Spring 2011 Beam Test of
Active Collimator

Table of Contents

- Saturday 3/26
  - Tunnels for accessing in-hall resources off site
  - Initial scan for ActiveCollimator orientation
    - Accessing Hall B photon beam settings
    - New LabVIEW VI history file column headers:
- Sunday 3/27
- Monday 3/28
- Tuesday 3/29
- Analysis of Active Collimator Data

Useful phone numbers:

- P-403B conference room 860-486-5081
- Richard Jones 860-377-5224 (cell)
- Igor Senderovich 347-733-1306 (cell)
- John Turner 201-747-3871 (cell)
- Ann Marie Carroll 860-716-6539 (cell)
- Hall B counting house 757-269-5126, 5244, 5246, 5247
- James McIntyre 860-617-6722 (cell)

Saturday 3/26

Richard Jones - new shift started at midnight

Connected up to gummo (129.57.167.28) to confirm that it is still reachable. All 4 channels are set to 10^{12} gain and seem to show noise levels that are consistent with that gain setting. Igor noted that the noise levels on the outer wedges are smaller than what they were when the device was sitting on the floor near the entrance to the alcove earlier in the month. It is now mounted on top of the TAC. The plan is to use the TAC motion control system to scan the active collimator through the electron beam. Igor estimates that the active collimator axis is somewhat below the

height of the beam, within 2-3 cm. We will scan it horizontally through the beam and find the zero crossing in x, then go there and do a small vertical scan to find the symmetry point in y. Right now we have the problem that Igor is not able to access the EPICS variables that control the motion of the TAC. He believes that it may be a permissions problem. For the moment, the only way we have to move the TAC is by using the Hall B TAC motion control GUI, or remember the command-line commands that we used last time to make it carry out horizontal scans.

Action plan for the active collimator:

1. record values for the beam energy, current, radiator setting, and collimator.
2. scan the active collimator across the beam, without raising the height of the TAC at all.
3. determine where the horizontal zero crossing point is, and move the active collimator to the central x value.
4. record the GUI coordinate that corresponds to horizontal center, and record a left and right limit to be respected for all subsequent scans: [x_0 - 10cm, x_0+10cm]
5. slowly raise the height of the TAC by 3 cm, recording the rates in the active collimator channels as a function of height, searching for the symmetry point.
6. set the TAC vertical controls to this symmetry point, and go back to carry out several horizontal scans, recording the exact time vs. position for each step, and collected traces for each of the four readout channels.

Igor: The LabView VI was running at 3s intervals taking 2s traces and appears to “choke” at times: not enough overhead time to save the data etc., evidently. It was affecting other services like VNC access. Increased interval to 4s. Let’s keep watch of the extra time necessary for the computer to keep up.

Richard: Here is a perl program that I found in the folder I made during the last active collimator test. It is a script that moves the TAC in x, writes the position and time values, waits for a fixed time interval, and then continues.

tac.pl:

```
#!/usr/bin/env perl

use Pezca;
use lib ("$ENV{APP}/fcup_gain/scripts/");
use LSF;

$| = 1;

$n = 0;
$date_time = localtime;
print "----------------  $date_time
---------------------------------\n";
($error,$tacx) = Pezca::GetDouble('tac_x.RBV');
($error,$tac) = Pezca::GetDouble('frwd_scalerS13b.VAL');
($error,$slm) = Pezca::GetDouble('scaler_calc2');
($error, $na_2c21) = Pezca::GetDouble('IPM2C21A.IENG');
```

```
($error, $na_2c24) = Pezca::GetDouble('IPM2C24A.IENG');
$slm_s = &round_off($slm);
$c21_s = &round_off($na_2c21);
$c24_s = &round_off($na_2c24);
$tac_s = &round_off($tac);
$tacx_s = &round_off($tacx);
while ($tacx<$tacx_s+5.) {
  $tacx_p=$tacx+0.02;
#  while($n<5){
#    if ($na_2c21 < 5. || abs($c21_s - $na_2c21)>0.1*$c21_s ) {
## beam current does not match
#    }
#    else {
#      $n++;
#      sleep 2;
#   }
#    ($error,$slm) = Pezca::GetDouble('scaler_calc2');
#    ($error, $na_2c21) = Pezca::GetDouble('IPM2C21A.IENG');
#    ($error, $na_2c24) = Pezca::GetDouble('IPM2C24A.IENG');
# }
  sleep 20;
  $n=0;
  $error = Pezca::PutDouble("tac_x",$tacx_p);
  ($error,$tacx) = Pezca::GetDouble('tac_x.RBV');
  $tacx_a = &round_off($tacx);
  ($error,$tac) = Pezca::GetDouble('frwd_scalerS13b.VAL');
  $tac_a = &round_off($tac);
  $date_time = localtime;
  print "$date_time $tacx_a  $tac_a \n";
}

sub round_off {
    my ($x) = @_;
    $x = int(1000.*$x)/1000.;
}
```

The question came up, what is the variable above called “slm”. Franz suggests it is a “synchrotron radiation light monitor”, a secondary way to monitor the beam current. According to Franz, the above script is expected to work on machine clon01, username “clasrun”. I [Richard] used it back during the April/May 2007 test run, presumably from that machine, but Igor and Hovannes would prefer to get the labview control GUI working, and let us do everything from gummo. I agree that this would be preferable, provided that it does not take too much time.

9:40am

Moving active collimator: +6.49, +0.1 (from 0,0; all TAC coordinates in inches). Sweeping the active collimator horizontally across the beam, with the vertical coordinate left fixed at the parked height, shows a significant displacement only in the fourth octant. Viewed from the front, this is the right-most. Some momentary oscillation is seen in the

first octant momentarily as it sweeps through the beam, but it does not show the large current (5V) seen in the fourth octant. The two central octants do not show any measureable response during the sweep, suggesting that the beam is either above or below the height of the central aperture.

Beam remains steady since last night, beam current is fluctuating between 7.5 and 10.5 nA. Effort this morning remains focused on getting the labview program to work that is designed to move the TAC by writing to EPICS variables controlling the x and y displacements. Igor and Hovannes are working together on the problem.

Tunnels for accessing in-hall resources off site

How to tunnel into the hall for Remote Desktop access to Windows PC's.

1. From a windows desktop, start the putty application. In the Session pane, enter the name of the login host and port, login.jlab.org port 22. Enter the name "jlab" for this session, and save it.
2. Under Window->Colours, select the check box "Use system colours".
3. Under Connection->ssh->Tunnels create a new Local forwarding from a Source port of your choice (eg. 3390) to 129.57.167.28:3389 and click Add. Go back to the Session tab and save the session again, then click Open.
4. Log in using the Jefferson Lab cue userid and password that you have been assigned.
5. Under Programs->Accessories, chose the Remote Desktop application on your Windows desktop, and enter localhost:3390 (or whatever the Source port was that you selected in step 3 above). It should open a connection over your tunnel to port 3389 on 129.57.167.28, which is the standard Remote Desktop port on the DAQ machine gummo located in the entryway to the Hall B alcove. Beware that if someone else is already using the machine and you log on, you will kick them off and acquire the desktop for your own exclusive list.

How to tunnel access to a web server inside the Hall for access from an offsite browser.

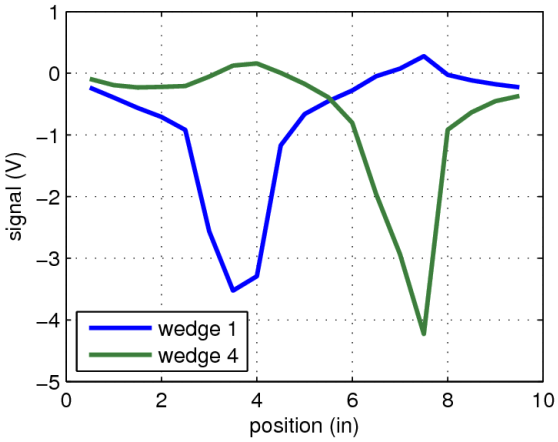
1. Starting from the session on login.jlab.org created in the above procedure, create a ssh connection to a machine inside the Hall to which you have access. This machine may be running Linux, or if Windows, it must have Cygwin installed so that it is possible to obtain a login prompt over ssh.
2. From the shell on the in-hall machine, start a ssh connection back to the machine on which you want to run the browser that accesses the hidden server. This can be a Linux box or a Windows box with Cygwin installed so that the sshd daemon is running. Create a remote listening port that forwards to the standard http port on the hidden server by using the -R option to the ssh command. For example, suppose I want to access the hidden server 129.57.96.66 (cctvsrv) from offsite machine gluey.phys.uconn.edu, then I can do "ssh -R 8080:129.57.96.66:80

myuserid@137.99.19.33" where "myuserid" is your userid on gluex. This outgoing connection must remain in place for as long as the access is required.

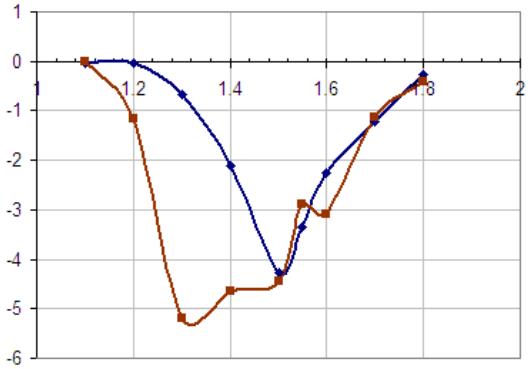
3. From another window on the offsite machine (gluex.phys.uconn.edu) start a browser and direct it to the url http://localhost:8080 or whatever local port you selected in the -R argument used when setting up the tunnel in step 2 above. The tunnel should forward the request to the hidden server on port 80.

Initial scan for ActiveCollimator orientation

Initial scan in the x direction at the default y=0.1" This indicated the center of the beam was aligned with the collimator axis at around x=5.5". A closer search in that area showed roughly comparable inner wedge currents at 5.4". Based on that, the x offset was fixed at 5.4" and a scan in y was performed.



These data were recorded in the directory: `OrientationScan-3-26-2011 run1`. The results are shown by the two series at the right, blue=wedge 2, brown=wedge 3.
Center appears to be at **1.4cm: this is the value set into Hall B GUI for subsequent scans**



During a preliminary, rough y-scan, where the beam likely went solidly through the needles of wedge 2, the signal exceeded 10V at maximum gain.

Accessing Hall B photon beam settings

First menu window, "clas_epics" in the descriptions below is accessed with "clas_epics" command from clonXX machines.

- Menu for radiators: **`clas_epics/Photon Devices/[radiator group choice]`** where the radiator groups include "radiators" and "Radiators Long" (latter typically Au

and Pt)
- Menu for collimators: **`clas_epics/Photon Devices/collimators`**
  The current choice will be highlights and/or the “motor position” will be shown to be compared to the listed location of the retractable element.

This is the first horizontal scan: `HorizontalScans-3-26-2011/run1`

- Beam energy: 3361 MeV
- Current: 15 nA
- Collimator: 2.6 mm
- Radiator: 10^{-4} radiation lengths, gold

Scan range was x=0.0 to x=11.0 in., y=1.4 in.
The settings of the scan GUI are as follows:

- trace length: 1 s + 100 ms overhead
- step interval: 5 s
- step size (x): 0.1 in.
- settling time: 1 s
- preamp gain setting: 10^{-9} A/V
- ADC voltage full scale: +/- 5 V all 4 channels prefix used for trace files: run1_trc_

Scan was aborted at x=6.5 in. when beam trip paused the scan and was unable to recover. Igor is looking into the code to fix this.

New LabVIEW VI history file column headers:

1. acquisition number (matches trace file numbering)
2. absolute acquisition time in seconds since some date (see LabVIEW documentation)
   Note that trace files will have times relative to this time stamp.
3. TAC x-position in inches
4. beam current in nA
5. wedge 1 signal - left outer wedge
6. wedge 2 signal - left inner wedge
7. wedge 3 signal - right inner wedge
8. wedge 4 signal - right outer wedge

Run 2: `HorizontalScans-3-26-2011/run2`
We are doing a re-run with the same values as run 1. Igor has changed the code so that the scan resumes after the beam stops and resumes.

Run 3: `HorizontalScans-3-26-2011/run3`
Values that have changed:

- preamp gain setting: 10^{-10} A/V
- ADC voltage full scale +/- 10 V all 4 channels

Run 4: `HorizontalScans-3-26-2011/run4`
Values that have changed:

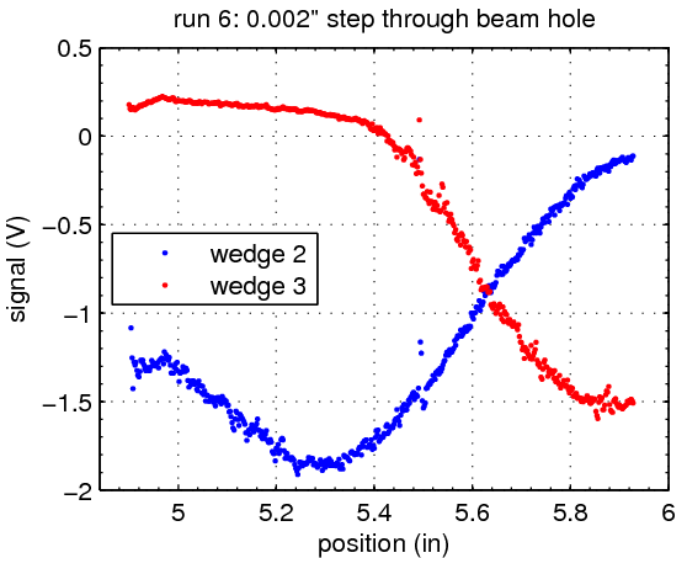
- ADC voltage full scale +/- 5 V all 4 channels

.
Run 5: `HorizontalScans-3-26-2011/run5`
Values that have changed:

- step size (x): 0.02 in.

Run 6: `HorizontalScans-3-26-2011/run6`
Igor suggested that we do a more precise run around the center of the beam. The scan range is concentrated around x=5.4 (the calculated center of the beam) and the step size has been reduced. Values that have changed:

- scan range x=4.9 to x=5.9 in., y=1.4 in.
- step size (x)=.002 in.



At this point the collimator was moved down by 0.02 in. to y=1.38 in. by a technician at Jlab.

Run 7:
`HorizontalScans-3-26-2011/run7`
Values that have changed:

- scan range x=0.0 to x=11.0 in., y=1.38 in.
- step size (x)=0.01 in.

Run 8: `HorizontalScans-3-26-2011/run8`
Values that have changed:

- scan range x=0.0 to x=11.0 in., y=1.42 in.
- step size (x)=0.01 in.

Sunday 3/27

Run 0: `HorizontalScans-3-27-2011/run0`
To follow up on the fine-step run6 of previous day, I [Igor] am doing a fine, long-trace scan

around the beam hole. I want to be able to get a stability analysis by frequency so long time windows are important to avoid smearing low frequency components (indeed, the scatter of DC in run6 probably comes from the short, 1s, traces gathered)
Scan:

- scan range: 5.5-5.7in
- step size: 0.001” (25.4um)
- time window: 5s
- time to move: 3s
- pre-amp gain: 10^{11}
- DAQ range: +/- 10V

Run 2: `HorizontalScans-3-27-2011/run2`
Long-time-window step through the whole collimator. Parameters:

- scan range: 2-9.5in
- step size: 0.01”
- time window: 5s
- pre-amp gain adjusted as needed during run.

Run 3: `HorizontalScans-3-27-2011/run3`

- ADC voltage range adjusted as needed during run
- pre-amp gain :10^{10}
- scan range x=2.0 in. (not positive) to x=9.0 in.

Run 4: `HorizontalScans-3-27-2011/run4`

- scan range x=5.5 in. to x=5.7 in.
- trace length: 5s
- step interval: 10s
- ADC range started at +/- 1.25 on all four channels and was adjusted when necessary to prevent clipping.

I (Ann Marie) had made a mistake with the timing of the moving of the collimator so am doing a new run with the changed values as follows:

Run 5: `HorizontalScans-3-27-2011/run5`

- trace length: 10s
- step interval: 16s
- time to move: 5s

Run 6: `HorizontalScans-3-27-2011/run6`

- x=4.9 to x=5.9

aborted at 5.57 inches due to channel two saturating.

Run7: HorizontalScans-3-27-2011/run7

To determine the exact center of the beam we will do a fine scan. From x=5.6 to x=5.7 with step size (x)=.01 inches. We will then look in the log book to determine where the center of the beam is.

- x=5.6 to x=5.7 in.
- step size=.01 in.

Run8: HorizontalScans-3-27-2011/run8 trc_1-15
Run at the center position determined from run7 (x=5.6465).

- 10s window
- 15s interval

Run8: HorizontalScans-3-27-2011/run8 trc_16-44

- Rerun of HorizontalScans-3-26-2011/run6

Analysis of Run6, Run7, and Run8 from 3-26-2011

- Slope(CH3-CH2),Run6=8.304

Horizontal scans from Saturday 3/26/2011

Run #	trace len. (s)	interval (s)	time to move (s)	step size (in)	x bounds (in)	y pos. (in)	gain V/A	ADC range (V)	Comments
1	1.0	5.0	1.0	0.1	0.0-11.0	1.4	10^9	+/- 5 .0	scan stopped at x=6.5in
2	1.0	5.0	1.0	0.1	0.0-11.0	1.4	10^9	+/- 5.0	code fixed for this run
3	1.0	5.0	1.0	0.1	0.0-11.0	1.4	10^{10}	+/- 10.0	
4	1.0	5.0	1.0	0.1	0.0-11.0	1.4	10^{10}	+/- 5.0	
5	1.0	5.0	1.0	0.02	0.0-11.0	1.4	10^{10}	+/- 5.0	
6	1.0	5.0	1.0	0.002	4.9-5.9	1.4	10^{10}	+/- 5.0	concentrated on center
7	1.0	5.0	1.0	0.01	0.0-11.0	1.38	10^{10}	+/- 5.0	lowered collimator
8	1.0	5.0	1.0	0.01	0-11.0	1.42	10^{10}	+/- 5.0	raised collimator

Horizontal scans from Sunday 3/27/2011

Run #	trace len. (s)	interval (s)	time to move (s)	step size (in)	x bounds (in)	y pos. (in)	gain V/A	ADC range (V)	comments
1	5.0	130	3.0	0.5	2.0-2.5	1.4	10^{11}	+/- 10.0	just 2 traces in this run
2	5.0	13	3.0	0.01	2.0-9.5	1.4	var.	+/- 10.0	gain changed as needed
3	5.0	13	3.0	0.01	2.0-9.0	1.4	10^{10}	var.	ADC changed as needed. Not sure about x
4	5.0	10	3.0	0.01	5.5-5.7	1.4	10^{10}	var.	ADC changed as needed
5	10.0	26	5.0	0.01	5.5-5.7	1.4	10^{10}	var.	ADC changed as needed
6	10.0	26	5.0	0.01	4.9-5.9	1.4	10^{10}	var.	ADC changed as needed
7	2.0	7.0	5.0	0.0001	5.645-5.648	1.4	10^{10}	var.	x moves around at first
8	10	13	3.0	.001	5.600 -5.628	1.4	10^{10}	var.	scan starts after initial few

Monday 3/28

Run0: HorizontalScans-3-28-2011
We are attempting to find the proper y orientation. Run0 is a sweep of the center at the current y-position of y=1.40in

- y=1.40 in
- step=.01 in

Run1: HorizontalScans-3-28-2011 -- started at 07:55

- y=1.39 in.
- step=0.002 in.
- gain is 10^{10} V/A
- interval: 3 s
- scan length: 1 s + overhead 100 ms

- time to move: 300 ms

Run 2: HorizontalScans-3-28-2011 started at 1840

- steps =0.1 in
- gain is 10^9 V/A
- beam current increased to 60 nA
- interval: 3 s
- time to move: 300 ms

Run 3: HorizontalScans-3-28-2011

- steps =0.02 in
- interval: 3 s

… a few more scans under the same conditions, finer step size for good measure.

Horizontal scans from Sunday 3/28/2011

Run #	trace len. (s)	interval (s)	time to move (s)	step size (in)	x bounds (in)	y pos. (in)	gain V/A	ADC range (V)	comments
1	1.0	3.0	0.3	0.002	0-1.964	1.4	10^{10}	+/- 10.0	
2	1.0	3.0	0.3	0.1	0-12.35	1.4	10^9	+/- 10.0	hit limit switch at 12.35 in
3	1.0	3.0	0.3	0.02	0-12.39	1.4	10^9	+/- 10.0	hit limit switch at 12.39 in
4	1.0	3.0	0.3	0.002	0-12.39	1.4	10^9	+/- 10.0	traces 946-999 lost/garbled

Igor: Had access to the hall late Monday evening. Checked on collimator - the “top” marking looked fairly well oriented. Now, the cables on the left hand side (wedges 1 & 2) were tilted up to stay clear of beam scanning in the x direction, but they were tilted close to 45deg. The connectors, have fairly solid copper cubes for elbows and the beam
may have showered on the corner of the connector to wedge 2. I thought it would be useful to tilt the cables to a more modest angle, the way it is on the right so that subsequent scans are cleaner. Either way this would teach us something. The photo shows the adjusted layout.



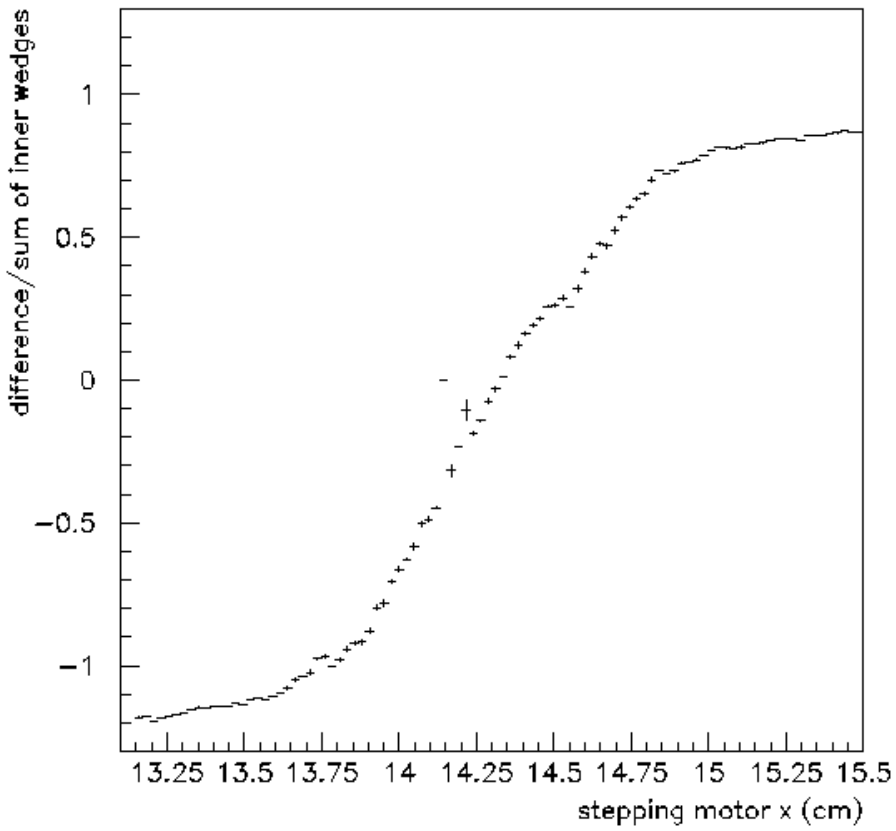
Tuesday 3/29

Richard Jones, Mar. 29 06:00
I set up jobs to copy the data files from the hard drive on gummo back to the cluster. My intention is to collect all of the trace files that go with a run summary file (runN) into a tarball and

store them as runN_trc.tgz in the same directory. These can then be archived on dcache.

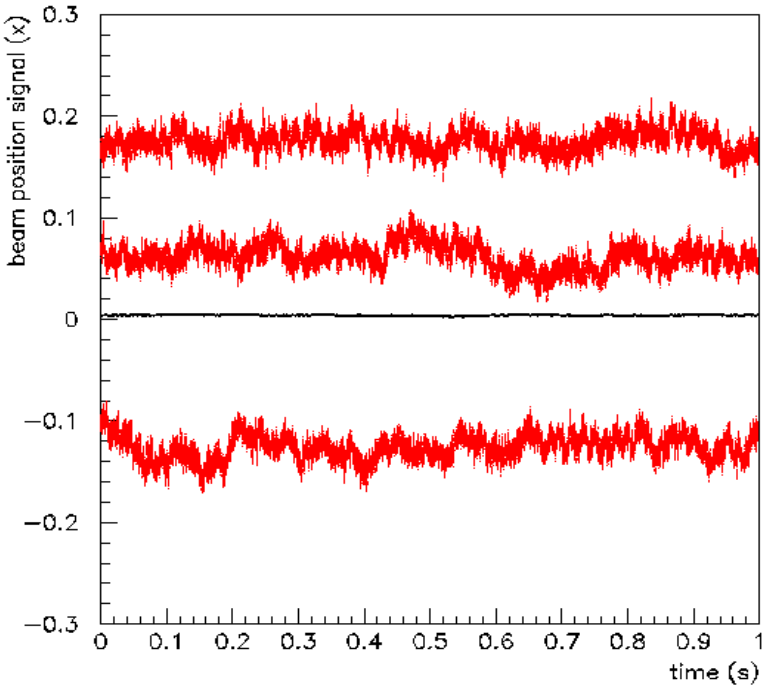
Analysis of Active Collimator Data

Here is a plot of the difference/sum of the current signals on the inner wedges.



Ratio of difference over sum of currents in the two inner wedges, as a function of displacement of the translation stage in the horizontal direction across the beam.

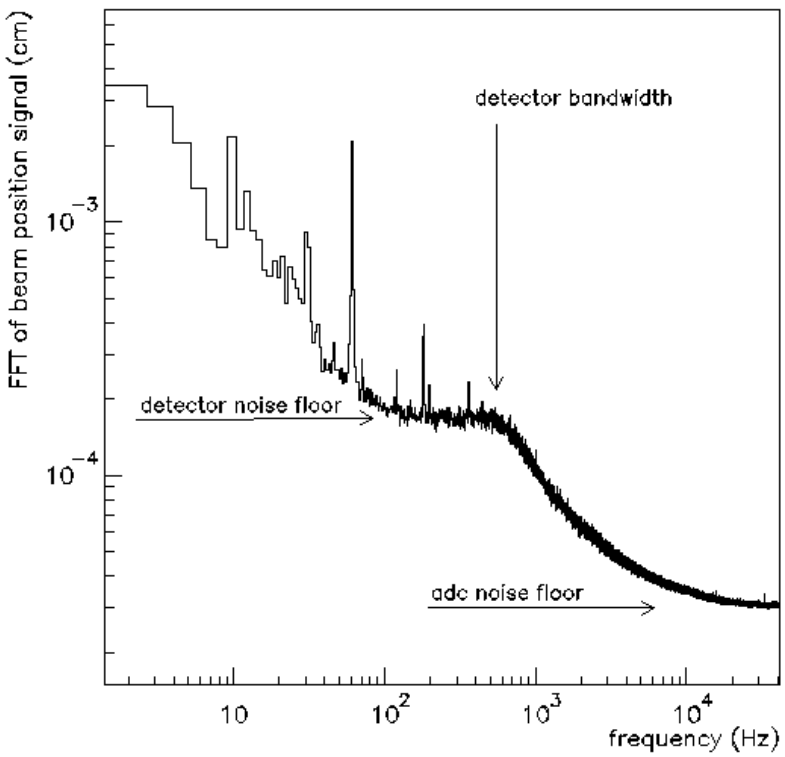
As an initial look at the frequency response of the active collimator, I look at 1-second traces on the inner two wedges that were captured when the beam was within a few mm of the center of the hole. The following traces came from 3.28.2011-run1.



Photon beam centroid x position signals (red) formed from difference/sum of the two inner wedges, converted to cm. The traces were taken at different offsets of the beam from alignment on the central axis of the collimator. The reference trace (black) formed from measurements taken without beam present indicates the level of detector and electronics noise

The above measurements were taken at 15 nA electron beam current, with a radiator of 10^{-4} radiation lengths thickness. The black trace was taken without beam present represents the intrinsic noise of the detector and electronics. It was formed by taking the difference between left and right wedges when the detector was mounted next to the photon beam dump in Hall B, without any beam in the hall, and dividing the difference by the average current sum observed on these two wedges under the conditions of 15 nA electron beam with the photon beam close to centered on the collimator. The total current in the active collimator is roughly constant as long as the photon beam is within 5 mm of centered on the collimator axis.

The data were collected using an ADC sampling at a rate of 82.5 kHz. This high sampling rate allows a detailed frequency analysis to be carried out on the signals. The following plot shows the FFT of the signal traces shown above. It has been averaged over 100 one-second traces, during which time the active collimator was scanned across the center of the photon beam in steps of 50 microns. The total range of the scan was from -2.5 mm to +2.5 mm in x. The detector was stationary during the sampling period, so only the zero-frequency component of the FFT is affected by the shifts in x. That bin has been suppressed in the plot below.



FFT coefficients (magnitude) of the x beam position signal taken while the photon beam is within 2.5 mm of the center of the collimator axis. Prominent peaks are seen in the spectrum at 30, 60, 120, 180, 198, and 360 Hz, corresponding to different modes of beam motion. The edge near to 600 Hz shows the bandwidth of the preamplifier at the gain setting used in this measurement.