Precision measurements on charge-changing cross sections and total fission cross sections

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1. Motivation
•Collecting of exp. data for the development of ADS and Nuclear Waste Incineration Projects
-Total fission cross sections in proton-induced reactions with Pb at various energies
-Total reaction-cross sections and charge changing cross sections in proton-induced fragmentation of Fe at various energies

•Questions related to the analysis of experiments performed at the FRS

2. The experiments
•Setup for measurement of charge-changing cross sections in fragmentation reactions
•Setup for measurement of total fission cross sections

3. Beamtime and technical requirements

- Questions related to the production cross sections measurements performed at the FRS

$$B\rho = \frac{A.m_0 c^2.\beta}{Ze.c\sqrt{1-\beta^2}}$$
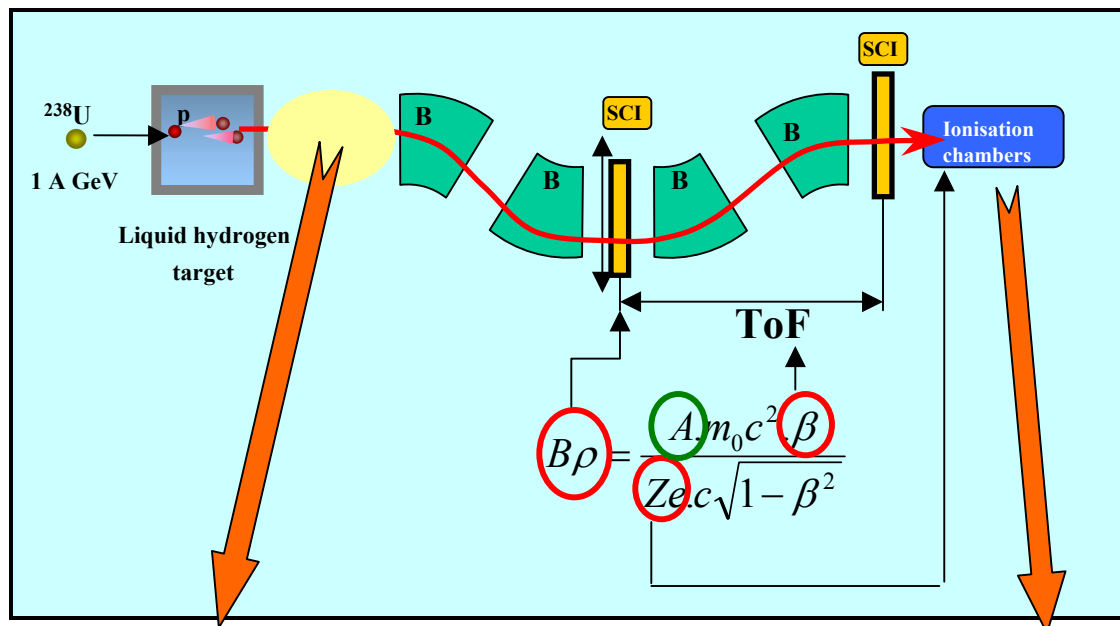
We need:

-comparison to independently evaluated cross section data

-verifying of the calculated angular transmission values and data normalization procedures

- measurement of total reaction- and charge-changing cross sections independend from the multiplicity of the outgoing residues
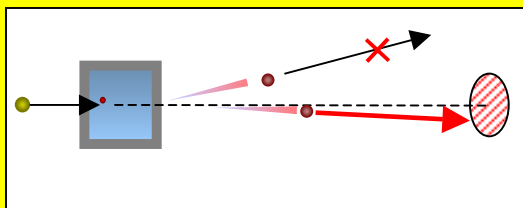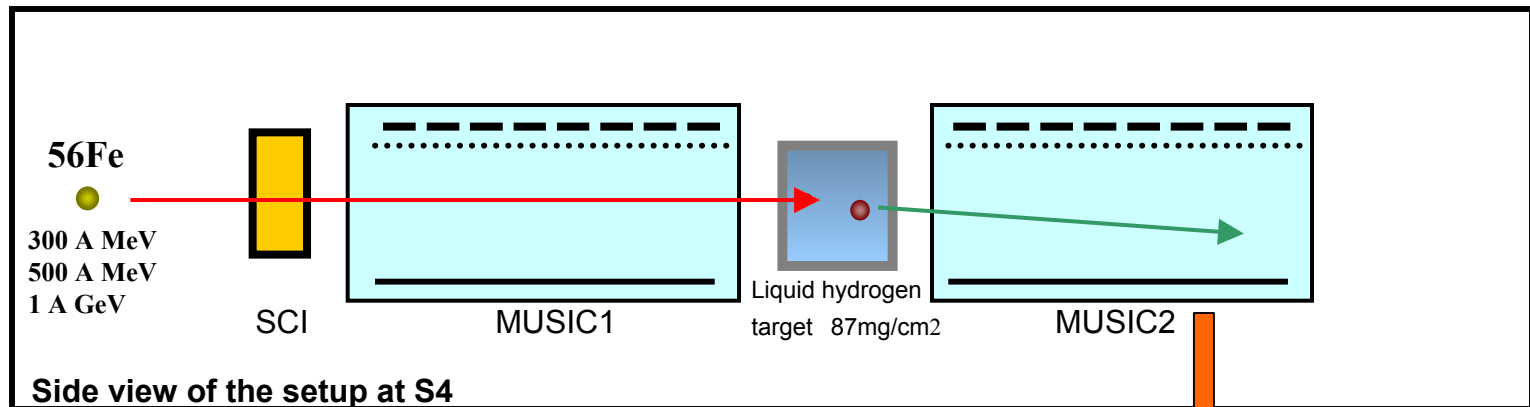
- Yprod(N,Z) > Ymeas(N,Z)
- T(N,Z) = Ymeas(N,Z) /Yprod(N,Z) < 1
- T(N,Z) **is not an experimental observable**
- T(N,Z) **has to be calculated**
- **Accurate calculation of T(N,Z) is possible if the reaction kinematics is well known**

1H(Xproj,xpynzα)Y
1H(Xproj,xpynzα)Y1, Y2
?

- **Fragmentation reactions: M=1**
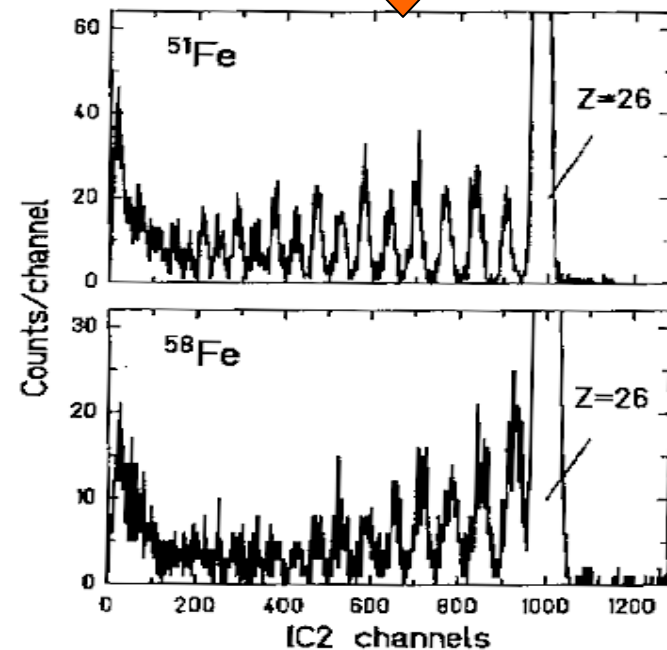- **Fission reactions: M=2**
- **Production of light residues : M>1**

2. The experiments

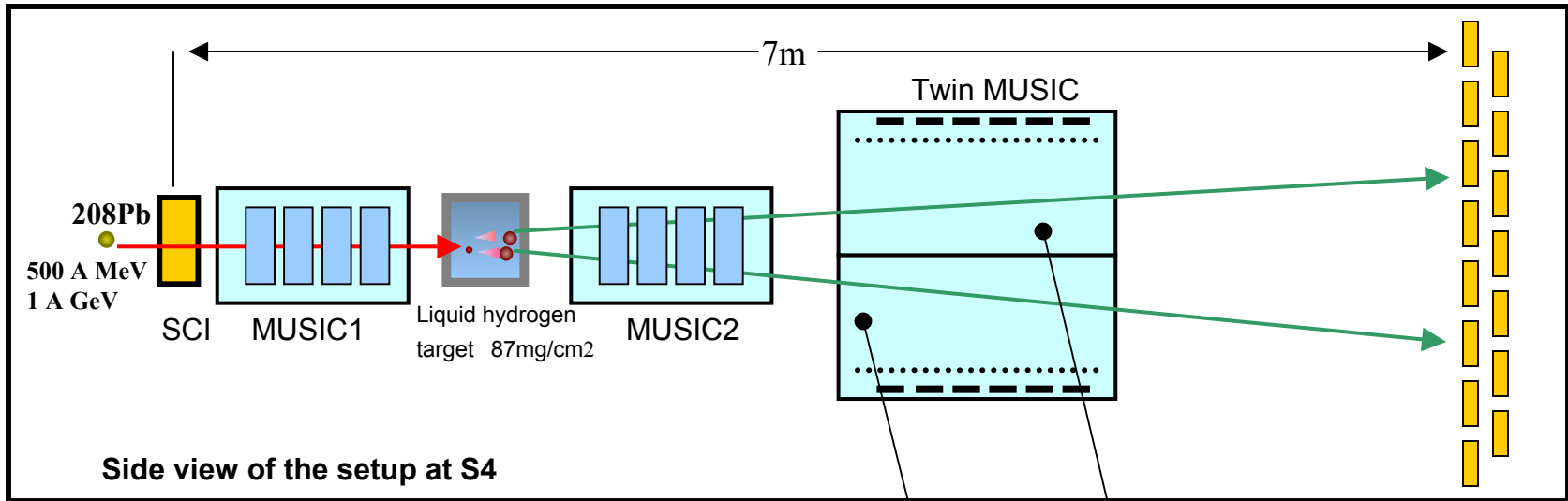•Measurement of charge-changing cross sections in proton-induced fragmentation reactions on 56Fe

Side view of the setup at S4

56Fe

300 A MeV
500 A MeV
1 A GeV

SCI   MUSIC1   Liquid hydrogen target 87mg/cm2   MUSIC2

Energy loss spectra of fragments produced in fragmentation reactions of 51Fe and 58Fe impinged on a (CH2)n target 1.
1 T. Brohm et al., Nucl. Phys. A 550 (1992)

•full acceptance of all reaction products
•the measurement has to be performed using the primary beam of 56Fe only
•the measured counting rates are independent from the ang. transmission
•results could be directly compared to previously measured cross section data

•Measurement of total fission cross sections for proton-induced fission of 208Pb

Side view of the setup at S4

7m

Twin MUSIC

208Pb

500 A MeV
1 A GeV

SCI   MUSIC1   Liquid hydrogen   MUSIC2
                     target   87mg/cm2

Scatter plot of energy loss spectra of fission
fragments produced in fission reactions of 238U
Impinging on a (CH2)n target 2.
2 Beatriz Jurado, PhD Theses, GSI 2002.

•full acceptance for the fission fragments (!)
•simultanious detection of both fission fragments
•data on energy dependence of the total fission cross-
sections could be measured with high accuracy
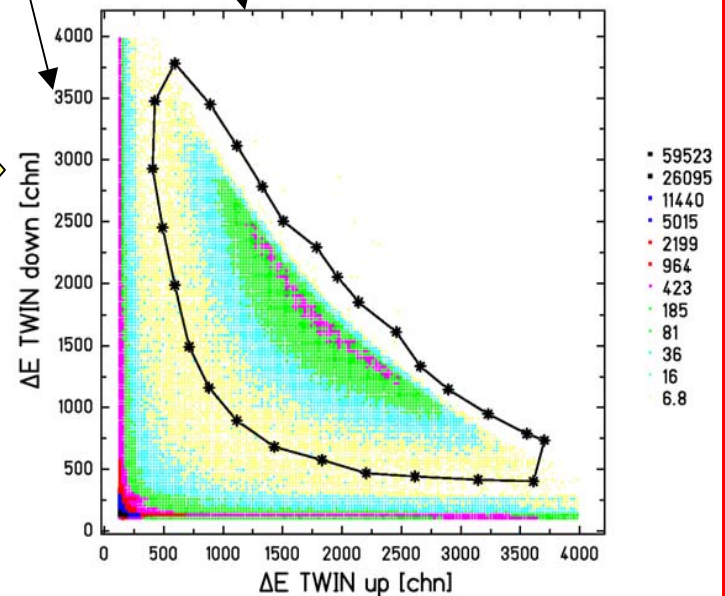
3.Beamtime and technical requirements

•need of rel. small amounts of beamtime:
- about 2 or 3 days of beamtime with ^{56}Fe beam depending on the energy range
- up to one week for total fission cross sections measurements on ^{208}Pb (partly in parasitic mode)

•Uncomplicated setup, which was already in use, specially designed to fit to the support existing at the S4-site