Institution: Swansea University

Unit of Assessment: 24 - Sport, Exercise Sciences, Leisure and Tourism

1. Unit context and structure, research and impact strategy

1.1 Unit Context

The **Applied Sport, Technology Exercise and Medicine Research Centre (A-STEM)** at Swansea University (SU) advances an inclusive and thriving research culture that inspires an international community of creative, curious, communicative and collaborative scholars who make a difference to people's lives. Our mission is to engage students and scholars in open science through innovative thinking, research-informed debate and knowledge exchange using interdisciplinary and solution focused approaches. This transformation has been assisted by relocation in 2015 into state-of-the-art laboratories and a dedicated Postgraduate Research Hub on the University's Bay (Science and Innovation) Campus (Figure 1) co-located with the School of Management, College of Engineering (CoE) and Computational Foundry.

Figure 1 - Swansea University Bay Campus

Highlights and achievements include (see Table 1, p.2):

- **Enhanced international collaborations and income**, £3m facilities investment including doubling of Cat A staff and laboratory space;
- Developed **stronger links with industry**, supported by PGR funding of >£1m from Knowledge Exchange Skills Scholarships (KESS) and ESRC doctoral training programme;
- **Founding two national institutes** (WIPS, WIPAHS) and an ERASMUS **network** for research impact;
- Development of **new research group**, Sport Ethics, Integrity and Governance (SEIG);
- **Enhanced the quality of outputs**, 1 in 6 of our outputs in the top 10% cited worldwide and nearly half including an international collaborator (SCOPUS 2020);
- **Tenfold increase in research only staff**;
- **46% increase in research funding** and;
- **Fourfold increase in PhD completions** since REF2014.

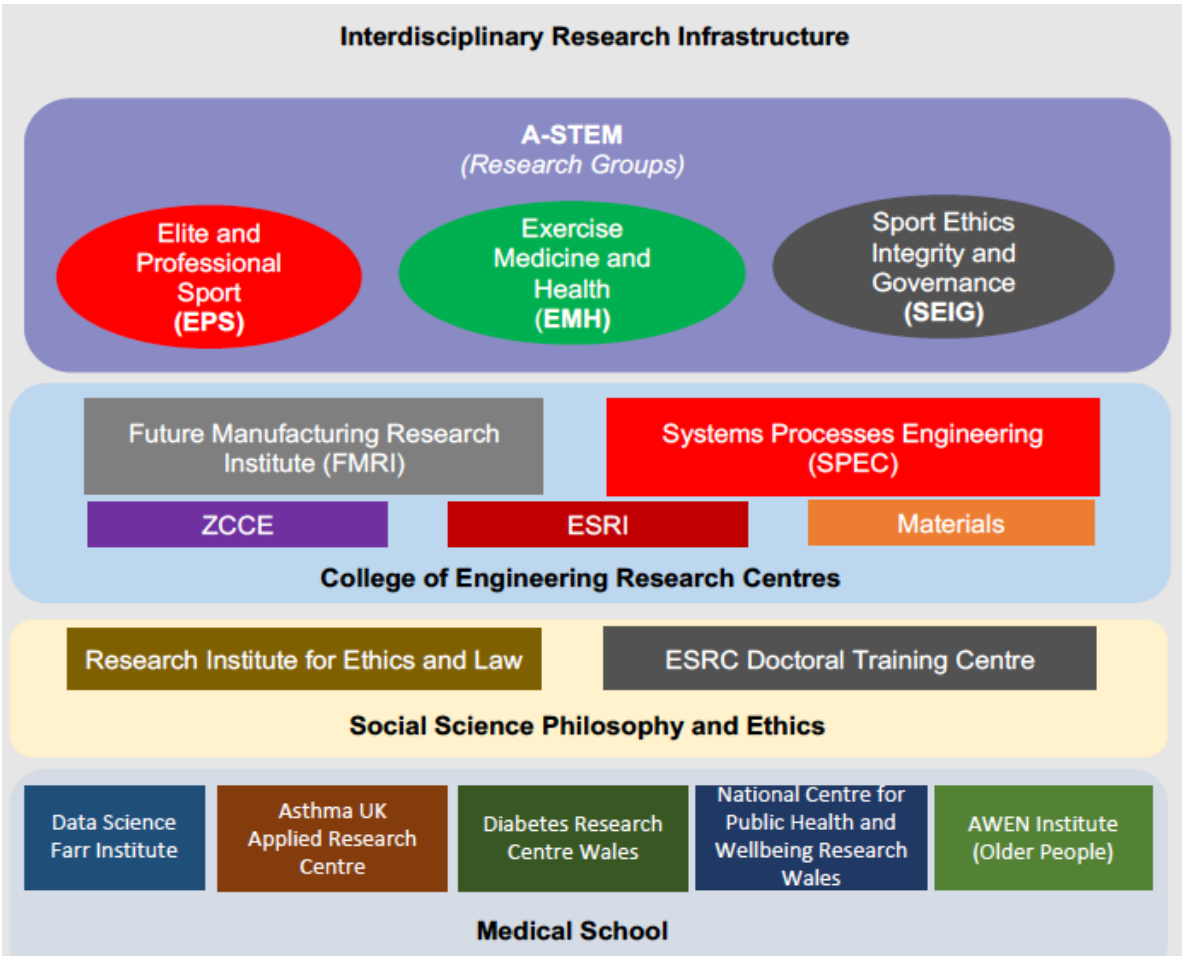
Table 1 - Quantitative Changes over REF Census Period

Indicator	2014	2020
Cat A staff (FTE)	10	19
Infrastructure for Research (£m)	0.5	3.0
Research Funding (£m)	1.5	2.19
Outputs	NA	514
PhD completions	4	21
Research only staff	2.5	24

1.2 Unit Structure

To support its growth and identity the CoE established the School of Sport and Exercise Sciences (SPEX; 2017). A-STEM resides in SPEX, is one of six research centres in the College of Engineering (CoE) and functions as a semi-independent unit with devolved responsibility for leadership and management of resources. A-STEM is led by a Head of Centre supported by research group leaders (RGL) for **Elite and Professional Sport (EPS), Exercise Medicine and Health (EMH) and SEIG.** Research groups promote an interdisciplinary, open border and open science culture of collaboration, with colleagues in Engineering, Medicine and Social Sciences, Ethics and Law. Figure 2 illustrates the rich diversity of interdisciplinary research collaboration across the university available to academics in ASTEM in the wider structure of SU (see REF 5a). The growth of ASTEM has prompted deeper reach across this infrastructure resulting in higher quality research outputs and increased income.

Figure 2 - The A-STEM Research Centre situated in an interdisciplinary university infrastructure



Elite and Performance Sport (EPS)
Staff: Bezodis (RGL), *Kilduff, Knight, Waldron, Heffernan and Hill*
Impact Network: Welsh Institute of Performance Science (WIPS).

EPS work directly with elite and professional athletes under three broad themes: heat, rugby and technology, and engineering. EPS researchers have led WIPS providing high-level performance science support particularly for Team Wales athletes in the 2014 and 2018 Commonwealth Games. WIPS was built on the success of WEPSIN (Wales Elite Performance Information Network) and now drives the research strategy for Sport Wales, partnering with academics and industry to address user-led challenges in elite sport. The group also works with the English Institute of Sport (EIS), the body responsible for delivery of scientific support to most UK Olympic sports, as well as a plethora of professional sports and domestic and international teams. These collaborations have resulted in increased funding for interdisciplinary work, with materials engineers and future manufacturing developing scientific innovations that promote performance in elite and professional sport in both adult and child populations. EPS has recruited four new academic staff over the REF cycle to strengthen applied and impactful research and fundamental science in environmental physiology, nutrition, genetics, psychology and biomechanics.

Exercise Medicine and Health (EMH)
Staff: Mackintosh (RGL), *Stratton, Hudson, McNarry, Williams, Metcalfe, Churm, Bracken, Lewis*
Impact Network: Welsh Institute of Physical activity Health and Sport (WIPAHS)

EMH focuses on physical activity and public health, clinical exercise science and engineering, and analytical approaches to quantifying human movement with a particular focus on physical activity and health of children, and exercise and diabetes. The group has attracted significant research funding to support interdisciplinary work with public health, the pharmaceutical industry and engineers, and medics to develop real time systems to prevent concussion in sport. In partnership with Sport Wales and Public Health Wales EMH, researchers founded WIPAHS, (£325k to 2024) in 2020. WIPAHS harnesses a network of academics and stakeholders from community, sport, public health, third sector and industry to develop solutions to physical inactivity. WIPAHS has also helped secure £600k to investigate the effect of COVID-19 on physical activity, fitness and health. EMH has recruited four additional academics since 2014 augmenting mechanistic research expertise in diabetes and obesity, exercise physiology dose response, aging and health psychology, and concussion and sport technology research.

Sport Ethics Integrity and Governance (SEIG)
Staff: Bloodworth (RGL), *McNamee, Harvey, Devine*
Impact Network: ERASMUS Collaboration

SEIG focuses on anti-doping, fairness and the spirit of sport, and employment relations in professional athletes. The development of the world's first postgraduate MA in Sport Ethics and Integrity (MAiSI) has supported the addition of two academics to the discipline. SEIG researchers lead the ERASMUS collaboration that includes national and international sport organisations and professional bodies, such as the International Centre for Security in Sport, International Ice Hockey Federation (IIHF), UK Anti-Doping (UKAD), International Olympic Committee (IOC) and Union of European Football Associations (UEFA). SEIG academics have also materially affected Amateur International Boxing Association, IIHF, IOC, UKAD and WADA policies on therapeutic use exemptions in sport, anti-doping and the spirit of sport, and also co-founded the Research Institute for Ethics and Law (RIEL) in 2017.

1.3 Research strategy

1.3.1 Review of REF 2014 Strategic Drivers

Our REF2014 submission identified six strategic drivers (SD1-6, Table 2) for the 2014-21 period. These are reviewed annually with A-STEM and CoE research committees, and fora.

Table 2 - Strategic Drivers 2014-21

Strategic Driver	Description
SD1	Develop novel and rigorous sports-related research of international significance that improves athletic performance, development pathways, and ethically sound sports practices in adult and youth elite and professional athletes.
SD2	Develop innovative research technologies and methodologies that quantify the dose response, in elite and professional sport and exercise medicine and health.
SD3	Increase impact by targeting the development of industrial and public partnerships and collaborations at local, national, and international level.
SD4	Provide specific opportunities for developing international excellence in postgraduate students and early career researchers and connect to and help connect them to world-leading academics and projects.
SD5	Increase competitive grant capture for multidisciplinary STEM related research and seek to further develop significant international projects.
SD6	Exploit opportunities for world-class research through state-of-the-art, purpose-built facilities, laboratories and infrastructure after relocation in 2015 to the University's new, £250 million, 64-acre, Science and Innovation Bay Campus.

We have **increased the quality and quantity of our research significantly**, publishing 514 outputs over the census period. 31% of publications were in the top 10% of journals while 17% were in the top 10% cited worldwide (Scopus JUL/20). The most highly cited were those that included international or industrial collaborators (SD1). Of the 48 outputs submitted, a third were related to innovative technologies and methodologies (SD2), 80% included an element of research impact on strategies, practices, products and policies at national and international level (SD3). Nearly half of A-STEM outputs included an international co-author(s), (SD4). Academics submitted 45 successful grant applications to the value of £2.17m increasing income by 45% from the REF2014 period (SD5), not including £1m for KESS funded PGRs. The transformation of our research infrastructure (SD6) has advanced interdisciplinary research with several research units across the university, as well as nationally and internationally. The transformation has also augmented our strategic growth plan by increasing international reach for research and impact (SD1, 3 and 4). A-STEM academics collaborate with peers across all continents, sharing outputs, grant funds, congress presentations and PGR supervision. Over this census period we have developed formal agreements with Texas A+M, JFF Grenobles-Alpes, Auckland University of Technology, University of Western Australia, Porto University, and the MAiSI ERASMUS collaboration. We have grown our partnership with industry, for example, collaboration with the Future Manufacturing Research Institute (FMRI) in CoE and the EIS has attracted a £1.8m SMARTExpertise grant to produce heated garments for Olympic athletes. Collaboration between

A-STEM, Novo-Nordisk and the Diabetes Research Unit-Wales has provided scientific support to the professional Novo-Nordisk cycling team (£512k).

1.4 Interdisciplinary research

Figure 2 illustrates ASTEM's **'research with no borders' approach**, enabling academics to engage in interdisciplinary work with academic and industrial partners across SU (REF5a), nationally and internationally. 25% of our submitted outputs are interdisciplinary in nature, encompassing genetics, social sciences, clinical health and life sciences, engineering, physical and computer sciences, and maths. Collaborations with the Systems and Process Engineering Research Centre (SPEC) in physical activity, sensor development and data analytics have resulted in published outputs in Q1 journals. A-STEM academics collaborate with other disciplines, notably Medicine, where collaborations with the Data Science Farr Institute and National Centre for Public Health and Wellbeing Research, and clinical research facilities in the Diabetes Research Unit-Wales for integrated exercise and treatment studies. A-STEM researchers in SEIG collaborate closely with RIEL nurturing research in law, ethics, integrity and governance, including work with ethicists and social scientists in innovative medical treatments, professional cycling and the English Premier League medical teams.

1.5 Impact

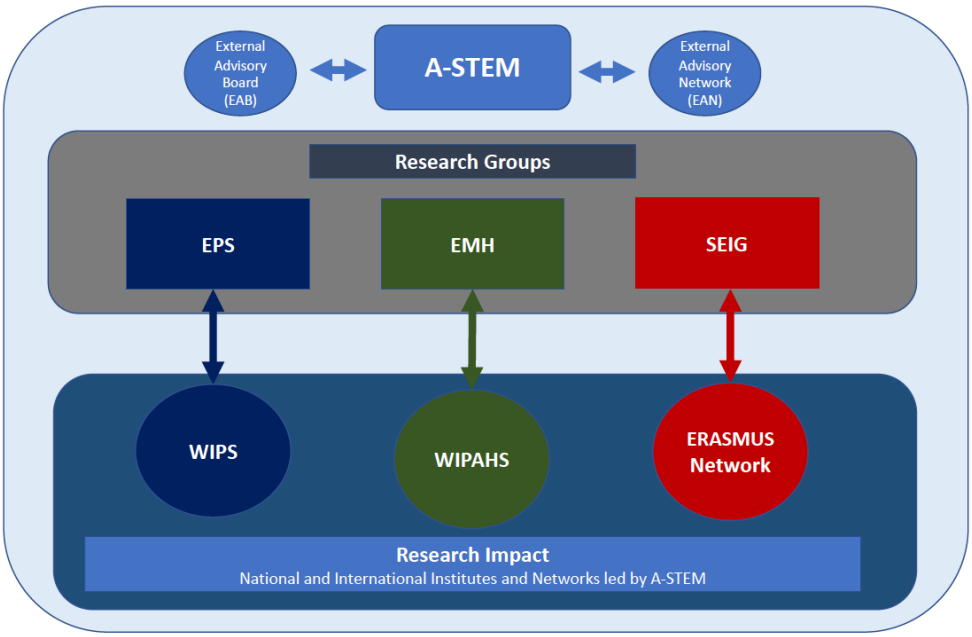
Academics blend their research in partnership with industry, elite and professional sports, and the third and public sectors to deliver impactful research that meets user need.

Our strategy (SD3) is:

(i) Guided by the CoE external advisory board (EAB), which includes engineers and senior executives from NGOs and Sport Tech industries, and external advisory network (EAN) comprising UK-based and international members from academia and industry,

(ii) Delivered in partnership with WIPS, WIPAHS and the ERASMUS collaboration as well as bespoke projects with individual organisations. This strategy has advanced the development of sustainable institutes (WIPS and WIPAHS) and networks (ERASMUS) with national and international reach that are co-located to each research group (see Figure 3).

Figure 3 - Research Impact and Industrial Engagement



Using our interdisciplinary infrastructure and impact-focused institutes, collaborations and networks, A-STEM has **deeply embedded research impact into its infrastructure and processes** producing a pipeline of potential case studies. For example, ASTEM academics have secured £1m in Knowledge Exchange Student Scholarships (KESS) over the period as well as industry co-funded PhDs with Swim Wales, Swansea City, Sport Wales and the child protection support unit. Each KESS scholarship also involves an industrial, co-funding partner. Further support for this pipeline is provided through University level SEED funding (SU 5a).

As a result, A-STEM academics have created significant public benefit in Children's Physical Activity and Health, Parenting in Sport, Anti-doping and Therapeutic Use Exemption, Employment Relations in Professional Football, Biomechanics, Archaeology and Genetics and Biomechanics, Exercise and Diabetes and Pre-Competition Strategies in Elite Sport. The latter led to our two impact case studies:

- Competition day strategies for enhanced performance in elite and professional athletes,
- Mitigating Risk of Exercise-induced Dysglycaemia in type 1 Diabetes.

1.6 Strategic Drivers for 2021-2027

To build on the successes outlined above, we have developed **five strategic drivers (SDI-V) for the 2021-27 period** (Table 3). Continued growth will be driven by an increase in:

(i) funding for research and impact,
(ii) taught FTEs,
(iii) formal international and industrial collaborations.

These will be supported by a parallel increase in academic and technical staff, postdoctoral researchers and PGRs, and international projects, helping A-STEM remain at the forefront of research and impact.

Table 3 - Strategic Drivers REF2021-2027

Strategic Driver	Description
SDI	Increase the international reach and significance of research that impacts policies, products and professional practice.
SDII	Extend the reach of our applied fundamental research that advances interdisciplinary science aligned to sport and exercise.
SDIII	Expand our engagement with the physical, engineering and data sciences to develop applied technological innovations (analytics, materials development) that have measurable impact in industrial, sport, health and clinical settings.
SDIV	Increase the diversity of research income, capturing funding that enables international research and strengthens impact.
SDV	Strengthen PGR progression pathway by (i) developing funded programmes of research (in areas of academic strength) and (ii) prioritising leadership of these areas by postdoctoral researchers and early career academics.

1.7 Open Scholarship and Research Integrity

SU has an Open Access deposit policy (2015), which requires all published research outputs to be deposited in the institutional Research Information System (RIS), which feeds the repository, Cronfa, with an Open Access copy of each full-text article. The REF Officer for CoE provides a mediated deposit service to help staff comply with REF Open Access requirements.

A-STEM has a **0% Non-compliant output submission** (REF 2), as defined by the REF-2021 guidelines. While compliance has been achieved mostly via the Green Open Access route, our REF submission is **39.6% Gold Open Access**. Gold Open Access is made possible via a fund provided by the CoE for academic staff and a UKRI central grant held within the Library.

1.7.1 Research Data – Sharing and Management

The data requirements for all researchers are outlined in Swansea's 'Research Integrity: A Policy Framework on Research Ethics & Governance' document. Staff receiving grant awards from the UKRI councils must comply with funder data requirements. Swansea's Research Data Manager supports the ethical, open, and compliant production, use, and discovery of research data for all staff. Researchers are encouraged to apply FAIR (Findable, Accessible, Interoperable, and Reusable) data practices as a matter of normal research practice. Beyond funder requirements, we advise our staff to deposit their data in the Zenodo repository and to record the location of datasets that underpin research outputs in the RIS.

1.7.2 Research Integrity

CoE follows the 'Concordat to Support Research Integrity: A Policy Framework on Research Ethics & Governance'. An Academic Dean for Research Integrity is also available, aided by a Research Integrity team led by the University's Research Integrity Manager. This team provides an annual report outlining the activities undertaken through the year, reports progress at both the College and University levels, and indicates future initiatives. The University mandates that all staff complete discipline-relevant research integrity training by passing an Epigeum online course exam on Research Integrity.

2. People

The Unit has **doubled in size since 2014** following a strategic approach to recruitment and promotion. Eleven new academics (one associate professor [AP], two senior lecturers [SL], and eight lecturers [L]) and one technician have been recruited. All academic staff are recruited to an enhanced research, **Academic Career Pathway**, and are supported through mentoring and biannual appraisal (see REF5a). We have achieved a balance of early career and experienced researchers and have created a critical mass in each research group, ensuring a thriving and sustainable community.

2.1 Recruitment

Academic recruitment is managed through an inclusive and transparent process. The Heads of each CoE Research Centre, in consultation with their research group leads and academic staff, prioritise areas for recruitment based on teaching requirements and research strategic drivers and themes. These are considered by the College Research Committee with recommendations put forward to the Executive Committee for decision.

Four academics joined the EMH group: Hudson (AP, 2016) sport and exercise psychology, Williams (SL, 2016) forensic biomechanics, Metcalfe (L, 2017) exercise physiology and Churm (L, 2019) metabolomics. Four joined the EPS group: Bezodis (L, 2016) biomechanics, Hill (L, 2017) sport psychology, Heffernan (L, 2019) performance sciences and genetics, and Waldron (SL, 2019) environmental physiology. Two new staff bolstered the SEIG group: Devine (L, 2016) conceptual and Harvey (L, 2017) sociology of sport. Two academic staff departed over the period: Mellalieu (2016) and Edwards (joined in 2017, left 2018). **Our low turnover of staff reflects a vibrant, supportive research environment.**

2.2 Staff development:

2.2.1 Support

CoE places a **strong emphasis on supporting every academic as an independent researcher** and gives them the flexibility to follow their individual research agenda. A-STEM infrastructure fosters interdisciplinary collaboration and networking, with peer support provided within research groups and between research centres. Regular workshops are held by Research, Engagement and Innovation Services (REIS) to inform and update staff on funding calls, strategies for industrial engagement, open access policies and IP development as well as fostering cross-University interdisciplinary research opportunities and ideas through sandpits and workshops.

Academic staff performance and development is supported through the University Professional Development Review (PDR) system. Each academic receives two face-to-face PDR meetings annually with their research group leader or Director of Research. Meetings encourage individuals to plan research activity focusing on specific targets aligned to strategic drivers and to identify any support needed to achieve their goals. Importantly, feedback is provided in a professional, informal environment to enable individuals to recognise effective pathways for career progression. Furthermore, these meetings provide a platform to discuss the overall allocation of duties to ensure that the staff workload model is followed. The model attributes 50% of staff time to research, including PGR supervision and research support. In response to increasing pressures on staff, the CoE appointed an officer with the specific purpose of promoting health and wellbeing. This officer has set up a campus wellbeing network increased training of mental health first aiders and recruited wellbeing champions. This infrastructure has been timely given the COVID19 pandemic.

CoE considers academic promotion as a pathway to reward successful members of staff, including those on probation and fixed-term contracts. Information sessions on application procedures, as well as guidelines for writing supporting narratives are offered each year. Staff wishing to apply initiate discussions regarding their suitability and readiness with their Head of Centre and mentors from the College executive. Career progression in Sport and Exercise Sciences during the REF period was marked by **nine promotions,** 44% of which were female. In addition to Stratton's progression to deputy pro-vice chancellor (2018), personal chairs were awarded to Kilduff (2015) and Lewis (2016). Knight (2016), McNarry (2018) and Mackintosh (2018) have progressed from SL to AP and Bezodis was promoted twice, from L to SL and SL to AP (2019). Hill has progressed from L to SL (2019).

Newly appointed academics at junior level receive practical start-up support comprising £5k of flexible funding, a PhD studentship, reduced teaching load and minimal administration for their first two years to ensure that time is devoted to setting-up lab-facilities, special interest groups, and writing grant applications. Induction training encompasses College structure and policies, research aids, PGR supervision, academic performance, and career development. As part of the three-year probation period, ECR staff are allocated a senior mentor and a probation line-manager. For support in developing industrial partnerships, grant applications and collaborations, newly appointed staff can seek funding for equipment or travel directly from centre funds. Furthermore, **CoE returns 20% of overheads raised by grant income to the researcher to invest in a faster expansion of their research area in line with A-STEM strategic drivers.**

CoE also has established **policies to support mid-career and senior academics**. Those with a large research portfolio have their departmental workloads reduced while still contributing to teaching activities. Importance is placed on training senior academic staff and encouraging attendance on targeted Leadership and Management courses. Five staff have also benefitted from participation in the funded Welsh Crucible ECR development programme and all have assumed

significant leadership roles. Over the past year Kilduff (EPS), Lewis (EMH) and McNamee (SEIG) have been succeeded as research group leads by Bezodis, Mackintosh and Bloodworth respectively. Knight co-leads WIPS, Mackintosh and McNarry co-lead WIPAHS and Metcalfe and Waldron are A-STEM's leads for impact and interdisciplinary research respectively. Kilduff succeeded Stratton as Head of A-STEM in 2019.

A-STEM's inclusive and supportive culture celebrates and rewards success but also offers **sustenance to staff encountering difficulties in attracting funding**. Senior staff can apply for a College-funded studentship, support towards national and international conference travel, and small items of equipment to encourage them to continue in their efforts towards successful grant applications. Researchers benefit from a wide range of courses and workshops offered by the University's Development and Training Services, which are mapped to the Vitae Researcher Development Framework. Training on research integrity, data protection, equality and diversity in the workplace, and sustainability is compulsory for all staff.

A-STEM **promotes sabbatical leave** as a means to enhance research profile, boost career development and promote research centre strategy. One semester of leave is permitted every five years and academics apply through the PDR process. Every year CoE offers up to five awards of £5k towards sabbatical leave-related expenses, allocated through a competitive internal process; applications to work with external agencies are particularly encouraged. There is an expectation that sabbatical leave should enhance A-STEM's international profile and lead to grant applications, outputs and/or strengthen impact cases. During this cycle Mackintosh had a travel fellowship to Deakin University (Alfred Deakin Foundation) and a Churchill fellowship at Michigan State. McNarry was awarded an Endeavour Fellowship funded by the Australian Government and hosted by the Baker Institute in Melbourne. These Fellowships were integrated into sabbaticals and helped realise successful grant applications, two invited presentations, one research paper and the establishment of WIPAHS.

2.2.2 PGR Research, Support and Development

Over the census period 66 MSc (Res) and 21 PhD students have graduated, representing a fourfold increase in PhDs since REF2014. More than a third of A-STEM PGRs are female. Funding for PhD studentships has been secured from a variety of sources, including KESS (33), Cotutelle PGRs with AUT and JFF Grenobles-Alpes partnerships the ESRC Wales DTP (3), Zienckewicz Foundation (2), University scholarship (1), and industry partners (3). A-STEM academics are also part of supervisory teams for students in SU Medical School and in Engineering, as well as in partner universities in the UK and overseas. **We currently have 53 MSc (Res) and 63 PhD students enrolled.**

Table 4 - PhD Graduates 2014-2020

	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
PhD	5.5	2	2	3	6.5	2
Prof Docs	0	0	0	0	0	0

CoE's strategic lead for PGRs is supported by a PGR lead in A-STEM and a professional services team dedicated to PGR matters. Each research centre has a nominated student representative that reports directly to the PGR committee and subsequently to the CoE research committee. In addition, the Research Hub runs postgraduate supervision workshops for new academics and provides induction support guided by the University's PGR Matters strategy. Supervisory teams use the Concordat framework to guide the career progression of their PGRs. After induction, PhD

progress and engagement are monitored during monthly meetings between the student and supervisory team using the online platform E-Vision.

A-STEM provides a **PGR hub** adjacent to laboratory facilities, where students, postdoctoral researchers and research visitors are co-located, enabling cross-fertilisation of ideas and experiences. To augment their research training, postdocs and ECRs host visiting academics and industry-driven researchers who contribute to A-STEM's research seminar programme, which has delivered 73 seminars over the period, drawing speakers from Europe, the USA, Australia, Indonesia and New Zealand. Students also present at the A-STEM seminar series, the PGR A-STEM conference, and the annual Pan-Wales PGR Sport and Exercise Science research conference supported by an ESRC DTP support fund. Research centre grant funding provides the opportunity for all students to present their work at least once at an international conference during their studies. The PGR experience is further rounded by opportunities to serve as student members on major committees, engage in undergraduate teaching, and participate in entrepreneurship and outreach activities. There is also a sport and exercise science society, and industrial links and student support officers, ensuring a vibrant and cohesive student community.

2.3 Equality, Diversity and Inclusivity (EDI)

Abiding by the SU Code of Practice, all members of the UoA team with responsibility for decisions on the selection of outputs and impact case studies for this submission undertook mandatory equality training, including specialised courses on equality and diversity and unconscious bias. The submission comprises the one best-quality output from each Cat. A submitted staff member with the balance made up of the best-quality outputs from the available pool of eligible outputs that includes outputs of former eligible colleagues. The University's Equality and Diversity Sub-Group considered all self-reported individual staff circumstances and made recommendations on reductions to an individual's expected contribution to the output pool, which we have respected.

EDI is a CoE strength. Swansea is a charter member of Athena Swan, holding an Institutional Silver Award since 2017, and ranked 47th in the 2019 Stonewall's Top 100 Employers List. In 2019, SPEX secured an 'enhanced' Athena SWAN silver award.

Our commitment to address gender equality and inclusivity is evidenced by the appointment of a full-time EDI and staff support officer and BAME champion to drive progress. Growth in female staff is directly attributable to **proactive recruitment approaches** that include wording of job adverts with links to Swansea's family friendly policies, gender balance on interview panels and direct targeting of potential female academics. There are also **intensive mentoring programmes**, the Women for women in STEM.

Progress has been made over the census as a result, four female academics have been recruited, three have been promoted to AP and one to SL. **This has resulted in an increase in female (27 to 37%) and non-UK academic staff (18 to 26%) over the census period.**

Similarly, the **proportion of female RAs and PGRs has grown to 46% and 36%**, respectively.

25% of staff are non-UK (5% BAME), up from 18% in 2014, with 16% reporting a known disability, up from 9% in 2014. Two staff have taken maternity and five paternity leave over the census. All have returned to their substantive posts.

3. Income, infrastructure and facilities

In September 2015, CoE's and A-STEM's relocation to the Bay Campus (SD6) augmented **substantial innovation and change**:
(i) impacting the local, regional and national economy,
(ii) enabling high quality transformative research through state-of-the-art infrastructure,
(iii) creating an open and collaborative working environment,
(iv) fostering international partnerships with global industry and research institutions, and
(v) putting in place financial resources to ensure long-term sustainability.

3.1 A-STEM laboratories

Swansea University has invested circa **£3m in circa 1000m^2 of A-STEM facilities** (650m^2 in 2015, 350m^2 in 2019), including newly equipped biomechanics, physiology and psychology laboratories with specialist facilities in biochemistry, DEXA, environmental chamber, a special populations laboratory, nutrition preparation areas and interview rooms to support qualitative research. A-STEM facilities complement those available across the rest of SU and are aligned to staff research strengths and impact interests.

3.2 University Facilities

Academics have access to other facilities and infrastructure across the University (Figure 2). A unique characteristic of A-STEM in the UK HEI system is that it is housed within the **College of Engineering**, facilitating direct access to sector-leading engineering facilities and collaboration between engineers, sport and exercise scientists and industry that promotes highly novel lines of research and research impact. This infrastructure has **directly supported the ICS on competition day strategies**. For example, the £1.2m wind tunnel has been used by EPS researchers in partnership with GB Cycling and GB Bobsleigh. Specialist equipment in CoE has enabled:

(i) the £1.8m SMARTExpertise partnership work with the English Institute of Sport work on intelligent materials and heated garments, and;
(ii) the partnership with Sport and Wellbeing Analytics (SWA) that led to the development of the PROTECHT intelligent mouthguard system used in concussion prevention research which has developed into a SMART Partnership;
(iii) the Systems and Processing Engineering Centre also engineered its own movement tracker (Slamtracker) for measuring physical activity, as well as advanced analytical signal processing methods that sport and exercise scientists have used in collaboration with users (Sport Wales, Dragon Challenge) to publish new insights into physical activity and quality of movement in children and young people;
(iv) further, engineers and sport and exercise scientists have delivered captivating science exhibits at public engagement events such as the British Science Festival, where they used 3D printing to characterise patterns of children's physical activity.

Academics also have regular access to the Clinical Research facilities offered by the **School of Medicine** and collaborate with the Diabetes Research Unit-Wales to undertake clinical trials and fundamental research into the mechanisms underpinning whole systems physiology in diabesity. These have enabled A-STEM academics to contribute to the €9m diabetes prevention project (FP7, PREVIEW) and a £512k project funded by Novo-Nordisk, investigating the interaction between new insulin analogues and exercise in type 1 diabetes. **This work has directly supported the ICS in this area.** Clinical facilities that support exercise related trials for children with cystic fibrosis and asthma are ongoing. Swansea's clinical imaging facility and midwifery and obstetrics have been used for studies on breast cancer, and exercise and pregnancy. Further,

collaborative partners with academics in Swansea's Data Science Farr Institute allows routine data linkage studies to be developed and funding secured by NIHR- Blue-Green Spaces (£600k), MRC-NHMRC BEACHES project (£800k) and the Health and Attainment of Pupils in a Primary School Education Network (HAPPEN) that is core funded from a grant of £3.4m awarded to the National Centre for Public Health and Wellbeing Research Wales.

The EPS research group also benefits from the University's elite performance facilities. A partnership between Swansea City Football Club and the University resulted in a £6m development of the Fairwood training ground that includes 6 Premier League Quality pitches, cryotherapy, performance analysis and sports medicine facilities. The Swim Wales Elite Performance Centre is used by scientists in WIPS and is based at the Wales National Pool (WNP). Both the Fairwood and WNP facilities are part of University estate.

SEIG and sport psychology colleagues also share generic space with the wider University social science community, including the Sport and Exercise Science Pathway in Wales ESRC DTP.

3.3 National and International infrastructure, opportunities and networks and consortia

All academics are involved in international collaborations. Many of these collaborations involve shared use of facilities, shared data, access to participant populations as well as industry. The external advisory network (EAN) provides focus and impetus for A-STEM research and are a key conduit in achieving research impact on professional practice, product or policy. WIPS and WIPAHS and the ERASMUS collaboration are key vehicles operating between A-STEM and collaborating groups allowing access to the NHS, schools, elite sports facilities and environments (professional sports clubs) and international committees such as WADA.

3.4 Research Administration Support for Staff

In 2015, supported centrally by the department of Research Engagement and Innovation Services (REIS), the University created the **Bay Campus Research Hub,** comprising a Hub Manager, two Research Development Officers, two Research Support Advisors, a Bid Writer, an Impact and Engagement Officer, a Project Assurance and Risk Manager, a REF Officer, and a Procurement Officer and Contracts Manager. The Hub deploys its resources to support researchers to achieve their research income targets and to assist them in developing and implementing impact activities. The Hub also runs fortnightly research information and training sessions for ECRs, Cat A and research only staff.

3.5 Research Income

Over the census period our strategy (SD5) was to increase competitive grant capture for multidisciplinary STEM-related research and to develop significant international projects. This success has been augmented by the support of the Research Hub supporting funding applications. The Hub has also improved online support and guidance for researchers, which will help to sustain a pipeline of excellent research grant applications. **Forty-five grants were awarded** over the census period. A third were from government bodies, local health authorities and the NHS, a quarter from industry and 15% from research councils, 10% from Europe and 6% from UK charities. Research spend in A-STEM amounted to **£2.19m** over the census period, a **46% increase** on the previous REF cycle.

To complement income generation activity, A-STEM academics have collaborated with colleagues on large, funded projects within and outside of the University.

3.5.1 EMH

- Have continued diabetes prevention work with the PREVIEW consortium (FP7; €8.9m) and have captured funding from the pharmaceutical industry for studies related to exercise and type 1 diabetes and to support the Novo-Nordisk professional road cycling team (£512k);
- Are partners in the Cystic Fibrosis and physical activity strategic partnership (£750k) and lead on Global Challenges funded work to develop a school physical activity, obesity and health research network in Kenya (Kenya-Linx);
- Co-investigate on the NIHR Blue-Green Space and Mental Health project (£599k), the main trial for Project Active (BHF: £300k) and the WEFO-funded AWEN institute (£2.8m);
- Won collaborative grants with industry both in education (Department for Education £600k) and concussion prevention (SWA £350k);
- Have two Marie Curie COFUND research fellowships;
- Contribute as Co-investigators to the National Centre for Public Health Research Wales (Healthcare Research Wales, (£918k), the UK Asthma Research Centre (£2m), Centre for Aging and Dementia Research (£758k) Diabetes Research Unit-Wales (£758k) and the Active Buildings Centre (EPSRC £3.0m).

3.5.2 EPS

- Are co-leads of a £1.8m SMARTExpertise grant and recipients of £125k from the English Institute of Sport for initial developmental research in this area;
- Received £76k to work with Swim Wales, £96k to work with professional soccer and £490k to support elite athletes in Wales through the continued work of WIPS;
- Have a research council EPSRC Case award with the Rugby Football Union that generated £93k;
- Seen substantial funding (£339k) from ERASMUS, KESS, Swansea City Football, the IOC and the ESRC to support research related to parenting in sport.

3.5.3 SEIG

- A-STEM established the SEIG group as a result of a successful grant application to run an ERASMUS+ MA in Sport Ethics, Integrity and Governance (MAiSI) that attracted circa £4.5m. The ERASMUS+ was awarded to Swansea because of the significant and long-term research contribution to the field by existing academics;
- Received research support from UKAD for their work on Doctors and Doping, which culminated in several papers on Therapeutic Use Exemptions;
- Received £55k of ESRC funding to explore the ethical dimensions of novel treatments in the English Premier League and professional cycling as part of the BIOSPORT project.

4. Collaboration and contribution to the research base, economy and society

4.1 Research collaborations, networks and partnerships.

Our interdisciplinary base has augmented **academic and industrial collaborations at international, national and local levels**. Our research groups promote connectivity across disciplines, co-producing research to influence professions, products, practice and policies. These include parenting children in sport, promoting elite sports performance in collocated elite and professional sports, influencing policy change at WADA, augmenting medal hauls in major games, influencing diabetes management, and promoting active and healthy kids through schools' networks from local to global level. Our research without borders approach starts with collaborations across research groups, College and University, cutting across life sciences, medicine, social sciences, ethics and law, history, archaeology and the physical sciences.

Swansea University's **strategic partnerships** with JFF Grenobles-Alpes and Texas have resulted in collaborative and exchange agreements that are complemented by formal partnerships with the Universities of Porto, Auckland University of Technology and the University of Western Australia, and the MAiSI consortia of six European universities (SU, KU Leuven, JGU Mainz, UPF Barcelona, Charles University Prague, University of Peloponnese). These collaborations are sustained through cotutelle PhDs, competitively funded research sabbaticals, joint workshops and presentations at international meetings, research training and exchanges, joint publications, and joint grant applications and awards.

Aligned to our strategic drivers, these **international collaborations** enable academics to add greater rigour and novelty to their research, share fiscal and physical resources, widen connections, and share knowledge and experience. Both our outputs and impact case studies have a strong international dimension while our broader impact work has affected policy in major sport organisations and professional practices, in performance in elite, professional and youth sport, and in health promotion and clinical exercise and diabetes medicine nationally and internationally.

4.2 Research only Staff

Our research fellows, post docs and research assistants contribute significantly to our research collaborations. Research only staff, not yet demonstrating research independence as defined in SU Code of Practice, **increased nearly tenfold over the REF period**. We have employed 24 research staff (13M; 11F), 15 from the UK, six from Europe and one each from Brazil, New Zealand and Iran. Marie Curie COFUND research fellows Moser and Roldan have made significant contributions to research into exercise and diabetes, including successful funding applications to Novo-Nordisk (£565k) research outputs and an impact case study, and to research and networks in exercise and pregnancy. Other post-doctoral positions are resourced with funds from UKRI, industry, third sector and University funds and are balanced 50:50 between research and impact work and 45:55 between short and long-term contracts. Longer term contracts for research only staff are funded by WIPS and WIPAHS and resources from UKRI grants.

4.3 Leadership roles and networks.

A-STEM academics occupy **strategic leadership roles** in national and international groups and networks. Over this REF period:

- Kilduff and Knight have co-led WIPS;
- Mackintosh and McNarry co-led WIPAHS;
- Stratton led the Active Healthy Kids-Wales network;
- McNamee contributed to Integrity and Governance developments with Sport Wales, and led the pan-European MAiSI consortium;
- McNamee also helped establish Ethics and Integrity functions at the Amateur International Boxing Association and the International Ice Hockey Federation, and drove ethical policy innovations with the WADA and World Athletics;
- Kilduff and Bezodis are collaborators on the International Rugby Board, Rugby Science Network;
- Kilduff and Heffernan are collaborators on the Genomics of Rugby Union international research group;
- Knight leads a European project on parenting in sport with partners from Northern Ireland, Wales, England, Norway, Netherlands, Belgium, Denmark with support from ERASMUS+

and the IOC. This project complements other global collaborations with academics based in Canadian, American and Australian institutions;

- Harvey and McNamee are research collaborators on a Europe-wide project on athletes' rights funded by Erasmus+;
- Stratton is a member of the World Health Organisation led NCD Risk Factor Collaboration (NCD-RisC) and was European representative on the seminal version of 24h movement guidelines produced by an international collaborative for Canadian children;
- Stratton, Mackintosh and McNarry co-authored, shared conference presentations, academic exchanges and fellowships and successfully secured research funding for collaborative research with academics from the University of Western Australia;
- Stratton leads the international "Linx" network for healthy and active schools, including Swanlinx, Bridgelinx, Kenyalinx and Nigerialinx;
- Bracken has developed international research collaborations in diabetes and exercise with Austria (Graz Medical School), Germany (Bayreuth, Dusseldorf), Denmark (Steno diabetes Copenhagen, and Aarhus), Canada (University of Alberta, University of Toronto), Switzerland (Bern Inseptial), Spain (Madrid);
- McNarry and Stratton are Co-Is in the Asthma UK Centre for Applied Research;
- Mcnarry and Mackintosh are collaborators in the European Cystic Fibrosis Society exercise working group and Co-Is in the Strategic Research Centre of the UK Cystic Fibrosis Trust with the University of Exeter, La Trobe University, Sick Kids Toronto and University College London;
- Lewis's research into exercise and pregnancy has developed key partnerships with the Universities of Granada and North Carolina.

4.4 Engagement with research users and beneficiaries

4.4.1 Contributions to economy and society

A-STEM academics contribute widely to **research impact and public benefit**. Performance scientists (Kilduff, Bezodis, Knight) work with all elite and professional sport organisations in Wales, with EIS, and the Olympic sport programme. Competition day preparations research produced by A-STEM was used by athletes in the Commonwealth Games (Glasgow 2014, Gold Coast 2018, Wales' largest medal haul), Winter Olympic Games (Sochi 2014, Pyeongchang 2018), Summer Olympic Games (Rio 2016), and Rugby World Cups (England 2015, Japan 2019). Team GB are currently implementing these procedures in preparation for the upcoming Olympic Games in Tokyo (2021) and Beijing (2022).

Other **significant contributions** include:

- Kilduff, Bezodis and Knight continue their collaborative work with engineering industrial partners (Haydale), the English Institute of Sport and GB Sport, the RFU, and UK Athletics in developing intelligent materials to support Olympic Games athletes who will compete in Tokyo;
- Kilduff is Trustee, and Mackintosh and McNarry act as performance scientists supporting the "65 degrees north charity", helping disabled ex-military to complete extreme challenges, such as climbing Everest, Mount Kilimanjaro and reaching the polar ice cap;
- Owen (EPS-Teaching) has continued his biomechanics and archaeology work on "The elite athletes of the day: the long bowmen of the Mary Rose." This unique project has augmented exhibits in "The Many Faces of Tudor England exhibition";
- Knight has engaged in significant impact work related to parenting in sport, developing resource materials for sport governing bodies and professional clubs both in the UK and

internationally, raising the importance of parenting and safeguarding in the context of elite youth sport, Including the world's first consensus statement regarding parental involvement in youth rugby (RFU);
- Stratton authored a report for the Public Policy Information Unit for Wales on Physical Activity and Health and worked alongside Mackintosh on the UK Chief Medical Officer's expert group that published the UK Physical Activity and Health Guidelines (2019);
- Stratton is an expert advisor on the National Obesity Strategy for Wales and is an expert member for the National Institute for Health Care Excellence (NICE) chairing the evidence update group for children's physical activity and contributing to the Quality Statement for Childhood Obesity;
- McNamee has served as an expert ethicist for organisations including the UN Office on Drugs and Crime. He is Chair of UKADs ethics committee for Therapeutic Use Exemption, and is a member of the Ethics Expert Group of the World Anti-Doping Agency;
- Devine's research helped shape World Athletics new transgender participation policy;
- Harvey's research impact into match-fixing in professional football continues to shape PFA player education.

Public engagement is part of A-STEM's impact strategy. Members contribute to the University-wide engagement programme in science cafes, soapbox science events, science festivals and outreach programmes. The British Science Festival was held in Swansea in 2016 and has since been followed up with annual Swansea Science Festivals. A-STEM Academics ran workshops on 3D printing of children's physical activity and shared the scientific discoveries of the Mary Rose with the public at the festivals, which attracted around 9,000 visitors to each event. The 3D printing workshop was also delivered in the Urdd national Welsh culture and language festival for youth. Over the period, 9 A-STEM academics contributed 19 articles to the Conversation, receiving 180,302 reads. Notable papers included: *How to improve your running – smiling boosts efficiency, researchers find* and *Wimbledon: Nick Kyrgios may be the bad boy of tennis, but he's playing by the rules*.

All academics in A-STEM have been involved in **broadcast media**. McNamee has appeared on numerous radio and TV broadcasts to share insights into sports ethics and anti-doping, Devine has been featured on BBC Radio 4 ('The Moral Maze'), BBC World Service, Cycling Weekly, The Forum for Philosophy, The Irish Times, The Irish Examiner website, and the University of Oxford website ('Oxford Debates' series). Metcalfe has featured on a BBC horizon documentary: The Truth About Getting Fit in 2018. Williams has been regularly sought by media to discuss concussion in rugby union as a result of her pioneering work developing an instrumented mouthguard that measures head acceleration in real time. Knight received more than 200 media reports for her contribution to Parents in Sport Week (2016, 2017 and 2018). Owen's work on the longbowmen of the Mary Rose was featured on Channel 4, with viewing figures in excess of 10 million.

4.5 Contributions to the research base

A-STEM academics are highly active in reviewing papers and grants, organising and chairing meetings and delivering keynotes, lectures, plenaries, workshops and symposia. A-STEM staff hold **28 positions on editorial boards**:

- Mackintosh and McNarry are section editors for the Journal of Measurement in Physical Education and Exercise Science;
- McNarry is associate editor for the European Journal of Sport Sciences (EJSS);
- Stratton is associate editor of the International Journal of Environmental Research and Public Health;

- Hudson occupied four editorial board positions over the census period, is on the editorial board of the International Review of Sport and Exercise Psychology and is editor of the Journal of Motivation, Emotion and Personality;
- Metcalfe is the reviews editor for Frontiers in Physiology;
- Kilduff is on the editorial boards of EJSS, the International Journal of Sports Physiology and Performance, and the International Journal of Sports Nutrition;
- Bezodis sits on the editorial board for the Journal of Sports Biomechanics;
- Knight occupied six editorial board positions over the census period, is section editor of the International Journal of Sport and Exercise Psychology and associate editor of Sport, Exercise and Performance Psychology (SEPS);
- Harvey is on the editorial board of Sport Management;
- Waldron is on the editorial board of the Journal of Science and Medicine in Sport;
- McNamee is Editor Emeritus: Sport, Ethics and Philosophy and Ethics and Sport book series editor;
- McNamee and Bloodworth are editorial board members of Performance Enhancement and Health.

Academics have also **published full texts** during this period. McNamee has authored Sport Ethics and Philosophy (2018) Stratton co-edited Physical Activity: A Multi-disciplinary Introduction (2018), and Knight has co-authored Parenting in Youth Sport (2014), and edited Sport Psychology for Young Athletes (2017).

4.5.1 Conferences and workshops

A-STEM academics delivered **53 keynotes, workshops, symposia and plenaries** at international conferences and meetings over the REF cycle. Notably:

- Hudson hosted the Reversal Theory Society's international meeting at Swansea in 2017;
- Stratton ran workshops at ICAMPAM meeting in Washington in 2017 and at ECSS in 2017 and was a member of the scientific and organising committees for ISPAH London (2018);
- Metcalfe gave keynote lectures at the Italian Physiologic Society (2017) and Stratton at the AESEAN congress (Bali, 2014);
- Kilduff delivered a keynote at the SPRINZ international meeting (NZ, 2016);
- Knight delivered a keynote at the Academy of Dance Science and Medicine Conference (Helsinki, 2018);
- McNarry and Mackintosh delivered invited lectures on novel technologies and physical activity at ISBNPA, ICAMPAM and HEPA between 2016 and 2018;
- McNamee delivered thirty lectures globally in areas of sport ethics, integrity and governance and anti-doping, including the Chief Medical Officers of the IOC (2020), USA anti-doping agency symposium (2015), International Paralympic Committee Scientific Convention (2017).

4.5.2 Grant Reviewing, membership of committees etc.

All senior academics in A-STEM are members of grant review panels, including: ESRC, Czech Science Foundation, Swedish Research Council, Swiss National Sciences Foundation, Flanders Research Foundation, Canadian Social Sciences and Humanities Research Council, Finnish Academy of Science, British Heart Foundation, NIHR, Health and Medical Research Fund Hong Kong, and IRB Rugby Science Network.

4.5.3 Leadership, Fellowships and Awards

- Devine is Vice-Chair of the British Philosophy of Sport Association and an Executive Council member of the International Association for the Philosophy of Sport,
- Bezodis is Vice President – Awards. International Society of Biomechanics in Sports (ISBS),
- Bezodis (ISBS, 2018) and Stratton (Royal Society, 2019) have been awarded fellowships,
- Hudson was President of the Reversal Theory Society (2017-19),
- McNamee was visiting Professor at the Universities of Ghent, Leuven, Hunan and Pennsylvania State University,
- Stratton is adjunct Professor at the University of Western Australia,
- Waldron is Fellow at the University of New England,
- Bloodworth was accepted as a visiting fellow at the Hastings Centre New York,
- Mackintosh was recipient of a Churchill Foundation award to Michigan State and Deakin University Melbourne,
- McNarry was awarded an Endeavour Fellowship (Australian Government) and was hosted by the Baker Institute in Melbourne,
- McNarry was runner-up in the ACSM International Scholar Award (2020),
- Mackintosh won the ECR Research Star Award (Health Enhancing Physical Activity (HEPA)-Europe, 2016),
- Eddolls (EMH – PGR) was awarded 5th position for his mini-oral in the YIA ECSS awards (2017),
- Bezodis was placed joint 2nd in the New Investigator Award at the International Society of Biomechanics in Sports annual conference (2017),
- Greybe (EMH - Postdoc) was runner-up for best paper in the Journal of Sports Engineering (2020),
- Stratton was co-author of paper that received the most cited award in the observational category of the International Journal of Behaviour Nutrition and Physical Activity,
- Knight was reviewer of the year in 2017 for the journal of SEPS.