Nuclear Analytical Techniques at NIST

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This is an overview of nuclear analytical techniques at NIST employed at the NIST Center for Neutron Research (NCNR), operated based on the principle of thermal neutron capture and subsequent emission of MeV gamma rays (PGAA) or charged particles (NDP) (Fig. 1). PGAA was employed as a complementary technique for the certification of standard reference material (SRM), particularly for light elements in various matrices, based on the established comparator method for quantitative analysis. The absolute method based on tabulated partial gamma cross section and measured detector efficiency was also investigated. A recent addition of a linear motion chopper enabled in-neutron beam analysis of prompt and decay gamma rays for short lived radionuclides, mimicking cyclic INAA but without the need for sample transfer. This method was applied to F-20 (11 s half-life) in biological reference materials. In addition to the separate spectral acquisitions according to the chopper's phase, list-mode data were also acquired and processed by using time and energy windows at various chopper duty cycles to evaluate the timing settings. Other research activities include prompt gamma imaging based on Compton imaging using a dual-plane detector with spectral and spatial information, and a planned emission ghost imaging in which spatial resolution is achieved using a single pixel spectral detector. The PGAA instrument is expected to be available when the reactor returns to operation later this year. The NDP instrument was recently relocated to a new curved neutron guide and is expected to accommodate limited users access within a year. The INAA method with in-reactor irradiation (thermal neutron fluence rate about 10^{14}/cm^2-s) is an indispensable technique for SRM certification. Its availability depends on the accessibility of the irradiation area after the reactor resumes operation, as well as the thermal neutron PGAA station heavily utilized for SRM measurements (fluence rate 3.4×10^8/cm^2-s) atop the reactor.

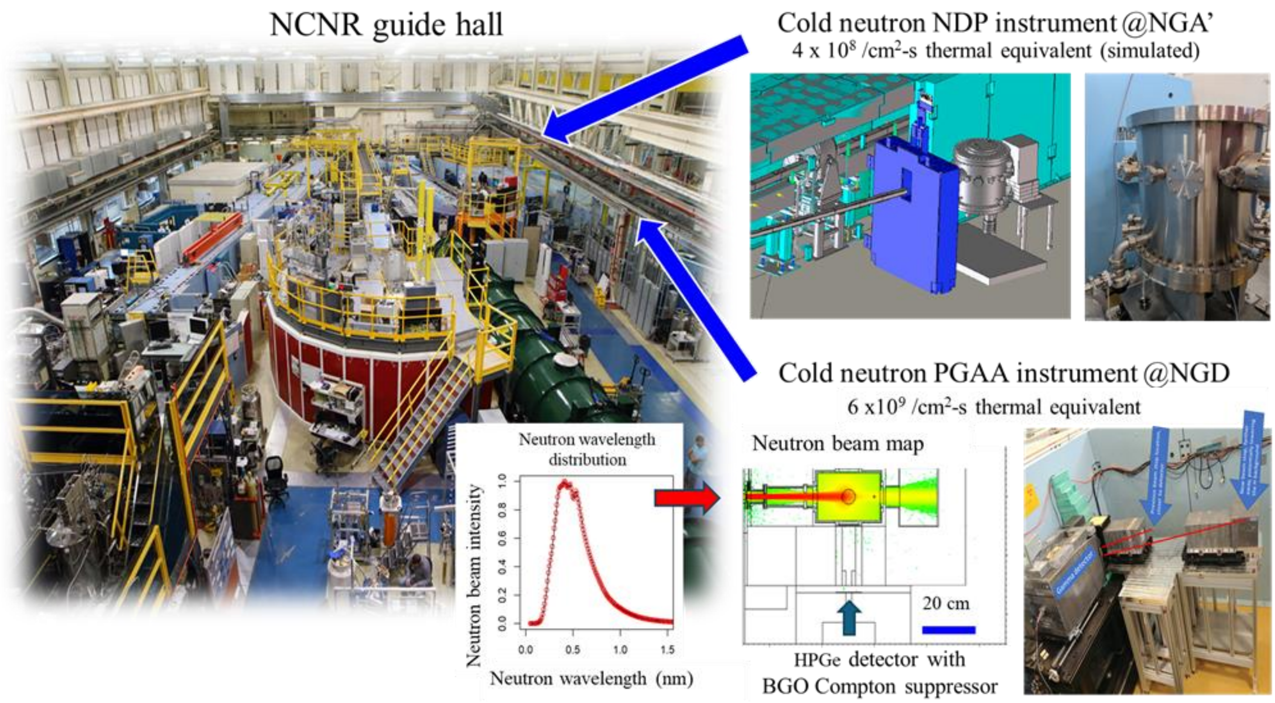

Fig. 1. Cold neutron beam instruments for NDP and PGAA at NIST Center for Neutron Research (NCNR)