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Modulation strategies to mitigate island effect with the pyramid wavefront sensor

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The pyramid wavefront sensor is so far the most appropriate design for adaptive optics systems in the context of the Extremely Large Telescope. However, island effect has been identified as a critical issue: the presence of a six legged 50cm-wide spider supporting the secondary mirror breaks the spatial continuity of the incoming wavefront. It is therefore necessary to measure the gap, aka differential piston, present between each petal in order to reconstruct a continuous wavefront. We show that a modulated pyramid in the visible, on an ELT and under partial turbulence correction is not suitable for differential piston measurement: residual phase errors are read as a non-zero differential piston signal for zero piston error, leading to diverging petal pistons. We propose and study different modulation strategies which combine the benefits from the modulated, linear regime on one hand for a good atmospheric turbulence correction and the unmodulated, diffractive regime on the other hand for a better differential piston measurement.

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