An introduction to ISAC LEBT beam envelope calculator TRANSOPTR

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Objective:Beam envelope calculation

- Understand the beam transport properties of low energy ion beamline.
- Minimizing the tuning effort and establish a reliable tune.
- Improve the efficiency of ion beam transport.

Approach

I Simulation tool

- To calculate the beam enevelope:TRANSOPTR

II Experimental tool

- To measure the Phase-space distribution: Emittance scanner
- To determine the beam profile and its position: Wire Harps
- To estimate the beam transmission: Faraday Cups

An introduction to TRANSOPTR

- TRANSOPTR is a beam transport design code and it is based on the same theoretical foundation as TRANSPORT.
- An automatic optimization of a beam transport system can be performed under some general constraints for either first order (with or without space-charge effects) or second order.
- In the space-charge calculation the beam's evolution is calculated by numerically integrating a differential equations for the evolution of beam (σ) matrix along the reference trajectory.

An introduction to TRANSOPTR cont...

- The beam matrix(σ matrix) defines the shape of an ellipsoid(in 6D space where the coordinate frame has axes x, θ, y, ϕ, l and δ) which contains the collection of particles.
- In first-order beam transport calculations, the effect of a transport element on the beam envelope coordinates can be represented bt the linear transformation

$$X(2) = R_{12}X(1) \tag{1}$$

where R_{12} is characteristic of the element.

- Similarly the σ matrix undergoes the following transformation

$$\sigma(2) = R_{12}\sigma(1)R_{12}^{T} \tag{2}$$

A two-dimensional beam phase-space ellipse

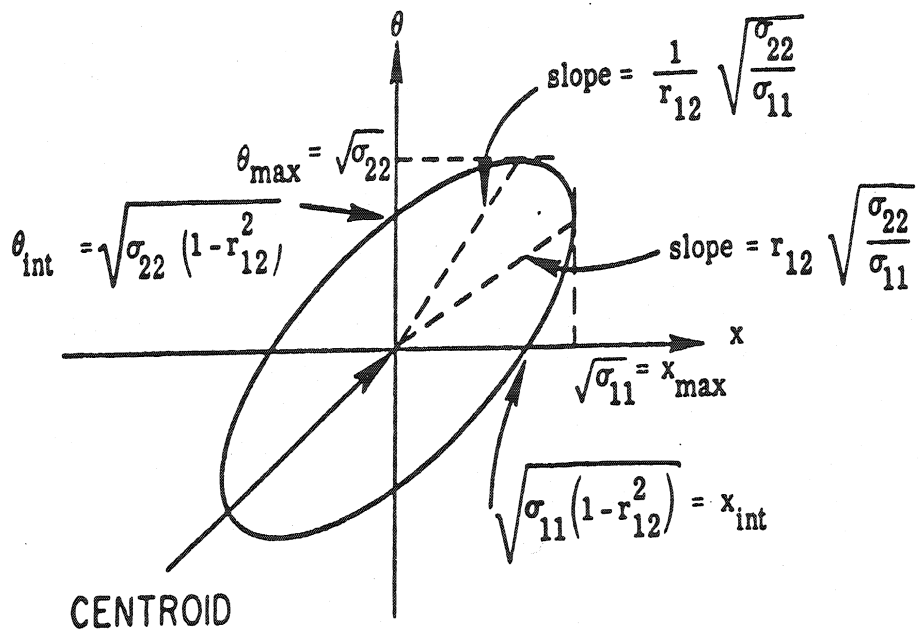

Figure 1: An example of an (x,x') plane ellipse.

Measured phase-space distribution

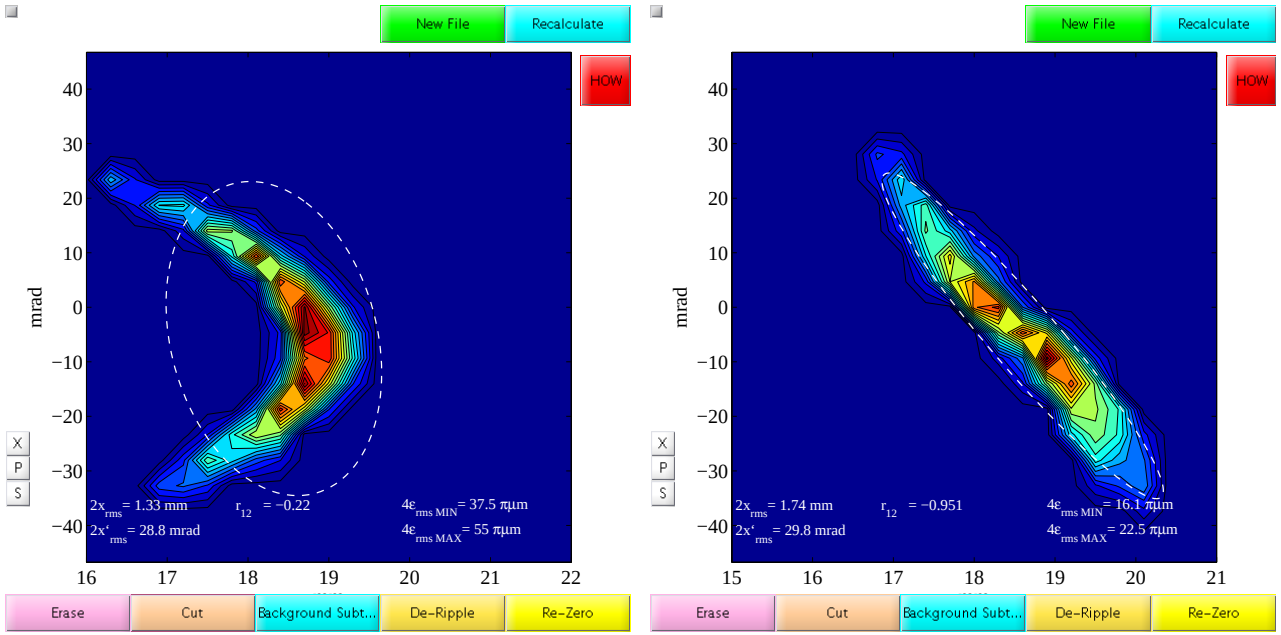

Figure 2: An example for a measured phase-space distribution(bend plane) behind the ISAC main separator(MB2) without higher-order correction[left] and with higher-order correction(β coil)[right]. The ellipse orientation shows that the α coil needs some optimization according to the slit position at MB2.

A snap-shot of phase-space input for the beam envelope calculator

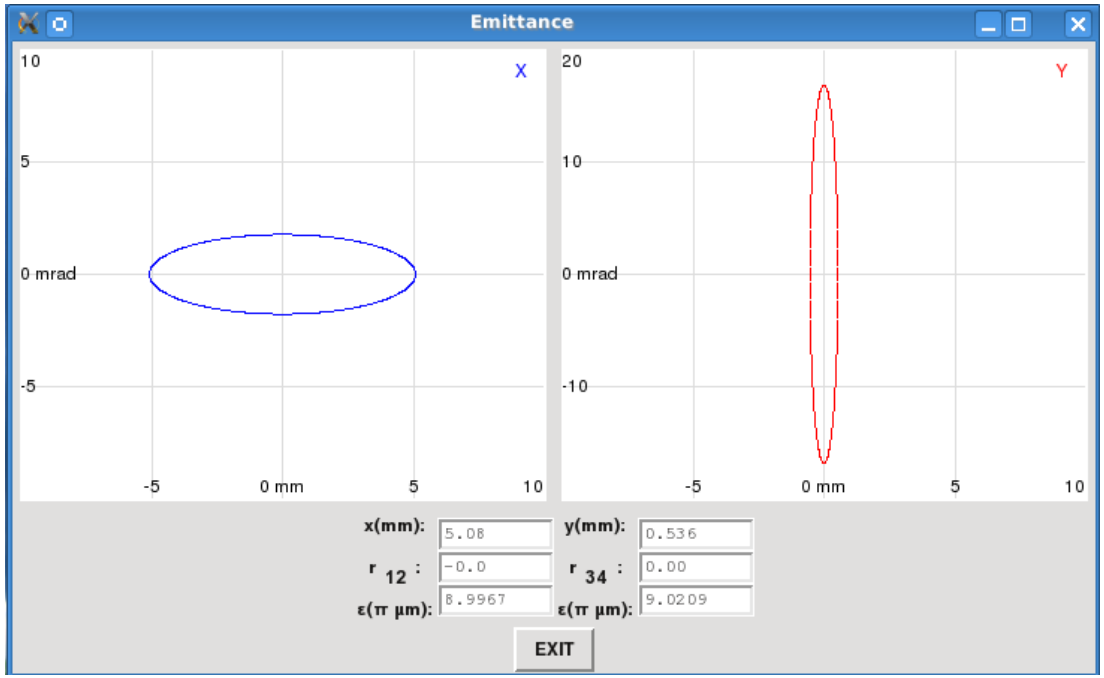

Figure 3: A 4D phase-space input for TRANSOPTR

A snap-shot of calculated beam envelope

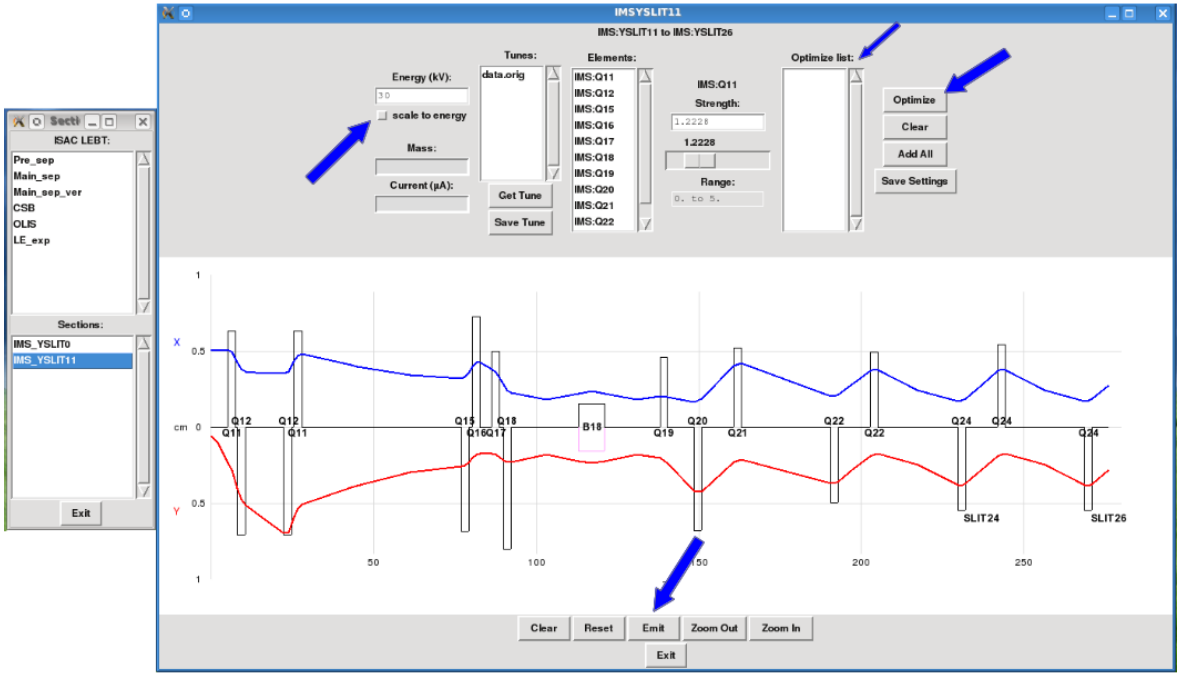

Figure 4: An example for a calculated beam envelope from the ISAC main separator to the SLIT-26.

Thank you !