ANNUAL HIGHLIGHTS

The year 2021 was clearly marked by the slow and unsteady return to normalcy after the COVID-19 pandemic. In SPOC, we were yet again fortunate enough to be able to have our annual workshop with physical presence by almost all the SPOC members based in Denmark. The workshop was a great success fueled by people's desire to meet and engage in discussions, presentations and group work.

In terms of research, 2021 was another successful year for SPOC. Several important results were achieved as outlined below.

In 2021, SPOC reached an important milestone for the work on optical angular momentum (OAM) transmission. We demonstrated the first silicon photonic chip-based OAM multimode/multi-wavelength transmission. From the silicon chip, we generated and transmitted 2 OAM modes each containing 8 wavelength channels - yielding 16 independent data channels each carrying data at 10 Gbit/s. This is an important result as integrated solutions to broadband generation and multiplexing of OAM is a key requirement for using this technology in practical communication systems. This achievement rests on the enthusiastic collaboration of SPOC researchers with quite diverse areas of expertise – ranging from design and fabrication of optical integrated devices, over optical mode propagation in fibre, to optical communication systems.

Another SPOC highlight from 2021 was the public demonstration of the first intergovernmental quantum communication, linking Italy, Croatia, and Slovenia (Trieste, Rijeka, and Ljubljana). This took place as part of the "Digital Ministers Meeting" at the G20, and demonstrated communication between the three countries, protected by quantum cryptography. SPOC researcher Davide Bacco played a key role in the successful realization of the demonstration. This is an important addition to the strong international position of quantum research in Denmark in general – and in SPOC in particular.

SPOC also reached an important performance-milestone with the Silicon Carbide (SiC) material platform when we successfully realized integrated optical ring resonators with a quality factor (Q) exceeding 1,000,000. This establishes SiC as a promising new platform for the generation of optical frequency combs. Based on our work on frequency combs in Silicon Nitride together with collaborators from Chalmers University in Sweden, we have also developed new tools for modelling frequency combs. This novel method will aid in the design of improved structures for comb generation allowing SPOC to further advance from our milestone Petabit per second transmission result from 2020.

Finally, SPOC has played a key role in realizing and demonstrating an integrated silicon circuit capable of generating error-protected qubits. This step towards realizing on-chip quantum processing was published in Nature Physics in 2021. The use of error correction on an integrated platform is a promising approach to realizing practical quantum computing.

SPOC remains at the research forefront and highly visible internationally. Numerous researchers in SPOC are invited to give talks at conferences, participate in conference committees, and engage in a broad range of international collaborations. The young researchers trained in SPOC are highly attractive to international research institutions and industry alike. Students gravitate towards the SPOC centre for special courses and projects. We are extremely excited about what SPOC has achieved so far and expect much more to come.