into a host of biomedical applications used in the treatment of common diseases.

The nature of this achievement may be appreciated by understanding a few of the technical details. In many cases of exposure, the most common route of entry into the body of the heavier radioactive elements, more formally called transuranic nuclides, is via the respiratory system. Typically, they take the form of dust, attach themselves to fine airborne particles, or to minute droplets of water, such as found in condensing steam. As such, they are inhaled and deposited, mainly in the lungs.

An accurate medical assessment of this situation requires precise knowledge of the type and quantity of each nuclide deposited, of which there may be more than a dozen. Once deposited, however, they are very difficult to detect. This is because most of the telltale signs that would otherwise arise from the radioactive elements are either fully hidden by the surrounding tissues or of such weak or varying strengths that they cannot be uniquely identified using conventional radiation detectors.

In the natural course of the radioactive decay of a heavy element, however, there is a faintly detectable secondary reaction, which gives rise to the emission of a number of low energy x-rays. The emissions from this secondary reaction provided the key to the information the Seed Money researchers were seeking.

Technically speaking, as the nucleus of a large and unstable atom transforms itself into a slightly smaller one, in a process called decay, it gives off among other things an energetic, electrically charged (alpha) particle. This type of emission forms the bulk of the radioactivity.

In many instances, however, the newly formed nucleus is left in a highly perturbed or excited state. In a nuclear process called "internal conversion," this extra energy may be transferred to one of the nucleus' orbiting electrons. This causes the electron to become excited, knocking it out of its normal or so-called ground state. The resulting "hole" is then filled by a neighboring electron, which falls into the hole, creating a new one, and gives off an x-ray in the process.

As this process is repeated, the cascade of falling electrons gives off a wide range, or spectrum, of low energy x-rays. The characteristics of the spectrum are unique to each nuclide and are akin to an identifying signature or fingerprint. Some of these x-rays pass out of the body unobstructed and, in theory, could be detected.

The Seed Money researchers reasoned that if they could develop a detector of sufficient sensitivity to count the x-rays, and of sufficient power of resolution to finely measure their identifying energies, then they could work back through the reference data on x-ray spectra and determine all the contributing sources.

Although seemingly straightforward, there were several problems to overcome. The x-rays were so weak that a highly sensitive, wide-area detector had to be built and calibrated. Second, reference data for many of the manmade elements were either uncertain or did not exist. The researchers had to confirm them or develop them from scratch. Third, the detected signal from one element appeared among the data with all the others. Like a complex puzzle, each piece had to be carefully examined, matched with others, and then each matched set sorted out one-by-one. Overcoming all these problems, they were able to identify the sources.

Determining their quantities, however, was another matter. This is because the strength of the signal varies with the depth of the source and the extent to which the x-rays might have been obstructed by absorption in the body's tissues. Since these facts were not known, the quantity of each nuclide could not be inferred from the strength of the signal alone.

The solution to this problem involved a combination of physics and mathematical modeling of the body's tissues. The physics made use of the fact that the likelihood of an x-ray being absorbed by the body is roughly proportional to its energy. Typically, the lower the energy, the higher the rate of absorption. Hence, a comparison of two or more different x-rays from the same nuclide, each having a discrete energy, should show a proportionally greater fall-off in signal strength among those at the lower end of the energy spectrum. The extent of this fall-off reveals crucial information about the depth of the underlying tissue and its absorption characteristics.

The mathematical modeling provided a three-dimensional picture of the body's bone, lung, and muscle tissues, each of which absorbs x-rays in varying degrees. By fitting the detected signal to the mathematical picture, and by comparing the expected values of absorption to the apparent values, the model could estimate the average depth of each source at each location, and calculate the amount of each nuclide present.

The Seed Money researchers developed the theory, data, and methods necessary to overcome each problem. The success of their experimental work proved the viability of the concept. This ultimately led to the development and commercialization by others of a highly sensitive, workable and reliable instrument.

Today, thanks to the existence of the whole body radiation counter, any individual who suspects that he or she may have been exposed to radioactivity from uranium and related manmade elements can be assured of an accurate medical assessment of the situation. With reliable information, a prognosis may be made with confidence. Importantly, the psychologically debilitating effects of uncertainty, which often accompany such cases, may be eliminated altogether. Treatment, if required, can proceed in a carefully deliberated fashion with increased likelihood of success.