CC activity from April 2020 to Jan 2021

Context for whole CC report- Daresbury, Liverpool and Manchester have all responded to the government's Covid first lockdown by imposing work at home regimes, which have halted lab-based and hands-on work. However, the CC teams have continued to work productively from home during the first lockdown on aspects of projects that don't require lab work.

After Covid-safety measures were put in place to work on all sites, the lab-based and hands-on work was able to resume in June 2020. These measures also allowed for establishing a new regime of working partially from home and on-site during the second and current lockdown.

Software

The Daresbury and Liverpool software effort consists of D. Judson (DJ), V. Pucknell (VP - now retired since Jan 2021) and C. Unsworth (CU).
In the period from April 2020 to Jan 2021, they have worked on many projects including:

- R3B Silicon Tracker – (VP,CU)
  The support of DAQ systems at DL continues as further detector tests are being carried out (by DL & York groups) to investigate the threshold and efficiency issues. Following the KVI beam test, the test system was rebuilt in the electronics lab at DL. Modifications of the I2C bus software have been completed by CC electronics team. This solved the DAQ failures when reading/writing certain ASIC registers. The software team has had to build new software library to implement the changes and this library have been deployed to the production DAQ system used for the full array (DL Clean room).
  The work on the component to time order the raw data from the ASICs and facilitate the data merging is still ongoing.

- ISOL-SRS Support of DAQ systems at CERN and GSI and test system in Liverpool – (VP,CU)
  The ISS DAQ system came back in mid-March following detector test at CERN, in order to build the production system. A number of requests (Liverpool, Manchester, DL) that included some modifications in the GUI have been implemented. Development and tests on the ISS spectrometer low voltage power control and interlock systems have been carried out.
  The new software library build for R3B to include the improved I2C bus mechanism has also been deployed to the ISS DAQ system.

- AIDA Support of the DAQ systems deployed at RIKEN and GSI – (VP)
  The team provided updates to the software which relays AIDA data to the GSI MBS system.
  The limit of the maximum data throughput has been improved by a factor 10 after an investigation identified and removed an obsolete piece of code in the data MERGE task that was still responsible for using a considerable amount of CPU. The limitation is now dominated by the network hardware constraints.

The team supplied the configuration options needed to record data traces following a request from the group in Edinburgh in preparation of an experiment run scheduled in early 2021. This has never been considered as a requirement before but it was possible with the existing software.

The Data Storage GUI version which supports multiple data streams has been enhanced to be more user friendly in the manner of the standard user GUI.

- LyrTech electronics at Jyvaskyla (VP)
  The update of the data acquisition to use the latest version of the MIDAS infrastructure was started in early March. The GUI update is now complete. It is intended to complete testing of the system using a pulser data source in the near future.

- ZyDF (VP)
  Support for the ZyDF board has been added to the MIDAS infrastructure. This is adequate for the initial requirements at Jyvasykla where the 3 boards ordered by Liverpool will be used. Certain software features require work on the relationship between the embedded firmware and the Embedded Linux software system. At present this is on hold during the shutdown.

- TIMEPIX (CU)
  For the Timepix project (Glasgow) the team has developed a basic user interface using Python which will run on the main data acquisition PC. A basic DAQ program has been produced to run on the embedded core of the Xilinx FPGA in the readout system, developed by the CC electronics team. The embedded DAQ program can transmit data to the main PC which is written to disk and receive commands from the UI to implement register reads/writes etc.
  A dedicated DAQ PC has been purchased and commissioned along with 10 Gbit networking hardware to meet the bandwidth requirements of the final project. Once the prototype FPGA firmware and embedded Linux OS is ready, tests at 10Gbit/s will begin.

- FEBEX (Miniball) – (VP,CU)
  Great progress is being made on the new data acquisition system for Miniball using the FEBEX electronics from GSI. This is particularly important for the Miniball user community, which includes many UK groups (Liverpool, UWS, York, …), as there is no other eDAQ system solution for the experimental campaign in 2021. The MIDAS data acquisition system is now in the state that the GUI can perform the usual set and monitor of firmware parameters. It can also control the data readout program and display results such as data histograms, data traces and statistics. The software has been tested remotely using the hardware in T9 with the latest firmware developed by the CC electronics team. The data readout program currently has a simple limited readout of ADC data blocks which are formatted to the MIDAS TDR standard. This will be replaced by the full software developed by the team.

- AGATA – (DJ)
  An analysis code has been developed in Liverpool to support the characterisation of AGATA detectors.

- SIGMA (Segmented Inverted-coaxial GerMAnium) – (DJ)
  Also in Liverpool, an analysis code have been developed for the characterisation of the SIGMA detector, which could revolutionise the gamma-ray tracking performance of large volume HPGe detectors.

- Commercial digitisers – (DJ)
  Interface and readout systems for CAEN digitisers have been produced and tested for use in projects including Agata, SIGMA, Mu2e, GRi, MBI.

- Support for Liverpool applied work (DJ)
  - GRi (Gamma-Ray Imager)
    Developed an image reconstruction algorithm code for the GRi project, a portable Compton camera, and provided support in the analysis of GRi Thyroid data.
  - MBI project (Molecular Breast Imaging)
    Support provided on the data collection and electronics design
  - CapeSym TlBr projects
    Support provided on the data collection and electronics design for a novel detector fabricated from the compound semiconductor Thallium Bromide.

- New funding proposals- Grant preparation work (writing proposals, planning work, cost estimates) (DL, York, UWS, Liverpool) (VP, CU)

- Detector and DAQ Laboratory Responsibilities.
  All members of the team have other responsibilities in the operation of detector and DAQ Laboratories. This includes a various kind of activities:
  - Computing Server maintenance,
  - Computing support activity,
  - Risk Assessment (covid-19 safe),
  - RPS role (DJ).

Electronics

The Daresbury and Liverpool electronics effort consists of Thornhill (50%), Wells, Kogimtzis, Lawson and Lazarus (30%). The team is supported by Hill (AGATA repair work) and currently has an arrangement allowing advice to be sought from Coleman-Smith (retired). In the period from April 2020 to January 2021, the team has worked on the following tasks:

- Timepix3 (Glasgow) (MK, JL)
  - Managing the development of the timepix3 readout (finance/hardware/software/mechanical)
  - Design and implementation of:

- ASIC and flange pcbs (designed, manufactured and commissioned)
- VHDL register block (completed).
  - Design (schematics and PCB layout) of double FMC card to interface the FPGA to the Timepix PCB. Including:
    - Low noise multichannel floating detector bias supply with nA current sensing
    - parallel high speed trigger bus to convey trigger information between modules
    - LV supplies (1.8V and 3.3V)
    - FMC Compliant ROMS
    - ADCs for analogue outputs of TIMEPIX
    - Interfaces for external trigger hardware

- RITU/MARA/GREAT JYFL (DL/Liverpool) (MK, JT):
  - Metronome JYFL Design is based on ZyDF platform. Completed updates to the prototype designs and all pcbs/metal enclosures/rack components have been manufactured/procured.
  - New detector designs and PCBs with Micron, quotations, ordering and subsequent production management.
  - SPEDE Detector upgrade advice and general support.
  - SAGE Assembly of new PCBs and detectors.

- R3B Si tracker (York/DL) (MK, JT, IL)
  - Bench test of new VHDL for i2c interface, and commissioning into the clean room test system.
  - Investigation and procurement of a pulsed laser system suitable for testing the R3B detector and electronics
  - Captured and analysed data as part of investigating issues with missing coincidences between the 2 sides of the detector.
  - Repairs and fault diagnosis, support for DAQ and ASIC for readout tests.
  - Support for the silicon/ASIC noise investigations.
  - Looking into alternative methods of construction for any replacements in the future, possibly using 3D printing.

- ISS (Liverpool/Manchester/DL) (MK, JT)
  - Support for physicists commissioning the ISS electronics and DAQ (very similar to R3B Si tracker so R3B developments such as new I2C VHDL code are applicable here too.
  - General detector support. Advice, quotations etc. for silicon devices. Delivery to CERN.

- AGATA project (York, UWS, Liverpool, DL) (IL)
  Electronics team leader (EDAQ WP leader for UK AGATA grant and also Team leader for AGATA international Electronics work) Scoping out work for FPGA algorithm improvements for AGATA at LNL with AGATA Management Board.

- AGATA Support (DL/Liverpool (support for existing projects)) (MK)

- o Supervising the repair of the Phase 0 digitisers and attending monthly meetings to report on progress.

- TACTIC (York) (MK)
  Advising and running simulations for UoY regarding adjustments they could do to an existing pre-amplifier design that it is already built and commissioned.

- Miniball DAQ (Liverpool/DL) (JL)
  Working on the Febex hardware selected by Miniball collaboration for their DAQ system upgrade:
  - o Set up a 2nd Febex system running with 4 cards for software testing
  - o Found issues with 2nd system's EXPLODER which prevents triggering on 2nd system- sent for repair by GSI
  - o Developed firmware modules for modification of FEBEX trigger behaviour and to reduce data transfer requirements.
  - o VHDL code for CFD with filters and threshold mode completed; currently verifying that the operation is exactly as per MATLAB simulation and that the CFD delay output is correct under different filter settings.
  - o Investigating how Febex card works to understand how to add MWD energy calculation code
  - o Various unexpected Febex behaviour/bugs/limitations discovered
  - o Meetings continue with GSI/Miniball

- New funding proposals- Grant preparation work (writing proposals, planning work, cost estimates) (DL, York, UWS, Liverpool) (IL, JT, DW)

- Support for Liverpool applied work (MBI) (DW)

- Miscellaneous underpinning support work (Liverpool) (JT, DW)
  - o Support for all Liverpool software licensing. (JT)
  - o Technical training (JT)
  - o Procurement training (JT)
  - o Investigations into 3D printing techniques/Costs for future experiment designs (JT)
  - o Development of temperature controlled chamber (DW)
  - o Construction of pcb trace milling unit (DW)

Mechanical and Technical

The Daresbury, Liverpool and Manchester mechanical effort consists of A. Grant (AG - Now retired and replaced by R. Smith), I. Burrows (IB- now retired and replaced by M. Cordwell), D. Seddon (DS) and A. Smith (AS) with technical support from P Morrall (PM) Over the past year, they have worked on a range of projects including:

AG/RS, IB/MC and PM:

- AGATA support structure for the latest STFC grant, including the design of the support and schemes for LNL phase using axle driven design similar to that being adopted by GRETA and Gammasphere. Assembly of the support, its drive system and subsequent performance tests are currently in progress at Daresbury prior to shipping to LNL. (UK-AGATA collab.)
- MARA-LEB conceptual design and detail design of a new section of beamline at Jyvaskyla. Two configurations (horizontal and vertical) generated to enable early testing (away from the beamline) before being installed in final location. (DL)
- ISOLDE redesign of shield mount mechanism and an upgrade to stabilise the detector support. (UK-ISS collab.)
- ProSPECTus (Medical imaging device), Cryostat optimisation undertaken, design of a new cold finger and flange adaptor. (Liverpool/DL)
- ZyDf electronics module design of prototype electronic enclosures. (Liverpool/DL)
- R^3B Laser design of the R^3B detector mount, motorised laser mount and chamber. Technician support in the testing and development of the system. (DL/York)
- ISOL-SRS:
  - WP2 (storage ring option) at GSI/ completion of design and support for procurement by University of Edinburgh. All vacuum vessel components have been successfully vacuum tested at Daresbury with technical support and delivered to GSI. Cable harnesses have been vacuum processed at Daresbury and shipped to GSI.
  - GSI is currently under COVID 19 restrictions. Once these restrictions are lifted and we gain lab access at GSI, the vacuum chambers will undergo further vacuum tests when full (including cable harnesses).
  - WP4 at CERN there is a planned magnet He fill in late January 2021.

AS:
- ISS Recoil Detector (Manchester), part of system at ISOLDE. Work includes design and liaison over fit into overall layout for area. Also insertion/removal support mechanism and coordination of manufacturing of components.
- MARA Beamline design of BGO shields for germanium detectors. (York)
- RIKEN new Ge6 detector array design. (York)
- SHARC @ ELIADE and ALIGANT at ELI-NP (York).
- FiFI, STEFF, CRIS prototype ion trap design and coordination of its manufacture. (Manchester)

DS:
- GAMKA structural analysis of a 4π Germanium detector array designed by iThemba lab. (Surrey/York?)
- AGATA detector installation fixture optimise the fixture design to improve the control of the detector decent during the mounting process. (UK collab.)
- NEDA concept design for an aluminium structure to support 320 liquid scintillators based on design used in experiments at GANIL. (York)

- AGATA test station design and analysis of a support gantry for scanning tests of the AGATA detector and other detectors, such as the SIGMA detector. (Liverpool)

Targets productions and other technical support (PM):

Targets were requested by
- Liverpool University (R. Page): ^{109}Ag complete and sent to Andrej Herzan
- Edinburgh University (B. Carlo): CD 100 ug/cm2 work to start in January on these targets
- Edinburgh University (C. Lederer-Woods): KCl target.

The number of requests for targets has dropped down compare with previous year as experiments were being cancelled or postponed due to the pandemic. However, PM has used his time efficiently by focusing on other of his essential responsibilities, which include:
- The assembly of the new R3B vessel chamber in the clean room and the installation of the inner detector inside in order to resume the tests in vacuum with radioactive sources. He also removed 3 outer detectors from the array that displayed shortcut issues between ASIC's grounding and PT100 temperature sensors. PM set up those 3 detectors in the electronics lab where they tested and repaired.
- The guidance for the remote maintenance of the ISS magnet. PM dealt with the cold head issues and a proposed solution that is being now addressed.
- The management of the target/detector laboratories and the clean room facility at Daresbury. This includes day to day maintenance, upgrades and SHE requirements (risk assessments, fume cupboards and gas lines inspections).
- The AGATA support frame assembly and its mechanical drive system tests for SPES at LNL.
- The completion of the training refreshers that were due this year. PM has also accepted a new role as a Laser Responsible Officer for the group to ensure the safe installation and use of a 3B Class Laser for detector testing (R3B). PM has now received all the necessary training for this.
- His role as Radiation Protection Supervisor for the group to deal with all safety aspects of the group's activities involving radioactive sources. PM is responsible for the secure storage of the group's sources and, provides monthly reports on the current location of the sources.