Longitudinal Dynamics in the Drive Beam Accelerator

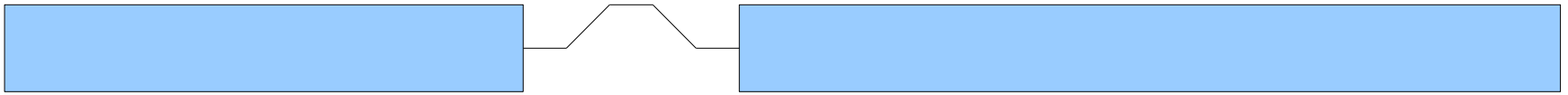
A.Aksoy

Layout

DBL1

Bunc Compressor

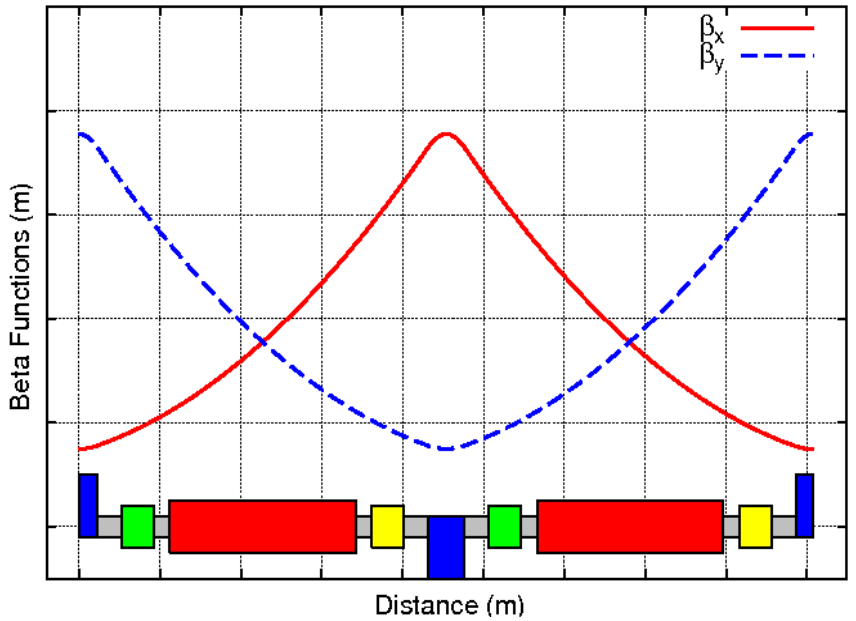
DBL2



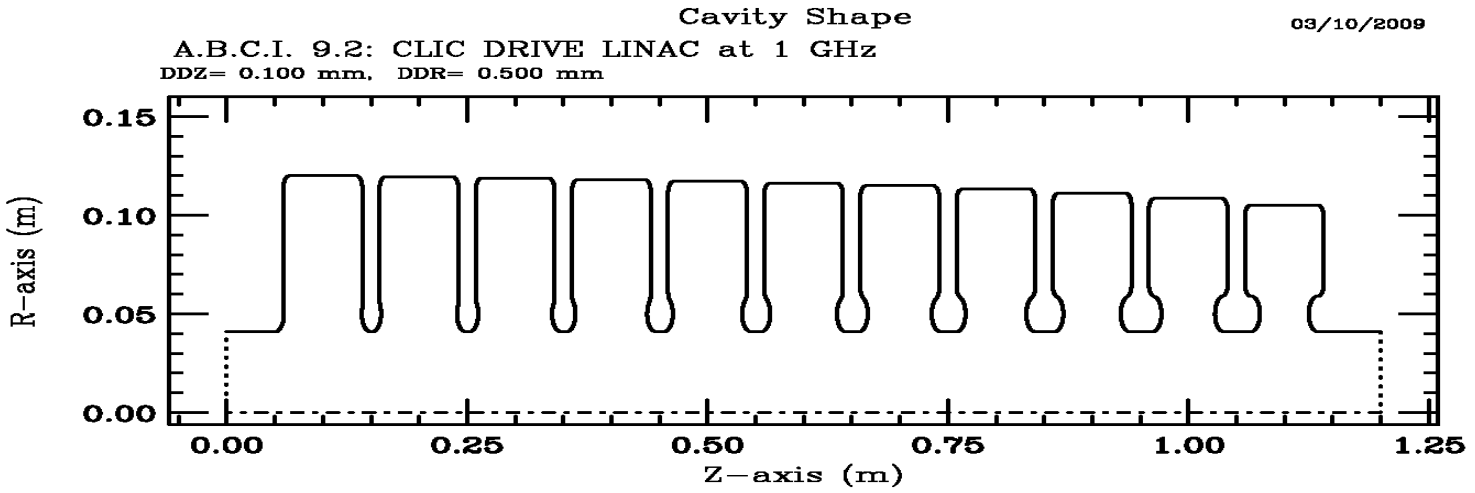
Beam energy
50 → 250-300 MeV
Bunch lenght:
3 mm
No of structures:
62 - 92

Compression
3mm →1mm

Beam energy
250-300 → 2500 MeV
Bunch lenght:
1 mm
No of structures:
698-1046



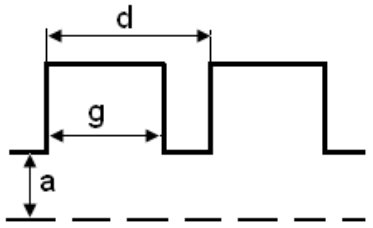
Structures



Strucutre	Cell Length (mm)	Bore Radius (mm)	Diameter (mm)	Gap Lenght (mm)	Input power (MW)
11 Cell	99.97	41	240-210	80-50	10
14 Cell	99.97	47	245-189	80-32	10
16 Cell	99.97	47	240-209	75-46	12.5
17 Cell	99.97	49	244-204	78-36	12.5
18 Cell	99.97	47	242-215	78-51	15
19 Cell	99.97	49	246-204	80-40	15

Short Range Longitudinal Wakes

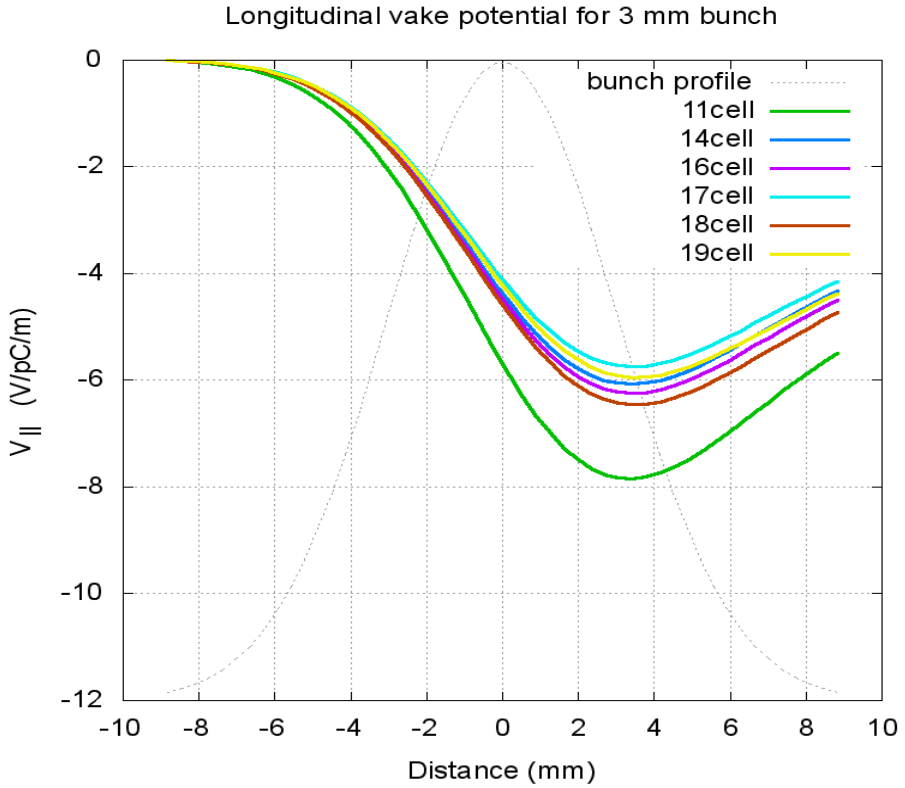
Karl Bane's Formula

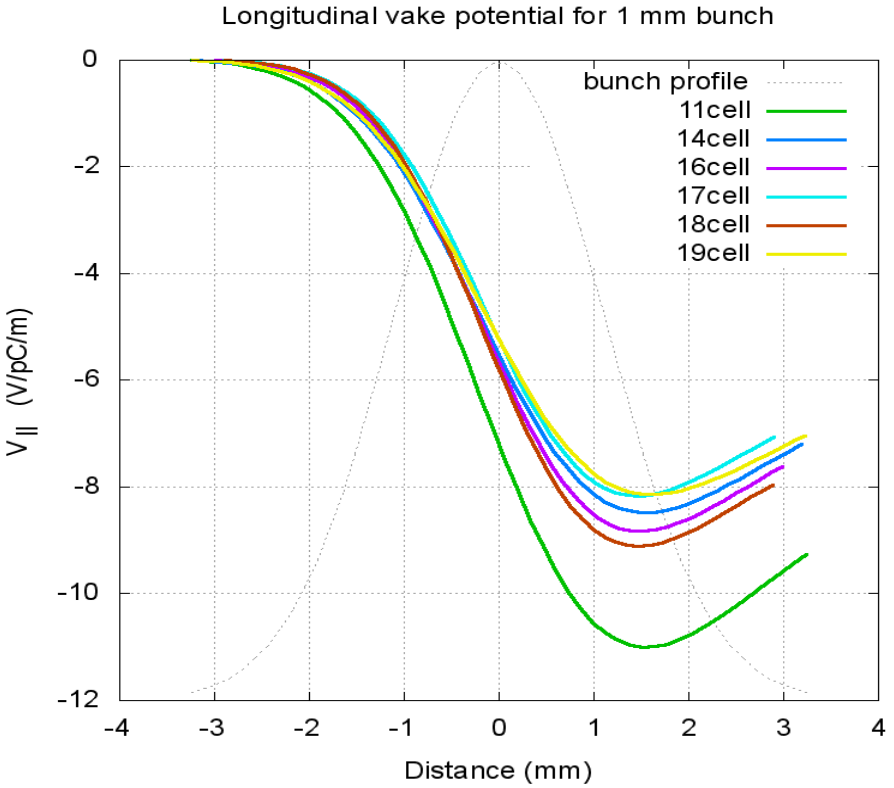


$$s_{0,i} = 0.41 \frac{a^{0.18} g_i^{1.6}}{d^{2.5}} \quad , \quad Z_0 = 120\pi\,\Omega$$

$$W_{\parallel,\mathrm{i}}(s) = \frac{4Z_{0c}}{\pi a^2} \exp\left(-\sqrt{\frac{s}{s_{0,i}}}\right) \quad , \quad W_{\parallel}(s) = \frac{1}{n}\sum_{i=1}^{n} W_{\parallel,\mathrm{i}}(s)$$

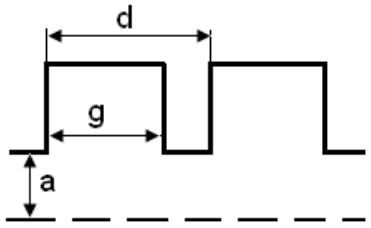
$$V_{\parallel}(s) = \int_{-\infty}^{s} W_{\parallel}(s-x)\,\sigma(x)\,dx$$





Short Range Transverse Wakes

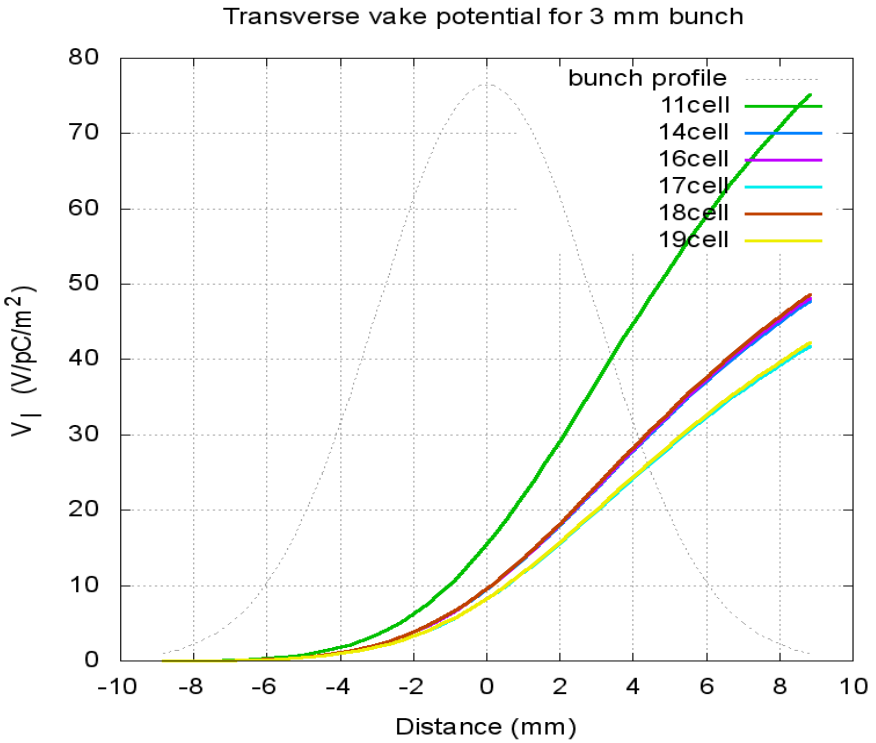
Karl Bane's Formula

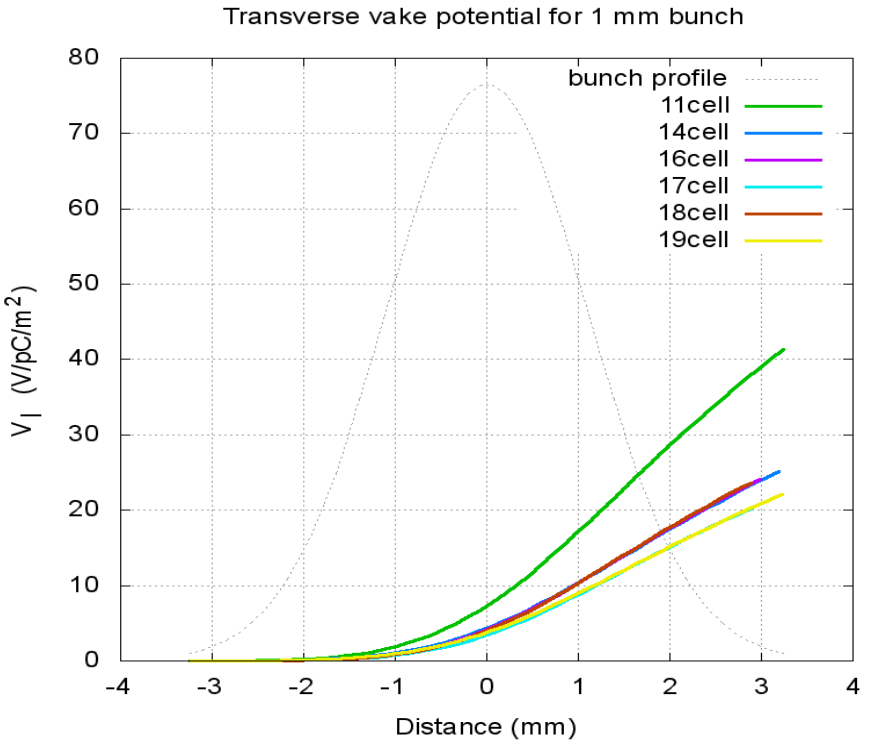


$$s_{0,i} = 1.69 \frac{a^{1.79} g_i^{0.38}}{d^{1.17}} \quad , \quad Z_0 = 120\pi\,\Omega$$

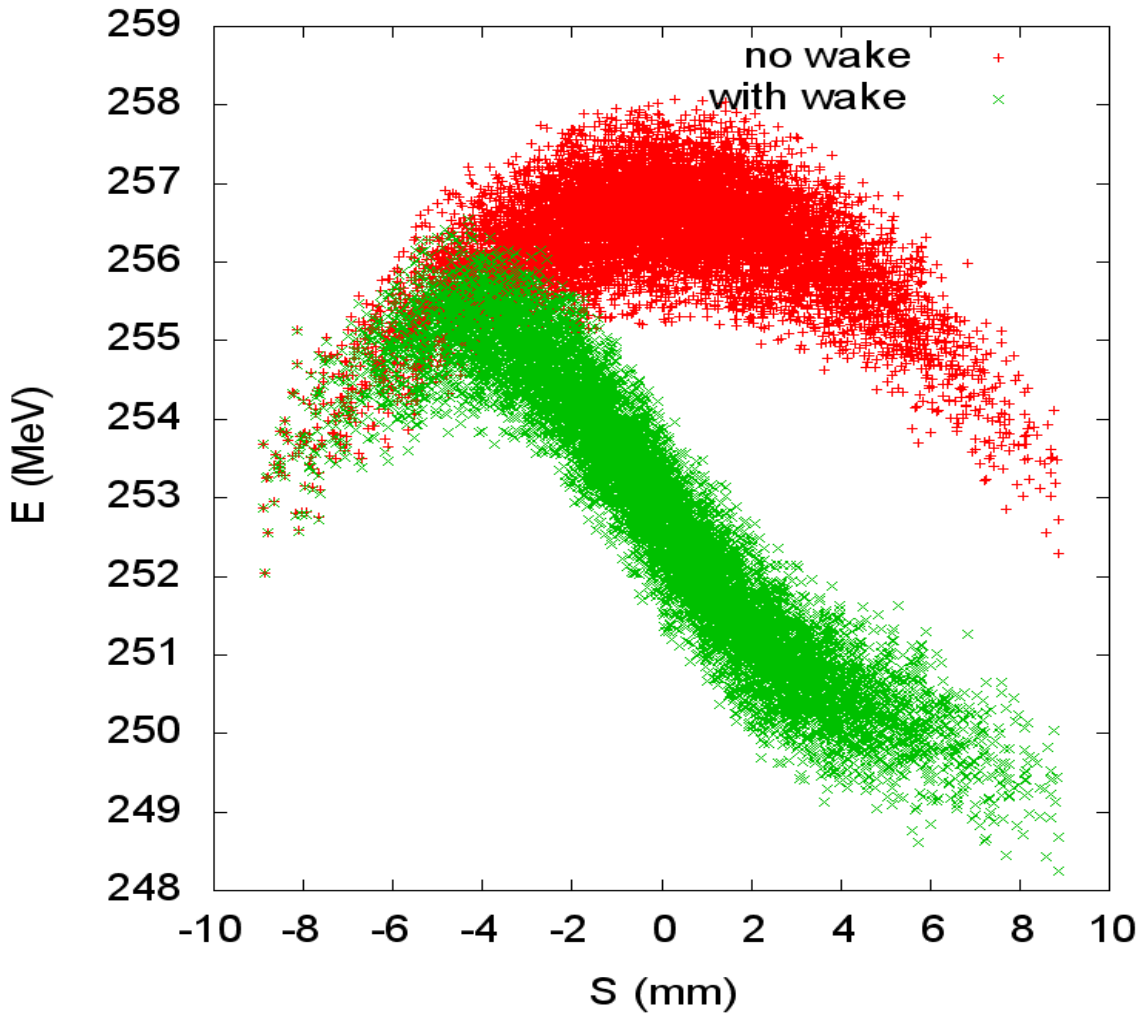
$$W_{\perp,\mathrm{i}}(s) = \frac{4 Z_0 c\, s_{0,i}}{\pi a^4}\left[1-\left(1+\sqrt{\frac{s}{s_{0,i}}}\right)\exp\left(-\sqrt{\frac{s}{s_{0,i}}}\right)\right] \quad , \quad W_\perp(s) = \frac{1}{n}\sum_{i=1}^{n} W_{\perp,\mathrm{i}}(s)$$

$$V_\perp(s) = \int^{s} W_\perp(s-x)\,\sigma(x)\,dx$$





Effect of longitudinal wake



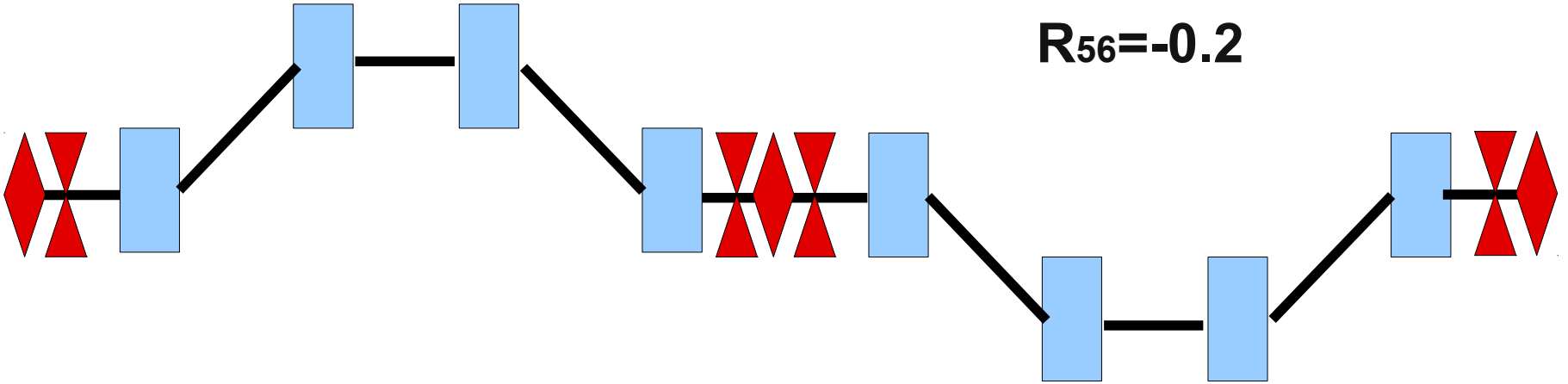
$$\Delta E = -\int_{-\infty}^{\infty} \rho(z) V_{\parallel}(z)$$

Trailing particles looses energy due to wake field generated leading particles

This case generated large energy spread

Solution is off-crest acceleration

CHICANE

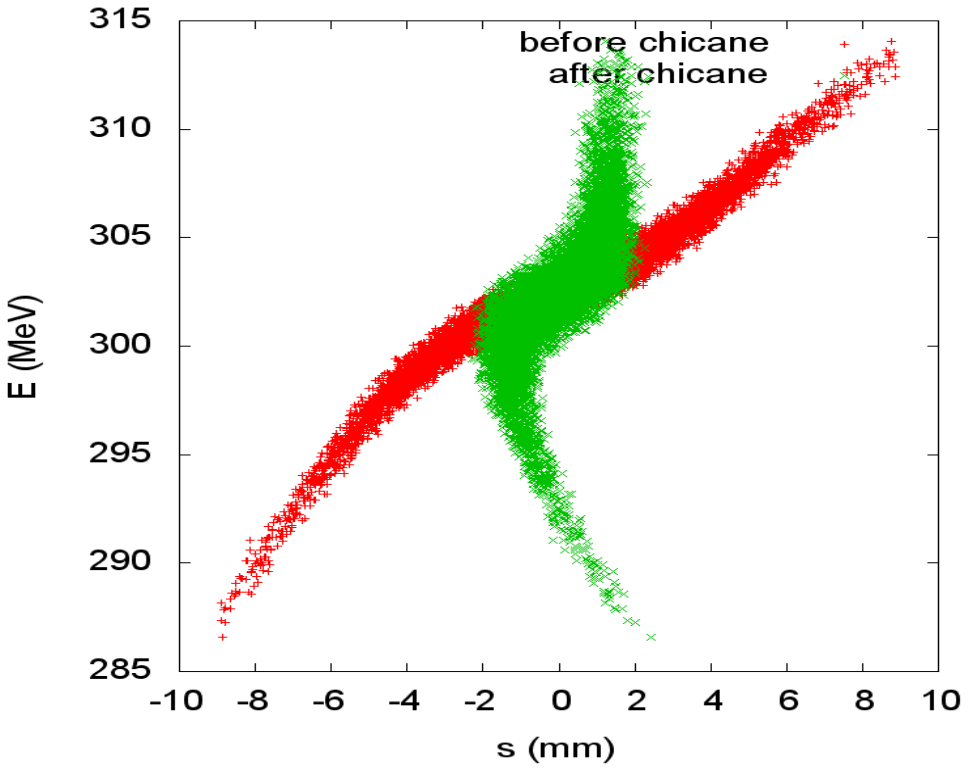


R_{56}=-0.2

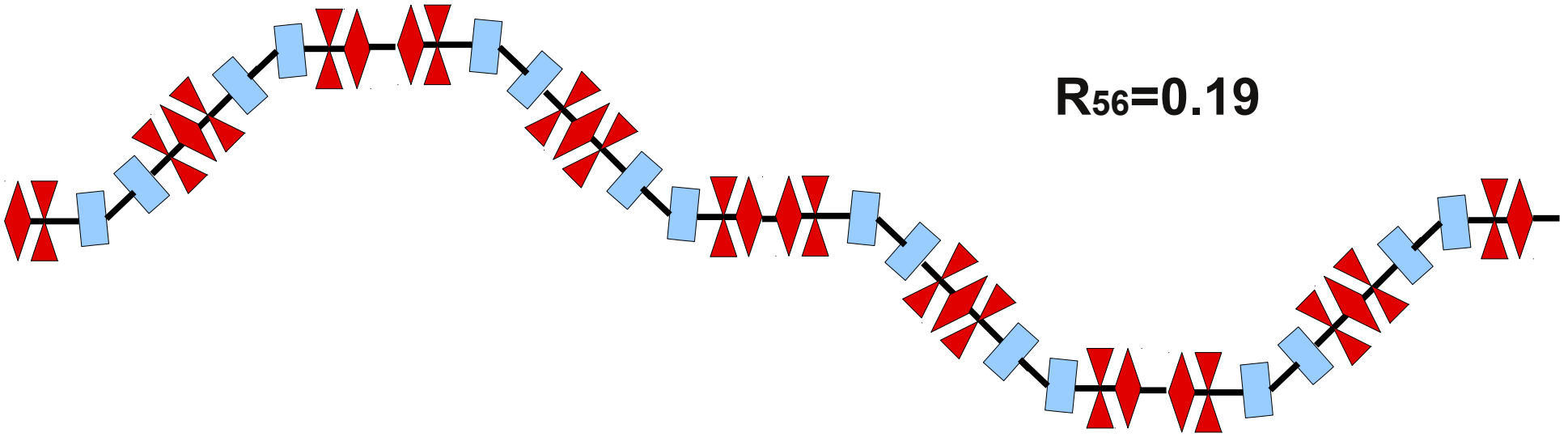
Chicane located at 300 MeV

DBL1 off-crest 18 degree

No of accelerator in DB1
76



Positive R_{56}

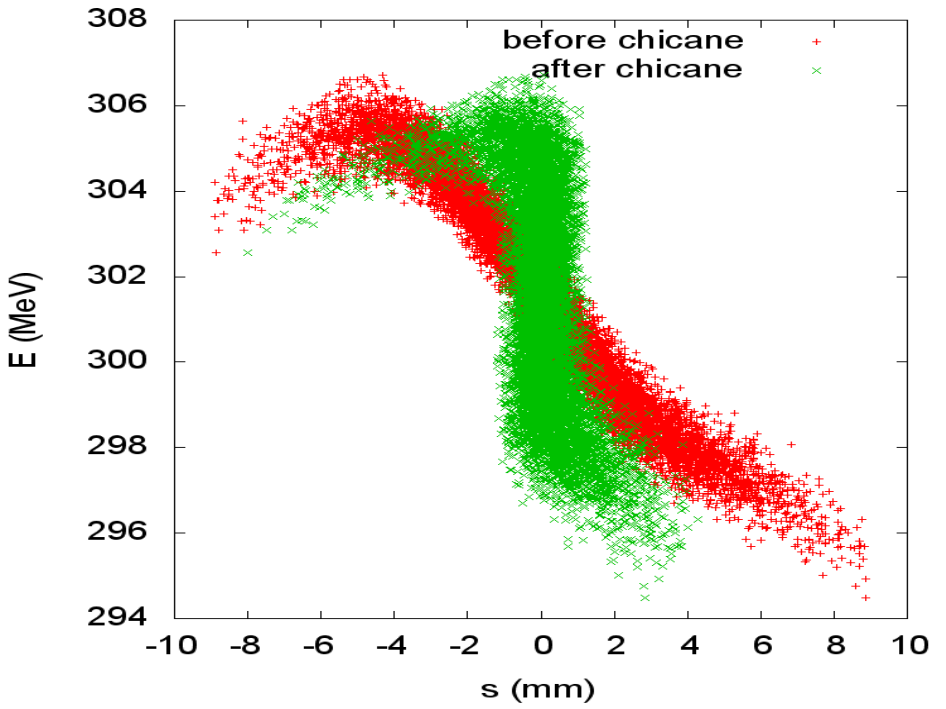


R_{56}=0.19

Compressor located at 300 MeV

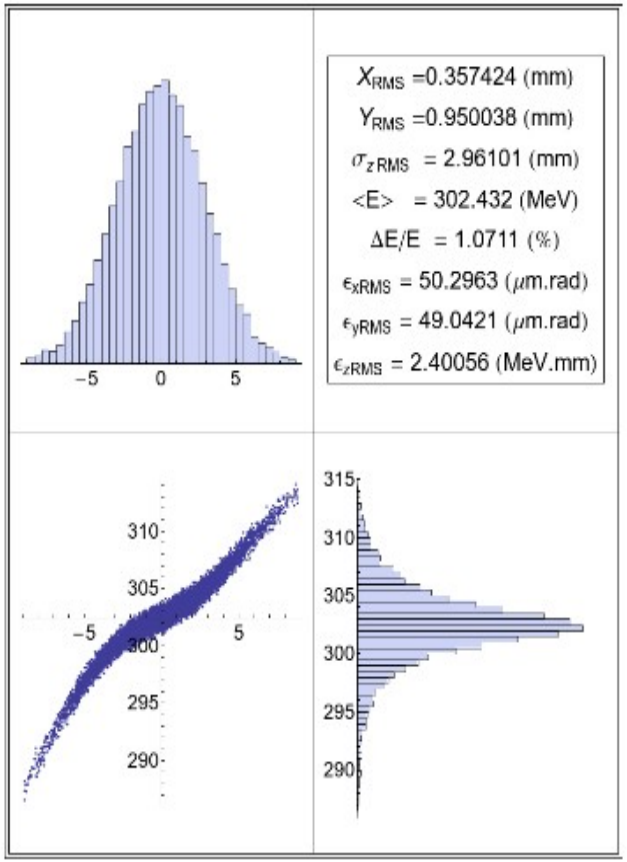
DBL1 linac off-crest -2 degree

No of accelerator in DB1
72

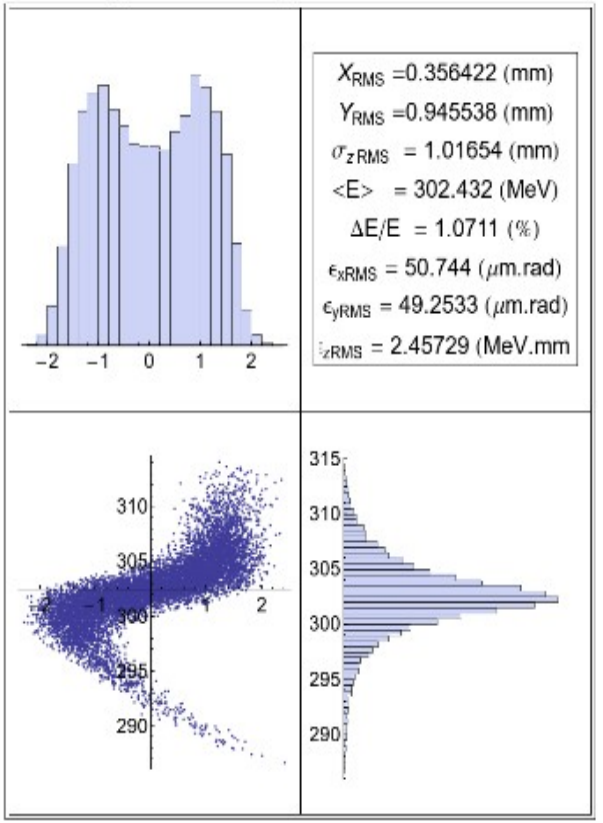


Results for Chicane

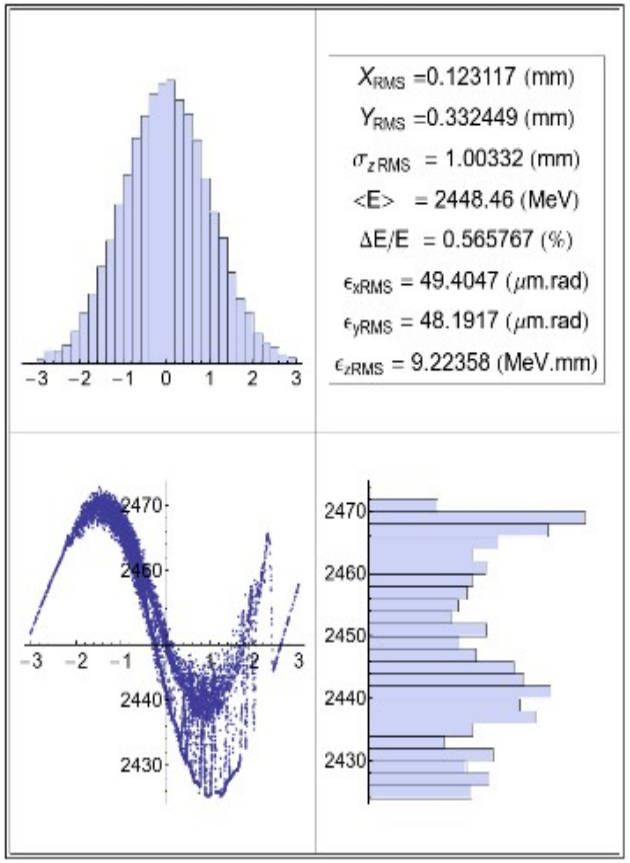
Longitudinal Phase plot at the end of DB1



Longitudinal Phase plot at the end of chicane



Longitudinal Phase plot at the end of DB2



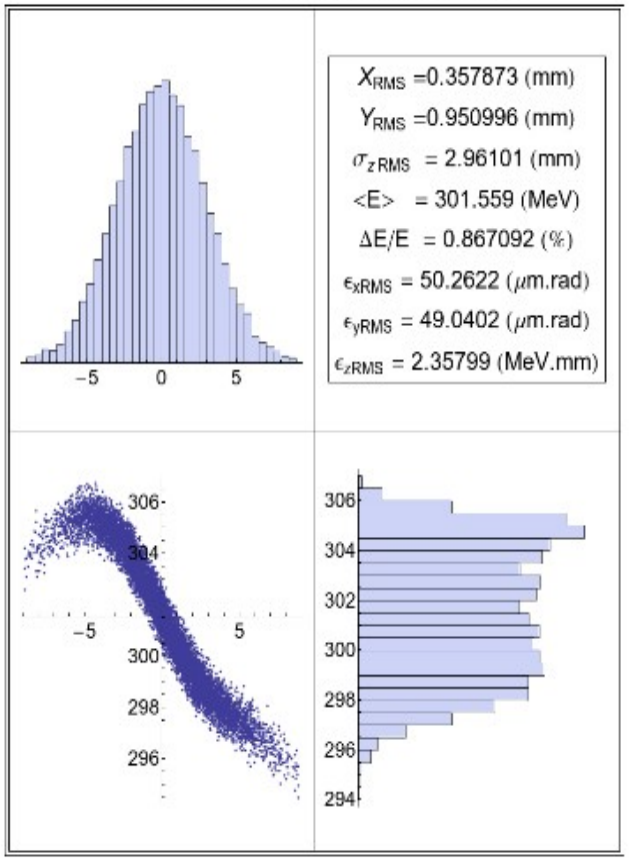
No of structure: 76
Phase : 18

Total structure : 730

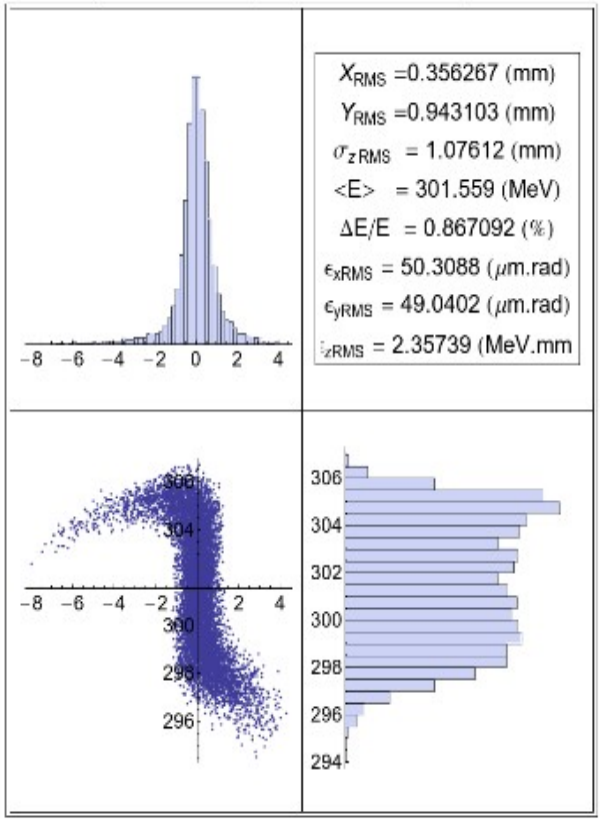
No of structure: 654
Phase: 19

Results for positive R_{56} compressor

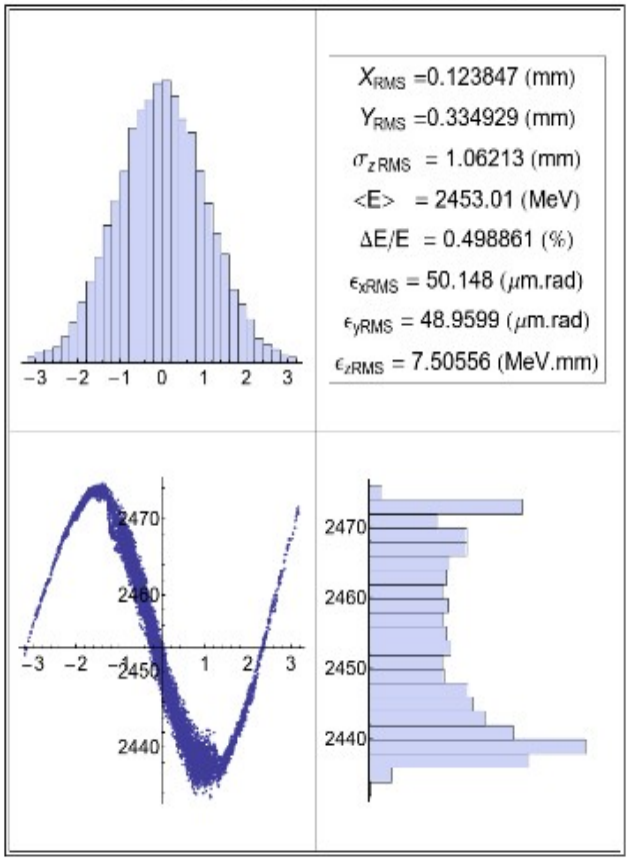
Longitudinal Phase plot at the end of DB1



Longitudinal Phase plot at the end of compression



Longitudinal Phase plot at the end of DB2

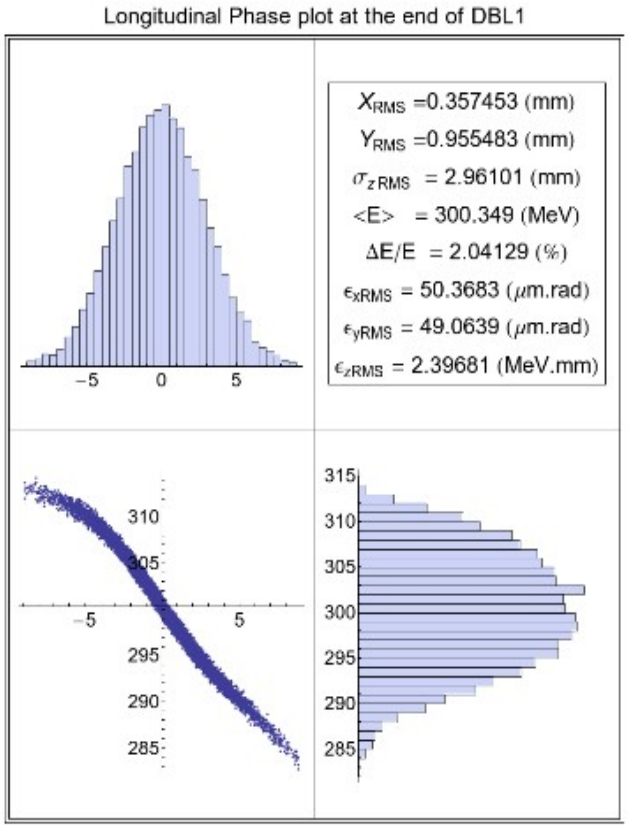


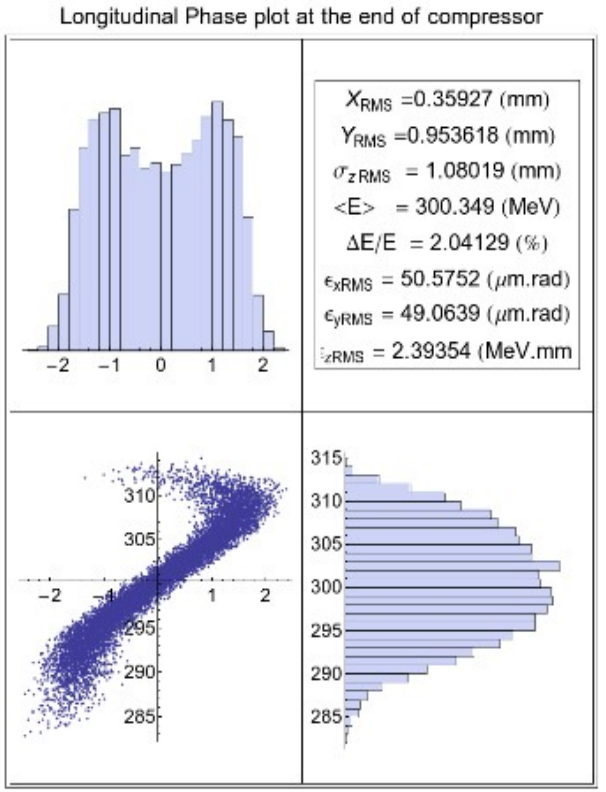
No of structure: 72
Phase : -2

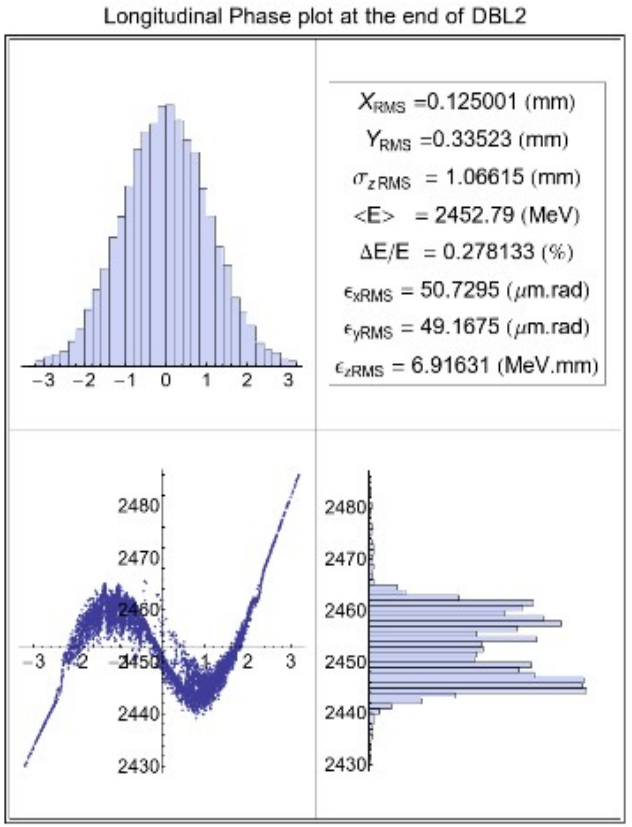
Total structure : 726

No of structure: 654
Phase: 19

Results for positive R_{56} compressor 2







No of structure: 74
Phase : - 14.5

Total structure : 728

No of structure: 654
Phase: 19

	BEAM PARAMETERS FOR DIFFERENT ACCELERATING STRUCTURES						
ACCELERATOR	Input RF power (MW)	10.00	10.00	12.50	12.50	15.00	15.00
	No of acc cell	11	14	16	17	18	19
	Beam Pipe Radius (mm)	41.00	47.00	47.00	49.00	47.00	49.00
	Accel length with edge (m)	1.20	1.50	1.70	1.80	1.90	2.00
	Accel gradient per struc (MeV)	2.3753	2.3753	2.9691	2.9691	3.56	3.5629
	Accel gradient (MeV/m)	2.15	1.69	1.85	1.74	1.98	1.87
	RF phase of DBL1 (deg)	19	19	19	19	19	19
	RF phase of DBL2 (deg)	25	25	25	25	25	25
DBL1 SECTION	Quad strength (1/m2)	2.70	2.65	2.70	2.75	2.75	2.75
	Quad length (m)	0.25	0.23	0.21	0.20	0.19	0.18
	One FODO cell length (m)	4.70	5.26	5.62	5.80	5.98	6.16
	Number of accel used in DBL1	92	92	74	74	62	62
	Length of DBL1 (m)	216.32	242.07	208.04	214.7	185.47	191.05
B at DBL1 end	Rms bunch length (um)	2961.00	2961.00	961.00	2961.00	2961	2961.00
	Average energy (GeV)	0.2519	0.2520	0.2534	0.2535	0.25	0.2547
	Rms enegry spread (%)	1.0550	1.0606	1.0972	1.1106	1.11	1.1295
	Rms energy width (MeV)	2.6577	2.6728	2.7799	2.8149	2.834	2.8770
CHICANE	Chicane bending angle (deg)	5.5000	5.5000	5.5000	5.5000	5.500	5.5000
	Number of hicane used	4	4	4	4	4	4
	Length of one one chicane (m)	7.3253	7.3253	7.3253	7.3253	7.325	7.325
	Total length of chicane section (m)	48.8511	48.8311	48.8111	49.2011	49.59	50.131
B at CHI end	Rms bunch length (um)	1107.54	1091.72	1013.69	986.06	979.10	947.39
	Average energy (GeV)	0.2519	0.2520	0.2534	0.2535	0.254	0.2547
	Rms enegry spread (%)	1.0550	1.0606	1.0972	1.1106	1.113	1.1295
	Rms energy width (MeV)	2.6577	2.6728	2.7799	2.8149	2.834	2.8770
DBL2 SECTION	Number of accel used in DBL2	1046	1046	836	836	698	698
	Length of DBL2 (m)	2458.2250	2751.095	2349.265	2424.50	2087.1	2149.93
	Total number of accel used DBL1&DBL2	1138	1138	910	910	760	760
	Total bealine length (m)	2723.4011	3042.0011	2606.1211	2688.401	2322.1	2391.1
B at DBL2 end	Rms bunch engtth (um)	1107.54	1091.72	1013.69	986.06	979.10	947.39
	Average energy (GeV)	2.4384	2.4400	2.4429	2.4442	2.450	2.4523
	Rms enegry spread (%)	0.4641	0.4473	0.4370	0.4340	0.416	0.4122
	Rms energy width (MeV)	11.3167	10.9139	10.6753	10.6069	10.20	10.109
INTEGRATION ALL LINAC							
	integral{(0->L)Beta_x(s)/E(s)} (m/MeV)	7.0918	10.1608	9.9004	10.9121	9.96	10.89
	integral{(0->L)Beta_y(s)/E(s)} (m/MeV)	7.0907	10.1566	9.8999	10.9107	9.96	10.89