

Total reaction cross section for ${}^9\text{Li}$, ${}^8\text{Li}$ and ${}^6\text{He}$ nuclei at energies of about 30 MeV/u on nat Al and nat Pb



USING TRANSMISSION METHOD

Madalina Ravar

Coordinators:
A. Artyukh
B. Erdemchimeg

JOINT INSTITUTE
FOR NUCLEAR RESEARCH

Outline



- **Flerov Laboratory of Nuclear Reactions (FLNR)**
- **COMBAS fragment separator**
- **Experiments on COMBAS**
- **LISE**
- **Transmission method**
- **Experimental results**
- **Kox parameterization – Theoretical results**

Flerov Laboratory of Nuclear Reactions (FLNR)



- was founded in the Joint Institute for Nuclear Research in 1957.
- The laboratory got its name after the soviet physicist Academician G.N.Flerov.

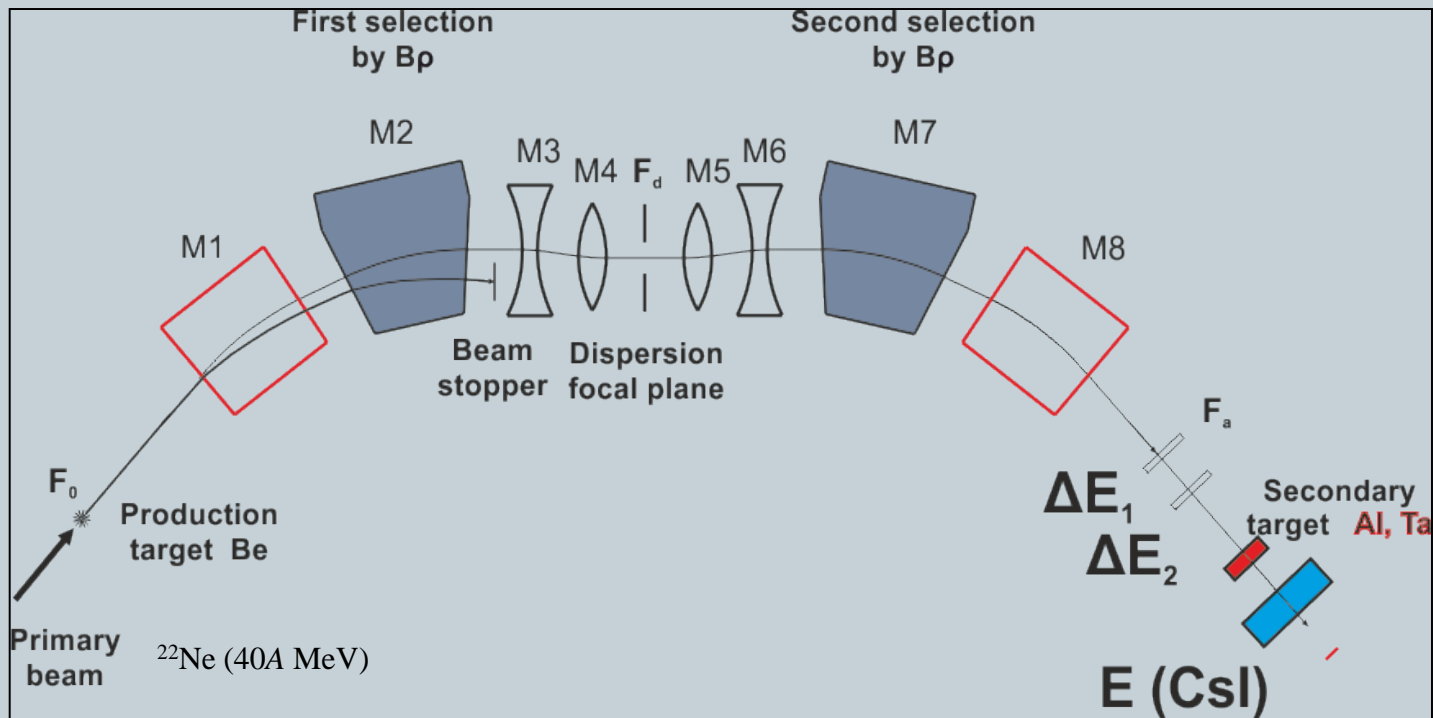
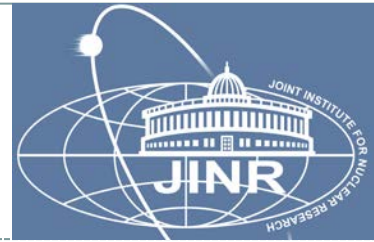


COMBAS fragment separator

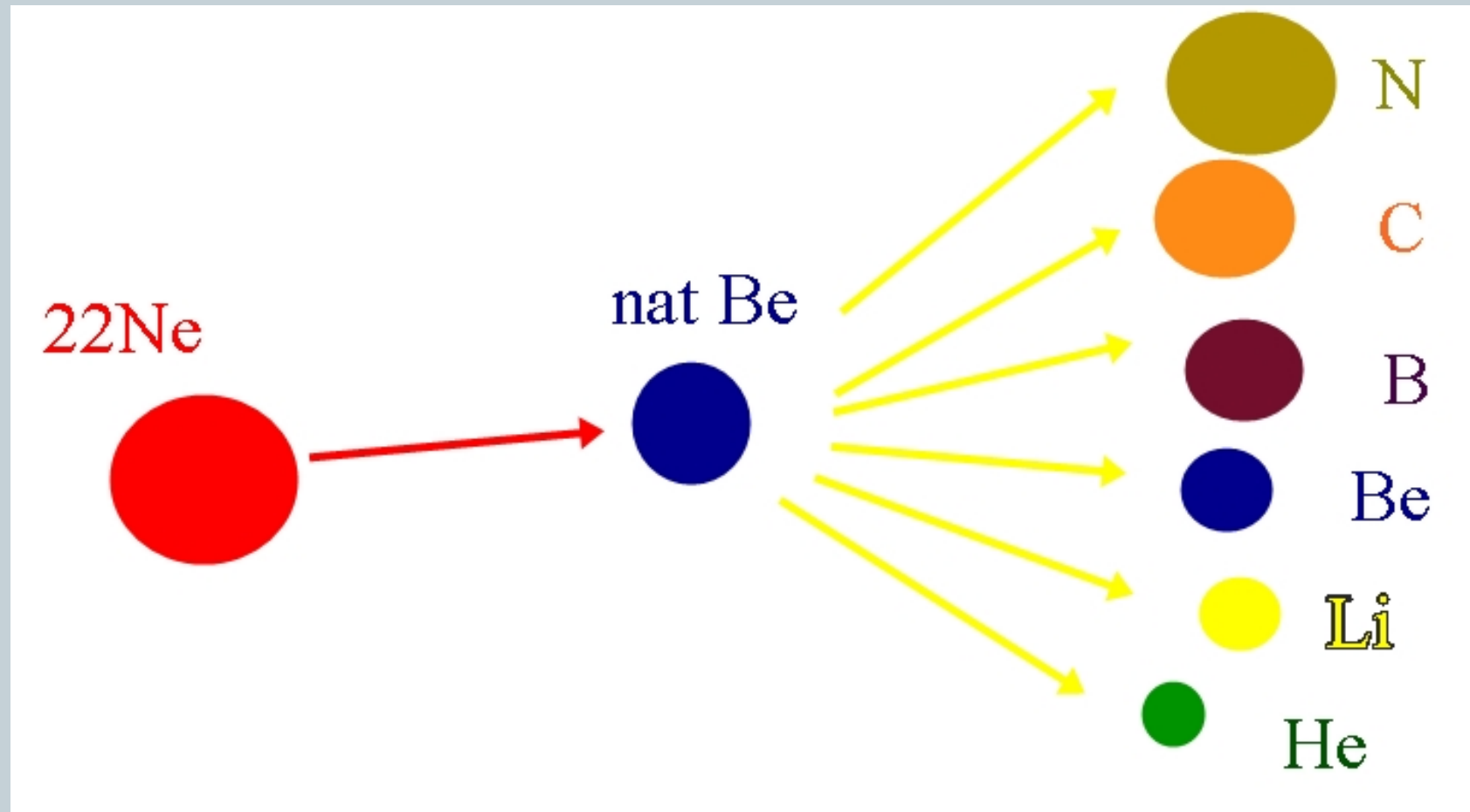


- designed for separating and forming beams of unstable nuclei obtained in reactions with low- and intermediate energy (~ 40 MeV/u) heavy ions.

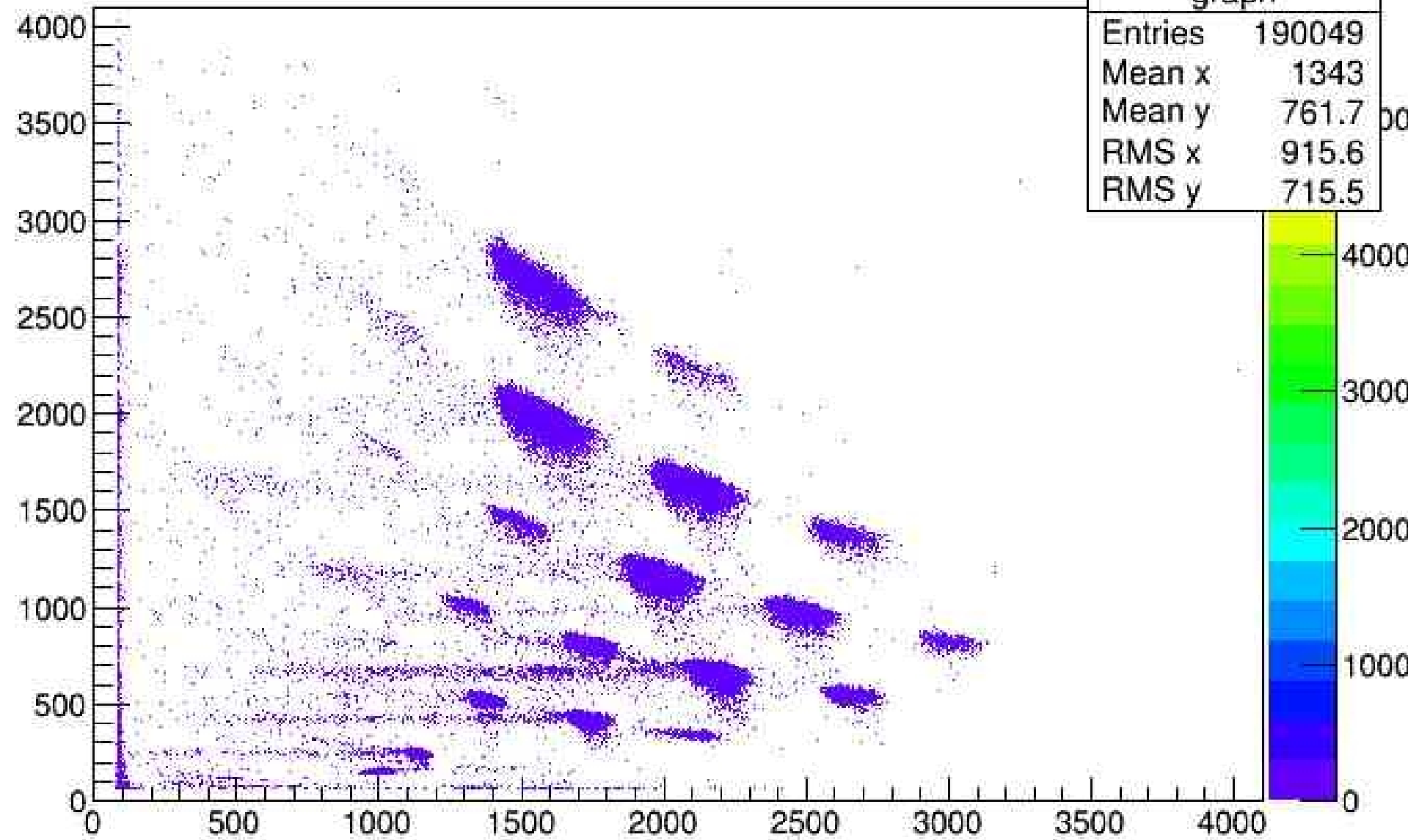
COMBAS U400M



Experiments on COMBAS



ADC_VOIE_4:ADC_VOIE_7



LISE- fragmentation simulation program



LISE ++ [C:\Users\Acer\Desktop\22ne-2017.lpp]

File Settings Options Calculations Utilities 1D-Plot 2D-Plot Databases Help



P rojectile $^{22}\text{Ne}^{10+}$
35 MeV/u 1 pA

F ragment $^7\text{Be}^{4+}$

T Target **Be**
89 micron

Stripper

D DP1 **Brho**
1.6300 Tm

S Slits 31
slits
-50 | +50

Wedge **Be**
200 micron

D DP2 **Brho**
1.6300 Tm

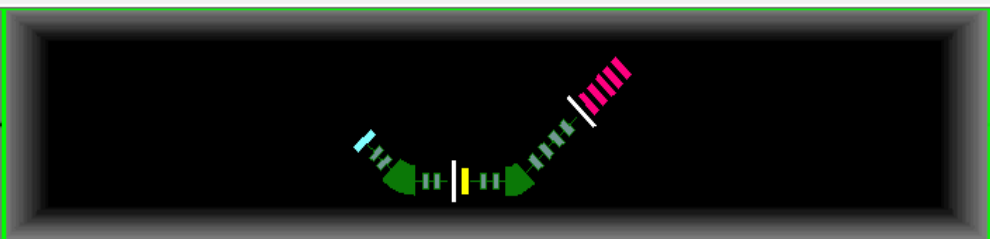
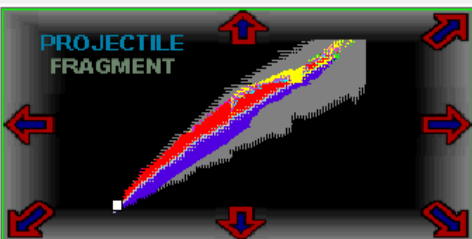
S Slits 43
slits
-30 | +30
-30 | +30

M DeltaE Si **Si**
300 micron

config LISE_D4_foc215 dp/p
option A1900_2007 6%
version 9.1.23 total

MICHIGAN STATE UNIVERSITY

Projectile Fragmentation



		^9C	^{10}C	^{11}C	^{12}C	^{13}C	^{14}C	^{15}C	^{16}C	^{17}C	
		^8B		^{10}B	^{11}B	^{12}B	^{13}B	^{14}B	^{15}B		
		4.06e-3 0%									
		^7Be		^9Be	^{10}Be	^{11}Be	^{12}Be			^{14}Be	
		1.46e-1 0%									
		^6Li	^7Li	^8Li	^9Li		^{11}Li				
		2.23e-2 0%									
	^3He	^4He		^6He		^8He					
	3.28e+0 0.008%	8.08e+0 0.01%									
^1H	^2H	^3H									

Identification



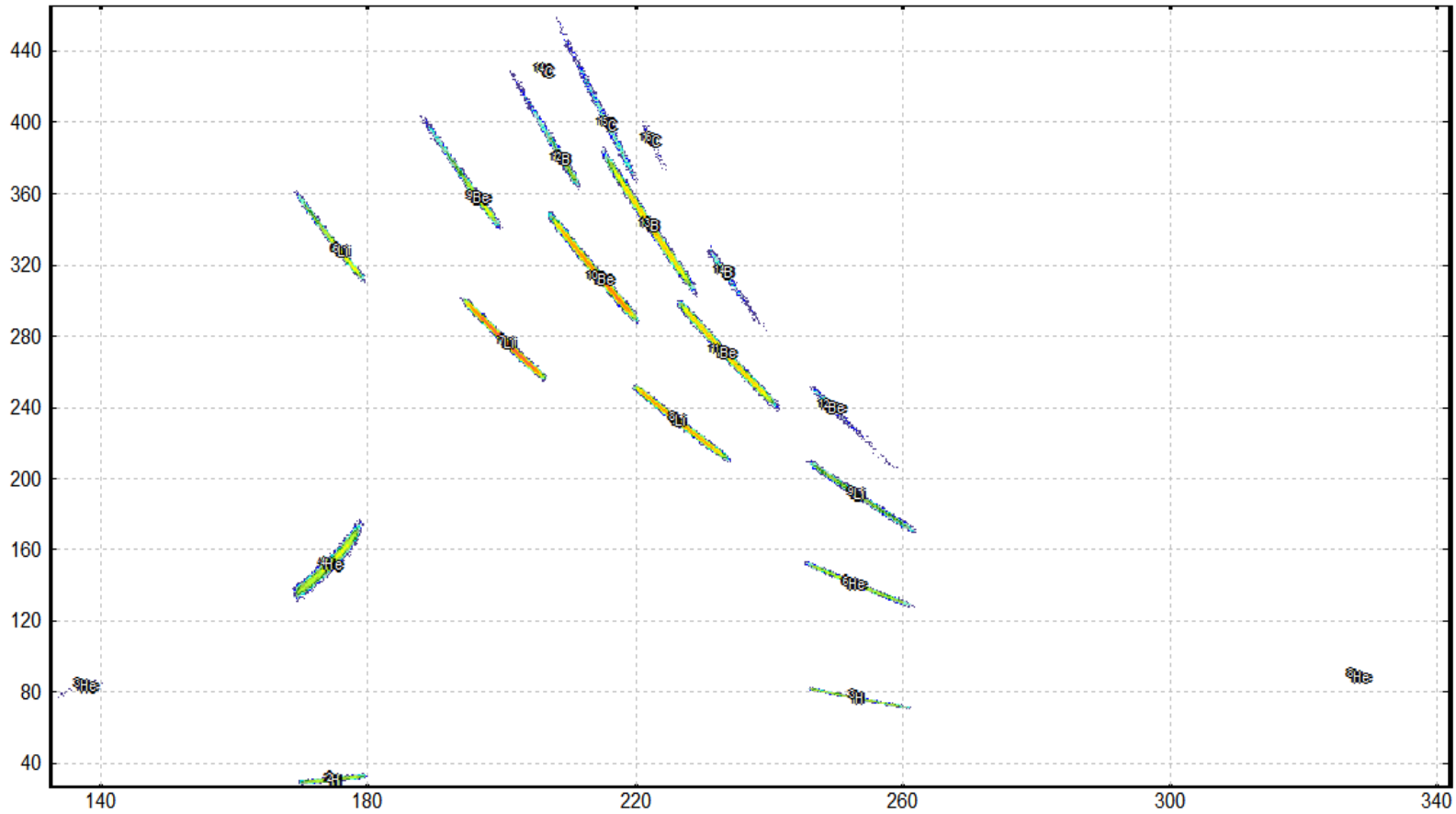
dE-TOF

^{22}Ne (35.0 MeV/u) + Be (89 μm); Settings on ^7Be ; Config: DSWDSMMMMMM
dp/p=6.00%; Wedges: Be (200 μm); Brho(Tm): 2.2800, 2.2708
Start: Target; Stop: E SI; ACQ_start: Detector **dE: E SI- Csl (10000 μm)

Continue

without charge states
all reactions separ.

Energy loss (MeV) / E SI/



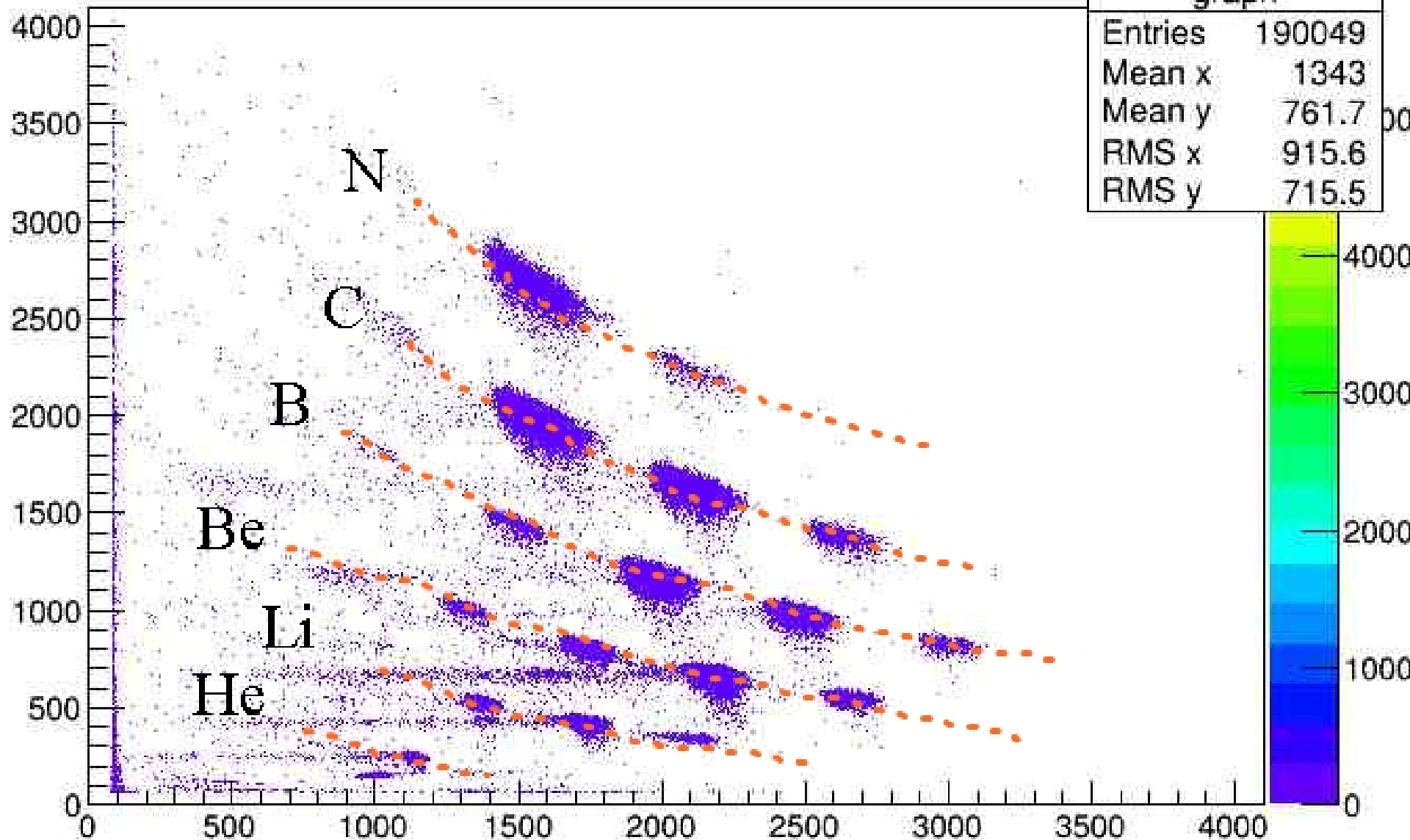
X=137.5
Y=329.7

Channels:
X=137.5
Y=329.7

SUM
5.500e+05
CPU speed
0 pps

- 886
- 546
- 337
- 207
- 128
- 79
- 49
- 30
- 19
- 12
- 7
- 5
- 3
- 2
- 1

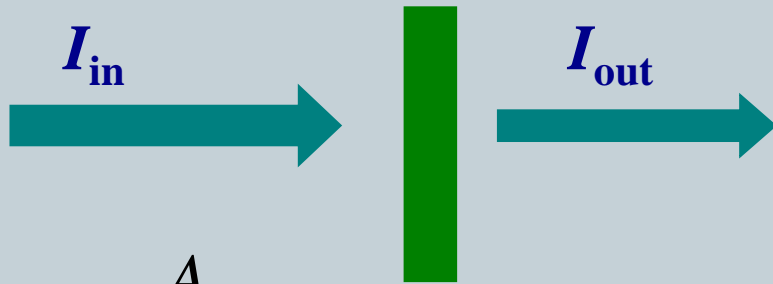
ADC_VOIE_4:ADC_VOIE_7



Transmission method

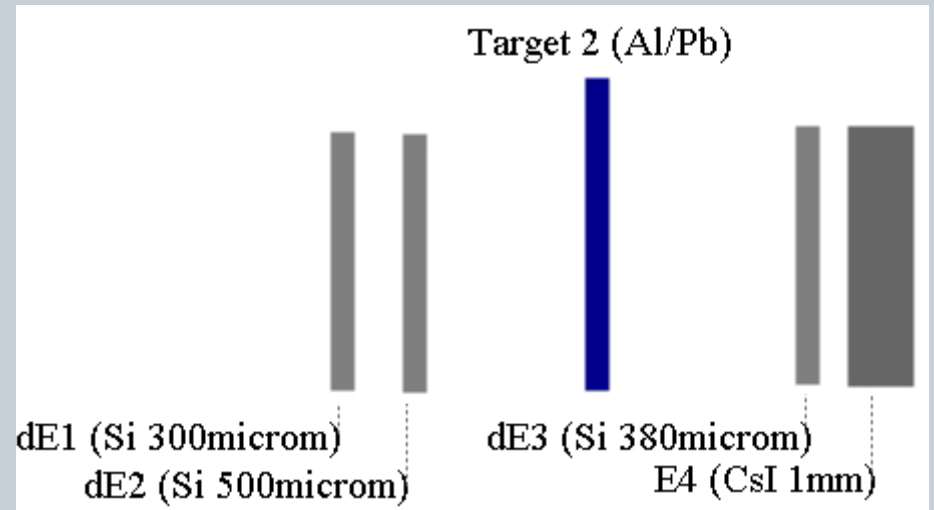
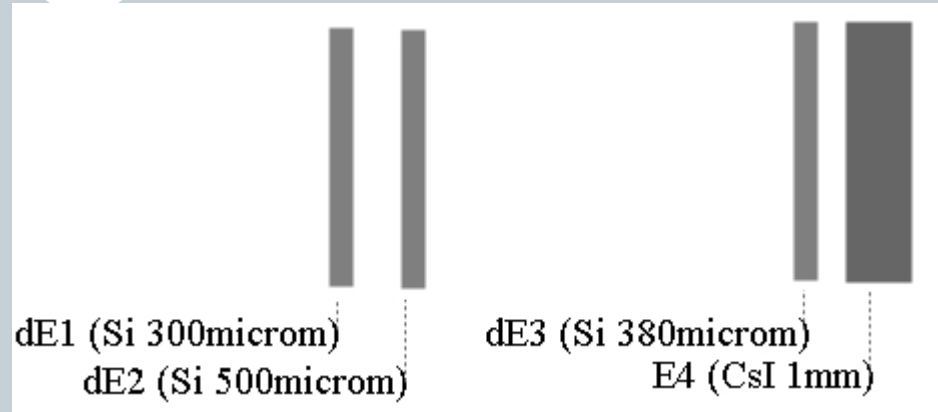


$$I_{out} = I_{in} \exp(-N\sigma_R)$$

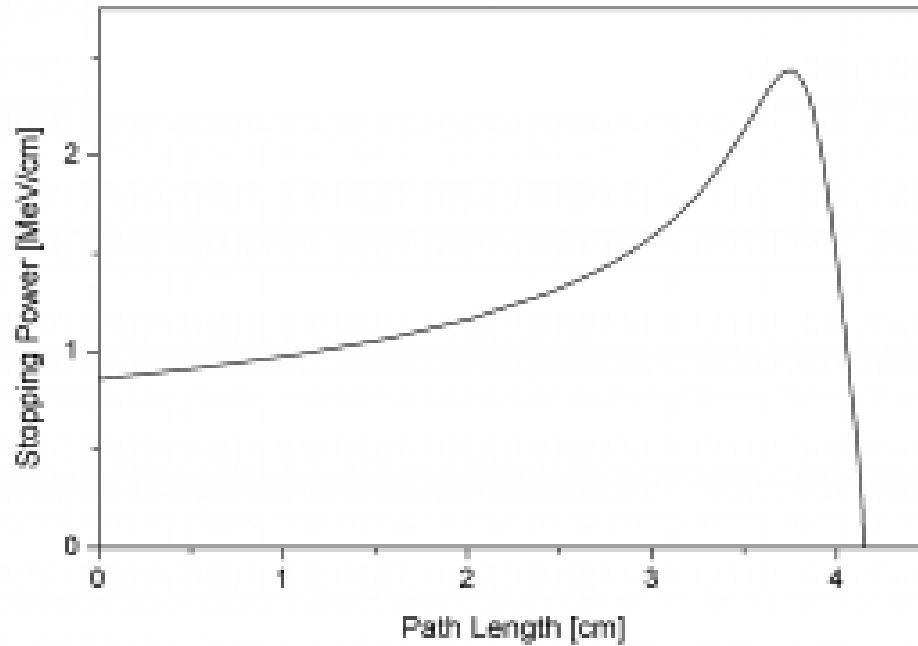


$$N = \frac{A}{t \cdot N_A}$$

- I_{in} : the number of incident nuclei
- I_{out} : the number of out-going unreacted nuclei
- t : thickness of the reaction target



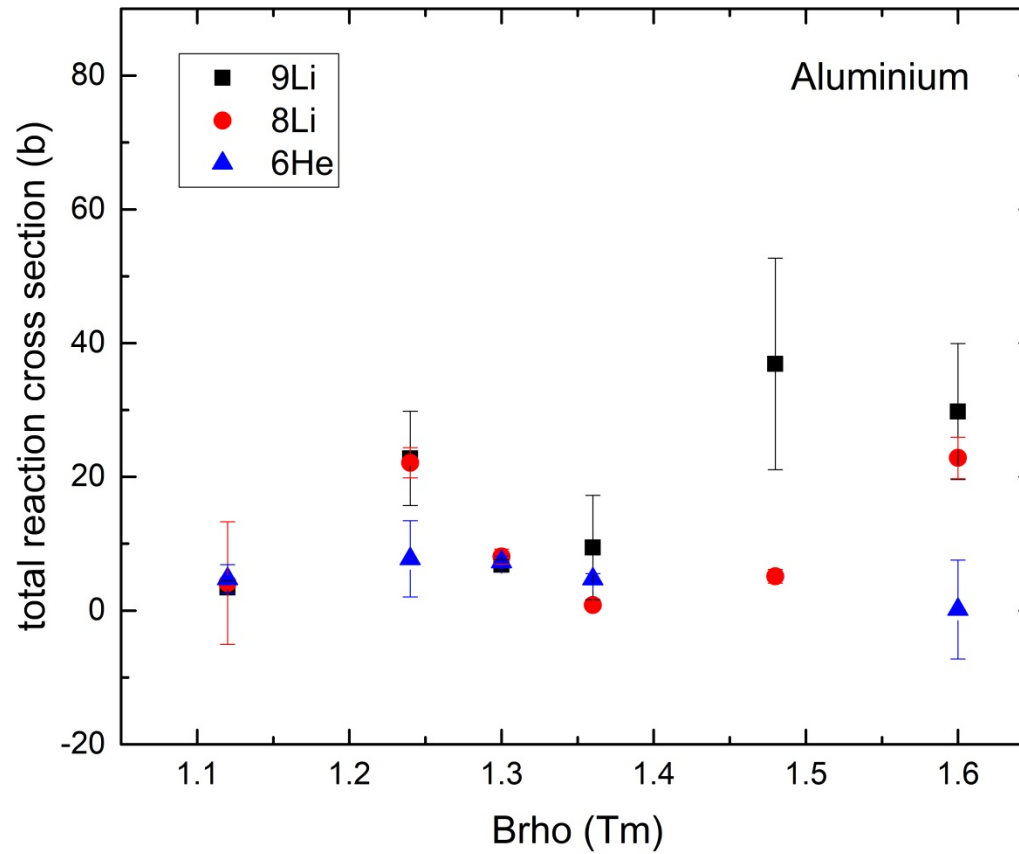
Interaction of charged particles with matter



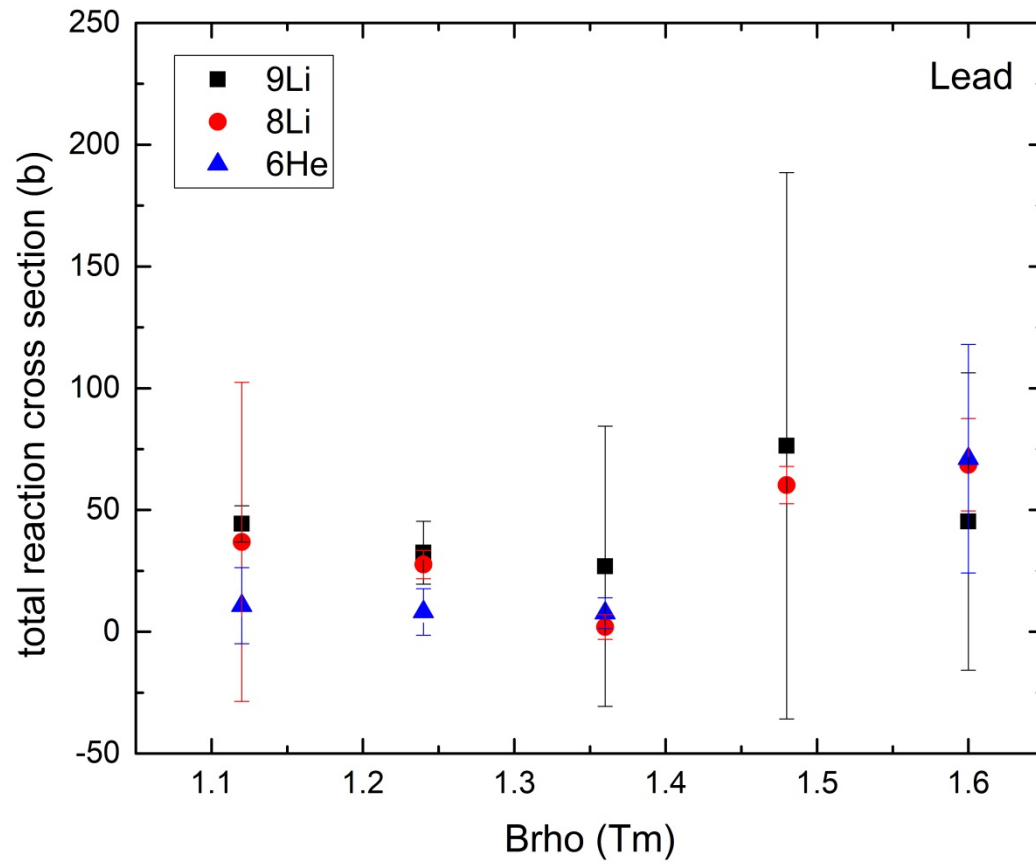
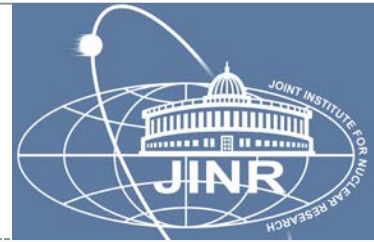
Bragg Curve is typical for heavy charged particles and plots the energy loss during its travel through matter.

$$S(T) = \frac{4\pi Q^2 e^2 n Z}{m\beta^2 c^2} \left[\ln \left(\frac{2mc^2 \gamma^2 \beta^2}{I} \right) - \beta^2 \right]$$

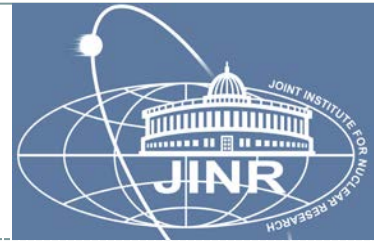
Experimental results



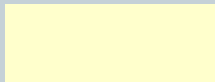
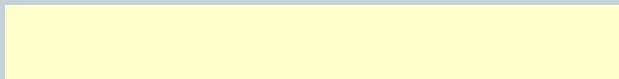
Experimental results



Kox parametrization (strong absorption method)

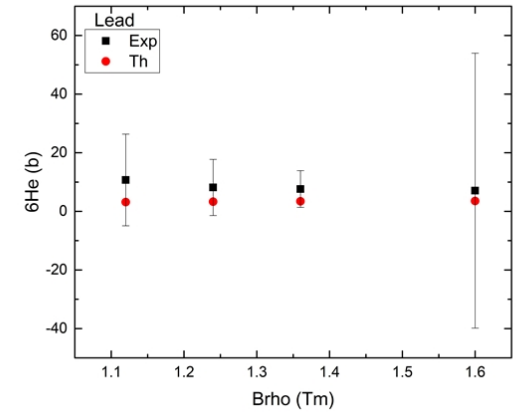
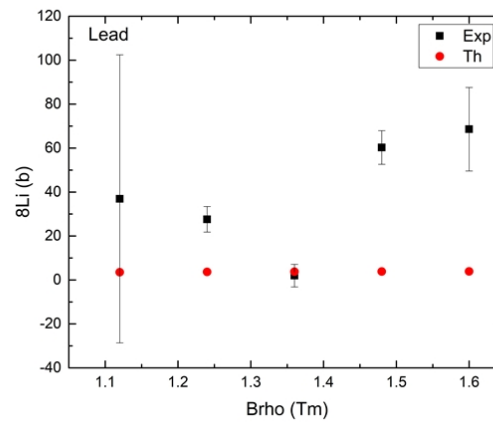
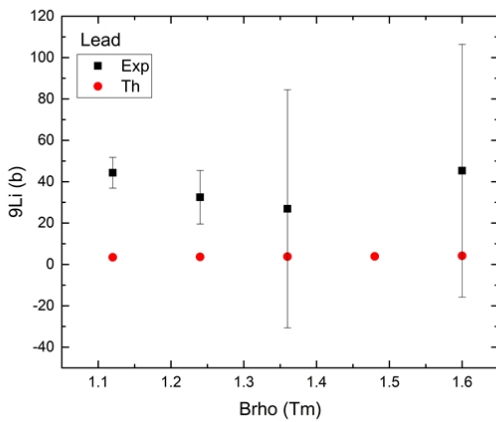
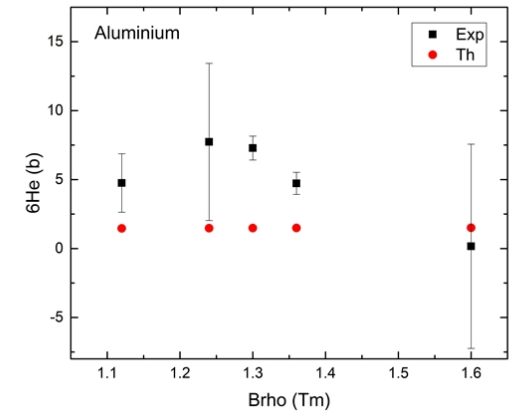
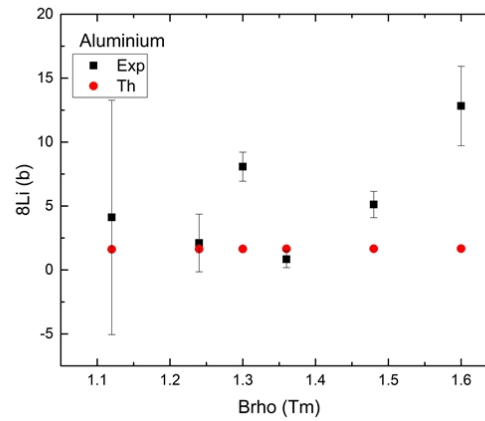
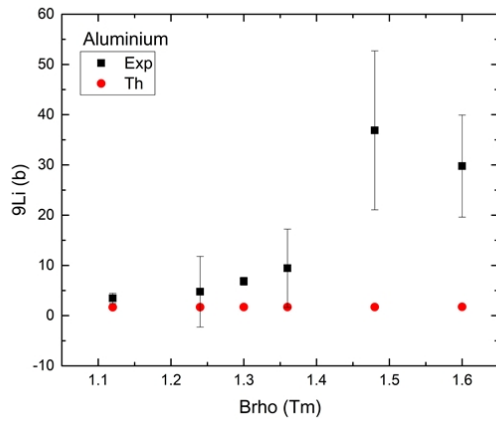


$$\sigma_R = \pi r_0^2 \left[\frac{1}{A_t^3} + \frac{1}{A_p^3} + b \frac{\frac{1}{A_t^3} \times \frac{1}{A_p^3}}{\frac{1}{A_t^3} + \frac{1}{A_p^3}} - C(E) + D \right]^2 \times \left(1 - \frac{B_c}{E_{cm}} \right)$$



$$D = 5 (A_T - 2Z_T) Z_P / (A_P A_T)$$

Results



Conclusions



- the experiment took place at COMBAS facility.
- the identification of clusters was done comparing the experimental data with simulated data in LISE.
- the cross section was obtained through transmission method.
- The experimental results were of the order of 1-10 barn.

Thank you for your attention!

