Super*B* Magnets

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Introduction

- Super*B* magnets are based on the PEP-II magnet design
  - > use as many PEP-II magnets as one can get
  - > additional magnets needed do not need full-blown design effort
- Field-uniformity requirements for Super*B* are not expected to be tighter than for PEP-II
  - Beam sizes in SuperB much smaller
  - Orbit excursions will have to be less (for emittance reasons)
- Fiducialization requirements for Super*B* likely to be tighter than for PEP-II

Magnet Counts, Opt. Lattice

- Dipoles

L_{dipole} (m)	0.45	5.4
PEP-II Total	194	194
SuperB Total	224	148
Needed	30	0

- Quadrupoles

L_{quad} (m)	0.56	0.73	0.43	0.7	0.4
PEP-II Total	202	82	353	-	-
SuperB Total	253	216	165	4	4
Needed	51	134	0	4	4

- Sextupoles

L_{sext} (m)	0.25	0.5
PEP-II Total	188	-
SuperB Total	372	4
Needed	184	4

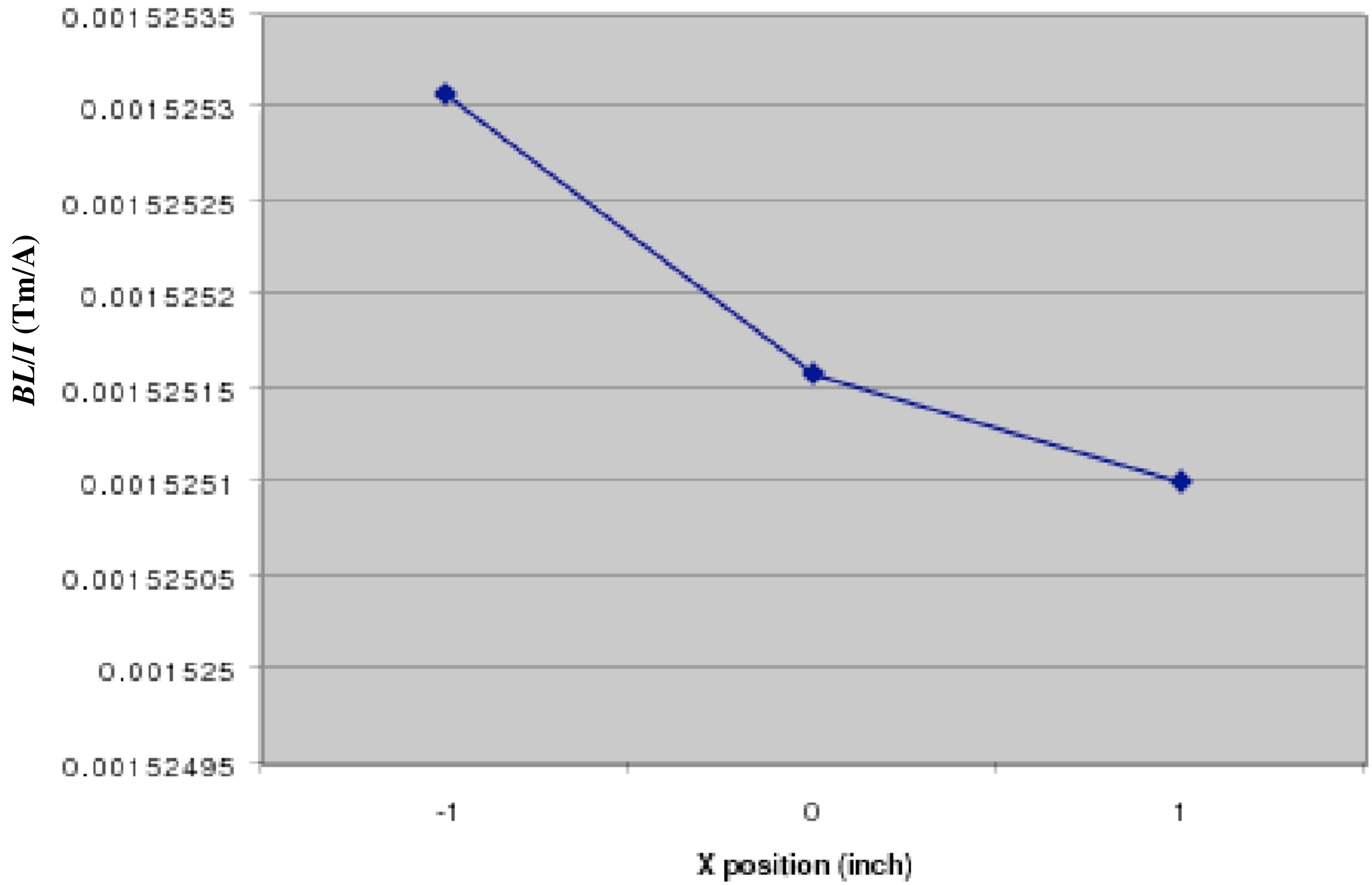
Magnet Field Tolerances (HER)

Multipole index(n)	Systematic: b_n	Random: b_n
dipole magnet: (r=0.03m)		
3	1.00×10^{-5}	3.20×10^{-5}
4	-	3.20×10^{-5}
5	-	6.40×10^{-5}
6	-	8.20×10^{-5}
quadrupole: (r=0.0449m)		
3	1.03×10^{-3}	5.60×10^{-4}
4	5.60×10^{-4}	4.50×10^{-4}
5	4.80×10^{-4}	1.90×10^{-4}
6	2.37×10^{-3}	1.70×10^{-4}
10	-3.10×10^{-3}	1.80×10^{-4}
14	-2.63×10^{-3}	7.00×10^{-5}
sextupole: (r=0.05652m)		
5	-	1.70×10^{-3}
7	-	1.80×10^{-3}
9	-1.45×10^{-2}	-
15	-1.30×10^{-2}	-

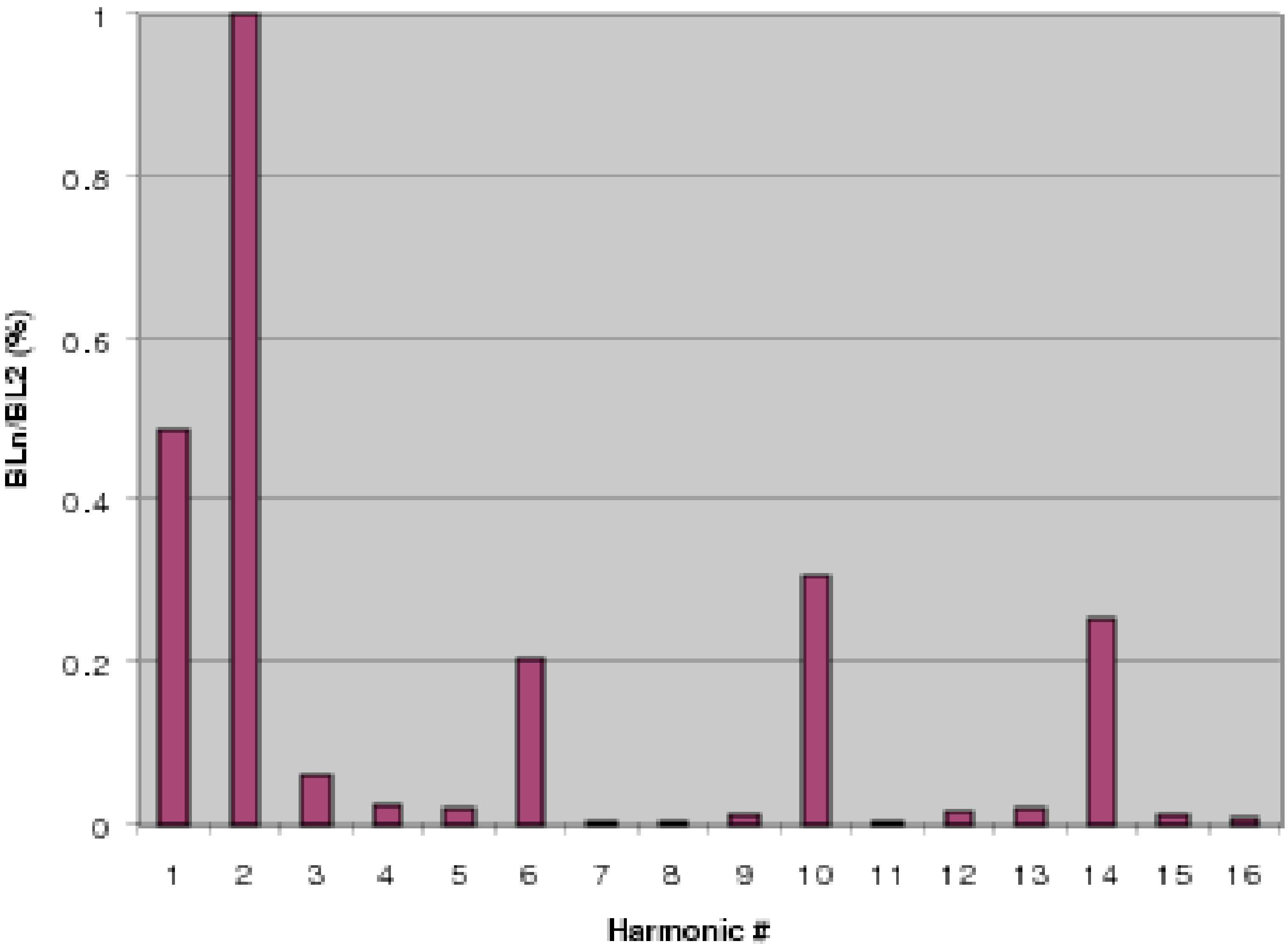
Magnet Field Tolerances (LER)

Multipole index(n)	Systematic: b_n	Random: b_n
dipole magnet: (r=0.03m)		
3	-0.50×10^{-4}	1.00×10^{-4}
5	3.00×10^{-4}	1.00×10^{-4}
7	-	1.00×10^{-5}
9	-	1.00×10^{-5}
quadrupole: (r=0.05m)		
3	1.02×10^{-4}	4.63×10^{-5}
4	1.91×10^{-4}	8.09×10^{-5}
5	1.89×10^{-5}	8.86×10^{-6}
6	5.69×10^{-4}	2.80×10^{-5}
7	6.60×10^{-6}	3.45×10^{-6}
8	9.60×10^{-6}	5.72×10^{-6}
9	7.14×10^{-6}	3.85×10^{-6}
10	3.37×10^{-4}	5.62×10^{-6}
11	6.08×10^{-6}	3.32×10^{-6}
12	5.34×10^{-5}	6.20×10^{-6}
13	1.10×10^{-5}	6.53×10^{-6}
14	6.65×10^{-5}	8.20×10^{-6}

PEP-II HER Dipoles



PEP-II HER Quadrupoles



IR Quadrupoles

- The insertion quadrupoles are in a different class.
  - β_y up to 1300 m, twice PEP-II
  - β_x up to 400 m, ≈ like PEP-II
- Needs significant study, but expect tolerances to be equal or tighter than for PEP-II ($1\ldots3 \cdot 10^{-4}$)
  - typically achieved by individually tuning each magnet

Quad/Sext Alignment Sensitivities

Note		SuperB LER	SuperB HER	ILC DRs	KEK ATF
	Vertical emittance (pm)	4	4	2	4.5
	Orbit amplification factor	46	44	32	21
rms, causing orbit equal to y beam size	Quadrupole jitter sensitivity (nm)	209	217	221	227
rms, causing 4 pmr y emittance	Sextupole alignment sensitivity (μm)	95	87	70	50
rms, causing 4 pmr y emittance	Quadrupole tilt sensitivity (μrad)	166	183	79	800

Compare to PEP-II

- Example: Emittance from vertical dispersion:

$$\varepsilon = \frac{2J_\varepsilon}{J_y}\frac{\langle D_y^2 \rangle}{\beta_y}\sigma_\delta^2$$

- => for 4 pmr need D_y < 4 mm
- roughly a factor of 10 better than PEP-II
  - PEP-II was spec'd at 250 μm rms
  - > SuperB should aim near 25 μm rms… challenge
    - … but LCLS at SLAC achieves this with vibrating wire.
  - Better correction algorithms may relieve this somewhat

Summary

- We expect the field tolerances for the ring magnets to be similar to those of PEP-II.
- We expect the field tolerance of the IR quadrupoles to be equal or tighter than those of PEP-II IR quadrupoles.
- Alignment tolerances are significantly tighter than those of PEP-II:
  - > fiducialization tolerances will also be tighter
  - ATF, ILC DR work serves as guidance
  - LCLS fiducialises to ≈ 25 μm.
- Significant tracking studies needed to verify the ring assumptions & specify the tolerances for the IR magnets.