The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

**DOCTOR OF ENGINEERING SCIENCES**

of **Robbe de Mey**

The public defense will take place on **Monday 10th June 2024 at 3:30 pm** in the room **D.0.08** (Building D, VUB Main Campus)

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**LASERS WITH MULTIPLE FEEDBACKS FOR WIDEBAND CHAOS GENERATION**

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Abstract of the PhD research

The unpredictable and random character of optical chaos can be used for secure communication, imaging with chaotic lidar, or for random number generation. Generating wide-bandwidth optical chaos can be achieved by coupling a semiconductor laser to optical feedback, i.e., a mirror at a distance. Using optical feedback is beneficial as it can be implemented on photonic integrated circuit platforms so that this solution would be widely deployable. However, three main problems currently stand in the way of the widespread use of these peculiar devices. First, the size of the system is too large. Second, the time-delay signature (TDS), the distance between the laser and the mirror, manifesting itself in the output signal, reduces the unpredictability. Third, the bandwidth of the optical chaos is limited and should be increased.

To address these problems, I propose to use multiple optical feedbacks. Specifically, I studied the laser dynamics due to double optical feedback or feedback from a deformed microcavity, so-called asymmetric resonant cavities (ARCs). To tackle the second problem, the TDS, we investigated new methods to detect this signature based on all dynamical variables. We showed that using double optical feedback can suppress the TDS without reducing the chaotic bandwidth. We showed that the feedback phase is a crucial parameter to control in this approach. Moreover, the feedback phase plays an important role in the stability of this system. Finally, I studied ARCs to reduce the footprint further while suppressing the TDS and increasing the chaotic bandwidth. We designed, manufactured, and experimentally tested these devices and showed that they can be used to generate chaos in semiconductor lasers.