VEPP-2000 ELECTRON-POSITRON COLLIDER COMMISSIONING AND FIRST RESULTS OF ROUND COLLLIDING BEAM TEST

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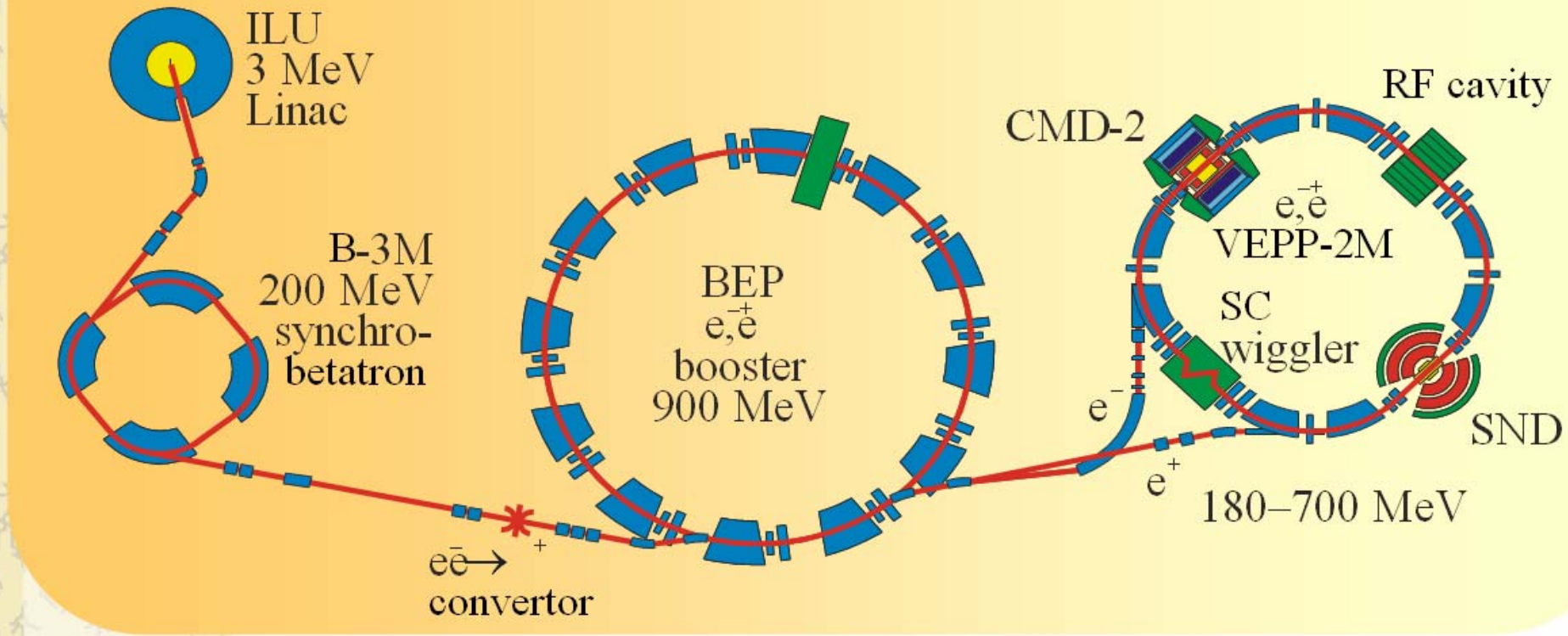
OUTLINE

- VEPP-2M ⟹ VEPP-2000
- Round beams - a way to increase luminosity.
- VEPP-2000 systems
- First beam
- Round beam
- Beam-beam study
- Conclusion

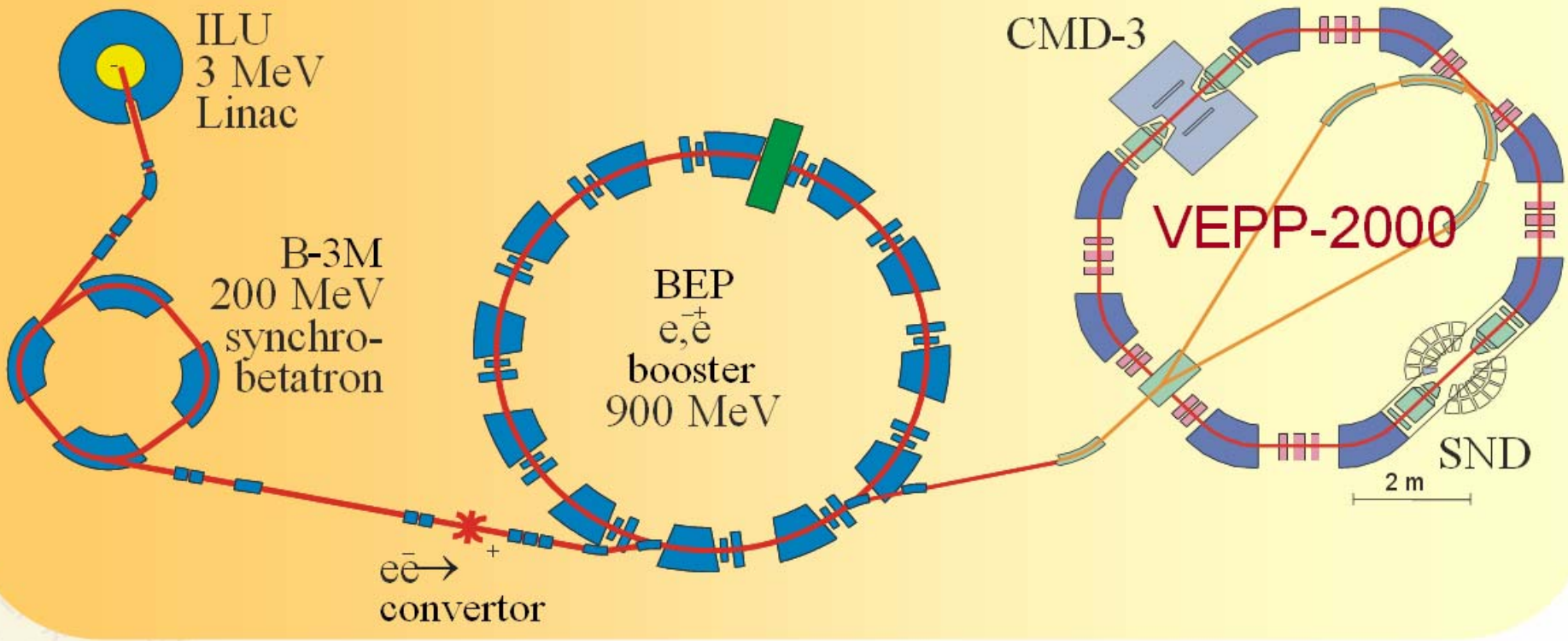
VEPP-2M → VEPP-2000

(2000-2007)



VEPP-2M → VEPP-2000

(2000-2007)



- $E \approx 1$ GeV (per beam)
- $L \approx 1 \times 10^{32}$ cm^{-2} sec^{-1} (1×1 bunch)

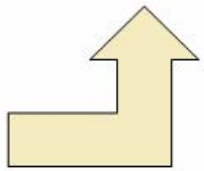
Increasing of Luminosity

- Number of bunches (i.e. collision frequency)
- 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 Beams:

$$L = \frac{4\pi\gamma^2 \xi^2 \varepsilon f}{r_e^2 \beta^*}$$



✓Geometric factor (gain=4)

✓Beam-beam limit enhancement

✓IBS for low energy? worth life time!

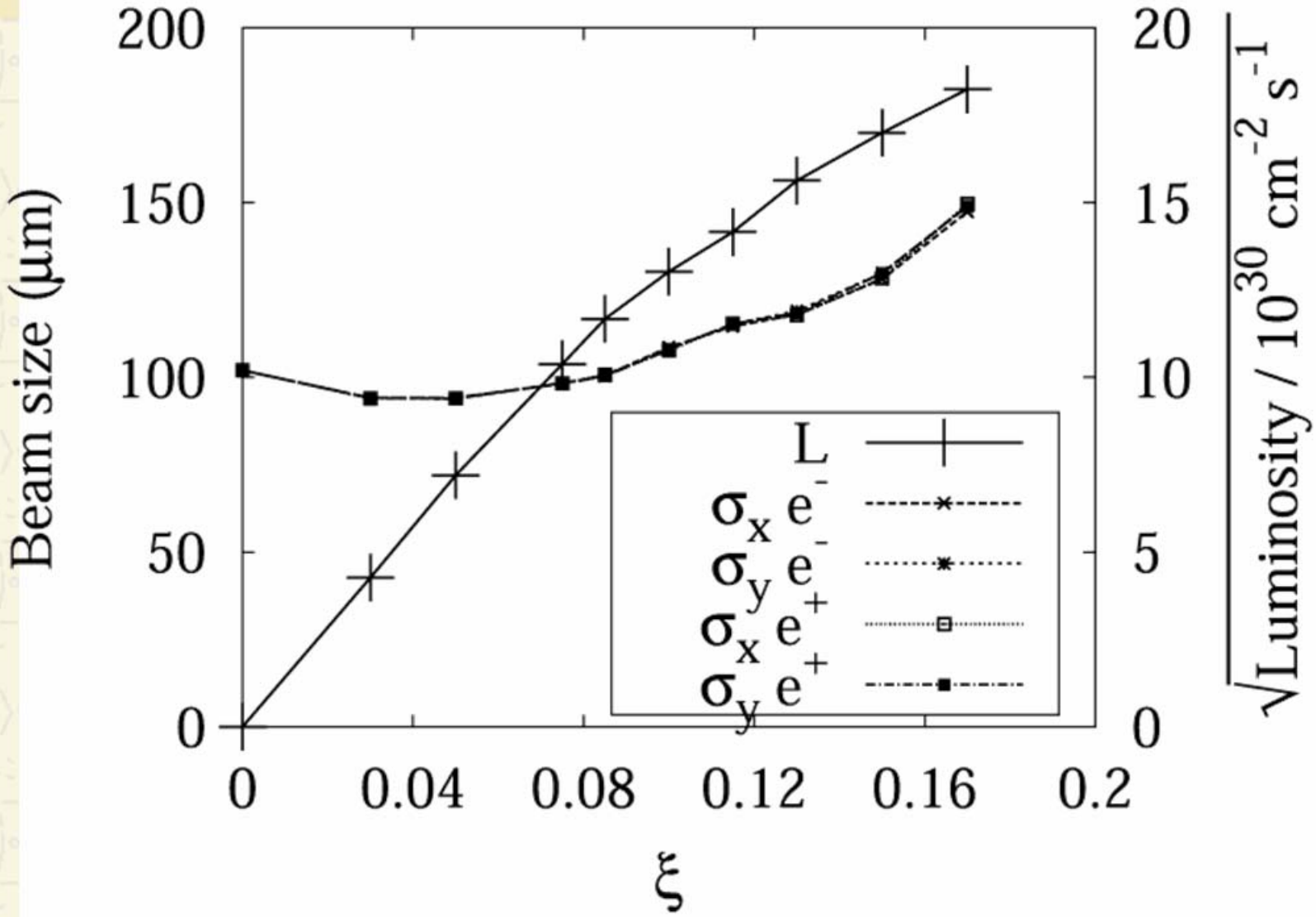
$$\xi_{x,y} \geq 0.1$$

Round Colliding Beams Concept

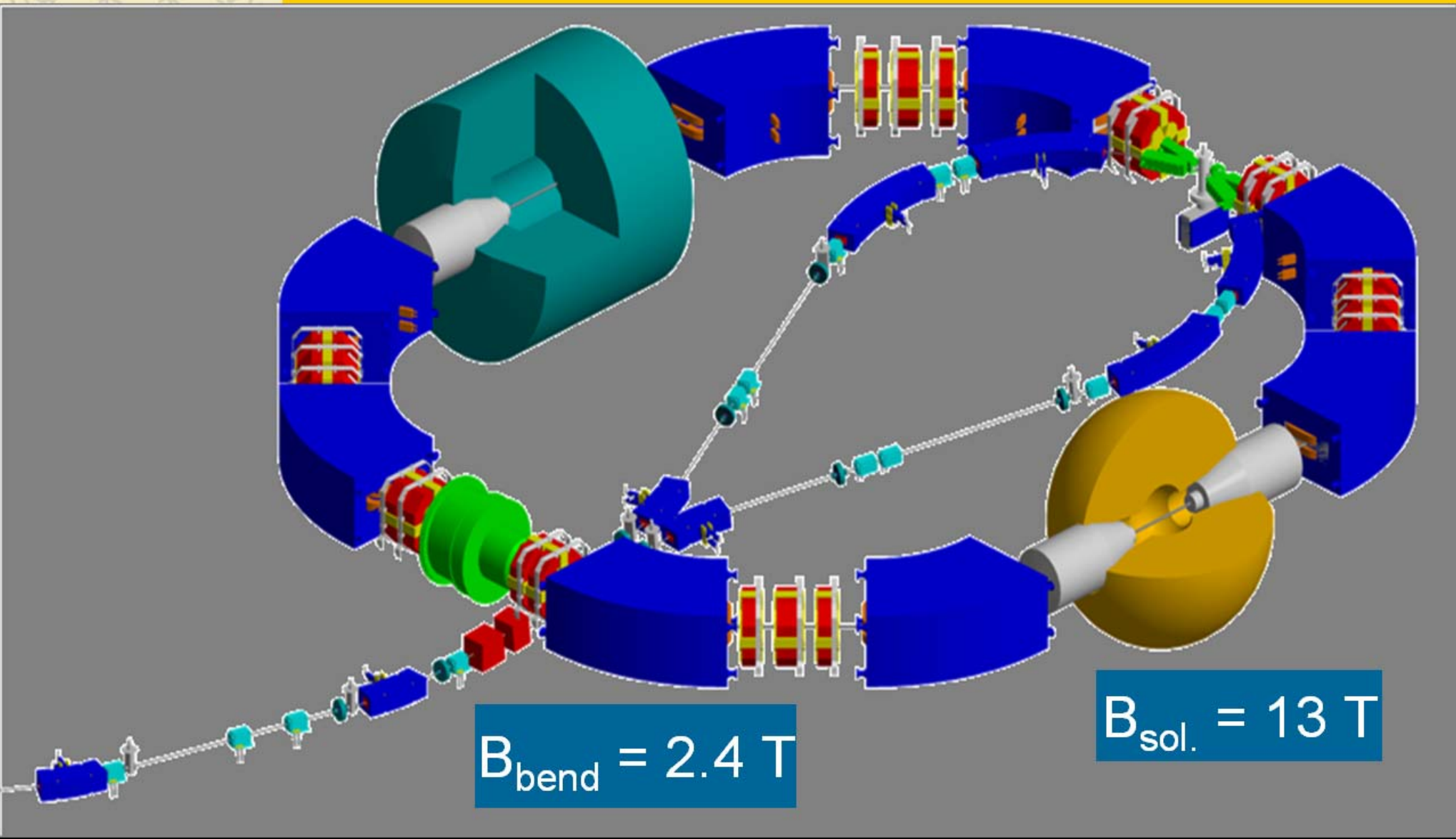
- Angular momentum conservation! $M_z = x'y - xy'$

- Small and equal β-functions at IP: $\beta_x = \beta_y$
- Equal beam emittances: $\varepsilon_x = \varepsilon_y$
- Equal betatron tunes: $\nu_x = \nu_y$
- Small and positive fractional tunes

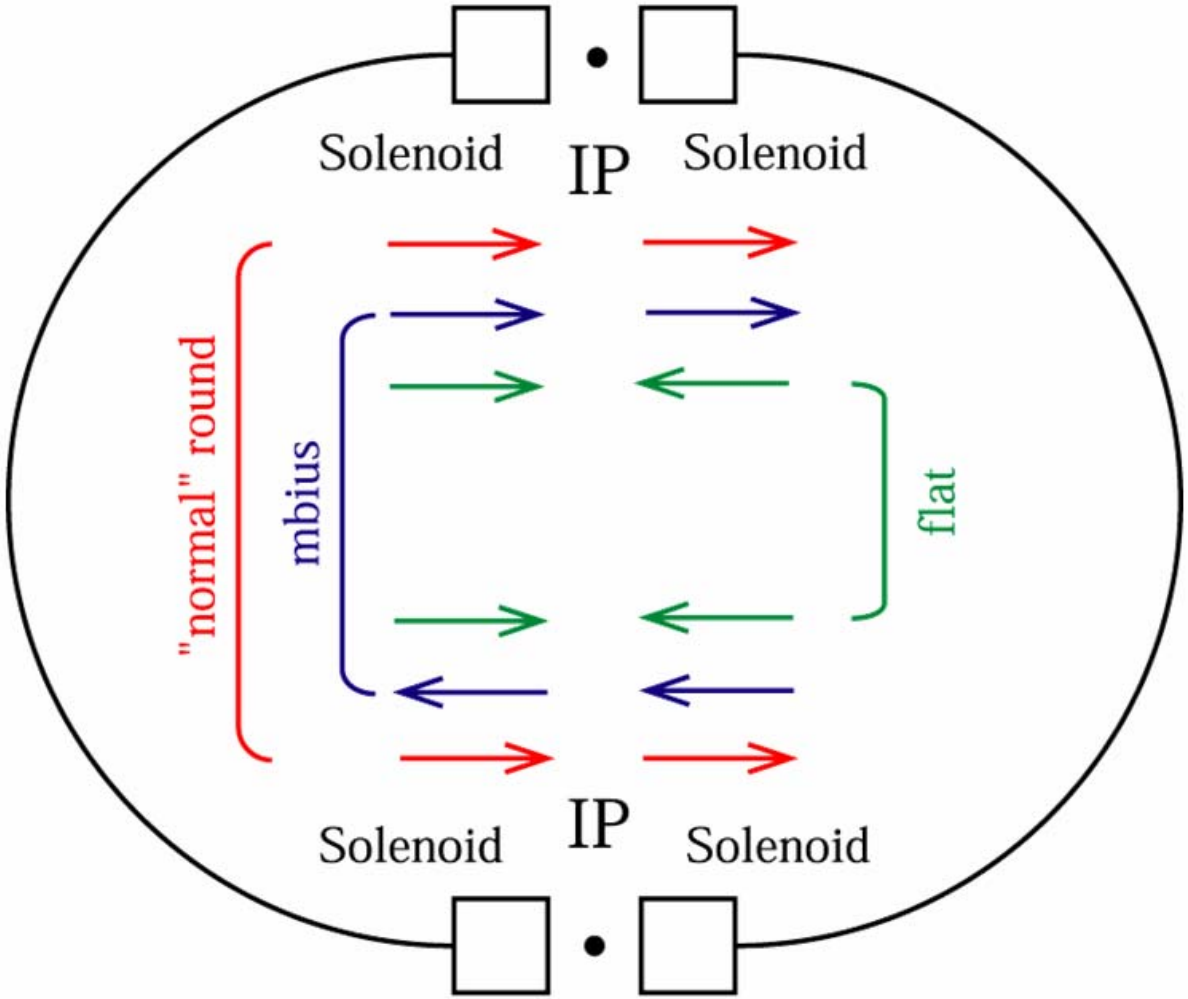
“Strong-Strong” Beam-Beam Simulations



Practical Realization of Round Beams Options for VEPP-2000

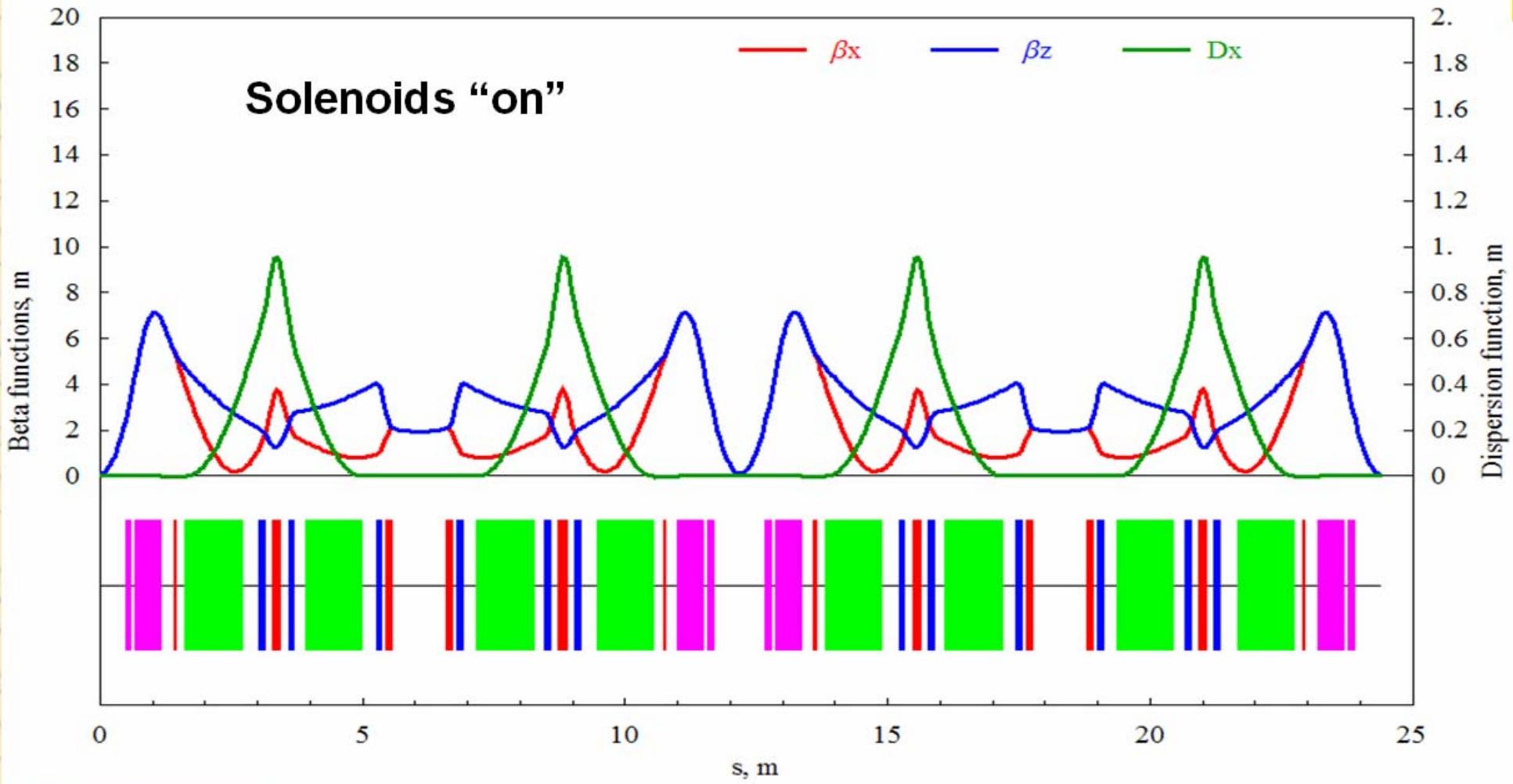


Practical Realization of Round Beams
Options for VEPP-2000



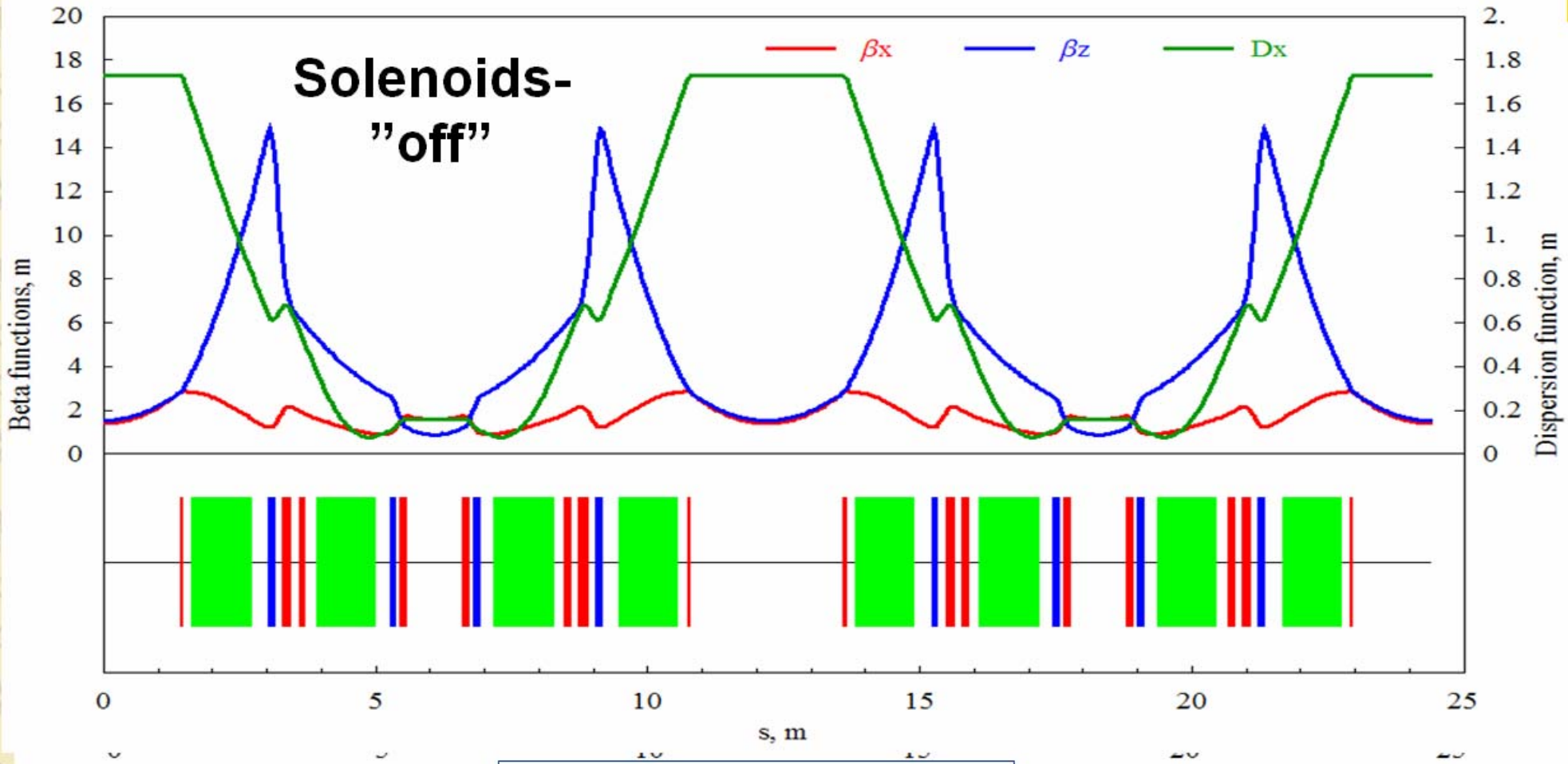

VEPP-2000 (12.01.2007)

VEPP-2000 Lattice



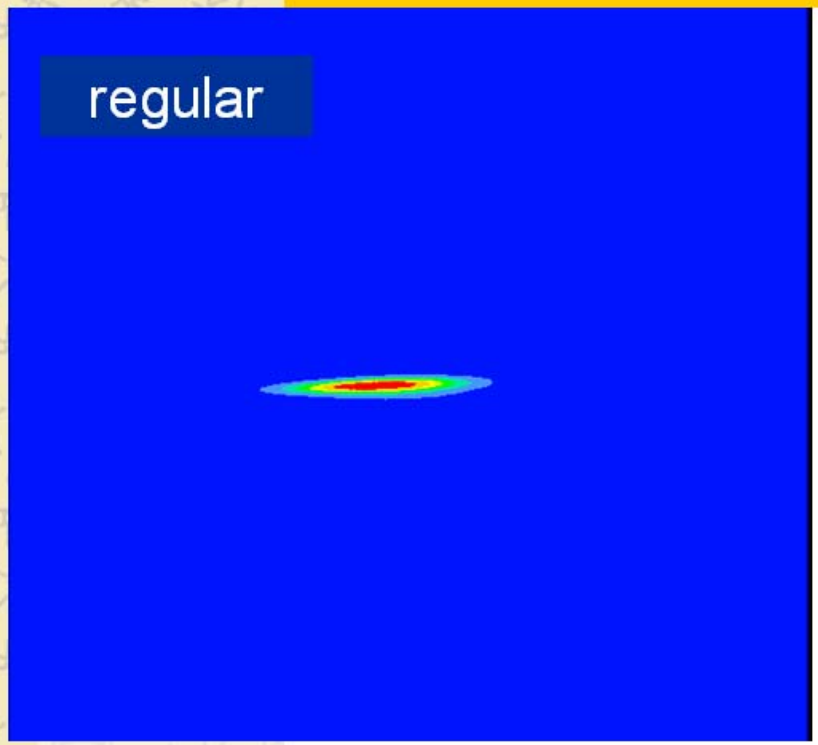
$$\nu_1 = 2.1; \quad \nu_2 = 4.1$$

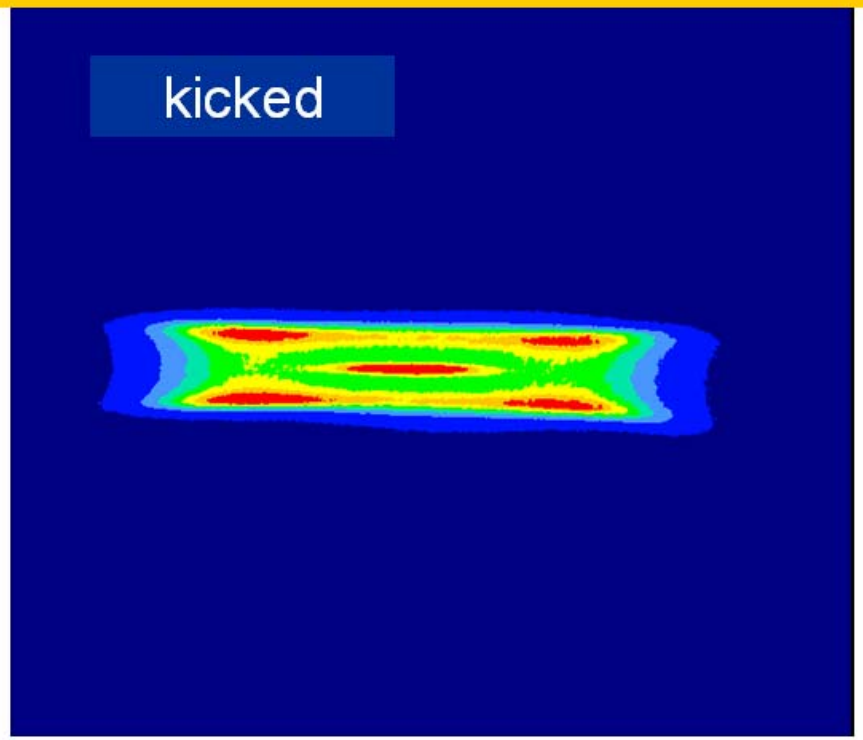
VEPP-2000 Lattice



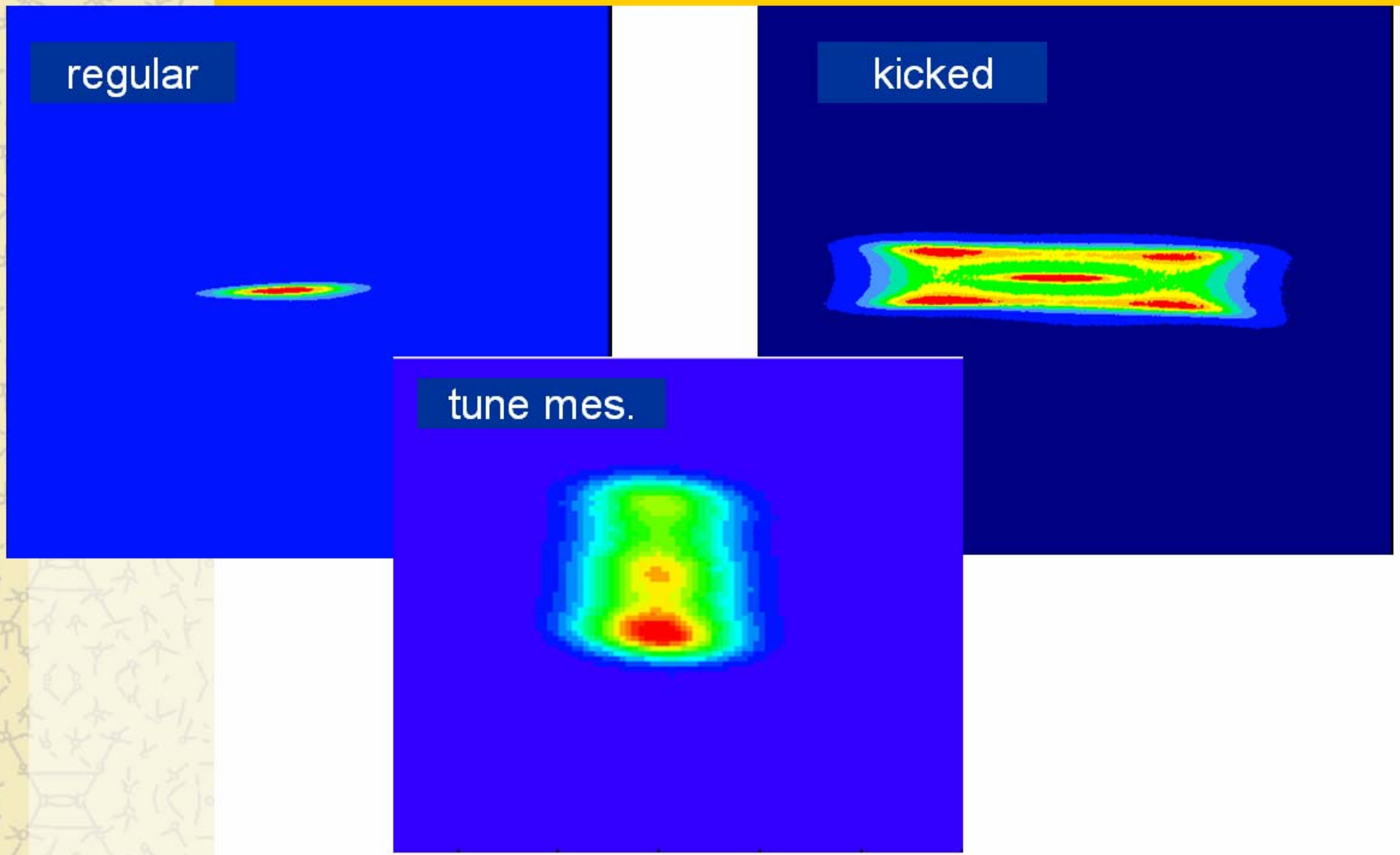
$$\nu_z = 1.38; \quad \nu_x = 2.44$$

Beam's CCD pictures

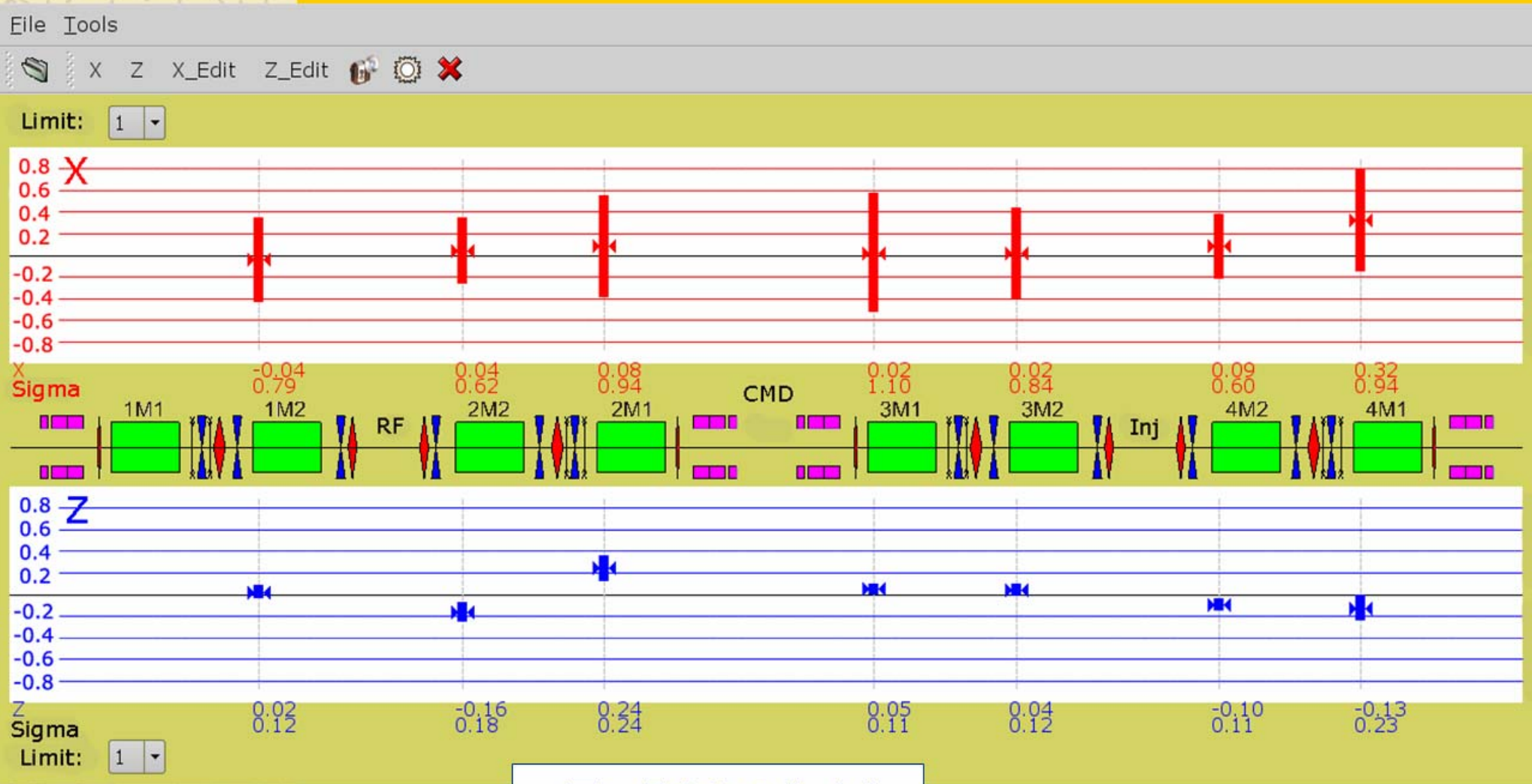




Beam's CCD pictures



CO and Beam Sizes (solenoids “off”)



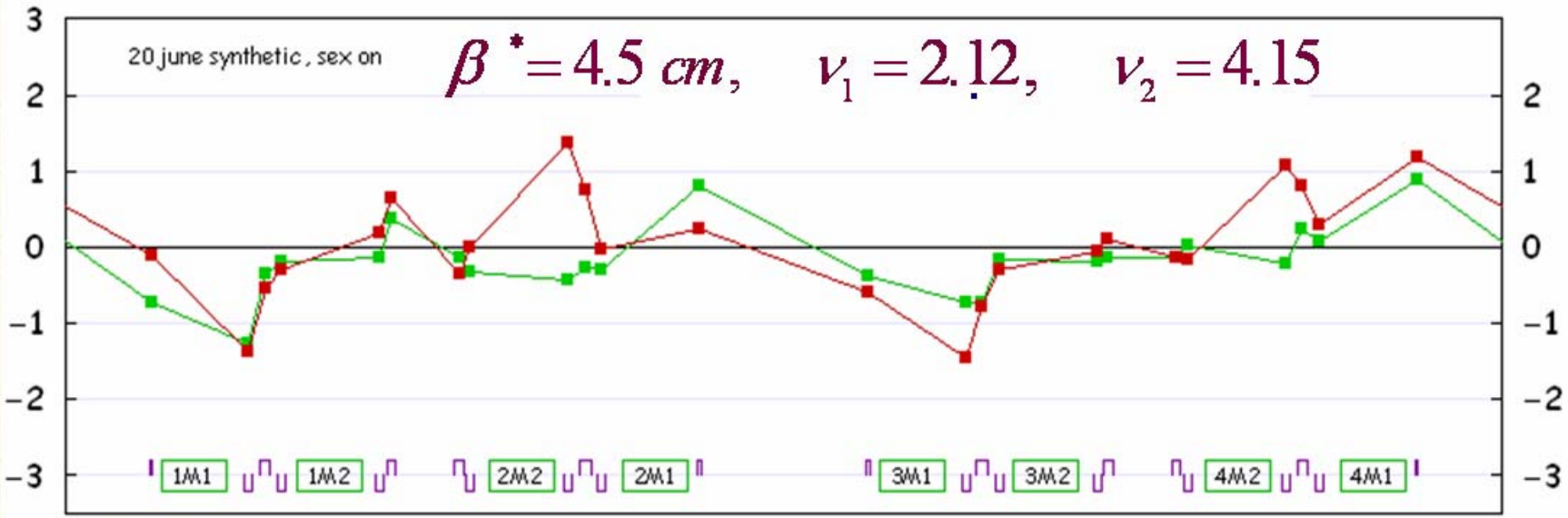
E=508 MeV

Round beam operation

- E = 508 MeV
- Solenoids alignment by beam (flat beam + 4T solenoid)
- Round beam lattice (solenoid field 10T+1T in anti-solenoid)
- First injection (tune near one half)
- CO + lattice symmetry corrections (tunes near one half)
  CO + lattice symmetry corrections (intermediate tunes)
- CO + lattice symmetry corrections (tunes: 0.1 ÷ 0.15)
- Orbit response matrices on dipole and quadrupole corrections + Singular Values Decomposition

Round beam operation

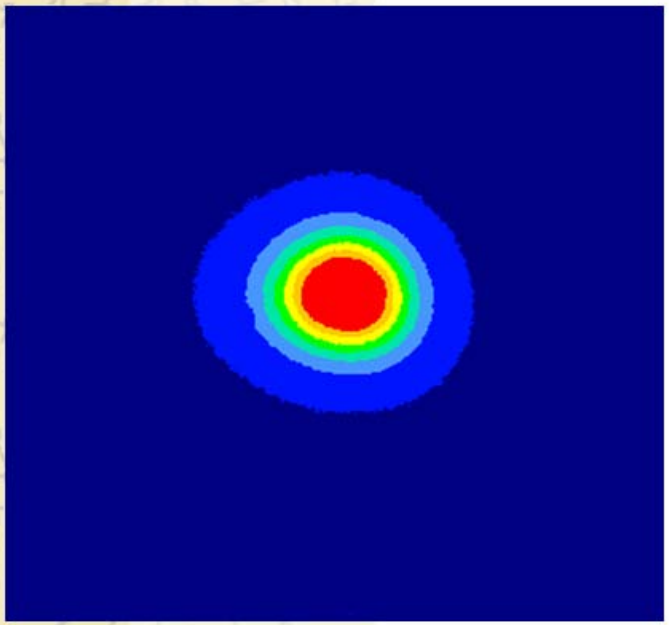
- E = 508 MeV

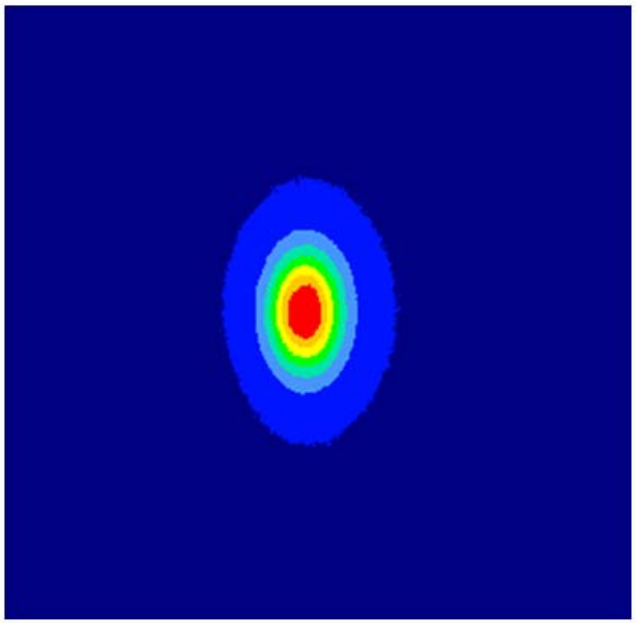


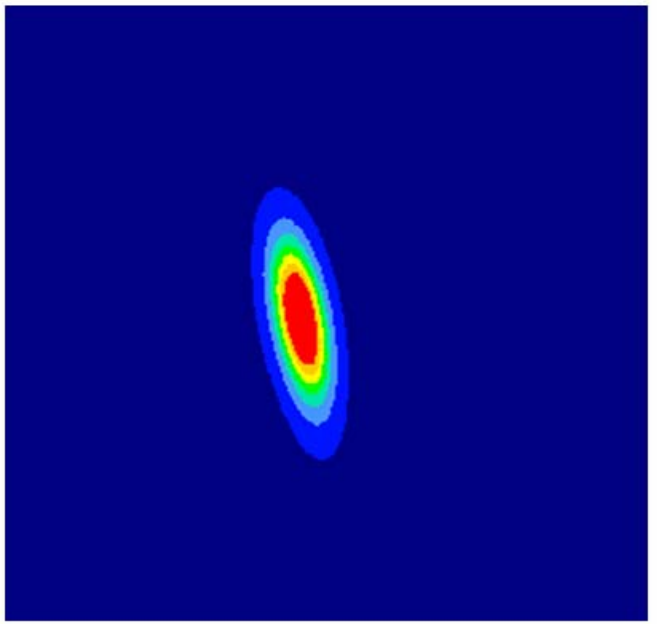
- Orbit response matrices on dipole and quadrupole corrections + Singular Values Decomposition

Round beams (solenoid field 10 T)

positron beam





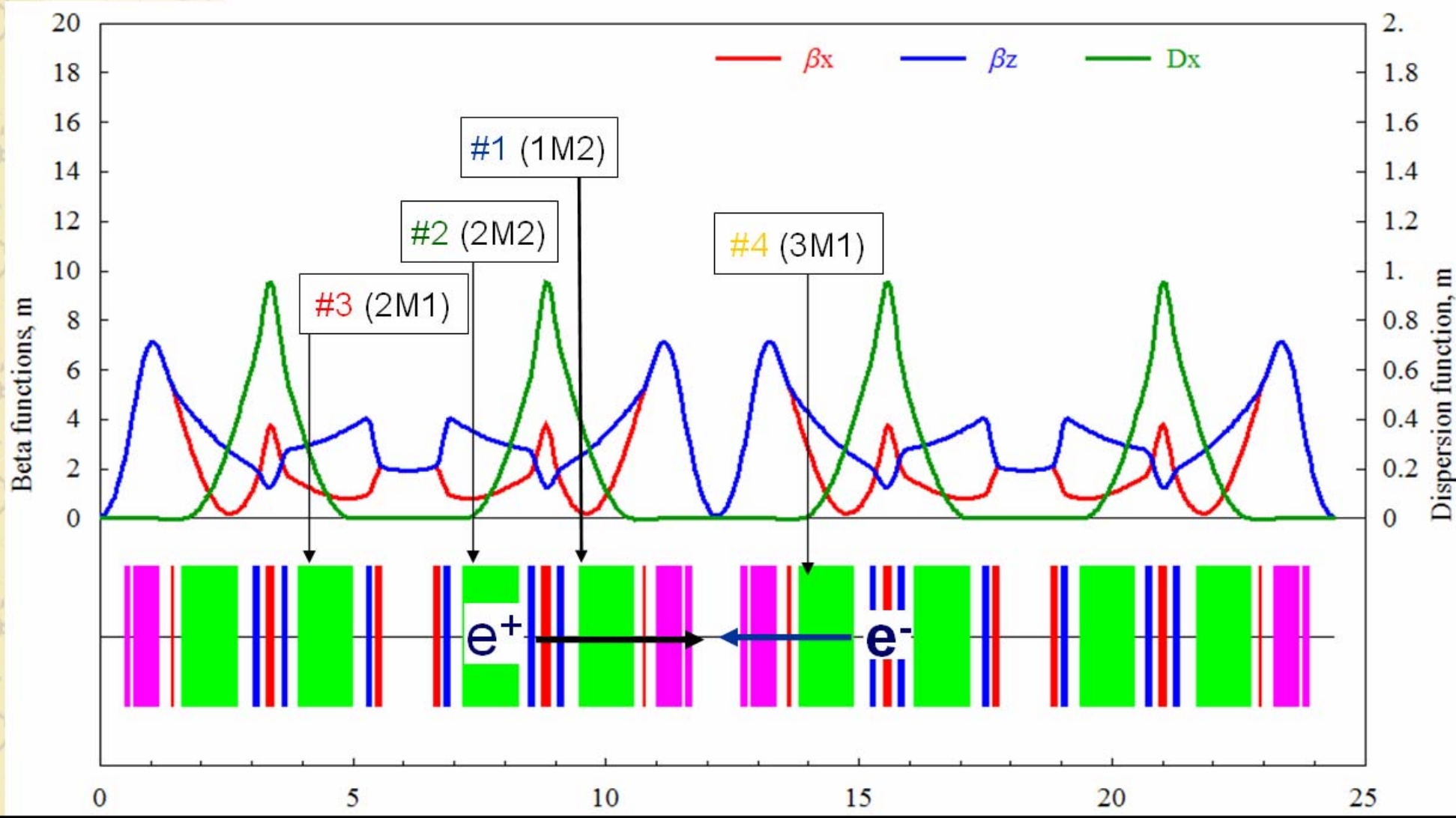


#1 (1M2)

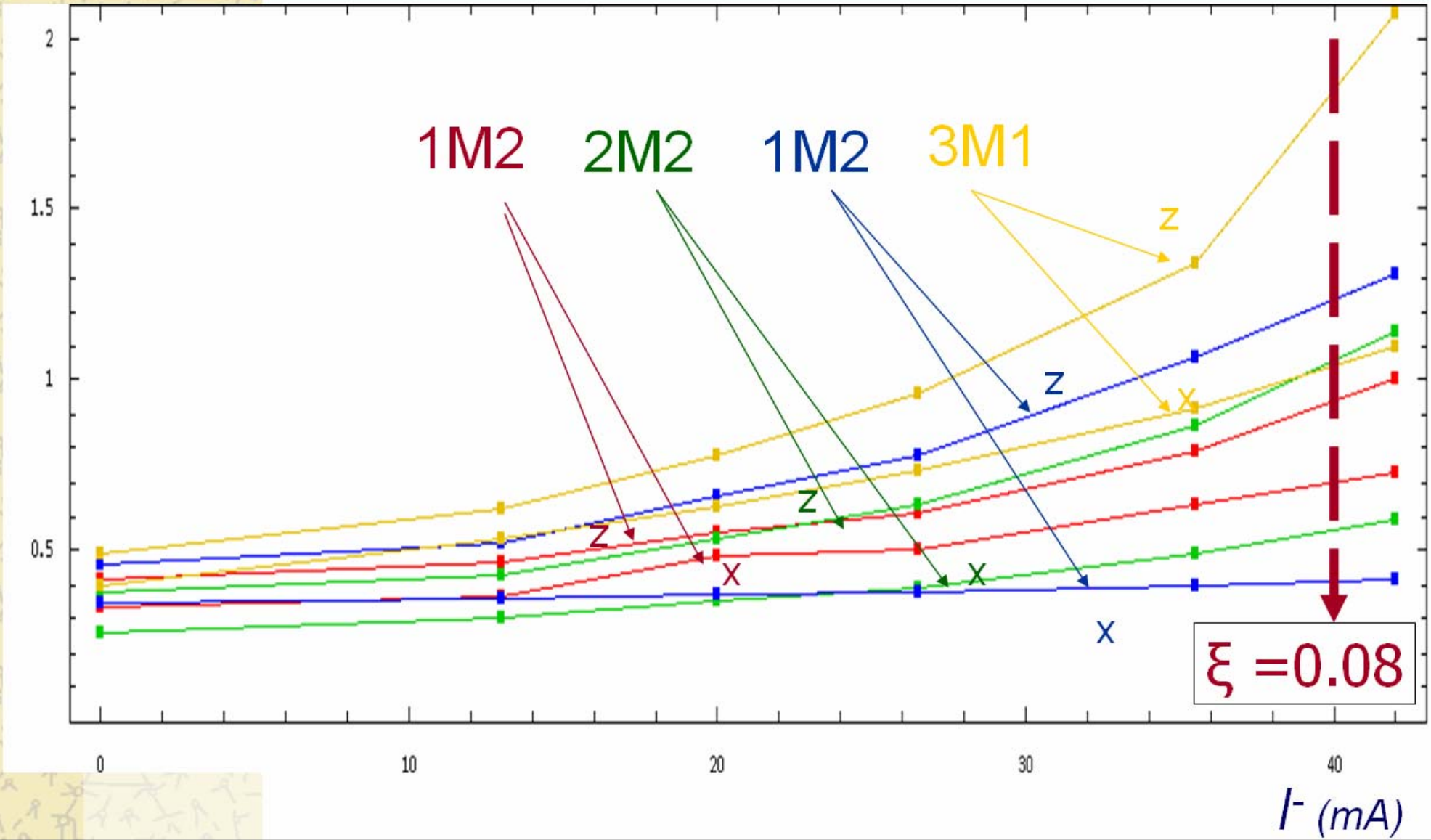
#2 (2M2)

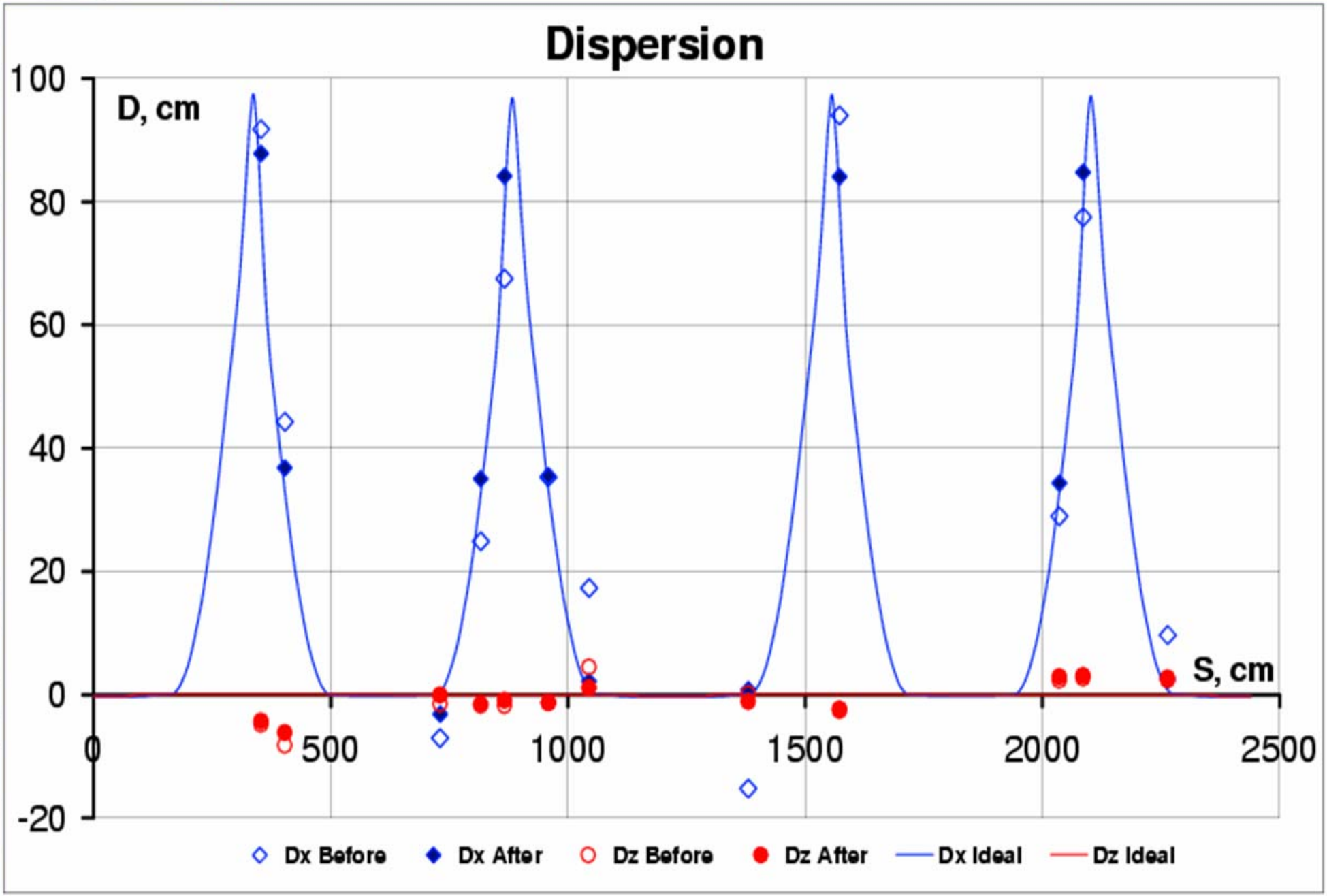
#3 (2M1)

Round beam lattice

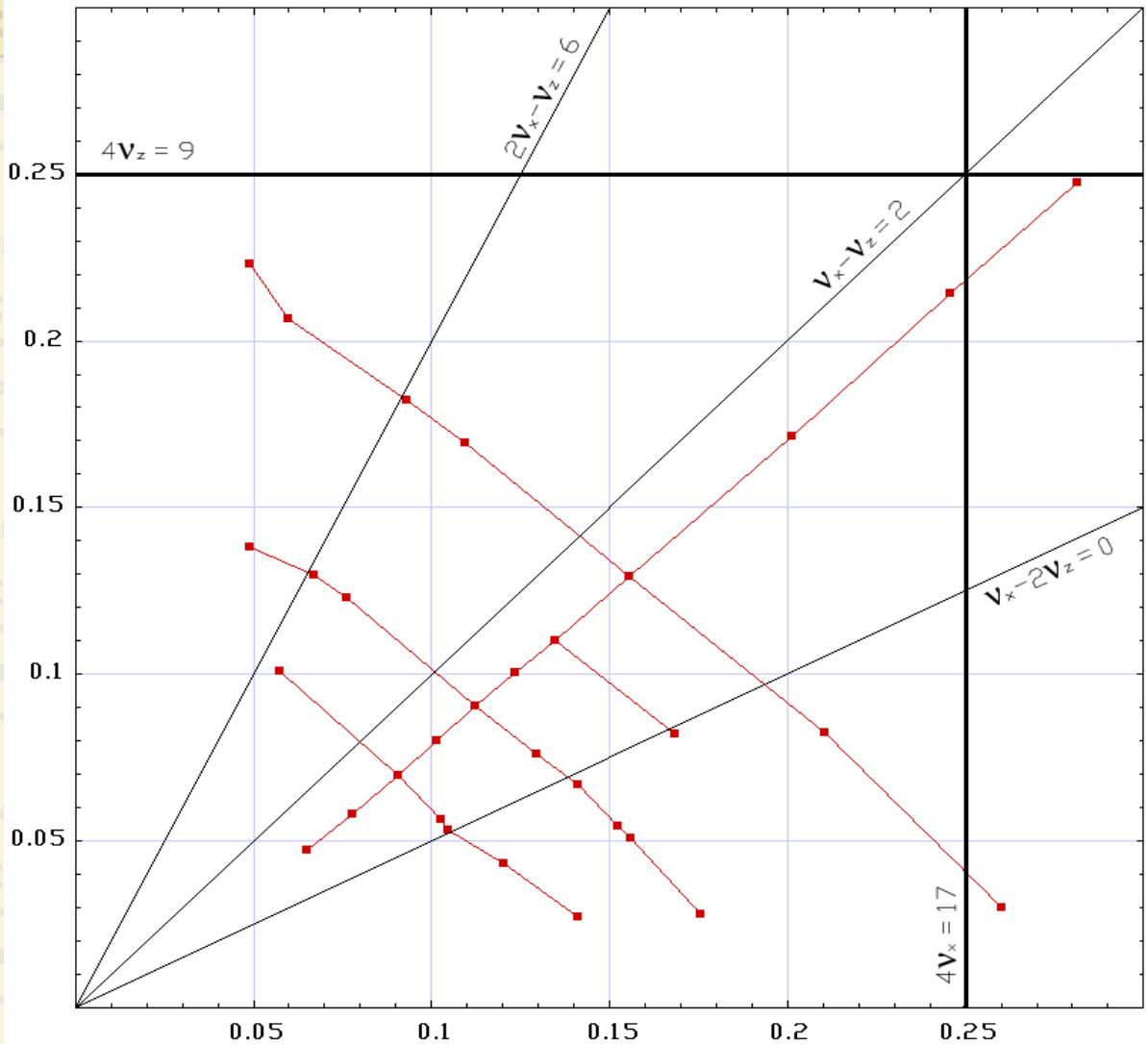


“Weak-strong” beam-beam study

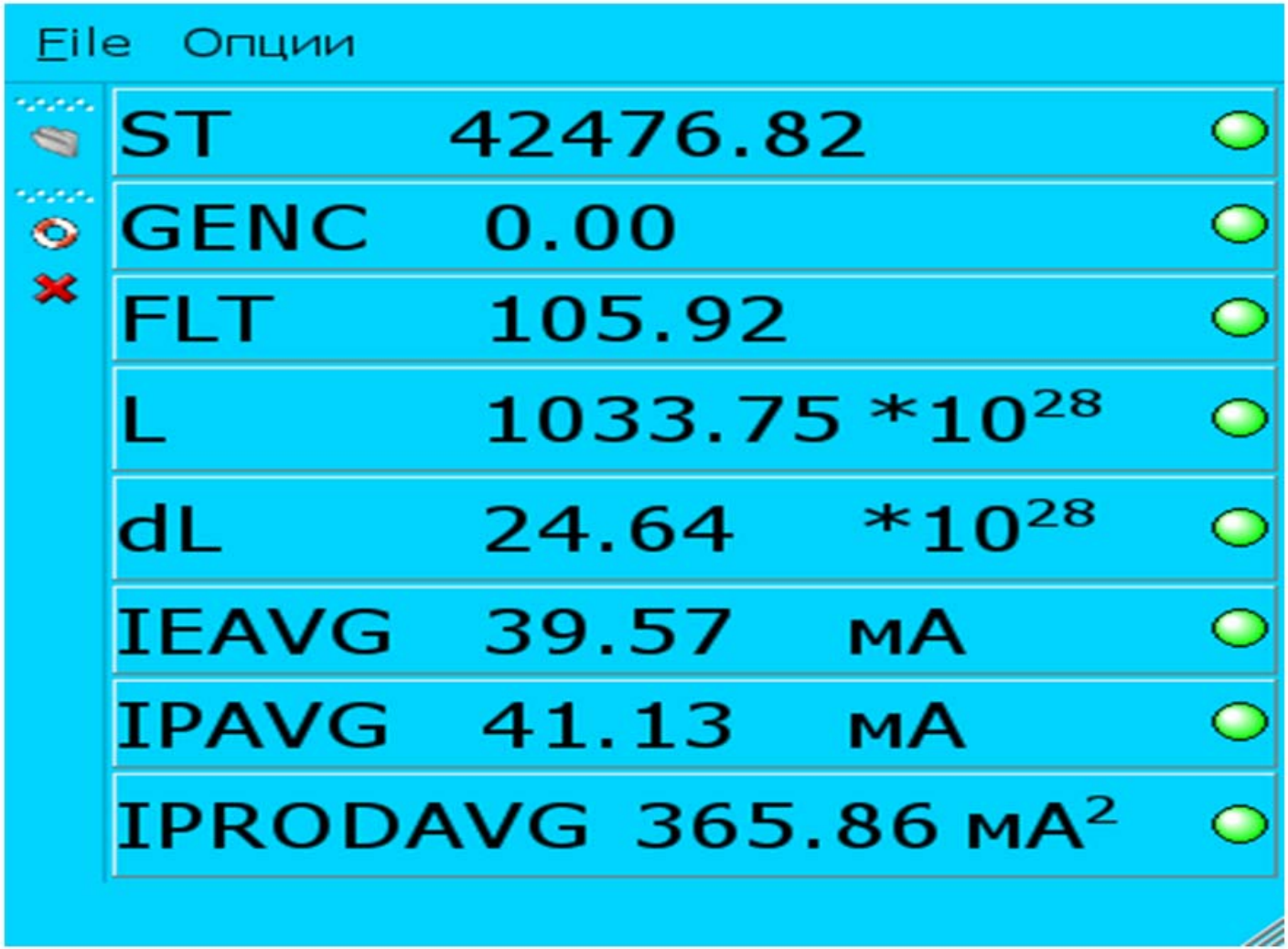



Dispersion
D, cm
S, cm
100
80
60
40
20
0
-20
0
500
1000
1500
2000
2500
Dx Before
Dx After
Dz Before
Dz After
Dx Ideal
Dz Ideal

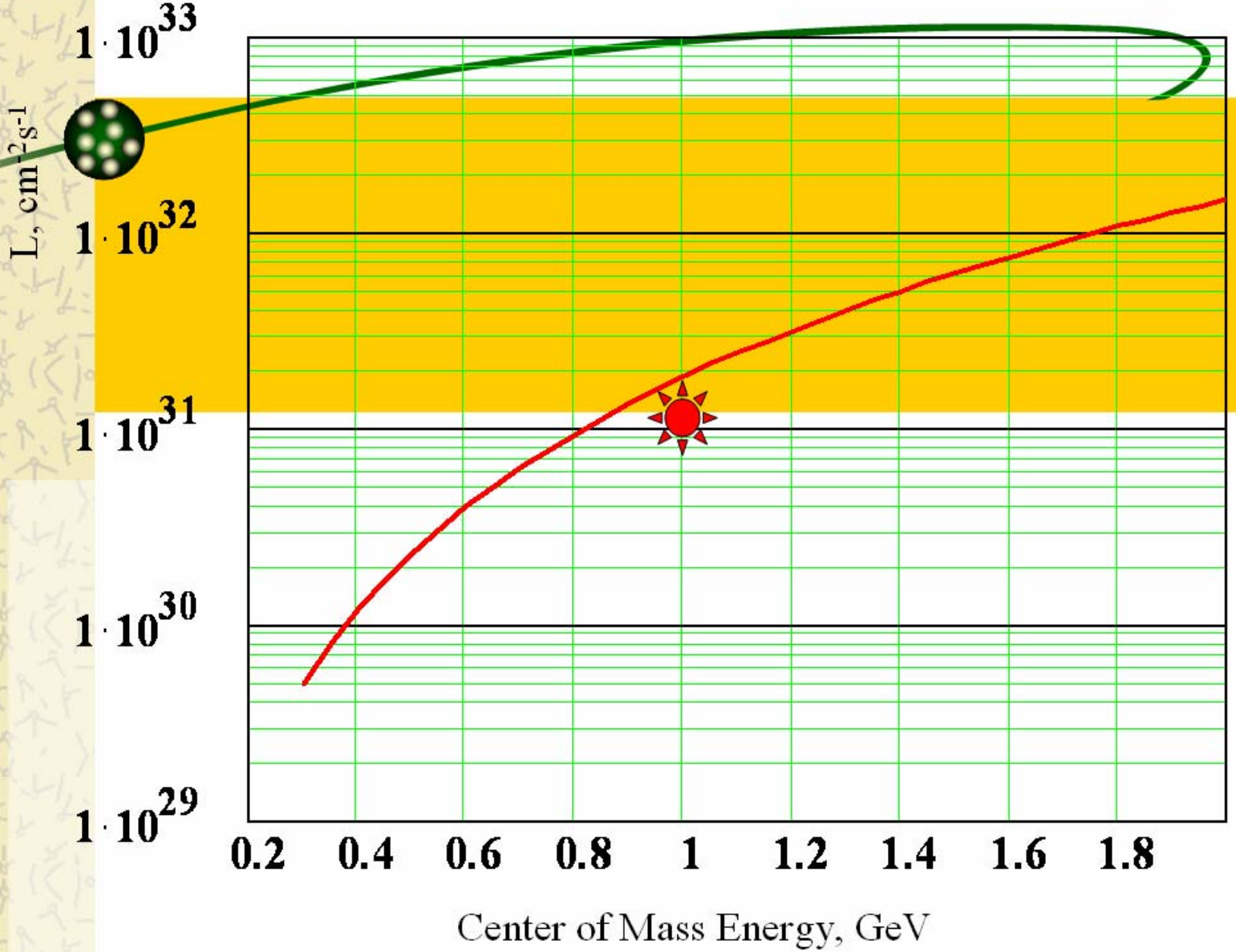
Tune scan


$4\nu_z = 9$
$2\nu_x - \nu_z = 6$
$\nu_x - \nu_z = 2$
$\nu_x - 2\nu_z = 0$
$4\nu_x = 17$
0.25
0.2
0.15
0.1
0.05
0.05
0.1
0.15
0.2
0.25

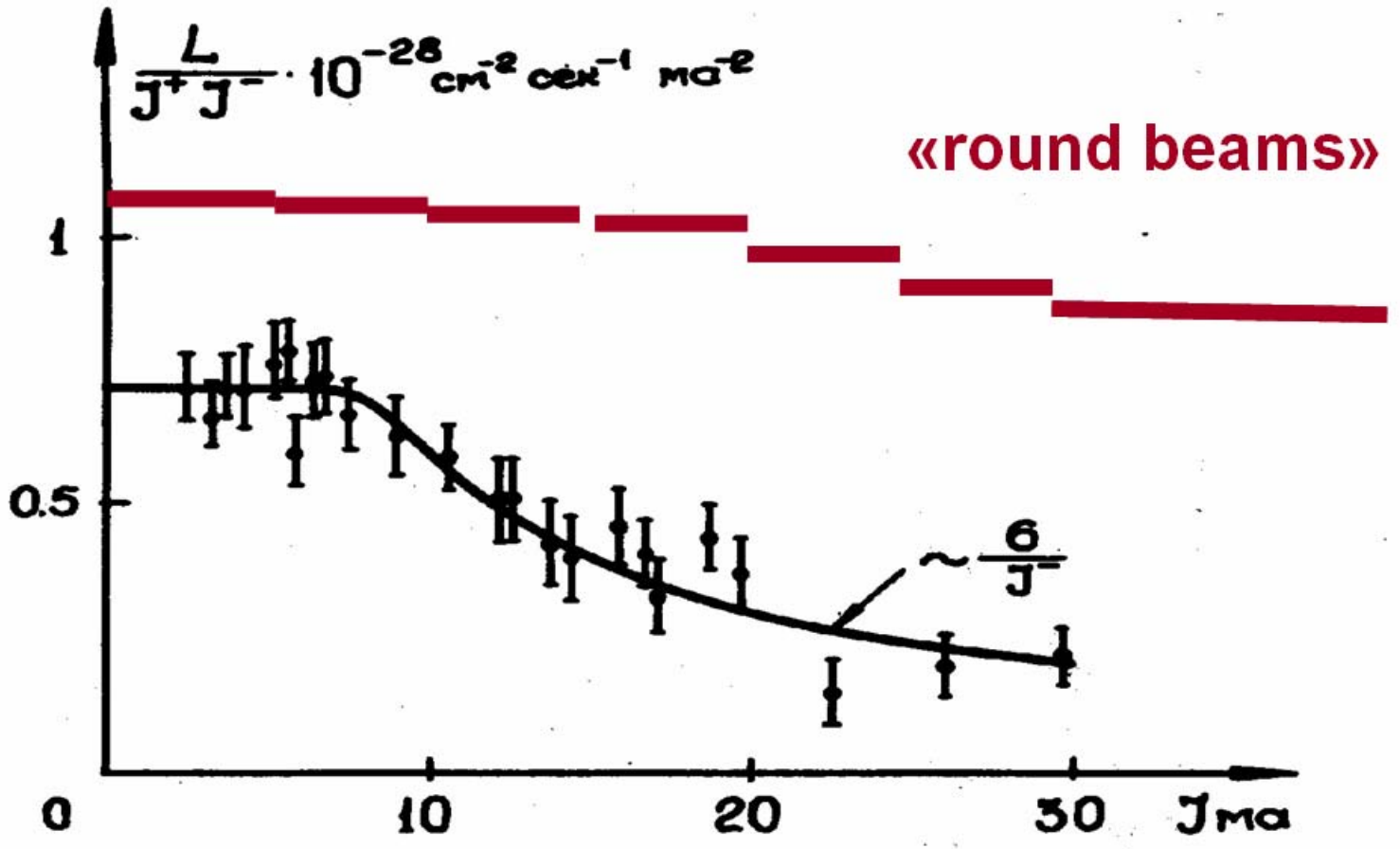
Best luminosity run



VEPP-2000 Luminosity



«flat» - «round»



Specific luminosity versus electron beam current

Conclusion

- VEPP-2000 is ready for operation
- «Round beams» – not a bad idea!
- Max. Lumi. achieved $1*10^{31}$ $cm^{-2}s^{-1}$ at φ-meson energy
- Potentially $2*10^{31}$ $cm^{-2}s^{-1}$ possible at φ and $1.6*10^{32}$ $cm^{-2}s^{-1}$ at 2 GeV
- More positrons required!

Physical program at VEPP-2000

1. Precise measurement of the quantity
   $R=\sigma(e^+e^- \to \text{hadrons})/\sigma(e^+e^- \to \mu^+\mu^-)$
2. Study of hadronic channels:
   $e^+e^- \to 2h, 3h, 4h \ldots$, $h= \pi, K, \eta$
3. Study of 'excited' vector mesons: ρ', ρ'', ω', φ',..
4. CVC tests: comparison of $e^+e^- \to$ hadr. (T=1) cross section with τ-decay spectra
5. Study of nucleon-antinucleon pair production – nucleon electromagnetic form factors, search for NNbar resonances, ..
6. Hadron production in 'radiative return' (ISR) processes
7. Two photon physics
8. Test of the QED high order processes 2->4,5