Beyond microns - next generation USAXS instrument at upgraded APS

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APS USAXS instrument has been available to user community for over 22 years and during this time its users published over 650 journal publications and theses. While this instrument has yet to find serious synchrotron based following, multiple commercial devices are currently available and provide similar capabilities, albeit at much longer data collection times and only fixed (normally lower) X-ray energies. APS upgrade, planned for 2023/2024, will result, among others, in major increase in brightness and reduction in X-ray divergence, offering capabilities which will enable major performance improvements of our next generation APS USAXS. This new device, planned to be installed and commissioned in fall of this year, will extend the low Q range to below 3e-5 [1/A] with possibility to reduce this low Q range even lower in the future. X-ray energy range will be extended to approximately 10 – 30 keV. This will allow study of materials (such as metal alloys) that are hard to perform using commercial USAXS lab source devices. In combination with improved SAXS and diffraction (WAXS) devices, next generation USAXS-SAXS-WAXS will offer up to 6 decades of scatter size characterization. Taking advantage of higher X-ray flux of new APS, data collection times will decrease by at least factor of 2 to less than 90 seconds for full data set; faster data collection is important for in-situ time-resolved studies (such as temperature dependent studies). Overall, next generation USAXS will provide world-unique facility with combined capabilities of USANS instrument for low-q range, SAXS instrument for medium Qs, and powder diffraction device on high-q/WAXS, with penetration capabilities comparable with neutrons for many materials but much shorter times. This new instrument will be available to general user community after APS-U and commissioning, likely by the end of 2024. This talk will present design of the new device, preliminary results obtained on existing instrument, and planned capabilities which user community should find useful to understand.