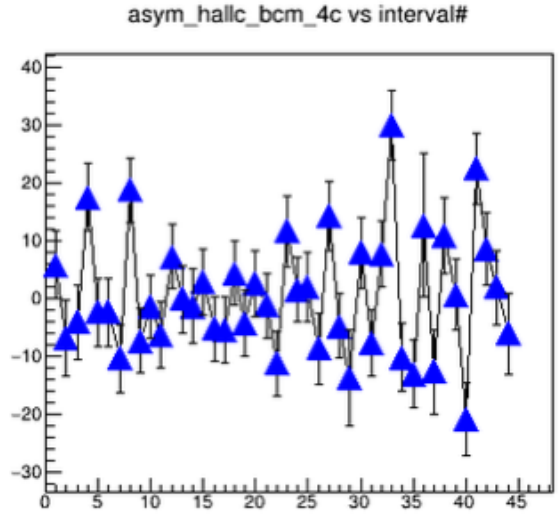






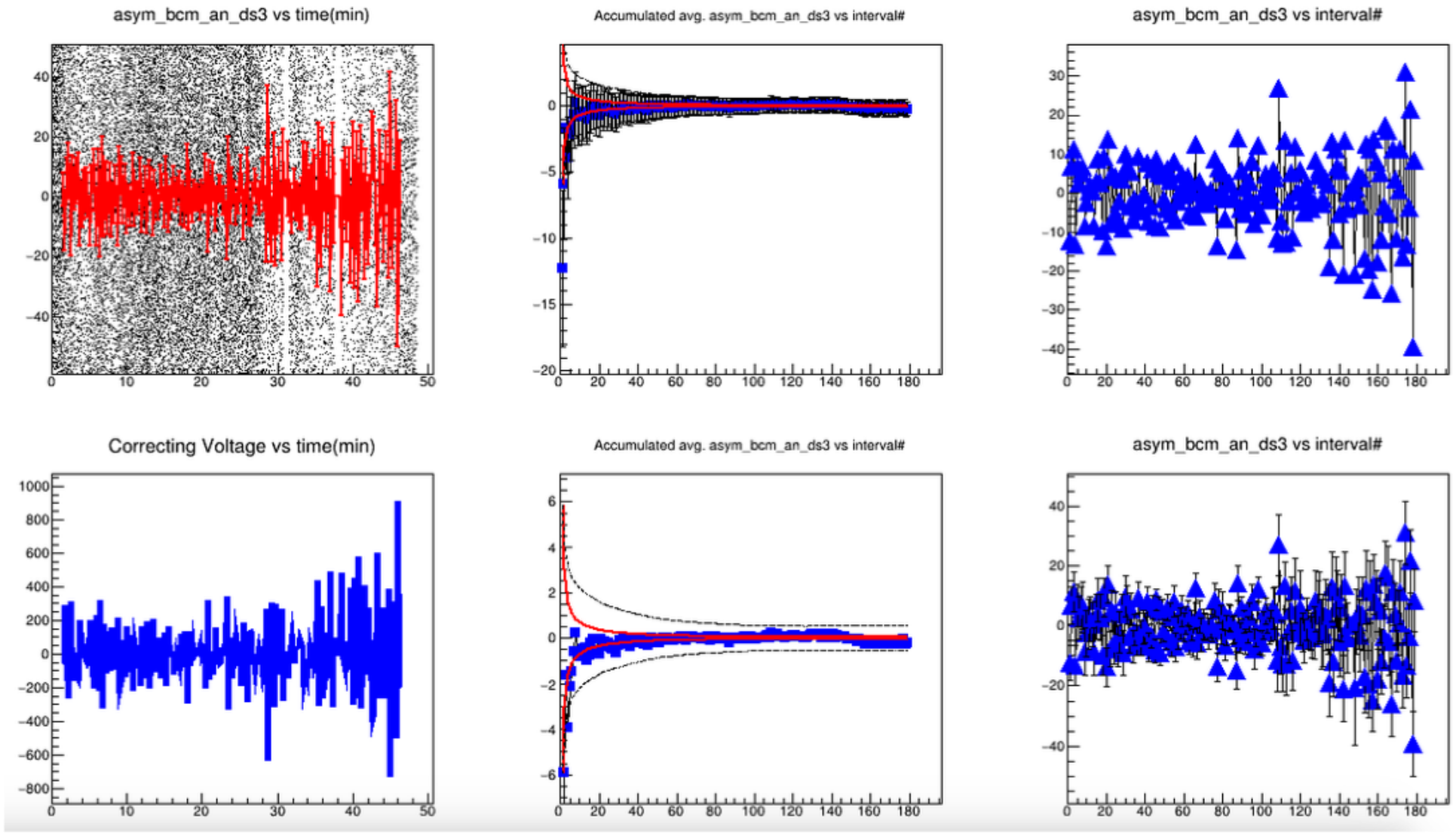






Run3454_IHWP_IN_hallc_bcm_4c.png

Same Run – HallA Aq on RTP feedback



Run3454_IHWP_IN_bcm_an_ds3.png