Experiments of Laser Pointing Stability on Different Surfaces To Validate Micrometric Positioning Sensor

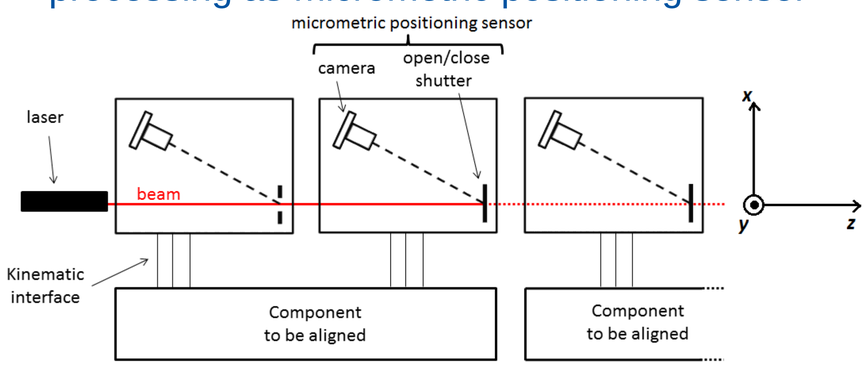
1. Introduction

Requirements for the alignment of the Compact Linear Collider (CLIC)

- Accuracy up to 10 µm at 1σ over 200 m for the pre-alignment of beam related components

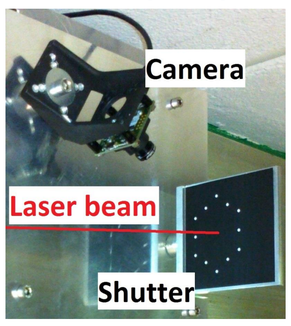
Alignment system under study at CERN

- Laser beam as straight line reference
- Camera / shutter assembly combined with image processing as micrometric positioning sensor



Requirements for the micrometric positioning sensor

- Compact
- Low cost
- Compatible with its environment
- Measurement repeatability: 1 µm
- Measurement accuracy: 5 µm



2. Objective

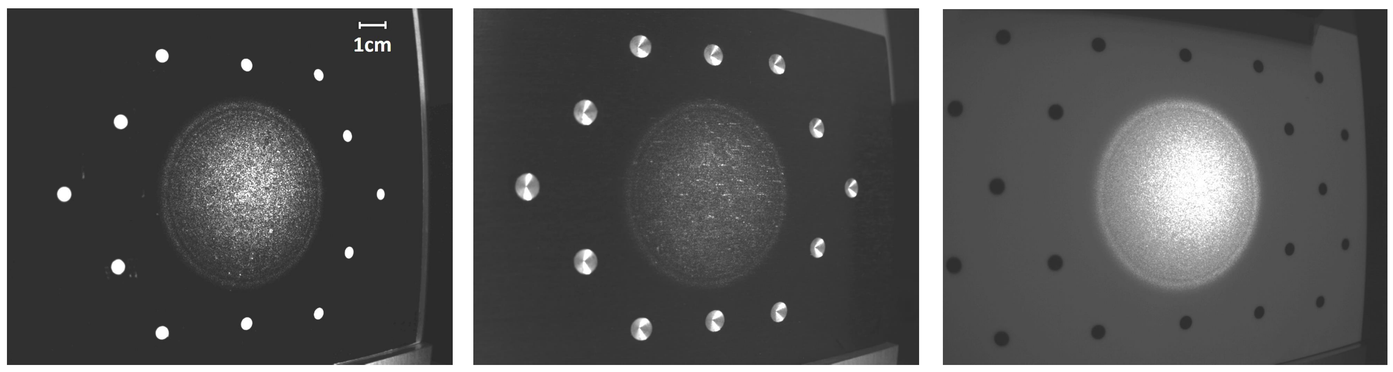
- Determine the most appropriate shutter for the micrometric positioning sensor in terms of flatness and laser pointing stability

3. Method

- Pick materials with different roughness values to make shutters
- Add at least 4 targets on the shutters to have references points, and thus, determine the 8 parameters of projective geometry (transform CCD plane -> shutter plane). Take disks for targets which have the advantage of looking like ellipses regardless of the position of the camera.
- Mount camera and shutter on the same support without open/close mechanism in order to avoid uncertainty due to repositioning
- Determine shutter flatness by measurements in the metrology lab
- Determine laser pointing stability on the shutters by experiments

4. Results

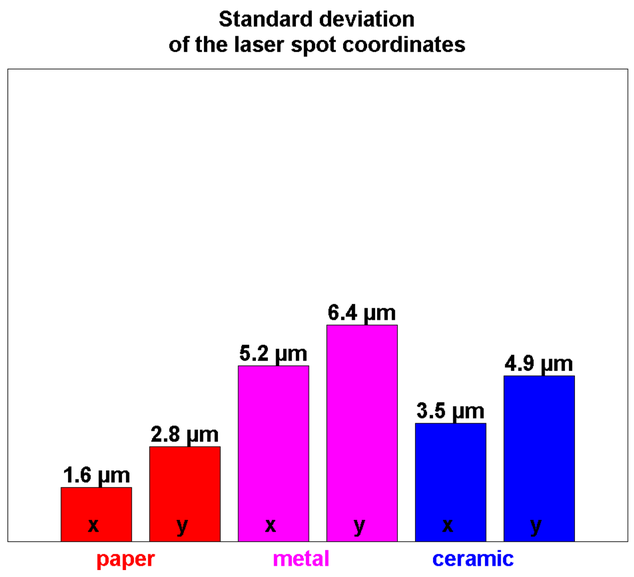
Manufacturing of shutters



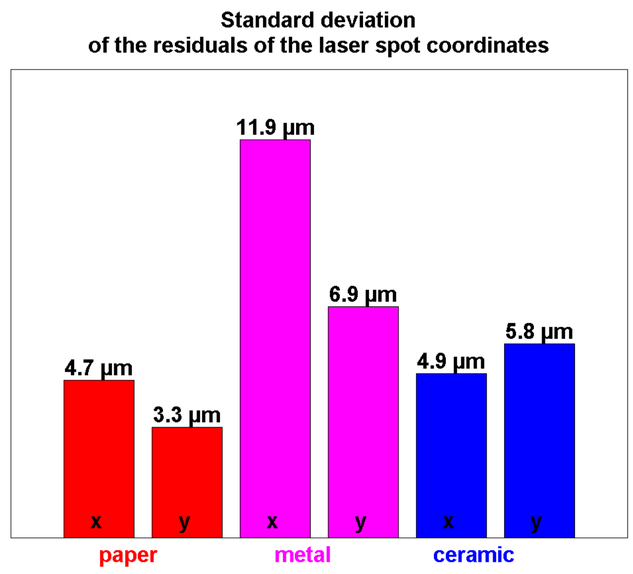
paper metal ceramic

Shutter type	Targets	Surface flatness	Surface roughness (R_a)
Paper	Targets are printed on a sheet of paper which is glued on an aluminium plate	30-110 µm	2.8-4.8 µm
Metal	Targets are machined conical grooves in a black anodised aluminium plate	15-16 µm	0.1-0.9 µm
Ceramic	Targets are obtained through laser siltering on an alumina plate	36-37 µm	1.4-2.2 µm

Laser pointing stability



Sensor not moving



Sensor moving
over 2 mm along x axis

- Paper surface presents the best laser pointing stability, followed by ceramic and finally metal (possibly due to their roughness values)

5. Conclusion and outlook

- Paper surface has the best laser pointing stability but is not satisfying regarding flatness. Metal surface is the opposite: it has the best flatness but the worst laser pointing stability. In between, ceramic surface presents a good compromise.
- In a future study, we will test shutter repositioning by adding an open/close mechanism to the micrometric positioning sensor.

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