Science at the Hard X-ray Diffraction Limit: XDL-2011 Workshops Summary

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In June, 2011 about 500 researchers and students participated in a series of six international workshops devoted to studying the scientific opportunities of x-ray sources operating near fundamental physical limits. The workshops occurred at Cornell University and were jointly sponsored by CHESS, DESY, KEK, and SSRL and supported by the U.S. DOE-Basic Energy Sciences division and the NSF-Division of Materials Research.

Two types of diffraction-limited, high repetition rate, hard x-ray sources were discussed: Energy Recovery Linacs and Ultimate Storage Rings. These new sources will provide two to three more orders of magnitude of coherent flux than current rings and result in ultra-intense nanometer-scale x-ray probes not yet available. They would enable new imaging opportunities of ultra-small features approaching atomic resolution for many areas of scientific inquiry. The machines also feature short x-ray pulses occurring at MHz to GHz repetition rates with durations of 50 femtoseconds to 10s of picoseconds. This will greatly extend repetitive pump-probe experiments currently done at storage rings and will enable new classes of timing experiments that can illuminate how materials respond to external stimuli. The six workshop titles indicate the science areas that were covered: WS1: Diffraction Microscopy, Holography and Ptychography using Coherent Beams; WS2: Biomolecular Structure from nanocrystals and Diffuse Scattering; WS3: Ultra-fast Science with “Tickle and Probe”; WS4: High-pressure Science at the Edge of Feasibility; WS5: Materials Science with Coherent Nanobeams at the Edge of Feasibility; WS6: Frontier Science with X-ray Correlation Spectroscopies using Continuous Sources.

The workshop programs encouraged speakers to present novel ideas and to brainstorm about new science that could be done that is currently impractical at today's x-ray sources. Participation was very lively and many good ideas were identified. The machine characteristics will be very succinctly summarized, followed by examples of science that would be enabled by these new types of x-ray sources.