ILC positron source simulation update

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ANL

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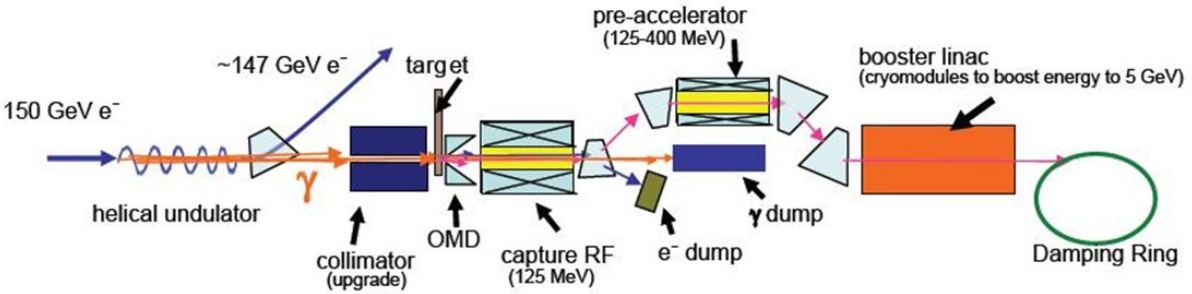
Simulation assumptions

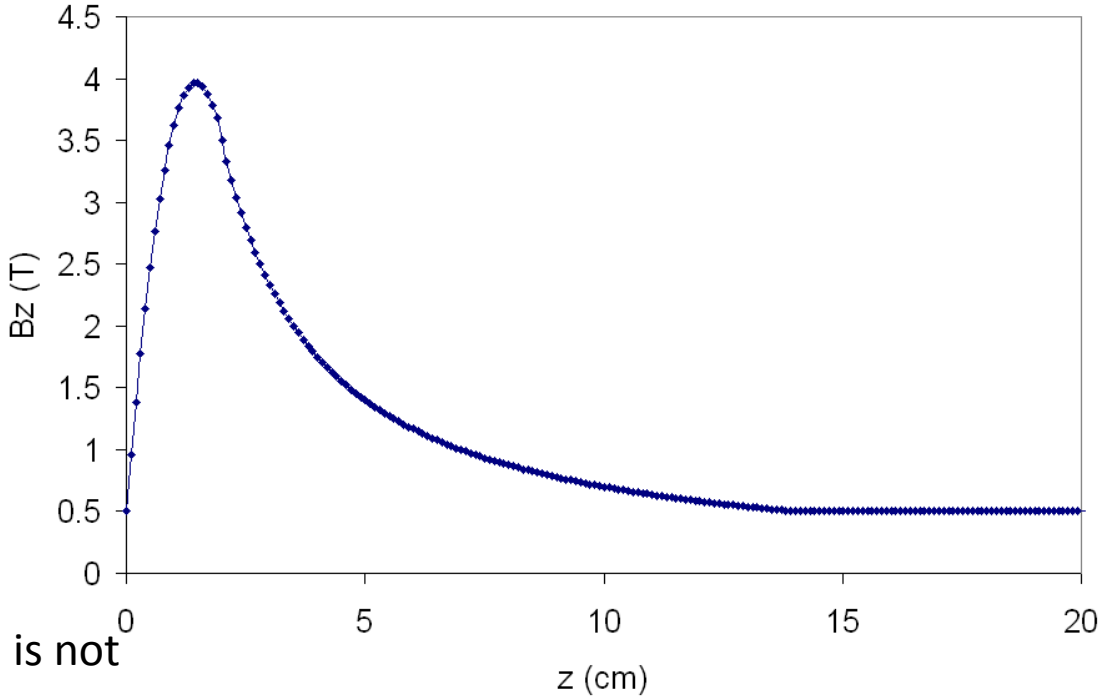
- Length of undulator:
  - 231m for ¼ wave transformer
  - 137m for FC
- Drive beam energy:
  - 175GeV
  - 250GeV
- Target:
  - 0.4X0 Ti target,
  - 2m diameter,
  - 900 RPM



- Capturing:
  - Evaluated at end of PCAP, a ~125MeV accelerating beam line.
  - +/-7.5 degrees of L band RF,
  - +/-25MeV
  - $\gamma\varepsilon x+\gamma\varepsilon y$ <0.09 m.rad

FC field profile

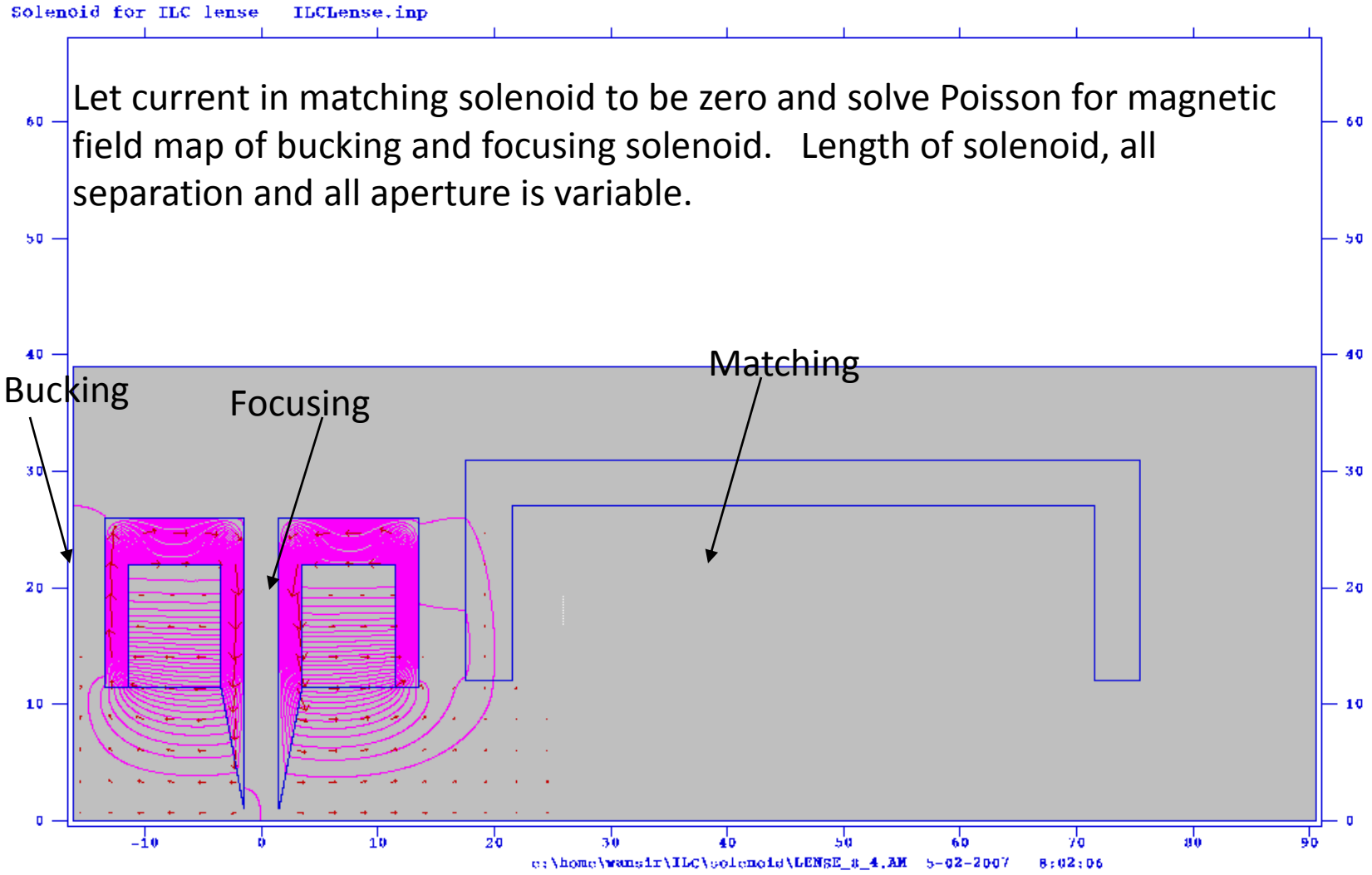
- It is an artificial field profile
- 1st order derivative is continued within 0-14cm.
- Paraxial approximation is used to obtain all other field components near the axis



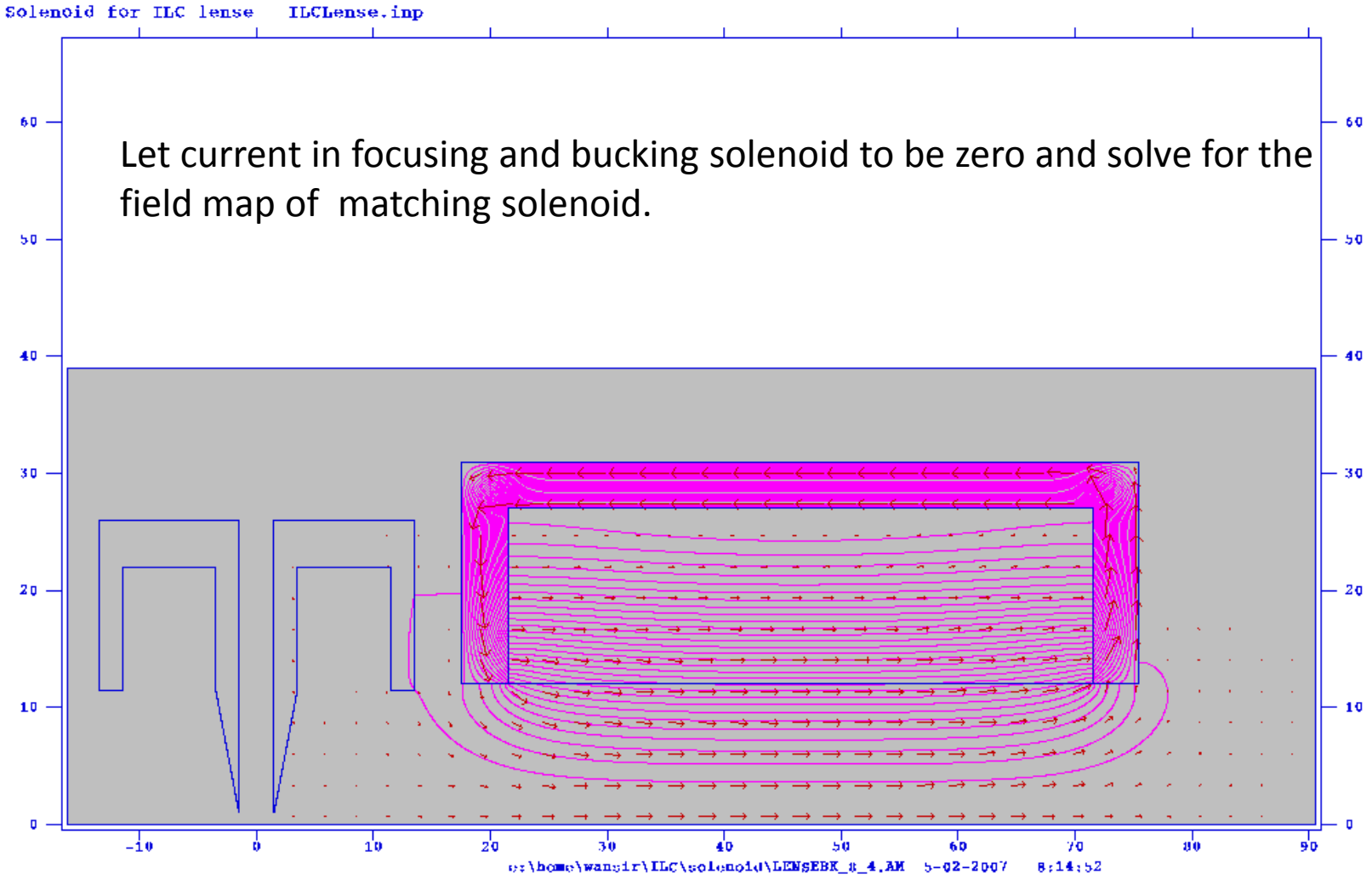
Bz field on axis

Need to be re-optimized if this profile is not achievable in engineering design

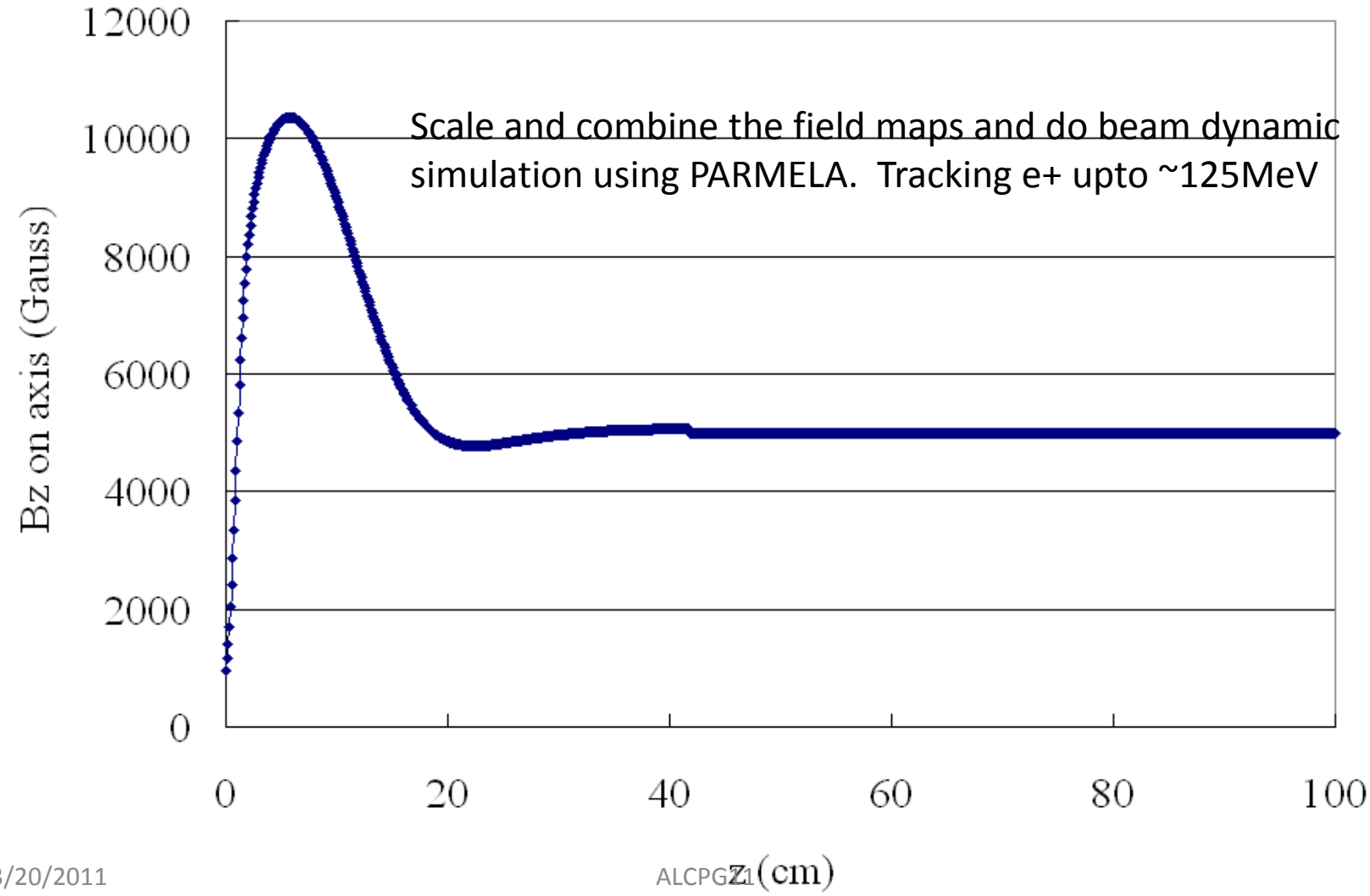
Quarter wave transformer



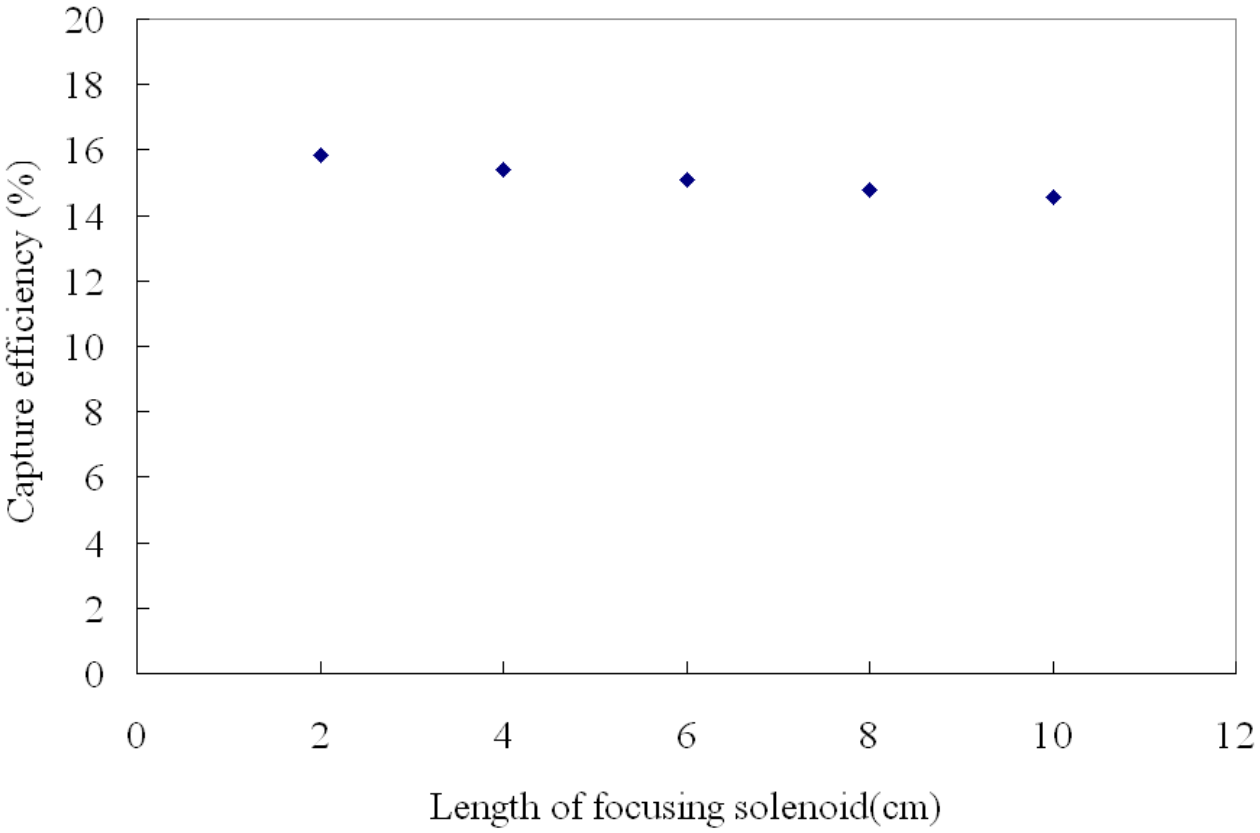
Quarter wave transformer



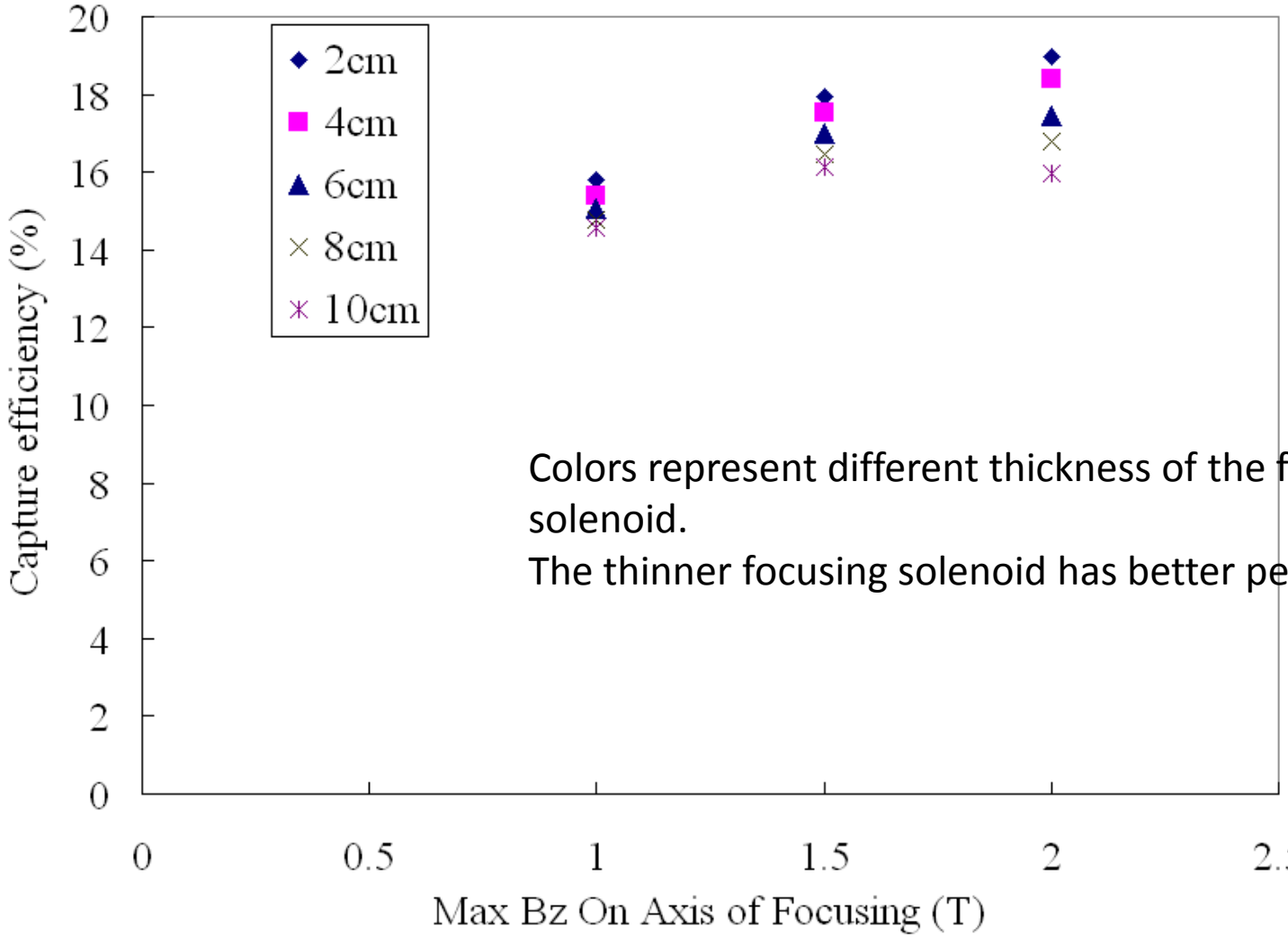
On axis Bz profile of QWT



Capture efficiency as function of length of focusing solenoid.
Max B field on axis is ~1T. Gap between bucking and focusing is at 2cm.
Separation between focusing and matching is 0. (150 GeV Drive)

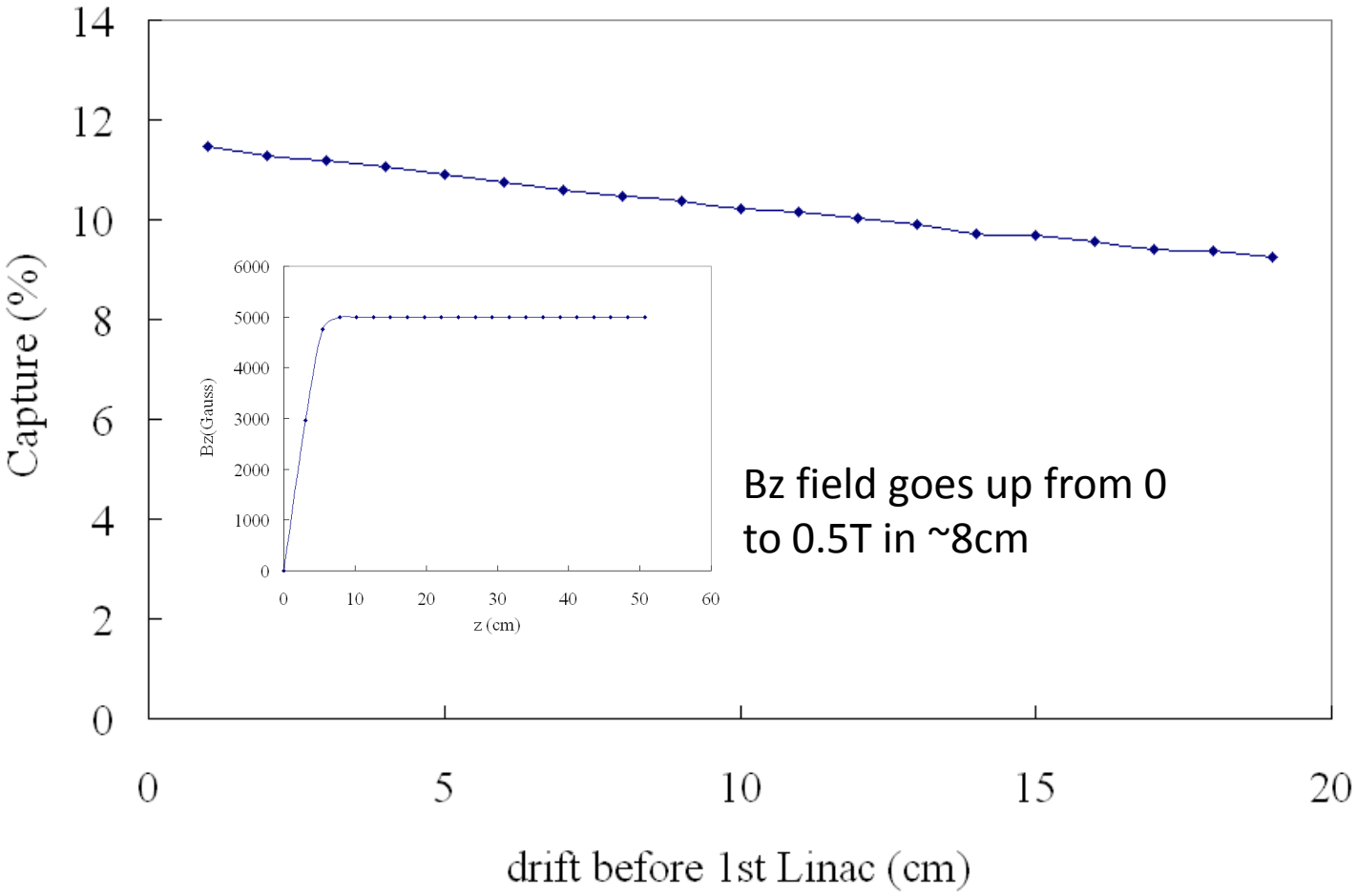


Capture as function of focusing field (150 GeV Drive beam)

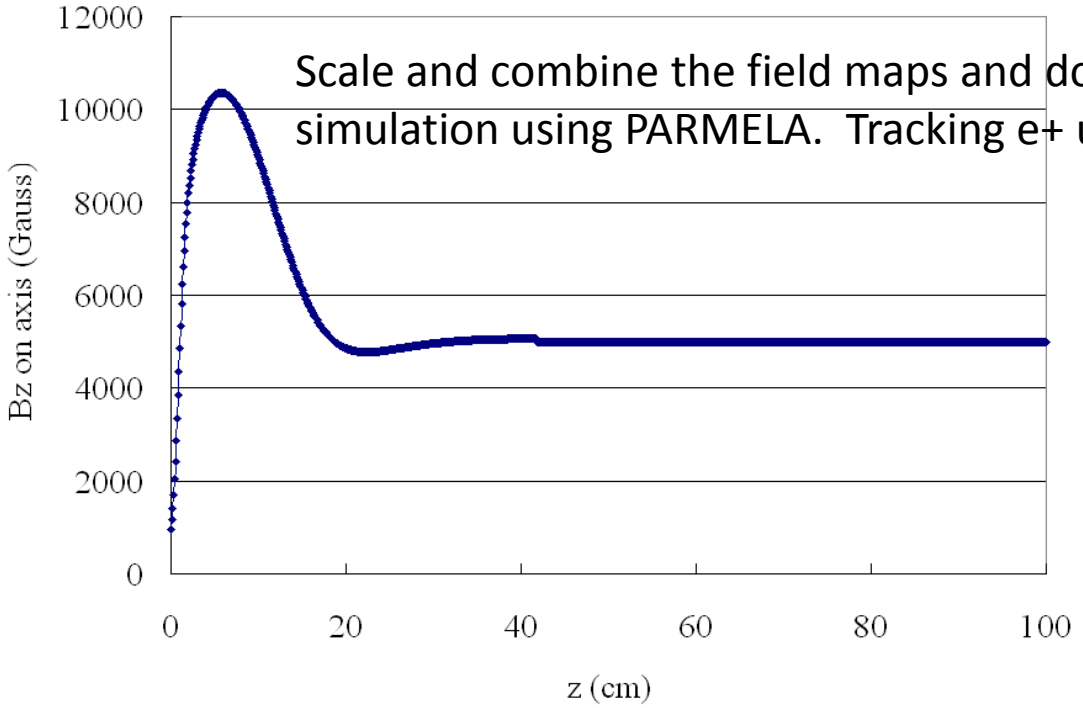


Colors represent different thickness of the focusing solenoid.
The thinner focusing solenoid has better performance.

Capture efficiency with only 0.5T background solenoid (150 GeV drive beam energy)



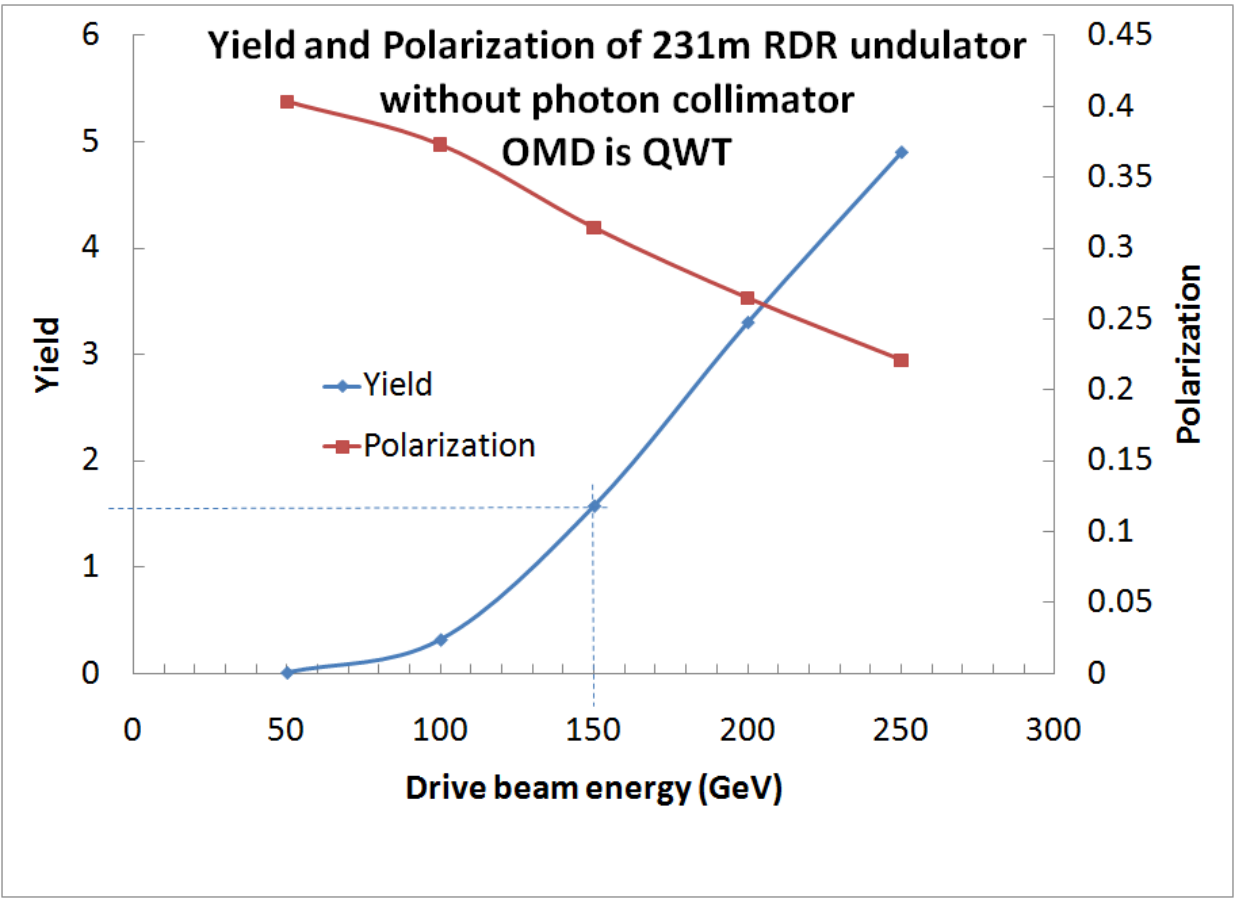
On axis Bz profile of QWT



Scale and combine the field maps and do beam dynamic simulation using PARMELA. Tracking e+ upto ~125MeV

The assumption we used in QWT simulation is very conserved: RF structure starting at 20cm; the length focusing solenoid is 10cm. Looks like there shouldn't be too much challenge to design and build one but still need to be confirmed with engineering design.

Yield and polarization of RDR configuration for different drive beam energy (for SB2009)



Drive beam energy	Energy lost per 100m	Energy lost for 1.5 yield
50GeV	~225MeV	N/A
100GeV	~900MeV	~9.9GeV
150GeV	~2GeV	~4.6GeV
200GeV	~3.6GeV	~3.7GeV
250GeV	~5.6GeV	~3.96GeV

Drive beam energy	Yield	Polarization
50GeV	0.0041	0.403
100GeV	0.3138	0.373
150GeV	1.572	0.314
200GeV	3.298	0.265
250GeV	4.898	0.221

Density of accumulated deposit energy (for RDR rotating target)

1.5 yield / 3e10 e+ captured,	Ti target (density=4.5 g/cm^3)				
	Thickness for highest yield (X0)	Energy deposition per bunch (J.)	Average power (KW)	Peak energy density	
				(J/cm^3) ;	(J/g)
150GeV,FC (137 m)	0.4	0.72	9.5	348.8	77.5
250GeV, FC (40 m)	0.4	0.342	4.5	318.8	70.8
150GeV, QWT (231 m)	0.4	1.17	15.3	566.7	126
250GeV, QWT (70 m)	0.4	0.61	8.01	568.6	126.4

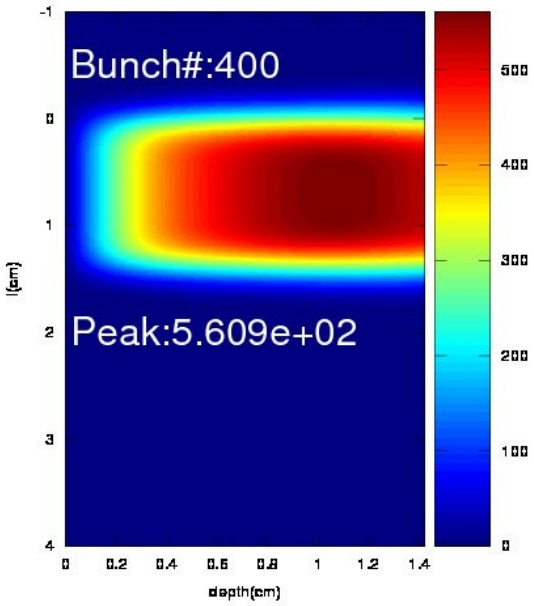
Drive beam energy 175GeV

	QWT, Fixed K	QWT, Fixed Length	FC, Fixed K	FC, Fixed length
Required effective undulator length	152	231 ; k=0.75	88	137; K=0.75
Average photon power(kW)	168	178	100	106.7
Photon energy per bunch (J)	12.8	13.56	7.6	8.13
Energy deposition per bunch (J)	0.92	0.98	0.54	0.586
Relative energy deposition (%)	7.1%	7.2%	7.1%	7.2%
Peak energy density in target (J/cm^3)	561	685.7	351.8	443
Peak energy density in target (J/g)	124	127	78.2	82
Pol.	0.28	0.33	0.29	0.34

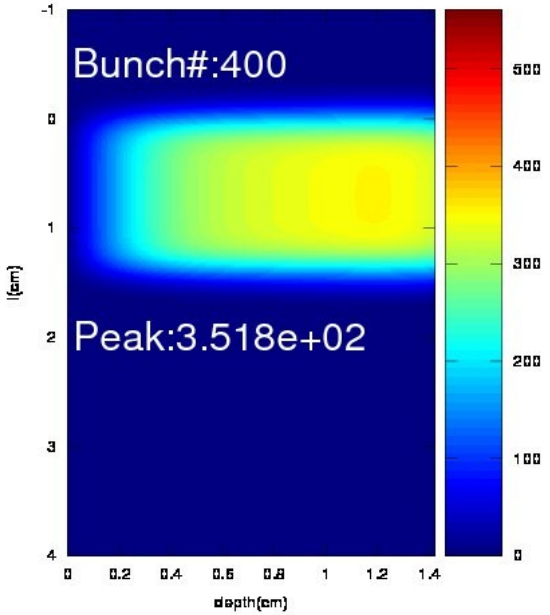
Drive beam energy 250GeV

	QWT, Fixed K	QWT, Fixed Length	FC, Fixed K	FC, Fixed length
Required effective undulator length	70	231 ; k=0.47	40	137; K=0.45
Average photon power(kW)	164	145	94.1	79.3
Photon energy per bunch (J)	12.5	11.05	7.17	6.04
Energy deposition per bunch (J)	0.61	0.573	0.34	0.313
Relative energy deposition (%)	5%	5.2%	4.9%	5.2
Peak energy density in target (J/cm^3)	568.6	793.1	318.8	456.4
Peak energy density in target (J/g)	126.4	176.3	70.8	84.5
Pol.	0.22	0.29	0.23	0.34

Accumulated energy deposition (bunch separation 369.2ns, 175GeV, fixed K)

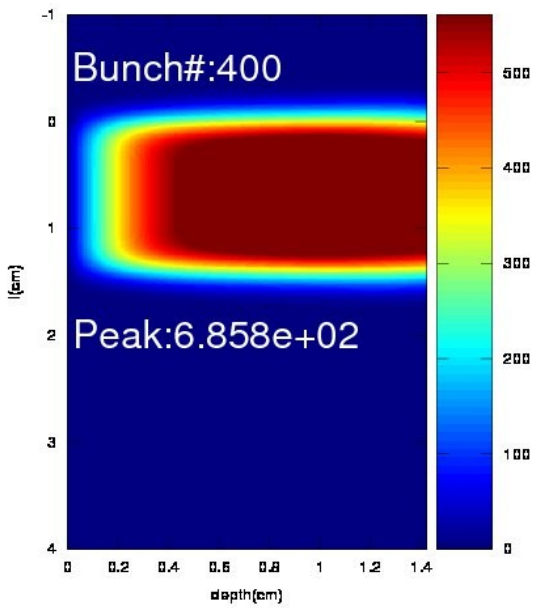


QWT

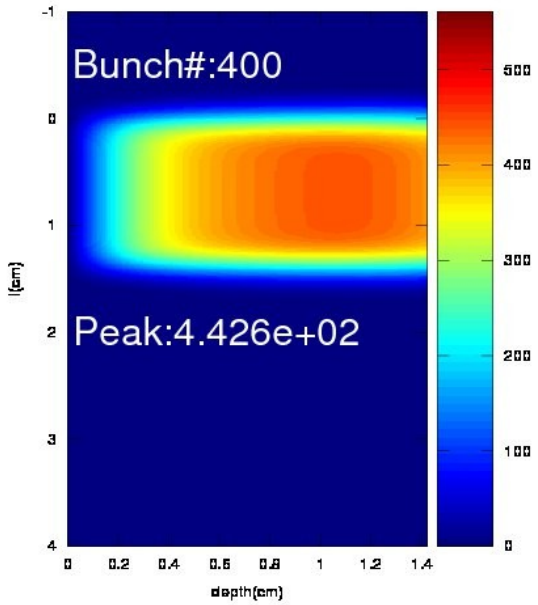


FC

Accumulated energy deposition (bunch separation 369.2ns, 175GeV, fixed length)

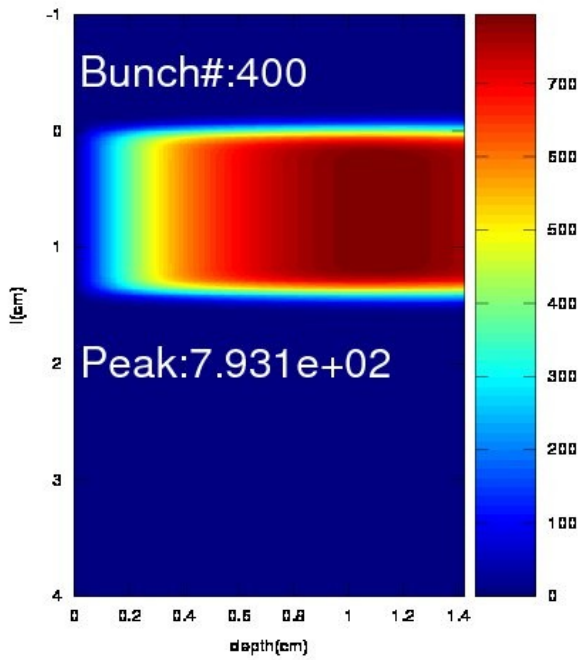


QWT

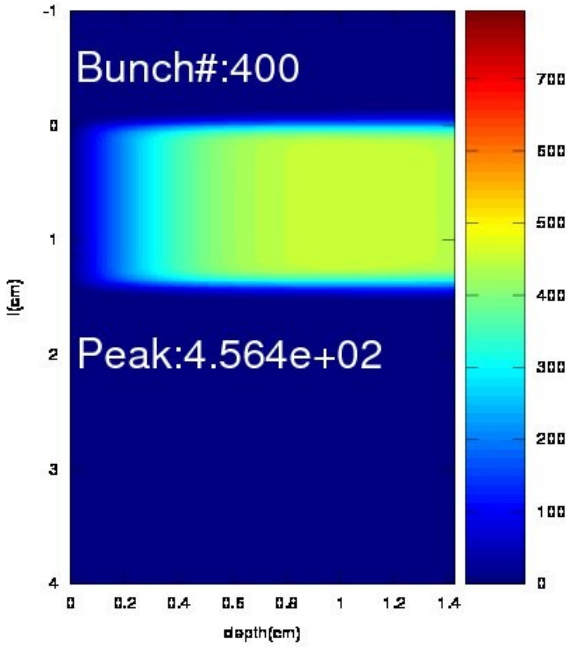


FC

Accumulated energy deposition (bunch separation 369.2ns, 250GeV, fixed length)



QWT



FC

For SB2009, bunch separation has been increased to 534ns and thus the peak energy deposition will be lowered by about 30%

Effects not included which may have impact on the performance

- The difference between the real length of undulator including cryomodule Quad assembling and the effective length of undulator.

Thanks