Evaluation of the Zyla sCMOS imaging camera for IMSE diagnostic

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Application Note

A polarization imaging diagnostic called IMSE (Imaging Motional Stark Effect) [1] was developed in 2013 for the ASDEX Upgrade experimental fusion reactor. Initial results were promising but poor signal/noise ratio and temporal resolution limited the capability of the system. It was decided to upgrade the imaging camera and from several commercially available options, the Zyla-4.2-CL10 sCMOS (scientific CMOS) camera from Andor Technology was chosen.

Environment tolerance

Inside the ASDEX Upgrade experiment hall, the camera is exposed to a very harsh environment:

- Strong vibrations
- Strong and rapidly varying magnetic field: B > 50 mT
- High gamma-ray and neutron radiation fluxes: $>10^7$ cm^{-2} s^{-1} 14 MeV and 2.45 MeV neutrons
- EM interference from nearby high power sources (e.g. 6 MW RF heating at >30 MHz)

LOT-QuantumDesign provided a Zyla example camera for magnetic field testing before purchase. In the ASDEX Upgrade hall, the camera was able to operate up to 40 mT field and above this operation was possible with a small iron shield. The EM interference and violent vibrations had no detectable effect.
The camera saw significant radiation noise but an acceptable level of permanent damage, which manifests as an increase in the dark current of some pixels. This was slightly worse than the original camera but not significantly. Andor gave an acceptable cost estimate for replacement of the sensor chip in case the collected radiation damage becomes too severe.

Usability

The camera offers an extensive, although complex, range of exposure and triggering modes which give a flexibility very useful to the IMSE experiments. Extremely fast frame rates can be achieved for small regions of the image (2560 x 64 pixels at >3,000 fps).

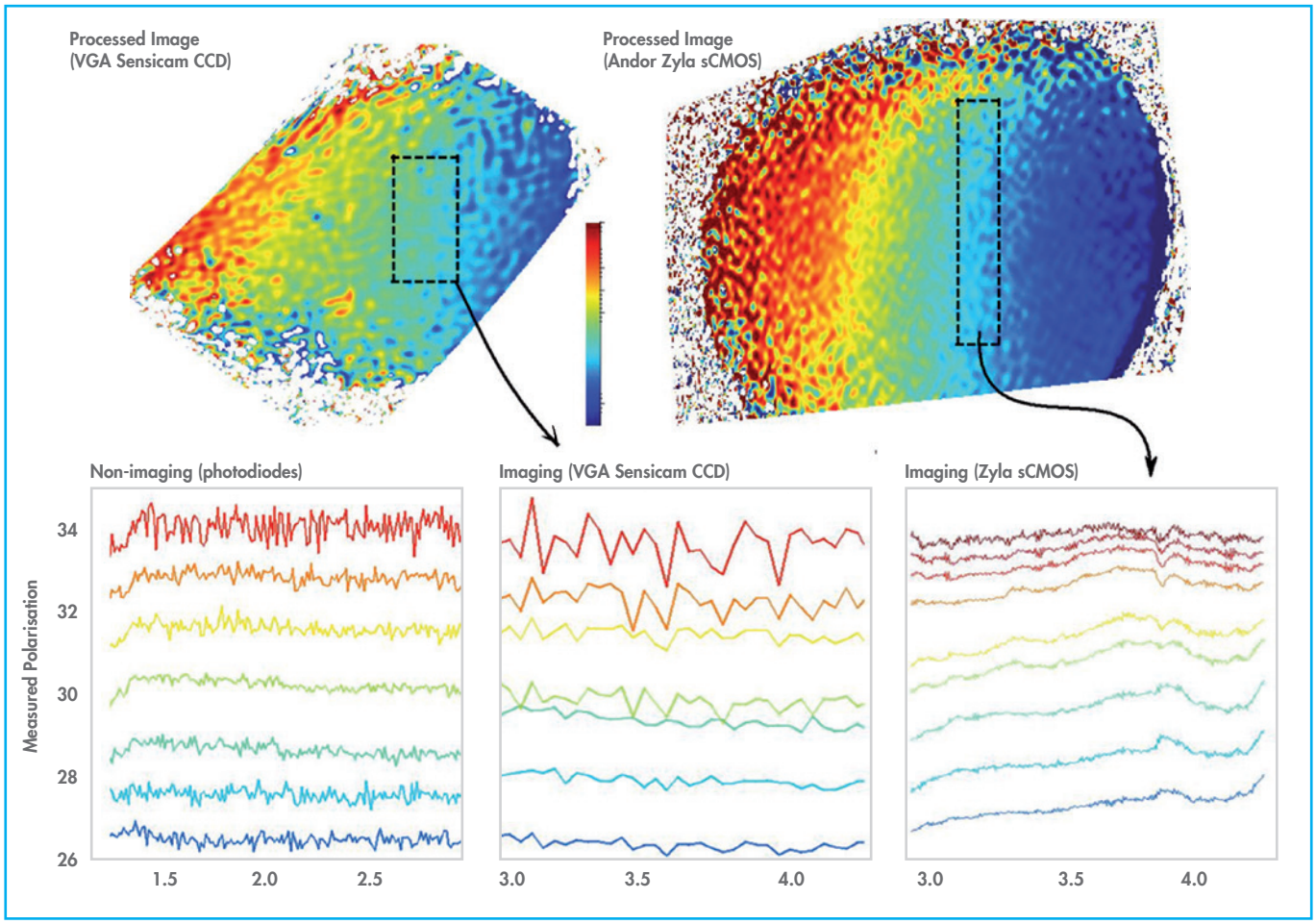

Figure 1: Comparison of MSE measurements from non-imaging system and the imaging system with old and new cameras.

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The provided software and SDK worked under Windows and the SDK acceptably under Linux. The SDK is simple and the camera was quickly integrated into existing software. The SDK documentation provided is good but source-code for the Linux drivers is not provided, making debugging unnecessarily difficult.

Performance
The camera performed well and gave a significant improvement in both image quality and temporal resolution. The figures show the desired measurement made with a photo-diode based system and with the imaging system using the old (Sensicam VGA interline transfer CCD) and the new (Zyla sCMOS) cameras.

Reference
[1] "First results from the Imaging Motional Stark Effect diagnostic on Asdex Upgrade", O2.110 40th EPS Conference on Plasma Physics, Espoo, Finland 2013', http://ocs.ciemat.es/EPS2013PAP/pdf/O2.110.pdf

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