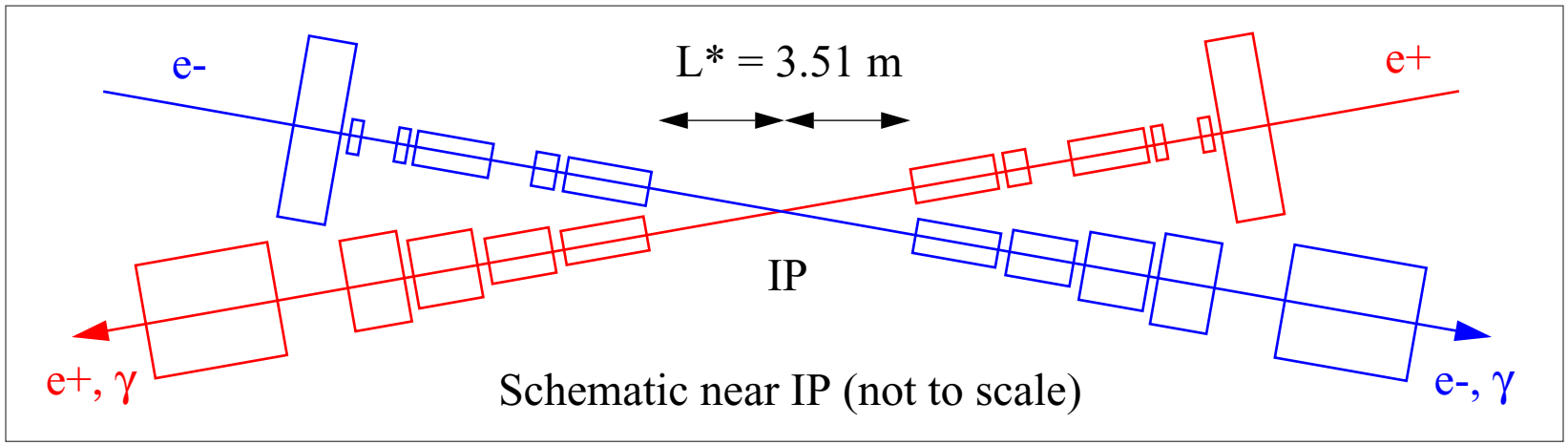
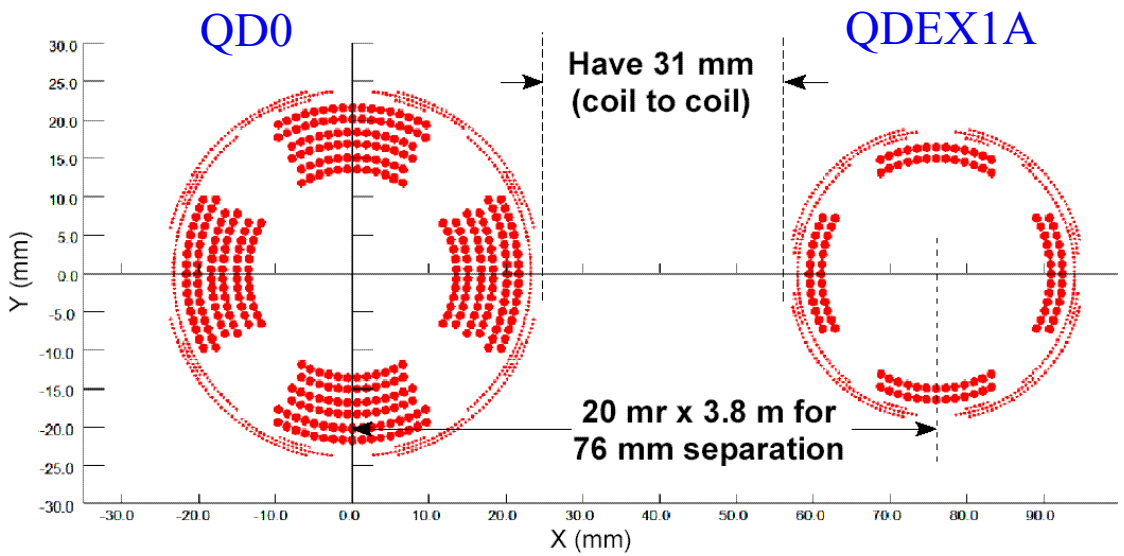
Extraction Line Optics for 20 mrad Crossing Angle

Changes since LCWS 2005

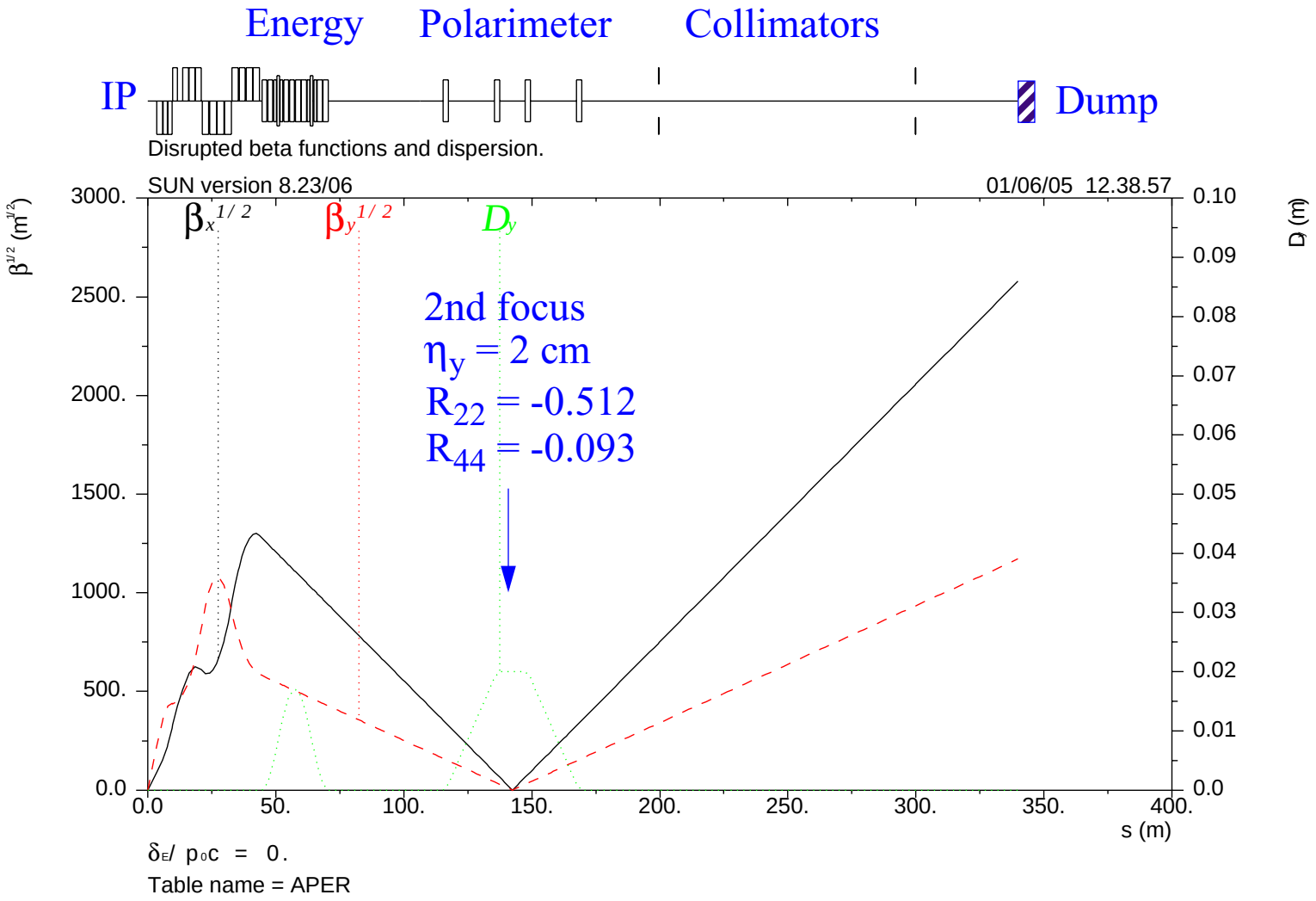
- Initial focusing after IP is done by DFDF quadruplet instead of the five quad system.
- The large bore quad doublet after the polarimeter chicane is removed.
- The R_{22} matrix term between the IP and the Compton IP is close to -0.5.
- The dump is moved farther from the IP, from ~180 m to ~340 m, to increase the undisrupted beam size and reduce the beam density at the dump for realistic design.
- Two pre-dump collimators are included to limit the undisrupted beam size at the dump to R < 15 cm for realistic size of the dump window.



- SC compact quad design for the incoming and extraction quadrupoles near IP.



Beam optics


Energy
Polarimeter
Collimators
IP
Dump
Disrupted beta functions and dispersion.
SUN version 8.23/06
01/06/05 12.38.57
$\beta_x^{1/2}$
$\beta_y^{1/2}$
D_y
2nd focus
η_y = 2 cm
R_{22} = -0.512
R_{44} = -0.093
$\beta^{1/2}$ ($m^{1/2}$)
D_y (m)
s (m)
$\delta_E / p_0 c$ = 0.
Table name = APER

Magnet parameters at 1 TeV CM

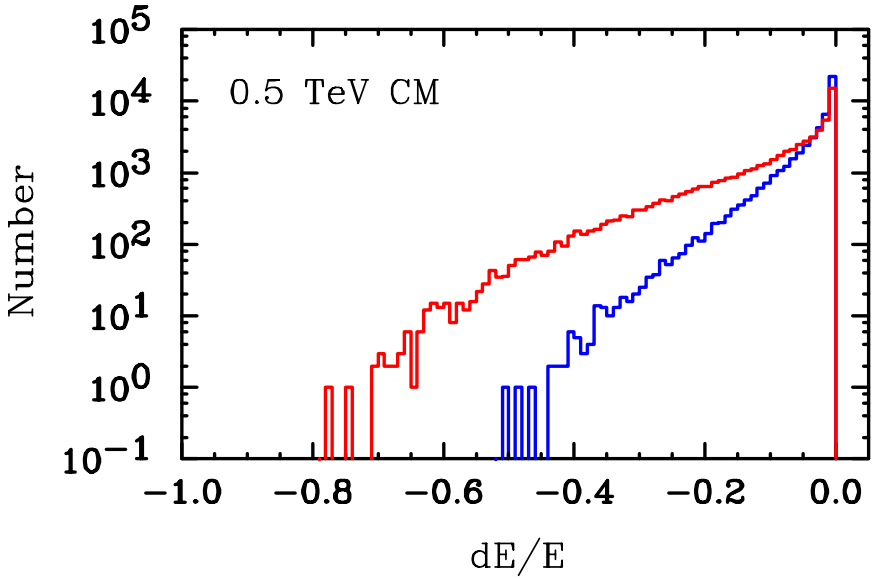
Quad	L (m)	G (T/m)	B (T) at aperture	R (mm)
QDEX1A SC	2.2	-38.46	-0.5	13
QDEX1B SC	1.5421	-80.00	-1.2	15
QDEX1C SC	1.5421	-57.14	-1.2	21
QFEX2A SC	1.8058	42.86	1.2	28
QFEX2B,C,D	2.2583	24.39	1.0	41
QDEX3A,B	2.6254	-24.39	-1.0	41
QDEX3C	2.6254	-20.41	-1.0	49
QDEX3D	2.6254	-16.67	-1.0	60
QFEX4A	2.4306	14.08	1.0	71
QFEX4B,C,D	2.4306	12.05	1.0	83

- Chicane bends are L = 2 m long with B = 0.8339 T field at 1 TeV CM.

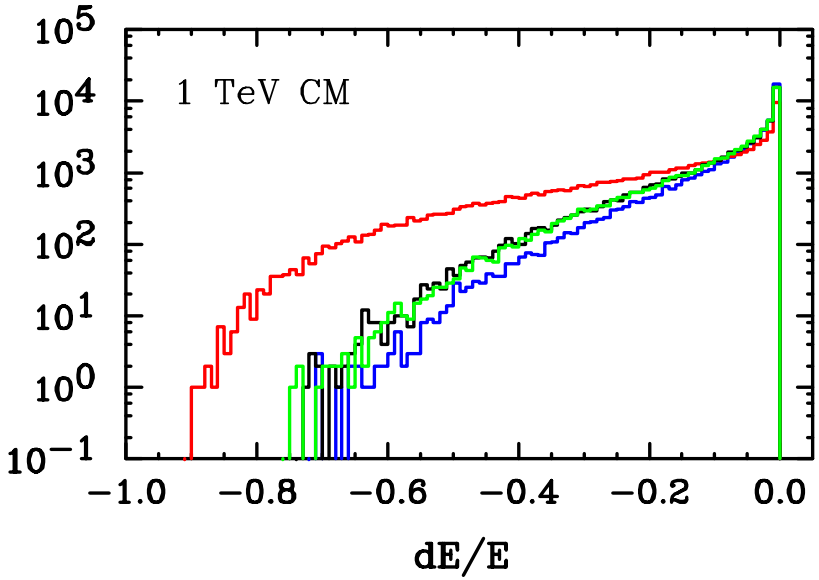
Disrupted beam parameters at IP (based on "suggested ILC beam parameter range," Feb. 2005)

E_{CM}	Luminosity ($m^{-2}s^{-1}$)	Total power (MW)	y-offset at IP (nm)	$\frac{E_{min}}{E_0}$	electron X'_{max} / Y'_{max} (μrad)	photon X'_{max} / Y'_{max} (μrad)
0.5 TeV nominal (c11)	2.03e+38	11.3	0	0.36	529 / 253	369 / 212
			200	0.36	474 / 674	366 / 537
0.5 TeV high-L (c15)	4.92e+38	11.3	0	0.17	**1271** / 431	**723** / 320
			120	0.17	**1280** / **1415**	**782** / **1232**
1 TeV nominal (c21)	2.81e+38	18.1	0	0.20	496 / 159	271 / 148
			100	0.19	423 / 566	279 / 408
1 TeV high-L (c25)	7.81e+38	18.1	0	0.063	**2014** / 489	**937** / 296
			80	0.062	**1731** / **1592**	**974** / **1200**
1 TeV high-L (c26)	5.72e+38	21.7	0	0.15	661 / 249	338 / 170
			100	0.14	598 / 696	376 / 585
1 TeV high-L (c27)	4.64e+38	18.1	0	0.15	597 / 236	546 / 159
			100	0.14	537 / 691	342 / 532

Energy spread in the disrupted beam (for 7e+4 particles)



Blue - nominal
Red - high-L



Blue - nominal
Red - high-L (c25)
Black - high-L (c26)
Green - high-L (c27)

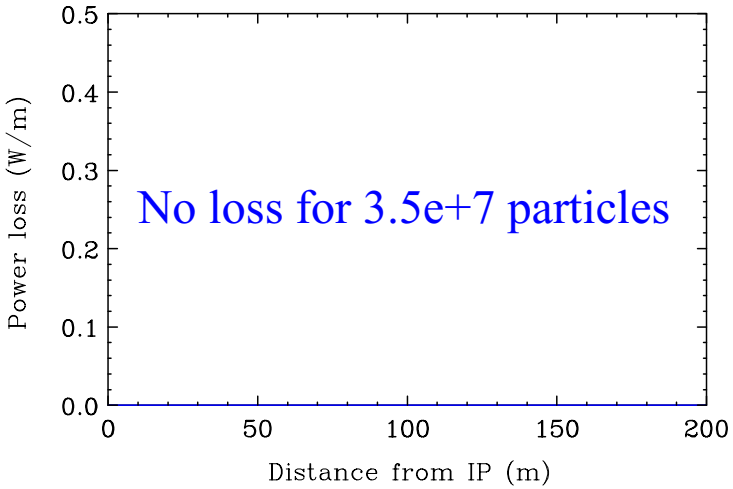
Disrupted electron and beamstrahlung loss

E_{CM}	y-offset at IP (nm)	Max. e-loss density in magnets (W/m)			Total e-loss (kW)			γ-loss in collimators (kW) (L. Keller)	
		SC quads	Warm quads	Bends	Excluding Coll. 1,2	Coll. 1	Coll. 2	Coll. 1	Coll. 2
0.5 TeV nominal	0	0	0	0	0	0	0	0	0
	200	0	0	0.13	0.003	0	0	0.15	0.05
0.5 TeV high-L	0	15 (2.1*)	60	37	1.9	47	74	2.8	0.7
	120	3.8 (0*)	95	372	11	47	95	151	10
1 TeV nominal	0	0	1.8	4.8	0.19	0.85	0	0	0
	100	0	7.1	77	2.4	4.8	0.11	0	0
1 TeV high-L (c25)	0	1106	4379	2032	98	64	44	1.5	0.2
	80	1071	5391	7362	280	129	15	69	9.5
1 TeV high-L (c26)	0	0	16	25	1.6	3.6	0.50		
	100	0	49	352	11	17	1.3		
1 TeV high-L (c27)	0	0	14	22	1.1	2.7	0.21		
	100	0	27	213	7.2	12	1.2		

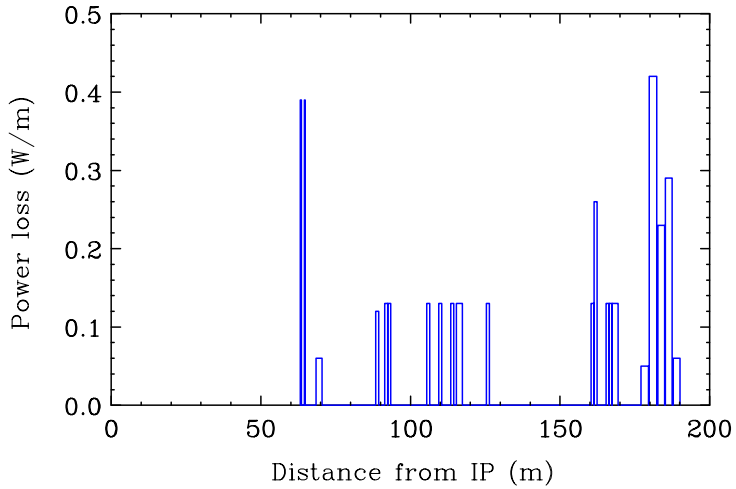
* After increasing aperture in QDEX1C and QFEX2A to r = 25 and 36 mm, respectively.

Density of disrupted electron loss (W/m) (collimators are not shown)

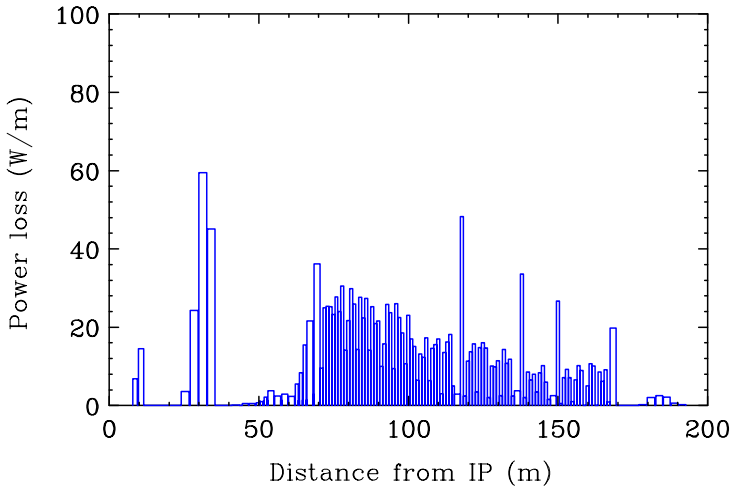
0.5 TeV CM nominal, Δy = 0



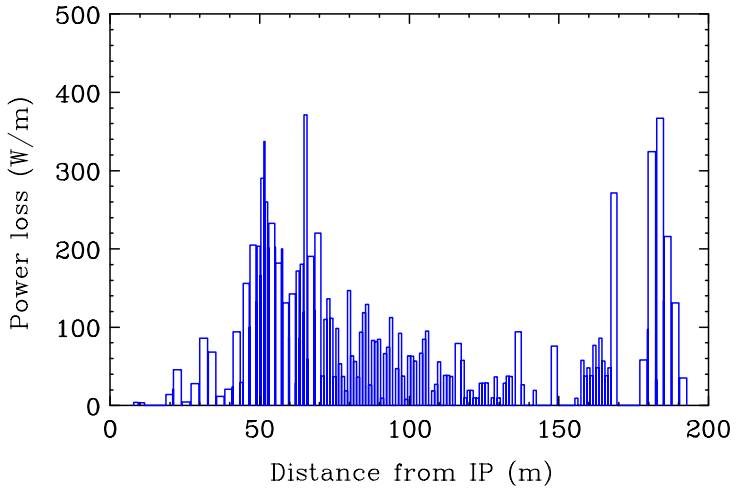
0.5 TeV CM nominal, Δy = 200 nm



0.5 TeV CM high-L, Δy = 0

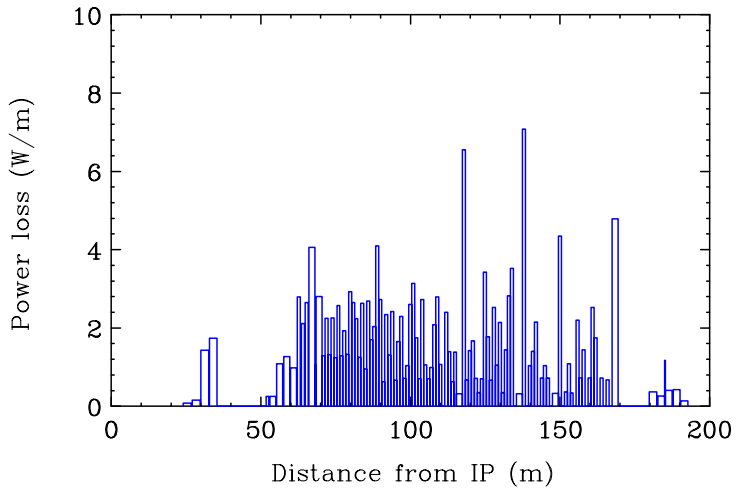


0.5 TeV CM high-L, Δy = 120 nm

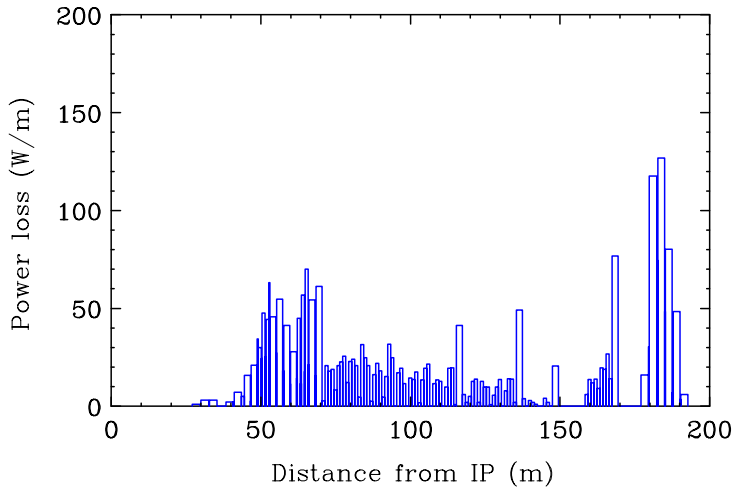


Density of disrupted electron loss (cont'd)

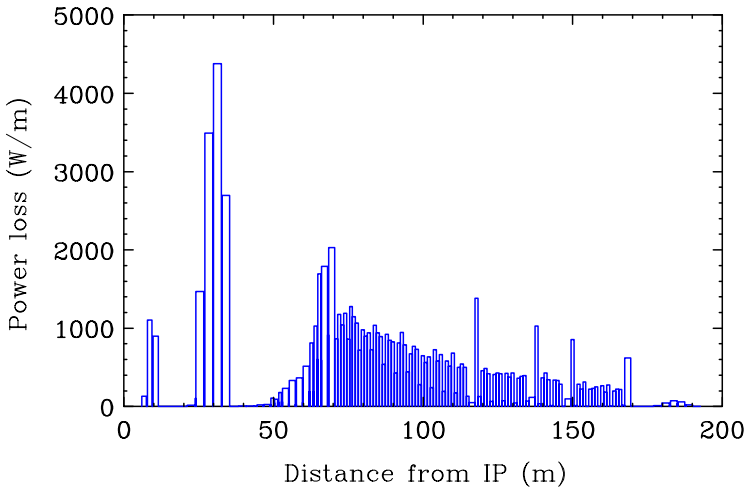
1 TeV CM nominal, Δy = 0



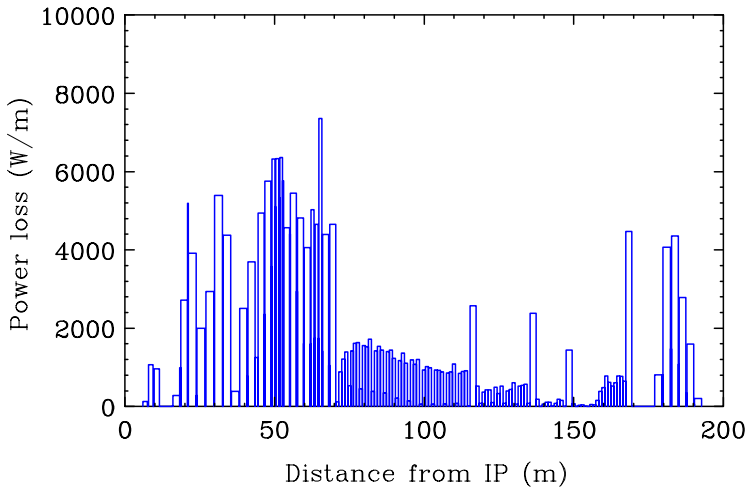
1 TeV CM nominal, Δy = 100 nm



1 TeV CM high-L (c25), Δy = 0

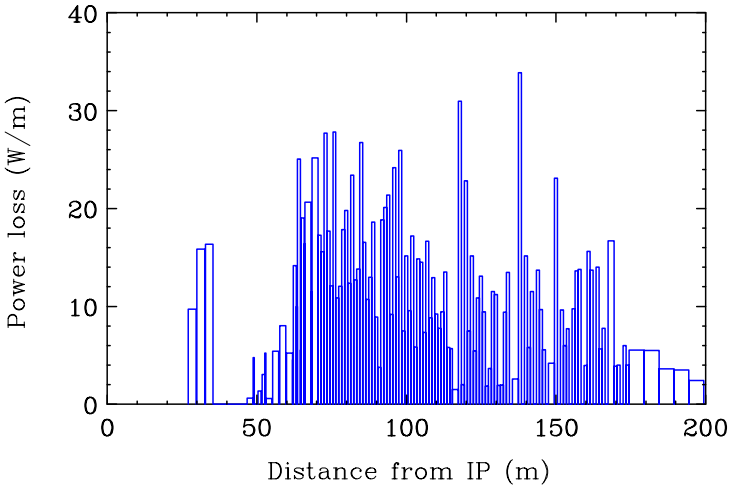


1 TeV CM high-L (c25), Δy = 80 nm

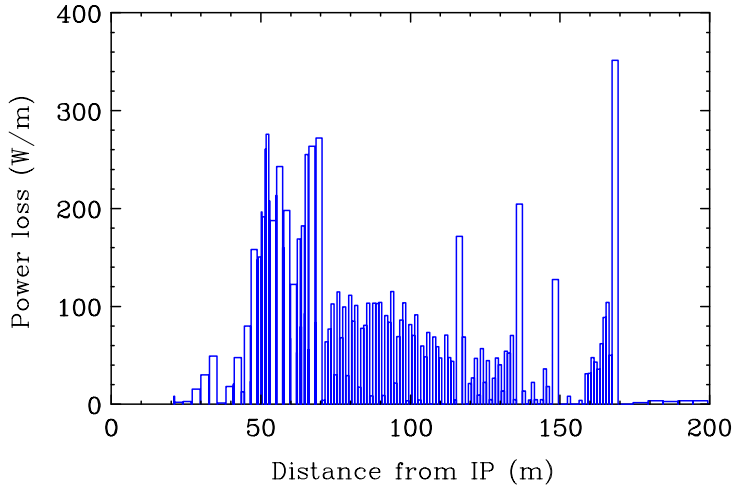


Density of disrupted electron loss (cont'd)

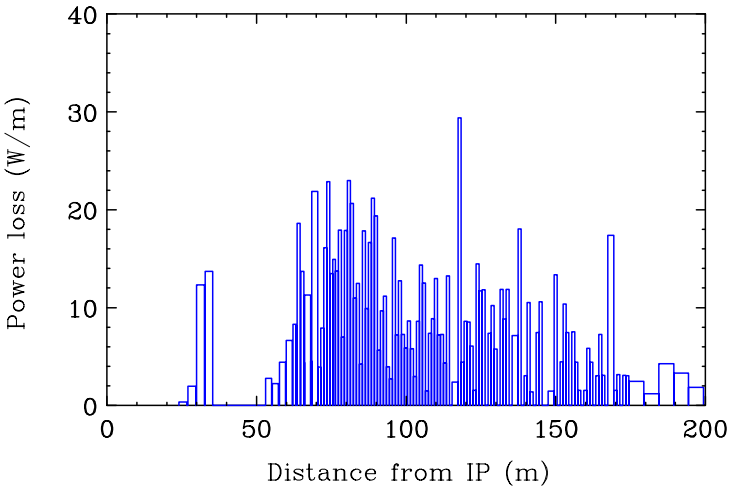
1 TeV CM high-L (c26), Δy = 0



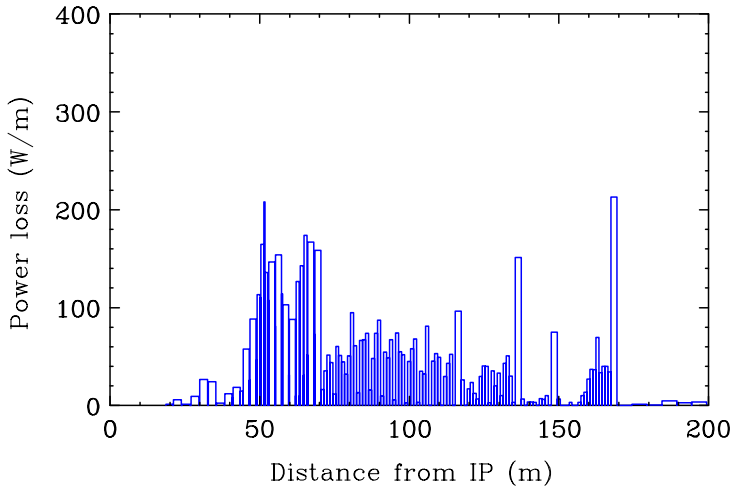
1 TeV CM high-L (c26), Δy = 100 nm



1 TeV CM high-L (c27), Δy = 0

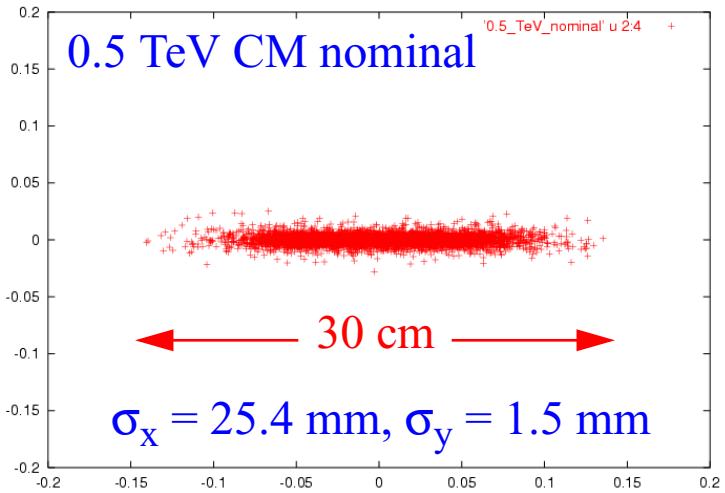


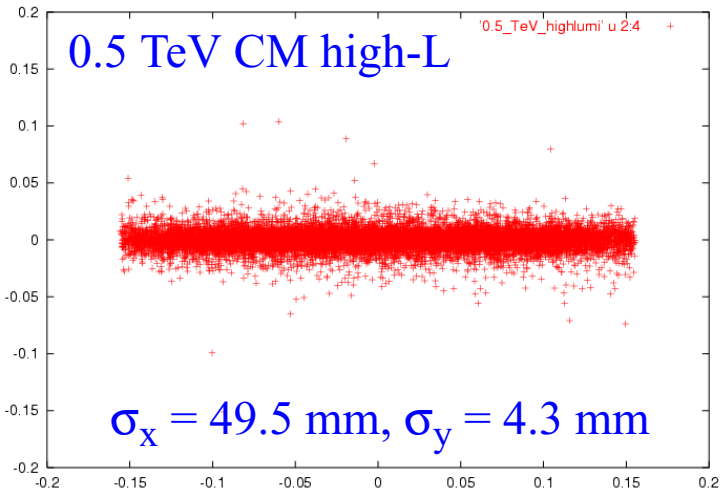
1 TeV CM high-L (c27), Δy = 100 nm

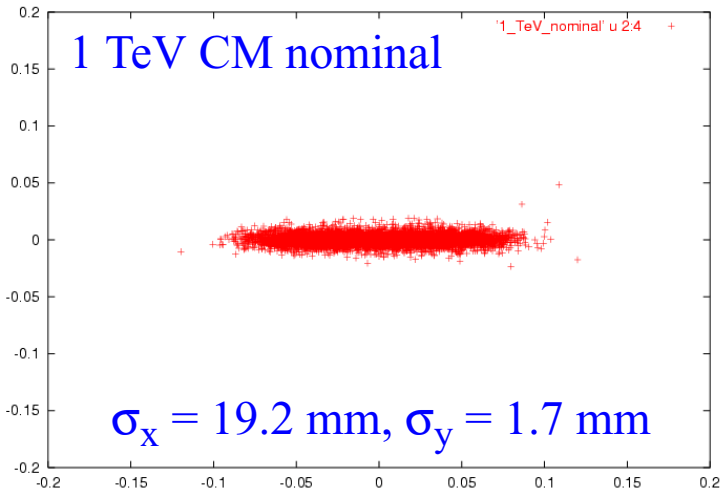


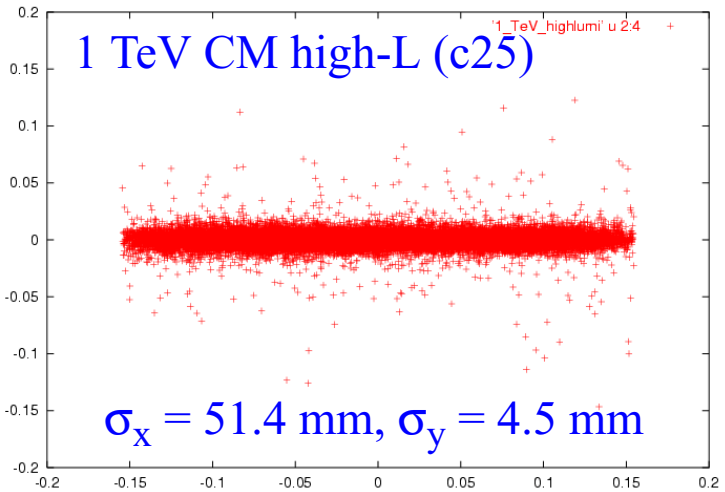
X-Y disrupted distribution at dump (no IP offset)

- Collimators limit the beam size at dump to R < 15 cm.









Undisrupted beam size at dump

E_{CM}	Option	$\sigma_x\sigma_y$ (mm^2)
0.5 TeV	nominal (c11)	3.16 x 0.28 = 0.88
	high-L (c15)	4.57 x 0.34 = 1.55
1 TeV	nominal (c21)	1.87 x 0.63 = 1.18
	high-L (c25)	3.23 x 0.62 = 2.00
	high-L (c26)	1.87 x 0.61 = 1.14
	high-L (c27)	2.20 x 0.61 = 1.34

- Sync. radiation helps to increase the vertical beam size, especially at high energy.
- Further increase of undisrupted beam size to $\sigma_x\sigma_y \sim 1.7$ mm^2 (per D. Walz) may be needed for realistic dump design.

Conclusion

- The 20 mrad design appears conceptually acceptable.
- It provides a satisfactory optics for energy and polarization diagnostics.
- It provides a low beam loss for the nominal luminosity options.
- Further study is needed to verify the acceptable level of beam loss in the high luminosity options.
- Further optics optimization will include:
  - adjustments to satisfy the minimum beam size requirements at the dump,
  - converging on the realistic magnet parameters,
  - possible collimators to reduce beam loss on magnets.