Status of the VEPP-2000 Collider Project

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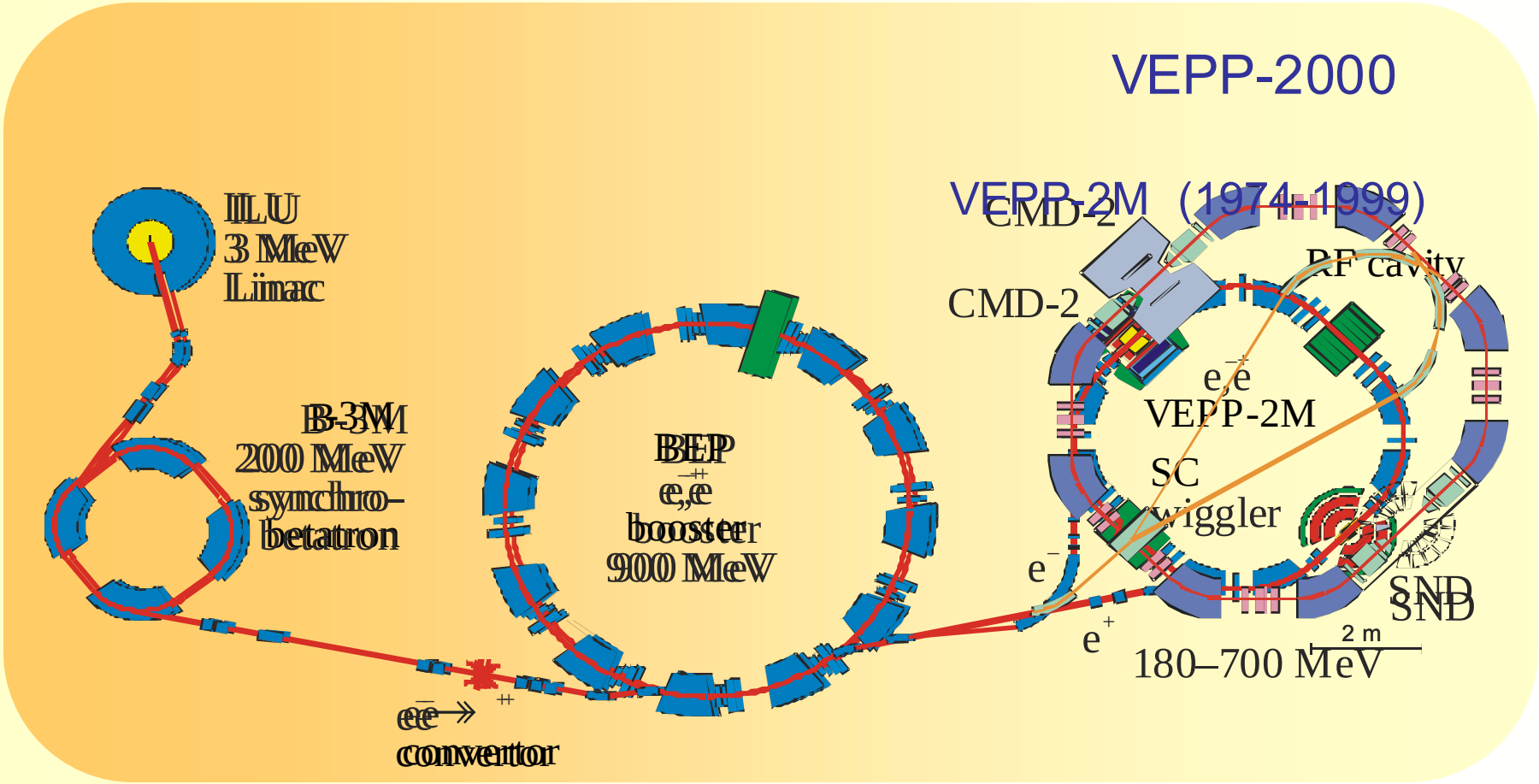
Layout of the VEPP(-2M)-2000 collider complex



- **E ≈ 1 GeV (per beam)**
- **L ≈ 1×10^{32} cm^{-2} sec^{-1} (1×1 bunch)**

ВЭПП-2000

TASKS for VEPP-2000:

1. To study “peculiarities” above 1.4 GeV (total).

2. To measure with good enough precision total hadron cross-section in 1.4 - 2 GeV (total) - for hadron contribution to muon g-2.

3. To measure form-factors (in time-like region) for protons and neutrons

$e^+ + e^- \longrightarrow p + \text{anti-}p$; $e^+ + e^- \longrightarrow n + \text{anti-}n$.

4. For accelerator physics: “Round Beams”!

Increasing the Luminosity

- Number of bunches
- Bunch-by-bunch luminosity

$$L = \frac{\pi \gamma^2 \xi_x \xi_y \varepsilon_x f}{r_e^2 \beta_y^*} \left(1 + \frac{\sigma_y}{\sigma_x}\right)^2$$

Round Beam:

- ✓Geometric factor
- ✓Beam-beam limit enhancement

Concept of Round Beams

Conservation of the z-component of angular momentum $M_z = yp_x - xp_y$

Requirements:

- ✓Round cross-section of beams at IP
- ✓Machine optics has rotational symmetry

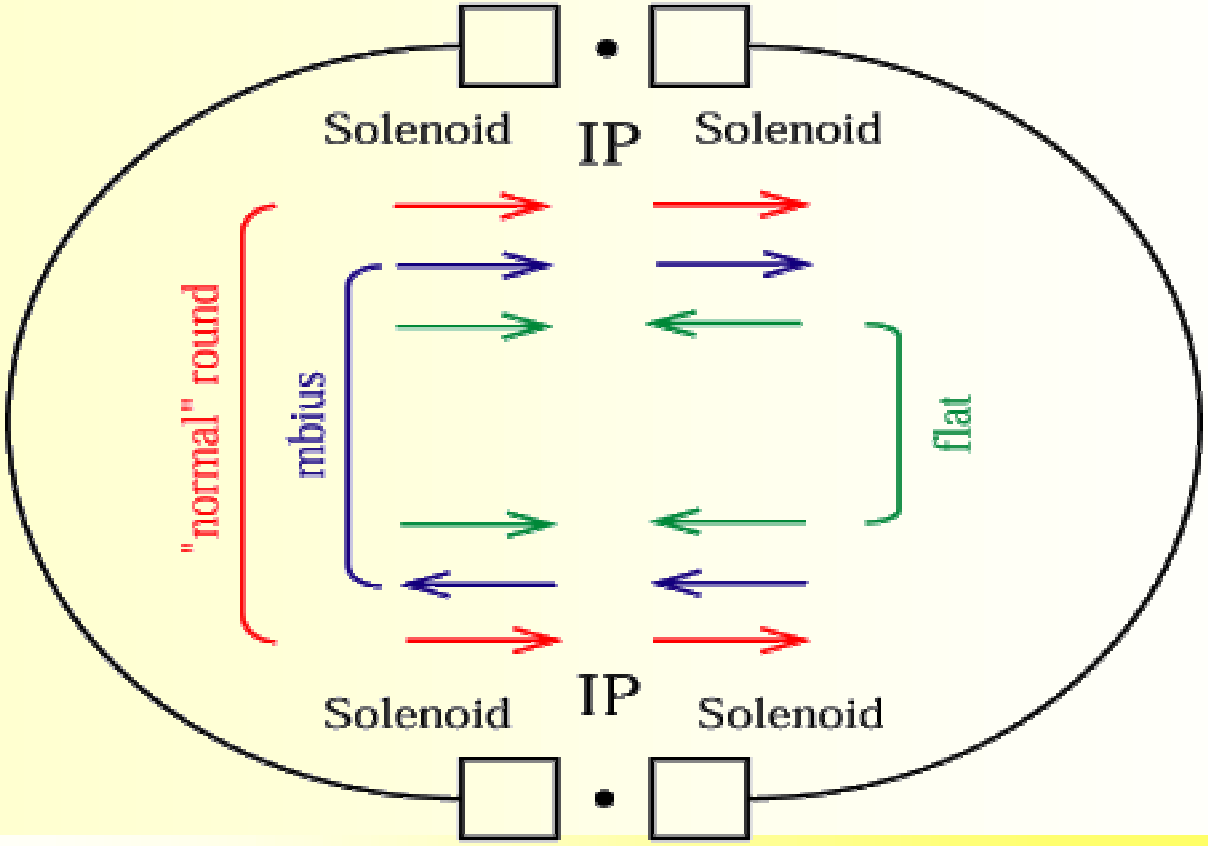
4×4 transfer matrix $T = \begin{pmatrix} A & -B \\ B & A \end{pmatrix}$

Motion in central field with additional integral of motion reduces the transverse oscillations from 2D to 1D!

(V.V.Danilov *et al*, Frascati Physics Series Vol. X (1998), p.321)

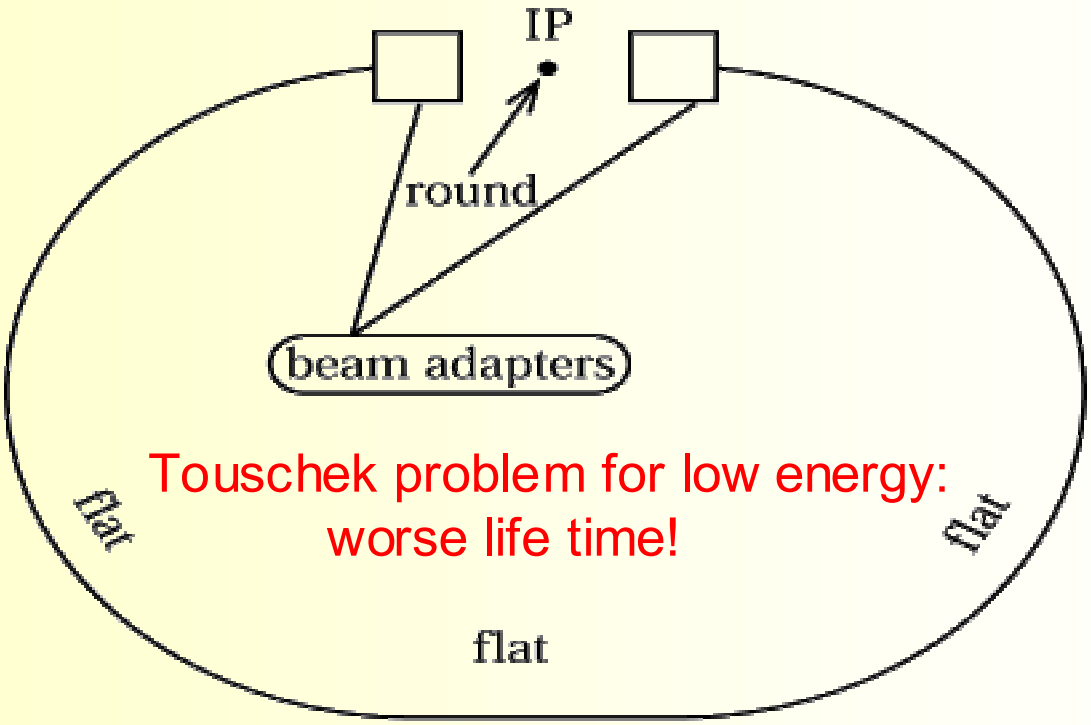
Practical Realization of Round Beams: Options for VEPP-2000

$$\int_0^l H_{sol}\,ds = \frac{1}{2}\oint H_z\,ds$$



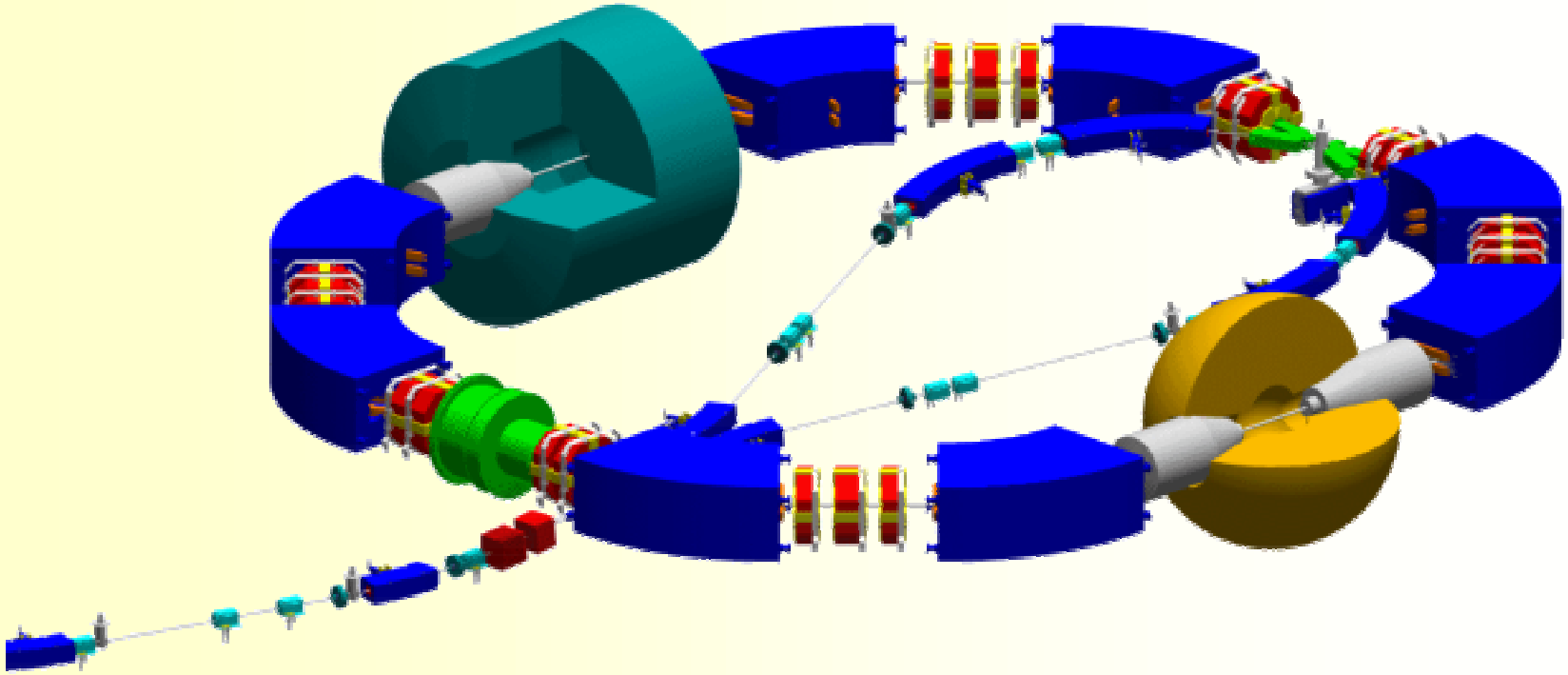
Practical Realization of Round Beams

Conversion of conventional machine using beam adapters

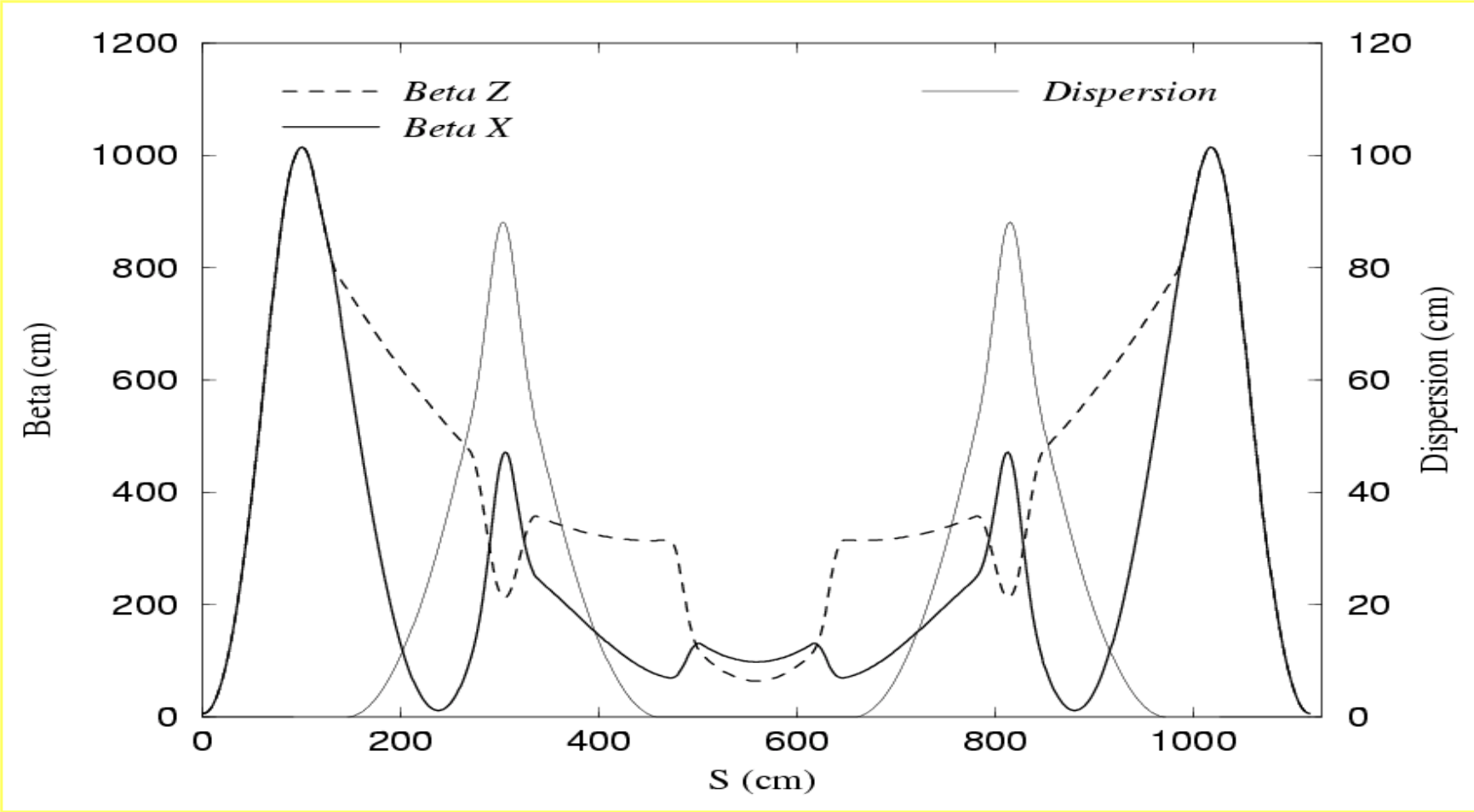


(A.Burov, S.Nagaitsev, Ya.Derbenev, FERMILAB-Pub-01/060-T)

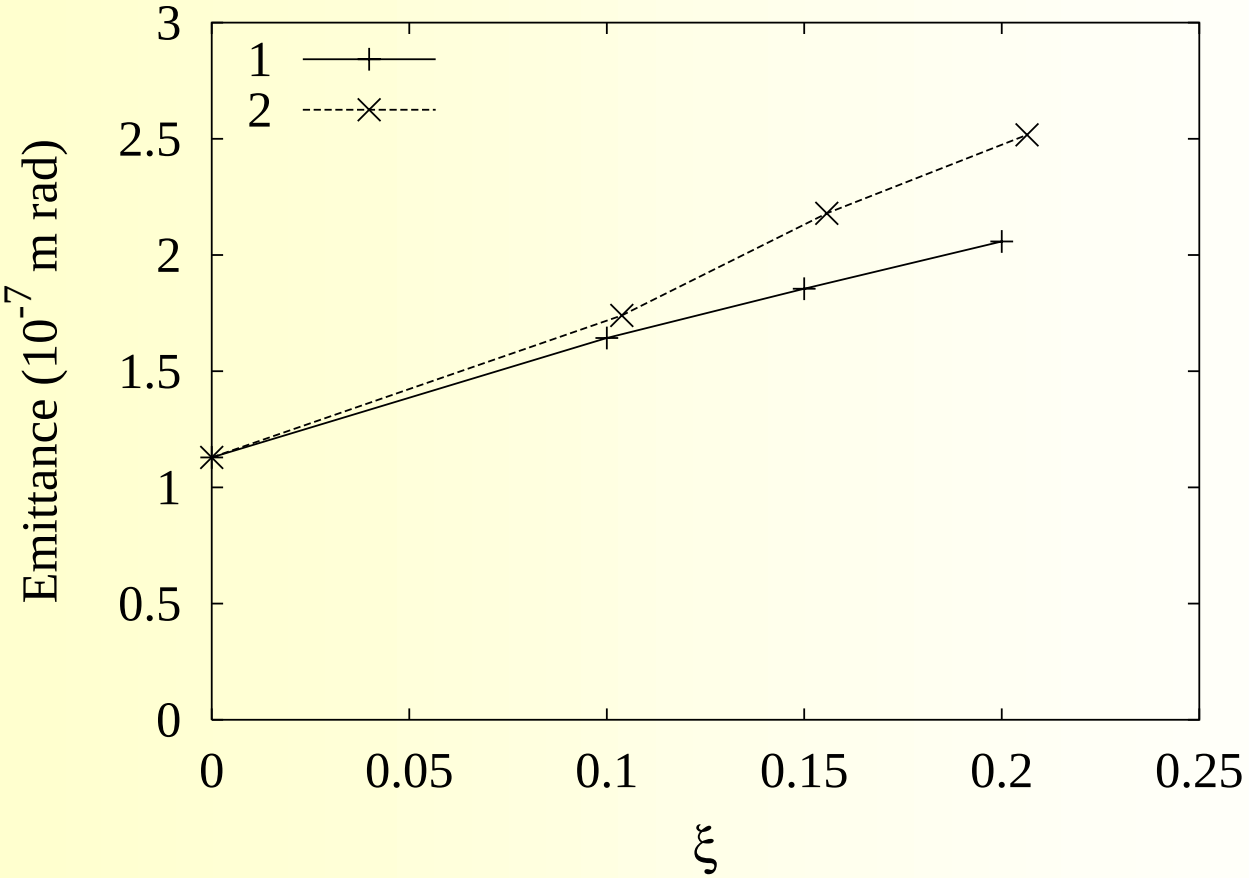
View of the Collider



Lattice

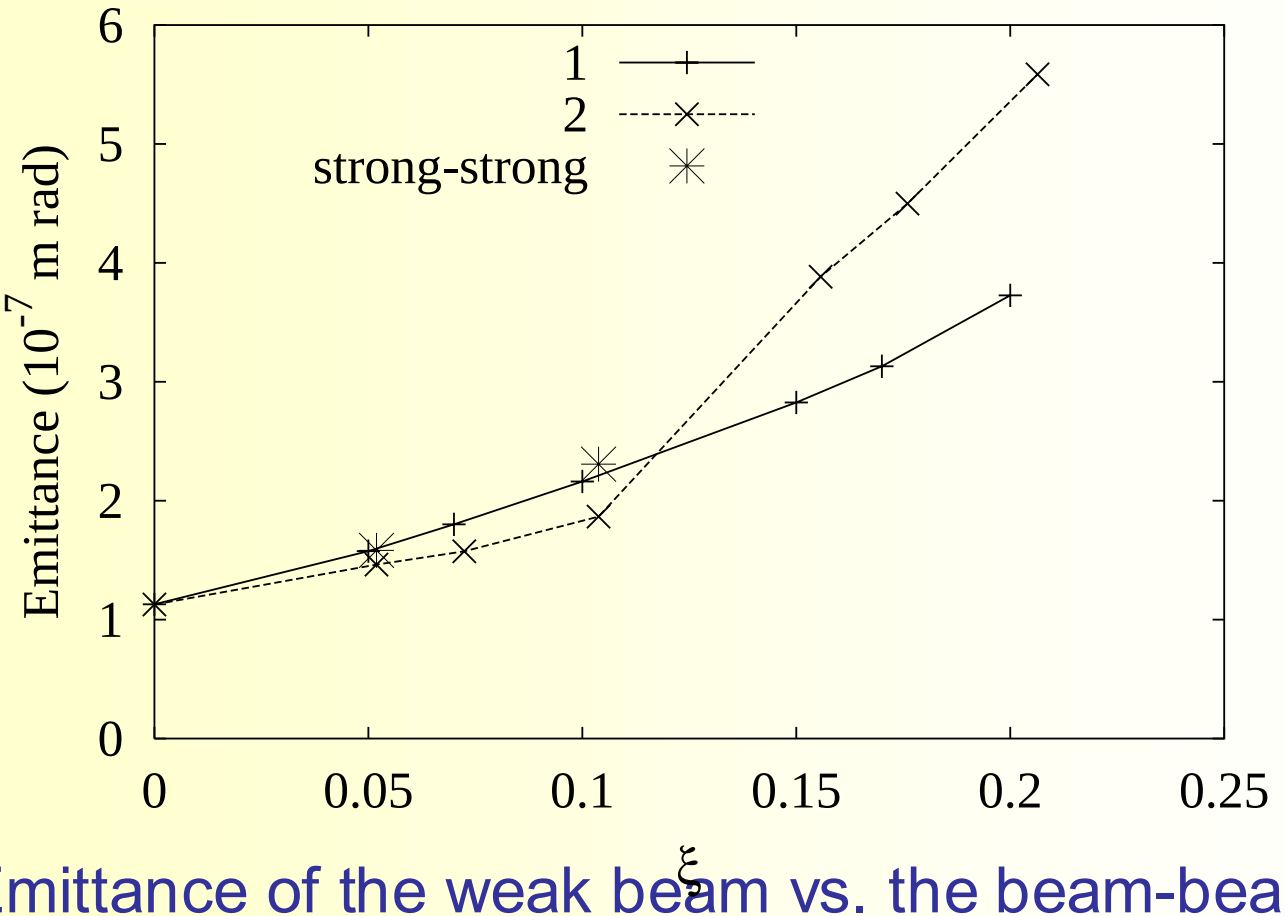

Beta Z
Beta X
Dispersion
Beta (cm)
Dispersion (cm)
S (cm)
0
200
400
600
800
1000
1200
0
20
40
60
80
100
120

Weak-Strong Beam-Beam Simulation



Emittance of the weak beam vs. the beam-beam parameter. Sextupoles off. 1,2 – two codes.

Weak-Strong Beam-Beam Simulation



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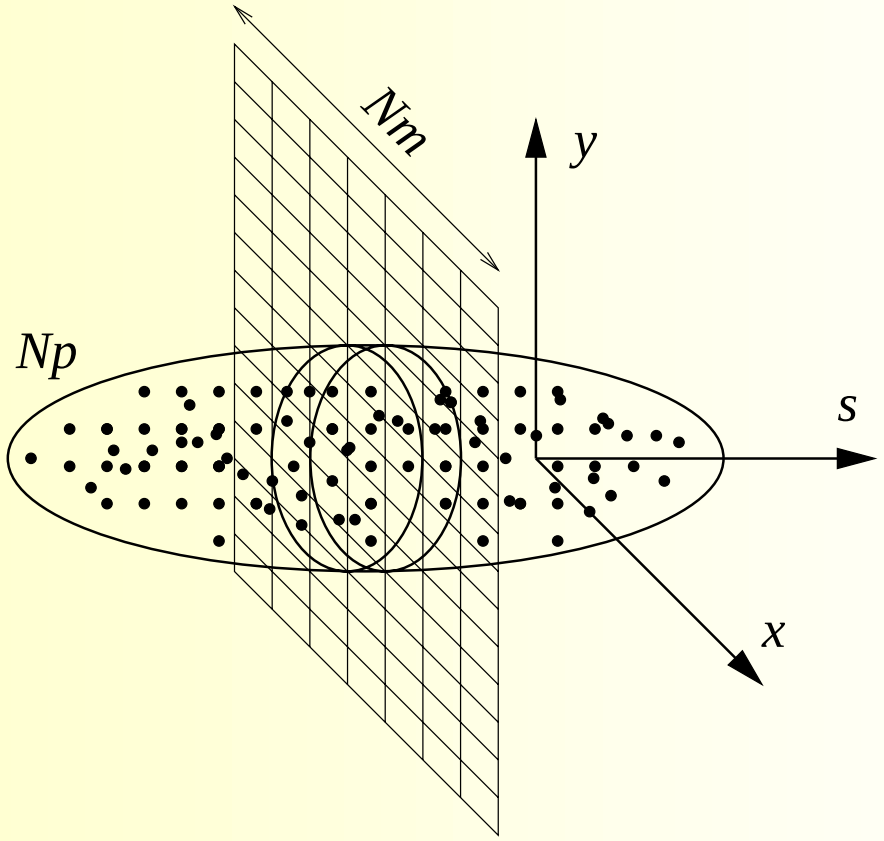
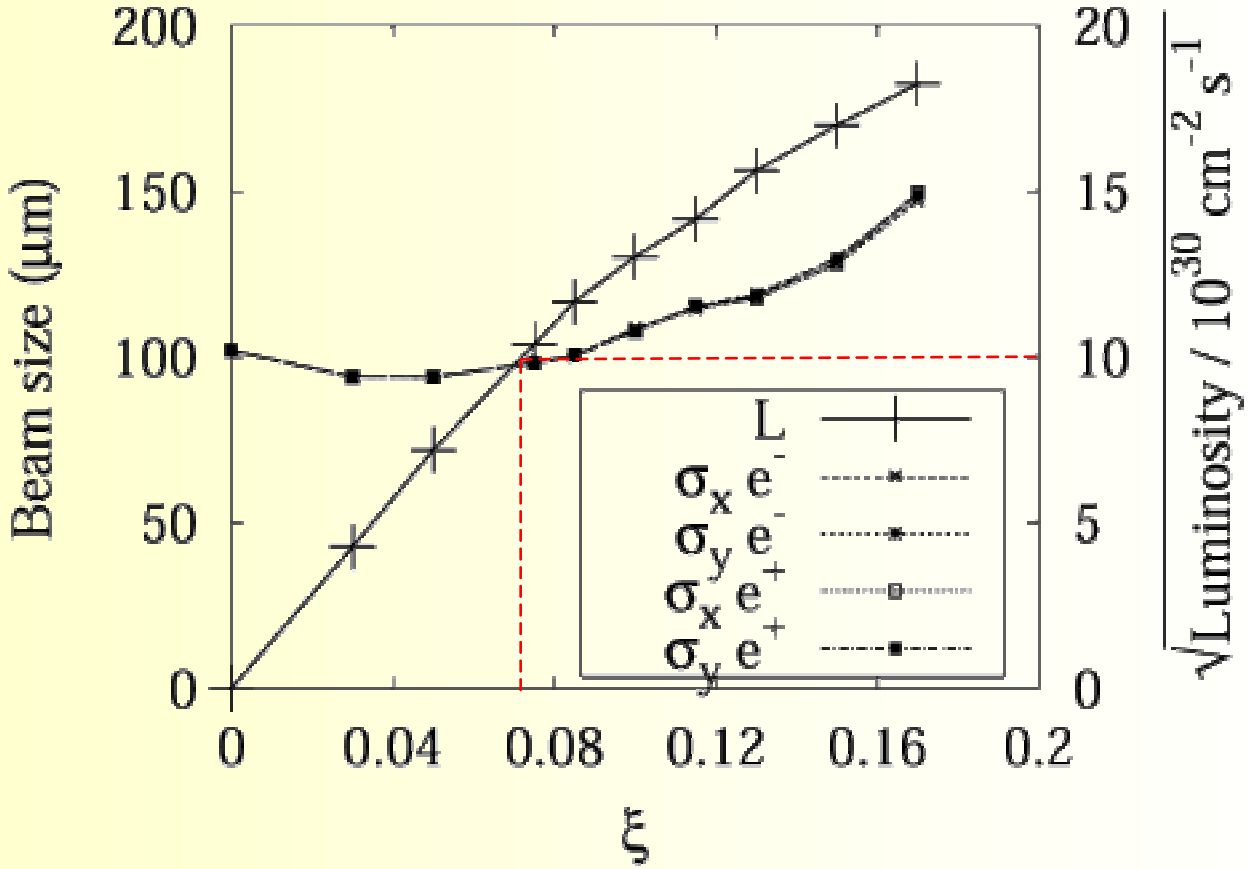


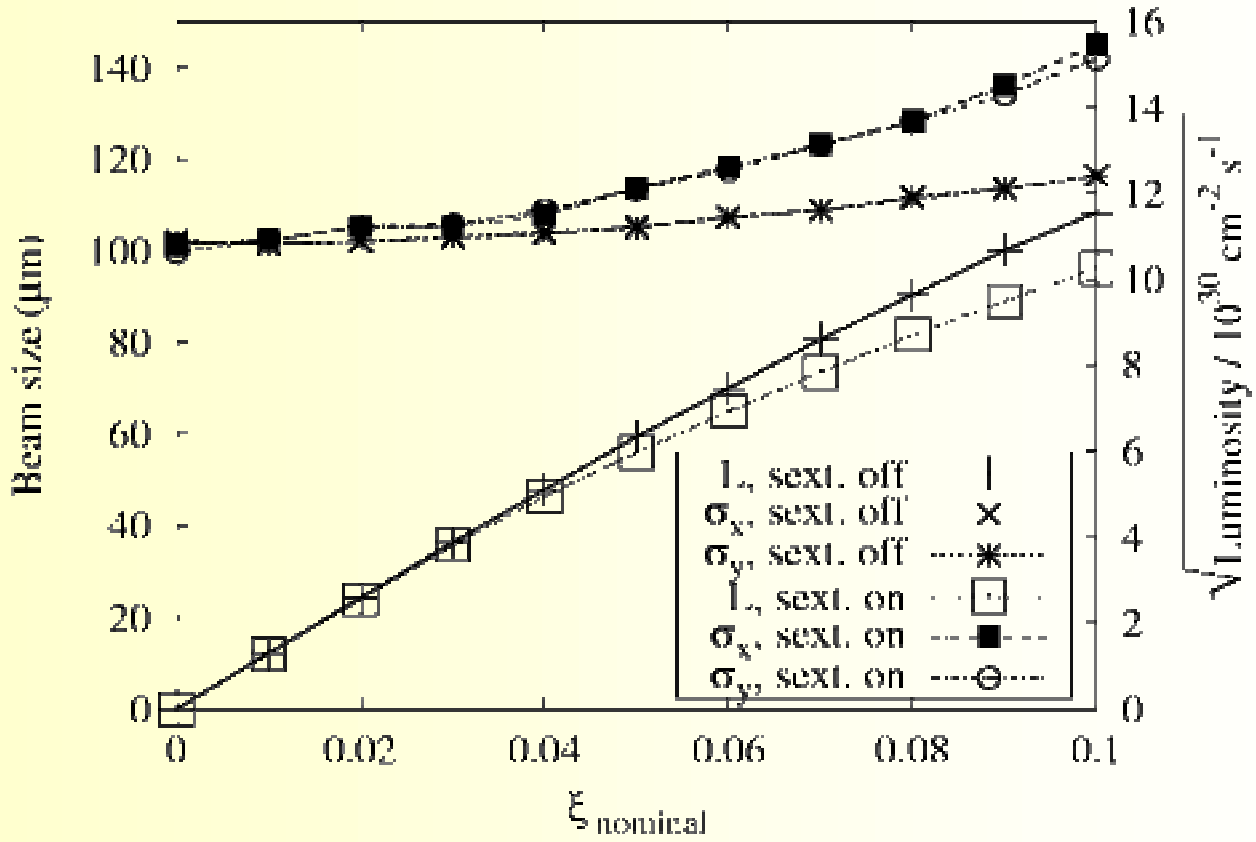
Macroparticles/bunch N_p = 50000, transverse mesh 128x128;
Field calculated via FFT
(K.Ohmi, Phys. Rev. E **59**, 7287 (2000))

Strong-Strong Beam-Beam Simulation



Beam size and luminosity vs. the nominal beam-beam parameter (*PAC'2003*)

Strong-Strong Beam-Beam Simulation

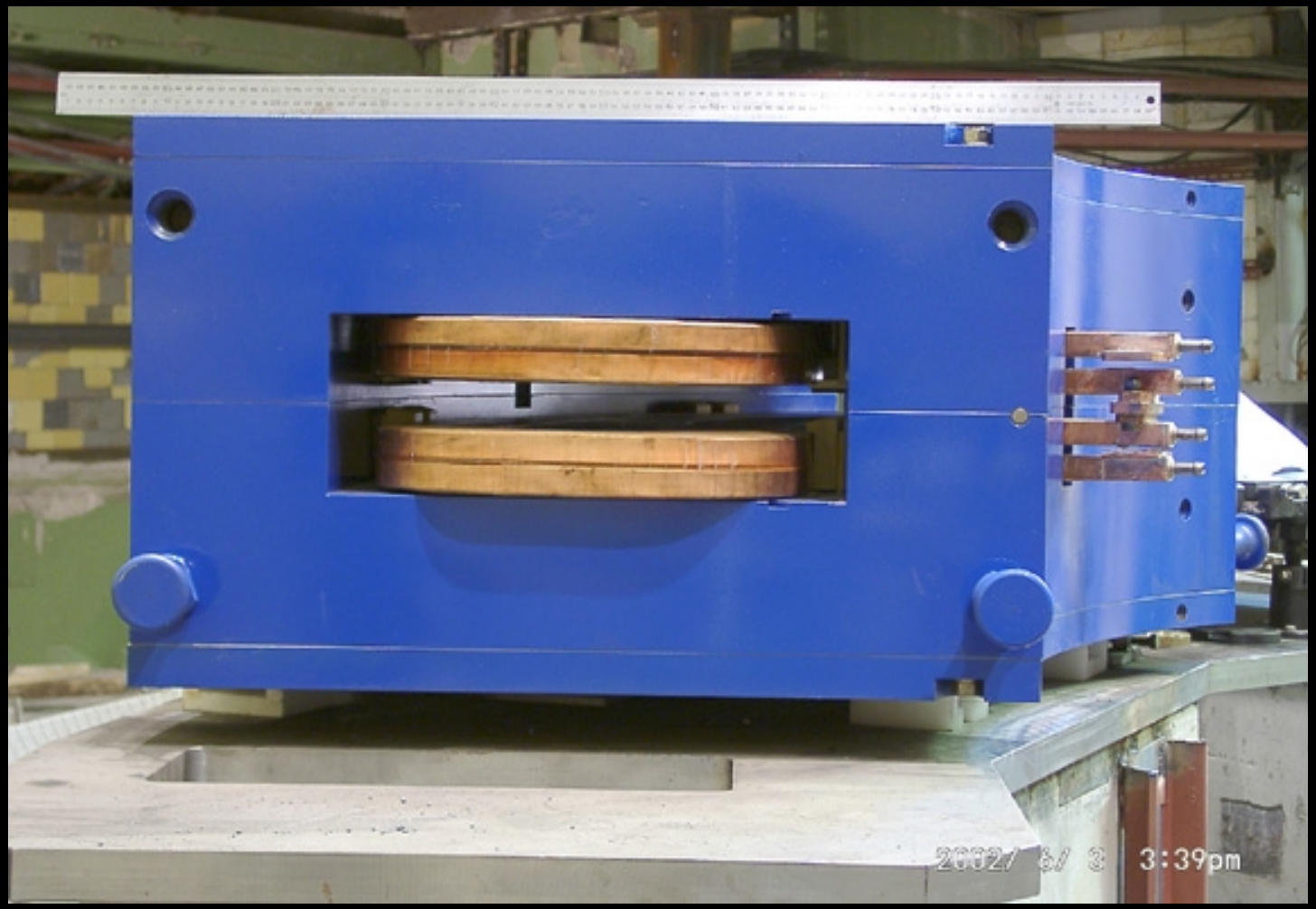


Comparison of the sextupoles on and off options.

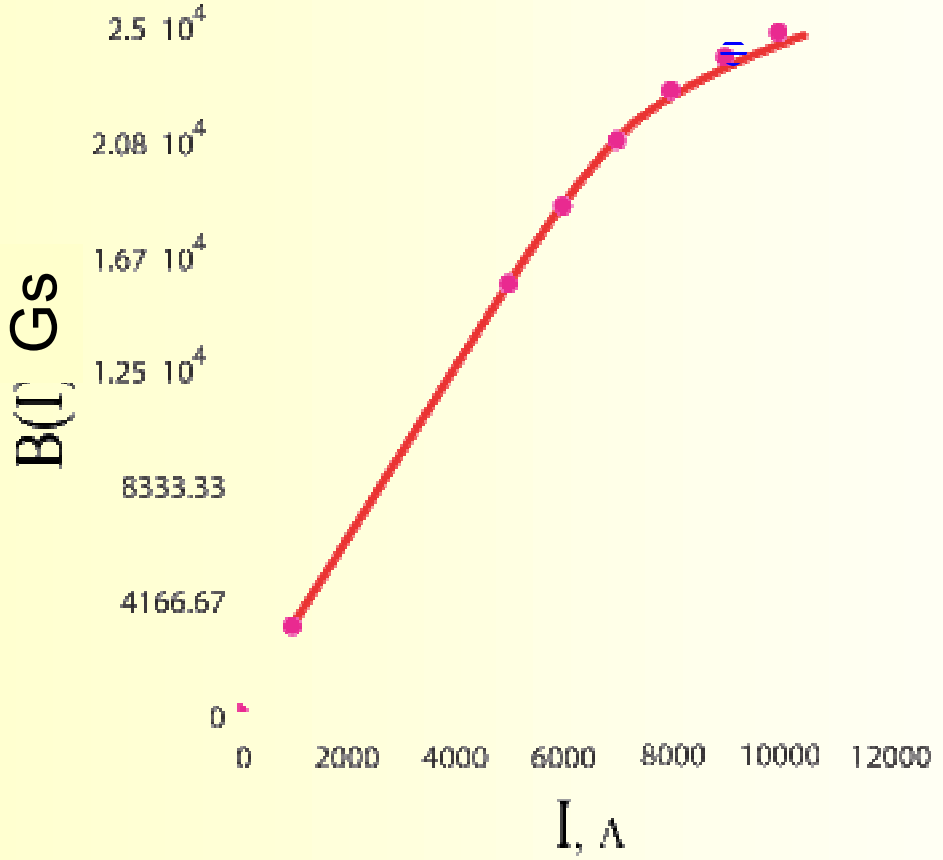
Main Parameters of VEPP-2000

Parameter	Value
Circumference	24.38 m
RF frequency	172 MHz
RF voltage	100 kV
RF harmonic	14
Momentum compaction	0.036
Synchrotron tune	0.0035
Energy spread	6.4×10^{-4}
Beam emittances (x,y)	1.29×10^{-7} m rad
Dimensionless damping decrements (x,y,z)	$2.19\times10^{-5}, 2.19\times10^{-5}, 4.83\times10^{-5}$
Betatron tunes	4.05, 2.05
Betatron functions @ IP	10 cm
Particles per bunch	1×10^{11}
Beam-beam parameter (x,y)	0.075, 0.075
Luminosity per IP (at 1GeV)	$1\times10^{32} cm^{-2} s^{-1}$

Dipole Magnet (2.4 T)



Dipole: Magnetic Measurements



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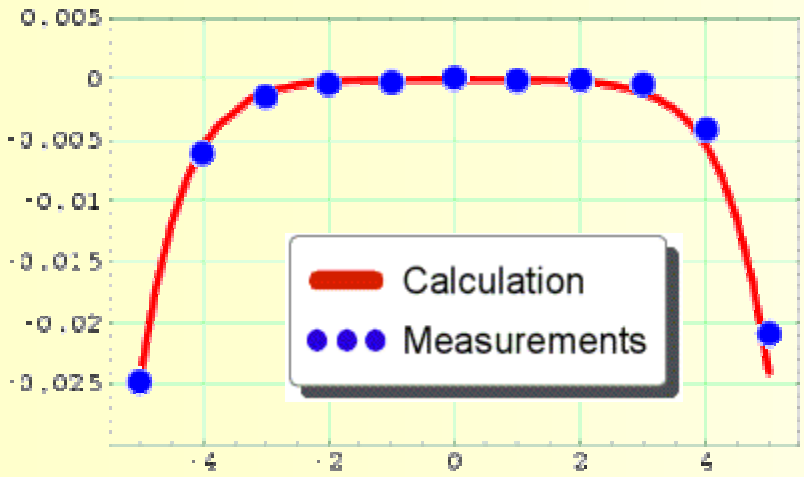
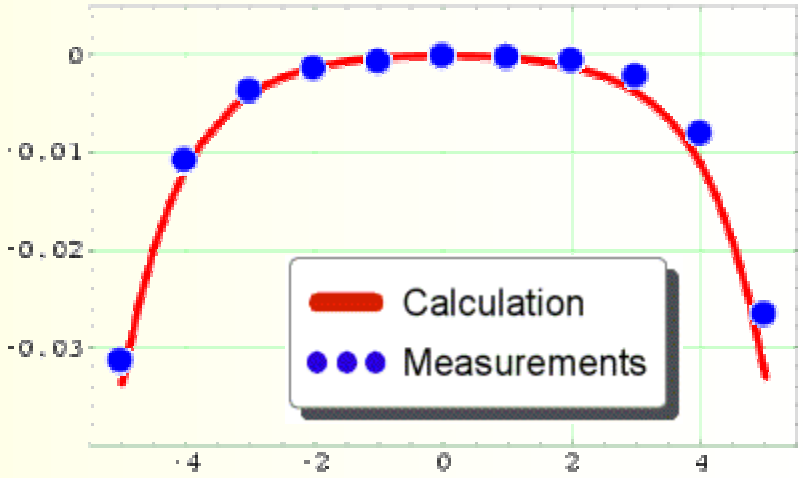


x, cm

Guiding field 0.6 T

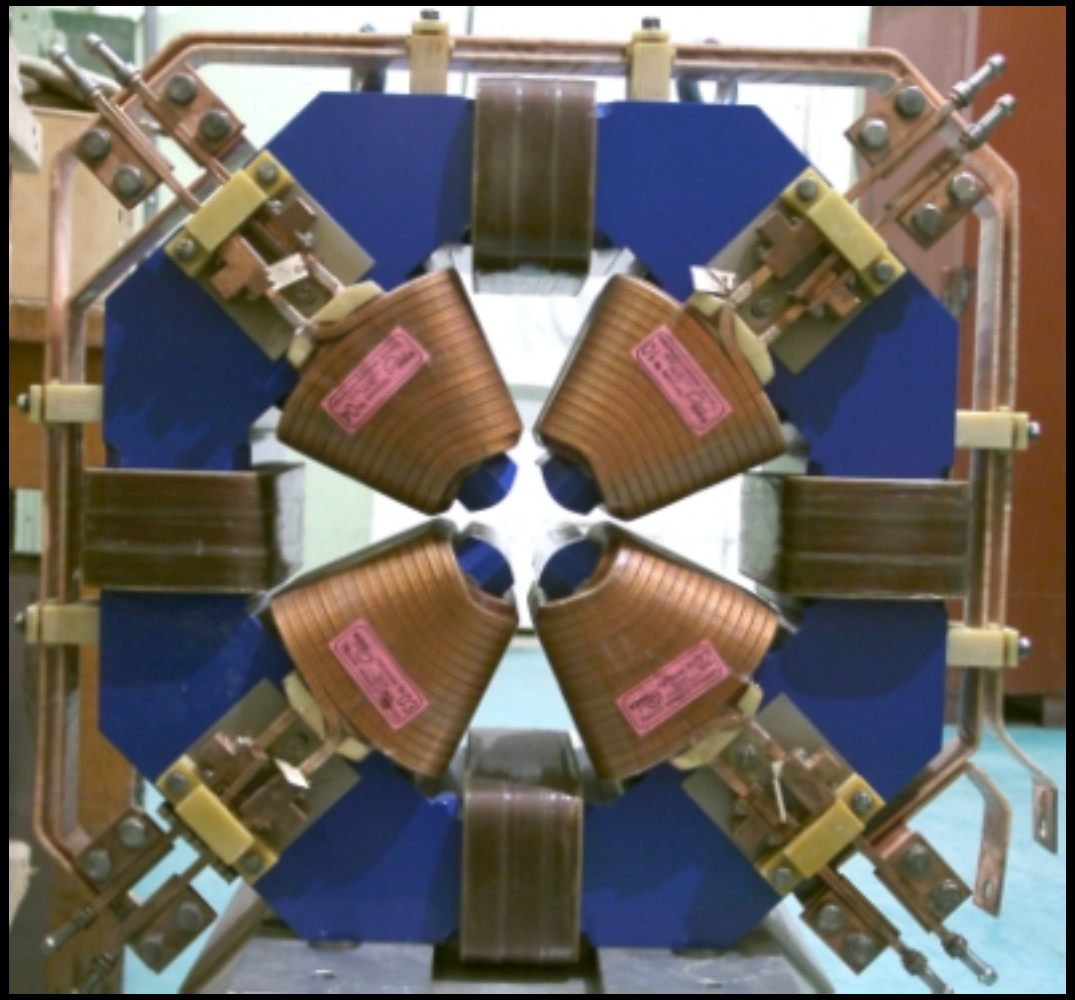
Guiding field 2.38 T



x, cm

31.10.02

Quadrupole



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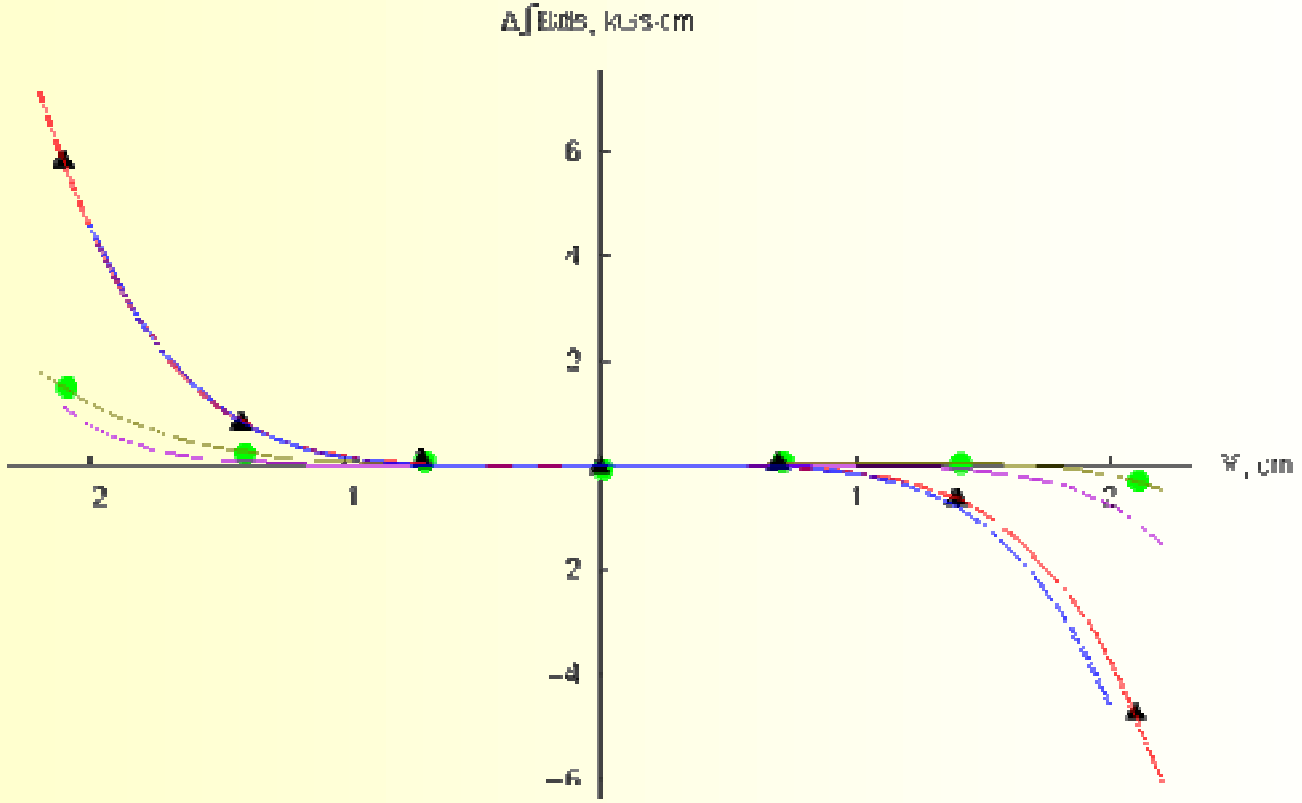
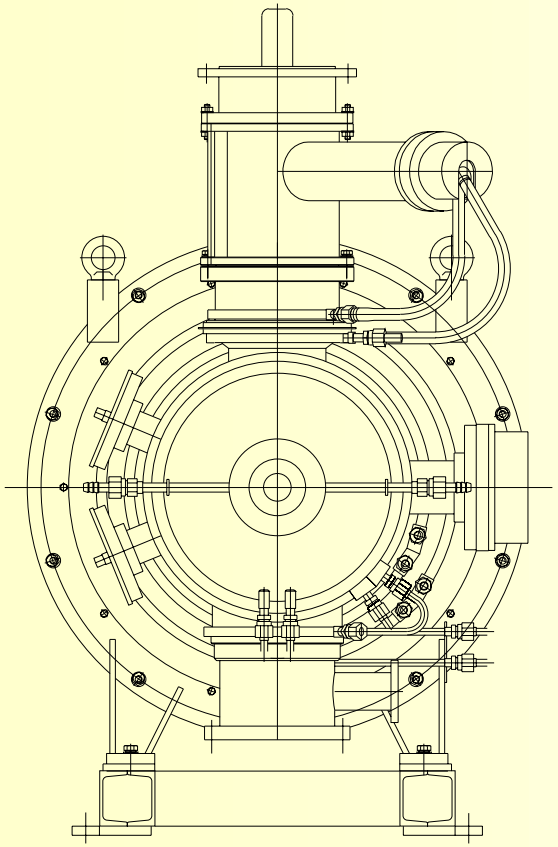
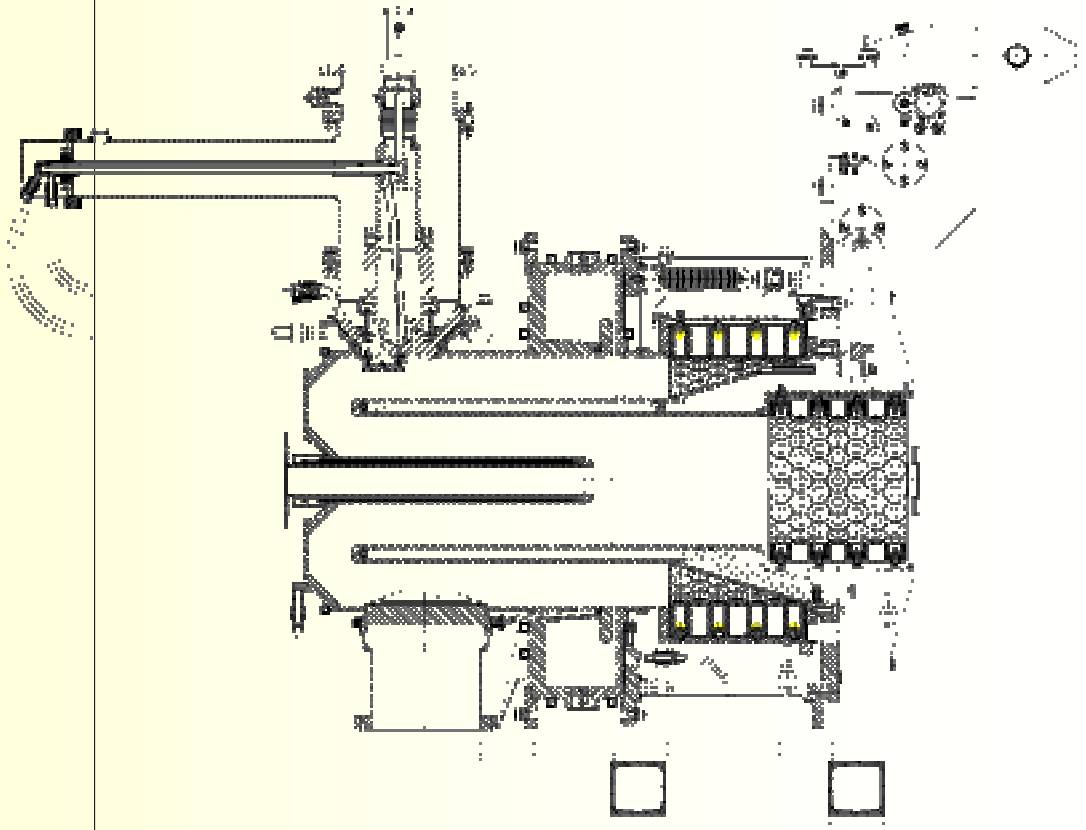


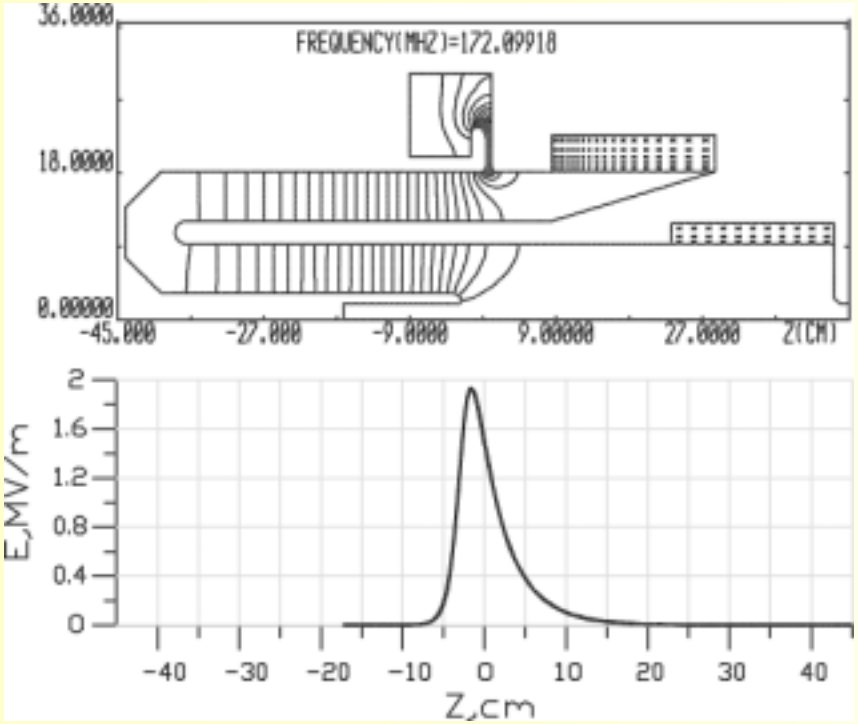
Vacuum Chamber

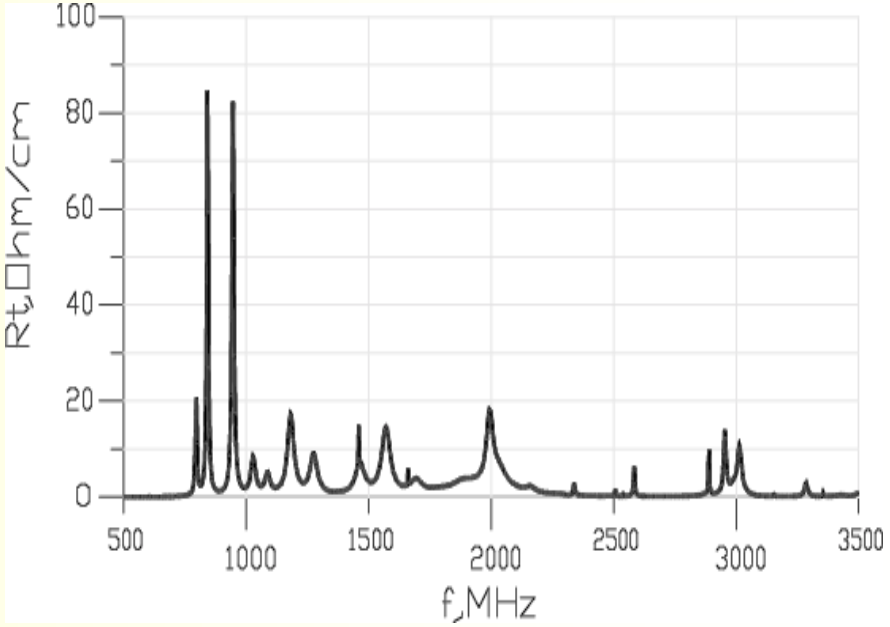
Single-Mode RF Cavity (172 MHz)





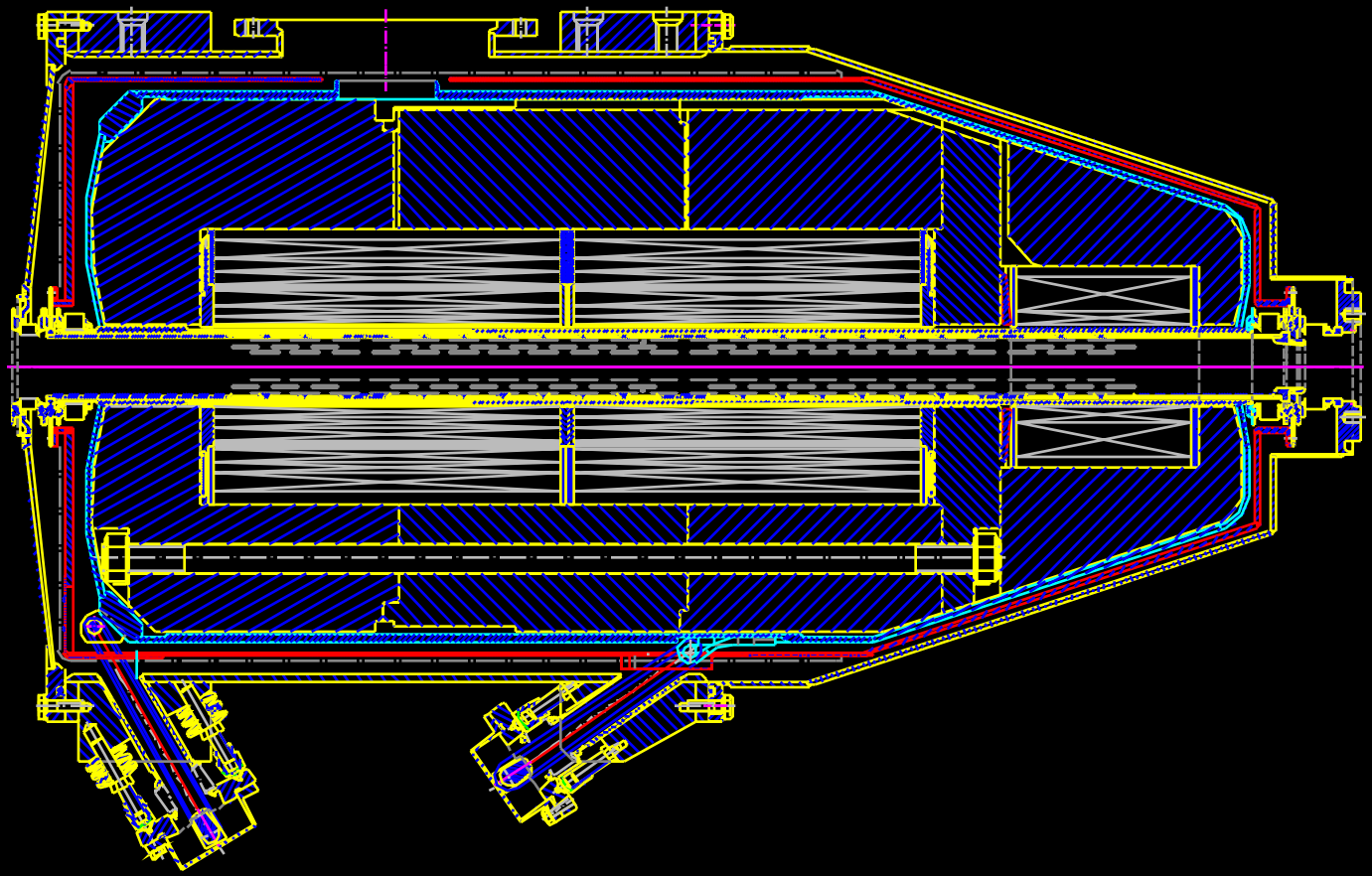
Calculated main mode & HOM





RF cavity parts

Solenoid 13.0 T



Solenoid: Coils

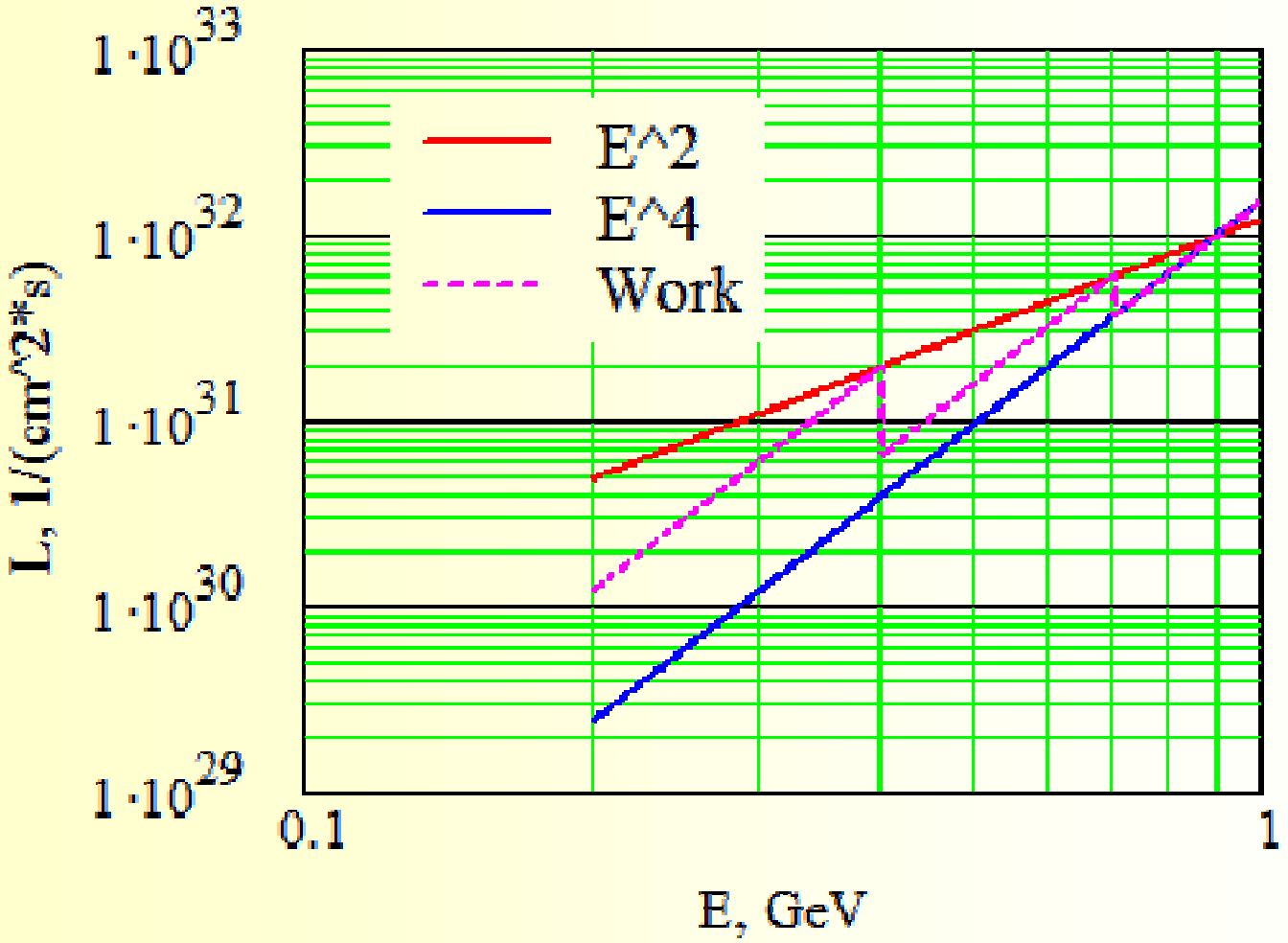
Nb-Sn

Nb-Ti

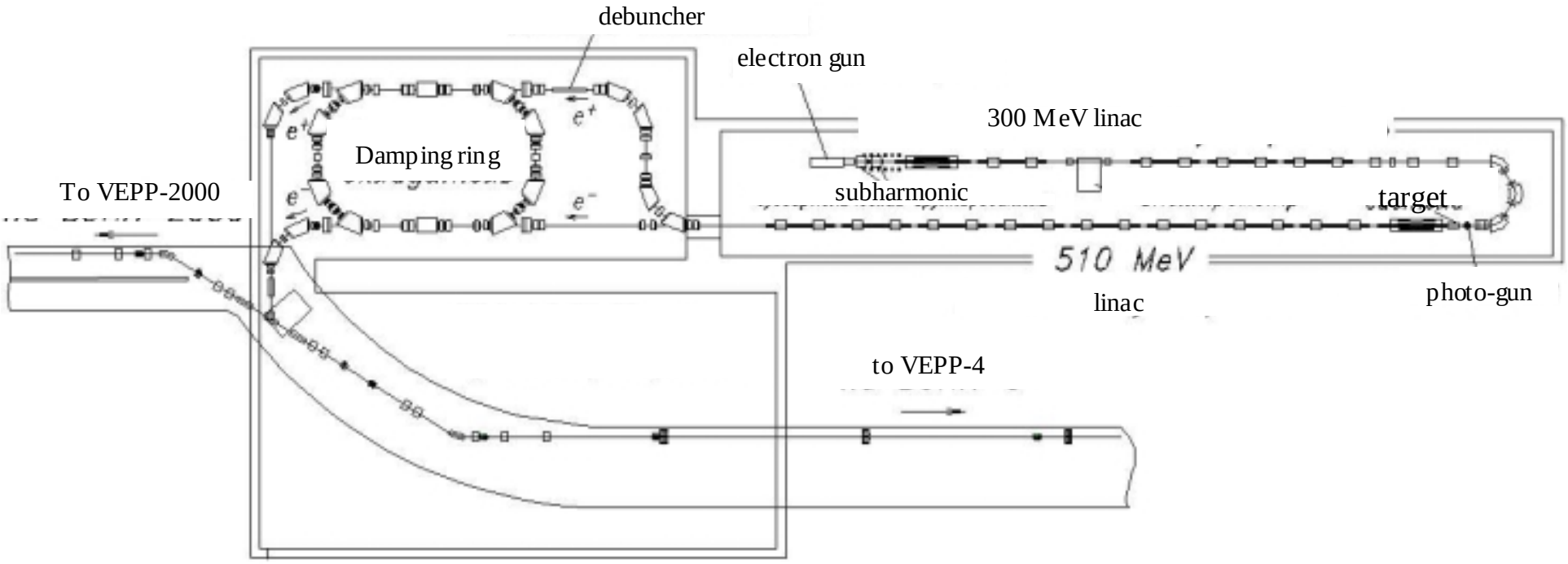
13.08.01

Assembly of the Nb-Ti and Nb-Sn coils

VEPP-2000 Luminosity



POSITRON SOURCE




hall of 300 @500 MeV linacs


510 MeV dampintg ring

21.08.03

Summary

♠ Start of VEPP-2000 construction – January 2000

♠ Dipole, quads, sextupoles, skew-quads, steering coils, 6 from 8 vacuum chamber are ready, tested and installed

♠ 13 T field is achieved in solenoid prototype

♠ Weak-strong and strong-strong simulation show high ξ for the round beams

♠ Construction of transfer line from e^+ source is going on

♠ Beam → at the end of 2004