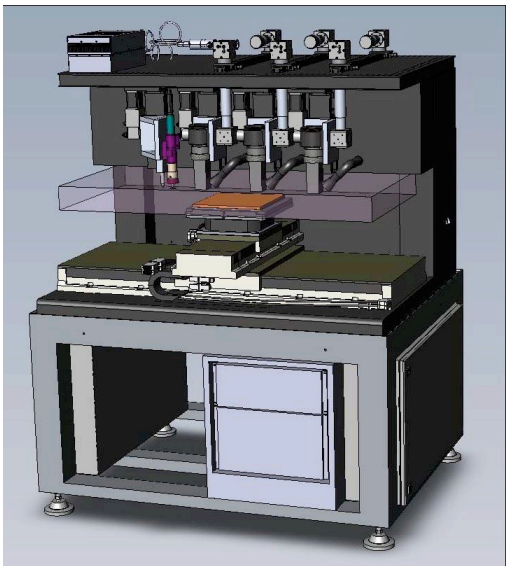
System Architecture – In-line vs Turret Optics

Modern multipurpose, possibly multiwavelength, short pulse laser systems frequently require **multiple optics heads**, either **scanners** or **fixed/cutting optics**, plus **diagnostic equipment**, where all of these optics must access all regions of a part measuring for e.g. 300mmx300mm.

One solution is to place all the **optics in a line**, with long X axis, shown at right below; in this case, X stage travel would be on the order of 1000mm. Where there is no particular space constraint this in itself is not a major issue, but there are other weak points about this arrangement: -

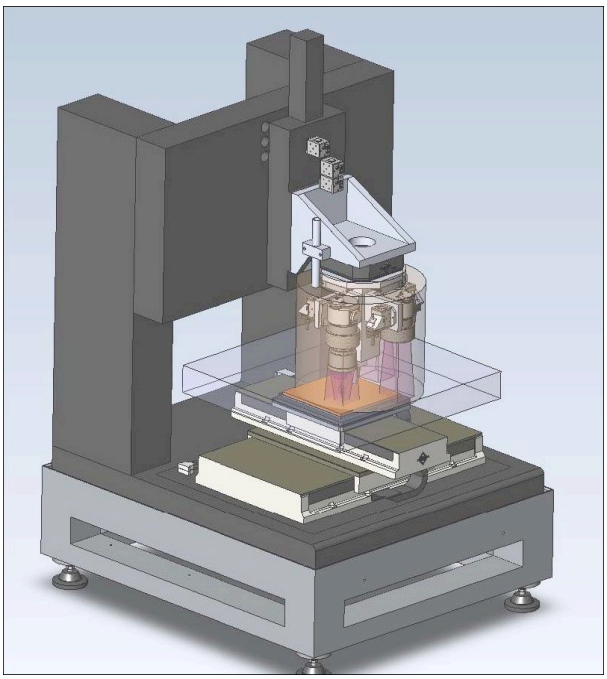


a) Optics heads are set physically far part. That means that the **position register** between the different heads (calibrated offset parameters stored in software) will be affected by position repeatability over very long distances, never easy to achieve, and which of course is also affected by environmental aspects like temperature. The most important will be the **loss of accurate registration** between inspection microscope used for aligning parts, and the laser head making the subsequent processing.

b) Worse, since heads are mounted on different Z stages, errors in parallelism of those stages lead to **errors in the position register as a function of the working height/thickness of parts**. Practically speaking errors of 1µm over 100mm in Z would imply Z stage parallelism better than 2arcsecs, probably impossible to achieve. Similarly, errors in flatness/straightness of travel between the different Z stages will produce registration errors which depend on working height in an uncontrollable way.

Who would buy an optical microscope where the different objectives were arranged in a row, requiring the object under inspection to be translated from one to another? Fortunately there is an sensible alternative, universally used in microscopes, which is to mount the optics on a turret, sometimes motorized.

Optec (Lasea group) developed similar turret optics for such laser systems a decade ago. The optics are mounted as a balanced load on a rigid post suspended downwards from a motorized theta stage; that stage is in turn mounted on a bracket fixed to a common heavy duty Z stage. Already, problem b) has disappeared, whilst the working point is essentially the same for all optics, which are just moved into place as required by rotation of the theta stage, so problem a) is gone as well, and the repeatability of positioning of each optic is essentially the angular repeatability of the rotation stage. The model selected has repeatability +/-0,5arcsecs repeatability or approx. +/- 0,3µm on the planned PCD of a little less than 300mm; much better than can be achieved over long stroke on X. (Attn. NOT to be confused with the repeatability of positioning of the laser spot under galvo operation). Other strong points are:-



Each galvo head has a manual adjustment for height on the faces of the post, so that all beams and diagnostic optics can be set to work on the same horizontal plane.

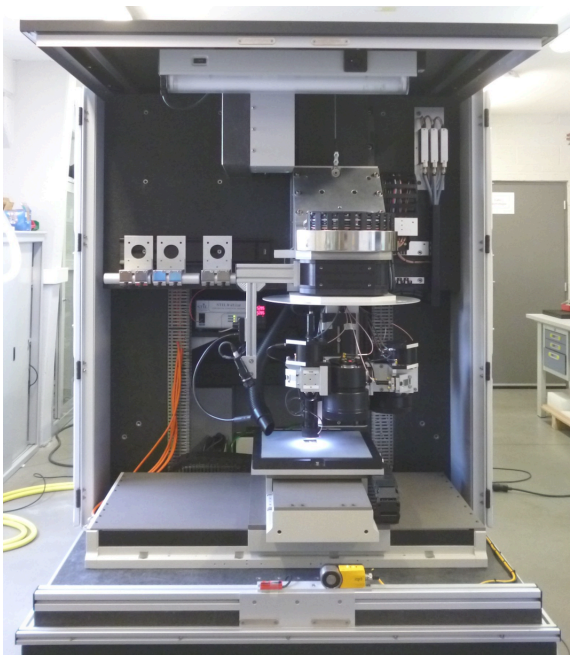
In hybrid systems which Optec has also built, one turret position is used for a mechanical spindle miller.

The arrival point for all laser beams is in the same position from above, leading to a neater & more compact optics layout on the laser side, with steering mirrors being indexed into position.

X stage need not be much more than the 300mm part size; 450mm travel stages shown here, which in fact would allow parts almost 400mm size to be processed, but with less than 2/3 of the overall length of 1000mm stage. The cost saving is not only in the stage, but also of granite and safety enclosure.

There are also area view optics, which are fixed to the bracket so that they move vertically in concert with all other optics, but view the process area independently of which head is in use, which of course would be impossible using ILO.

SP450-TO, showing large turret optics & unparalleled workstation access with large safety doors double folding entirely to the rear.



MM200-USP, compact fs laser workstation, complete with small turret optics