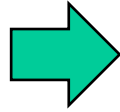# Observatory Sciences Limited (OSL)

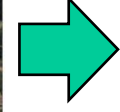*Providing EPICS software and services for physics and astronomy projects*

Genealogy
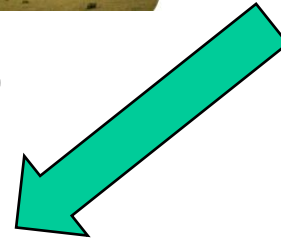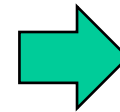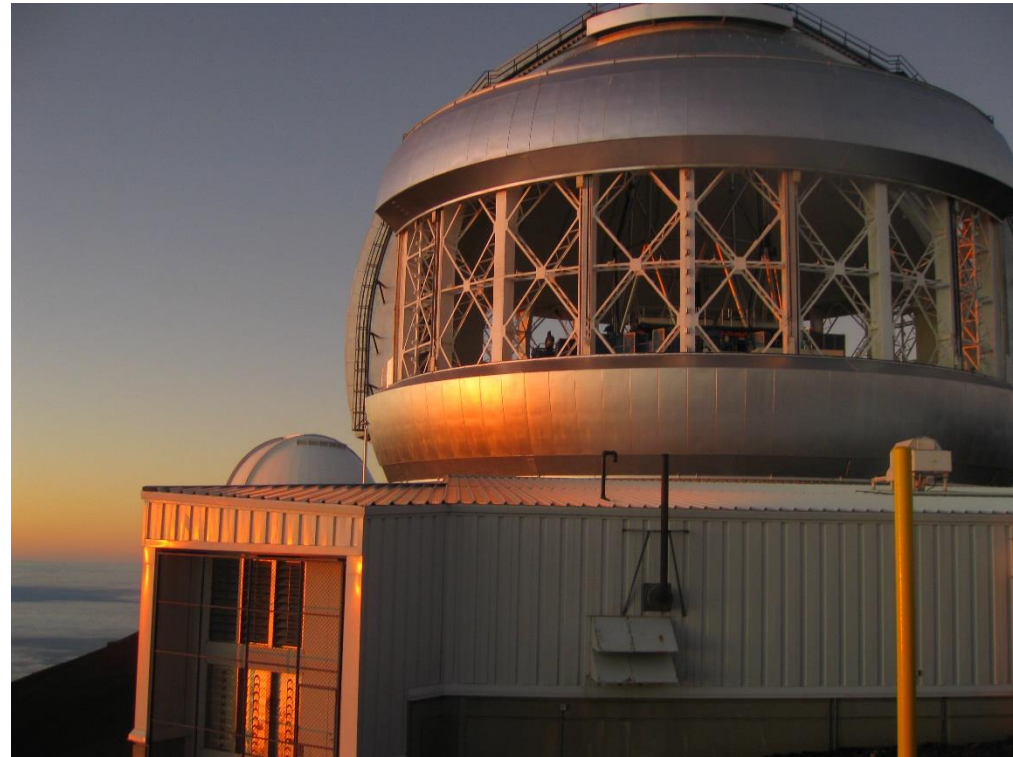
1675 - 1957

1948 - 1990

1990 - 1998

1998 - 2017

2017 -

First Projects - Gemini

TCS and commissioning of many
subsystems: ECS, PCS, MCS…

Where are we now?

12 staff spread across 4 locations:

St Ives, Cambridgeshire
Brighton
Dunfermline (Scotland)
Oxfordshire

85+ years of EPICS experience

50% have a Ph.D. in a scientific discipline
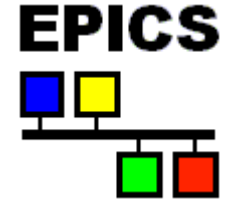
All staff trained in EPICS

For any new companies who want to be involved with EPICS, training is important

Lots of ways to obtain EPICS training these days
- Online YouTube videos from various accelerator schools
- EPICS meetings – first couple of days

EPICS Training

We also offer EPICS training:
- Under normal circumstances, this can be on-site
- Tailored to the requirements of the customer
- Exercises to help with understanding

Over the years, we have given training to many projects:

- Diamond Light Source Ltd
- Australian Synchrotron
- Gemini Observatory (Chile)
- Keck Observatory (Hawaii)
- Australian Square Kilometre Array Pathfinder Project
- ITER Fusion Energy Project, France
- GANIL Heavy Ion Accelerator, France

How we operate in the EPICS Community
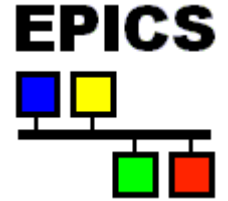
Attendance at EPICS Collaboration Meetings, ICALEPCS…

Work with scientific facilities

Work with hardware manufacturers who want to place their equipment into an EPICS facility

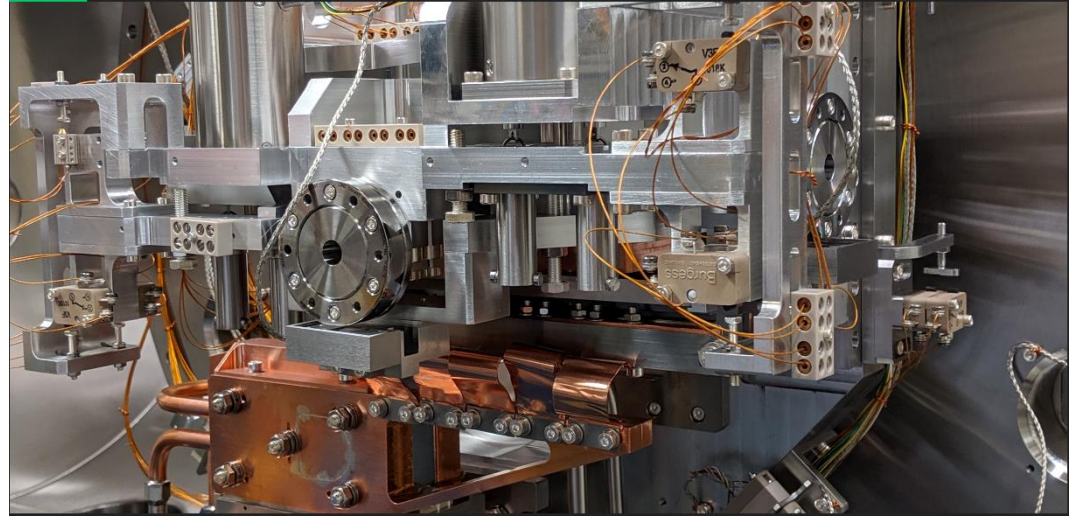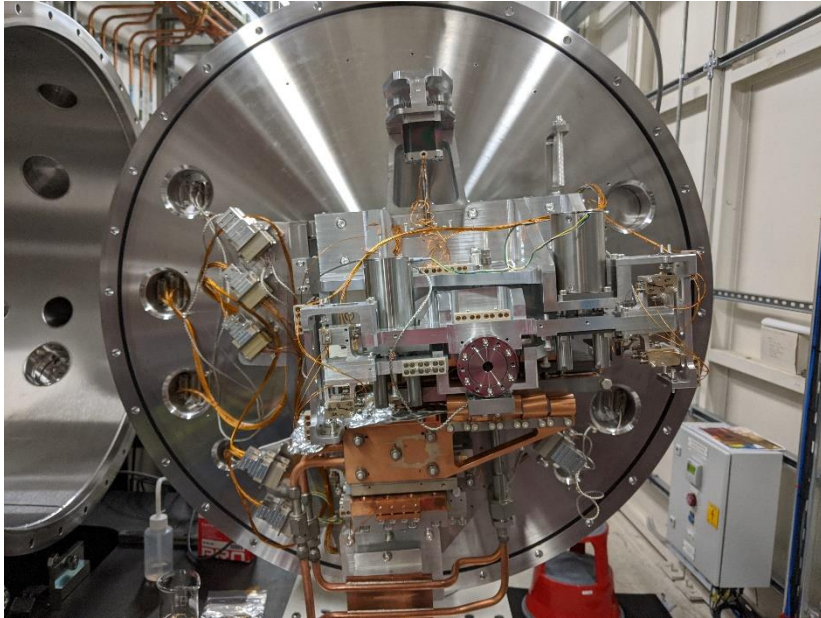On-site (under normal conditions) or office/home based working

On-site working
- Commissioning visits
- Longer term - integration with a team

Fixed price or hourly rate contracts

All of our EPICS software is freely available: website downloads (https://www.observatorysciences.co.uk/downloads_epics_drivers.php) or from Github

Diamond Light Source – DCM's

- Mechanical stability issues lead to new in-house design
- Bounce-up Mono
- Pitch and Roll axes are piezos – control second crystal
- Motor records one for each axis, homing routines, limit-to-limit tests
- Commissioning of Bragg, Perp (Gap), Pitch and Roll axes
  - Working with Diamond survey team to determine Bragg and Gap offsets
- *Andy Peach (Diamond), Mechanical Engineer*
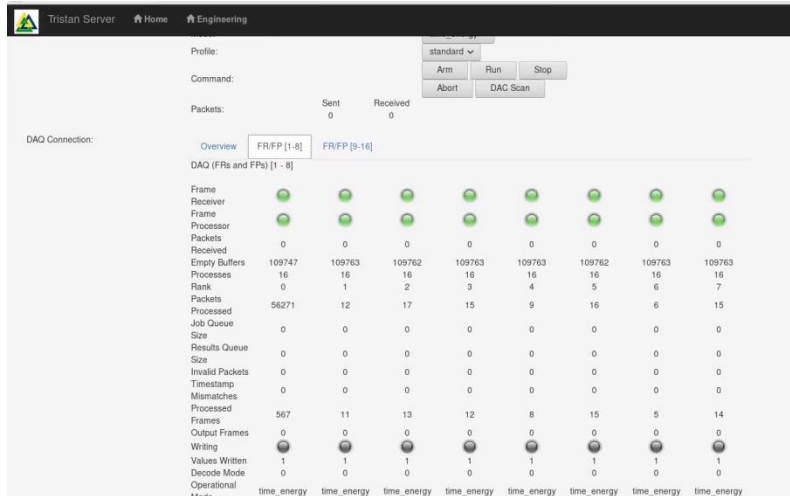
Miro Camera Driver Development Diamond I12

- Vision Research

- Visual camera

- Resolution 1280 x 800 pixels

- 3,200 fps

- Ethernet areaDetector driver

- RAM store and file management (Cine format)

- Export frames to HDF5, TIFF

- Stream frames as MJPG

- Also used in automotive industry for crash testing (not just applicable to scientific institutions)

Tristan Detector Development
Diamond Light Source

- Time-resolved detector (25ns)
- Integrated EPICS with Python Tornado Web Server
- Very high data rates of 400 Gbps
- Software distributed across 10 high performance servers
- Monitoring laser induced nucleation (see new diffraction peak occur as crystal forms)

- *Team: Mark Warren, Giulio Crevatin, David Omar, Scott Williams, William Nicholls, Gary Yendell from Diamond and Tim Nicholls (STFC)*

Fast Bimorphs – Diamond Light Source

- But not just slew rate: Phenomenon such as piezo creep mean bimorphs take a long time to settle (15 minutes on the nanometre scale)
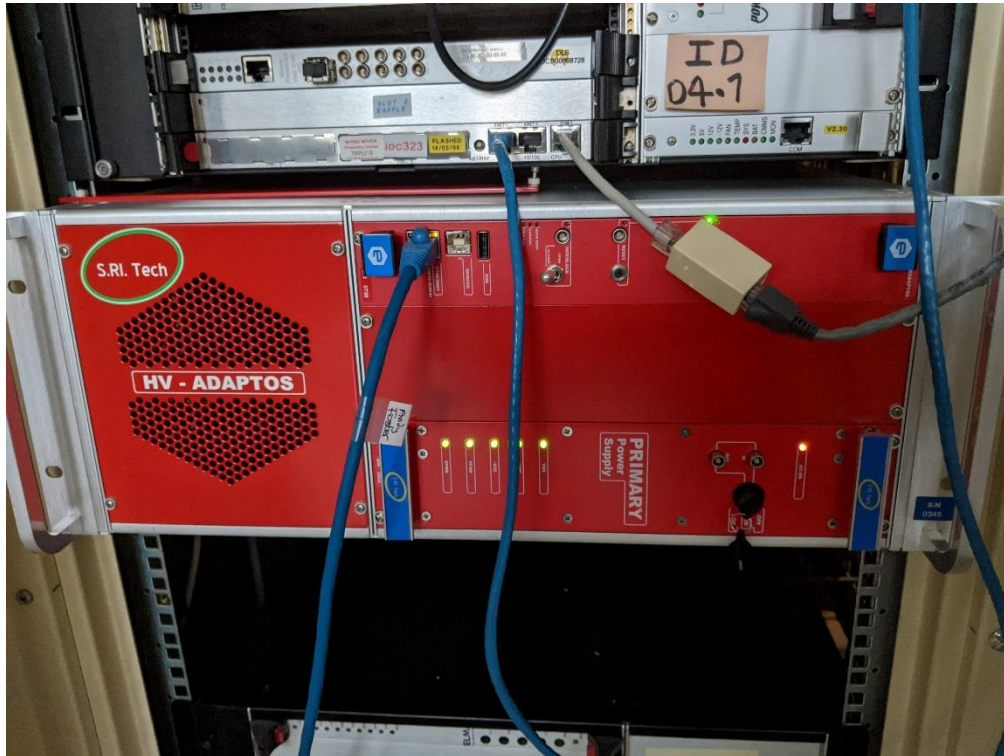
- Deformable "bimorph" mirrors are used to focus X-rays at many synchrotrons & XFELs

- HV-ADAPTOS from CAENels used to control 14 bimorphs on 5 beamlines at Diamond

- Up to 16 piezo strips attached to the back of each mirror

- Apply voltages to bend mirror and change beam size Traditionally, this has been a very slow process (slew rates 10 V/s)

- This PSU is capable of providing slew rates of 100's V/s

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Fast Bimorphs – Diamond Light Source
Automated compensation of piezo creep

- Piezo creep can be reliably predicted and automatically compensated

- Apply larger target voltage

- Then, automatically apply small voltage offsets as a time series afterwards

- *Team: Simon Alcock, John Sutter from the Diamond Optics Group and Riccardo Signorato (Cinel), Matteo Fusco (Caen).*
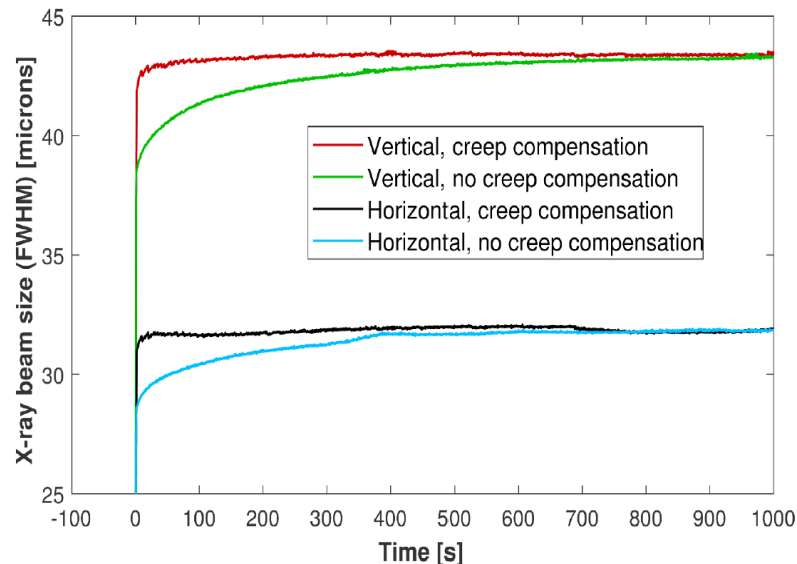
-> 2D X-ray beam size changed and stabilised in < 10 s!!!

→ Can focus / defocus both mirrors simultaneously

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VMXm: A new micro/nanofocus protein crystallography beamline
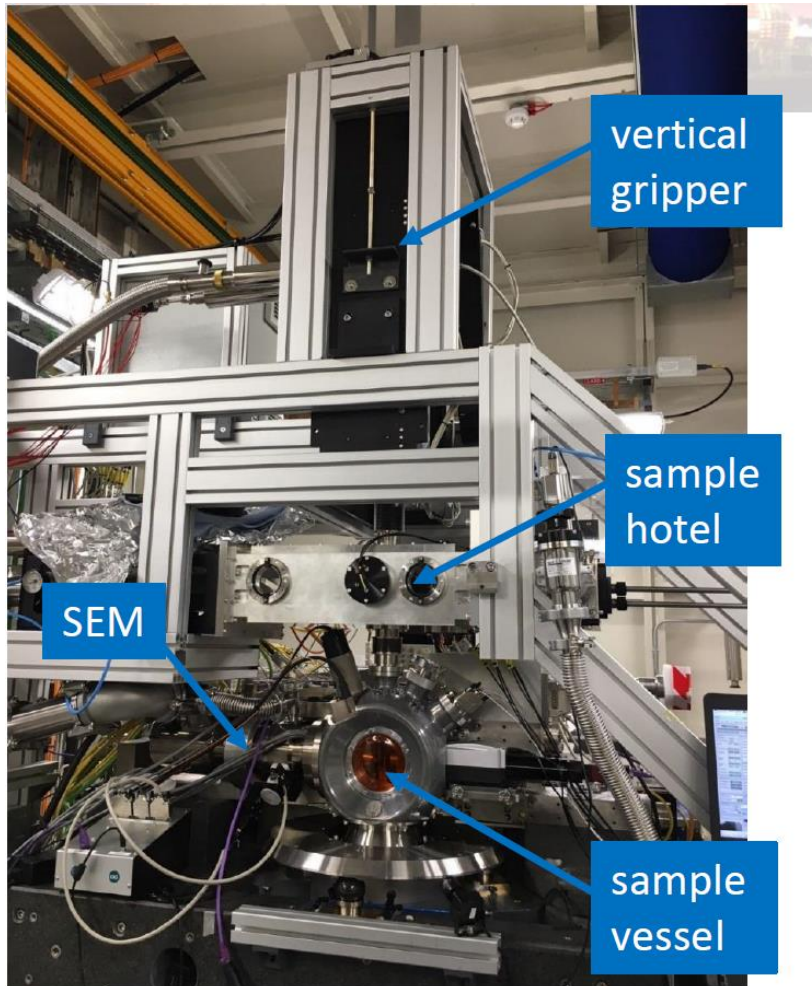
- Lots of challenges!
- Samples sizes down to 500nm (Human hair width ~20,000nm)
- X-ray beamsize < 0.5µm
- Need an electron microscope to see them!
- Very high stability (30nm), using 14 interferometers
- Complex sample loading
  - Sequencing of moves with careful checks to avoid collisions
  - EPICS / PMAC PLC's
  - Optical sensors

VMXm: Fast Shutter
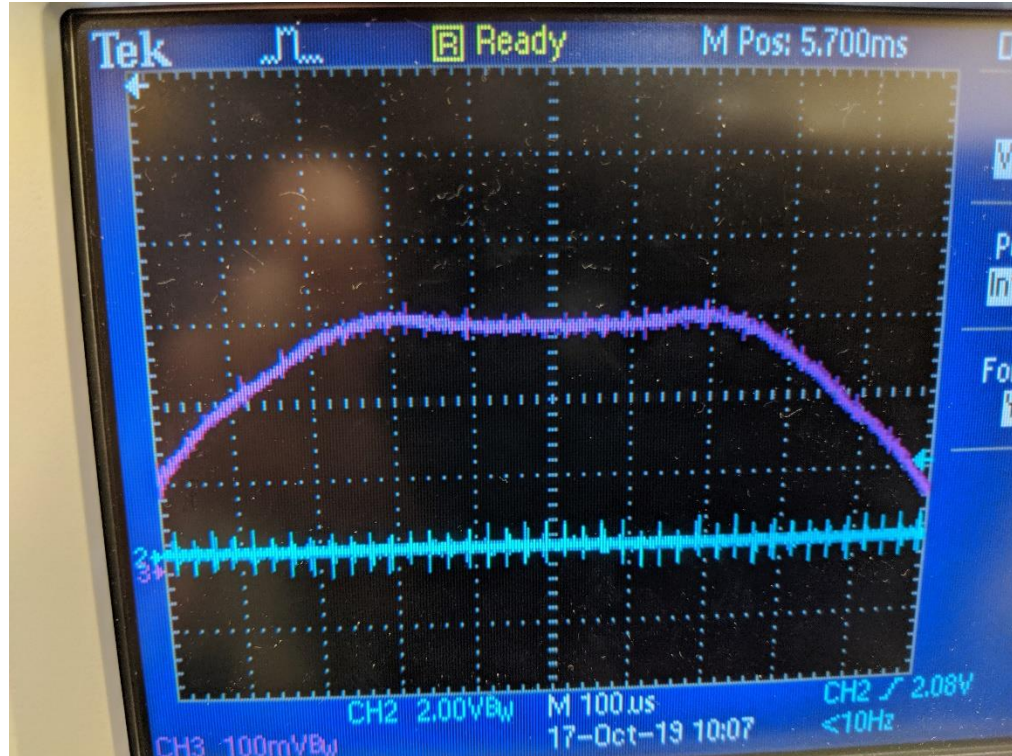
- Propellor blades
- 7200 rpm
- PMAC PLC 0

- 300µs opening time
- *Diamond Beamline Team: Gwyndaf Evans, Jose Trincao, Graham Duller et al.*

Australian Synchrotron

- Became operational during 2007.

- Working with Accel GmbH (Cologne, Germany), developed beamline control software.

- Assisted in commissioning.

- 2011: On-site (Melbourne) consultancy for 10 weeks
    - working to upgrade and improve the EPICS control software for the XAS beamline
    - Sharing ideas and "best practices" regarding EPICS infrastructure set-up learned from Diamond
    - Sharing our experiences with Delta Tau (PMAC) motion control

NSLS-II Insertion Devices

- Observatory Sciences, working with Heason Technology Ltd and Danfysik (Denmark)

- EPICS control system for a set of 6 Damping Wigglers

- EPICS control system for an In-Vacuum Undulator device for the IXS beamline

Indian Medical Cyclotron

October 18, 2018

EPICS Control:
- Siemens PLCs
- GigE cameras
- Magnet Power Supplies
- Vacuum equipment
- Signal Generator

- 15kW Medical Cyclotron at the Variable Energy Cyclotron Center (VECC), Calcutta, India

- Used to produce radioisotopes for diagnostic and therapeutic use

- Operational: September 2018

- BARC and IGCAR Beamlines (4th and 5th Beamlines). Hardware produced by Danfysik (Denmark)

- Their requirements were to run IOC's on 64-bit Windows 7 and use LabVIEW for the GUI.

- Office development and On-site commissioning.

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PMAC: Device Integration

- Observatory Sciences, working with Diamond & Faraday Motion Controls (formerly Delta Tau UK). A new EPICS driver for Turbo PMAC and PowerPMAC motion controllers:
  - Trajectory scanning
  - Improved logging & debugging (single motor or coordinate system)
  - Statistics on messages transferred between EPICS and controller
  - Dynamically swapping between pre-defined coordinate systems
- *Diamond Team: Giles Knapp, Gary Yendell, Brian Nutter & the motion team*
- https://github.com/dls-controls/pmac

EPICS driver for IOxOS's ADC_3117

The ADC_3117

- 20 channel analog-to-digital converter
- 16-bit data @ 5 Msps
- Form Factor: FPGA Mezzanine card with High Pin Count
- Fits on carrier board with an FPGA to control the ADC
- Slots into a μTCA crate

- Created an asyn-based EPICS driver
- Runs on a single-board computer (RT Linux)
- Communicates with FPGA over the ePIC bus
- EPICS database to control ADC parameters
- Collected data appears as a waveform record.
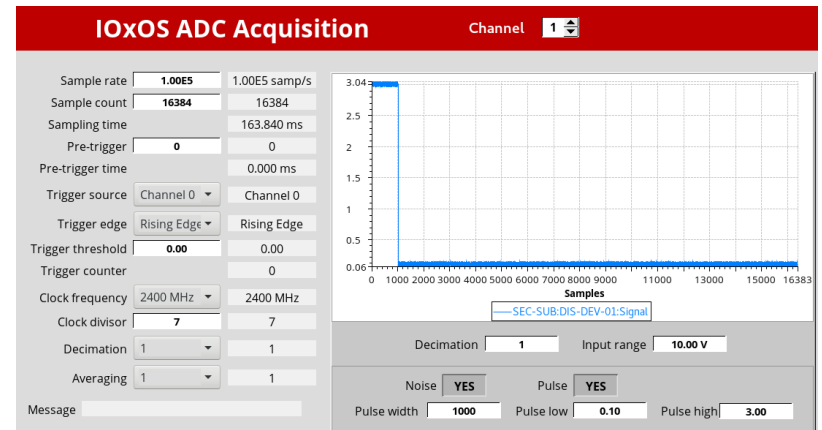
Electron Analyser
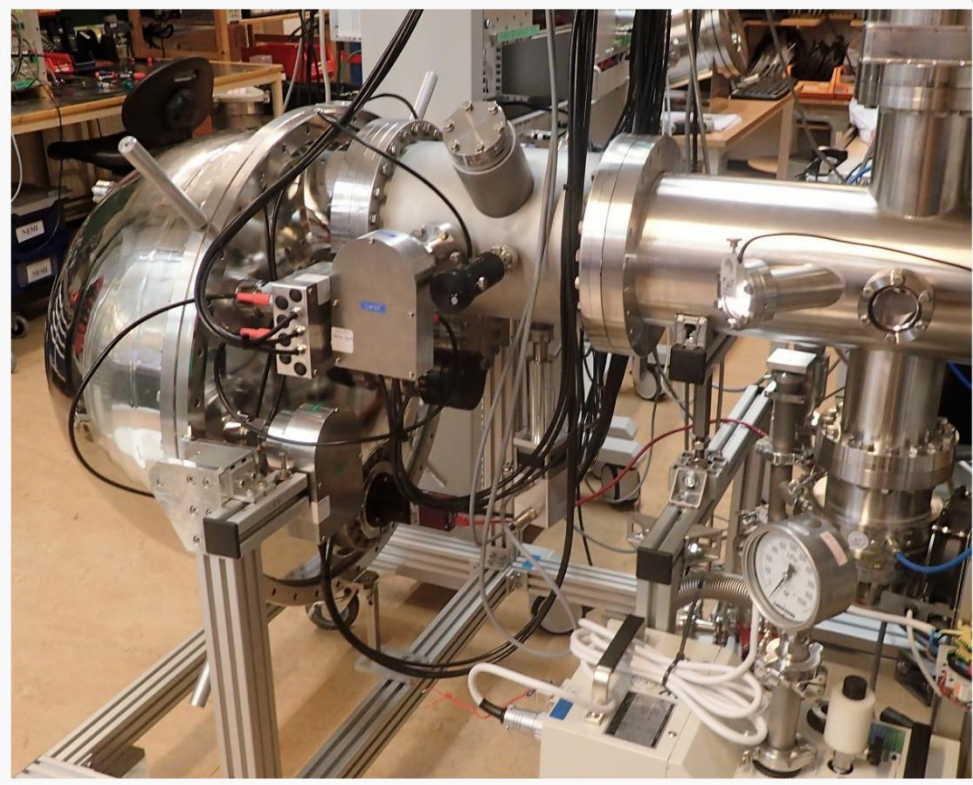
- Separates electrons out into a spectrum around hemisphere; Extremely high resolution
- Working closely with an Electron Analyser manufacturer we have developed EPICS support for their equipment.
- LabVIEW "wrapper" application, running on a Windows PC
- EPICS areaDetector (Linux) with socket communication to Windows LabVIEW

Summary
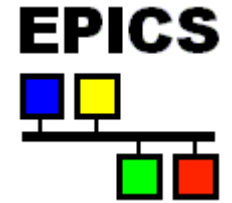
- What is our experience of working in the EPICS community?
  - Extremely Positive!

- Why?
  - Open source software
  - Very helpful community where 99% of the time, someone will be able to answer your question
  - By following a few simple rules, you get a lot for free!
  - There's always a way of solving your control problem with EPICS!