Status of the BiPo Detector

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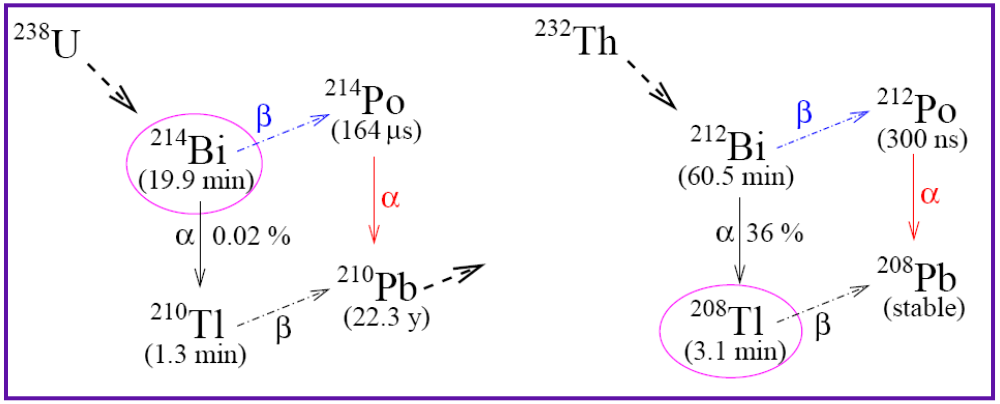
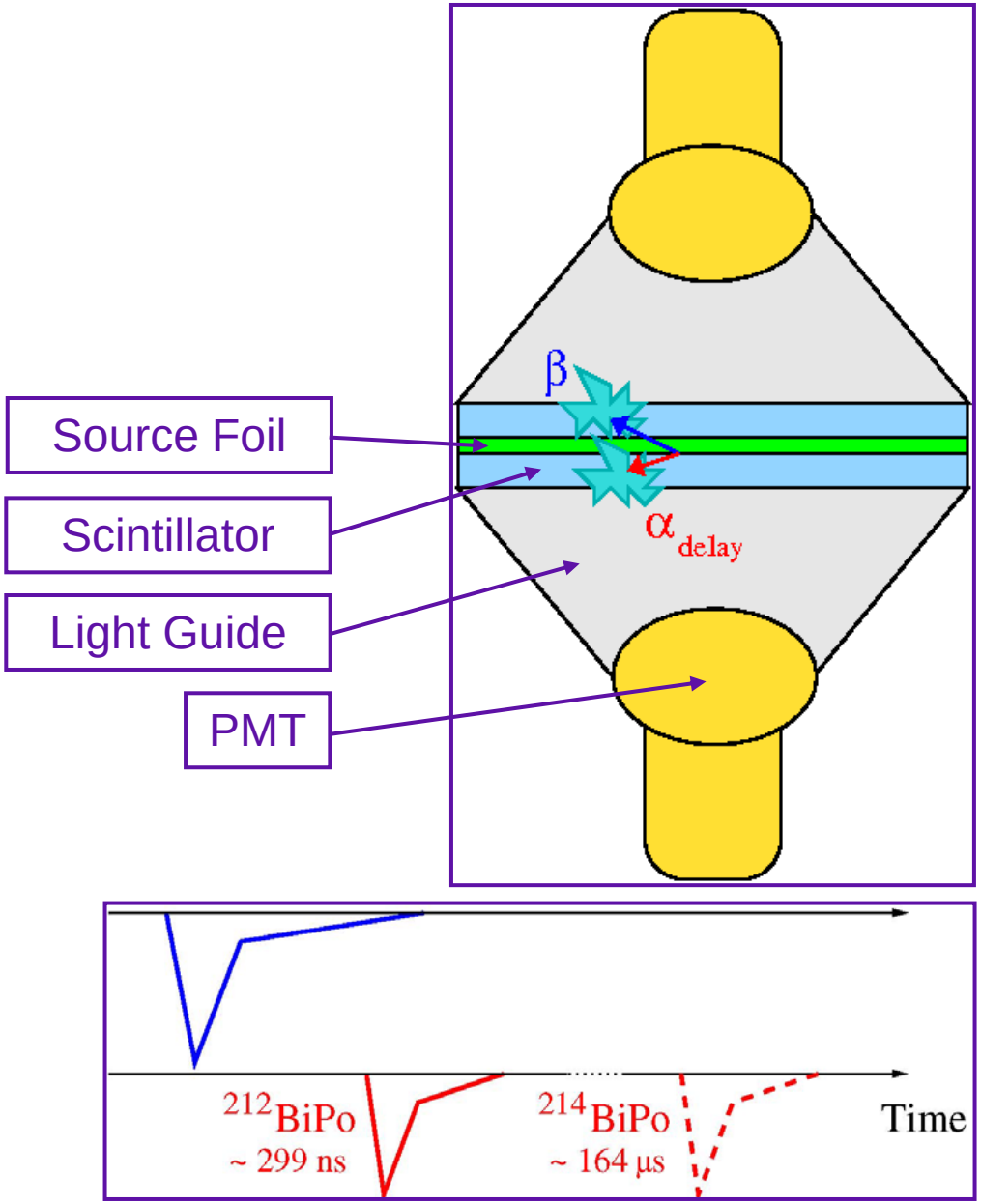
- Experimental setup
- Measurements:
  - Background measurement
  - Aluminum calibrations
  - Backing film (first SuperNEMO measurments)
- Outlook: Future measurements
- Summary and conclusions

BiPo DETECTION PRINCIPLE

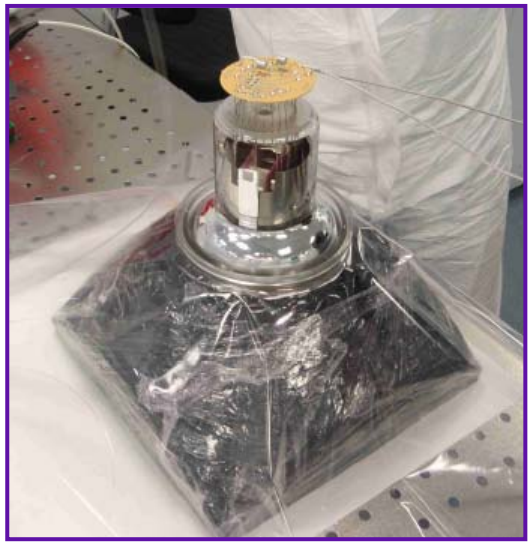
- β–α delayed coincidence detection
  - Face to face scintillators
  - Measured sample between them
    - Each of the scintillators detect one particle
    - Pulse characteristics saved for analysis
      - Q, A, timing …

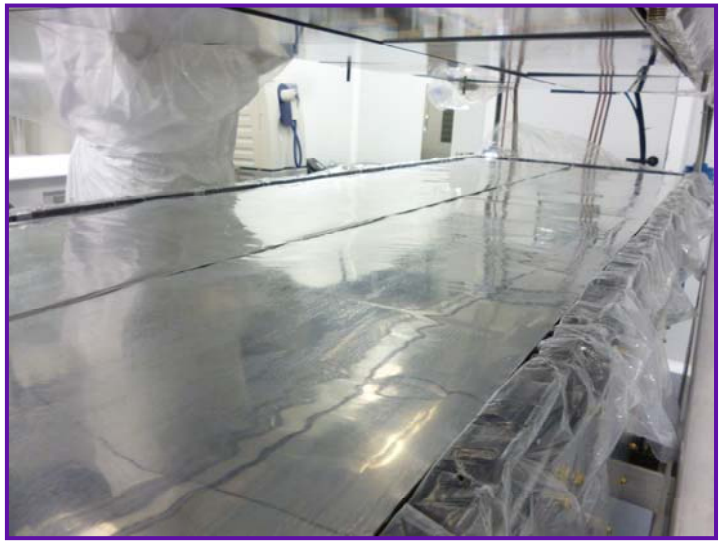




EXPERIMENTAL SETUP

- ***BiPo*** is ***fully operative*** at Canfranc Underground Laboratory since ***January 2013***
  - Two 1.8 m^2 each independent modules → 3.6 m^2 of sensitive surface
    - Possibility to measure up to 8 SuperNEMO source foils simultaneously
  - Twenty 30 x 30 cm^2 optical sub-modules per module
    - 2 mm thick polystyrene scintillator plates (200 nm aluminization)
  - Light guide geometry optimized for light collection
  - Detector volume separation and N_2 flushing for Rn suppression
  - 10 cm of Lead + 20 cm of Iron as external shielding





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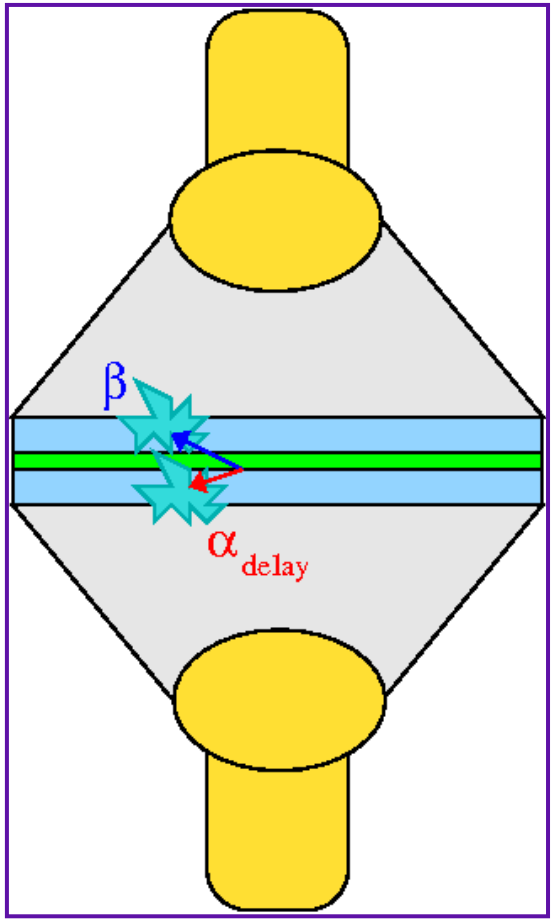
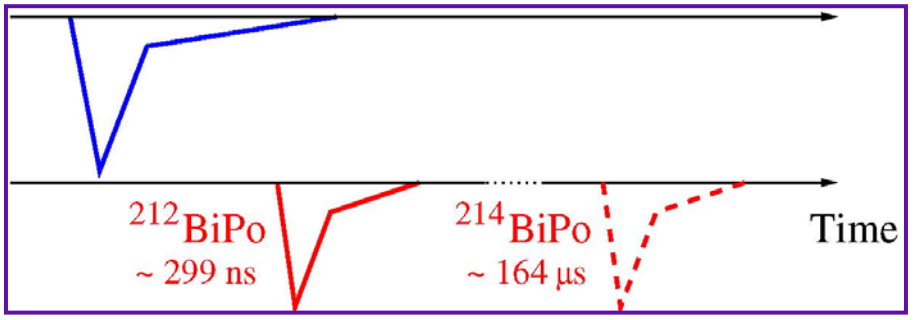
MEASUREMENTS

- Module 1
  - ***Background*** Run with temporary shielding → July'12 – October'12
    - Scintillators radiopurity
  - ***Al foil*** without LN_2 flushing neither shielding → December'12 – January'13
    - Statistics for β/α discrimination development
  - ***Al foil*** with LN_2 flushing and full shielding → February'13
    - ***Calibration*** with future samples geometry
  - ***Backing Film measurement*** → Since March'13
- Module 2
  - ***Background*** Run without LN_2 flushing and temporary shielding → December'12 – January'13
    - Statistics for β/α discrimination development
  - ***Background*** Run with LN_2 flushing and full shielding → February'13 – May'13
    - Scintillators radiopurity
  - ***Al foil*** with LN_2 flushing and full shielding → Since June'13
    - ***Calibration*** with future samples geometry

MEASUREMENTS: Analysis reminder





Δt: ^{212}BiPo ***[20-1500] ns*** → ~ 5 $T_{1/2}(^{212}Po)$
^{214}BiPo ***[10 -1000] µs*** → ~ 6 $T_{1/2}(^{214}Po)$

E_{thr}(prompt) = E_{thr}(delay) = 160 keV

Higher than the hardware thresholds calculated after calibrations

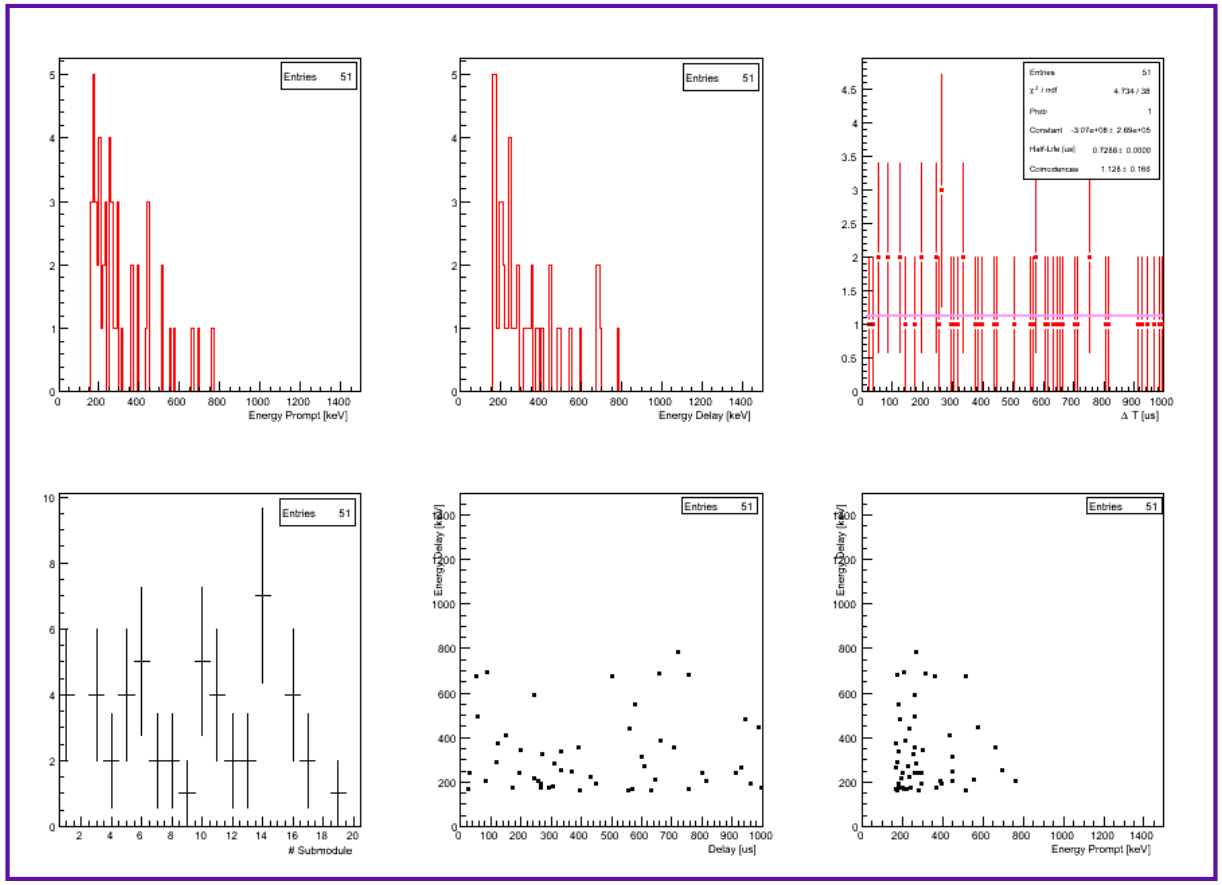
It could vary between measurements

Q/A_{cut} = <Q/A> - 3σ

Reject scintillations events coming from light guide or photocatode and noises

MEASUREMENTS: Background

- Module 1
  - 85 days of measurement (***230 d x m²*** exposure)
  - ***2 ^{212}BiPo*** events candidates with 30 % detection efficiency
  - ***51 ^{214}BiPo*** candidates with 27 % detection efficiency → ***6 "surface"*** events



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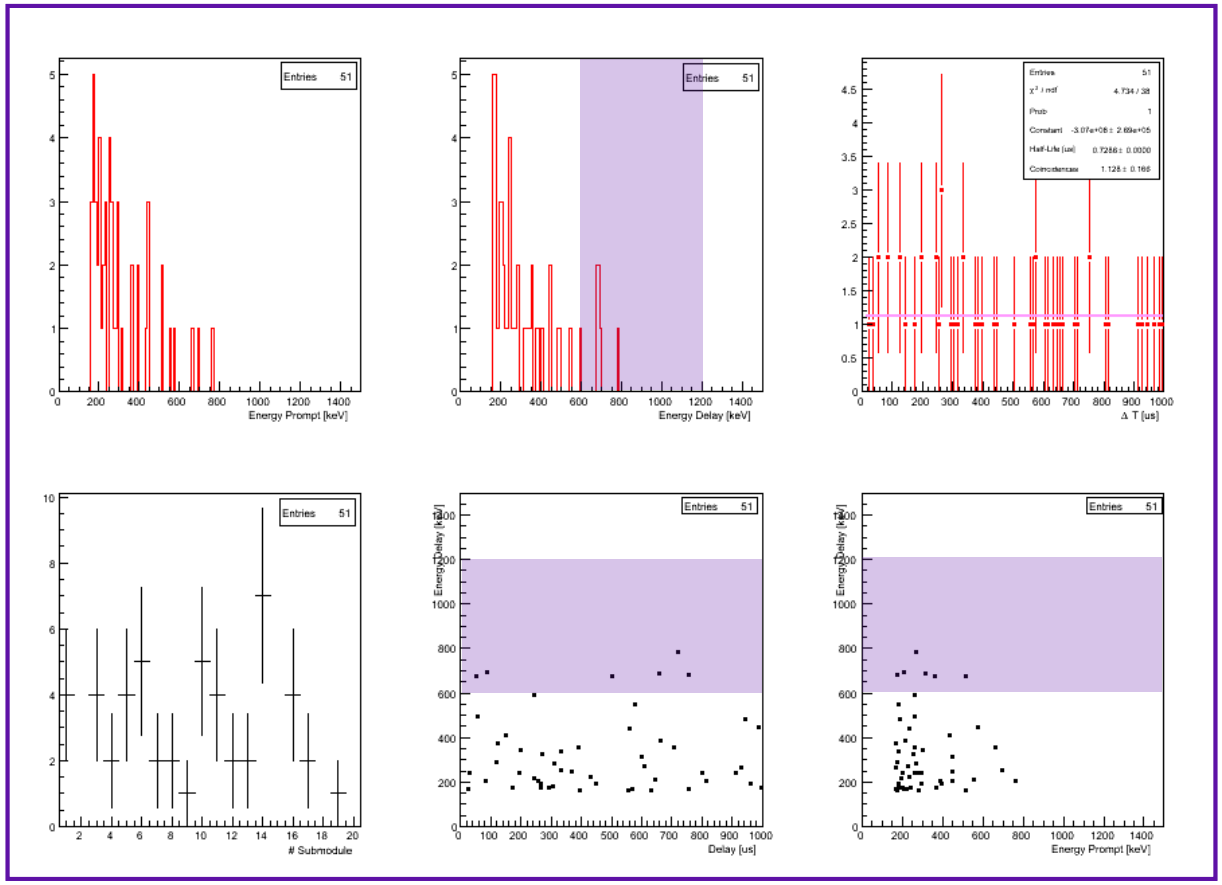


^{214}Po α

7.70 MeV

Quenching Factor

0.91 MeV

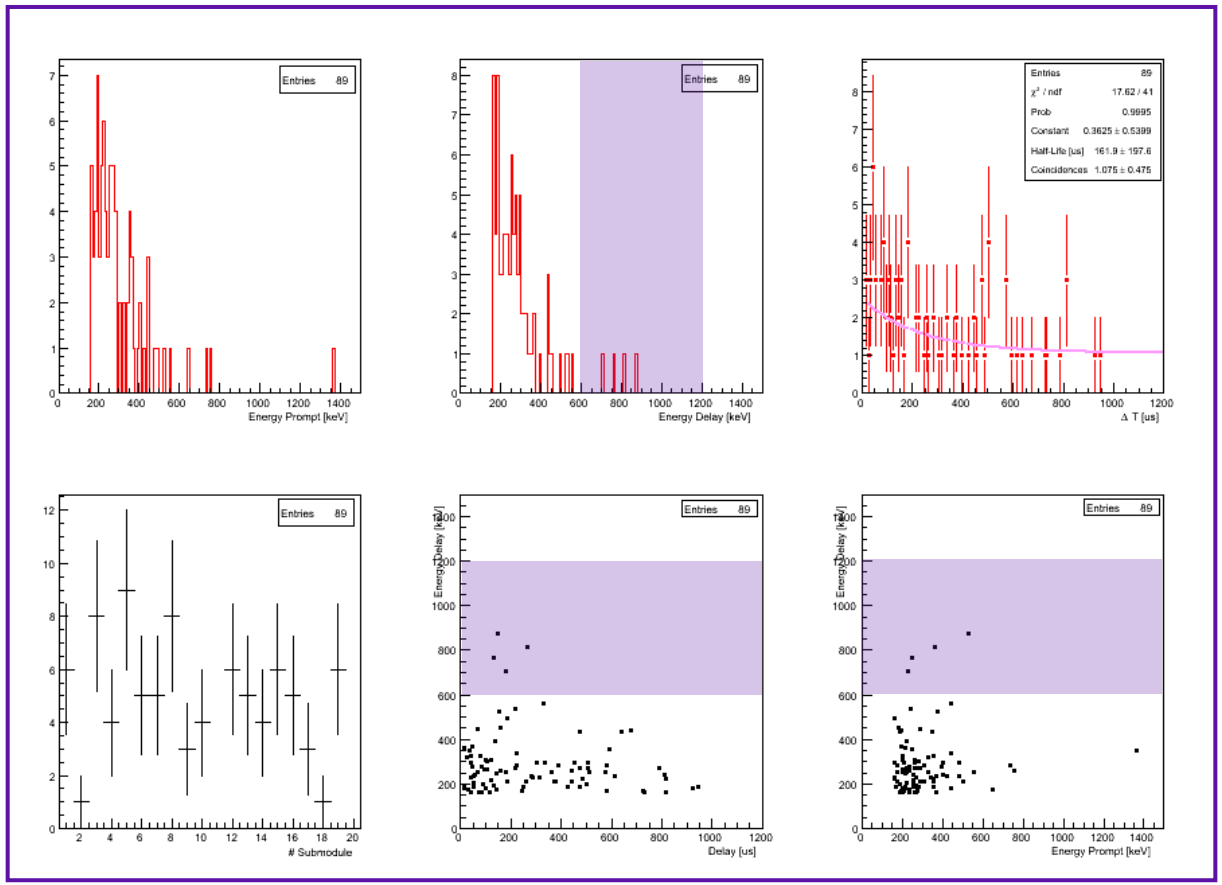
Energy Resolution

[0.72 - 1.10] MeV

[0.60 – 1.20] MeV

MEASUREMENTS: Background

- Module 2
  - 99 days of measurement (***338 d x m²*** exposure)
  - ***2 ^{212}BiPo*** events candidates with 30 % detection efficiency
  - ***89 ^{214}BiPo*** candidates with 27 % detection efficiency → ***4 "surface"*** events



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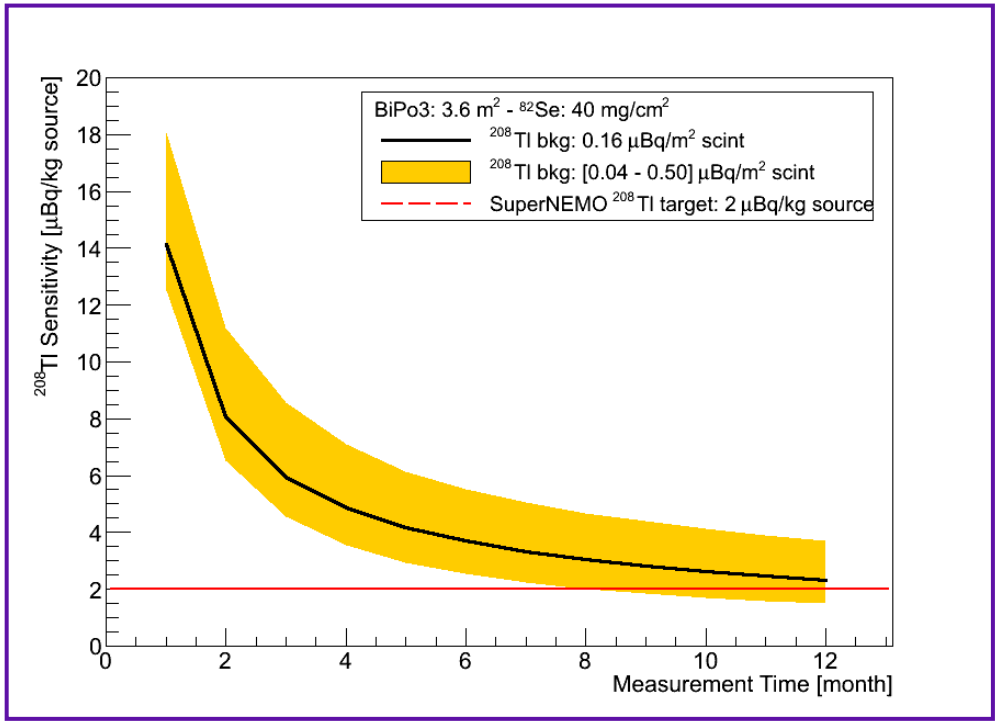
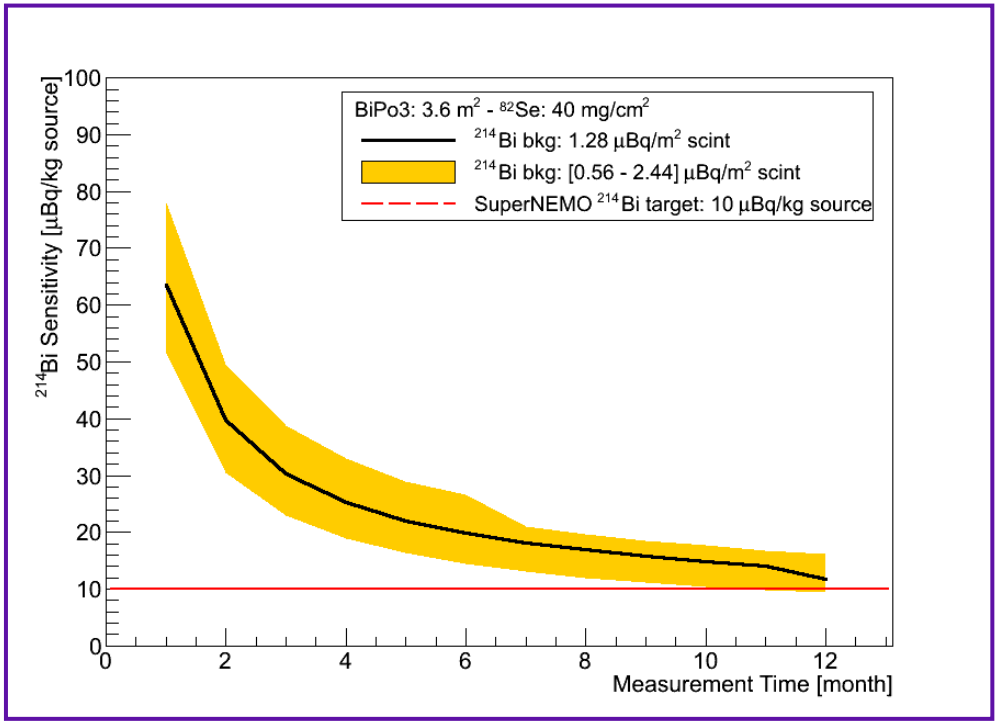
Background level @ 90 % C.L. (μBq/m² scintillator)		
	Module 1	Module 2
^{208}Tl	0.16 [0.04 – 0.50]	0.13 [0.04 – 0.37]
^{214}Bi	1.28 [0.56 – 2.44]	0.28 [0.08 – 0.82]

MEASUREMENTS: Background

- Expected ***sensitivity*** for the ***SuperNEMO source foils***
  - Taking into account the geometry and density of these foils
  - From the background levels obtained in Module 1 (higher background level)





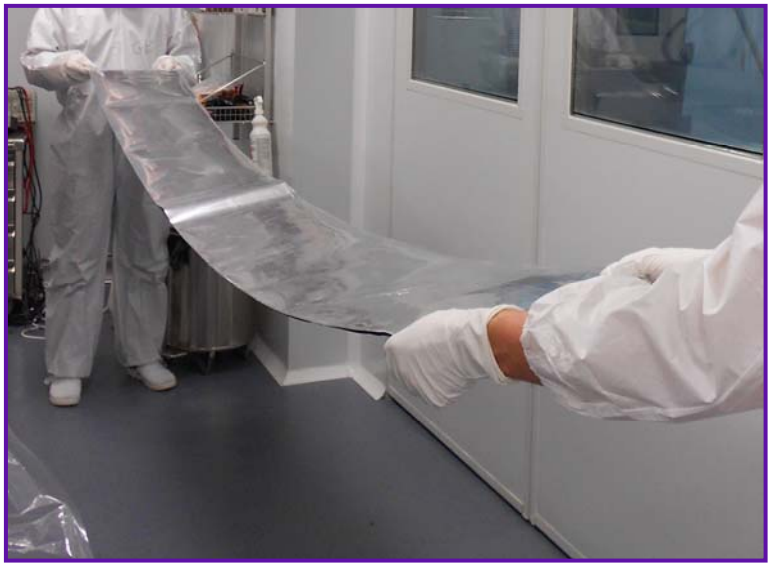
~ 0.13 bkg events expected per month

~ 1.5 bkg events expected per month

MEASUREMENTS: Aluminum calibrations

- 2 Al foils (85 and 170 μm respectively, wrapped with 4 μm polyethylene film) installed inside the Module 1
  - Calibrate the detector with a sample with the same geometry than the SuperNEMO source foils
  - Validate the simulations to estimate the detection efficiency of the samples
  - Have high statistics of BiPo events to develop and test the β/α discrimination algorithms

2	***1 x 85 μm*** Aluminium foil inside 4 μm polyethylene film (for detectors protection)	20
1	***2 x 85 μm*** Aluminium foil inside 4 μm polyethylene film (for detectors protection)	19



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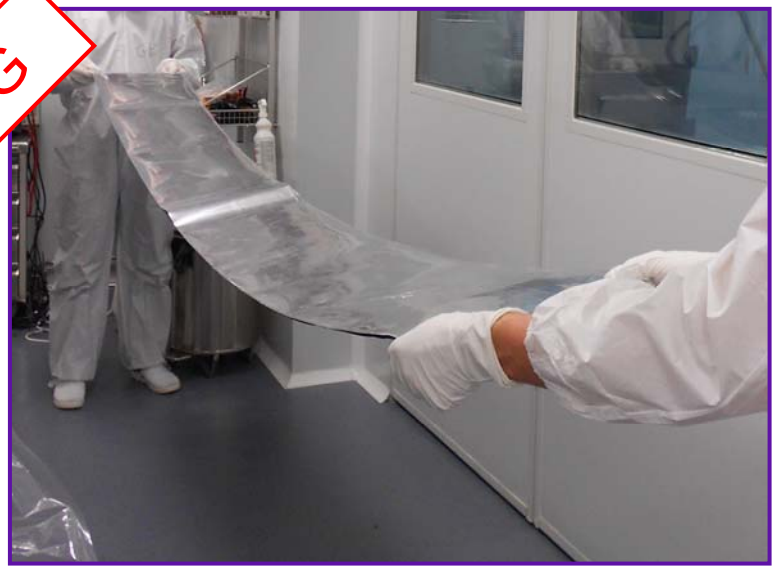
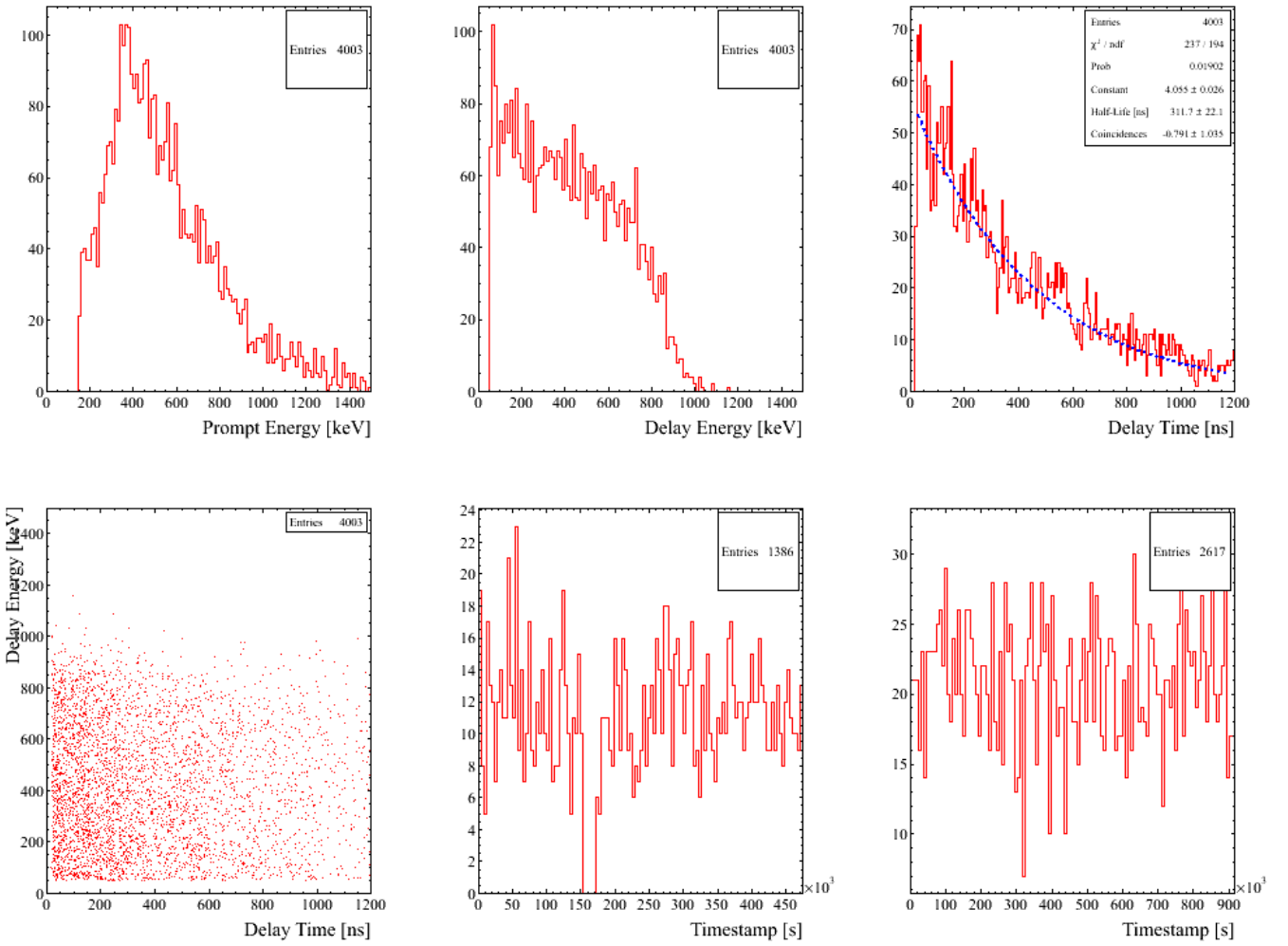
ANALYSIS ONGOING



MEASUREMENTS: Aluminum calibrations

- Preliminary results: 212BiPo events after 23 days of measurement



From BiPo:

A(^{212}BiPo) =

130 ± 4(stat) ± 28 (sys) mBq/kg

From HPGe*:

A(^{212}BiPo) =

160 ± 30 mBq/kg

* More precise measurement is ongoing

THEY SEEM IN GOOD AGREEMENT

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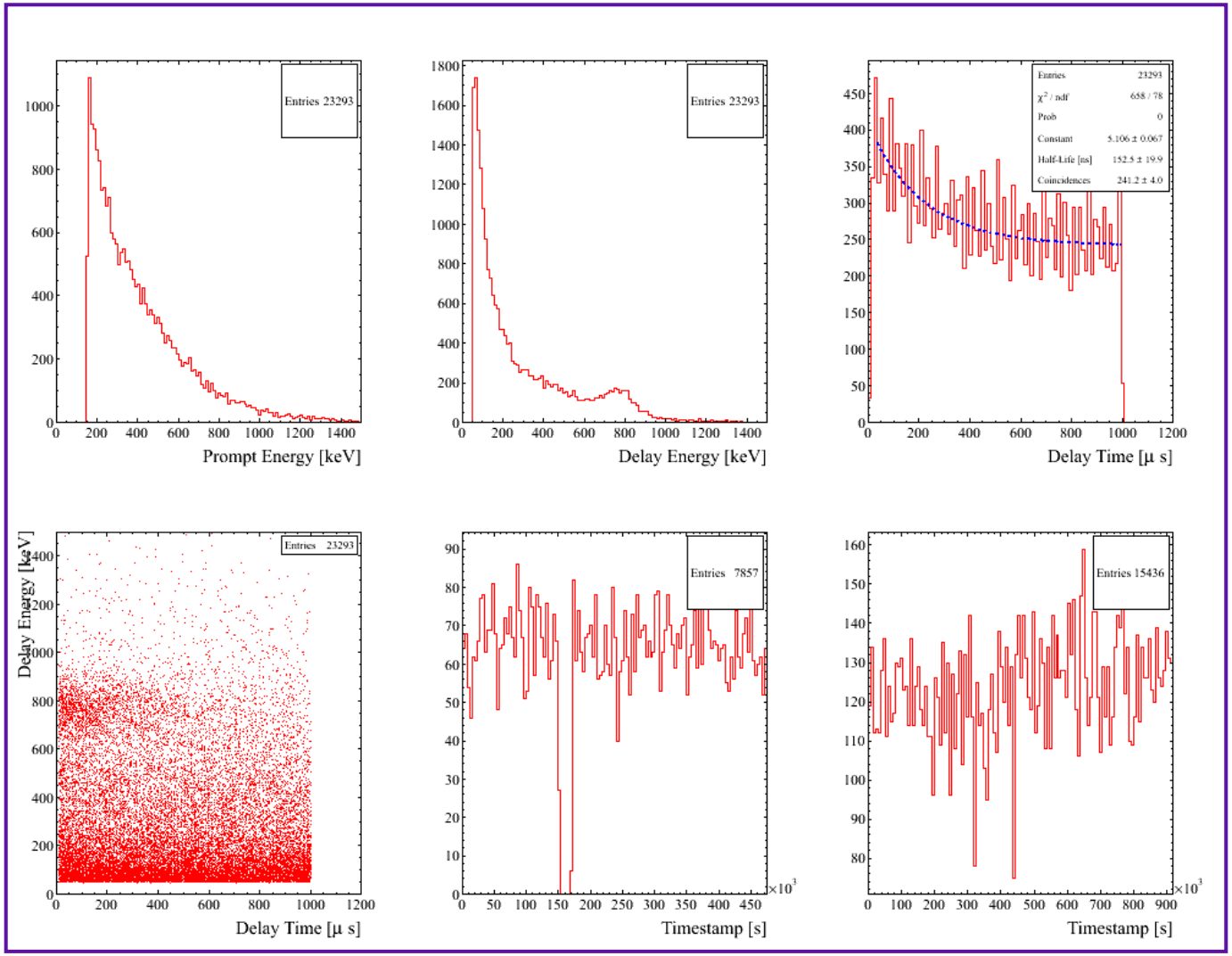

More than 23000 candidates

→ Al events

→ Rnd Coincidences

→ Radon events

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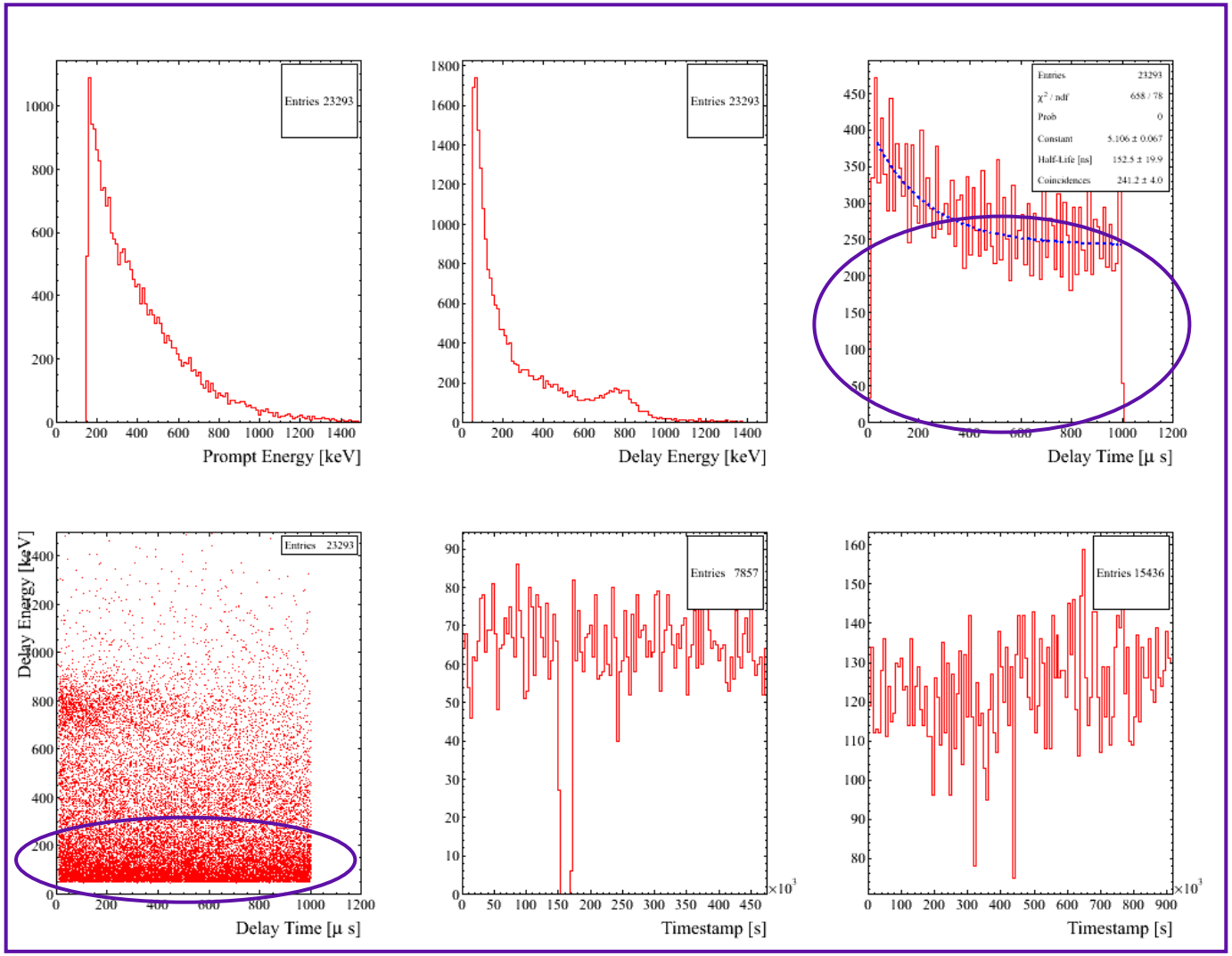

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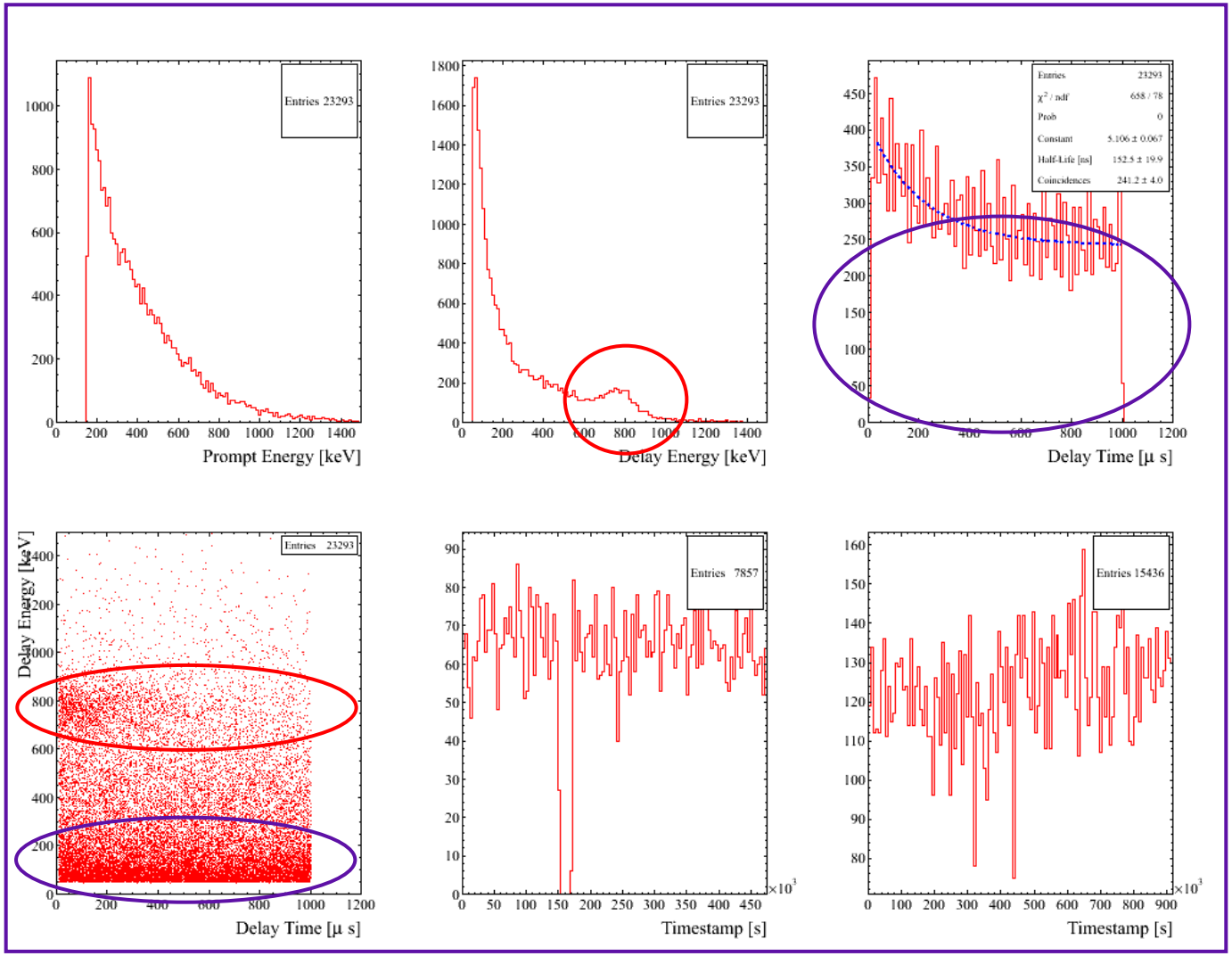

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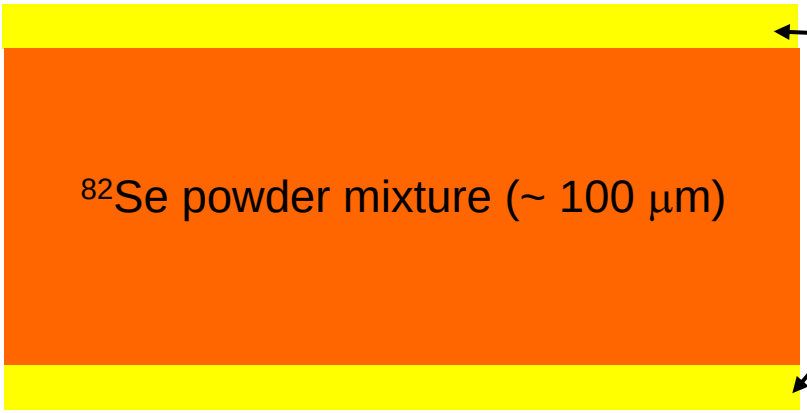
HIGH STATISTICS AND PHENOMENOLOGY TO DEVELOP THE β/α DISCRIMINATION

MEASUREMENTS: Backing Film

- First “real” measurement in BiPo since March’13:



Backing Film (~ 10 μm)

2 samples prepared to measure in ***BiPo***

8 layers of 300 x 30 mm^2 each (96 μm)

Protected with 4 μm polyethylene film

OUTLOOK:

- Measurements:
  - End of July:
    - Module 1

      New Background Run after first measurement (and final configuration)
    - Module 2

      PVA Glue for the Se mixture

      Microbulk Micromegas (collaboration with Universidad de Zaragoza)

      Aluminized mylar for the Calorimeter scintillators?
  - New measurements after summer

    Depending on the available samples
- Analysis:
  - Development and application of the β/α discrimination algorithm

SUMMARY & CONCLUSIONS:

- BiPo is fully ***operative*** since ***January'13***
  - 2 Modules → 3.6 m^2 of sensitive surface
- ***Background*** level of both detectors ***measured***
  - Equivalent levels
  - Valid for the expected sensitivity
- First SuperNEMO measurements already started
  - ***Backing Film*** for the source foils
  - Some points of the analysis under study
- Measurement plan for next months almost fixed

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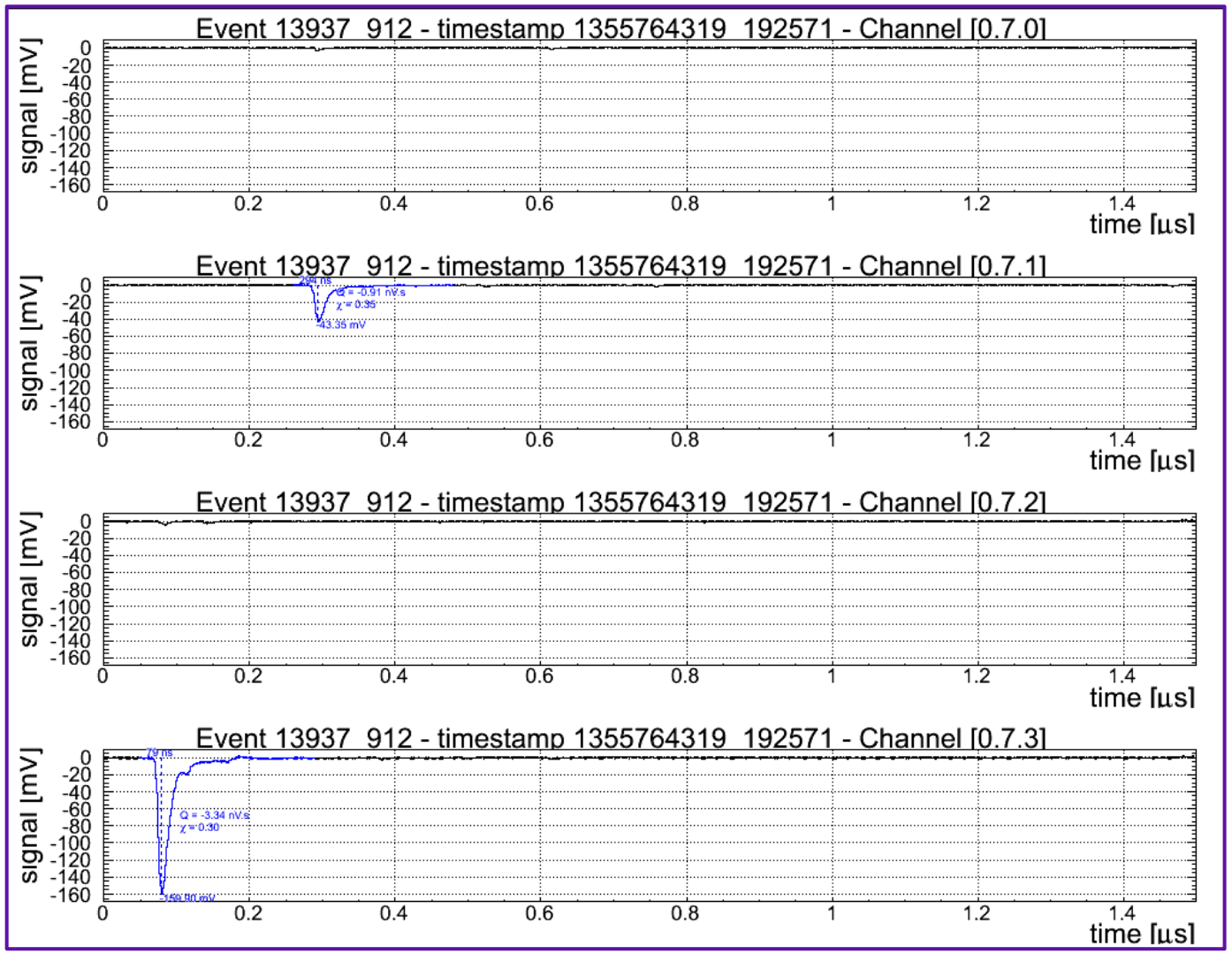

β/α discrmination

$$\chi = \frac{Q_{Delay}}{Q_{Total}} \rightarrow \chi_\alpha > \chi_\beta$$

Try to find the integration windows that optimize the difference

Compatible with the digitization windows

Expected:

>80% rejection of β events

>90% accpetance of α events