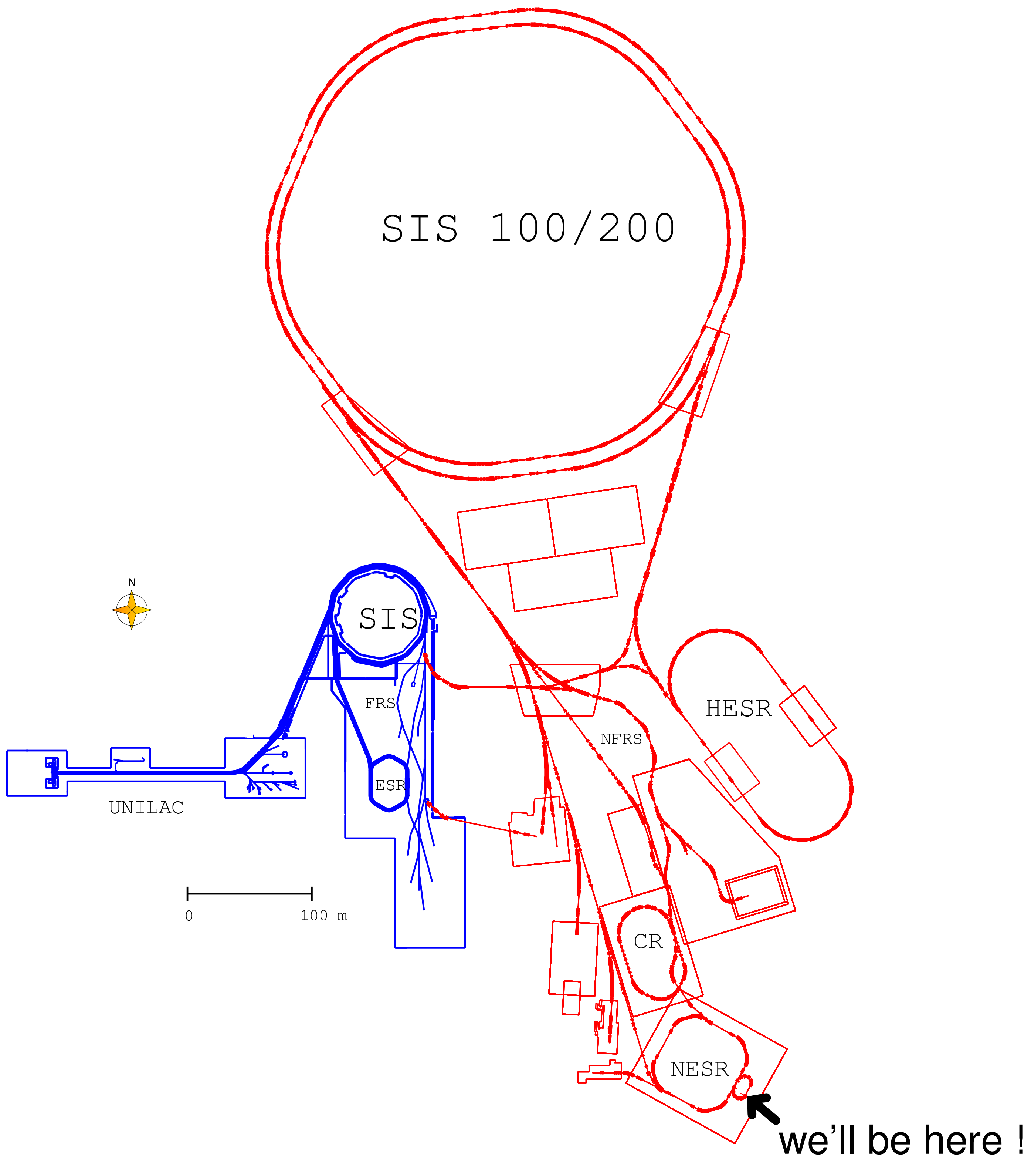
The new GSI facility



Electron Scattering

<u>Electron</u>

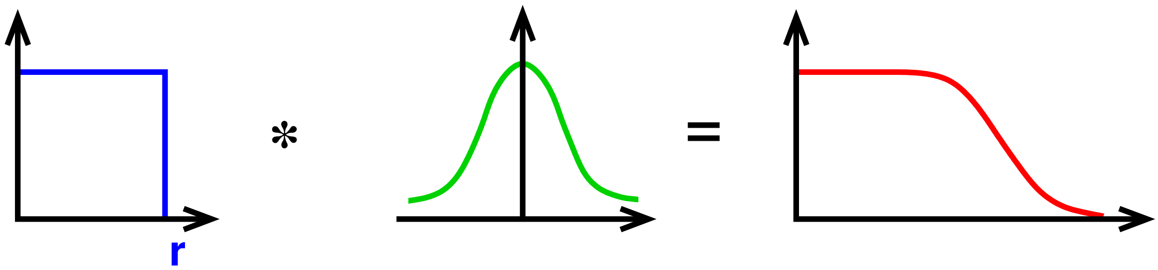
- point like particle
- pure electromagnetic probe
  $\rightarrow$ formfactors: F(q)
- F(q) transition formfactors
  $\rightarrow$ high selectivity of certain
  multipolarities
- single step excitation
  $\rightarrow$ one photon exchange

<u>e-A Collider</u>

- unstable nuclei
- large recoil velocities
  $\rightarrow$ identification (Z,A)
- forward/backward kinematic
  $\rightarrow$ 4π-geometry / reac. trigger
- small e-spectrometer
- bare ions
  $\rightarrow$ no Atomic-background

Elastic Scattering

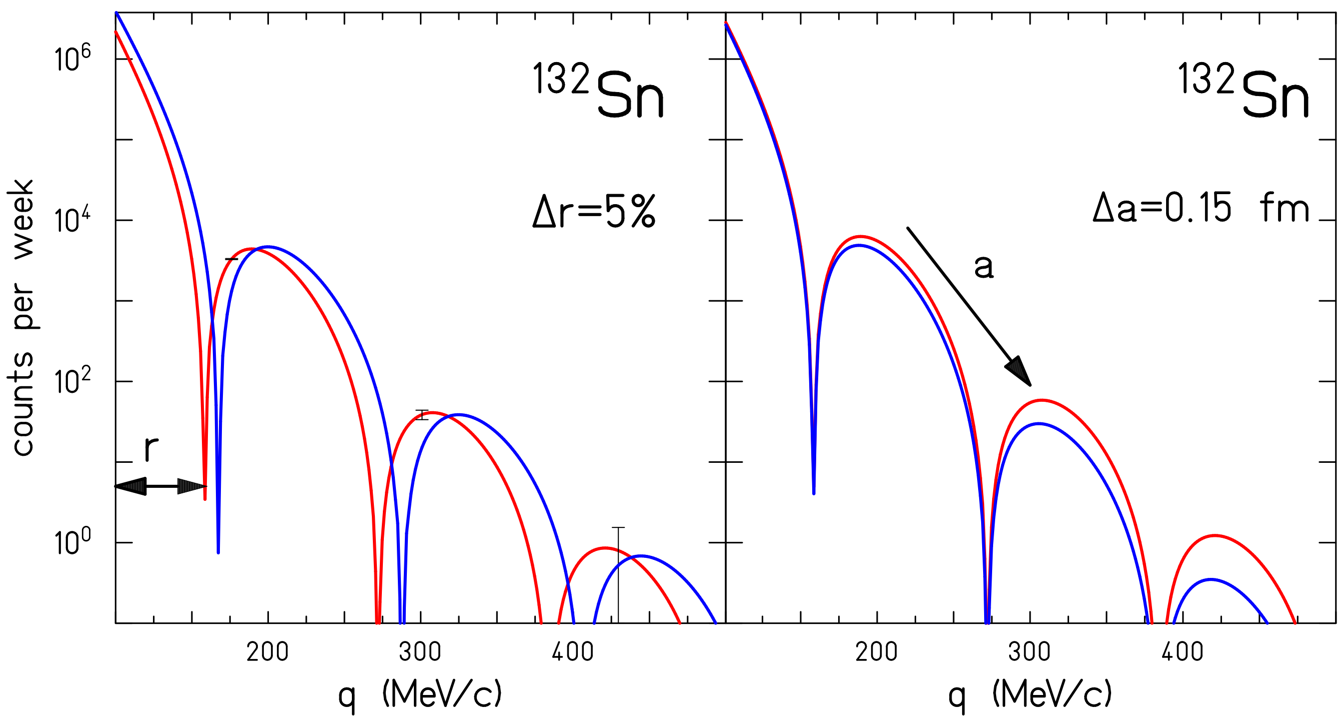
$$F(q) \Longrightarrow \rho(r)$$



$$\rho_1(r) \quad * \quad \rho_2(r) \quad \rightarrow \quad \rho(r)$$

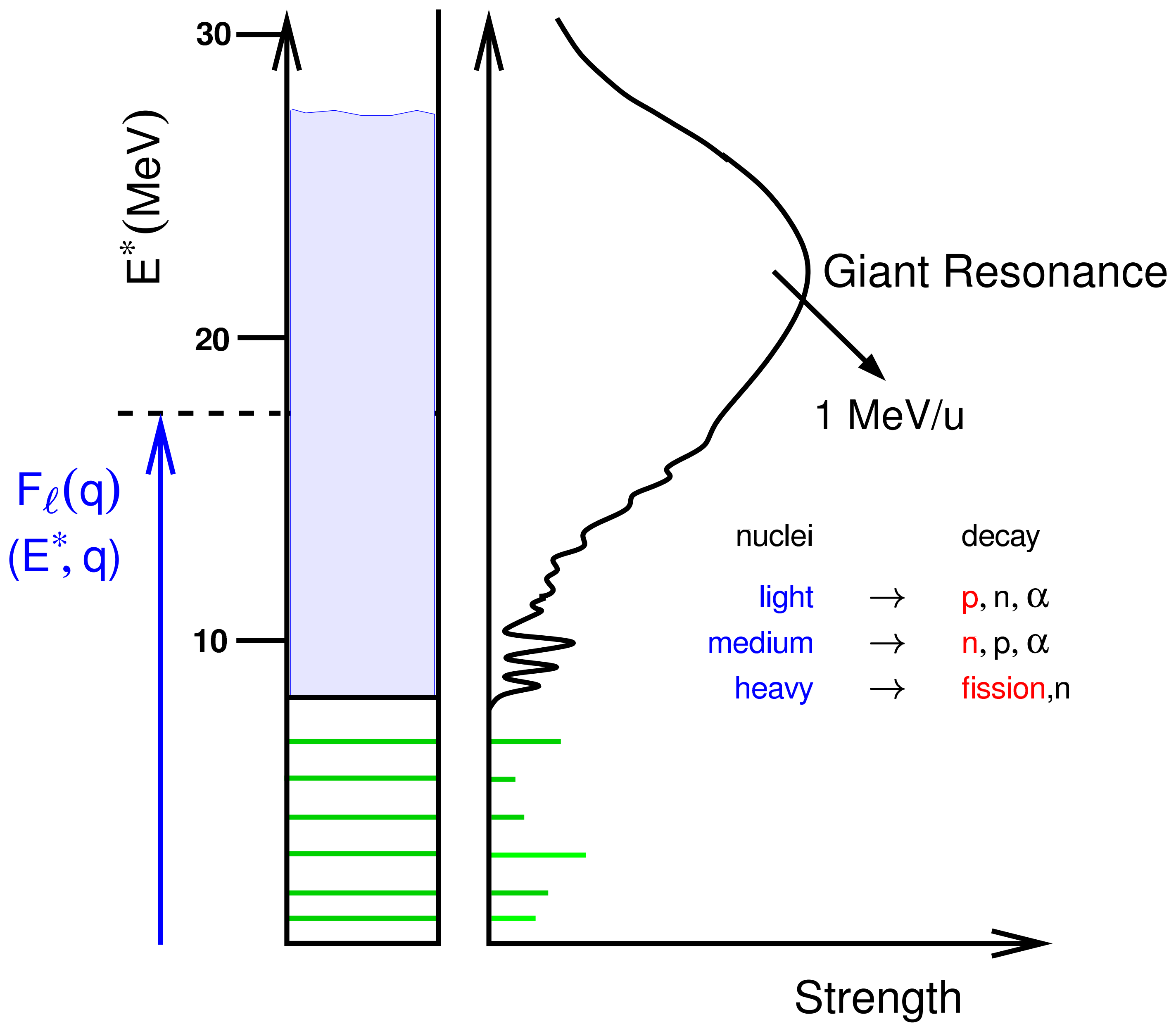
$$F_1(q) \quad \cdot \quad F_2(q) \quad \rightarrow \quad F(q)$$

$$F(q) = \frac{3}{(qr)^3}\left(\sin(qr) - qr\cos(qr)\right) \cdot \exp(-\sigma^2 q^2/4)$$



$$L > 10^{25} cm^{-2} s^{-1}$$

Inelastic Scattering



Collective Oscillations

Giant Monopol	Nuclear compressibility	EOS
Giant Dipol	Nuclear shapes	r-process

Neutrino induced Problems

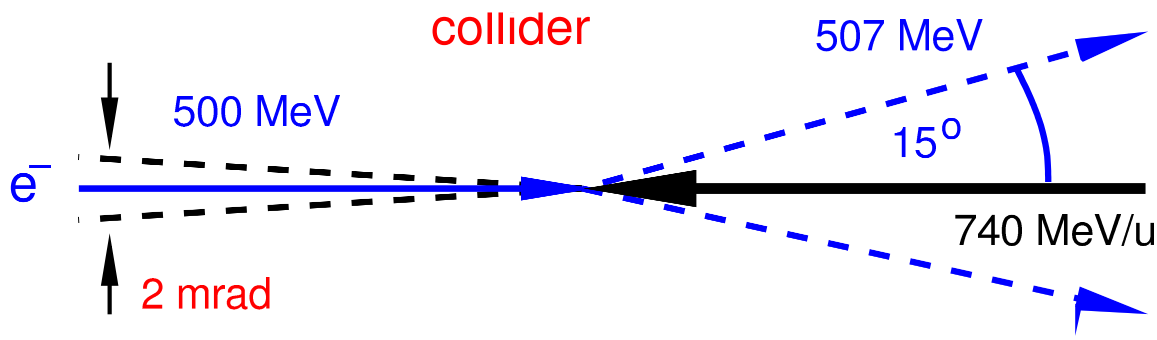
$A\,(\nu,\nu' n;p)\,X\,;\;A\,(\nu,e' n;p)\,Y$

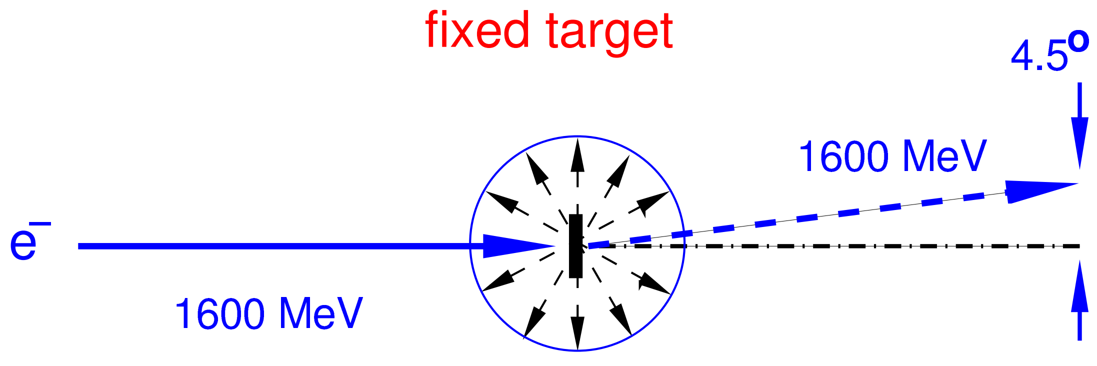
SU_4 ; branching ratios

Kinematics

$$q = 80\,\mathrm{MeV/c} - 180\,\mathrm{MeV/c}$$

$$\Theta_{lab} = 10^o \quad - 20^o$$

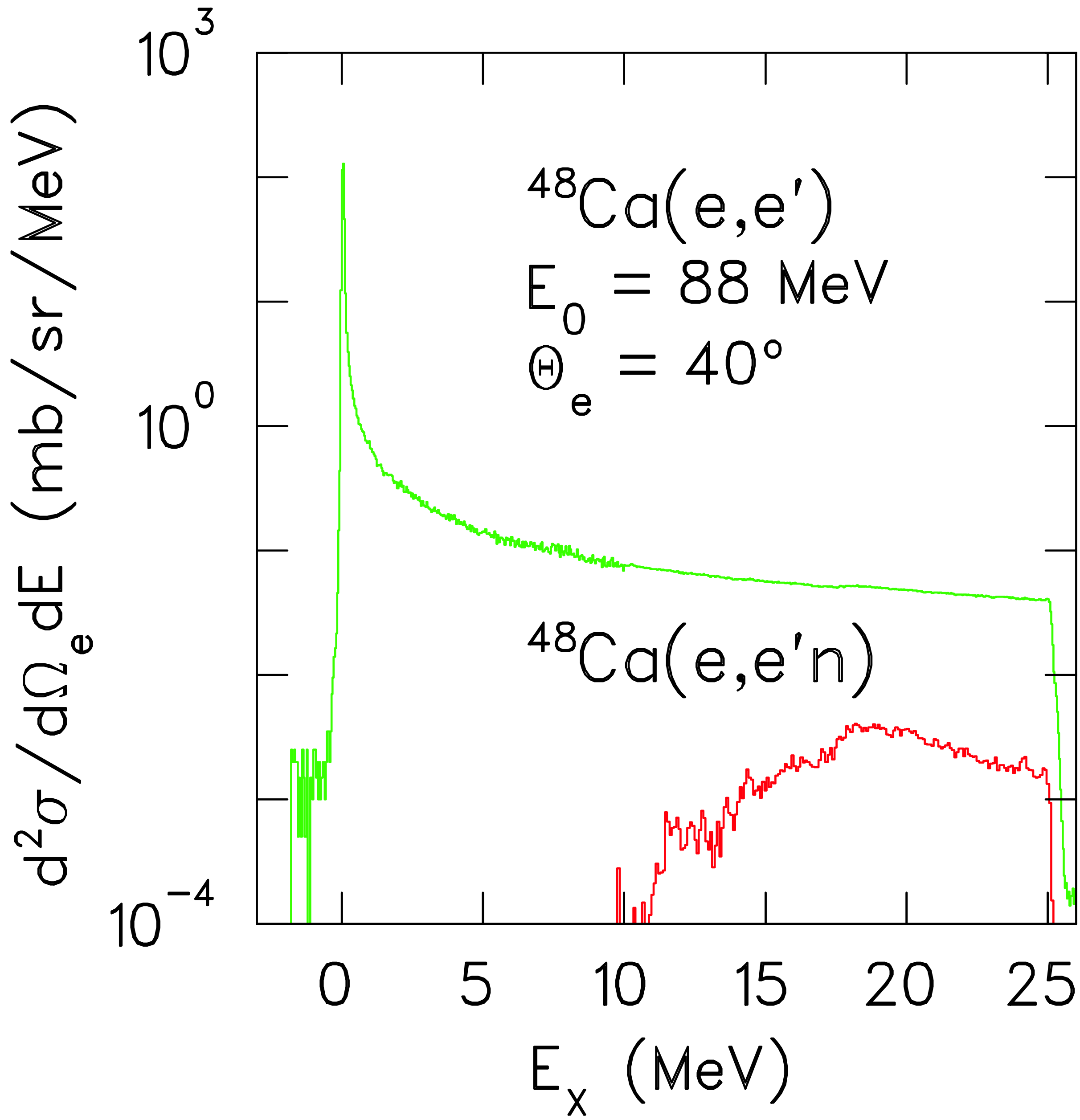




E_{ion}	Θ	E_e(fixed target)
740 MeV/u	$2.5^o - 6.5^o$	1600 MeV
100 MeV/u	$6.3^o - 12.4^o$	785 MeV

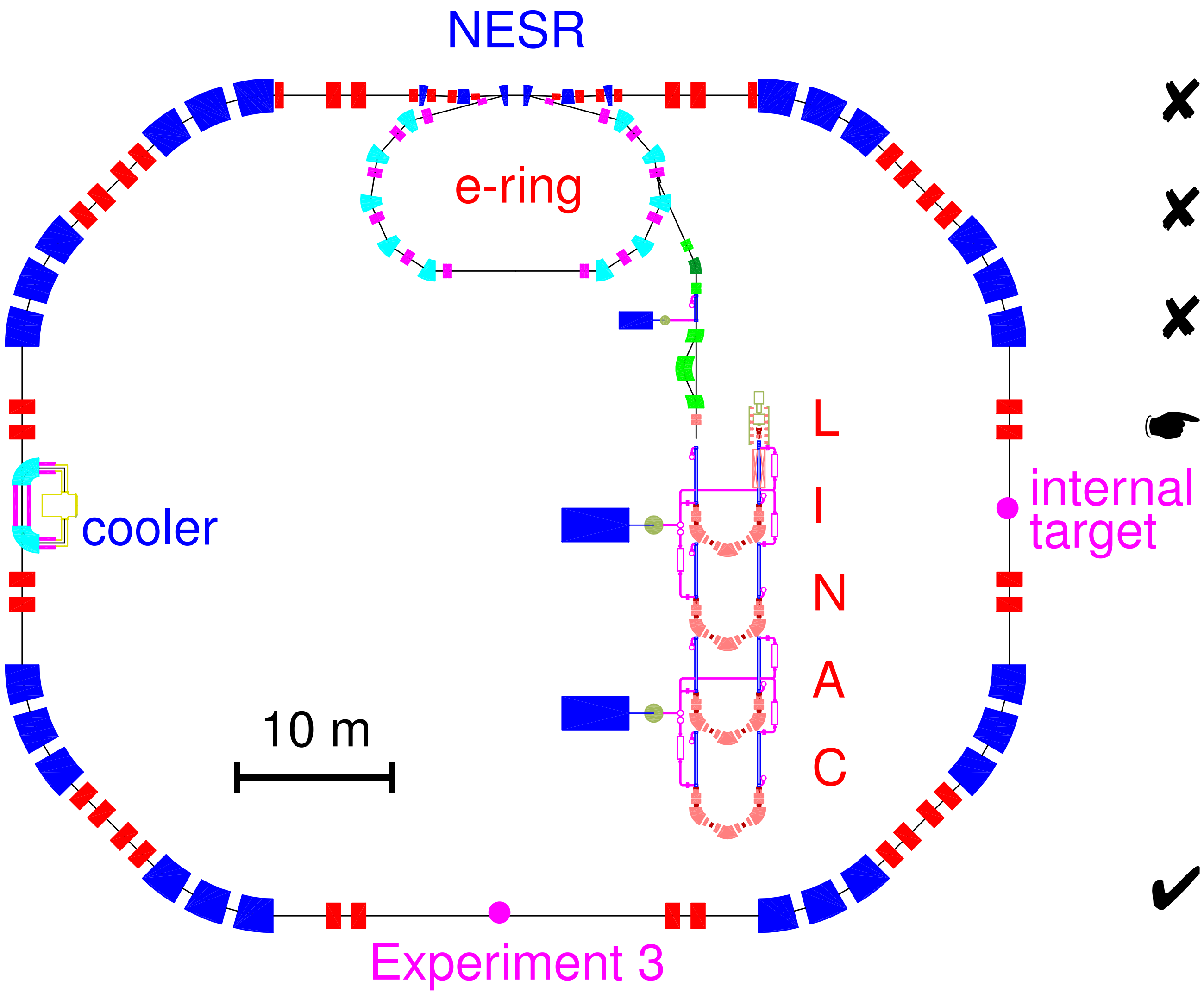
Tracking of all particles

Suppression of the Radiative Tail



S-DALINAC

eA-Collider (preliminary)



✘ $E_e = 125{,}250{,}375{,}500$ MeV

✘ $E_I = 200\text{-}740$ MeV/u

✘ $\mathcal{L} = f_e n_e \frac{N_e N_I}{4\pi\sigma_x\sigma_z}$

☛ $\sigma_{x,z} \approx 100\ \mu m$

$n_e = 5 - 8$, $f_e = 6.6$ Mhz

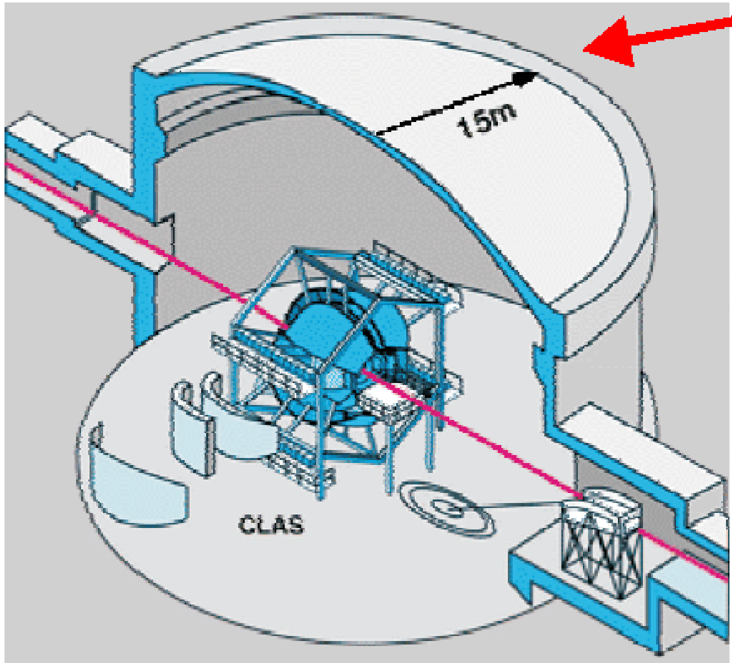
$N_e = 5 \cdot 10^{10}$

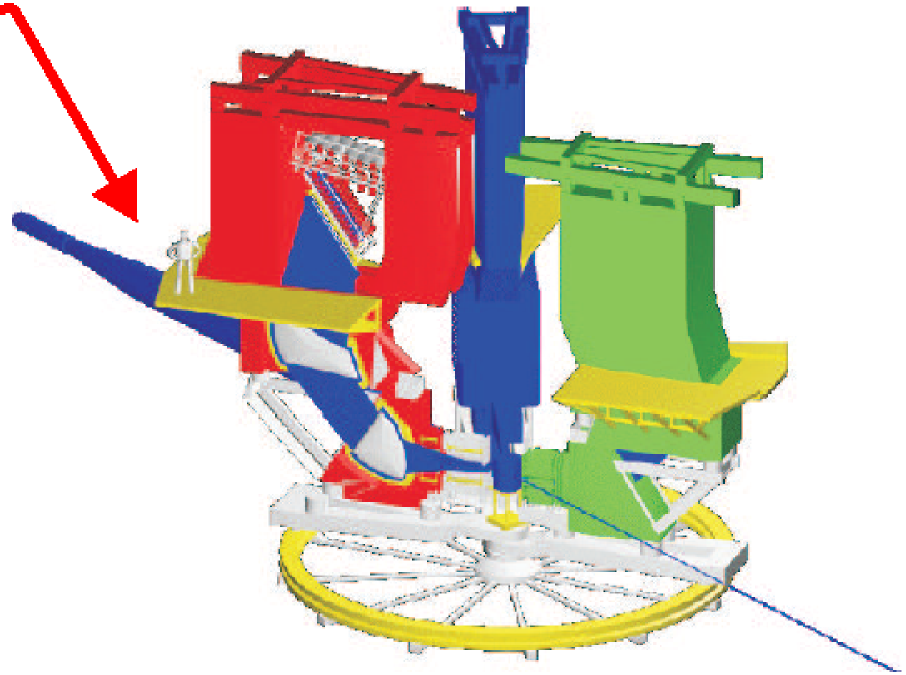
$N_I = 10^5 \ldots 10^{10}$

✔ $\mathcal{L} \approx 10^{26} - 10^{31}\ cm^{-2}s^{-1}$

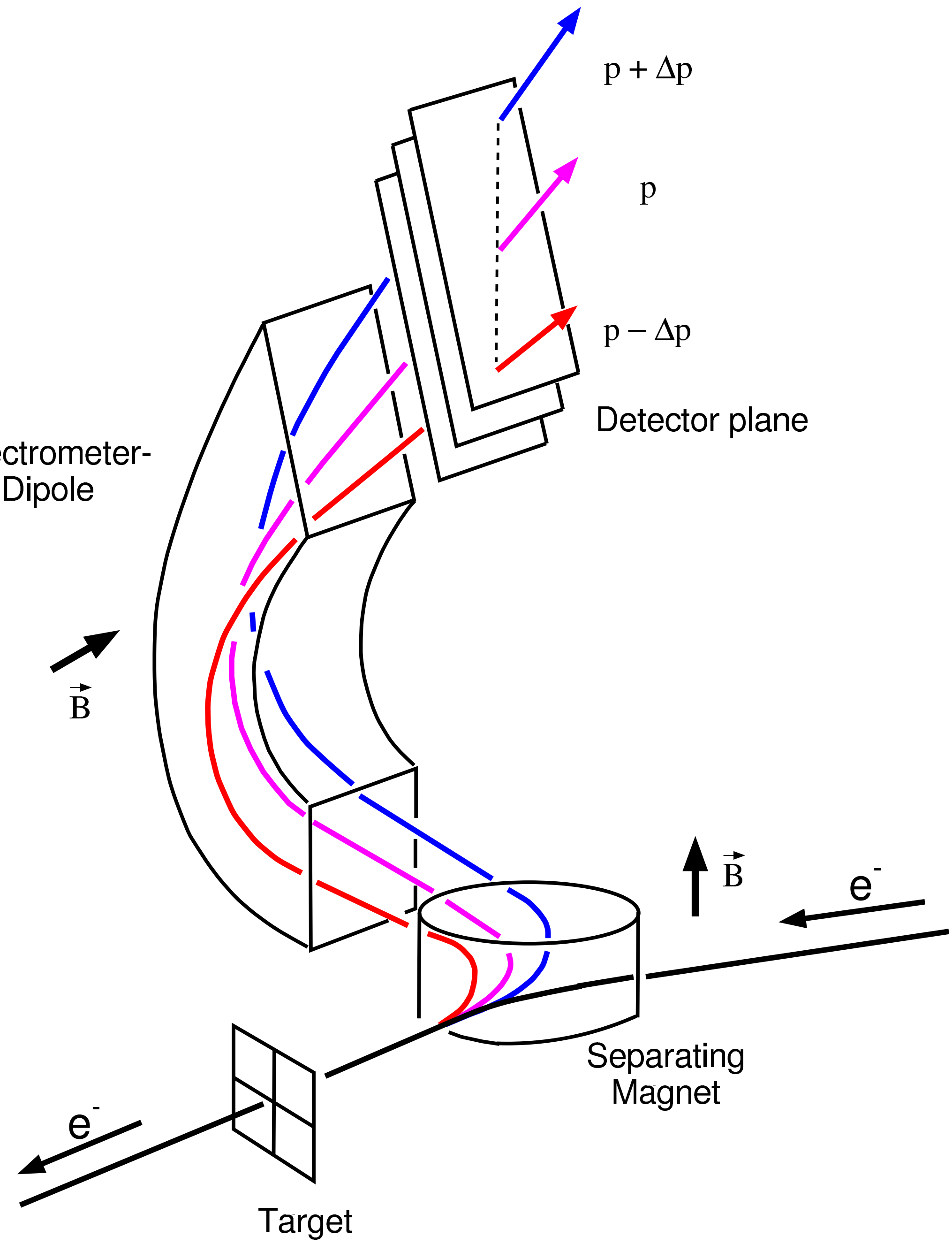
Typical Spectrometer Setups

	Large Acceptance	High Resolution
	8-142 degree	28 msr
	0.2-4 GeV/c	20 %
$\Delta p/p$:	0.5 %	0.01 %
	2 mrad	1 mrad





Spectrometer Integration (ii)

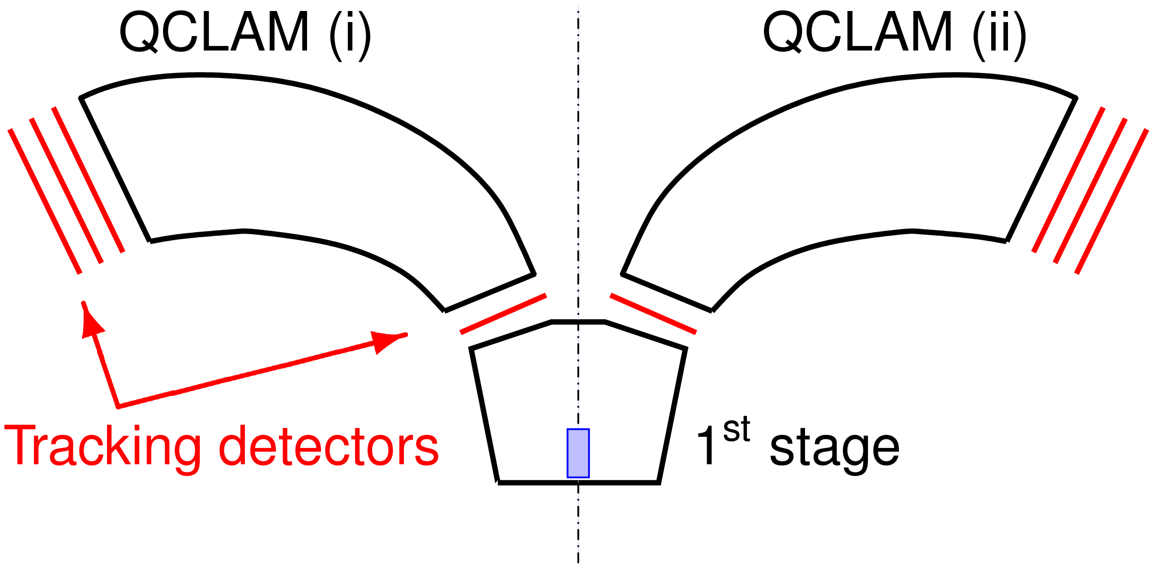


✏ Dispersive 1st stage
(QCLAM, TUD, 180° system)

✔ Principle works

✖ Beam deflection/ring operation

Possible Spectrometer Setup



NOT to scale !

QCLAM

point-to-point image
compact
large solid angle with good resolution

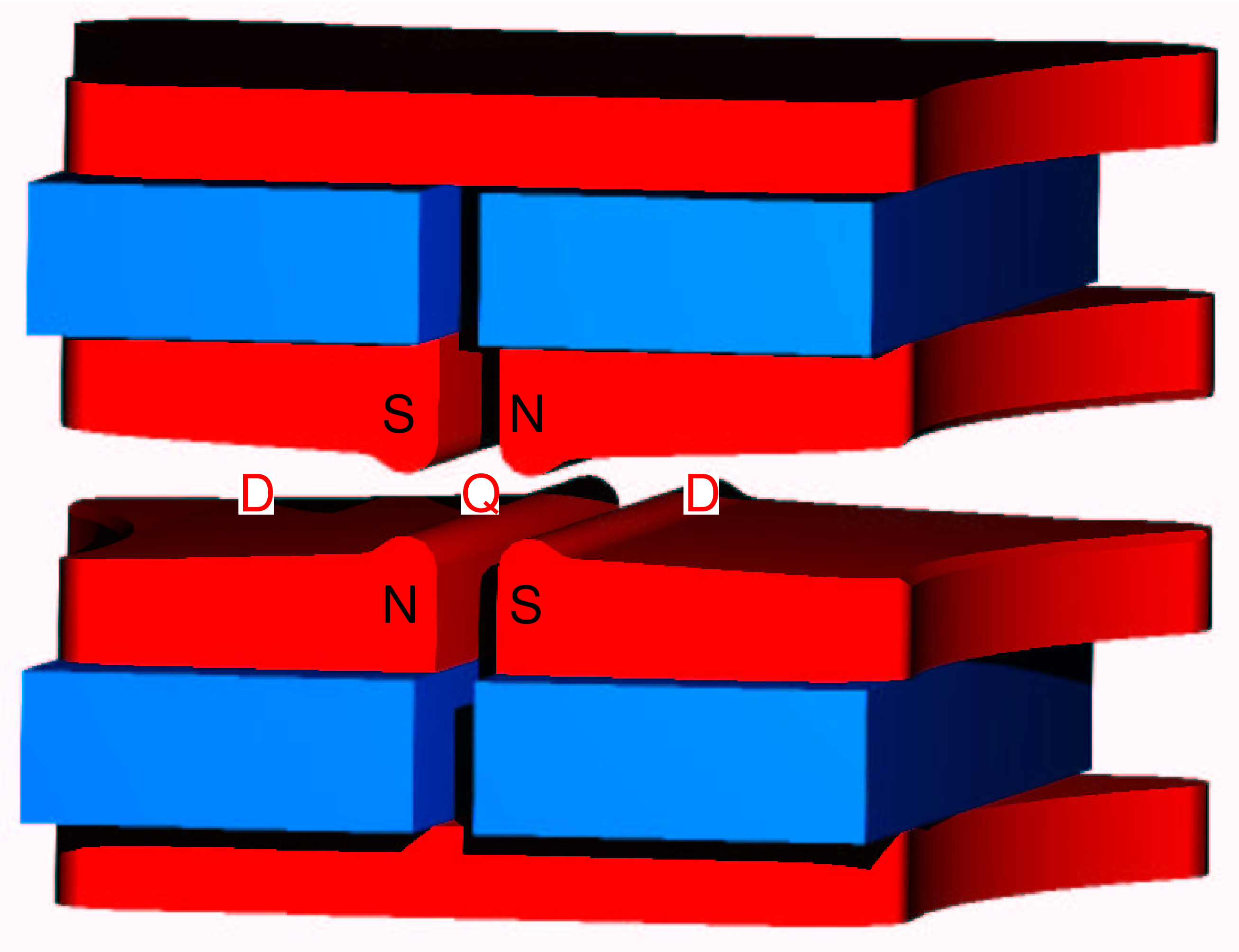
✘ Solid angle limitations
vertical: by the 1^{st} stage
horizontal: by the QCLAM spectrometer

→ lying spectrometer

→ tracking after 1^{st} stage needed

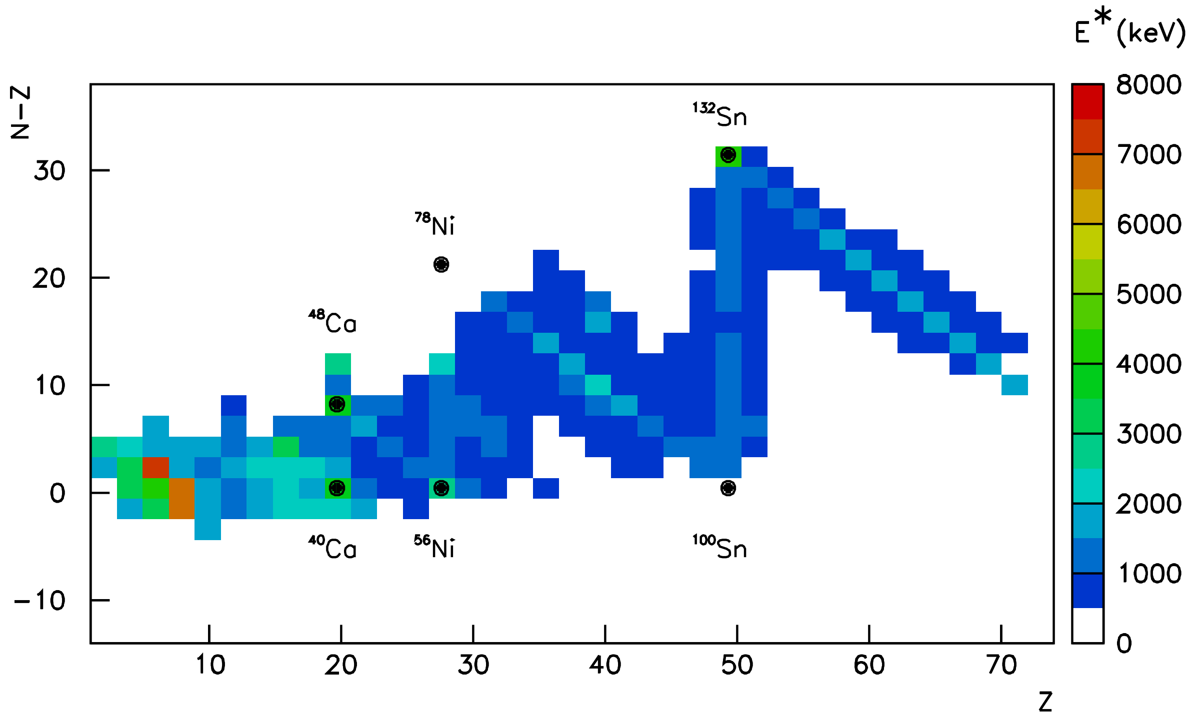
✘ achievable resolution ?

Spectrometer Magnet: Approaching 2π



- ✔ non scattered particles are focussed on axis
- ✔ scattering electrons (E',q) are bend away to the other stages of the spectrometer

Required Resolution



- ✎ Charge distribution ⇒ Separation of ground and excited states
- ☞ Resolution 0.5-1.0 MeV

MC Simulations

- MC Simulations for a spectrometer setup for the GSI e-RI collider based on presently available technologies

(i) Boundary conditions

(ii) Ring specific design customization

(iii) Achievable energy resolution

Kinematics (MC)

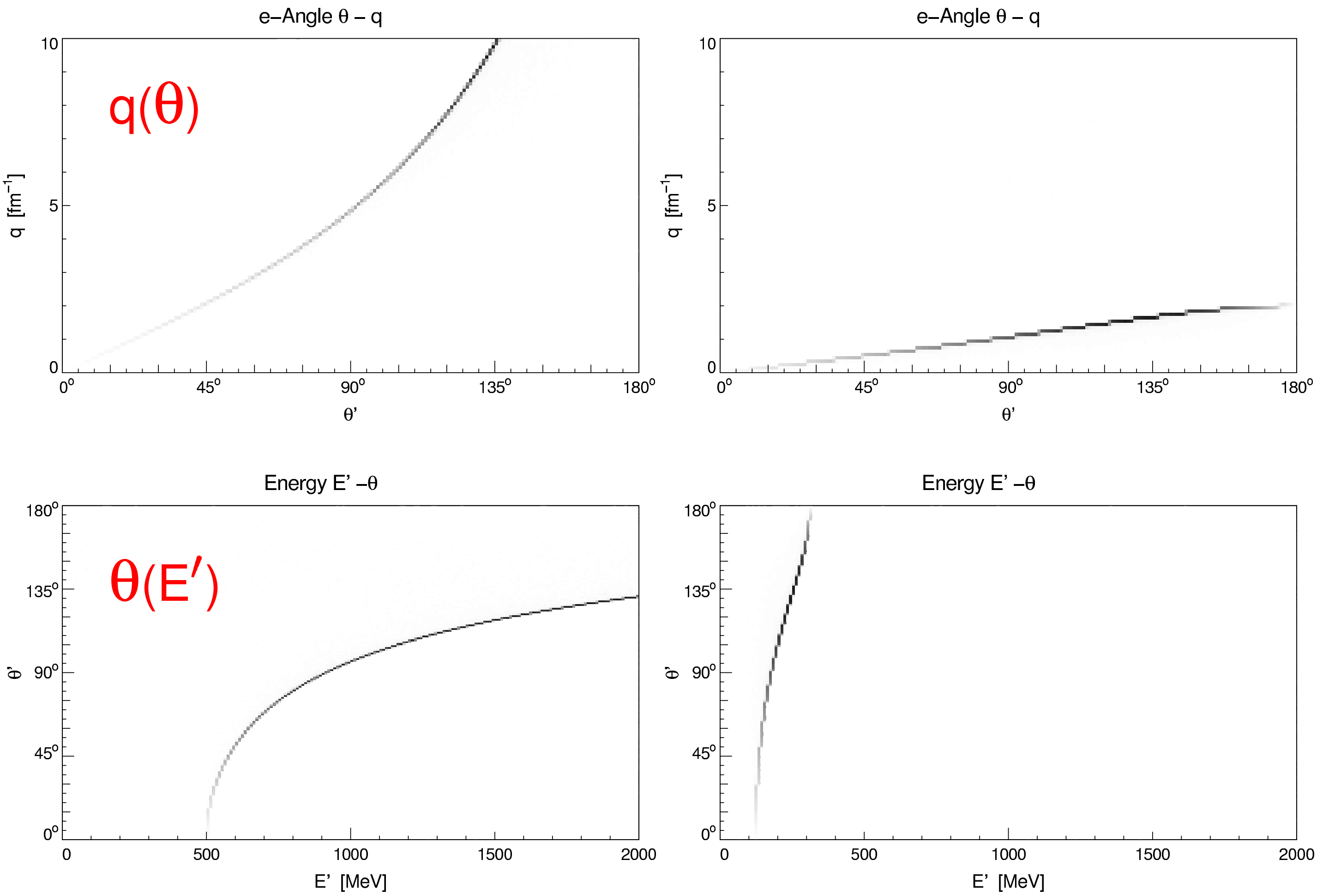
Monte Carlo Code: Cola++, Simul++

H. Merkel et al., Univ. of Mainz

Written in C++, Open Source

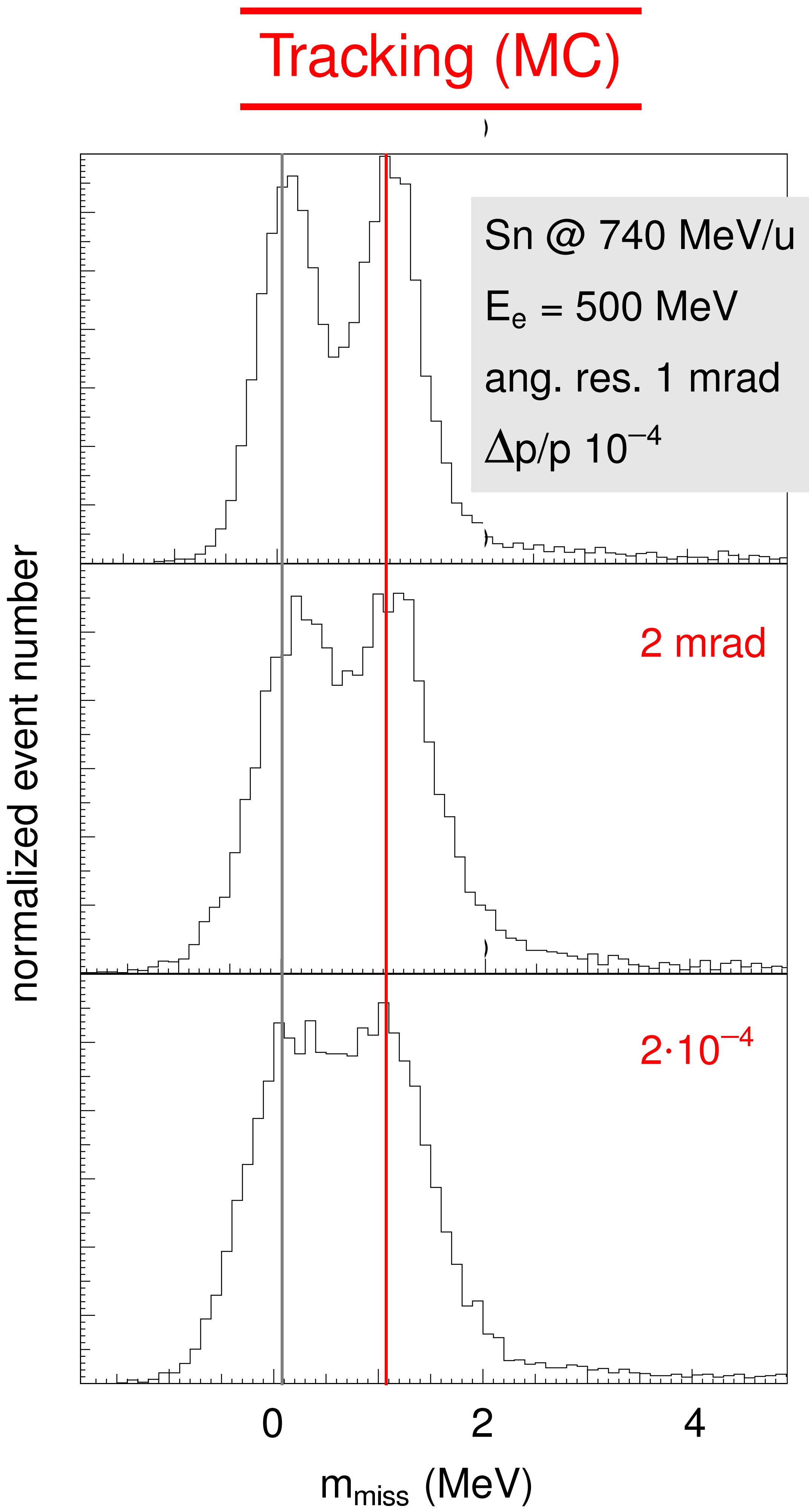
fixed target ➔ moving target

E_e=500MeV, E_I=740 MeV/u E_e=125MeV, E_I=100 MeV/u

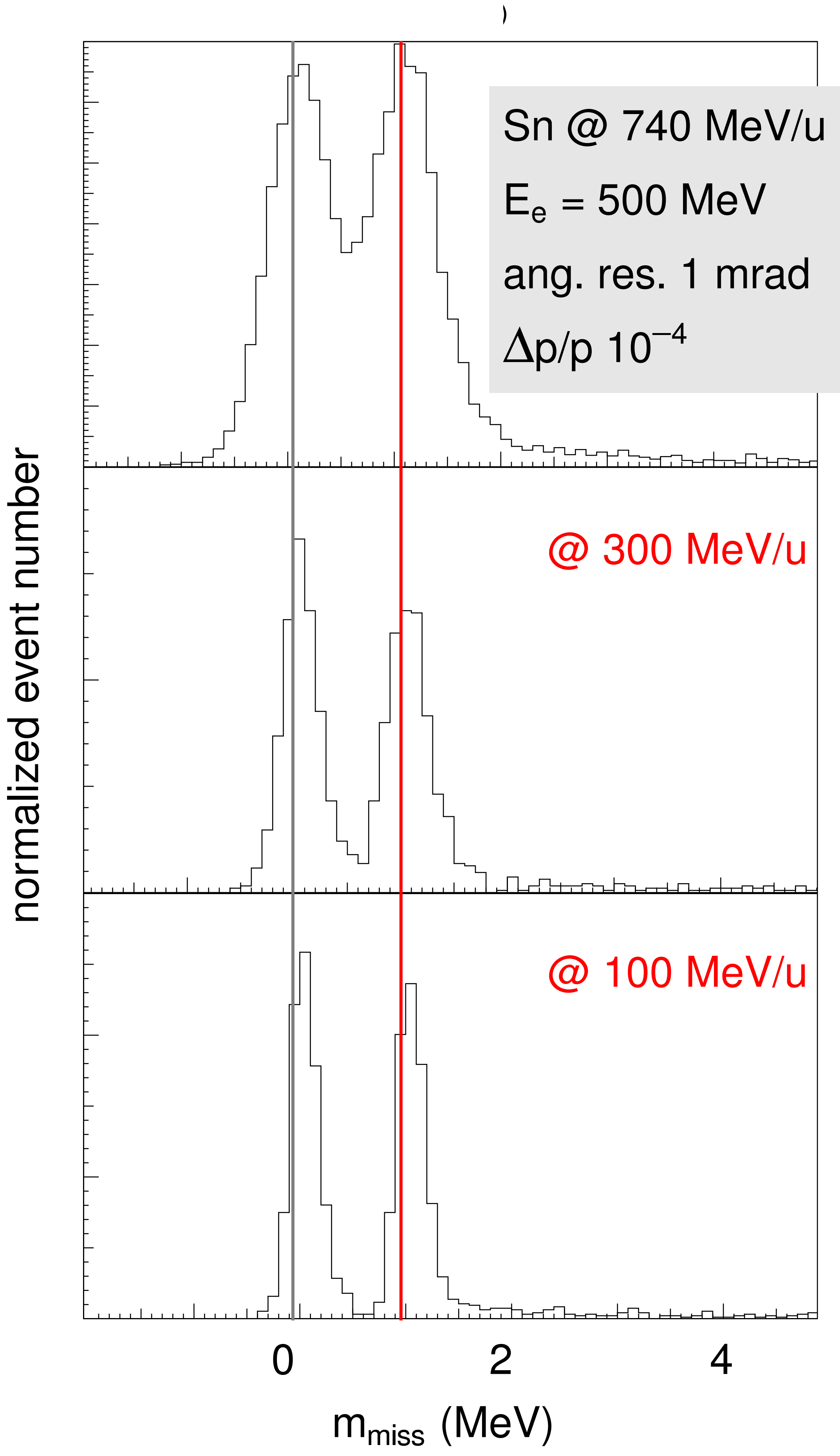


4 π acceptance ➔ angular range to be covered

spectrometer settings, resolution to be expected . . .


Tracking (MC)
Sn @ 740 MeV/u
E_e = 500 MeV
ang. res. 1 mrad
$\Delta p/p$ 10^{-4}
2 mrad
$2 \cdot 10^{-4}$
normalized event number
0
2
4
m_{miss} (MeV)

Energy resolution (MC)



Tracking Detector

- A tracking detector would be favourable between in beam magnet-system and spectrometer.

✘ Is the required resolution still achieved ?

$$\Delta E_{\mathrm{min.ion.}} = 1 \ldots 3\ \mathrm{MeV/(g/cm^2)}$$

$$\rightarrow \approx 70 \text{ primary ionizations/cm}$$

$$\theta_0 = \frac{13.6\mathrm{MeV}}{E_e}\sqrt{\frac{x}{X_0}}\left(1 + 0.038\log\left(\frac{x}{X_0}\right)\right)$$

(i) Ar:Ethane(50:50) $X_0 = 166$ m

(1 cm gas, $2 \times 50\mu$ Kapton)

$\rightarrow \theta_0 \approx 0.25$ mrad @ E_e=500 MeV

(ii) He:Propane(60:40) $X_0 > 330$ m

(1 cm gas, $2 \times 50\mu$ Kapton, 20μ Al)

$\rightarrow \theta_0 \approx 0.52$ mrad @ E_e=500 MeV

✔ Seems feasible, rates moderate

✘ Energy straggeling ?

Yield Requirements