Magnetic Field Requirements in the IR

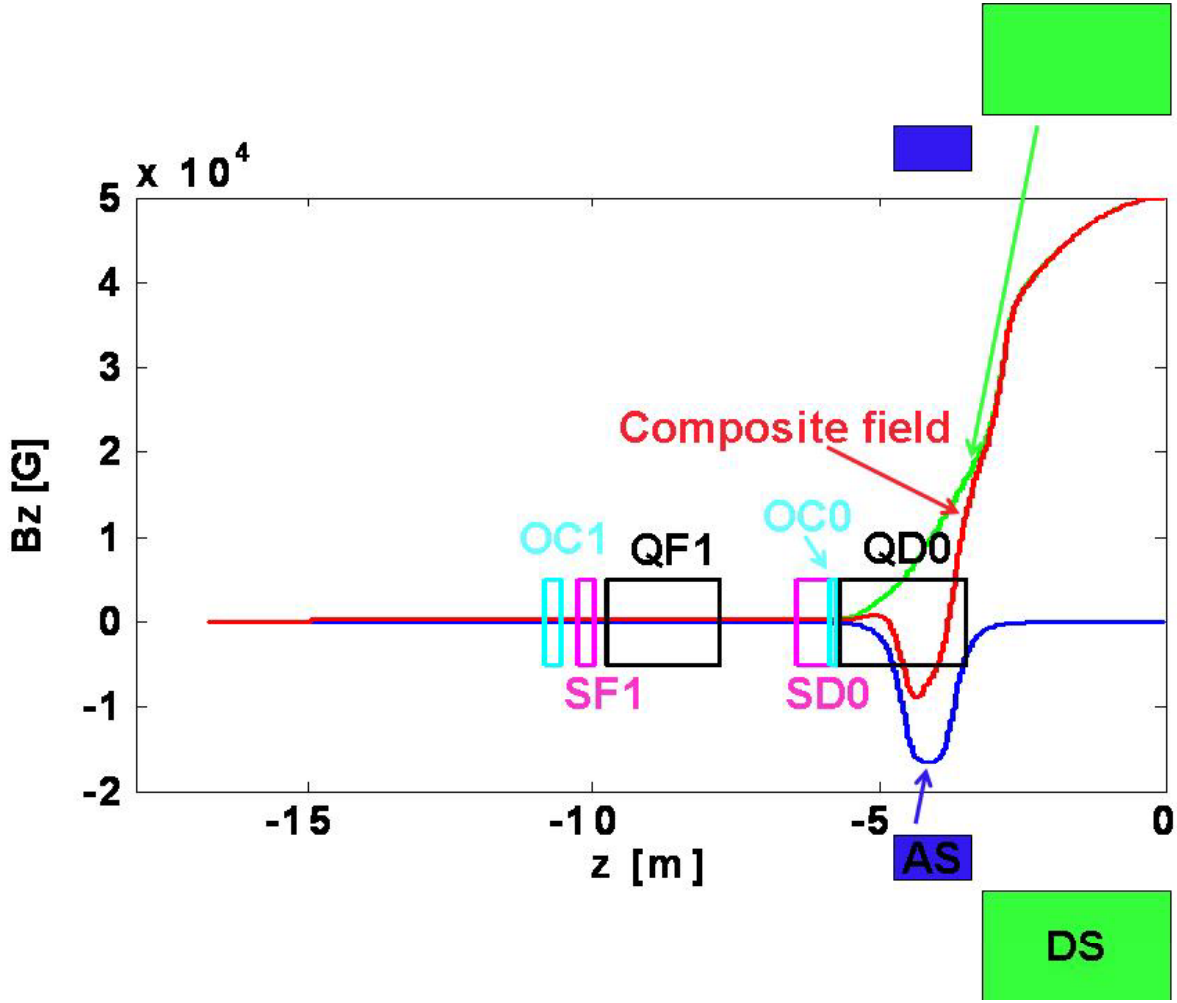
Sergei Seletskiy

IRENG07 • September 17-21, 2007

September 18, 2007

Introduction

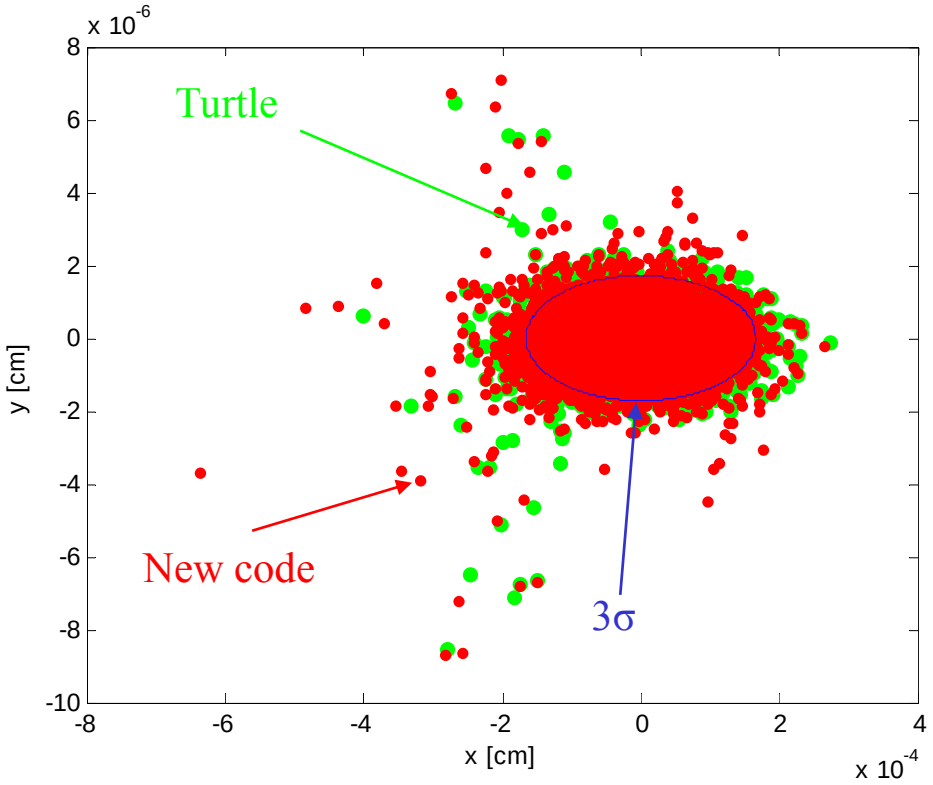
- Our goal is to study the effect of parasitic magnetic field, "leaking" from the detector solenoid, on the beam at the IP.



- The tool suitable for studies has to allow simulation of beam kinematics in the customary distributed solenoidal field overlapping with quads and higher multipoles.

Introduction

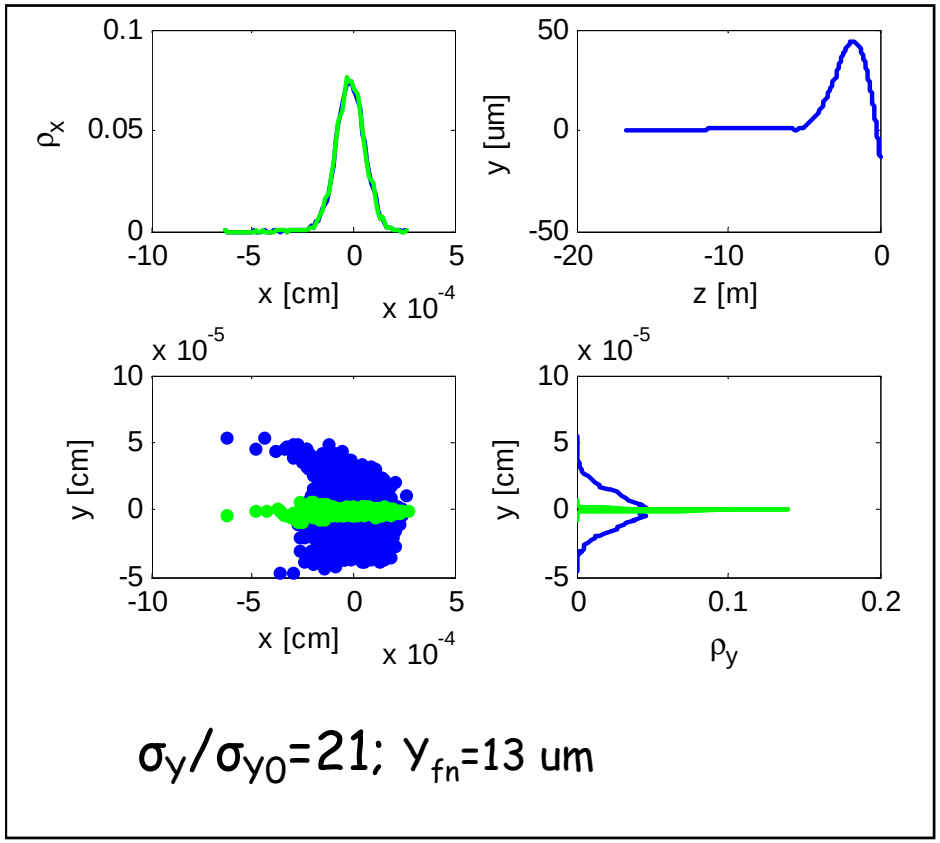
- We developed the code that allows one to do necessary simulations.
- The code been checked for analytically calculable models.
- Also, the code was checked versus Turtle model for zero DS field.
- Plus to it , we compared the new code with Andrei, Yuri & Brett results for NLC beam (SiD, 20mrad angle). In their simulations they used DIMAD model with IR sliced in 10^n elements that included proper solenoid, quad , sextupole and octupole components of the field.



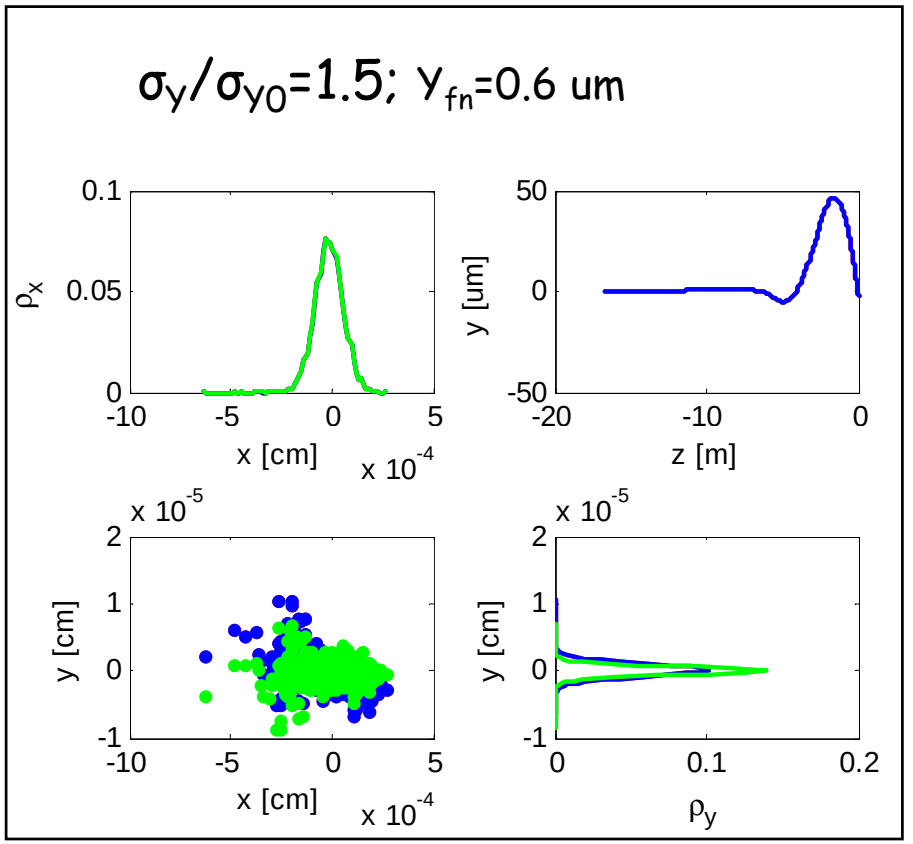
- Recently, the SR effect on the beam has been also included in the code. SR block has been checked with semi analytical formulas.

Studies' procedure

- To give our simulations a touch of reality, we first of all compensate the beam coupling and trajectory displacement with the AS.

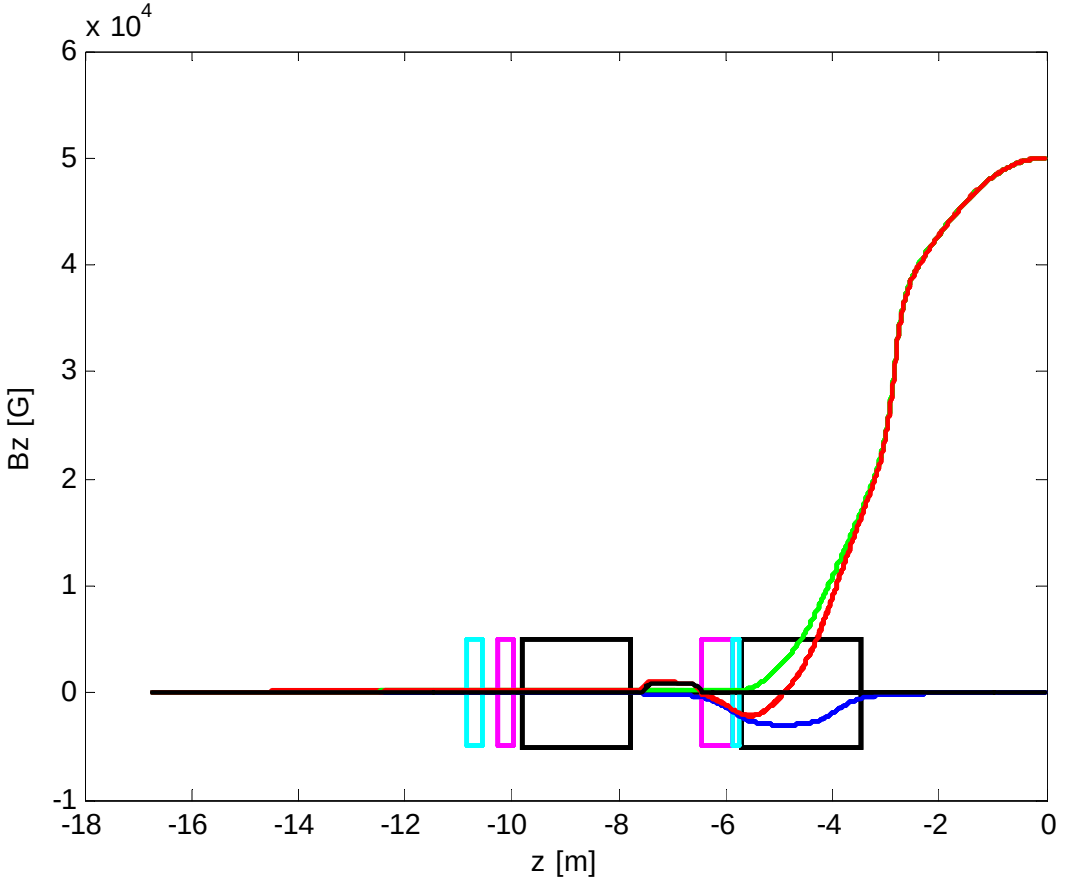


- SiD; L*=351 cm



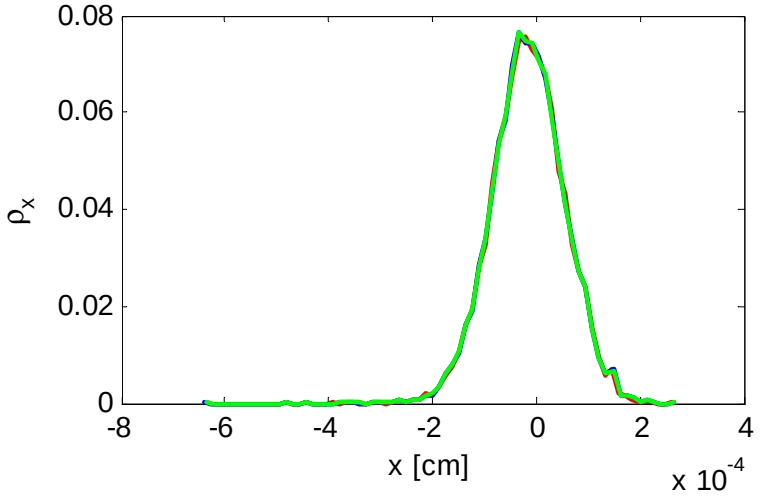
Studies' procedure

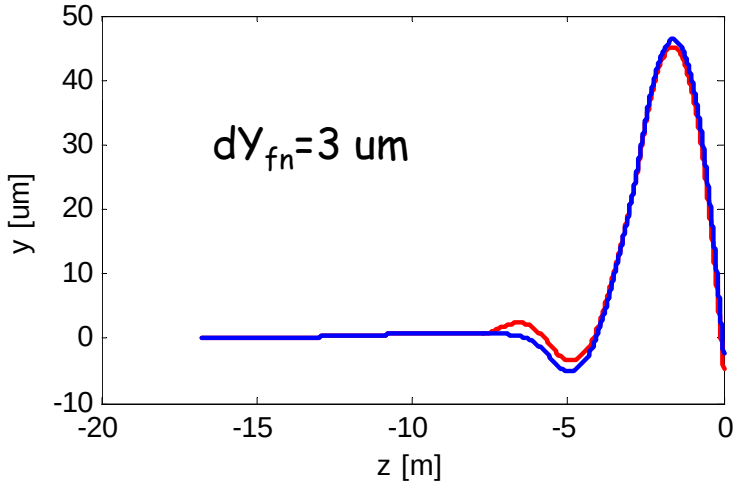
- SiD; L*=351 cm; Bz(parasitic)*L=835G*1m
- First we consider the effect on the beam of 1 m long Bz bump

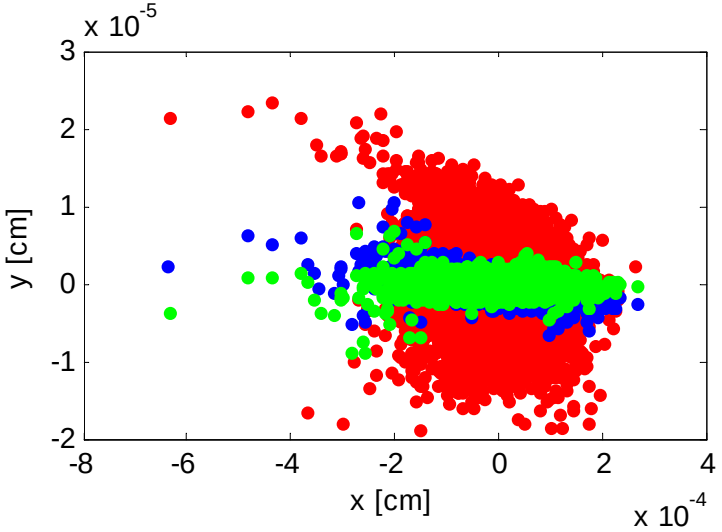


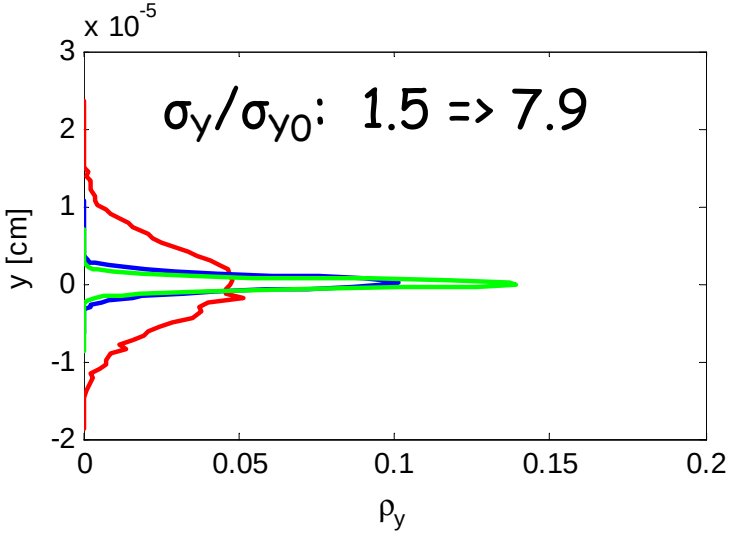
Studies' procedure

- SiD; L*=351 cm; Bz(parasitic)*L=835G*1m



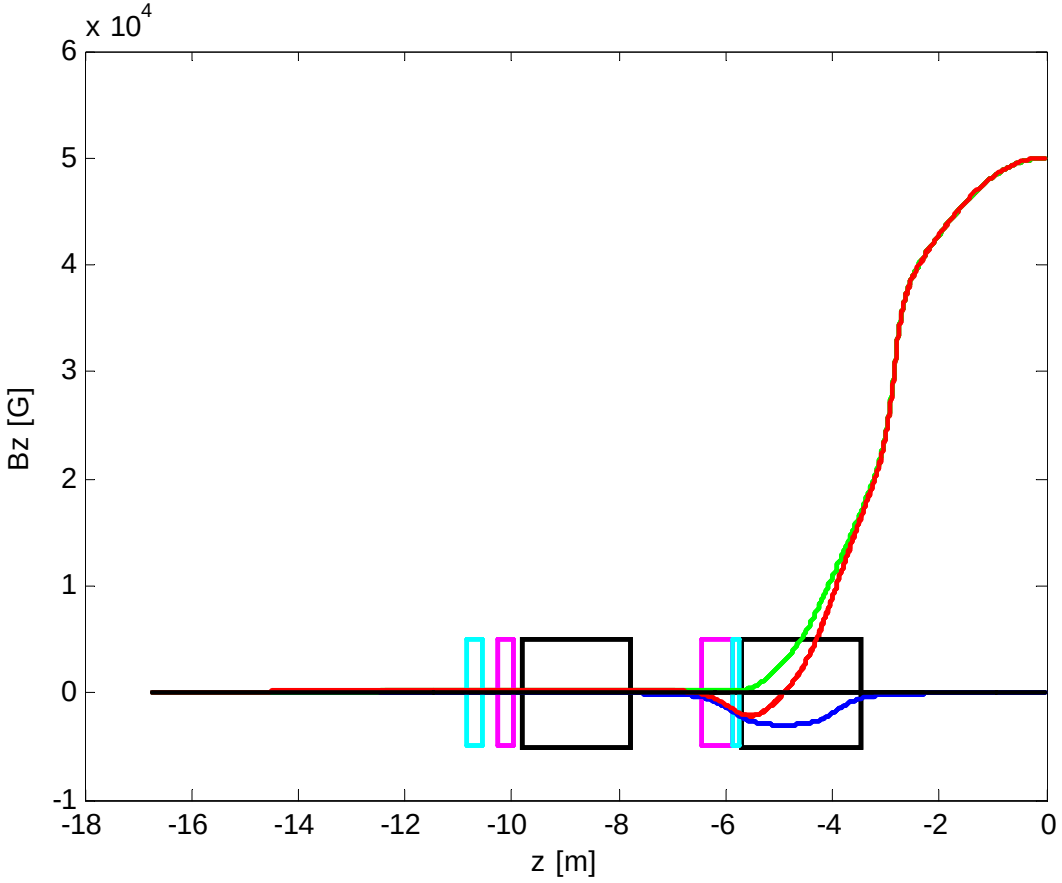






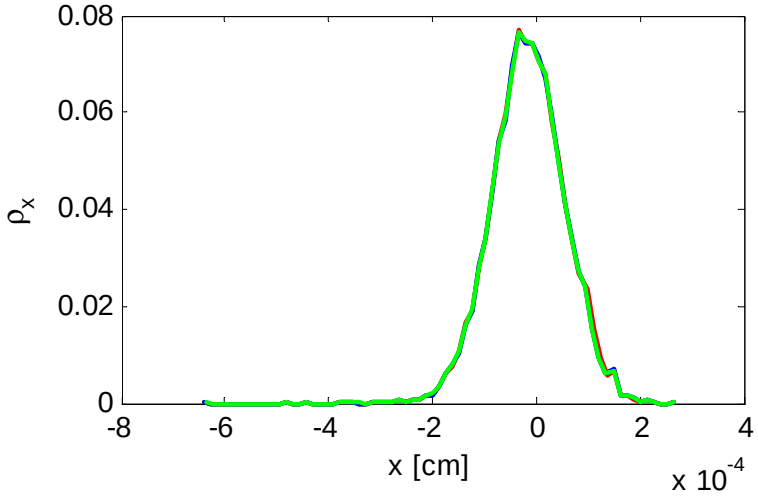
Studies' procedure

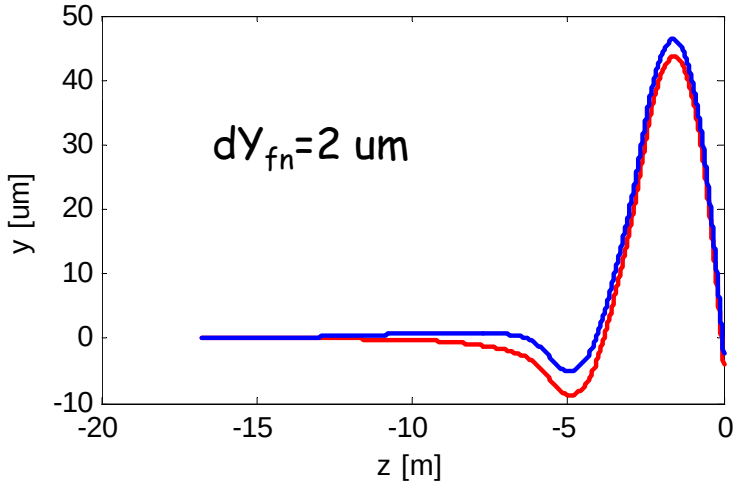
- SiD; L*=351 cm; Bz(parasitic)*L=50G*16.7m
- Next we study the case of uniformly distributed parasitic Bz field.

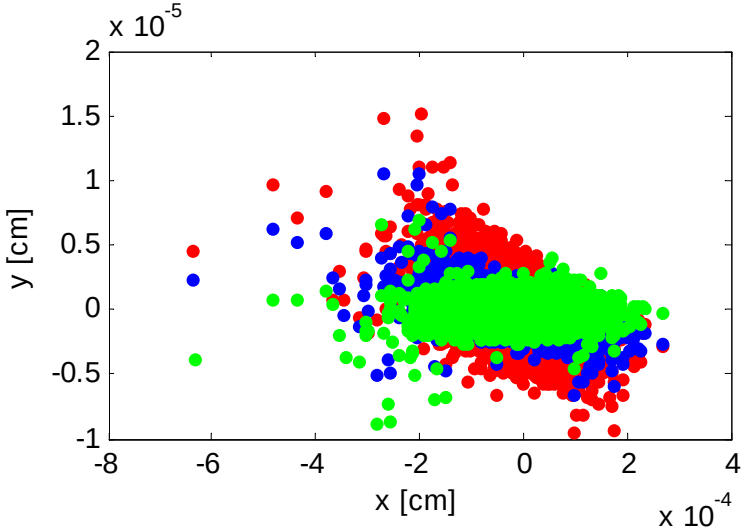


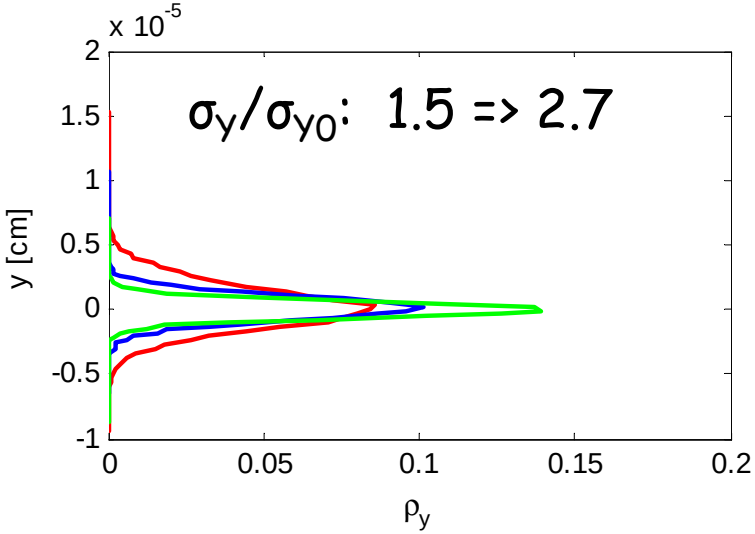
Studies' procedure

- SiD; L*=351 cm; Bz(parasitic)*L=50G*16.7m



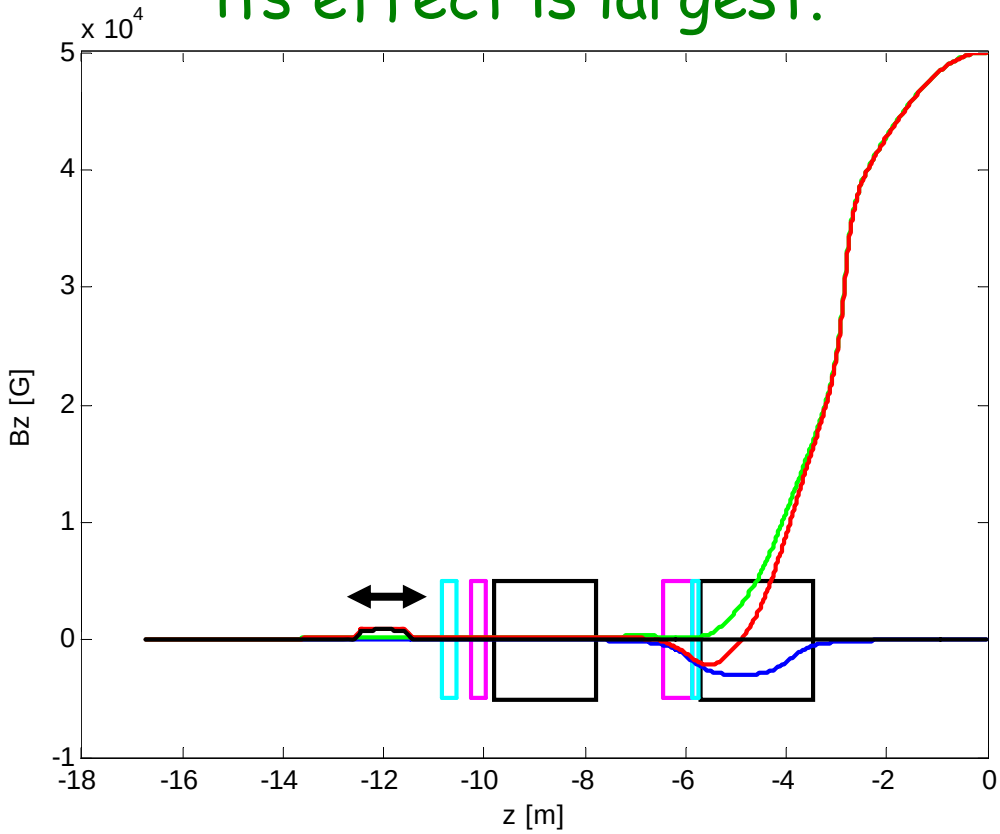


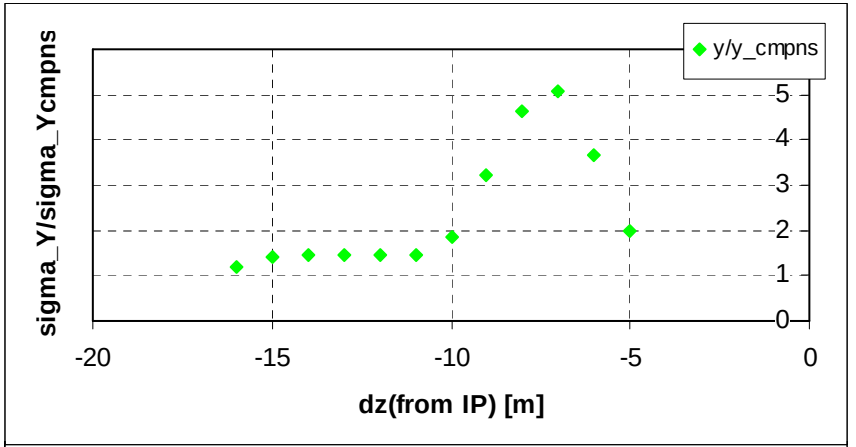


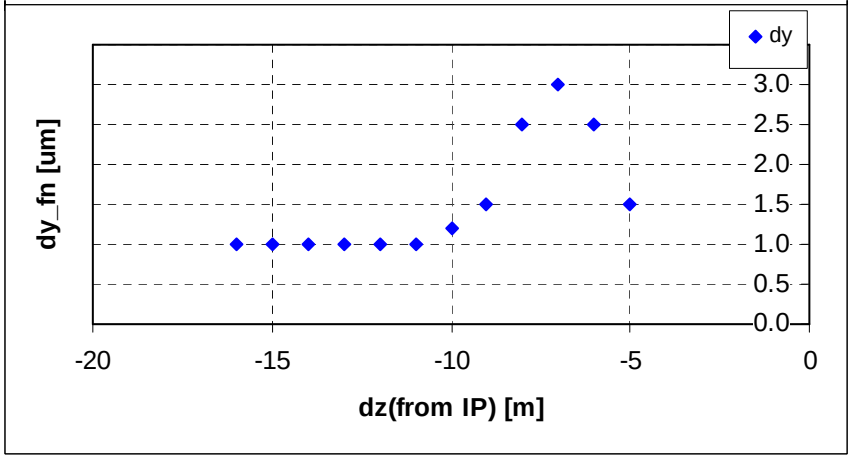


Studies' procedure

- Moving the Bz bump along the axis to see where its effect is largest.







- It looks reasonable to place it at 7 m from the IP

Studies' procedure

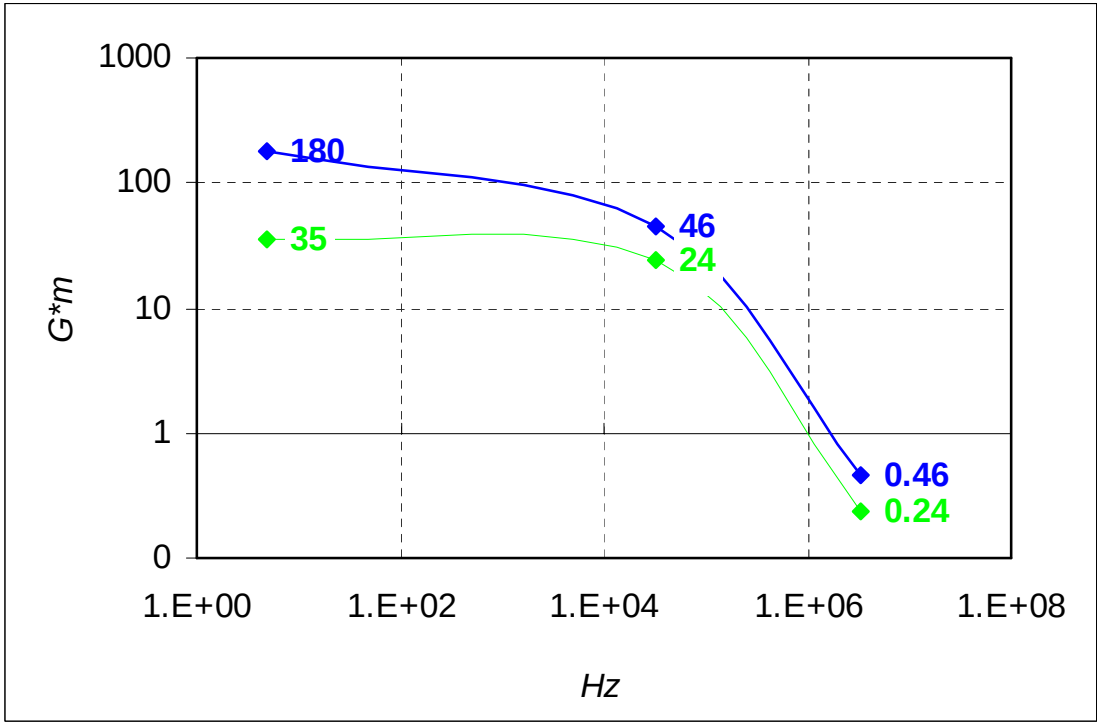
- The offset is to be compared with:
  - ¼ sigma or 1nm of maximum tolerable bunch-to-bunch jitter in the train with 300ns between bunches
  - roughly 100nm, which intratrain feedback can follow with time-constant of ~100 bunches (0.03ms).
  - about 500nm of train-to-train offset, which intratrain feedback can comfortably capture (0.2s between trains)
- The coupling effect should be compared with desired tuning stability time, say 10 hours (for this exercise we choose to allow $\sigma_y/\sigma_{y0}=1.05$)
- Note, that in Andrei Seryi's talk for August 15 preparation meeting he had conservative limits of 10nm and 100nm for 30us and 0.2s respectively. For these studies we take the limits provided by Glen White .

Results

- Finally we get:

	L*=351 cm		L*=450 cm		
	SiD	GLD	SiD	LDC	GLD
t ~ 300 ns	0.35-0.46	0.35-0.5	0.24-0.37	0.24-0.36	0.24-0.36
t ~ 0.03 ms	35-46	35-50	24-37	24-36	24-36
t ~ 0.2 ms	175-230	175-250	120-185	120-180	120-180
t ~ 10 hrs	35-100	50-70	40-100	60-200	65-100

1 m bump – spread field [G·m]



Questions

- What level of field "leakage" can we expect to have in the IR?
  - Josef Frisch and Steve Smith measured 120nT of the magnetic field at 50 Hz at the ATF Damping Ring at KEK with a pickup coil (of course this measurement is not much relevant to our studies).
  - 120nT • 16.73m=$2 \cdot 10^{-2}$ Gm and our tolerance at 50 Hz in the worst case is ~ 30 Gm.
- Nevertheless, it would be nice to see the measurements of "parasitic" fields at different frequencies produced by a solenoid similar to the DS.