OFFICE OF COMMERCIALISATION
AND INNOVATION

MACQUARIE University
SYDNEY·AUSTRALIA

EUREKA WINNER

Winner of the 2017 Australian Museum Defence Science and Technology Eureka Prize for Outstanding Science in Safeguarding Australia

"The diamond-based technology invented by Associate Professor Richard Mildren is capable of radically increasing the power and spectral range of lasers. Australian and United States defence agencies are investing in this technology to increase their power capability, and a UK company has licensed commercial applications in quantum science..."

dHEL

HIGHER POWER ON TARGET

Macquarie's diamond-based **H**igh **E**nergy **L**aser (HEL) tech runs at an eye safer 1.24 μm, with unprecedented ultra-high power potential of 100's of kW to MWs. Backed by an extensive patent portfolio and 20 years of world-leading expertise, our Diamond HEL (dHEL) is on track to go where no other HEL can.

Current HEL systems are restricted to wavelengths near 1 µm and developers are striving for higher powers without beam quality degradation. Future defence applications demand electrically driven solid-state systems with increased wavelength choice and with high beam quality output at 100's kW – MWs to improve efficacy, increase applications and improve personnel safety.

dHEL
UNIQUELY DIAMOND

OUR SOLUTION

Macquarie University has developed a new laser technology capable of sustaining ultra-high power without saturation. The power of multiple laser beams is transferred into a single intense output beam by using ultra-pure synthetic diamond as the laser gain medium. This enables the usual thermal thresholds to be offset by orders of magnitude, allowing ultra-high powers without thermal degradation. Configured as a Raman-type laser, the system operates with outstanding beam quality over the full power range, whilst also enabling access to previously unobtainable wavelengths.

ULTRA-HIGH POWER

Our diamond lasers comprise a generic technology adaptable for generating pulsed and continuous wave output with high efficiency (up to 80 %). By exploiting diamond's extremely high thermal conductivity, power capability is more than 100-fold higher than for other materials, with projected outputs of 10's of kW at ambient temperatures, and up to unprecedented 100's of kW with cryo-cooling.

CUSTOMISED OUTPUTS

Our world-leading advances enable laser beam generation in the near and mid infrared, visible and ultraviolet spectrum. Output options include ultra-short (femtosecond) pulsed and continuous wave - all with high beam quality, and all part of our patent protected package of laser technologies.

EYE SAFER

One of the greatest concerns around HEL development is personnel & bystander safety. Diamond HEL can operate at an eye-safer 1.24 µm wavelength, meaning lower user risk and collateral damage.

LOW BLOOMING | HIGH ATMOSPHERIC PENETRATION

Increased wavelength options enable system designers to optimize atmospheric transmission and reduce thermal blooming (atmospheric defocusing) and scatter loss.

'BOLT-ON' TECHNOLOGY

Our approach operates downstream of mature pump laser technology inputs. It can be adapted to a range of pump laser infrastructures including fiber, slab and thin-disk. If you already have an existing development platform you can still benefit from our diamond approach without going back to square one.

BETTER THAN ALL OTHERS

Our diamond approach is the only HEL technology that has the capacity to deliver all the features demanded in defence applications, including solid-state generation, ultra-high power levels (100's kW), high-beam quality, and wavelength choice.

dHEL

THE POTENTIAL TO DELIVER VIABLE DIRECTED ENERGY (DE) DEFENCE SOLUTIONS

"Researchers are developing high power lasers to combat threats to security from the increased proliferation of low-cost drones and missile technology... This technology is transformative as laser researchers are struggling with increasing power due to the challenges in handling the large heat build-up. Beam-conversion in diamond is one of the most promising ways to substantially raise the power barrier."

Lead experimentalists Assoc. Prof. Richard Mildren and Dr Aaron McKay.

APPLICATIONS

Macquarie's Diamond HEL is being developed towards meeting real-world, and high-stakes defence demands, where ultra-high power lasers will revolutionise defence capabilities. For example, in:

- **Counter UAV / drone / swarm destruction systems**
- **Anti-missile defence systems**
- **Remote IED destruction**
- **Anti- shell and anti-mortars**
- **Land and air combat weapons**
- **Ship defence systems**
- **Passive (e.g. orbital debris) and aggressive space-born threats**

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dHEL OPPORTUNITIES

Macquarie's Diamond HEL tech is open for partnership and licensing opportunities in the defence space. Interested? Contact us.

FIND OUT MORE:

Dr. Mike Skalsky
Commercialisation consultant
T: +61 413 942 546
E: mike_sci2rx@optusnet.com.au

Anna Grocholsky
Director
T: +61 437 463 317
E: anna.grocholsky@mq.edu.au

The Office of Commercialisation and Innovation:

Level 3 (West), Building C5C
Macquarie University
NSW 2109 Australia
T: +61 9850 4576
E: innovation@mq.edu.au

mq.edu.au/innovation
twitter.com/MQInnovation

INVENTORS

Prof. David Coutts
Assoc. Prof. Rich Mildren
Assoc. Prof. David Spence
Dr. Aaron McKay
Dr. Ondrej Kitzler
Dr. Robert Williams

PATENT PORTFOLIO

WO2011/103630 (AU, CA, EU, JP, US): *Mid-infrared diamond laser*

WO2013/155568A1 (EU, US): *Continuous wave converter*

WO2015/103667A1 (EU, US): *Brightness conversion*

PCT: *Cascaded continuous wave converter*

PCT: *Ultra-high power lasers*

KEY PUBLICATIONS

A.M. McKay, D.J. Spence, D.W. Coutts, R.P. Mildren, "Diamond based concept for combining beams at very high powers," *Laser and Photonics Reviews*, vol. 11, 1600130, (2017)

R.J. Williams, J. Nold, M. Strecker, O. Kitzler, A. McKay, T. Schreiber, and R.P. Mildren, "Efficient Raman frequency conversion of high-power fiber lasers in diamond," *Laser Photon. Rev.*, vol. 9, no. 4, pp. 405–411, (2015).

R.J. Williams, A.M. McKay, O. Kitzler and R.P. Mildren, "Investigating diamond Raman lasers at the 100 W-level using quasi-cw pumping," *Opt. Lett.*, vol. 39, 4152-4155 (2014)

and many more at: research.science.mq.edu.au/diamond/publications