FFS Orbit-Steering/FB: Software Task

16-12-08

7th ATF2 Project Meeting

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Yves Renier (LAL), Glen White (SLAC)

Philip Burrows (JAI), Javier Restalopez (JAI)

The Group

- **Orbit correction**
  - Anthony Scarfe
  - Glen White
  - Yves Renier
- **Feedback**
  - Glen White
  - Javier Restalopez

Javier’s Feedback Method

Overview

- Design of a fast beam based intra-train IP-FB: to combat jitter due to vibration of magnets in the FFS and reduce residual beam position jitter at the IP (for multibunch mode operation)
- Using Honda IP-BPM with nm resolution level
- See previous talk for more detail

Glen’s Feedback Method

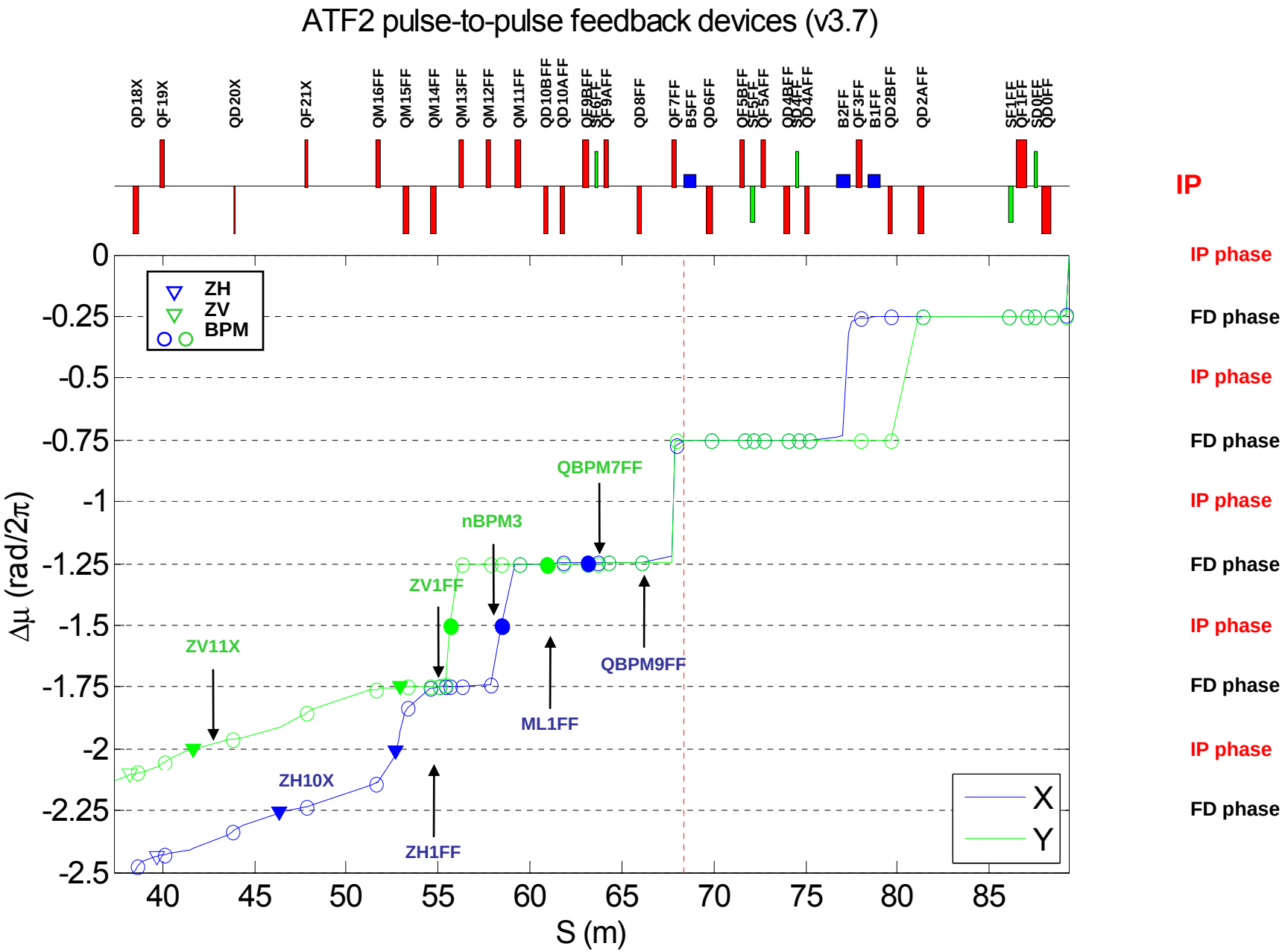
Feedback Studies

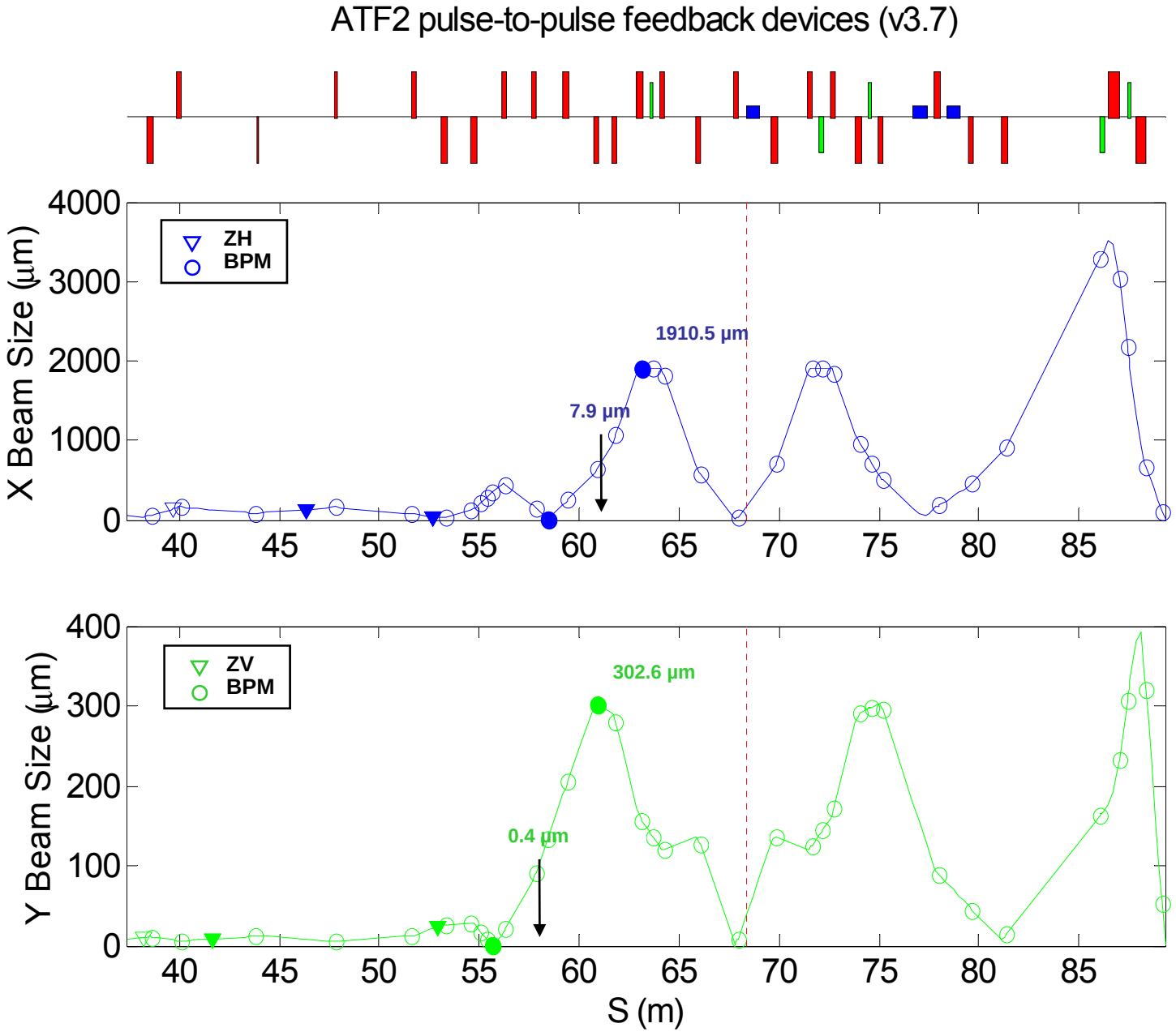
Feedback Model

- Use all available correctors and BPM's in EXT
  - 10 correctors in x, 11 in y
  - 23 BPMs
- Use 2 corrector/BPM pairs at start of FFS in non-dispersive region
- Feedback weights: 0.1 (FFS) 0.01 (EXT)

Study Jitter Effects

- Fast = 90 pulses
  - Study effects of fast jitter on beam size measurement
  - Orbit jitter => beam size jitter + beam position jitter -> beam size jitter through Shintake monitor measurement process
  - First effort towards integrating a Shintake Monitor simulation
- Slow = hours -> 2 weeks
  - Ground motion causes slow drifts at IP and throughout machine
  - Need to periodically retune to restore beam size


ATF2 pulse-to-pulse feedback devices (v3.7)
QD18X
QF19X
QD20X
QF21X
QM16FF
QM15FF
QM14FF
QM13FF
QM12FF
QM11FF
QD10BFF
QD10AFF
QF9BFF
QF6FF
QF9AFF
QD8FF
QF7FF
B5FF
QD6FF
QF5BFF
QF5FF
QF5AFF
QD4BFF
QD4FF
QD4AFF
B2FF
QF3FF
B1FF
QD2BFF
QD2AFF
SF1FF
QF1FF
SD0FF
QD0FF
IP
IP phase
FD phase
IP phase
FD phase
IP phase
FD phase
IP phase
FD phase
IP phase
FD phase
ZH
ZV
BPM
QBPM7FF
nBPM3
ZV1FF
ZV11X
QBPM9FF
ML1FF
ZH10X
ZH1FF
X
Y
Δμ (rad/2π)
S (m)
0
-0.25
-0.5
-0.75
-1
-1.25
-1.5
-1.75
-2
-2.25
-2.5
40
45
50
55
60
65
70
75
80
85


ATF2 pulse-to-pulse feedback devices (v3.7)
X Beam Size (μm)
ZH
BPM
1910.5 μm
7.9 μm
Y Beam Size (μm)
ZV
BPM
302.6 μm
0.4 μm
S (m)

Orbit Correction

- Three different methods
- Comparison test underway (same 100 seeds test) 2 complete sets of results
- Order of importance (average values after correction)
  - Vertical beamsize
  - Vertical IP jitter
  - Horizontal beamsize
  - Horizontal IP jitter
  - Orbit RMS
  - Orbit jitter

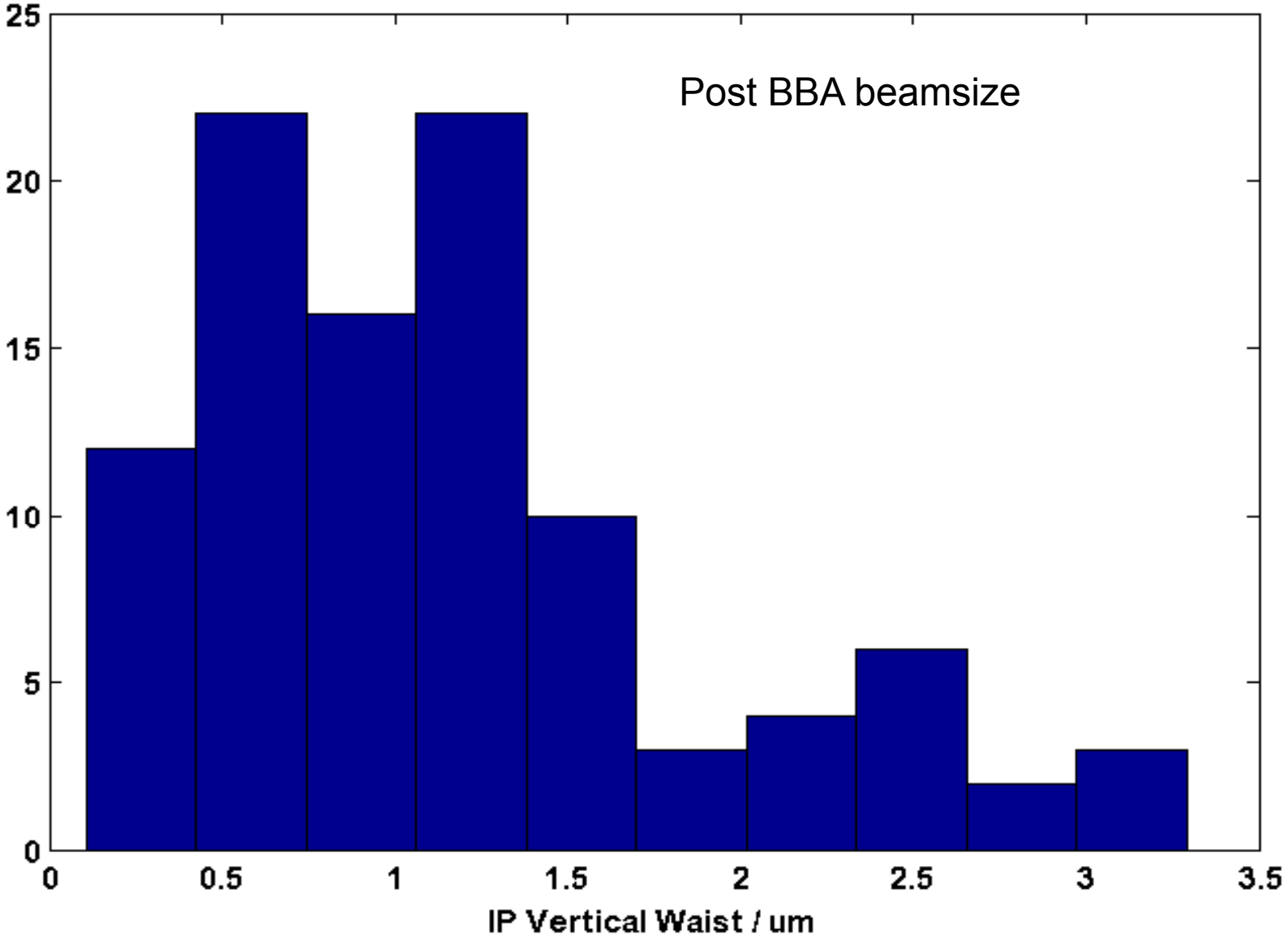
Anthony's Method

- Record the horizontal orbit in the FFS
- Set a quad mover to 10μm horizontal position
- Record the horizontal orbit
- Reset the mover to previous setting
- Calculate the difference in the horizontal orbit at each BPM in FFS
- Repeat for all quad movers
- Construct a response matrix
- Repeat for vertical plane, assuming orthogonality
- Zero weight QM11FF & QD2BFF and BPMs at QM16FF & QM13FF
- Pseudo-invert the response matrices using SVD, retain 20 Eigen values for SVD for both response matrices
- Record current orbit
- Set horizontal and vertical mover positions to X.Rhor.10-5 and Y.Rvert.10-5 respectively, where X and Y are the horizontal and vertical FFS BPM readings, Rhor and Rvert are the horizontal and vertical response matrices and the mover positions are in meters

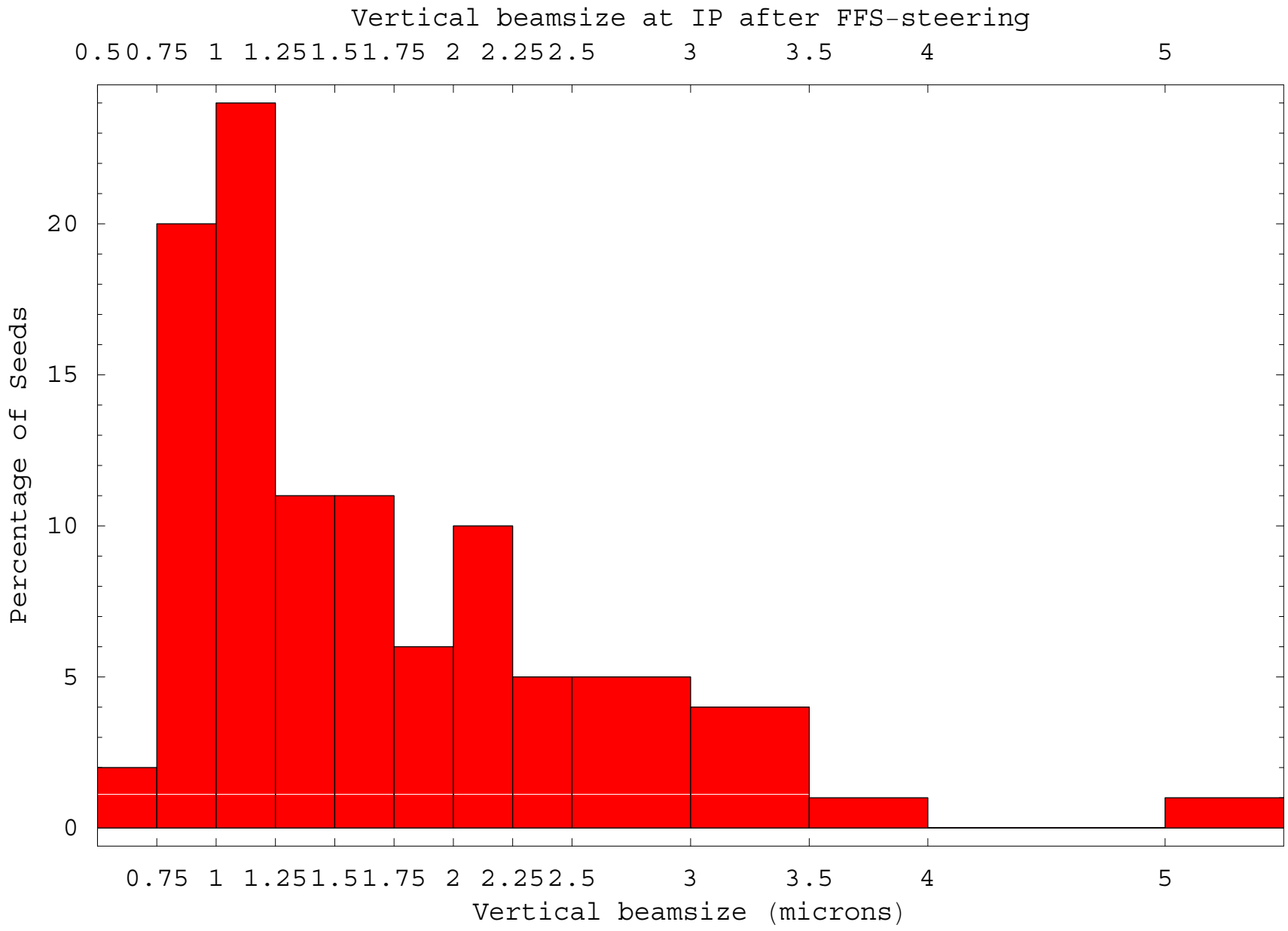
Timetable

- Glen’s software is ready if chosen
- Javier’s software should be in the flight simulator by April at the latest
- Anthony’s software will need to be converted to flight simulator if chosen, ETA February
- Yves software should be ready by February if chosen

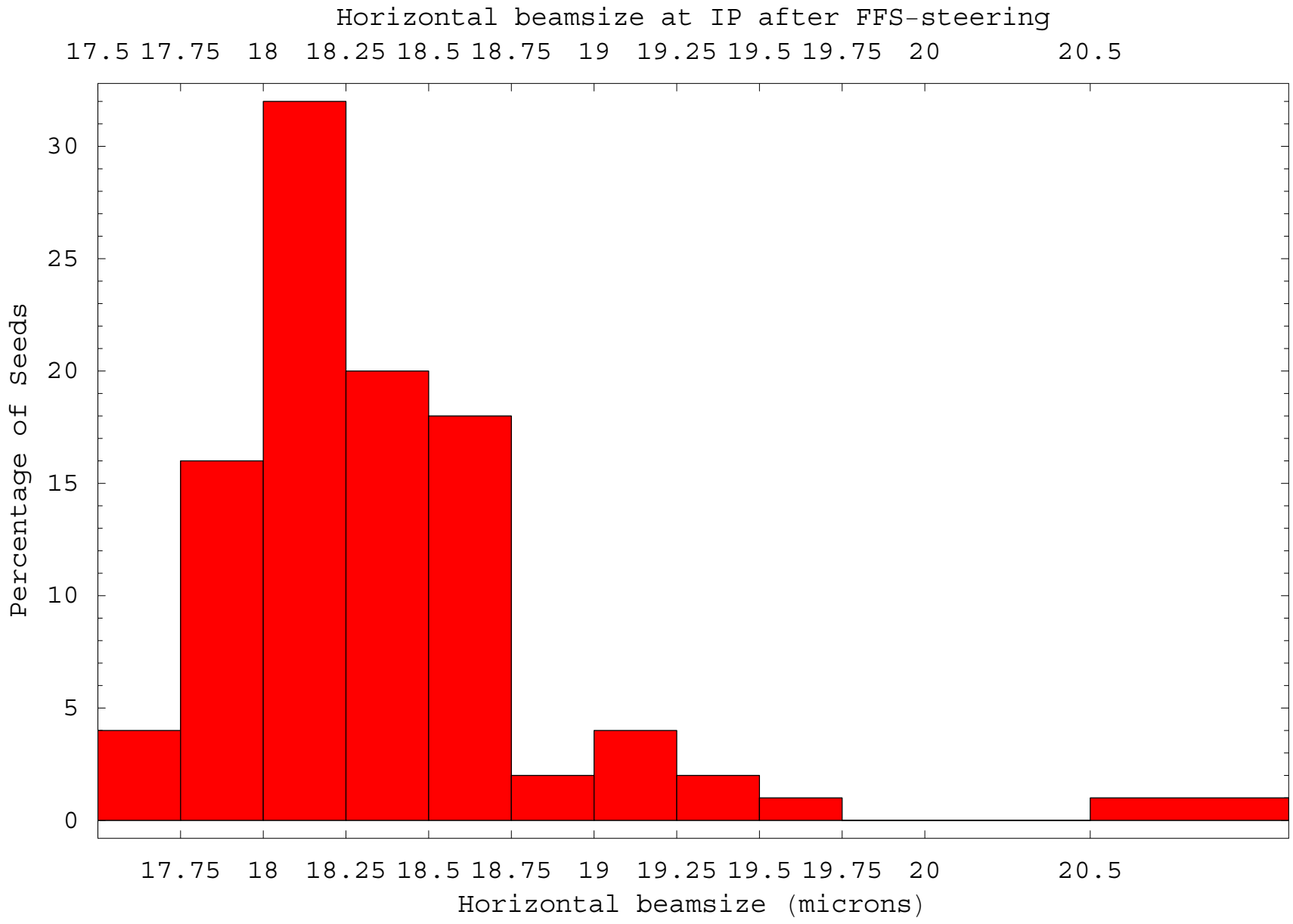
Glen


Post BBA beamsize
25
20
15
10
5
0
0
0.5
1
1.5
2
2.5
3
3.5
IP Vertical Waist / um

Anthony


Vertical beamsize at IP after FFS-steering
0.5 0.75 1 1.25 1.5 1.75 2 2.25 2.5 3 3.5 4 5
Percentage of Seeds
0
5
10
15
20
0.75 1 1.25 1.5 1.75 2 2.25 2.5 3 3.5 4 5
Vertical beamsize (microns)

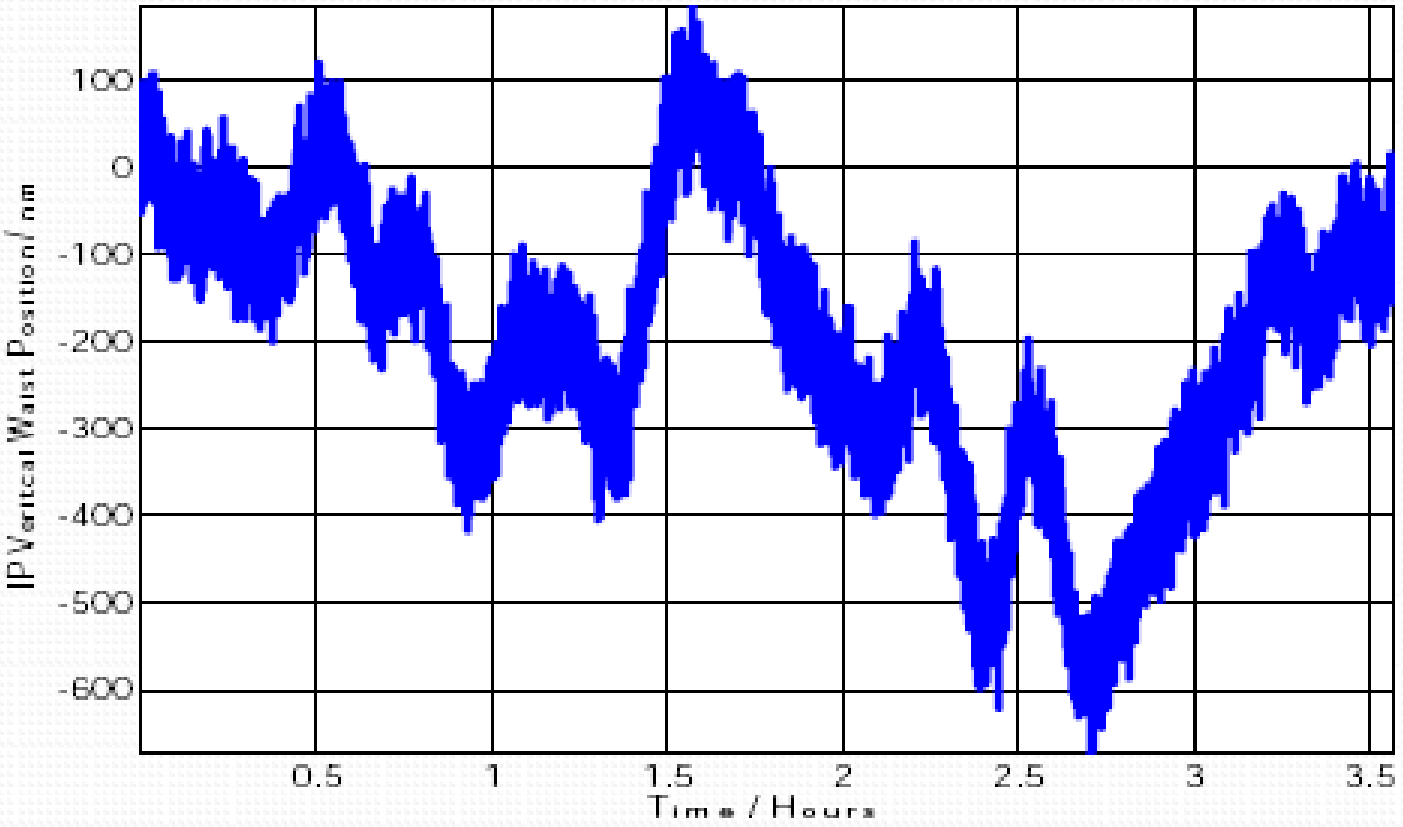
Anthony


Horizontal beamsize at IP after FFS-steering
17.5 17.75 18 18.25 18.5 18.75 19 19.25 19.5 19.75 20 20.5
Percentage of Seeds
0
5
10
15
20
25
30
17.75 18 18.25 18.5 18.75 19 19.25 19.5 19.75 20 20.5
Horizontal beamsize (microns)

Glen

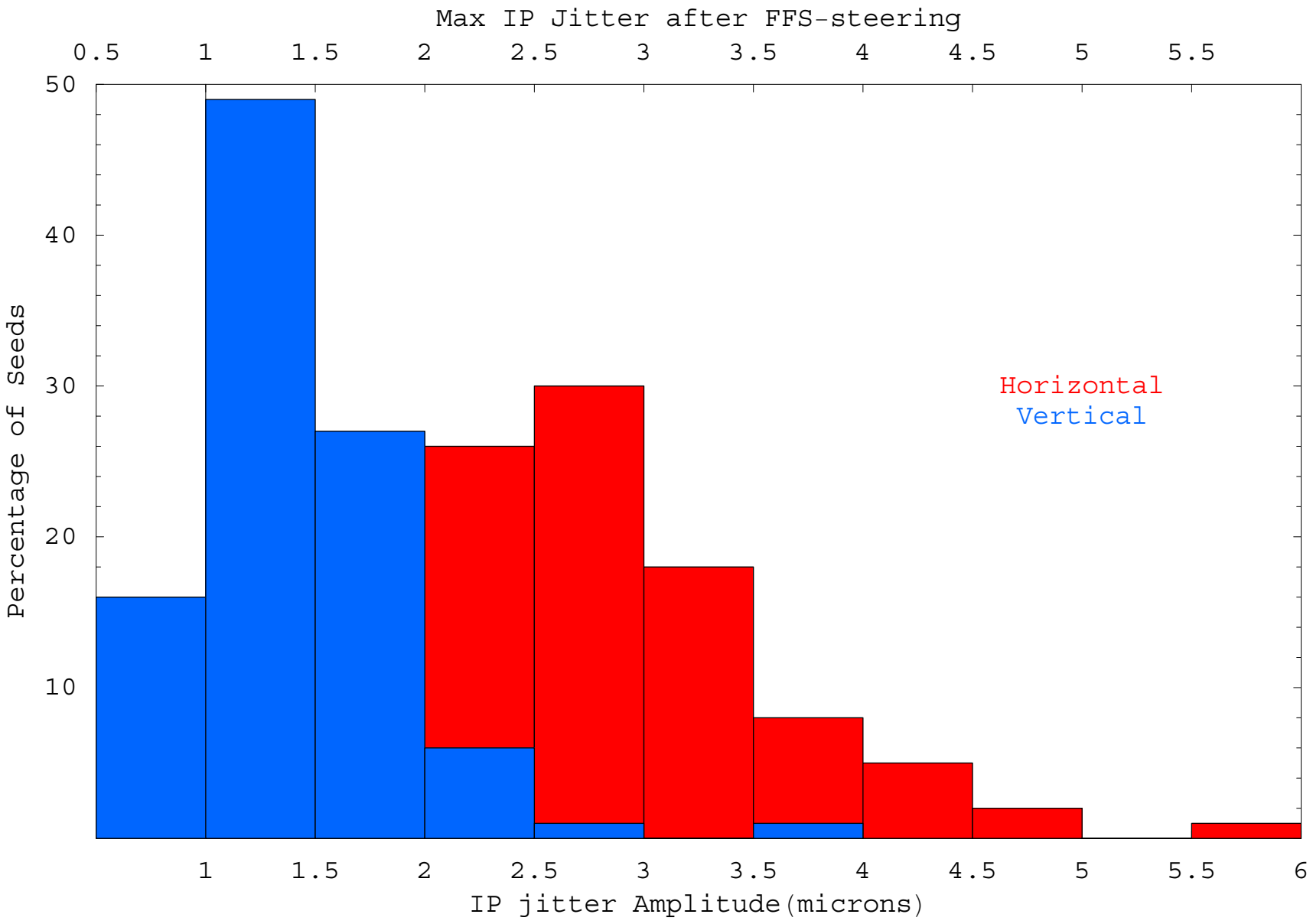
IP Motion

Post-tuning

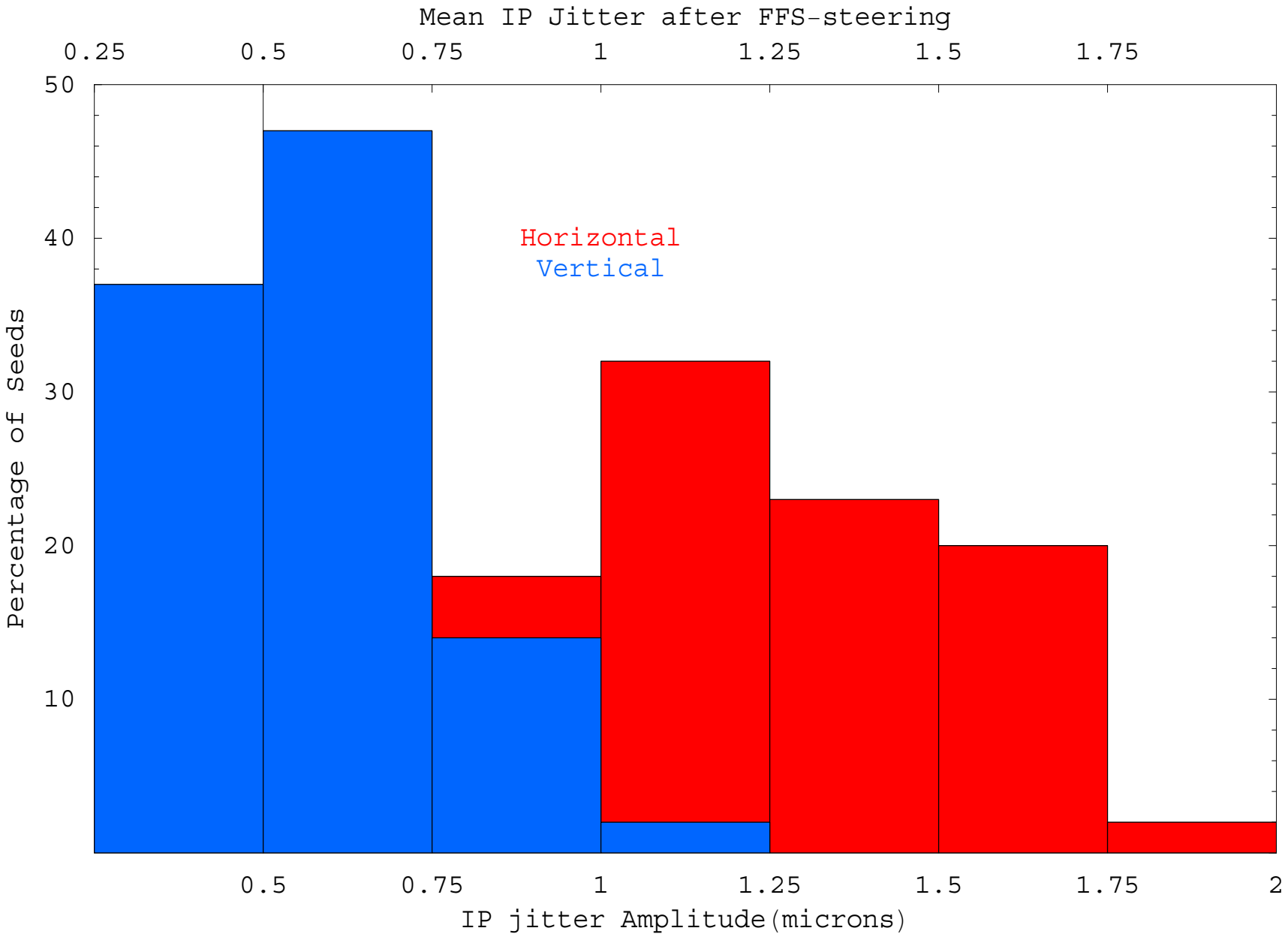


- 20,000 pulses @ 1.56 Hz (1 seed)
- IP vertical position drifts around on scales of a few 100 nm an hour.
- Slow enough that this can be 'de-trended' using Shintake Monitor as IP position monitor.

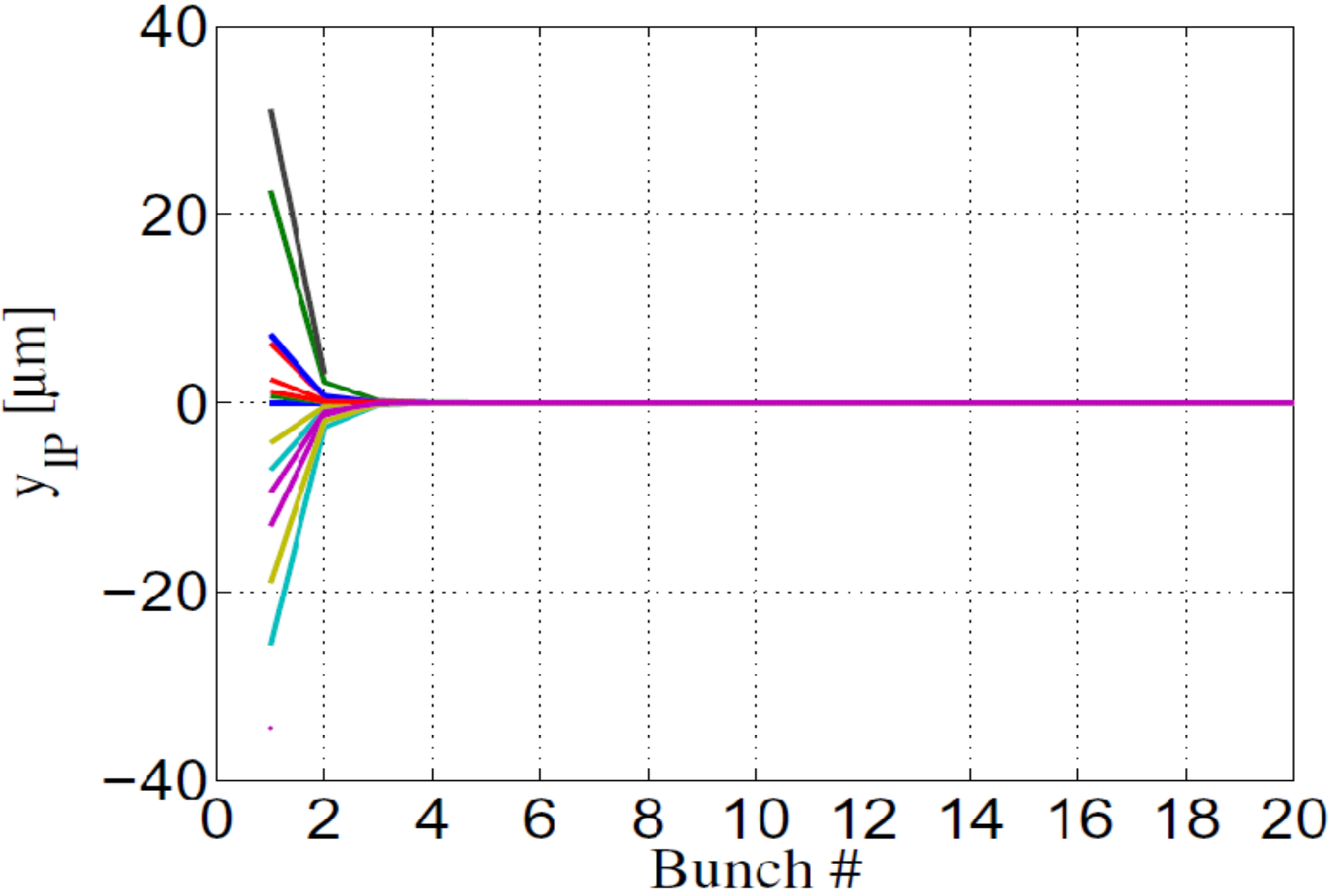
Anthony


Max IP Jitter after FFS-steering
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
50
40
30
20
10
Percentage of Seeds
Horizontal
Vertical
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
IP jitter Amplitude(microns)

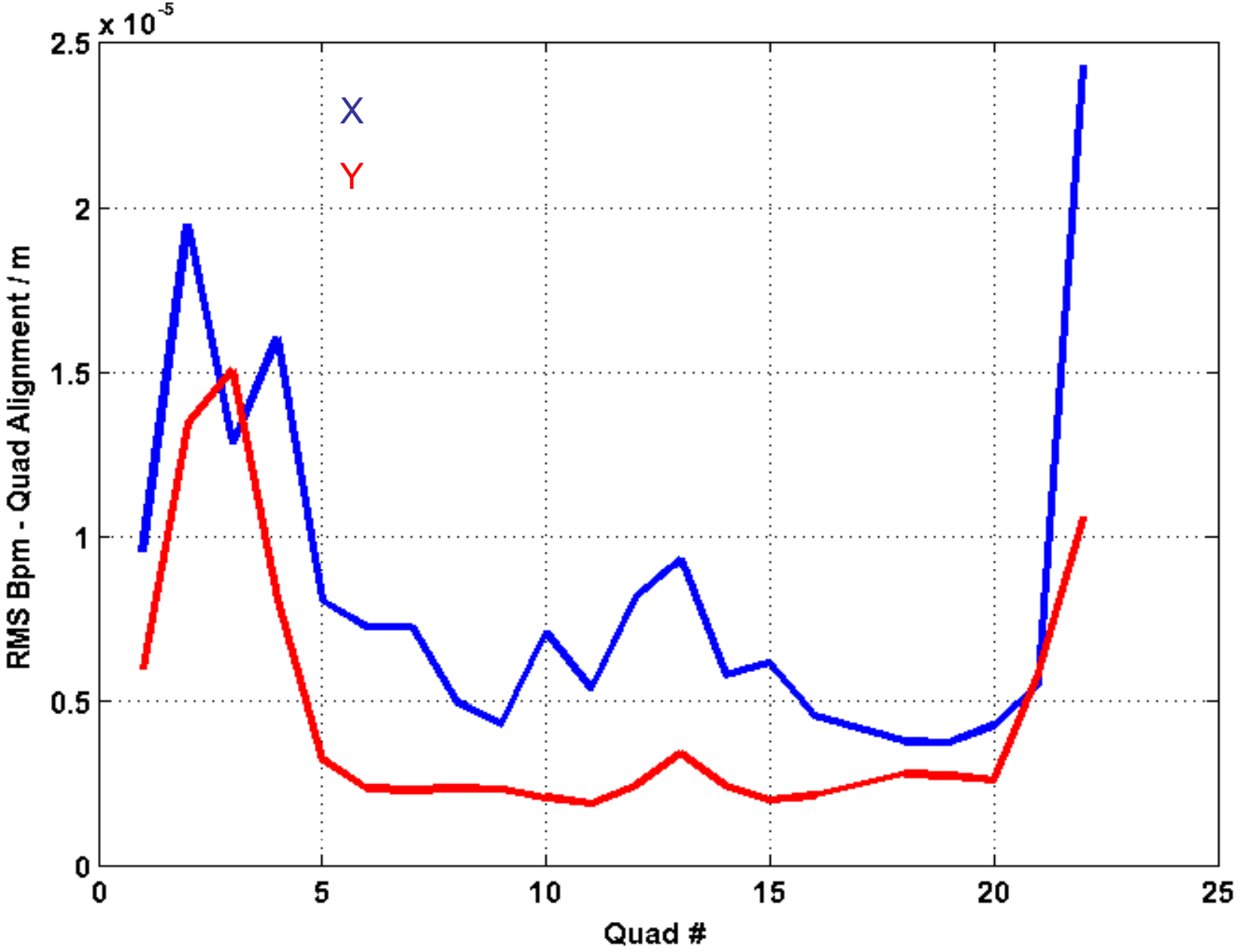
Anthony


Mean IP Jitter after FFS-steering
0.25
0.5
0.75
1
1.25
1.5
1.75
50
40
30
20
10
Percentage of Seeds
Horizontal
Vertical
0.5
0.75
1
1.25
1.5
1.75
2
IP jitter Amplitude(microns)

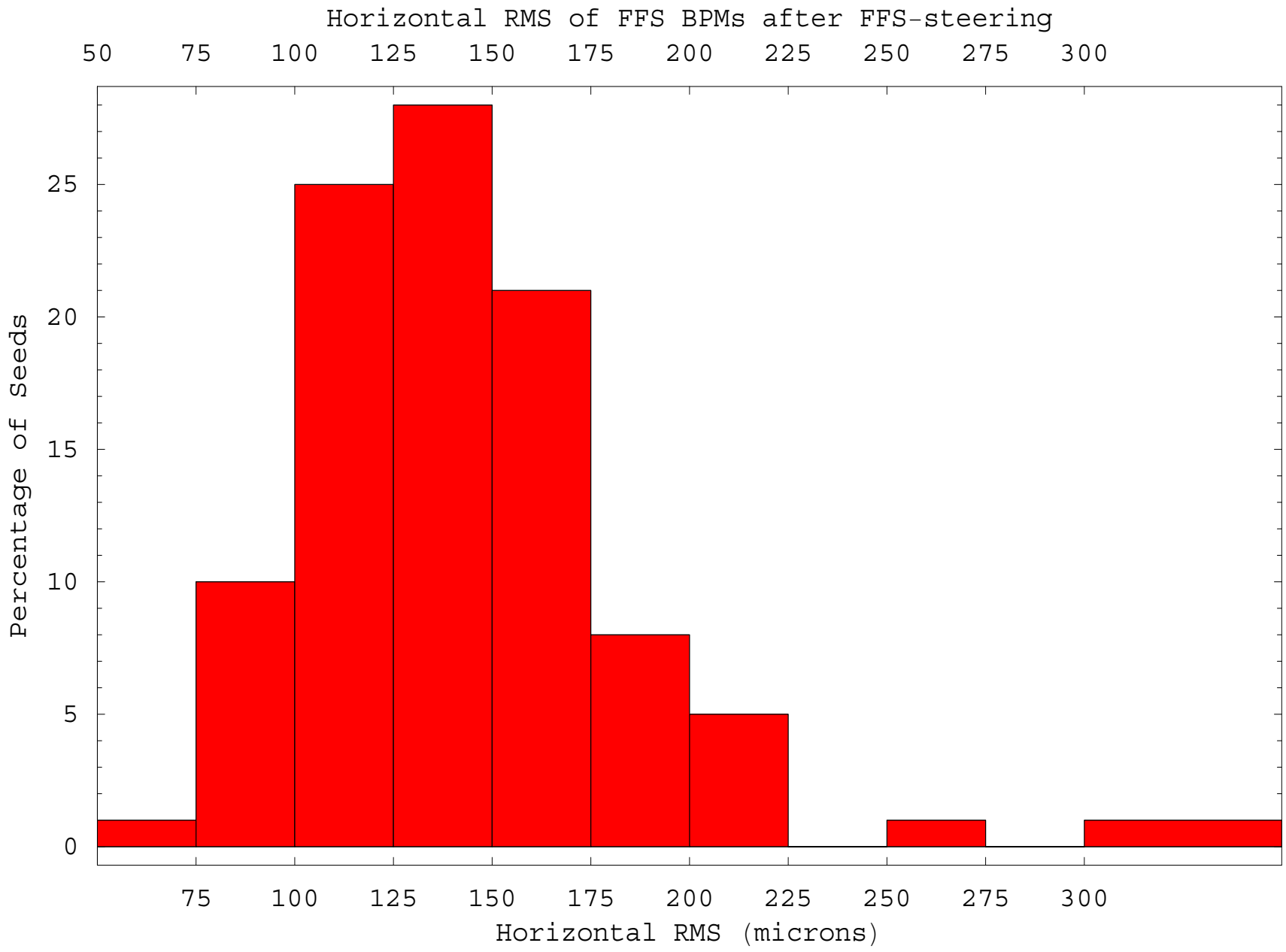
Javier IP Feedback



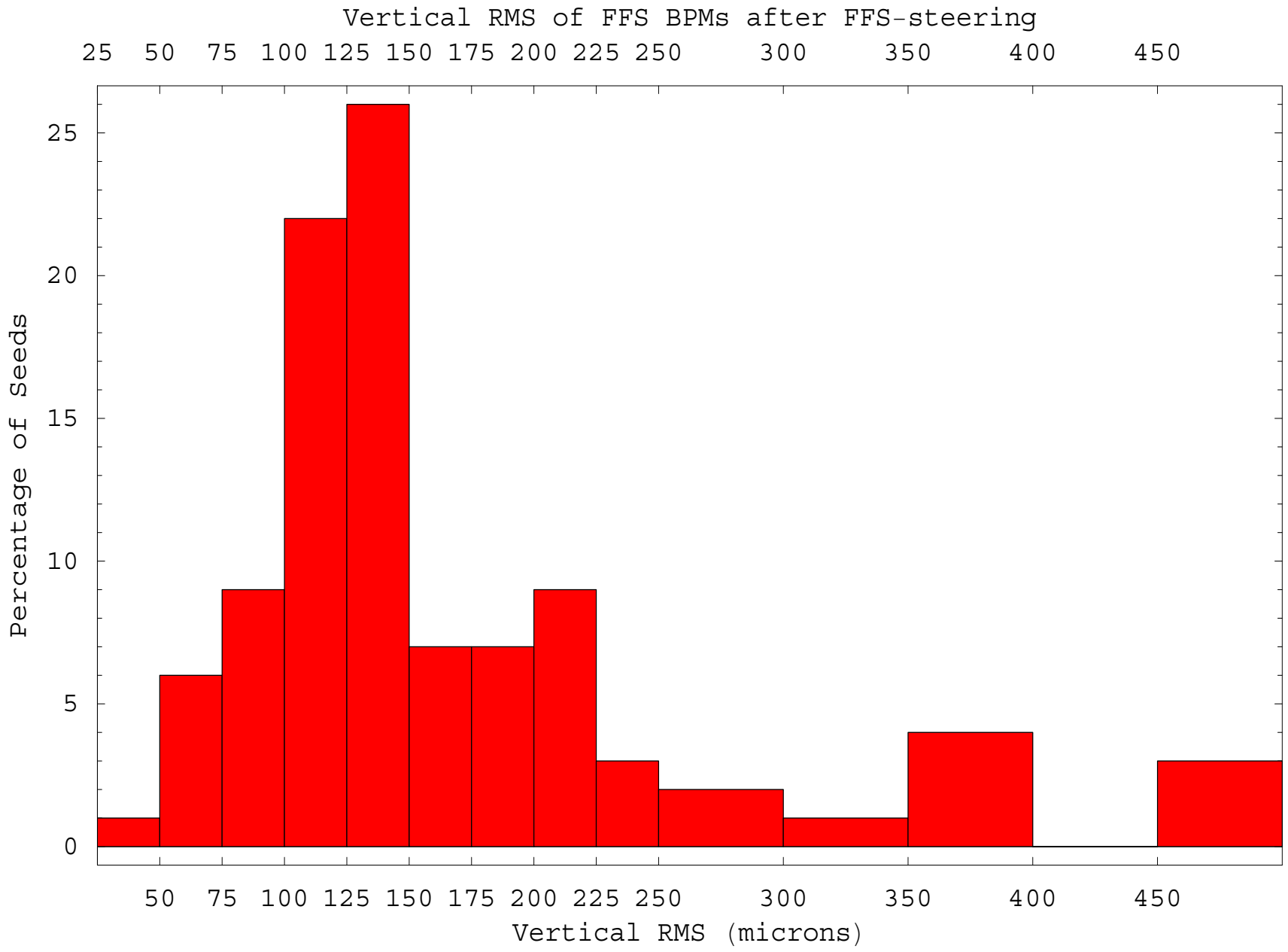
Glen



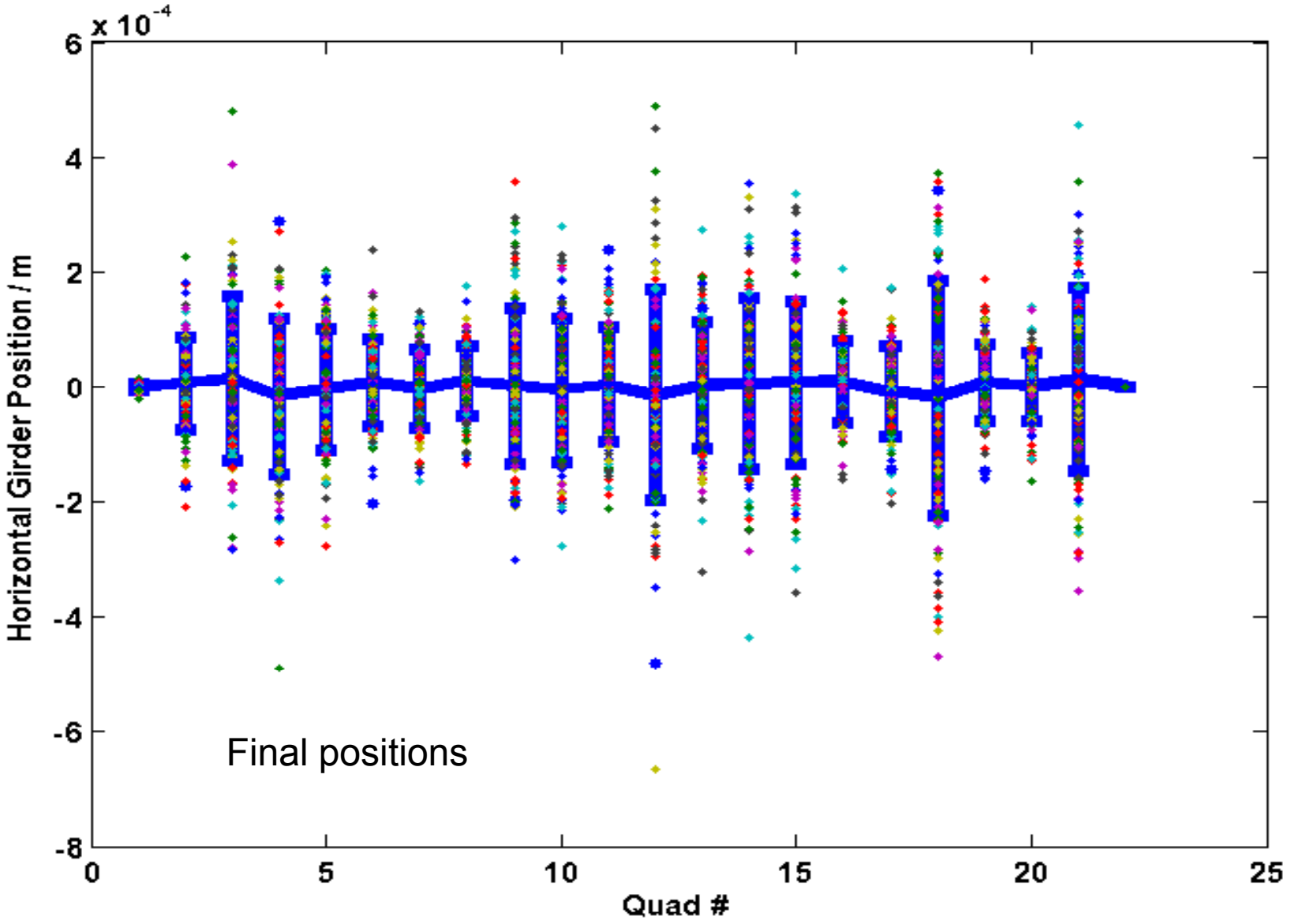
Anthony


Horizontal RMS of FFS BPMs after FFS-steering
50
75
100
125
150
175
200
225
250
275
300
Percentage of Seeds
0
5
10
15
20
25
75
100
125
150
175
200
225
250
275
300
Horizontal RMS (microns)

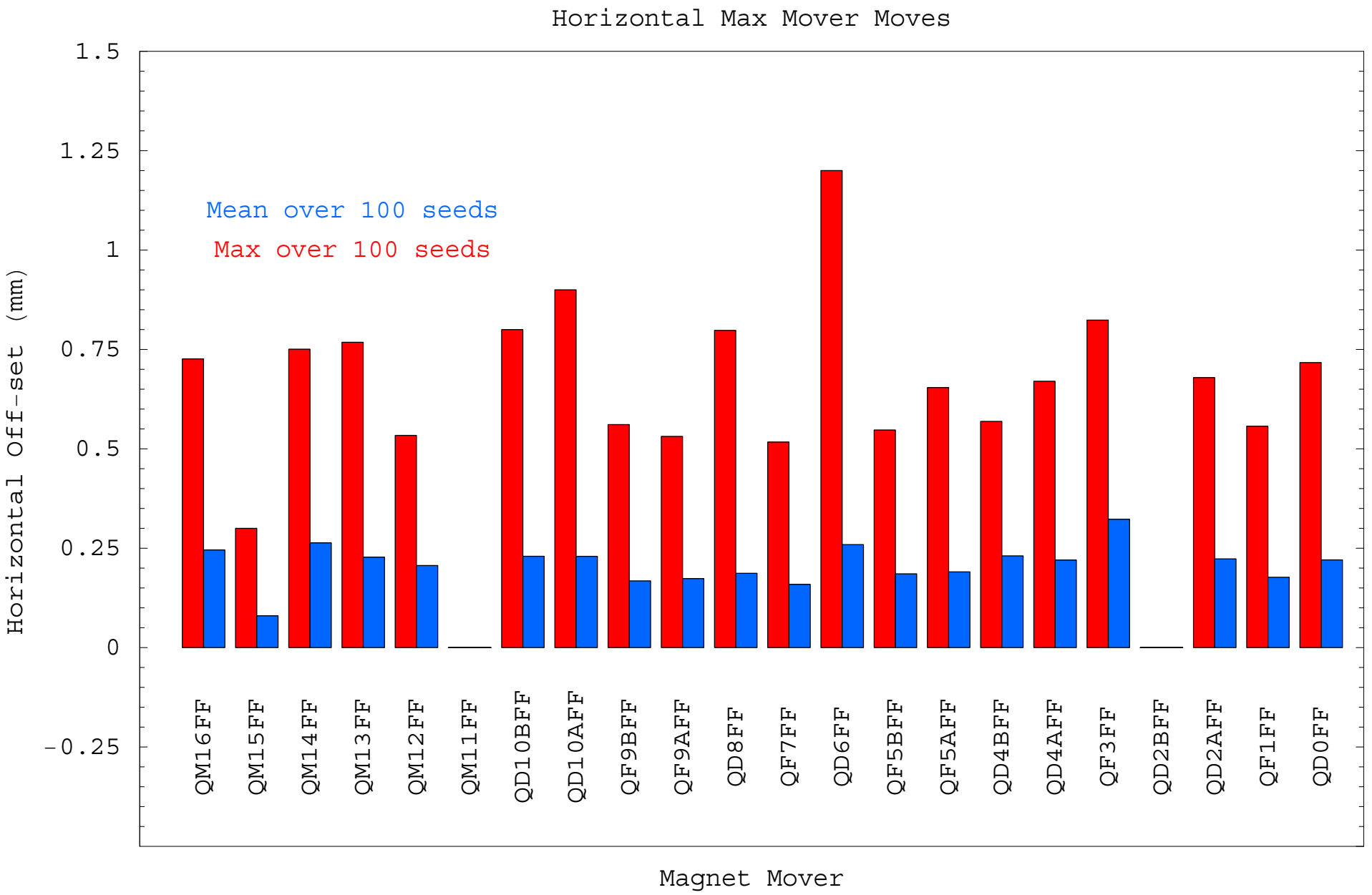
Anthony


Vertical RMS of FFS BPMs after FFS-steering
25 50 75 100 125 150 175 200 225 250 300 350 400 450
Percentage of Seeds
0
5
10
15
20
25
50 75 100 125 150 175 200 225 250 300 350 400 450
Vertical RMS (microns)

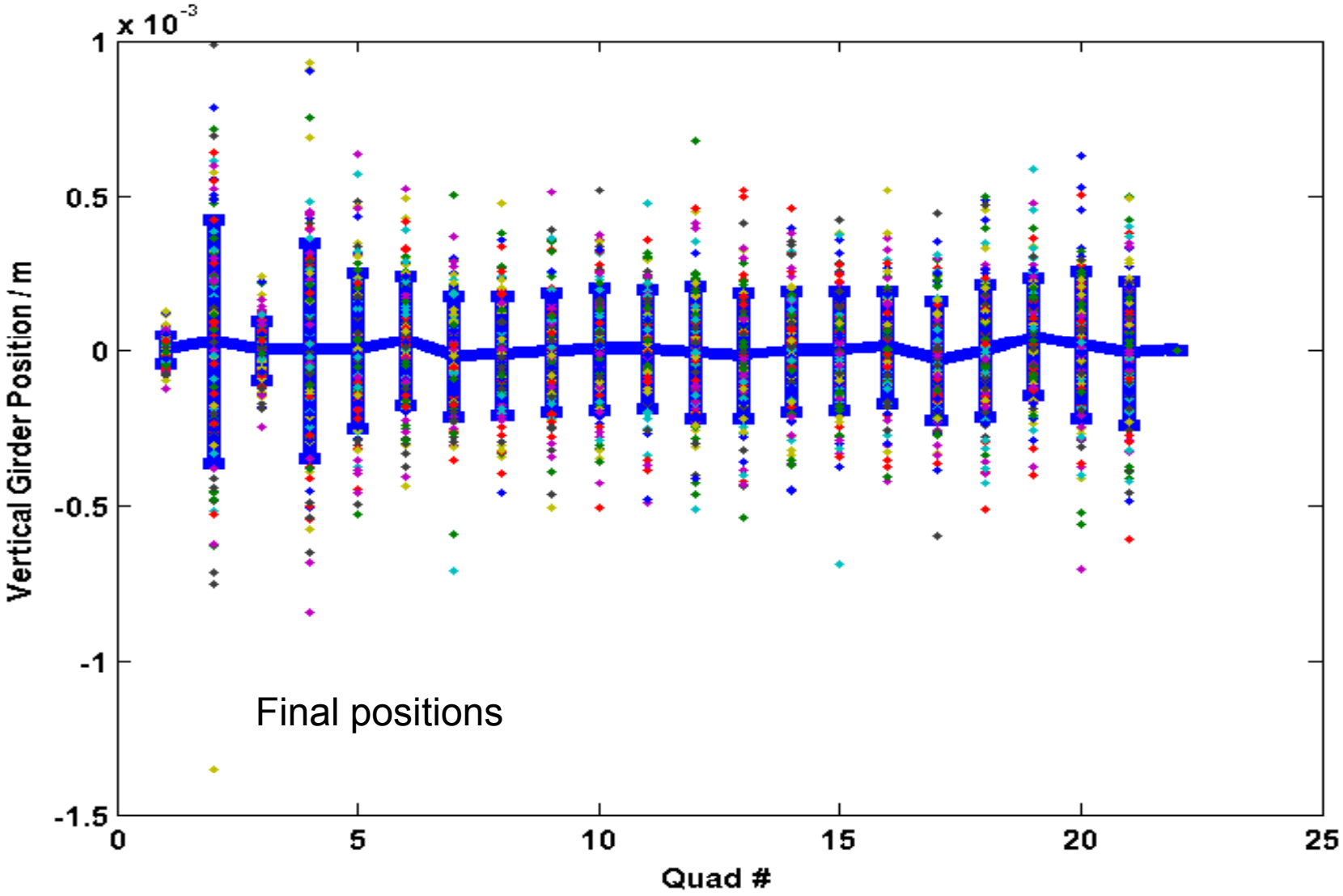
Glen


x 10^-4
6
4
2
0
-2
-4
-6
-8
Horizontal Girder Position / m
0
5
10
15
20
25
Quad #
Final positions

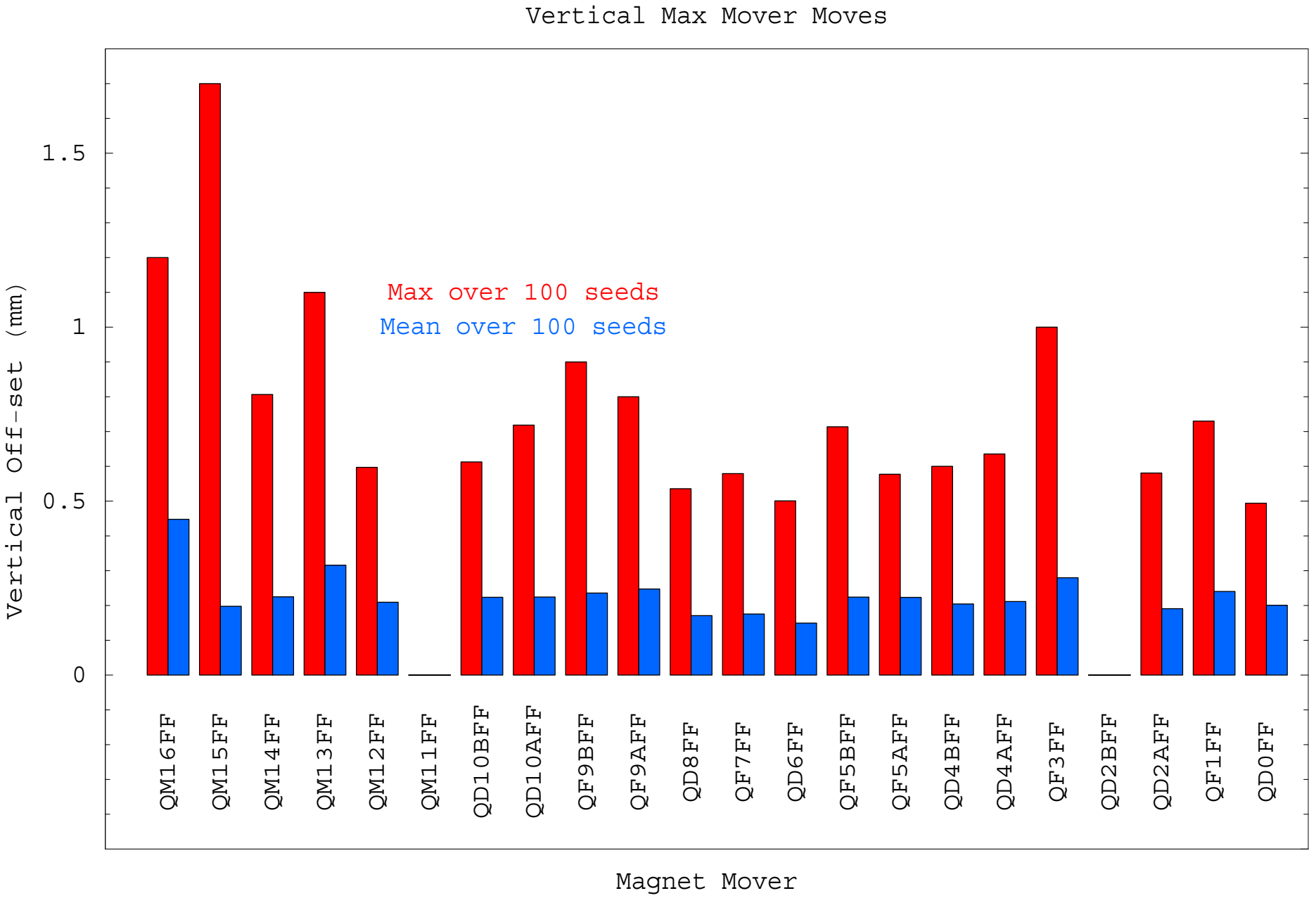
Anthony


Horizontal Max Mover Moves
Mean over 100 seeds
Max over 100 seeds
Horizontal Off-set (mm)
1.5
1.25
1
0.75
0.5
0.25
0
-0.25
QM16FF
QM15FF
QM14FF
QM13FF
QM12FF
QM11FF
QD10BFF
QD10AFF
QF9BFF
QF9AFF
QD8FF
QF7FF
QD6FF
QF5BFF
QF5AFF
QD4BFF
QD4AFF
QF3FF
QD2BFF
QD2AFF
QF1FF
QD0FF
Magnet Mover

Glen


x 10^-3
1
0.5
0
-0.5
-1
-1.5
Vertical Girder Position / m
0
5
10
15
20
25
Quad #
Final positions

Anthony


Vertical Max Mover Moves
Max over 100 seeds
Mean over 100 seeds
Vertical Off-set (mm)
1.5
1
0.5
0
QM16FF
QM15FF
QM14FF
QM13FF
QM12FF
QM11FF
QD10BFF
QD10AFF
QF9BFF
QF9AFF
QD8FF
QF7FF
QD6FF
QF5BFF
QF5AFF
QD4BFF
QD4AFF
QF3FF
QD2BFF
QD2AFF
QF1FF
QD0FF
Magnet Mover