17TH ADVANCED BEAM DYNAMICS WORKSHOP ON

FUTURE LIGHT SOURCES

Horizontal Focusing

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HORIZONTAL FOCUSING

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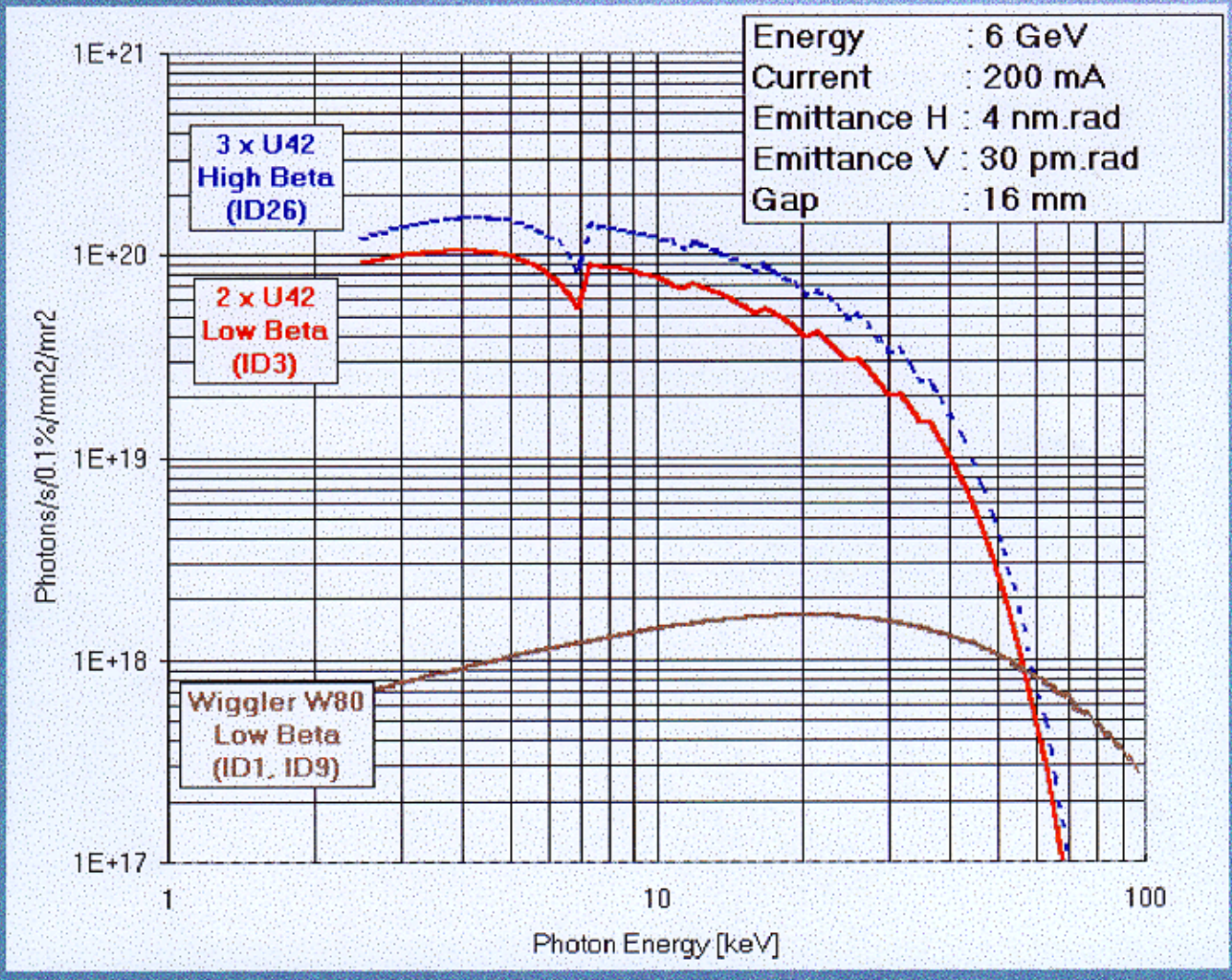
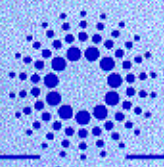
POSSIBLE BRIGHTNESS-RELATED IMPROVEMENT OF PERFORMANCES FOR AN OPERATING THIRD GENERATION LIGHT SOURCE ?

BEST BRILLIANCE ROUTINELY ACHIEVED AT THE ESRF AS OF JANUARY 1998



HORIZONTAL FOCUSING



ESRF

POSSIBLE BRIGHTNESS-RELATED IMPROVEMENT OF PERFORMANCES FOR AN OPERATING THIRD GENERATION LIGHT SOURCE ?

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MINIMIZATION OF THE PHOTON BEAM SIZE AT THE SAMPLE

- **LOWER HORIZONTAL EMITTANCE**

ESRF example: DBA ➜ ε_x = 7 NM
DISTRIBUTED DISPERSION ➜ ε_x = 4 NM
FURTHER REDUCTION ?
ε_x = 3 NM ➜ 1.7 GAIN IN BRILLIANCE

- LOWER COUPLING

ESRF example: PRESENT VALUE: 0.7 % ➜ ε_z = 25 PM
MEDIUM-TERM UPGRADE TO 0.3 %

- **OPTIMIZATION OF THE β FUNCTION IN THE IDS**

HORIZONTAL FOCUSING

ESRF

PHOTON BEAM CHARACTERISTICS AT A DISTANCE D FROM THE SOURCE

SIZE:

$$\sigma = \left[\varepsilon \left(\beta + 2\alpha D + \frac{1+\alpha^2}{\beta} D^2 \right) + D^2 \frac{\lambda}{2L} \right]^{\frac{1}{2}}$$

DIVERGENCE:

$$\sigma' = \left[\frac{1+\alpha^2}{\beta} \varepsilon + \frac{\lambda}{2L} \right]^{\frac{1}{2}}$$

OBJECTIVE:

MINIMIZING THE SPOT SIZE AT THE SAMPLE

BY OPERATING THE LATTICE WITH A NON-ZERO α_x IN THE MIDDLE OF A STRAIGHT SECTION

VIRTUAL FOCUSING OF THE ELECTRON BEAM SOMEWHERE DOWNSTREAM THE BEAM LINE

FOR A GIVEN β_x, σ IS MINIMUM FOR $\alpha_x = -\frac{\beta}{D}$

HORIZONTAL FOCUSING

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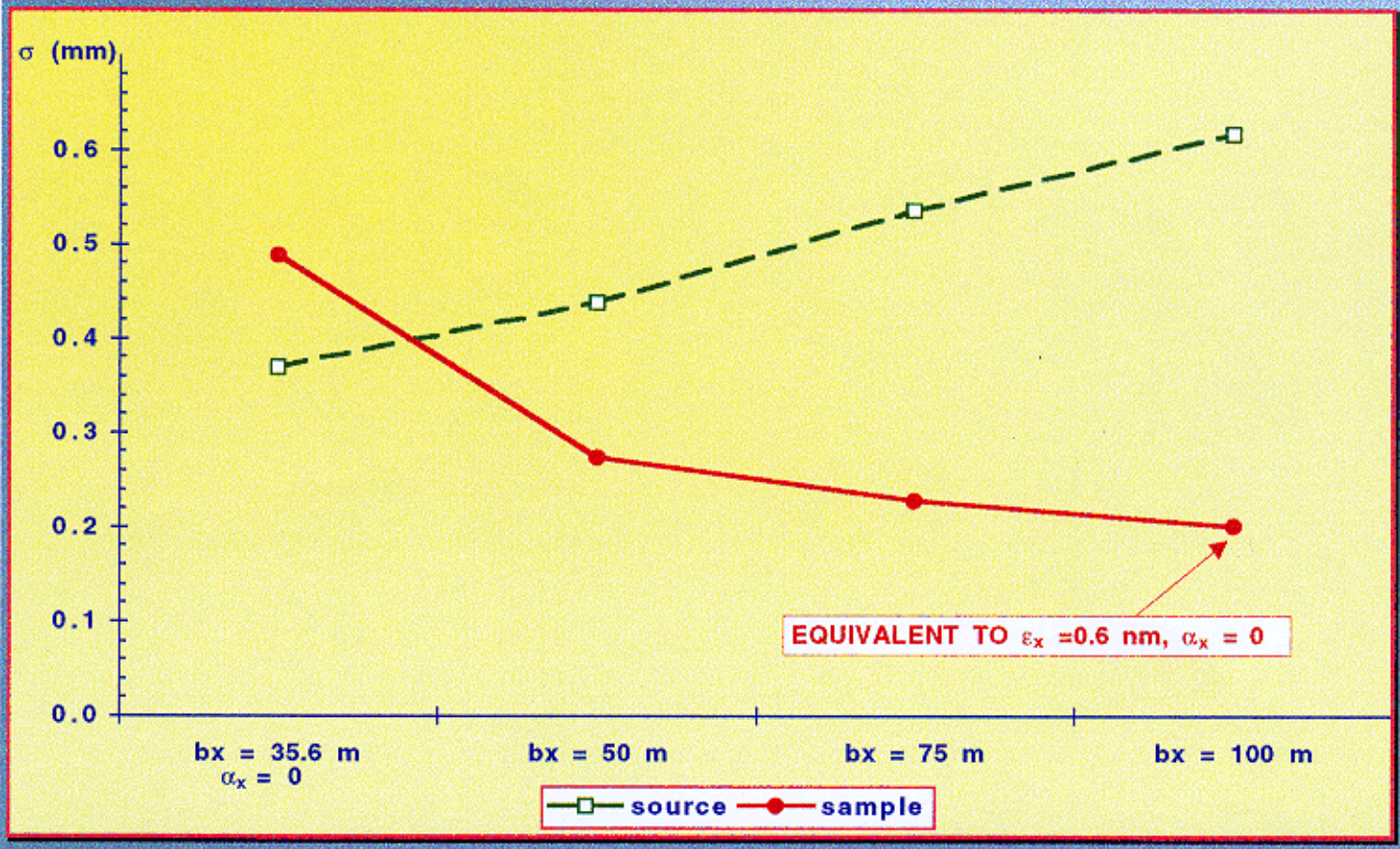
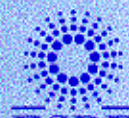
COMPARISON OF BEAM SIZES AT A PHOTON ENERGY OF 20 keV AT A DISTANCE OF 30 M



MACHINE TUNING CHALLENGES



- MAINTAIN THE CHARACTERISTICS OF THE STANDARD OPTICS
  - ELECTRON BEAM EMITTANCES
  - β VALUES AT THE OTHER SOURCE POINTS
  - SYMMETRY WITHIN EACH CELL

⇓

STRATEGY TO MATCH THE INSERTION TO THE REST OF THE LATTICE

- BREAKING THE PERIODICITY OF THE OPTICS

⇓

NUMEROUS RESONANCES

REDUCED DYNAMIC APERTURE

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LIFETIME REDUCTION

ONE STRAIGHT SECTION TUNED AT $\beta_x = 50$ M, $\alpha_x = -1.1$

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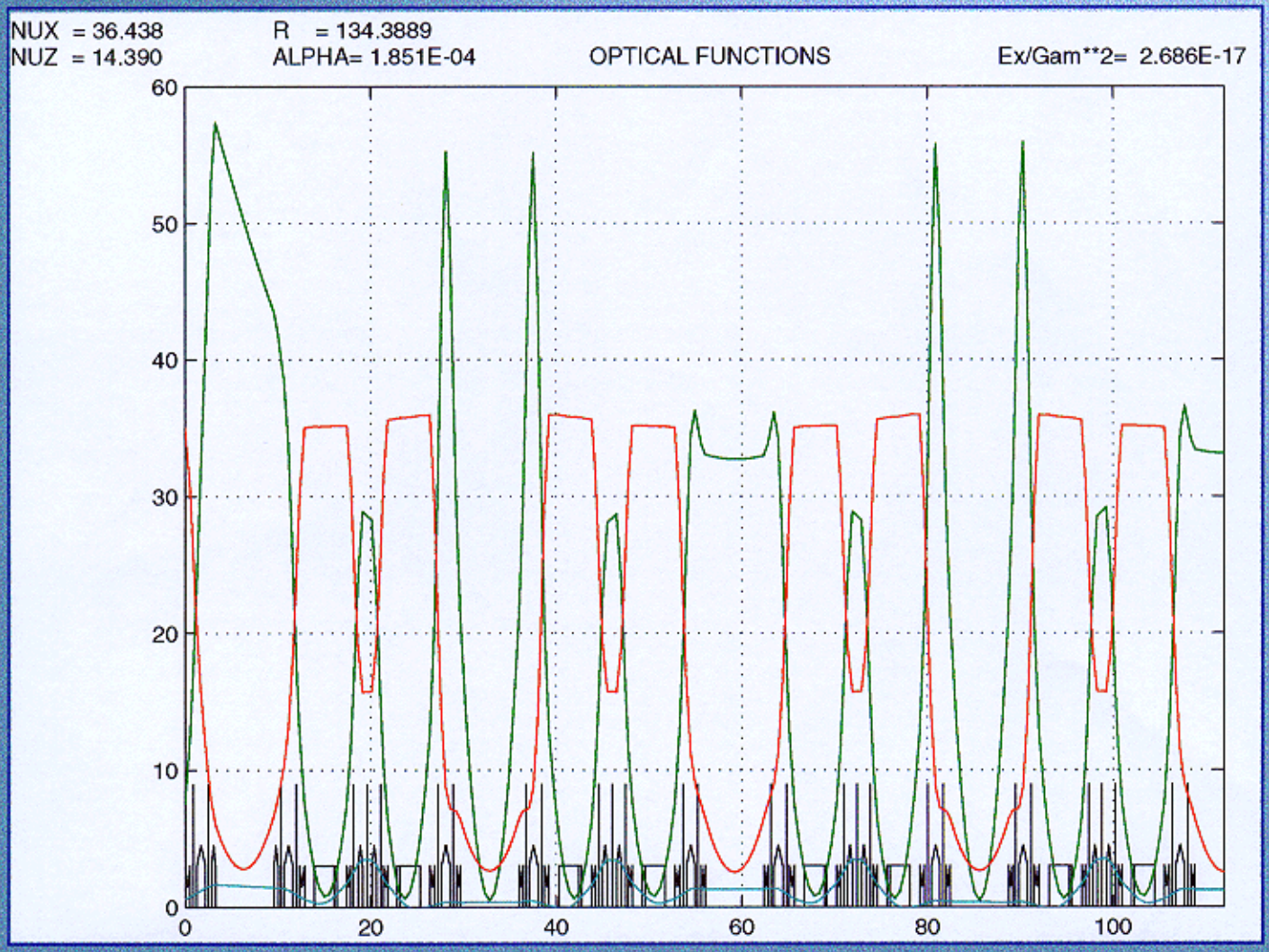

1 / 8 OF THE MACHINE

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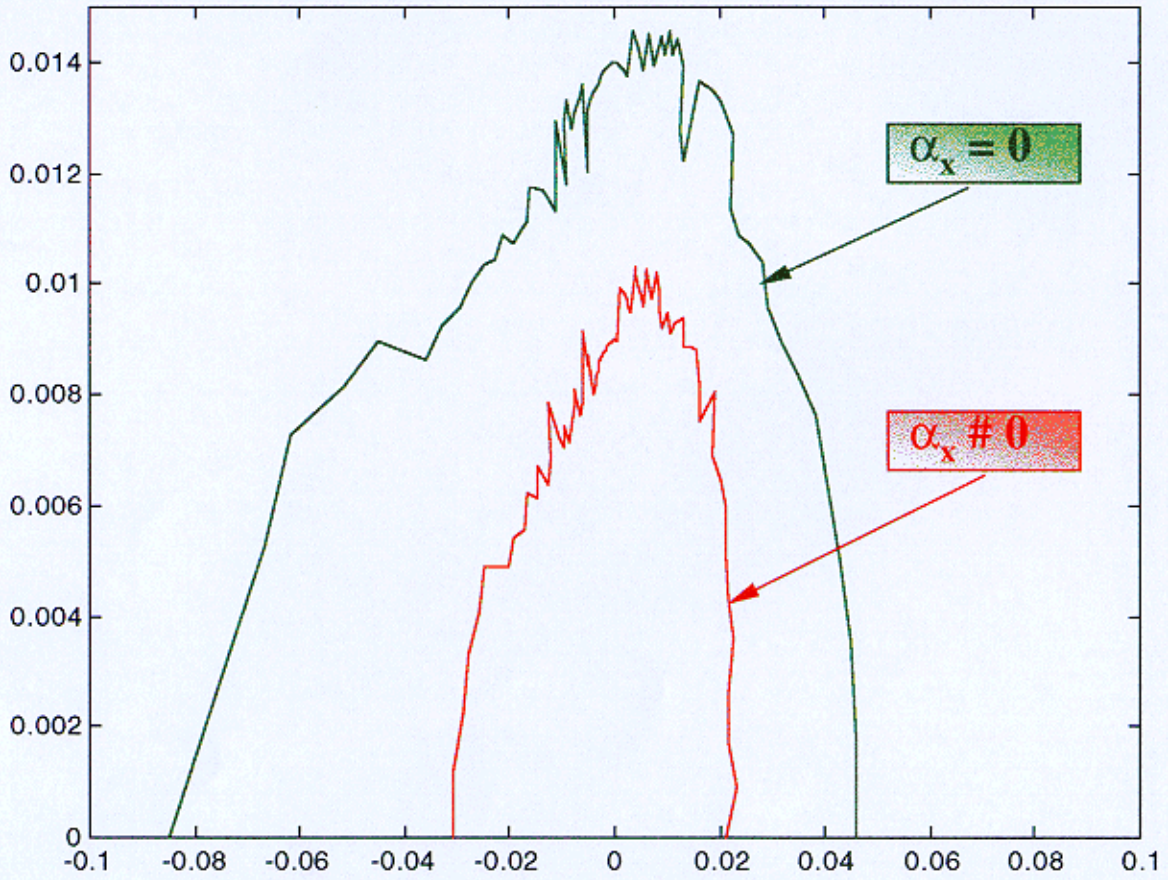
DYNAMIC ACCEPTANCE

REOPTIMIZATION OF FAMILY HARMONIC SEXTUPOLES + INDIVIDUAL TUNING IN THE $\alpha \neq 0$ STRAIGHT SECTION



PRESENT STATUS

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FIRST TESTS PERFORMED WITH ONE STRAIGHT SECTION TUNED AT $\beta_x = 50$ M, $\alpha_x = -1.1$

STRAIGHTFORWARD TUNING

- **INJECTION EFFICIENCY: 90 %**
- **RAMPING AT 200 MA**
- **LIFETIME: 41 H AT 100 MA**

TO BE COMPARED TO 45 H FOR THE STANDARD OPTICS

- **MEASURED CHARACTERISTICS OF THE OPTICS CLOSE TO PREDICTIONS**

OTHER TUNING ALSO TESTED: $\beta_x = 55$ M, $\alpha_x = -1.6$

MEASURED CHARACTERISTICS

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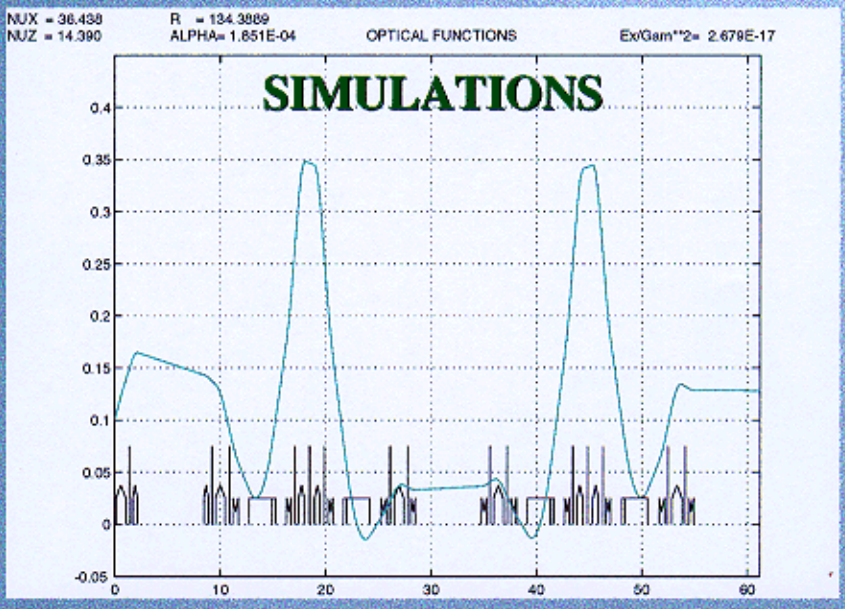
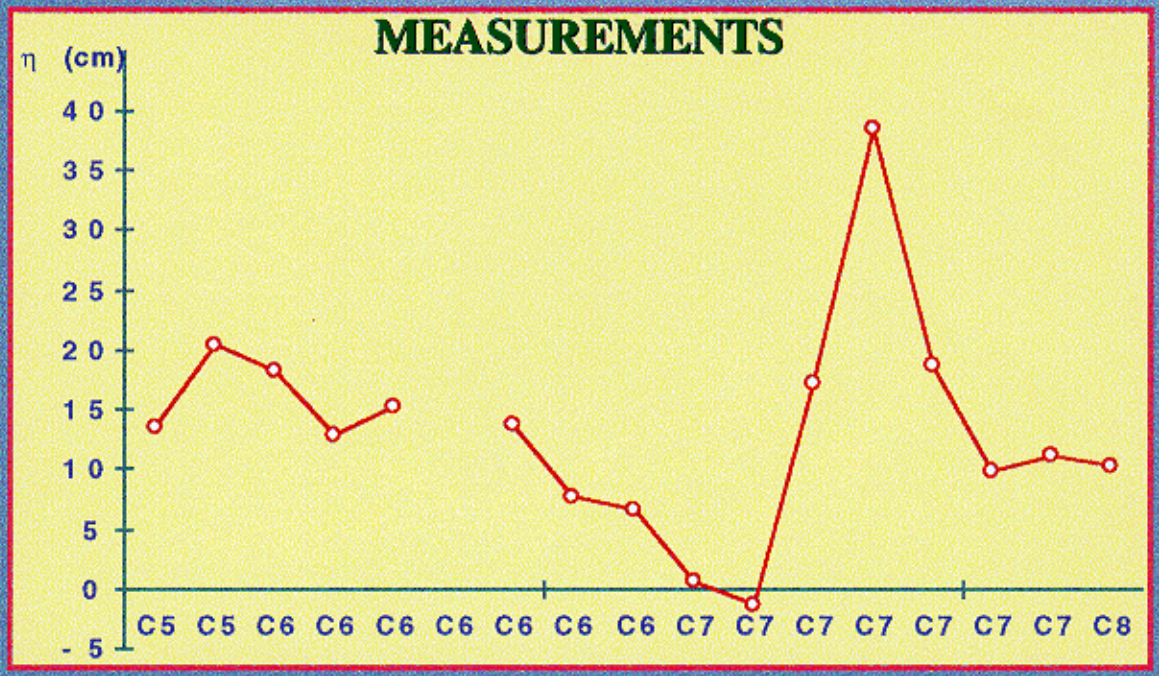
DISPERSION





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MEASURED β-FUNCTIONS

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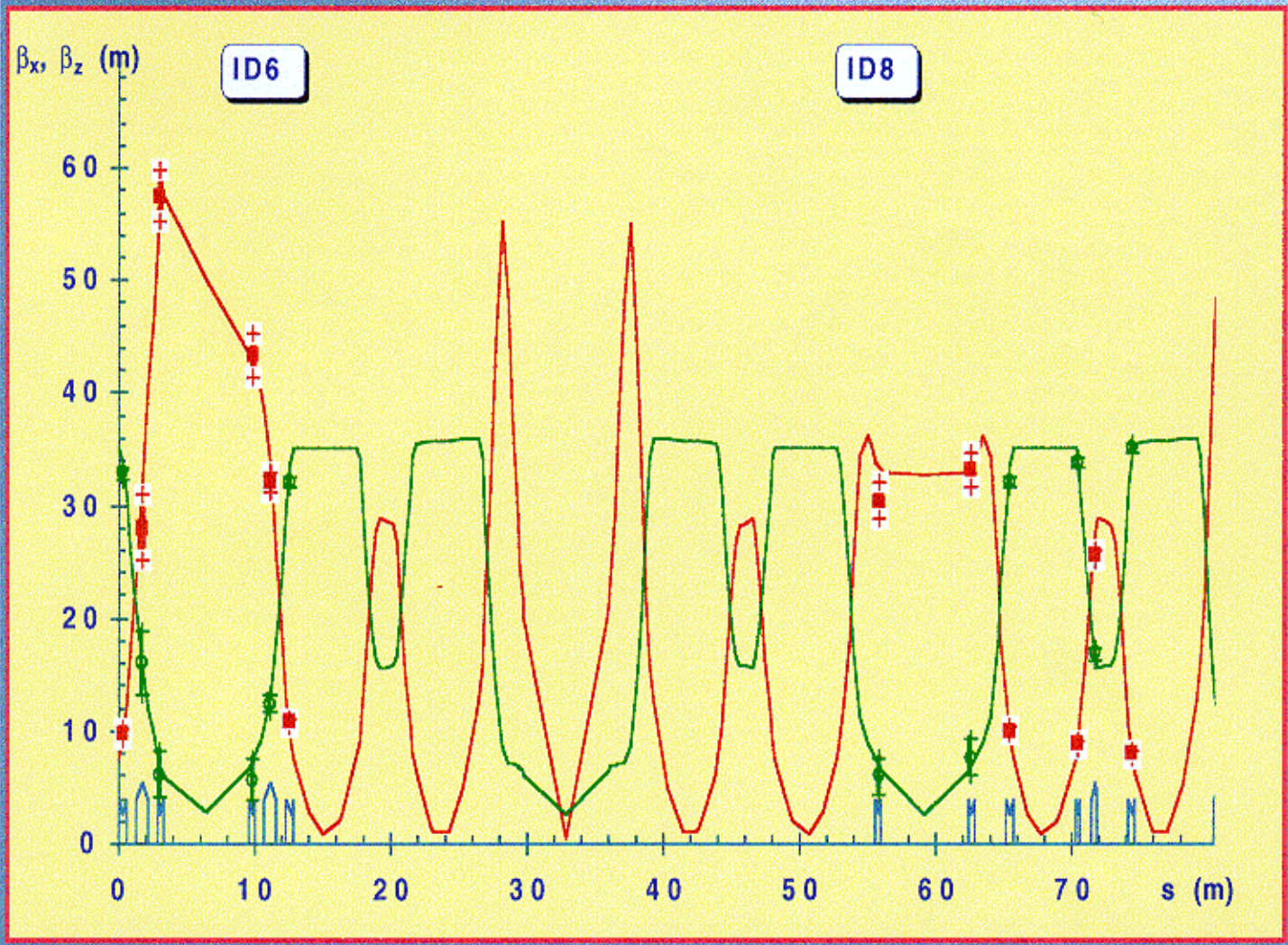
IN THE MODIFIED STRAIGHT SECTION



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MEASURED β-FUNCTIONS

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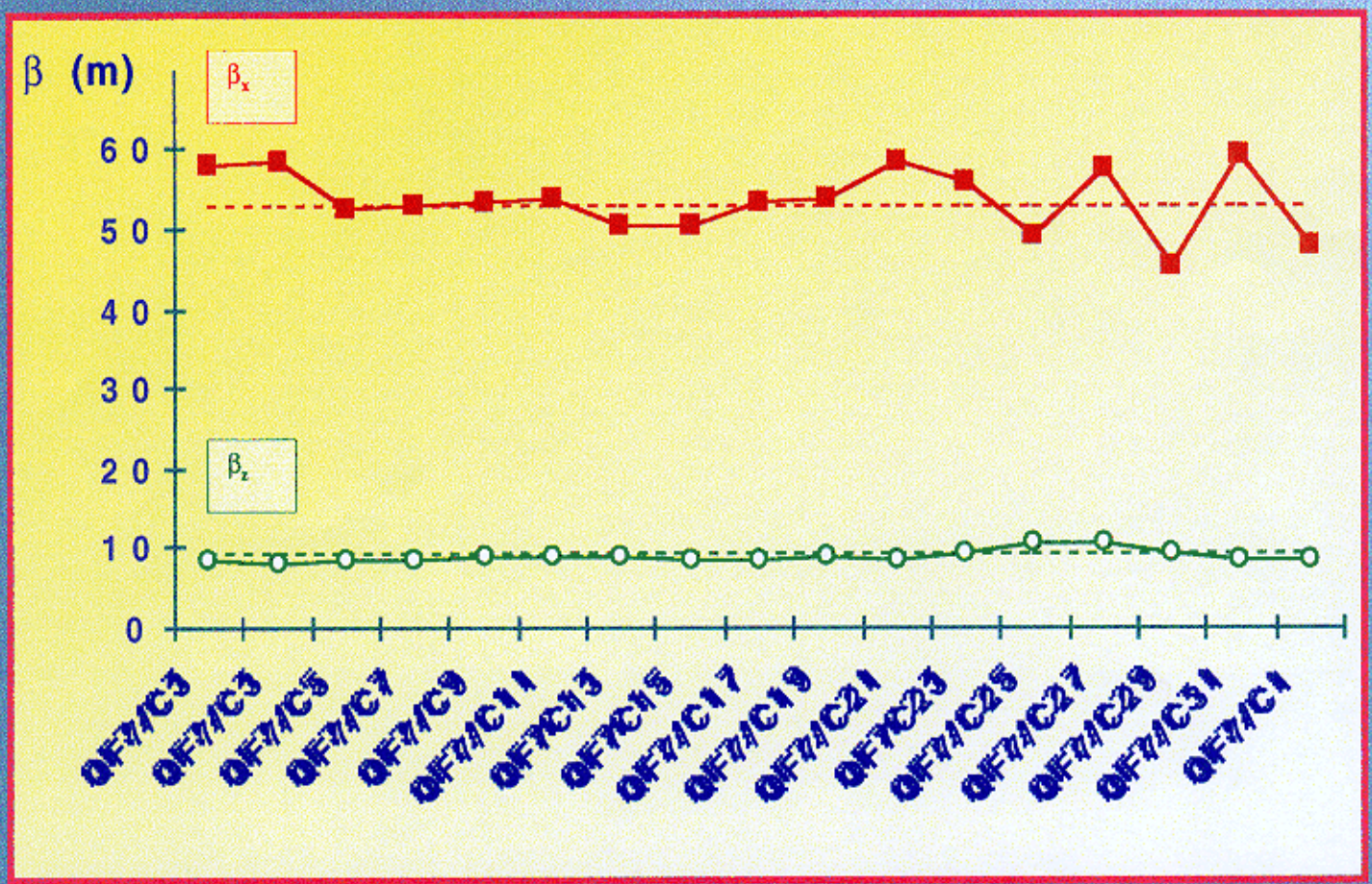
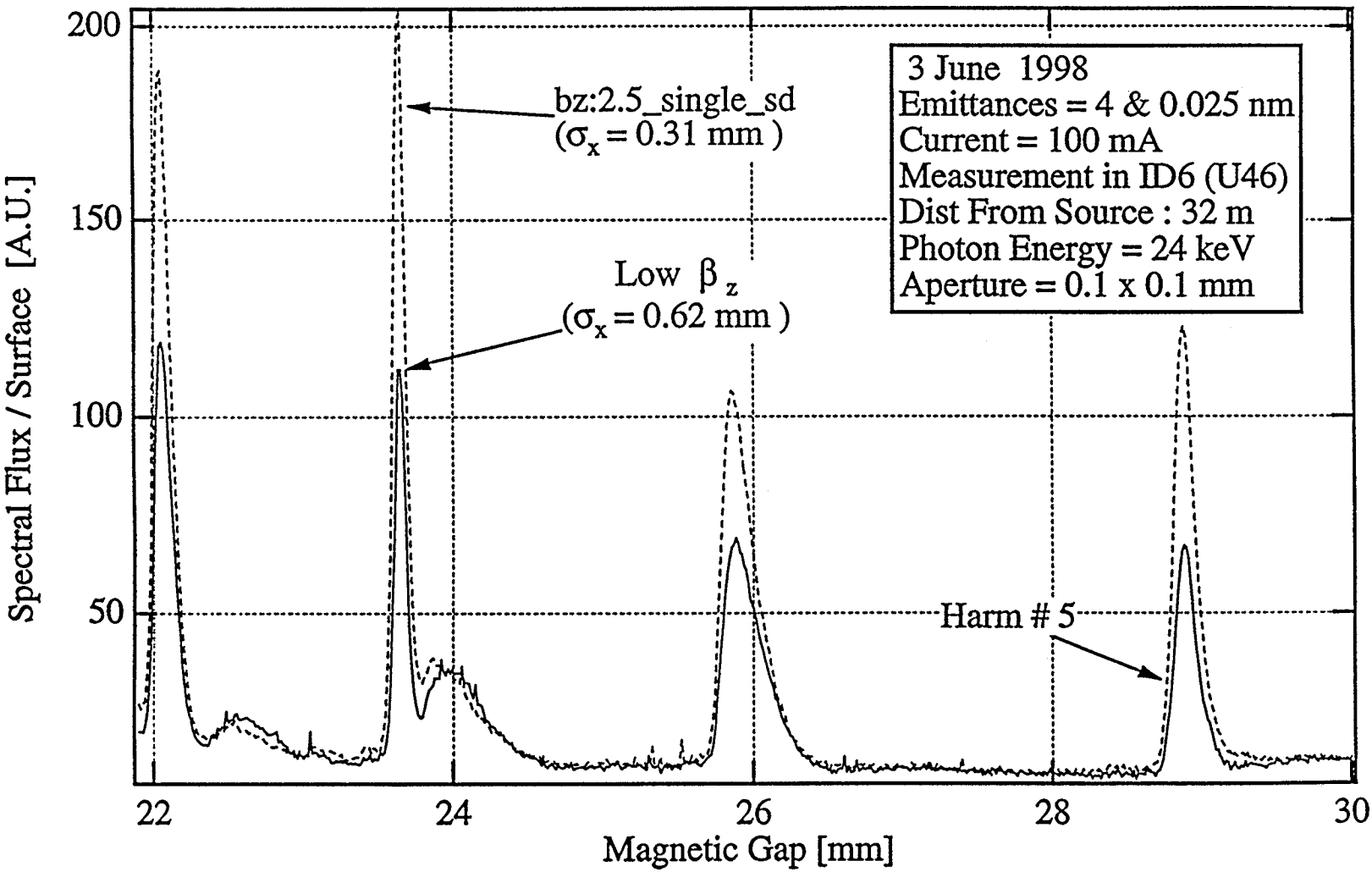
ALONG THE MACHINE



Focusing the Electron Beam in ID6



CONCLUSIONS

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- **NEW POSSIBILITIES OPENED BY INDIVIDUAL STRAIGHT SECTION TUNABILITY**

- **FUTURE PLANS:**

  - **PROBE THE ULTIMATE LIMIT OF CONVERGENCE OF THE ELECTRON BEAM (β_{max} ?)**

  - **TEST THE POSSIBILITY OF PROVIDING HORIZONTAL FOCUSING IN SEVERAL STRAIGHT SECTIONS SIMULTANEOUSLY**