A Recoil Separator at Notre Dame for radiative capture studies

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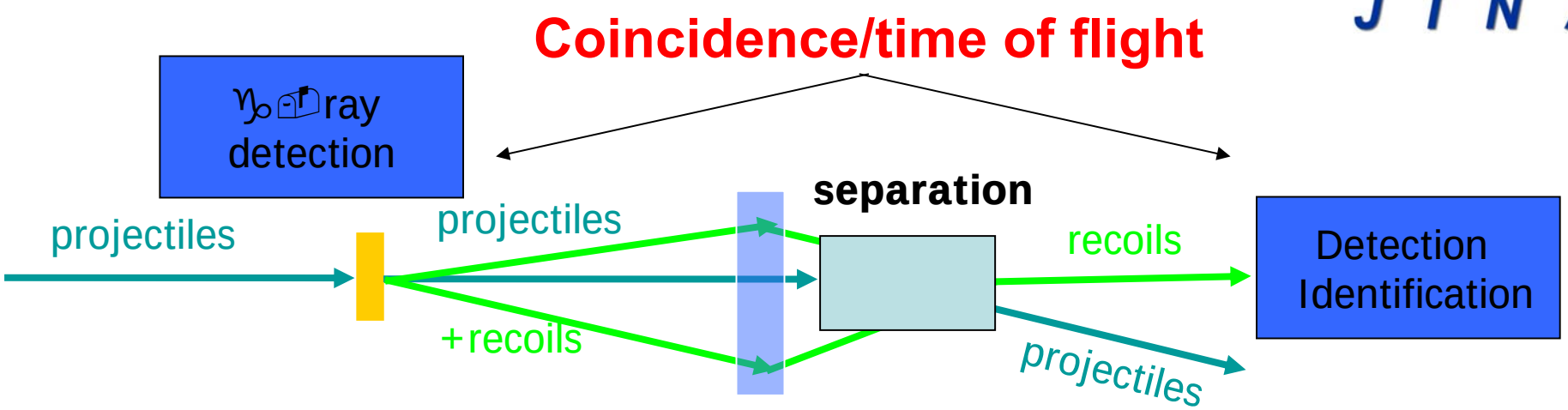
Direct radiative capture measurements

- Suffer from:
  - Very low cross section →Need high efficiency
  - Beam induced and room background
    → Need clear signature
- Direct kinematics
  - Signature is the γ's
  - Efficiency depend on the detectors (small compared to charge particles detectors)

→Inverse kinematics

Recoil separators: basic principles



$$\theta_{\max} = \arctan\left(\frac{E_\gamma / c}{\sqrt{2 m_b E_b}}\right)$$

$$p_r = p^* \pm p_\gamma$$

Velocity/energy selection

Rejection required for 100 μA > 10^{12} assuming 1k in the detector.

Drawings from D. Schürmann

The Notre Dame recoil separator: Design parameters

Stable beam from the KN (4MV) Van de Graaff accelerator

Beam intensity up to 100 μA

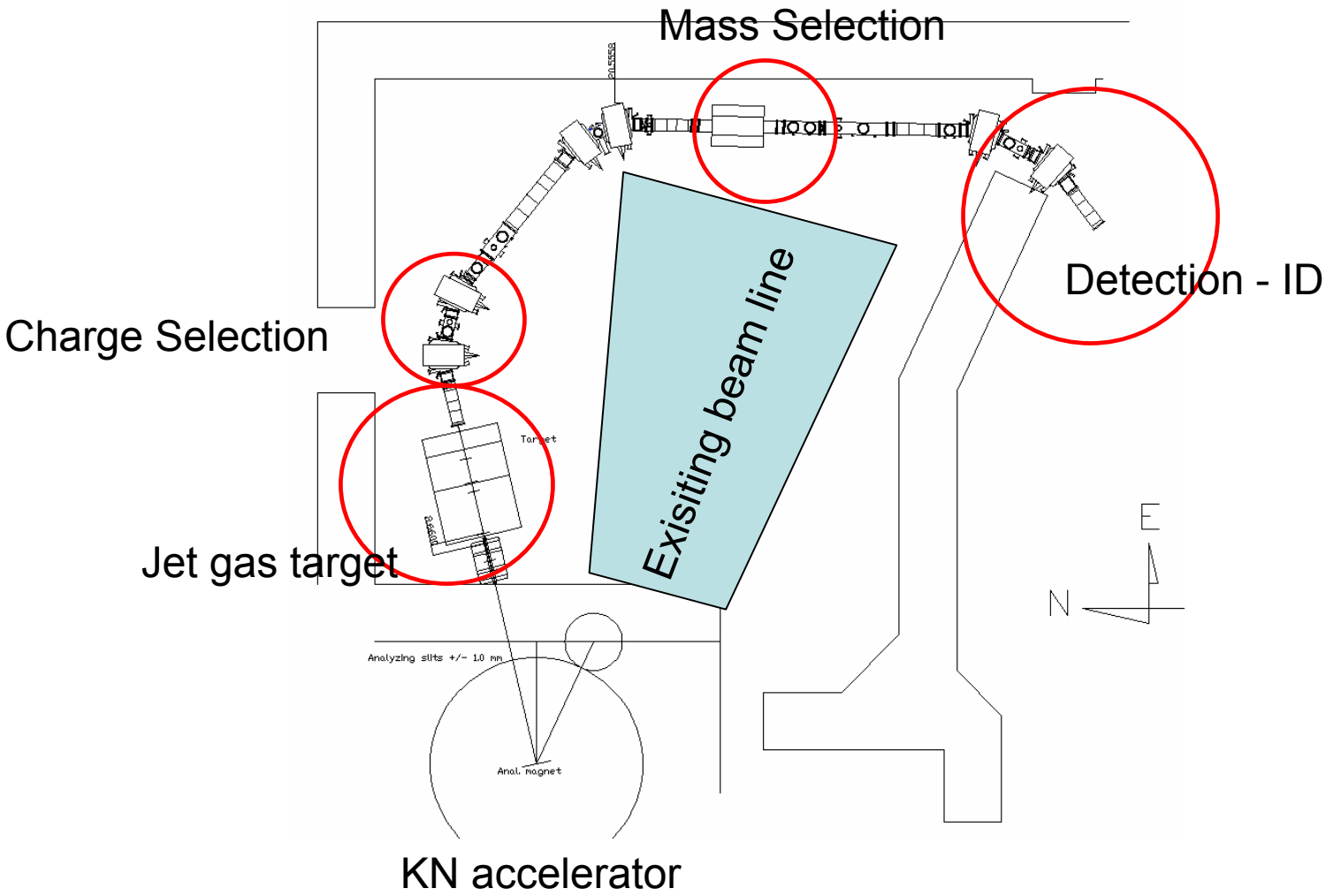
Beam mass up to ~40

Acceptance

Reaction	E_{beam}(MeV)	$\Delta E/E$ (%)	$\Delta\theta$ (mrad)
$^{18}O(\alpha,\gamma)^{22}Ne$	2. MeV	7.4%	40 mrad
$^{22}Ne(\alpha,\gamma)^{26}Mg$	3. MeV	6.5 %	32 mrad
$^{36}Ar(\alpha,\gamma)^{40}Ca$	2.7 MeV	3.5 %	17 mrad

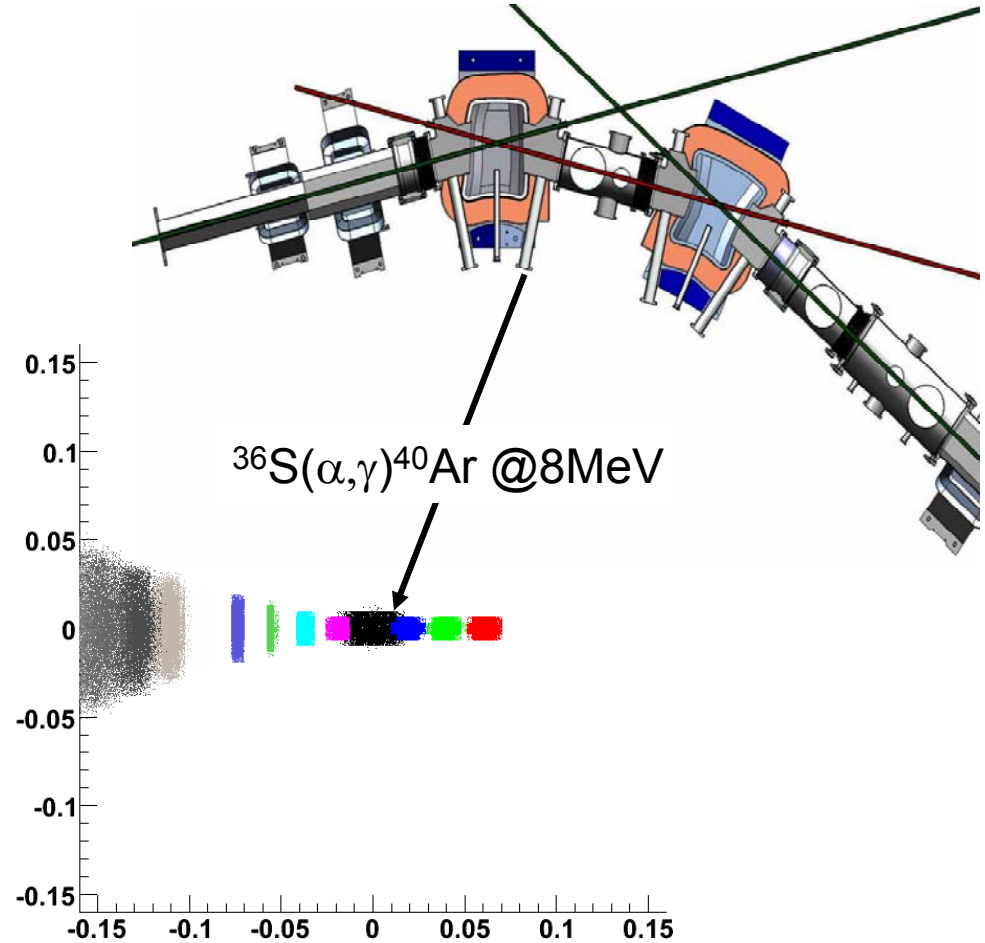
Minimum counting rate 1 per hour

St. George


Mass Selection
Detection - ID
Charge Selection
Jet gas target
Exisiting beam line
Target
Analyzing slits +/- 1.0 mm
Anal. magnet
E
N
KN accelerator

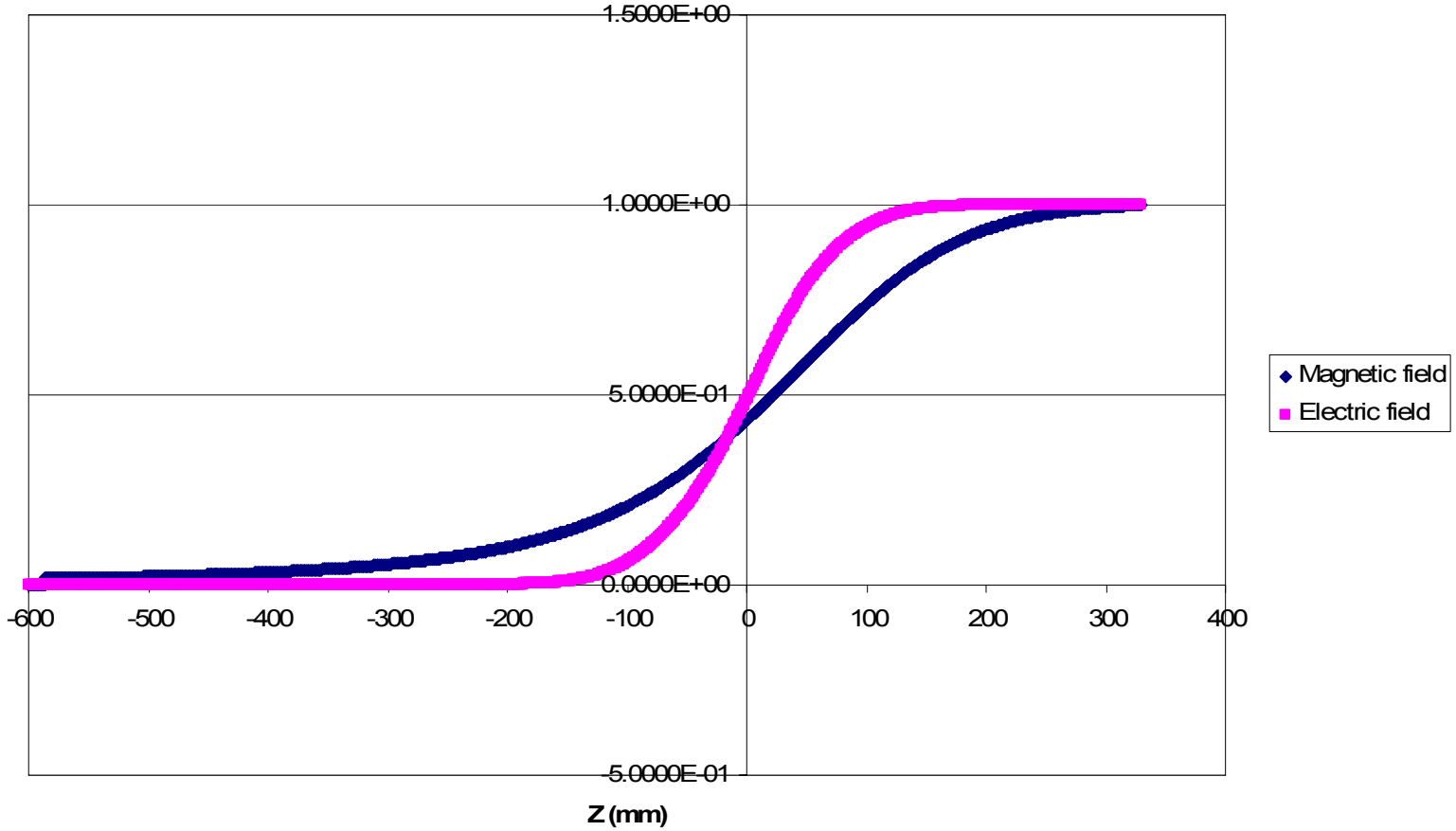
Charge selection

- Multiple charge state after gas target
  - Mass selection device are charge state dependant
  - Selection of the most abundant one (~40%)
  - Clean rejection of the other beam charge state
  - $\Delta Q/Q_0$ can be large → Selection in two step



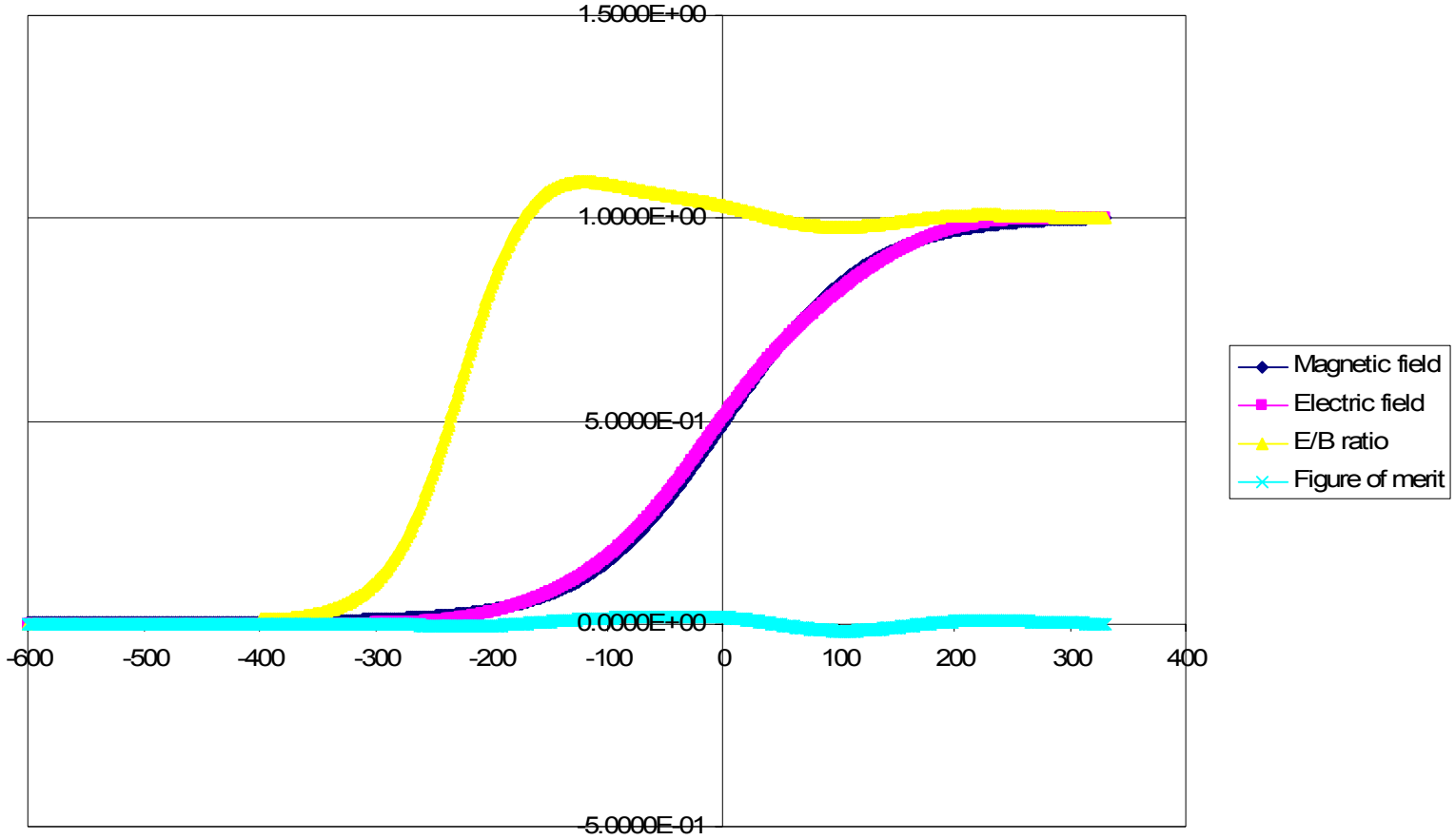
Mass separation: Wien filter fringe fields - longitudinal

Typical Wien filter fringe field

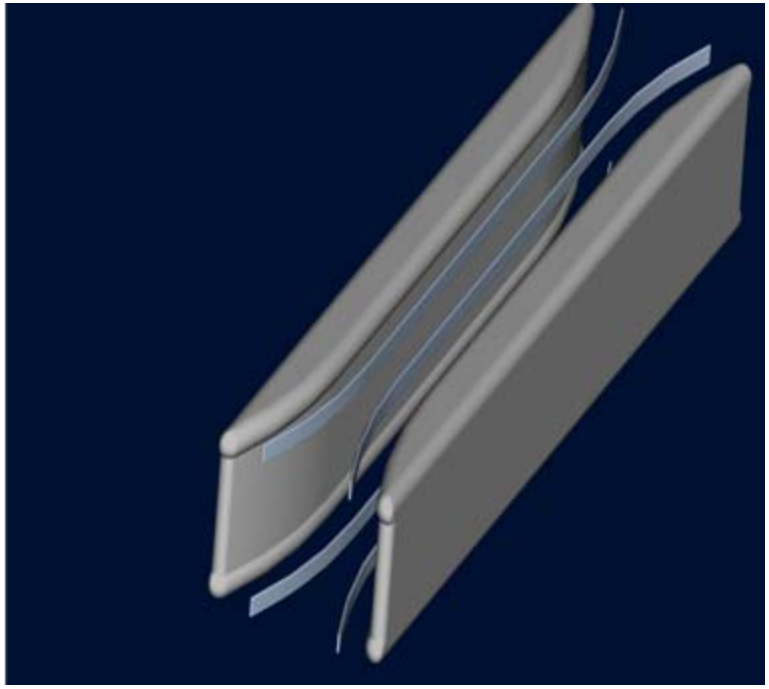


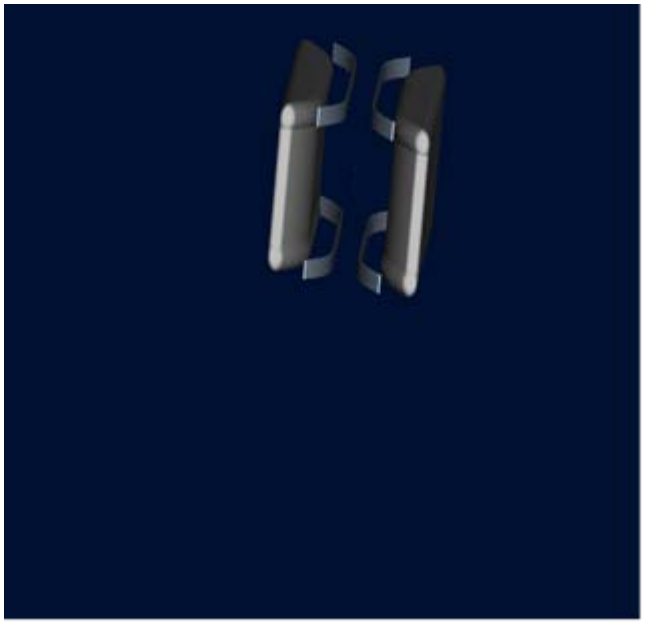
Mass separation: Wien filter fringe fields - longitudinal

Modified Wien filter fringe field



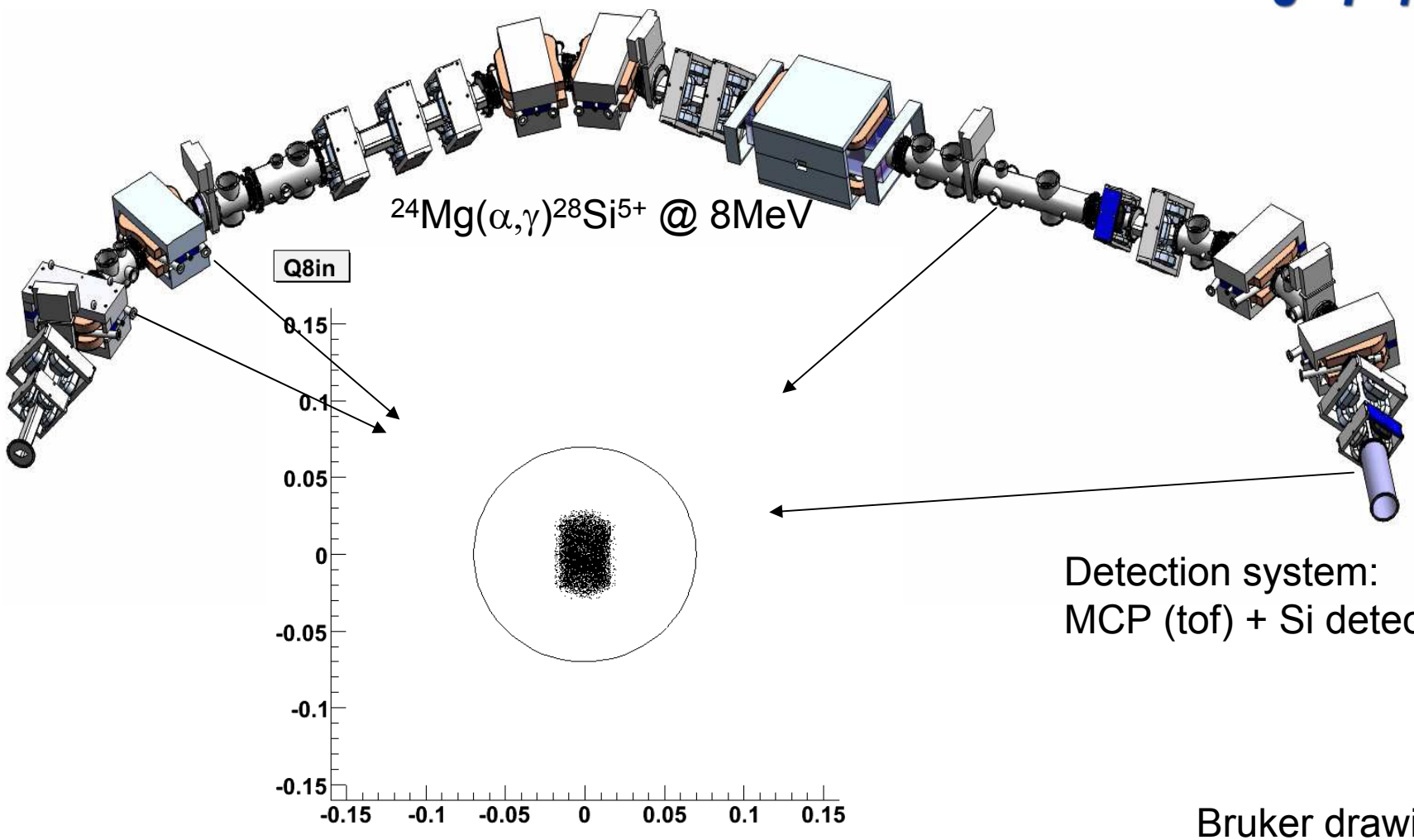
Wien filter





3D calculation to validate 2D result and decide on the end shape
Simion + Geant4

St. George

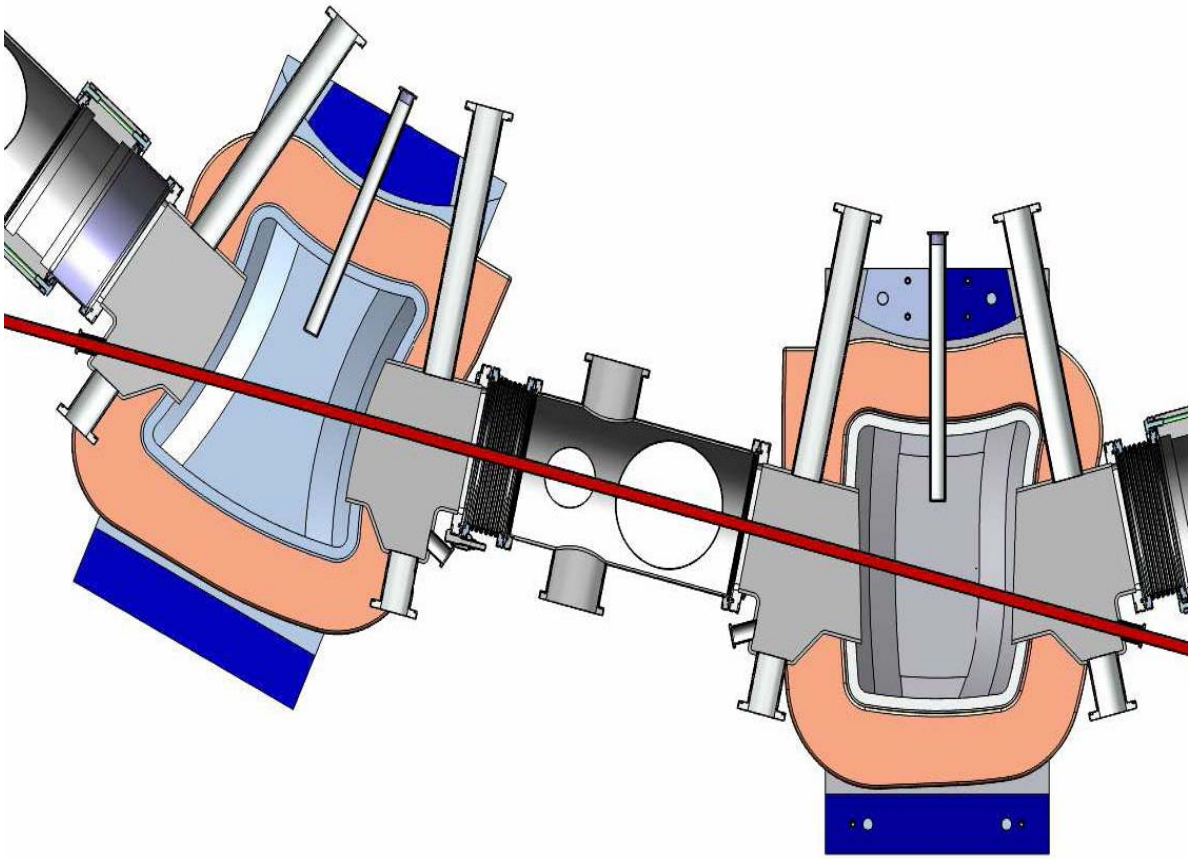


Detection system:
MCP (tof) + Si detector

Bruker drawing

Aberrations correction

Calculation up to 4th order
Corrections up to 3rd order embedded in the magnetic dipoles pole faces.



Status and perspective

- Elements orde
  - First shipment
- Scattering/bac
  - Slits position c
- Detector and g
- Charge state d rget study
- Commissioning 2008

Collaborators

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Source of background