Where APS Full-field x-ray imaging can be in 5 years.

A: 'Conventional' absorption/phase x-ray imaging with spatial resolutions ~ 1 micron

1. Larger field of views (~ 25 mm H x 10 mm V) to accommodate mouse-sized samples.
2. Improved spatial resolutions to below 1 micron (from current 1.2 micron).
3. Improved image quality for phase-contrast due to smaller angular source size; achieved via a long beamline and/or accelerator horizontal beta improvements.
4. Complete 3D tomography data set in ~ 1s
5. Improved S/N > 40 for single-shot (100 ps) exposure by optimized insertion device and cooling of scintillators.
6. Tomography of extended objects: either by local tomography or stitching
7. New contrast agents will be developed for animal physiology studies.
8. Increasing integration of simultaneous x-ray imaging to other techniques (eg., optical microscopy or x-ray scattering).
9. Tomography reconstruction times reduced to ~ 1 minute for 2Kx2K images.
10. Use of larger detectors (4K and larger).

Types of experiments:
Ultrafast imaging of supersonic liquid jets/sprays and crack propagation in materials.
High resolution real-time studies of fluid flow patterns in small animals, eg, intra-arterial blood flow or intra-gut mixing.
Very high spatial resolution CT of an extended object eg., 1 micron resolution of an internal crack on a 1 cm piece of material.
Almost-real-time (~ 1 Hz) 3D evolution of material dynamics such as fatigue-induced cracks and corrosion.
Simultaneous measurements in real and reciprocal space eg., to look at local strains in fatigue-induced cracks.

B: Full-field transmission x-ray microscope with spatial resolutions < 100 nm

1. 20 nm spatial resolution at 8-18 keV with ~ 50 micron field of view
2. Hardware/software developments to enable true automated tomographic data collection and reconstruction. (Current system severely limited by mechanical systems).
3. Increased imaging throughput to ~ 20 frames per second allowing for sub-second dynamic studies.
4. New targeted contrast agents will be developed for cellular imaging studies.

Types of experiments:
3D mapping of individual tagged neurons in very small animals (eg. fruit fly).
3D imaging of subcellular structures or organelles.
3D investigation of hard materials under in-situ environmental control
Almost-real-time nanoscale radiography of dynamics.