Ion Beam Analysis

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Aim

- To determine the elemental composition of thin films on the surface solid Target
- Enables technology for thin film scientists and engineer
- Possible applications are:
  - Microelectronics
  - Forensic etc.

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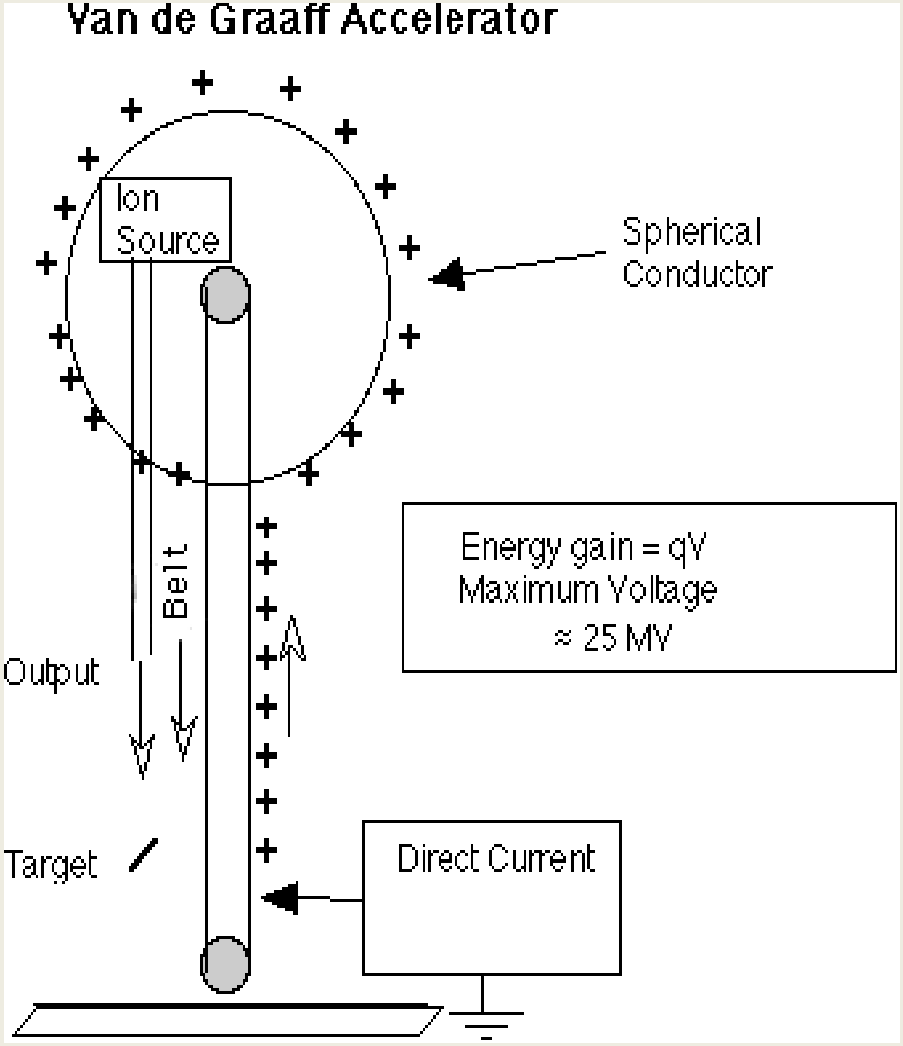
Part 1: Accelerator & PIXE

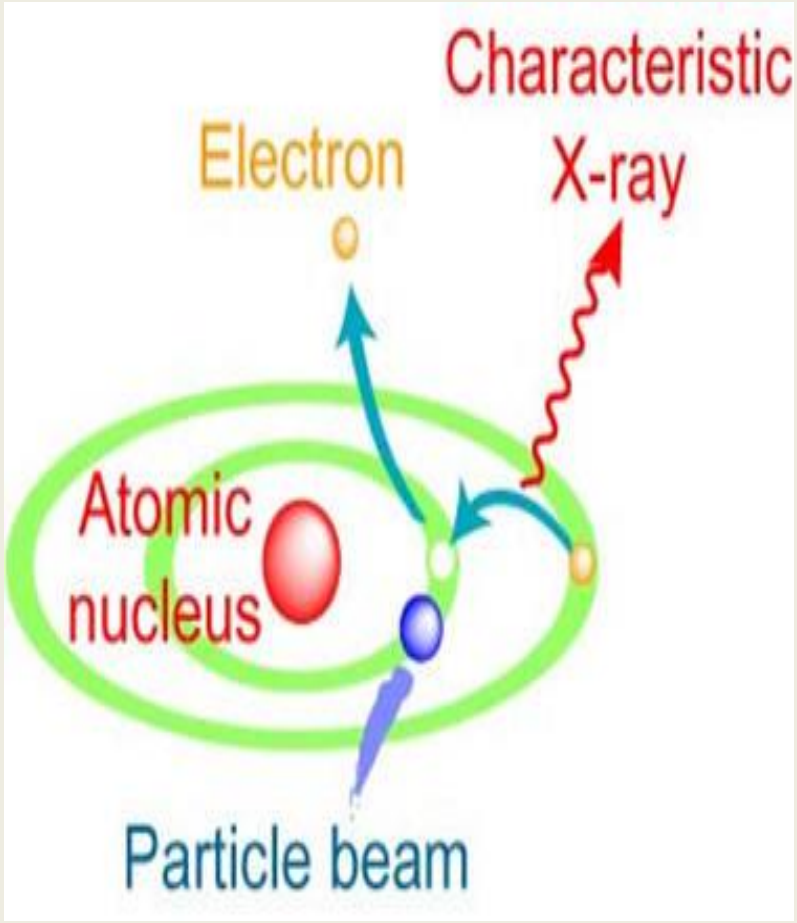


Parameters of EG-5 Accelerator

- Energy Region : 0.9-3.5Mev
- Beam intensity for H^+ :30μA
- Beam intensity for He^+ :10μA
- Energy Spread <500 eV
- Number of beam lines : 6

PIXE- Particle Induced X-ray Emission Method

- Proton beams are mainly used
  - Ionization of atom
  - Si(Li) Detector
  - Energy resolution about 150eV

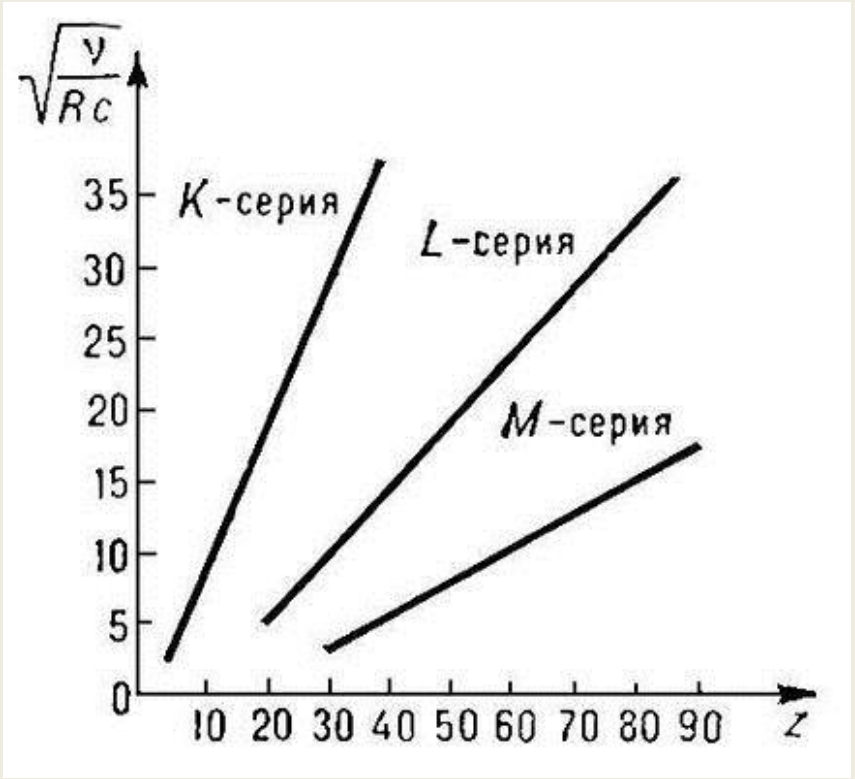


Moseley's law

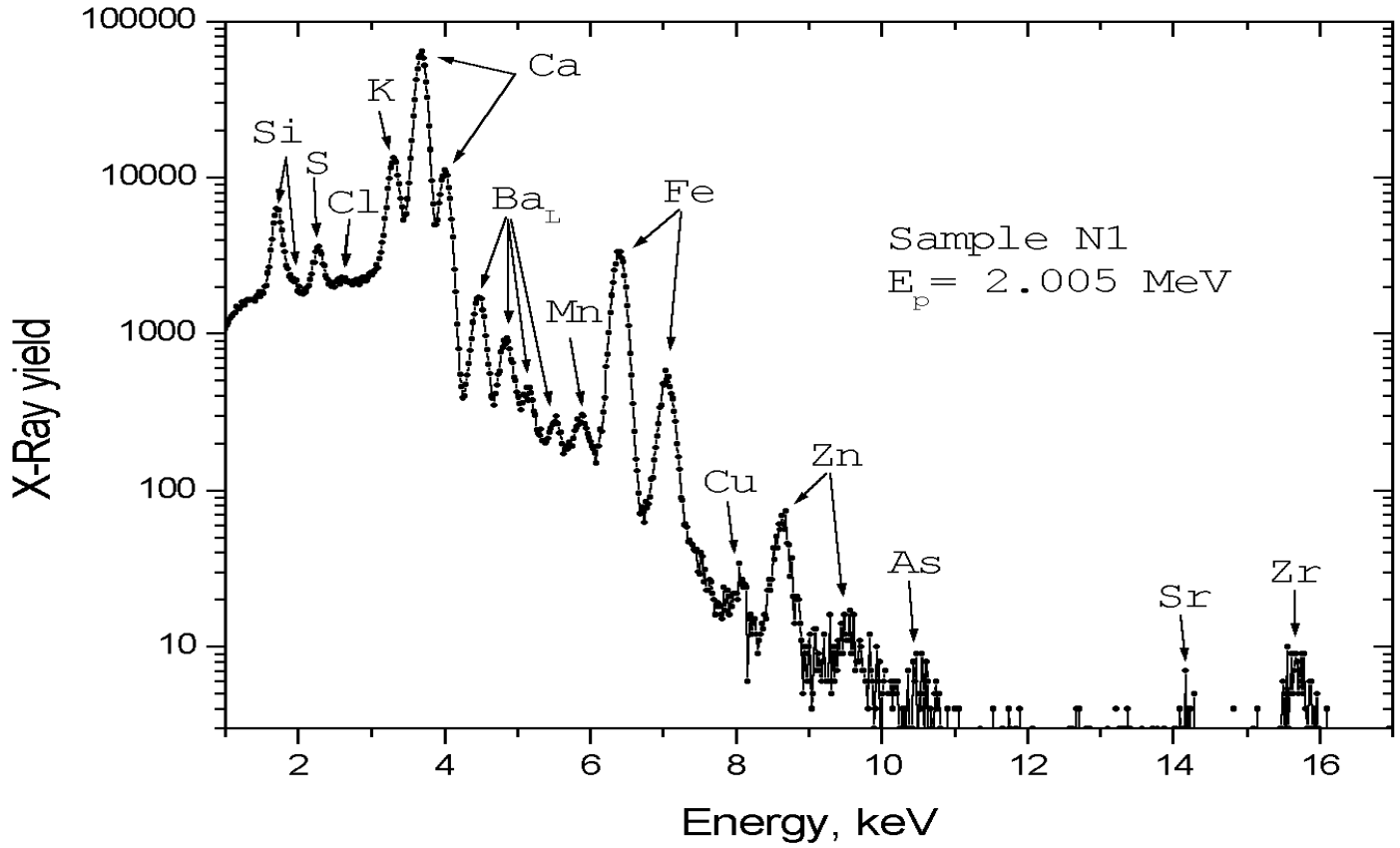
Moseley law

$$\sqrt{\frac{\nu}{R_c}} = \frac{Z - S_n}{n}$$

- ***Rc*** – Rydberg's constant
- ***Z*** – atomic number
- ***Sn*** – screening constant
- ***n*** – main quantum number
- ***v*** - frequency of X-ray quantum



PIXE Results



Aerosol analysis by PIXE & RBS

Element	Concen. At. %	Method	Element	Concen. At. %	Method
C	41	RBS	K	0.1	PIXE
N	20.5	RBS	Ca	0.53	RBS
O	28	RBS	Mn	0.007	PIXE
F	2.6	RBS	Fe	0.14	RBS
Na	2.5	RBS	Cu	0.002	PIXE
Mg	1.3	RBS	Zn	0.01	PIXE
Al	1.3	RBS	As	0.001	PIXE
Si	1.8	PIXE	Sr	0.0006	PIXE
S	0.2	RBS	Zr	0.005	PIXE
Cl	0.01	PIXE	Ba	0.01	PIXE

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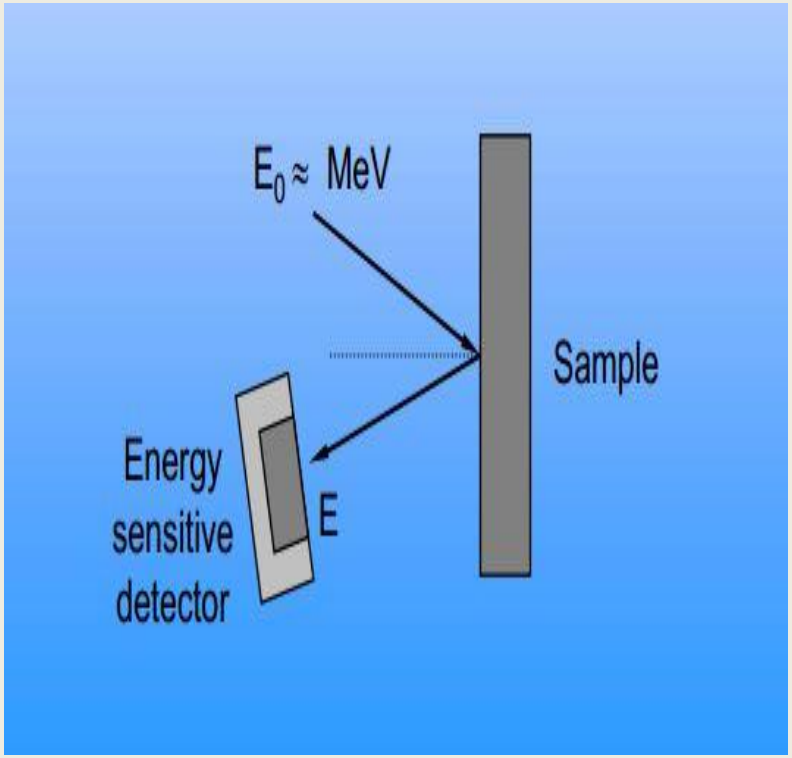
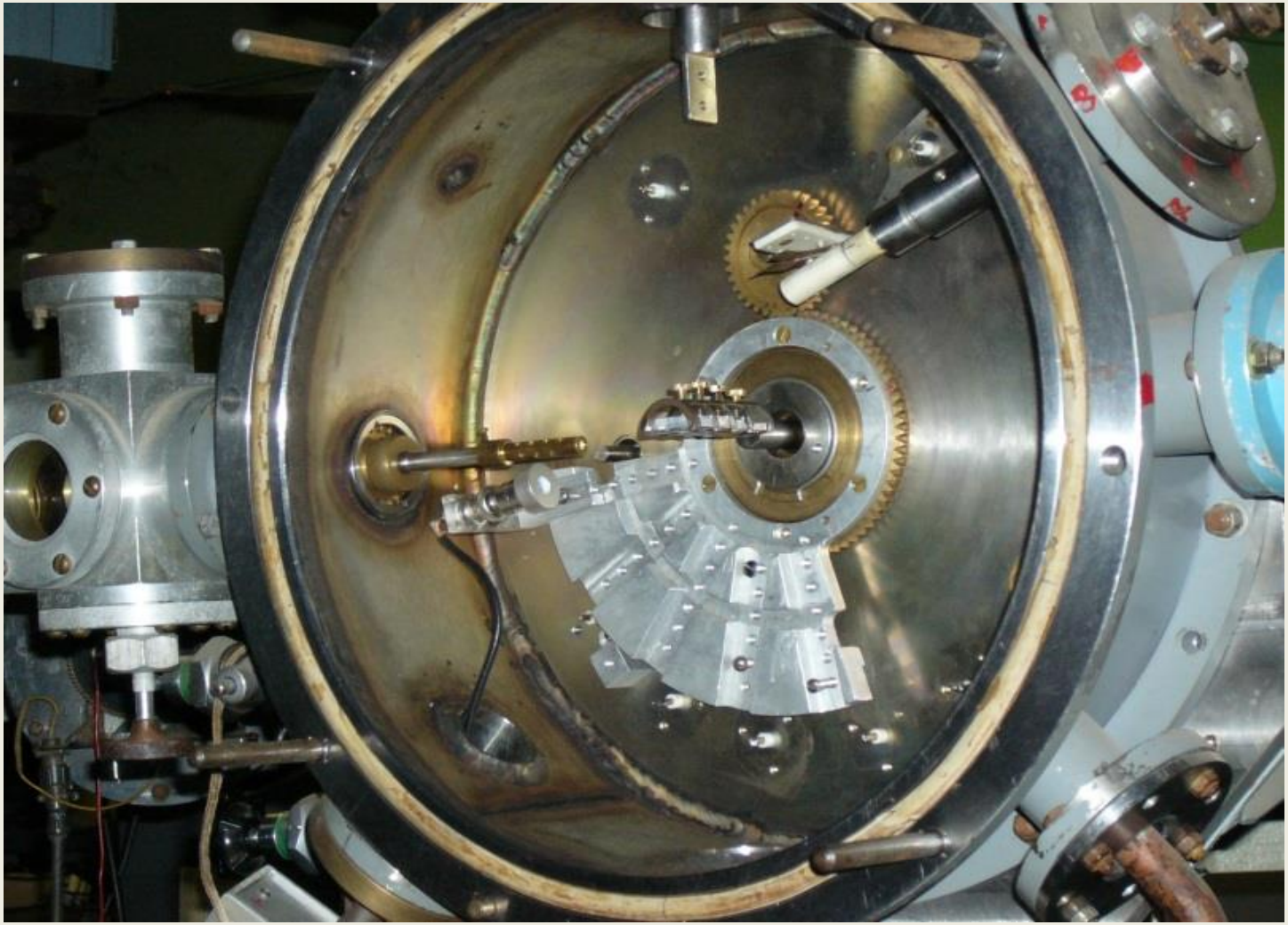
Part 2:RBS-Rutherford Backscattering Spectrometry Method



- Near-surface layer analysis of solids
- Elemental composition
- depth profiling of individual elements
- Very sensitive for heavy elements
- Less sensitive for light elements

Experimental chamber



RBS

- Kinematic Factor

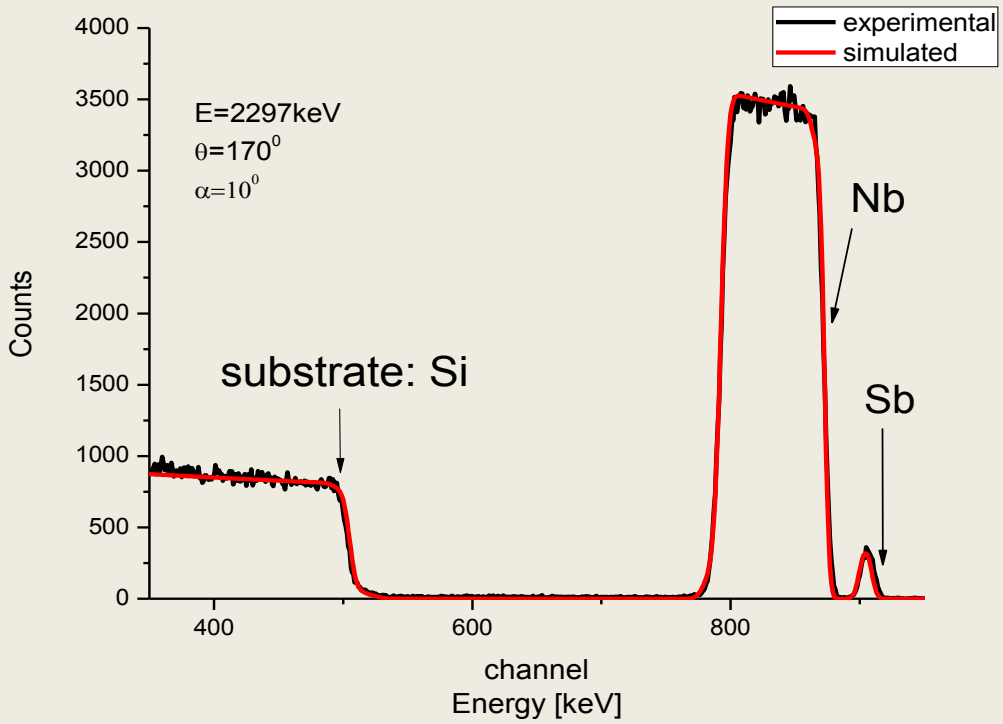
$$K = \frac{M_1^2}{(M_1 + M_2)^2}\left\{\cos\theta \pm \left[\left(\frac{M_2}{M_1}\right)^2 - \sin^2\theta\right]^{1/2}\right\}^2$$

- Cross-section

$$\sigma_i = \left(\frac{Z_1 Z_i e^2}{2E\sin^2\theta}\right)^2 \frac{\left\{\cos\theta + \left[1 - (M_1/M_i)^2\sin^2\theta\right]^{1/2}\right\}^2}{\left[1 - (M_1/M_i)^2\sin^2\theta\right]^{1/2}}$$

RBS

Program used for the analysis of experimental results was SIMNRA



Experimental condition

- Calibration
  - Offset=27.95keV
  - Energy/channel=2.185
- Number of particles
  - 1.56E11
- Thickness
  - Nb =161nm

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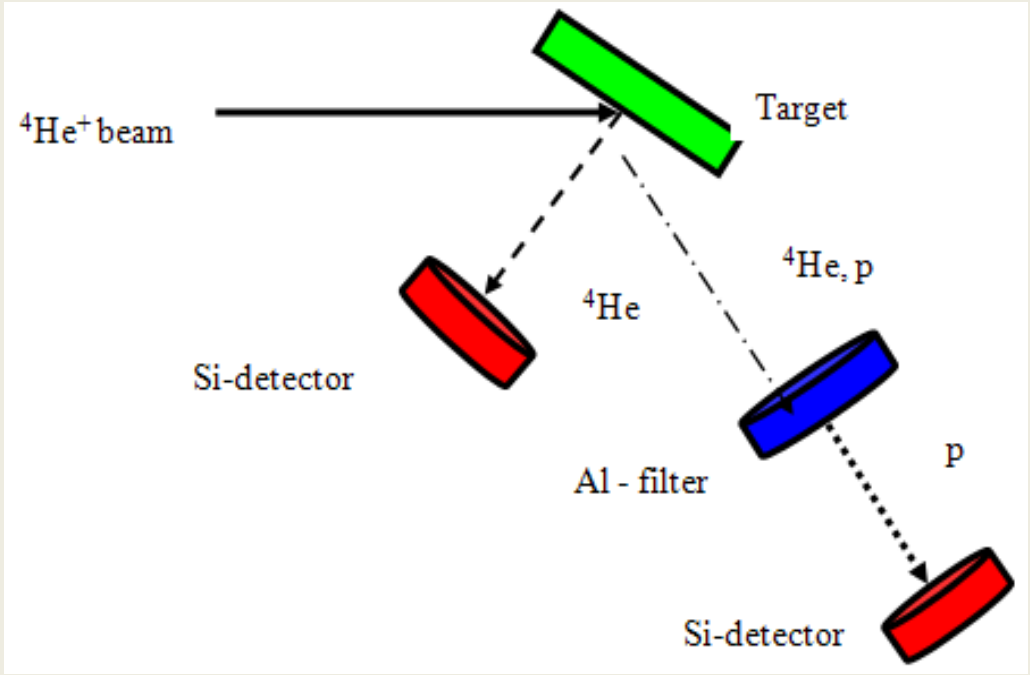
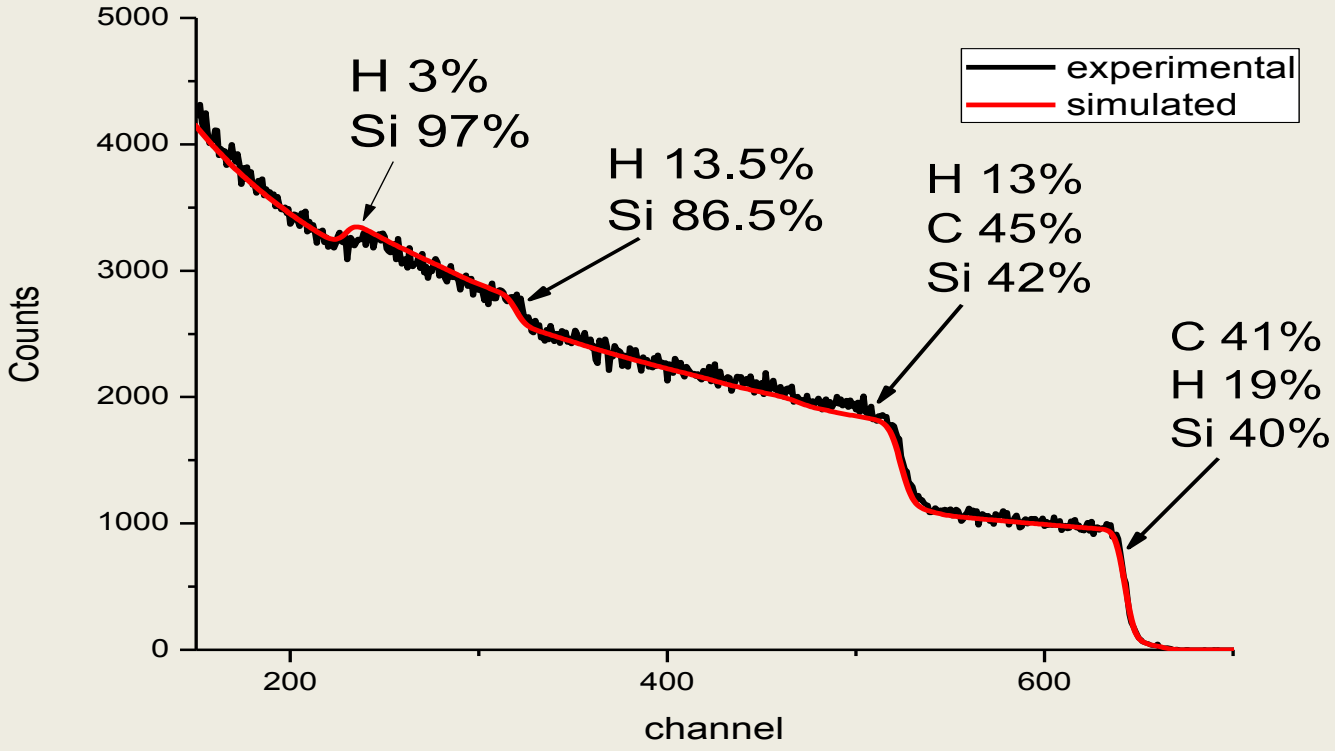
Part 3:ERD-Elastic Recoil Detection

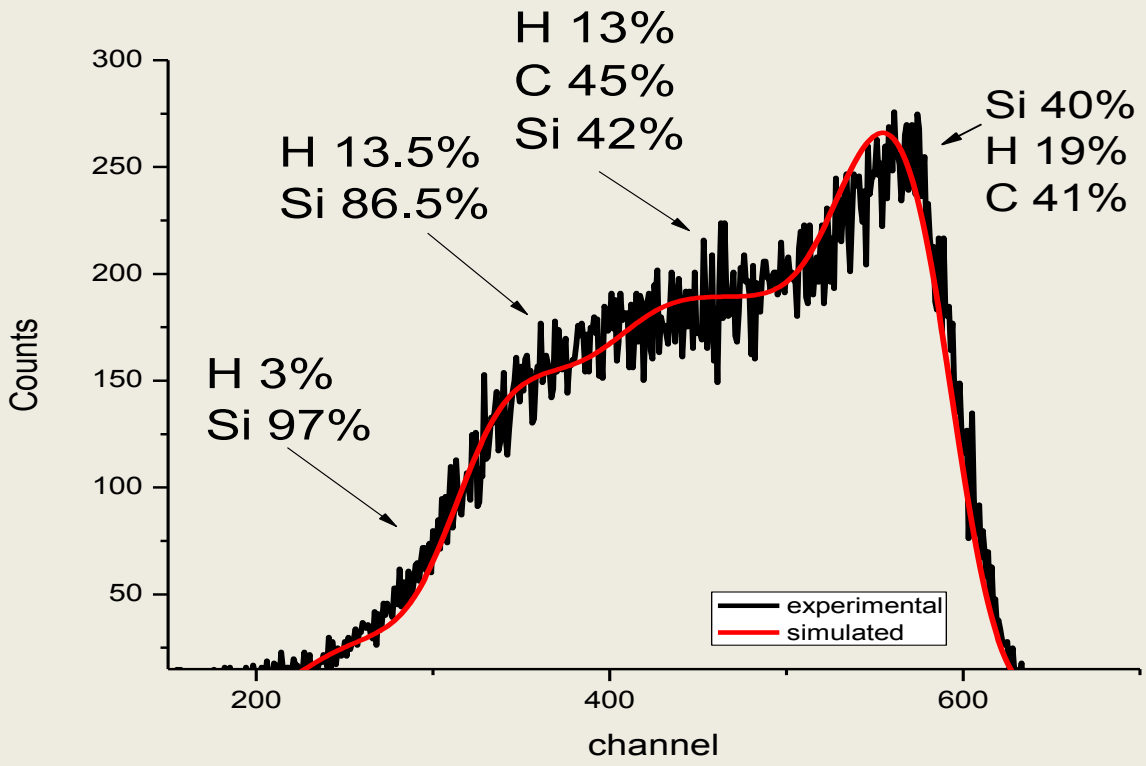


- Forward Recoil
- Good for light elements(H,D)
- Al foil

RBS


5000
4000
3000
2000
1000
0
Counts
200
400
600
channel
experimental
simulated
H 3%
Si 97%
H 13.5%
Si 86.5%
H 13%
C 45%
Si 42%
C 41%
H 19%
Si 40%

ERD


H 13%
C 45%
Si 42%
H 13.5%
Si 86.5%
Si 40%
H 19%
C 41%
H 3%
Si 97%
experimental
simulated
Counts
channel
300
250
200
150
100
50
200
400
600

Conclusion

- Three methods were used in order to obtain information about elements depth contents for different elements from hydrogen to barium

- Sensitivity of method for heavy elements less than 0.001 atomic %

Acknowledgements

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Thanks for your attention

From left to right : Dr A.P Kobzev, Sintwa Nolufundo, Lukhwa Rendani, Sinazo Mselana and Dr Mirosław Kulik