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BACKGROUND ANALYSIS IN RECENT SNO+ DATA

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SNO+ experiment

- Located in Sudbury, Canada
- Continuation of the SNO experiment
- Has three phases
  - Light water
  - Organic liquid scintillator
    - PPO: May 2022- March 2023
    - bis-MSB: December 2023- June 2024
  - Tellurium addition (0.5% by weight)

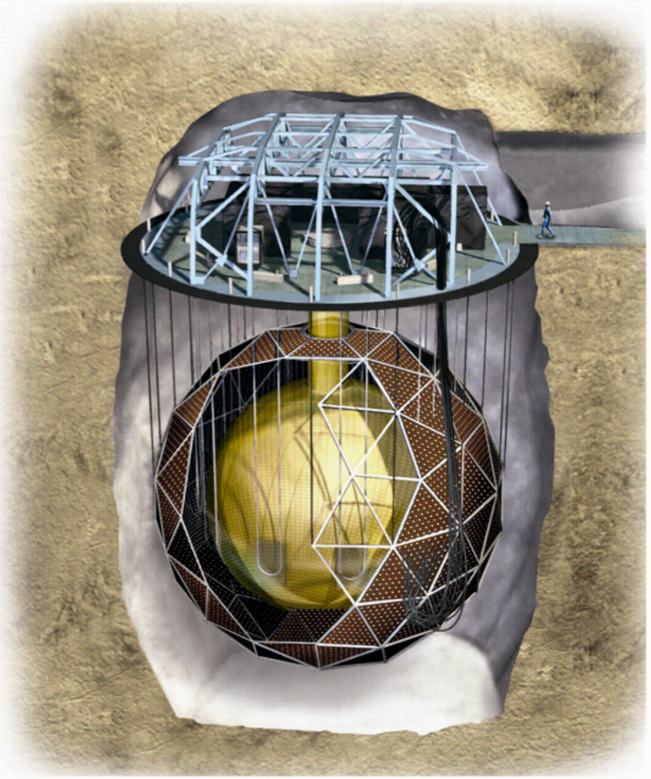

Fig.1 -Overview of the SNO+ experiment

SNO+ Detector

- Located at a depth of 2km, under a flat overburden
- 6m radius acrylic vessel
- Photomultiplier tubes support structure (PSUP) located at 2.5m from the vessel surface. It has about 9500 PMTs, for a coverage of 54%

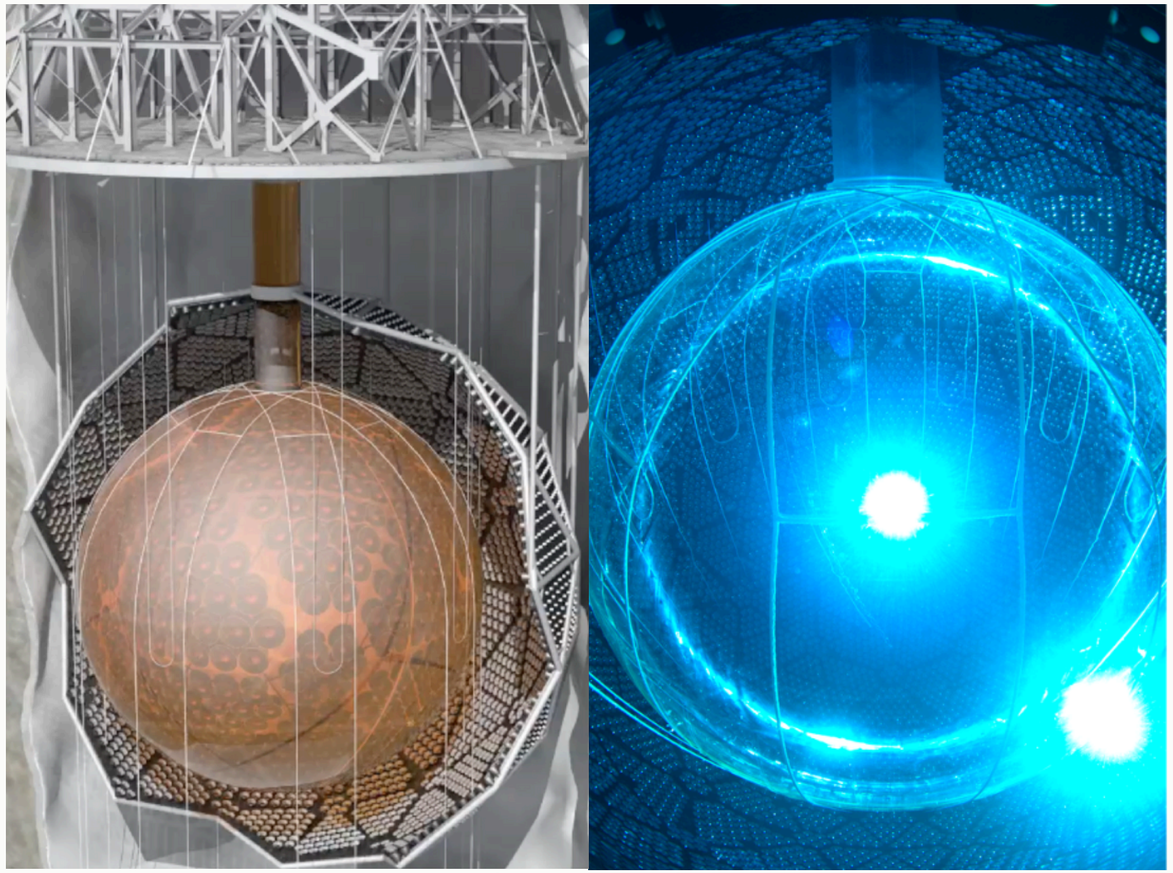

Fig.2 -The SNO+ detector

SNO+ energy spectrum during the scintillator phase

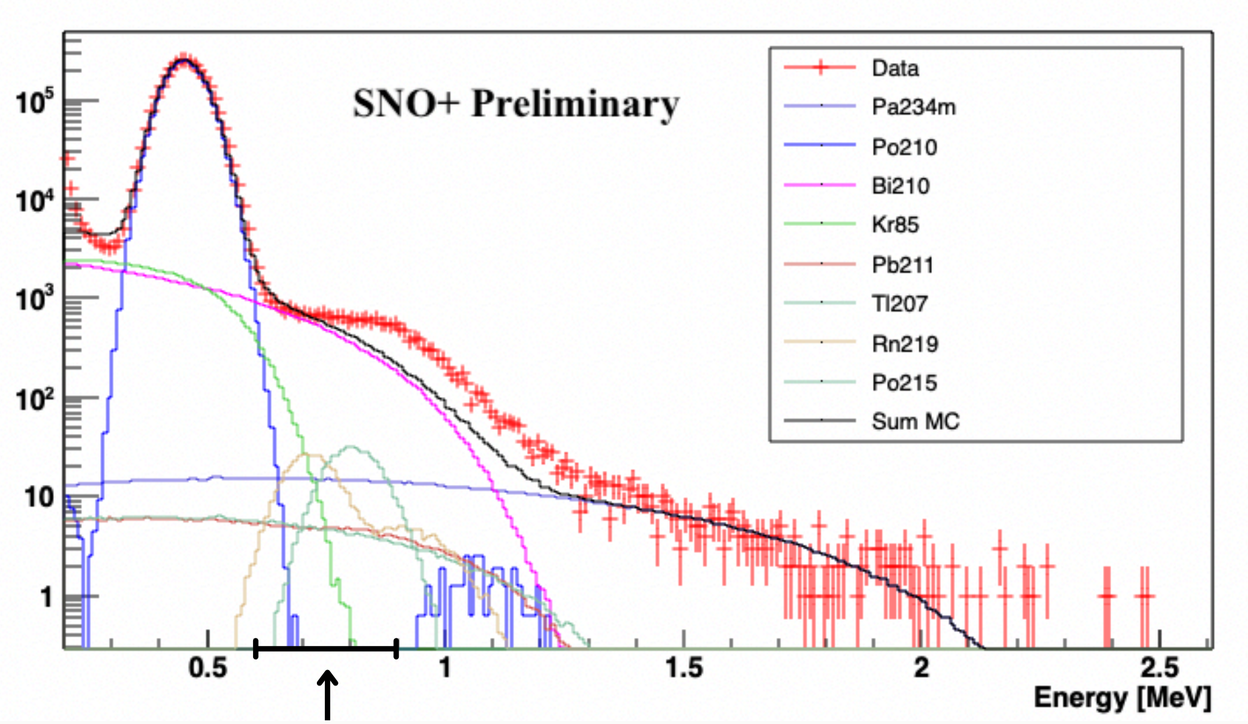

Fig. 3- Example of the energy spectrum of the SNO+ scintillator during the 2.2 g/L PPO phase

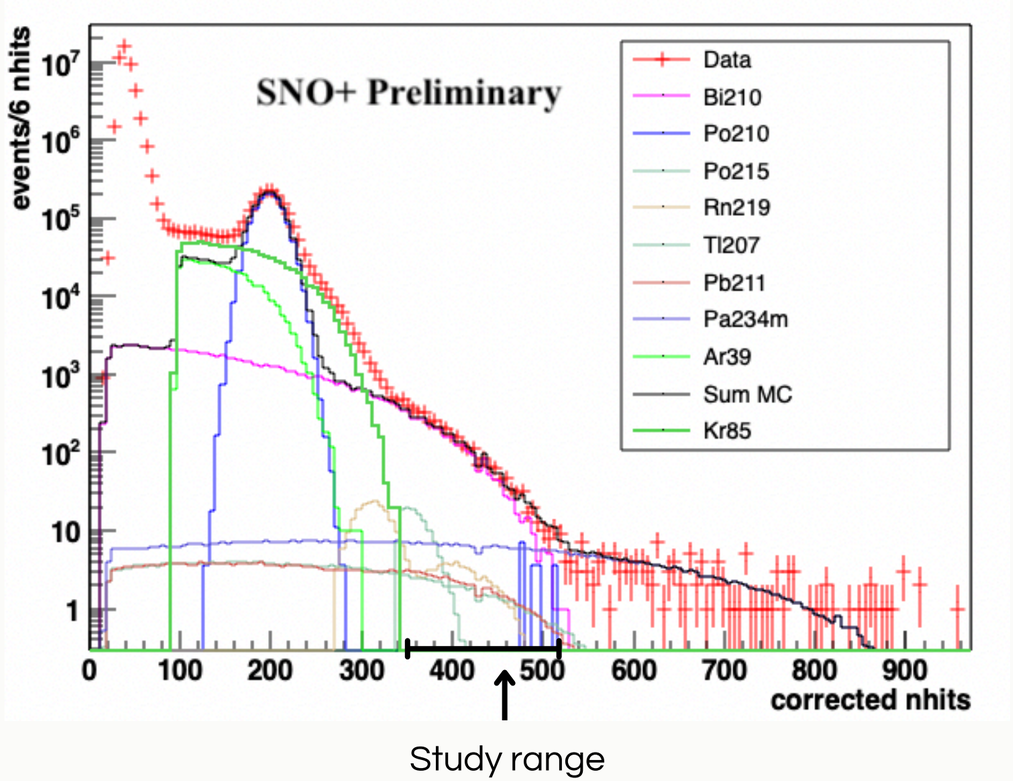

Fig. 4- Example of the PMT hit (proportional to energy) corrected nhits spectrum of the SNO+ scintillator during the Bis-MSB

Bi-210 selection Efficiency

- Calculation of the efficiency:
  - Use MonteCarlo simulations of the Bi-210 spectrum in energy and PMT hits.
  - Identify the energy and position/volume cuts for the events of interest
  - Count the number of events that pass the previous cuts (# events pass cuts)

$$eff = \frac{events\ pass\ cuts}{total\ simulated\ events}$$

- Results:

	FV 6000	FV 5000	FV 4000	FV 2500
Efficiency bis (%)	10.3666	6.25635	3.2161	0.790491
Efficiency bismsb (%)	2.57426	2.06215	1.01384	0.2064

Table. 1- Efficiencies for the Bi-210 events in the 2.2 g/L PPO and the Bis-MSB phase for various FVs

Bi-210 activity, 2.2 g/L PPO phase

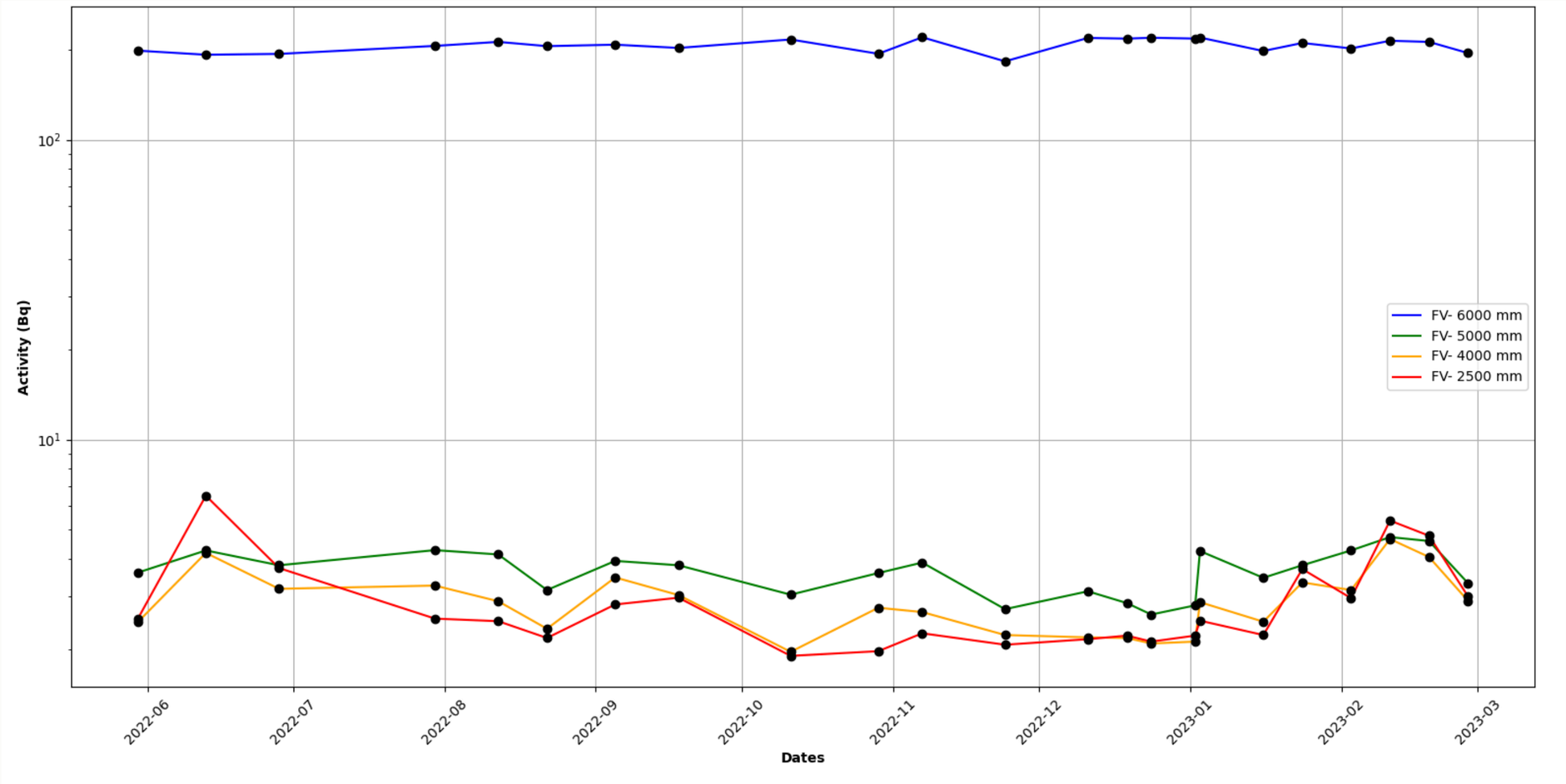

Fig. 5- Bismuth 210 activity for the 4 different FV during the 2.2 g/L PPO phase

The Bi-210 spectrum

- Data normalized to 23h/ day
- Comparing the spectral shapes for the May 2022 to March 2023 period it appears that a contamination enters the detector around February 2023

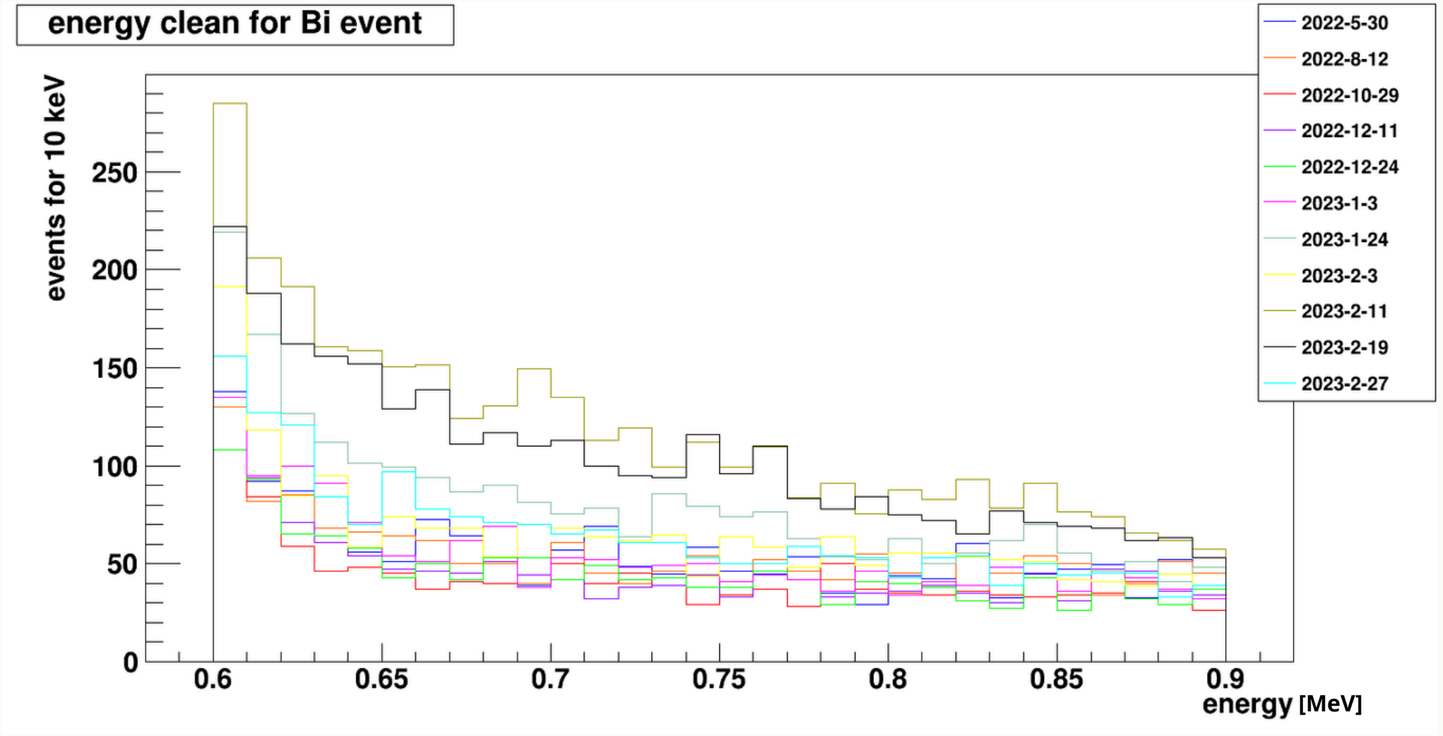

Fig. 6- Plot of the bismuth 210 decay for the FV of 2500

Bi-210 activity, Bis-MSB phase

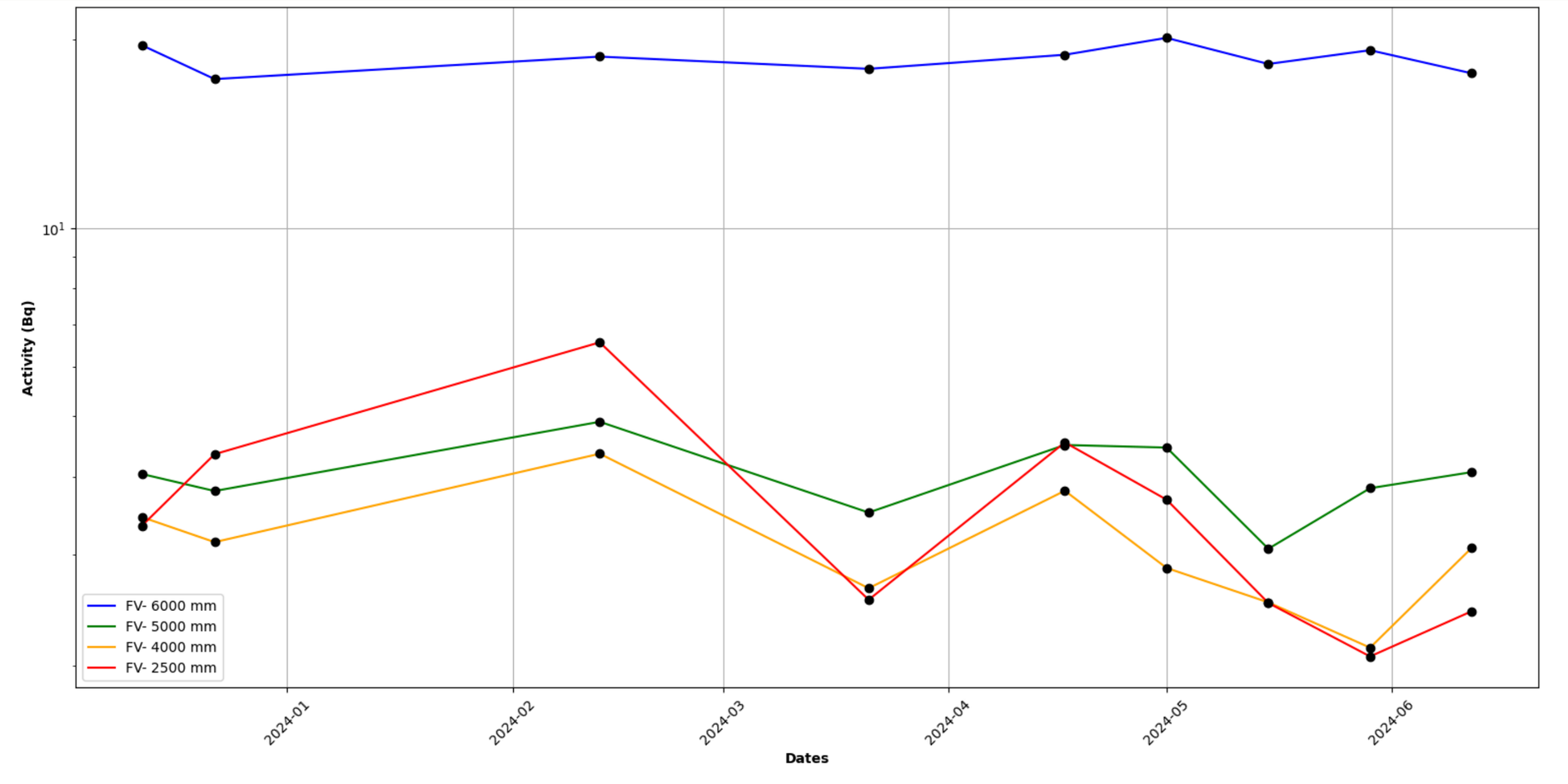

Fig. 7- Bismuth 210 activity for the 4 different FV during the Bis-MSB phase

Comparison of the PPO and Bis-MSB periods

- Possible contamination in June 2022 and February 2023
- Possible contamination in the addition process of the Bis-MSB

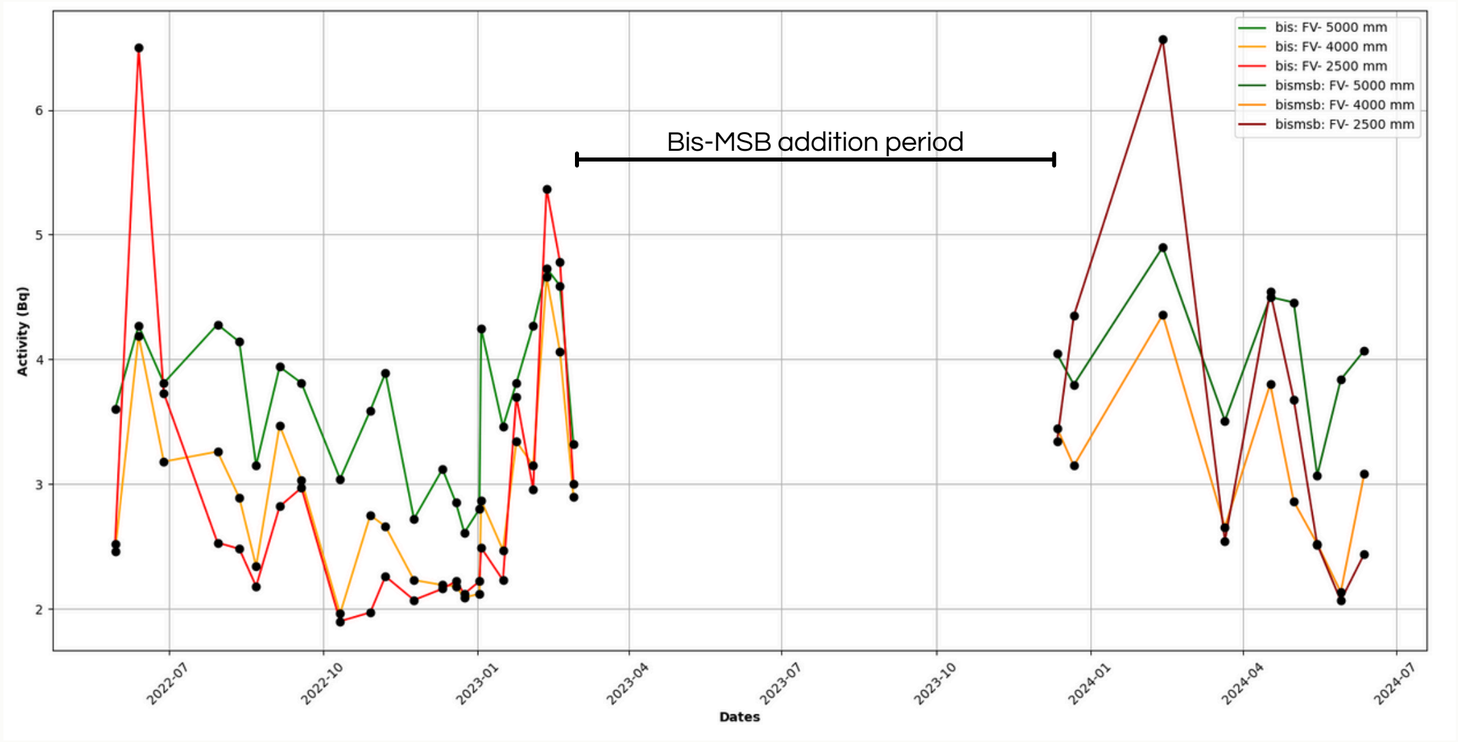

Fig. 8- Bismuth 210 activity for the 3 different FV for the entire analysis period

Comparison of the PPO and Bis-MSB periods

- Average activity for each FV for the entire PPO and bisMSB period (including the contamination period)

- Results:

	Average PPO (Bq)	Average bismsb (Bq)
FV 5000	3.65	4.02
FV 4000	2.89	3.11
FV 2500	2.92	3.56

Table. 2- Average of the activity for the smaller three FV

Overview and conclusions

- Overview
  - The goal of this study was to identify the Bi210 activity inside the SNO+ detector and its evolution with time
  - Started by selecting the appropriate range in energy and PMT hits for the study
  - Calculated the efficiency of the cuts in the previous points via MC simulations
  - Extracted the Bi-210 activity from SNO+ data
  - Investigated any variation in Bi-210 activity
- Conclusions
  - A possible contamination was spotted in the months of June 2022 and February 2023.
  - During the addition of the Bis-MSB a contamination may have also happened

Thank you!

Backup

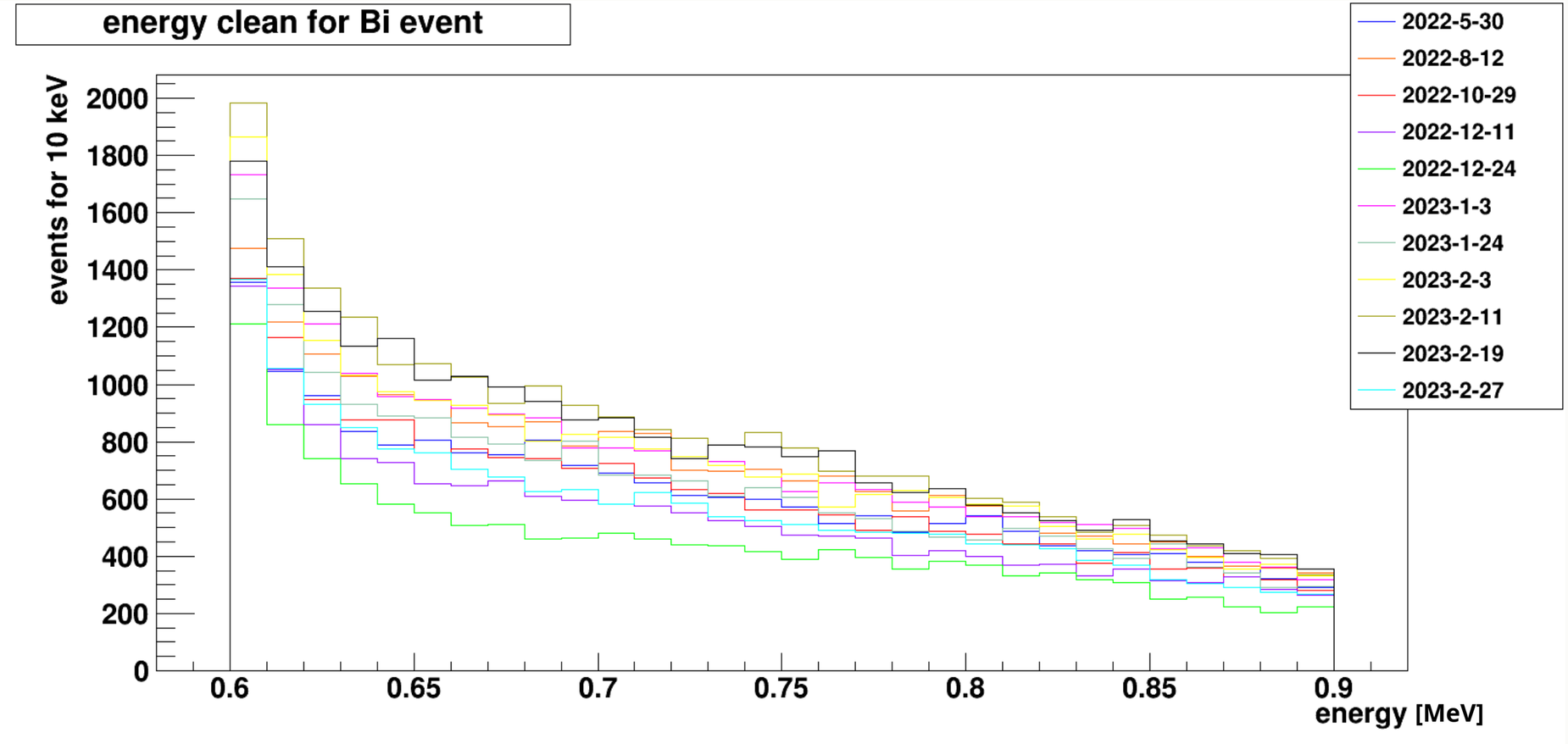

Fig. 9- Plot of the bismuth 210 decay for the FV of 5000

Backup

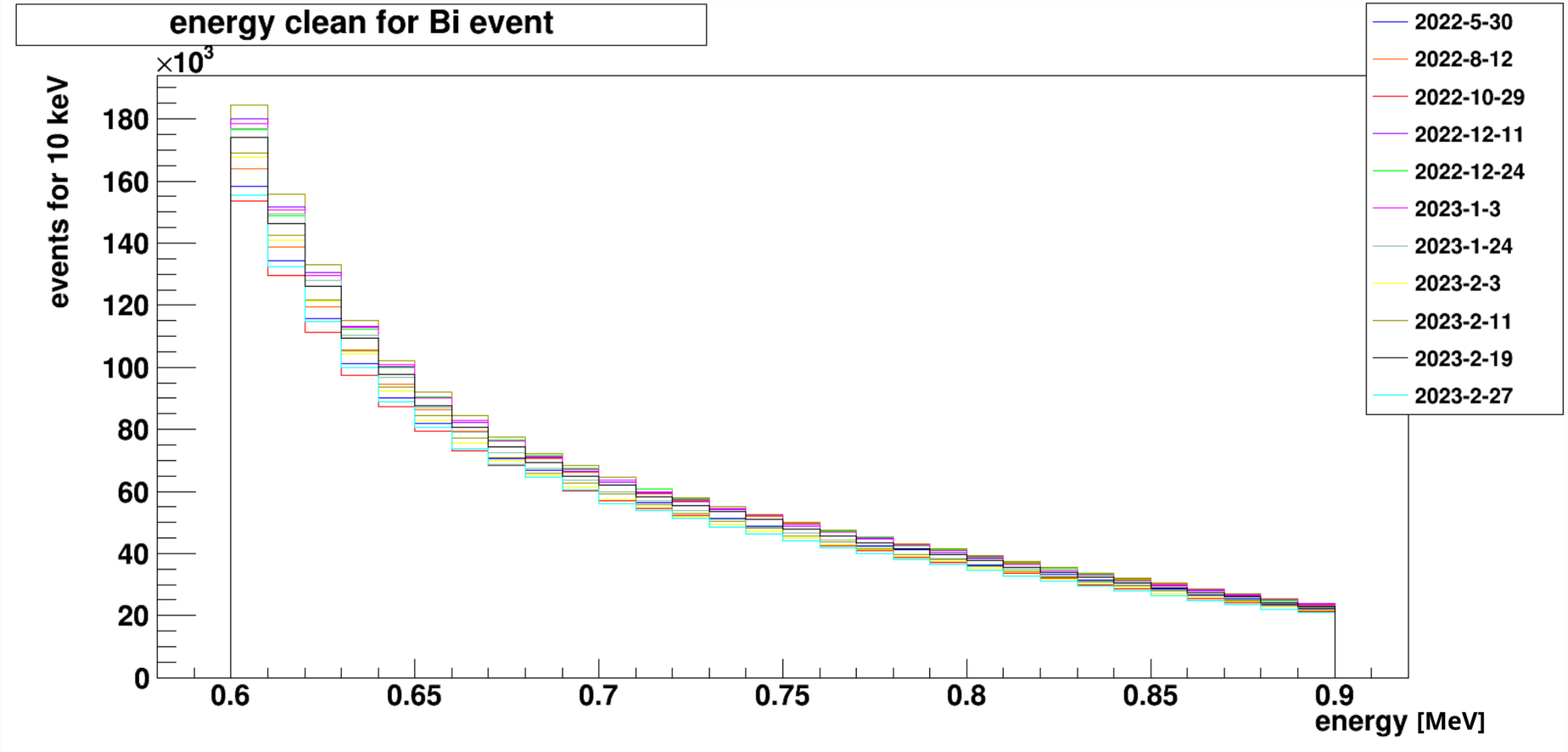

Fig. 10- Plot of the bismuth 210 decay for the FV of 6000