Thesis Title: High-Performance Microwave Photonic Signal Processing Using Brillouin Scattering

Name: Reena Parihar

Abstract: Microwave photonics (MWP) techniques offer significant potential in achieving exceptional performance characteristics, including lossless operation, power efficiency, high speeds, high extinction ratios, immunity to electromagnetic interference (EMI), high-frequency agility, fast reconfigurability, and high-resolution RF signal processing. The principles of integration, functionality, and performance form the foundation of MWP systems. Integration involves seamlessly combining electronic and photonic elements to create an MWP system. Functionality refers to the system's ability to surpass the limitations of traditional electronics. Performance encompasses the overall efficiency, speed, reliability, and responsiveness of the MWP system. Thus, the goal of this thesis is to develop a well-integrated, highly functional, and high-performance system. An analog photonic link (APL) plays a key role in converting electrical signals to optical and vice versa. Various parameters, such as input powers and bias angles of electro-optical modulation devices, are analyzed to optimise noise figure (NF), link gain (G), Spurious-free Dynamic Range (SFDR), and Compression Dynamic Range (CDR).

Stimulated Brillouin scattering (SBS) is particularly favored in microwave photonic signal processing due to its capability to deliver high-resolution filters with exceptional performance attributes such as ultra-high gain/loss, narrow linewidth, low threshold power, high extinction ratios, and tunability or programmability tailored to user requirements.

In many applications involving APLs, achieving low noise figure, minimizing nonlinear distortion, and maximizing link gain are critical objectives. Balancing these parameters poses a challenge, as enhancing one often compromises the others. SBS offers potential improvements for APLs by providing high resolution and increased gain. However, SBS may also introduce additional noise, necessitating thorough performance evaluation within APLs to optimize their overall performance. Therefore, our investigation focuses on exploring the potential integration of SBS in APLs to achieve high link gain while minimizing noise figure to practical limits and avoiding distortion.