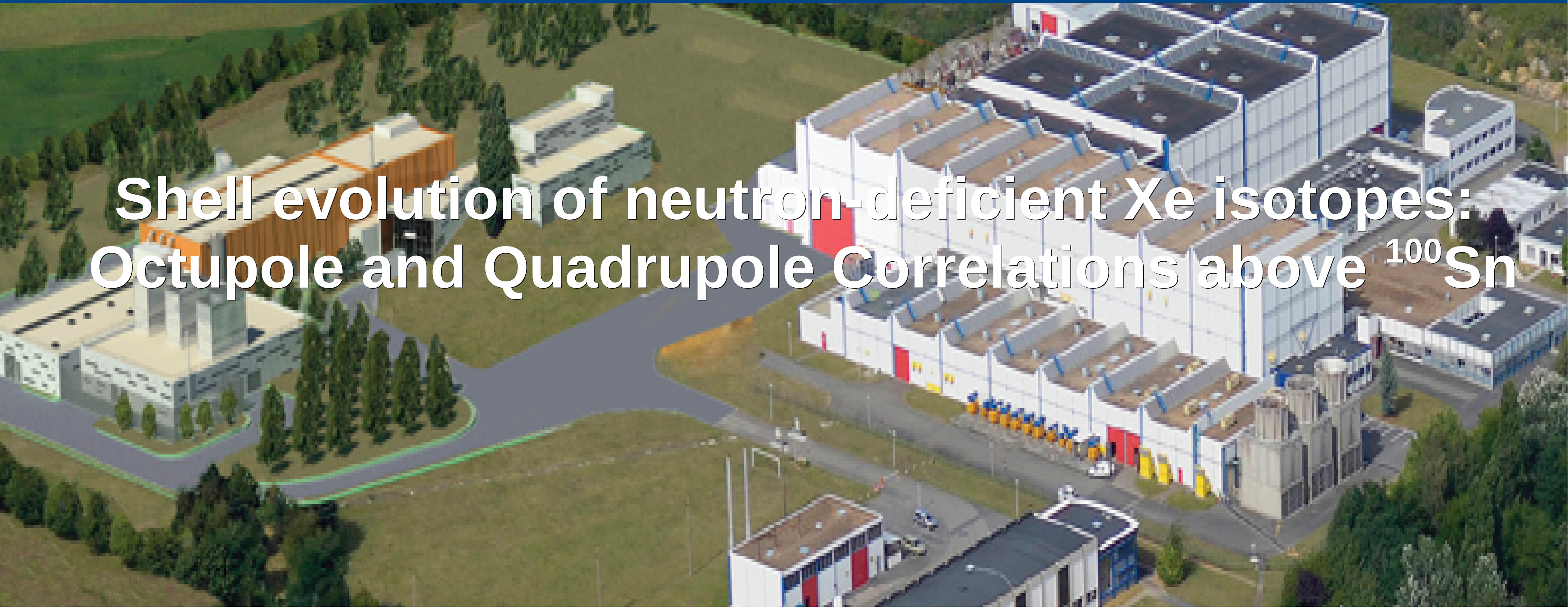
Shell evolution of neutron-deficient Xe isotopes: Octupole and Quadrupole Correlations above ^{100}Sn



Instituto de Física Corpuscular, CSIC-Universidad de Valencia, Spain

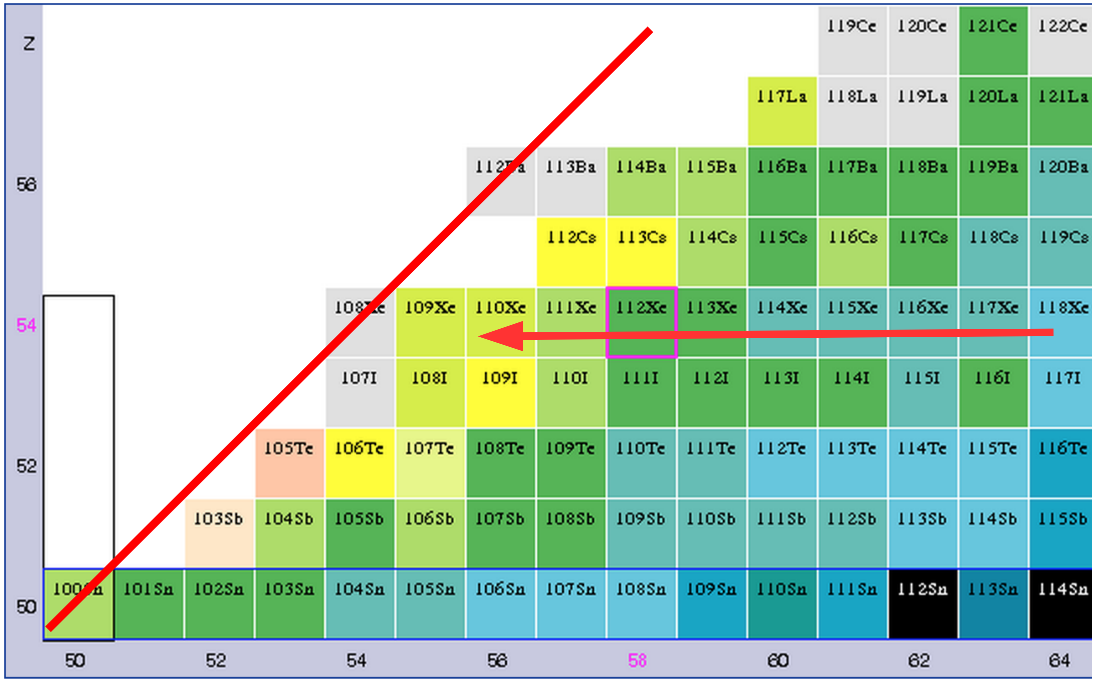
For the E730 Collaboration

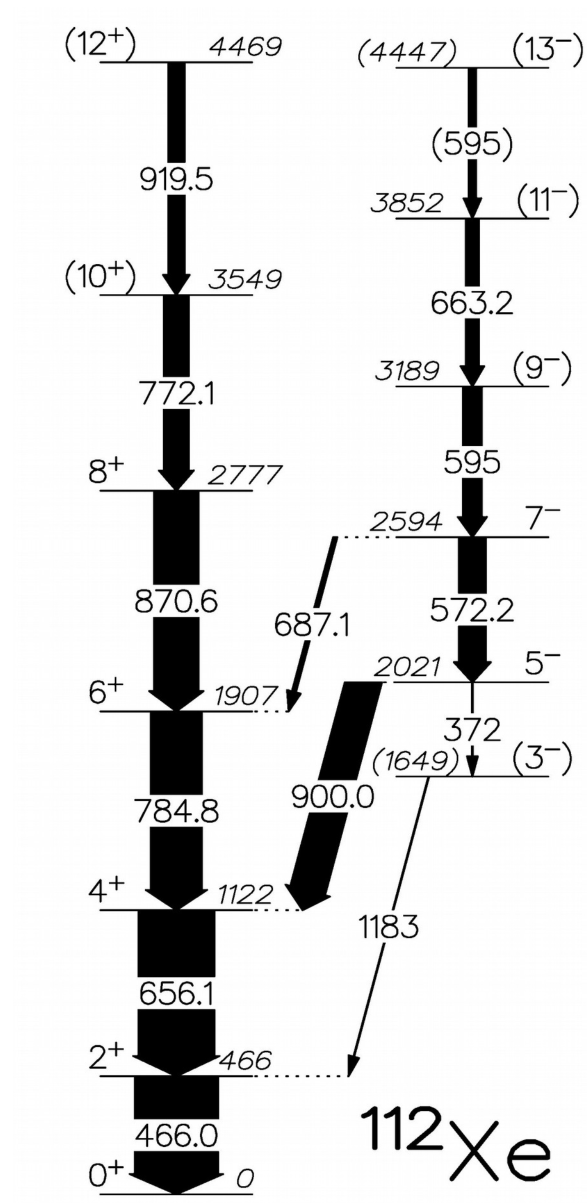
María de la Luz Jurado Gómez

10/09/2019

Contents

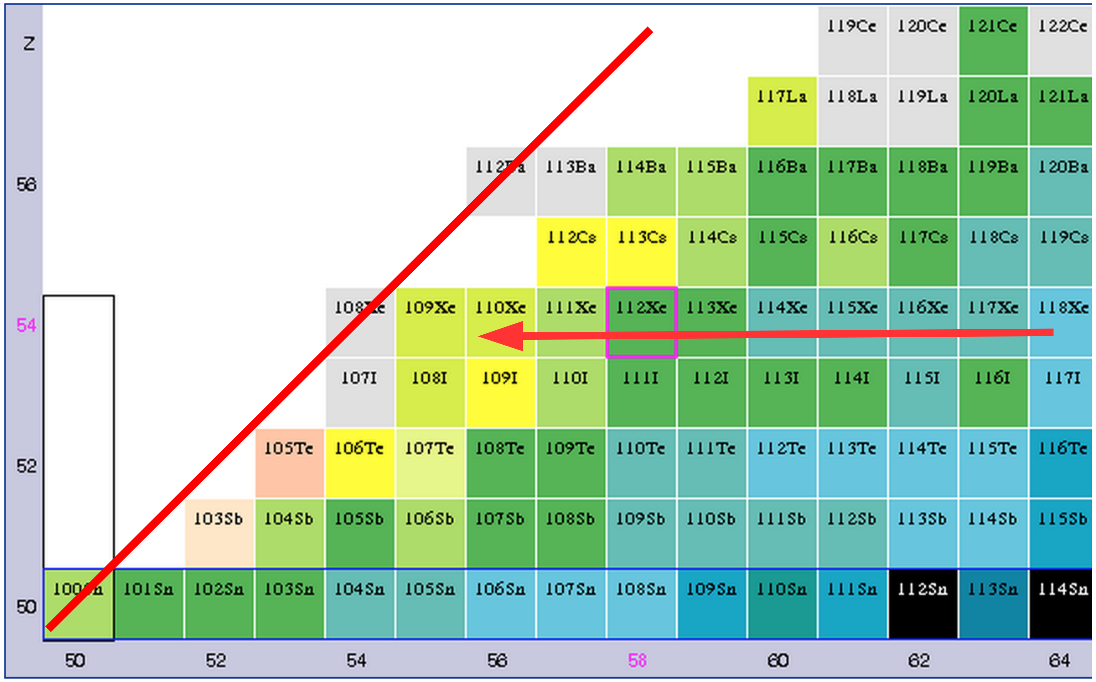
1. Physic motivation





- LIFETIMES OF EXCITED STATES IN ^{112}Xe
  - Octupole correlation: 3^- and 5^- states
  - Quadrupole collectivity: 2^+ and 4^+ states

1. Physic motivation



- Enhanced octupole due to the interaction of $d_{5/2}$ and $h_{11/2}$
  $\Delta L=3$, $\Delta J=3$, inverse parity.
- Z or N close 56, 88 and 136.
- No B(E3) have been measured in this region close to N=Z beyond ^{114}Xe.
- Correlations predicted for both: protons and neutrons in region with N=Z=56.
- Fermi surface in this region lies between the $d_{5/2}$ and $h_{11/2}$ orbitals.
- Removing neutron from the $h_{11/2}$ orbital gradually decreases the 3^- excitation energy and enhances the B(E3) value for the Xe isotopes.

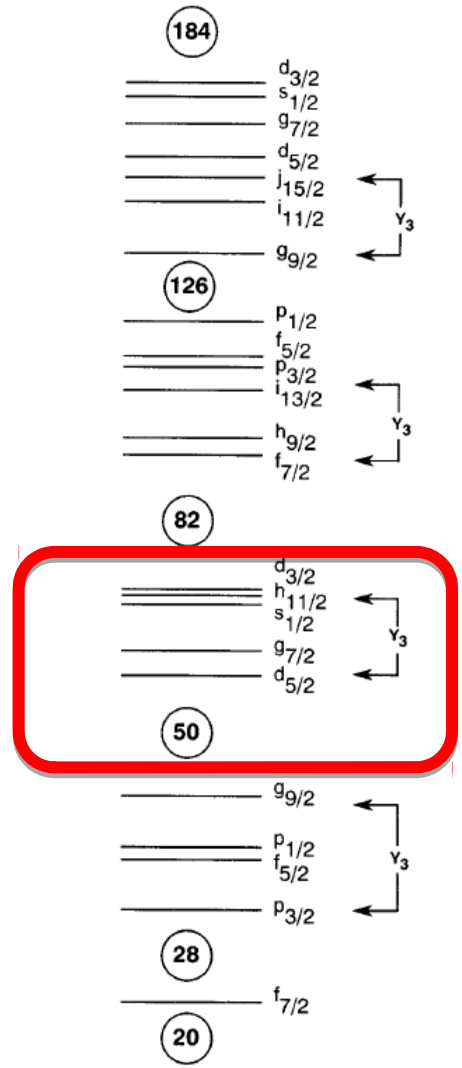


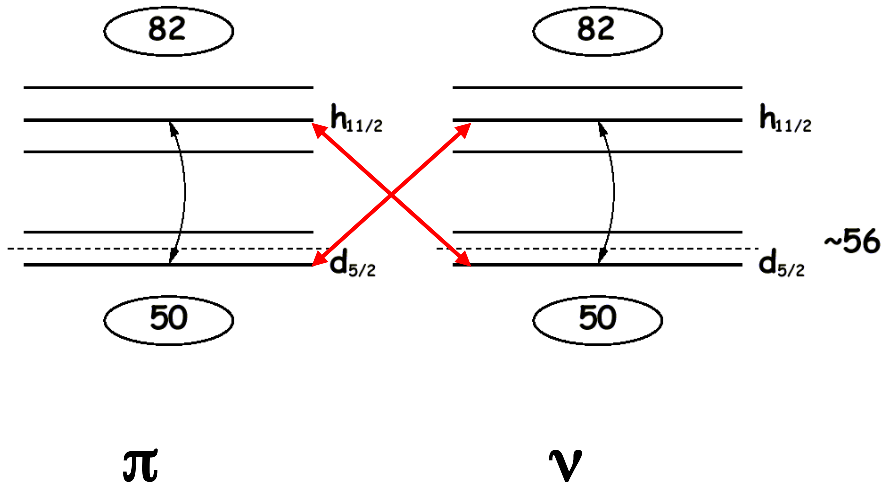
FIG. 4. Nuclear spherical single-particle levels. The most important octupole couplings are indicated.

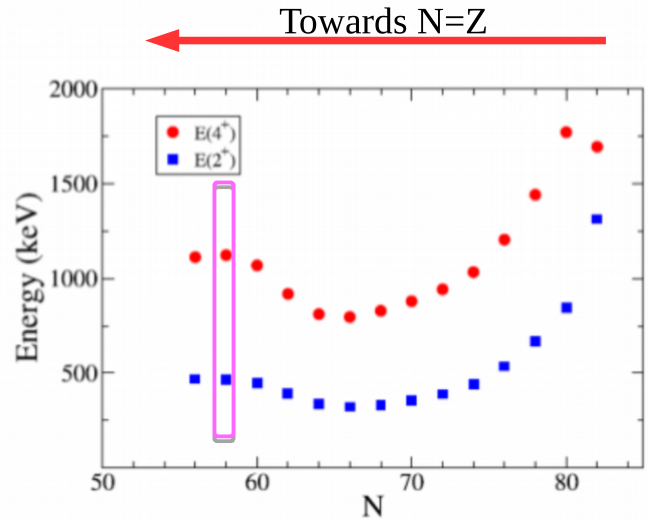
1.1 Physic motivation: Octupole

- Calculations using GCM (Generator-Coordinate Method) of the HFB (Hartree-Fock-Bogoliubov) self-consistent mean field theory with the Gogny force.

	^{114}Xe	^{112}Xe	^{118}Ba
E (3$^-$) (MeV)	**1.84/1.62**	**1.99/1.65**	**2.11**
B (E3, 3$^-$ → 0$^+$)$_{Theo}$ (W.u.)	**17**	**25**	**17.46**
B (E3, 3$^-$ → 0$^+$)$_{Exp}$ (W.u.)	**77(27)**	**-**	**-**

- Good agreemet with excitation energy of the 3$^-$ state.
- B (E3, 3$^-$ → 0$^+$) turns out to be too small in the case of ^{114}Xe with a factor of ~ 4 times difference with the experimental value.
- Ingredients missing in the model. *G. de Angelis et al, Physics Letters B 535 (2002) 93* → p-n additional corr.
- We expect the B(E3) of ^{112}Xe higher.
- Experimental data fundamental to shed light on the issue.





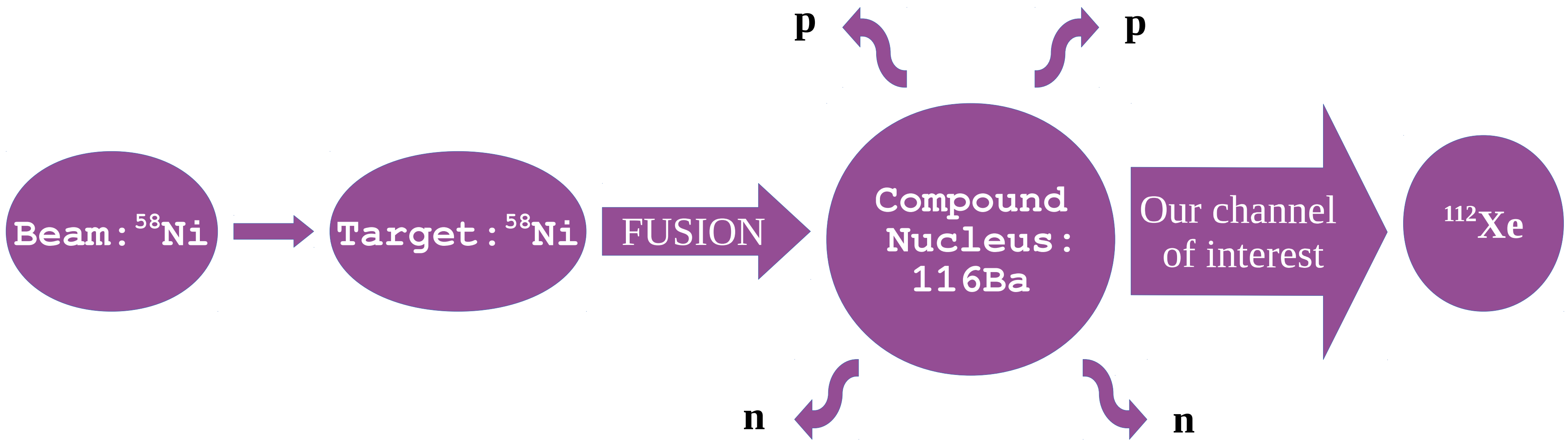
Evolution of the two first excited states in the Xe isotopic chain

- Preserving collectivity approaching N=50 in the vicinity of N=Z.
- These findings constitute possible evidence for the importance of isoscalar n-p interactions for the development of nuclear collectivity.
- Nevertheless, lifetimes provides a better indication of collectivity.
- More spectroscopic data are needed. We have performed the first measurement of the B(E2)'s of the first excited states in ^{112}Xe via their lifetime using the plunger technique.

M. Sandzelius et al, Phys. Rev. Lett 99, 022501 (2007)

2. Production Mechanism

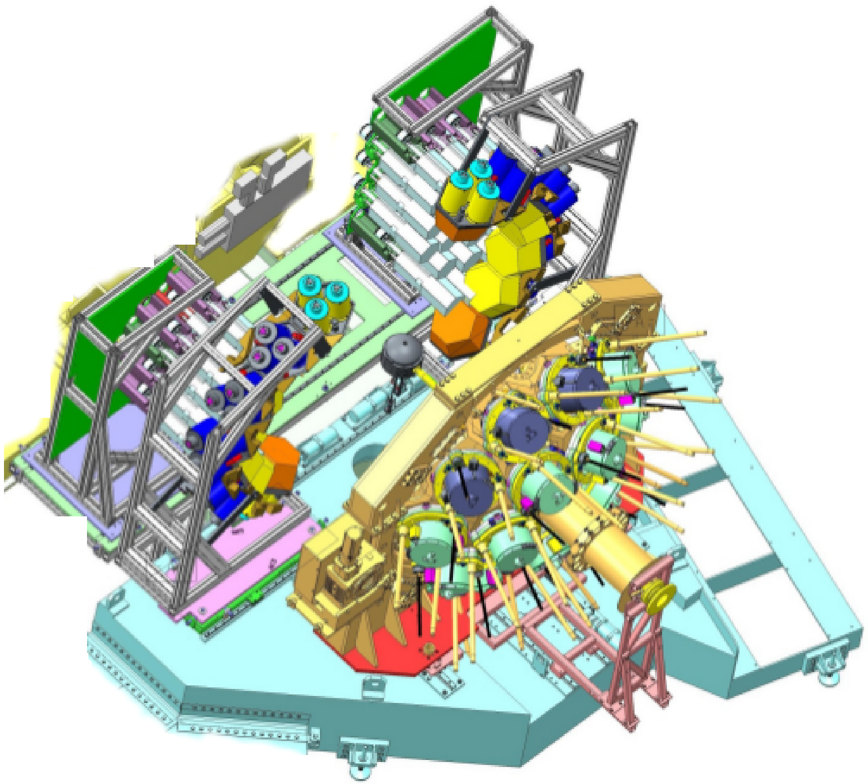
- **Fusion-Evaporation Reaction**



- Beam energy of 250 MeV.
- The cross section was estimated to be a few hundred μbarns.
- The channels with higher population in the reaction are ^{112}Te(4p), ^{109}Sb(α3p), ^{113}I(3p) and ^{110}Te(α2p) which constitute respectively 46%, 16%, 12% and 10% of the reaction products.
- Trigger: at least 1 neutron in coincidence with γ-rays is required, discriminated with PSA.
- This trigger eliminates already ~85% of unwanted channels and suppress the background from the β-decay.

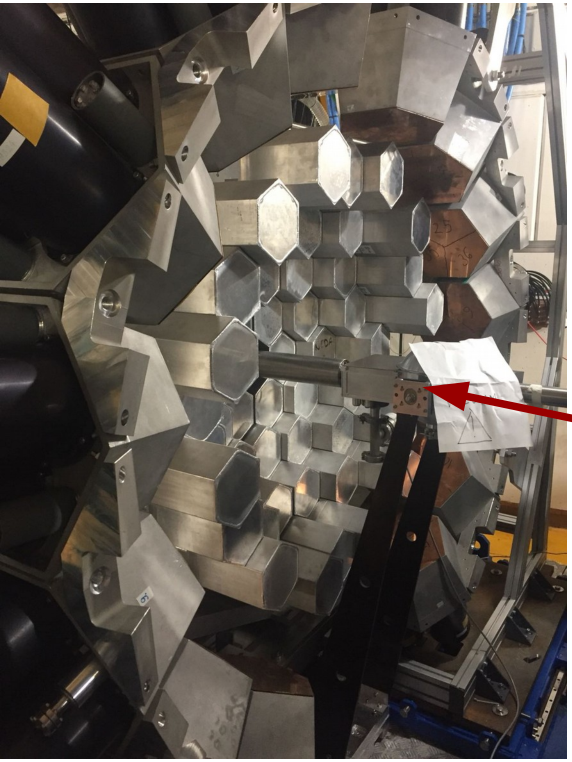
3. Experimental Setup

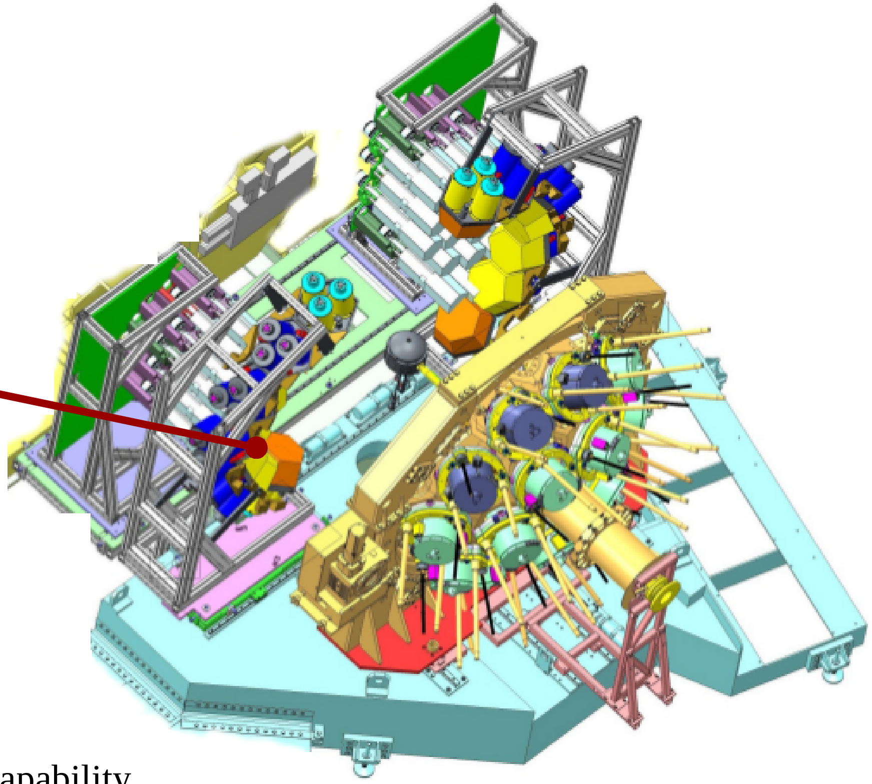
- **GANIL**



CAD drawing of the experimental set-up. From the left to right, the different detectors are drawn: NEDA+NEUTRON WALL, DIAMANT (placed in the target chamber) and AGATA.

- **GANIL**



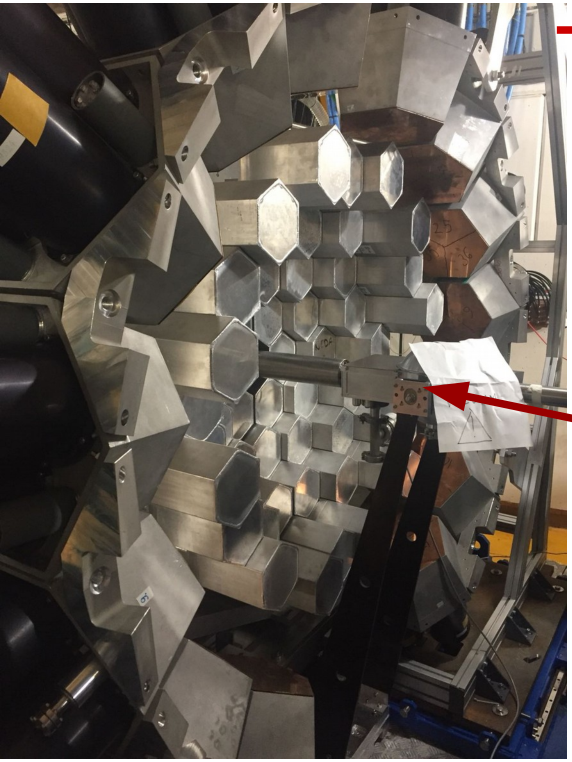


BC501A liquid scintillator with PSA capability

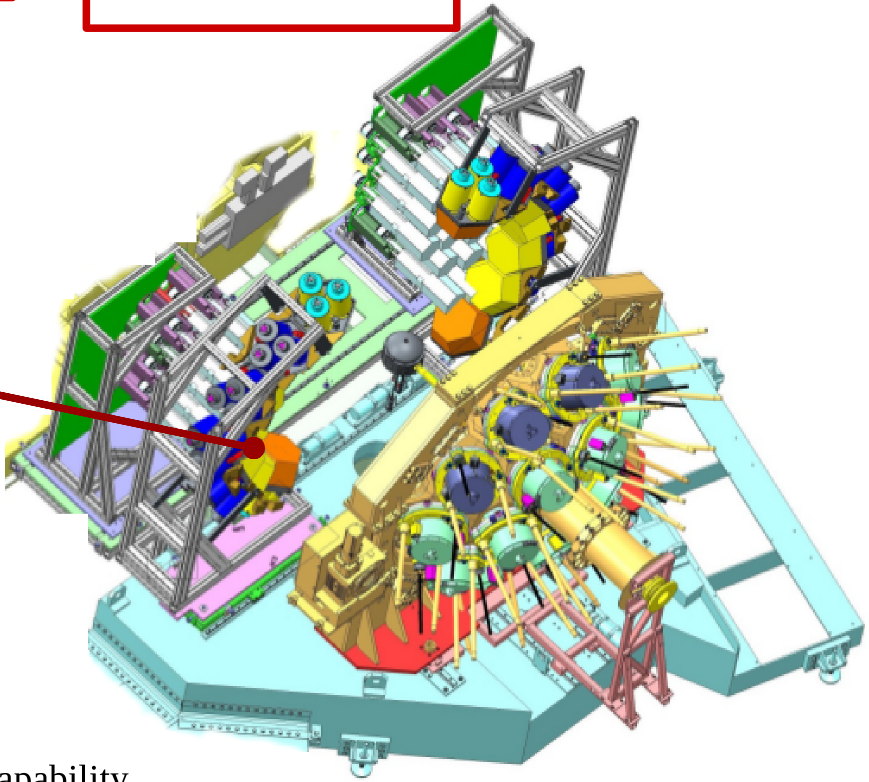
P.-A. Söderström et al, Nuclear Instruments and Methods in Physics Research A 594 (2008) 79– 89

CAD drawing of the experimental set-up. From the left to right, the different detectors are drawn: NEDA+NEUTRON WALL, DIAMANT (placed in the target chamber) and AGATA.

- **GANIL**



$Eff_n=(30\pm6)\%$

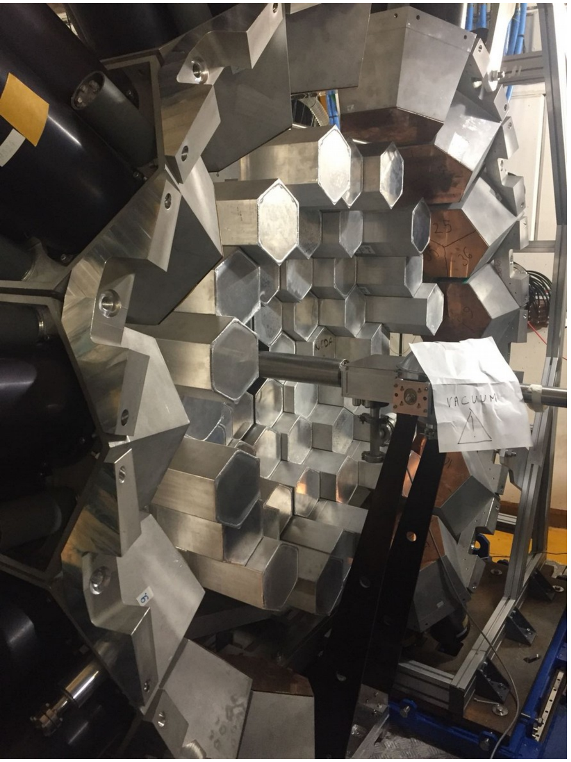


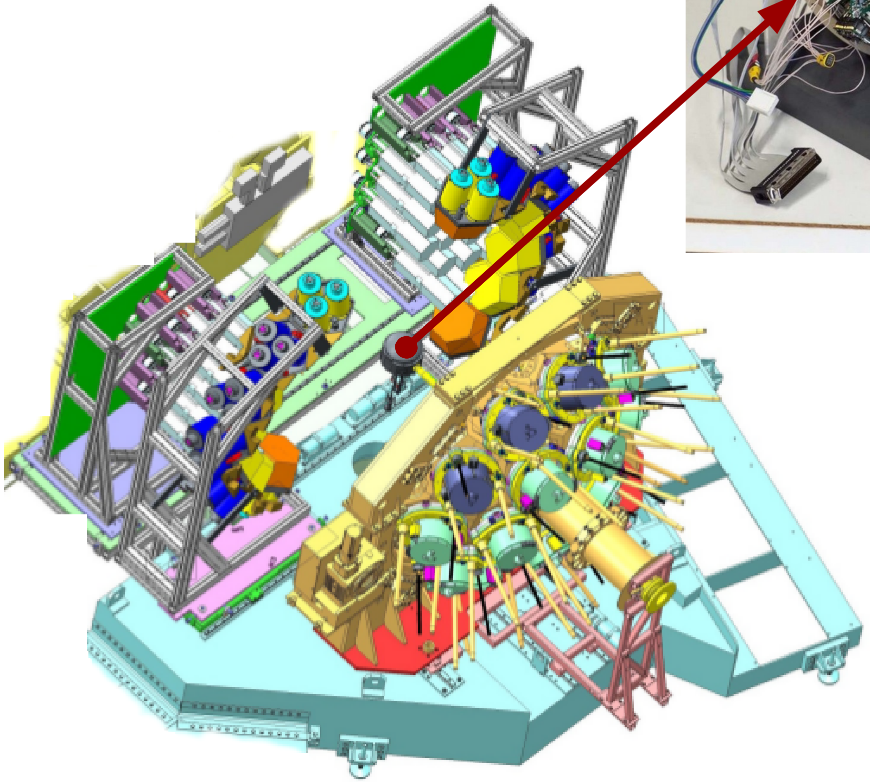
BC501A liquid scintillator with PSA capability

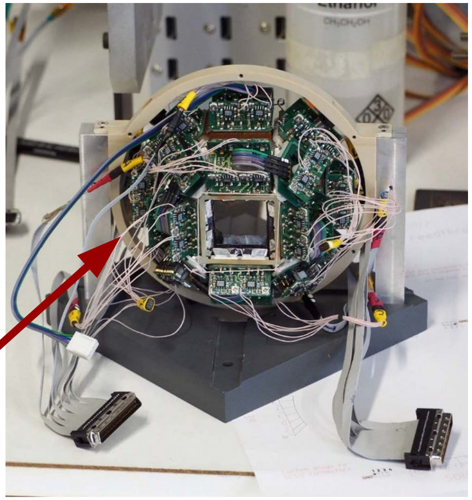
P.-A. Söderström et al, Nuclear Instruments and Methods in Physics Research A 594 (2008) 79– 89

CAD drawing of the experimental set-up. From the left to right, the different detectors are drawn: NEDA+NEUTRON WALL, DIAMANT (placed in the target chamber) and AGATA.

- **GANIL**

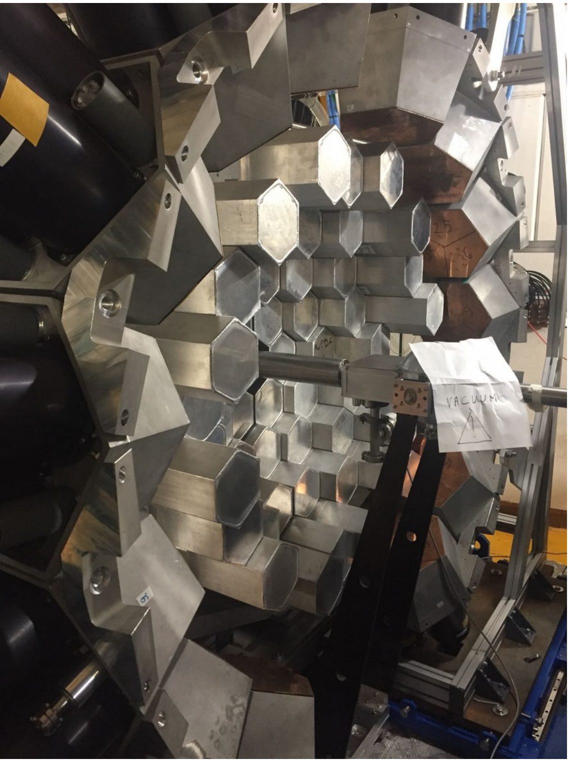


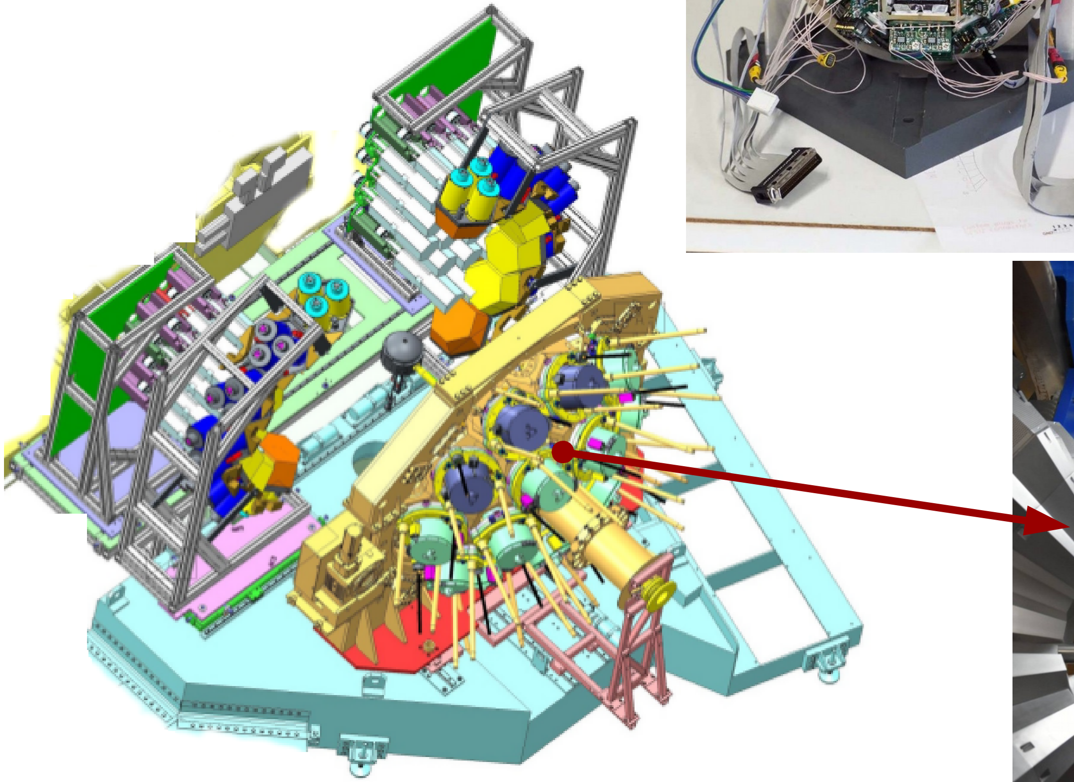


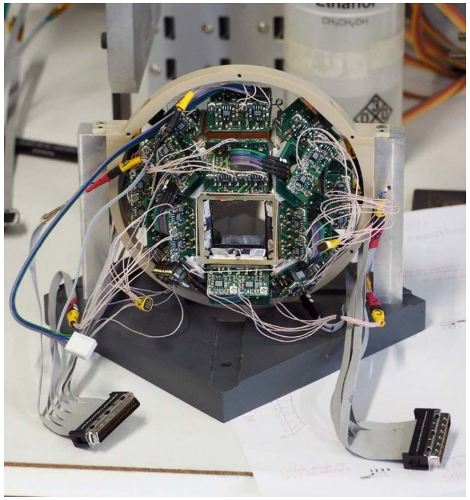


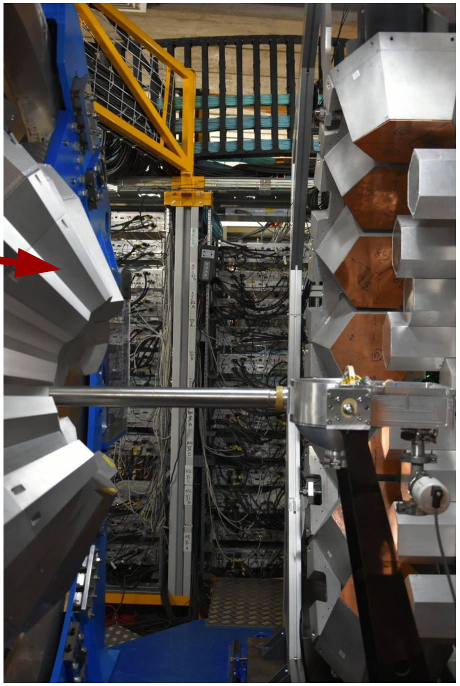
CAD drawing of the experimental set-up. From the left to right, the different detectors are drawn: NEDA+NEUTRON WALL, DIAMANT (placed in the target chamber) and AGATA.

- **GANIL**









CAD drawing of the experimental set-up. From the left to right, the different detectors are drawn: NEDA+NEUTRON WALL, DIAMANT (placed in the target chamber) and AGATA.

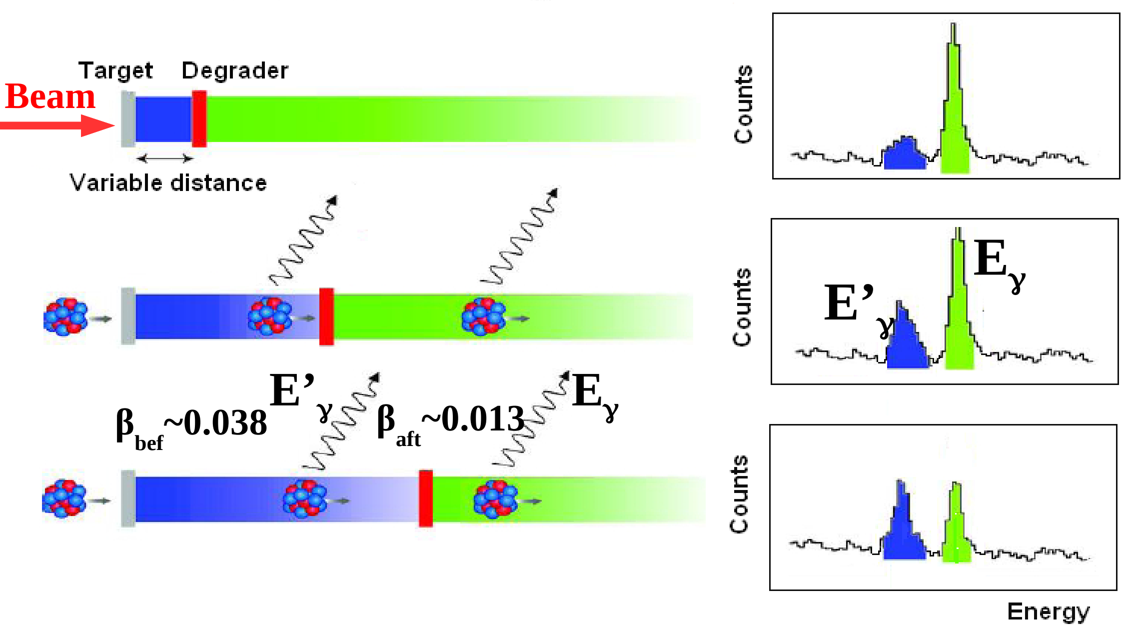
3.2. Experimental Setup: Plunger

Target: ^{58}Ni 1 mg/cm^2

Degrader: ^{197}Au 5 mg/cm^2

CSNSM "OUPS" plunger

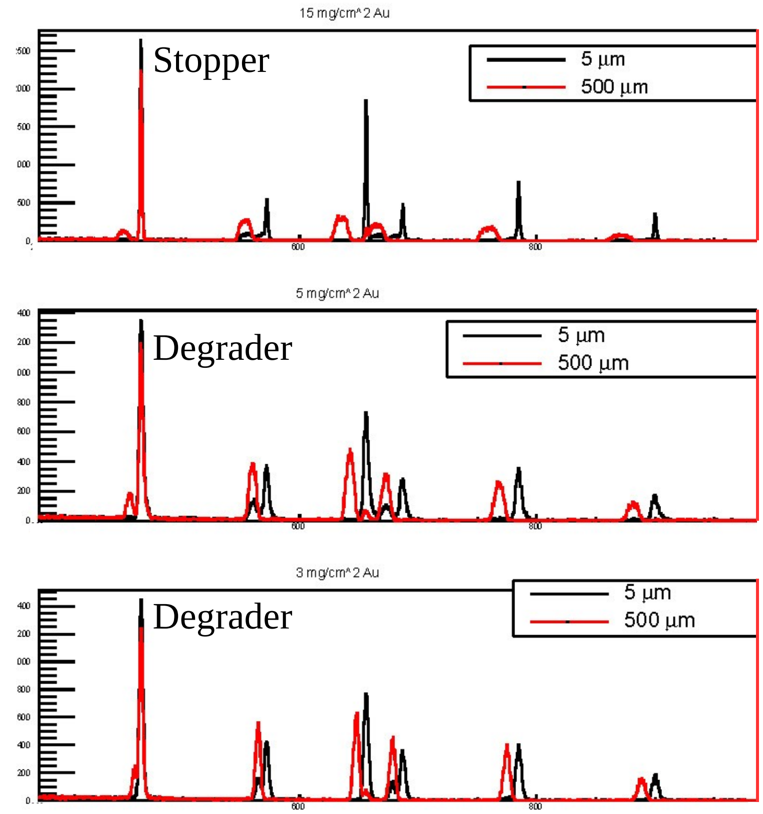
OUPS Plunger, J. Ljungvall et al, NIM A 679 (2012) 61-66. Degrader mode



Distances ranging from 10 to 1500 µm

$$E_\gamma' \approx E_\gamma \left(1 - \frac{v_{rec}}{c}\cos\theta\right) \qquad \frac{I(t)}{I(t)+I'(t)} = N_0\, e^{-(x/v_{rec})/\tau}$$

Plunger used in differential mode to maximize the energy resolution



Simulation done by J. Ljungvall

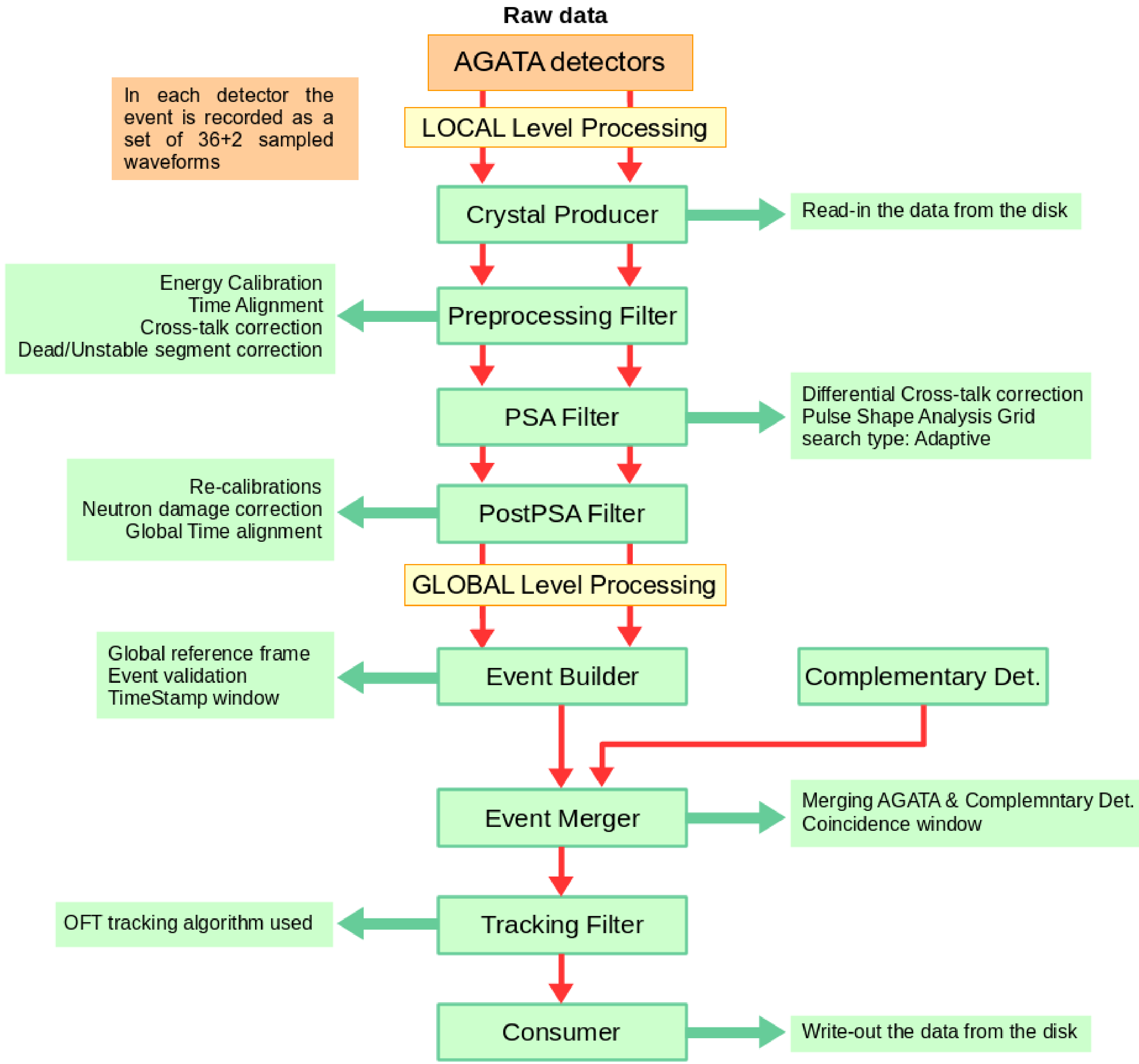
A. Dewald et al, Progress in Particle and Nuclear Physics 67 (2012) 786–839

4. Analysis Status

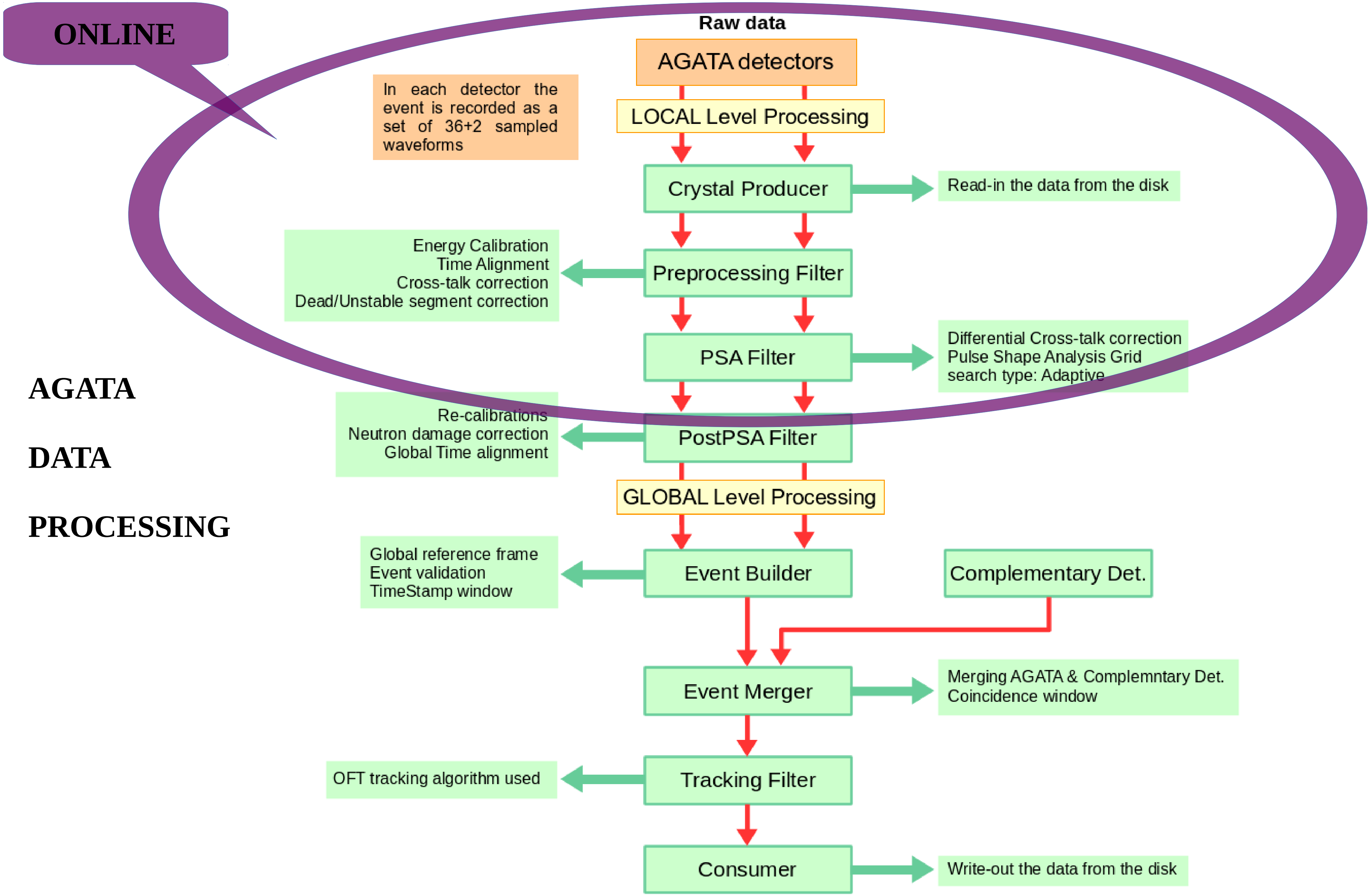
AGATA

DATA

PROCESSING



4. Analysis Status

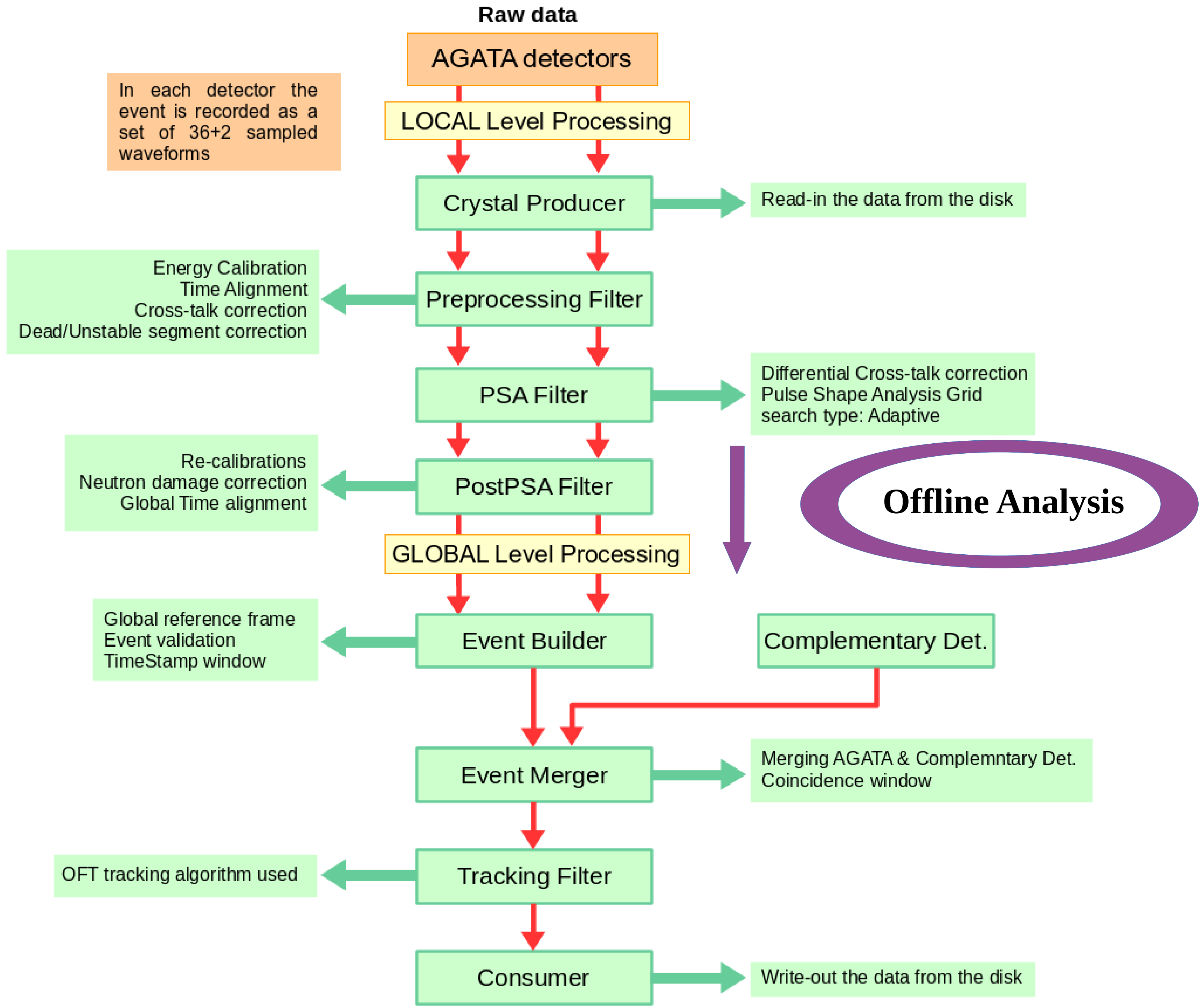


4. Analysis Status

AGATA

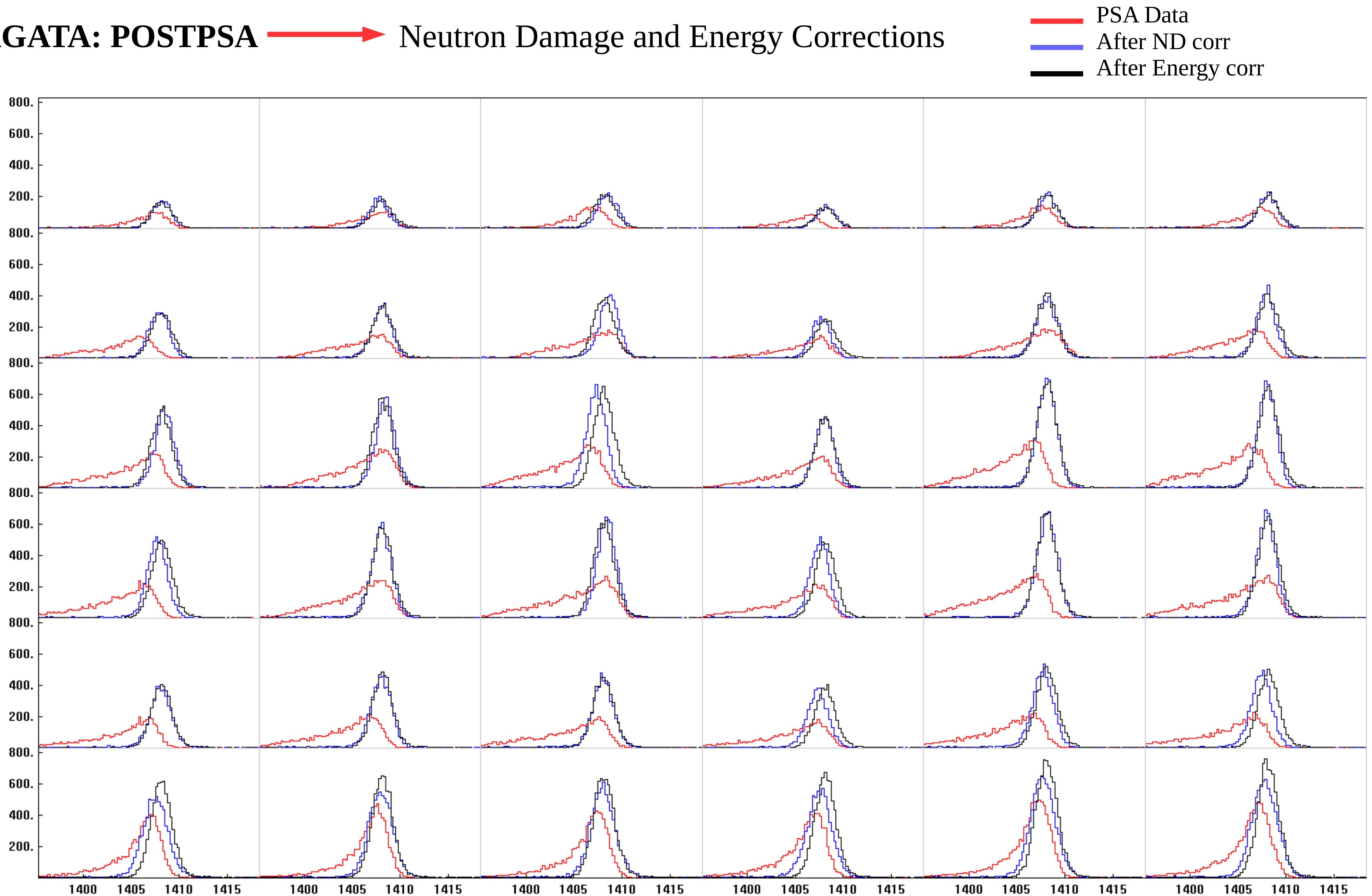
DATA

PROCESSING



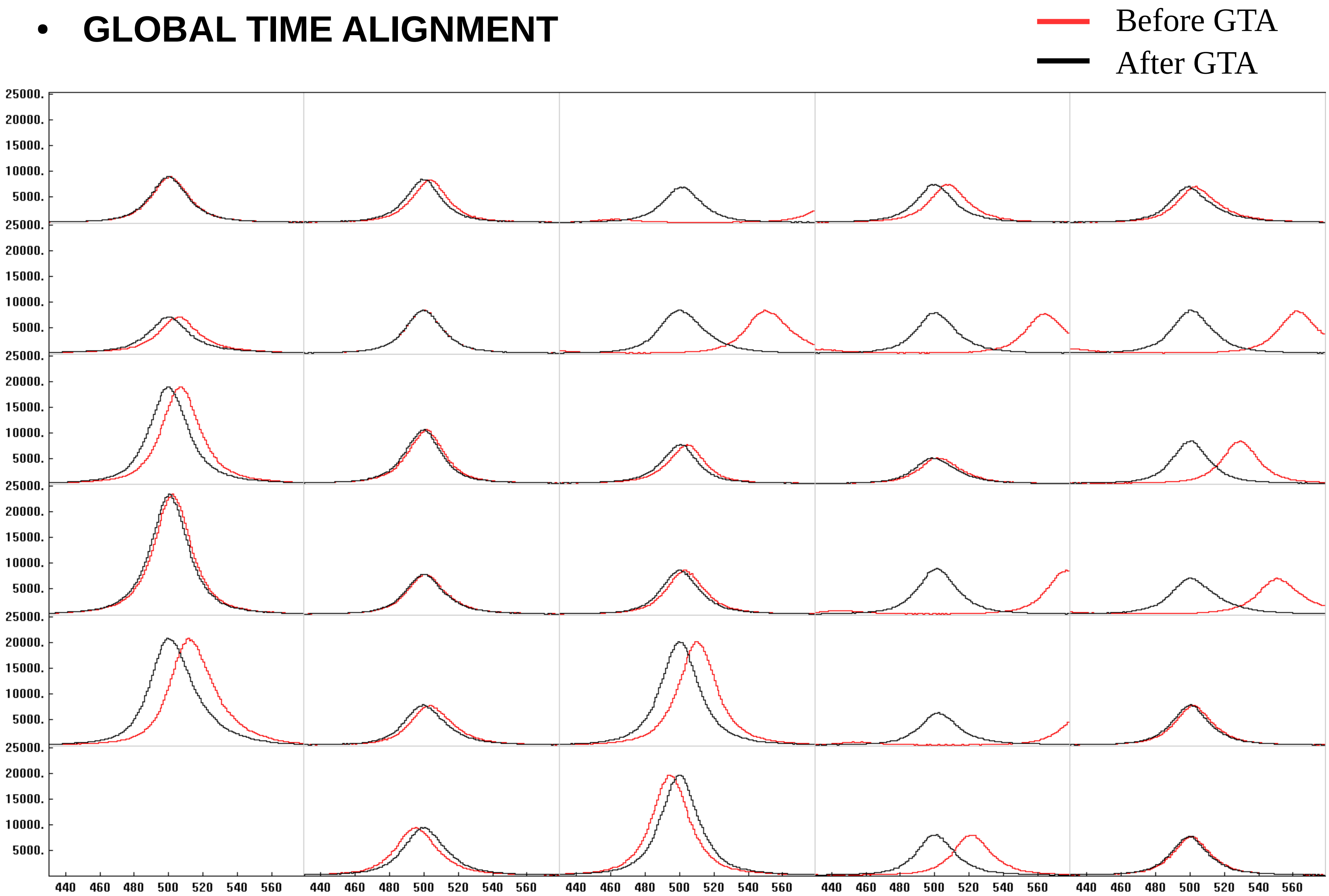
4. Analysis Status

AGATA: POSTPSA → Neutron Damage and Energy Corrections



4. Analysis Status

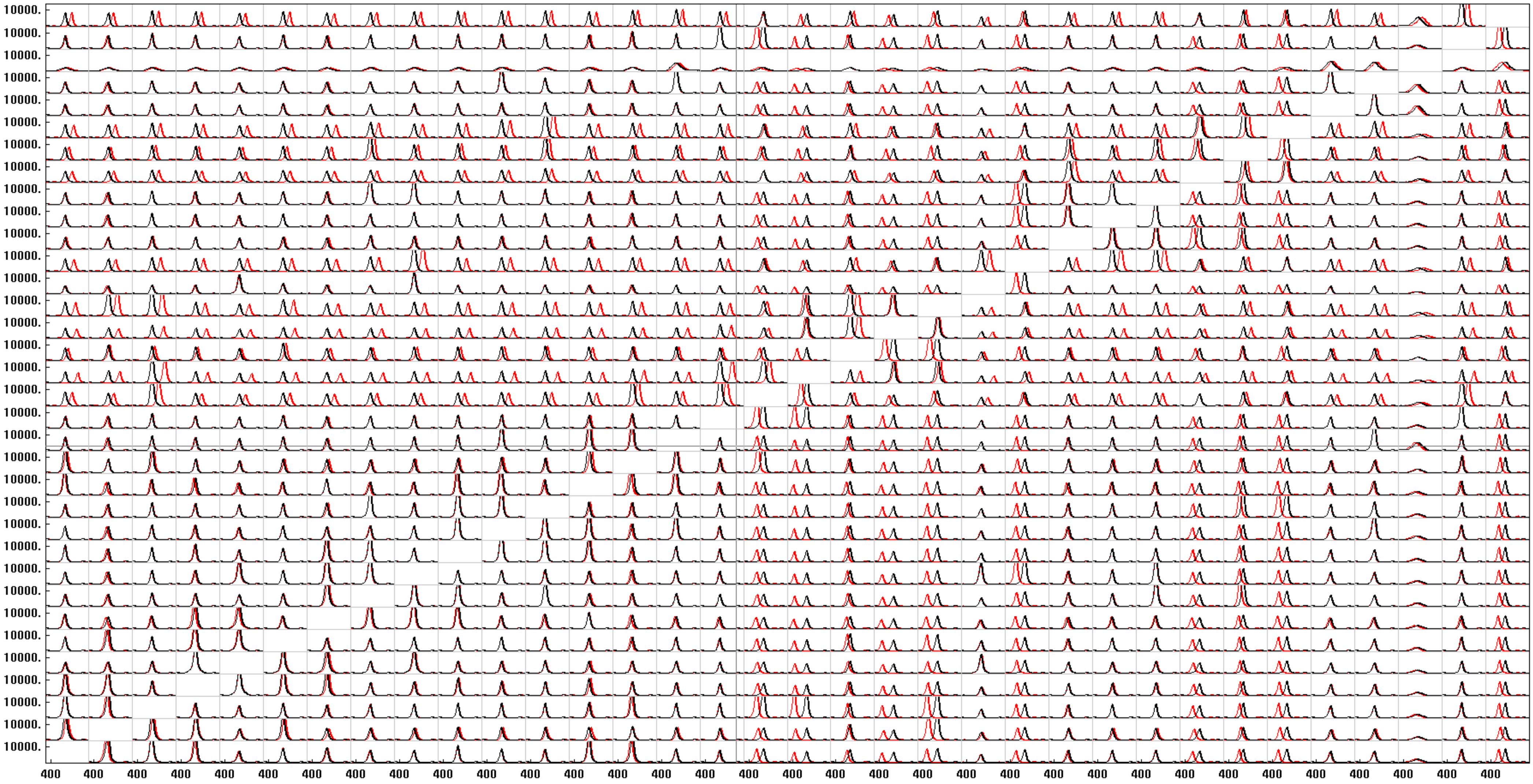
- **GLOBAL TIME ALIGNMENT**



4. Analysis Status

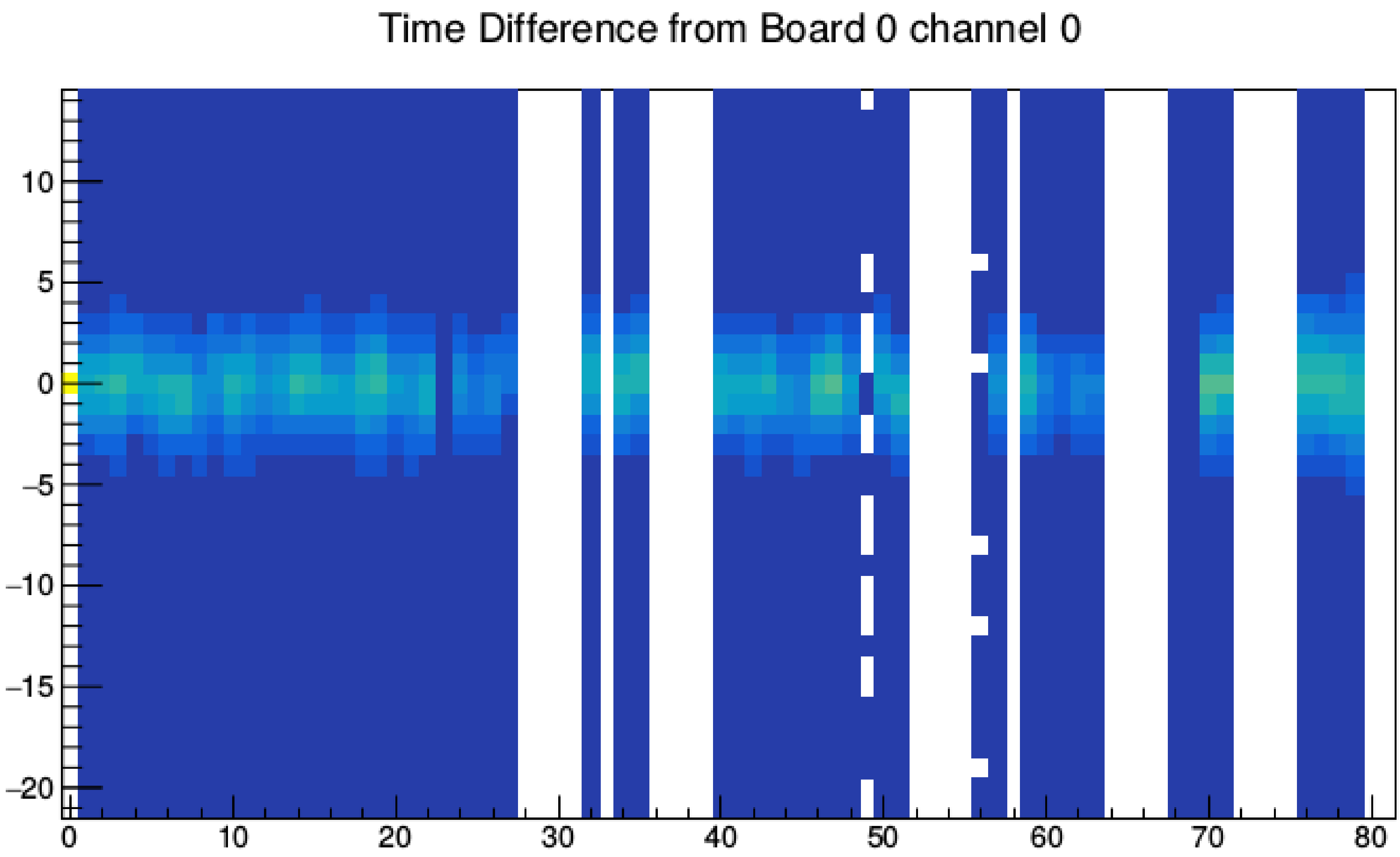
- **GLOBAL TIME ALIGNMENT**

Before GTA
After GTA



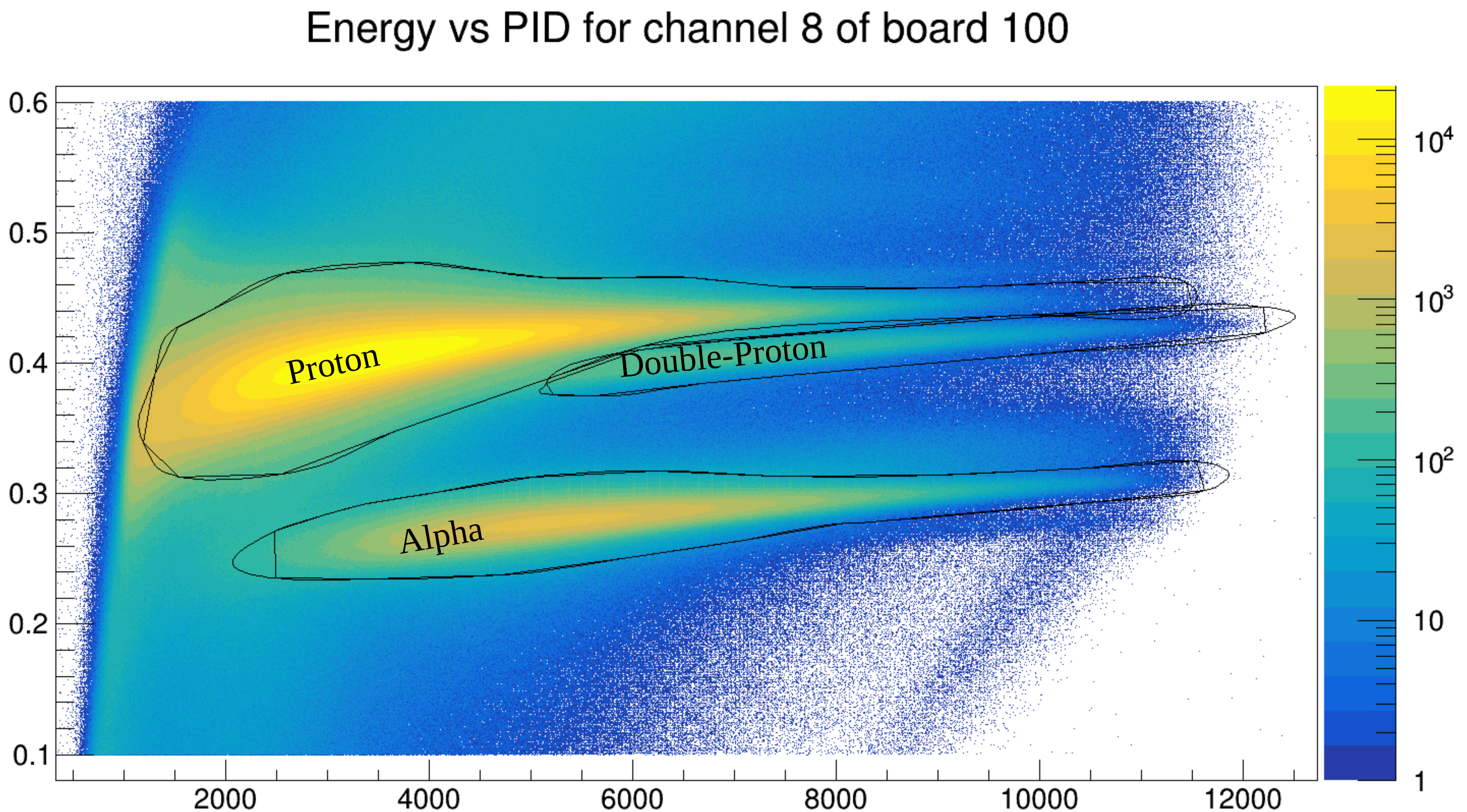
4. Analysis Status

- **Time Align of DIAMANT**



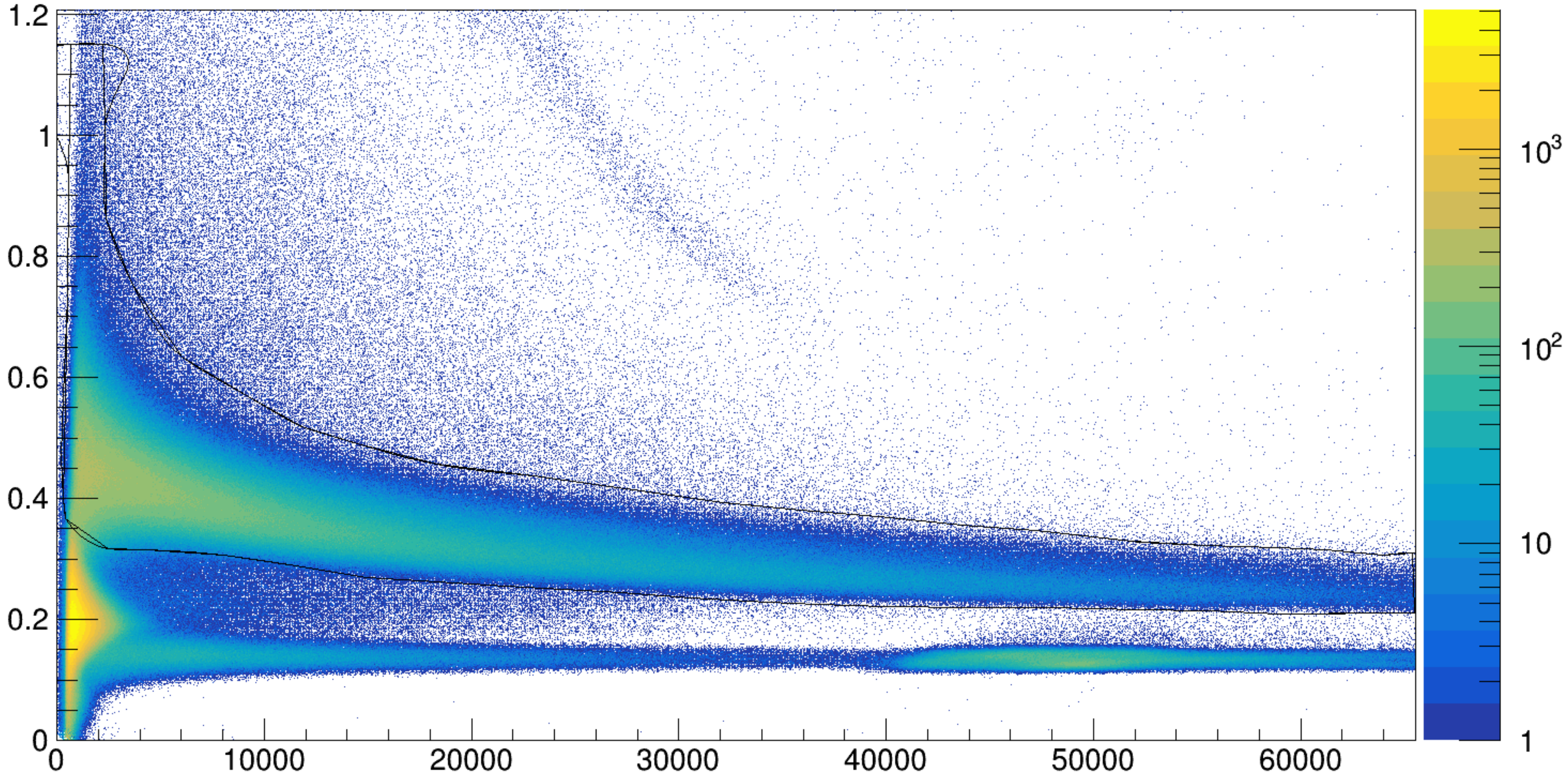
4. Analysis Status

- **DIAMANT GATES**



- **NEDA+NW GATES**

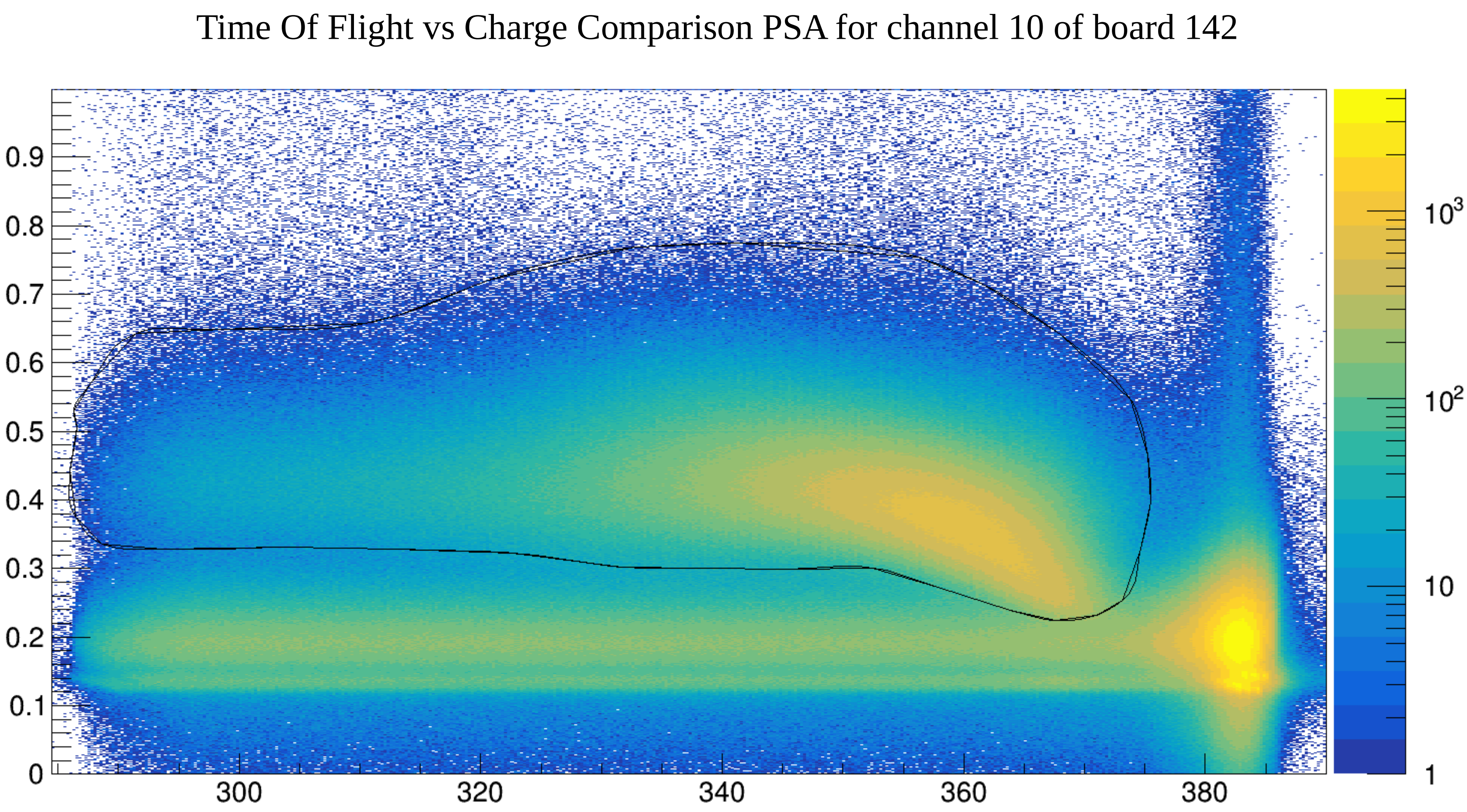
Energy vs Charge Comparison PSA for channel 10 of board 142



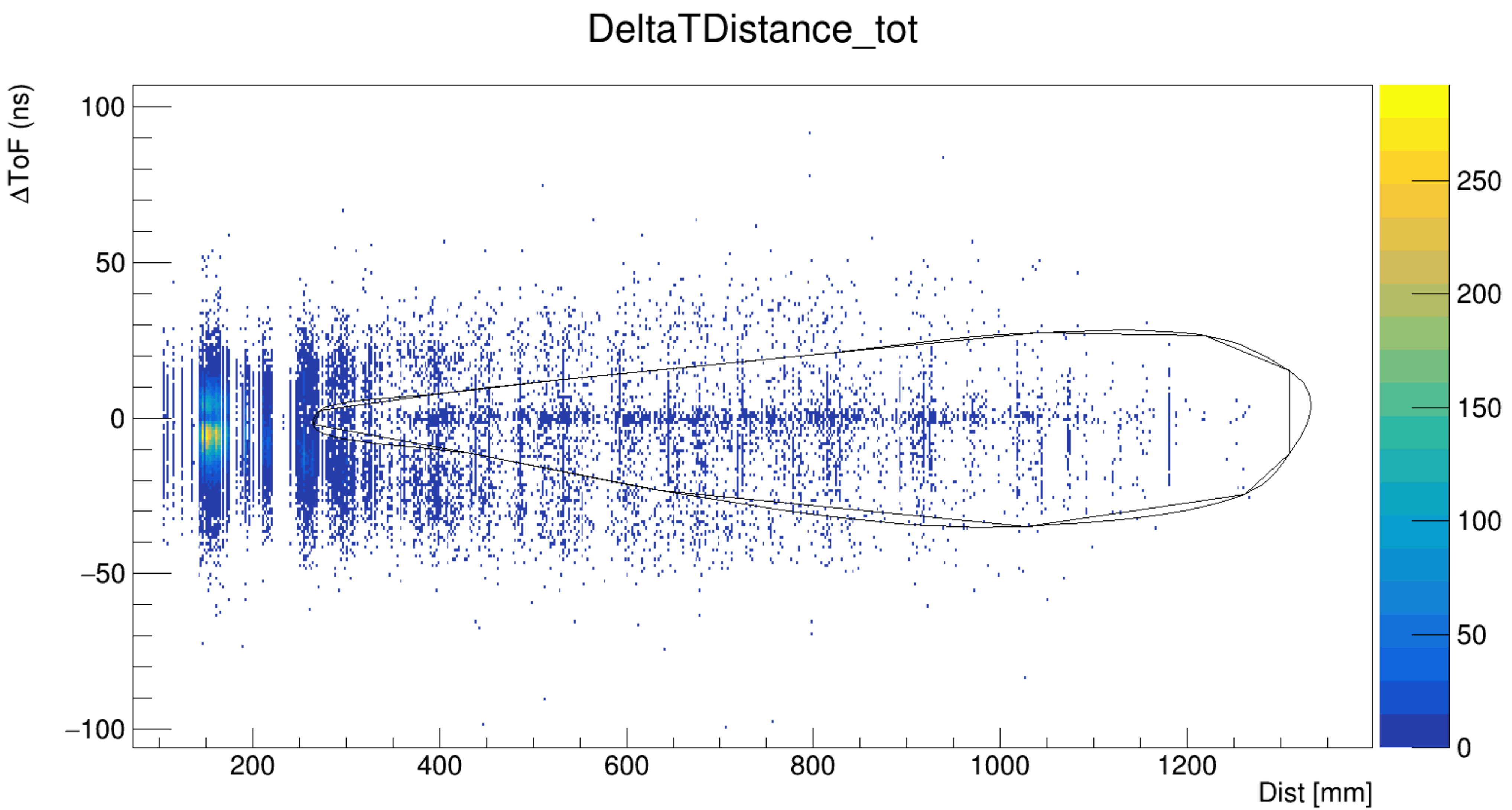
Nuclear Instruments and Methods in Physics Research A 594 (2008) 79– 89

4. Analysis Status

- **NEDA+NW GATES**

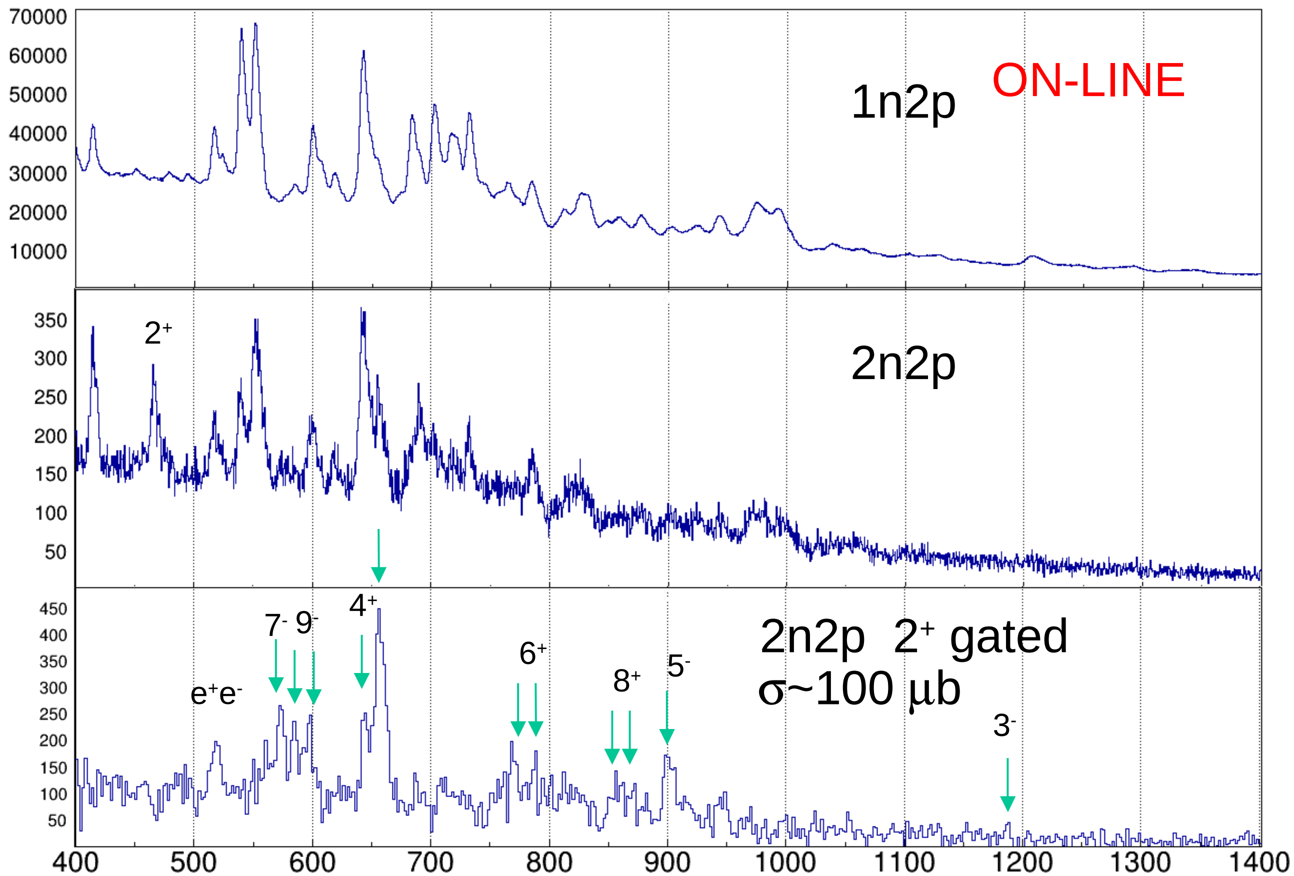


- **Neutron scattering**

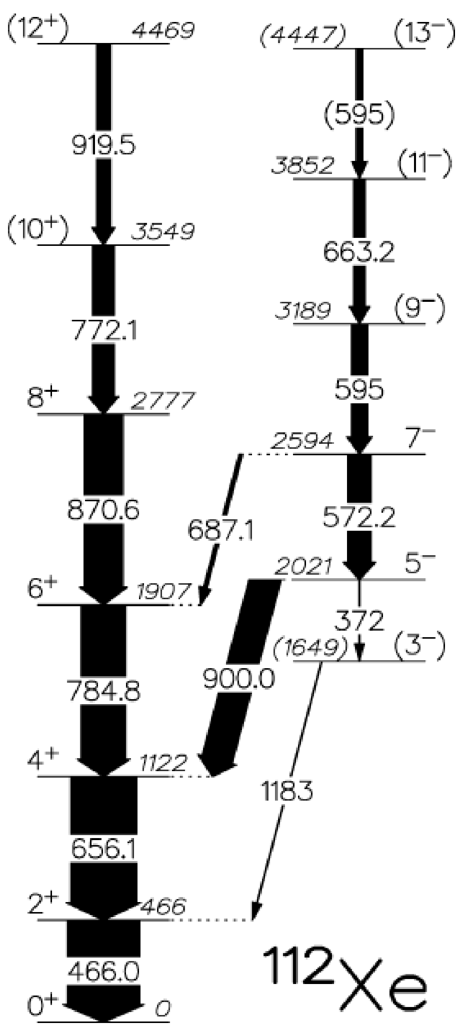


4.1 Online Analysis Result

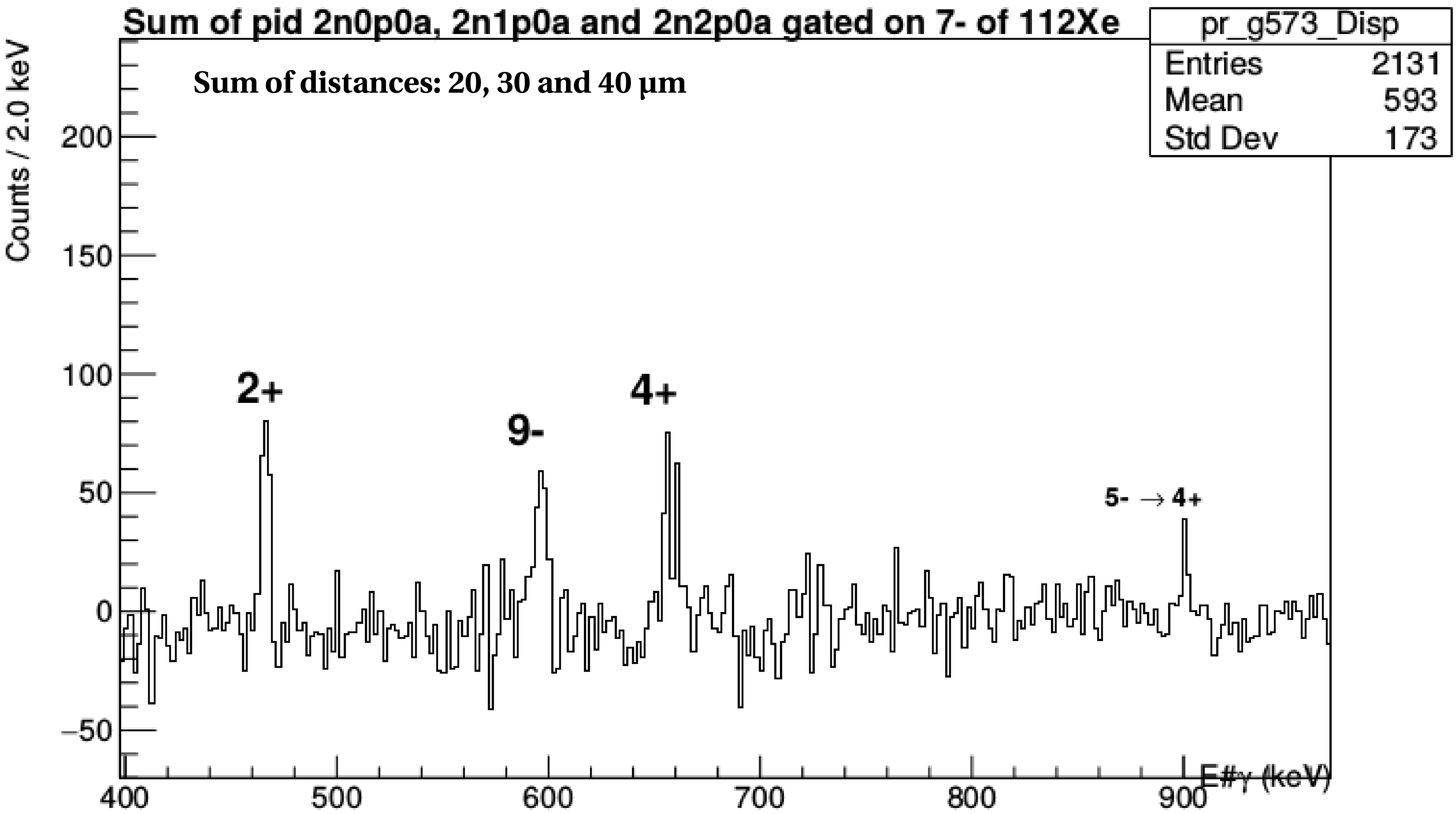
- We can see after the proper gates, with the 2n2p particle identification, the principal transitions online.



M. L. Jurado, E.Clement, D.Ralet, J.J.Valiente-Dobon, A.Gadea et al

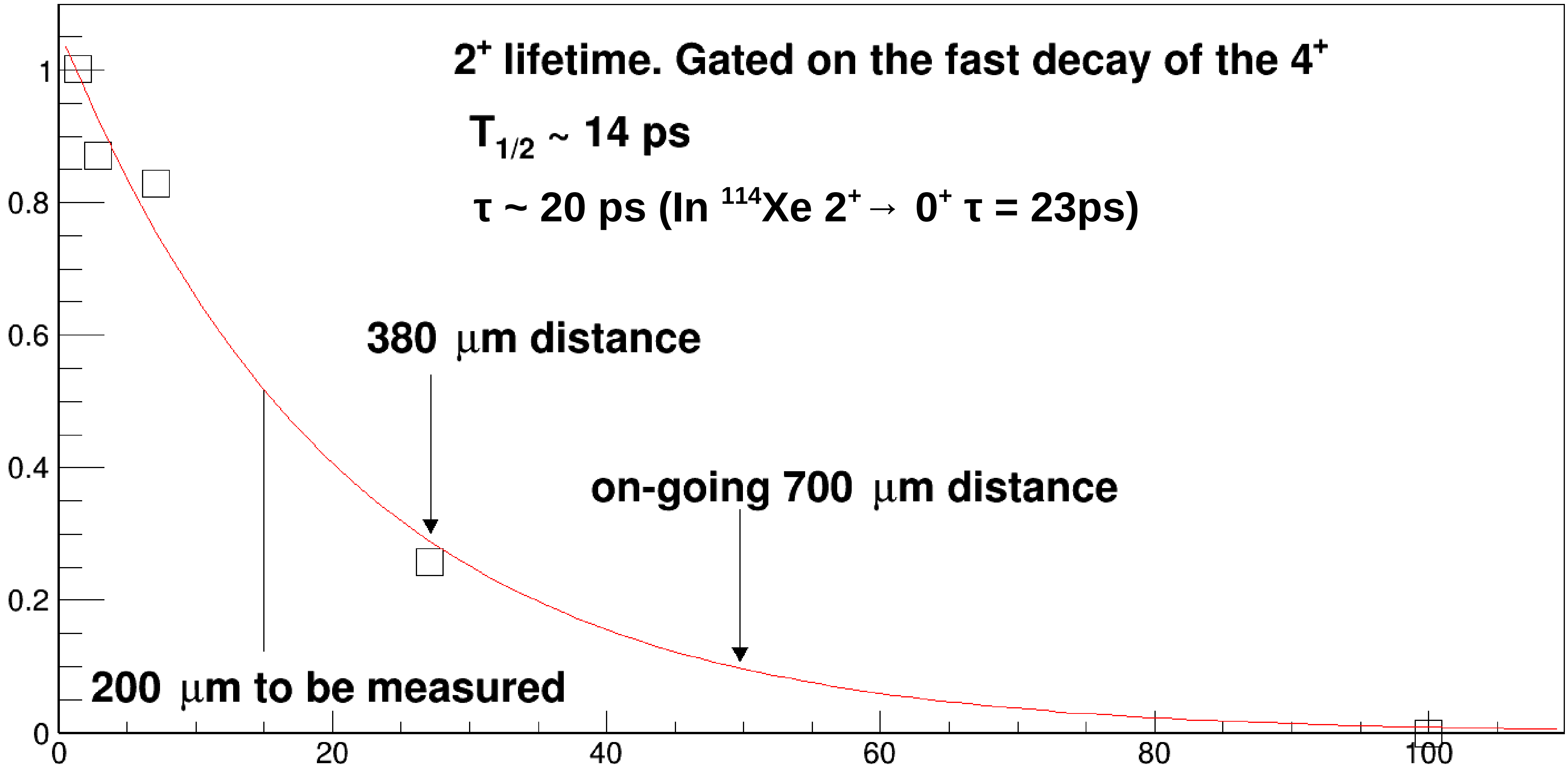


4.1 Online Analysis Result



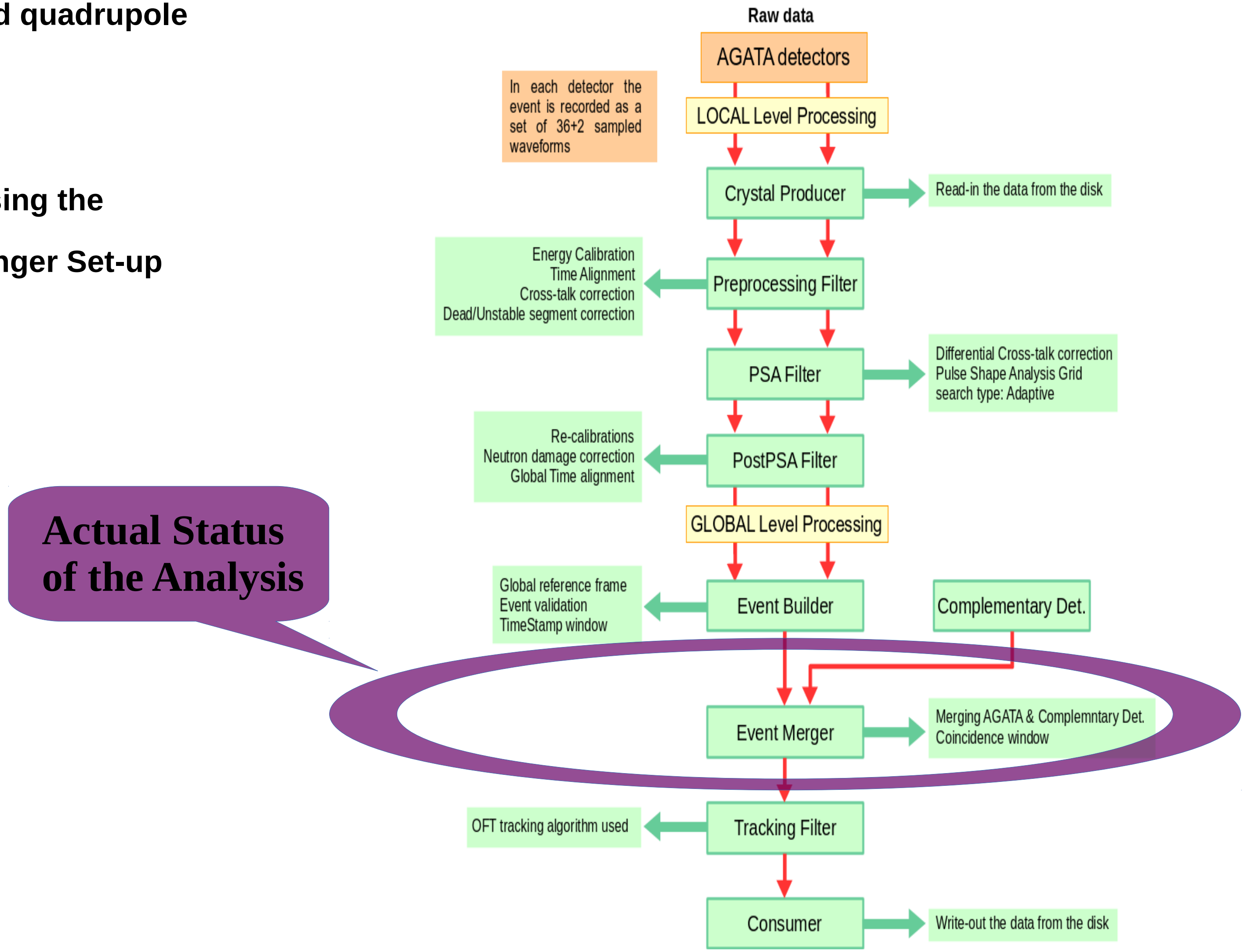
4.1 Online Analysis Result

- **Example of online Lifetime**



5. Summary

- Experimental study of octupole and quadrupole correlations in ^{112}Xe
- Experiment performed at GANIL using the AGATA+NW+NEDA+DIAMANT+plunger Set-up
- Post-PSA corrections in AGATA
- Time Alignment of detectors
- Particle gates in DIAMANT
- Neutron gates in NEDA and NW
- Neutron efficiency
- Ongoing Analysis. Actual step: Event Merger



Instituto de Física Corpuscular, CSIC-Universidad de Valencia, Spain

For the E730 Collaboration

María de la Luz Jurado Gómez

10/09/2019

GOBIERNO DE ESPAÑA | MINISTERIO DE ECONOMÍA Y EMPRESA

CSIC Consejo Superior de Investigaciones Científicas

IFIC INSTITUT DE FÍSICA CORPUSCULAR

VNIVERSITAT DE VALÈNCIA