PiAI Seminar Series: Physics informed AI in Plasma Science
7:00-8:00, 11 July 2022 Los Alamos (MDT)
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Web Seminar

“6H” X-ray imaging frontiers and some recent highlights

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Several themes are emerging that offer unprecedented opportunities in mesoscopic material discoveries: X-ray free electron lasers, ultrafast X-ray imaging technology, exascale computing, and data science [1]. The challenges and opportunities may be summarized as the “6H” frontiers. We first highlight recent development and applications of complementary metal-oxide semiconductor (CMOS) active pixel sensor (APS) imaging technology, which was invented at JPL by Eric R. Fossum (now at Dartmouth) and his team. In addition to material science and broad civilian use as in the cellular phones, CMOS APS sensors are also emerging as a workhorse in fundamental science such as quantum information, for which we highlight recent development in position-sensitive measurement of ultracold neutrons. Traditional hard-ware-centric approaches to high-speed detectors and fast electronics are limited by detector material properties, low signal-to- noise ratio, high cost, and the long development cycles of critical hardware components such as application-specific integrated circuits (ASICs). Interpretation of experimental data is frequently hindered by the fidelity and reliability of the models against which the data is compared. Alternatively, data science is emerging for high-energy physics, medical and material applications of radiography and tomography [2-4]. Advances in artificial intelligence and machine learning approach may contribute significantly to the interpretation of imaging data through statistical, inferential analysis techniques. As a third topic, we highlight recent advances in X-ray radiography and phase contrast imaging through data-driven algorithms and data fusion methods. The work also

paves the way towards better hardware performance, higher information yield and automated interpretation. This work has been made possible by LANL C3, MaRIE TMP, and LDRD programs. LANL Report number LA-UR-24837.

1. P. Denes, S. Gruner, M. Stevens and Z. Wang, Los Alamos Report number LA-UR-17-22085 (2017).
2. https://iml-wg.github.io/HEPML-LivingReview/
3. K. Albertsson et al, IOP Conf. Series: Journal of Physics: Conf. Series 1085 (2018) 022008 doi:10.1088/1742-6596/1085/2/022008.
4. Z. Wang, Applied Optics 61 (6), RDS1-RDS4 (2022).