Effect of inaccuracy TWISS parameter estimation in ATF extraction line.

Note from J. Brossard, 16 may 2008.

In order to perform an accurate matching procedure in the diagnostic section of ATF extraction line, we have to estimate the effect of the error on measured TWISS parameter. Because if this error is too big, the matching procedure might not work.

Here, we focus only on y-y' TWISS parameters, assuming that the coupling is negligible.
In this study the QD8X quad scan measurement performed during the 14 may 08 shift is analysed.

In the model we used the following input :
1/ Status of the machine used to create a mad file (using Mark's tool) : SET08MAR12_1130.dat.
In the output mad file, the following quadrupoles strength have been change (needed to correct dispersion) : QF3X : K1 =0.690966756033 QF4X : K1 =0.666314119888
QS1X : K1 =0.2812e-3 QS2X : K1 =-0.14362e-2
3/ K1(QF3X)=[95%]*K1(QF3X).
2/ Twiss parameters values at QD8X entrance from measurement (assuming 10% error on R matrix element) : β_y=41+/-9 m α_y=-10+/-3.

Assuming gaussian errors on β_y and α_y values measured at QD8X entrance (with σ=9 (resp. 3)) and performing 100 trial of Monte-Carlo simulation, the following plots for the vertical beam size and the vertical phase advance in the ATF extraction line are obtained.

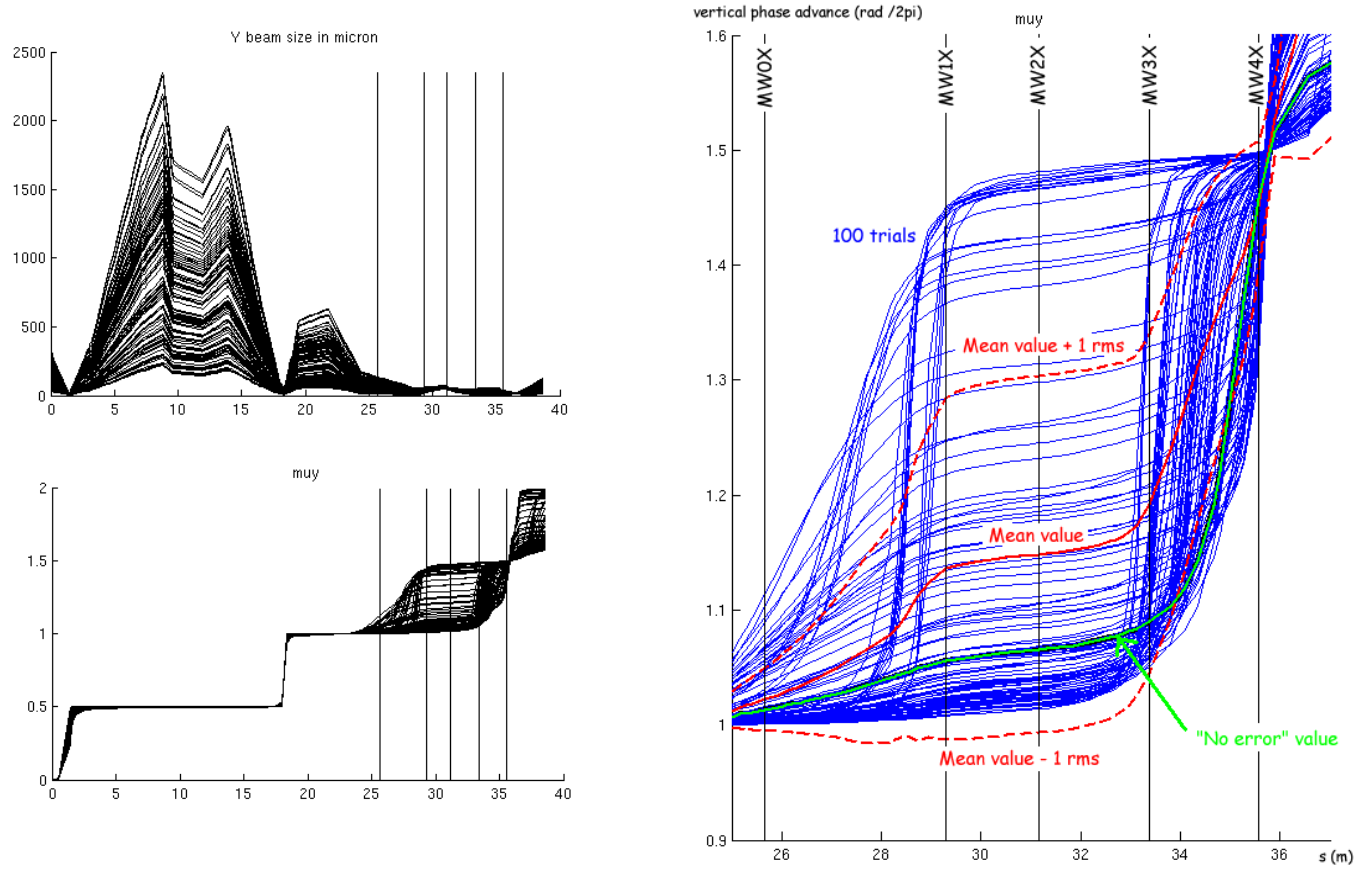


Figure 1 : **left panel**: vertical beam size and phase advance in the ATF extraction line.
Right panel: vertical phase advance [in rad/(2π)] in diagnostic section. The vertical black lines represent the wire scanner position. The blues curves are the 100 Monte-Carlo trials. The green curve is the phase advance using the TWISS parameter determine at QD8X without error.

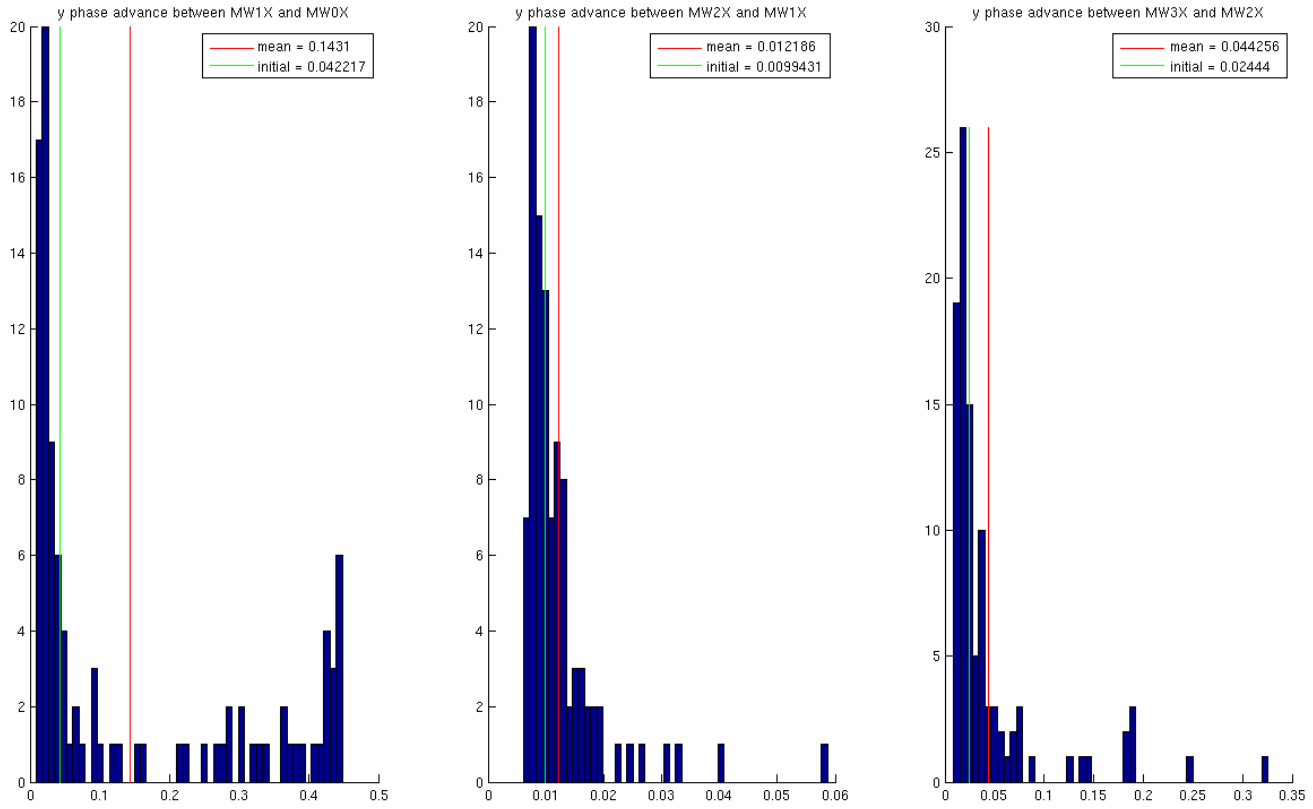
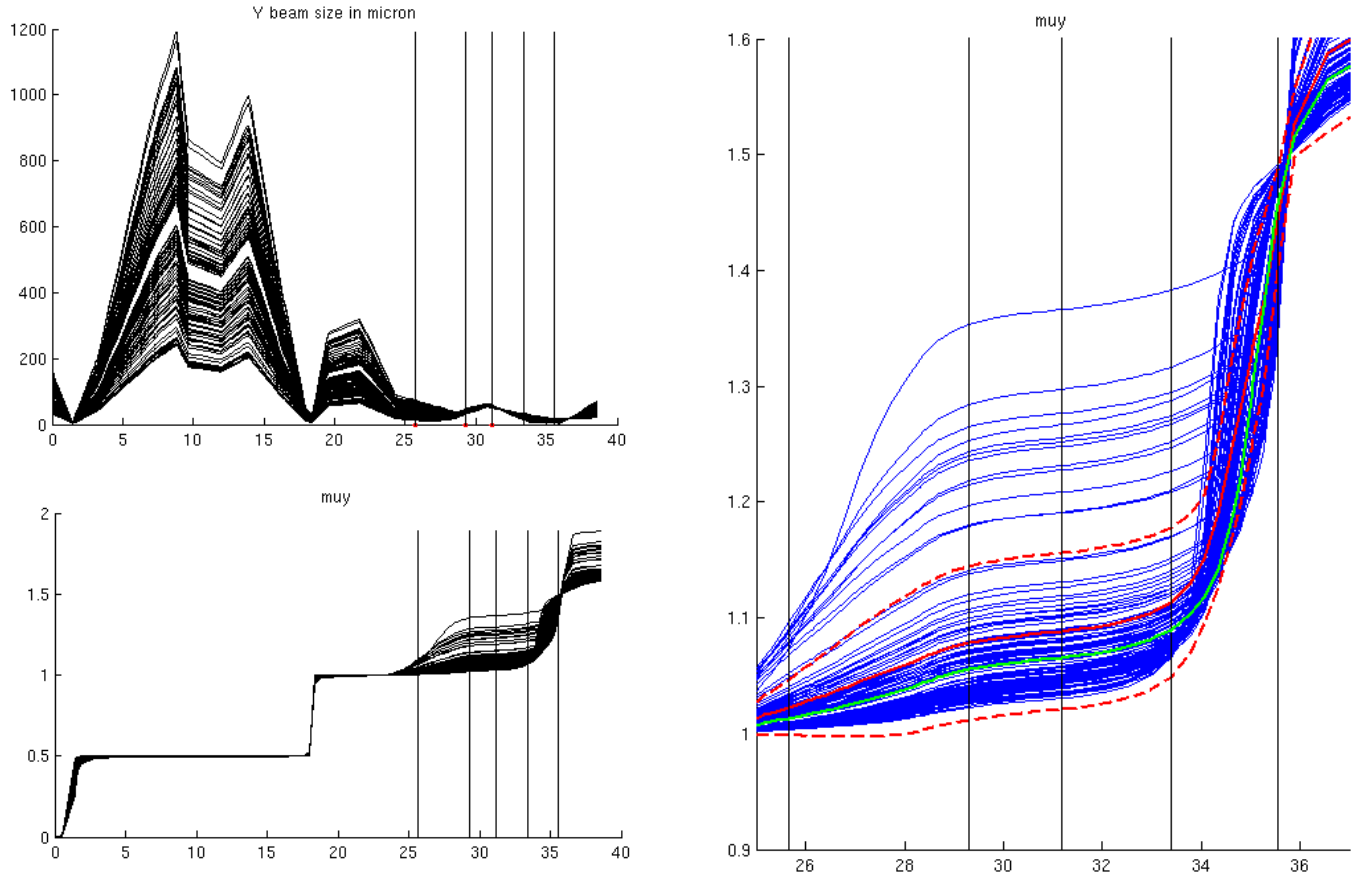


Figure 2 : histograms of difference of phase advance [rad / (2*π)] between wire scanner station obtain from Monte-Carlo simulation. The vertical red line is the mean value of the entire trail. The vertical green line is the difference phase advance obtains using the TWISS parameters at QD8X without error.

An other simulation has been performed assuming a better determination of the TWISS parameter at QD8X. In the following exercise, we have taken: β_y=41+/-3 m α_y=-10+/-1. (One third of the preceding error level). The following plots show that the mean value of the Monte-Carlo simulation and the "without error" green curve are more similar than it is in the preceding simulation.



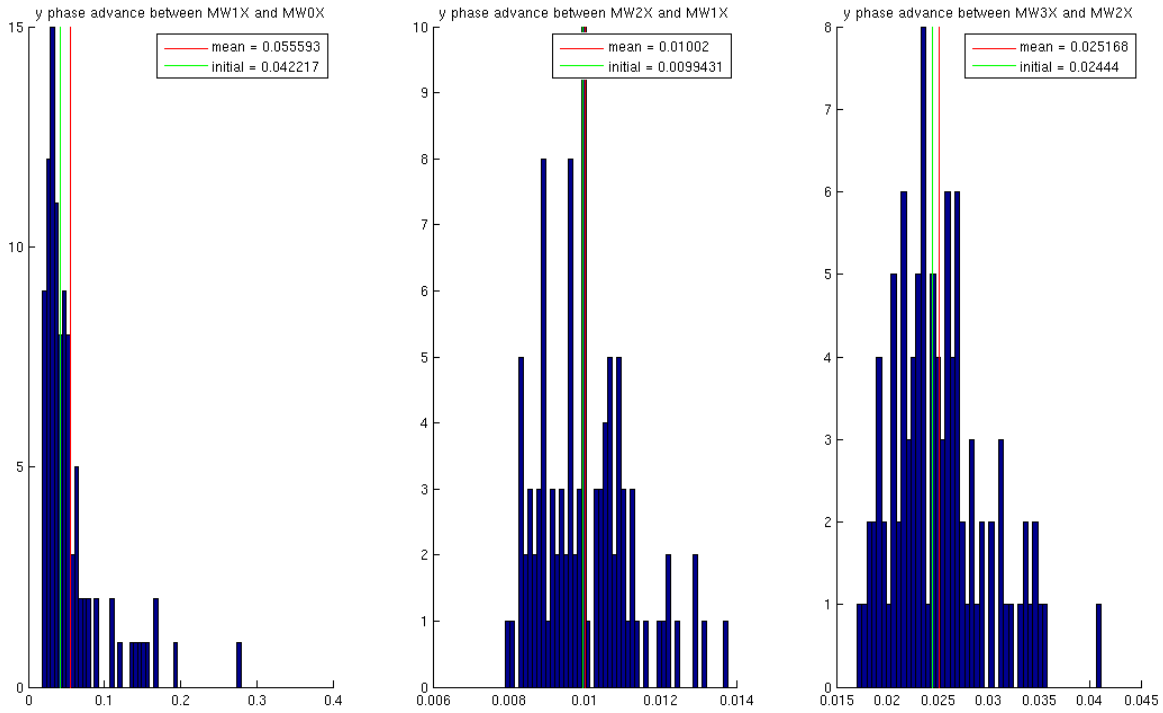


Figure 3 : histograms of difference of phase advance [rad / (2*π)] between wire scanner station obtain from Monte-Carlo simulation. The vertical red line is the mean value of the entire trail. The vertical green line is the difference phase advance obtains using the TWISS parameters at QD8X without error.

Thus, this study shows that the error on measured TWISS parameters should be well determined in order to insure an accurate matching procedure. If this error level is too big, then, the matching procedure should be numerically tested for a set of TWISS parameters included in the range deduced from measurement (with errors) in order to determine the validity of this procedure.

Matched line and TWISS parameter propagation.

A matching procedure – developed by Rob - has been applied using the initial TWISS parameters (with no error) obtained from QD8X quad scan measurement. The TWISS parameters values along this new line have been computed assuming 2 different error levels on initial TWISS values (see Table 1). For each error level, a Monte-Carlo simulation has been performed using 100 trials.

	β_y (m)	α_y
Case 1 : “High” error level	41+/- 9	-10 +/- 3
Case 2 : “Low” error level	41+/- 3	-10 +/- 1

Table 1 : Error level on initial TWISS parameters used in both analysis.

Case 1 : "High" error level

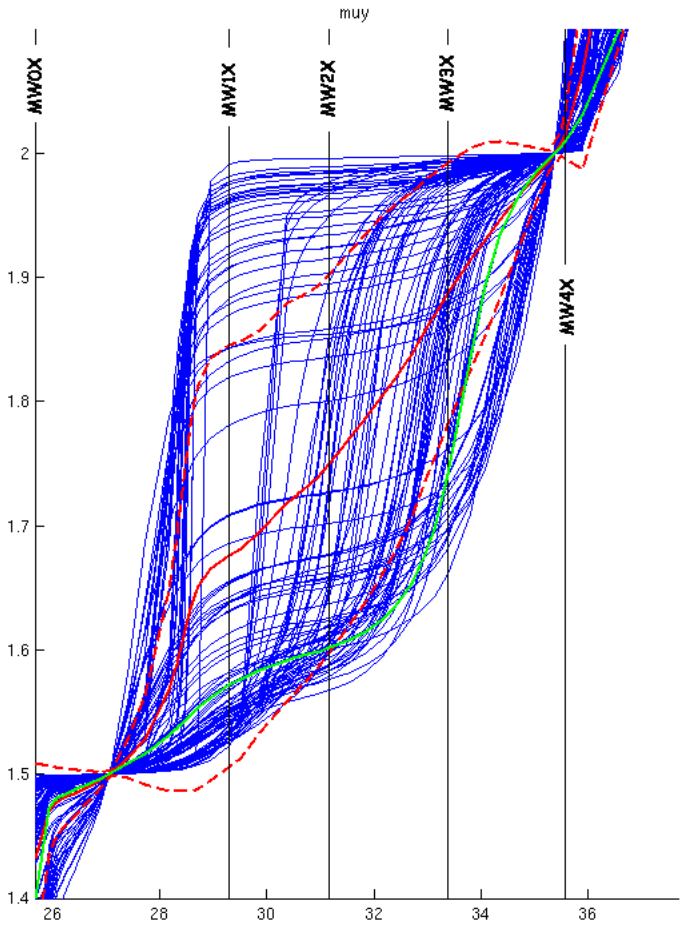


Figure 4 : vertical phase advance [in rad/(2π)] in diagnostic section for the matched line (assuming an error of 9m and 3 on β_y and α_y value at QD8X entrance).

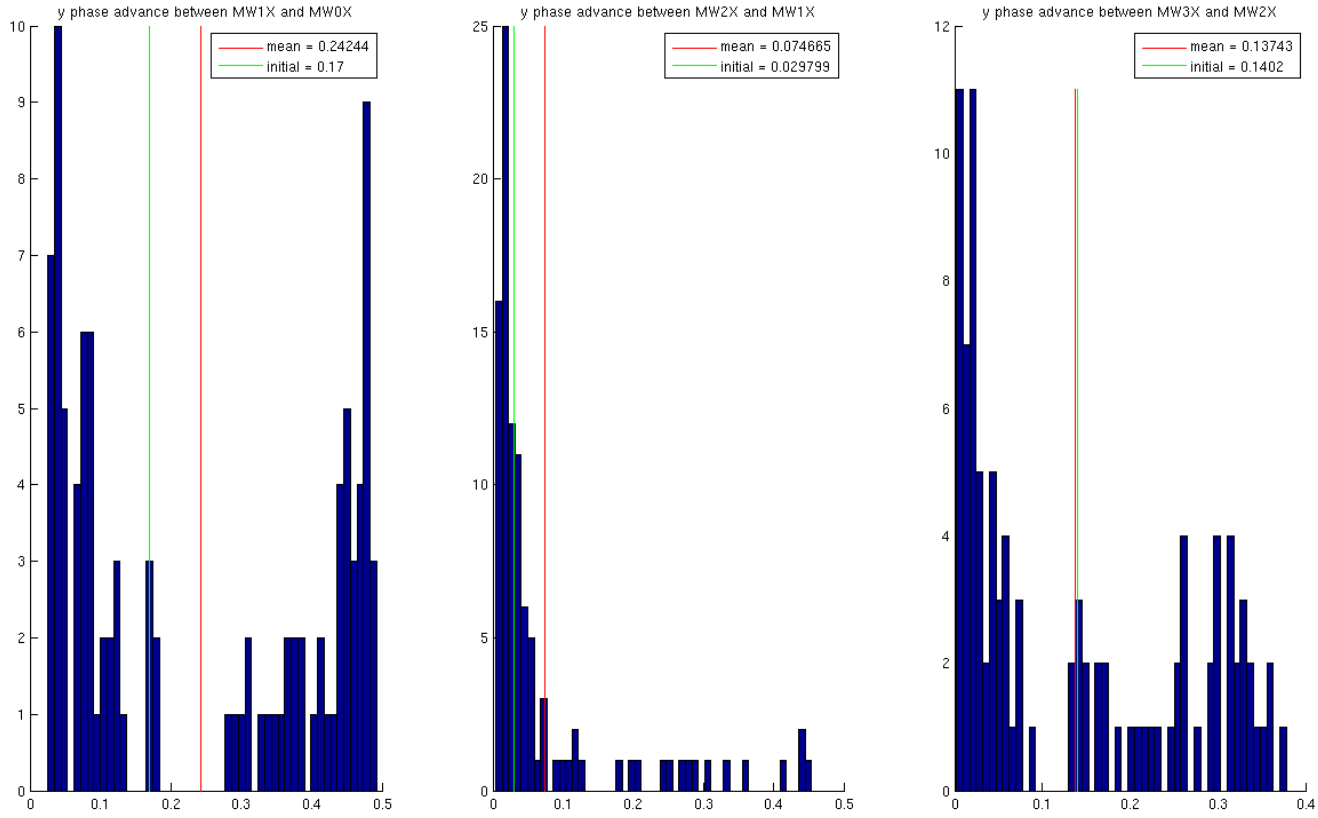


Figure 5 : histograms of difference of phase advance [rad / (2*π)] between wire scanner station obtain from Monte-Carlo simulation. The vertical red line is the mean value of the entire trail. The vertical green line is the difference phase advance obtains using the TWISS parameters at QD8X without error.

Case 2 : "low error level"

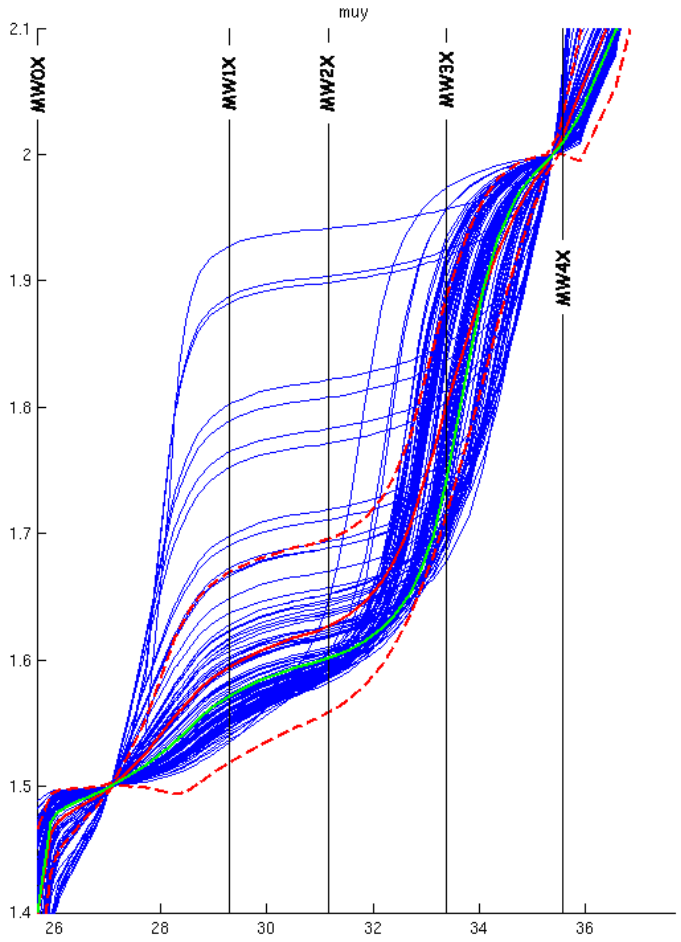


Figure 6 : vertical phase advance [in rad/(2π)] in diagnostic section for the matched line (assuming an error of 3m and 1 on β_y and α_y value at QD8X entrance).

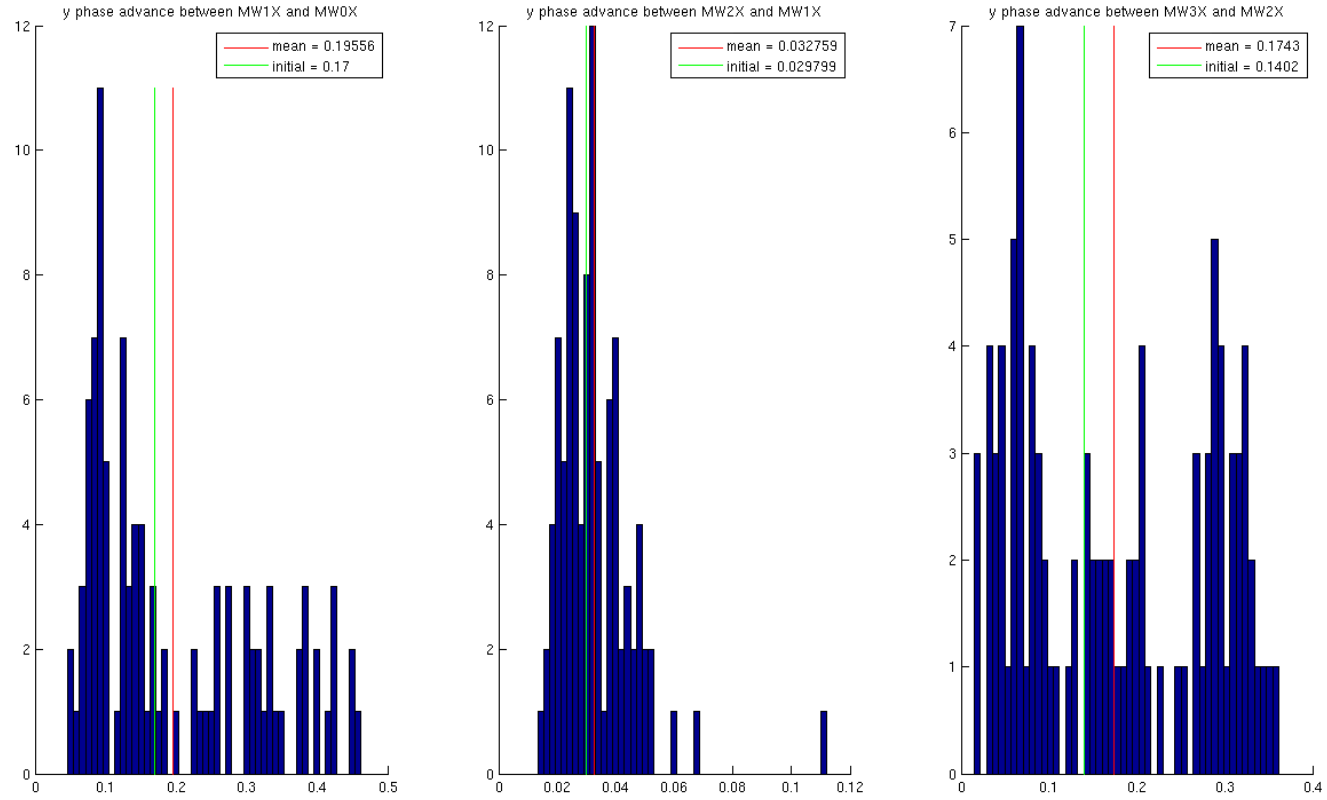


Figure 7 : histograms of difference of phase advance [rad / (2*π)] between wire scanner station obtain from Monte-Carlo simulation. The vertical red line is the mean value of the entire trail. The vertical green line is the difference phase advance obtains using the TWISS parameters at QD8X without error.

Conclusions :

If the error on initial TWISS parameters (at QD8X entrance) is near the “high” level error case, then the confidence in the matching procedure is poor (the dispersion of the blues curves [see Figure 4] around the mean value is very large, and phases advance in diagnostic section cannot be correctly constrained).

If the error on initial TWISS parameter is near the “low” level error case, the matching procedure validity is better because the mean value (of the 100 trails) and the “no error” μ_y curves [see **Figure 6**] give similar phase advance. *Nevertheless, this error level is not small enough to insure a systematic “correct” matching procedure.*