Performance Characteristics of WDS and EDS Detectors

Part 2 - EDS

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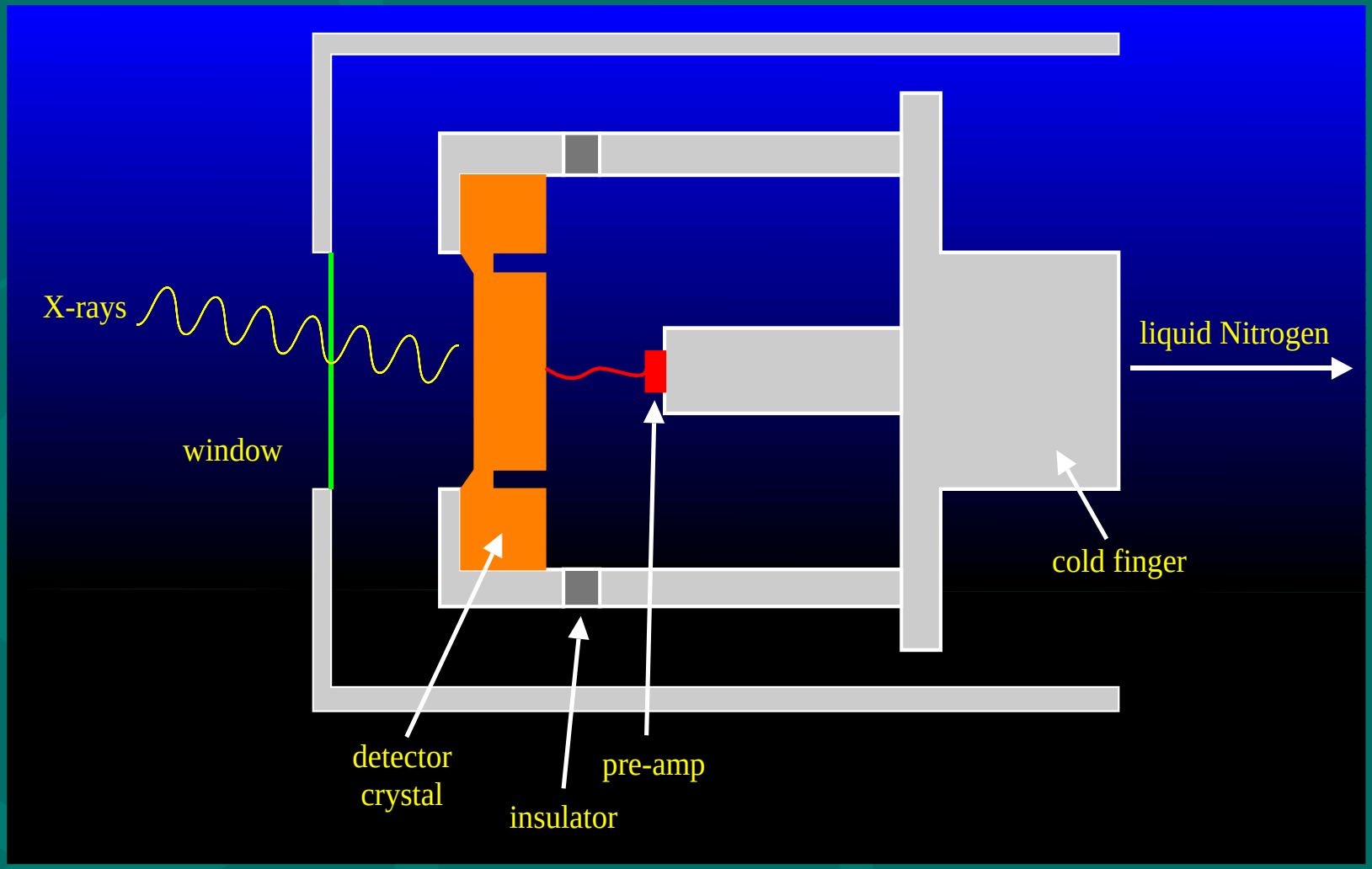
Outline

- Energy Dispersive Spectrometers
  - *basic principles*
  - *characteristics*
  - *practical performance*
- Summary

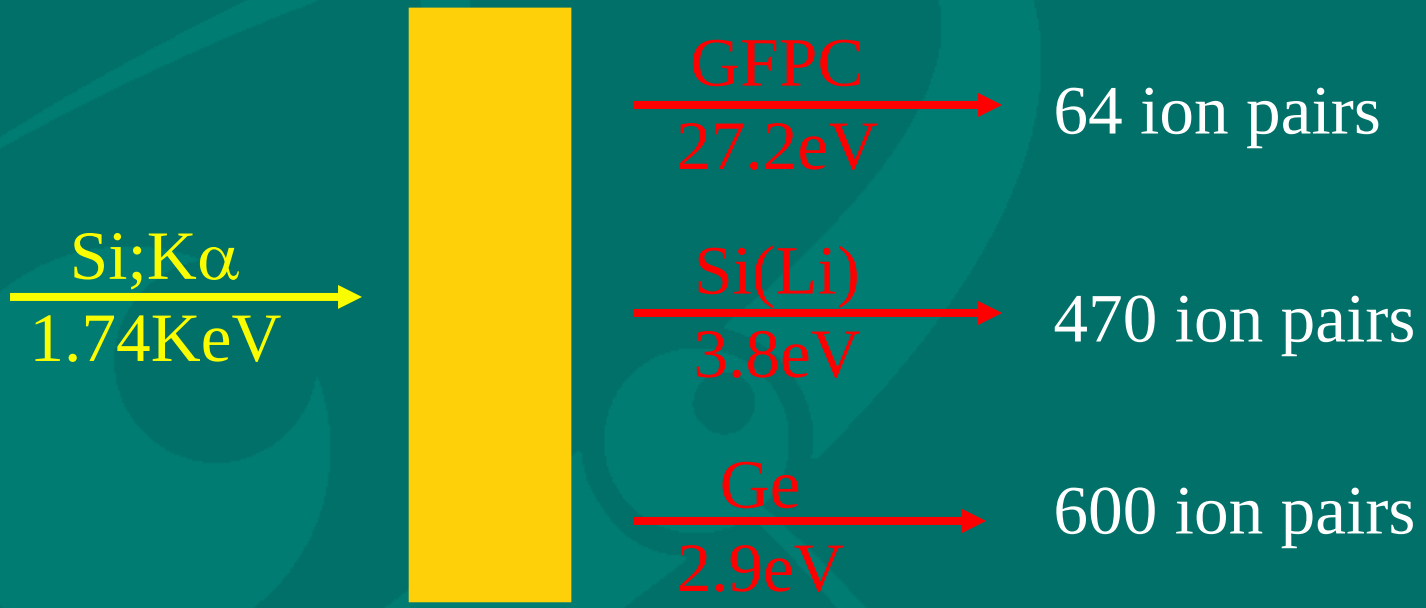
Energy Dispersive Spectrometers

- Principles of operation



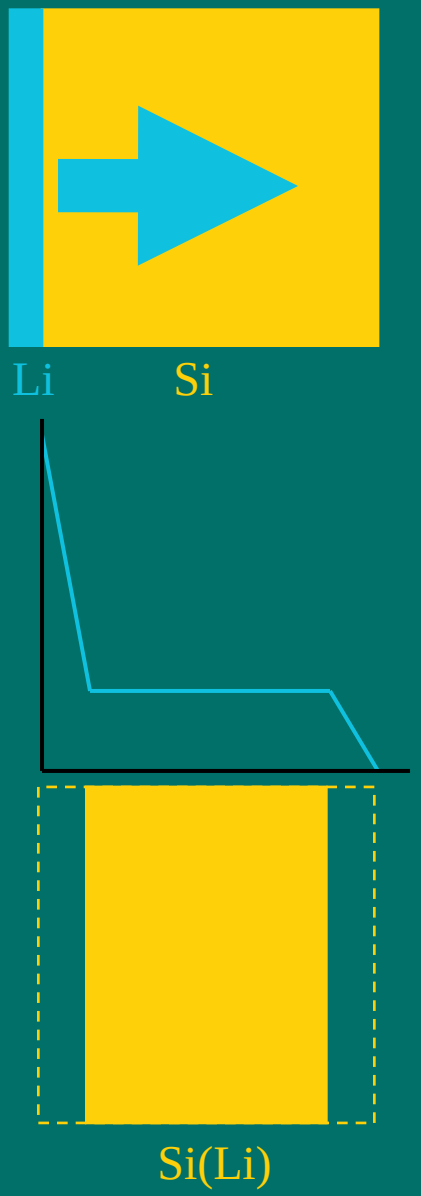
Energy Dispersive Spectrometers

- Principles of operation

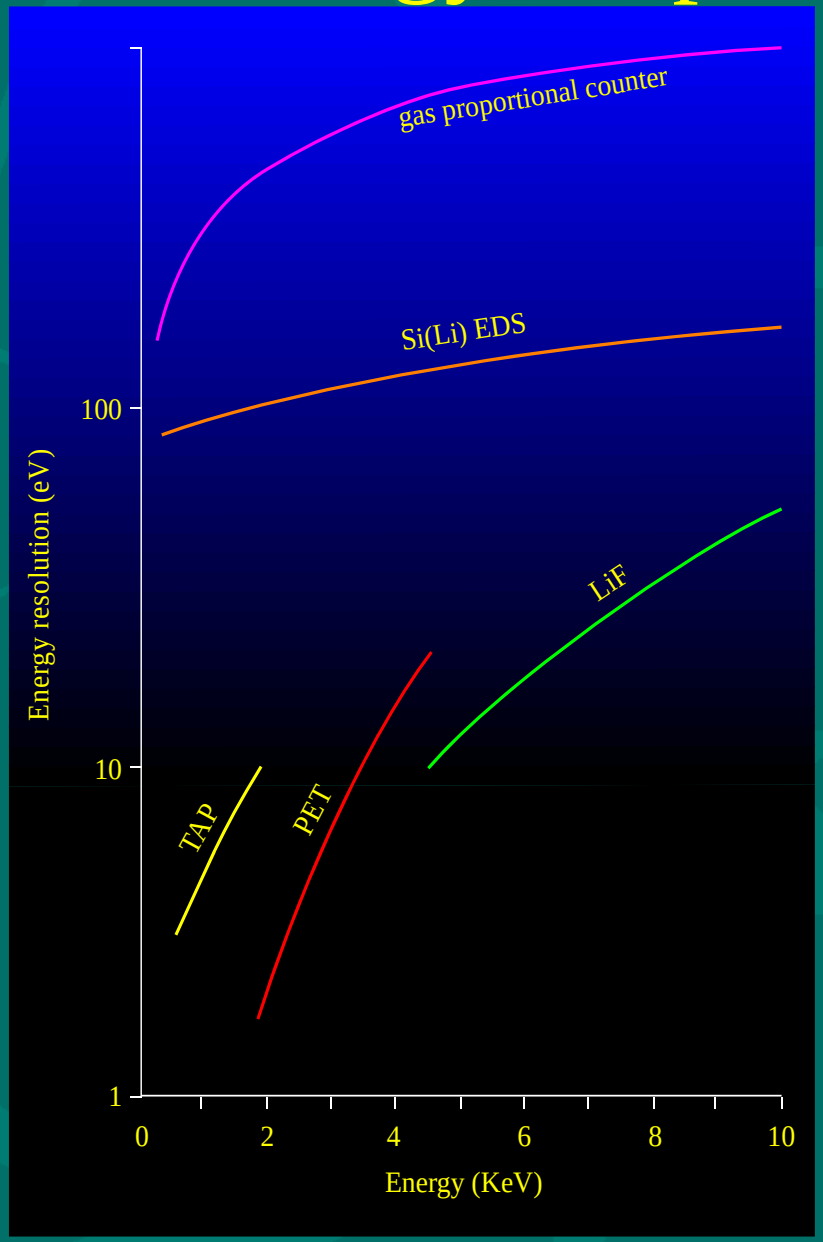


Energy Dispersive Spectrometers

- Si(Li)
  - Intrinsic impurities in ‘pure’ Si
  - Counteraction by Li
  - Li ‘drifting’
- Advantages
  - mechanically simpler
  - no de-focussing
  - parallel X-ray collection
  - simple to apply

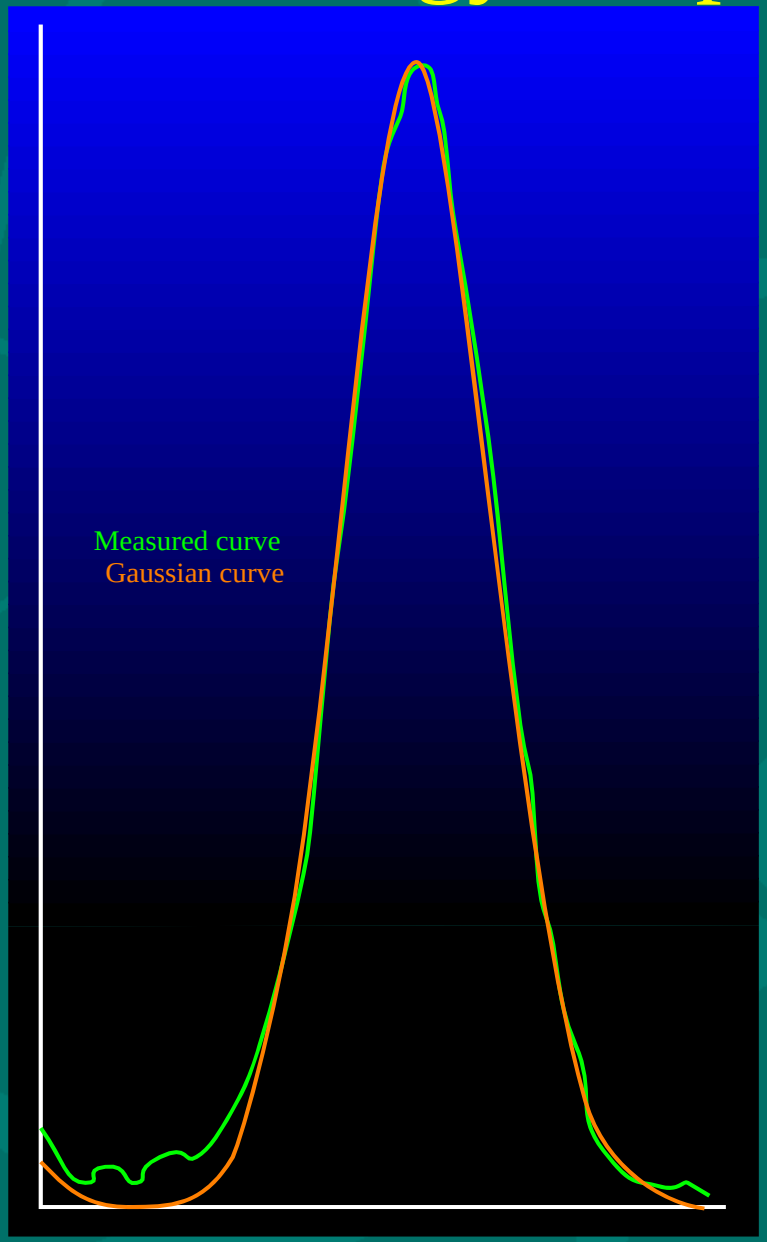


Energy Dispersive Spectrometers



- Factors Affecting Resolution
  - Noise
    - Statistical
    - Thermal
    - Electrical

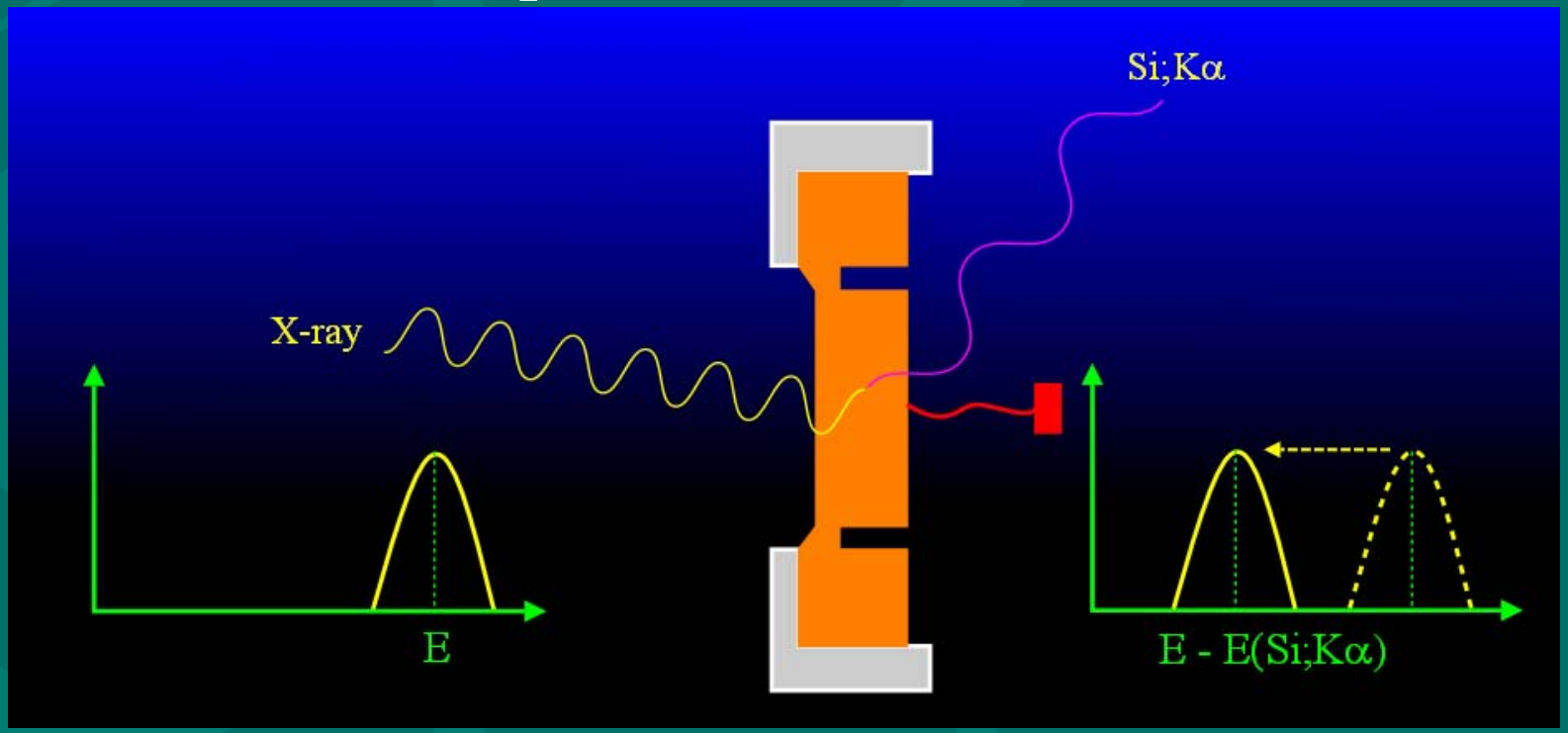
Energy Dispersive Spectrometers



- Factors Affecting Resolution
  - Incomplete charge collection
    - Dead layer
    - Trapping

Energy Dispersive Spectrometers

- Escape Peaks
  - Absorption by Si;K shell
  - Emission of Si;Kα X-ray
  - Poor re-absorption



Energy Dispersive Spectrometers

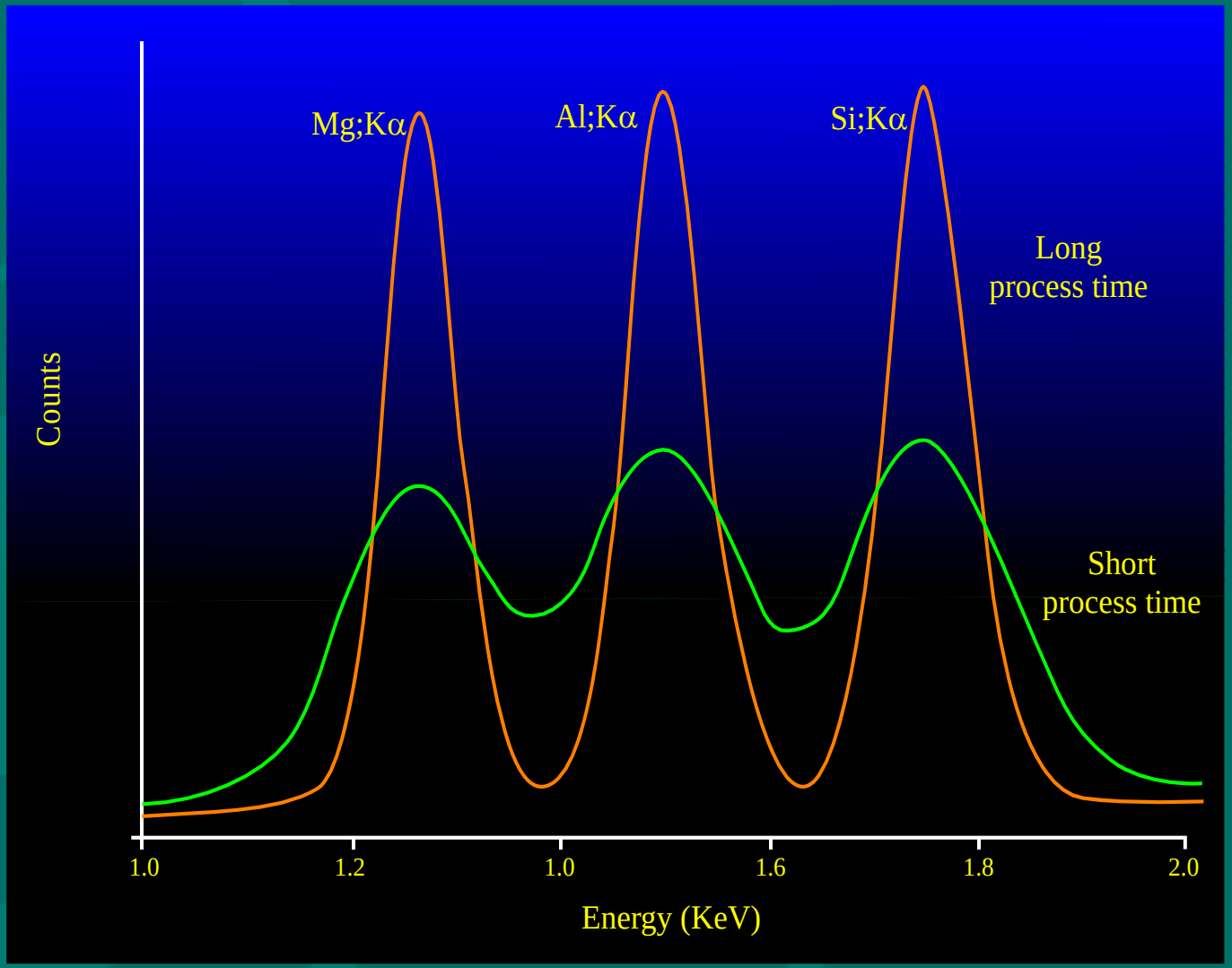
- Internal Fluorescence
  - Excitation of Si;Kα in the dead layer
    - Lose auger electron
    - Absorb Si;Kα X-ray
  - Direct excitation of Si;Kα
    - Background radiation
    - Stray electrons
  - Si;Kα peak in spectrum

Energy Dispersive Spectrometers

- Dead Time
  - Pulse process time
  - Time Constant
    - Count rate
    - Resolution

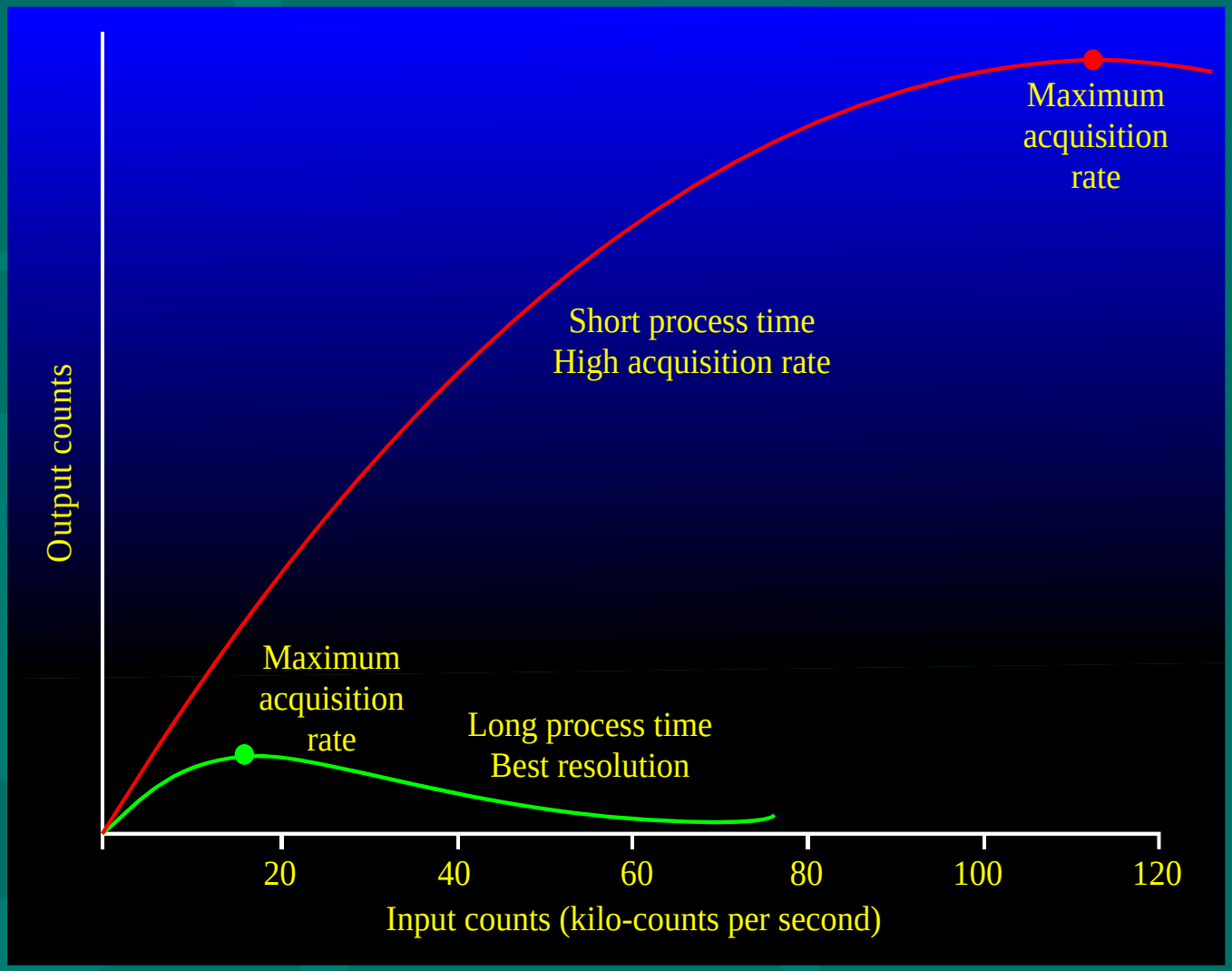
Energy Dispersive Spectrometers

- Dead Time



Energy Dispersive Spectrometers

- Dead Time

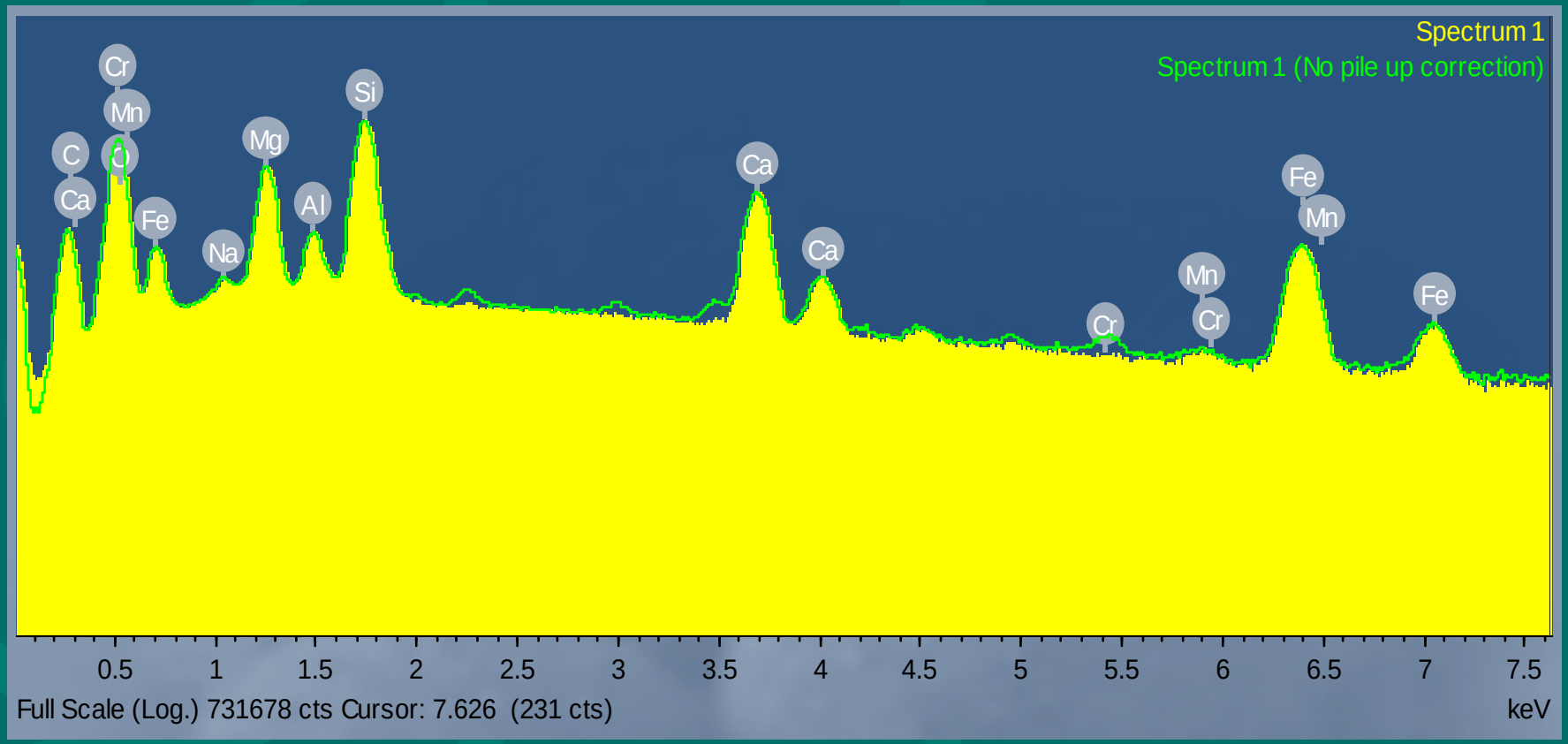


Energy Dispersive Spectrometers

- Dead Time
  - Time variant pulse processing
  - Low noise FET’s
  - High speed ADC
  - Intelligent base-lining

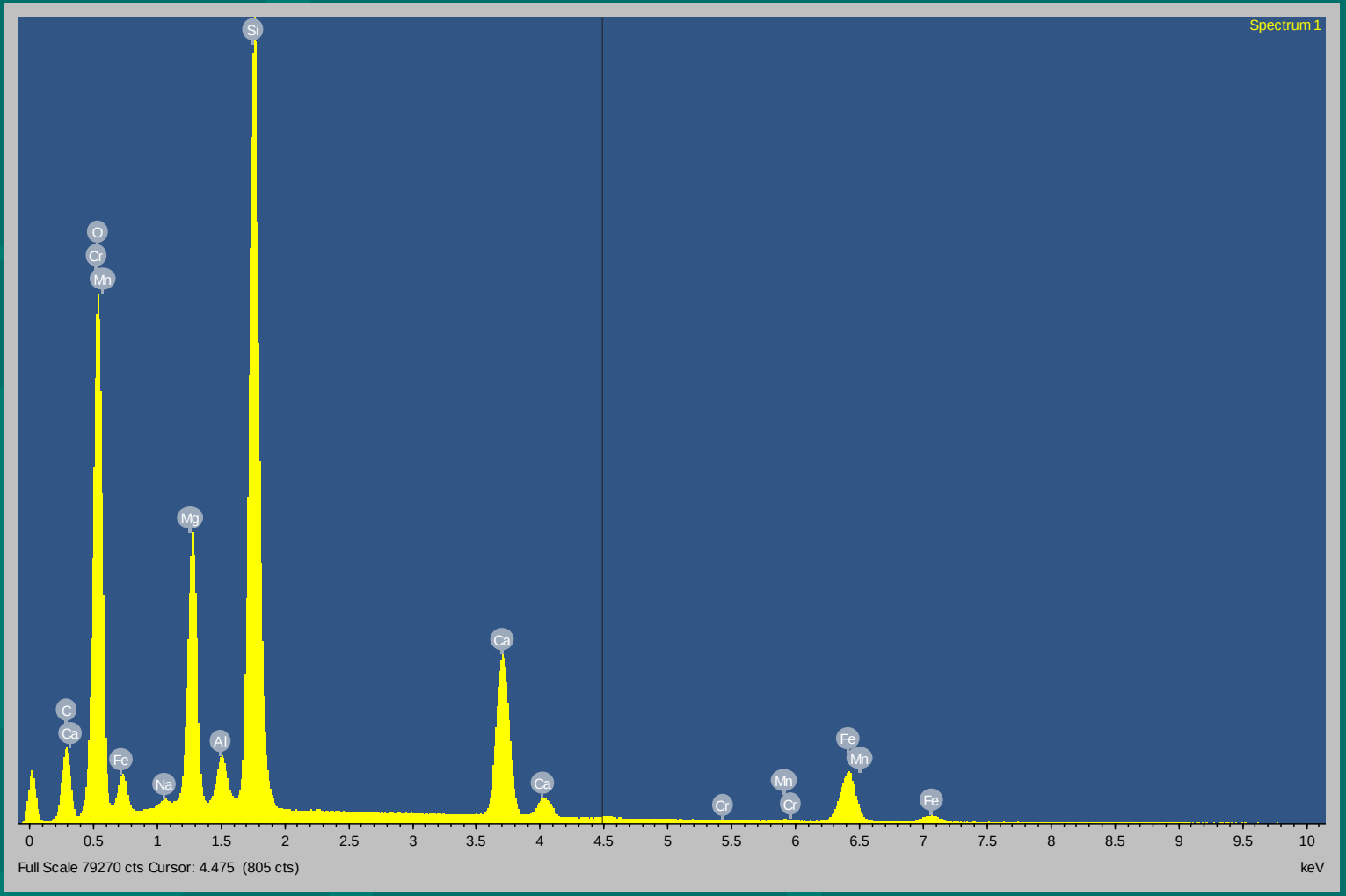
Energy Dispersive Spectrometers

- Pulse Pile-Up
  - Sum peaks
  - Reduced parent peak



Energy Dispersive Spectrometers

- Counter Window



Energy Dispersive Spectrometers

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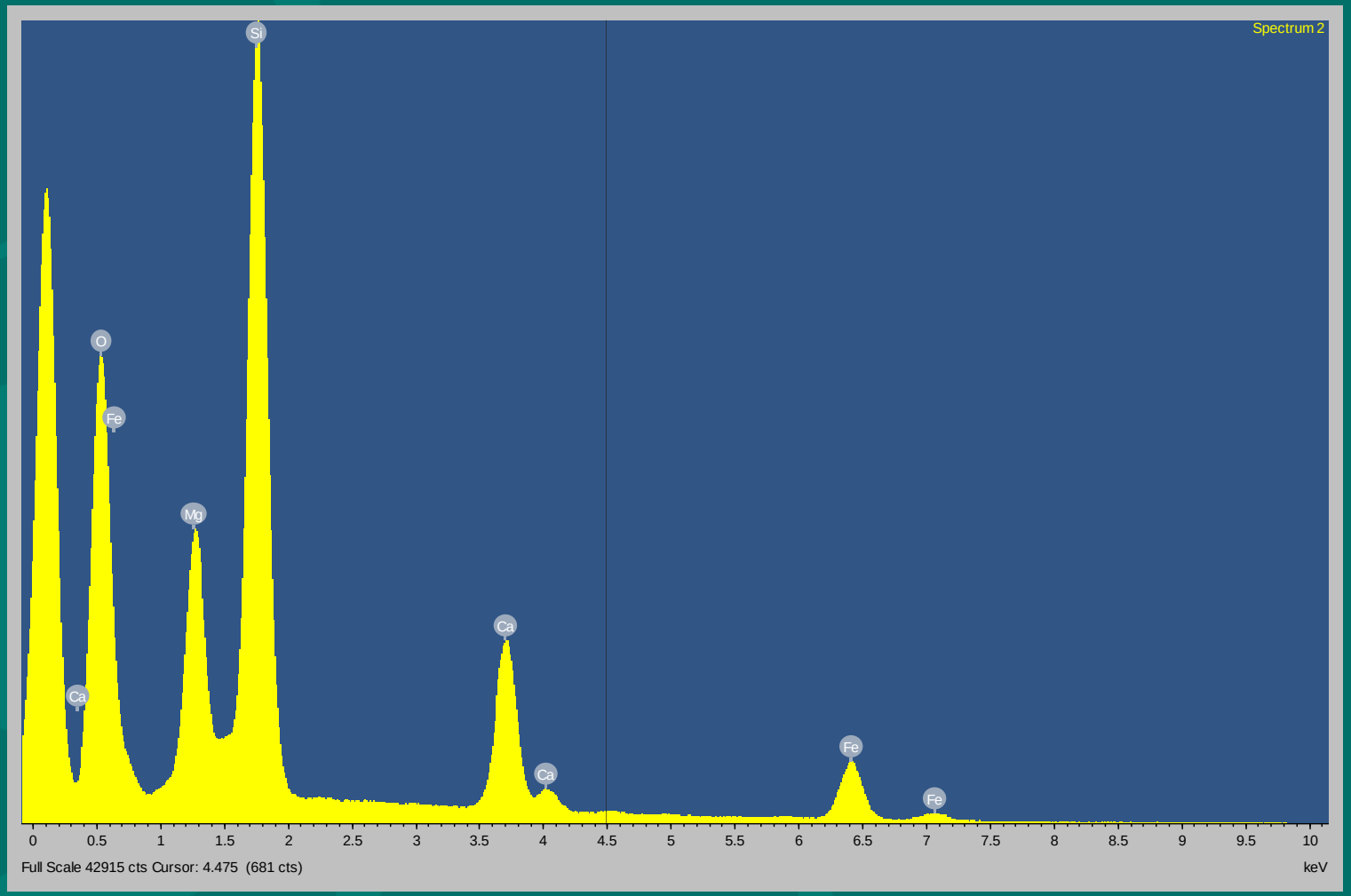

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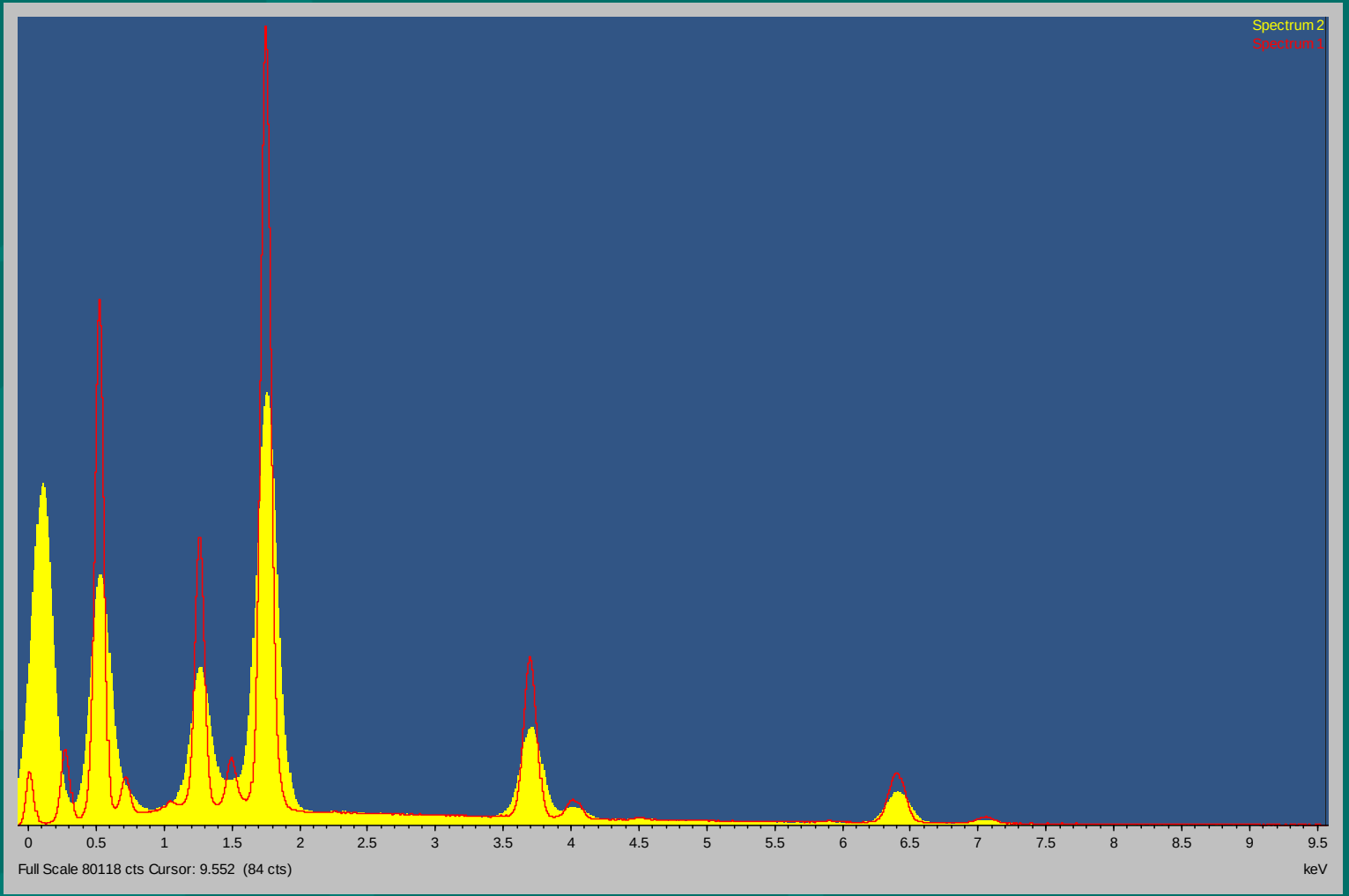

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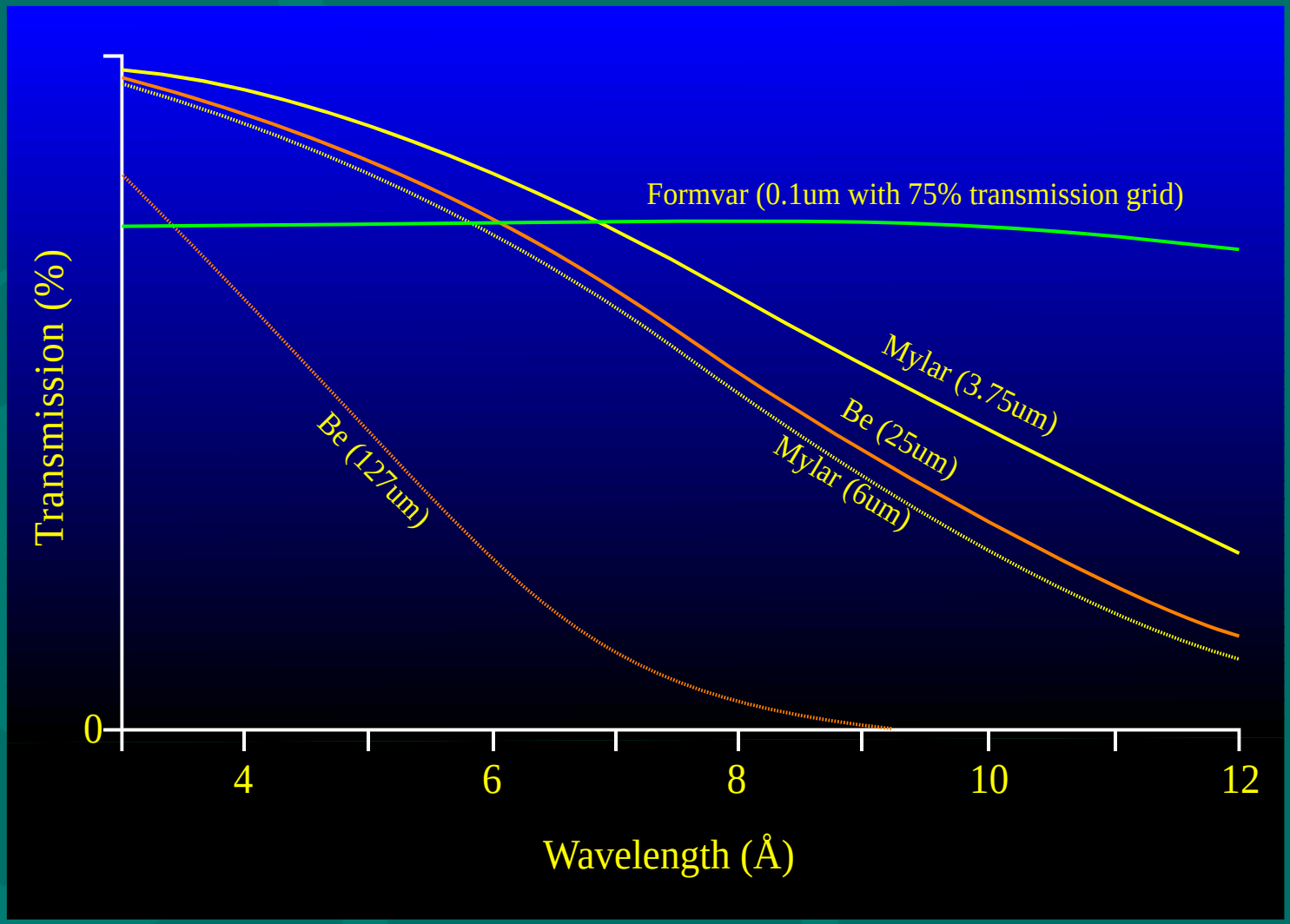
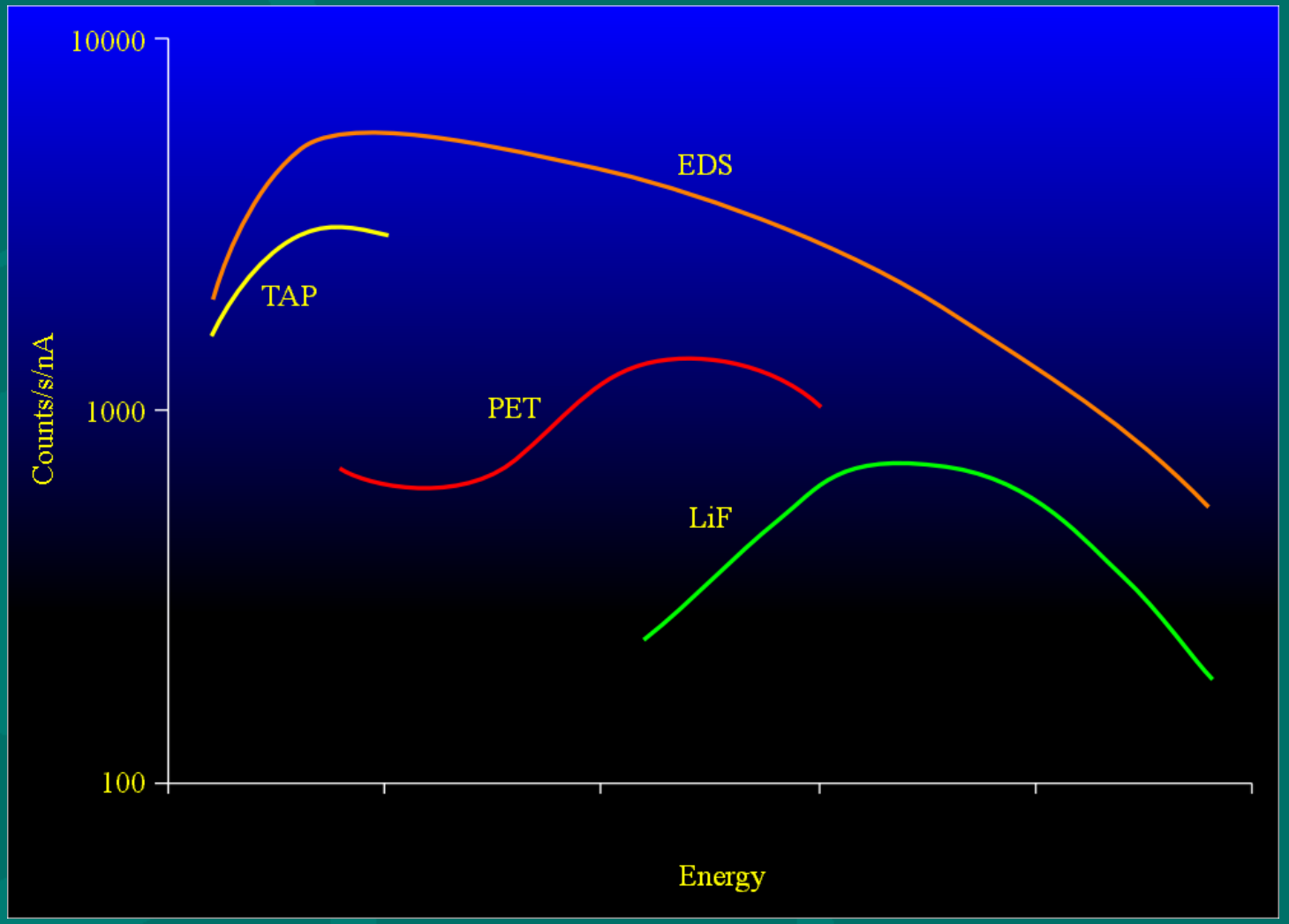


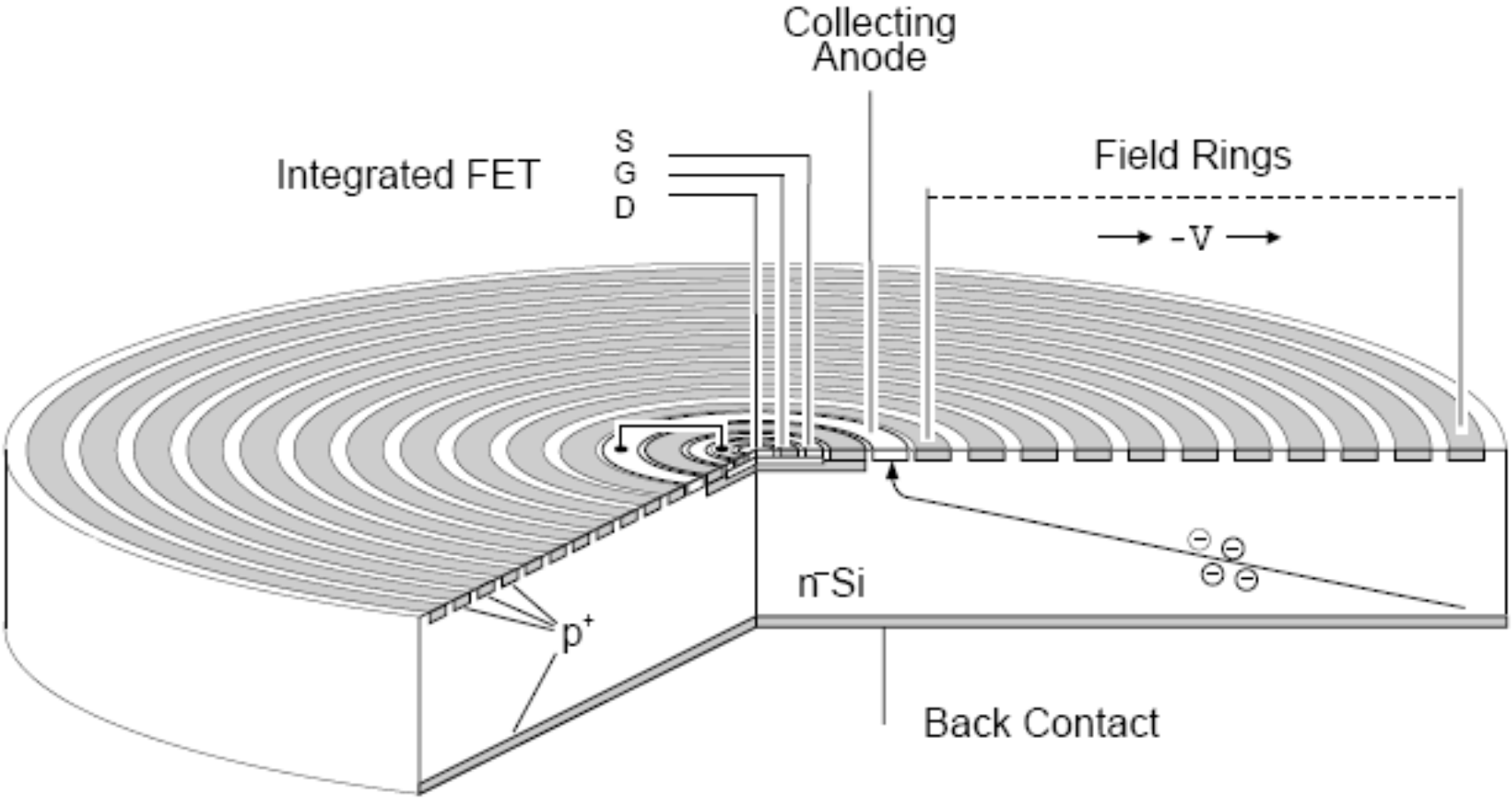
Energy Dispersive Spectrometers

- Efficiency



Energy Dispersive Spectrometers

- Silicon Drift Detectors



Energy Dispersive Spectrometers

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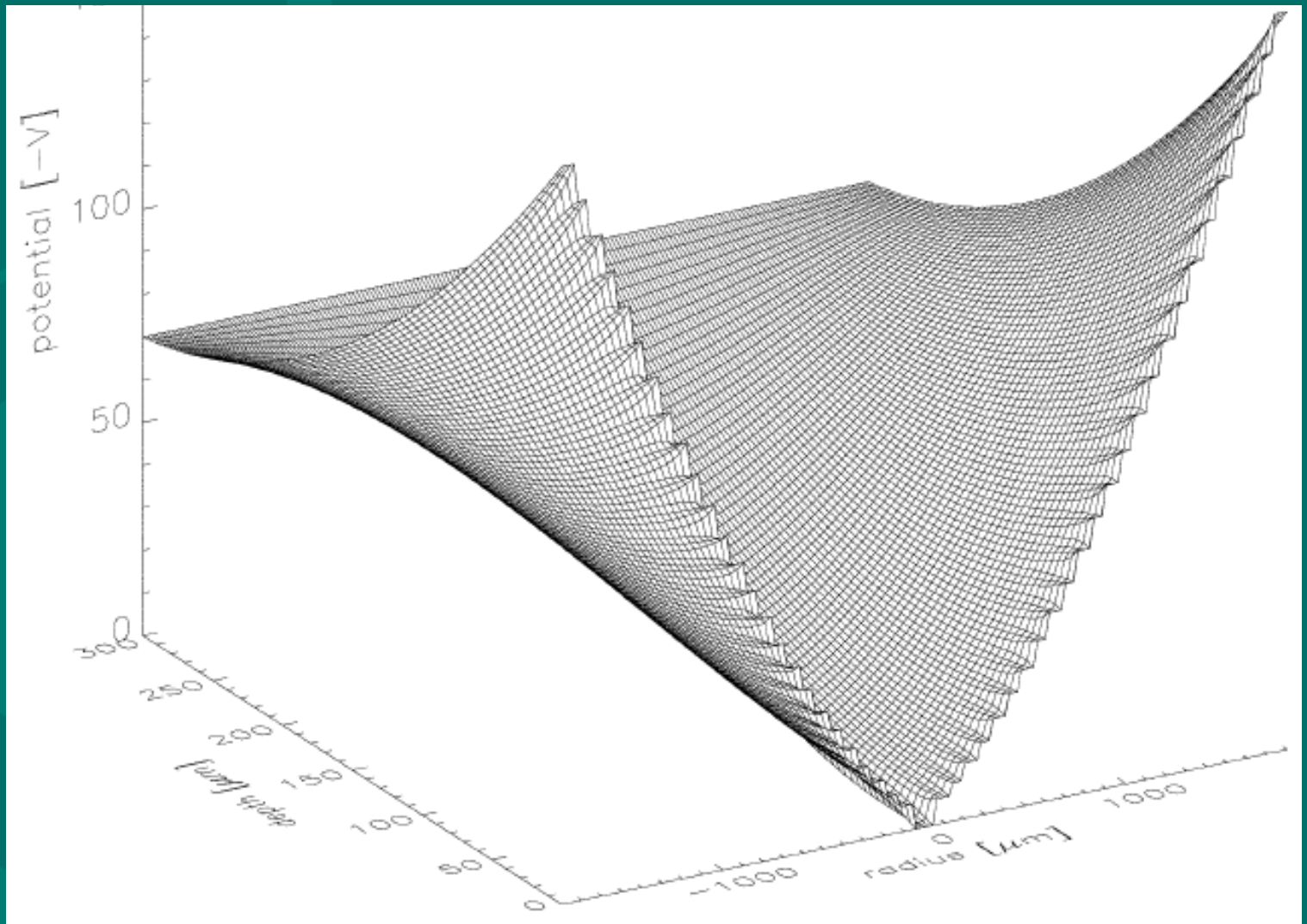

Energy Dispersive Spectrometers

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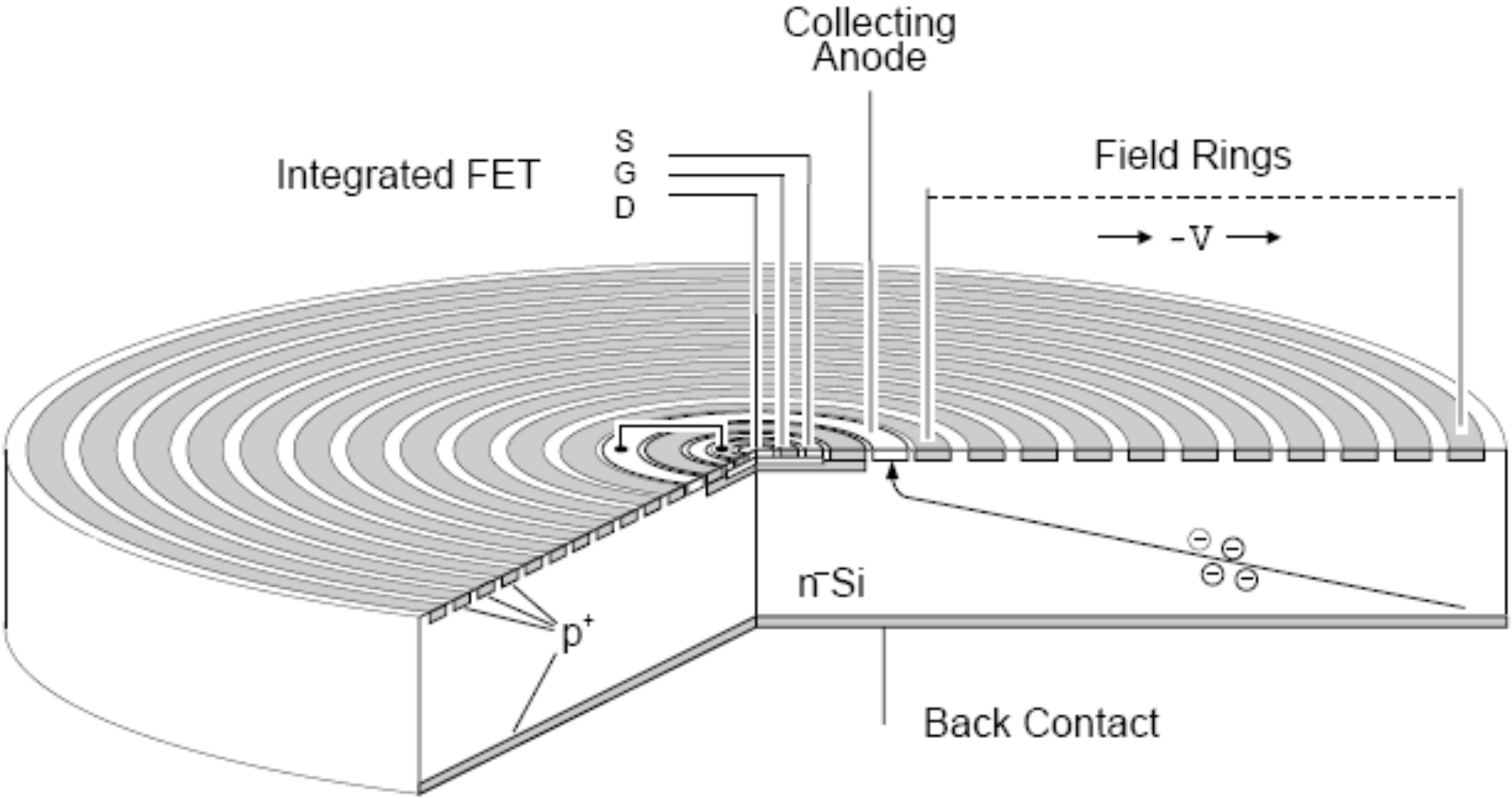
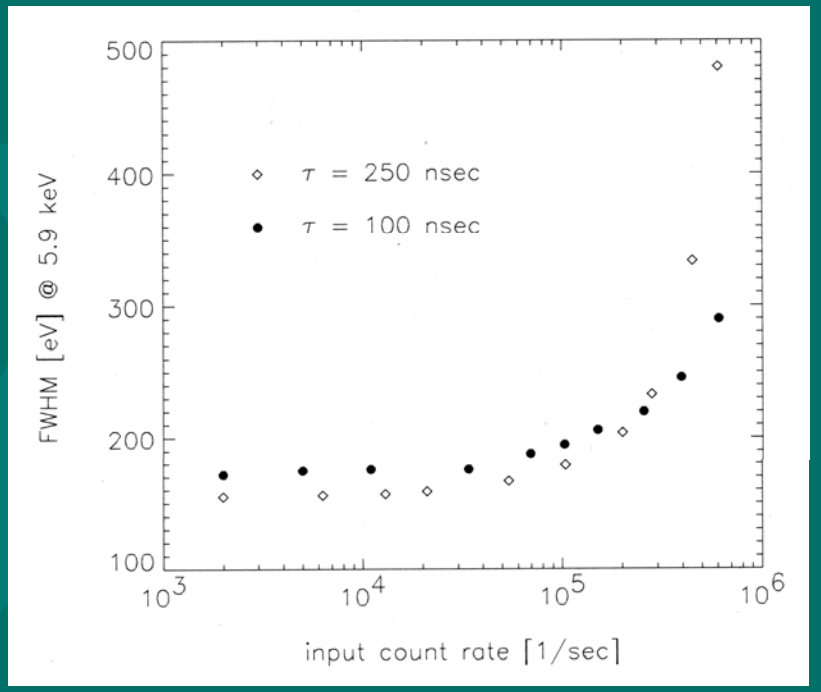


Energy Dispersive Spectrometers

- Silicon Drift Detectors
  - + Very low capacitance
    - Higher energy resolution
    - Shorter shaping times
    - High count rates
  - + Very low leakage current
    - Only moderate cooling
  - + Self re-setting anode
    - Simple DC voltage to operate
    - No detector clock re-set overhead
  - + Simple robust package



Energy Dispersive Spectrometers

- Silicon Drift Detectors
  - Thin
    - >90% efficiency @ 10KeV
    - >50% efficiency @ 20KeV
  - FET ‘burn’
  - Pulse pile-up
  - ICC
    - Low energy performance
  - Ballistic deficit

Energy Dispersive Spectrometers

- Summary
  - + Simple to apply
  - + Parallel acquisition
  - + Virtually no pre-configuration
  - + No De-focussing
  - – Poor resolution
    - Overlaps
    - Detection limits
  - – Poorer accuracy and precision
  - – Spectrum artefacts
    - Escape peaks
    - Si;Kα peak
    - Sum peaks

End of Part 2

Thank you for your attention