

# **Beta-Beat Measurement and Correction for SIS100**

Vera Chetvertkova  
PBBP

# Contents

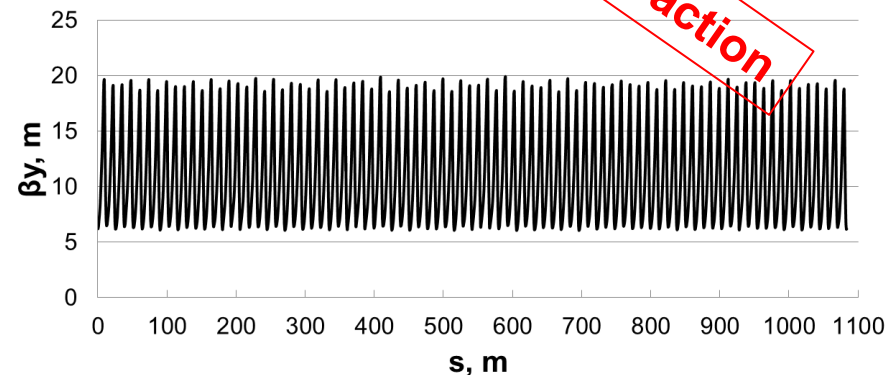
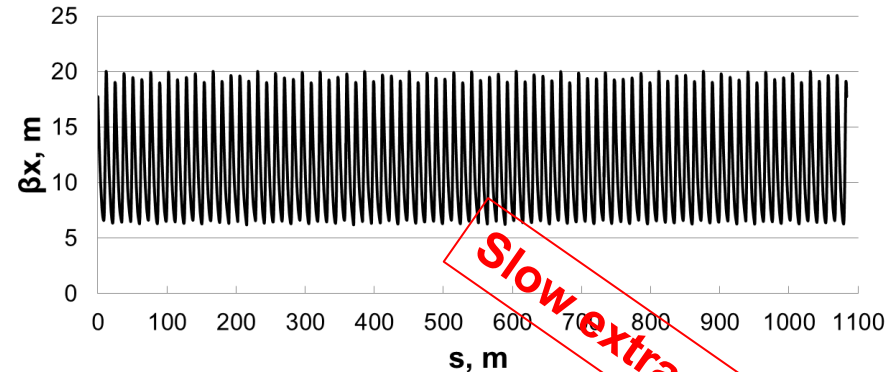
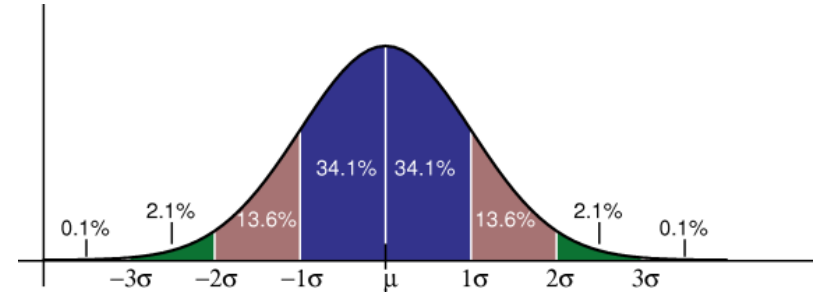
- What is a beta-function and beta-beating?
- Why do we want to measure and correct it?
- SIS100-specific issues
- How could we correct it?
- What do we need for correction?
- Summary and Conclusion

# What is a beta-function and beta-beating?

- $\beta$ -function describes the transverse size of the beam at the location  $s$  along the nominal beam trajectory:

$$\sigma(s) = \sqrt{\varepsilon\beta(s)}$$

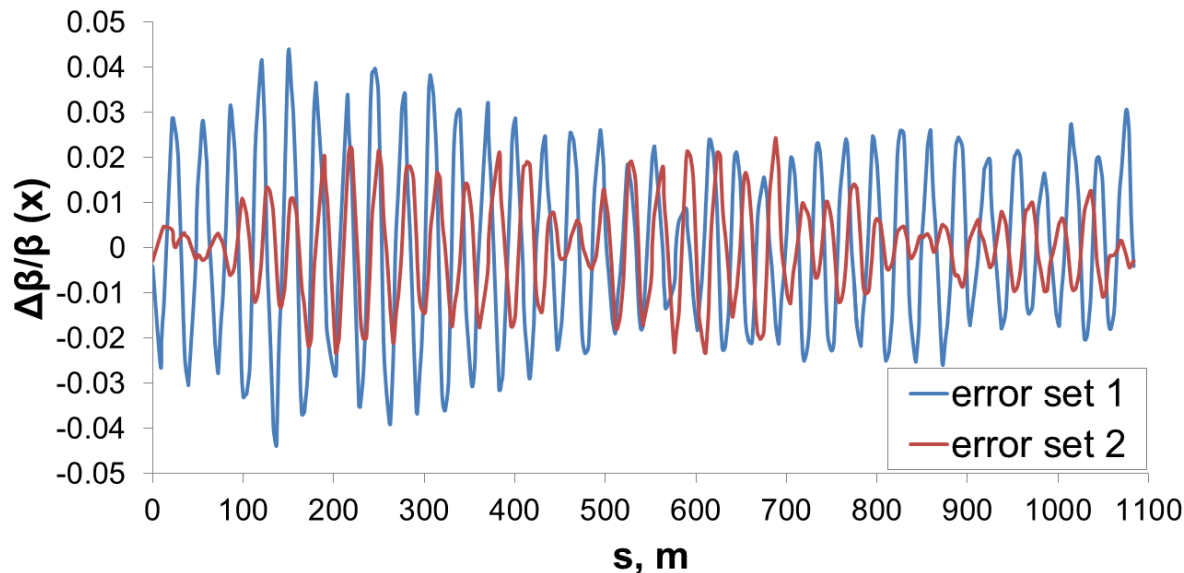
- $\varepsilon = \frac{\varepsilon_n}{\beta\gamma}$ ,  $\varepsilon_n = 34 \times 14 \text{ mm}\cdot\text{mrad}$
- $U^{28+}$  at 200 MeV/u:  
25x15mm<sup>2</sup>



# What is a beta-function and beta-beating?

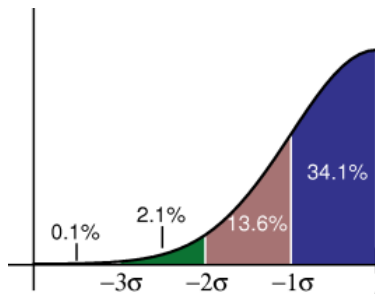
- $\beta$ -beating is relative change of  $\beta$ -function in presence of quadrupole field errors or sextupole-magnets misalignment

$$\frac{\Delta\beta}{\beta} = \frac{\beta_e - \beta_0}{\beta_0}$$



# Why do we want to correct $\beta$ -beating?

- Optimization of accelerator optics
- Minimization of losses in case of large  $\beta$ -beating (Vacuum chamber dimensions: 60x30mm)



$U^{28+}$  at 200 MeV/u

Beam profile at  $2\sigma$ : 25x15mm<sup>2</sup>

=> ~factor 2 margin until the beam loss

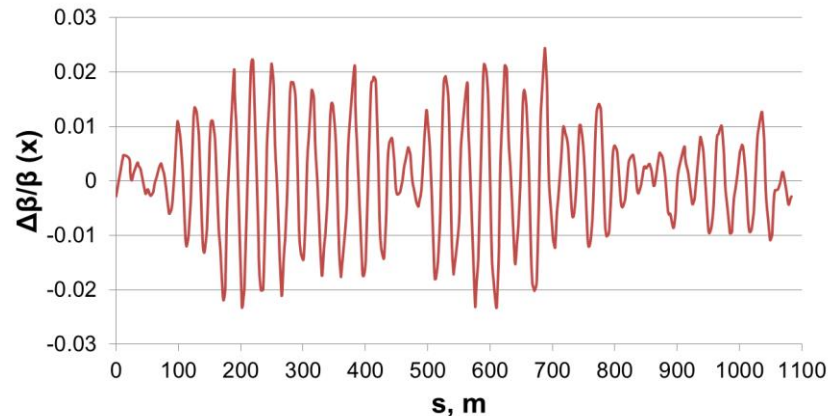
- Possible quenching of the SC magnets
- Possible damaging of the equipment

# SIS100-specific issues

- High-intensity effects: space charge
  - $\beta$ -beating changes at high intensities (to be studied)
  - $\beta$ -beating at high intensities might lead to unwanted resonances and emittance blow-up
  - $\beta$ -beating will depend on the working point

# How could we correct it?

- Various correction methods:
  - K-modulation
    - changing the strength of an individual quadrupole and measuring the tune change
  - Orbit response analysis (see talk of O. Kovalenko)
- SIS100: 12 quadrupole corrector magnets
- Proper choice of BPMs (83 hor. + 83 vert. BPMs)



# What do we need for correction?

- $\beta$ -functions are measured at the locations of BPMs, in between they are extrapolated, according to the model
  - Take into account BPM uncertainties
- In order to correct, one needs a point of reference:  
Data base with
  - locations of the accelerator components and uncertainties of their positioning
  - magnet strengths and uncertainties of the field
- Take into account possible powering issues ( $\beta$ -function will change)
  - 5 families of main quadrupoles (3 SC, 2 warm)



# Summary

- Beta-beating depends on the magnet errors and misalignment
- Space charge influences beta-beating and can lead to resonances and emittance blow-up (effect has to be thoroughly studied)
- For correction one will need
  - model of SIS100, i.e. data base with elements, their locations and magnetic strengths
  - properly chosen BPMs
  - proper powering
  - ...

- Will we be able to correct  $\beta$ -beating?
  - What level of correction is satisfactory?
- Will we have to sort magnets in the ring, according to their errors, to compensate  $\beta$ -beating?
- ...