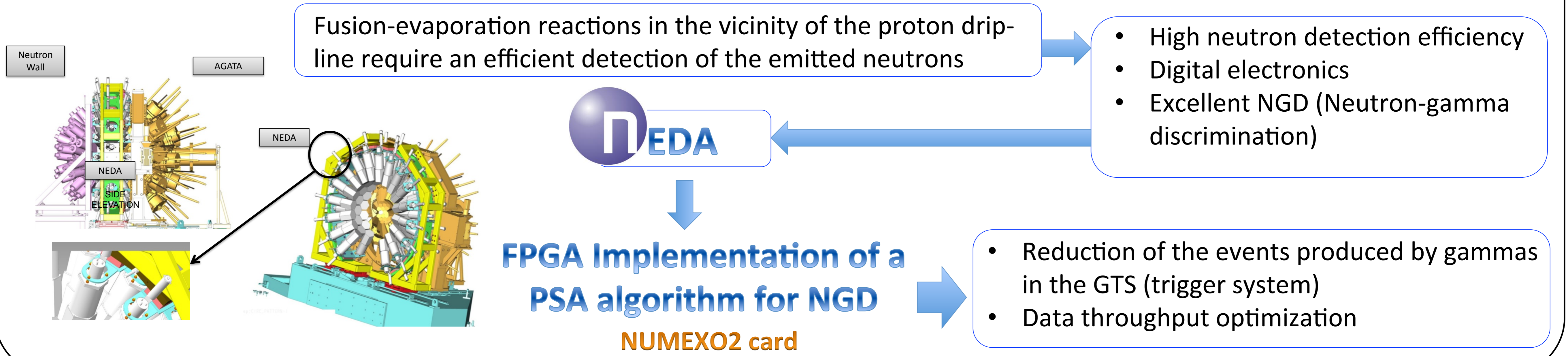# An FPGA Implementation of a Neutron-Gamma Discrimination Algorithm for the NEDA Neutron Detector
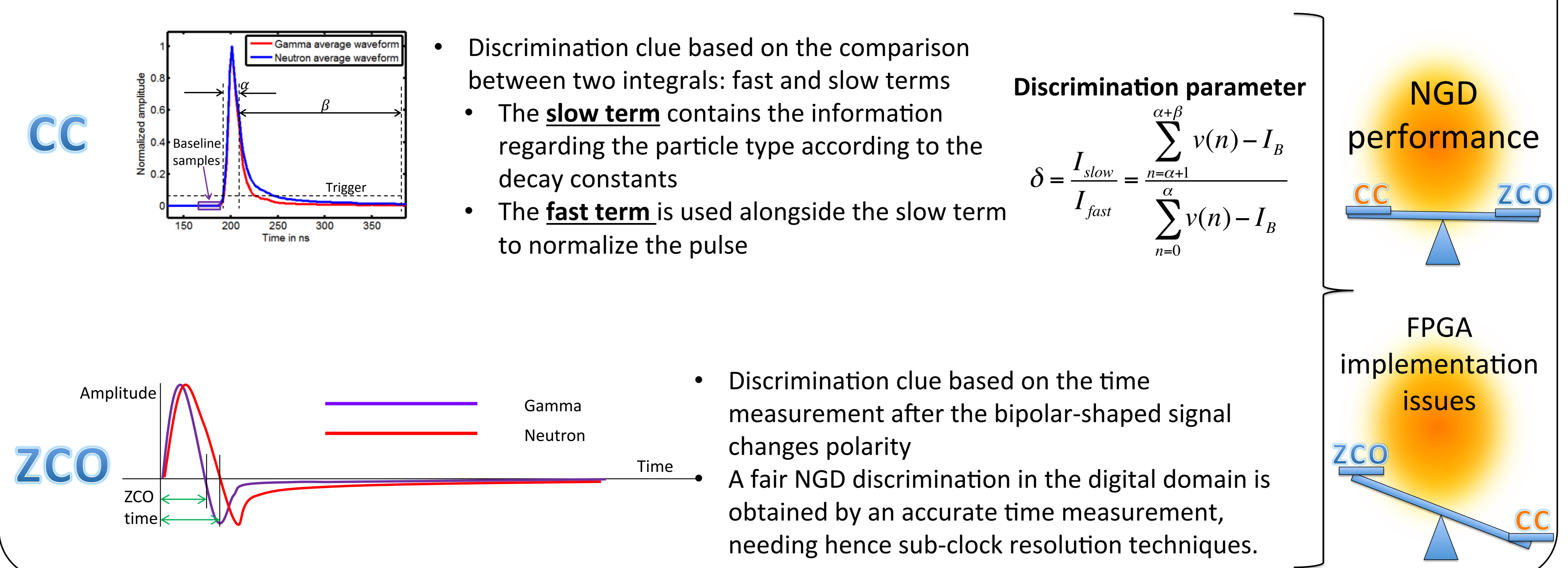
F.J. Egea, C. Houarner, V. González, P-A Söderström, J. Nyberg, M. Tripon, A.Boujrad, A. Gadea, M. Jastrząb, J.J. Valiente-Dobón, G. de France, I. Lazarus, G. Jaworski, T. Hüyük, A. Triossi, X.L. Luo, M.N. Erduran, S.Ertürk, M. Moszyńksi, V. Modamio, M. Palacz, E. Sanchis, R. Wadsworth
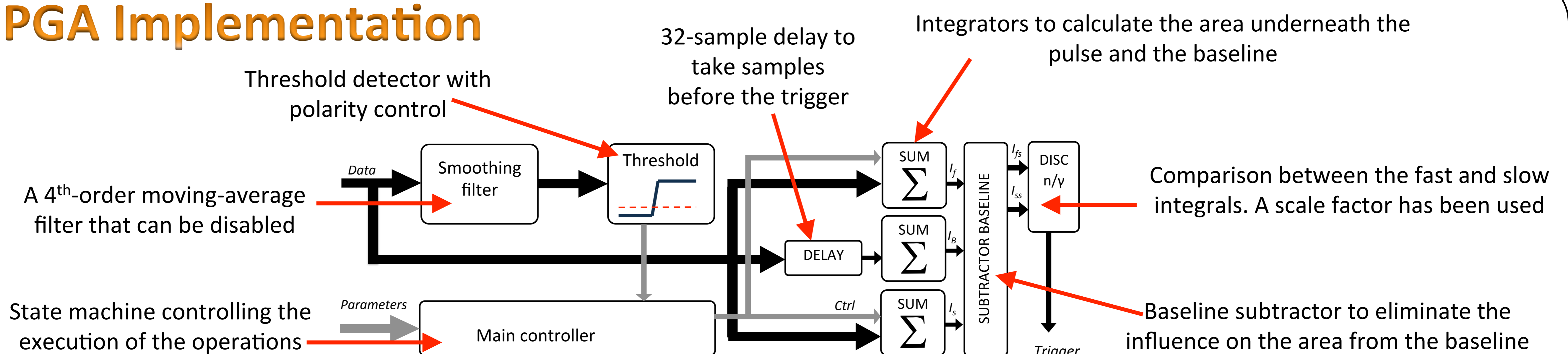
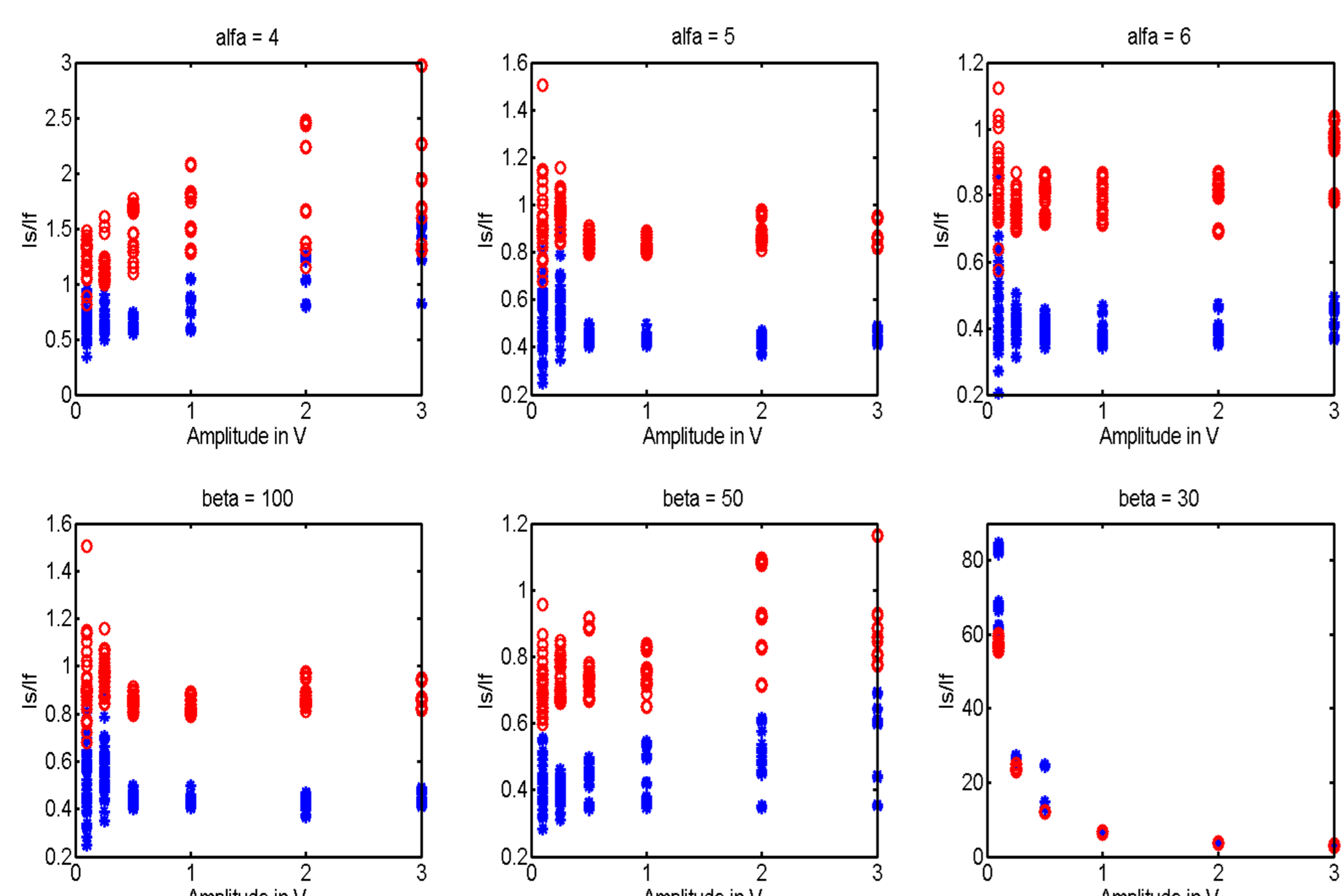## Background: The NEDA neutron detector

Fusion-evaporation reactions in the vicinity of the proton drip-line require an efficient detection of the emitted neutrons

- High neutron detection efficiency
- Digital electronics
- Excellent NGD (Neutron-gamma discrimination)

NEDA

FPGA Implementation of a PSA algorithm for NGD

NUMEXO2 card

- Reduction of the events produced by gammas in the GTS (trigger system)
- Data throughput optimization

Algorithms: Zero Crossover (ZCO) vs charge comparison (CC)

CC

- Discrimination clue based on the comparison between two integrals: fast and slow terms
  - The **slow term** contains the information regarding the particle type according to the decay constants
  - The **fast term** is used alongside the slow term to normalize the pulse

Discrimination parameter

$$\delta = \frac{I_{slow}}{I_{fast}} = \frac{\sum_{n=\alpha+1}^{\alpha+\beta} v(n) - I_B}{\sum_{n=0}^{\alpha} v(n) - I_B}$$

NGD performance

CC   ZCO

FPGA implementation issues

ZCO   CC

ZCO

- Discrimination clue based on the time measurement after the bipolar-shaped signal changes polarity
- A fair NGD discrimination in the digital domain is obtained by an accurate time measurement, needing hence sub-clock resolution techniques.

FPGA Implementation

32-sample delay to take samples before the trigger

Integrators to calculate the area underneath the pulse and the baseline

Threshold detector with polarity control

A 4th-order moving-average filter that can be disabled

Comparison between the fast and slow integrals. A scale factor has been used

State machine controlling the execution of the operations

Baseline subtractor to eliminate the influence on the area from the baseline

Preliminary results and future overview

The first algorithm verification tests were carried out the of using real samples from a PMT XP4512 and an arbitrary waveform generator 33522A able to reproduce them.

Besides, the algorithm was tested at high counting (but periodic) rates between 10 kHz and 50 kHz. Some of the patterns used involved only-gammas, only-neutrons and alternating patterns

For values of α = 20 and 25 ns, and β = 500 ns and 250 ns we observed the algorithm best behavior in terms of discrimination

Next future tests foresee a 252Cf with a NEDA detector. Those will be performed along the 2016.