Comments for low P option for breakdown session

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Issues with low P

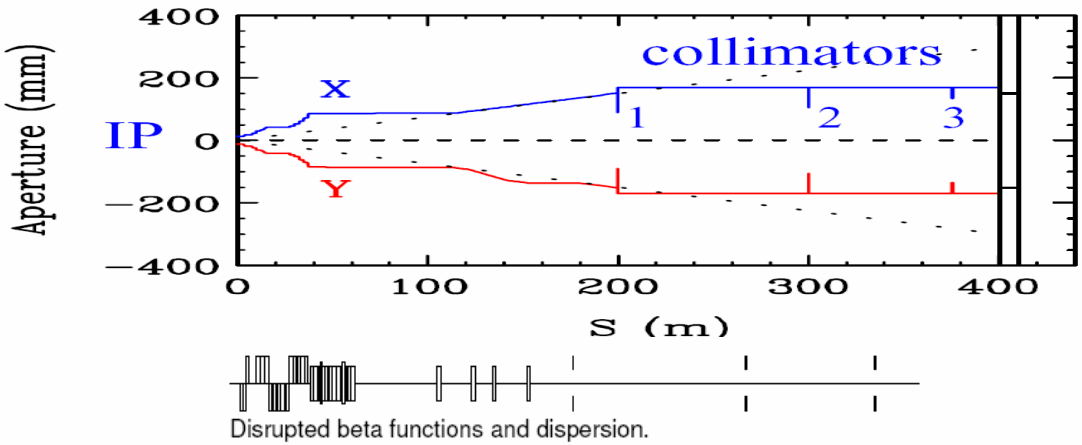
- Accelerator physics:
  - **Extraction line losses**
  - **High disruption**
  - **Tighter focusing, tighter tolerances**
  - **Tighter collimation depth**
  - **Larger collimation wakes**
  - **Larger wakes due to vacuum chamber**
  - **…**

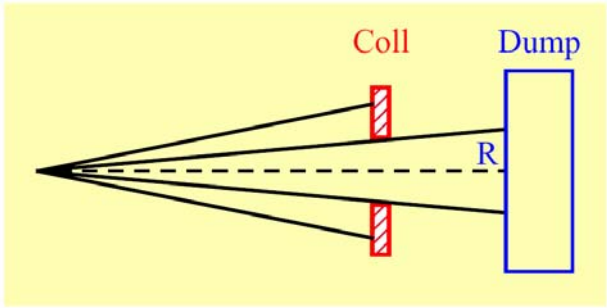
- Particle Physics: (Hitoshi's slides)
  - **hits from pairs to VXD**
  - **background from pairs at BEAMCAL & LUMICAL**
  - **Energy bias of Lumi spectrum due to large Dy and beamstrahlung**

500 GeV Beam and IP Parameters

	TESLA	USSC	Nominal	Low Q	Large Y	Low P	High Lum
E_cms (GeV)	500	500	500	500	500	500	500
N	2.00E+10	2.00E+10	2.00E+10	1.00E+10	2.00E+10	2.00E+10	2.00E+10
Nb	2820	2820	2820	5640	2820	1330	2820
T_sep (ns)	336.9	336.9	307.7	153.8	307.7	461.5	307.7
Buckets @ 1.3 GHz	438	438	400	200	400	600	400
I_ave (A)	0.0095	0.0095	0.0104	0.0104	0.0104	0.0069	0.0104
Gradient	23.40	28.00	30.00	30.00	30.00	30.00	30.00
IP Parameters							
gamepsX (m-rad)	1.00E-05	9.60E-06	1.00E-05	1.00E-05	1.20E-05	1.00E-05	1.00E-05
gamepsY (m-rad)	3.00E-08	4.00E-08	4.00E-08	3.00E-08	8.00E-08	3.50E-08	3.00E-08
BetaX	1.50E-02	1.50E-02	2.10E-02	1.20E-02	1.00E-02	1.00E-02	1.00E-02
BetaY	4.00E-04	4.00E-04	4.00E-04	2.00E-04	4.00E-04	2.00E-04	2.00E-04
SigX	5.54E-07	5.43E-07	6.55E-07	4.95E-07	4.95E-07	4.52E-07	4.52E-07
SigY	5.0E-09	5.7E-09	5.7E-09	3.5E-09	8.1E-09	3.8E-09	3.5E-09
SigZ	3.00E-04	3.00E-04	3.00E-04	1.50E-04	5.00E-04	2.00E-04	1.50E-04
Dx	2.26E-01	2.35E-01	1.62E-01	7.08E-02	4.68E-01	2.26E-01	1.70E-01
Dy	2.53E+01	2.23E+01	1.85E+01	1.00E+01	2.86E+01	2.70E+01	2.19E+01
U_ave	0.054	0.055	0.046	0.061	0.036	0.100	0.133
delta_B	0.030	0.031	0.022	0.018	0.024	0.057	0.070
P_Beamstrahlung (W)	3.35E+05	3.47E+05	2.48E+05	2.05E+05	2.67E+05	3.06E+05	7.90E+05
N_gamma	1.477	1.504	1.257	0.823	1.664	1.756	1.725
Hd_x	1.061	1.069	1.022	1.002	1.465	1.061	1.026
Hd_y	5.317	5.071	4.727	3.764	3.211	4.142	5.037
Hd	1.80E+00	1.78E+00	1.70E+00	1.56E+00	1.79E+00	1.65E+00	1.74E+00
Geometric Luminosity	1.64E+38	1.45E+38	1.20E+38	1.29E+38	1.12E+38	1.24E+38	2.83E+38
Luminosity ($m^{-2}s^{-1}$)	2.94E+38	2.57E+38	2.03E+38	2.01E+38	2.00E+38	2.05E+38	4.92E+38
Coherent pairs/bc	7.14E-35	4.65E-34	7.71E-43	4.29E-31	3.19E-56	3.31E-15	2.21E-09
Inc. Pairs/bc	4.14E+05	3.66E+05	2.59E+05	8.37E+04	3.50E+05	6.12E+05	6.37E+05

Losses in extraction line





Disrupted beta functions and dispersion.

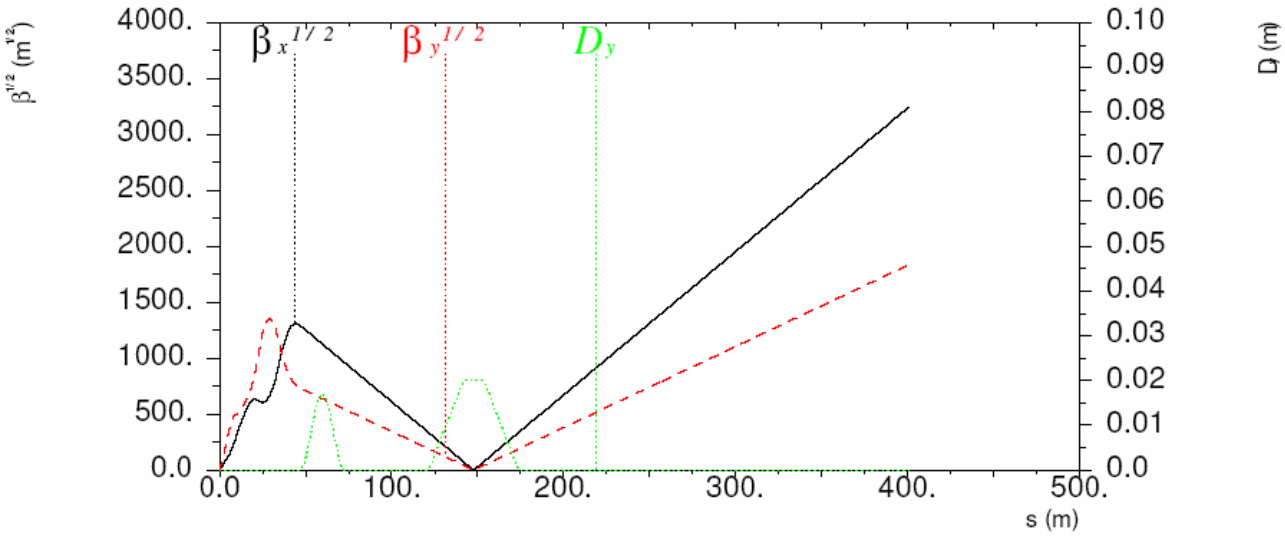


Figure 3: Disrupted beta functions and vertical dispersion in the 14 mrad extraction line. IP is at s = 0.

Table 1: Disrupted beam power loss in the 14 mrad extraction line for 0.75 mrad photon aperture model.

CM energy	x/y offset [nm]	Total electron loss (kW)				Total BS photon loss (kW)				Electron loss on SC quads [kW]
		Prior to collim.	Collimators			Prior to collim.	Collimators			
			1	2	3		1	2	3	
0.5 TeV nominal (c11)	0 / 0	0	0	1.4	0.77	0	0	0.002	0	0
	0 / 200	0.0009	3.8	25	2.7	0	0.09	13	0	0
0.5 TeV low-P (c14)	0 / 0	0.27	11	88	18					0
	400 / 0	0.21	13	83	18					0
	0 / 120	1.2	131	232	22	0.06	53	79	0	0
0.5 TeV high-L (c15)	0 / 0	2.0	39	230	46	0	1.8	28	0	0.002
	0 / 120	15.5	477	584	53	0.48	136	195	0	0
1.0 TeV nominal (c21)	0 / 0	0.25	0.46	0.39	0	0	0	0	0	0
	0 / 100	2.3	1.1	14	2.1	0	0	0.17	0	0
1.0 TeV large-Y (c23)	0 / 0	1.4	4.3	87	20					0
	200 / 0	1.2	5.6	87	21					0
1.0 TeV low-P (c24)	0 / 0	18.0	6.9	74	17					0.010
	200 / 0	17.7	5.9	87	19					0.013
	0 / 120	46	114	499	19	0.06	4.9	40	0	0.005
1.0 TeV high-L (c25)	0 / 0	105	32	376	60	0.013	1.2	7.2	0	0.55
	0 / 80	256	587	1404	69	0.99	47	276	0	0.58
1.0 TeV high-L (c26)	0 / 0	1.8	1.5	1.4	1.4	0	0	0	0	0
	0 / 100	10.2	4.2	203	17	0	0.07	2.1	0	0
1.0 TeV high-L (c27)	0 / 0	1.3	0.84	0.94	0.15	0	0	0.003	0	0
	0 / 100	6.7	4.3	119	8.4	0	0.04	0.90	0	0

Disruption

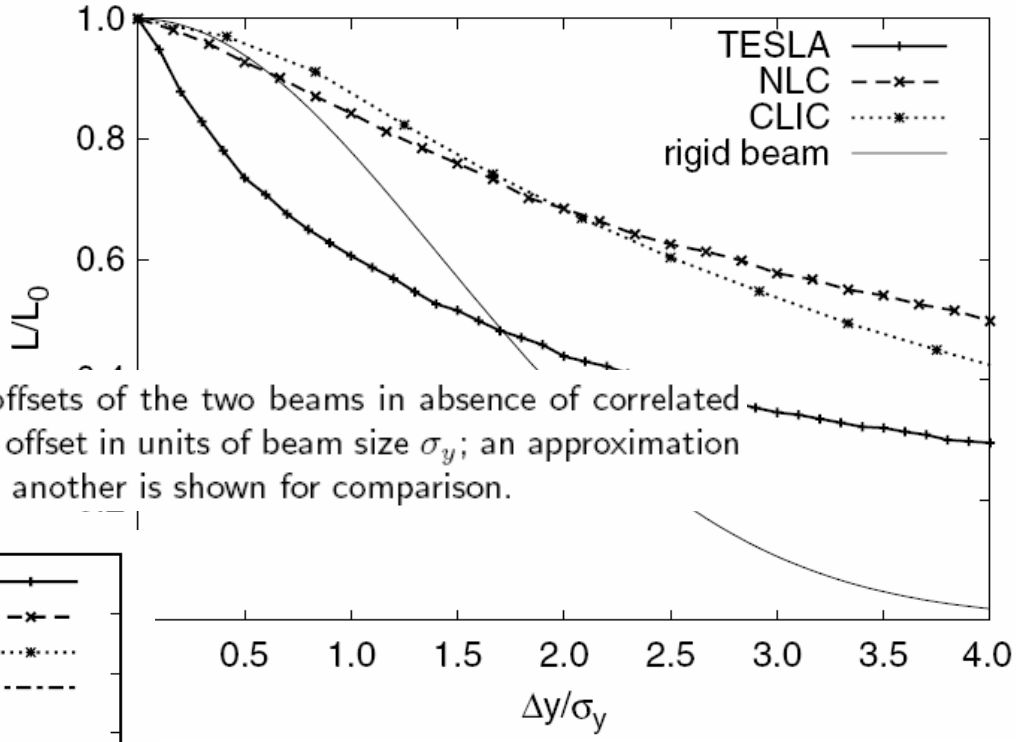


FIGURE 7.11. Luminosity as a function of the vertical offsets of the two beams in absence of correlated emittance growth. Left: offset in absolute values. Right: offset in units of beam size σ_y; an approximation for the luminosity of rigid beams which do not focus one another is shown for comparison.

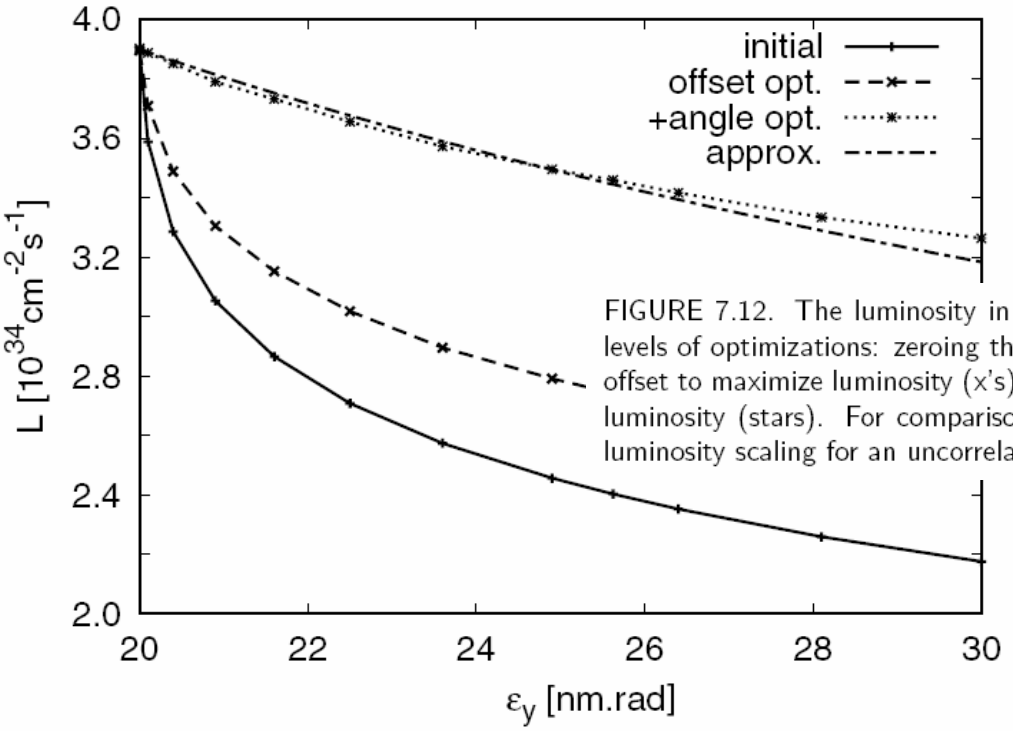


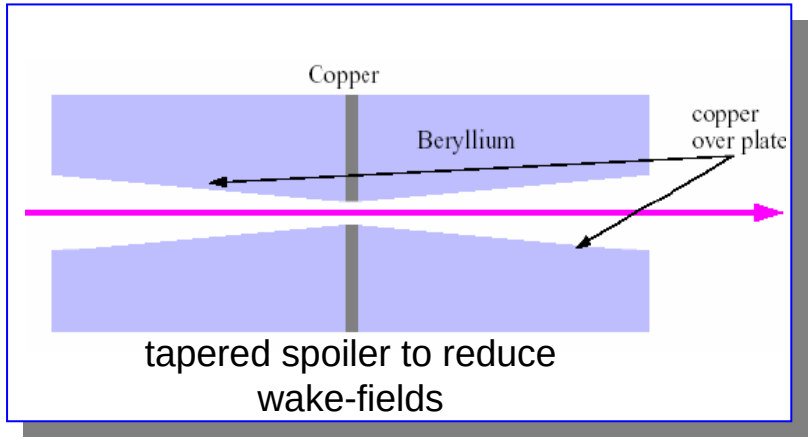
FIGURE 7.12. The luminosity in TESLA as a function of the vertical emittance growth using different levels of optimizations: zeroing the offset and vertical crossing angles of the beams (crosses), varying the offset to maximize luminosity (x's), and varying both the offset and the vertical crossing angle to maximize luminosity (stars). For comparison the approximate scaling with $\mathcal{L} \propto 1/\sqrt{\epsilon_y}$ is also shown; this is the luminosity scaling for an uncorrelated emittance growth.

High Dy regime is more difficult for achieving the luminosity

Collimation wakes

For typical spoilers, A_β scales as $A_\beta \sim \beta N / (\sigma_z^{1/2} \gamma \, gap^{3/2})$

or, equivalently, as $$A_\beta \propto \frac{N L_*^2}{\gamma \beta^* \sigma_z^{1/2} R_{VX}^{3/2}}$$



Jitter amplification in y-plane (due to y') is $(1+ A_\beta^2)^{0.5}$ times

For Low P option, stronger focusing (β_y /2) and shorter bunch (/1.5) increase the A_β by about three times. The effect is ~1/E

Possible consequences:
Has to require smaller beam jitter coming from linac
May have to degrade luminosity expectations at lower E
May have to increase radius of vertex detector