

Evaluation of different materials as potential trigger foils for MCP detectors

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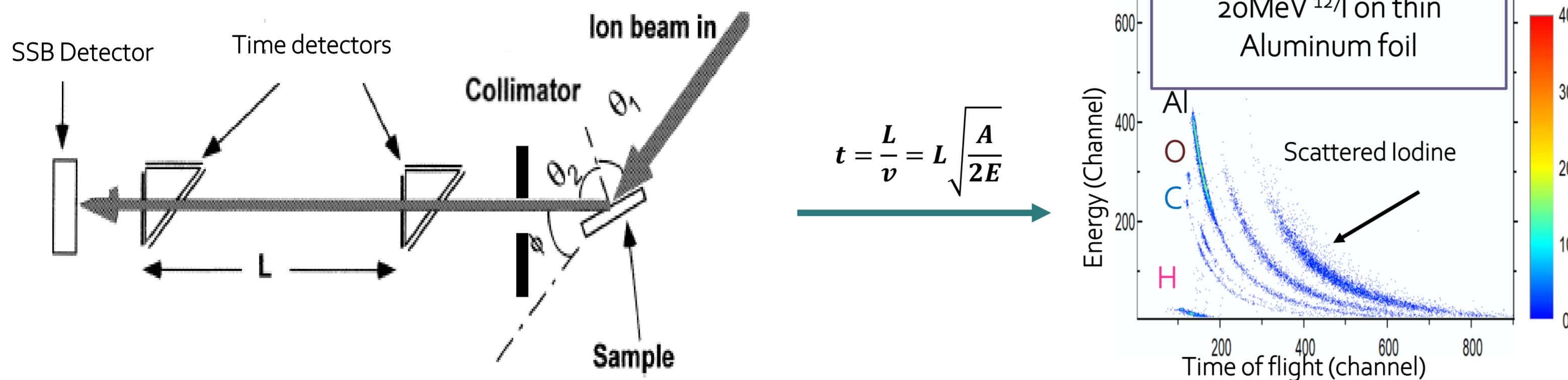
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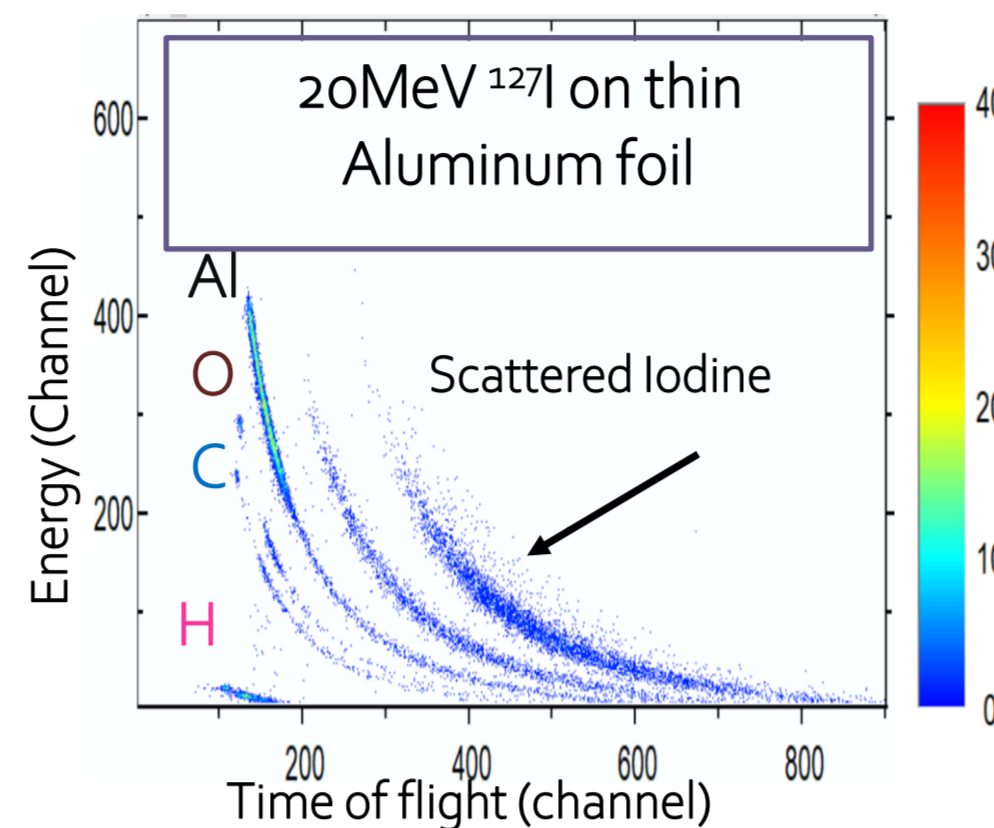
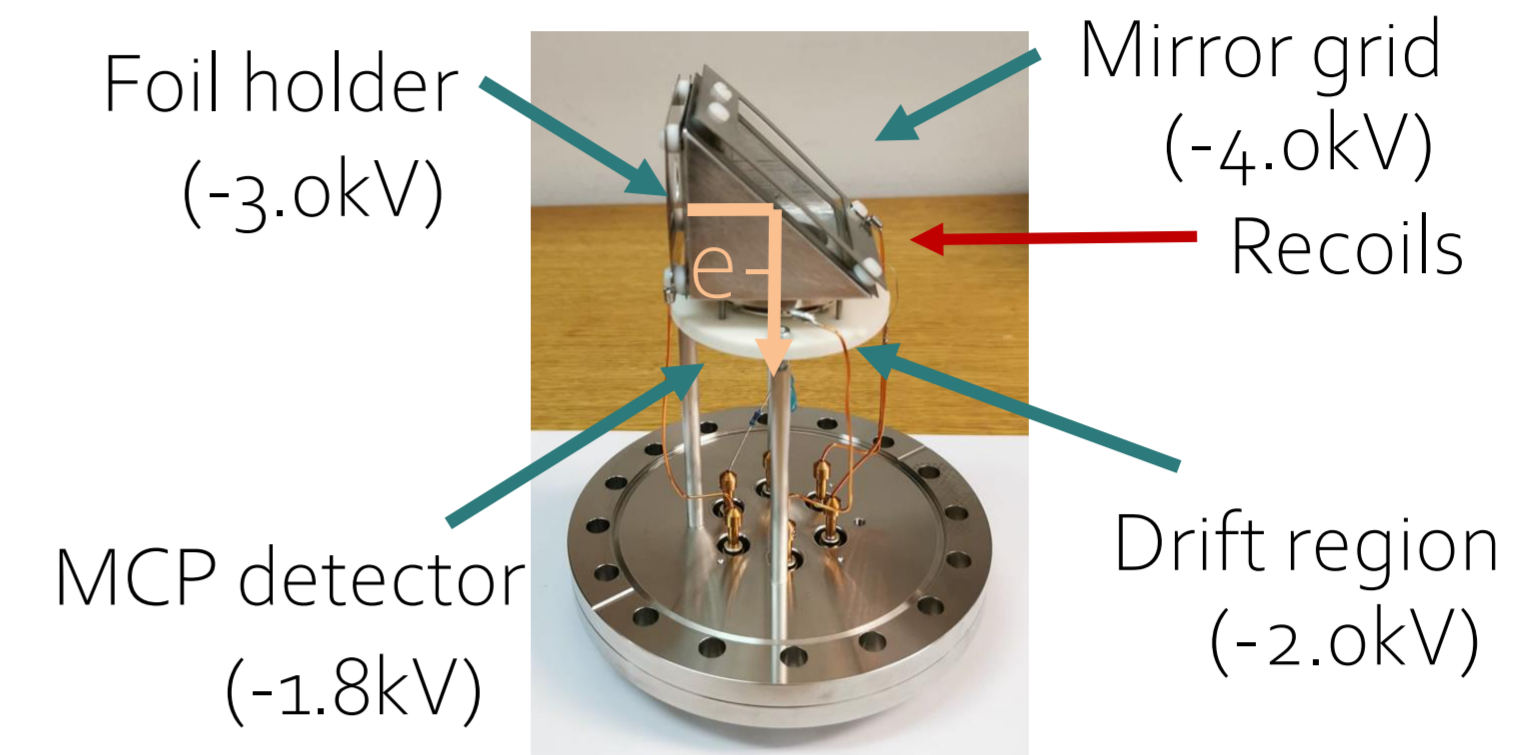
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Introduction

Time of Flight-Elastic Recoil Detection Analysis (ToF-ERDA) experimental setup was recently installed at the Tandem Laboratory of N.C.S.R. "Demokritos". For the determination of the *time-of-flight* of each recoil, two Multichannel Plate (MCP) detectors are used.



- A very thin carbon foil is affixed in Busch configuration with each of the MCP's
- Recoils produce secondary electrons while passing through the foil and the MCP is triggered



The problem!

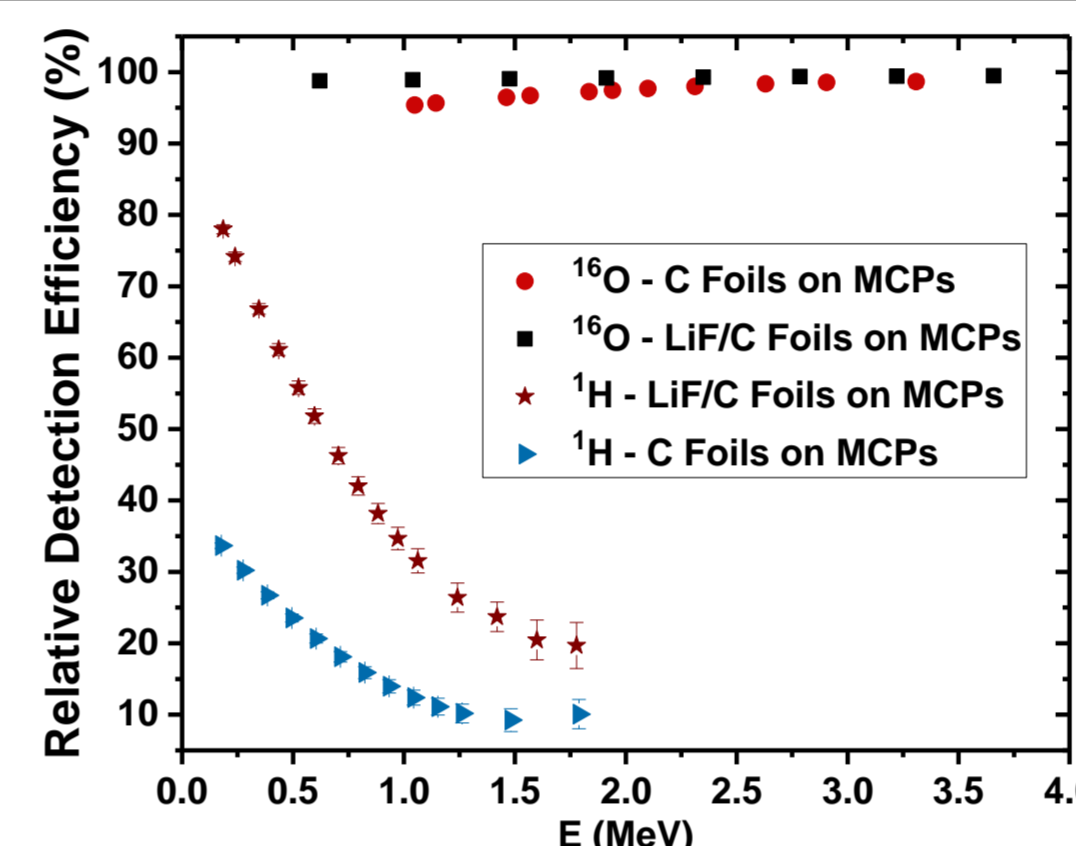
The yield of the produced electrons from the MCP foil → **Strongly dependent on energy loss!**

Therefore:

- Hydrogen, deuteron, lithium, ... & ... up to oxygen
- **Low energy loss** → **Reduced yield of emitted electrons**
- **Decreased detection efficiency for ToF-ERDA setup**

The Solution!

Deposition of thin layers of LiF or Al₂O₃ on carbon foils → **Leads to detection efficiency increment by up to 35%!**



The Demand!

Evaluate **different materials** as potential trigger foils for the MCP detectors

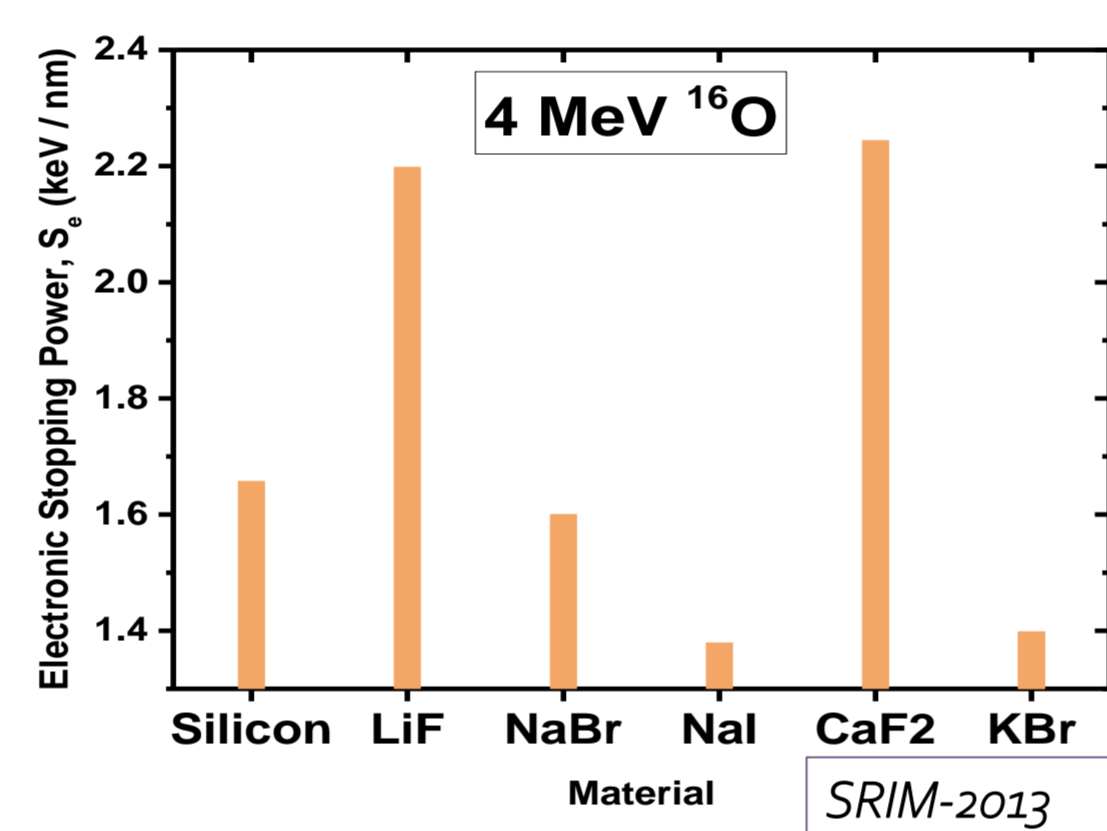
→ Leading to higher Hydrogen & low mass elements detection efficiency of ToF-ERDA

Candidate materials

The secondary electron yield, γ , is given by:

$$\gamma = \Lambda^* \cdot S_e$$

where, S_e is the electronic stopping power & Λ^* defined as "material parameter"



- LiF
 - NaBr
 - KBr
 - NaI
 - CaF₂
- Constructed through evaporation technique (tandem laboratory of N.C.S.R. "Demokritos")
 - Thickness: ~ 7-20 nm
 - Substrate: Thick amorphous Silicon wafer
 - Fully characterised through IBA techniques
 - Comparison of electron emission at the single ion hit detection setup (tandem accelerator of Ruđer Bošković Institute)

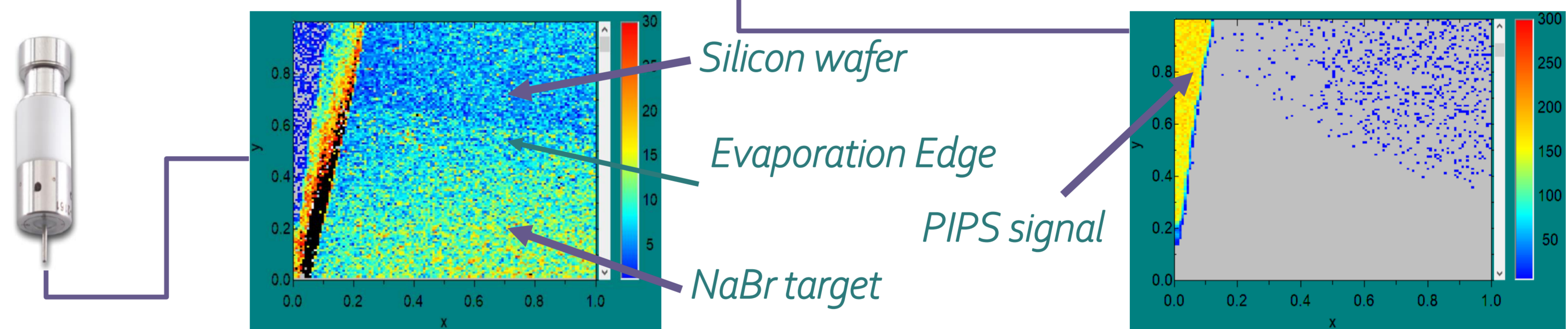
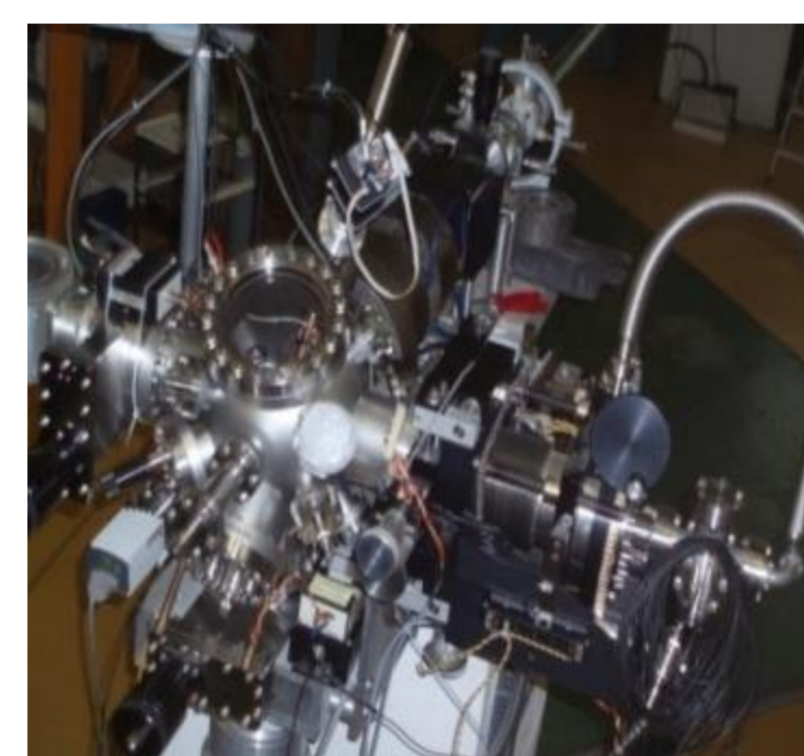
Experimental Setups

Target characterisation:

- Dual Microprobe setup of laboratory for Ion Beam Interactions at RBI
- 3 MeV α -beam for RBS (135° det. angle)
- 2 MeV p-beam for PIXE / PIGE
- Goniometer chamber of tandem accelerator at INPP - 11.9 MeV
- ⁶³Cu-beam for ToF-ERDA

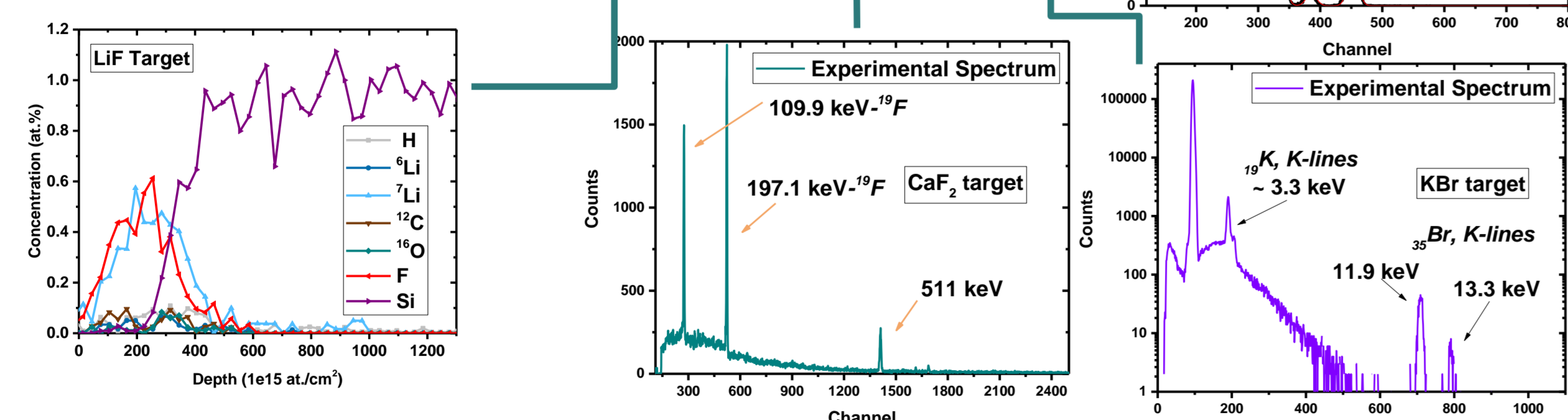
Secondary Electron Emission detection:

- Ion Microprobe of laboratory for Ion Beam Interactions at RBI
- ✓ 4 MeV Oxygen Beam
- ✓ Current: ~1 kHz
- ✓ CEM placed at 45°, 2mm away from the target
- ✓ PIPS placed on beam axis behind the target position for normalisation purposes
- ✓ Intensity maps of CEM & PIPS recorded while beam was scanning between target and energy detector



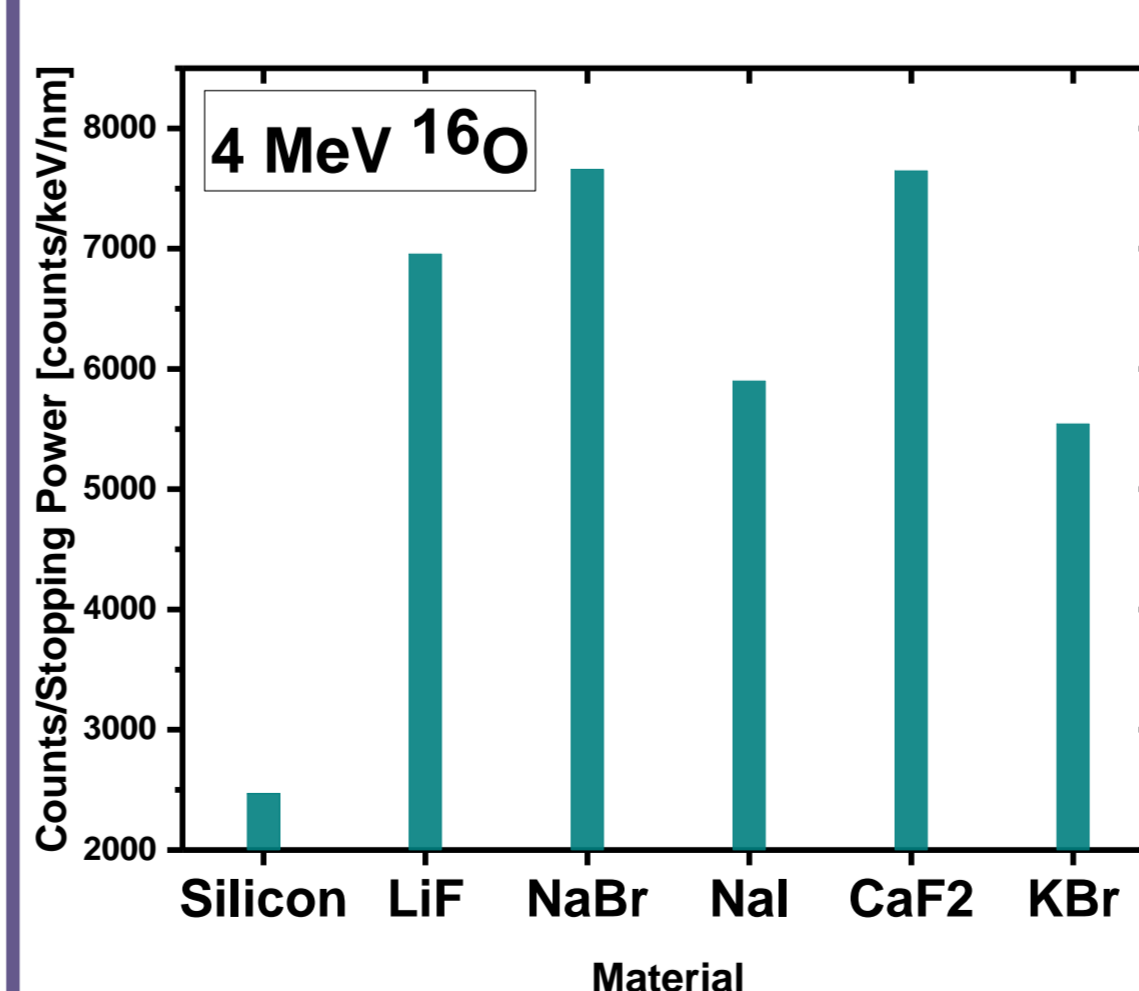
Target Characterisation

- α -RBS → SIMNRA 7.03
- PIXE → GUPIXWIN 2.2.4
- PIGE → SPECTRW
- ToF-ERDA → Potku 2.3.2 beta7



IBA Technique	a-RBS	PIGE	PIXE	ToF-ERDA	*Uncertainty <10% in all cases
Material					
	Thickness [nm]		Conc. At. %		Energy Loss [keV]
LiF	-	19.6	-	50 Li / 50 F	43.31
NaBr	7.4	-	7.4	55 Na / 45 Br	12.04
CaF ₂	16.3	19.3	17.6	65 F / 40 Ca	43.56
NaI	19.0	-	17.5	78 Na / 22 I	27.81
KBr	21.8	-	21.6	-	30.79

Results



- ✓ CaF₂ & NaBr seem to be promising candidates
- ✓ More theoretical investigation for the validation of the results needs to be done
- ✓ Deeper investigation for the valid implementation of the results in ToF-ERDA setup due to straggling
- ✓ Construction of new foils suitable for the experimental setup & evaluation of the final detection efficiency of the spectrometer