Impact of Travelling Focus & Strawman Baseline 2009 Changes to MDI - discussion

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SB2009 Parameters (WA)

		RDR	SB2009	
Beam and RF Parameters				
No. of bunches		2625	1312	
Bunch spacing	ns	370	740	
beam current	mA	9.0	4.5	
Avg. beam power (250 GeV)	MW	10.8	5.4	
Accelerating gradient	MV/m	31.5	31.5	
P_{fwd} / cavity (matched)	kW	294	147	
Q_{ext} (matched)		3×10^6	6×10^6	
t_{fill}	ms	0.62	1.13	
RF pulse length	ms	1.6	2.0	
RF to beam efficiency	%	61	44	
IP Parameters				
Norm. horizontal emittance	mm.mr	10	10	
Norm. vertical emittance	mm.mr	0.040	0.035	
bunch length	mm	0.3	0.3	
horizontal b*	mm	20	11	
horizontal beam size	nm	640	470	
			no trav. focus	with trav. focus
vertical β^*	mm	0.40	0.48	0.2
vertical beam size	nm	5.7	5.8	3.8
D_y		19	25	21
dE_{BS}/E	%	2	4	3.6
Avg. P_{BS}	kW	260	200	194
Luminosity	$cm^{-2}s^{-1}$	2×10^{34}	1.5×10^{34}	2×10^{34}

Travelling focus [1] allows lengthening the bunch

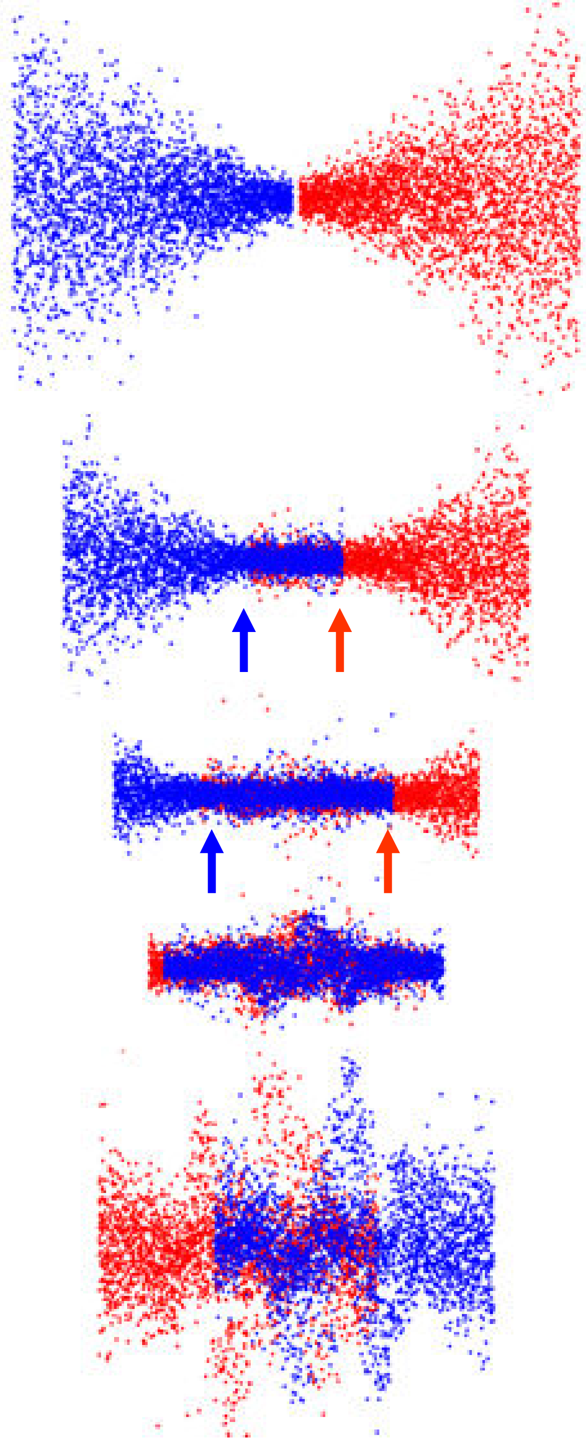
Thus, beamstrahlung energy spread is reduced

Focusing during collision is aided by focusing of the opposite bunch

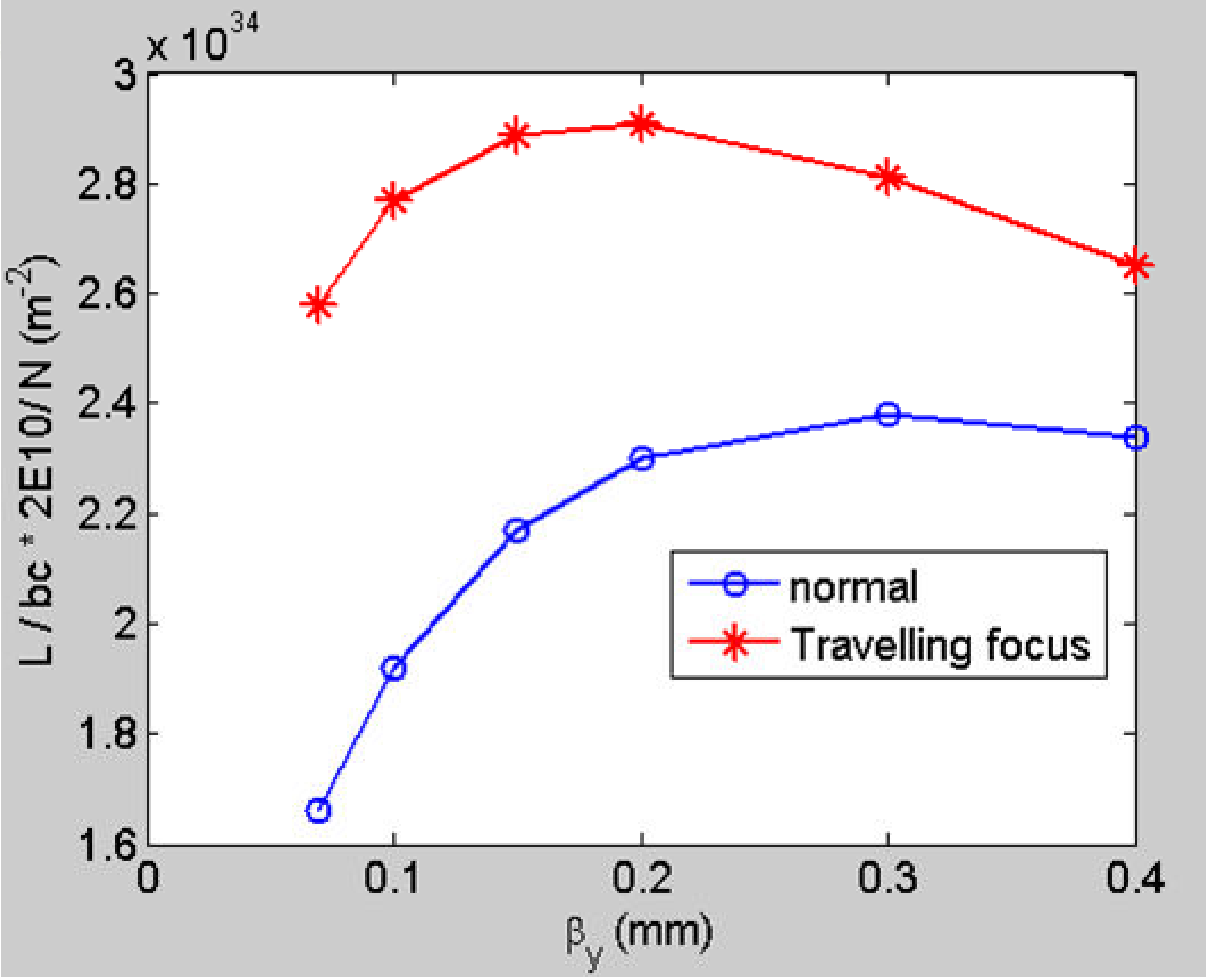
Focal point during collision moves to coincide with the head of the opposite bunch

Parameters	**Nominal RDR**	**Low P RDR**	**Possible new Low P**
E CM (GeV)	500	500	500
N	2.0E+10	2.0E+10	2.0E+10
n_b	2625	1320	1320
F (Hz)	5	5	5
P_b (MW)	10.5	5.3	5.3
$\gamma\varepsilon_X$ (m)	1.0E-05	1.0E-05	1.0E-05
$\gamma\varepsilon_Y$ (m)	4.0E-08	3.6E-08	3.6E-08
β_x (m)	2.0E-02	1.1E-02	1.1E-02
β_y (m)	4.0E-04	2.0E-04	2.0E-04
Travelling focus	No	No	Yes
Z-distribution	Gauss	Gauss	Gauss
σ_x (nm)	639	474	474
σ_y (nm)	5.7	3.8	3.8
σ_z (μm)	300	200	300
G-P dE/E	0.023	0.045	0.036
G-P L ($cm^{-2}s^{-1}$)	2.02E+34	1.86E+34	1.92E+34
G-P L in 1%	1.50E+34	1.09E+34	1.18E+34

[1] V. Balakin, LC-91, 1991



Arrows show location of focal point for each bunch at a particular moment

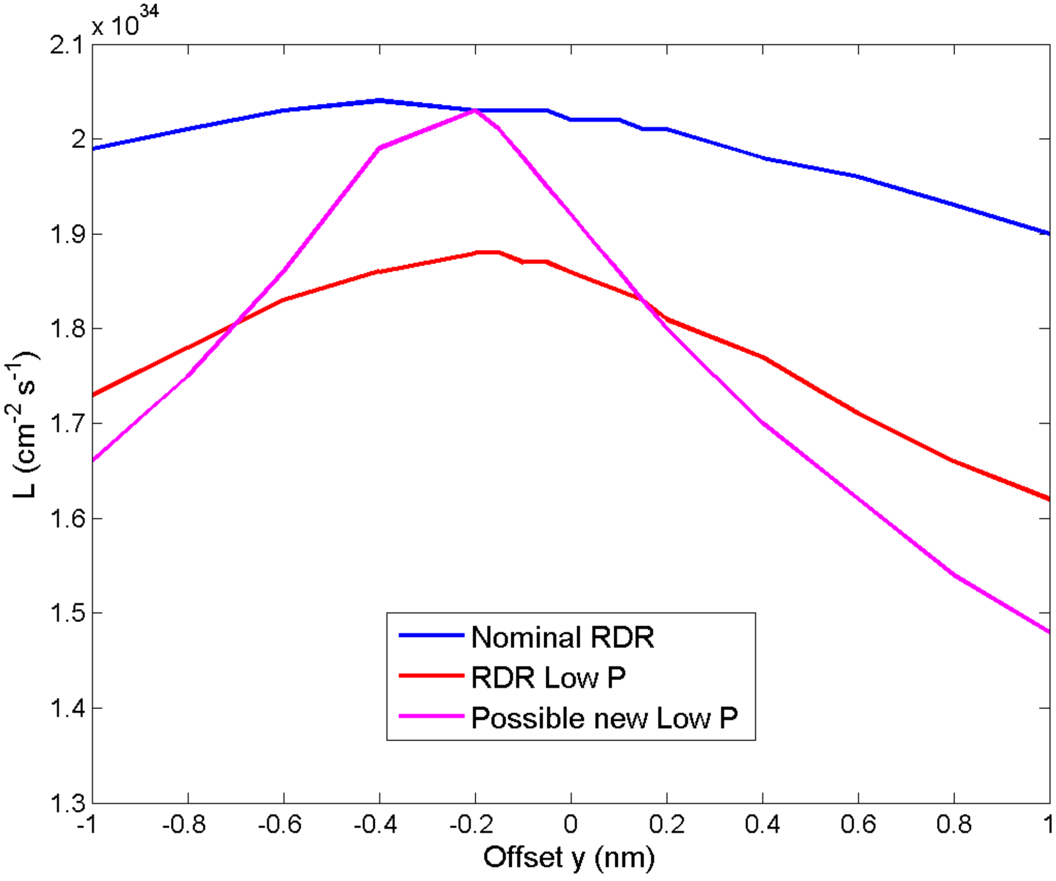

x 10^34
3
2.8
2.6
2.4
2.2
2
1.8
1.6
0
0.1
0.2
0.3
0.4
L / bc * 2E10/ N (m^-2)
β_y (mm)
normal
Travelling focus

- The travelling focus can be created in two ways.
- The first way is to have small uncompensated chromaticity and coherent E-z energy shift $\delta E/\delta z$ along the bunch. One has to satisfy $\delta E\ k\ L^{*}_{eff} = \sigma_z$ where k is the relative uncompensated chromaticity. The δE needs to be 2-3 times the incoherent spread in the bunch. Thus, the following set may be used: δE=0.3%, k=1.5%, L^{*}_{eff} =6m.
- It is clear that additional energy spread affect the physics. Therefore, second method is considered:

- The second way to create a travelling focus is to use a transverse deflecting cavity giving a z-x correlation in one of the FF sextupoles and thus a z-correlated focusing
- The cavity would be located about 100m upstream of the final doublet, at the $\pi/2$ betatron phase from the FD
- The needed strength of the travelling focus cavity can be compared to the strength of the normal crab cavity (which is located just upstream of the FD):
  - $U_{trav.cav.}/U_{crab.cav.} = \eta_{FD} R_{12}^{cc}/ (L^{*}_{eff}\, \theta_c\, R_{12}^{trav})$.
  - Here η_{FD} is dispersion in the FD, θ_c full crossing angle, R_{12}^{trav} and R_{12}^{cc} are transfer matrix elements from travelling focus transverse cavity to FD, and from the crab cavity to IP correspondingly.
- For typical parameters η_{FD} =0.15m, θ_c =14mrad. R_{12}^{cc} =10m, R_{12}^{trav} =100m, L^{*}_{eff} =6m one can conclude that the needed strength of the travelling focus transverse cavity is about 20% of the nominal crab cavity.

T-F & IP feedback

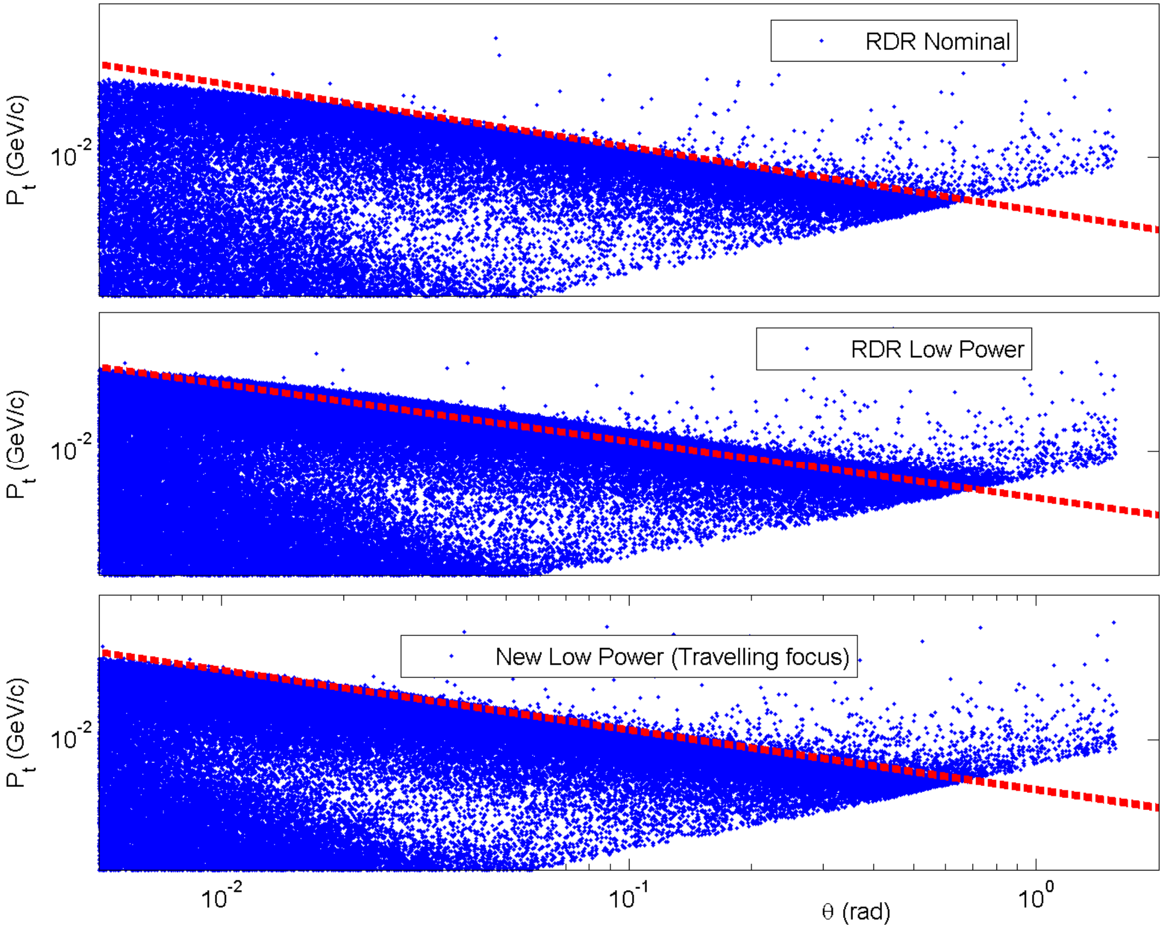
- The moving focus and beam-beam force keep the beams focused on each other
- For optimal focusing, one is in a regime of higher disruption, which causes higher sensitivity to any beam offset
- Thus, operation of the intratrain feedback and intratrain luminosity optimization is more challenging
- Larger number of bunches in the front of the train may be consumed by feedback convergence process



SB09 & collimation

- SB09 parameters have twice smaller beta_x* and for TF case also twice smaller beta_y*
  - Thus, collimation depth need to be increased ~1.4 times (collimate closer to beam core)
    - This may make the bunch-bunch jitter requirement tighter
      - longer bunch-bunch spacing helps
  - This may also increase flux of muons from collimators
    - But remember, we can install muon shield walls which can deal with much more conservative halo than is expected
      - (The muon wall caverns will be oversized, and only fractions of walls installed from the start)
- There is also x-z correlated effect for collimation.
  - Preliminary estimation show that this is not an issue unless there are tails beyond tens of sigma_z in longit. direction

e+e- pairs



Detailed studies of the impact needs to be done by detector groups

Discussion