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Linac Straight Dump Beam Transport Line

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Accelerator Physics Meeting

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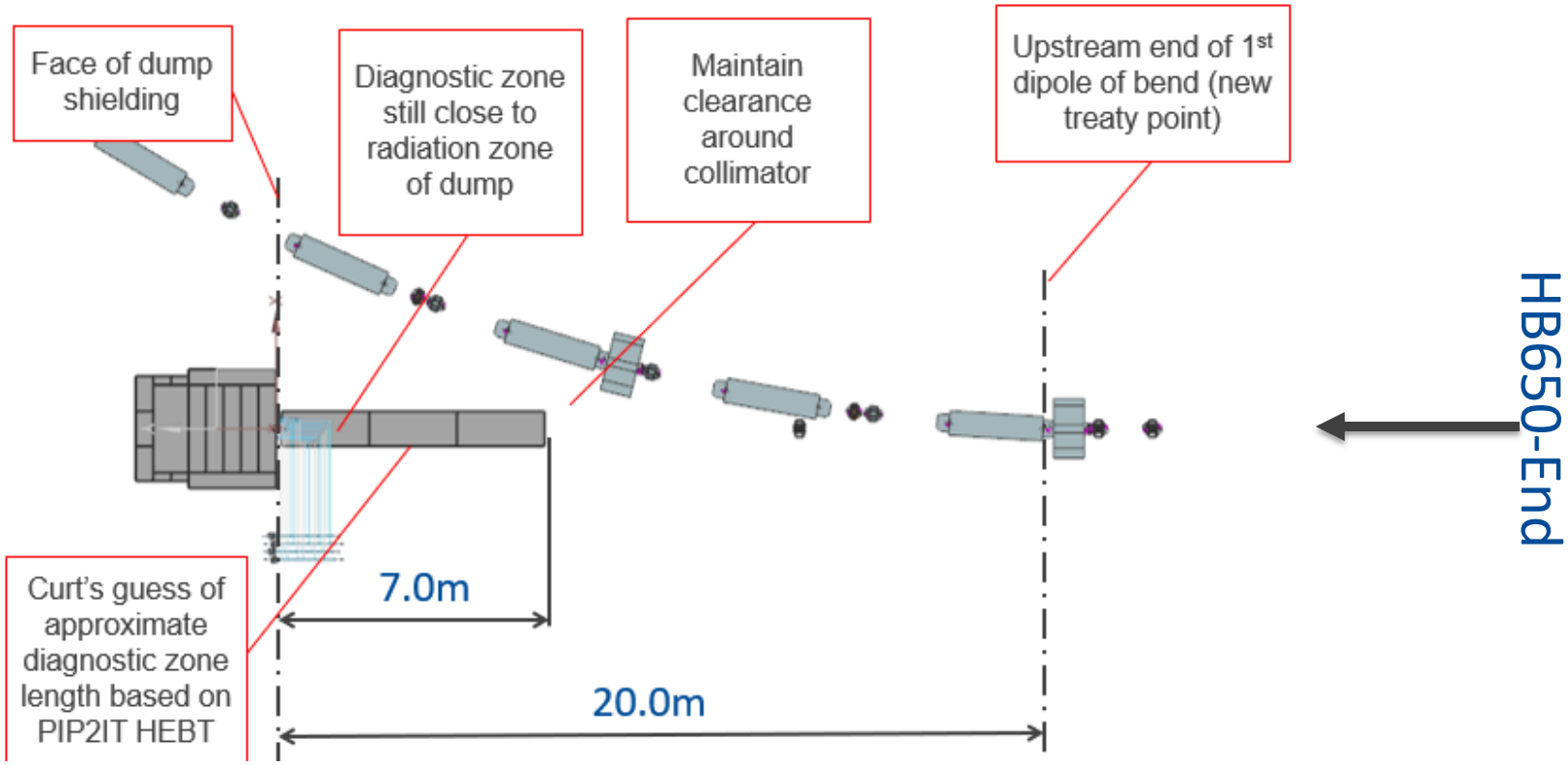
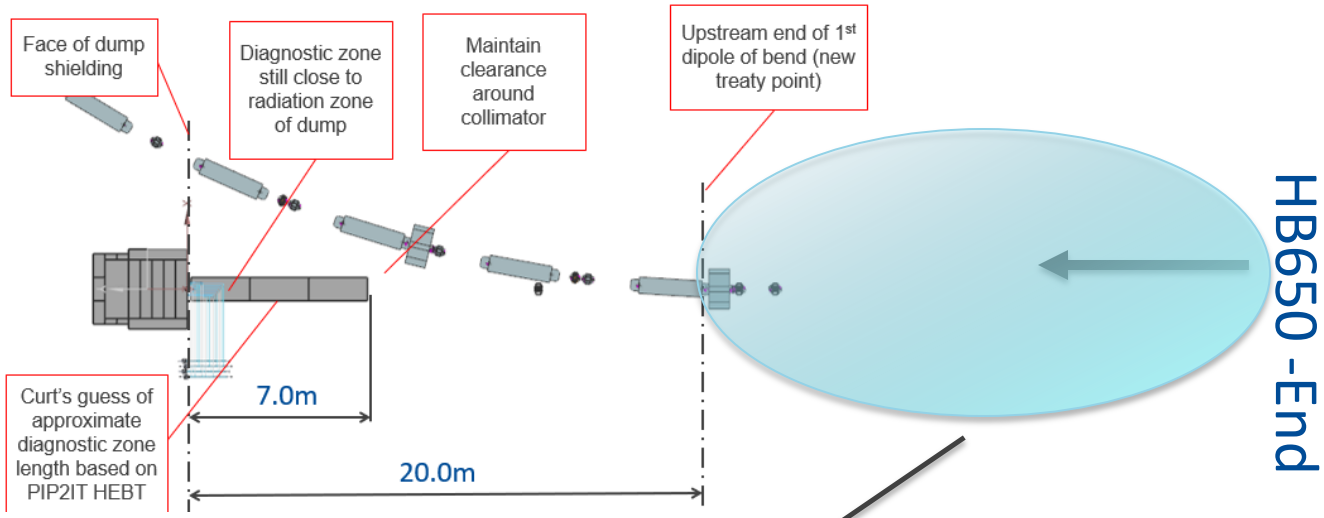
Straight Ahead Beam Dump for PIP-II SRF Linac

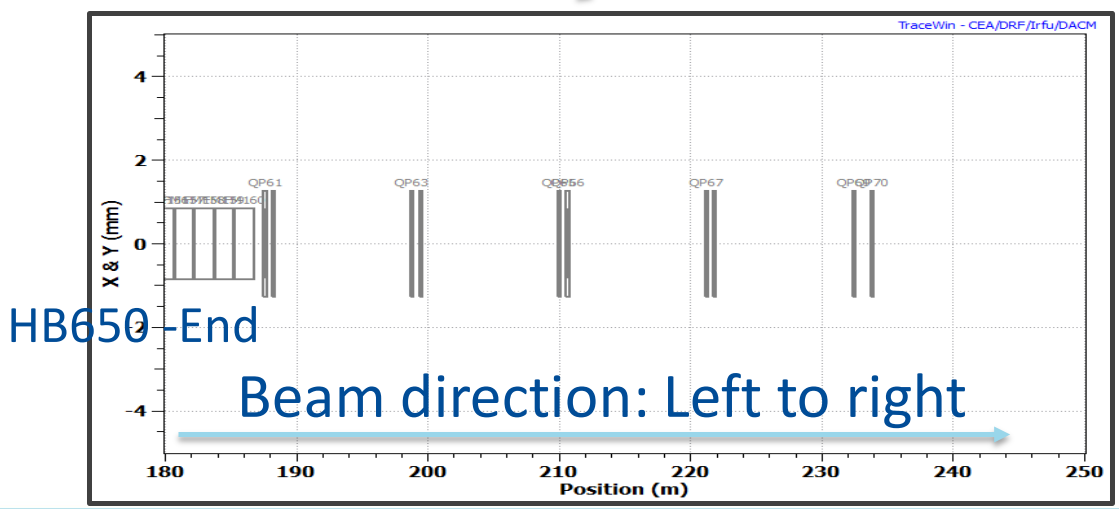
- To be used for linac tuning and commissioning purpose.
- Following layout was considered in this presentation.



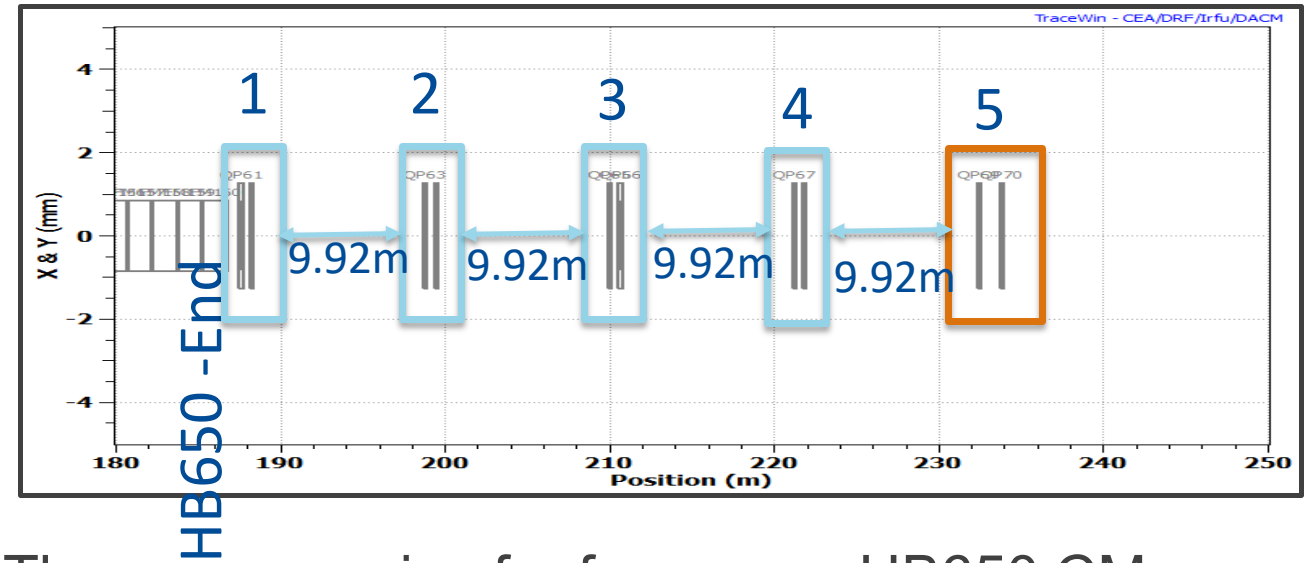
Layout from Eduard, Curt Talk from last week, AP meeting

Region Between HB650 End and Upstream of Bending Magnet (1)





Details of Region Between HB650 End and Upstream of Bending Magnet (2)



- There are spacing for four spare HB650 CMs.
  - HB650 CM length is 9.92 m (flange to flange)
- Except 5th doublet, all four doublets are arranged in same configuration as LB650 and HB650 linac doublet.
  - Linac quad doublet unit is 1.3 m long(1 to 4 doublet units).
  - There is 1.4 m center to center separation between quads in 5th unit.

Highlights of Changes from earlier version of beam transport line (1)

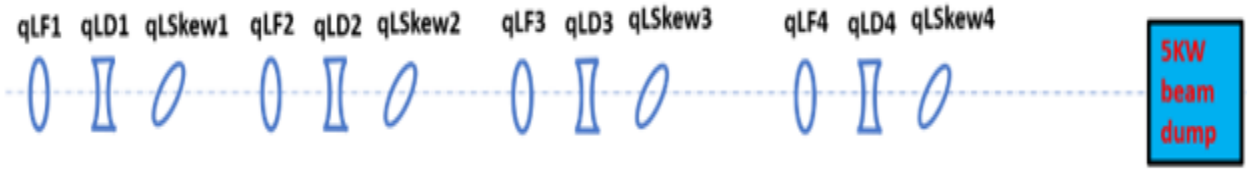
MADX output from Meiqin Xiao

- Length allotted for HB650 CM in previous line was 9.4 m in comparison to 9.92m.
- New line is using 9.92 m
- Does it affect BTL matching ?

begin	BTL2019r	1	0.000	25.001	1.218	0.000	0.000	0.000	0.000	0.000	10.706	-0.589	0.000	0.000	0.000	0.000	0.000
1	ISTART	1	0.000	25.001	1.218	0.000	0.000	0.000	0.000	0.000	10.706	-0.589	0.000	0.000	0.000	0.000	0.000
begin	SCLEND22	1	0.000	25.001	1.218	0.000	0.000	0.000	0.000	0.000	10.706	-0.589	0.000	0.000	0.000	0.000	0.000
2	OCM	1	9.400	10.880	0.284	0.097	0.000	0.000	0.000	0.000	32.896	-1.772	0.083	0.000	0.000	0.000	0.000
3	H	1	9.400	10.880	0.284	0.097	0.000	0.000	0.000	0.000	32.896	-1.772	0.083	0.000	0.000	0.000	0.000
4	HQ	1	9.400	10.880	0.284	0.097	0.000	0.000	0.000	0.000	32.896	-1.772	0.083	0.000	0.000	0.000	0.000
5	QSKEW	1	9.600	10.770	0.264	0.099	0.000	0.000	0.000	0.000	33.609	-1.797	0.084	0.000	0.000	0.000	0.000
6	OLQ3	1	9.800	10.669	0.244	0.102	0.000	0.000	0.000	0.000	34.333	-1.822	0.085	0.000	0.000	0.000	0.000
7	QLF4	1	10.000	11.603	-5.060	0.105	0.000	0.000	0.000	0.000	31.897	13.621	0.086	0.000	0.000	0.000	0.000
8	HQ	2	10.000	11.603	-5.060	0.105	0.000	0.000	0.000	0.000	31.897	13.621	0.086	0.000	0.000	0.000	0.000
9	H	2	10.000	11.603	-5.060	0.105	0.000	0.000	0.000	0.000	31.897	13.621	0.086	0.000	0.000	0.000	0.000
10	OLQ	1	10.150	13.172	-5.404	0.107	0.000	0.000	0.000	0.000	27.942	12.744	0.087	0.000	0.000	0.000	0.000
11	KHV	1	10.250	14.276	-5.633	0.108	0.000	0.000	0.000	0.000	25.452	12.159	0.088	0.000	0.000	0.000	0.000
12	OLQ	2	10.400	16.017	-5.977	0.110	0.000	0.000	0.000	0.000	21.935	11.282	0.089	0.000	0.000	0.000	0.000
13	H	3	10.400	16.017	-5.977	0.110	0.000	0.000	0.000	0.000	21.935	11.282	0.089	0.000	0.000	0.000	0.000
14	HQ	3	10.400	16.017	-5.977	0.110	0.000	0.000	0.000	0.000	21.935	11.282	0.089	0.000	0.000	0.000	0.000
15	QLD4	1	10.600	17.024	1.087	0.112	0.000	0.000	0.000	0.000	19.341	2.060	0.090	0.000	0.000	0.000	0.000
16	OLQ3	2	10.800	16.595	1.061	0.114	0.000	0.000	0.000	0.000	18.527	2.006	0.092	0.000	0.000	0.000	0.000
17	QSKEW	2	11.000	16.176	1.035	0.116	0.000	0.000	0.000	0.000	17.736	1.952	0.094	0.000	0.000	0.000	0.000
18	HQ	4	11.000	16.176	1.035	0.116	0.000	0.000	0.000	0.000	17.736	1.952	0.094	0.000	0.000	0.000	0.000
19	H	4	11.000	16.176	1.035	0.116	0.000	0.000	0.000	0.000	17.736	1.952	0.094	0.000	0.000	0.000	0.000
20	OCM	2	20.400	8.028	-0.169	0.270	0.000	0.000	0.000	0.000	5.003	-0.597	0.354	0.000	0.000	0.000	0.000
21	H	5	20.400	8.028	-0.169	0.270	0.000	0.000	0.000	0.000	5.003	-0.597	0.354	0.000	0.000	0.000	0.000
22	HQ	5	20.400	8.028	-0.169	0.270	0.000	0.000	0.000	0.000	5.003	-0.597	0.354	0.000	0.000	0.000	0.000
23	QLF5	1	20.600	8.809	-3.848	0.274	0.000	0.000	0.000	0.000	4.824	1.465	0.361	0.000	0.000	0.000	0.000
24	HQ	6	20.600	8.809	-3.848	0.274	0.000	0.000	0.000	0.000	4.824	1.465	0.361	0.000	0.000	0.000	0.000
25	H	6	20.600	8.809	-3.848	0.274	0.000	0.000	0.000	0.000	4.824	1.465	0.361	0.000	0.000	0.000	0.000
26	OLQ2	1	21.800	20.630	-6.002	0.288	0.000	0.000	0.000	0.000	2.247	0.683	0.420	0.000	0.000	0.000	0.000
27	H	7	21.800	20.630	-6.002	0.288	0.000	0.000	0.000	0.000	2.247	0.683	0.420	0.000	0.000	0.000	0.000
end	SCLEND22	1	21.800	20.630	-6.002	0.288	0.000	0.000	0.000	0.000	2.247	0.683	0.420	0.000	0.000	0.000	0.000
begin	ARC1	1	21.800	20.630	-6.002	0.288	0.000	0.000	0.000	0.000	2.247	0.683	0.420	0.000	0.000	0.000	0.000
begin	ARC101	1	21.800	20.630	-6.002	0.288	0.000	0.000	0.000	0.000	2.247	0.683	0.420	0.000	0.000	0.000	0.000
28	HQ	7	21.800	20.630	-6.002	0.288	0.000	0.000	0.000	0.000	2.247	0.683	0.420	0.000	0.000	0.000	0.000
29	QLD5	1	22.000	21.316	2.663	0.290	0.000	0.000	0.000	0.000	2.176	-0.317	0.434	0.000	0.000	0.000	0.000
30	HQ	8	22.000	21.316	2.663	0.290	0.000	0.000	0.000	0.000	2.176	-0.317	0.434	0.000	0.000	0.000	0.000
31	H	8	22.000	21.316	2.663	0.290	0.000	0.000	0.000	0.000	2.176	-0.317	0.434	0.000	0.000	0.000	0.000
32	OC1	1	22.175	20.398	2.597	0.291	0.000	0.000	0.000	0.000	2.302	-0.406	0.447	0.000	0.000	0.000	0.000
33	HCOLL	1	22.175	20.398	2.597	0.291	0.000	0.000	0.000	0.000	2.302	-0.406	0.447	0.000	0.000	0.000	0.000
34	DICOLLB	1	23.175	15.584	2.217	0.300	0.000	0.000	0.000	0.000	3.619	-0.911	0.503	0.000	0.000	0.000	0.000
35	ICOLLB1	1	23.175	15.584	2.217	0.300	0.000	0.000	0.000	0.000	3.619	-0.911	0.503	0.000	0.000	0.000	0.000
36	HCOLL	2	23.175	15.584	2.217	0.300	0.000	0.000	0.000	0.000	3.619	-0.911	0.503	0.000	0.000	0.000	0.000
37	OC1	2	23.349	14.821	2.151	0.302	0.000	0.000	0.000	0.000	3.953	-1.000	0.511	0.000	0.000	0.000	0.000
38	H	9	23.349	14.821	2.151	0.302	0.000	0.000	0.000	0.000	3.953	-1.000	0.511	0.000	0.000	0.000	0.000
39	HB	1	23.349	14.821	2.151	0.302	0.000	0.000	0.000	0.000	3.953	-1.000	0.511	0.000	0.000	0.000	0.000

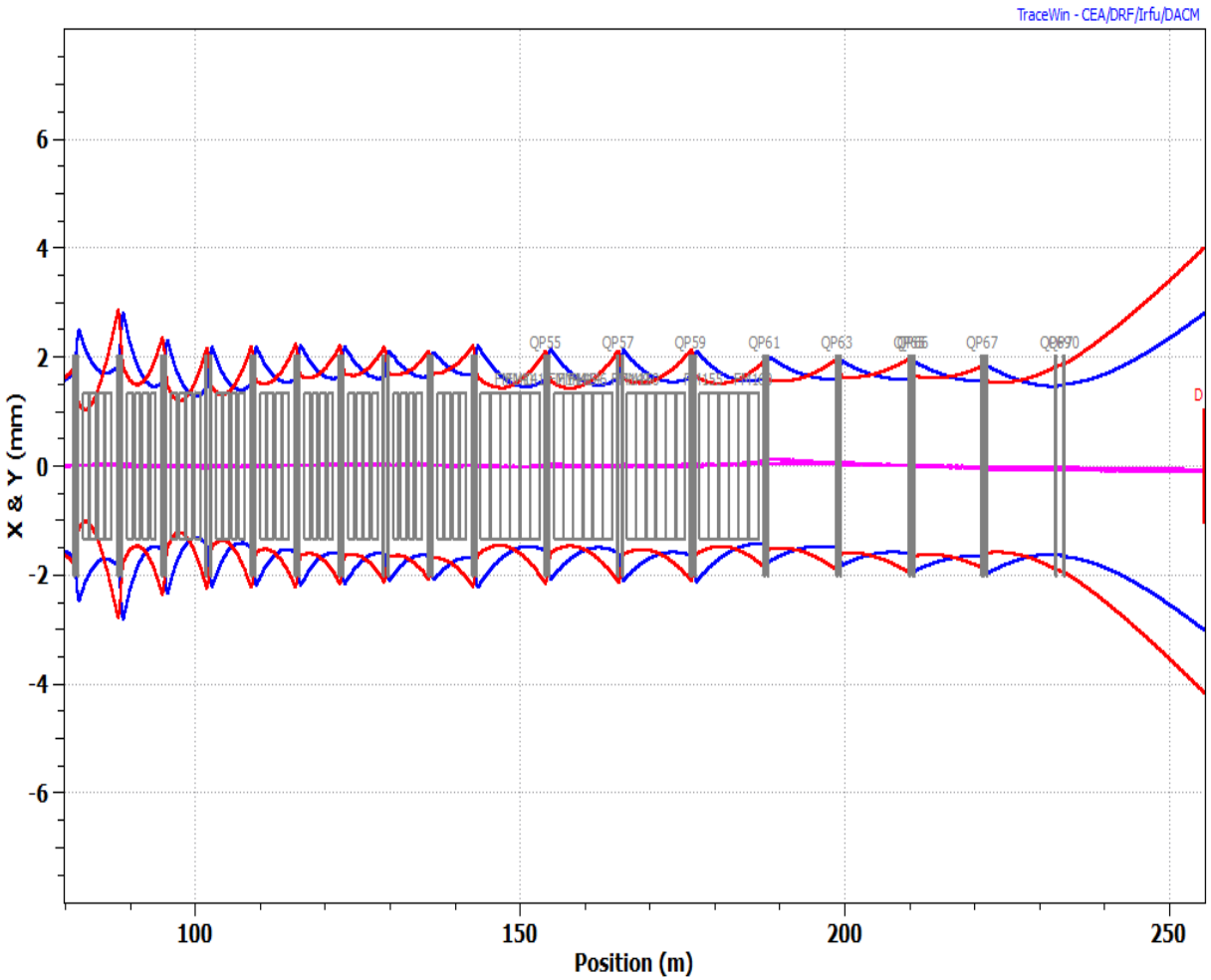
Highlights of Changes from earlier version of beam transport line (2)

Picture from Meiqin Xiao write-up



- There were skew quadrupoles at upstream of each CMs.
  - Gradient of these quads were set to zero
  - Space allocated to skew quad is 0.2m
  - Not used for BTL matching
  - Purpose of them not clear to me at this moment.
- I removed skew quadrupoles in presented new beam transport line.
- Note that the first quadrupole in doublet is a vertical focusing quad followed by a horizontal focusing quad.
  - Check MADX definition and use appropriately.

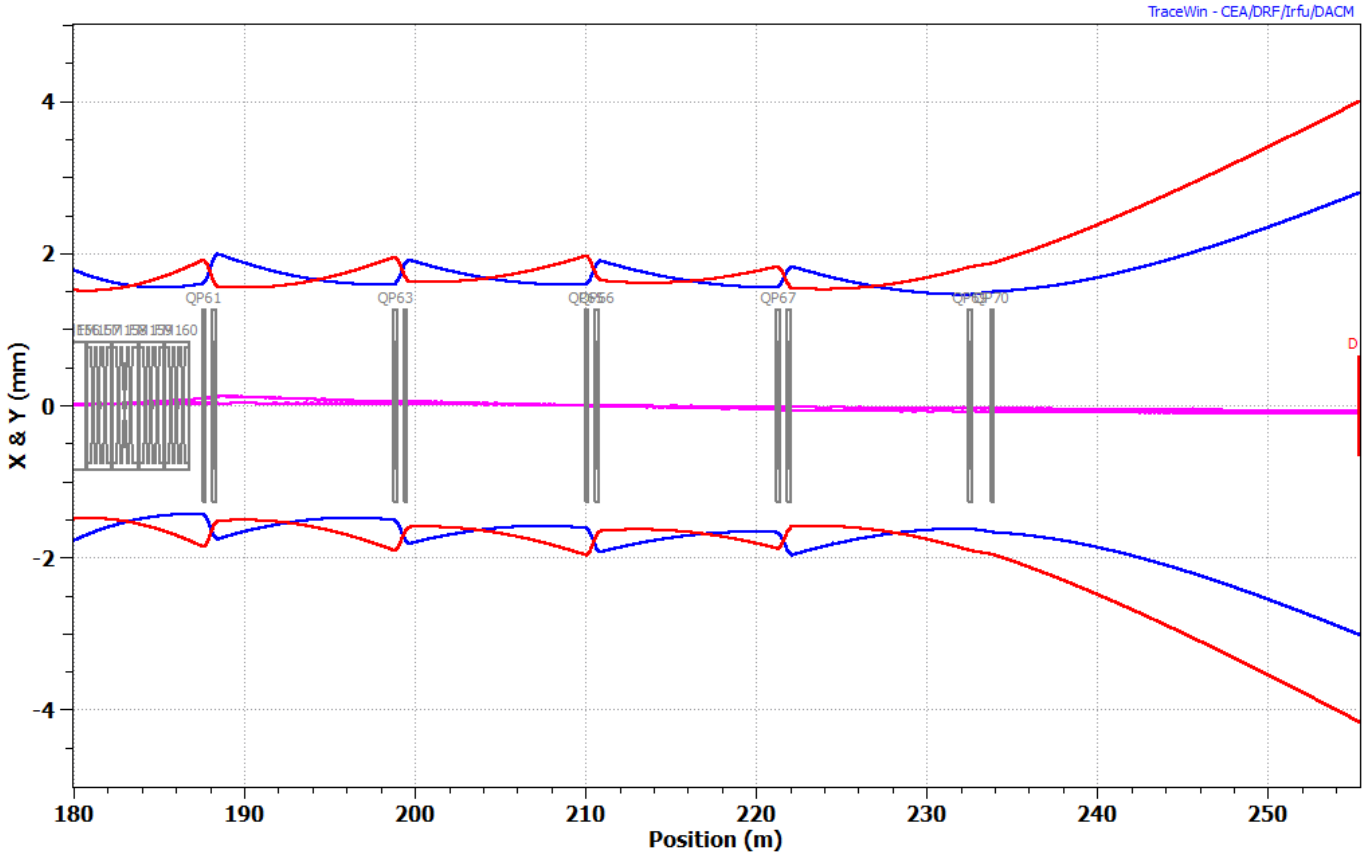
RMS Beam Envelope : LB650 TO DUMP Line



- Multiparticle simulation using 25k particles.
- 3-D space charge force calculation.

Blue : Horizontal; Red: Vertical

Dump Transport Line



σ_x at dump entrance: 2.8mm

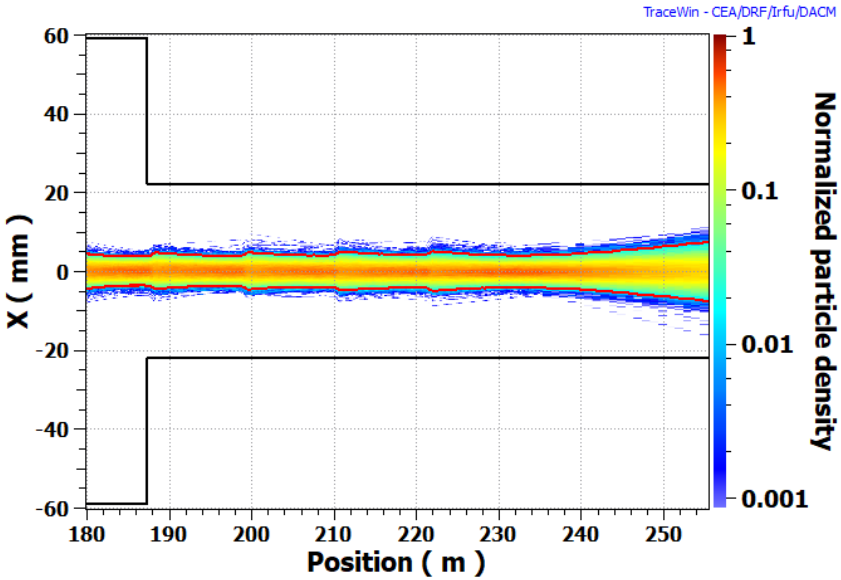
σ_y at dump entrance :4mm

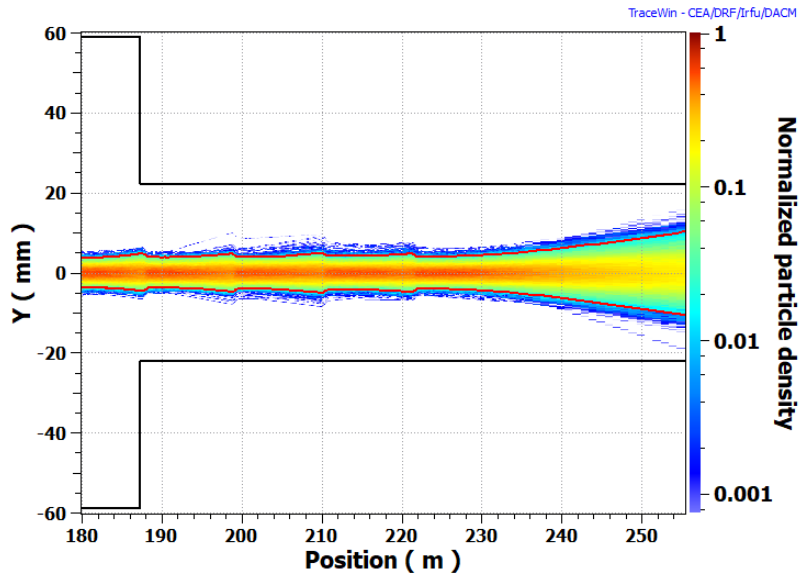
Dump design specification:

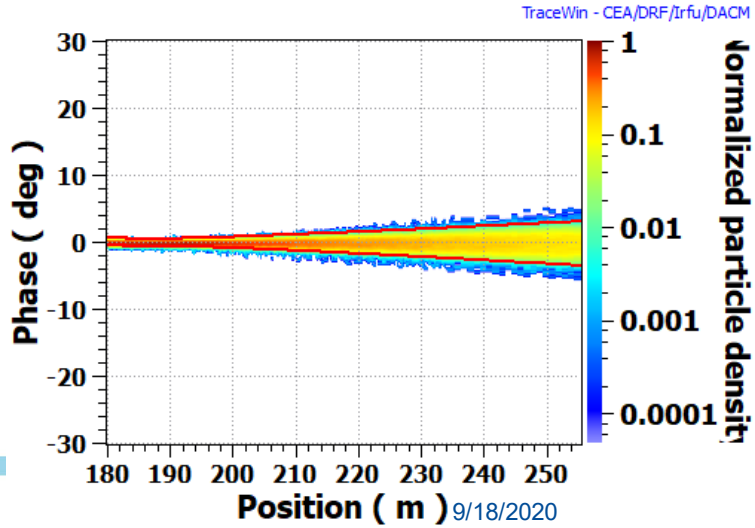
$\sigma_{x,y} > 2.5$ mm

- Last quadrupole to upstream of bending magnet: 1.349 m
- Bending magnet upstream to dump entrance : 20 m
- Last doublet is ~0 gradient

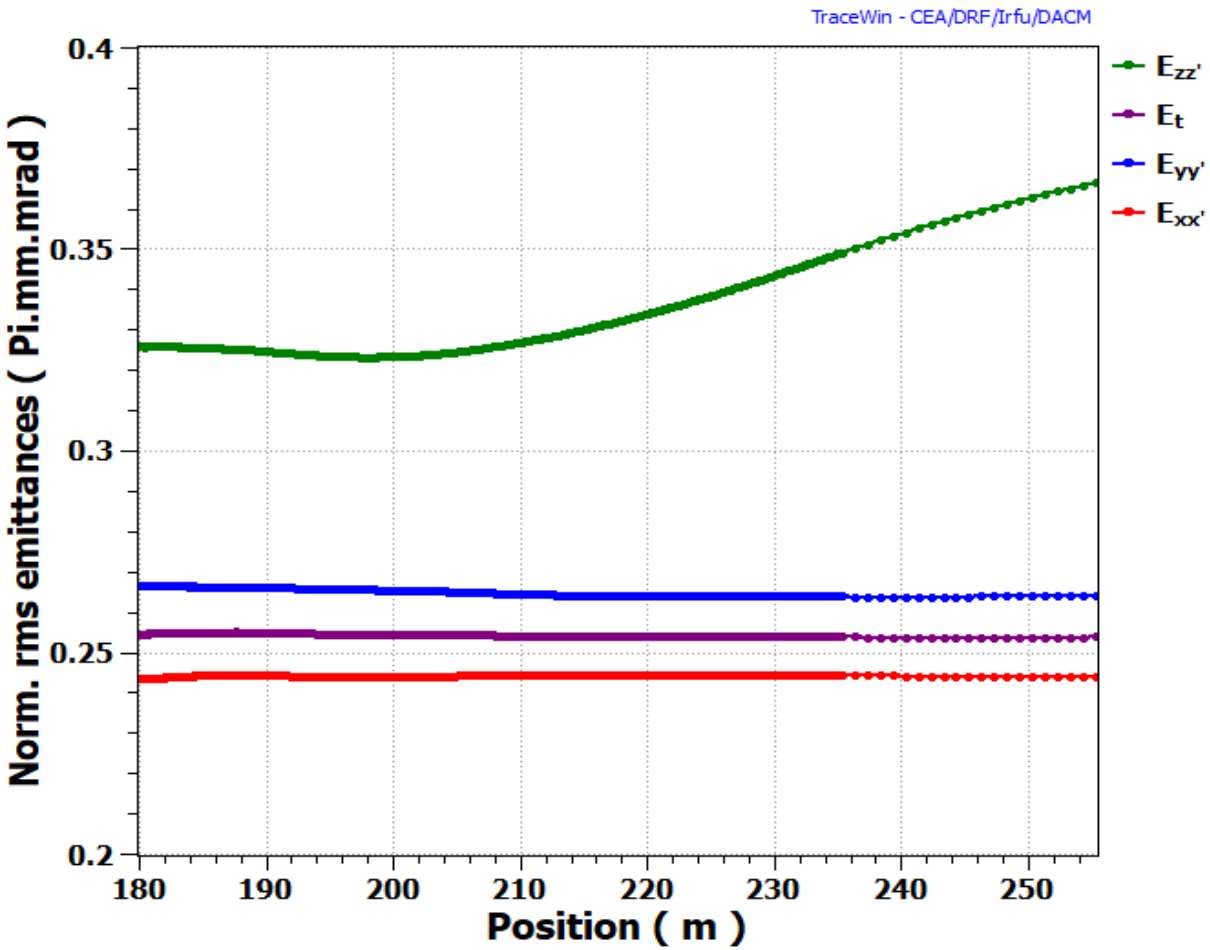
Beam Normalized Density Along the Line







RMS emittance in Beam Transport Line



Summary

- A preliminary design of new beam transport line is developed for the straight ahead dump of the linac.
  - A tentative assumption about locations of elements were made.
  - Dump is located at 20 m from upstream edge of the magnet.
  - Skew quadrupoles were removed
  - Space allocation for HB650 CM was changed to 9.92 m
- New optics suggests beam RMS sizes are > 2.5 mm in both horizontal and vertical planes
  - There is no beam loss in the line of aperture of 44 mm.