

EXPERIMENTAL TABLE

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1.0 Introduction

TSW Engineers Ltd is a precision Mechanical Engineering Company specialising in the manufacture of precision beamline equipment including fully adjustable table, platforms and support structures for particle physics experimental equipment.

Before any experiment can begin experimental equipment and detectors must be precisely aligned with respect to the incoming x-ray beam. Experiments may take several days so it is important that any equipment or detectors are mounted on a stable platform. As a result of this TSW Engineers Ltd has manufactured motorised experimental tables with several degrees of freedom which are stable and combine high accuracy with high load capability.

The following is based on a technical offer that was made to the Molecular Biophysics Dept at the Max Lund University in Sweden.

2.0 General Description

The general design principles are the production of an accurate, reproducible, high load bearing and stable experimental table. The proposed system is based on the standard design that has been developed over a number of years and manufactured for Daresbury Laboratory, with some modifications to match the requirements of the Lund University specification.

The specification is for the supply of an experimental table system. The system is broken down into 3 main components: -

1. jacking and tilt system
2. translation and yaw system
3. mounting platform

The translation and yaw system are mounted on an aluminium plate, which in turn will be mounted on to the existing 2 θ at the Max II synchrotron BL711. The jacking and tilt system is then mounted to the translation system again via an aluminium plate. The top plate is fixed to the jacks with a link pivot assembly. A breadboard is then fitted to the top plate, which provides the mounting platform for the detectors and station equipment.

These three components are described further below.

General Assembly Drawing:

See Fig1

Fig1 shows a typical general arrangement detailing the overall size and the limits of the movements in X, Y and Z axes. The estimated weight is less than 500kg..

3.0 Jacking and tilt system

For stability and high loading capabilities the jacking and tilt system comprises 4 precision ball screw jacks each capable of lifting 500 Kg. The jacks are supplied with a backlash eliminator, which can be progressively adjusted to take up any wear between the internal thread of the worm and the screw. The lifting ball screw is single start and the gearing ratio between worm and worm wheel is 20:1. One rotation of the worm will provide 0.25 mm of lift. The ball screw jacks are supplied by Precision Actuation who

specify a pitch accuracy for the ball screw of 0.05mm / 300mm length. This would suggest an accuracy of 13µm over 80mm. This Bid is based on this figure but can only be verified after testing.

The jacks are so arranged that they operate in pairs. The pairs are positioned at the front and back of the system to coincide with the plane of the pivot position of the translation system. Each pair is equi-spaced about the centre of the table to provide optimum distributed loading conditions. A single stepper motor drives each pair. Parallel is achieved by driving both pairs simultaneously, tilting is achieved by driving one pair.

4.0 Translation and yaw system

The cross roller slide is supplied by Capital Bearings who specify a pitch accuracy of within .0001" per inch (0.0025mm / 25mm). The cross roller bearing can be pre loaded to minimise backlash by adjusting the side screws provided. The slides are maintenance free with no need to lubricate the cross roller assemblies.

The cross roller slides are arranged such that the first is positioned at the front of the table on the central axis above which is a slewing ring. This subassembly will act as the pivot in the horizontal plane for the whole table system. The second cross roller slide is positioned at the rear of the table above, which is a slewing ring and a linear slide. Opposite this slide is a slewing ring and linear slides mounted above and below. The combination of these subassemblies allows translation and yaw. For stability a further two slewing ring and linear slides assemblies are included either side of the first cross roller slide.

5.0 Mounting Platform

The mounting platform is essentially a breadboard that provides a matrix of M6 x 1mm tapped holes on a 25mm grid pattern onto which detectors and experimental equipment can be mounted. The breadboard is a honeycomb structure that provides a combination of high rigidity, low weight and excellent damping properties. Manufacturers specify a flatness tolerance of ± 0.1 mm over 600mm and a 2 μ m deflection for a 600 x 900 x 60mm breadboard with a 22.7 kg centred load. *Fig 2* shows the construction of the breadboard.

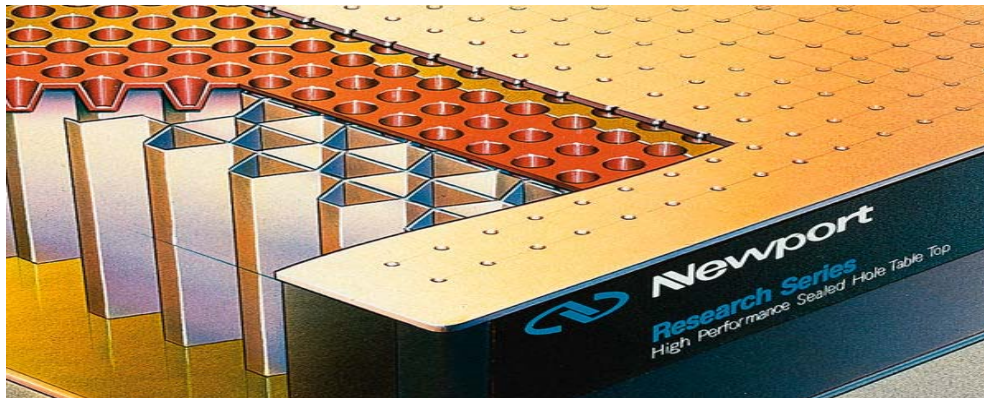


Fig 2

6.0 Motorisation

Two 34 HS-209E McLennan stepper motors are proposed to drive the two pairs of jacks providing lift and tilt. Two 23 HS-104E McLennan stepper motors are proposed to drive the cross roller slides providing translation and yaw. This is exactly the same as the current system on BL711 therefore the two PM162C and two PM164C stepper motor translators and four PM301 stepper controllers from McLennan Servo Supplies Ltd will be adequate and as existing are consequently excluded from the supply.

To eliminate any wind up in the drive chains a Huco coupling are specified. These provide the solid coupling effect but allow for small mis-alignments via slip rings.

The system is currently designed to operate in open loop mode. All motors have extended shafts on to which encoders can be fitted, thus allowing the system to be operated in closed loop if required.

Table 1 shows a table of the theoretical resolution of this design based on supplier's specification for individual items.

Axis	Range	Resolution Required	Motor	Full Steps /rev	Half Steps /rev	Screw Pitch (mm)	Gearing Ratio	Move/step (mm)	Move/half step (mm)	Perceived accuracy
Vertical	80mm	.005 mm	34HS-209E	200	400	0.25 1 rev = 0.25 mm lift	20	0.001	0.0006	13µm over 80mm
Translation (y axis)	80mm	.005 mm	23HS-104E	200	400	1	1	0.005	0.0025	2.5µm over 25mm

Note :- accuracy figures are based on individual suppliers specifications and data sheets
table 1

7.0 Limit Switches

Limit switches are provided for all movements to ensure the table cannot be driven past end positions. All the limit switches are mounted in such a way as they can be adjusted according to user preference. The limit switches will be arranged in pairs, each pair consisting of one Burgess switch and one Baumer switch. The Baumer switch is repeatable to $\pm 1\mu\text{m}$. It is this switch that should be used as the datum or reference position.

8.0 Load Capacity

The ball screw jacks are each rated at 500 kg giving a theoretical carrying capacity of 2 tonne. The cross roller slides are each rated at 155 kg, in addition there are three slewing ring / THK linear slides assemblies each with a maximum load of 2500 kg.

Fig 3, 4 and 5 show experimental tables supplied to Daresbury Laboratory, Warrington, England that were manufactured and assembled by TSW Engineers Ltd.

Fig 3



Fig 4

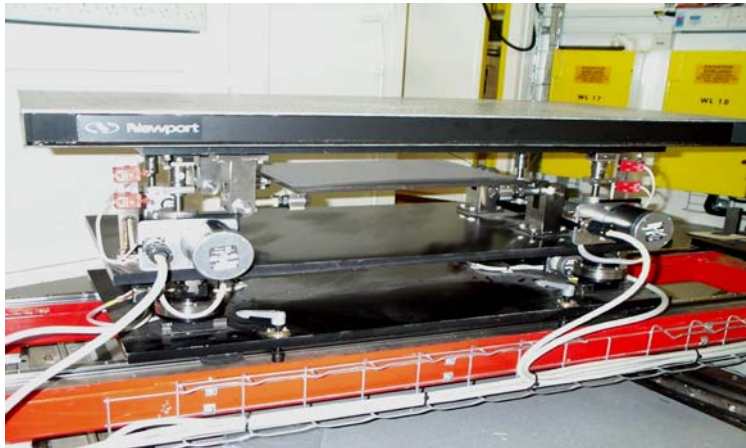


Fig 5

