

Development of a high-resolution neutron transmission station at the GELINA facility

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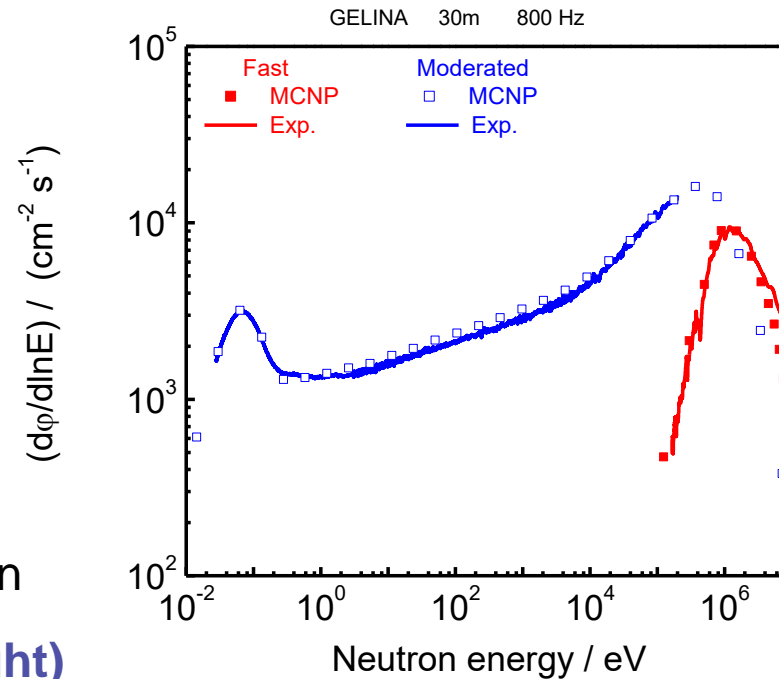
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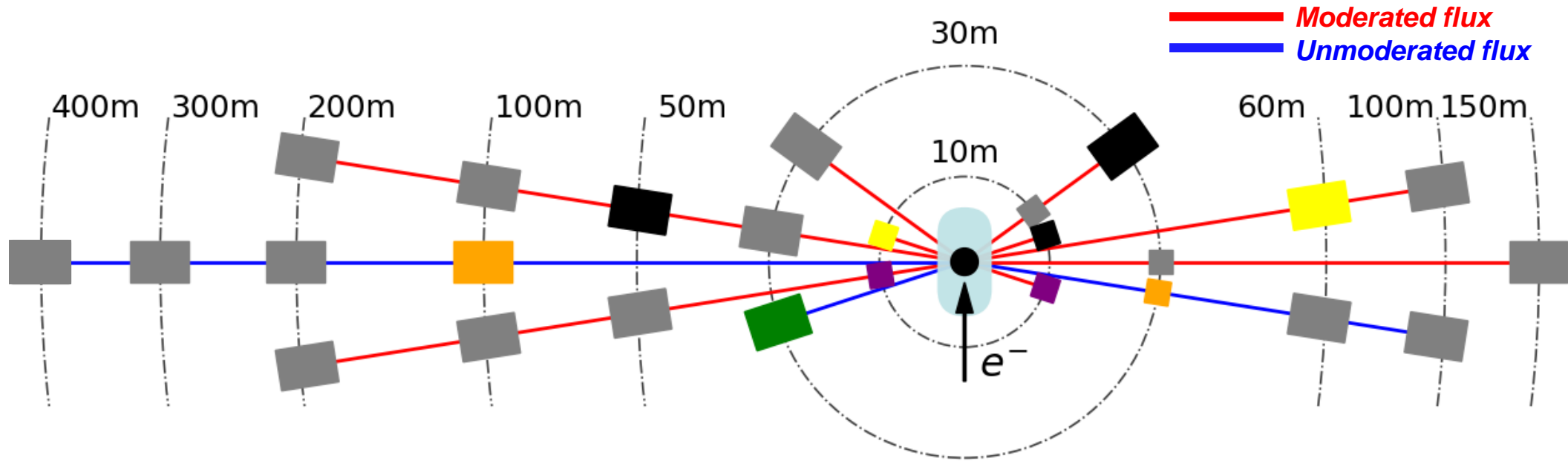


Motivation – The GELINA facility

- e^- accelerated to $E_{\max}=140\text{MeV}$
- **Bremsstrahlung** in U-target
- (γ,n) & (γ,f) in U-target
- Low energy neutrons by **moderation**
- Neutron energy determination using the **TOF (Time-Of-Flight)** technique



Motivation – The GELINA facility



(n,n) - Elastic (30m)

(n,n'γ) - Inelastic (60m, 100m)

(n,γ) - Capture (10m, 60m)

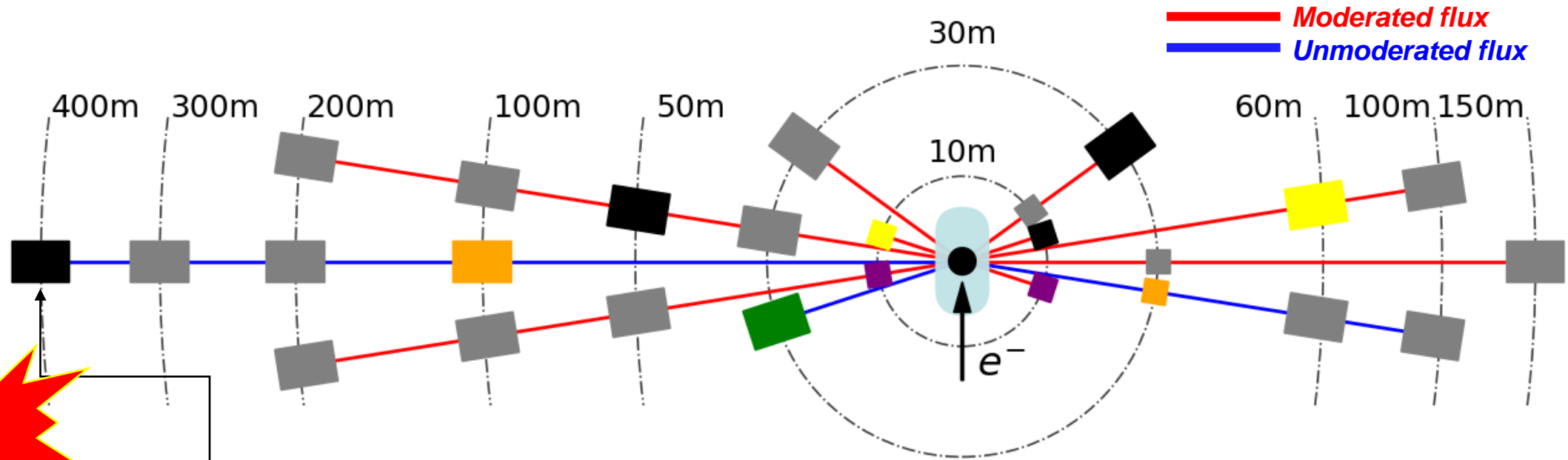
(n,tot) - Transmission (10m, 30m, 50m) →

(n,f) - Fission/PFNS (10m)

Rest

Flight path #	Length (m)	Energy range (MeV)
4	50	5eV – 150keV
12	30	1eV – 100keV
13	10	0.5eV – 10keV

Motivation – The GELINA facility



- Flight path 3 – 400m from the neutron target
- Neutron energy range 100keV – 20MeV
 - Important for nuclear fission & fusion applications
- Ultra high-resolution 2ns@400m

- (n,n) - Elastic (30m)
- (n,n'γ) - Inelastic (60m, 100m)
- (n,γ) - Capture (10m, 60m)
- (n,tot) - Transmission (10m, 30m, 50m)
- (n,f) - Fission/PFNS (10m)
- Rest



Transmission measurements

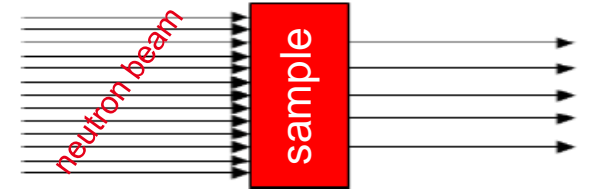
- Transmission: fraction of the neutron beam traversing a sample without any interaction

$$T_{exp} = \frac{C_{in}}{C_{out}} \propto e^{-n\sigma_{tot}}$$

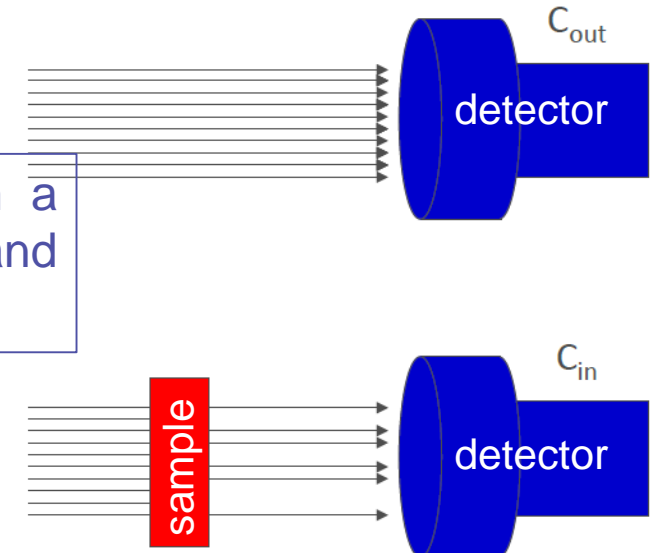
- σ_{tot} : total cross section
- n : areal number density

In this type of measurement the:

- Incoming neutron fluence rate cancels
- Detection efficiency cancels



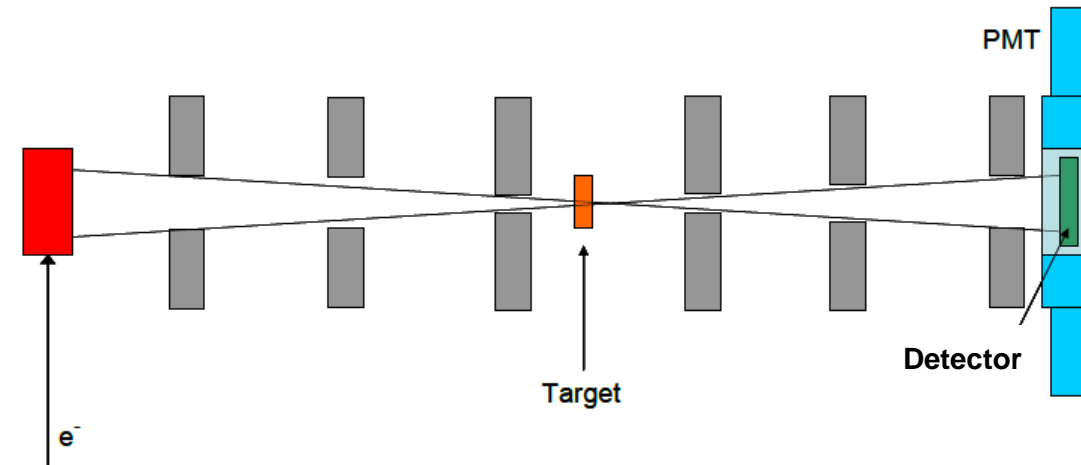
Absolute measurement with a direct relation between T_{exp} and σ_{tot}



Transmission principle

A good transmission measurement needs to fulfill the following conditions:

1. All detected neutrons passed through the sample
2. Neutrons scattered in the target do not reach the detector
3. Sample perpendicular to parallel neutron beam
4. Homogeneous target (no spatial distribution of n)



Good transmission geometry (**collimation**) is very important!

Flight path 3 – 400m

- **B₄C overlap filter** → absorb slow neutrons from previous burst
- **U-nat filter** → reduce intensity of the γ -flash
- **40mm Cu-nat collimator** → last collimator at 200m

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- Sample placed at ~**200m** from the neutron target
 - Detector placed at ~**387m** from the neutron target

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- Detector → **3" x 2" EJ301** (n-p based)
 - DAQ → **SP Devices ADQ14 digitizer** (1GS/s)



natC measurements

- $^{nat}\text{C}(n,\text{tot})$ well known up to **4.5MeV** (<1% uncertainty)
- **2.077MeV** resonance is an **energy standard** by the **IAEA**
- **Sharp resonance** in the high energy region → help validate the **TOF** to E_n transition
- Many data available in **EXFOR** → **compare resolution**

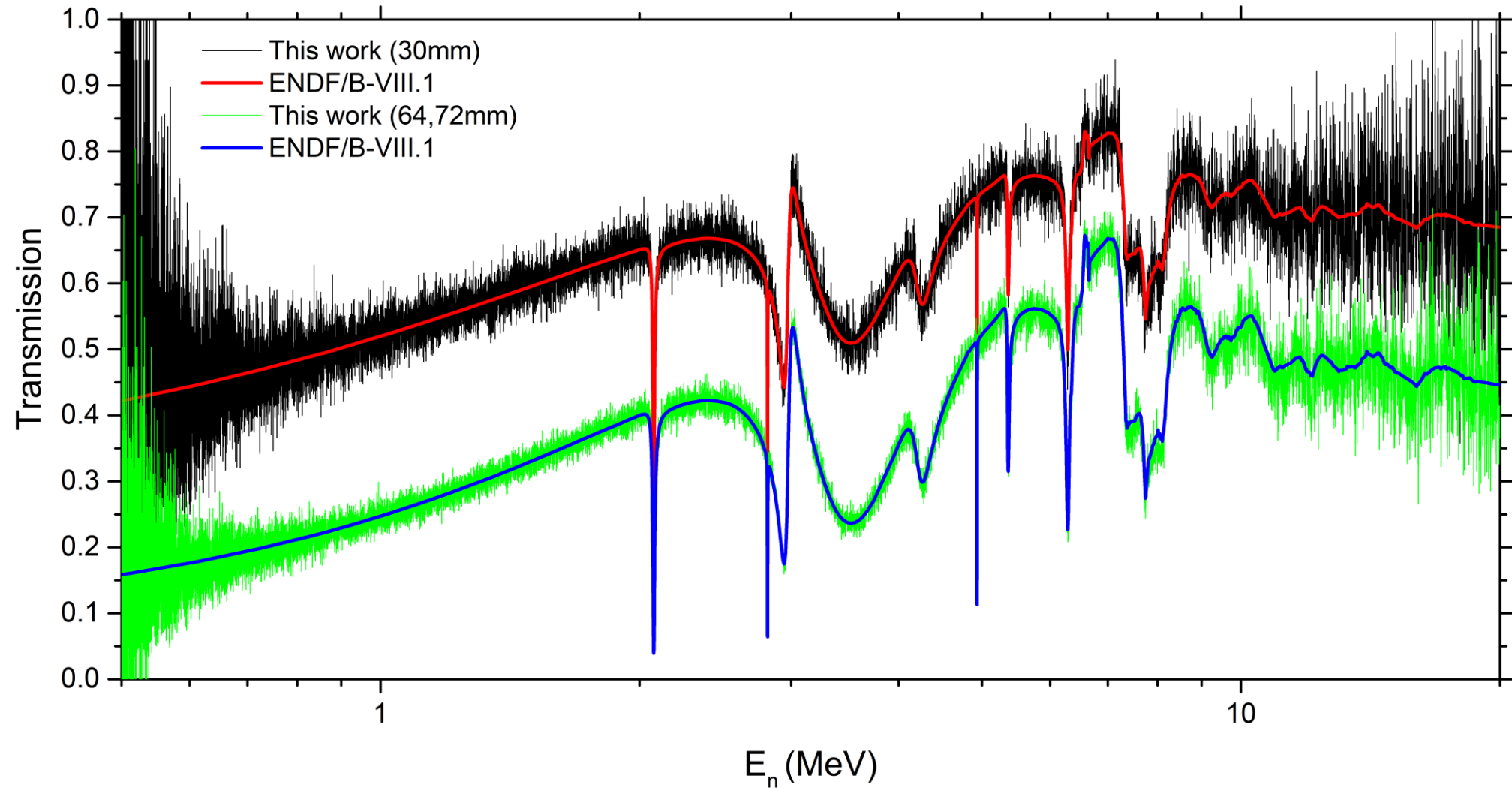
ID	Thickness (mm)	Mass (g)	Diameter (mm)	Areal density (at/b)
1	30.00	475.5	110.0	0.251
2	64.72	822.5	110.0	0.536

Data Analysis

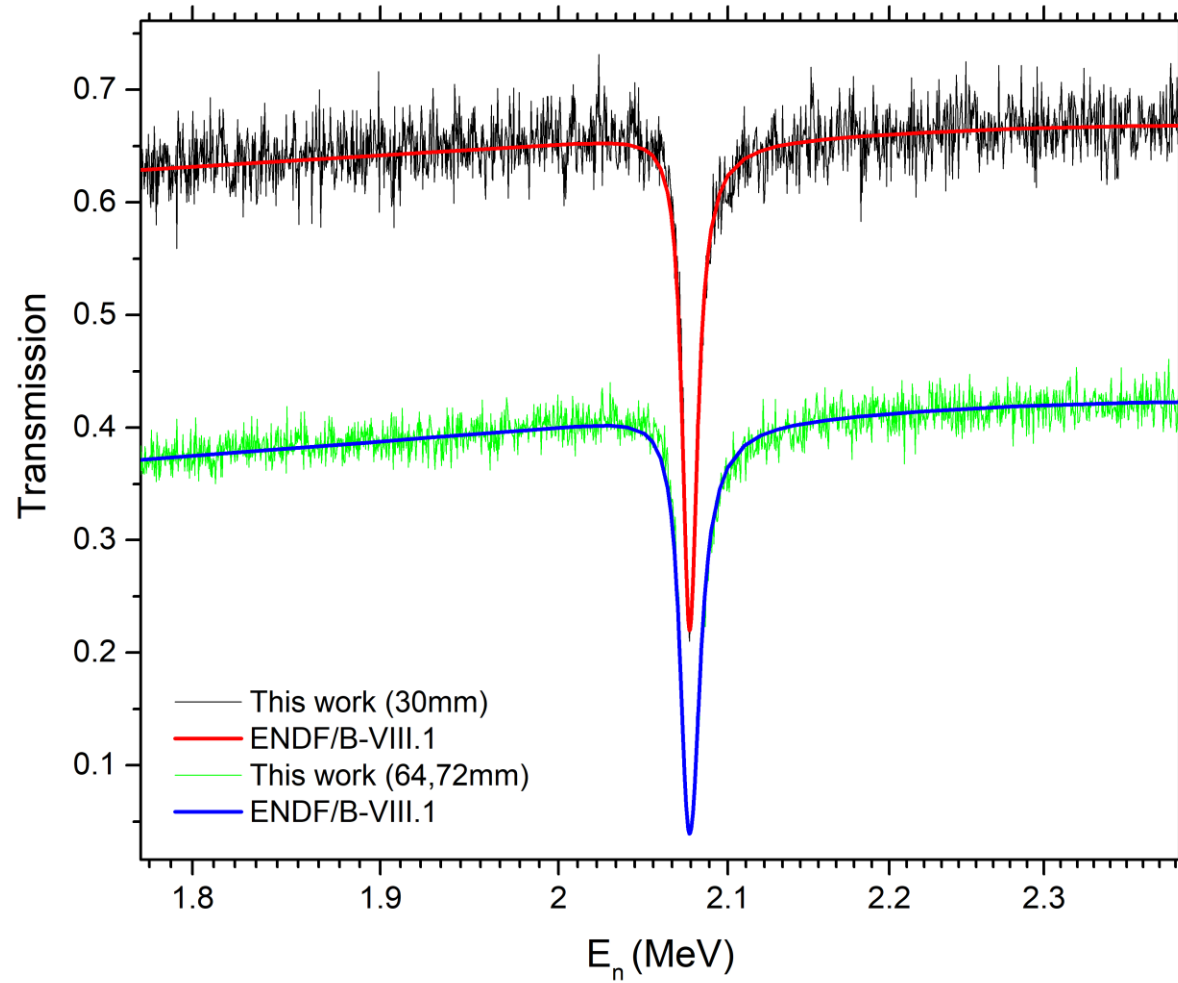
1. Pulse shape discrimination (**n- γ separation**)
2. Sample-in & Sample-out **normalization** (**CM3** flux monitor of GELINA)
3. **Transmission calculation** → **Cross section calculation**



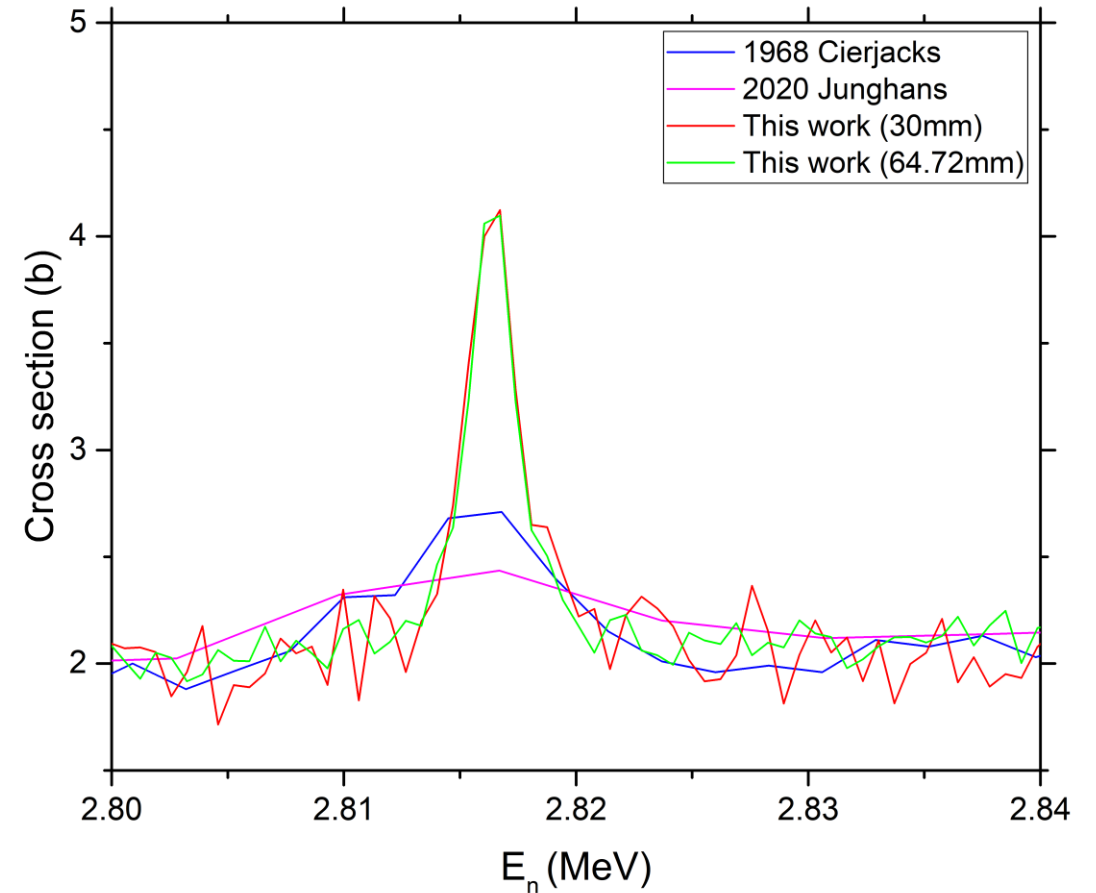
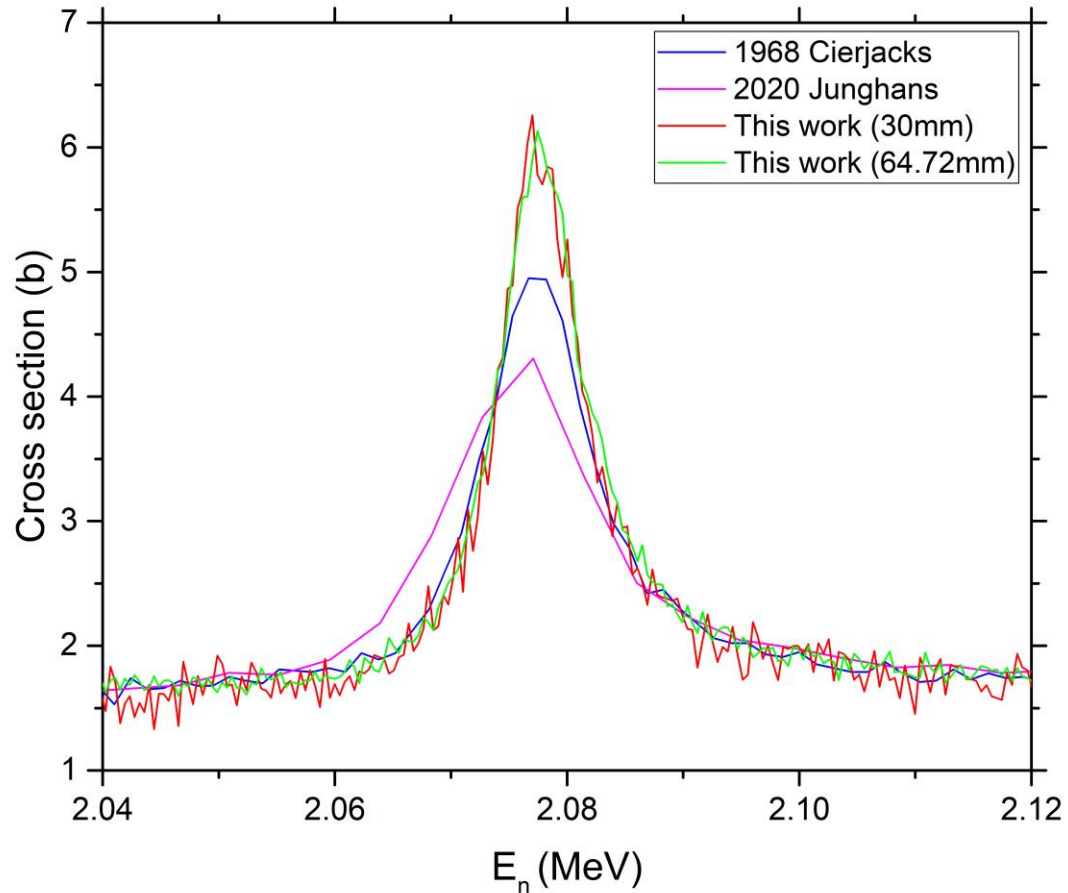
Results



Results@2.077MeV



Results – Resolution 2ns@400m



Summary / Future perspectives

- **New 400m high-resolution transmission station established at GELINA FP3.**
- **First natC transmission measurements successfully performed.**
- **Accurate reproduction of the 2.077MeV carbon standard resonance**
- **Time resolution of ~2ns achieved at 400m!**

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- **Complete station characterization and background studies.**
 - ***Optimize detector performance and data acquisition.***
 - ***Measure high-resolution nuclear data for fission and fusion applications***
 - ***natPb, natFe, natCu, ¹⁹F, ²³Na, ⁶⁵Cl, ⁹Be ...***



Thank you



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