CLAS-NOTE 94-015
September 15, 1994.

Tape Loop Strength and Stretch Tests for TOF Scintillator/Support Structure Interfaces

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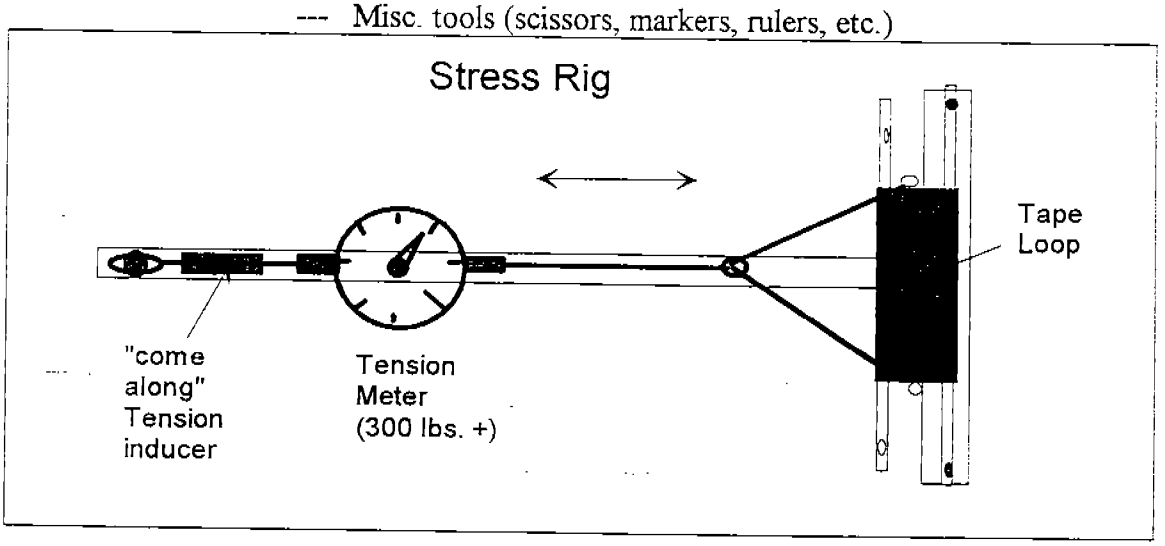
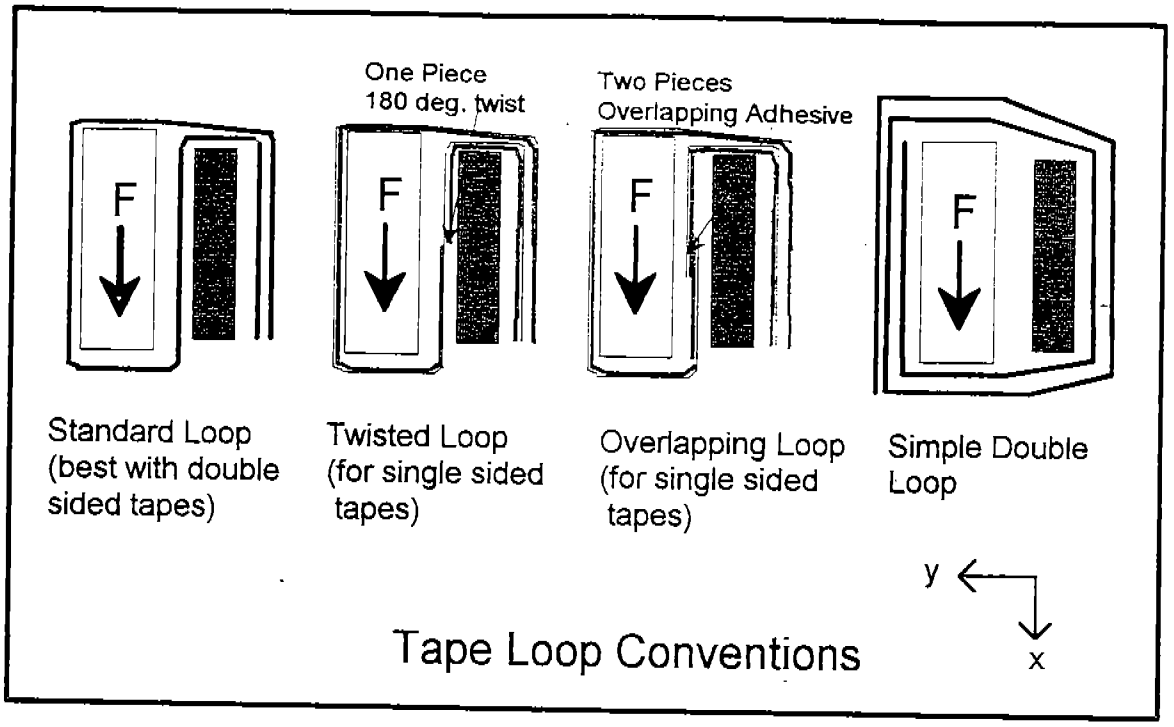
May 1994

Objectives: To gauge the performance of various tapes used in TOF detectors and to compare them to other tapes. Performance areas measured included stretching over time, adhesion to various surfaces and strength of various tape looping methods to affix the scintillators to the structures.

Equipment Used:

--- Aluminum frame stretching rig with 300 lb. pull tension meter, cabling, eyebolts and "come-along" tensioning device
--- Simulated small detector (spare #2 structure with a 2" slab of wood wrapped in Kapton)
--- Valley Industrial type 7007 bi-directional, single-sided, 2.5" glass fiber tape with **acrylic** adhesive (proposed alternative)
--- Valley Industrial type 7007 bi-directional, double-sided, 2.0" glass fiber tape with **silicone** adhesive (currently used as a strength loop)
--- Valley Industrial Red Mylar tape with silicone adhesive (currently used outside of the strength loop)
--- Standard Duct Tape
--- Misc. tools (scissors, markers, rulers, etc.)





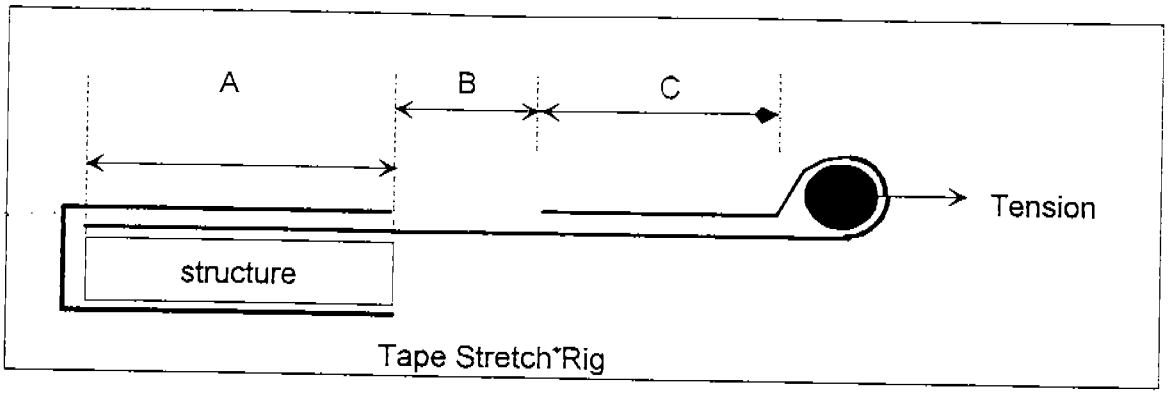
Method:

1.) The simulated scintillator and structure was taped together with one of the loop methods outlined.
2.) The piece was bolted to the stress rig and the harness hooked up.
3.) The tension device was cranked to a certain tension value and the deflection recorded. Force was in the "x" direction as in the loop chart, i.e. trying to slide the scintillator off the structure with shearing force.
4.) The deflection was re-measured a few minutes and recorded.
5.) The tensions were increased to a maximum amount and the rig was sometimes left overnight to see if it lasted.
6.) If the joint broke overnight, any observables were recorded (where it broke on the tape loop, any other factors that may have been involved, etc.).
7.) The same types of measurements were done with the force in the "y" direction to see the various loops effectiveness when the scintillator is pulled directly away from the structure.

Measurements:

Force in "x" Direction

#	Tape Type(s)	Loop Used	Initial Tension (lbs.)	Final Tension (lbs.)	Time	Deflection (mm)
1	DS, Silicone and Red Mylar	Standard Loop (mylar outer)	45	40	15 min.	1.5
			85	75	15 min.	2.5
			125	120	15 min.	3.0
			180	90	18 hr.	25.0 (broke)
2	SS, Acrylic	Twisted Loop	45	22	15 min.	13
			85	60	15 min.	22
			125	? (broke)	0	---
3	SS, Acrylic	Overlap Loop	54	42	15 min.	6
			95	68	15 min.	14
			128	65	15 min.	28
			185	? (tape slipped off)	30 sec.	---
4	SS, Acrylic	Simple Double Loop	51	46	15 min.	8
			97	90	15 min.	12
			142	26 (tape slipped off)	18 hrs.	---
5	Duct Tape	Overlap Loop	42	32	15 min.	12
			75	? (broke)	0	---
6	DS, Silicone (no Mylar)	Standard Loop	54	51	15 min.	1
			96	90	15 min.	3
			125	121	15 min.	6
			160	? (broke)	0	---
7	SS, Acrylic	Overlap Loop	50	36	31 min.	7
			98	80	4 min.	11 (slipping)
8	SS, Acrylic	Overlap Loop	47	39	15 min.	4
			98	86	15 min.	7
			135	123	15 min.	9
			200	86 (broke/slip)	15 min.	---
9	DS, Silicone (no Mylar)	Standard Loop	55	46	15 min.	2
			99	89	15 min.	3
			141	? (broke)	0	---



Tape Stretch Rig

The following data was collected for both tapes:

Tape Type	Dim. "A" (cm)	Dim. "B" (cm)	Dim. "C" (cm)	Tension (lbs.)
SS, Acrylic Glass Fiber	13.5	7.3	17.0	0
	13.8	7.45	17.2	20
	14.0	7.5	17.3	39
	14.1	7.5	17.4	66
slipped off	14.3	7.5	17.5	113 (5 min.)
DS, Silicone Glass Fiber	14.4	5.8	14.2	0
	14.4	5.8	14.2	21
	14.5	5.9	14.3	87 (1 hr.)
(broke)	14.5	5.9	14.3	209 (20 min.)

Conclusions: From the large number of tests performed, we were able to determine that the double sided, silicone adhesive, bi-directional glass tape is still the best option to use in the Large Angle TOF detectors. To economize the design, we can increase the spacing between tape loops and use less tape (approximately half the previously calculated amount) without any expectation of stress failure while holding the scintillators and structures together. The stretch tests prove that the deflections in the data tables were mostly due to stretching in the nylon belts and rope used in the stress rig. This was verified by tensioning the stress rig on itself, resulting in a drop in tension over 15 minutes of 5 - 7 %.

The recommended tape loop arrangement is one set of two strength loops (standard loops) at each end and one in the middle. In between the strength loops can be one set of loops (simple double loops) for extra safety (not needed on the smaller FATOF style detectors in the Large Angle array). This makes a total of 5 tape loop points on each 4 meter detector and 3 tape loop points on the smaller ones.