A new Doppler shift spectroscopy for the measurement of neutral beam profile

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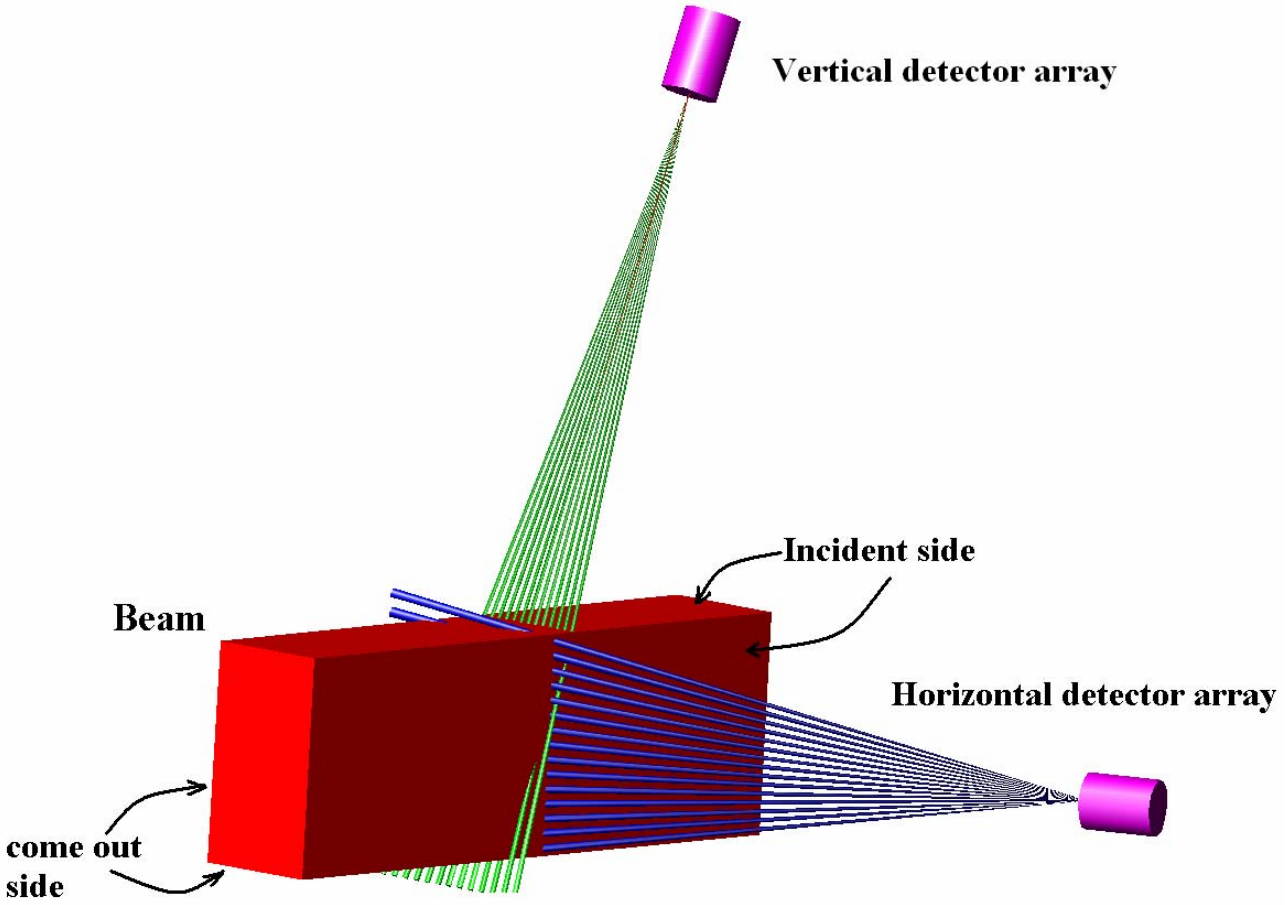
Abstract

A new diagnostic base on Doppler shift is designed which measures the profile of hydrogen or deuterium neutral beam on the magnetic confined fusion machines. The interference filters and multi-channel PDA detectors are the main components of this diagnostic. The multi-channel PDA detectors measure the line integrated Doppler shifted Ha signal emitted by the neutral beam at one section in two directions. The local intensity of neutral beam can be obtained with the tomography technique. Compare to the conventional calorimeter diagnostics, this diagnostic can provide the beam profile without blocking the injection of neutral beam.

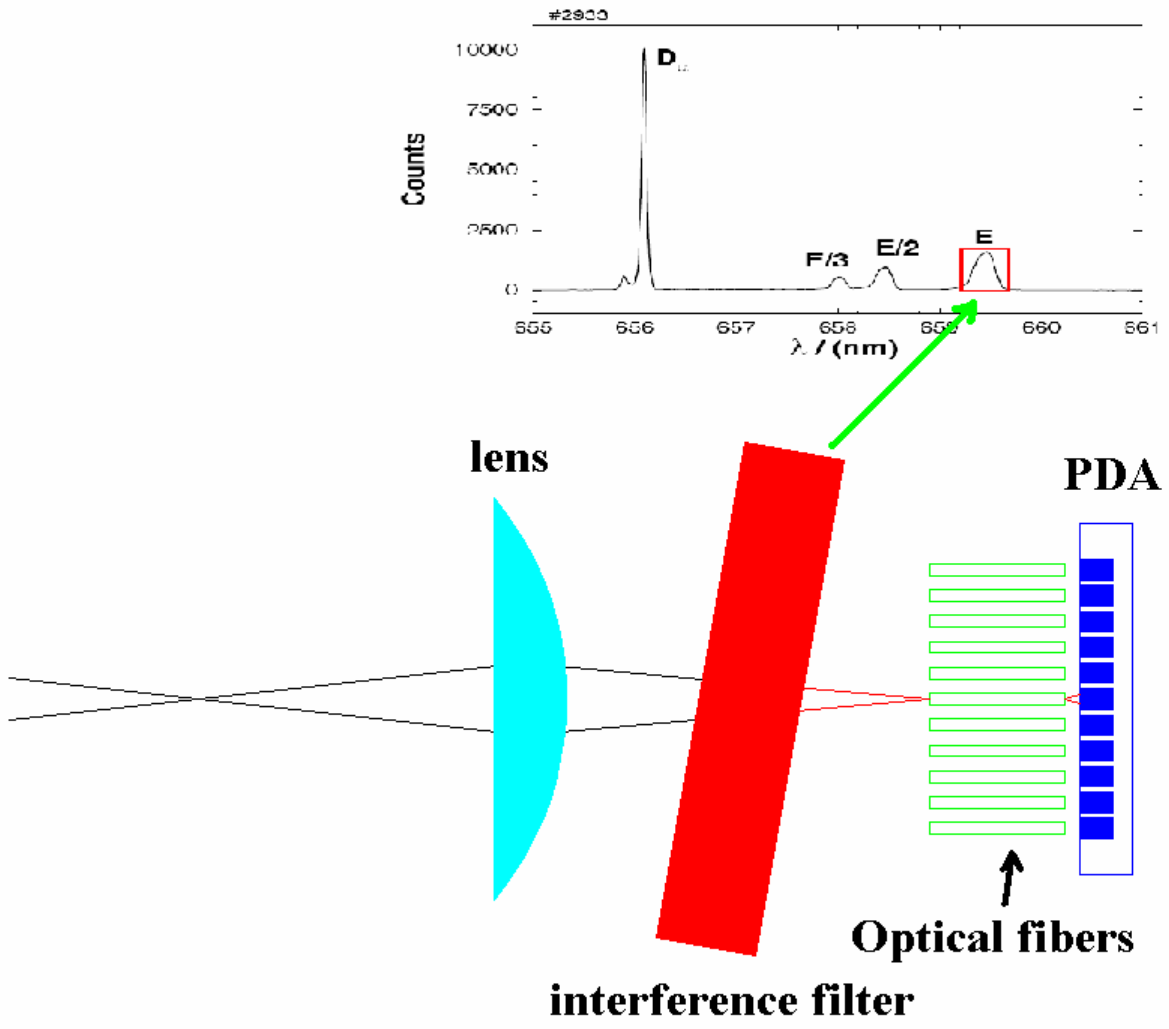
Disadvantages of the calorimetry technique

- Blocking the injection of neutral beam
- No time resolution
- Complex design and installation

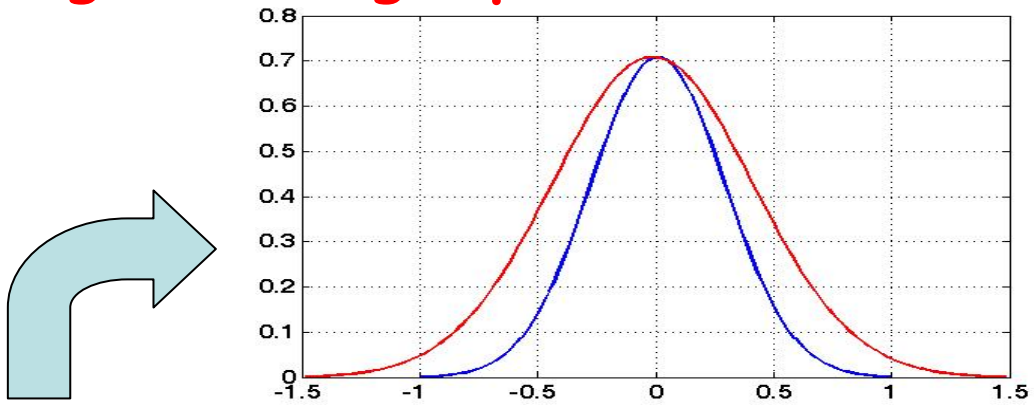
The sketch of new Doppler shift spectroscopy

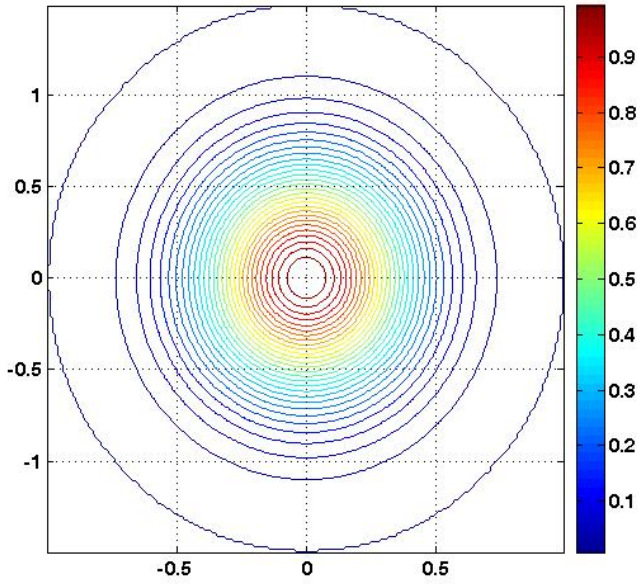


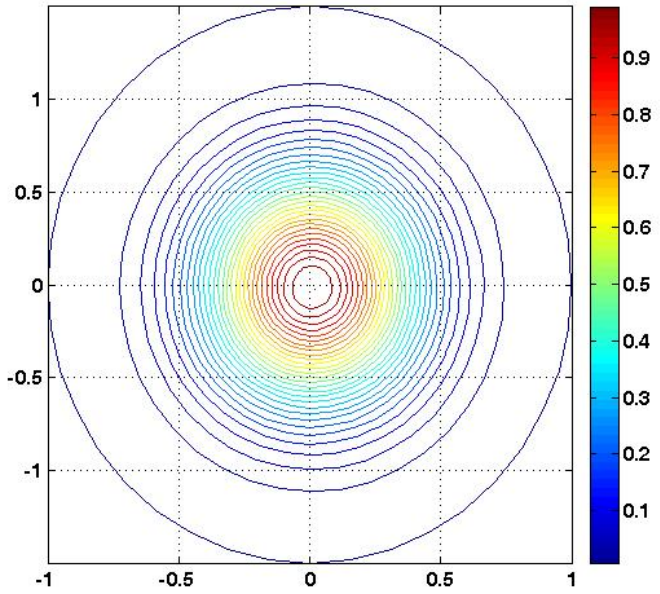
The detail structure of the detector array. A typical Doppler shifted D_α spectrum is shown on the top part



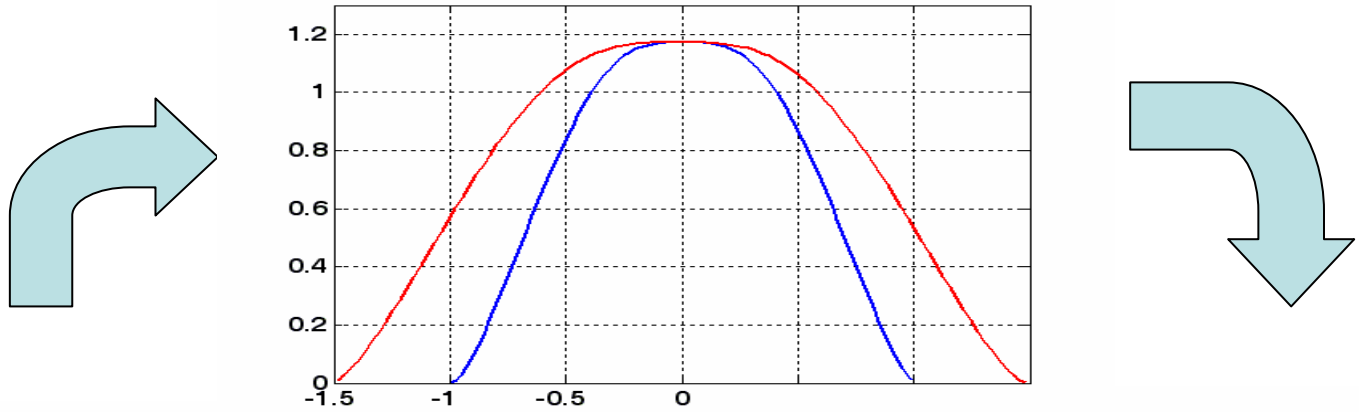
The source profile,line integrated signal and reconstructed image for single peak Gaussian distribution

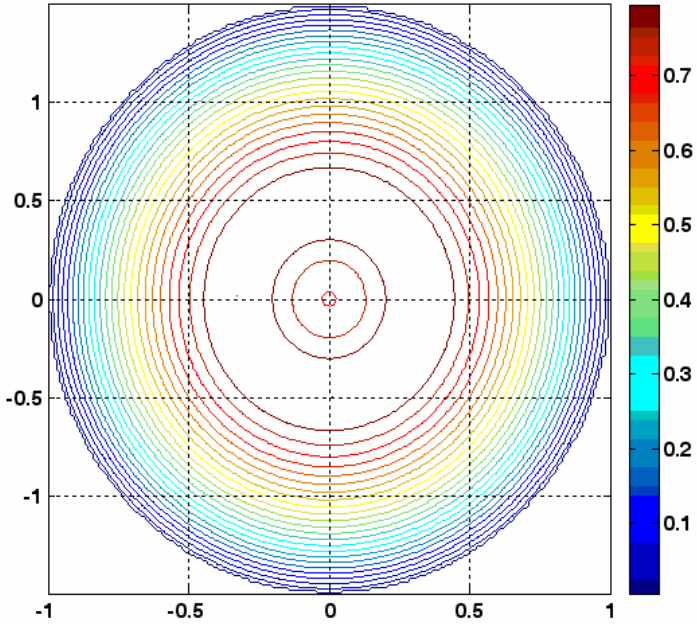


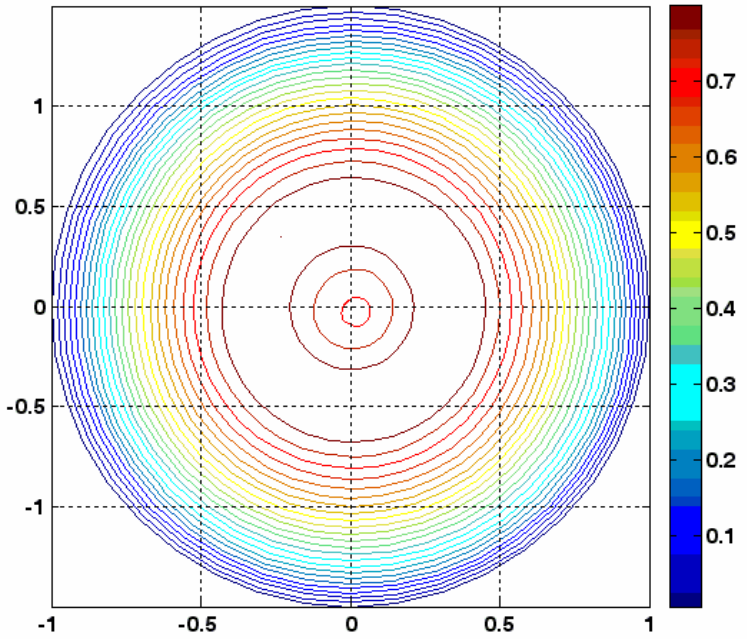




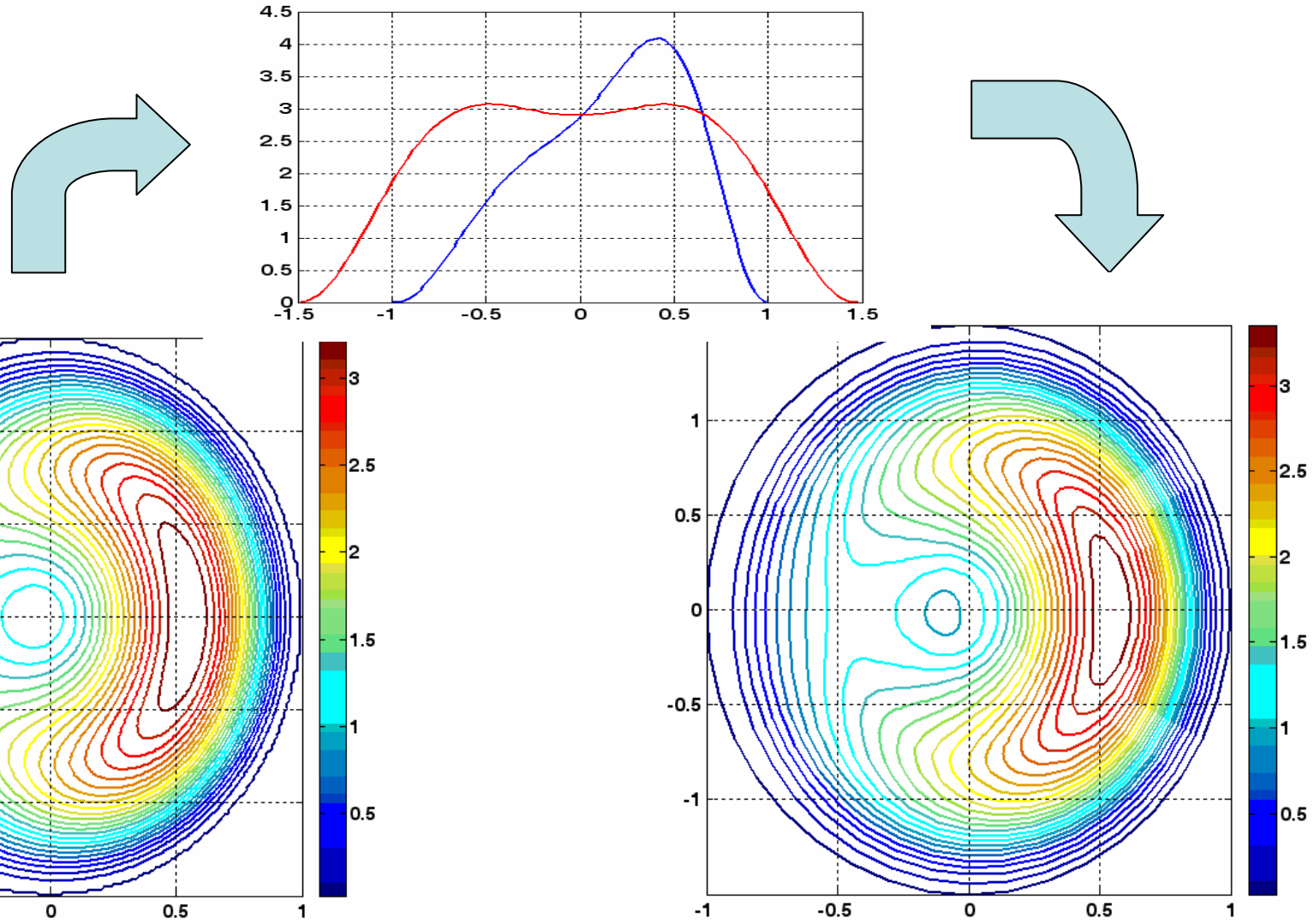
The source profile,line integrated signal and reconstructed image for hollow distribution



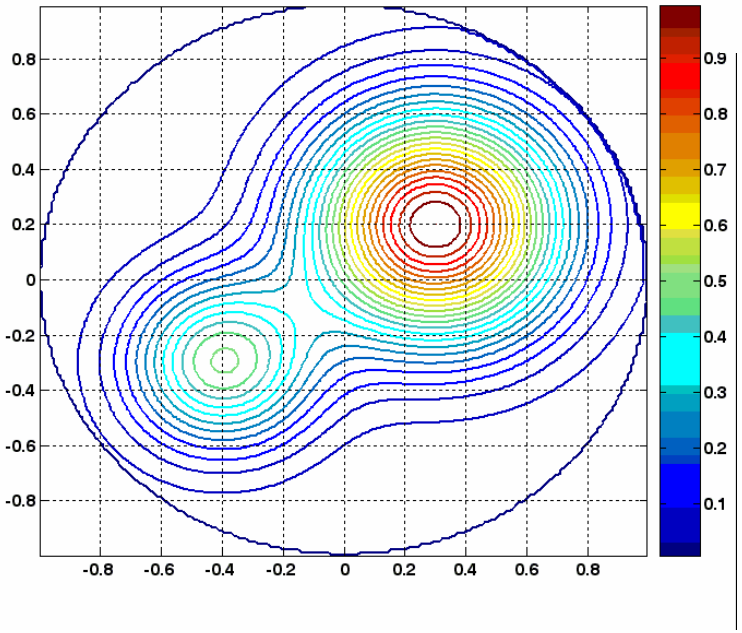


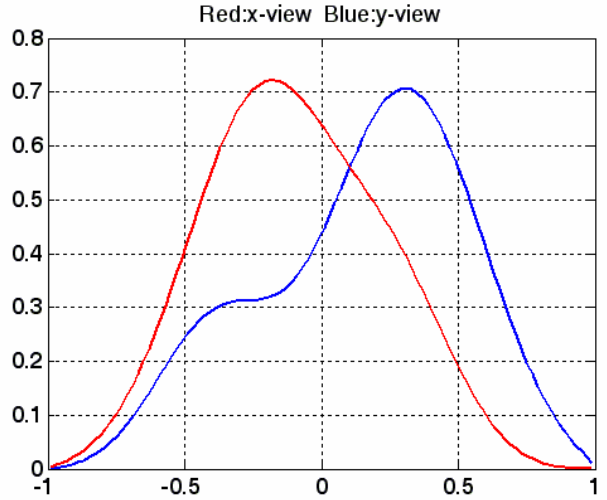


The source profile,line integrated signal and reconstructed image for asymmetric distribution



The source profile,line integrated signal and reconstructed image for two peaks Gaussian distribution





A_1=0. 997 (1. 0) w_{d1}=0. 401 (0. 4)

x_{01}=0. 300 (0. 3) y_{01}=0. 199 (0. 2)

A_2=0.496(0.5) w_{d2}=0.300(0.3)

x_{02}=-0.401(-0.4) y_{02}=-0.301(-0.3)

Discussion

Some imperfect properties of the beam profiles and measurement errors are not considered in above simulation. On the other hand, the beam profile should be relatively stable for one NBI device, in fact. A specified reconstructed technique will be more suitable for a specified NBI device.