Academia Sinica, Institute of Astronomy & Astrophysics

Subject:	Date:	From:
GLT Fiber Optic System Status, Thule Air Base	2017-Dec-12 DK006-2017	Derek Kubo
To:	**cc:**	**Location:**
Ming-Tang Chen	S. Matsushita, T. Norton, Y-H Chu, P. Oshiro	Hilo Office

Background

The GLT utilizes single-mode optical fibers for all communications to and from the telescope and eliminates the need for electrical cables. This design provides scalability both from the standpoint of the number of communications links required and physical distance (up to several km) between the telescope and control container modules. The only copper cables to the telescope are for the primary power consisting of 5 copper conductors (3 phases, neutral, and protective earth).

To accommodate the very low temperatures expected at summit station (-65C), we identified and ordered a custom low temperature cable from AFL consisting of 4 single-mode glass fibers coated with polyimide, refer to Figure 1. These fibers are encased in stainless steel tubing and further protected by armored wires and a black HDPE jacket. We also identified and ordered the associated fusion splicing equipment required to terminate the ends with SC/APC connectors in the field.

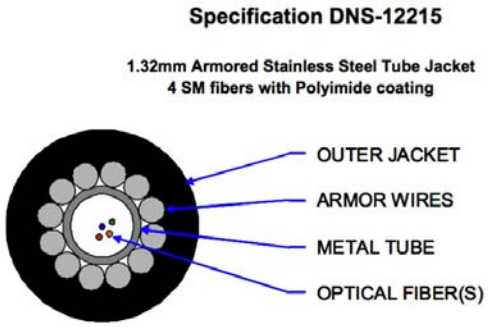

Figure 1 – AFL single-mode fiber optic cable

Design

The physical partitioning of the fiber optic system is described in Table I. The design was originally to have a single large control module for summit station but was partitioned to consist of a separate control container, VLBI container, and maser container for the interim location at Thule Air Base. The 12 cables were pulled from the 3 containers and installed into the telescope by ICP/ASIAA in September. Peter Oshiro arrived in Thule on September 14 and began preparation for fusion splicing of the SC/APC pigtail fibers onto the ends of the AFL cable. Due to problems encountered during parts procurement and shipping, we were missing some key items including the 900-um fiber holders, thermal stripper, and fusion splice chassis. Peter accommodated the first two items with work around solutions but as a result was only able to finish 7 of the 12 cables. I arrived in Thule on November 16 about 2 weeks after arrival of the rack mount fusion splice chassis and proceeded to install the cables and fusion splice trays into the racks. Figures 2-8 illustrate the 7 completed rack mount chassis with SC/APC panel mount connectors.

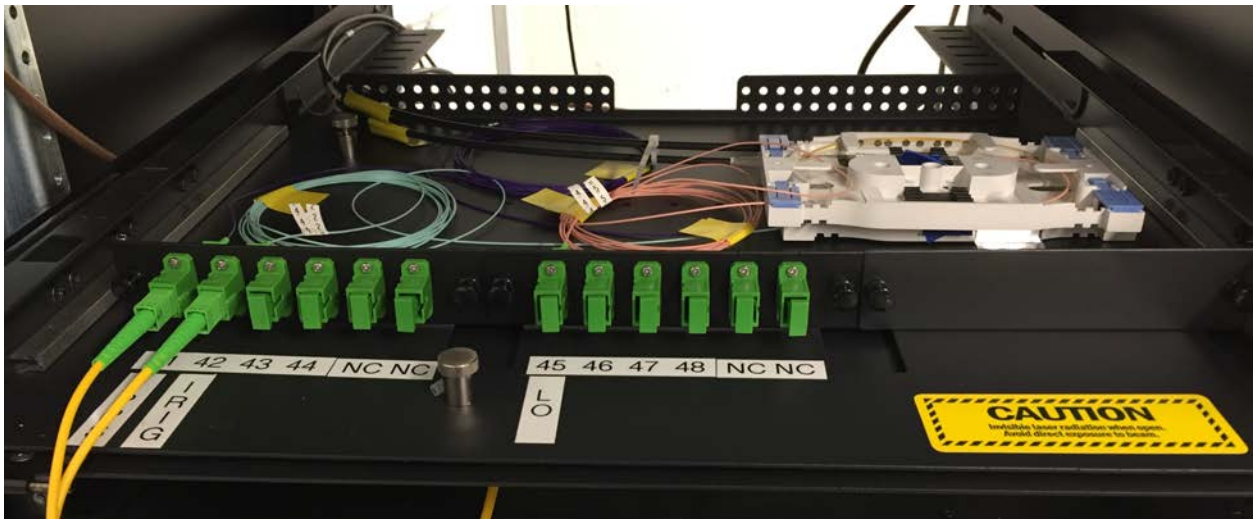

Figure 2. Maser house splice chassis for W11 to RSC and W12 to Rx Cabin

Table I. W1-W12 cable functions and definitions

W#	FIBER #	SIGNAL	LOCATION 1 / ITEM	LOCATION / ITEM	COMMENTS
W1	-1	SPECTROMETER, BIDI	CONTROL / CTL-A19	RX CABIN R/ CAB-A19	
	-2	SPARE	CONTROL	RX CABIN R	
	-3	1-GBE COMM	CONTROL / CTL-A16-G3-R	RX CABIN R / CAB-A16-G3-L	L = TX, R = RX
	-4	1-GBE COMM	CONTROL / CTL-A16-G3-L	RX CABIN R / CAB-A16-G3-R	L = TX, R = RX
W2	-5	R2DBE TO MARK6, BIDI	VLBI / VLB-A11-1	RX CABIN L / CAB-A6-1	
	-6	R2DBE TO MARK6, BIDI	VLBI / VLB-A11-2	RX CABIN L / CAB-A6-2	
	-7	R2DBE TO MARK6, BIDI	VLBI / VLB-A12-1	RX CABIN L / CAB-A7-1	
	-8	R2DBE TO MARK6, BIDI	VLBI / VLB-A12-2	RX CABIN L / CAB-A7-2	
W3	-9	R2DBE TO MARK6, BIDI	VLBI / VLB-A13-1	RX CABIN L / CAB-A8-1	
	-10	R2DBE TO MARK6, BIDI	VLBI / VLB-A13-2	RX CABIN L / CAB-A8-2	
	-11	R2DBE TO MARK6, BIDI	VLBI / VLB-A14-1	RX CABIN L / CAB-A9-1	
	-12	R2DBE TO MARK6, BIDI	VLBI / VLB-A14-2	RX CABIN L / CAB-A9-2	
W4	-13	SPARE	CONTROL	RX CABIN	NO CONNECTORS
	-14	SPARE	CONTROL	RX CABIN	NO CONNECTORS
	-15	SPARE	CONTROL	RX CABIN	NO CONNECTORS
	-16	SPARE	CONTROL	RX CABIN	NO CONNECTORS
W5	-17	SPARE	CONTROL	RX CABIN	NO CONNECTORS
	-18	SPARE	CONTROL	RX CABIN	NO CONNECTORS
	-19	SPARE	CONTROL	RX CABIN	NO CONNECTORS
	-20	SPARE	CONTROL	RX CABIN	NO CONNECTORS
W6	-21	SPARE	VLBI	RX CABIN	NO CONNECTORS
	-22	SPARE	VLBI	RX CABIN	NO CONNECTORS
	-23	SPARE	VLBI	RX CABIN	NO CONNECTORS
	-24	SPARE	VLBI	RX CABIN	NO CONNECTORS
W7	-25	1-GBE COMM	CONTROL / CTL-A16-G2-R	LSC-A2-G2-L	L = TX, R = RX
	-26	1-GBE COMM	CONTROL / CTL-A16-G2-L	LSC-A2-G2-R	L = TX, R = RX
	-27	SPARE	CONTROL	LSC	
	-28	SPARE	CONTROL (MISSING CONN)	LSC	
W8	-29	SPARE	CONTROL	LSC	NO CONNECTORS
	-30	SPARE	CONTROL	LSC	NO CONNECTORS
	-31	SPARE	CONTROL	LSC	NO CONNECTORS
	-32	SPARE	CONTROL	LSC	NO CONNECTORS
W9	-33	SPARE	CONTROL	RX CABIN	NO CONNECTORS
	-34	SPARE	CONTROL	RX CABIN	NO CONNECTORS
	-35	SPARE	CONTROL	RX CABIN	NO CONNECTORS
	-36	SPARE	CONTROL	RX CABIN	NO CONNECTORS
W10	-37	1-GBE COMM	CONTROL / CTL-A16-G1-R	RSC / RSC-A4-G1-L	L = TX, R = RX
	-38	1-GBE COMM	CONTROL / CTL-A16-G1-L	RSC / RSC-A4-G1-R	L = TX, R = RX
	-39	SPARE	CONTROL	RSC (MISSING CONN)	
	-40	SPARE	CONTROL	RSC (MISSING CONN)	
W11	-41	1-PPS	MASER / MAS-A10-A	RSC / RSC-A8-A	
	-42	IRIG-B	MASER / MAS-A10-B	RSC / RSC-A8-B	
	-43	SPARE	MASER (MISSING CONN)	RSC (MISSING CONN)	
	-44	SPARE	MASER (MISSING CONN)	RSC (MISSING CONN)	
W12	-45	LOCAL OSCILLATOR	MASER / MAS-A4-J6	RX CABIN L / CAB-A3-J1	
	-46	SPARE	MASER (MISSING CONN)	RX CABIN L (MISSING CONN)	
	-47	SPARE	MASER (MISSING CONN)	RX CABIN L (MISSING CONN)	
	-48	SPARE	MASER (MISSING CONN)	RX CABIN L (MISSING CONN)	

Figure 3. RSC splice chassis for W9 and W10 from control room, and W11 from maser house

Figure 4. Control container splice chassis for W1 to Rx cabin, W7 to LSC, and W10 to RSC

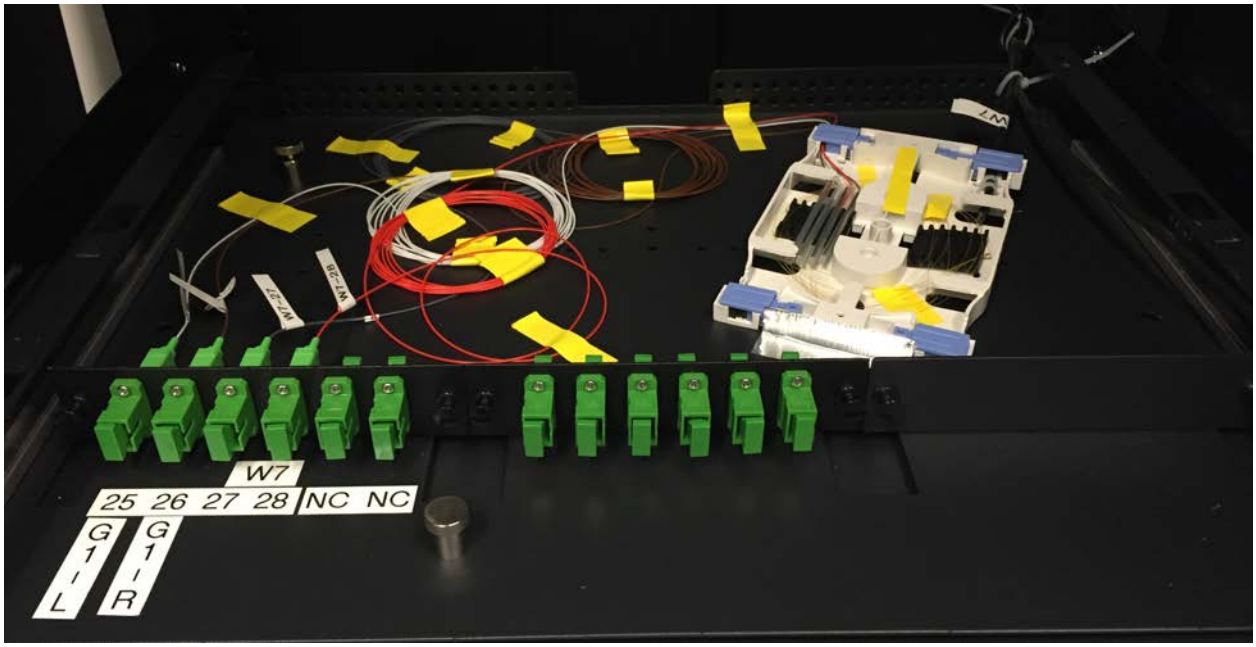

Figure 5. LSC splice chassis for W7 from control container

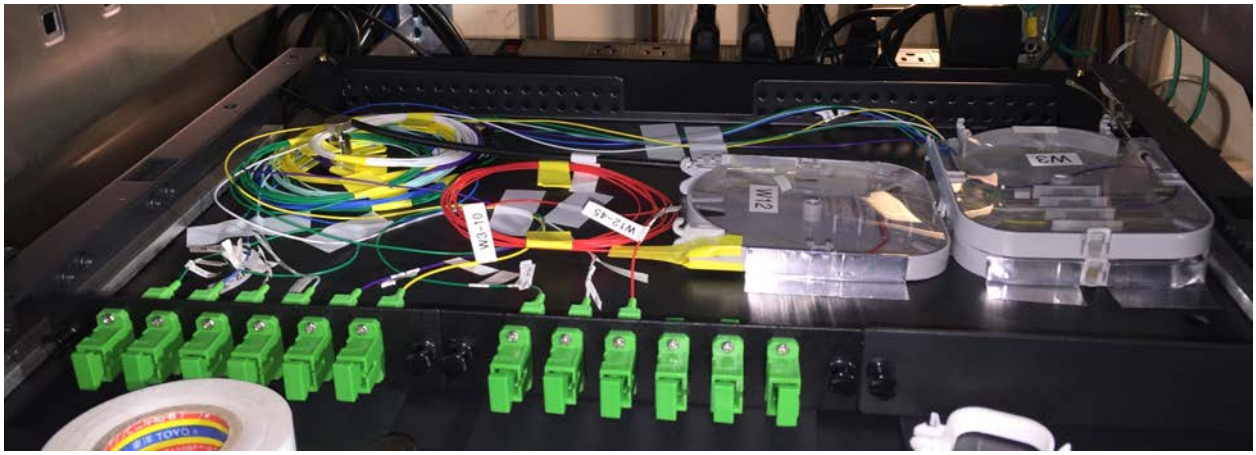

Figure 6. Receiver cabin left rack splice chassis for W2 and W3 from VLBI container and W12 from maser house

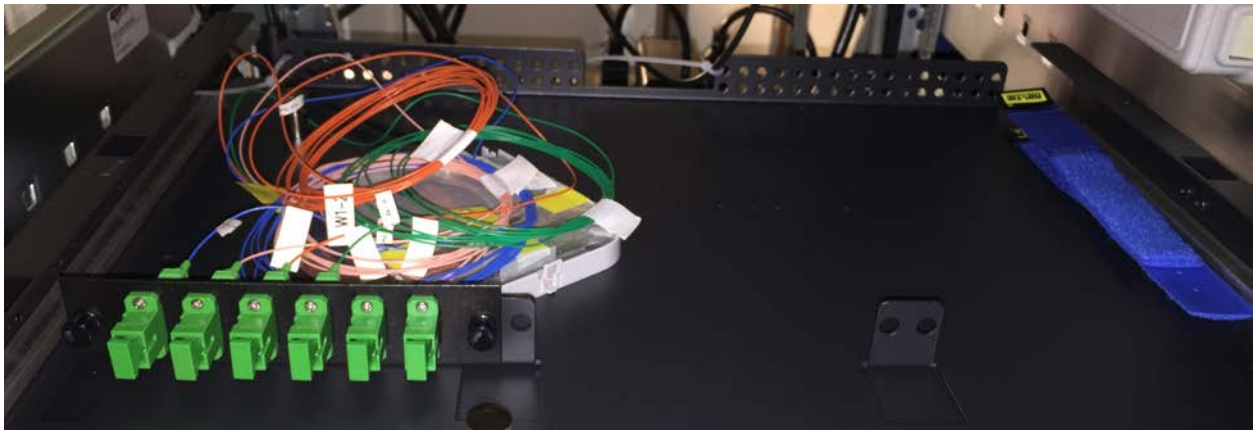

Figure 7. Receiver cabin right rack splice chassis for W1 from control container

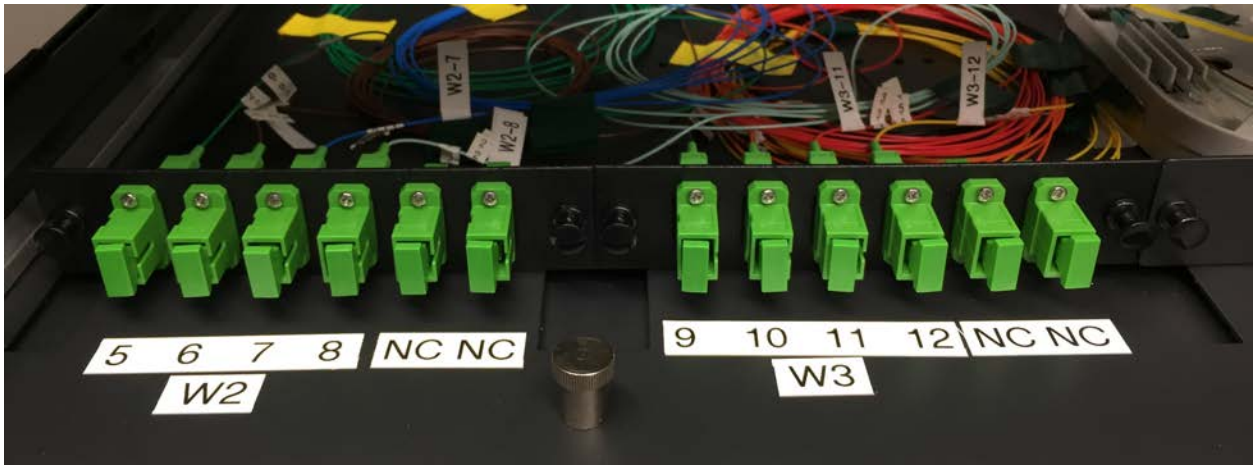

Figure 8. VLBI container splice chassis for W2 and W3 from left rack of receiver cabin

Conclusions and Recommendations:

The main question I wanted to bring to light in this memo is whether we should proceed to continue to complete the fusion of SC/APC connectors for the spare fibers. So far the fusion splices performed by Peter have held up well even after rough handling myself. In my experience one of the primary causes of failure is at the connector end faces that are easily damaged. So as long as the connectors remain in place and are not un-mated and re-mated unnecessarily then these will probably be OK.

Having said the above, however, the current situation leaves us vulnerable to single point failures. If we are to operate in Thule for the next few years I would recommend that at a minimum we complete the suite of 4 fibers in

each of the following partially completed active cables: W7, W10, W11 and W12. I suspect that completing these will be difficult because it requires removing the splice trays from the chassis and unspooling of the bare glass fibers for fusion splicing with the SC/APC pigtail fibers. This operation will take portions of the telescope offline for the duration of the work. For the unused spare cables, I would recommend completion of W4 (control container to receiver cabin right rack) and W6 (VLBI container to receiver cabin left rack). I should note that I did not see the spare W6 cable in the VLBI container and am guessing that it was pulled from the control container. If this is the case then it should be rerouted.