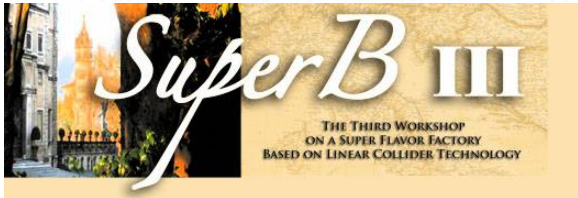
Updates on IR and FF for super-B factory

June 15, 2006

Andrei Seryi
SLAC



Content

- Not really any new work, thoughts on
  - optics optimization
  - optimization for common FD (like in ILC 2mrad IR)
  - benefits of separate beamlines (like in ILC 20mrad IR)
  - use of antisolenoids in IR (like in ILC)

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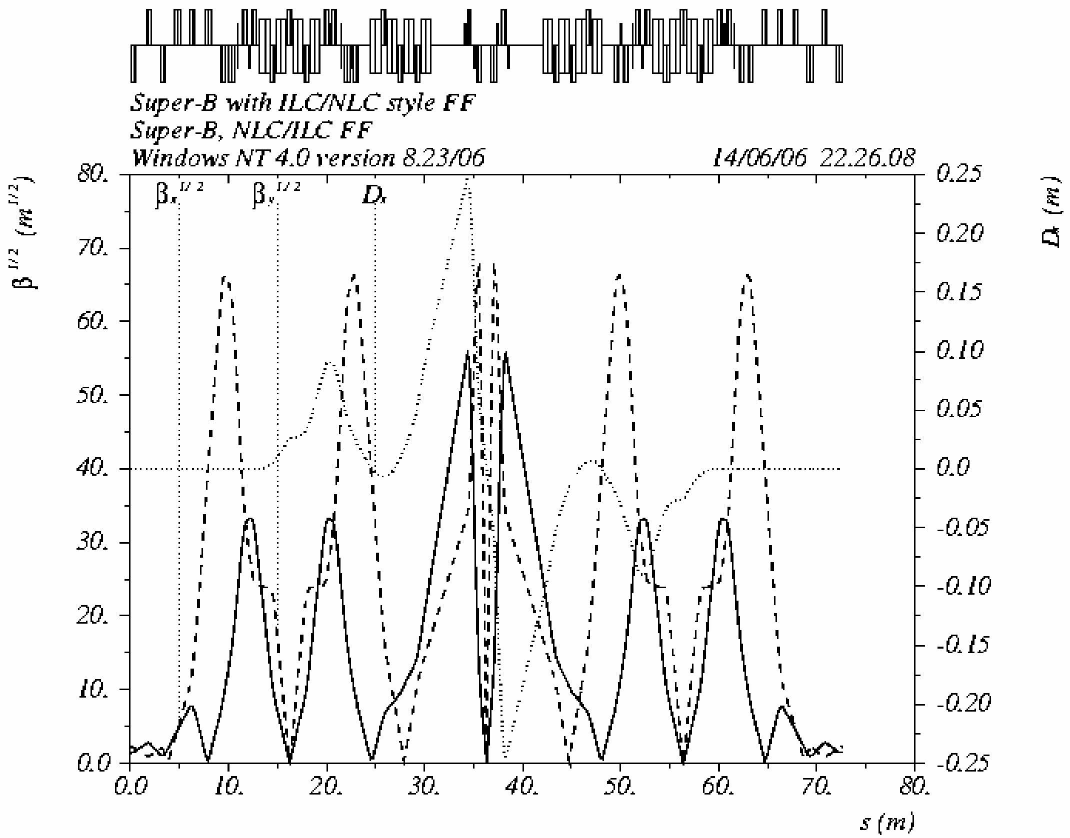
Summary from March 16 talk:

- Optics of FF can be designed
- Requirements of the ring to aberrations in FF need to be checked
- IR layout need to be discussed

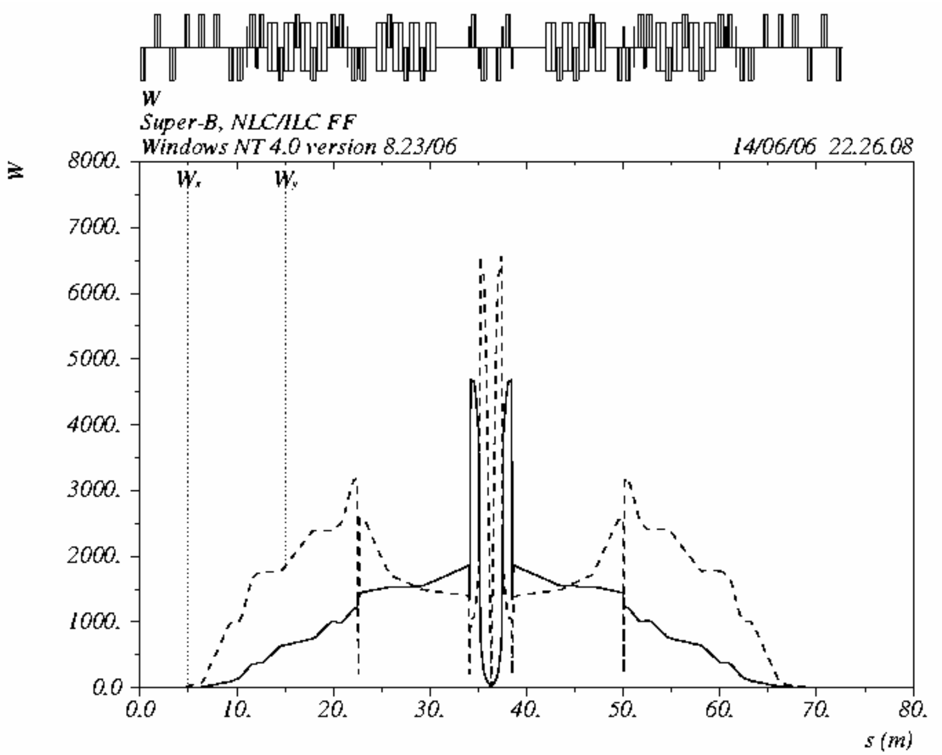
- Results presented yesterday show that dynamic aperture need to be improved

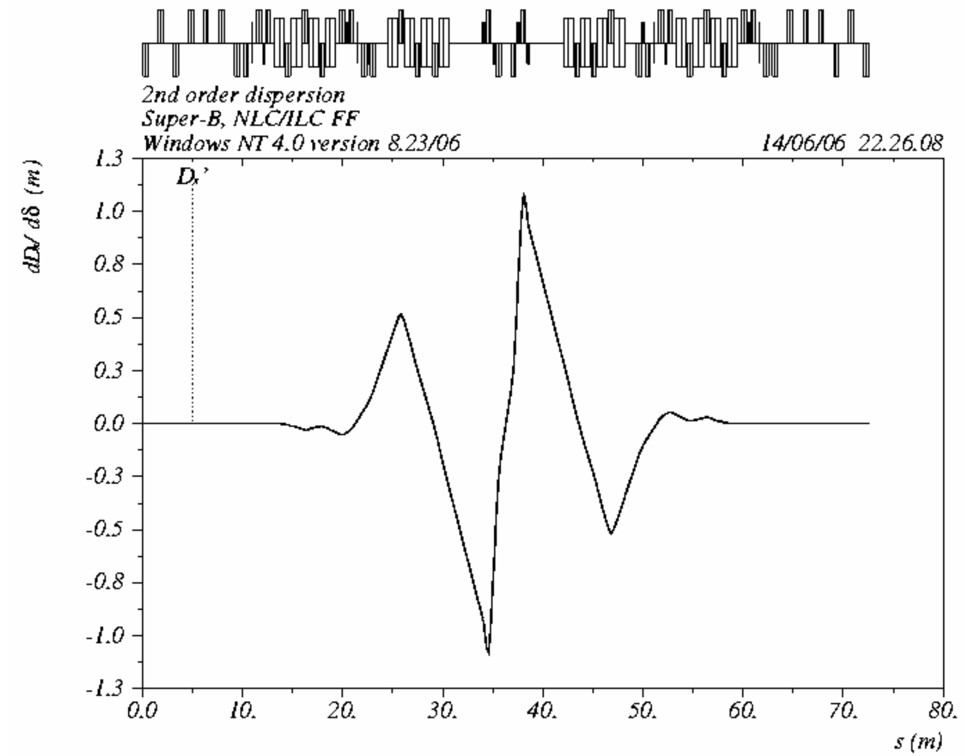
Optimization of optics

- Changed optimization procedure to look simultaneously at IP and at the exit from ff and to improve symmetry
  - (assuming symmetric ff with bends and sextupoles reversed)

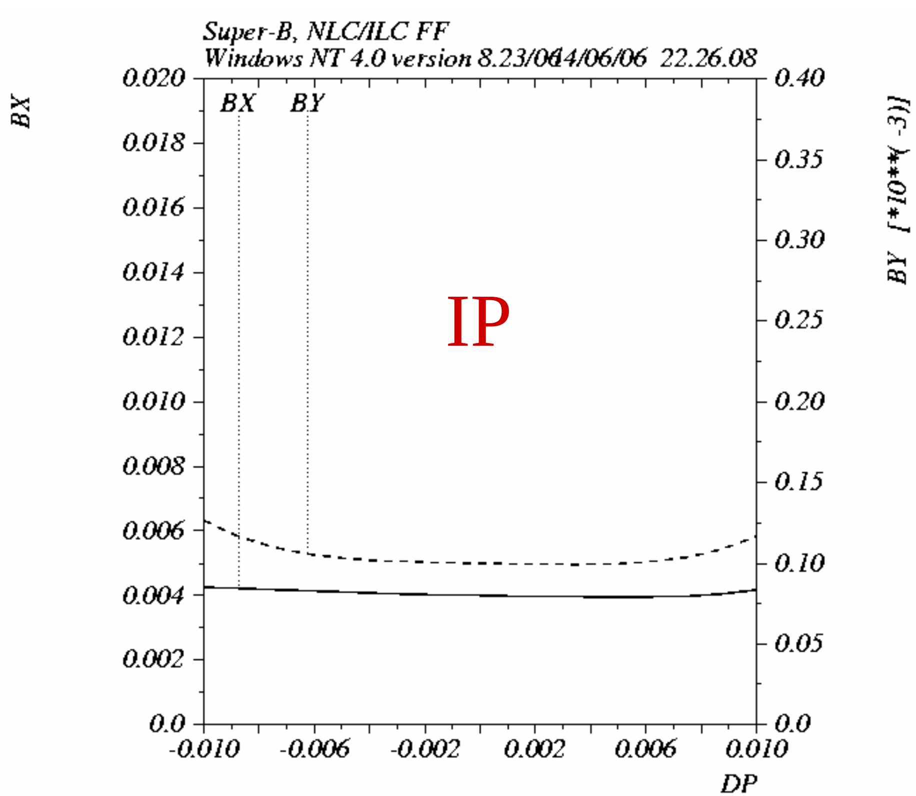


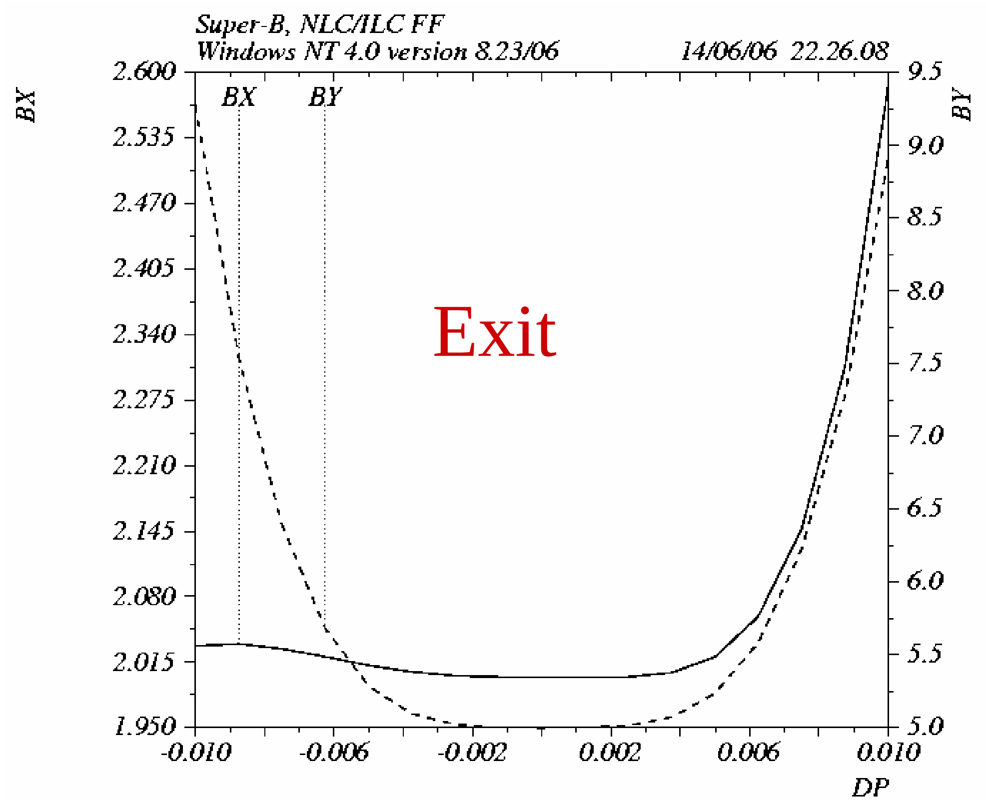
Chromaticity & second order dispersion





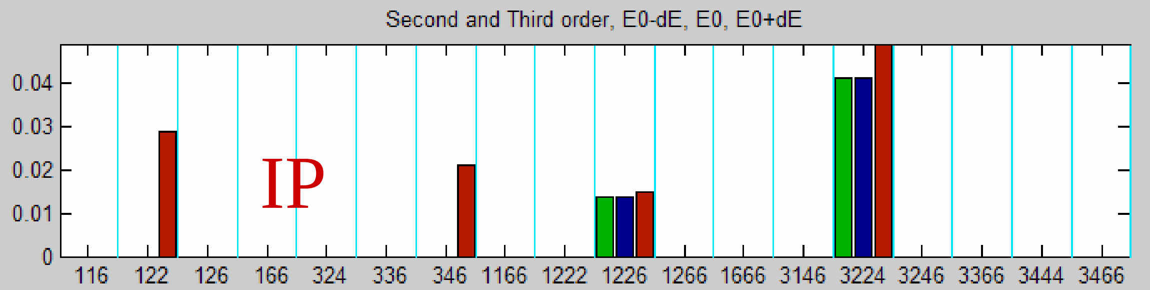
Bandwidth at IP and exit

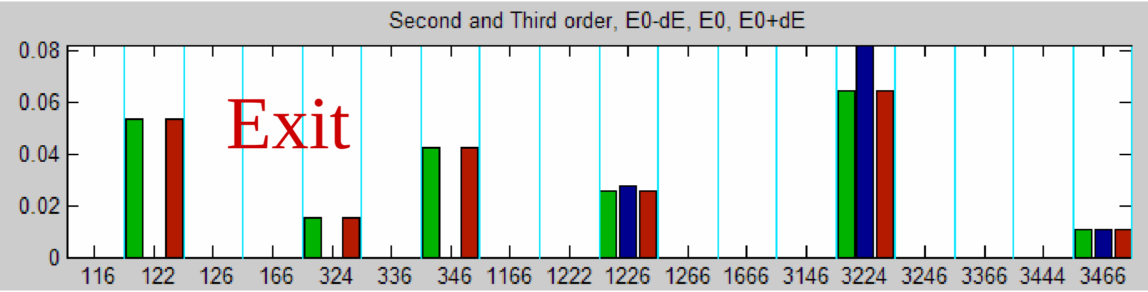




Clearly, the exit bandwidth is not great and need improvements

Aberrations and tracking



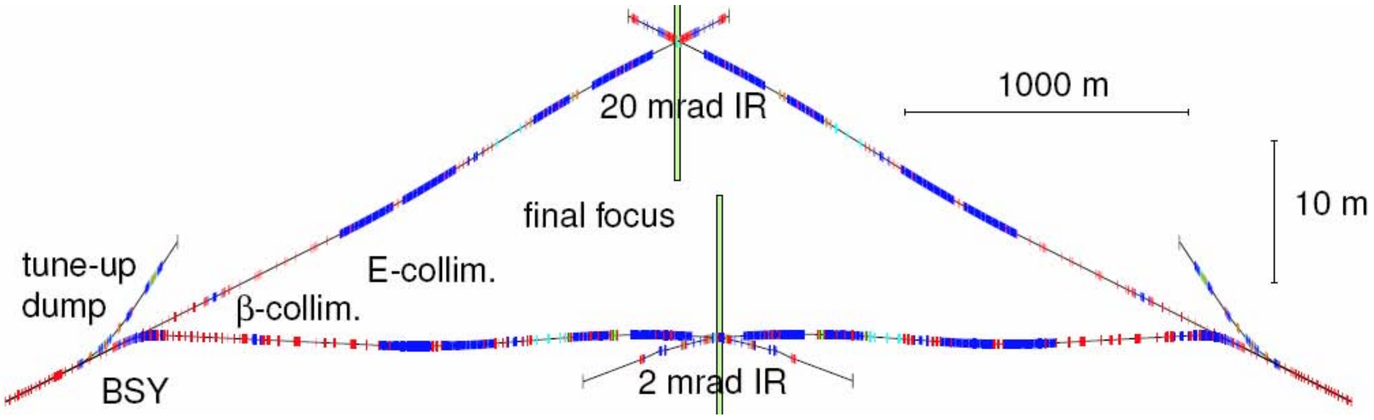


- Aberration terms from Transport
- Tracking with Turtle (100k particles, σ_E=0.1%):
  - IP
    - sgx=2.6785 , sgy= 0.012823 μm
    - sgx/x0=0.99859 sgy/y0= 1.0028
  - Exit:
    - sgx/x0=0.99999 sgy/y0= 1.007
- Further optimization require lengthening the optics

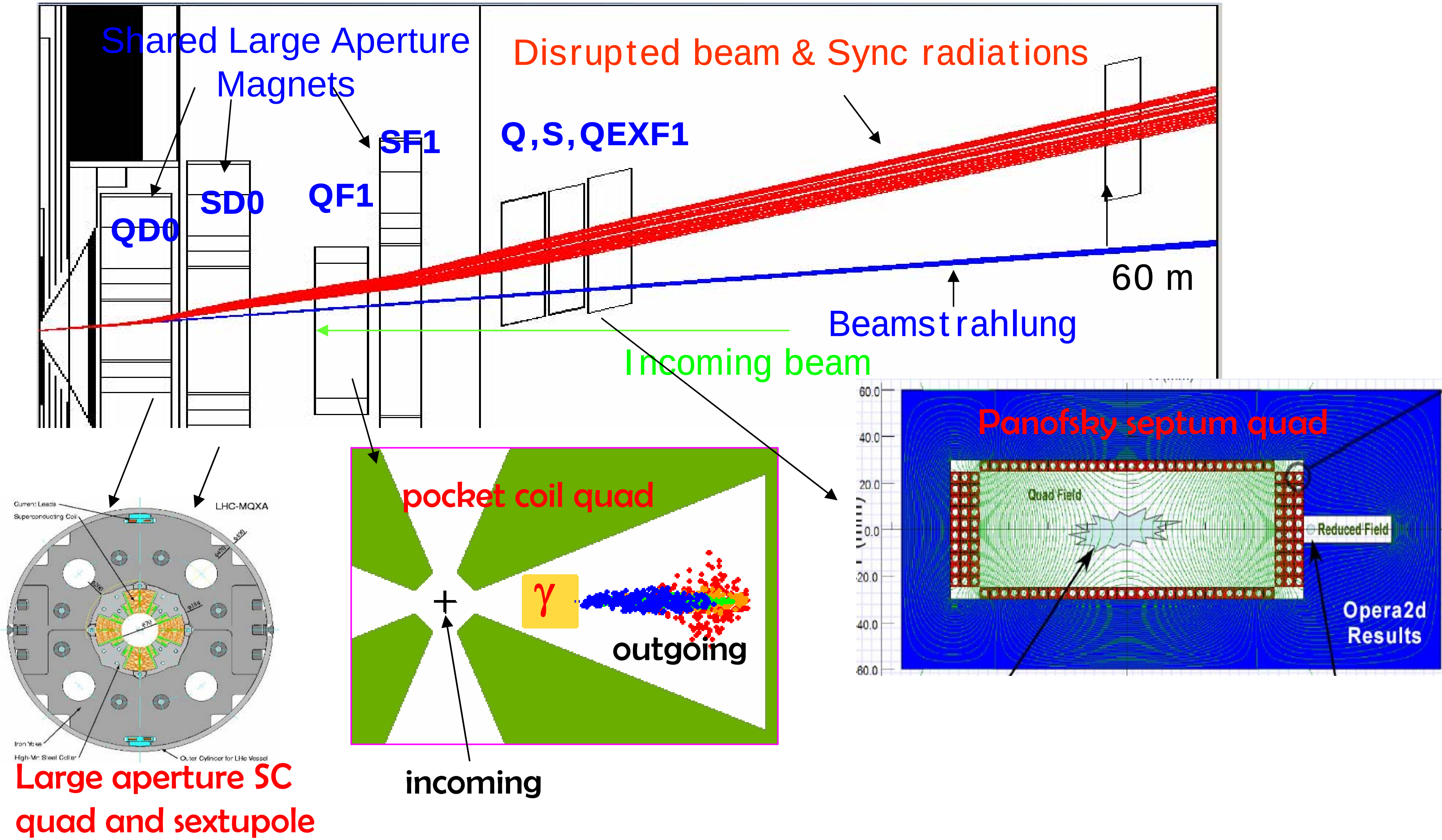
May 16 results at IP:
sigma/sigma_0 = 0.99859 , 1.0087

Optimization of optics if FD is common

- In ILC design one of IR has 2mrad crossing angle, where FD is common for both beams (except QF1)
- We found that one could optimize FD so that sextupole SD0 give additional focusing for the disrupted beam
- That was the main reason that allowed the design of 2mrad extraction optics

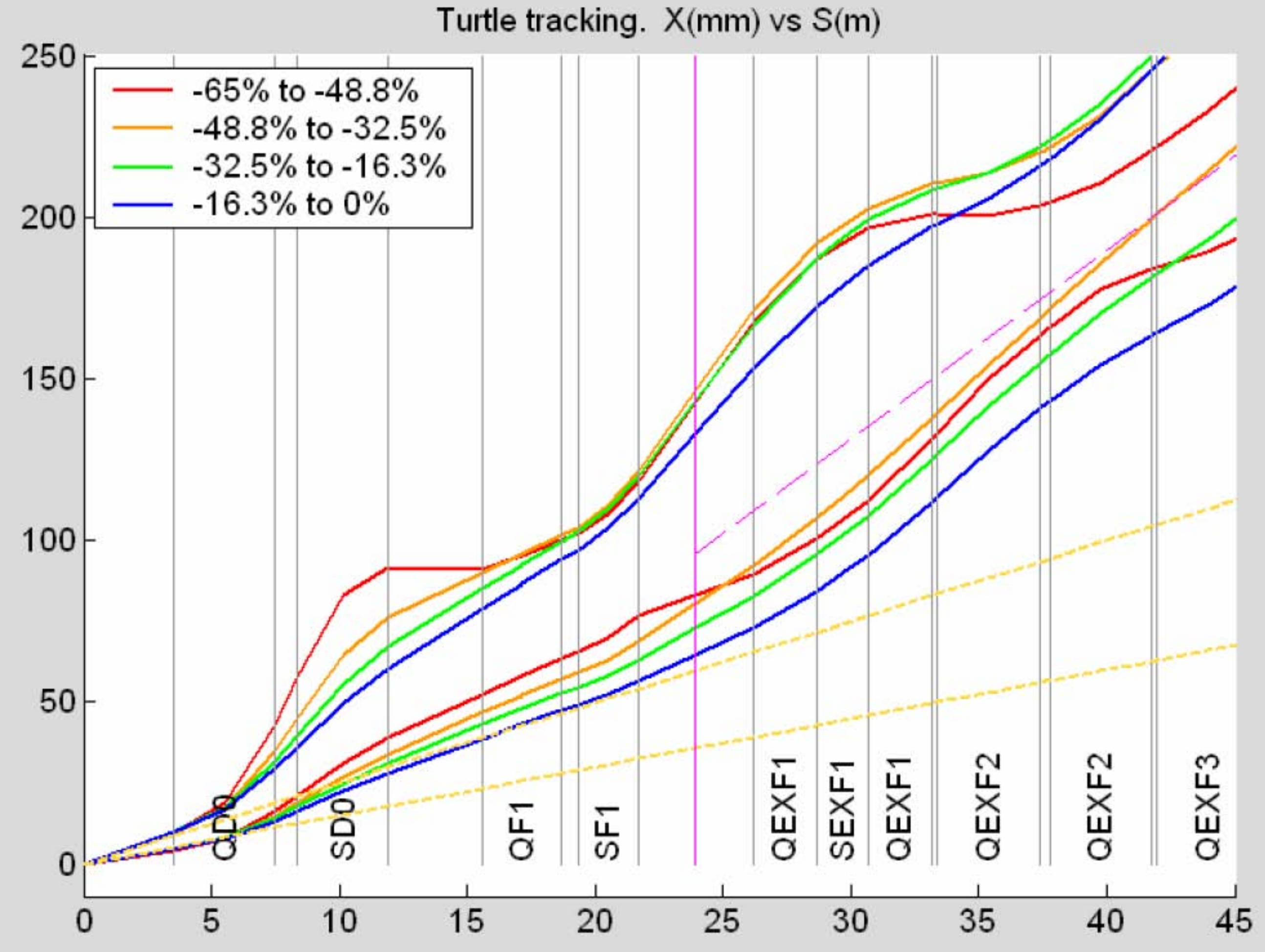


2mrad IR



Shared Large Aperture Magnets
Disrupted beam & Sync radiations
SF1
Q,S,QEXF1
SD0
QF1
QD0
60 m
Beamstrahlung
Incoming beam
LHC-MQXA
Large aperture SC quad and sextupole
pocket coil quad
γ
outgoing
incoming
Panofsky septum quad
Quad Field
Reduced Field
Opera2d Results

Outgoing beam in 2mrad extraction. Beam is well contained up to dE=-65%



- The FD, incoming FF optics and extraction optics are optimized simultaneously
- Similar approach can be used in Super-B

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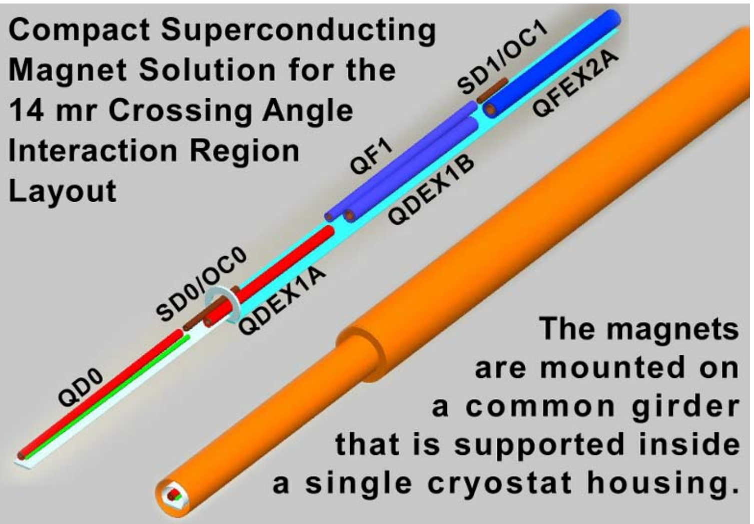
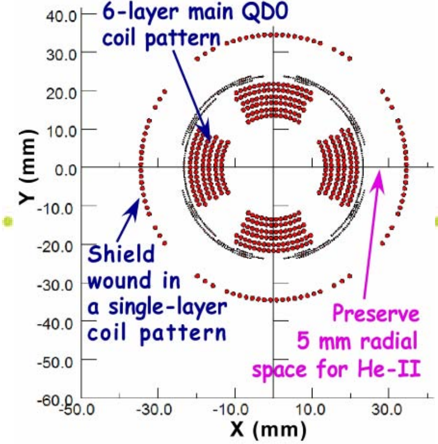
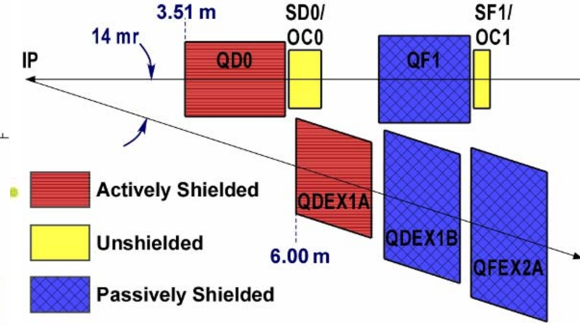
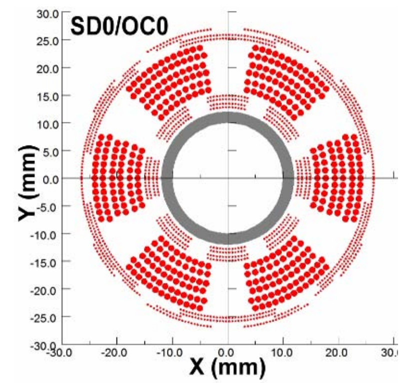
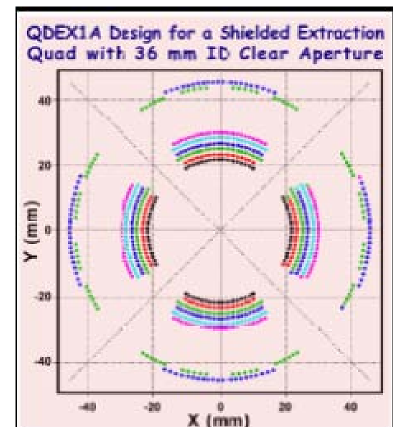
14mr, L*=3.5m
BNL design

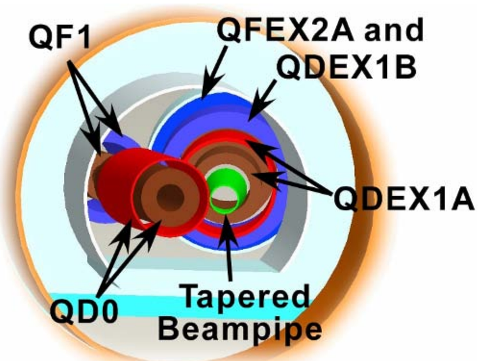


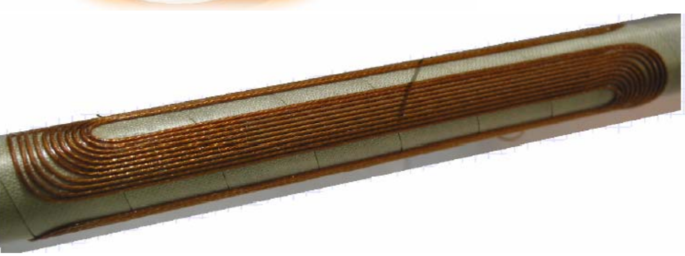


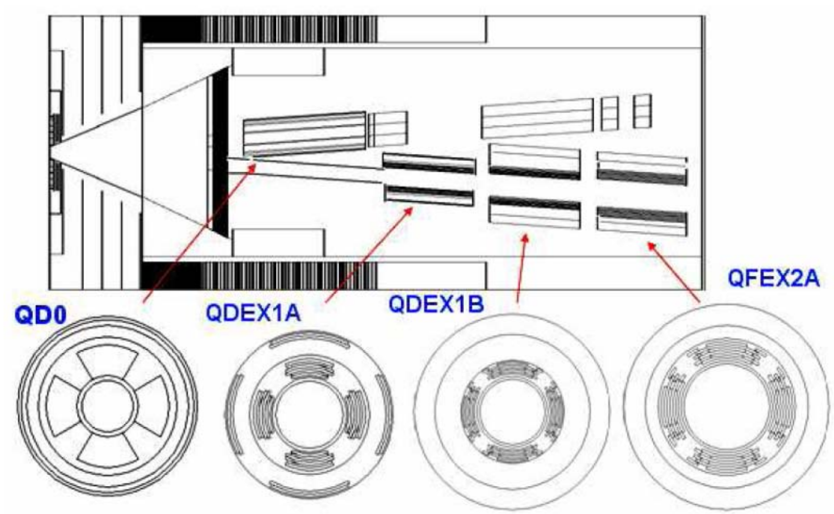


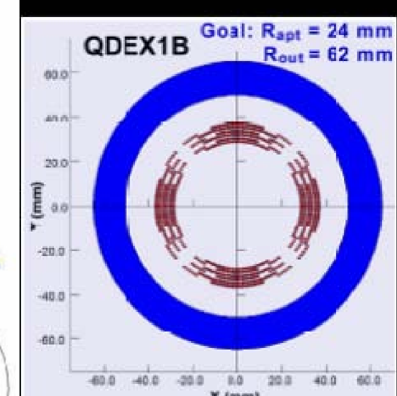












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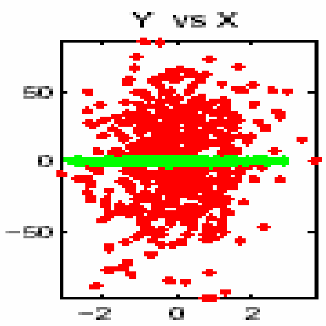
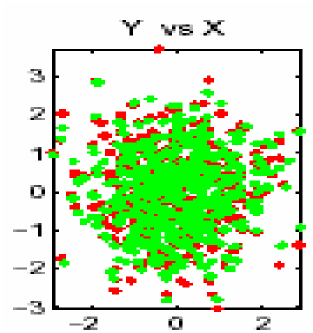
Anti-solenoid for IR



without compensation

$\sigma_y / \sigma_y(0)=32$



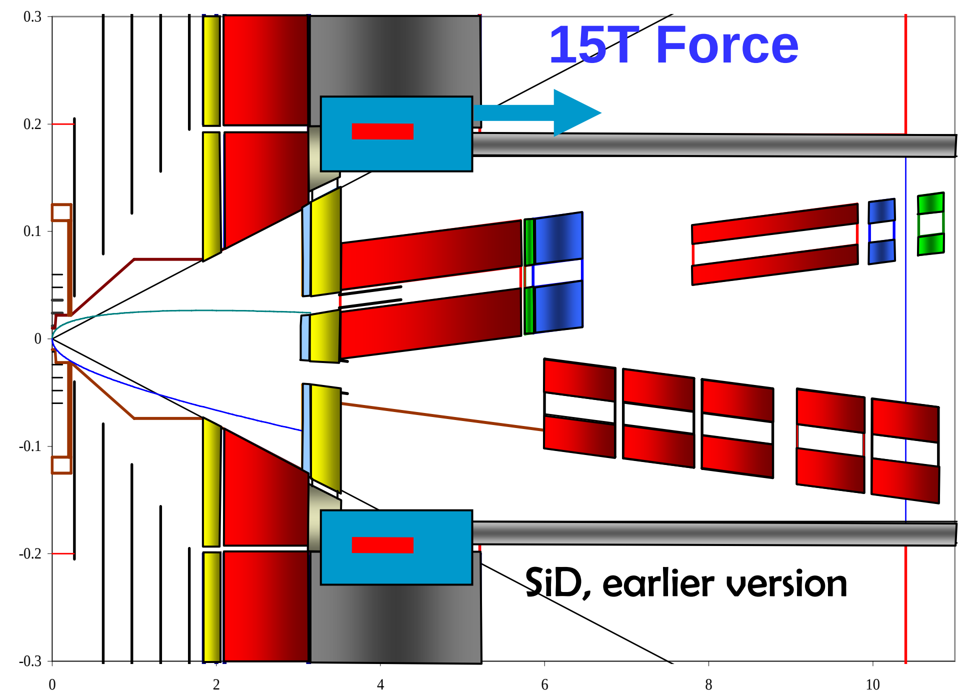
with compensation by antisolenoid

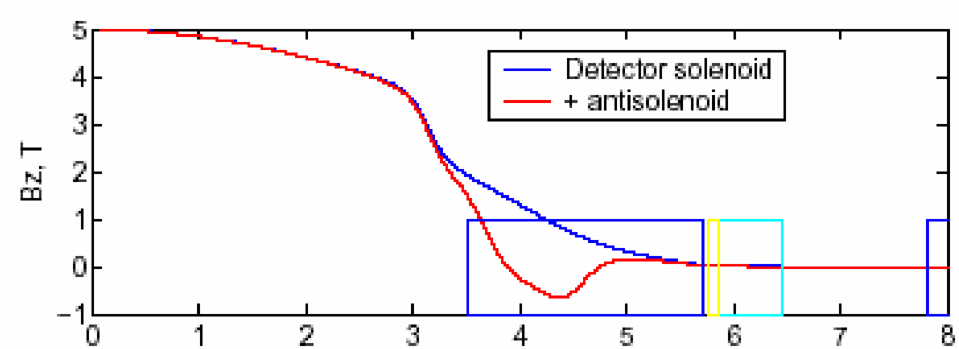
$\sigma_y / \sigma_y(0)<1.01$

When solenoid overlaps QD0, anomalous coupling increases the IP beam size 30 – 190 times depending on solenoid field shape (green=no solenoid, red=solenoid)

Even though traditional use of skew quads could reduce the effect, the LOCAL COMPENSATION of the fringe field (with a little skew tuning) is the best way to ensure excellent correction over wide range of beam energies

Local correction requires anti-solenoid with special shape. The antisolenoid is weak since its integrated strength is much smaller than that of detector solenoid





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Phys. Rev. ST Accel. Beams **8**, 021001 (2005)

Weak antisolenoids for super-B

- Coupling due to solenoid not overlapping with FD ~ $\dfrac{B\ell}{2B\rho}$
  - assume 5GeV beam (16.7T*m) and Bℓ=1T then coupling ~ 3% , very small
- If field overlap with FD by Bℓ, coupling is

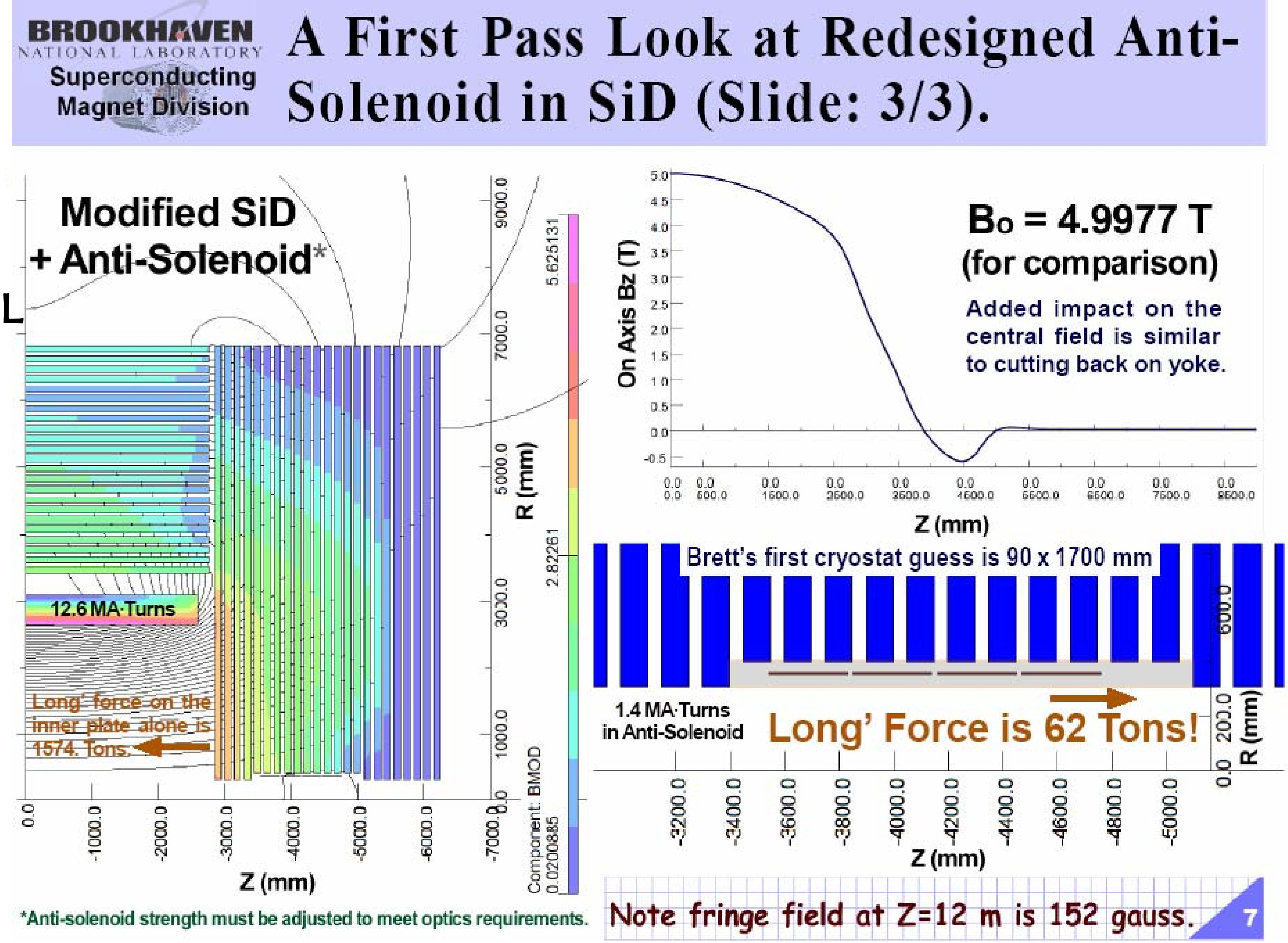
$$\approx \frac{\sigma_{xp0}}{\sigma_{y0}} \frac{B\ell}{B\rho} L_*$$

this is one of the terms. there are many other. see ref. for details

- Assume Bℓ=0.5T, L*=0.8m, σ_{xpo}=0.3mrad, σ_{yo}=12.6nm => coupling ~ 570 !!!
  - This coupling is about 10 times more than in ILC
  - weak antisolenoids probably unavoidable for local compensation

at SLAC

B.Parker, BNL



Antisolenoid was recently redesigned, and use of high temperature superconductor was considered. Top ~20-35K would make cooling much easier

http://ilcagenda.cern.ch/conferenceDisplay.py?confId=696

ATF2
model of ILC FF

Optics Design of ATF2

(A) Small beam size

Obtain $\sigma_y \sim 35$nm

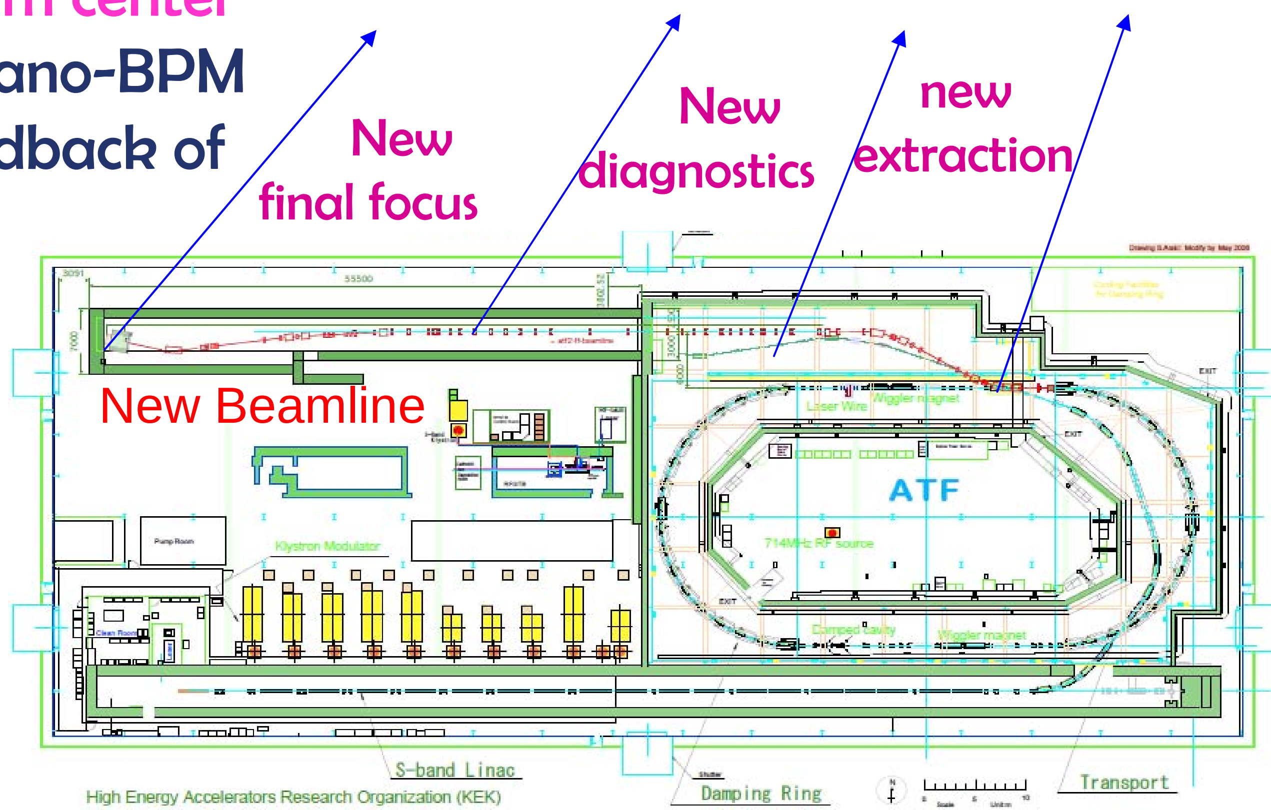
Maintain for long time

(B) Stabilization of beam center

Down to < 2nm by nano-BPM

Bunch-to-bunch feedback of ILC-like train

Beam ←



Designed and constructed in international manner, with contributions from all three regions

Summary

- Need to lengthen the optics to decrease aberrations in FF and improve dynamic aperture of the ring
  - there are other optics ideas (e.g. sextupole for crab) that need to be implemented
- If FD is common, optics can be optimized to improve focusing of the outgoing beam with
- Separate FD give a lot of advantages and L* of ~0.8m or less may be possible
- Weak antisolenoids are beneficial for local compensation of coupling