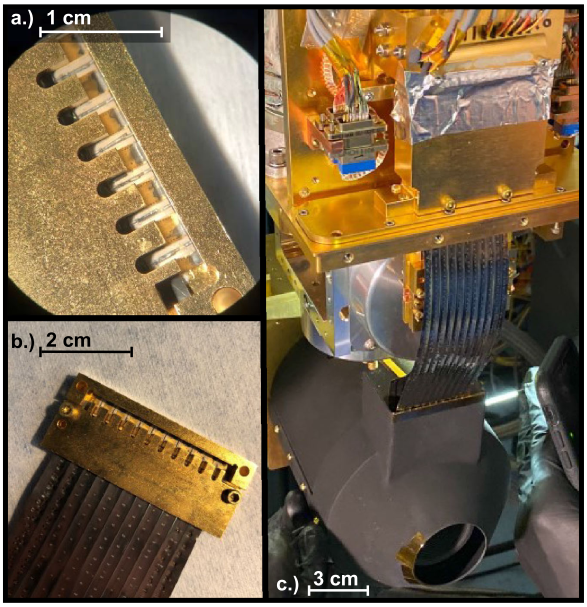

Fig. 1. Photographs showing (a) Close-up of cable end where NbTi center conductors connect to center trace of GCPW transition board via stainless steel capillary tubing. (b) Fully assembled cable end with protruding microspot-welded, shared Nb47Ti ground shield. (c) Fully assembled cable spanning the 3.4 K stage and the 90 mK cold ADR stage with a thermal sink at 800 mK halfway down the length of the cable in the MKID Expolanet Camera (MEC) experiment [15], [17].

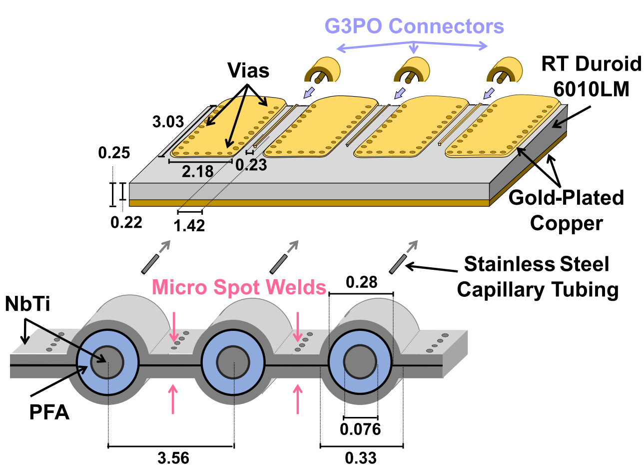

Fig. 2. Exploded view of cable-end assembly diagram with key dimensions shown in mm. Drawing is not to scale. From top/back to bottom/front: G3PO half-shell connectors are soldered to the transition board. Two ground tabs with via borders and an intervening signal trace create a 50 Ω grounded coplanar waveguide. The FLAX cable center conductors are crimped into stainless steel capillary tubing and soldered to the center traces. The FLAX ground shield is spot welded to the ground tabs. The cable cross-section shows the PFA (blue) insulated NbTi (grey) wire set in semicylindrical crimps made in the shared Nb47Ti foil ground shield. The two sides of the shield are mechanically and electrically bonded with microspot welds less than $\lambda/16 \simeq 2$ mm (at 8 GHz) apart which run in-between the traces down the length of the cable.

sides of the ground shield are mechanically and electrically bonded by microspot welds which run the length of the cable between each trace. The welds are approximately every 2 mm which is less than $\lambda/16 = 2.3$ mm at 8 GHz (see Figs. 1 and 2).

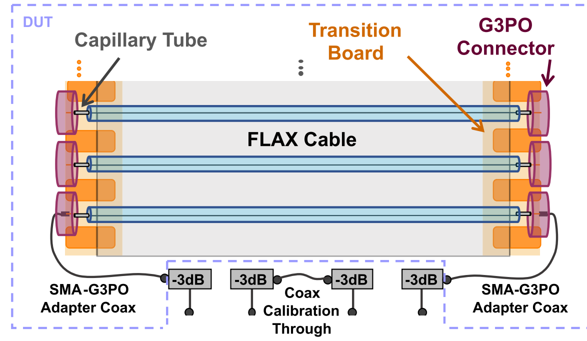

Fig. 3. Schematic diagram depicting FLAX attachment to the G3PO push-on connectors via a capillary tube soldered to a coplanar waveguide transition board and the device under test (DUT) circuit at 4 K.

At the ends of the cable, the protruding center conductors are threaded into ⌀1.6 mm, 0.13 mm thick stainless steel capillary tubing. The tubing is crimped onto the center conductor before the assembly is soldered to the center traces of the transition board using a stainless steel soldering flux [see Figs. 1(a) and 2]. The transition board is a 0.25 mm thick RT/Duroid6010LM PCB with 50 Ω grounded coplanar waveguide (GCPW) geometry for increased signal isolation. Between each trace, the Nb47Ti outer conductor foil is microspot welded to the ground tabs of the transition board while surface mount coaxial G3PO push-on connectors are soldered to the other end of the GCPW [see Fig. 1(a)]. The cable end assembly is clamped in a 3×7 cm gold-plated copper box which provides strain relief and allows for easy push-on connection of all ten traces with G3PO blind-mate bullet connectors [see Fig. 1(b)].

III. Performance Characterization

Transmission loss (S_{21}), cross talk (S_{41}), and time domain reflectometry (TDR) measurements were performed in a dilution refrigerator under vacuum at 4 K with a Keysight N9917 A network analyzer. The device under test circuit consisted of the assembled FLAX cable with a 3 dB cryo-attenuator obtained from XMA[5] and a 25 cm nonmagnetic SMA-to-G3PO adapter coaxial cable obtained from Koaxis[6] on either end (see Fig. 3). A Crystek[7] braided, semirigid coax through line was used as a calibration reference. Repeated handling through the testing process revealed the cables have a minimum inside bend radius close to 2 mm and are robust to cryogenic cycling.

A. Transmission

Ripples in the FLAX transmission suggest standing wave modes are present on the traces which is indicative of an impedance mismatch between the FLAX cable and the 50 Ω circuit (see Fig. 4). The transmission ripples are not uniformly harmonic which suggests the impedance is changing with length

[5]XMA Corporation-Omni Spectra, 7 Perimeter Road, Manchester, NH. P/N: 2082-6040-03-CRYO
[6]Koaxis RF Cable Assemblies, 2081 Lucon Road, Schwenksville, PA. P/N: AO10-CC047C-YO18
[7]Obtained through Digikey. P/N: CCSMA18-MM-141-12