

Report on cable bending test

A test of cable bending was performed in Pisa on 9/8/2004 with the following equipment:

- Reduced tower mock-up consisting of -X and +Y walls (i.e. cables C2, C3, C4, C5) of 2 trays and a top tray; only one MCM was installed on each tower side
- Corner bracket mock-up installed on the top tray
- 2 minitower cables with 3 layers each
- bending tool for cactus-arm bending
- clip to fix bent cable onto corner bracket



Reduced Tower Mock Up

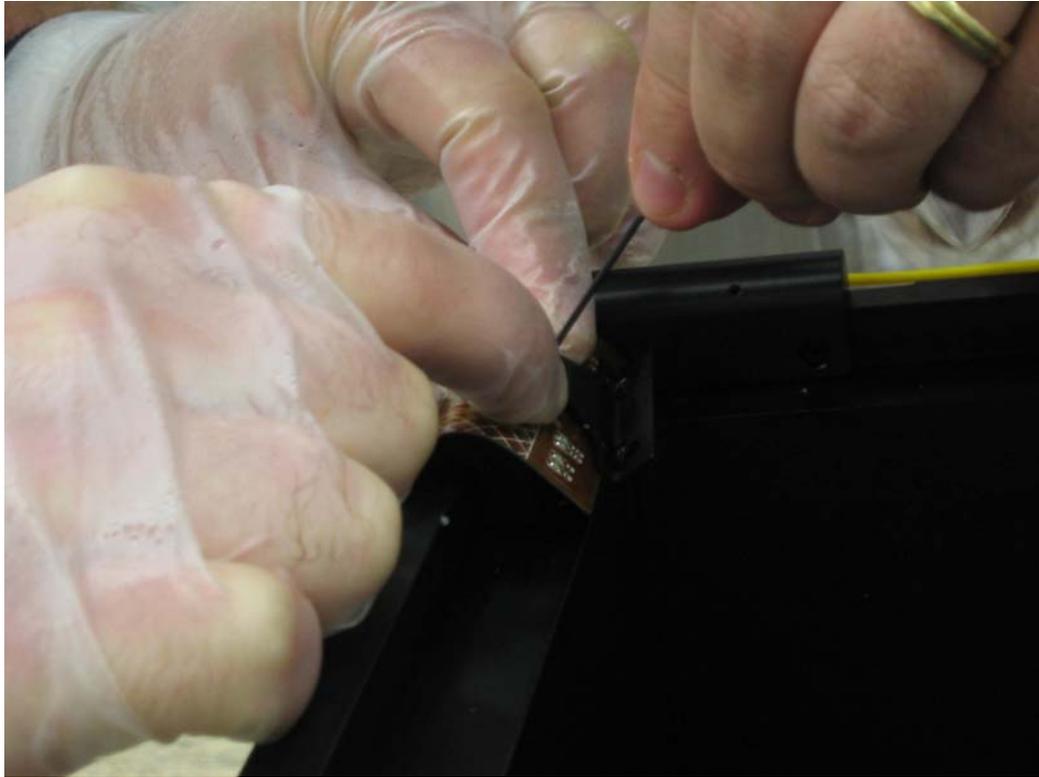
In order to check the effect of the bending on the flex-cables, a preliminary test was performed connecting 3 MCMs to the minitower cables prior to bending. The trigger line turned out to be interrupted on both cables just before the top layer, preventing trigger request from the top MCM to reach the TEM. All other lines worked fine. One cable was bent and connected to the tower mock-up according to the following draft procedure:

Cable bending and assembly draft procedure:

- 1- Bend cactus arms on each cable using the provided tool
- 2- Put arm in place, firm it to the tool, screw inner screws until the inner bar pushes uniformly across the whole cable width
- 3- Check bending of the arm
- 4- cut-off first 5cm from roll of transfer adhesive (3M 966) to use fresh non-contaminated tape
- 5- cut small bits (specify length) and attach to each tray closeout pocket (see picture)
- 6- push tape to ensure adhesion
- 7- place cable on tower side and connect all omnetics connectors onto MCMs
- 8- remove protection from transfer adhesive
- 9- push cable against closeout pockets where the tape was placed to firm the cable
- 10- put tape (or silicon glue) around corner bracket
- 11- bend top part of cable against corner bracket without touching the resistors on the cable
- 12- screw top central screw (M2) of fixing clip and retain cable in place
- 13- complete and fix the bend by screwing the two M2.5 SHCS of the clip in place onto corner bracket



Bending the cable

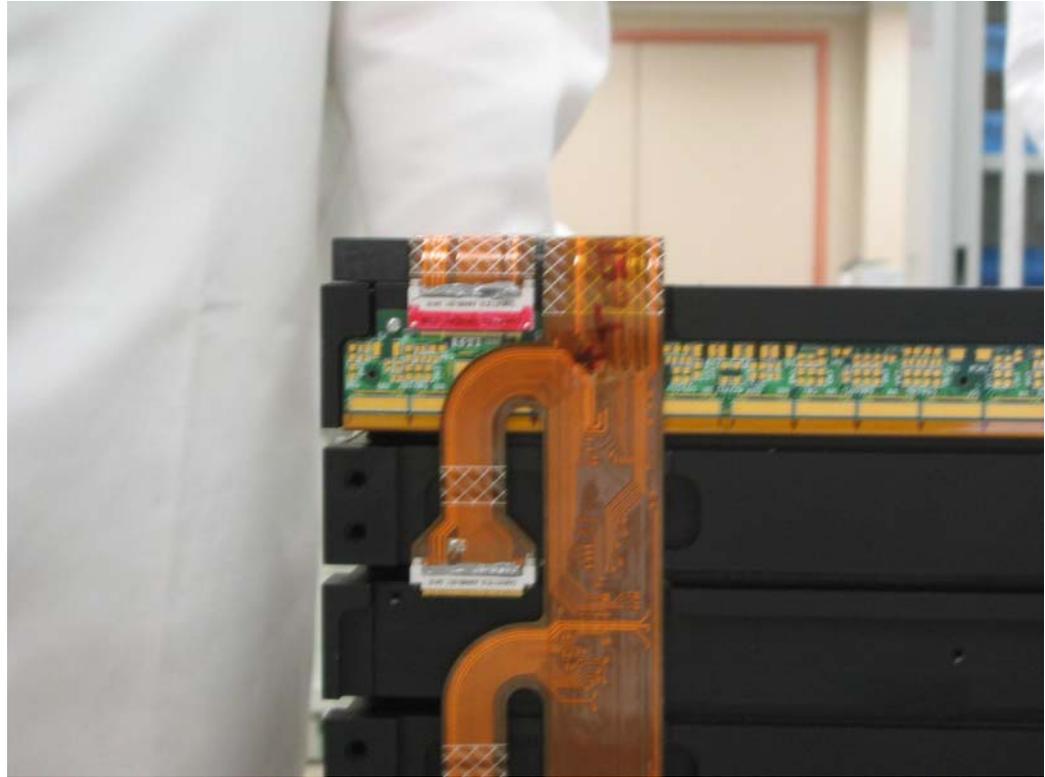


Attaching the clip

The cable was then disconnected from the mock-up and tested in the same way as it was tested before bending. No new lines turned out to be broken.

Nevertheless, the test can only be considered fully representative of the real situation that we will face during tower assembly because of the following reasons:

- 1- the minitower cables shipped had the trigger line broken on the top layer, so the functional test performed on the cables prior to bending was not complete and was not addressing one key line placed in the most stressed part of the cable
- 2- the tower mock-up could only hold 1 MCM per side, and did not reproduce the difficulties we will face when connecting all 9 tower layers at the same time



Finished Bend

The following list of issues and suggestions was collected during the test. Many of them are considered critical and need specific addressing before finalizing the tools and the procedure for bending:

List of critical issues:

1. a cable stiffener to the top part of the cable, on both sides, should be added just above the omnetics connector, to prevent the bend from stressing that connector
2. the clip which keeps the bent in place has sharp edges that might cut into the flex after time or pressure or vibrations. The sides of the clip are too close to some of the flex cable circuitry (R1, R2, R23, R24 – see picture of installed cable clip). Clips should have rounded edges and a modified shape on the side
3. in order to minimize friction between the cable and the clip, a layer of kapton tape should be applied to the whole surface of the clip and to the last part of the cable that would come in contact with the clip
4. the top central screw of the clip is placed in between the main flex arm and the top cactus arm, and during vibration might cut into the cable. On the other hand the screw is not necessary to keep the cable in place after the cable is bent and the clip is in place, therefore it could be used for defining the bend and the position of the cable and then removed when the clip is locked in its final position



Installed Cable Clip

List of suggestions:

1. the bending tool for the cactus arms should be modified to allow faster bending and increase reproducibility. Use of a tool that bends all arms at the same time and a piston or crimping system could be considered
2. in the current setup the cable is attached to the trays by means of transfer adhesive and could become loose after vibration. Some way of keeping the cable firm between the trays and the sidewall should be considered

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