DEVELOPMENT OF A NOVEL BEAM PROFILE MONITOR BASED ON LIGHT EMISSION FROM EXCITED REST GAS ATOMS

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Early Stage Researcher
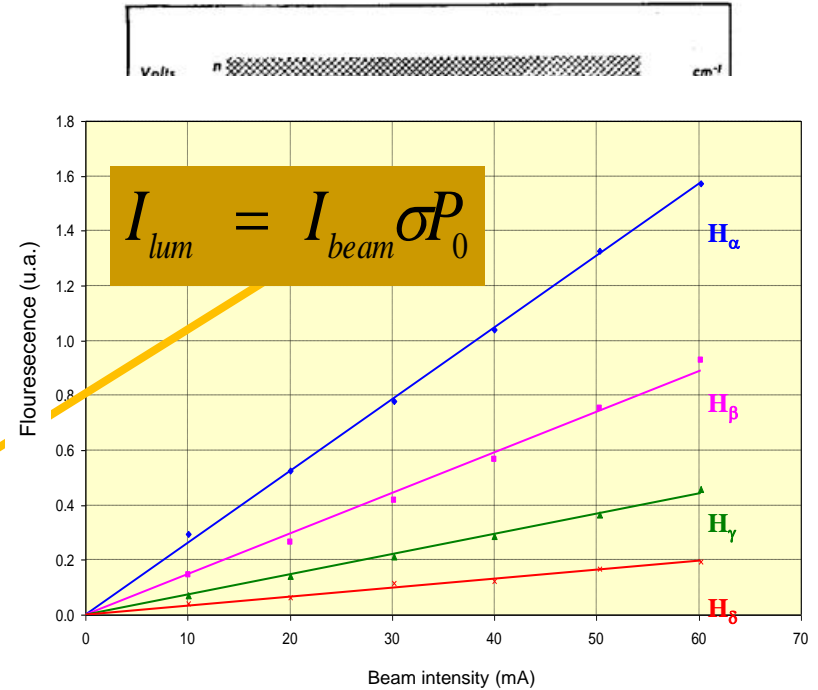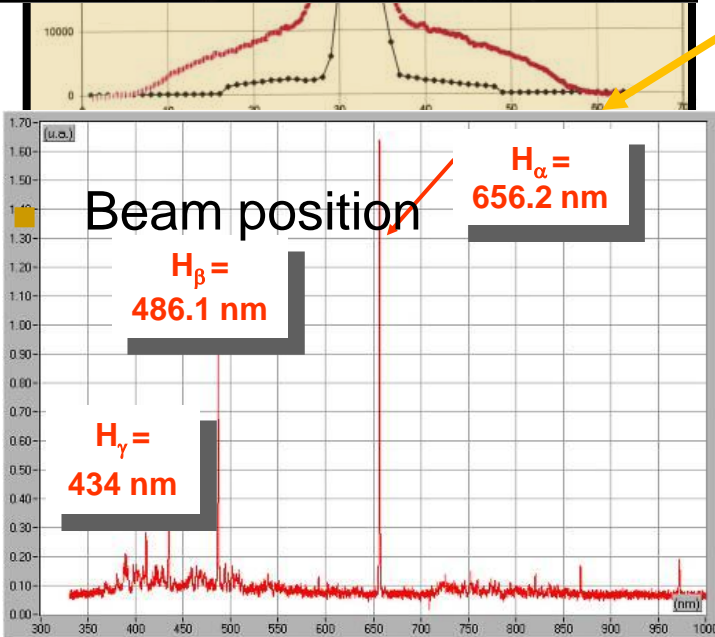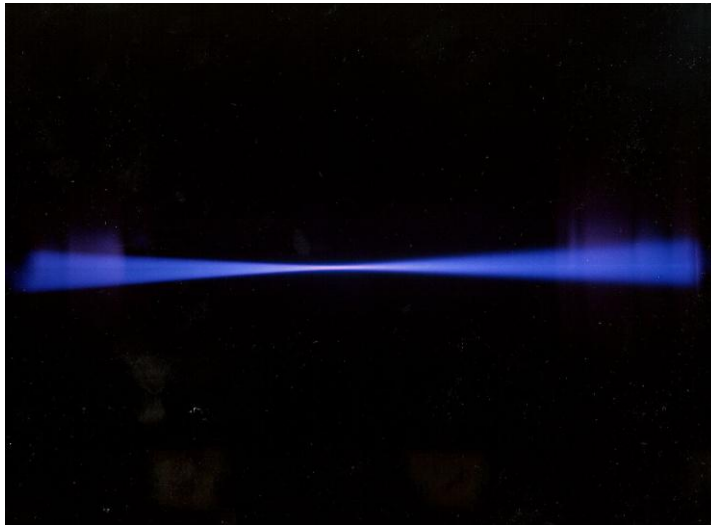
Diagnostics for high-intense beams

- **IPHI**
- **IFMIF**
- **FAIR**

- Interceptive diagnostics are prohibited

- Optical diagnostics have advantage

Emission from residual gas

$$I_{lum} = I_{beam}\sigma P_0$$

Beam position

$H_\alpha = 656.2$ nm

$H_\beta = 486.1$ nm

$H_\gamma = 434$ nm

- Intensity of luminescence as a function of beam intensity

Pottin, B, (2001) *Etude d'un profileur optique de faisceaux intenses de protons par absorption laser,* Doctor of Science thesis. Institut de Physique Nucléaire

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Emission from residual gas

$$\lambda = \lambda_0 \frac{1 - (v/c)\cos\theta}{\sqrt{1 - (v/c)^2}}$$

- Doppler effect enables us to isolate spectra of one species from another

Hydrogen beam

Plasma H⁰ 656.2 nm

$H^0(H^+)$ $H^0(H_2^+)$ $H^0(H_3^+)$ Plasma H^0 656.2 nm

$$\Delta\lambda \approx \lambda_0 \frac{v}{c} \cos\theta$$

$\Delta\lambda H^+$

$\Delta\lambda H_2^+$

$\Delta\lambda H_3^+$

Luminescence

646   648   650   652   654   656

Wavelength (nm)

$\theta = 20°$

Pottin, B, (2001) *Etude d'un profileur optique de faisceaux intenses de protons par absorption laser,* Doctor of Science thesis. Institut de Physique Nucléaire
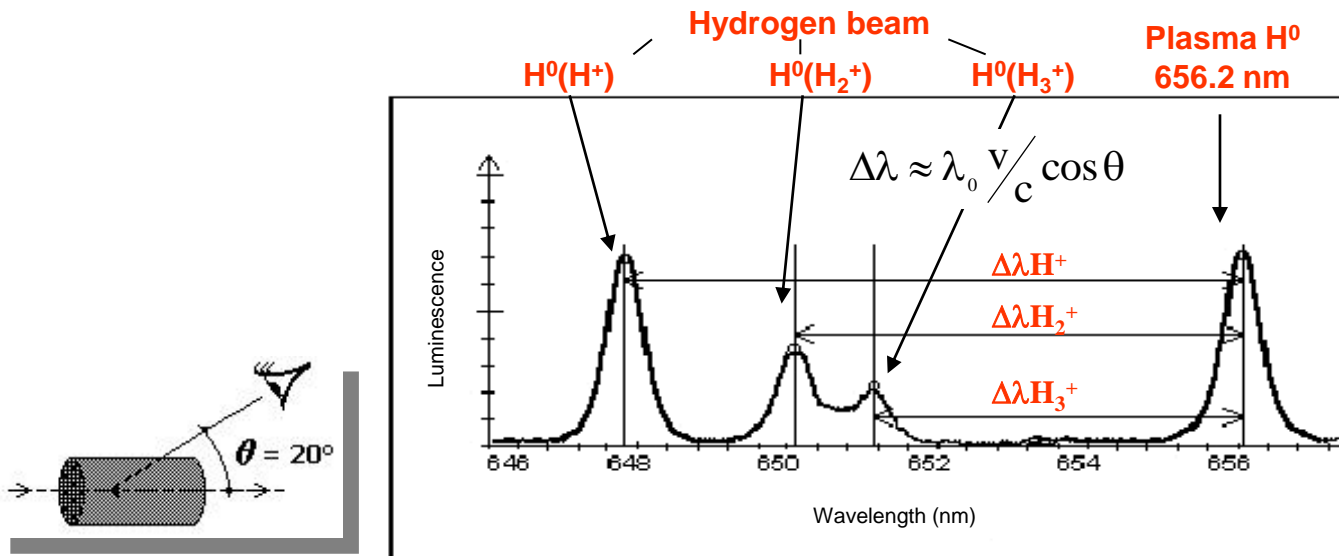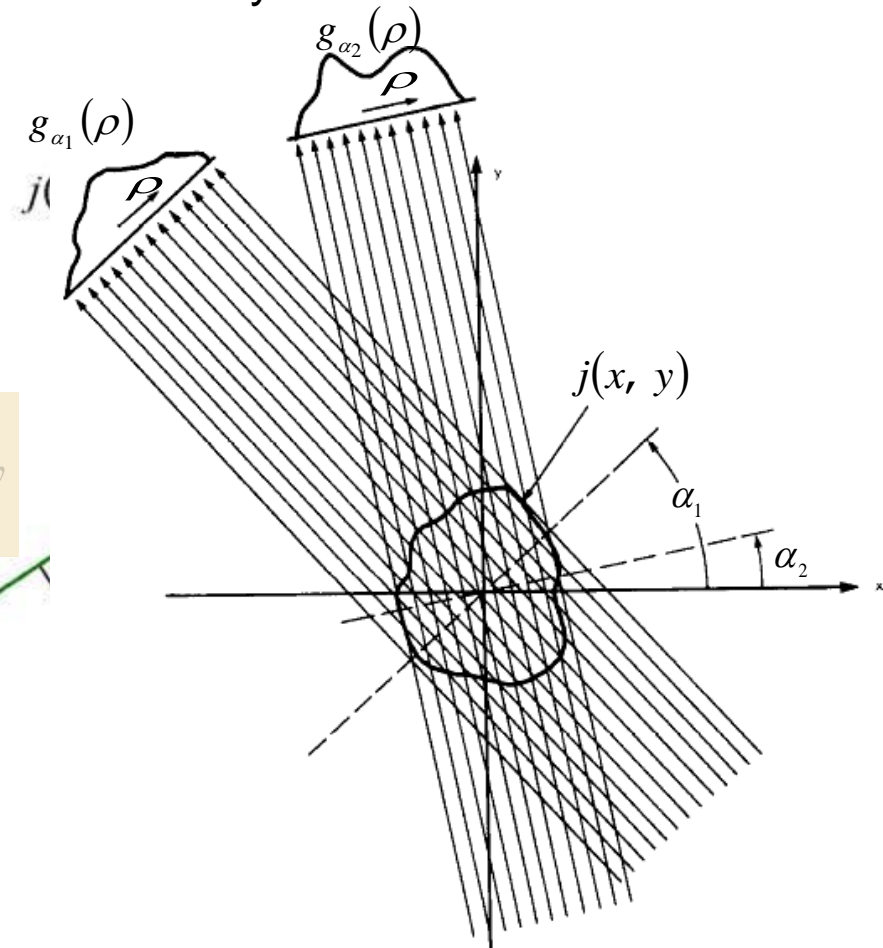
Tomography

Tomography refers to the cross-sectional imaging of an object from a data collected by illuminating the object from many different directions.
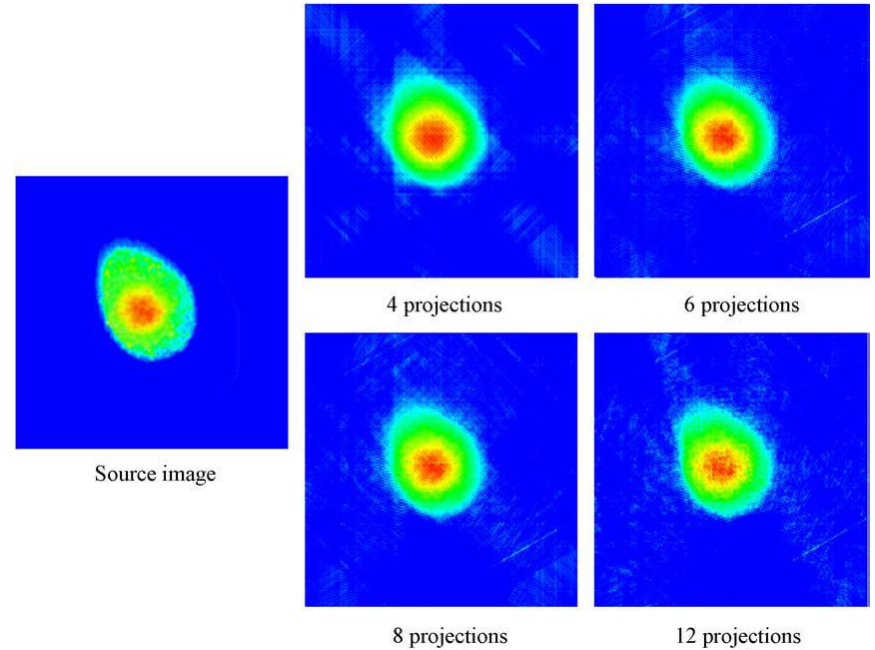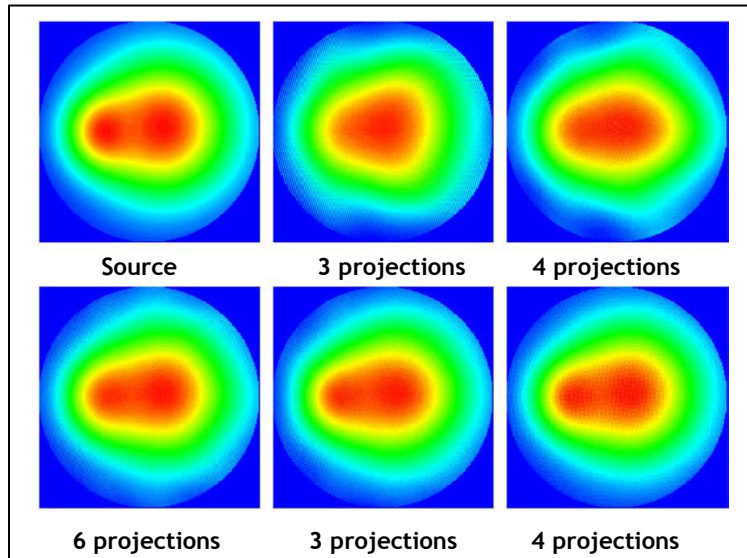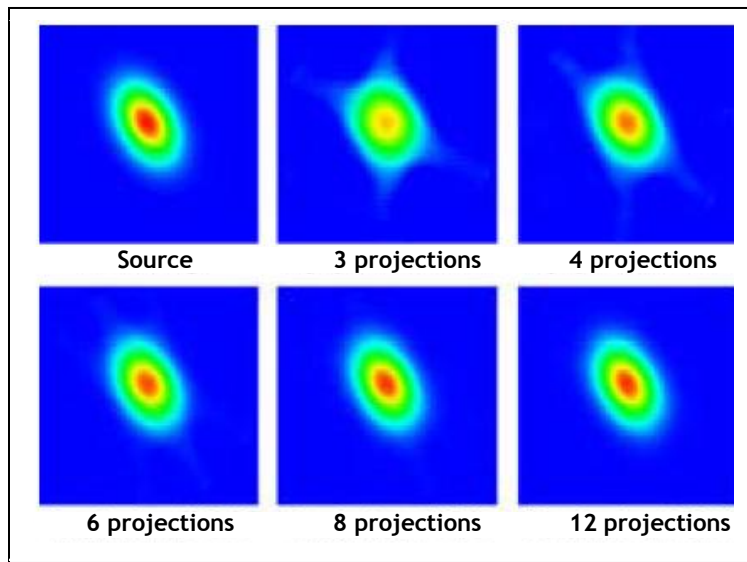
$$g_\alpha(\rho) = \int_{l(\alpha,\rho)} j(x,y)$$

Radon transform

$$g_\alpha(\rho) = \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} j(x,y)\delta(x\cos\alpha + y\sin\alpha - \rho)\,dxdy$$

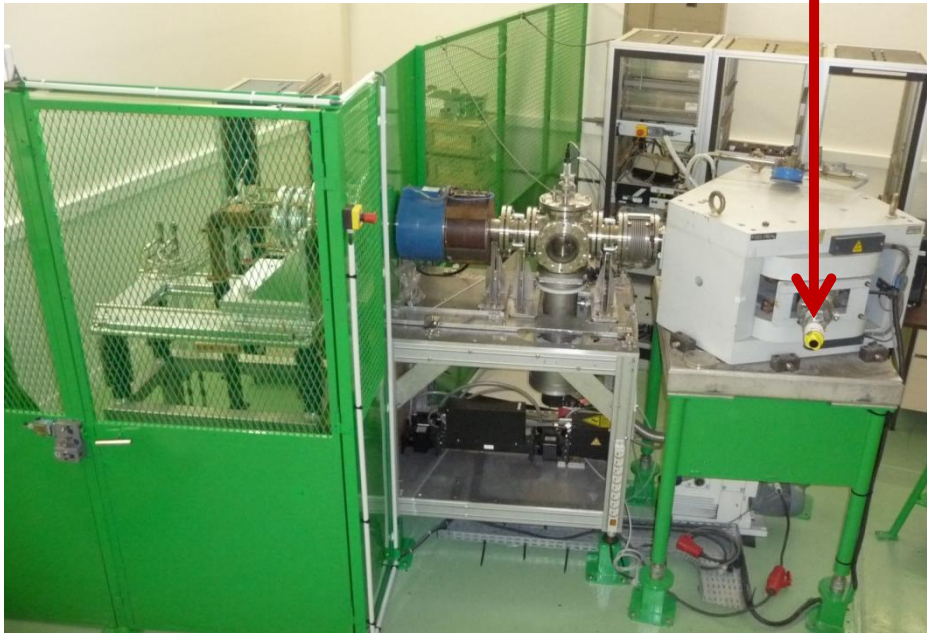A projection is formed by combining a set of parallel ray integrals

Tomography

Source | 3 projections | 4 projections
6 projections | 8 projections | 12 projections

Source | 3 projections | 4 projections
6 projections | 3 projections | 4 projections

Source image

4 projections | 6 projections
8 projections | 12 projections

G.E. Belyaev, I.V. Roudskoy, D. Gardes, P. Ausset, A. Olivier, *Nuclear Instruments and Methods in Physics Research A*, **578** (2007) 47-54

Irfu
cea
saclay

•6 CCD Camera
•Monochromator with PMT

BETSI test bench

SILHI

•Spectrometer with CCD camera for Doppler shift measurement

- Realization of a transverse profile monitor based on residual gas emission and reconstruction of beam image by tomography will be of importance to high-intense ion beams

THANK YOU FOR LISTENING