THE ESS LINAC

HS_2011_11_23

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5 December 2011

ESS LINAC

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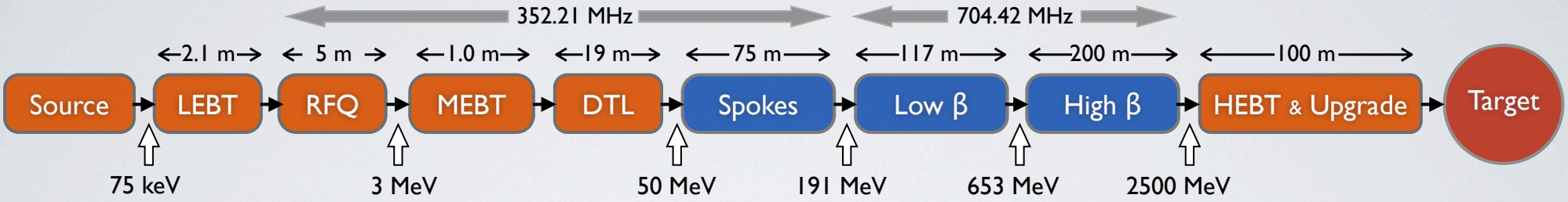
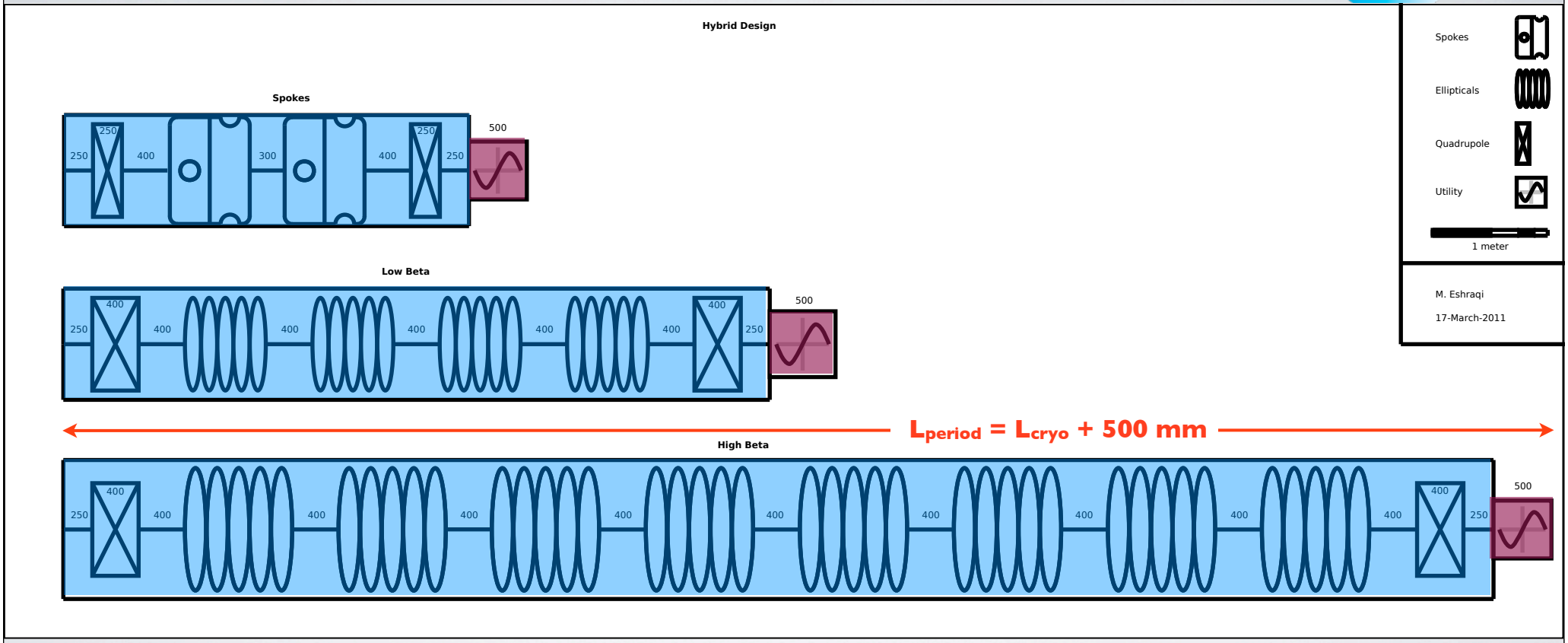


	Energy (MeV)	No. of Modules	No. of Cavities	βg	Temp (K)	Cryo Length (m)
Source	0.075	1	0	–	~300	–
LEBT	*0.075*	–	0	–	~300	–
RFQ	3	1	1	–	~300	–
MEBT	*3*	–	2	–	~300	–
DTL	50	3	3	–	~300	–
Spoke	191	18	2 × 18	0.46 β_{opt}	~2	3.67
Low β	653	16	4 × 16	0.70	~2	6.80
High β	2500	14	8 × 14	0.92	~2	13.81
HEBT	*2500*	–	0	–	~300	–

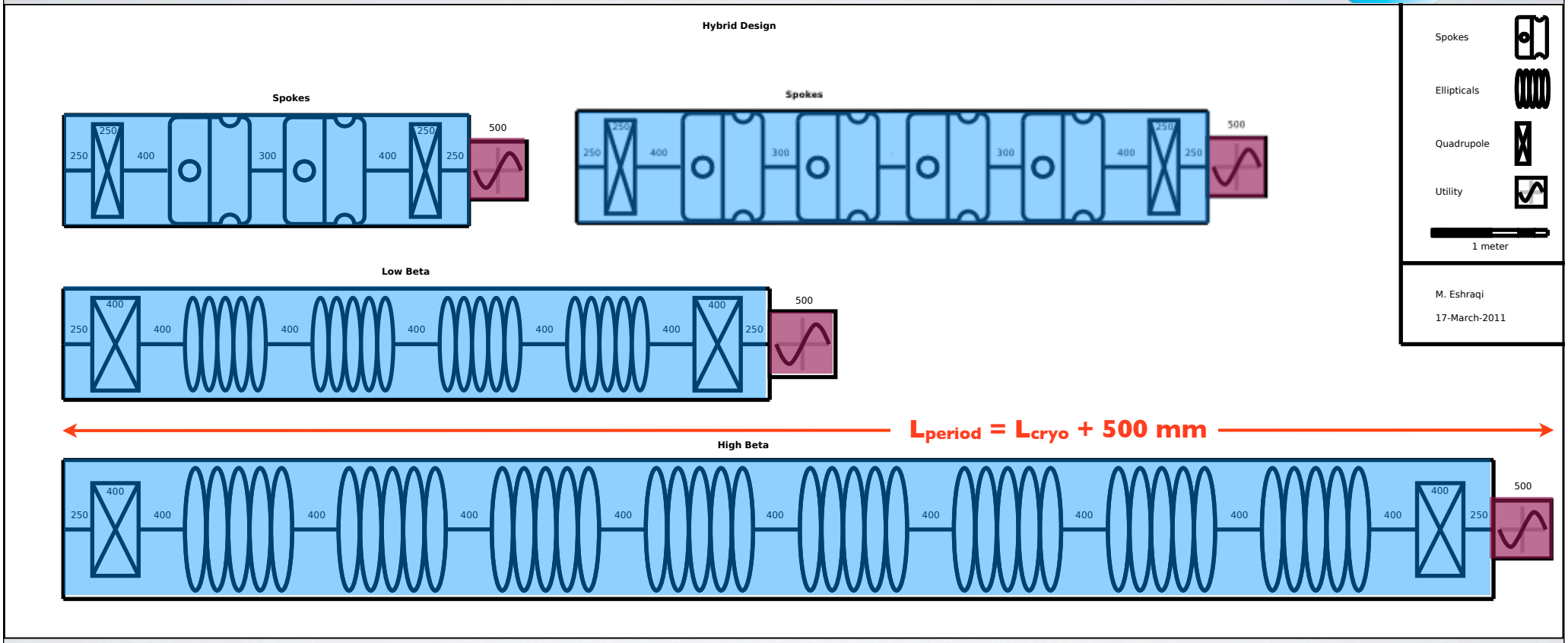
CRYOMODULE



For exact lengths visit:

http://esss.se/linac/Parameters/pdf/Cryomodules%20Spoke.pdf
http://esss.se/linac/Parameters/pdf/Cryomodules%20Low%20beta.pdf
http://esss.se/linac/Parameters/pdf/Cryomodules%20High%20beta.pdf

CRYOMODULE ?



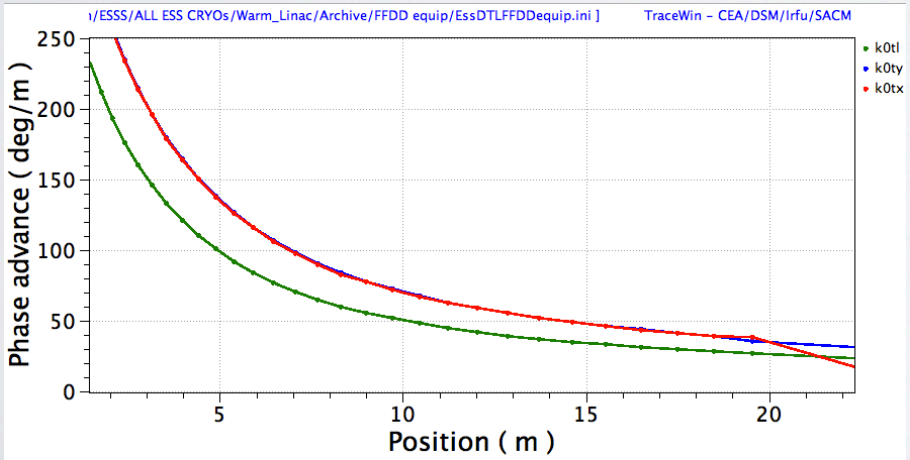
Warm quads? Could save ~30 m in length

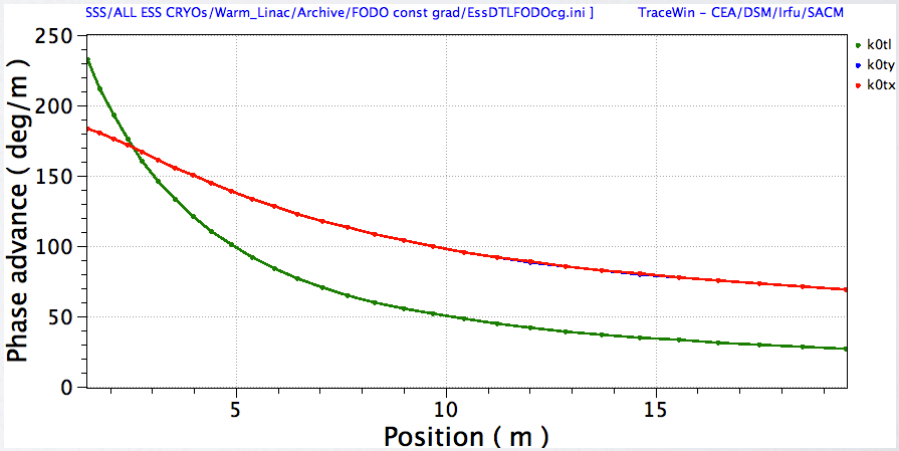
DTL

The DTL is designed by Michele Comunian

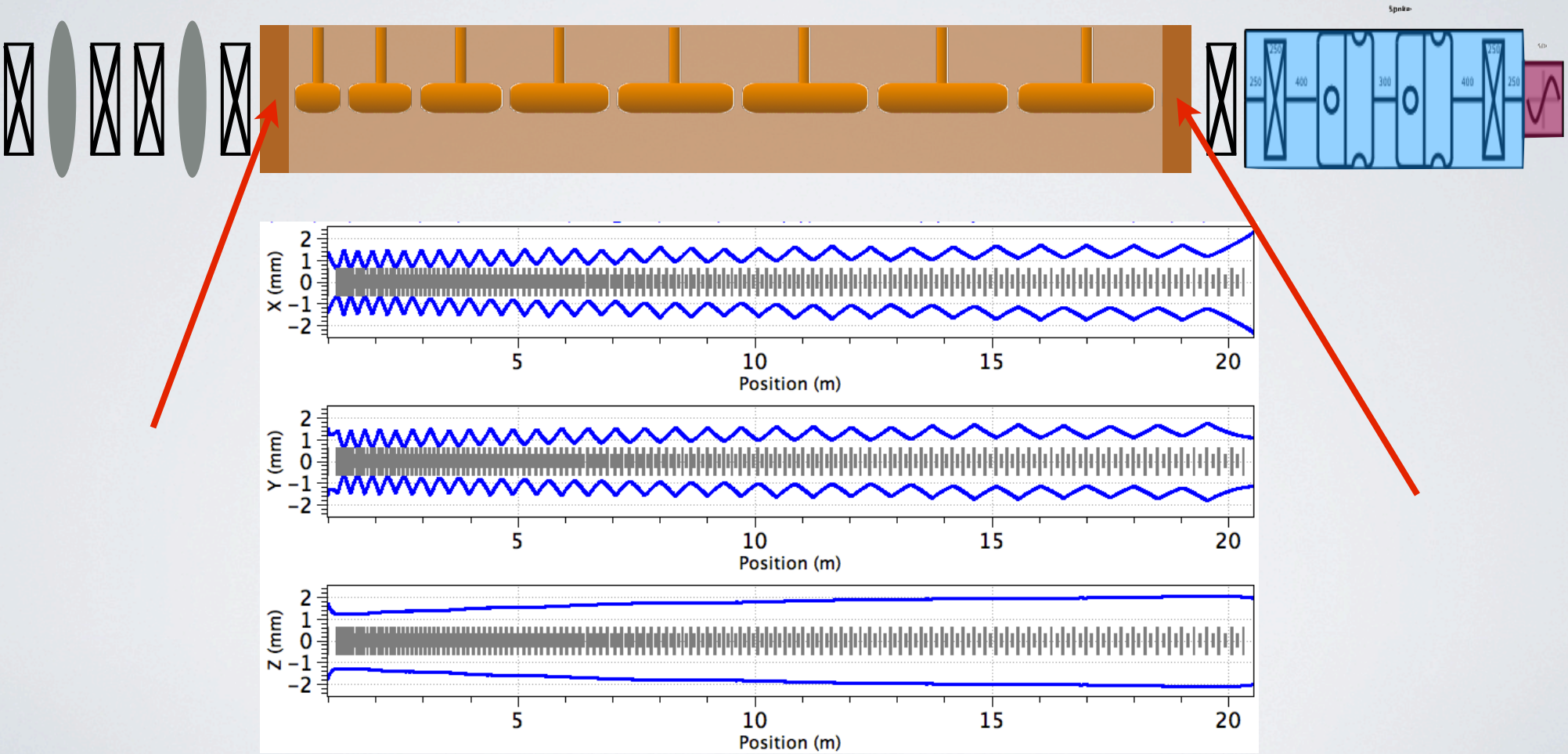
- The DTL is designed, for the moment, as one RF tank and there are 2 different focusing schemes used, FFDD and FoDo.

- Each of these designs have two settings for the gradients, one "Constant Gradient" and one "equipartitioned".

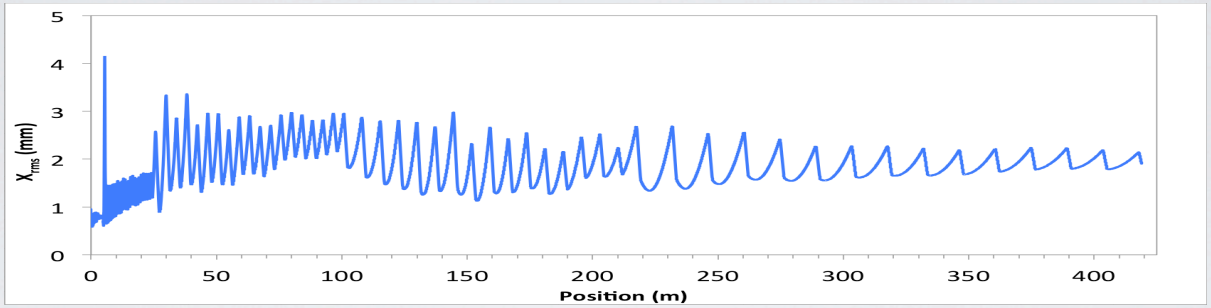


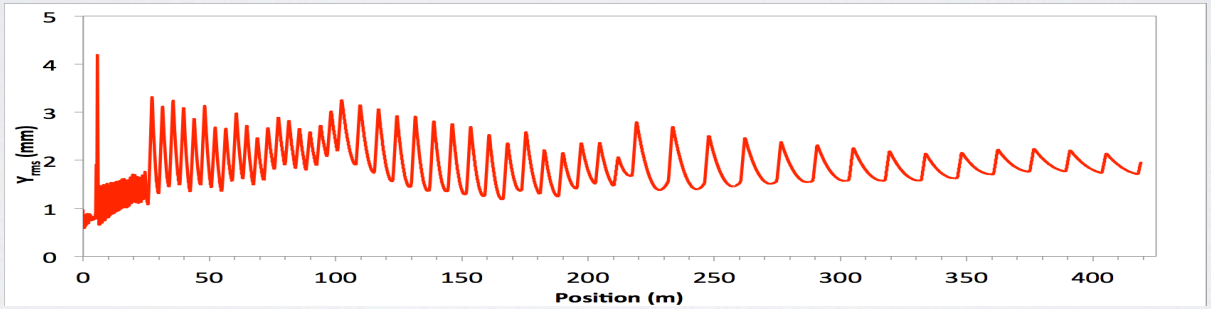


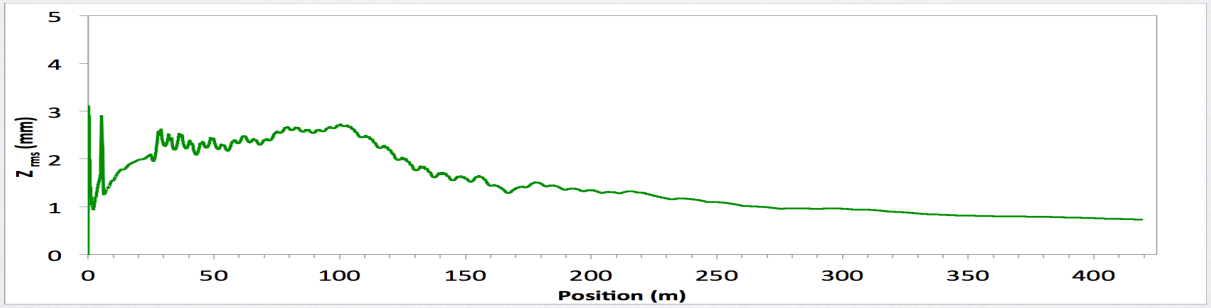
DTL II



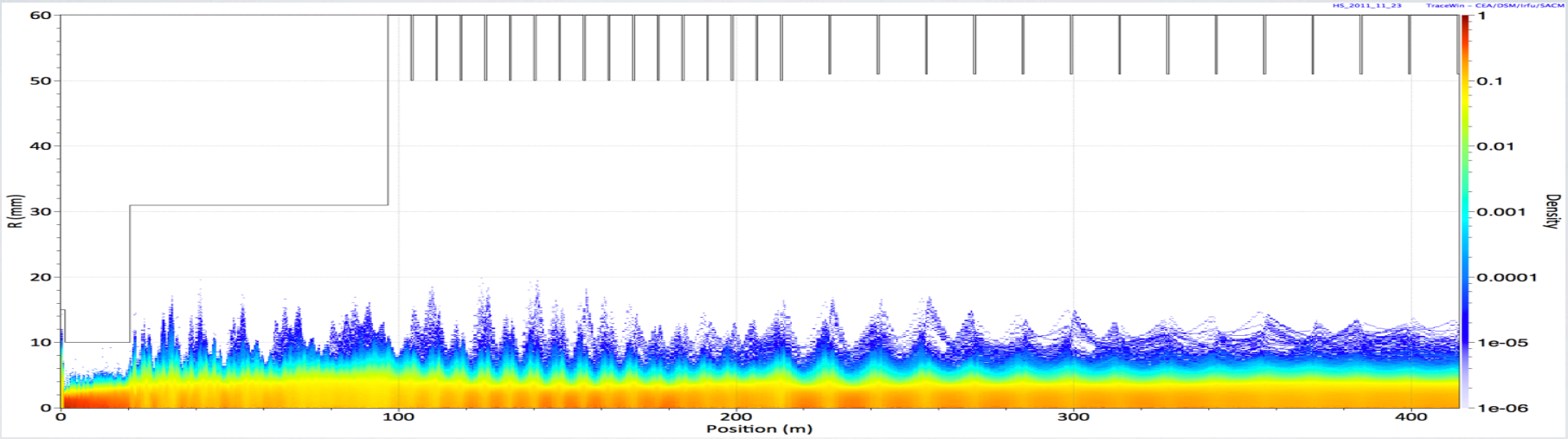
ENVELOPES

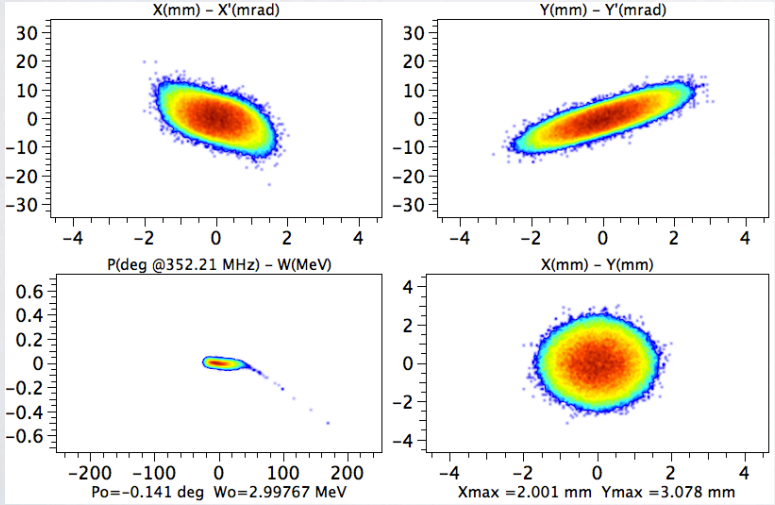

X_{rms} (mm)
0
1
2
3
4
5
0
50
100
150
200
250
300
350
400
Position (m)

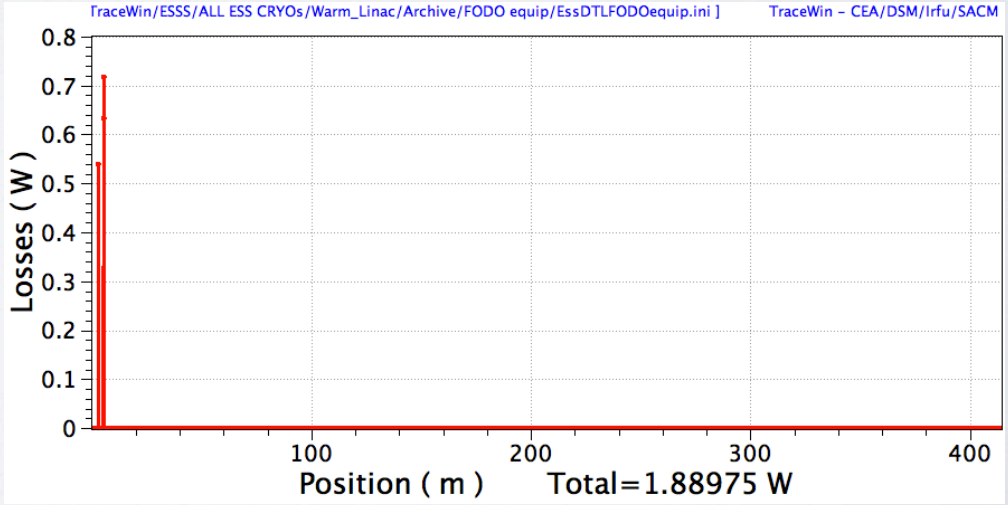

Y_{rms} (mm)
0
1
2
3
4
5
0
50
100
150
200
250
300
350
400
Position (m)


Z_{rms} (mm)
0
1
2
3
4
5
0
50
100
150
200
250
300
350
400
Position (m)

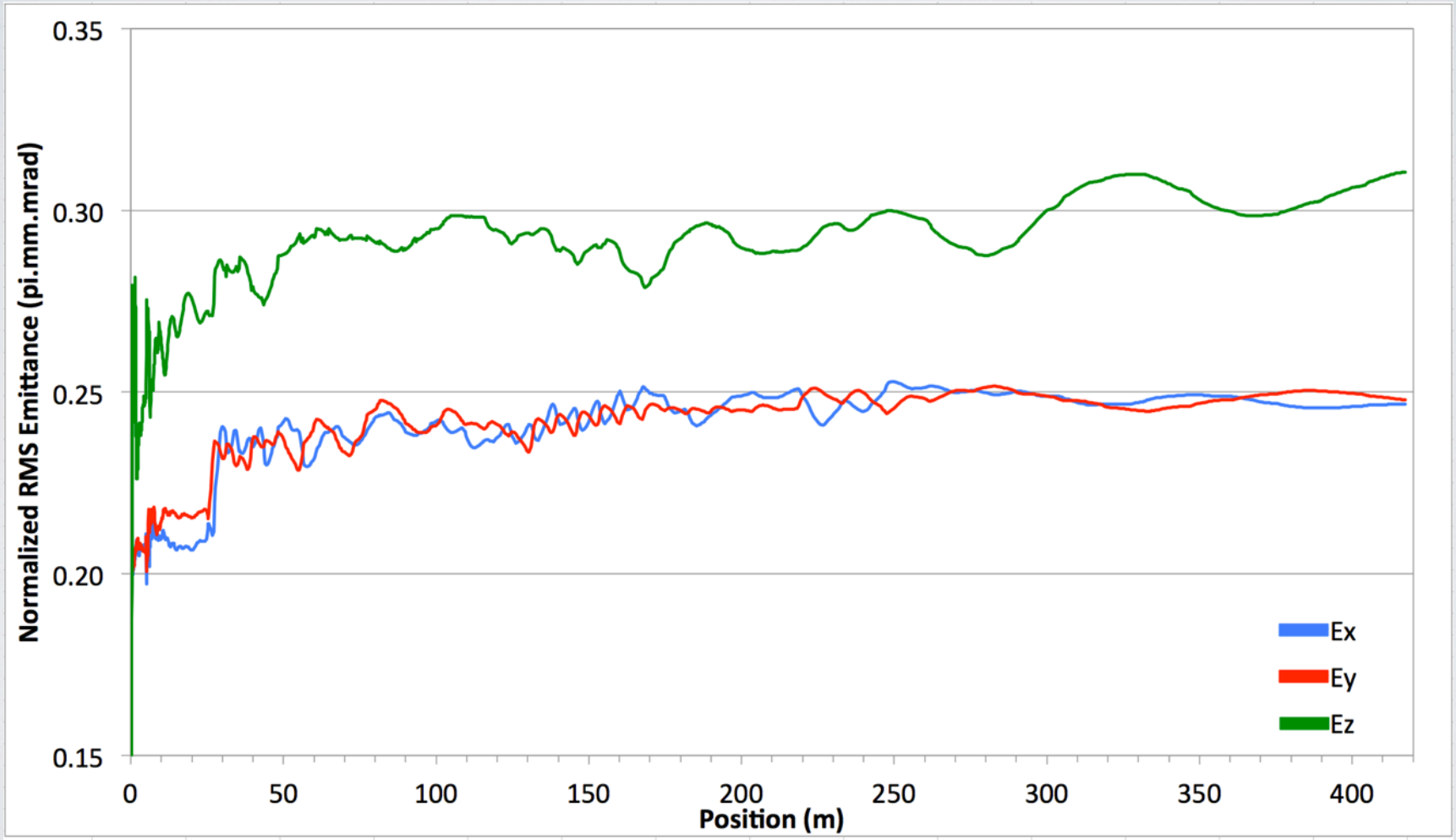
DENSITY


R (mm)
Position (m)
Density
0
100
200
300
400
1
0.1
0.01
0.001
0.0001
1e-05
1e-06

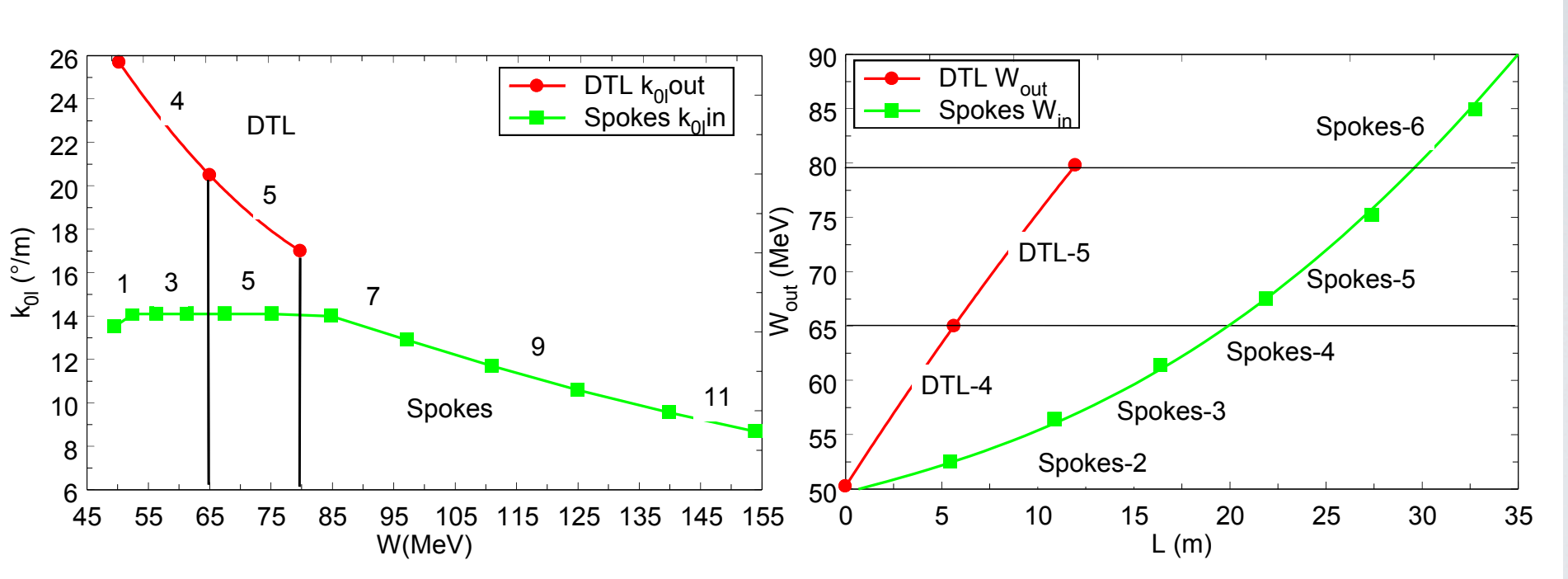

X(mm) - X'(mrad)
Y(mm) - Y'(mrad)
P(deg @352.21 MHz) - W(MeV)
X(mm) - Y(mm)
Po=-0.141 deg Wo=2.99767 MeV
Xmax =2.001 mm Ymax =3.078 mm


TraceWin/ESSS/ALL ESS CRYOs/Warm_Linac/Archive/FODO equip/EssDTLFODOequip.ini]
TraceWin - CEA/DSM/Irfu/SACM
Losses (W)
Position (m)
Total=1.88975 W

EMITTANCE


0.35
0.30
0.25
0.20
0.15
Normalized RMS Emittance (pi.mm.mrad)
0
50
100
150
200
250
300
350
400
Position (m)
Ex
Ey
Ez

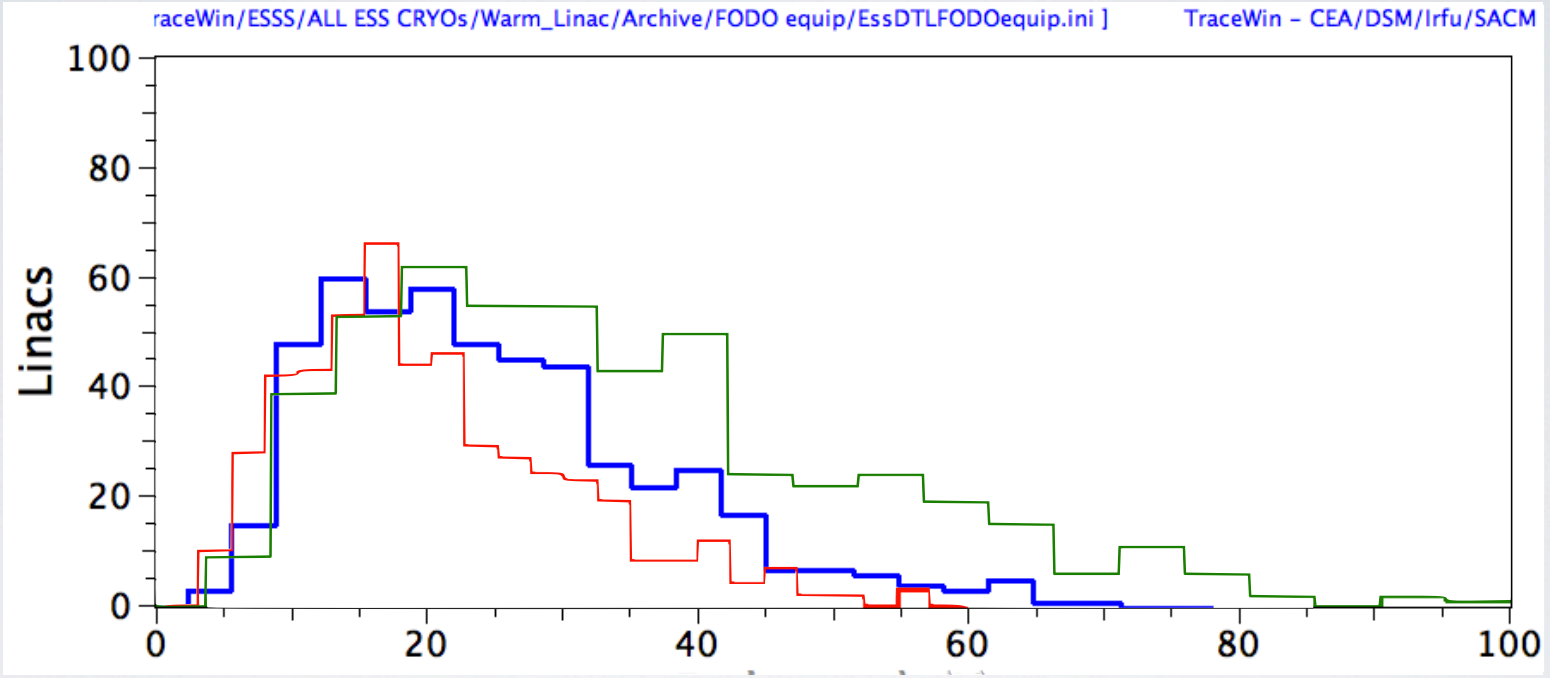
A REMEDY?



Courtesy of James Stovall

Reducing the number of spoke cavities/cryomodule from 3 to 2 increased the k_{0l} to ~18 deg/m.

QUAD EROURR FODO



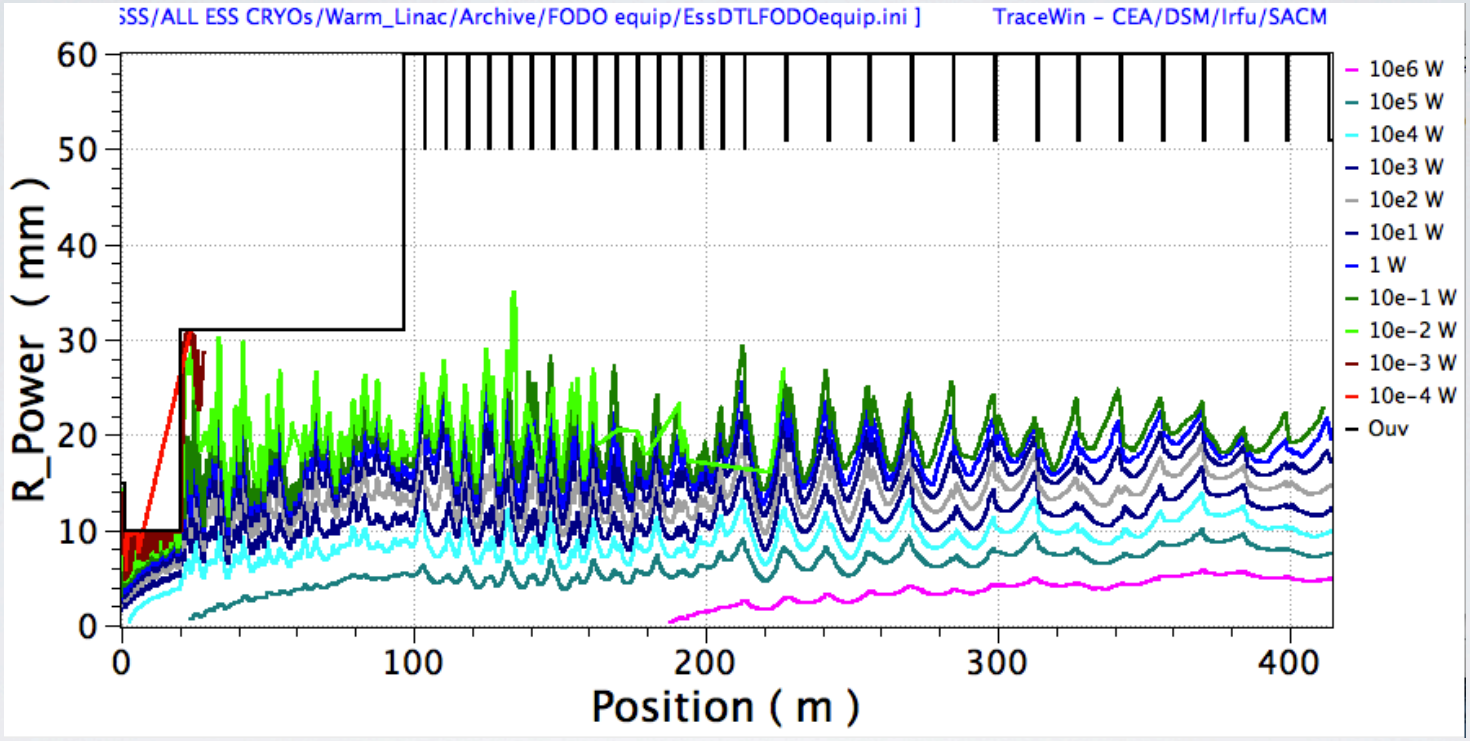
$\Delta x = \Delta y = 0.1$ mm, $\Delta G = 0.5\%$

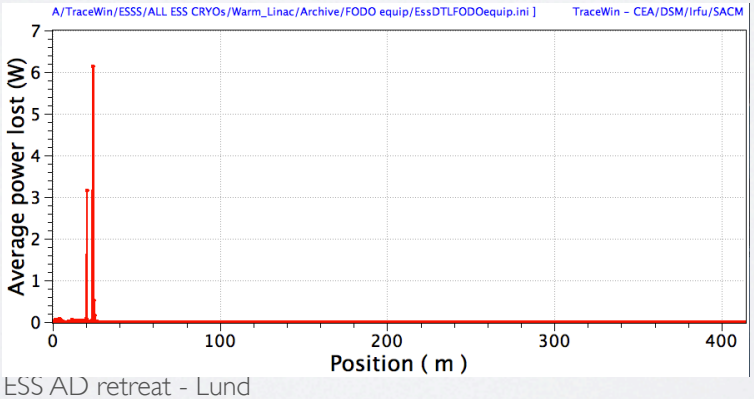
$\Delta\varepsilon_x = 25 \pm 12$

$\Delta\varepsilon_y = 20 \pm 10$

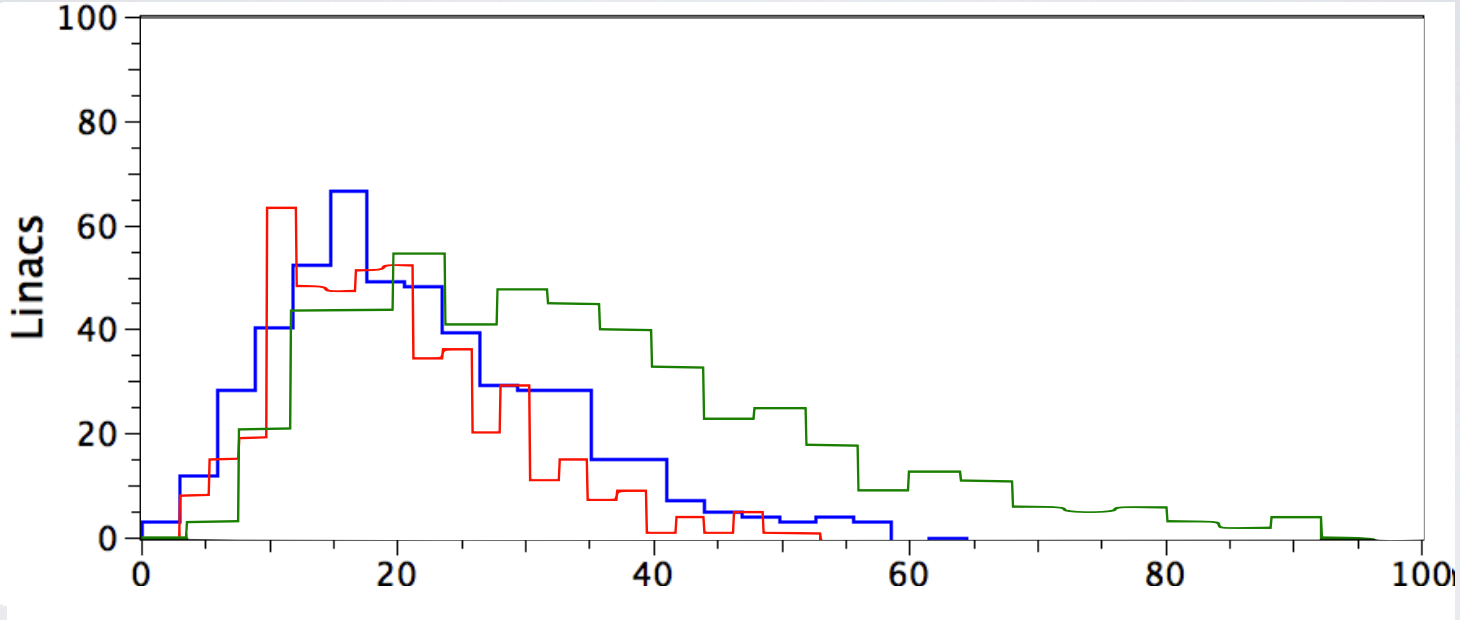
$\Delta\varepsilon_z = 34 \pm 18$

QUAD EROURR FODO





QUAD ERRRUR FFDD



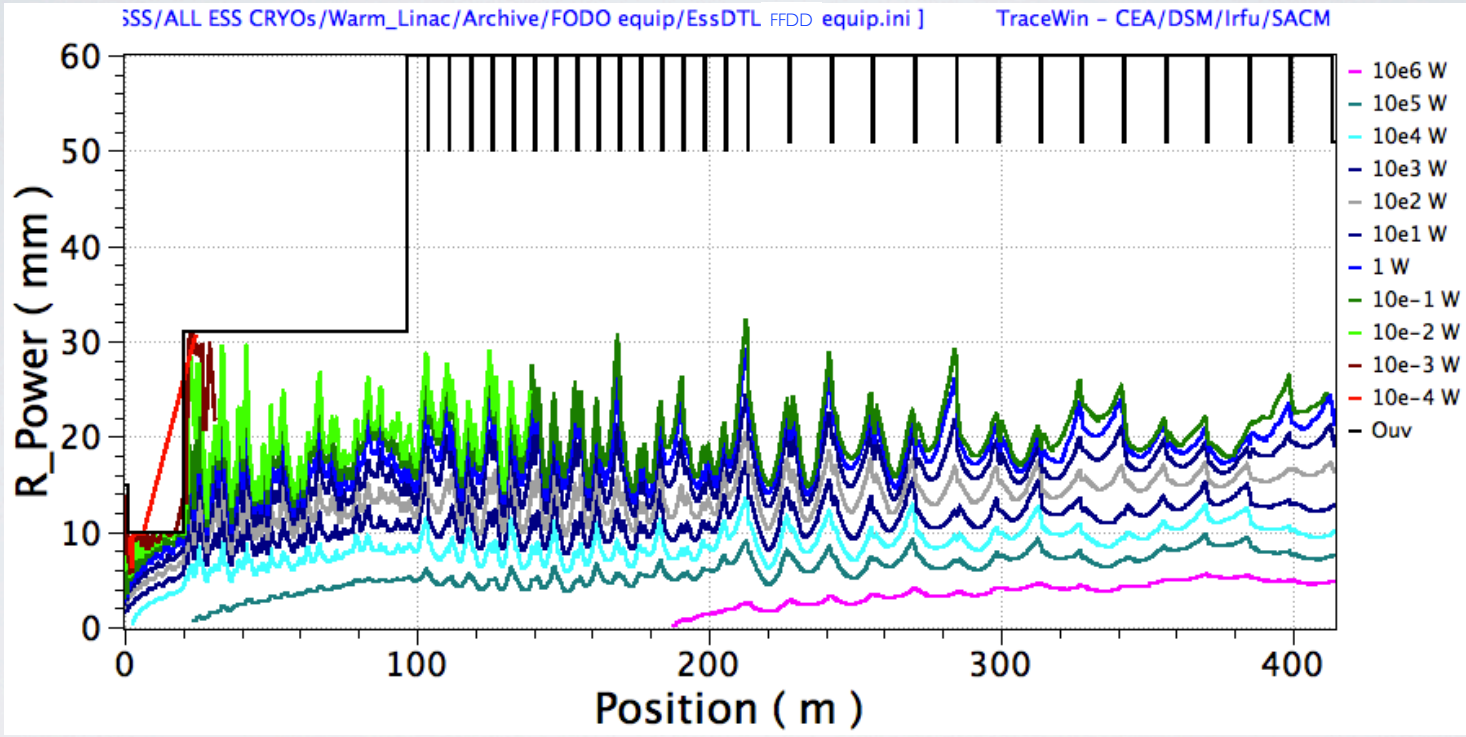
$\Delta x = \Delta y = 0.1$ mm, $\Delta G = 0.5\%$

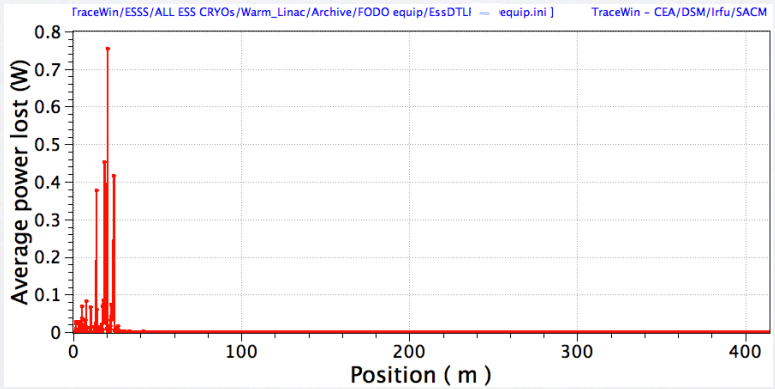
$\Delta\varepsilon_x = 22 \pm 11$

$\Delta\varepsilon_y = 20 \pm 9$

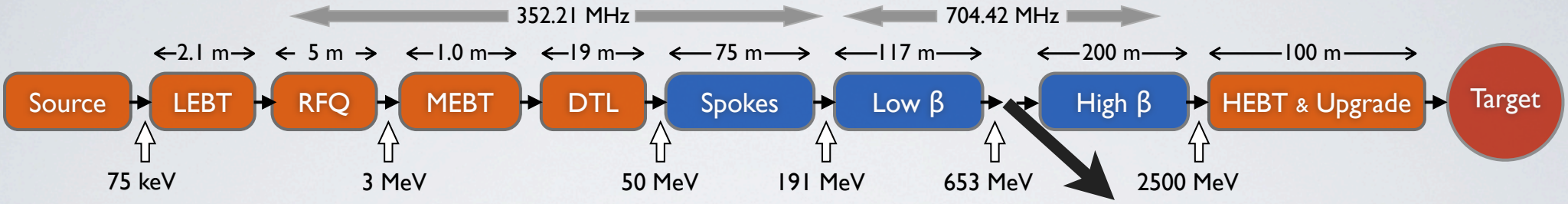
$\Delta\varepsilon_z = 34 \pm 18$

QUAD ERRRUR FFDD





BRANCHING



A 2.4 m, 1 T dipole is enough to divert the beam by 32 deg at 650 MeV, plus 2.7 m or , 2.16 m for the quadrupoles.

Leaving one period respects the periodicity and provides space to extract the beam using NC dipoles.

SUMMARY AND FURTHER STUDIES

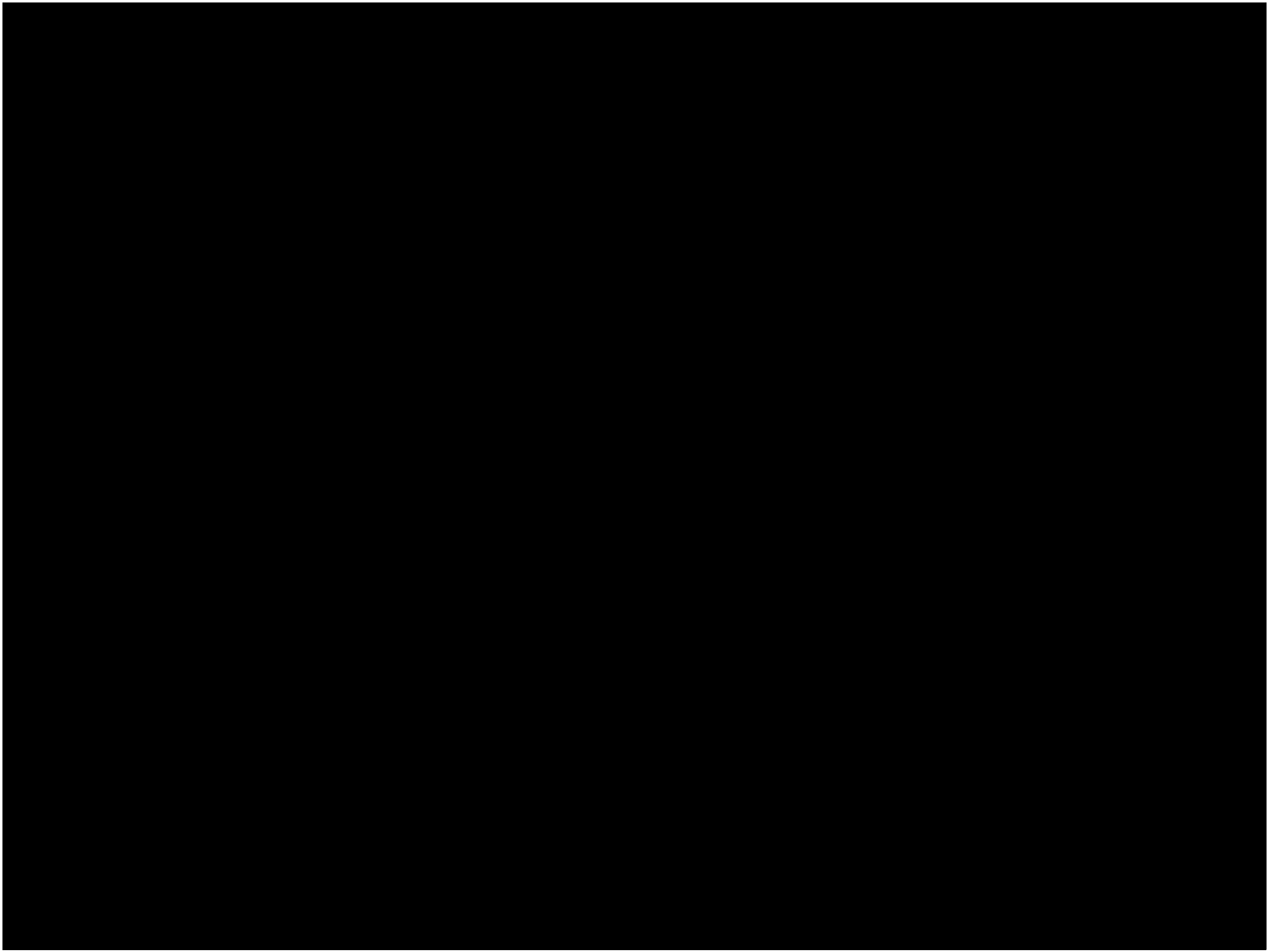
The discontinuity in the average phase advance causes emittance increase in transition between RFQ-MEBT, MEBT-DTL, and DTL-Spoke.

The current baseline uses a FoDo lattice in the DTL, however, an FFDD lattice would cause less losses **in the spokes** in cases of errors.

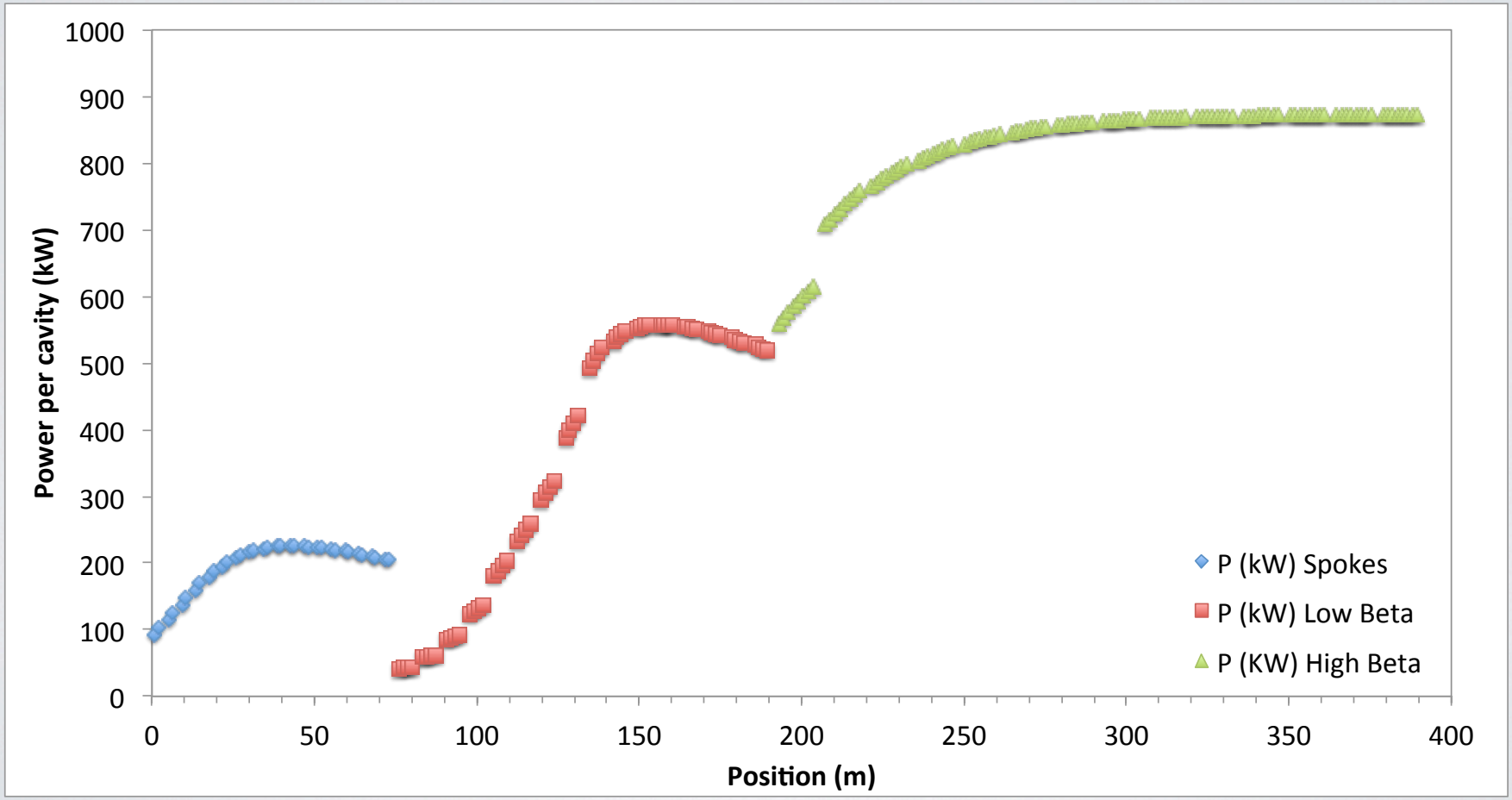
Alignment precision of 0.1 mm and 0.5% gradient error is results in losses within the limit in the FFDD DTL.

Quad error in the SC linac is left to be studies, although the same error as in DTL caused no extra losses in SC linac.

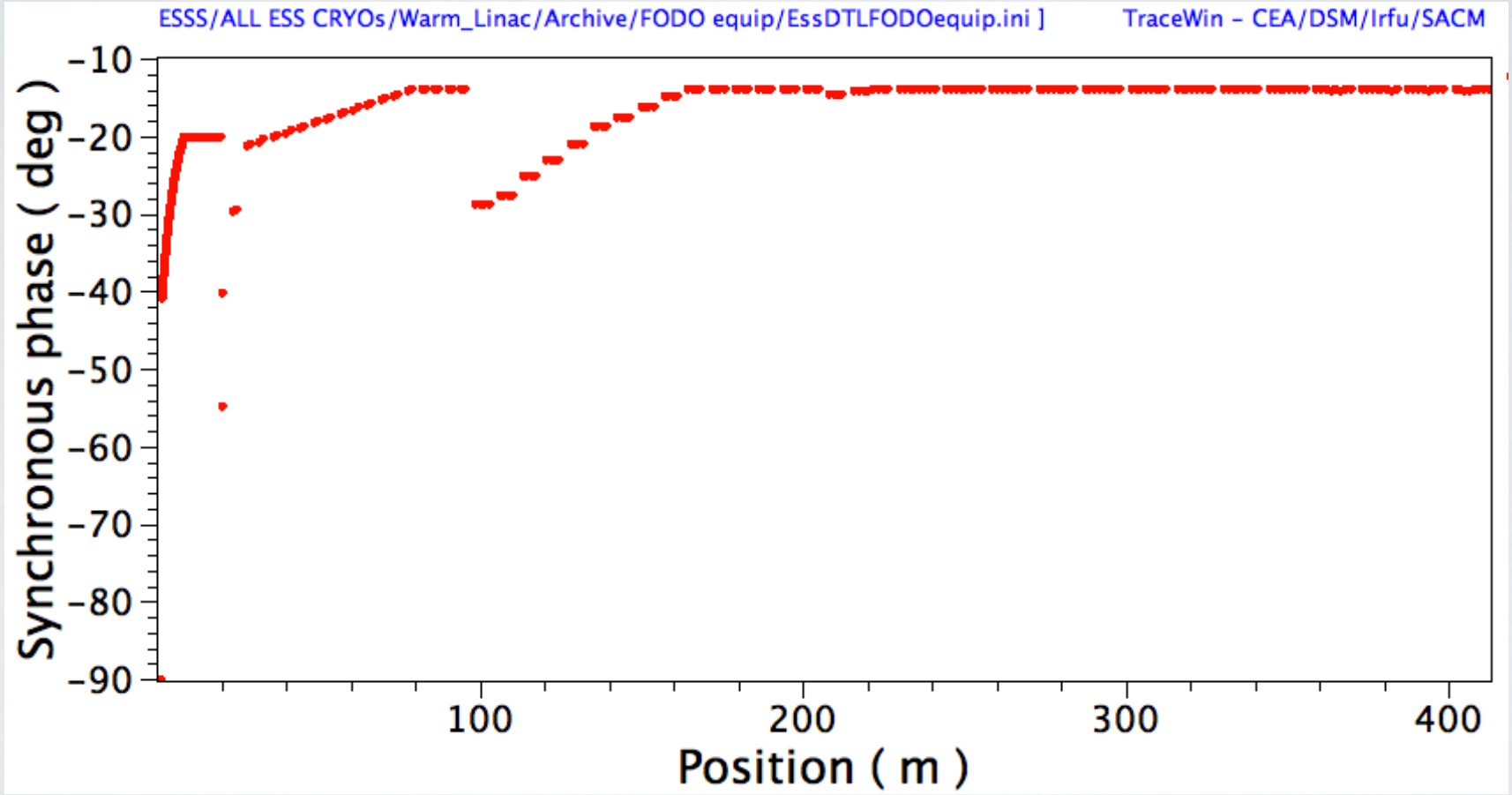
THANK YOU!



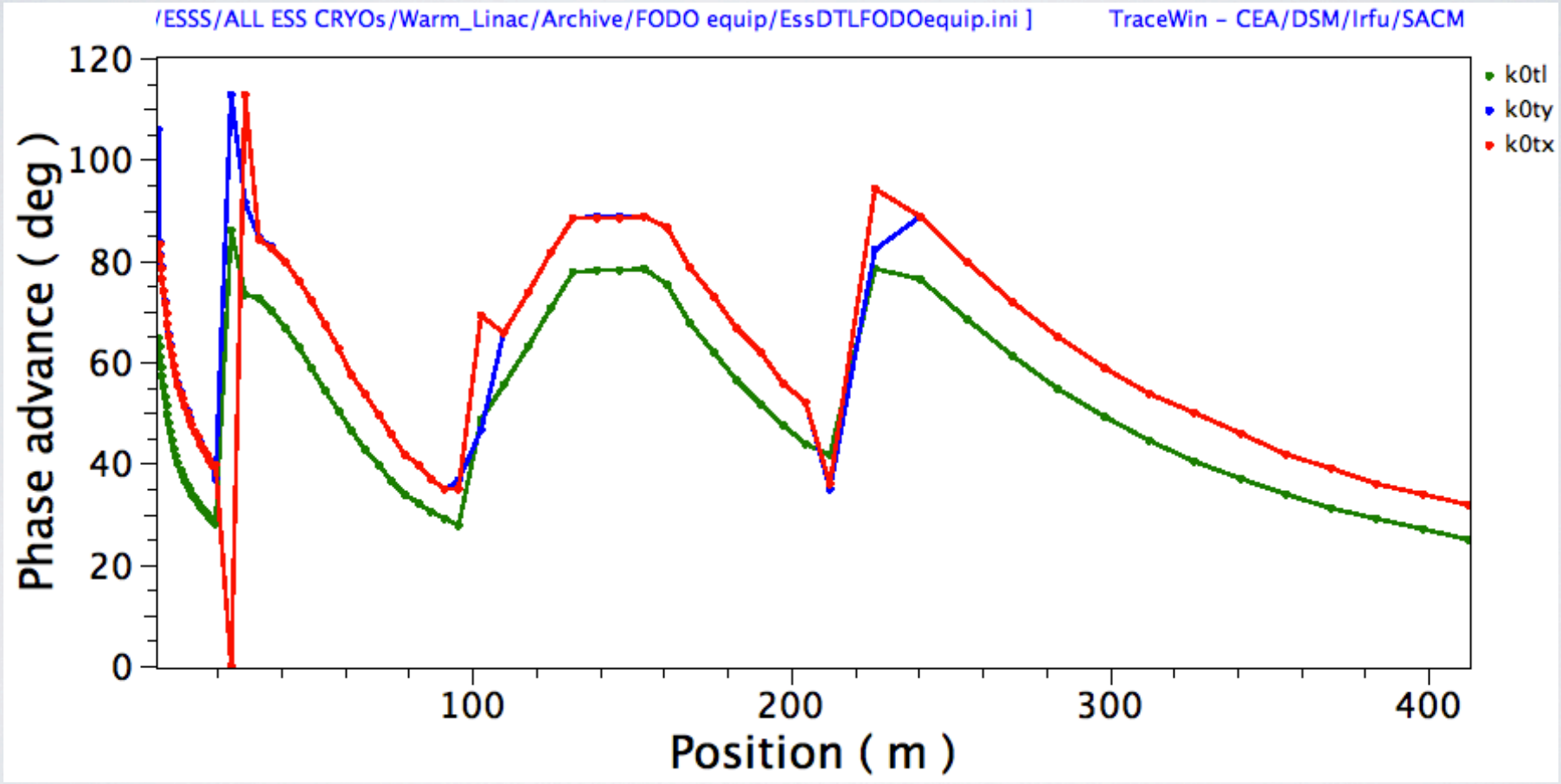
POWER PER CAVITY



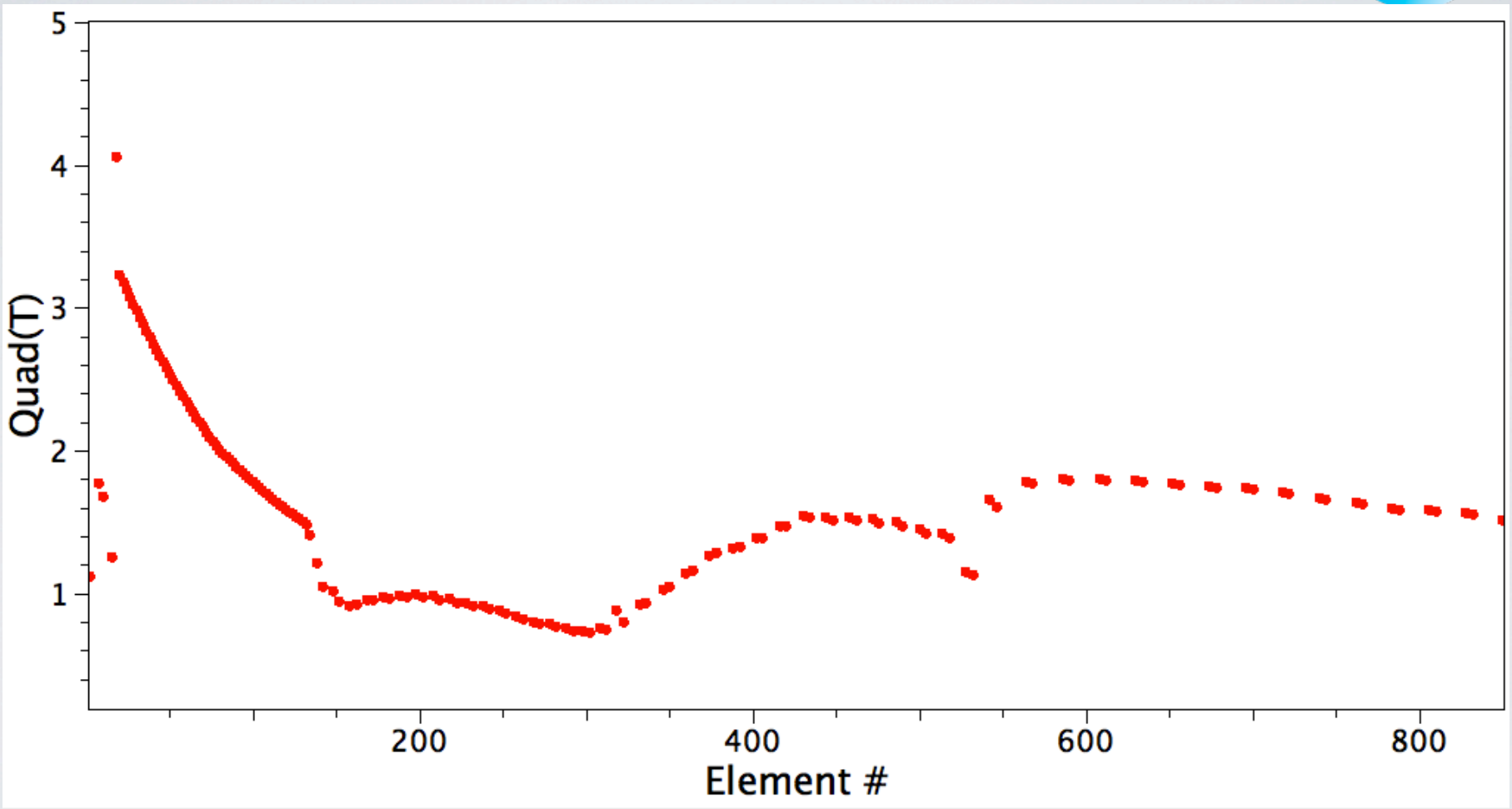
PHASES


ESSS/ALL ESS CRYOs/Warm_Linac/Archive/FODO equip/EssDTLFODOequip.ini]
TraceWin - CEA/DSM/Irfu/SACM
Synchronous phase (deg)
-10
-20
-30
-40
-50
-60
-70
-80
-90
100
200
300
400
Position (m)

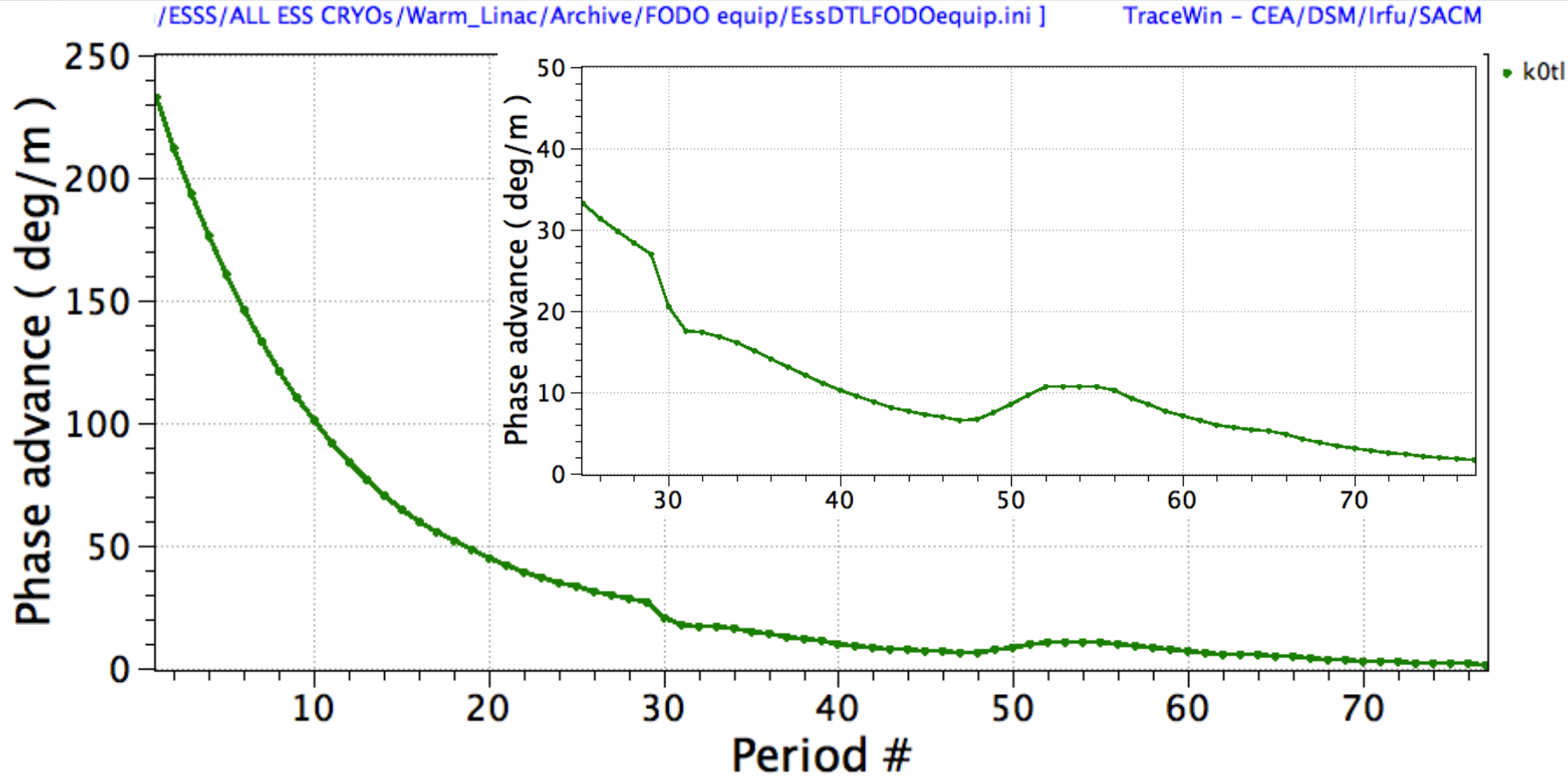
PHASE ADVANCE



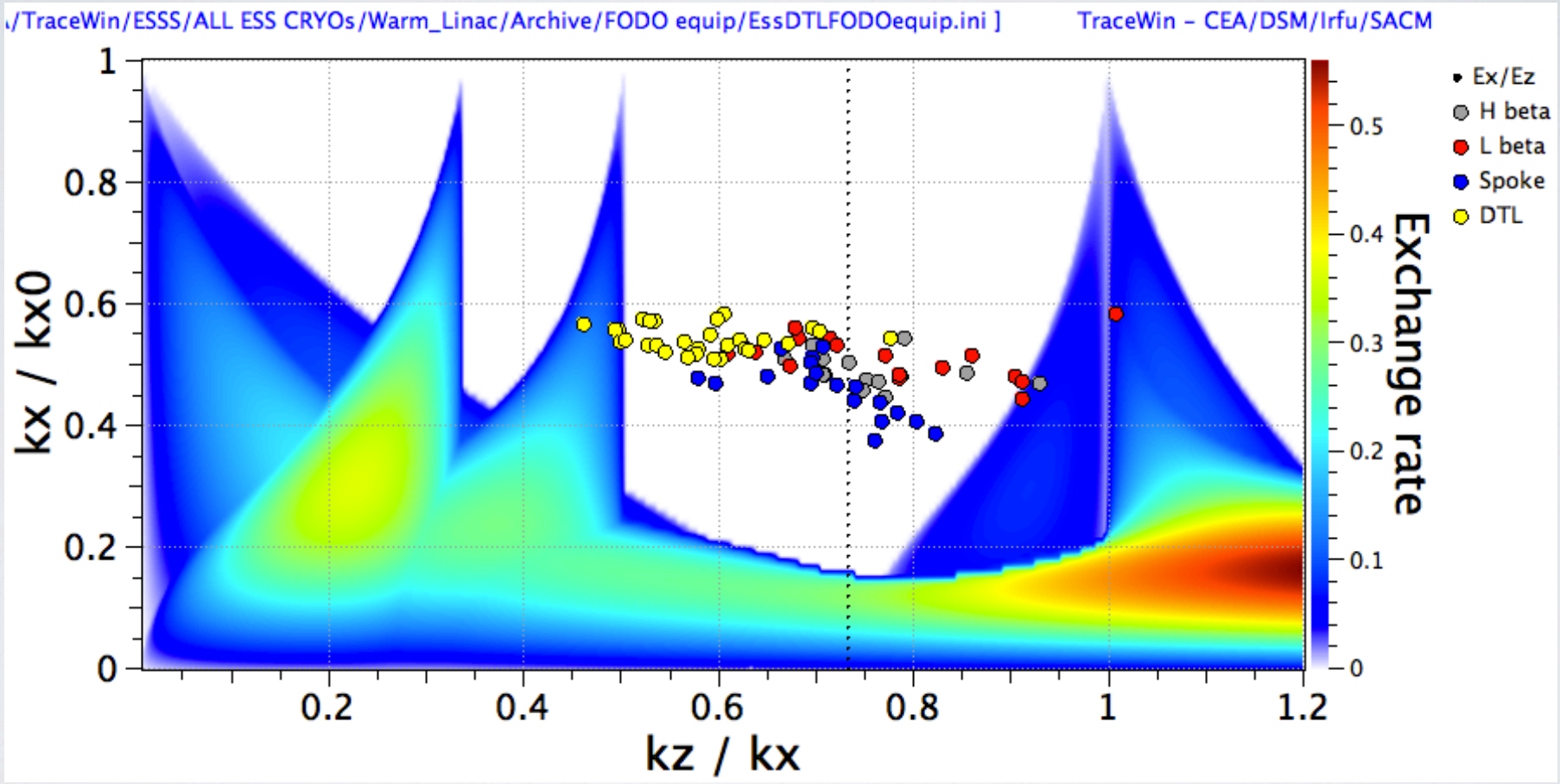
INTEGRATED GRADIENT



AVE. PHASE ADVANCE



RESONANCES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TraceWin - CEA/DSM/Irfu/SACM
kx / kx0
kz / kx
Exchange rate
Ex/Ez
H beta
L beta
Spoke
DTL
0
0.2
0.4
0.6
0.8
1
1.2
0.1
0.3
0.5

FIELD AND TTF IN SPOKE