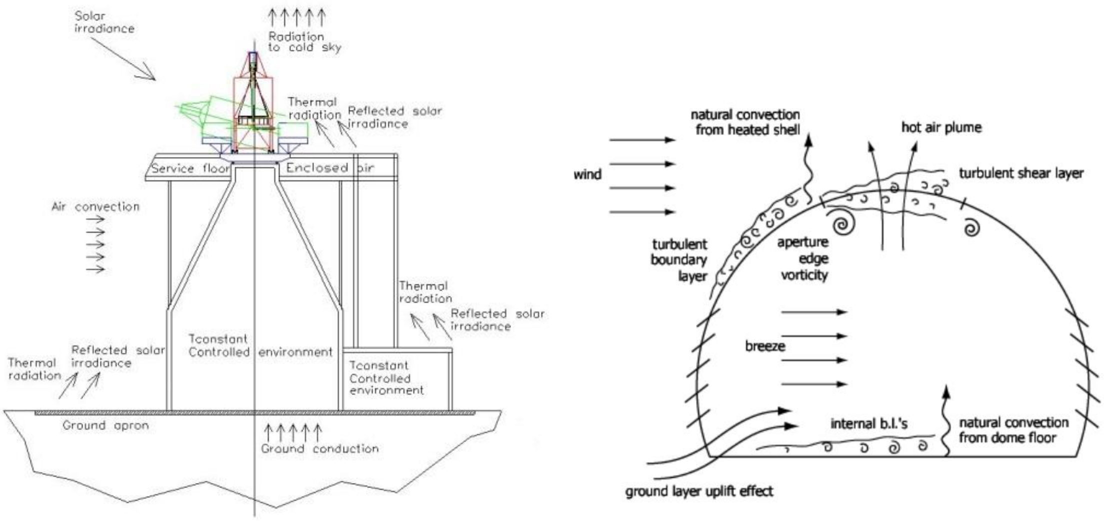
LOCAL SEEING OPTIMIZATION

Progress Report May 2014

EST THERMAL ANALYSIS

Thermal conditions

A solar telescope is exposed to solar irradiation which changes during the day and the season. The telescope receives direct solar irradiation and also indirect solar irradiation reflected from different surfaces of the facility which affects in different way depending on the sun position.



1. Left. Thermal effects on the telescope and facilities. Right. Convective effects on the conventional dome that affect the local seen.

Apart of radiation, conduction and convection are present on the thermal transient analysis of the telescope, which is oriented to minimize the degradation of the local seeing (phenomenon that consists of different disturbing effects that the density of the atmosphere has on light beams) produced when convective flows and air plumes are generated due to differences between the temperature of the telescope and the ambient air, the facilities or surroundings. Therefore, the objective is to keep the temperature of the surfaces of the facility as close as possible to the ambient temperature in order to minimize the local seeing effect. The induced local seeing has to be minimized for elements which are close to the optical path (telescope tube, telescope platform…), hence the admitted temperature difference is tiny for these elements (+/-1ºC) while for elements which are far from the optical path (ground, building…) the temperature difference is more relaxed (+/- 5 º C).

Objective

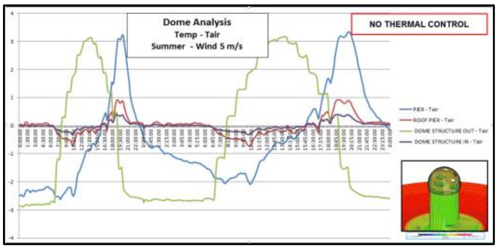
Transient analysis are performed during 48 hours in order to get the temperature distributions at the dome, pier, building and floor of the EST, in different moments of the day (morning, noon and afternoon), in summer with a wind speed of 5m/s at OT (Teide Observatory) in different configurations:

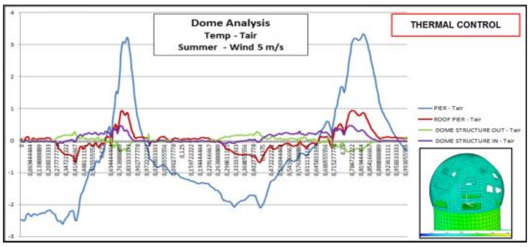
- Conventional Dome without thermal control.
- Conventional Dome with thermal control ($T_{DOME}= T_{AIR}$).
- Dome analysis considering the Heat Stop effect, with stagnant air inside and with wind inside dome (two configurations).
- Analysis of the EST pier with windshield, in open air configuration.

Once obtained the temperature maps, CFD analyses will be performed to evaluate the local seeing degradation. This second analysis consists in obtaining the Cn^2 distribution for each case and from this distribution to obtain the seeing degradation along 100m of the primary mirror light beam in terms of θ_{FWHM} (arcsec). Thermal analysis -> CFD-> Logarithm Distribution Cn^2

Analysis performed

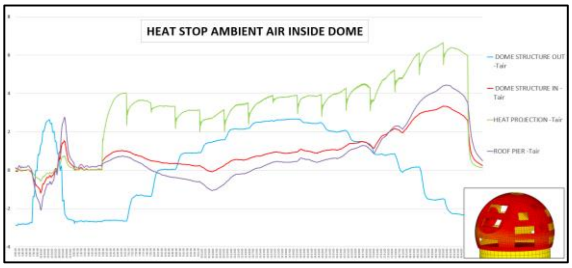
1. Conventional dome with and without thermal control:

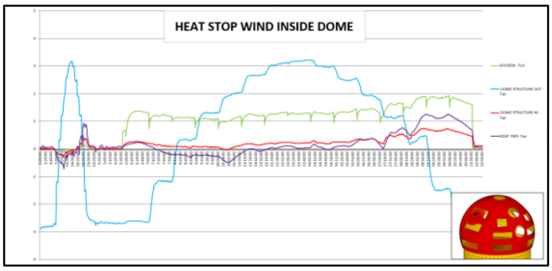




MAXIMUN TEMPERATURE DIFFERENCE T – Tair (ºC)				
	DOME OUT	DOME IN	PLATFORM	PIER
DOME NO THERMAL CONTROL	**3.2**	0.4	0.95	3.4
DOME THERMAL CONTROL	**0.3**	0.4	0.95	3.4

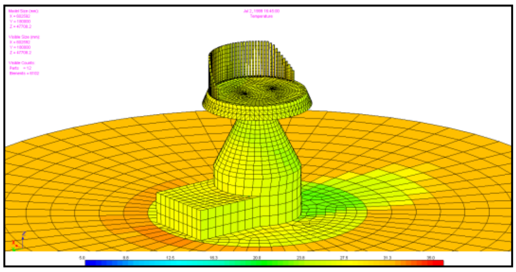
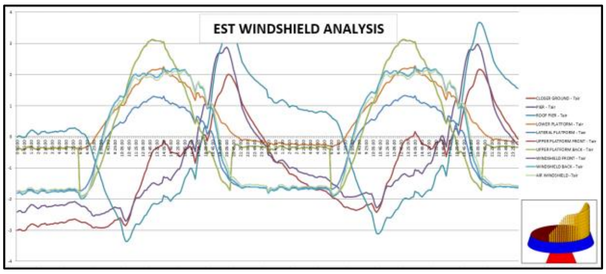
2. Conventional dome with heat stop effect, with stagnant air inside and forced convection:





MAXIMUN TEMPERATURE DIFFERENCE T – Tair (ºC)				
	DOME OUT	DOME IN 8.9KW	PLATFORM 2.5KW	HEAR PROJECTION 2KW
DOME HEAT STOP STAGNANT AIR	2.66	**3.32**	**4.41**	6.64
DOME HEAT STOP WIND INSIDE	3.19	**0.70**	**1.21**	1.90

3. EST pier with windshield, in open air configuration.

The effects produced by windshield, conventional dome and heat stop will be evaluated with the CFD analysis results.

Next Steps

- Comparison of the performance of the telescope pointing out of the sun with "open configuration" and "conventional dome."
- Basic design of the thermal control system of the transfer optics and laboratory instruments.