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Bottle Scanner Technologies

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Ben Cantwell
New Technology Manager

Conclusions

- Kromek's Identifier Bottle Scanner is CZT based multispectral X-ray system for scanning single bottles
- Benefits and pitfalls of multispectral detectors
- Simple operation of Bottle Scanner
- Certified to Standard 3, Europe's highest level of threat detection, with a false alarm rate < 15%
- Developing a "Type C" system for scanning bottles on trays on a conveyor belt
- Multispectral techniques showing estimated sub-5% FAR

The Kromek Group

Group UK Headquarters

US Operations

NOVA R&D Inc.

eV Products Inc.

Kromek Germany Ltd

Corporate facilities & sales

Sales and Distribution

Integrated Activities

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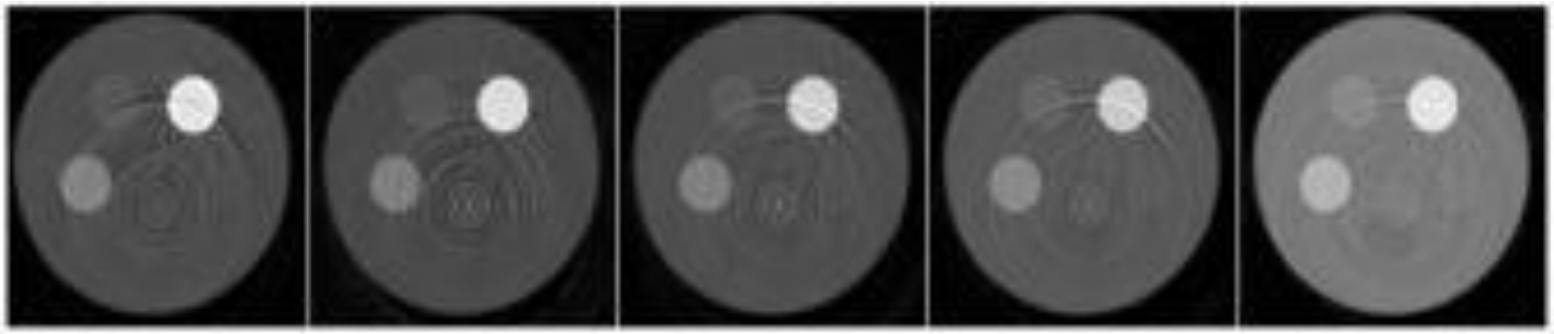
Materials & Detectors | Detector Fabrication | ASICs & Electronics | Bonding & Hybridisation | Application Development | Algorithms & Software | Systems Engineering

End User Products

OEM Components

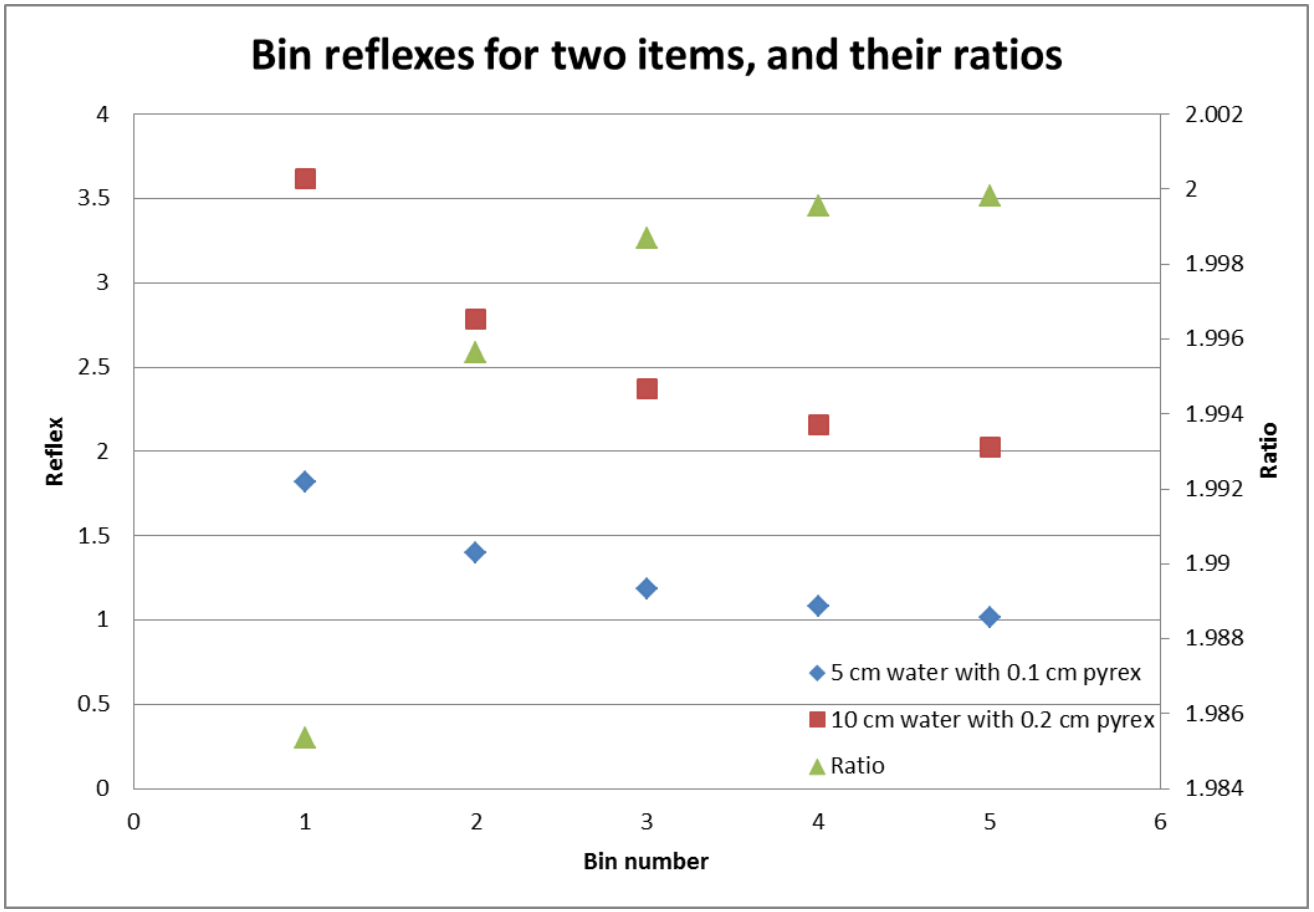
Multispectral detectors

- Semiconductor detectors such as cadmium zinc telluride (CZT) allow energies of incoming photons to be measured with good resolution, unlike conventional energy-integration dual energy detectors.
- Allows you to make use of energy dependency of absorption coefficient to separate material
- Already making progress in medical industry
- Example below* shows imaging of phantom containing 5 different materials at 5 different energy levels – clear separation



*Wang et al, *Phys Med Biol* (2011)

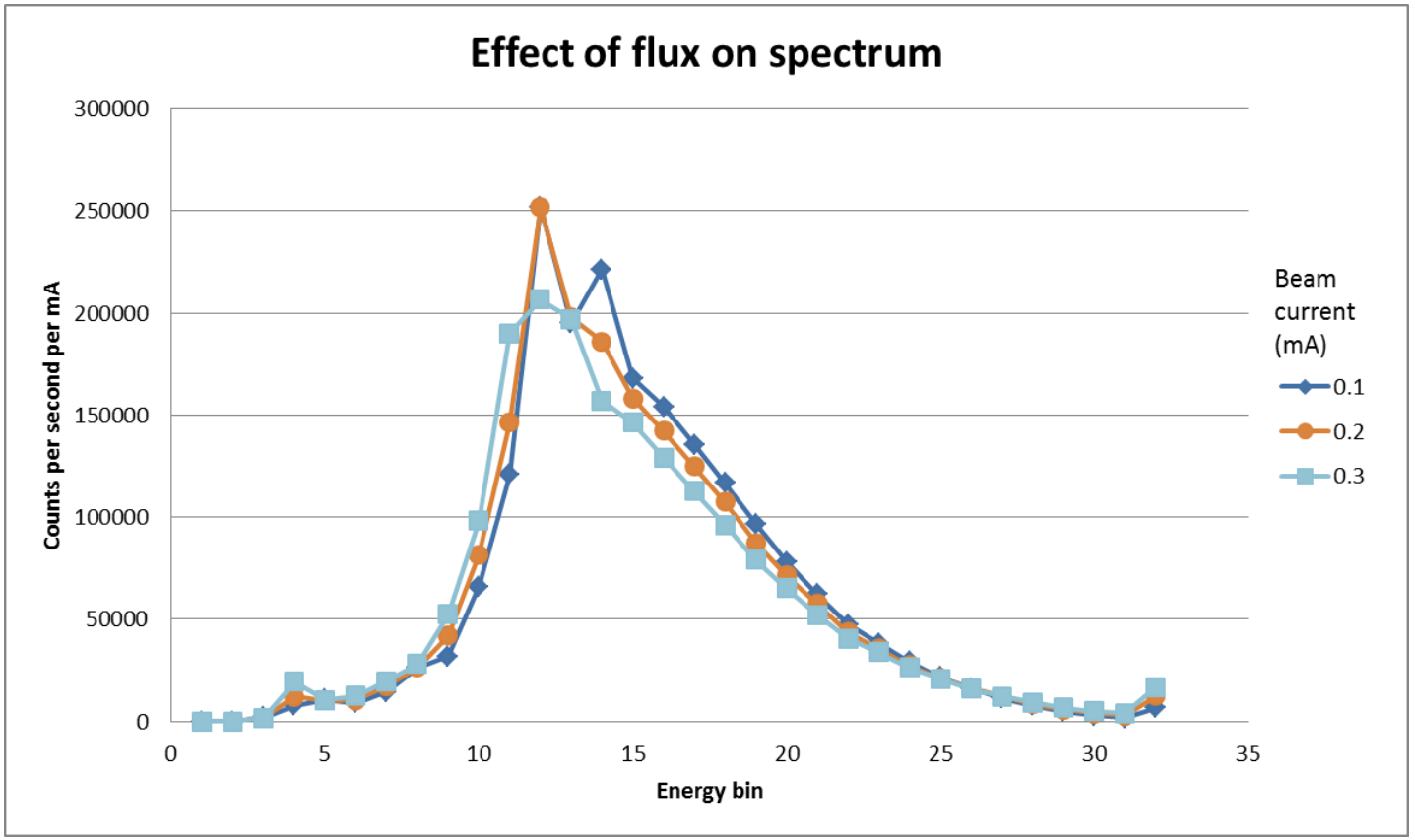
Artefacts with detectors – beam hardening



Reflex = -Ln (Transmission)

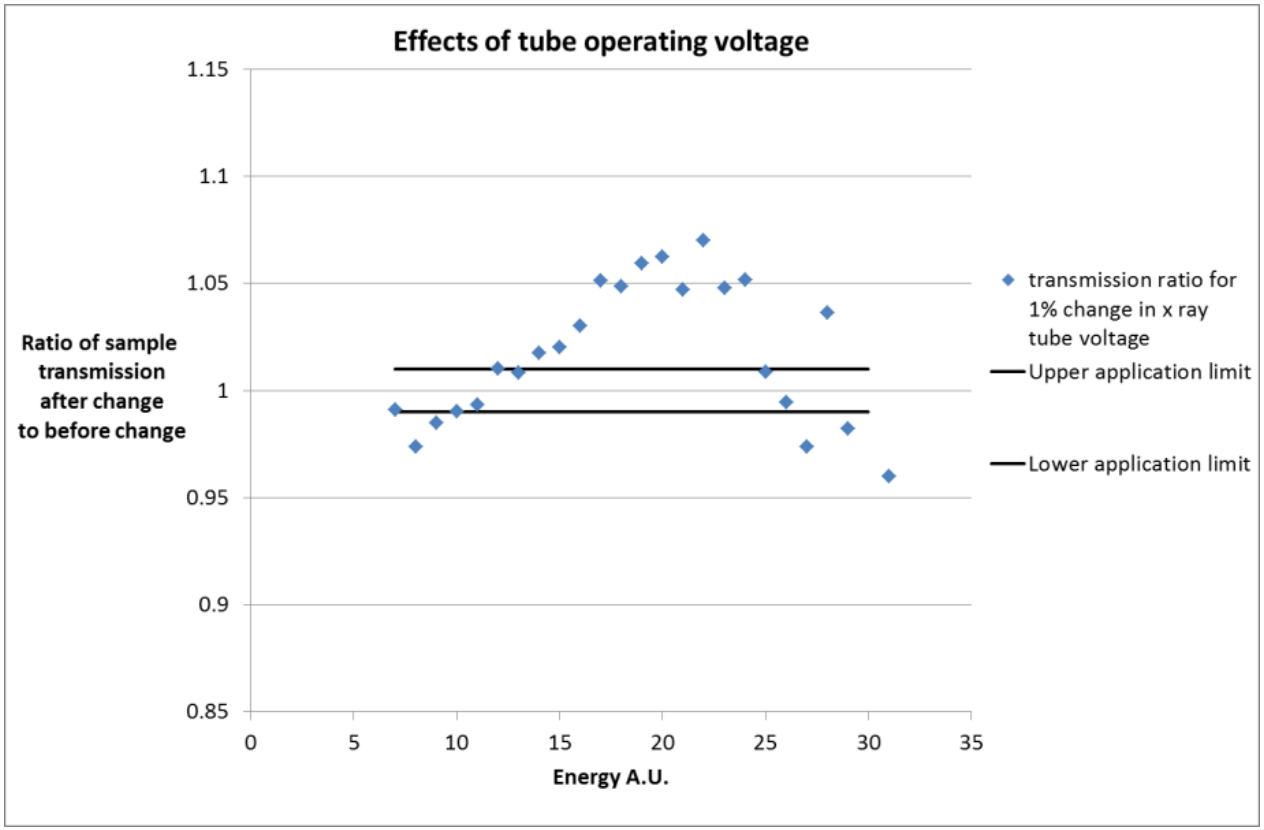
Artefacts with multispectral detectors – count rate effects

- Pulse pileup occurs when photon is absorbed before the charge from the previous photon is fully detected
- Charges add and information about energy and number of photon events is distorted
- Effect higher at higher photon rates
- Depending upon electronics, baseline may also shift as count rate varies



Effects on transmission

- Artefacts mean small changes in e.g. tube voltage can lead to large changes in transmission

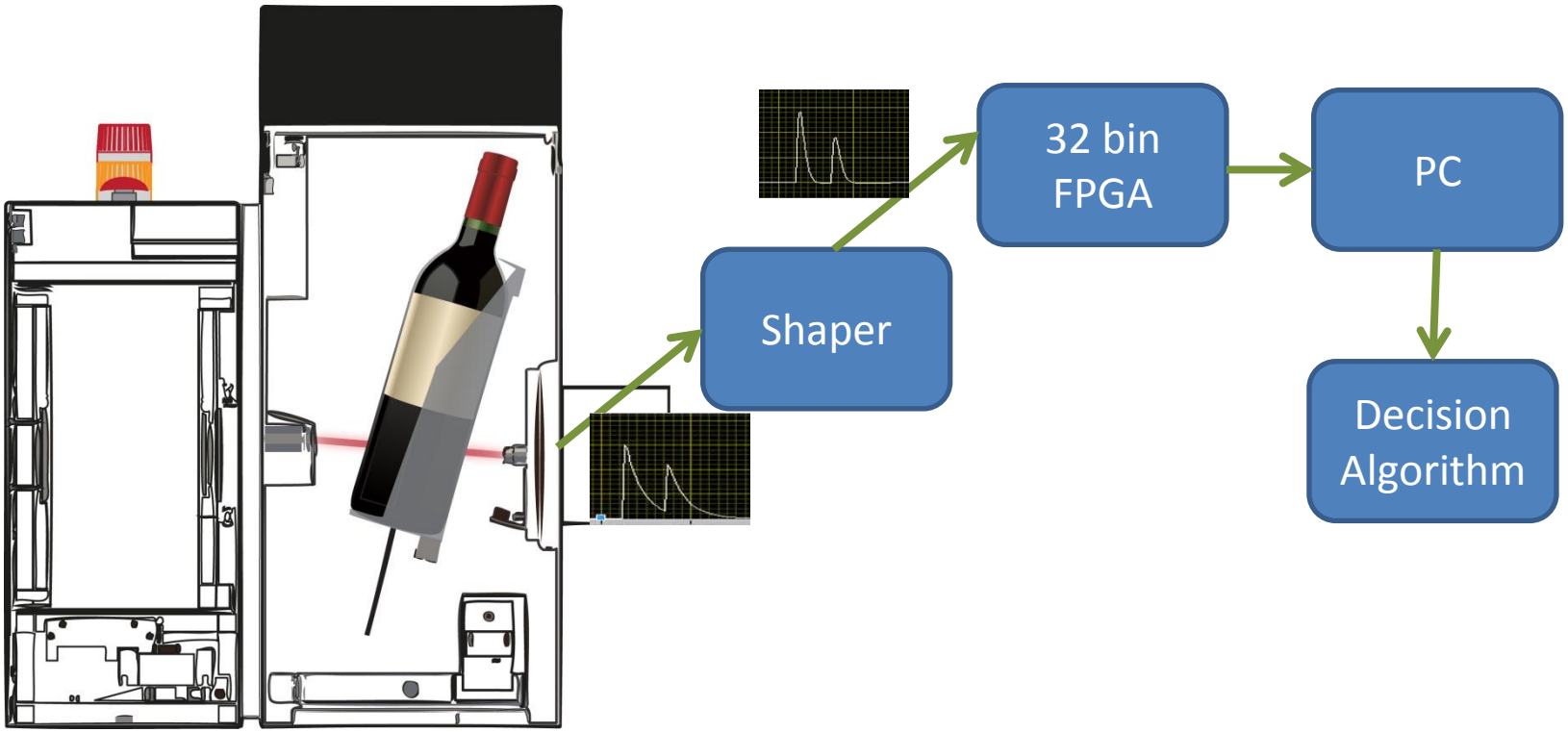


Ways around multispectral artefacts

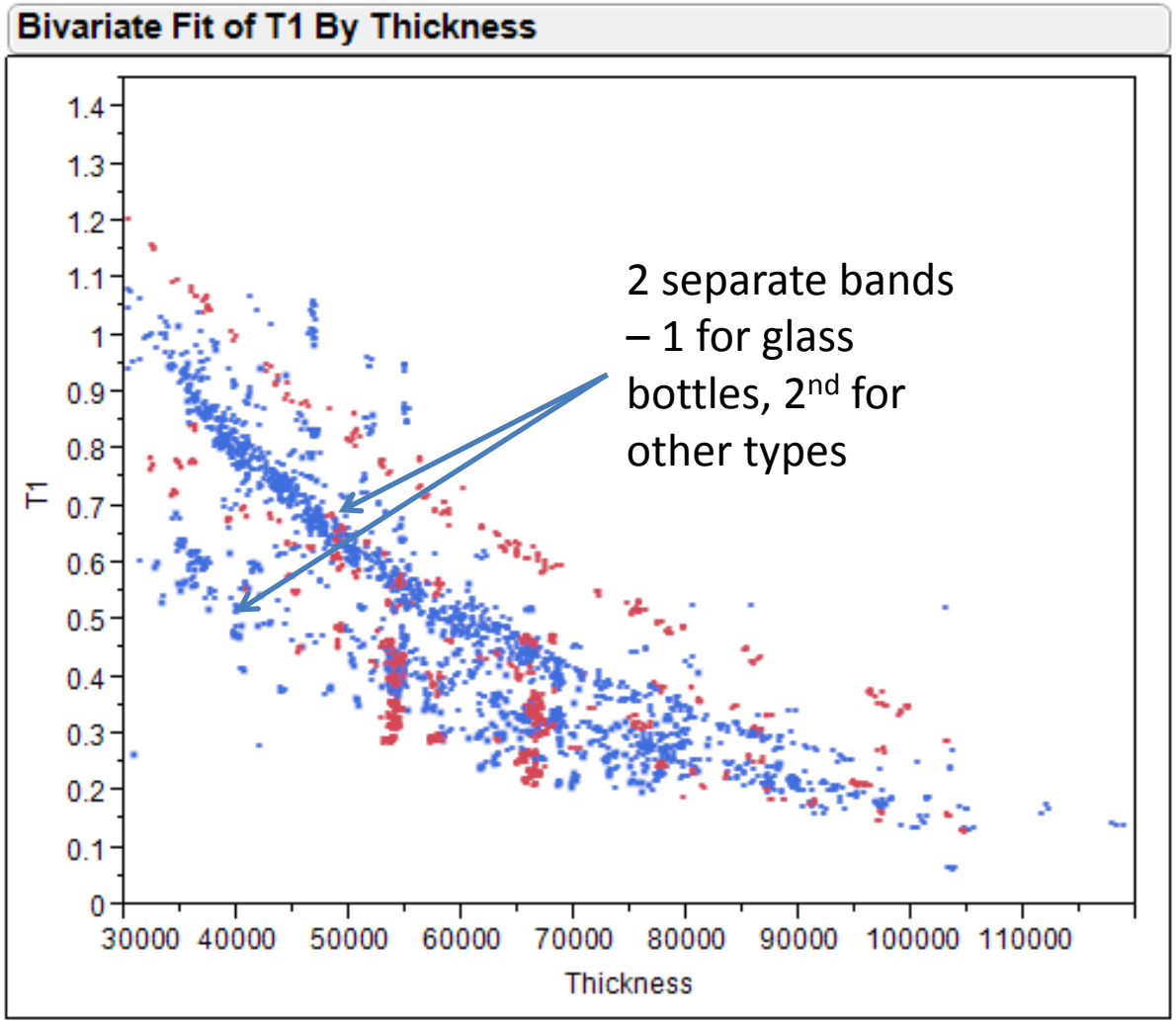
- Do not try to reconstruct NIST!
- Teach/calibration method should take detector effects into account
- Take steps to keep measurements you will wish to compare in the same count rate regime

How the Bottle Scanner Works

- Scans one bottle at a time using single CZT detector

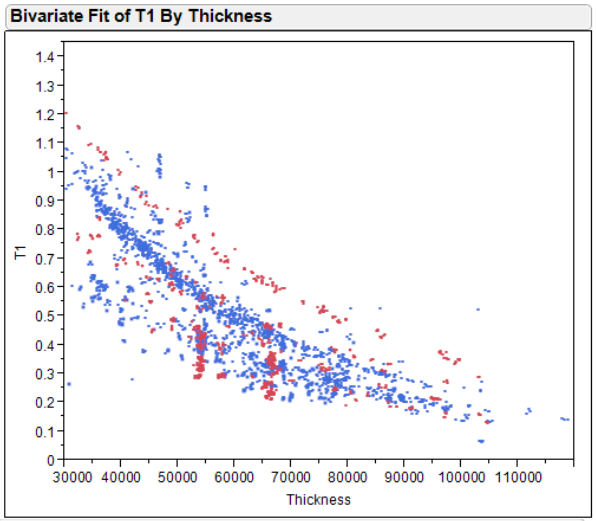


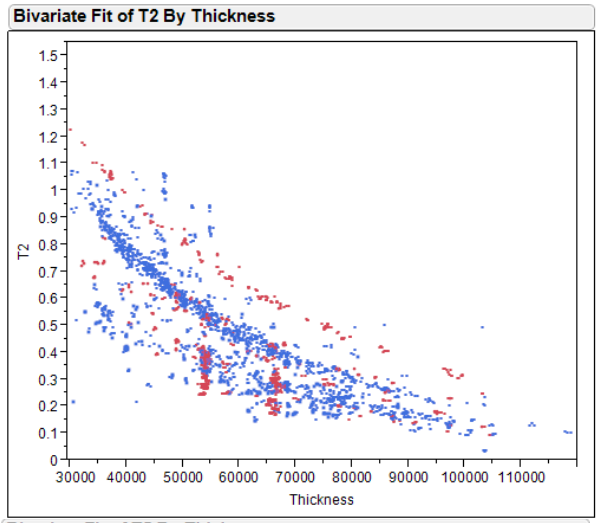
Results – Bin 1

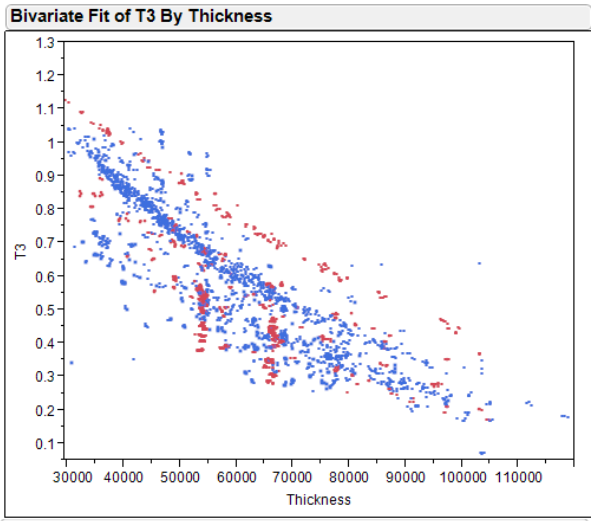


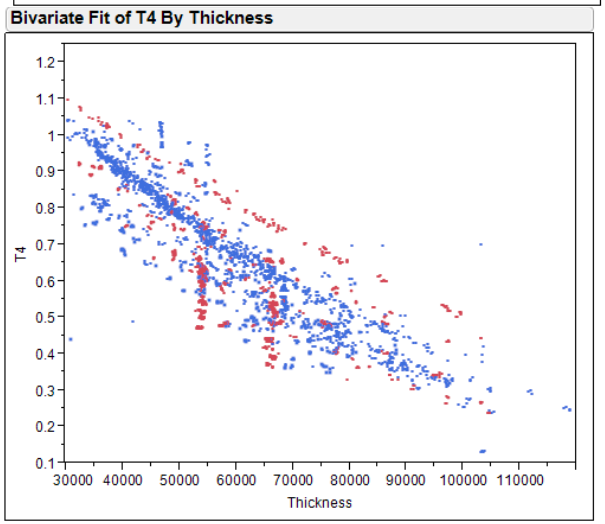
Red – THREAT Blue - BENIGN

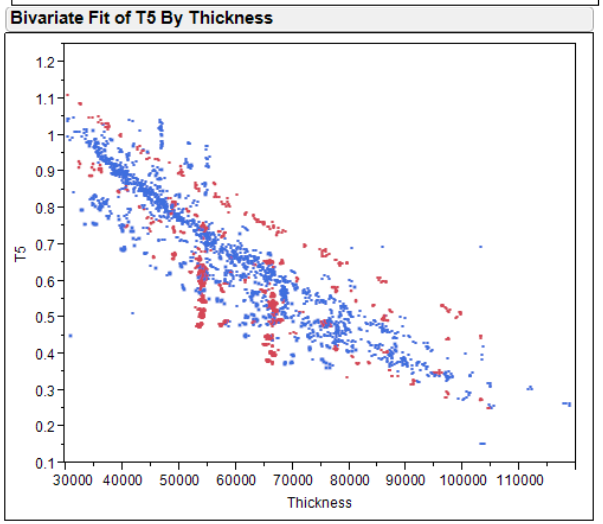
Results – All 6 bins

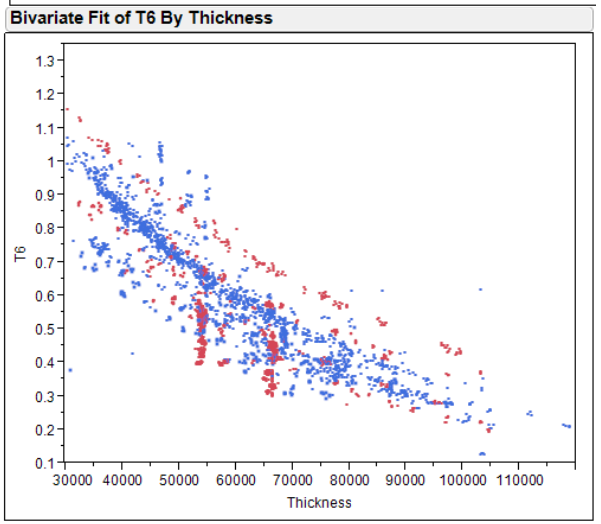








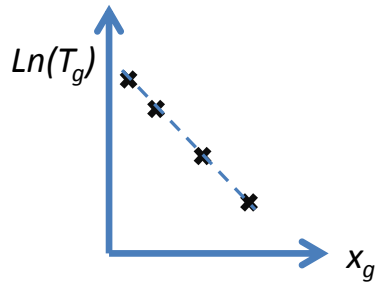




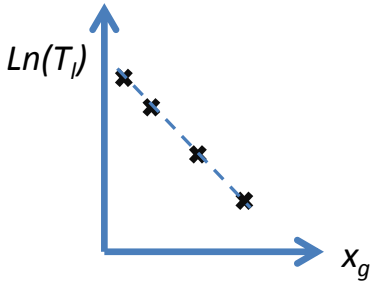
Red – THREAT Blue - BENIGN

Database Teach

- Scan different sized liquid filled glass cuvettes



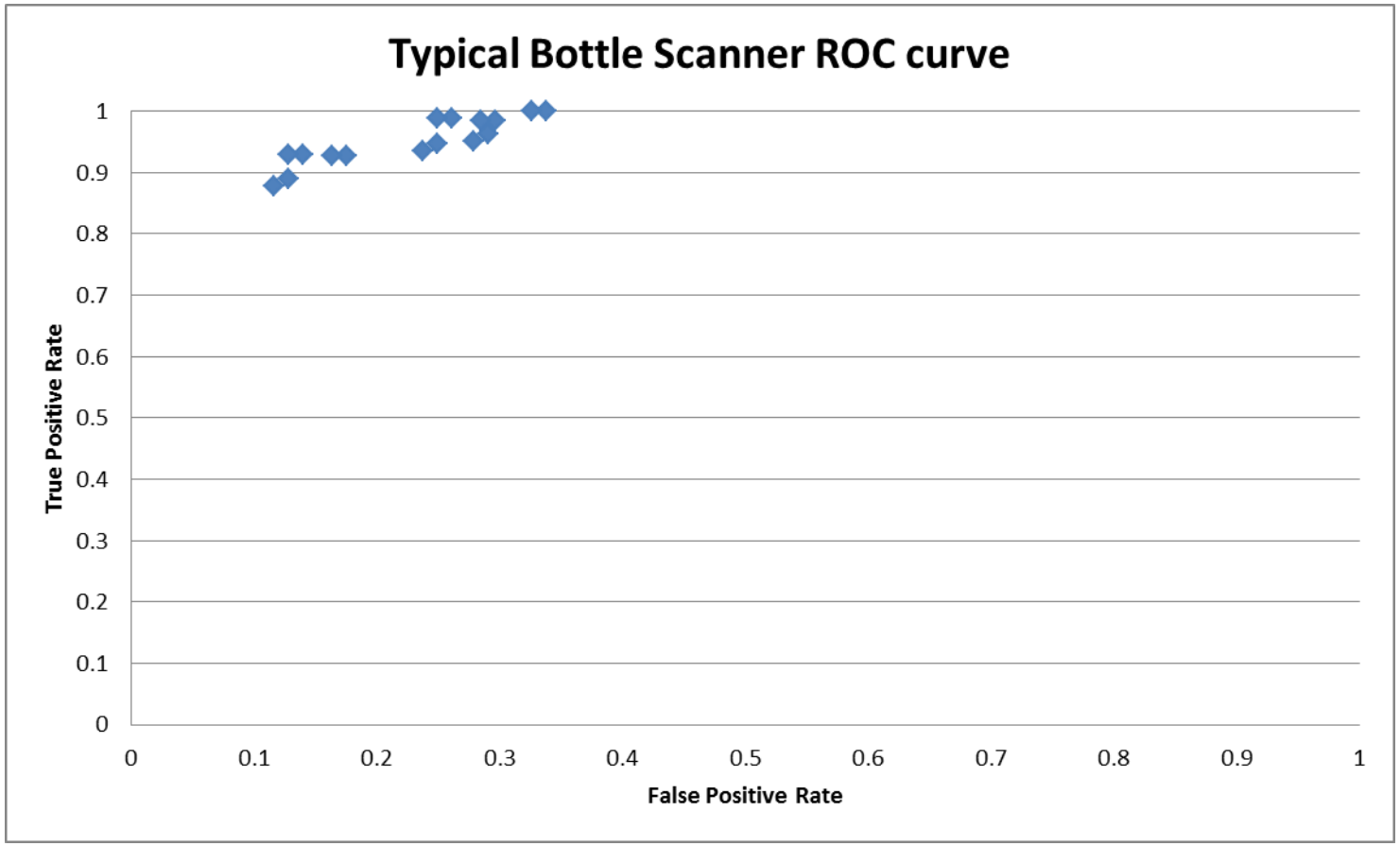
- Similar for different sized glass thicknesses, get Ln(T_g) vs thickness function
- Remove effect of cuvette walls to get liquid Ln(T_l) vs thickness graph
- Repeat for different liquids and wall materials
- Have range of equations to generate transmissions as function of liquid and wall thickness to create database



What is bottle scanner - algorithm

- Scan is measured against items in taught database
- THREAT/BENIGN classification based on taught materials it matches to
- Trade-off between False Alarms and Probability of Threat Detection
- ROC curve can be manipulated by
  - Selection of items in database
  - Match criteria
  - Decision on items which are matched

Results

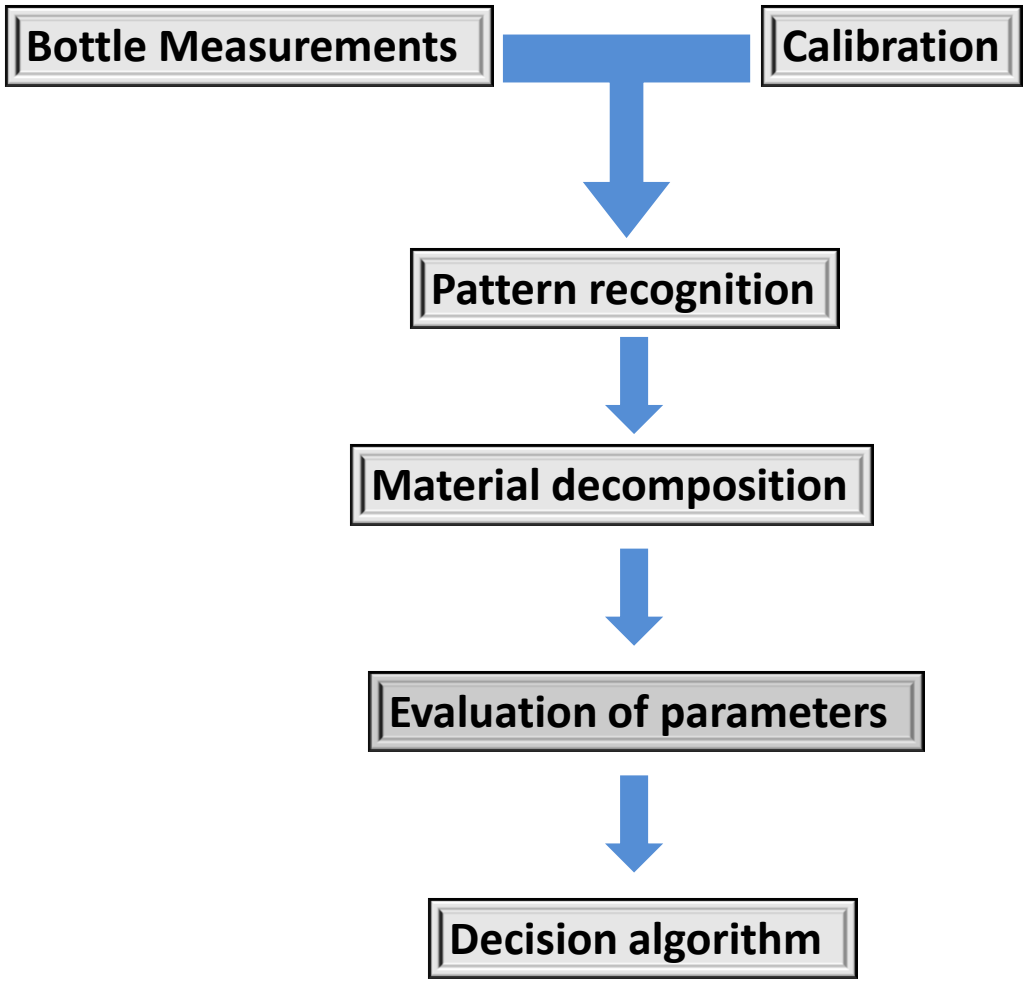


False Alarm Rate < 15% at Standard 3, Europe's highest level of threat detection

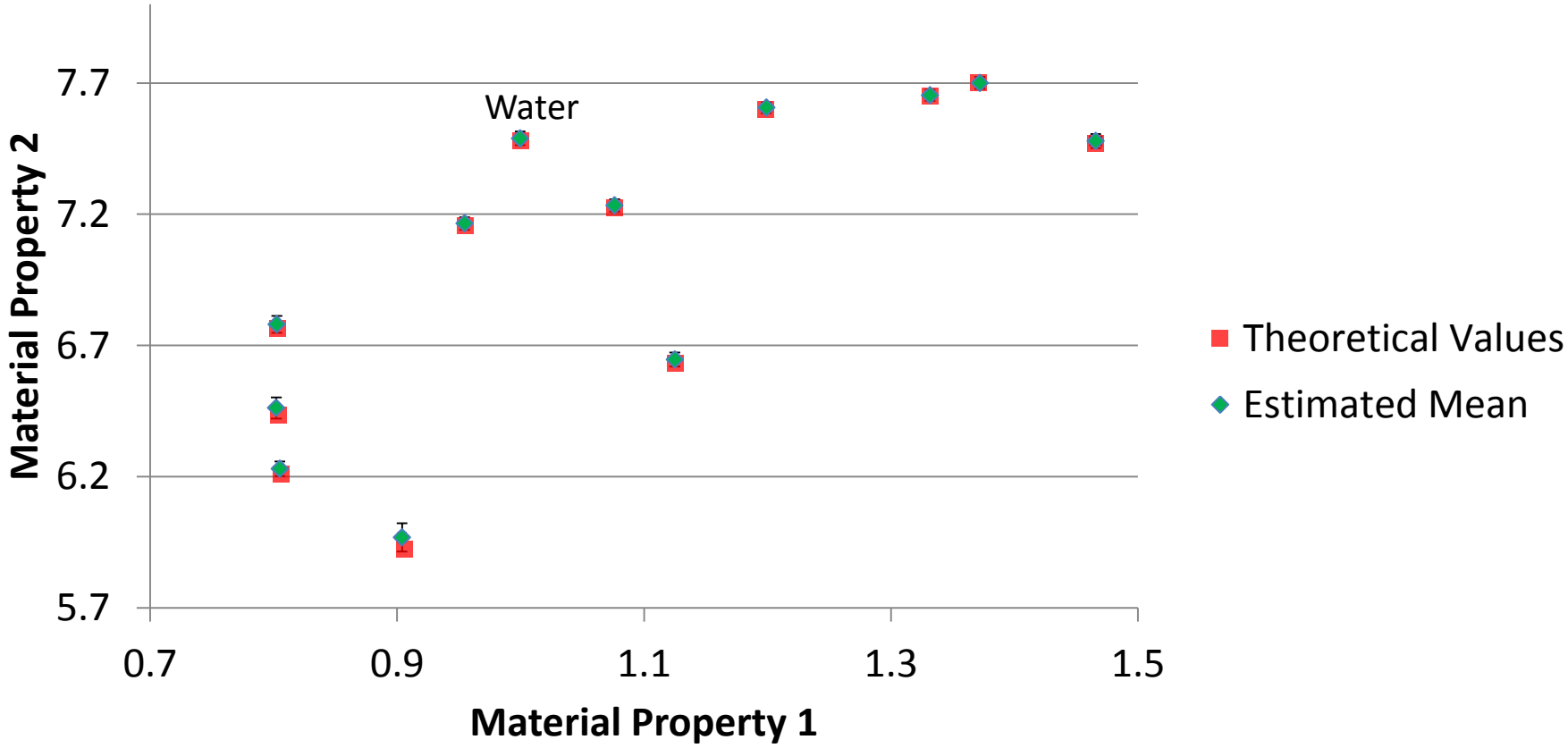
Eurostars scanner – what it is

- Wheras Identifier Bottle Scanner scans 1 bottle at a time (called “Type B” in Europe), this is a “Type C” scanner which will scan mutiple bottles in the same load
- It is likely bottles will be placed in trays which will go on a conveyor belt
- Current design has two generators and linear arrays which scan items in 2 planes
- Target False Alarm Rate <5%

Eurostars scanner - method



Results
Different Bottle Scenarios



Eurostars scanner - results

- Testing with simulations using artefacts from real multispectral detectors
- On target for sub 5% False Alarm Rate
- Targeting ECAC approval testing in April 2014
- Looking for potential partners for commercialisation