Francesco

C.Biscari

LNF - INFN

Francesco Ruggiero Memorial Symposium, CERN, 3 October

1982 - 1985 at CERN

Organization of seminars from and for young scientists

- TMC and Beam beam interaction
- Particle detectors
- RFQ design
- Gravitational waves
- …

EPS-AG

EPAC organization

http://epac06.org/general/committees/OC/

http://epac06.org/general/committees/SPC/

Coordinates session on

- Beam Dynamics and ElectroMagnetic Fields - Paris 2002 –
- Beam Dynamics and ElectroMagnetic Fields - Lucerne 2004 -
- Circular colliders - Edinburgh 2006

Frascati colliders e$^+$ e$^-$

		E$_{cm}$ (GeV)	L (10^{32})
ADA	1960	0.4	
ADONE	1969/78 1990/93	0.6/3.1	0.003
DAΦNE	1998/2003.. .. 2003/2006	1.	1.

FUTURE   x 2   x 100
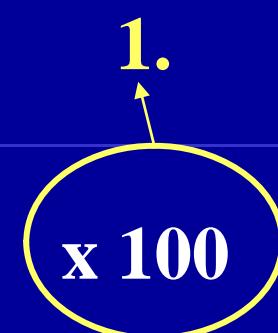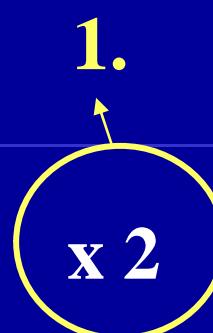
Varying bunch length along the ring by large longitudinal phase advance

Drift Space

$$M(s_0, s) = \begin{bmatrix} 1 & R_{56}(s) - R_{56}(s_0) \\ 0 & 1 \end{bmatrix}$$

Longitudinal conjugate variables => $\begin{bmatrix} z \\ \varepsilon_E \end{bmatrix}$

$z = c \cdot \tau$ (τ = particle delay respect to synch. phase)

$\varepsilon_E = \Delta E / E$ = relative energy error

$$R_{56}(s) = \int_0^s \frac{\eta(\tilde{s})}{\rho(\tilde{s})} d\tilde{s}$$

$$M(s_c^-, s_c^+) = \begin{bmatrix} 1 & 0 \\ -\dfrac{V_{RF}}{E/e} \dfrac{2\pi}{\lambda_{RF}} & 1 \end{bmatrix}$$

RF Cavity = long. thin lens
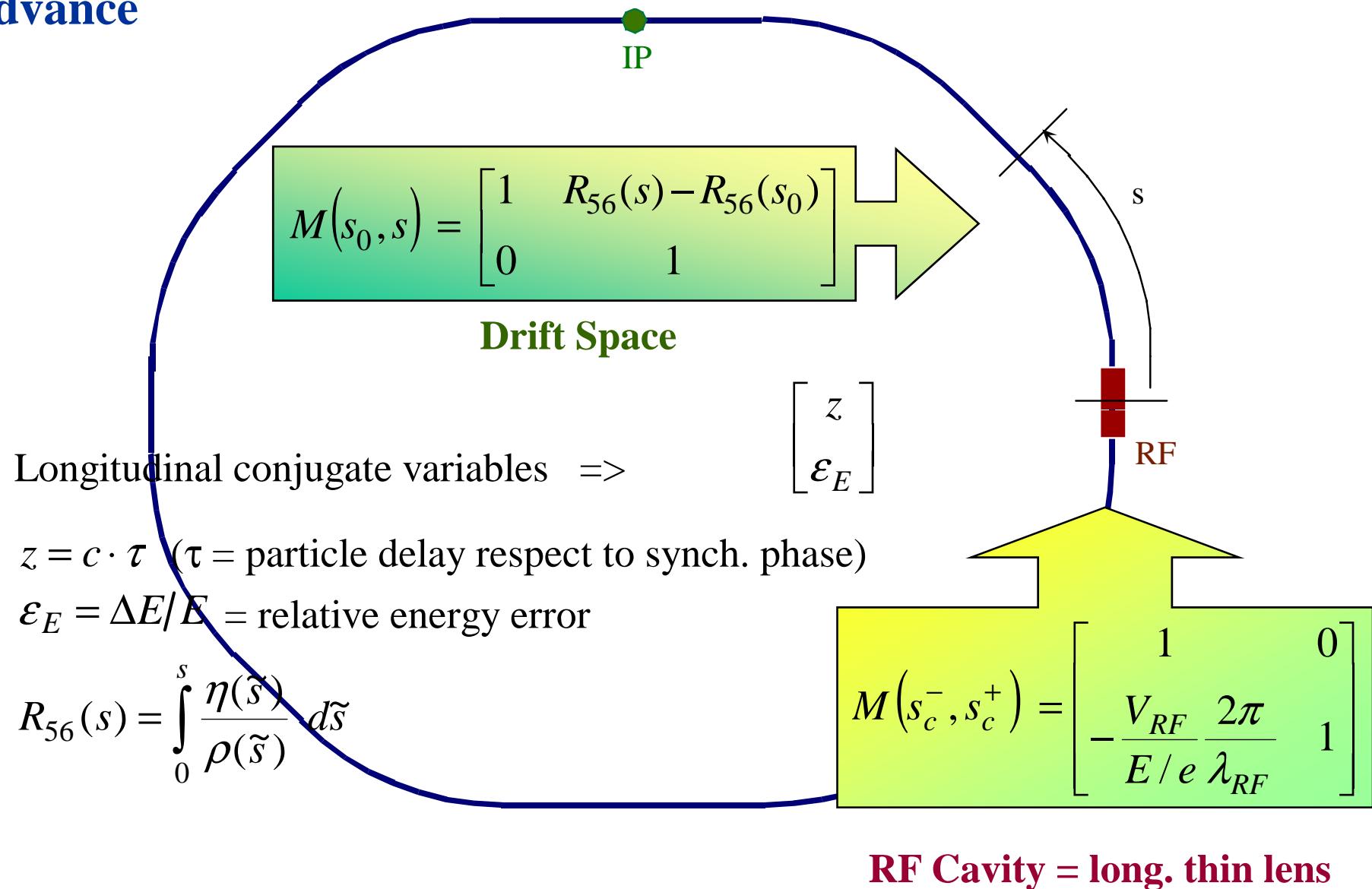
Strong rf focusing – monotonic R_1

$$R_1(s) = \int_s^{s_{rf}} \frac{D(s')}{\rho(s')} ds'$$

High rf voltage + high momentum compaction:
High synchrotron tune
**Ellipse rotates always in the same direction**

Longitudinal phase space

From RF to IP

IP

Energy spread

RF input

RF center

RF output

Bunch length
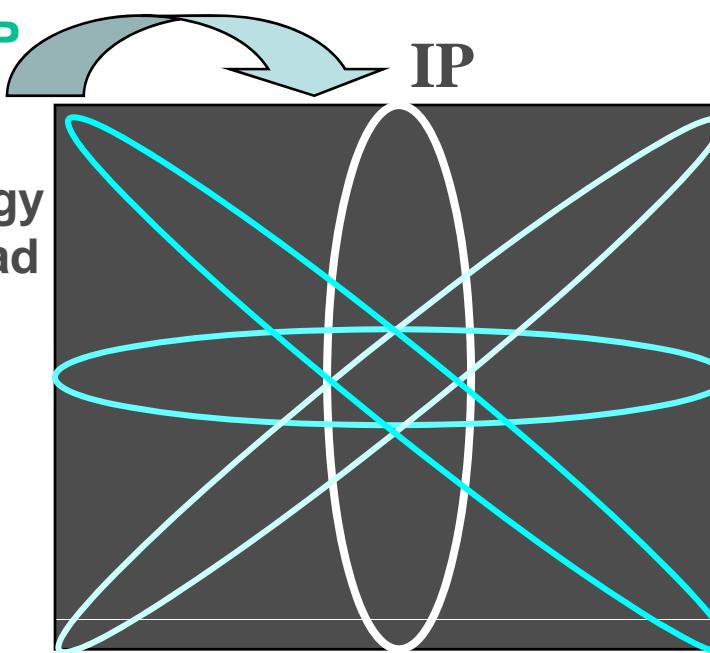
Evolution of Strong rf focusing – non monotonic R_1

High rf voltage + high derivative of R_1 (s):
Low synchrotron tune
Ellipse rotates on both directions

$dR_1/ds > 0$

$dR_1/ds < 0$

Energy spread

Bunch length
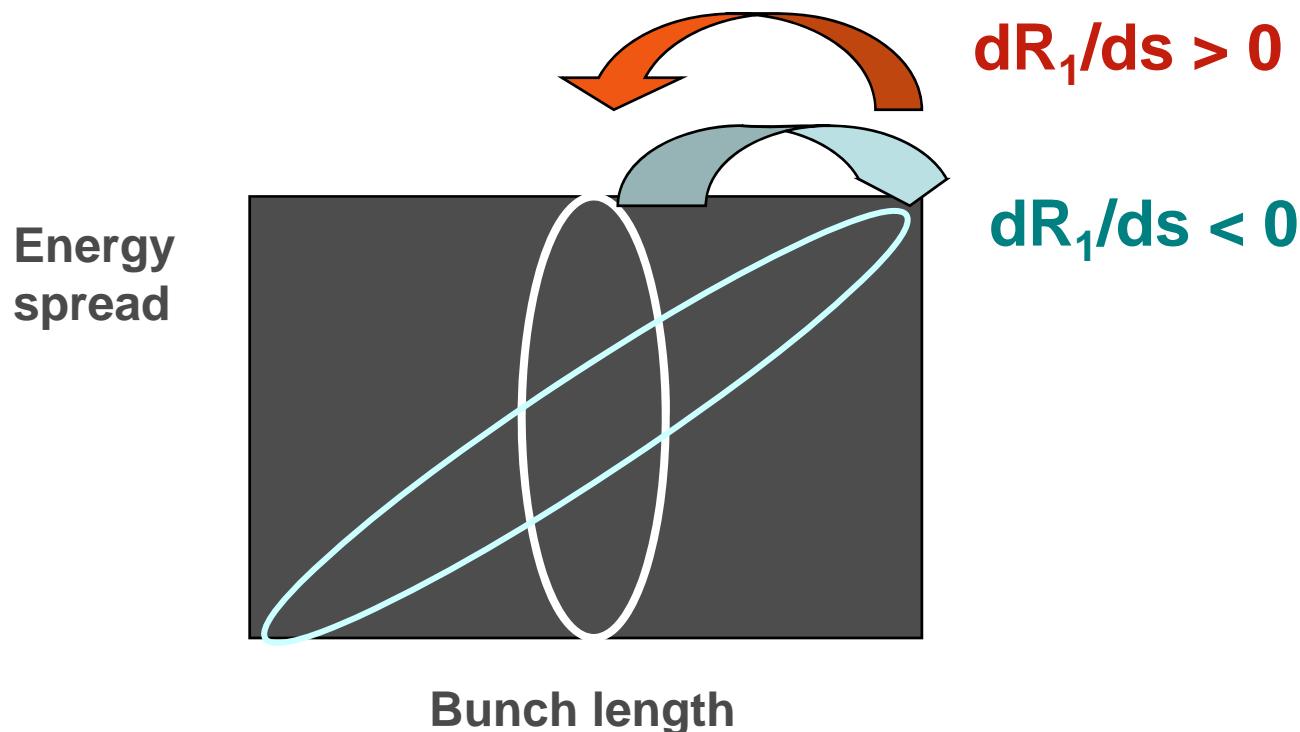
Workshop on

e+ e- in the 1-2 GeV range: Physics and Accelerator Prospects

ICFA Mini-workshop - Working Group on High Luminosity e+e- Colliders

10-13 September 2003, Alghero (SS), Italy

Organizing Committee

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S. Bertolucci (Chairman) (INFN-LNF)
M. Biagini (INFN-LNF)
C. Biscari (INFN-LNF)
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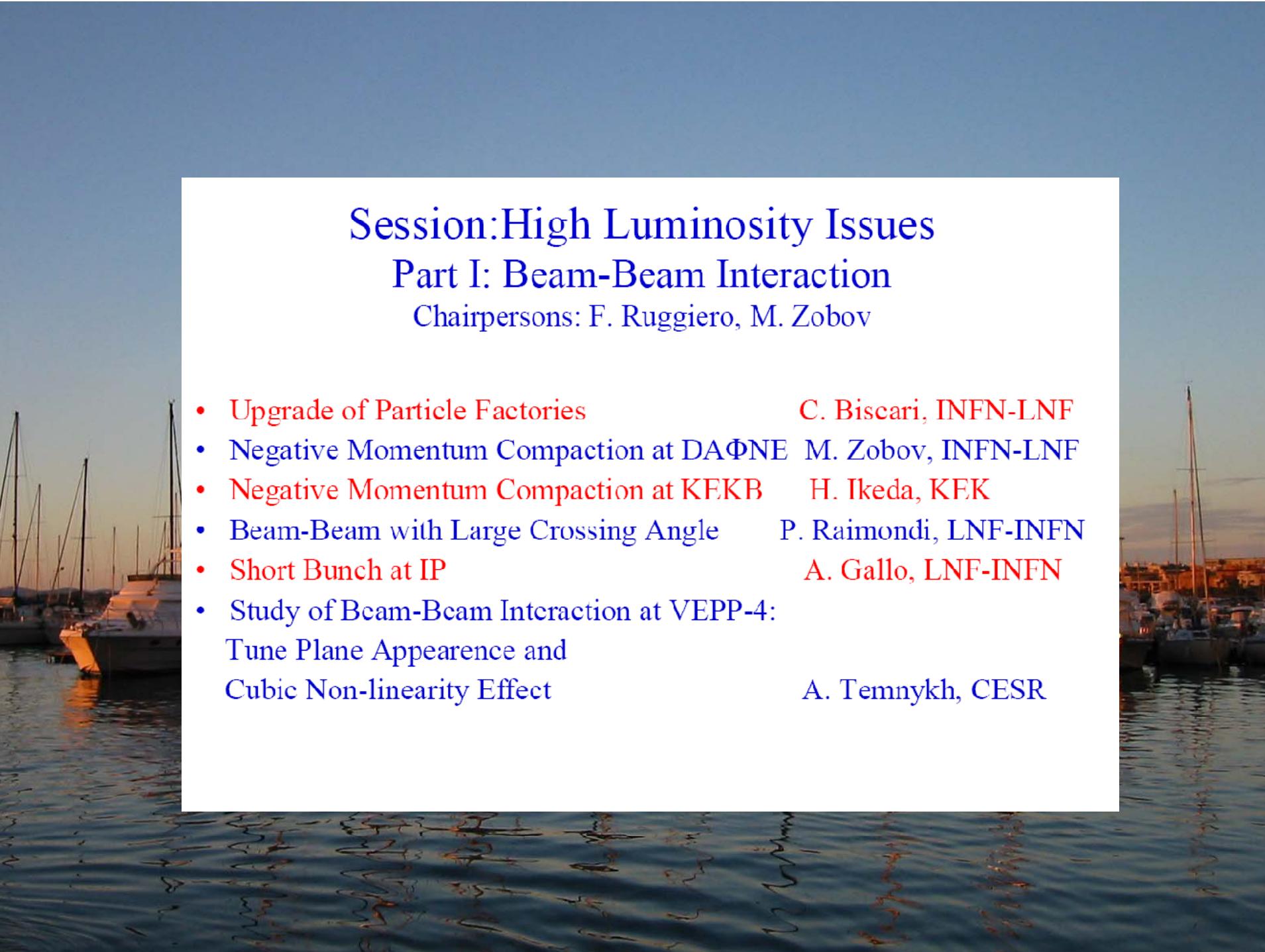
Session:High Luminosity Issues
Part I: Beam-Beam Interaction
Chairpersons: F. Ruggiero, M. Zobov

- Upgrade of Particle Factories   C. Biscari, INFN-LNF
- Negative Momentum Compaction at DAΦNE   M. Zobov, INFN-LNF
- Negative Momentum Compaction at KEKB   H. Ikeda, KEK
- Beam-Beam with Large Crossing Angle   P. Raimondi, LNF-INFN
- Short Bunch at IP   A. Gallo, LNF-INFN
- Study of Beam-Beam Interaction at VEPP-4:
  Tune Plane Appearence and
  Cubic Non-linearity Effect   A. Temnykh, CESR

Beam-beam scalings and constraints

$$L \cong f_{coll} \frac{N^2}{4\pi \cdot \sqrt{\varepsilon_x \varepsilon_y \beta_x \beta_y}} \cdot H \cdot F$$

f_{coll} Bunch collision frequency $\implies$ fill all buckets, increase RF-frequency

$H \approx 1$ Hourglass factor for $\beta_x, \beta_y \geq \sigma_z$ $\implies$ Reduce $\sigma_z \begin{cases} \alpha_c < 0, \\ \text{Strong RF} \end{cases}$

$F \approx 1$ Crossing angle factor for $\theta_c \sigma_z << \sigma^2$ $\implies$ Reduce θ_c, Crab-crossing

$\Delta Q \propto \dfrac{N}{\varepsilon} \dfrac{F}{E}$ Linear beam-beam tune shift $\implies$ Maximize ΔQ

$\left\{ \begin{array}{l} \text{BB limit:} \Delta Q < \Delta Q_{max} = g\left(\left(\dfrac{\tau_{rev}}{\tau_{damp}} \right)^{1/3}, Q, J_z \right) \implies \text{Increase damping, Optimize } Q_x, Q_y, \text{ Round beams} \\ \\ \text{Parasitic BB collisions:} \quad d_{sep} \geq 10\sigma \implies \text{Increase } \theta_c \end{array} \right.$
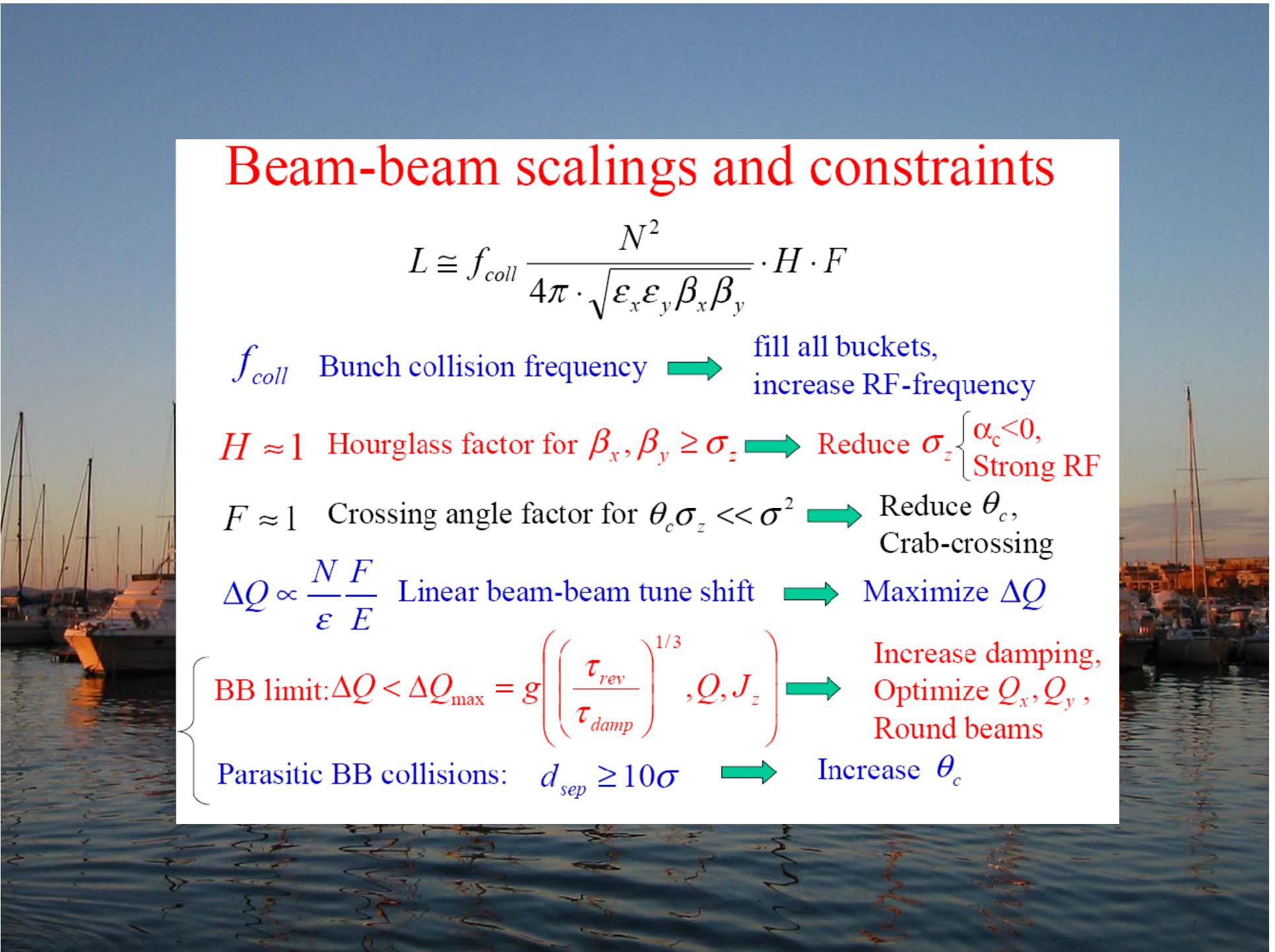
Other new ideas for high L

· **collisions with neutralized beams**

(four beams) + feedback system

beam 1 e⁻   beam 2 e⁻

8 GeV   3.5 GeV

collision

beam 3 e⁺   beam 4 e⁺
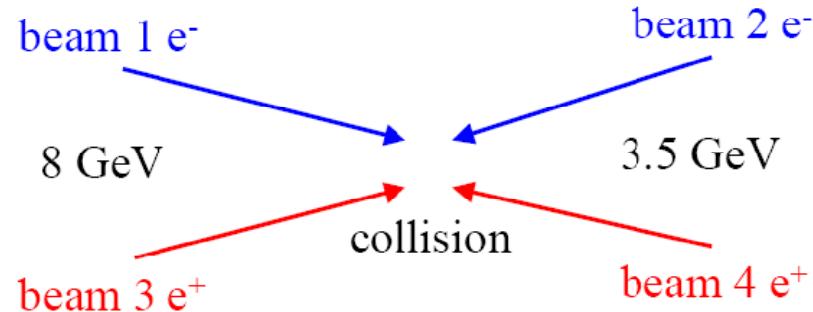
· **ring against linac**

· **Monochromators**

· **Collisions with large crossing angle:**

$E_{cm}= 2E_{beam}\cos(\theta_c/2)$, e.g. $\theta_c/2 =60°$, $E_{beam}=1GeV$

CONCLUSIONS

- New ideas to increase luminosity can/will be tested in the near future:

- ❑ Crab cavities (KEK-B)
- ❑ Collisions with round beams (VEPP2000)
- ❑ Negative α_C and strong damping (KEK-B, DAΦNE)
- ❑ Strong RF focussing (CESR?)

- The approach of the DAΦNE machine team is sound: $L=10^{34}$ is already a challenging target

- $L=10^{35}$ needs many combined new ideas/technologies

  ➡ higher risk and longer time scale