AHEAD 2020
Funded by the Horizon 2020 Framework Program of the European Union Grant Agreement No. 871158

INSERT INTERNAL SERIAL NUMBER (OPTIONAL)

WP 14 Deliverable No. 14.4

Performance of AI techniques for the reconstruction of X-IFU detector pulses

Project acronym:
AHEAD2020

Project Title:
Integrated Activities for the High Energy Astrophysics Domain

Grant Agreement No: **871158**
This deliverable is part of a project that has received funding from the European Union's Horizon 2020 research and innovation programme

Start date of the project:
2020-03-02

Due date of deliverable: 01 Mar 2022
Submission date: 21 Feb 2022
File Name: WP14_D14.4_performance_of_AI_1.0
Prepared by: M.T. Ceballos

Version	Revision Date	Prepared by	Review and approval
1.0	21/02/2022	M.T.Ceballos	

Distribution List	Date	Version

Performance of AI techniques for the reconstruction of X-IFU detector pulses.....4
Abstract.....4
Paper publication.....4

Performance of AI techniques for the reconstruction of X-IFU detector pulses

Abstract

Transition Edge Sensors detector devices, like the core of the X-IFU instrument that will be on-board the Athena X-ray Observatory, produce current pulses as a response to the incident X-ray photons. The reconstruction of these pulses has been traditionally performed by means of a triggering algorithm based on the derivative signal overcoming a threshold (detection) followed by an optimal filtering (to retrieve the energy of each event).

However, when the arrival of the photons is very close in time, the triggering algorithm is incapable of detecting all the individual pulses which are thus piled-up. In order to improve the efficiency of the detection and energy- retrieval process, we study here an alternative approach based on Machine Learning techniques to process the pulses. For this purpose, we construct and train a series of Neural Networks (NNs) not only for the detection but also for the recovering of the arrival time and the energy of simulated X-ray pulses. The data set used to train the NNs consists of simulations performed with the SIXTE/XIFUSIM software package, the Athena/X-IFU official simulator. The performance of our NN classification clearly surpasses the detection performance of the classical triggering approach for the full range of photon energy combinations, showing excellent metrics and very competitive computing efficiency. However, the precision obtained for the recovery of the energy of the photons cannot currently compete with the standard optimal filtering algorithm, despite its much better computing efficiency.

Paper publication

This study has been accepted for publication by PASP in 2022 as:

Event detection and reconstruction using Neural Networks in TES devices: a case study for Athena/X-IFU

by Vega-Ferrero, Jesús; Ceballos, Maria Teresa; Cobo, Beatriz; Carrera, Francisco Jesús; García, Pere; Puyol Gruart, Josep

Article reference: PASP-101270.R1 (2022)