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2015 Shared Knowledge Conference Presentation

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It is February 17, 2015. Delegates and scientists from 30 nations have gathered in Nabat, Morocco hours after intelligence agencies received information about a stolen nuclear device with possible intent to use it there. The international team in Nabat is barely assembled when they receive the first blood curdling reports that a low-yield nuclear device has been detonated in Casablanca, a nearby city of over 3 million. As a mushroom shaped cloud rises in the distance, teams scramble to minimize casualties and collect data in an effort to identify the source of the attack.

This simulated event, which the United States Domestic Nuclear Detection Office, a part of the Department of Homeland Security, participated in with international partners is one of many such exercises with the mission of preventing scenarios like these from becoming reality. The DNDO's front line of defense against nuclear terrorism includes screening people and cargo at all major entries to the US by land, air, and sea for nuclear material using radiation portal monitors, a device which relies upon the types of math and algorithms that my research works to improve.

A typical radiation portal monitor looks a lot like a highway toll-booth, except that instead of people or baskets taking money, there are mounted, box-like radiation detectors. Dangerous nuclear material gives off radiation signals, which these detectors can pick up. A nuclear material smuggler can try to hide these signals using materials that block radiation, but an ever so faint and unique signal will still get through. The detectors must be well designed to pick up these faint signals, and from them back-calculate what is in the vehicle, not knowing what the smuggler may have done to try throw off these calculations. My research applies or creates new mathematical methods and algorithms which solve radiation calculations involving unknowns like these.

Other applications of my mathematically based research include making nuclear energy cheaper and safer, new technologies like fusion for usable energy, and making sure the United States' aging nuclear arsenal can work when we want, how we want, but in no other way.

Last year over 600 million containers entering the United States were checked with radiation portal monitors, helping protect us from the threat of nuclear terrorism, however, the current system required further investigation on too many of these which did not contain contraband, and our equipment is already aging. My research improves the ability to make these types of radiation calculations involving unknowns, and could potentially make more accurate, cheaper, and longer-lasting nuclear forensics equipment for the DNDO, helping provide us with a safer tomorrow, and in fact a tomorrow.