PXIE RFQ without frequency stabilization

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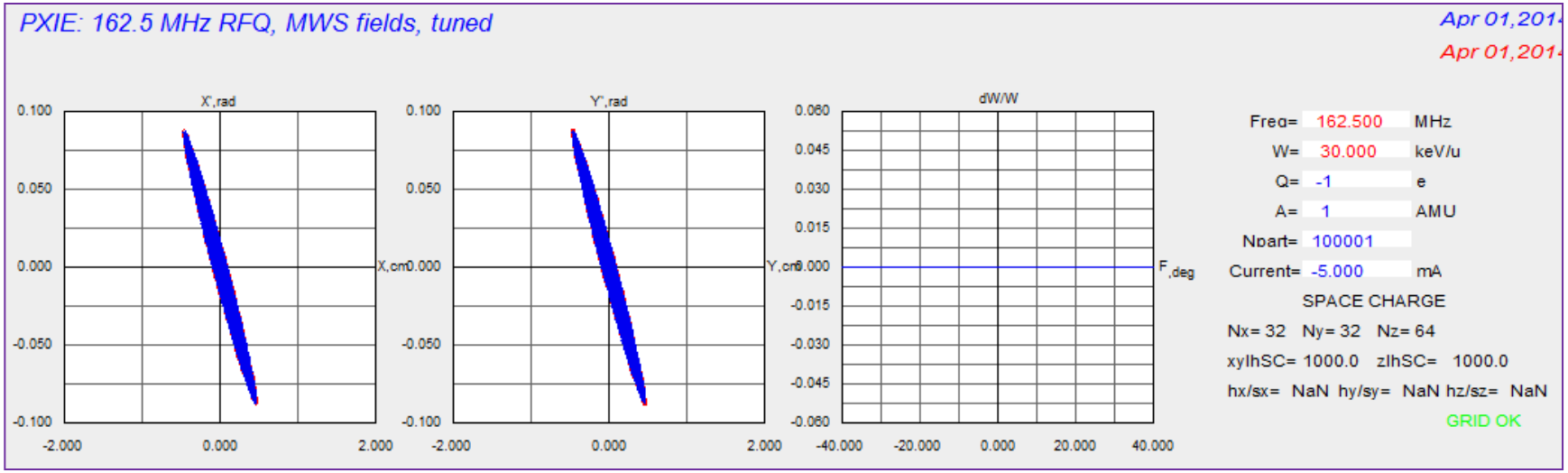
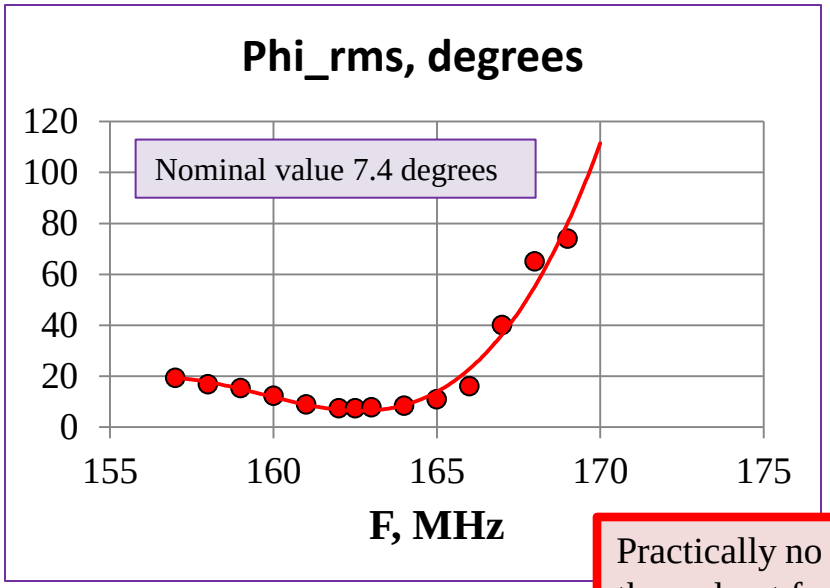
Input beam

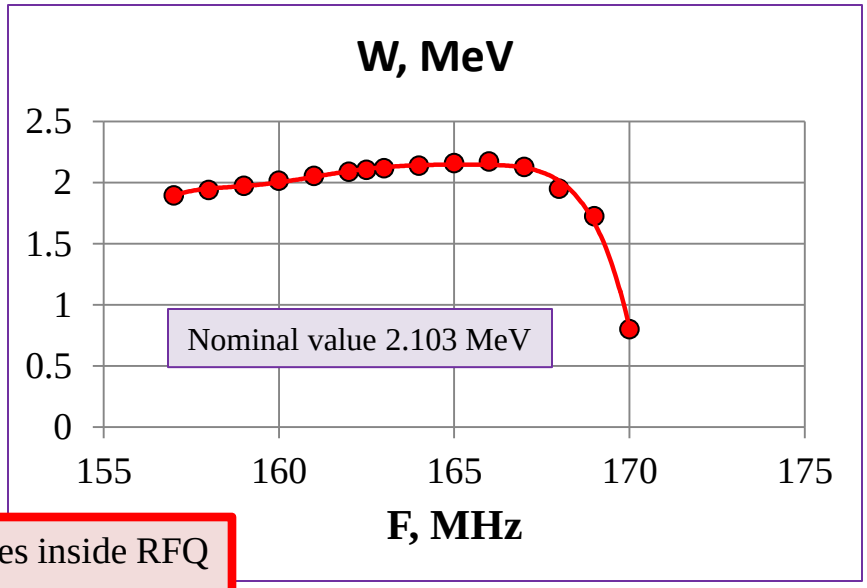
$6\cdot\varepsilon_norm_rms = 0.0695\ \pi$ cm·mrad (nominal value).
$\alpha_x = \alpha_y = 4.75$; $\beta_x = \beta_y = 26.11$ cm/rad (matching at RFQ's entrance).
Uniform distribution, I = 5 mA, W = 30 keV.
Length of DC beam is 2π, number of particles 100000.
Fields – from complete tuned CST MWS model.

Input beam in TRACK

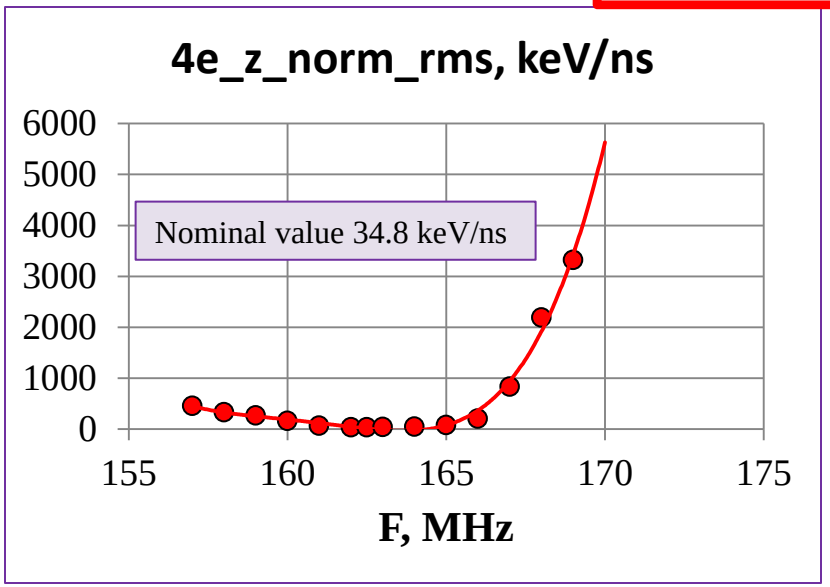


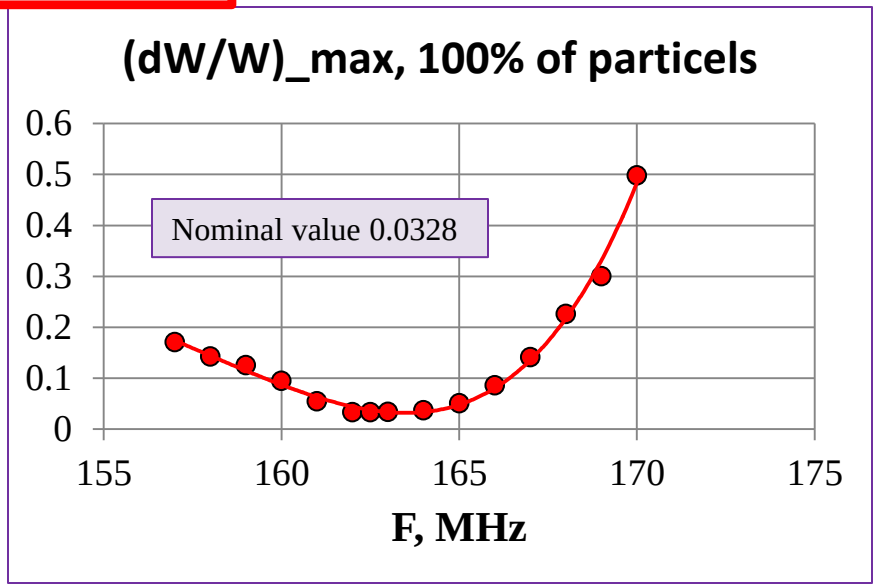
Main output beam parameters vs operating frequency



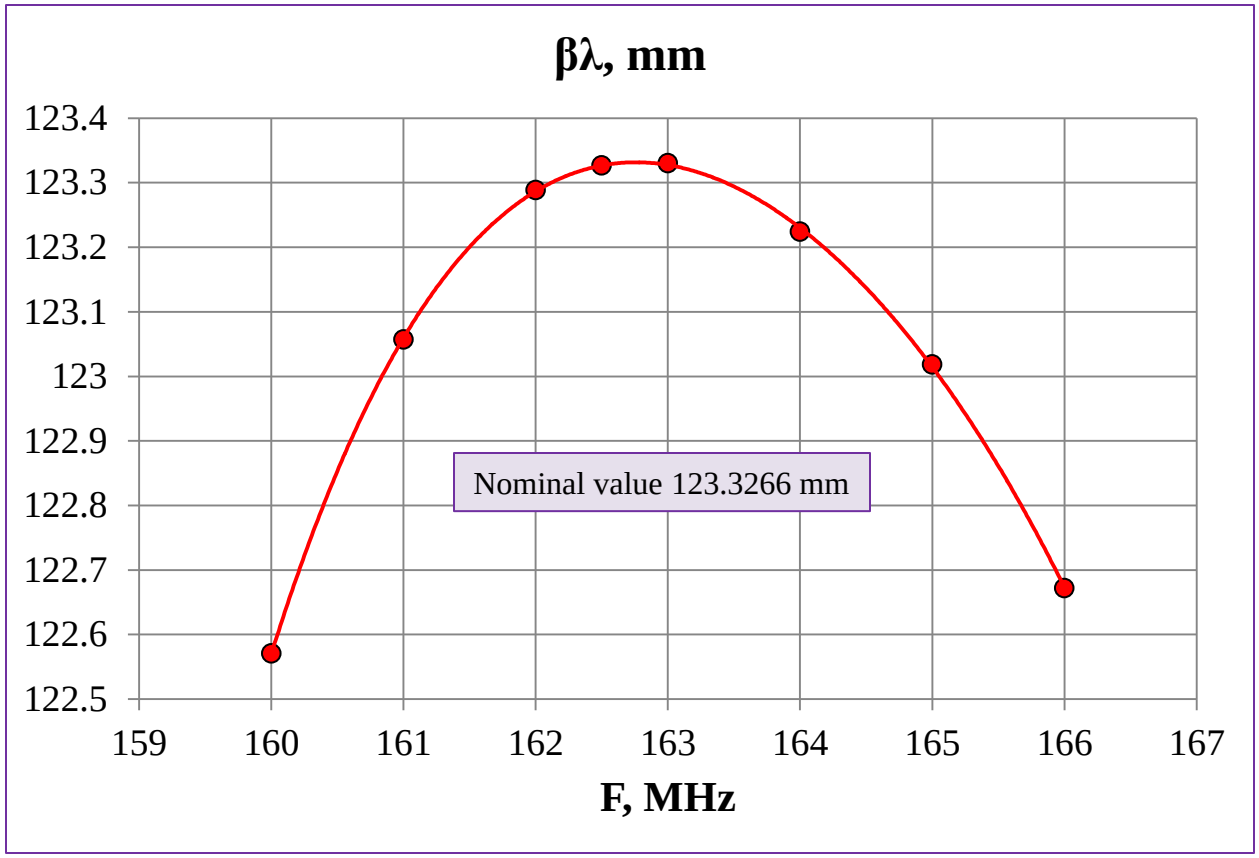


Practically no losses inside RFQ throughout frequency sweep.

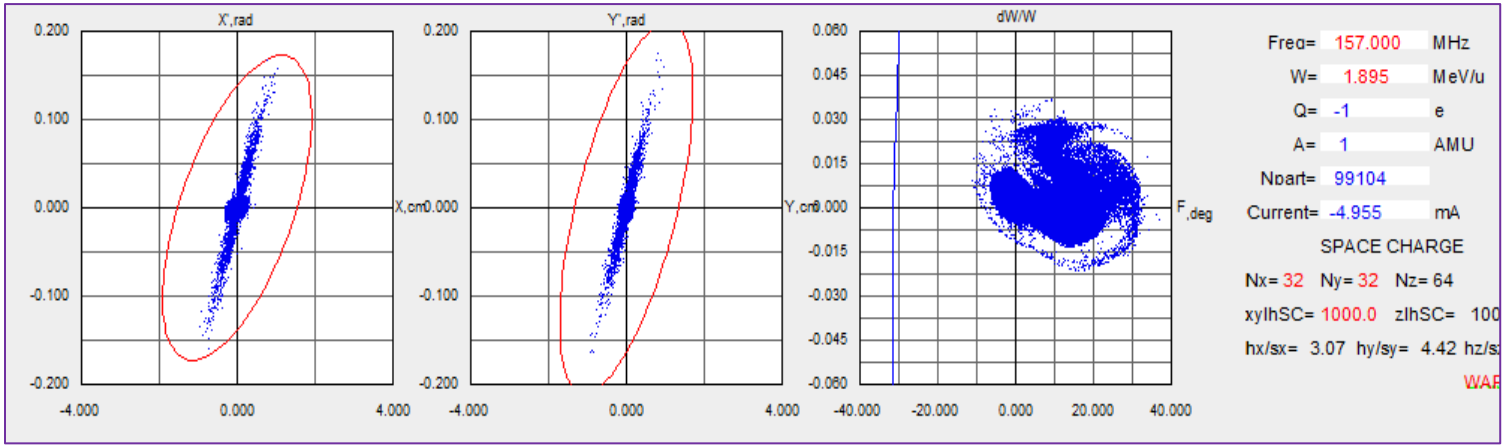


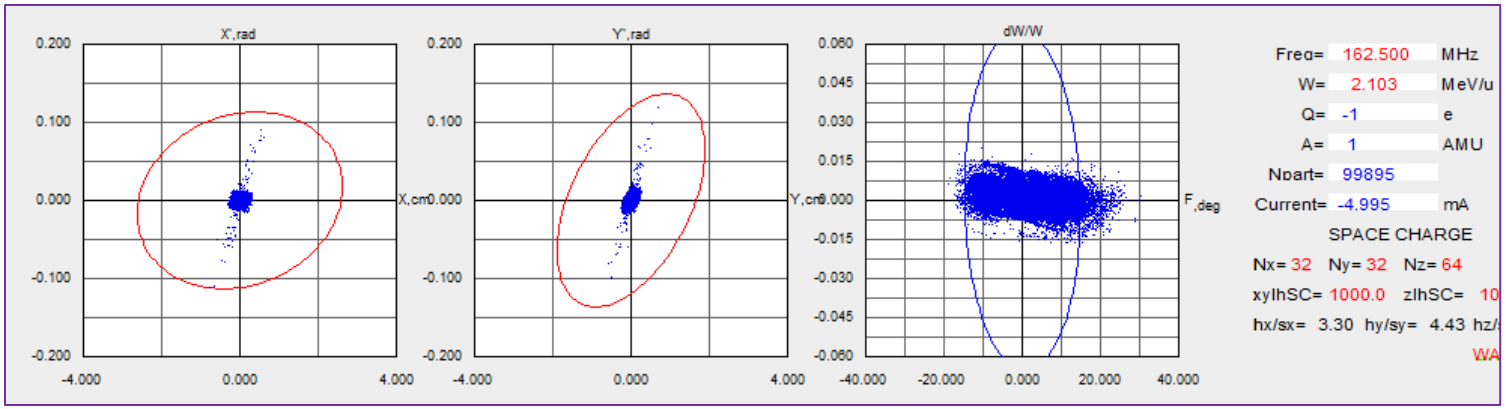


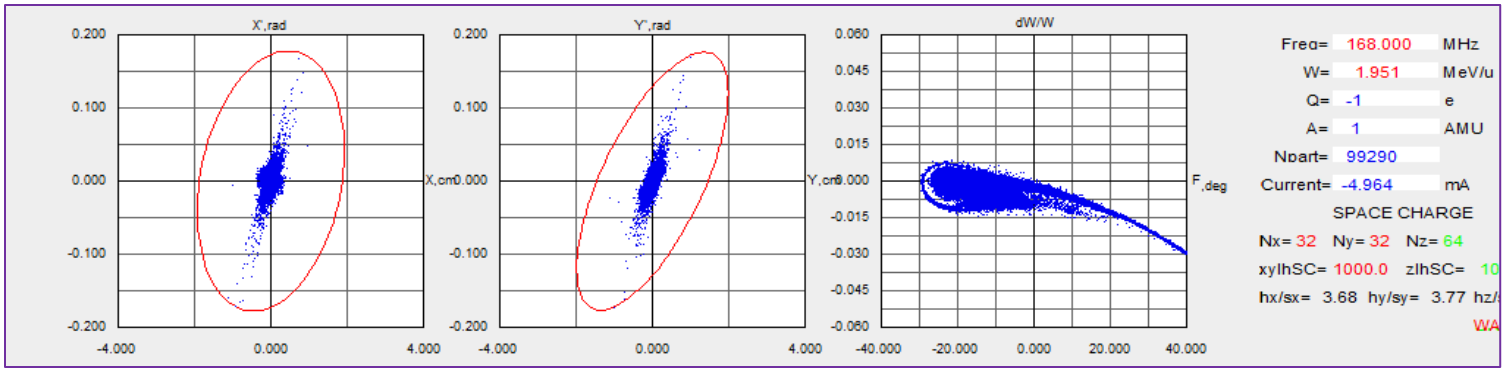
Distance between bunches in output beam



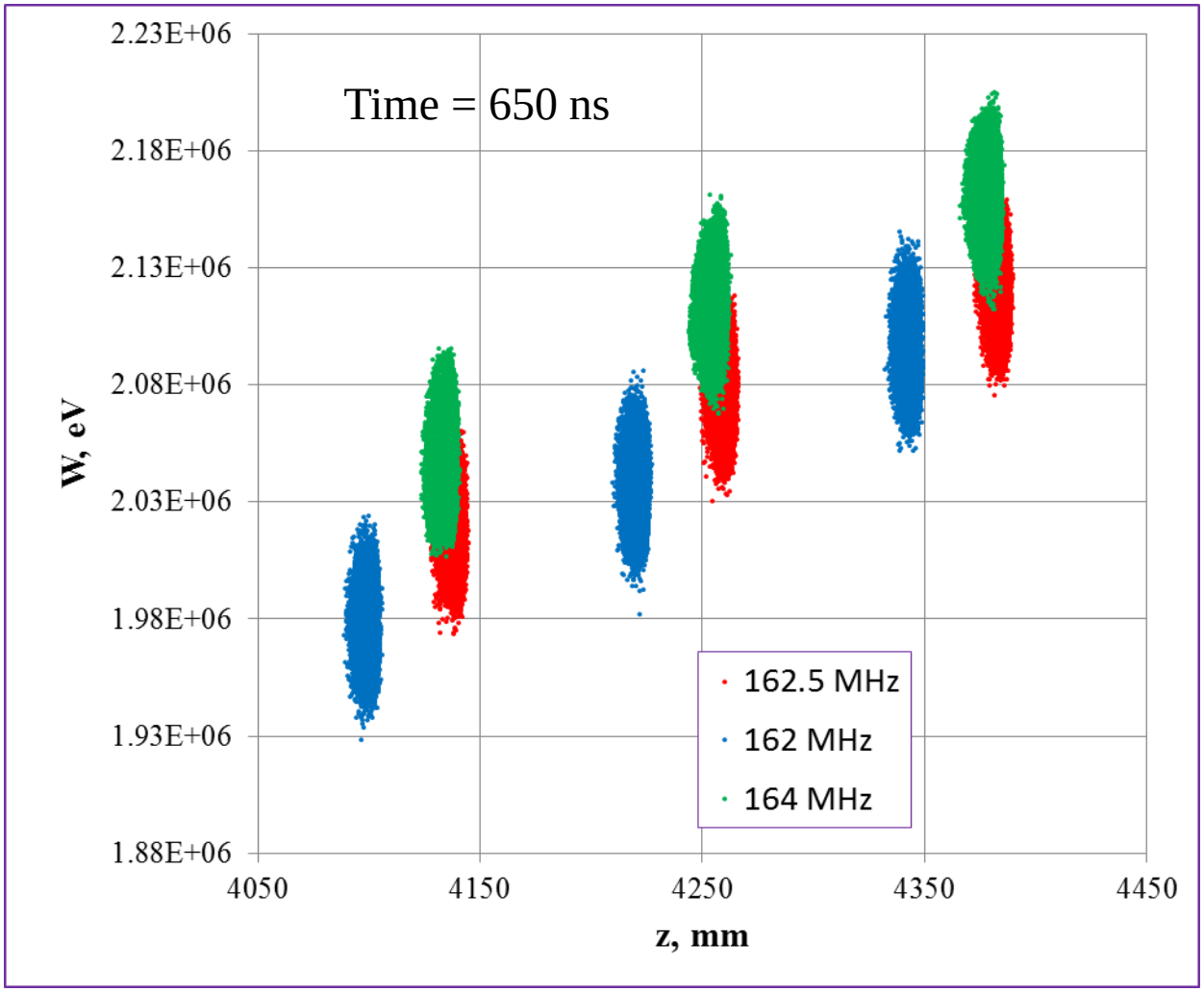
TRACK output beam







CST PIC simulation. Bunches at the end of RFQ.



Comparative table for maximal possible frequency deviations

ΔF, MHz	W, MeV	$\Delta\varphi_{rms}$, °	dW/W, total spread	$4\varepsilon_{norm_rms}$, keV/ns	βλ, mm
1	2.128	8.02	0.046	41	123.258
0	2.103	7.4	0.0328	34.8	123.3266
-1	2.072	8.04	0.0351	51	123.159

Conclusion

1. The simulations show that we can start commissioning the RFQ without comprehensive frequency stabilization system.
2. We can allow frequency deviation at least ± 1 MHz still having an output beam of quality acceptable for commissioning. Further acceleration is questionable though.
3. The beam losses inside the RFQ are negligible, if the input beam has the nominal emittance and it is properly matched at 162.5 MHz. There is no need to re-match the beam during frequency sweep.