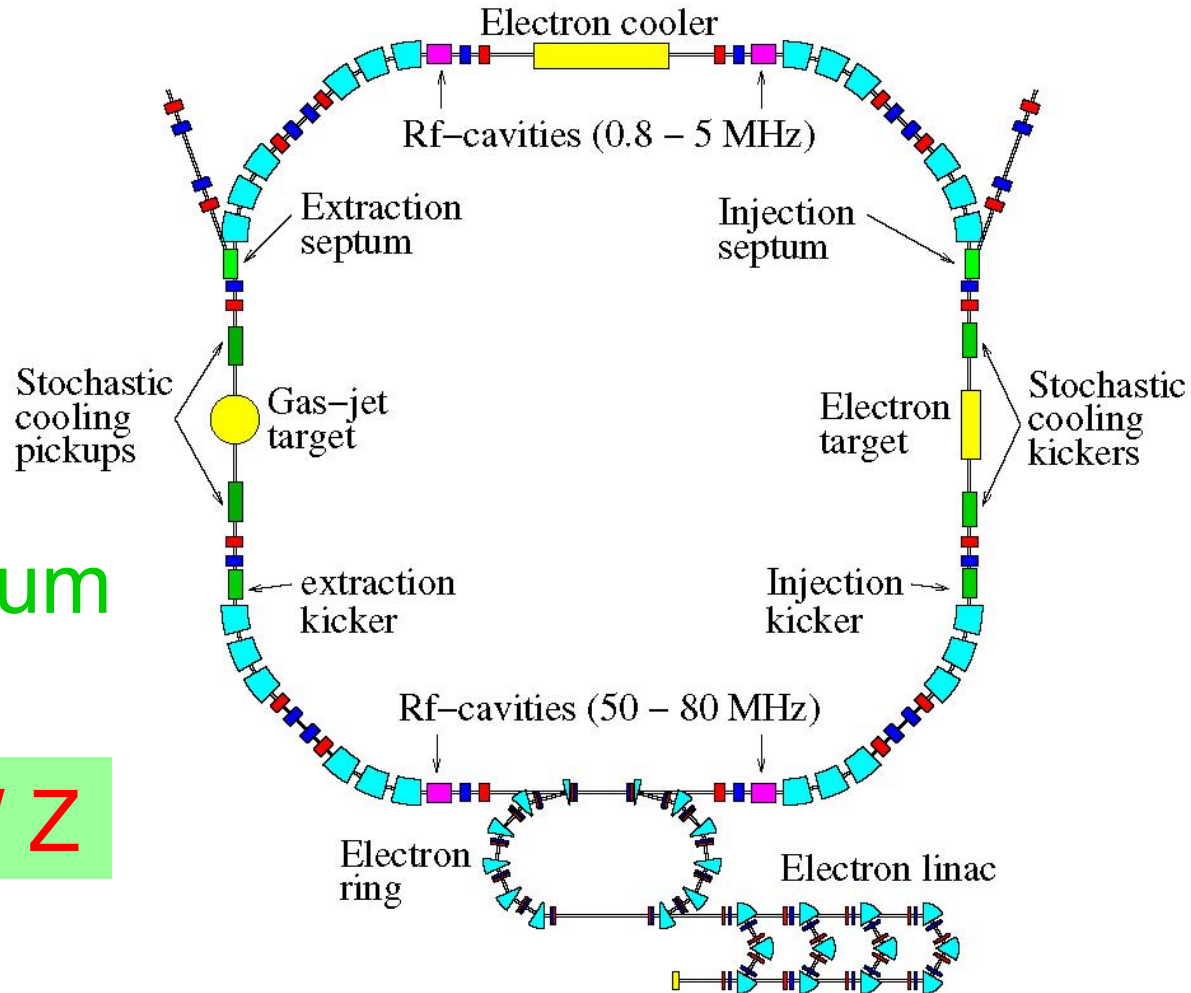


some thoughts about a projectile fragment spectrometer

objectives:
identify Z and A
measure momentum

$$B \cdot \rho = P/q \sim A \cdot \beta \gamma / Z$$



by Thomas Faestermann - with help from Helmut Weick

Detector

sideview

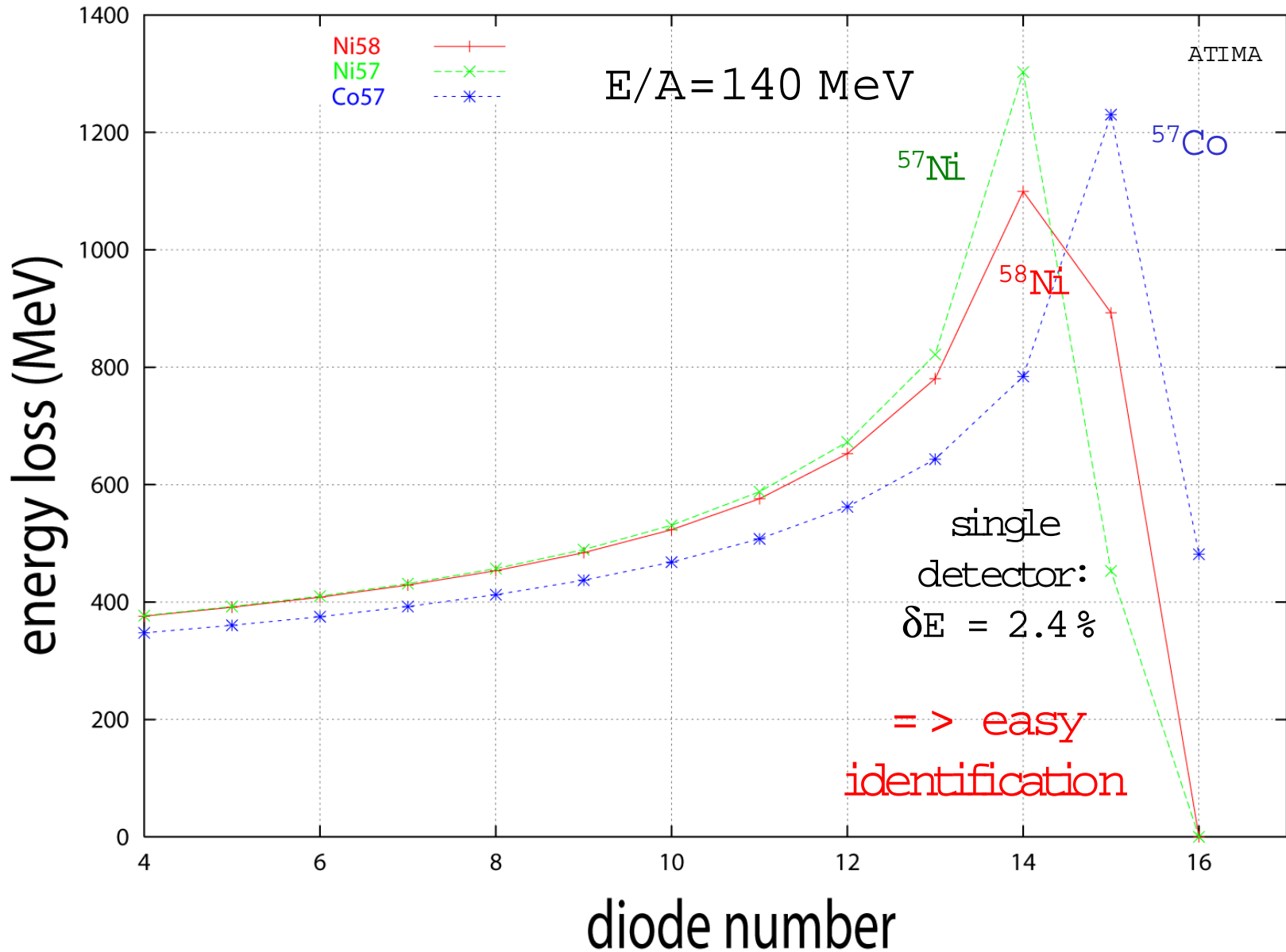
topview

^{238}U in diode stack

individual diodes

averaged total

Energy loss in 0.4 mm intervals of Si



momentum resolution

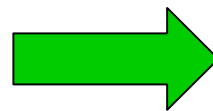
resolution = dispersion / X_{image}

$$X_{\text{image}} = (X|X) X_{\text{obj}} + \underbrace{(X|X')}_{\text{small ! => focal plane}} \underbrace{X'_{\text{obj}}}_{\text{small ! => small angles}} + (X|p) \delta p/p$$

small ! =>
focal plane

small ! =>
small angles

e.g. $X_{\text{image}} = 1 \text{ mm}$
 $(X|p) = 5 \text{ m}$



resolution = 5000

100 mm



10 m

$(X|p) \sim 5m$

$\underline{\pm} \sim 3 \text{ mrad}$

from H. Weick

FWHM $2.7 \cdot 10^{-4}$

from H. Weick

types of reactions

- a) **elastic scattering** on p or α @ small angles
 $\Delta Z = \Delta A = 0$ $\Delta \beta \sim 0$ \Rightarrow **not possible**, not necessary?
- b) **inelastic scattering** on p or α
 $\Delta Z = \Delta A = 0$ $\Delta \beta \sim 0$ \Rightarrow **not possible**
e.g. 500 · A MeV p($^{58}\text{Ni}, ^{58}\text{Ni}^*$)p' $E^* = 20\text{MeV}$ $\Delta B_p/B_p = -4 \cdot 10^{-4}$
but, if particle emission: $\Delta A = -1$ $\Delta B_p/B_p = -1/A$ (+1/Z)
good for $A > 50$
small CM angles \Rightarrow very small lab angles
- c) **transfer** e.g. $d(^AZ, ^{A+1}Z)p$
 $\Delta Z = 0$ $\Delta A = +1$ $\Delta \beta/\beta < 0 \Rightarrow 0 < \Delta B_p/B_p < 1/A$
matching conditions require low energies $\sim 10\text{-}30$ A MeV
small CM angles \Rightarrow very small lab angles

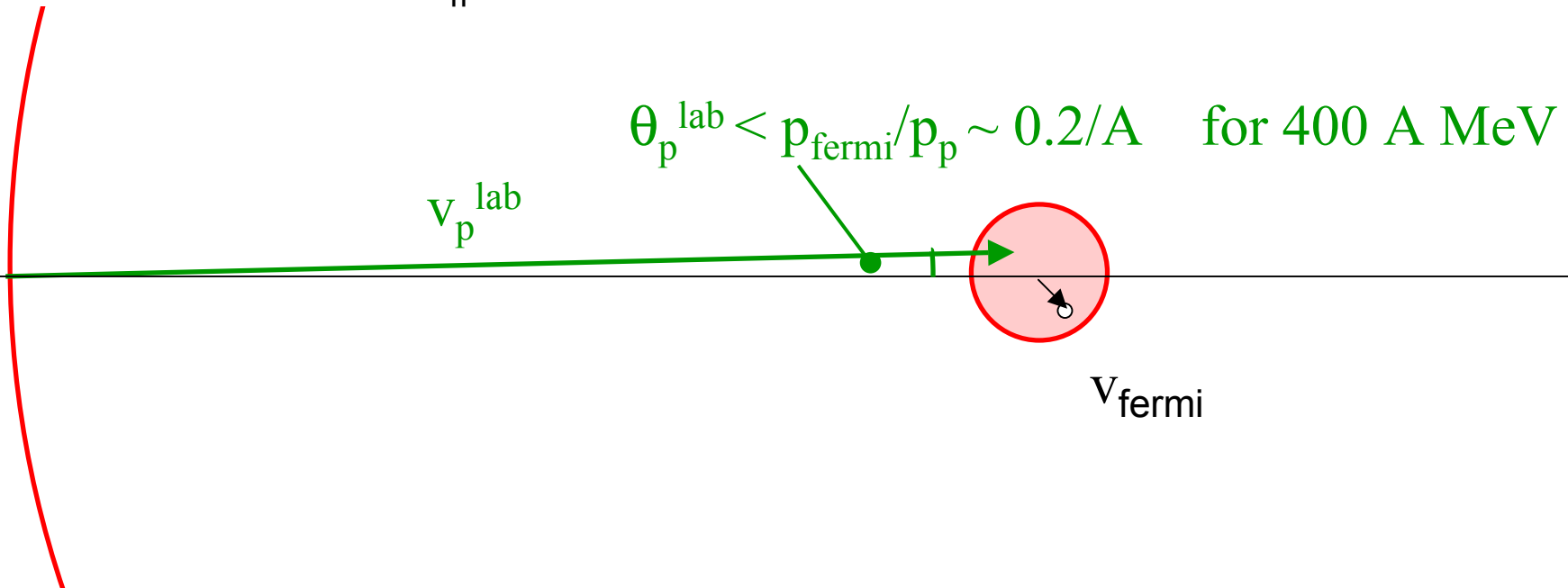
reactions continued

d) knockout reactions

$$\Delta A = -1 \quad \Delta Z = 0, -1 \quad \Delta p = \pm p_{\text{fermi}}$$

$$|\Delta B_p / B_p| < 1/A$$

if we cut on p_{\parallel} : small lab angles



e) charge exchange reactions (p,n), (3He,t) ...

$$\Delta A = 0 \quad \Delta Z = \pm 1$$

$$|\Delta B_p / B_p| = 1/Z \quad \text{but acceptance} < \pm 1.75\%$$

from H. Weick

summary

identification

seems possible with Si stack

B_p acceptance

problematic

tune beam to opposite side!

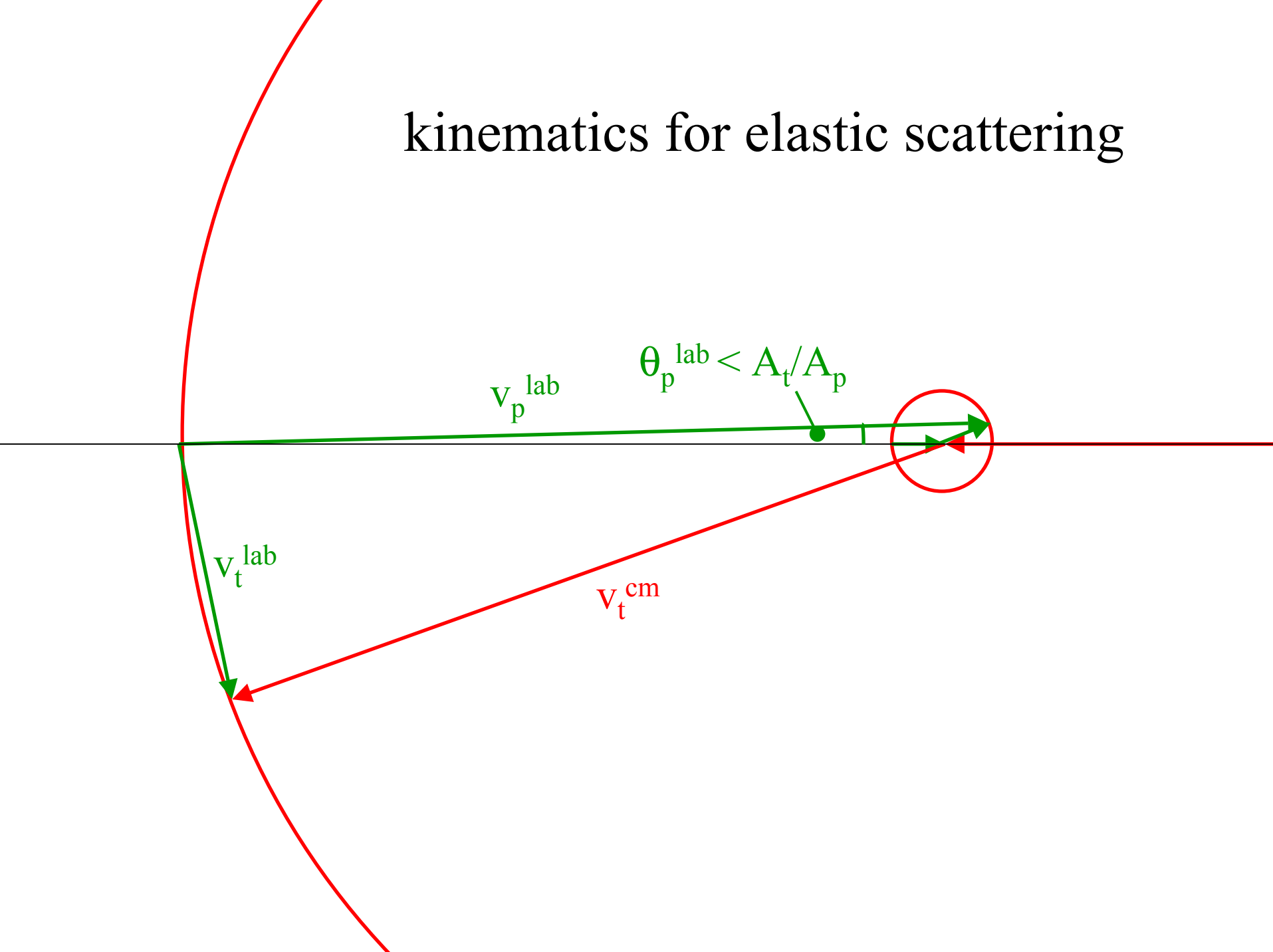
momentum resolution

seems feasible for small angles
especially with additional Q's

still much to do

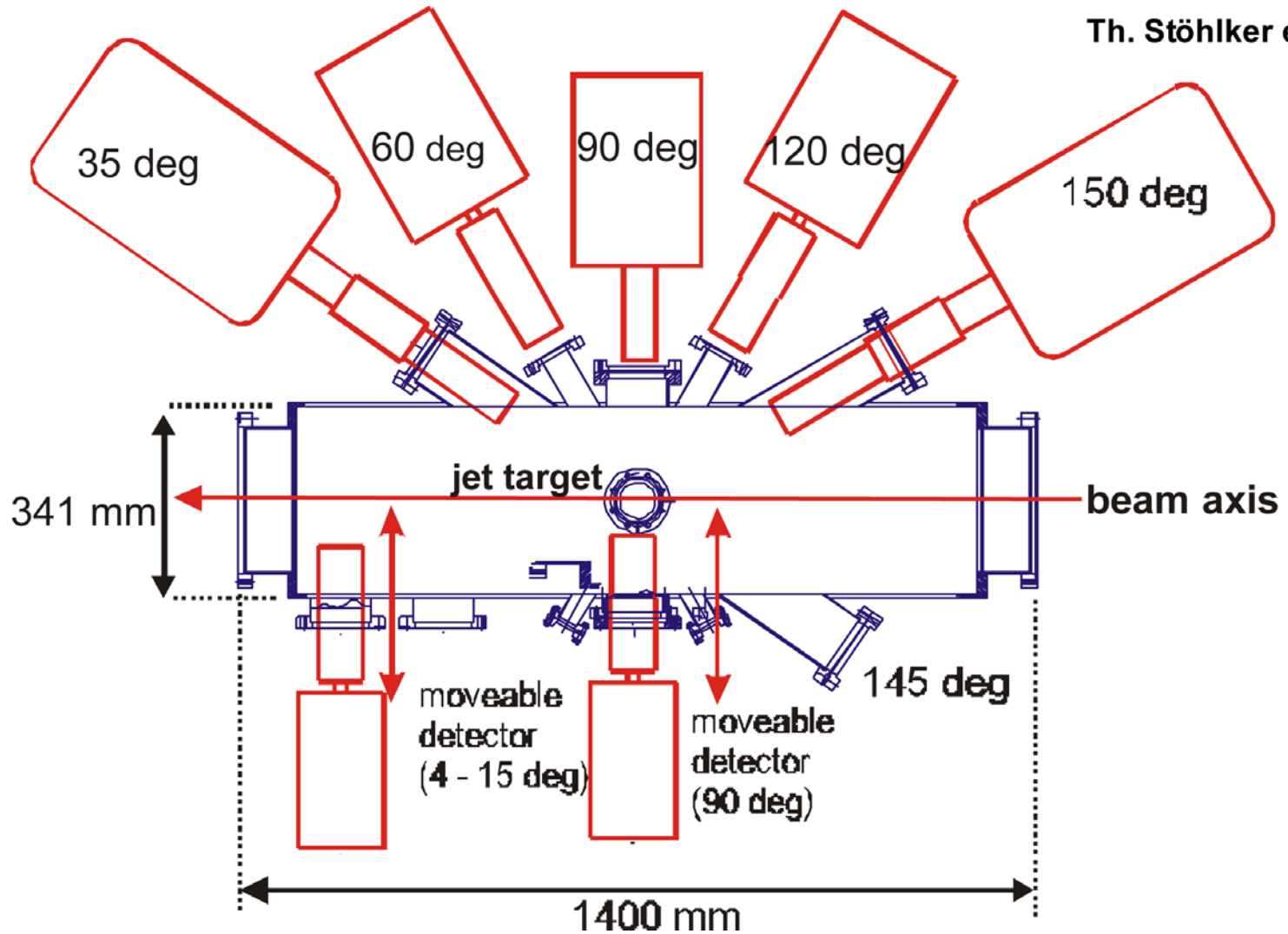
from H. Weick

kinematics for elastic scattering



Gamma coincidences?

Th. Stöhlker et al.,



View of experimental chamber

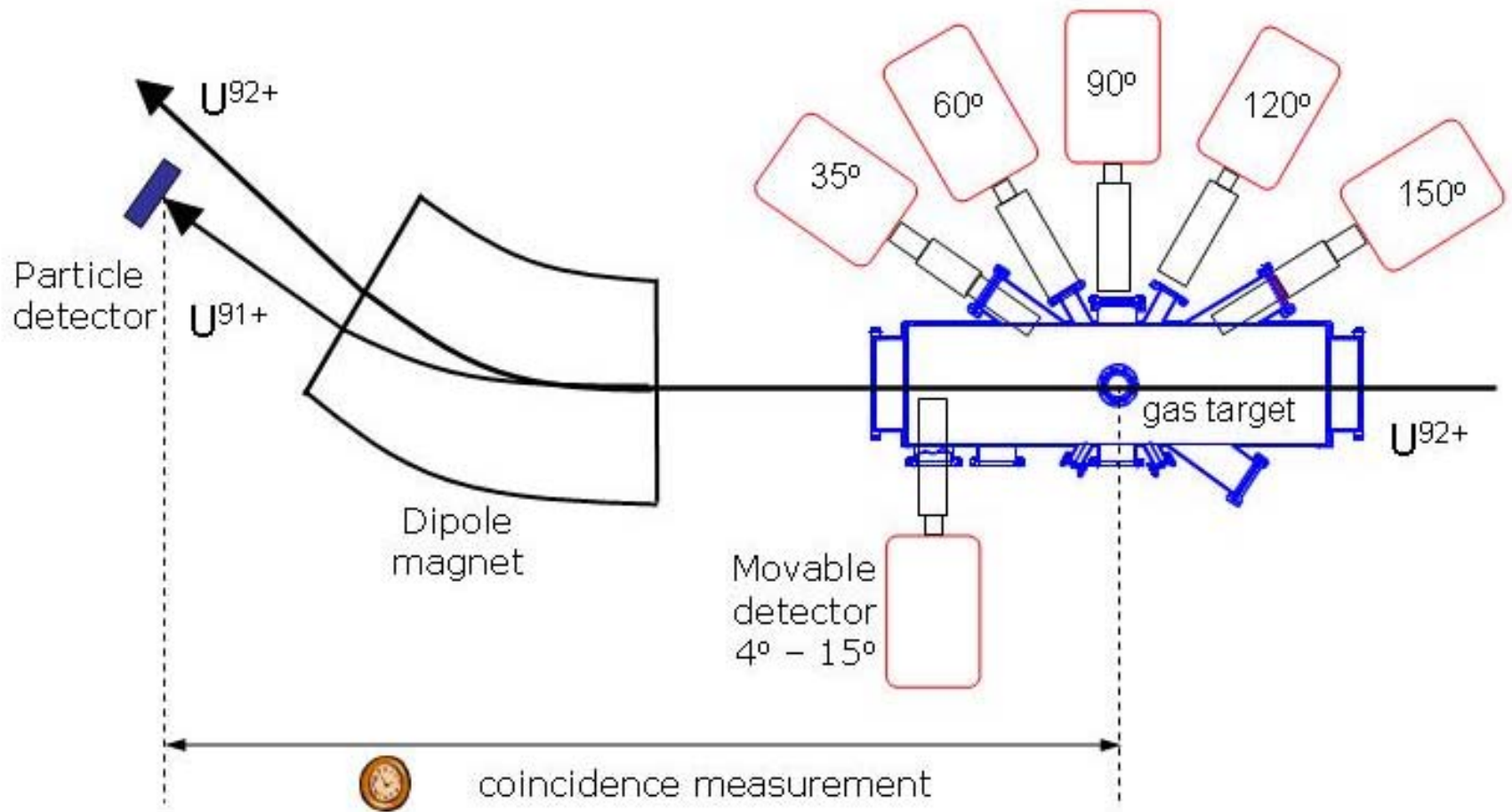
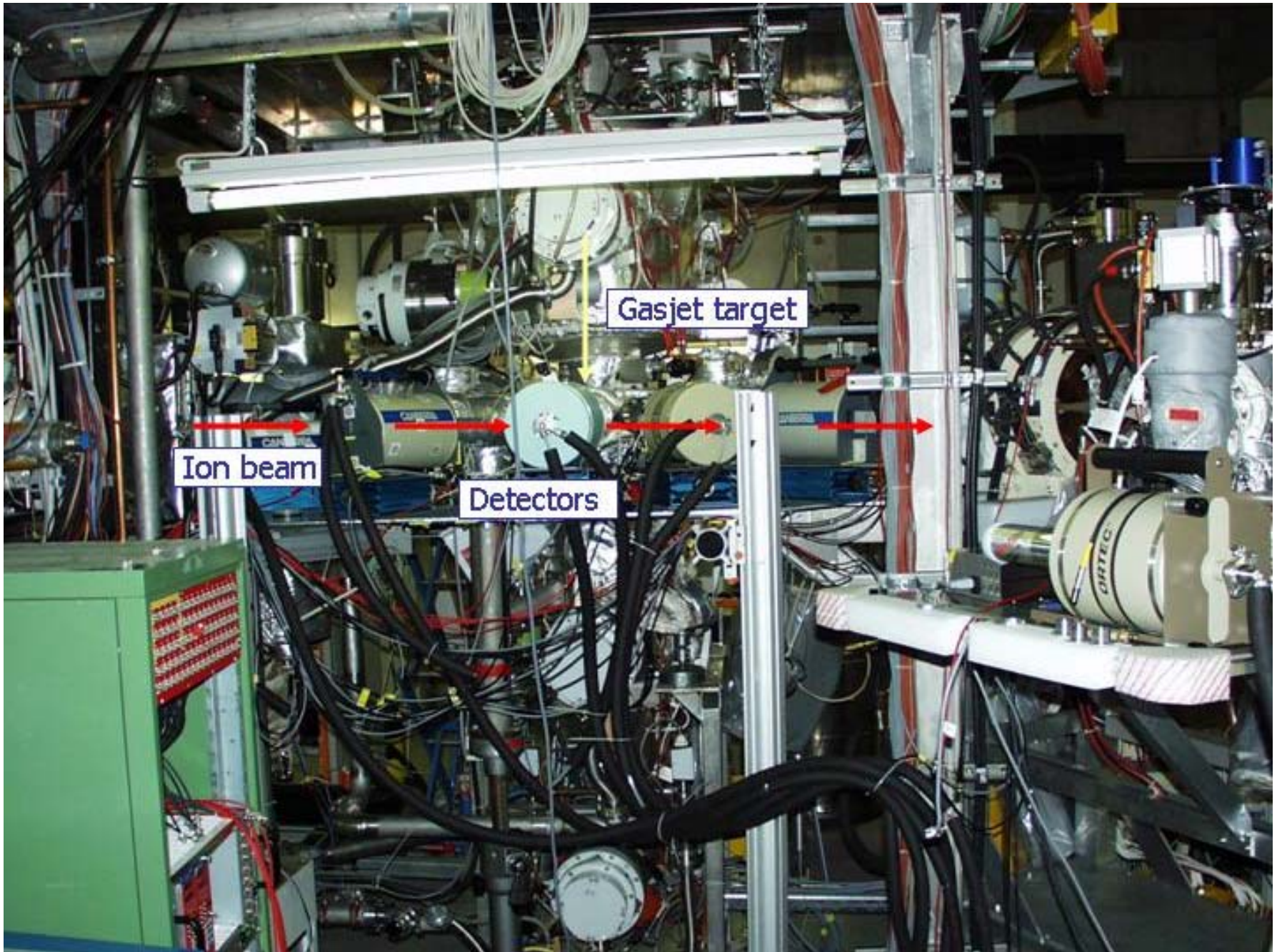
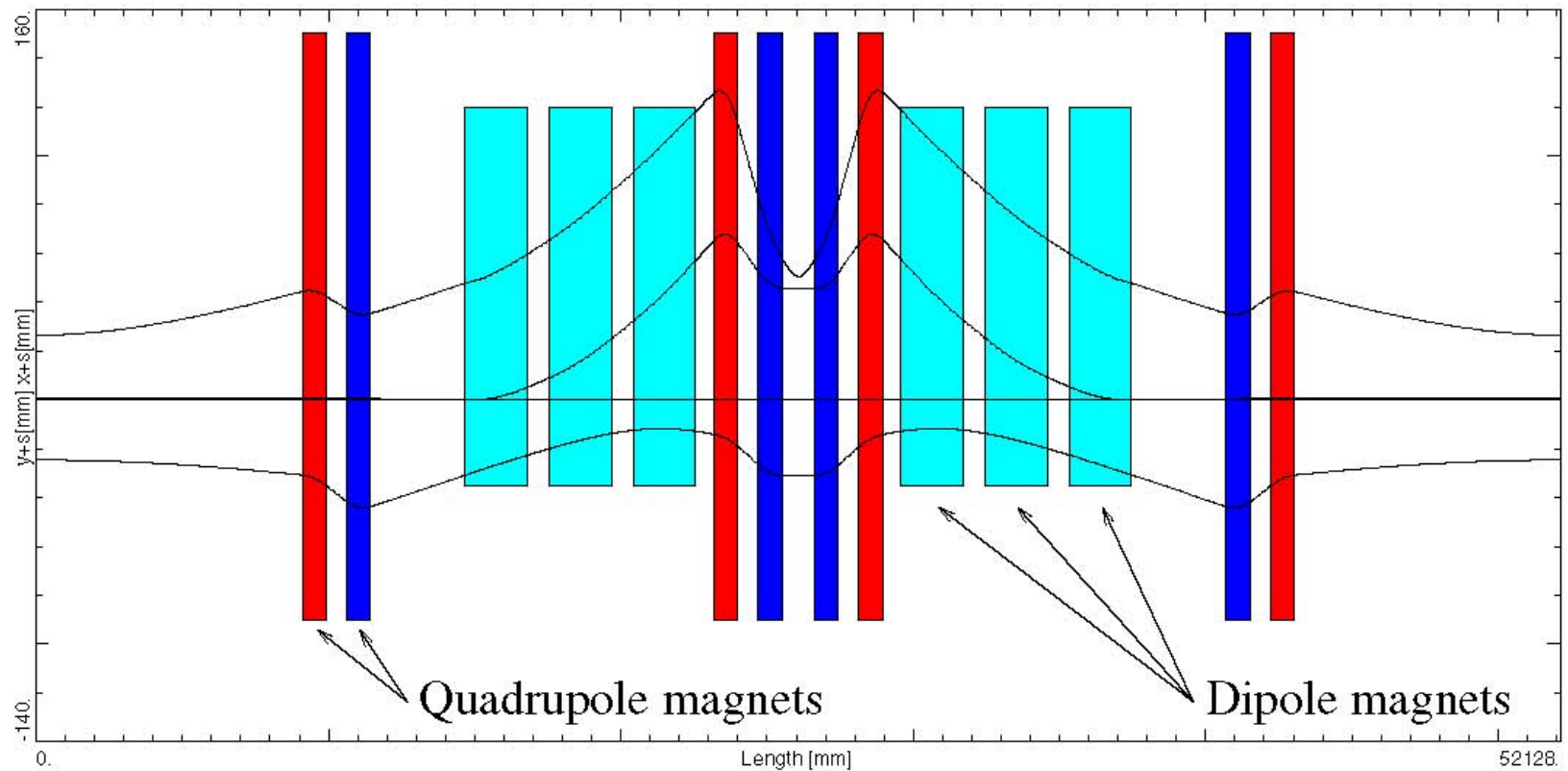


Photo of Gas Target



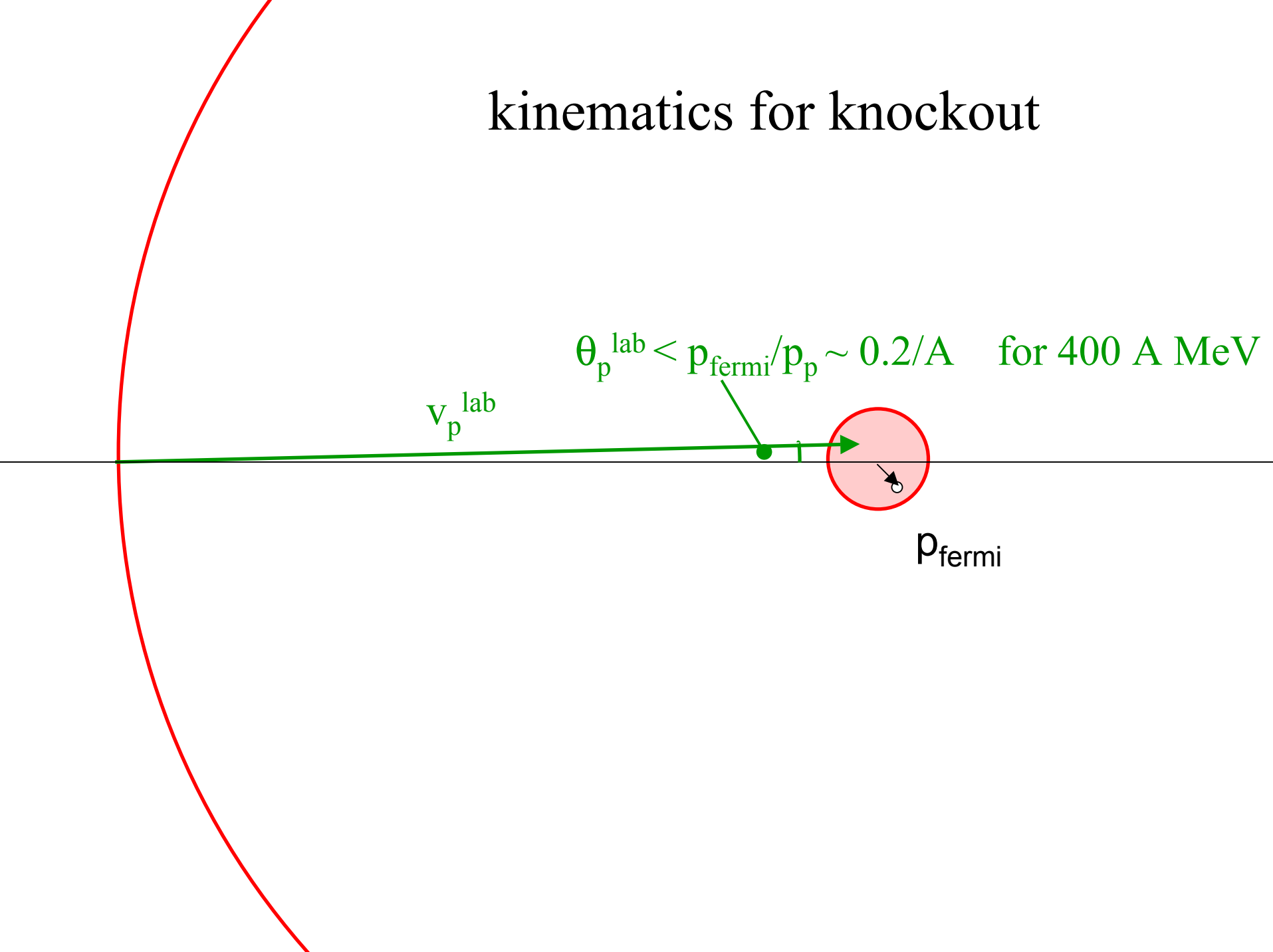
Ion optics in quarter of NESR



sketch of knockout

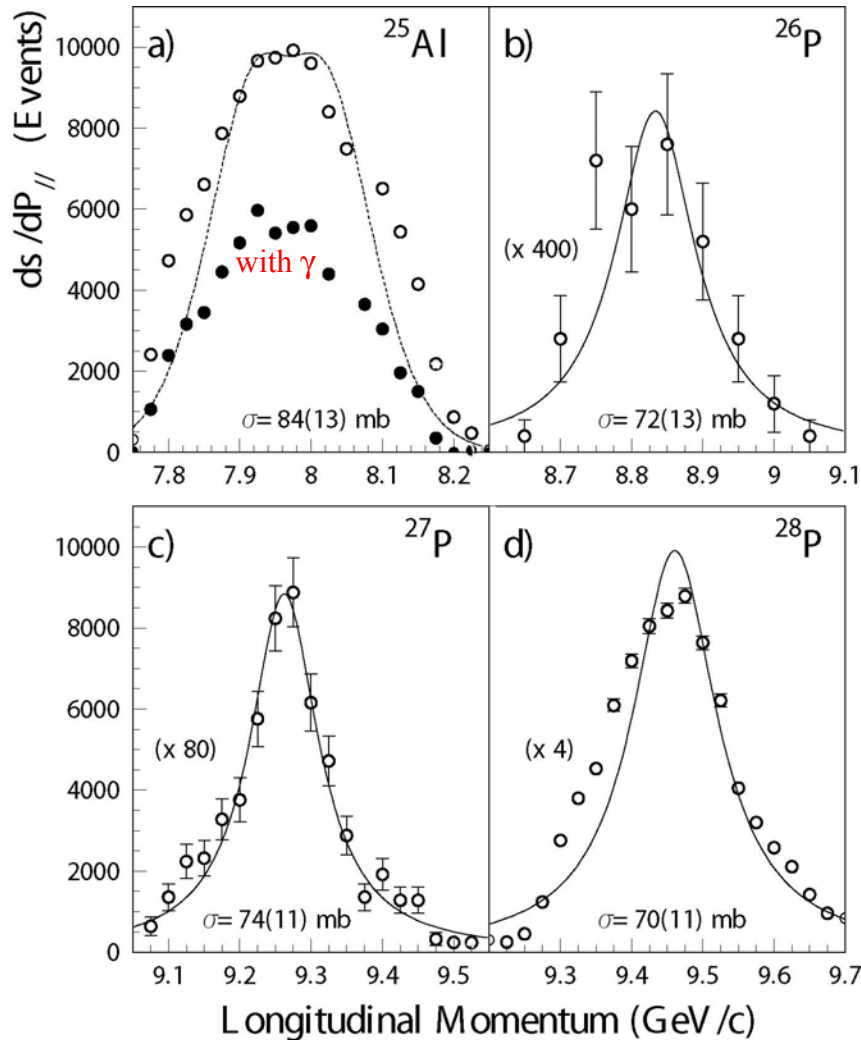


kinematics for knockout



Knockout Reactions

65·A MeV $^A Z$ on $^9\text{Be} \Rightarrow A-1 Z-1$



huge cross sections

70 - 80 mb

from $d\sigma/dP_{//}$

\Rightarrow L-value of knocked-out nucleon

from σ to a specific state

$\Rightarrow C^2S(j,n)$

needs:

- shell model calculation
- eikonal reaction theory

NESR

