

## **The beam optics of nuclear microbeams: how to model and design probe-forming lenses for MeV ions.**

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Focusing high energy ions to small diameters (micron and below) remains a challenge. The relatively high momentum of MeV ions means that strong focusing lenses with high transverse fields must be used, while the relatively low brightness of beams from small accelerators means that the lenses must have large apertures in order to transmit a useable beam current and thus suffer from significant aberrations.

This lecture examines the implications of these constraints for the design of MeV microbeams. A brief introduction to beam optical concepts and software will lead us into a discussion of magnetic quadrupole lenses and how these can be optimised for microbeam applications. This will not involve detailed mathematics, but we will encounter a simple equation which encapsulates the relationship between the beam diameter, the quality of the beam and the lenses and the type of application. This will allow us to explore the limitations on spot size faced by the present generation of focused microbeam systems.

Finally we will look at some of the practical engineering issues of constructing a lens system with mechanical and electrical stability suitable for high resolution applications.