(Very) Preliminary analysis of CODs behavior

Stable Beams

Injection

Thanks to: T.Baer, M.Koratzinos, R.Schmidt, J.Wenninger

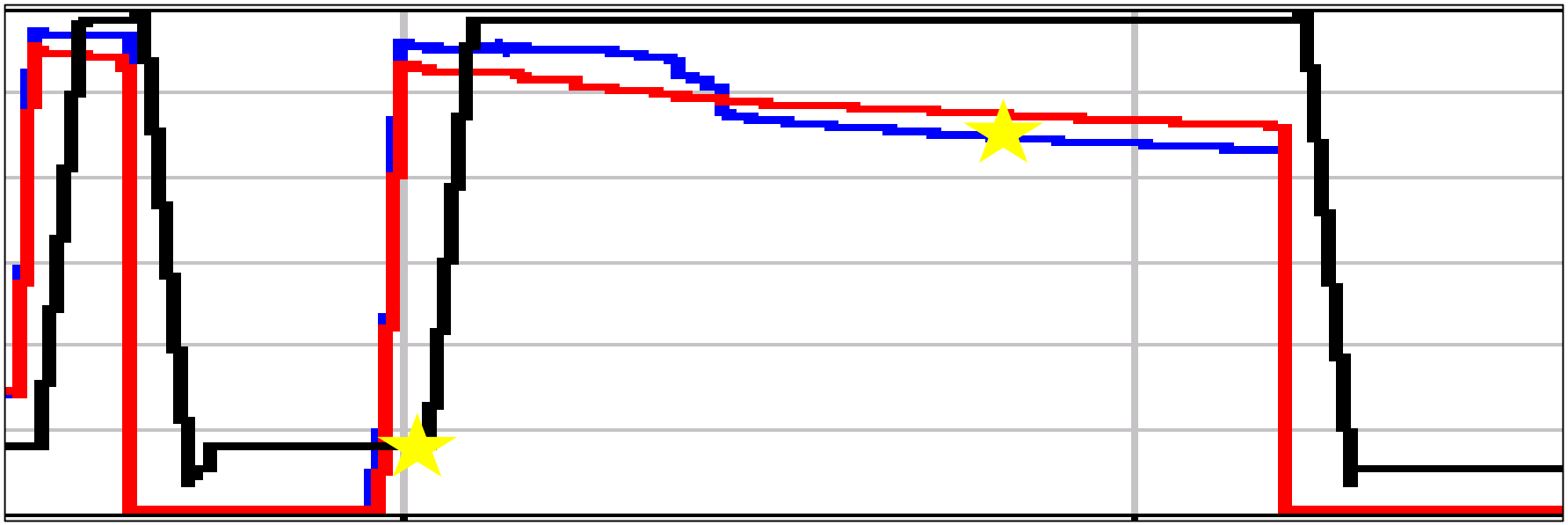
G.Kourkafas/M.Solfaroli

Consideration

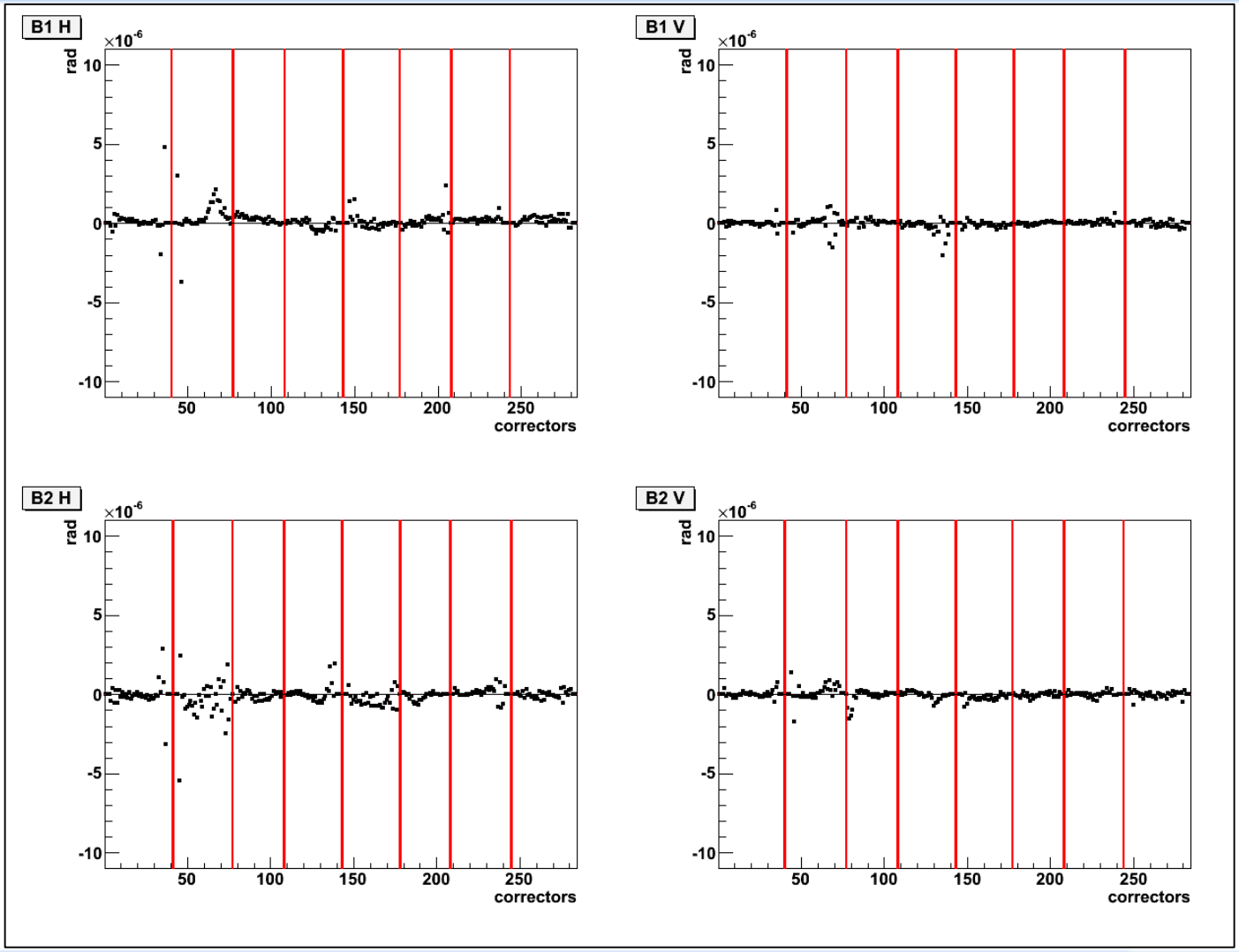
- The idea is to look at the orbit by checking the CODs behavior:
  - Spot possible errors of BPMs
  - A good method to check the reproducibility of the machine
  - (Maybe) a good method to see if structures (i.e. bump) are present and try to spot out potentially risky situations
  - To understand the range of corrections in the different phases of a fill aiming to develop some additional interlocks
- A fill is taken as reference (namely 1364) and for every fill CODs currents are compared to the reference fill ones (obviously originally existing structures wouldn't appear)
- In case a structure shows up the consequent effect on the orbit is checked (via MADX) to see if it generates a **real** bump
- Some general analysis on the orbit behavior can be done

Content

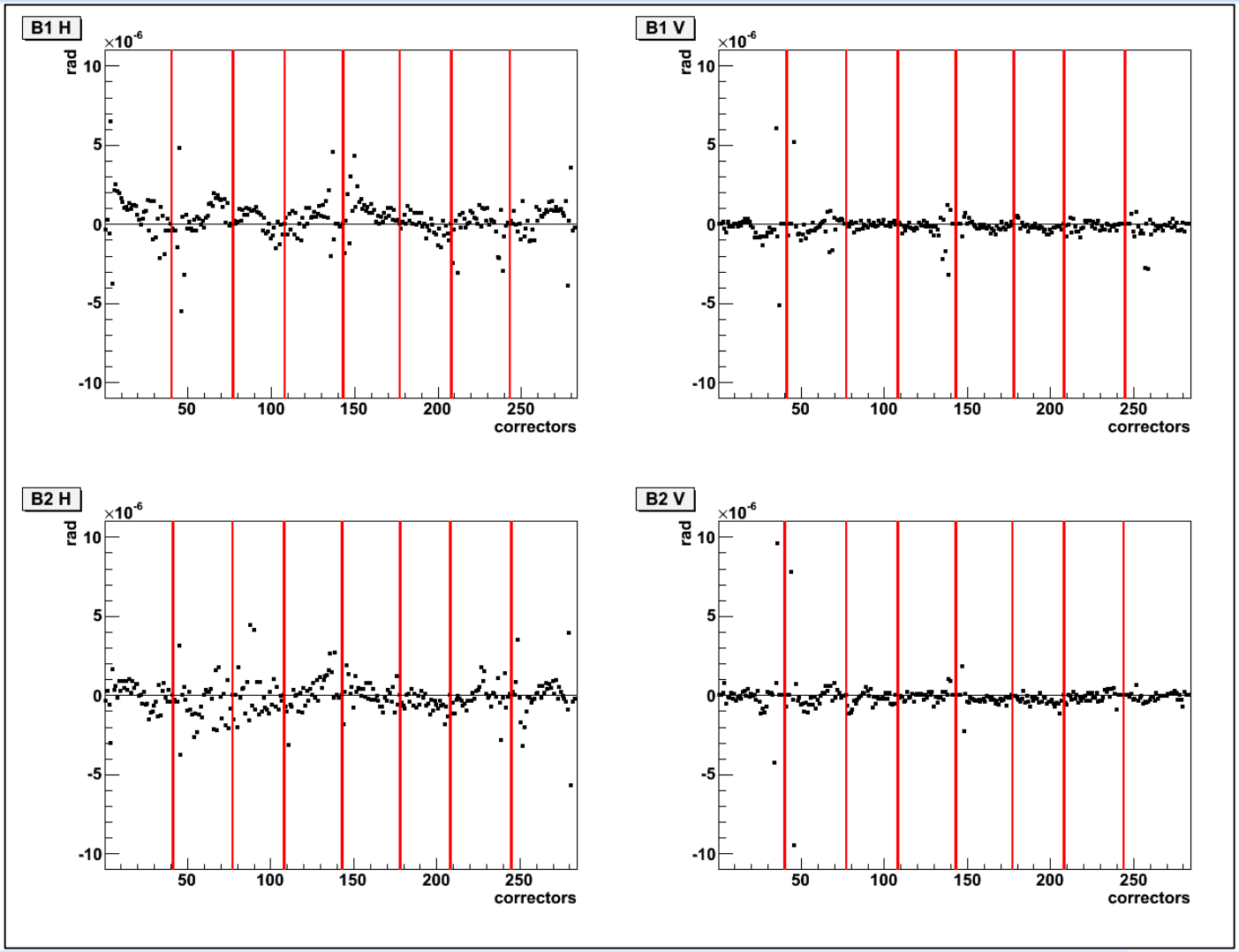
- Kick differences @ INJ and SB wrt a given fill
- Kick differences generated orbit @ INJ and SB



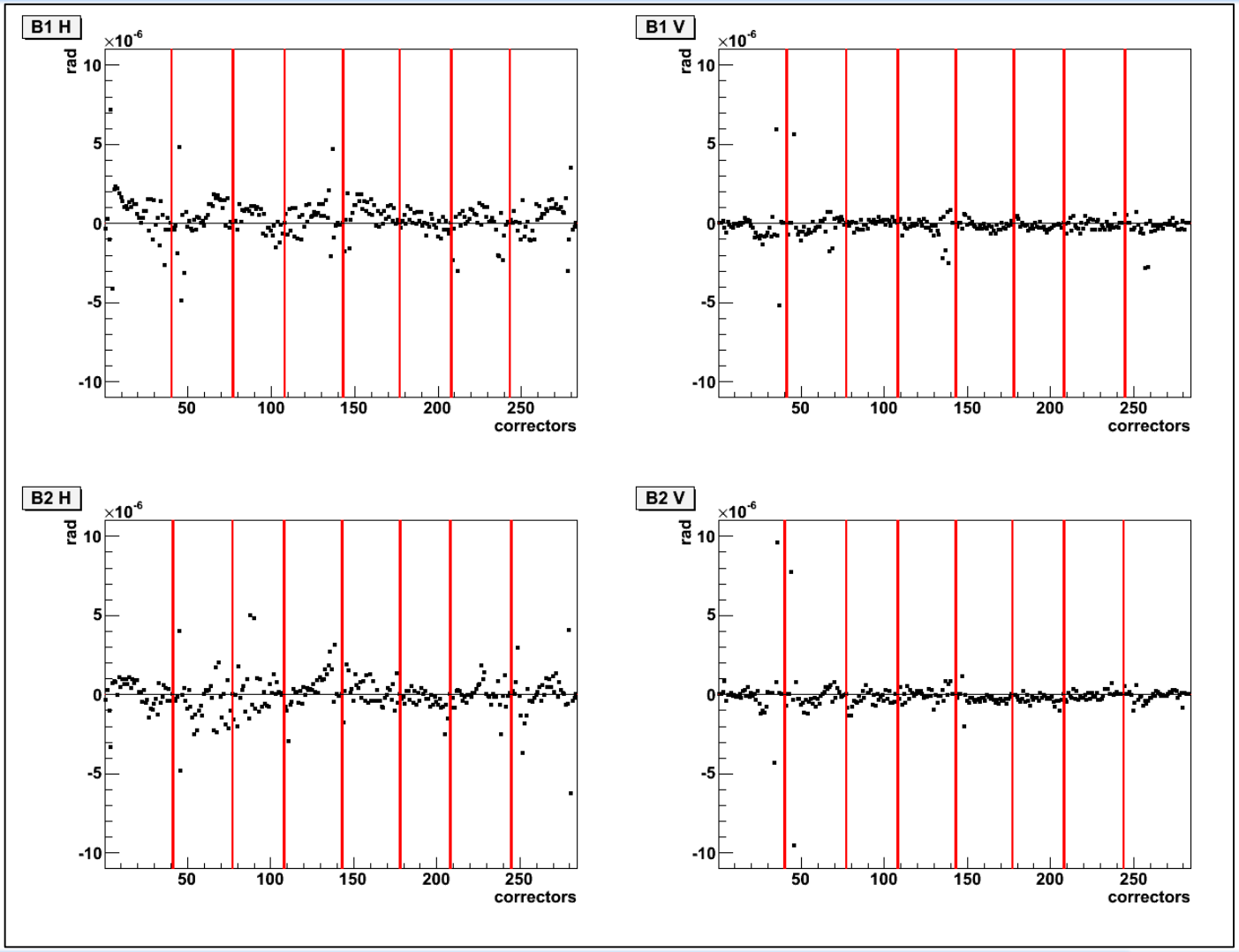
STABLE BEAMS (1366vs1364)



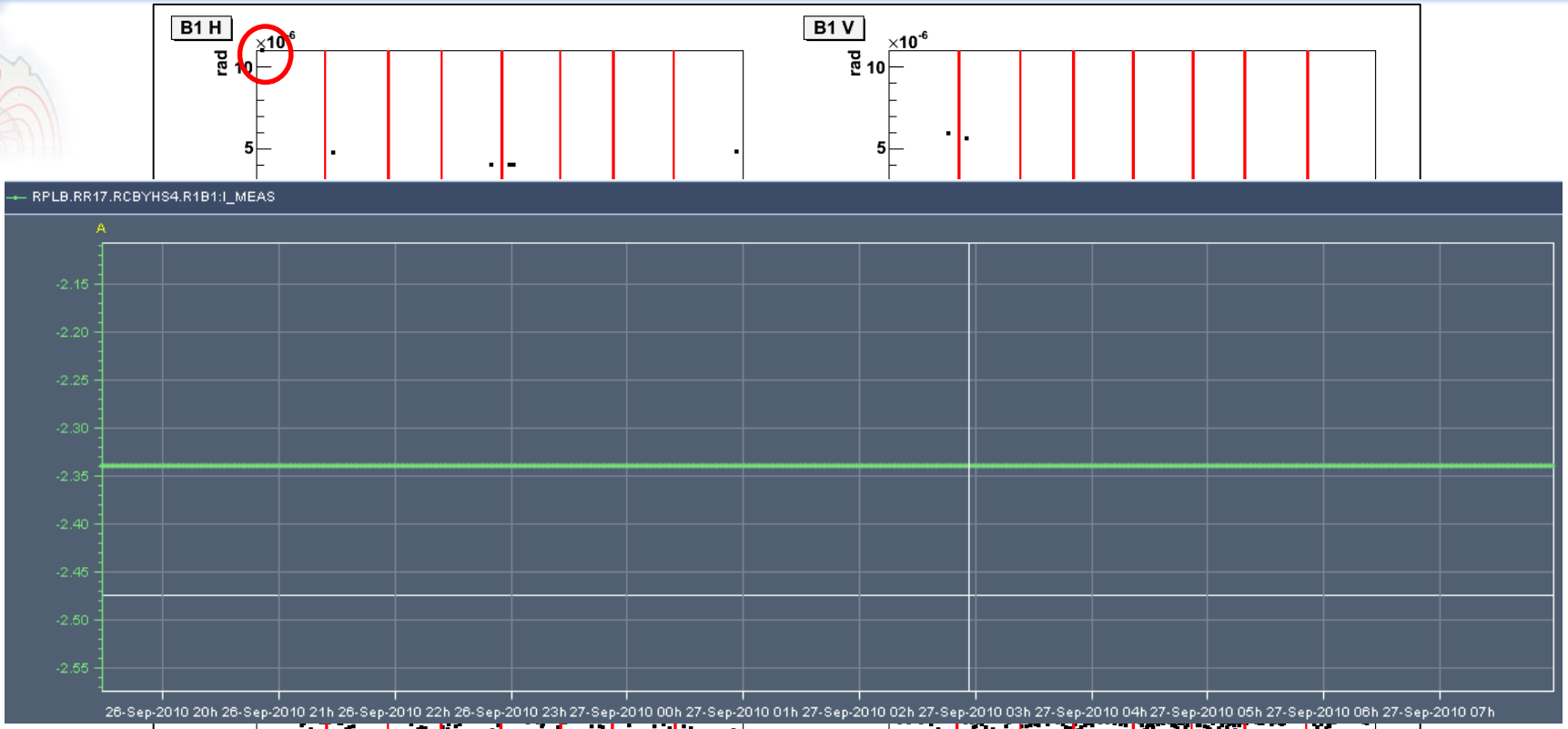
STABLE BEAMS (1369vs1364)



STABLE BEAMS (1372vs1364)

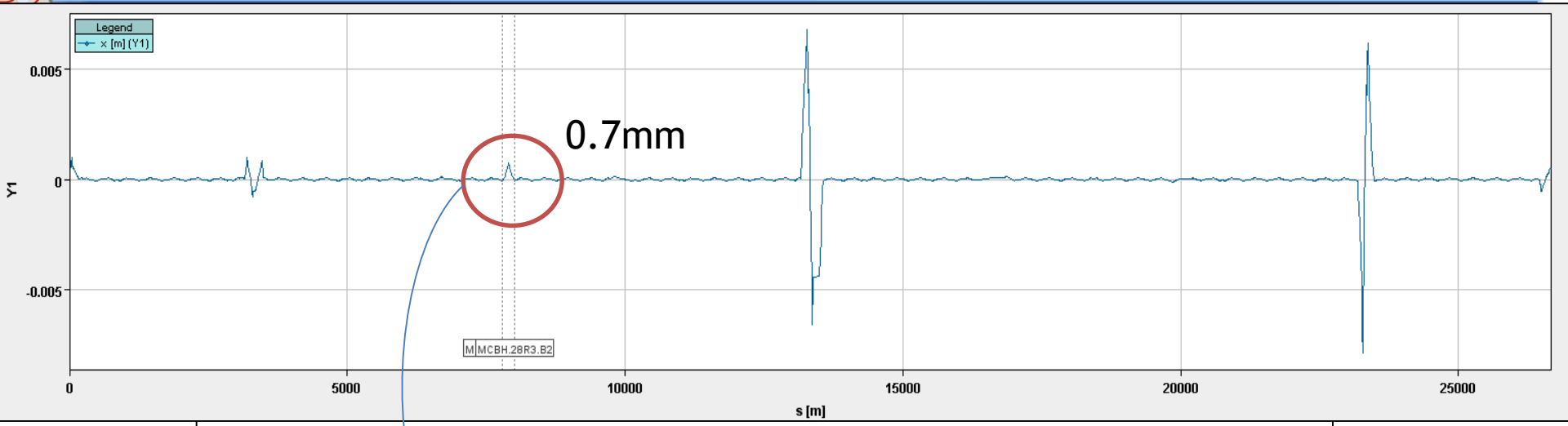


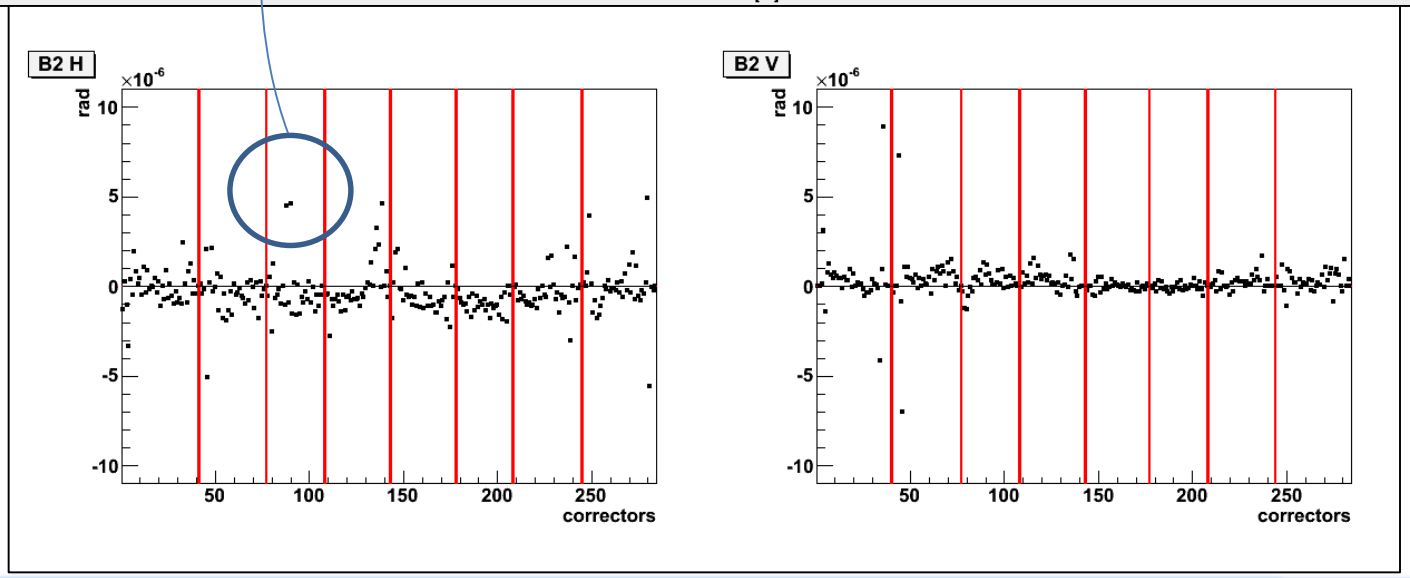
STABLE BEAMS (1373vs1364)



RCBYHS4.R1B1 (used for S and L)

STABLE BEAMS (1375vs1364)





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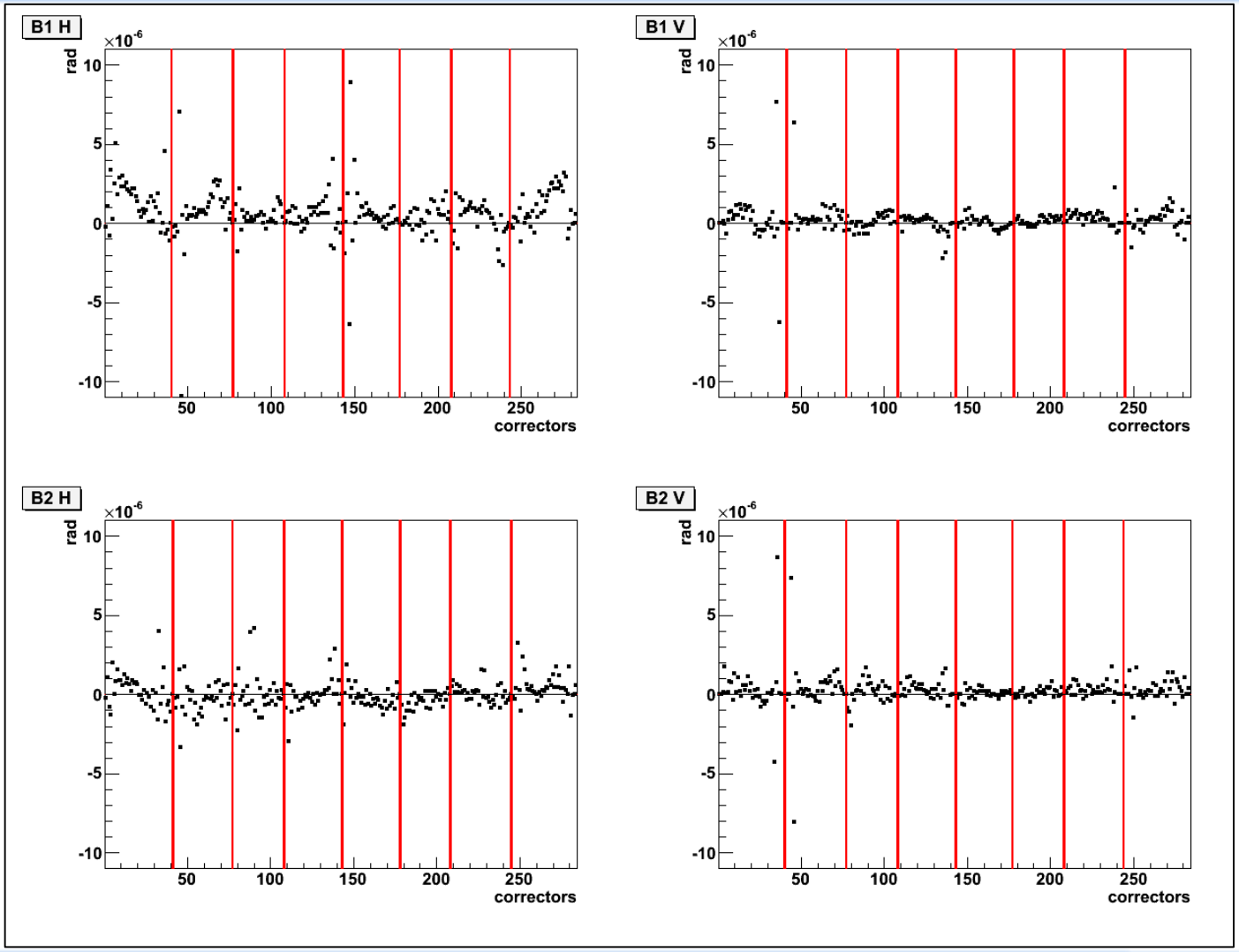
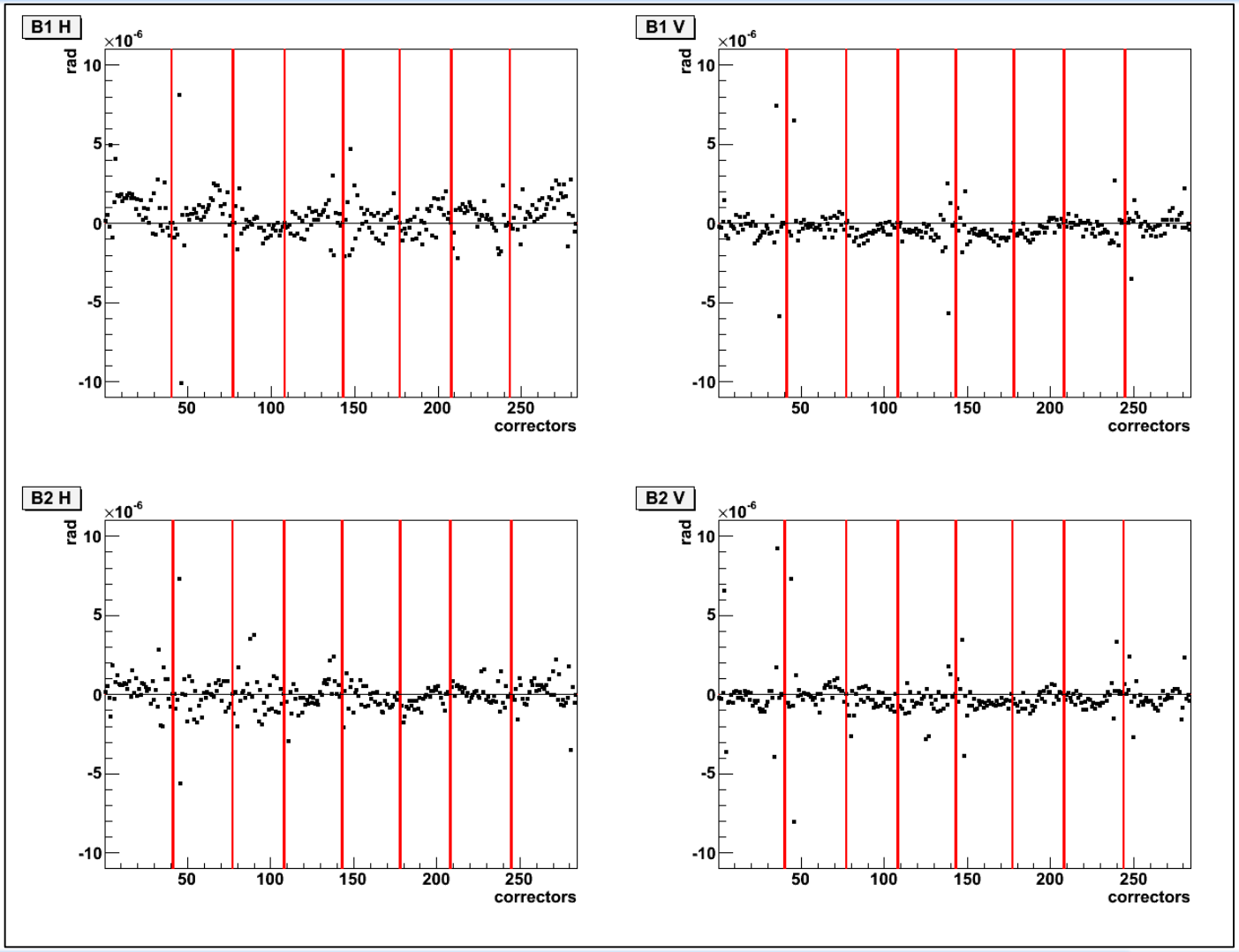


STABLE BEAMS (1386vs1364)



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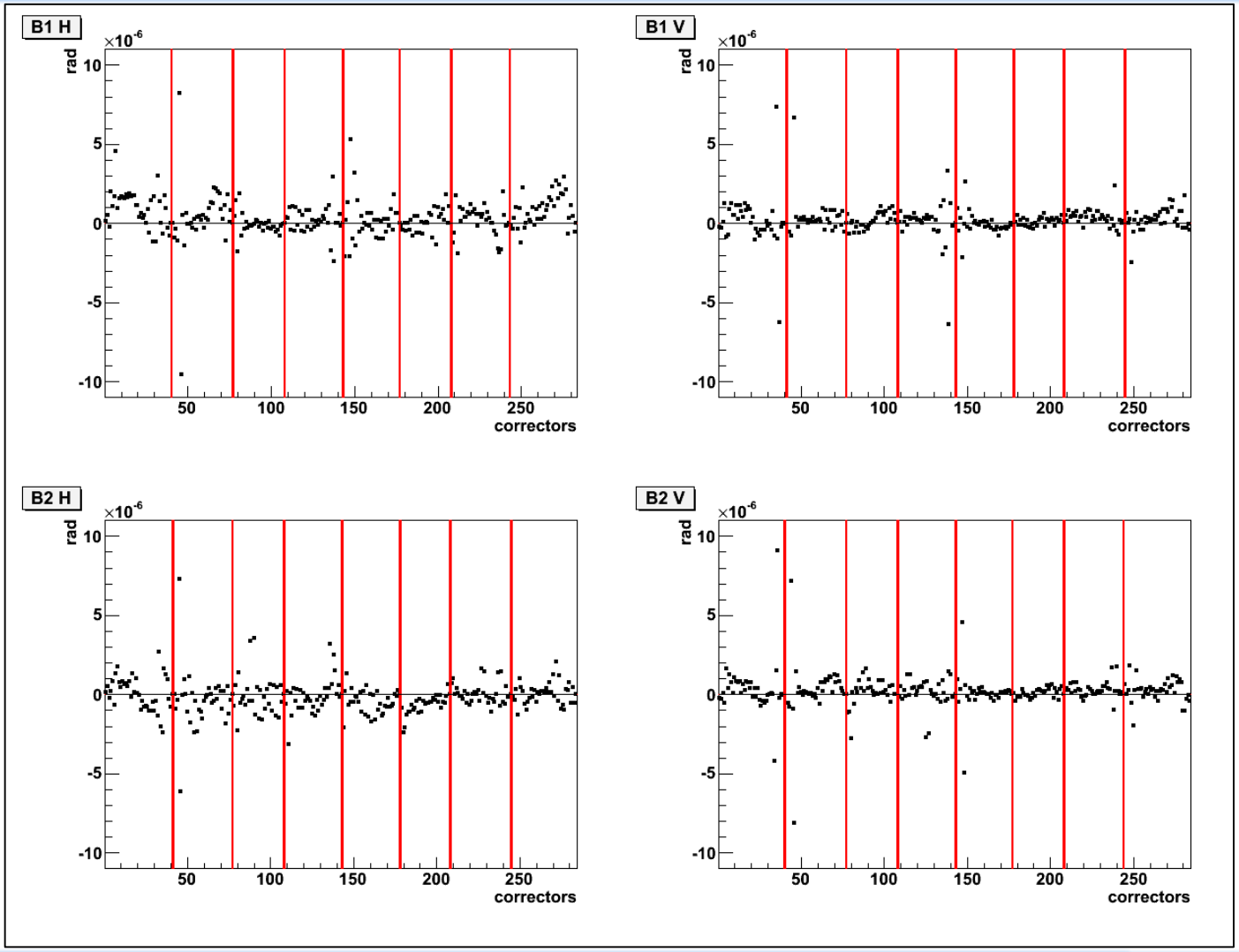

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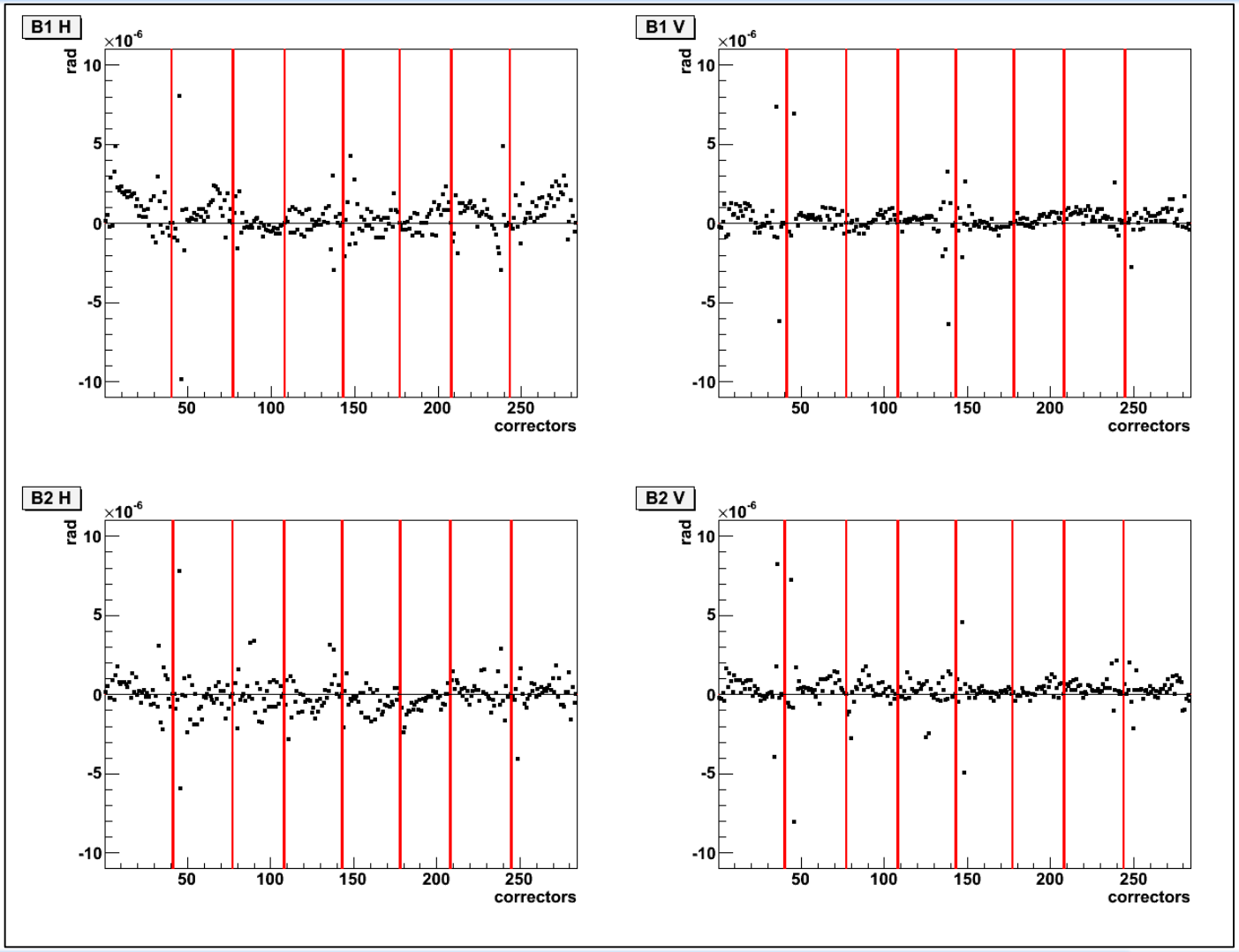
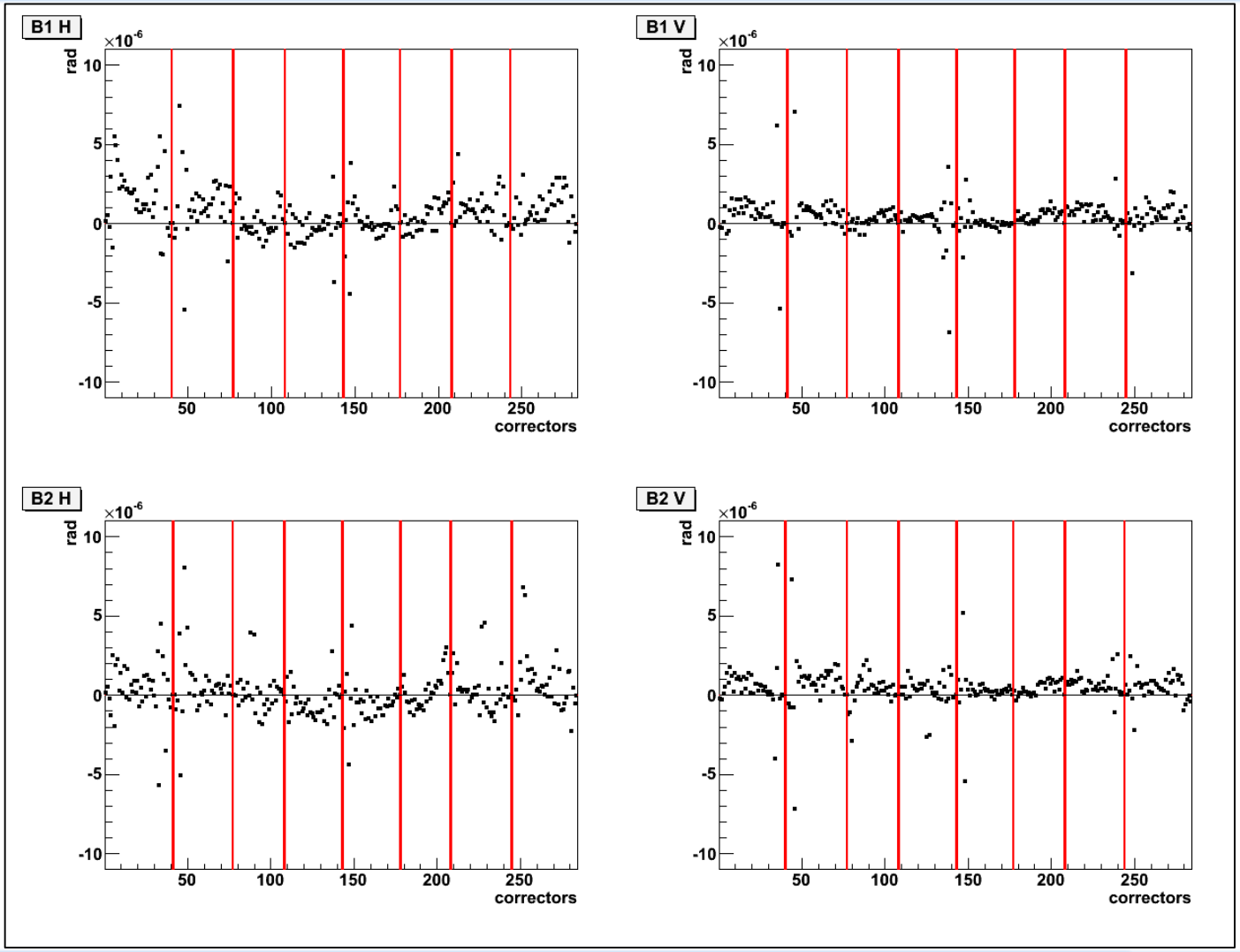
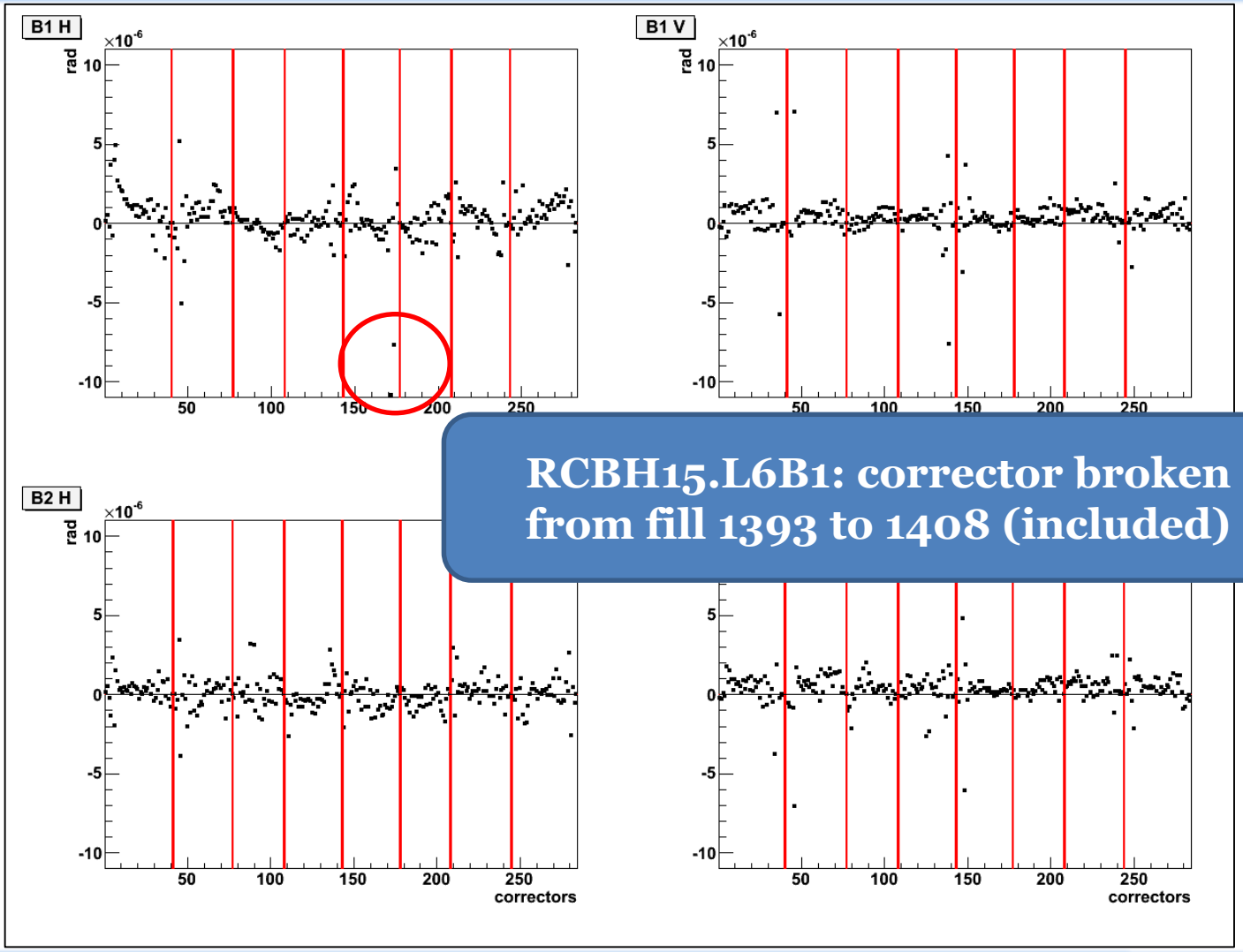


STABLE BEAMS (1389vs1364)

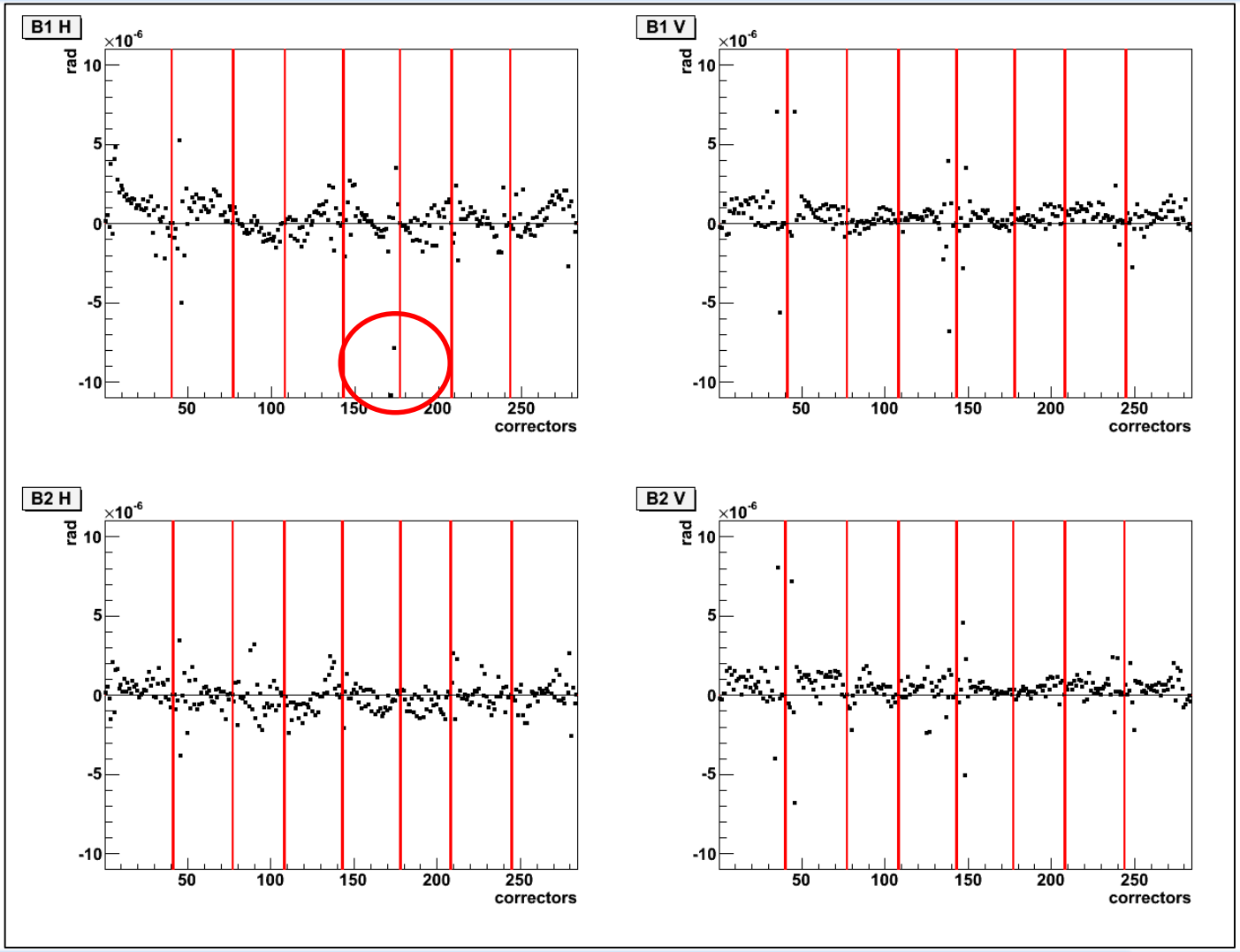


STABLE BEAMS (1393vs1364)



RCBH15.L6B1: corrector broken from fill 1393 to 1408 (included)

STABLE BEAMS (1394vs1364)



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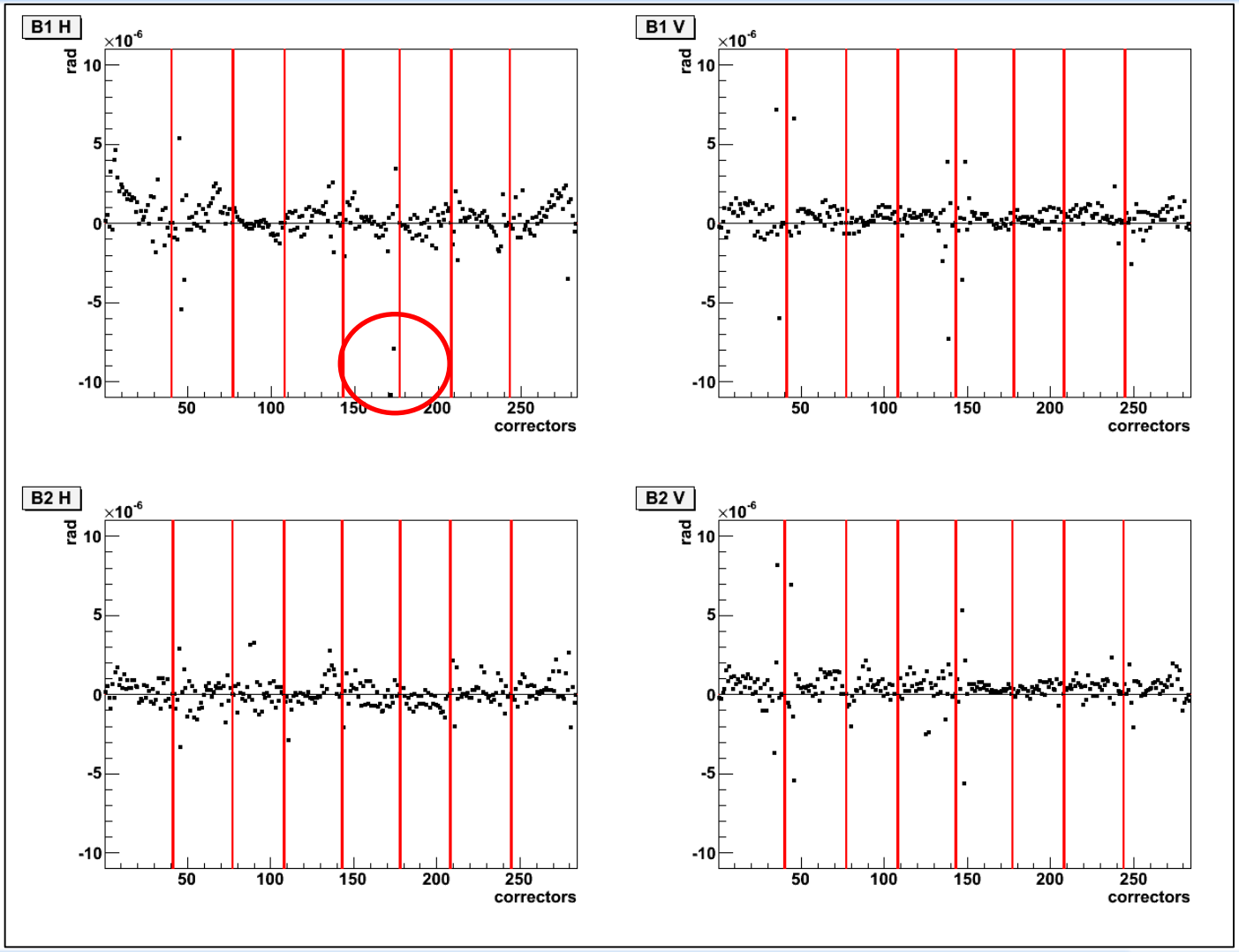
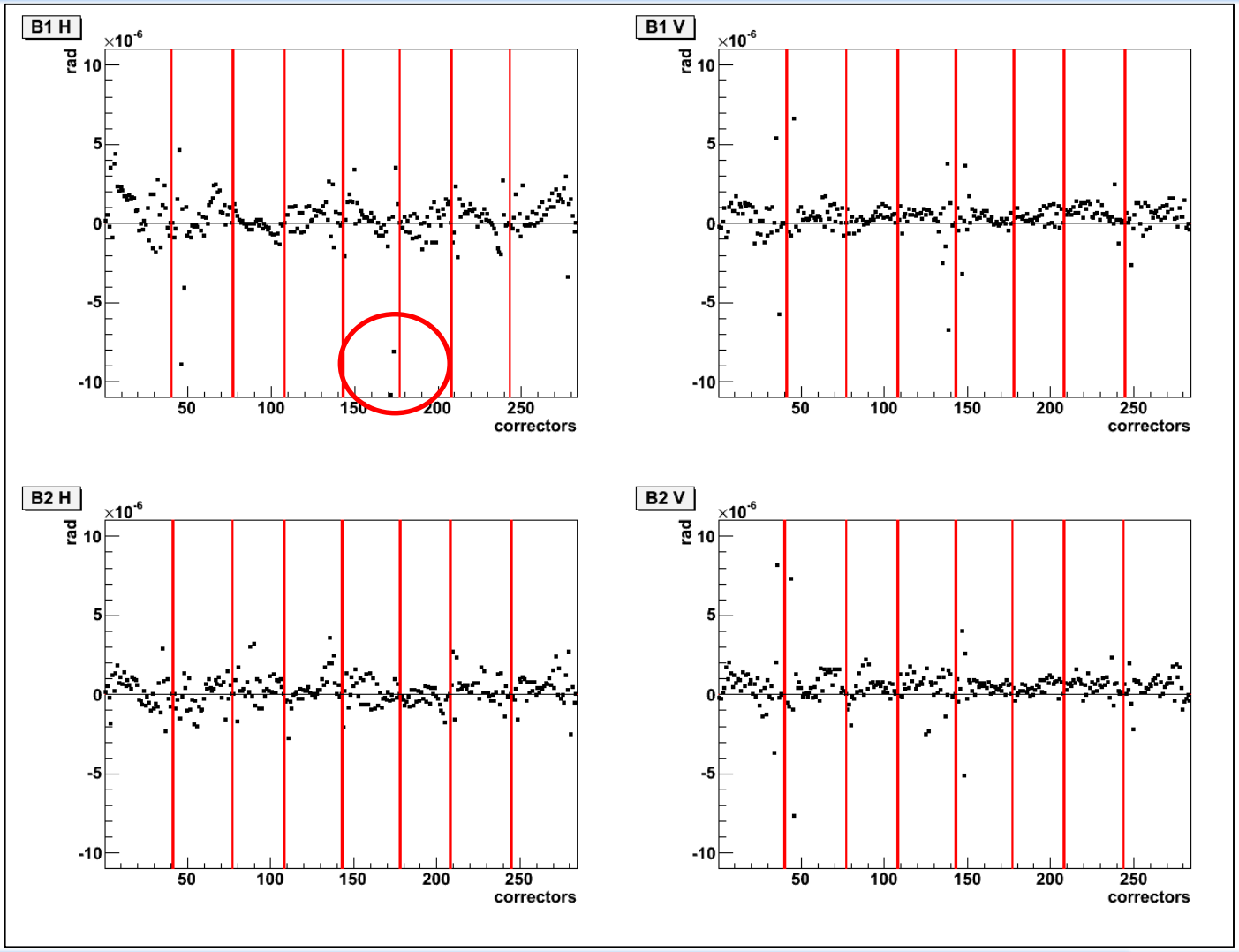


STABLE BEAMS (1400vs1364)



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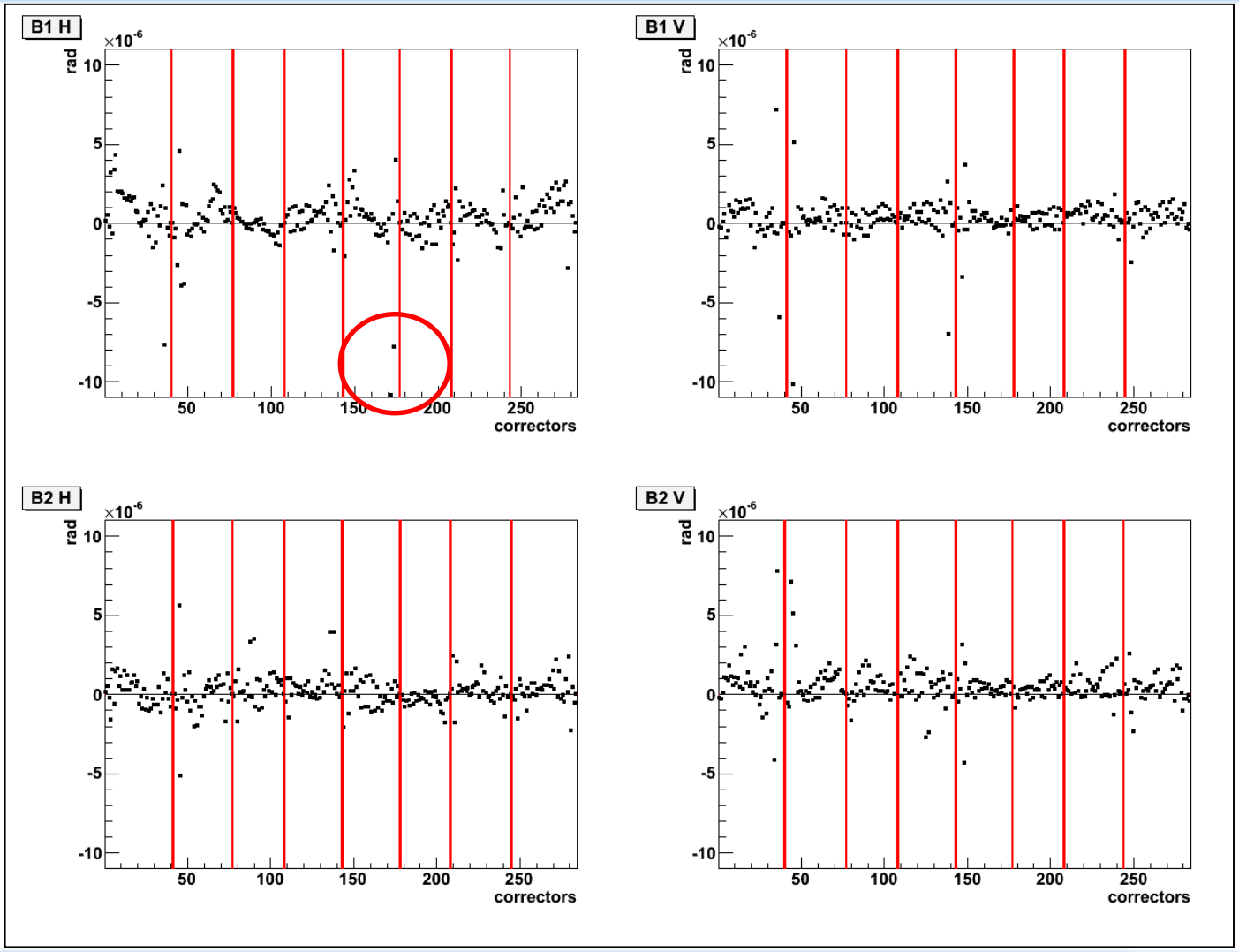
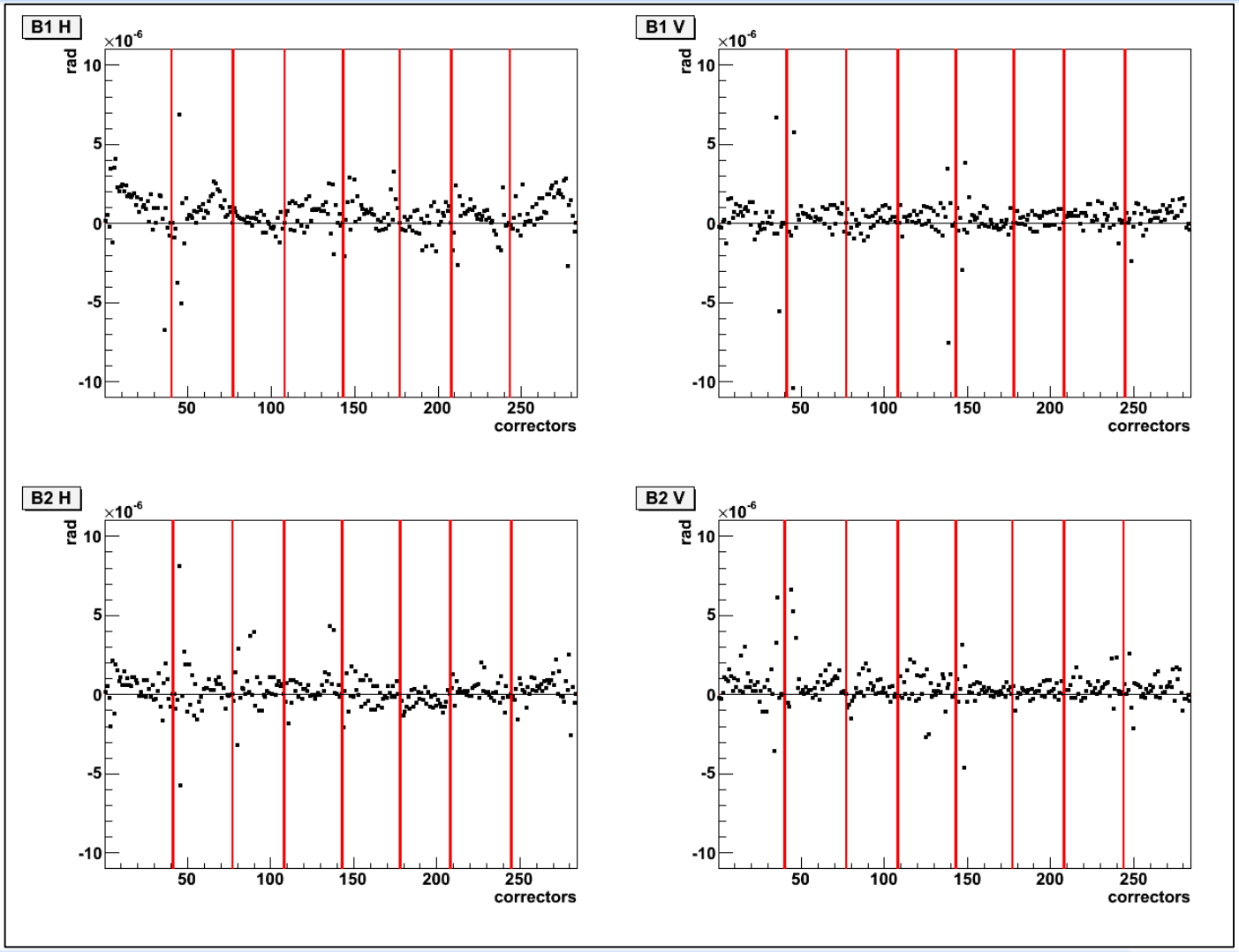
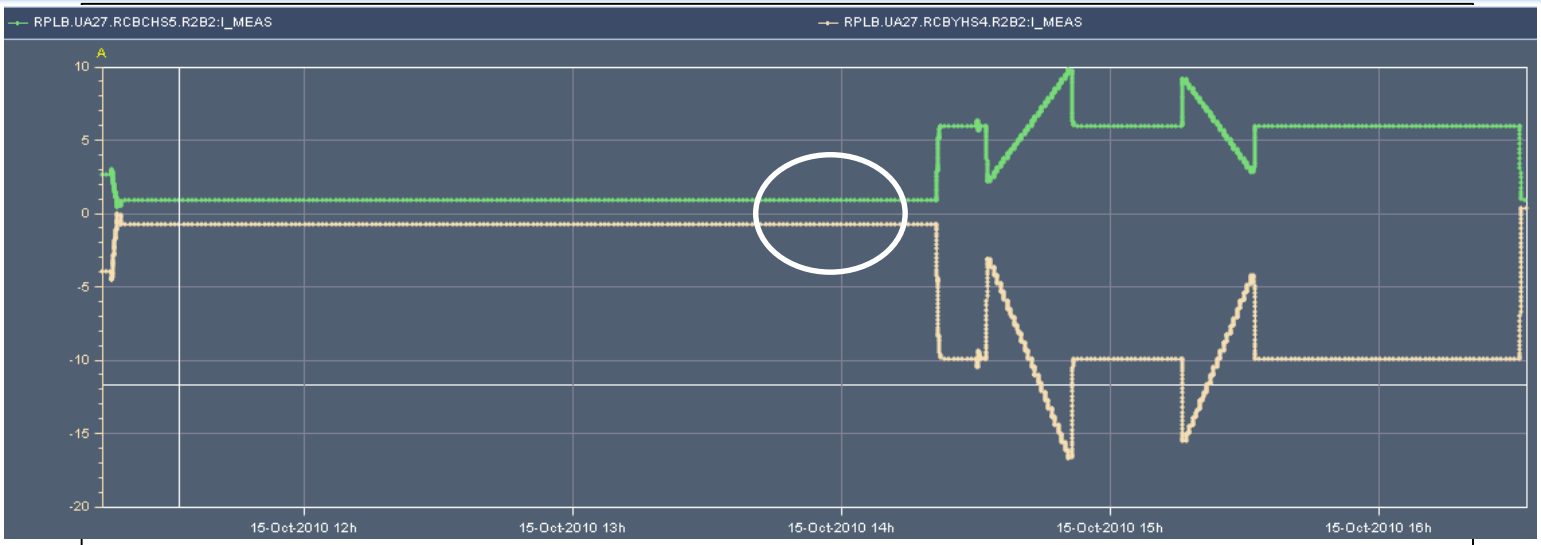
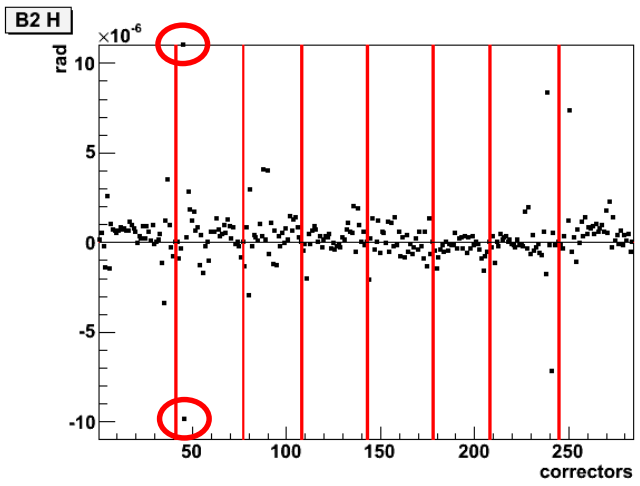


STABLE BEAMS (1418vs1364)

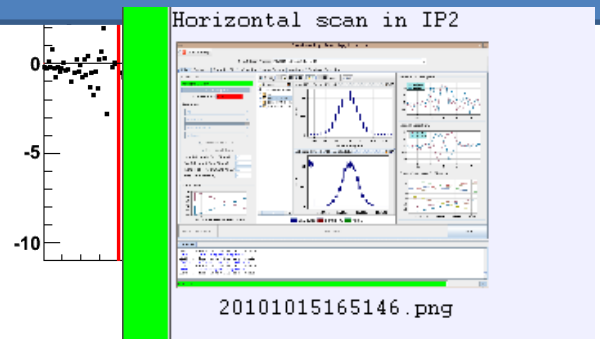


STABLE BEAMS (1422vs1364)

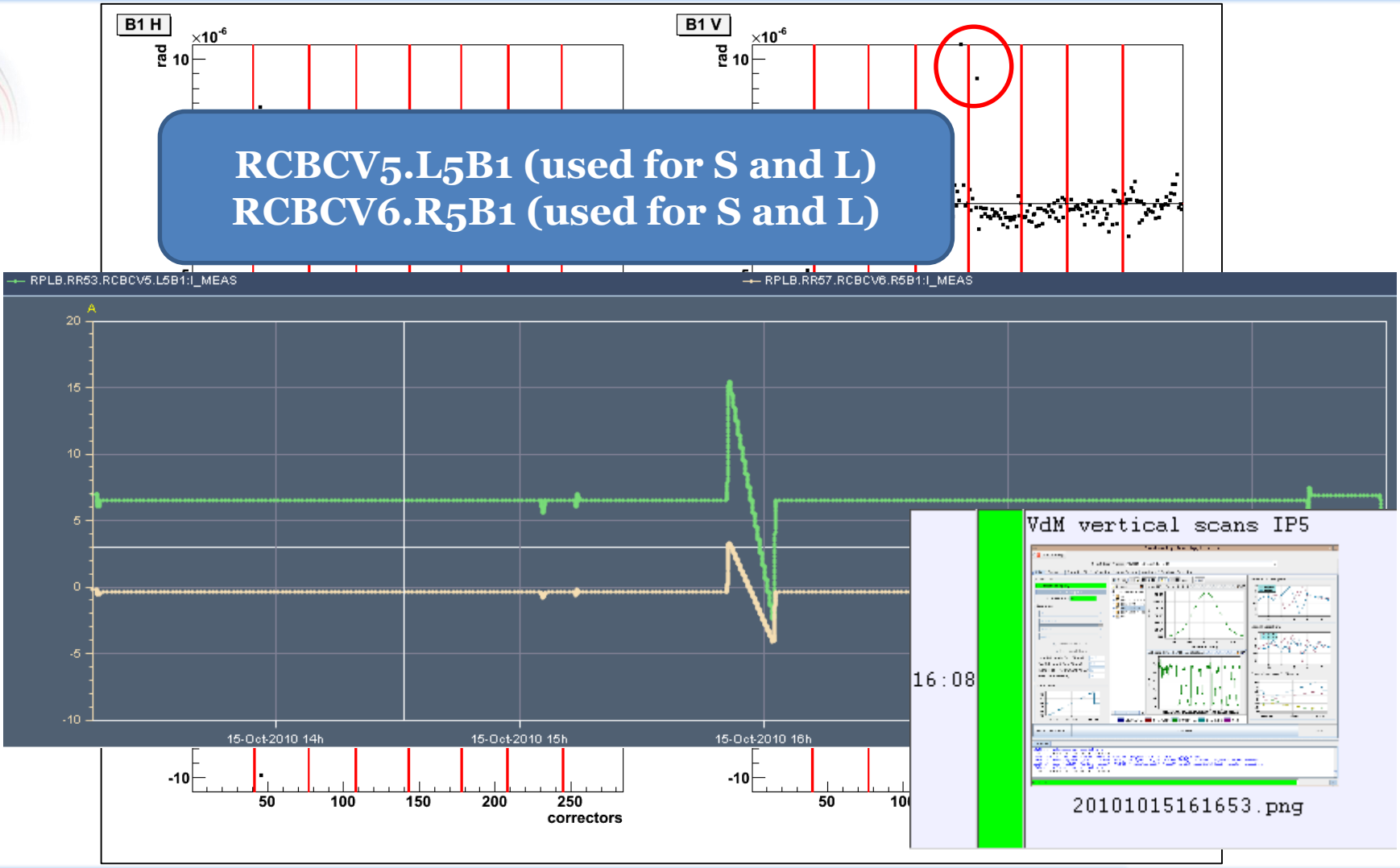




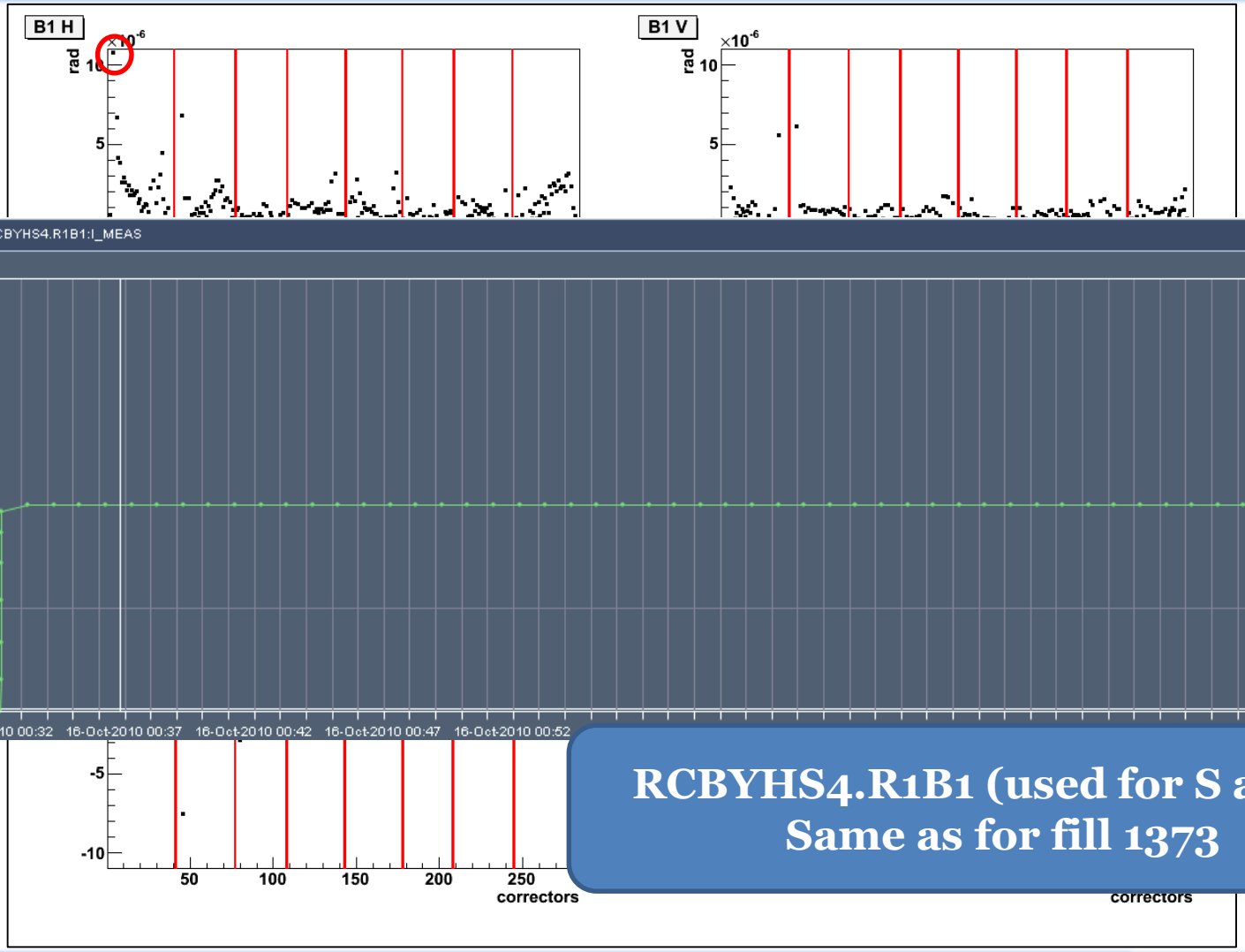
RCBYHS4.R2B2 (used for S and L)
RCBCHS5.R2B2 (used for S and L)



STABLE BEAMS (1422vs1364)

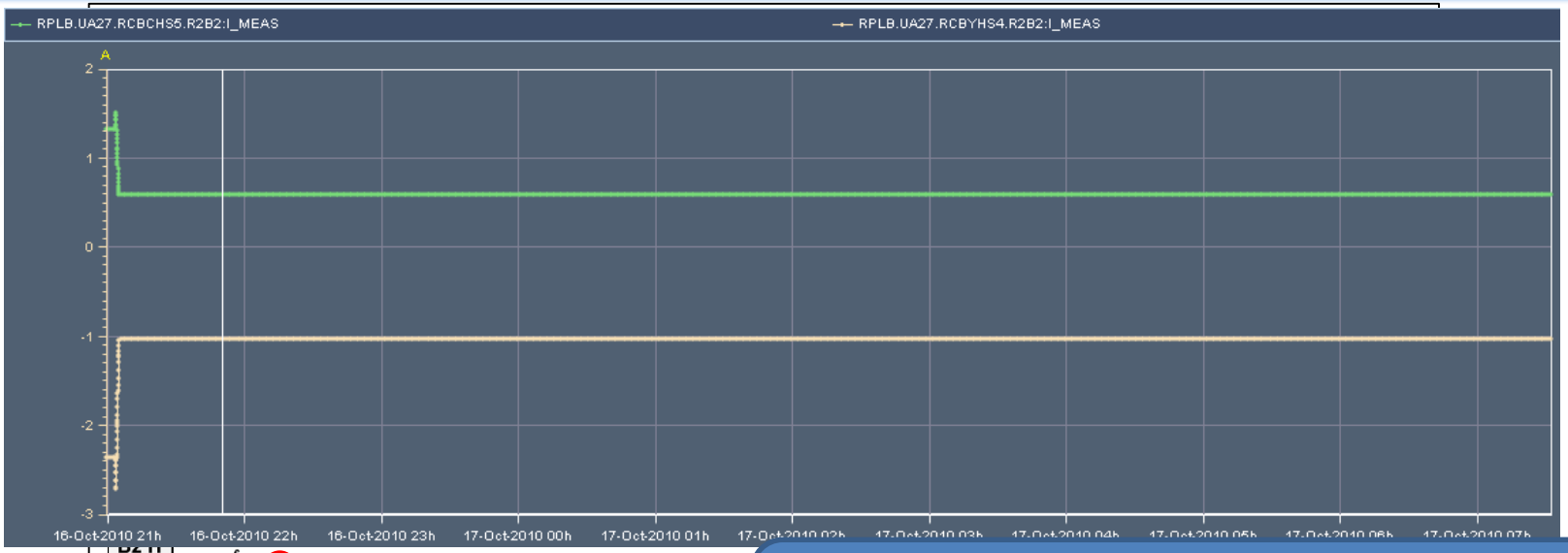


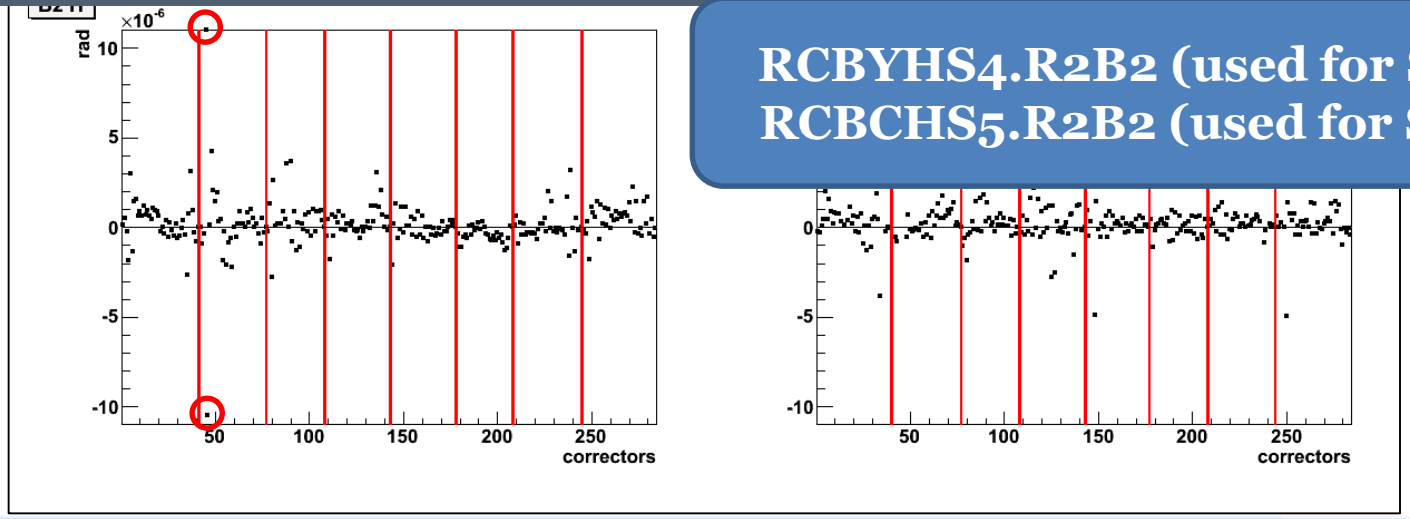
STABLE BEAMS (1424vs1364)



RCBYHS4.R1B1 (used for S and L)
Same as for fill 1373

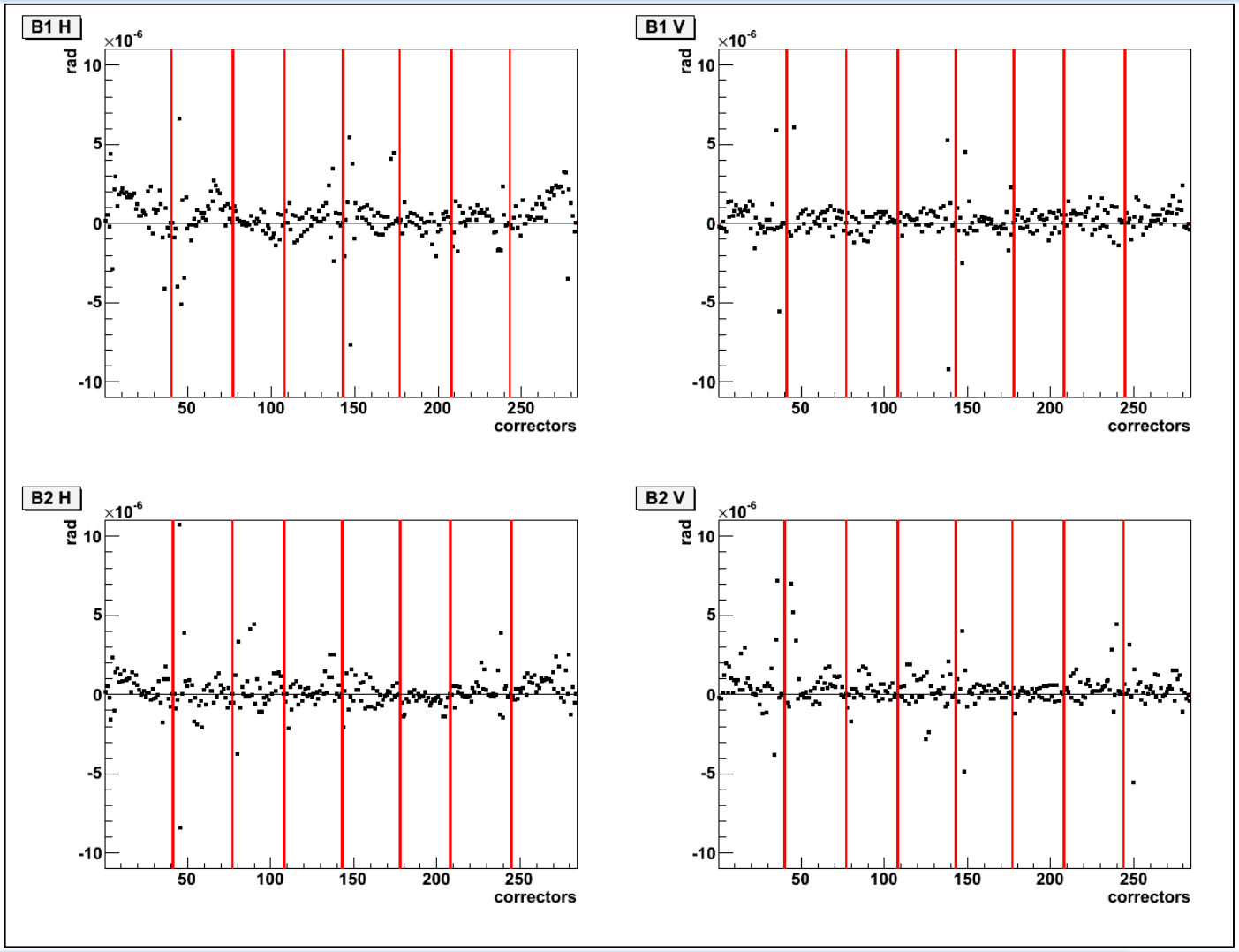
STABLE BEAMS (1427vs1364)



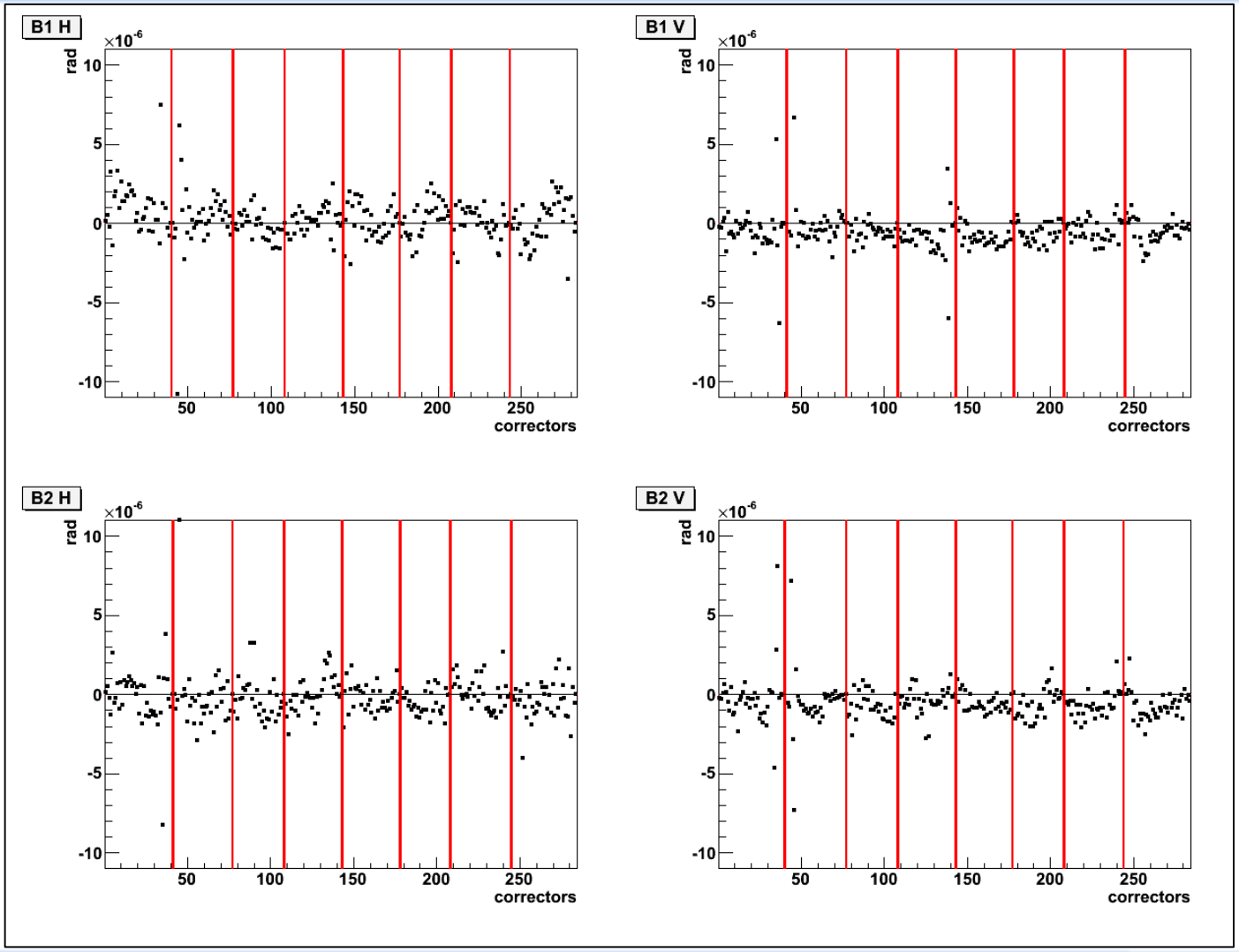


RCBYHS4.R2B2 (used for S and L)
RCBCHS5.R2B2 (used for S and L)

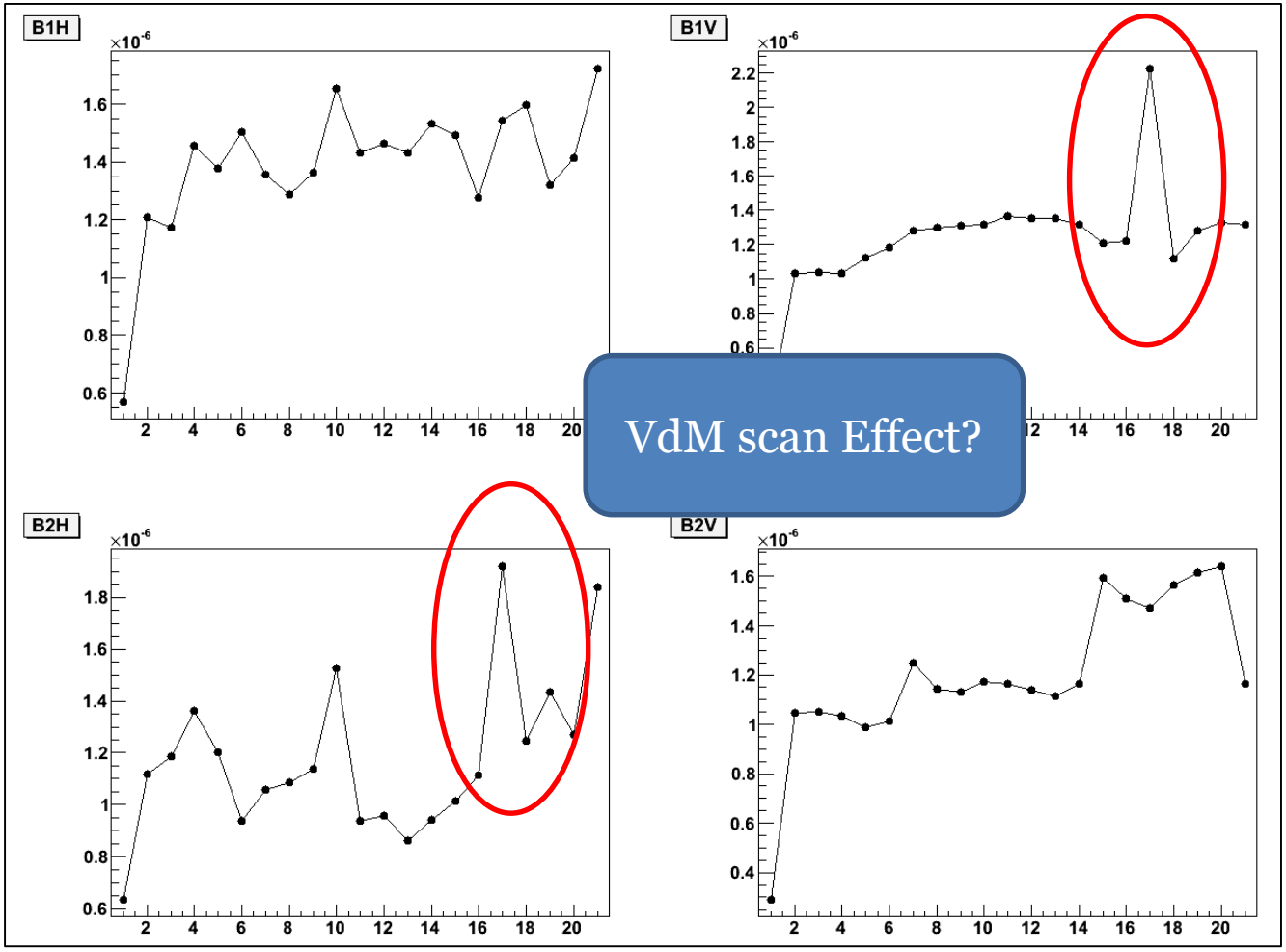
STABLE BEAMS (1430vs1364)



STABLE BEAMS (1439vs1364)



RMS @ STABLE BEAMS



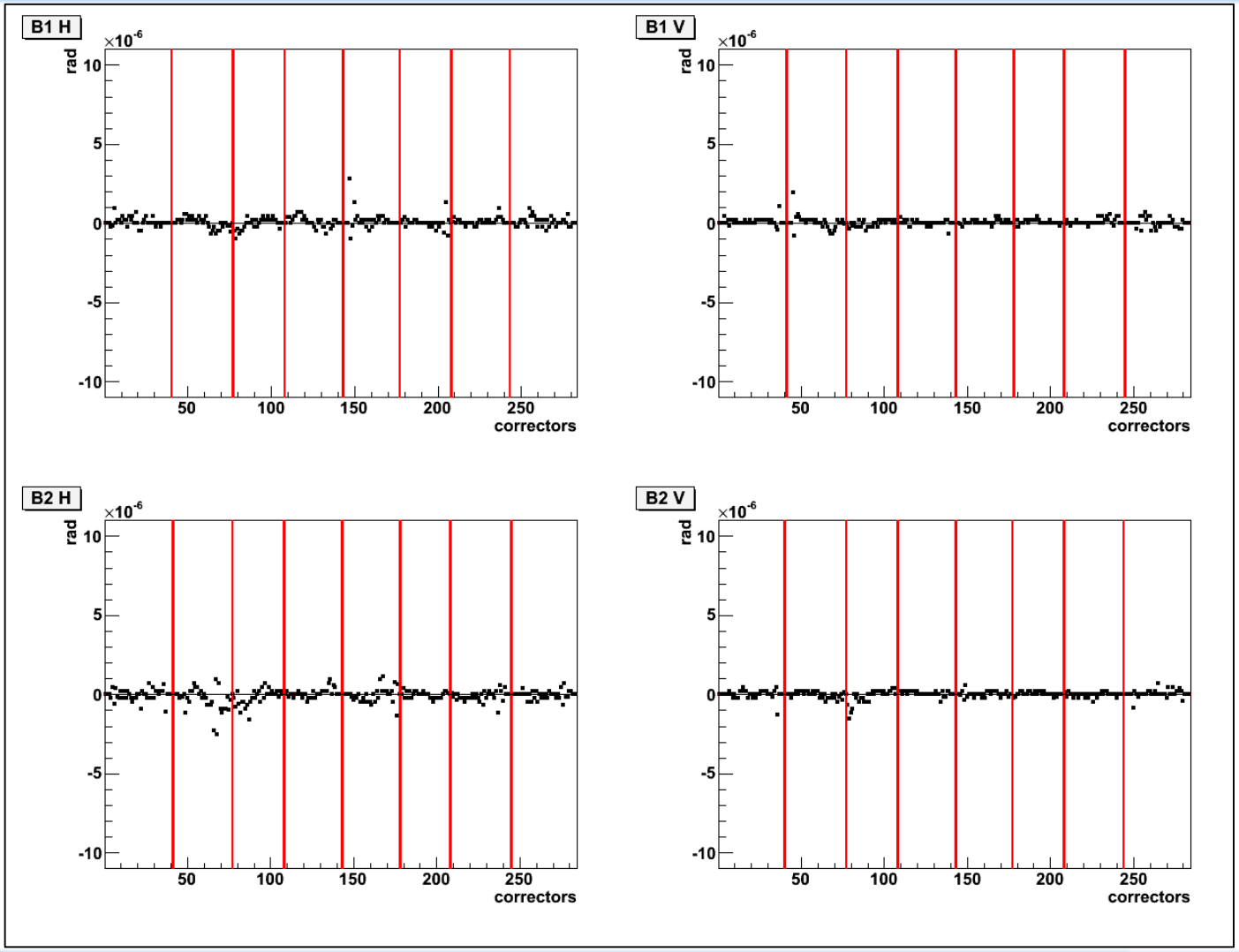
always below 2e-06 (but VdM scan)

FIRST CONCLUSION

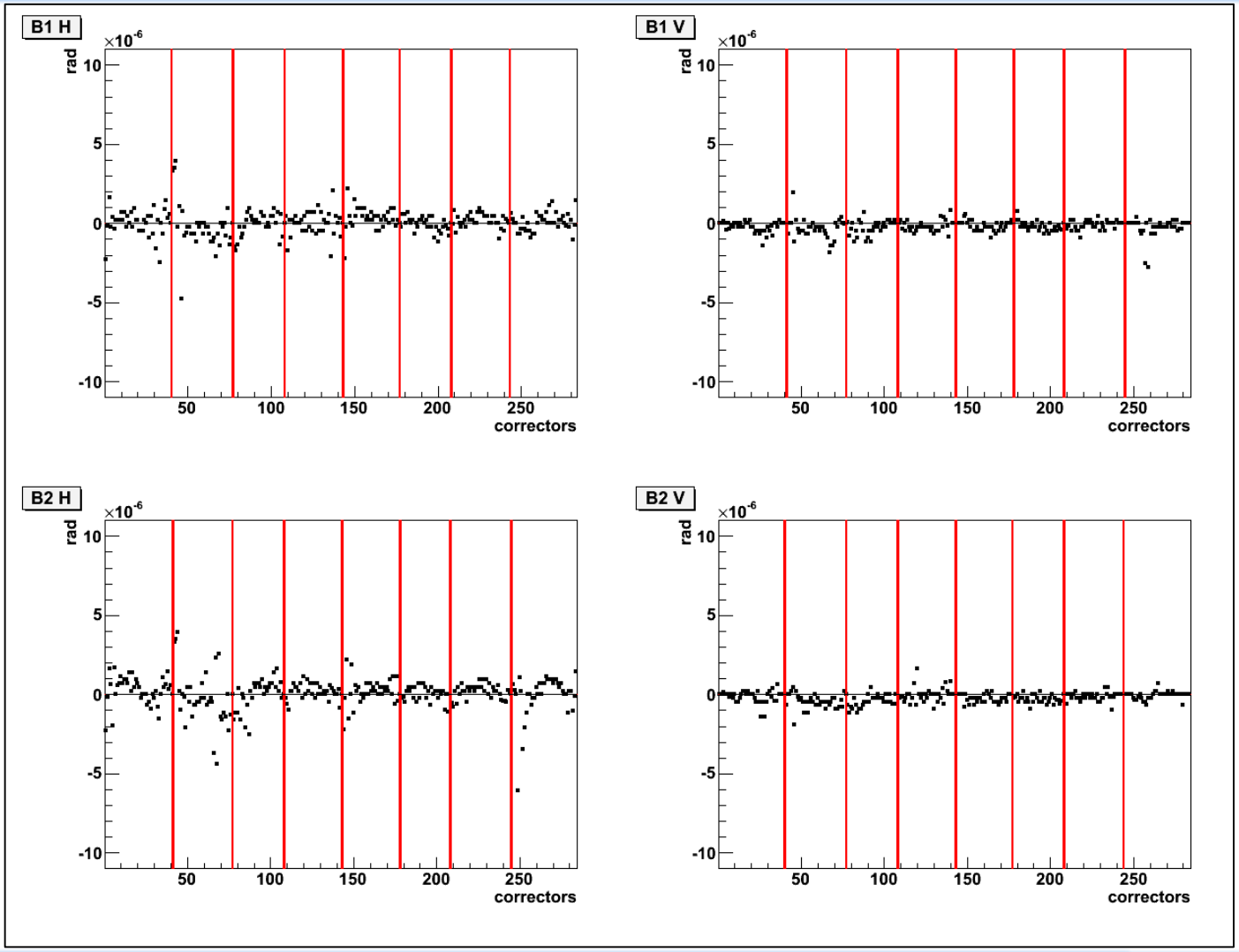
@ STABLE BEAMS

- Orbit in the arc seems to be good as no strange affect seen so far
- Some behaviors on MS has to be more carefully analyzed
- RMS is in general small over many fills (and more than a month time) showing a good reproducibility of the orbit

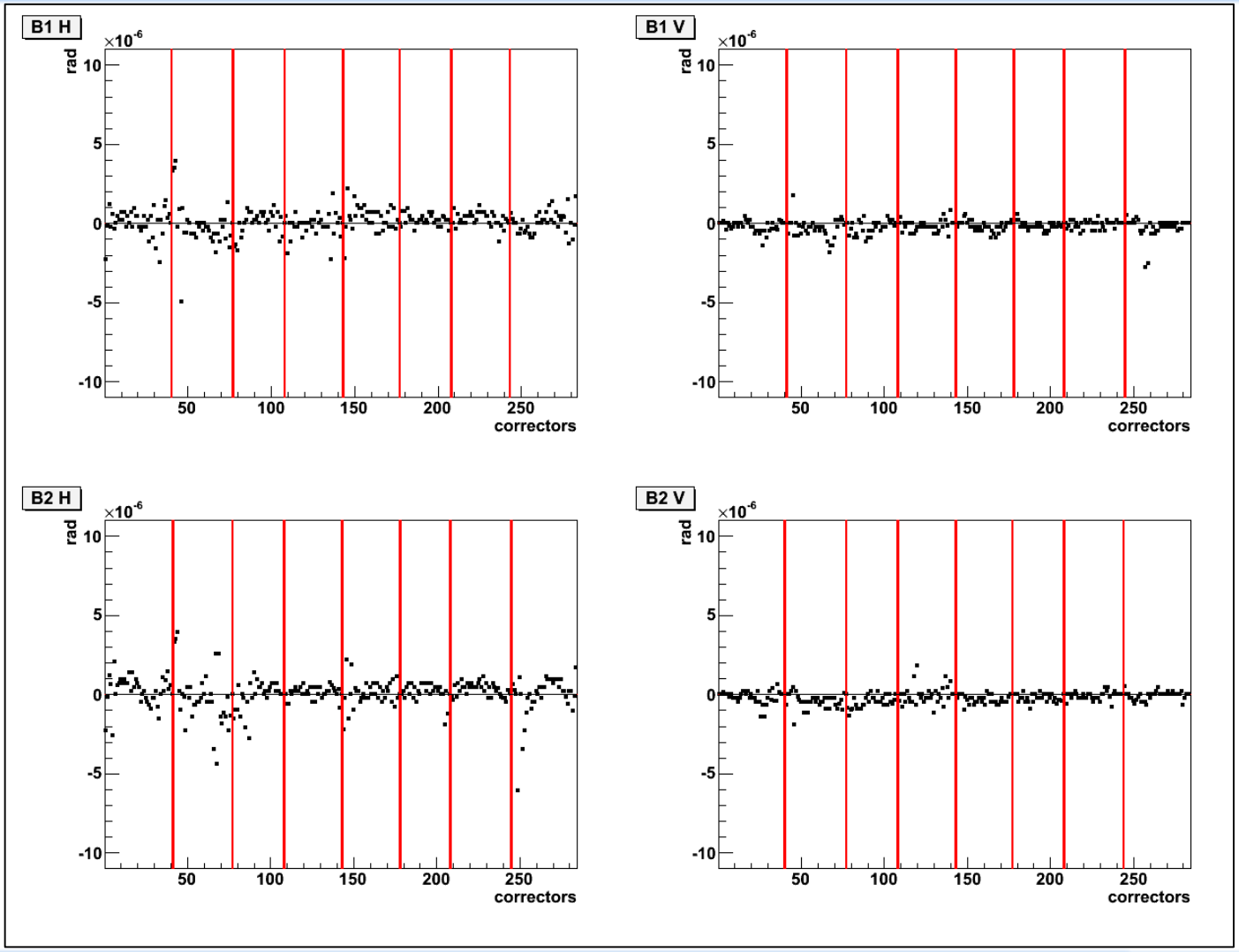
INJECTION (1366vs1364)



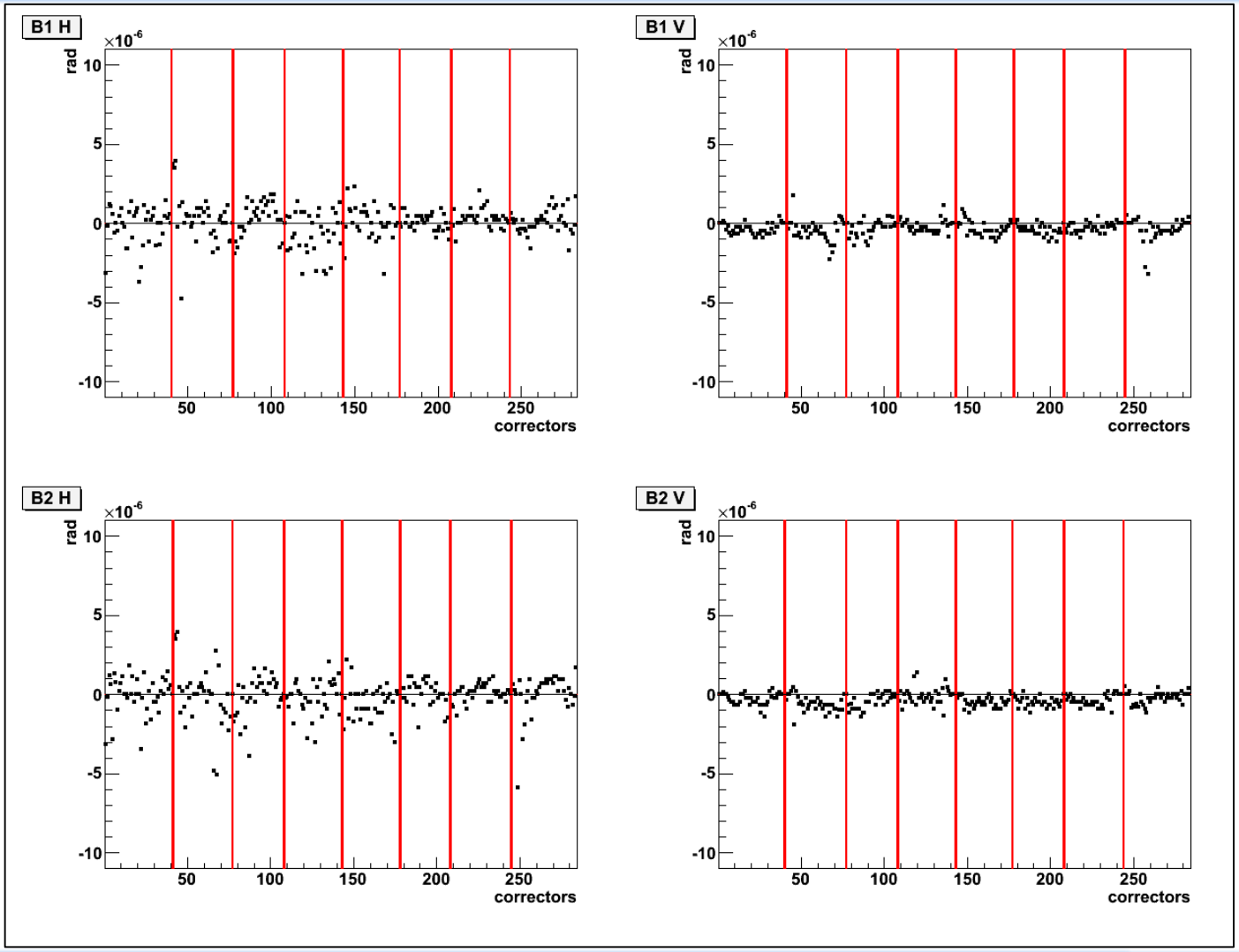
INJECTION (1369vs1364)



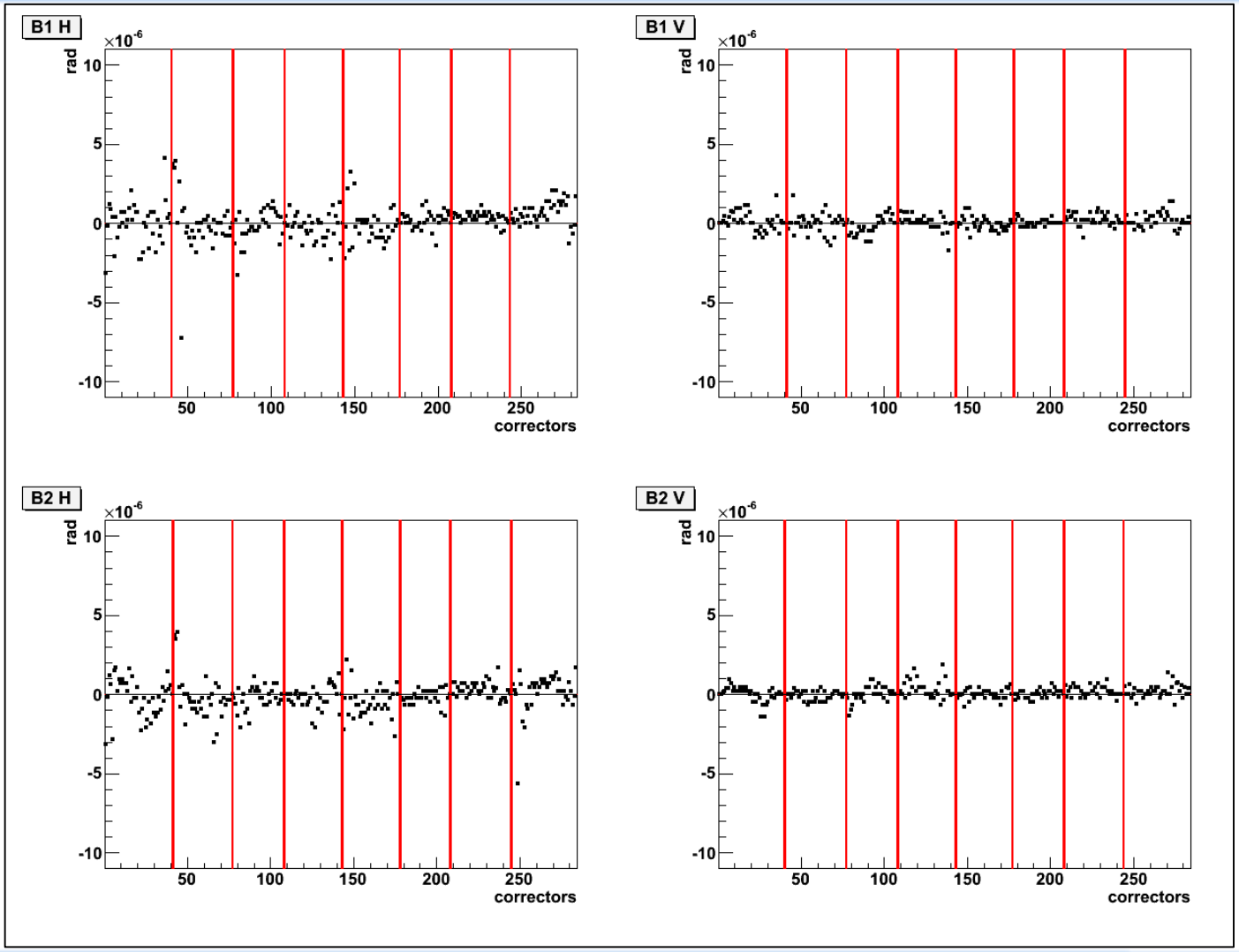
INJECTION (1372vs1364)



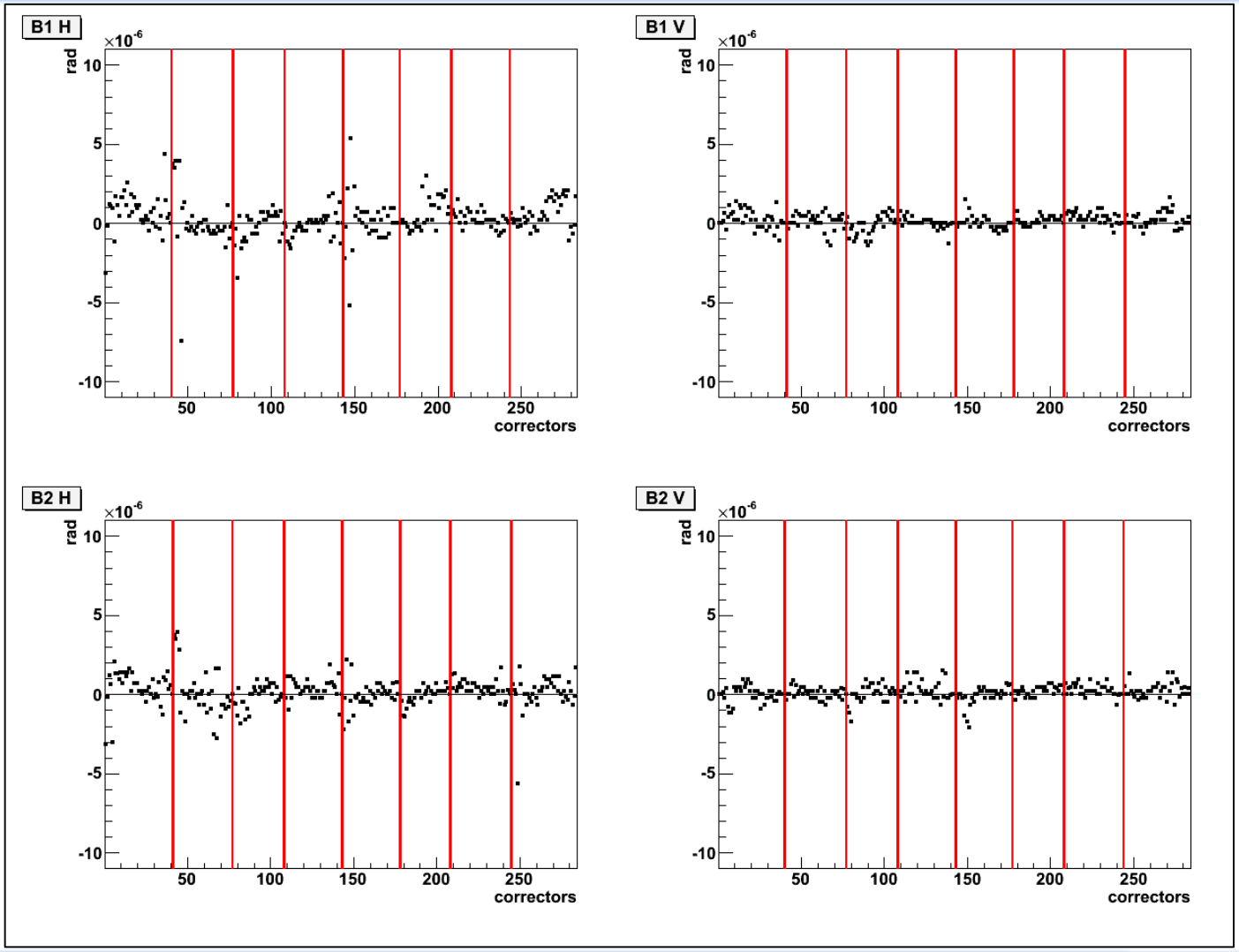
INJECTION (1373vs1364)



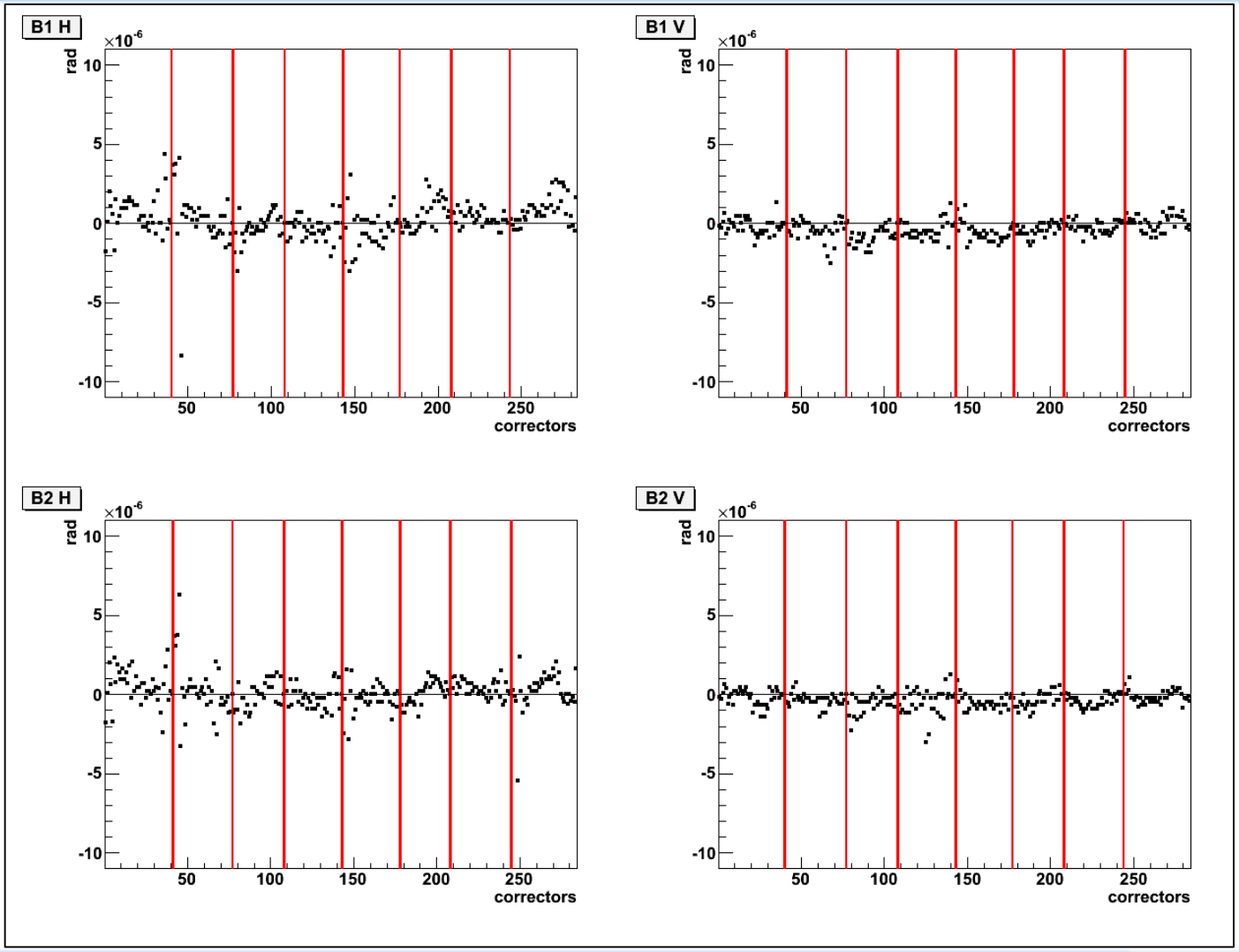
INJECTION (1375vs1364)



INJECTION (1381vs1364)



INJECTION (1386vs1364)



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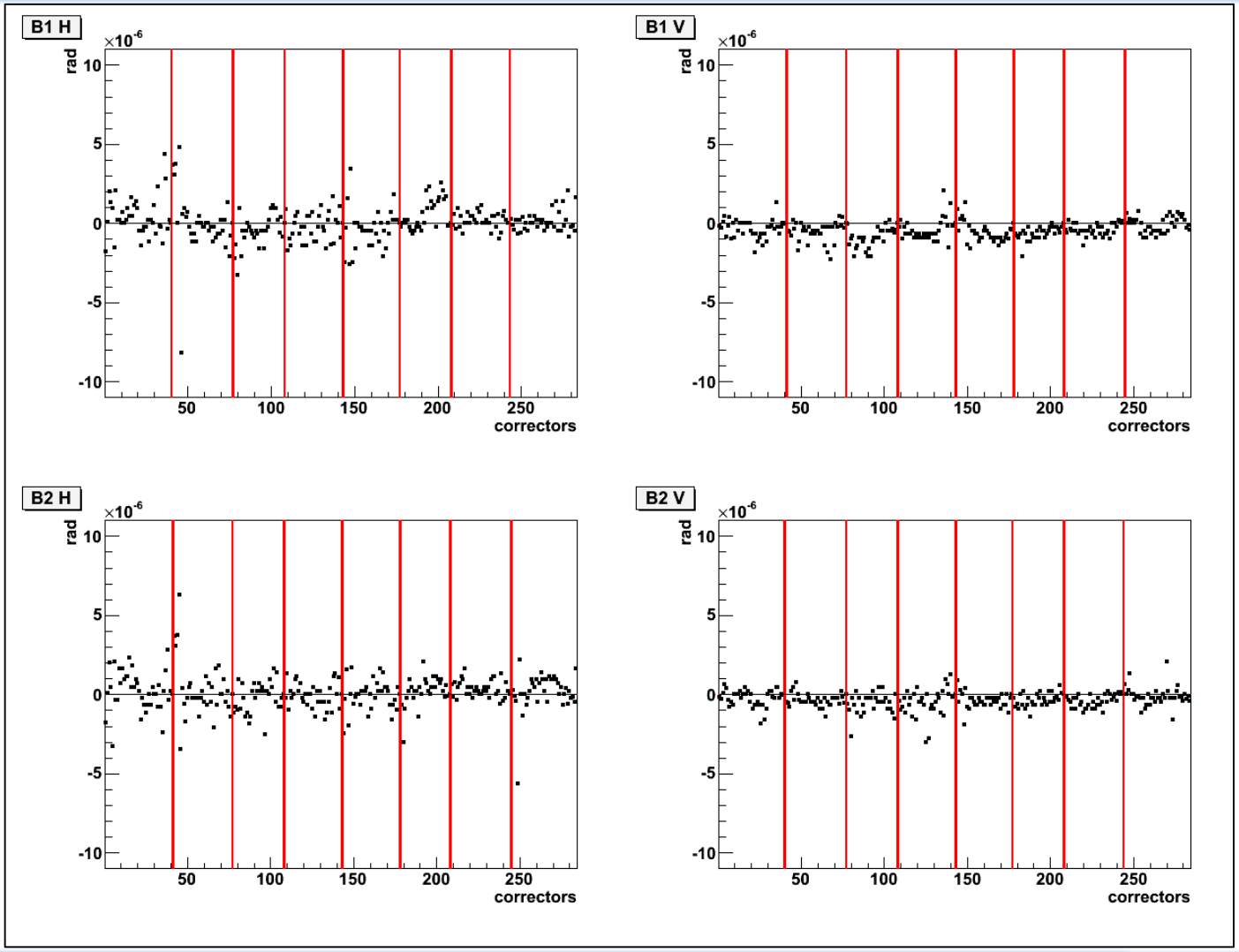

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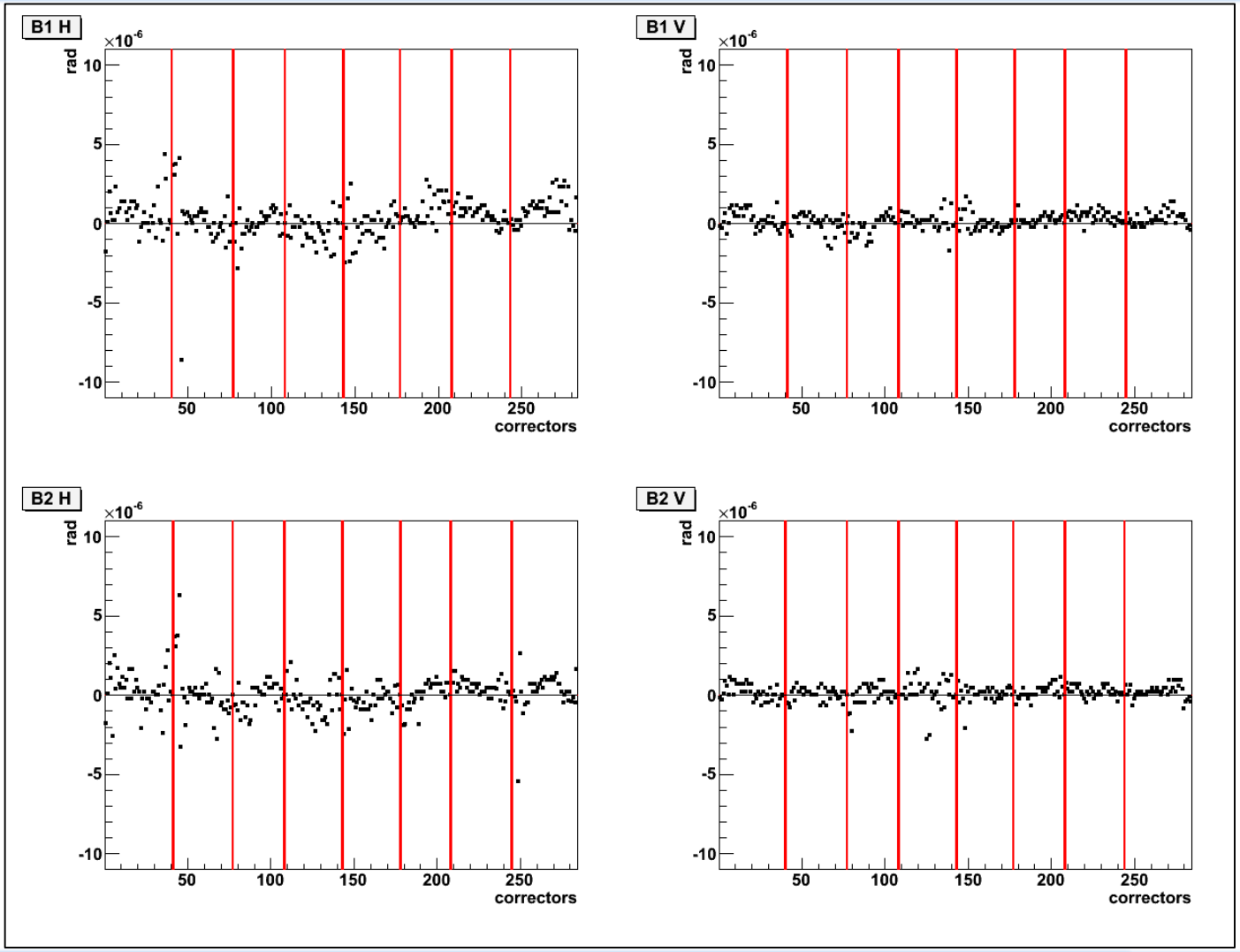

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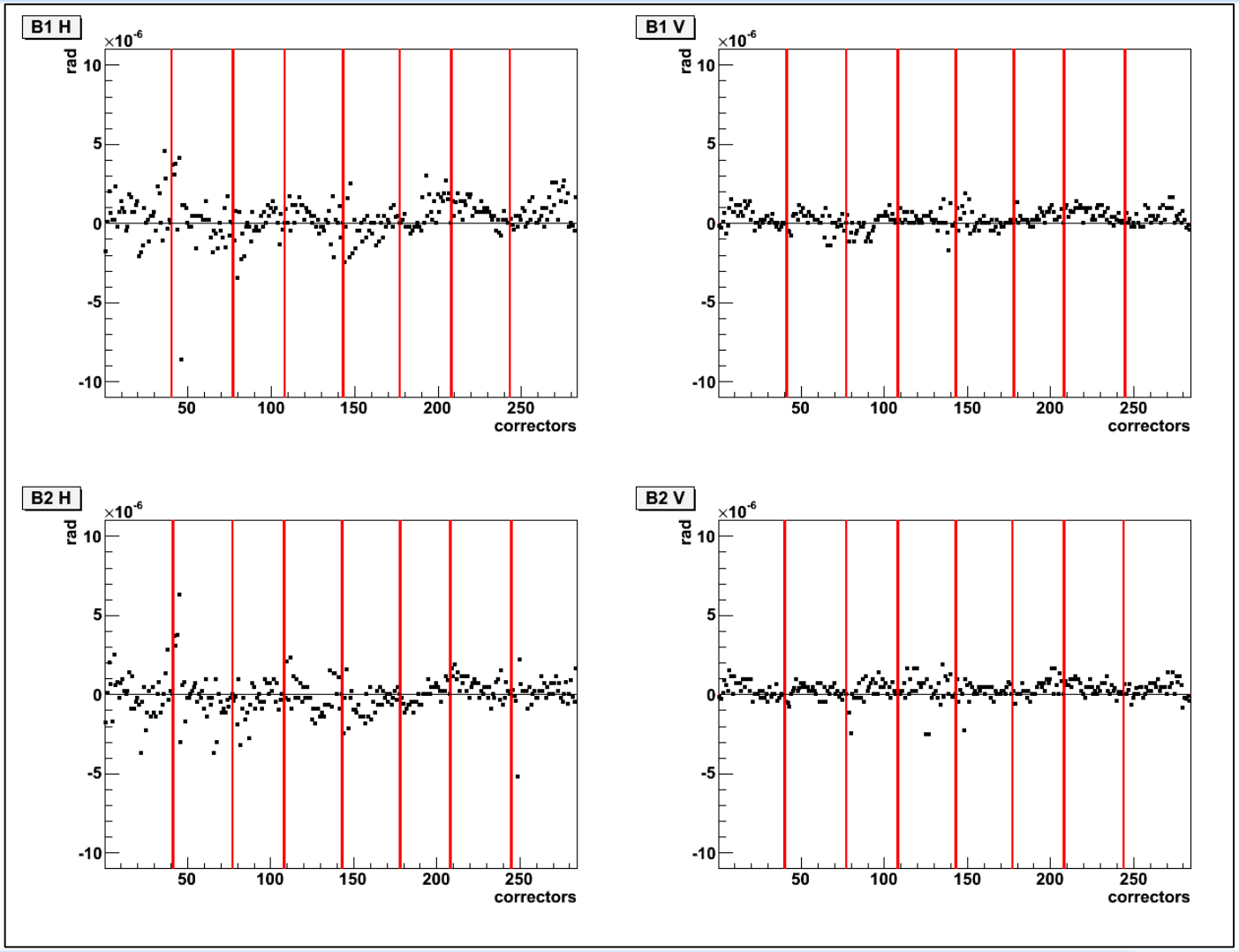
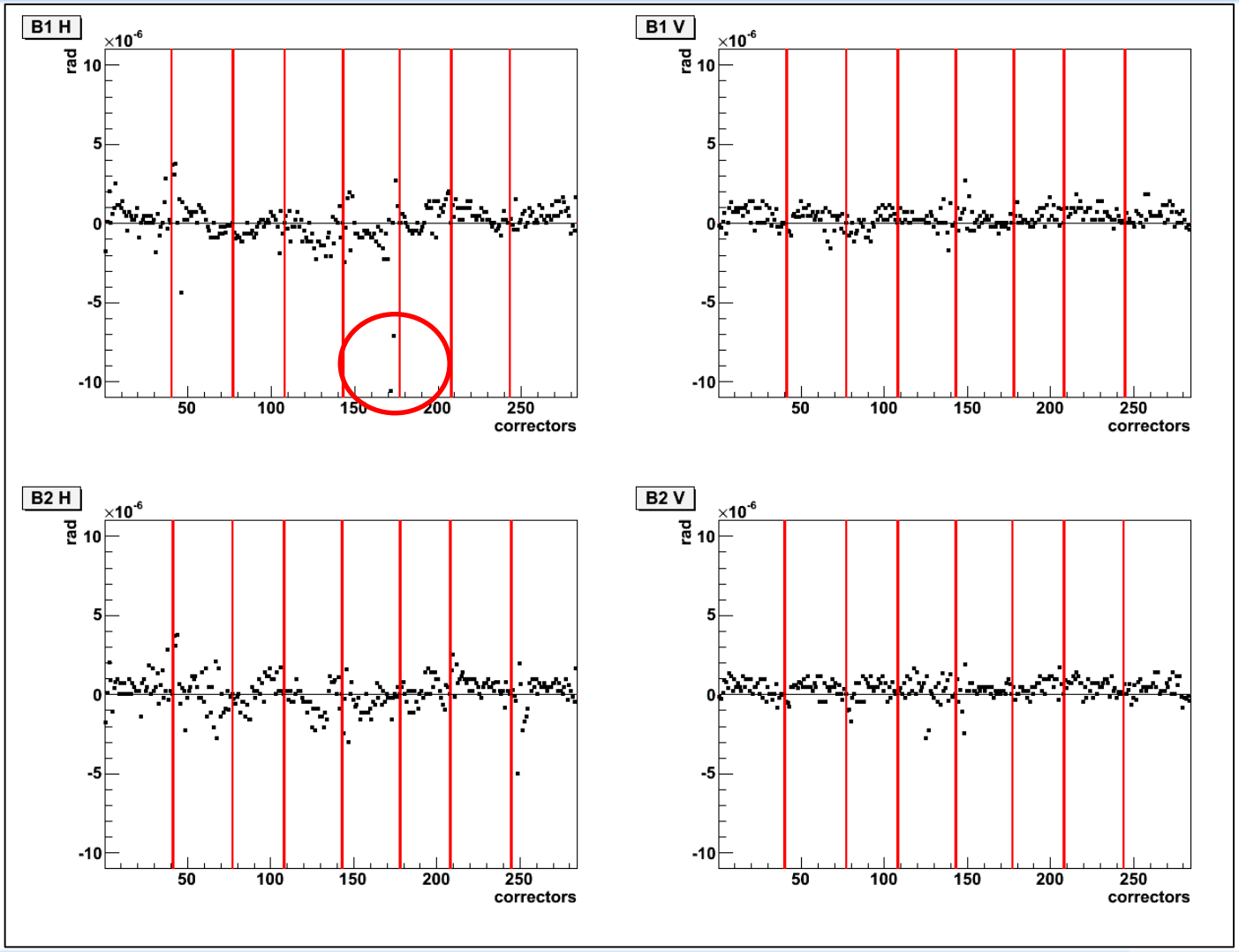
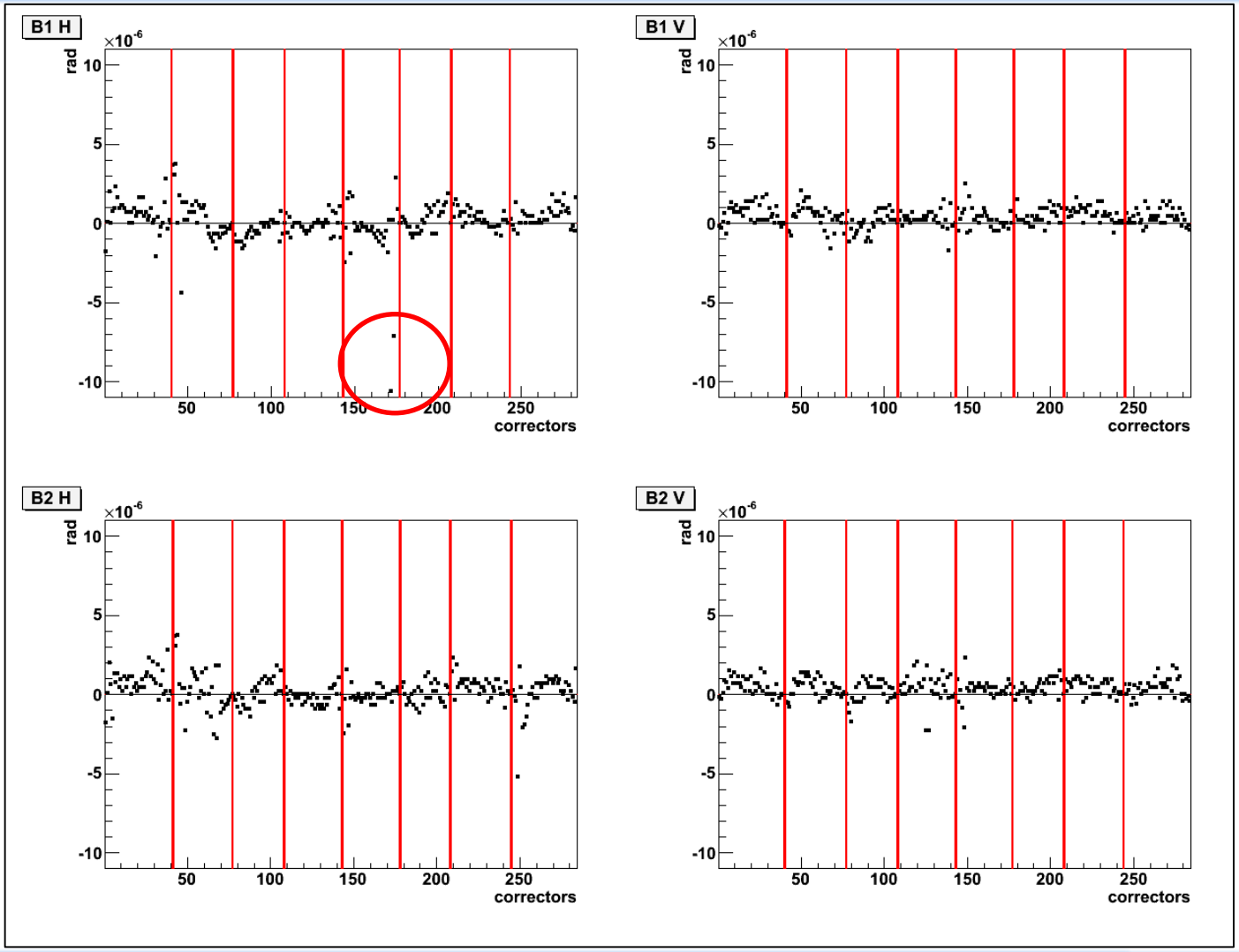


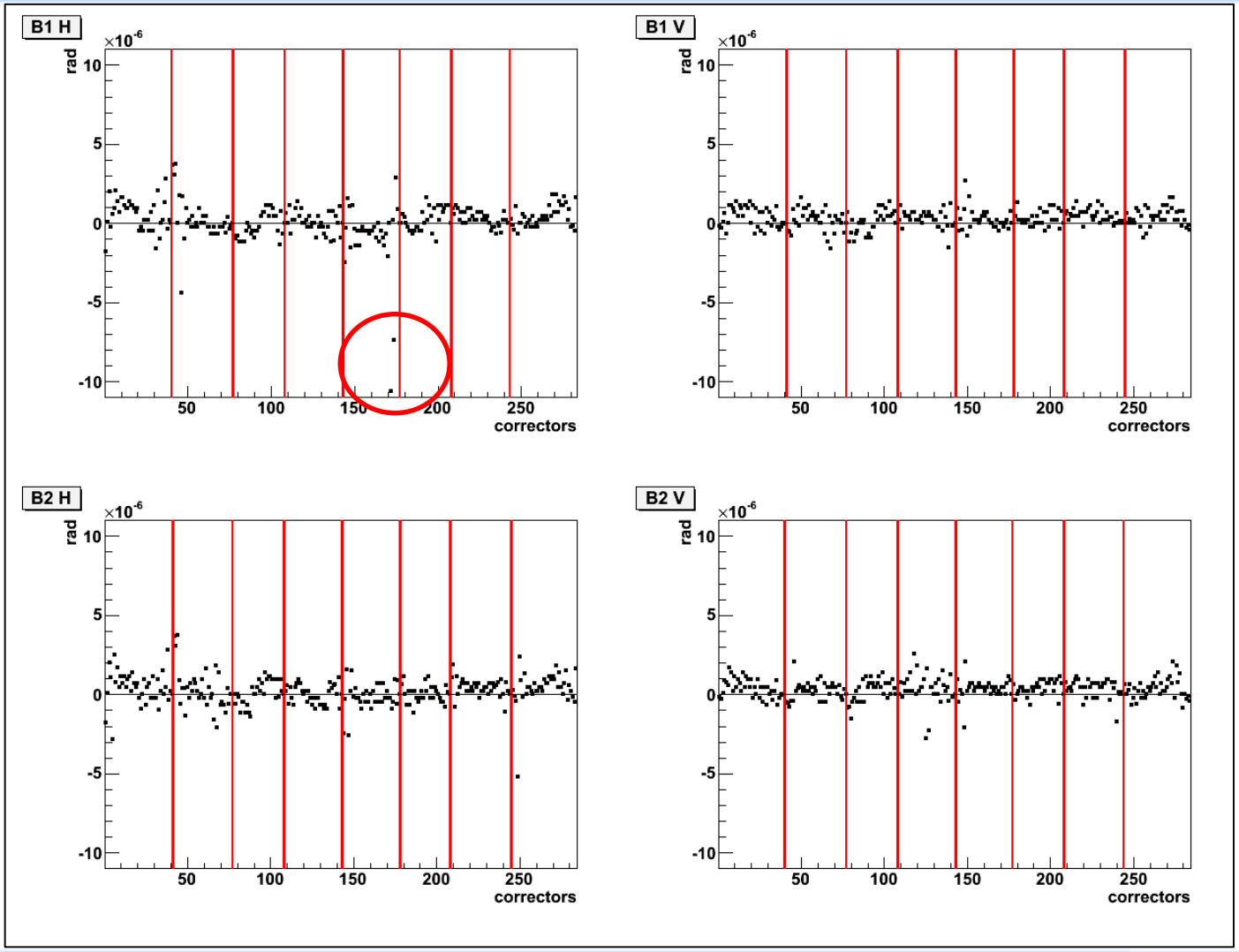
INJECTION (1393vs1364)



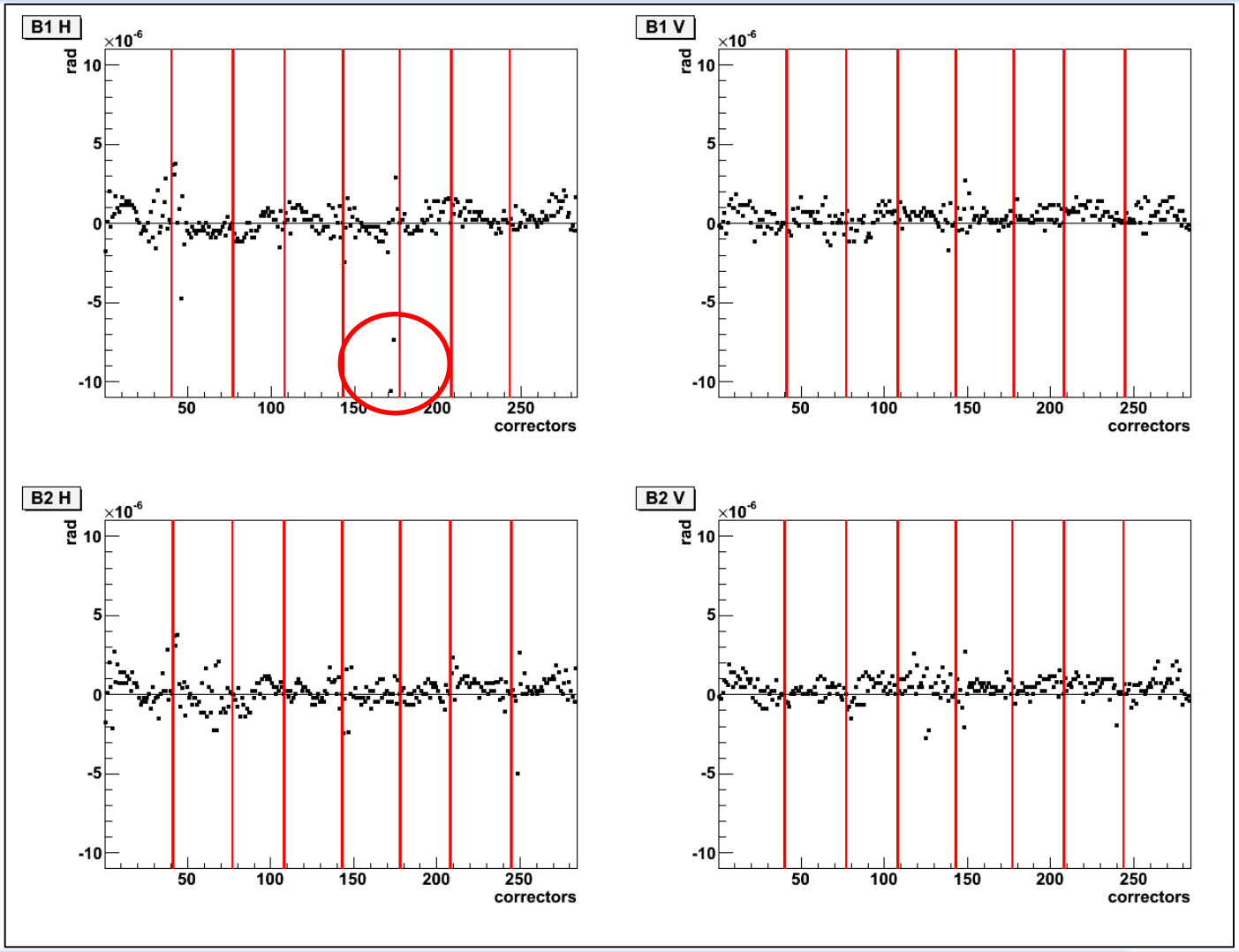
INJECTION (1394vs1364)



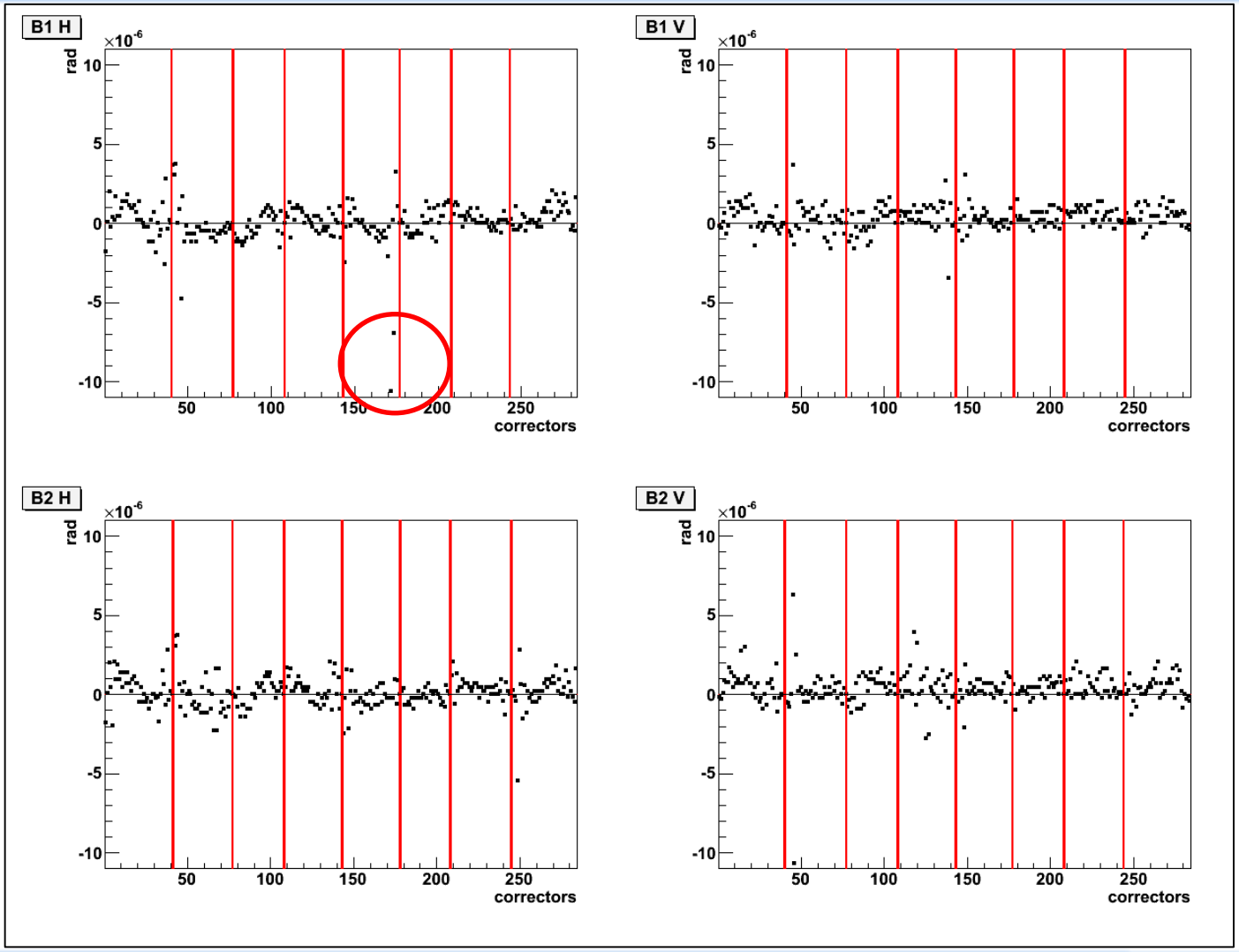
INJECTION (1397vs1364)



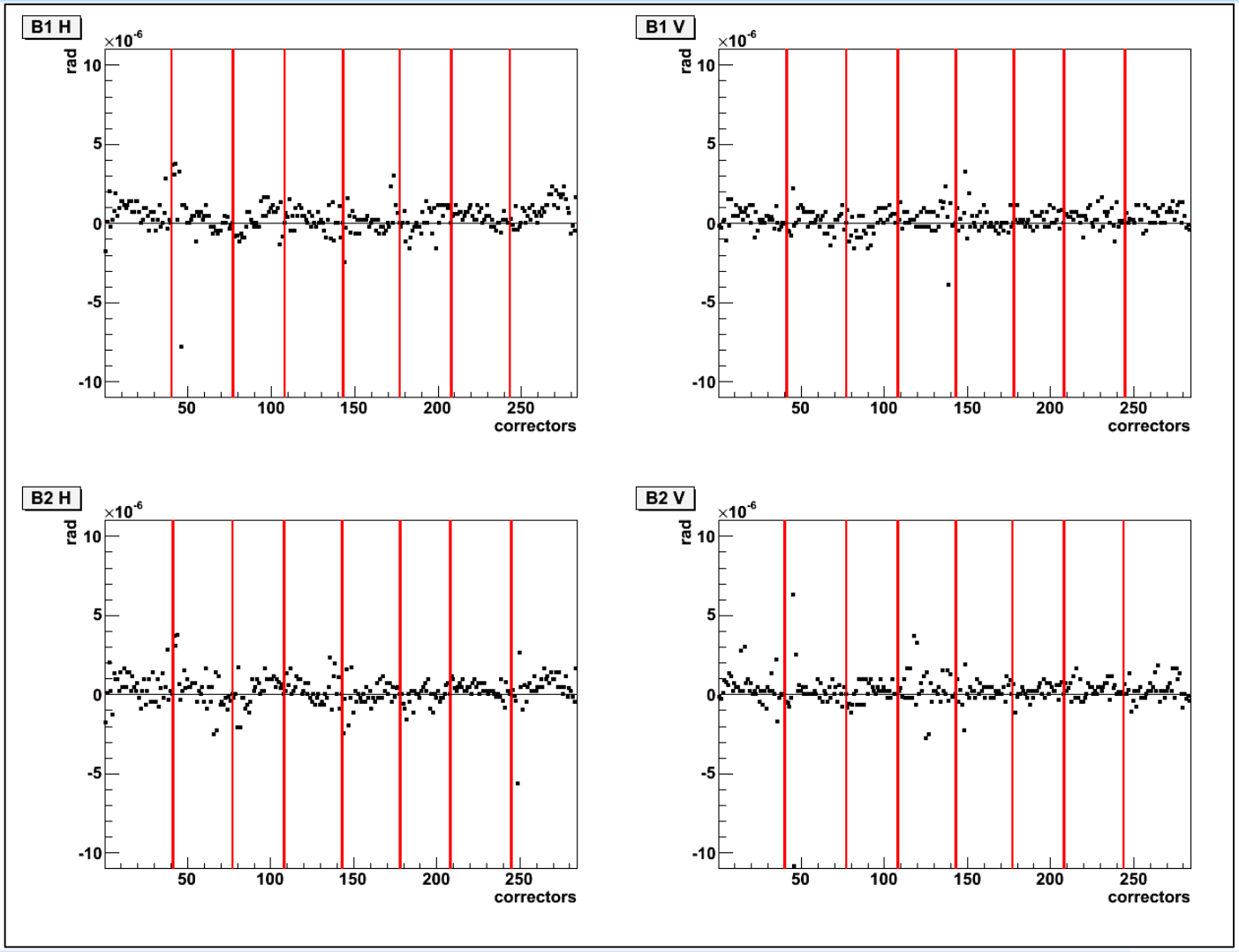
INJECTION (1400vs1364)



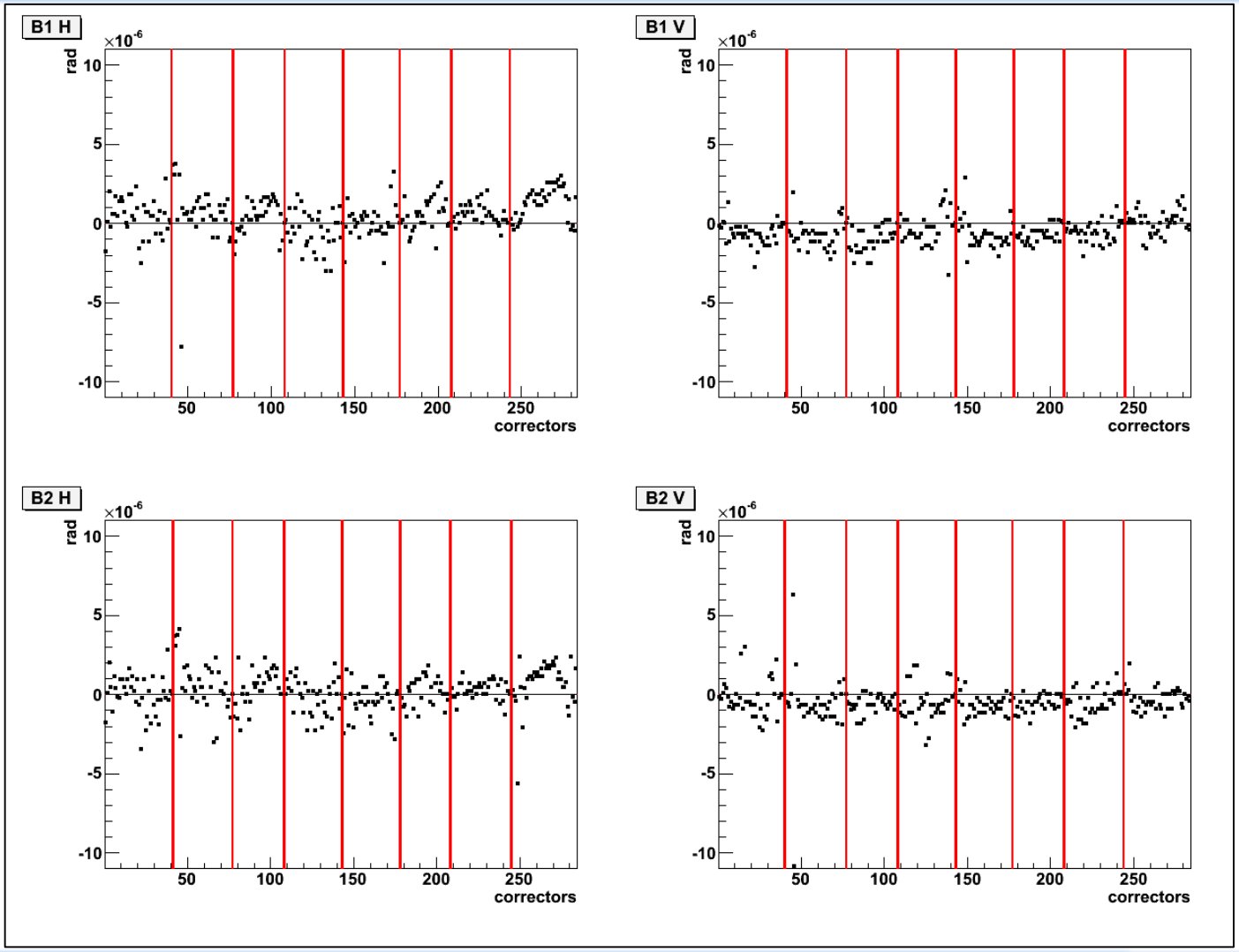
INJECTION (1408vs1364)



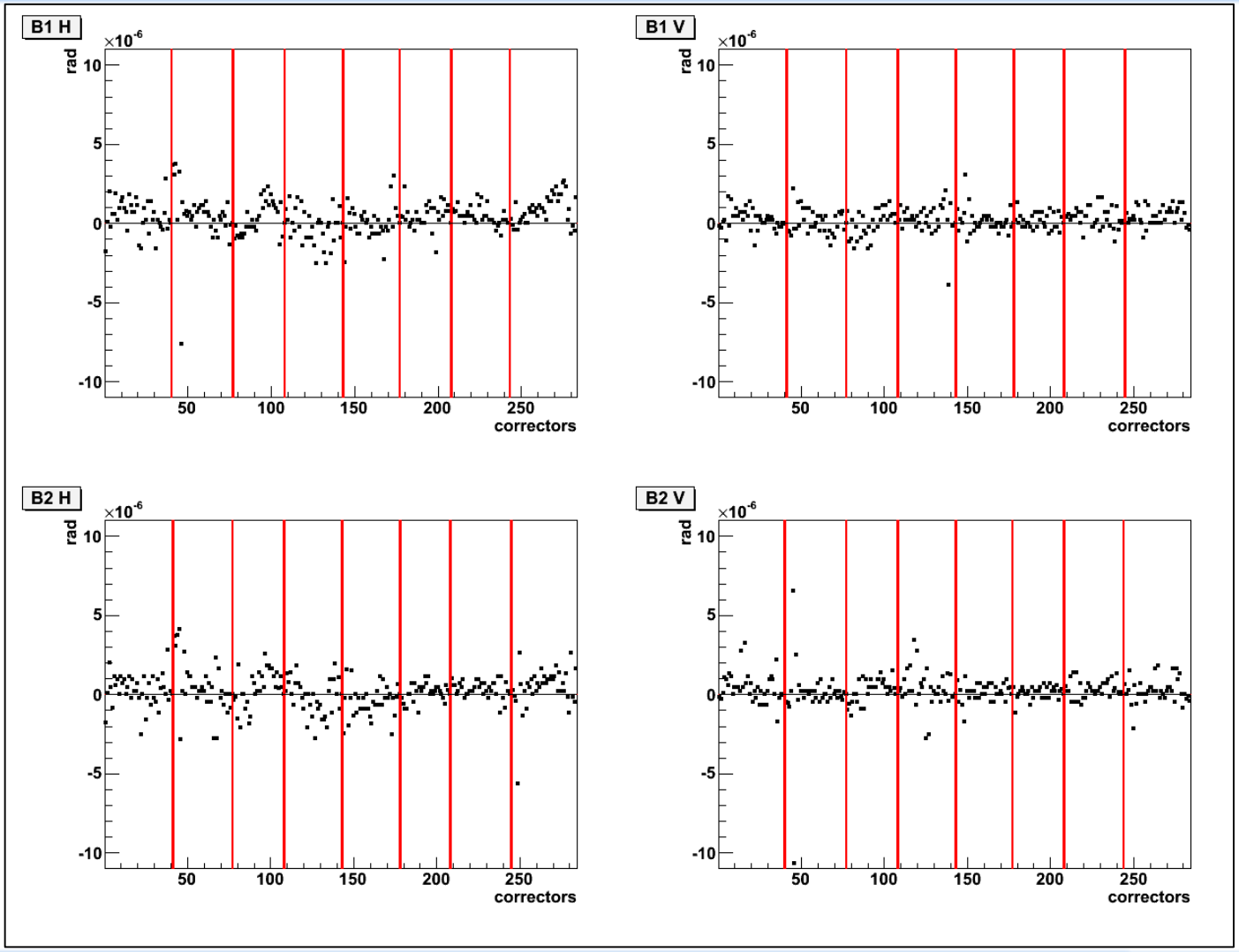
INJECTION (1418vs1364)



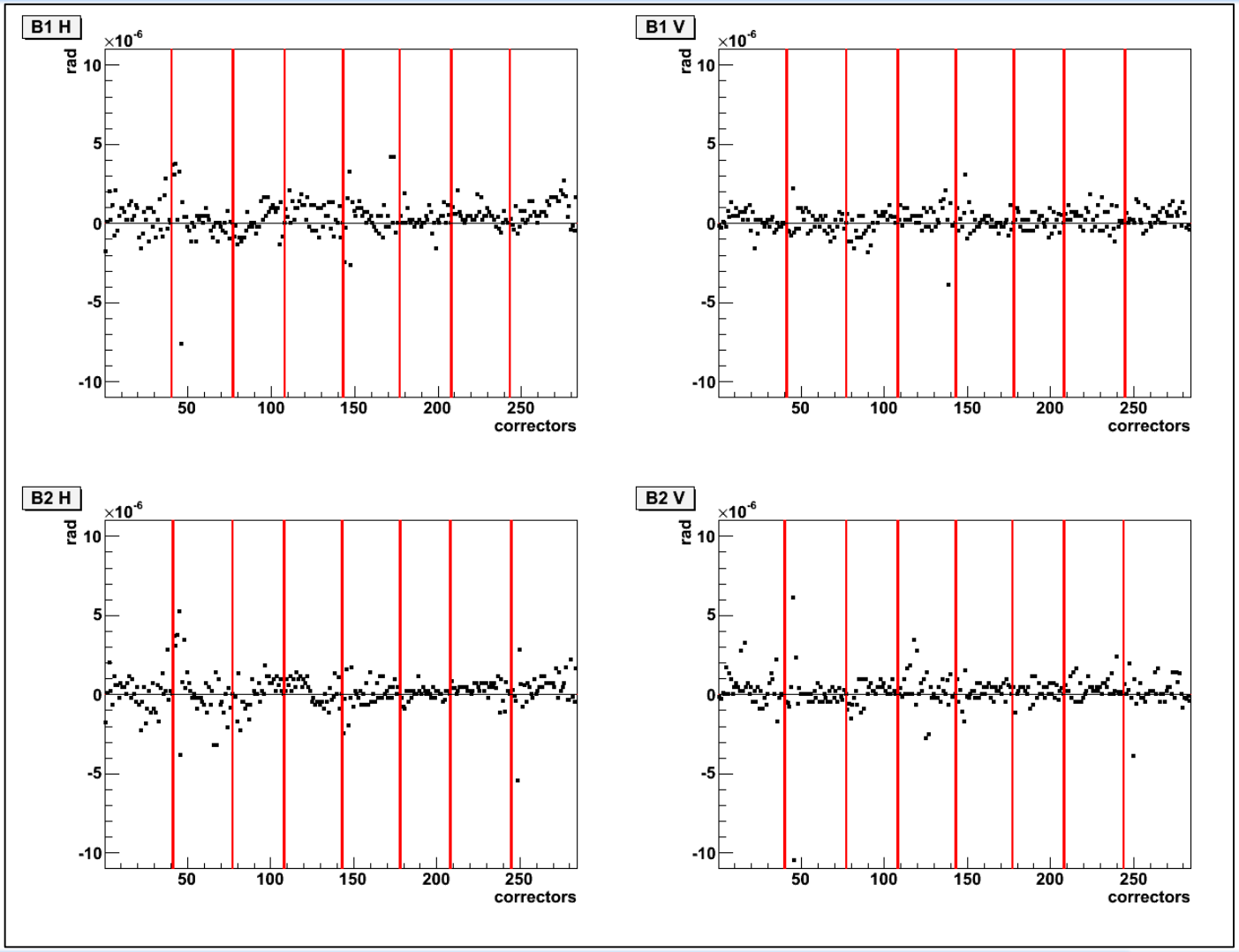
INJECTION (1422vs1364)



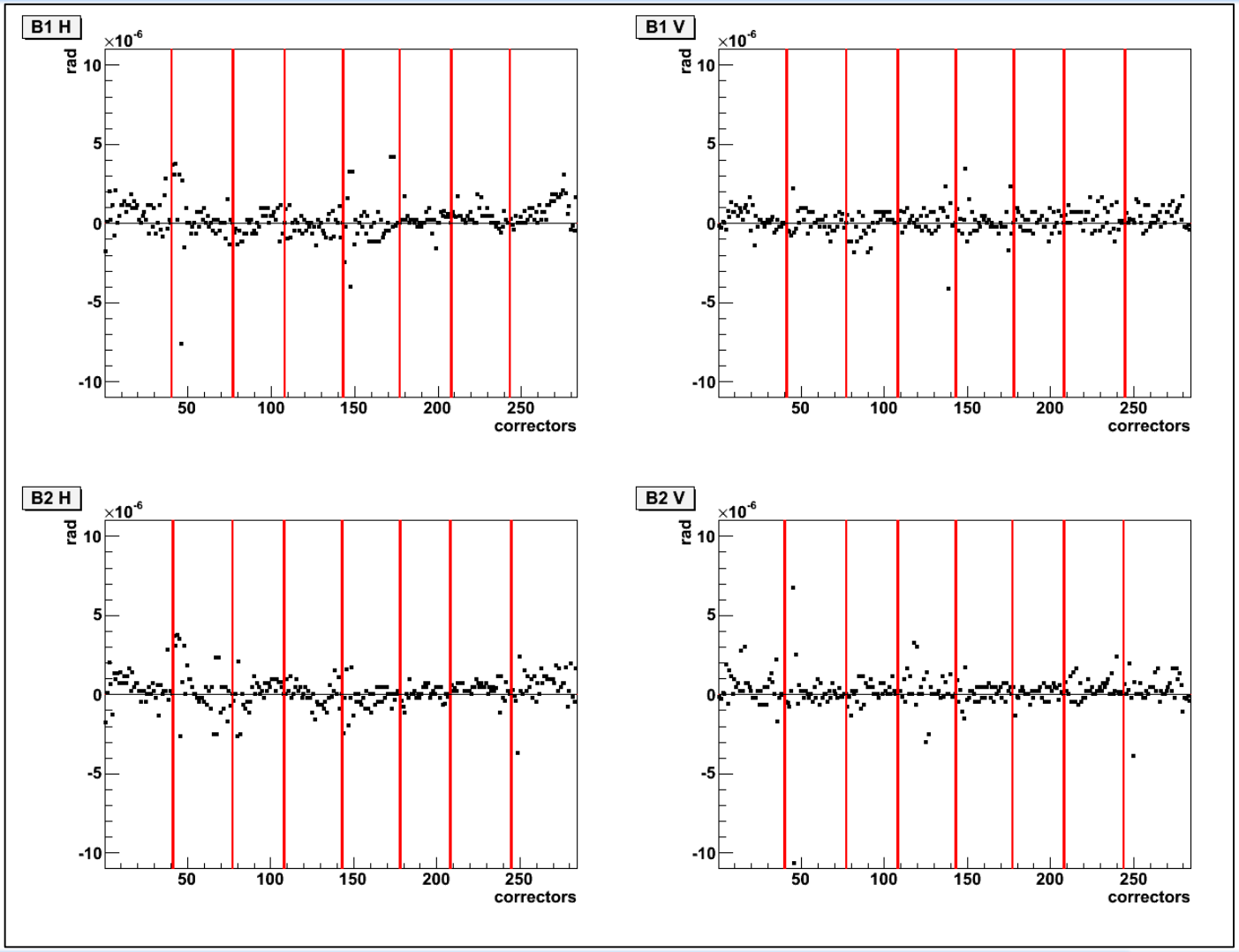
INJECTION (1424vs1364)



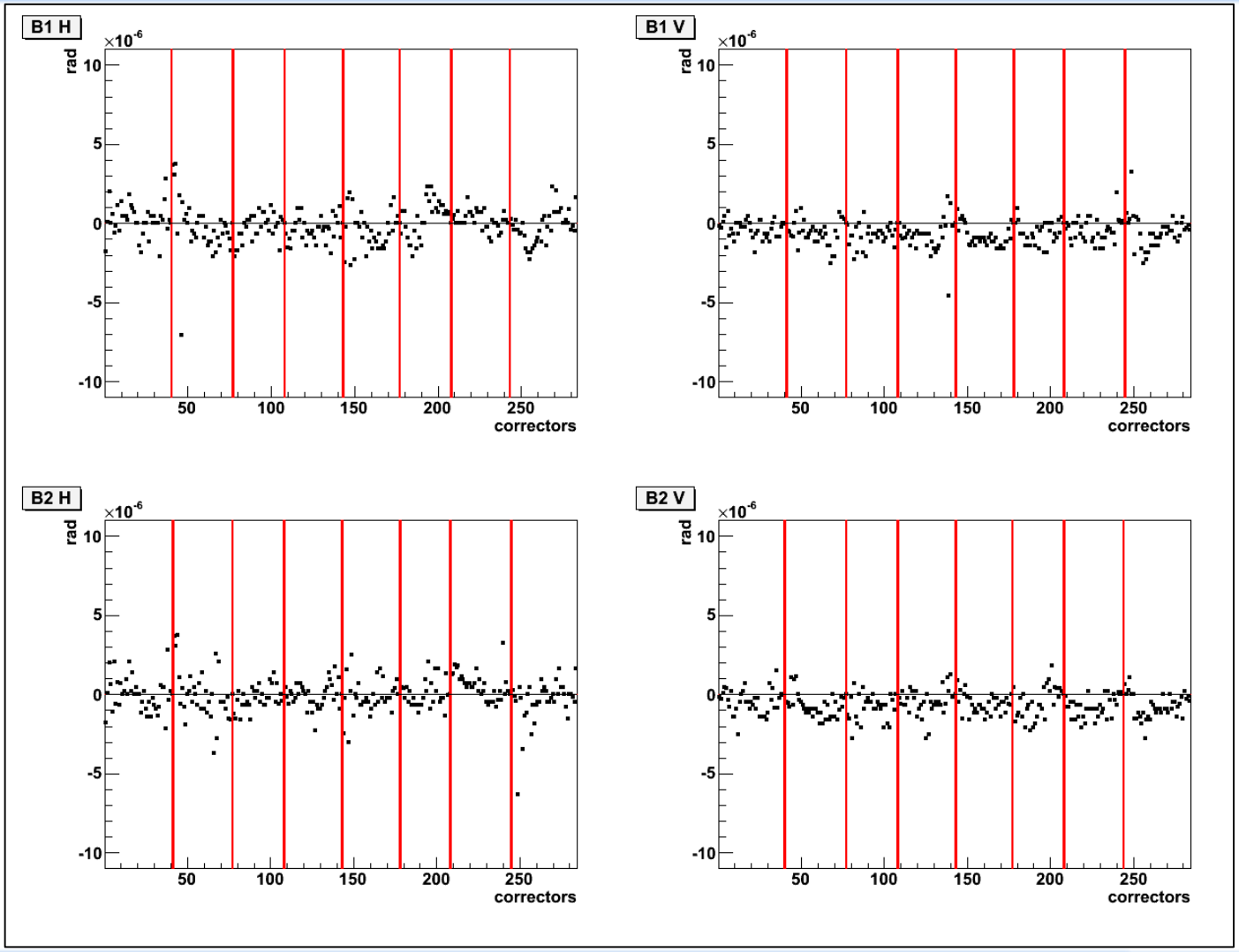
INJECTION (1427vs1364)



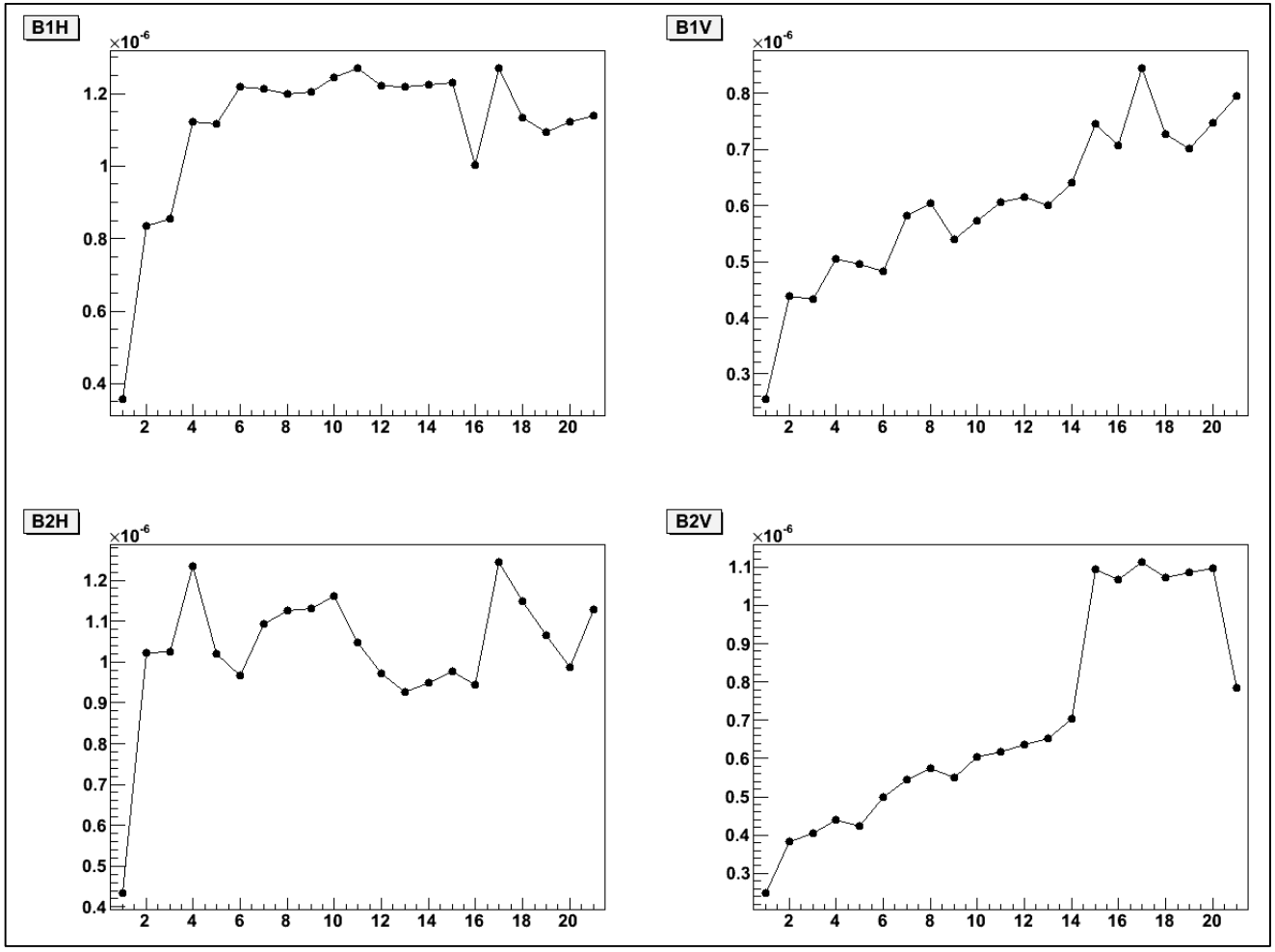
INJECTION (1430vs1364)



INJECTION (1439vs1364)



RMS @ INJECTION



always below 1.3e-06

FIRST CONCLUSION

@ INJECTION

- RMS is in general small over many fills (and more than a month time period) showing a good reproducibility of the orbit
- No strange behavior seen so far

MADX simulation

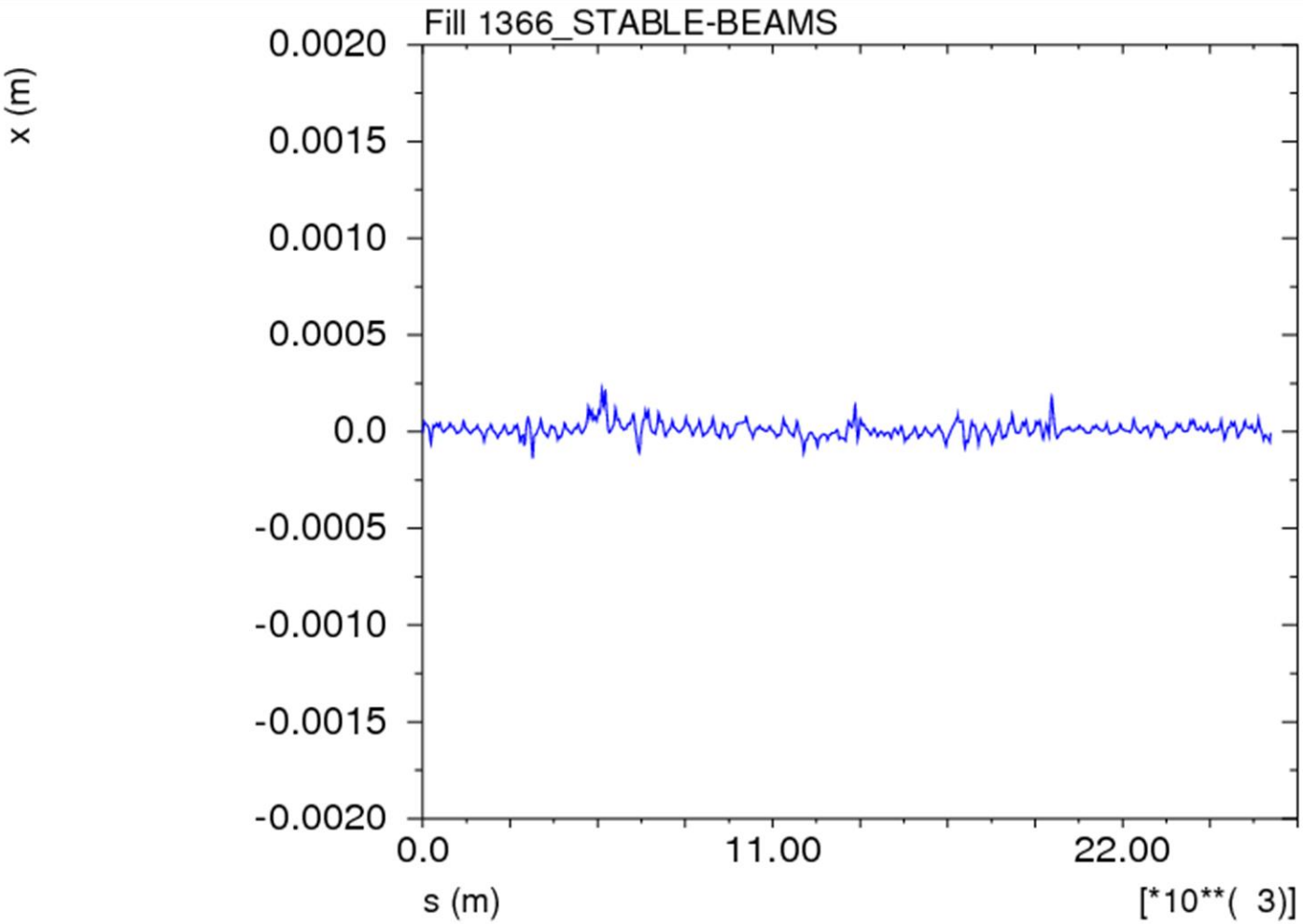
• COD kick differences between each fill and a reference fill (1364) as an input in MADX and plotting of the calculated orbit.

• Plotted orbit shouldn’t resemble exactly to the actual difference in orbit (due to feedback, misplacements, etc.), but should indicate a general tendency in the orbit correction setup throughout time and highlight possible unexpected effects (bumps)

MADX simulation

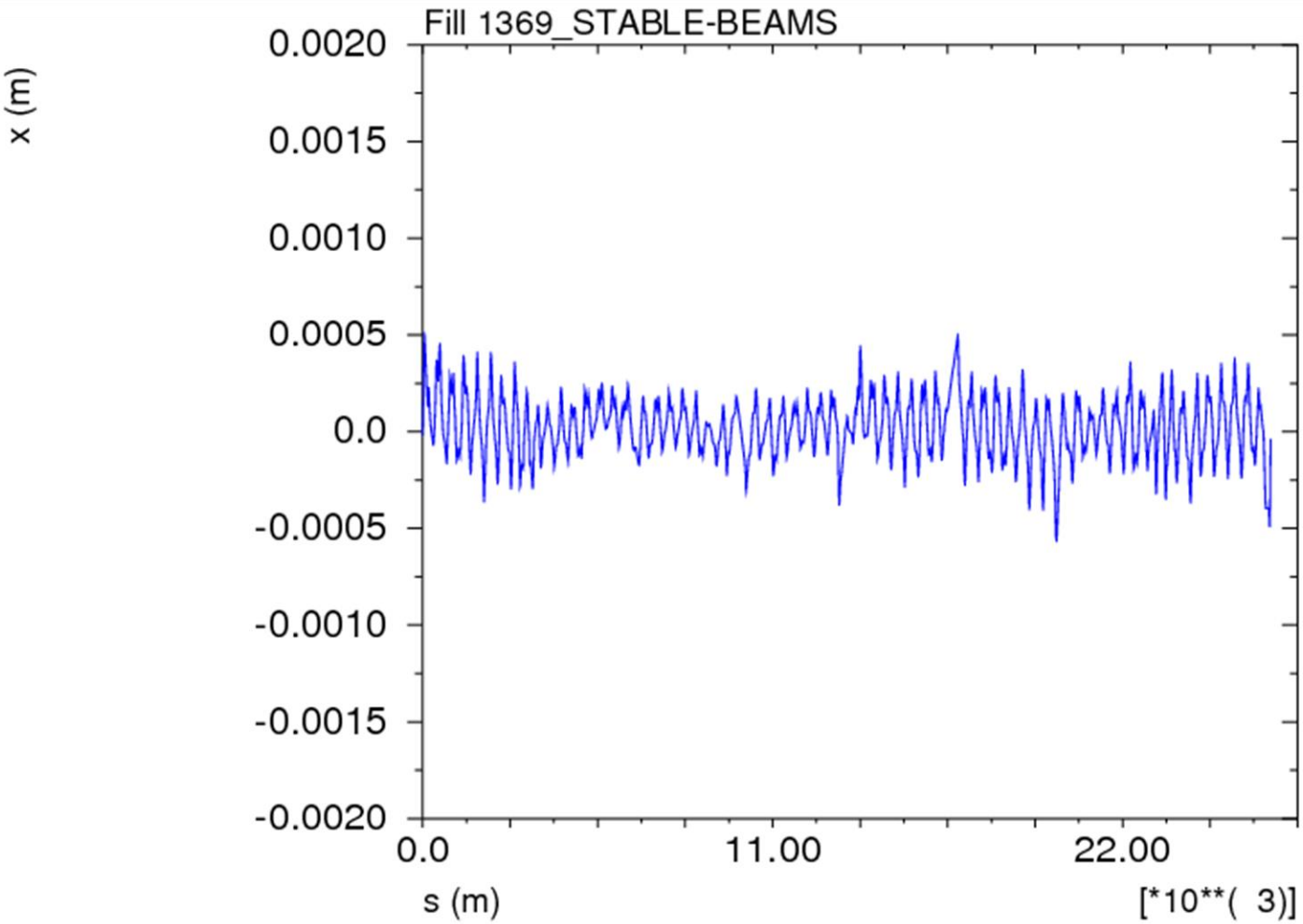
STABLE BEAMS

Horizontal B1 (1366vs1364)



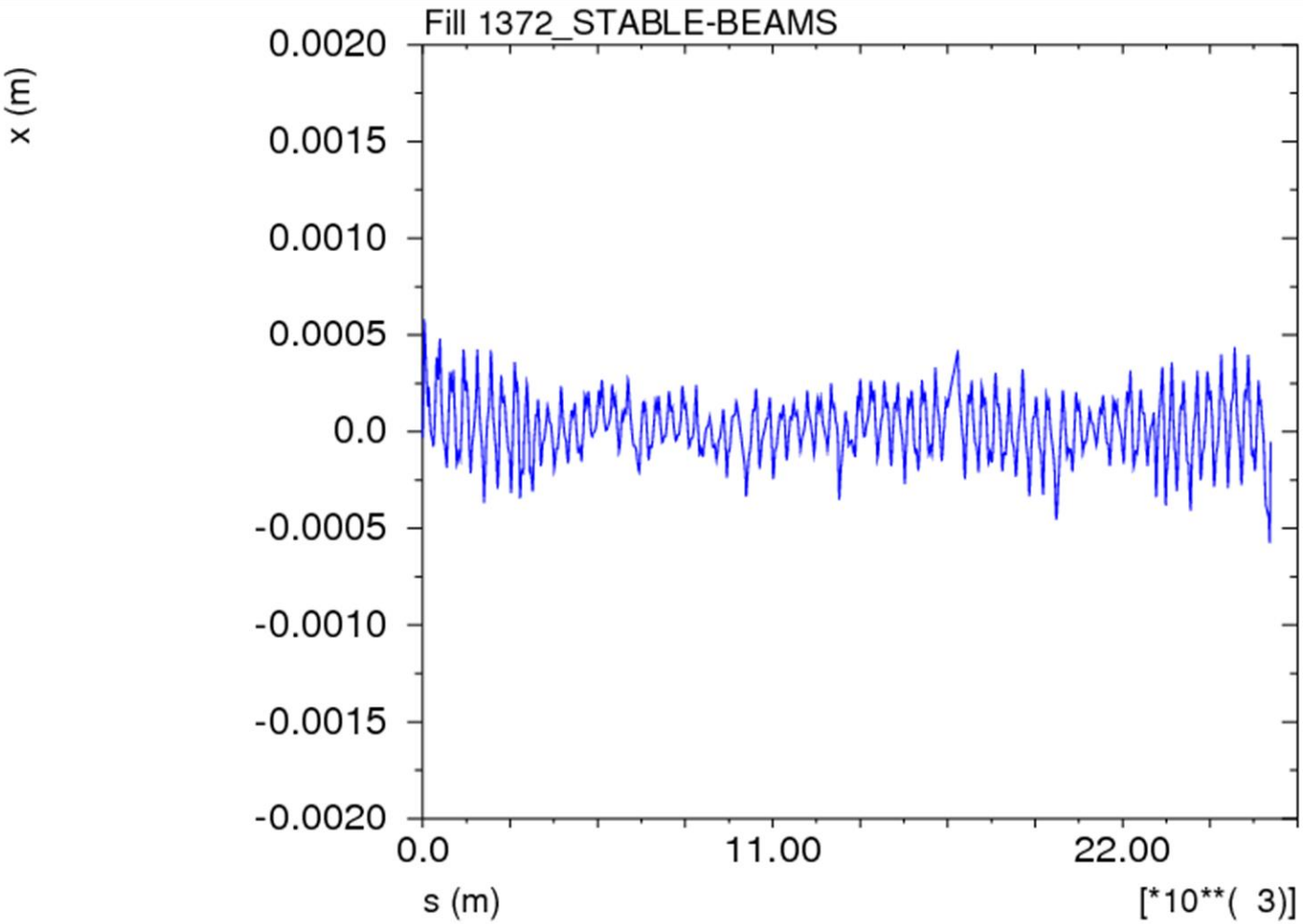
RMS (mm) = 0.04

Horizontal B1 (1369vs1364)



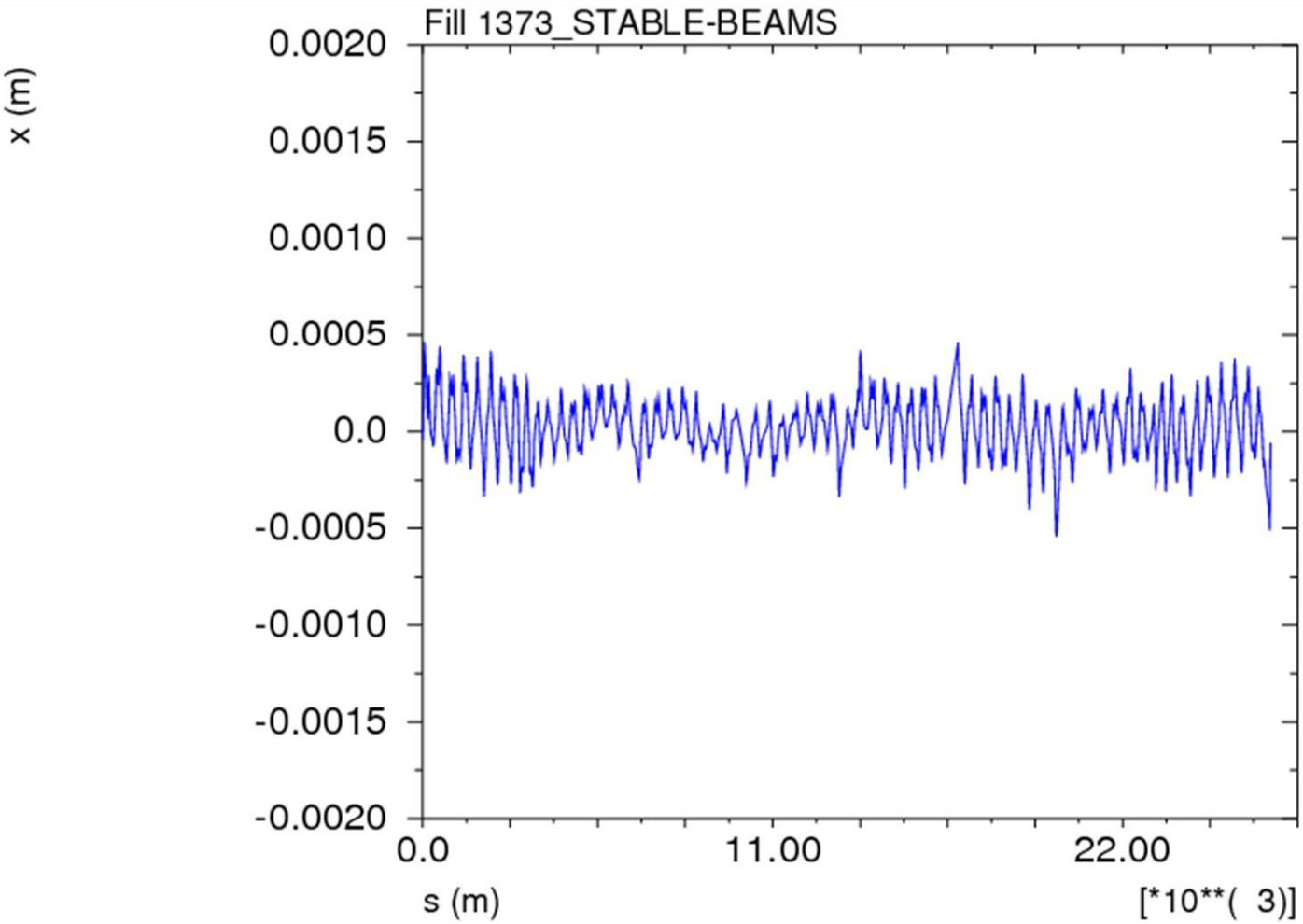
RMS (mm) = 0.16

Horizontal B1 (1372vs1364)



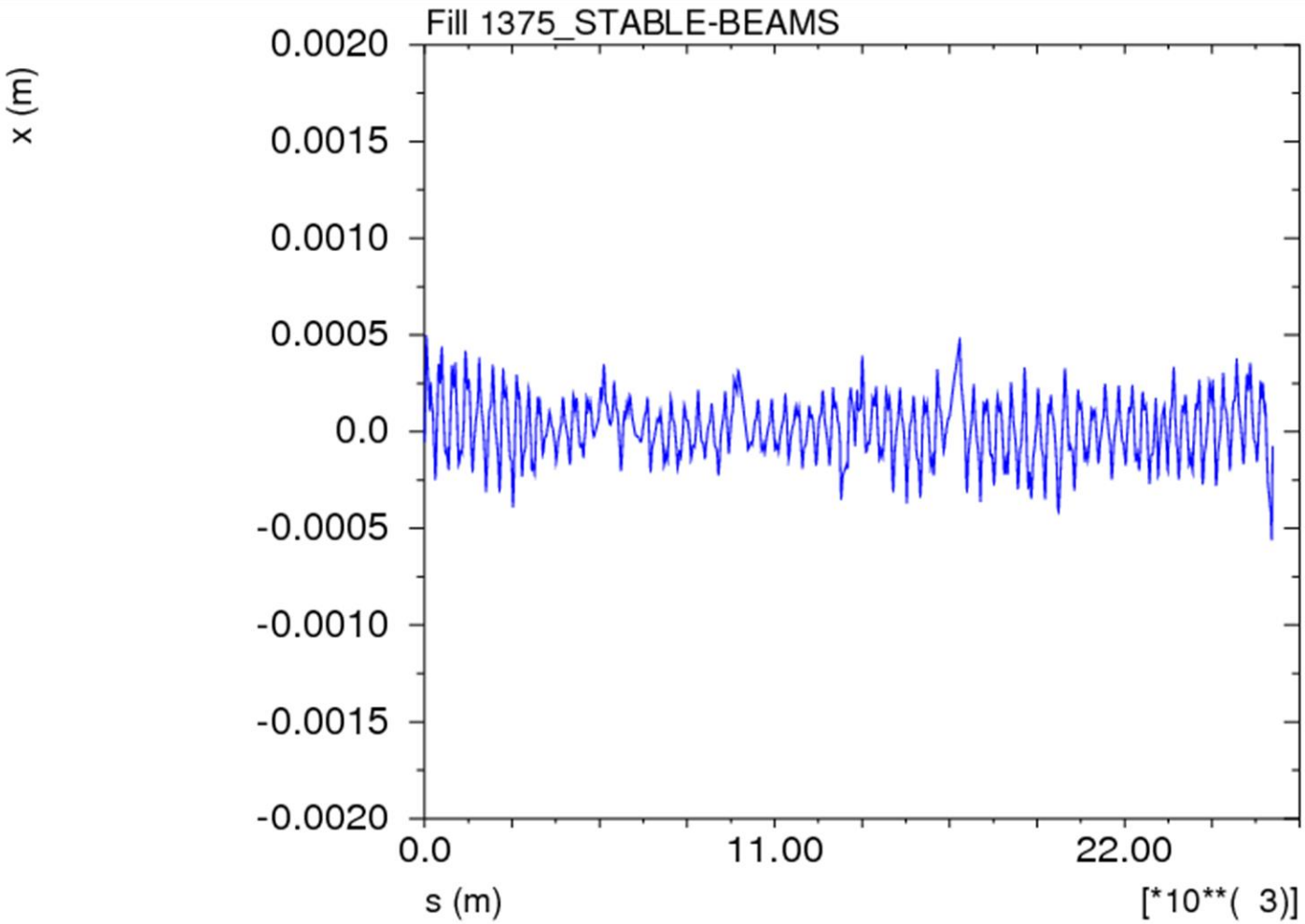
RMS (mm) = 0.16

Horizontal B1 (1373vs1364)



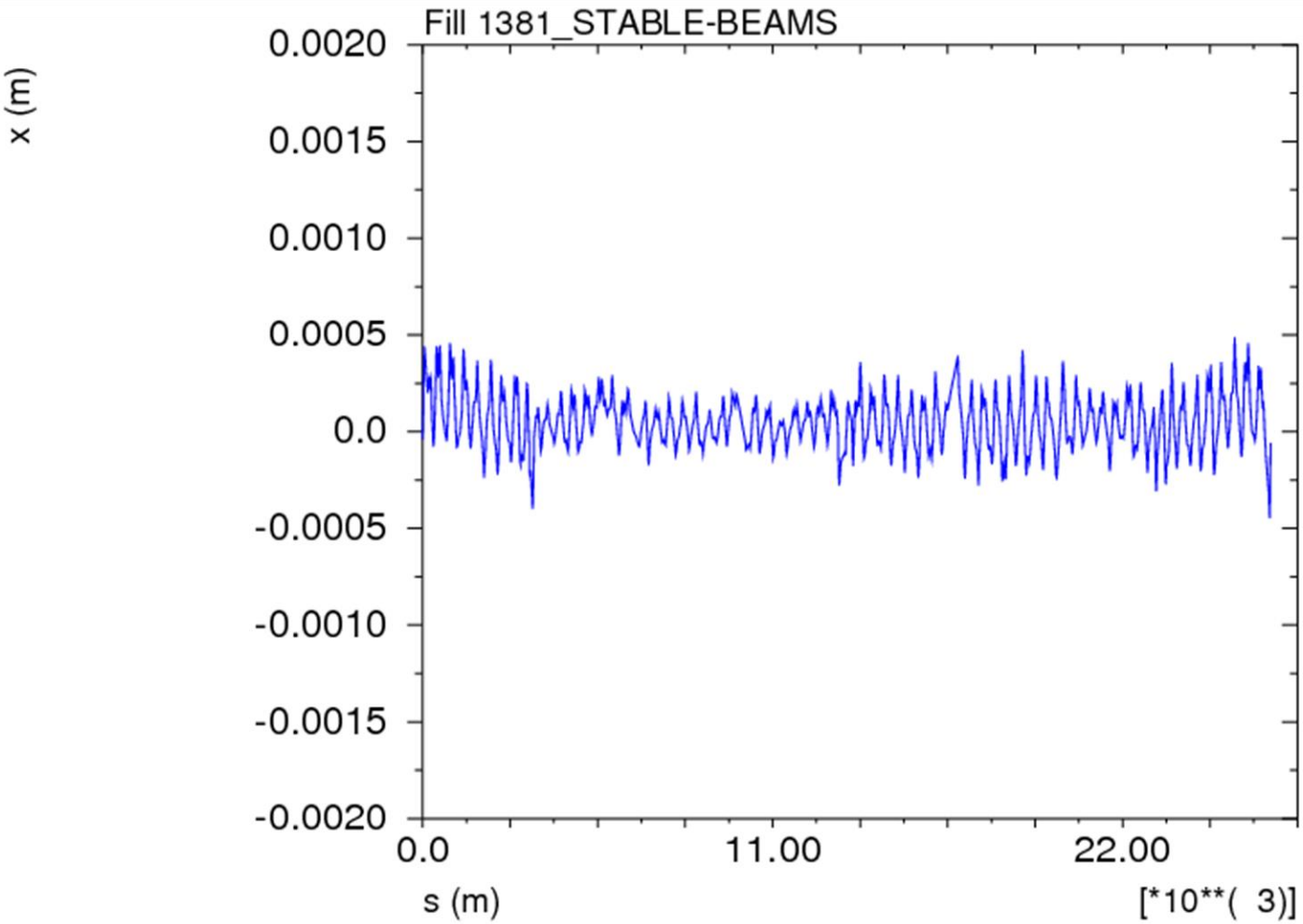
RMS (mm) = 0.15

Horizontal B1 (1375vs1364)



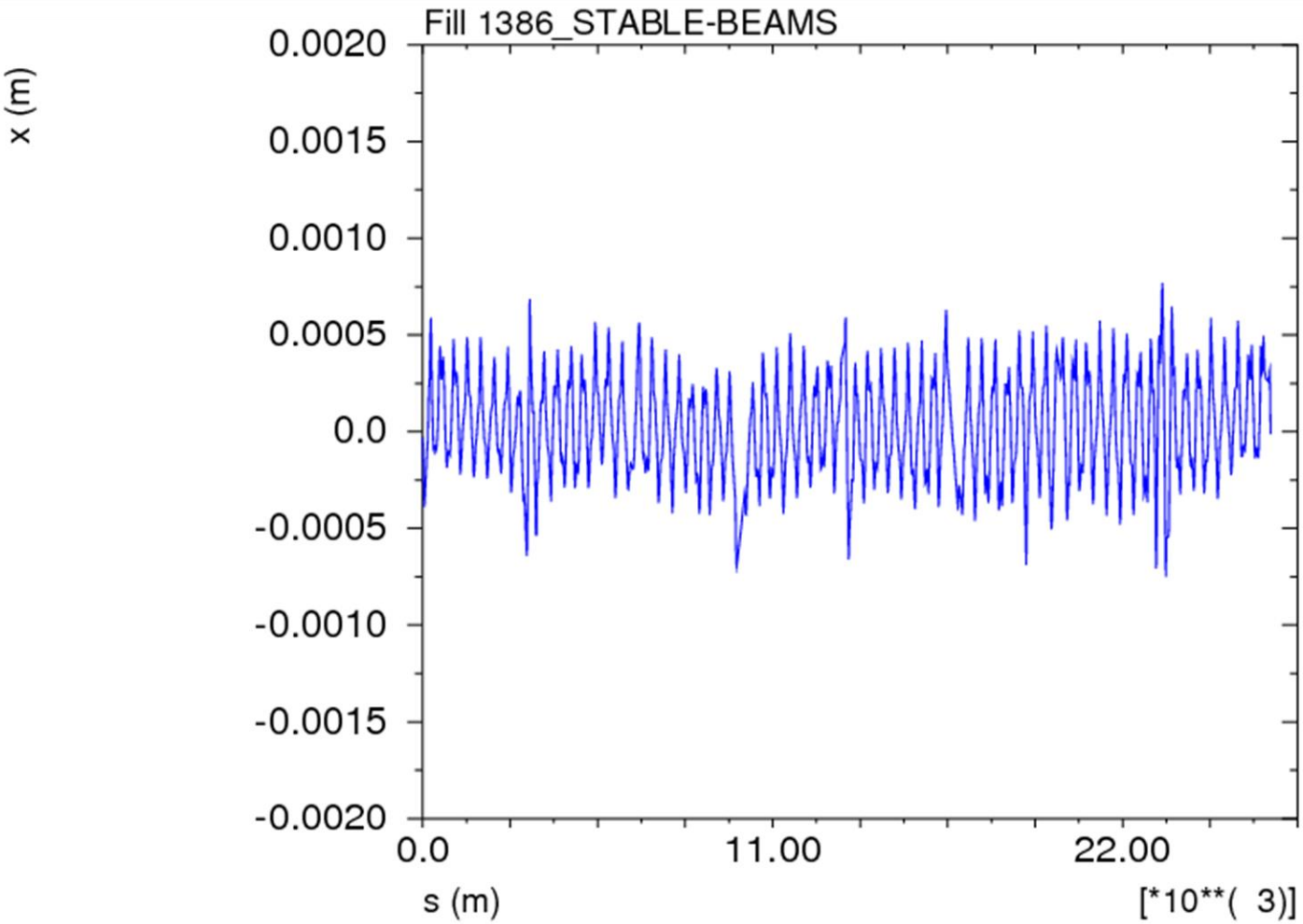
RMS (mm) = 0.15

Horizontal B1 (1381vs1364)



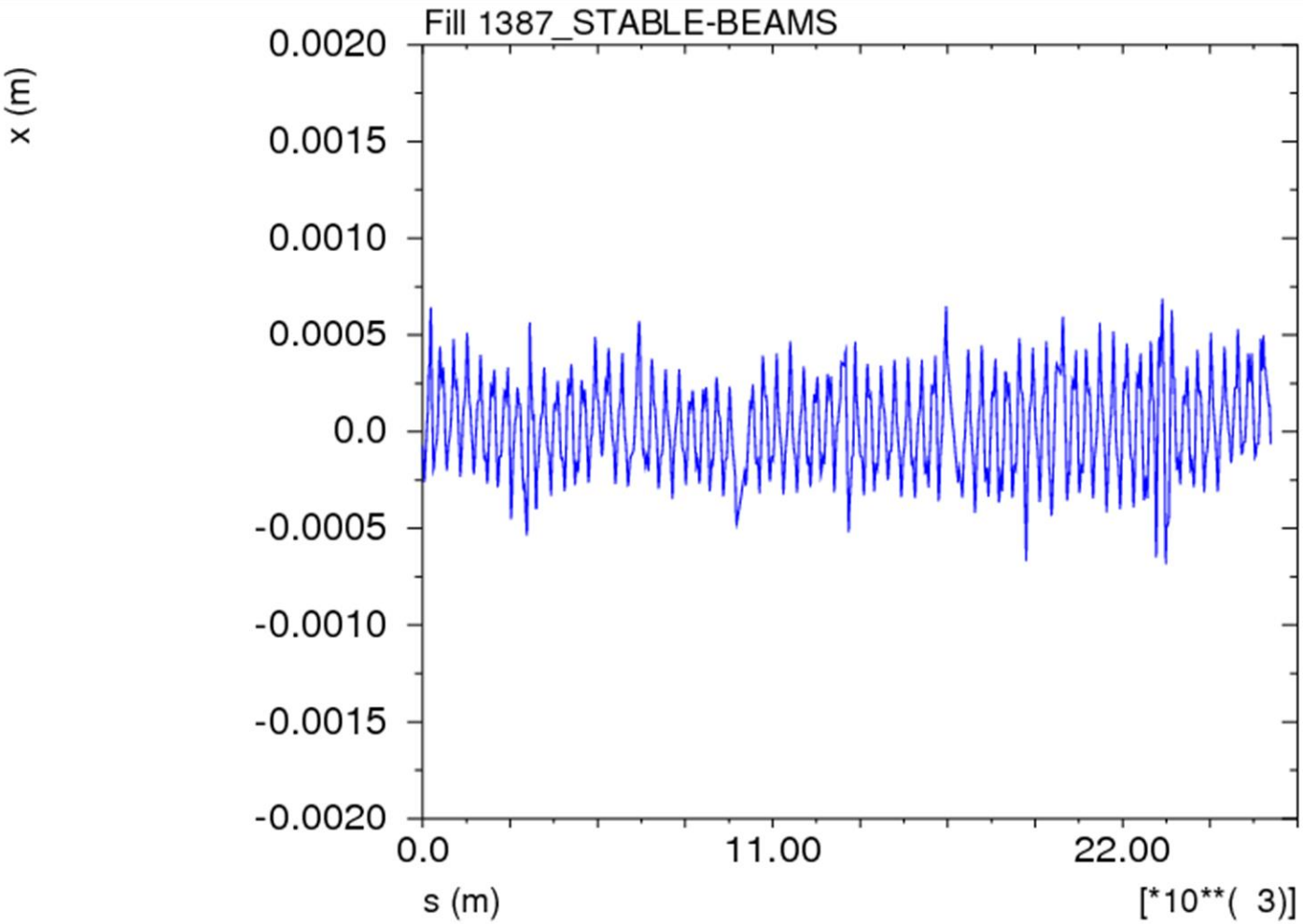
RMS (mm) = 0.15

Horizontal B1 (1386vs1364)



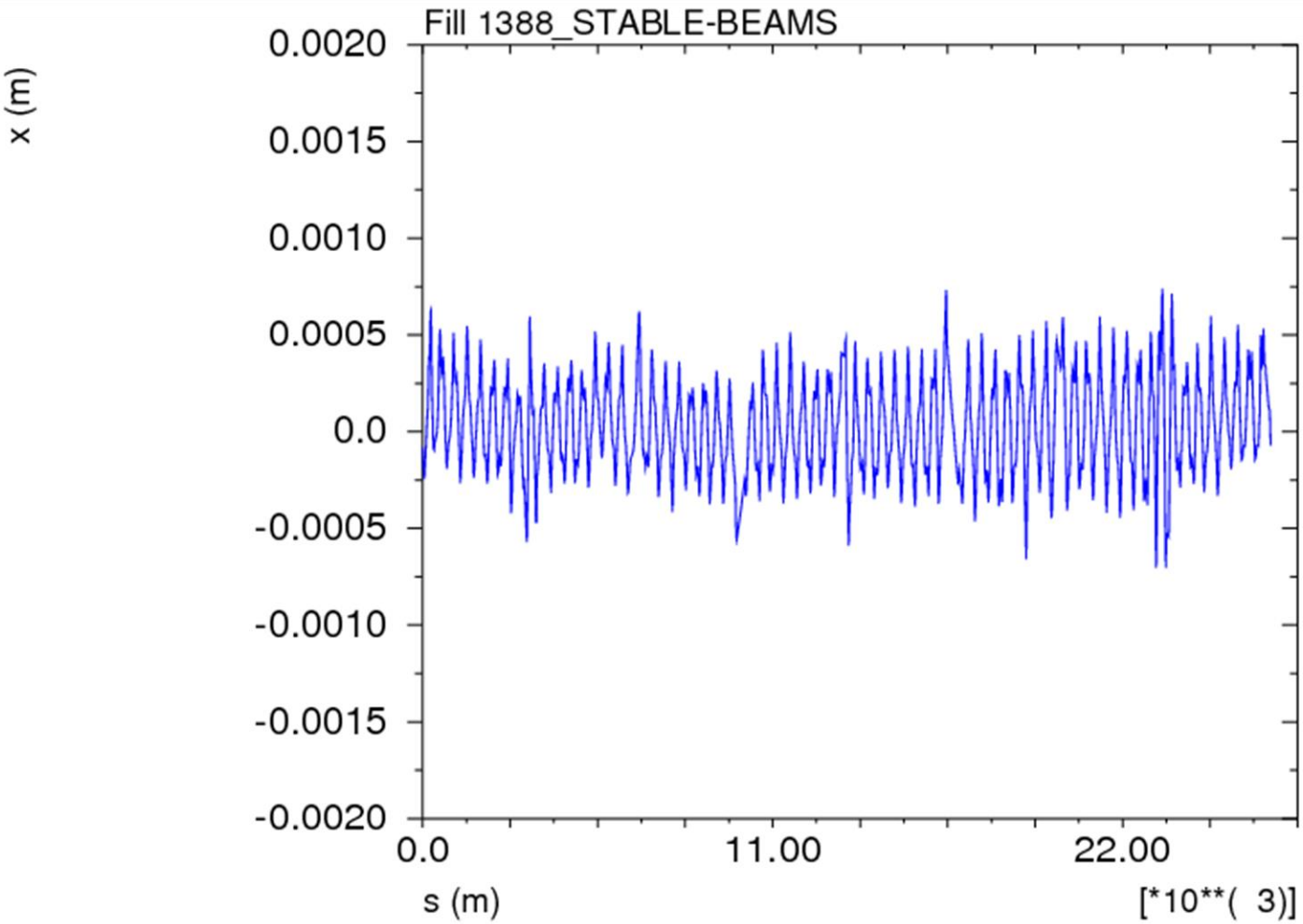
RMS (mm) = 0.26

Horizontal B1 (1387vs1364)



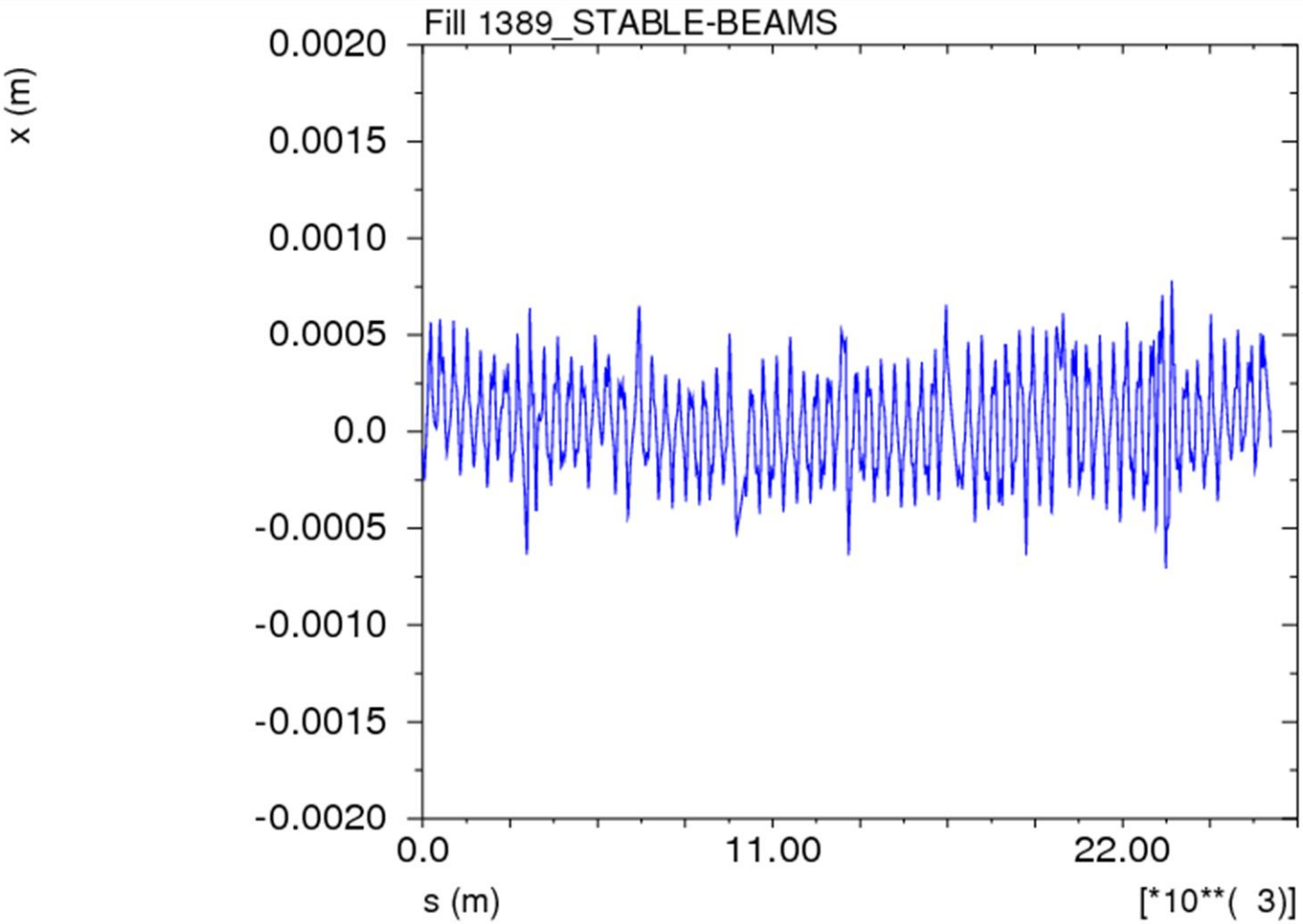
RMS (mm) = 0.23

Horizontal B1 (1388vs1364)



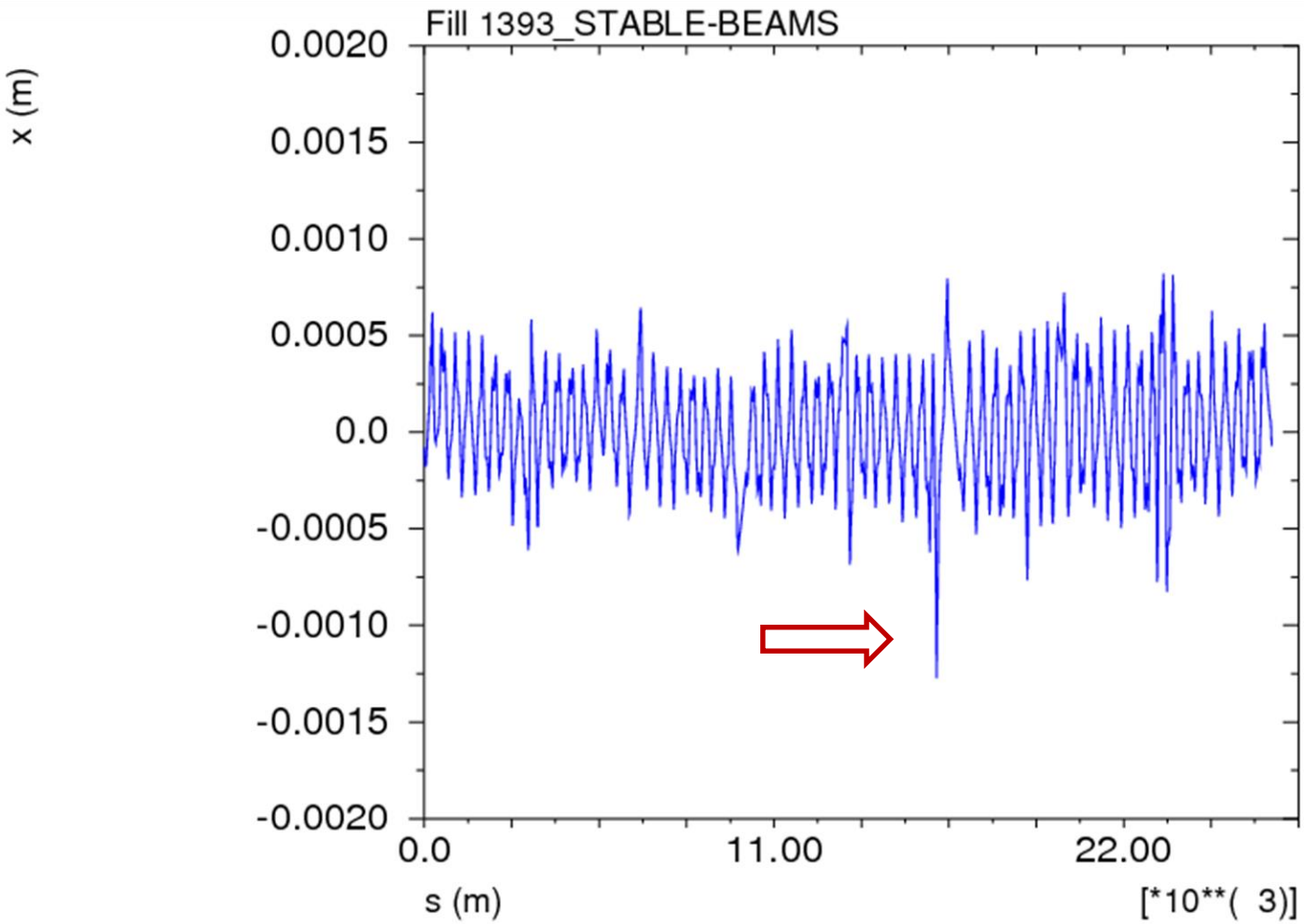
RMS (mm) = 0.25

Horizontal B1 (1389vs1364)



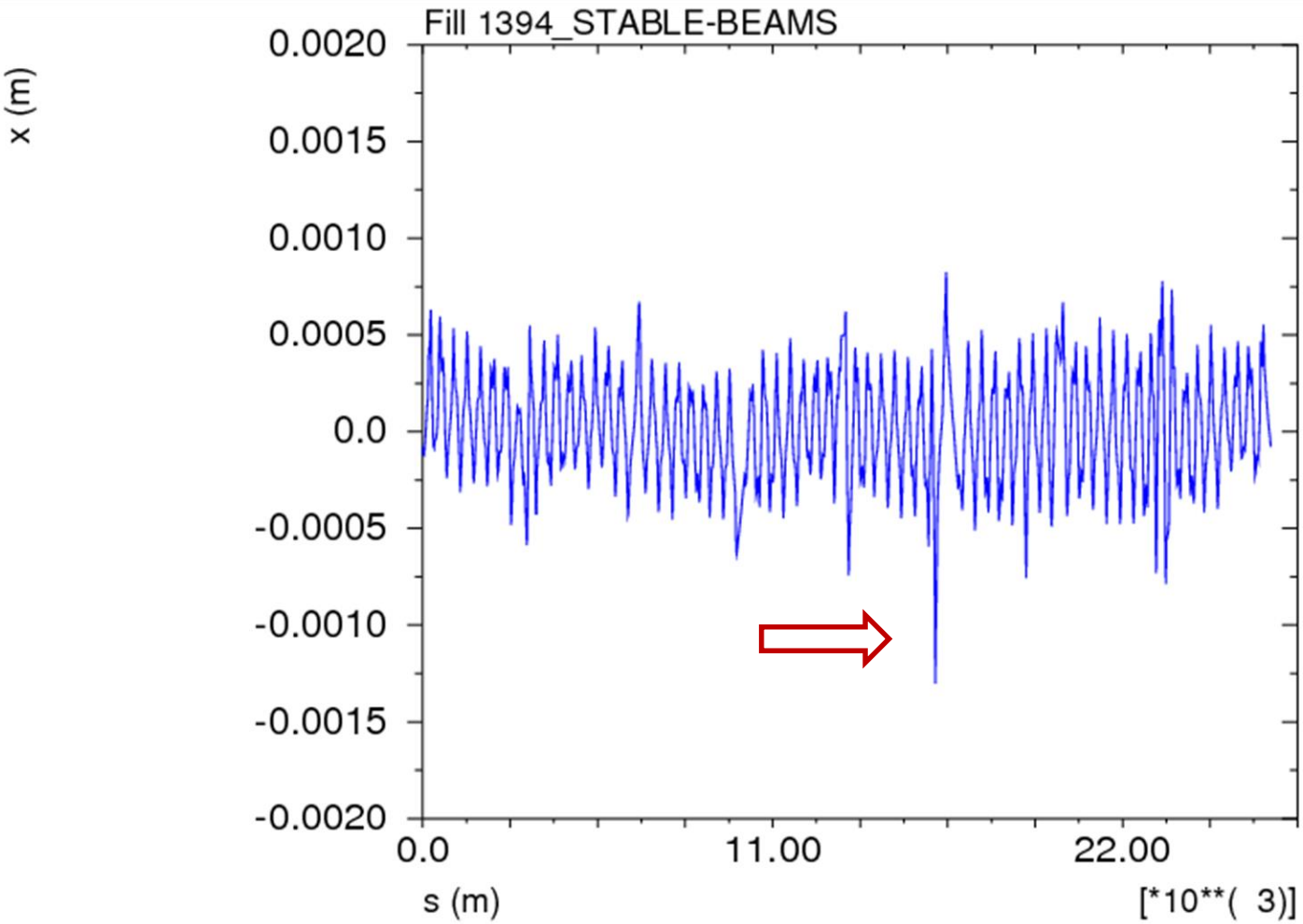
RMS (mm) = 0.25

Horizontal B1 (1393vs1364)



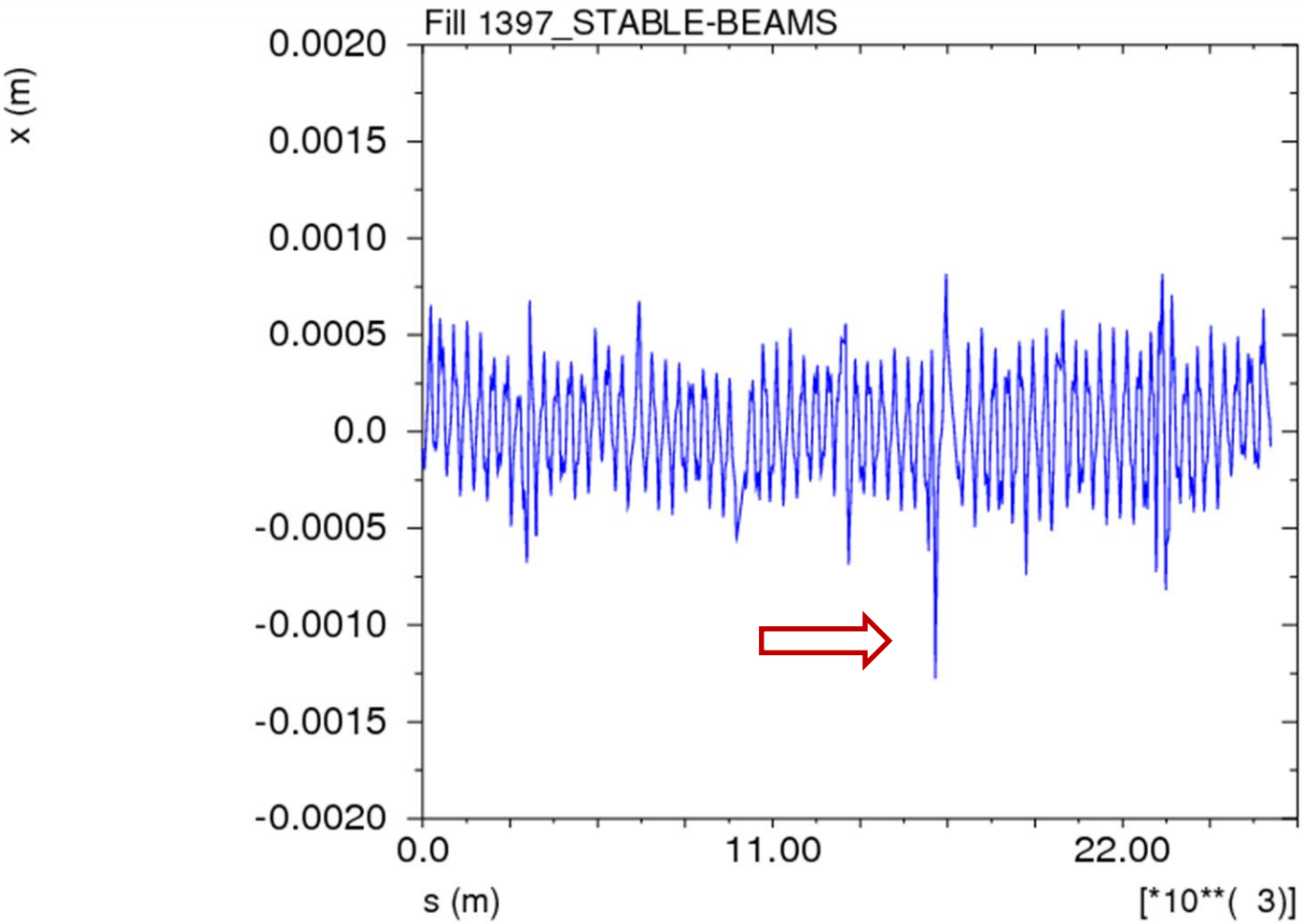
RMS (mm) = 0.28

Horizontal B1 (1394vs1364)



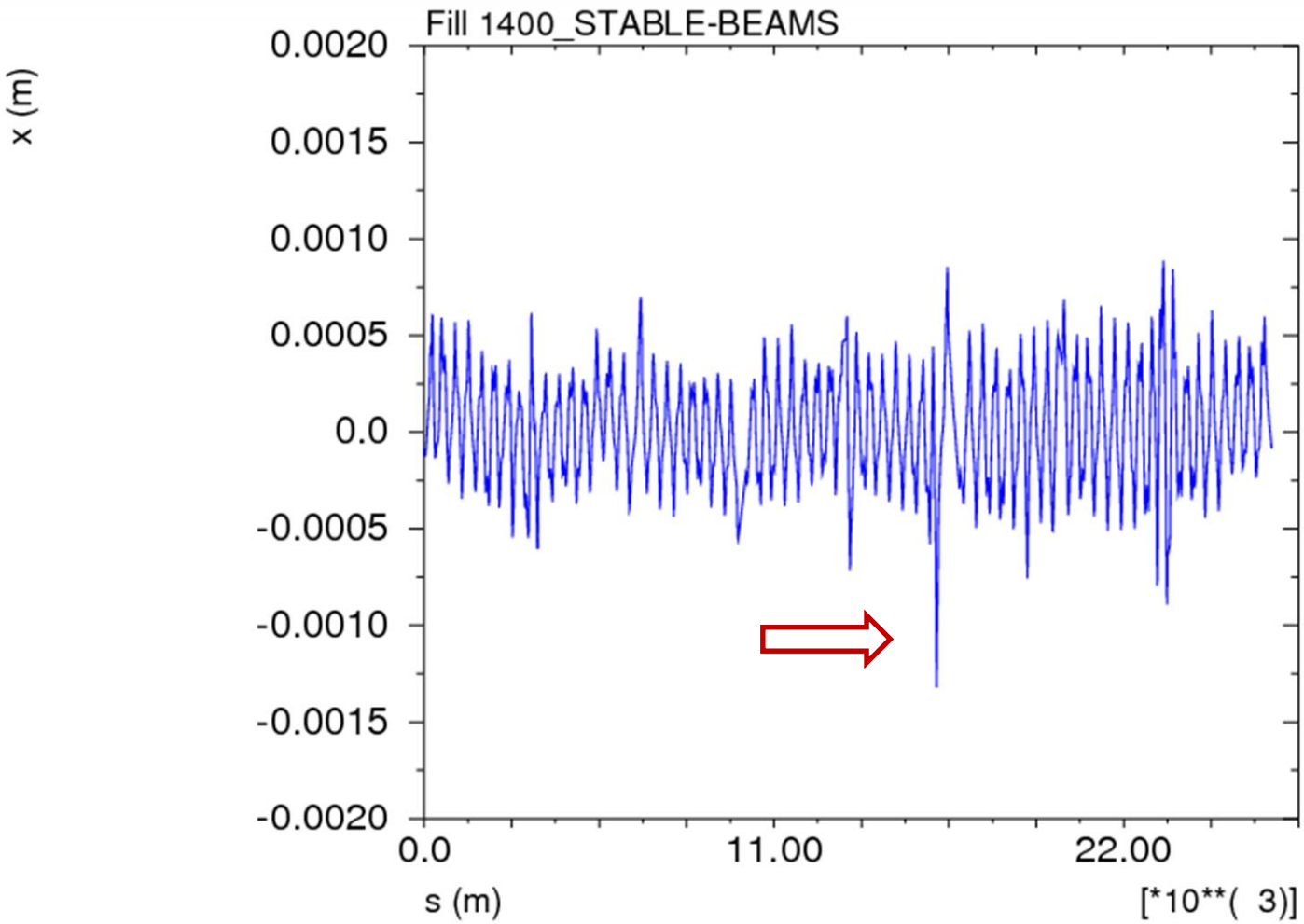
RMS (mm) = 0.27

Horizontal B1 (1397vs1364)



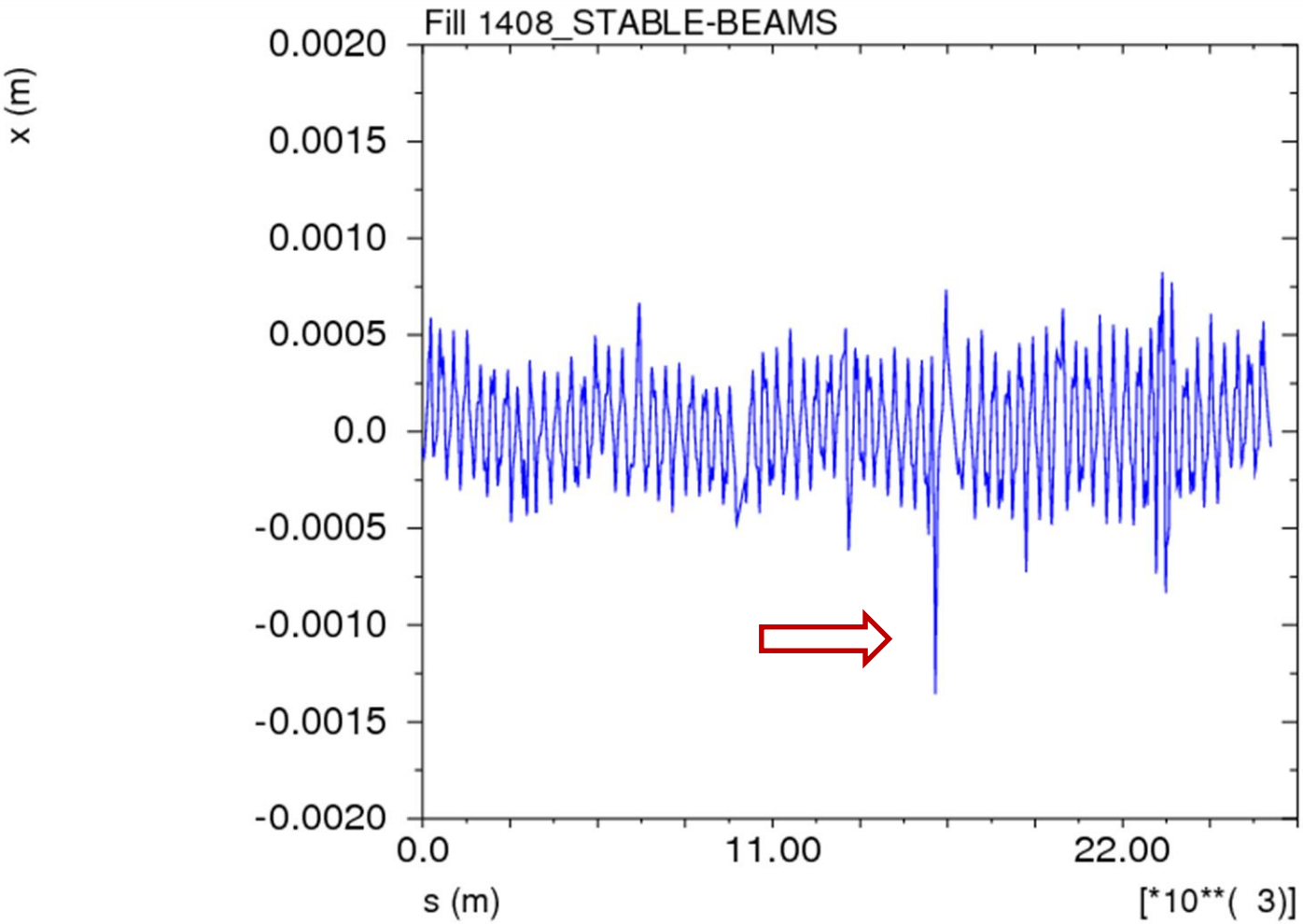
RMS (mm) = 0.27

Horizontal B1 (1400vs1364)



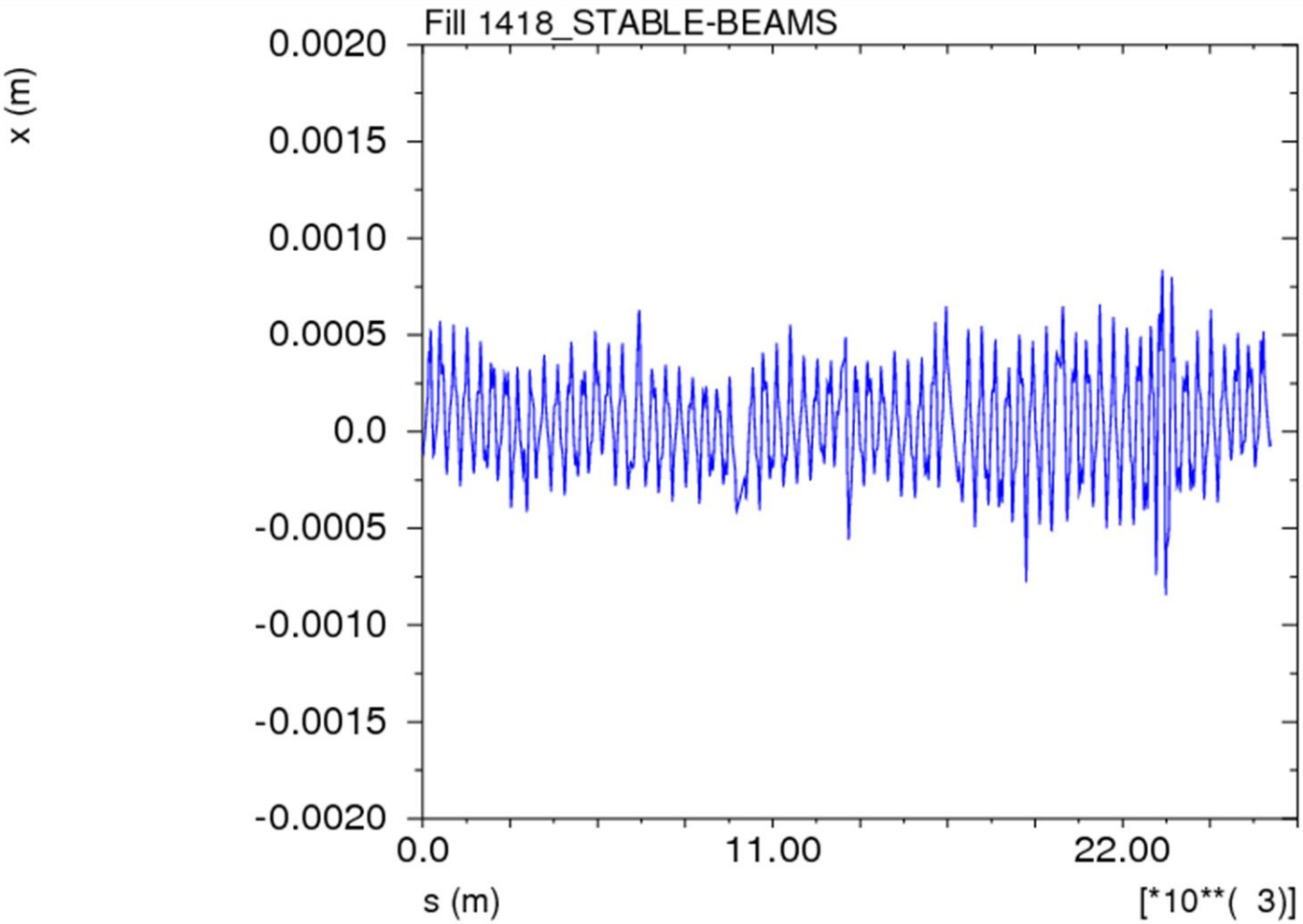
RMS (mm) = 0.28

Horizontal B1 (1408vs1364)



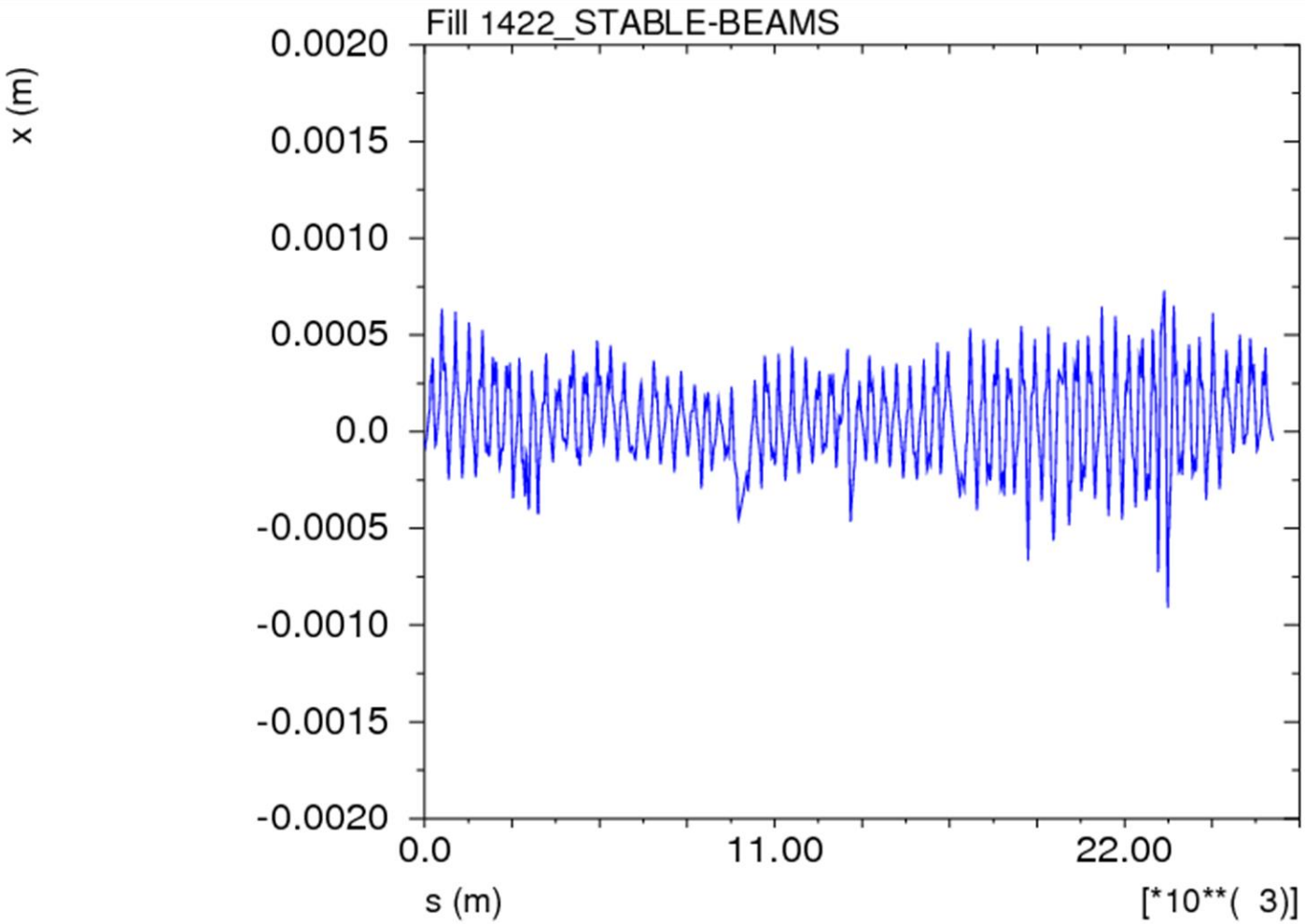
RMS (mm) = 0.26

Horizontal B1 (1418vs1364)



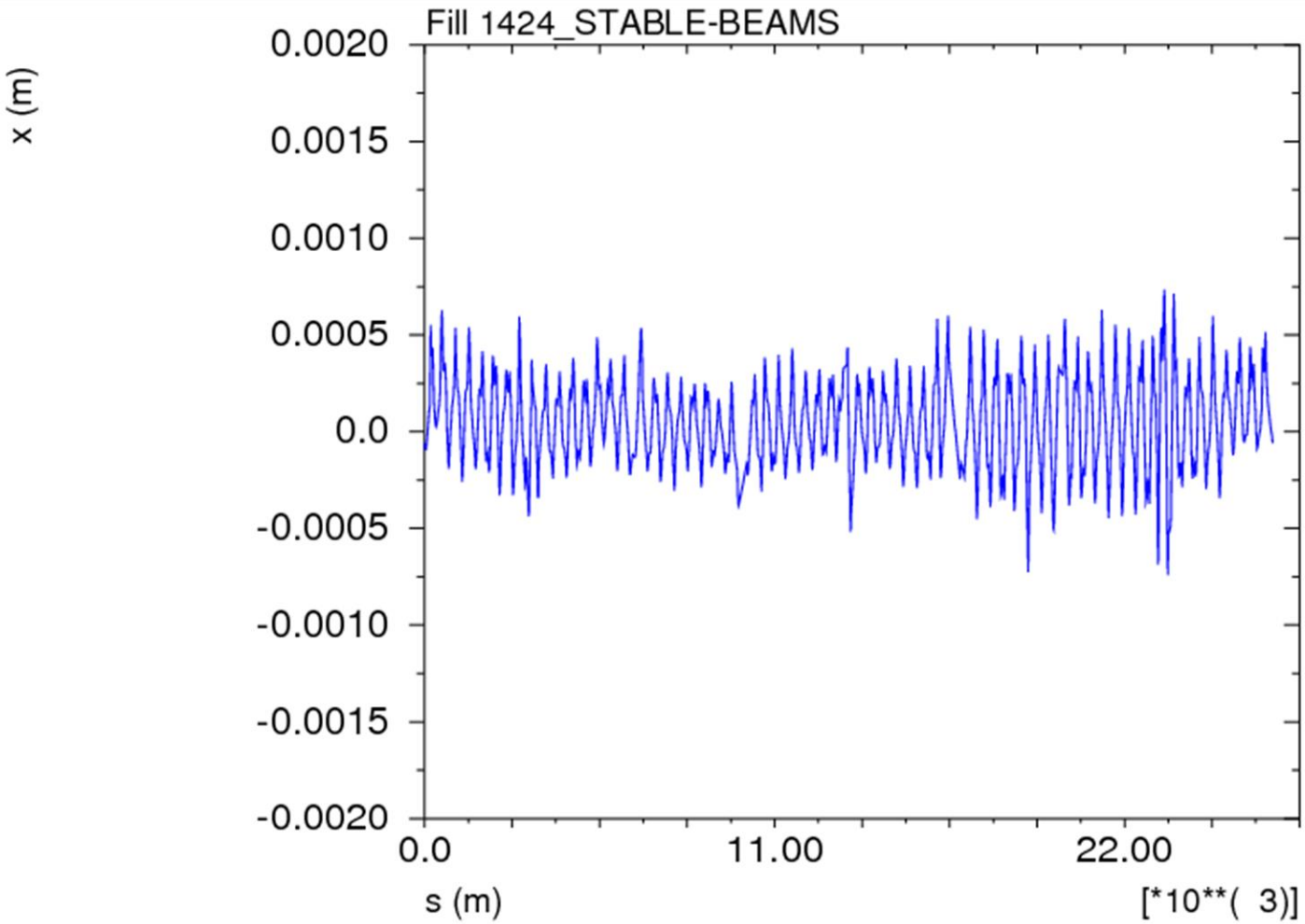
RMS (mm) = 0.25

Horizontal B1 (1422vs1364)



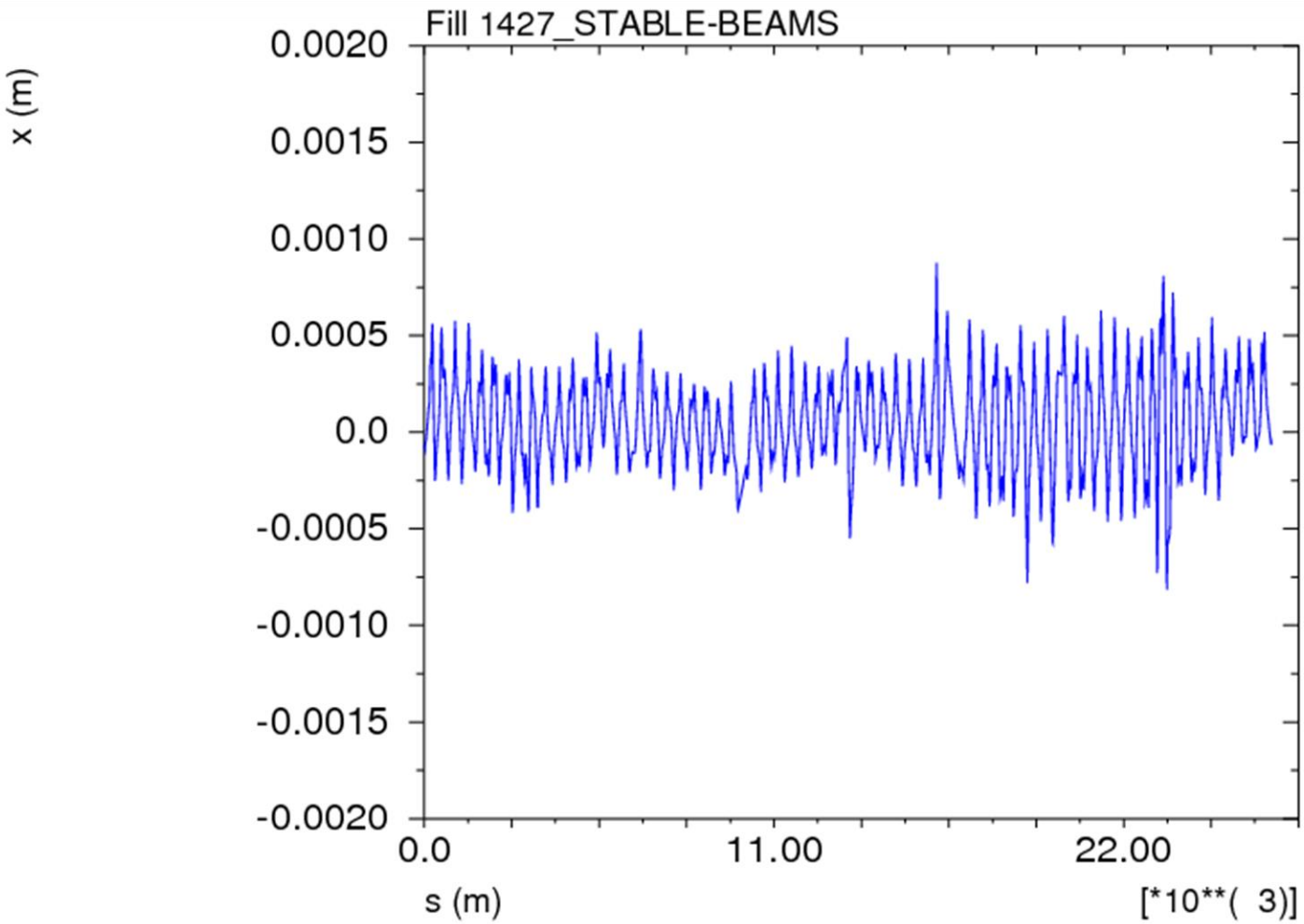
RMS (mm) = 0.23

Horizontal B1 (1424vs1364)



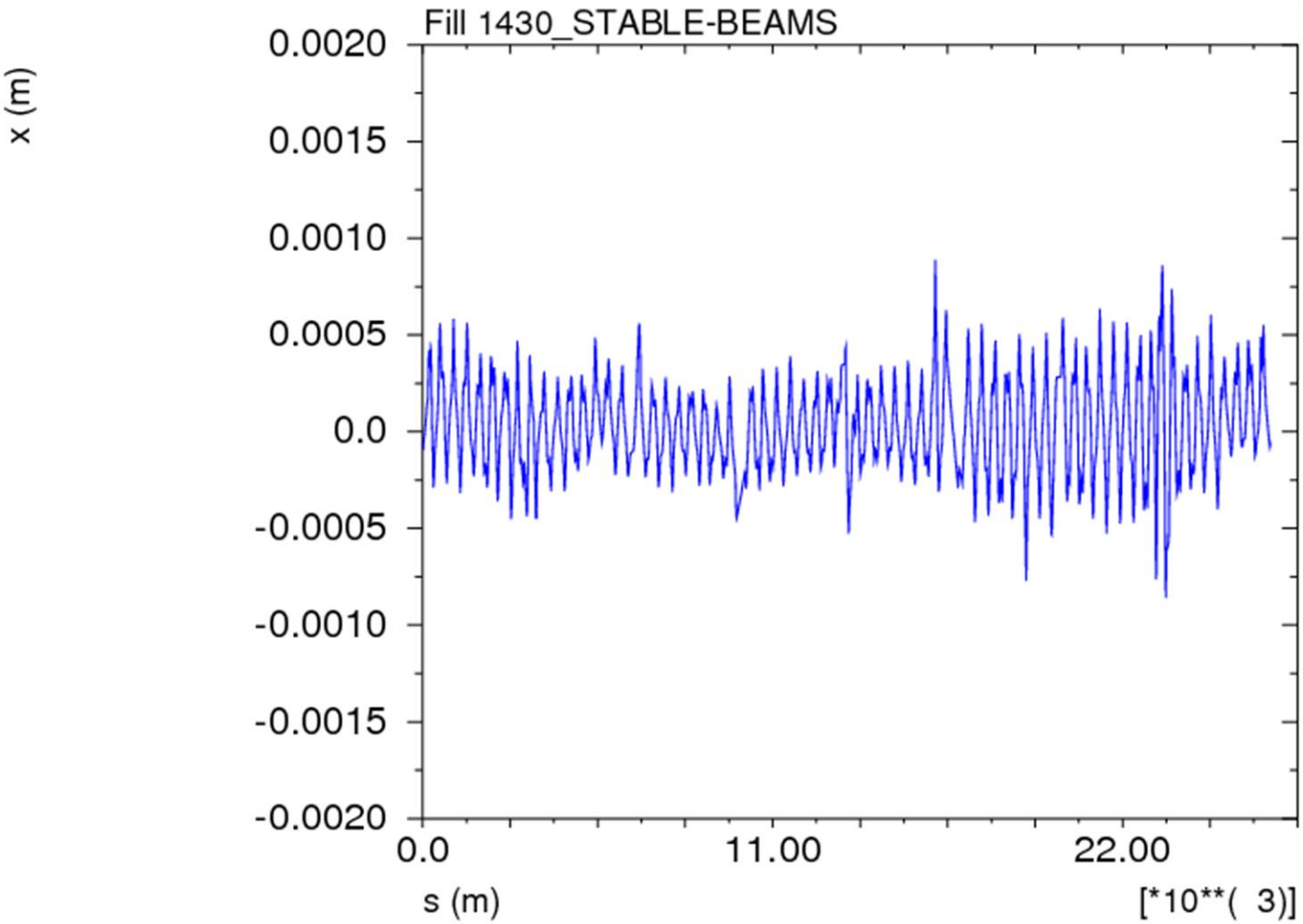
RMS (mm) = 0.23

Horizontal B1 (1427vs1364)



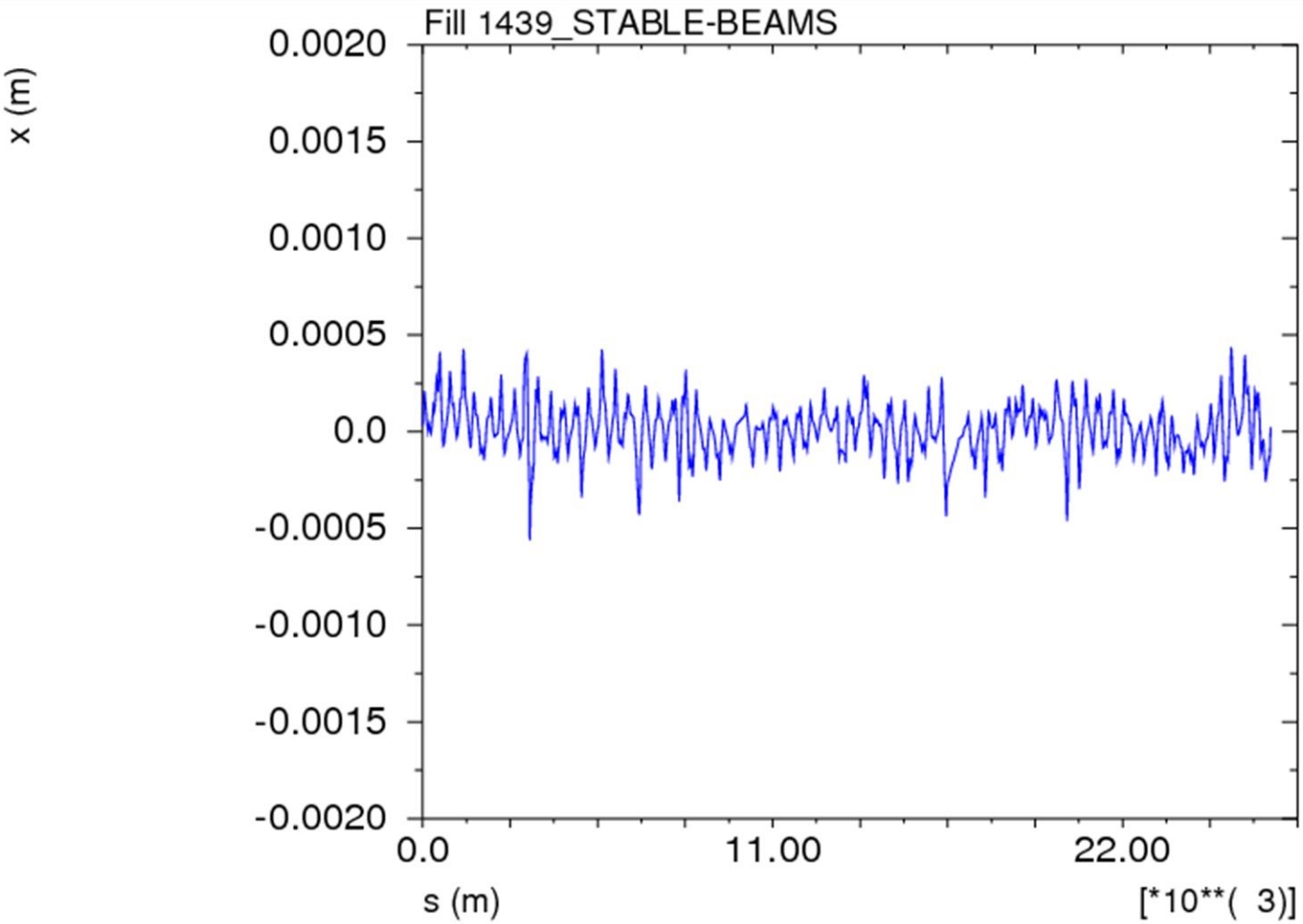
RMS (mm) = 0.24

Horizontal B1 (1430vs1364)



RMS (mm) = 0.24

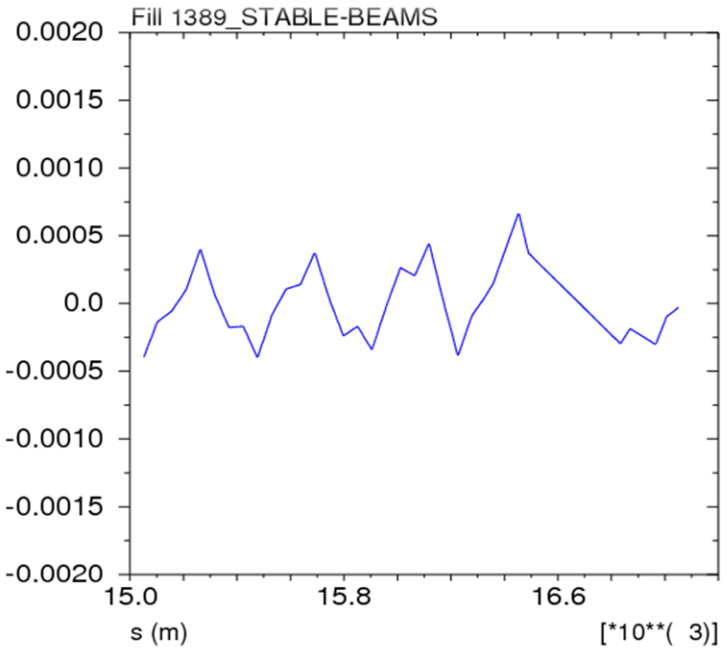
Horizontal B1 (1439vs1364)

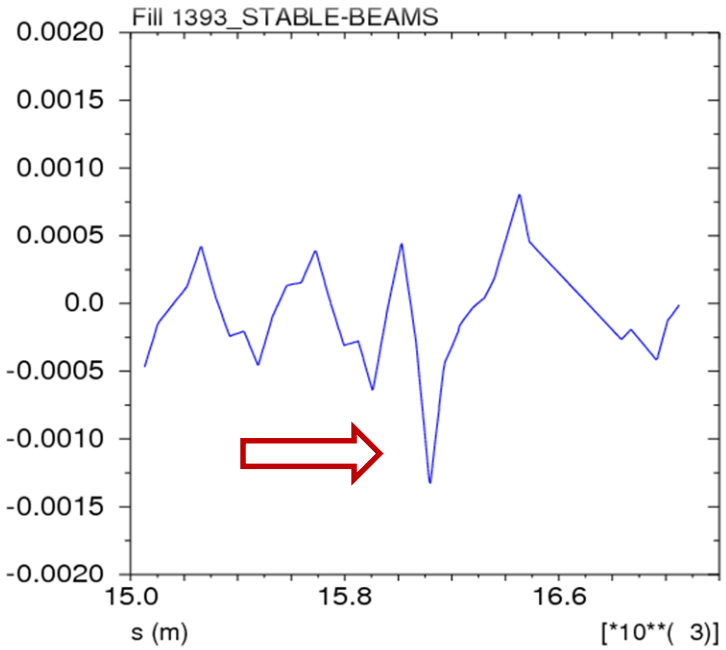


RMS (mm) = 0.13

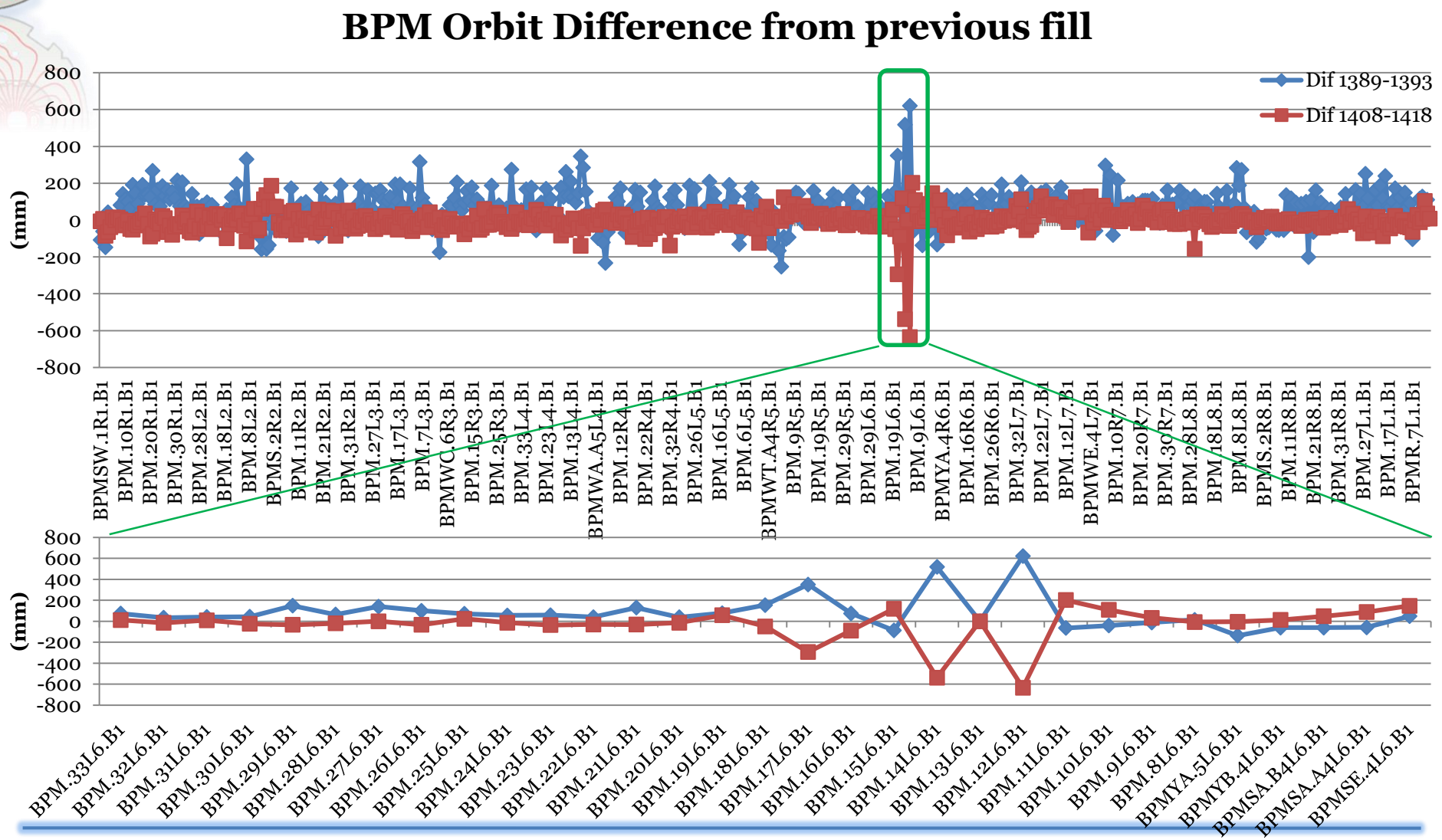
MCBH.15L6.B1 case

- Due to a problem in the powering module, MCBH.15L6.B1 was not powered during the period corresponding to the fills 1393-1408 (5 fills). Results:
  - a large compensation kick from an adjacent COD
  - obvious displacement in the orbit, which can be seen both from the simulation and the BPM readings.





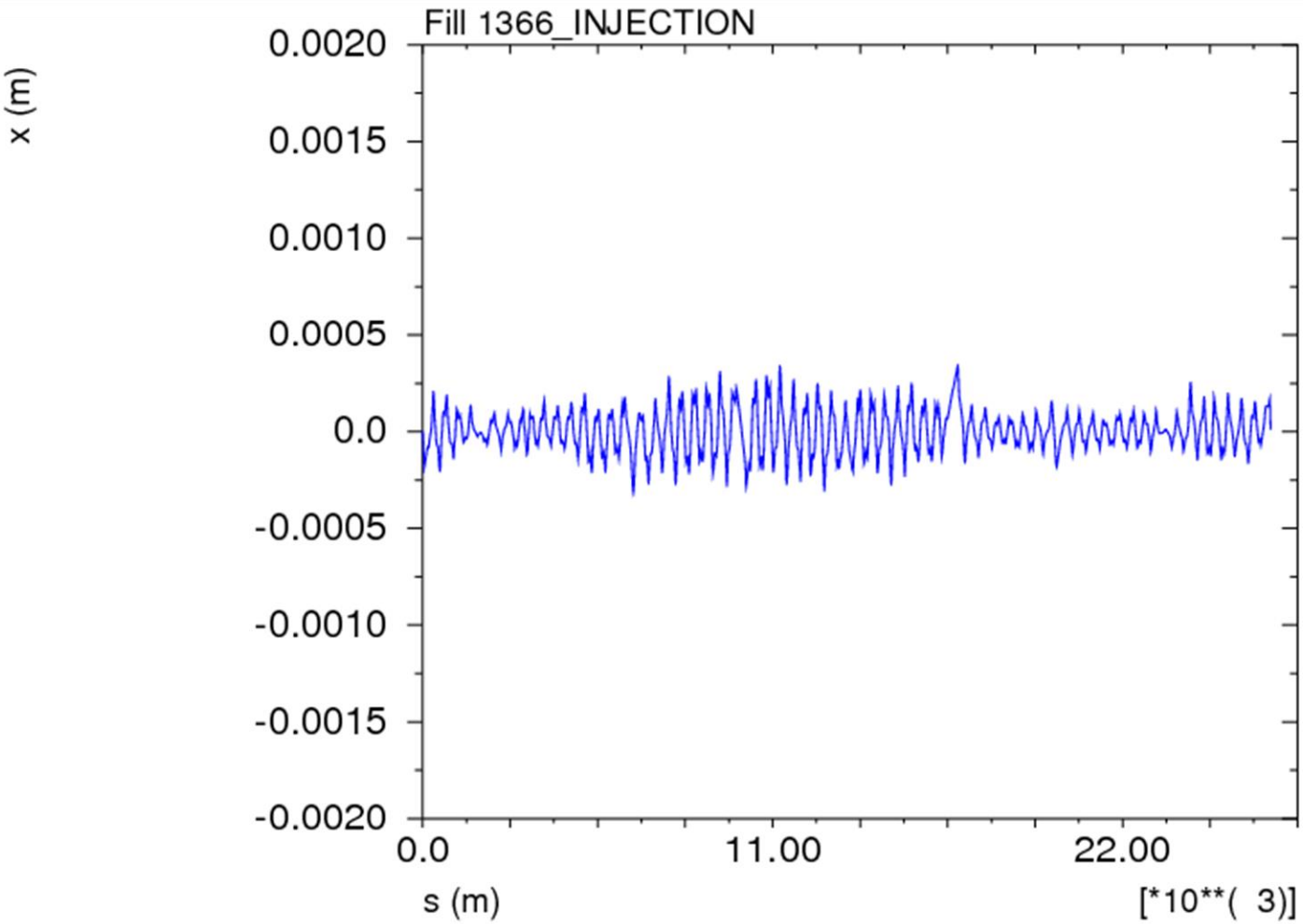
MCBH.15L6.B1 case



MADX simulation

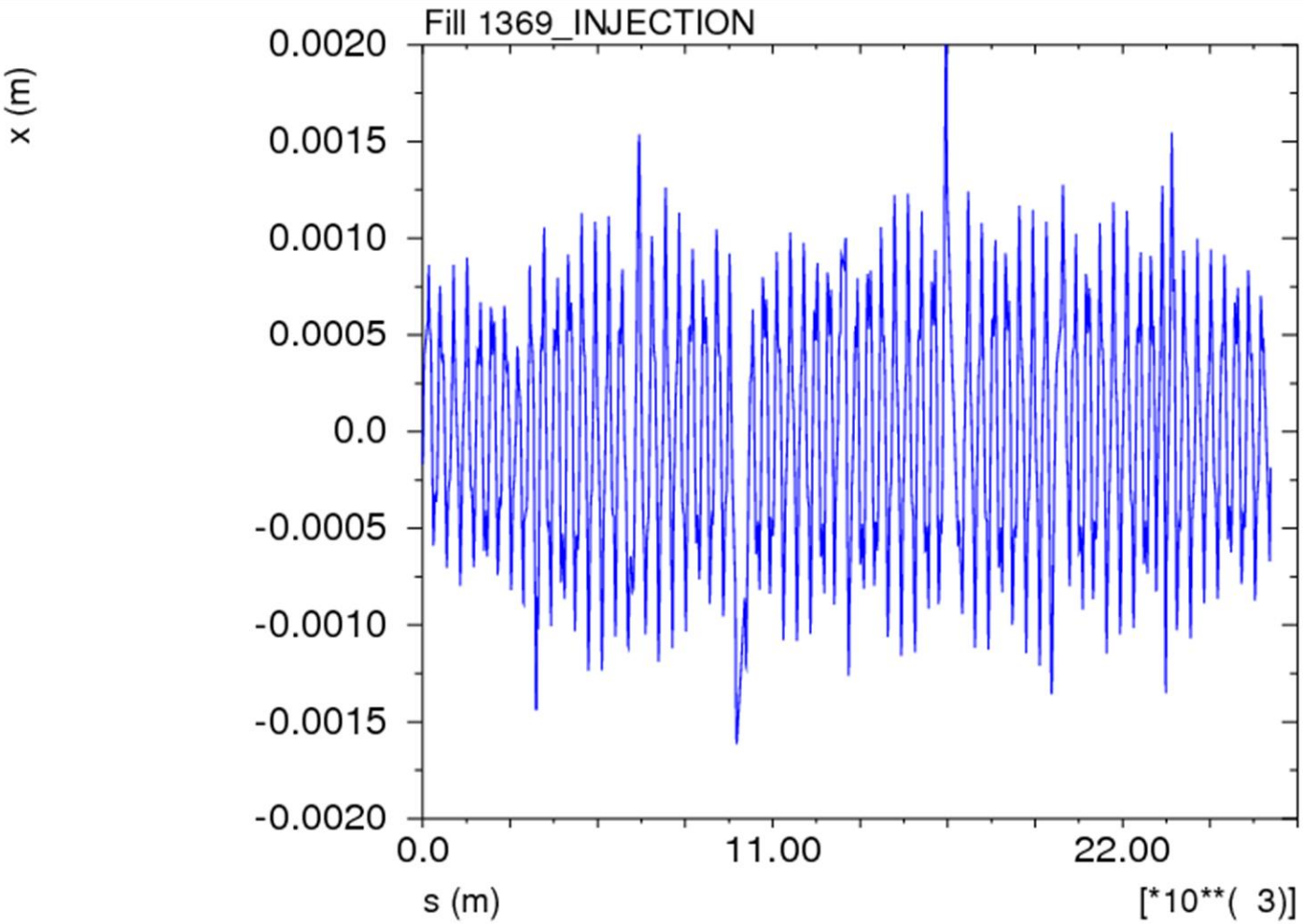
INJECTION

Horizontal B1 (1366vs1364)



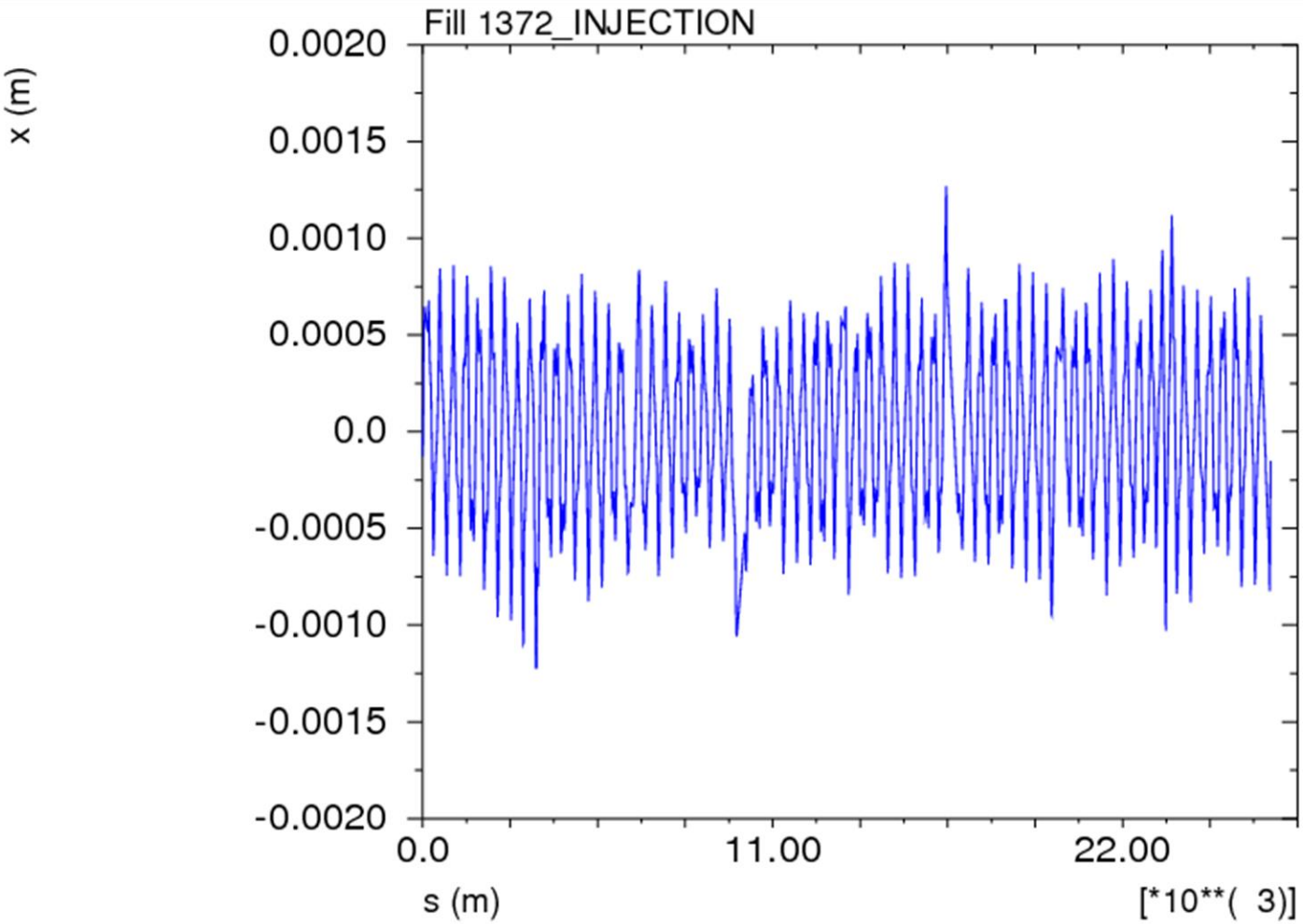
RMS (mm) = 0.11

Horizontal B1 (1369vs1364)



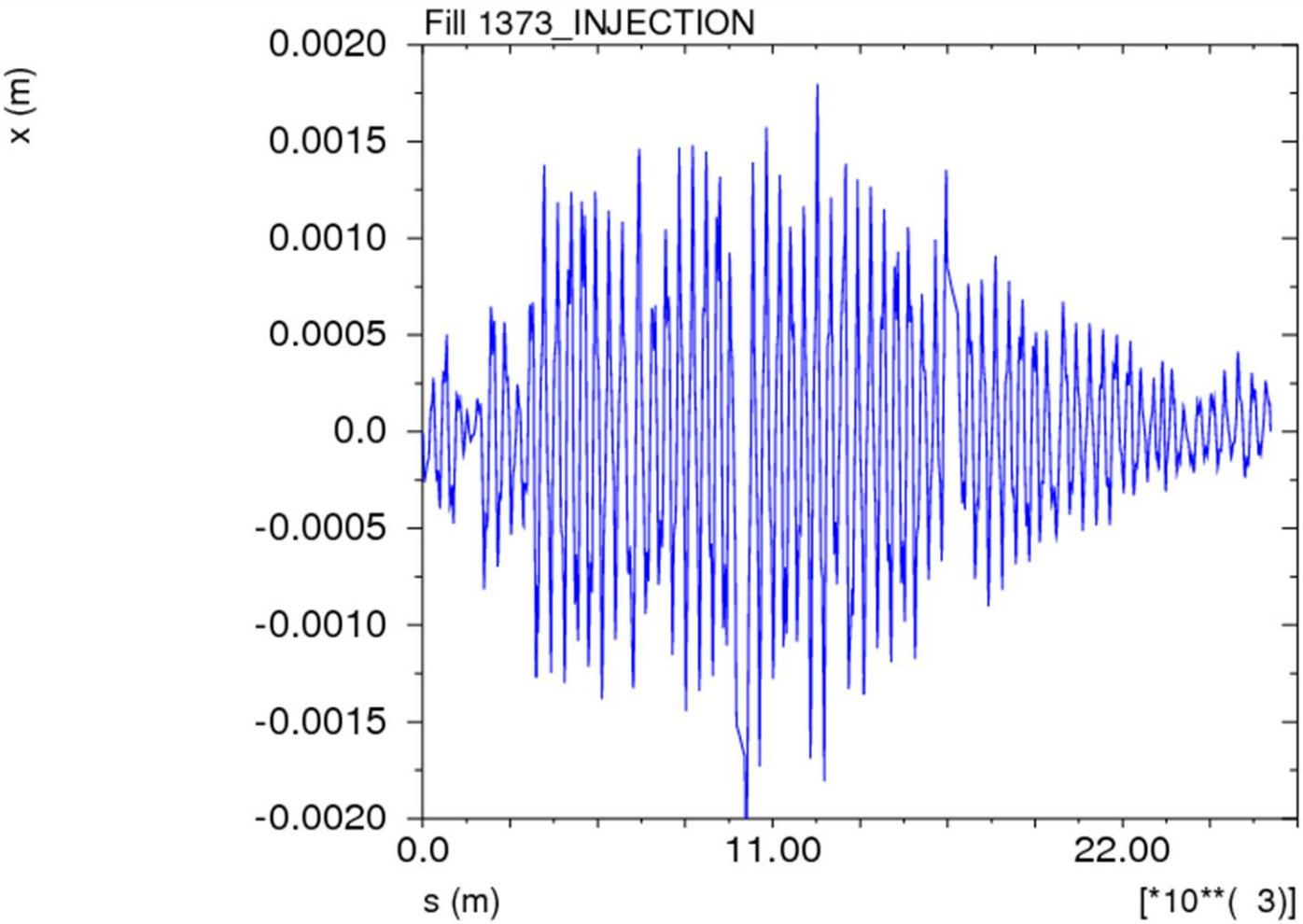
RMS (mm) = 0.60

Horizontal B1 (1372vs1364)



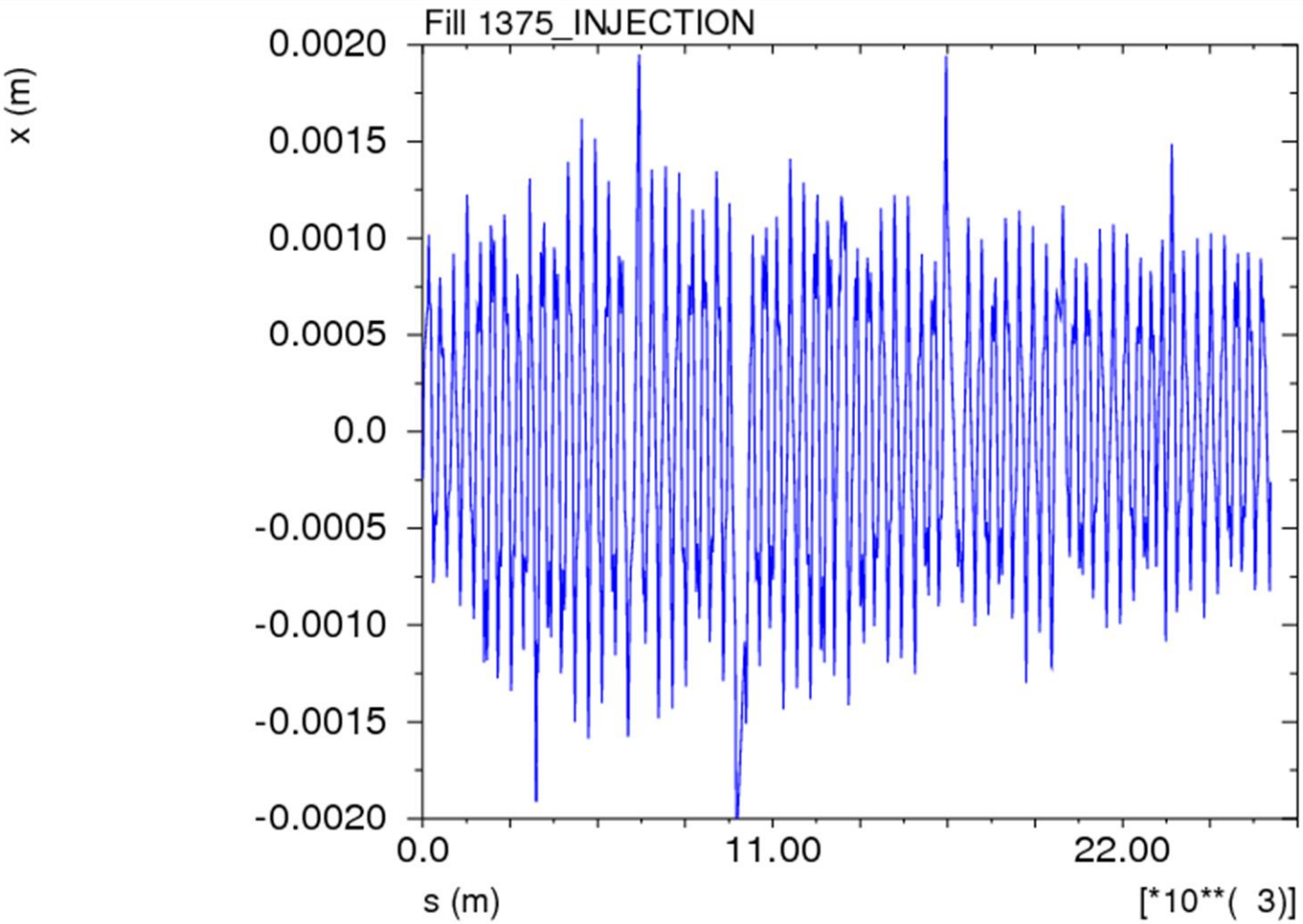
RMS (mm) = 0.43

Horizontal B1 (1373vs1364)



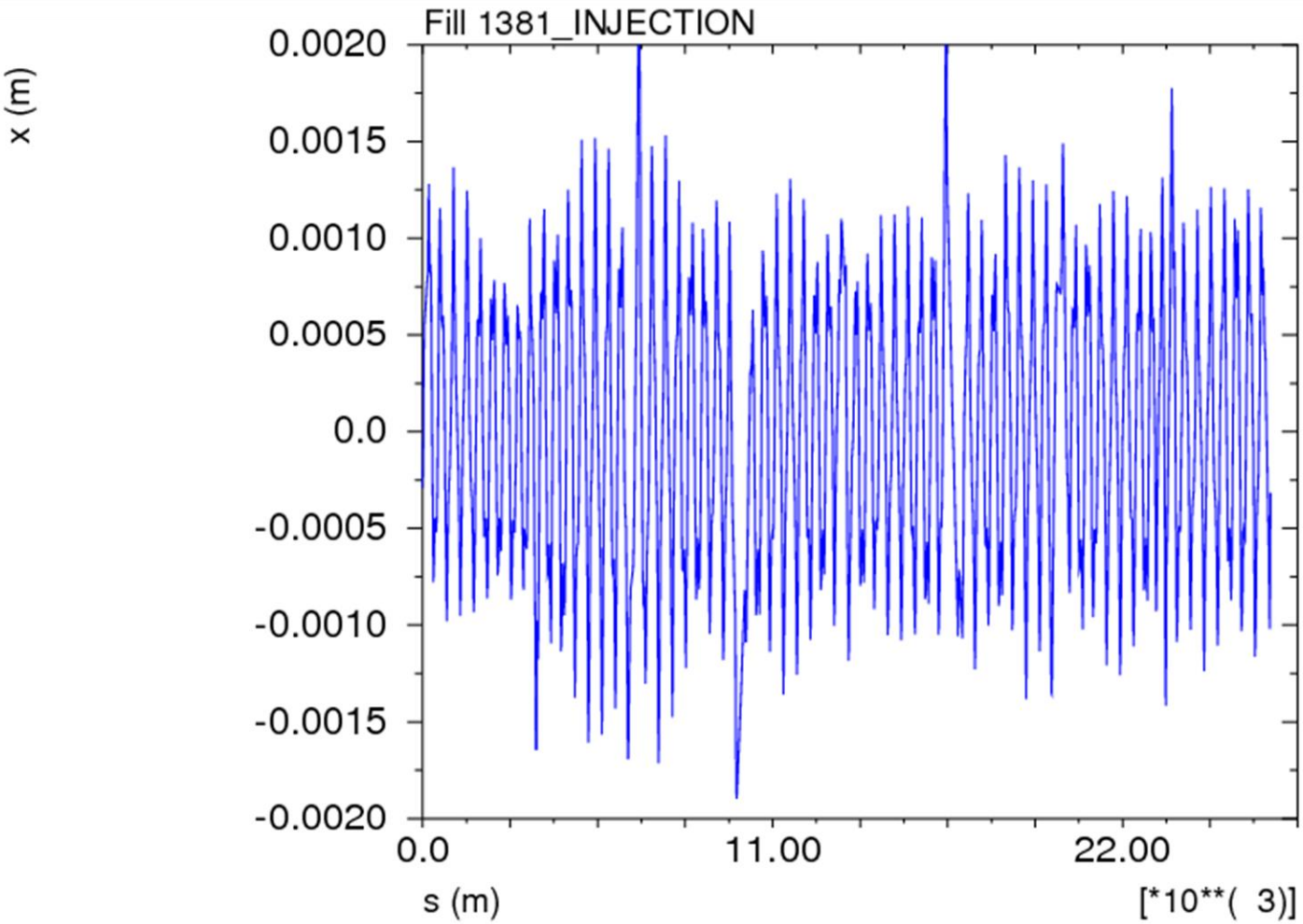
RMS (mm) = 0.58

Horizontal B1 (1375vs1364)



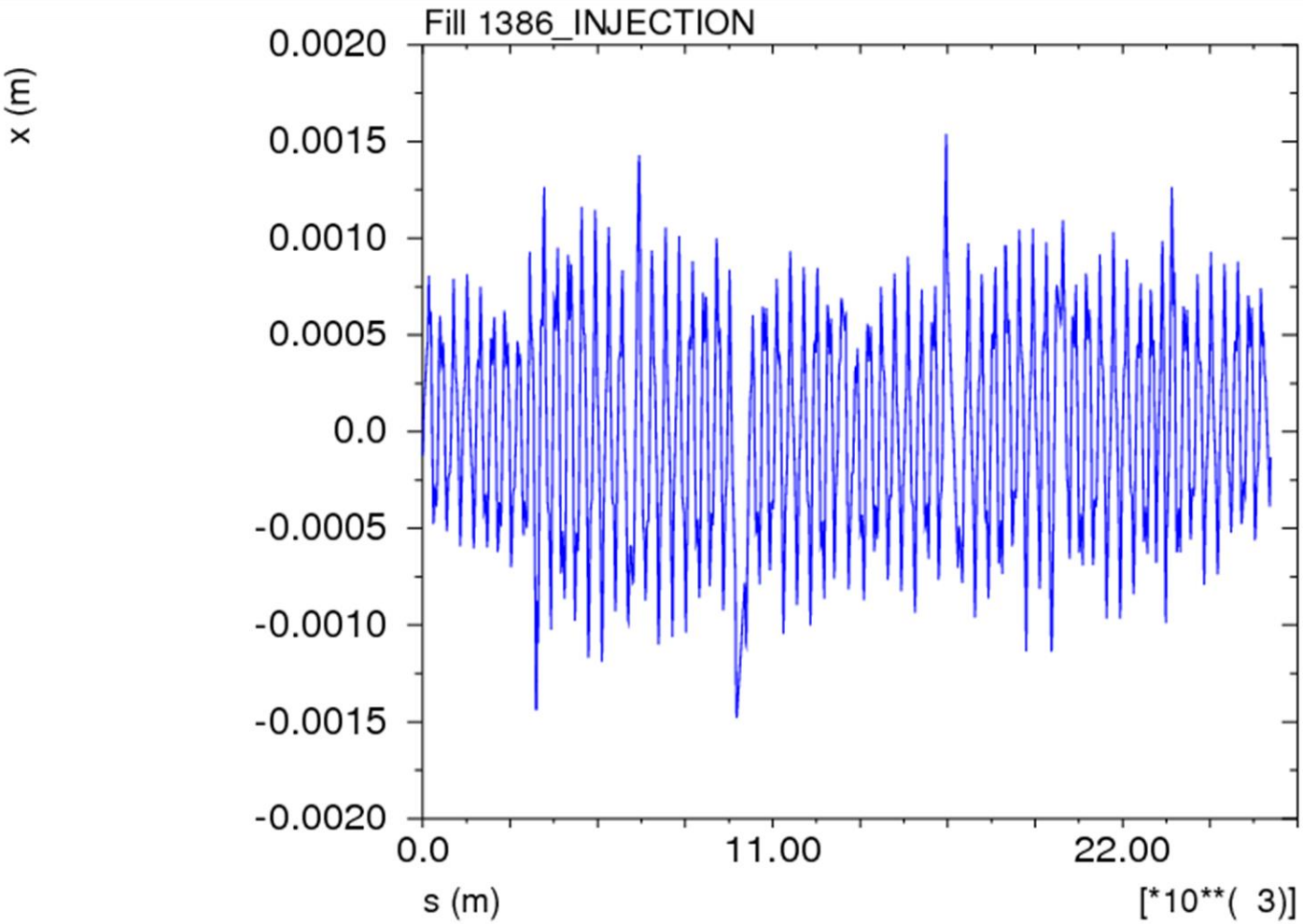
RMS (mm) = 0.70

Horizontal B1 (1381vs1364)



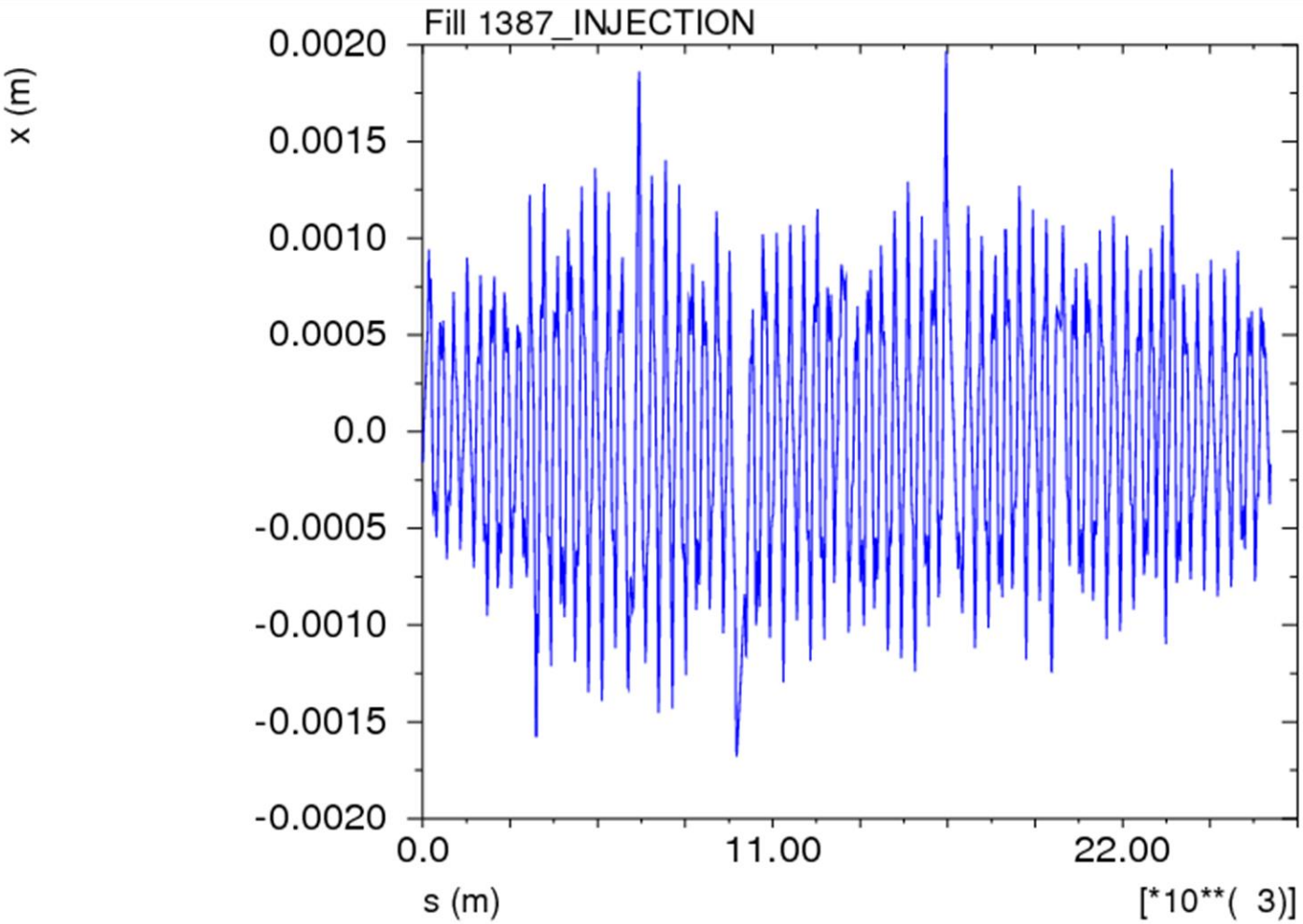
RMS (mm) = 0.71

Horizontal B1 (1386vs1364)



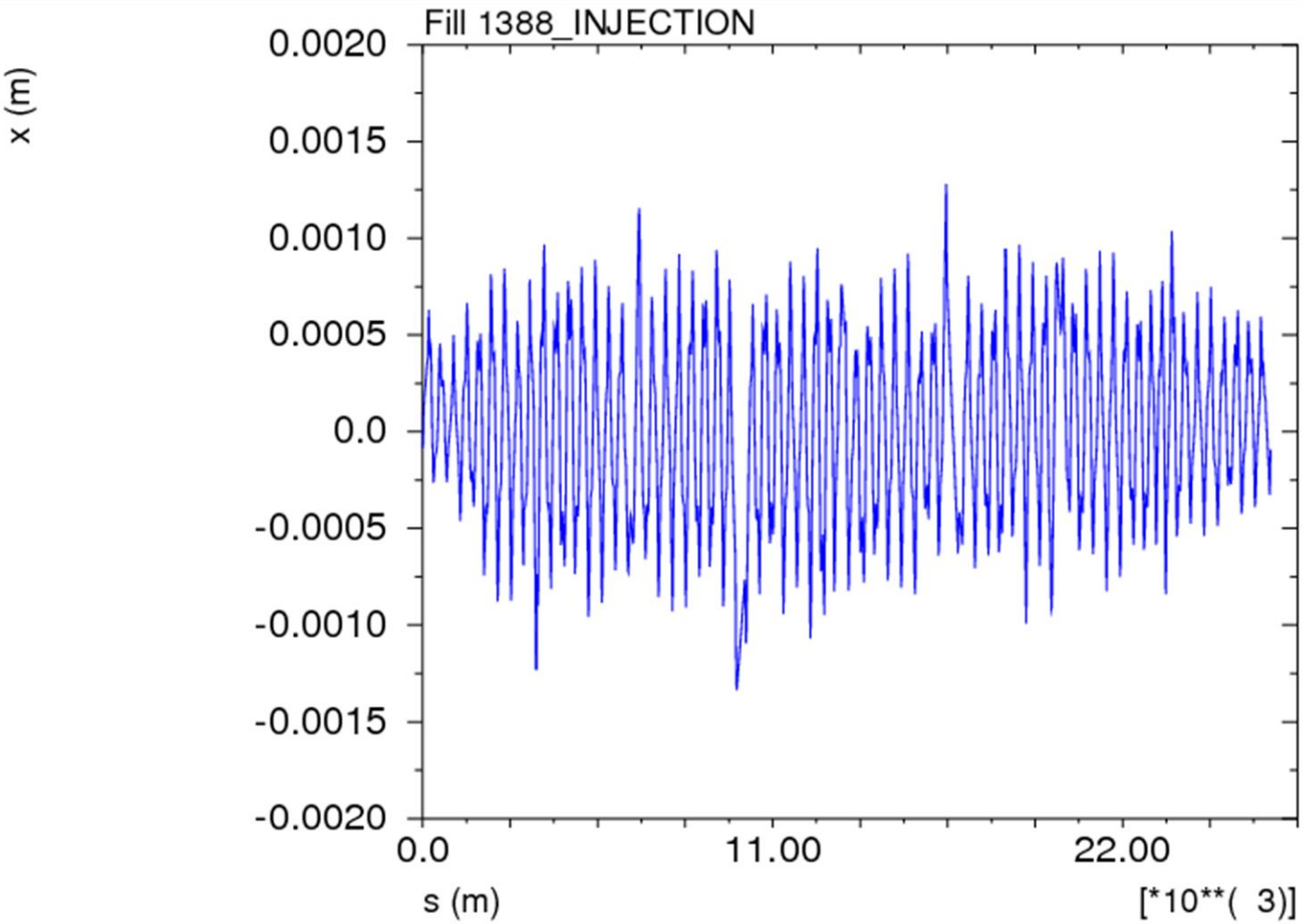
RMS (mm) = 0.53

Horizontal B1 (1387vs1364)



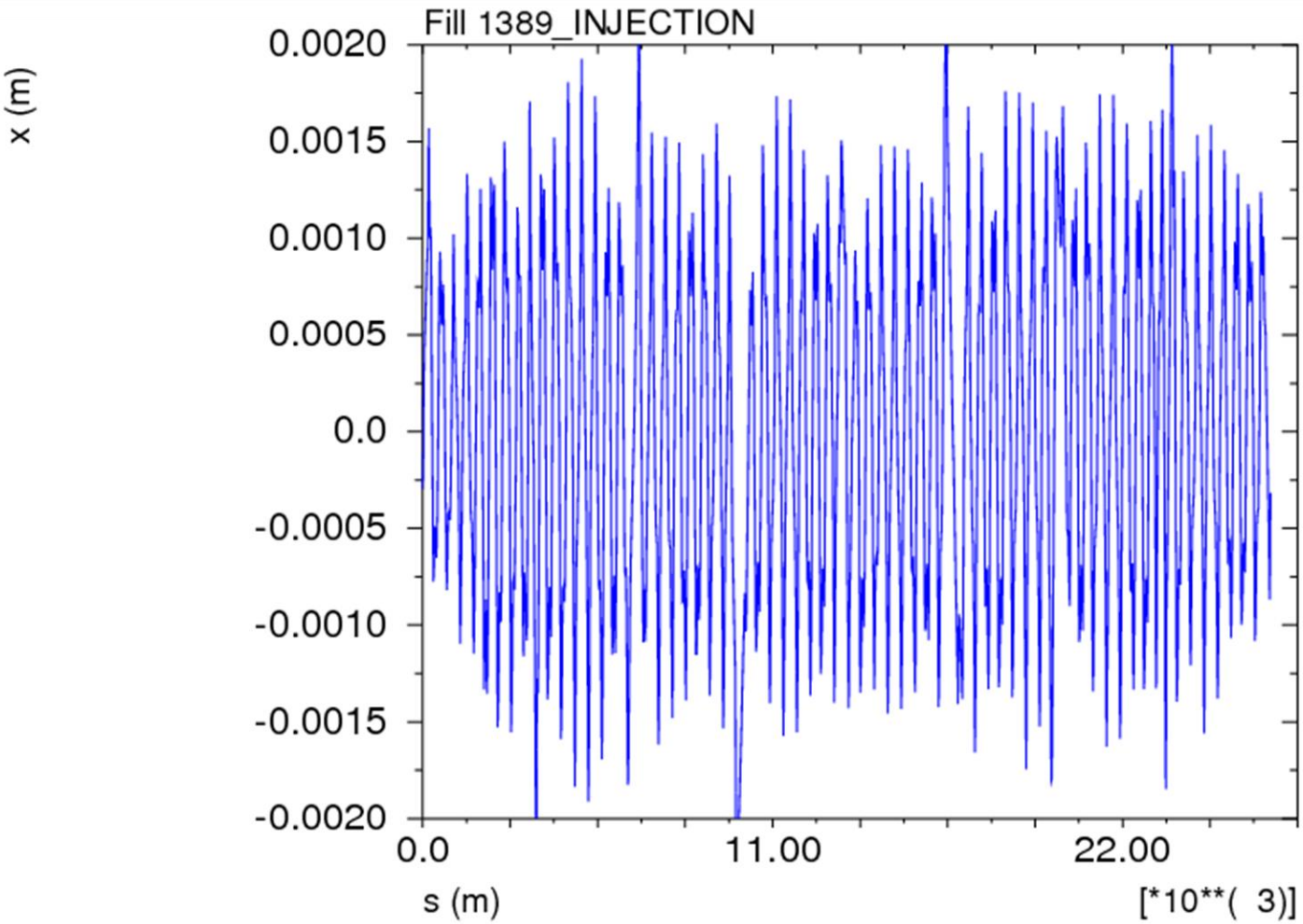
RMS (mm) = 0.63

Horizontal B1 (1388vs1364)



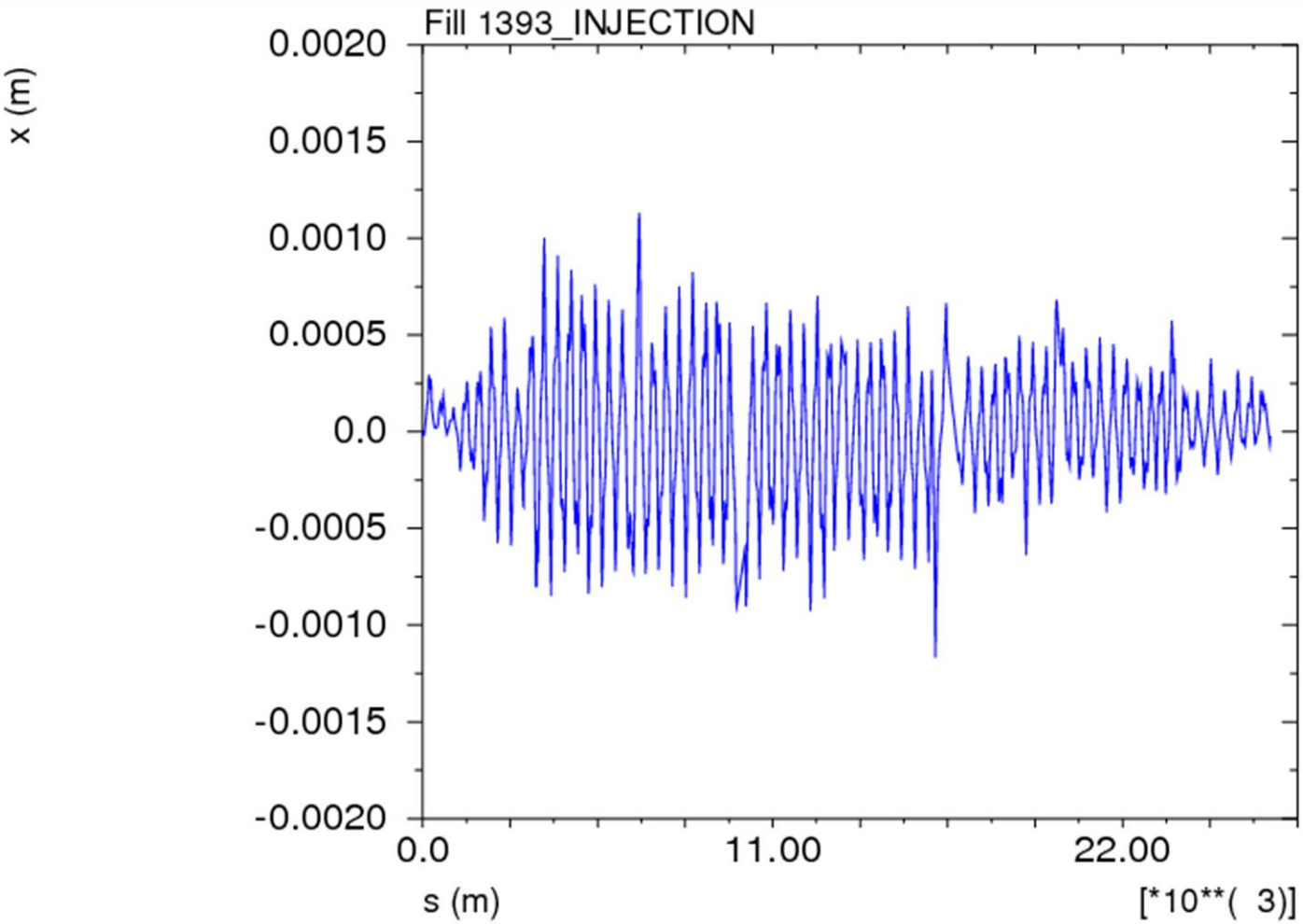
RMS (mm) = 0.46

Horizontal B1 (1389vs1364)



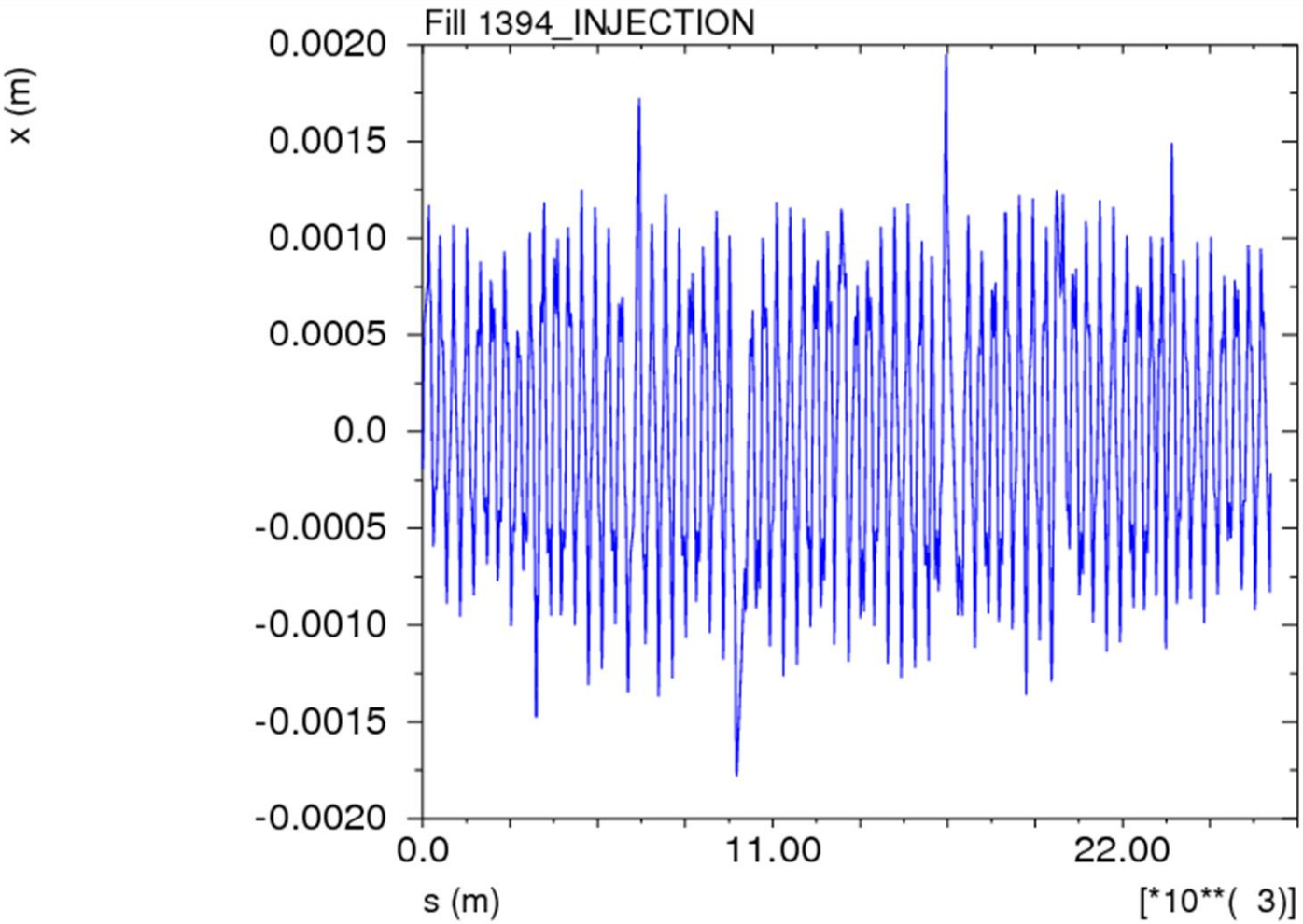
RMS (mm) = 0.89

Horizontal B1 (1393vs1364)



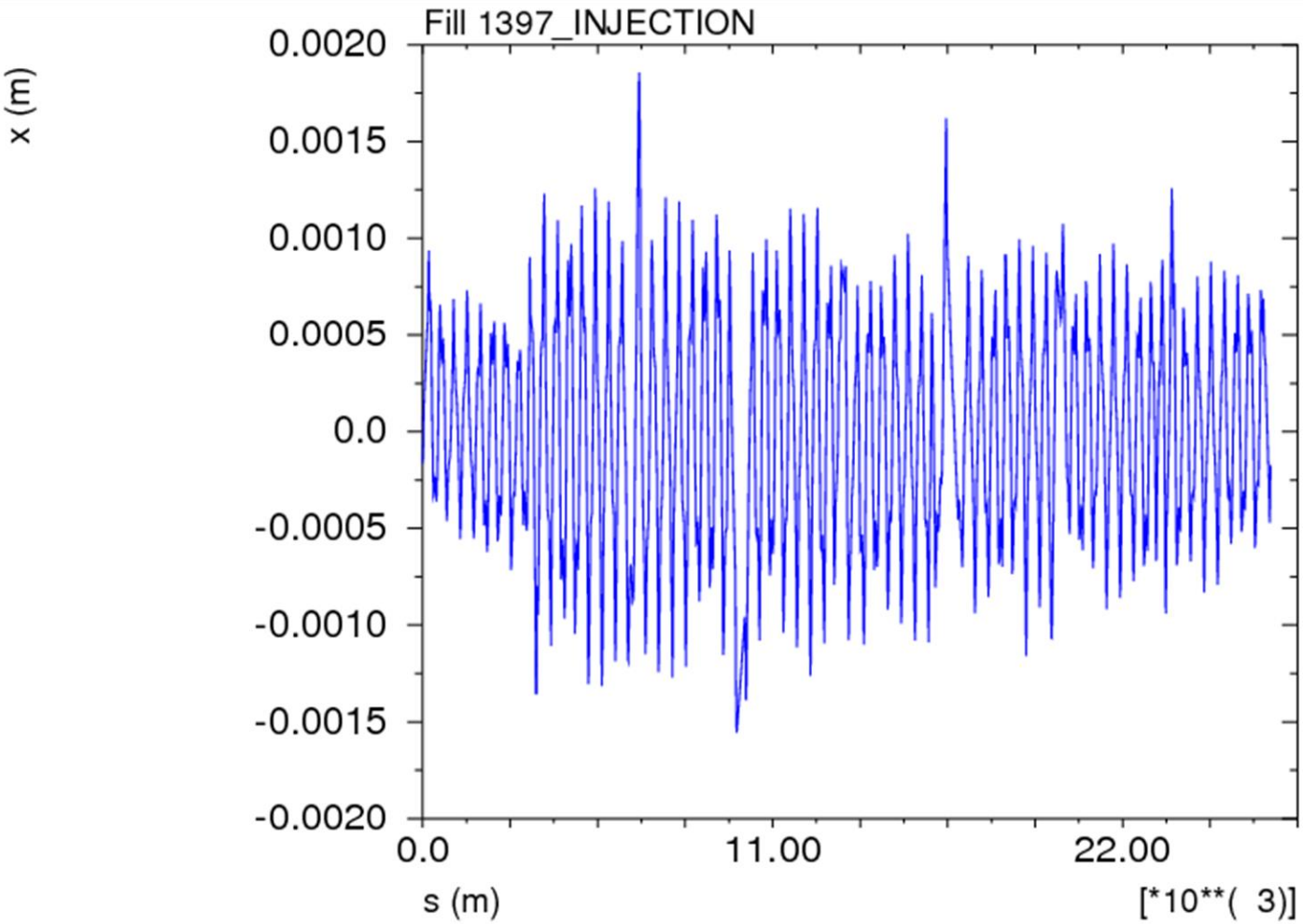
RMS (mm) = 0.34

Horizontal B1 (1394vs1364)



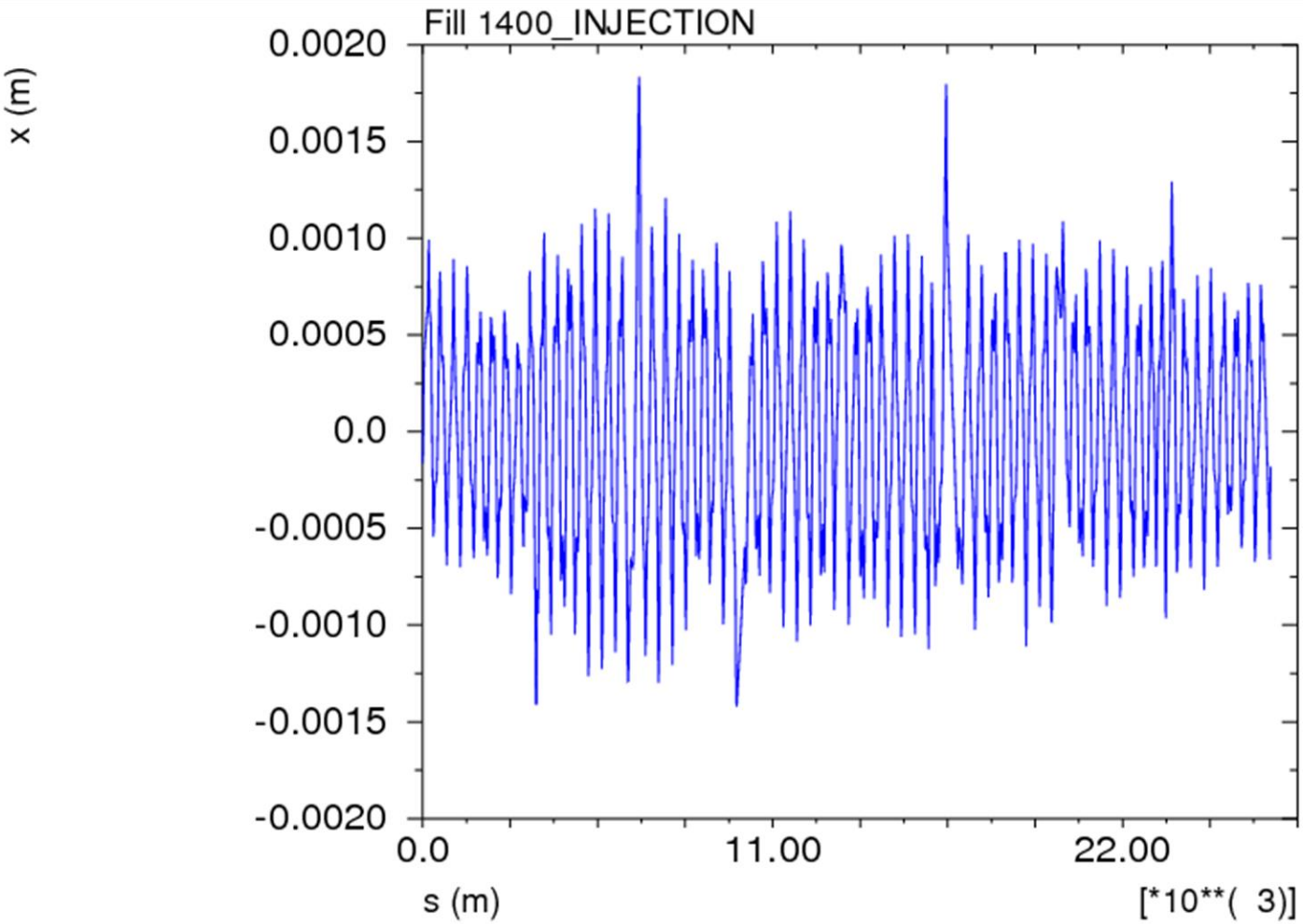
RMS (mm) = 0.64

Horizontal B1 (1397vs1364)



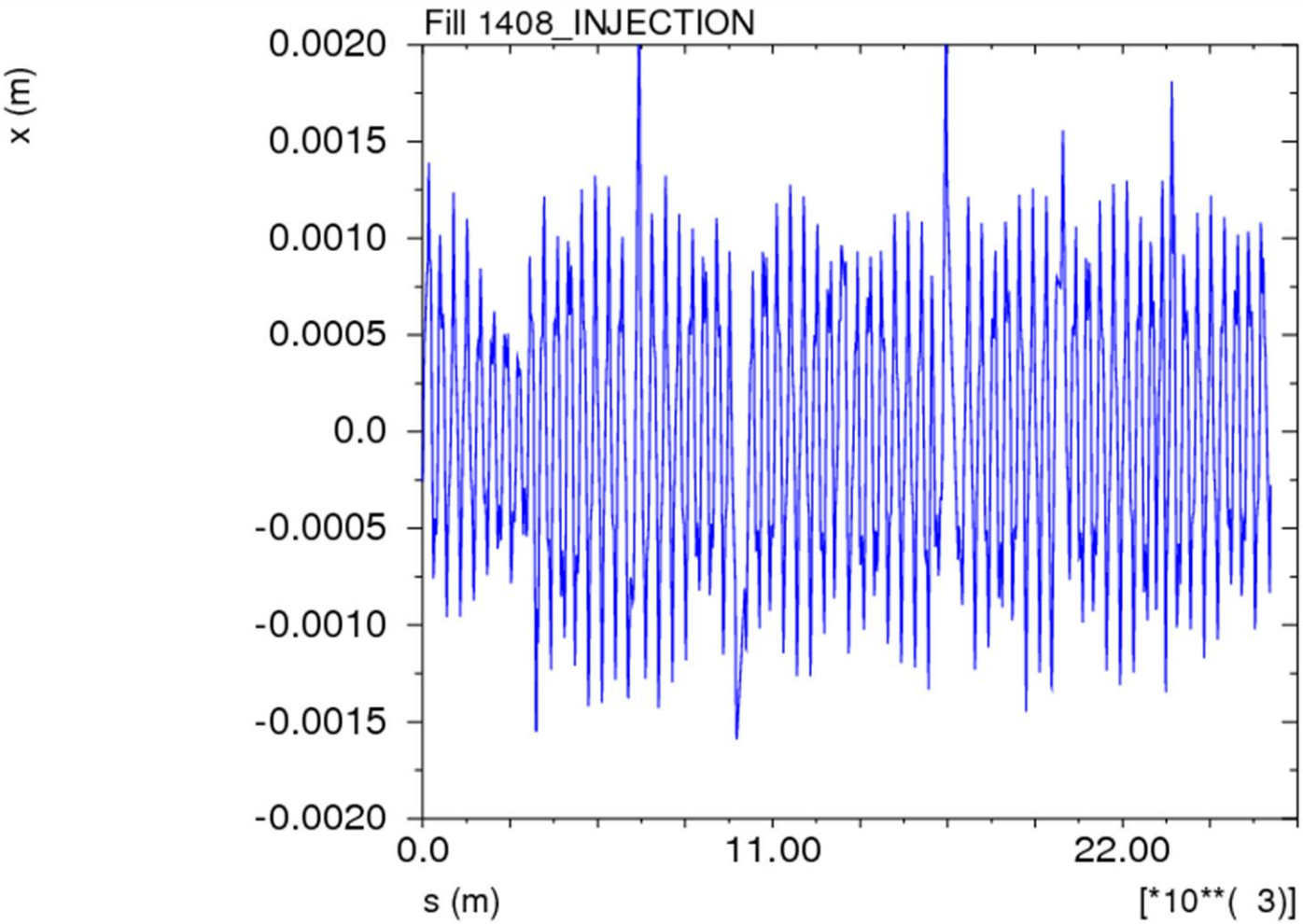
RMS (mm) = 0.57

Horizontal B1 (1400vs1364)



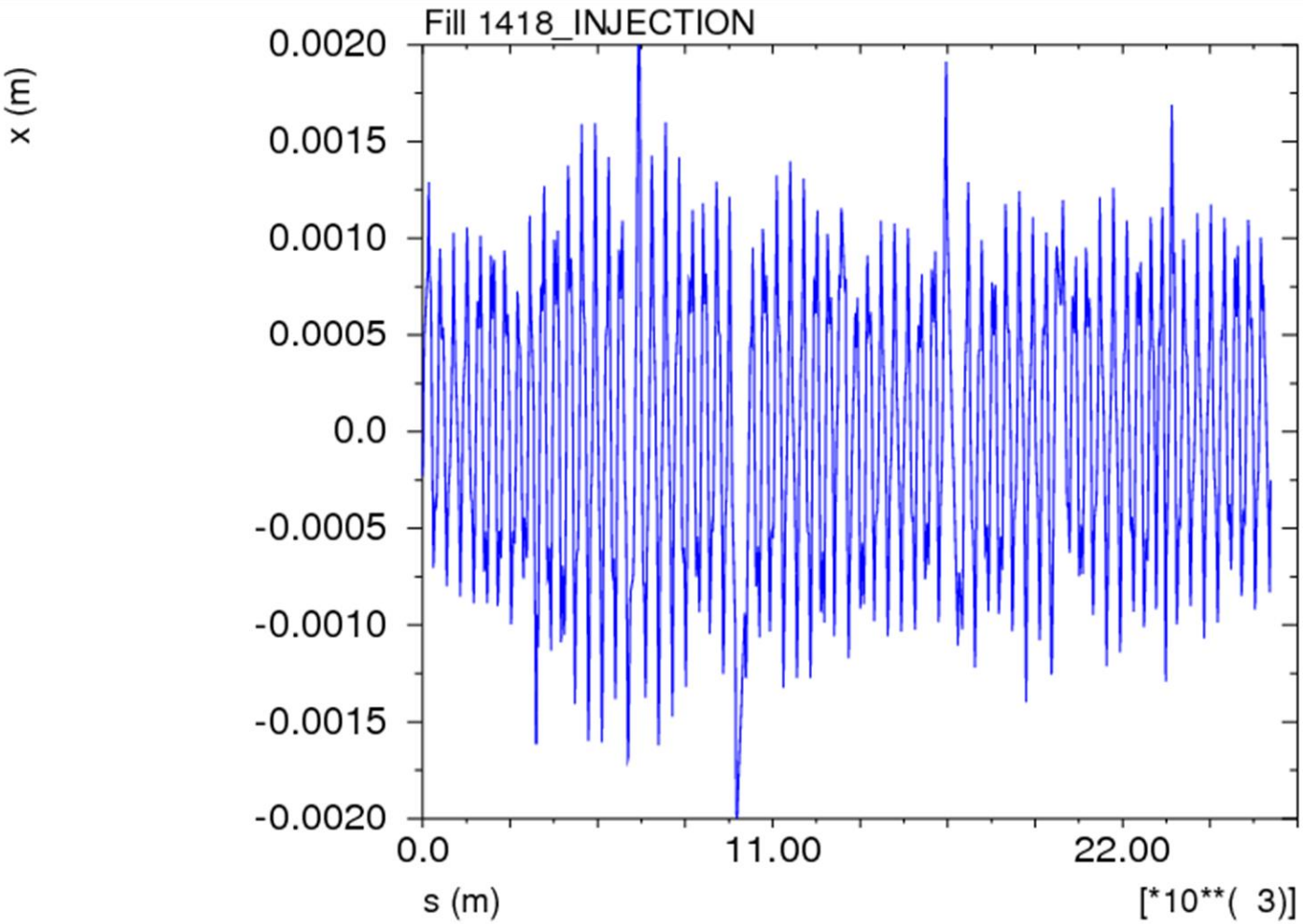
RMS (mm) = 0.55

Horizontal B1 (1408vs1364)



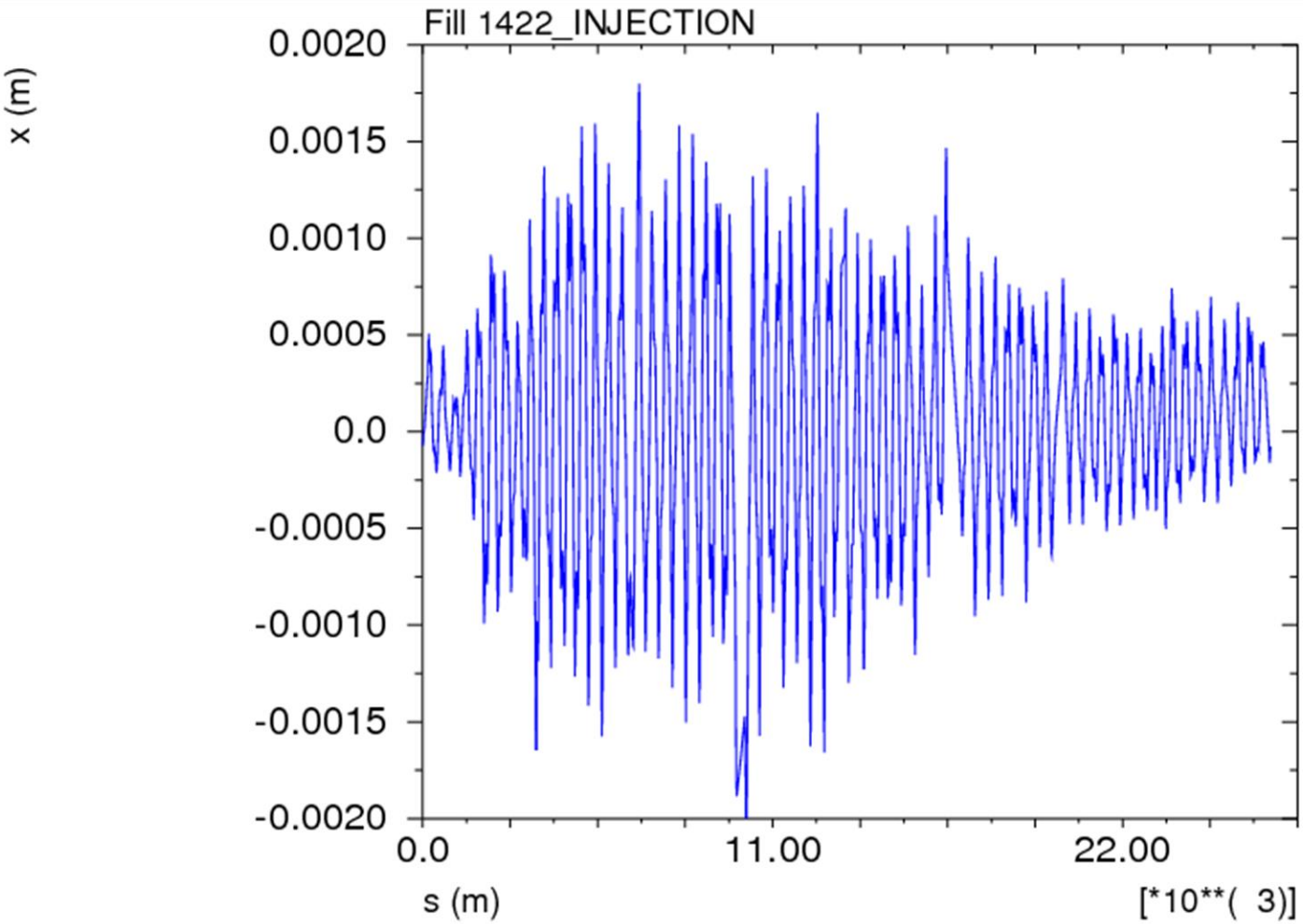
RMS (mm) = 0.67

Horizontal B1 (1418vs1364)



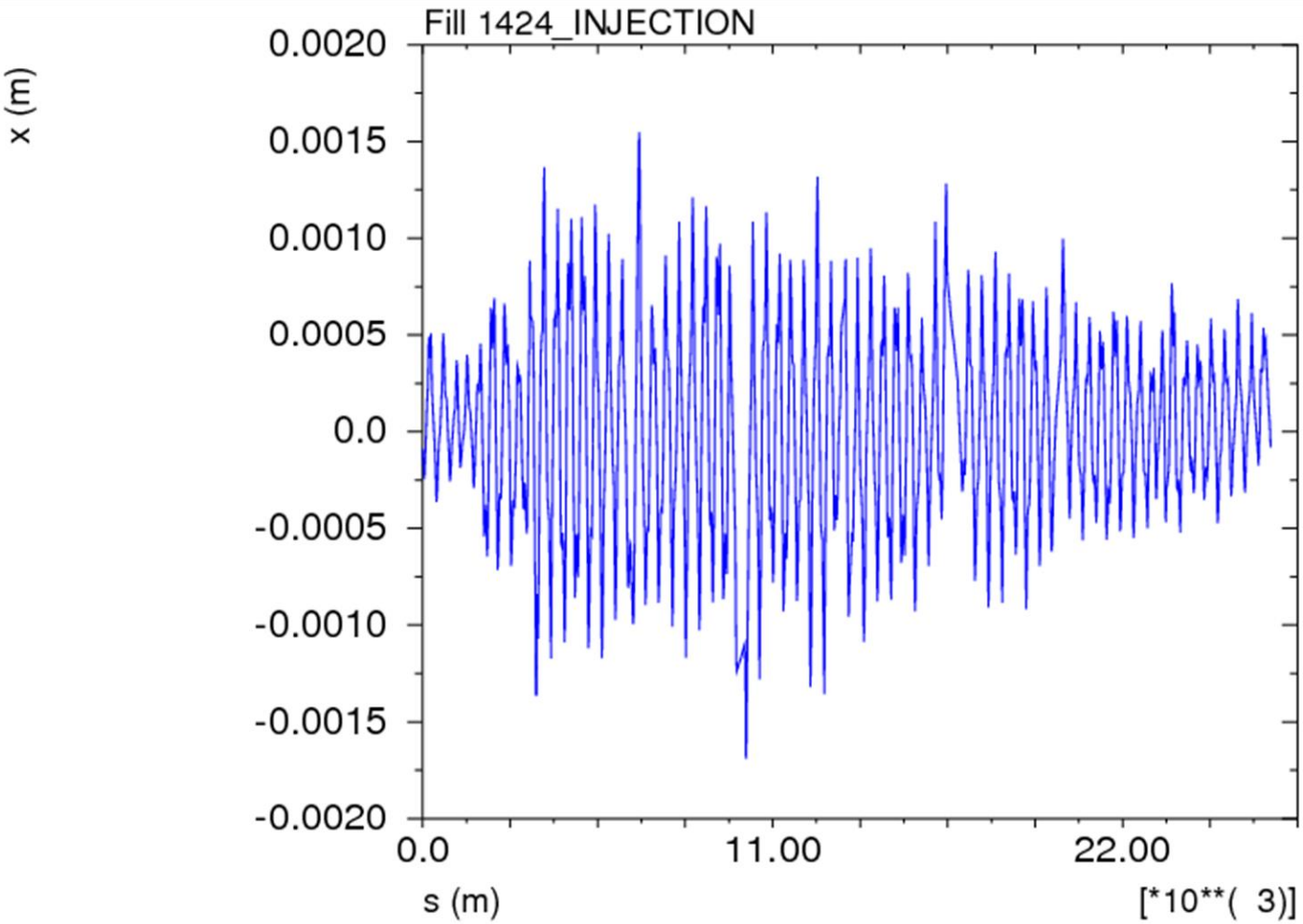
RMS (mm) = 0.70

Horizontal B1 (1422vs1364)



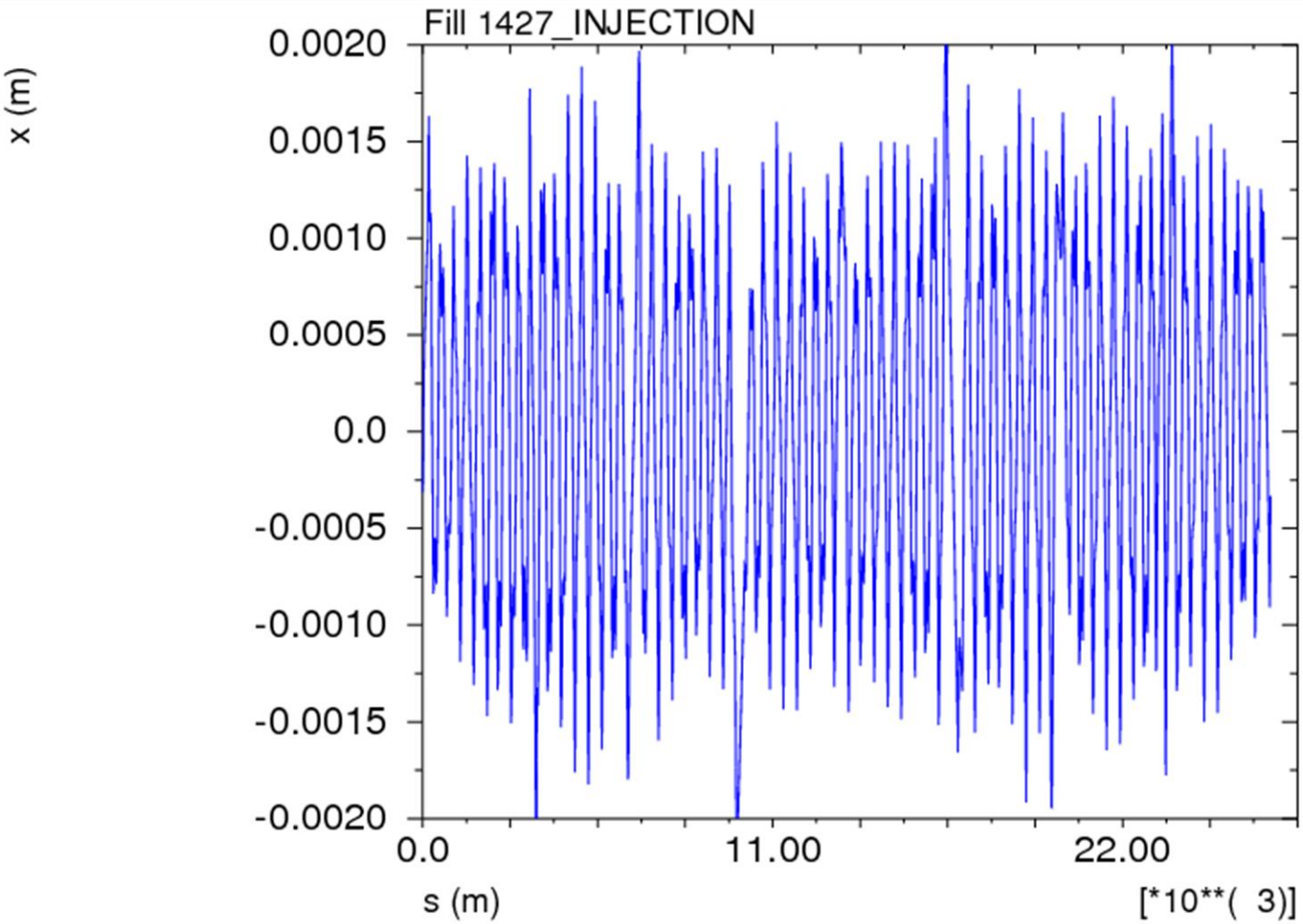
RMS (mm) = 0.61

Horizontal B1 (1424vs1364)



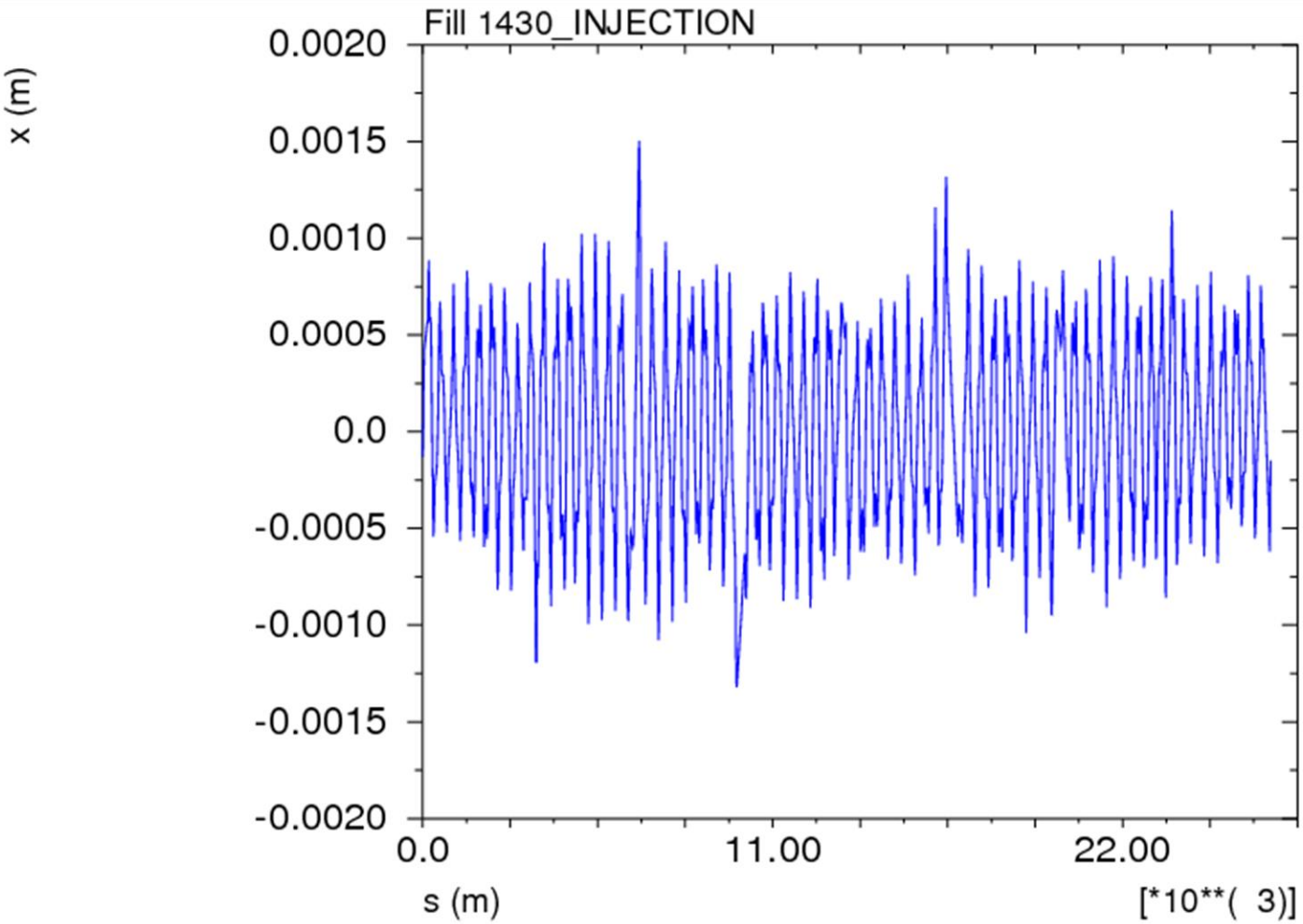
RMS (mm) = 0.51

Horizontal B1 (1427vs1364)



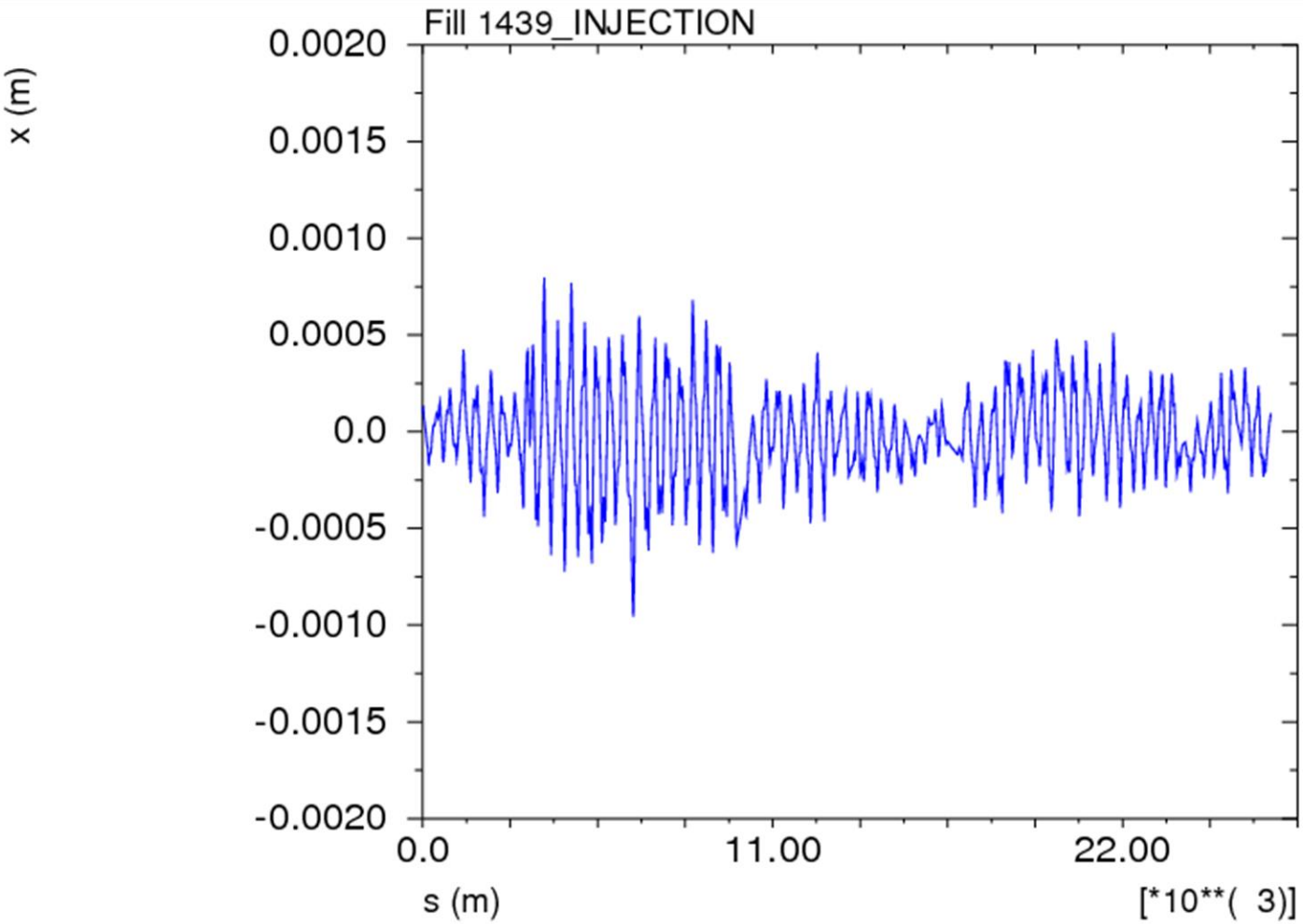
RMS (mm) = 0.88

Horizontal B1 (1430vs1364)



RMS (mm) = 0.48

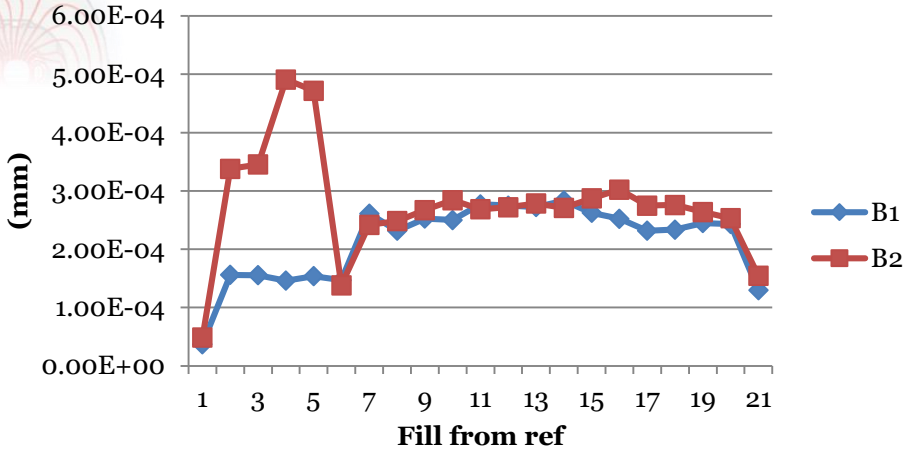
Horizontal B1 (1439vs1364)



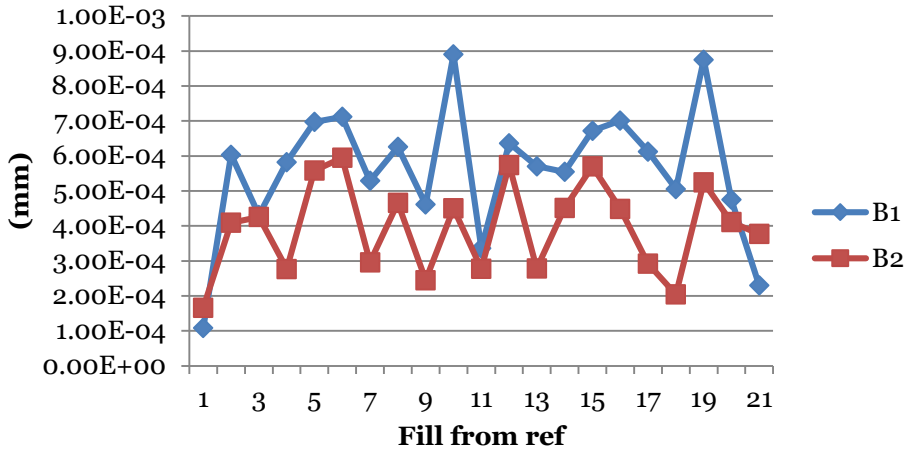
RMS (mm) = 0.23

Simulated Orbit RMS values

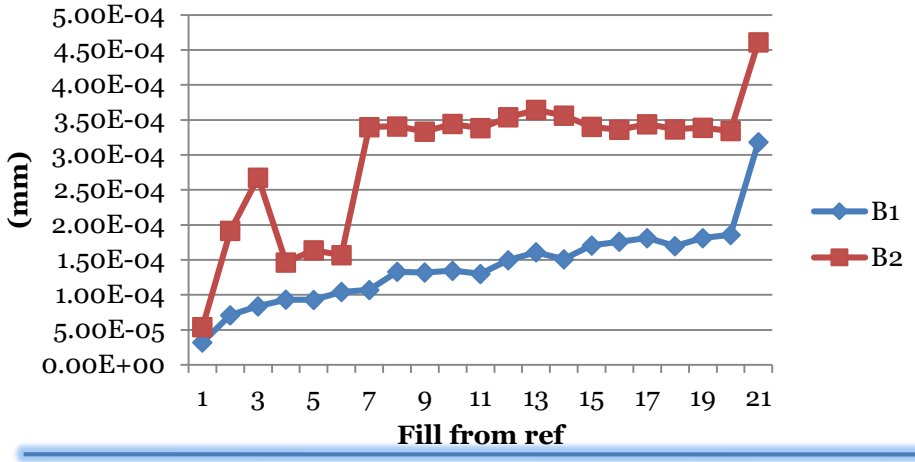
Horizontal Orbit RMS in SB



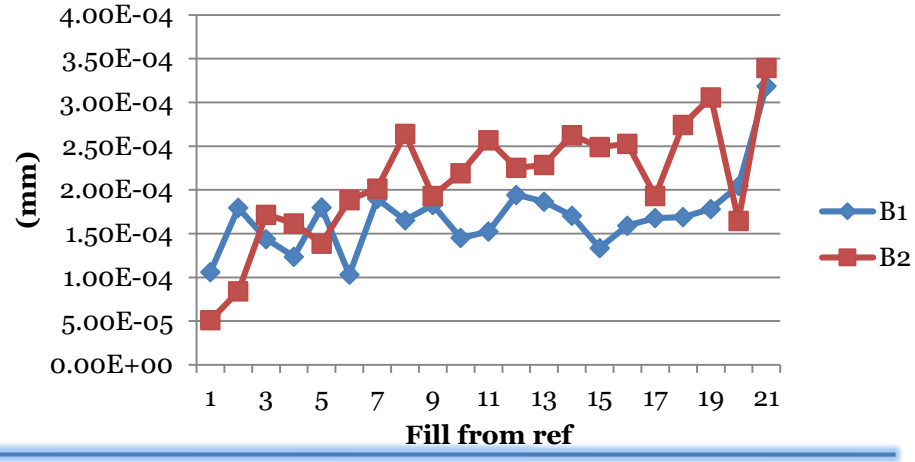
Horizontal Orbit RMS in INJ



Vertical Orbit RMS in SB



Vertical Orbit RMS in INJ

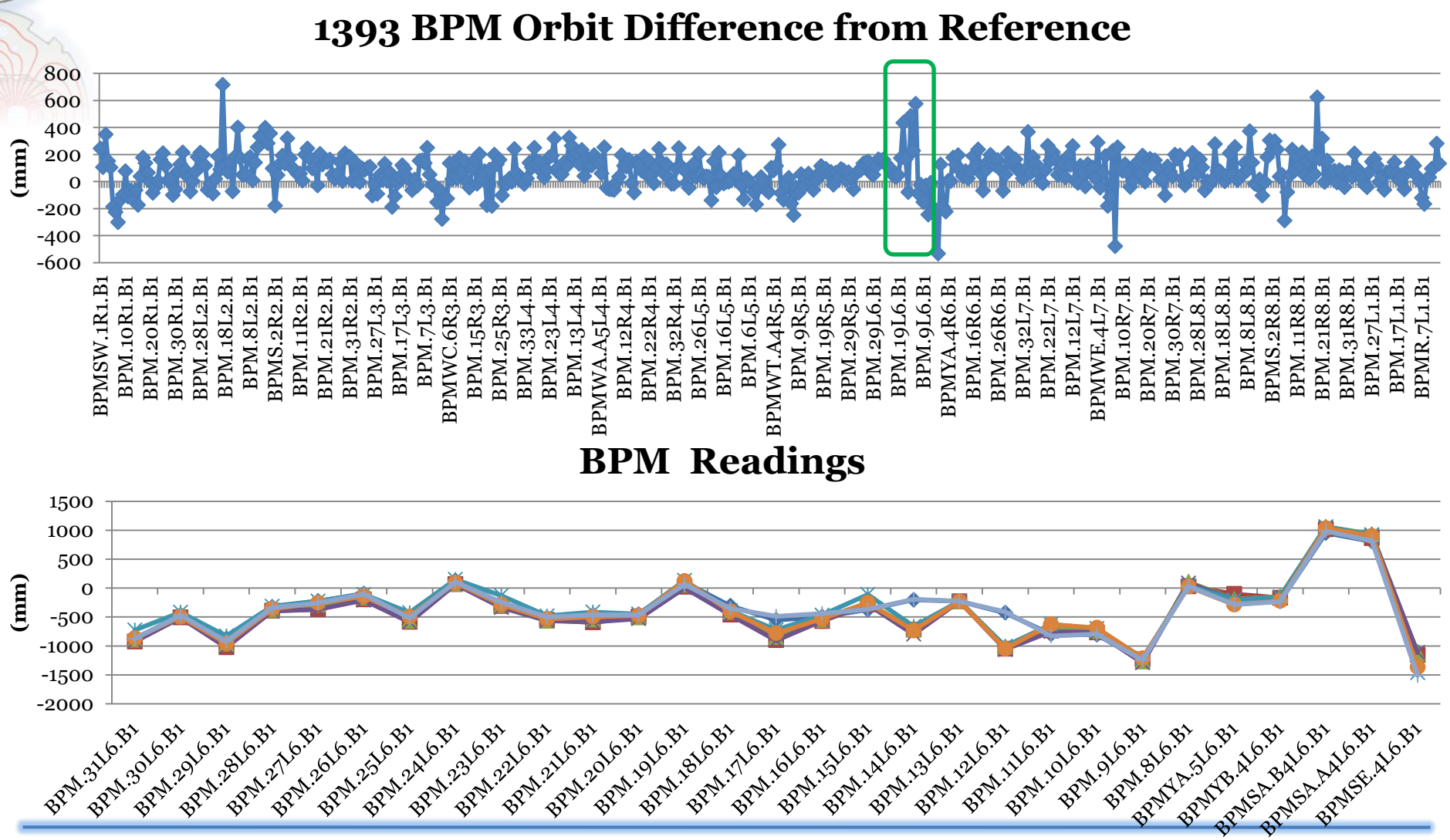


Conclusions

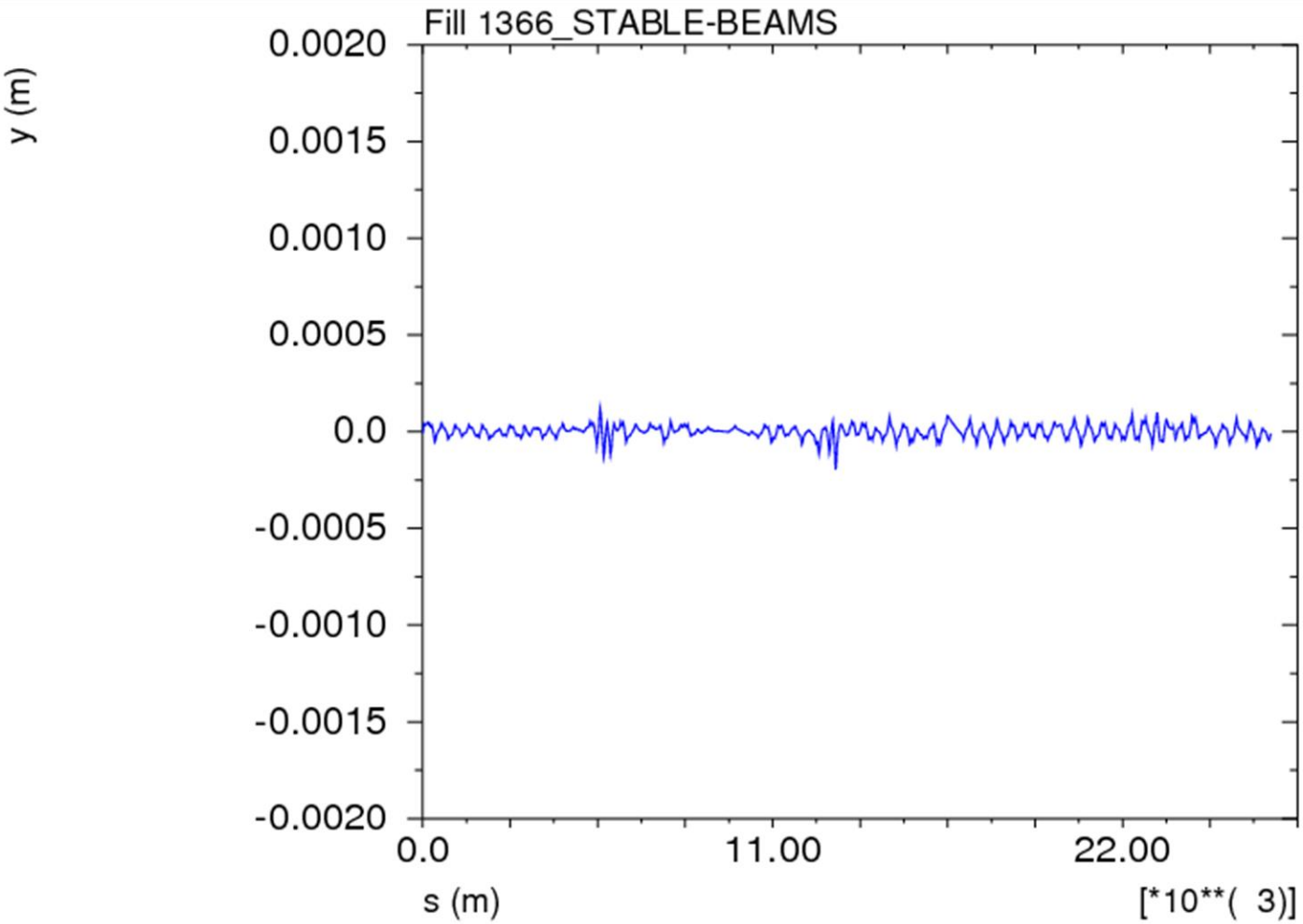
- The method seems to be promising BUT further improvements and more thoughts are needed.
- Already able to spot unexpected local behavior (i.e. the broken RCBH15.L6B1) – accordance between real and simulated data.
- The RMS of differences in the corrector kicks gets slightly “larger” with time, but still stays small showing high reproducibility of the orbit.
- V plane seems to be more stable than H plane.
- INJECTION orbit seems to be less reproducible than STABLE BEAMS one (as seen on real data).

Extra Slides

MCBH.15L6.B1 case

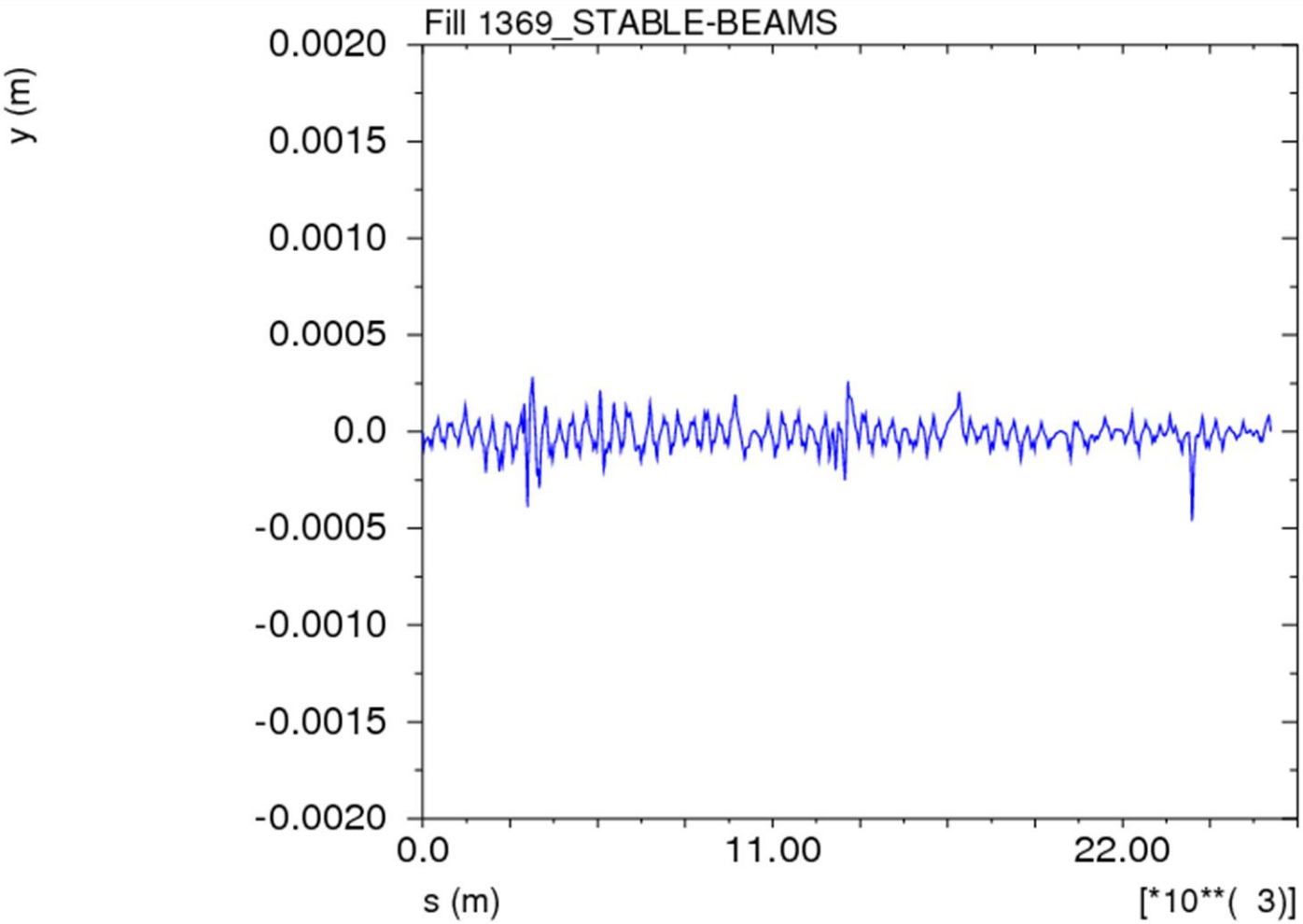


Vertical B1 (1366vs1364)



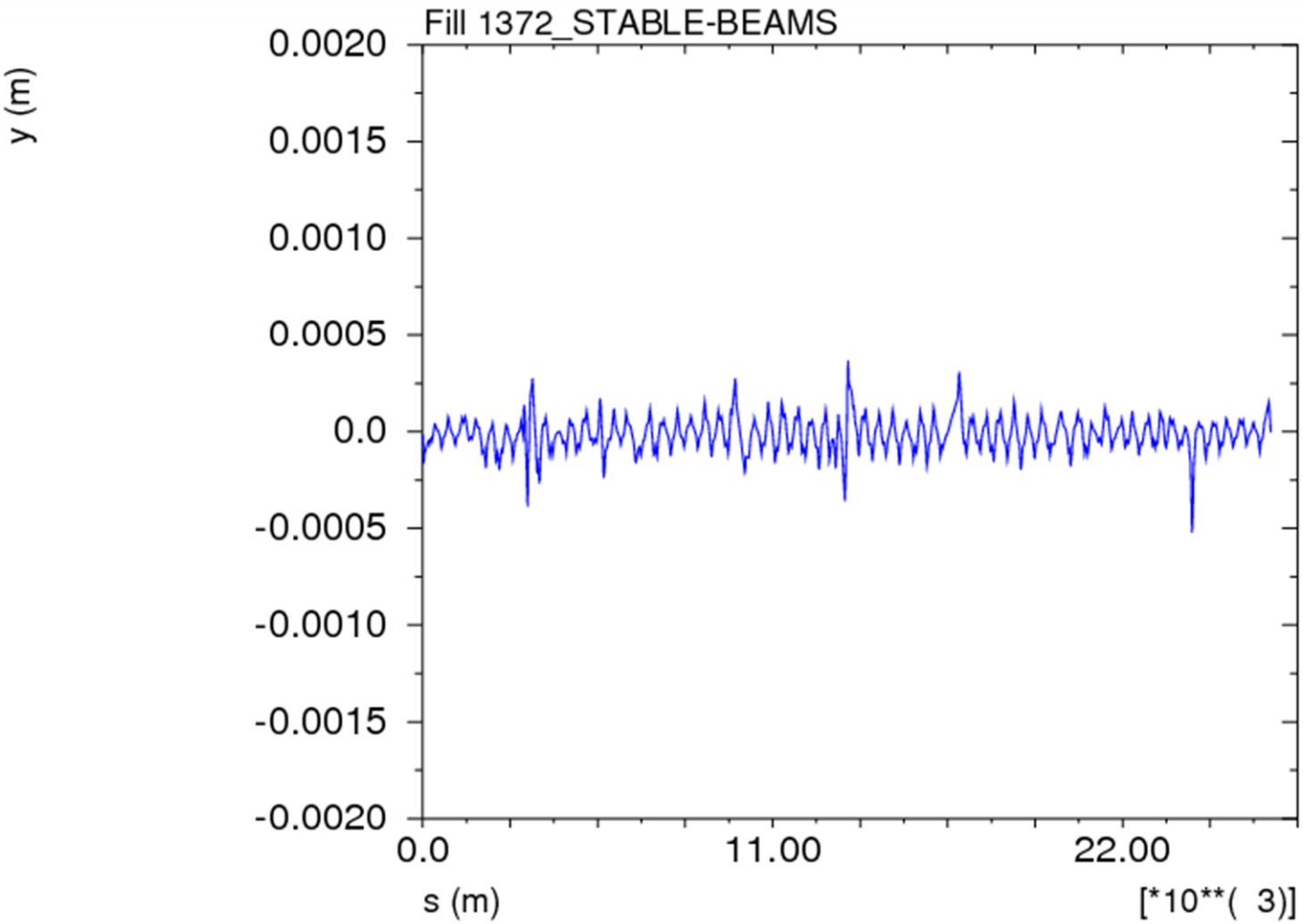
RMS (mm) = 0.03

Vertical B1 (1369vs1364)



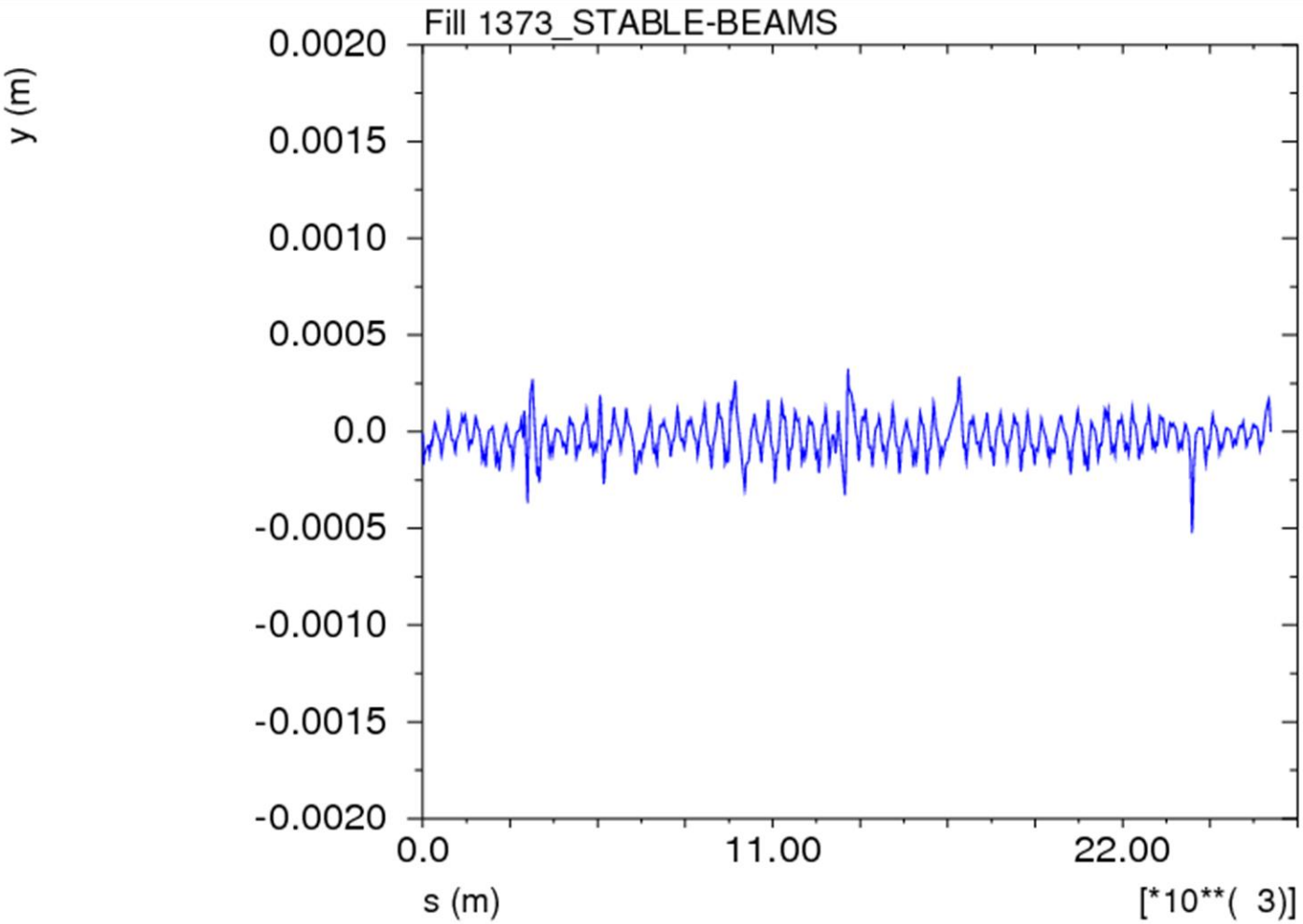
RMS (mm) = 0.07

Vertical B1 (1372vs1364)



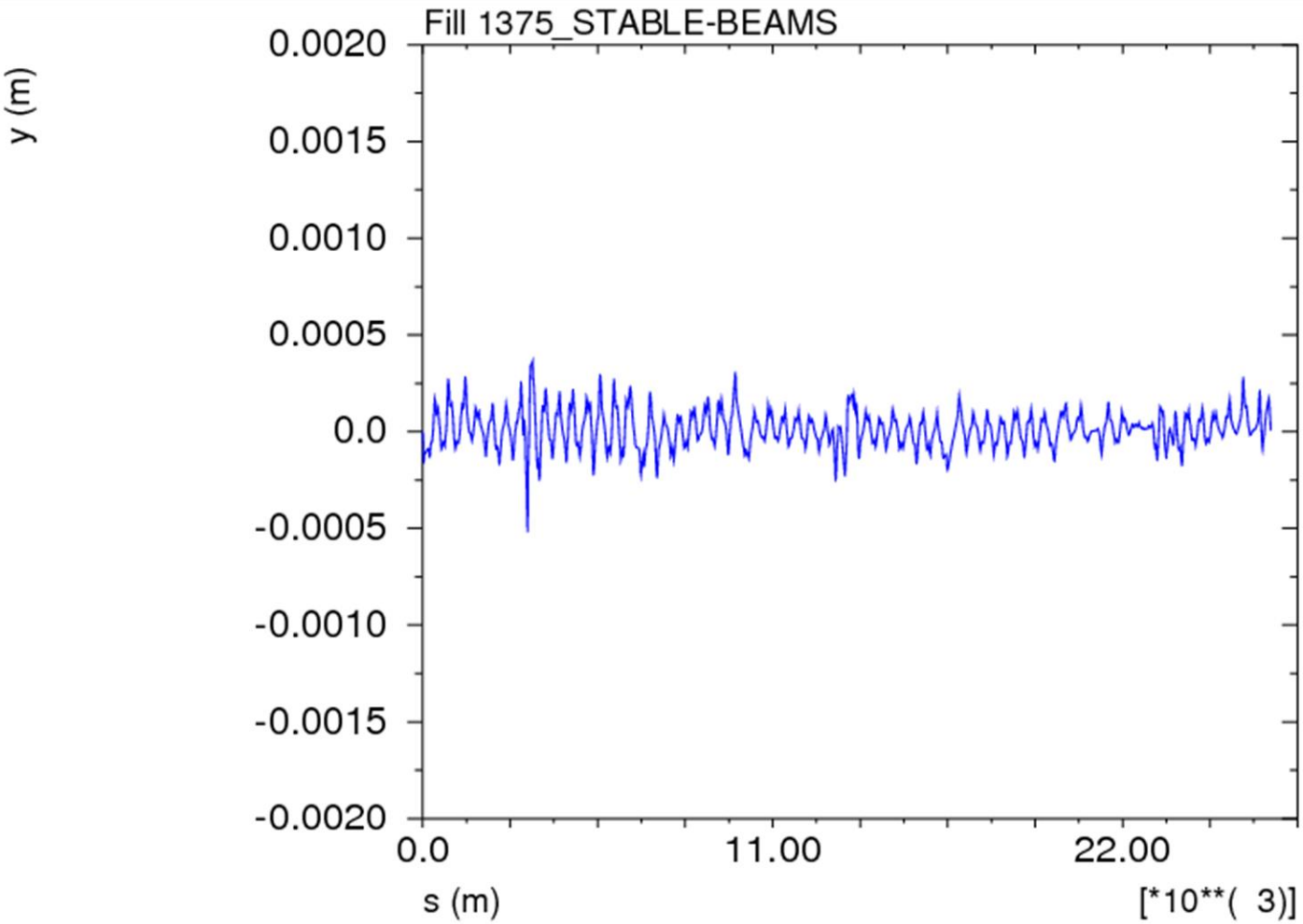
RMS (mm) = 0.08

Vertical B1 (1373vs1364)



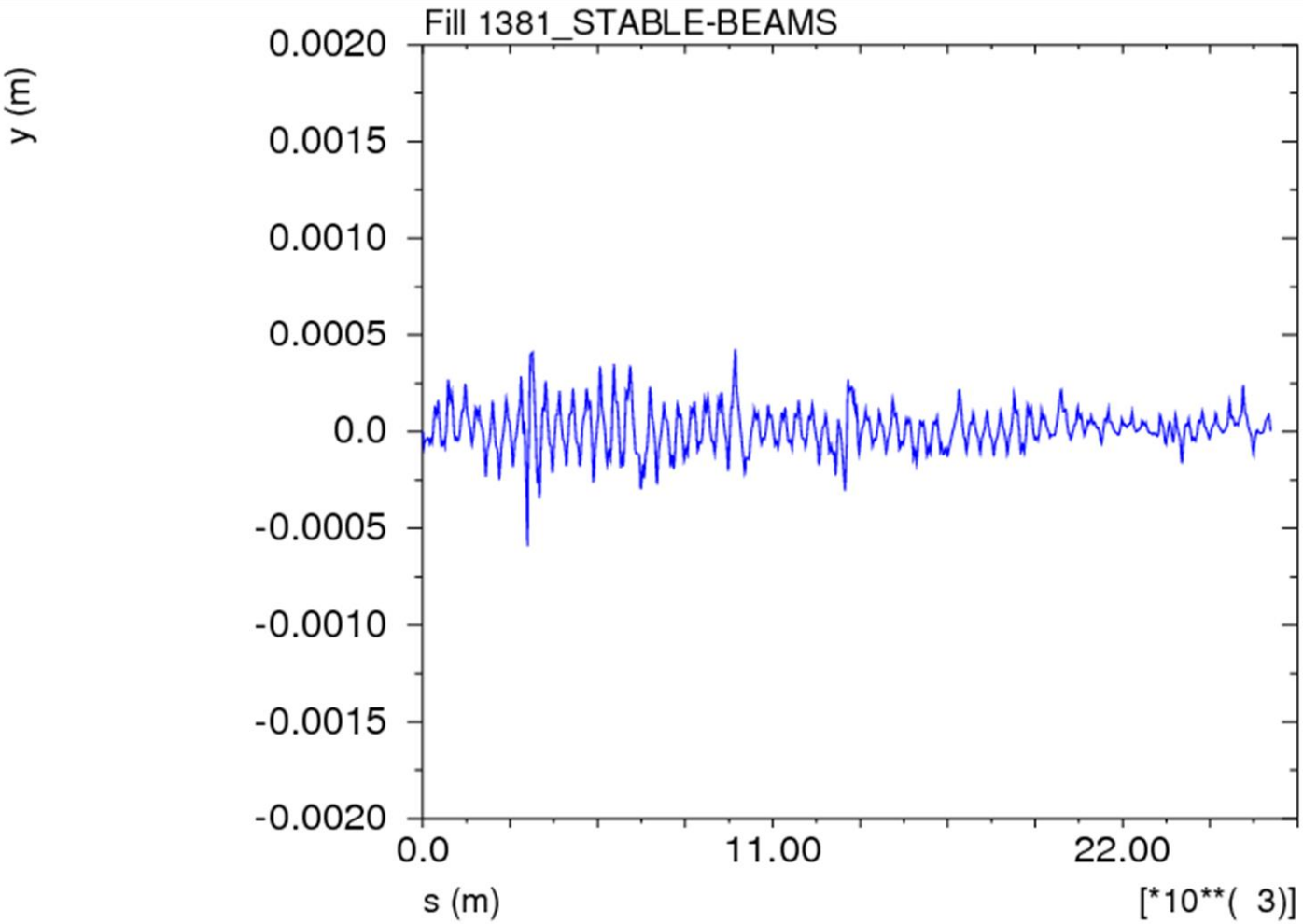
RMS (mm) = 0.09

Vertical B1 (1375vs1364)



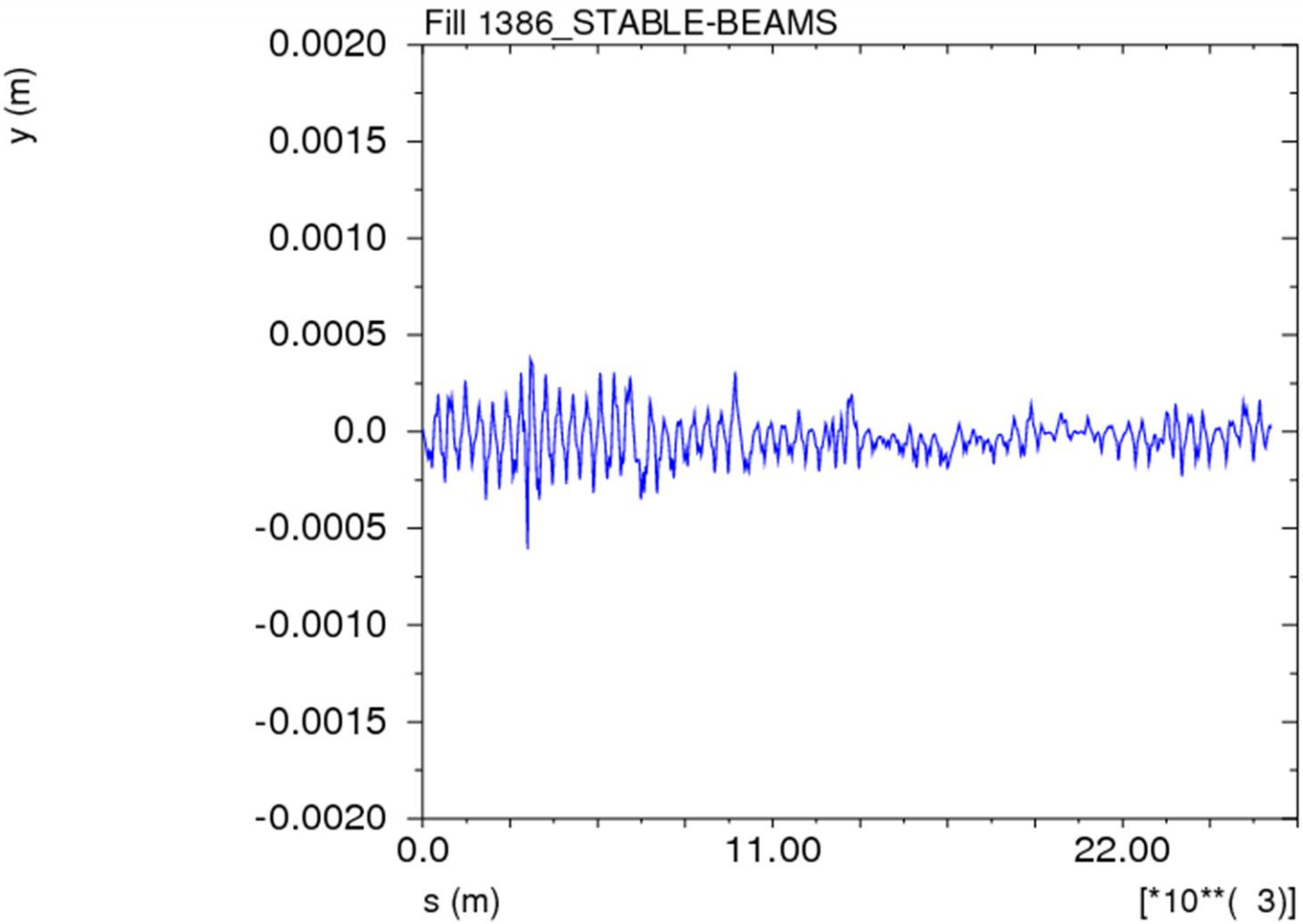
RMS (mm) = 0.09

Vertical B1 (1381vs1364)



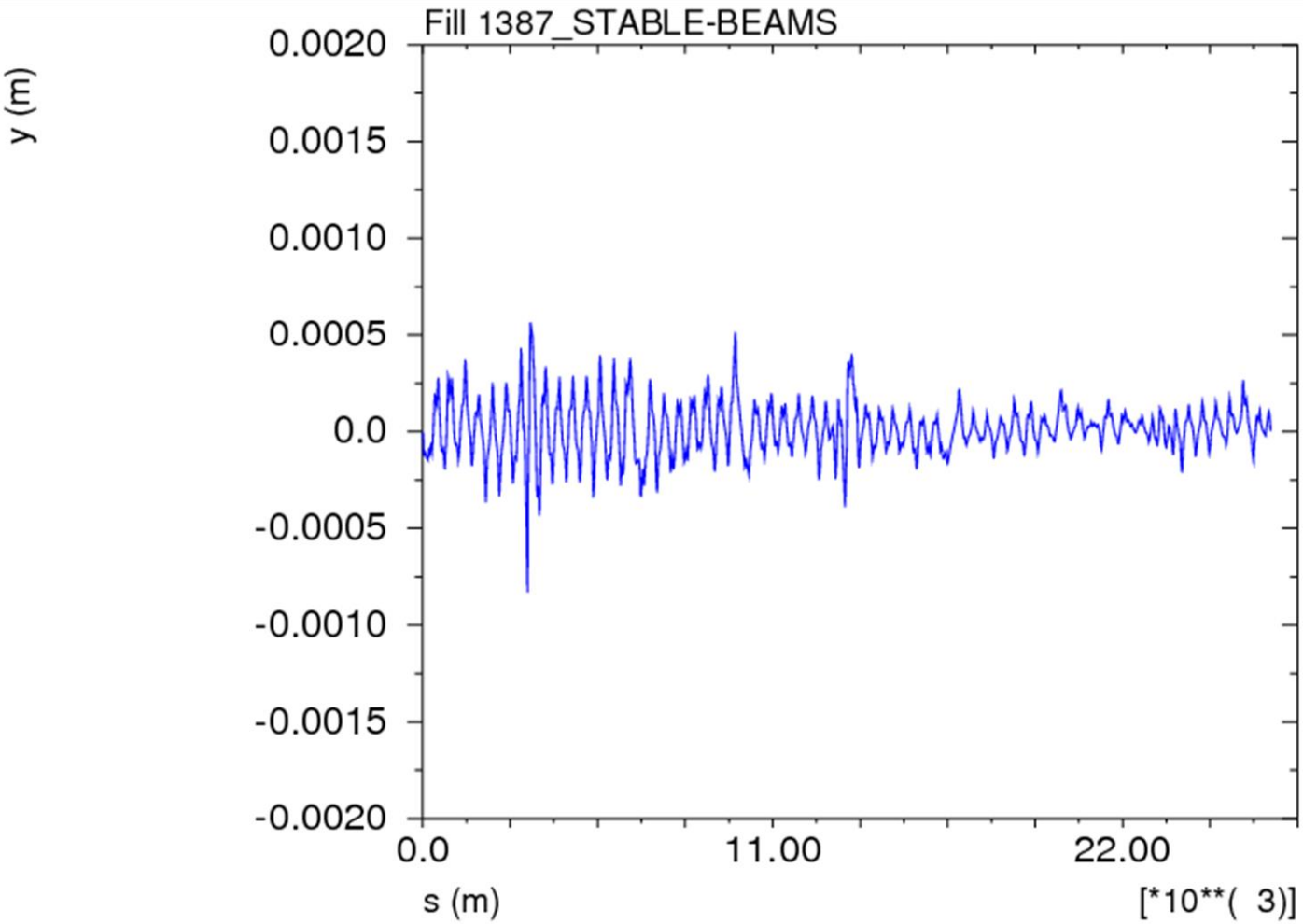
RMS (mm) = 0.10

Vertical B1 (1386vs1364)



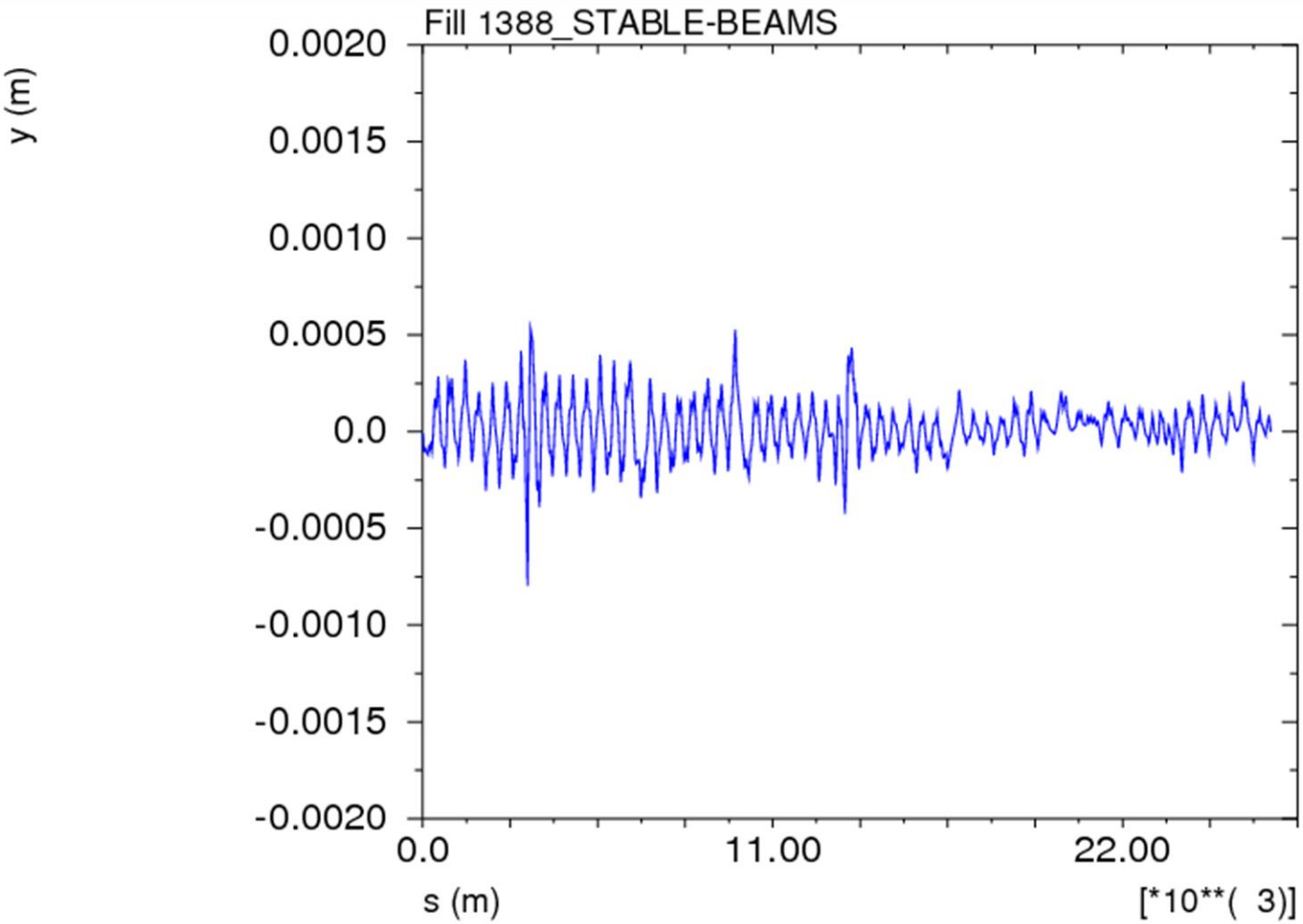
RMS (mm) = 0.10

Vertical B1 (1387vs1364)



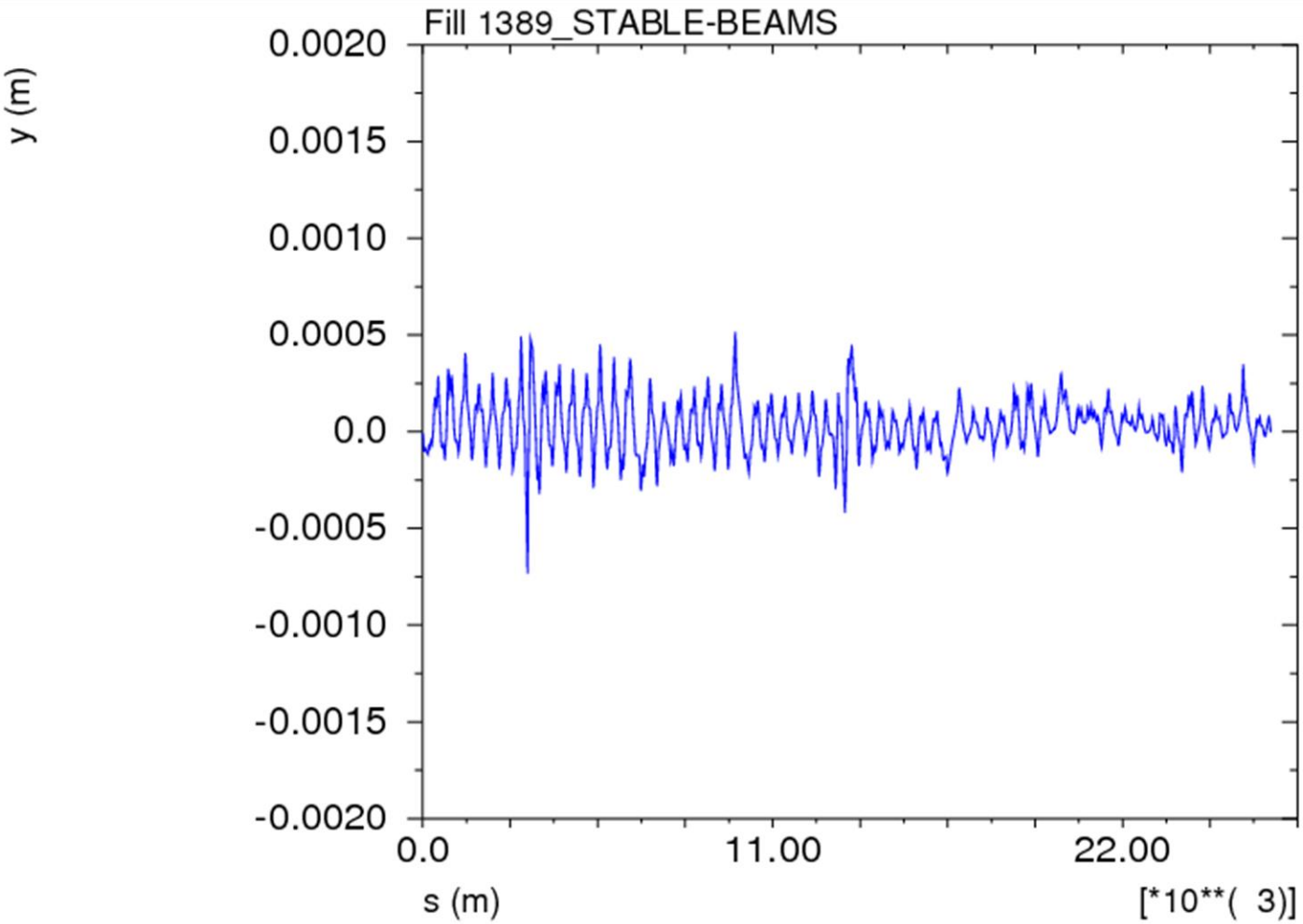
RMS (mm) = 0.13

Vertical B1 (1388vs1364)



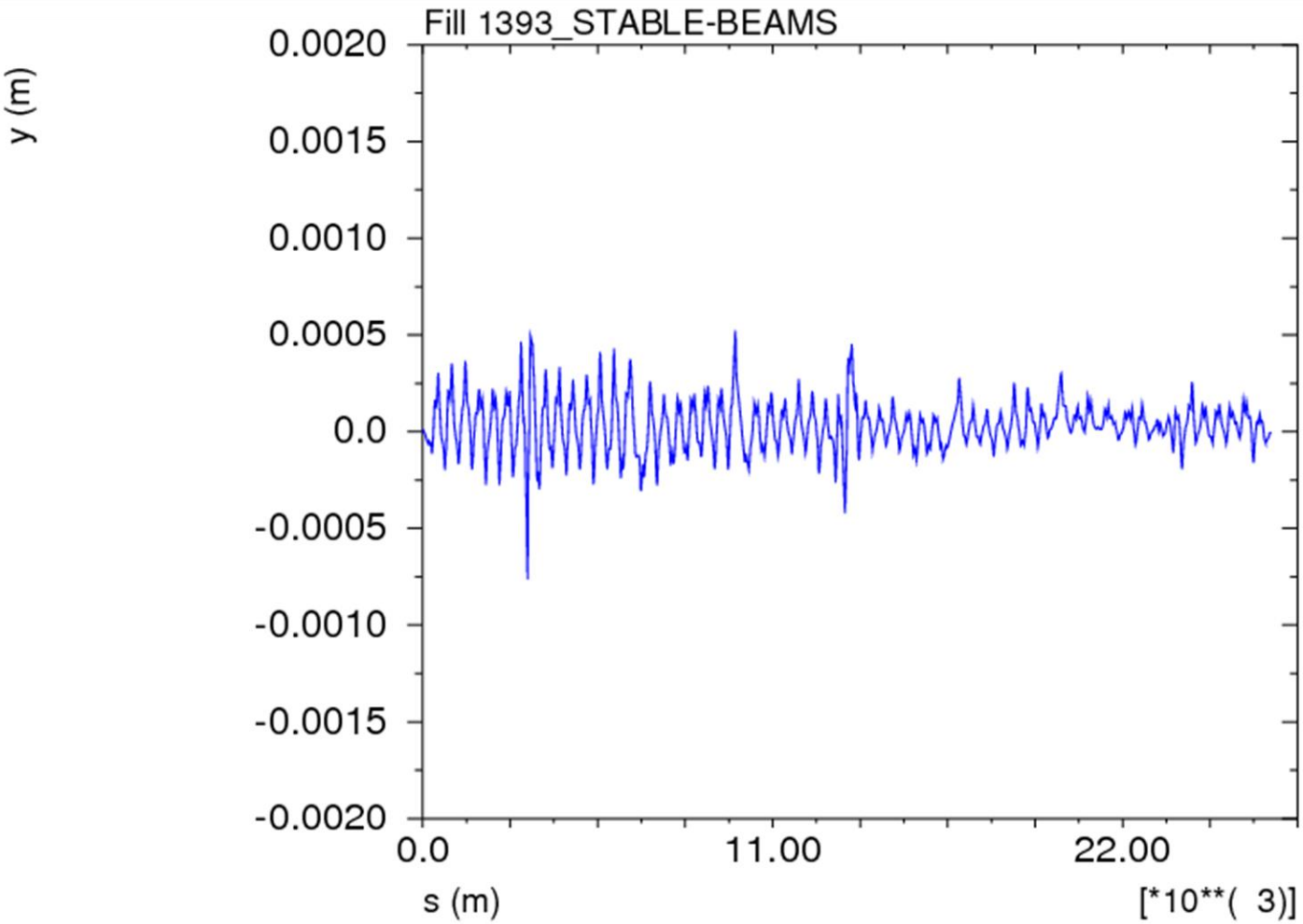
RMS (mm) = 0.13

Vertical B1 (1389vs1364)



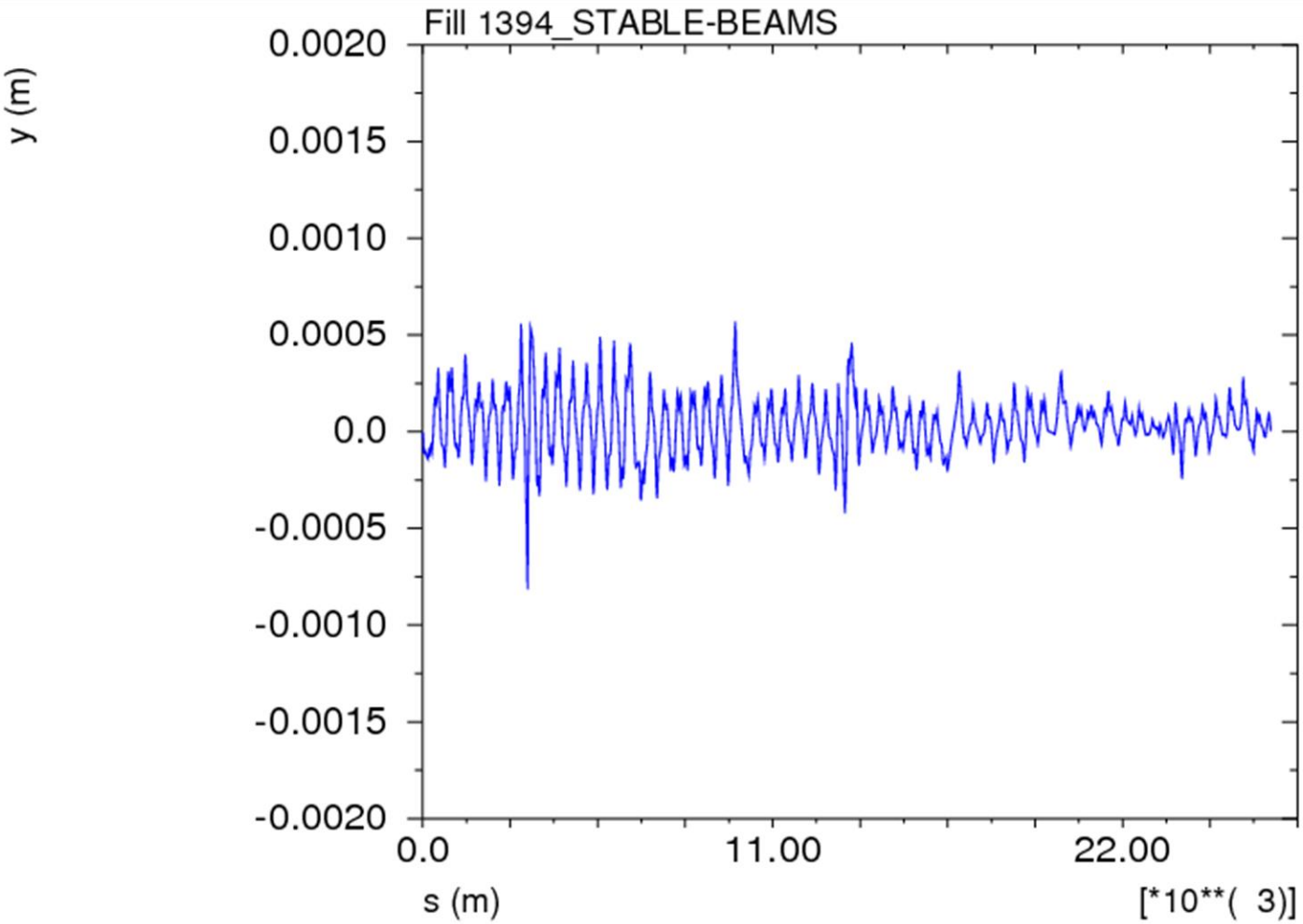
RMS (mm) = 0.13

Vertical B1 (1393vs1364)



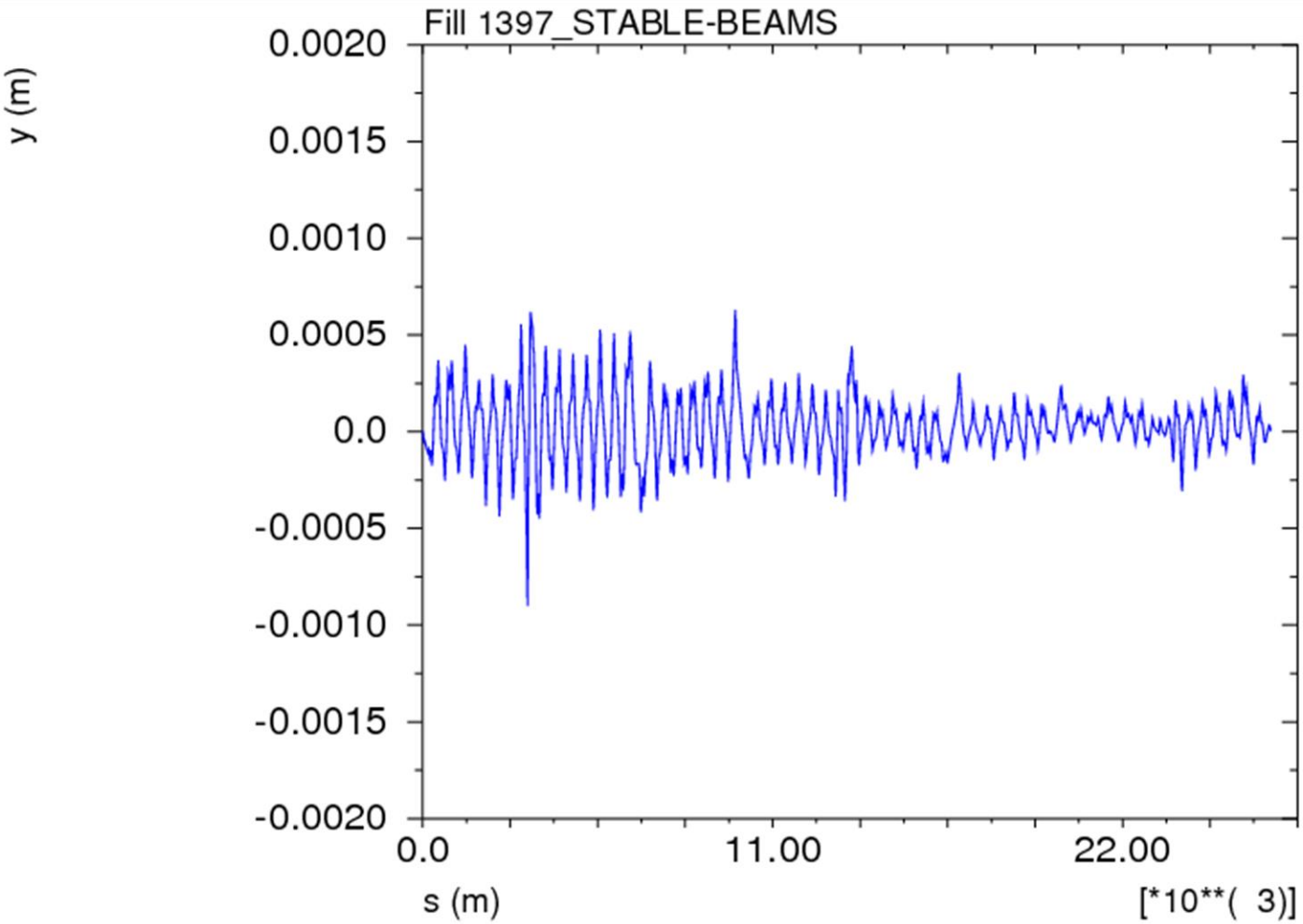
RMS (mm) = 0.13

Vertical B1 (1394vs1364)



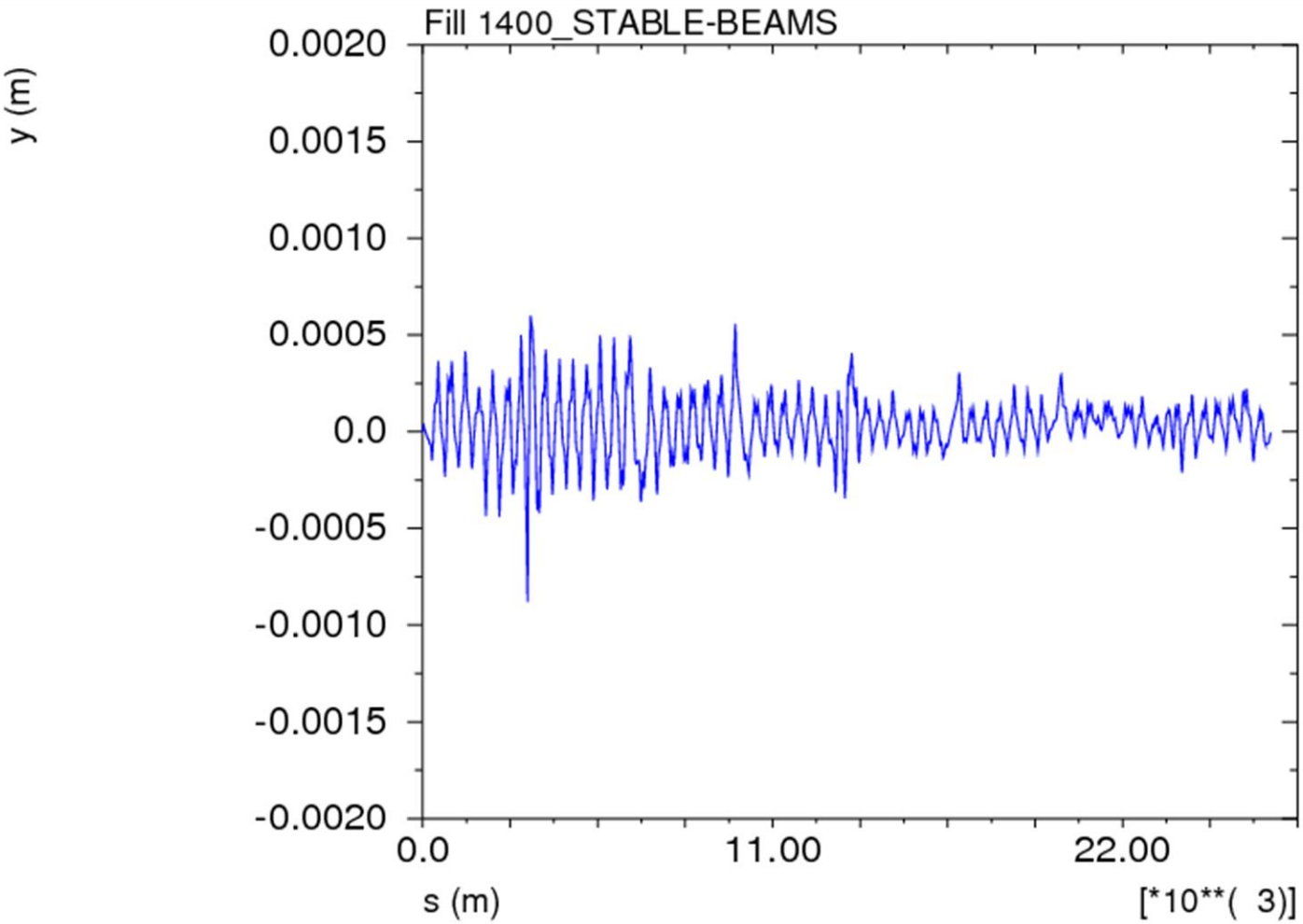
RMS (mm) = 0.15

Vertical B1 (1397vs1364)



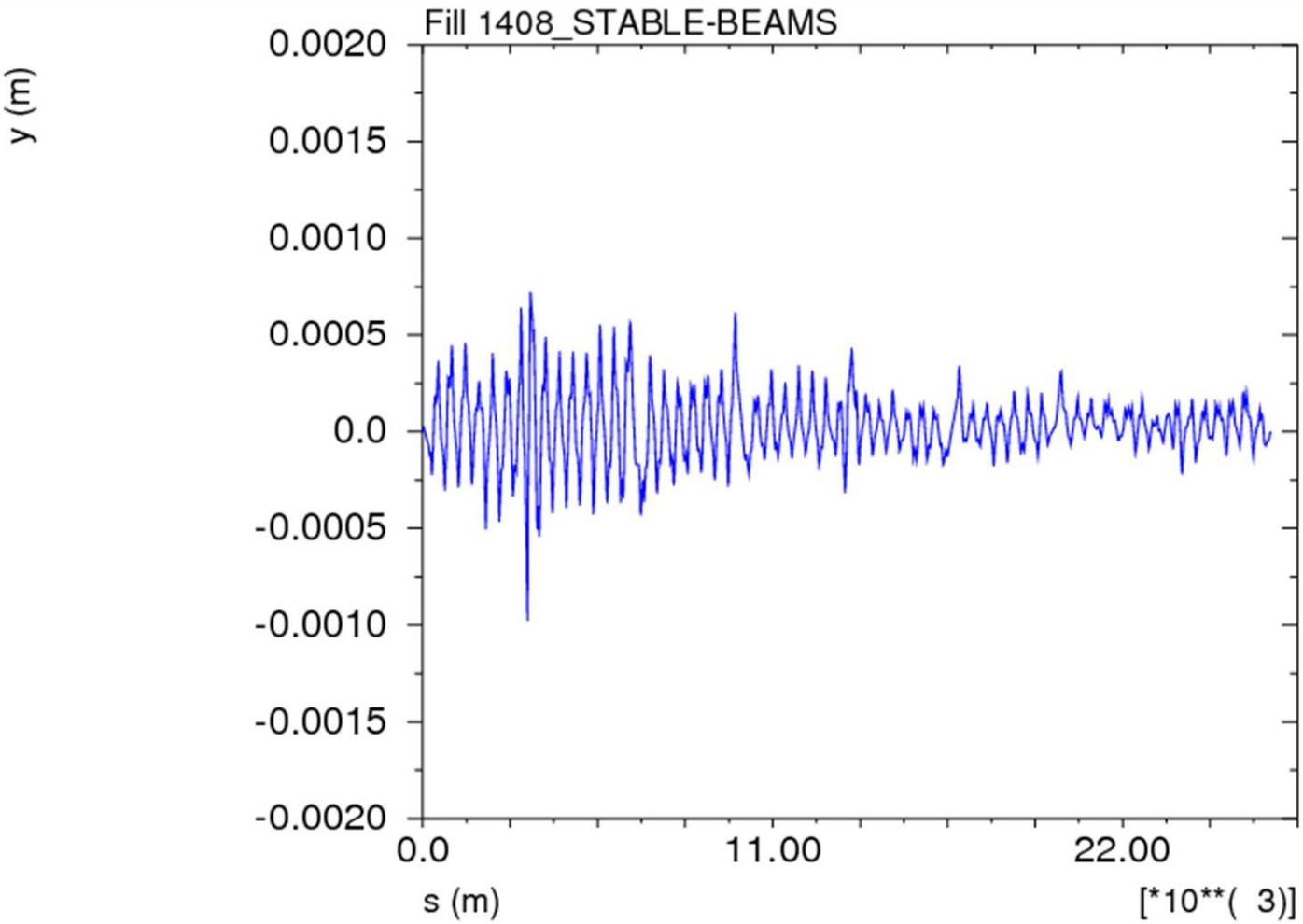
RMS (mm) = 0.16

Vertical B1 (1400vs1364)



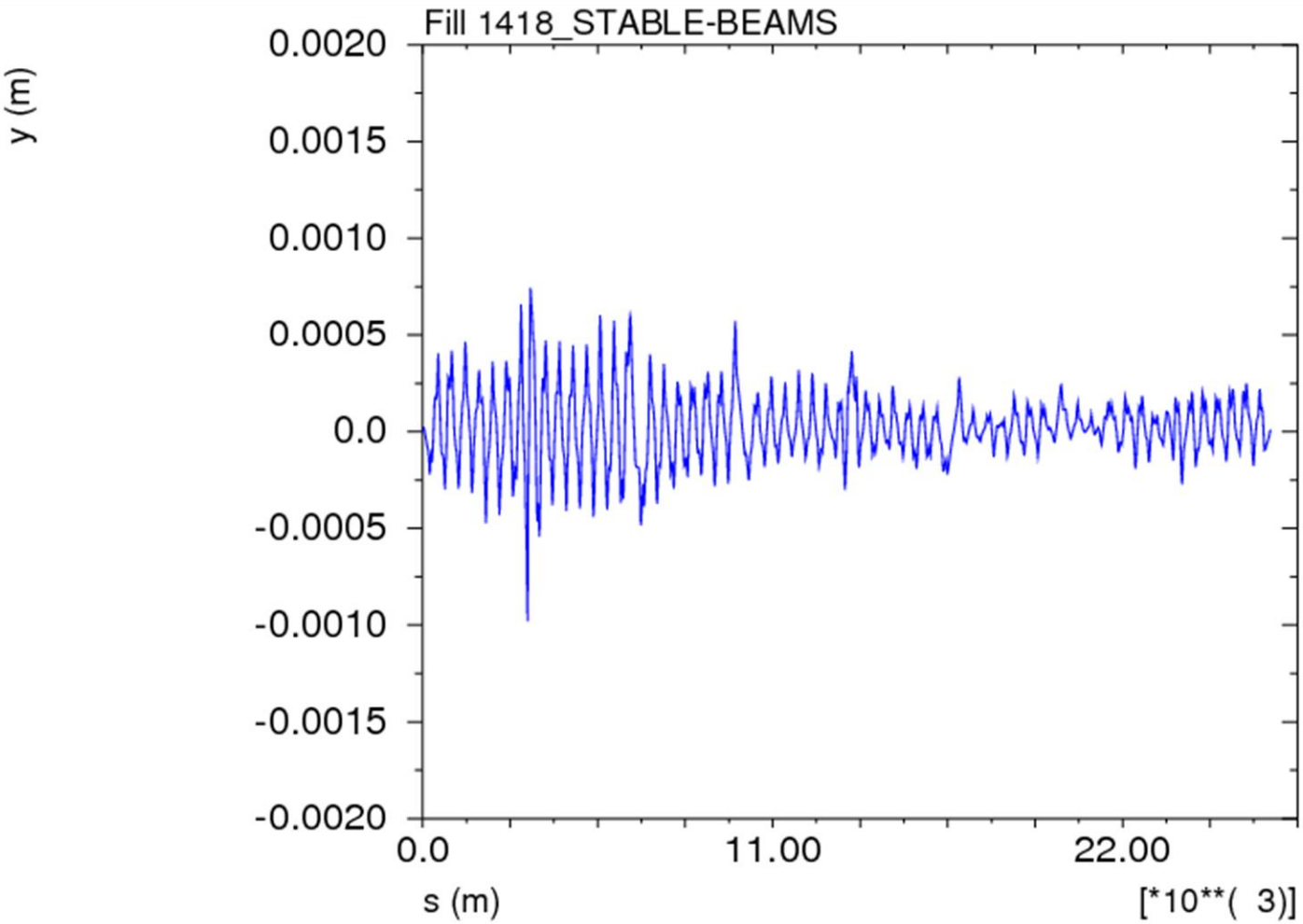
RMS (mm) = 0.15

Vertical B1 (1408vs1364)



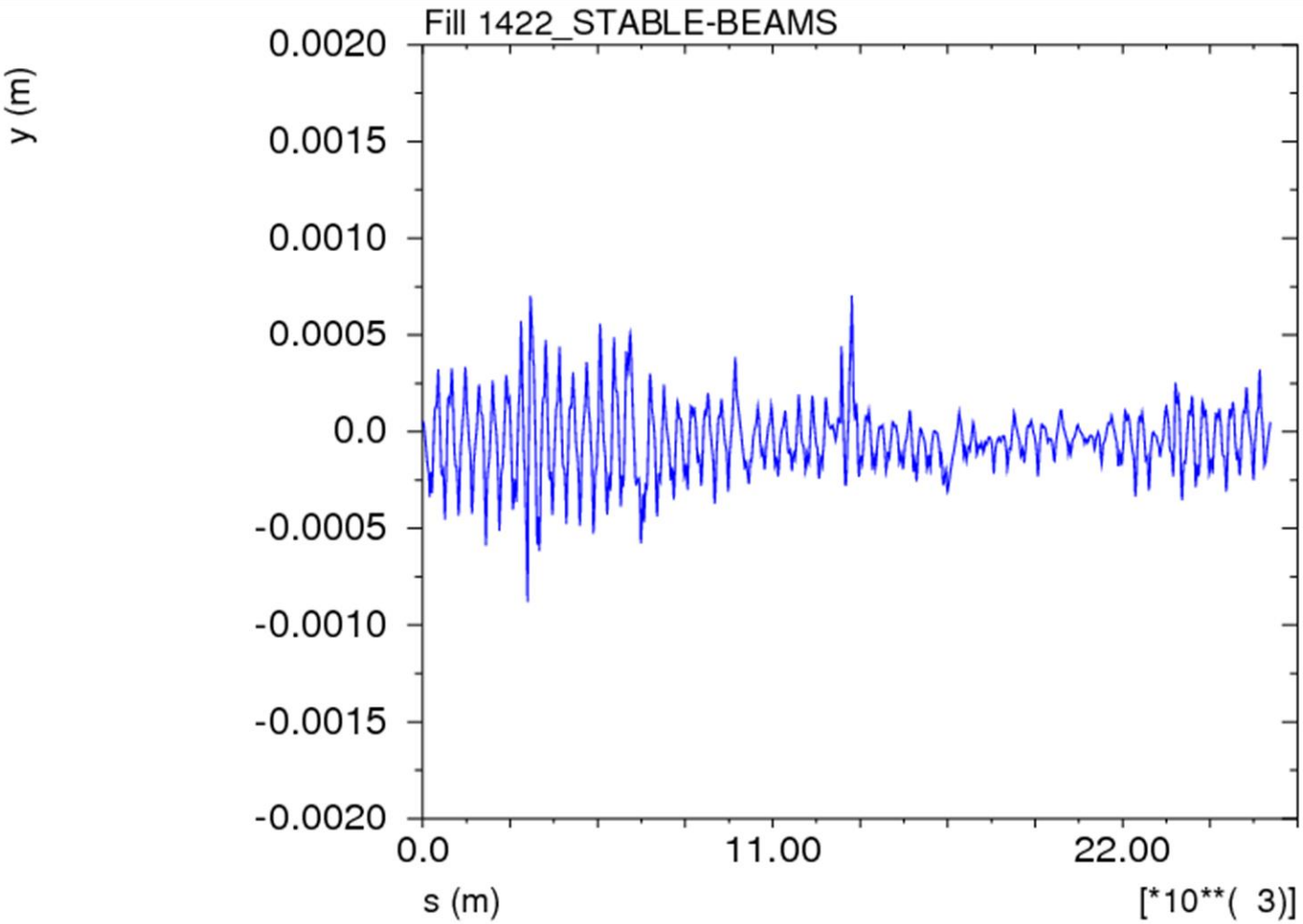
RMS (mm) = 0.17

Vertical B1 (1418vs1364)



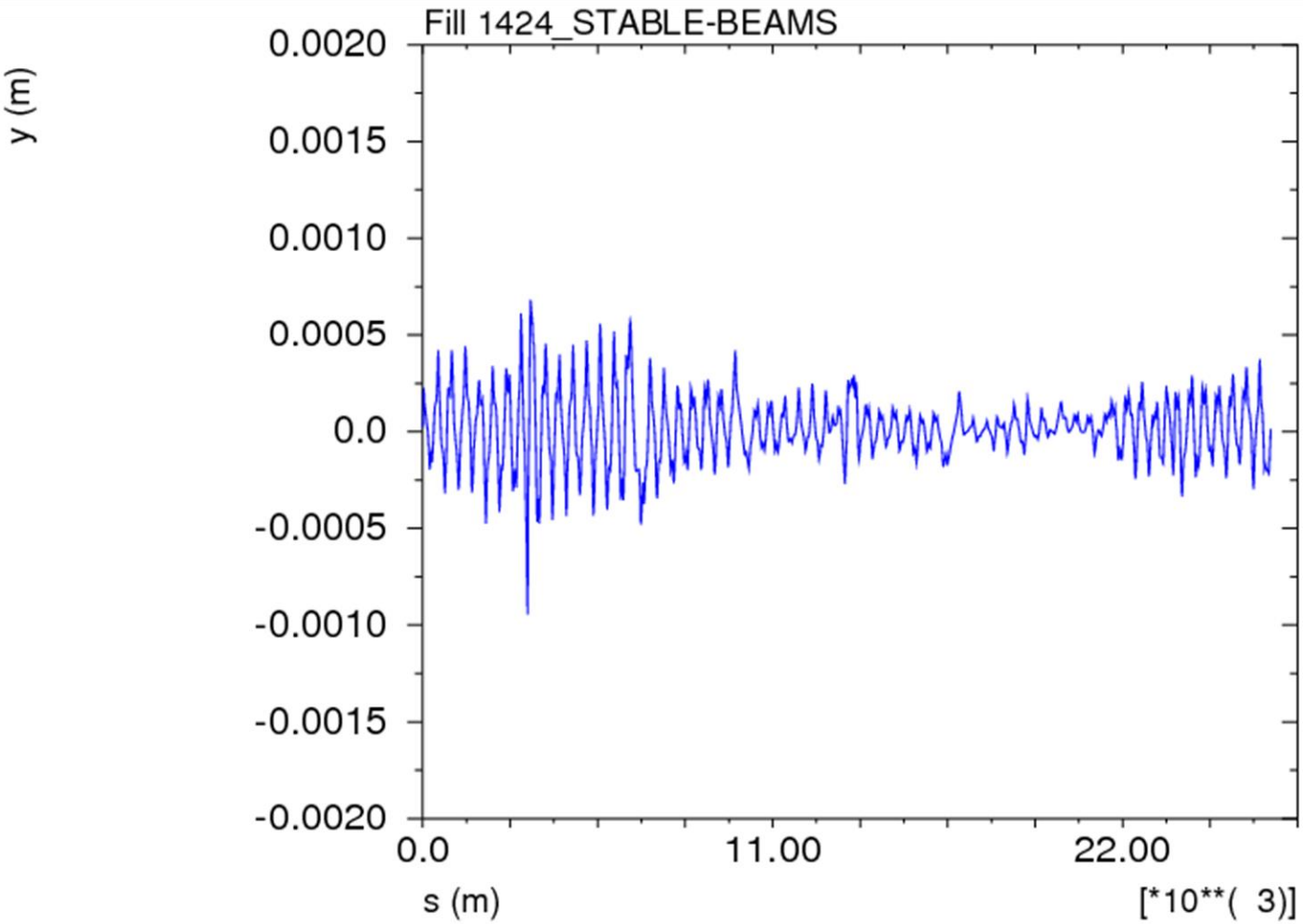
RMS (mm) = 0.18

Vertical B1 (1422vs1364)



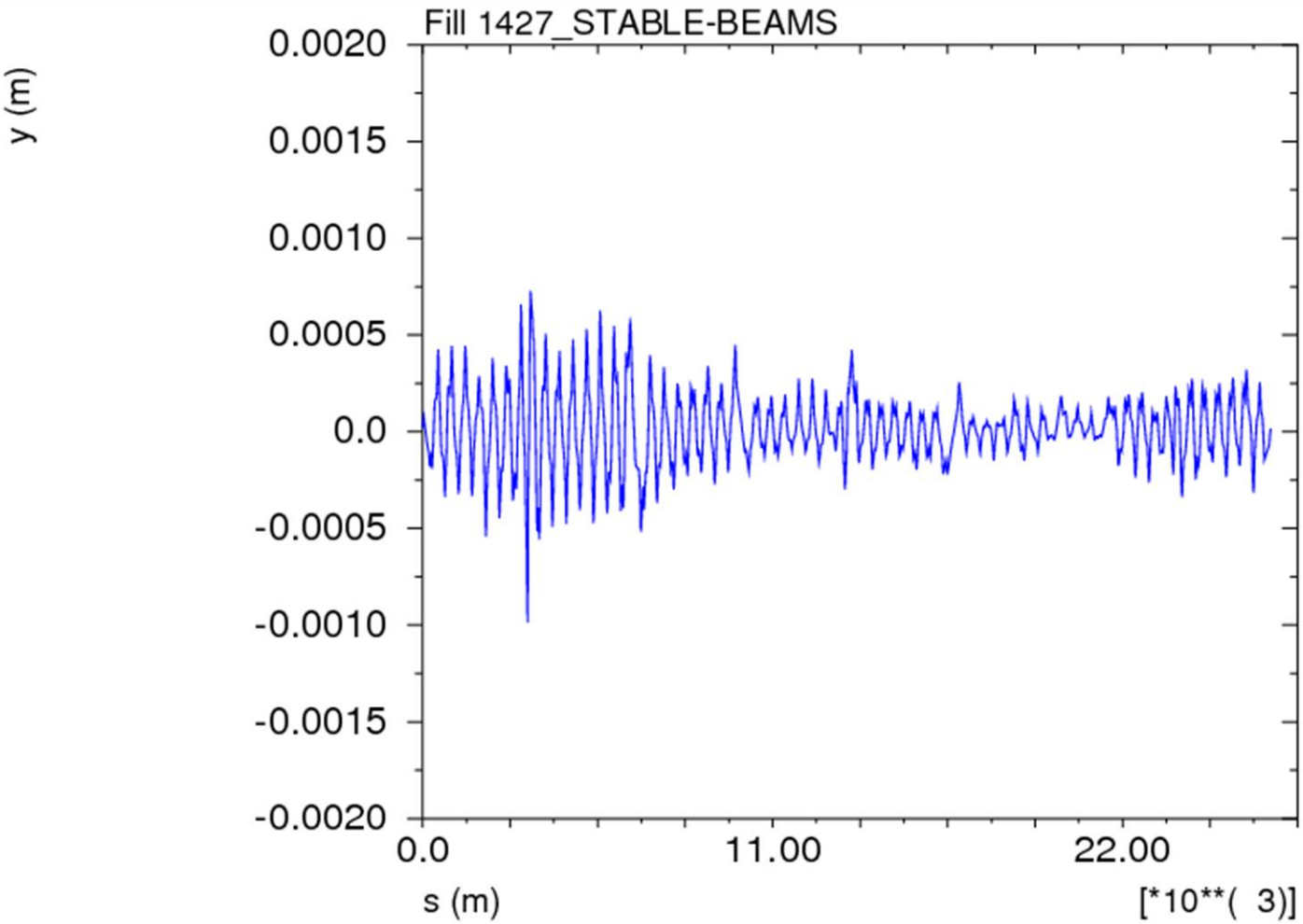
RMS (mm) = 0.18

Vertical B1 (1424vs1364)



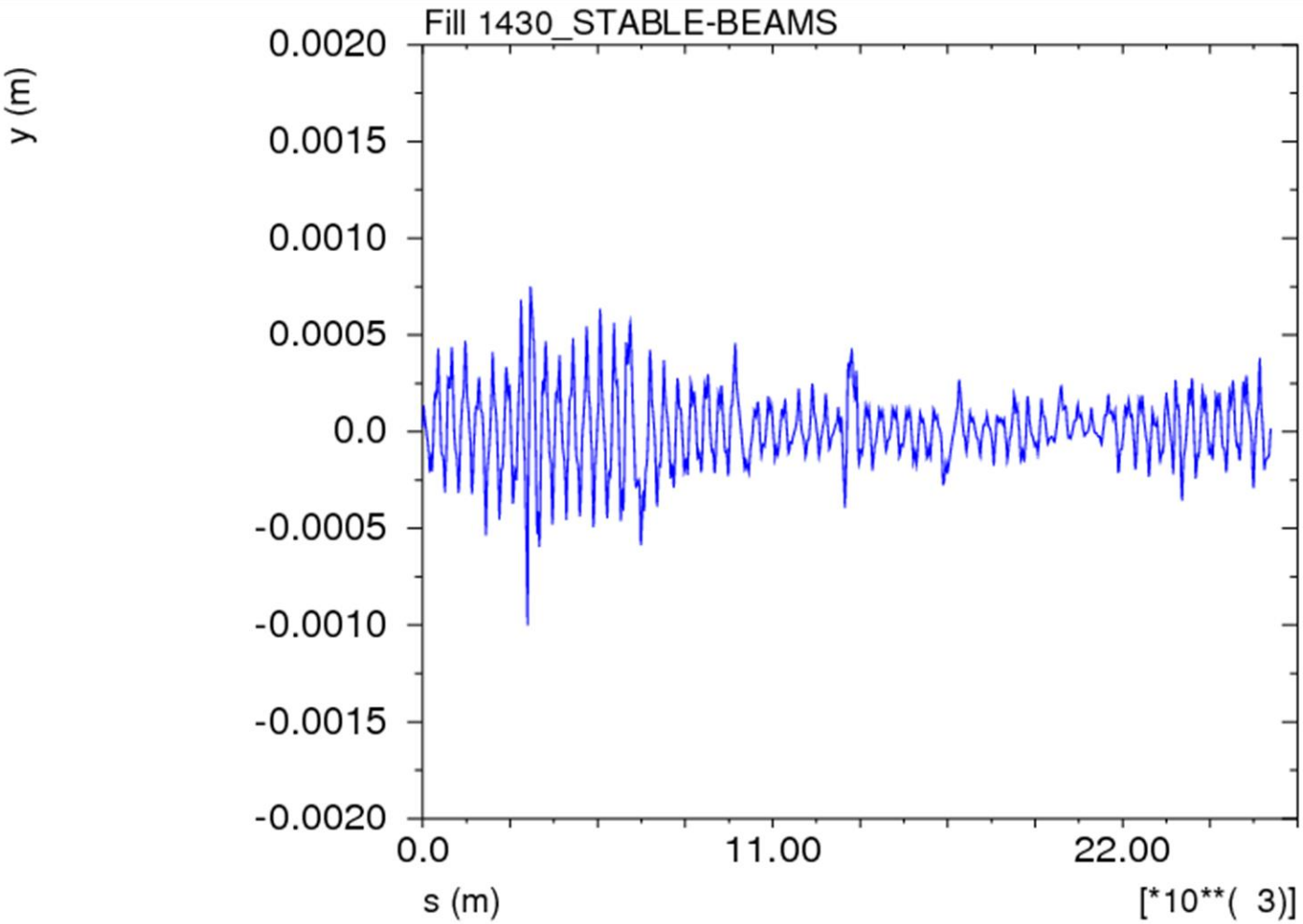
RMS (mm) = 0.17

Vertical B1 (1427vs1364)



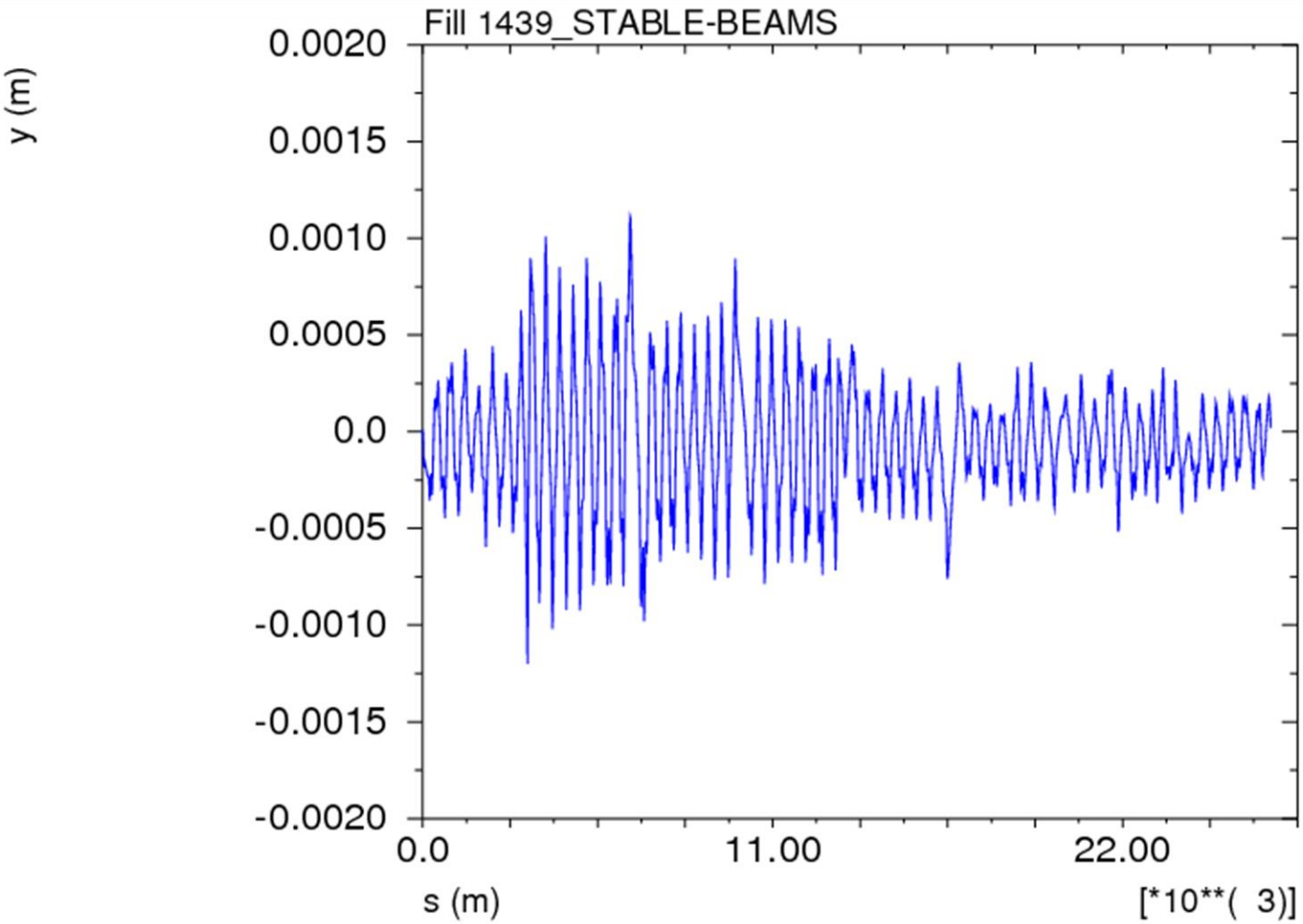
RMS (mm) = 0.18

Vertical B1 (1430vs1364)



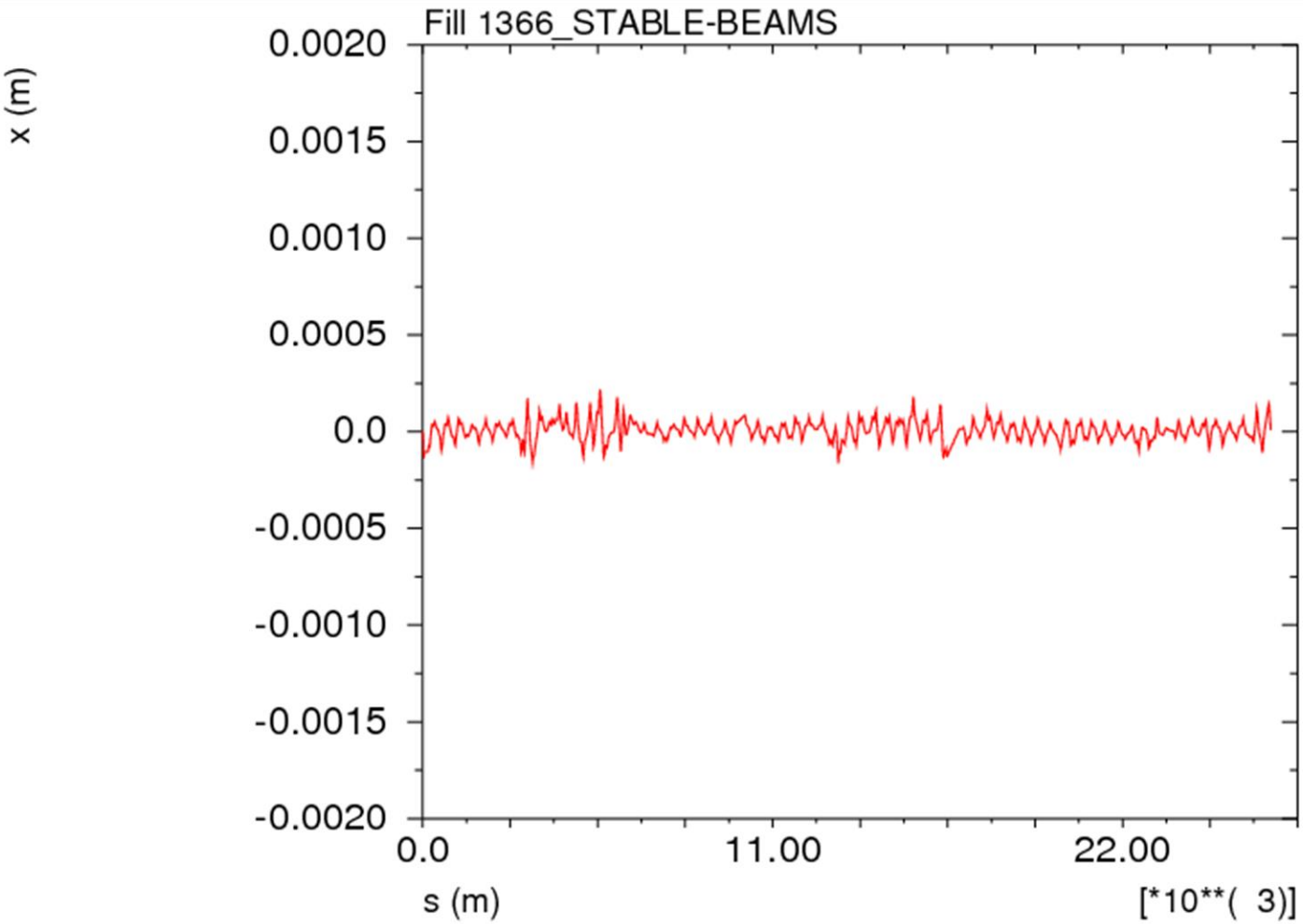
RMS (mm) = 0.19

Vertical B1 (1439vs1364)



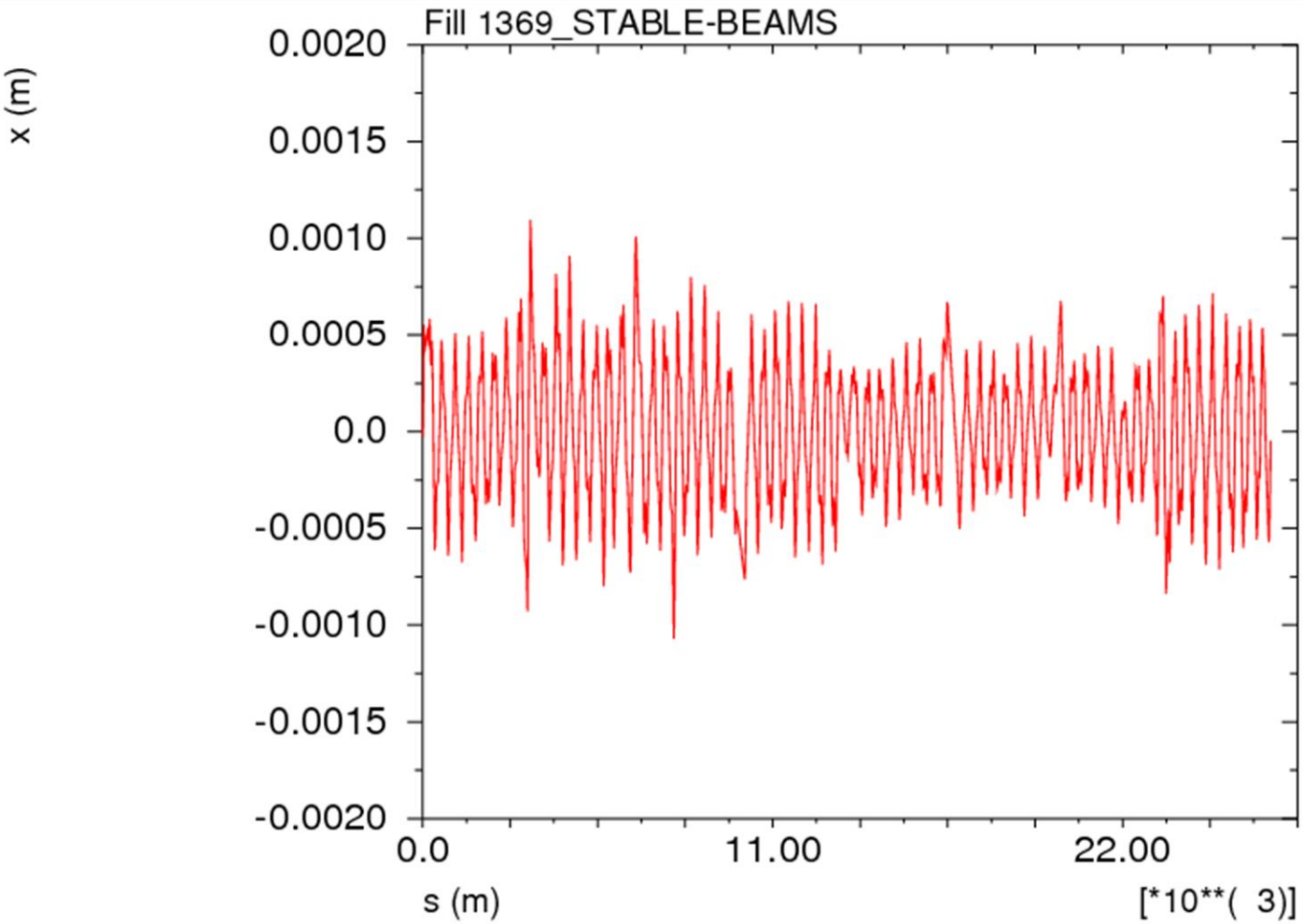
RMS (mm) = 0.31

Horizontal B2 (1366vs1364)



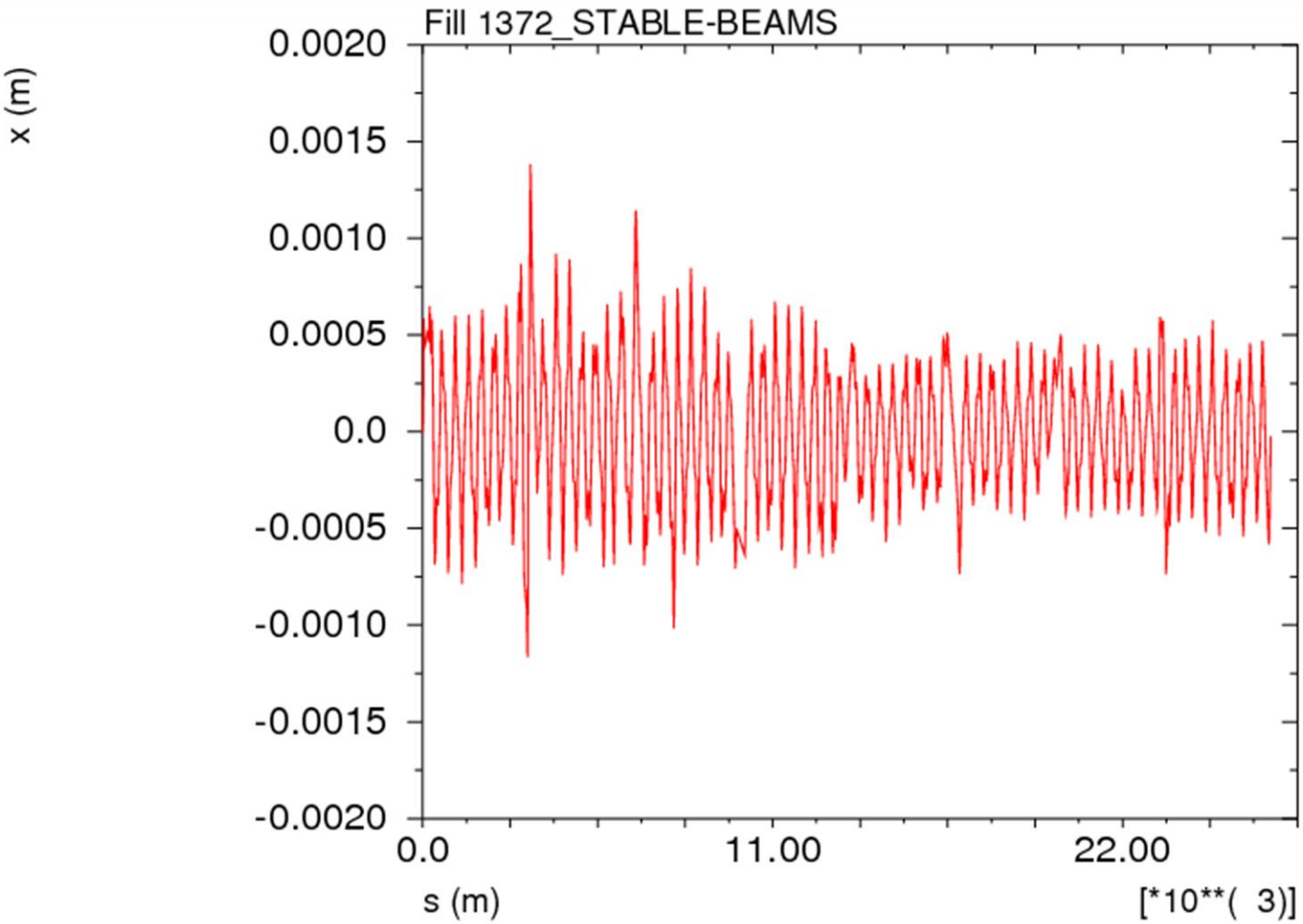
RMS (mm) = 0.05

Horizontal B2 (1369vs1364)



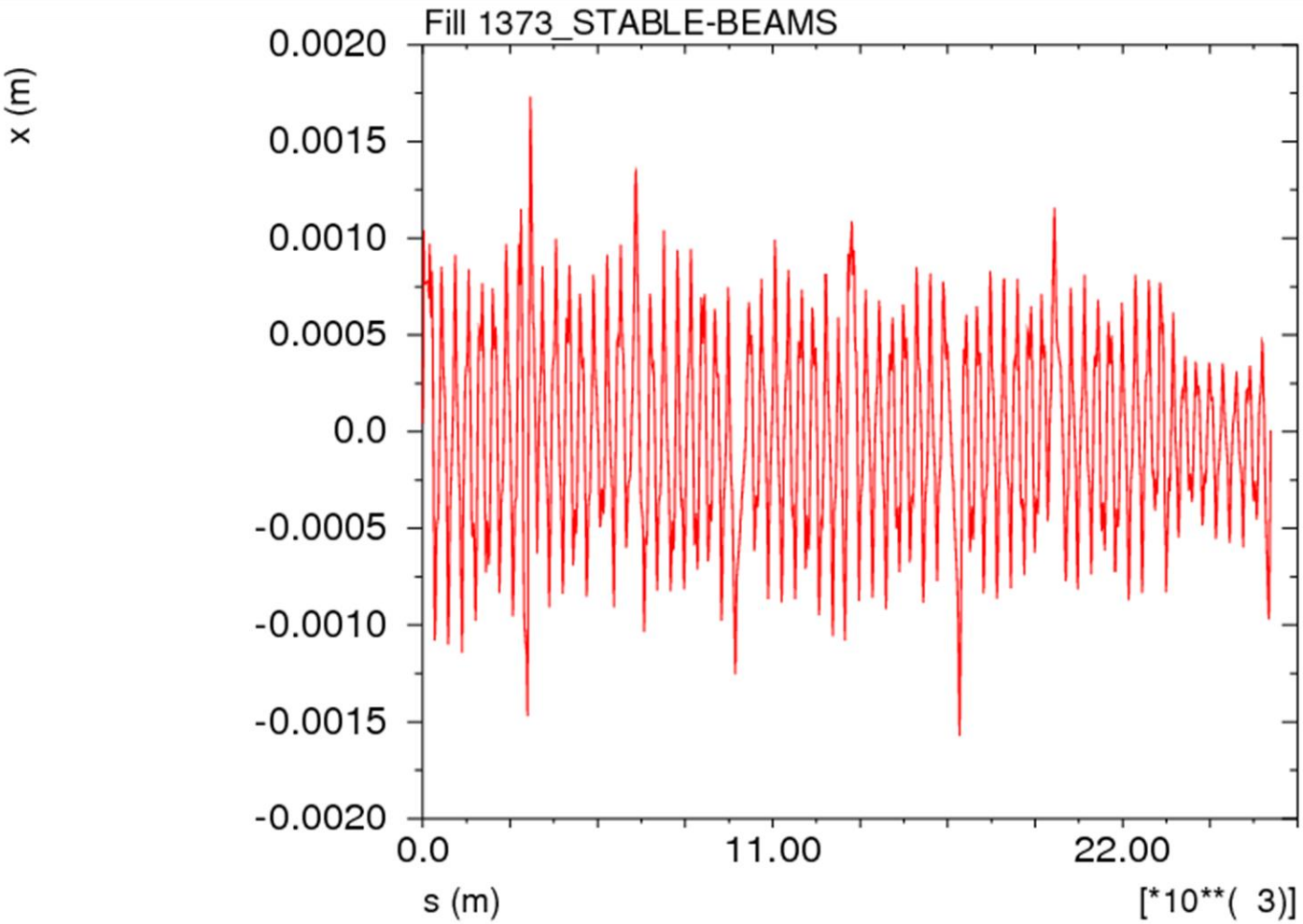
RMS (mm) = 0.33

Horizontal B2 (1372vs1364)



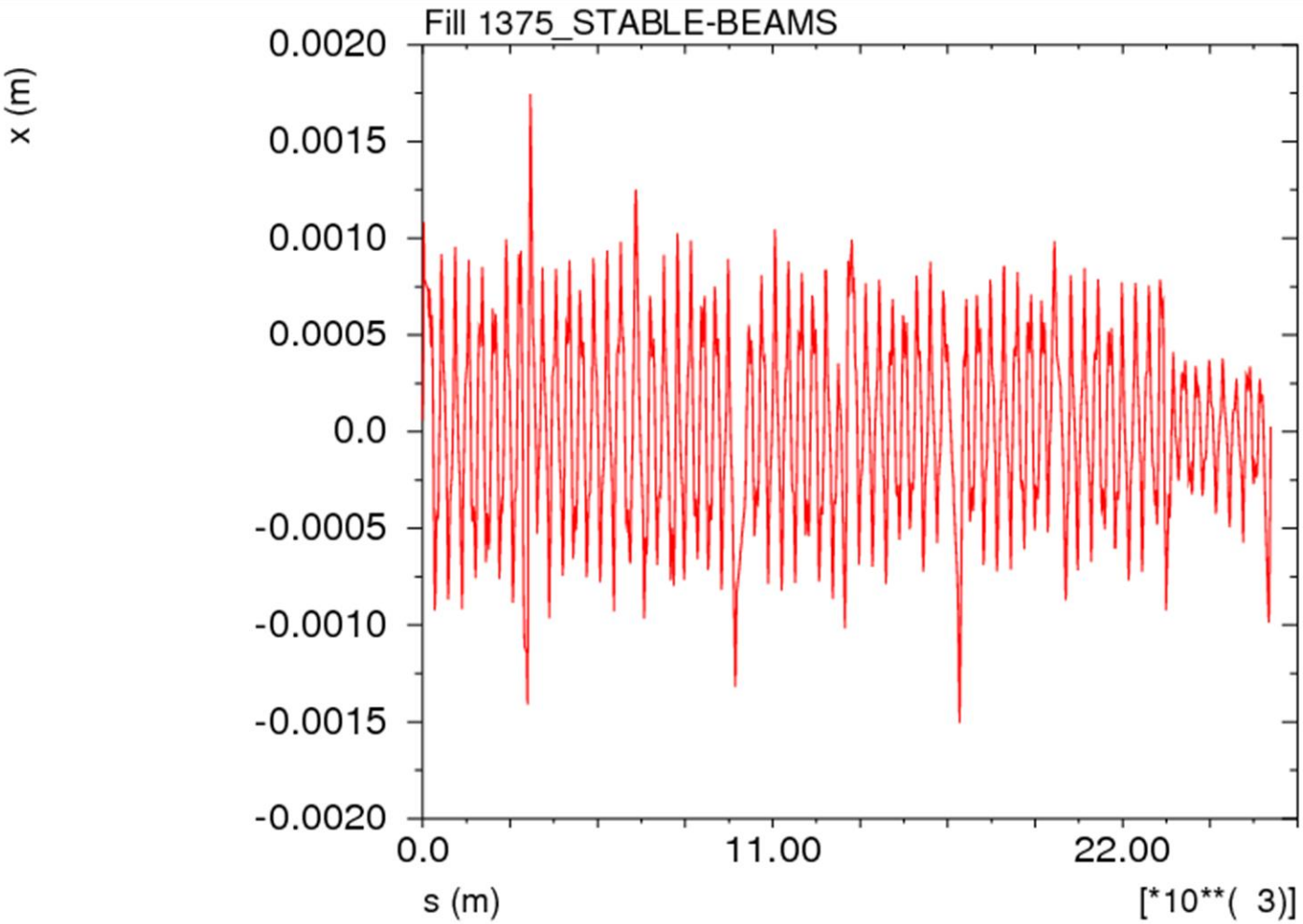
RMS (mm) = 0.34

Horizontal B2 (1373vs1364)



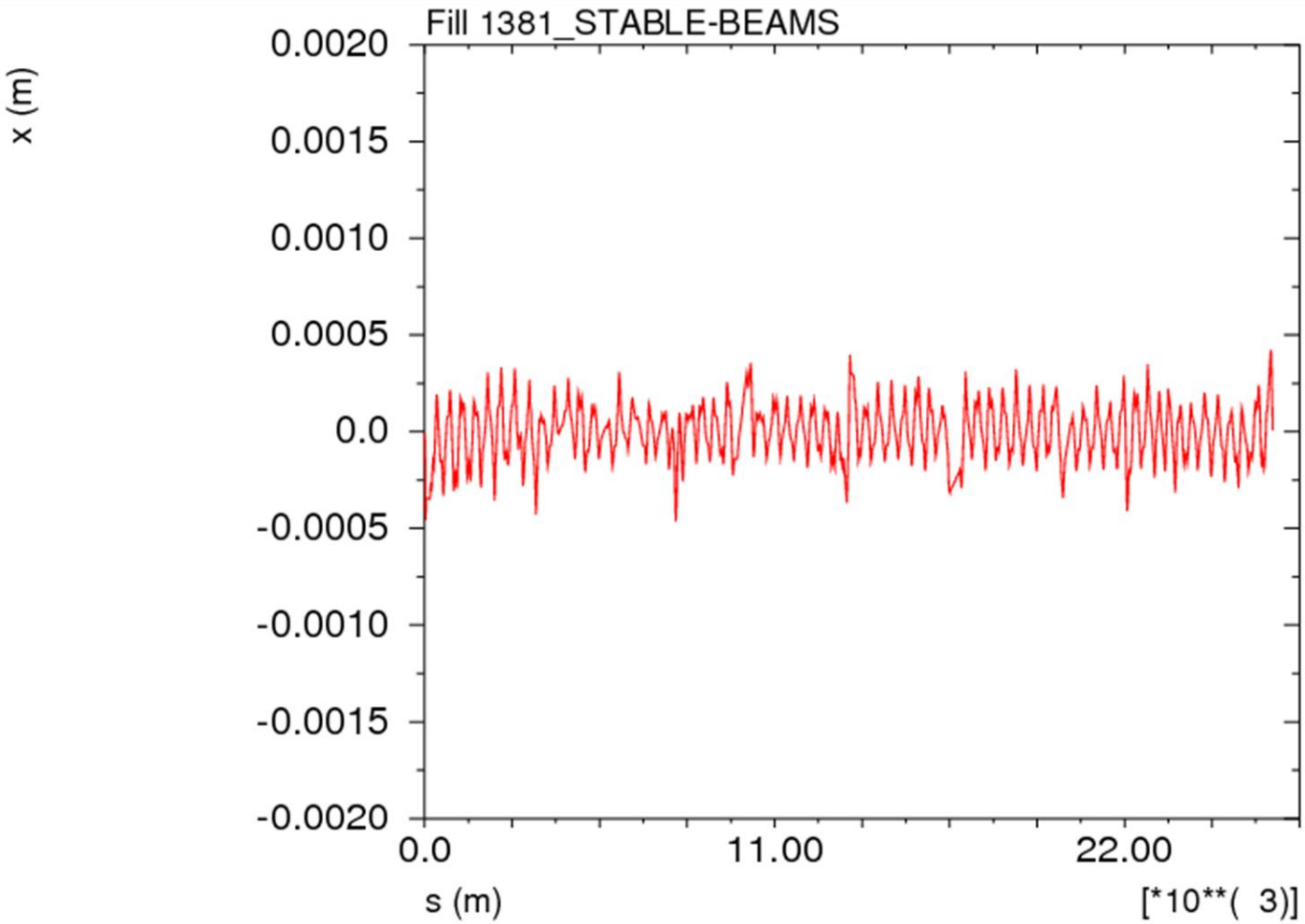
RMS (mm) = 0.49

Horizontal B2 (1375vs1364)



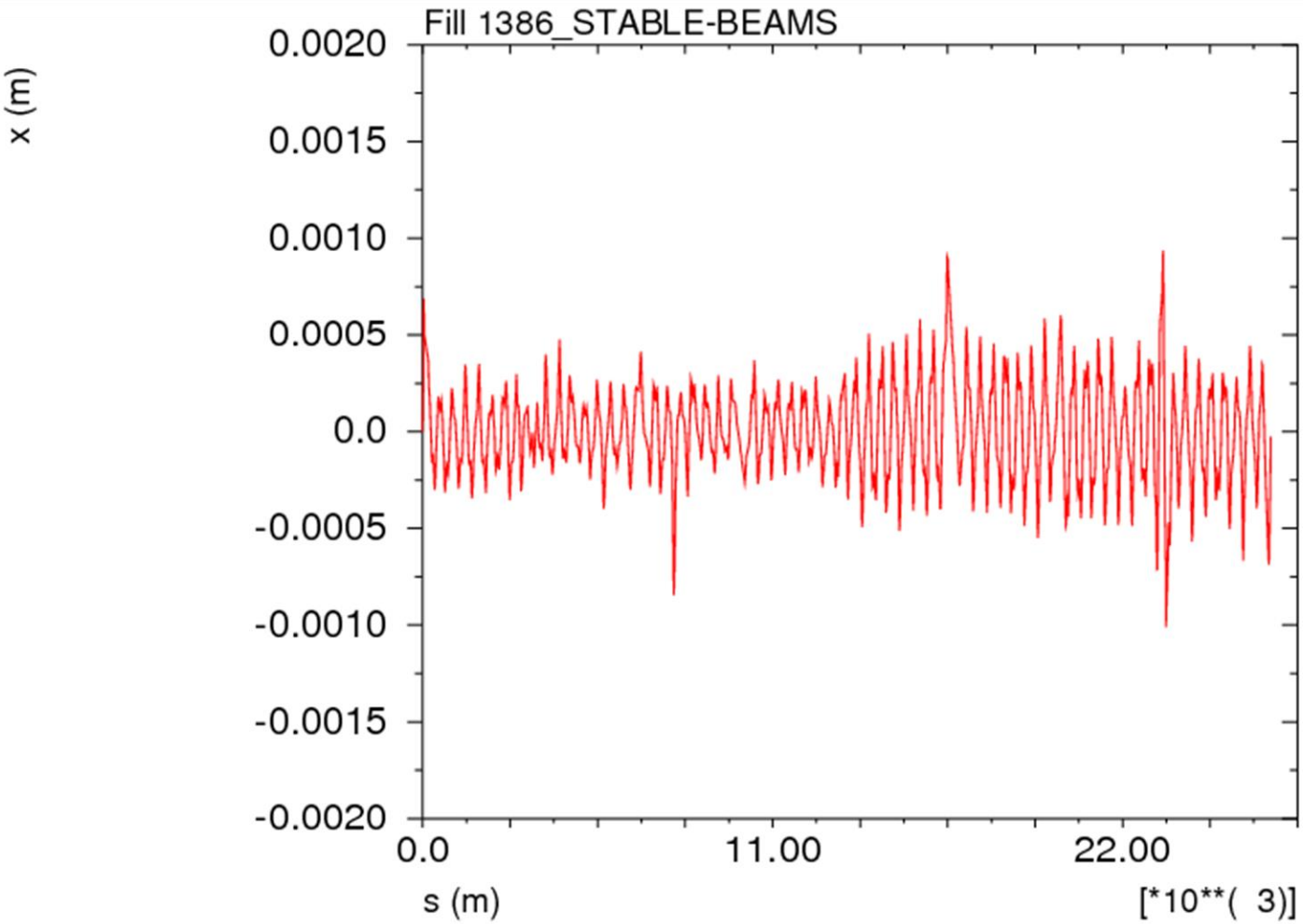
RMS (mm) = 0.47

Horizontal B2 (1381vs1364)



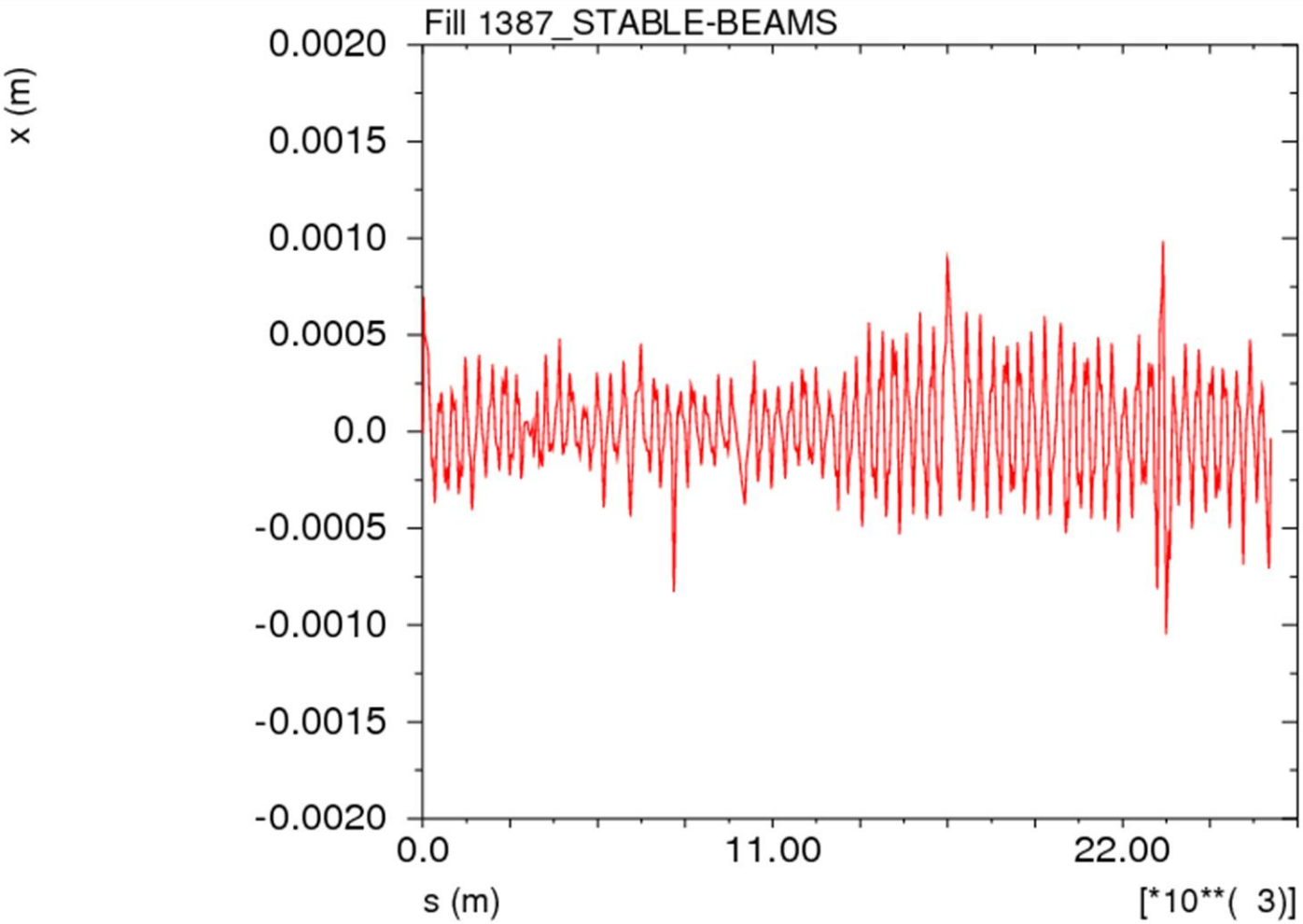
RMS (mm) = 0.14

Horizontal B2 (1386vs1364)



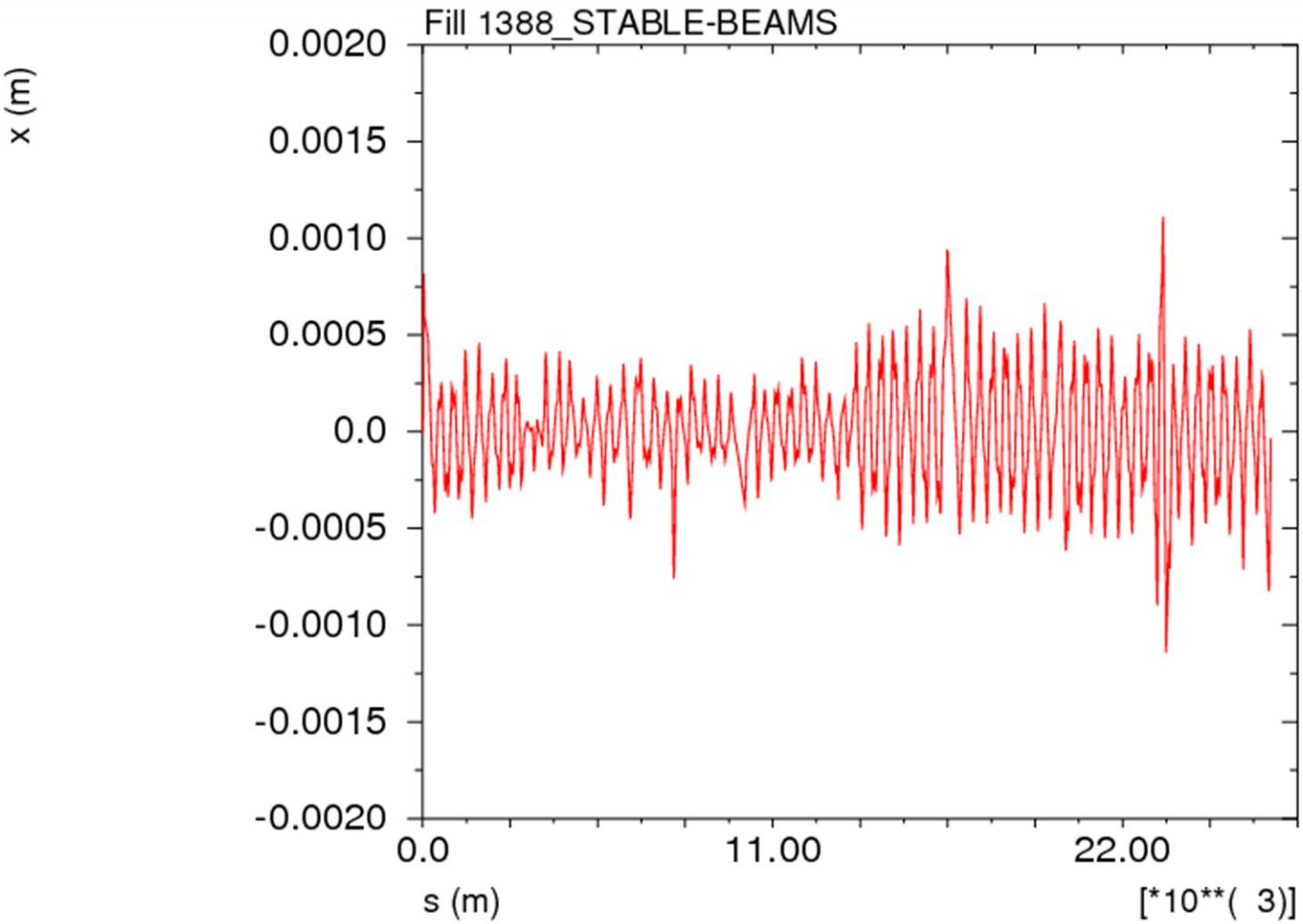
RMS (mm) = 0.24

Horizontal B2 (1387vs1364)



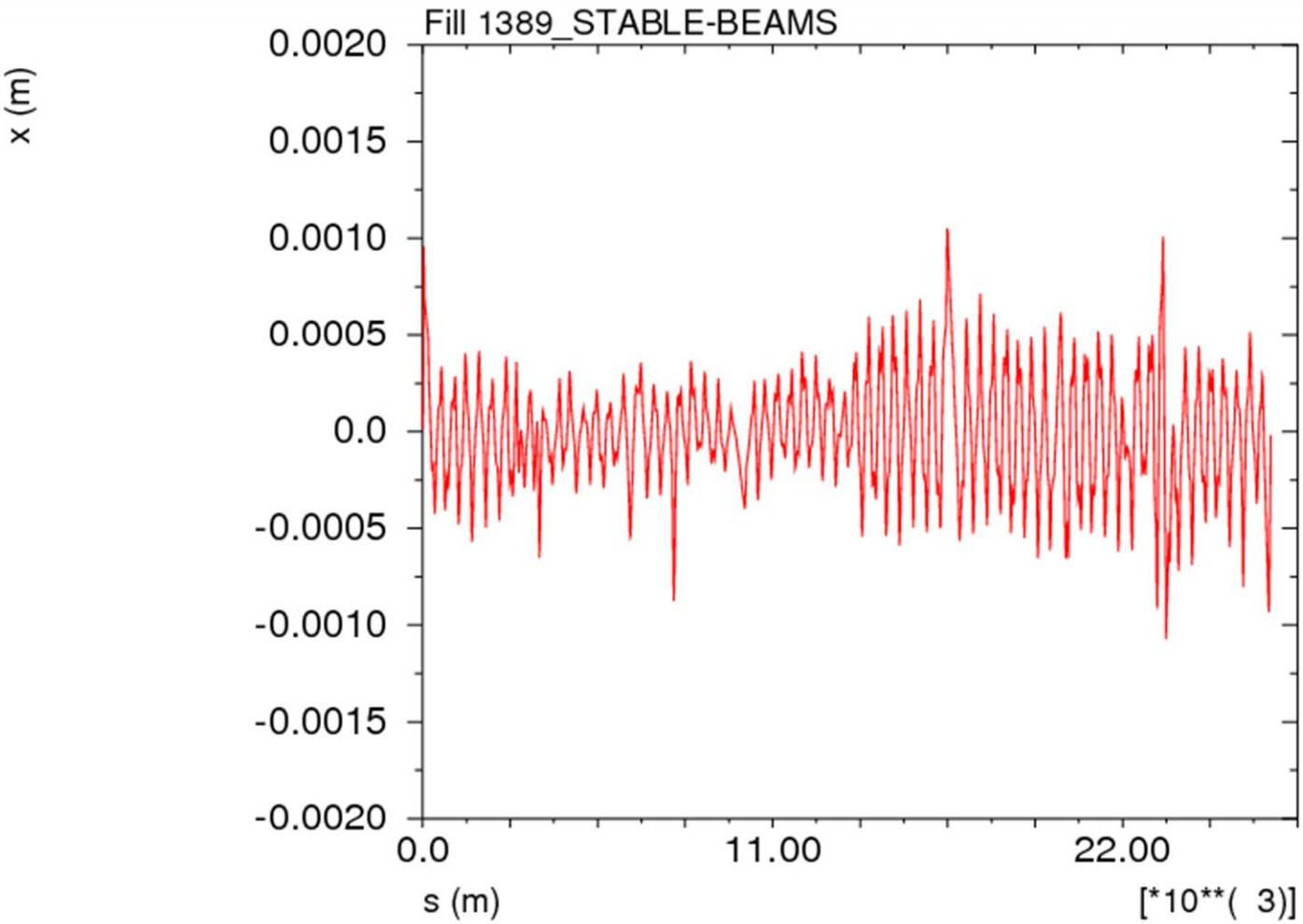
RMS (mm) = 0.25

Horizontal B2 (1388vs1364)



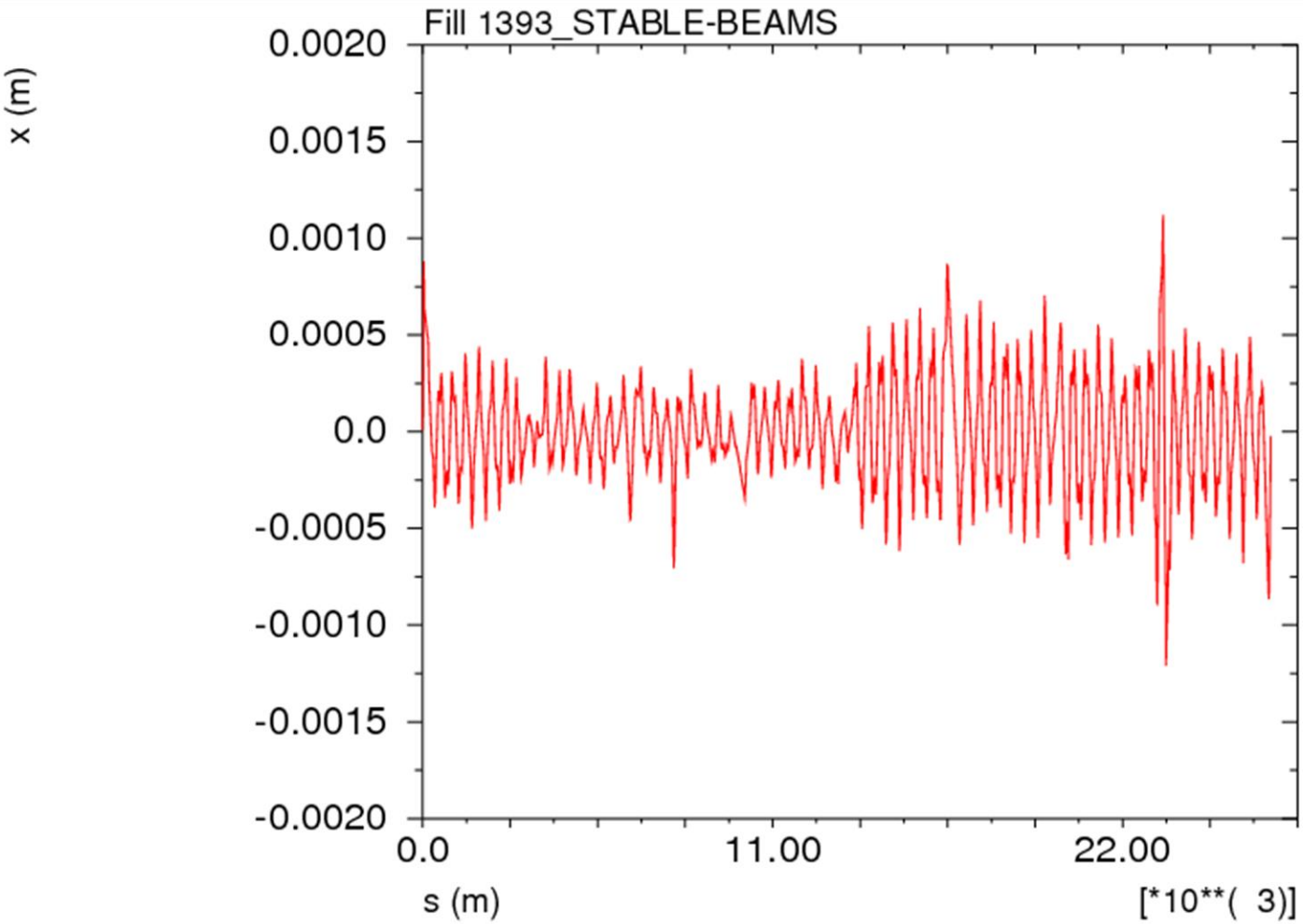
RMS (mm) = 0.27

Horizontal B2 (1389vs1364)



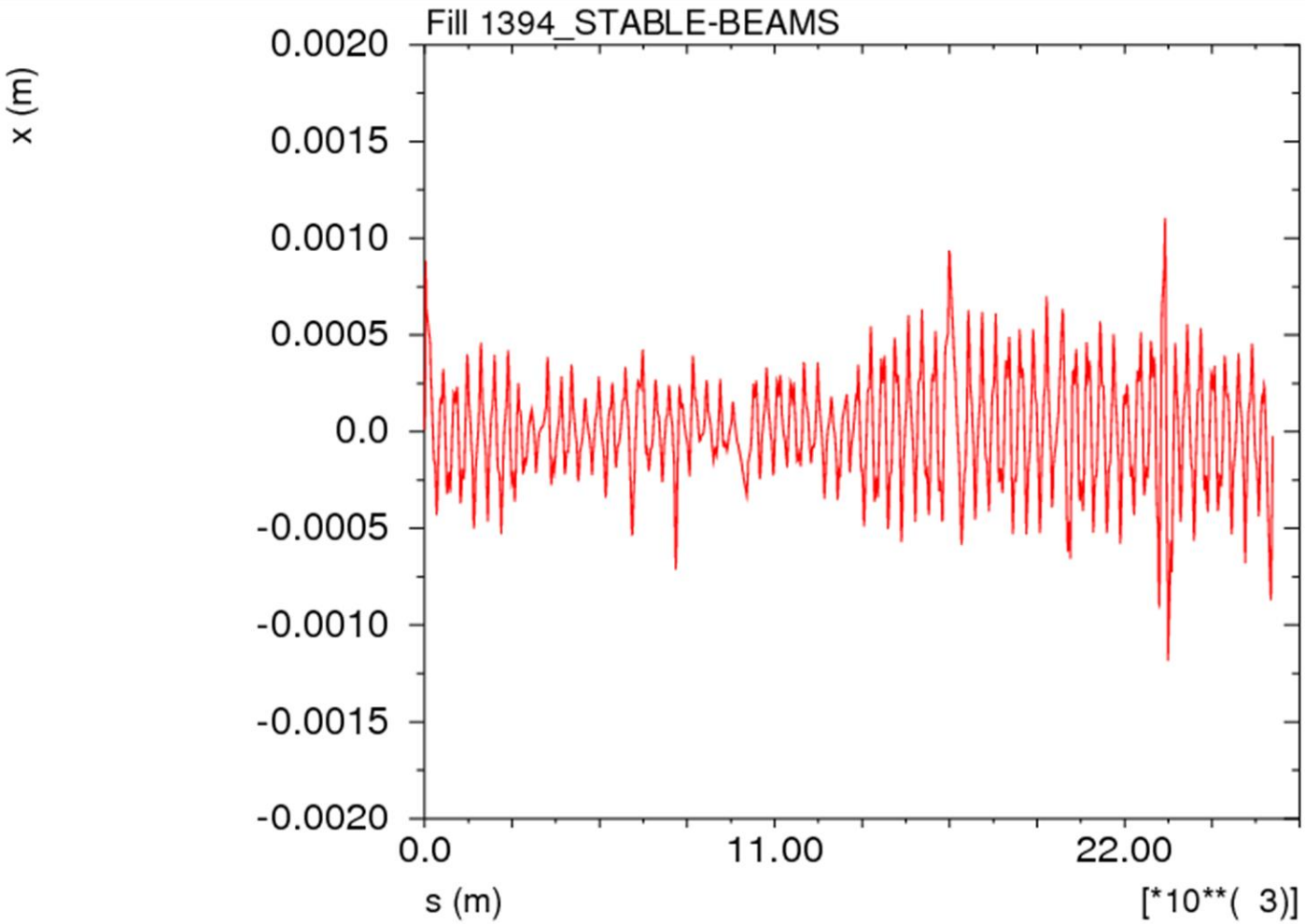
RMS (mm) = 0.28

Horizontal B2 (1393vs1364)



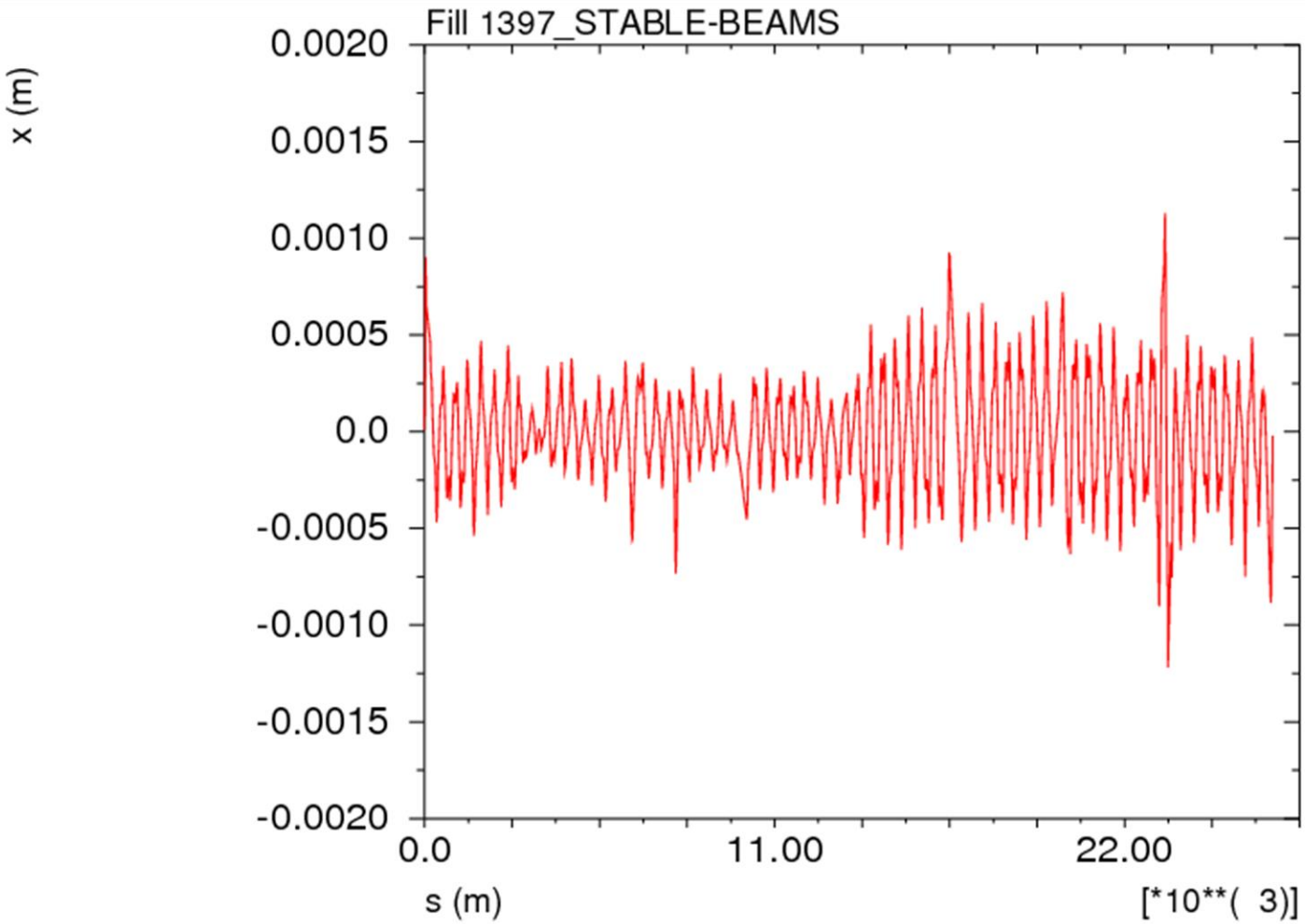
RMS (mm) = 0.27

Horizontal B2 (1394vs1364)



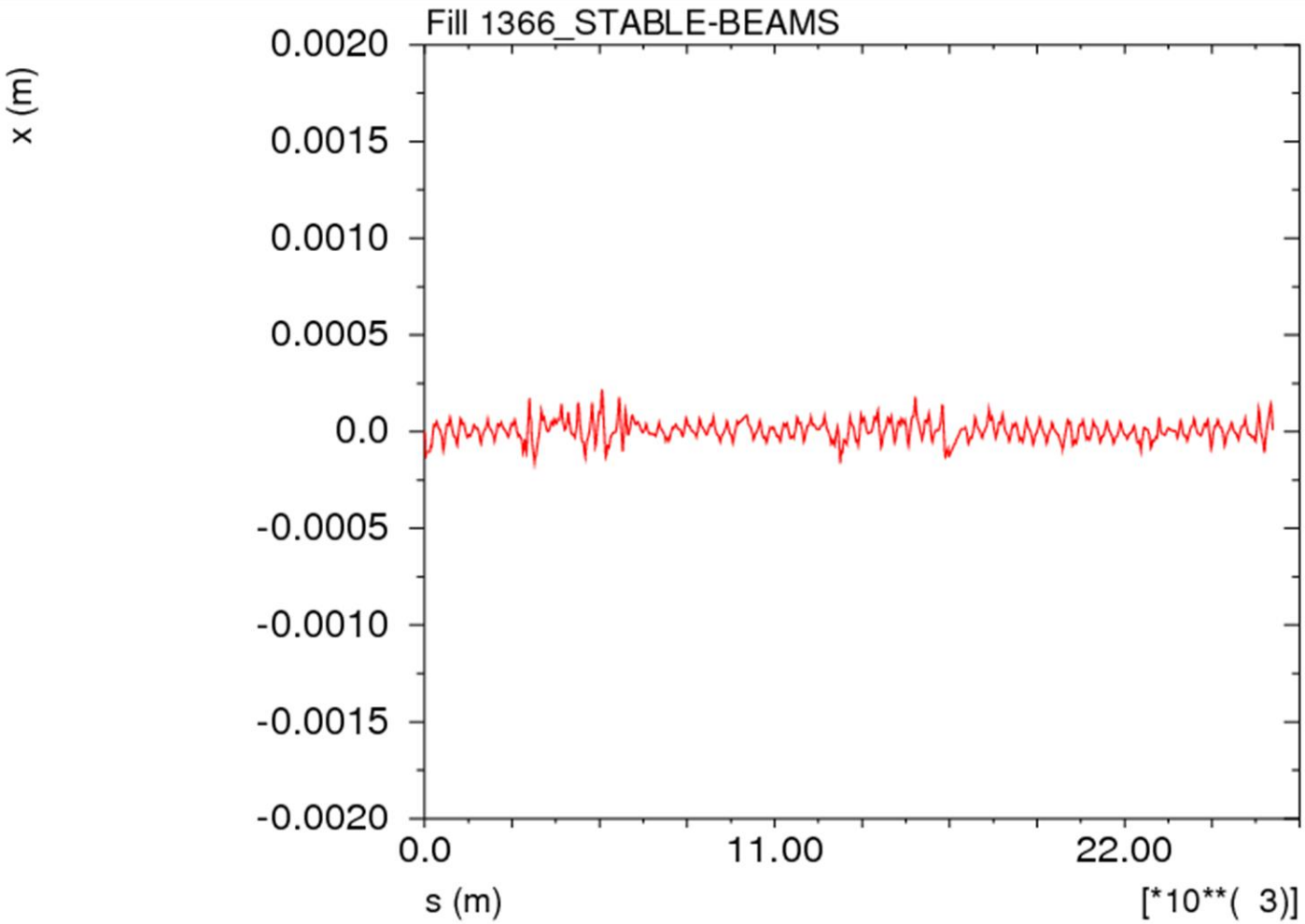
RMS (mm) = 0.27

Horizontal B2 (1397vs1364)



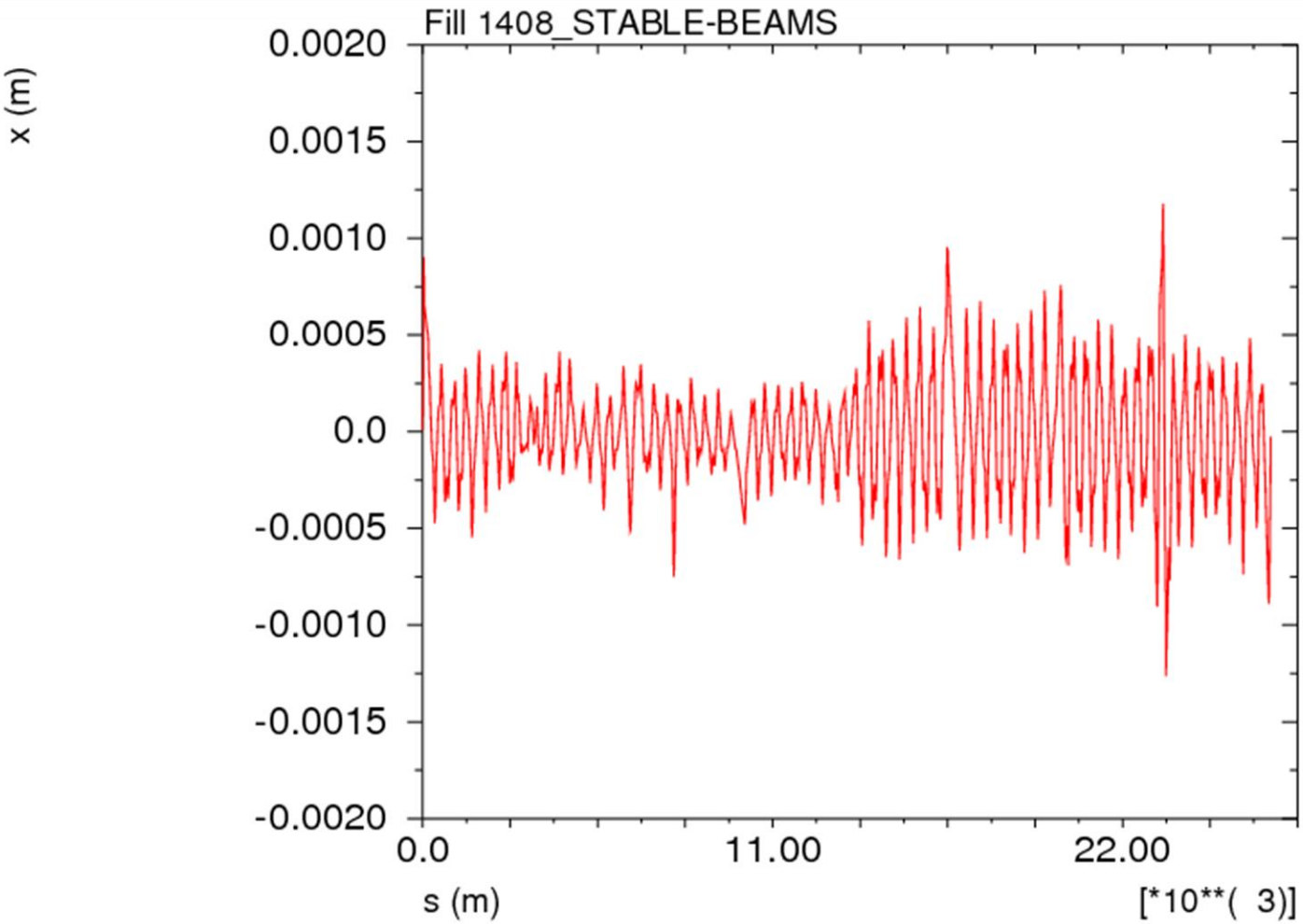
RMS (mm) = 0.28

Horizontal B2 (1400vs1364)



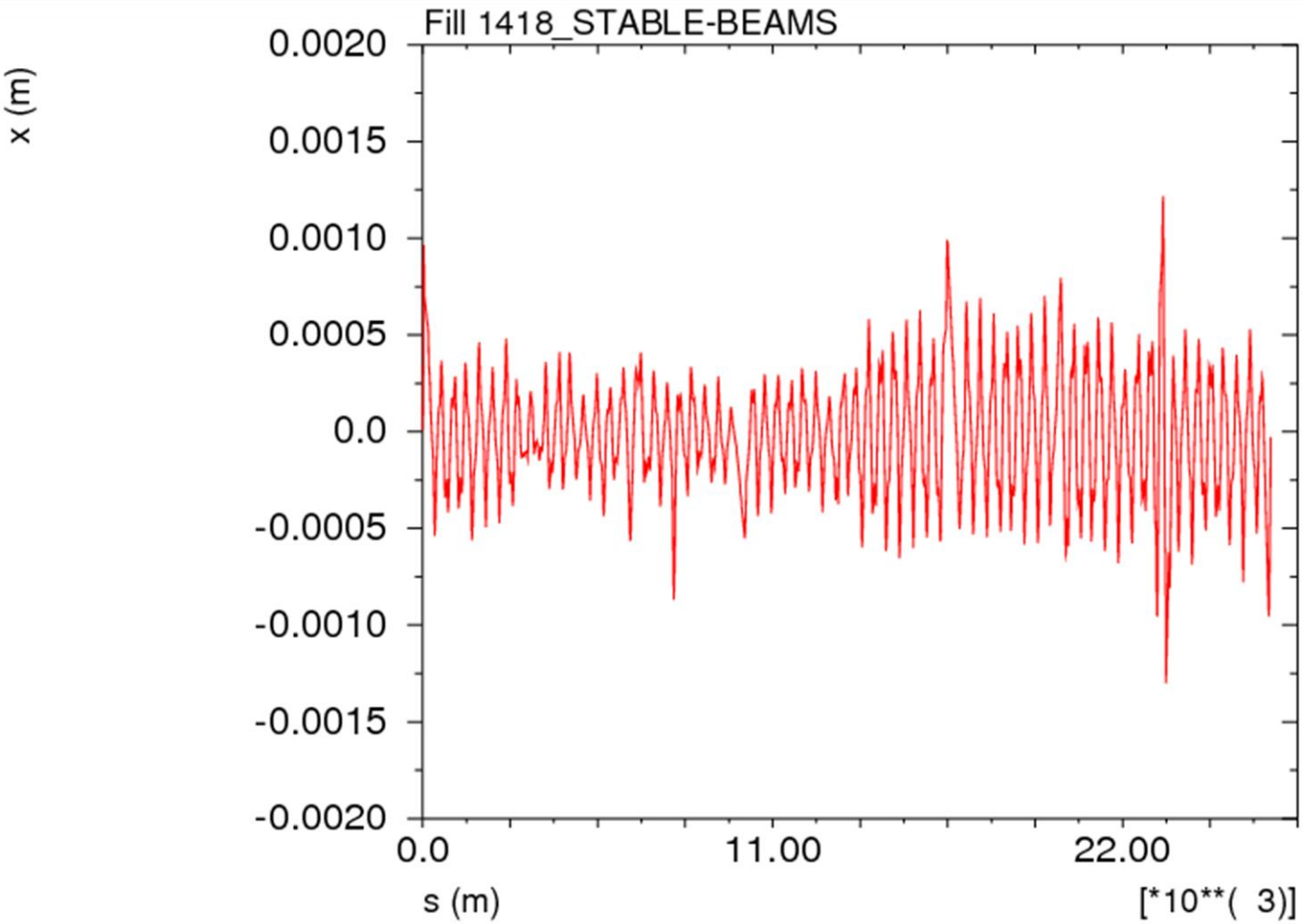
RMS (mm) = 0.27

Horizontal B2 (1408vs1364)



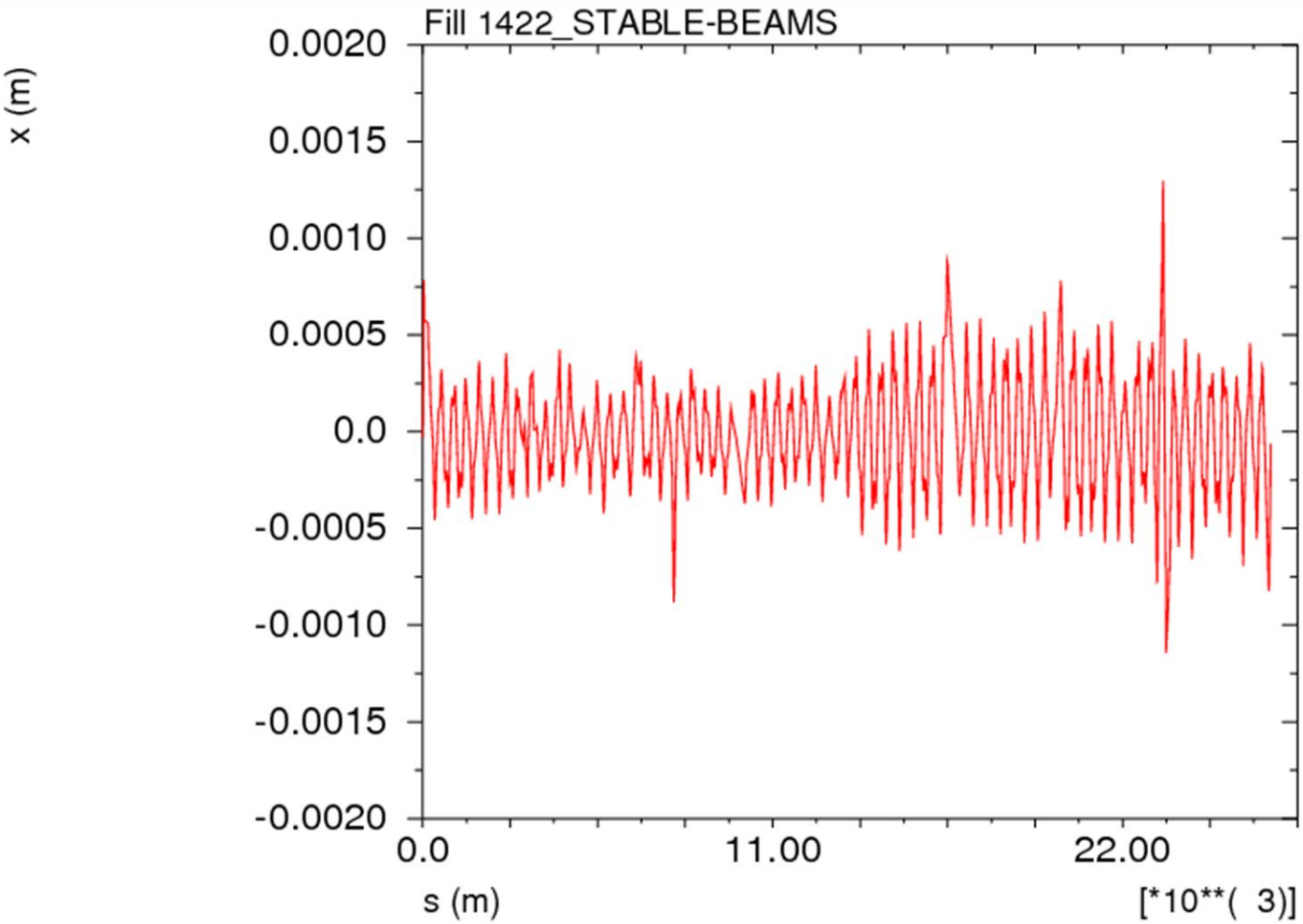
RMS (mm) = 0.29

Horizontal B2 (1418vs1364)



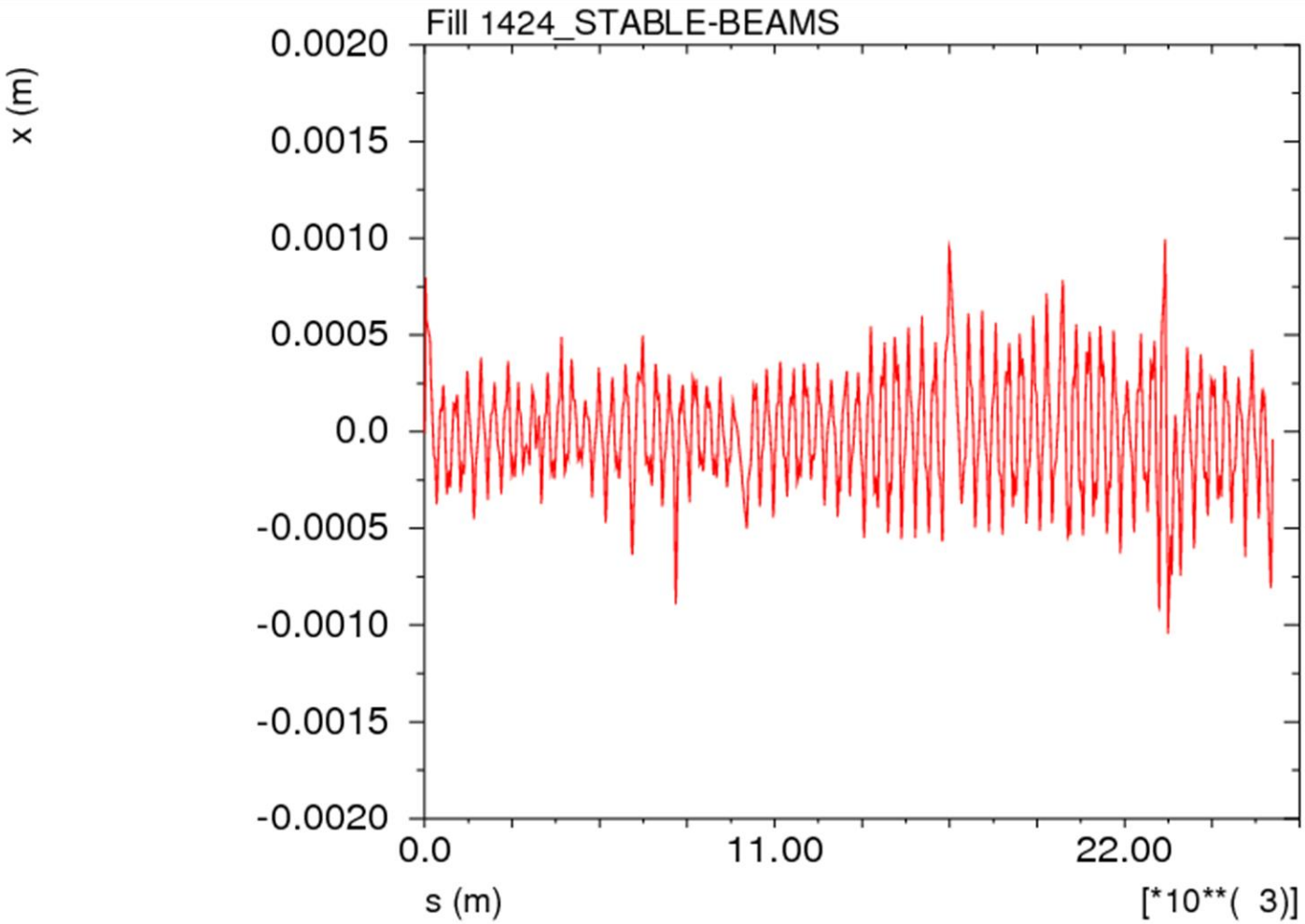
RMS (mm) = 0.30

Horizontal B2 (1422vs1364)



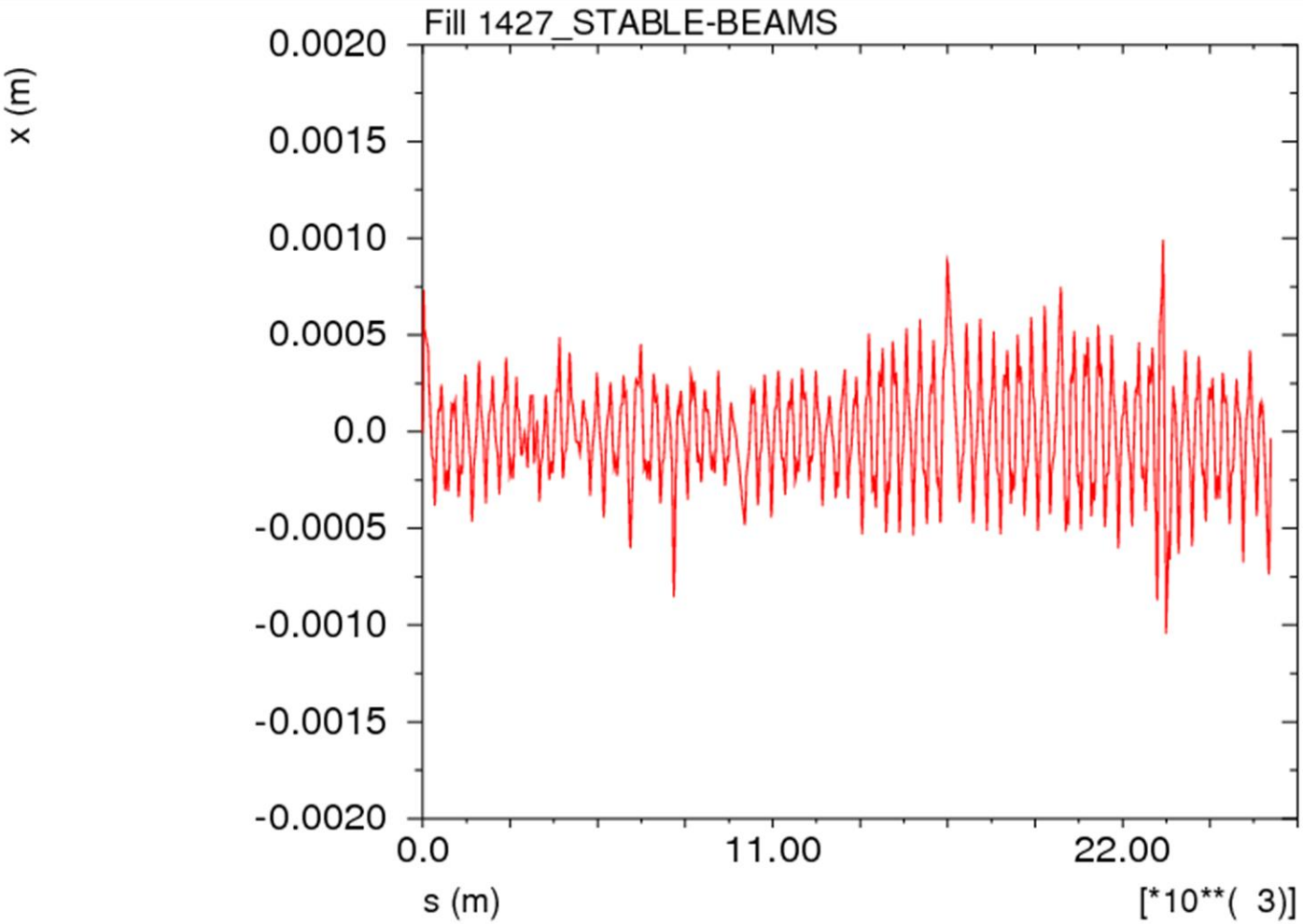
RMS (mm) = 0.27

Horizontal B2 (1424vs1364)



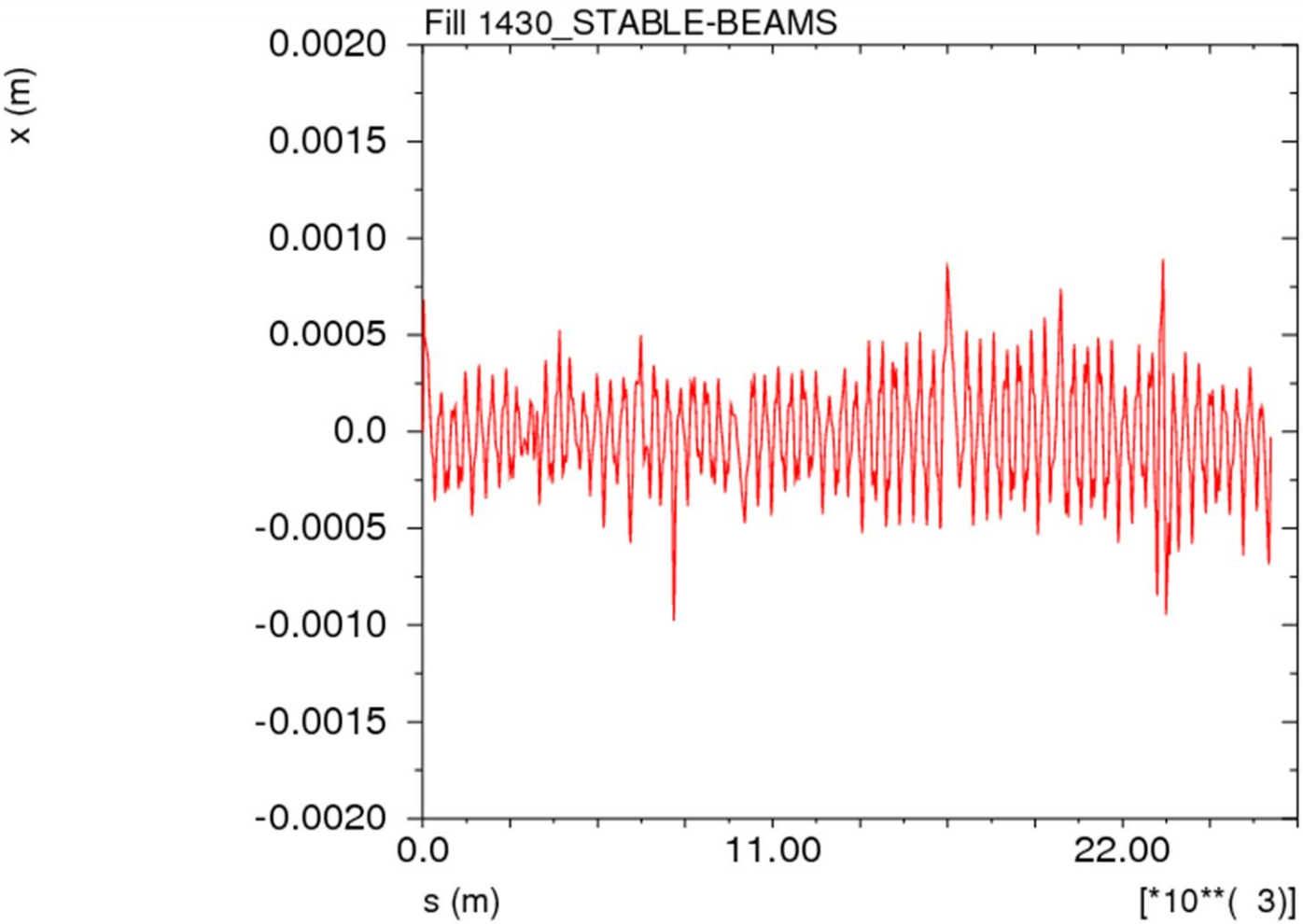
RMS (mm) = 0.28

Horizontal B2 (1427vs1364)



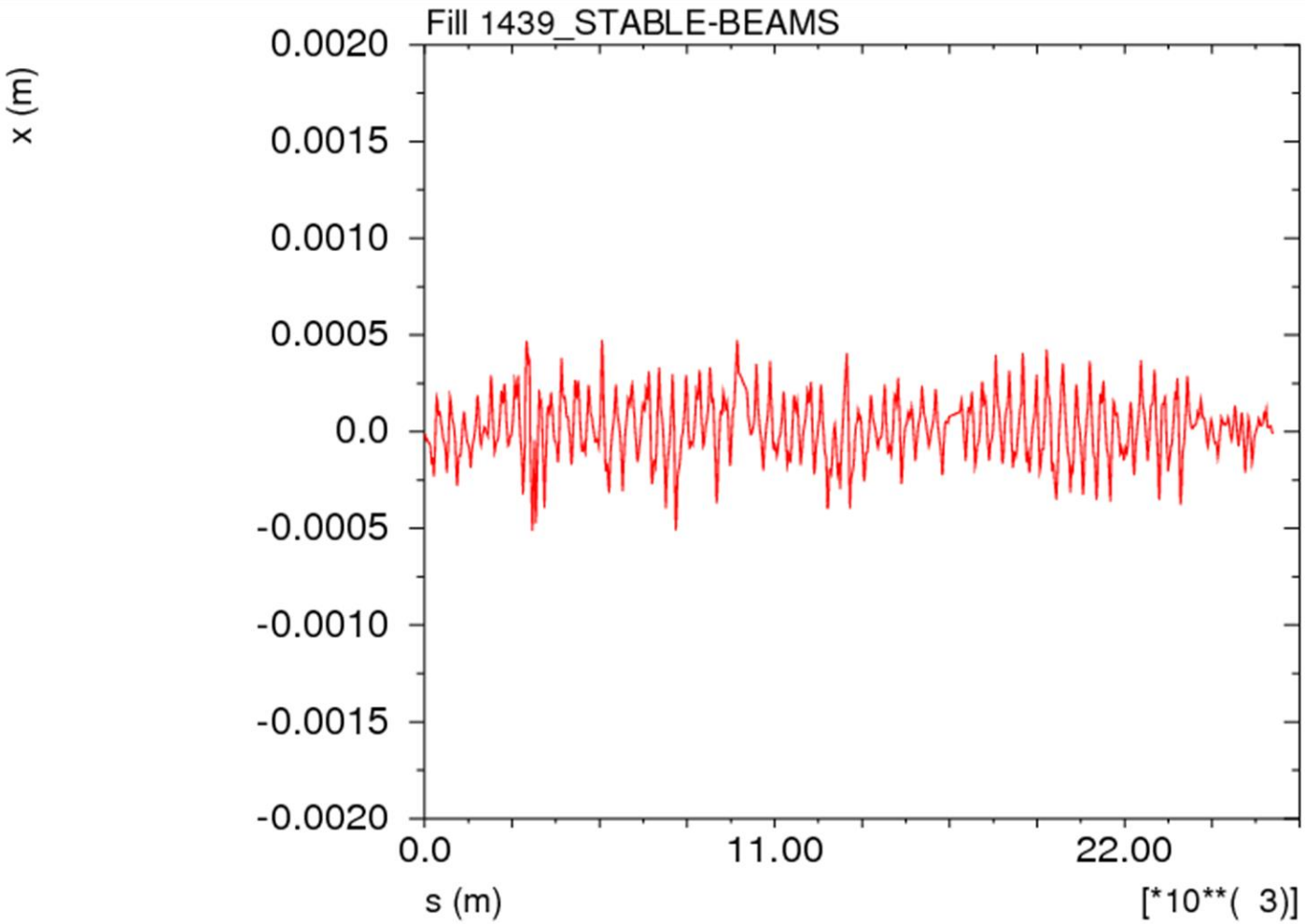
RMS (mm) = 0.26

Horizontal B2 (1430vs1364)



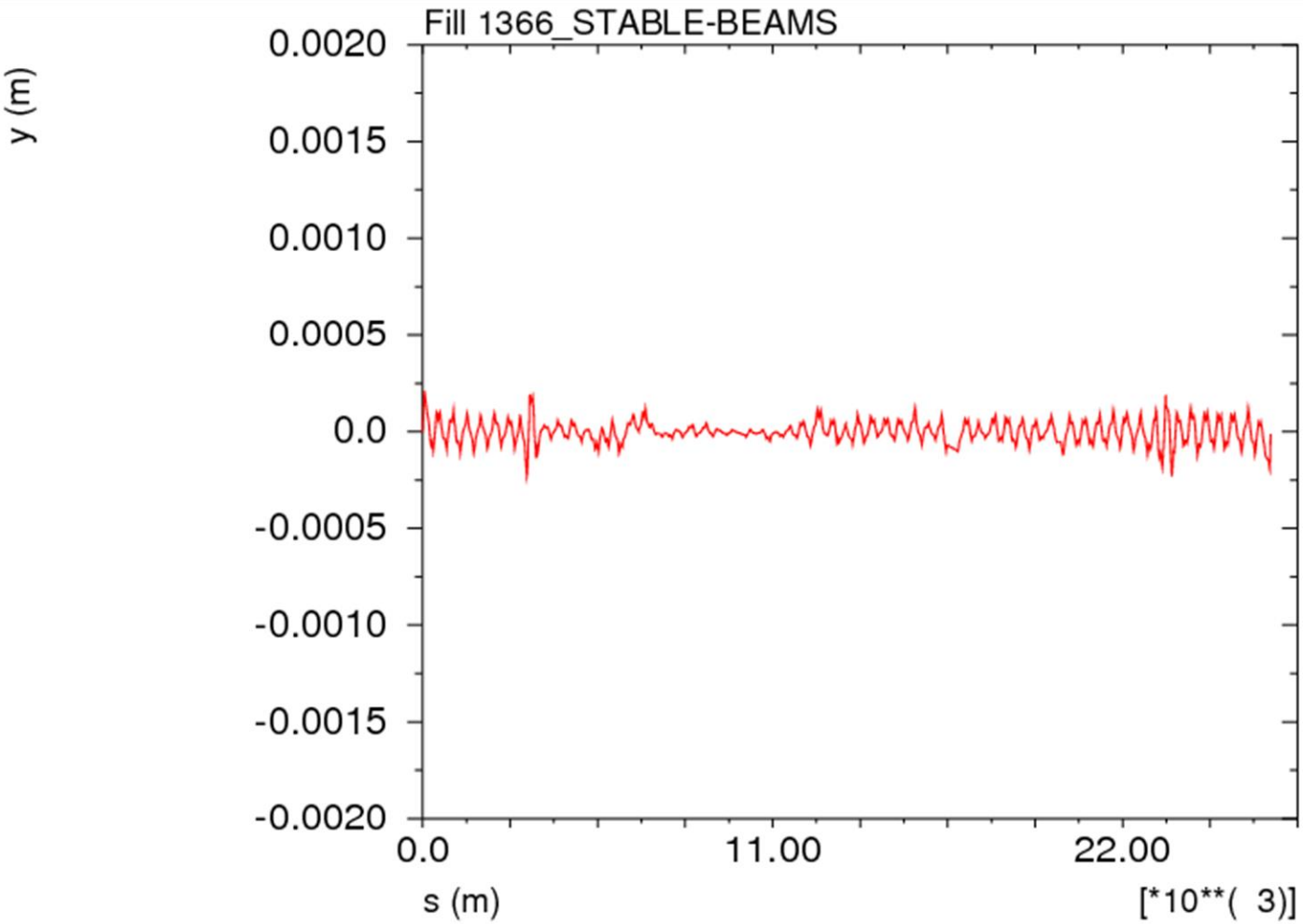
RMS (mm) = 0.25

Horizontal B2 (1439vs1364)



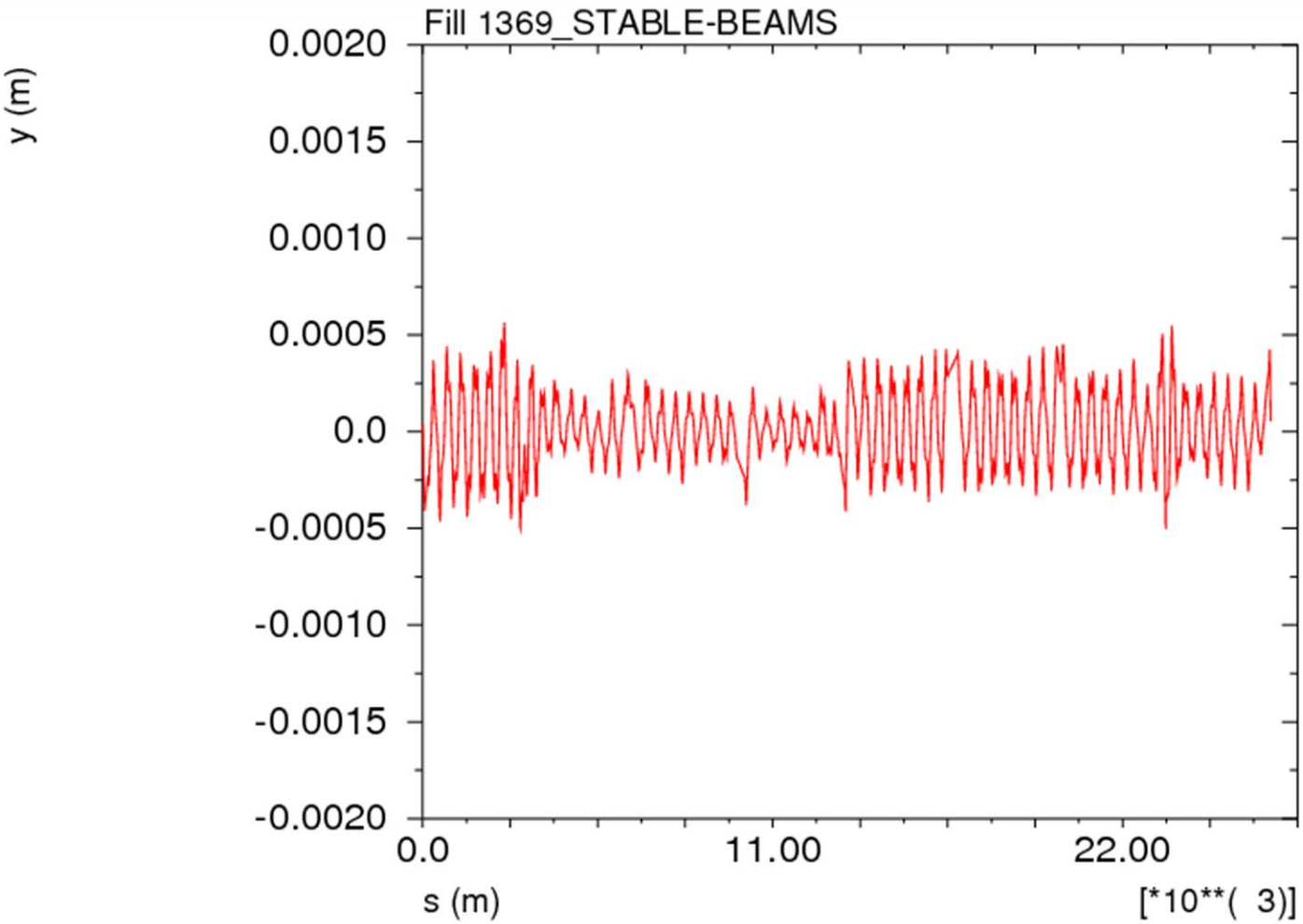
RMS (mm) = 0.15

Vertical B2 (1366vs1364)



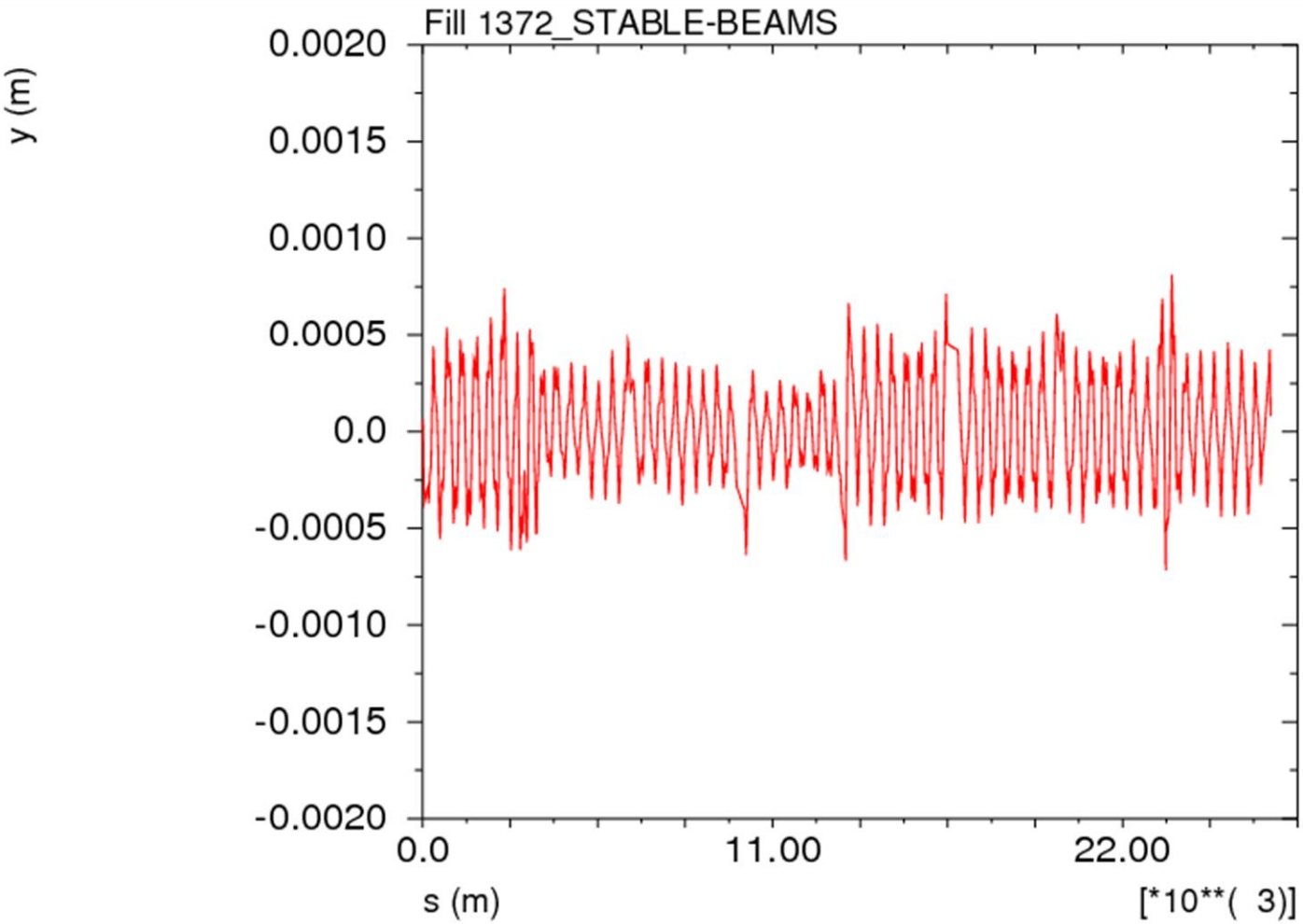
RMS (mm) = 0.05

Vertical B2 (1369vs1364)



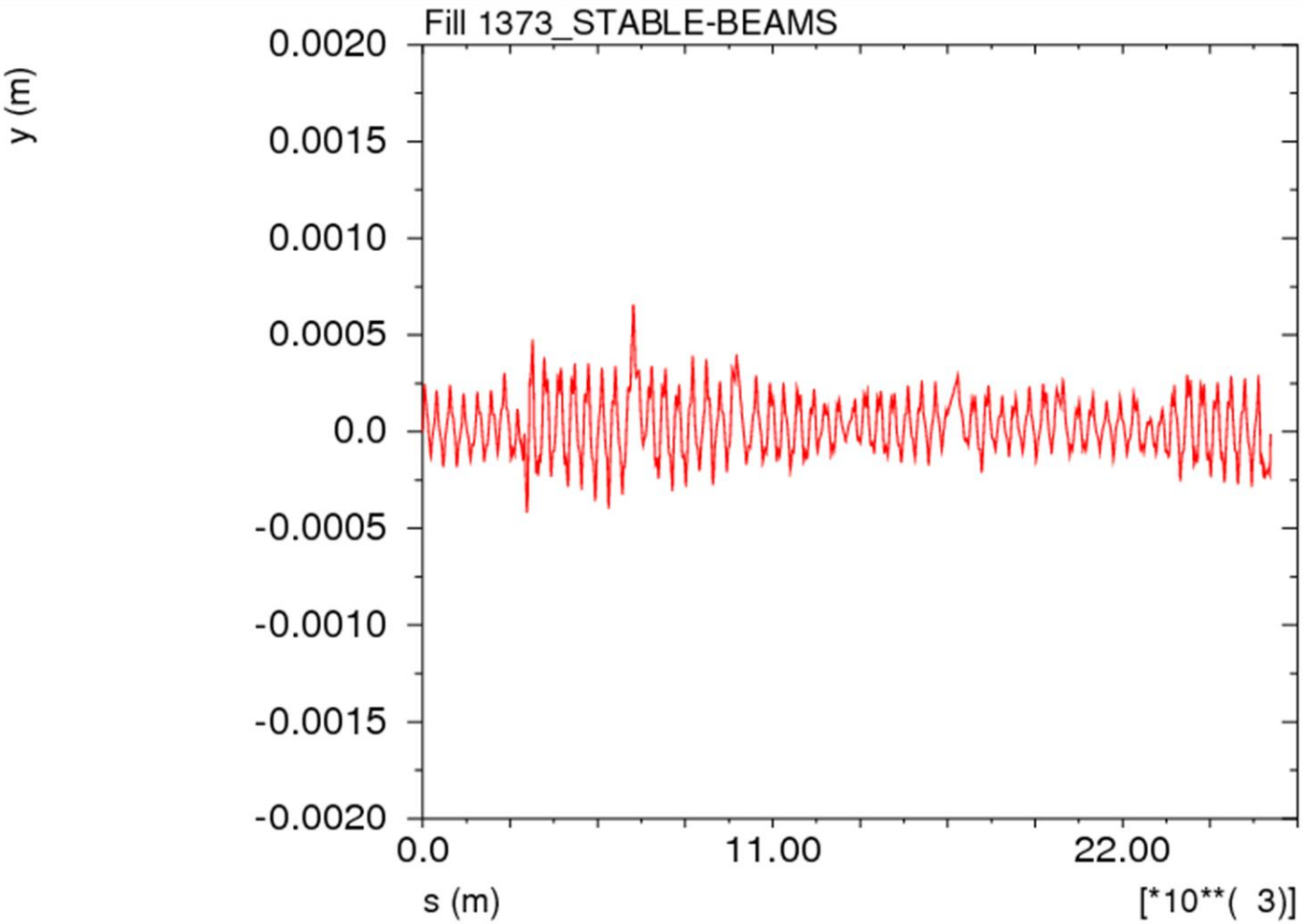
RMS (mm) = 0.19

Vertical B2 (1372vs1364)



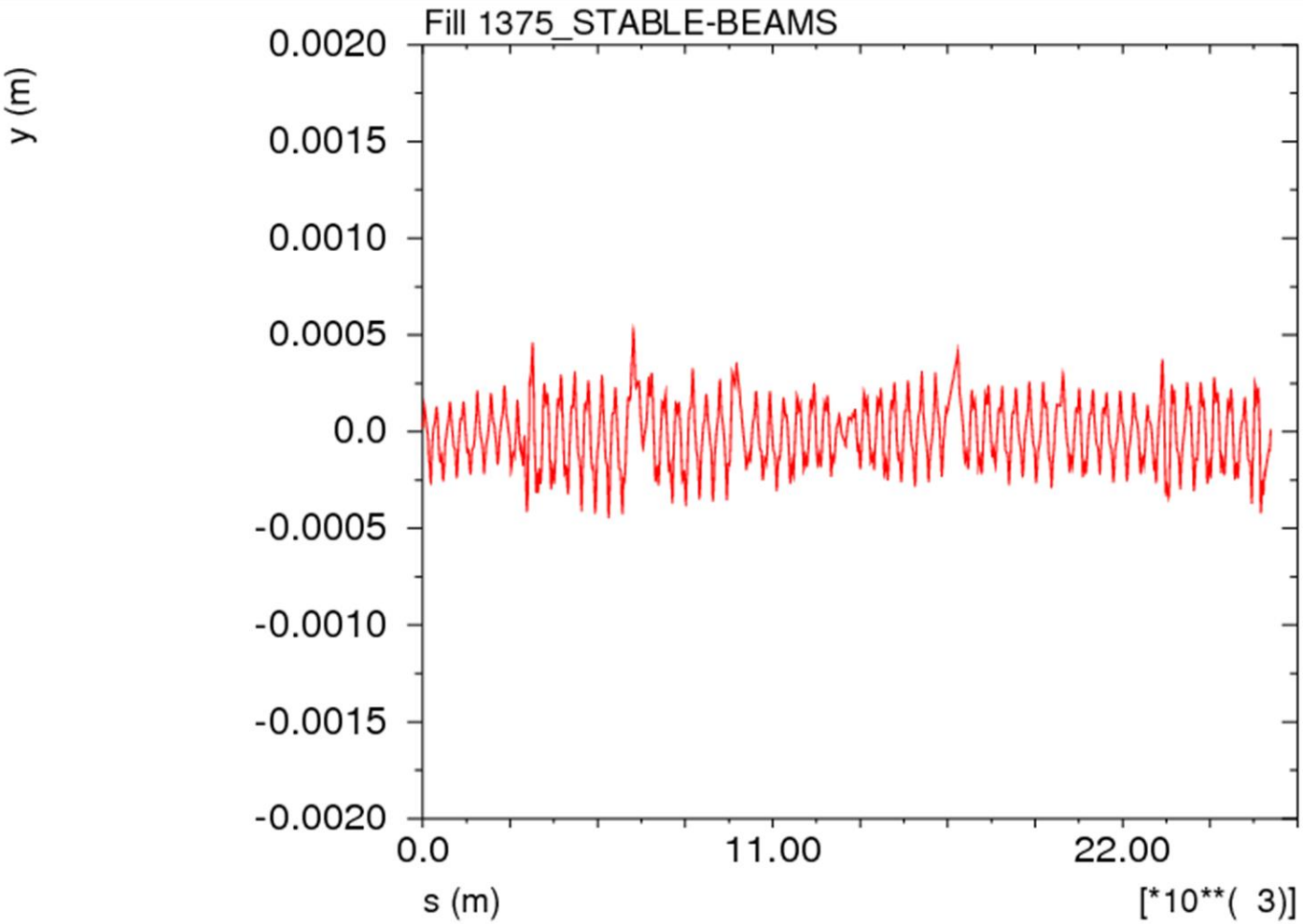
RMS (mm) = 0.27

Vertical B2 (1373vs1364)



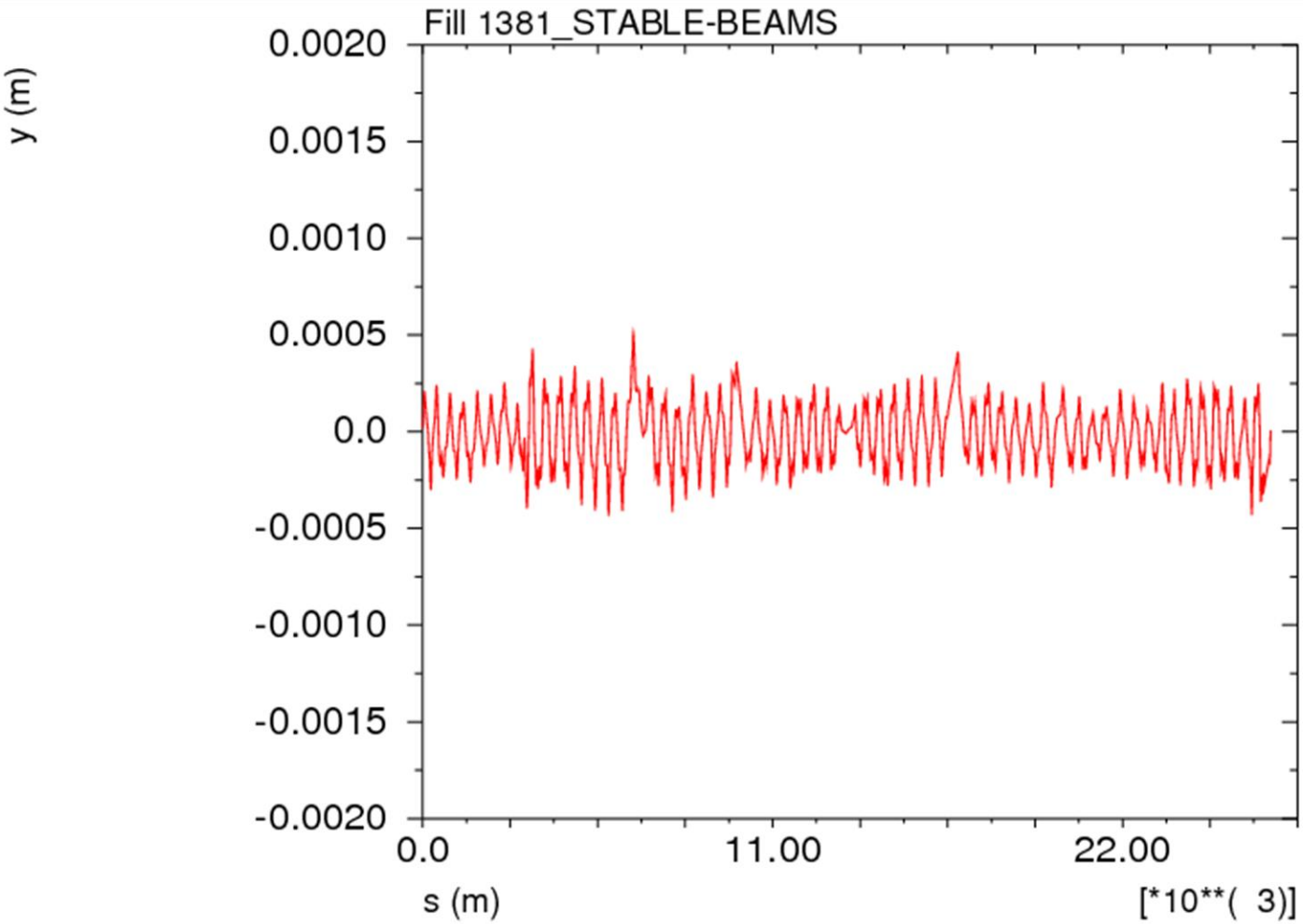
RMS (mm) = 0.15

Vertical B2 (1375vs1364)



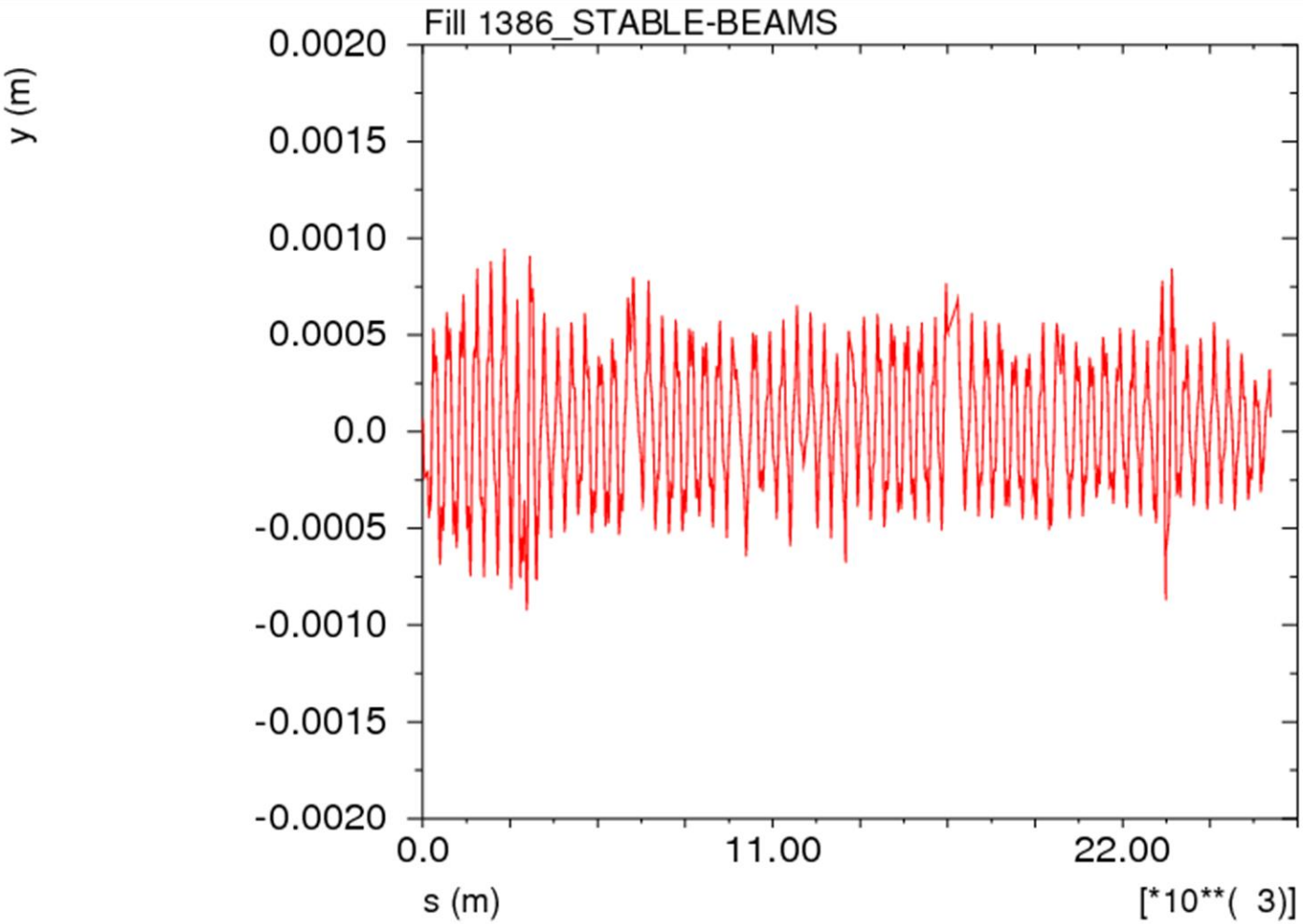
RMS (mm) = 0.16

Vertical B2 (1381vs1364)



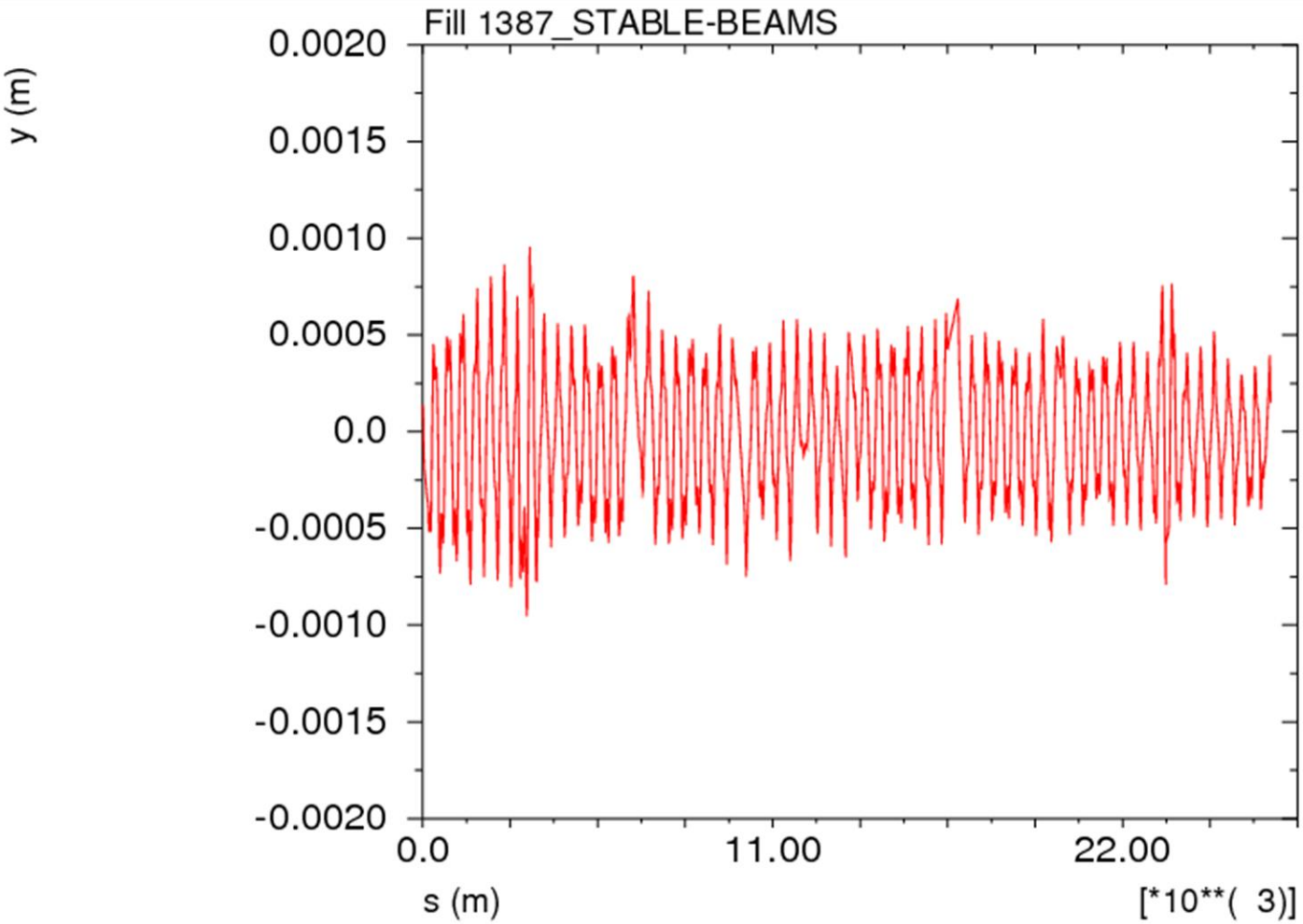
RMS (mm) = 0.16

Vertical B2 (1386vs1364)



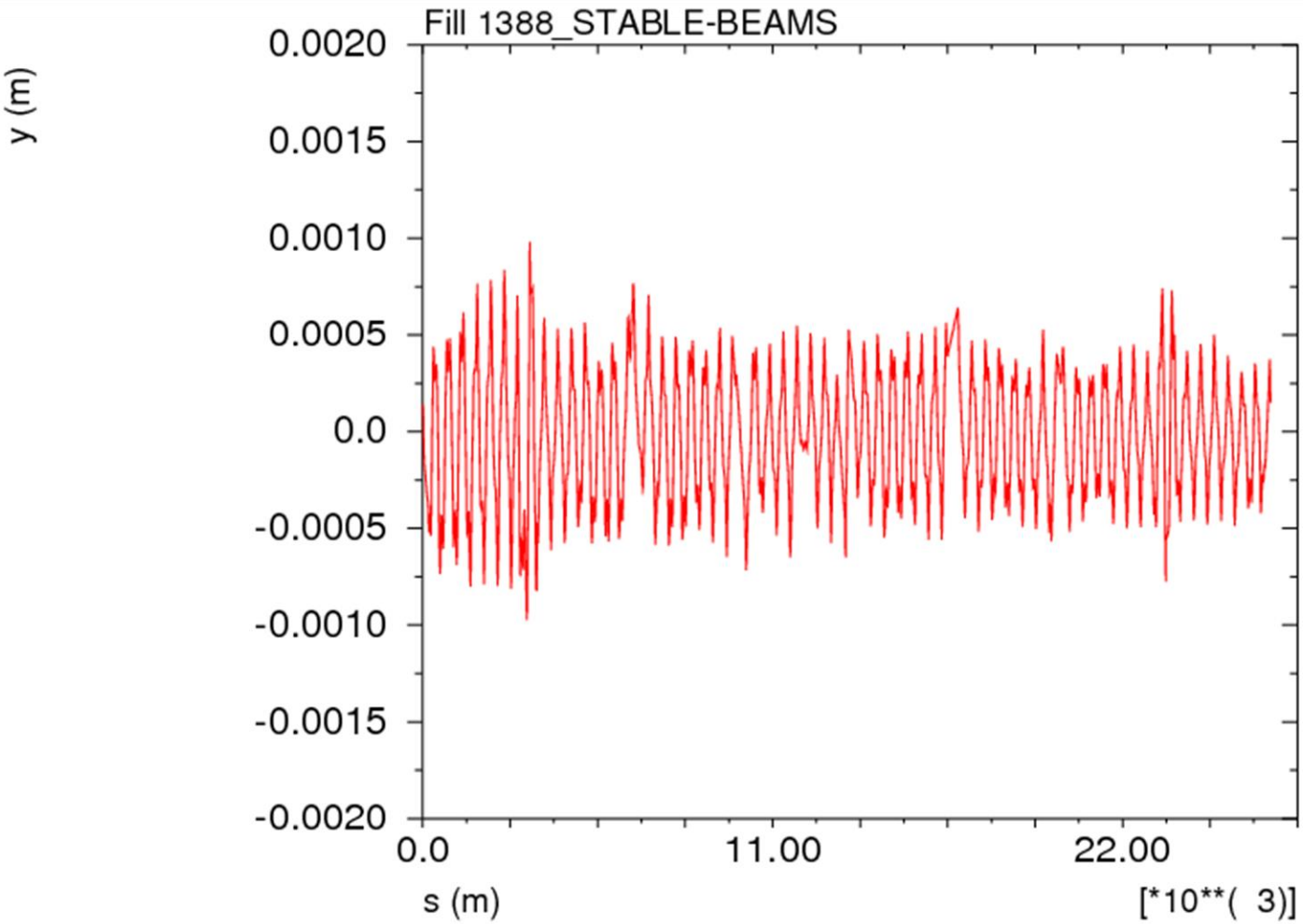
RMS (mm) = 0.34

Vertical B2 (1387vs1364)



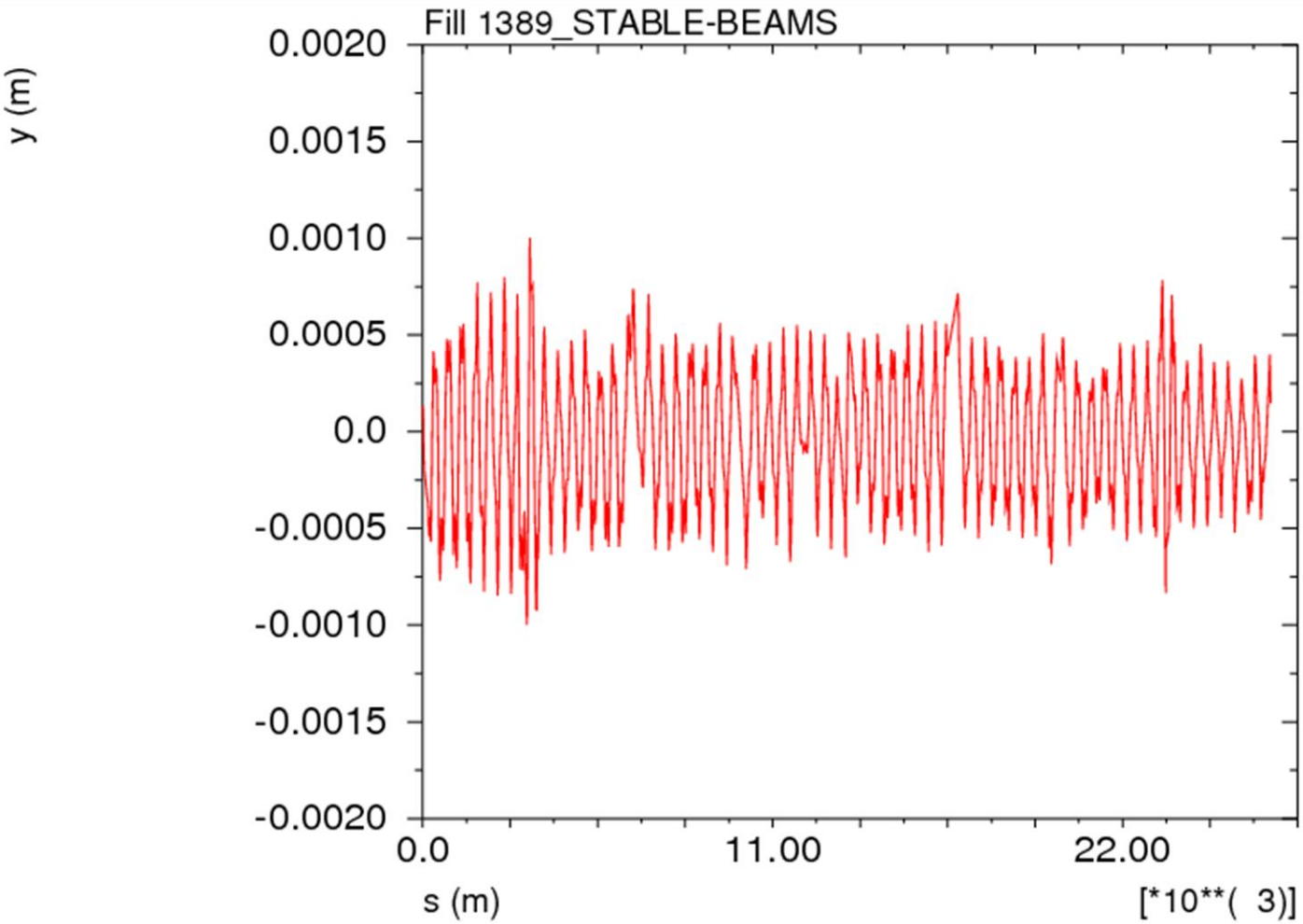
RMS (mm) = 0.34

Vertical B2 (1388vs1364)



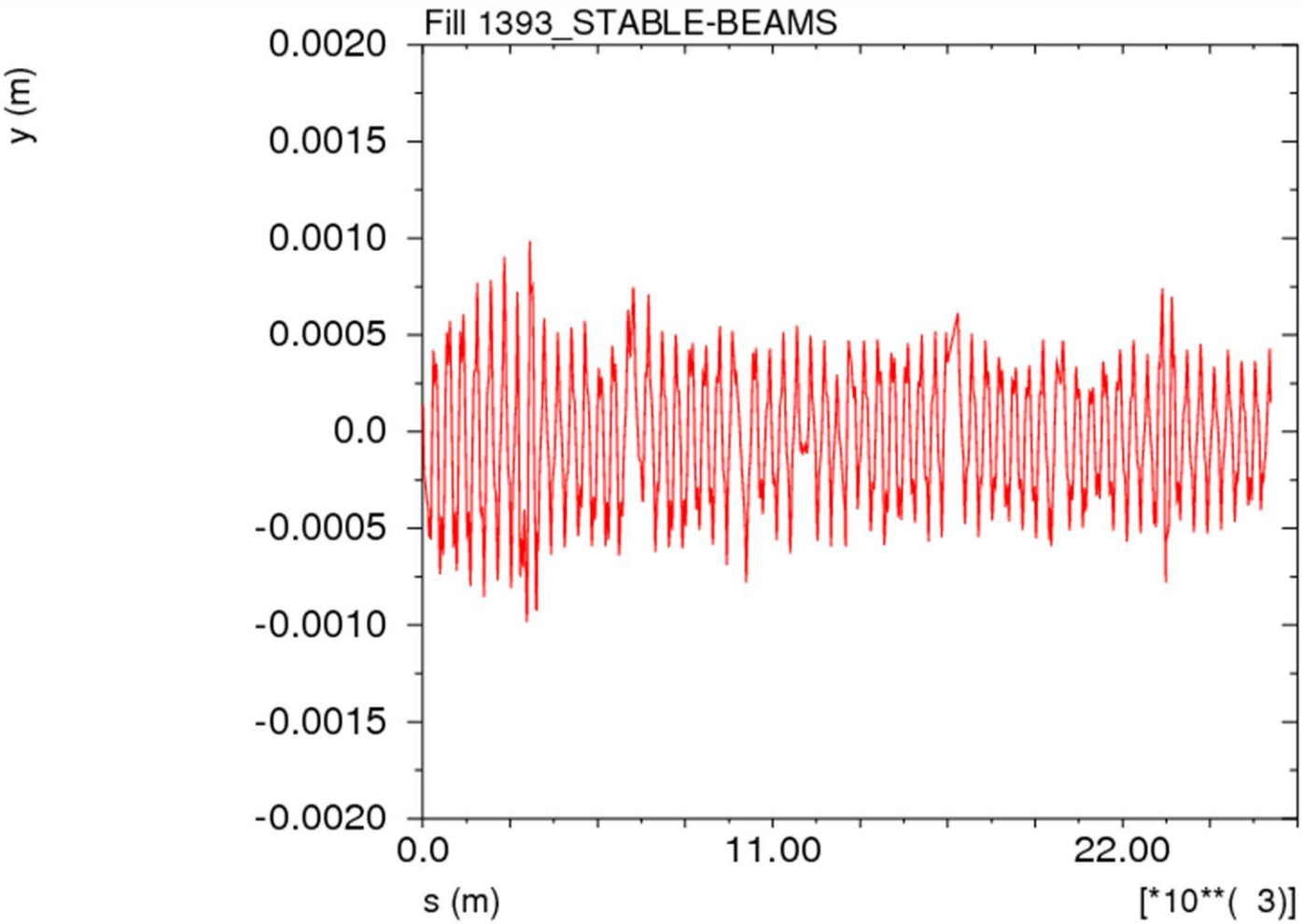
RMS (mm) = 0.33

Vertical B2 (1389vs1364)



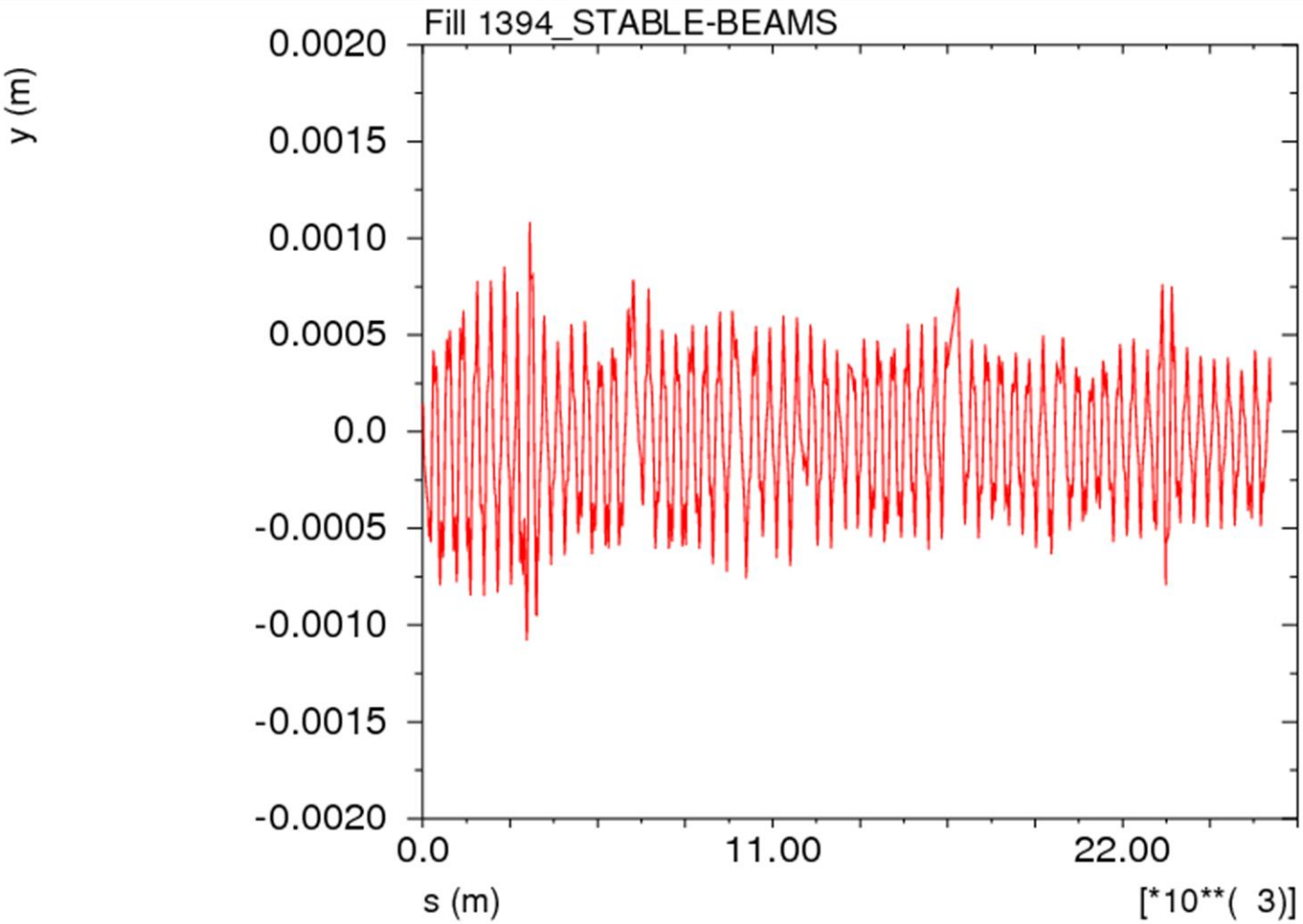
RMS (mm) = 0.34

Vertical B2 (1393vs1364)



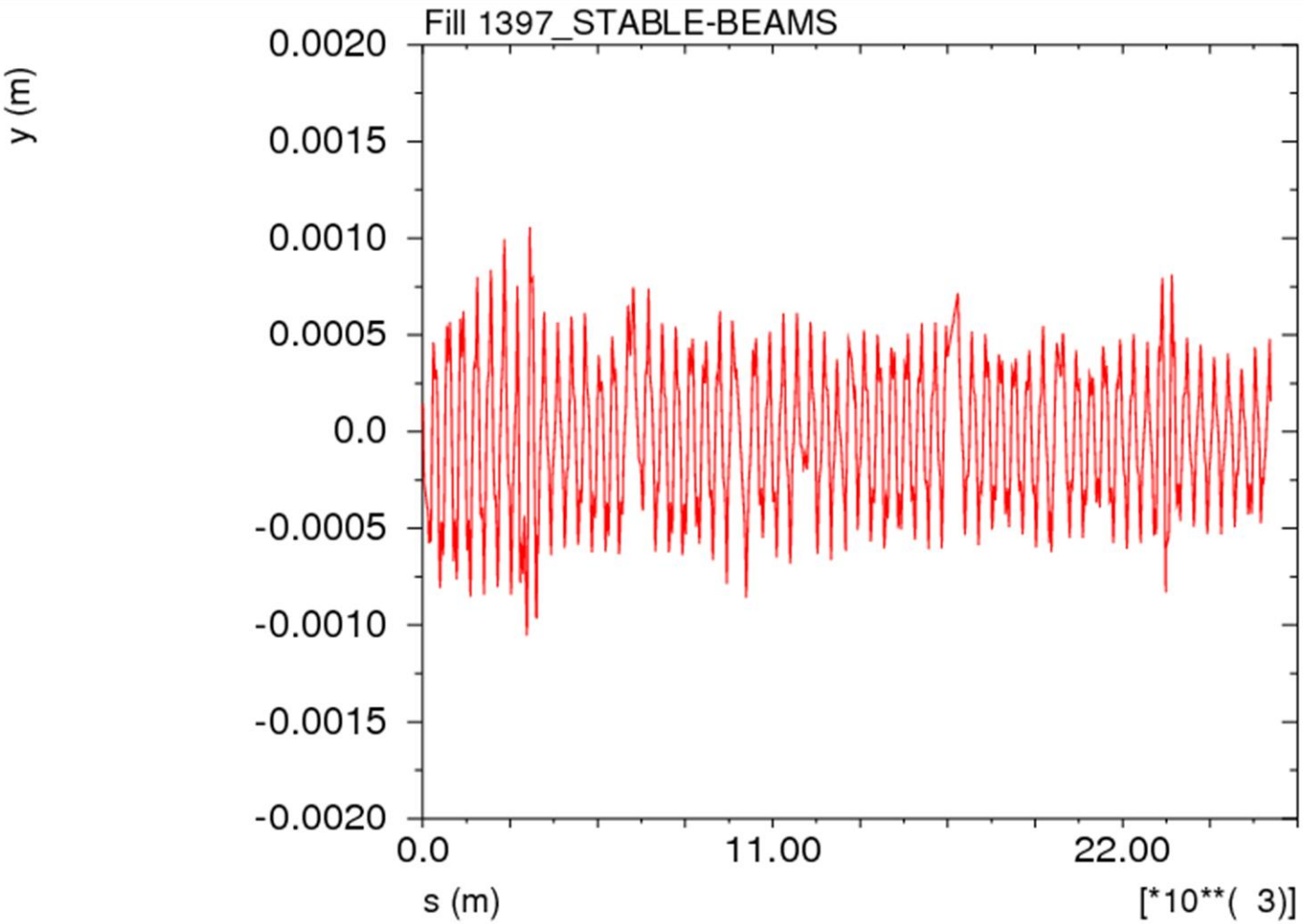
RMS (mm) = 0.34

Vertical B2 (1394vs1364)



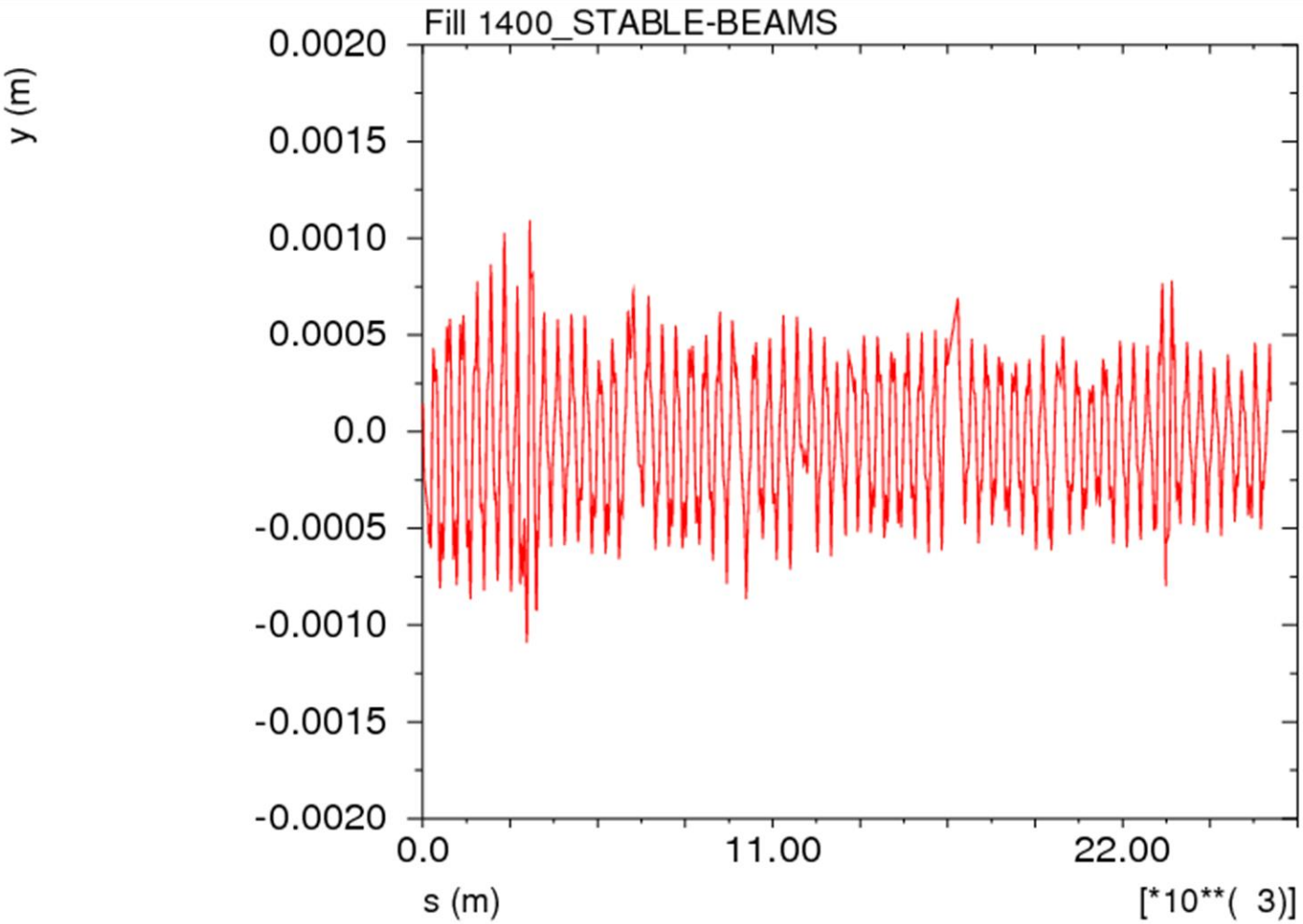
RMS (mm) = 0.35

Vertical B2 (1397vs1364)



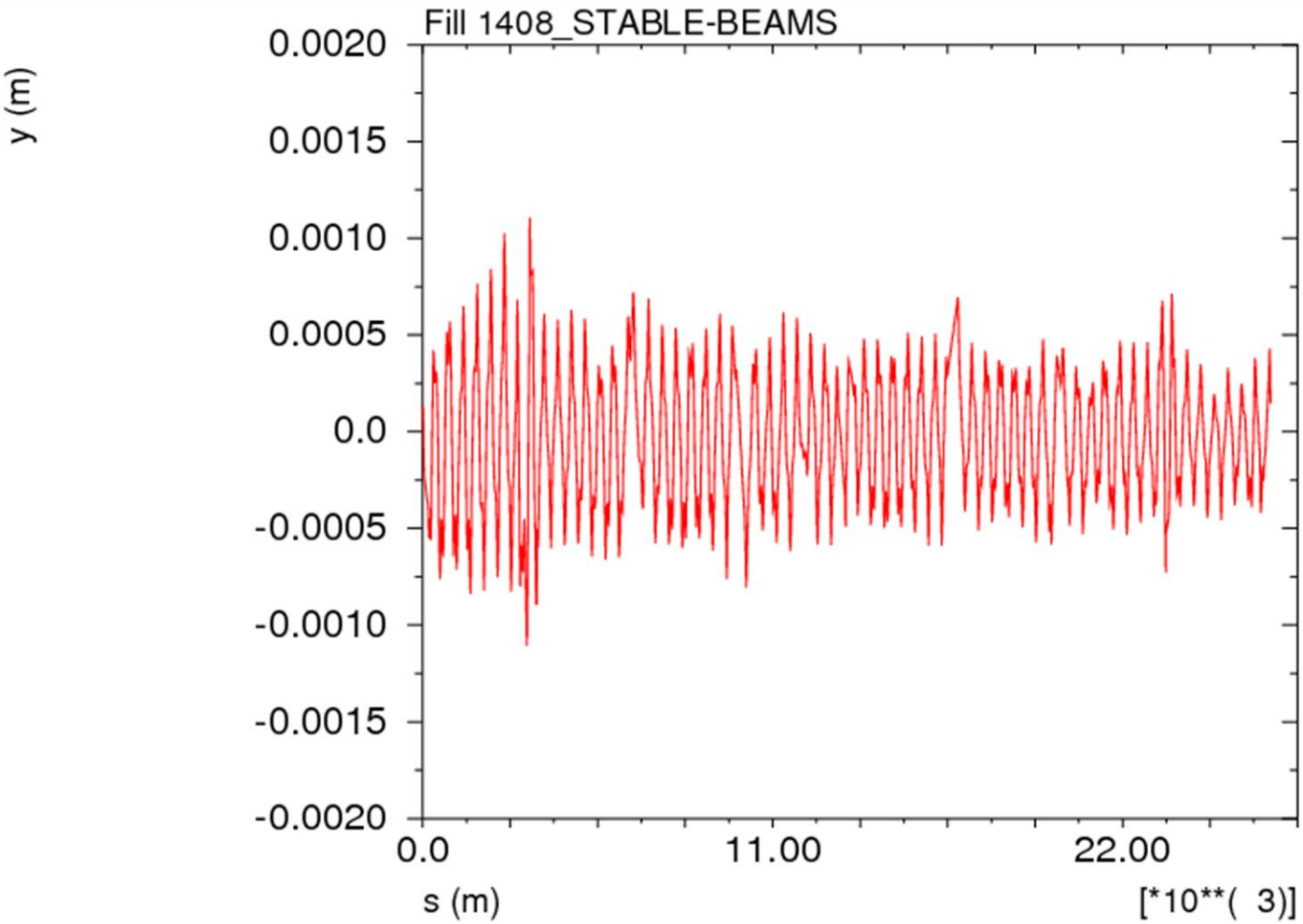
RMS (mm) = 0.36

Vertical B2 (1400vs1364)



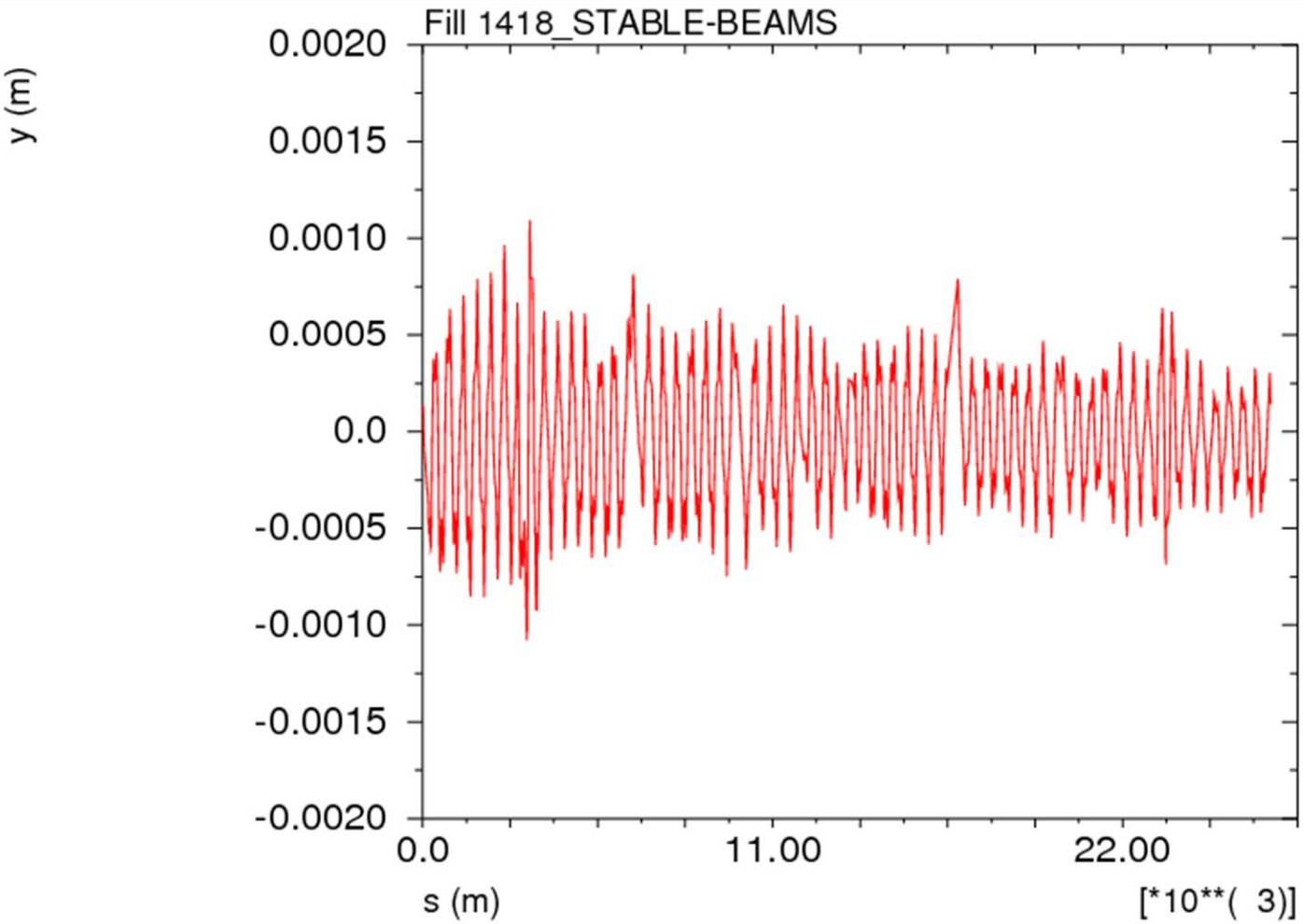
RMS (mm) = 0.36

Vertical B2 (1408vs1364)



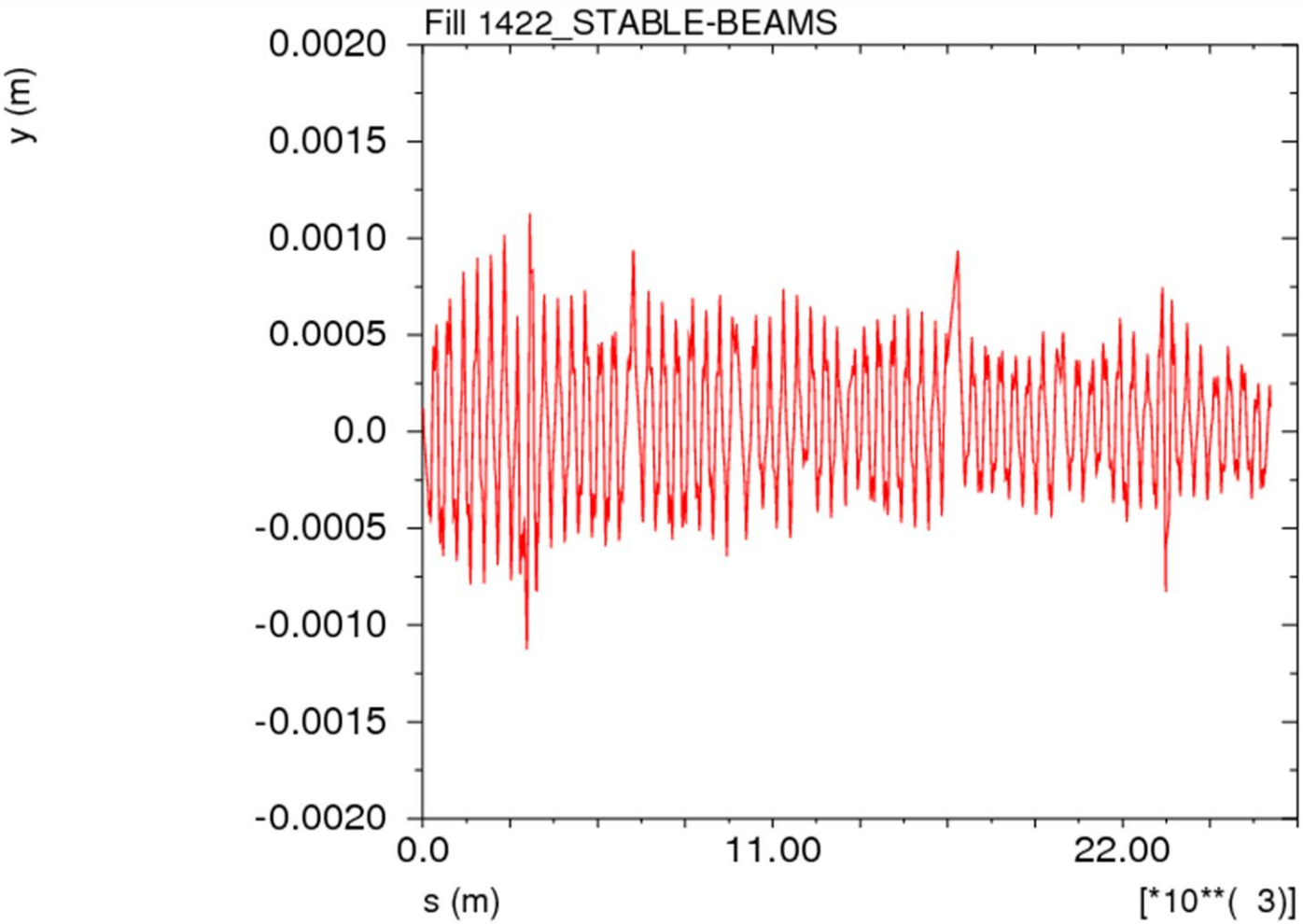
RMS (mm) = 0.34

Vertical B2 (1418vs1364)



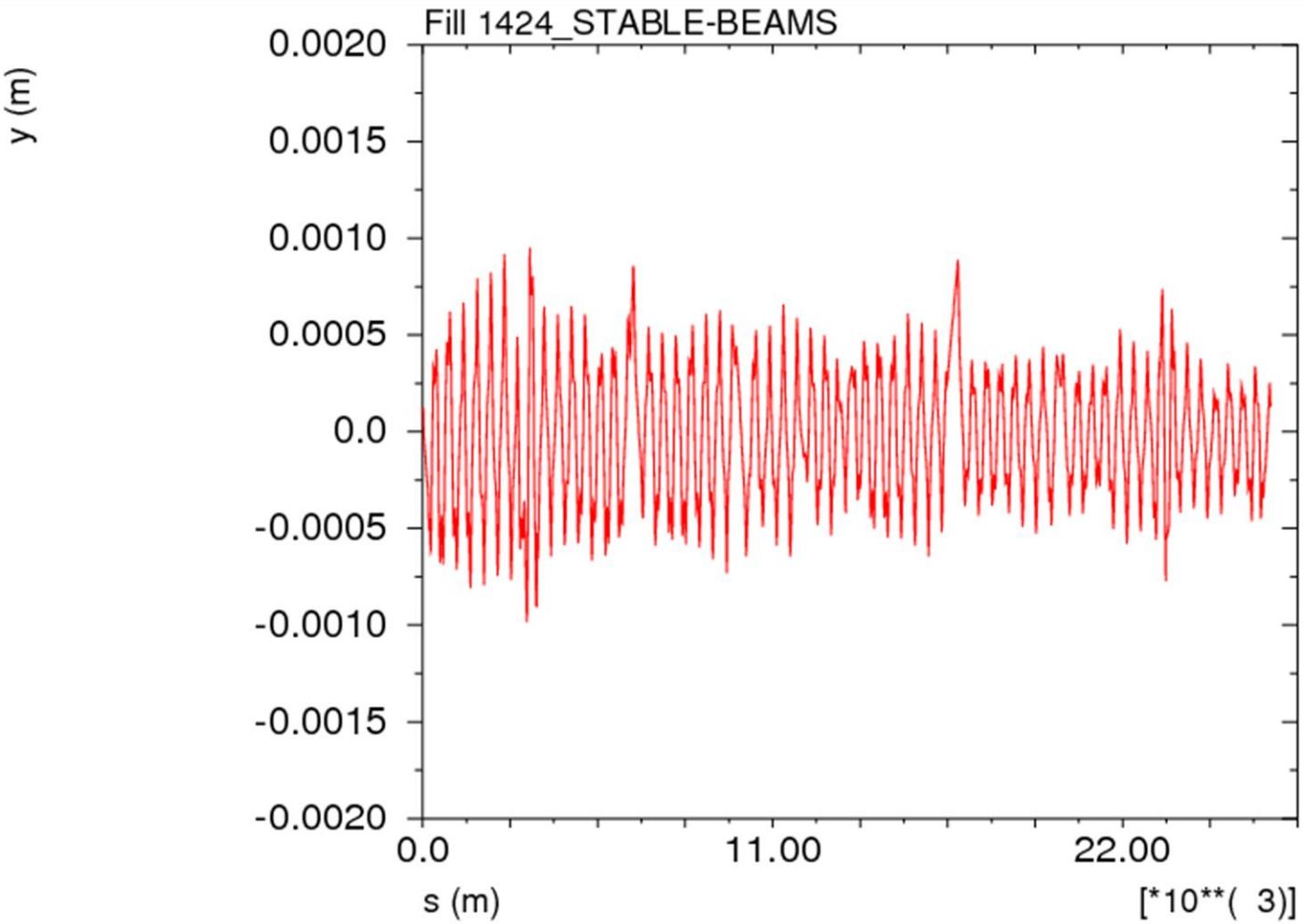
RMS (mm) = 0.34

Vertical B2 (1422vs1364)



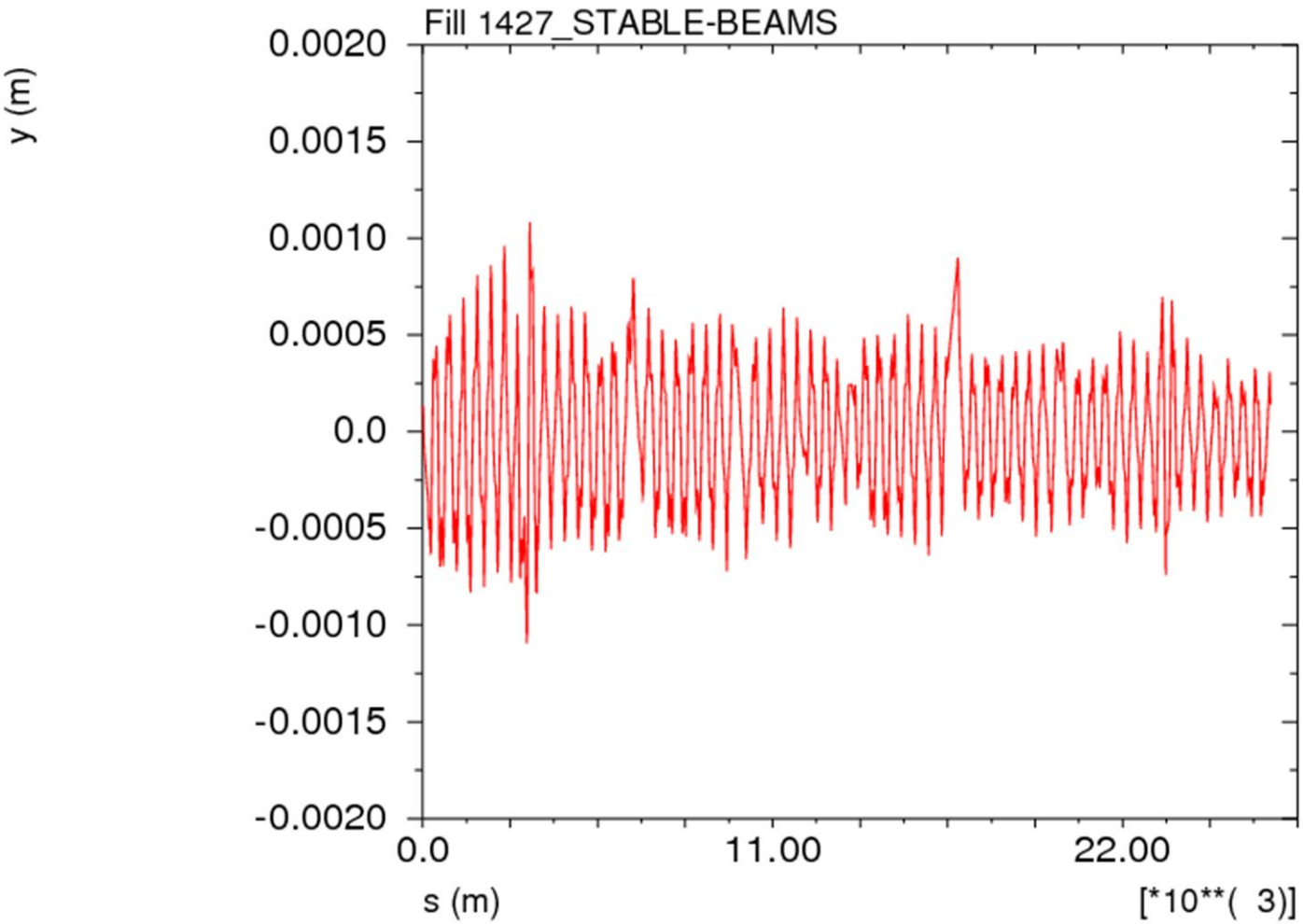
RMS (mm) = 0.34

Vertical B2 (1424vs1364)



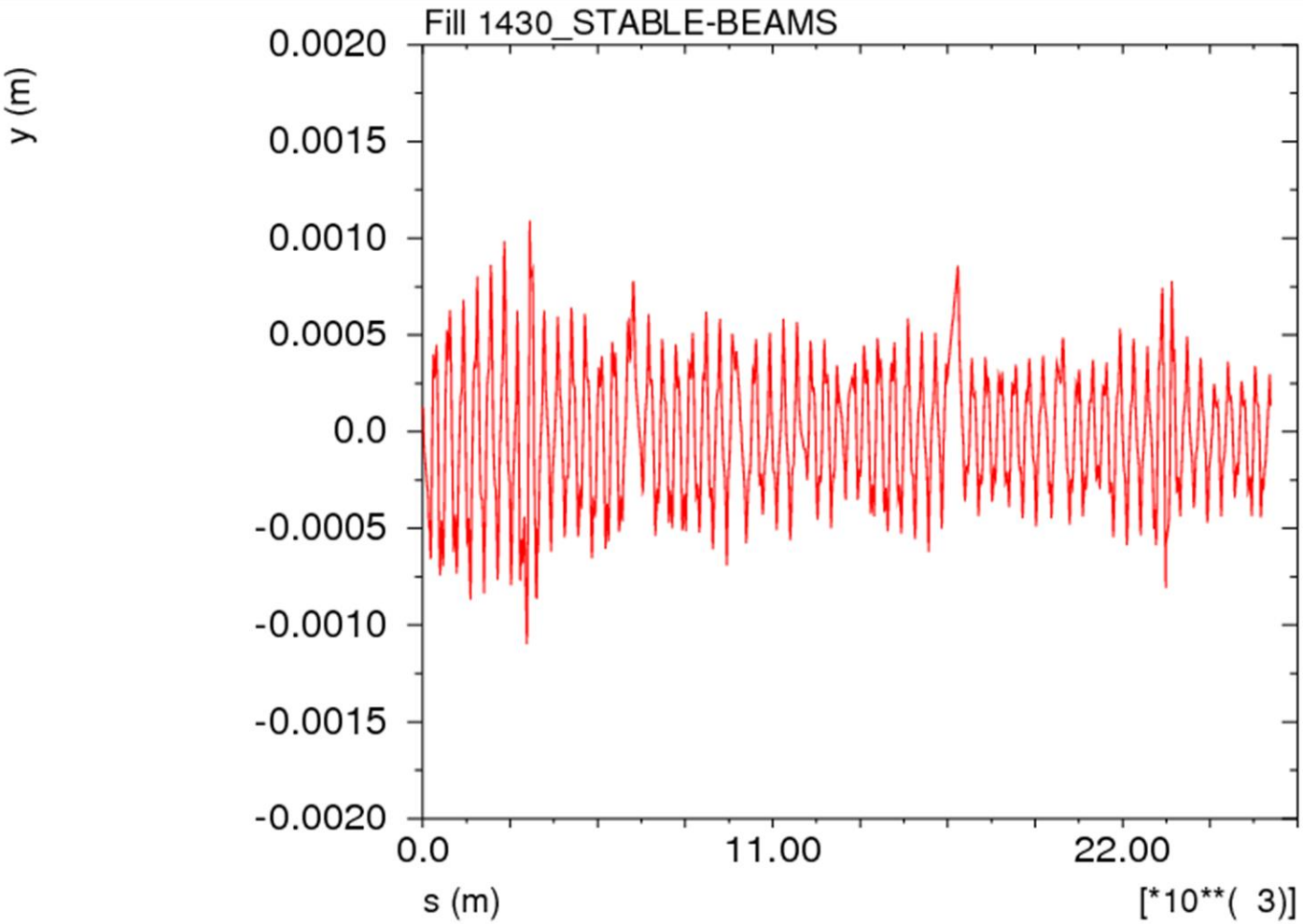
RMS (mm) = 0.34

Vertical B2 (1427vs1364)



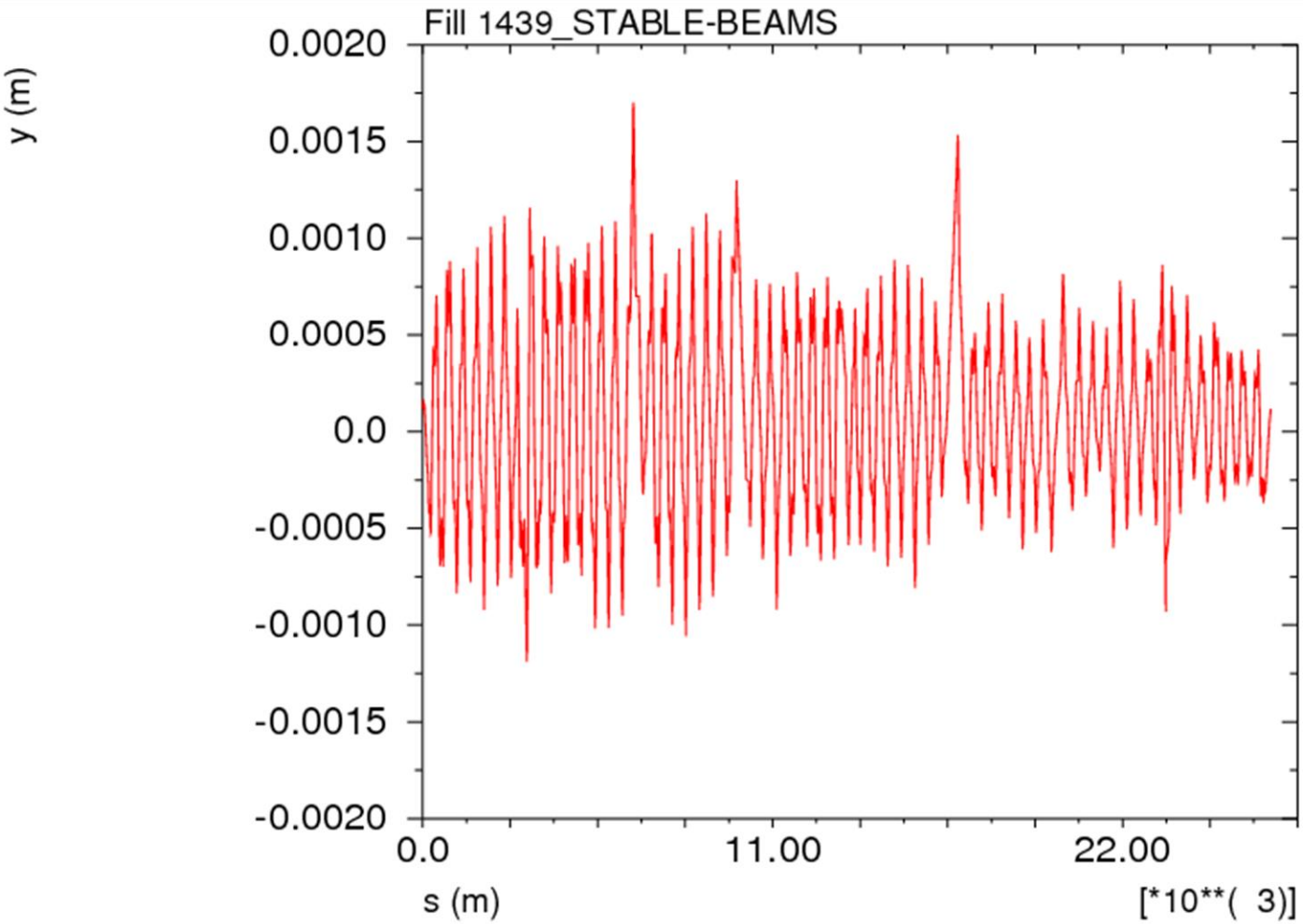
RMS (mm) = 0.34

Vertical B2 (1430vs1364)



RMS (mm) = 0.33

Vertical B2 (1439vs1364)



RMS (mm) = 0.46