

Design of Vertical Separation Schemes for the CEBAF 12 GeV Upgrade Extraction Lines

Due to the large horizontal beam size in higher passes of the upgraded 12 GeV CEBAF, a vertical extraction scheme is conceived to circumvent this problem. This note summarizes efforts carried out so far to prototype such a scenario in the 4th and 5th passes.

The vertical separation scheme consists of vertically separating RF separators, followed by a Lambertson magnet at the point of maximal vertical separation (E02, which is traditionally the horizontal separation point), where vertically separated extraction beam is diverted to the extraction channel and further down to a YR septum, and then brought back to the main linac axis via the BP-BQ chicane similar to the 6 GeV configuration. The recirculated beam does not receive a kick from the Lambertson and is brought back on axis through orbit correction. A main departure from 6 GeV extraction optics is in the polarity of the 3 extraction quads (E01-03). In the current case both E01 and E02 are vertically defocusing, and E03 is vertically focusing. This is seen not to introduce any disadvantage to the extraction optics, while much better matched to the Arc for the recirculated optics.

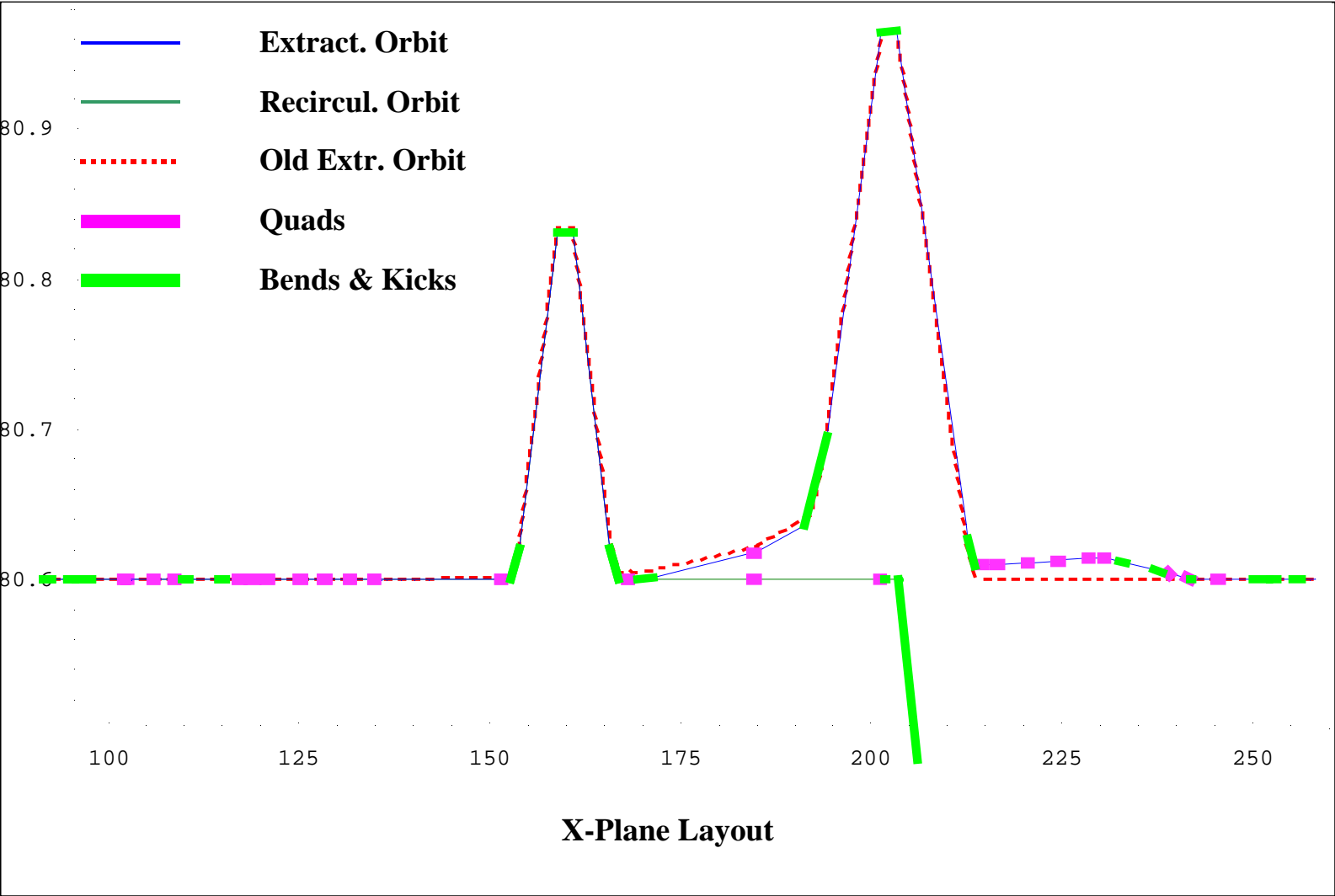
4th Pass:

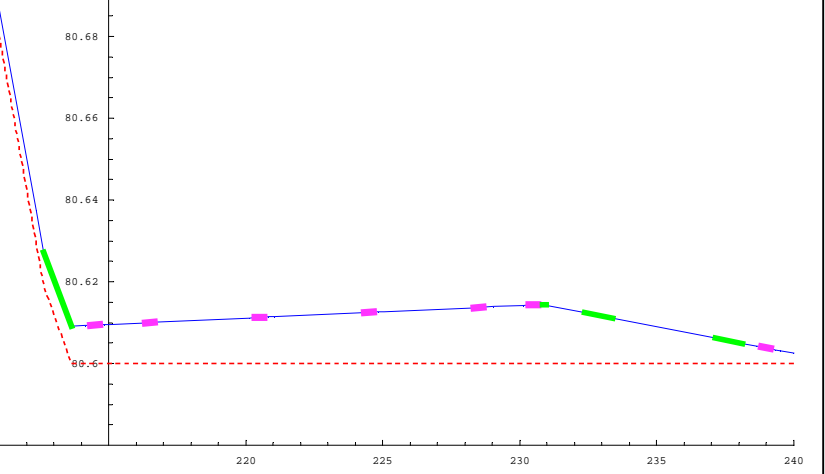
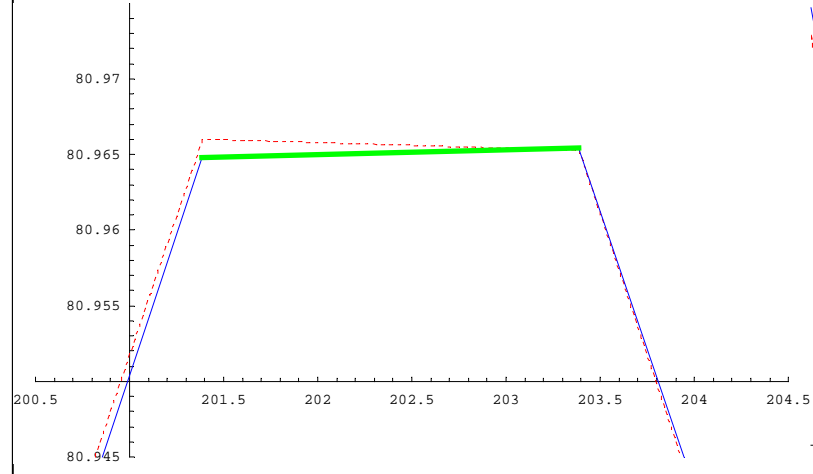
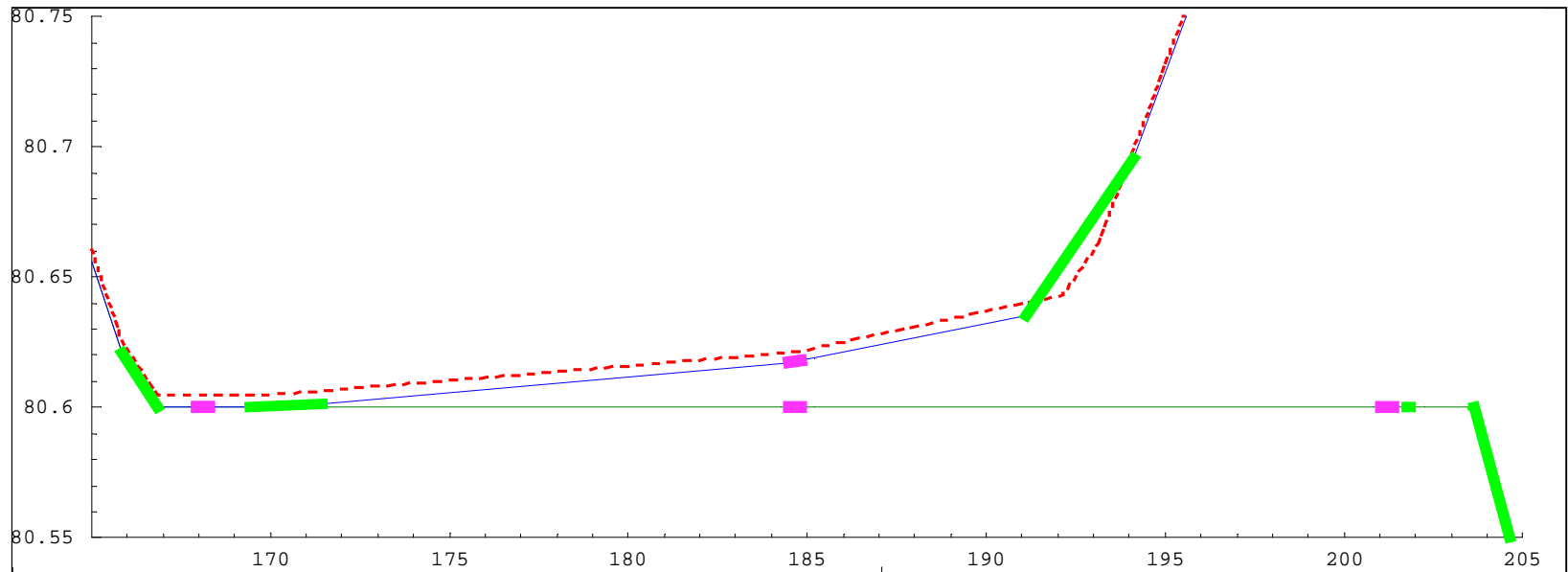
Study has been made with the RF separators operating at 48% and 60% of their full design gradients. In the latter case reduction in Lambertson & YR strengths can be attained. Beam line geometry and Twiss parameters for both extracted and recirculated beams are shown in the following pages. Nominal magnet strengths and beam separation in critical elements are also given.

5th Pass:

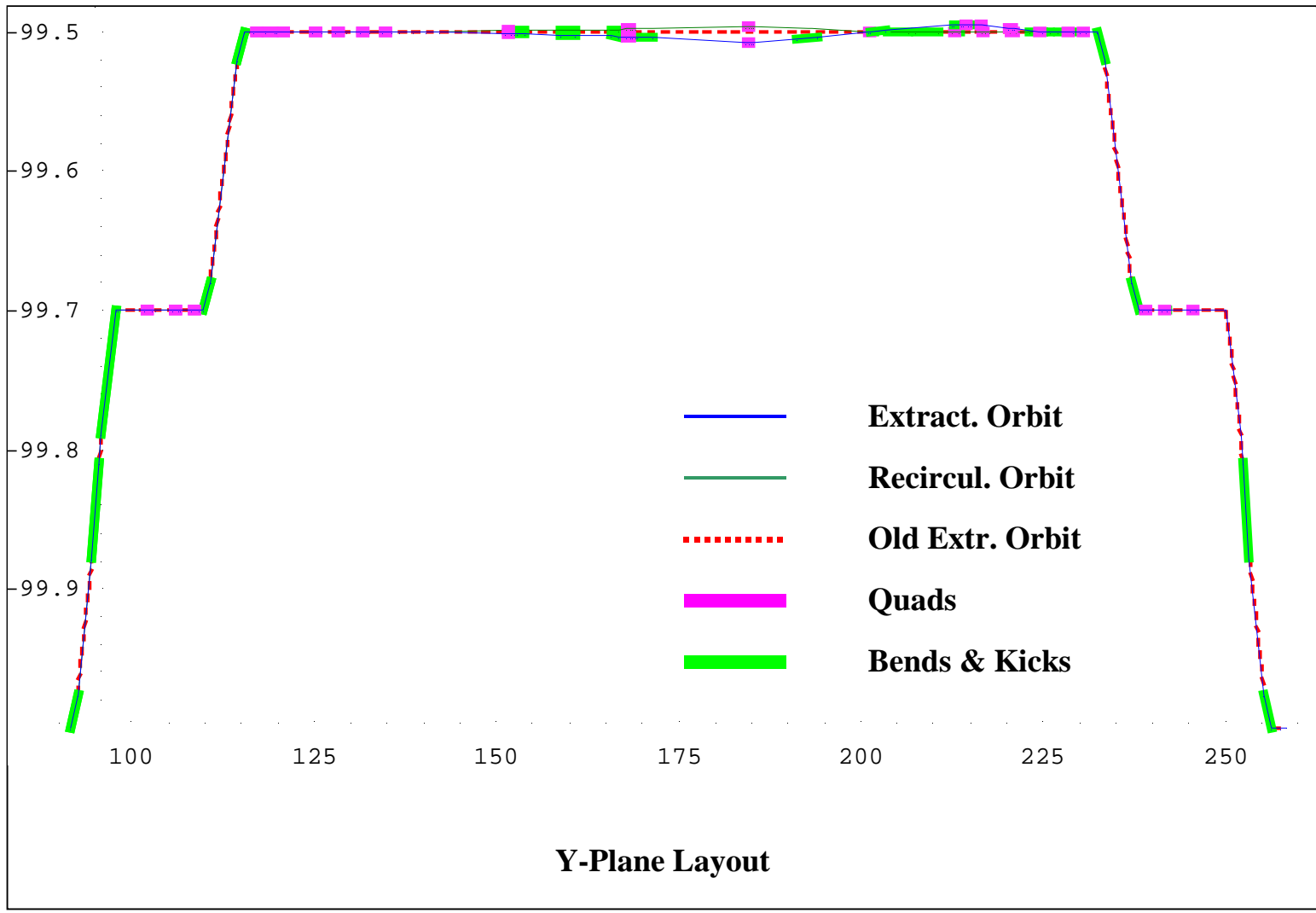
At this point only extracted beam line geometry has been completed. This is shown in the last page.

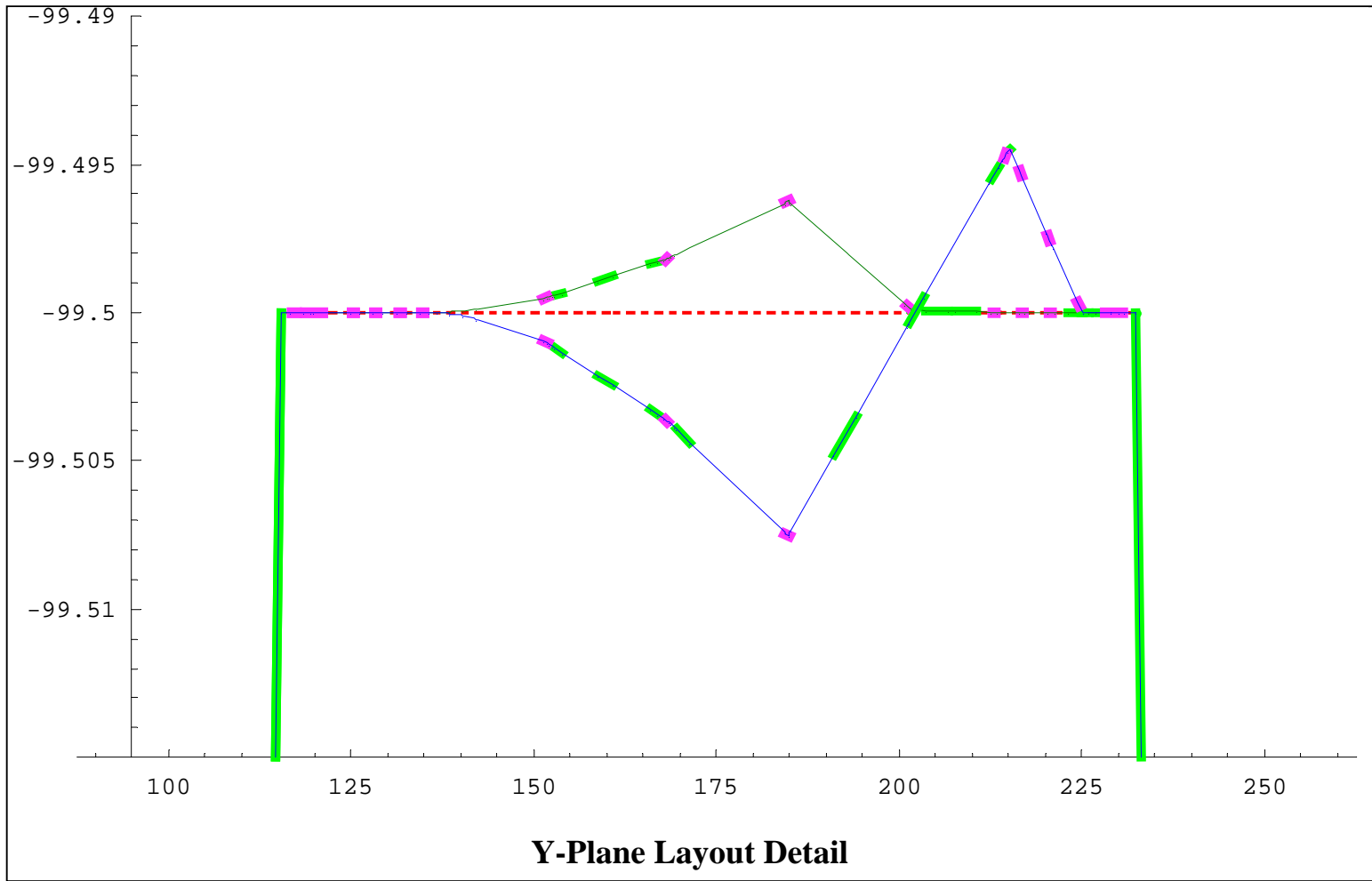
Pass 4 Extraction Layout

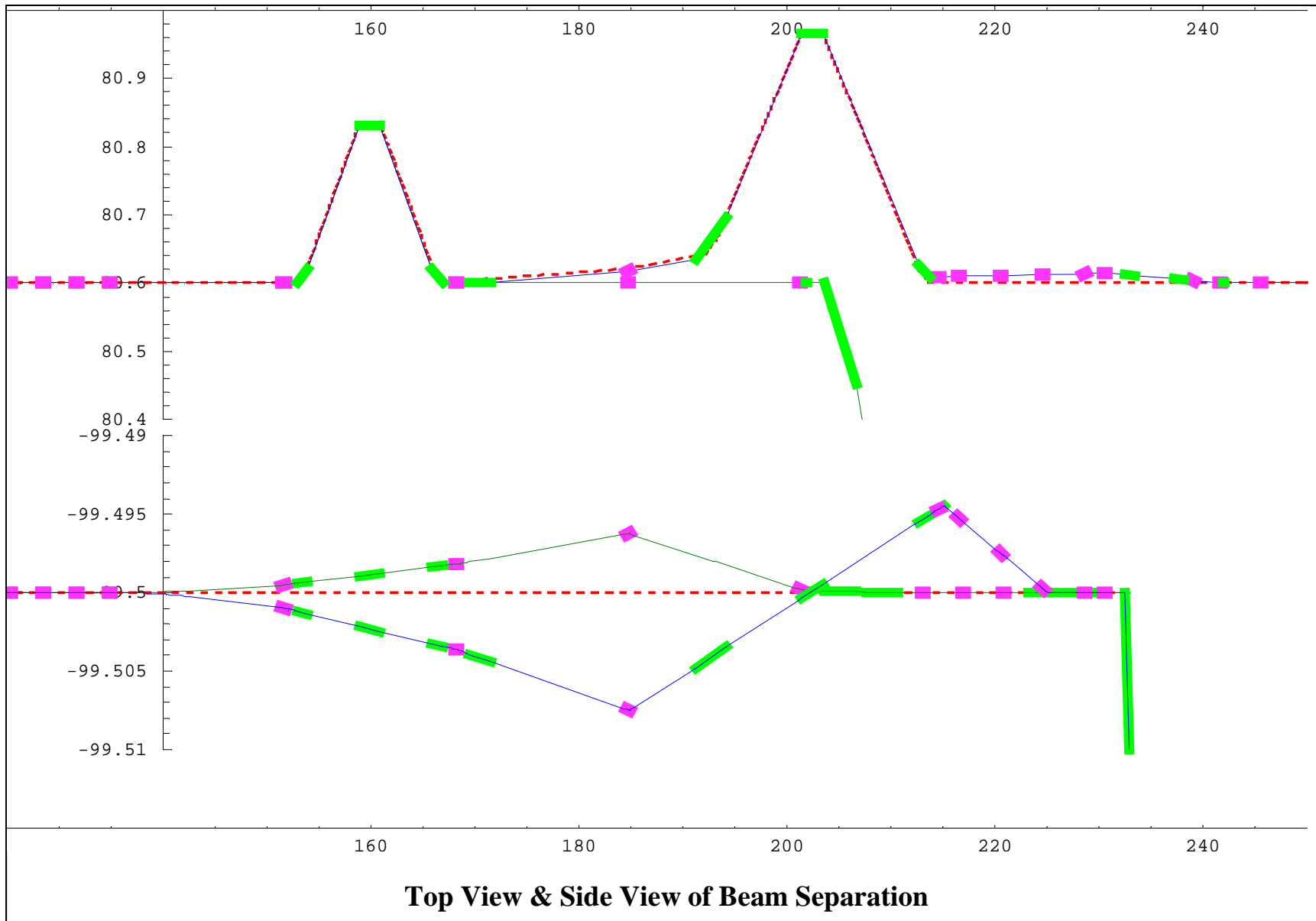


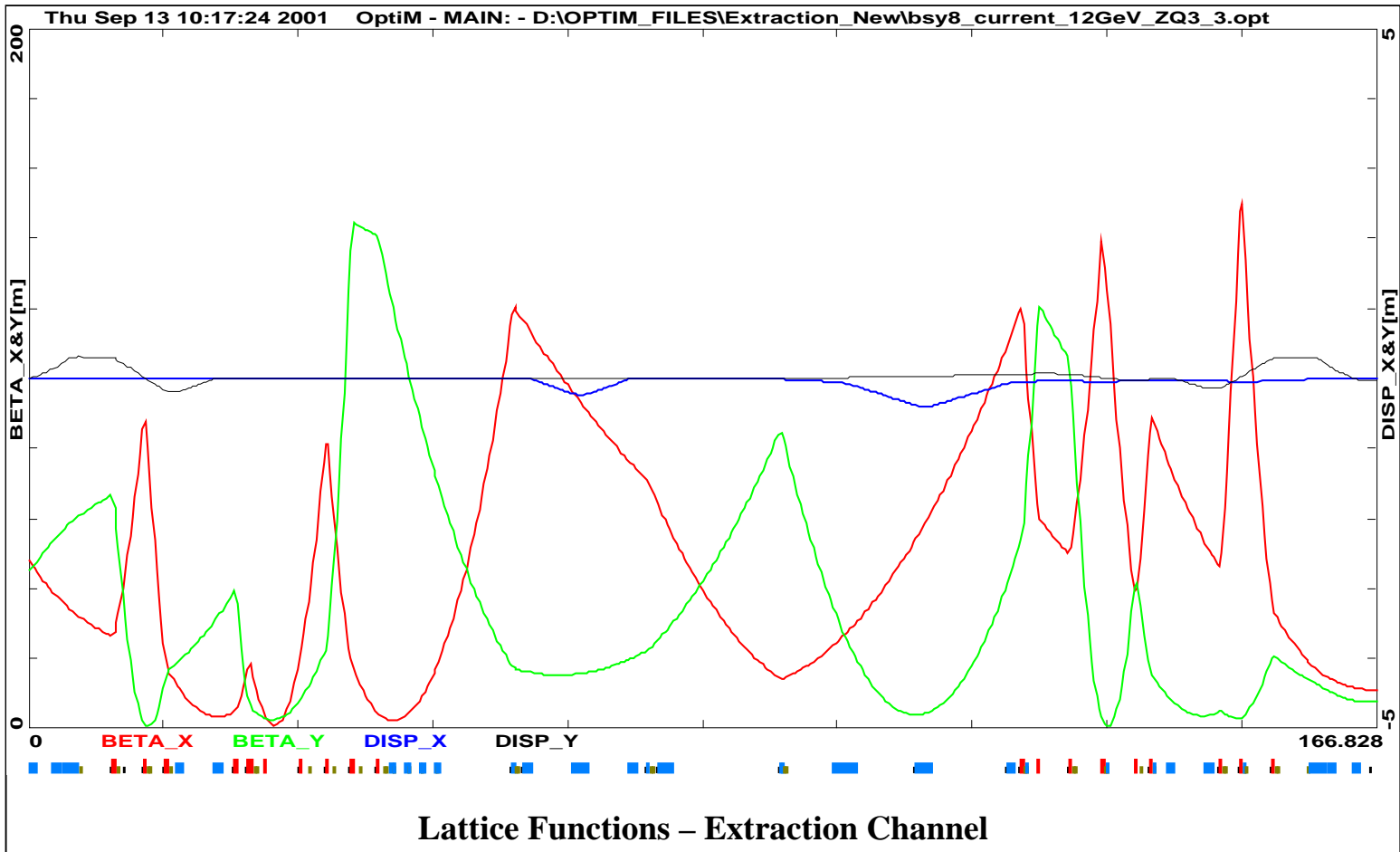


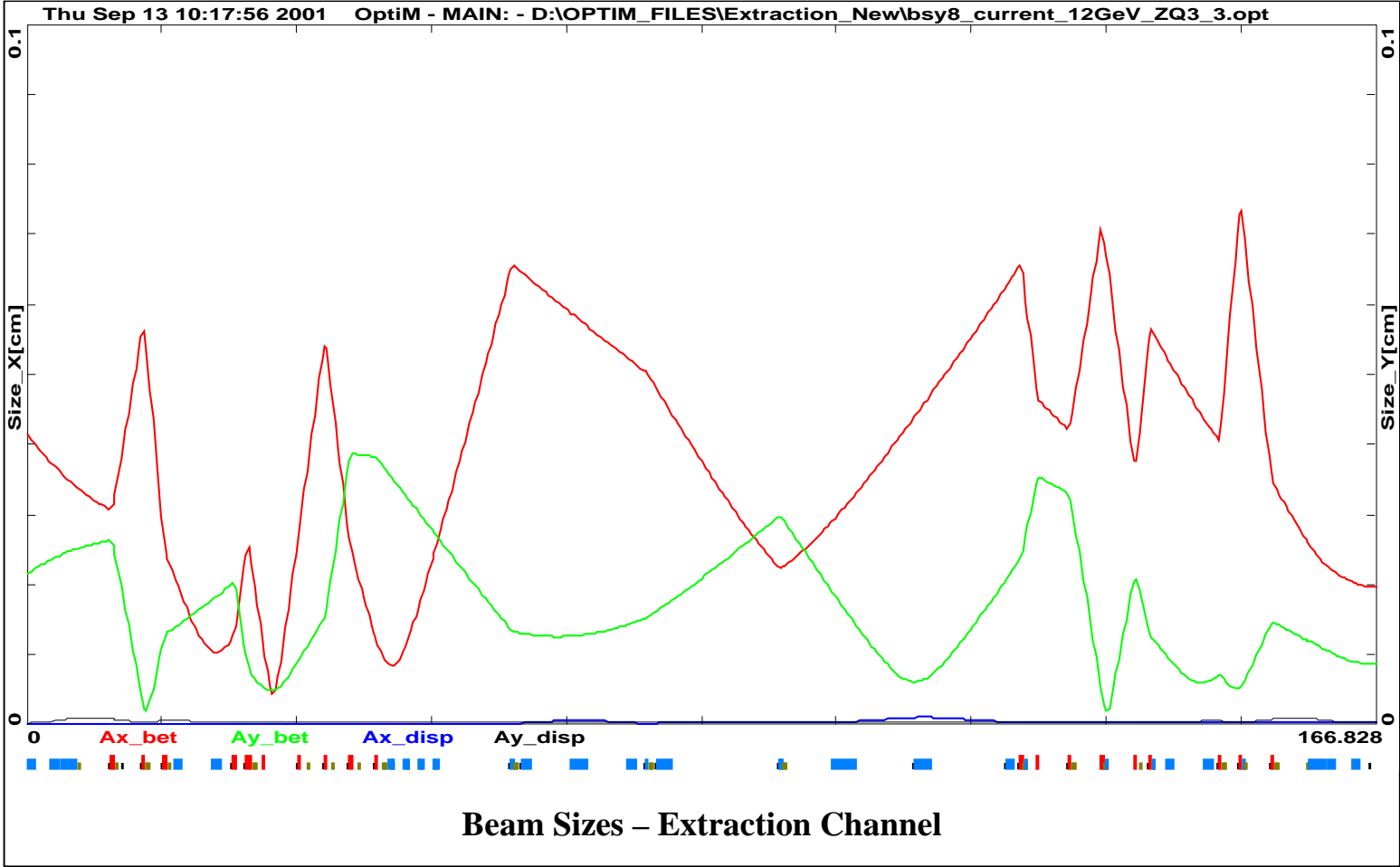
X-Plane Layout Detail

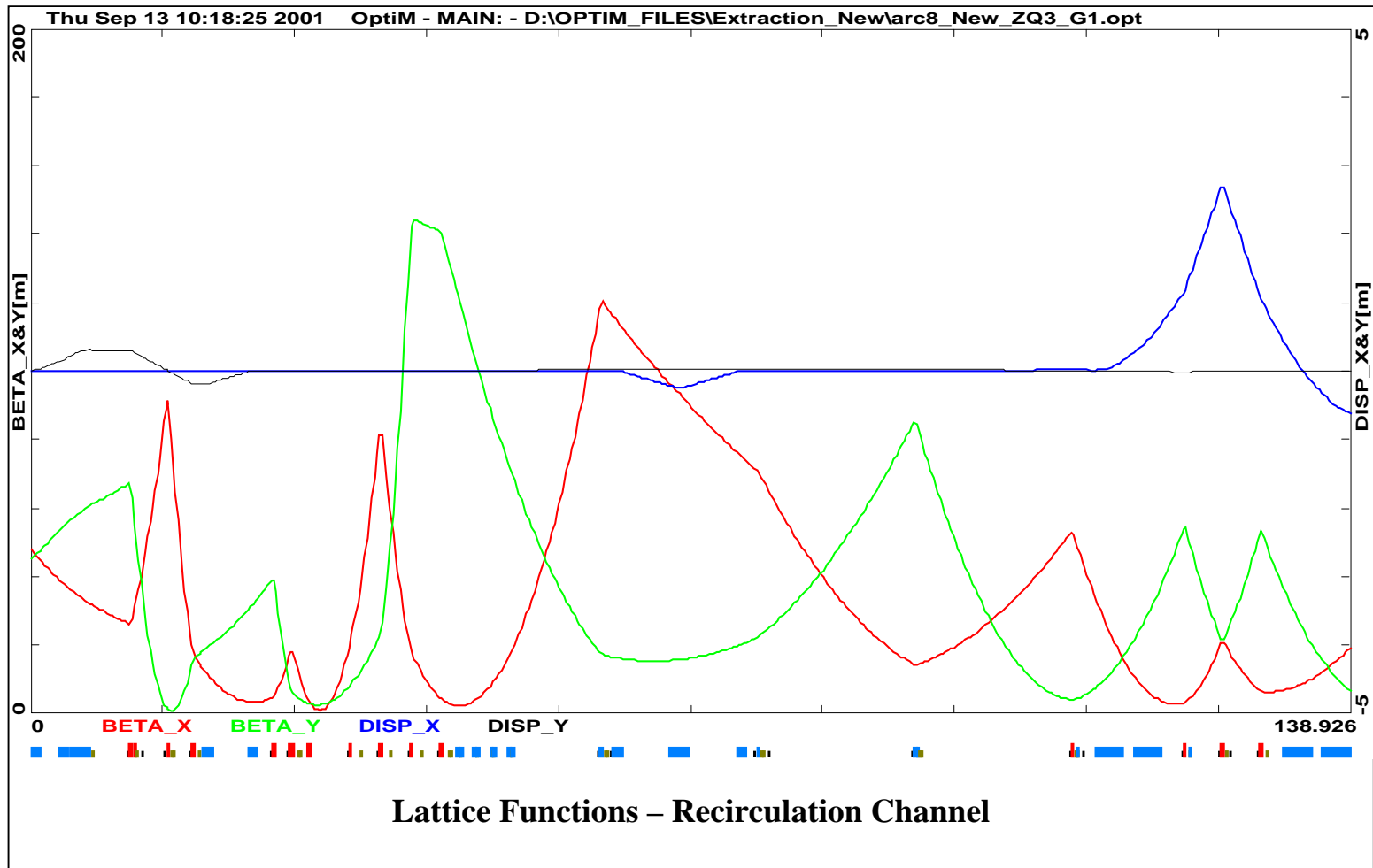


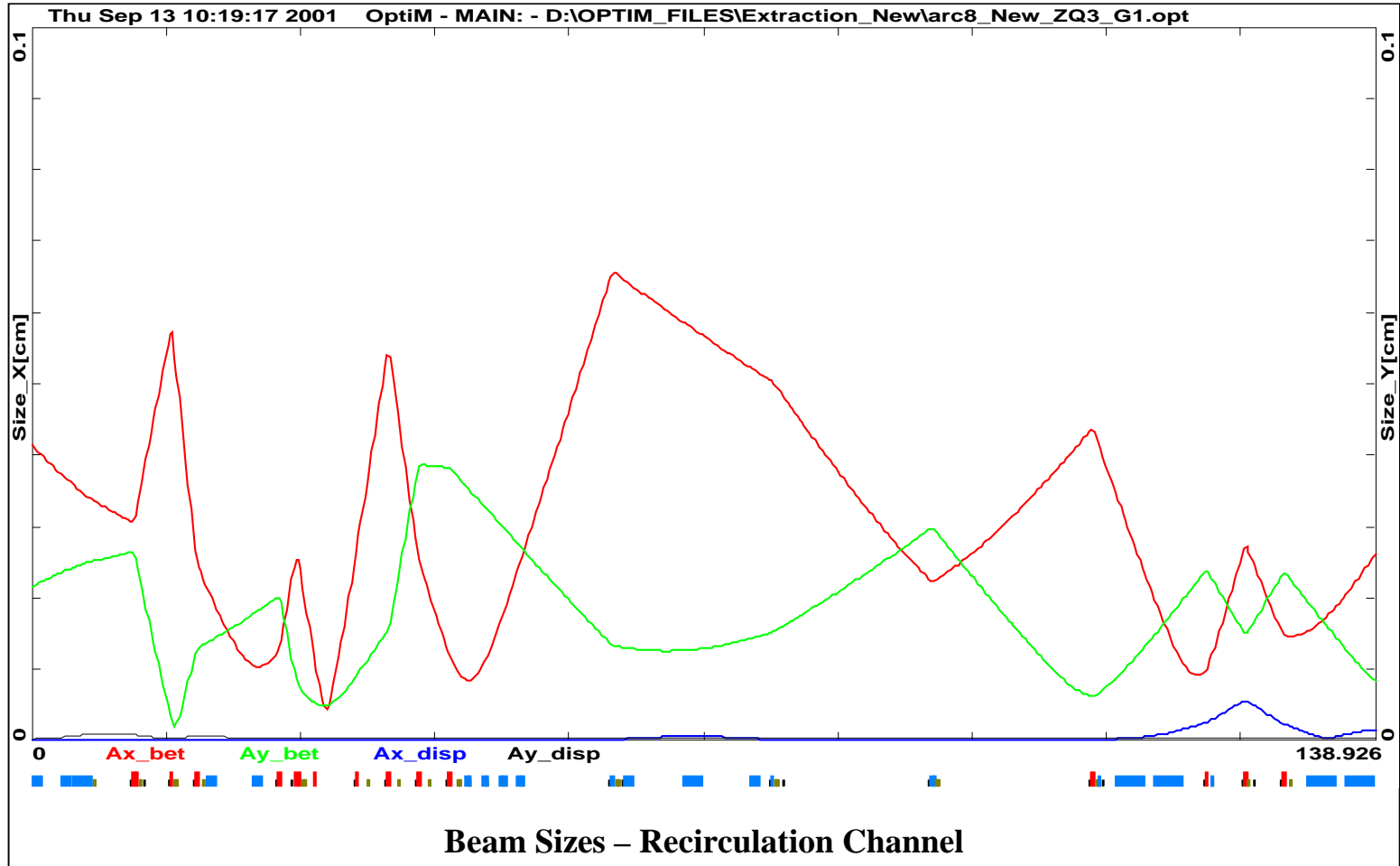












Beam Offset & Separation (All numbers in **cm**)

Baseline:

Location	X-Separation	Y-Separation	Offset (Recirc.)	Offset (Extrac.)
MQC8E01 in	0.000	0.241	0.080	0.161
MQC8E01 out	0.000	0.250	0.083	0.167
MQC8E02 in	0.000	0.897	0.299	0.598
MQC8E02 out	0.000	0.912	0.304	0.608
MLA8T01 in	0.000	0.980	0.327	0.653
MLA8T01 out	0.170	1.097	0.366	0.751
MQC8E03 in	2.388	1.860	0.620	2.691
MQC8E03 out	2.471	1.878	0.626	2.770
MYR8T02 in	4.910	1.133	0.336	4.974
MYR8T02 out	10.826	0.906	0.325	10.842

48% RF Separation:

Location	X-Separation	Y-Separation	Offset (Recirc.)	Offset (Extrac.)
MQC8E01 in	0.000	0.116	0.038	0.077
MQC8E01 out	0.000	0.120	0.040	0.080
MQC8E02 in	0.000	0.431	0.144	0.287
MQC8E02 out	0.000	0.438	0.146	0.292
MLA8T01 in	0.000	0.470	0.157	0.313
MLA8T01 out	0.170	0.527	0.176	0.390
MQC8E03 in	2.388	0.893	0.298	2.461
MQC8E03 out	2.471	0.901	0.300	2.543
MYR8T02 in	4.910	0.544	0.161	4.925
MYR8T02 out	10.826	0.435	0.156	10.830

60% RF Separation + Reduced Lambertson & YR:

Location	X-Separation	Y-Separation	Offset (Recirc.)	Offset (Extrac.)
MQC8E01 in	0.000	0.144	0.048	0.096
MQC8E01 out	0.000	0.150	0.050	0.100
MQC8E02 in	0.000	0.539	0.180	0.359
MQC8E02 out	0.000	0.547	0.182	0.365
MLA8T01 in	0.000	0.588	0.196	0.392
MLA8T01 out	0.122	0.658	0.219	0.456
MQC8E03 in	1.719	1.116	0.372	1.873
MQC8E03 out	1.779	1.127	0.376	1.931
MYR8T02 in	3.538	0.680	0.202	3.570
MYR8T02 out	9.528	0.543	0.195	9.534

Bending Elements (**Horizontal/Vertical**)

RF Separation: 80 μ rad + 40 μ rad (60% of design)

Extraction Channel

Name	S[cm]	L[cm]	B[kG]	G[kG/cm]	Tilt[deg]
MAW8S01	483592	100.04	14.3943	0	90
MAX8S02	483893	100.245	11.82	0	90
MYR8S03	484115	200.264	-13.1072	0	90
MAE8S04	485410	100.007	12.4133	0	90
MAE8S06	485886	100.007	-12.4133	0	90
MQC8E01	489512	30	-0.0783206	-0.800824	90
MBY8E01	489725	100.029	-12.3834	0	0
MBZ8E02	490425	200.059	12.3834	0	0
MBY8E03	491026	100.029	-12.3834	0	0
MQC8E02	491168	30	-0.0733176	-0.202983	90
MLA8T01	491484	200	-0.18	0	0
MQC8E03	492823	30	0.65396	0.87474	90
MQC8E03	492823	30	-1.53386	-0.87474	0
MYR8T02	493756	300	-3.38	0	0
MBP8T03	494681	200.046	10.8667	0	0
MBQ8T04	495707	100.023	-10.8667	0	0
MBD8T01V	495848	0.1	-289.92	0	90
MBD8T04V	496848	0.1	163.05	0	90
MBD8T06H	497428	0.1	476.2	0	0
MAE8T01	497682	100.007	-12.4133	0	90
MAE8T03	498157	100.007	12.4133	0	90
MBD8T08H	498536	0.1	-385.1	0	0
MYR8T04	499552	200.264	-13.1072	0	90
MAX8T05	499675	100.245	11.82	0	90
MAW8T06	499975	100.04	14.3943	0	90

Recirculation Channel

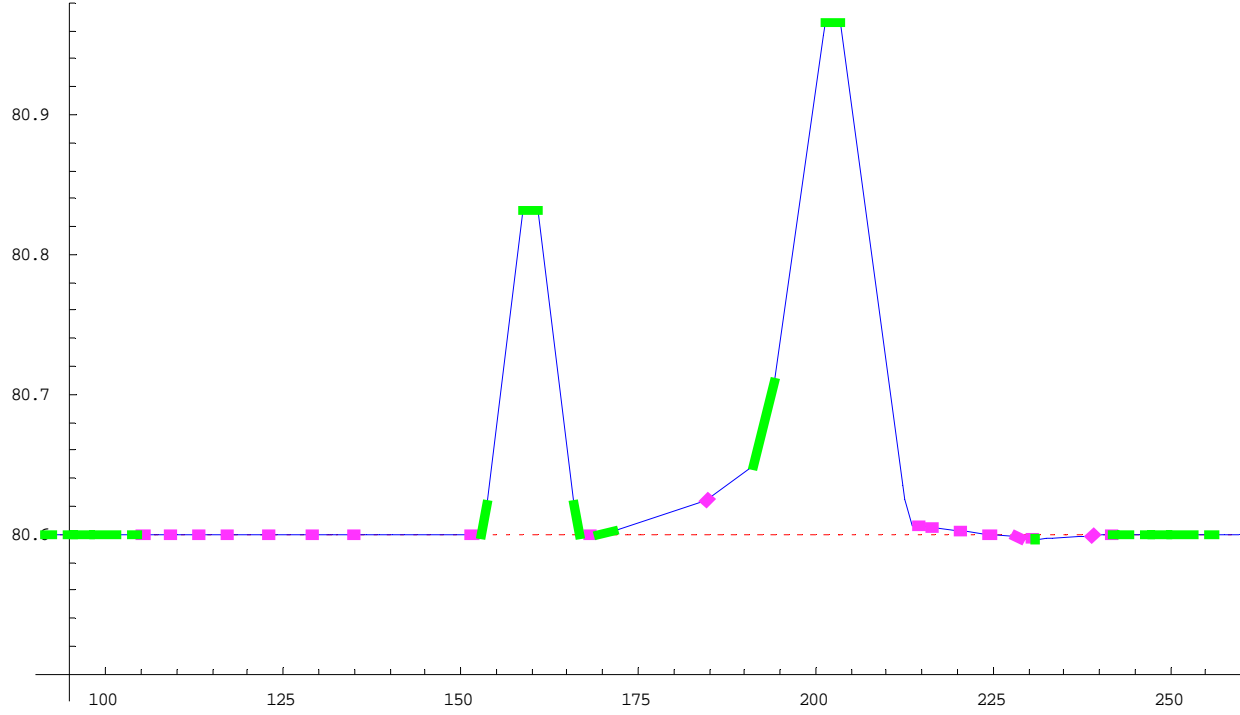
Name	S[cm]	L[cm]	B[kG]	G[kG/cm]	Tilt[deg]
MQC8E01	489452	30	0.0391603	-0.800824	90
MQC8E02	491108	30	0.0366588	-0.202983	90
MQC8E03	492763	30	-0.32698	0.87474	90
MBC8A01V	494457	0.1	61.2	0	90
MBA8A01	494944	300.12	9.64902	0.000976421	0
MBA8A02	495345	300.12	9.64902	0.000976421	0
MBC8A02V	495640	0.1	2.4	0	90
MBA8A03	496924	300.12	9.64902	0.000976421	0
MBA8A04	497325	300.12	9.64902	0.000976421	0

Quadrupoles

Name	S[cm]	L[cm]	G[kG/cm]
MQA8S01	484565	30	-2.47442
MQA8S02	484955	30	3.44561
MQA8S03	485215	30	-3.77394
MQA8S04	486075	30	-4.0967
MQA8S05A	486265	30	3.2529
MQA8S05B	486265	30	3.2529
MQA8S06	486439	30	-0.128833
MQA8S07	486875	30	-0.13255
MQA8S08	487195	30	3.30441
MQA8S09	487515	30	-1.91793
MQA8S10	487835	30	-0.355358
MQC8E01	489512	30	0.800824
MQC8E02	491168	30	0.202983
MQC8E03	492823	30	-0.87474
MQA8T01	495809	30	1.72654
MQA8T02	496009	30	-1.80364
MQA8T03	496409	30	-1.99156
MQA8T04	496809	30	2.27567
MQA8T05	497209	30	-5.05886
MQA8T06	497409	30	2.17474
MQA8T07	498257	30	-3.5573
MQA8T08	498517	30	3.15397
MQA8T09	498907	30	-2.3231
MQA8A01	494418	30	1.22845
MQA8A02	495601	30	-1.70022
MQA8A03	495999	30	3.01127

Pass 5 Extraction Layout

X-plane SW Spreader to Transport Recombiner:



Y-plane SW Spreader to Transport Recombiner:

