PushPull deformable mirror: performances in closed loop operation and comparison with membrane mirror.

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Purpose

In this paper the performances a new model of push pull membrane deformable mirror are evaluated. Push pull deformable mirror have the advantage that the membrane can either be attracted from the back, as conventional electrostatic mirror, or be attracted from the front. This has several advantages such as: a doubled dynamic, a better accuracy in phase mode reproduction and the bipolarity of the reproduced deformation that allow closed loop operations without biasing.

Methods

Deformable membrane mirrors have a lot of advantages if compared with other adaptive optics devices such as bimorph mirrors, liquid crystal modulators, and thermal mirrors. Their properties are good optical power, low cost, limited power consumption, achromaticity and a good dynamic behavior. Their use in technological applications is limited by the quite low spatial resolution and maximum stroke. In this paper we deal with a new concept of push-pull membrane mirror (SATURN, Adaptica srl) which improves typical performances [1,2]. Push pull mirrors have the advantage of having electrodes on both side of the membrane. The top-side electrodes are conductive and transparent (ITO) whereas the back electrodes are printed on an electronic PCB such as in the Adaptica PAN deformable mirror. A sketch of both devices is depicted in Figure 1 along with a sketch of the back and front actuator distribution.

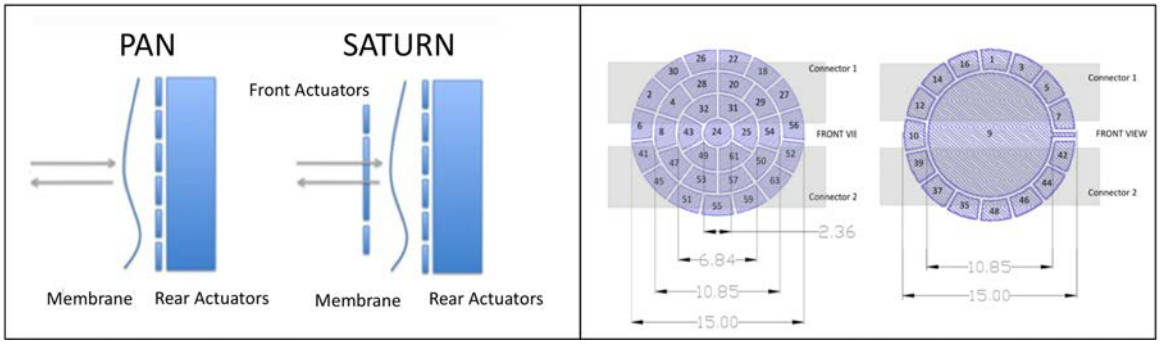

Fig. 1 Left: comparison between PAN membrane defomable mirror and SATURN push pull mirror structures. Rigth: rear and front actuator distribution of SATURN mirror.

The ITO structure has an antireflection coating and it is designed in such a way that the active area of 11 mm of the mirror covers the central actuator so avoiding unwanted diffraction effects due to the actuator pattern.

The two mirror are compared in two different setups: the fist is a characterization system in which a closed loop approach is used to impose to the mirrors various target wavefronts that reproduce a set of Zernike terms with increasing amplitudes. The second setup is a Didaptica kit, a standard Adaptica products that includes an imaging path beside the adaptive optics path. By means of this last system the correction capabilities on an imaging system will be compared.

Results

The SATURN mirror is found to behave better in terms of Zernike mode reproduction and the dynamic behavior is compatible with the expected doubled value with respect to PAN mirror. In Fig. 3 a 0.5 waves astigmatism example is reported where SATURN (error rms 0.032 waves) behaves better that biased PAN (error rms 0.081 waves) in closed loop operations.

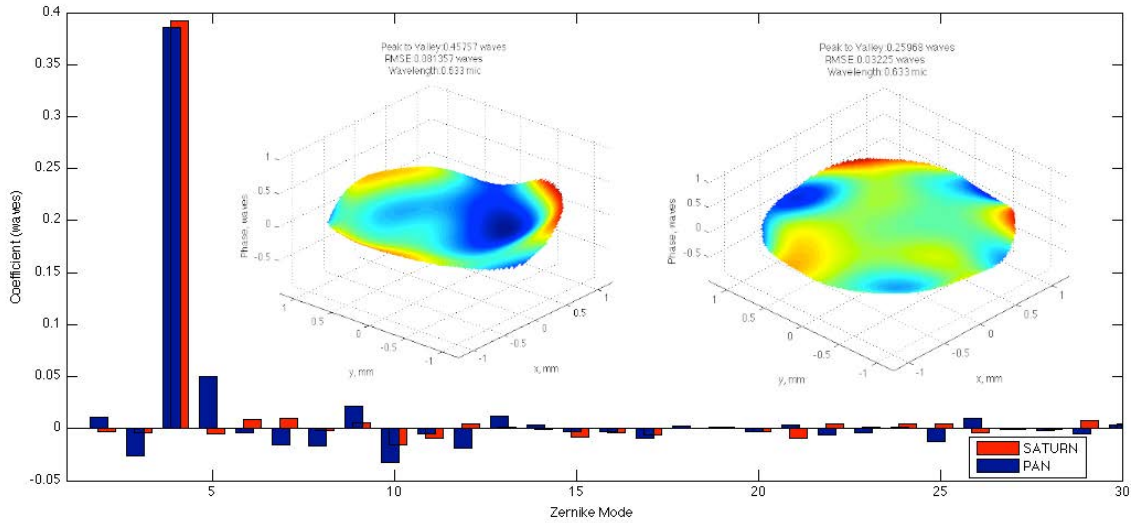

Fig. 2 Comparison of Saturn and Pan mirror for 0.5 waves astigmatism.

Conclusions

The push pull SATURN mirror is an advance in adaptive optics device due to its capability of pushing and pulling the membrane in both direction. It is particularly suited for opthalmic AO systems in wich standard membrane devices have poor stroke.

References

1. Stefano Bonora and Luca Poletto, “Push-pull membrane mirrors for adaptive optics” , Optics Express, Vol. 14, Issue 25, pp. 11935-11944 (2006)

2. Patent: S.Bonora, Metodo di realizzazione di uno specchio a membrana deformabile del tipo “push-pull” PD2009A000262, 11.09.2009