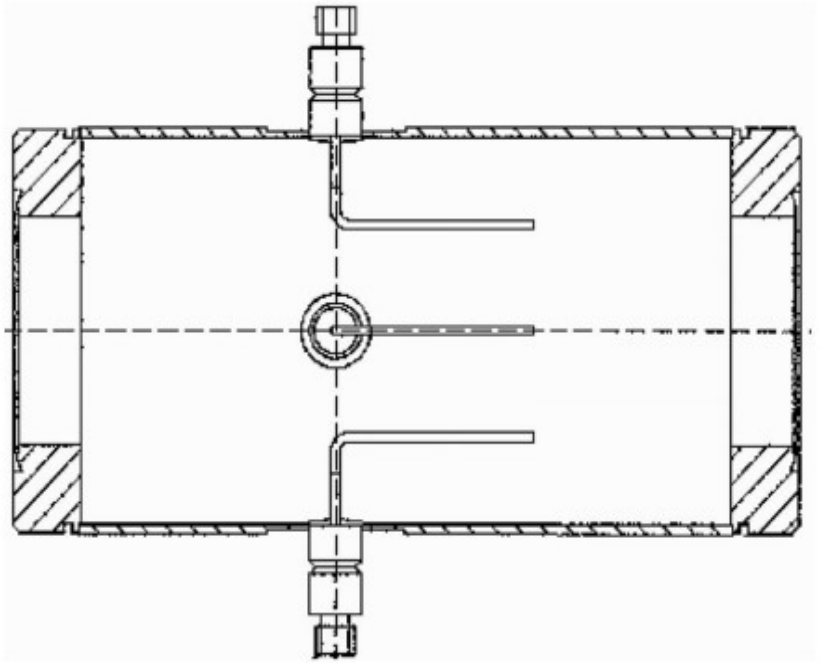
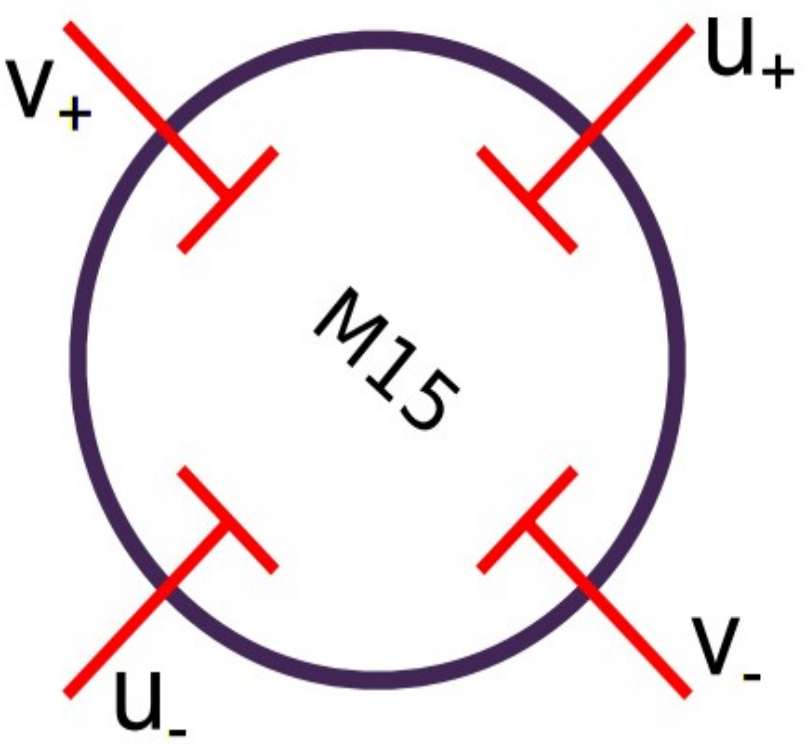
BPMs and Harps



(a) BPM design diagram, from JLab instrumentation group



(b) BPM chamber which contains 4 antennas

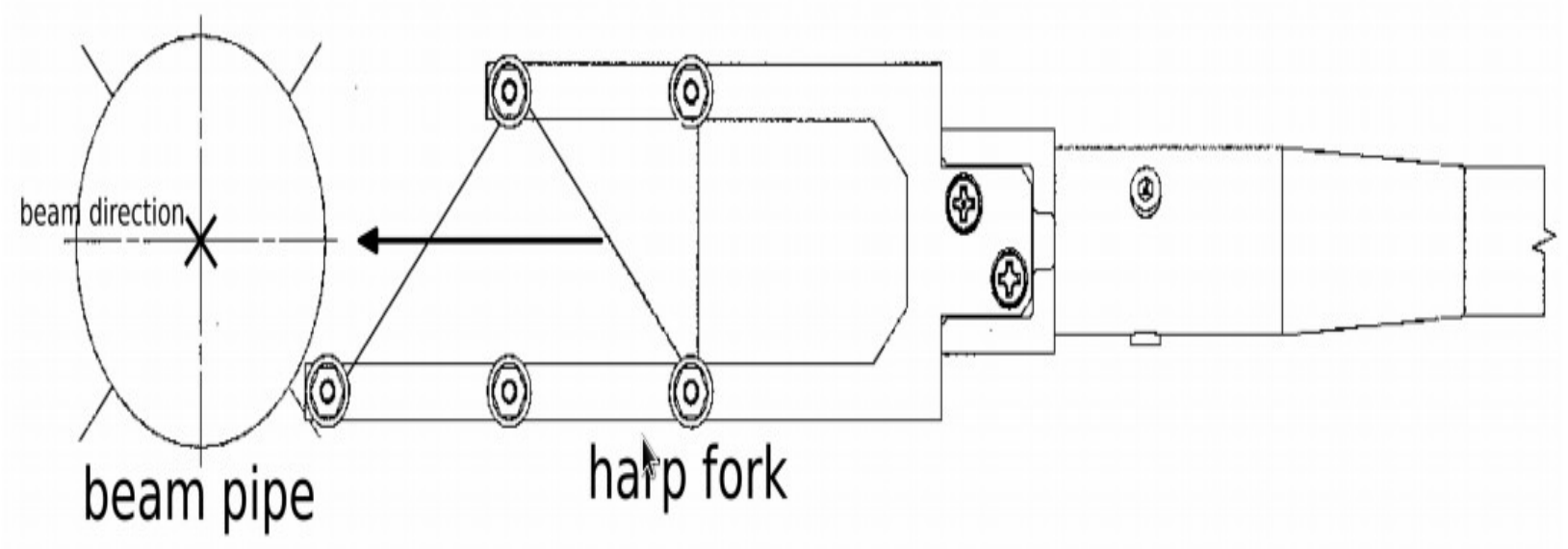


Figure 3: Harp diagram

BMP calibration

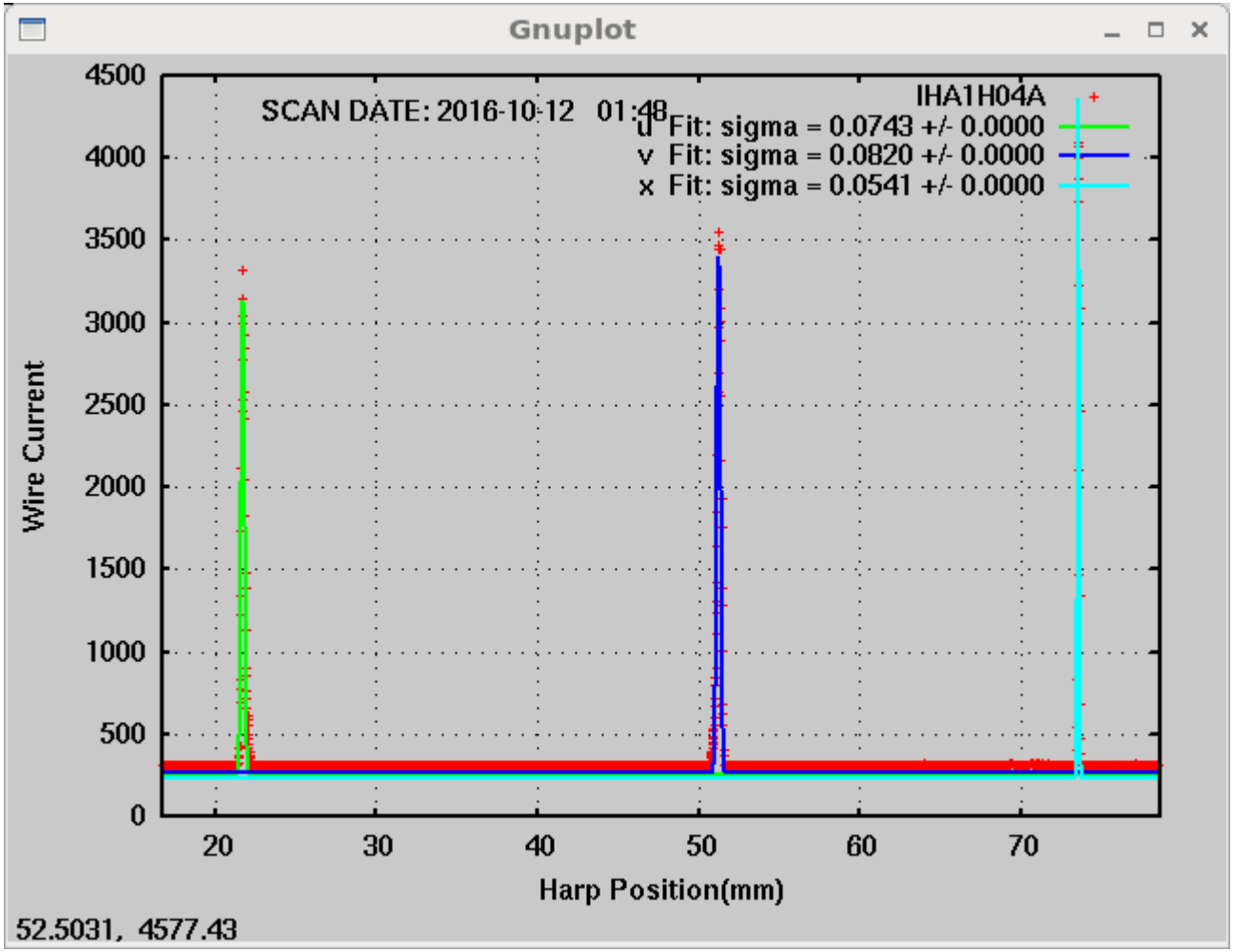
- There are two steps to calibrate the BPMs
  - Twiddle: Use one signal wire to output a known signal.
    - Calibrate the BPM wires to detect to a relative position.
    - This gives a meaning to the BPM readings
  - Calibration with HARPS:
    - Use harps to determine an exact beam position
    - Then compute a transformation matrix.

BPM and HARP

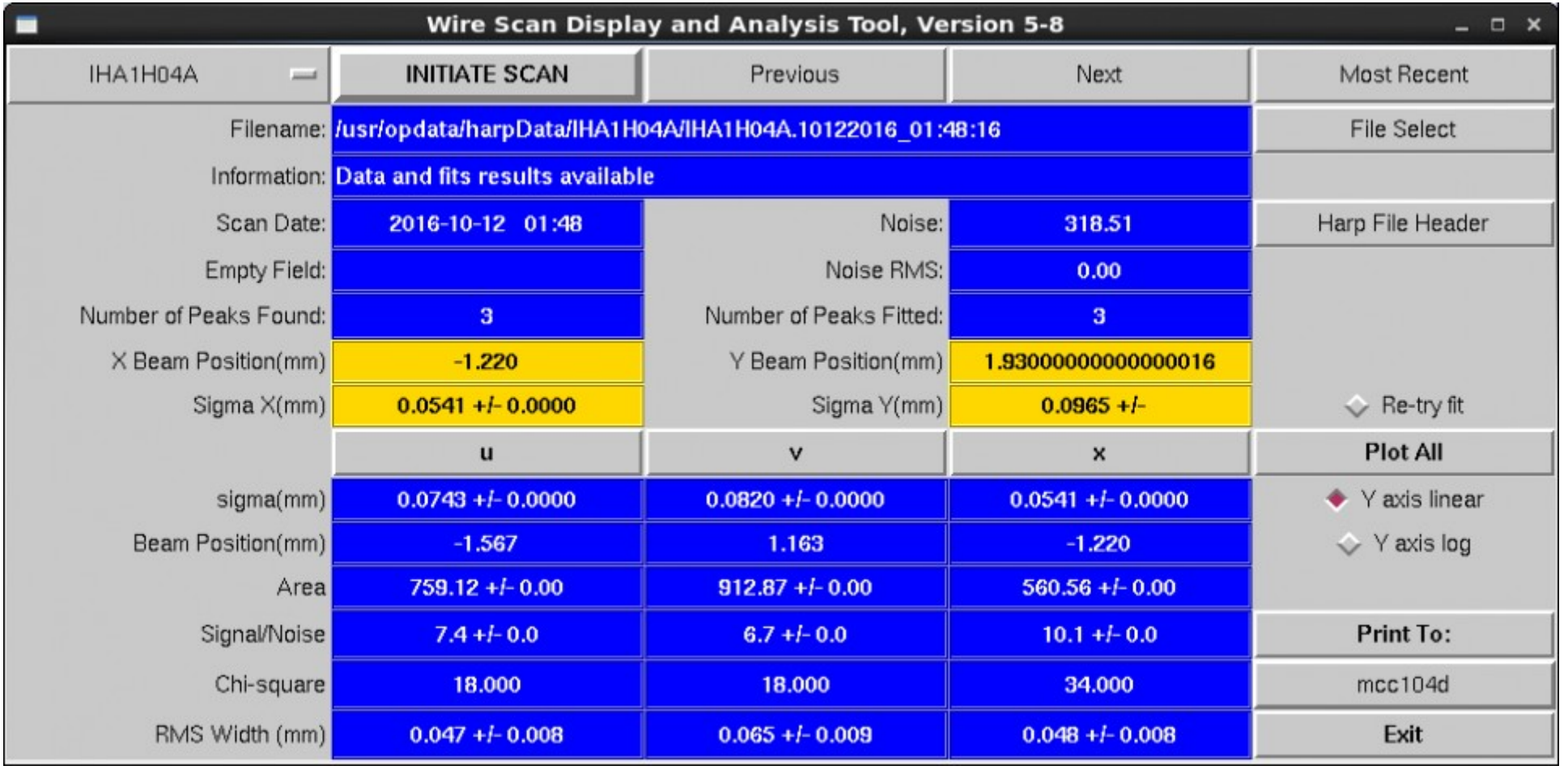
$$\begin{pmatrix} x \\ y \end{pmatrix}_{Lab} = \begin{pmatrix} C(0,0) & C(0,1) \\ C(1,0) & C(1,1) \end{pmatrix} \times \begin{pmatrix} x \\ y \end{pmatrix}_{BPM} + \begin{pmatrix} Offset(0) \\ Offset(1) \end{pmatrix}$$

- BPM is not an absolute measurement of position.
- Calibrate the BPM using the absolute position of the Harps
- Need to convert the harp results to absolute position and transform to correct coordinate system.

First (Harp Scan) Completed (10/12/2016)



First (Harp Scan)



a-onl@aonl1:~/rastersize/thir/harp_2016

File Edit View Search Terminal Help

```
# ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++ #
#
# File: /usr/opsdata/harpData/IHA1H04A/IHA1H04A.10122016_01:48:16
# Ioc Name:      iochaharp1
# Harp Name:     IHA1H04A
# Time Taken:    Oct 12, 2016 01:48:16
# Beam Current: 0.000000
# Beam Mode:     UP
# Motor Speed:  1.000000 mm/sec
# Harp Type:     SuperHarp
# Gain:          1
# Beam Sync:     YES
# Number of Digitized Points:   4976
# Pos min:       2.921992        Pos max:        85.724380
# Signal min:    0.000000        Signal max:     0.137329
# Conversion factor:    1.000000
#
# index      pos        signal
# ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
1       2.921992        0.010681
2       2.921992        0.010681
3       2.922612        0.010681
4       2.925093        0.010681
5       2.928193        0.010681
6       2.933774        0.010681
7       2.941216        0.010681
8       2.950517        0.010681
9       2.961680        0.010681
10      2.975322        0.010681
11      2.990205        0.010681
12      3.006328        0.010681
13      3.022451        0.010681
14      3.039194        0.010681
15      3.055938        0.010681
16      3.072681        0.010681
17      3.089424        0.010681
18      3.106167        0.010681
19      3.122910        0.010681
20      3.139653        0.010681
21      3.155776        0.010681
22      3.172519        0.010681
23      3.189263        0.010681
24      3.206006        0.010681
25      3.222129        0.010681
26      3.238872        0.010681
27      3.255615        0.010681
28      3.272358        0.010681
29      3.289102        0.010681
30      3.305845        0.010681
31      3.322588        0.010681
32      3.339331        0.010681
33      3.356074        0.010681
34      3.372817        0.010681
35      3.389560        0.010681
--More--(1%)
```

a-onl@aonl1:~/rastersize/thir/harp_201

File Edit View Search Terminal Help

```
35      3.389560        0.010681
36      3.406304        0.010681
37      3.422427        0.010681
38      3.439170        0.010681
39      3.455913        0.010681
40      3.472656        0.010681
41      3.488779        0.010681
42      3.505522        0.010681
43      3.522266        0.010681
44      3.539009        0.010681
45      3.555752        0.010681
46      3.571875        0.010681
47      3.588618        0.010681
48      3.605361        0.010681
49      3.622104        0.010681
50      3.638848        0.010681
51      3.655591        0.010681
52      3.672334        0.010681
53      3.689077        0.010681
54      3.705820        0.010681
55      3.722564        0.010681
56      3.739307        0.010681
57      3.755430        0.010681
58      3.772173        0.010681
59      3.788916        0.010681
60      3.805659        0.010681
61      3.822402        0.010681
62      3.839145        0.010681
63      3.855268        0.010681
64      3.872012        0.010681
65      3.888755        0.010681
66      3.905498        0.010681
67      3.922241        0.010681
68      3.938984        0.010681
69      3.955728        0.010681
70      3.972471        0.010681
71      3.989214        0.010681
72      4.005957        0.010681
73      4.022700        0.010681
74      4.039443        0.010681
75      4.056187        0.010681
76      4.072309        0.010681
77      4.089053        0.010681
78      4.105796        0.010681
79      4.122539        0.010681
80      4.139282        0.010681
81      4.156025        0.010681
82      4.172769        0.010681
83      4.189512        0.010681
84      4.206255        0.010681
85      4.222378        0.010681
86      4.239121        0.010681
87      4.256485        0.010681
88      4.272607        0.010681
--More--(2%)
```

Harp Scan results

Finding the Peak

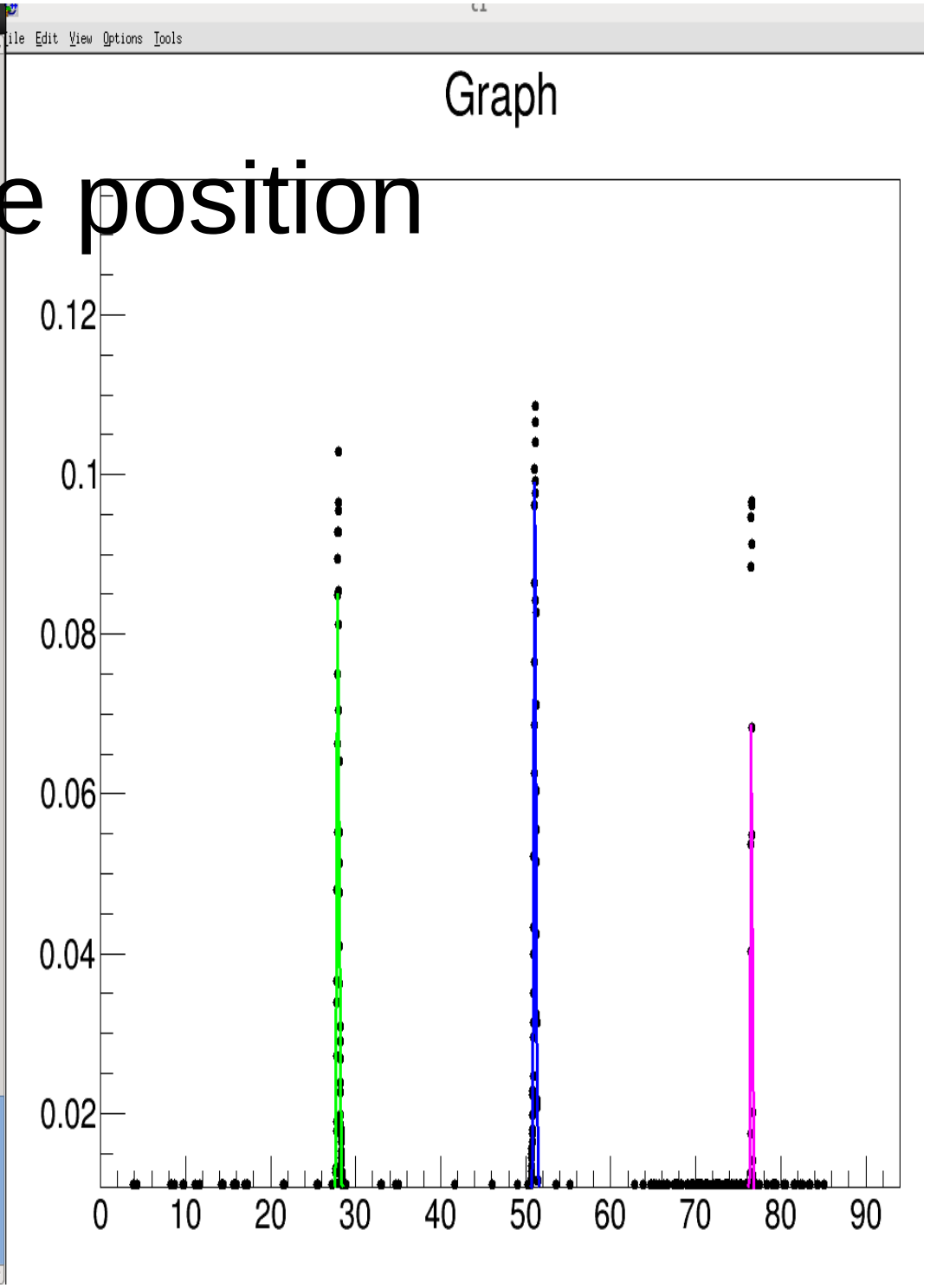
1113	21.361176	0.010986
1114	21.377920	0.010986
1115	21.394043	0.010986
1116	21.410786	0.010986
1117	21.428148	0.010986
1118	21.444273	0.012207
1119	21.461016	0.012207
1120	21.477758	0.012512
1121	21.494501	0.014038
1122	21.511246	0.014343
1123	21.527988	0.023499
1124	21.544731	0.025940
1125	21.560854	0.028076
1126	21.577597	0.041199
1127	21.594341	0.045166
1128	21.610464	0.058289
1129	21.627827	0.070801
1130	21.643950	0.082703
1131	21.660692	0.084839
1132	21.677437	0.093079
1133	21.694180	0.105286
1134	21.710922	0.100403
1135	21.727665	0.111084
1136	21.744410	0.101929
1137	21.761152	0.097961
1138	21.777895	0.095520
1139	21.794638	0.086365
1140	21.811382	0.081177
1141	21.828125	0.068665
1142	21.844868	0.061340
1143	21.861610	0.049744
1144	21.878355	0.046692
1145	21.895098	0.038147
1146	21.911840	0.030212
1147	21.927963	0.028687
1148	21.944706	0.025635
1149	21.961451	0.024109
1150	21.978193	0.022278
1151	21.994936	0.020447
1152	22.011679	0.019836

2888	50.953167	0.020142
2889	50.969910	0.022583
2890	50.986656	0.024109
2891	51.003399	0.026855
2892	51.020142	0.028381
2893	51.036884	0.030212
2894	51.053627	0.037231
2895	51.070370	0.041504
2896	51.086494	0.043945
2897	51.103855	0.047607
2898	51.120602	0.055237
2899	51.136723	0.062256
2900	51.153465	0.073853
2901	51.170208	0.086365
2902	51.186951	0.090332
2903	51.203697	0.099487
2904	51.220440	0.107422
2905	51.237183	0.116272
2906	51.253925	0.119019
2907	51.270668	0.115356
2908	51.287411	0.115662
2909	51.304153	0.103455
2910	51.321518	0.100708
2911	51.338261	0.096741
2912	51.354385	0.085754
2913	51.371128	0.072632
2914	51.387871	0.064697
2915	51.404613	0.058899
2916	51.421356	0.046692
2917	51.438099	0.043030

Finding the position

```
a-onl@aonl1:~/rastersize/thir/harp_2016 (on aonl1.jlab.org)
[a-onl@aonl1 harp_2016]$
[a-onl@aonl1 harp_2016]$
[a-onl@aonl1 harp_2016]$
[a-onl@aonl1 harp_2016]$
[a-onl@aonl1 harp_2016]$
[a-onl@aonl1 harp_2016]$
[a-onl@aonl1 harp_2016]$
[a-onl@aonl1 harp_2016]$
[a-onl@aonl1 harp_2016]$
[a-onl@aonl1 harp_2016]$
[a-onl@aonl1 harp_2016]$ analyzer
  ************************************************
  *                                              *
  *           W E L C O M E  to  the             *
  *      H A L L A   C++  A N A L Y Z E R        *
  *                                              *
  *       Release     1.5.32        Nov  1 2016  *
  *  Based on ROOT  5.34/17         Feb 24 2014  *
  *                                              *
  *           For information visit              *
  *       http://hallaweb.jlab.org/root/         *
  *                                              *
  ************************************************

CINT/ROOT C/C++ Interpreter version 5.18.00, July 2, 2010
Type ? for help. Commands must be C++ statements.
Enclose multiple statements between { }.
analyzer [0] .x harpAnalyzer_2016.C
Pick a harp to analyze
0) IHA1H04A
1) IHA1H04B
0
Pick a run to analyze
0) 01:48:16
1) 02:02:00
2) 02:10:48
3) 02:25:17
4) 02:37:43
5) 03:19:26
6) 03:31:44
6
Info in <TCanvas::MakeDefCanvas>:  created default TCanvas with name c1
Position X = -4.228 mm,  Sigma X = 0.080 mm
Position Y = -1.252 mm,  Sigma Y = 0.112 mm
analyzer [1]
analyzer [1]
analyzer [1]
analyzer [1]
analyzer [1]
```



BPM Calibration

- Take the harp scan and calculate the absolute beam position in the lab frame.
  - Example script located at:
    - /adaqfs/home/a-onl/rastersize/thir/harp_2016
    - harpAnalyzer_2016.C
  - Take all harp scans and compile them into a text file
  - Example of this file:
    - /lustre/expphy/work/halla/triton/Bane/thir
    - harp_resultsR.text
  - In the same directory:
    - Thir_RHRS_bpm.c
    - Uses the text file to produce the coefficients:

Calibration results:

I was asked to run the Calibrations and compare with the current database as of (10/25/16): **** Has been updated since!
BPMA constants :

- c(0,0), c(0,1), c(1,0), c(1,1), Off(0), Off(1)

-
- mine 0.759072 -0.726608 0.787124 0.730018 -0.0010599 0.00170399
- current 0.759028 -0.737819 0.787136 0.736787 -0.0010817 0.0017238

- BPMB constants :
- mine 0.636639 -0.775111 0.673286 0.721734 -0.0002521 -0.00068270
- current 0.636623 -0.680089 0.673286 0.716724 -0.0002599 -0.00068229

Calibration results:

- Some of my results are diff:
  - C(0,1) for BPMb has a large difference.
  - After further investigation:
    - In the current DB, one of the calibrating harp positions was incorrect.
    - This was corrected and the new DB values have been entered.