The SB2009 machine parameters from GDE@DESY December '09

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Introduction

At last week's GED meeting at DESY, among many other topics, Brian Foster presented the current official machine parameters of the SB2009 proposal.
Jim Clarke also presented the present idea on the positron source.

This is a summary of

`http://ilcagenda.linearcollider.org/getFile.py/access?contribId=14&sessionId=5&resId=1&materialId=slides&confId=4255`

and

`http://ilcagenda.linearcollider.org/getFile.py/access?contribId=8&sessionId=1&resId=1&materialId=slides&confId=4255`

(All slides are stolen from these talks)

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.

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

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

Energy Spread Assumptions

- Energy spread at the entrance to the main linac is 1.5% at 15 GeV for RDR and 1.08% at 15GeV for SB2009 (N Solyak)
- No growth due to linac etc
- In RDR case e+ are generated by e- at 150GeV
  - **e- are either accelerated or decellerated after the undulator to achieve their required energy at the IP**
- In SB2009, energy of e- is variable in the undulator
  - **125 to 250GeV @ 5Hz operation or**
  - **150 GeV @ 2.5Hz operation**
  - **Length of undulator is varied (modules are switched on/off) to keep yield at 1.5e+/e-**

Questions

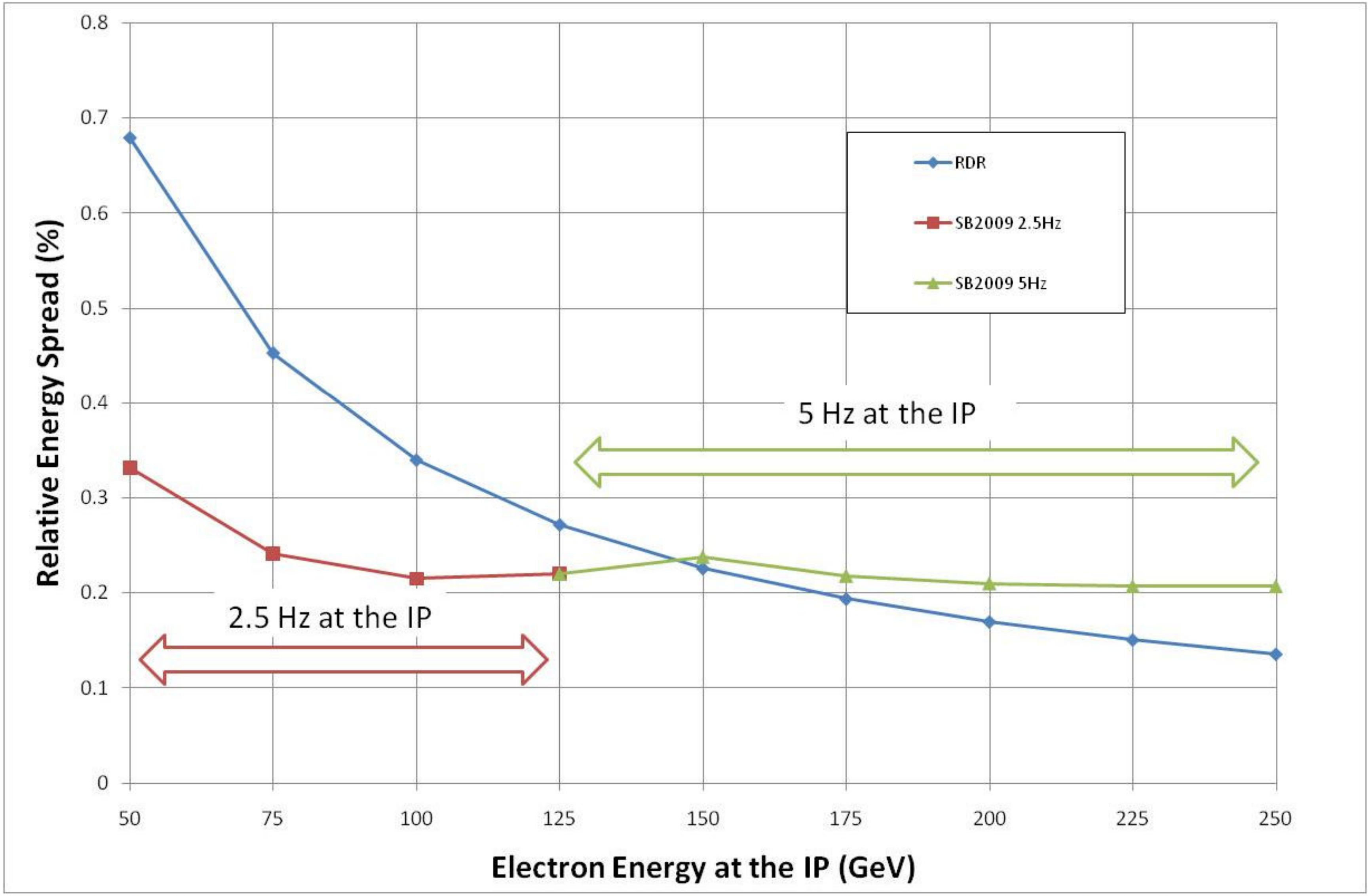
2. Beam parameters should include electron/positron beam energy spread.

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.

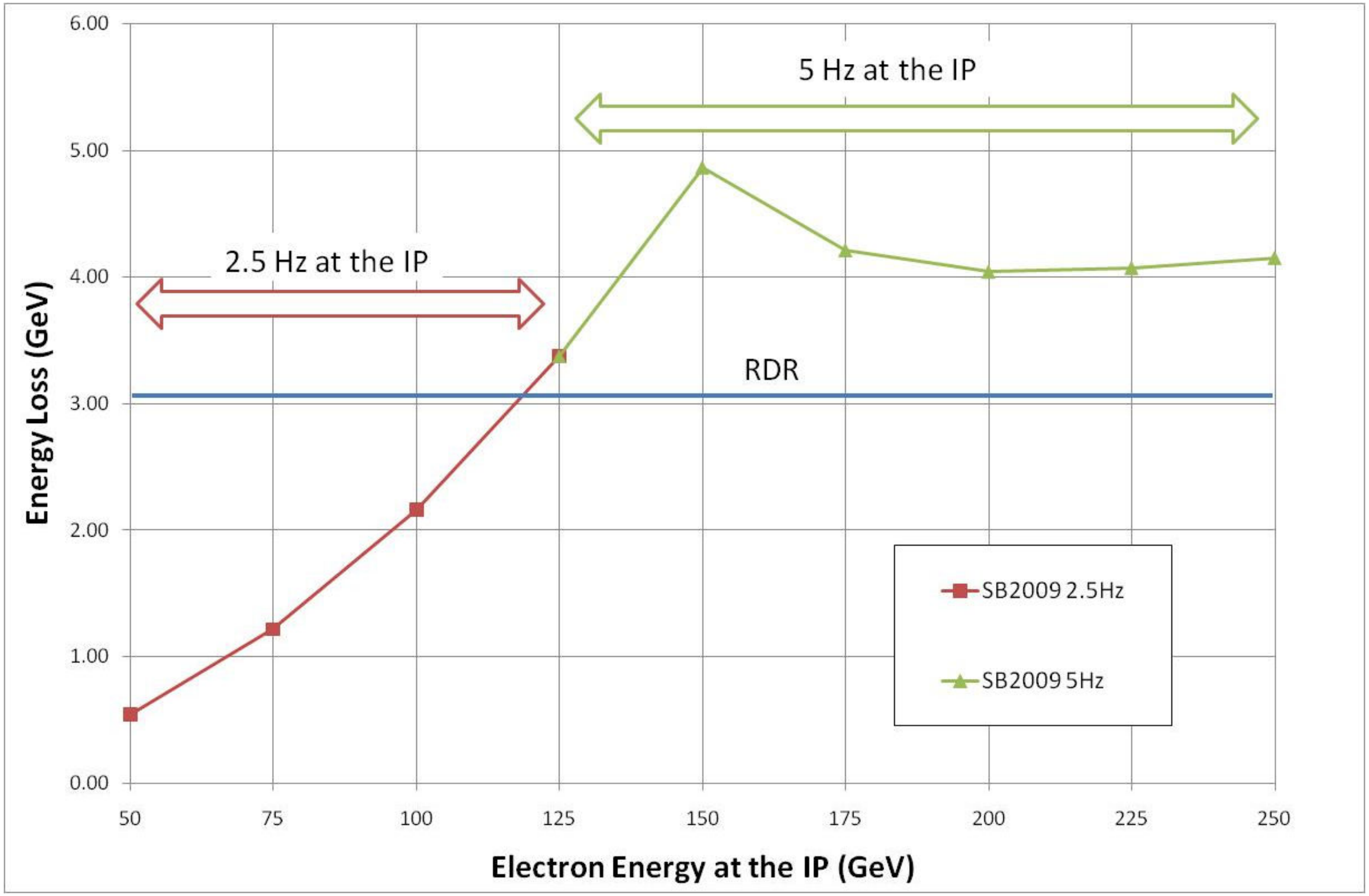
Questions



Relative Energy Spread (%)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
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

Electron Energy Loss

- Loss due to SR emission in undulator



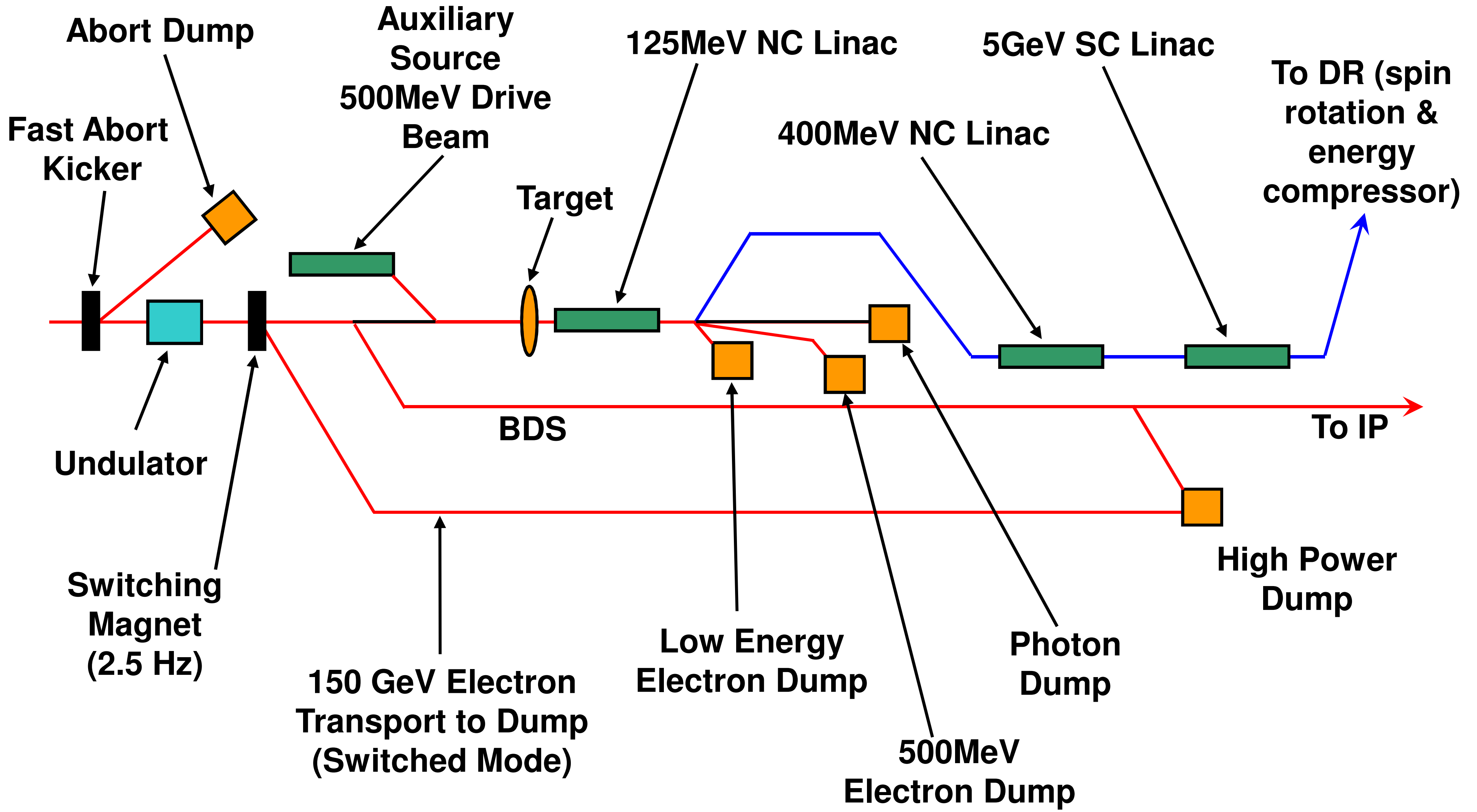
Questions

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

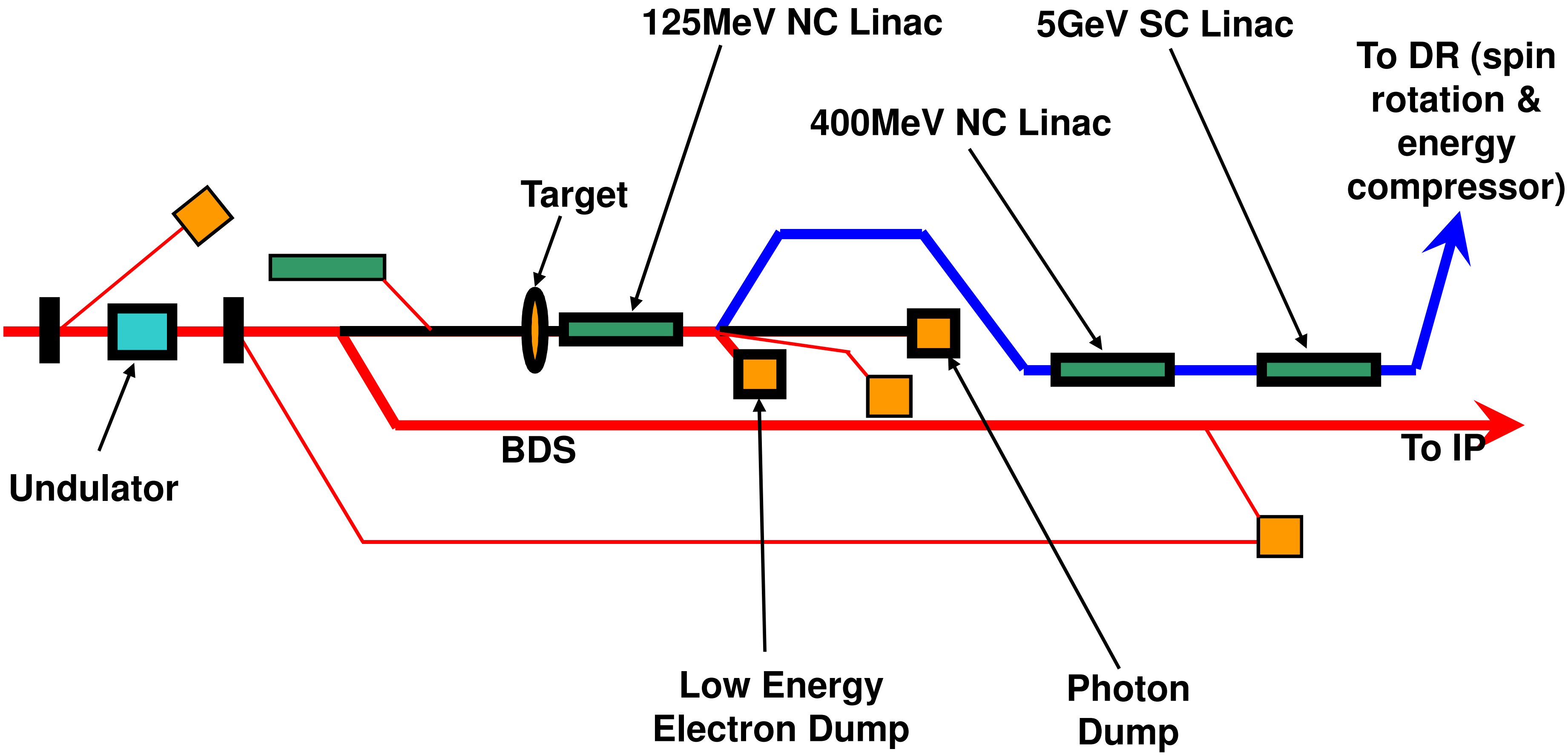
	RDR			SB2009 w/o TF				SB2009 w TF			
Par/E	250	350	500	250.a	250.b	350	500	250.a	250.b	350	500
δE %	0.6	1.2	2.4	0.3	0.6	1.6	4.1	0.3	0.6	1.6	3.6
Npairs* 10^3	97	156	288	48.7	97.4	214	494	57.4	115	255	596
L	0.75	1.2	2.0	0.2	0.22	0.7	1.5	0.24	0.27	1.0	2.0
L (1%)/L	0.97	0.92	0.83	0.98	0.96	0.88	0.73	0.94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

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

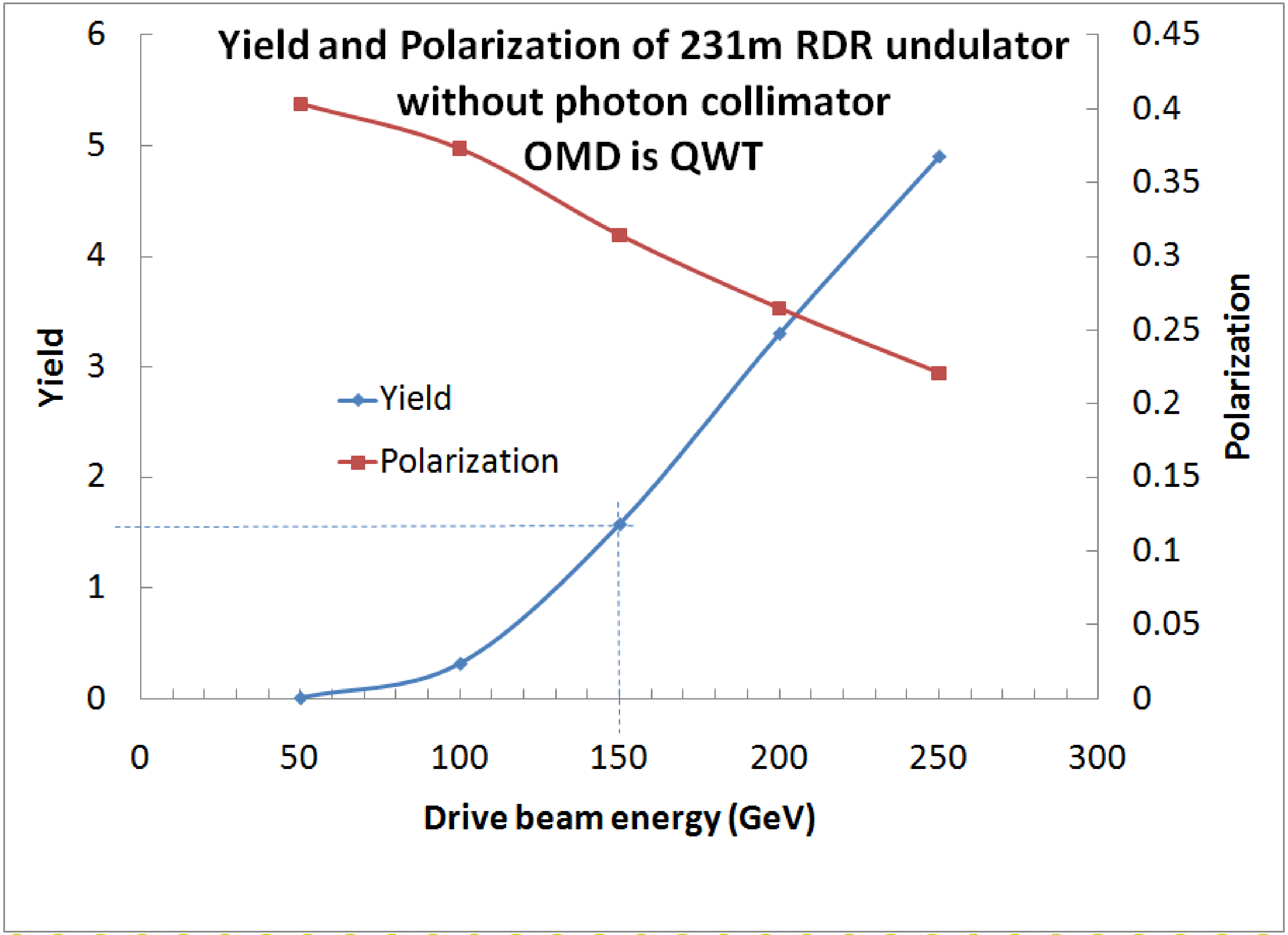
Schematic Layout



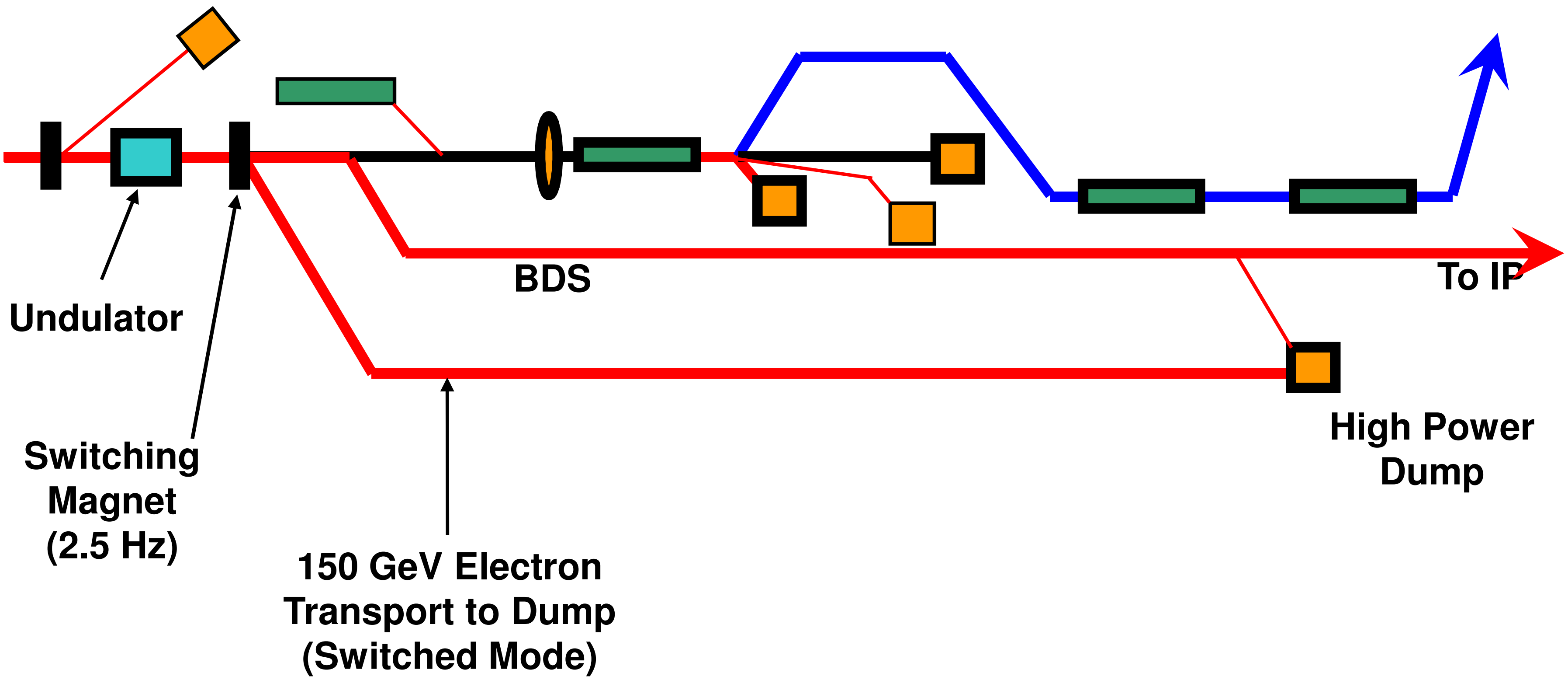
Normal Operation



Positron Yield

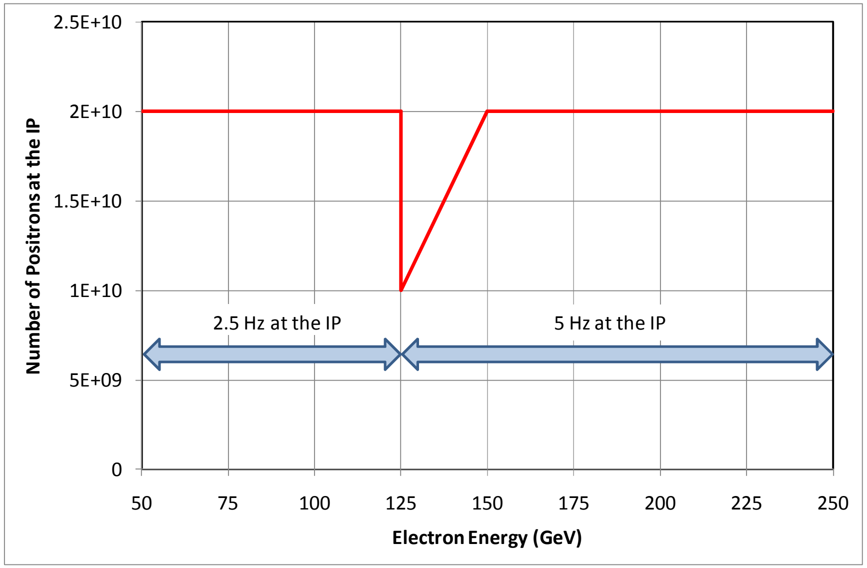


Switched Mode

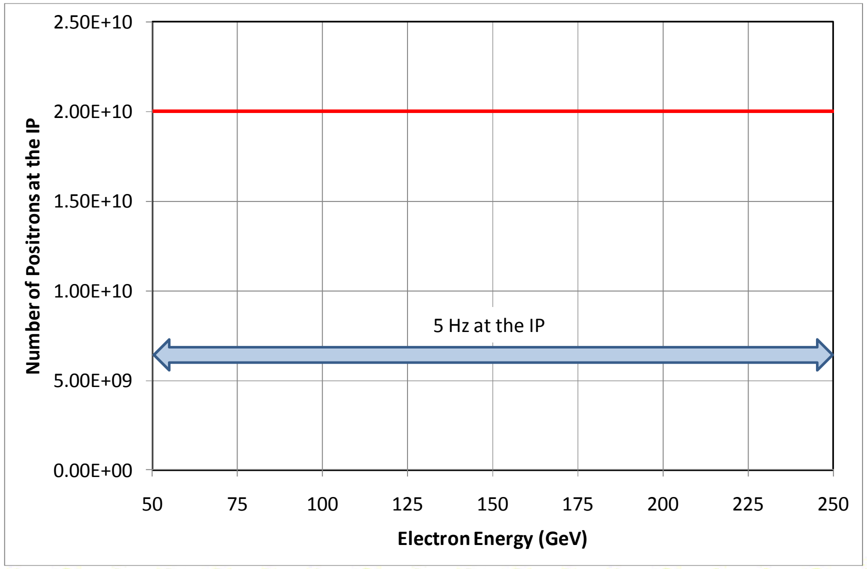


Number of Positrons per Bunch

SB2009



RDR

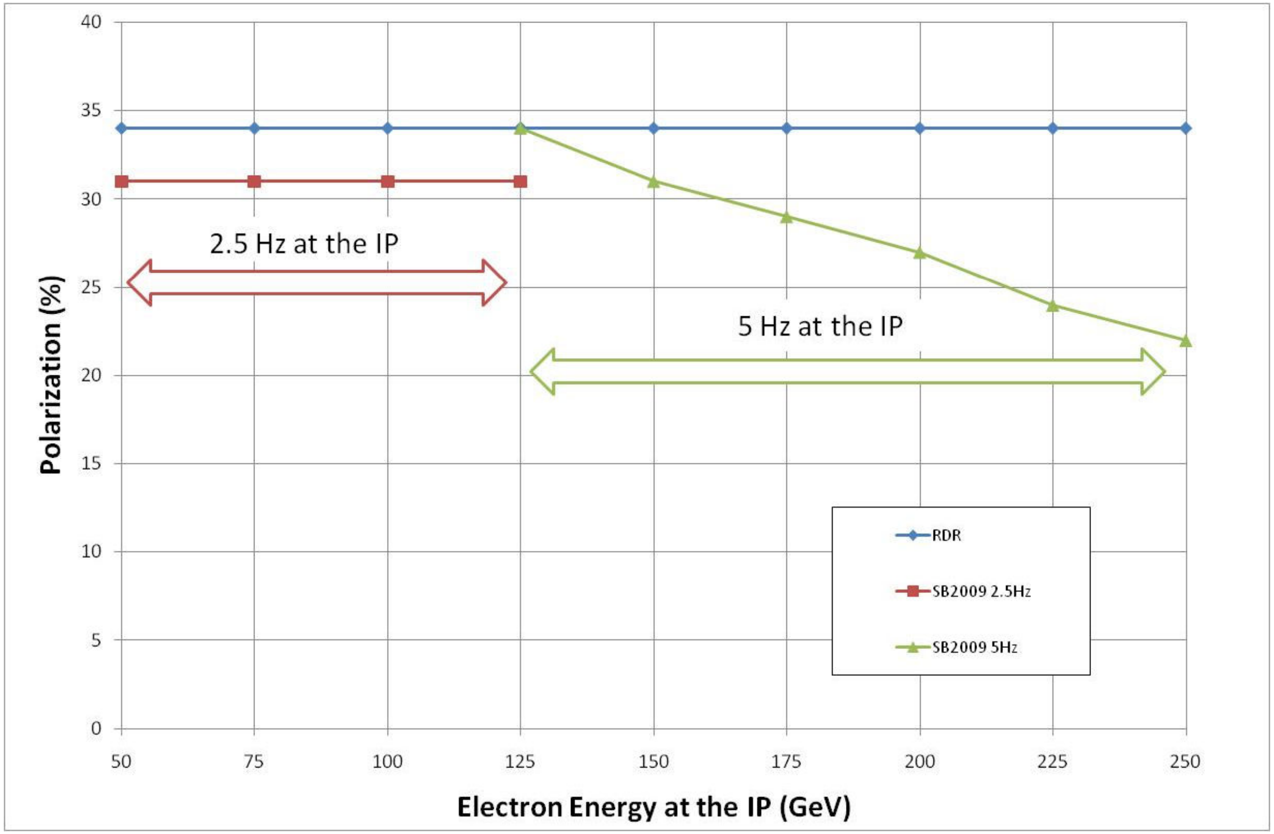


Parameters

Parameter	RDR	SB2009	Units
Positrons per bunch at the IP	2×10^{10}	1 to 2×10^{10} (see Figure 4.4.3 for details)	
Bunches per pulse	2625	1312	
Pulse repetition rate	5	5 (125 to 250GeV) 2.5 (50 to 125GeV)	Hz
Positron energy (DR Injection)	5	5	GeV
DR transverse acceptance	0.09	0.09	m-rad
DR energy acceptance	±0.5	±0.5	%
Electron drive beam energy	150	125 to 250	GeV
Electron energy loss in undulator	3.01	0.5 to 4.9 (see Figure 4.4.5 for details)	GeV
Undulator period	11.5	11.5	mm
Undulator strength	0.92	0.92	
Active undulator length	147 (210 after polarisation upgrade)	231 (maximum, not all used when >150GeV)	m
Field on axis	0.86	0.86	T
Beam aperture	5.85	5.85	mm
Photon Energy (1^{st} harmonic)	10	1.1 (50 GeV) to 28 (250 GeV)	MeV
Photon beam power	131	102 at 150 GeV (less at all other energies)	kW
Target material	Ti – 6%Al – 4%V	Ti – 6%Al – 4%V	
Target thickness	14	14	mm
Target power adsorption	8	8	%

Polarisation

- This is the polarisation before any sort of upgrade



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**

Comments and Conclusions

- The 500 GeV parameters ≡ Nick Walker's talk @ ALCPG.
- The 250 GeV parameters somewhat different from previous, un-official, numbers from Andre Seryi.
- Number of pairs quoted looks different (double !) from our GuineaPig, but also does for RDR ?
- Positron source:
  - Work is going on.
  - No estimate of cost-savings from moving the ondulator given.
  - Our concerns are taken seriously.
  - We are promised to get parameters for all of SB2009, except the odulator move.
  - As side-remark from me: What about asymmetric running ? Eg. $E_{e^-} = 150$ GeV and $E_{e^+} = 104.2$ GeV gives $E_{cms} = 250$ GeV.
  - My feeling was that the outcome might well be that the ondulator stays at the 150 GeV point.
- Look at the slides for more information:

  http://ilcagenda.linearcollider.org/conferenceDisplay.py?confId=4255