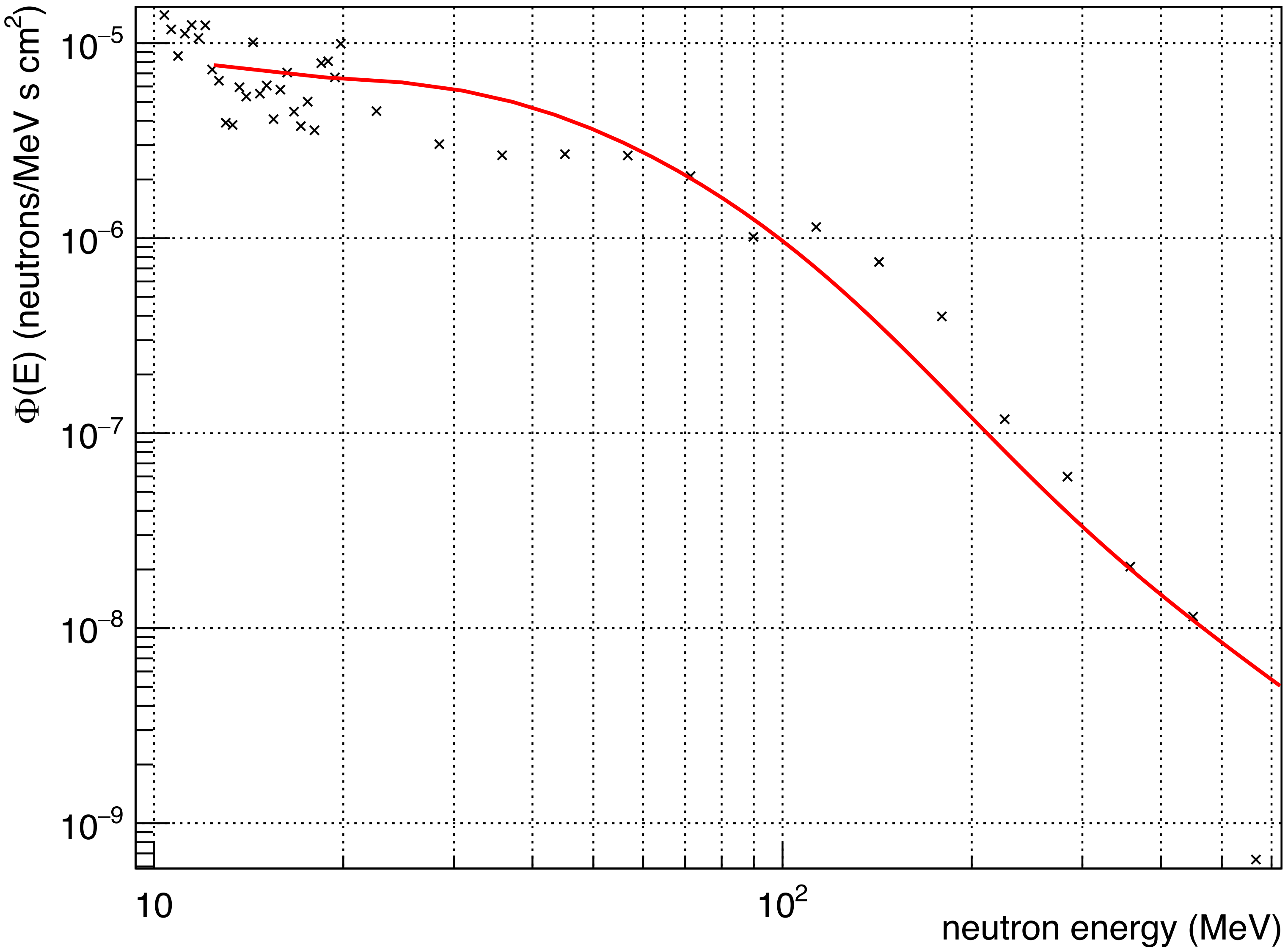
n_TOF measurement updates

Sara Rabaglia – 10/06/2025

Summary

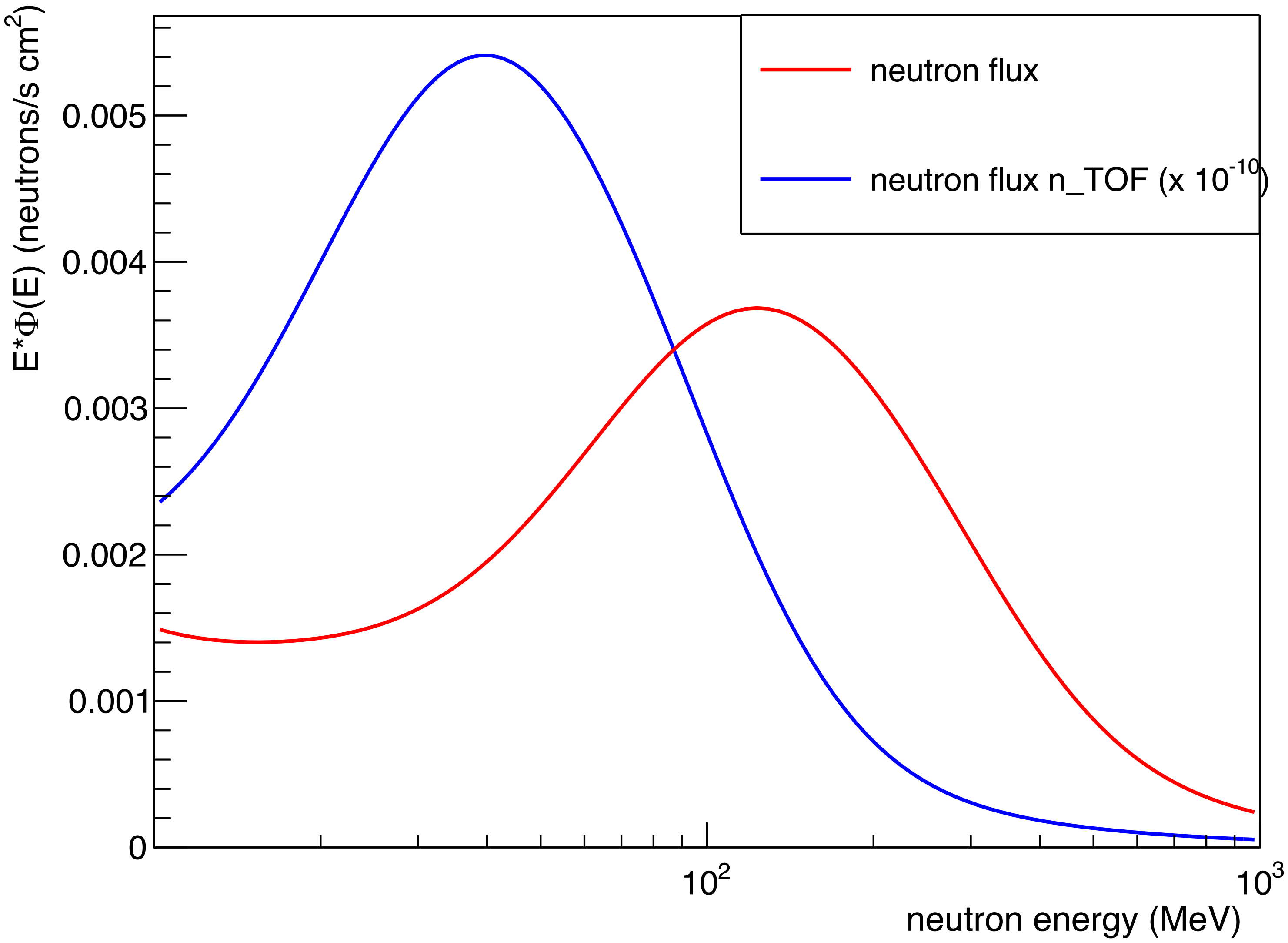
- Brief report of the study on the variation of the production rate due to different shapes of the neutron flux
- Updates on n_TOF measurements

Production Rate: Neutron Flux @n_TOF



Fit of the flux measured at n_TOF in the NEAR experimental area (the neutron flux is scaled with a factor 10^{-11})

Production Rate: Neutron Flux comparison

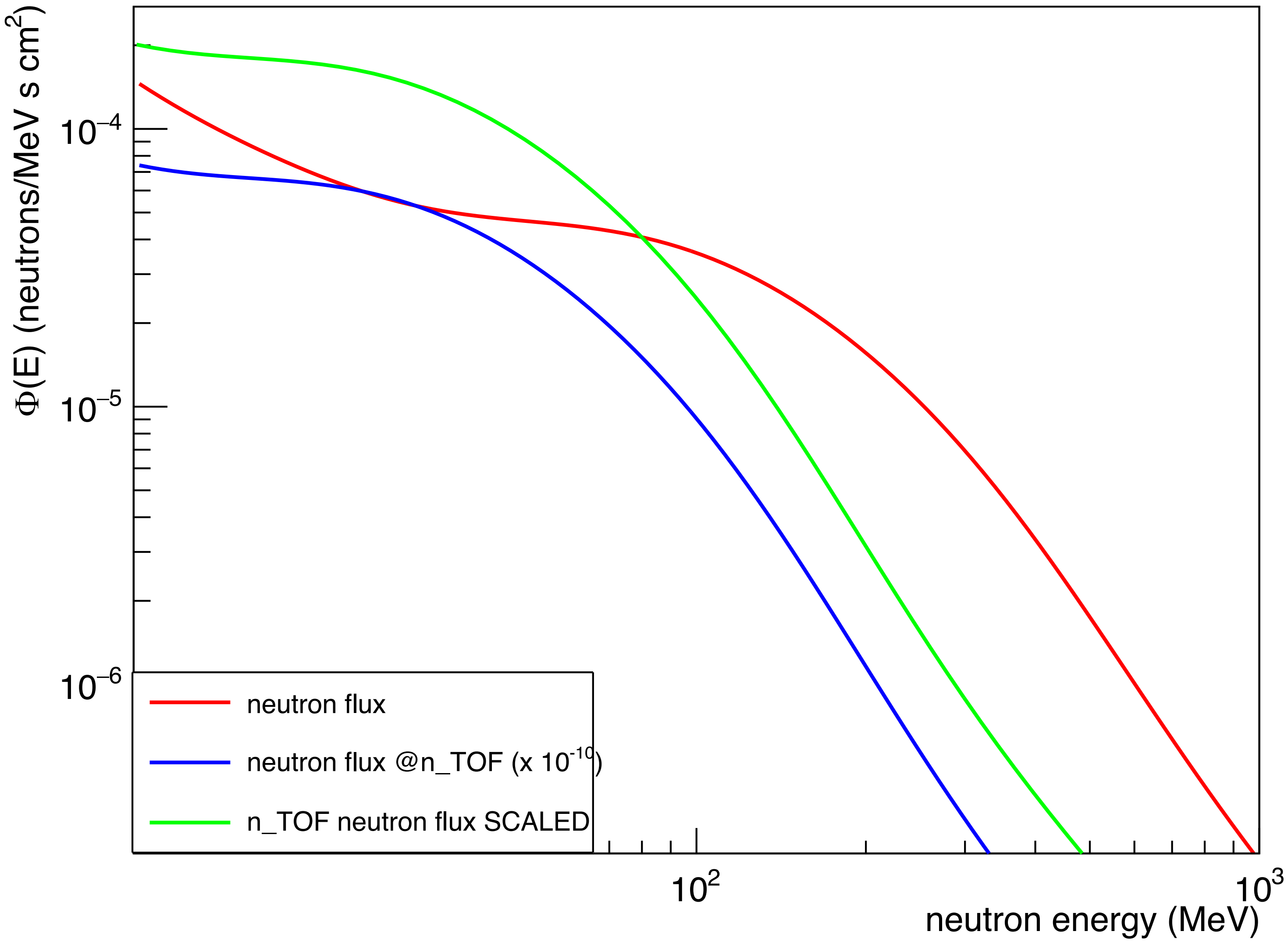


Comparison of neutron flux generated with PARMA generator (red), that simulates the neutron flux of cosmic rays for a location at 1500 m as Rising Star cave, and the flux measured @n_TOF in the NEAR (blue)

↓

Similar shape, but the spallation peak is in a different position

Production Rate: Neutron Flux Scaling

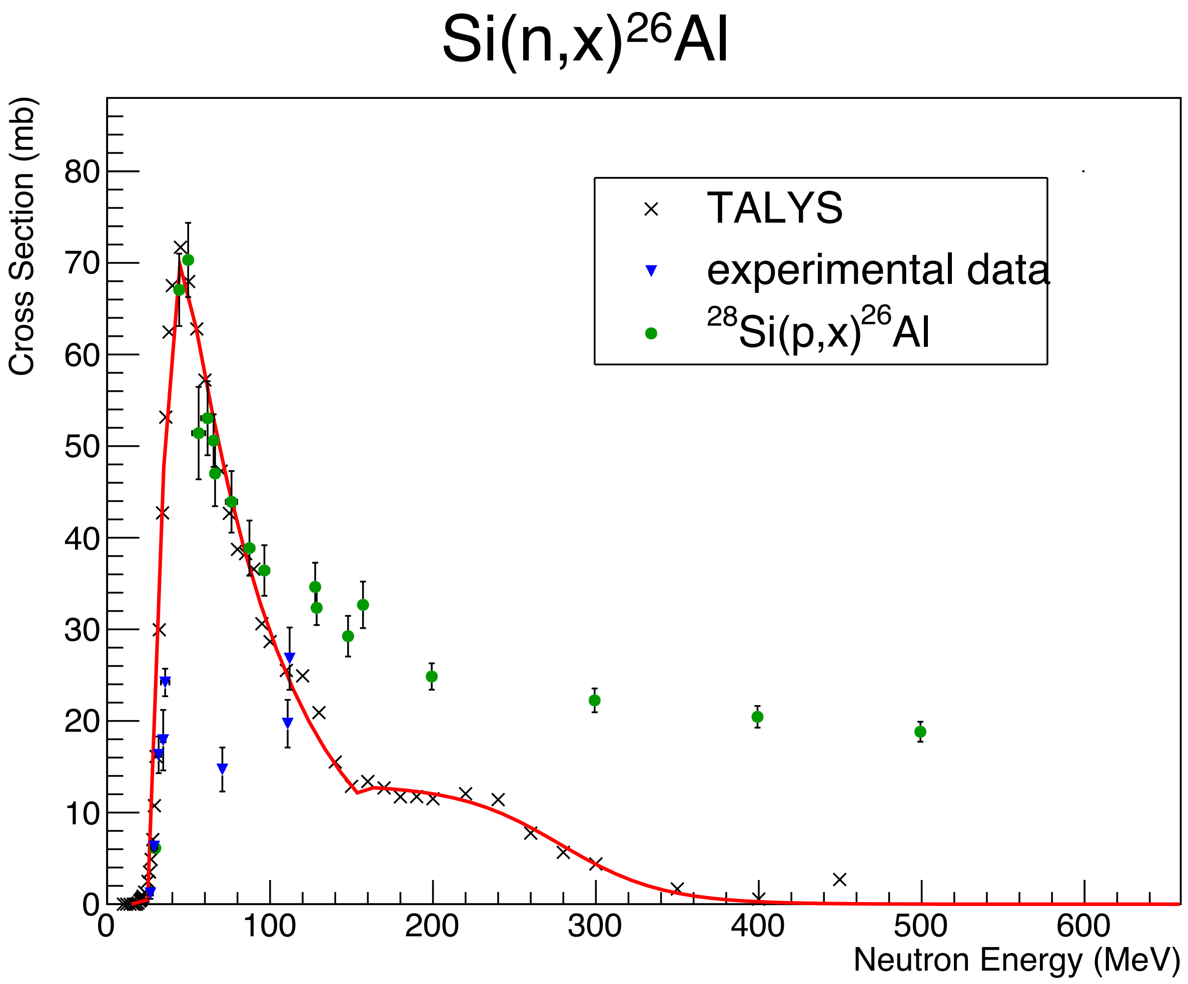


Since the two fluxes under consideration differ by several orders of magnitude, it is necessary to find a way to rescale the flux using data that we have available. Therefore, to determine the scaling factor, the integral of the two fluxes from 15 to 1000 MeV was used:

$$f_{scale} = \frac{\int_{15}^{1000} \Phi_{CR}(E)}{\int_{15}^{1000} \Phi_{n\_TOF}(E)}$$

$$\Phi_{n\_TOF}^{scaled}(E) = f_{scale} \cdot \Phi_{n\_TOF}(E)$$

Production Rate: cross section by TALYS



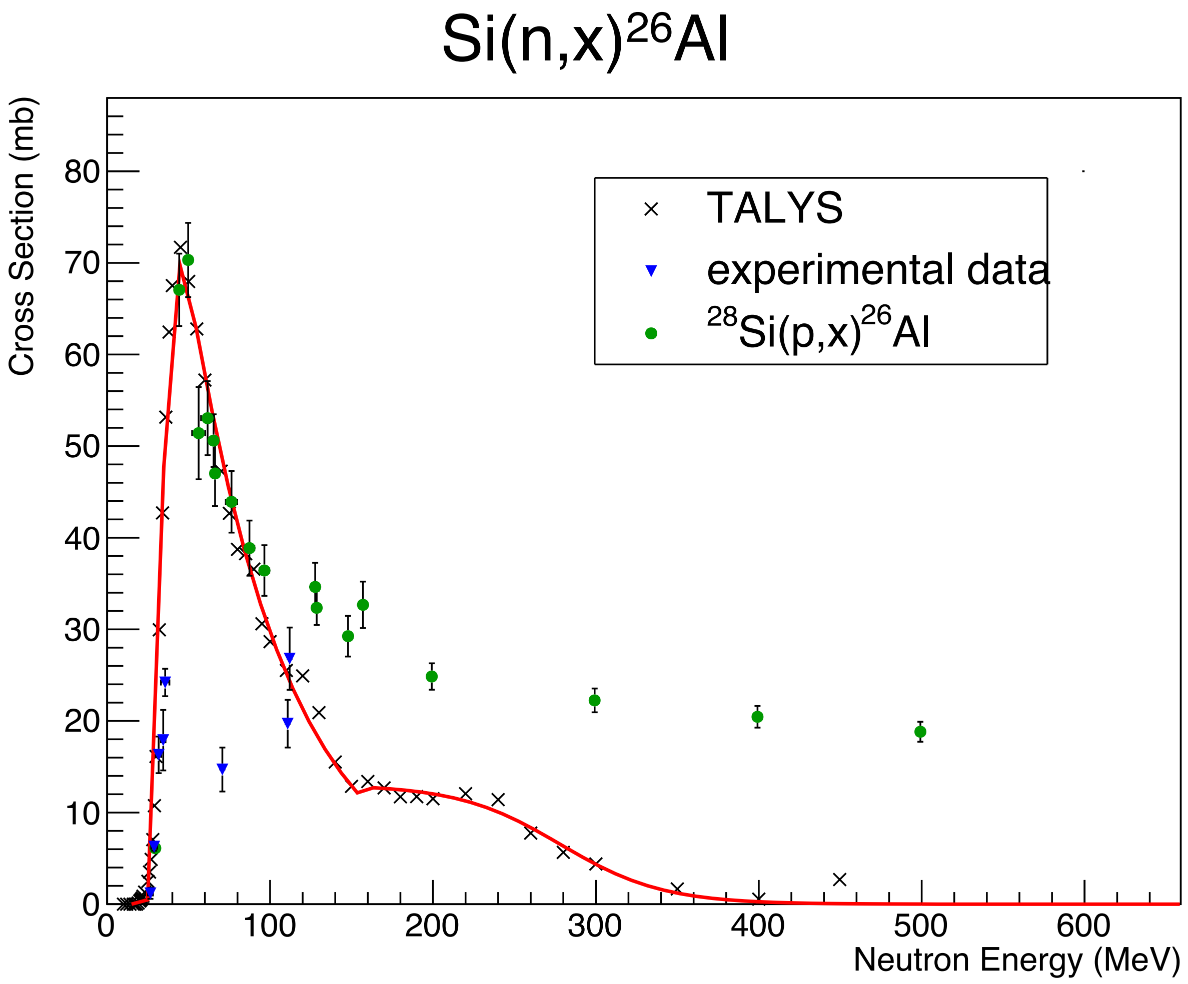
TALYS is an open source software and datasets (MIT License) for the simulation of nuclear reactions.

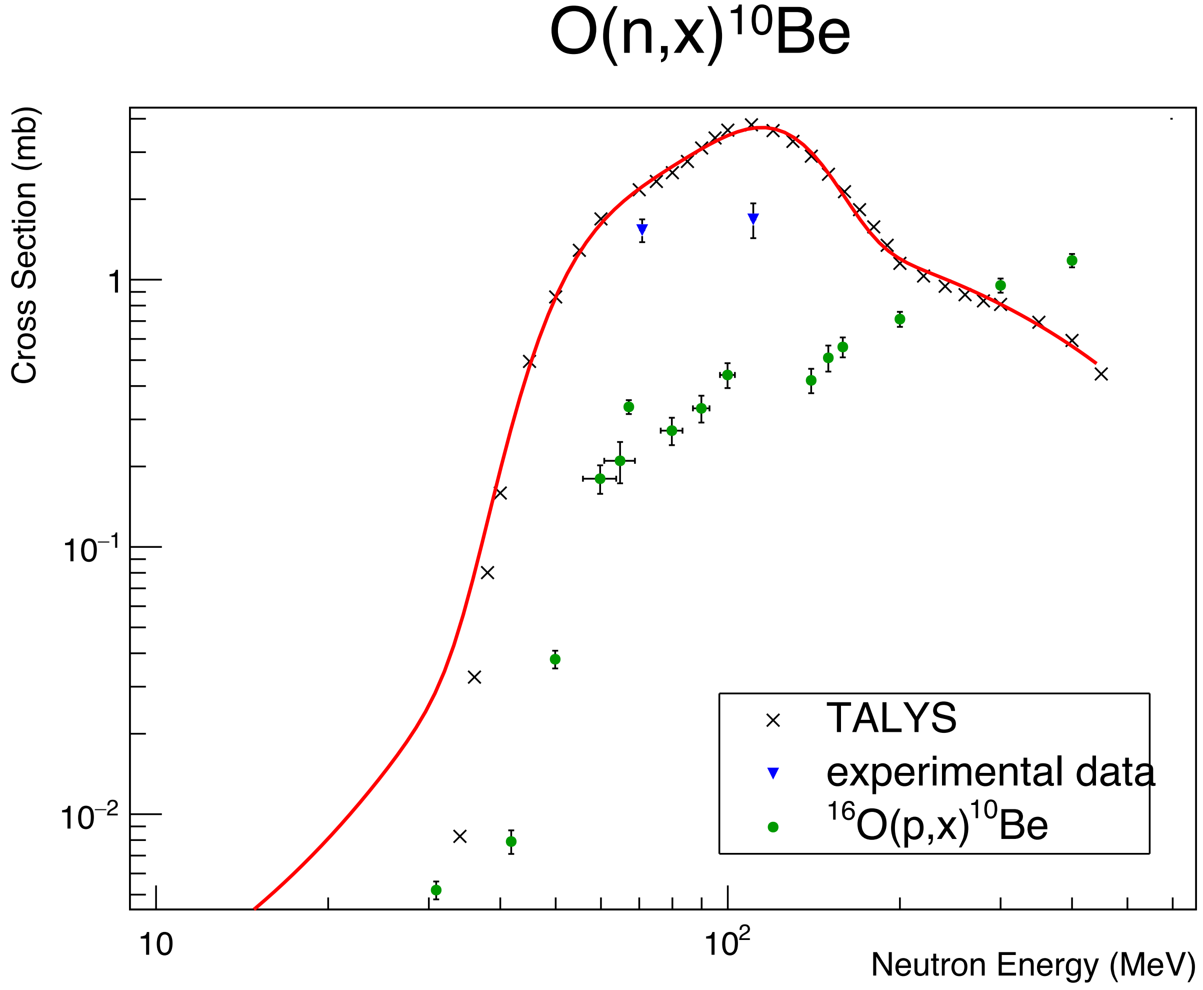
Cross section for $^{28}Si(n,x)^{26}Al$

Data by TALYS are fitted to obtain a cross section function in the region of interest.

Experimental points from: M.W. Caffee et al. Nuclear Instruments and Methods in Physics Research B 294 (2013) 479–483

Production Rate: cross section by TALYS





Experimental points from: M.W. Caffee et al. Nuclear Instruments and Methods in Physics Research B 294 (2013) 479–483

Production Rate

P_{26} (1500 m) = Flux_CR * crossSection_talys * N_target_Si = 65 atoms/g yr

P_{10} (1500 m) = Flux_CR * crossSection_talys * N_target_O_2 = 8.4 atoms/g yr

P_{26} = Flux_ n_TOF * crossSection_ talys * N_target_Si = 88.6 atoms/g yr

P_{10} = Flux_ n_TOF * crossSection_ talys * N_target_O_2 = 5.7 atoms/g yr

$\Rightarrow P_{26}/ P_{10} = 7.7$
$\Rightarrow P_{26}/ P_{10} = 15.4$ (n_TOF)

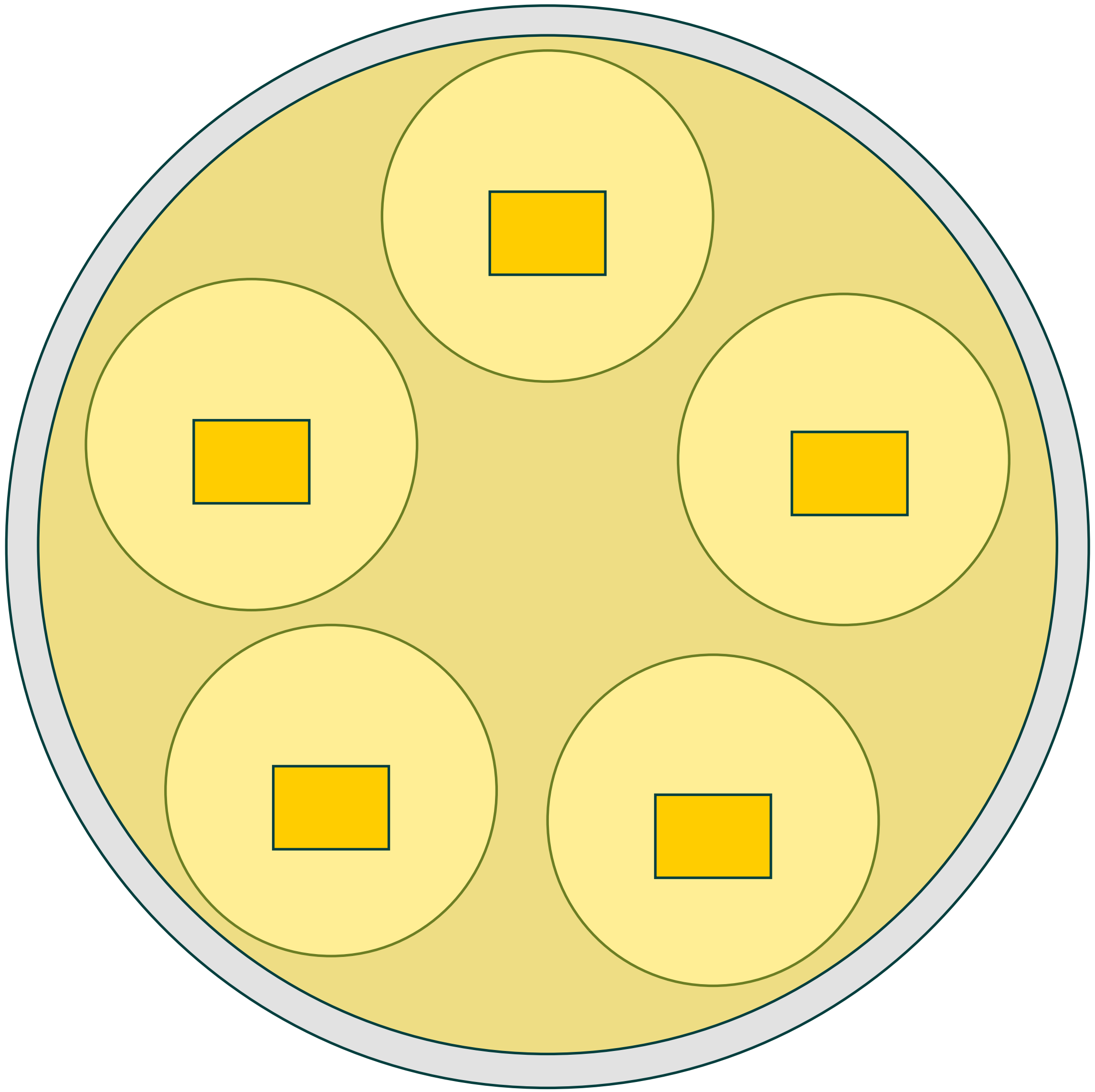
n_TOF measurements

Campaign @n_TOF: RECAP

Sample	**Filter**	**Experimental Area**	**Physical motivation**
South Africa (SA) rocks powder (site 1) purified*	no	NEAR	REFERENCE SAMPLE Measurement of the production rate.
SA rocks powder (site 2) purified*	no	NEAR	Study of the possible effect of different contaminants in various sites.
SA rocks powder (site 1)	no	NEAR	Study of the effect of contaminants by comparing samples before and after chemical treatment.
SA rocks powder (site 2)	no	NEAR	
Pure SiO_2 (commercial provider)	no	NEAR	Control sample for the purity of the silicon sample from South Africa after chemical treatment.
SA rocks powder	B_4C	NEAR	Estimation of the contribution of the low-energy flux to the production rate.
SA rocks powder purified*	B_4C	NEAR	
Pure SiO_2 (commercial provider)	B_4C	NEAR	
SA rocks powder purified*		EAR1	Study of the corrections to be applied to the production rate due to slightly different neutron fluxes.
SA rocks powder purified*		EAR2	

*After chemical treatment

Irradiation setup: NEAR



Ring in PEEK (ø 4 cm)printed with 3D printer

⟹ Standard dimensions for the mechanical support inside near station.

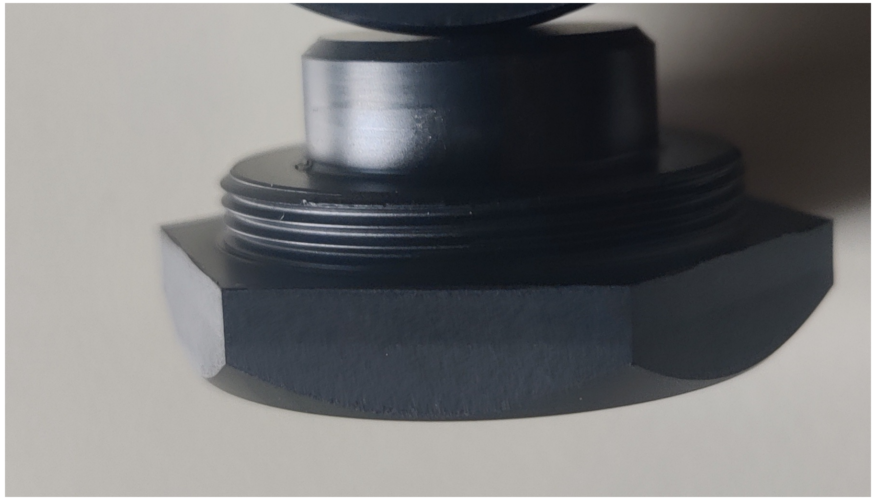
Targets of rock powder:

1. Produce tablets with the press available at n_TOF (ø 1.3 cm).
2. Build small capsule in PEEK to put inside the powder.

2 Capton foils to attach the quartz tablets.

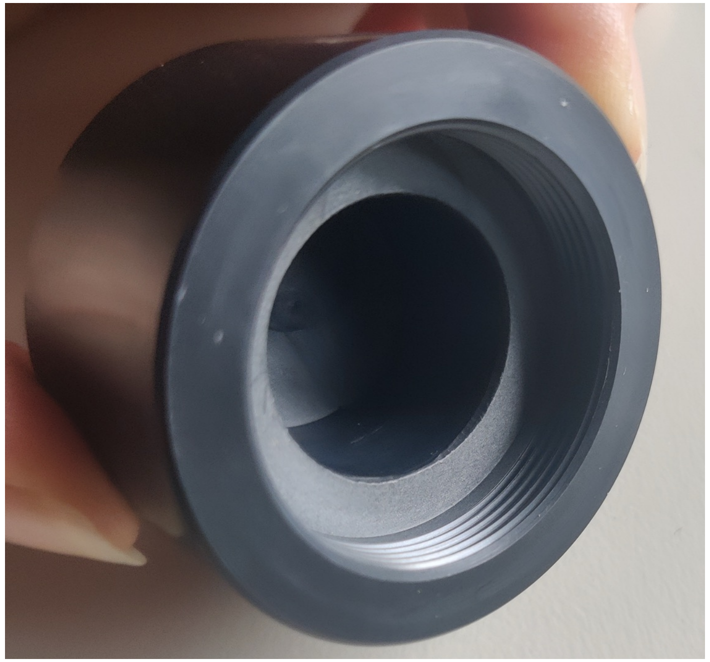
Gold foils as reference on each sample.

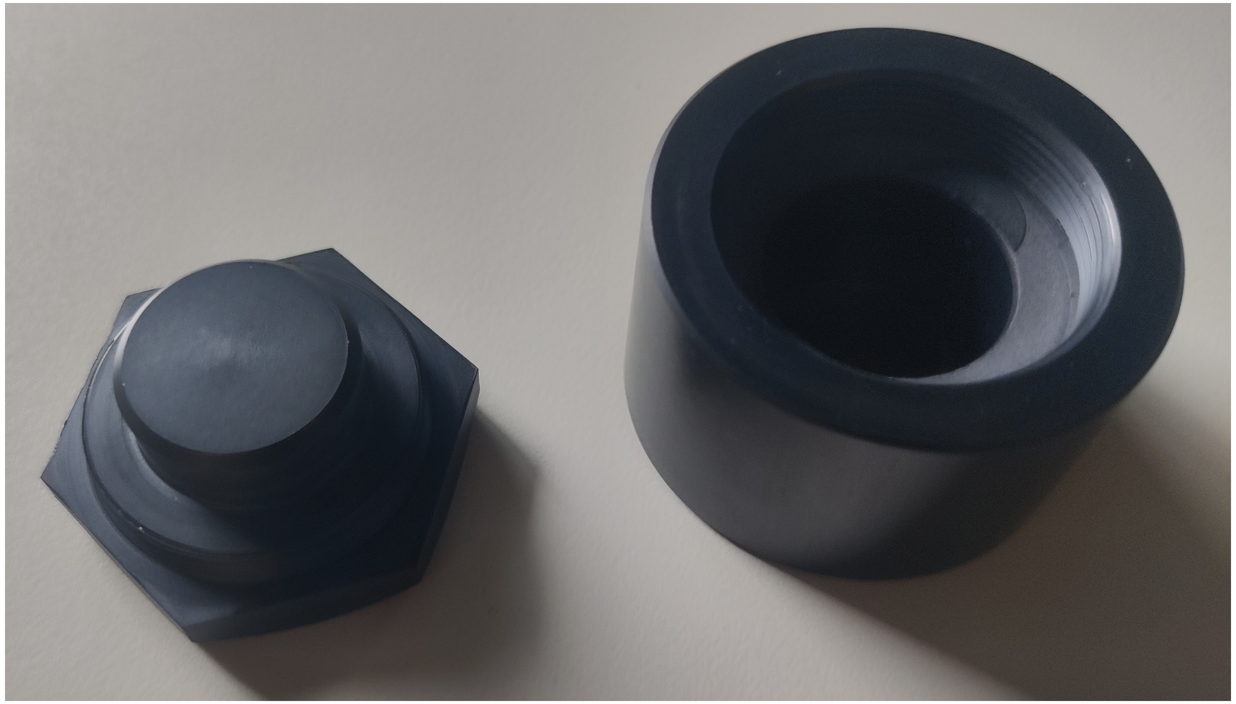
Irradiation setup: EAR1 - EAR2



PEEK container for rocks powder:

- 10 gr
- ∅ 2 cm
- h = 1.2 cm
- Cap can press the powder





Measurement at n_TOF: rough schedule

- 1 week in September to prepare the sample and to schedule the period for our irradiation in the NEAR station + security courses to enter in the experimental area
- Irradiation in NEAR: 2 weeks at the end of October

→ DEPENDS on WHEN the rocks powder can be shipped to us

AMS measurements

Expected concentrations:

NEAR 2 x 10^8 (2 g) [6 x 10^{17}]

EAR1 5.21 x 10^6 (10 g) [4 x 10^{18}]

EAR2 3.23 x 10^7 (10 g) [4 x 10^{18}]

Start speaking about necessary components for the measurements:

- Which chemical elements must be bought?
- General cost?
- Time required to perform the measurement.
- Which could be a good period to perform the measurment?
- Could be usefull have a sample before (or during) irradiation at n_TOF to test the measurement procedure

Next Steps

Any updates from PoliMi?

Define an analysis procedure to calculate the Inclusive cross section for ^{26}Al and ^{10}Be

Try to define in more details the planning for the n_TOF campaign