

Online alignment survey for long components hidden under shielding

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WHY?

Instruments specs at ESS:

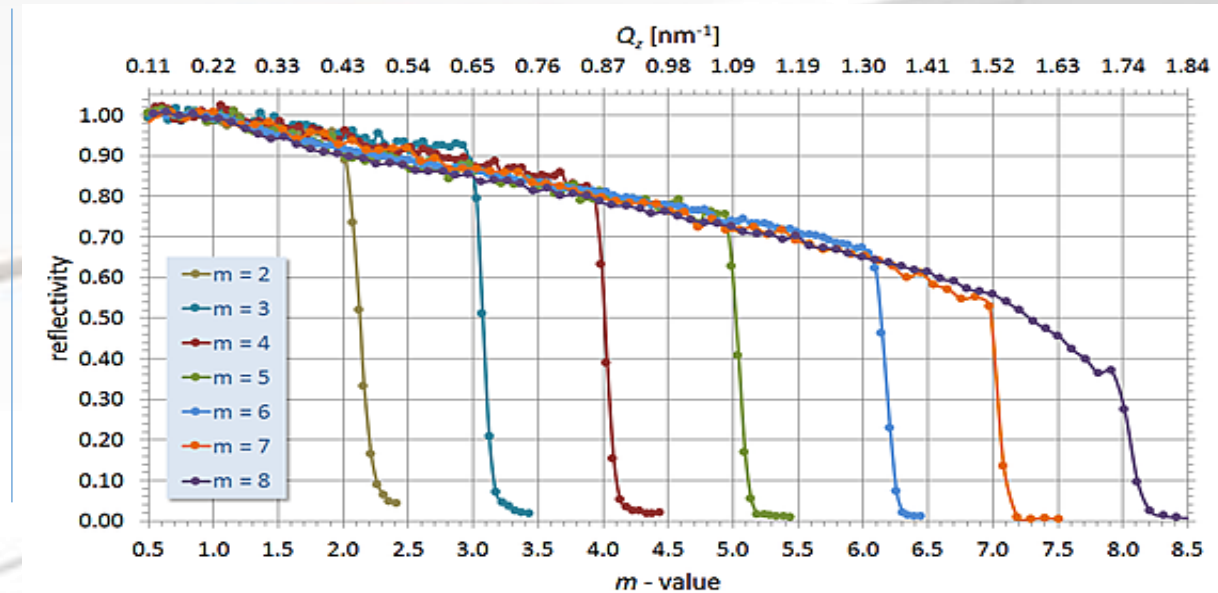
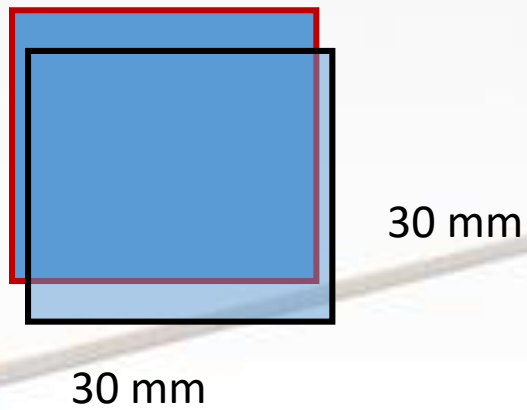
- 20 m to 150 m mirror's shielding
- 60 cm thickness concrete shielding
- 4m foreseen guide housings
- neighboring instruments won't be built in the same time

If there is a loss of neutrons, where shall we open?

BECAUSE TIME IS MONEY!!!!!!

SOME NUMBERS

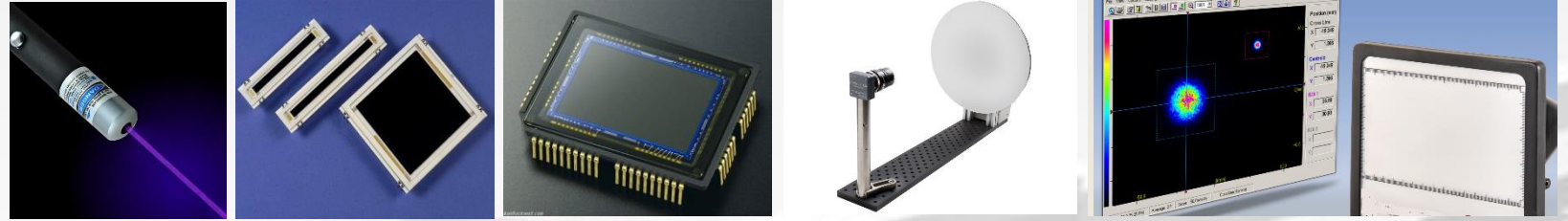
translation of 5mm OR rotation of $0,1^\circ$ → Loss of flux $\approx 15\%$



Solution : Online alignment survey

HOW WITHOUT CONTACT?

Laser + PSD / CCDsensor / camera



Distance photoelectric Sensors



Ultrasound detectors



Magnetic sensors



Inclinometers



HOW WITH CONTACTS ?

LVDT probe sensors



Linear scales



MEASUREMENT CONSTRAINTS

- Work in a dark and closed environment
- Uncertainty (100-500 μm)
- Repeatability
- Low cost
- Easy to install
- Radiation resistant

TECHNICAL SOLUTIONS

Incompatible solutions

Magnetic sensor



very short distance between sensor and ref (10 mm)

Ultrasound sensor



bad uncertainty for 1m between sensor and ref

LVDT probe sensors



the sensor musn't be in contact with the ref

Linear scales



Limited distance (30 cm) for target uncertainty

photoelectric Sensors



To expensive > 1800€ per housing

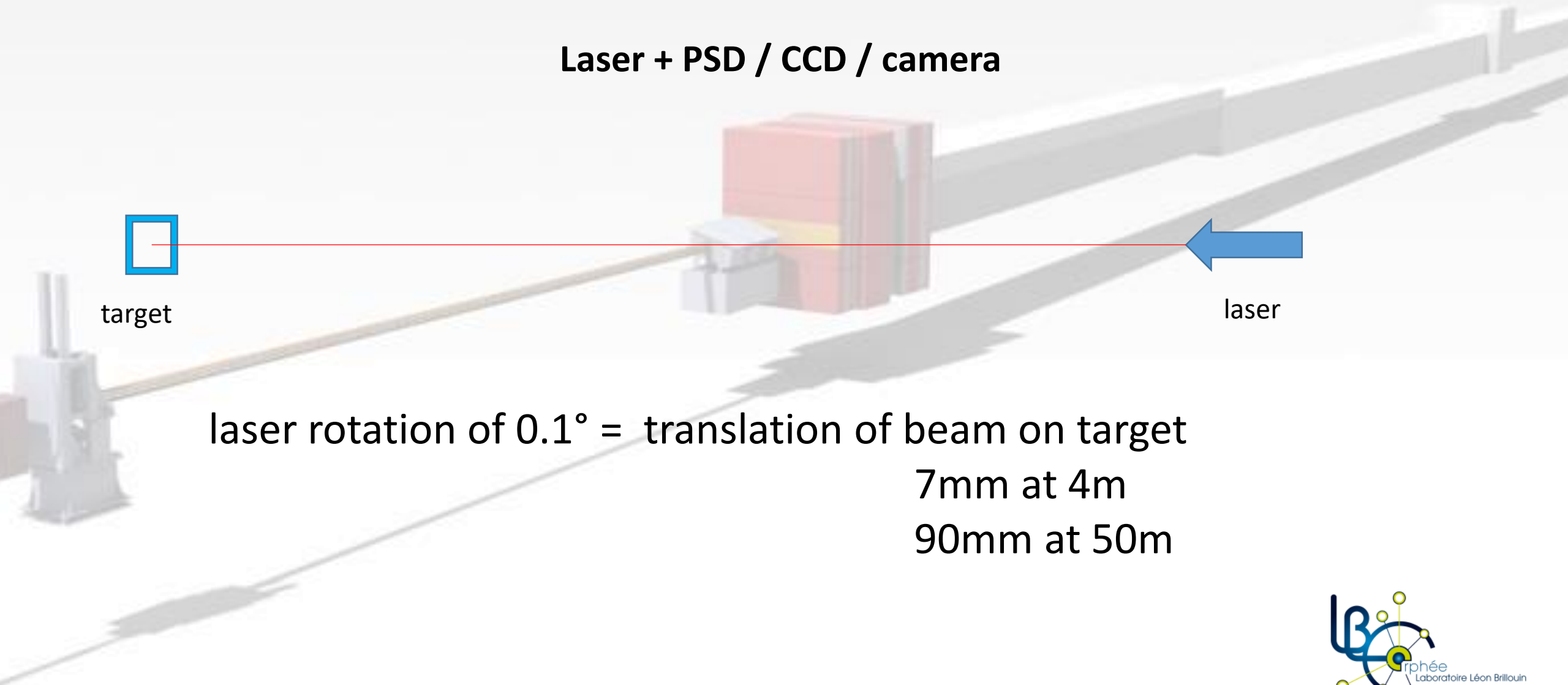
Focus on:

Laser + PSD / CCD / camera

Inclinometers

PRINCIPLE

Laser + PSD / CCD / camera



target

laser

laser rotation of 0.1° = translation of beam on target
7mm at 4m
90mm at 50m

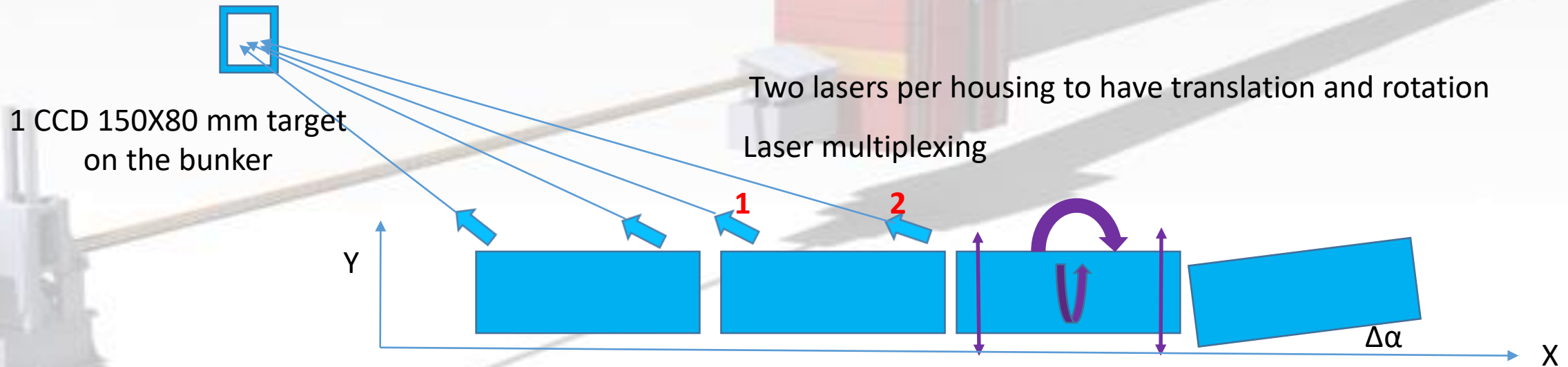
ABSOLUTE REFERENCE

Laser + CCD

For short instruments (to 40m/50m)

0,1° for a 40 m instrument = 70 mm translation

Precision $\leq 100\mu\text{m}$ and $2 \cdot 10^{-3}^\circ$



Y_0 = original adjustment

Y_{m1} = shifting of the laser 1

Y_{m2} = shifting of the laser 2

If translation \longrightarrow

$$Y_{m2} - Y_{o2} = Y_{m1} - Y_{o1}$$

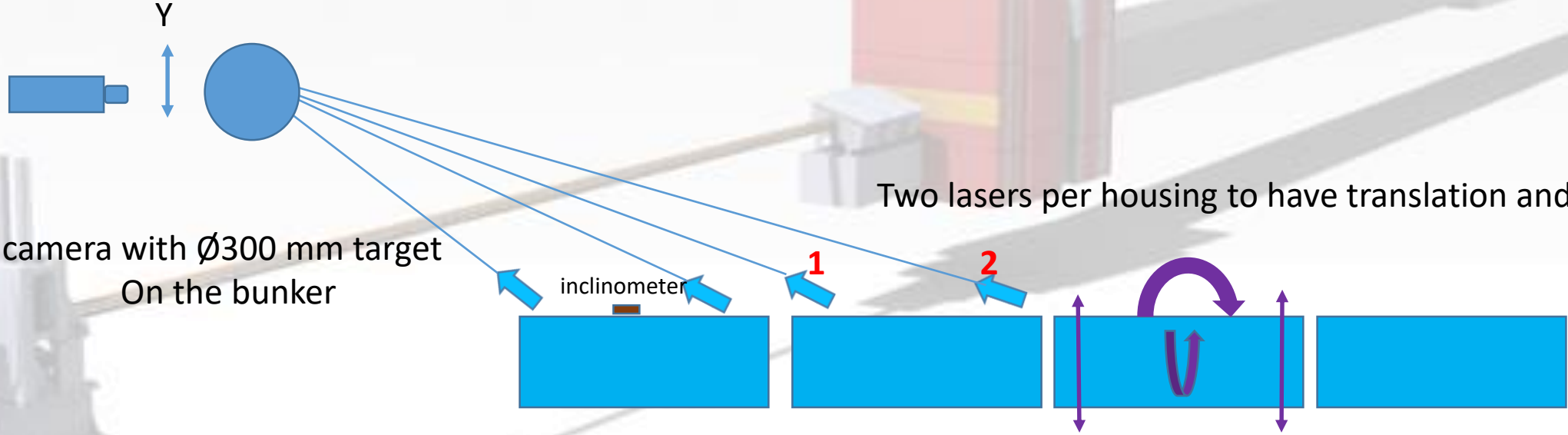
If rotation \longrightarrow

$$Y_{m2} - Y_{m1} = (X_2 - X_1) \sin \Delta\alpha$$

ABSOLUTE REFERENCE

Laser + camera

For instruments up to 80m



ABSOLUTE REFERENCE

Laser + CCD or camera

Advantage:

low cost

≈6000€ total for a CCD
≈12000€ total for a camera

Disadvantage :

limited up to 80m instruments
measurement 1 by 1
fine ajustement for lasers far from the sensor.
Impact on shielding?

RELATIVE REFERENCE

Laser + PSD

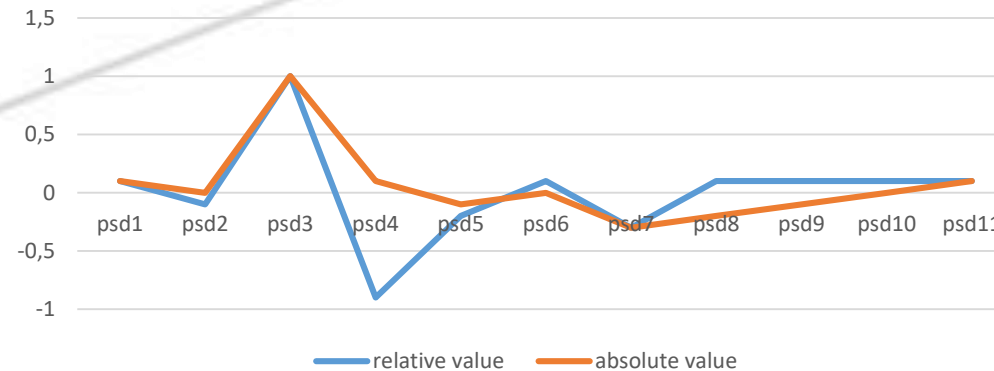
A reference on the bunker wall and a laser / PSD on each housing.

If we add an inclinometer, we can know if it is a translation or a rotation.

1 PSD on a wall of the bunker as reference



Relative/absolute position of the housings



Laser + PSD

Advantage :

easy to position
can be used on all the instruments.

Disadvantage :

price 1500€ per housing in the industry.

Driver development to decrease the price $\approx 700\text{€}$?

Inclinometers

Add to laser solutions

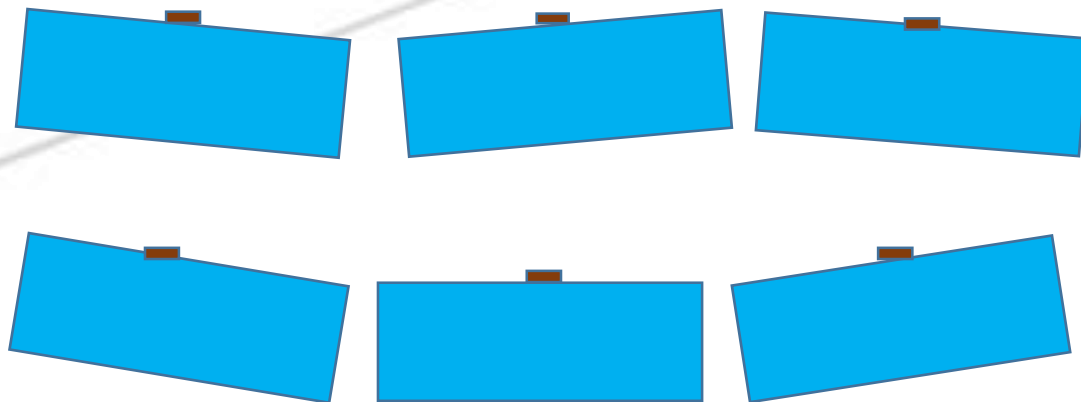
Single?

Only the rotation in 2 axis

If rotation or translation = effect on each housing?

High precision inclinometer $\approx 0.01^\circ$

Need to study more



Inclinometers

Advantage :

easy to position and to install
can be used on all the instruments
very low price $\approx 200\text{€}$ per housing

Disadvantage :

can not measure directly a translation
(but may be indirectly)

conclusion

Several solutions from 200€ to 1500€ per housing of 4m

Mixing of solutions for long instruments

Can be used only in some strategic point

Exemple of Cost

for 50m instrument minimum $\approx 6000\text{€}$

for 150m instrument maximum $\approx 45000\text{€}$

The good questions are :

What is the price?

What is the benefit?

THANK YOU

Open to any comment, discussion or
information

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