Improvement in Pixelated CdZnTe Detector Energy Resolution by Principal Component Regression

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Objectives

High-level objective: Reduce uncertainty in numerical analyses obtained with CdZnTe detectors

Low-level objective: Optimize energy resolution through analysis of the statistical patterns in the acquired data

Introduction and Motivation

- Energy deposition is estimated from digital signals (Figure 1). Deficiencies of conventional methods:
  1) Uses few signal characteristics to estimate energy → Leverages information inefficiently
  2) Relies on limited understanding of complex physical processes → Susceptible to systematic error

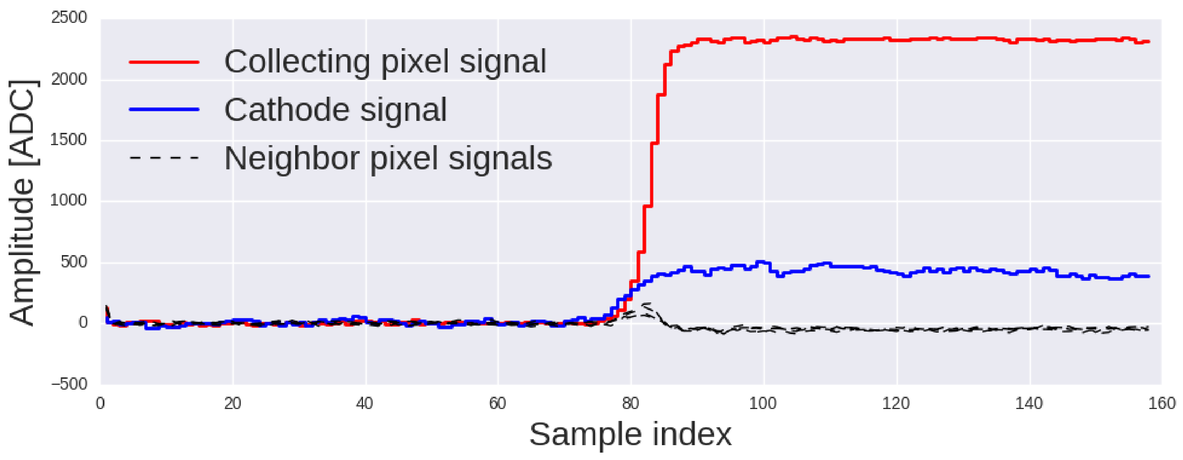


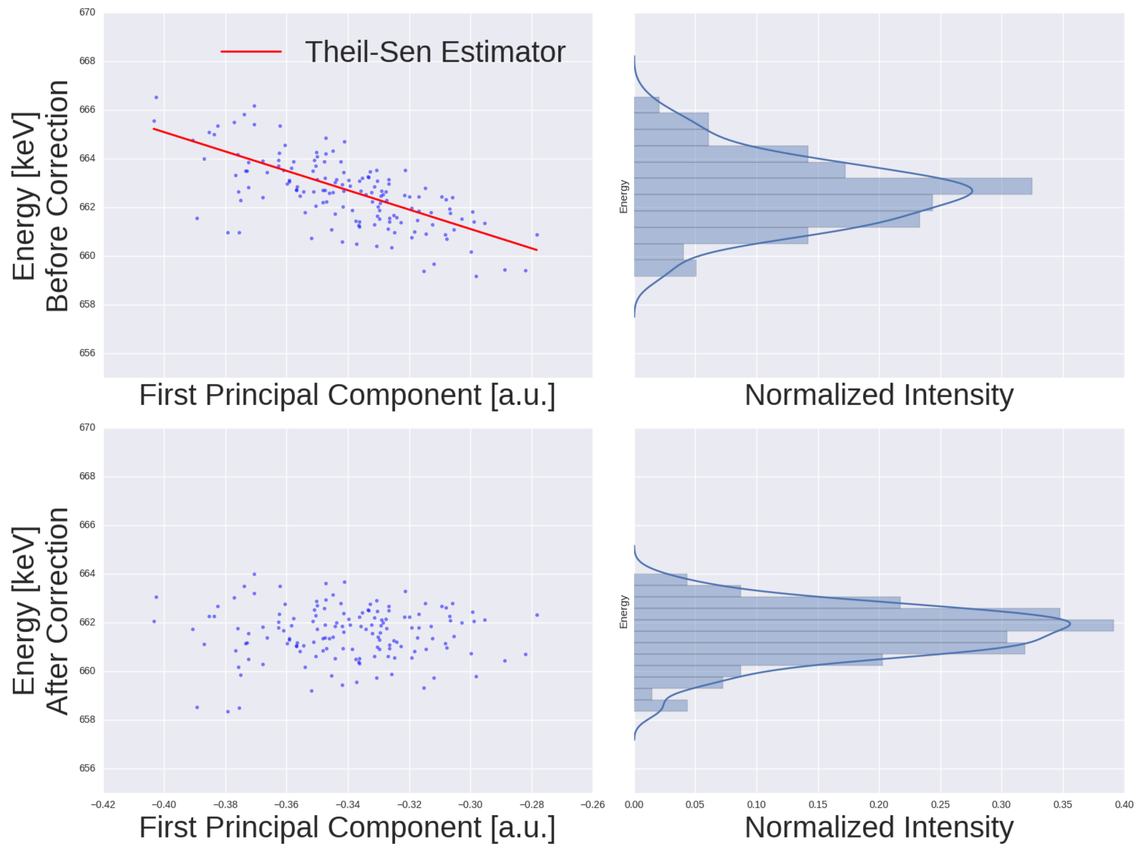
Figure 1: Sample of digital signals recorded by pixelated CdZnTe detectors

Mission Relevance

- Energy resolution is the primary competitive advantage of HPGe over CdZnTe detectors
- Optimizing energy resolution of CdZnTe closes the gap for practitioners that require instruments with HPGe energy resolution in a fieldable instrument with imaging capability

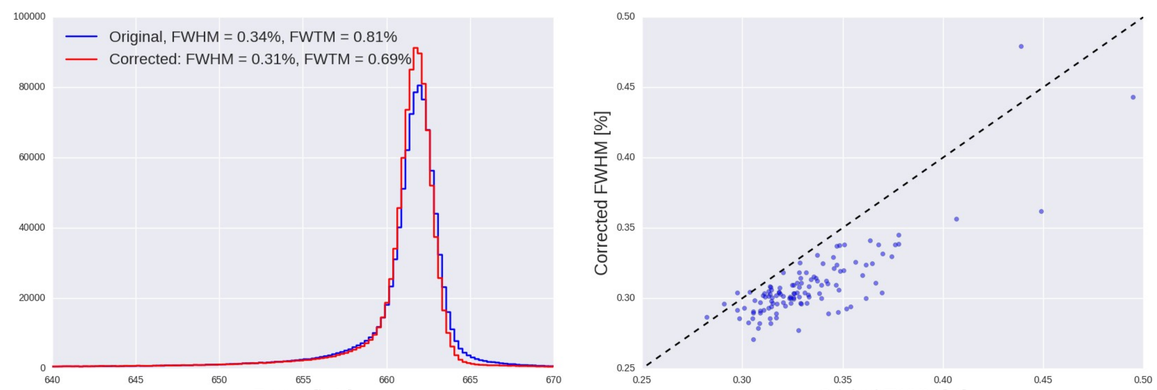
Technical Methods

- Principal component analysis efficiently finds the most important signal characteristics
- Principal component regression uses these characteristics to mitigate systematic error



Results

- Energy resolution for single-pixel events improves after mitigating systematic error



Conclusion

- Principal component regression improves CdZnTe detector single-pixel FWHM and FWTM by 10-15%
- Efficiently mitigates systematic error in energy deposition estimation through rigorous statistical analysis

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