PNDetector

THE pnCCD (S)TEM CAMERA

The pnCCD (S)TEM Camera is a pixelated, fast, and direct electron detector for applications in both TEM and STEM. Thanks to its outstanding **signal to noise ratio of 300:1** (for 80 keV electrons), single primary electron detection from **20 keV to 300 keV** is possible. With its high readout speed it opens up new scientific and analytical possibilities in electron microscopy such as **4D-STEM imaging** and low dose **TEM imaging**.

The full system is now available at PNDetector and comes with

The pnCCD Camera

- pnCCD with 264 x 264 pixels
- Readout speed: 1 000 fps (full frame), up to 20 000 fps (windowing/binning mode)
- Radiation hard
- Lead shielded camera head (bottom mount)

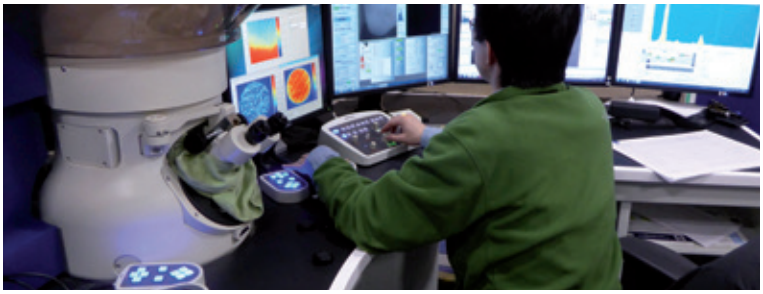
Electronics & Data Acquisition System

- Uninterruptible power supplies
- Camera control unit
- High performance data acquisition

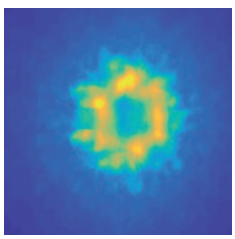
Software Package

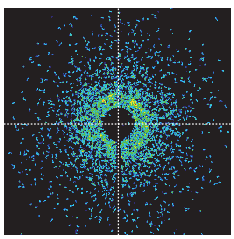
- Camera control (COS), data recording & analysis (PNOnline)
  - One button on/off
  - Windowing & binning
  - Choice of operation modes
- User-selectable virtual apertures for live synthetic STEM images (DPC, disk, ring, centroids, etc.)
- Save all data to hard drive for later analysis

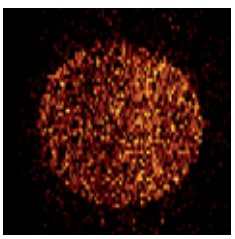
Example for the pnCCD live view screen (colored graphs next to TEM column): operators can use a live single frame view, a live rolling average view and live synthetic STEM images.

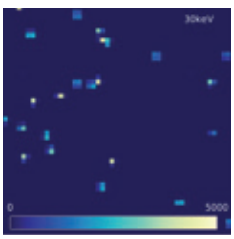


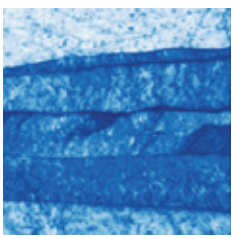
... and a wide variety of application possibilities







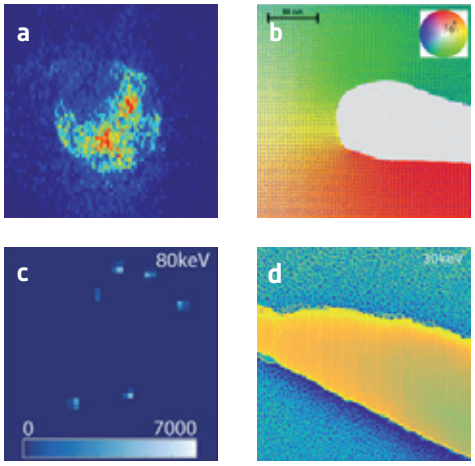




NEW scientific techniques

With the unique properties of the pnCCD (S)TEM camera new scientific techniques become accessible. **In STEM** the full 2D scattering pattern can be recorded for each probe position at high speed and high granularity providing **4D datasets** of the sample. In **ptychography** these datasets allow to completely recover the amplitude and phase information. By analyzing the position of the BF disk on the detector **electrical and magnetic fields** are mapped with high precision. Analogous, by determination of the position of a diffraction reflex, the **strain** in the sample can be measured. **In TEM** single electron measurements are possible with energies down to 20 keV. With subpixel analysis the resolution is enhanced from 48 to 10 µm pixel size. Highly dynamic processes can be observed with a time resolution well below 1 ms.

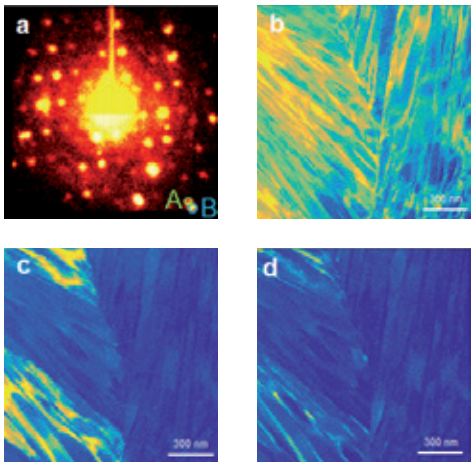
(a) Bright field disk recorded at 4000 fps. (b) STEM-Mapping of the electric field around a probe needle. Analyzed by determination of the position of the BF disk for each probe position. (c) Single electrons detected with 80 keV energy. (d) TEM image of a crack in a sample of gold nanoparticles. Recorded with 30 keV electron energy.



NEW post processing and post correction possibilities

All camera images can be saved to hard drive. After recording one single STEM scan the user can extract BF, ABF, DF, ADF, HAADF and many more synthetic images by using **virtual apertures** (virtual diffraction imaging). With ptychographic analysis it is possible to change the focus and even **correct aberrations after the measurement**.

(a) Diffraction pattern of a Ti-Fe-Mo sample. (b) 512x512 STEM image of a Ti-Fe-Mo sample calculated from the sum intensity of the full camera image at each probe position in CHC mode. Summing the intensity of area A or B, as indicated in panel (a), reveals the position of (c) the A2-phase and (d) the B2-phase (Ti-Fe), respectively.



NEW efficient workflow

With its extreme radiation hardness the pnCCD can be used for both **alignment and recording**, minimizing the time between alignment and measurement to almost zero. The **high performance software** calculates synthetic images real time by applying user-selectable, virtual apertures to the recorded data, while the measurement is running. **The camera can be tuned to your experimental needs** by using dedicated operation modes: The single electron mode allows for the best subpixel resolution in low dose conditions. The imaging mode is ideal for quantitative analysis and the anti-blooming mode suppresses charge spilling.

PNDetector

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July 2016