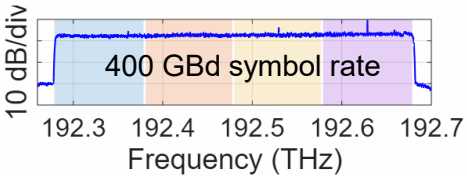
Master Thesis:
Advanced Digital Signal Processing Algorithms for Ultrabroadband Data Communications

Karlsruhe Institute of Technology

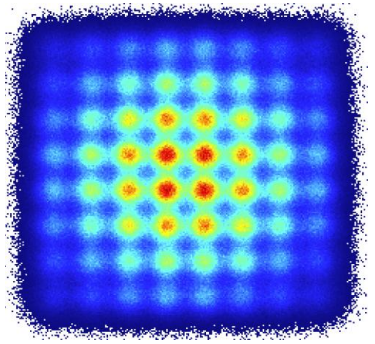
The increasing demand for higher data rates in optical communication systems requires advanced techniques to improve spectral efficiency and signal robustness. One promising approach is Probabilistic Constellation Shaping (PCS), which enhances communication performance by optimizing the probability distribution of transmitted symbols. Conventional M-ary QAM constellations use uniformly distributed symbols and therefore reach Shannon capacity only under specific channel conditions. PCS enables a more efficient use of the available channel capacity by shaping the symbol distribution, often using a Maxwell–Boltzmann distribution, to approach the theoretical Shannon limit.

In our research group, we investigate ultrabroadband signal generation by coherently combining multiple IQ signals. This architecture allows the generation of extremely broadband optical waveforms that can significantly increase transmission capacity but also introduces new challenges for digital signal processing (DSP), synchronization, and equalization.



The goal of this master's thesis is to develop and evaluate advanced DSP algorithms for such ultrabroadband coherent transmission systems. One possible direction is the implementation and evaluation of a radius-directed descent (RDD) algorithm for improved carrier recovery and constellation optimization. In addition, new DSP concepts—such as pilot-tone-based equalization techniques—can be investigated to enhance system stability and performance.

400 GBd PCS-64QAM



Your task:

- Offline DSP development using previously recorded experimental datasets (Python or MATLAB)
- Experimental validation using a coherent optical transmission setup in the laboratory, enabling real-time testing of newly developed algorithms.

M. Sc. Lennart Schmitz
Lennart.schmitz@kit.edu
Tel. 0721-608-42487

Prof. Dr. Christian Koos
Christian.koos@kit.edu
Tel. 0721-608-42481