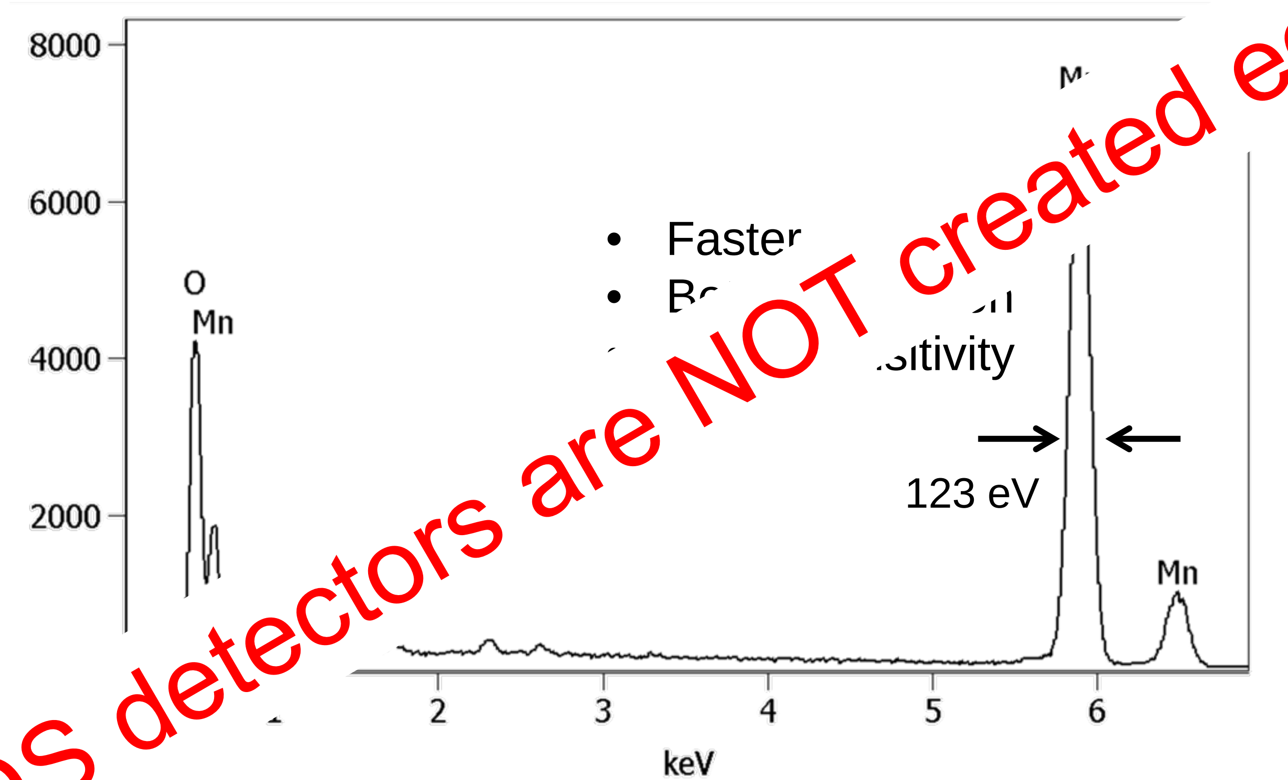
Light element sensitivity:

EDS detectors are NOT created equal

Keith Thompson
Aug 2014

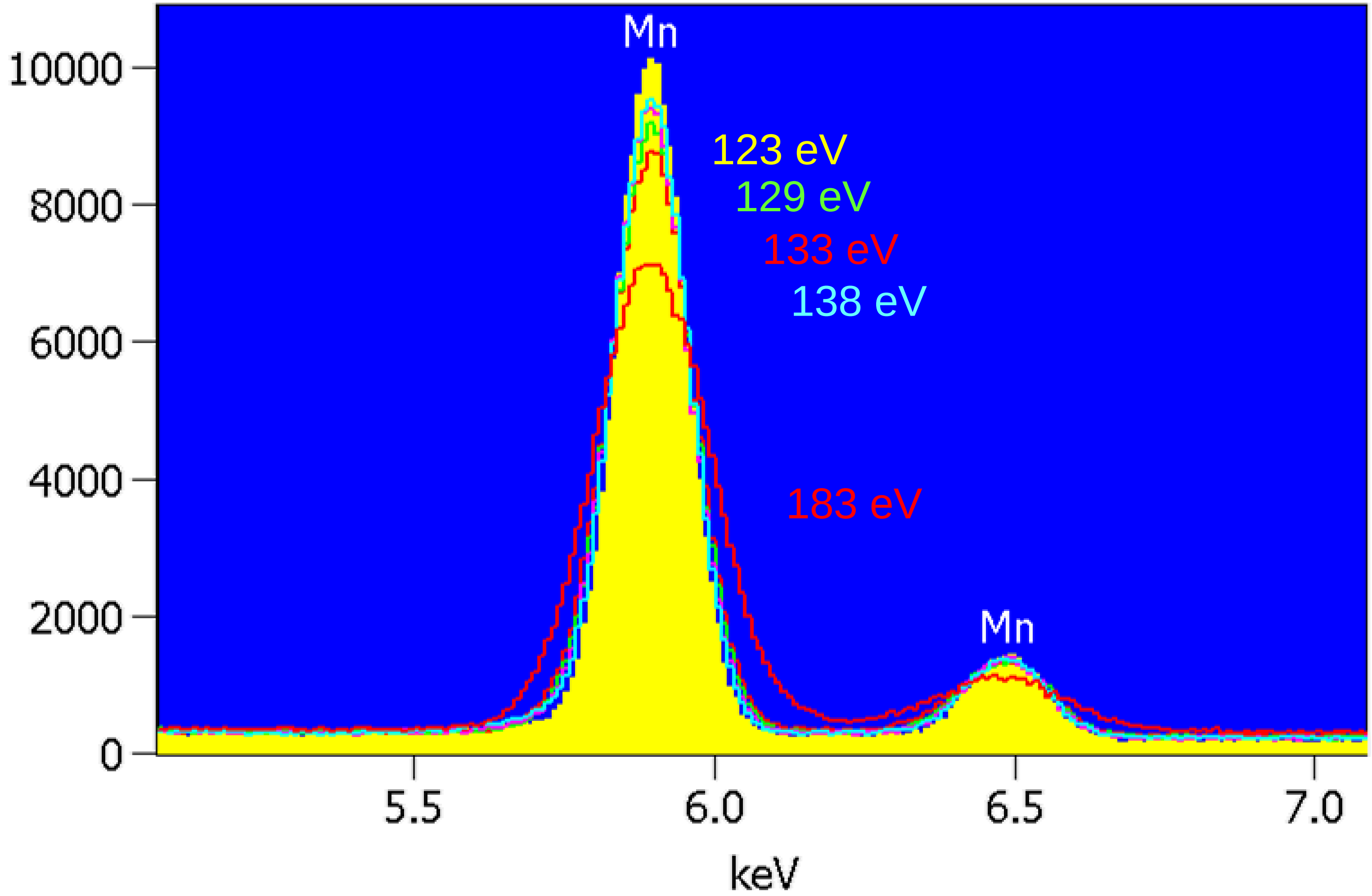
EDS detectors have come a long way over the past decade



EDS detectors are NOT created equal

Most people will tell you that all detectors are basically the same

In the "middle – high" energy range:
detector performance is mostly the same between detectors.



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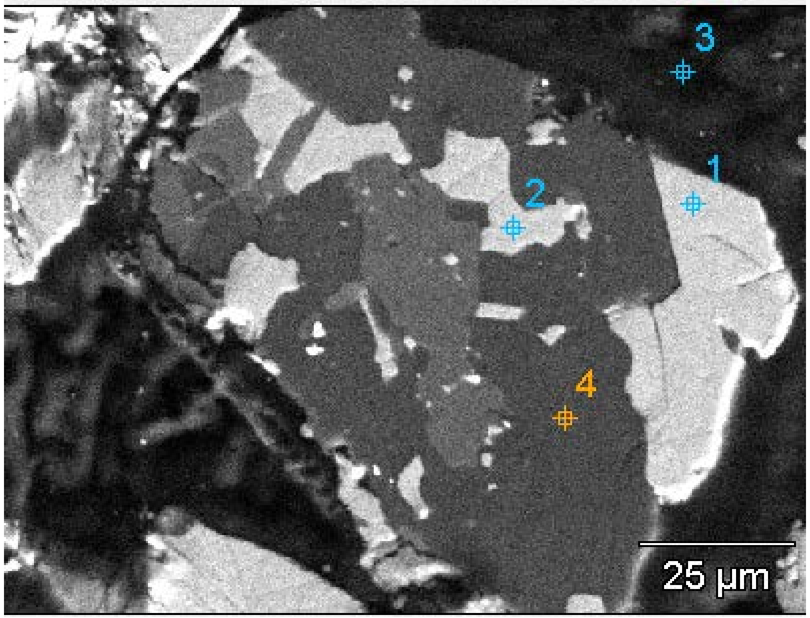
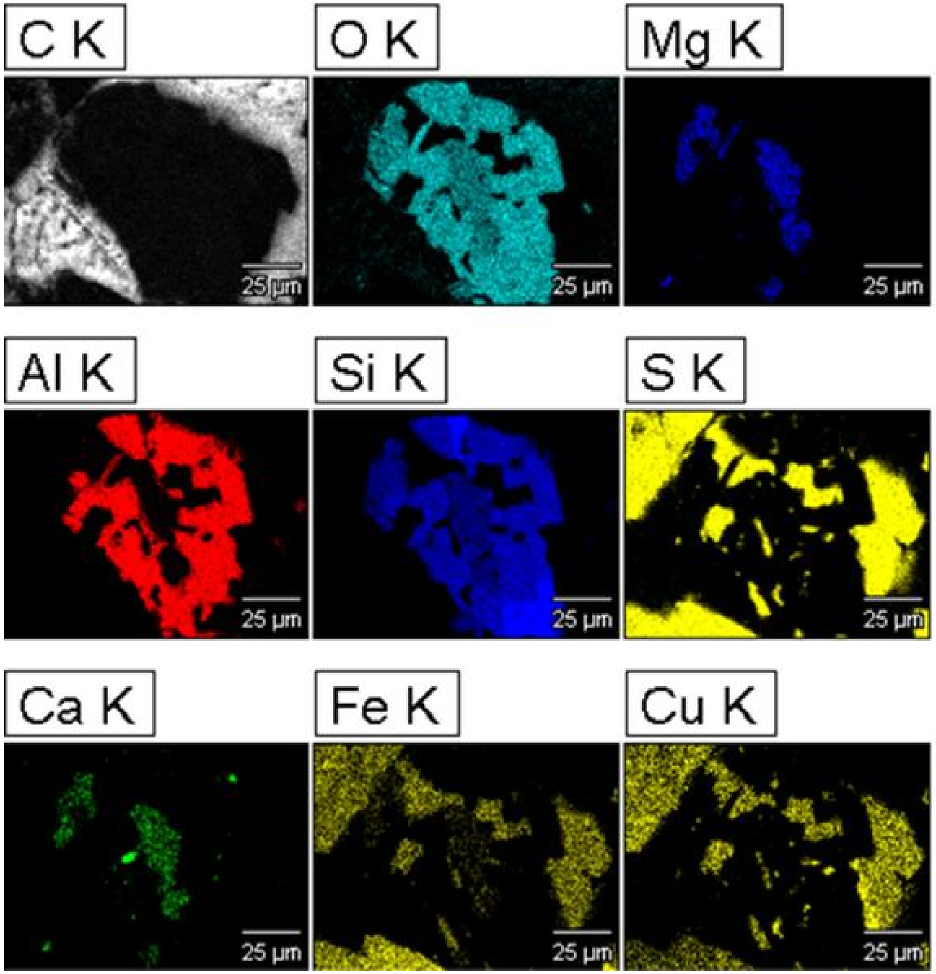
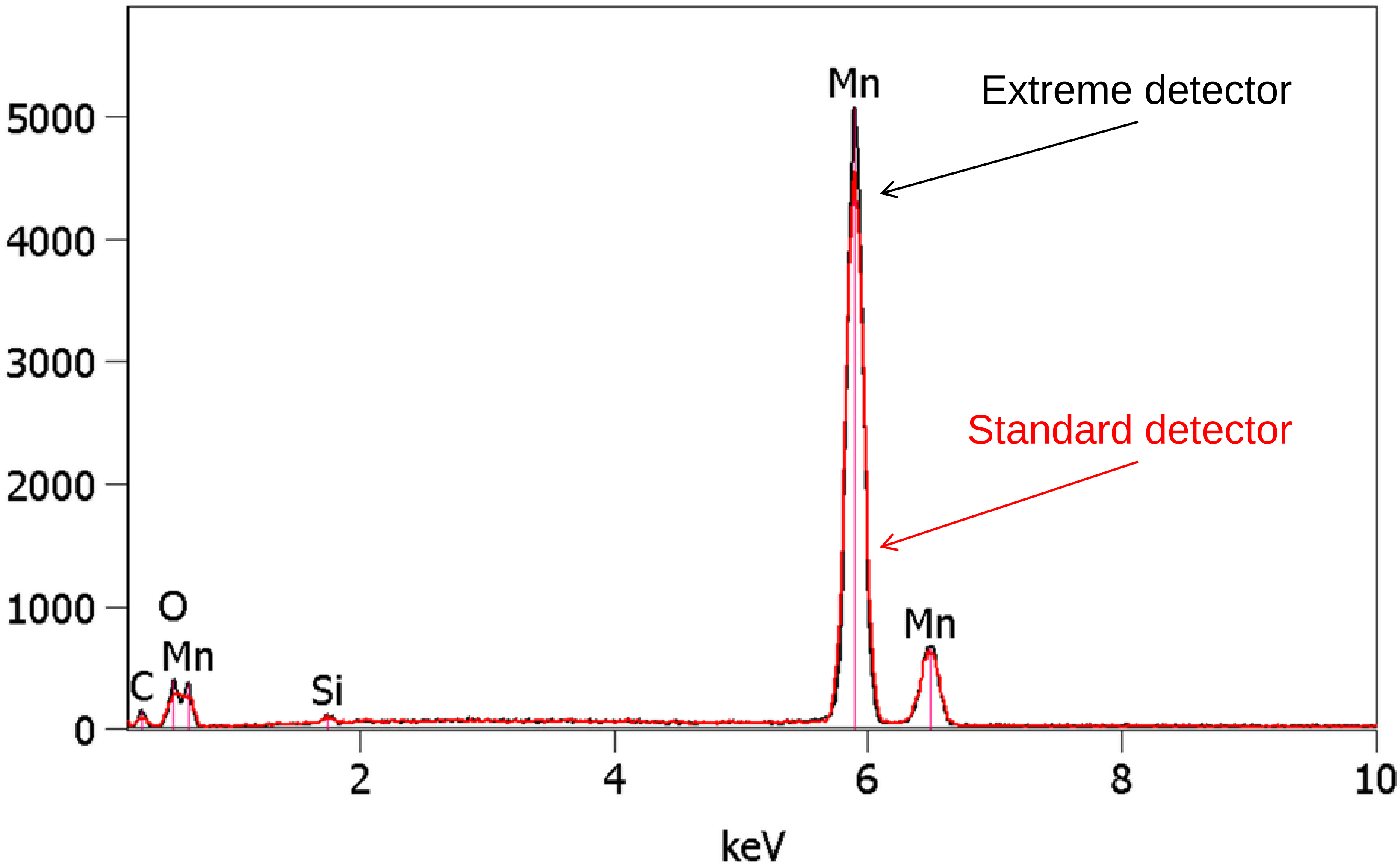


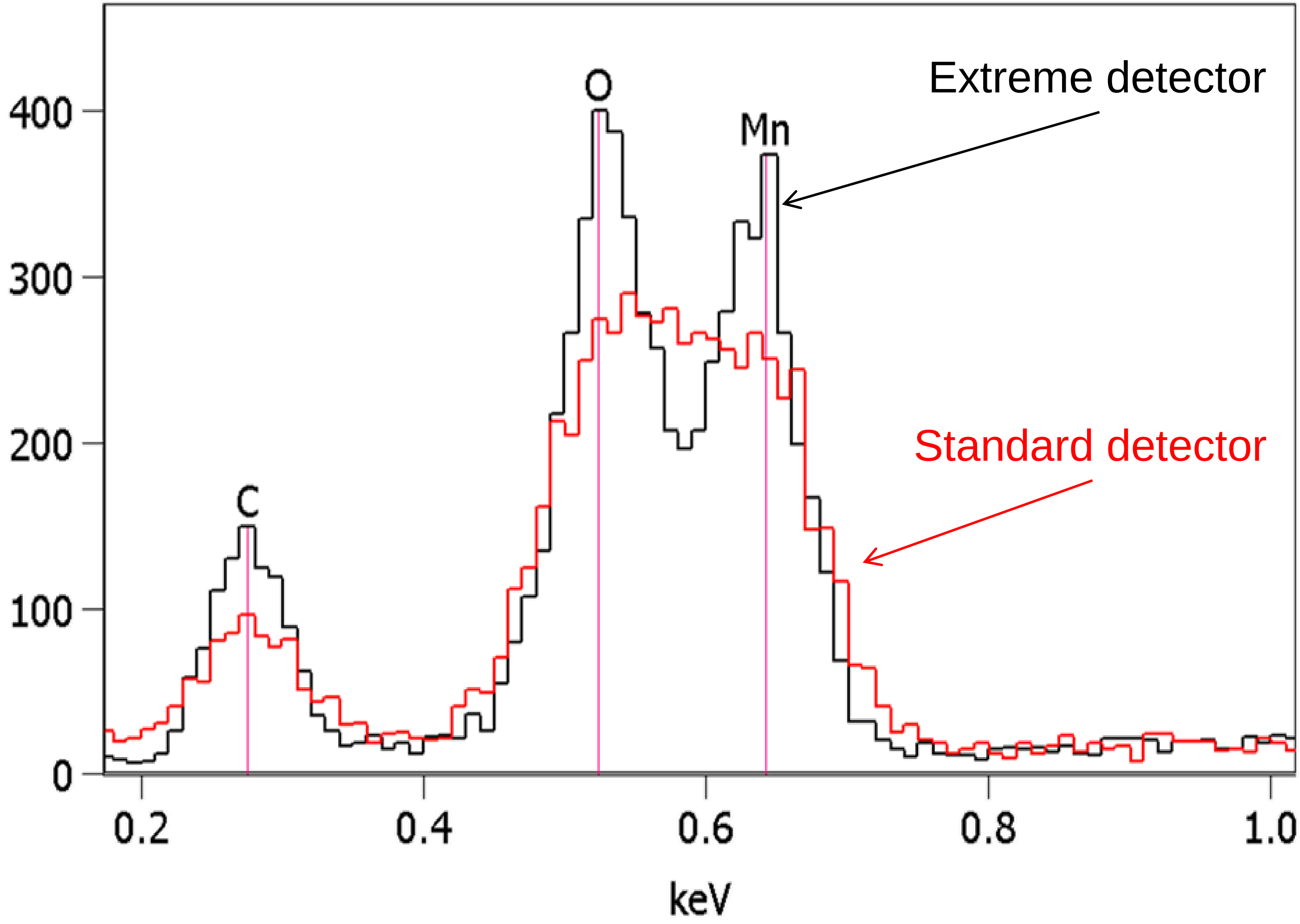


EDS map at 145 eV

In the "middle – high" energy range:
detector performance is mostly the same between detectors.



In the light element world: some EDS detectors just don't hold up.



Why are some detectors better than others at low energies?

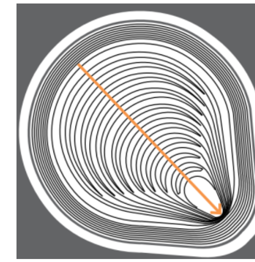
- Impact of the SDD Module
- Impact of the architecture
- Impact of the window

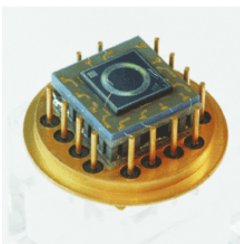
Three main factors in SDD light element performance

Traditional – circular / symmetric

vs.

Modern – tear drop, small FET

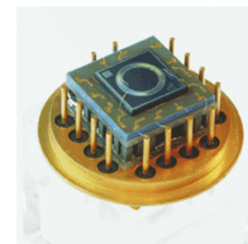


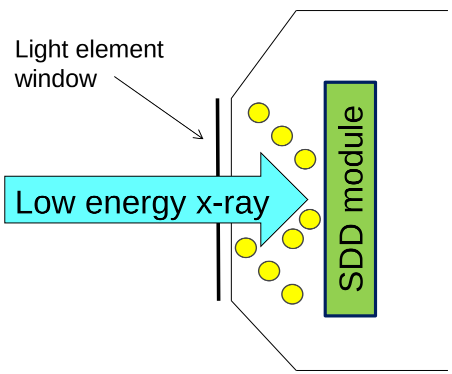


Traditional: wire-bonded FET

vs.

Modern: integrated, “on-chip” FET

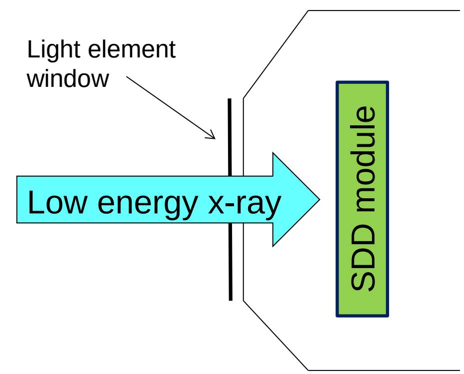




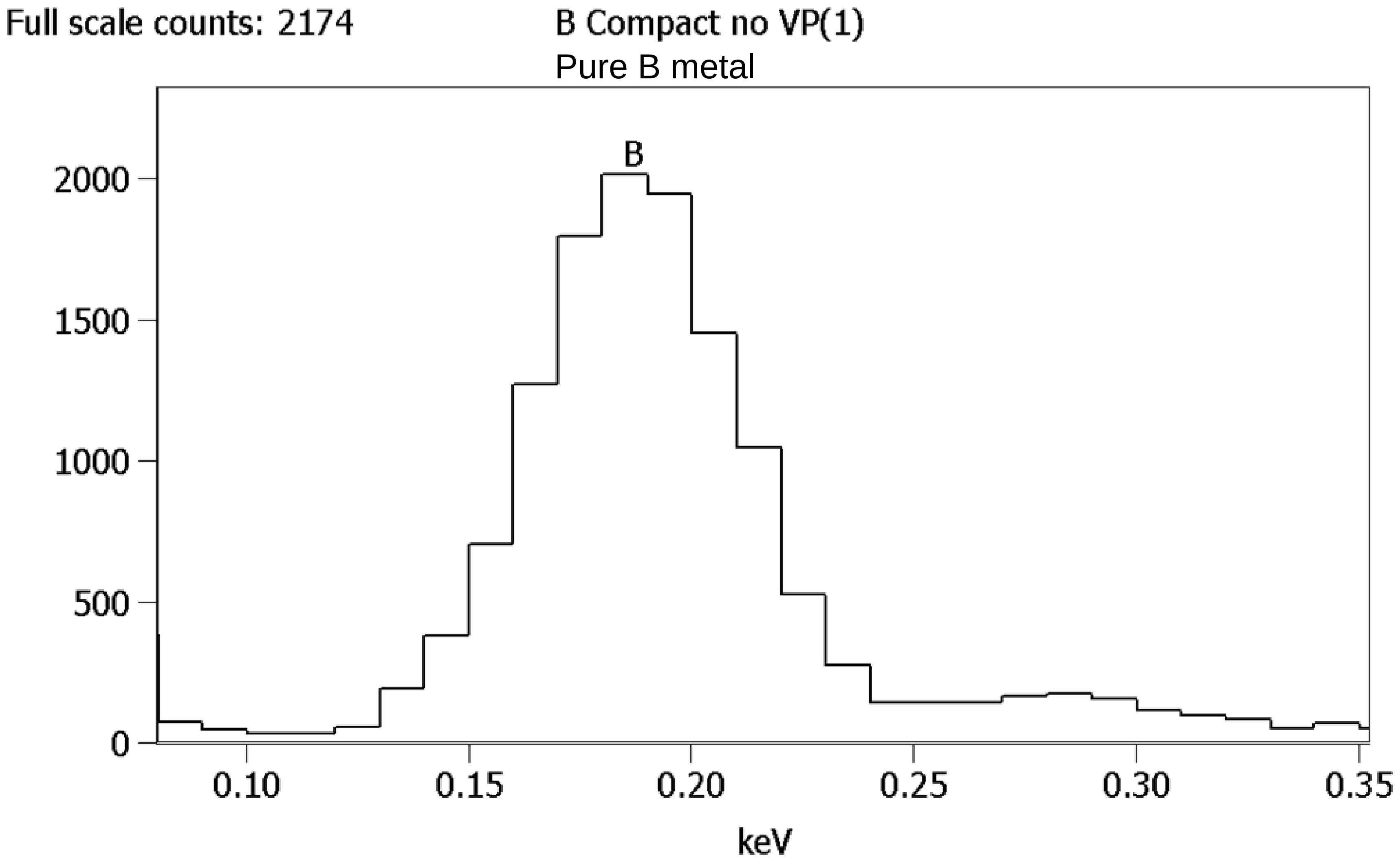
Traditional: N_2 backed window

vs.

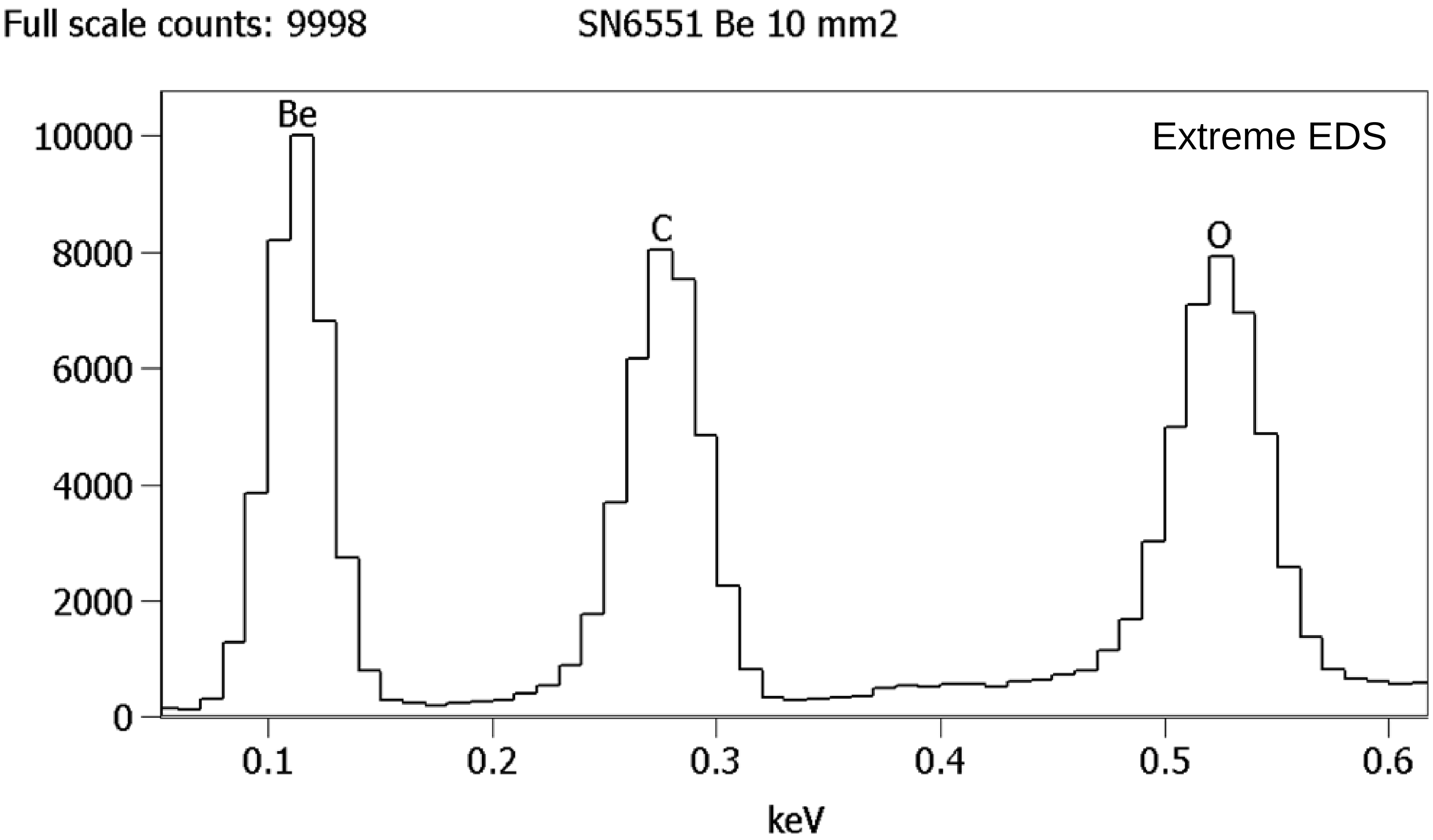
Modern: evacuated window



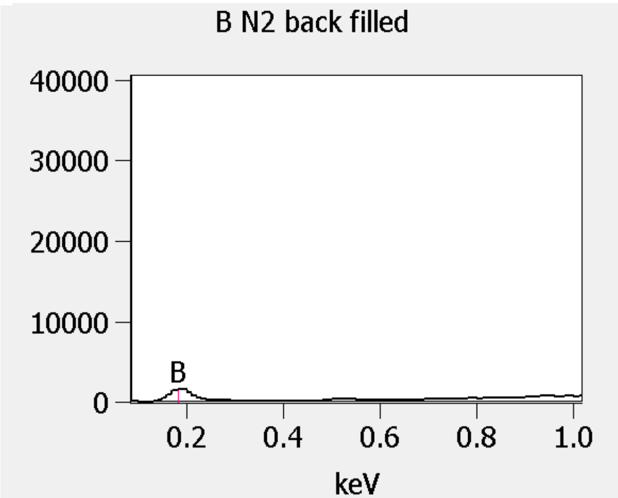
Light element sensitivity: “Sensitive to B”



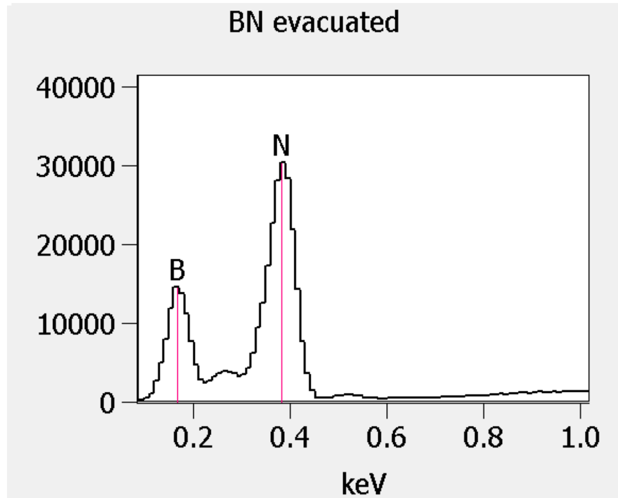
Light element sensitivity: “Sensitive to Be”



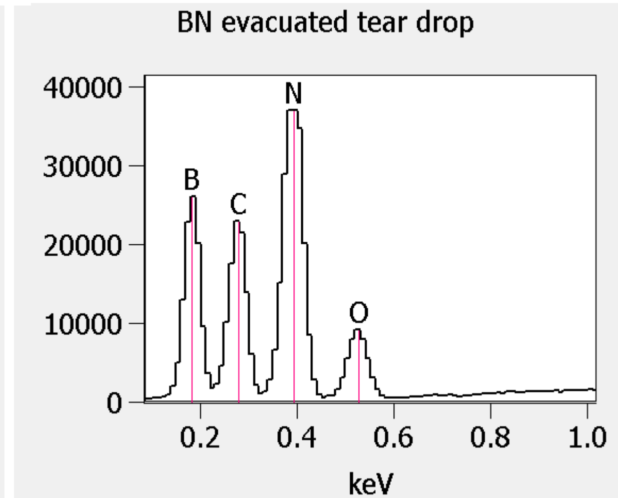
Impact of the module



N2 back-filled window
Traditional round geometry



Evacuated window
Traditional round geometry



Evacuated window
Tear-drop geometry

Stronger B peak

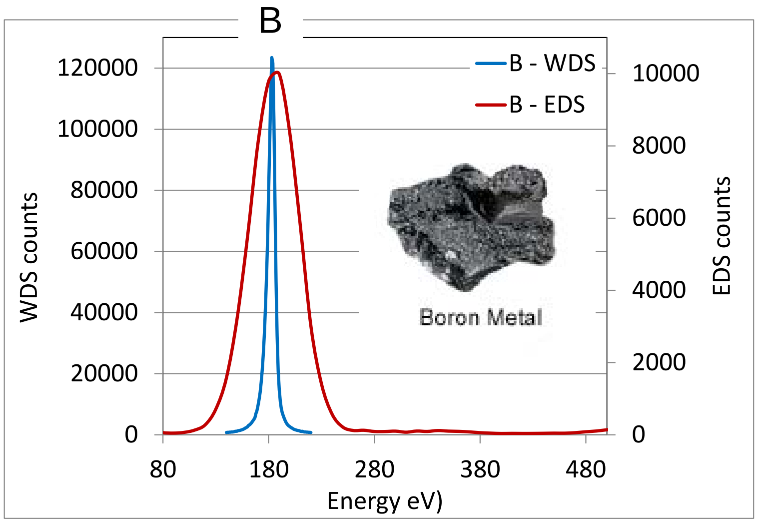
Smaller zero width

Better signal to noise

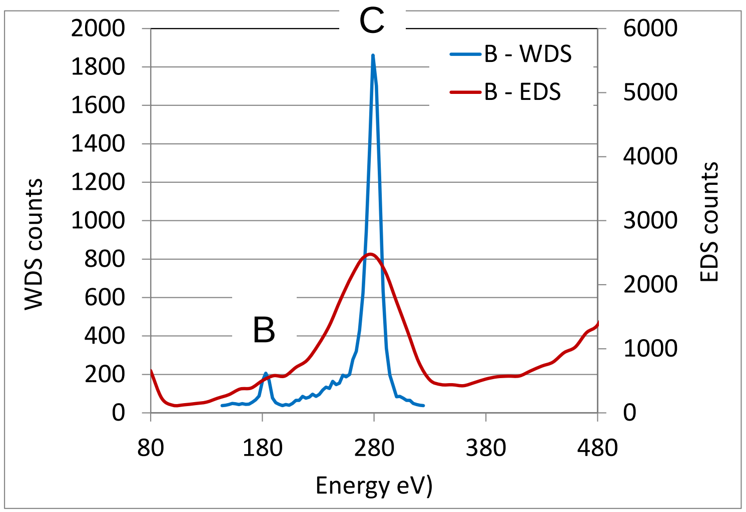
Some Examples

- Trace B in steel

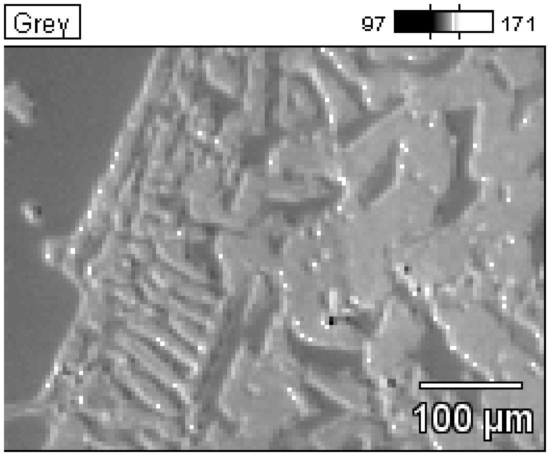
Mapping 2% B in Fe-Cr: Traditional detector

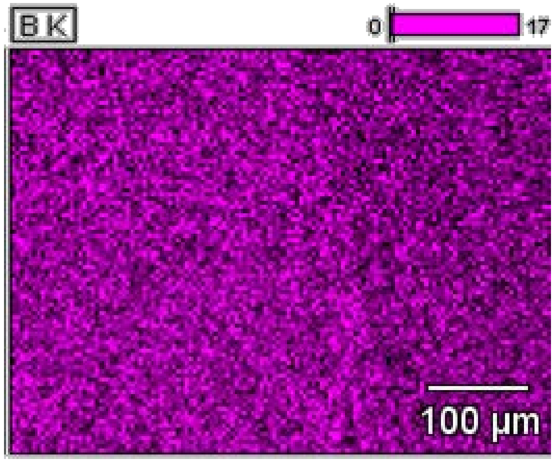


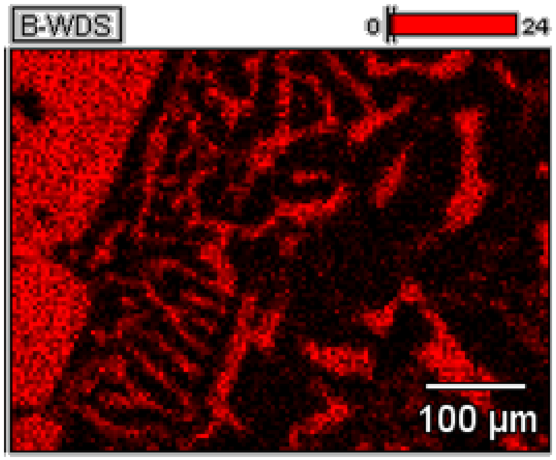
B metal is easy for EDS/WDS



Trace B (2% B in Fe-Cr) is harder

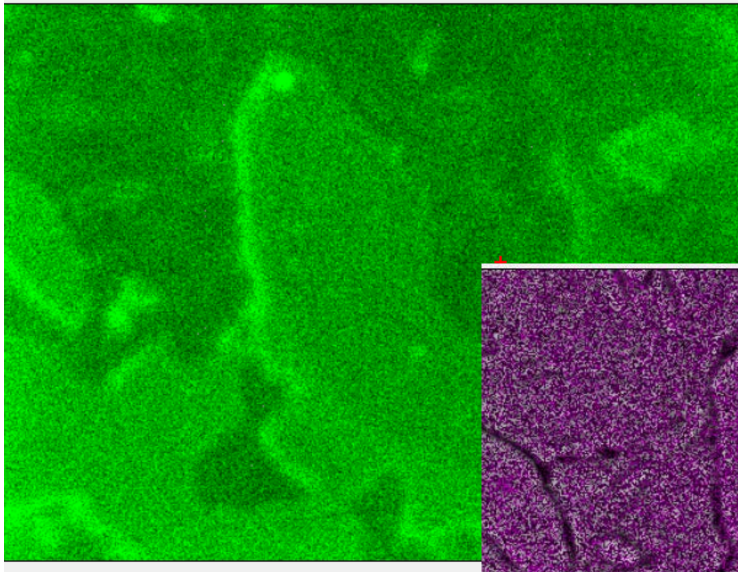




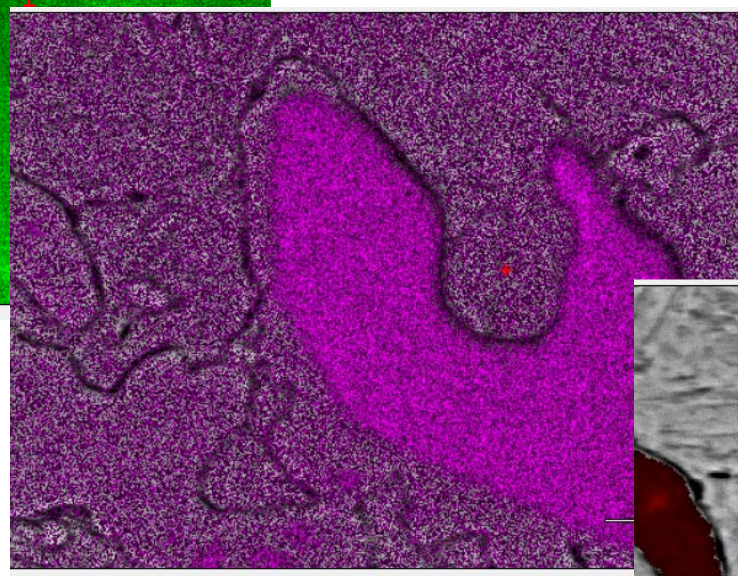


Mapping 2% B in Fe-Cr

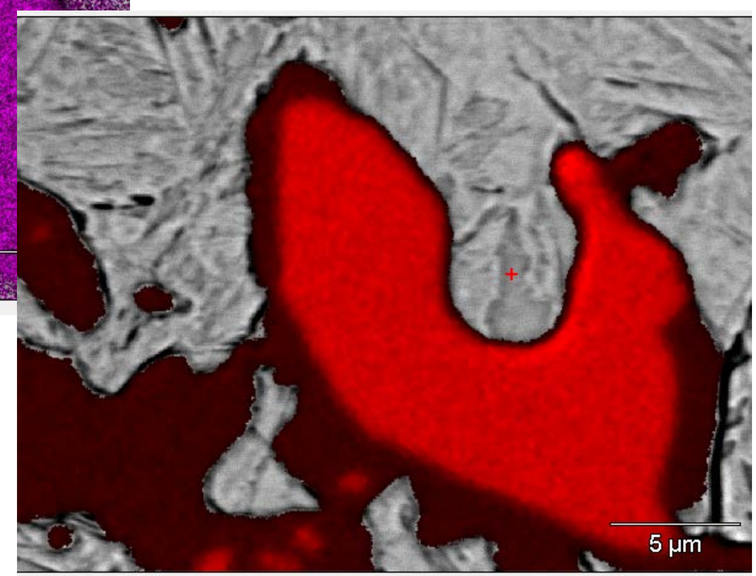
B raw counts



B Net counts
(processed)



B WDS

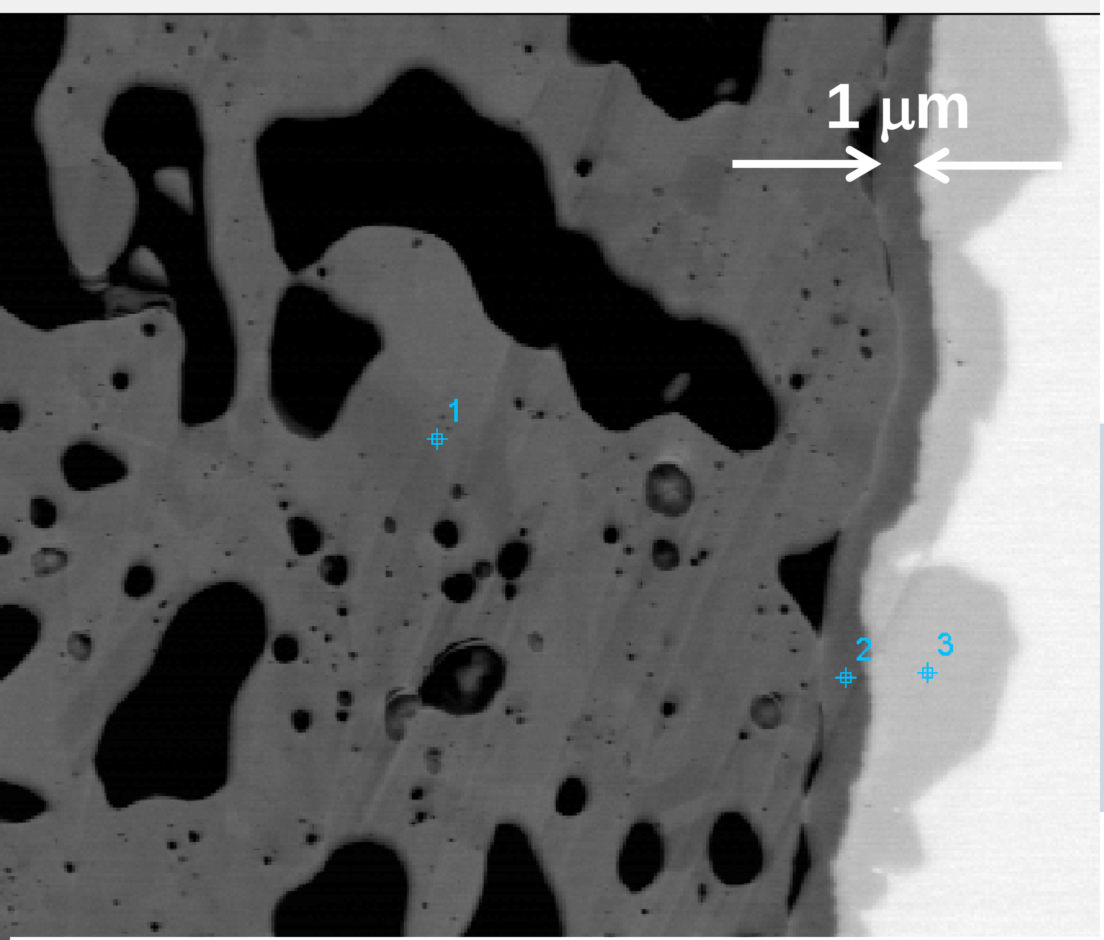


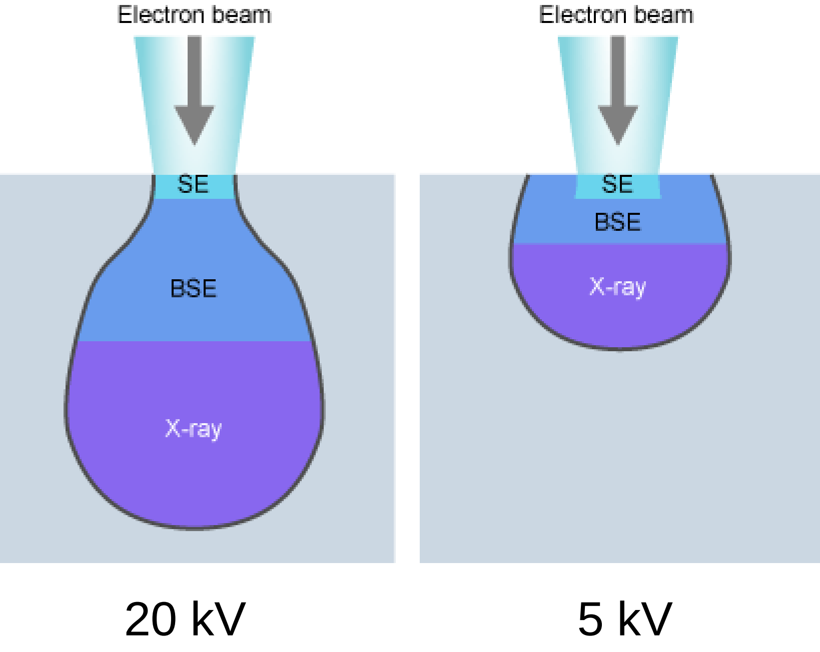
1. With an evacuated tear-drop detector trace B mapping is possible.
2. “Processing” the maps to remove background helps.
3. WDS still provides the best answer.

Some Examples

- Sn: Ni-Cu intermetallic

EDS Ni-Cu intermetallic

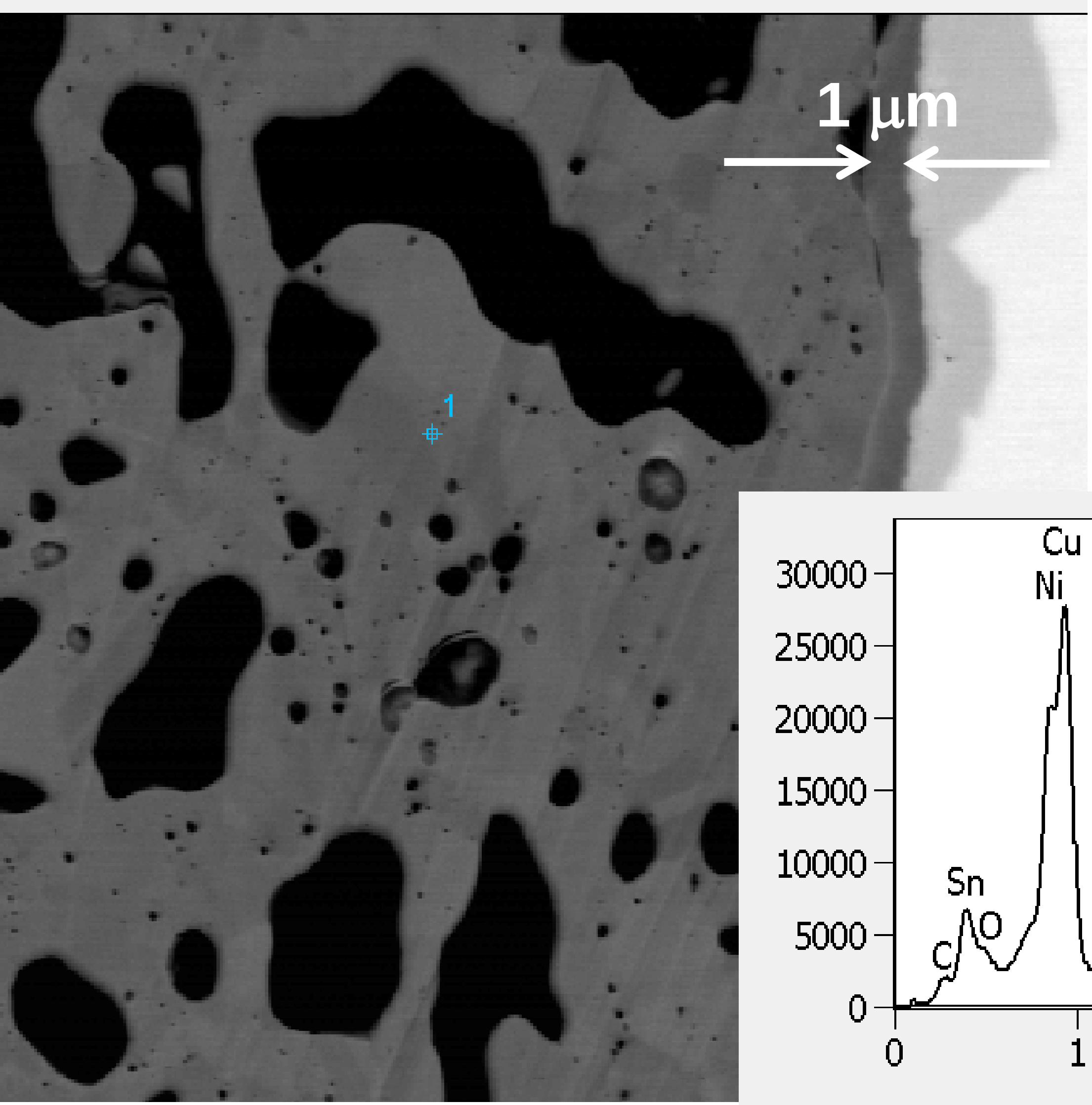




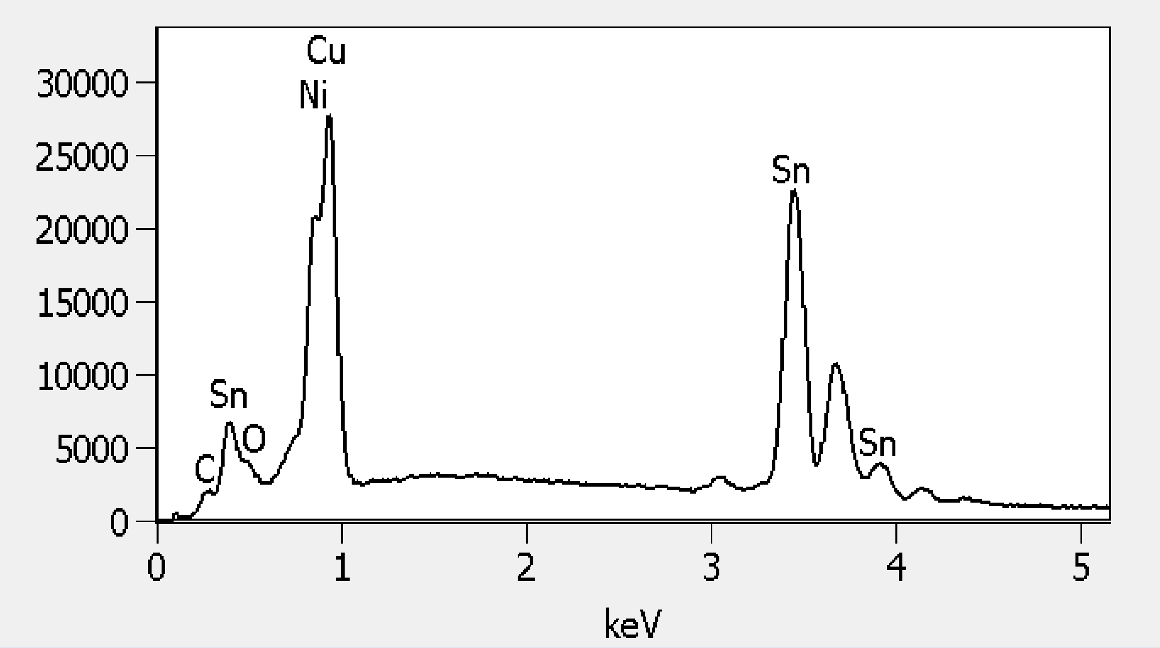
The goal is to examine potential interdiffusion through a thin barrier layer.

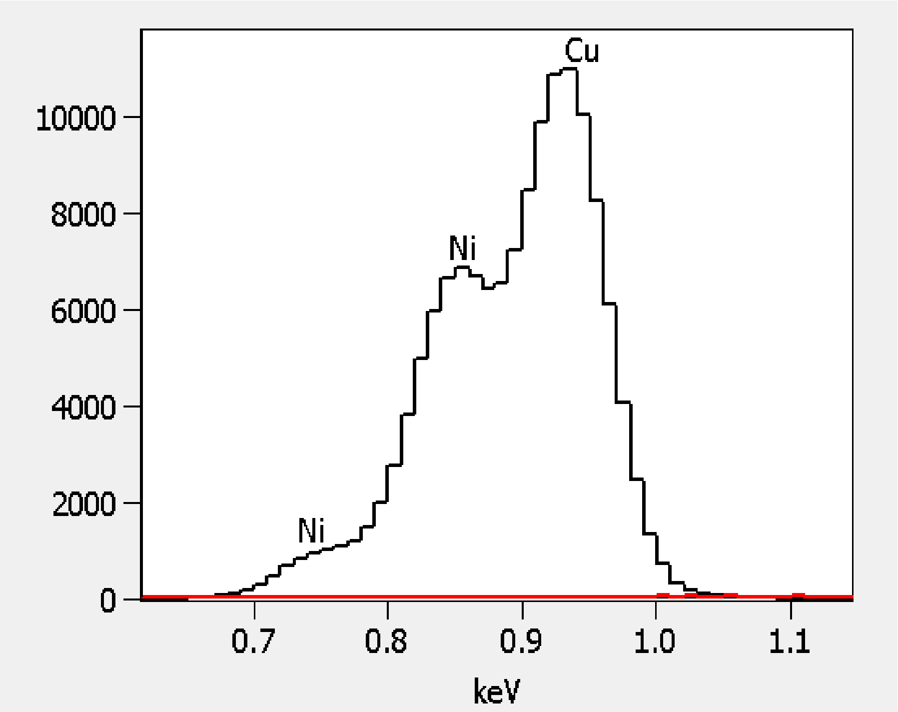
Low kV analysis to avoid an interaction volume that may pollute the data

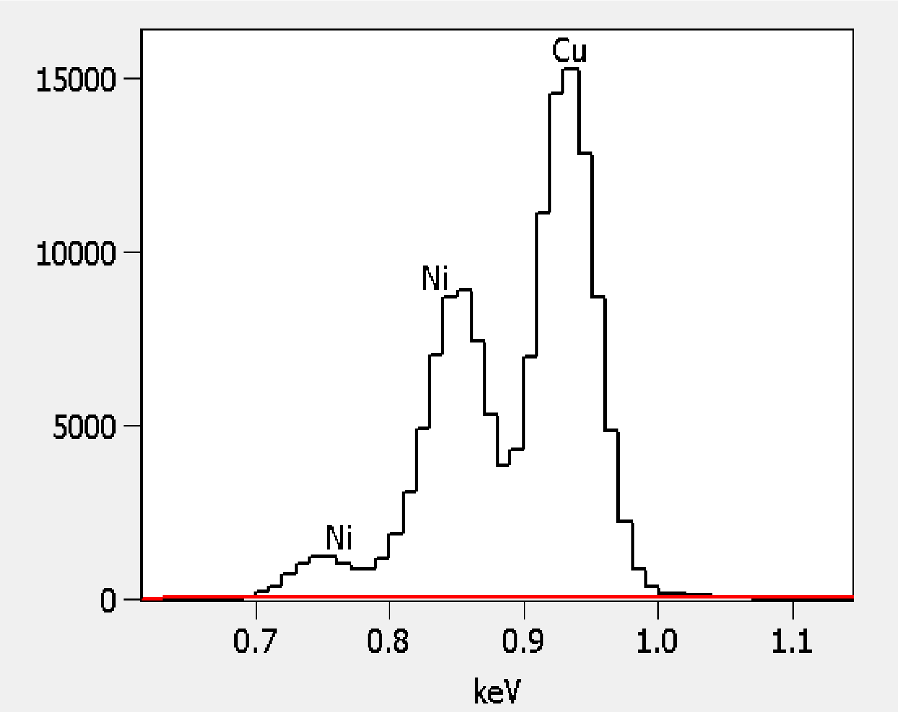
Spectrum analysis: EDS Ni-Cu intermetallic



Serious overlap



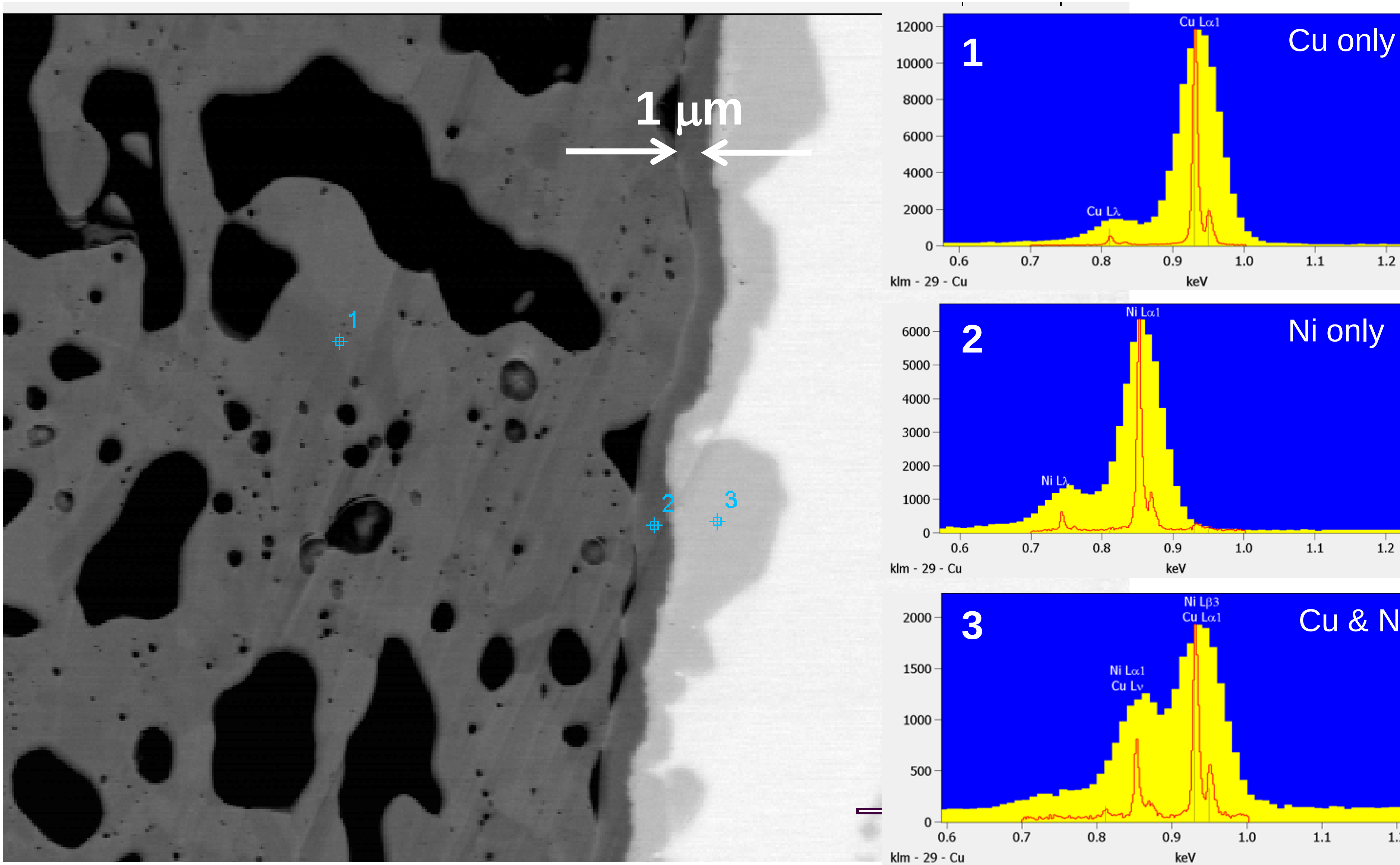




Standard module

Advanced module

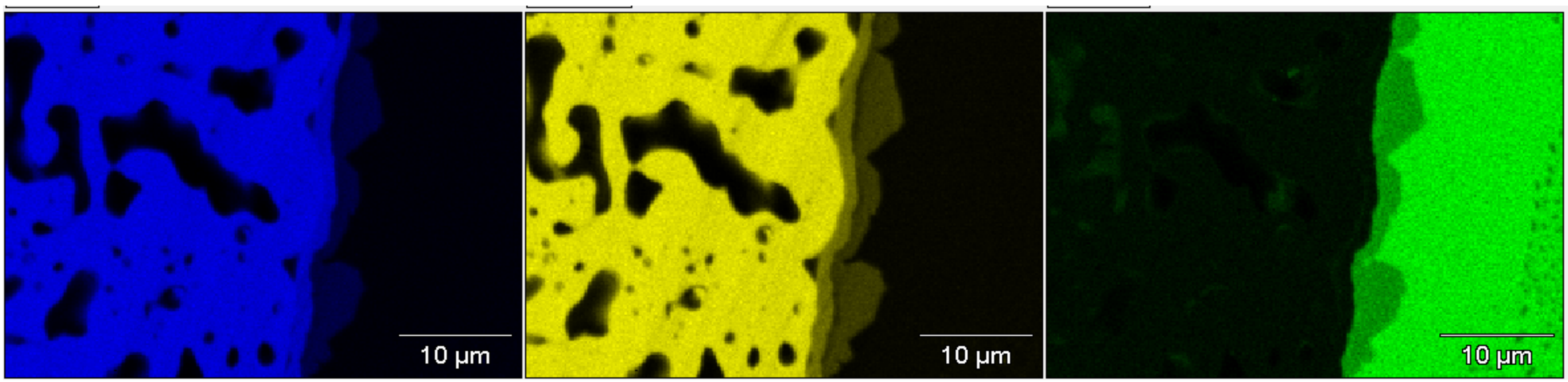
Spectrum analysis: WDS vs. EDS Ni-Cu intermetallic



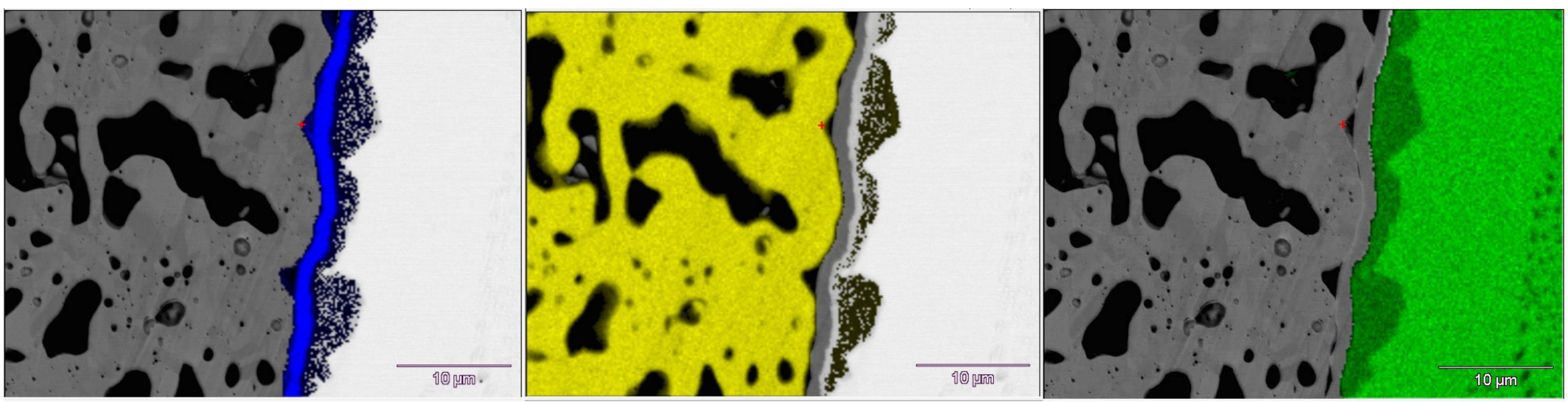
ThermoFisher SCIENTIFIC

EDS vs. WDS maps – Ni, Cu, Sn

EDS element maps are confounded



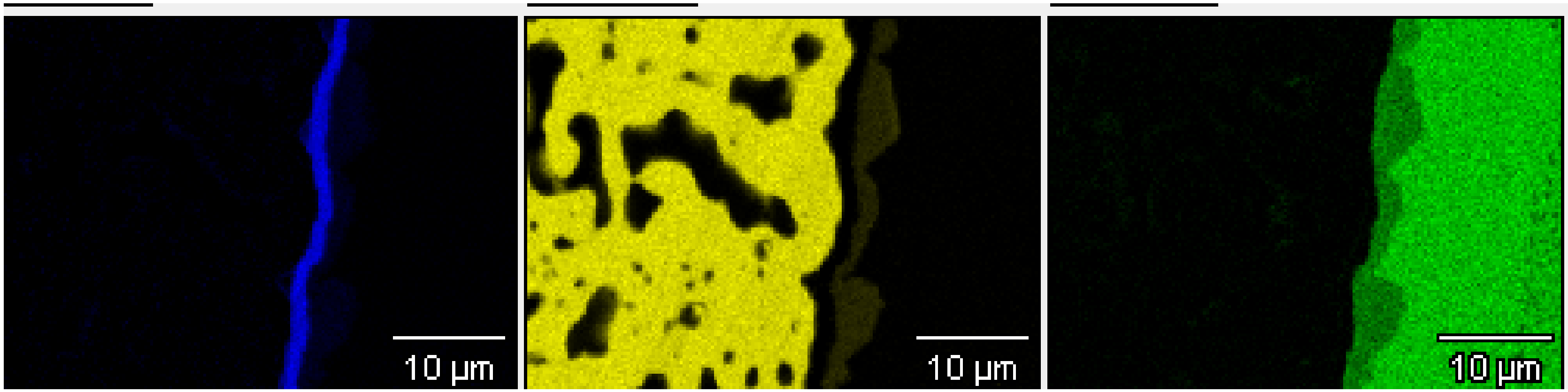
WDS element maps provide complete confidence



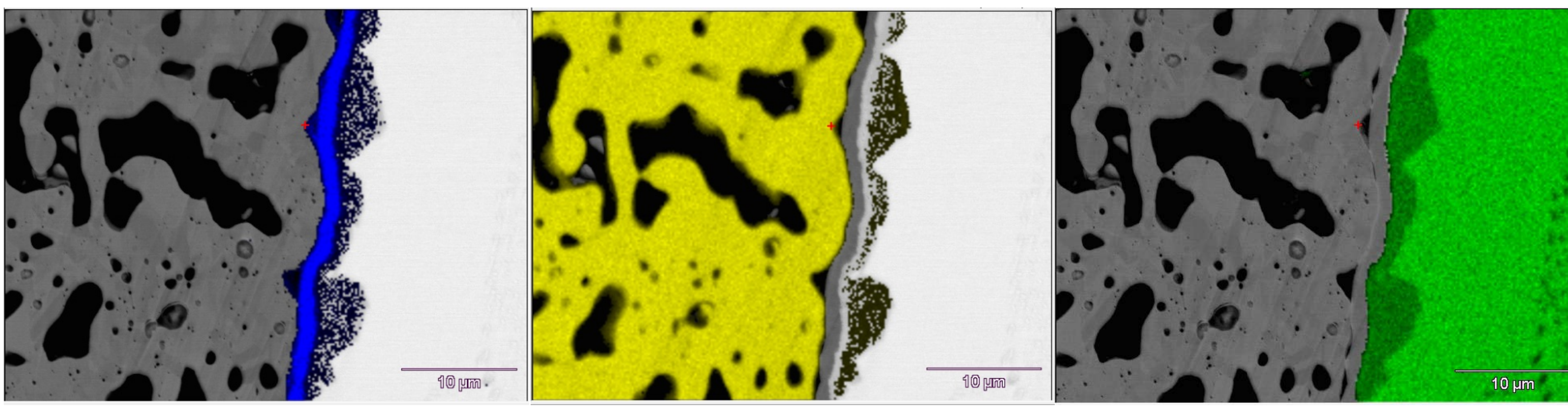
Ni Copper Sn

EDS vs. WDS maps – Ni, Cu, Sn – Processed!

The PROCESSED EDS element maps provide a better look



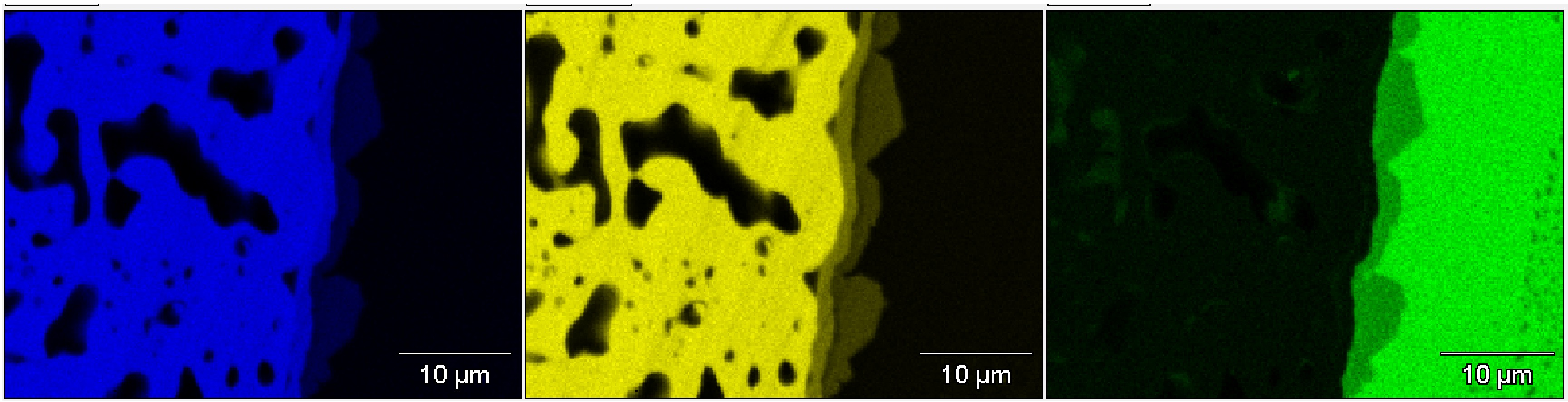
WDS element maps provide complete confidence



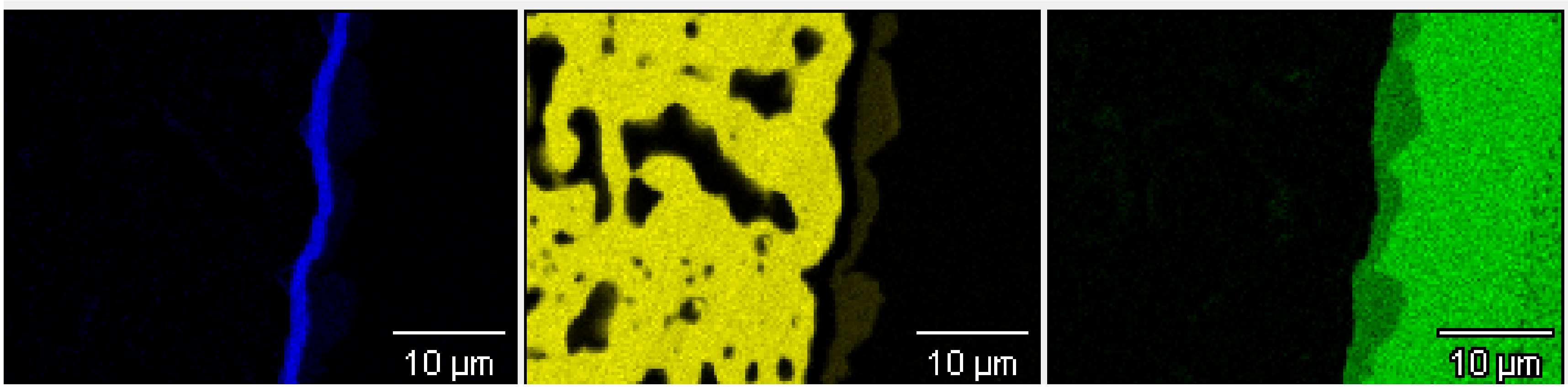
Ni Copper Sn

EDS vs. WDS maps – Ni, Cu, Sn – Processed!

Raw EDS element maps



PROCESSED – Net Counts – EDS element maps



Summary

- EDS detectors are not all the same.

- The light element performance is very different based on
  - SDD module type
  - Detector window
  - Overall detector architecture

- Know your application
  - Mid – high energy applications: Most EDS detectors are fine
  - Low energy applications: Need the best possible EDS detector.
    - Often post-processing algorithms can extract the correct answer even when the raw data is confounding.