



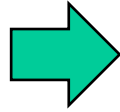
Observatory Sciences Limited (OSL)

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

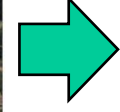
Genealogy



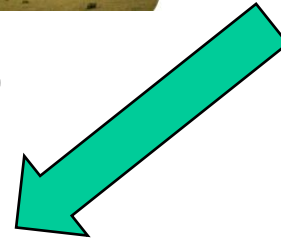
1675 - 1957



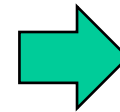
1948 - 1990



1990 - 1998



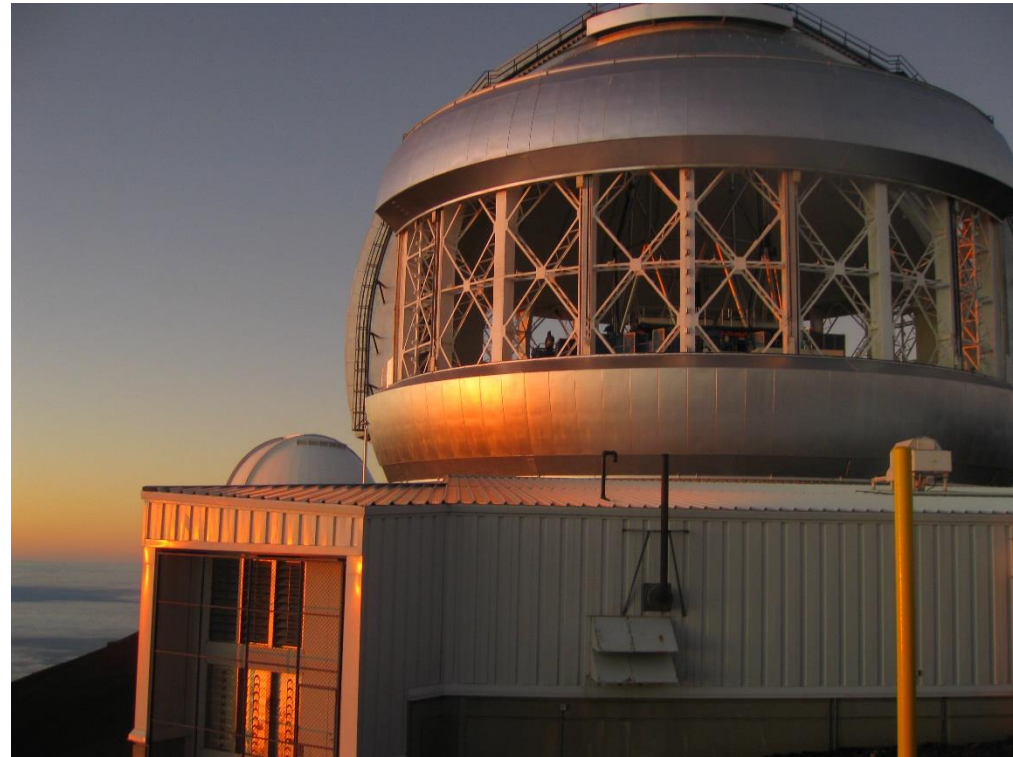
1998 - 2017



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

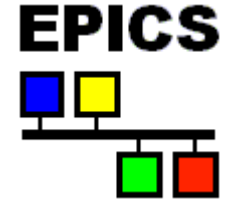
For any new companies who want to be involved with EPICS, training is important

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:

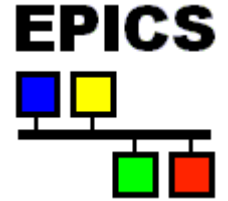
- Under normal circumstances, this can be on-site
- Tailored to the requirements of the customer
- Exercises to help with understanding

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

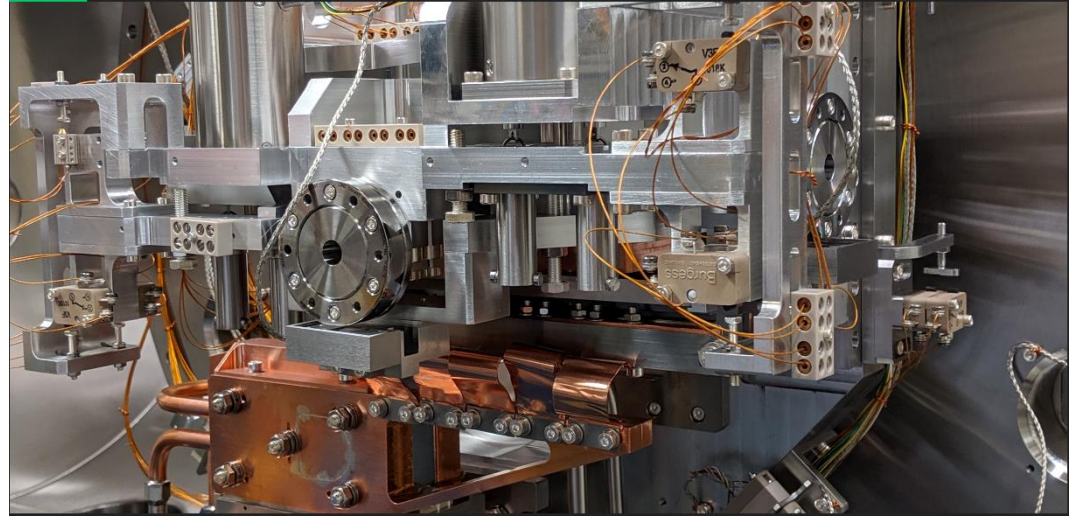
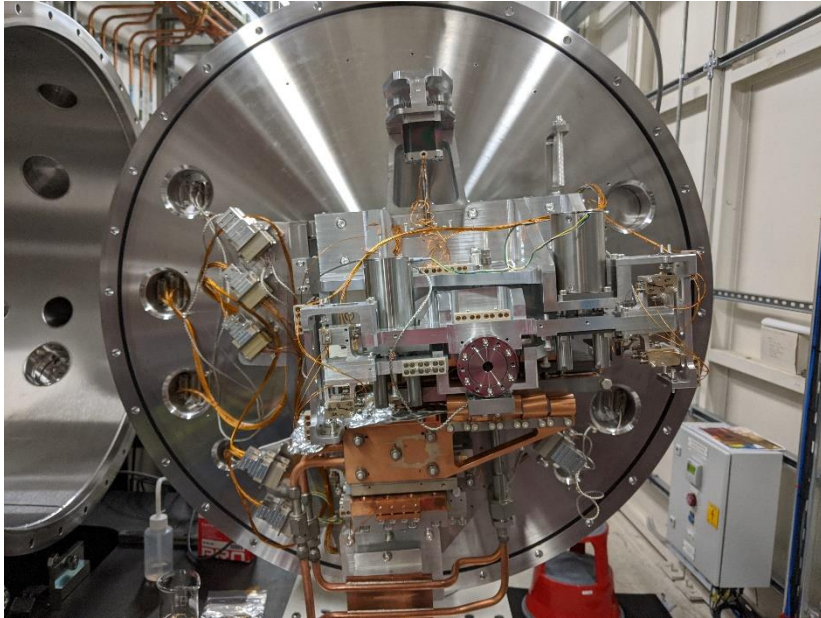
On-site working

- 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

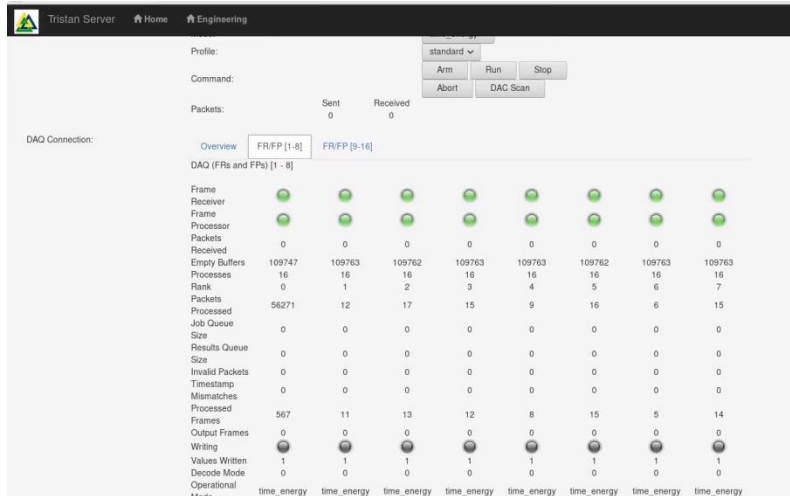
Diamond I12

- 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)



The image displays three overlapping windows from the Miro camera driver software. The top-left window, titled 'Device - miro', shows the main configuration interface with tabs for 'Info', 'Image', 'Acquisition', 'Status', 'Live Preview', 'Perform Black Reference', 'Cine File', and 'Details'. The 'Acquisition' panel is active, showing parameters like Exposure (0.010000 s), Acquisition Period (0.010000 s), and Sensor Size (1280 x 800). The 'Status' panel shows 'Acquisition Active' as green. The 'Cine File' panel shows 'Selected Cine to acquire to' as 1. The top-right window, titled 'miro Top', shows 'Camera Details' and 'Cine Files'. The 'Camera Details' panel shows Sensor Temperature (25.00 deg), Camera Temperature (25.00 deg), Thermo Electric Power (0.00 %), Fan Power (0.00 %), EDR (ns), External Sync (FSYNC), Frame Delay (us), Trigger Edge (RISING), Trigger Filter (us), Ready Signal (TRIGGER), and Aux Pin Mode (MEMGATE). The 'Cine Files' panel shows a table of 16 cine files with columns for Cine, Invalid, Valid, Ready, Saved, and Active. The bottom window, titled 'miroFlashDetails.edl', shows 'Flash Memory Status' and 'Flash File Download'. The 'Flash Memory Status' panel shows Memory State (Ready), Action Counter (0), Total Size (2048000 bytes), Used Size (0 bytes), and Action Progress Counter (0). The 'Flash File Table' shows a table of files with columns for File Name, File Size, and Date. The 'Flash File Download' panel shows a 'Selected File' section and a 'Download' button.

Tristan Detector Development Diamond Light Source



Tristan Server Home Engineering

Profile: standard

Command: [Buttons: Arm, Run, Stop, Abort, DAC Scan]

Packets: Sent 0 Received 0

DAQ Connection: Overview FR/FP [1-8] FR/FP [9-16]

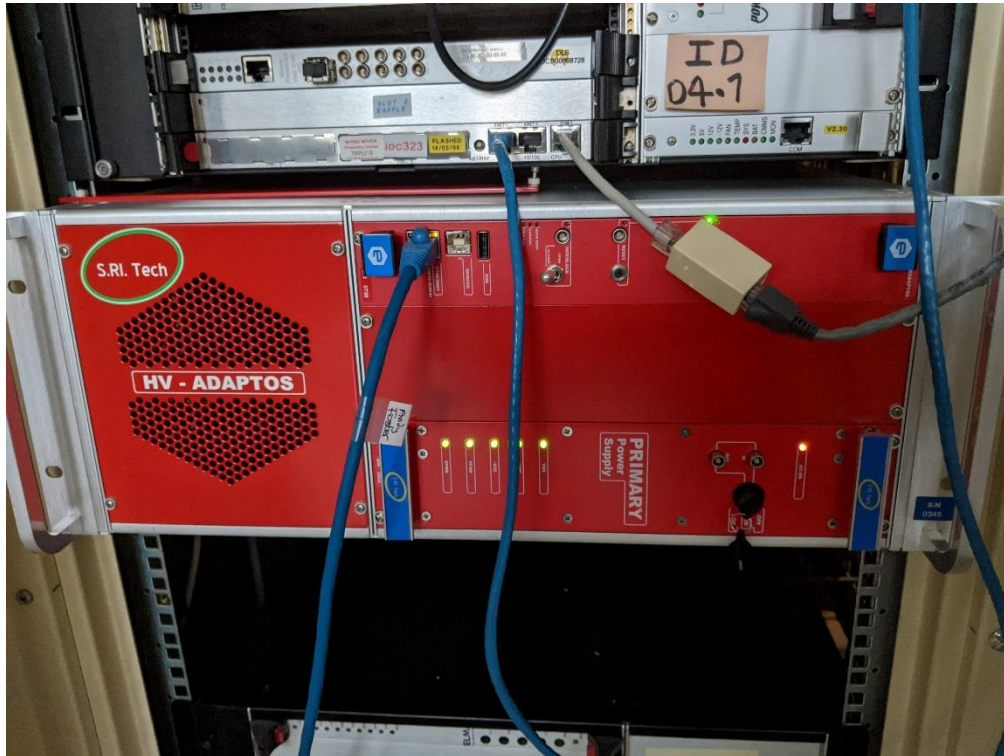
DAQ (FRs and FPs) [1 - 8]

Frame Receiver	●	●	●	●	●	●	●	●
Frame Processor	●	●	●	●	●	●	●	●
Packets Received	0	0	0	0	0	0	0	0
Empty Buffers	109747	109763	109762	109763	109763	109762	109763	109763
Processes	16	16	16	16	16	16	16	16
Rank	0	1	2	3	4	5	6	7
Packets Processed	56271	12	17	15	9	16	6	15
Job Queue Size	0	0	0	0	0	0	0	0
Results Queue Size	0	0	0	0	0	0	0	0
Invalid Packets	0	0	0	0	0	0	0	0
Timestamp Mismatches	0	0	0	0	0	0	0	0
Processed Frames	567	11	13	12	8	15	5	14
Output Frames	0	0	0	0	0	0	0	0
Writing	●	●	●	●	●	●	●	●
Values Written	1	1	1	1	1	1	1	1
Decode Mode	0	0	0	0	0	0	0	0
Operational Mode	time_energy	time_energy	time_energy	time_energy	time_energy	time_energy	time_energy	time_energy

- 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)*



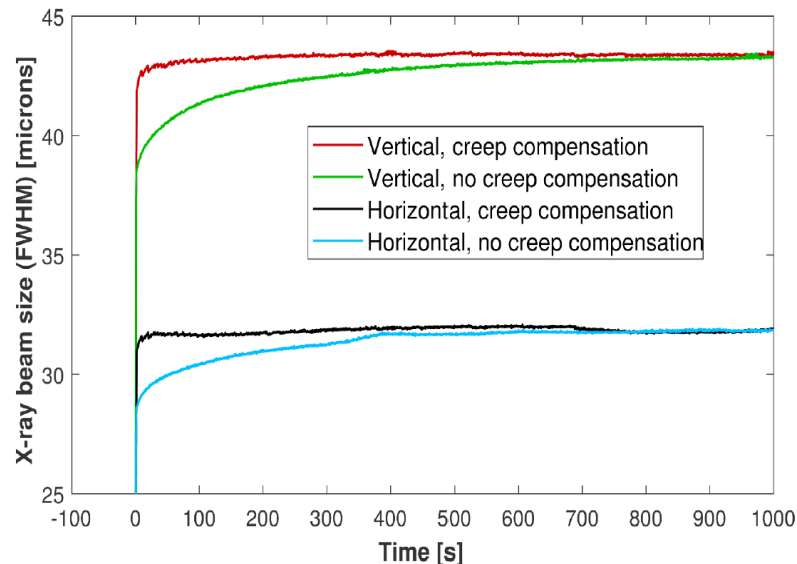
Fast Bimorphs – Diamond Light Source



- 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
- But not just slew rate: Phenomenon such as piezo creep mean bimorphs take a long time to settle (15 minutes on the nanometre scale)

Fast Bimorphs – Diamond Light Source

Automated compensation of piezo creep

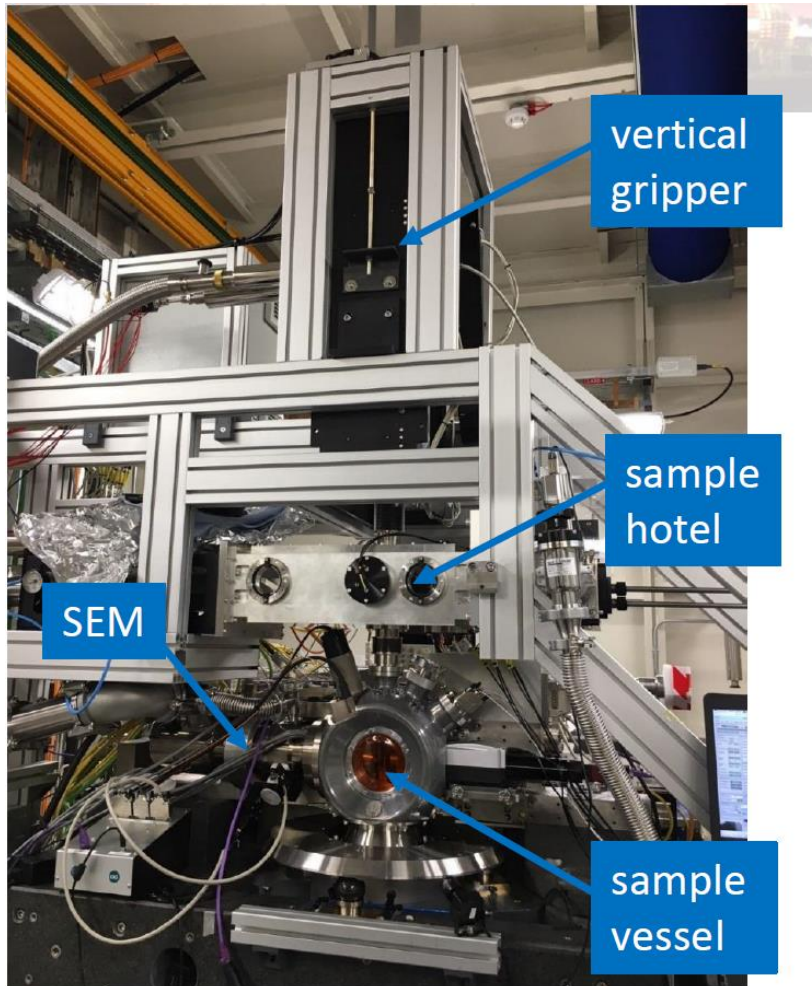


-> 2D X-ray beam size changed and stabilised in < 10 s!!!

→ Can focus / defocus both mirrors simultaneously

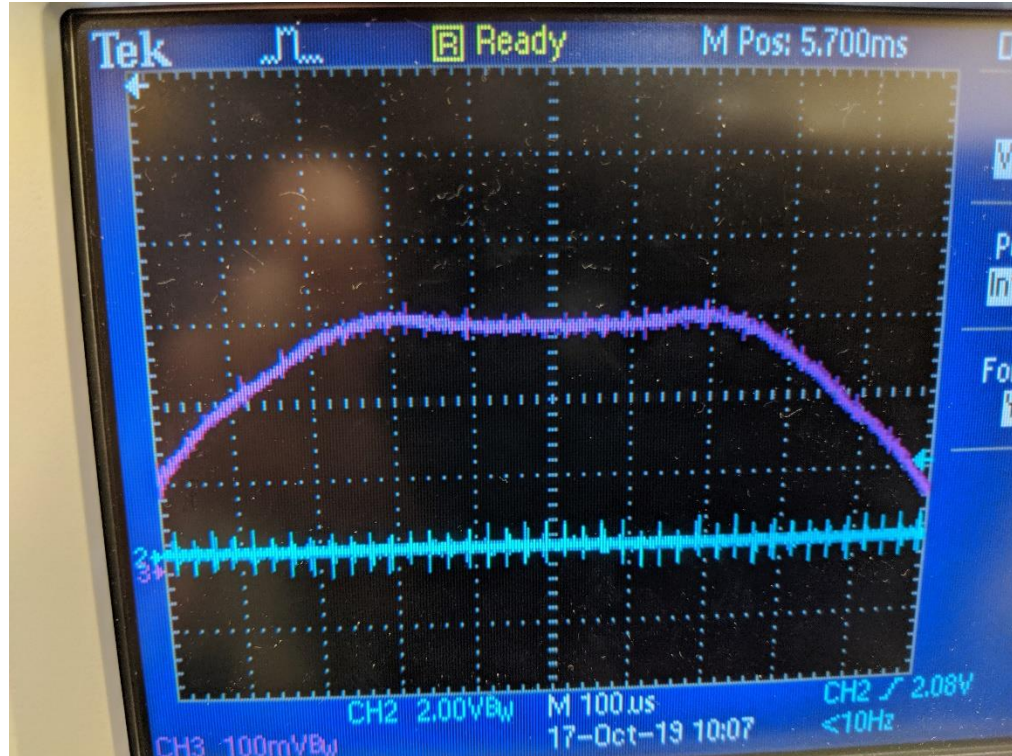
- Piezo creep can be reliably predicted and automatically compensated
- Apply larger target voltage
- Then, automatically apply small voltage offsets as a time series afterwards
- *Team: Simon Alcock, John Sutter from the Diamond Optics Group and Riccardo Signorato (Cinel), Matteo Fusco (Caen).*

VMXm: A new micro/nanofocus protein crystallography beamline



- Lots of challenges!
- Samples sizes down to 500nm (Human hair width ~20,000nm)
- X-ray beamsize < 0.5 μ m
- 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

- 300 μ s opening time
- *Diamond Beamline Team: Gwyndaf Evans, Jose Trincão, 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



- 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.

EPICS Control:

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

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>

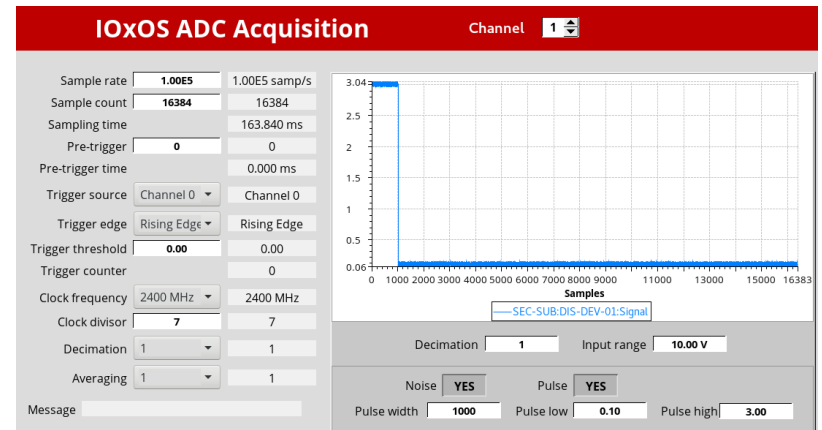
EPICS driver for IOxOS's ADC_3117



The ADC_3117

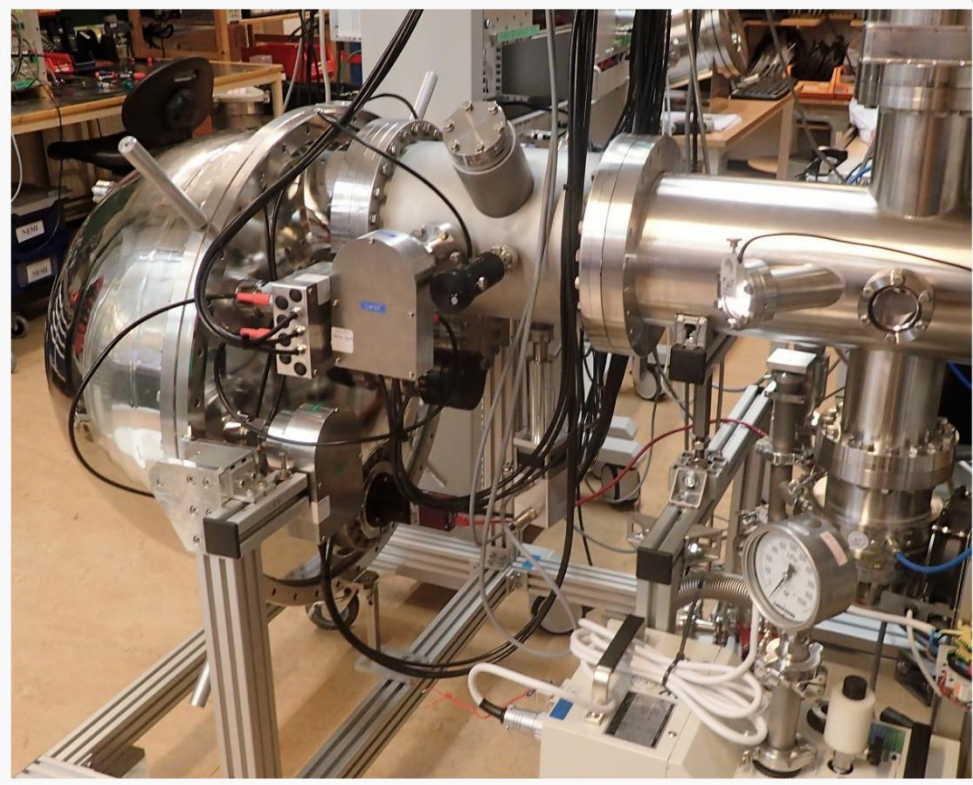
- 20 channel analog-to-digital converter
- 16-bit data @ 5 Msp/s
- Form Factor: FPGA Mezzanine card with High Pin Count
- Fits on carrier board with an FPGA to control the ADC
- Slots into a μ TCA crate

- 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.





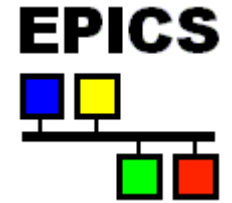
Electron Analyser



- 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!