

On-line pulse pile-up correction.

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Executive Summary

- **Southern Innovation (SI) has developed and patented a disruptive, platform, digital pulse processing technology.**
- **The technology enables up to a 25 fold increase in pulse processing performance in radiation detection & measurement.**
- **SI's technology decodes rather than discards corrupted (or "piled-up") detector data.**
- **The technology accelerates time critical tasks in radiation detection and measurement.**
- **SI is currently commercialising the technology via strategic licensing with OEM's across a number of industries.**



Presentation Outline

Background to Southern Innovation

Genesis of the technology

Problem definition

Solution methodology

Some performance results

Conclusions

Southern Innovation

Background

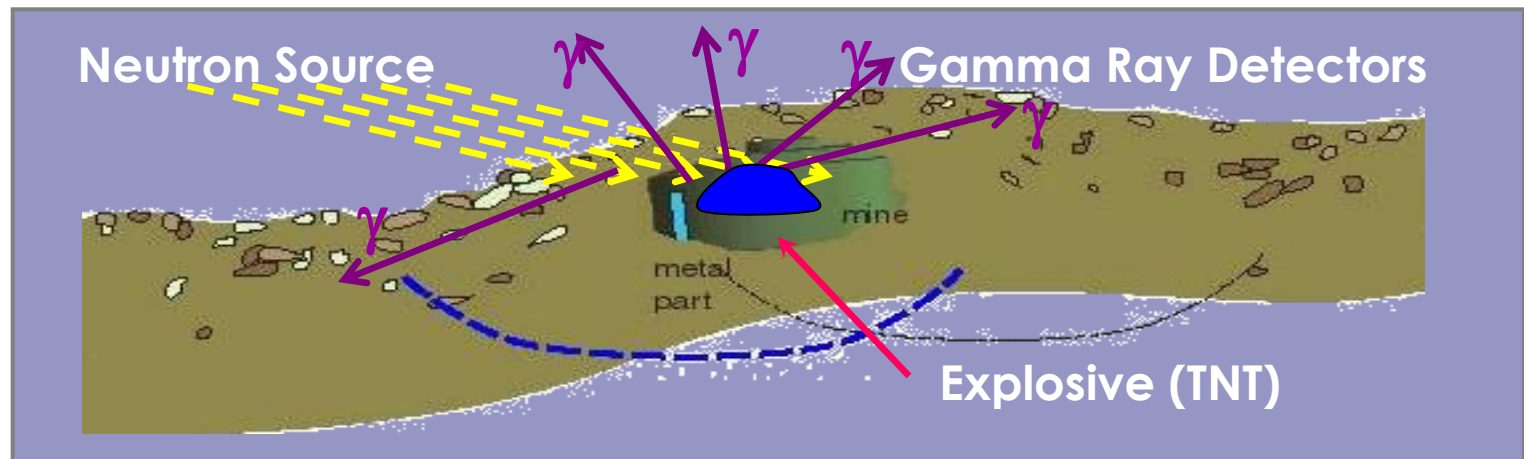
- SI was founded in 2004 to commercialise technology developed at the University of Melbourne.
- SI's core business is the design development and sale of innovative technologies for radiation detection and measurement.
- SI is executing a “Dolby-Like” commercialisation strategy.
- SI has exclusive ownership of its technology with patents granted in Australia and the US and others pending.



Problem Introduction

Genesis of the research.

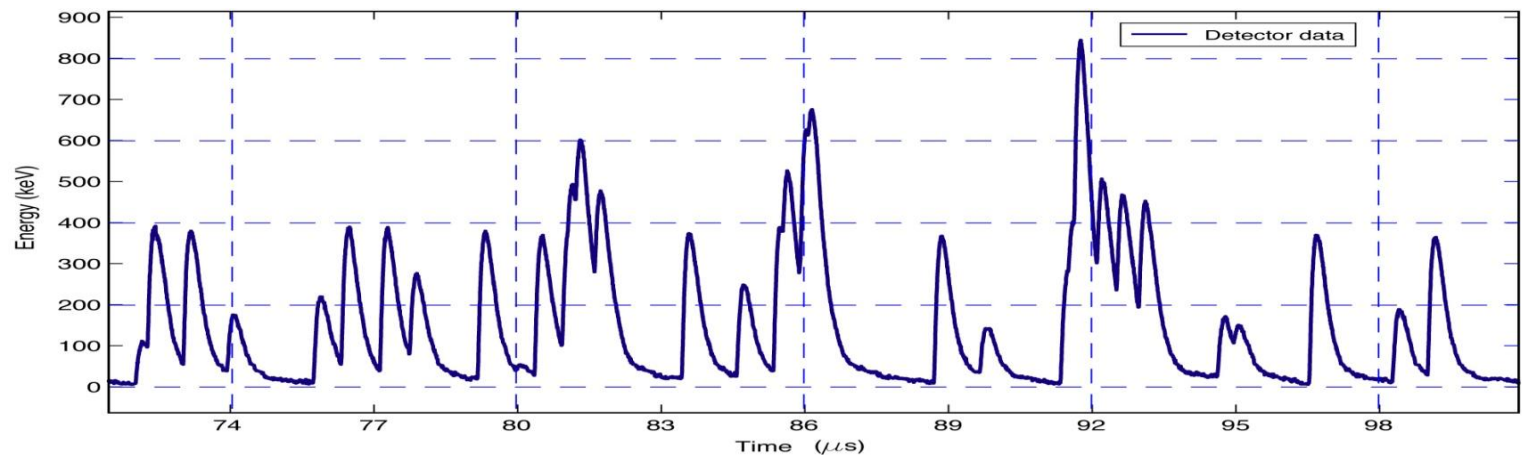
- Humanitarian landmine detection using neutron / gamma based explosive detection.
- Large background signal and direct cross coupling between detectors and source.



Problem Introduction

Pulse Pile-up

- When a burst of radiation “arrives” in a short period data is corrupted.
- Pulse pileup results in reduced energy resolution, increase dead-time & extended measurement time.
- Reduce the neutron generator current & reject pulse pile up.



Model Based Signal Processing

Modelling the measurement process

- The 'Black Box' approach to detection.



To what extent can M be characterised?

- If it can then, by solving for M^{-1} determine the 'unobservable' input to the detector process.



Linear Filtering Approaches

Convolution Filtering

- In the frequency domain $Y = S.M$
- Robust against noise but extends pulses.

Inverse Filtering

- $Y = M^{-1} .S$
- Shortens pulse length but amplifies noise power.

Wiener Filtering

- A trade off between Convolution and Inverse

- $$W_f = \frac{M^*}{|M|^2 + \lambda}$$

As the noise variance (λ) $\rightarrow 0$ the Wiener Filter approaches Inverse filtering, as (λ) get larger the Wiener Filter approaches Convolution filtering.



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Linear Filtering Approaches

Convolution Filtering

- In
- Rok

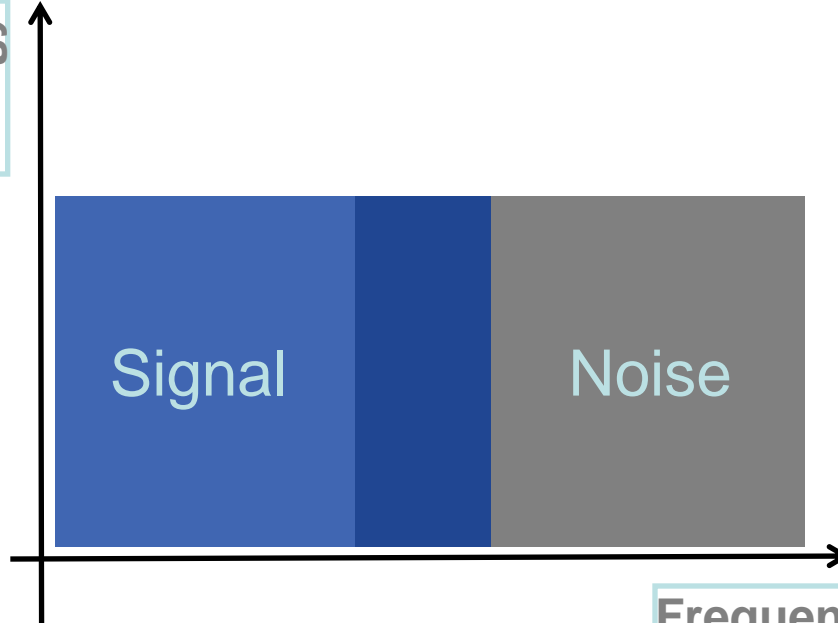
Inverse Filtering

- $Y =$
- Sho

Wiener Filtering

- A tr
- $W_f =$

Energy



Frequency

As λ approaches 0 the filter becomes an inverse filter. As λ gets larger the Wiener Filter approaches Convolution filtering.



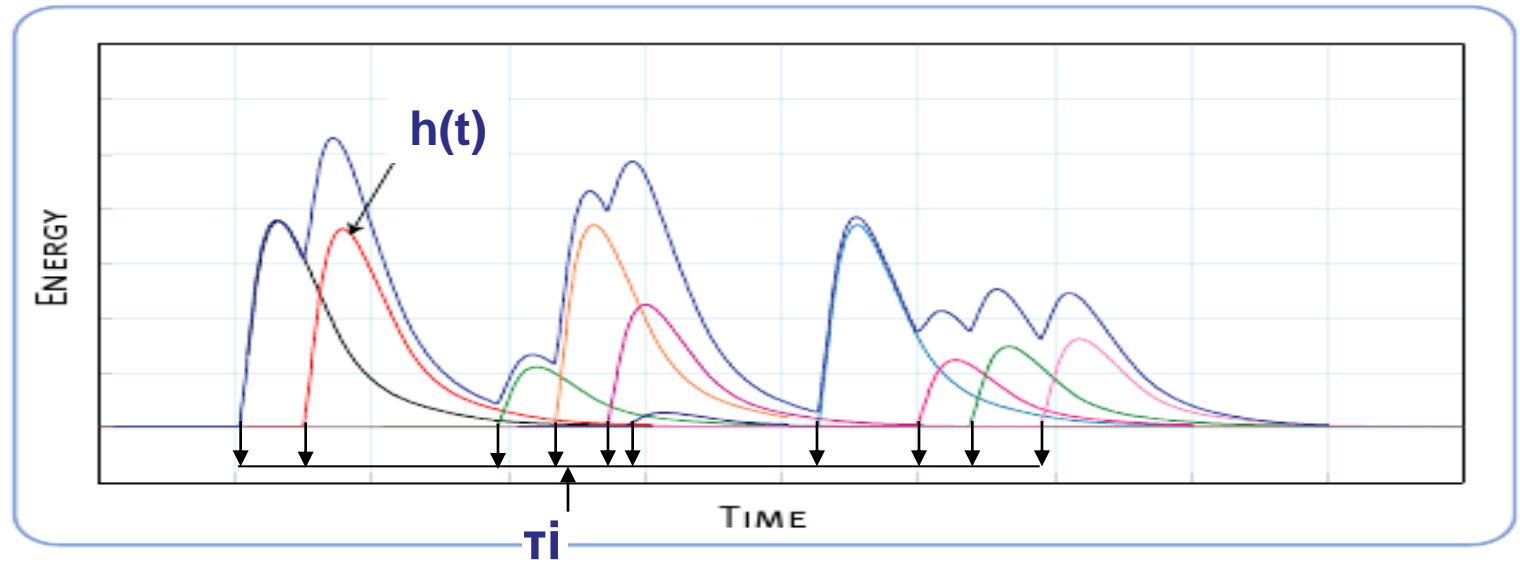
Maximum Likelihood Estimation

Continuous Time

$$y(t) = s(t) \star h(t) + w(t)$$
$$= \left[\sum_{i=1}^N \alpha_i \delta(t - \tau_i) \right] \star h(t) + w(t)$$

Discrete Time

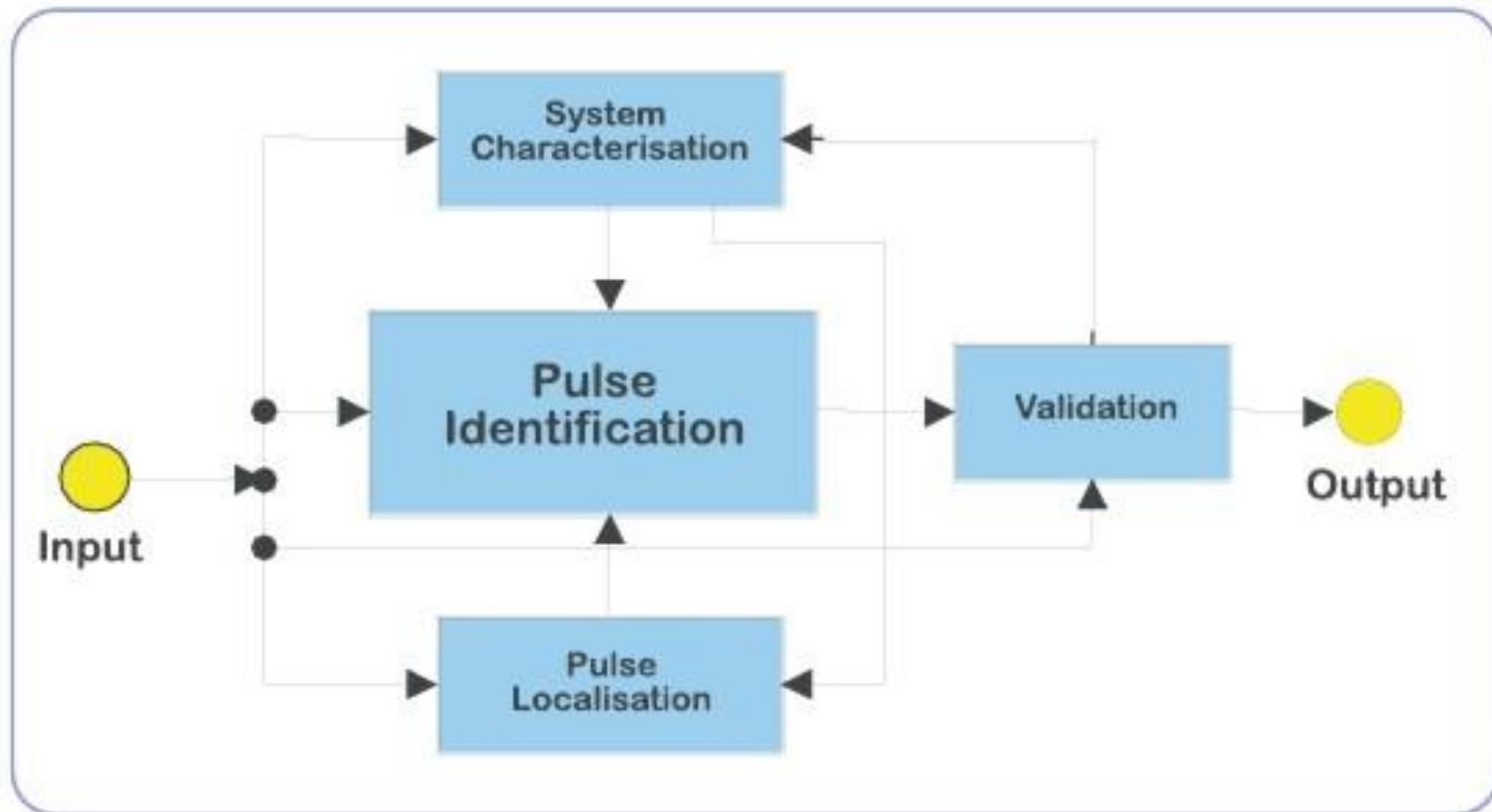
$$y[n] = \sum_{i=1}^N \alpha_i h[n - \tau_i] + w[n]$$



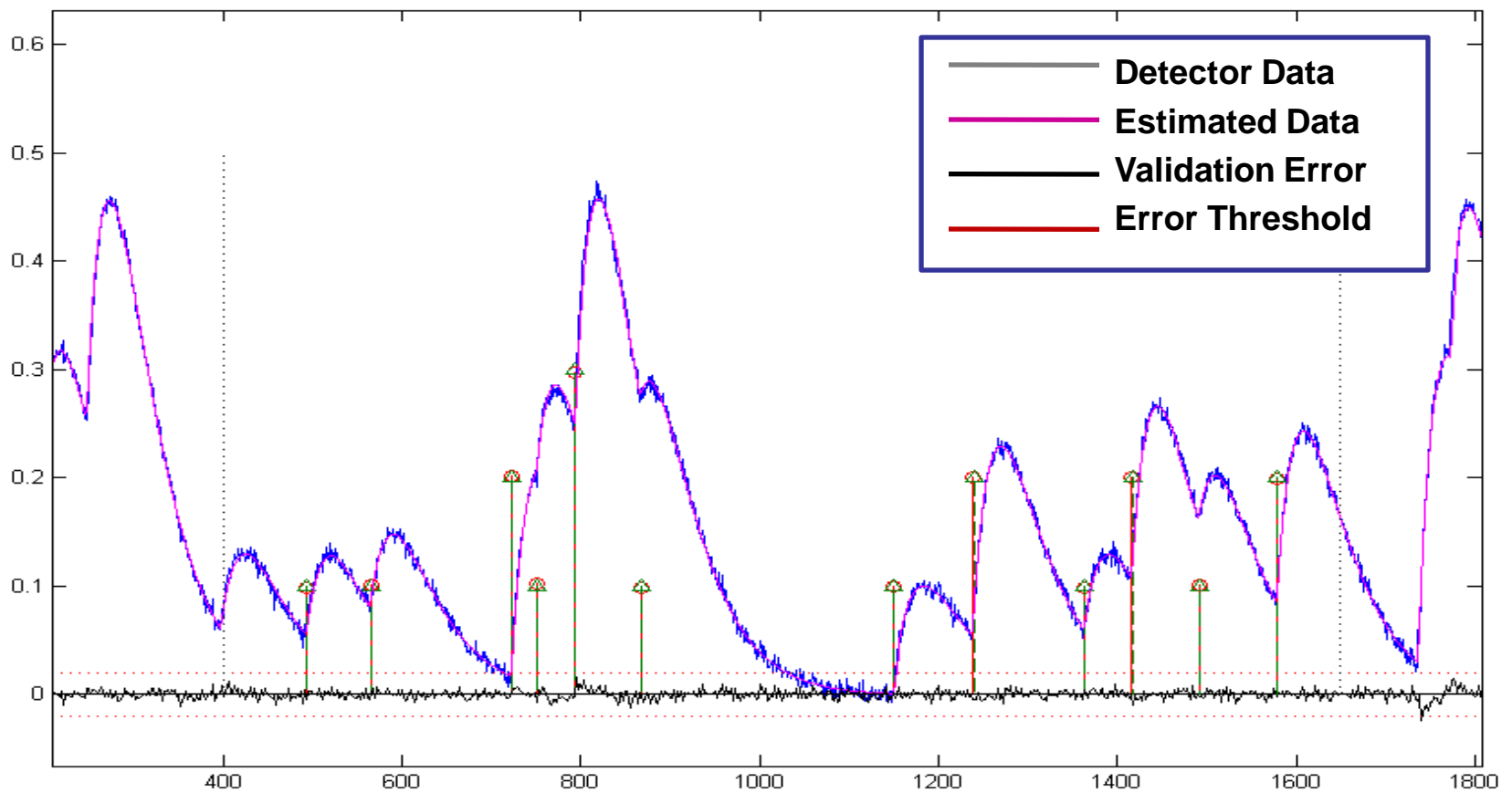


Algorithm Overview

The Pulse Pile-up Recovery Algorithm

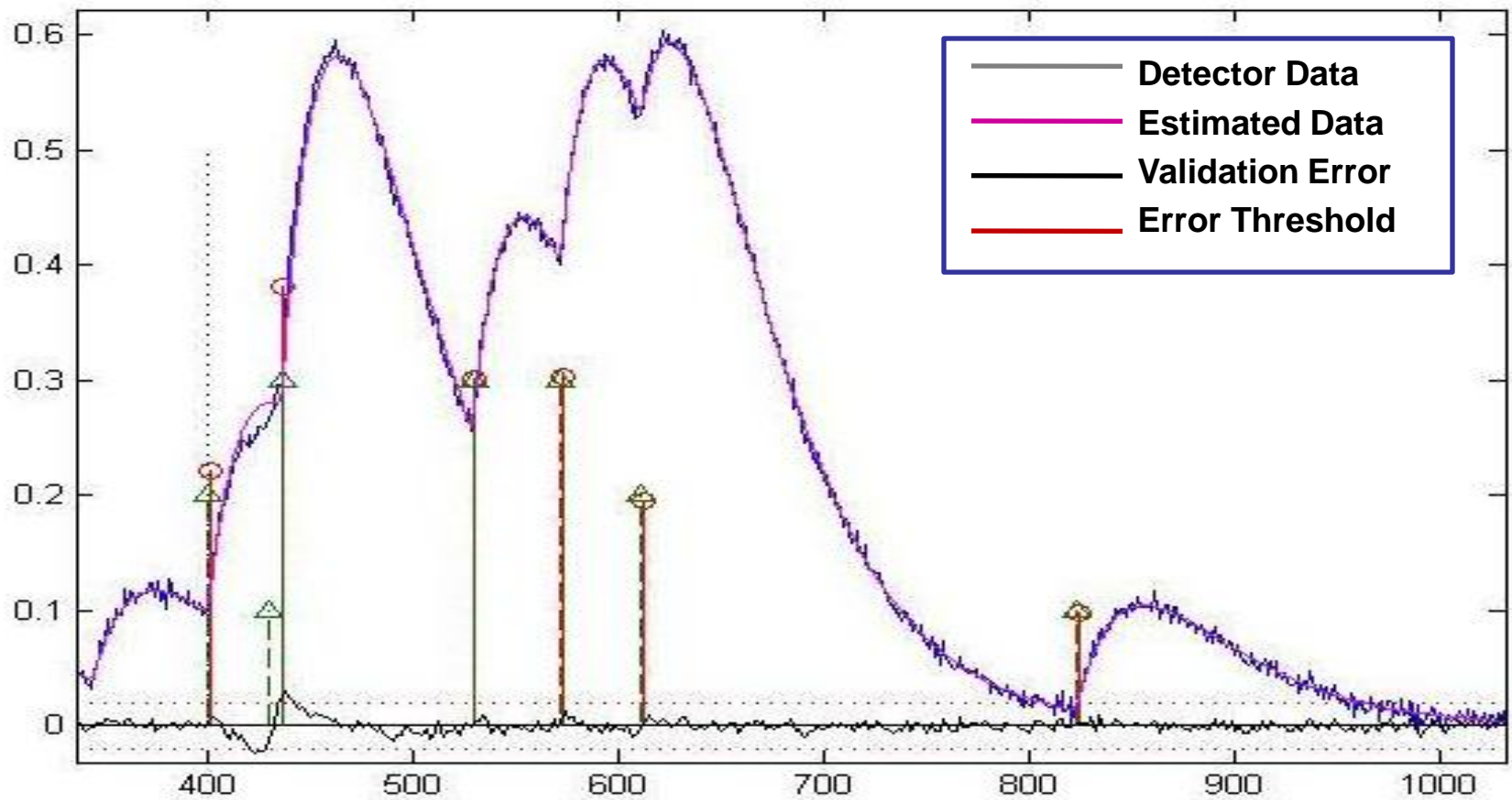


Algorithm in Action.



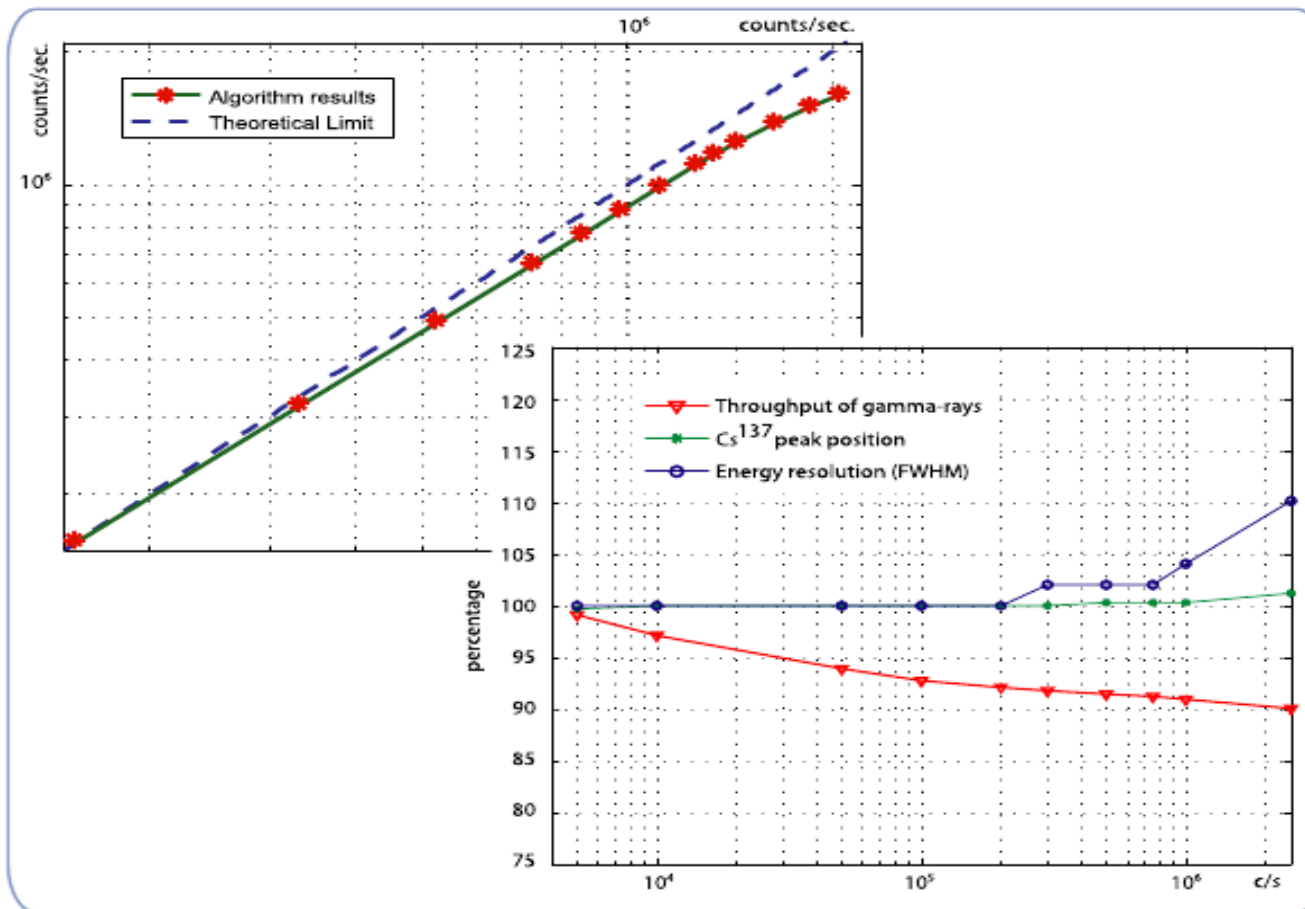


Error Detection.



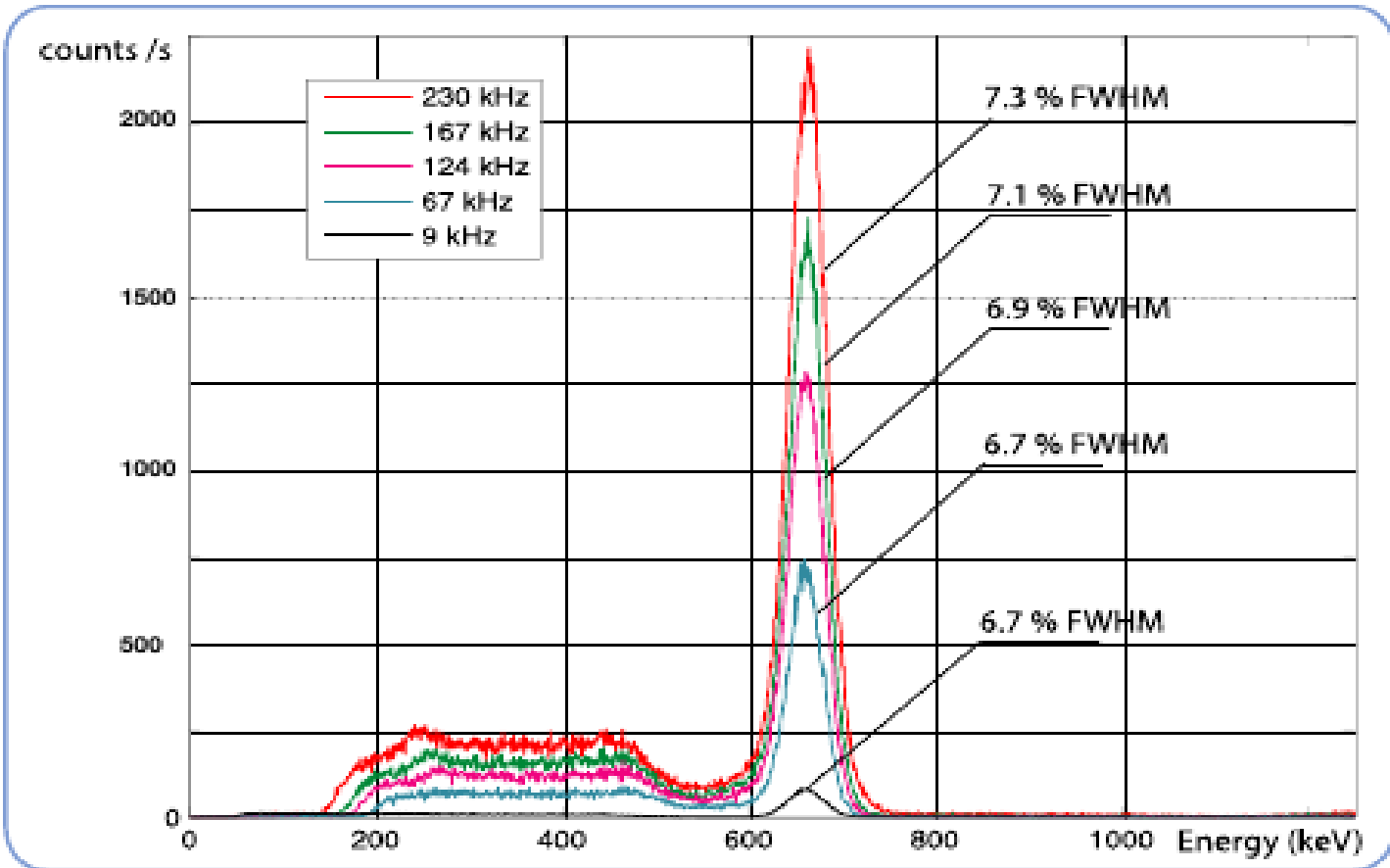


Results – Simulation.



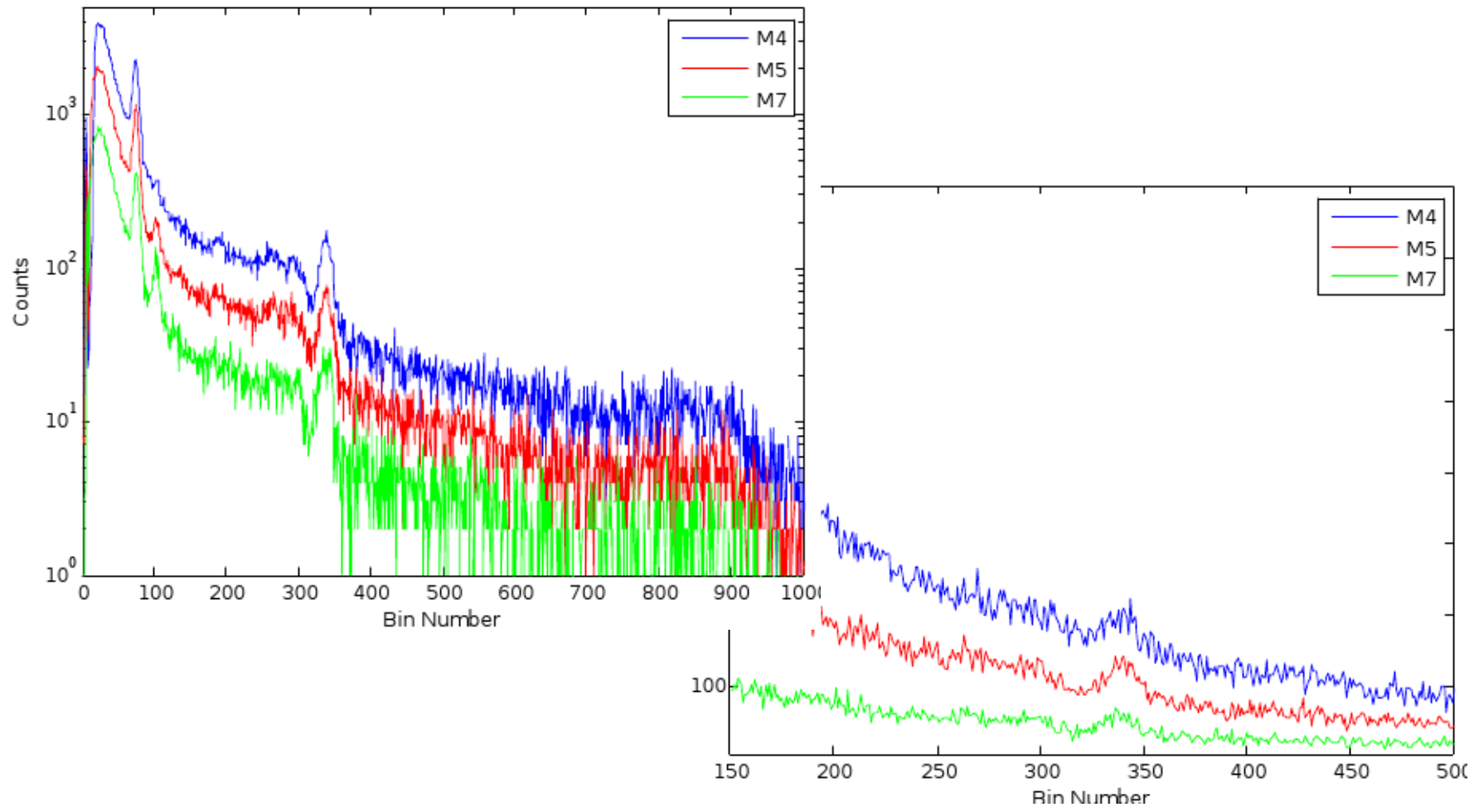


Results – Real Data.





Down Hole PNA – Real Data



Technology Application

- **Applicable wherever fast, accurate, radiation detection, measurement & analysis is required. Industrial applications being pursued include:**



Homeland Security – cargo, baggage & personnel scanning for explosive and other contraband.



Medical Imaging – faster imaging for PET and Gamma Cameras with less isotope.



Geological logging – analysis of bore-holes in the oil, minerals and resource sectors.



Materials Analysis - electron microscopes, x-ray fluorescence, x-ray diffraction.



In Summary

We have presented a model based signal processing technology for the estimation of key parameters in pulse processing including: the number; energy; and time of arrival of pulses.

- Adaptable to a range of radiation and detectors types.
- Decodes rather than discards data corrupted by pileup.
- Dramatically reduced Deadtime at a given count rate.
- Improves detector throughput and efficiency.
- Reduces measurement time - more counts more quickly.



Questions?



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Medical imaging

Technological advances in medical imaging aim to increase patient throughput and decrease patient exposure to radiation whilst maintaining or improving image resolution. SITORO™ significantly increases the efficacy of medical imaging techniques improving speed, sensitivity and accuracy.

Defence & security

Fast, accurate threat and contraband detection is essential to national security. Southern Innovation's SITORO™ technology dramatically improves detector speed and accuracy facilitating significant improvement to a range of existing defence and security screening applications.

Minerals exploration and analysis

Rapid, accurate sample analysis improves the efficiency and cost effectiveness of minerals exploration and mining. Whether in an off-line laboratory, in a real-time "down-hole" environment or in an in-line production facility SITORO™ technology facilitates faster more accurate analysis.

Materials analysis

Materials analysis utilising radiation detection and measurement technologies is an integral component of numerous industrial processes. Southern Innovation's SITORO™ technology improves the speed and accuracy of materials analysis which is often a time critical element of the process.