“Design and realization of a novel device for straightness measurement” – Thesys summary

The conceptualization of a novel technique aimed to straightness measurements and the practical realization of a mechanical device able to perform them without contact is presented. Such device – called InPlanT– is based on the acquisition of the luminous signal backscattered by a spherical dielectric target by means of a photodiode placed in the backward beam; the device proved capable of extracting the information about the lateral position of the target with respect to the onward beam. Three different prototypes were built (**Figure 1**), all of them based on the mechanical modulation of the signals retroreflected by the target (**Figure 2**). Suitable mathematical approaches to deal with the peculiar patterns of the signals (changing with the longitudinal distance of the sphere) were implemented, an acquisition procedure and a processing strategy of the data were implemented in order to extract the sought spatial information from them by means of a proper software expressly written. Quantitative evaluations –carried on with a statistical approach– of the factors affecting the accuracy of the measurements (primarily the jitter and the air turbulence, especially over large distances) were key to gain a better knowledge of the dynamics of the phenomena involved, and proper software adaptations to deal with these issues were applied.

The last versions of the device (**Figure 3**) were preliminary tested on a high-accuracy CMM (**Figure 4**) to evaluate their response in terms of maximum error of indication with respect to targets exploring a nearly perfect straight line in space. Experimental results showed that the achieved accuracy is better than ±2.1 μm within the measuring range of $\sim(0 \div 1.7)$ m. A straightness measurement on a simulated sinusoidal path was also performed, obtaining a peak-to-peak indication error of ±7 μm.

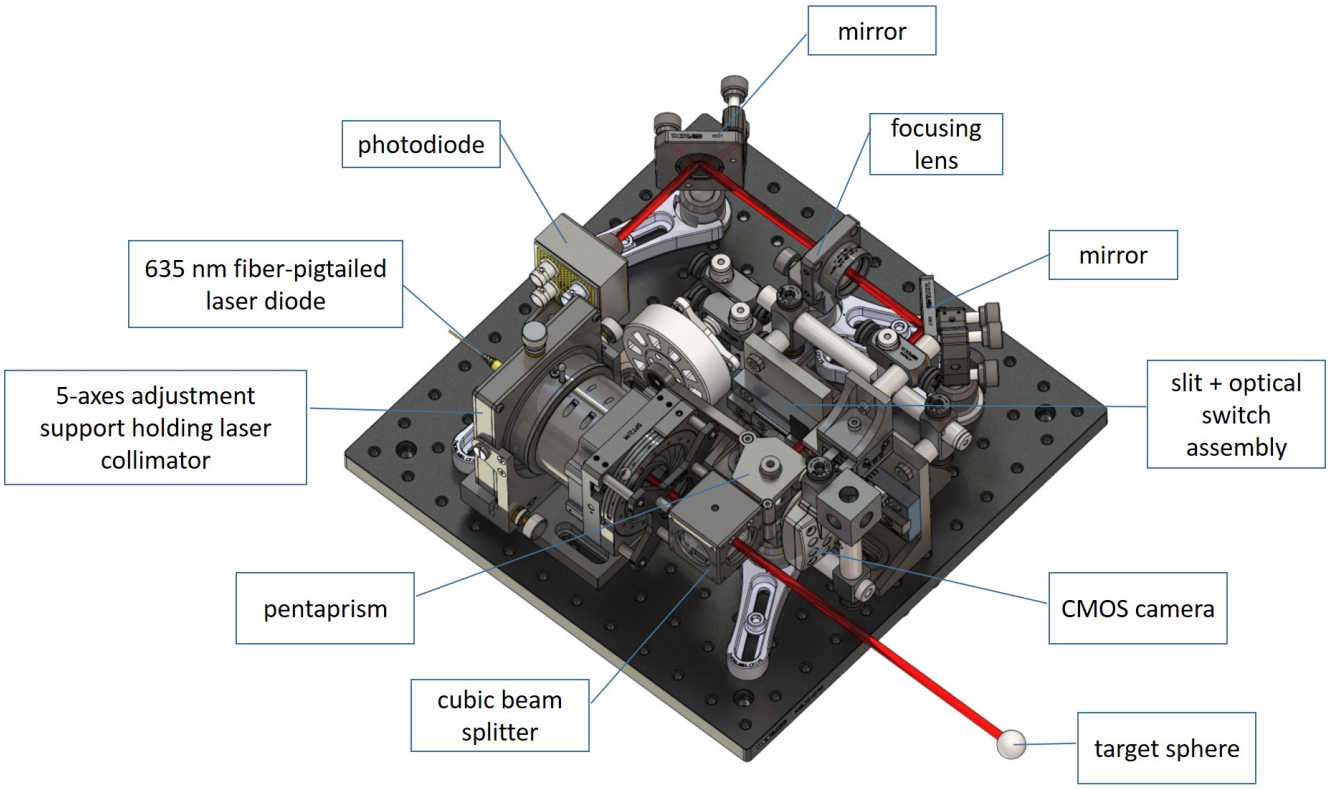

***Figure 1**. Interior of last prototype built, with key components.*

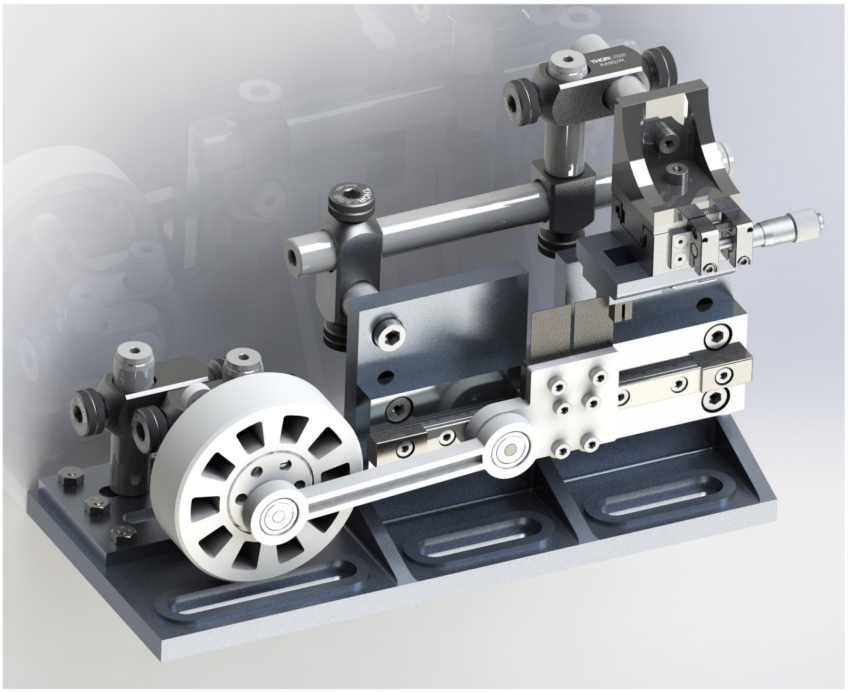

***Figure 2**. Slider-crank mechanism for the mechanical modulation of the signals.*

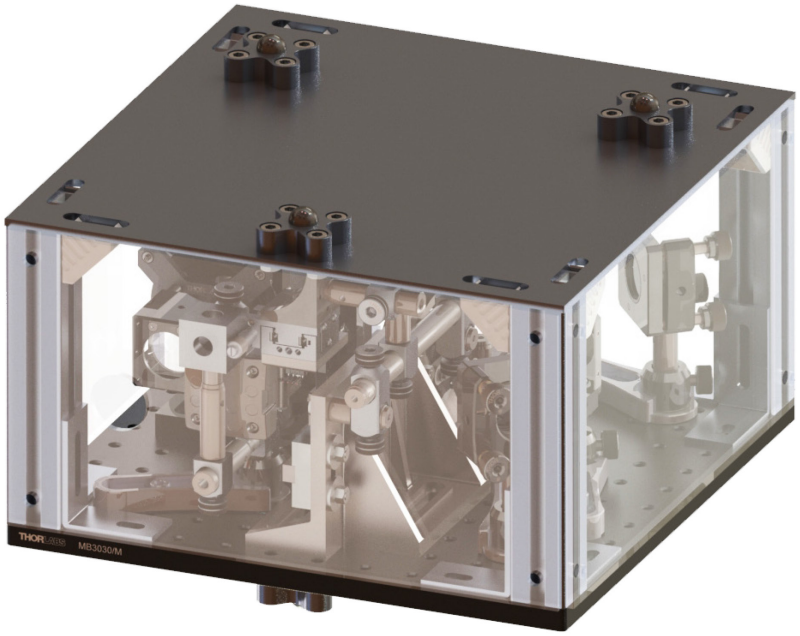

***Figure 3**. Rendered model of last assembled prototype.*

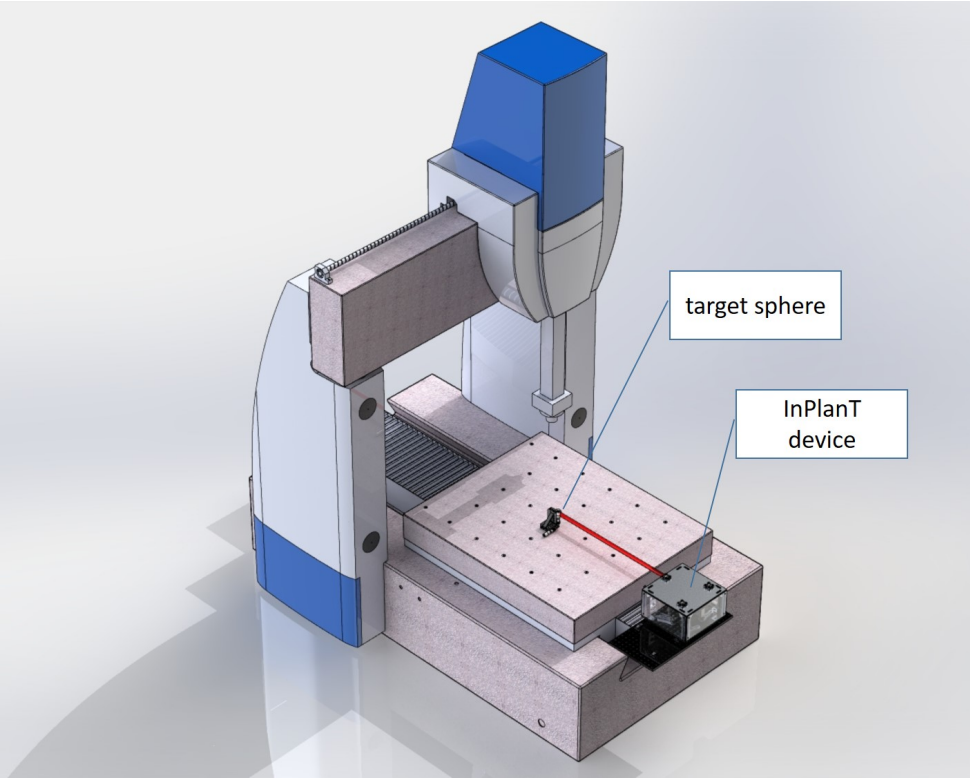

***Figure 4**. Testing setup of last prototype.*