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VELO Module Production – Cable and Clamp Attachment

LHCB Technical Note

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Abstract

This note describes in detail the procedures used in the fixing of the clamps to hold the cables in position on the pedestal in the final module assembly for the LHCb VELO detector modules. It summarizes the effects on the module of applying the cables.

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1. Introduction

This document outlines the procedures followed in the attachment of the cable clamps to the module bases. It also summarizes the module movements, in terms of tilt and twist, of attaching the cables to the modules (see Section 5)

2. Components

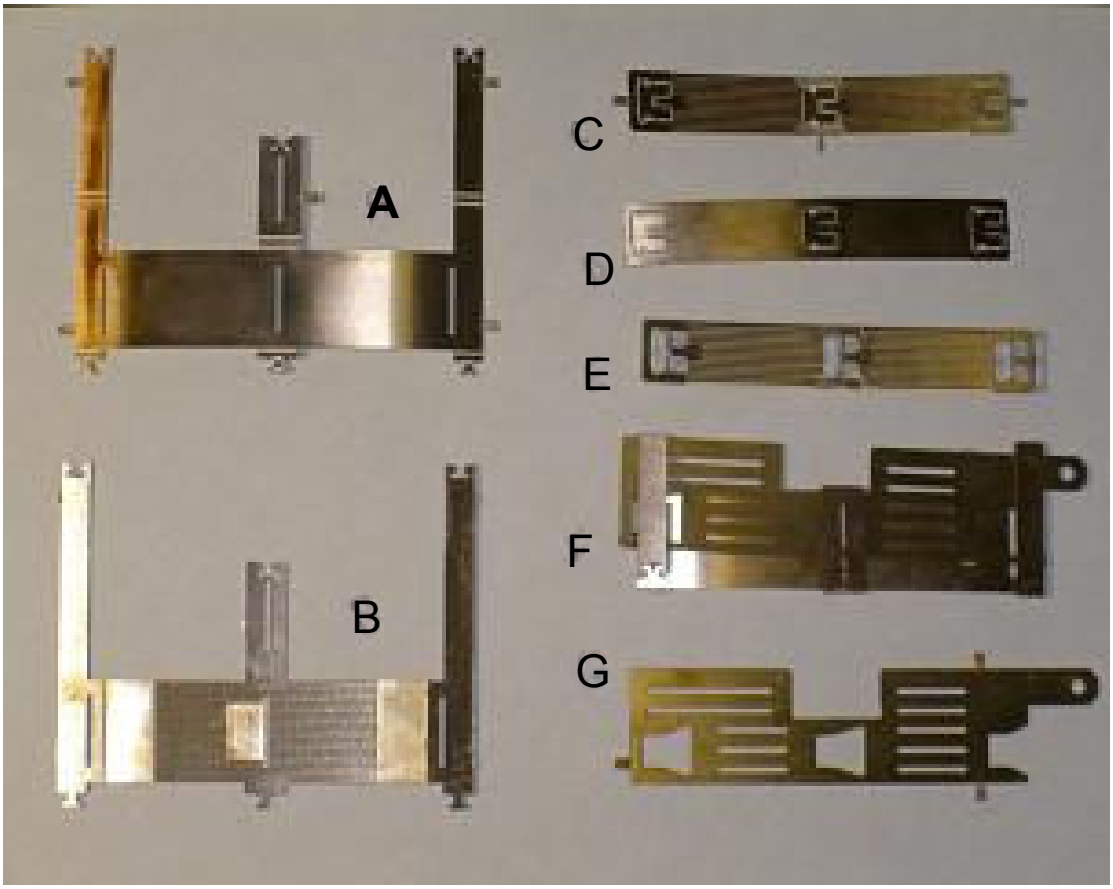

Figure 1: Photograph of the components of a cable clamp

Clamp parts: A) Clasp before de-tagging seen from the cable attachment side.

B) Clasp de-tagged and seen from the engagement side

C) Seat before de-tagging seen from the engagement side

D) Seat de-tagged and seen from the base side

E) Seat de-tagged and formed seen from the engagement side

F) Clasp formed to shape with slide inserted

G) Slide before de-tagging

N.B. Production clamp parts are now supplied de-tagged and do not need any rework

3. Cable Clamp Attachment

3.1. Clamp seat attachment

Cable attachment is done with the module mounted on a support "throne". Two sets of tested cables and four sets of inspected clamp parts are required.

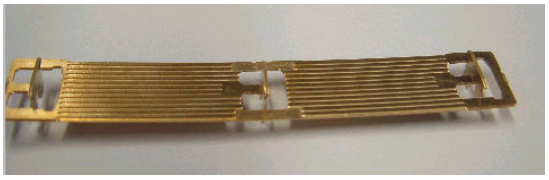

Figure 2: Clamp seat with ears bent to shape and lugs protruding below. The engagement side is uppermost

The clamp seat parts are bent to shape with pliers and inserted into the six holes in the base. NOTE that the clamp seat is a handed part and the plain section near the center must always be mounted to the right of the center when looking at the base. N.B. Production parts have two small protrusions on one of the long edges – these protrusions must always be on the top side when the clamp seat is mounted.

If the module is an extended version then mount the extension on the base with two screws and check that it seats correctly before proceeding.

Quick set Araldite is mixed and applied to the module base where the clamp seat will be attached. Only a very thin film of adhesive is required and any excess should be removed before clamping. A pointed stick is then used to apply a little adhesive down each hole to secure the lugs. The clamp seat is now located in the jigging bar and the seat and the bar are offered up to the base (check the small protrusions on the long side of the seat are at the top!) and the lugs are pushed home. The slots in the bar are precisely machined so that the lugs are pushed in to the correct depth.

An inspection is made and any protruding adhesive or any adhesive on the mating surface is removed with a scalpel blade before the adhesive is fully set.

3.2. Cooling Screw Insertion

When the hybrid is glued to the pedestal, wires are used to set the glue thickness. The wires that protrude from the sides of the module should be removed by putting a scalpel blade against them and pulling them against the blade with pliers. If necessary move the wire backwards and forwards a few times to remove it by metal fatigue rather than cutting.

In the holes where the screws are inserted it will be seen that the wire crosses the hole approximately in the centre. This portion of wire must be removed. To do this, cut one side of the wire with a pointed scalpel blade. Bend the wire outwards and, whilst holding the end with pliers, cut away the wire at the other side of the hole. Repeat this procedure for all 5 holes. Now try inserting the screws from the pedestal side through the threaded aluminium inserts. If the hole is clear then the threaded portion of the screw should pass through the threaded insert and then become free and floating so that it may be pushed completely through and then back again so that the end of the screw is only just protruding through the hole. In some cases it is possible that the holes in the paddle and the hybrid are slightly misaligned and the thread of the screw tries to cut a thread in the occluding portion of the hybrid substrate so that the screw does not push back into the assembly. In this case it will be necessary to remove the screw and to open the hole with either a scalpel blade or a 3mm drill bit. If this is the case then ensure that any debris is removed by using a vacuum as you work. Afterwards wipe the surface with a cleanroom wipe (the silk like type from the class 100 area – NOT a standard wipe [1]) moistened with a little IPA.

Repeat for all 5 screws.

3.3. Clamp Clasp and Slide Attachment to Cables

The two sets of cables (previously marked to indicate the gluing points and roughened with emery cloth in the fume cupboard and cleaned with DI water ready for gluing) are then bent to shape by hand (see template at the assembly station). The cables are then located gently into position and squeezed into correct engagement using the connector insertion tool. Note that, as a general rule the lower numbered cables are mounted on the R side of the module, but this is not essential.

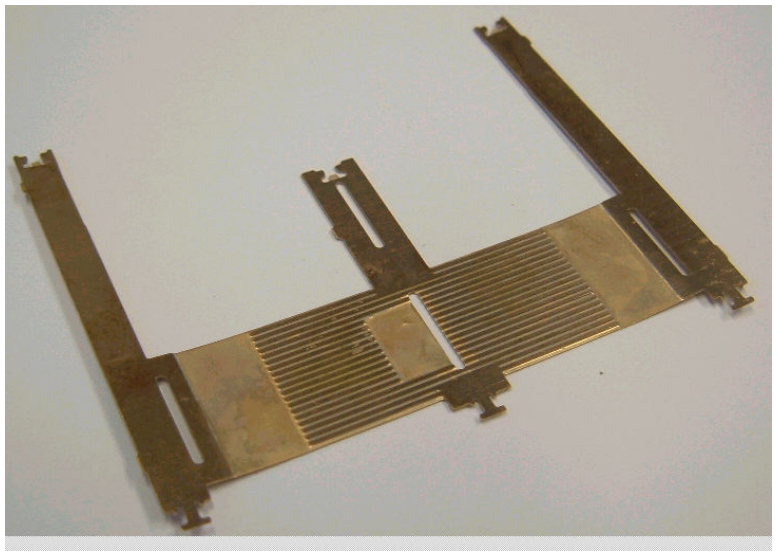

Figure 3: Clamp Clasp before forming showing engagement side

The clamp clasps are formed to their final shape but the holding tabs are not folded over. It is important to check that the slide retaining flaps can engage with their locating nibs on the short spacing flaps.

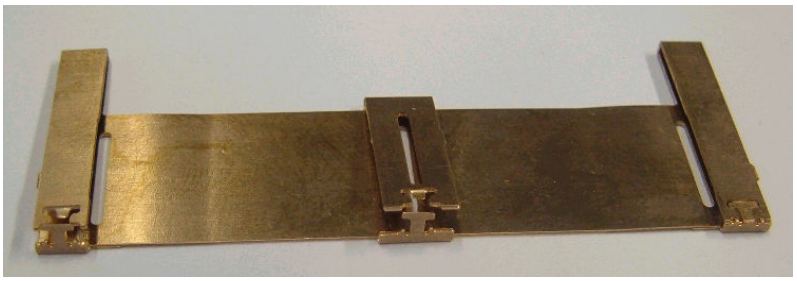

Figure 4: Clasp shown folded to shape and the rightmost holding tab engaged

The clasps are now mated with the clamp seats and held in place on their inner sides in opposed pairs with G-clamps. Using the height jig, held in place with the screw jack make sure the clamps are set at the correct height Adhesive is applied to the unclamped half of each clasp and the corresponding leg of the cable is deformed around the cable former and held in place with a G-clamp. Once the adhesive has set, the inner clamps are removed and adhesive is applied to the other half of the clasps. The remaining cable legs are then clamped to the clasps with G-clamps.

After the adhesive has hardened the G-clamps are removed. The Clamp slides are now inserted into the clasp, positioned over the lugs of the clamp ears and slid into the closed position. A check is made to ensure that the mating surfaces fit and the cable is securely clamped to the pedestal base. The slide holding flaps are now pushed home and the locking tabs are bent over to secure the slide within the clasps. A final check

is made that the clamps can be removed and replaced and that they hold the cable securely when the lower part of the cable is pushed upwards.

3.4. Cable Numbering and Data Entry

The cables should now be labeled with the module number MXX and side (R or Phi) on the LH bottom stiffener of both the HT and LT.

The used cables should be associated with the module in the DB[2] by following the "Attach Cables" link against the module in the Update Module page.

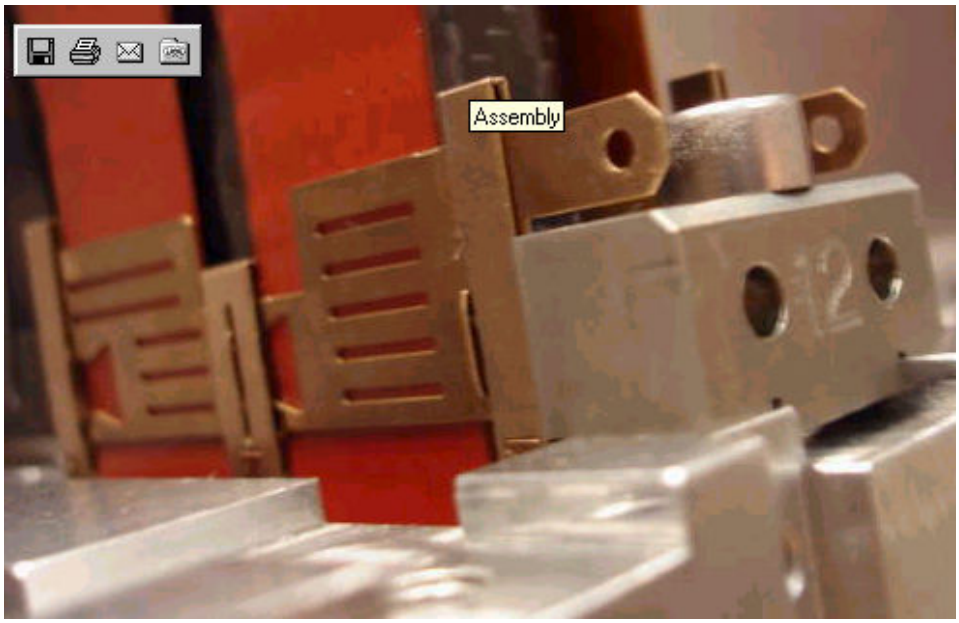

Figure 5: Cable and clamp assembled and locked to the module base

The clamp and cable are released simply by pushing the arm with the hole towards the center of the module and reattached by locating the slots in the clasp over the seat ears and pulling away from the centre of the module

4. Checklist

The following must be checked before the module is released for further processing:

- If the module is extended that the extension piece is mounted (before gluing the seats)
- The small protrusions on the long side of all 4 seats are at the top
- The cooling mounting screws are inserted and can move freely in and out.
- Protruding wires at the sides have been removed.
- There is no excess adhesive or adhesive on any of the mating surfaces
- The clamps can be engaged and disengaged correctly and that there is no movement of the upper part of the cable when the cable is pushed upwards from below

- The clamp tabs are all bent correctly into position and correctly seated. If there is a tendency for them to spring out then apply a little spot of adhesive to the tab to hold it in place.
- All cables are numbered with the correct Module number and side.
- All debris is removed.
- Update the DB to associate the cables with the module

5. Metrology

The module is measured before and after assembly. This is to ensure that attaching the cables has not significantly distorted the module. The tilt and twist measured for all module are listed in the Appendix. They are plotted in Figure 7. The correlations between the tilts and twists before and after mounting the cables are shown in Figure 8 and Figure 9. The tilt changes by a mean of approximately 50microns with a sigma of approximately 50 microns. (See Figure 6).

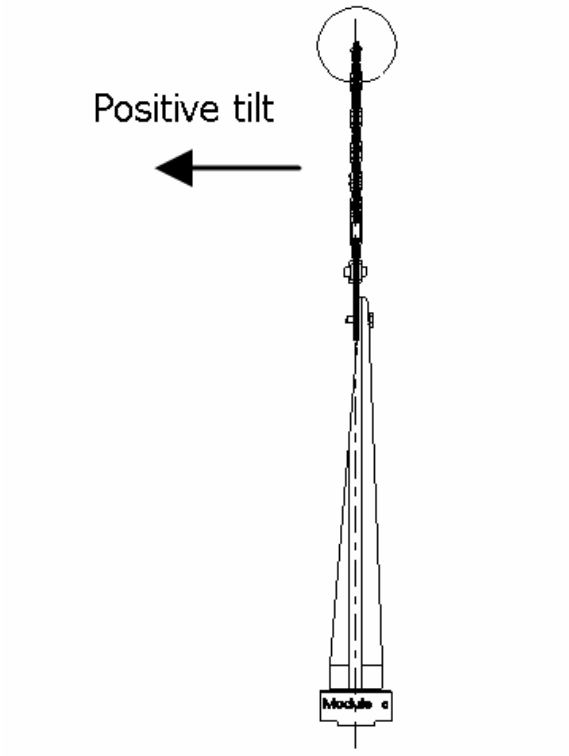

Figure 6: Diagram defining direction of positive tilt

The twist (which reflects the twist of the hybrid[3]) changes by only about 20microns with a sigma of 40microns. The effect on both the twist is and tilt is very small.

6. Summary

The procedure for attachment of the cables and cable clamps has been described. The process of attaching the cables clamps makes small differences to the tilt and twist but is a significantly smaller than the intrinsic tilt and twist of the module.

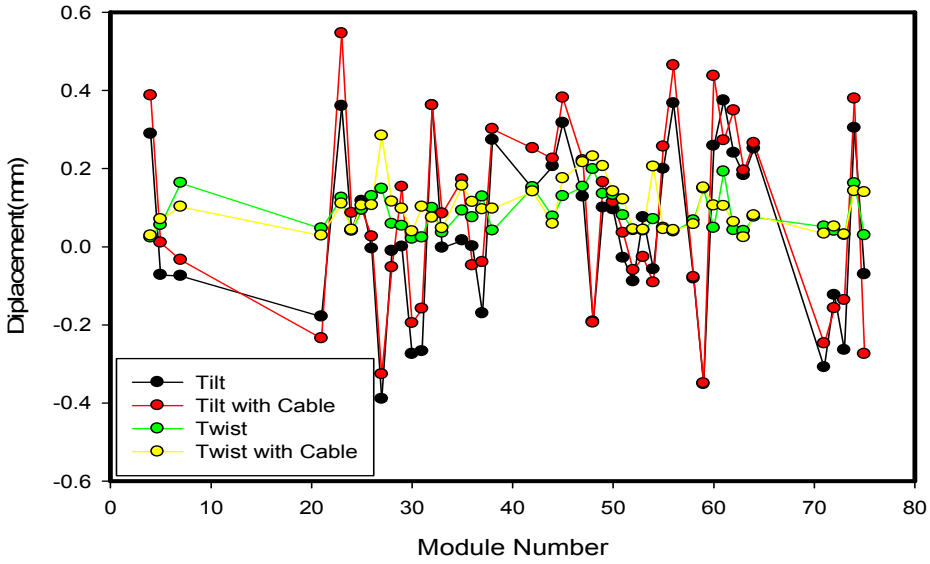

Figure 7: The tilt and twist of the module before and after cable attachment

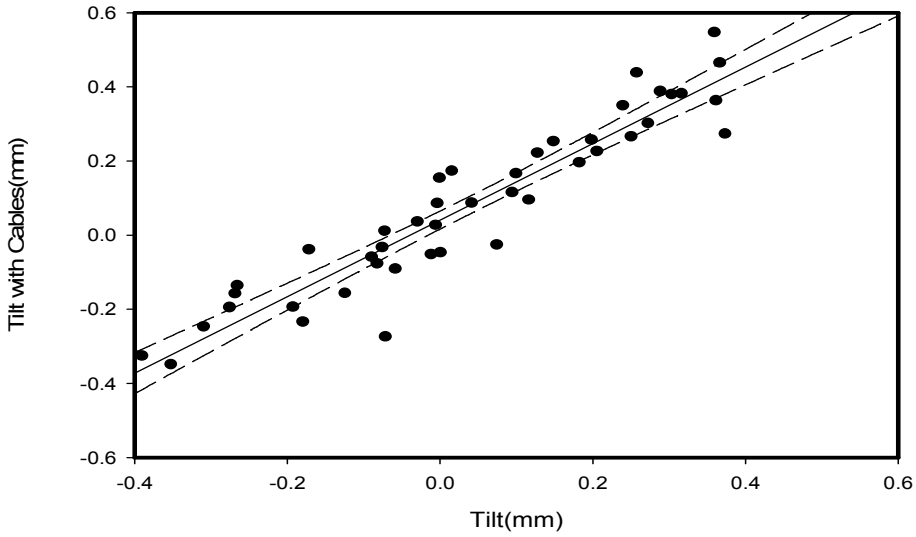

Figure 8: Scatter plot of the tilt before and after cable attachment showing the close correlation.

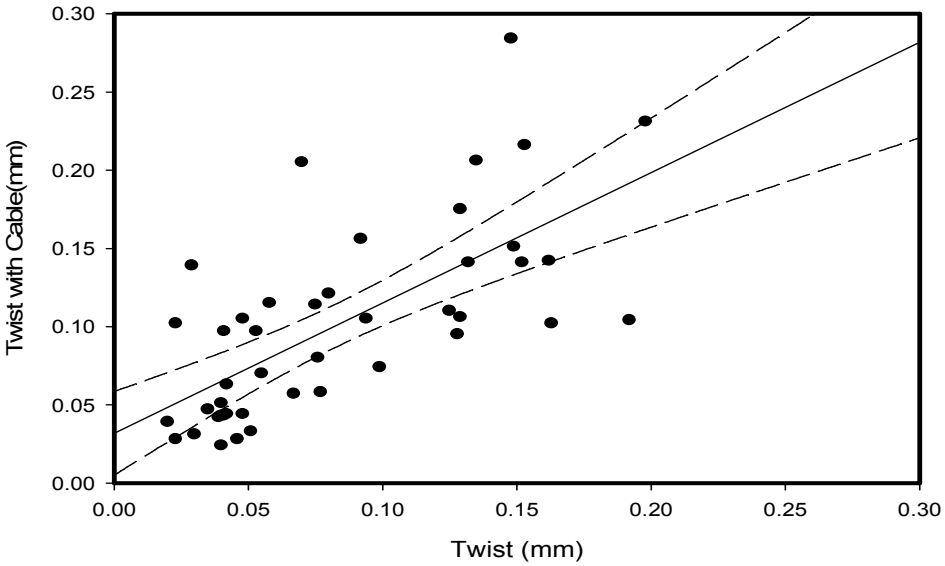

Figure 9: Scatter plot of the twist before and after cable attachment

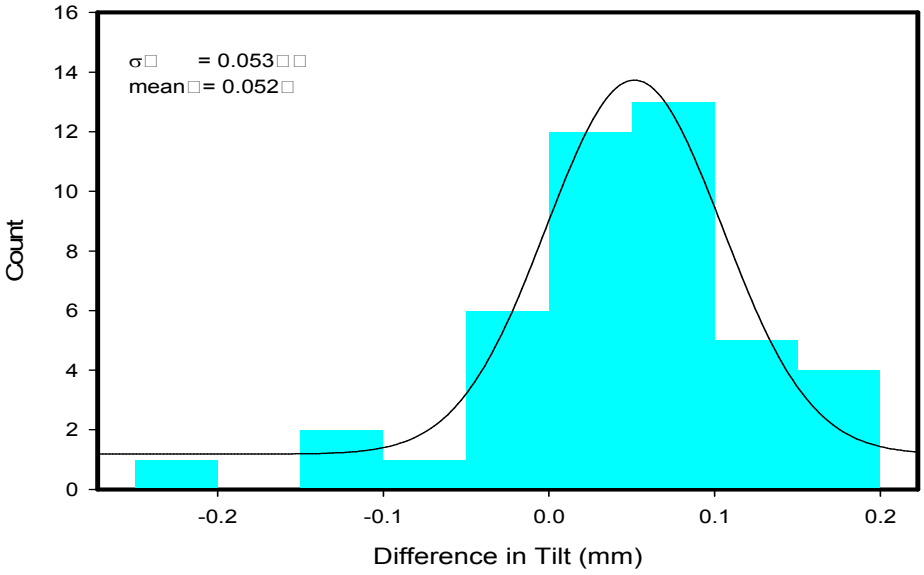

Figure 10: Histogram of the changes in the tilt

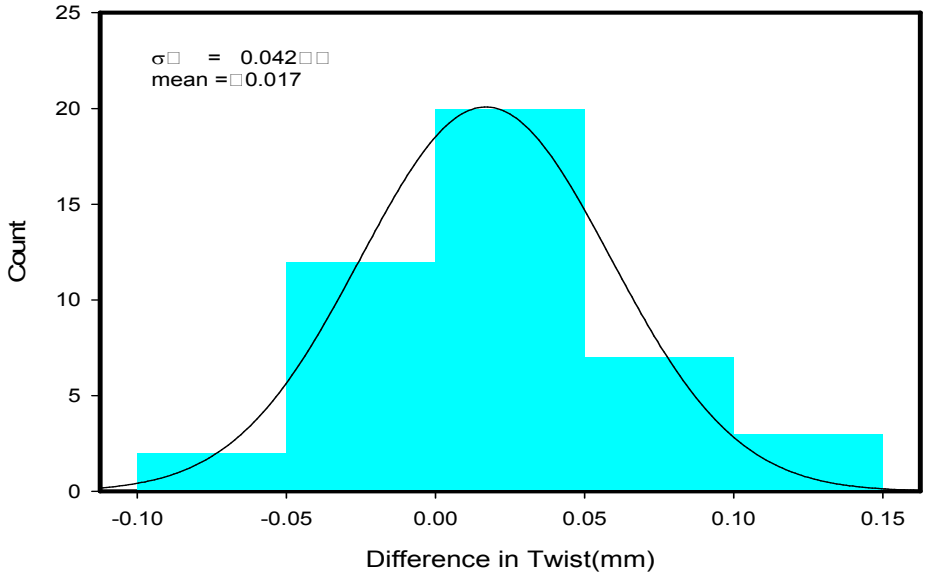

Figure 11: Histogram of the changes in the twist.

7. References

1. Lockwood, M., *et al.*, *VELO Module Production - Clean Room Procedure.* LHCb Internal Note, 2007(070).

2. Patel, G.D., *LHCb VELO module production database.* http://hep.ph.liv.ac.uk/lhcb/html/database.html, 2006.

3. Turner, P.L., *et al.*, *VELO Module Production - Bare Hybrid Metrology.* LHCb Internal Note, 2007(084).

Appendix: Twist and Tilt of Modules

Module	Type	Tilt (mm)	Tilt post cabling(mm)	Tilt post Burnin(mm)	Twist (mm)	Twist post Cabling(mm)	Twist post Burnin(mm)
4	R	0.289	0.387	0.339	0.023	0.028	0.032
5	R	-0.072	0.01	0.003	0.055	0.07	0.082
7	Phi	-0.075	-0.034	-0.113	0.163	0.102	0.184
21	Phi	-0.179	-0.235	-0.16	0.046	0.028	0.022
23	R	0.36	0.546	0.495	0.125	0.11	0.102
24	R	0.042	0.086	0.04	0.04	0.043	0.049
25	R	0.117	0.094	0.173	0.094	0.105	0.059
26	R	-0.005	0.026	-0.031	0.129	0.106	0.089
27	Phi	-0.39	-0.327	-0.525	0.148	0.284	0.126
28	Phi	-0.011	-0.053	-0.077	0.058	0.115	0.024
29	Phi	0	0.153	-0.047	0.053	0.097	0.031
30	R	-0.275	-0.196	-0.3	0.02	0.039	0.014
31	Phi	-0.268	-0.159	-0.188	0.023	0.102	0.031
32	R	0.362	0.362	0.378	0.099	0.074	0.073
33	Phi	-0.003	0.085	0.051	0.035	0.047	0.073
35	R	0.016	0.172	-0.04	0.092	0.156	0.095
36	Phi	0.001	-0.048	0.001	0.075	0.114	0.075
37	R	-0.171	-0.04	0.047	0.128	0.095	0.216
38	R	0.273	0.301	0.296	0.041	0.097	0.06
42	R	0.149	0.252	0.202	0.152	0.141	0.155
44	Phi	0.206	0.225	0.241	0.077	0.058	0.046
45	R	0.317	0.381	0.321	0.129	0.175	0.131
47	R	0.128	0.221	0.14	0.153	0.216	0.136
48	Phi	-0.192	-0.195	-0.193	0.198	0.231	0.278
49	Phi	0.1	0.165	0.097	0.135	0.206	0.127
50	Phi	0.095	0.114	0.125	0.132	0.141	0.085
51	Phi	-0.029	0.035	0.045	0.08	0.121	0.052
52	Phi	-0.089	-0.06	0.023	0.042	0.044	0.114
53	Phi	0.075	-0.027	0.075	0.041	0.043	0.044
54	R	-0.058	-0.092	-0.01	0.07	0.205	0.036
55	Phi	0.199	0.256	0.141	0.048	0.044	0.027
56	R	0.367	0.464	0.292	0.039	0.042	0.161
58	R	-0.082	-0.078	-0.106	0.067	0.057	0.068
59	R	-0.352	-0.35	-0.377	0.149	0.151	0.134
60	Phi	0.258	0.437	0.29	0.048	0.105	0.052
61	Phi	0.374	0.272	0.452	0.192	0.104	0.121
62	R	0.24	0.349	0.43	0.042	0.063	0.121
63	Phi	0.183	0.195	0.407	0.04	0.024	0.025
64	R	0.251	0.265	0.367	0.076	0.08	0.15
71	Phi	-0.309	-0.248	-0.268	0.051	0.033	0.071
72	R	-0.124	-0.158	-0.094	0.04	0.051	0.063
73	Phi	-0.265	-0.137	-0.198	0.03	0.031	0.038
74	R	0.304	0.379	0.463	0.162	0.142	0.066
75	Phi	-0.071	-0.275	-0.053	0.029	0.139	0.044

Table 1 Data for the tilt and twist of modules before and after cable attachment.

Also included for completeness are the tilt and twist post burnin.