Physics Questions Committee Status Report

Brian Foster (Oxford & GDE)

SB2009 Meeting
DESY 2/12/09

Members

- BF Co-Chair
- A. Seryi Co-Chair
- J. Clarke
- M. Harrison
- D. Schulte
- T. Tauchi

First Meeting took place 19/11/09. Present were above plus J. Brau, F. Richard, S. Yamada.

Health Warning

- For the purposes of this exercise, we should not take absolute numbers too seriously but rather differences between RDR and SB2009 under similar assumptions.
  - **Accuracy of results depends on accuracy of the accelerator tools and models used for the calculations. Generally accuracy of tools well established. There is still uncertainty in beam parameters (such as bunch-to-bunch jitter in the train, for example) and in characteristics of the systems that could only reliably be obtained from measurements (for example, collimator wake fields). These uncertainties may translate to systematic uncertainties of many tens of percents. However, since the models are applied to different parameter sets in a uniform manner, the uncertainties between *different parameter sets* should be smaller, ~ 10 – 20%.**

Questions

1. To assess the physics impact, we need beam parameters at several key energies:
   - **250 GeV (to compare with LoI),**
   - **350 GeV (a likely operating energy for SB2009),**
   - **500 GeV (again to compare with the LoI).**

Proviso: The 500GeV parameters are provided officially in SB09 tables and can be compared with RDR case. The 250 and 350GeV parameters were never officially provided, the tables used by Detector concept colleagues were provided via private communication, or via work-in-progress presentations at workshops. The GDE Physics Questions Committee will make its best effort to provide the needed 250 and 350 GeV parameter sets, expecting that the semi-official character of these sets will be understood.

Beam Parameters

	RDR			SB2009 w/o TF				SB2009 w TF			
CM Energy (GeV)	250	350	500	250.a	250.b	350	500	250.a	250.b	350	500
Ne- ($*10^{10}$)	2.05	2.05	2.05	2	2	2	2.05	2	2	2	2.05
Ne+ ($*10^{10}$)	2.05	2.05	2.05	1	2	2	2.05	1	2	2	2.05
nb	2625	2625	2625	1312	1312	1312	1312	1312	1312	1312	1312
Tsep (nsecs)	370	370	370	740	740	740	740	740	740	740	740
F (Hz)	5	5	5	5	2.5	5	5	5	2.5	5	5
γex ($*10^{-6}$)	10	10	10	10	10	10	10	10	10	10	10
γey ($*10^{-6}$)	4	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
βx	22	22	20	21	21	15	11	21	21	15	11
βy	0.5	0.5	0.4	0.48	0.48	0.48	0.48	0.2	0.2	0.2	0.2
σz (mm)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
σx eff ($*10^{-9}$ m)	948	802	639	927	927	662	474	927	927	662	474
σy eff ($*10^{-9}$ m)	10	8.1	5.7	9.5	9.5	7.4	5.8	6.4	6.4	5.0	3.8
L (10^{34} $cm^{-2}s^{-1}$)	0.75	1.2	2.0	0.2	0.22	0.7	1.5	0.25	0.27	1.0	2.0

- RDR parameters from A. Seryi talk in March 2008 - red colour indicates >10% difference from what experiments used for TDR.

Beam Parameters

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- The major difference between SB2009 and the RDR is the luminosity at 250 GeV. See later.

Questions

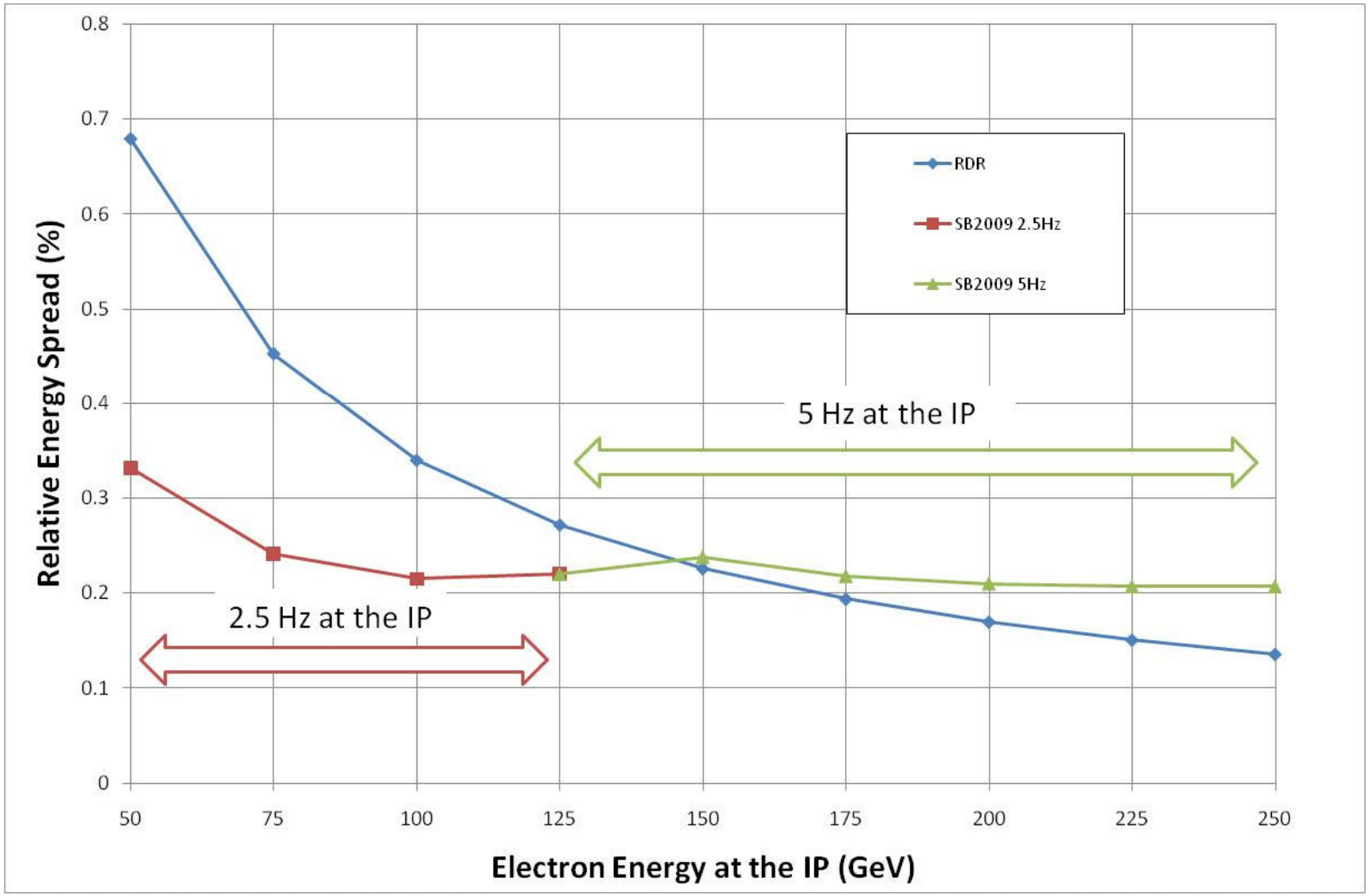
2. Beam parameters should include electron/positron beam energy spread.

dE/E in %	250 GeV CM	350 GeV CM	Official 500 GeV CM
RDR, electrons	0.272	0.194	0.136
RDR, positrons	0.180	0.129	0.09
SB09, electrons	0.220	0.218	0.207
SB09, positrons	0.130	0.093	0.065

Based on energy spread of 1.08% in SB2009 and 1.5% in RDR at 15 GeV.

Electrons passing the undulator emit SR - added in quadrature to inherent energy spread.

Questions


0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Relative Energy Spread (%)
50
75
100
125
150
175
200
225
250
Electron Energy at the IP (GeV)
RDR
SB2009 2.5Hz
SB2009 5Hz
5 Hz at the IP
2.5 Hz at the IP

Questions

3. We would like to understand the effect on backgrounds/luminosity spectrum for SB2009 with vs without traveling focus.

	RDR			SB2009 w/o TF				SB2009 w TF			
Par/E	250	350	500	250.a	250.b	350	500	250.a	250.b	350	500
δE %	0.6	1.2	2.4	0.3	0.6	1.6	4.1	0.3	0.6	1.6	3.6
Npairs* 10^3	97	156	288	48.7	97.4	214	494	57.4	115	255	596
L	0.75	1.2	2.0	0.2	0.22	0.7	1.5	0.24	0.27	1.0	2.0
L (1%)/L	0.97	0.92	0.83	0.98	0.96	0.88	0.73	0.94	0.89	0.77	0.72

Npairs is an analytical estimate – Guineapig etc many be different by many 10s of %.

Questions

4. Despite the questions of feasibility, the conventional positron source remains very interesting in order to maximize yield and therefore luminosity. Please provide estimates of the expected luminosity and beam energy spread that would be possible with either a conventional positron source, or an undulator source, at cms energies between 200 and 300 GeV. Will the conventional source possibility remain an option in the re-baselined design? What R&D will be pursued either within the GDE or by other groups to ensure its development?

Repeat of JC's Answer

- Energy spread for e- and e+ is independent of the source (set by DR & RTML)
- Positron Source would be unpolarised (no simple upgrade option would be possible)
- No feasible design exists yet
- R&D into one particular option is being actively pursued in Japan (so-called 300Hz source)
  - **See http://ilcagenda.linearcollider.org/getFile.py/access?contribId=100&sessionId=31&resId=0&materialId=slides&confId=3461 for most recent status report**

Repeat of JC's Answer

- "Despite the questions of feasibility, the conventional positron source remains very interesting in order to maximize yield and therefore luminosity" – Jim Brau
- There are **no indications** that the conventional source will ever **outperform** the undulator based source in terms of number of positrons generated per bunch
- If the reduction in e+/bunch at below 150GeV is of such major concern then the undulator should be placed at the 150GeV location (as it was in the RDR) so that 2E10 @ 5Hz is **always available**

Questions

5. How stable would the Luminosity, Energy spread, and positron polarization be during a threshold scan, for example for ttbar or Susy?

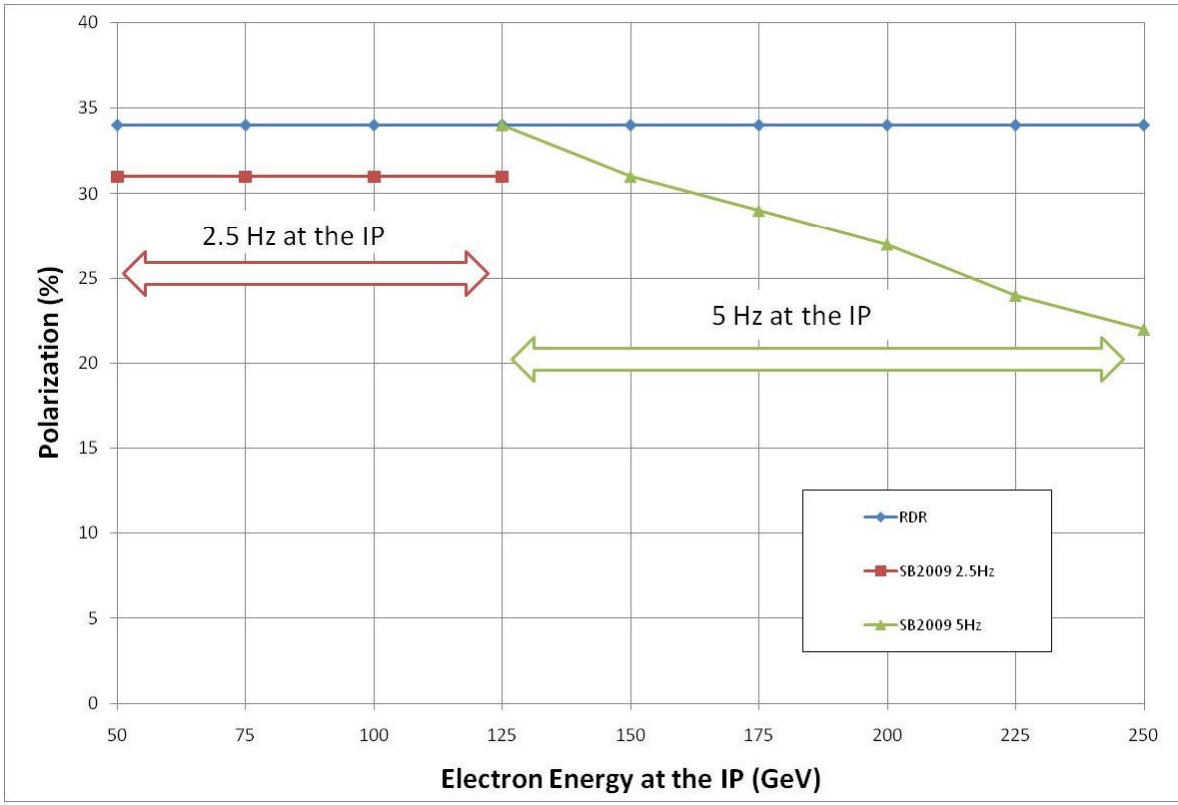
These questions require very detailed studies. We will do our best to respond whenever possible. (Detector colleagues will tell us the assumptions about the integrated Luminosity, energy range and timescale for the scans. Best approach needs to be worked out by the Physics Question Committee. Time scale for the answers is not yet known). It would be helpful of the Brau committee framed much more detailed questions about the stability over specific time-scales and for example scans – such as Higgs, t-threshold etc.

Questions

6. Can you provide a rough sketch of L(Ecm), Energy spread(Ecm), and Pol e+(Ecm) showing how they might be expected to vary between Ecm=91 and 500 GeV?

Points above 250 GeV exist in previous tables, except for e^+ polarisation, given here:
e^- polarisation is unchanged in SB2009 @ ~80%.

Question – what is required at 91 GeV? Physics? Calibration? If GigaZ, need bypass and different machine.



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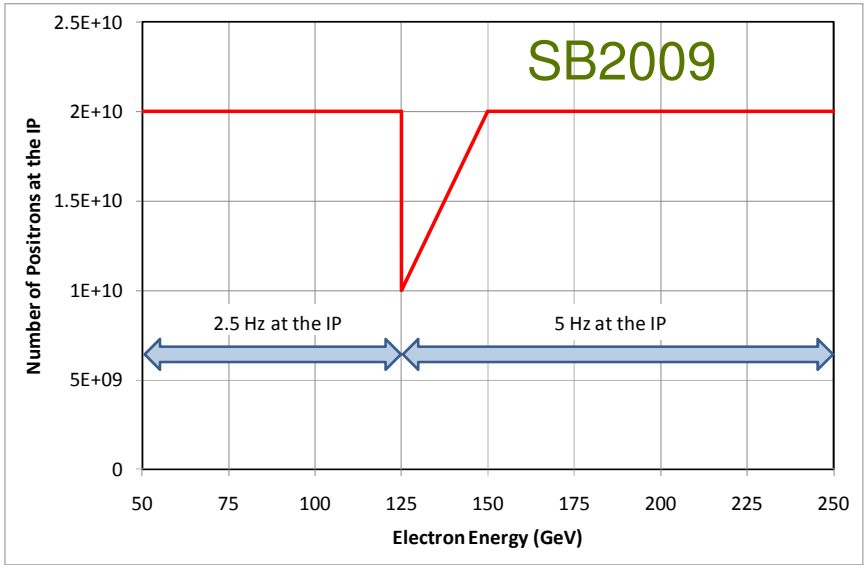
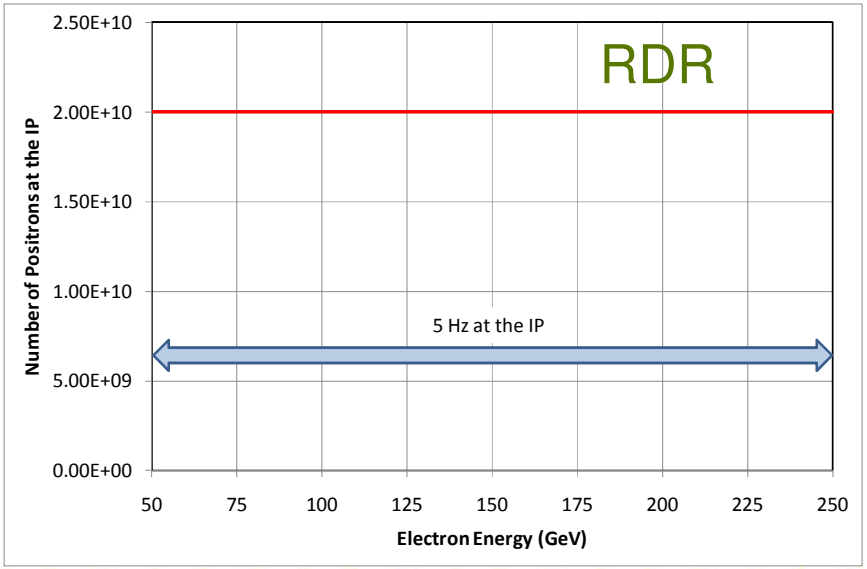
- Major difference between SB2009 and RDR is L @ 250 GeV. Naively this would be 1/4 RDR – optimisation saves a bit to make it ~1/3.

Beam Parameters

- However, one factor of 2 can be "tuned away" once we know M_{Higgs}. Either we increase the undulator length which moves "V" above to left, and/or increase the frequency above 5 Hz (and increase 2.5 Hz proportionally).





Summary

- We have “answers” to all questions other than 5) which we should discuss and refine.

- Answering Q5 will require both much more work, much tighter definition and significant extrapolation and uncertainty.

- Although generally speaking SB2009 does worsen the physics performance, particularly at low energy, the changes are relatively mild and can be to a large extent ameliorated.