

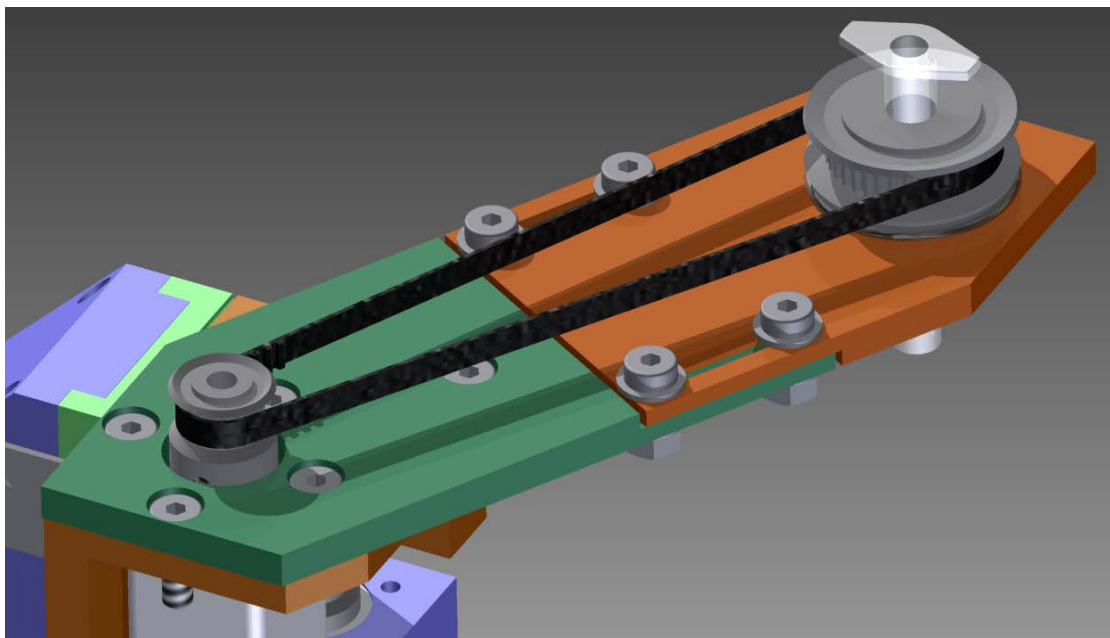
Improvements of the OpenSPIM setup

Precise sample positioning for rotational movement

While testing the motorized stage from Picard Industries, it was observed that there is a problem concerning the transmission of the rotational movement from the rotational motor axis to the sample holder axis. In the current design of the 4D-stage, the rotational movement is transmitted to the sample holder through a round belt and pulleys. The problem is that due to slipping of the belt on the pulleys, a lag in the angular position of the sample holder axis relative to the angular position of the axis of the motor occurs.

To overcome this issue a timing belt (toothed belt) and timing pulleys were selected to replace the circular belt and circular pulleys. Because of the construction of the timing belt, it was necessary to redesign the sample arm so that the belt can be tensed properly. The new design of the arm takes as a base the dimensions of the original arm so that it can fit into the stage, at the same time the distance at which the stage is fixed relative to the sample chamber remains the same. The new sample arm consists of two shiftable parts so that the belt can be tensed.

Furthermore, the timing pulleys were selected so that there is a reduction (2:1) in the angular position between the pulleys. It means that every time the motor pulley completes a rotation of 360° , the sample holder pulley only rotates half the way (180°). This reduction factor also improves the resolution of the angular position from 1.8° to 0.9° .



Temperature controlled sample chamber for long-term experiments

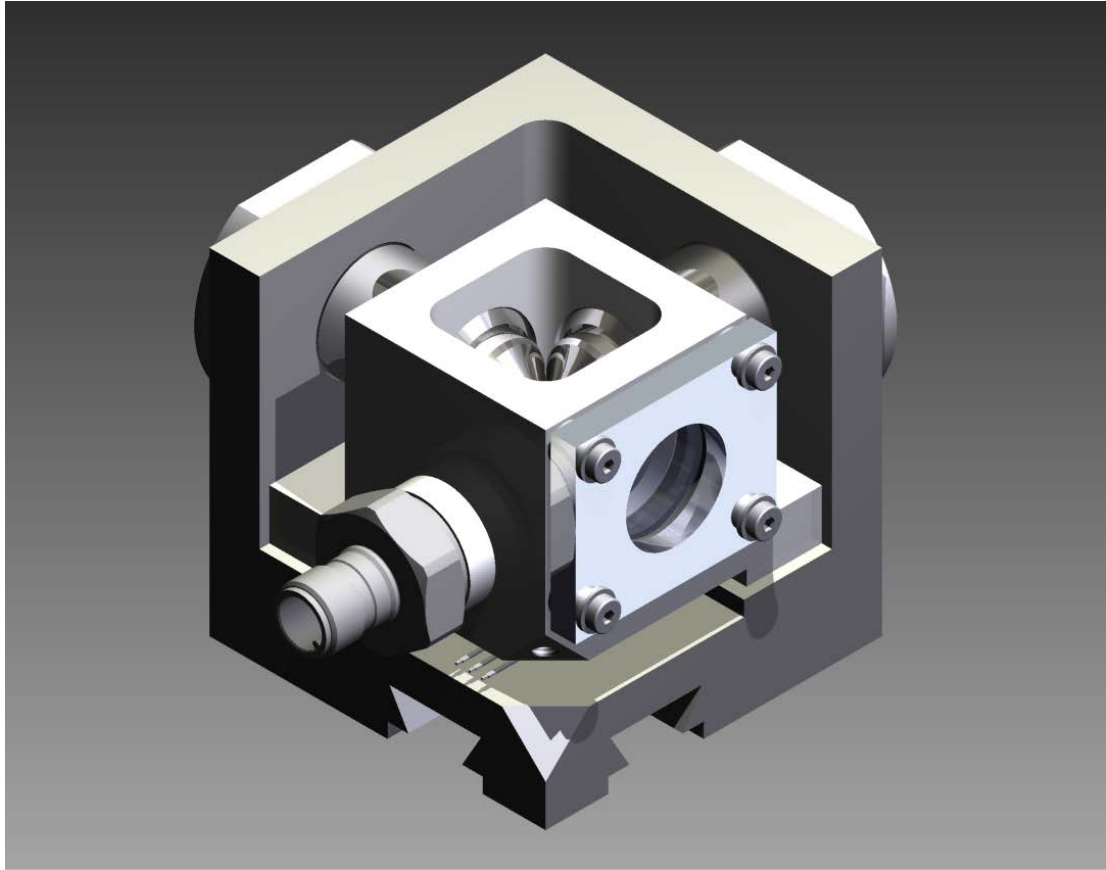
Although the OpenSPIM project provides a good design for anyone who wants to experiment with light sheet microscopy, there is still room for improvements. Especially for long term experiments, it is important to have the possibility to control the temperature, which plays an important role in the development of an embryo. For long term experiments, in order to maintain the embryo under the best conditions during the imaging process, the temperature in the imaging experiment should be matched to the physiological temperature in which the embryo normally develops.

The sample chamber from the OpenSPIM design does not allow controlling the temperature of the liquid medium in which the sample is immersed during imaging. However this feature would be of great benefit since it permits to conduct experiments under vital conditions for the sample over longer periods of time. Furthermore it also permits to apply temperature changes to the liquid medium in order to study the effects that these changes yield to the specimen.

The material used in the original design of the OpenSPIM sample chamber is acrylic. However, acrylic is not the best material to transmit heat. Therefore a material with a good thermal conductivity had to be chosen. A material easy to machine and with a good thermal conductivity is Aluminum but this material can oxidize easily with the immersion liquid employed, e.g. phosphate buffered saline (PBS). Because of that, a material with a good thermal conductivity and suitable for the liquid medium was finally selected (stainless steel).

For measuring the temperature of the liquid medium, an immersion temperature sensor had to be selected. A temperature sensor directly immersed into the liquid medium near to the specimen is found to be the best option to measure the temperature to which the sample is exposed. The chosen temperature sensor has to be compact enough in order to fit inside the sample chamber with its small dimensions.

The temperature controller allows the monitoring of the temperature of the immersion liquid medium and opens the possibility to control the temperature of the medium using TO-220 power resistors as heating elements. The power resistors are attached at the bottom of the sample chamber. Thermal pads or thermal grease should be applied between the mounting surface of the resistors and the bottom surface of the sample chamber in order to fill air gaps and increase the heat conductivity.



The list of components, the technical drawings, CAD files (STEP) and an assembly video of the chamber can be found as attachments.