Status of collinear resonance ionization developments:

Ion optics and beam transport simulations for the CRIS beam line at ISOLDE

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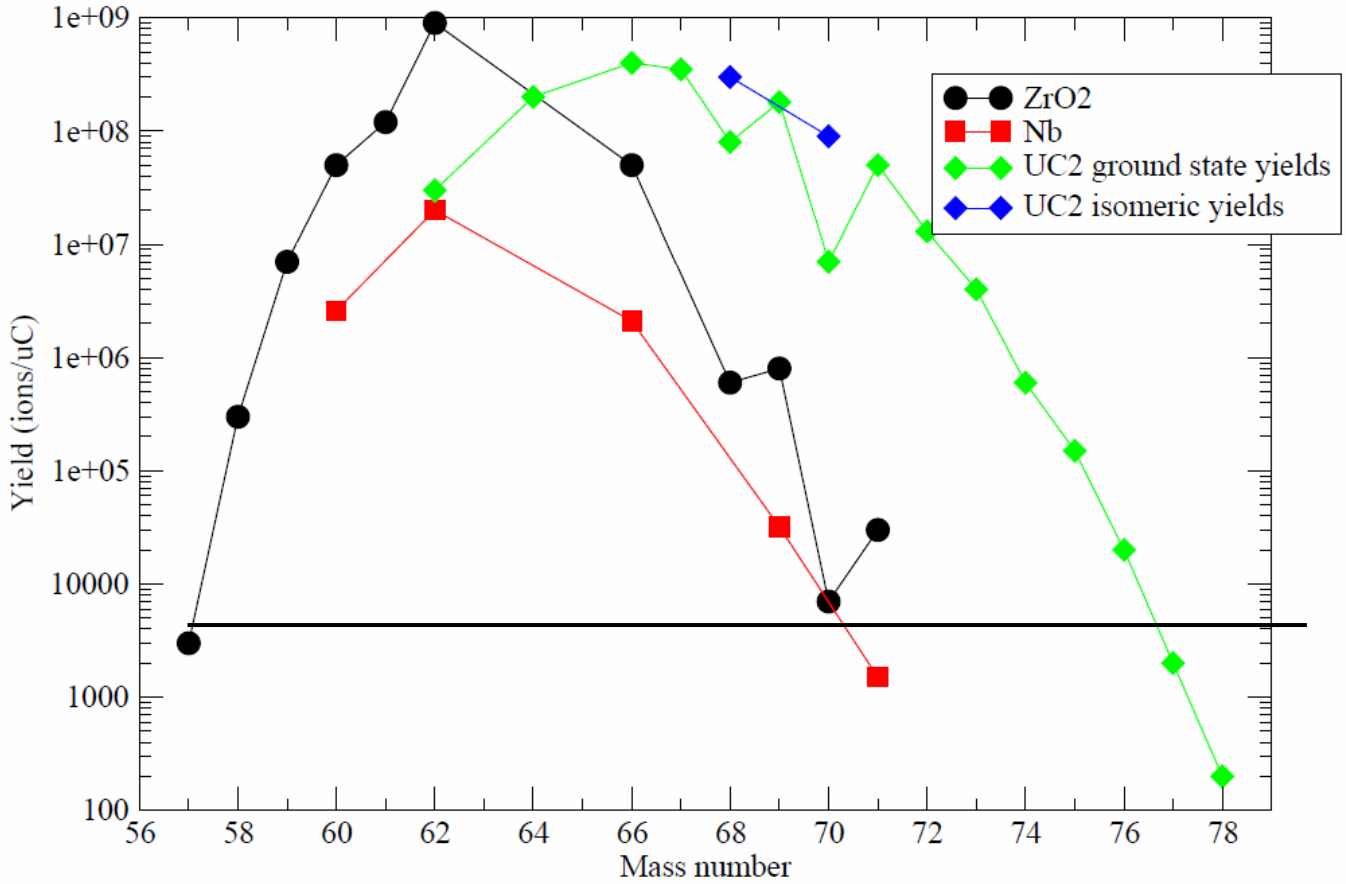
Motivation

- Research nuclear properties far from valley of stability
- Measure dipole and quadrupole moments of exotic nuclei by using hyperfine interactions
- Production yields drop orders of magnitude

Motivation

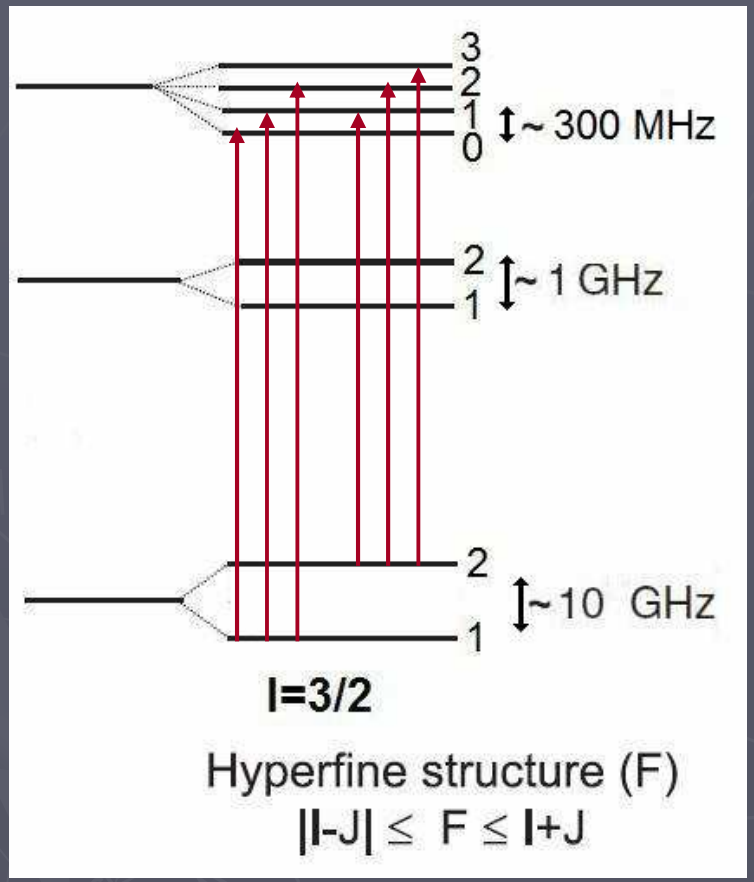
Copper isotopes yields at ISOLDE for different targets



→Current limit with bunched-beam collinear spectrosocopy

➔ Need a more sensitive collinear laser method to study the most exotic cases (< 58Cu, > 75Cu) with high resolution

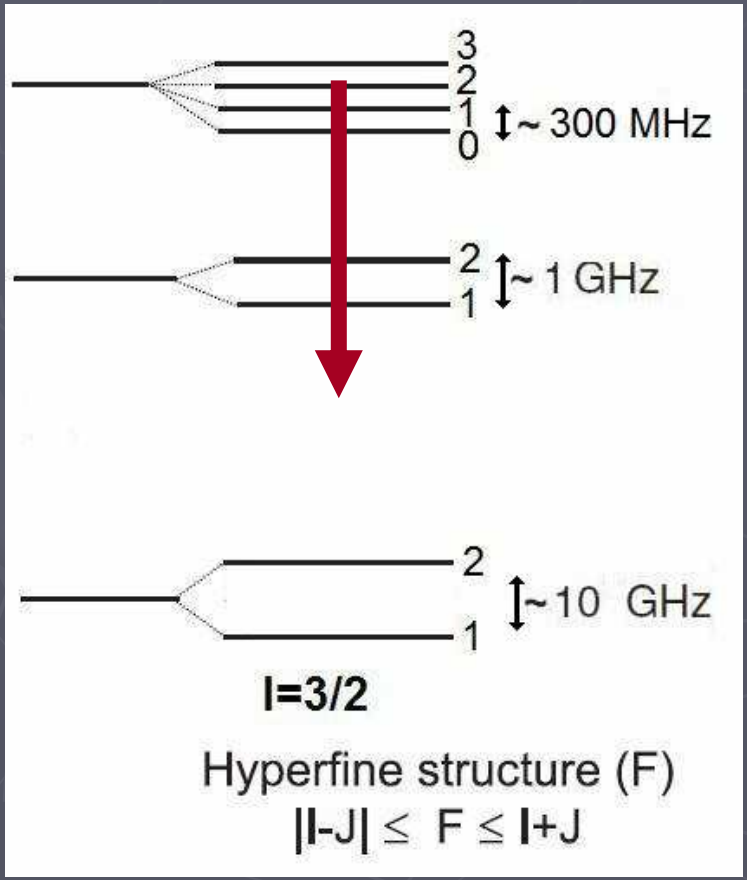
Collinear Laser Spectroscopy



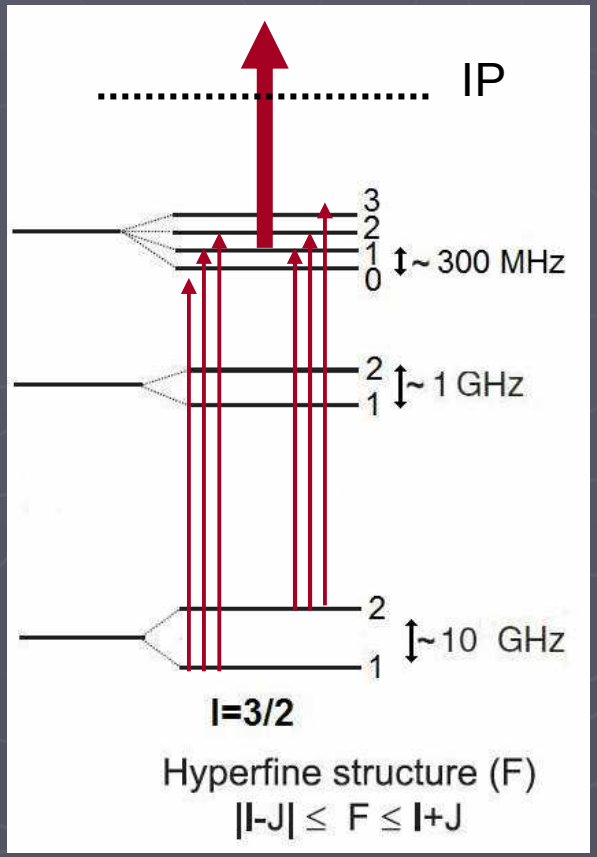
- Overlap the atom beam with a laser beam
- Scan the laser frequency
- Resonantly excite hyperfine levels

Detection of HFS signal

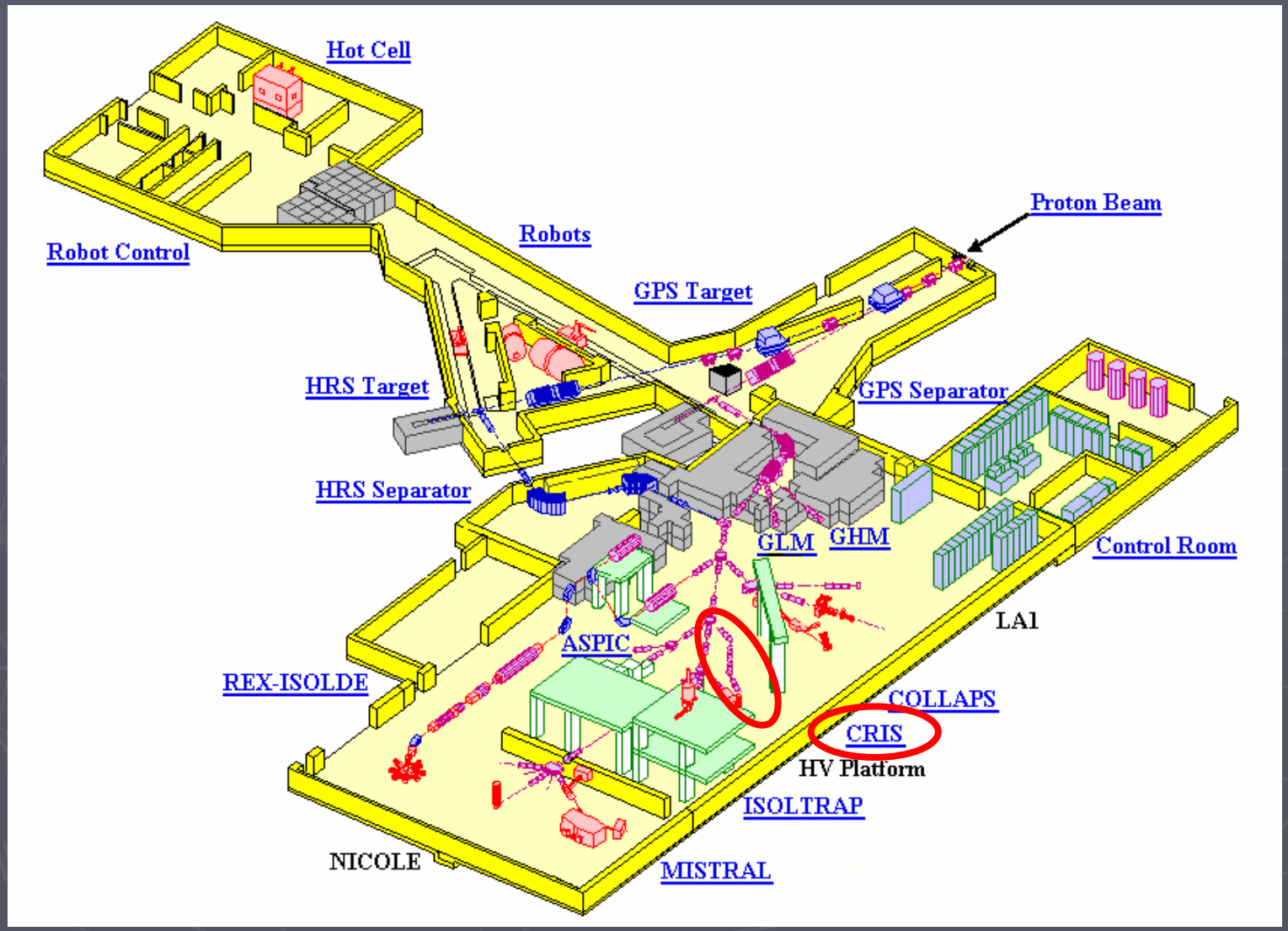
Fluorescent decay



Resonant re-ionisation and ion detection

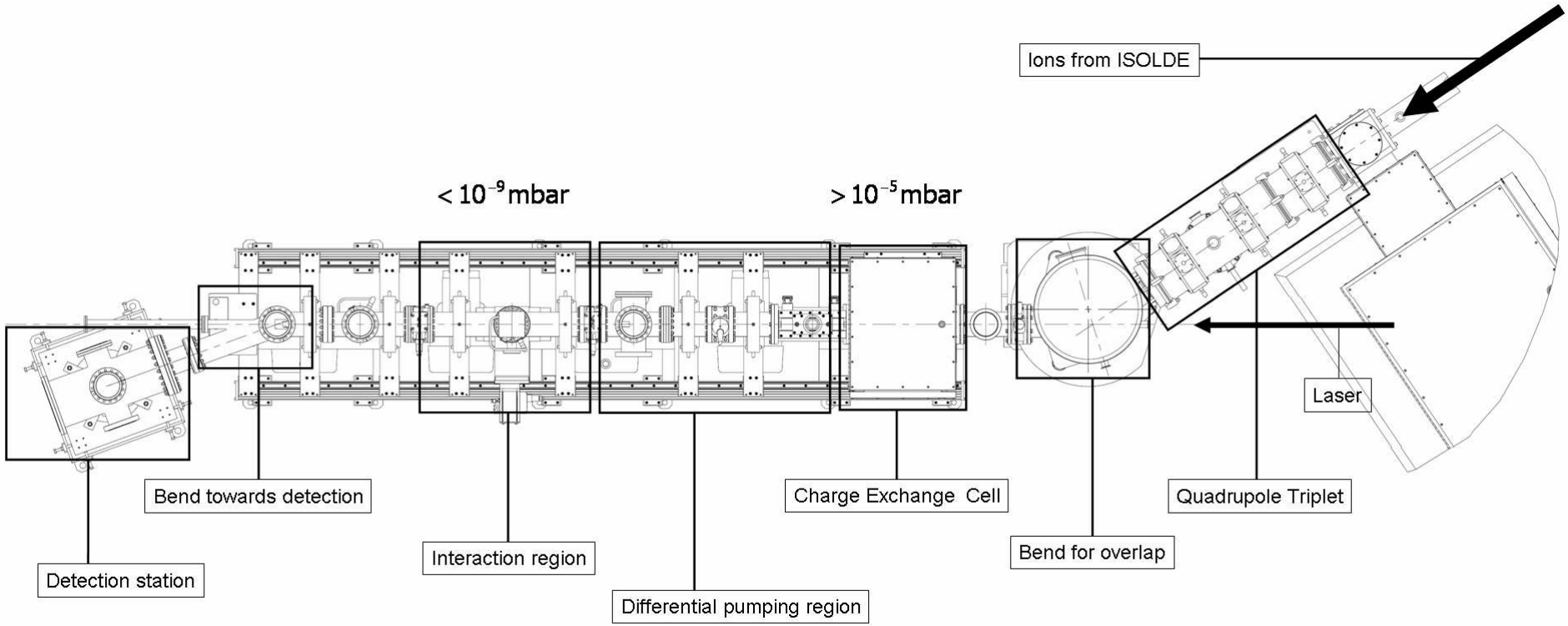


ISOLDE


Hot Cell
Robot Control
Robots
Proton Beam
GPS Target
HRS Target
GPS Separator
HRS Separator
GLM
GHM
Control Room
LA1
ASPIC
REX-ISOLDE
COLLAPS
CRIS
HV Platform
ISOLTRAP
NICOLE
MISTRAL

Collinear Resonant Ionisation laser Spectroscopy

- Neutralize pulsed ion beam in charge exchange cell
- resonantly excite and re-ionize with overlapping pulse-amplified CW laser beam
  (laser pulses synchronized to ion pulses → high efficiency)
- deflect the ions towards a detection station → background free signal detection !

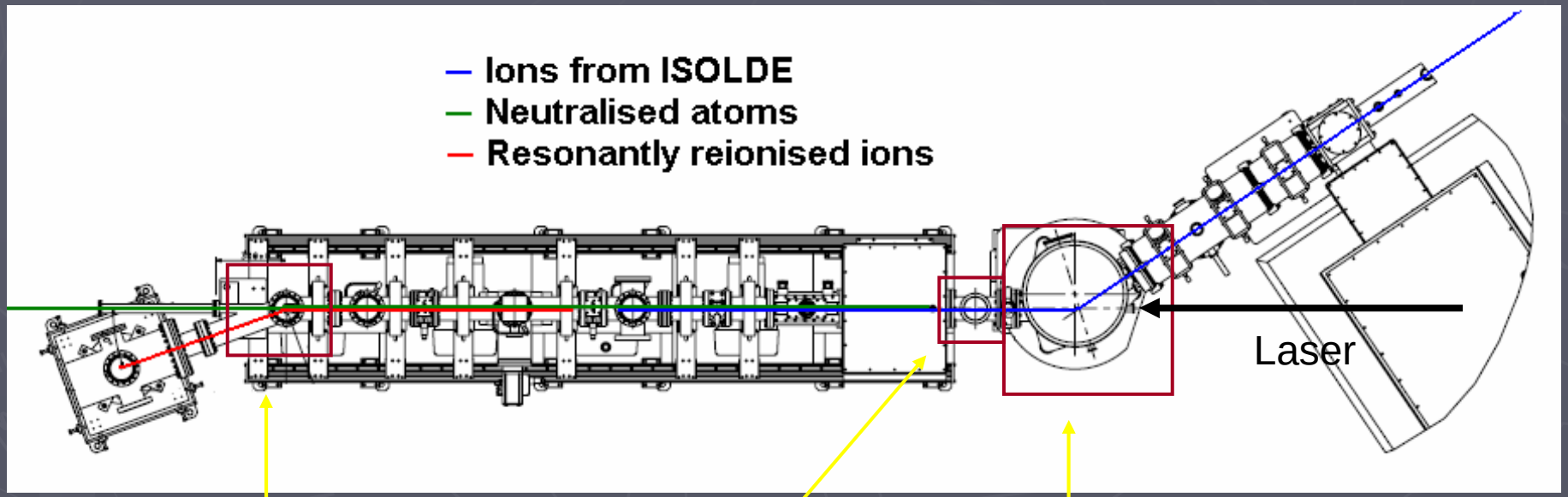


Simulations for ion optics and beam transport

- Start from the original design
- Minimize the loss of ions
- Pumping apertures are bottlenecks
- Keep the ion beam small and aligned

CRIS @ ISOLDE

Top view of the beamline

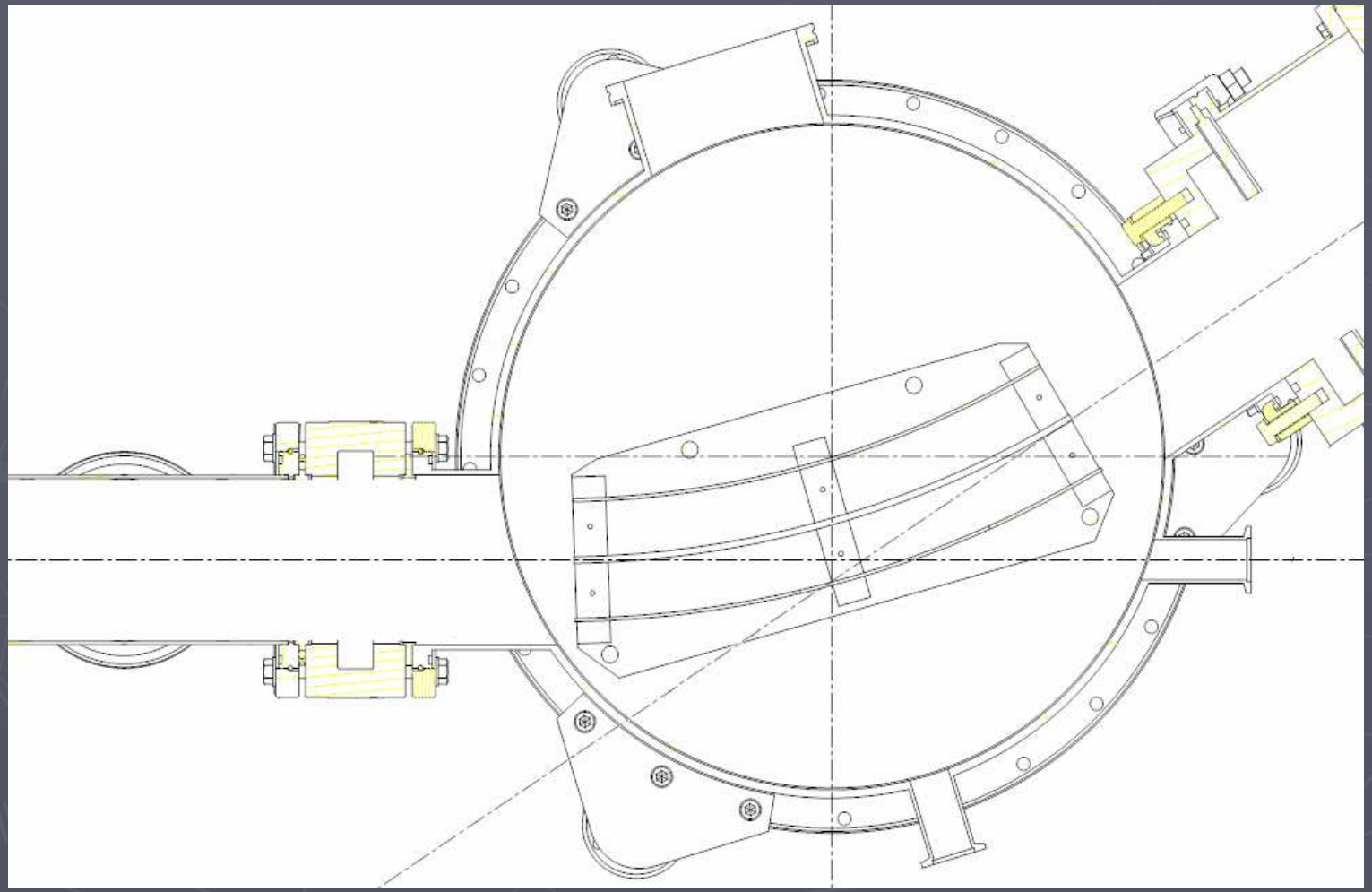


Bend towards detection

Additional focussing

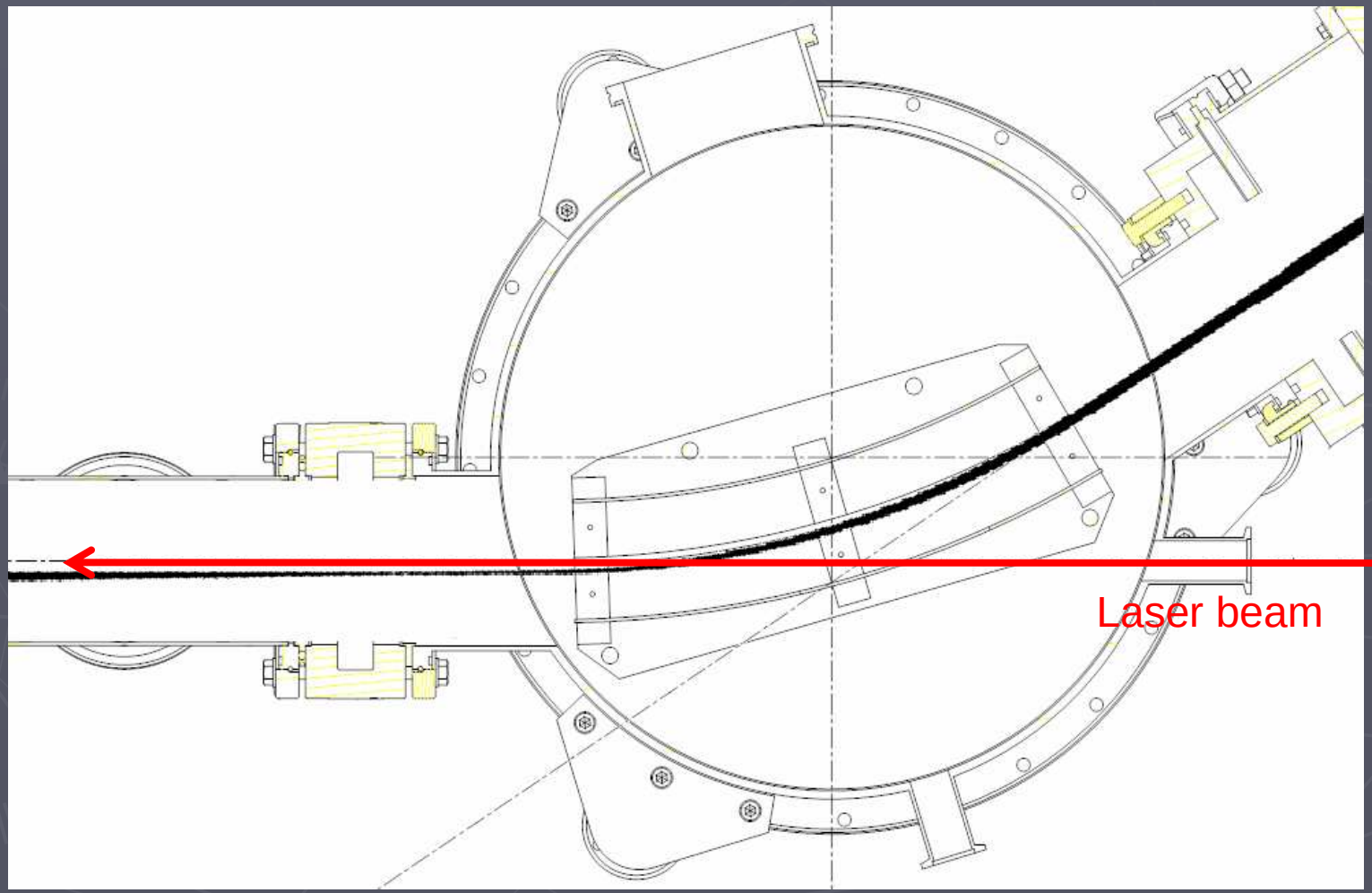
Bend for overlap with the laser

Ion-bend for overlap with laser



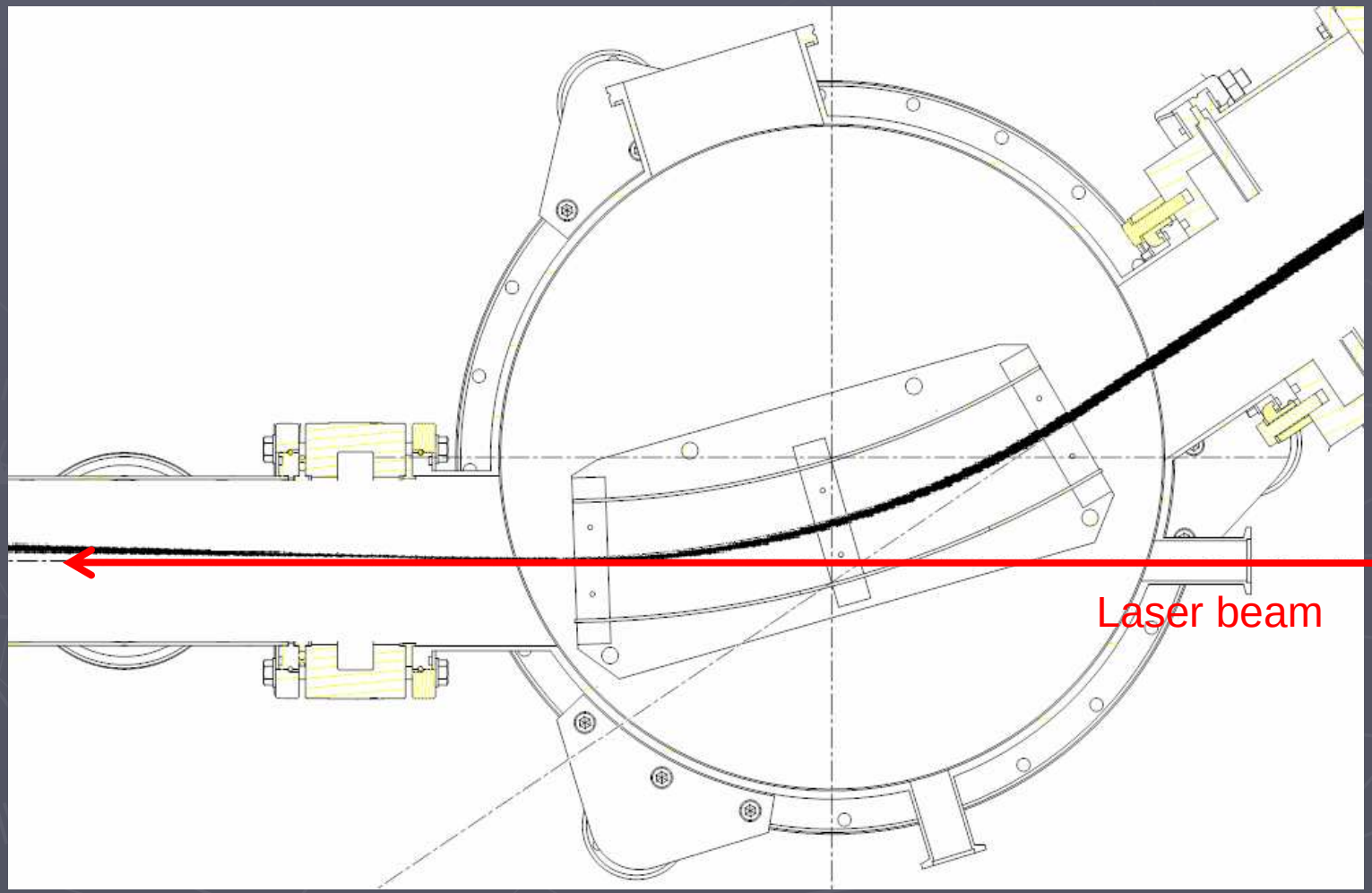
Bend for overlap with laser

Deflection over de bend angle of 34° → beam not aligned with laser beam



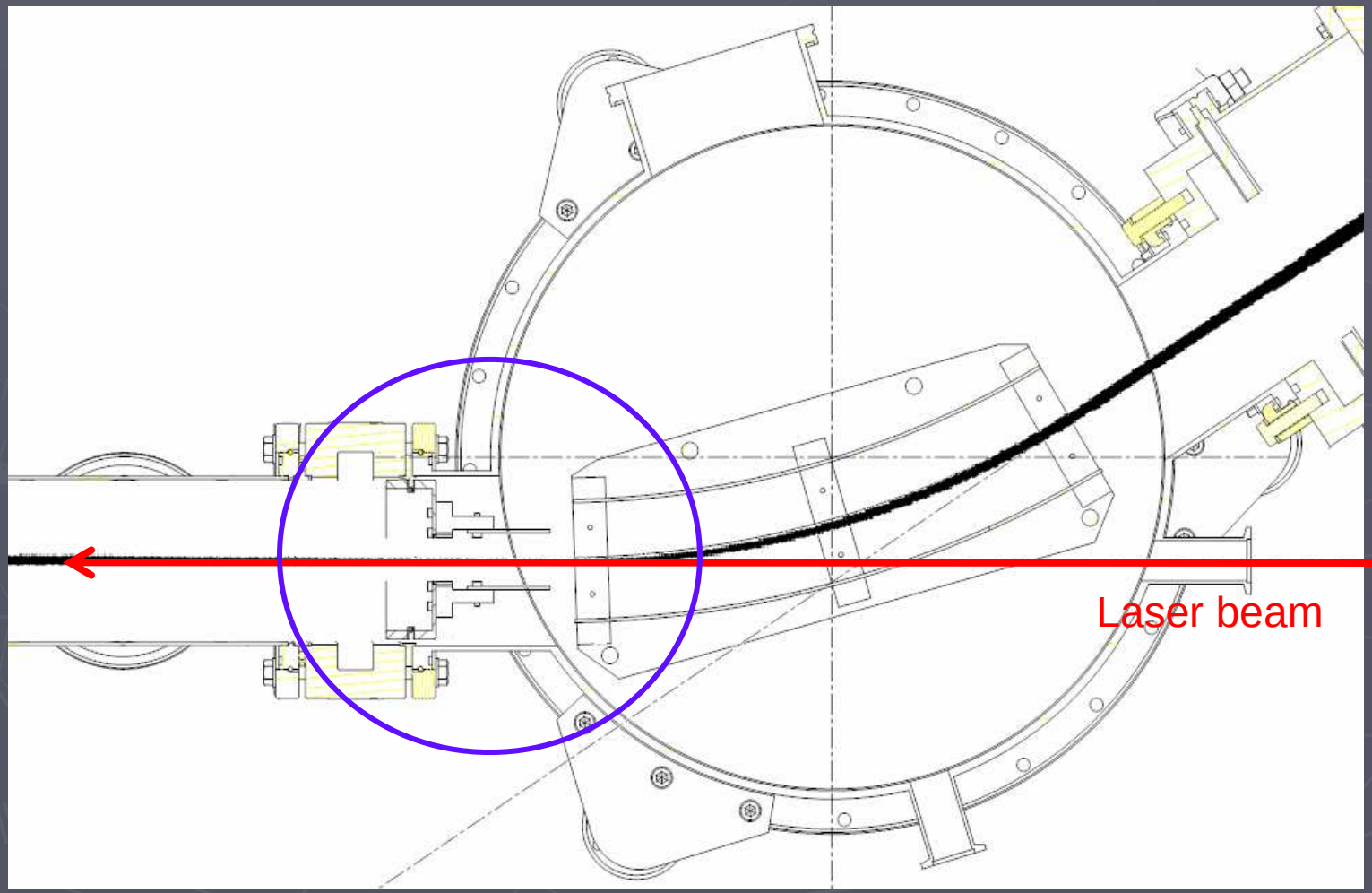
Bend for overlap with laser

Deflection to arrive at beam center → beam deflected too much, no overlap

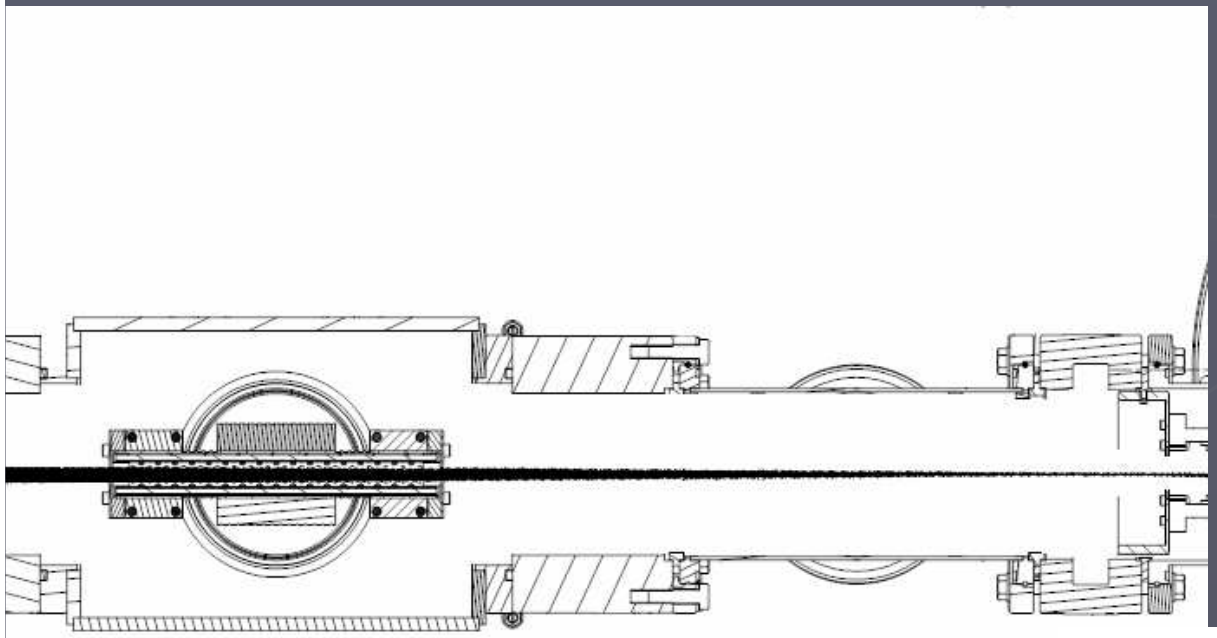


Bend for overlap with laser

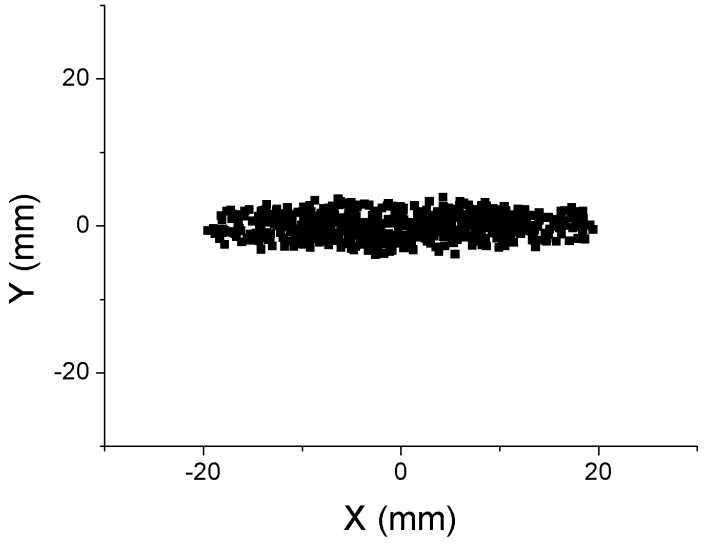
ADD additional deflection plates → beam aligned with laser beam



Beam divergence after deflection



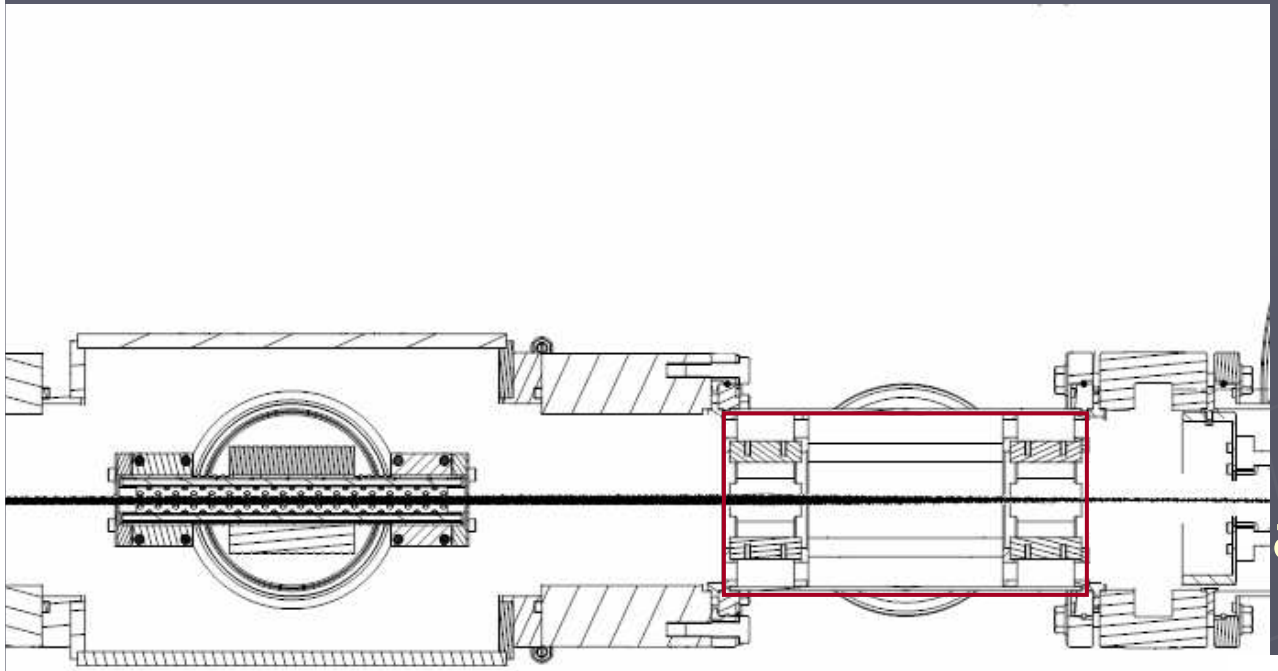
Size of the beam spot after charge exchange cell



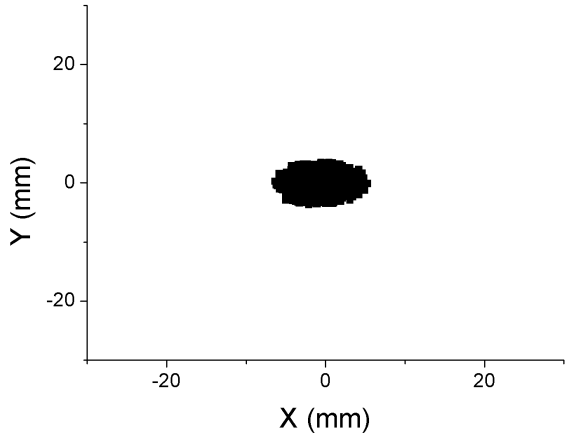
Add a Quadrupole doublet

- Ion beam diverges and ions are lost
- Need for extra focussing just after bend
- Quadrupole doublet designed to fit in the beam line

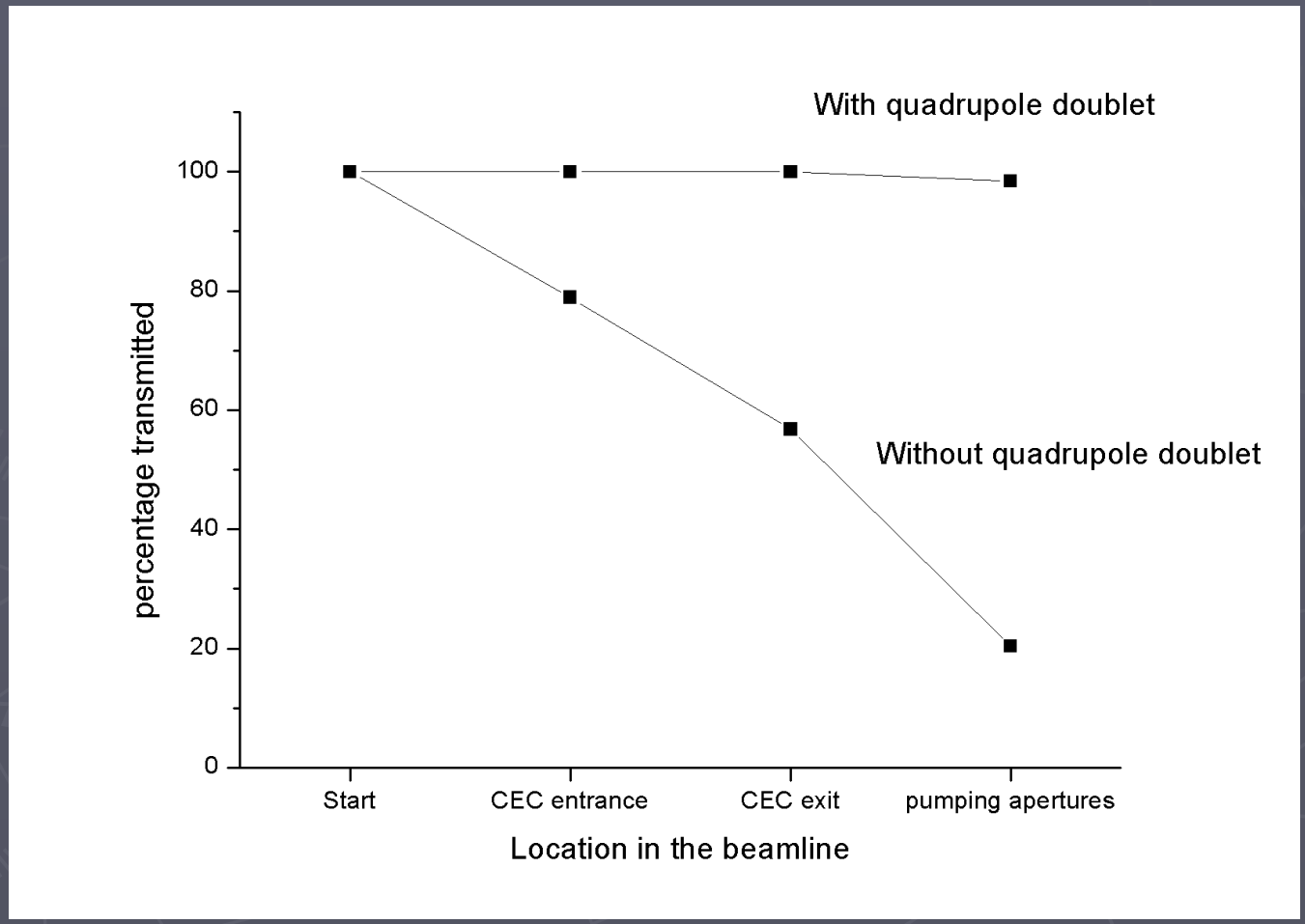
Focussing with new Quadrupole doublet



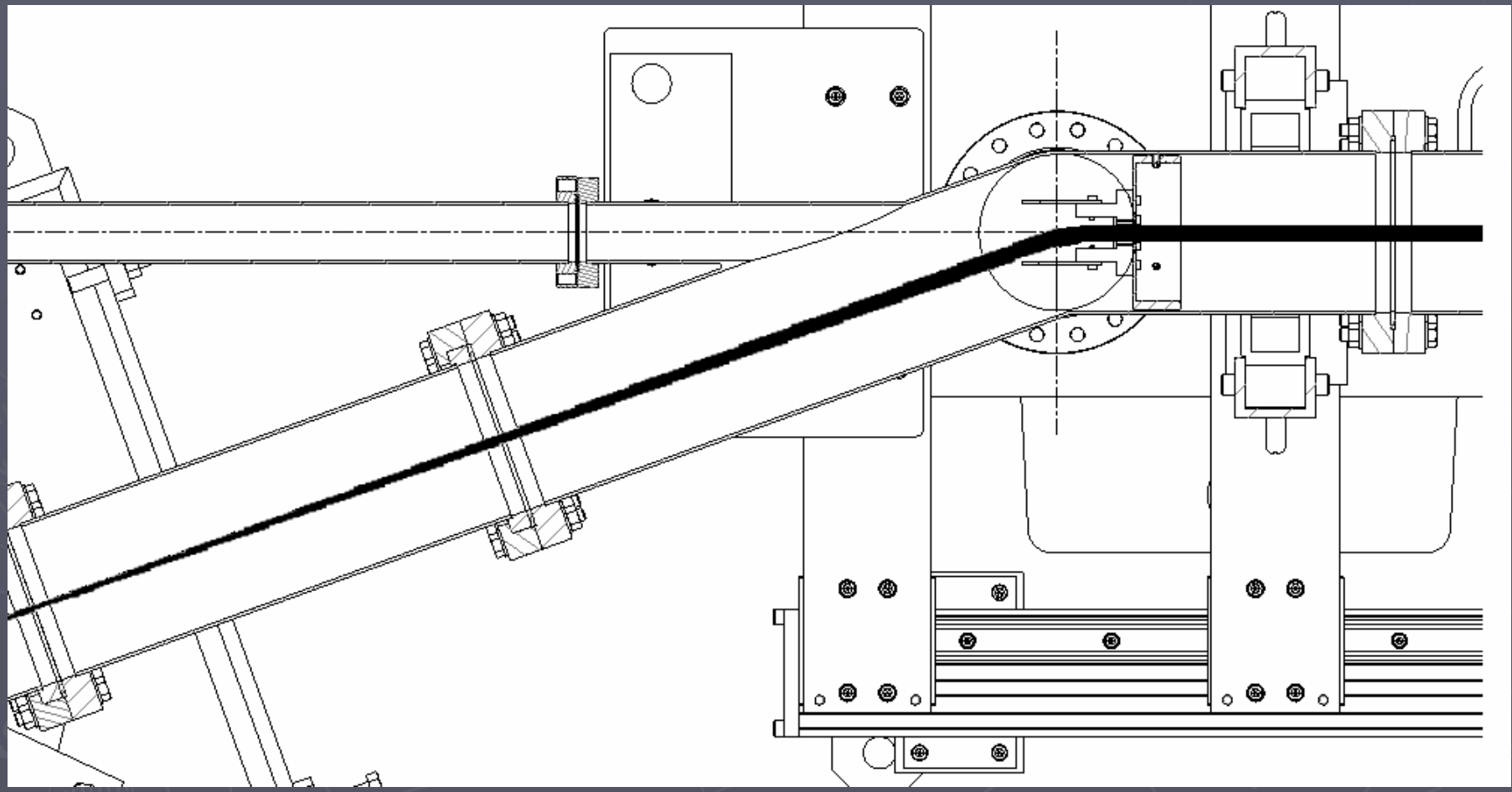
Beam spot using additional quadrupole lenz



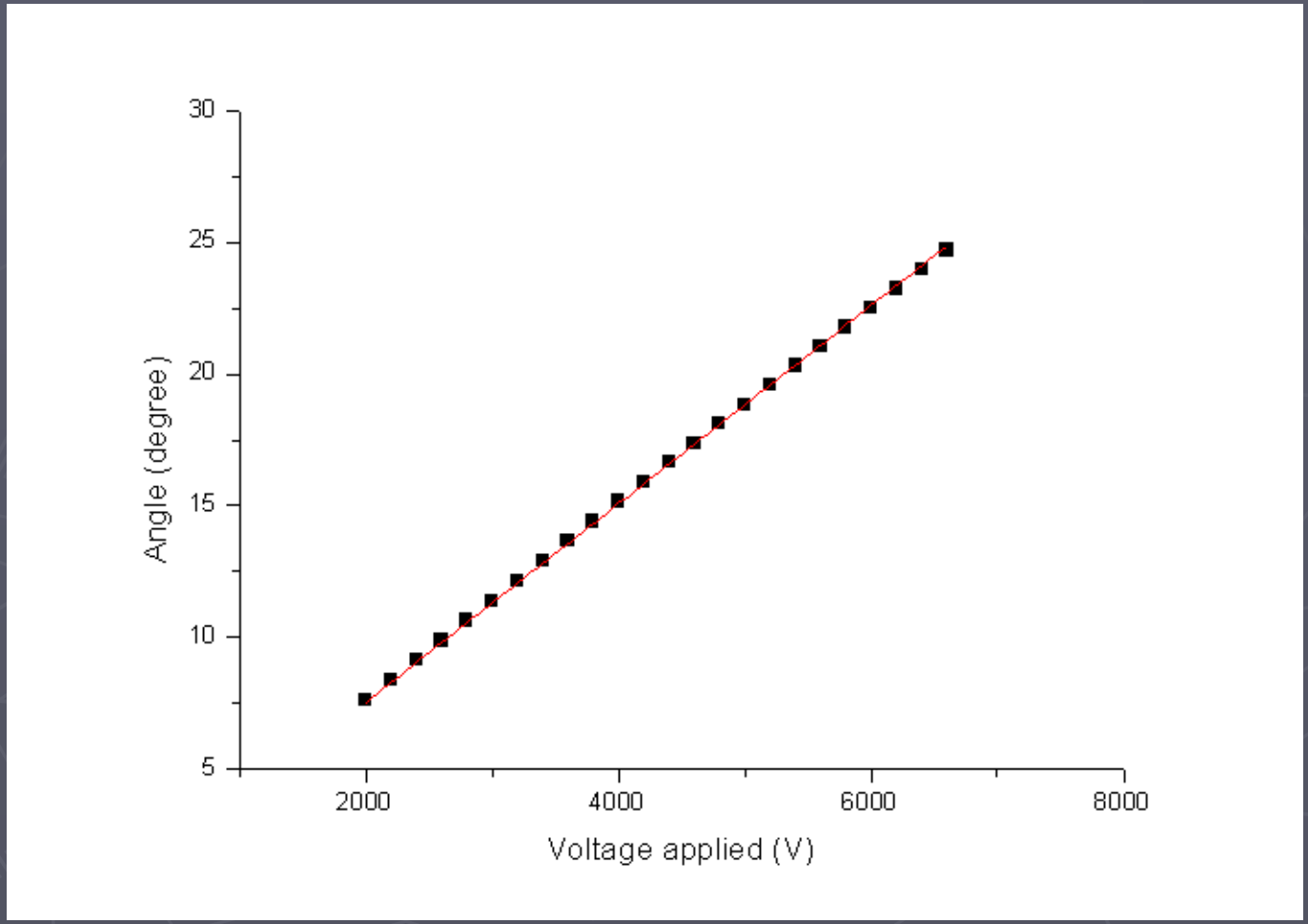
Transmission



Bend towards detection



Voltages needed to bend the beam



Summary of the simulations

- With extra bending plates the beam was aligned
- Quadrupole doublet keeps the beam small enough so there are almost no losses in the beam line
- Voltages on electrodes determined

Conclusions

- Ion optic simulations proved to be necessary
- Extra bending plates and quadrupole doublet were added for correction
- Offline tests this month with stable ions
- First online experiment in November