A Fast Switching Mirror Unit at FLASH.

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**Introduction**

At the “Free Electron Laser Hamburg” (FLASH) the created laser light is diverted towards different test sites by massive silicon mirrors, of which one can be operated in permanent switching mode. In order to match the native FLASH frequency of 10 Hz, the aim is to achieve a switching frequency of 5 Hz. With the initial concept, where the mirror was moved together with the vacuum vessel by a linear drive, a maximum switching frequency of 2.5 Hz was attained with the required precision. Therefore new concepts for the switching process are being developed, putting the focus on reducing the translational inertia in order to increase the switching frequency.

**Initial motion Concept: Motion of mirror and vessel with a linear drive**

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<th>3-dimensional CAD model</th>
<th>Comparison: Steel vs. Titanium Vessel</th>
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<tr>
<td></td>
<td>Vessel material</td>
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<td></td>
<td>mass (kg)</td>
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<td>Maximum switching frequency $f_{\text{max}}$</td>
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<td>Bellow replacement interval at $f_{\text{max}}$</td>
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**Measurements: Steel Vessel**

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<tr>
<th>Horizontal angular distortion</th>
<th>Positional misalignment</th>
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**Measurements: Titanium Vessel**

<table>
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<tr>
<th>Horizontal angular distortion</th>
<th>Conclusions</th>
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<td>Strong vibrations during the switching process with $f = 5$ Hz</td>
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<td>Frequent bellow replacement necessary (23 days at $f = 5$ Hz)</td>
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<td>Motion of the mirror inside the vacuum preferential</td>
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**UHV-motion with piezo motors**

**Piezo motor Nanomotion HR8**

- Number of finger tips: 8
- Maximum driving force: 32 N
- Maximum speed: 250 mm/s
- Heat generation: 2 Watts
- Baking temperature: 140°C

**Test setup**

- Mass of the assembly: ca. 10 kg
- Number of motors: 4
- Driving force / motor: 25 N
- Speed limit: 50 mm/s

Too slow to use it as drive unit for the switching mirror!

**Temperature measurements**

- $P = 1000$ mbar
- $P = 10^4$ mbar

**Temperature measurements**

- $P = 10^4$ mbar (mounted covering plate)

**Conclusions**

- 25%-30% increased temperatures in vacuum (max. 85°C)
- Extra 25% increased temperatures with mounted covering plate (105°C)
- Stable plateau not reached after 15 minutes

**Proposed temperature test setup**

- Development of a new piezo motor housing
- Provisions for water cooling
- Possibility to test both old and new motor housing