MicroMAX Detector Stage

WEPPP030

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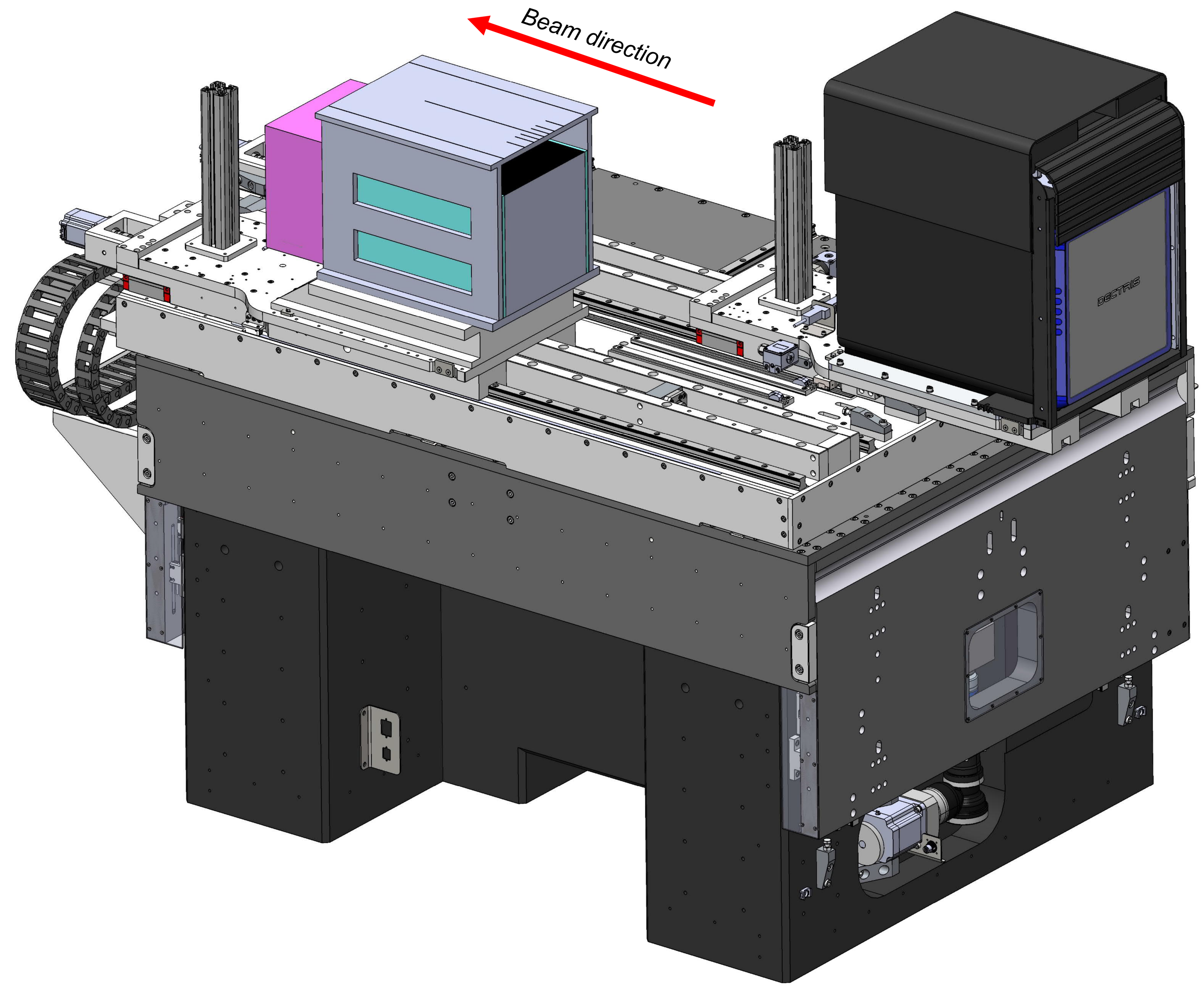
The MicroMAX beamline at MAX IV Laboratory will employ two detectors to be used independently and move along the beam depending on the diffraction target resolution, starting close to the sample hanging partially over the sample table. The X-ray beam can be deflected by Kirkpatrick-Baez (KB) mirrors in the horizontal and vertical directions or pass undeflected.

The Max IV Design office designed a detector stage as an in-house project based on the ALBA table skin concept design [1] to switch between the two detectors and accurately position the selected detector, either with or without the KB mirrors.

To achieve stability and precision during translations, a large granite block is used, as well as preloaded linear and radial guides, and preloaded ball screws with stepper motors and, in most cases, a gear box. Flexures are used to allow linear motion's pitch and yaw angles.

The various motions are layered so that alignment to the beam axis can be do ne first, and then sample-to-detector distance can be adjusted independently.

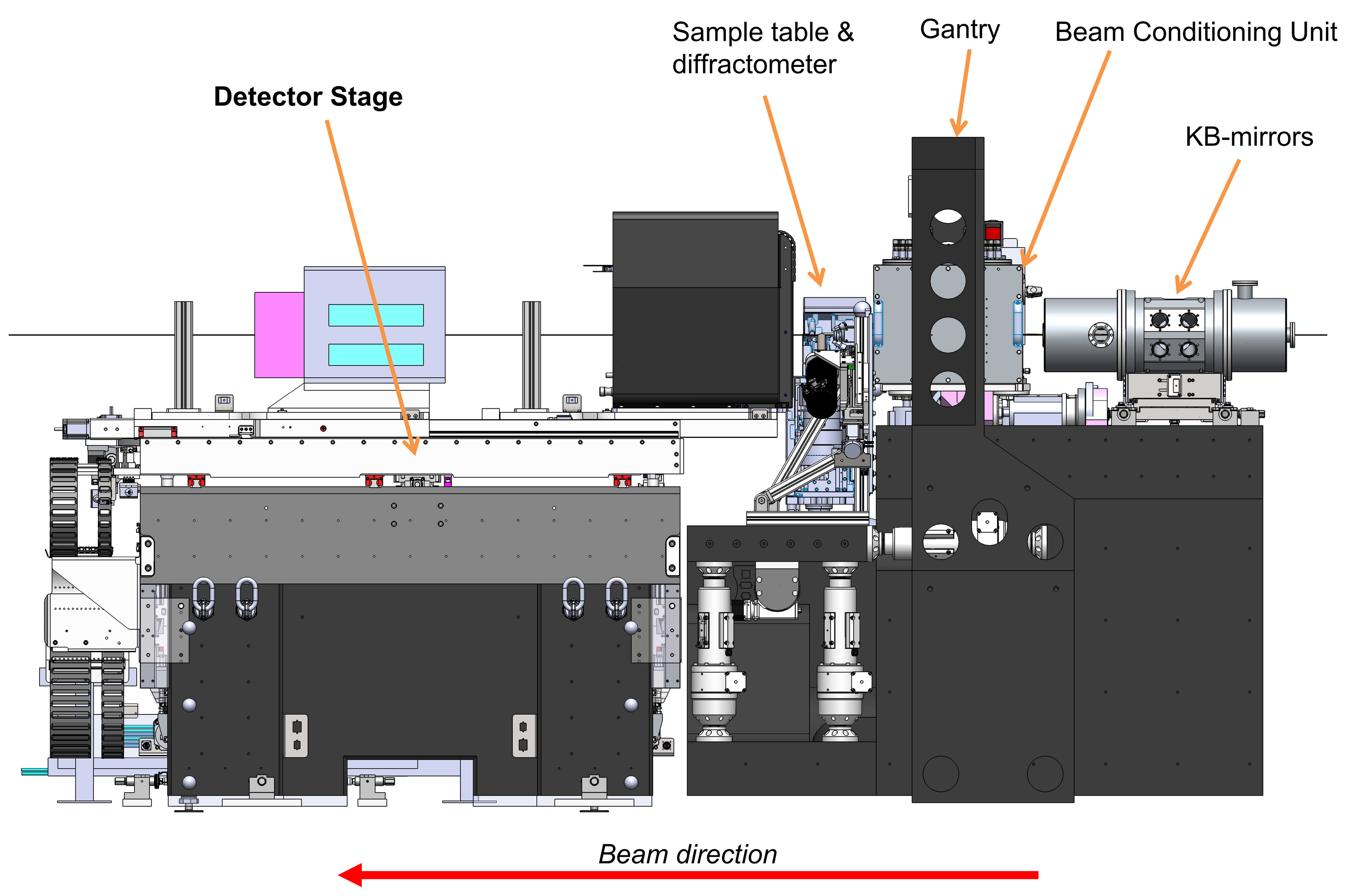
A Finite Element Analysis (FEA) were performed to achieve a stable design and measurements of resonance frequencies on the finalized stage were done to verify it.

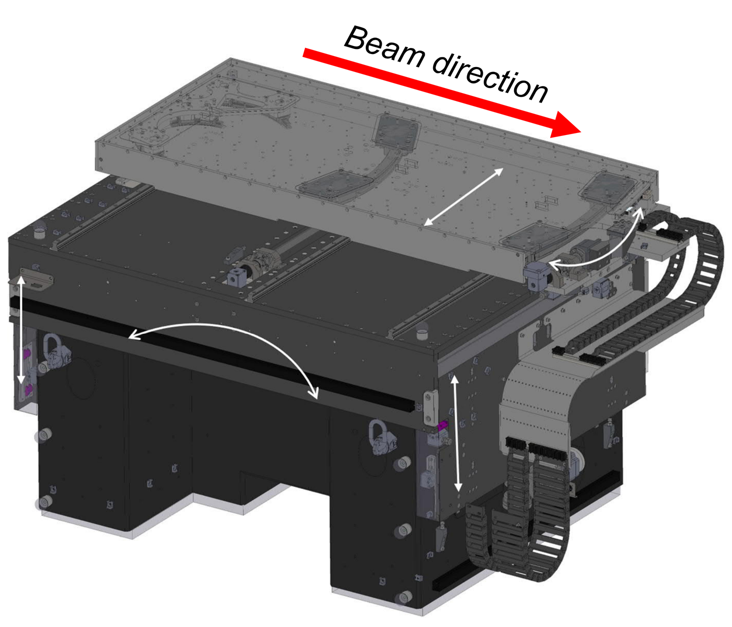


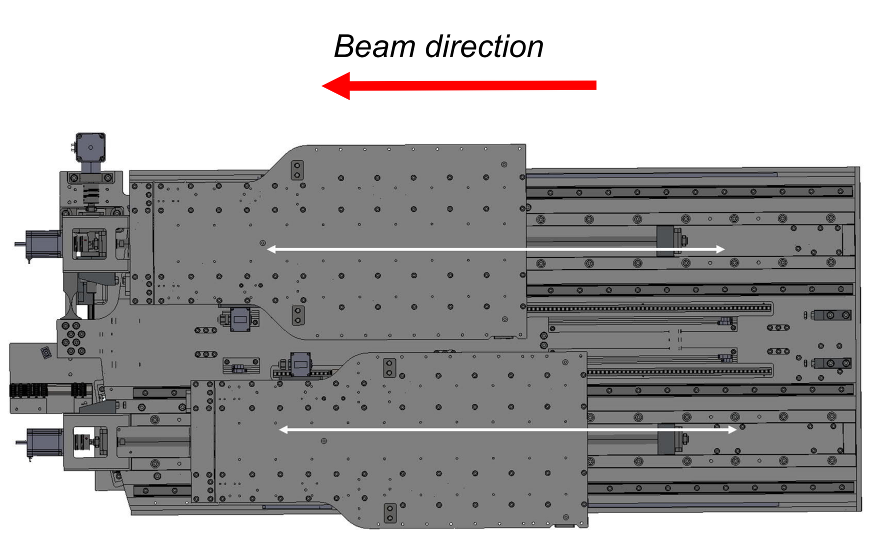
- Switch between two detectors and a position allowing a passthrough vacuum pipe to a second experimental hutch
- Align with the beam, which can be straight or deflected by two Kirkpatrick-Baez (KB) mirrors
- Variable positioning along the beam path, depending on the target resolution of the diffraction data collection.

Specifications

	Vertical	Horizontal	Longitudinal	Pitch	Yaw
Range	10 mm	382.5 mm	940 mm	±0.5°	±0.5°
Resolution	10 µm	10 µm	100 µm	10 µrad	10 µrad
Repeatability	50 µm	50 µm	100 µm	50 µrad	50 µrad
Resonance frequency f0	>55 Hz				
RMS displacement	<7.5 µm (<10 % of pixel size)				







Motion tests[1]

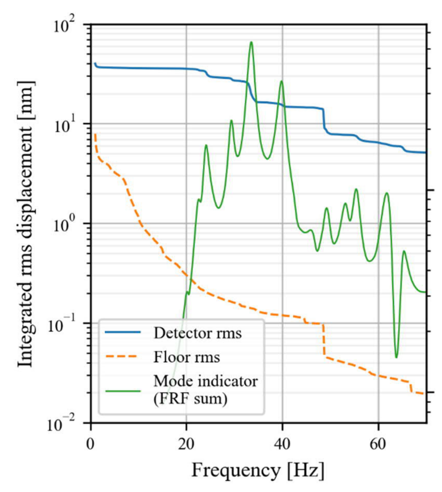
	Vertical	Horizontal	Longitudinal	Pitch	Yaw
Resolution	0.1 µm	1 µm	1 µm	<1 µrad	<1 µrad
Repeatability (closed loop)	<1 µm	<3 µm	<3 µm	<3 µrad	<1 µrad
Repeatability (open loop)	<5 µm	<7 µm	<7 µm	<5 µrad	<4 µrad

Modal analysis simulation results

Case	Mode 1	Mode 2
Small detector by sample	60.1 Hz	65 Hz
Detectors centred	63.2 Hz	64.6 Hz

Measured RMS Displacements[2]

Direction	Floor	Detector
Horizontal	3.9 nm	36.8 nm
Vertical	2.2 nm	60.4 nm

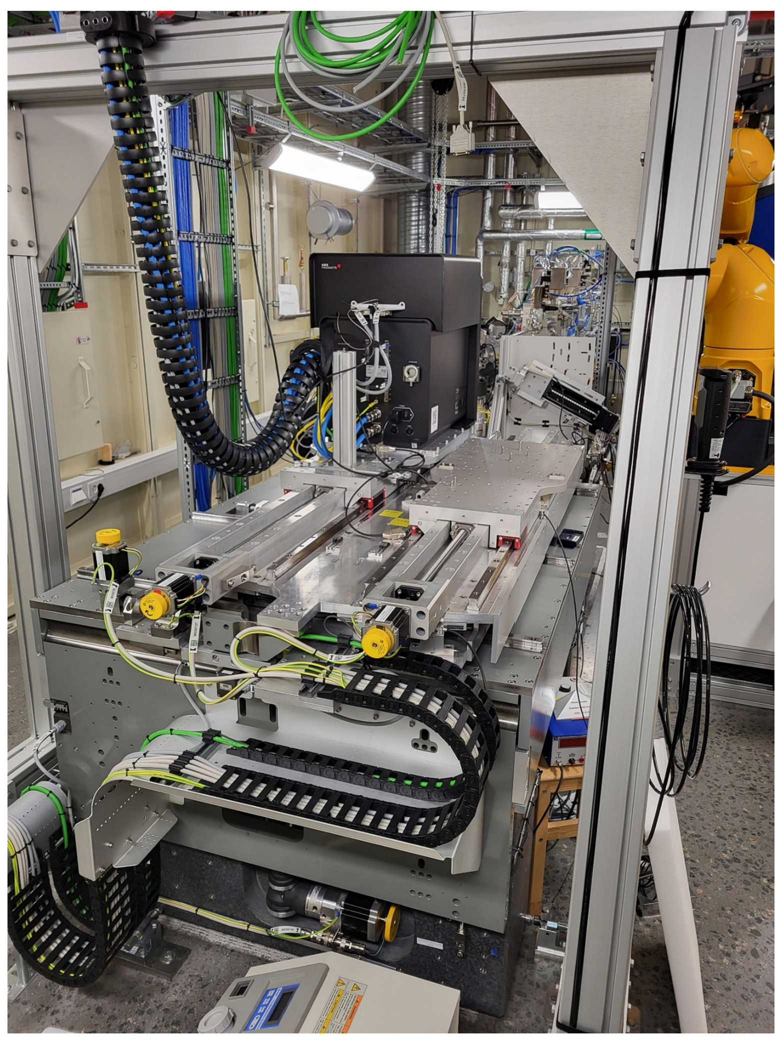


Integrated RMS ofhorizontal displacement (left y-axis) and mode indicator (right y-axis)

The mode indicator function, sum of squared Frequency Response Functions (FRF), indicates vibration modes between 24 and 40 Hz. According to previous experience, these are likely to be related to rigid body rocking ofthe entire unit on the alignmentfeet and will be mitigated once the unitis grouted to the floor. Comparison with the integrated RMS function between detector and floor indicates significant contribution to the total RMS at 48.6 Hz originating from the floor that will prevail even after grouting.

[1] Based on comparison between intended translation and encoder measurements

[2] Measured as currently installed on adjustmentfeet, not grouted



Contacts

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[1] Colldelram C., Rudget C., Nikitina L. October 2011. ALBA XALOC beamline diffractometer table skin concept design. Diamond Light Source Proceedings.

MEDSI 2023 Beijing Mechanical Engineering Design of Synchrotron Radiation Equipment and Instrumentation

Funded by **Novo Nordisk Fonden** for the MicroMAX project

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