

Curriculum Vitae – Richard John Buttery

Vision: *To foster the development of solutions to make fusion energy a reality through exploration of innovative approaches and their underlying scientific foundations, and through the development of excellent scientific teams and personnel.*



Accomplishments

Scientific – see attached selected papers and citation details

- **Interaction of ‘3-D’ field asymmetries with tokamak plasmas:** Led multi-machine experiments to understand and determine principle scalings of these interactions to predict effects and define requirements in ITER. These early studies led to considerable interest in the application of ‘3-D’ fields more broadly for a range of applications and for tokamak ‘error field’ correction.
- **Discovered the Neoclassical Tearing Mode in the spherical tokamak, MAST,** validating key aspects of its behavior and in particular the role of Green Glasser Johnson field curvature effects.
- **Neoclassical Tearing Mode Onset Physics** – identified the crucial role of mode coupling to seed this instability, the physics of seed decay and mode growth, and key dependencies on rotation. This work has highlighted the importance of underlying classical tearing stability arising from current gradients in the plasma, providing a framework for stability optimization in ITER.
- **Pursued a range of work on stability and ELM physics** including ELM MHD and control on COMPASS-D, interpretation of spherical tokamak reconnection events and disruption resilience through a helicity constraint, ideal limits and disruptions.
- **Developed new concept for Compact Advanced Tokamak net electric pilot plant.**

Leadership

- **Director of Experimental Science, DIII-D National Fusion Facility** – leading a collaborative multidisciplinary team of over 600 collaborators, training over 40 PhD and postdocs, to address critical issues of fusion science and prepare for ITER. Our program is internationally recognized for its excellence, with two recent Dawson awards and two Landau Spitzer prizes, also securing three times more talks at the IAEA Fusion Energy Conference than the next best facility.
- **DIII-D Frontiers Science Initiative** – led team of university professors to propose, define and execute exciting research from outside the fusion energy sphere, providing a powerful tool for basic plasma research, with high impact results already (PRL, postdeadline APS, EPS invited talk).
- **DIII-D Student/Postdoc Support program** – conceived and oversee initiative to support and train students with early career mentors, talks and pizza.
- **MAST-Upgrade Physics Leader** – established physics basis, implementing innovative elements such as super X divertor, and presenting at high level to secure favorable reviews. Now funded.
- **JET Task Force and Program leader** – led JET task forces on stability and ITER baseline scenario, as well as overall UK program on JET, leading to important results such as control of sawteeth to prevent tearing modes, validation of kinetic effects in ideal MHD & projection to ITER, cross-machine neural network disruption predictions, and developing the ITER baseline to high shape and performance with reduced ‘ELM’ heat loads.
- **UK stability program on COMPASS-D, START and MAST** – leading to key accomplishments such as world’s first current drive stabilization of NTMs (Warrick PRL) and influence of 3D fields on ELMs (Fielding EPS) and divertor heat loads (Buttery, NF) on COMPASS-D, understanding of reconnections and disruptivity in the spherical tokamak, and providing key insights into NTM physics and plasma multi-mode response to 3-D fields.

Community Service

- **APS-DPP Executive Committee Member, 2017-present**
- **U.S. IAEA FEC Program Committee, 2016:** secured more talks for U.S. than any other party.
- **USBPO Council Member, 2010-2013:** oversee the US Burning Plasma Organization with long range strategic guidance. In particular I led an effort to determine USBPO's future direction, and served on the panel to choose candidates for its new director.
- **FESAC Collaboration Panel Member, 2011-12:** providing advice requested by DOE to determine US collaboration opportunities abroad and domestic program needs.
- **ReNeW, 2008-9:** reviewer for thrust 8 and contributor to other thrusts & themes.
- **National Tokamak Working Group, 2007:** co-chair of DIII-D/CMOD/NSTX planning activity
- **Honorary Secretary to UK Institute of Physics Plasma Physics Group, 2007-2009:** Coordinated activities to support the UK plasma physics community – conferences, prizes, bursaries, web, and a new thesis prize.
- **International Tokamak Physics Activity:** Led and closed 2 joint coordinated experiments and an analysis activity as well as regular support and advice in the MHD Disruptions & Control Group

History

2012-today DIII-D Experimental Science Director

Lead team of 75 scientists, developing vision, budgets, and priorities, coordinating experimental run, line managing 29 GA staff and overseeing scientific outputs.

2009-2012 DIII-D Program Planning Coordinator

Developed concepts for long range strategy for DIII-D, securing support for gyrotron upgrade program, developing strategy for new divertor upgrade and several other concepts, as well as bidding the program to FES and outreach.

1993-2009 Scientist and Program Leader with UKAEA

From scientific studies on stability to leadership of UK stability program, leadership of JET task forces on stability and ITER scenarios, coordination of UK program on JET, an EU topical group and MAST upgrade physics leader.

Qualifications & Honors

2014-2015 UCSD Management Diploma: Executive Perspective for Scientist & Engineers
Extensive one year course with leading SD tech companies, lectures & projects.

2009 Fellow, UK Institute of Physics.

2001-2006 Licensed JET Session Leader – full 4MA license with tritium experience.

1990-1993 PhD in Theoretical Particle Physics, University of Manchester, UK.

Used Quantum Chromodynamics to study photon emission from quarks as they emerge from particle collisions in an accelerator. This involved understanding complex problems, theoretical and computational work to model QCD processes, and integrating results into a larger field to predict experimental observations.

1987-1990 BSc in Physics, First Class Honours, University of Manchester, UK.

Detailed physics knowledge development, plus laboratory work, with extended experiment and analysis projects, including quantum, thermal, optics, maths, dynamics, electromagnetism, relativity, nuclear, astrophysics, and electronics.

1985-1987 4 A levels grade A (Maths, Further Maths, Physics, Chemistry) with **2 special paper distinctions**, plus a further **O level** at Lincoln Christ Hospital School, UK.

1981-1985 10 O levels at William Farr Comprehensive, Welton, Lincoln, UK.

Selected Papers & Citation Count (google scholar)

Error and '3-D' Fields:

Error Field Mode Studies on JET, COMPASS-D and DIII-D, and Implications for ITER

R. J. Buttery, et al., Nucl. Fus. 39 (1999) 1827 – **136 citations**.

Error field experiments in JET, *R. J. Buttery, M. De'Benedetti, T. C. Hender, B. J. D. Tubbing*, Nucl. Fus. 40 (2000), 807 – **112 citations**.

Error field locked modes thresholds in rotating plasmas, anomalous braking and spin-up, *E. Lazzaro, R. J. Buttery, T. C. Hender, P. Zanca, R. Fitzpatrick, M. Bigi, et al.*, Phys. Plasmas **9** (2002), 3906 – **91 citations**.

The Limits and Challenges of Error Field Correction for ITER, *R.J. Buttery, A.H. Boozer, Y.Q. Liu, J.-K. Park, et al.*, Phys. Plasmas **19** (2012) 056111 – **31 citations**.

Effects of Resonant Magnetic Perturbations on Divertor Target power loads in COMPASS-D, *R. J. Buttery, T. C. Hender, et al.*, Nucl. Fus. 36, (1996), 1369 – **18 citations**.

Neoclassical Tearing Modes:

The Influence of Rotation on the β_N Threshold for the 2/1 Neoclassical Tearing Mode in DIII-D, *R. J. Buttery, R. J. La Haye, P. Gohil, G. L. Jackson, H. Reimerdes, E. J. Strait, and the DIII-D team*, Phys. Plas. 15 (2008) 056115 – **90 citations**.

Neoclassical Tearing Modes, *R. J. Buttery, S. Günter, G. Giruzzi, T. C. Hender, D. Howell, G. Huysmans, R. J. La Haye, M. Maraschek, H. Reimerdes, O. Sauter, C. D. Warrick, H. R. Wilson and H. Zohm*, Plasma Phys. Control. Fusion 42 (2000) 61 – **88 citations**.

Onset of neoclassical tearing modes on JET, *R.J. Buttery, T.C. Hender, D.F. Howell, R.J. La Haye, O. Sauter, D. Testa*, Nuclear fusion 43 (2003), 69 – **67 citations**.

Neoclassical Tearing Physics in the Spherical Tokamak MAST, *R. J. Buttery, O. Sauter, R. Akers, M. Gryaznevich, R. Martin, C. D. Warrick, H. R. Wilson, and the MAST Team*, Physical Review Letters 88 (2002) 125001 – **46 citations**.

Complete stabilization of neoclassical tearing modes with lower hybrid current drive on COMPASS-D, *C.D. Warrick, R.J. Buttery, G. Cunningham, S.J. Fielding, T.C. Hender, et al.*, Phys. Rev. Lett 85 (2000) 575 – **44 citations**.

On the Form of NTM Onset Scalings, *R. J. Buttery et al.*, Nucl. Fus. 44 (2004) 678 – **41 citations**.

Controlled seeding of neoclassical tearing modes in COMPASS-D, *R. J. Buttery, M. Valovic, C. D. Warrick, H.R. Wilson, Compass-D Team*, Nuclear fusion 41 (2000), 985 – **20 citations**.

Other Selected Papers

DIII-D Research to Address Key Challenges for ITER and Fusion Energy, *R. J. Buttery and the DIII-D Team (DIII-D IAEA overview paper)*, Nucl. Fus. **55** (2015) 104017 – **11 citations**.

Stability at High Performance in the MAST Spherical Tokamak, *R. J. Buttery, et al.*, Nucl. Fus. 44 (2004) 1027 – **30 citations**.

ELM control in COMPASS-D, *SJ Fielding, RJ Buttery, AR Field, PB Jones, et al.*, Proc. 28th EPS Conference on Controlled Fusion and Plasma Physics, Funchal (2001) – **41 citations**.

Progress Towards an Integrated Solution for the ITER Baseline Scenario Based on High Current & Highly Shaped Plasma Operation at JET, *R. J. Buttery, et al.*, Plas. Phys. Cntr. Fus., 49 (2007) A59.

Fusion: The Way Ahead – Physics World, 2006 by *R. Pitts, R. J. Buttery and S Pinches*.

PhD: The Photon Structure Function in Higher Orders of QCD, *R. J. Buttery, J. K. Storrow* Modern-Physics-Letters-A. vol.7, no.34, 10 Nov. 1992, p.3229 – **2 citations**.

Selected Presentations

- *“DIII-D Research to Address Key Challenges for ITER and Fusion Energy”*, overview talk at IAEA Fusion Energy Conference, St. Peterberg, 2014.
- *“Tearing Under Stress – The Collision of 3D Fields and Resistivity at Low Rotation”*, invited talk APS DPP, 2011.
- *“Developing MAST to explore the Physics of Fusion Power”*, talk at UK Institute of Physics Annual Plasma Physics Conf., 2009.
- *“The Need for a Fusion Science Integration Experiment”*, *“Disruptions – Research Needs”*, two talks given at ReNeW theme 1&2 workshop, San Diego, 2009.
- *“Extrapolating Neoclassical Tearing Mode physics to ITER”*, invited talk at APS-DPP 2007.
- *“High plasma current and high triangularity operations in the JET tokamak”*, invited talk at International Congress Plasma Physics Kiev, 2006.
- *“Cross-machine NTM physics studies and implications for ITER”*, talk at IAEA Fusion Energy Conference, Portugal, 2004
- *“Stability at high performance in the MAST Spherical Tokamak”*, talk at IAEA Fusion Energy Conference, Lyon, 2002.
- *“Neoclassical Tearing Modes”*, invited talk at EPS Plasmas Physics Conf., Budapest, 2000
- *“Error field mode studies on JET, COMPASS-D and DIII-D, and implications for ITER”* talk at IAEA Fusion Energy Conference, Yokohama, 1998.
- *“ELM related MHD activity on the COMPASS-D tokamak compared with ASDEX-Upgrade”* talk at EPS Plasmas Physics conference, Bournemouth, 1995.
- *“Effects of Magnetic Perturbations on Divertor Target Loads in COMPASS-D”*, talk at UK Institute of Physics Plasma Physics meeting, Oxford, 1995.

Multiple talks at ITPA MDC meeting on stability issues & coordination of tasks.