UNIVERSITY of FLORIDA

Department of Physics
Dark Cosmos Laboratories | LIGO Group

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Experimental Techniques for Future Gravitational Wave Detectors

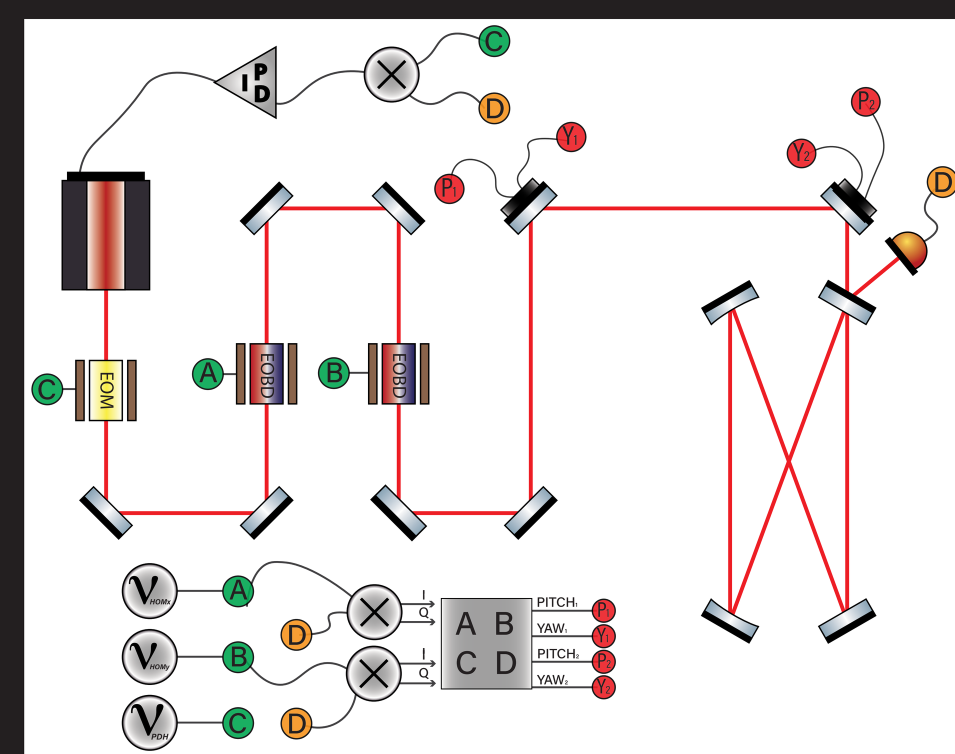
L. F. Ortega, M. Diaz-Ortiz, H. Y. Chia, A. Schindler-Tyka, K. J. Loring, C. Perkins, R. Goetz, F. Magaña-Sandoval, P. Fulda, J. W. Conklin, D. B. Tanner

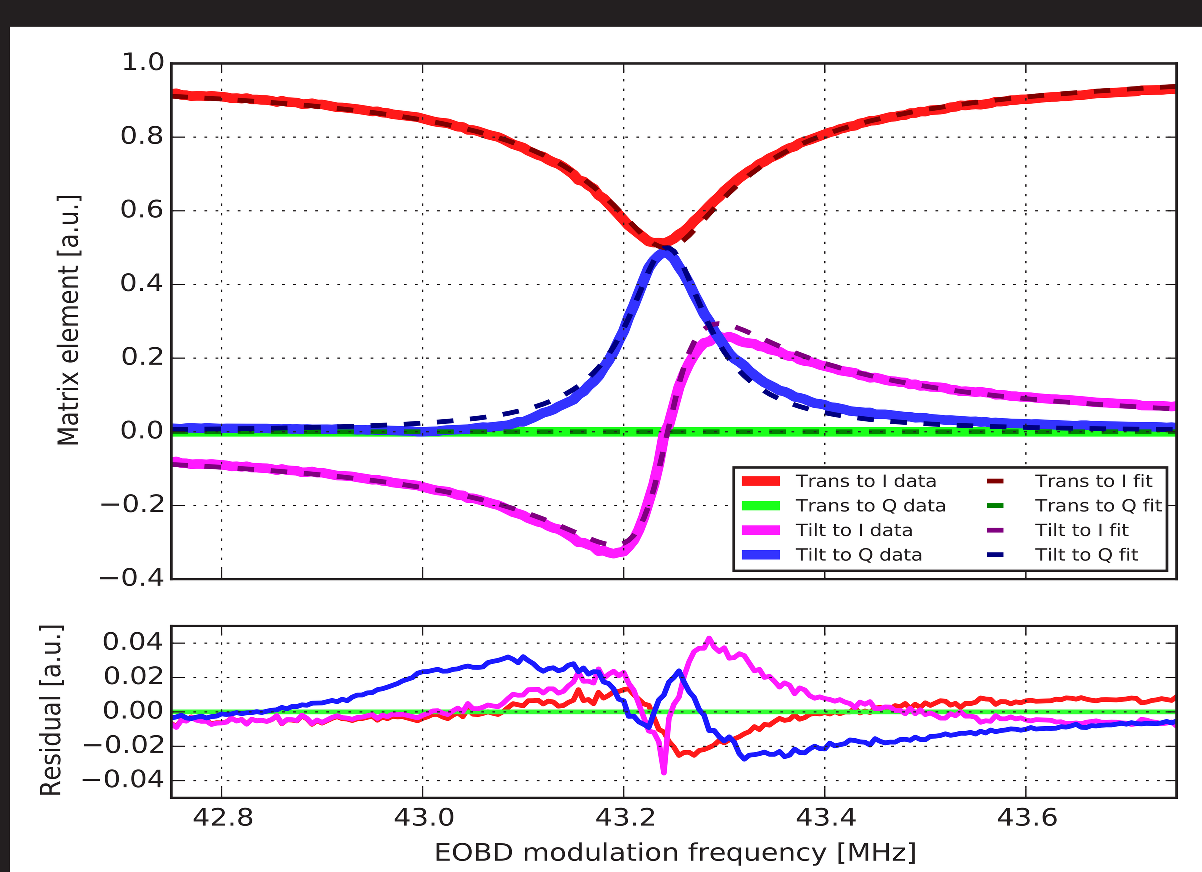
QPD-Free Alignment Sensing and Control (ASC)

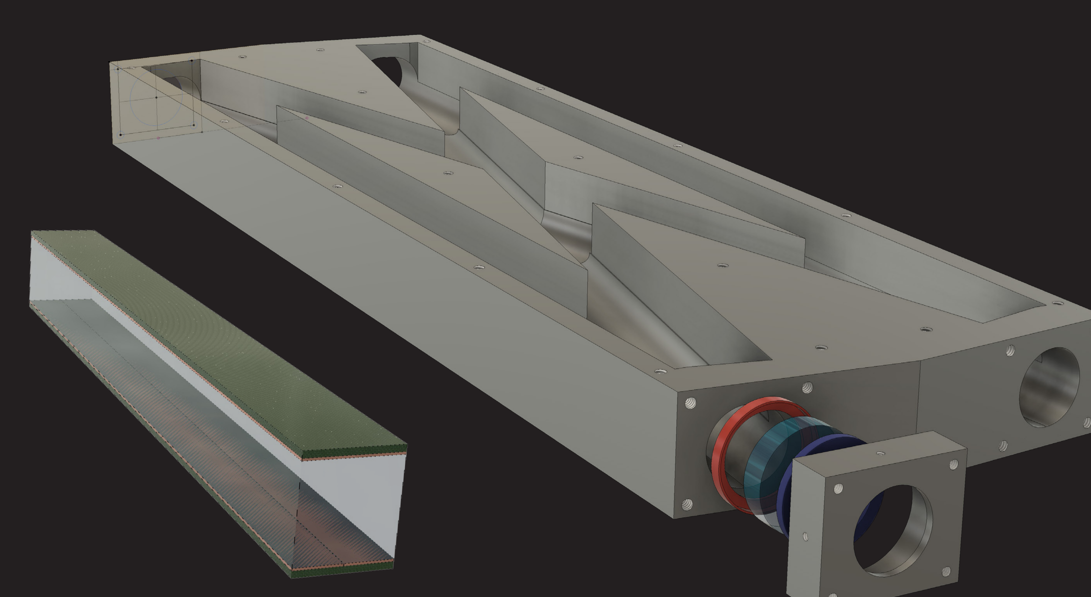
- A demonstration of RF Jitter AS, as described in an earlier paper by Dr. Fulda.
- Does not need QPDs, centering loops or Gouy phase telescopes.
- A bowtie cavity: We want to separate the resonant frequency of HG_{10} and HG_{01}, allowing the excitation and separate demodulation of the two.

Future work

- Implementation of beam deflectors in both orthogonal axes.
- Development of a proper demodulation and control scheme using PZT mirrors.
- Measurement of angular fluctuations and cavity visibility with active RFJASC scheme.
- Finesse simulation of performance in LIGO-like intereferometers and demonstration in larger experimental setups.





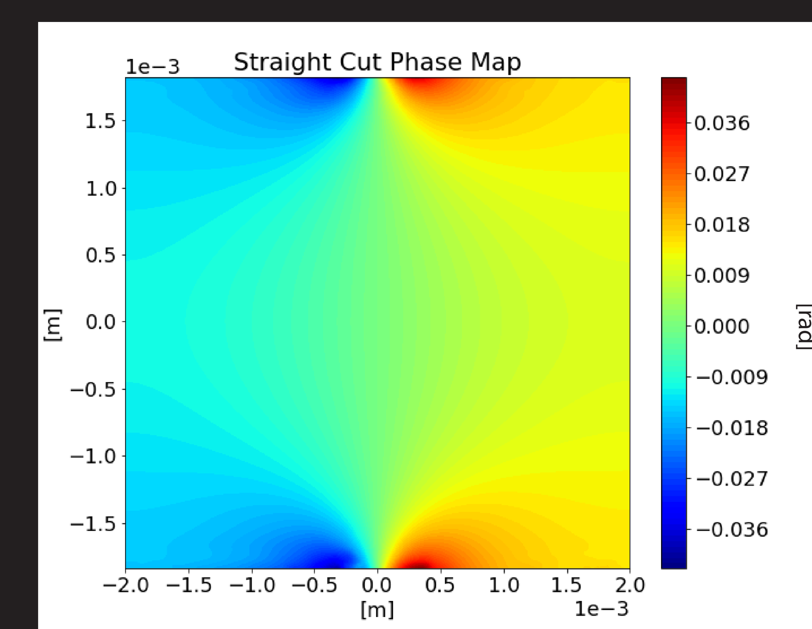


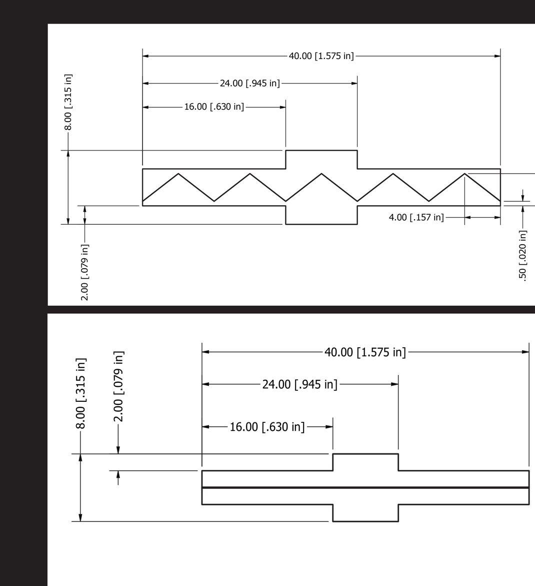
Electro-Optic Beam Deflectors

- Simulation and design of novel electrode geometry to generate misalignment sidebands for ASC.

Future work

- Further development and fabrication of resonant circuits.
- Investigation of electrode geometry to generate mode-mismatch sidebands.



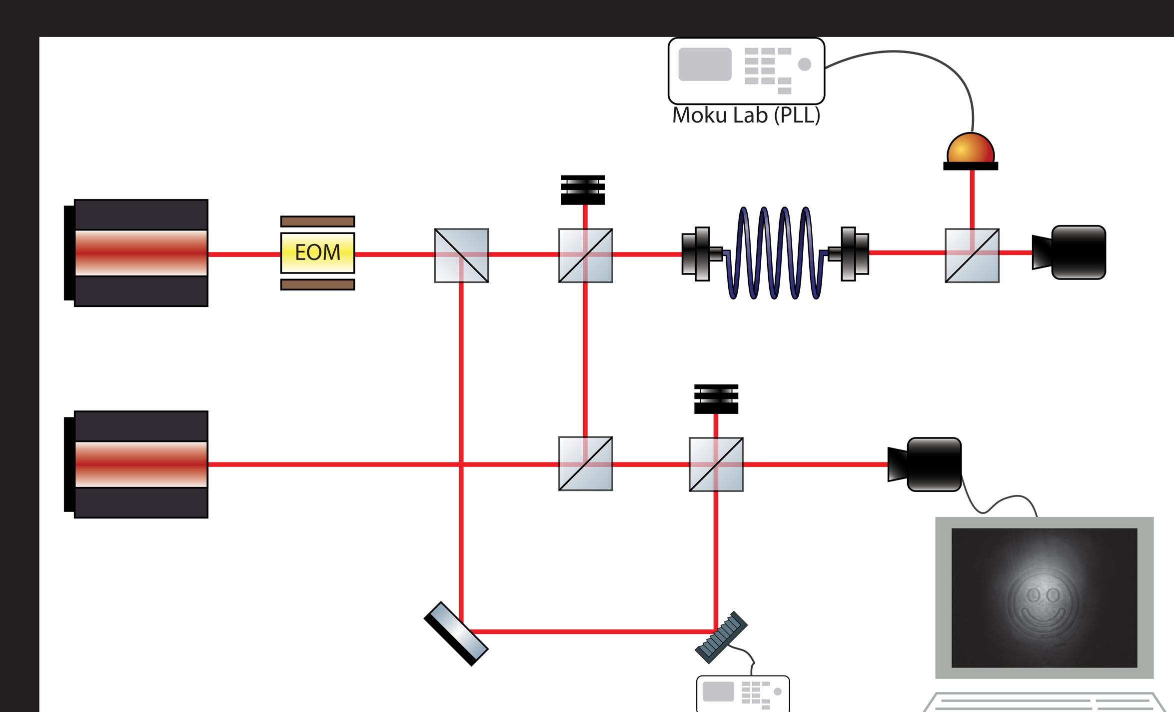


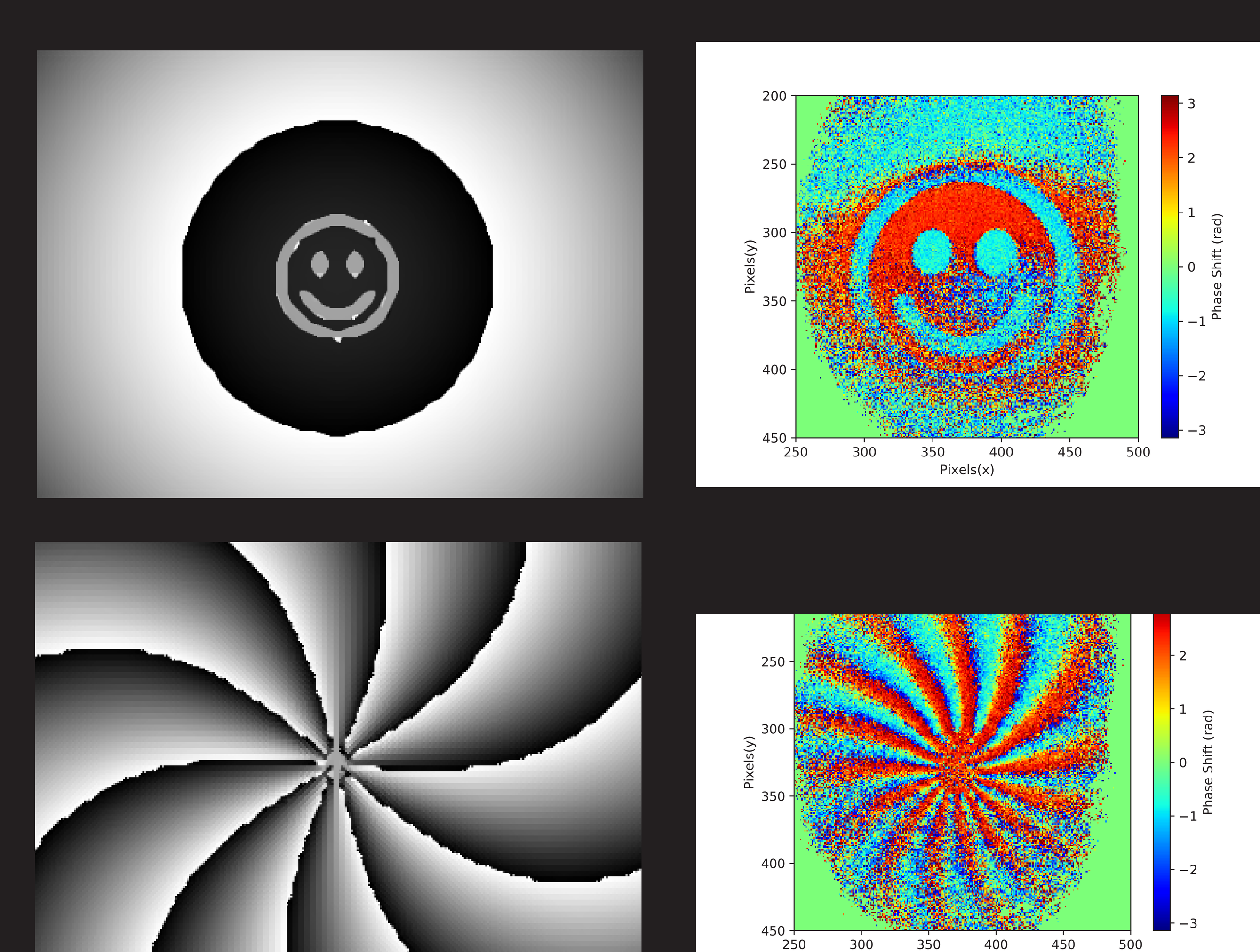
Heterodyne Phase Camera

- Low cost solution to measure the mode mismatch between two laser fields in real -time.
- A slower, more precise phase measurement can measure surface distortions.
- We can accurately display the phasefront of mode matched and mode mismatched laser fields in real-time.

Future work

- Optimize code to improve real-time performance.
- Measure accuracy of phase calculation and improve algorithms which derive the phasefront measurement.
- Develop misalignment, mode mismatch, and Zernike polynomial analysis.



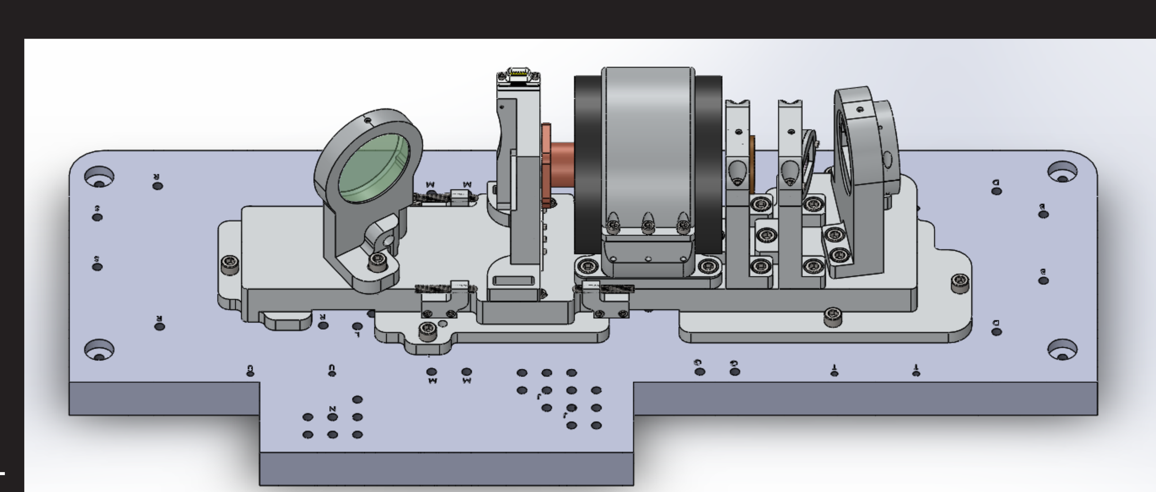


Low Loss Faraday Isolator

- UF group is responsible for significant optical, mechanical, and feedback design and manufacture for high efficiency optical isolators. These devices will act as high-throughput circulators to inject squeezed vacuum into the signal port of the LIGO interferometers, and are a critical need for gravitational wave detectors operating beyond the standard quantum limit.

Future work

- Developing low-loss techniques for in-situ performance evaluation.
- Exploration of optical materials for isolators for next-generation gravitational wave detectors operating with 2 um laser light.

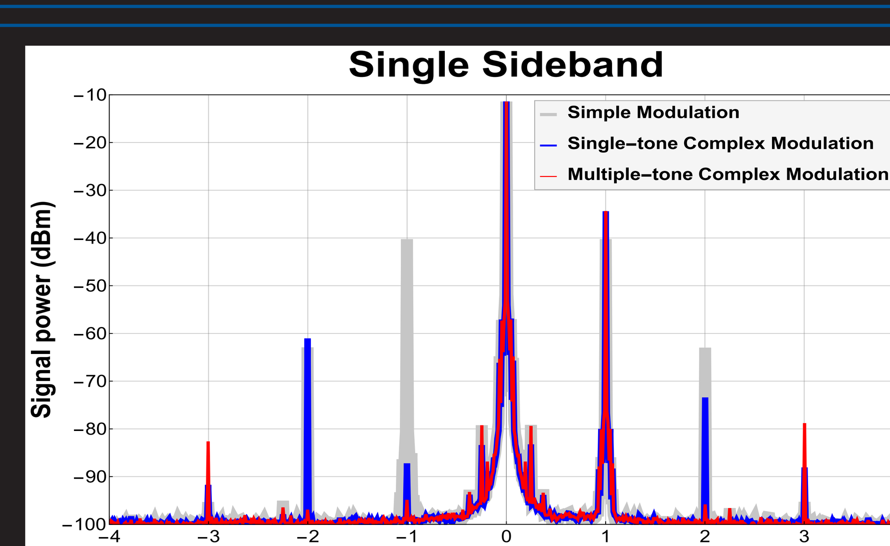


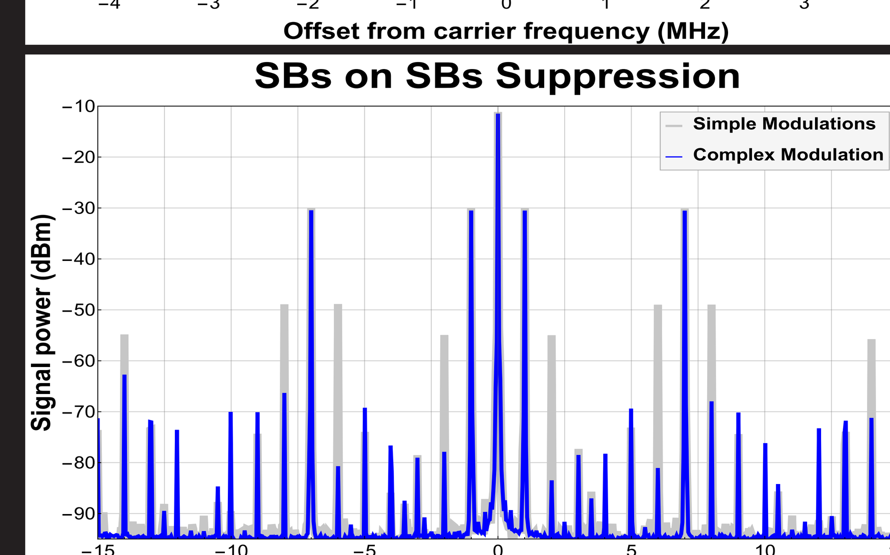
Complex Modulation

- Demonstration of single sideband suppression using complex modulation.
- Possible solution to avoiding sidebands on sidebands in multistage phase modulation used in gravitational wave detectors.
- Designer sidebands: We want to know what kind of signals complex modulation can generate. Ideally, complex modulation can do all kinds of modulations because it modulates the phase and amplitude of a carrier wave.

Future work

- Better characterization of amplitude and phase modulators.
- Stabilize the operation point of amplitude modulation.
- Reduce residual amplitude modulation in the phase modulator.
- Control parasitic phase modulation in the amplitude modulator.





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