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Neutron Imaging John Wiley & Sons
This dissertation advances the capability of autonomous manipulation systems for non-destructive testing applications, specifically computed tomography and radiography. Non-destructive testing is the inspection of a part that does not affect its future usefulness. Radiography and tomography technologies are used to detect material faults inaccessible to direct observation. An industrial 7 degree-of-freedom manipulator has been installed in various x-ray and neutron imaging facilities, including the Nuclear Engineering Teaching Laboratory and Los Alamos National Laboratory, for imaging purposes. Inspection of numerous components manually is laborious and time consuming, and there is the risk of high radiation dose to the operator. As Low As Reasonably Achievable exposure can be significantly reduced by installing a robot in an x-ray or neutron imaging facility to perform part placement in the beam for radioactive parts and nuclear facilities. Automation has the additional potential benefit of improving part throughput by obviating the need for human personnel to move or exchange parts to be imaged and allowing

for flexible orientation of the imaged object with respect to the x-ray or neutron beam. When the process is fully automated, it eliminates the need for a human to enter the beam area. The robot needs to meet certain performance requirements, including high repeatability, precision, stability, and accuracy. The robotic system must be able to precisely position and align parts, and parts need to be held still while the image is taken. Any movement of the specimen during exposure causes image blurring. Robotics and remote systems are an integral part of the ALARA approach to radiation safety. Robots increase the distance between workers and hazards and reduce time that workers must be exposed. Research performed aims to expand the role of automation at nuclear facilities by reducing the burden on human operators. The robot ' s control system must manage collision detection, grasping, and motion planning to reduce the amount of time that an operator spends micro-managing such a system via tele-operation. The subject of this work includes modeling (in MCNP) and measuring flux, dose rates, and DPA rates of neutron imaging facilities to develop predictions of radiation flux, dose profiles, and radiation damage by examining neutron and gamma fields during operation. Dose and flux predictions provide users the means to simulate geometrical and material changes and additions to a facility, thus saving time, money, and energy in determining the optimal setup for the robotic system.

Neutron Imaging and Applications Springer Nature

Small accelerator neutron sources offer considerable potential for applied neutron radiography applications. Among the desirable features are relatively low costs, limited operating hazards, opportunities for tailoring primary neutron spectra, compactness and portability, and modest licensing requirements (compared to fission reactors). However, exploitation of this potential has been somewhat limited, in part, by incomplete knowledge of the primary-neutron yields and energy spectra from the favorable source reactions. This work describes an extensive experimental determination of zero-degree neutron yields and energy spectra from the 9Be(d, n) 1 ° B source reaction, for incident deuterons of 2.6 to 7.0 MeV on a thick beryllium metal target. This information was acquired by means of time-of-flight measurements that were conducted with a calibrated uranium fission detector. Tables and plots of neutron-producing reaction data are presented. This information provides input which will be essential for applications involving the primary spectrum as well as for the design of neutron moderators and for calculation of thermal-neutron yield factors. Such analyses will be prerequisites in assessing the suitability of this source for various possible neutron radiography applications and, also, for assisting in the design of appropriate detectors to be used in neutron imaging devices.

Automating X-ray and Neutron Imaging Applications with Flexible Automation Springer

Neutron Imaging and ApplicationsSpringer

Imaging and Radioanalytical Techniques in Interdisciplinary Research BoD – Books on Demand

Neutron radiography represents a powerful non-destructive testing technique that is still very much in development. The book reveals the amazing diversity of scientific and industrial applications of this technique, the advancements of the state-of-art neutron facilities, the latest method developments, and the expected future of neutron imaging.

Neutron Applications in Earth, Energy and Environmental

Sciences Springer Science & Business Media

We are proceeding with the development of a high-energy (10 MeV) neutron imaging system for use as an inspection tool in nuclear stockpile stewardship applications. Our goal is to develop and deploy an imaging system capable of detecting cubic-mm-scale voids, cracks or other significant structural defects in heavily-shielded low-Z materials within nuclear device components. The final production-line system will be relatively compact (suitable for use in existing or proposed facilities within the DOE complex) and capable of acquiring both radiographic and tomographic (CT) images. In this report, we will review our programmatic accomplishments to date, highlighting recent (FY06) progress on engineering and technology development issues related to the proposed imaging system. We will also discuss our preliminary project plan for FY07, including engineering initiatives, proposed radiation damage experiments (neutrons and x rays) and potential options for conducting classified neutron imaging experiments at LLNL.

High-Energy Neutron Imaging Development at LLNL. Springer Science & Business Media

The overall goal of this book is to promote research and development of imaging and radioanalytical techniques by publishing high-quality chapters in this rapidly growing interdisciplinary field. This book discusses the principles and applications of imaging and radioanalytical techniques across a wide spectrum of interdisciplinary science, technology and medicine, where these techniques are expected to make significant difference and contribution. It also explores the history of the field, current trends, and future directions. The book focuses mainly on cutting-edge applications, and associated equipments and methods, such as instrumentation systems and computing hardware/software. The primary target audience for this book includes students, researchers, clinicians, and professionals who are interested in medical and ground penetrating radar (GPR) imaging, and radioanalytical techniques.

Neutron Imaging Materials Research Forum LLC

Neutron Imaging and Applications offers an introduction to the basics of neutron beam production in addition to the wide scope of techniques that enhance imaging application capabilities. An instructional overview of neutron sources, detectors, optics and spin-filters allows readers to delve more deeply into the discussions of radiography, tomography and prospective applications available in neutron holography techniques. A section devoted to current applications describes imaging single grains in polycrystalline materials, neutron imaging of geological materials and other materials science and engineering areas. Coverage of thermal neutron imaging of biological tissues, plant physiology, Homeland Security and contraband detection explore the future prospects of this cutting-edge research. Written by key experts in the field, researchers and engineers involved with imaging technologies will find Neutron Imaging and Applications a valuable reference.

Report on Measurements at Ohio University to Estimate Backgrounds for Neutron Radiography in the 10-14 MeV Region Neutron Imaging and Applications

This publication contains examples of how neutron imaging has been used in applications requiring the identification of (light) materials inside solid samples. It provides detailed information on how the technique has become a standard method for various applications, from the examination of nuclear fuels, explosives, electronic components and engine turbine blades to the characterization of fuel cells and geological samples.--Publisher's description.

Neutron Radiography Springer

Neutron radiography has proven itself to be an invaluable research tool in the field of nuclear engineering. There are a great many applications that utilize neutron imaging, and further research continues to increase its applicability to a growing number of fields. Many new facilities have been built over the past several years, and an even greater number of existing facilities have been upgraded to more sophisticated neutron sensory equipment. The Sandia National Laboratories has been home to a neutron imaging facility for several decades. Over this time, it has been used with great success in a number of applications. However, with the great advances in neutron collimation and neutron detection in the recent years, it is not unlikely that the facility may soon be retrofitted with more up-to-date technologies. As such, the neutron and gamma ray parameters of the facility must be well-established. This work sought to characterize the neutron beam for the neutron radiography facility at Sandia National Laboratory in Albuquerque, New Mexico. Furthermore, a model of the neutron radiography tube assembly, experiment chamber, and collimator assembly was written and amalgamated to the existing MCNP core deck. The validity of the MCNP model will ultimately be confirmed by performing a number of experiments. These experiments will consist of flux foil calculations at the imaging surface and along various points within the experiment chamber and radiography tube assembly. Additionally, L/D collimation ratios will be found using the ASTM standard method.

Thermal Neutron Imaging Using A New Pad-Based Position Sensitive Neutron Detector Springer Science & Business Media

Neutron Applications in Earth, Energy and Environmental Sciences offers a comprehensive overview of the wide ranging applications of neutron scattering techniques to elucidate the fundamental materials properties at the nano-, micro- and meso-scale, which underpin research in the related fields of Earth, Energy and Environmental Sciences. Introductions to neutron scattering fundamentals and instrumentation are paired with a thorough review of the applications to a large variety of scientific and technological problems, written through the direct experience of leading scientists in each field. Tailored to a wide audience, this volume provides the novice with an inspiring introduction and stimulates the expert to consider these non-conventional problem solving techniques in his/her field of interest. Earth and environmental scientists, engineers, researchers and graduate students involved with materials science will find Neutron Applications in Earth, Energy and Environmental Sciences a valuable ready-to-use reference.

Neutron Imaging and Applications Springer Science & Business Media

Rapid advances in tomography and imaging techniques and their successful application in soil and plant science are changing our sciences today. Many more articles using imaging and tomography are being published currently compared to 20 years ago. Soil–Water–Root Processes: Advances in Tomography and Imaging is a unique assemblage of contributions exploring applications of imaging and tomography systems in soil science—it provides an updated collection of X-ray computed tomography, synchrotron microtomography, neutron imaging, magnetic resonance imaging, geophysical imaging tools, and other tomography techniques for evaluating soils and roots. Exciting new procedures and applications have been developed, with the promise to propel forward our understanding of soil and plant properties and processes.

Neutron Imaging John Wiley & Sons

Proceedings of the Second World Conference, Paris, France, June 16-20, 1986

Accelerator System for Neutron Radiography Springer Science & Business Media

This paper will describe ongoing efforts at Oak Ridge National Laboratory to develop a unique experimental capability for investigating flow through porous and fractured geological media using neutron imaging techniques. This capability is expected to support numerous areas of investigation associated with flow processes relevant to EGS including, but not limited to: experimental visualization and measurement of velocity profiles and other flow characteristics to better inform reduced-order modeling of flow through fractures; laboratory scale validation of flow models and simulators; and a 'real-time' tool for studying geochemical rock/fluid interactions by noninvasively measuring material effects such as precipitation and dissolution in EGS representative conditions. Neutron scattering and attenuation based techniques have many distinctive advantages over other radiographic imaging methods for studying certain types of physical processes because cold and thermal neutrons are more highly attenuated by materials with large Hydrogen compositions while they more easily penetrate higher Z materials, such as those used in structural applications. Experiments exploiting this behavior may therefore be devised to study flow behaviors in samples even when thick pressure vessel walls and large sample masses are present. The objective of this project is to develop an experimental setup and methodology for taking EGS representative core samples with engineered fractures and fracture features, subjecting them to a triaxial stress state at EGS representative temperatures (up to 300 degrees C), and pumping high pressure fluid through the sample while imaging and measuring fluid flow characteristics using high flux neutron beams. This effort will take advantage of signature Oak Ridge National Laboratory facilities, including the Spallation Neutron Source and High Flux Isotope Reactor, as well as its core expertise in Neutron Science. Towards this end, a geothermal pressure test cell and flow system has been developed that can accommodate 1.5 diameter, 6 long core samples and apply a radial confining pressure up to 10,000 psi with fluid flow pressures up to 5,000 psi. This cell has been specially designed to optimize the transmission of neutrons and permit improved imaging of the interior of the sample of interest. Proof of principle measurements of the system have been performed and will be discussed in this paper. Techniques for injecting fluid contrast agents to permit visualization and quantification of flow profiles are also being developed and will be described along with future development plans.

Recent Results in the Development of Fast Neutron Imaging

Techniques Springer

Neutron Imaging and Applications offers an introduction to the basics of neutron beam production in addition to the wide scope of techniques that enhance imaging application capabilities. An instructional overview of neutron sources, detectors, optics and spin-filters allows readers to delve more deeply into the discussions of radiography, tomography and prospective applications available in neutron holography techniques. A section devoted to current applications describes imaging single grains in polycrystalline materials, neutron imaging of geological materials and other materials science and engineering areas. Coverage of thermal neutron imaging of biological tissues, plant physiology, Homeland Security and contraband detection explore the future prospects of this cutting-edge research. Written by key experts in the field, researchers and engineers involved with imaging technologies will find Neutron Imaging and Applications a valuable reference.

Neutron Radiography (3) CRC Press

This book provides an extensive overview of the application of neutron characterization techniques in cultural heritage to a broad audience and will be of interest to both scientists and non-scientists in the field. Archaeologists, paleontologists, restaurateurs and conservators, historians and collectors will be fascinated by the wealth of information that can be obtained using neutron techniques, while material scientists and engineers will find details of the experimental techniques and materials properties that can be determined. Neutrons, due to their weak interactions with materials, provide a penetrating, but non-invasive probe of bulk properties. They allow the characterization of the composition and mechanical properties of materials, helping to answer questions related to the dating, the manufacturing process or the state of degradation of artefacts. They allow detailed interrogation of the internal structures of objects that may be otherwise hidden from view. The first section of the book is dedicated to stories describing spectacular discoveries brought about by the use of neutron techniques in a range of applications. The second section covers the experimental techniques in appropriate detail: basic principles, limitations and fields of application.

Neutron Detection and Imaging Springer

In evaluating the feasibility of neutron radiography and tomography in the 10-14 MeV region, it is important to estimate the radiation backgrounds that could potentially interfere with the measurements. In this context, backgrounds refer to all counts in the detector other than those due to neutrons transmitted through the sample without scattering. There are two principal sources of backgrounds: (1) neutrons and gammas resulting from incident neutrons interacting in the sample, and (2) events in the detector arising from neutrons scattering in the accelerator vault and collimation system, together with natural and induced activation. Counts due to these backgrounds are spread fairly uniformly across the detector, and therefore do not compromise the ability to identify small features in the sample on the millimeter scale in a tomographic reconstruction; however, they do increase the neutron dose required to achieve sufficient statistical accuracy to reveal features of interest. Backgrounds are generally considered to be tolerable if their count rates are less than or comparable to the rates from the transmitted (uncollided) beam. If they are significantly above this level, they are a potentially serious problem. Understanding radiation backgrounds is thus critically important in determining the required source strength and running time. The backgrounds must be characterized by their energy, radiation type (neutron or gamma), and their timing relative to emission time at the source. These properties may have a profound effect on the design of the source and detector (e.g., whether a pulsing-and-timing technique is necessary to reduce backgrounds, and whether a simple plastic-scintillator based integrating detector will suffice). In the geometry that we have chosen to study, the sample is located approximately two meters from the neutron source, and the detector (a plastic-scintillator neutron-imaging camera; Ref. 1) is located another two meters downstream. A thick shielding wall with a collimating channel approximately 30 cm in diameter is located between the sample and detector to reduce room-scattered backgrounds. We have studied the first source of background ("internal" or "sample" scattering) in this geometry using the COG Monte Carlo radiation transport code, and have found that these backgrounds should be tolerable (the effect of internal scattering should, in fact, be minimized in a system geometry with 2:1 magnification). The second type of background ("external" or "room" scattering and activation) is more difficult to study with a simulation code because these backgrounds are dependent on specific details of a facility that are difficult to know a priori. We have therefore carried out a measurement of these backgrounds in an existing facility, the Ohio University Accelerator Laboratory (OUAL), whose layout closely resembles the system geometry we envisage using for neutron radiography. These measurements were carried out in February, 1996. The results of this experiment indicate that room-scattering and residual activation backgrounds are low enough to allow the use of an integrating plastic-scintillator-based detector in radiographic applications. It appears that neither time gating nor neutron/gamma discrimination will be necessary to obtain satisfactory images. This results in a significant simplification of the requirements for both the neutron source and the detector; however, it is clear that the detector must be placed in a sufficiently well isolated detector cave, and attention must be paid to optimizing the shielding in the neighborhood of the detector. While these measurements were carried out with 10 MeV neutrons from the D+D reaction, it is likely that the results would be similar for 14 MeV neutrons from a D+T source. We currently favor a D+D source for a practical facility, largely because there is no need for handling tritium with this source.

Characterization of an Accelerator Neutron Source Based on the Be(d, N) Reaction ASTM International Neutron radiography has in recent years emerged as a useful and complementary technology for radiation diagnosis. It is now routinely used in industrial quality assurance and in support of selected research and developmental activities. Conferences are held on the subject, pertinent handbooks exist, and technical papers appear regularly reporting on new developments. While neutron radiography has indeed passed through the transition from a scientific curiosity to technological relevance, it is a sign of its continuing dynamic evolution that little material has appeared which provides an integrated mathematical and physical analysis of the subject possessing both an instructional as well as reference function. It is our hope that this monograph will fill this need. The distinctiveness of neutron radiography rests on the unique interactions between neutrons and nuclei. This leads to some special relationships between the material and geometrical properties of an object and the neutron radiographic image. The evolution of a technical discipline demands that specific conceptual constructs be developed and their mathematical representations examined and compared with controlled experiments. Experience has convinced us that a particular and substantial body of knowledge has accumulated endowing neutron radiography with the essential foundations of a unique mathematical and physical science. Our scientific and professional involvement in neutron radiography began some 15 years ago when the senior author (A.A.H.) found himself with convenient access to the McMaster University Nuclear Reactor and research support from the Government of Canada.

The Characterization and Monte Carlo Simulation of the Neutron Radiography Facility at Sandia National Laboratories CRC Press

Neutron and synchrotron facilities, which are beyond the scale of the laboratory, and supported on a national level in countries throughout the world. These tools for probing micro- and nano-structure research and on fast dynamics research of atomic location in materials have been key in the development of new polymer-based materials. Different from several existing professional books on neutron science, this book focuses on theory, instrumentation, an applications. The book is divided into five parts: Part 1 describes the underlying theory of neutron scattering. Part 2 describes the various instruments that exist and the various techniques used to achieve neutron scattering or bombardment. Part 3 discusses data treatment and simulation methods as well as how to assess the environment of the sample (temperature, pressure, shear, and external fields). Part 4 addresses the myriad applications of small and large molecules, biomolecules, and gels. Part 5 describes the various global neutron sources that exist and provides an overview of the different reactors.

X-Ray Imaging Springer Verlag

We are continuing with the development of fast ((almost equal to) 12 MeV) neutron imaging techniques for use in NDE applications. Our goal is to develop a neutron imaging system capable of detecting sub-mm-scale cracks, cubic-mm-scale voids and other structural defects in heavily-shielded low-Z materials within thick sealed objects. The final system will be relatively compact (suitable for use in a small laboratory) and capable of acquiring both radiographic and full tomographic image sets. The design of a prototype imaging detector will be reviewed and results from several recent imaging experiments will be presented. The concurrent development of an intense, accelerator-driven neutron source suitable for use with the final production imaging system will also be discussed.

Neutron Radiography John Wiley & Sons

Neutrons are an invaluable probe in a wide range of scientific, medical and commercial endeavors. Many of these applications require the recording of an image of the neutron signal, either in one-dimension or in two-dimensions. We summarize the reactions of neutrons with the most important elements that are used for their detection. A description is then given of the major techniques used in neutron imaging, with emphasis on the detection media and position readout principle. Important characteristics such as position resolution, linearity, counting rate capability and sensitivity to gamma-background are discussed. Finally, the application of a subset of these instruments in radiology and tomography is described.