16th International Workshop on Low Temperature Detectors
20 | 24 July 2015

Processing of x-ray micro-calorimeter data with pulse shape variation using principal component analysis

Main author:

YAN Daikang

Co-authors:

Cecil Thomas, Argonne National Laboratory

Gades Lisa, Argonne National Laboratory

Jacobsen Chris, Argonne National Laboratory / Northwestern University

Madden Timothy, Argonne National Laboratory

Miceli Antonino, Argonne National Laboratory

Yan Daikang, Northwestern University

A common method of pulse processing for low temperature micro-calorimeters is the optimal filter. This method maximizes the signal to noise under the conditions that the pulse shape and noise are stationary. However in real detectors, these conditions are not always satisfied. We explore an alternative to the optimal filter. We present a method using principal component analysis (PCA) to process data independent of the pulse shape. In particular, PCA is a non-parametric technique that makes no assumption of the data. PCA provides an orthogonalized, decomposed representation of the data by their degree of covariance or significance. By selecting the first few components according to their degree of covariance, and rebuilding the data matrix, main features remain and noise is filtered. We demonstrate that PCA is able to noise-filter x-ray pulses independent of the shape of the pulses. This is crucial for pulses with severe position dependence that result in variable pulse shapes at the beginning of the pulse. We apply this method to a dataset from an x-ray thermal kinetic inductance detector that has severe pulse shape variation arising from position dependence. Traditional methods give no energy information for such a dataset. However, the PCA method is able to provide noise-filtered energy information.