Development of Six Sample Positioning Stages for X-ray diffraction, X-ray Scattering, X-ray Imaging and Tomography Experiments

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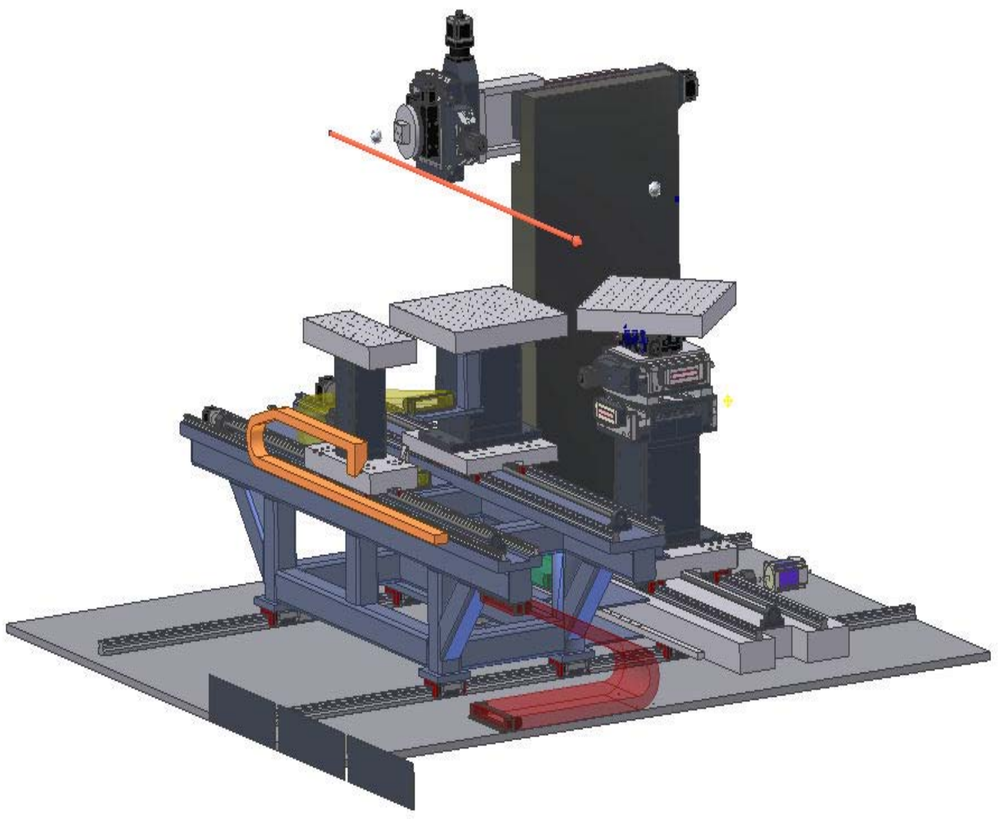
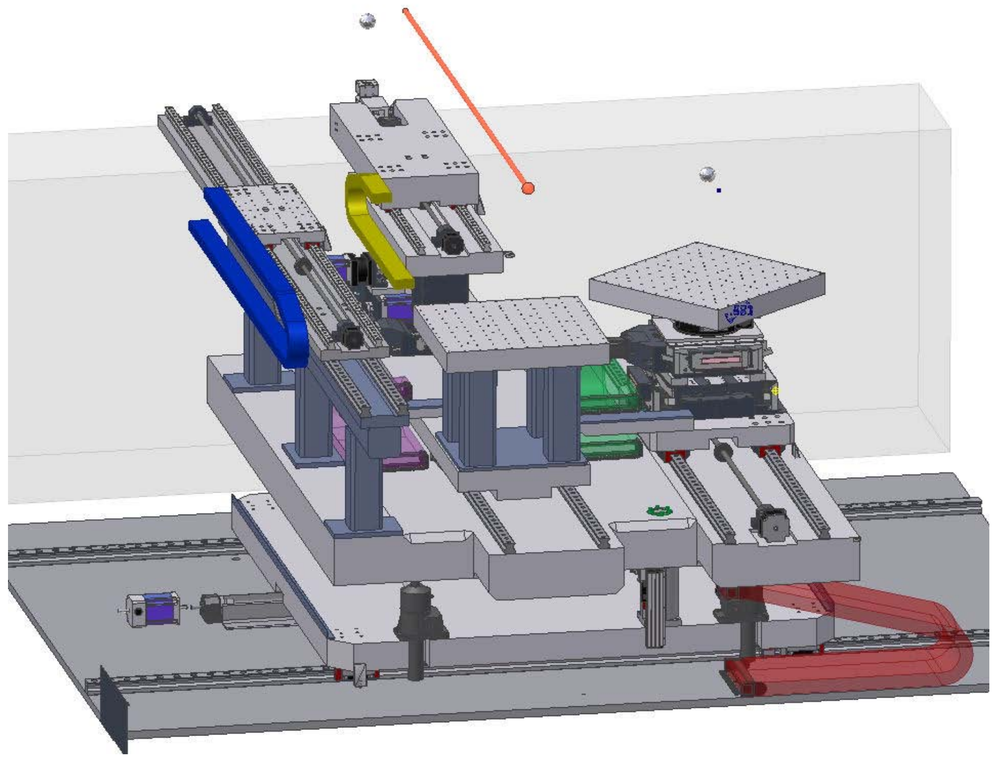
The design of six high precision systems for detector and optical element positioning stage to be used in a X-ray diffraction, X-ray Scattering, X-ray Imaging and Tomography Experiments for Diamond Light Source will be presented. The stages are designed to position with micron accuracy a variety of detector and optical elements. Stage motions includes orthogonal motions in X,Y, & Z, tilt motions and rotation motions. In operation, the stages will be used to position and translate detector and optical elements for X-ray diffraction, X-ray scattering, X-ray imaging and tomography experiments



The Large Detector Table 2, as shown in Figure 2, was designed to support three different detectors on individual units. The purpose is to change and align these detectors during one experiment without manual interaction. By this, different information can be obtained from one sample in a remotely controlled way.

Module 1 support an x-ray camera for imaging and tomography. Module 2 hold a large 2-dimentional detector or an energy-dispersive detector. Module 3 is a multipurpose unit for different kinds of detectors and will also allow performing off-axis measurements, where the detector is not directly behind the incoming x-ray beam.

These three modules are linked with a common transverse translation for the switching of the detectors. The range of this transverse translation X is large enough to switch between the three Modules plus a margin on both sides of the travel. At the positive limit, the centre of Module 1 is 100 mm on one side the x-ray beam. At the negative limit of X, the centre of Module 3 is 200 mm on the other side the x-ray beam. The specifications of motions and interface plates are given in the following Tables 4-5.



These six high precision systems will be installed 3 in Experimental Hutch 1 (EH1) and 3 in EH2 of the I12 Joint Engineering, Environmental and Processing (JEEP) beamline at DLS. The beamline is designed for experiments on engineering materials and components, including the use of sample environments to simulate in-service conditions or materials processing. Mounted elements could include x-ray cameras, detectors, beam stops, slits, and detectors, as well as other specialist rigs designed by beamline users. The high precision systems will be mounted on a floor carriage so it can be translated perpendicular to the X-ray beam. Over the last fourteen years ADC has developed many high precision motion systems in collaboration with major synchrotron and neutron facilities around the world

TABLE 1: Large Detector Table 1 - Overall X-Translation

X, transverse translation	Range	Enough to switch between centres of Module 1,2 and 3 plus a margin of 50 mm. Approximate 1300 mm.
	Resolution	1 µm
	Repeatability	2 µm
	Maximum Speed	> 2 mm/s
	Home switch, encoder	

TABLE 2: Large Detector Table 1

	Module 1		Module 2	
Y, vertical translation	Range	50 mm. At 0-position, the overall table height is 1105 mm	Range	50 mm. At 0-position, the overall table height is 1105 mm
	Resolution	1 µm	Resolution	10 µm
	Repeatability	2 µm	Repeatability	50 µm
	Maximum Speed	> 2 mm/s	Maximum Speed	> 2 mm/s
	Home switch, encoder		Home switch, encoder	
Z, longitudinal translation	Range	1000 mm	Range	1000 mm
	Resolution	20 µm	Resolution	20 µm
	Repeatability	200 µm	Repeatability	200 µm
	Maximum Speed	> 20 mm/s	Maximum Speed	> 20 mm/s
	Horizontal and vertical straightness	>100 µm	Horizontal and vertical straightness	>100 µm
	Home switch, no encoder		Home switch, no encoder	
Pitch, roll and yaw	< 200 µrad for all axes		< 200 µrad for all axes	
Load	50 kg		100 kg	
Top interface plate dimension x	220 mm		520 mm	
Top interface plate dimension z	520 mm		520 mm	
Upstream z-limit	≤ 300 mm		≤ 300 mm	
Downstream z-limit	0 mm		0 mm	

TABLE 3: Large Detector Table 1 - Module 4

X, Transverse translation	Range	150 mm,
	Resolution	1 µm
	Repeatability	5 µm
	Maximum Speed	> 1 mm/s
	Home switch, encoder	
Y, vertical translation	Range	40 mm. At 0-position, the interface plate height above floor is 1675 mm
	Resolution	1 µm
	Repeatability	5 µm
	Maximum Speed	> 1 mm/s
	Home switch, encoder	
Z, longitudinal translation	Range	150mm
	Resolution	20 µm
	Repeatability	200 µm
	Maximum Speed	> 20 mm/s
	Horizontal and vertical straightness	100 µm
	Home switch, encoder	
Ry	Range	180
	Resolution	0.005
	Home switch, no encoder	
Rx	Range	5
	Rotation centre	250 mm below interface plate
	Resolution	0.005
	Home switch, no encoder	
Pitch, roll and yaw	< 200 µrad for all axes	
Load	5 kg	
Top interface plate dimension x	60 mm	
Top interface plate dimension z	60 mm	
Upstream z-limit	≤ 300 mm	
Downstream z-limit	0 mm	

TABLE 4. Large Detector Table 2 – Overall X-translation

X, transverse translation	Range	Enough to switch between centres of Module 1, 2 and 3 plus a margin of 50 mm. Approximate 1300 mm
	Resolution	1 µm
	Repeatability	2 µm
	Maximum Speed	> 2 mm/s
	Home switch, encoder	
Y, vertical translation (alternatively individual for each module)	Range	50 mm
	Resolution	1 µm
	Repeatability	2 µm
	Maximum Speed	> 2 mm/s
	Home switch, encoder	

TABLE 5. Large Detector Table 2 - Module 1

Z, longitudinal translation	Range	1030 mm
	Resolution	20 µm
	Repeatability	200 µm
	Maximum Speed	20 mm/s
	Horizontal and vertical straightness	100 µm
	Home switch, no encoder	
Z, manual extension	Range	0 mm – 800 mm
	Encoder with 100 µm resolution	
Pitch, roll and yaw	< 200 µrad for all axes	
Load	20 kg	
Top interface plate dimension x	220 mm	
Top interface plate dimension z	520 mm	
Upstream z-limit	0 mm	
Downstream z-limit	0 mm	

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