SB2009
LOW POWER OPTION

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For the BDS team

Main changes related to BDS

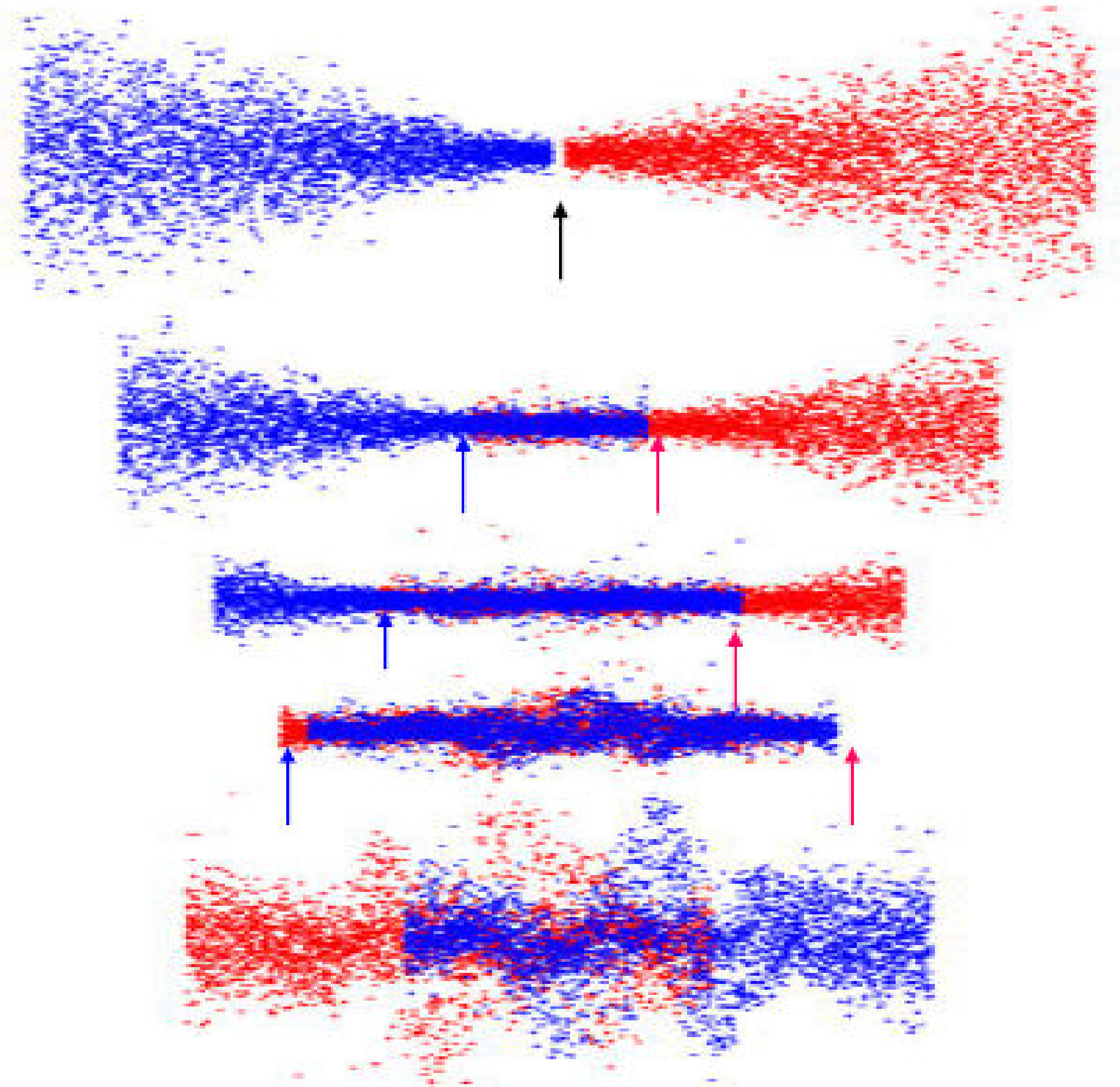
- Changes in the subsystem integration of the central region …

- Changes in the baseline parameter set: Proposed adoption of the low power beam parameter set (same machine pulse repetition rate and the same bunch intensity, but a reduced number of bunches per pulse) leads to a desire to push the beam-beam parameter, so that the same luminosity as in RDR can be achieved. As a solution the so-called *travelling focus scheme* is being considered.

Reduced beam-power parameters

- The proposed reduction in the beam power (number of bunches per pulse) requires us to squeeze the beam-beam parameters to compensate the nominal factor-of-two reduction in luminosity.
- SB2009 explores two possibilities:
  - Pushing the beam-beam parameters into a high-disruption regime close to the single-beam kink-instability limits, at the expense of higher beamstrahlung and tighter collision tolerances. The proposed parameters could in principle recover the nominal RDR luminosity to within 25% (1.5×10^{34} cm^{-2}s^{-1}).
  - Making use of the so-called Travelling Focus [V.Balakin, LC91] effect, which can recover the remaining 25% luminosity without a further increase in the beamstrahlung. This approach comes at the cost of a very high disruption parameter, and the need for additional hardware

Travelling Focus $\beta^* < \sigma_z$



RDR parameter plane ranges compared to SB2009

		RDR			SB2009	
		min	nominal	max	no TF	with TF
Bunch population	x 10^{10}	1	2	2	2	2
Number of bunches		1260	2625	5340	1312	1312
Linac bunch interval	ns	180	369	500	530	530
RM bunch length	mm	200	300	500	300	300
Normalized horizontal emittance at IP	mm-mr	10	10	12	10	10
Normalized vertical emittance at IP	mm-mr	0.02	0.04	0.08	0.035	0.035
Horizontal beta function at IP	mm	10	20	20	11	11
Vertical beta function at IP	mm	0.2	0.4	0.6	0.48	0.2
RMS horizontal beam size at IP	nm	474	640	640	470	470
RMS vertical beam size at IP	nm	3.5	5.7	9.9	5.8	3.8
Vertical disruption parameter		14	19.4	26.1	25	38
Fractional RMS energy loss to beamstrahlung	%	1.7	2.4	5.5	4	3.6
Luminosity	x $10^{34} cm^{-2} s^{-1}$		2		1.5	2

Travelling Focus Scheme

- The travelling focus[BDS1] is a technique in which the focussing of opposing bunches is longitudinally controlled so as to defeat the hourglass effect and to restore the luminosity.
- The matched focusing condition is provided by a dynamic shift of the focal point to coincide with the head of the opposing bunch.
- The longer bunch helps to reduce the beamstrahlung effect and improvement of background conditions is expected.
- Similar to the nominal 500GeV CM case, the 250GeV CM parameters would also benefit from application of travelling focus – the work on development of a corresponding parameter set is ongoing (see one of the next presentations)

The travelling focus can be created in two ways

- Method 1 is to have small (uncompensated) chromaticity and coherent E-z energy shift dE/dz along the bunch. The required energy shift in this case is a fraction of a percent.
- Method 2 is to use a transverse deflecting cavity giving a z-x correlation in one of the Final Focus sextupoles and thus a z-correlated focusing. The needed strength of the travelling focus transverse cavity was estimated to be about 20% of the nominal crab cavity

R&D and Design Work to Pursue in TDP2

- The more demanding beam-beam parameters associated with SB2009 force us to be in a regime of higher disruption. Although there appears to be no fundamental show stoppers, a comprehensive study involving simulations is still required in an attempt to quantify the performance. Specifically:
  - The higher disruption results in a higher sensitivity to any beam-beam offset. Thus, operation of the intra-train feedback and intra-train luminosity optimisation becomes more important and more challenging than in the case of RDR. Early estimates suggest that in order to contain the luminosity loss within 5%, a bunch-to-bunch jitter in the train needs to be less than 0.2nm at the IP (~5% of a nominal beam sigma).
  - The parameter sets also have twice as small vertical betatron functions at the IP, which imply either tighter collimation, with gaps 40% closer to the beam core. This has implications for wakefields (emittance preservation) and fast feedback systems.
  - Enhanced beam-halo loss in the tighter collimation could potentially increase the number of generated muons and hence the muon shielding requirements[BDS2]. (This is difficult to quantify as it depends on the specifics of the models of beam halo used.)

Summary

- A beam parameter set supporting the low power operation has been created, so that the same luminosity as in RDR can be achieved
- The low power parameter set naturally leads to a desire to push the beam-beam parameter to a higher value, which emphasise the need to focus on luminosity preservation issues that will be the focus of attention in TDP2