1. Abstract

Sites selection for ELTs conducted and a new era opens for turbulence studies in application to the ground-based astronomy supported by AO. In the last decade the main interest of astronomy has been focused on the characterization of sites, now priorities change. In the last years more and more AO systems have seen their first light, few more complex AO techniques are still in a phase of verification/validating. The efficiency of the operating and forthcoming AO systems can strongly be affected by turbulence and operation strategies rely on our ability in knowing in advance the turbulence spatial distribution in a region around the telescope. Progress in development of more sophisticated AO techniques (such as the LTAO, MCAO and MOAO) definitely depend on a more detailed knowledge of the main turbulence features such as the turbulence stratification at high vertical resolution. A European working group has been recently set-up aiming at defining the roadmap of a program of site testing campaigns for OT measurements having multiple goals mainly addressed to support requirements for AO systems. The idea is to conceive one experience trying to maximize the outputs that are, at the same time, critical for the site fast AO and the OT supporting.

2. Scientific Motivations

★ AO main requirements

- MCAO:
- LTAO:

★ OT modelling main requirements

1) Absolute calibration (different from different instruments) (see also section 4.1.2 & 4.1.3 of the MOSE project) not negligible uncertainty.
2) Rich statistical analysis of measurements: the different atmospheric parameters sampled by different instruments running simultaneously. At least one of these datasets must be a vertical one (i.e. providing the [0-20km] range e.g.). This condition is mandatory otherwise it is not possible to disentangle between measurements differences due to spatial turbulence inhomogeneity and biases introduced by instrument.
3) Access to OT measurements from AO systems is a key element of the optical turbulence modeling (specifically the focus and turbulence).
4) Classical meteorological parameters near the surface (Automatic Weather Stations
5) Measurements of the vertical stratification in the boundary layer (1km above ground) at high vertical resolution (from a few tens of meters up to 100m) with preferably two different vertical profilers.
6) Measurements of the solar radiation, ground heat flux and the sensible heat flux performed at the site.

3. Vertical resolution

★ At present there do not exist a vertical profiler monitor for the OT that is able to achieve a vertical resolution of the order of 100-200m on the whole [0,20km] a.g.l range.

- A Generalized Scinder (GS) can achieve such a resolution (Eq.(1)) provided a suitable telescope pupil size is used. Using the GS technique and assuming $h_o = 2km$ (ho is the cropped plane underground), one has to select binary stars with different separations ($\theta$) to be able to retrieve $C_n^2$ profiles all along the whole 20km. In other words, for each pupil size D, one has to associate a specific value of $\theta$.

\[
\theta = \frac{7.8 \times (h_o - h)}{D} \quad \text{Eq.(1)}
\]

Fig.1 shows the vertical resolution achievable by a GS for different telescope pupil sizes assuming $h_o = 2km$. The GS is not a monitor and it can hardly be conceived to be an instrument for systematic monitoring. However, it can provide fundamental measurements of reference to test other techniques that are under study in the last years.

4. Site testing campaign strategy

The first main experience we propose to consider on the use of several sites.

- The sequence of stars observed by the different instruments during each night should be done so that all instruments look at the same direction on sky during the night or at least inside a cone of width +/- 10 degrees. The line of sight should be preferably the zenith (or a cone of width +/- 10 degrees around zenith).
- At least one of these instrument need to be a vertical profiler (MASS) that can achieve such a resolution [Eq.(1)] provided a suitable telescope pupil size is used.
- Criteria used to conceive the first experiment:

1) Assumed vertical stratification (see section 4.2).
2) $C_n^2$ profilers at high vertical resolutions on the [0-20km] range
3) Criterions used to conceive the first experiment:

- At present there do not exist a vertical profiler monitor for the OT that is able to achieve a vertical resolution of the order of 100-200m on the whole [0,20km] a.g.l range.

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** Other instruments might be taken into considerations provided they fit in the general framework.