The HRS upgrade project: current status

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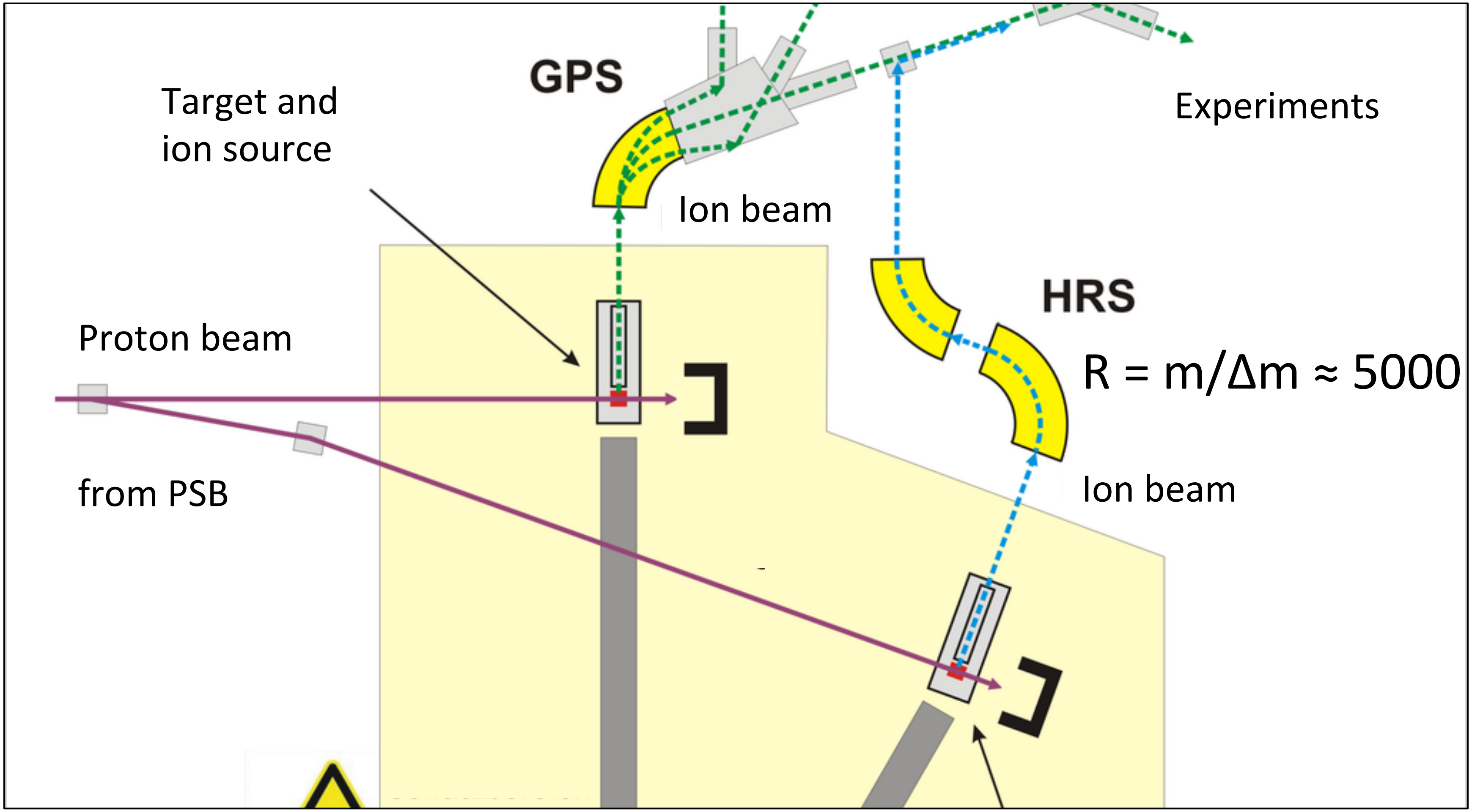
Separators at ISOLDE



http://www.wikiwand.com/de/ISOLDE

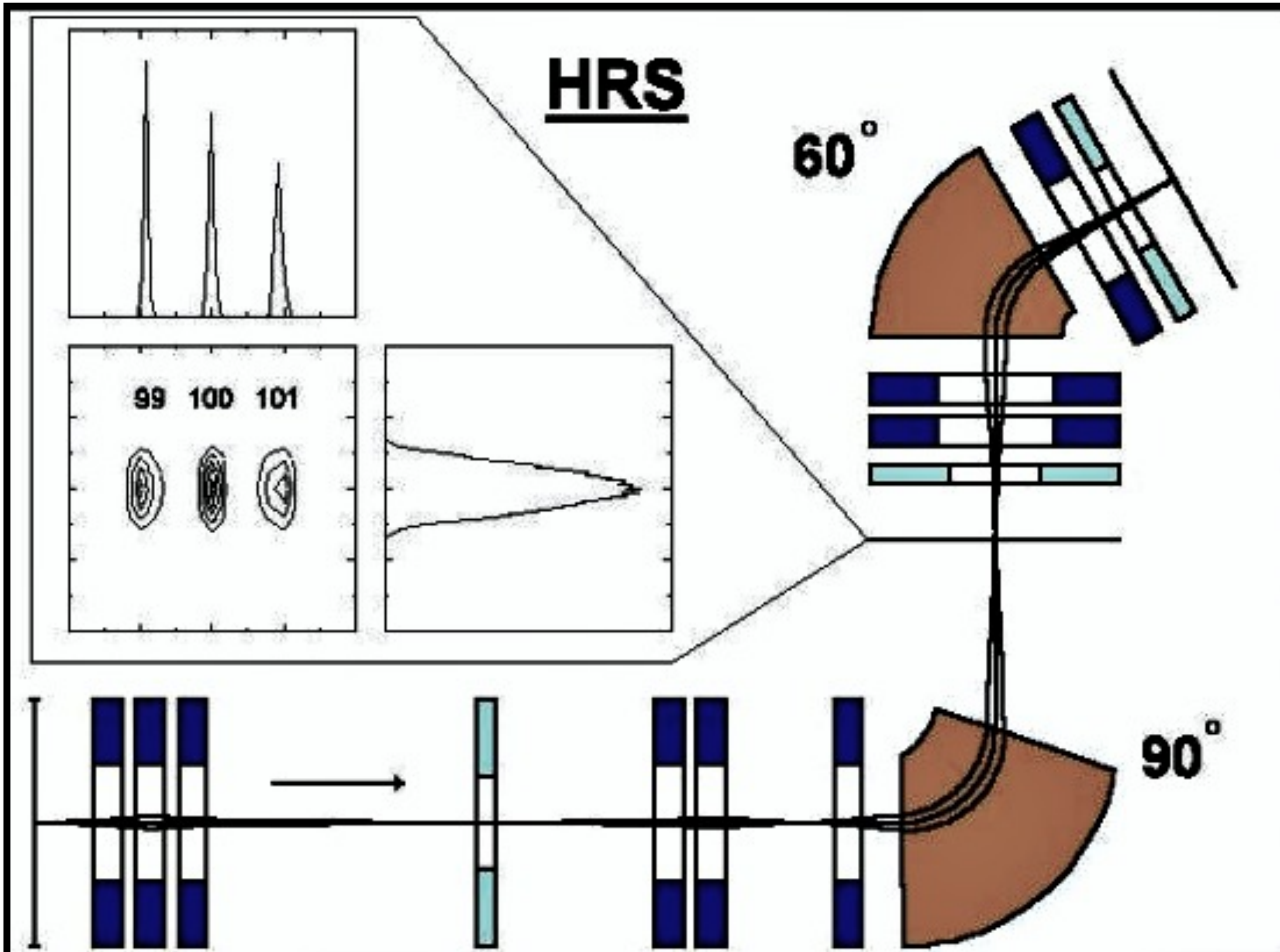


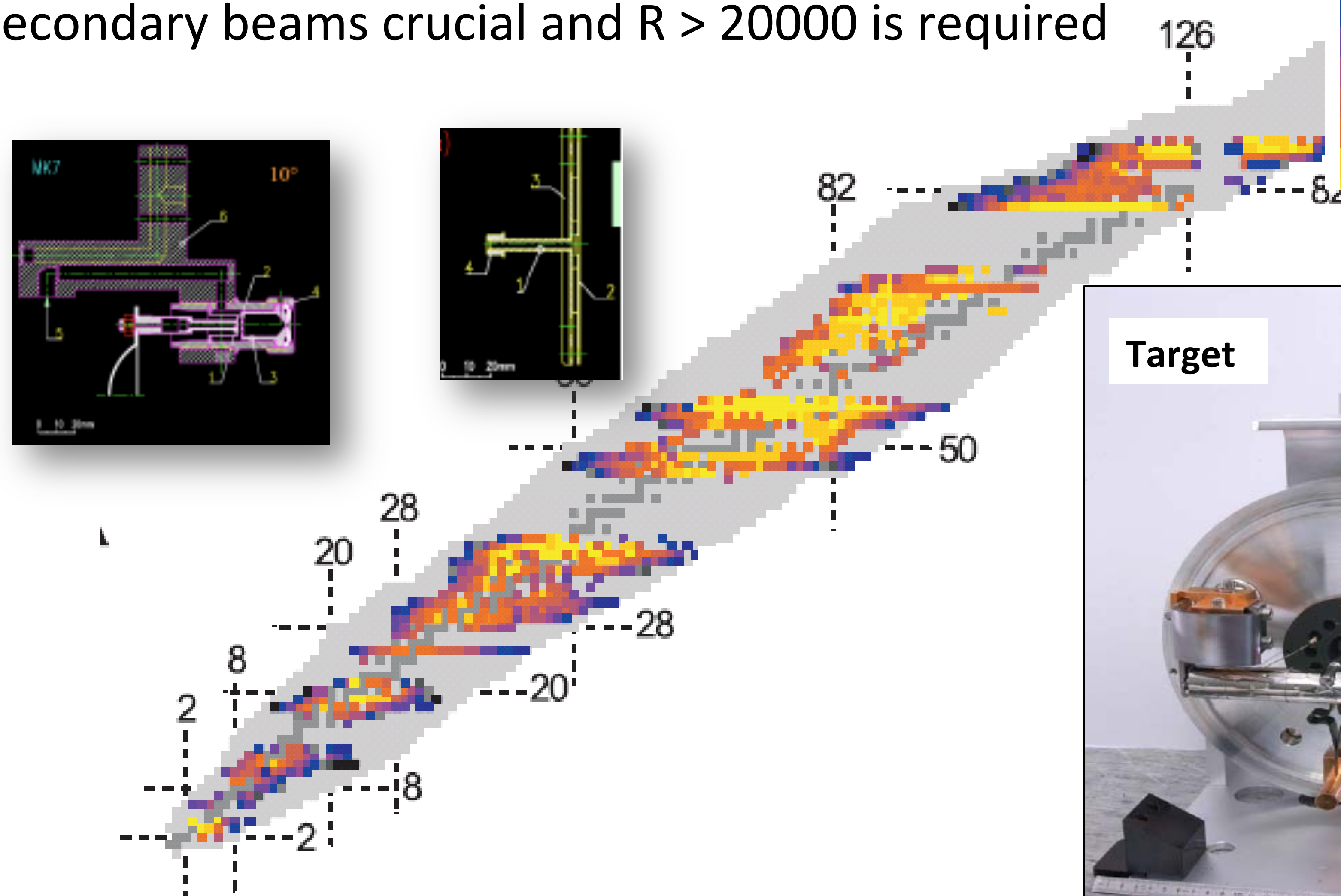
Image from http://www.ikp.uni-koeln.de/~warr/doc/rex-isolde.pdf

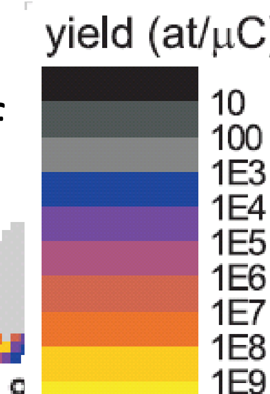
Why upgrade the HRS?

- Exploit the possibilities of the intensity upgrade – experiments with more exotic isotopes
- Facilitate reaction or decay studies with “difficult isotopes” that require high beam purity

Developments in mass separation and beam preparation: HRS upgrade design

An increase in intensity will make better mass separation of secondary beams crucial and R > 20000 is required

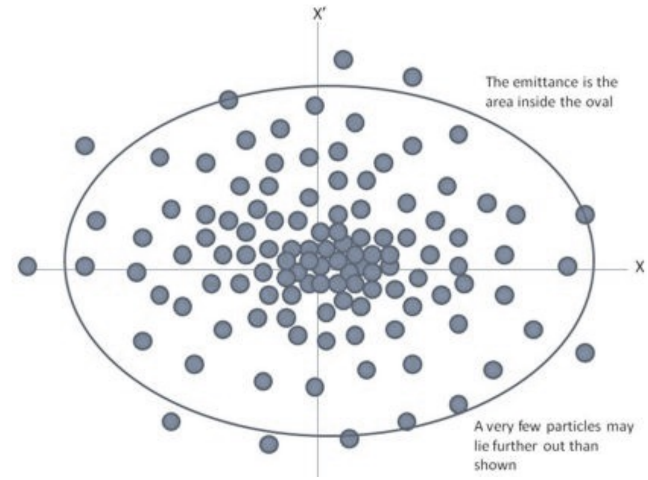




Options for the upgrade

- Improve the existing magnets
- Improve the emittance, leave HRS as before
- Improve the emittance and change the design of the HRS

$$R_{\Delta} = -(x|\Delta)/2x_{00}M = (\overleftarrow{x|\Delta})/2x_{00}$$



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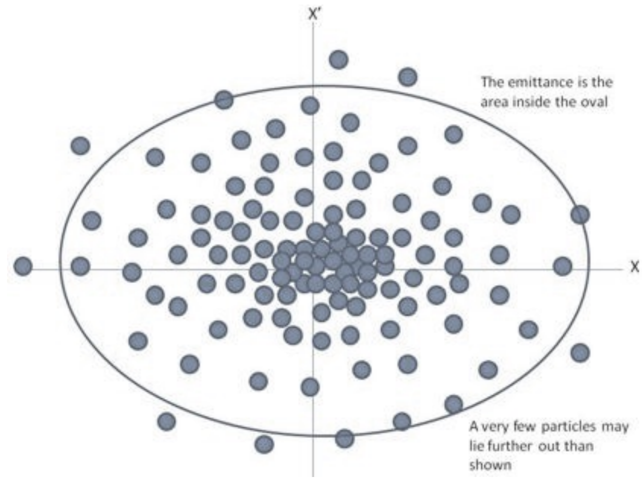
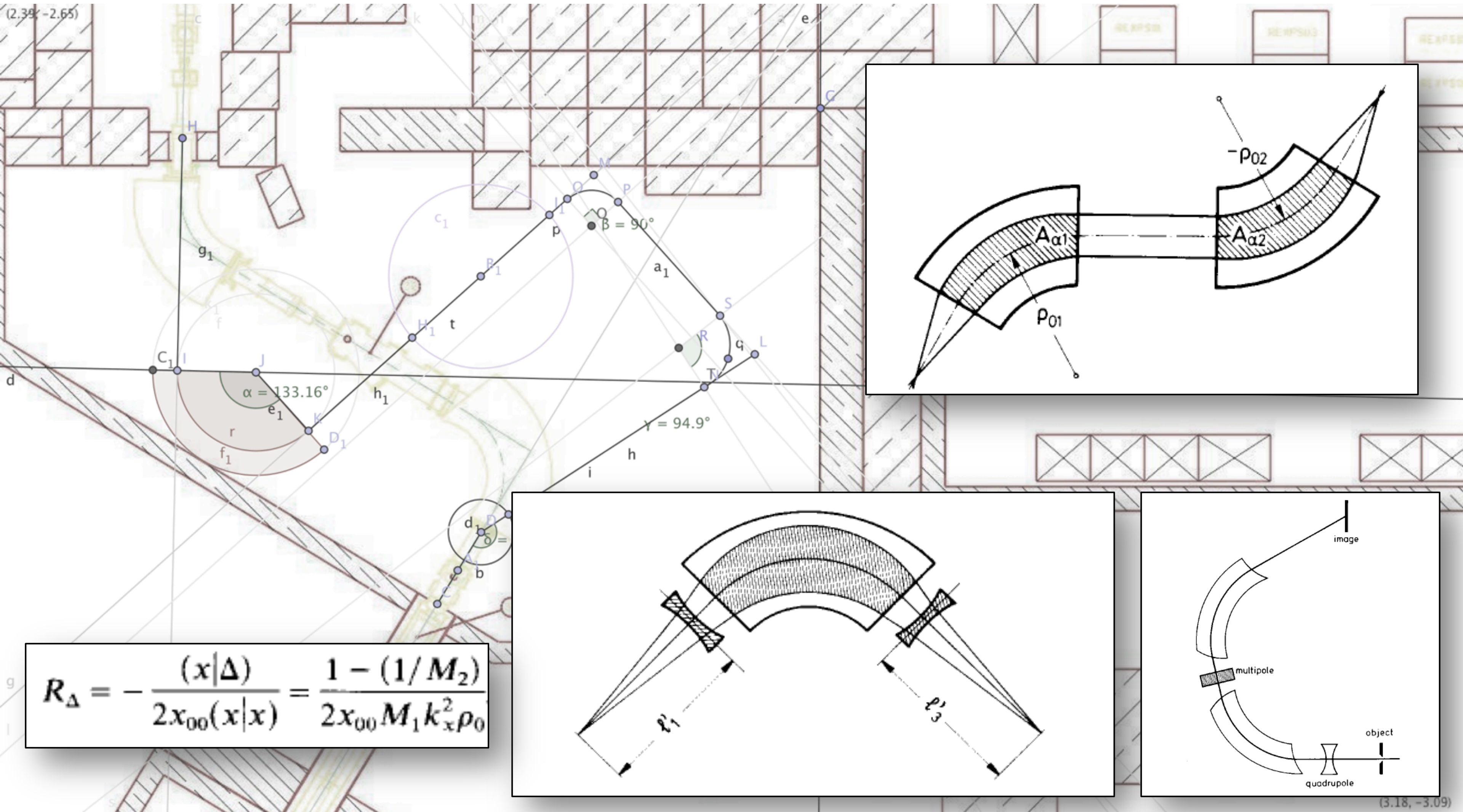


A wide range of separator solutions were considered – available space the main limitation

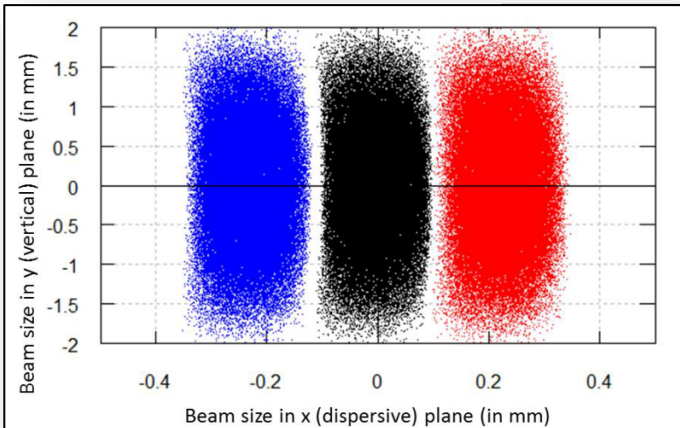


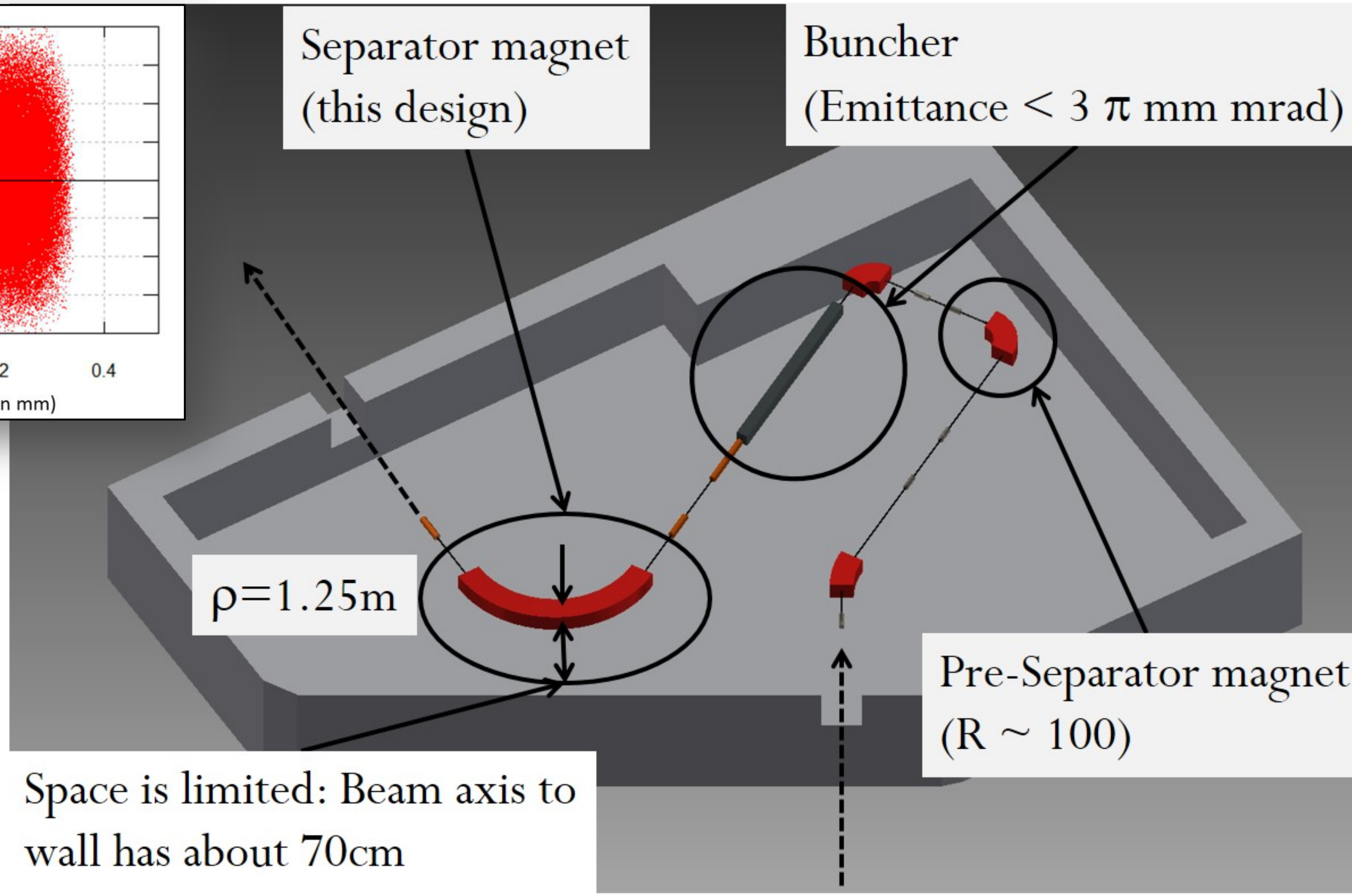
$$R_\Delta = -\frac{(x|\Delta)}{2x_{00}(x|x)} = \frac{1-(1/M_2)}{2x_{00}M_1k_x^2\rho_0}$$

The chosen design consists of three parts

- Pre-separation
- Beam cooling (RFQ)
- High Resolution Magnetic Separator

Layout of the beamline in the HRS room





Details in "CATHI Technical report - Design study of the High Resolution Mass Separator for ISOLDE: Report on the layout possibilities for the HRS magnet (D38)" by M. Augustin and T. Giles

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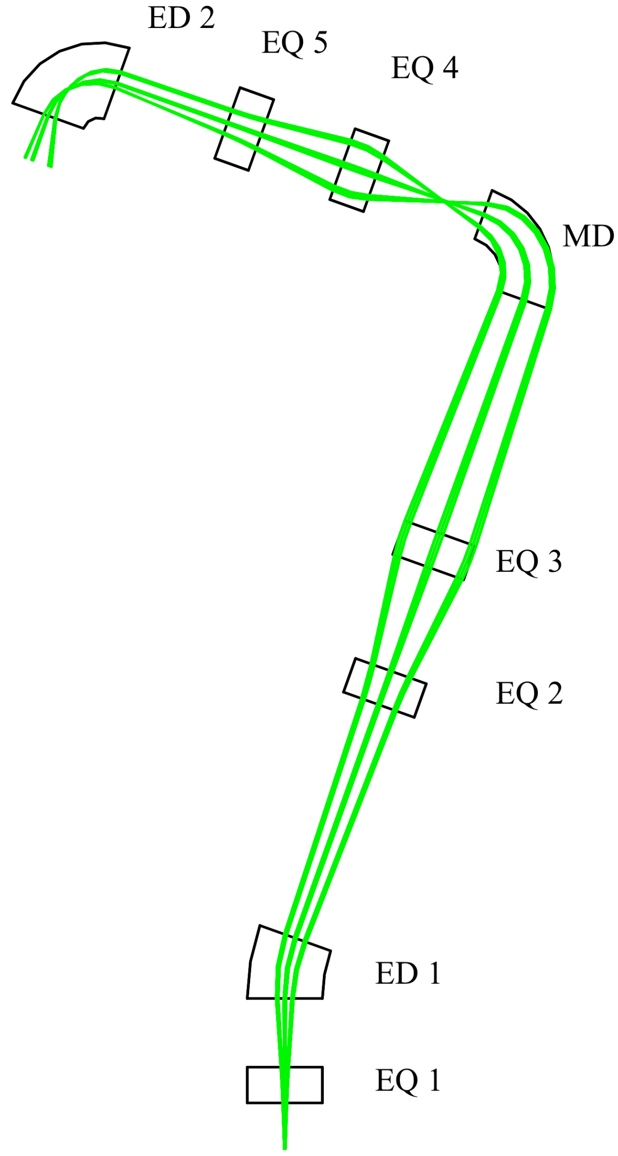
Pre-separation

ED: Electrostatic dipoles (bending)

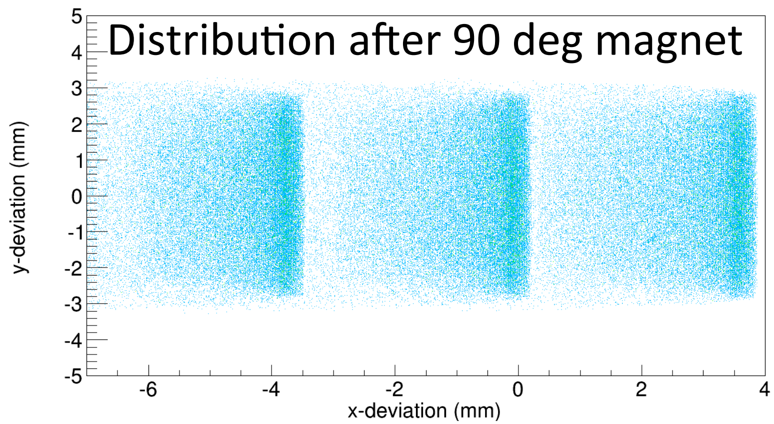
EQ: Electrostatic quadrupoles (focusing)

MD: Magnetic dipole

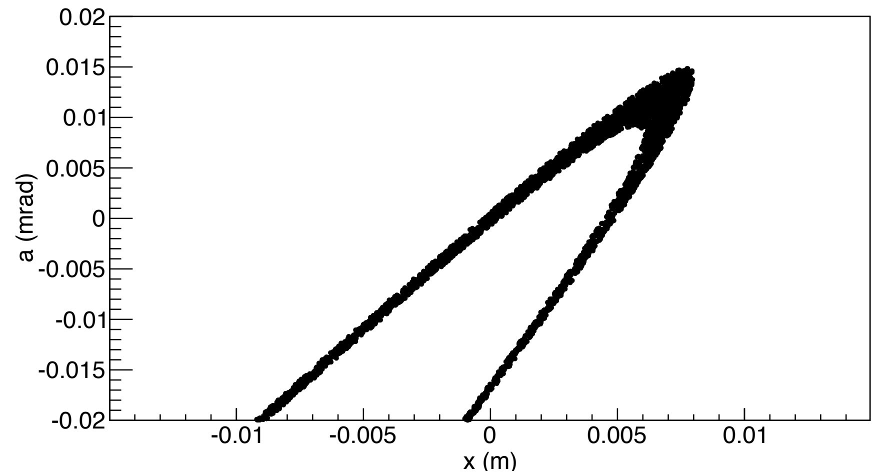
(separation)



Reduction of contamination - not full suppression



Square emittance of 20 π *mm mrad*
$\Delta M = 1$ u



Strong aberrations at entrance of the RFQ

The aberrations introduced by the beamline with the pre-separator do not represent a problem since the cooling of the RFQ removes all ”memory” of the effect of the beamline.

The chosen design consists of three parts

- Pre-separation
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- High Resolution Magnetic Separator

Beam cooling with the RFQ cooler

- Reduces emittance from 20 π *mm mrad* to < 3 π *mm mrad*
- The transmission and space charge limits for the cooler will limit the possible beam intensity with the HRS

The chosen design consists of three parts

- Pre-separation
- Beam cooling (RFQ)
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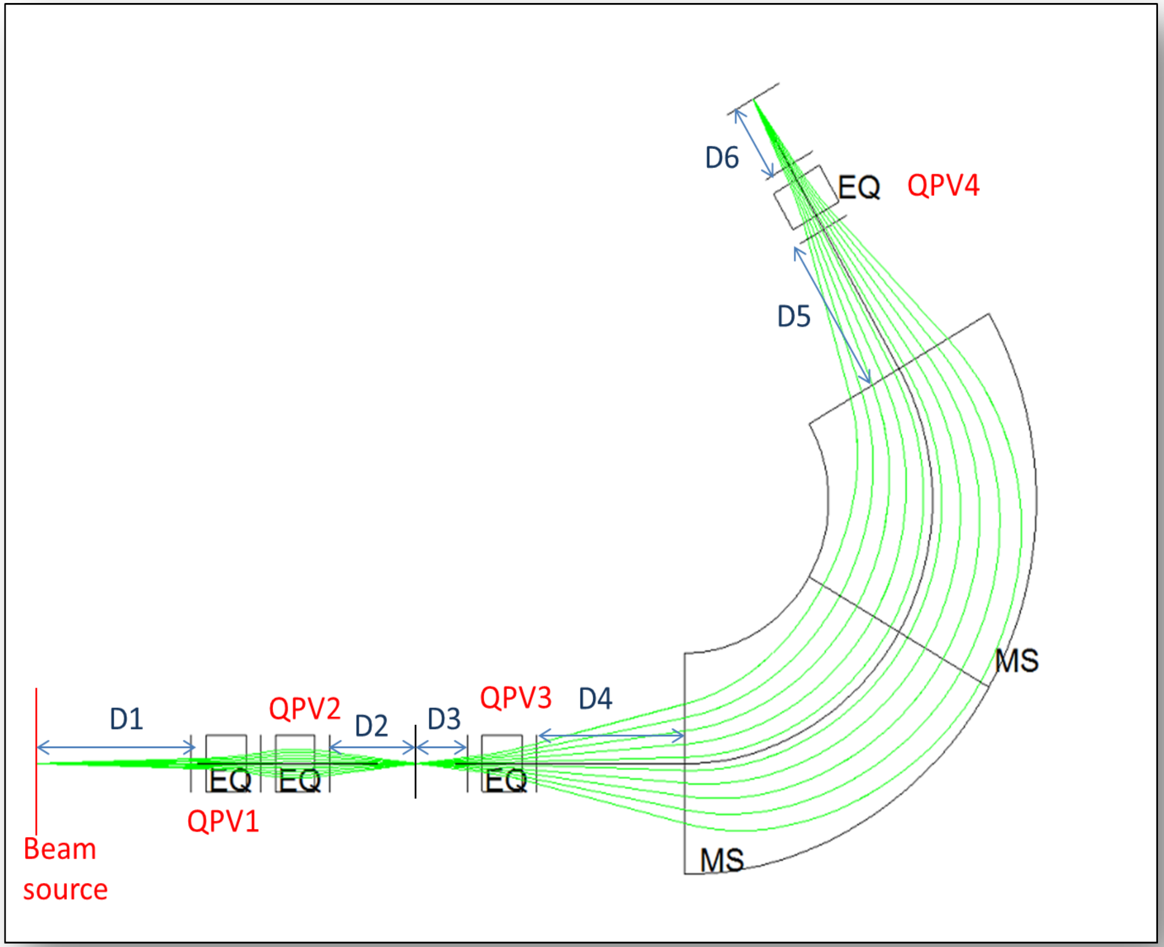
Specifications of the separator

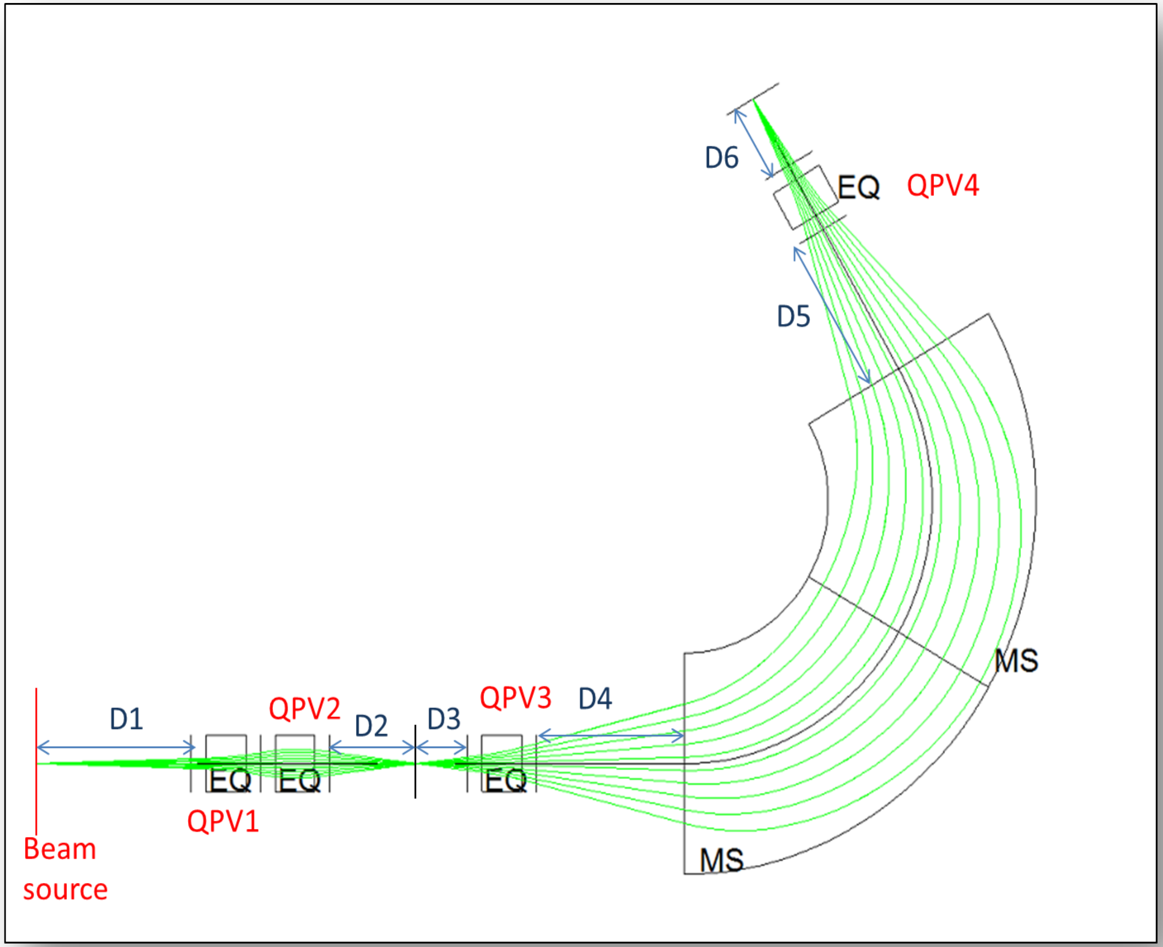
- 120 degree bending magnet
- Bending radius 125 cm
- Correction coils providing higher order terms
- Electrostatic quadrupoles for focusing
- R = 23 000 according to COSY infinity calculations



Do we reach the design goal of R > 20 000?

The ion optical calculations wiht COSY infinity indicate that a mass resolution of R = 23 000 is feasible with this design for the emittance from the RFQ.

Can we translate into a magnet design that will provide this mass resolution?



The magnet is being designed in OPERA

H-type yolk

About 30 cm wide good field region

120 degree bending and 125 cm bending radius

Correction coils

Rogovski-profile

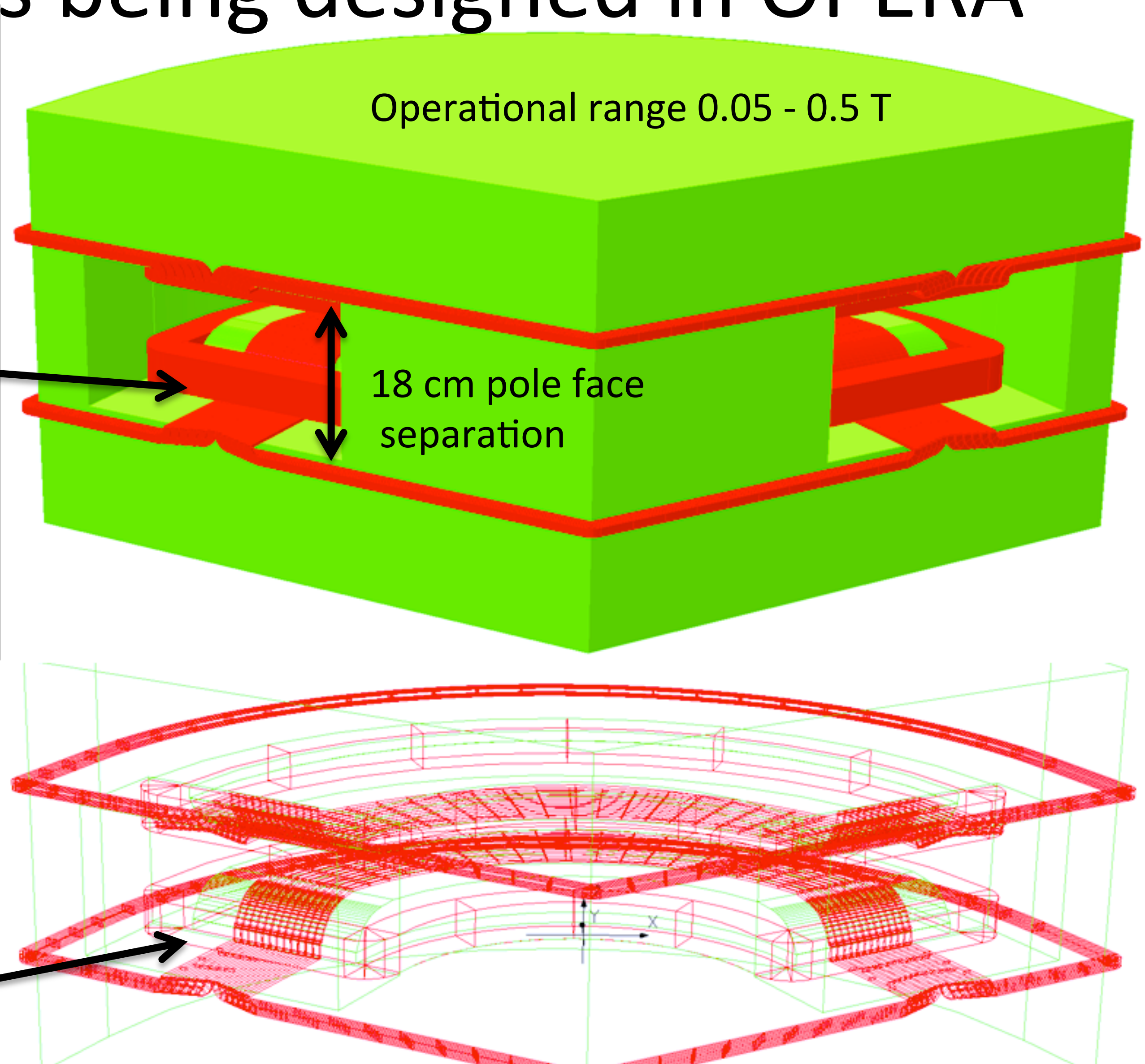
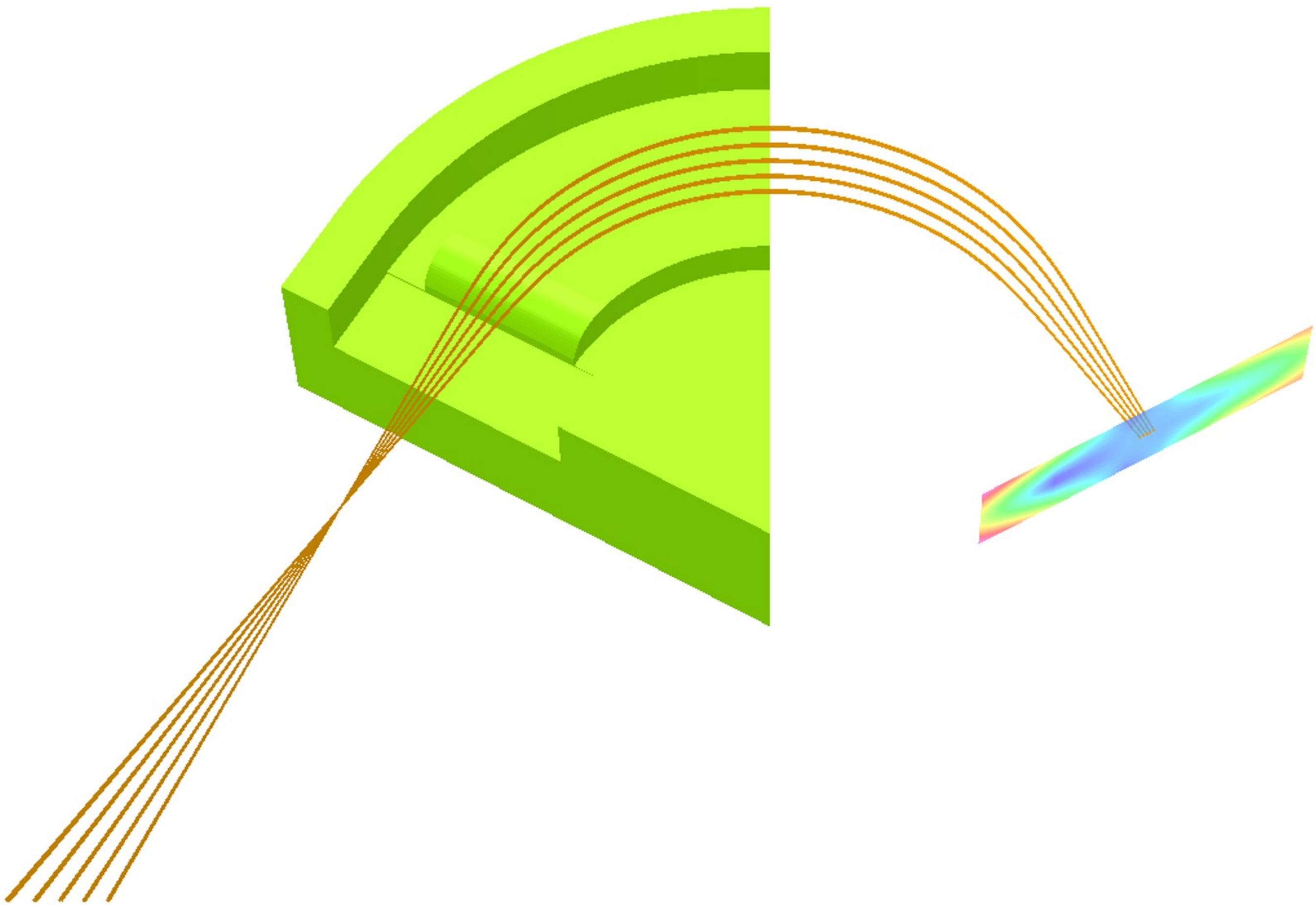


Figure by Martin Breitenfeldt and more information to be found in EMIS proceeding submitted to NIM B.

Raytracing with OPERA vs. COSY infinity

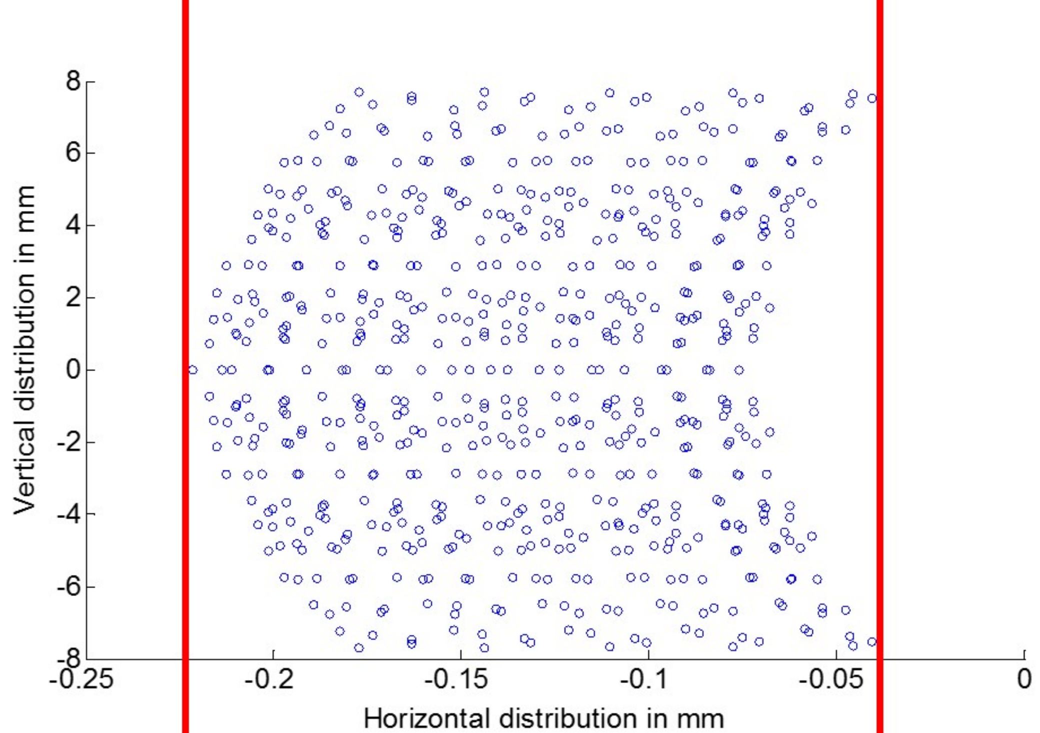
We use the same particle distribution and transport particles through the magnet with the transfer matrix method (COSY) and finite elements method (OPERA) and compare. The COSY results show less aberrations than the OPERA results, indicating that indeed the 3D nature of the magnet must be taken into account.

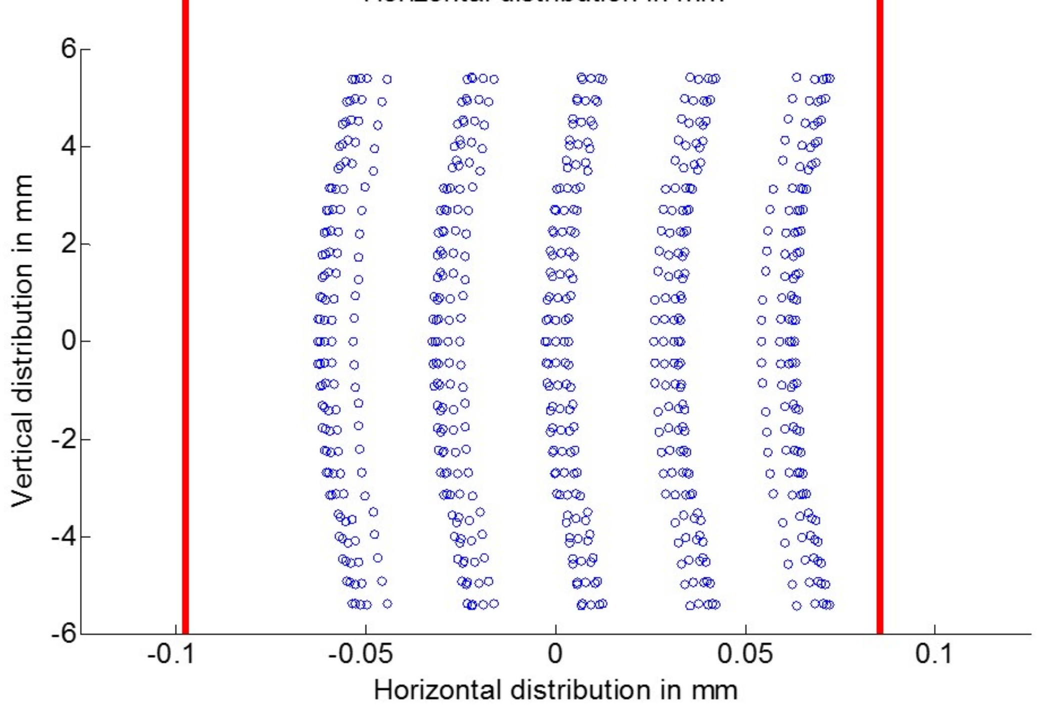


Comparison

OPERA 3D raytracing

COSY Infinity transport





Things still to be done

- Misalignment analysis of the whole beamline
- 45 degree jumper rather than rogowski profile
- Finalize optimization of the magnet
- Verify the design with realistic cases
- Write a very long paper/report with a rather detailed description of the process from idea to separator design

Questions or comments?
Thank you for your attention!

The people contributing to this work:

Martin Breitenfeldt, Mathieu Augustin, Richard Catherall, Tim Giles, Daniel Schörling and G. M. Tveten.

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