National Optics Congress 2022

November 30 + December 1

Aarhus, Denmark

We look forward to welcoming you in **Aarhus** for this two-day event organized by the **Danish Optical Society** (DOPS), **LaserLab.dk**, and **FORCE Technology**. This year, we are delighted to have **three keynote speakers**, **10+ oral presentations**, **50+ posters**, pitches from **exhibitors**, one **research panel** and one **industry panel** co-organized by **Optica** and the **European Physical Society** (EPS).

Venue: **Navitas**, Inge Lehmanns Gade 10, 8000 Aarhus C, Denmark | Auditorium 137

For Bachelor and Master students interested in Optics and Photonics:

- Transportation is **free of charge** (DTU, KU, and SDU). See bus information on page 9.
- Accommodation is **free of charge** (DTU, KU, SDU, and AAU)

November 30

9:00	**Registration, coffee + croissants**
10:15	Welcome messages **Asger Jensen**, DOPS, **Michael Drewsen**, LaserLab.dk, and **Henrik Mertz**, FORCE Technology
	Session 1 chaired by **Henrik Stapelfeldt**
10:30	**Your Reliable Transmission Grating and Spectrometer Supplier** **Raheleh Hosseinian**, Ibsen Photonics (*Invited Talk*)
11:00	**Continuous-Variable Quantum Key Distribution** **Tobias Gehring**, Technical University of Denmark
11:15	**Sculpted nanodrums for photonics and sensing** **Aurelien Dantan**, Aarhus University
11:30	**Granting businesses access to photonics product development expertise** **Henrik Mertz**, FORCE Technology
11:45	**Exploring Cavity Superradiant-Enhanced Sensors** **Eliot Bohr**, University of Copenhagen
12:00	**Lunch**

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Session 2 chaired by **Michael Drewsen**

13:30	**Frequency Combs and Applications** **Thomas Udem**, Max Planck Institute of Quantum Optics, Garching, Germany (*Keynote Lecture*)
14:15	**Photonic ICs for the Age of AI** **Henning Lysdal**, Nvidia (*Invited Talk*)
14:45	1-min **pitches** from **exhibitors**
15:00	**Coffee break**
15:30	**Research Panel** *Current trends in funding: what scientists need to consider in the coming years* • **Morten Bache**, Scientific Director at Novo Nordisk Foundation • **René Bang Madsen**, Innovation Officer at Innovation Fund Denmark • **Peter Balling**, Chairman of the Research Council for Technology and Production at Independent Research Fund Denmark (DFF) • **David Lundbek Egholm**, Vice Dean for Research at Aarhus University Moderator: **Niels Hersoug**, DTU and Sparrow Quantum
16:30	**Booths**: see list of exhibitors on page 5 **Poster Session**: see abstracts on page 7
17:30	Congress pictures

Evening reception at **ARoS**, Aros Allé 2, 8000 Aarhus, Denmark

17:45	Leaving Navitas and walking 20 min to ARoS. See map on page 3.
18:30	Arrival to ARoS via main entrance (4th floor) Welcome drink in front of the restaurant (8th floor)
19:00	Three-course menu with wine pairing and coffee with the dessert
21:30	After-dinner talk in the auditorium (3rd floor) **Optics for Astronomy from small to very large scale** **Frank Grundahl**, Aarhus University
23:00	End of the evening. The museum closes.

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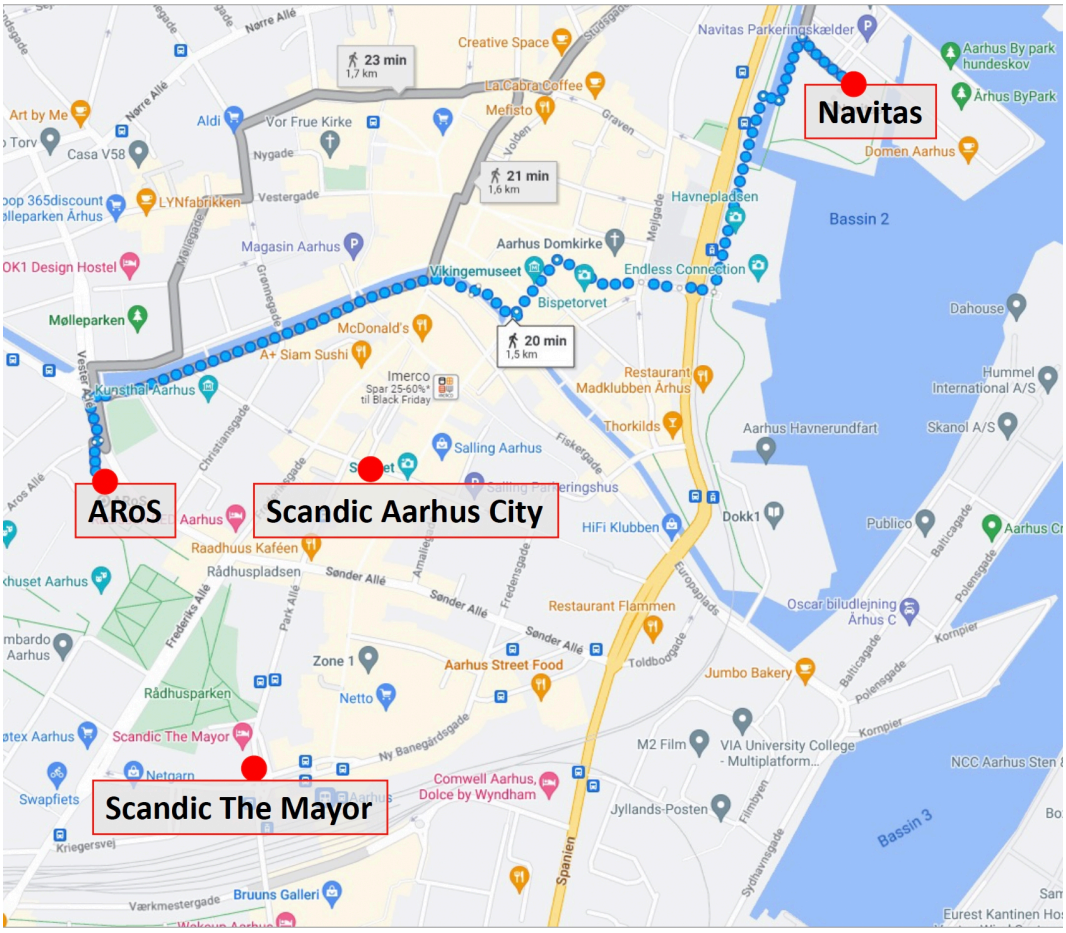
Map of Aarhus



December 1

8:30	**Coffee + croissants**
	Session 3 chaired by **Asger Jensen**
9:00	**Shedding light on dynamics and conformations of DNA structures and hybrid devices** **Victoria Birkedal**, Aarhus University (*Keynote Lecture*)
9:45	**High-dimensional optical encodings for integrated error-protected Quantum Computing and Quantum Communication** **Caterina Vigliar**, Technical University of Denmark
10:00	**Scanner Optics for Digital Dentistry** **Rasmus Kjær**, 3Shape (*Invited Talk*)
10:30	**Coffee + Company Booths + Poster Session**
11:00	**Industry Panel** *PhD to CEO series* organized by **Optica** and **EPS** • **Peter Tøttrup**, NLIR • **Niels Hersoug**, Sparrow Quantum • **Oliver Hvidt**, Norlase • **Anders Samuelsen**, UV Medico Moderators: **Claus Roll**, Optica, and Mattia Ostinato, EPS
12:00	**Lunch**
	Session 4 chaired by **Nicolas Volet**
13:30	**Semiconductor Quantum Dots, why are they so quantum? Genesis, prospects and challenges** **Frédéric Grillot**, Télécom Paris, France (*Keynote Lecture*)
14:15	**Waveguides for Efficient CW Frequency Conversion** **Eric J. Stanton**, EMode Photonix, USA
14:30	**Making steady-state superradiant lasers for active clocks** **Stefan Schäffer**, University of Amsterdam, the Netherlands
14:45	**Manipulating circularly polarized optical radiation with functional metasurfaces** **Fei Ding**, University of Southern Denmark (*DOPS Award Laureate*)
15:15	**Coffee + Company Booths + Poster Session**
16:00	**Awards Ceremony** + Closing Session • ***Best Poster Award*** sponsored by **Hamamatsu** • ***DOPS Award*** sponsored by **Thorlabs**
16:45	End of the congress
17:00	**Bus departure** from the parking lot at Ølandsgade (500 m from Navitas, 10 min walk). See schedule of arrivals on page 9.

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Exhibitors

4photonics
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COHERENT

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optical thin film

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Keynote speakers

Frédéric Grillot, Télécom Paris, France
Semiconductor Quantum Dots, why are they so quantum? Genesis, prospects and challenges: *Semiconductor nanostructures with low dimensionality like quantum dots are one the best attractive solutions for achieving high performance photonic devices. When one or more spatial dimensions of the nanocrystal approach the de Broglie wavelength, nanoscale size effects create a spatial quantization of carriers along with various other phenomena based on quantum mechanics. Thanks to their compactness, great thermal stability and large reflection immunity, semiconductor quantum dot lasers are very promising candidates for low energy consumption and isolation free photonic integrated circuits. When directly grown on silicon, they even show a four-wave mixing efficiency much superior compared to the conventional quantum well devices. This remarkable result paves the way for achieving high-efficiency frequency comb generation from a photonic chip. Quantum dot lasers also exhibit a strong potential for applications in optical routing and optical atomic clock. Last but not least, a quantum dot single photon source is a building block in secure communications, and therefore can be applied to quantum information processing for applications such as quantum computers. I will review the recent findings and prospects on nanostructure based light emitters made with quantum-dot technology. Many applications ranging from silicon-based integrated solutions to quantum information systems will be presented.*

Frédéric Grillot is currently a Full Professor at Télécom Paris (France) and a Research Professor at the University of New-Mexico (USA). His research interests include, but are not limited to, advanced quantum confined devices using III-V compound semiconductors, quantum dots quantum dashes, light-emitters based on intersubband transitions, non-classical light, nonlinear dynamics and optical chaos in semiconductor lasers systems as well as microwave and silicon photonics applications. Professor Grillot strongly contributes to promote and support the development of the general optics community. He has served diligently and successfully Optica in particular as an Associate Editor of Optics Express, now as a Deputy Editor since September 2022. As of now, he has published more than 130 journal articles, 3 book chapters, and delivered many invited talks in major international conferences and workshops. Frédéric Grillot is also a Fellow Member of the SPIE as well as a Senior Member of Optica and the IEEE Photonics Society. In 2022, he received the IEEE Photonics Society Distinguished Lecturer Award which honors excellent speakers who have made technical, industrial or entrepreneurial contributions to the field of photonics.

Thomas Udem, Max Planck Institute of Quantum Optics, Garching, Germany
Frequency Combs and Applications:

Victoria Birkedal, Aarhus University
Shedding light on dynamics and conformations of DNA structures and hybrid devices: *Fluorescence spectroscopy and resonance energy transfer are versatile techniques that allow investigating molecular interactions and conformational changes of polymer molecules and obtaining insights into the "machinery" of bio- and nanosystems. The combination of these techniques with single molecule microscopy is a powerful tool, as it offers real-time imaging of sample heterogeneity. I will present our experimental approaches and their applications to 1) uncovering the folding landscape of small DNA structures and 2) using DNA to control the aggregation of conjugated polymers.*

Victoria Birkedal received her PhD in Physics from the Ecole Polytechnique Federale de Lausanne, EPFL, in Switzerland in 2001. She did her postdoctoral work both at the University of California, Santa Barbara, USA and at Aarhus University, Denmark. In 2005, she moved from semiconductor physics to biophysics. She started to lead her own research group in 2011 and is now an associate professor at the chemistry department and interdisciplinary nanoscience center (iNANO) at Aarhus University, Denmark. Her research group focuses on examining structure-dynamics-function relationships of macromolecular assemblies in fundamental biological processes and nanotechnology applications.

Oral presentations

Aurelien Dantan, Aarhus University
Sculpted nanodrums for photonics and sensing: *Pretensioned, ultrathin suspended silicon nitride films benefit from outstanding mechanical and optical properties. We will discuss our recent progress on the fabrication and characterization of nanodrums patterned with photonic crystal structures and report on first applications to photonics (e.g. optical spatial differentiation or the realization of ultracompact, narrow linewidth microcavities) and gas sensing (absolute pressure measurements).*

Caterina Vigliar, Technical University of Denmark
High-dimensional optical encodings for integrated error-protected Quantum Computing and Quantum Communication: *The generation and manipulation of high-dimensional entangled states of single photons are key tasks for robust quantum computation and quantum communication protocols. I will report on some recent experimental results on this topics, based on my work on integrated photonics at University of Bristol and at the Danish Technical University.*

Eliot Bohr, University of Copenhagen
Exploring Cavity Superradiant-Enhanced Sensors: *Superradiance is a collective emission effect when emitters are closely packed with interparticle distance much smaller than the transition wavelength, or are strongly coupled together via a cavity. Lasing in the superradiant or "bad-cavity" regime has attracted interest in the optical clock community as it offers an alternative to conventional lasers limited by the thermal noise fluctuations of reference cavities. This is because the phase information in this regime is stored in the collective state of the atoms rather than in the cavity field. In our experiment, we cool down 88Sr atoms to microkelvin temperatures inside of an optical cavity. We investigate using a superradiant readout for cavity-enhanced Ramsey spectroscopy. This has the potential to be a fast and sensitive readout of the excited state population with minimal heating of the atomic ensemble. We also investigate quasi-continuous superradiance by incoherently repumping the atoms to get lasing for much longer than the natural lifetime of the transition. By conducting beat measurements against a reference laser, we see a narrowing of the frequency spectrum of the emitted light significantly below the natural linewidth.*

Eric J. Stanton, EMode Photonix, USA
Waveguides for Efficient CW Frequency Conversion: *New applications of photonics are increasingly demanding complex circuits with stringent demands on laser sources. Sensing and atomic interactions require high performance laser light at a wide range of wavelengths across the visible. While photonic chips have matured to scale the number of components on a chip, the optical wavelength has historically been challenging to deliver with flexibility due to fundamental material properties of laser gain. We focus on developing high conversion efficiency nonlinear photonic devices that can produce continuous-wave output from semiconductor pump lasers. In this presentation, we will discuss design techniques to optimize nonlinear frequency conversion in nanophotonic waveguides. We will give an overview of our commercially available software, EMode, which is used to simulate the waveguide optical modes and to calculate the nonlinear conversion efficiency. Finally, we will discuss the requirements of laser light, nonlinear conversion efficiency, and output power for applications of optical atomic clocks and far-UVC light generation for disinfection.*

Fei Ding, University of Southern Denmark
Manipulating circularly polarized optical radiation with functional metasurfaces: *Quantum technologies that exploit the laws of quantum physics form a cornerstone for future economic growth and security, which requires on-demand single-photon sources with compact footprints and super characteristics. However, up-to-date single-photon sources are suffering from bulky configurations and poor performance. Optical metasurfaces, extremely thin (typically 100 nm) nanoantennas arranged in a well-considered pattern, have unprecedented capabilities in manipulating all properties of classical and nonclassical light, hereby making a unique promising platform for quantum nanophotonics. In this talk, I first introduce*

our recent progress in the demonstration of a novel platform for quantum nanophotonics by integrating quantum emitters based on nano-diamonds containing color centers with optical metasurfaces. I will first talk about a conceptually new approach to the room-temperature generation of circularly polarized single photons entailing quantum emitters non-radiative coupling to surface plasmons that are transformed, by interacting with an optical metasurface, into a collimated stream of SSPs with the designed handedness. After that, I will introduce a room-temperature orbital angular momentum single-photon source that emits well-collimated single photons carrying entangled spin and orbital angular momentum states and forming two spatially-separated entangled radiation channels with different polarization properties.

Henrik Mertz, FORCE Technology

Granting businesses access to photonics product development expertise: *Technologies employing photonics makes disruptive innovations possible – a requirement for digitalisation and innovation in Denmark. Photonics technology supports the development of new high-performance sensors and devices that can be integrated into products and production systems. We, at FORCE Technology - Centre of Applied Photonics, grant start-ups, spin-outs and SMEs access to various facilities, services, and demonstration projects that support photonics product development and accelerate technological readiness level.*

Rasmus Kjær, 3Shape

Scanner Optics for Digital Dentistry: *Since the launch of its first dental scanner in 2005, Copenhagen-based 3Shape has pioneered the introduction of digital dentistry and changed the way dental professionals work across the globe. At the core of 3Shape's scanners is their optical design, which enables the class-leading scan performance and accuracy. This presentation introduces some example designs and discusses steps that go into designing scanner optics for performance and volume production.*

Stefan Schäffer, University of Amsterdam, the Netherlands

Making a steady-state superradiant laser: *A superradiant laser can have an extremely narrow linewidth and at the same time be highly insensitive to environmental perturbations. By using atoms with narrow optical transitions and coupling them weakly to a bad cavity, a laser that operates in a very different regime from traditional lasers can be made. This laser relies on a narrow gain medium to generate light, and couples to a cavity that does not provide any spectral filtering, but only acts as a coupling medium between the atoms. Because of the weak cavity-mediated coupling atoms can synchronize and emit coherent radiation on narrow atomic clock transitions. This is an exciting platform for the future of atomic clocks, as it could make reference-cavities with extreme stabilities redundant and provide an active optical atomic clock which can average down its uncertainties much faster than a traditional atomic clock. A challenge that is as yet unresolved, however, is to ensure continuous operation of such a superradiant laser that relies on cold atoms. I will show the recent progress towards steady-state operation of a strontium-based superradiant laser at the university of Amsterdam, and future plans.*

Tobias Gehring, Technical University of Denmark

Continuous-Variable Quantum Key Distribution: *Quantum key distribution uses quantum properties of light to distribute encryption keys between two parties whose security can be mathematically proven. This allows future proof cybersecurity in contrast to current cryptographic methods which will be broken by quantum computers. Here, we present our work on continuous-variable quantum key distribution which uses the amplitude and phase quadratures of light as observables. Our digital receiver structure requires only a simple coherent detector and a well-designed digital-signal-processing algorithm inspired from coherent telecommunication systems. We demonstrated a world-record transmission distance for continuous-variable quantum key distribution of 60 km which was achieved among others by employing machine learning for carrier recovery. Our work paves the way towards metropolitan quantum key distribution networks securing critical infrastructure.*

Before the Congress

A bus service is organised to come to Aarhus on **November 29** from Copenhagen and Odense. The bus leaves DTU at **15:00** from the parking lot at Anker Engelunds Vej 1.

Below is the approximate pick-up schedule.

15:30	**Copenhagen** (Ingerslevsgade)
17:55	**Odense** (Campusvej 55)
20:10	**Aarhus** (Fredensgade 45)

From here it is a walking distance to both Scandic and BOOK1. Note that buses will not wait for anyone, so please make sure you arrive at the pickup locations on time.

After the Congress

The Congress ends on **December 1** at 16:45. A bus service is organised for those going back to Odense and Copenhagen. The bus leaves Aarhus at **17:00** from the parking lot at Ølandsgade (500 m from Navitas, 10 min walk).

Below is the approximate schedule of arrivals.

19:00	**Odense** (Campusvej 55)
21:30	**Copenhagen** (Ingerslevsgade)
22:20	**DTU** (parking lot at Anker Engelunds Vej 1)