

Preparation of the measurement of the $^{39}\text{K}(n, cp)$ reaction cross section at n_TOF

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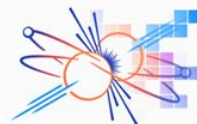
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⁸www.cern.ch/ntof



This measurement is a part of new EU project – **APRENDE** (Addressing PRiorities of Evaluated Nuclear Data in Europe), HORIZON-EURATOM-2023



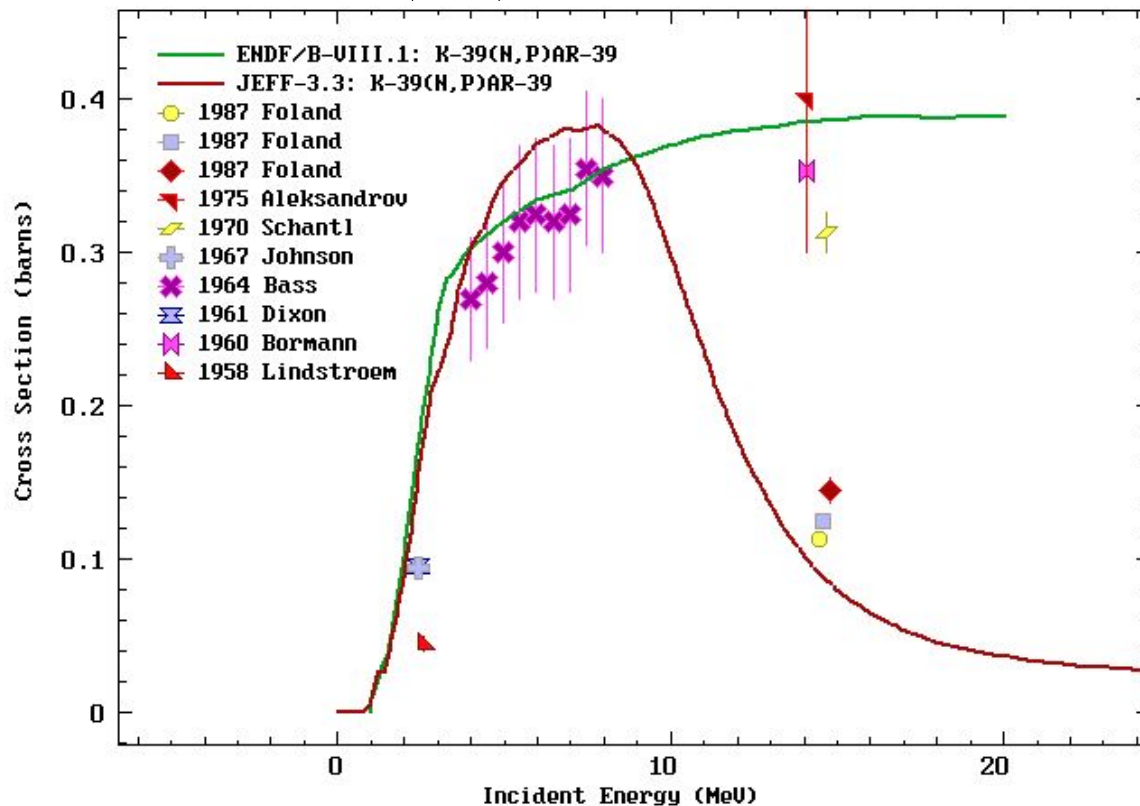
APRENDE

Motivation

- NEA high priority request – differential cross section measurements for $^{39}\text{K}(n,p)$ oraz $^{39}\text{K}(n,np)$ for energies 10-20 MeV with 10% accuracy [\[1\]](#)
- the results are crucial for the development of fast-neutron and fusion reactors that will use a sodium-potassium alloy as coolant
- the current experimental and evaluation data in the high energy region is scarce and inconsistent

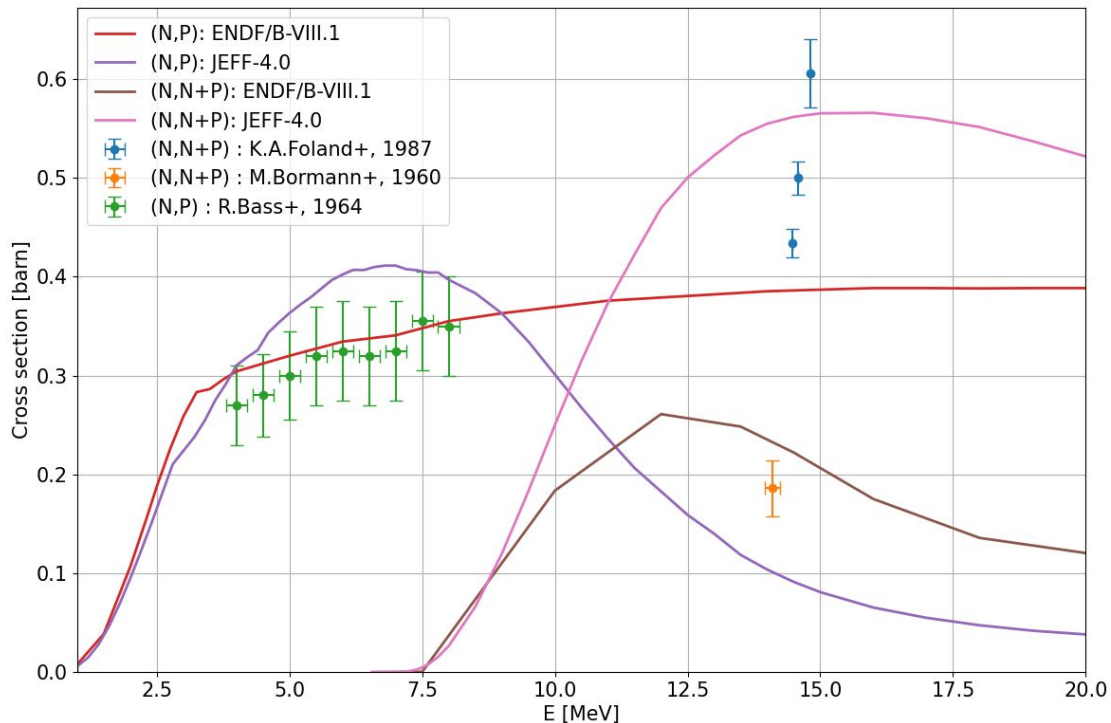
$^{39}\text{K} (n,p)$

$$Q_{(n,p)} \approx 0.2 \text{ MeV}$$



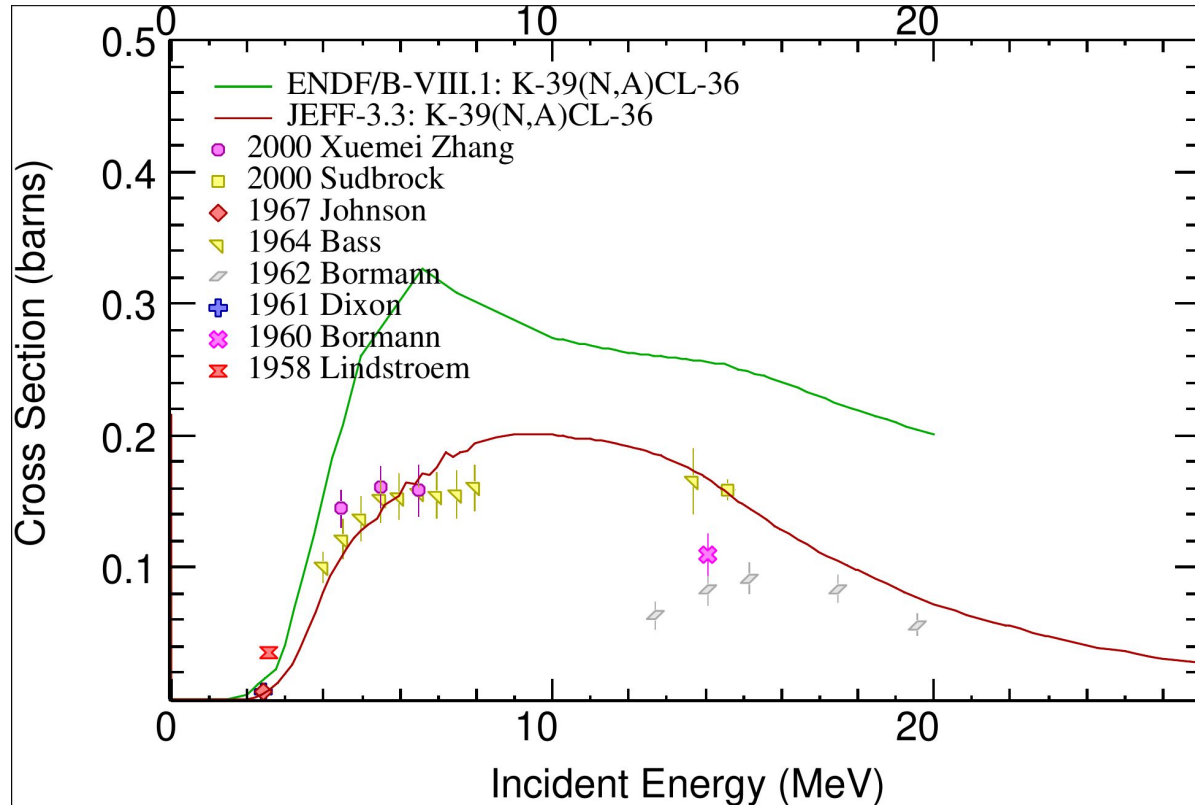
$^{39}\text{K} (n,p)$ vs $^{39}\text{K} (n,np)$

$$Q_{(n,np)} \approx -6.4 \text{ MeV}$$



$^{39}\text{K} (n,\alpha)$

$$Q_{(n,\alpha)} \approx 1.4 \text{ MeV}$$



Aim

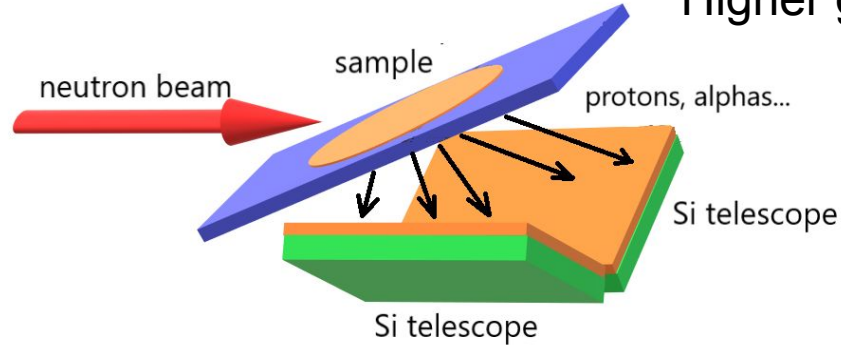
- $^{39}\text{K}(n,p)$ reaction cross section measurement for 5-15 MeV neutron energies
- potentially also $^{39}\text{K}(n,\alpha)$
- potentially also $^{39}\text{K}(n,np)$ and up to 20 MeV
- potentially also angular distribution

Preparation plan

- construct setup prioritizing efficiency and particle differentiation
- prepare the target for the experiment
- conduct a test experiment

V setup

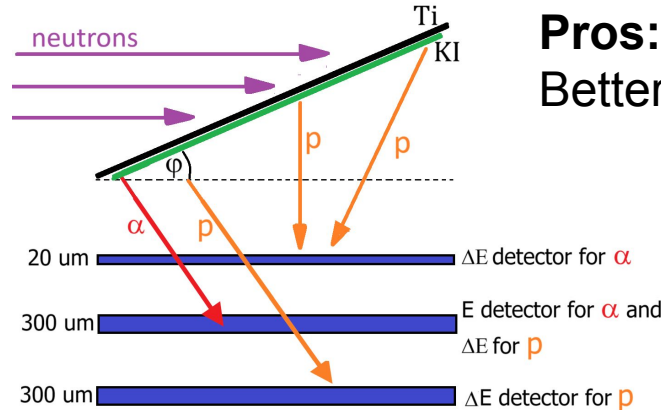
Geometric efficiency:
7.5-10%



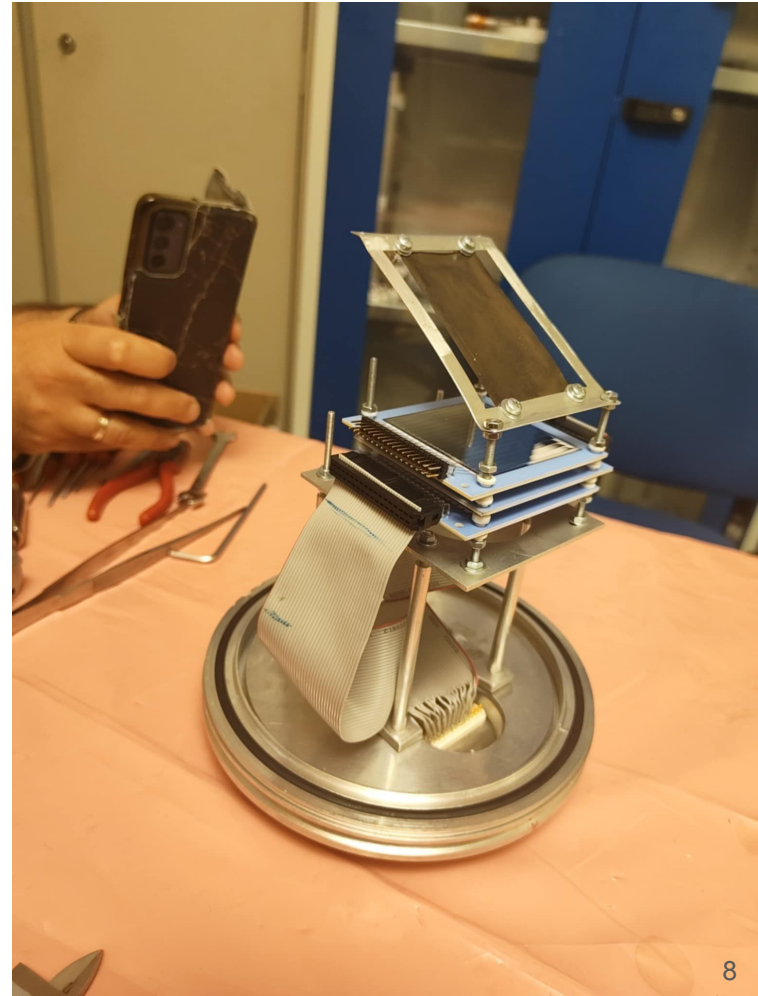
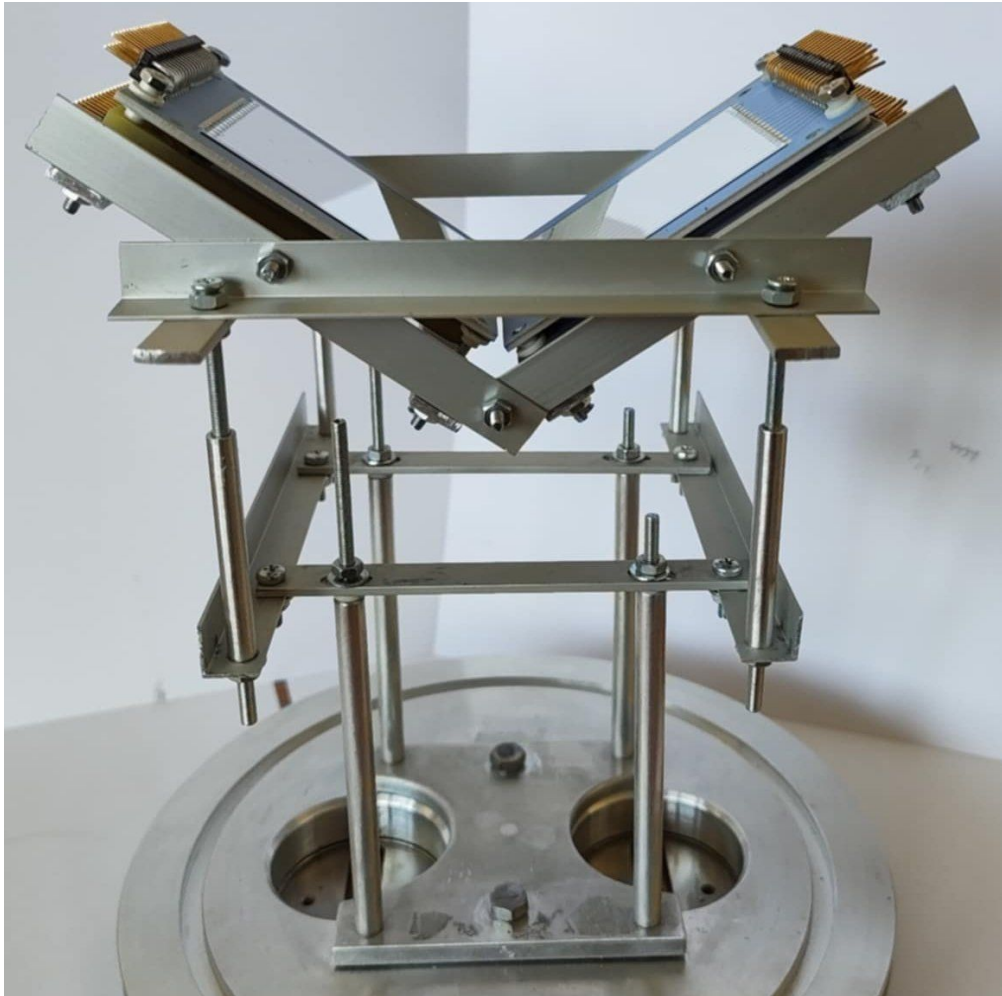
Pros:
Higher geometrical efficiency

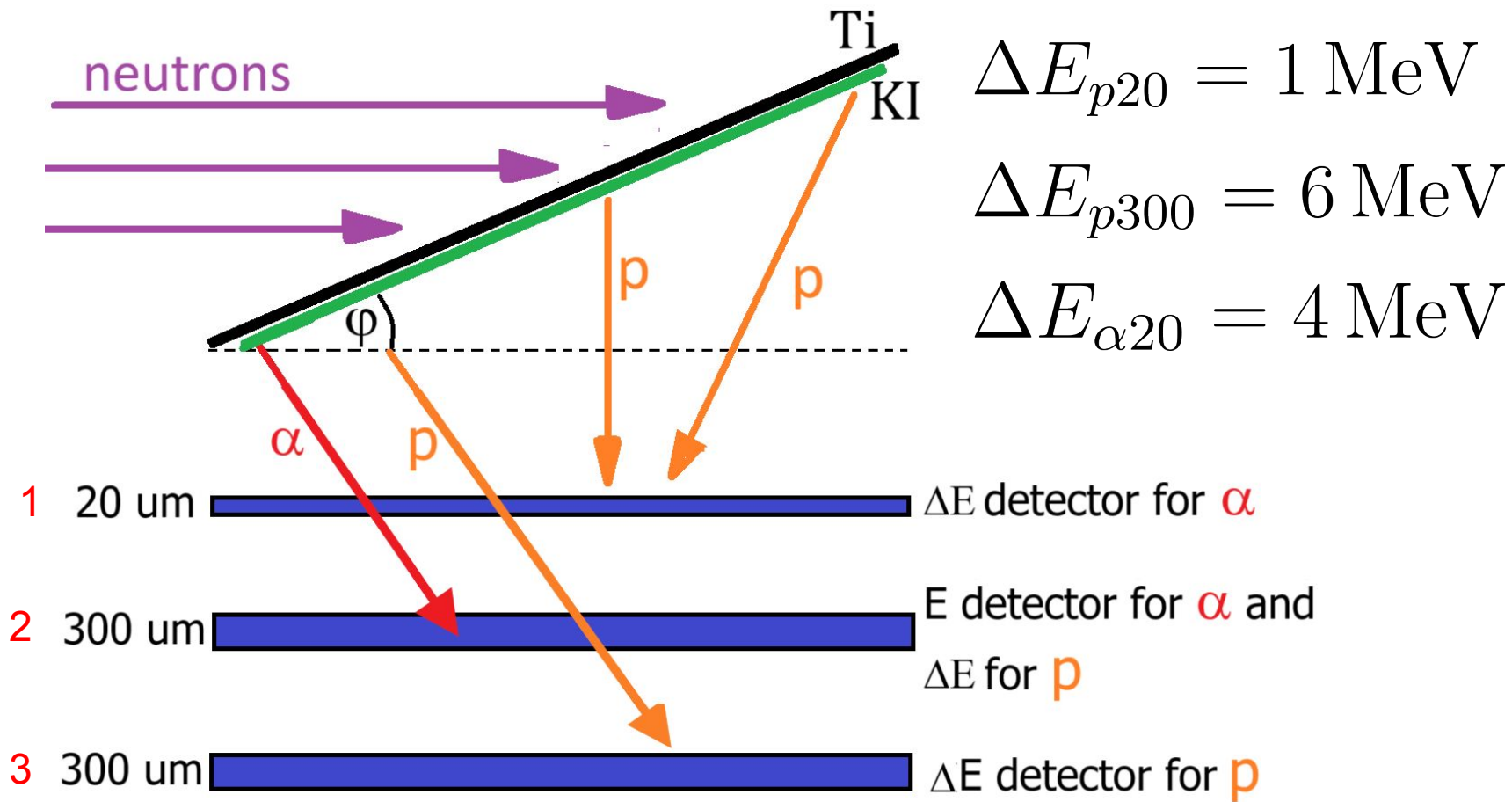
“Normal” setup

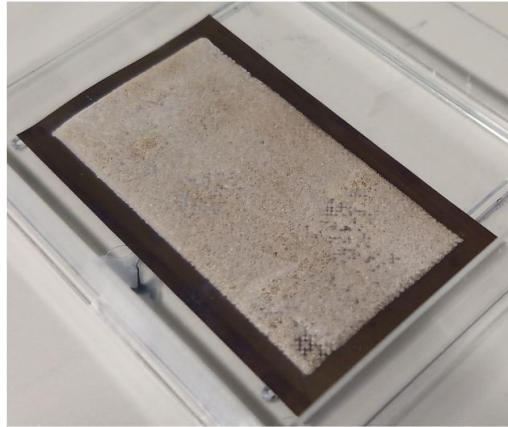
Geometric efficiency:
5.5-7%



Pros:
Better particle differentiation

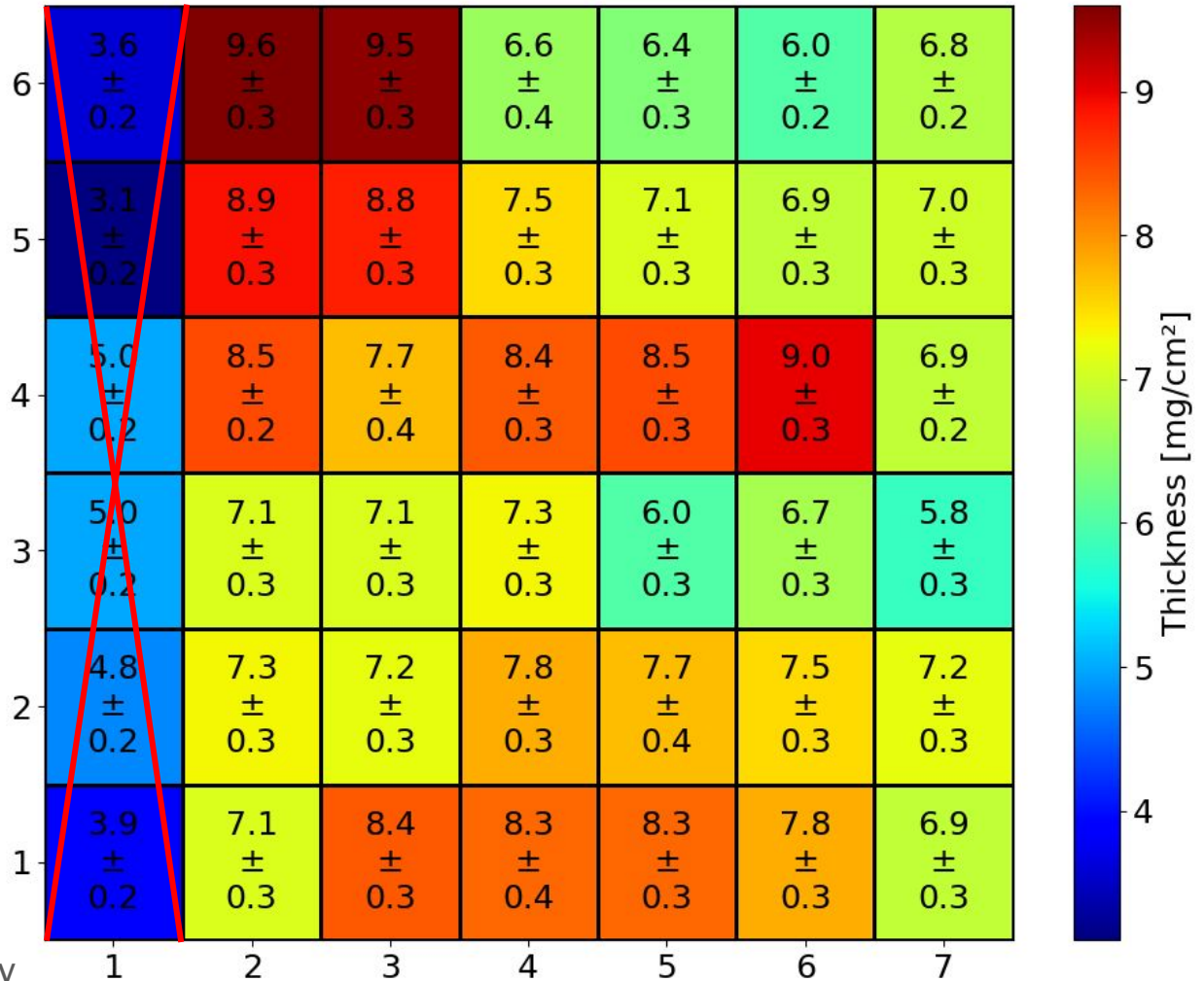






KI: $(7.1 \pm 0.3) \text{ mg/cm}^2$
 $3 \times 6 \text{ cm}^2$

Ti: $22 \mu\text{m}$
 $4 \times 7 \text{ cm}^2$



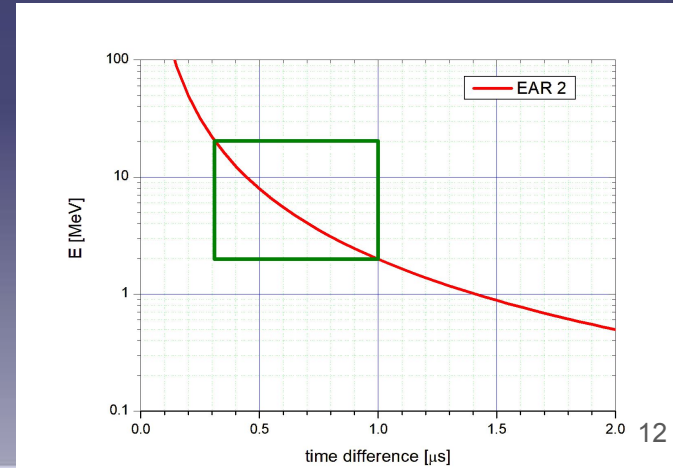
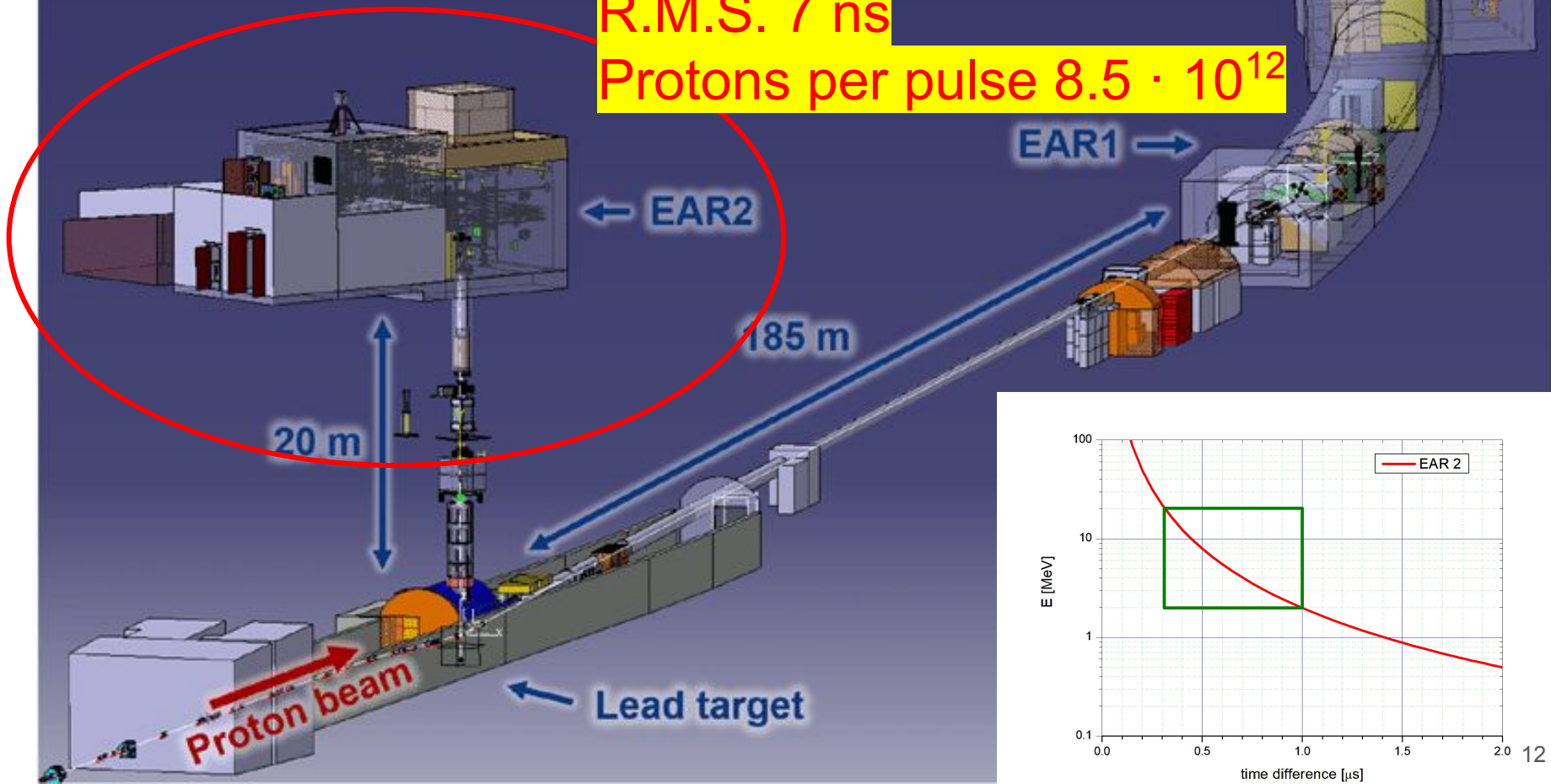
Test goals

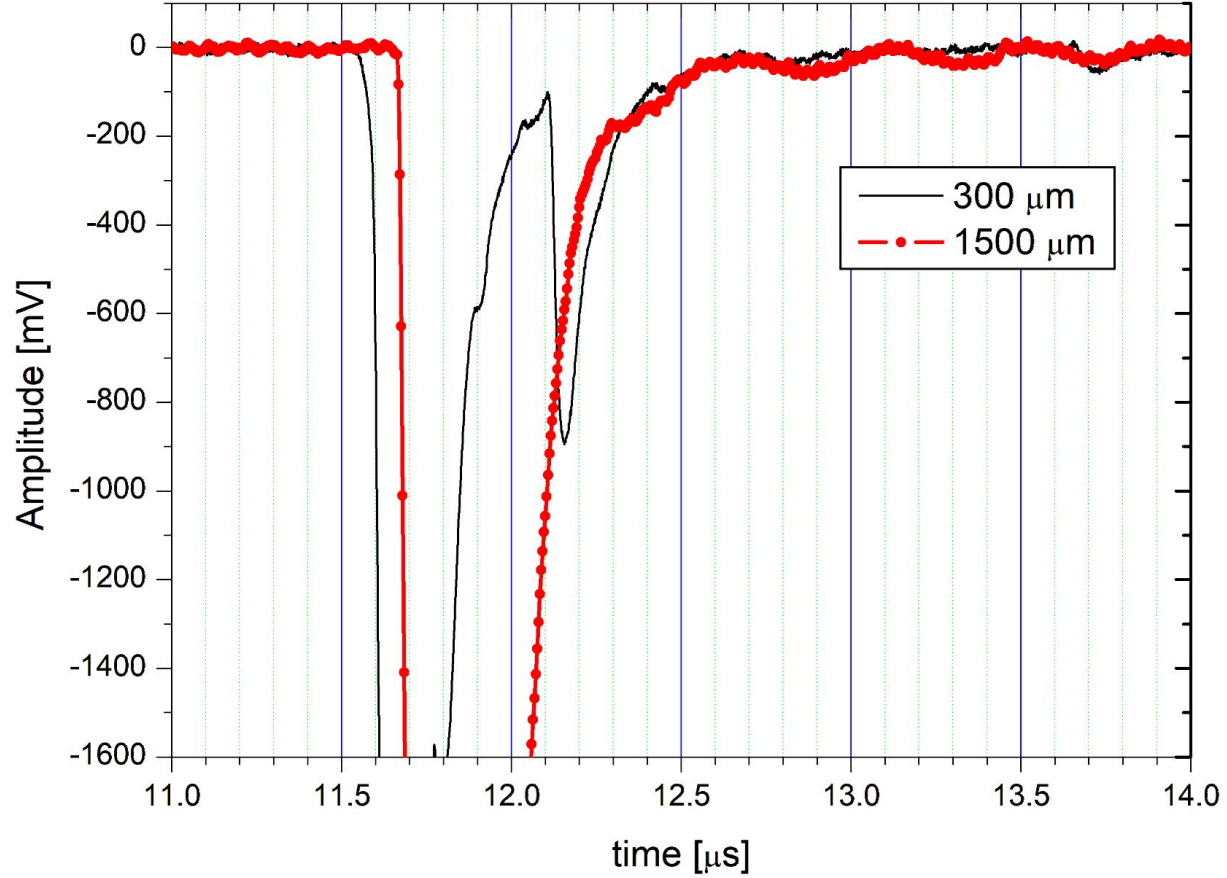
- Check if Ti backing is not giving too high noise
- Determine which one of 2 setups to use
- Check if we can use 1500 μm detector in this experiment
- Calculate the beam requirements for the experiment

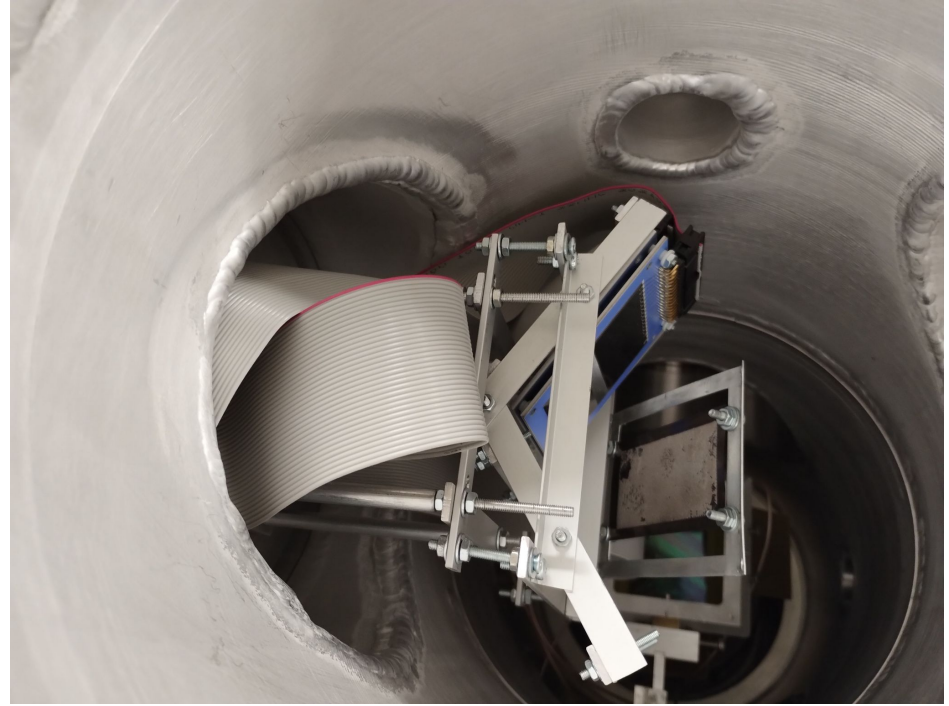
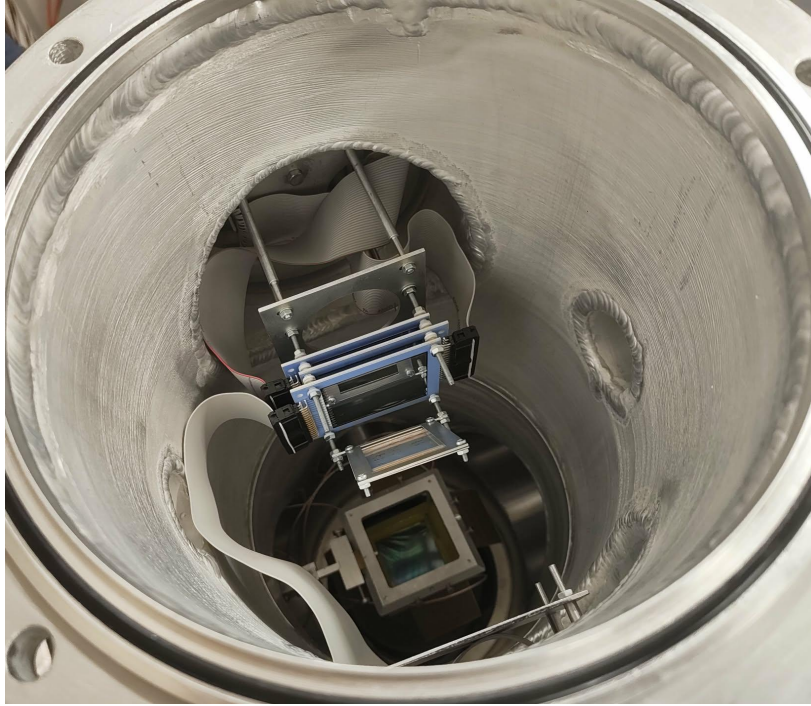
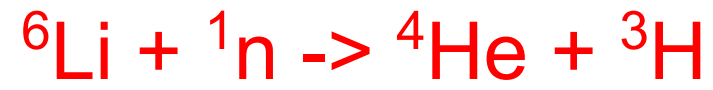
Proton Energy 20 GeV

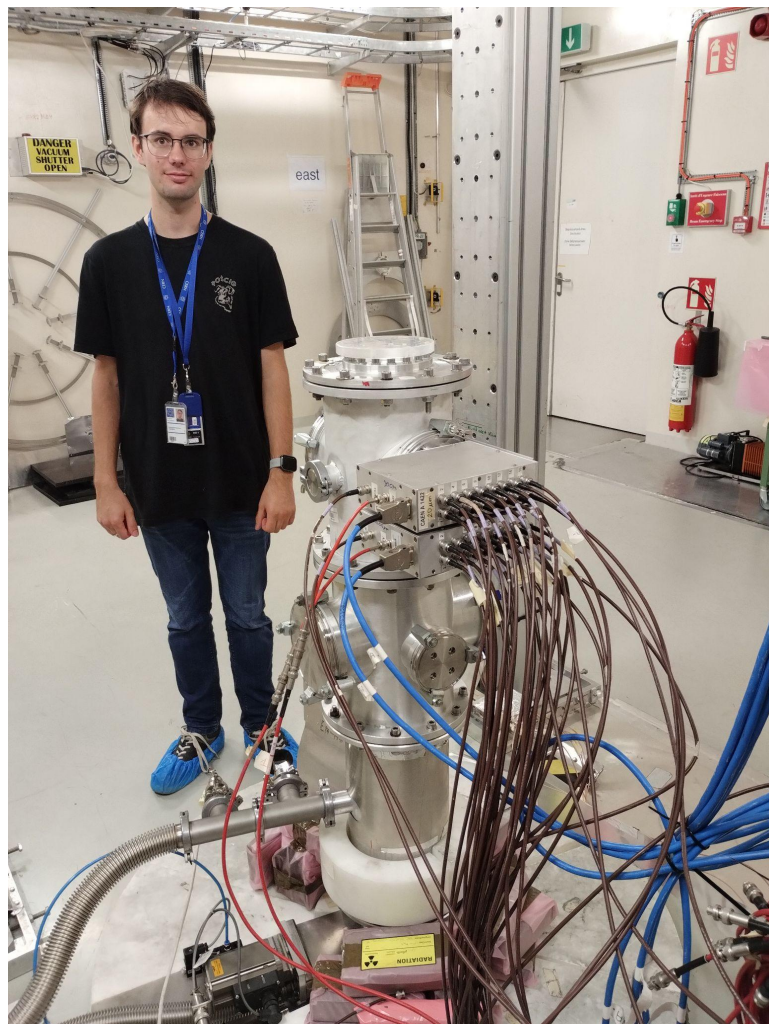
R.M.S. 7 ns

Protons per pulse $8.5 \cdot 10^{12}$





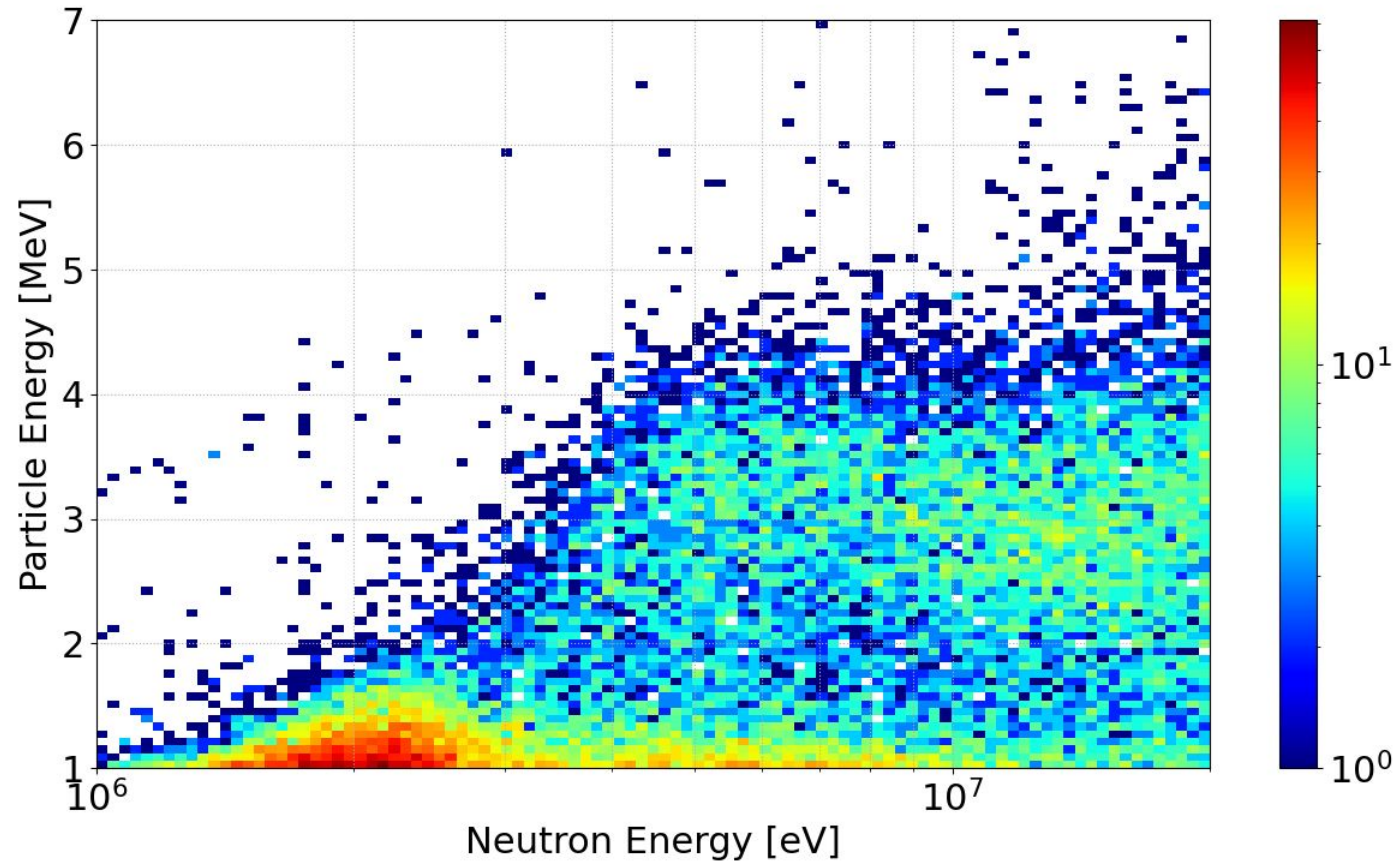




1st - 9th july 2025

measurement	protons
V-setup	$3.8 \cdot 10^{17}$
N-setup	$4.5 \cdot 10^{17}$
Ti backing	$2.5 \cdot 10^{17}$
sum	$1.1 \cdot 10^{18}$

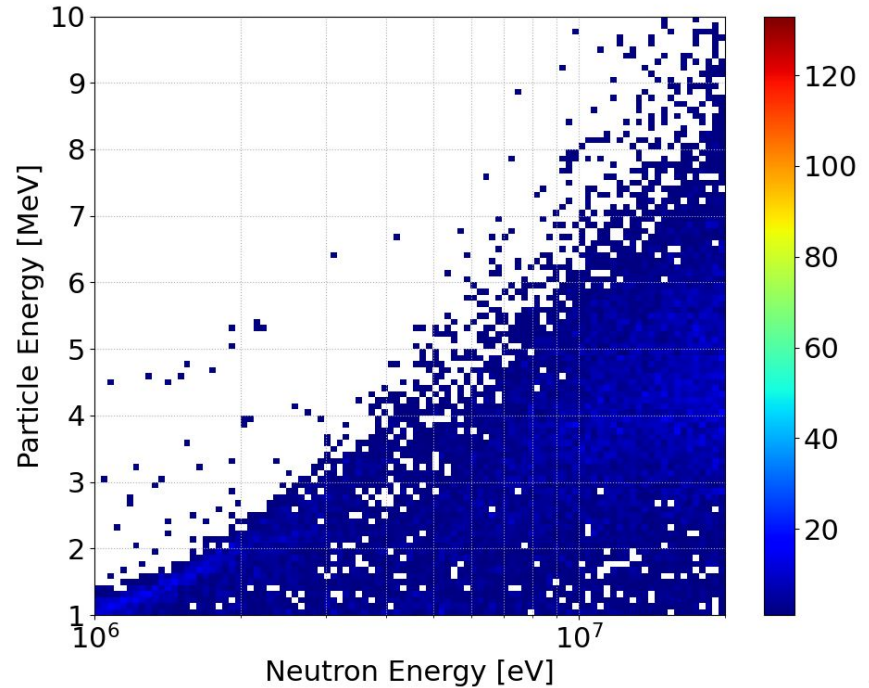
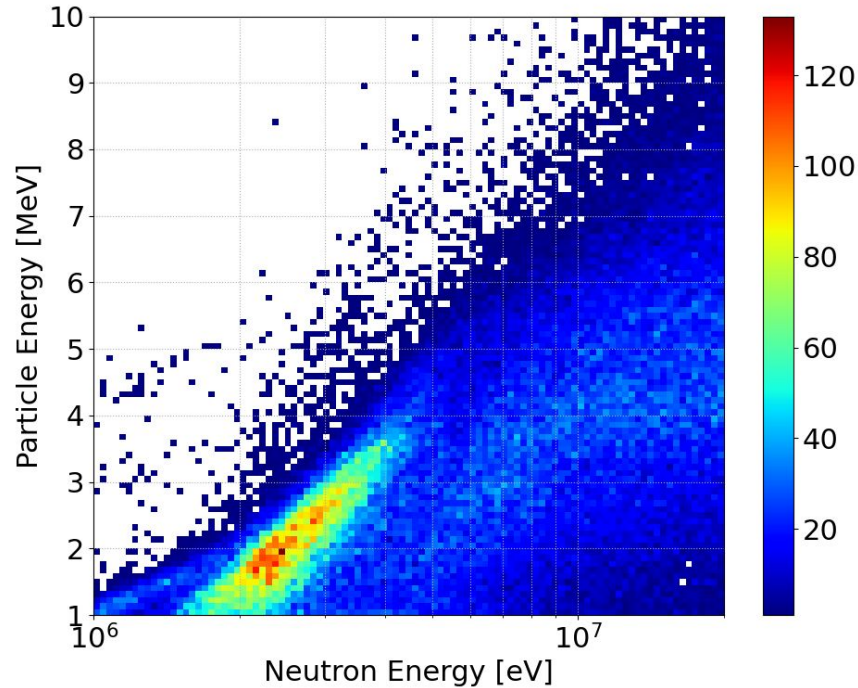
20 μm detector



The first 300 μm detector

KI+Ti

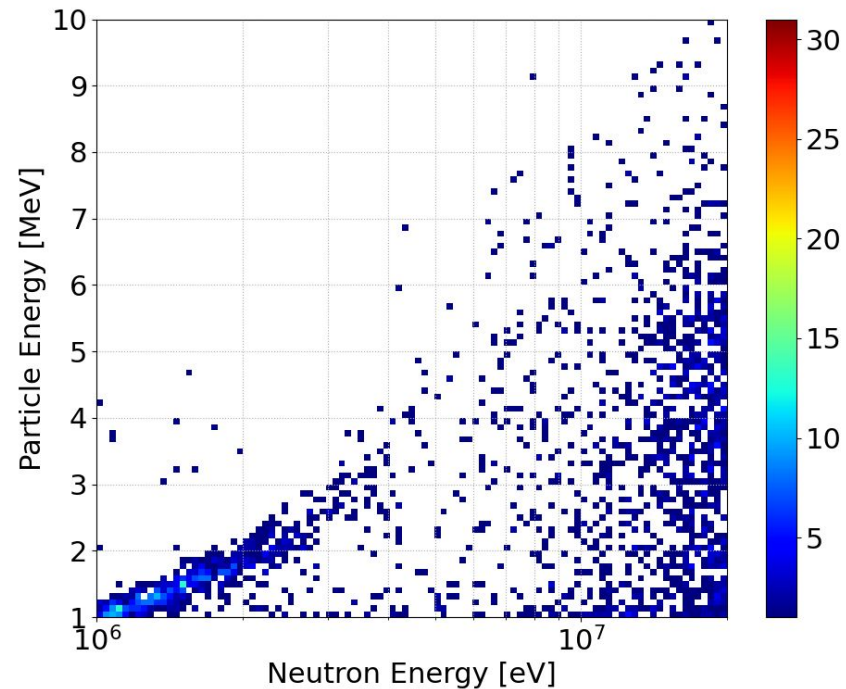
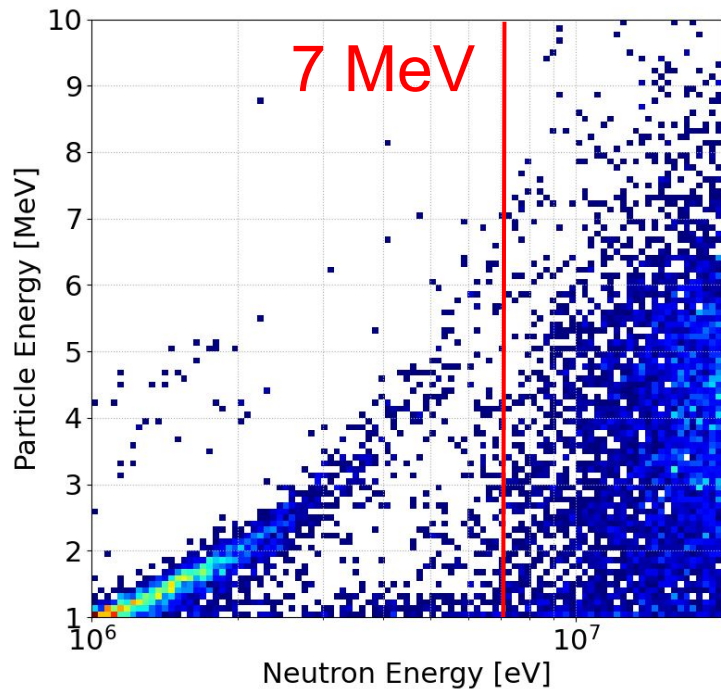
Ti



The 2nd 300 μm detector

KI+Ti

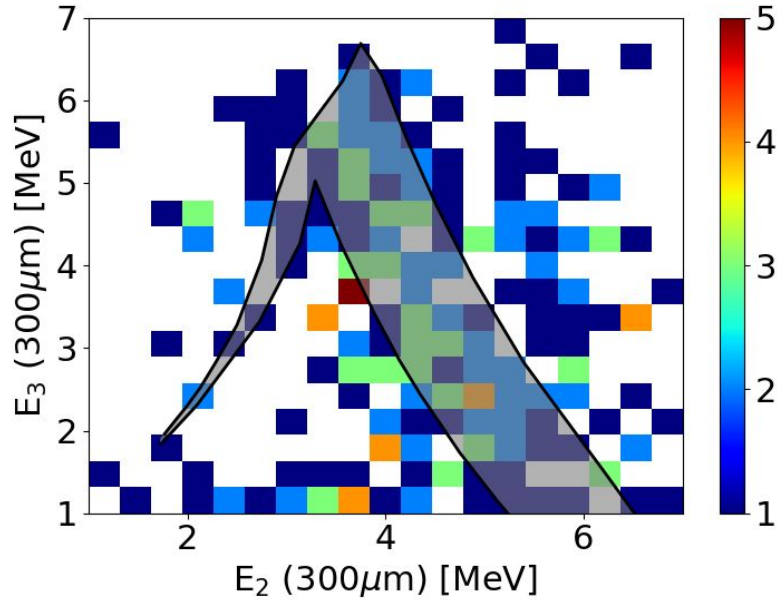
Ti



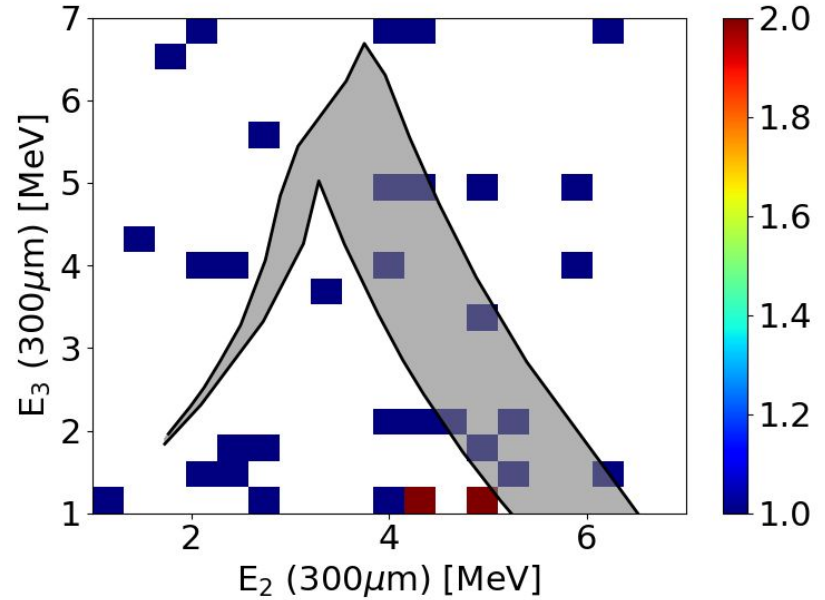
Proton coincidence

For neutron energies 5-15 MeV

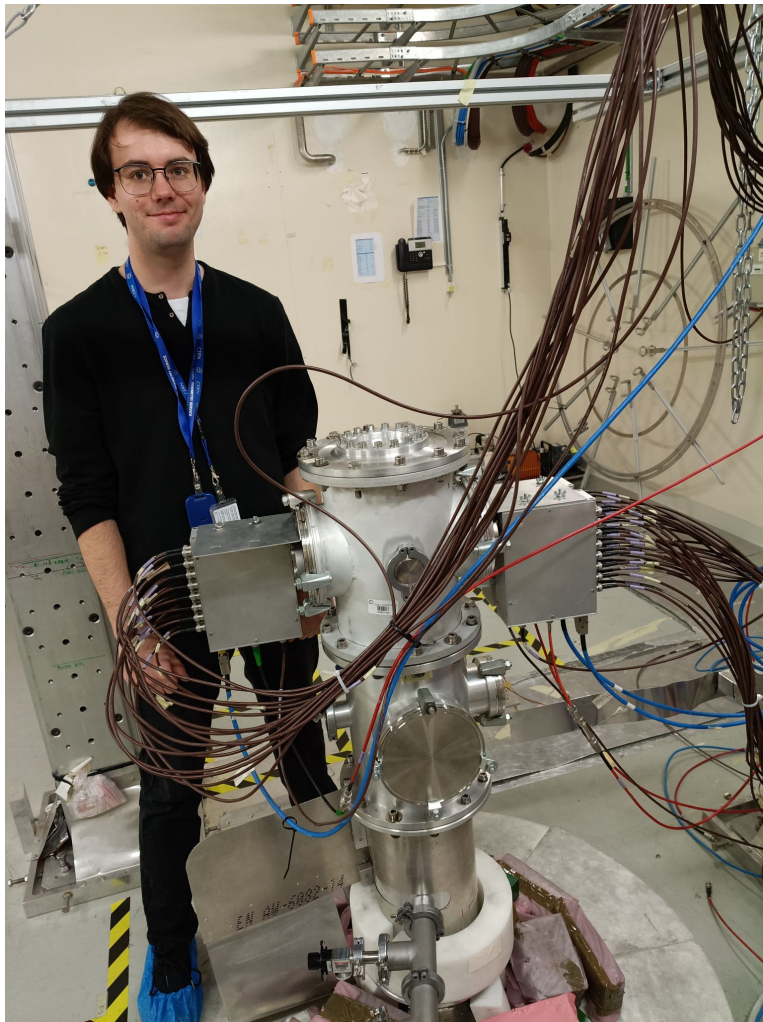
KI+Ti



Ti

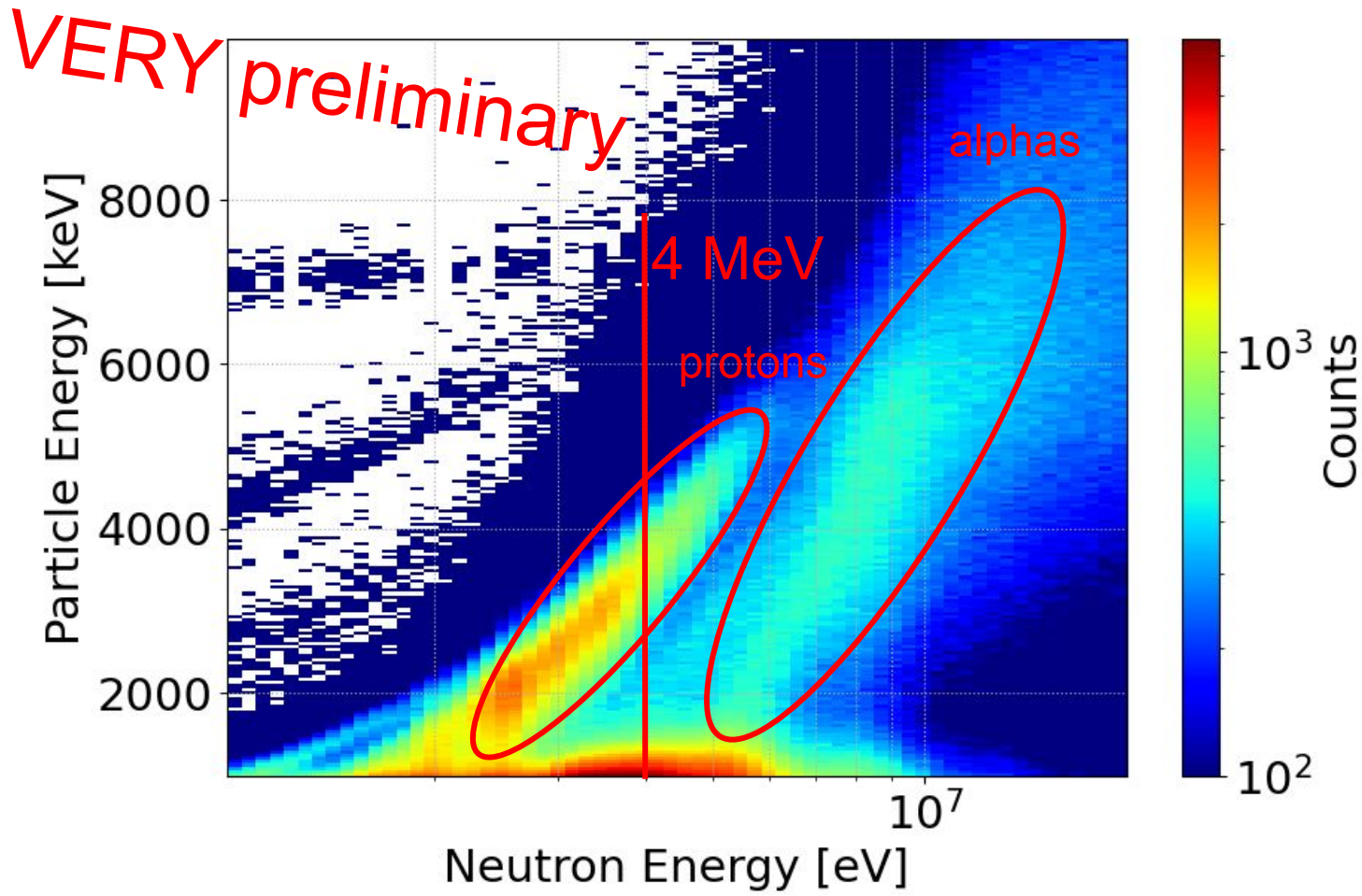


10th march - 5th may 2026

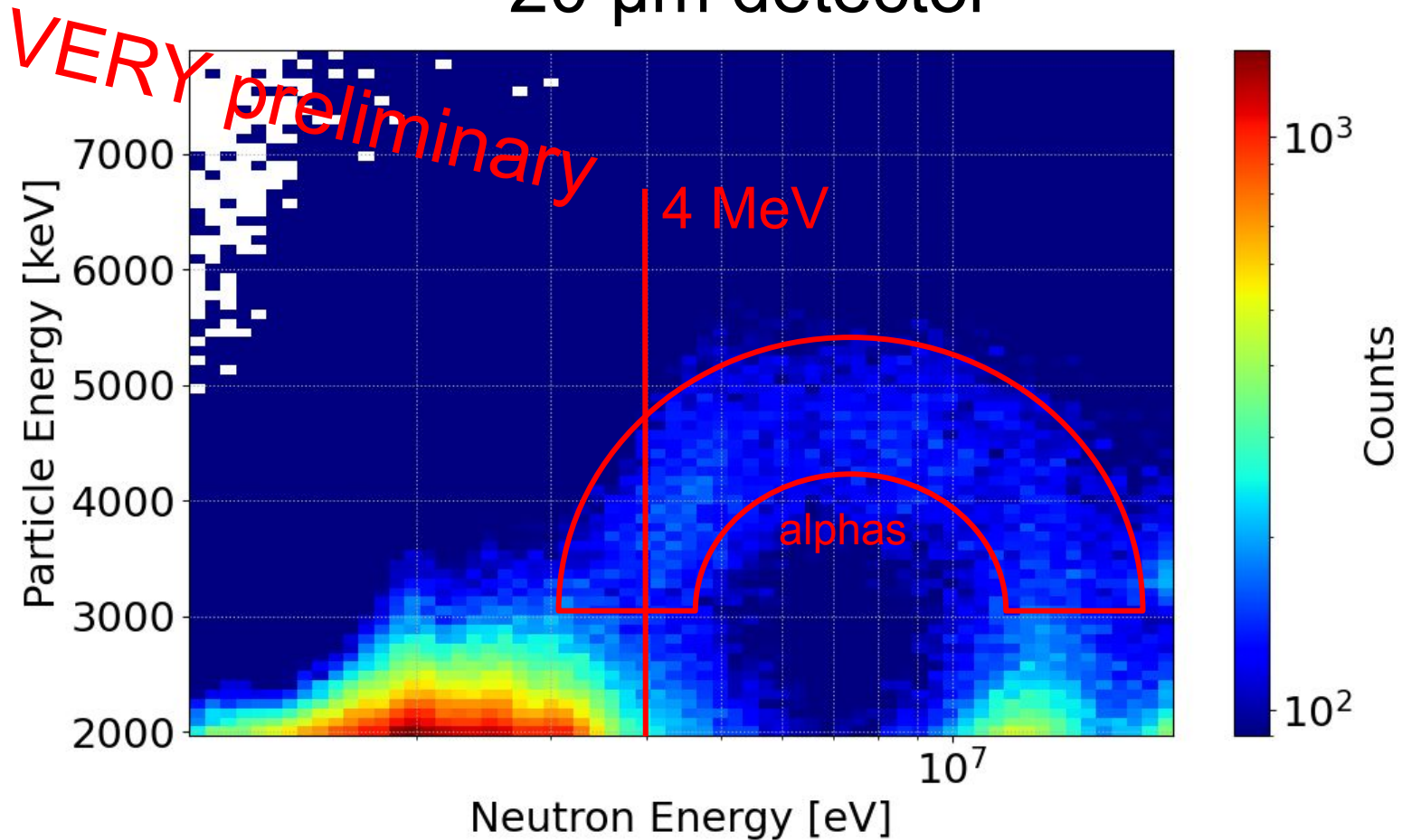


measurement	protons
Li	$0.25 \cdot 10^{18}$
KI	$5 \cdot 10^{18}$
Ti	$2.5 \cdot 10^{18}$
sum	$7.75 \cdot 10^{18}$

First 300 μm detector

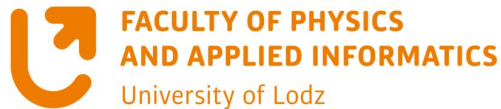


20 μm detector



Conclusions

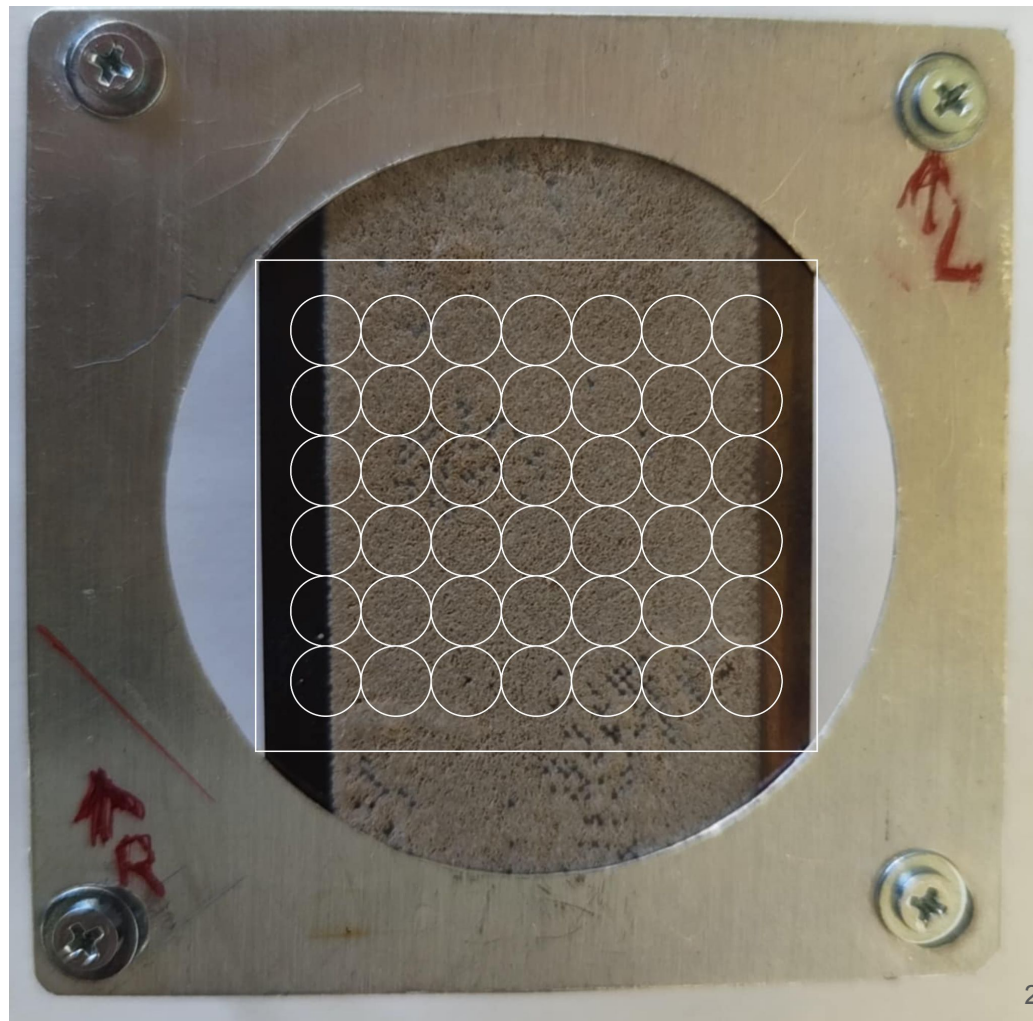
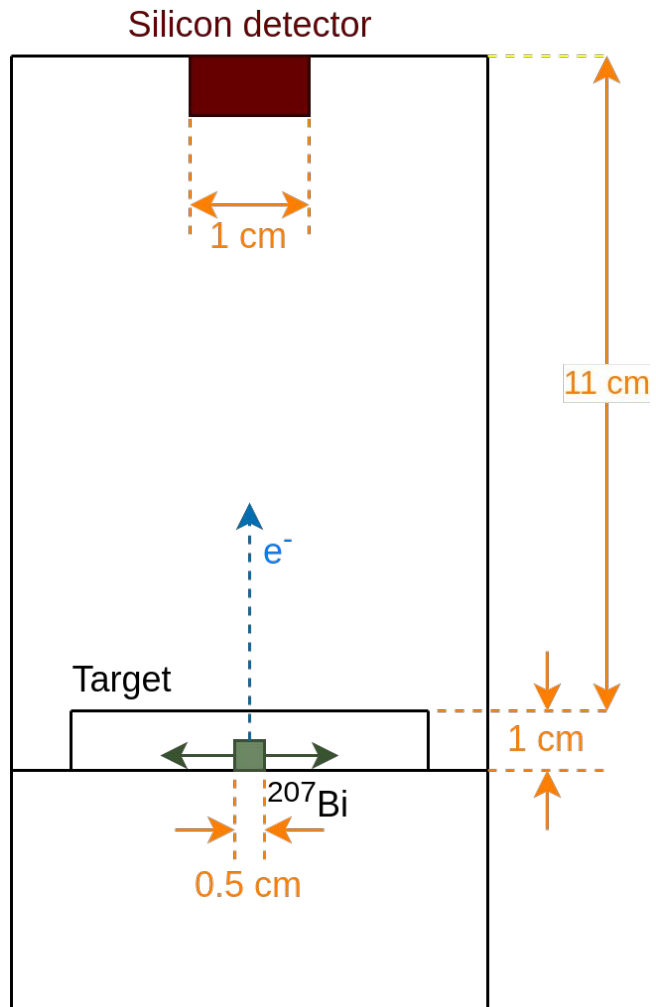
- **The experiment was successfully conducted**
- We selected the “normal” setup due to additional measurement capabilities
- 1500 μm detector did not meet our neutron energy requirements
- The E2-E3 coincidence selection is used for calculating required statistics
- Used KI target with Ti backing fulfils requirements of the conducted experiment
- The results from the test and the experiment are consistent

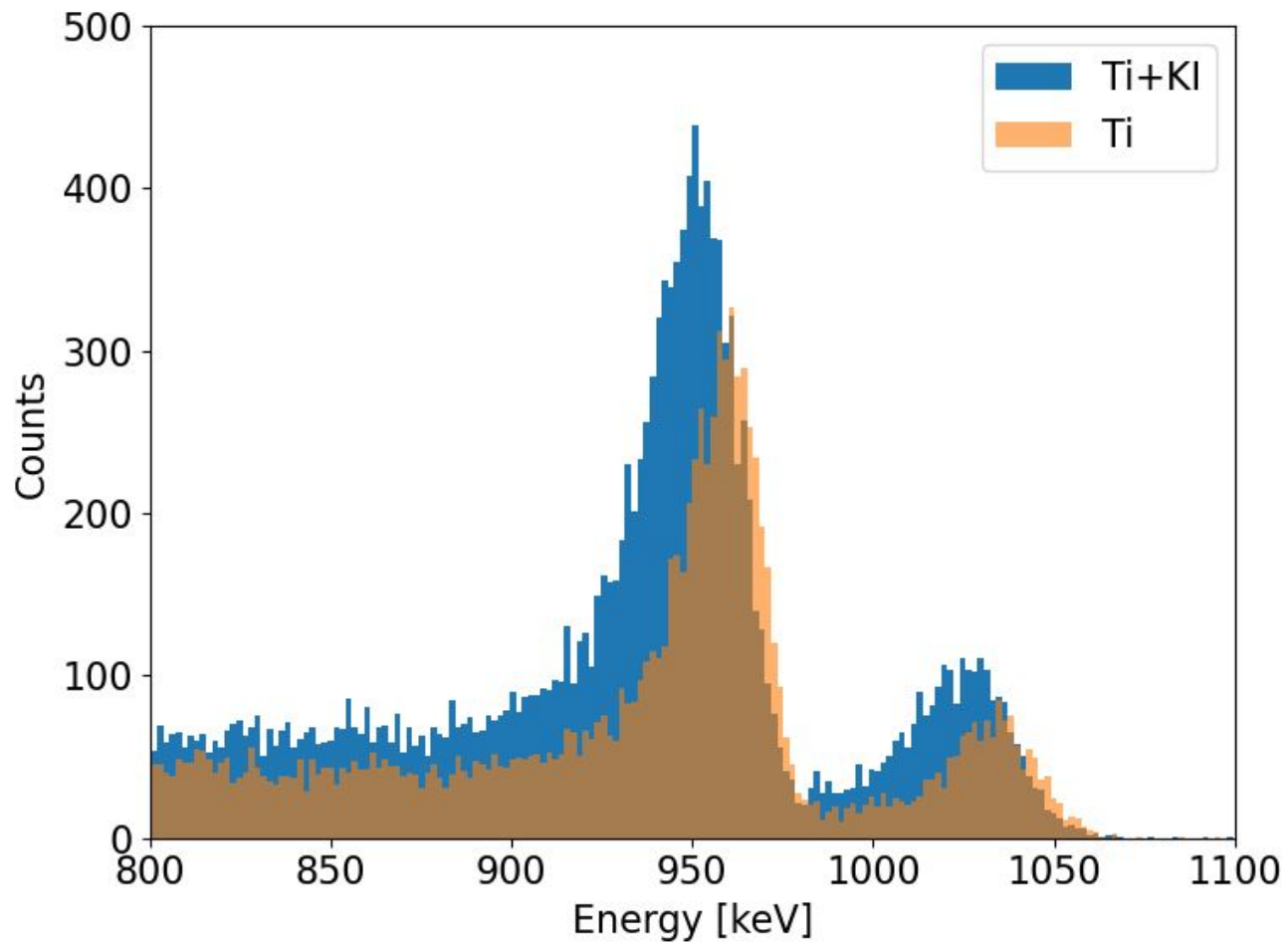


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Thank you for your attention

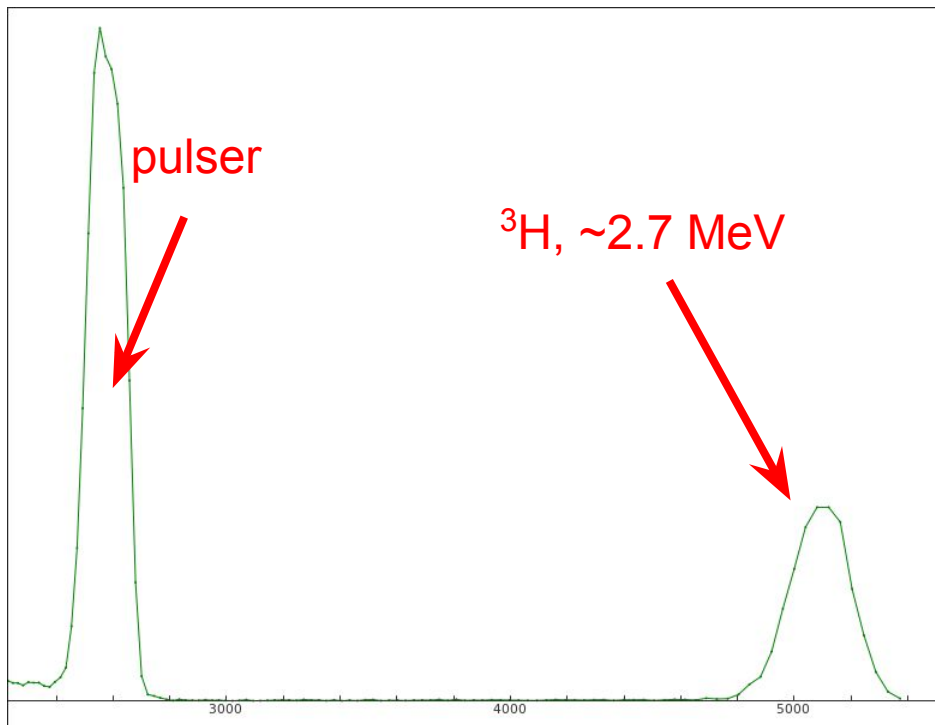




Calibration



The first 300 μm detector



20 μm detector

