

Emittance from Polarimeter

11-10-05

Haixin Huang

Polarimeter Target Scan

BLUE

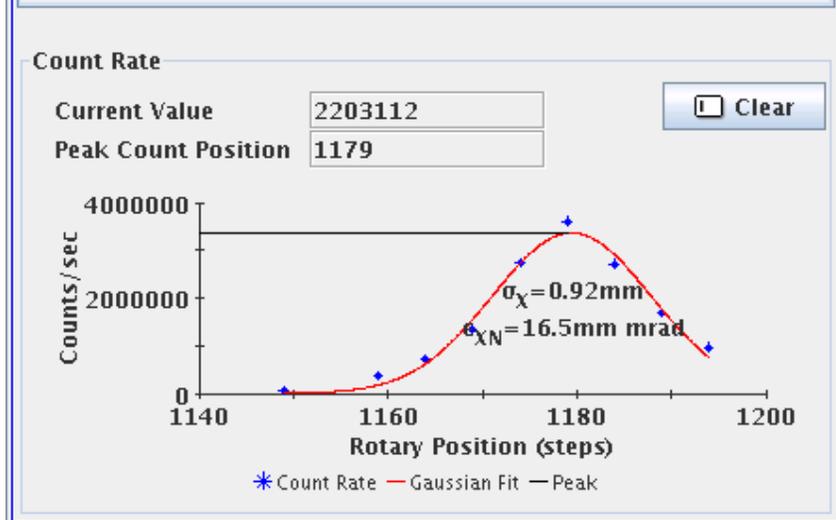
Start Stop Status W-Internal warning, se...

Automatic Manual

Time To Run 120 Number Events 15000000

Target stay at each position for 1 sec. Gaussian fit to give rms beam size and emittance (beta function from MAD).

Position 100 Time 1

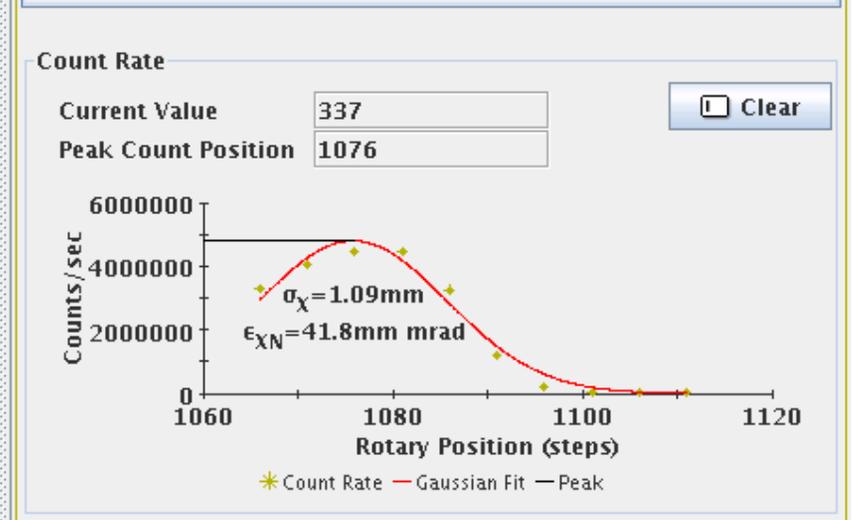


YELLOW

The target scan was done to center beam on the target. The beam profile is produced in such a scan and can be used as emittance measurement. Most data at injection with one bunch in run5.

Center Position 1091 Offset 25

Position 100 Time 1



Beta Functions

- The polarimeters located next to Q4 at YO12 and BI12.
- The lattice at injection: 10 meter beta*. Beta functions at polarimeter target location are:
 - Blue x: 23.2m (23.3m)
 - Yellow x: 28.45m (32.8m)
- The lattice at store: 5 meter beta*. Beta functions at polarimeter target location are:
 - Blue x: 32.8m(33.4m)
 - Yellow x: 16.4m(18.1m)
- We will measure beta functions near polarimeter by varying Q4 trim in addition to global measurement with AC dipole.

Injection on April 22

BLUE

Start Stop Status WInt WWFD

Automatic Manual

Time To Run 500 Number Events 15000000

Horizontal Vertical

Y-Rotary Target Position

Select Target Background Step Size 5

Target Position RotateOut Max Steps 10

Center Position 1177 Offset 25

Position 100 Time 3

Count Rate

Current Value 1291587 Clear

Peak Count Position 1173

$\sigma_Y = 1.34\text{mm}$
 $\epsilon_{YN} = 11.86\text{mm mrad}$

* Count Rate — Gaussian Fit — Peak

YELLOW

Start Stop Status OK

Automatic Manual

Time To Run 500 Number Events 15000000

Horizontal Vertical

Y-Rotary Target Position

Select Target Target2 Step Size 5

Target Position RotateOut Max Steps 10

Center Position 1612 Offset 25

Position 2100 Time 3

Count Rate

Current Value 1911725 Clear

Peak Count Position 1610

$\sigma_Y = 1.42\text{mm}$
 $\epsilon_{YN} = 9.64\text{mm mrad}$

* Count Rate — Gaussian Fit

Injection on April 22 with IPM



Comparison with IPM, AtR Flags

Measurement	Time	Ex	Ey
AtR	12:00	11.2+-0.4	4.6+-0.3
Blue Polarimeter Scan	11:26	12.0	
Yellow Polarimeter Scan	11:26	11.0	
Blue IPM	12:31	12.0	5.4
Yellow IPM	12:31	11.6	7.2

The comparison done on April 22 shows very good agreement (with all experts around). Bunch intensity was around 0.7×10^{11} .

June 19 Comparison with AtR (fill 7306)

BLUE

Start Stop Status E-Target control error

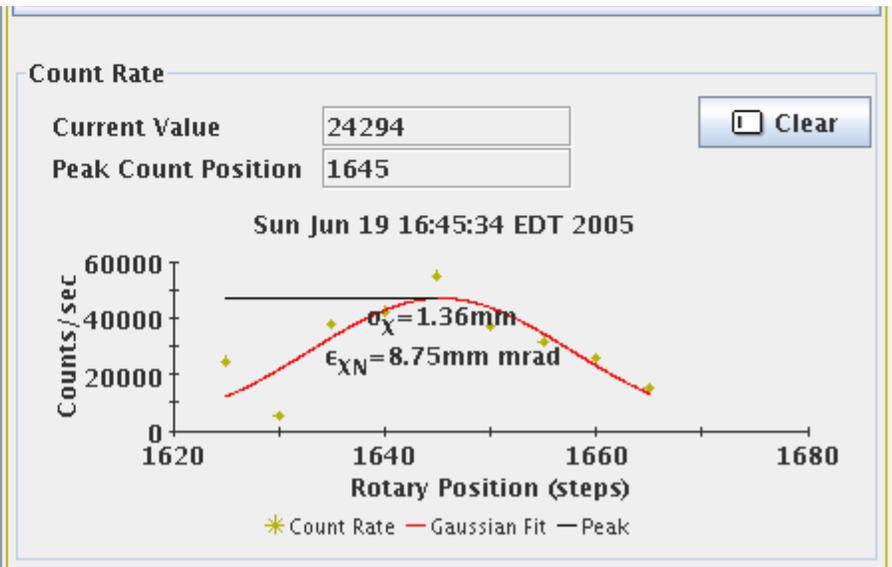
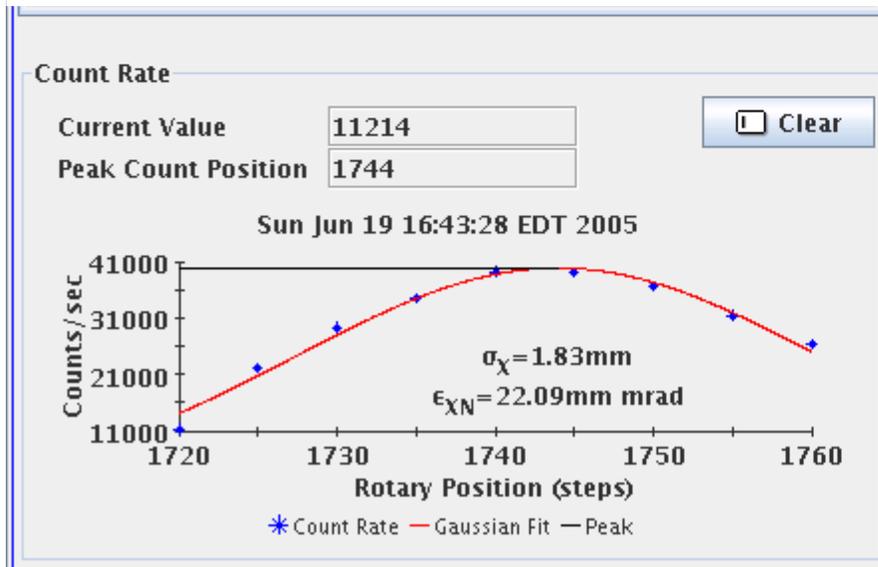
YELLOW

Start Stop Status E-Target control error

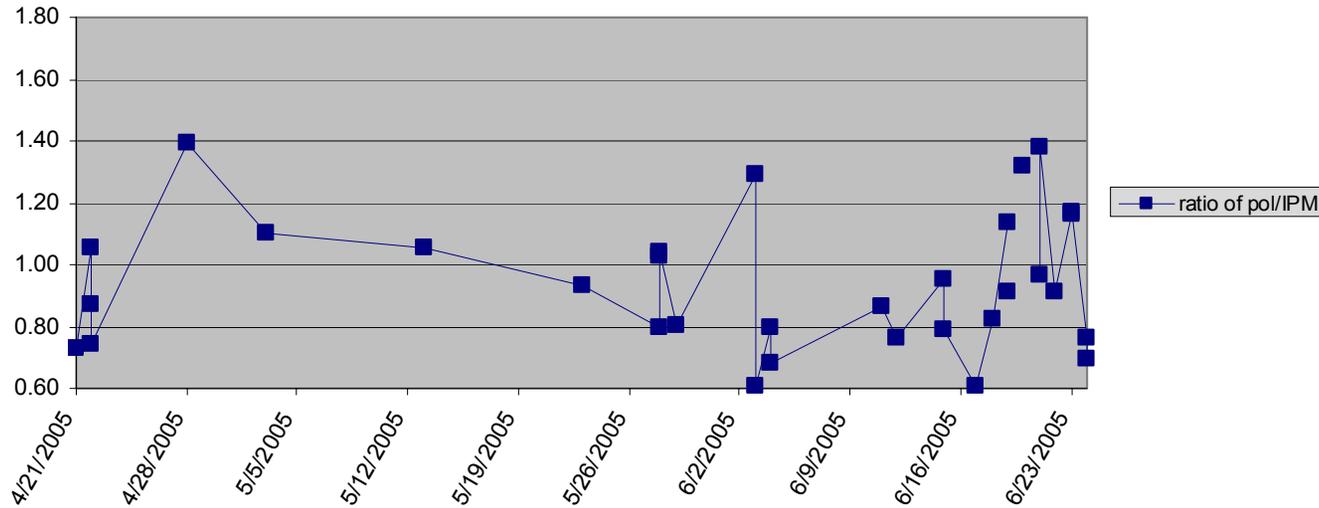
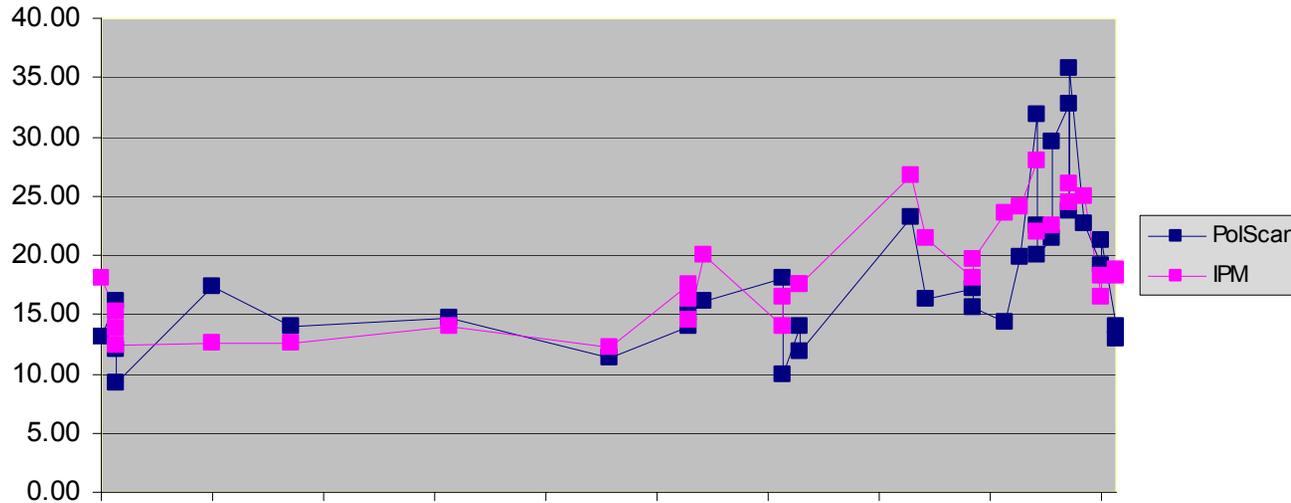
The measurement right after AtR measurement.

	Ex	Ey
Yellow	10.1 (poor fit)	
Blue	22.5	
W_line	30.3	7.5
U_line	33.9	5.8
AGS_IPM	27.5	10.7

at 1000 msec from T0



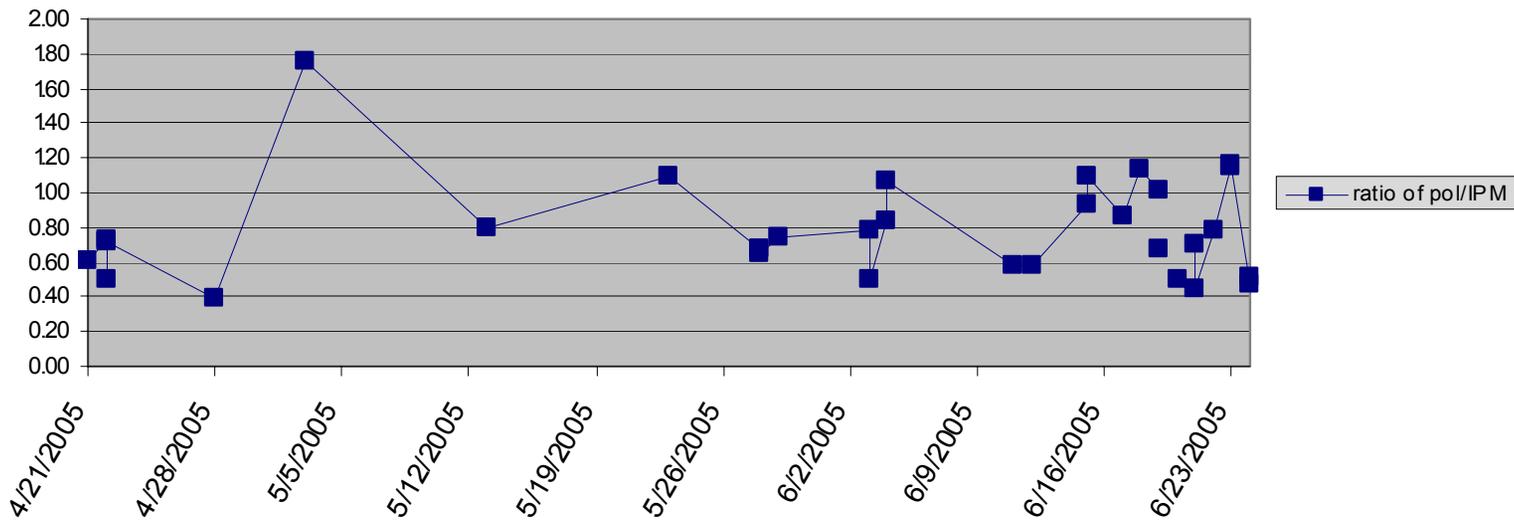
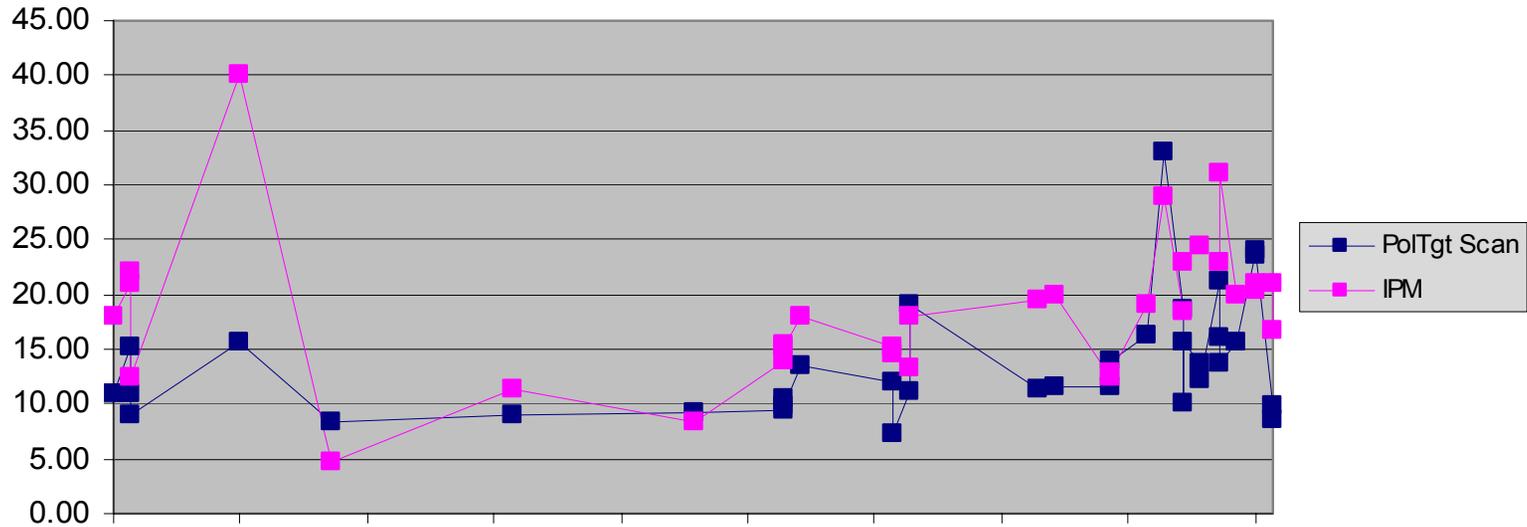
Blue Horizontal Emittance at Injection



Generally, the two methods correlated with each other and IPM gives bigger values.

The larger emittance in the middle of June was real.

Yellow Horizontal Emittance at Injection



Store Measurements

Date	Time	E_{bpol}	E_{ypol}	E_{bipm}	E_{yipm}	Conditions
04/21/05	13:46:00	18.4	13.2			6 bunch in store
04/28/05	03:46:00	24.1	36.8	45	32	6 bunch in store
05/28/05	14:36:00	11.6	12.7	34	30	7 bunch at store
04/21/05	14:53:00	19.6	17.6	28	27	0 hr in store
05/27/05	00:07:00	14.8		28		3 hr in store
05/01/05	06:00:00		15.5	37	30	5 hr in store
05/01/05	07:17:00		22.0	32	32	6 hr in store
04/25/05	14:30:00	39.4	36.1	42	54	8hr in store
04/27/05	02:04:00	59.2	27.0	44	58	8hr in store

The polarimeter target scan gives smaller emittance at store.

Comparison with ZDC Counts

DATE	Emi pol_B_H	Emi pol_Y_H	IPMB_H	IPMY_H	fill #	lumi(phenix)	bunch #	lumi(pol)	lumi(ipm)
04/21/05	13.15	17.57	28	26.5	6947	1400	55	1432	1070
04/28/05	17.39	36.83	45	32	6979	177	6	208	170
05/03/05	16.55	49.99	30.4	23.2	7010	1782	55	1816	1889
05/28/05	11.59	46.51	34.8	27.5	7156	270	7	304	263

Before and After Ramps

Date	Time	E_{bpol}	E_{ypol}	E_{bipm}	E_{yipm}	Fill
04/21/05	14:35:00	13.15	11.02	18	18	6947
04/21/05	14:53:00	19.55	17.57	28	27	6947
04/28/05	03:28:00	17.39	15.61	12.6	40	6979
04/28/05	03:46:00	24.09	36.83	45	32	6979
05/01/05	08:10:00		8.00	12.3	12.4	6998
05/01/05	08:25:00		49.99	31	45	6998
05/03/05	19:14:00	13.91	8.40	12.6	4.8	7010
05/03/05	22:52:00	16.55	46.51	30.4	23.2	7010
05/28/05	12:40:00	13.91	9.52	17.5	14	7155
05/28/05	14:36:00	11.59	12.72	34	30	7156

Both methods show emittance growth on the ramp.

Fill 6947 at Injection

BLUE

Status

Automatic Manual

Time To Run Number Events

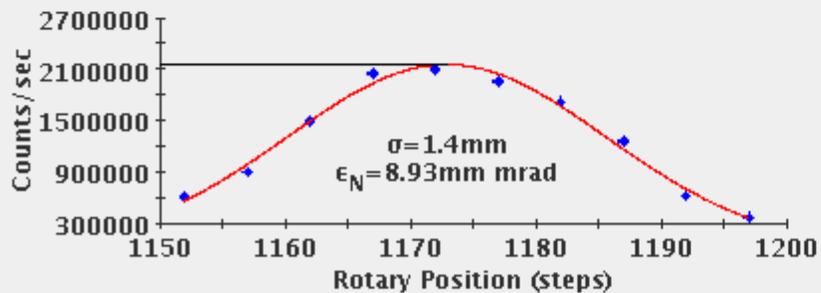
Y-Rotary Target Position

Select Target	<input type="text" value="Background"/>	Step Size	<input type="text" value="5"/>
Target Position	<input type="text" value="RotateOut"/>	Max Steps	<input type="text" value="10"/>
Center Position	<input type="text" value="1177"/>	Offset	<input type="text" value="25"/>
Position	<input type="text" value="100"/>	Time	<input type="text" value="3"/>

Count Rate

Current Value

Peak Count Position



* Count Rate — Gaussian Fit — Peak

YELLOW

Status

Automatic Manual

Time To Run Number Events

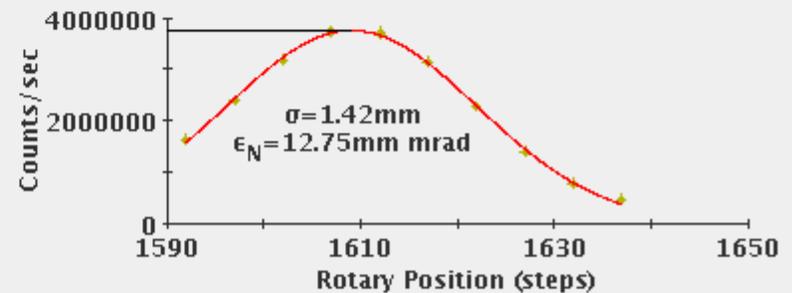
Y-Rotary Target Position

Select Target	<input type="text" value="Target2"/>	Step Size	<input type="text" value="5"/>
Target Position	<input type="text" value="RotateOut"/>	Max Steps	<input type="text" value="10"/>
Center Position	<input type="text" value="1612"/>	Offset	<input type="text" value="25"/>
Position	<input type="text" value="2100"/>	Time	<input type="text" value="3"/>

Count Rate

Current Value

Peak Count Position



* Count Rate — Gaussian Fit — Peak

Fill 6947 at Store

BLUE

Start Stop Status W-WFD unreliable

Automatic Manual

Time To Run 500 Number Events 20000000

Horizontal Vertical

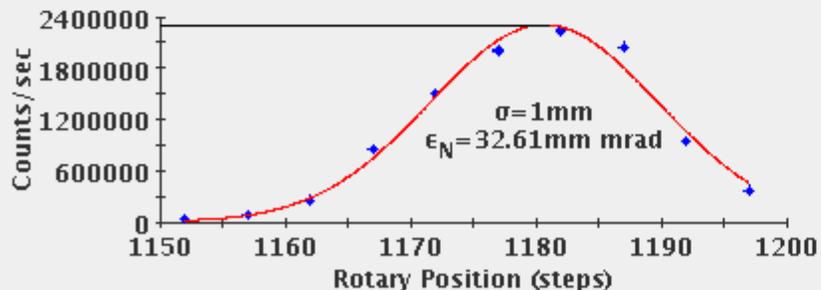
Y-Rotary Target Position

Select Target Background Step Size 5
Target Position RotateOut Max Steps 10
Center Position 1177 Offset 25
Position 100 Time 3

Count Rate

Current Value 365914
Peak Count Position 1181

Clear



YELLOW

Start Stop Status OK

Automatic Manual

Time To Run 500 Number Events 20000000

Horizontal Vertical

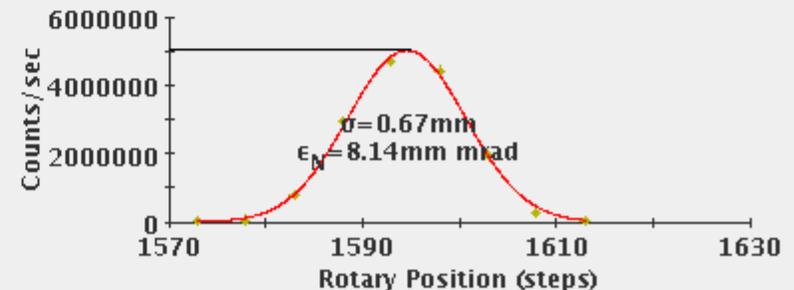
Y-Rotary Target Position

Select Target Target2 Step Size 5
Target Position RotateOut Max Steps 10
Center Position 1588 Offset 25
Position 2100 Time 3

Count Rate

Current Value 2889297
Peak Count Position 1595

Clear



Possible Error Sources

- There is a few percents uncertainty in the conversion between target steps and distance.
- The beta function at the polarimeter. Yellow injection horizontal beta was 32.5 m from online model but 28.5 m from MAD.
- The polarimeter data may not be exactly 1sec interval. This will be fixed for the coming run.
- Some targets are mounted loosely. There maybe an unknown effect from the target drifting. The effect would result bigger emittance.

Automation of Emittance Measurement

- To minimize the impact on target and detector lifetime, the profile will be taken similar to flying wire: target cross beam in less than a second.
- Signals from one of 45 degree detector will be processed (threshold, gate) by us.
- A simple correlation between the target step pulses and scaler readout will provide the profile.

A separate effort to provide a more sophisticated measurement will be done by the polarimeter group.

- One goal of next year's polarimeter measurement is to do all store measurement as profile measurement, namely, the target will scan through the beam(get polarization profile and beam profile the same time). Since polarimeter can separate data from different bunches, it can provide emittance of each bunch.

Summary

- Polarimeter target scan provides another way to measure emittance.
- In general, it shows similar emittance as IPM at injection and a smaller emittance than IPM at store.
- A few comparisons with AtR measurements show agreement.
- To compare with lumi data, we need emittances from both planes and both rings, which we did not have in last run.
- A systematic study of target scan vs. Vernier scan is needed in next polarized PROTON run.
- Work is underway to make such a profile measurement automatic and faster.