Optical and RF Component Testing Platform for Quantum Transduction Technology

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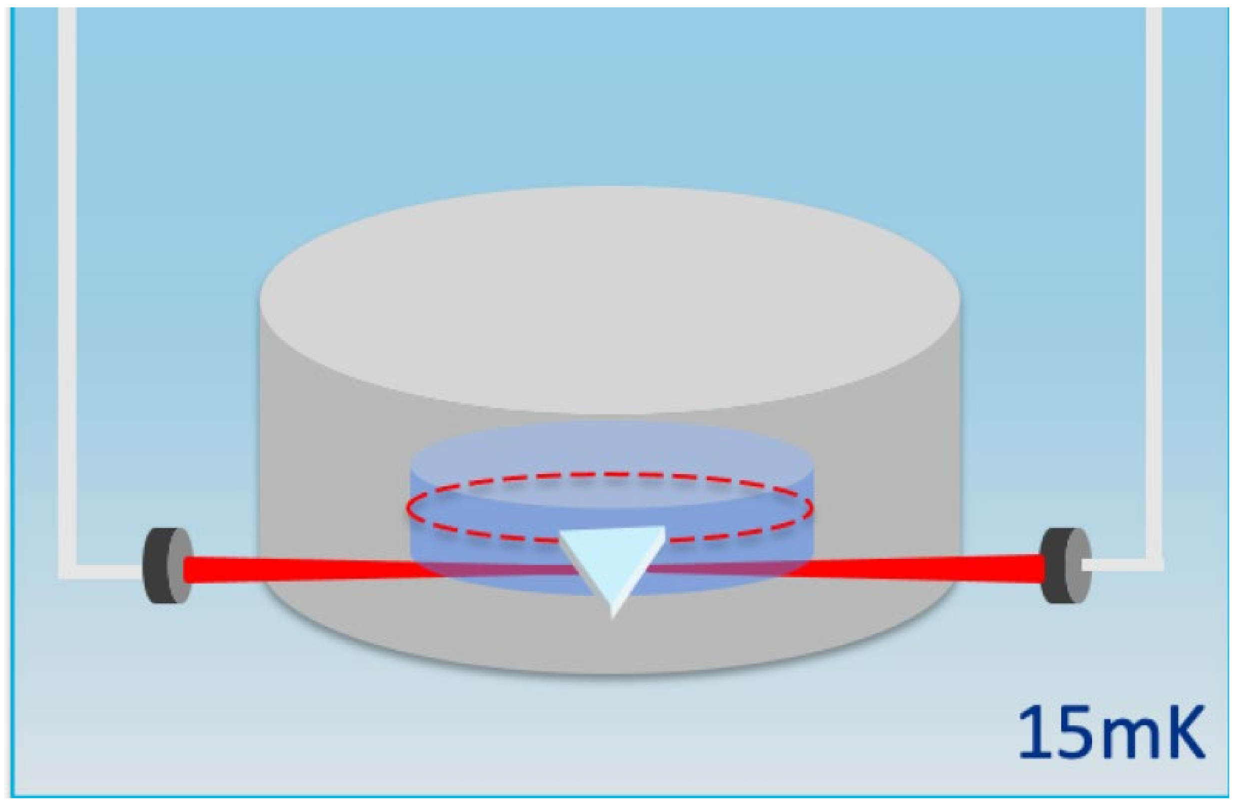
Microwave-to-Optic Quantum Transduction

The superconducting qubits of quantum processors operate at cryogenic temperatures, which restricts the ability to transfer quantum information over distance.

An electro-optic quantum transducer could convert quantum information from microwave-to-optical frequency with high efficiency. Transduced optical signals could be used for a future distributed quantum computing network.



Schematic diagram of EO quantum transduction scheme

A bulk niobium RF cavity is coupled to a nonlinear electro-optic LiNbO3 crystal. The resonator's optical refractive index is modulated by the microwave signal, coupling the RF and optical frequencies in the crystal. Light is coupled to the LN resonator by a diamond prism, to pump the signal and bridge the energy gap from microwave to optical frequencies through three-wave mixing.

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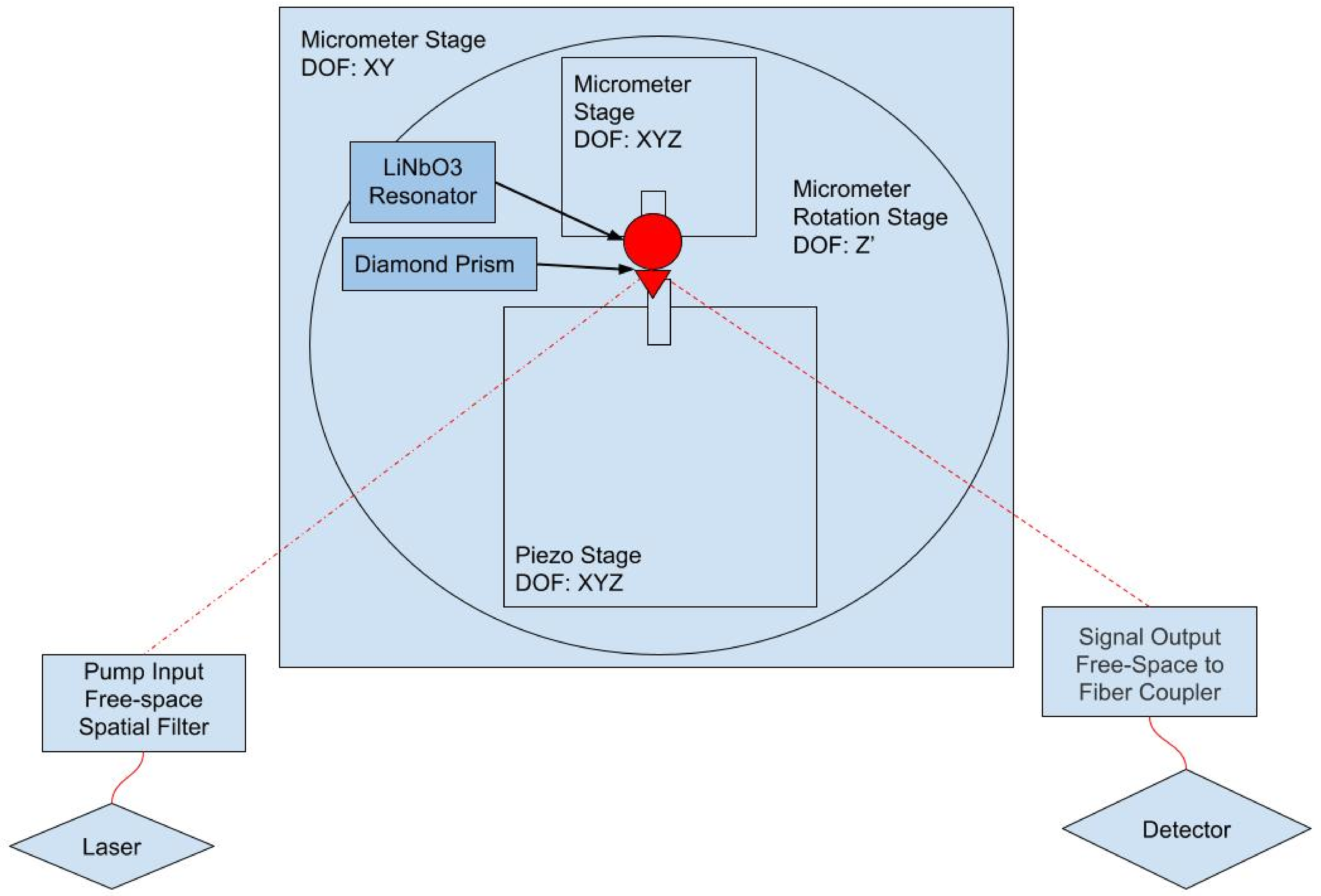
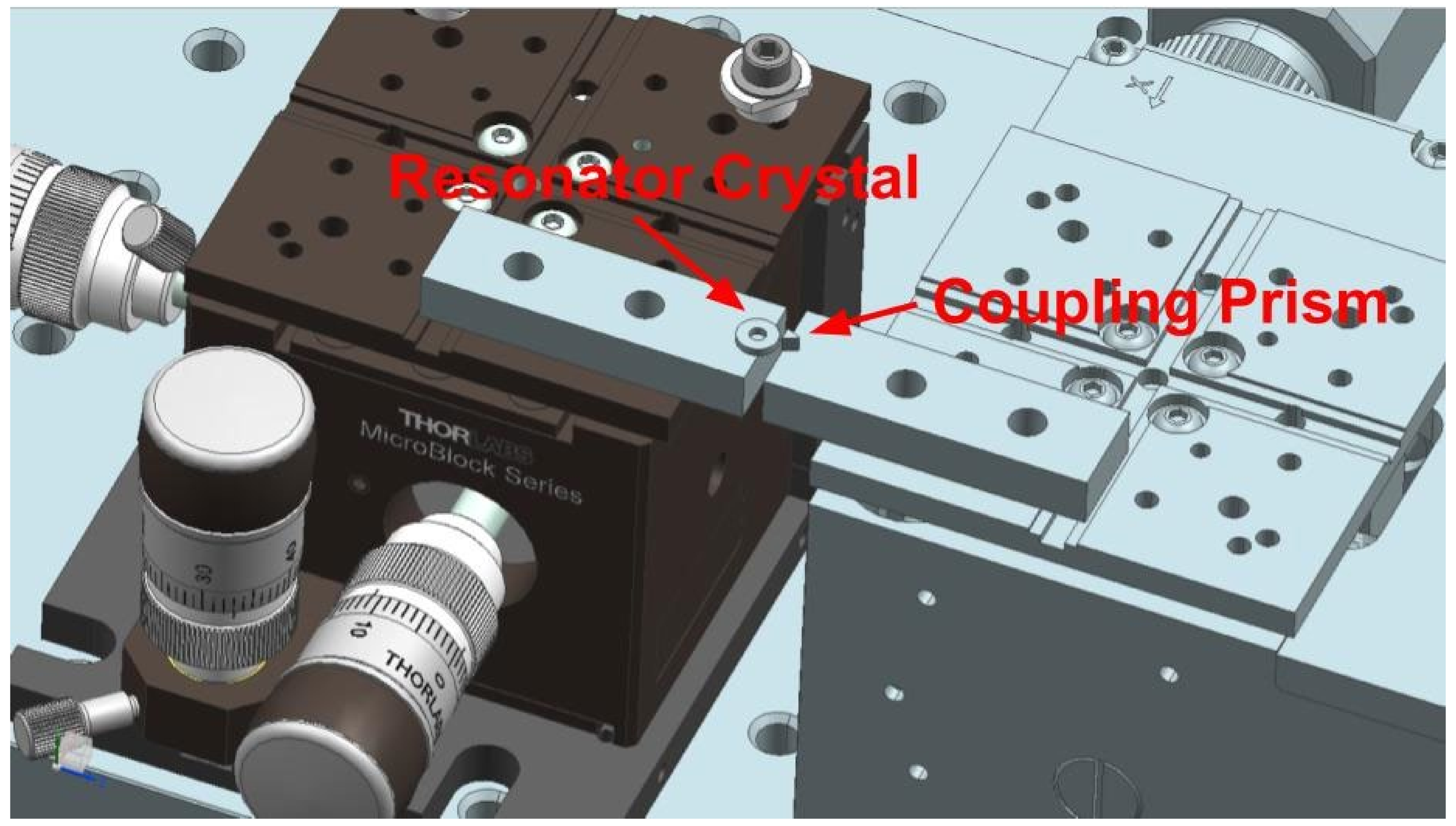


Diagram of mechanical setup

A platform was needed to test the optical and RF components of the quantum transducer at ambient temperature, and test optical coupling methods. The optical coupling strength of the resonator crystal is tunable by the distance between the prism & crystal.



Lithium Niobate resonator crystal and diamond prism mounted on stages

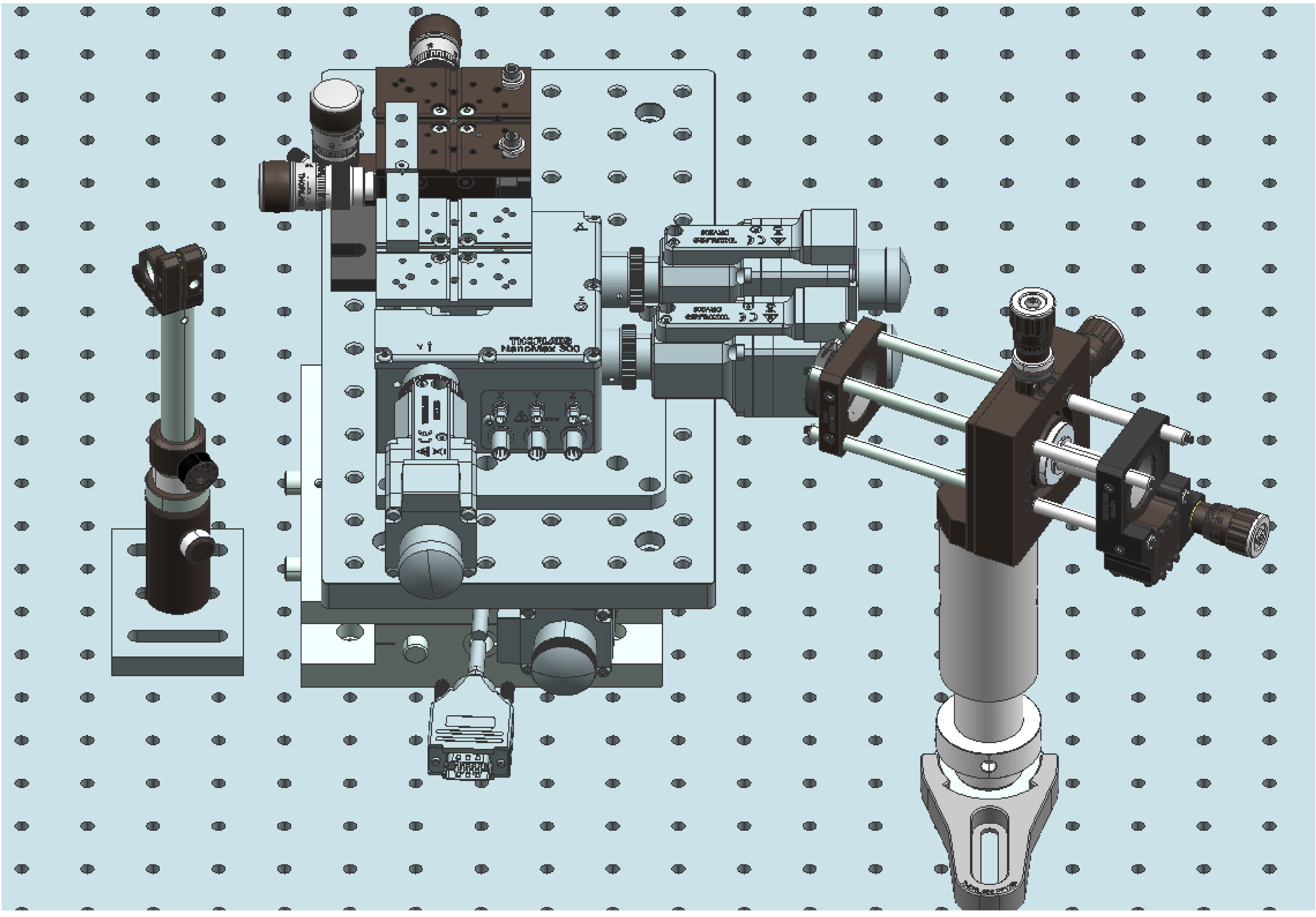
References

Wang, Changqing, et al. "High-efficiency microwave-optical quantum transduction based on a cavity electro-optic superconducting system with long coherence time." *arXiv preprint arXiv:2206.15467* (2022).

Future Work

The platform will be assembled and used to test the optical coupling methods of the transducer and determine necessary motion DOF.

The EO transducer will then be tested in a dilution refrigerator at cryogenic temperature for microwave-to-optical frequency conversion, and its transduction efficiency will be characterized.



Translation stages and experimental setup

Acknowledgements

Thank you to my supervisors for all your support and SQMS for providing a welcoming space for collaboration and innovation. Also, thank you to everyone from EDI at Fermilab and The National GEM Consortium for the amazing opportunity.

FERMILAB-POSTER-22-130-STUDENT

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics