Positron Source in SB2009

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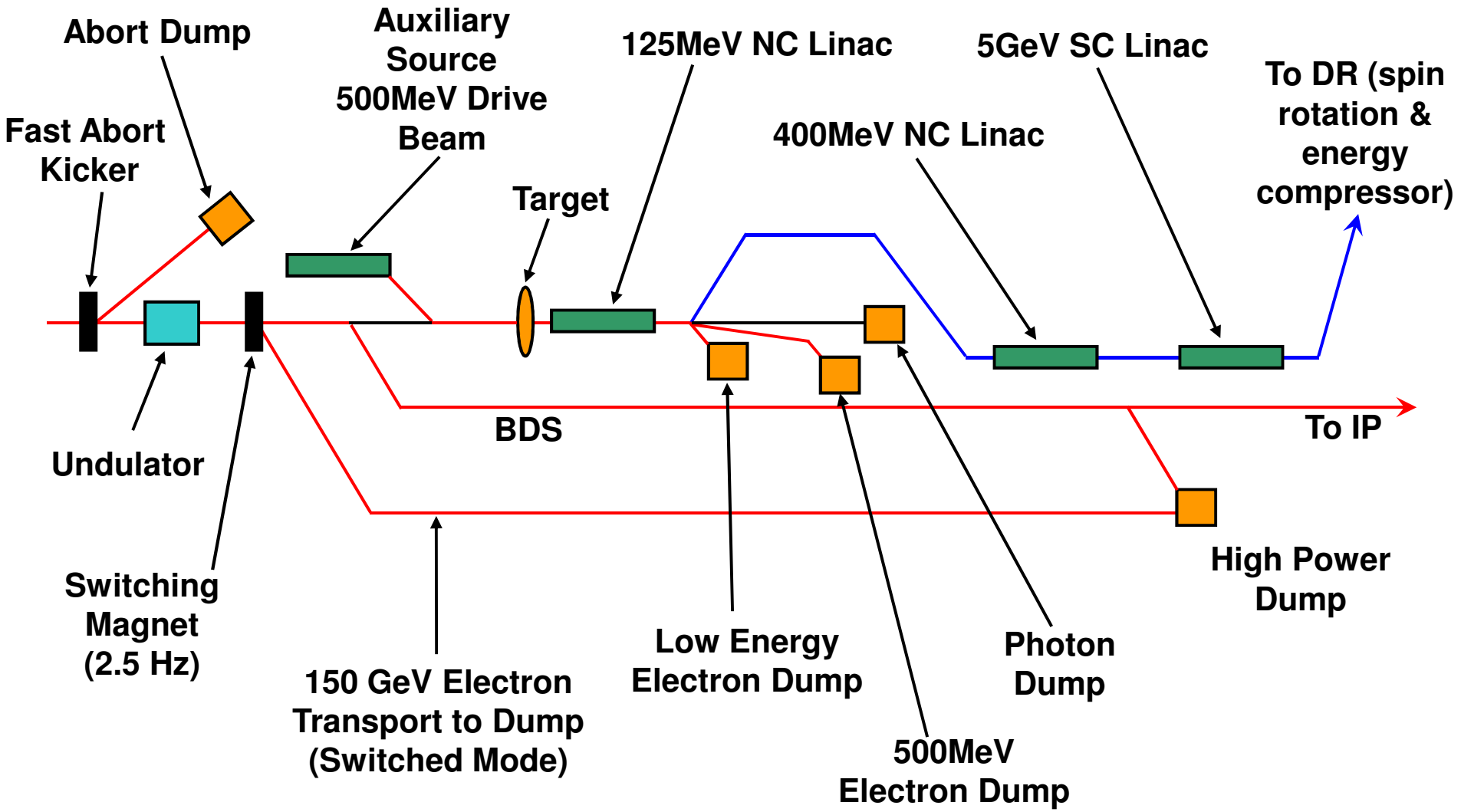
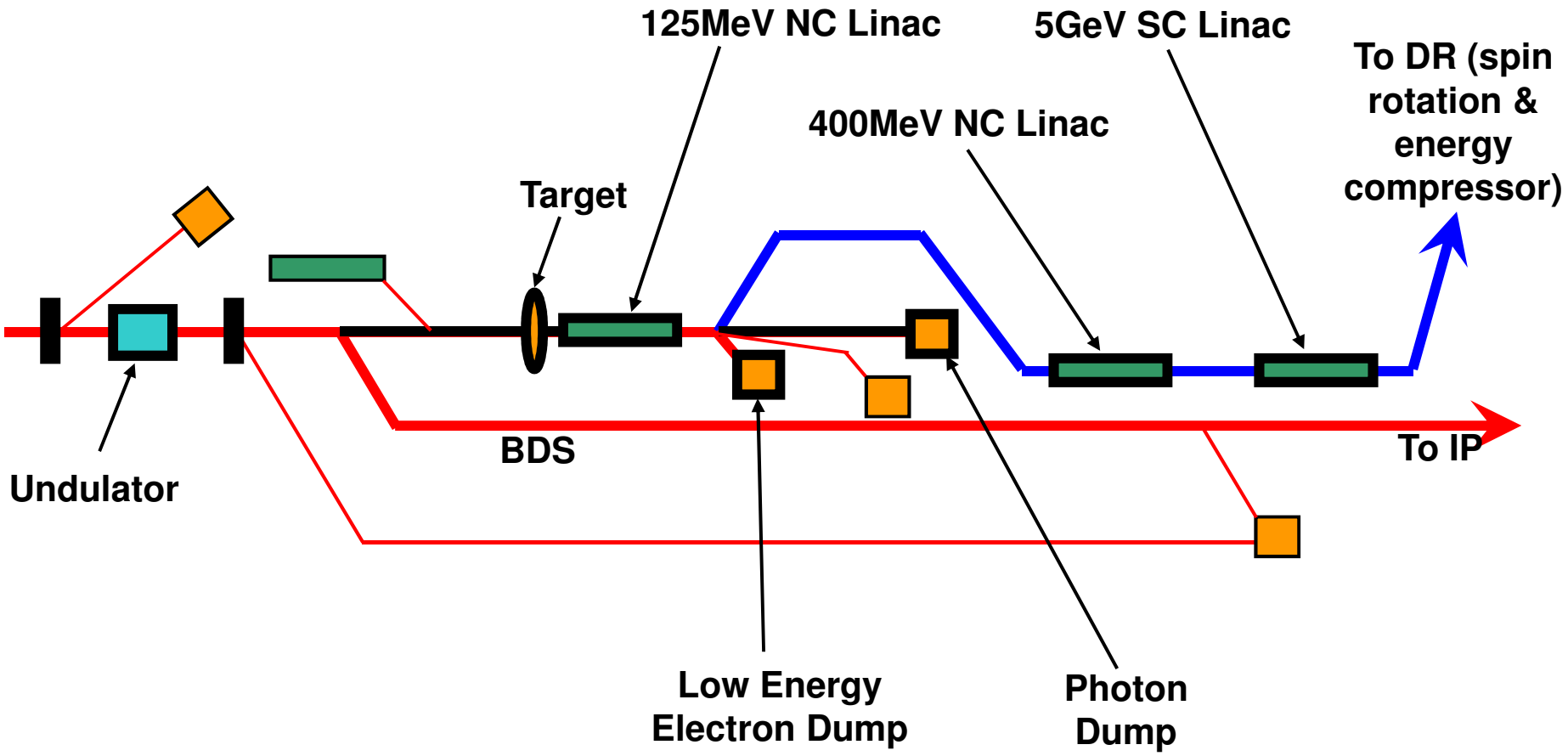
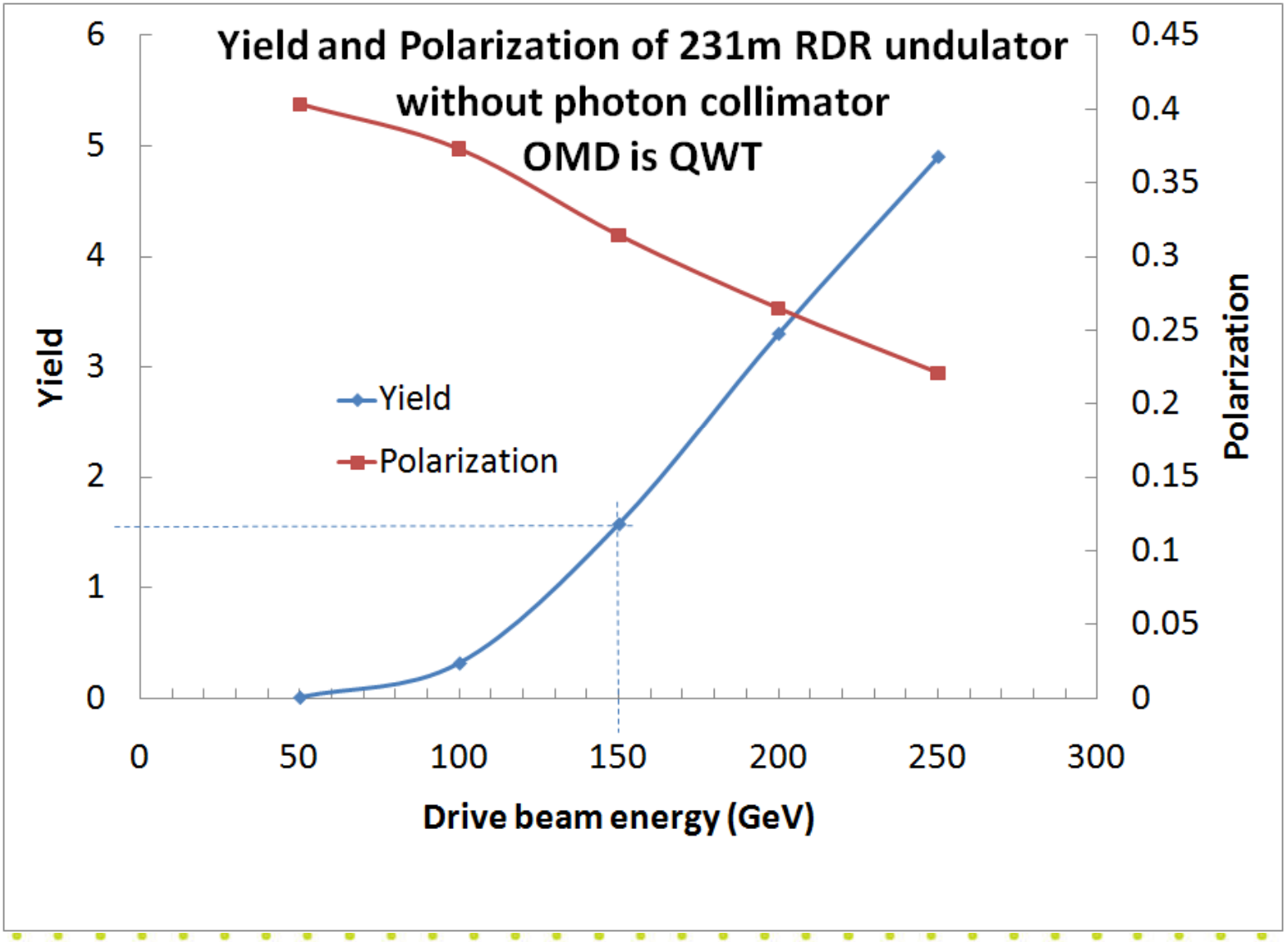
Schematic Layout



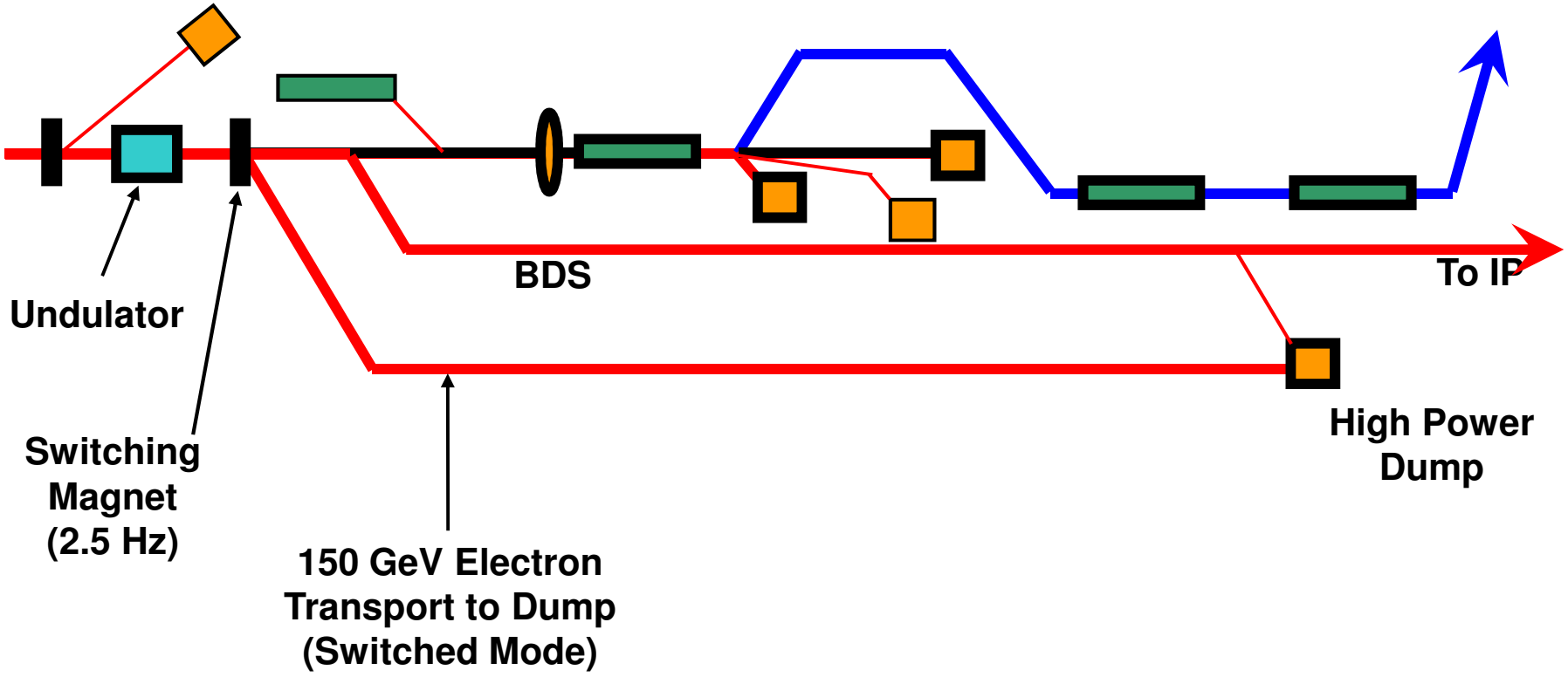
Normal Operation



Positron Yield

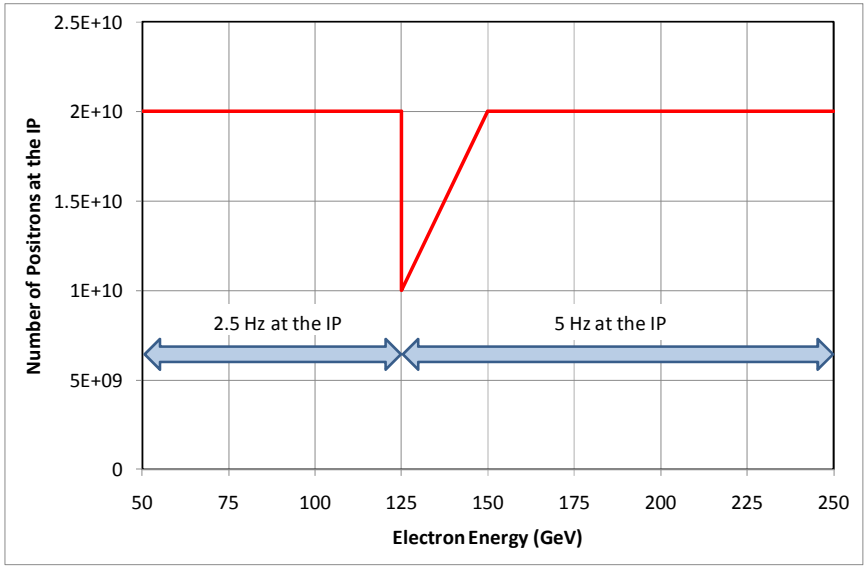


Switched Mode

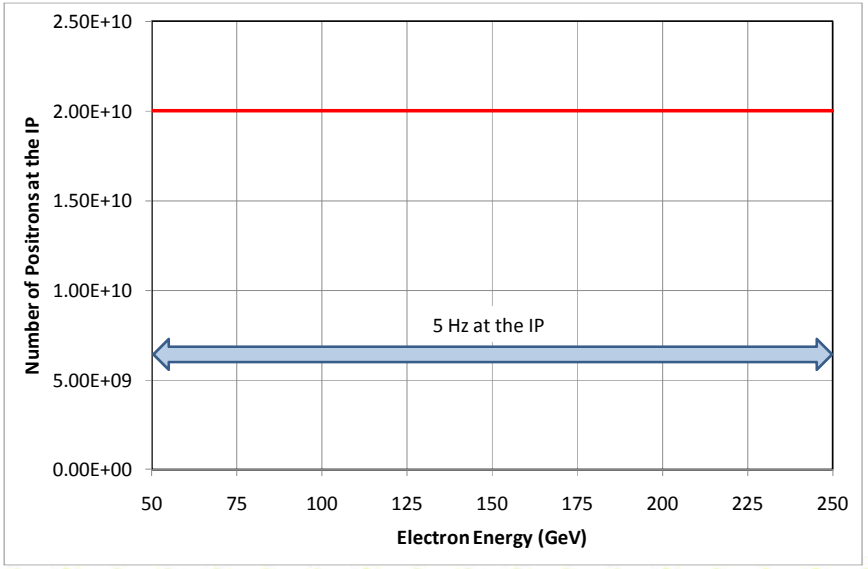


Number of Positrons per Bunch

SB2009



RDR

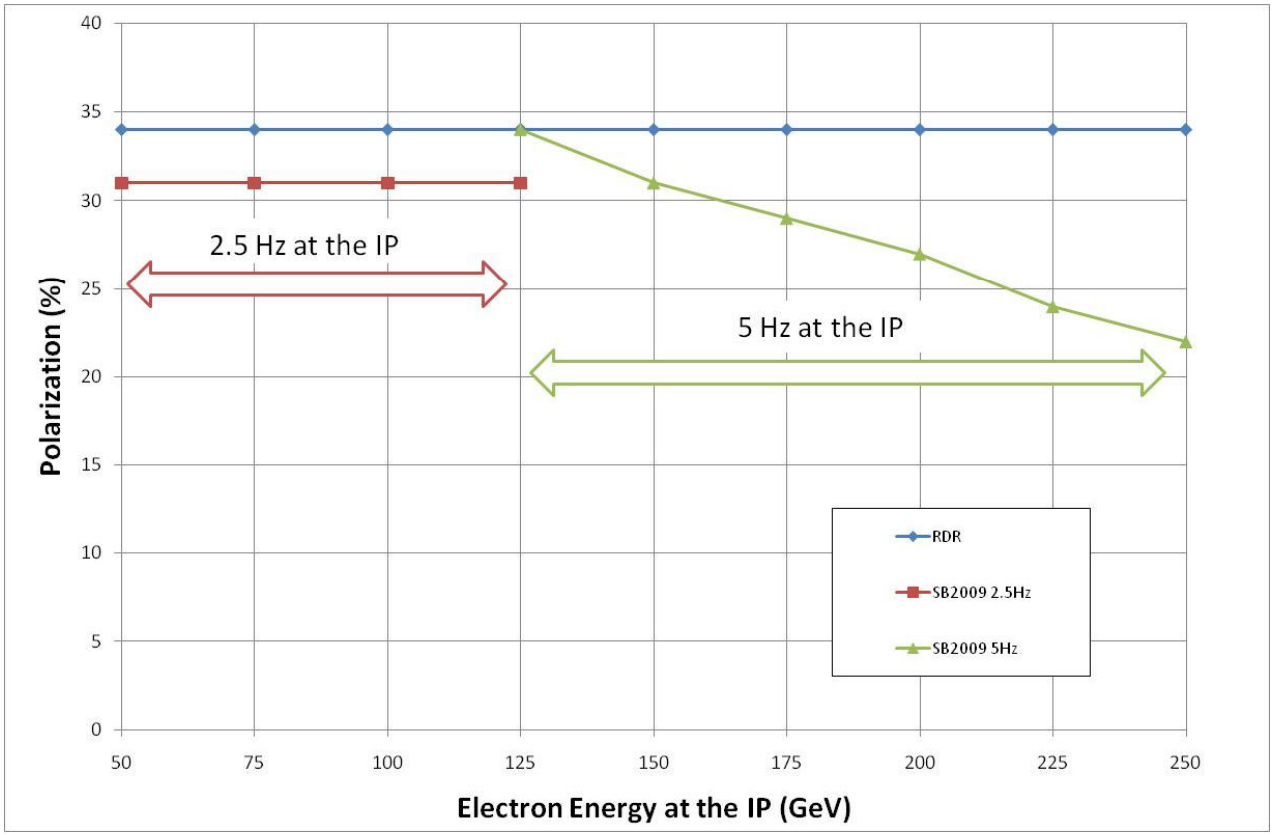


Parameters

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



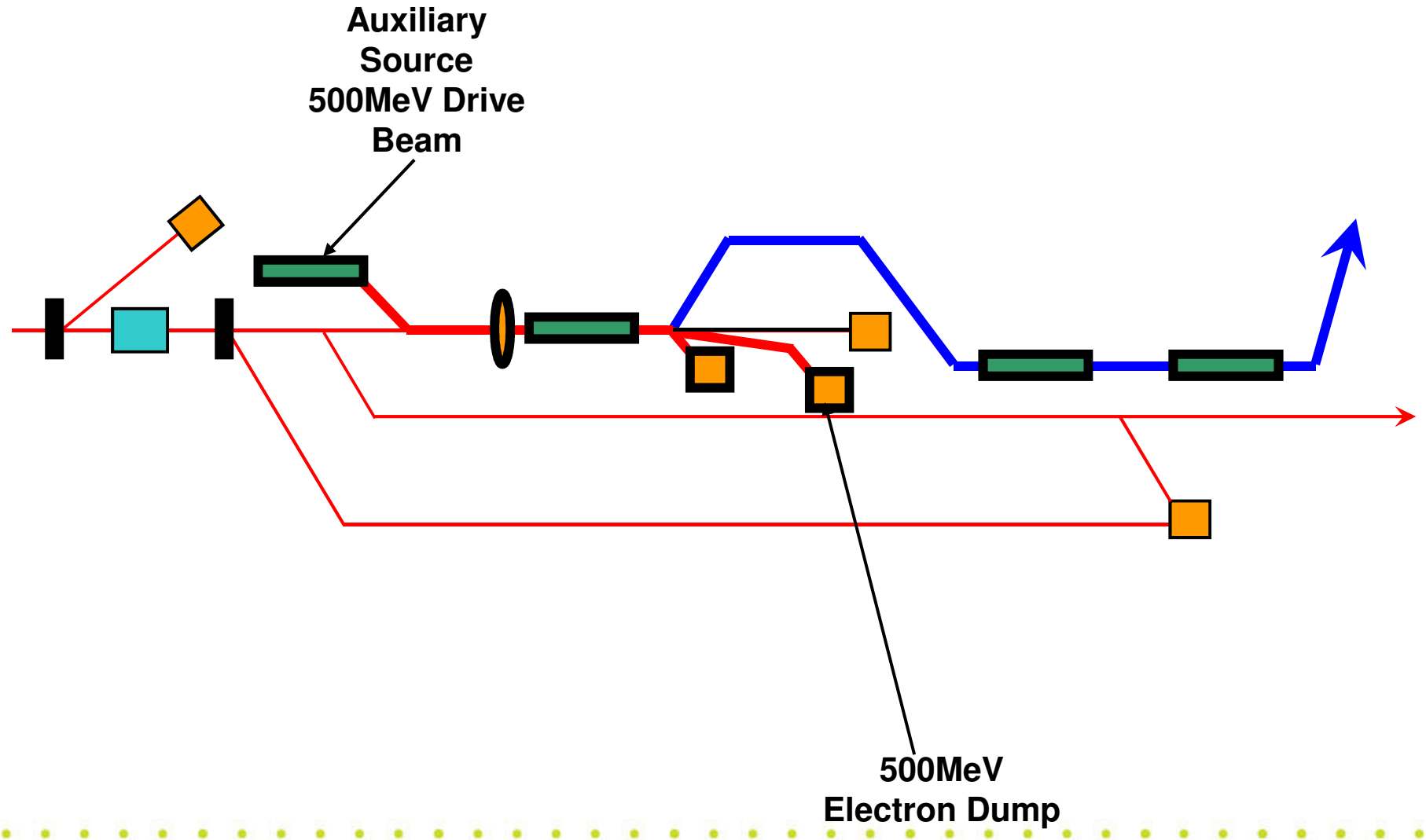
Polarisation

- After a simple upgrade (undulator length increased from 147 to 210m and addition of photon collimation) the RDR positron source will achieve 60%
- SB2009 could upgrade in the same way but then undulator so long that photon powers become worrying and electron energy loss very high
- A better upgrade path would be to replace the QWT by a flux concentrator (plus a photon collimator)
- Basically end up with similar system as RDR just in different location

Polarisation

- Polarisation level achievable in SB2009 after this upgrade still needs to be calculated
- Can achieve 60% (of course) at 150GeV but need to check other energies

Auxiliary Source Mode



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-**

Positron Energy Spread

- e+ energy spread is independent of the source (set by DR & RTML)
  - **Scales as inverse of IP energy**
  - **RDR and SB2009 are different**

	RDR	SB2009
Positron Energy at the IP (GeV)	Relative Positron Energy Spread (%)	Relative Positron Energy Spread (%)
50	0.450	0.324
75	0.300	0.216
100	0.225	0.162
125	0.180	0.130
150	0.150	0.108
175	0.129	0.093
200	0.113	0.081
225	0.100	0.072
250	0.090	0.065

Electron energy spread

- When e- emit SR in undulator energy spread is increased
- The SR induced contribution is added in quadrature to inherent energy spread

RDR

Electron Energy at the IP (GeV)	Relative Electron Energy Spread (%)
50	0.679
75	0.453
100	0.340
125	0.272
150	0.226
175	0.194
200	0.170
225	0.151
250	0.136

Electron energy spread

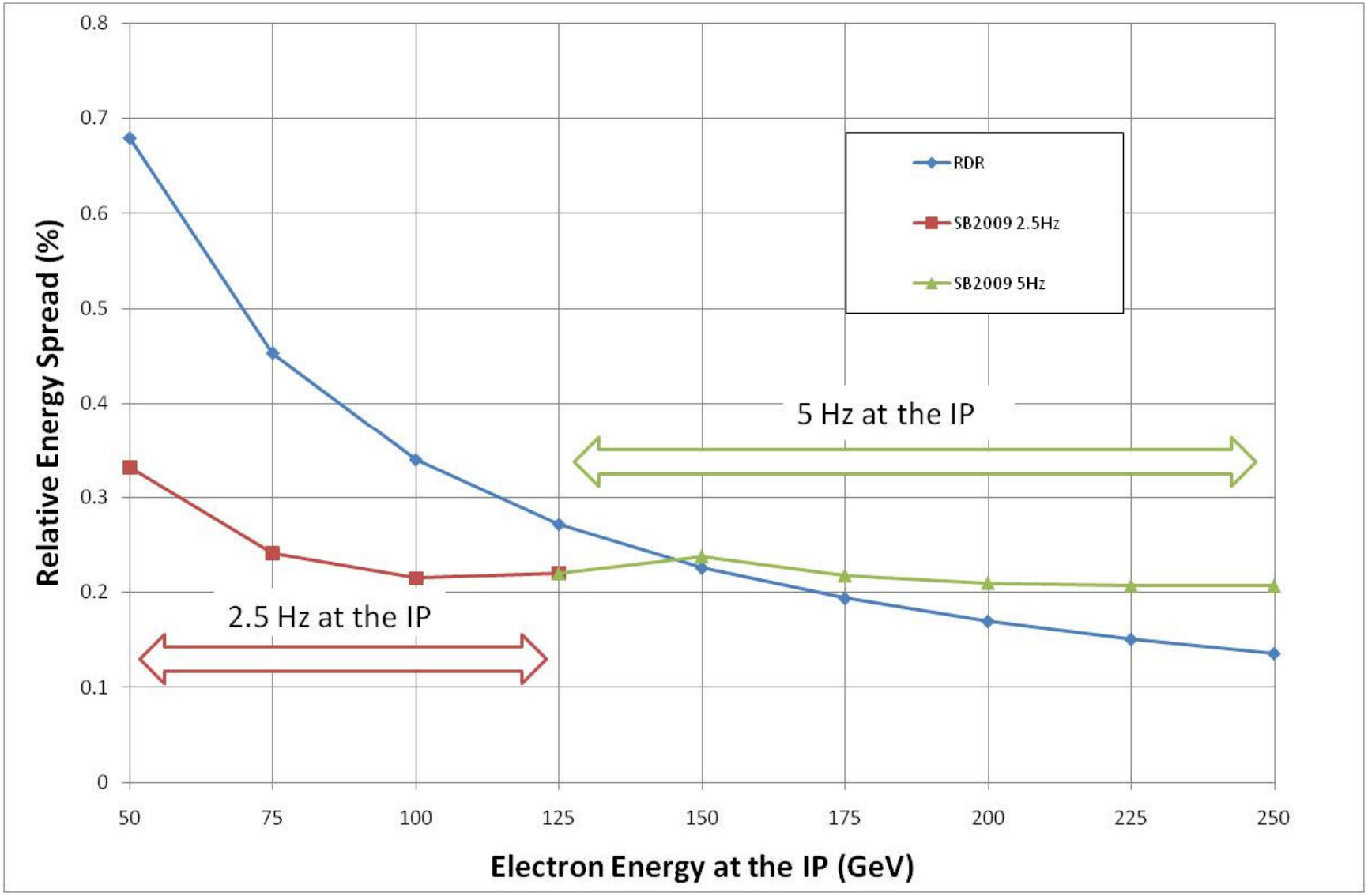
- SB2009 has two modes of operation
  - **First mode (5Hz) have to account for changing undulator length**
  - **Second mode (2.5Hz), although e- beam for IP is not used to generate e+ it still travels through the undulator and emits SR**

Electron energy spread

- SB2009

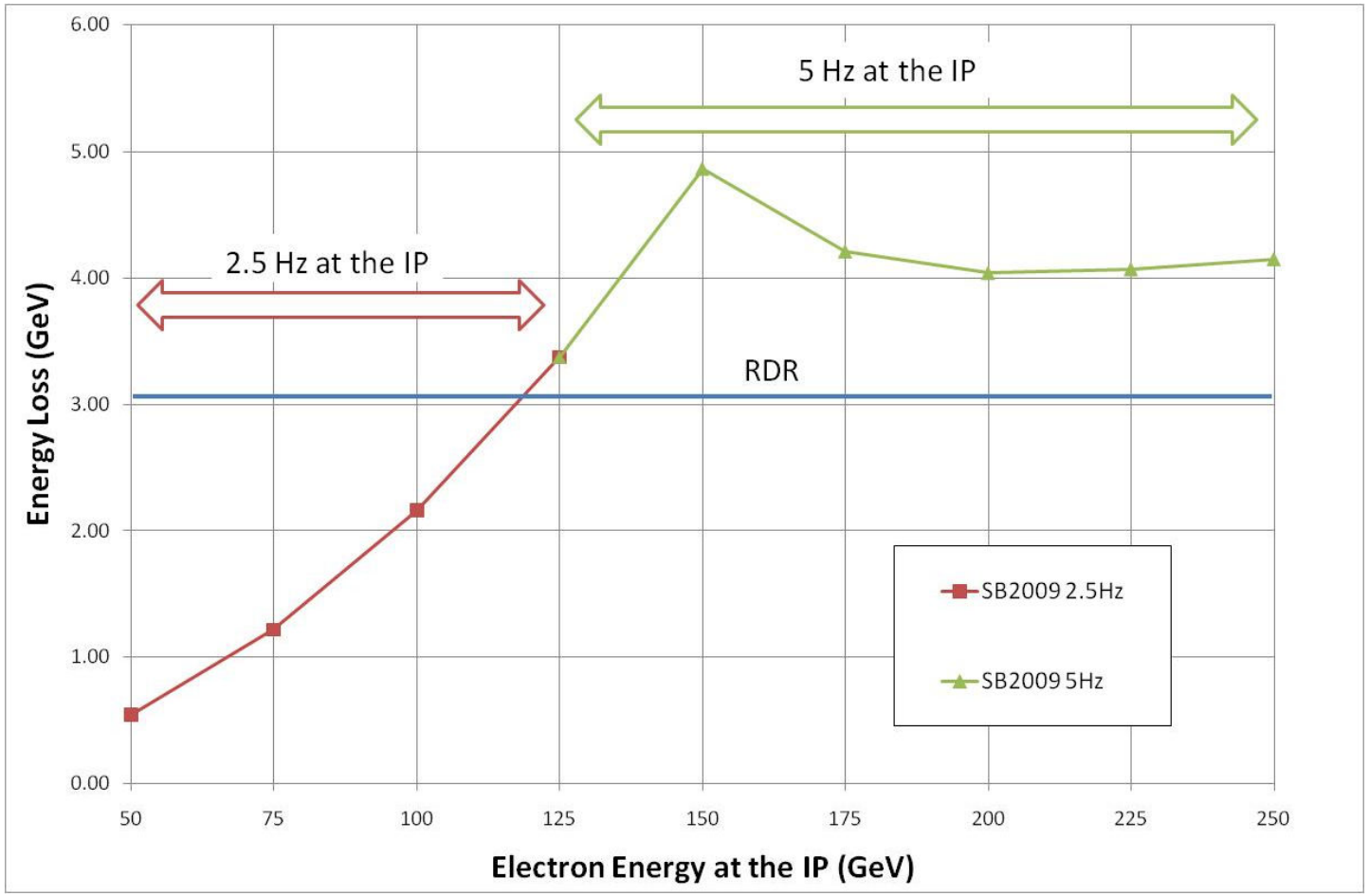
Electron Energy at the IP (GeV)	Undulator Energy (GeV)	Undulator Length (m)	Relative Electron Energy Spread (%)
50 (2.5Hz)	50	231	0.332
75 (2.5Hz)	75	231	0.241
100 (2.5Hz)	100	231	0.215
125 (2.5Hz)	125	231	0.22
125 (5Hz)	125	231	0.220
150 (5Hz)	150	231	0.238
175 (5Hz)	175	147	0.218
200 (5Hz)	200	108	0.210
225 (5Hz)	225	86	0.207
250 (5Hz)	250	71	0.207

Electron energy spread



Electron Energy Loss

- Loss due to SR emission in undulator



AAP Presentation

- Explain new baseline
- Explain different operating modes
- Discuss impact as a function of energy
- Show CAD model to illustrate how all the various beams fit inside the tunnel at the same time

Conventional Source – Quick Analysis

- 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**

Conventional Source – Quick Analysis

- "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**