OPTICAL ALIGNMENT OF PARABOLIC TROUGH MODULES

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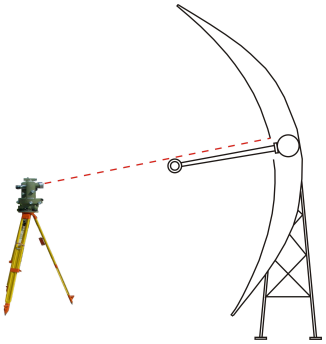
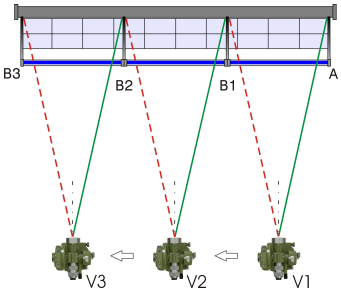
Heat Collection Element alignment: sighting method



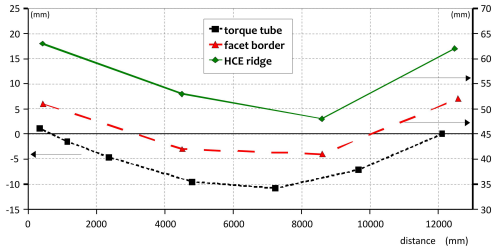
As shown in figure, with the module pointing just a bit lower than the horizon, the slope of the rotating support closer to the rigid support is correct when the two ends of the supported HCE unit appear from the same point of view simultaneously sighted with one of the two inner facet-mirror border; otherwise the slope of the rotating support has to be adjusted to accomplish that.

For the sake of symmetry, the point of view makes an isosceles triangle with the two considered supports.

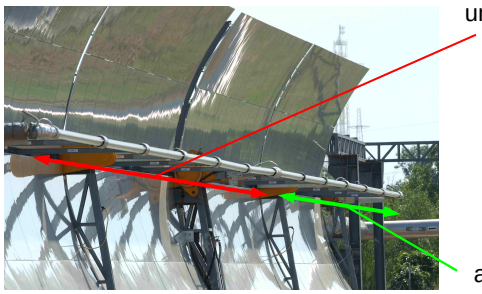
The alignment of the entire module HCE can be verified, and eventually adjusted, by repeating iteratively the procedure on all the units composing the HCE, starting from the one hang to the rigid support (5 min/support).



Results:



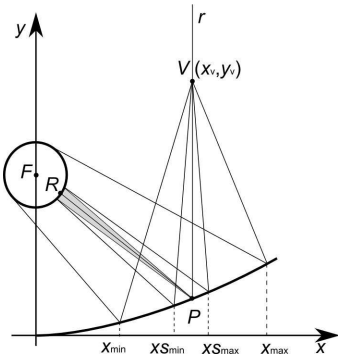
Distance from the rotation axis measured with Leica Total Station TDA5005



HCE & facet mutual-alignment: Visual Inspection System *field*

The **VISfield** is based on the **ray reversibility** (Helmholtz's theorem). As shown in the figure on the right, an hypothetical spot of the solar radiation that would reflected by *P* will appear from an observer in *V* as spread in the HCE image between *xsmin* and *xsmax*.
On the basis of the ray reversibility, a δ slope-imperfections of the facet-mirror cause the shift of the HCE image for $2M\delta FP$, with M image magnification; on the contrary the image of the hypothetical solar spot remains sighted with *xv*. Then, said Δ the image shift, the slope deviation is $\delta = \Delta / 2MFP$, and with good approximation the local IF is given by the portion of the range (*xsmin xsmax*) appearing superimposed to the HCE image.

In order to get the most complete information, this analysis has to be repeated on a set of frames captured from different observation points, with *xv* spanning the *x* axis from the vertex to the external parabola border; the optimal step between one frame and the following is the digital resolution of the parabola surface, that is the side of the pixel-image.



MARPOSS

First prototype of the VISfield made by Marposs

The VISfield is basically composed by a **firewire camera** (AVT Stingray F504 B with 8 mm objective) and a 3.2 m long **translational rail** installed on a **cargo trailer** able to travel on public roads. During the measurement, the cargo-trailer is stabilized by means of four hydraulically operated, retracted feet to guarantee the steadiness of the visual inspection of the module during the measurement cycle.

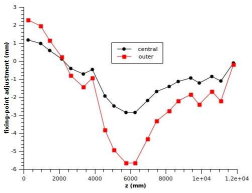
The VISfield Inspects the **lower half parabolic-trough of one module (12 m)** oriented towards the horizon.

Outputs: 1) i**ntercept-factor** (IF) map and mean for each facet at the working solar-declination of the plant;
2) adjustments at the facet **fixing-points** improving IF;
3) after the optimization, **facet-mirror compliance** by its IF (map and mean).

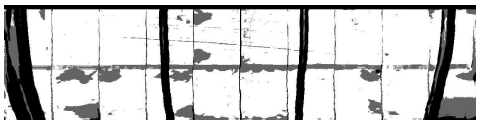
The **measuring cycle time**, including the image processing performed with a notebook Toshiba Satellite A300-280 (Pentium T4200), is about **2 minutes** long.

The VISfield is manufactured and commercialized by **Marposs** under ENEA license.

Intercept-factor map of an old PCS module. Dark, gray and white mean degraded-reflectance, IF < 1 and IF=1, respectively



Suggested correction for the central and outer fixing-points; the inner are assumed well positioned.



Final map of a re-aligned module; the black-grey strips are related to the thermal insulation protection applied in the HCE-unit connections, elsewhere the grey regions means that IF < 1. Several facet-mirrors show large regions where the shape is not sufficiently close to the one of the ideal-parabola to allow the complete capture of the reflected radiation.