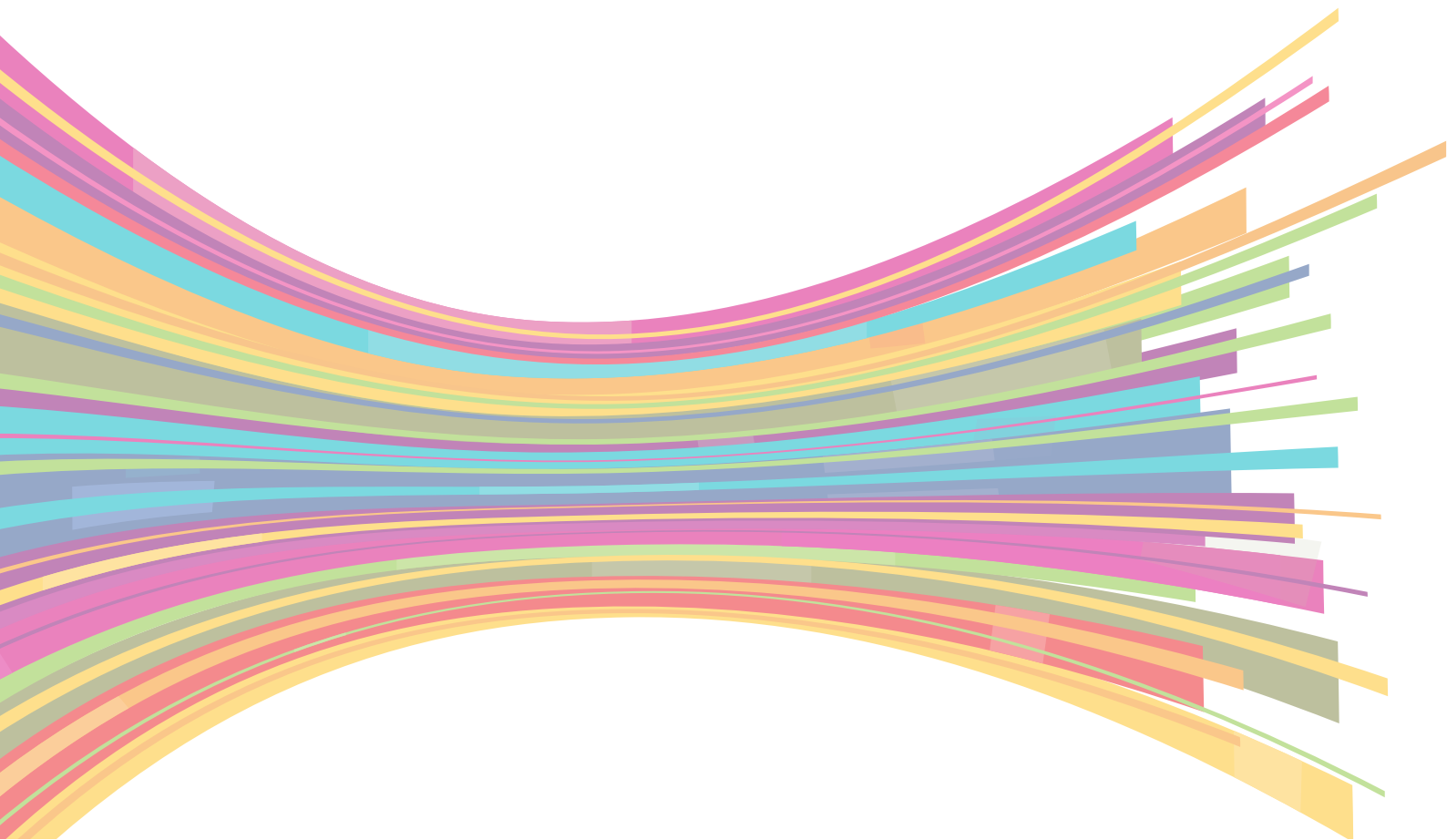


Capabilities in Space Applications


Optical Fabrication and Engineering Design Services



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Excerpt from a document written for STFC to promote the capabilities in design, production and research of Glyndwr Innovations Ltd and Wrexham Glyndŵr University in the fields of Space and Aerospace.

Glyndŵr University, Glyndŵr Innovations

Forming part of the University's North East Wales 'knowledge corridor', Glyndŵr University St Asaph, also known as the OpTIC Centre, is located just off the A55 and boasts: a well-equipped Conference Centre; an Incubation Centre supporting local businesses with facilities for company start-ups; and a well-equipped photonics Technology Centre. The Centre is a leading business and cutting-edge facility bringing together academics conducting research into highly specialised areas of technology and businesses looking to develop that technology for commercial purposes.

The Technology Centre performs both academic research and industrially-commissioned R&D alongside an industry-facing Engineering Projects Group trading as Glyndŵr Innovations Ltd.

Glyndŵr Innovations Ltd has completed design fabrication and integration projects for a number of leading Institutions and Companies in the fields of Aerospace, Space Science and Medical, including innovation projects for the CDE (Centre for Defence Enterprise).

The OpTIC Centre is part of the funded UK Space Agency Incubation Network.



Glyndŵr University St Asaph campus

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Precision Optical Components and Systems

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Glyndŵr University St Asaph Capabilities and Expertise

The capabilities offered by Glyndŵr University at its St Asaph campus are:

- Engineering Design and Analysis
- Optical Fabrication
- Verification of Optics and Optical Systems

These areas are summarised in what follows.

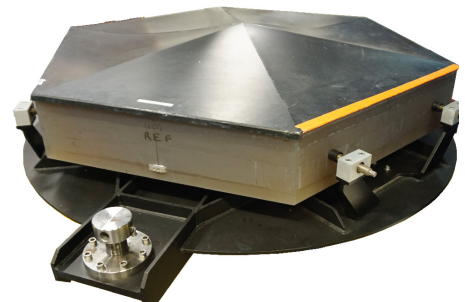
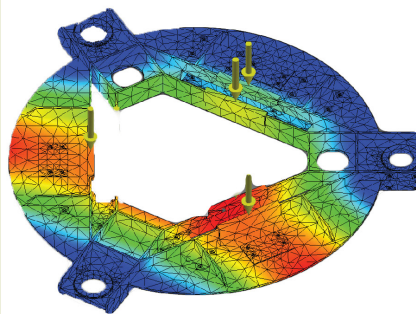
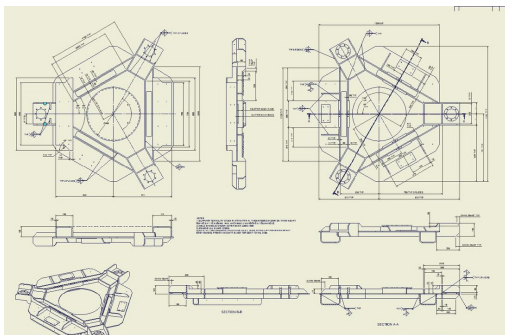
Engineering Design and Analysis includes the design of Airborne Optical Systems, Satellite Pre-flight Systems, Precision and High-performance Actuation, Thermal Design and Engineering, and Design for Additive Manufacture. The Engineering Projects Group based at the OpTIC Centre provides a multi-disciplinary design service to the UK aerospace and precision engineering sectors. Its links with the optics industry and its history of delivering innovative high precision engineering solutions make it a clear choice for the design, supply and integration of both airborne systems and ground support equipment. The team is staffed by professional engineers with substantial industrial and science-sector experience, including the design of large optical telescopes and instrumentation, vacuum and cryogenic system design and integration, and high performance structural engineering.

The team uses a full range of analytical and modelling software for the design of both optical and mechanical systems. Software in regular use includes:

- Zemax
- FRED
- Ansys
- Autodesk Inventor
- Solidworks
- Matlab

Mechanical Design and Analysis

Mechanical Systems: The team has unique UK expertise in designing and fabricating light-weighted optics for satellite and airborne imaging systems. Light-weighting of optics between 70% and 80% can be both designed and fabricated at the OpTIC Centre, up to a current size limit of 380 mm diameter. Light-weighting of optical systems for space-borne applications includes the design and analysis of light-weighted support structures, modelled to withstand demanding operating environments.

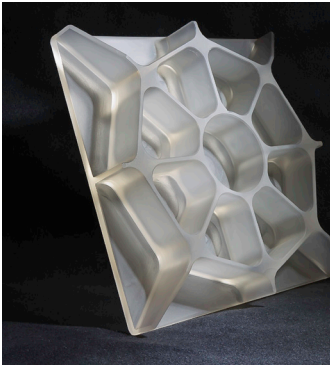


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Light-weighted optics

Satellite Pre-flight Verification Systems: The team has experience of providing both optical components and opto-mechanical assemblies for use in pre-flight ground support systems. Precision and High-performance Actuation Design: The team has commercial experience in designing precision actuation for aerospace applications, with high-performance actuators being designed to operate in challenging environmental conditions including high torque, acceleration and vibration.

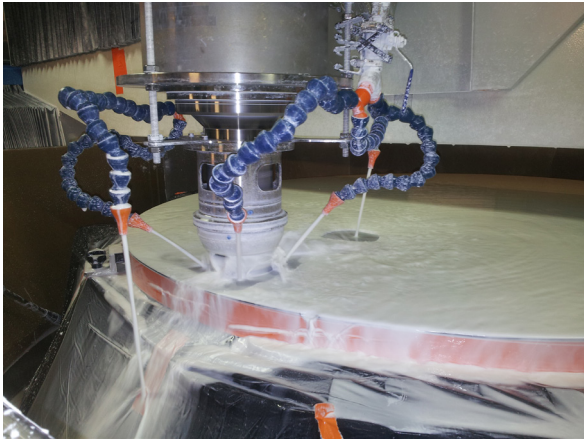


Ultra light optical system for HALE UAV

Thermal Design and Engineering: Recent client projects include the design and implementation of passive cooling of a high brightness UV LED system for a medical application; the design and integration of vacuum and cryogenic systems for nuclear research applications; high-precision optical mounting and actuation mechanisms designed for harsh environments, including the use of adhesives for mounting optics for operation at 77 Kelvin with high vibrational and impact loads.

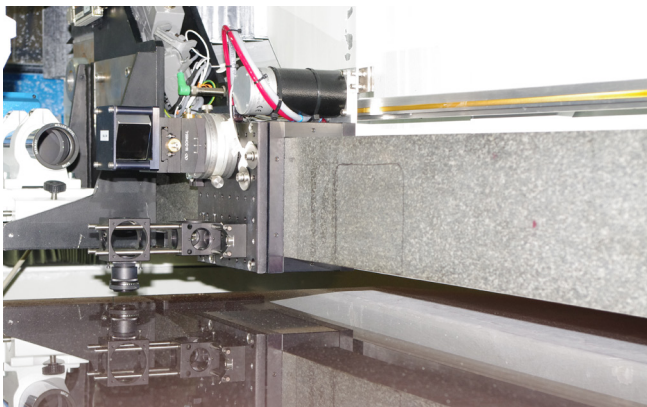
Additive Manufacturing: The team is capable of creating designs optimised to take advantage of the unique properties that additive manufacturing can offer for applications requiring low mass rigid structures. It has recently undertaken studies into the applicability of additive manufacturing processes to aerospace applications.

Optical fabrication: Optical Fabrication at the OpTIC Centre is focussed upon the small volume fabrication of large and challenging optics. The optical fabrication facilities are able to manufacture optics up to 1.6 m in diameter, using both conventional polishing methods and also CNC processing. The optical fabrication team is able to develop manufacturing processes for the fabrication of highly aspherical optical surfaces using CNC-based methods.



Polishing large diameter optics

Verification of Optics: This optical fabrication capability is complemented by a high level of competency in surface metrology, both form and texture, with a comprehensive suite of metrology instrumentation in use. Both profilometric and interferometric measurement methods are in use. For the fabrication of large optics and systems, the OpTIC Centre offers a high level of expertise in the critical mounting of optics required for both processing and verification. The metrology team is able to develop novel verification methods for challenging applications, from optical design through mechanical design to implementation.



Optics verification with NOM optical profilometer

Other Capabilities

Composite Materials Research at Glyndŵr University is focussed upon developing lightweight, dimensionally stable mirrors from Carbon Fibre reinforced Plastics. Glyndŵr University has completed a Framework 7 funded project for a feasibility study into the fabrication of a lightweight cryogenic mirror for space deployment. The mirror's dimensional stability was computationally modelled after cryogenic material tests were conducted. Current and future projects include CFRP mirrors for high altitude surveillance and also for active and adaptive optics (with University College London). All CFRP fabrication is undertaken at Glyndŵr's Advanced Composites Training and Development Centre, run in conjunction with Airbus, Broughton.

Capabilities sited on University Wrexham Campus: In addition to the team located at the OpTIC Centre, there is significant engineering design and analysis capability in the CoMManDO research group,

which is primarily comprised of research-active academic staff based on the Wrexham campus. Software in regular use for research and teaching enhances the overall capability that can be offered:

- CATIA V5
- Abaqus, Isight, FE Safe
- Ansys Fluent & Mechanical

Research capabilities include multi-physics modelling, impact analysis, structural dynamics and vibration, manufacture simulation, microwave cure simulation, and multi-objective optimisation.

Glyndŵr University St Asaph Optical Fabrication and Verification Facilities

Wrexham Glyndŵr University has the following facilities at the OpTIC Centre in St Asaph, available for the support of the UK space programme:

- Optical Fabrications facilities
- Optical and Dimensional Verification facilities

Optical Fabrication facilities comprise polishing and metrology facilities for the fabrication of large optics.

Polishing facilities include:

- Large bridge-type CNC machines: a Zeeko IRP1600 machine, capable of polishing optics up to 1600mm diameter; and a Zeeko IRP1200 machine, capable of polishing optics up to 1200 mm diameter
- Conventional polishing machines: two Bryant Symons dual-spindle GP300 polishing machines and two 600 mm single-spindle polishing machines.

These polishing facilities are unique within the UK for the manufacture of large optics.

Metrology capabilities situated at Glyndŵr University St Asaph include the following:

- Contact Metrology
- Interferometric Metrology
- Bespoke Metrology
- General Facilities

Contact Metrology facilities include:


- Leica AT901 Absolute Tracker (currently integrated into a 10m optical test tower): Measurement volume >10 m radius; in-line measurement accuracy of 10 µm; angular accuracy of approximately 40µm, SpatialAnalyser software.
- FARO Ion Laser Tracker: Measurement volume >10 m radius; in-line measurement accuracy of 10 µm; angular accuracy of approximately 40 µm, CAM2 Measure software.
- DEA Pioneer 6.10.6 CMM, offering a first term traceable measurement accuracy of 5 µm, PC-DMIS software.
- Taylor-Hobson Form Talysurf: One of a small collection of long range contact profilometers made

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by Taylor-Hobson. The Form Talysurf is a linear profilometer able to give a traverse of up to 300 mm, with a measurement precision of <100 nm.

- Taylor-Hobson Talysurf Intra: Contact profilometer made by Taylor-Hobson giving a traverse of up to 50 mm, with a measurement precision of <100 nm.
- NT-MDT standalone SMENA Atomic Force Microscope: Measurement footprint 100 µm x 100 µm; height measurement accuracy 0.1 nm or better.

Interferometric Metrology facilities include:

- Fisba µPhase 2 HR compact Interferometer: 1024x1020 camera resolution; associated diverger lenses, µShape software.
- 4D PhaseCam 4000 Interferometer: Stabilised Twyman Green interferometer; 473x475 camera resolution, 4Sight software.
- 4D PhaseCam 6000 Interferometer: Stabilised Twyman Green interferometer; 995x1003 camera resolution, 4Sight software.
- 4D PhaseCam 5030 Interferometer: Stabilised Twyman Green interferometer; 1967x1946 camera resolution, 4Sight software.
- 4D diverger lenses available for the 4D interferometers: F/1, F/2.5, F/4, F/6, F/8.
- Nikon ADE MicroXam Optical Surface Profiler: White light interferometer; measurement footprint approximately 1 mm x 1 mm height resolution of 0.1 nm.

Bespoke metrology facilities include:

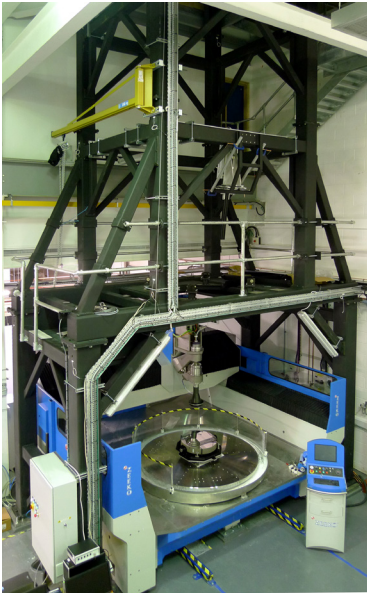
- NOM optical profilometer: Capable of measuring a sagittal distance of 70 nm over a scan length of 1.4m. Calibrated with a sagittal measurement accuracy of 350 nm (one standard deviation).
- Bespoke 10m optical test tower: Currently configured to interferometrically measure ESO E-ELT primary mirror segments, but can be reconfigured for other interferometric applications.
- Bespoke interferometric beam expander: Working beam diameter 183 mm.

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10m Optical Test Tower

General metrology facilities include:

- A temperature-controlled optical metrology laboratory with two actively isolated optical benches, one approximately 5.4 m in length, and several non-isolated optical benches. Other optical facilities exist at Glyndwr University St Asaph, including other isolated optical benches that are not currently in use.
Ocean Optics USB2000+ Spectrometer: The spectrometer operates at a range of integration times (1ms to 65 s) with an optical resolution of 0.3 nm (FWHM). The spectrometer is configured for best efficiency over 350nm-850nm spectral range, with a grating blaze wavelength at 500 nm, making it ideal for spectral analysis within the visible spectrum and for applications such as fluorescence analysis.
- Taylor Hobson Talyvel 6 Differential Electronic Level System.
- Taylor Hobson Small Angle Generator Type TA48 – Certified to 0.1 arc seconds.

Glyndŵr University View on Facilities

Wrexham Glyndŵr University offers significant design, fabrication and verification capabilities that can be utilised for the UK space programme, and has an active track record in commercially exploiting these capabilities in this sector through Glyndŵr Innovations Ltd. The University has encouraged and supported this activity for some years and the OpTIC Centre provides a geographical location appropriate to its activity in the UK photonics sector.

