Pixirad: unique hybrid pixel technology for X-ray diffraction, scattering and imaging

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Pixirad is a start-up company that turned hybrid pixel 2D detection technology originating from the Italian Institute of Nuclear Physics into commercial products. Over the last years, PANalytical and Pixirad have been collaborating on the use of this technology for X-ray diffraction, scattering and imaging applications in the Empyrean diffractometer. In the beginning of 2017, PANalytical acquired Pixirad, and both parties are now jointly working on next-generation hybrid pixel area detectors for applications in X-ray diffractometers and other instruments.

Hybrid pixel technology offers several advantages over other 2D detection technologies:

- A very low intrinsic noise, mainly set by cosmic radiation
- A very high dynamical range, allowing both the detection of weak and strong signals
- A point spread function of only 1 pixel, yielding sharp images without blurring and no parallax problems when dealing with short sample-to-detector distances
- A technology that is robust against accidental irradiation by the direct beam and does not require periodic maintenance such as replenishment of detection medium.

We currently have two complementary techniques, the Pixirad technology and the Medipix technology. On top of the generic advantages mentioned above, these technologies offer:

- very fine pixel sizes of only 55-60 microns, and
- two-level energy discriminators suppressing both fluorescent radiation, white radiation and higher harmonics, therefore allowing energy-selecting capabilities for imaging applications ("chromatic photon counting")
- in the latest generation, the possibility of charge-sharing correction, allowing corrections for photons spreading their charge over two adjacent pixels.

The Pixirad detector has specific advantages such as:

- It offers the largest number of pixels (>240,000) on one chip (31 mm x 25 mm), without dead areas, combined with a very small pixel size of only 60 microns
- Highest-grade Cadmium Telluride sensor material offering 100% detection efficiency not only for Cu radiation, but also for hard radiation (Mo, Ag, and higher)
- A detector designed from the beginning to be cooled during operation for maximum performance
- The detectors can be tiled to reach a larger active area – the largest product currently available offers almost 2,000,000 pixels

We named this detector GaliPIX^{3D}, to honor the famous Italian astronomer Galileo Galilei, who was born very close to the place where the Pixirad technology was invented. Integrated in the Empyrean instruments, GaliPIX^{3D} can be operated in 1D and 2D data collection strategies, either in static (snapshot) mode or in scanning mode – allowing a further extension of the angular coverage without introducing dead areas.

In this presentation, we will present some of the spectacular data sets that our users and application specialists have been able to collect on the Empyrean system.

Image: Transmission Wide Angle X-ray Scattering (WAXS) measurement of Silver Behenate using Cu radiation. The sample-to-detector distance was 25 mm.