TITAN Optics

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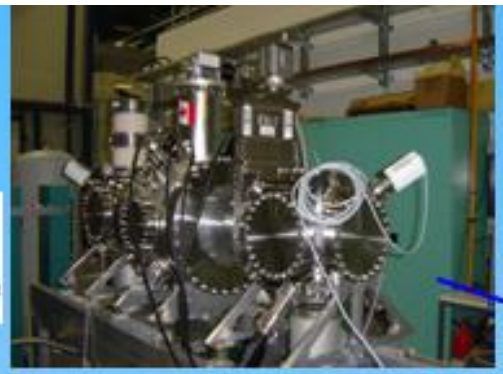
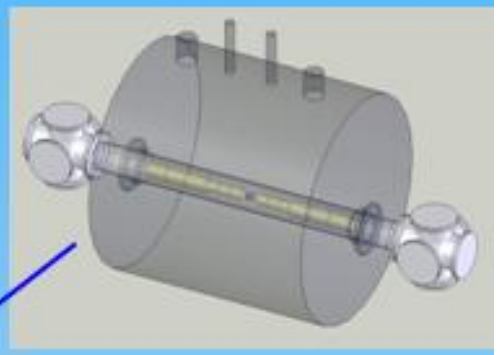
June 2005



EBIT under testing at MPI-HD.
to TRIUMF July 2005.

McGill

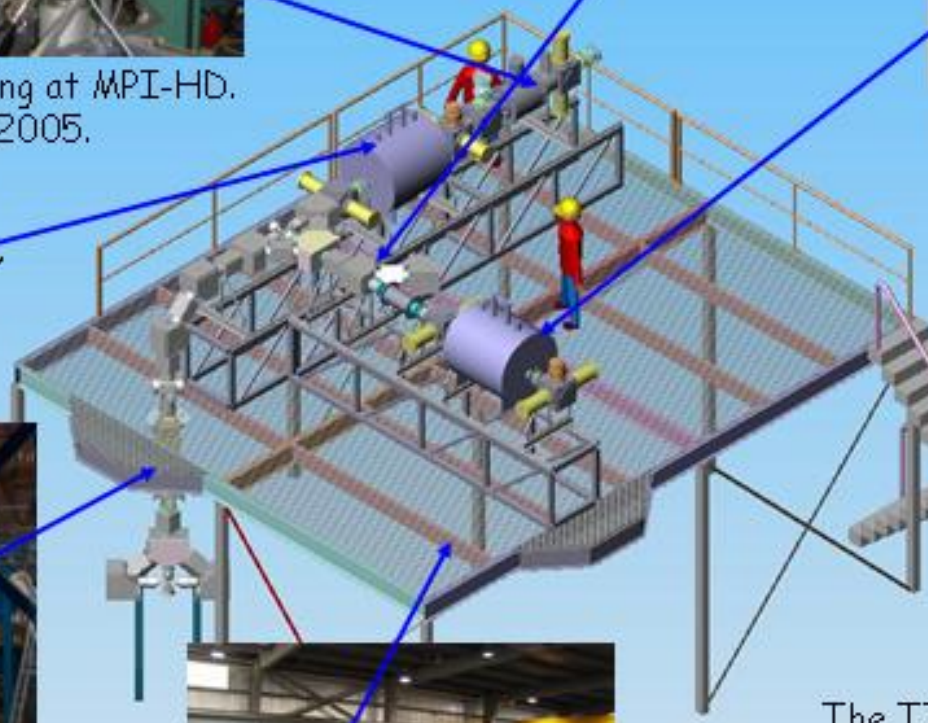
Wien filter
(R=500)



Penning trap magnet
ordered (del. July 2005)

Cooler trap for HCI
(to be built in Manitoba,
CFI grant received)

university of manitoba



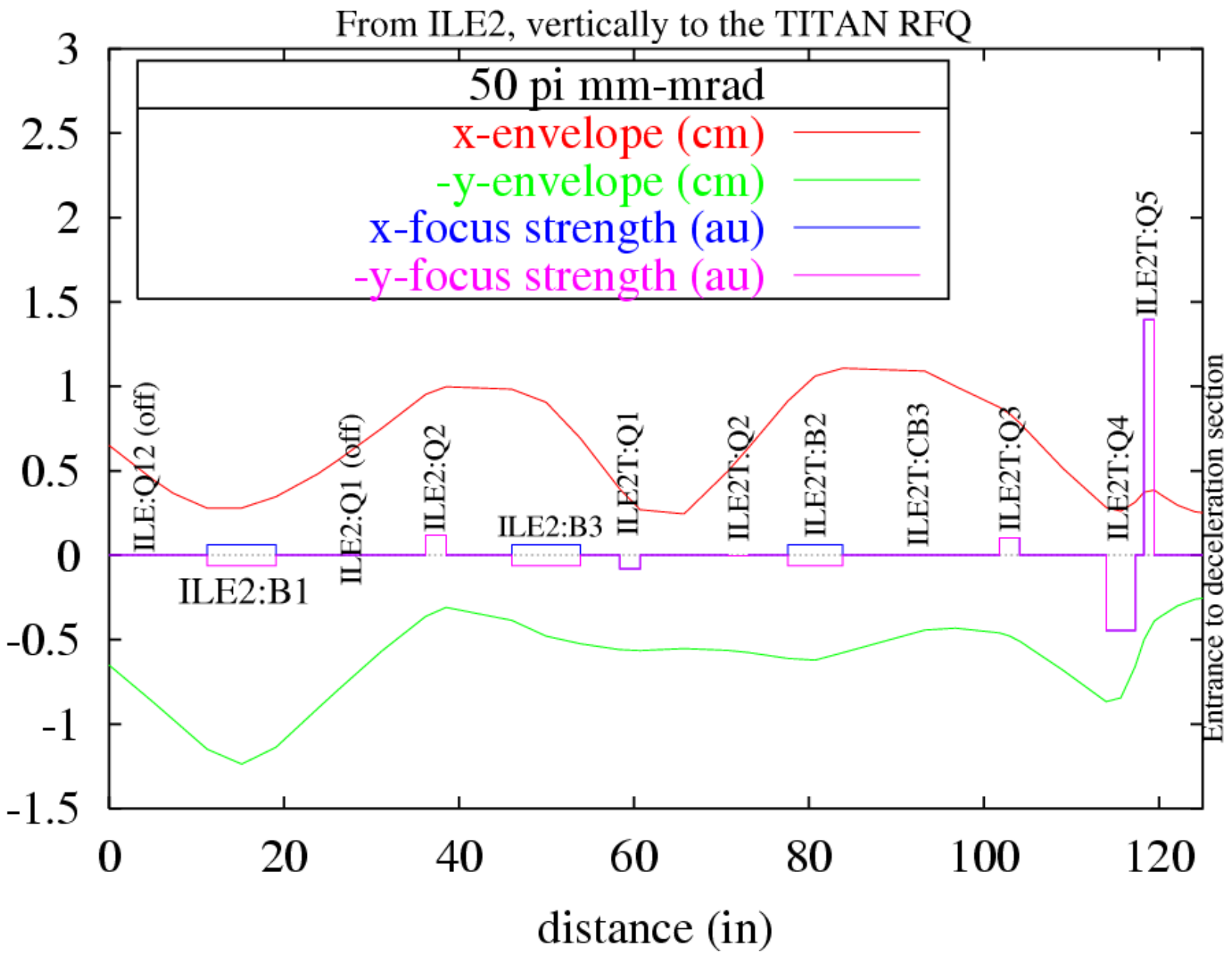
RFQ operational on test bench

TRIUMF ISAC

TITAN platform finished at ISAC

The TITAN system is under
construction and will be
operational for mass
measurements at ISAC/TRIUMF
in 2006.
Isotopes with $T_{1/2} \approx 10$ ms
$\delta m/m < 1 \cdot 10^{-8}$

ISAC to TITAN



Decelerating into RFQ Cooler

Think: time-reversed ion source.

Laplace:

$$\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial \Phi}{\partial r}\right)+\frac{\partial^2 \Phi}{\partial z^2}=0$$

implies:

$$\Phi(r,z)=\phi(z)-\phi''r^2/4$$

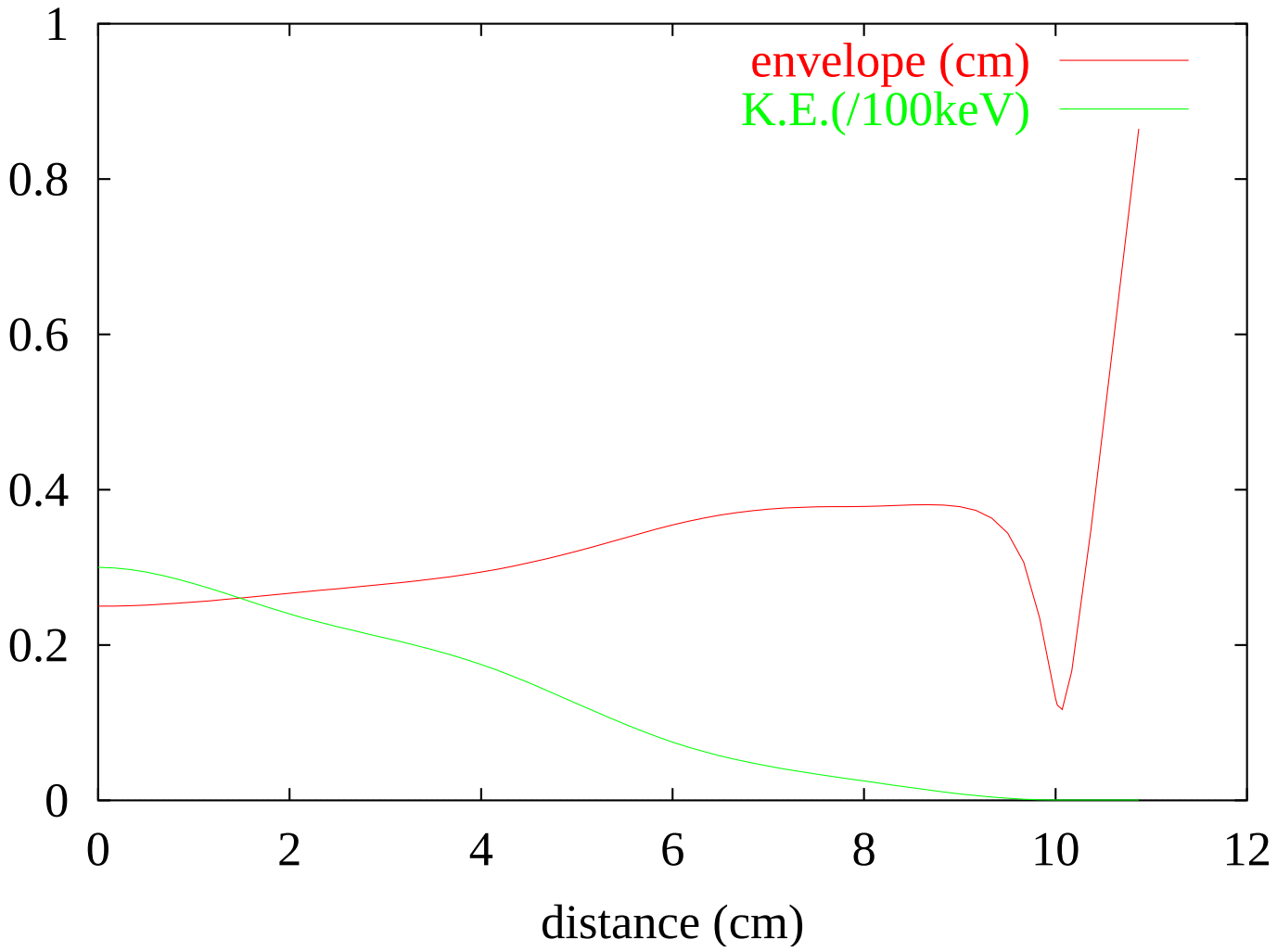
The radial force $F_r=-\phi''r/2$ can be integrated (giving $\Delta\phi'$, which is $\approx E_{\text{initial}}/L$) to get the focal length of the decelerating column exit:

$$f=4L\,E_{\text{final}}/E_{\text{initial}}$$

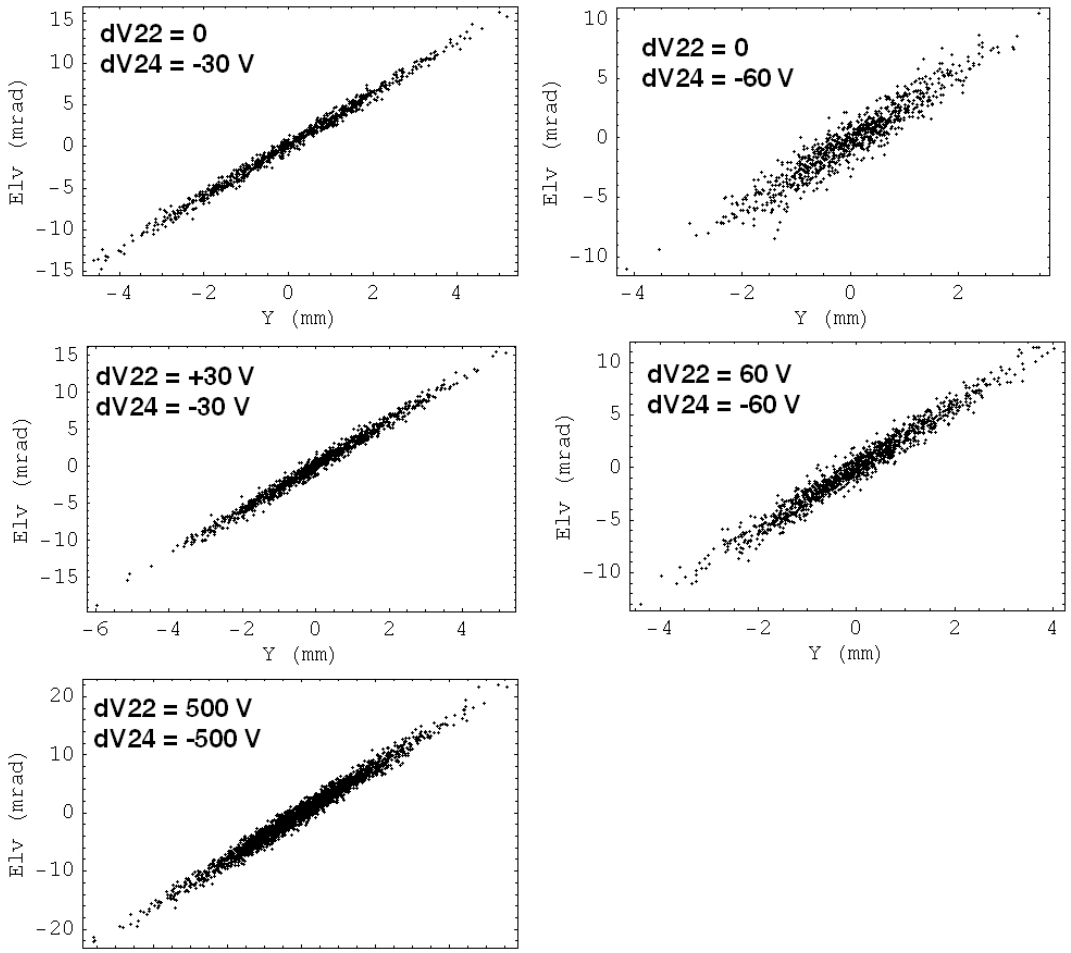
(Note in particular it is independent of the aperture size.) So if we want to decelerate from 30 keV to 50 eV with a column of length 10 cm, the focal length is 0.7 mm!

Decelerating into RFQ Cooler – cont'd

Here is an example:



Exiting RFQ Cooler



Mathew's
(2 keV, at exit of drift tube) simulations show a few common features:

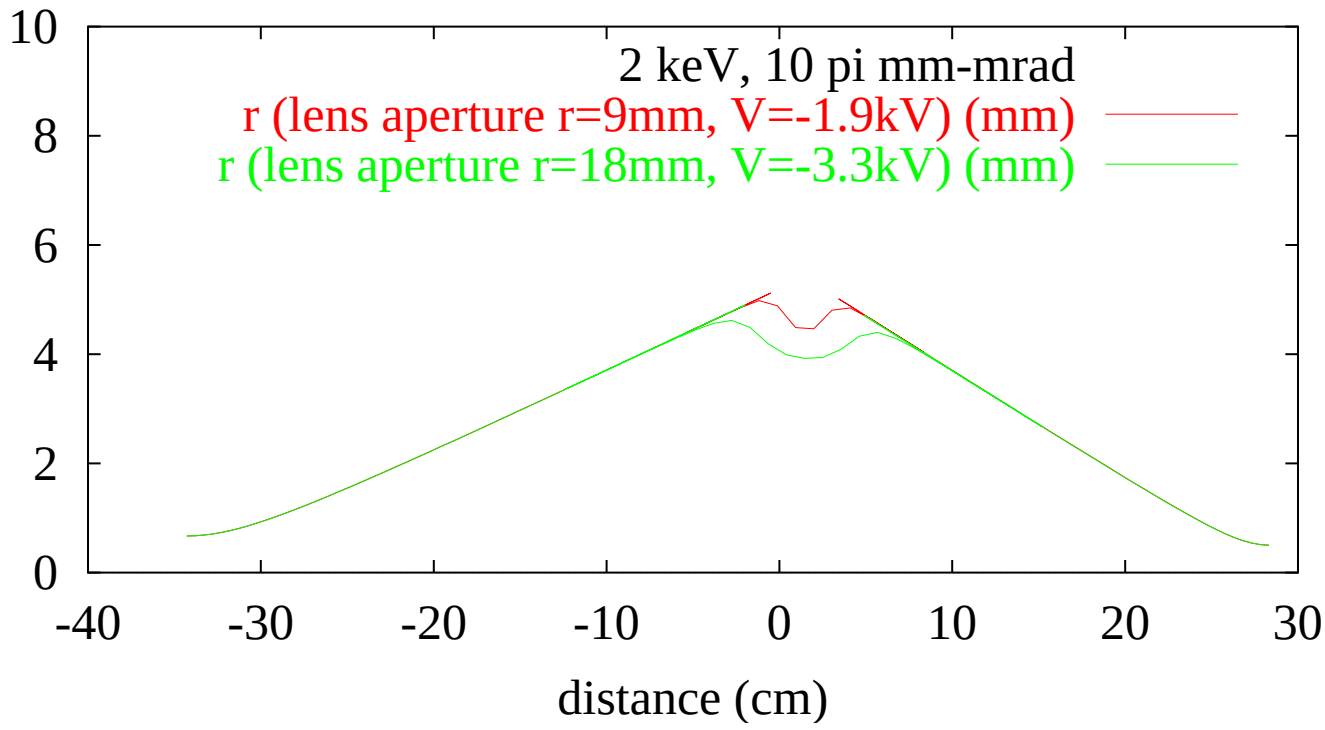
- 100%
  emittance $\approx 10\,\pi\mu$m
- Virtual
  waist upstream ≈ 34 cm
- Waist is
  approx. 1 mm $\times\ 10$ mrad
  ~ 0.7 mm $\times\ 15$ mrad

Exiting RFQ Cooler

A natural way to match out of drift tube is to use an einzel lens. But these (long, skinny) ellipses cause problems: the einzel lens causes large emittance growth.

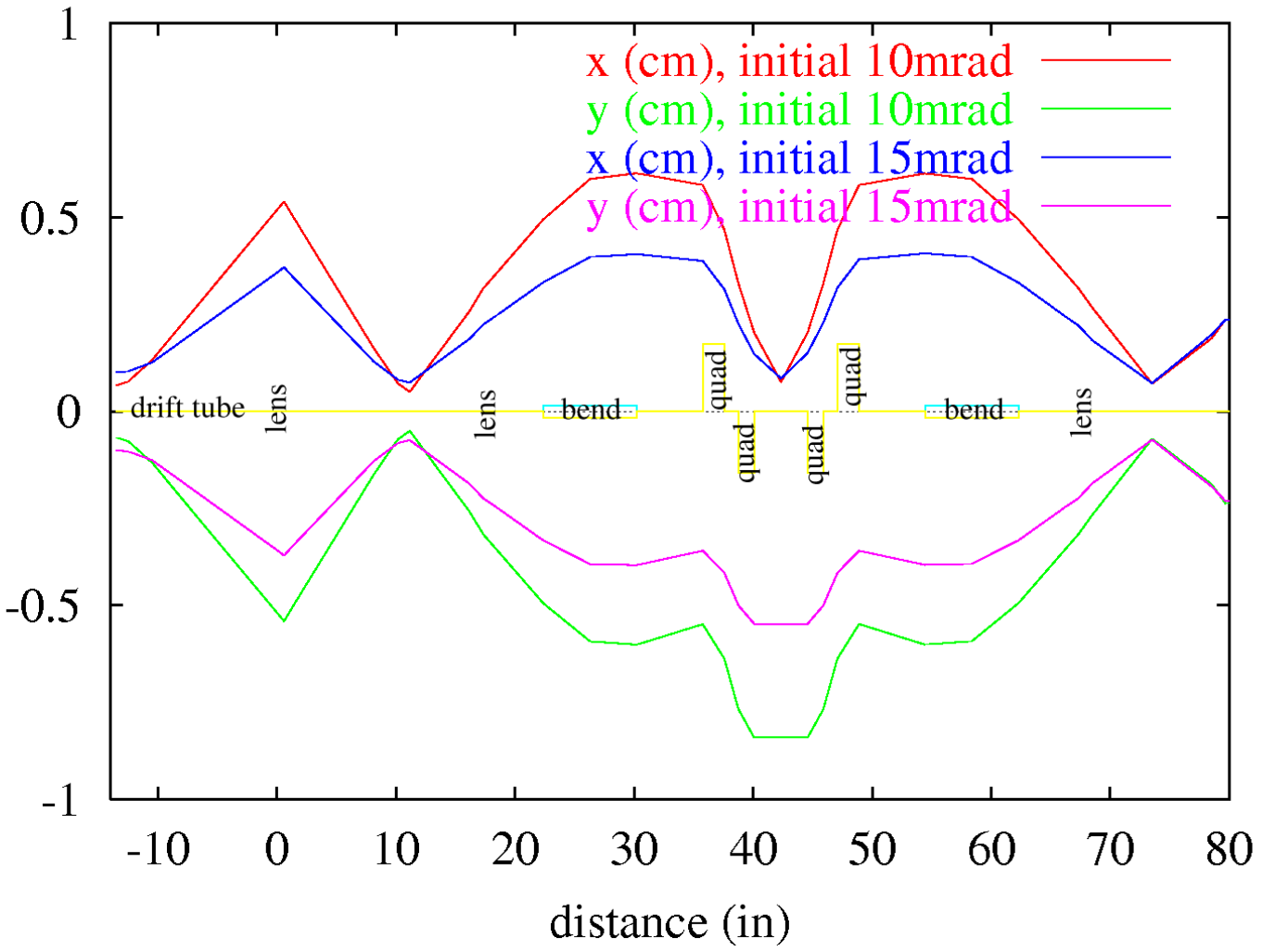
$$\Delta r' = 39\,\text{mrad}(r/1\,\text{cm})^3$$

We can use a larger einzel lens, but if drift tube not shortened, its centre is necessarily farther from the drift tube exit AND it must focus harder yet. It is preferable to shorten the drift tube. Even a little bit helps, because it is a 4^{th} power effect: 20% shorter gains factor of 2! Also, it is advantageous to flare the drift tube to match larger einzel lens.



Bend onto Mezzanine

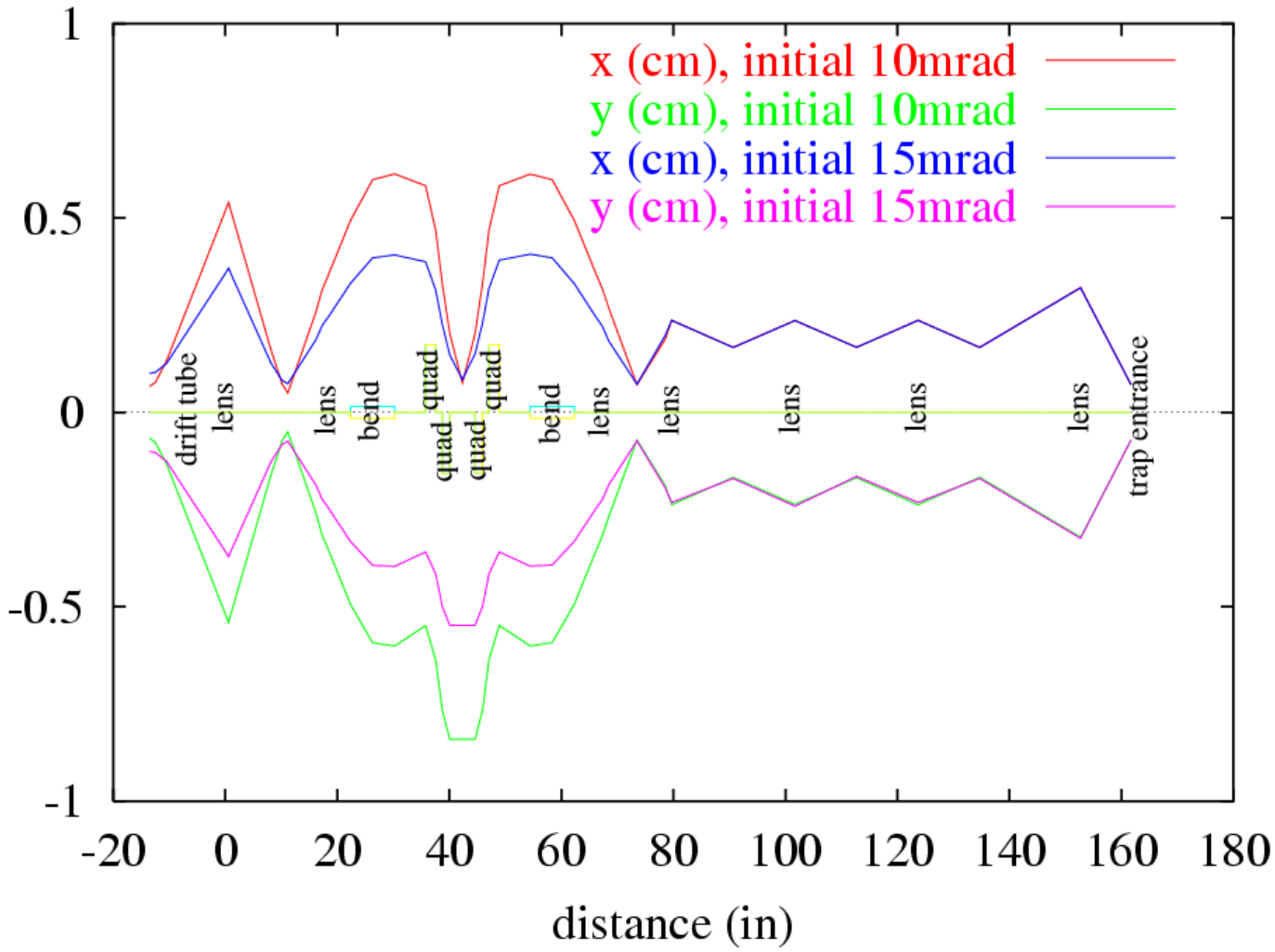
A 90° bending section is split into two 45° bends separated by a triplet. The triplet is needed to make the section achromatic.



Fast extraction from RFQ yields $\Delta p/p$ as large as 1%, so achromaticity is essential. For bypassing the EBIT, follow this section with another identical bend (but in Horiz. plane).

RFQ Cooler to Cooler Trap

Einzel lenses transport and match to the 2mm aperture of cooler trap.



talk is available here...

http://lin12.triumf.ca/text/2005TITAN/talk.pdf