Reconstructions in the real world

Pierre Thibault and **Veit Elser**

Cornell University, Ithaca, N.Y.

The last decade has seen many breakthroughs in the development of diffraction microscopy. This new imaging method involves the accurate measurement of a specimen's diffraction pattern and the use of an algorithm for the reconstruction of the image. The benefits of this method are numerous, but there are also many outstanding challenges. An essential requirement of any diffraction microscopy experiment is the reproducibility of the reconstructions.

Uniqueness of the reconstruction can be compromised in very many ways. It is now well known that missing data in the center of the diffraction pattern (due to the beam stop) can lead cross a threshold where information is irretrievably lost. Noise is important as well, as it replaces, from the algorithm's perspective, the unique solution with an ensemble of near solutions. Here averaging procedures are indispensable for restoring reproducibility.

Another casualty of noise is the elimination of vital interference effects in the diffraction pattern when these are suppressed due to pathological distributions of intensity. This situation arises in some electron diffraction experiments with specimens containing crystalline domains, such as carbon nanotubes or atom clusters. Information about the large-scale shapes of the domains is encoded in small regions around the diffuse Bragg peaks in the diffraction pattern. Weak interference between the diffuse signal in distinct peaks encodes the relative positions of domains and is easily lost to noise.