PIP RFQ in TRACK with 3D Fields

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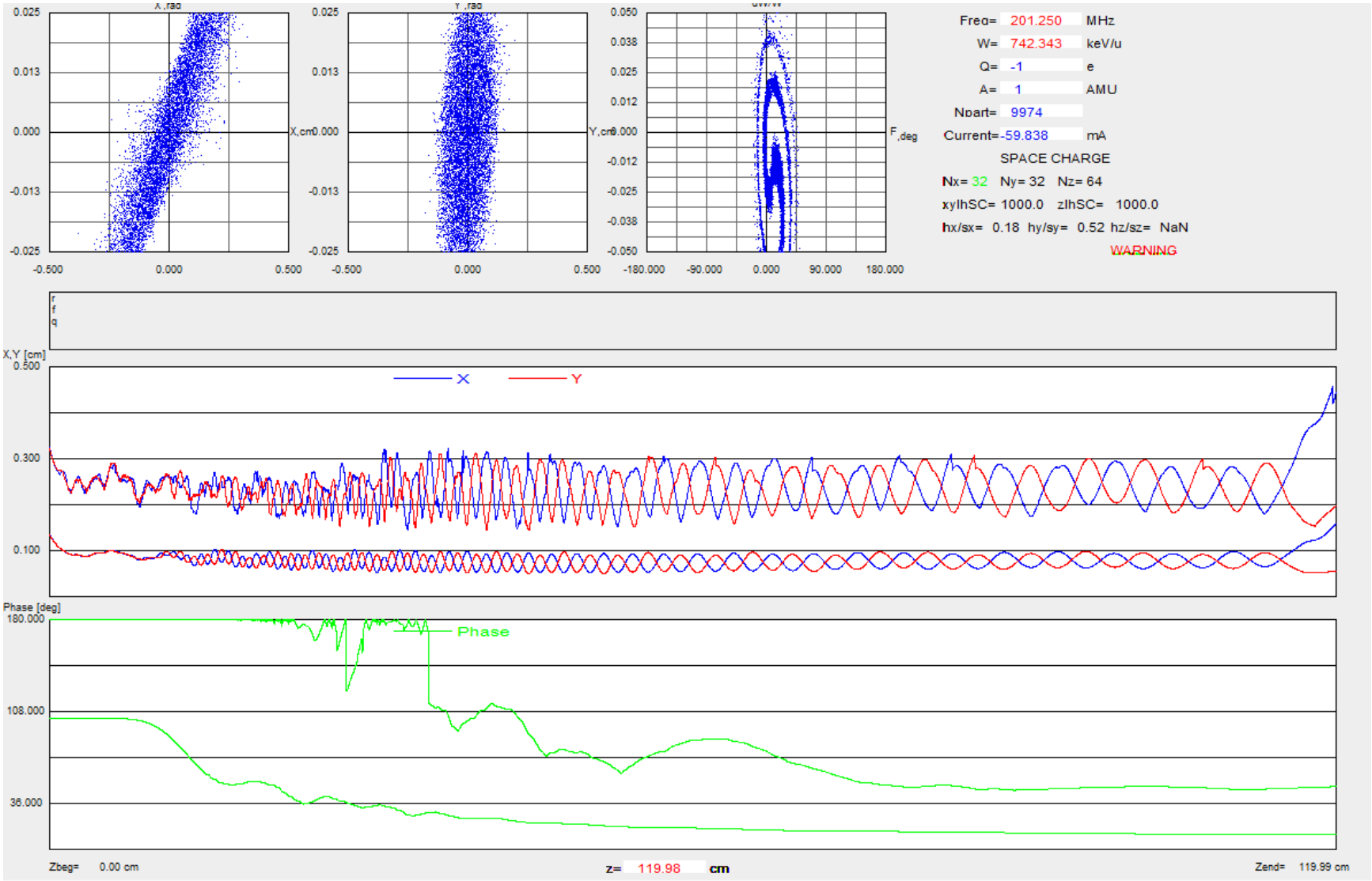
13-AUG-2013

PIP RFQ in TRACK using potential expansion in a multi-cell RFQ (parmteqm conversion)

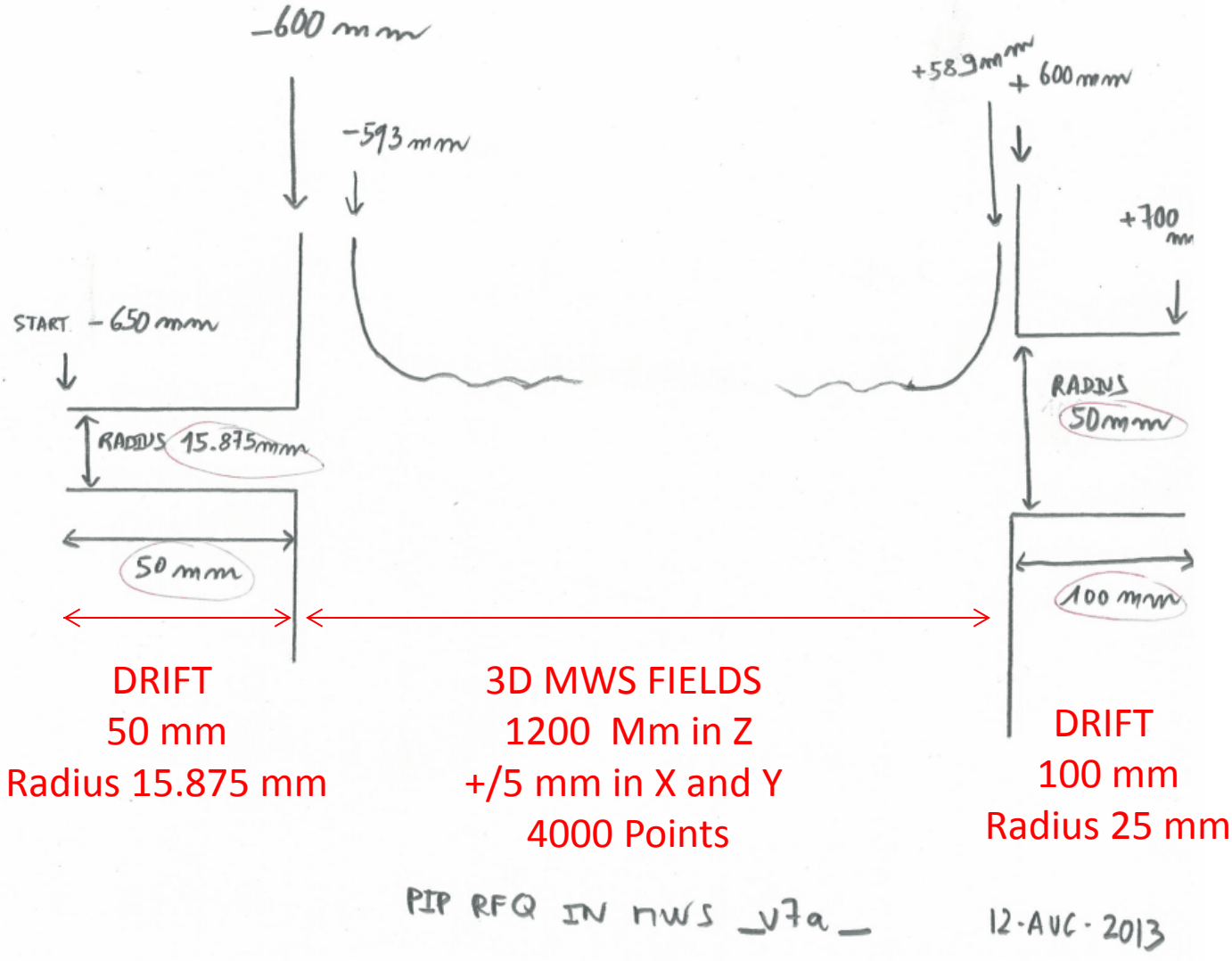
PIP RFQ in TRACK – ANALYTICS FROM PARMTEQM. MATCHED with 1.5 and 5.1 cm/rad 99.7 % transmission. 0.3 mm-mrad all along the RFQ.



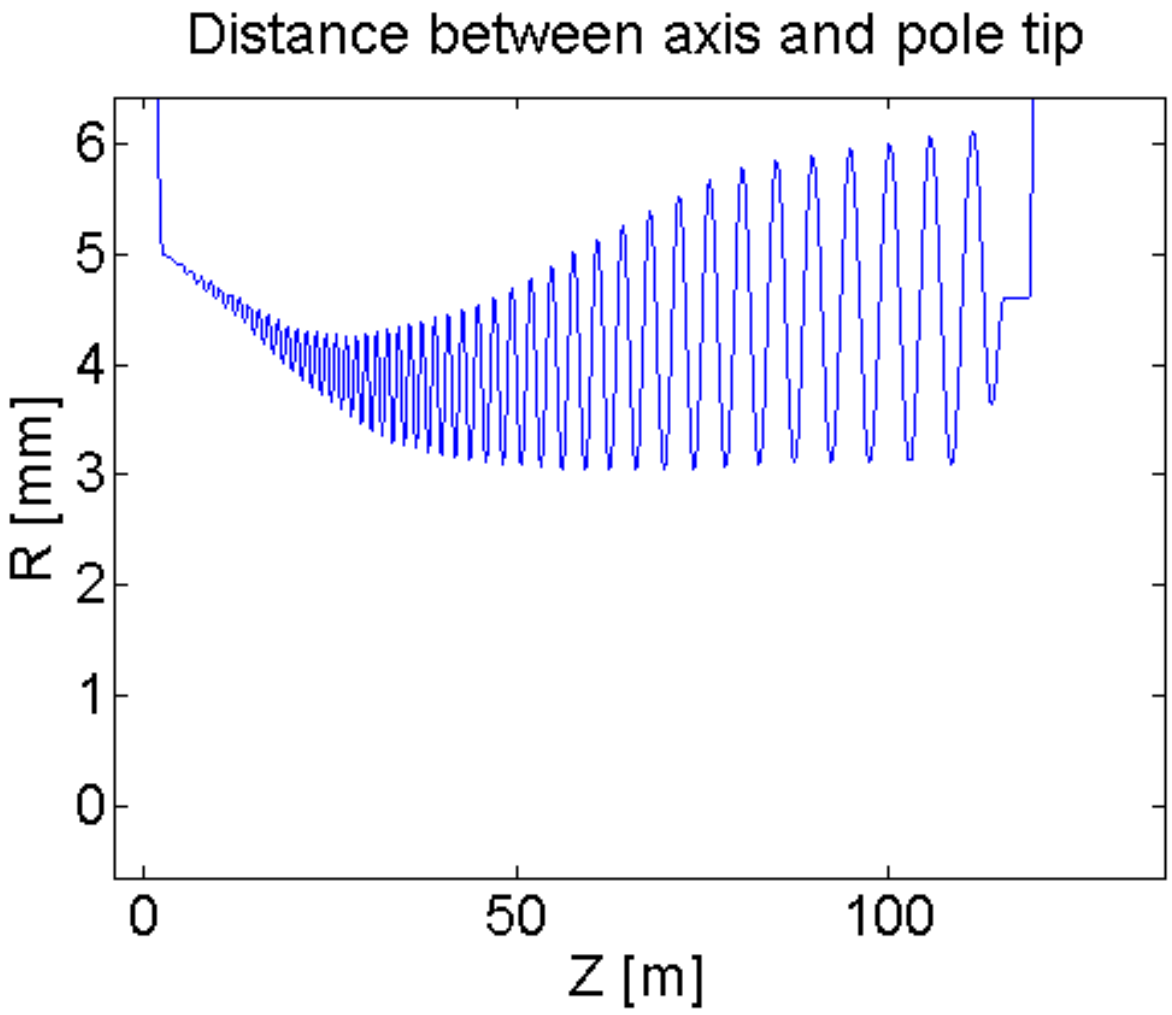
PIP RFQ in TRACK using 3D Fields from MWS Model _v7a_ provided by S. Kurennoy (LANL) and fields from R. Kostin and G. Romanov (FNAL)

How is the PIP RFQ implemented into TRACK as of now ?

DRIFT-3D FIELD- DRIFT (50 mm + 1200.15 mm + 100 mm)



Apertures from TOUTATIS of the PIP RFQ



How are the losses monitored in the TRACK 3D RFQ ?

As of today in TRACK losses are monitored only by the field extension (particle out of the field = lost).

Vanes apertures are being implemented (this week). More precise lost pattern should be available soon.

From S. Kurennoy document

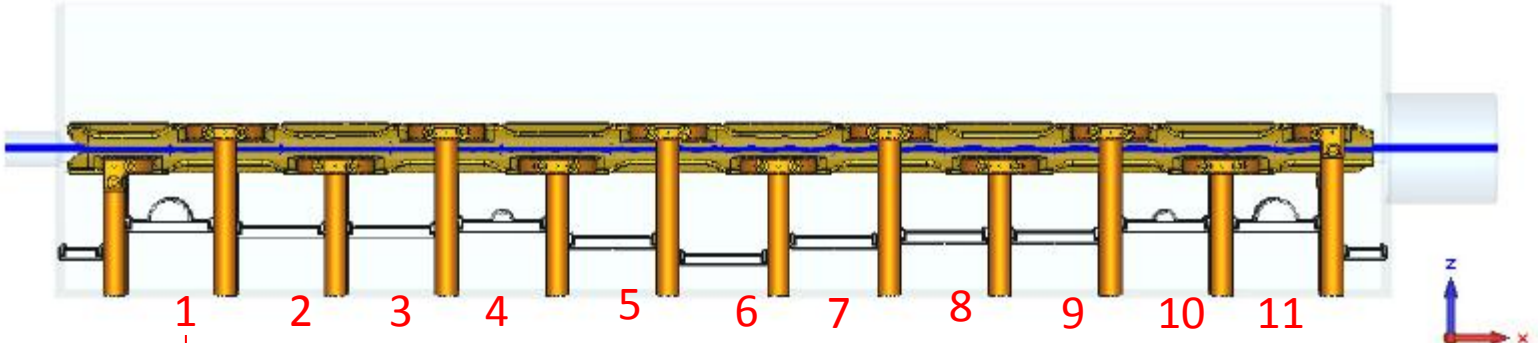


Figure 7: Side view of the RFQ MWS model C.

Tuning Cell with half-moons in Cells 1 + 4 + 10 +11

How confident should we be in the MWS model of the TRACK 3D RFQ ?

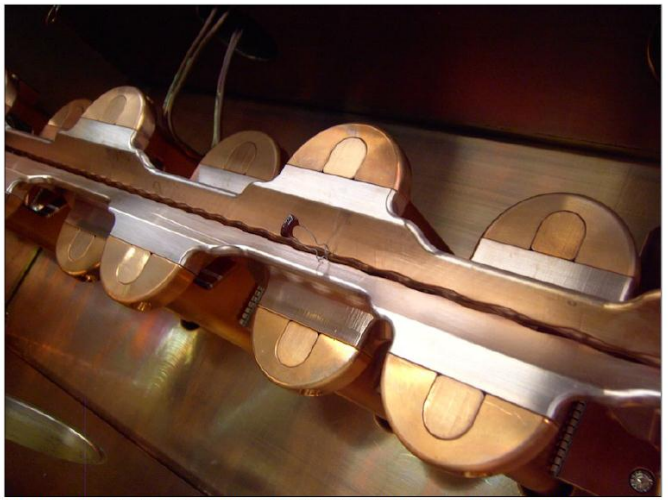
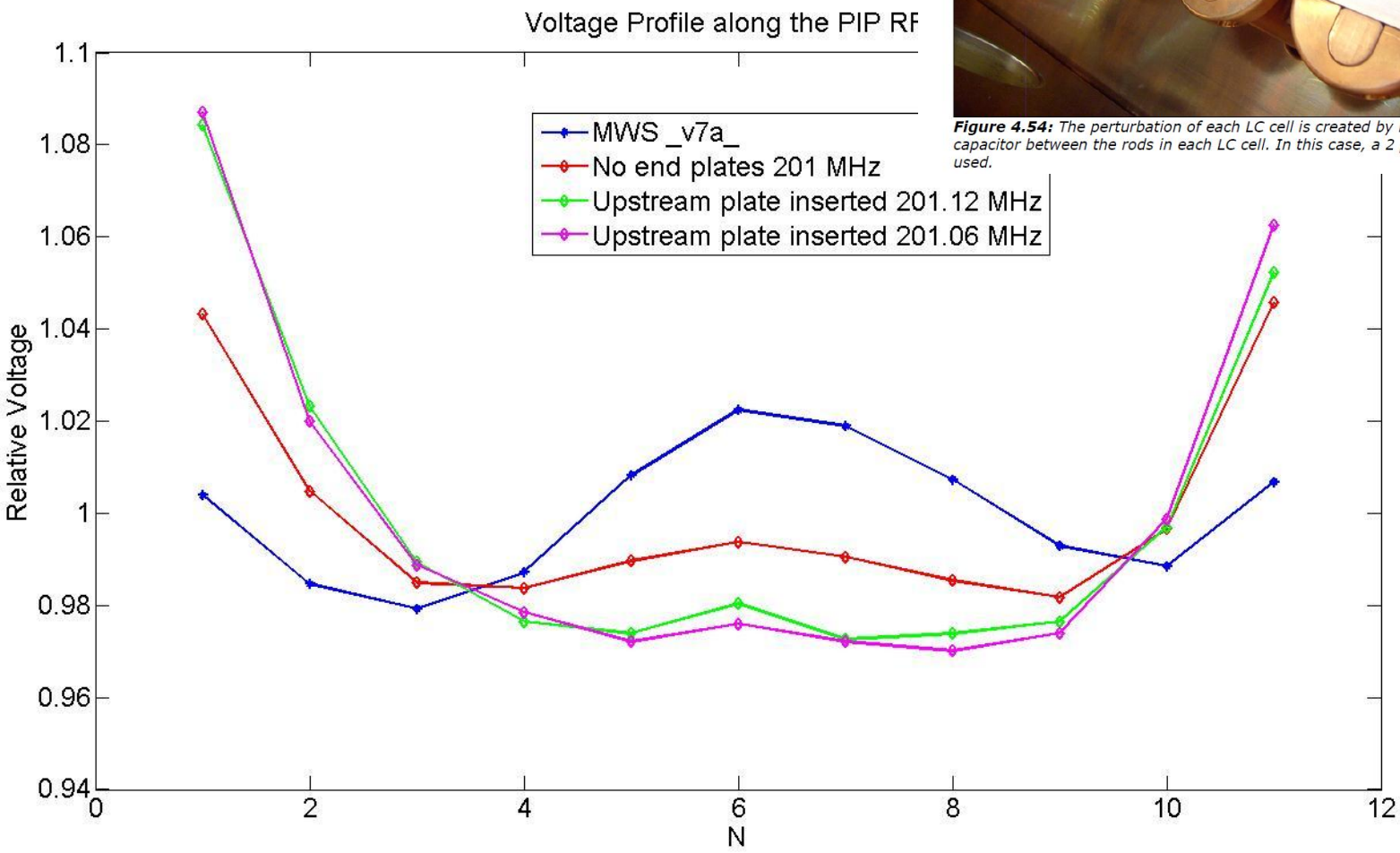
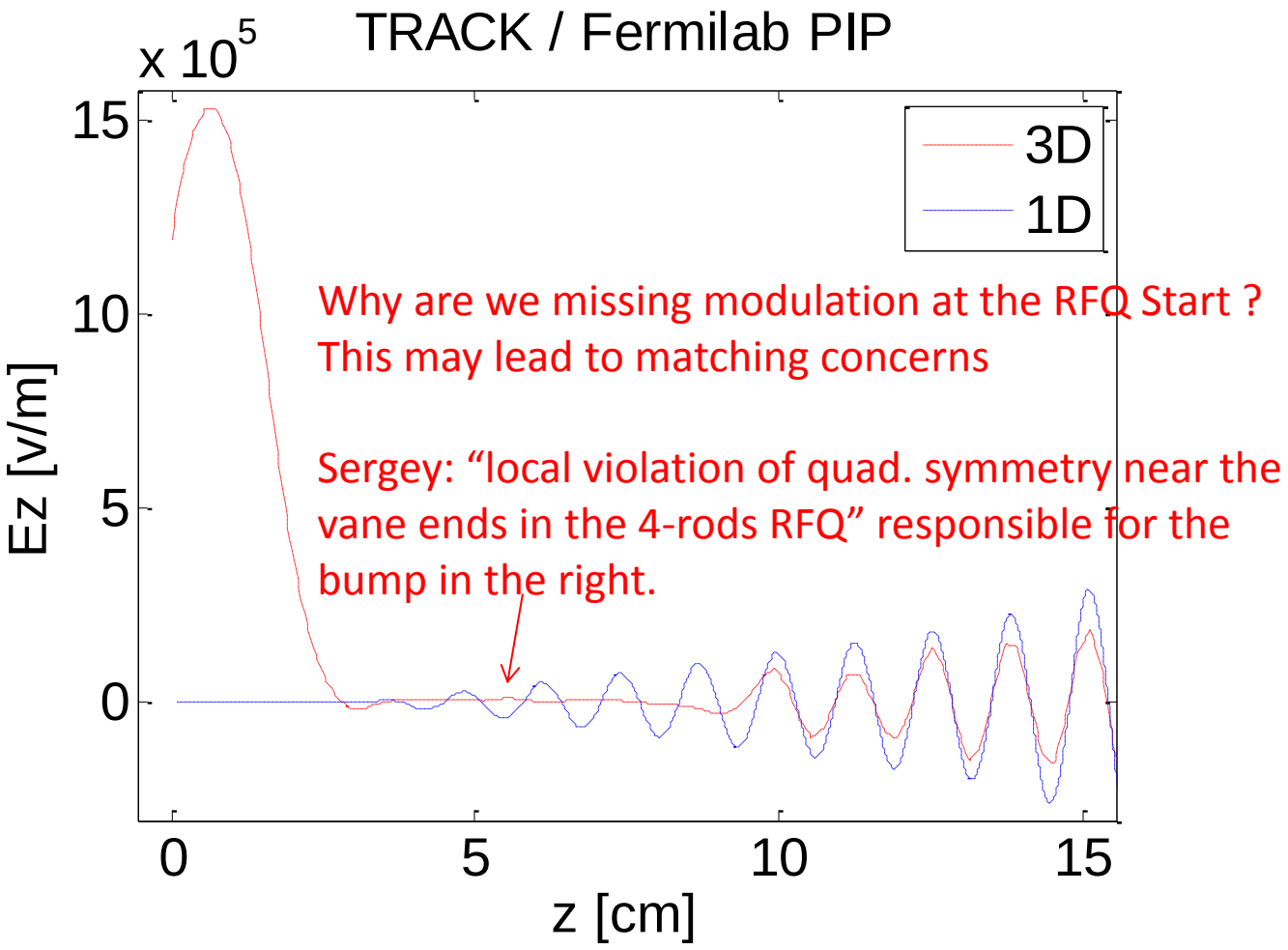


Figure 4.54: *The perturbation of each LC cell is created by inserting a capacitor between the rods in each LC cell. In this case, a 2 pF capacitor is used.*



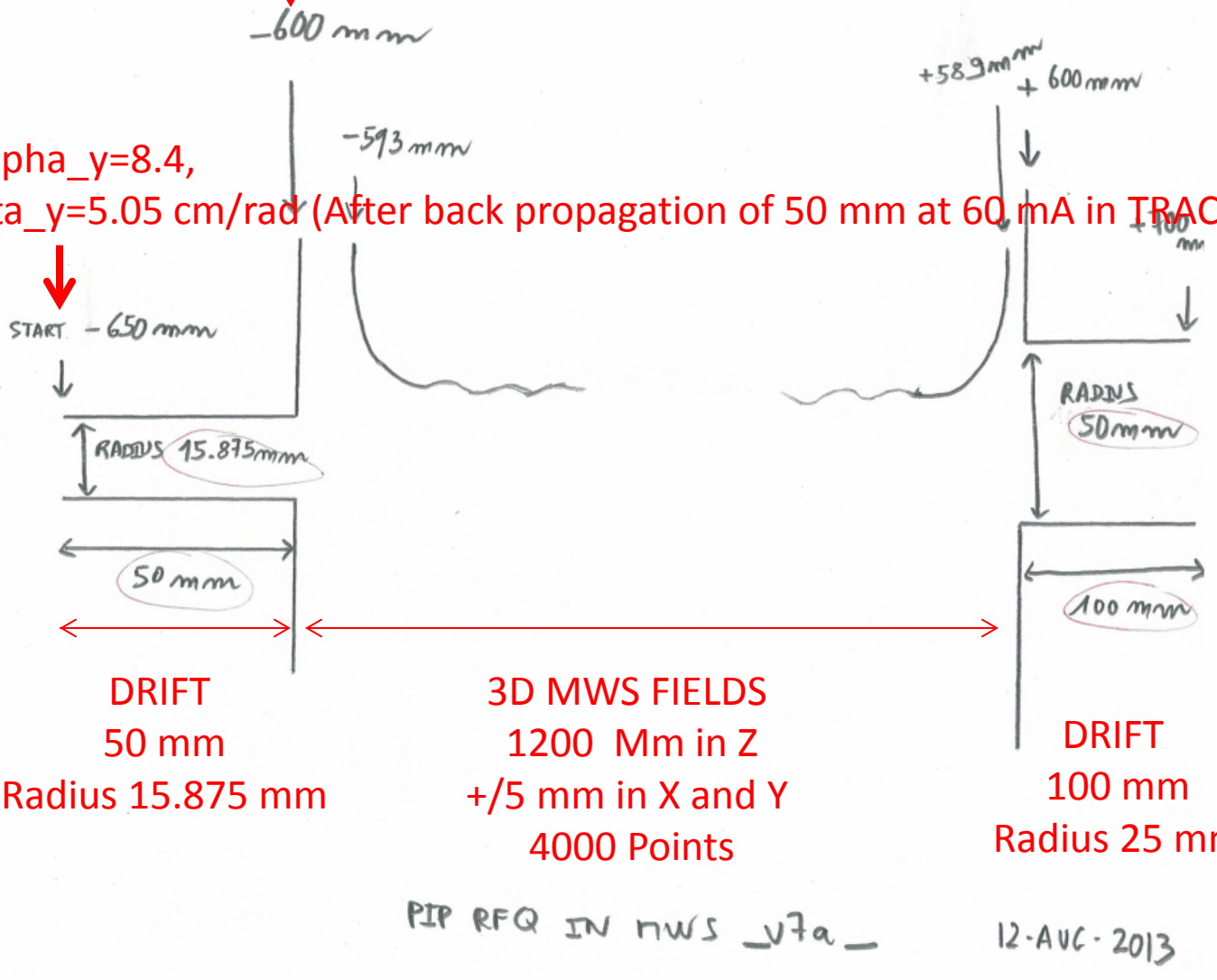
Field on Geometrical Axis.
TRACK Analytical (from PARMTEQM conversion) Vs TRACK 3D Fields (from MWS)



Back Propagation of 50 mm to fetch the TWISS parameters at the beam pipe entrance?

Alpha_x=Alpha_y=1.5, Beta_x=Beta_y=5.1 cm/rad (In PARMTEQM and TOUTATIS)

Alpha_x=Alpha_y=8.4,
Beta_x=Beta_y=5.05 cm/rad (After back propagation of 50 mm at 60 mA in TRACK)



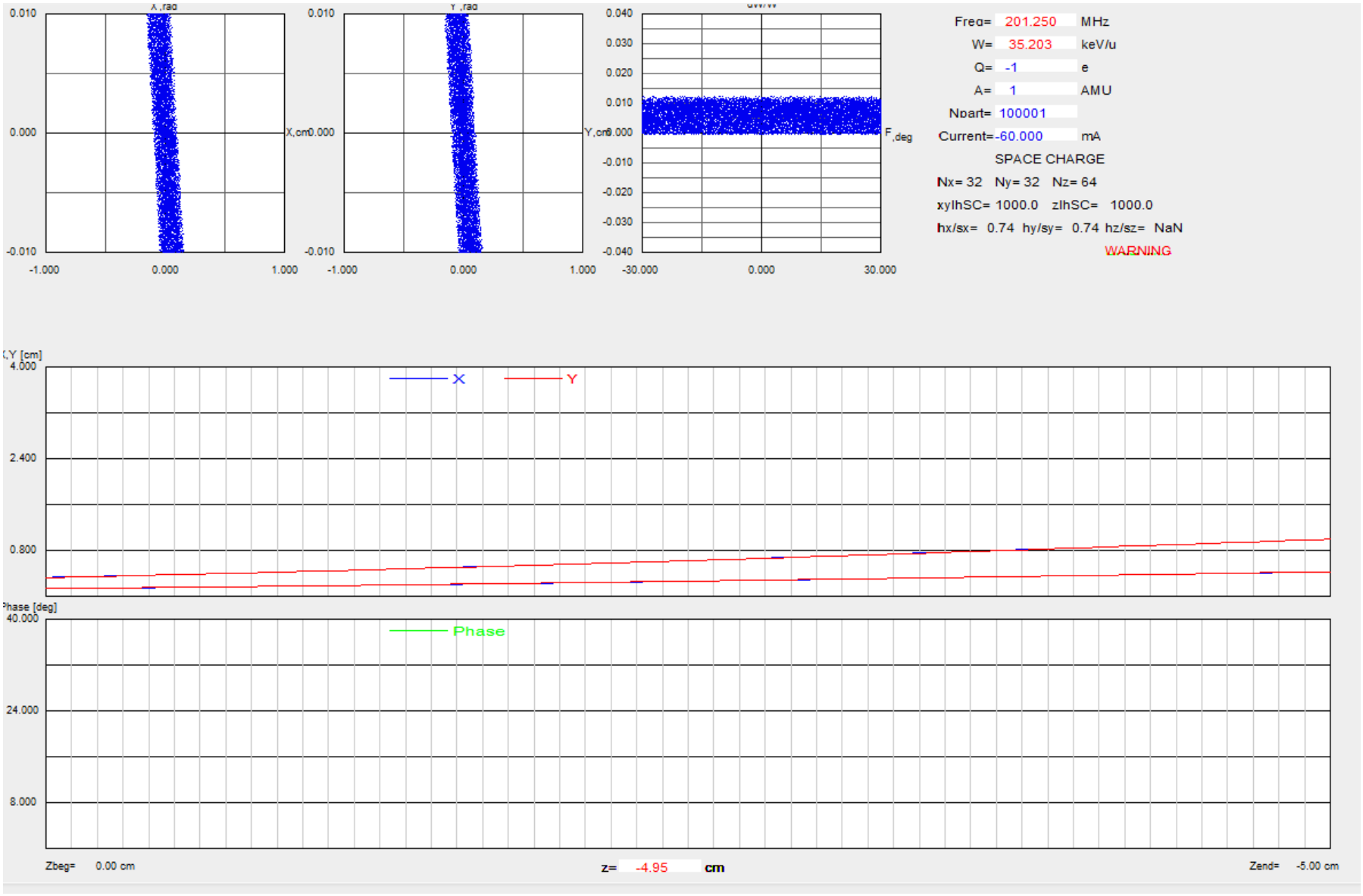
DRIFT
50 mm
Radius 15.875 mm

3D MWS FIELDS
1200 Mm in Z
+/5 mm in X and Y
4000 Points

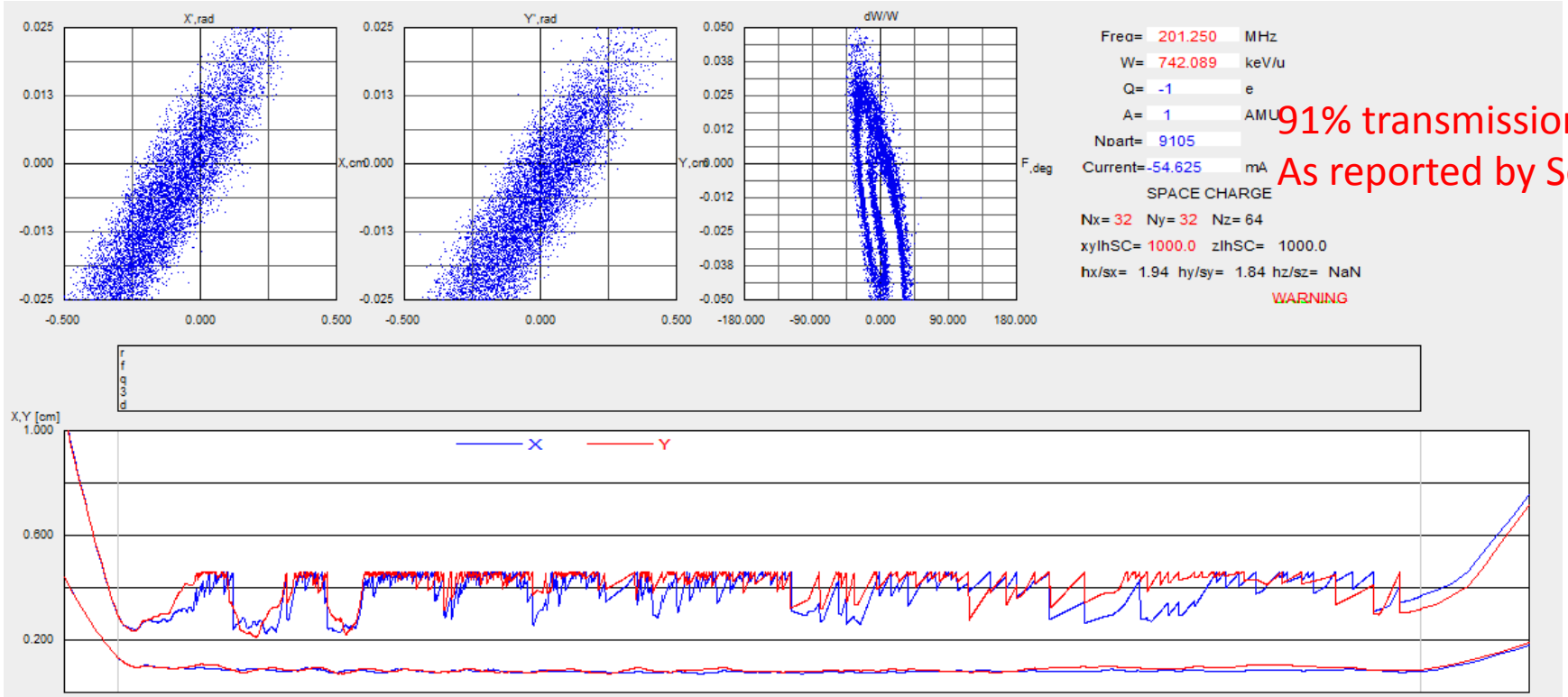
DRIFT
100 mm
Radius 25 mm

Alpha_x=Alpha_y=8.4,

Beta_x=Beta_y=5.05 cm/rad (After back propagation of 50 mm at 60 mA in TRACK)

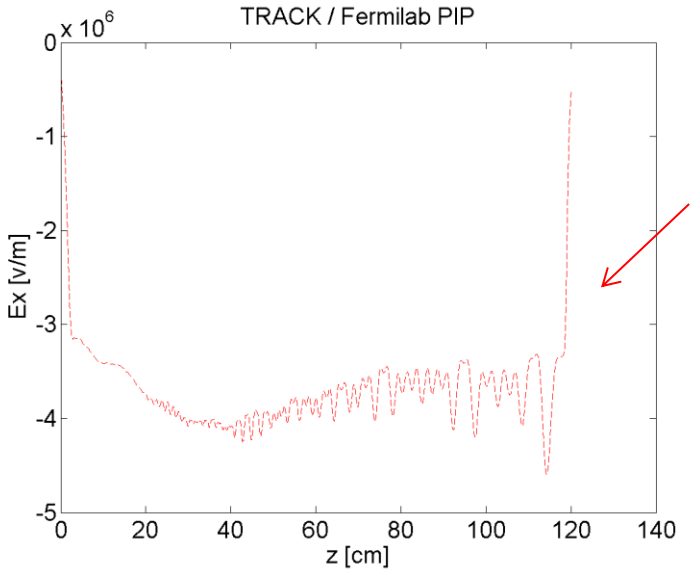


TRACK with 3D FIELDS. Injection Down in the RFQ geometrical axis.

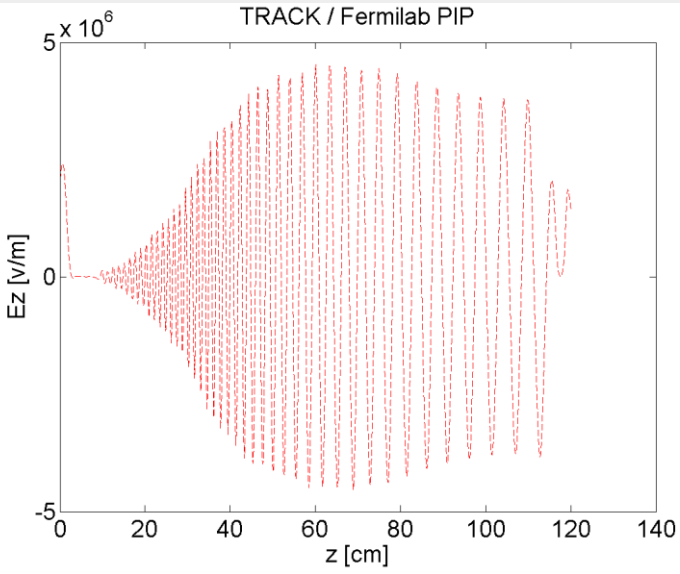


91% transmission

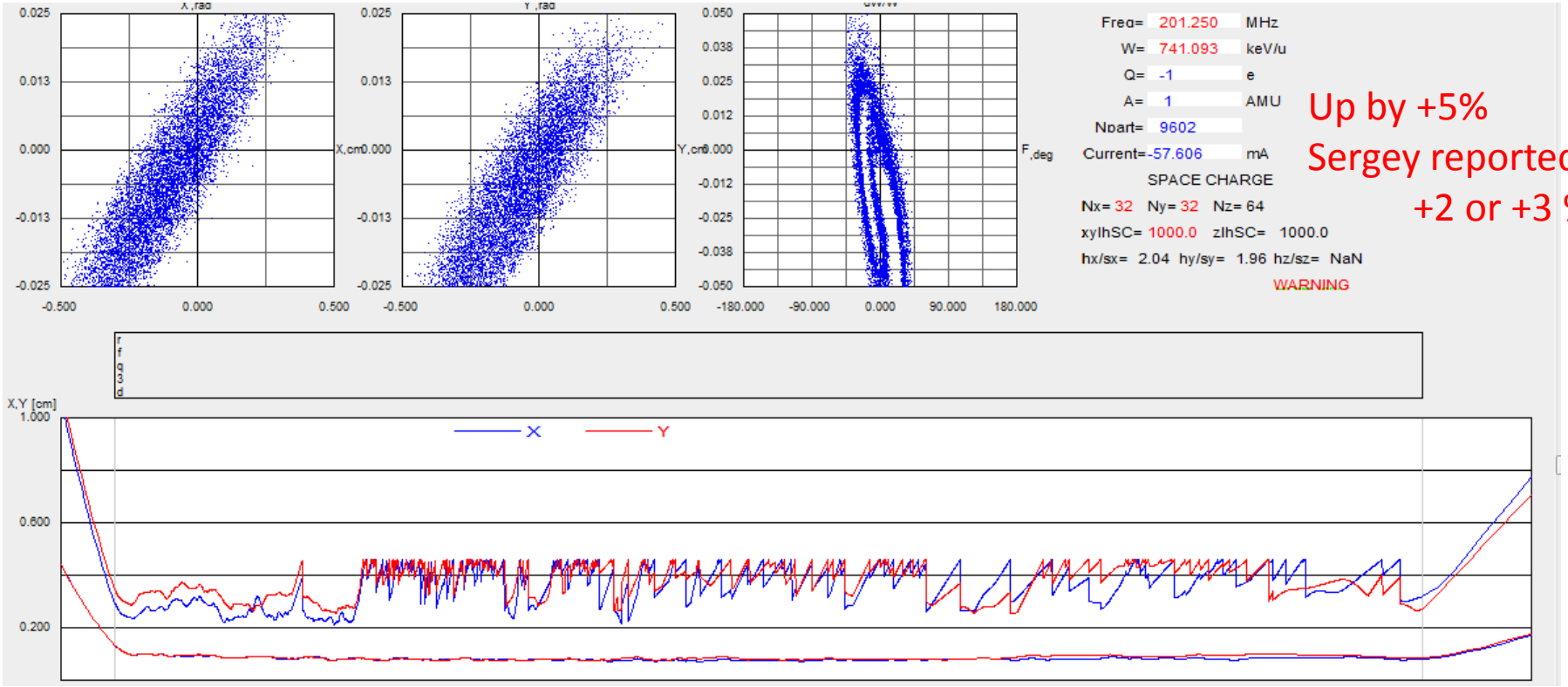
As reported by Sergey



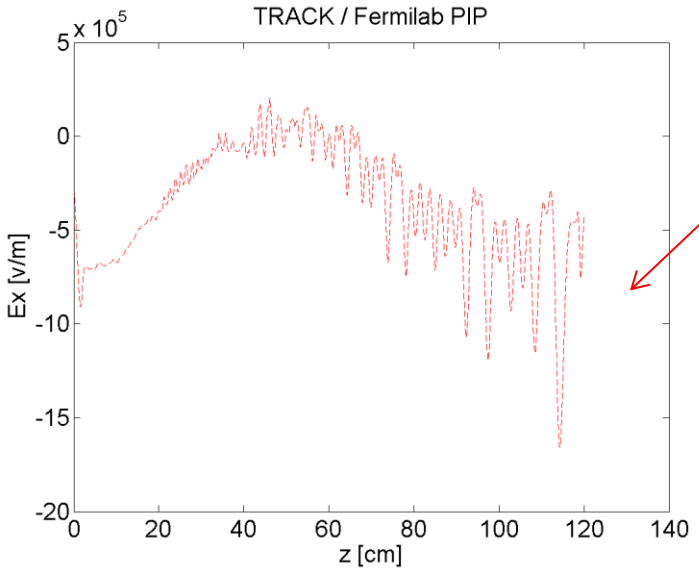
Dipole Field big on geo. axis



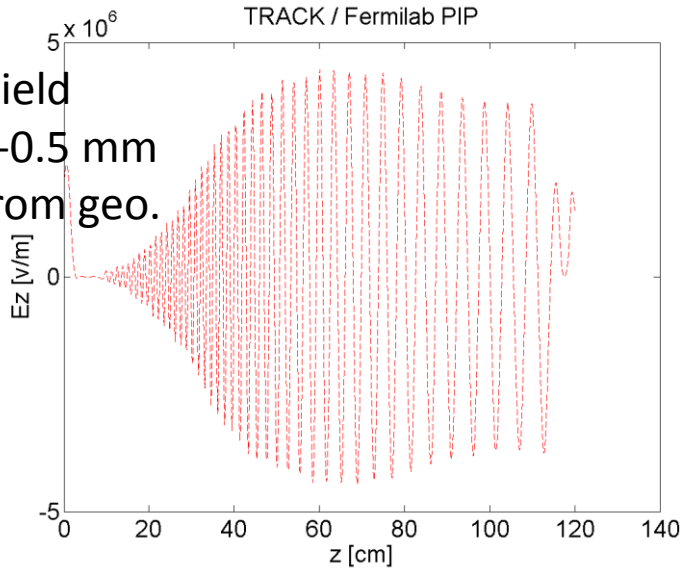
TRACK with 3D FIELDS. Injection Down in Y by -0.5 mm of RFQ geometrical axis.



Up by +5%
Sergey reported
+2 or +3 %



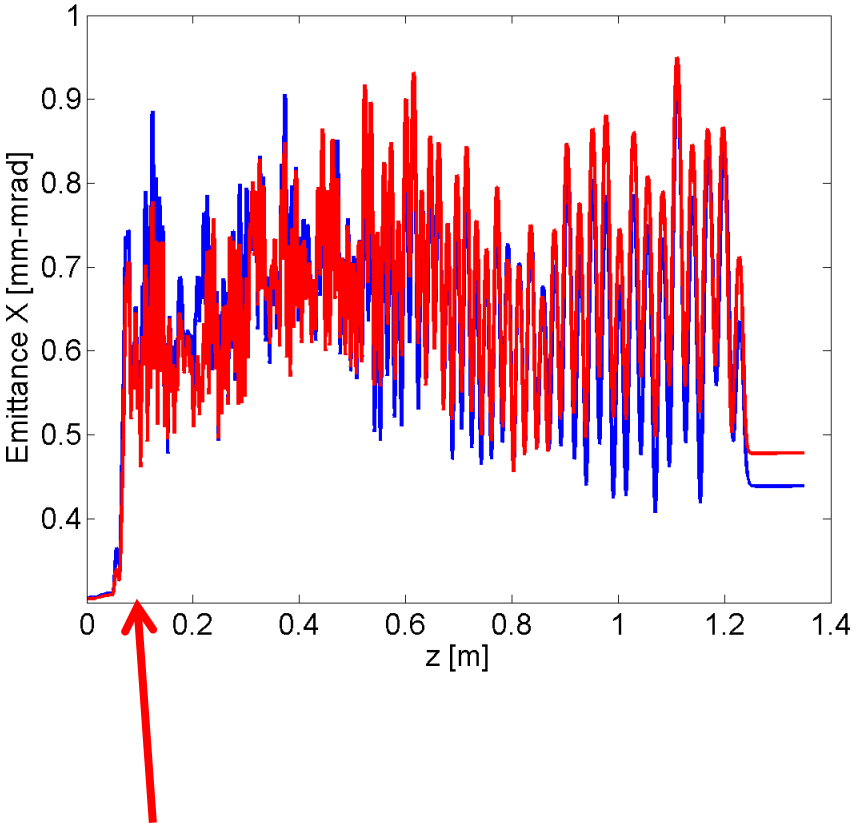
Dipole Field
smaller -0.5 mm
Lower from geo.
axis

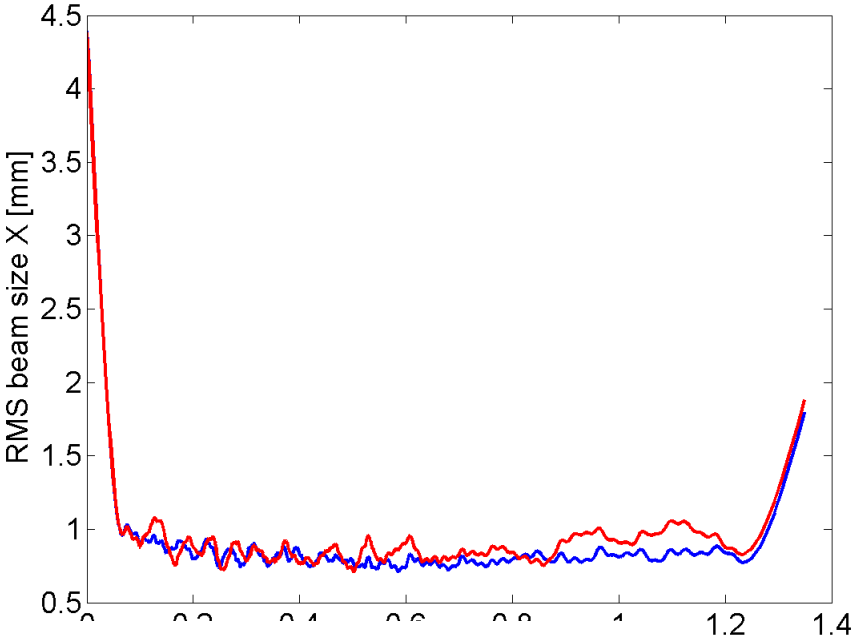


Are you matched with: Alpha_x=Alpha_y=8.4, Beta_x=Beta_y=5.05 cm/rad
(After back propagation of 50 mm at 60 mA in TRACK) ?

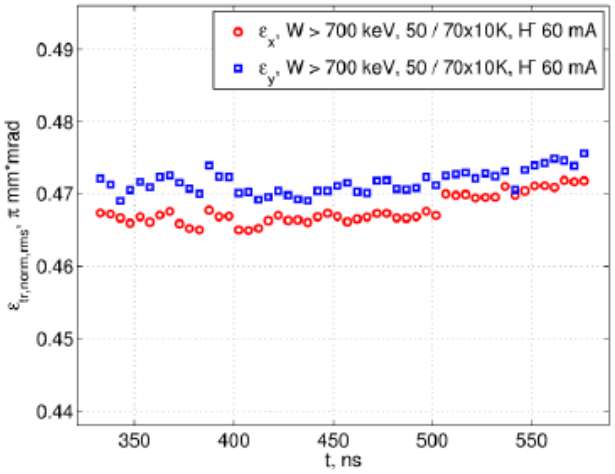
Could this matching be improved ?

Injection on RFQ geometrical axis

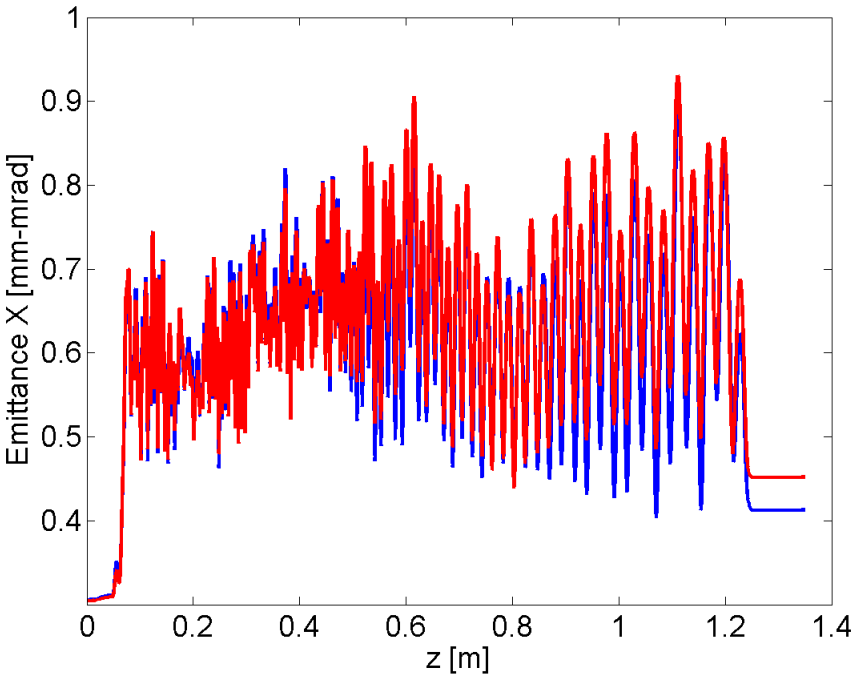


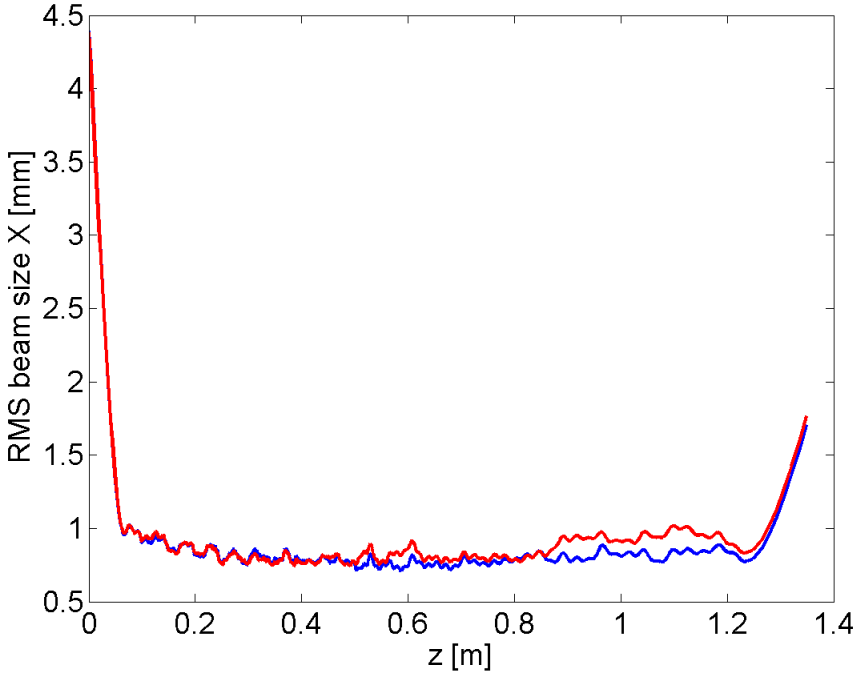


Emittance Increase Takes Place at the Start of the RFQ



Injection down by -0.5 mm on RFQ geometrical axis



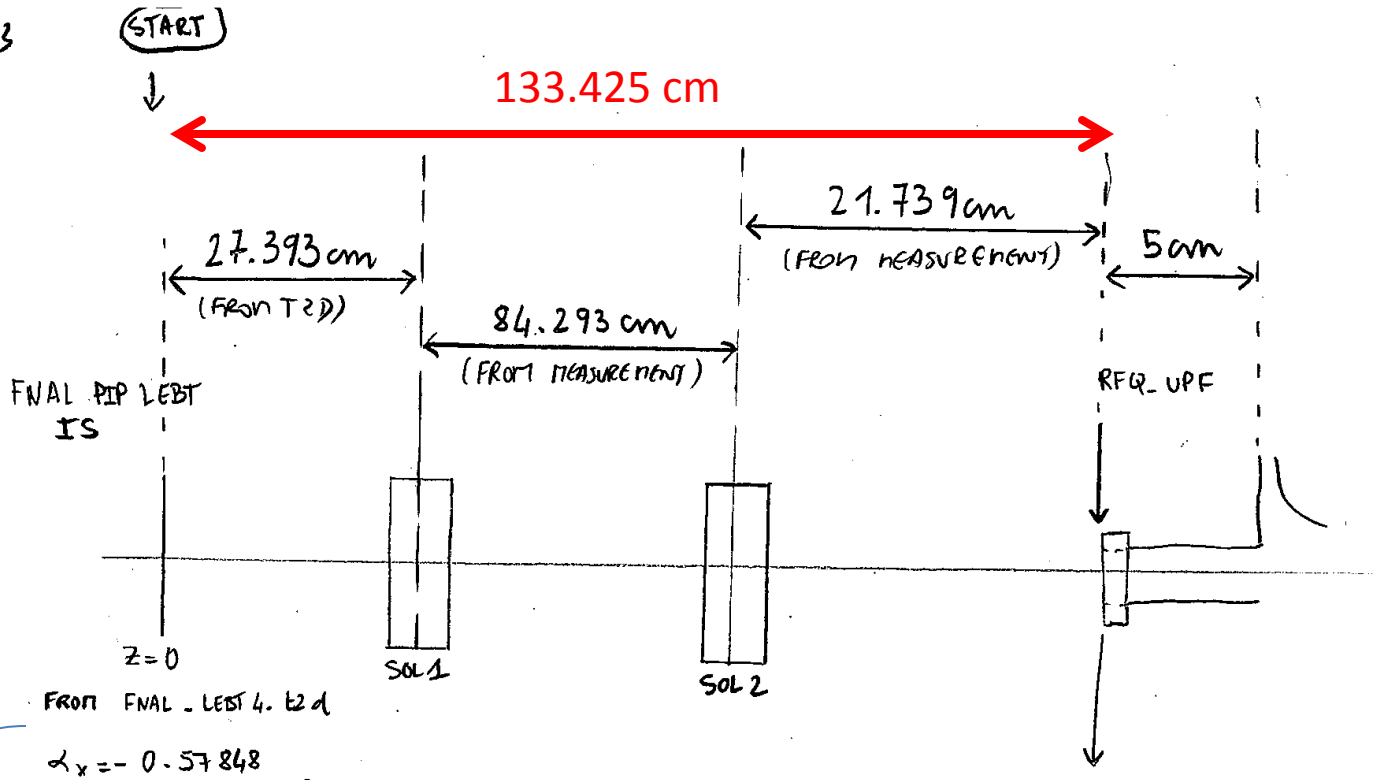


PIP LEBT

PIP LEBT DISTANCES (MODEL IN TRACE2d, TRACEWIN and TRACK)

13-AUG-2013

JPC



FROM FNAL_LEBT4.t2d

Asymmetric

$\alpha_x = -0.57848$

$\beta_x = 5.2643 \times 10^{-2}$ mm/mrad

$\alpha_y = -0.40643$

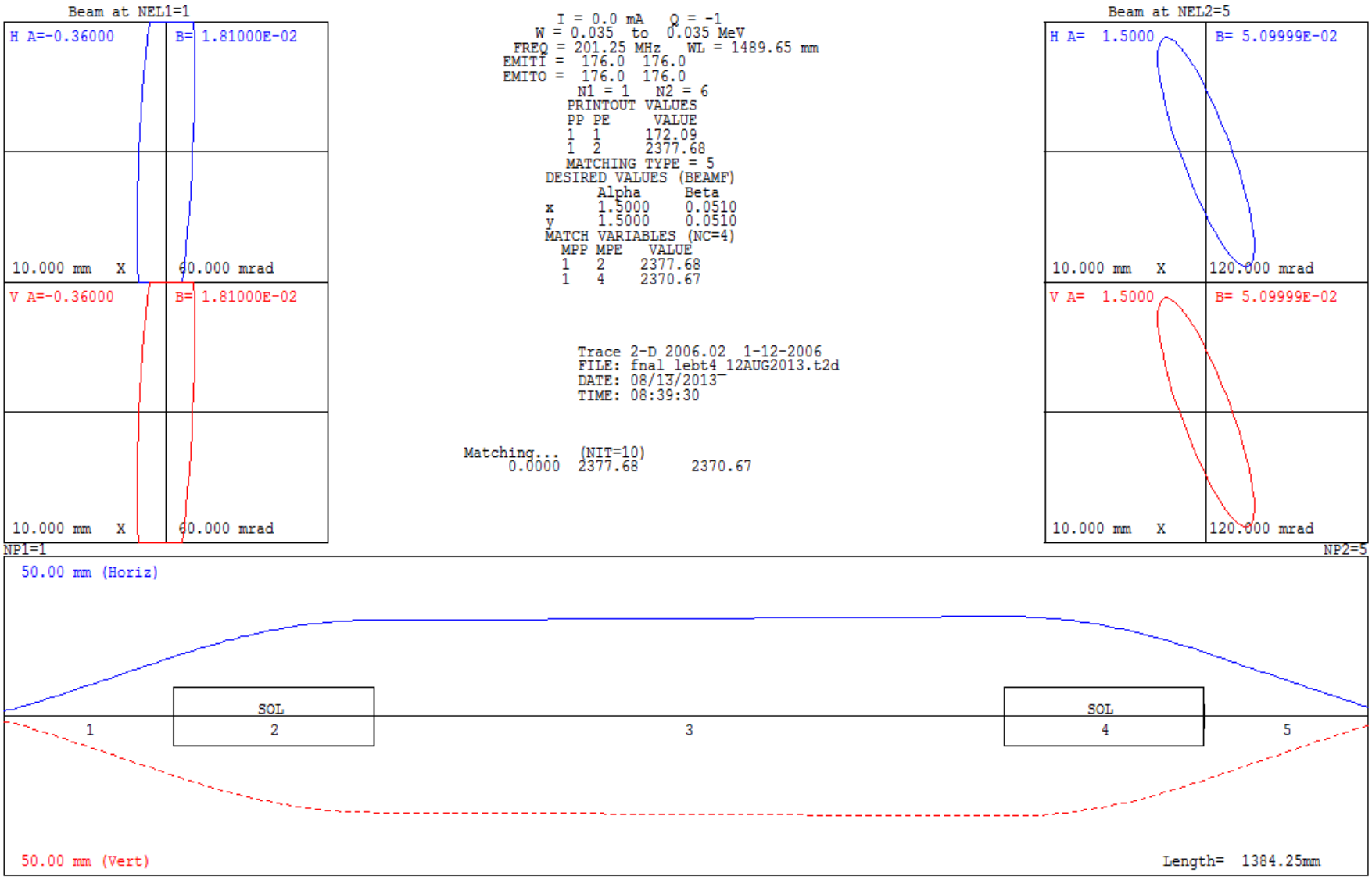
$\beta_y = 5.6954 \times 10^{-2}$ mm/mrad

$\alpha_x = 8.4$ $\beta_x = 0.5$ mm/mrad
$\alpha_y = 8.4$ $\beta_y = 0.5$ mm/mrad
} IF 50mm DRIFT TUBE AT 60mA

$\alpha_x = 4.7$ $\beta_x = 0.3$ mm/mrad
$\alpha_y = 4.7$ $\beta_y = 0.3$ mm/mrad
} IF 50mm DRIFT TUBE AT 0mA (100% NEUTRALIZED)

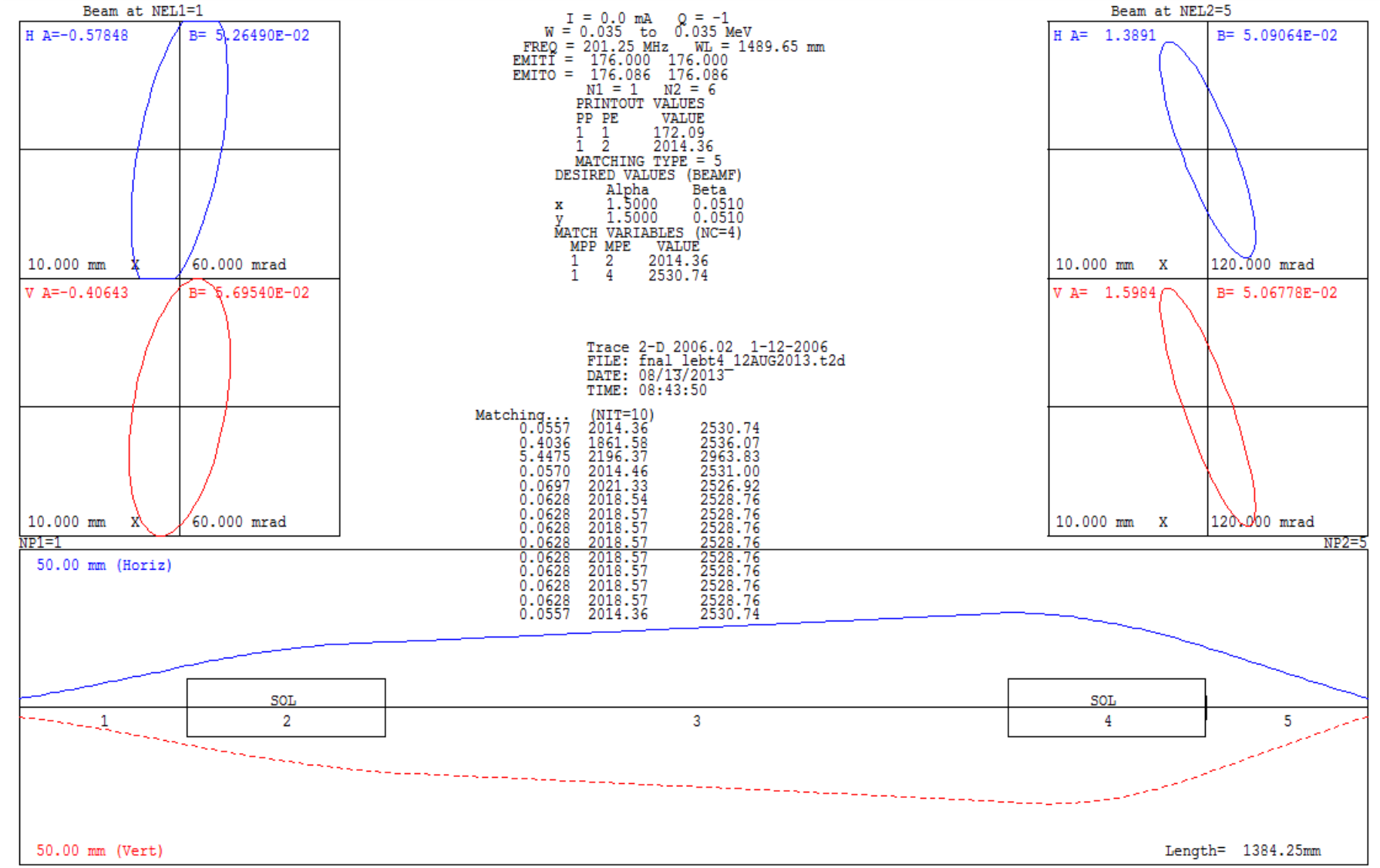
Here we start with a symmetric beam. And fetch 1.5 / 5.1E-2 at RFQ entrance (at the plate)

Sol1 = Sol2. 100% neutralized. Exact matching found.



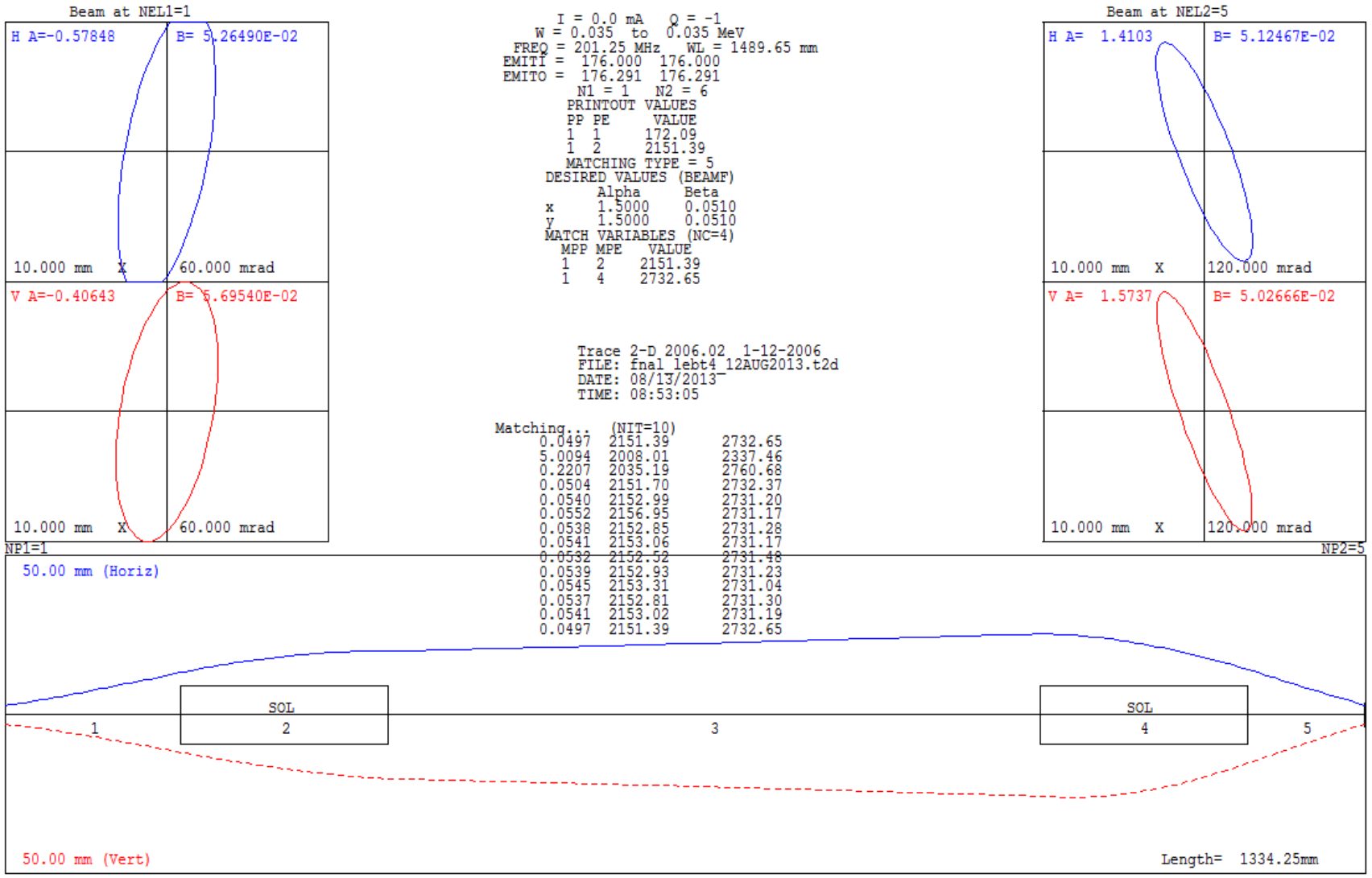
Here we start with the **asymmetric** beam. And fetch 1.5 / 5.1E-2 at RFQ entrance (at the plate)

Sol1 is about 20% lower than Sol2. 0 mA all along the LEBT. Matching not found.



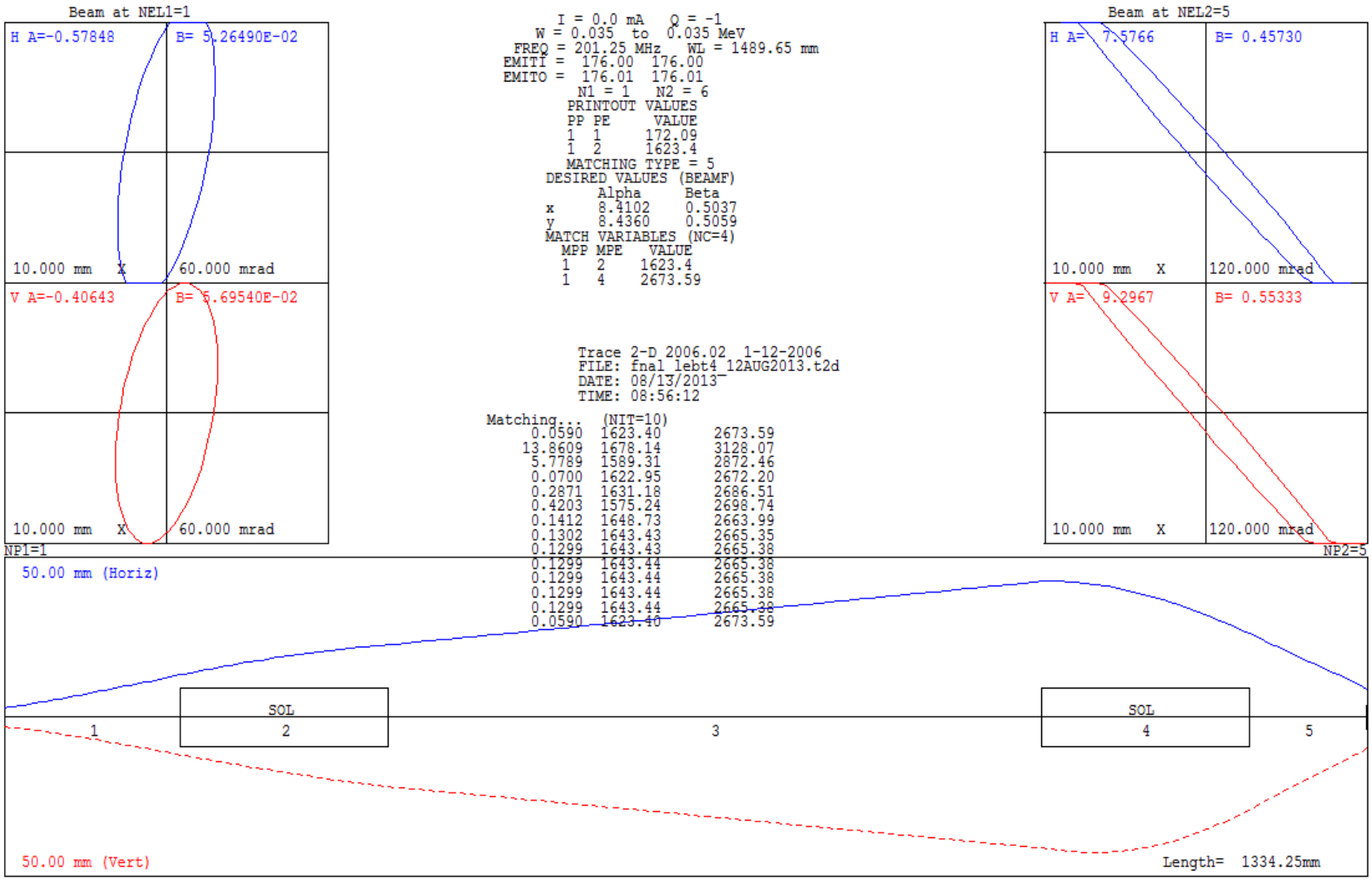
Here we start with a symmetric beam. And fetch 8.4/5E-2 at RFQ entrance (at the plate)

Sol1 about 20% lower than Sol2. 0 mA in LEBT. Exact matching not found.



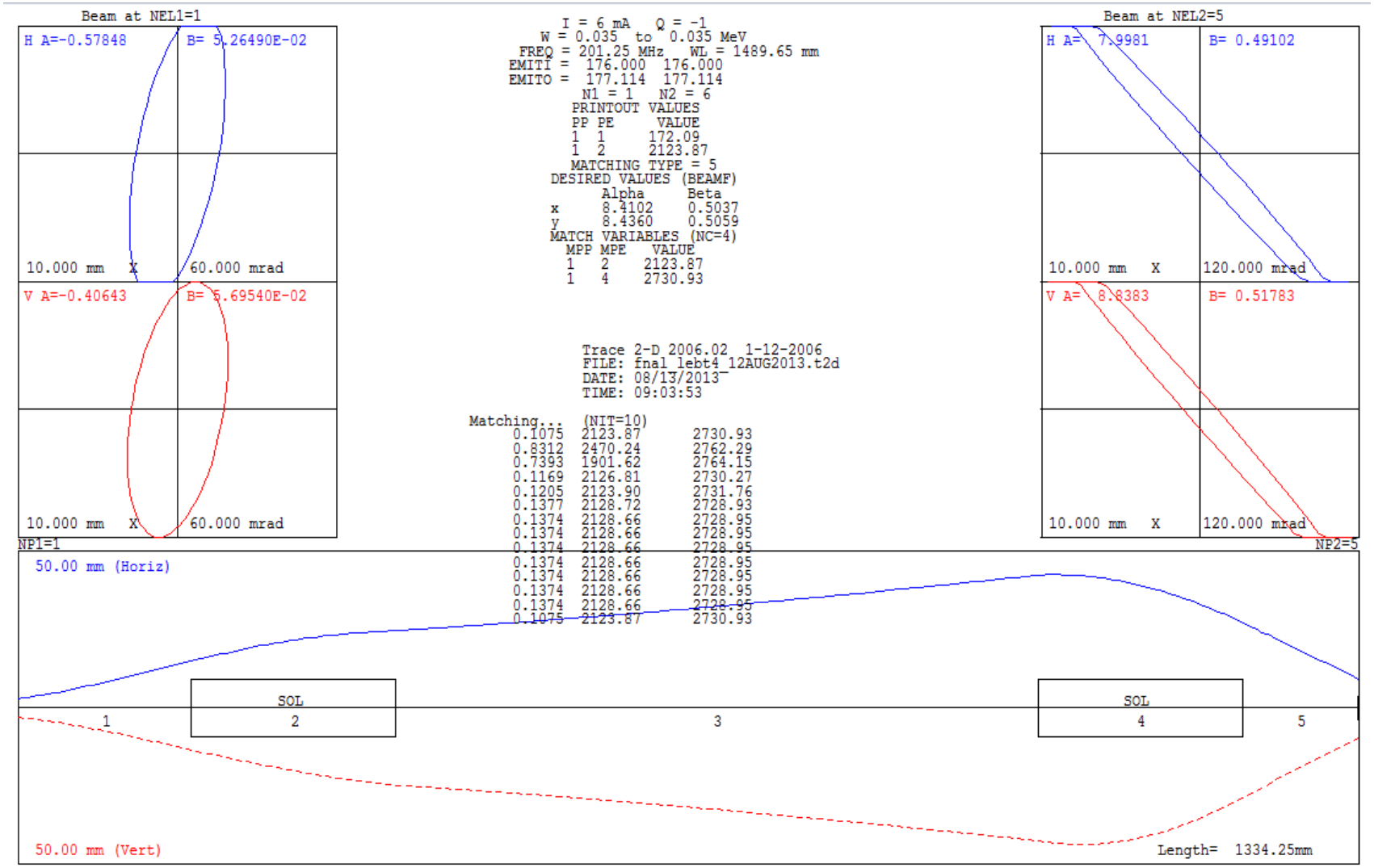
Here we start with the **asymmetric** beam. And fetch 8.4/5E-2 at RFQ entrance (at the plate)

Sol1 about 20% lower than Sol2. 0 mA in LEBT. Exact matching not found.



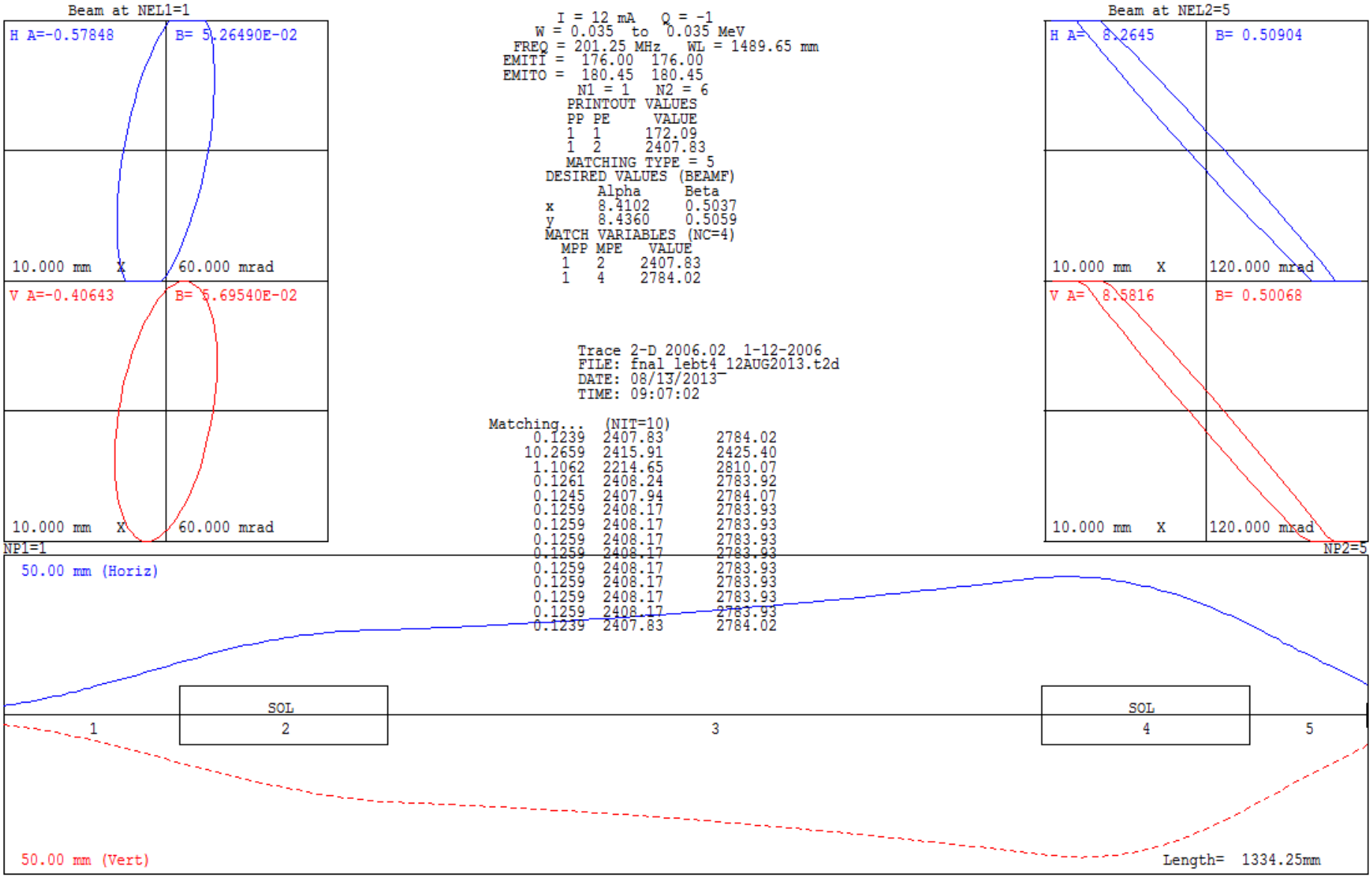
Here we start with the **asymmetric** beam. And fetch 8.4/5E-2 at RFQ entrance (at the plate)

Sol1 about 20% lower than Sol2. 6 mA in LEBT . Exact matching not found.



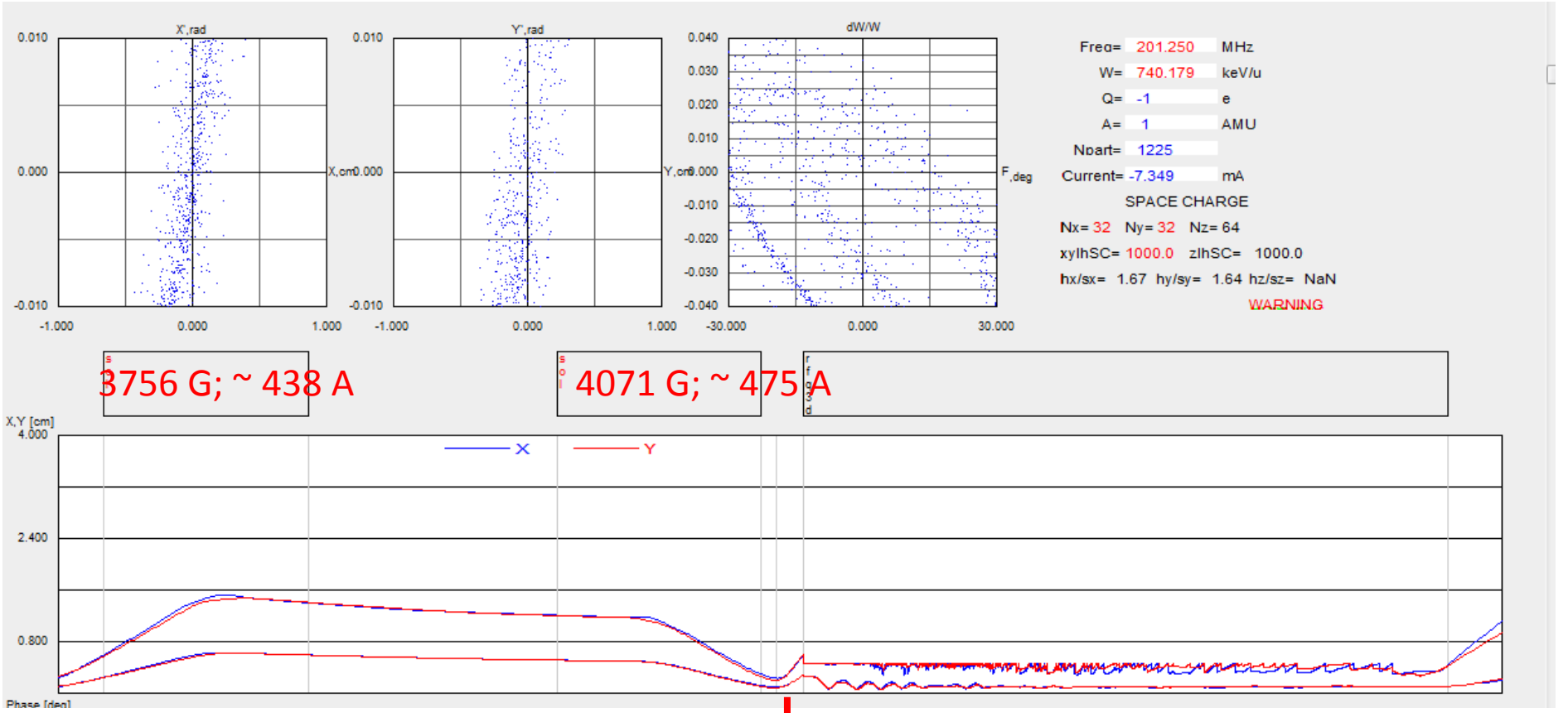
Here we start with the **asymmetric** beam. And fetch 8.4/5E-2 at RFQ entrance (at the plate)

Sol1 about 10% lower than Sol2. 6 mA in LEBT . Exact matching not found.



PIP LEBT
As of TODAY

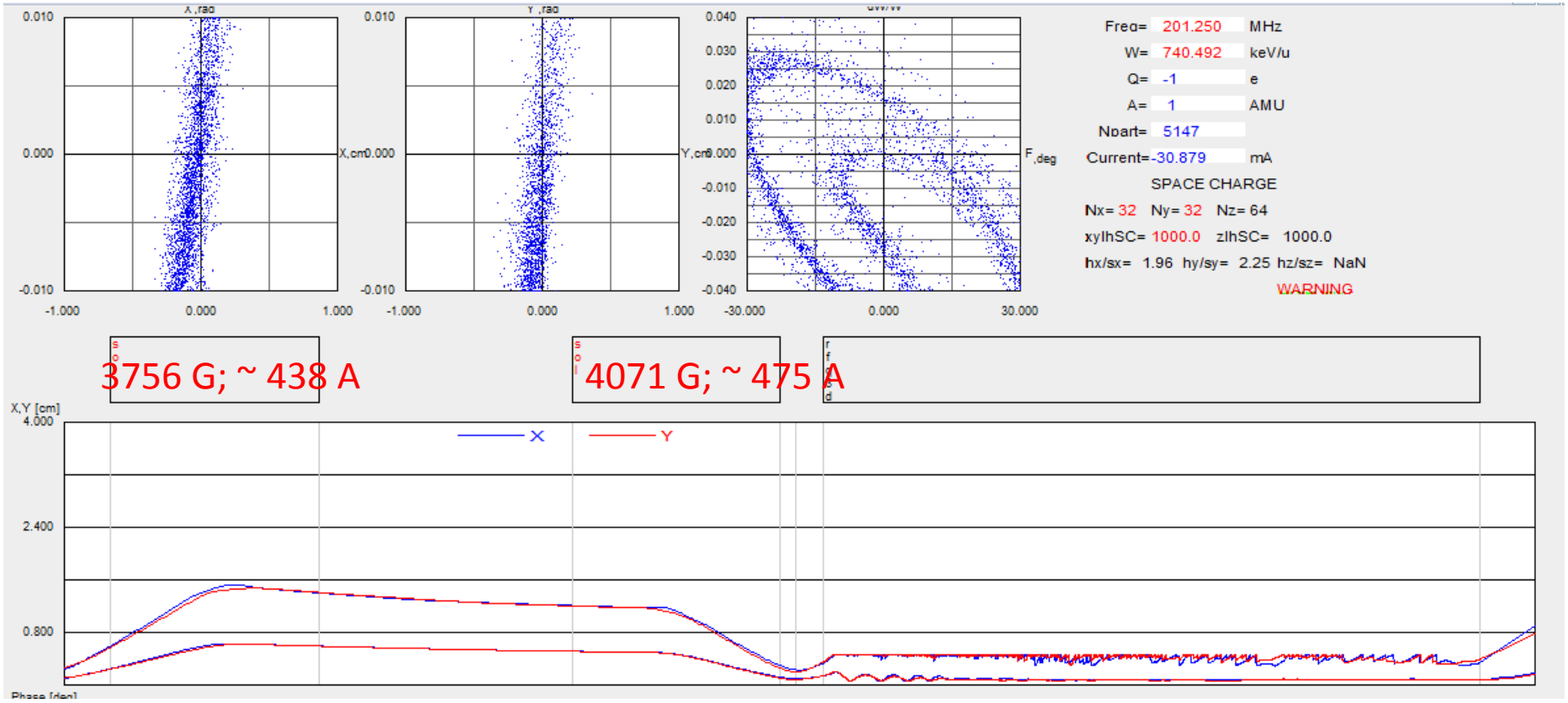
LEBT actual running. With Sol1 at 438 Amps and Sol 2 at 475 Amps.
Here we consider 0 mA (100% neutralized) up to the entrance of the RFQ 50 mm beam tube.
The RFQ 50 mm beam tube is at 60 mA (no neutralization in the beam tube).
Transmission is about 12 %
From TRACK.



0 mA

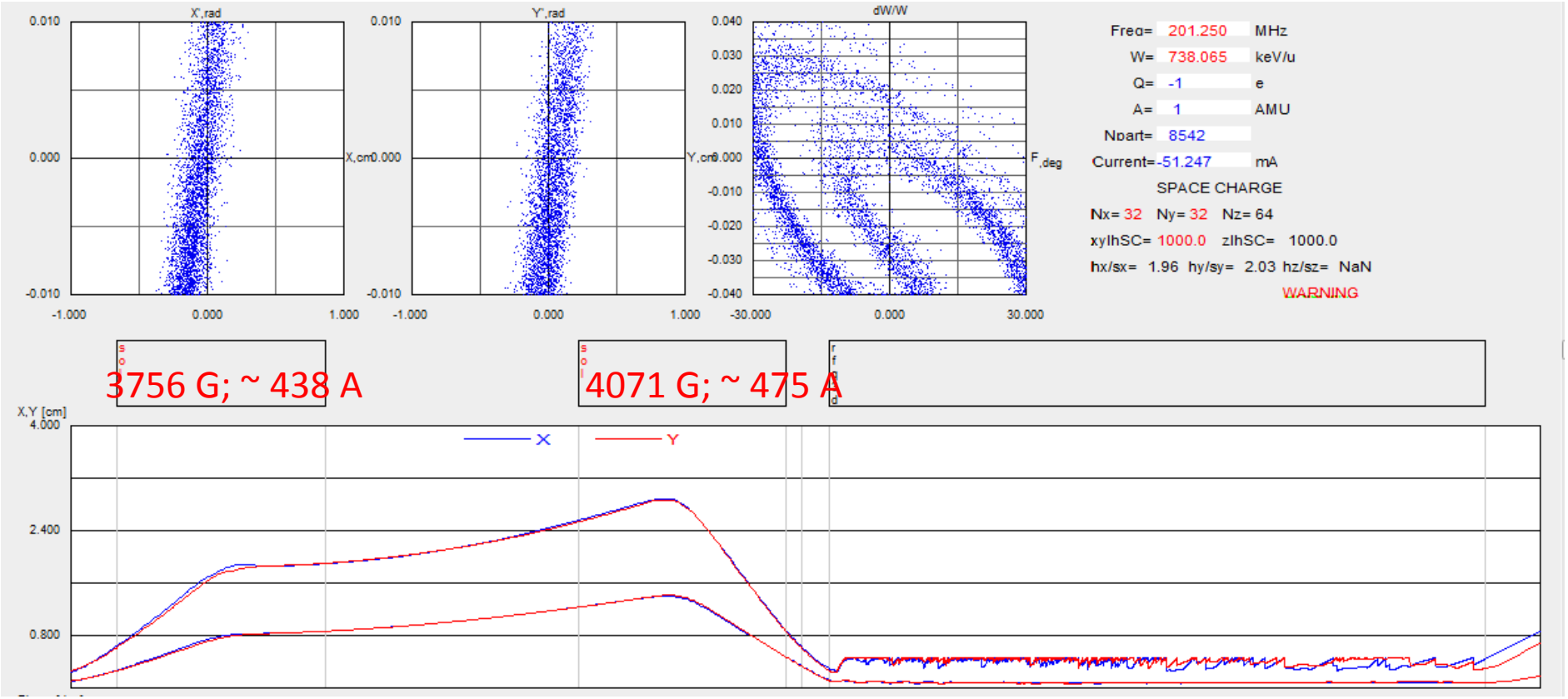
60 mA

LEBT actual running. With Sol1 at 438 Amps and Sol 2 at 475 Amps.
Here we consider 0 mA (100% neutralized) up to the entrance of the RFQ.
The 50 mm RFQ beam tube is at 0 mA (100% neutralization in the beam tube).
Transmission is about 51 %
From TRACK.



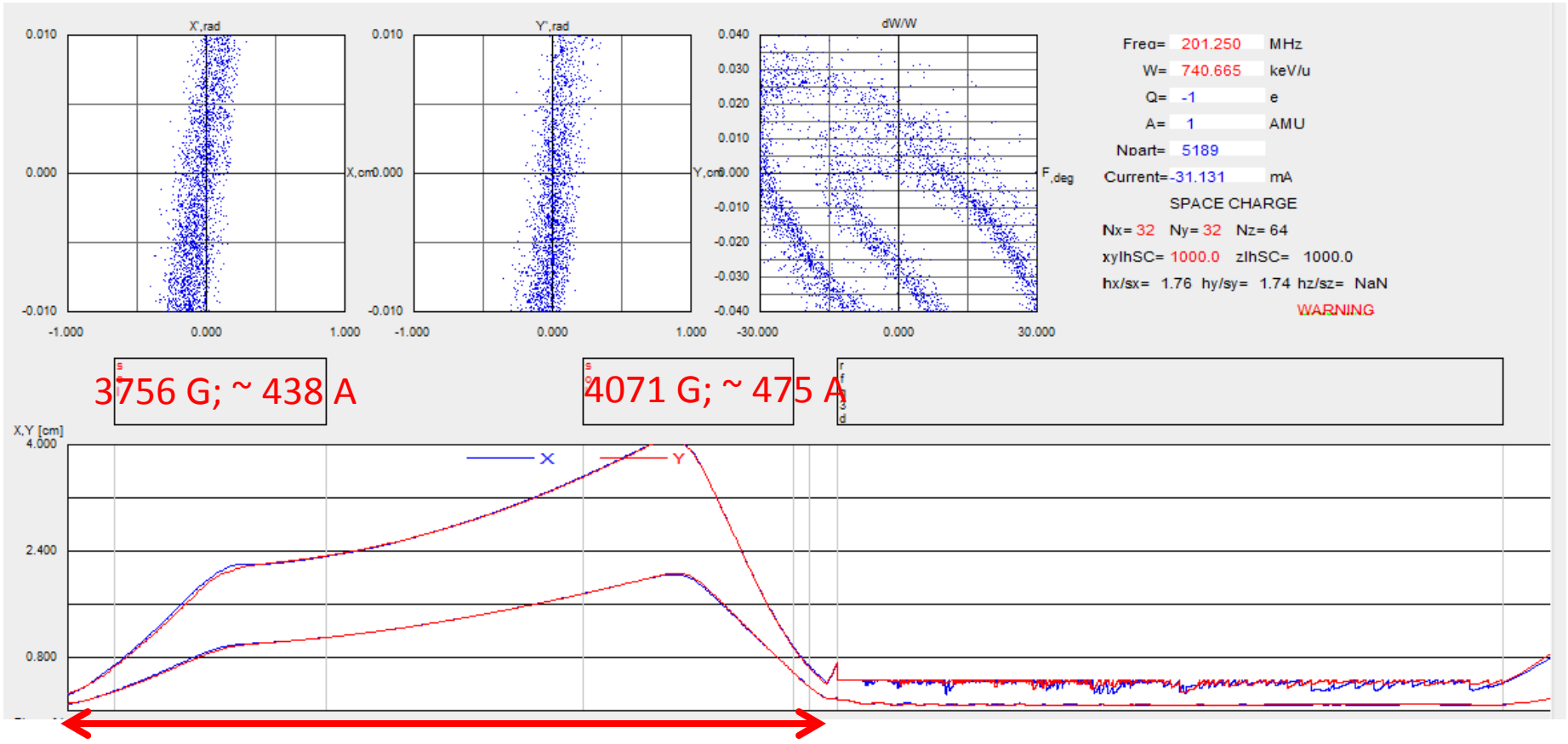
0 mA

LEBT actual running. With Sol1 at 438 Amps and Sol 2 at 475 Amps.
Here we consider 6 mA (90% neutralized) up to the entrance of the RFQ.
The 50 mm RFQ beam tube is at 6 mA (90% neutralization in the beam tube).
Transmission is about 85 % (!)
From TRACK.



6 mA

LEBT actual running. With Sol1 at 438 Amps and Sol 2 at 475 Amps.
Here we consider 12 mA (80% neutralized) up to the entrance of the RFQ.
The 50 mm RFQ beam tube is at 12 mA (80% neutralization in the beam tube).
Transmission is about 51 %
From TRACK.



12 mA

CONCLUSION AND NEXT STEPS

- TRACK3D and Particle Studio give good agreement.

- Insert (this week ?) the aperture vanes in TRACK. Peter gave agreement.
- Ask BNL about the TWISS at the source
- Perform with Saclay SOLMAXP simulation for space charge neutralization in LEBT
- BNL and WARP ?

- Check with LANL (Rybarcyk, Larry) about Particle Studio Input Distribution

Acknowledgment

- Many thanks to CY Tan, R. Zwaska, F. Garcia, S. Kurennoy, N. Solyak, G. Romanov, R. Kostin, V. Kapin, P. Ostroumov, B. Mustapha for your help in performing this work.