プラズマ加熱用負イオンビーム位相空間構造に基づくビーム光学評価

Evaluation of beam optical properties based on phase space structure of negative ion beams for plasma heating

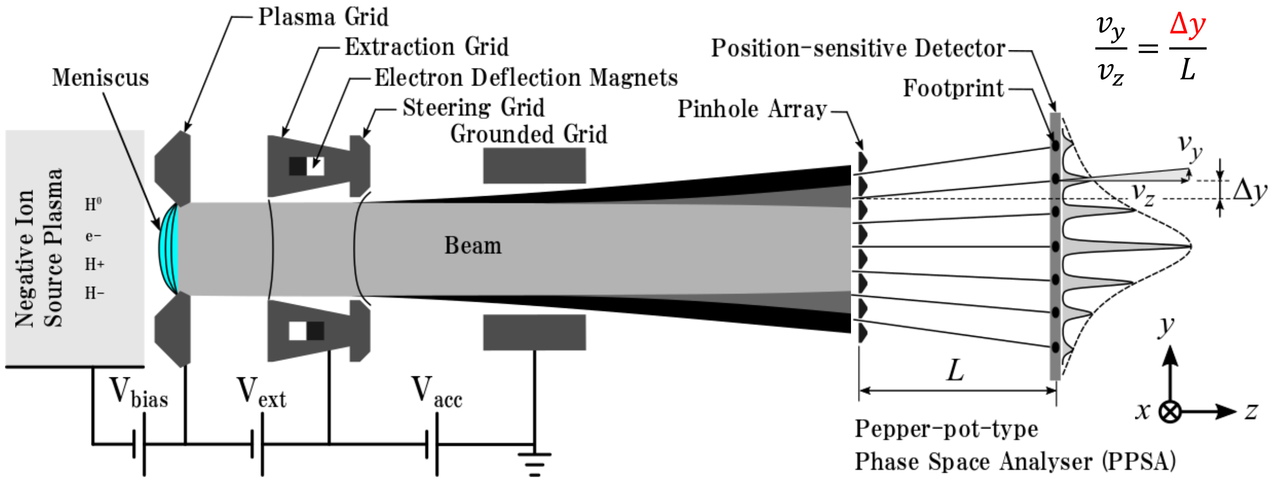
Y.Haba[1)], K. Nagaoka[2,1)], K. Tsumori[2,3)], M. Kisaki[2)], H. Nakano[2,3)], K. Ikeda[2)], M. Osakabe[2,3)]

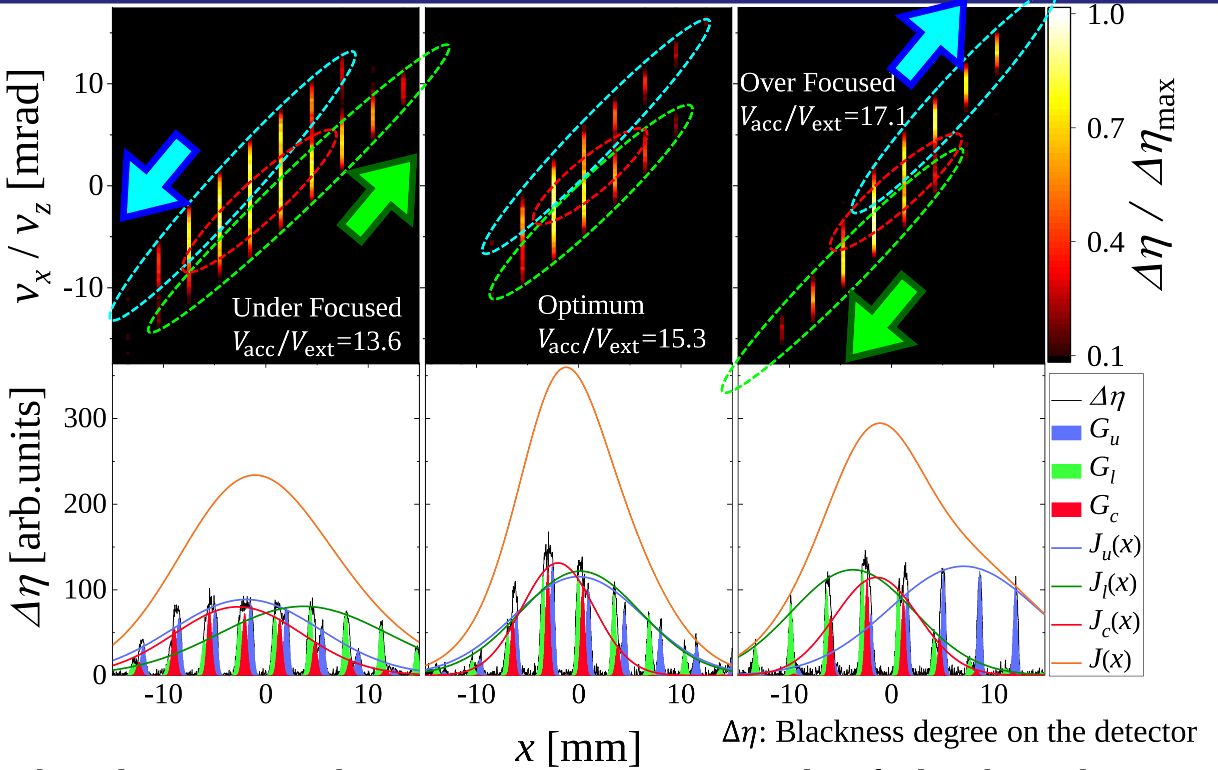
[1)] *Graduate School of Science, Nagoya University,* [2)] *National Institute for Fusion Science,* [3)] *SOKENDAI*

Well-focused beam is required for ITER (3-7 mad with RF negative ion source).
→ Achievement: 17-35 mrad with RF, ~5 mrad with filament-arc negative ion source

Beam focusing of negative ions are affected by two electrostatic-lens effects.
One is the plasma meniscus, which is described as the perveance $\propto n_{\mathrm{H}^-}/V_{\mathrm{ext}}^{1.5}$, where n_{H^-} and V_{ext} refer the negative ion density and the extraction voltage, respectively.
The other is the subsequent lens, which can be controlled by the voltage ratio of $V_{\mathrm{acc}}/V_{\mathrm{ext}}$, where V_{acc} is the acceleration voltage.

We focus on the phase space structure of a single negative ion beamlet to understand the negative ion beam focusing. The phase space structure measurements of the beamlet produced by a filament-arc-type negative ion source (NIFS-RNIS) have been performed by scanning $V_{\mathrm{acc}}/V_{\mathrm{ext}}$ with fixed perveance (fixed n_{H^-} and V_{ext}).





The beamlet consisting three-Gaussian components is identified in the x-direction.
The two components, which are shown with dashed lines in blue and green, move in the opposite direction by changing $V_{\mathrm{acc}}/V_{\mathrm{ext}}$.
The standard deviation of the axis-positions of three components (δ) is a key parameter to characterize the focusing of the negative ion beamlet.

$$\delta = \left[\sum_i (x_i - \bar{x})^2 \alpha_i\right]^{1/2} / \sigma_x \quad \text{with} \quad \bar{x} = \sum_i x_i \alpha_i$$

x_i: Position of each component
$\bar{x}$: Position of beamlet center
α_i: Normalized current
σ_x: Beamlet width