Testing of Silicon Vertex Tracker Spare Modules

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This note describes the results of the testing of eight Silicon Vertex Tracker spare modules over a six week period.

The Silicon Vertex Tracker (SVT) has 66 modules, each with two sides (top and bottom). Of these 66 modules, ten were found to not perform properly. A module which has an operation voltage V_o<70 V or draws current I_o>238 nA is considered "bad". Half of these ten bad modules are located on the outer region, R4, of the SVT and can be replaced; the rest are on regions farther in (R1—R3) and replacement would require disassembling the detector, giving rise to the possibility of causing damage to the "good" modules. Hence, non-intrusive methods of fixing bad modules are required to avoid further module damage.

When assembling the SVT, modules which drew the least current at V_o were chosen first for the assembly. The assembly continued through 66 modules; remaining modules, which drew higher current at V_o, were set aside as spares.

To understand the source of the poor performance of the modules and thereby, hopefully, be able to develop non-intrusive methods of fixing bad modules, eight spare modules were powered at 85 V, Fig. 1(a), and monitored for six weeks.

The current of each side of the module was read over the network directly from the MPOD crate, Fig. 1(b), and stored in a SQLite database. The high voltage card in the MPOD crate has 16 channels and one channel is used for each side of each module. Odd number channels correspond to top sides of the modules, even numbers to bottom sides.

Figure 2 shows the current draw of the eight spare modules for February 22, 2016 through April 4, 2016. The currents from six modules increased by ~75 nA before stabilizing. Two sides (Ch3 and Ch6) drew higher current than the rest at the start of the run and then their current decreased by ~50 nA through the first week.

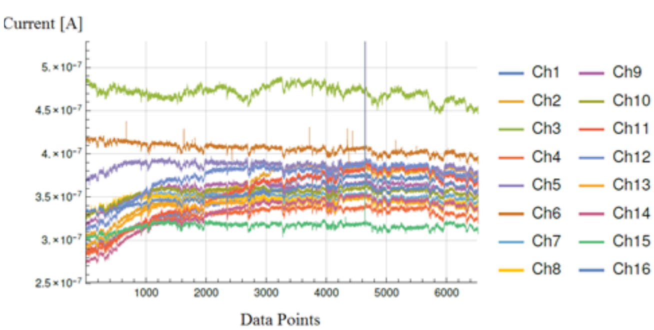

FIG. 2. The current draw of the 16 channels (two channels per module, one for top and one for bottom) from February 22, 2016 through April 4, 2016.

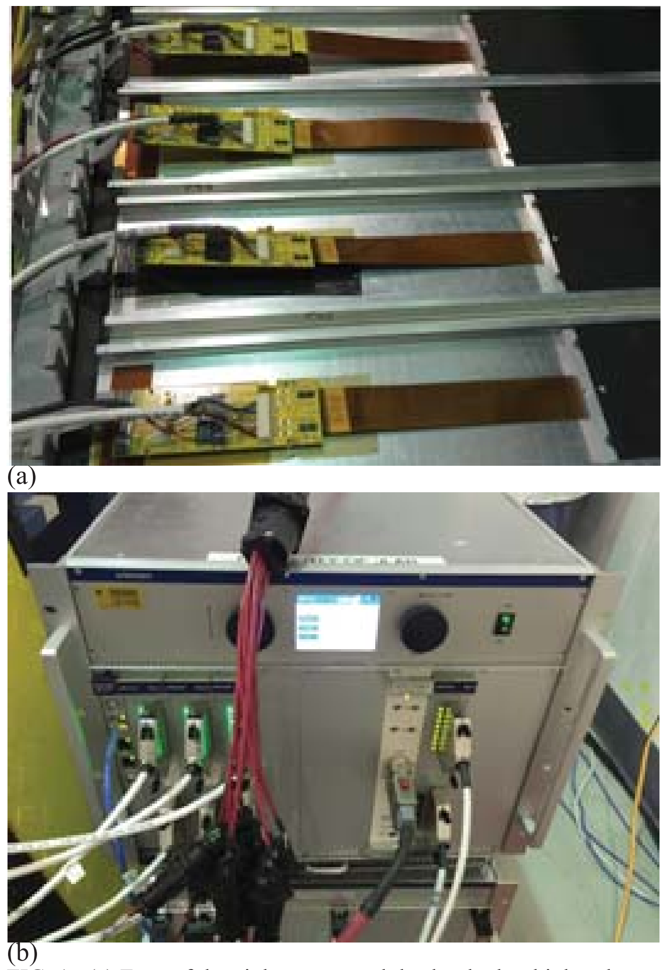

FIG. 1. (a) Four of the eight spare modules hooked to high voltage cables that are connected to (b) an MPOD crate.

A large spike occurred in the current for all modules, the cause of which is undetermined. Other collective dips and rises in current appear to be a response to the humidity of the cleanroom in which the testing was conducted.

The modules maintained a semi-steady state for several weeks, with some increasing in current and others decreasing. To study the change in current, a delta test was performed. The delta test involved taking the difference of current draw for each module from one week to the next, from the week of February 22 (measured on February 29) to the week of March 28 (measured on April 4), as shown in Fig. 3. The current difference was plotted and fitted to an exponential function:

$$\Delta I_o(t) = 42.3565e^{-0.933502t},$$

in which λ<1, showing that $\Delta I_o(t) \rightarrow 0$ A as $t \rightarrow \infty$.

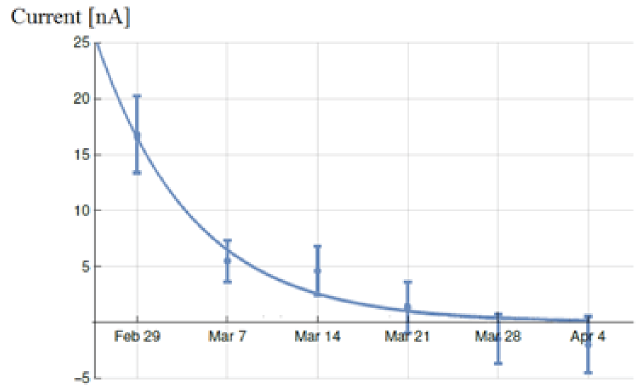

FIG. 3. The weekly change in current from the week of February 22 (measured on February 29) to the week of March 28 (measured on April 4). The change is exponential and will reach equilibrium within the next data point.

The eight spare modules will continue to be monitored for the next few months. The change in current ΔI_o was shown to tend to 0 A after six weeks. If one of the modules suddenly draws high current, as what happened to the bad modules in the assembly, more tests will ensue to determine if there is a way to fix these modules without dismantling the SVT.