Proposal for Conference Talk at ISPA by ESO detector group

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Title: Detector Systems Engineering for Extremely Large Instruments

Abstract:
With the advent of the next generation ground-based telescopes, in our case, the Extremely Large Telescope (ELT), a new era of discoveries is set to begin. Their very large light collecting areas and spatial resolutions are encouraging instrument builders to aim at spectral and spatial resolutions on the sky that are one to two orders of magnitude beyond currently available technologies. This push to ever fainter measurement regimes enables many exciting science cases such as the detection of biomarkers in atmospheres of nearby exoplanets.

However, at the spectral and spatial scales enabling this science, the photon shot-noise from the sky and objects of interest become negligible. This in turn makes instrumental signature and noise the fundamental limit for these measurements. In the ELT first light instruments, many operational modes may be limited by the characteristics of the science detectors, requiring not only measurements at the limit of the read noise, but also a requirement for better than 1% calibrations. For these state-of-the-art measurements, it is imperative to characterize, understand, model, and correct for these detector effects to this level.

This talk will cover our detector systems engineering work at ESO, to enable the best science to be extracted from our detectors and for a particular example, the ELT first-light spectrograph, HARMONI. The work on our detector systems covers everything from producing state-or-the-art detector control and readout electronics, to developing new detector characterization techniques in the lab. To achieve the ELT instruments' science goals, our work will include characterizing, understanding, modelling, and correcting for detector effects (such as detector cross-talk, persistence, PRNU, correlated noise, etc.) in the scientific analysis pipelines. For example, we are developing new test methods to characterize many of these effects such as the interaction between the video channels of any detector and persistence decay, and working with pipeline teams to implement corrections for these effects. Strong links between the detector engineers and scientists ensure that the scientific performance requirements can be met with our imperfect detectors, and any improvements required to meet scientific goals can be fed back into the detector system design process well before first-light. At the same time, efficiency is a must, as the project schedules require that we deliver the largest format detectors on a monthly basis over a 2 year period whilst testing and characterizing each device to a level such that the required performance levels can be achieved.