



## **BPM/Quadrupole Offset Measurements of 26 March 2024**

**The alignment measurements for the BPMs in the south arc date from early 2023.**

**The measurement of 35W on 28 February 2024 suffered from one bad phase measurement.**

**There was some hope that X5D and 44E would be newly available, but the quad centering code complained of “bad data.”**

**Also obtained repeatability data for 32E to see effect of beta functions compared to the earlier measurements at 18E.**

**Performed the “Shanks test” to isolate the contribution of the phase measurement and optimization repeatability.**

**Today: Iterative measurements for 20 south arc BPMs.**

30 March 2024

Added results for

- 1) 32E repeatability
- 2) Phase repeatability

Jim Crittenden

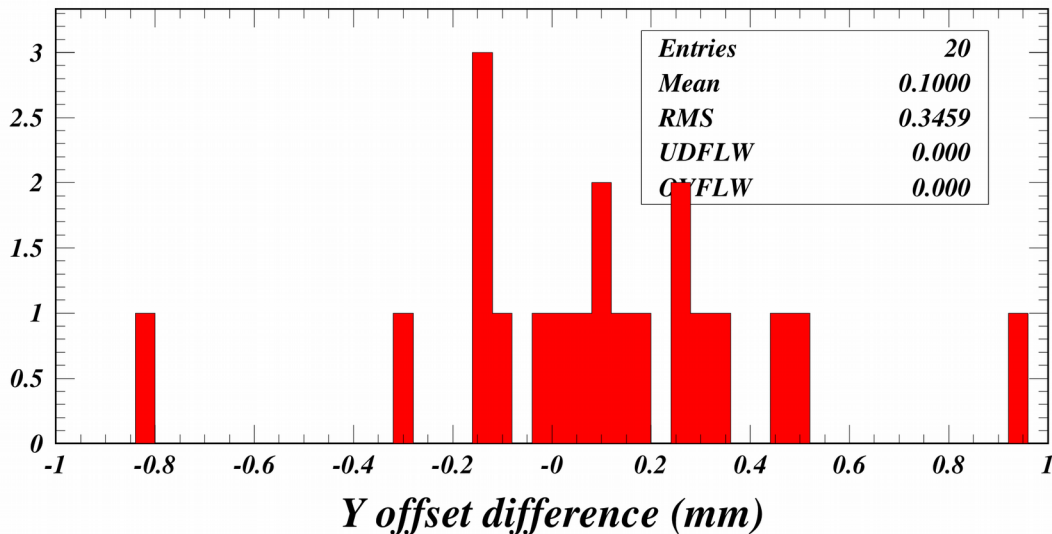
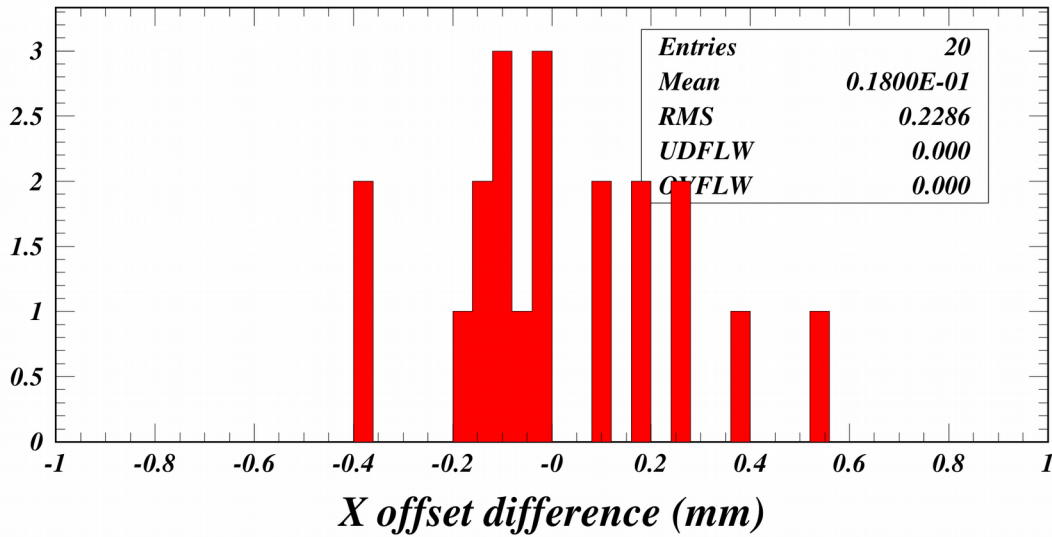
CESR Machine Studies Meeting

28 March 2024



# BPM offset measurement changes since early 2023

*Change in SA BPM offsets on 26 March 2024*



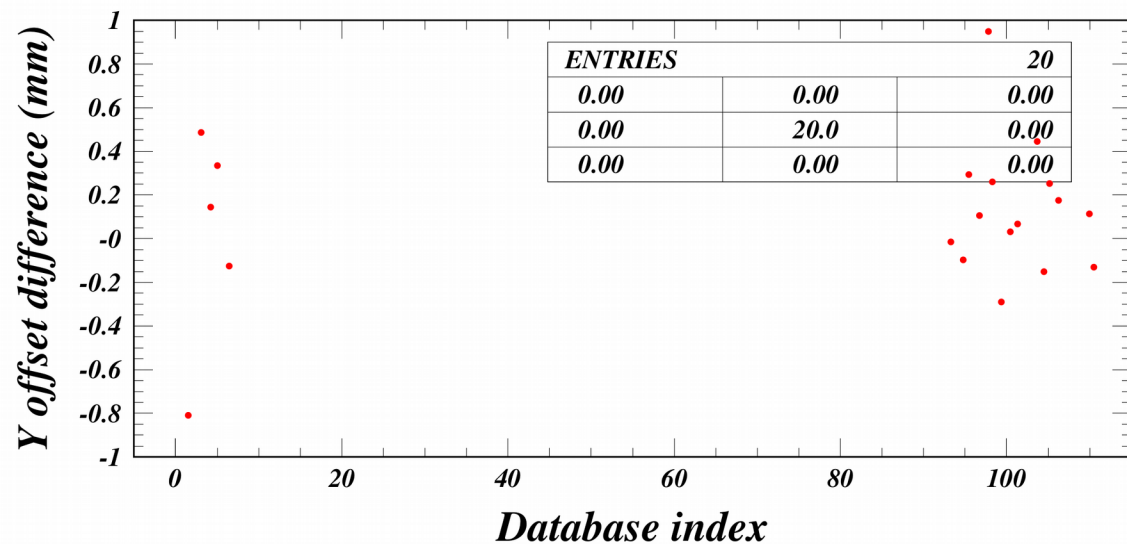
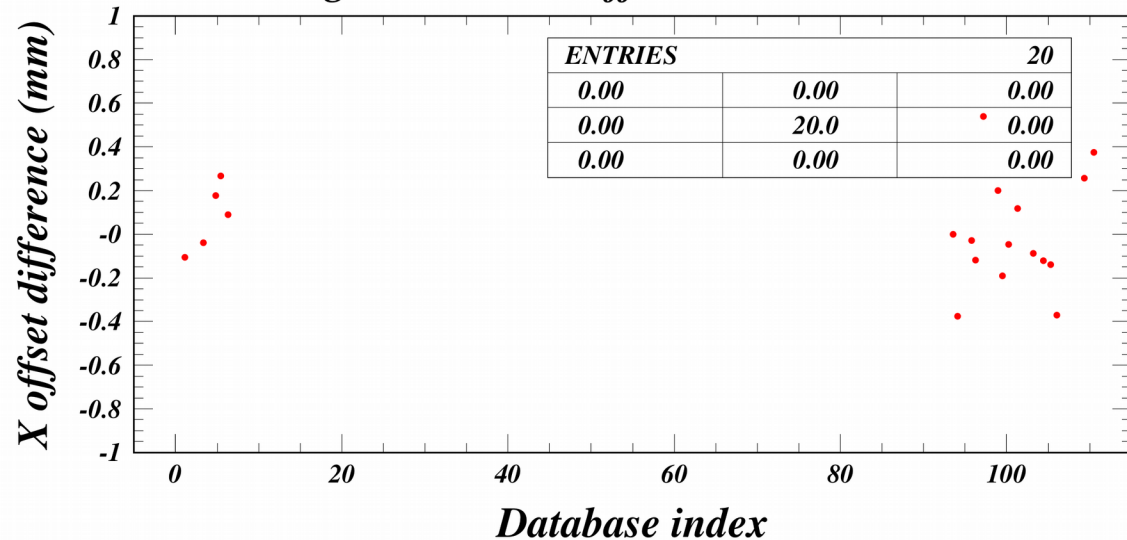
Changes of hundreds of microns are much larger than our single-shot orbit measurement accuracy of about ten microns.

If we want to take full advantage of the orbit measurement precision, we will need to understand the contributions to these changes.



# BPM offset measurement changes since early 2023

*Change in SA BPM offsets on 26 March 2024*

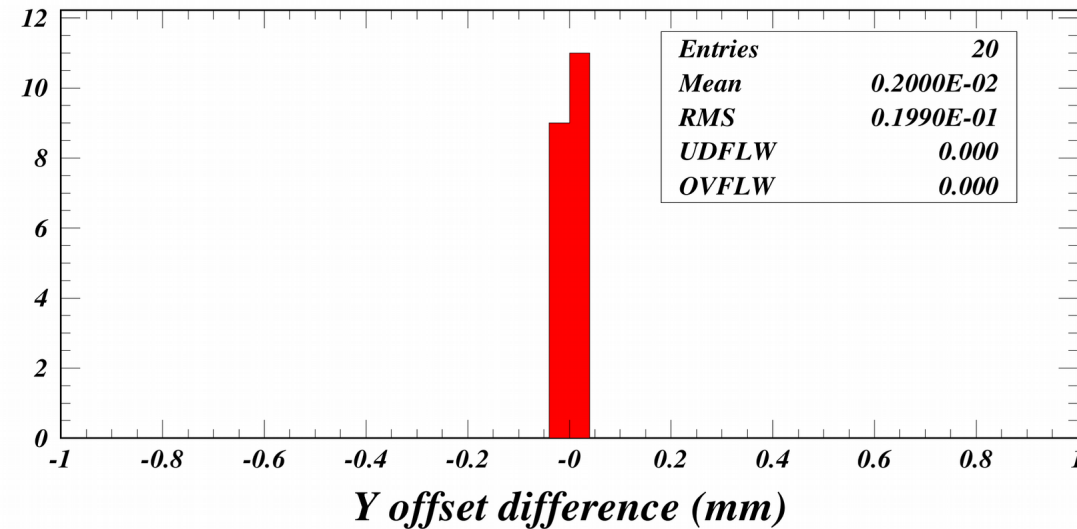
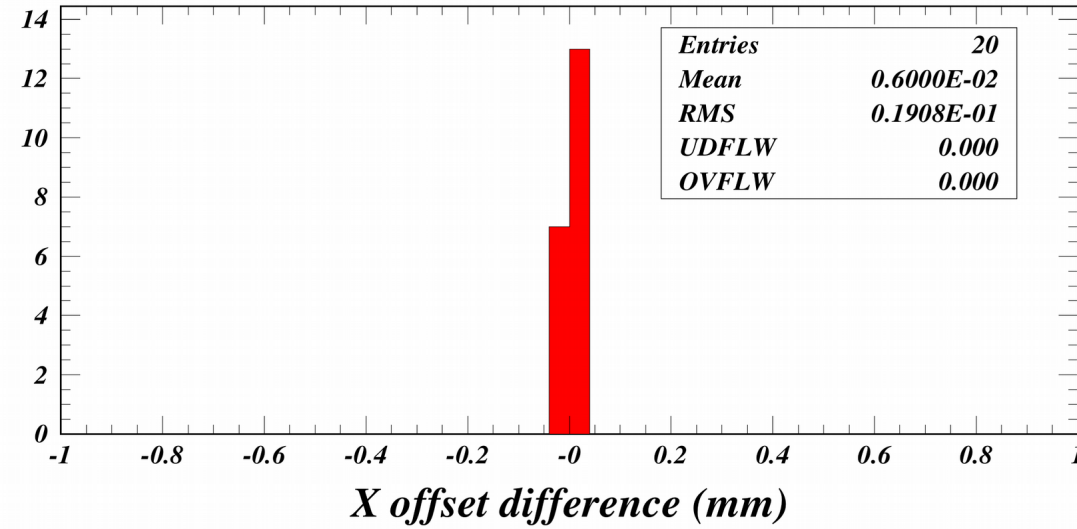


The changes in the BPM offsets are not obviously related their locations.



# One iteration in the measurement of the BPM offsets

## Change in SA BPM offsets after one iteration



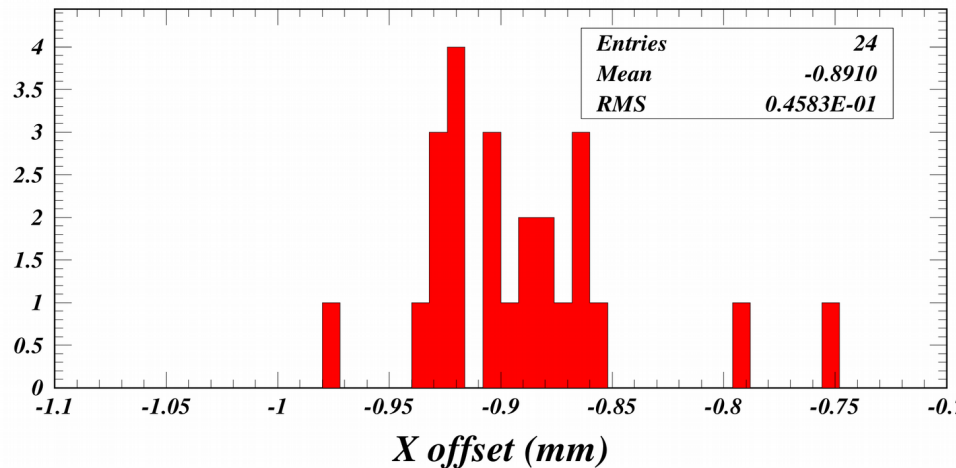
The offset calculation relies on the offsets used in the orbit calculations, so convergence needs to be tested.

A single iteration results in an acceptable convergence to 20 microns.

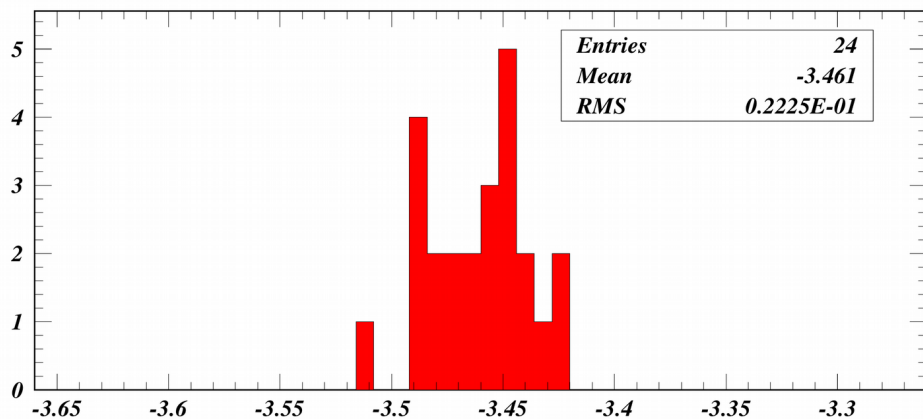


# Repeatability test for BPM 32E

26 March 2024 32E: +- 4 kHz



*X offset (mm)*



*Y offset (mm)*

## Summary of BPM/quadrupole offset measurements at 18E and 32E

### 2 March 2024 18E (Beta X/Y = 38.8/1.8 m)

Tune change X: +-4 kHz Y: +-0.2 kHz

X offset: N=10 avg = -0.200 +- 0.007 rms = 0.023 +- 0.007 mm

Y offset: N=10 avg = 0.231 +- 0.007 rms = 0.046 +- 0.014 mm

Tune change X: +-8 kHz Y: +-0.4 kHz

X offset: N=10 avg = -0.212 +- 0.004 rms = 0.011 +- 0.004 mm

Y offset: N=10 avg = 0.307 +- 0.014 rms = 0.043 +- 0.0 mm

### 19 March 2024 18E (Beta X/Y = 38.8/1.8 m)

Tune change X: +-4 kHz Y: 0.2 kHz

X offset: N=53 avg = -0.167 +- 0.002 rms = 0.017 +- 0.002 mm

Y offset: N=53 avg = 0.308 +- 0.007 rms = 0.060 +- 0.007 mm

Tune change X: +-6 kHz Y: +-0.3 kHz

X offset: N=9 avg = -0.15 +- 0.01 rms = 0.023 +- 0.01 mm

Y offset: N=9 avg = 0.34 +- 0.01 rms = 0.029 +- 0.01 mm

### 26 March 2024 32E (Beta X/Y = 19.3/12.5 m)

Tune change X: +-4.1 kHz Y: 2.7 kHz

X offset: N=24 avg = -0.891 +- 0.007 rms = 0.045 +- 0.007 mm

Y offset: N=24 avg = -3.461 +- 0.004 rms = 0.022 +- 0.004 mm

The X and Y offsets for the default tune range are repeatable at the 10-60 micron level.

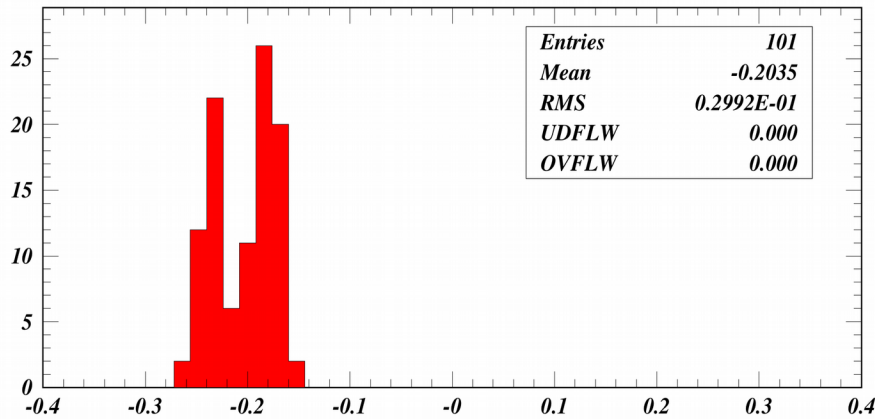
The RMS widths are not always smaller for larger beta (larger tune change).



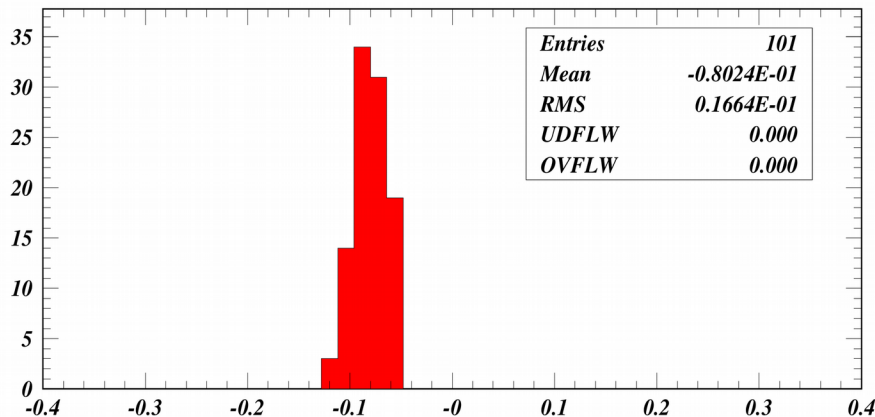


# Phase measurement and optimization repeatability (aka the Shanks test)

Change in offsets for 100 phase file pairs for 32E (2/28/2024--3/26/2024)



*X offset difference (mm)*



*Y offset difference (mm)*

## Recalibration using 100 phase file pairs for BPM 32E

The offset file in use on 26 March is now named offset.bpm.20240329. It was also used for these recalibrations.

The offset values for BPM 32E in this file are

$$X_{\text{offset}} = -3.41 \text{ mm} \quad Y_{\text{offset}} = -0.72 \text{ mm}$$

The Q32E settings used for these recalibrations were 22593 cu and 20615 cu, corresponding to a horizontal tune change of 101.16 kHz and a vertical tune change of 65.20 kHz.

The orbit kicks are -26.9 microradians in X and 8.9 microradians in Y.

Repeatability is found to be 30 microns in X and 17 microns in Y. This is a significant contribution to the overall repeatability of 45 microns in X and 22 microns in Y.

The odd double-peak structure in X is not correlated with phase file number.