

MEBT with Solenoids and Doublets

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10 Nov 2010

Why solenoids (dead end)?

- Quad design was getting very difficult
 - BNL quads may work. 2" quad, 3" physical space.
 - Modified so that $\frac{1}{2}$ windings are hollow for cooling
 - Dipole correctors outside the quad.
 - FNAL design. 70mm (2.75"), 105mm (4.13") physical space.
 - Problem is that they are too long!
 - Dipole correctors are inside quad.
- The new longitudinal emittance at RFQ output is about 2x larger than what we expect
 - Old MEBT design cannot work

Comparing my sim to Schempp's numbers

Input Numbers

$$\alpha_{x,y} = 1.5$$

$$\beta_{x,y} = 5.1 \text{ cm/rad}$$

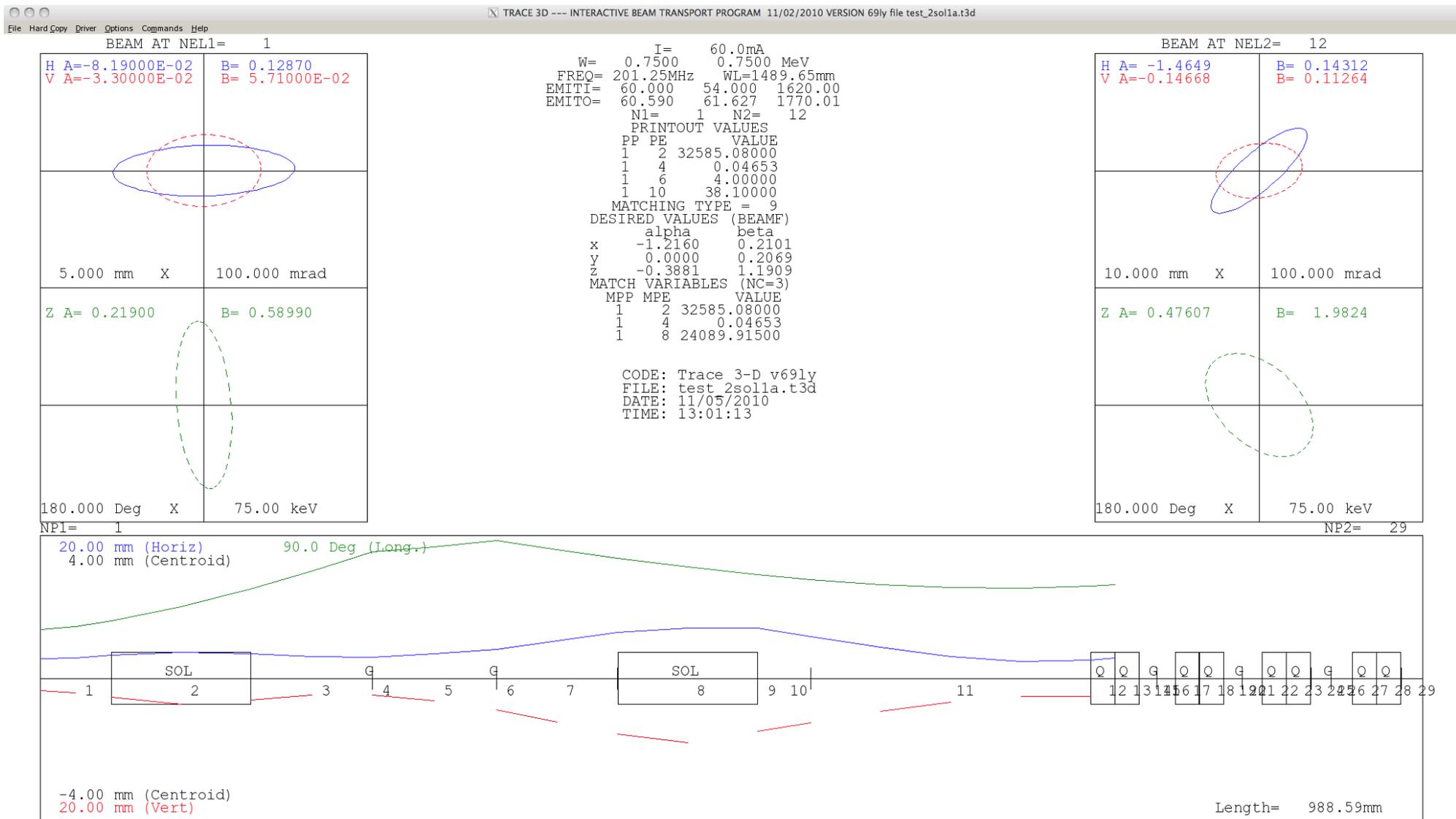
$$\epsilon_{x,y} = 0.021 \text{ pi cm rad}$$

unnormalised

Parameter	Schempp	Mine	Mine(28 Oct 2010)	Units
α_x	-0.18	-0.11	-0.0819	
β_x	12.5	12.8	12.867	cm/rad
ϵ_x	0.37	0.40	0.403	π mm mrad (rms norm)
α_y	0.07	-0.0125	-0.0327	
β_y	5.5	5.62	5.709	cm/rad
ϵ_y	0.35	0.36	0.36	π mm mrad (rms norm)
α_z	0.21	0.30	0.219	
β_z	1170	788.7	589.91	deg/MeV
ϵ_z	0.14	0.21	0.270	π MeV deg (rms unnorm)



Trace3D



Capture is 98.2%
BUT ...

Possible problems

- Solenoids may make life easier.
 - Instead of 3 quads, use 2 solenoids.
 - But strength is quite large
 - 2.5 T to 3.25T (focal length = 10cm and 6cm)
 - Is this doable? **NO!!!!!!!!**
 - Simple back of the envelope calculation using Ampere's law (ignore edges at our peril for now)
 - $$N I = \frac{B L}{\mu_0 \mu_r} = 278 \text{ kAmp turns}$$
$$B = 3.5 \text{ T}$$
$$\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$$
$$\mu_r = 1 \text{ (NOT 4000)}$$
$$L = 10 \text{ cm (4'')}$$

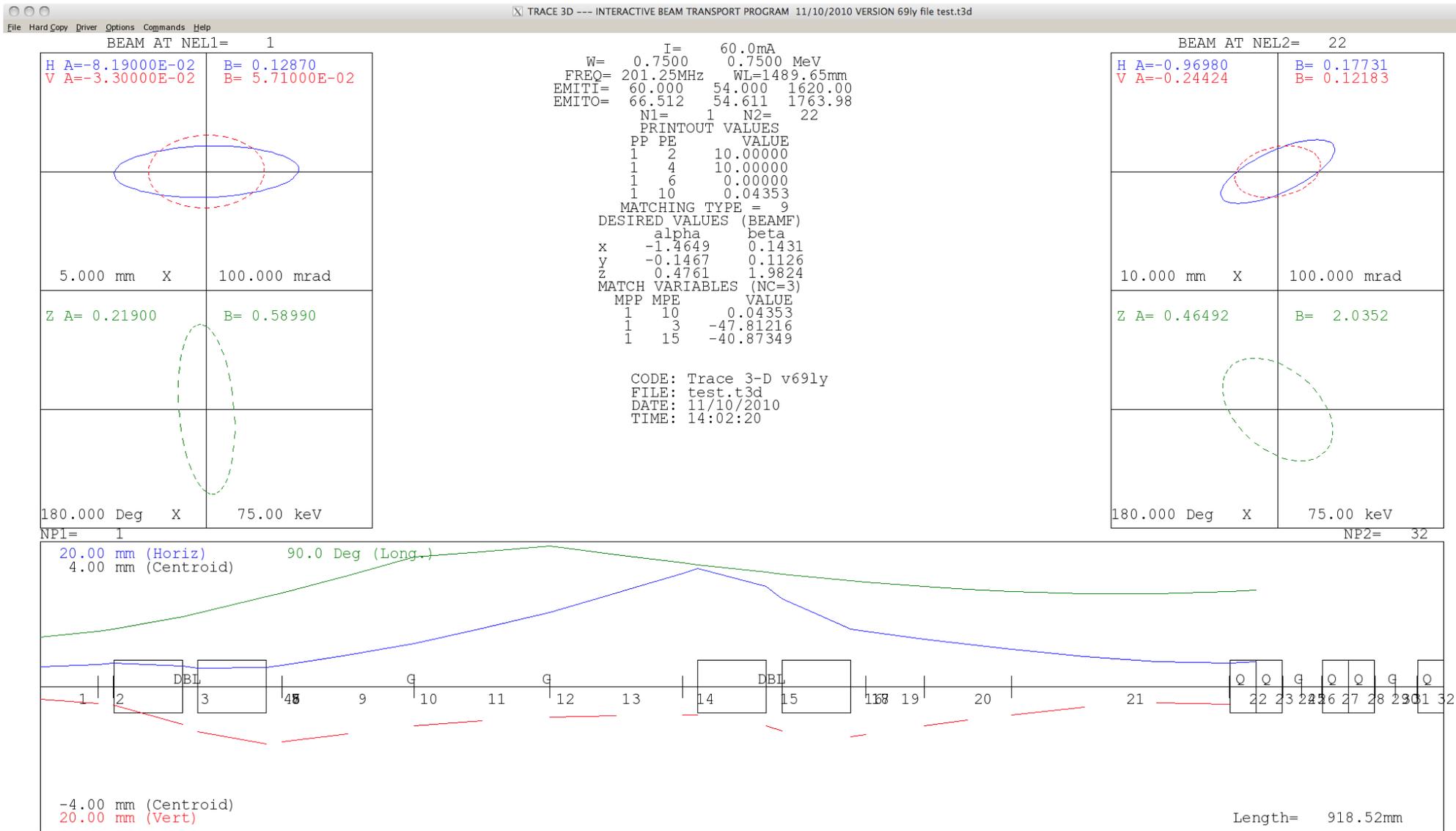
Possible problems (cont'd)

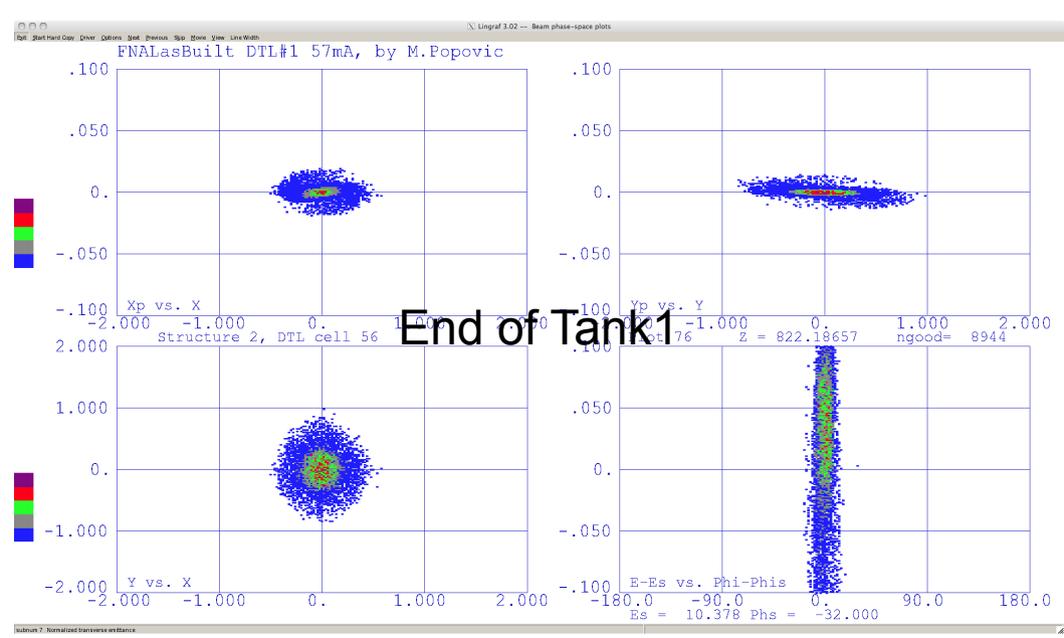
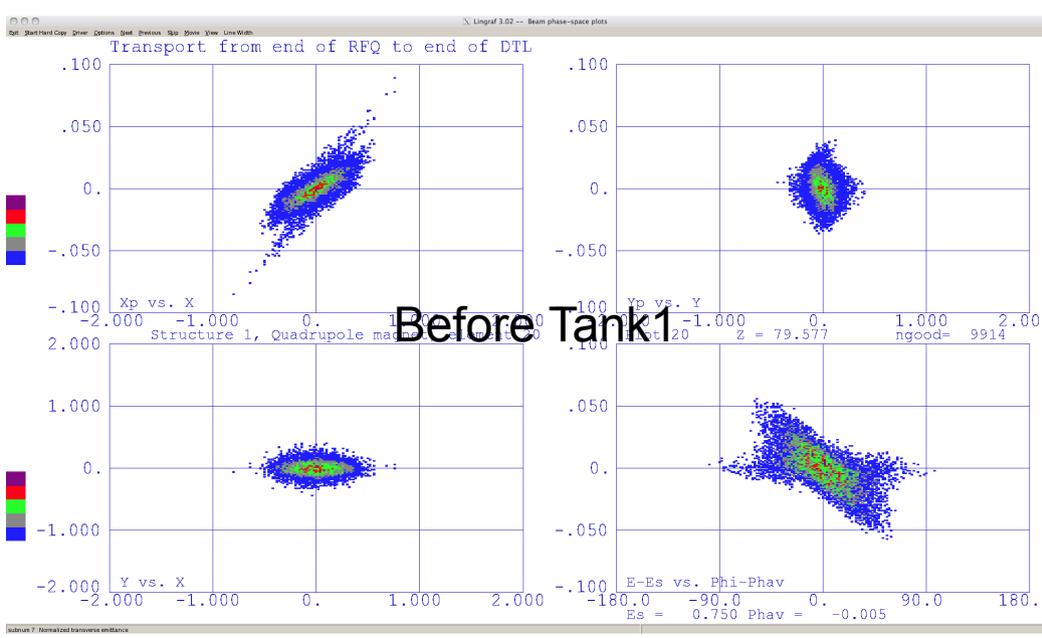
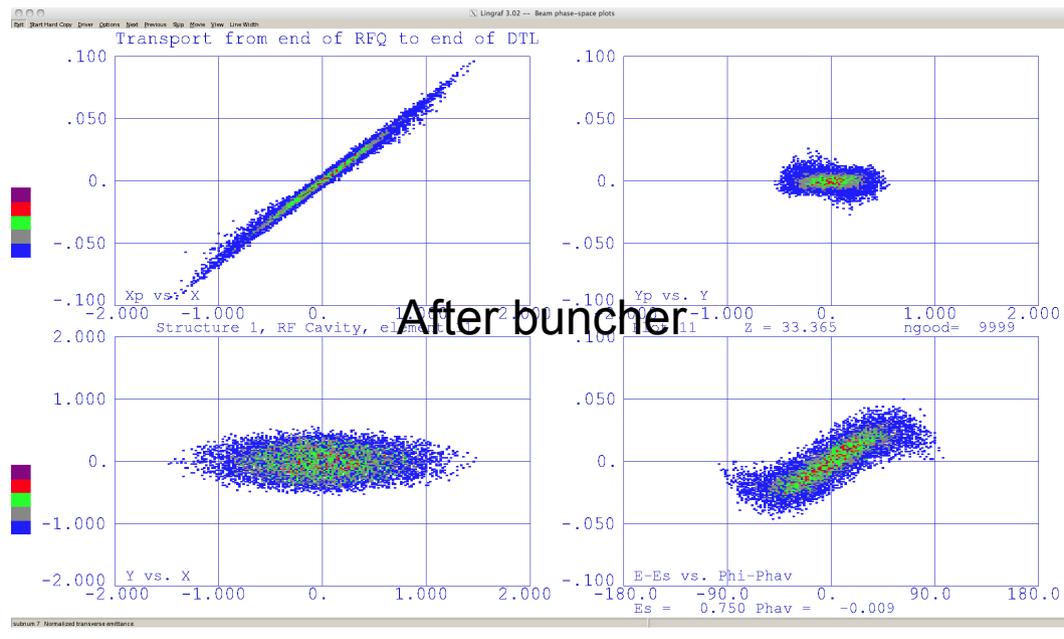
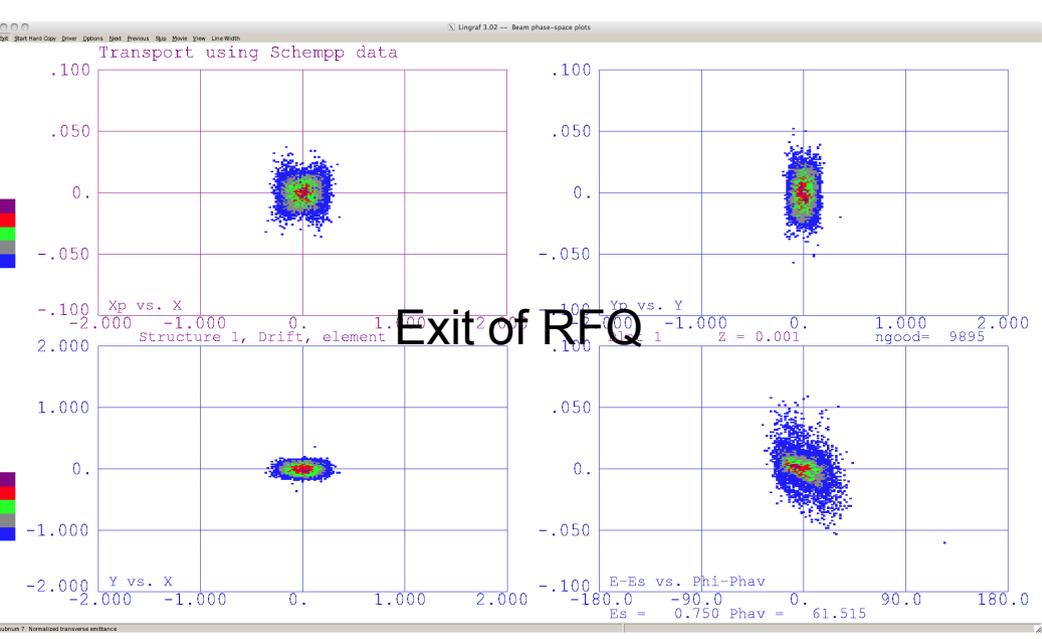
- Multipacting from B-field?
 - Concern brought up by Okamura (BNL)
- Coupling causing emittance growth (D. Raparia)
- Orientation of fields between the two solenoids will give different emittances. (D. Raparia)

Replace Solenoids with Doublets

- We have round beams at the exit of the RFQ
 - That's why solenoids work.
 - Solenoids focus in both planes
 - Replace with doublets.
 - Limit strength of doublet to 60T/m (BNL quads)

Trace3D





Capture is 89.4% at end of Tank 1

Before and End of Tank 1

