

# IOP HEPP Conference



UNIVERSITY  
of  
GLASGOW

## Gallium Nitride UV detectors for Synchrotron-based protein structure studies

Andrew Blue<sup>a</sup>

V. O'Shea<sup>a</sup>, W. Cunningham<sup>a</sup>, J. Grant<sup>a</sup>, F. Quarati<sup>a</sup> &  
S. Manolopoulos<sup>b</sup>

<sup>a</sup> University of Glasgow, <sup>b</sup> RAL

*21-23<sup>rd</sup> March 2005*

Andrew Blue

# Outline

## Gallium Nitride

- Properties of GaN
- Design requirements
- Photo & electron beam lithographic fabrication
- Characterisation & optimisation

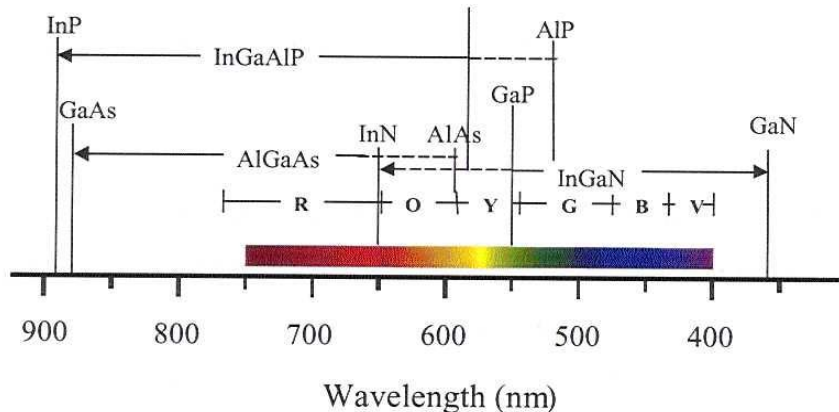
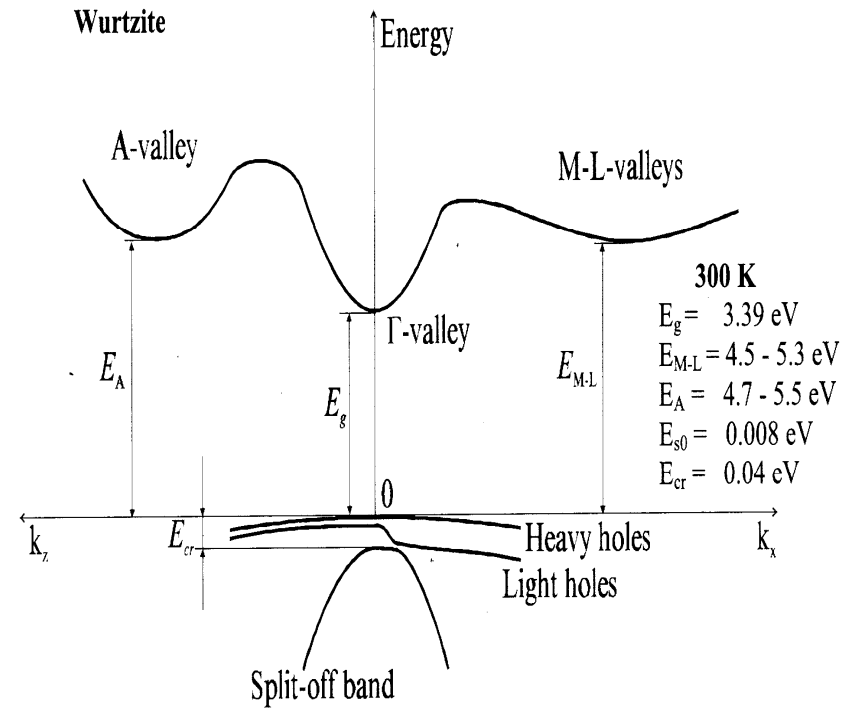
## Biological applications for UV detectors

- Proteomics
- Circular Dichroism (CD)
- Diode requirements for synchrotron based CD experiment
- Diode designs for synchrotron

# Properties of GaN

## GaN (Gallium Nitride)

- Compound semiconductor
  - Direct wide Bandgap ( $\sim 3.4\text{eV}$ )
  - Solar blind material ( $\lambda_{\text{cut}} \sim 360\text{nm}$ )
- $\Rightarrow$  Higher SNR for UV than for eg Si
- $\Rightarrow$  **Ideal material for UV detectors**

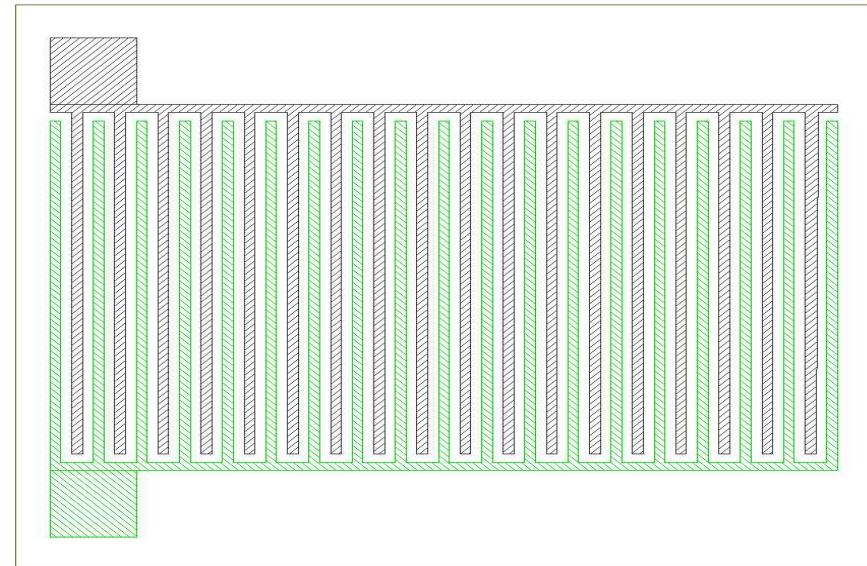
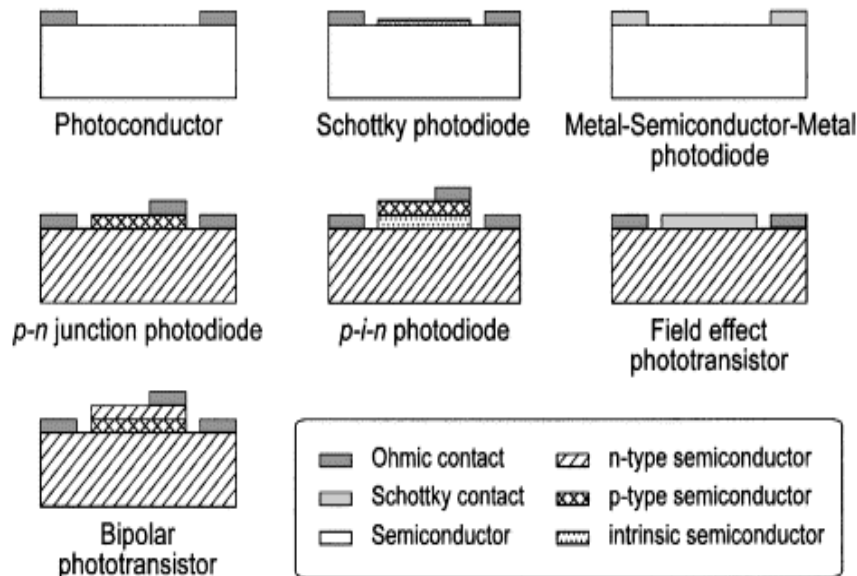


Also applications in blue and UV wavelengths such as lasers and high-brightness LEDs.

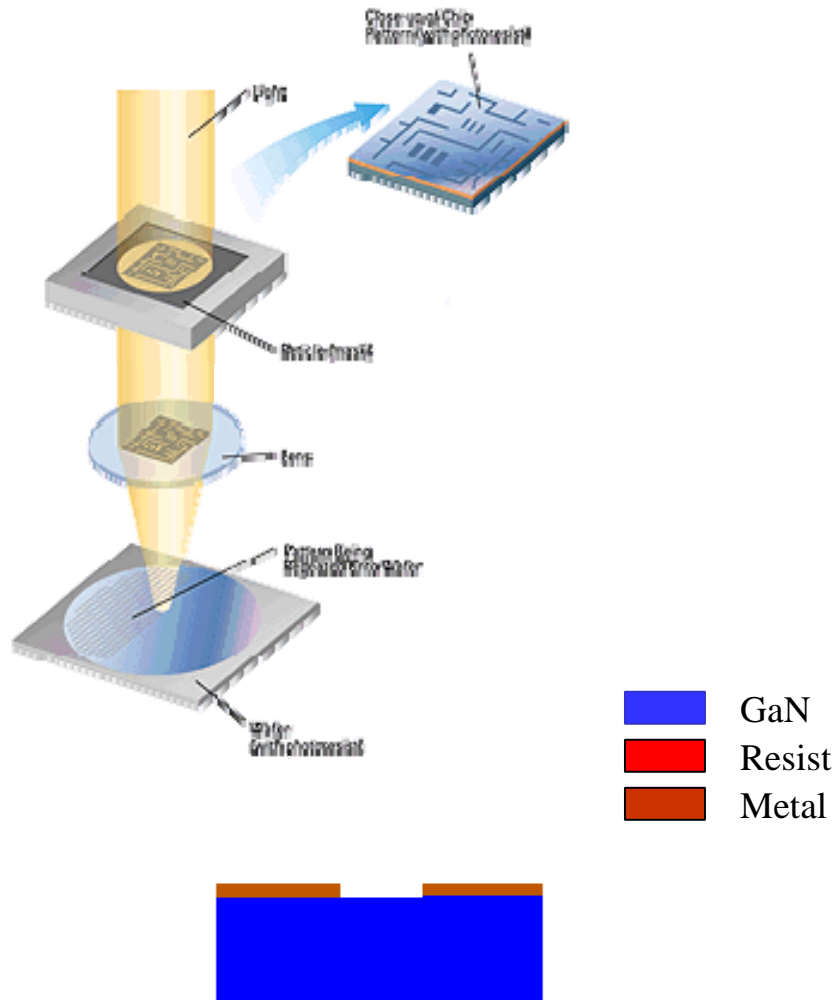
# Design of GaN UV Diodes

MSM (metal-semiconductor-metal) diodes

- Schottky (rectifying) contacts
- Interleaving finger design
  - minimised response time
  - Increased active area



# Fabrication Techniques



Step 1: Clean surface of sample and spin on resist

Step 2: Expose samples to UV/electrons

Step 3: Remove unwanted resist with developer

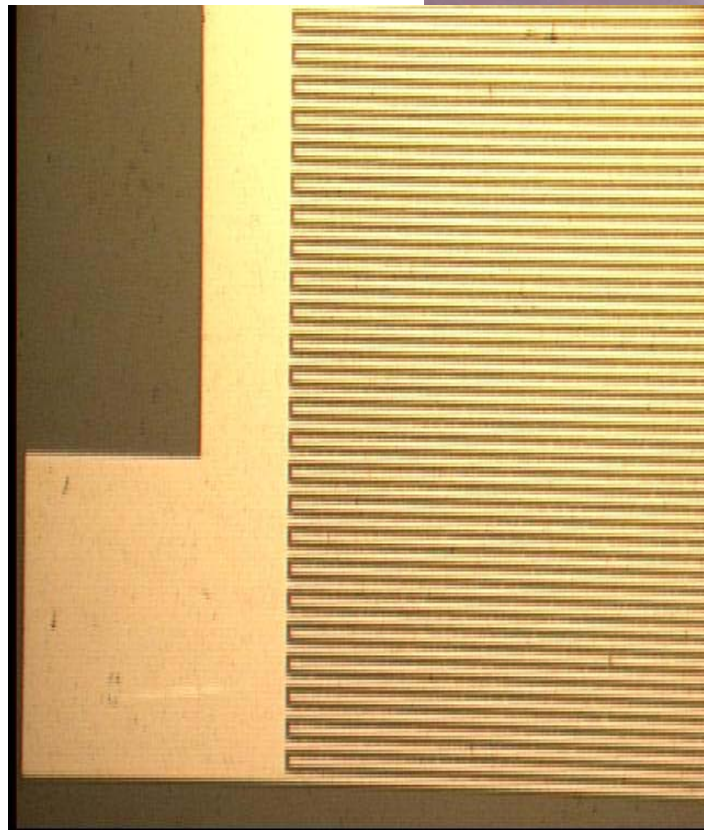
Step 4: Evaporate metal onto the surface of the sample

Step 5: Remove unwanted metal in Acetone

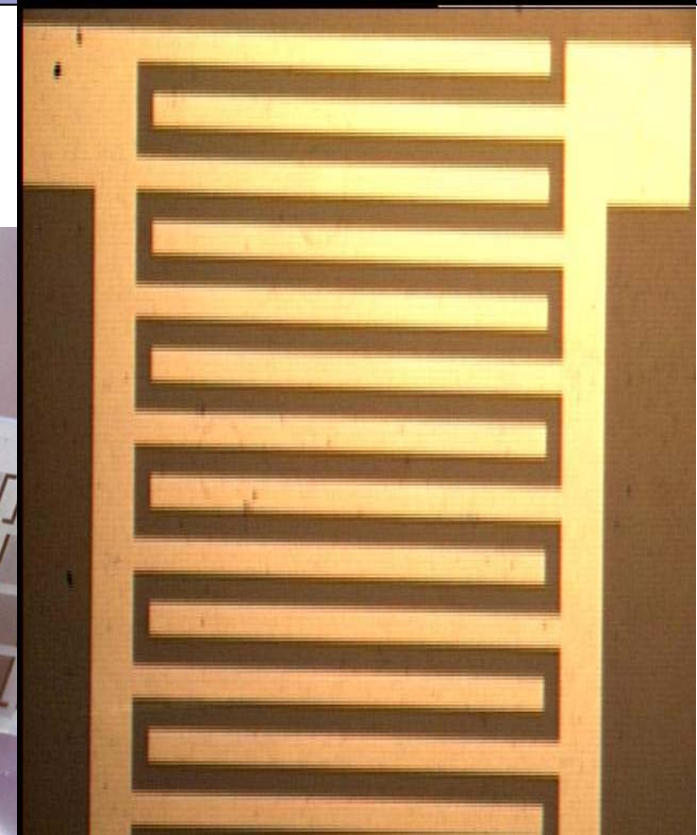
# Fabricated Detectors

Examples of fabricated diodes on GaN

Below: 5 $\mu\text{m}$  fingers  
with 5 $\mu\text{m}$  separation



Contacts formed  
using 80nm Pd



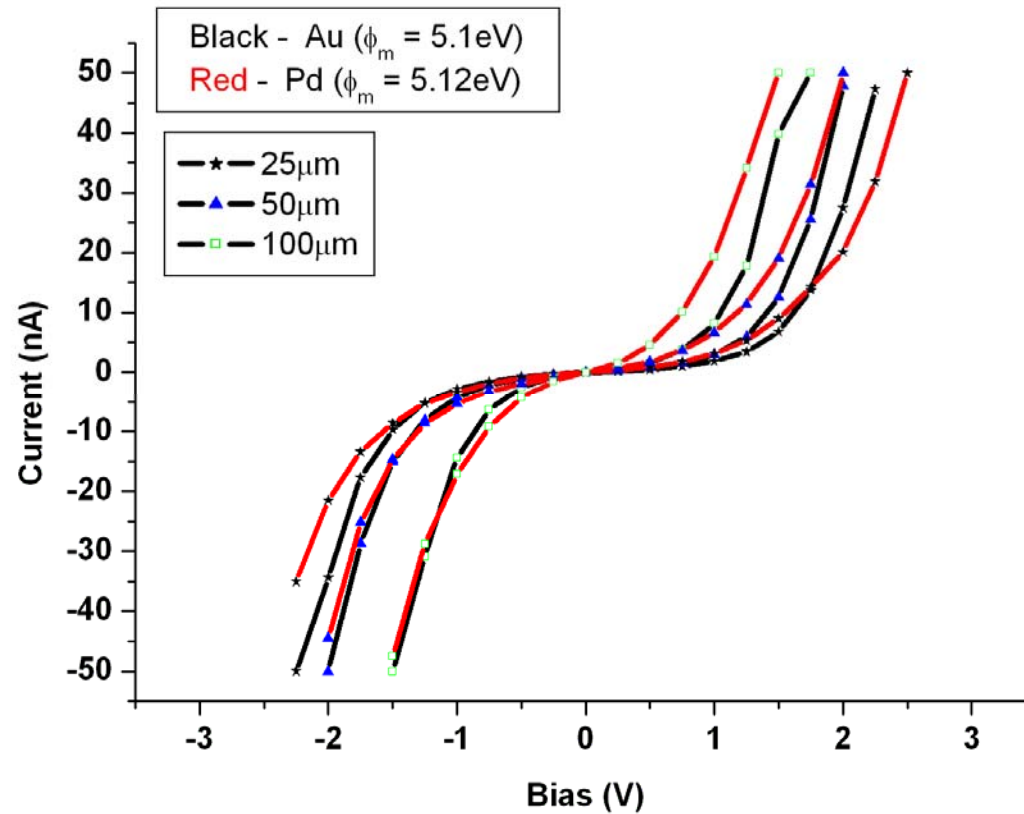
Above: 40 $\mu\text{m}$  fingers with  
40 $\mu\text{m}$  separation

21-23<sup>rd</sup> March 2005

Andrew Blue



# Schottky Contacts



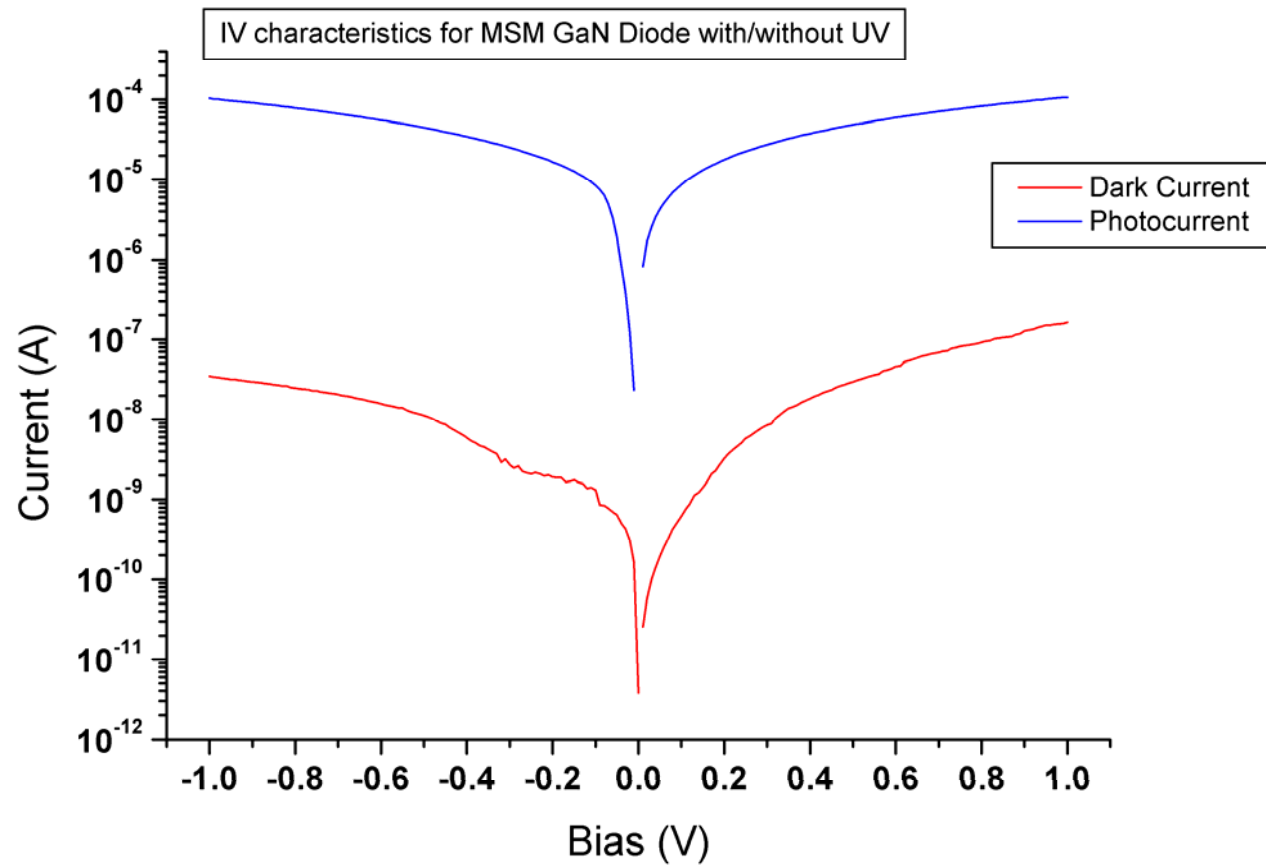
I-V's similar, but

- Pd more successful than Au at lift-off

- Pd more transparent than Au for UV  
(Pd~70%, Au~55%)

⇒ Semi-transparent Contacts

# UV Response

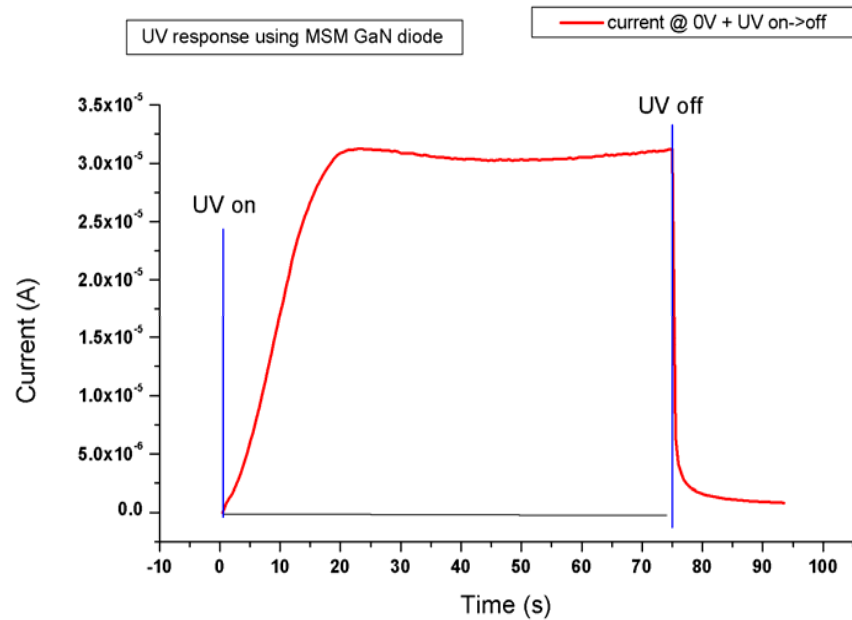


21-23<sup>rd</sup> March 2005

Andrew Blue

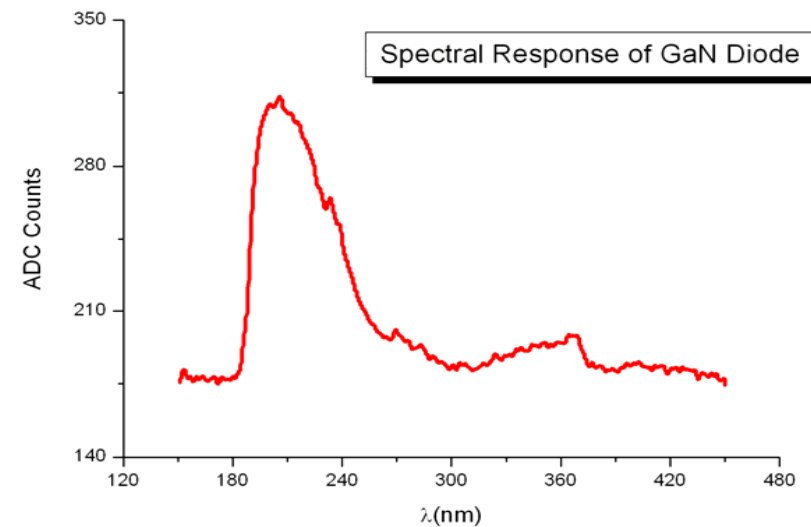


# UV Response



- Material response to UV @ 0V

- Spectral response to Deuterium Source

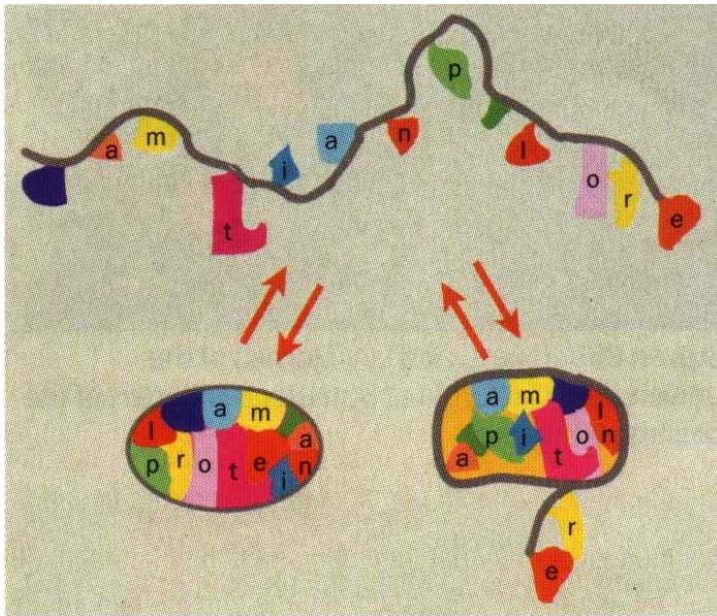
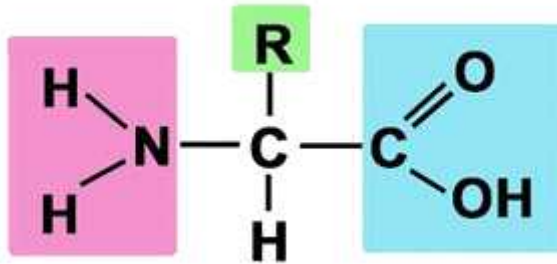


21-23<sup>rd</sup> March 2005

Andrew Blue

# Proteomics

Proteomics – the study of the full expression of proteins by cells in their lifetime

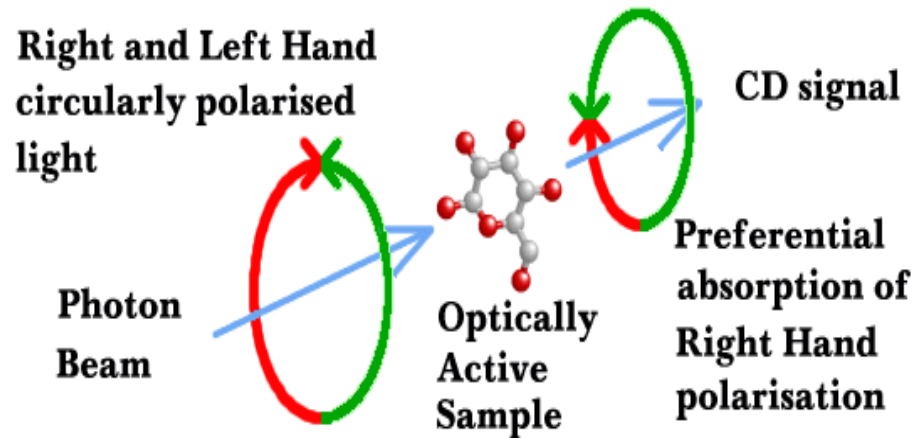


- Proteins are chains of amino acids
- For amino acids to form a protein the extended chain of amino acids must "fold" into a compact globular object with exactly the right shape
- We would like to know more about the “dynamic” and folded structures
- Offers insight to diseases such as Alzheimer's disease and cystic fibrosis, caused by “mis-folding” of proteins

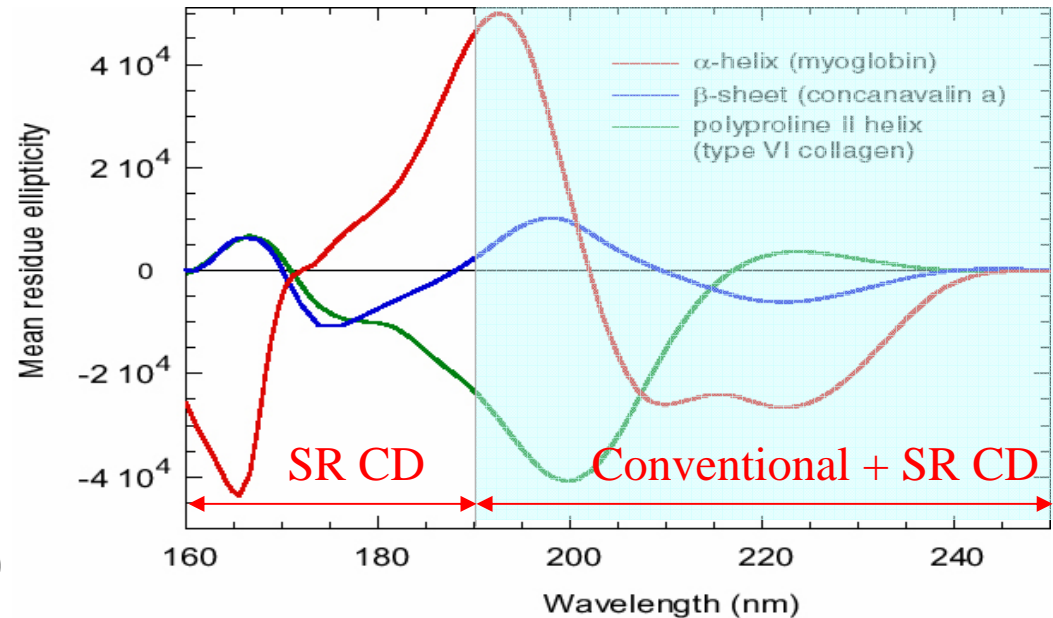
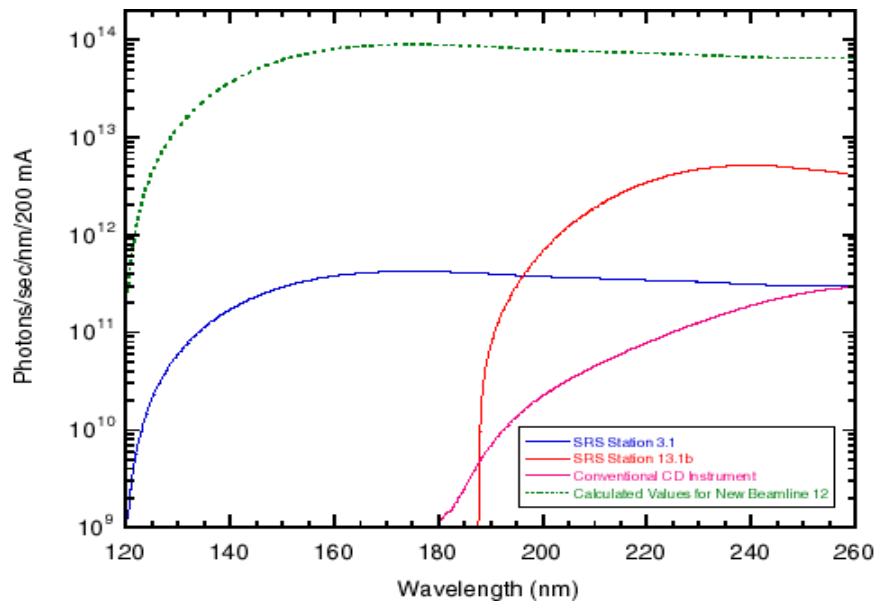
21-23<sup>rd</sup> March 2005

Andrew Blue

# Circular Dichroism



*CD is the measurement of the difference in absorption between left and right circularly polarised light as it passes through a medium*



21-23<sup>rd</sup> March 2005

Andrew Blue

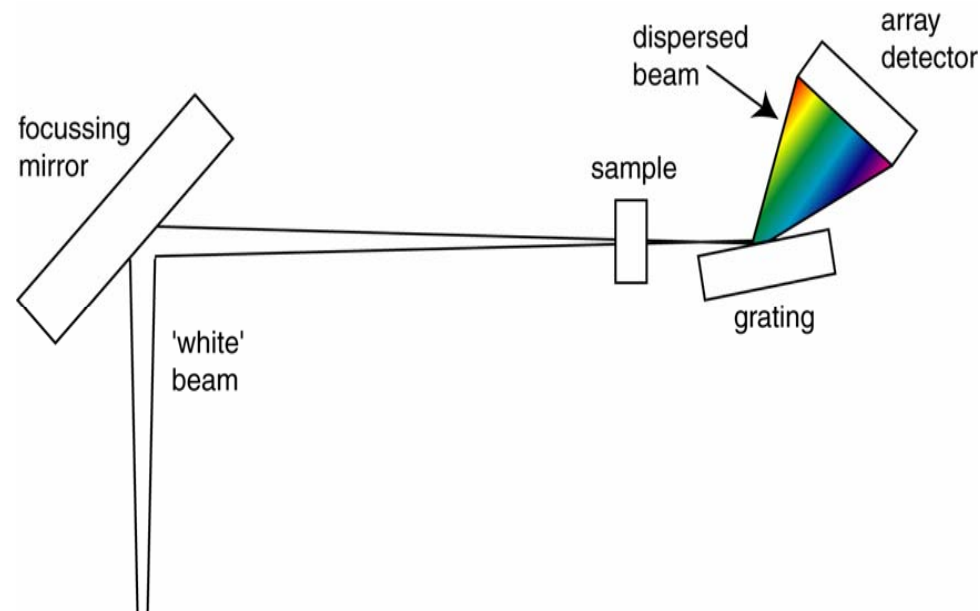
# Synchrotron Based CD Experiment

## Current Method

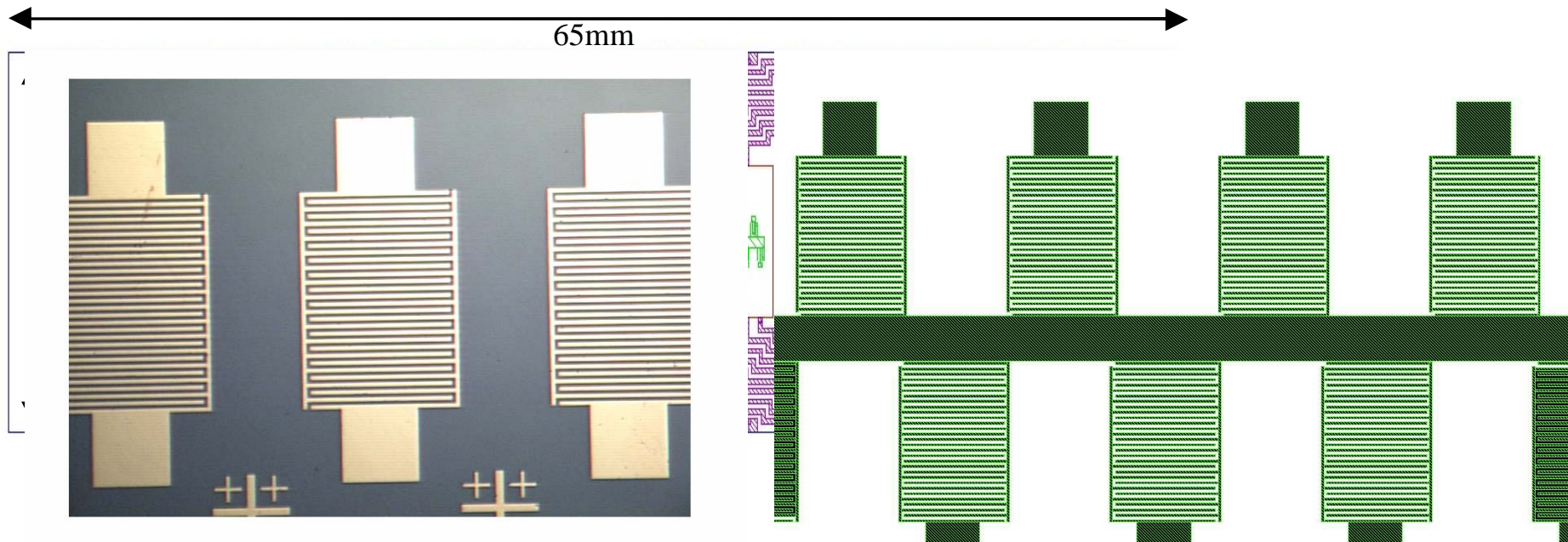
- Measure CD at a  $\lambda$
- Repeat for each  $\lambda$   
=> Slow (can take 2 days/run)
- Uses large amounts of protein

## New Method

- Use Array to measure all  $\lambda$  simultaneously
- Require design for diode with 46 channels



# Design for Synchrotron Diodes



10nm Pd contacts  
Purple - PCB design for  
integration to DIP  
socket

- Entire GaN diode =  $6 \times 20 \text{mm}^2$
- Solar Blind – No need for setup to be “light tight”
- Diode can be operated unbiased – 0V

21-23<sup>rd</sup> March 2005

Andrew Blue

# Conclusions

## Gallium Nitride

- MSM UV detectors designed
- Fabricated using photolithographic methods
- I-V & UV Characterisation

## Biological applications for UV detectors

- Synchrotron based CD experiment
- Diode designs for synchrotron

## Future Work

- Test 5 and 10 $\mu$ m Finger diodes
- Build 16 channel array for testing July '05