The MarEX initiative: First results of test measurements from gaseous detectors

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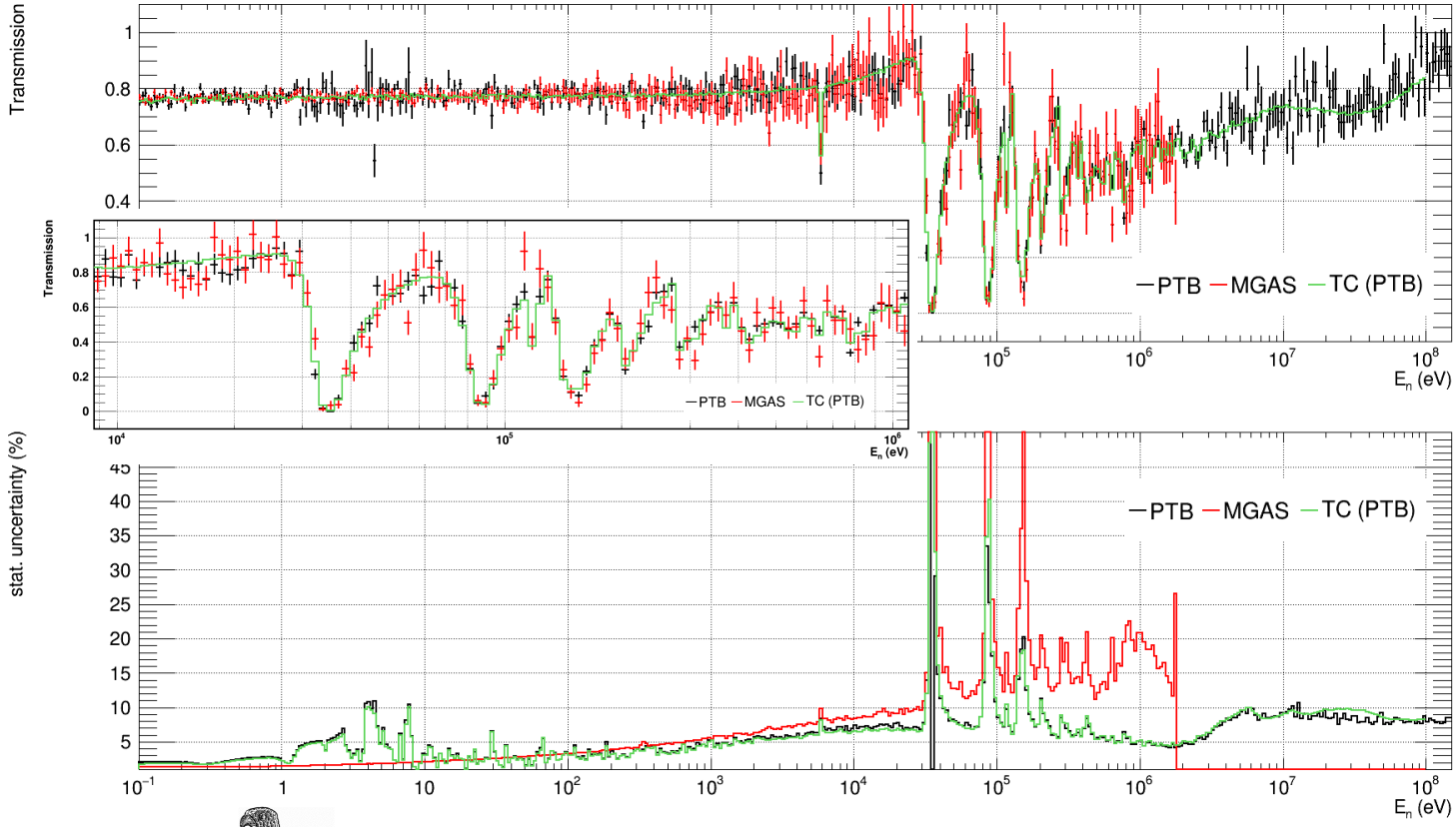
The goal of the tests

- The goal of the performed tests is the proof-of-concept of transmission studies for their feasibility and viability
- Step 1: Test the method in samples with well known (n,tot) cross section
- Step 2: Test the concept first to the Filter Station and then to the newly constructed Transmission Station

Filter Station: Al --3 cm thickness



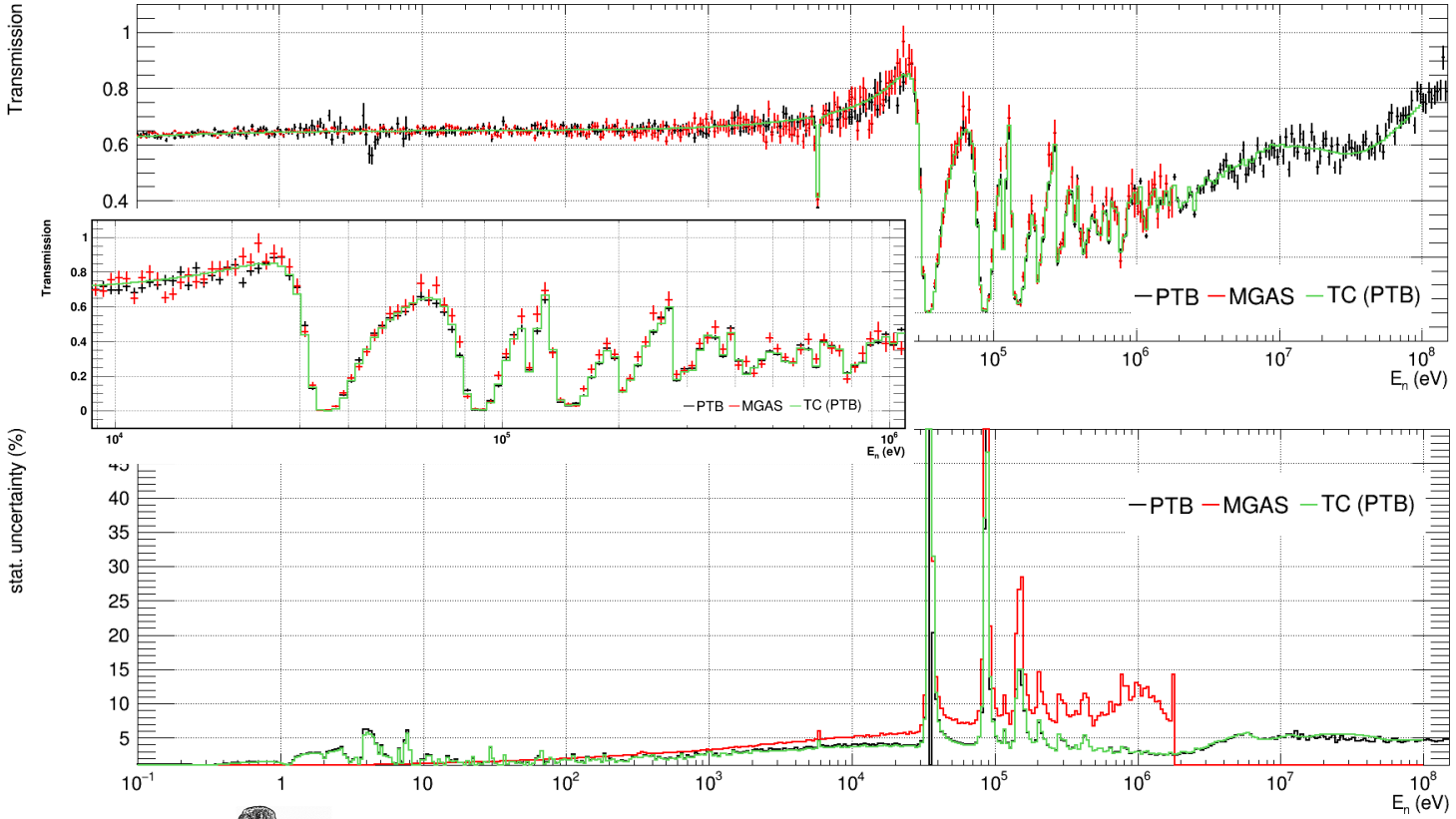
Transmission ~0.75

- Proton statistics

Sample	PTB	MGAS
Al3cm	1.50E17	1.50E17
Empty	7.40E17	5.10E17

- 50 bpd in the energy range
- Nice agreement between U5 and B10

Filter Station: Al --5 cm thickness



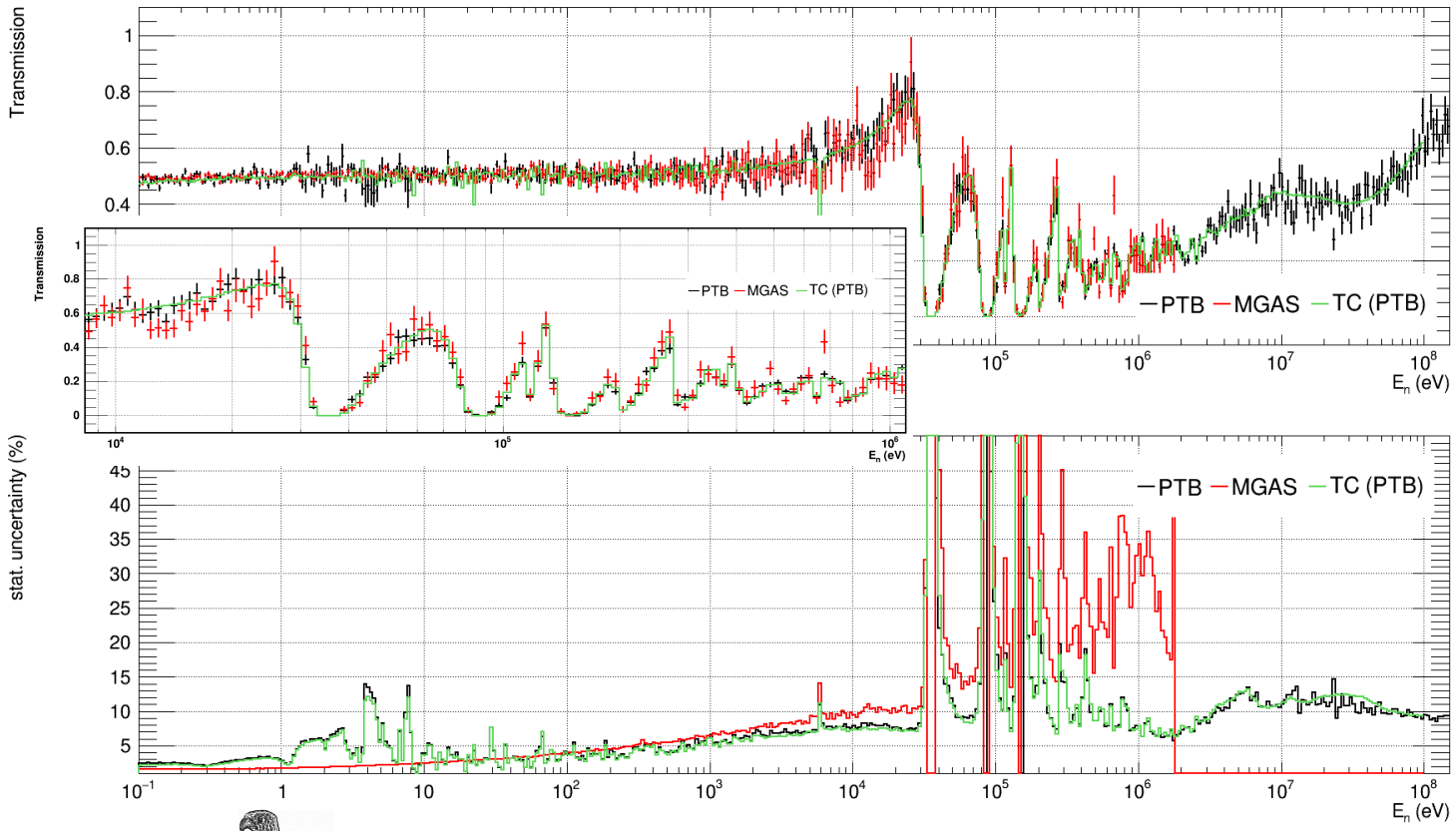
Transmission ~0.65

- Proton statistics

Sample	PTB	MGAS
Al5cm	8.27E17	8.27E17
Empty	7.40E17	5.10E17

- 50 bpd in the energy range
- Nice agreement between U5 and B10

Filter Station: Al --8 cm thickness



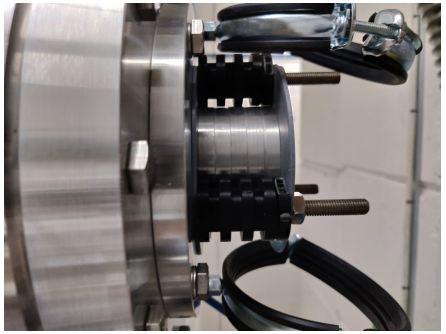
Transmission ~0.5

- Proton statistics

Sample	PTB	MGAS
Al8cm	1.54E17	1.54E17
Empty	7.40E17	5.10E17

- 50 bpd in the energy range
- Nice agreement between U5 and B10

Transmission Station: Al --5 cm thickness

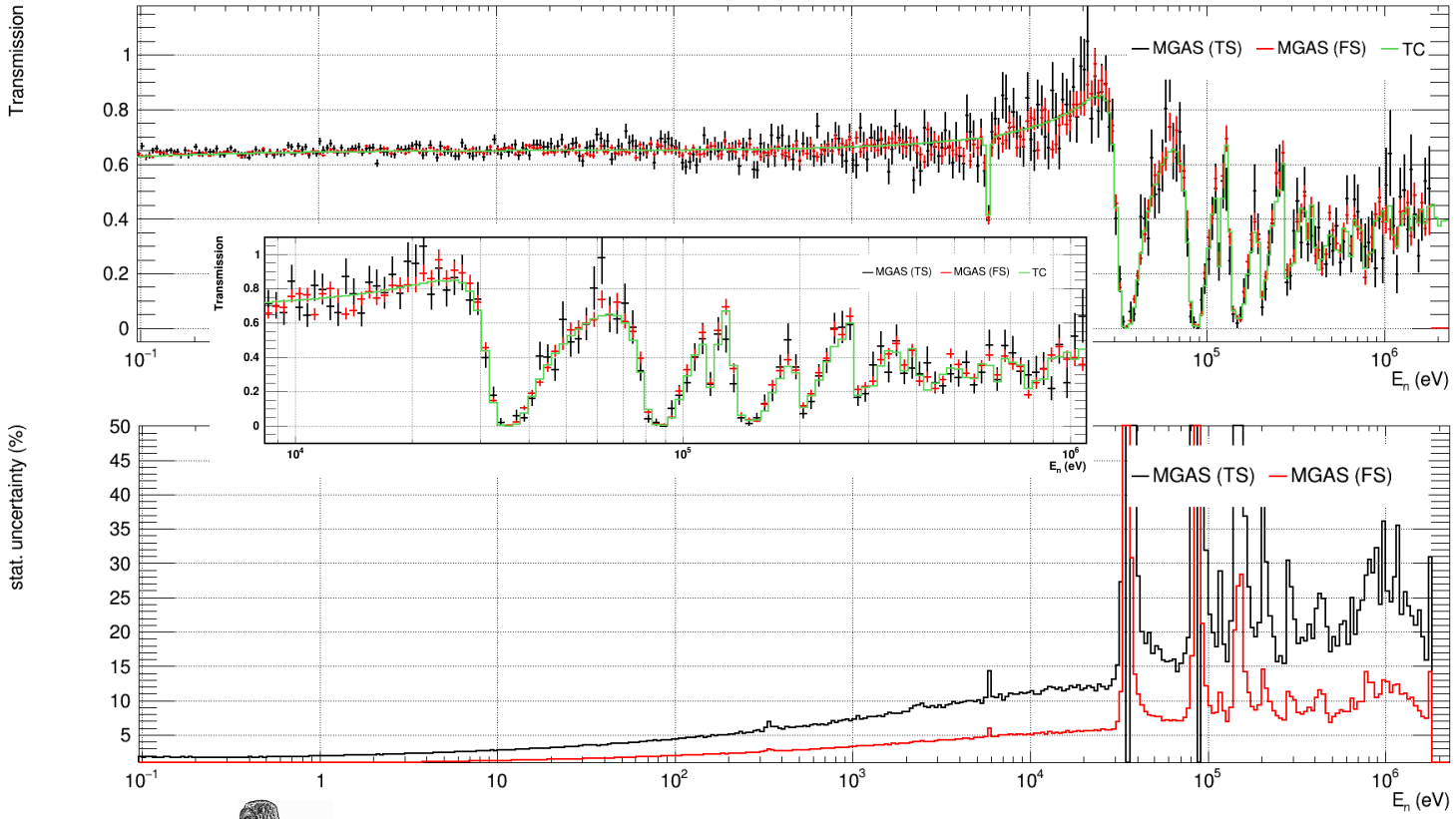


- Proton statistics

Sample	**PTB/MGAS**
Al5cm	1.24E17
Empty	1.85E17

- 50 bpd in the energy range
- Nice agreement between U5 and B10

Al --5 cm thickness: MGAS comparison of Filter (FS) and Transmission Station (TS)

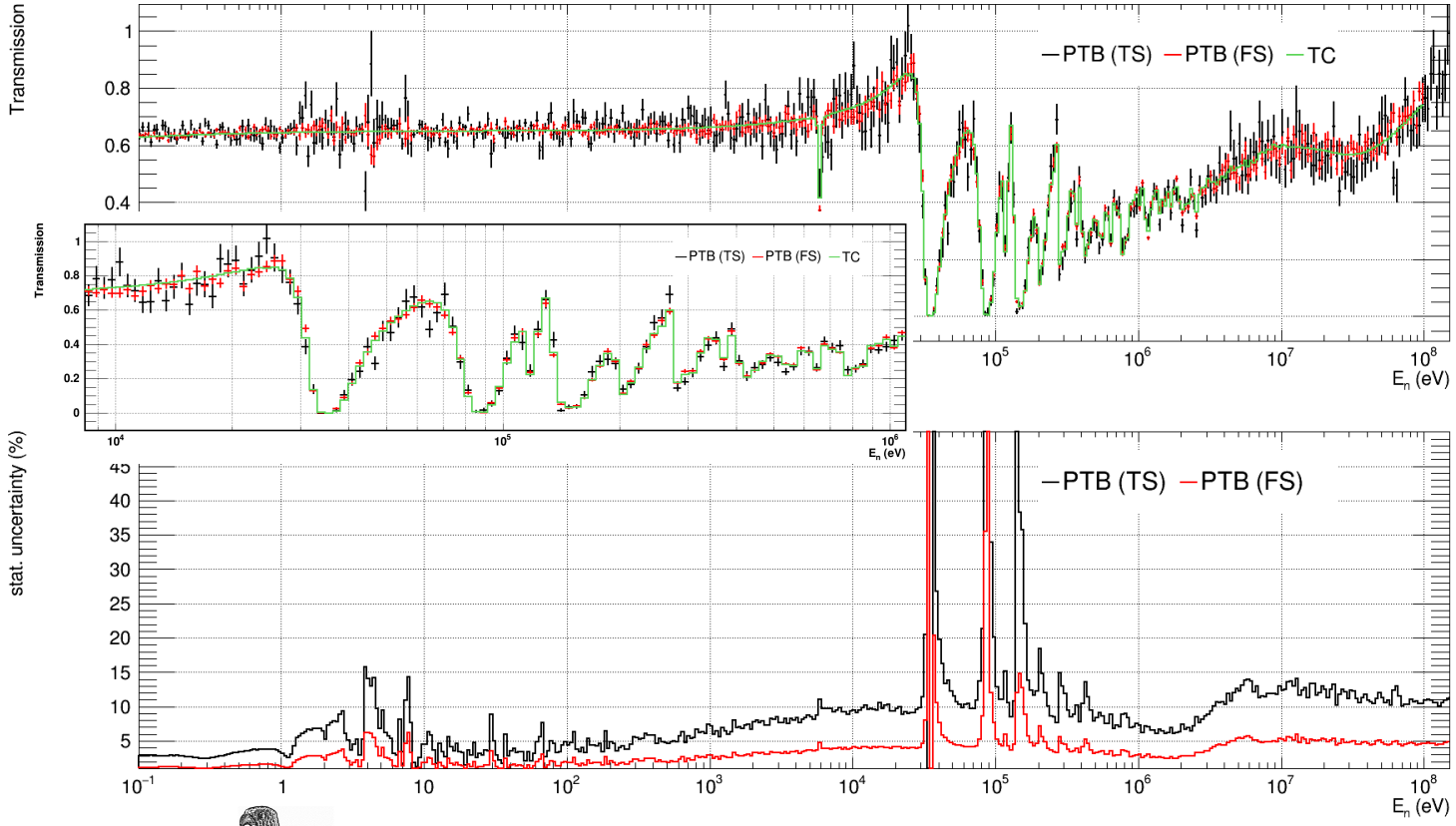


- Proton statistics

Sample	MGAS
Al5cm **TS**	1.24E17
Empty **TS**	1.85E17
Al5cm **FS**	8.27E17
Empty **FS**	5.10E17

- 50 bpd in the energy range
- Nice agreement between FS and TS for B10

Al --5 cm thickness: PTB comparison of Filter (FS) and Transmission Station (TS)

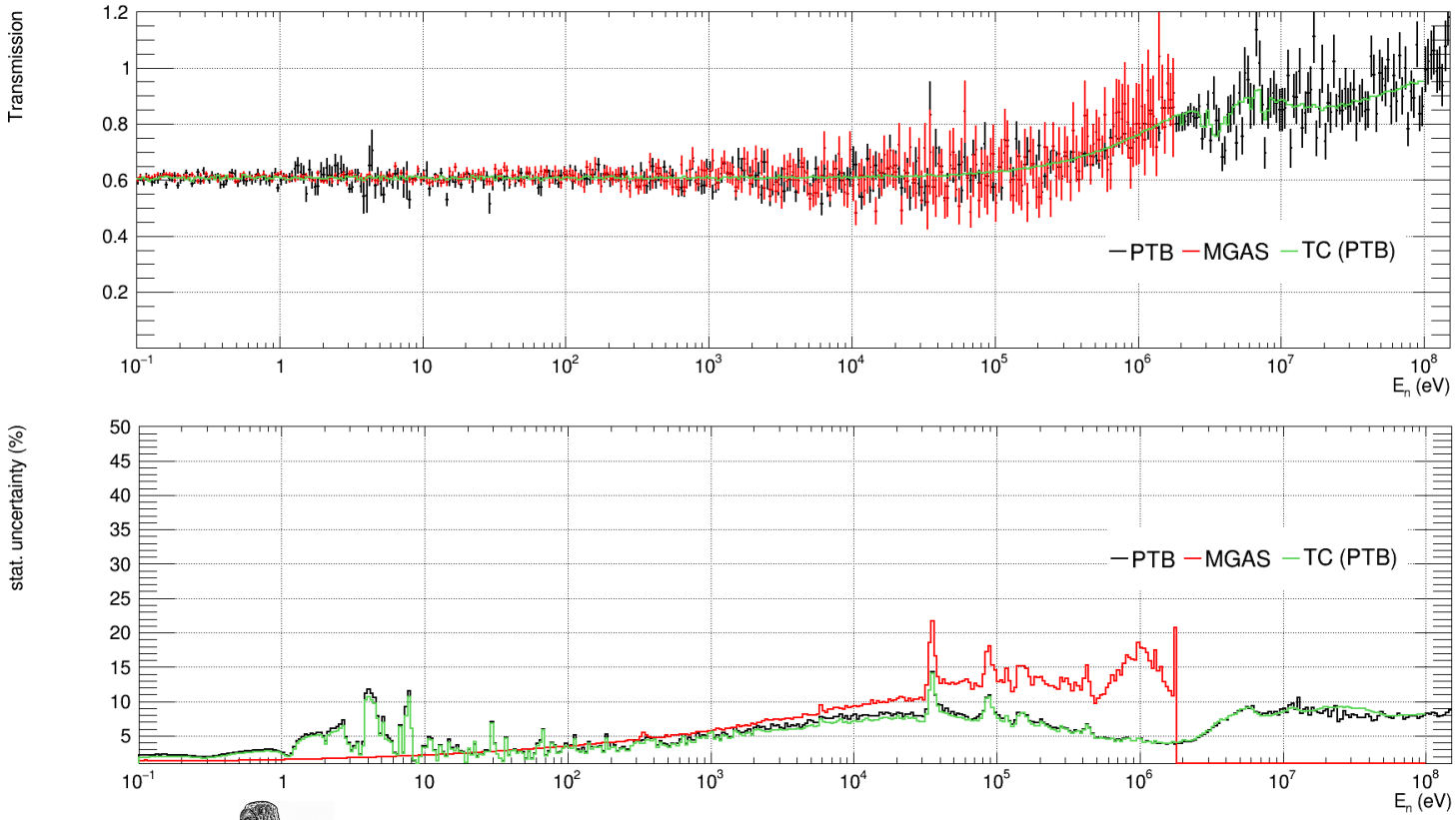


- Proton statistics

Sample	PTB
Al5cm **TS**	1.24E17
Empty **TS**	1.85E17
Al5cm **FS**	8.27E17
Empty **FS**	7.40E17

- 50 bpd in the energy range
- Nice agreement between FS and TS for U5

Transmission Station: C --1.2 cm thickness

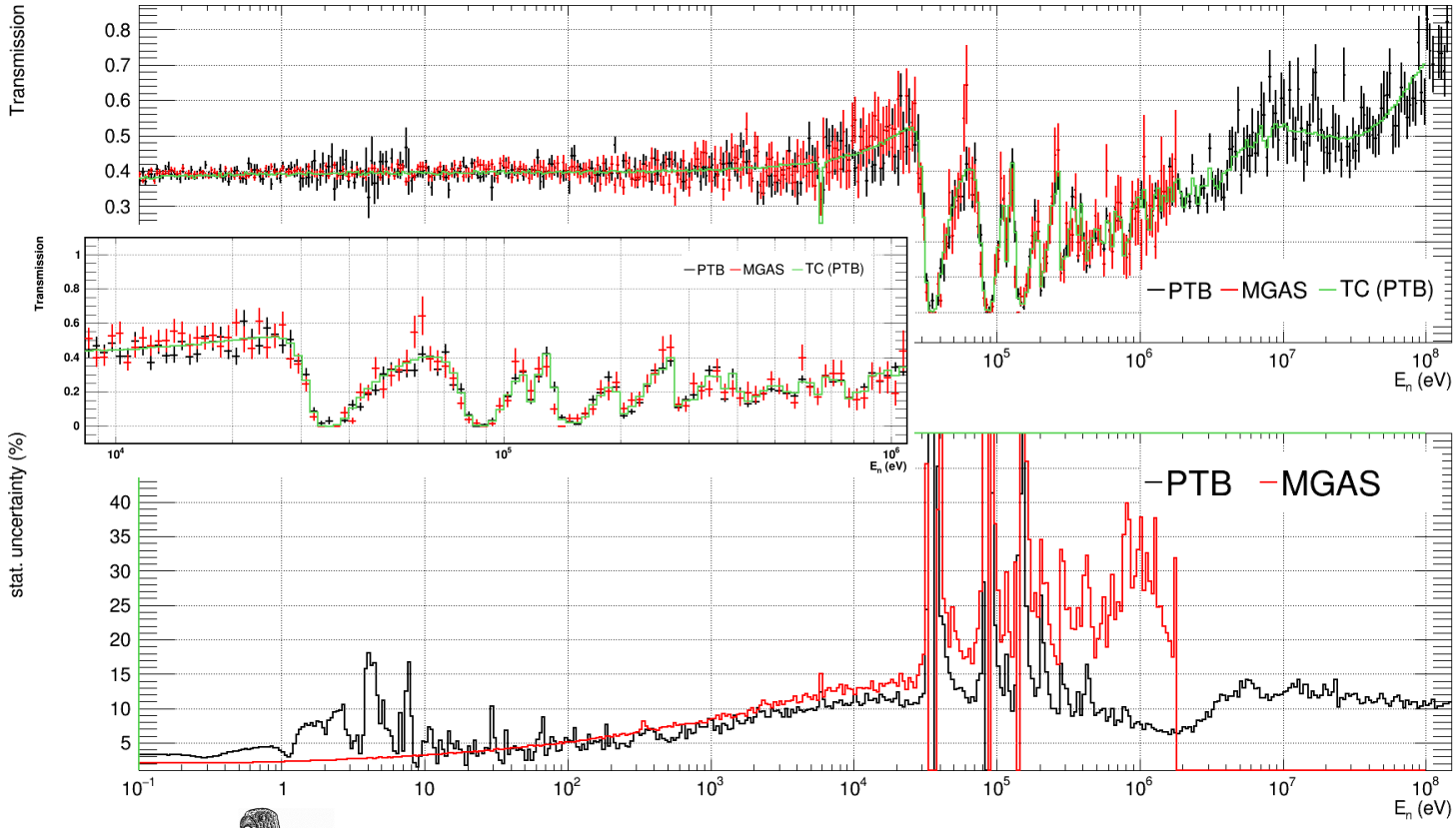


- Proton statistics

Sample	**PTB/MGAS**
C1.2cm	2.84E17
Empty	1.85E17

- 50 bpd in the energy range
- Nice agreement between U5 and B10

Transmission Station: C --1.2 cm thickness + Filter Station: Al --5 cm thickness

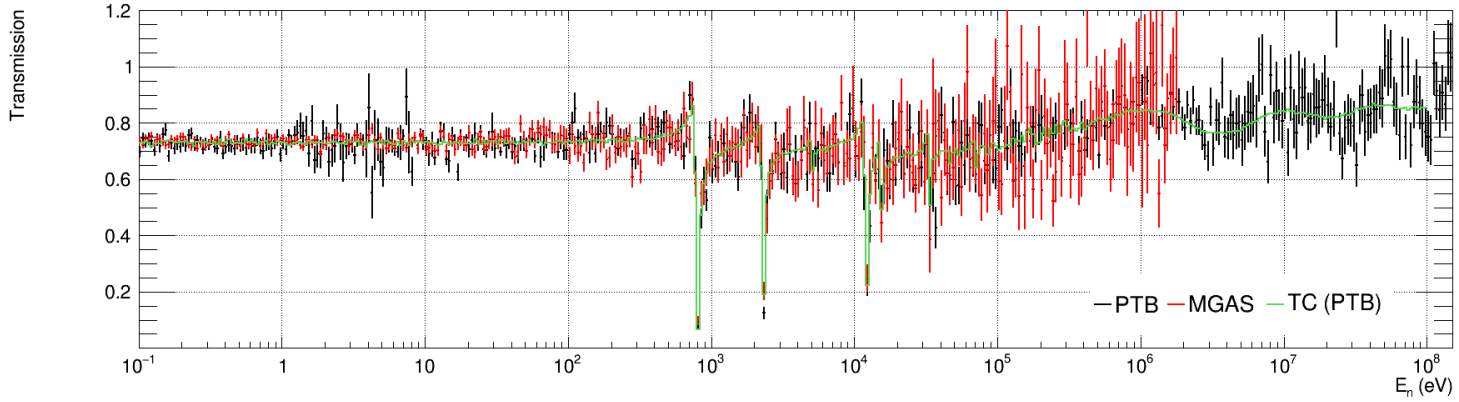


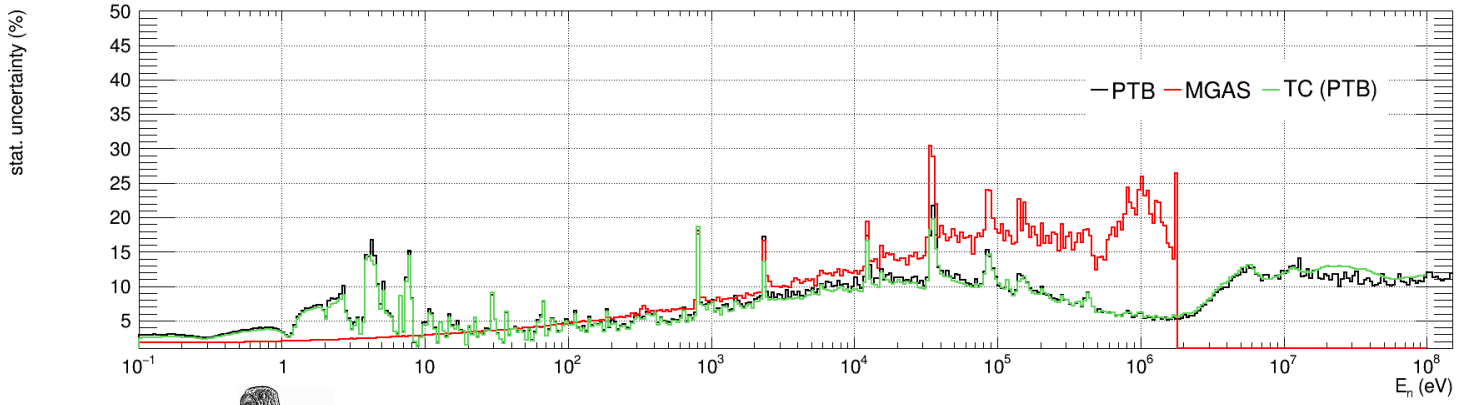
- Proton statistics

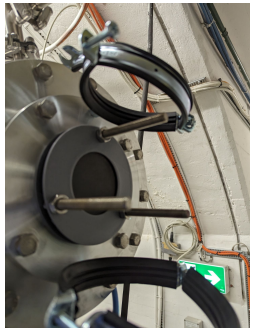
Sample	**PTB/MGAS**
C1.2cm+Al5cm	1.35E17
Empty	1.85E17

- 50 bpd in the energy range
- Nice agreement between U5 and B10

Transmission Station: Bi --1.2 cm thickness







- Proton statistics

Sample	**PTB/MGAS**
Bi1.2cm	0.96E17
Empty	1.85E17

- 50 bpd in the energy range
- Nice agreement between U5 and B10

Transmission Station: Bi --1.2 cm thickness

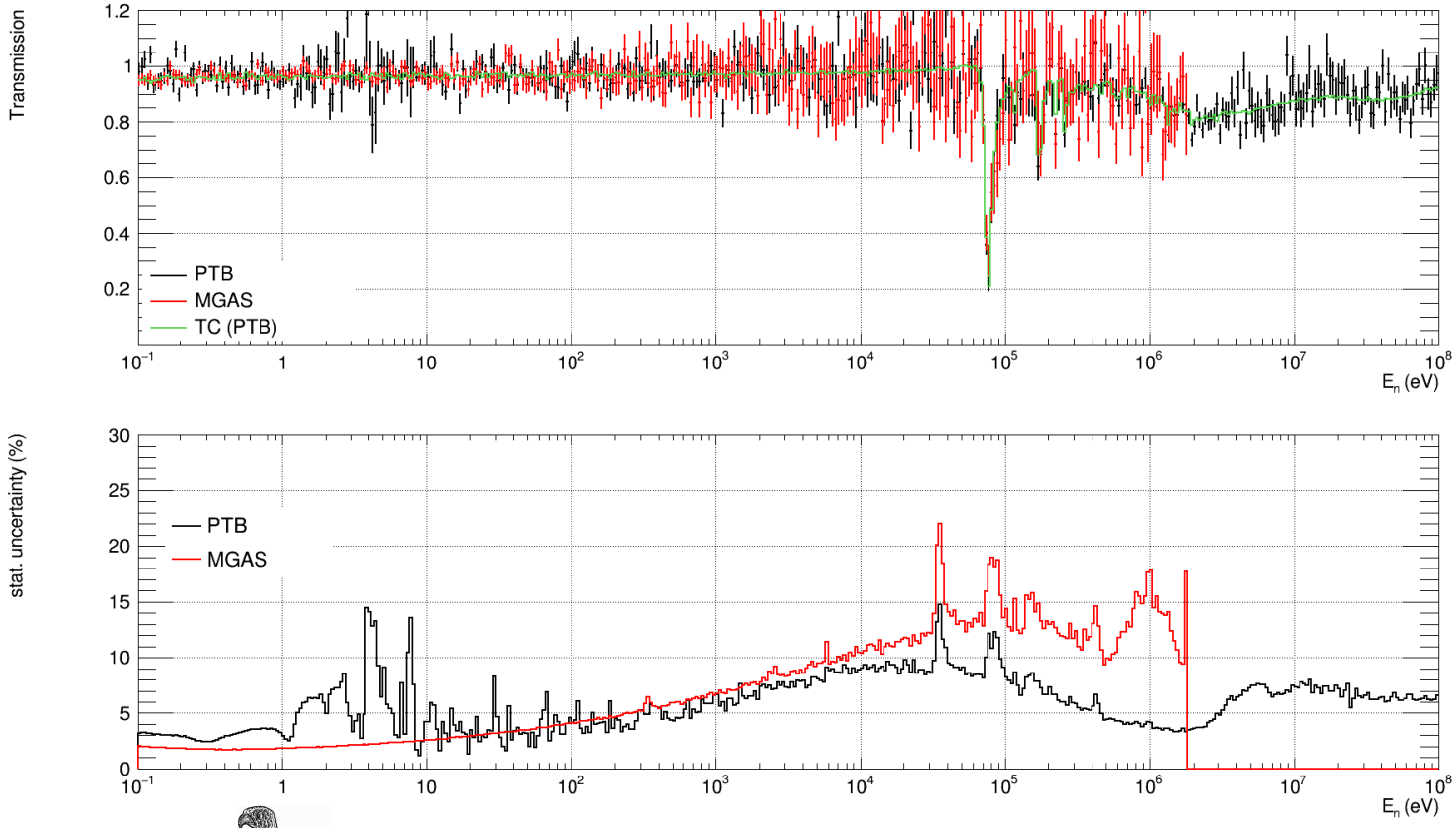
- Resonance dips of Bismuth

- Proton statistics

Sample	**PTB/MGAS**
Bi1.2cm	0.96E17
Empty	1.85E17

- 50 bpd in the energy range
- Nice agreement between U5 and B10

Transmission Station: Ar gas in a 3 L scuba tank @ 200 atm pressure

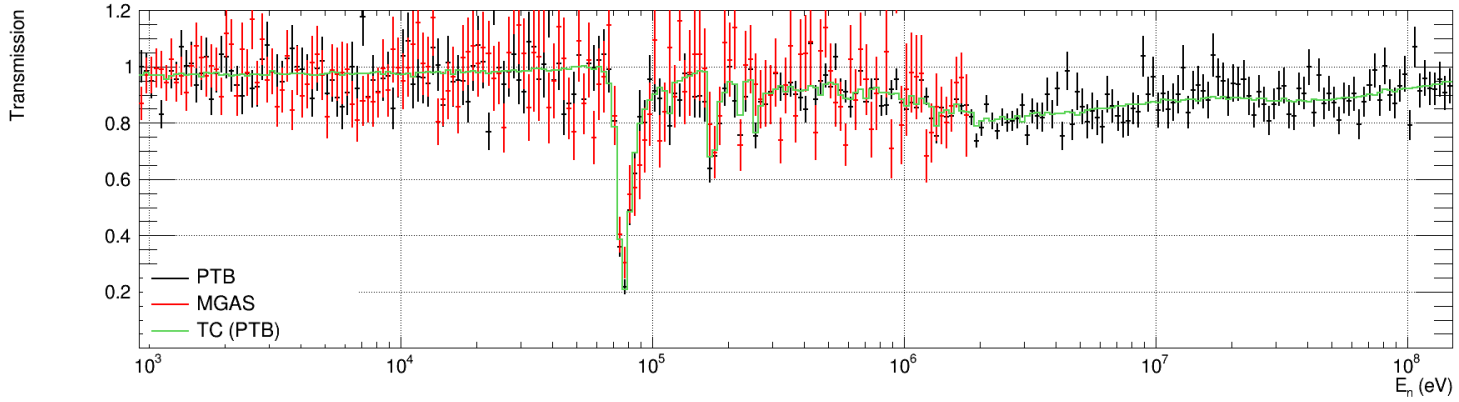


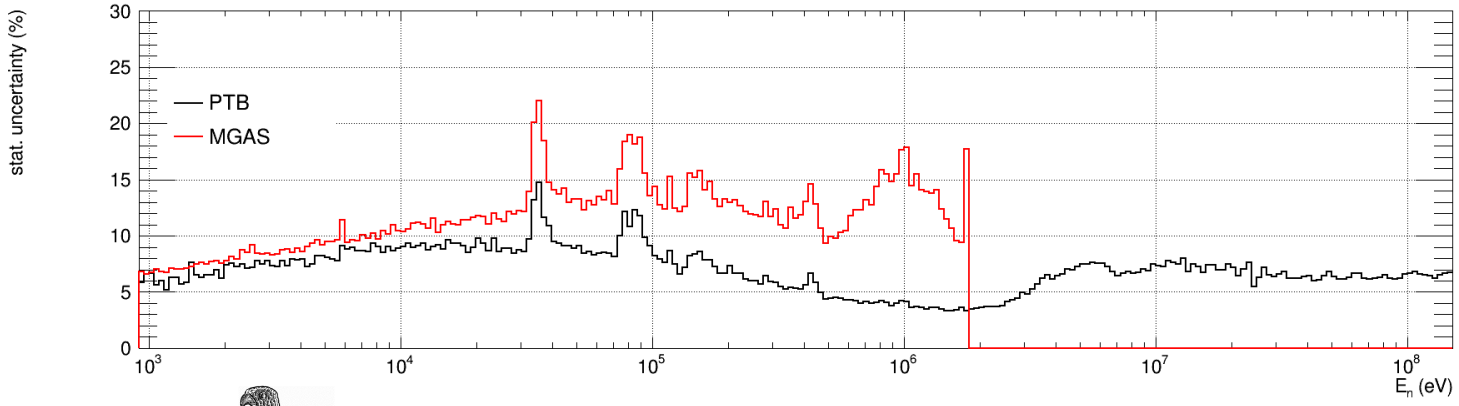
- Proton statistics

Sample	PTB/MGAS
Argon gas	5.43E17
Empty bottle	2.81E17

- 50 bpd in the energy range
- Nice agreement between U5 and B10

Transmission Station: Ar gas in a 3 L scuba tank @ 200 atm pressure





- Proton statistics

Sample	PTB/MGAS
Argon gas	5.43E17
Empty bottle	2.81E17

- 50 bpd in the energy range
- Nice agreement between U5 and B10

Conclusions for gaseous detectors

- **Proof of principle test successfully performed**
  - Two converters: U5 (PTB), B10 (MGAS)
  - Measurement of several well known/characterized samples (Al, C, Bi)
  - Data matches calculations within stat. uncertainties
- Transmission station (upstream colli2) vs Filter station (upstream colli1)
  - **No systematic difference observed within stat. Uncertainties**
  - Gives confidence to proceed with transmission measurements upstream colli2 (easier technical implementation)
- **First measurement with Argon gas-data matches calculations within stat. Uncertainties** (little statistics due to delays)

How to proceed?

- detector/converter?
- Further technical implementation of the Transmission Station
- ...

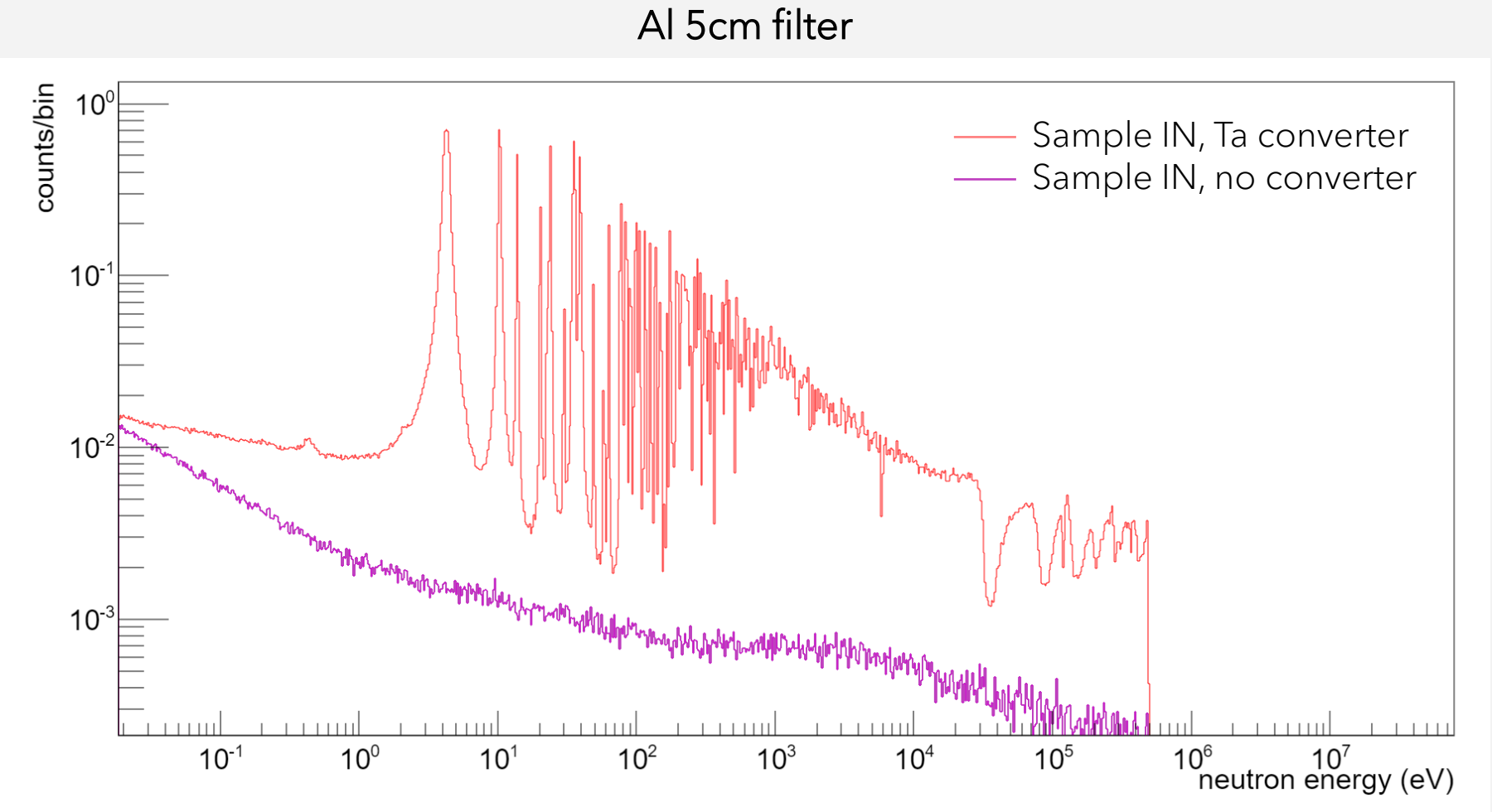
Thank you for your attention!!

Special thanks to Elissa and Mirco for providing the PTB fission chamber and supervising us in the setup!!

Preliminary analysis capture setup MArEX

RICCARDO MUCCIOLA

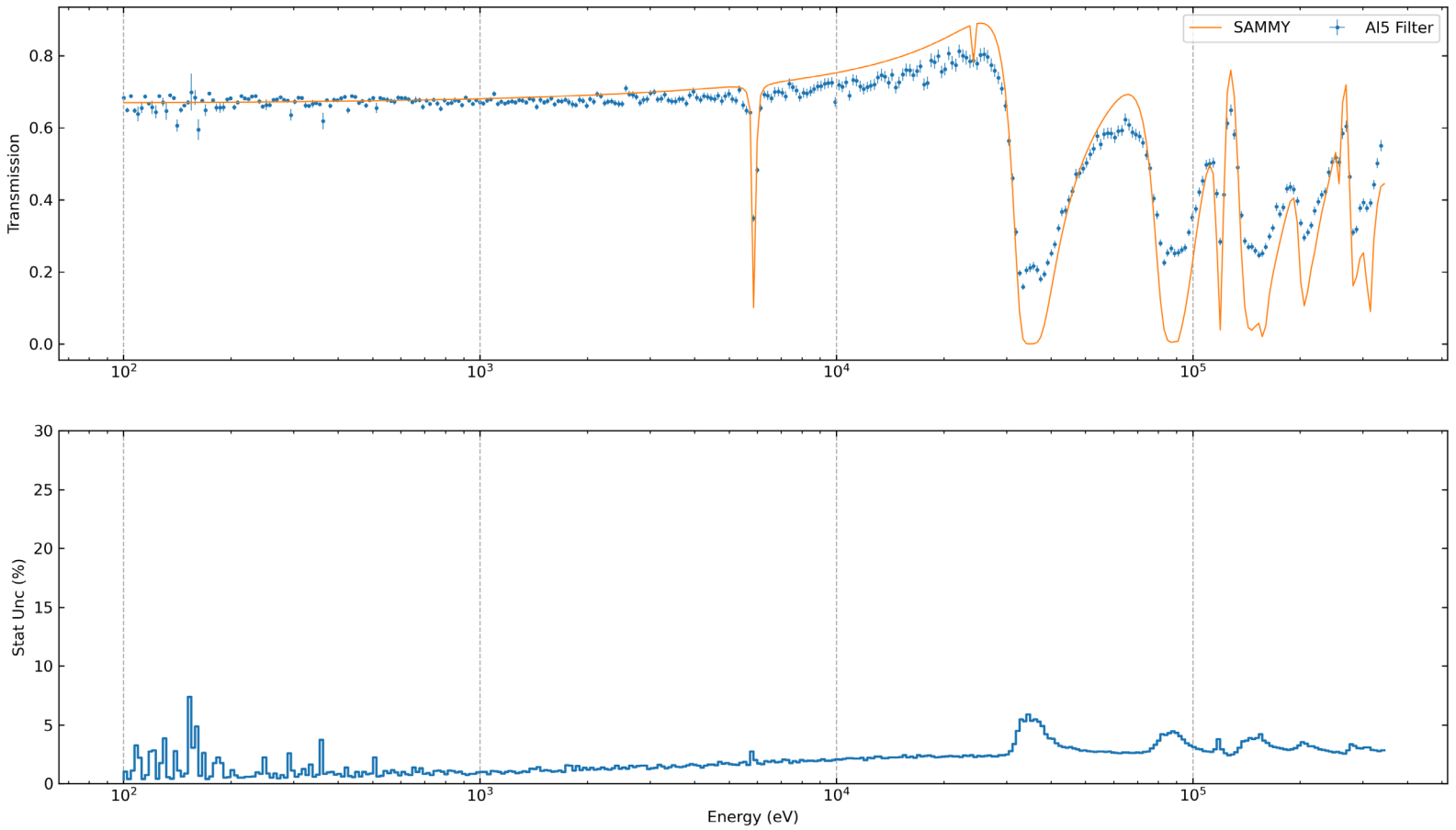
Sample in spectra, background



Each measurement must be corrected for the background.

First approximation of the background is obtained with measurements with no converter in the capture position

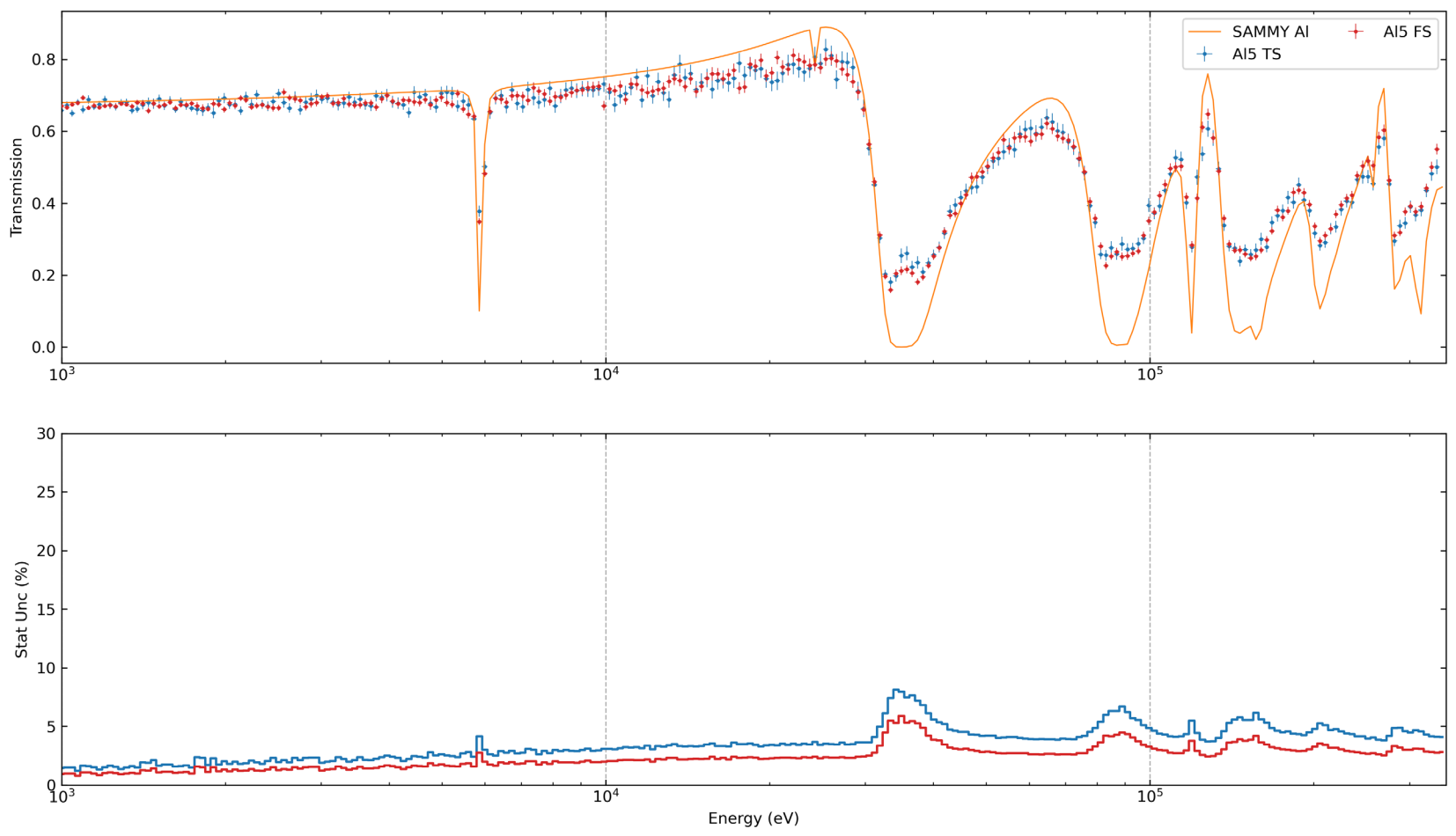
Al5 transmission



- Aluminum 5cm filter compared with SAMMY calculation;
- Same effect visible also in Argon transmission;

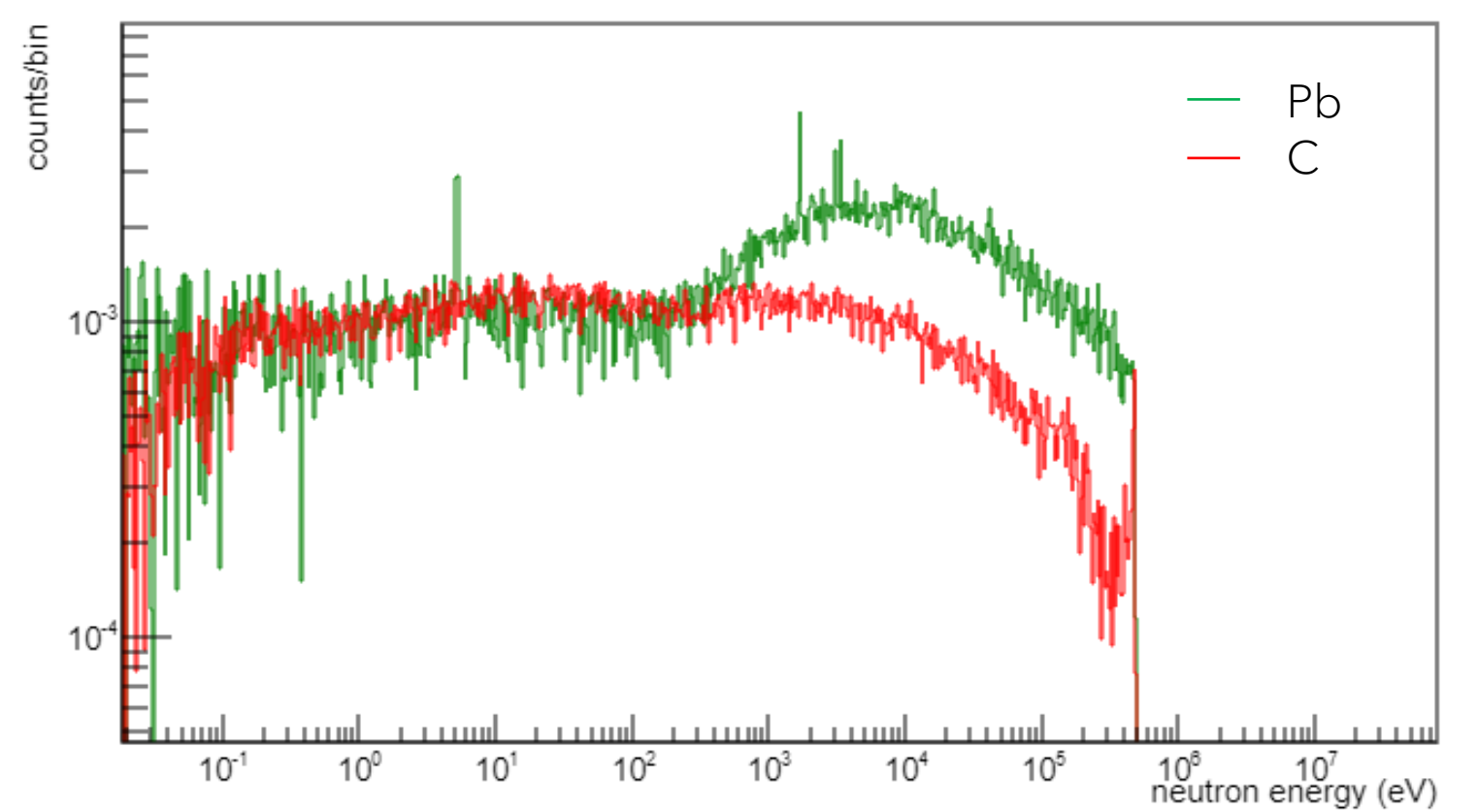
- Deviation caused by incorrect background.

Al5 filter vs sample comparison



- Comparison between sample and filter of 5cm Al;
- Perfect agreement between the two spectra;
- No additional background introduced by transmission station.

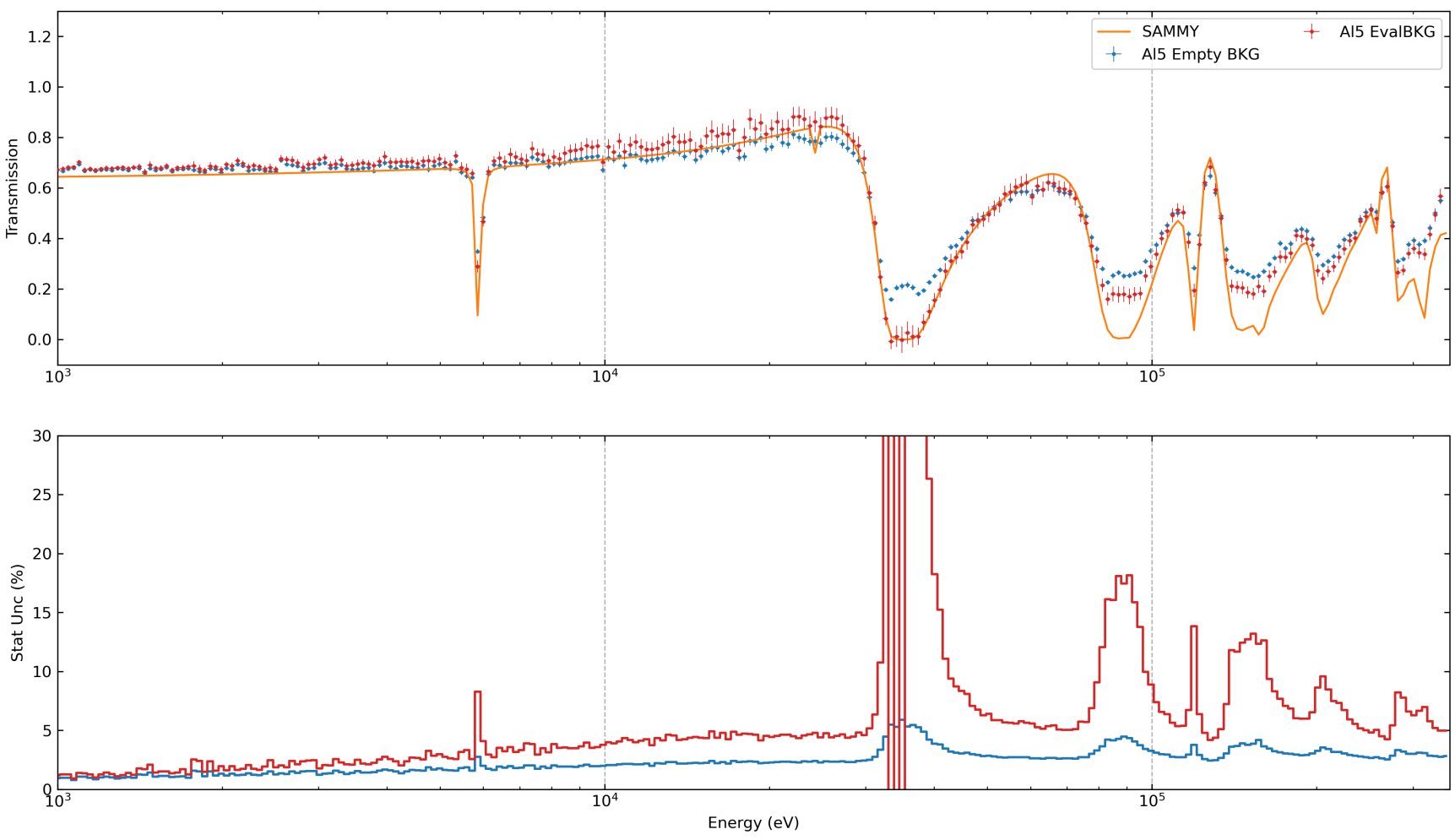
Background estimation, standard technique



- Missing background component estimated using Pb and C measurements
- Measurements performed with both sample in and sample out configurations
- Carbon spectra normalized to lead spectra between 1 and 100 eV

- Gamma component estimated with the subtraction of carbon spectra from lead spectra
- Neutron scattering component estimated using carbon
- Both component were adjusted for the cross sections and areal densities of the samples

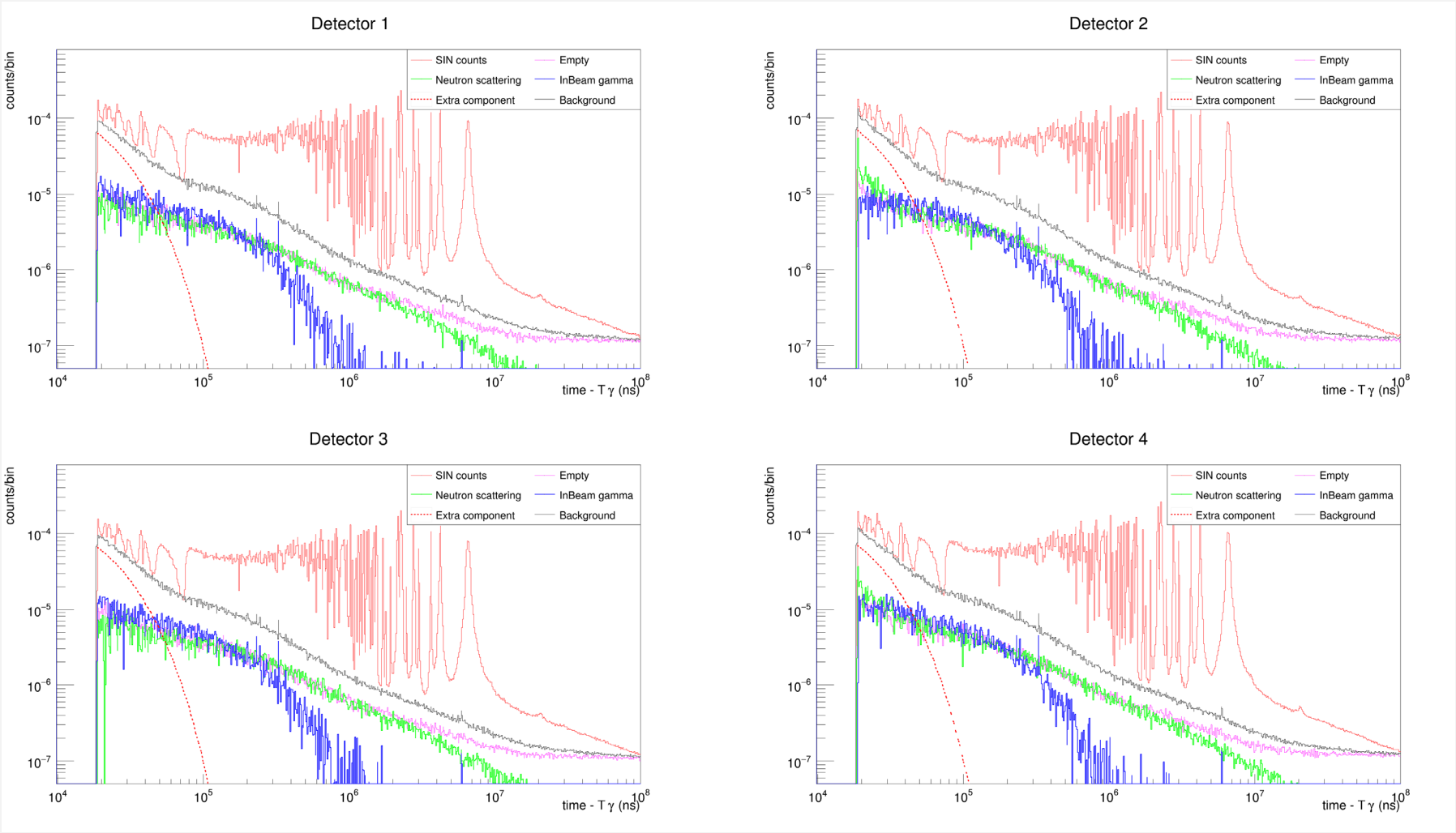
Al5 transmission, evaluated background



- Transmission spectra obtained with new estimated background
- Better agreement in the first resonance at 35 keV
- Still not possible to perfectly reproduce resonances at higher energies

Error in background estimation

Al5 transmission, background study

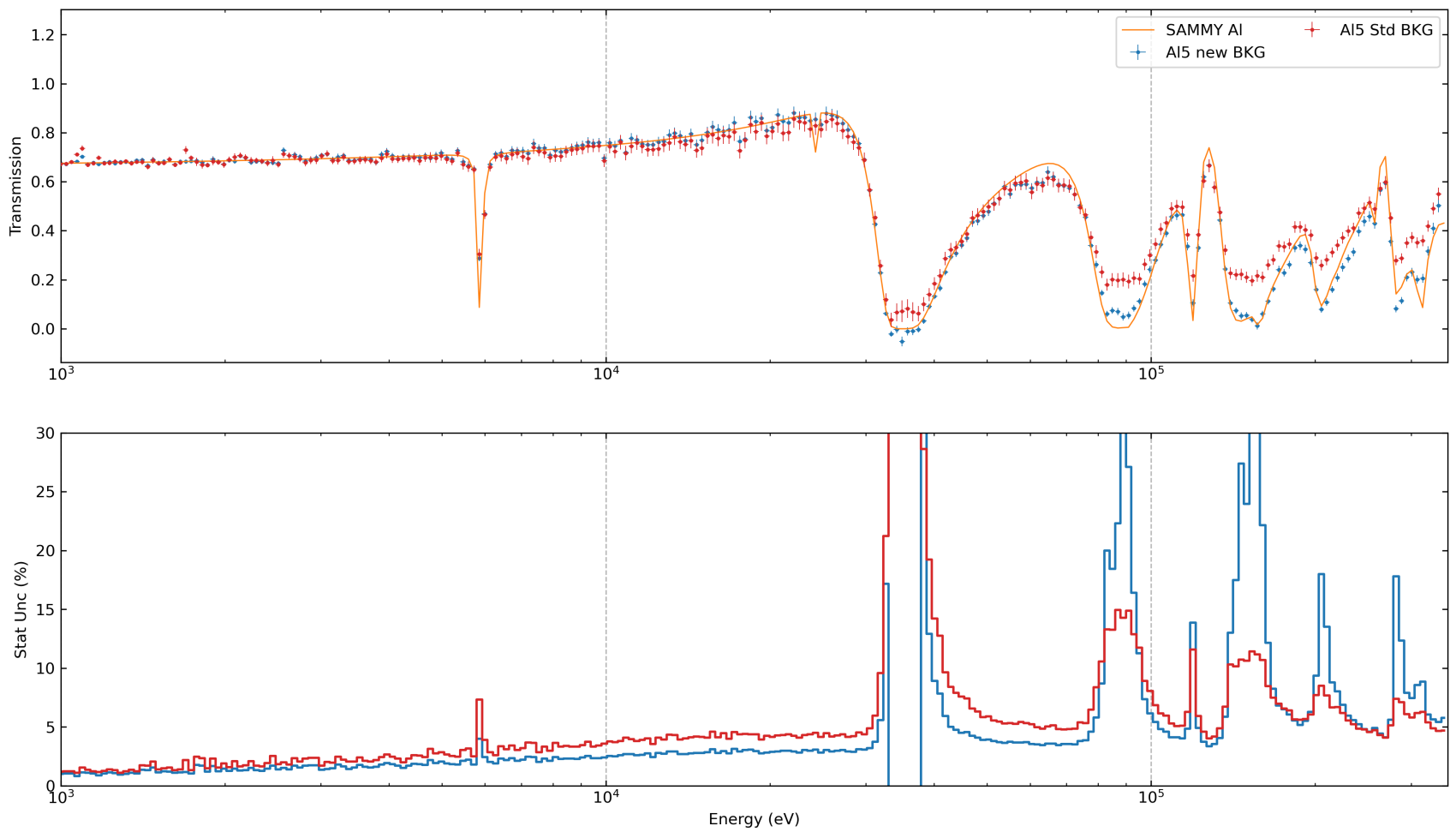


- Background plotted in counts/ns/bunch
- Additional component “ad hoc” added to the background
- Same functional shape of gamma background component (A*exp(-B*t))
- Normalization A scaled using plateau of gamma background to account for effect of sample

↓

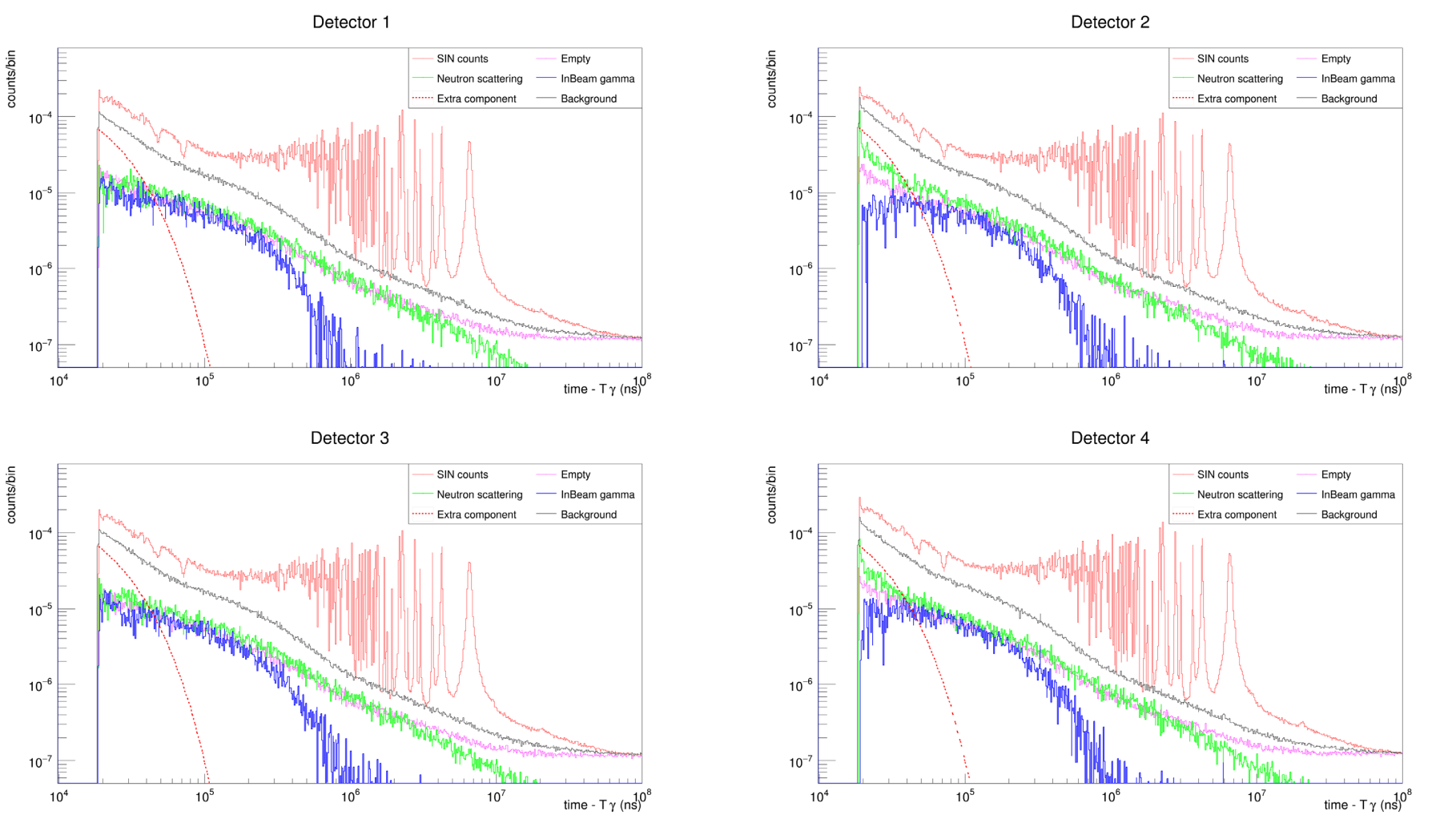
New transmission

Al5 transmission, new background



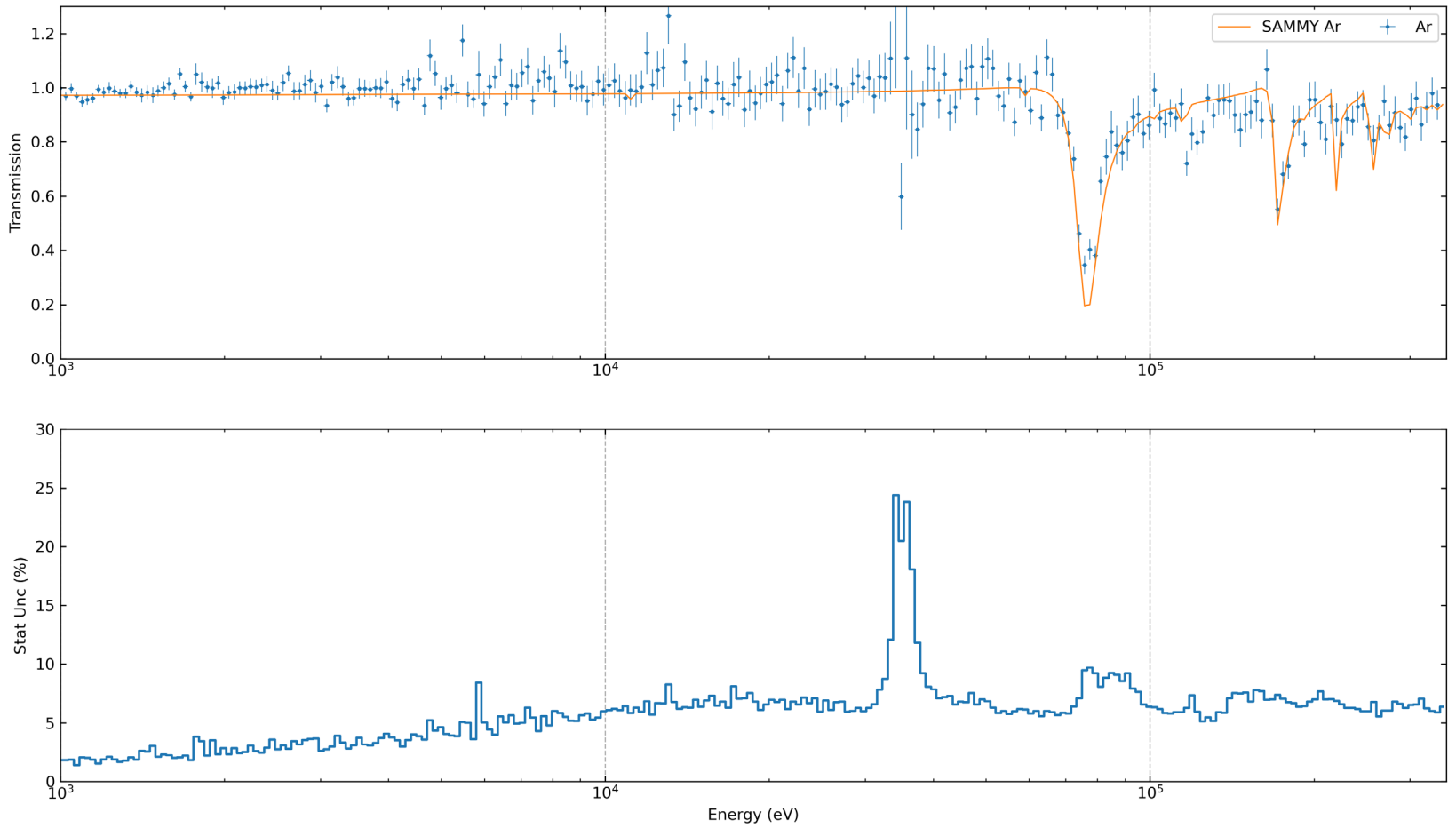
- Good agreement of new transmission with SAMMY;
- Better agreement of resonances with respect to standard background;
- Aluminum transmission reproduced up to 350 keV.

Ar transmission, background estimation



- The same technique was applied to the Argon measurements
- Shape of background is the same used for Aluminum
- Normalized to level of gamma component with respect to empty configuration

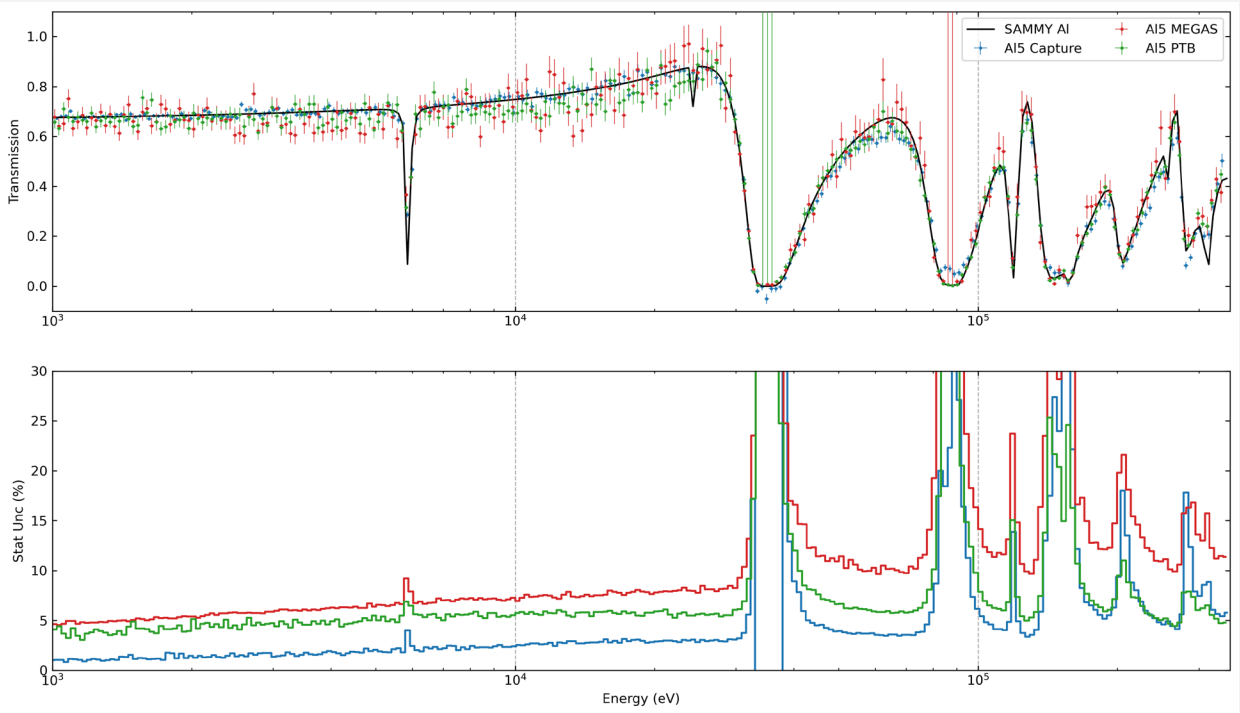
Ar transmission, new background

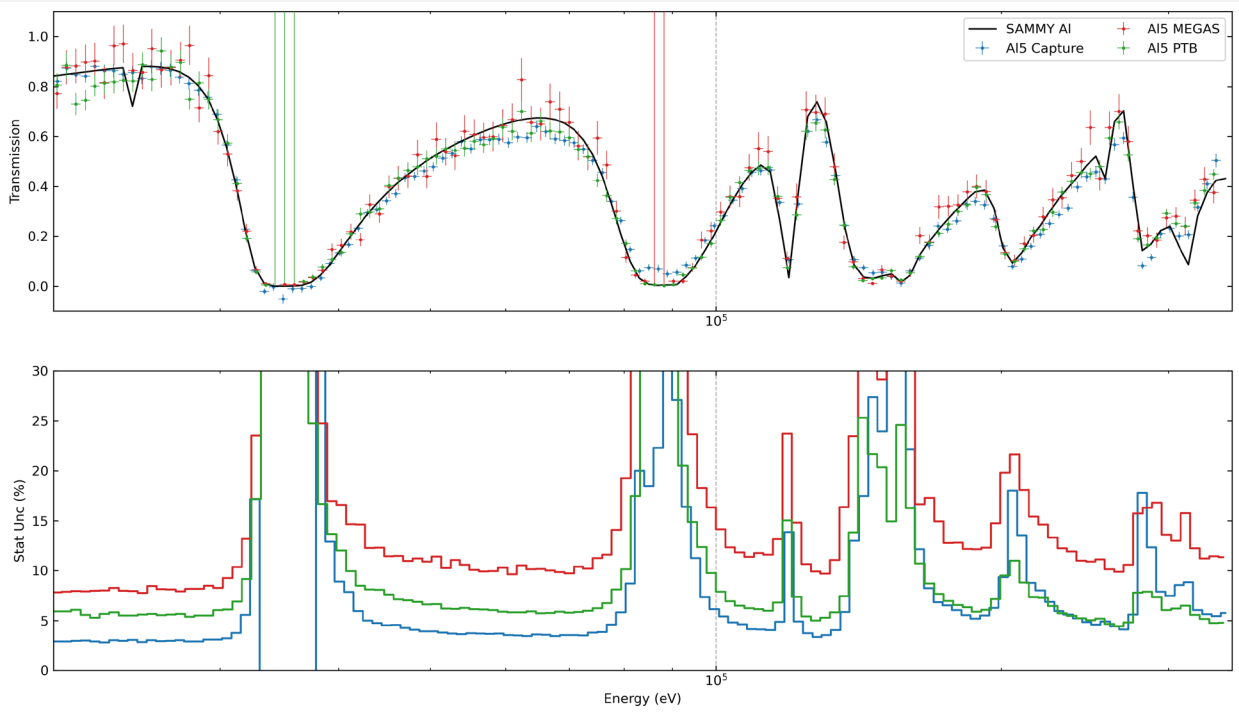


- Good agreement of new transmission with Sammy
- Regions between resonances correctly reproduced

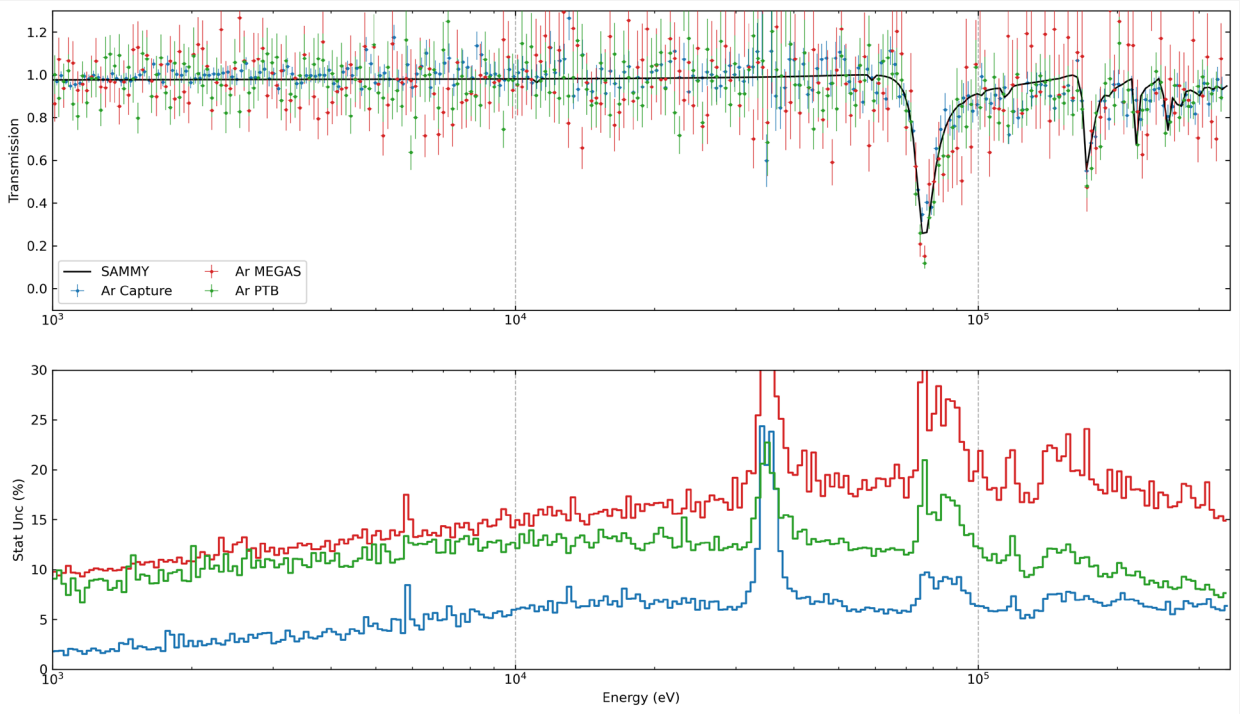
Indication of possible gamma background component

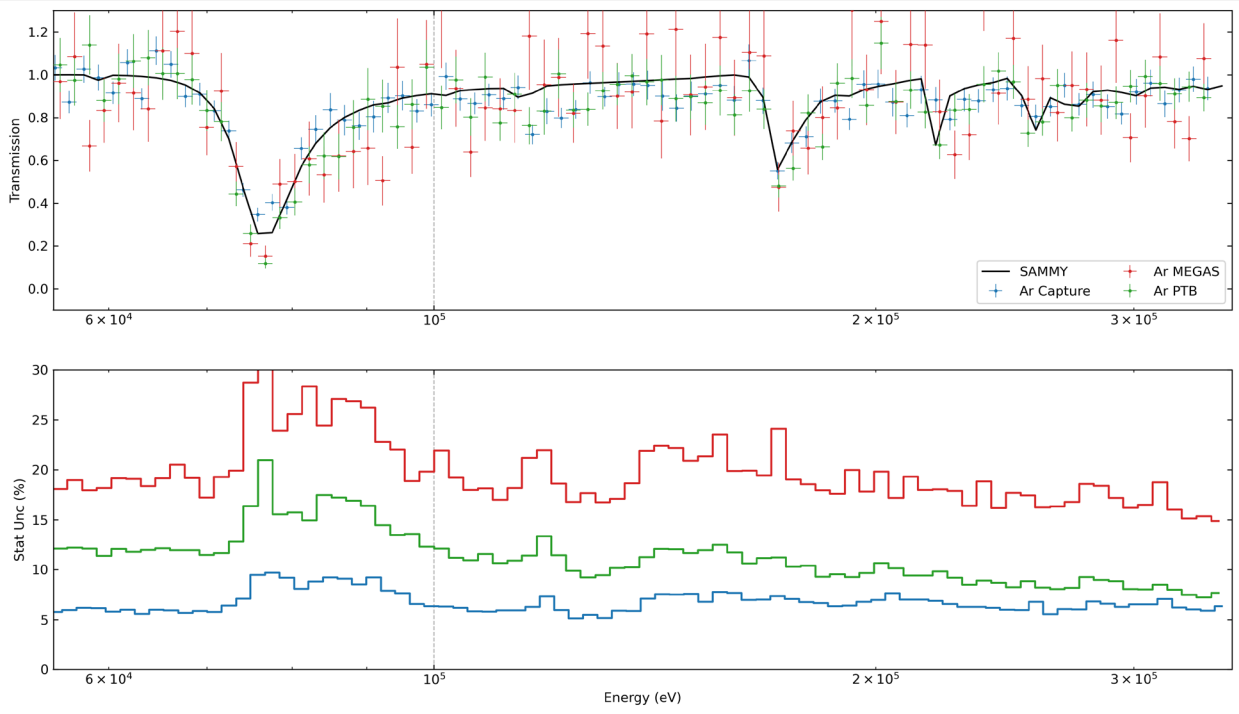
Detection setup comparison – Al5





Detection setup comparison - Ar



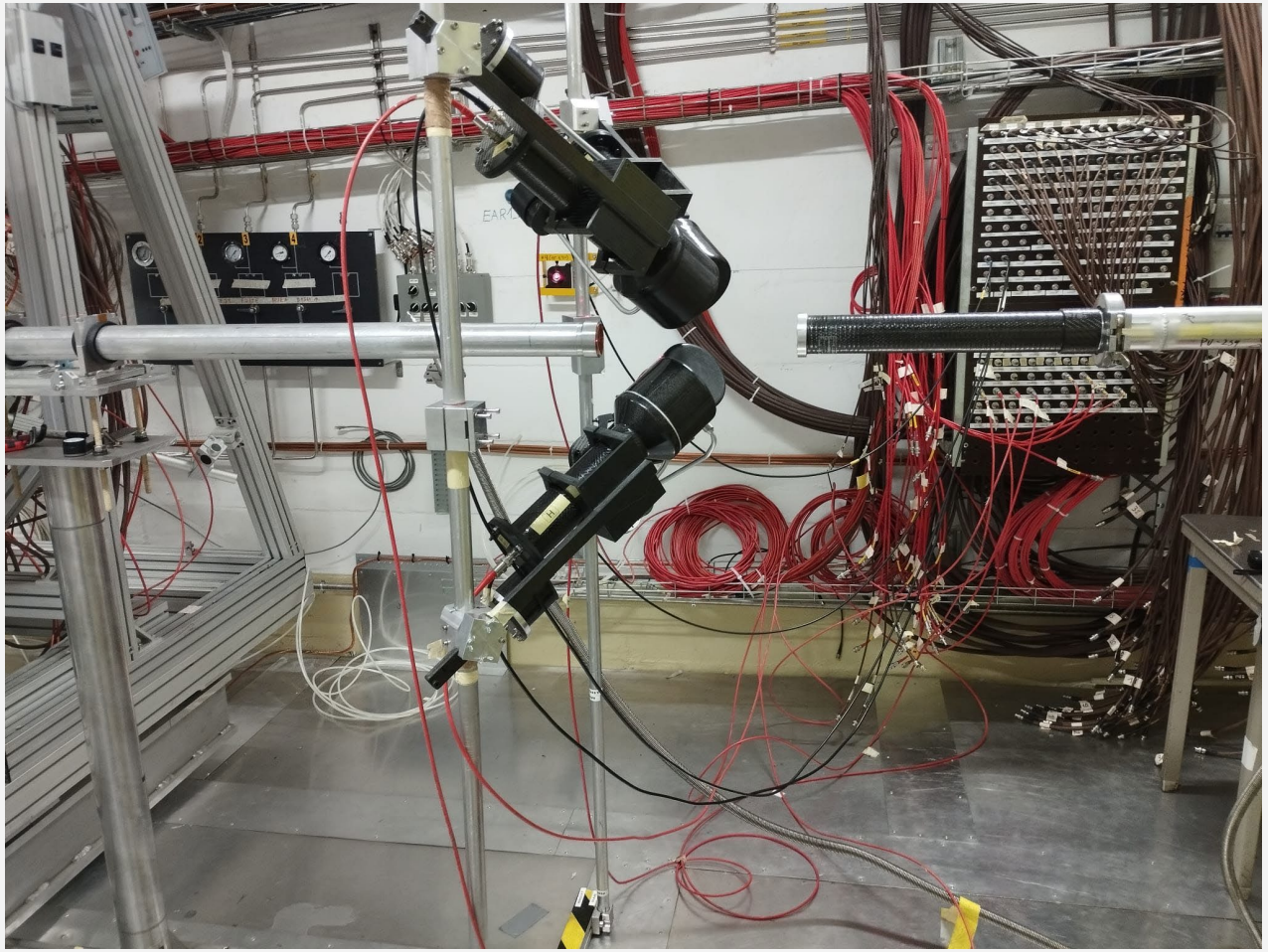


Conclusions

- Capture measurement can reproduce transmission of all the different samples and filters,
- No visible effect of the transmission station on the data, no additional background added by the modification of the beam line,
- Background estimation needs additional Pb and C measurements to be accurate,
- Indication of possible additional background component, probably gamma, present in the data,
- First effort to correct background lend promising results.

Thanks for your attention

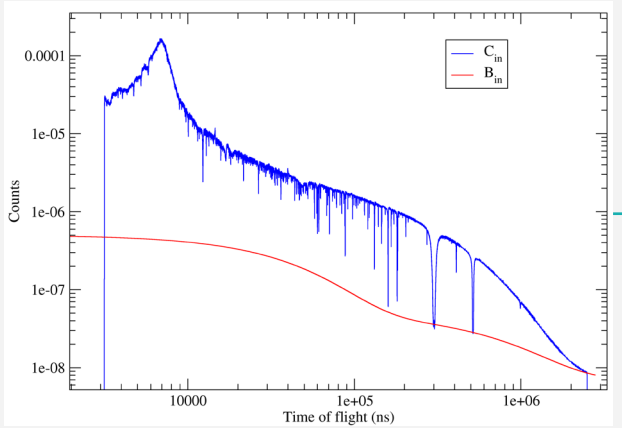
Setup

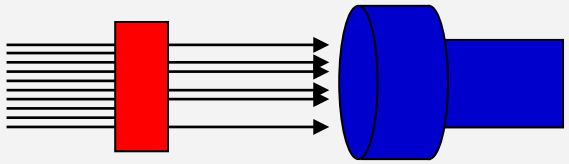


- 4 C6D6 detectors
- Mounted after the TAC
- Distance ~187,8 m

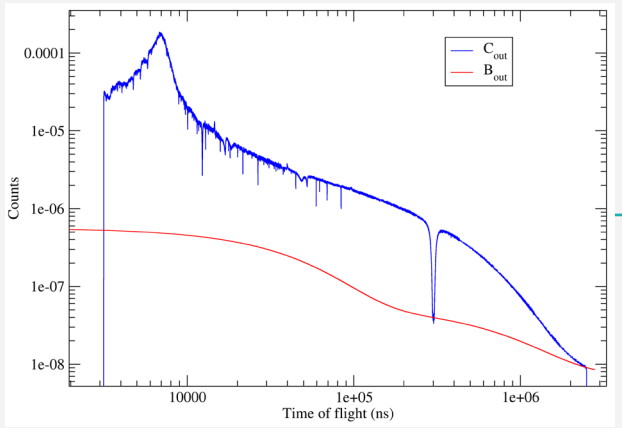
Transmission spectrum

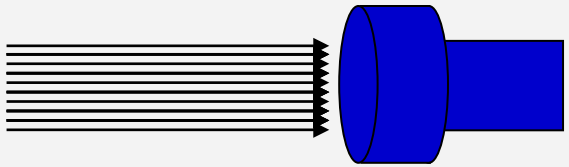
$$C_{in} = \varepsilon T \varphi_n$$



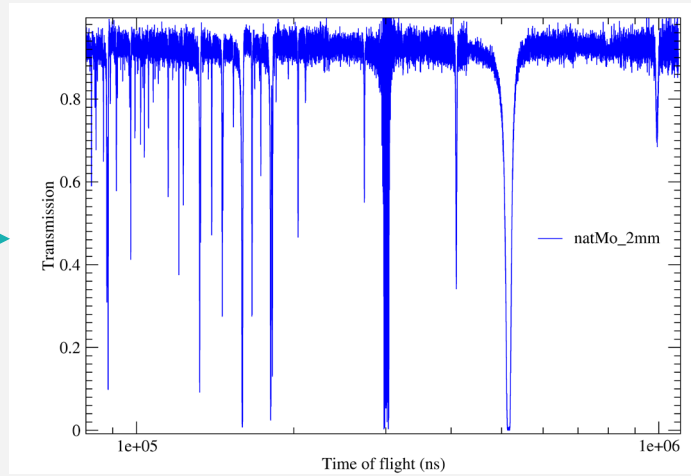


$$C_{out} = \varepsilon \varphi_n$$

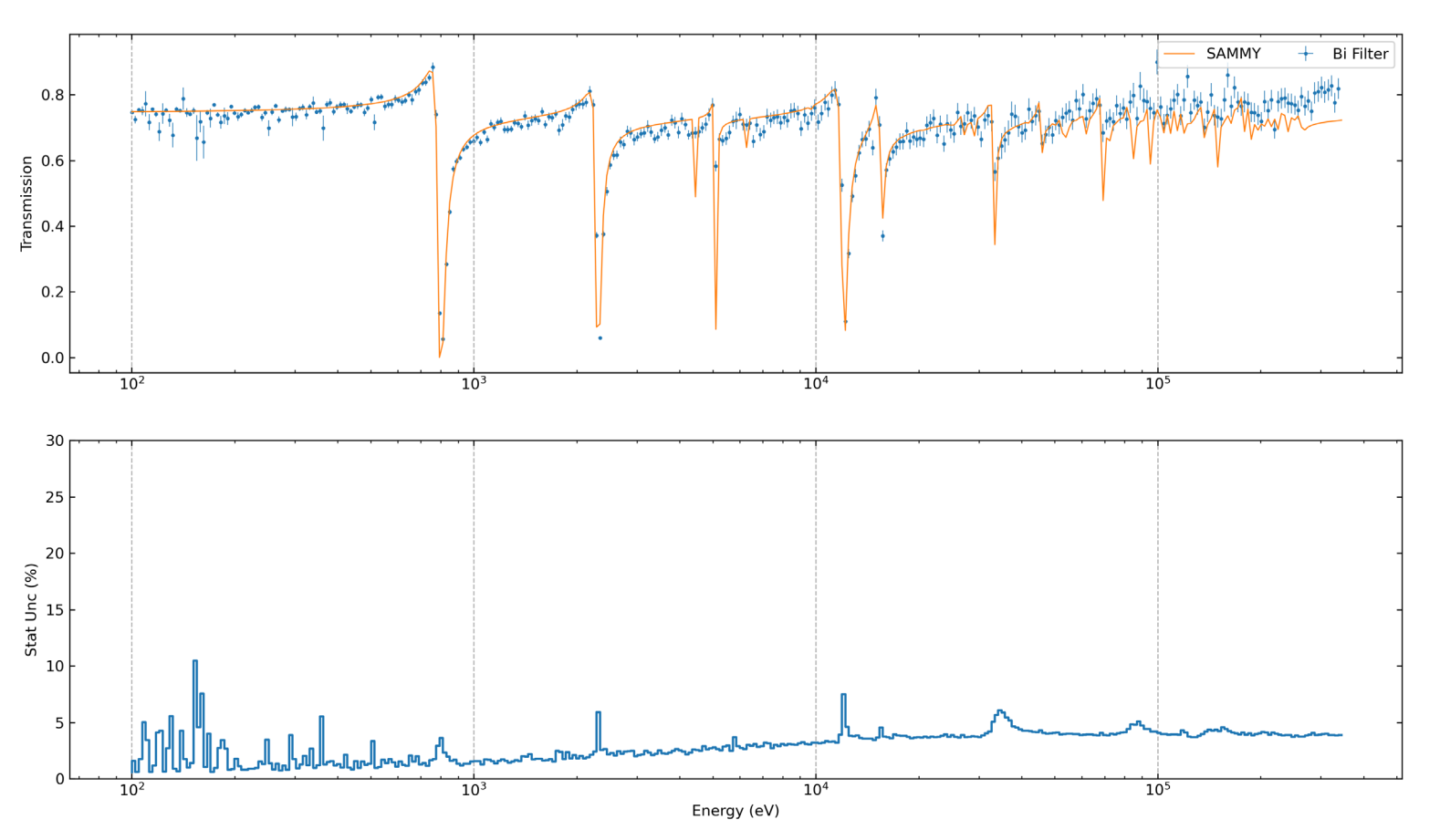




$$T_{exp} = N \frac{C_{in} - KB_{in}}{C_{out} - KB_{out}}$$

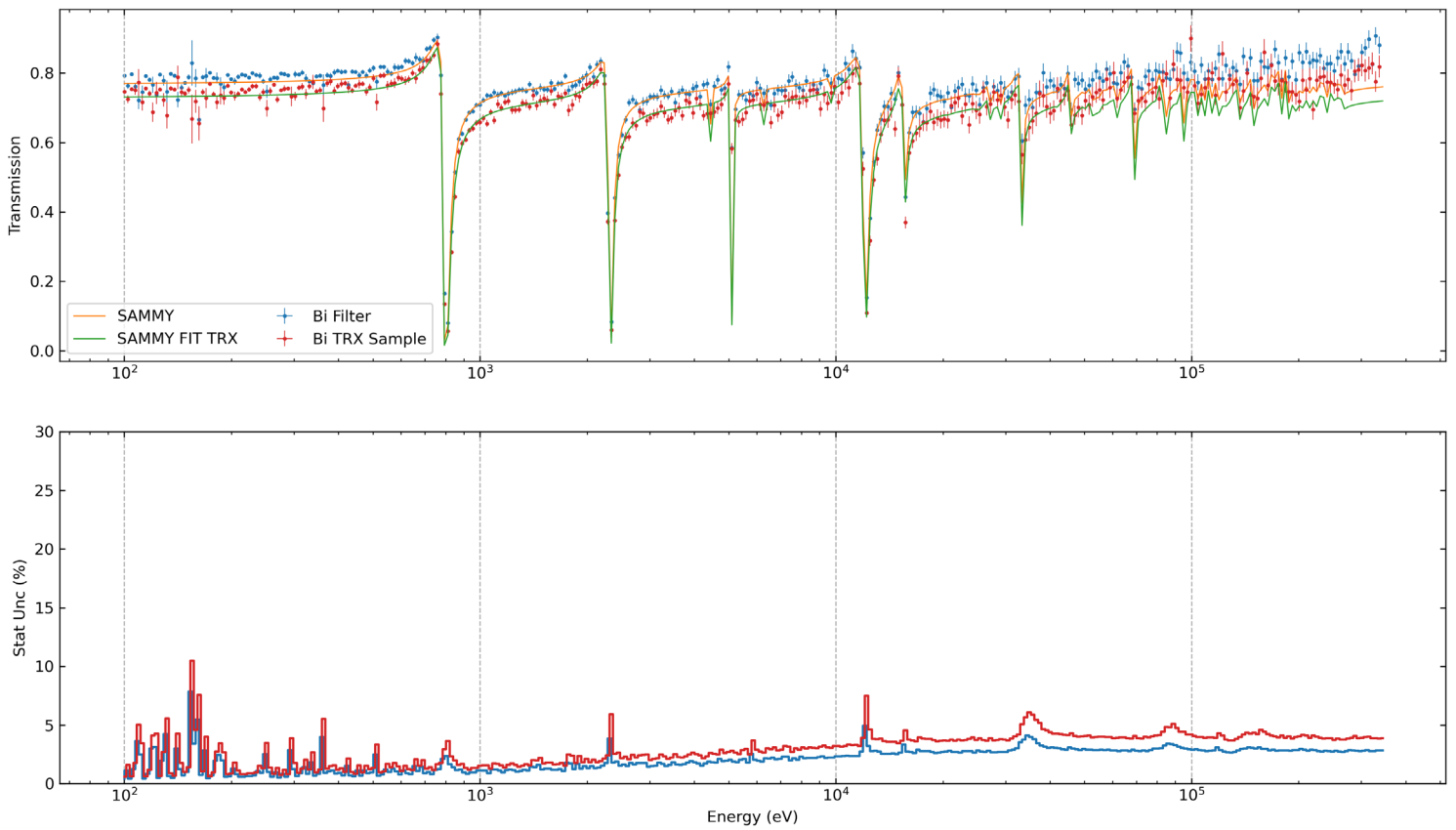


Bi filter transmission



- Transmission is compared to the expected spectrum using SAMMY and the resonances from JEFF3.3
- Good agreement in the first resonances
- Statistical uncertainty below 5% in all the range
- Deviation from expected transmission at higher energies (>50 keV)

Bi filter vs Bi sample



- Transmission from the Bi filter is compared to the transmission measured with Bi sample
- Bi sample slightly thicker (1,2 cm vs 1,0 cm)
- Both spectra perfectly compatible with the expected values

No visible effect on the spectra caused by the presence of the transmission station