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# THE FANCY TABLE, A 5-AXIS SILICON DETECTORS BEAM TEST BENCH

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**Abstract**

We describe a specially designed motorized table, the “fancy table”, to test on a beam line prototypes of devices, like MAPS, HyPixels, microstrip detectors, with sensible area varying from few mm$^2$ to dozens of cm$^2$.

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## 1 Introduction

The beam tests are the most important steps before to start the production of any kind of detectors to be used in a particle experiment. The beam time is always critical, so it is mandatory to not waste time in the setting up the test bench. When testing detectors, like MAPS, HyPixels or in general silicon detectors where the sensible area could vary from few $mm^2$ to dozen of $cm^2$, it's important the alignment and the possibility to scan in area and angle. A table, named "fancy table" by users, has been designed ad hoc as "a test bench" specific for generic silicon detectors to be tested on a beam line [1], [2].

The table is provided with 5 motorized and controlled movements: 4 linear and one rotational; the linear modules ensure a position repeatability as less than 0.1 mm and the rotational stage as less than $0.01^\circ$.

## 2 Mechanics

The driving idea was to have a table that could be placed quickly on the floor and to provide a way to mount DUTs, telescope and trigger scintillators easily and align all the items very precisely. The longitudinal dimension has been designed to allow to optimize the distance DUT-Telescope in order to reach the best resolution within the DUT, without overdo. The table, 107 cm at minimum high (fig.1), has been builded with plates of aluminum modular strut profiles[1] and is organized in two parts, the basement and the platform. The basement (45 x 150 $cm^2$) is equipped with four adjustable feet that enable to lay flat all the table and supports a plate with the platform; the plate could be lift up/down, guided by four calibrated steel shafts, Ø30 mm[2].

The platform (22.5 x 150 $cm^2$) could be moved across and outside the beam line, on top of the basement, sliding on two ball-bearing longitudinal guides. The platform consists of three elements: Two telescope supports and, in between, the DUT support. The telescope supports are integral with the platform, while the DUT is free to move vertically and transverse to the beam line as well as rotate. The support of the DUT can move up/down sliding on four calibrated steel shafts, Ø20 mm. fixed to the telescope supports, so that the centers of telescope and DUT could be aligned easily.

[1] Aluminum strut profiles from Bosch Rexroth AG
[2] Bosch Rexroth AG.

Figure 1: *The fancy table.*

### 2.1 Motors

The vertical movements are performed with two screw jacks[3], the linear one make use of roller rails[4] while the angular movement is performed with a rotating stage[5]. A part the rotating stage, that is a compact system with stage and motor, there are four brushless servomotors[6] to drive the move. In Table 1 are shown the working strokes for all the motor axis, with the maximum speed allowed. A reduction gear is applied to the Axis 1 to cope with the heavy load of the base plus platform. The values reported in the Table 1 have been selected to work with the "fancy table" fully equipped with DUTs, telescope and scintillators and all the stuff needed.

[3] NC componenti
[4] Bosch Rexroth AG
[5] Newport Corporation, series URS150 BPP
[6] Mini Motor s.r.l., Servomotors series BS

### 2.2 Slow Control

A table crate controller has been build housing all the single axis digital driving gears for DC servo motors. The communication with the controller/driver is achieved via integrated RS-232/485 interface or via individual keyboards. The controllers DRIVERT 300 [7] of the linear stages are connected via one serial line RS-485 and networked through a internal RS-485 communication link, while the communication with the SMC100cc[8], the rotating stage controller, is via a proper line RS232. A dedicated LabView application has been developed to communicate with the crate controller to handle the movements and protections, fig. 2. Each stage (or axis) “The ZERO position ”, located with a magnetic relay and two mechanical limit switches at booth ends. The precision to repeat the ZERO and any position is of $\pm$ 0.1 mm, for the linear one, and $\pm$ 0.01$^\circ$ for the rotational.

The LabView application, running on a PC, communicate with a USB-serial interface with the controller, it enables individually each driver, it allows to set velocity and position where to move and displays the STATUS and ACTUAL POSITION for each stage and store the positions in form of a ASCII string. The PC operate also as a server TCPIP so the DAQ main computer could connect to and receive on line the actual positions of all the stages; this is important when a scan in area and angle is part of the beam test for a particular detector.

### 2.3 Transport and alignment

The table, as it is, can be split in two parts, the basement and base plus platform so that , if needed, the upper part could be used independently. To make easier the transportation and placement of the table, four special tools with eye hook have been build that lock tightly the two parts and allow lifting and displacement with crane without damage.

The alignment is mandatory in case of beam tests regarding small area silicon detectors where the resolution is of order of only few microns, so special care should be adopted to be sure that all the equipment is in line and aligned to the beam. DUTs, telescope and trigger scintillators would be aligned, to less than 0.1 mm, taking in account the strut profiles used to support them and the full equipment aligned to the beam line pointing two sights located on top of the table with a laser beam to the beam marks, with misalignment of $\pm$1.0 mrad.

[7] Digital driving gear, Mini Motor s.r.l.
[8] SMC100 Series, Newport Corporation

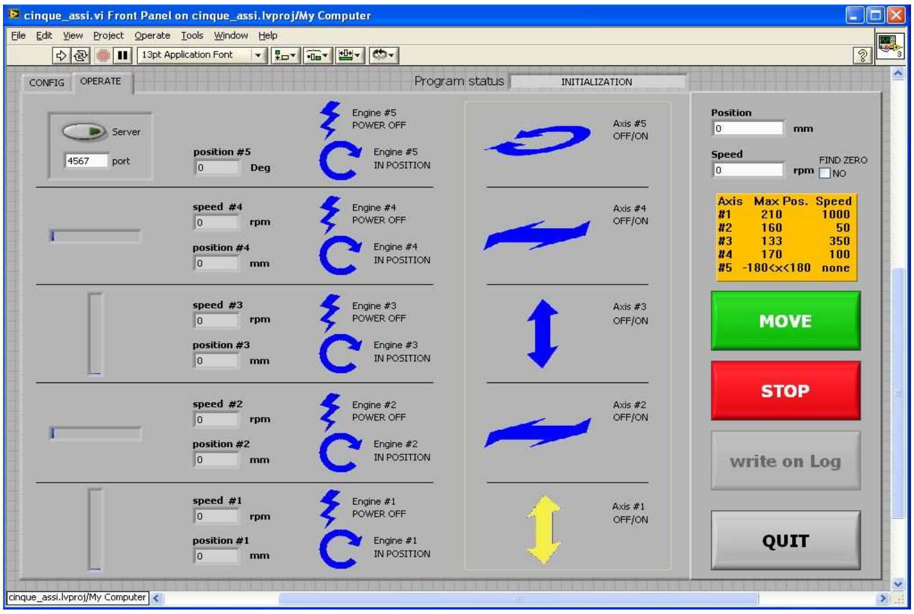


Figure 2: *Table control screen.*

Table 1: *Axis parameters.*

| | Working stroke (m) | Maximum Torque ($N \cdot m$) | Working speed (m/s) |
|---|---|---|---|
| Axis 1 | 0.235 | 0.92 | 0.0014 |
| Axis 2 | 0.160 | 1.02 | 0.0042 |
| Axis 3 | 0.158 | 1.02 | 0.0015 |
| Axis 4 | 0.170 | 1.02 | 0.0083 |
| | Angular stroke (°) | Maximum Torque ($N \cdot m$) | Working ang. speed (°/s) |
| Axis 5 | $-180° < \theta < +180°$ | 2 | 5° |

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