

ARC2

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29 December 2010

1 Requirements

- The TWISS values for the ARC2 section must be independent of how they are generated. That is, stand alone ARC2 must return the same TWISS values as LINAC2+ARC2 combined.

More or less the same requirements as for Arc1, see ../Arc1_selfconsistent/ARC1.org.

2 TWISS parameters in original Optim/Elegant files for Arc2

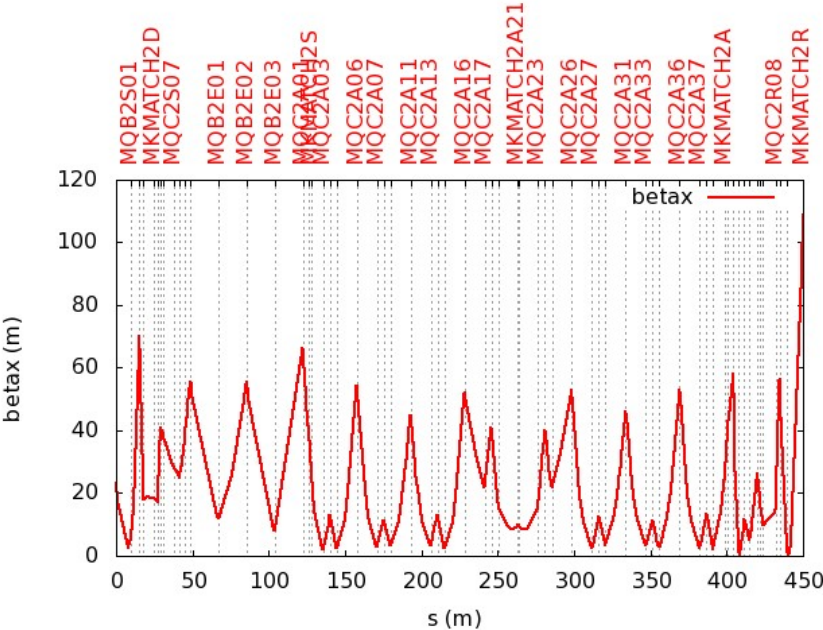
2010-12-29 Wed The following tables and plots are after changing the input TWISS values to equal the output LINAC2. Optics look to be in good shape, but will go through the fit process any way. Worse parameter appears to be β_y which disagrees at the 50cm level.

2.1 Entrance/Exit comparison table

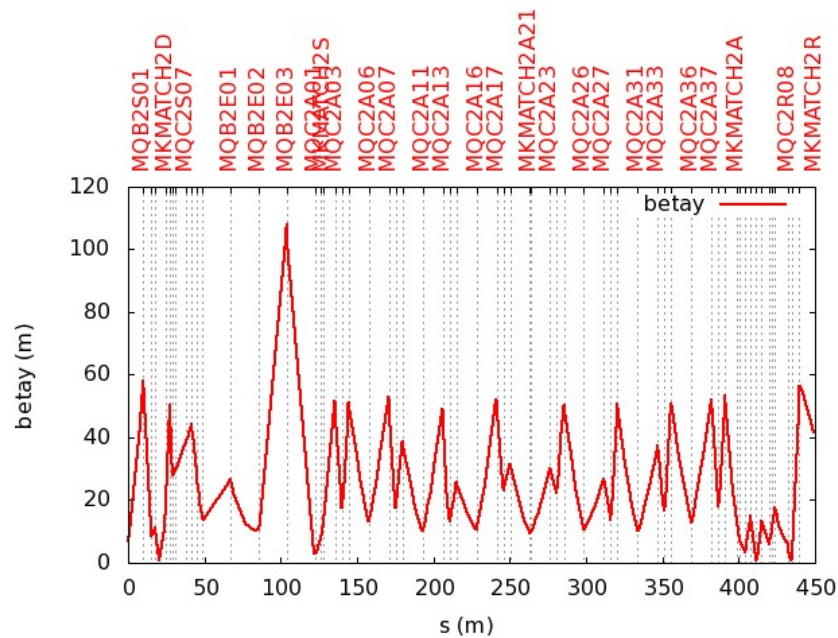
	β_x	α_x	β_y
MKMATCH2S	2.627181167766496e+01	3.438194901495889e+00	1.292694623084690e+01
MKMATCH2A21	9.823633213461928e+00	1.721963576181954e-02	9.669057819974167e+00
MKMATCH2A	2.630370346273434e+01	-3.476810906438576e+00	1.343047091701058e+01

	Entrance vs. Exit	Calculation	Units
β_x	-0.031891785	Difference	m
β_y	-0.50352469	Difference	m
α_x	-5.5843778e-3	Sum/Difference	
α_y	-0.018055625		

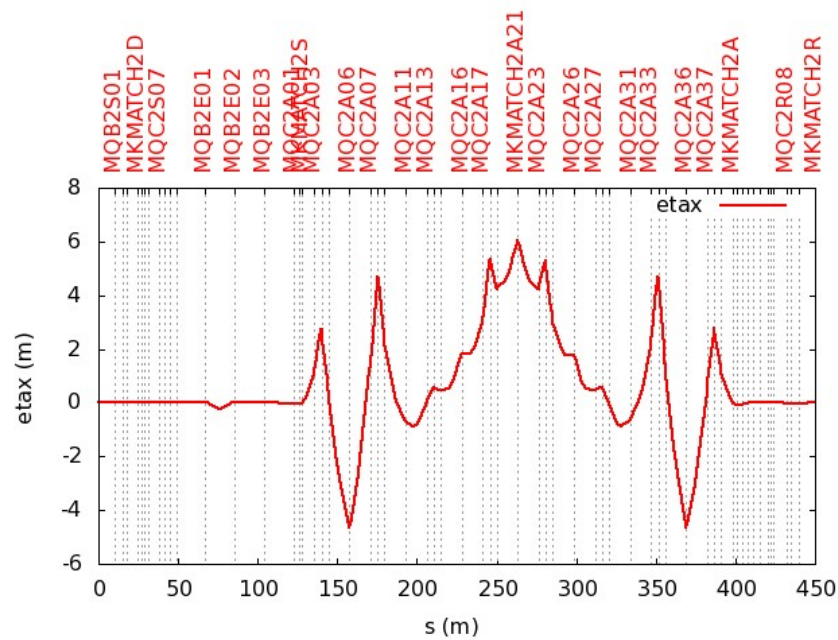
2.2 β_x



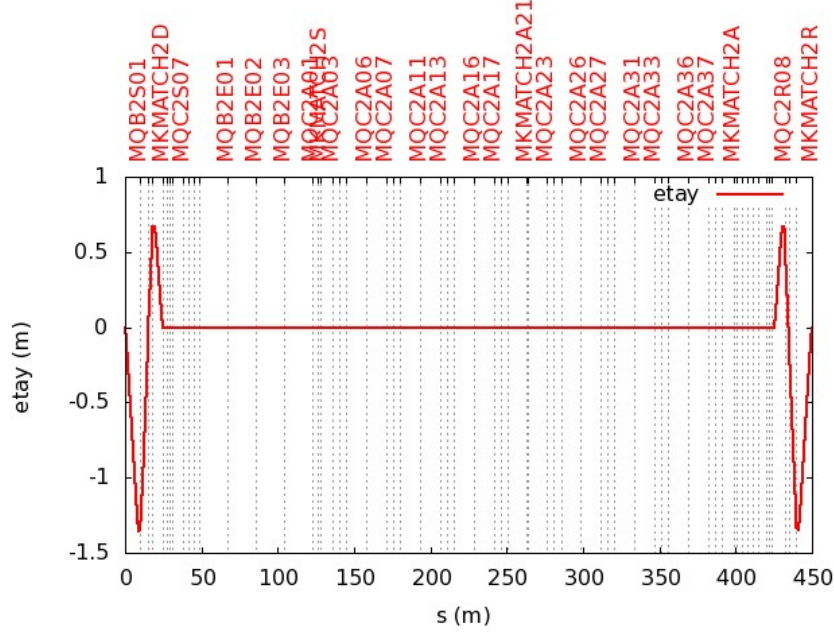
2.3 β_y



2.4 η_x



2.5 η_y



3 DONE [14/14] Steps towards self-consistency

Started at 2010-12-29 Wed 12:04 Completed at 2010-12-29 Wed 17:53

3.1 DONE Run LINAC2.ele and extract final TWISS values

2010-12-29 Wed

- $\beta_x = 23.16050$
- $\alpha_x = 3.092513$
- $\beta_y = 6.681382$
- $\alpha_y = -1.246666$
- $\eta_{xy} = \eta_{xy}' = 0$
- Notes

These are different than the values in ARC2.ele (revision1.7). TWISS values found for ARC2 entrance.

beta_x=23.2491, alpha_x=3.12569,
beta_y=6.7684, alpha_y=-1.24667

3.2 DONE Modify ARC2.ele to use the LINAC2.ele exit TWISS as input

2010-12-29 Wed Modified ARC2.ele to reflect the output of LINAC2, twiss_{output} parameters.

- $\beta_x = 23.16050$
- $\alpha_x = 3.092513$
- $\beta_y = 6.681382$
- $\alpha_y = -1.246666$
- $\eta_{xy} = \eta_{xy}' = 0$

3.3 DONE Verify quadrupole symmetry in ARC2.lte

2010-12-29 Wed The quadrupole magnets between the first and last dipole bends should be symmetric (in focal length and location) about the center (MQC2A21) of the Arc. The tables below show that the locations are symmetric at the tens of micron level and the focal lengths (K1s) are spot on.

- Arc2 Quad magnet S coordinate symmetry check

2010-12-29 Wed

First Half	Second Half	First Quad distance to center	Second Quad distance to center	
MQC2A03	MQC2A39	114.80718	114.80718	6.53699316899292e
MQC2A04	MQC2A38	110.82188	110.821879999999	7.105427357601e
MQC2A05	MQC2A37	106.83659	106.83658	1.000000060003e
MQC2A06	MQC2A36	94.9901900000002	94.9901799999996	1.000000060003e
MQC2A07	MQC2A35	83.1437900000002	83.1437799999996	1.00000005716083e
MQC2A08	MQC2A34	79.1584900000001	79.1584899999997	3.69482222595252e
MQC2A09	MQC2A33	75.1731900000001	75.1731899999998	3.12638803734444e
MQC2A11	MQC2A31	63.3267900000001	63.3267899999998	2.8421709430404e
MQC2A13	MQC2A29	51.4803900000001	51.4803899999998	2.8421709430404e
MQC2A14	MQC2A28	47.4950900000001	47.4950899999999	1.70530256582424e
MQC2A15	MQC2A27	43.5098	43.5097899999999	1.00000000884393e
MQC2A16	MQC2A26	31.6634	31.66339	9.99999997475243e
MQC2A17	MQC2A25	19.817	19.81699	9.99999997475243e
MQC2A18	MQC2A24	15.8317	15.8317	-2.8421709430404e
MQC2A19	MQC2A23	11.8464	11.8464	
			total	6.0000004566518274e

There are some issues at the 10micron level.

- Arc2 Quad focal length check

2010-12-29 Wed

First Half	Second Half	K1 (first half)	K1 (2nd half)	Δ
MQC2A03	MQC2A39	-0.619436	-0.619436	0
MQC2A04	MQC2A38	1.22451	1.22451	0
MQC2A05	MQC2A37	-0.501794	-0.501794	0
MQC2A06	MQC2A36	0.5345299999999999	0.5345299999999999	0
MQC2A07	MQC2A35	-0.510166	-0.510166	0
MQC2A08	MQC2A34	1.04916	1.04916	0
MQC2A09	MQC2A33	-0.442648	-0.442648	0
MQC2A11	MQC2A31	0.511691	0.511691	0
MQC2A13	MQC2A29	-0.571083	-0.571083	0
MQC2A14	MQC2A28	1.08029	1.08029	0
MQC2A15	MQC2A27	-0.390568	-0.390568	0
MQC2A16	MQC2A26	0.384866	0.384866	0
MQC2A17	MQC2A25	-0.441397	-0.441397	0
MQC2A18	MQC2A24	0.554253	0.554253	0
MQC2A19	MQC2A23	-0.276951	-0.276951	0

Ks match!

- Verify dipole focusing symmetry

2010-12-29 Wed

First Half	Second Half	K1 (first half of arc)	K1 (second half of arc)	Δ
MBR2A01	MBR2A16	0.00134235467176847	0.00134235467176847	0
MBR2A02	MBR2A15	0.00134235467176847	0.00134235467176847	0
MBR2A03	MBR2A14	0.00134235467176847	0.00134235467176847	0
MBR2A04	MBR2A13	0.00134235467176847	0.00134235467176847	0
MBR2A05	MBR2A12	0.00134235467176847	0.00134235467176847	0
MBR2A06	MBR2A11	0.00134235467176847	0.00134235467176847	0
MBR2A07	MBR2A10	0.00134235467176847	0.00134235467176847	0
MBR2A08	MBR2A09	0.00134235467176847	0.00134235467176847	0

joy to the world!

3.4 DONE Match to $\eta_y=\eta_y'=0$ at the 2SD and 2RD match points

2010-12-29 Wed 13:38

- 2S η location (MKMATCH2SD)

	New Value	Δ
MQC2S02.K1:	1.229084498662364e+00	-1.365501337636355e-03
MQC2S03.K1:	-1.447245917628756e+00	-1.591762875574609e-05
- η_y =	-3.821277558269109e-09 m	
- η_{yp} =	-5.412142956018329e-12	

- End of arc2, $\eta_x = \eta_x'^{=0}$

	New Value	Δ
MQC2A21A.K1:	2.717670863020785e-01	-1.433913697921507e-03
- η_x =		

- 1R η location (end of recombiner)

do at end? if needed

3.5 DONE Modify Lattice: set matched quad values

3.6 DONE Optimize 2A11 and 2A31 to achieve $M_{56} = 0$

Optimization results:

optimization function has value 0

Terms of equation:

MKMATCH2R#1.R56 0 1e-12 sene: 0.0000000000000000e+00

A total of 78 function evaluations were made.

Optimum values of variables and changes from initial values:

MQC2A11.K1: 4.885637537521026e-01 -2.312724624789742e-02

MQC2A31.K1: 4.885637537521026e-01

M_{56} for the entire spreader-arc-recombiner lattice after this fit is:

$M_{56}(\text{end of 2R}) = 3.030182e-14$

3.7 DONE Modify Lattice with matched quad values

2010-12-29 Wed 15:08 dispersion and M_{56} taken care of. Time to rematch based on symmetry. This matching appears to blown the betatron symmetry in the Arc proper. Good thing rematching is the next step.

3.8 DONE Optimize Spread matching quads for symmetry

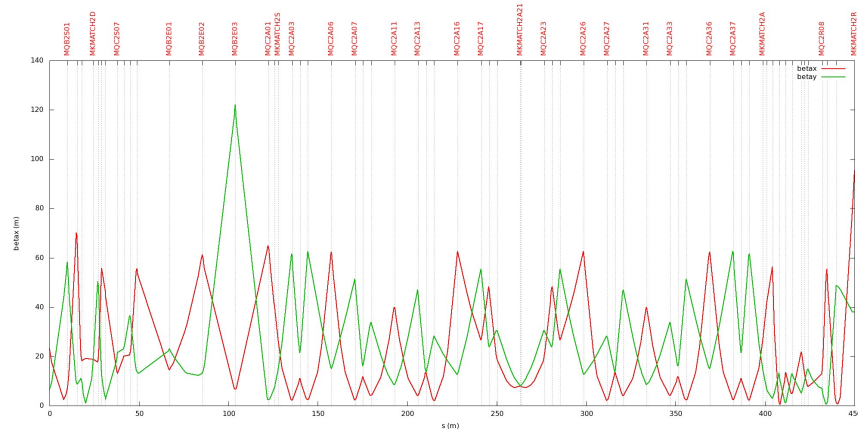
Use the spreader matching quads to achieve the desired symmetry: $\beta_{\text{entrance}} = \beta_{\text{exit}}$ and $\alpha_{\text{entrance}} = -\alpha_{\text{exit}}$

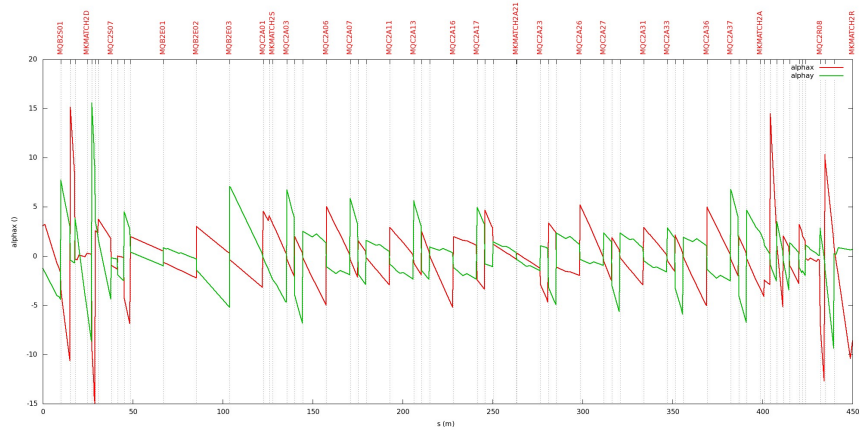
- Match Symmetry Results

With a symmetric lattice the entrance and exit twiss parameters are converge to exact symmetry; note the comparison column!

	Entrance	Exit	Comparison
β_x (m)	2.677652748202561e+01	2.677674314310504e+01	-2.156611e-4
α_x	3.317746819126919	-3.317771722771590	-7.5061624e-6
β_y (m)	1.447848600152878e+01	1.447815753592336e+01	3.284656e-4
α_y	-2.380332544943811	2.380293547558619	1.6383299e-5

- TWISS parameters after self-consistent effort: Elegant files for Arc1

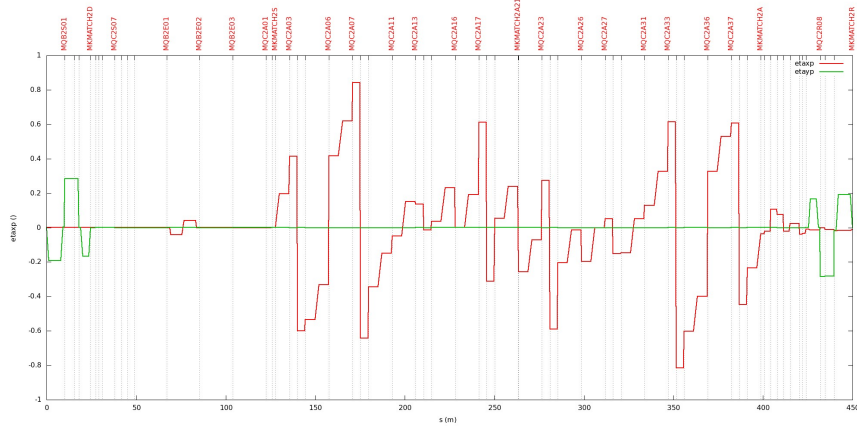
$$-\beta$$

$$= \alpha$$



– η



– η'



3.9 DONE Modify Lattice with matched quad values

2010-12-29 Wed 16:05

Optimum values of variables and changes from initial values:

Major changes from the K1 values in the original ARC2.lte mainly since 2S06, 2S07 and 2S09 were at 0 excitation in the original file and 2S08 had a sign that was not consistent with the pattern in 1S which I imposed on 2S.

Quad	Original K1	New K1 value	Δ from initial	% change
MQC2S04.K1	-1.15311	-1.632638113624815	0.47952811	-34.427241
MQC2S05.K1	0.832356	1.091085283560785	-0.25872928	-26.902748
MQC2S06.K1	0	9.869948276421882e-02	-0.098699483	-200.00000
MQC2S07.K1	0	-6.804239422022430e-01	0.68042394	-200.00000
MQC2S08.K1	-0.310781	2.266464275342820e-01	-0.53742743	1277.5424
MQC2S09.K1	0	-6.416648451118877e-01	0.64166485	-200.00000
MQC2S10.K1	0.309967	5.361582711767774e-01	-0.22619127	-53.465197

3.10 DONE Re-run ARC2 elegant deck for verification

2010-12-29 Wed 16:06

- Verify that $\eta=\eta' = 0$ at the 1SD and 1RD match points
- Verify that the TWISS parameters are symmetric

3.11 DONE Add LINAC2+ARC2 together

2010-12-29 Wed 16:10 LIN2_{ARC2}.lte LIN2_{ARC2}.ele

3.12 DONE Run LINAC2_{ARC2} and compare TWISS with stand alone ARC2

2010-12-29 Wed 16:10 no issues...all is good

3.13 DONE Match recombiner section

2010-12-29 Wed 16:38 Final TWISS paramaters at MKMATCH2R should equal those found in LINAC3.ele file.

	New K1	Δ from original
MQC2R02.K1:	-1.545783980612731e+00	2.601938726920494e-05
MQC2R03.K1:	1.774607177660828e+00	-6.125282233917195e-02
MQC2R04.K1:	-1.209700228440855e+00	5.343977155914503e-02
MQC2R05.K1:	8.903995028474436e-01	-2.691349715255642e-02

3.14 DONE Update ARC2.lte

2010-12-29 Wed 16:39 update the 2R quads to reflect the match