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Progress on the Aberystwyth Electron Counting Array

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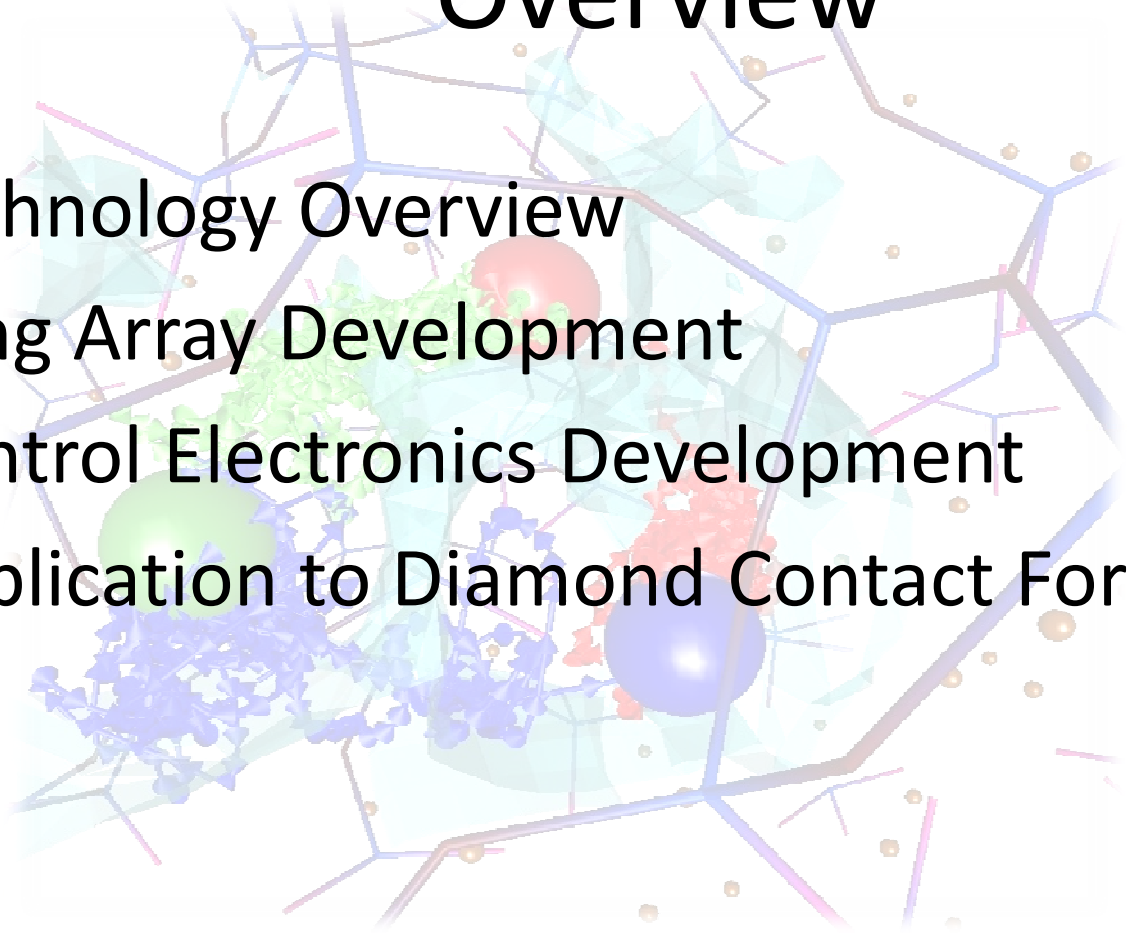
Overview



- Technology Overview
- Long Array Development
- Control Electronics Development
- Application to Diamond Contact Formation

Detector Technology Overview

- Readout Device for Microchannel Plate
- Custom ASIC
  - Linear Array of Collection Anodes
  - Amplifier Discriminators
  - 16-bit Counters & Readout Circuitry
  - Ceramic Substrate & MCP Holder
- ‘Bed-of-Nails’ mounting & Feedthrough
- Floating Control Electronics (ex vacuum)

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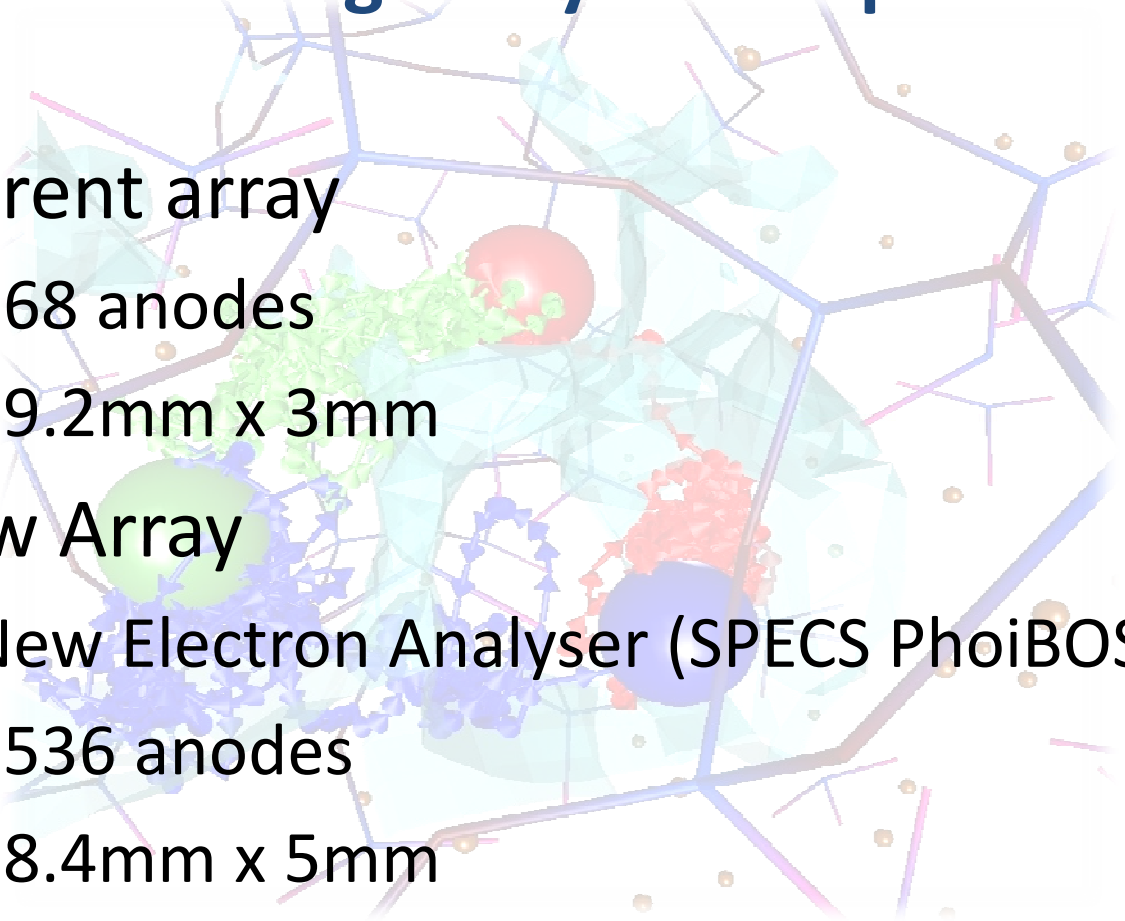
Long Array Development



- Current array
  - 768 anodes
  - 19.2mm x 3mm
- New Array
  - New Electron Analyser (SPECS PhoiBOS 100)
  - 1536 anodes
  - 38.4mm x 5mm

Long Array Technology Challenges

- Yield
  - Not an issue (Current device yields at 90%)
- Reticle Size
  - Standard 20mm x 20mm reticle
  - Need ‘stitched’ design (Left + Right)
  - No active devices across stitch boundaries
  - Tighter Design Rules over stitch boundary

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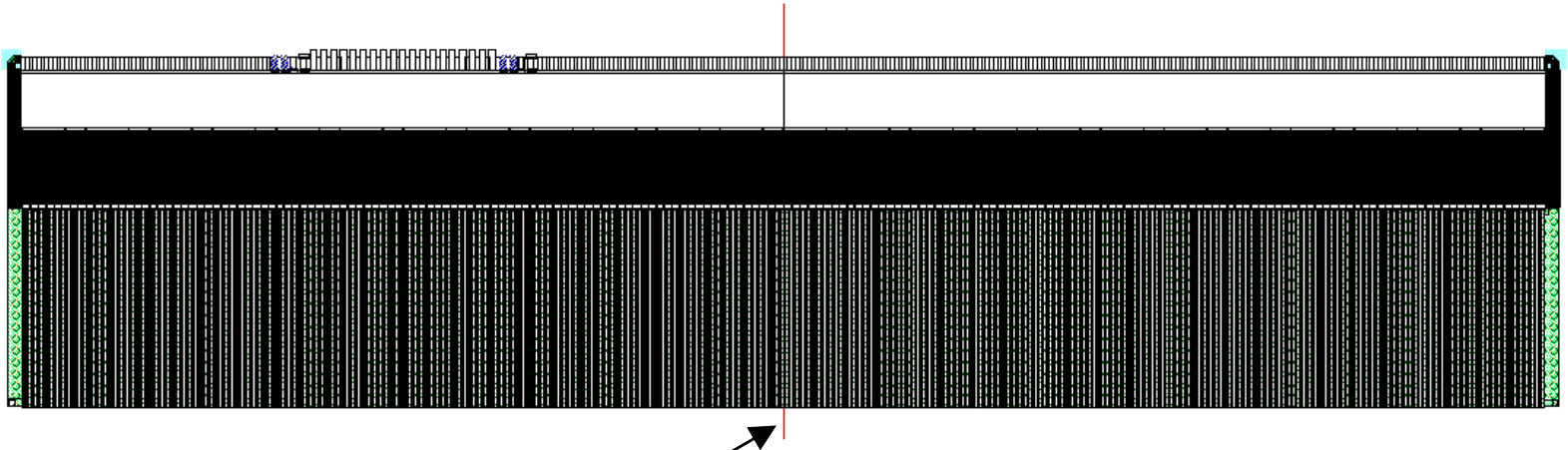
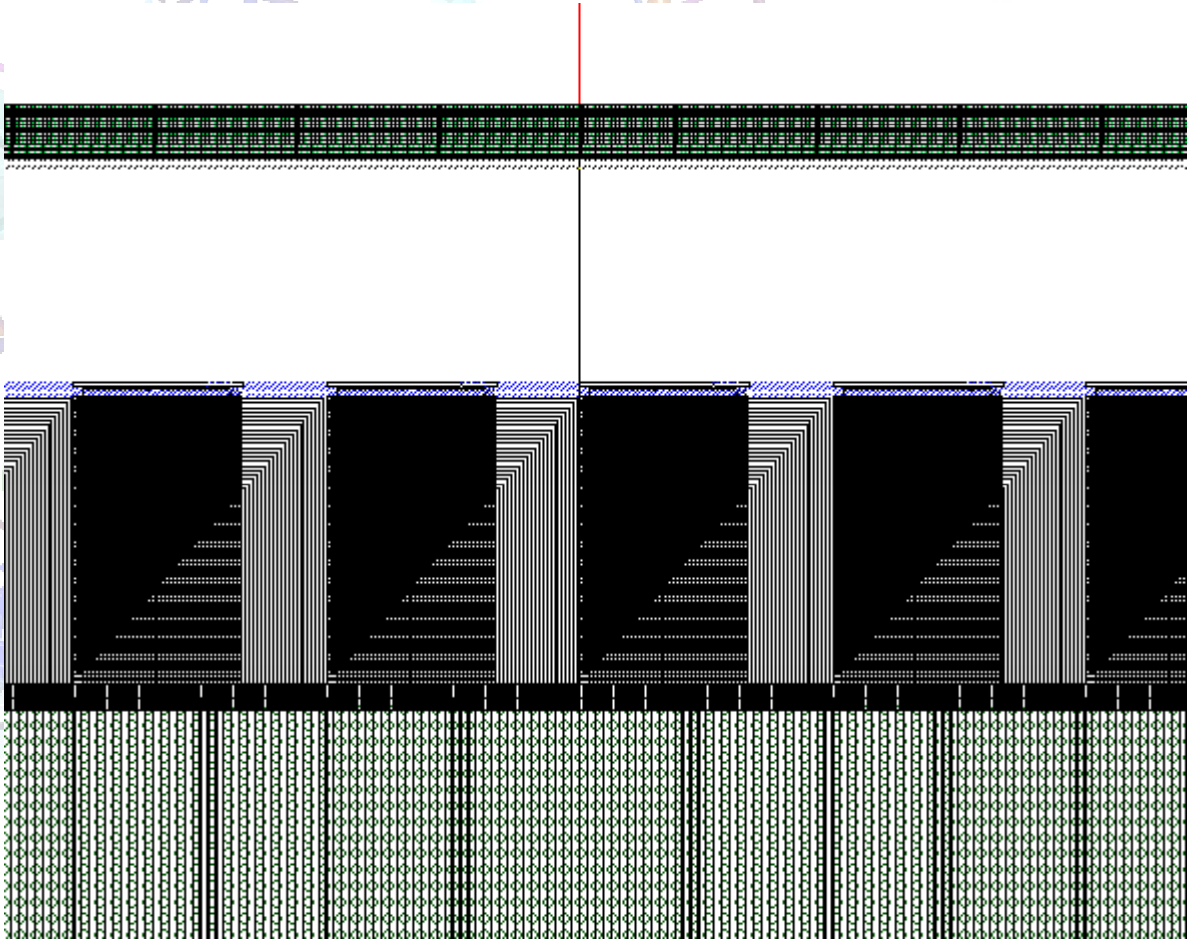
Long Array Stitching



Stitch Boundary

Long Array Stitching



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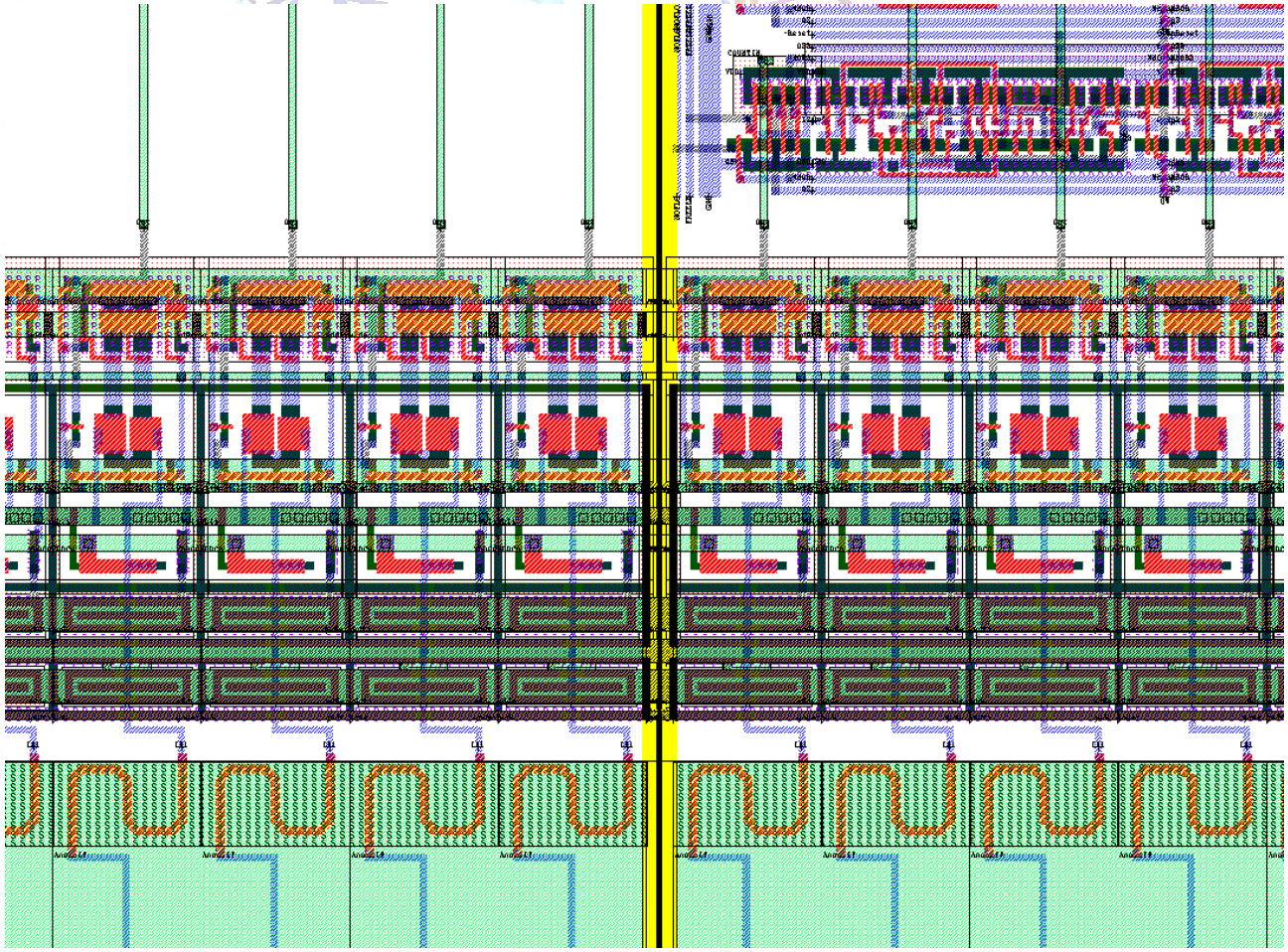
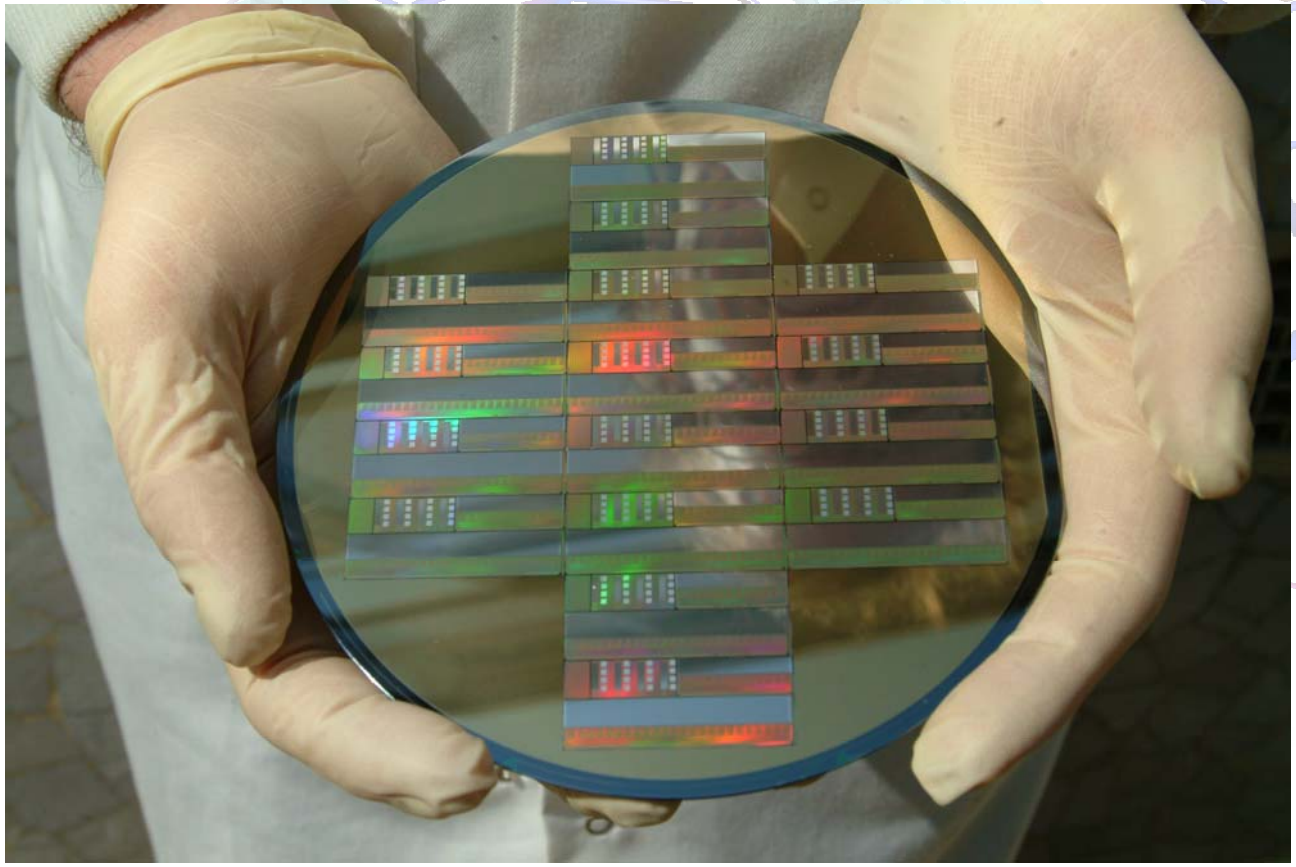
Long Array Stitching



Wafer with 40mm detector chips



- 40mm detector
- 20mm detector
- Test structures

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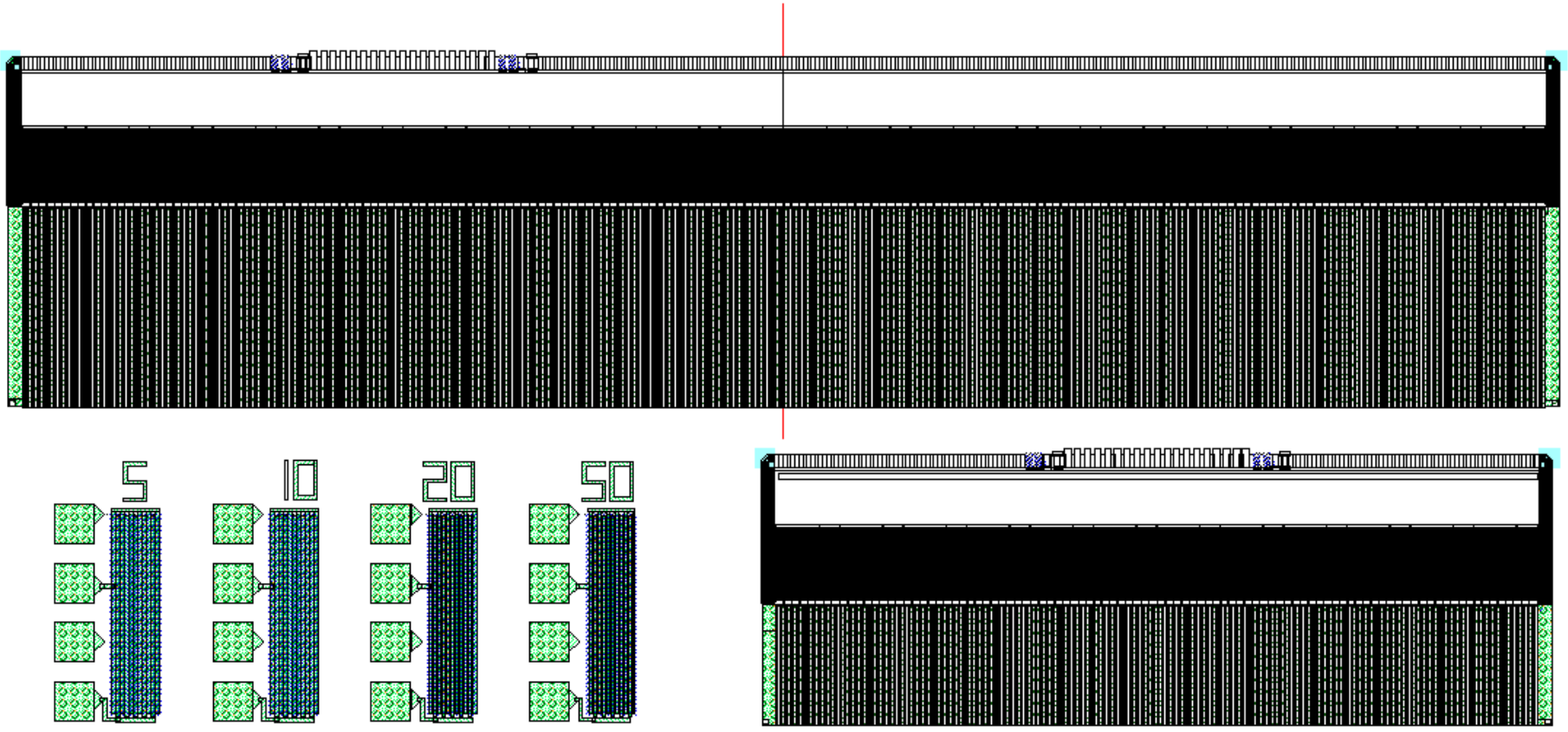

Control Electronics Development

- ≈ 2kV across MCP ⟹ Floating readout system
  - TCP/IP over fibre optic (10 Base F)
  - Data Acquisition
  - Gate Timing
- Existing system
  - Based on ipEngine (Brightstar Engineering)
  - Programmed in C
  - ≈ 1.5ms/frame (768 pixels @ 2us/pixel)
- In development:
  - Based on National Instruments cRIO
  - Labview programmable
  - ≈ 0.75 ms/frame (1us/pixel)
  - Easily re-programmed for special applications

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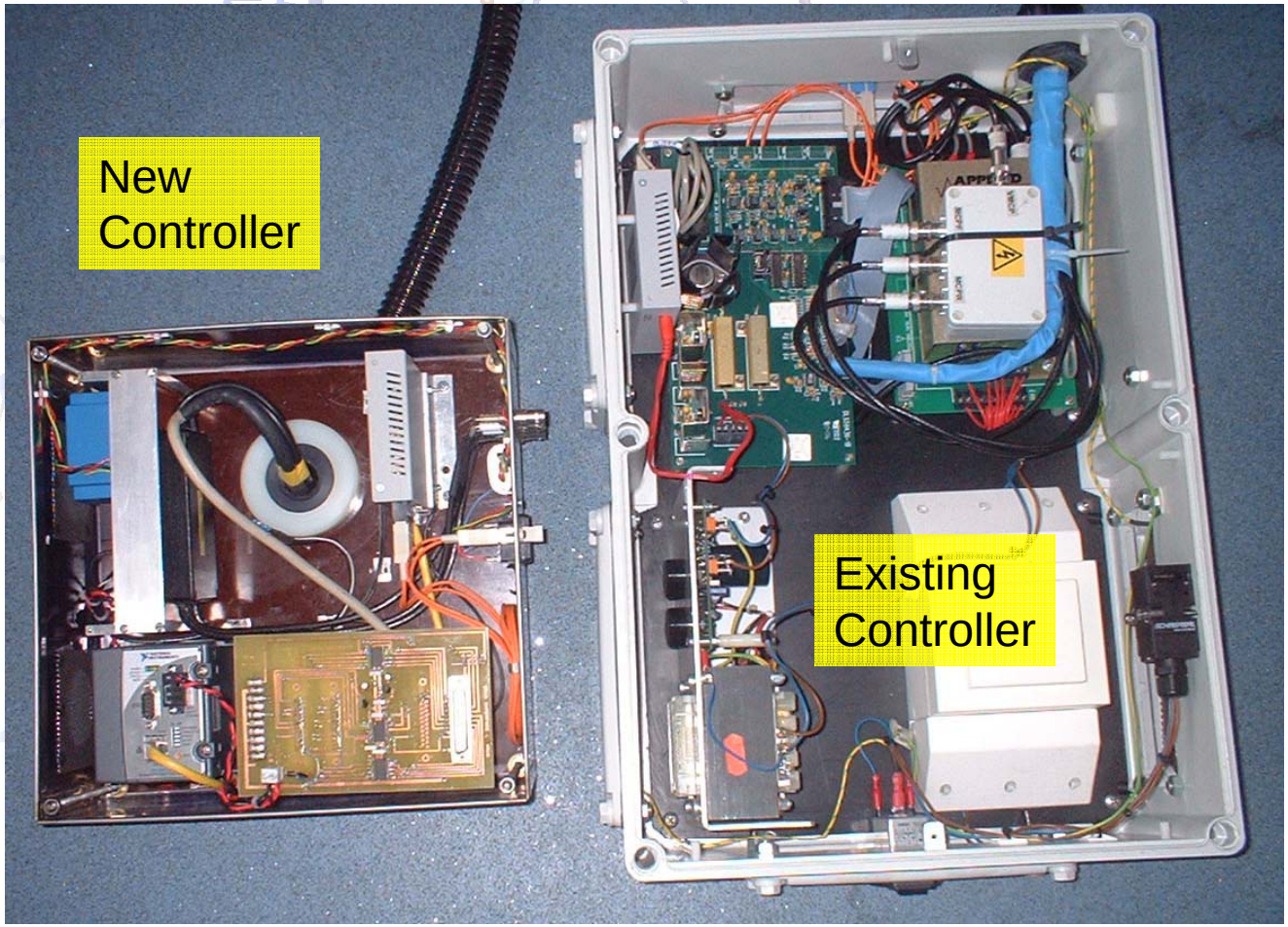
Control Electronics Development



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Detector Applications

- In-situ study of surface processes:
  - Contact Formation
  - Thin Film Growth
- In situ XPS/PES
- Heated stage (up to 1400 °C)
- K-cells + shutter
- CLAM4 Analyser (Lab & SRS)

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Contact Formation on Diamond

- Important for Diamond based devices
- Not predictable
  - Ohmic Contact
  - Shottky Diode
  - Graphitisation
- Depends on
  - Metal
  - Substrate Doping
  - Surface Termination
  - Temperature
  - Etc, etc

Contact Formation on Diamond

- Study by Real Time PES/XPS Lab-based (300W MgKα)
- Single crystal, B doped, p-type <100> CVD
- Deposit Al with k-cell
- Anneal
- Monitor peak intensity & position for C1s

- D. A. Evans, O. R. Roberts, A. R. Vearey-Roberts, et al., Applied Physics Letters 91, 132114 (2007).

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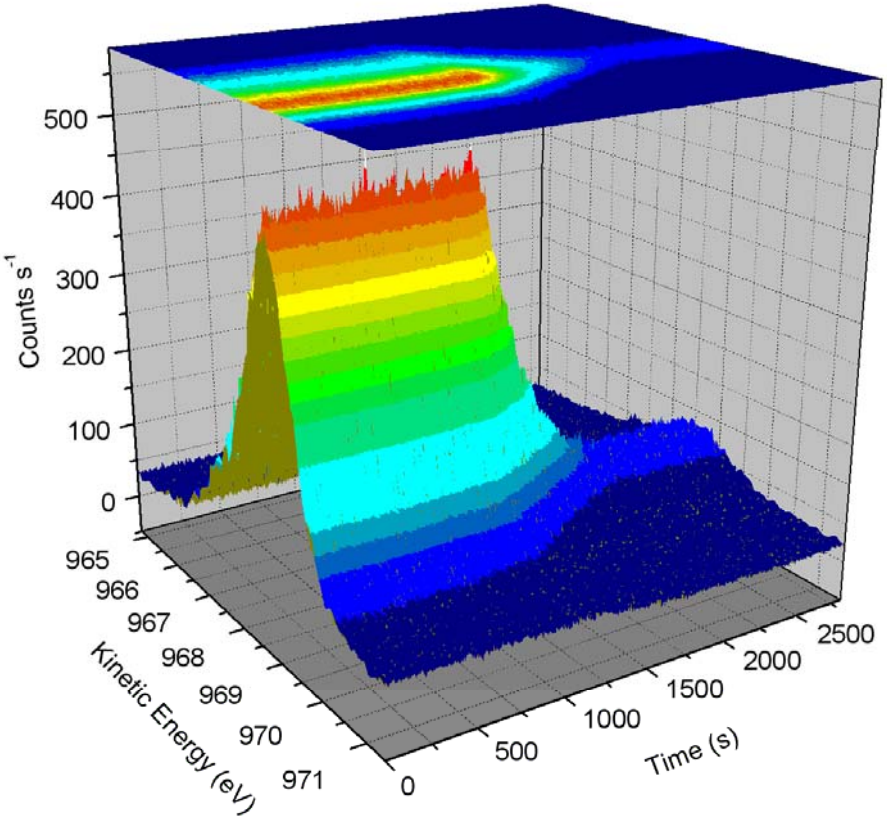
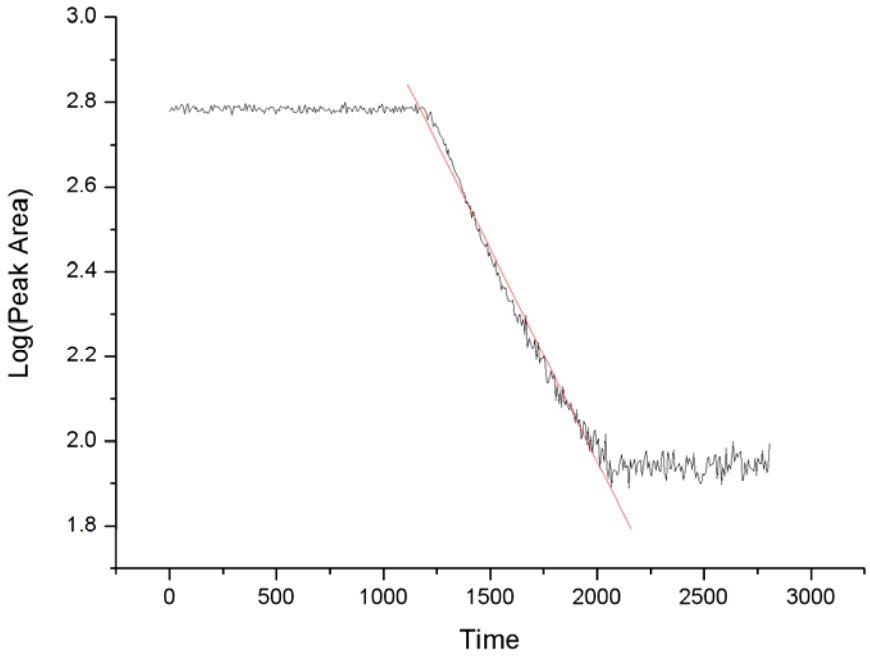
C1s core peak during growth



- 3D plot of array data
- Pixels calibrated in eV
- Shuttered K-cell
- Peak Attenuation gives growth mode



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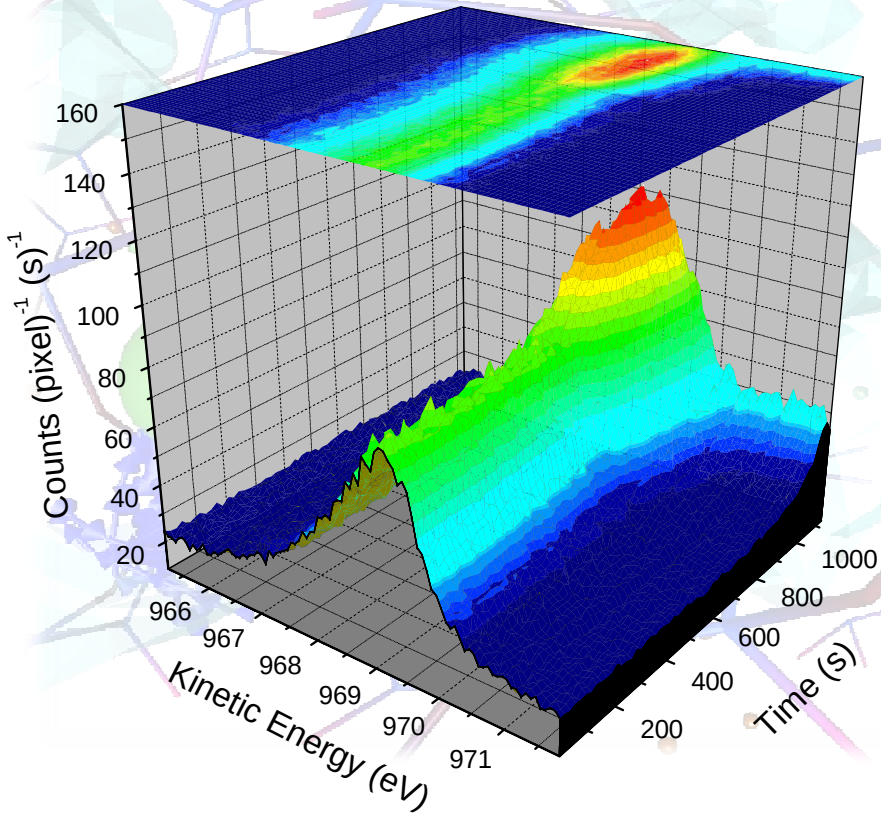
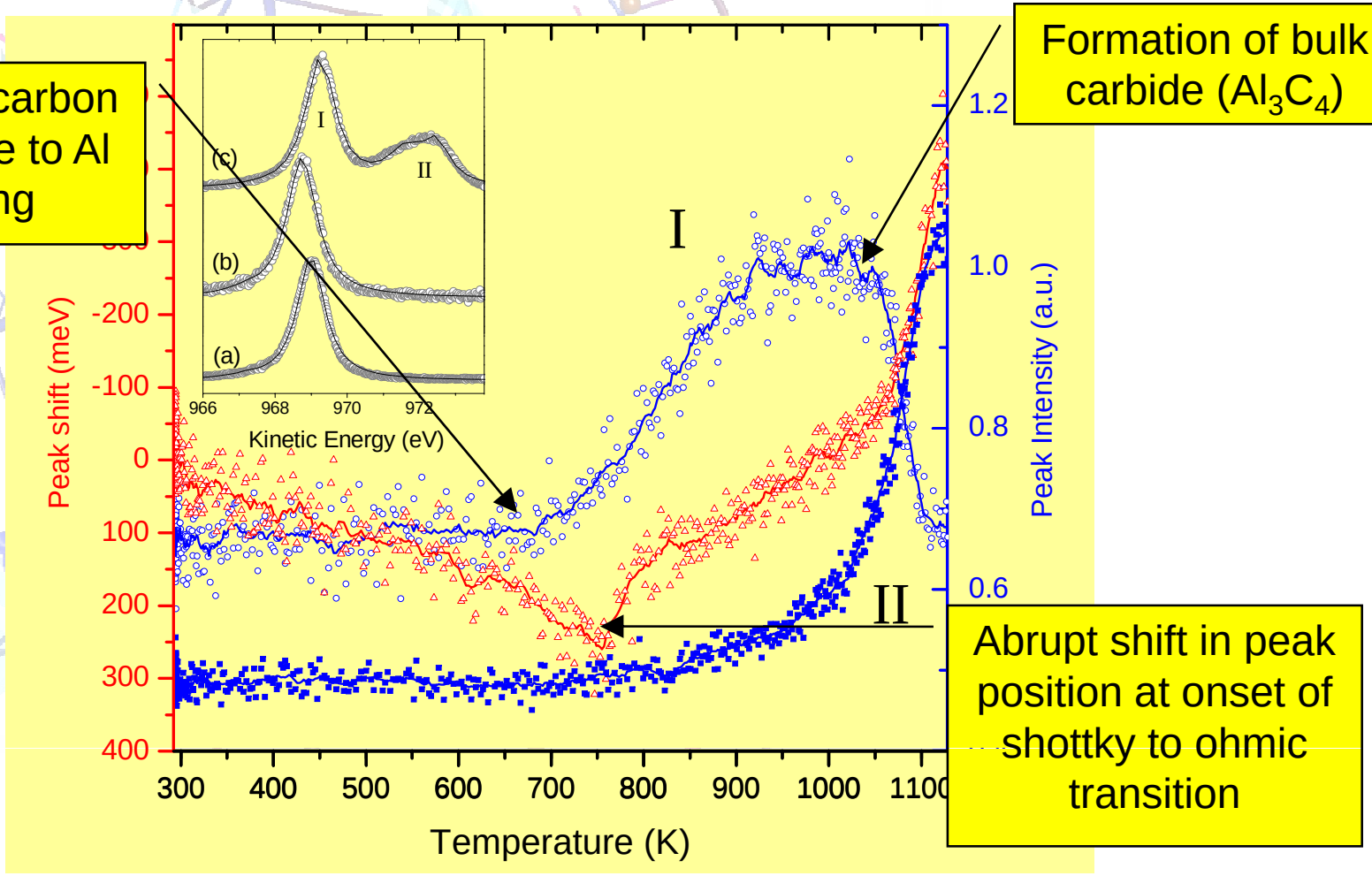
C1s core peak during anneal



- 3D plot of array data
- Pixels calibrated in eV
- 1 sec snapshots
- Heat Ramp applied

- Intensity variation
- Peak Shift

C1s core peak during anneal



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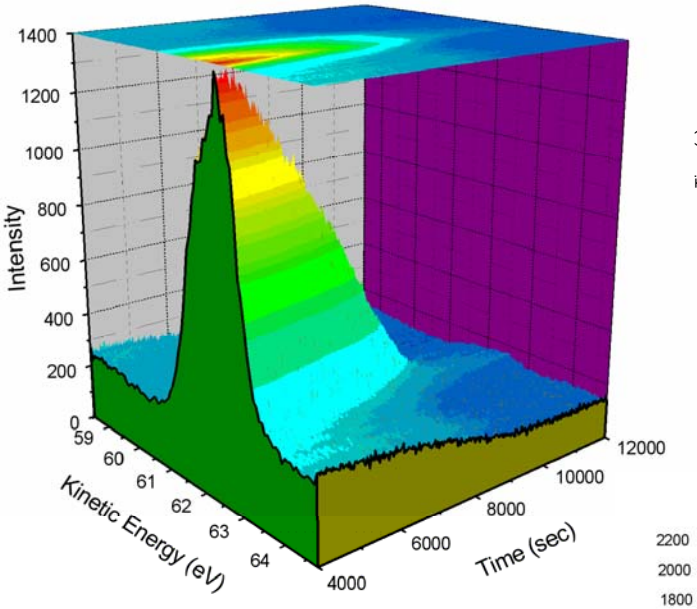
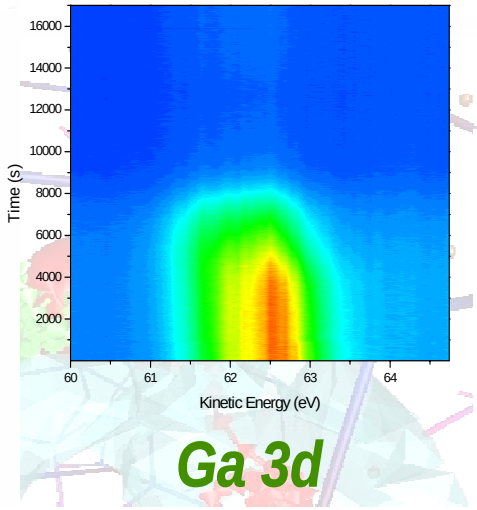
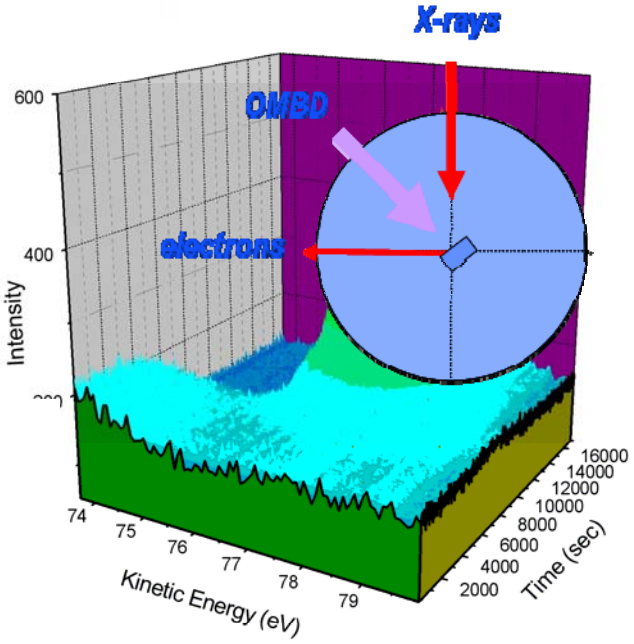
Real-time monitoring of organic thin film growth

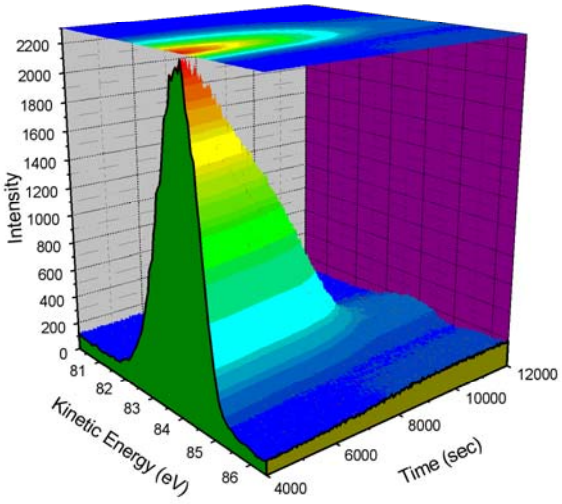




Ga 3d



As 3d



Sn Pc on GaAs

Sn 4d

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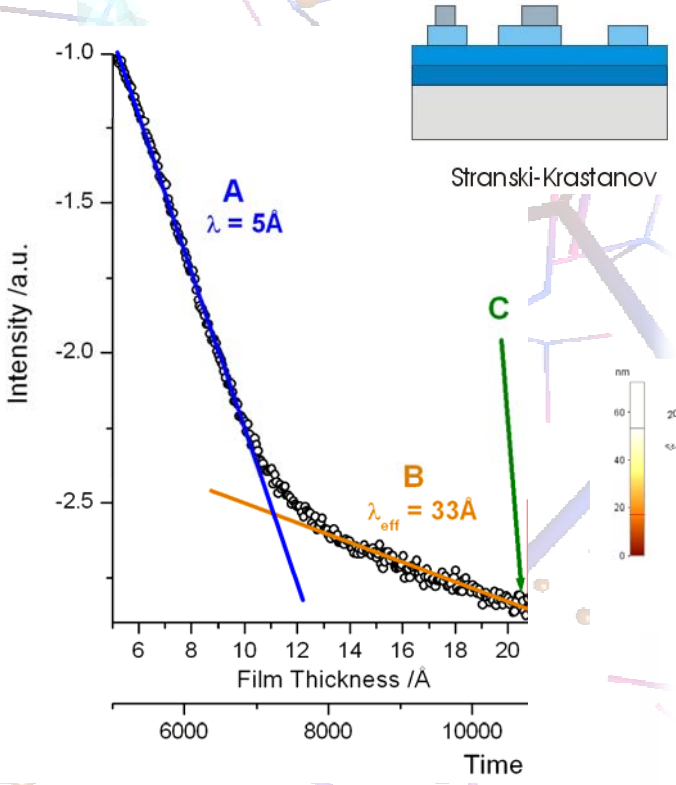
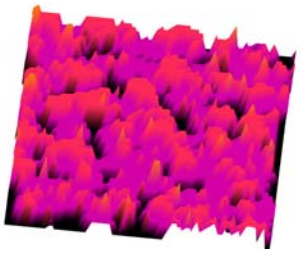
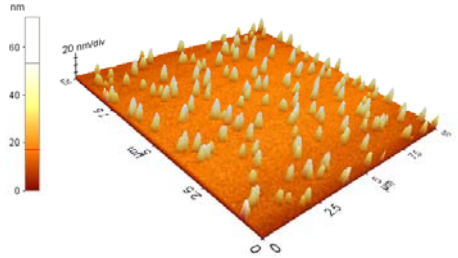
Real-time monitoring of organic thin film growth

- Thin film morphology
- Interface Energetics
- Interface chemistry
- Fast – high throughput





M-C simulation



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Into the Future

- Eliminate Multiple Triggering
  - Charge Cloud Spreading
  - Degrades Spectrum
  - Voting Circuit
  - Post-doc
  - See poster
- Commercialisation

- 2 Dimensions
  - Spatial + Energy
  - Angle + Energy
    ➔ Depth + Energy
  - High Flux / Short Pulse Applications
    ➔ Spread electrons over larger area

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