The MagViz team

The team in Physics Division has a decades-long history of science applications requiring detection of ultra-low magnetic fields. The focus has been using ultra-sensitive detectors know as SQUIDs or Superconducting Quantum Interference Devices.

These devices have been traditionally used for detection of the ultra-weak magnetic fields emanating from the brain for passive measurements of neuronal activity, a field known as magnetoencephalography.

The SQUID is also used in an application known as ultra-low field magnetic resonance, which relies on the same physics behind the traditional hospital MRI with one big exception: Instead of big magnetic fields, the fields are no stronger than the magnetic field of the Earth. The method retains the primary strength of traditional MRI: the abililty to probe chemical environments as well as provide images. The same physics which gives rise to tissue contrast in an anatomical MRI of the body is what allows MagViz to determine differences in the chemical environment of liquids.

While x-ray methods sample density and nuclear properties, MagViz has the ability to directly probe chemical environments, providing complementary information. The Department of Homeland Security sponsors work on MagViz.

New 7-channel SQUID MRI system for imaging and materials studies.

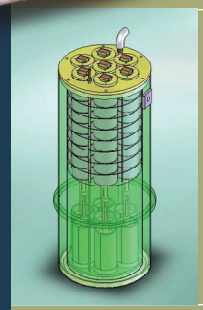
Microtesla MRI of the human brain combined with MEG
Journal of Magnetic Resonance 194 (2008) 115–120

MagViz was developed from low-field MRI scanning technololgy that produced the first microtesla MRI image of the human brain.

Collaboration

MagViz development was led by the Applied Modern Physics Group from Physics Division along with collaboration from science and engineering divisions across the Laboratory including:

- Accelerator Operations and Technology
- Applied Engineering and Technology
- Hydrodynamic Experiments
- International, Space & Response
- Laboratory Directed Research and Development
- Materials Science and Technology
- Nuclear Nonproliferation
- Safegaurd Science and Technology
- The National High Magnetic Field Laboratory



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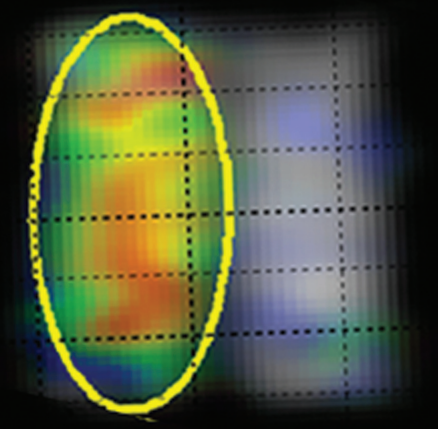
LALP-08-070

MagViz
Ultra-low-field MRI

Which one is the liquid explosive?



MagViz Knows

Los Alamos
NATIONAL LABORATORY

Liquid explosive?

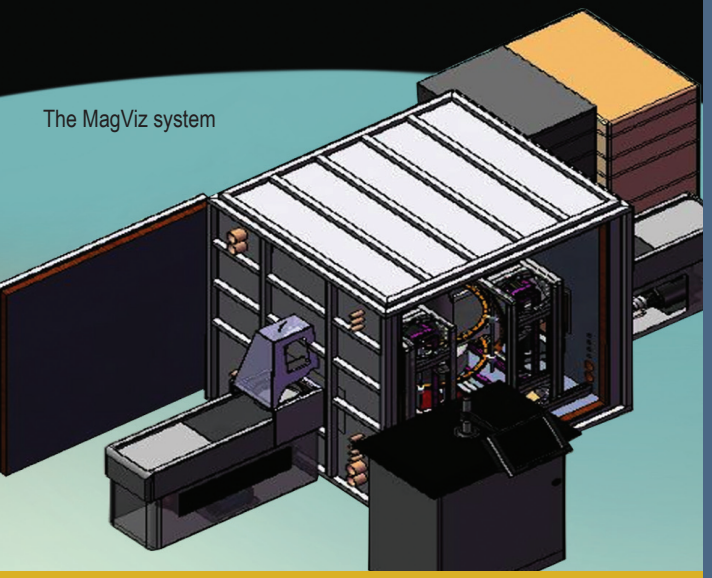
Does that clear bottle hold spring water, or does it contain a liquid explosive? MagViz makes that determination, even if the container is hidden among harmless objects or sealed in metallic foil.

Complementing x-ray's ability to detect guns and knives, MagViz detects harmful materials inside sealed containers. Questionable liquids are found without opening the container.

MagViz uses recent advances in ultra-low field magnetic resonance imaging (MRI) to classify materials into safe, unknown and dangerous categories.

MagViz works by manipulating and detecting hydrogen atoms with small magnetic fields. Pattern-matching software compares the detected signature with a database of dangerous materials.

Comparable in size to an ordinary baggage x-ray machine, MagViz may render unnecessary the rules limiting the amount of liquid transported in carry-on luggage. MagViz promises to speed airport security lines while increasing passenger safety.



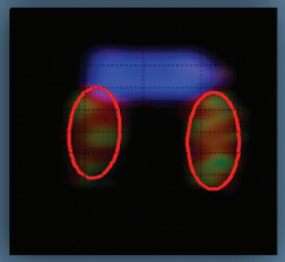
The MagViz system

MagViz applications

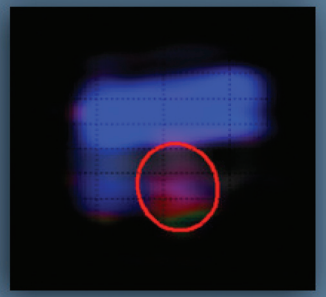
- Airport screening of carry-on liquids.
- Portal screening at government buildings, courthouses, and other potential target facilities.
- Differentiating spoiled from unspoiled foods, including substances in metal cans.
- Providing low-cost, portable MRI instrumentation for field applications, medical clinics, and hospitals in resource-poor settings.

A bin carrying multiple commodities enters the MagViz prototype.

The sealed bottles at right all look the same. Without time-consuming or potentially dangerous chemical tests, MagViz can tell the harmless from the harmful, and circles the harmful materials in red, below.



A bin loaded with various commodi-ties. A possible threat substance is partially layered beneath a foil package.



MagViz identifies the possible threat in the center container.

MagViz capabilities

- Provides identification of materials in a collection or packaged separately, regardless of the packaging material.
- Prevents the transportation of hazardous and/or toxic materials or materials that may be used as components of an explosive device. This applies to public transporation as well as access to public buildings.
- Is compatible with existing x-ray screening technology and other imaging methods.
- Evaluates liquids from their chemical fingerprints. By linking with a computer database, different threats can be added as they emerge.