University of Glasgow reports single-chip laser system with 983Hz linewidth

A topological interface state extended laser with optical injection locking has been integrated on an indium phosphide substrate.

The University of Glasgow has designed and built a narrow-linewidth laser on a single, fully integrated microchip that achieves what is claimed to be record performance in semiconductor lasers of its type (Xiao Sun et al, 'Narrow-linewidth monolithic topological interface state extended laser with optical injection locking', Science Advances, vol.11, issue 37, 10 September 2025). The new laser system could find applications in technologies such as advanced communication systems and unbreakable quantum cryptography.

The 'topological interface state extended laser with optical injection locking' (MOIL-TISE) can produce a linewidth of just 983Hz, which is a significant advance on monolithic distributed feedback (DFB) lasers currently on the market that operate at the MHz range.

Previous high-spectral-purity lasers faced a major challenge: balancing top-level performance with compact design. To achieve efficiency, designers often relied on hybrid integration and bulky external components, which limited their practicality and restricted their potential in on-chip integrated applications.

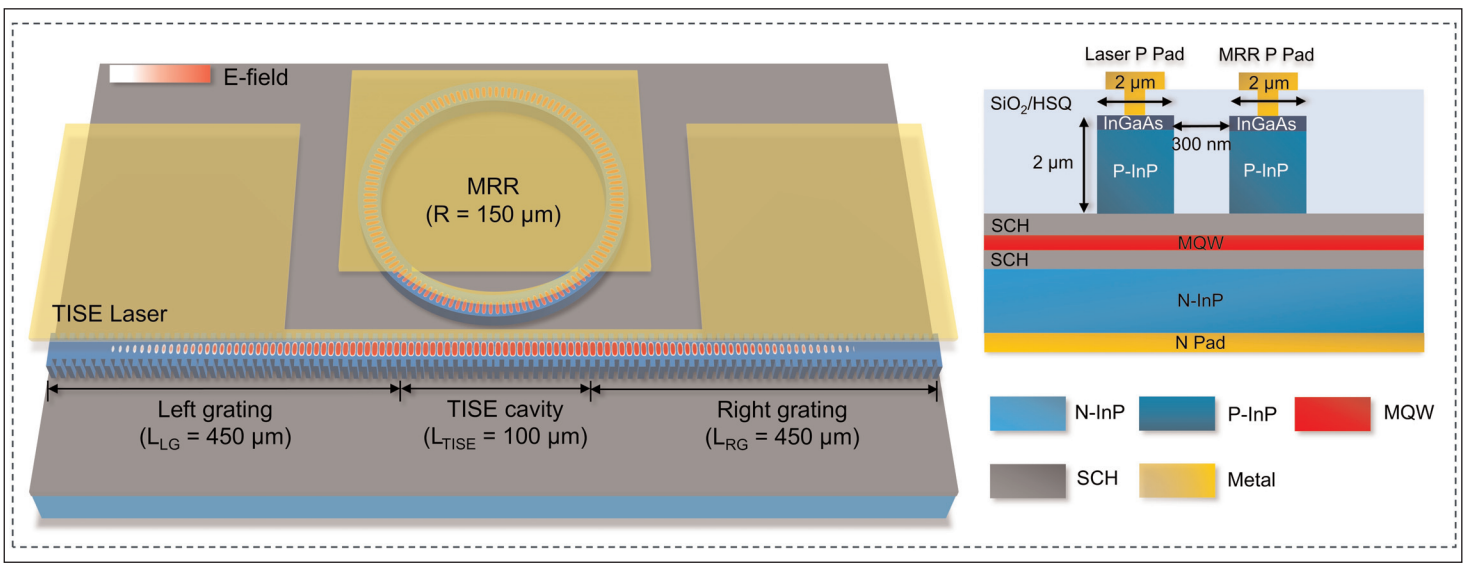
For the development of the MOIL-TISE laser on a single integrated chip, the team used the University of Glasgow's James Watt Nanofabrication Centre to fabricate the device on an indium phosphide substrate.

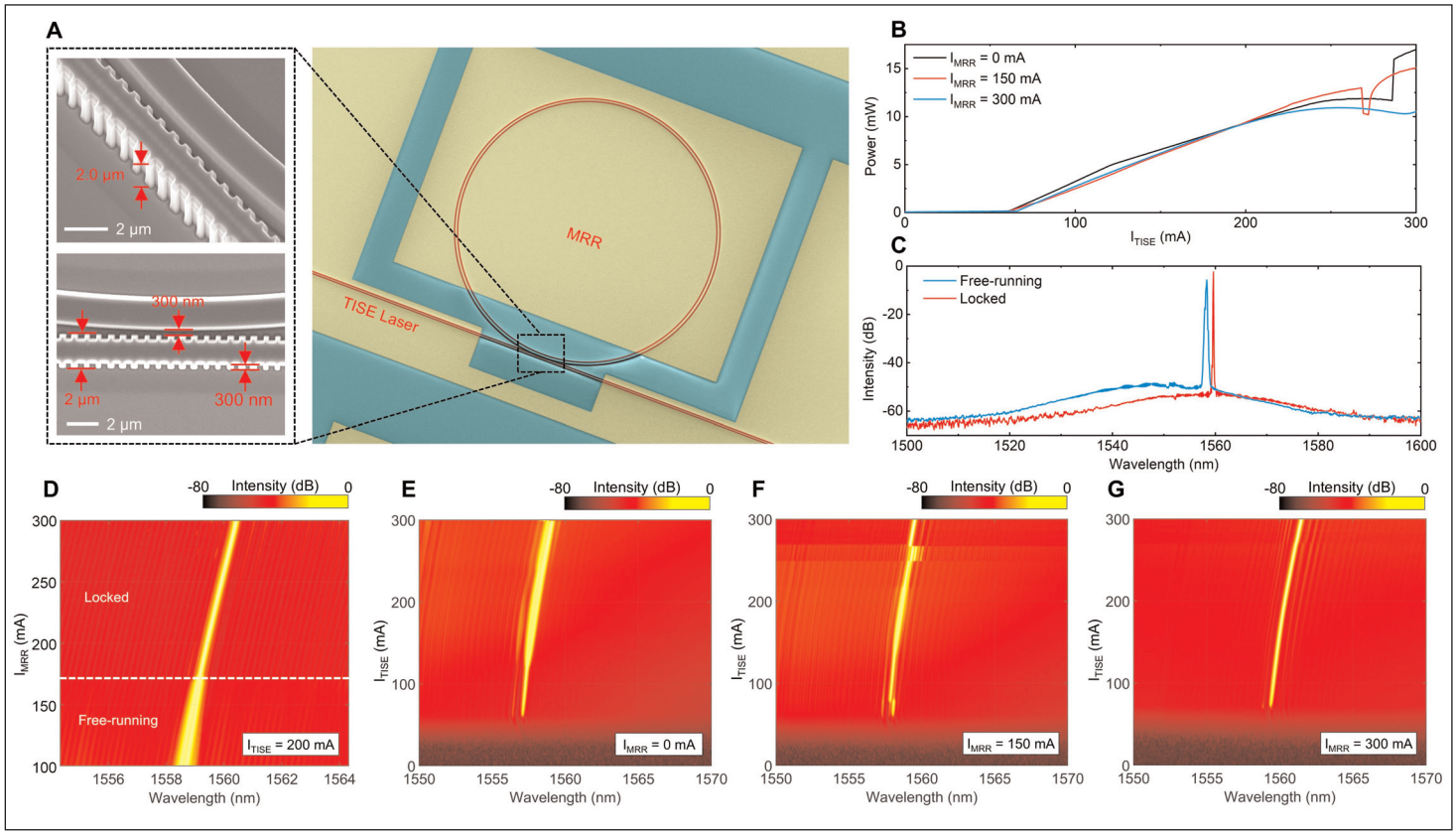
The system's performance is enabled by its uniquely shaped design, which breaks the chip into three regions, each with their own optical phase, specifically tuned to keep the light evenly distributed between them. Combined with a micro-ring resonator integrated into the chip, the system can internally recycle light to stabilize its performance and enable the tightly focused linewidth.

The development of the MOIL-TISE system was supported by the university's Critical Technologies Accelerator (CTA). The CTA is funded through a share of the Glasgow City Region's Innovation Accelerator fund and aims to develop cutting-edge nano-scale technologies for a range of applications.

The CTA's Dr Xiao Sun is the paper's first and corresponding author. "The University of Glasgow is unique in the UK in that it's possible to take a project like this from an initial idea to a fully featured prototype without leaving our campus," notes Sun. "The James Watt Nanofabrication Centre enabled us to design, fabricate and test our MOIL-TISE system, dramatically accelerating the research process," he adds.

"This research represents a great example of the kind of breakthroughs that the Critical Technologies Accelerator is working to make. Being able to fabricate this at the JWNC using technology which is commercially available





shows that industry could easily start to make their own MOIL-TISE-based devices easily affordably in the years to come," Sun states.

"Our MOIL-TISE laser makes three significant breakthroughs and improvements in this field," reckons professor Lianping Hou of the James Watt School of Engineering, who is the paper's co-corresponding author. "It's the first monolithic device of its kind, with every component integrated on a single chip," he adds.

"It can create a laser with remarkable frequency purity, the highest ever achieved in a monolithic distributed feedback laser of this kind. It is also capable of easily switching between optical phases, a property required in the quantum key distribution systems which will underpin the unbreakable encryption and communication devices of the future." ■

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