Design of a linearly colliding Super B-FACTORY

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- Basic Idea comes from the ATF2-FF experiment

  In the proposed experiment it seems possible to acheive spot sizes at the focal point of about 2um*20nm at very low energy (1 GeV), out from the damping ring
- Rescaling at about 10GeV/CM we should get sizes of about 1um*10nm =>
- Is it worth to explore the potentiality of a Collider based on a scheme similar to the Linear Collider one

Basic layout:

3-6Km damping rings with 10000-20000 bunches,6-12 Amps

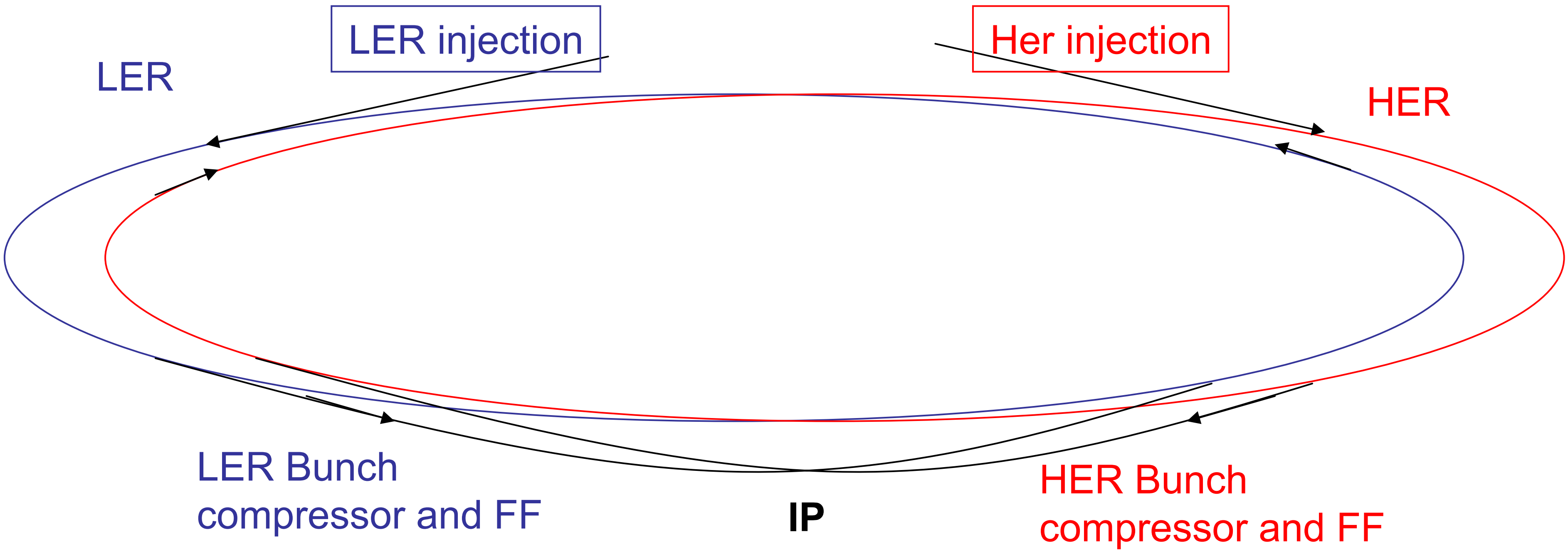
E_{nx}=6e-6, E_{ny}=6e-8,

damping time <1.5ms

- Estract the beams at 100-1000Hz, perform a bunch compression, focus them, collide and reinject the spent beam in the DR

- Maintain the currents constant in the DR with continuos injection

LinearB scheme



Overall rings lenght about 6Km (at the present),
Collision frequency about 120Hz*2400bunch_trains=300Khz
10 bunches in 1 train
Bunch train stays in the ring for 8.3msec, then is extracted, compressed and focused. After the collision is reinjected in its ring

Luminosity

- The luminosity for a linear collider is:

  $L = H_d N p P / 4\pi E \sigma_x \sigma_y$

  Hd : disruption enhancement

  P : average beam power

- For a storage ring is:

  $L = K(1+r) \zeta_y EI / \beta_y$

  I : beam current

  ζ_y : vertical tune shift

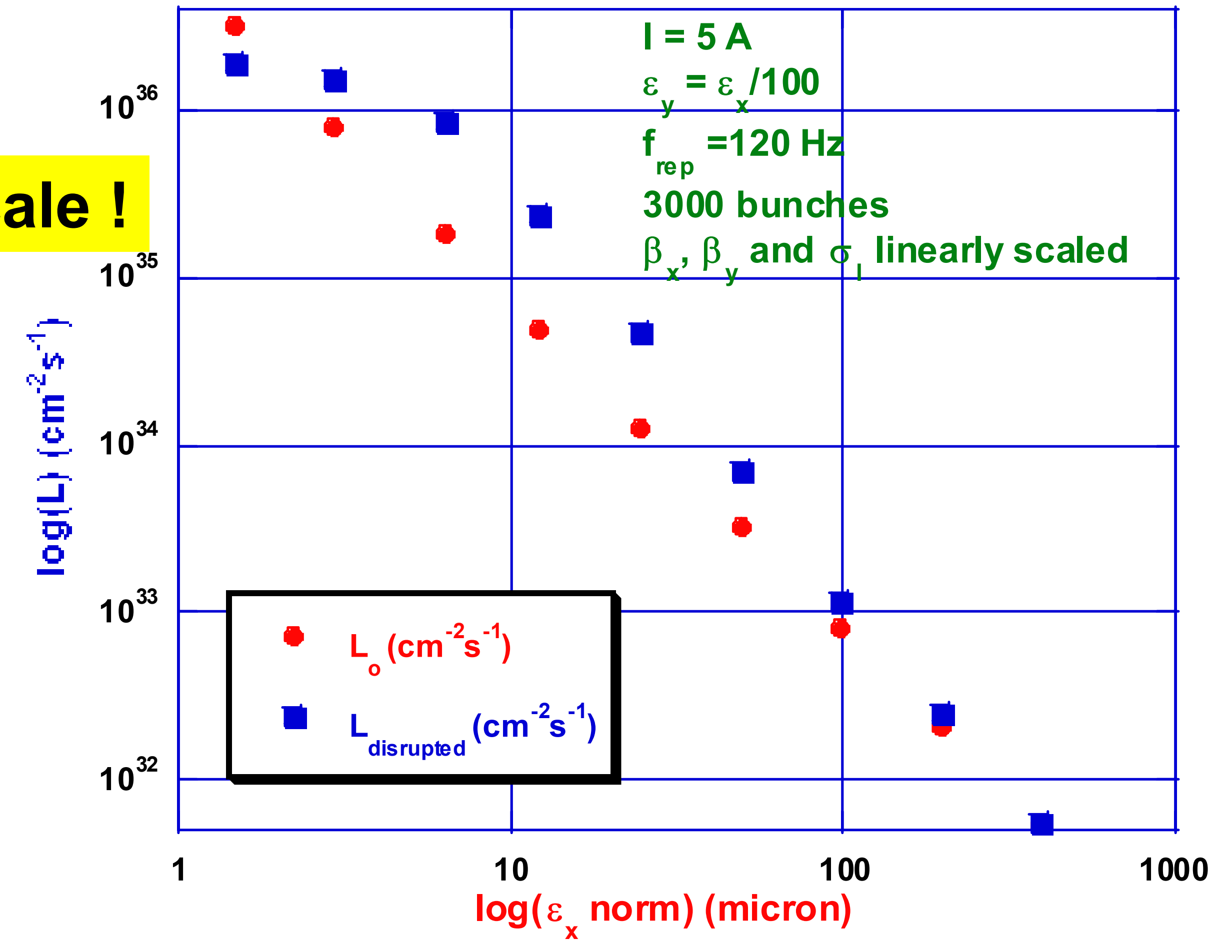
- Instead of being a limitation, Beam-Beam interaction might help to increase the luminosity, we should find a suitable parameters set:

  stable collisions,

  reasonable outgoing emittances and energy spread
- Almost linear relation between damping time and luminosity
- Average current through the detector 10-100 times smaller than in the rings (10-100 mAmps)
- Rings, althought with a parameter set very similar to the LC ones, have still to handle a lot more current and more radiation from increased damping
- A lot of the limitations of both kind of colliders are gone. Worth to explore the concept at least with very preliminary calculations and simulations

L *vs* ε_x with scaled $\beta_x, \beta_y, \sigma_l$ (I_{beam}=5A, 3000 bunches)

Bi-log scale !



Scaling laws

- Disruption:

$$D \approx \frac{N\sigma_z}{(\sigma_x \sigma_y)}$$

Decrease σ_z + decrease N
Increase spotsize

- Luminosity

$$L \approx \frac{N^2}{(\sigma_x \sigma_y)}$$

Increase N
Decrease spotsize

Contraddicting requests!

- Energy spread:

$$\delta_E \approx \frac{N^2}{(\sigma_x^2 \sigma_z)}$$

Increase σ_z + decrease N
Increase spotsize

Parameter sets for the Pep and the Linear SuperB:

	Linear B	SuperPeP
N_b	24000	5000
f_o	120Hz	136KHz
ε_x	0.6nm	20nm
ε_y	0.006nm	1nm
β_x	1mm	100mm
β_y	1mm	3.0mm
σ_z	0.7mm	3.0mm
σ_x	0.8um	45um
σ_y	0.08 um	1.7um
τ_d	1.4ms	20ms
I+	7.2 A	10 A
I-	7.2 A	20 A
N+	4 e10	1.3 e11
N-	4 e10	2.6 e11
Hd	2.3	1.0
L	$1.1\ 10^{36}$	$1.7\ 10^{36}$

- Both solutions very similar in terms of total charge stored and luminosity
- Super Pep requires more current
- LinearB requires shorter damping time and smaller emittances from the rings
- LinearB probably costs at least 5 times more in power for the increased damping
- LinearB Current through the detector about 100 times smaller
- LinearB Beam spot sizes at the IP smaller
- LinearB Background and aborts easier to handle
- LinearB kickers very challenging
- Handling the spent beam might be difficult as well
- LinearB Energy spread larger due to the bunch compressor and the beamstralung

LinearB present solution at the moment does not look any better than the conventional collider.

Probably we have not yet optimized the machine parameters to take full advantage of the small beam emittances and high charge, and a potentially much higher disruption enhancement.

An “intermediate” solution with higher collision frequency and smaller disruption might get the best of the two schemes

I hope that during the workshop many ideas will come to improve the potential of this scheme and to be able to decide if it has to be abandoned and we have to concentrate all our efforts for the conventional solution.

Hot points for the workshop:

- find the “absolute best” set of beam parameters:
  high luminosity and acceptable energy spread
- find out if a ring or a stack of rings capable of delivering such beam is conceivable and reasonable to be built
- address the less critical points:
  - bunch compressor
  - final focus
  - trickle injection
  - IR
  - background
  - life times
  - kickers (critical but small)
  - etc…