Fraunhofer Institute for Technological Trend Analysis INT

Detector Systems for Fast Search and Identification of R&N Material in situ

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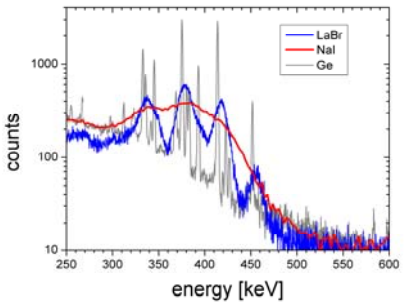
Detector Materials

For in-situ detection of gamma radiation scintillation detectors are widely used. Although they have a lower energy resolution compared to semiconductor detectors (e.g. Germanium-detector) they feature better detection efficiency because of the possibility of producing detectors with bigger crystals. Furthermore they can be better handled and are more portable because they need not to be cooled. To improve the energy resolution and the detection efficiency of such detectors continuous research and development of new scintillation materials is in progress. One of the most recent developed scintillation materials is Cerium doped Lanthanum Bromide ($LaBr_3$).



Measured ^{239}Pu spectrum with LaBr, NaI and Ge-detector for demonstration of their different energy resolution

- Relative efficiency is up to 50 % higher for $LaBr_3$ crystals compared to NaI.
- Measured energy resolution for three detectors with different detection material for a gamma-energy of 662 keV:

  NaI : 6.8 %

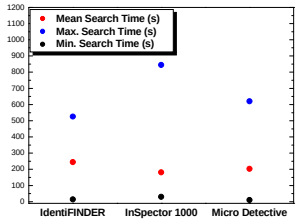
  $LaBr_3$: 3.3 %

  Ge : 0.3 %

Detector Comparison in Test Searches

To compare the qualification of detection devices concerning localization and identification of radioactive material a series of surveys was performed. A small Co-60 source was hidden in various places inside one of our institute's labs (ca. 30 m²). Seven test persons performed the surveys with three detectors which featured the three different crystal types mentioned above and varied in size, weight, and software. The time required for the location of the test source was noted for each survey. Additionally, identification measurements were performed after the source had been localized.

Test person localizing a Co-60 source (red arrow) hidden in a cable rack with the HPGe detector "Micro Detective"



Comparison of the mean, minimum, and maximum search times for the three investigated detection devices

All three detection systems (IdentiFINDER: NaI, InSpector 1000: $LaBr_3$, Micro Detective: HPGe) showed similar and satisfactory results at localization and identification of radioactive material

- The search time in the 30 m² room varied from a few to several hundred seconds (mean value around 200 s), the Micro Detective allowed for the quickest identification time (3 s for Co-60)
- Drastic differences in weight and therefore in handling need to be taken into account (Micro Detective: 6.9 kg; IdentiFINDER: 1.25 kg; InSpector 1000: 2.4 kg)
- Acoustic signals of the detectors proved to be very useful for localization
- "Best" choice of detector depends especially on user's experience (e.g. Micro Detective is preferred by experienced users) and capabilities, but also on the requirements of the task (e.g. Micro Detective is difficult to handle in tight and angled space)

Portal Monitor

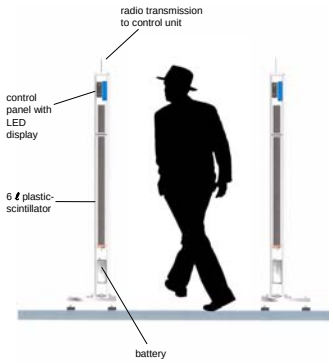
The Portal Monitor is used for monitoring passing persons or vehicles

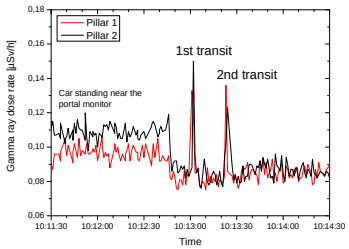
- Range of the radio link: about 1 km in unobstructed area
- Battery operation time: approx. 1 day
- Data recording and analysis by a measuring computer (PC or laptop)

Example:

Pass through the Portal Monitor with 45 km/h

^{137}Cs (265 MBq) source placed in shielding-container (Fe+Pb) inside the car





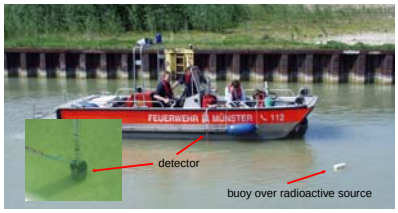
Measuring Container NaNu

- Electromagnetically shielded container with measurement instruments and communication devices
- Trailer-mounted diesel generator with 25 kVA
- Rapid transport by helicopter to inaccessible or difficult to access areas
- Maximum weight of the container including equipment: 5 t (typically 3,5 t)
- Maximum transportation speed: 90 km/h

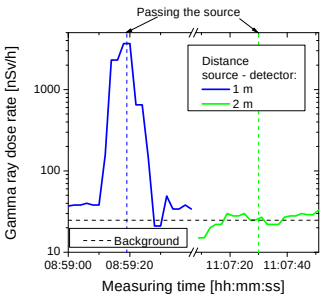
Submersible Probe IdentiSPEC

The submersible probe IdentiSPEC is used for search and identification of radioactive material

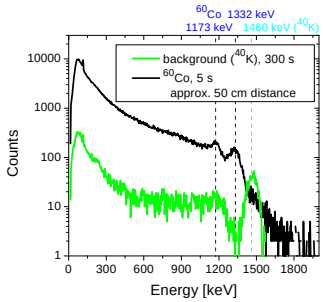
- γ - spectrometry component: NaI(Tl) scintillation detector
- Neutron-component: ^3He counter
- Watertight up to 10 m water depth
- Compact system → flexible application



Example: ^{60}Co source (330 MBq) in a water basin.



Localisation: Passing the detector at different distances from the source



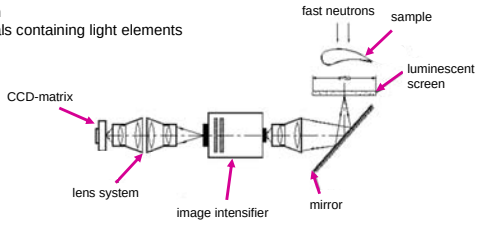
Identification: Gamma ray spectra compared to background

Neutron Radiography

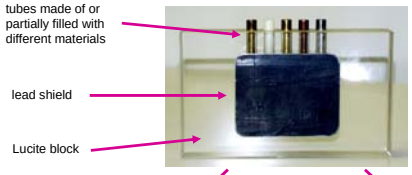
Neutron image camera system
for visualizing concealed materials containing light elements

Intense neutron beams can easily be produced by a nuclear reactor facility.

In the last years compact neutron generators were improved considerably and mobile neutron radiography becomes feasible.

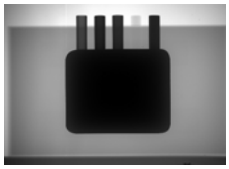


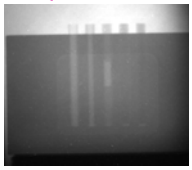
Sketch taken from: www.sciner.com



Neutrons can penetrate heavy materials easily and are strongly absorbed in light materials.

X-ray image





fast neutron image

Collaboration partners:
- **Bundesanstalt für Materialforschung und -prüfung, Berlin**
- **Technische Universität München**