# Ultra Low Loss Integrated Photonic Circuits

**Tobias J. Kippenberg**
Swiss Federal Institute of Technology Lausanne (EPFL), Switzerland

**Abstract**— Silicon photonics has transitioned from academic research to industry, yet the limitations of silicon as an optical material preclude the wider use of integrated photonics for application that require low loss or visible operation. Over the past decade the emergence of ultra low loss silicon nitride waveguides with losses in the dB-meter level, have allowed for the first time to unlock novel nonlinear device principles and achieve a performance of integrated photonic devices on par with legacy optical systems; ranging from ultra low noise frequency agile lasers that achieve fiber laser phase noise; to chipscale frequency combs with unprecedented repetition rates in the 10's GHz domain, traveling wave parametric amplifiers, to femtosecond lasers on chip. In a more recent development we demonstrate that low loss integrated photonic circuits based on Lithium Tantalate, are suitable for ultra high speed modulators, and electro-optical devices.