Backscatter Radiography as a Non-Destructive Imaging Tool

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Abstract:

Backscatter radiography by selective detection is a form of Compton backscatter radiography that collimates the dominant near-surface x-ray scatter signal to allow for sub-surface imaging of flaws and features of interest in applications in which traditional transmission radiography is impractical. Backscatter radiography by selective detection can utilize x-ray tubes up to 1 MV, although practical limitations of the backscatter signal normally limit use to below 600 kVp. While most backscatter imaging techniques use a highly collimated pencil beam of x-rays to provide position information, this limits acquisition speeds and reduces application space. The use of x-ray fan beam geometries and high frame-rate linear detector arrays allows one to overcome these challenges and produce images over large areas. Current commercial off-the-shelf linear detector arrays have the potential to acquire images at rates of 5 meters per second or higher. In this presentation, the principles of backscatter radiography by selective detection are reviewed. The use of linear detector arrays with x-ray fan beams is discussed. We present preliminary results for a prototype system that shows sub-cm position resolution is possible for a number of backscatter radiography applications, with significantly improved scanning rates of better than approximately 3.5 m^2/s. We discuss several examples of backscatter radiography by selective detection, including land mine detection, spacecraft components, and applied areas such as the inspection of reactor pressure vessel steel, aircraft components, railroad infrastructure, and a new project in *in-situ* imaging of plant root structure.

Bio

Dr. James E. Baciak (PI) (Ph.D., Nuclear Engineering, University of Michigan, 2004) is currently a Florida Power and Light Professor and Director of the Nuclear Engineering Program in UF's Materials Science and Engineering Department. Dr. Baciak was a faculty member in Nuclear and Radiological Engineering at the University Florida from 2004-2010. From 2010-2012, he was a Research Scientist within the National Security Directorate at Pacific Northwest National Laboratory (Richland, WA),

before returning to the University of Florida and the Nuclear Engineering Program in 2012. He is the former Interim Chair for Materials Science and Engineering at the University of Florida. His expertise areas include detector development and radiation measurements, scintillation detectors, compound semiconductor materials, radiation imaging, background rejection techniques, national security - nuclear nonproliferation applications, and non-destructive examination (medical and industrial). In his nine years at the University of Florida, he has been a PI or Co-PI on over $20 million in project grant funding (including ~$9 million as PI), from federal agencies, national laboratories, and industrial partners. He has received over funding from the Department of Energy, Department of Homeland Security, National Nuclear Security Administration, Nuclear Regulatory Commission, and Defense Threat Reduction Agency. He and his students have published over 50 papers and over 100 conference presentations. He is the current chair for the International Society for Optical Engineering's (SPIE's) Penetrating Radiation Technical Event, and is the past chair of the American Nuclear Society Scholarship Policy and Coordination Committee. He is also a co-developer of the Nuclear Security Summer School at Pacific Northwest National Laboratory. He is a member of many professional societies, including ANS, IEEE, SPIE, and ASNT.