CPOTS – 3rd ERASMUS Intensive Program

Introduction to Charged Particle Optics: Theory and Simulation

http://cpots2013.physics.uoc.gr

Dept. of Physics, University of Crete

Aug 15 – 30, 2013

Heraklion, Crete, GREECE

Education and Culture DG

Lifelong Learning Programme

ΙΚΥ

TOF-Fragment Separators

SIMION project

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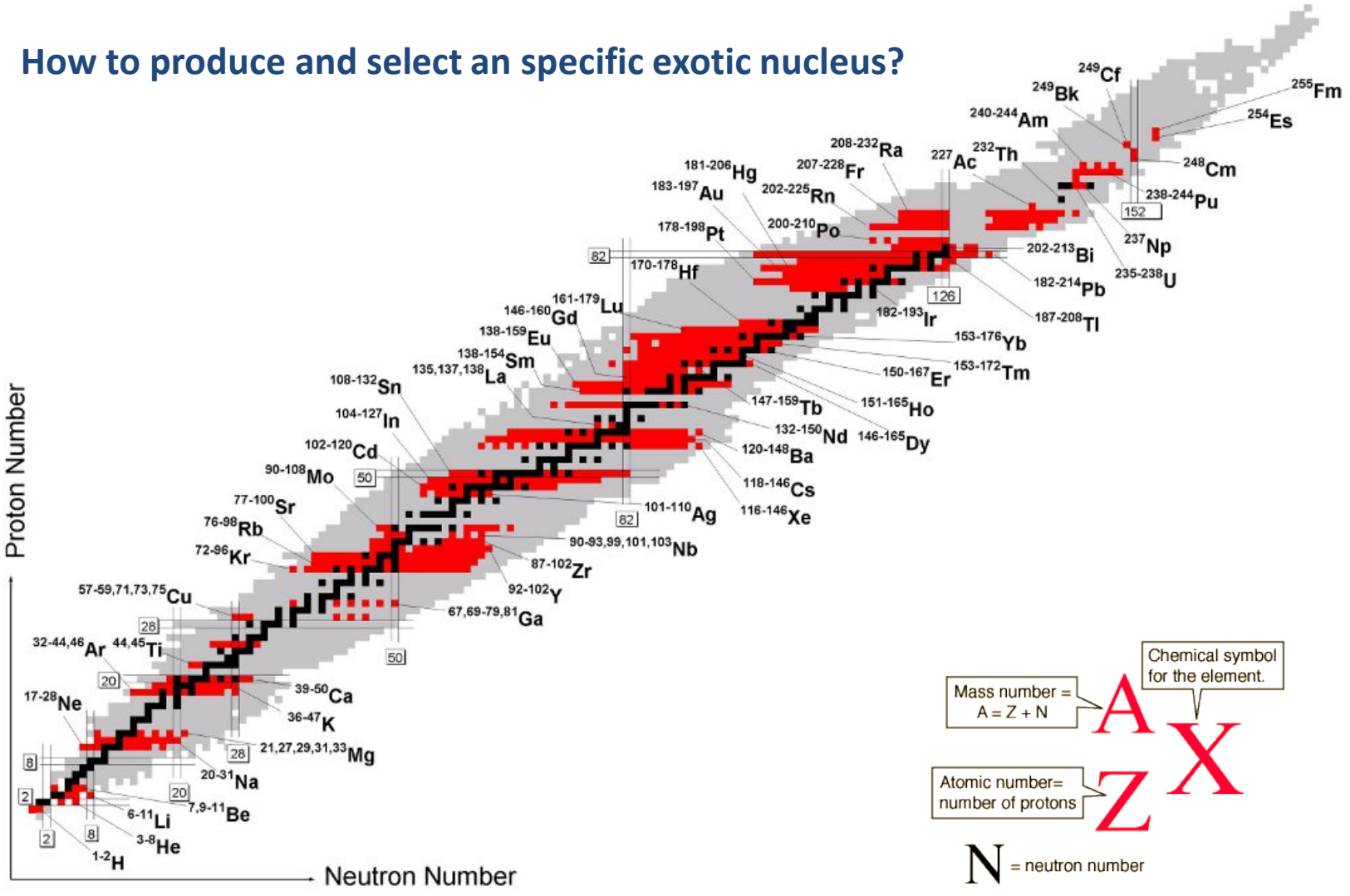
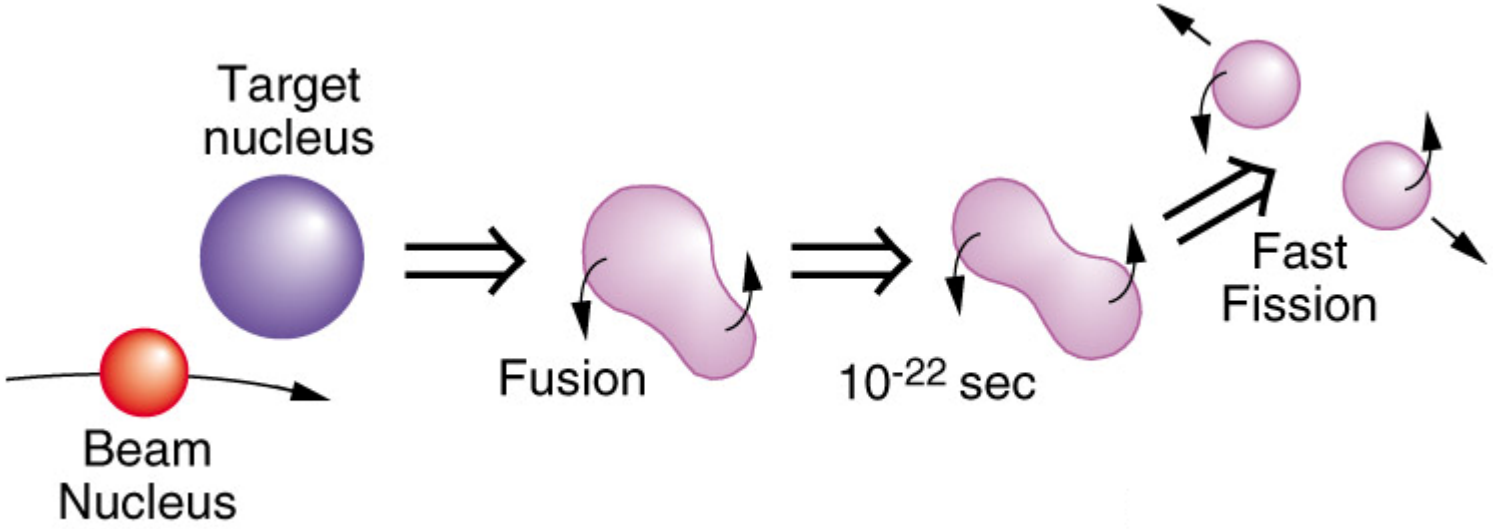
Introduction

How to produce and select an specific exotic nucleus?



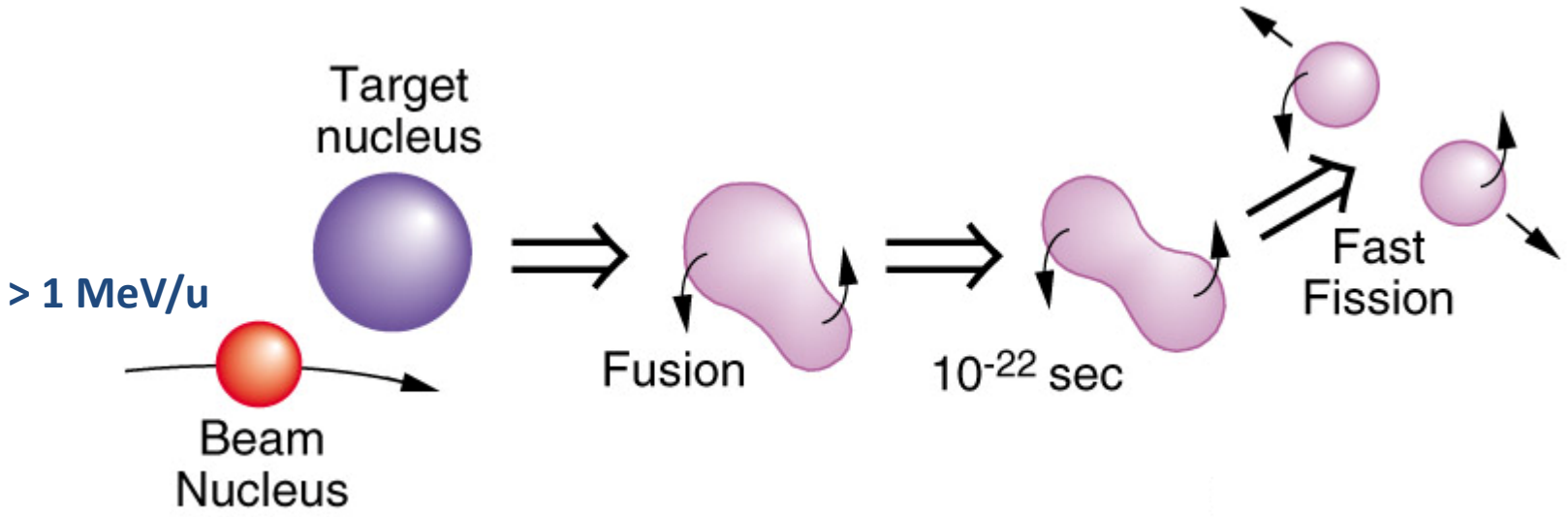
Introduction

Production -> Fusion evaporation reactions



Introduction

Production -> Fusion evaporation reactions



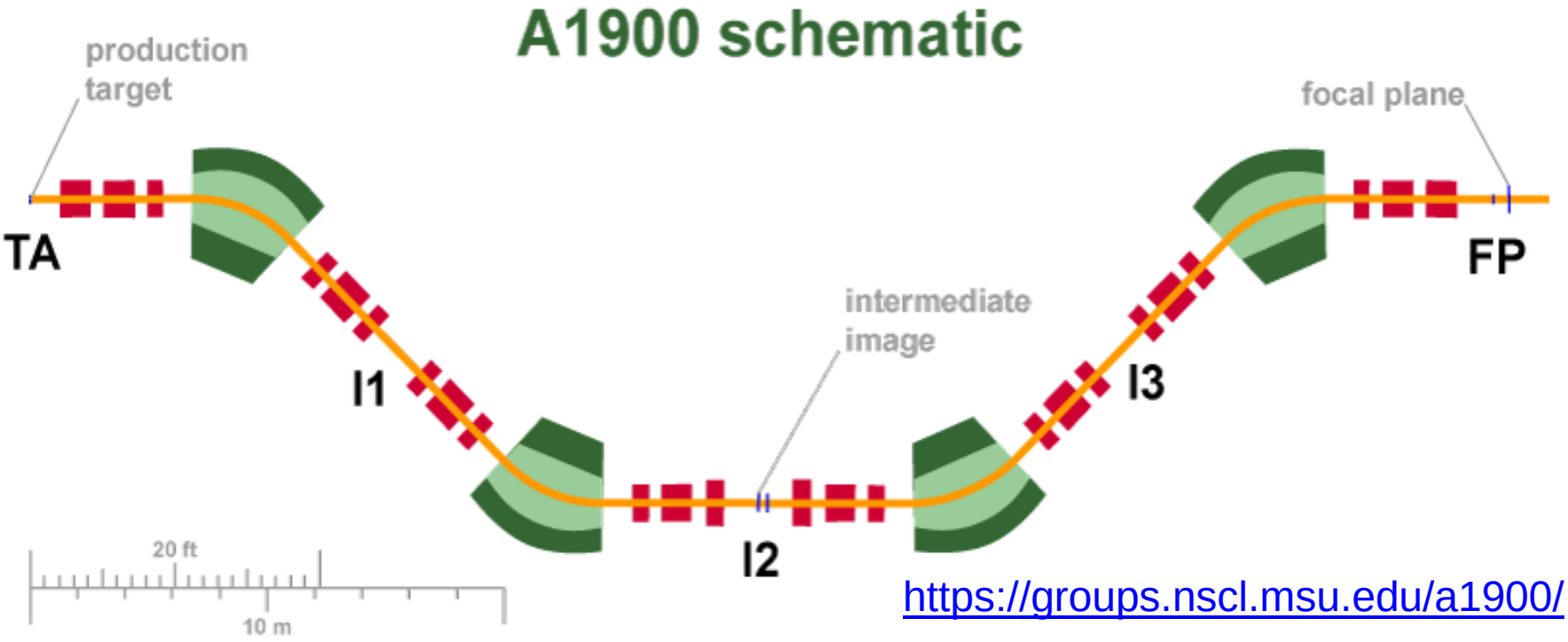
- **How to select an specific nucleus?**
- **Could we use TOF methods ? Mass analyzers?**
- **Could we separate nuclei with same mass number A? Same A/Z ratio?**

e.g.

$^{100}_{52}\mathrm{Te}$ $^{100}_{50}\mathrm{Sn}$ $^{100}_{48}\mathrm{Cd}$

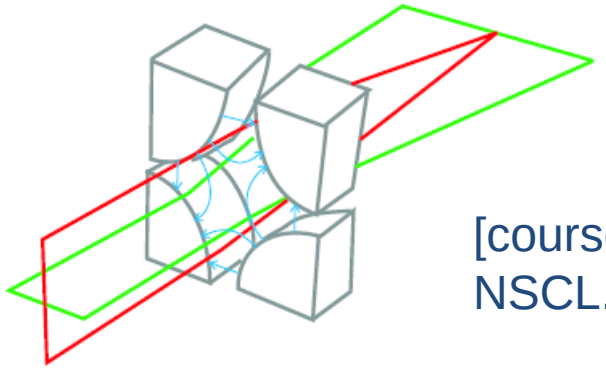
Experimental setup

SIMION model -> based on spectrometer A1900 at MSU,NSCL



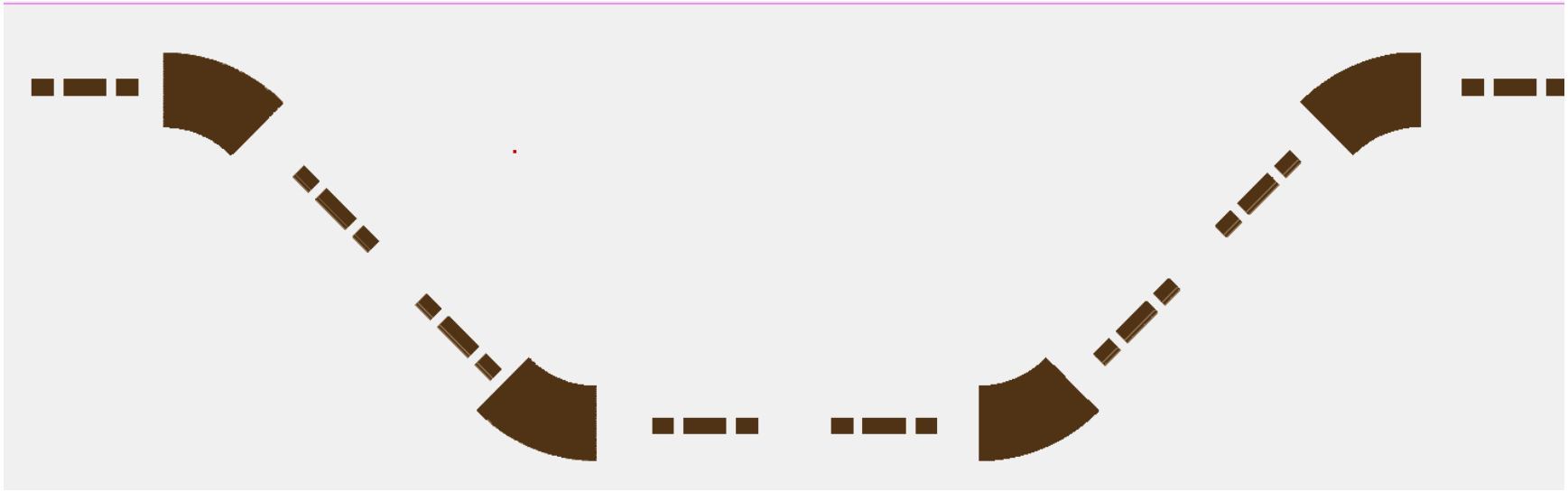
https://groups.nscl.msu.edu/a1900/

[NIM B. 126 (1997) 316-319]



[course on Experimental techniques at the NSCL. T. Baumann (2001)]

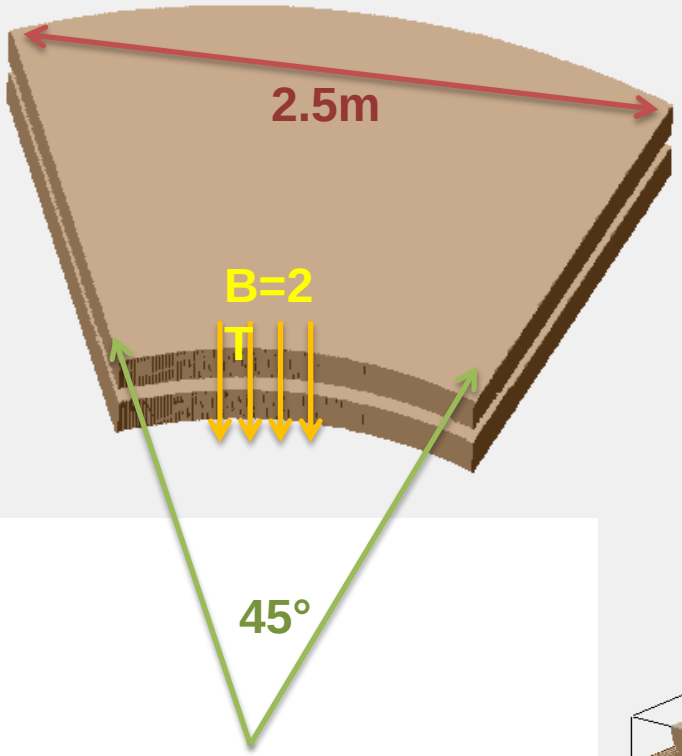
imitating reality



28 m

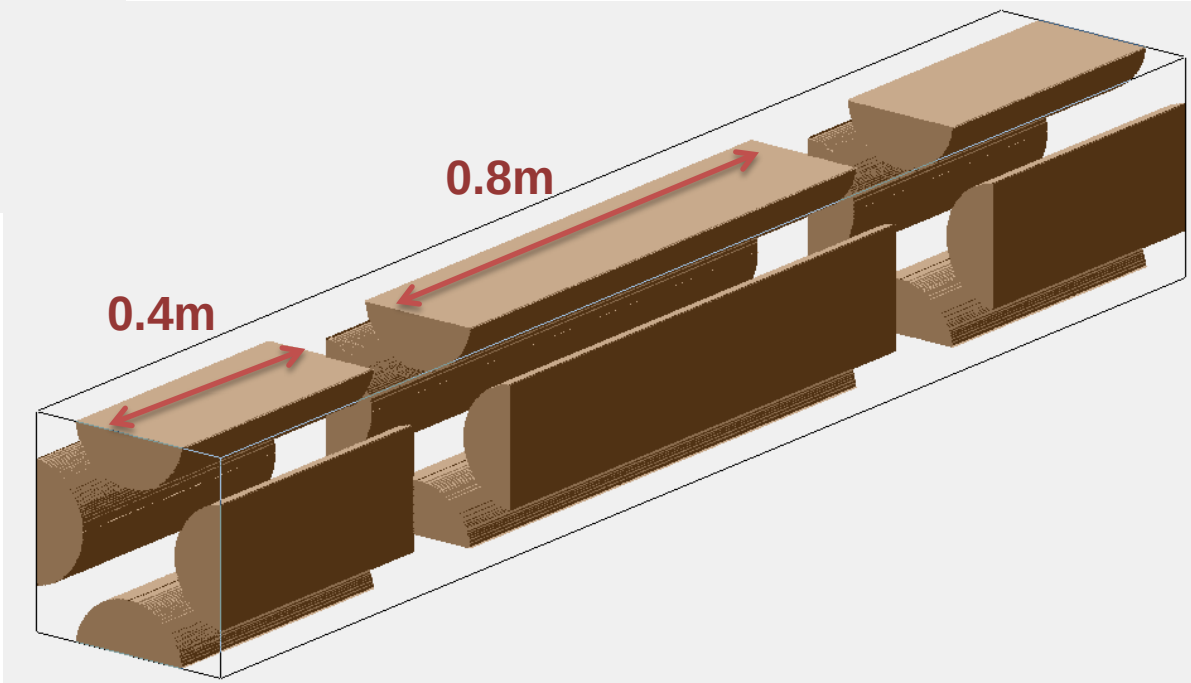
Building elements of theTOF fragment separator

dipole magnet



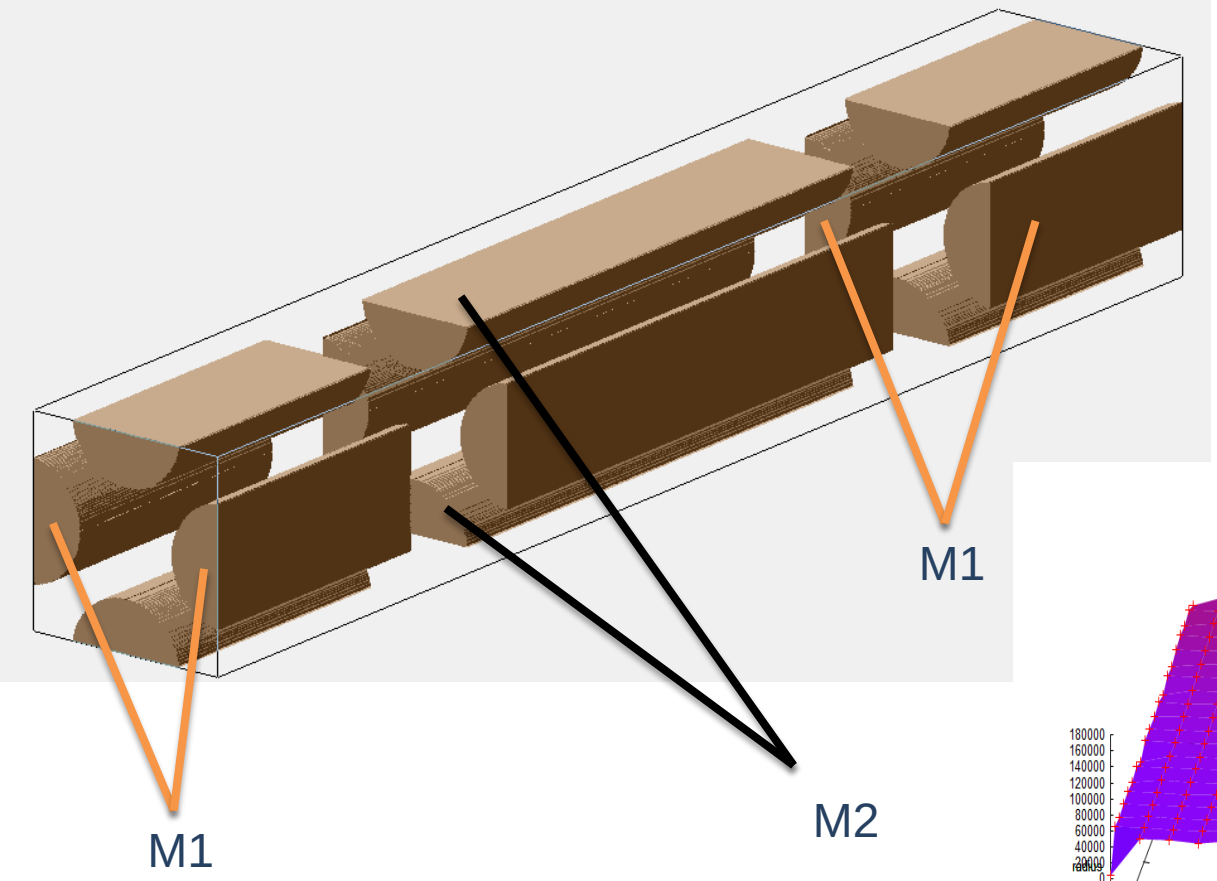
- mass separation
- magnetic rigidity:
  Bρ=p/q

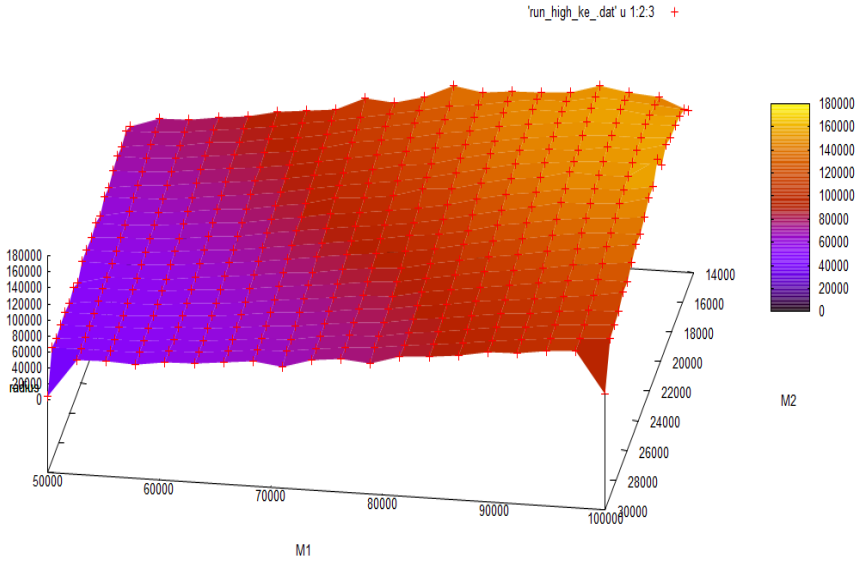
quadrupole triplet

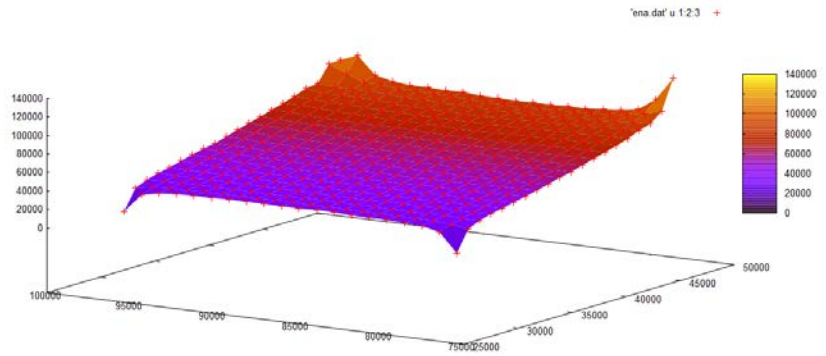


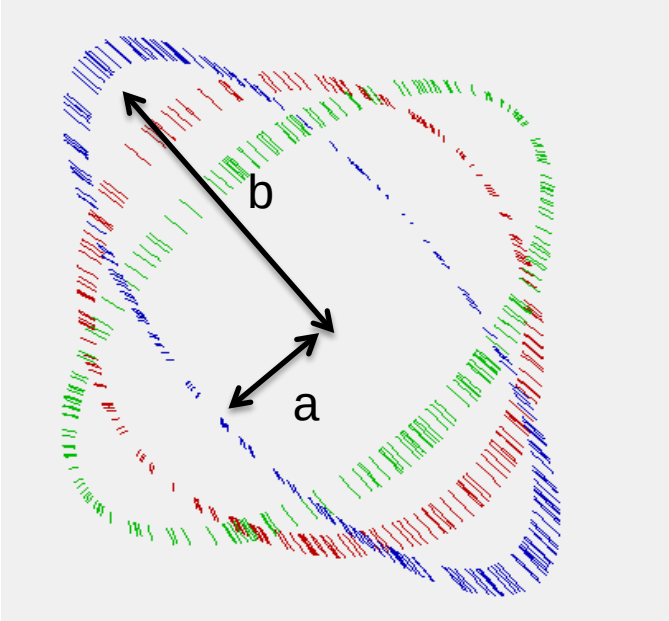
- focusing

finding the focus of the quadrupole triplet by minimizing the sum over all particle radii in the focal plane









In order to get a round beam:
Use the eccentricity as a parameter

$$\epsilon = \sqrt{1 - \frac{b^2}{a^2}}$$

initial considerations

• the nuclear reaction that created the particles was not included

•particle mass:around 100 amu

•only single charged ions

•beam properties: a spatial gaussian distribution and a parallel initial beam

Results

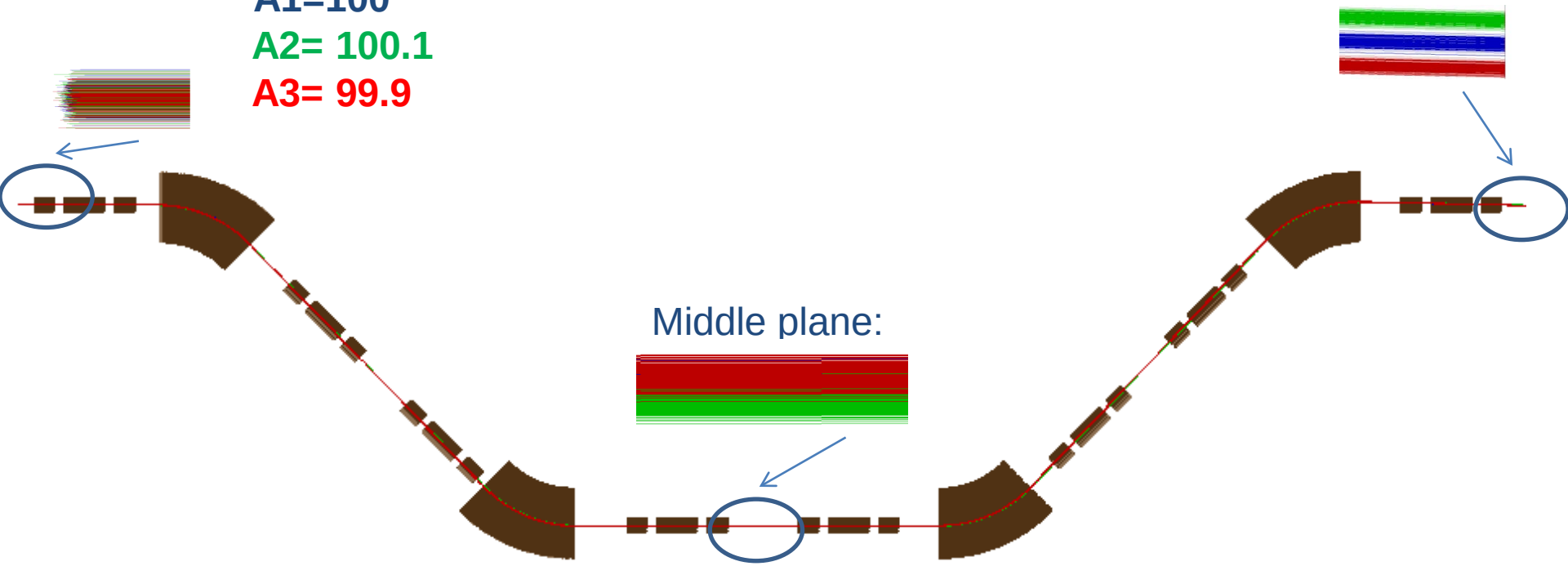
Initial beam:

A1=100

A2= 100.1

A3= 99.9

Focal plane:



Middle plane:

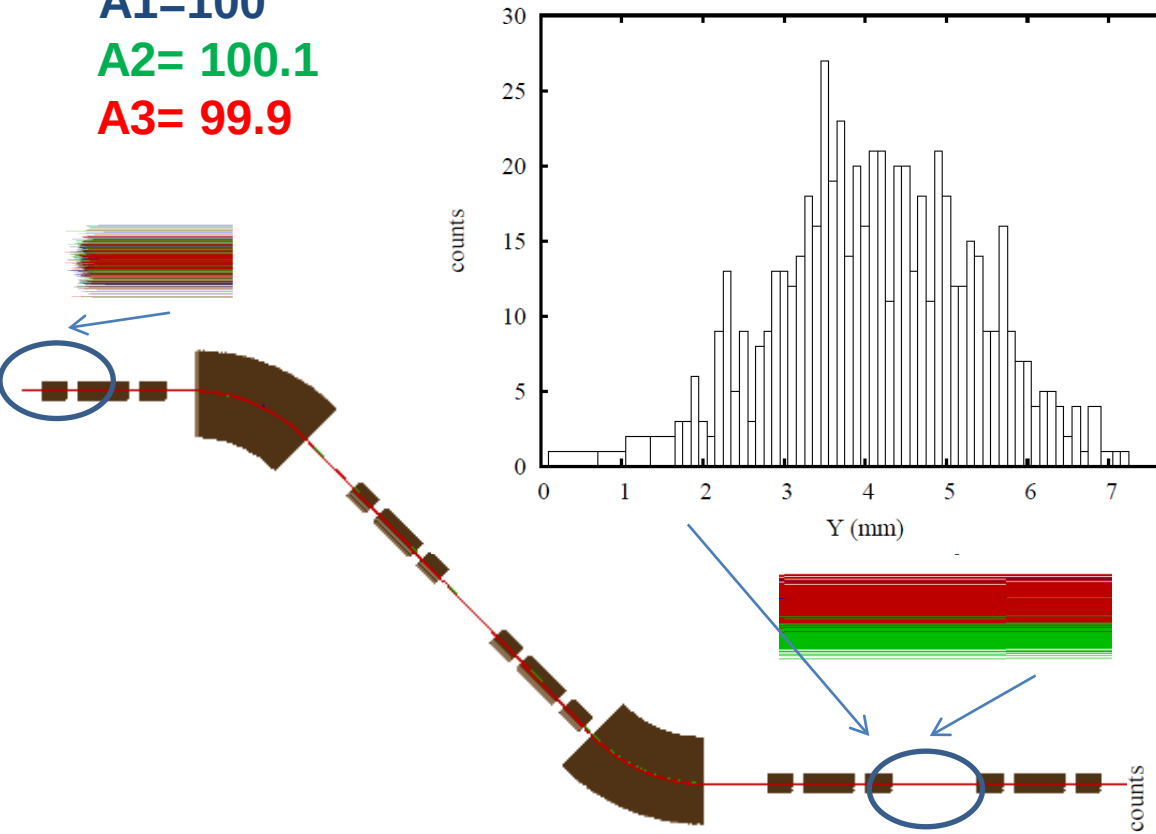
Results – Mass separator

Initial beam:

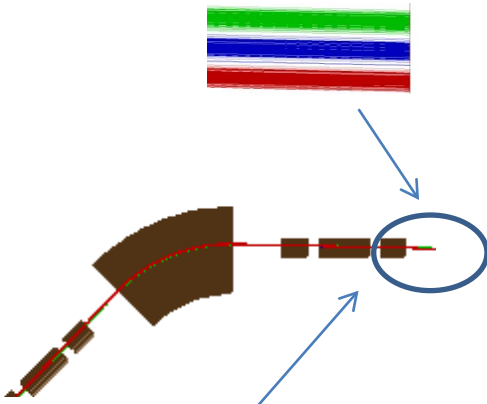
A1=100

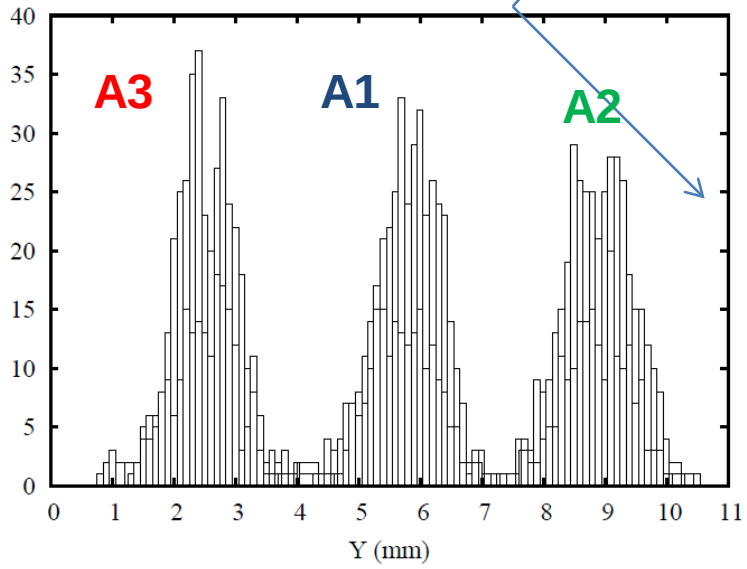
A2= 100.1

A3= 99.9

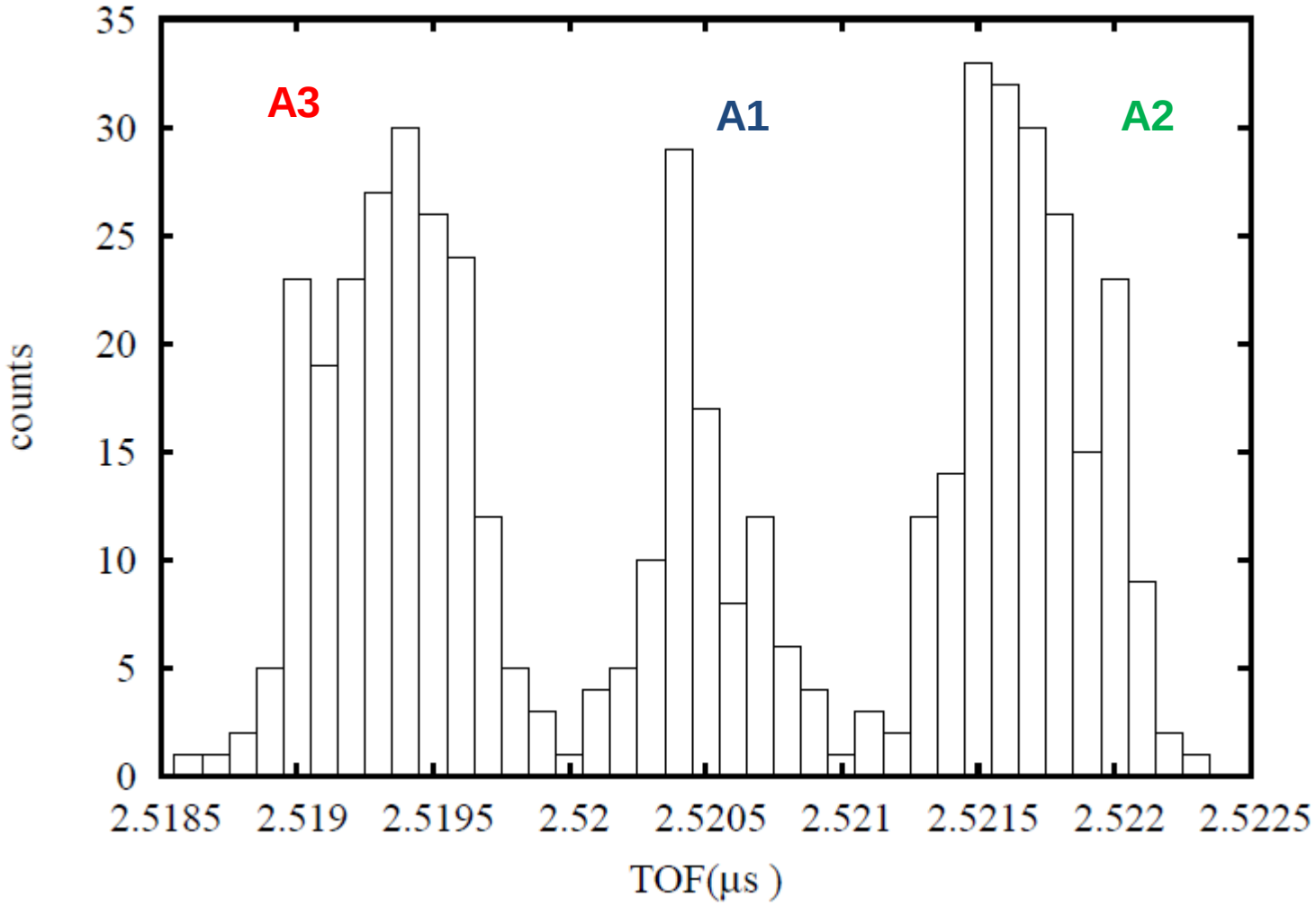


Focal plane:



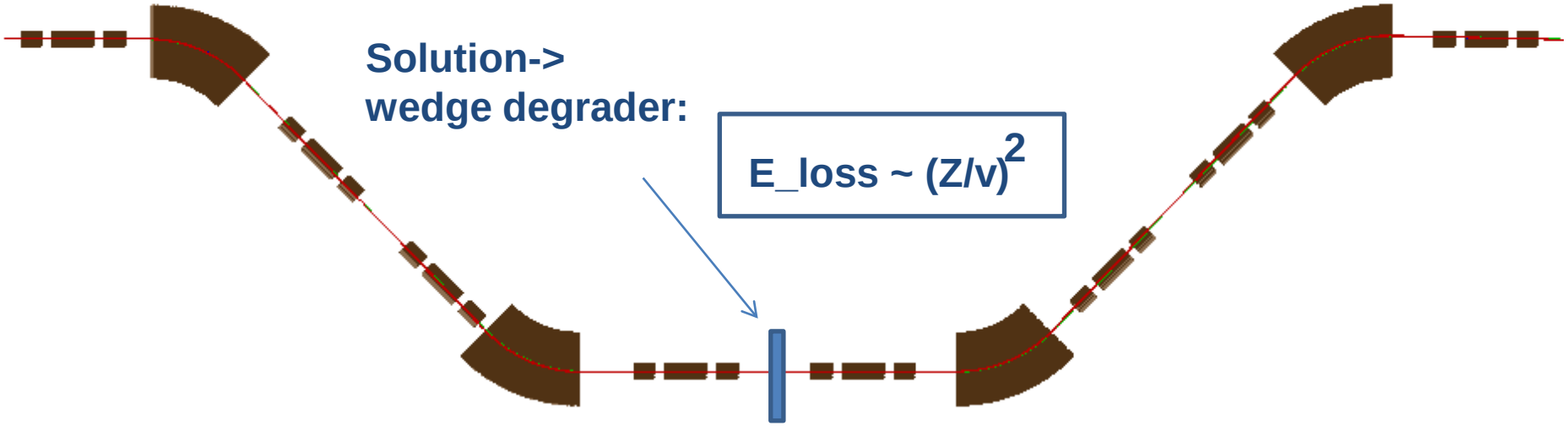


Results – TOF


A3
A1
A2
counts
0
5
10
15
20
25
30
35
2.5185
2.519
2.5195
2.52
2.5205
2.521
2.5215
2.522
2.5225
TOF(μs)

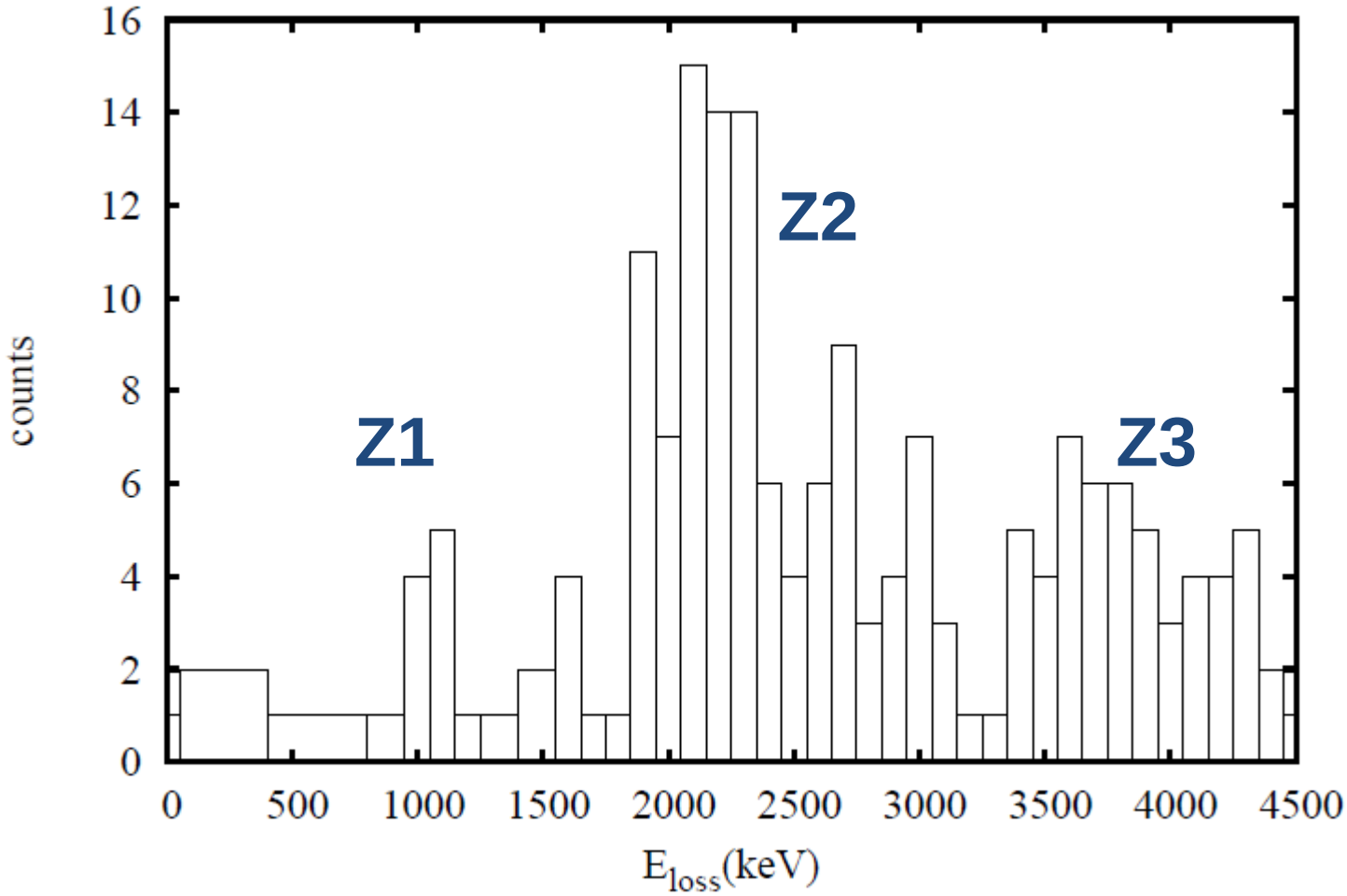
Results

Nuclei with the same A -> Are inside the same distribution



Results – Nuclei with same A

Monte-Carlo simulations: Energy loss, atomic number, velocity

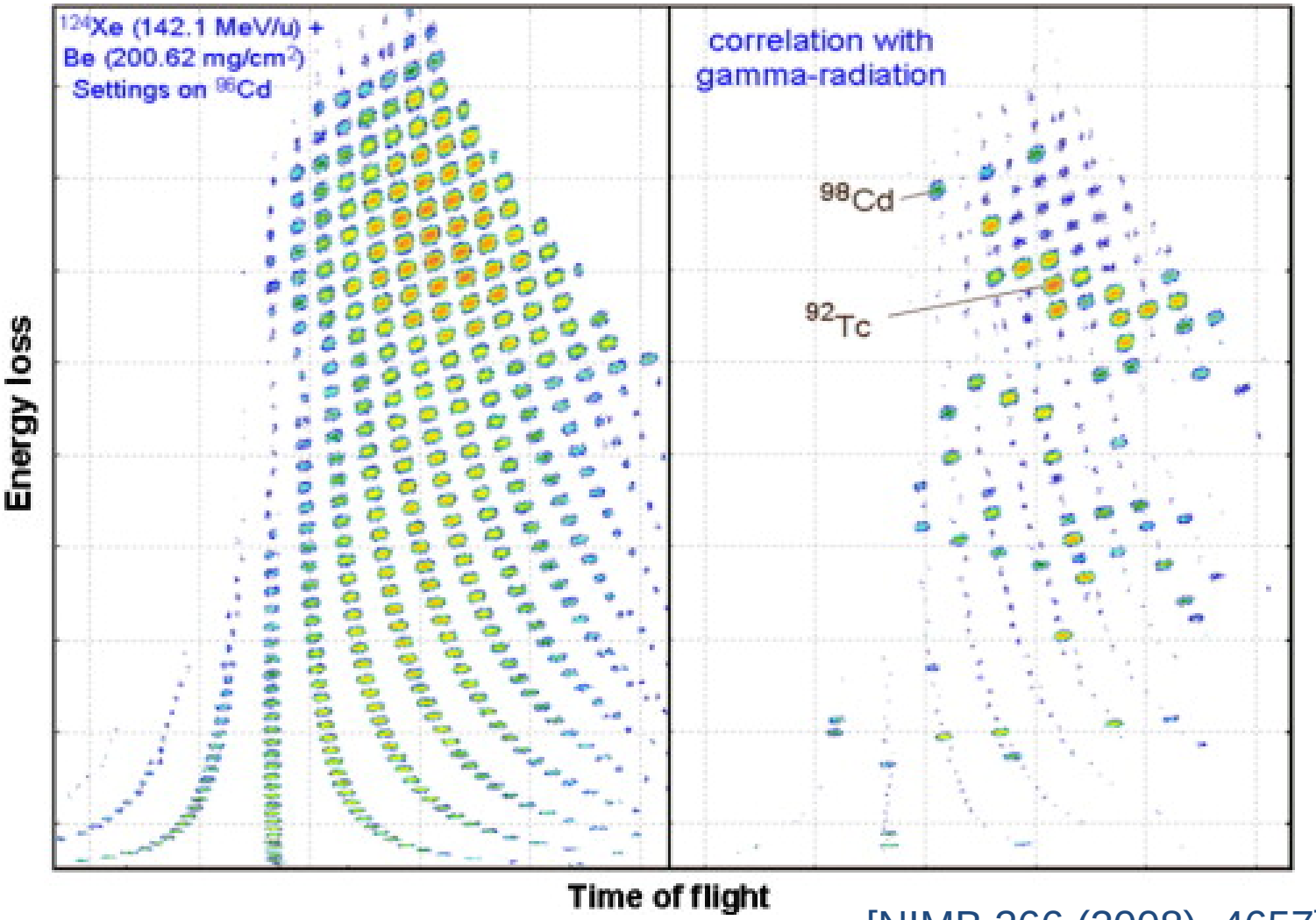


Conclusions

TOF + Energy Loss=

Selectivity of A and Z

Example: TOF + Energy loss



[NIMB 266 (2008) 4657]

End

Thank you for your attention