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Isonics corporation

NEUTROTEST- A NEUTRON BASED NONDESTRUCTIVE DEVICE FOR EXPLOSIVE DETECTION

by Dr. Jürgen Leonhardt

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The problem

Detecting hidden storage of explosives devices and explosives is a complicated problem, particularly in view of the development of plastic casings and plastic explosives

→ Solution: **Neutron-based devices**

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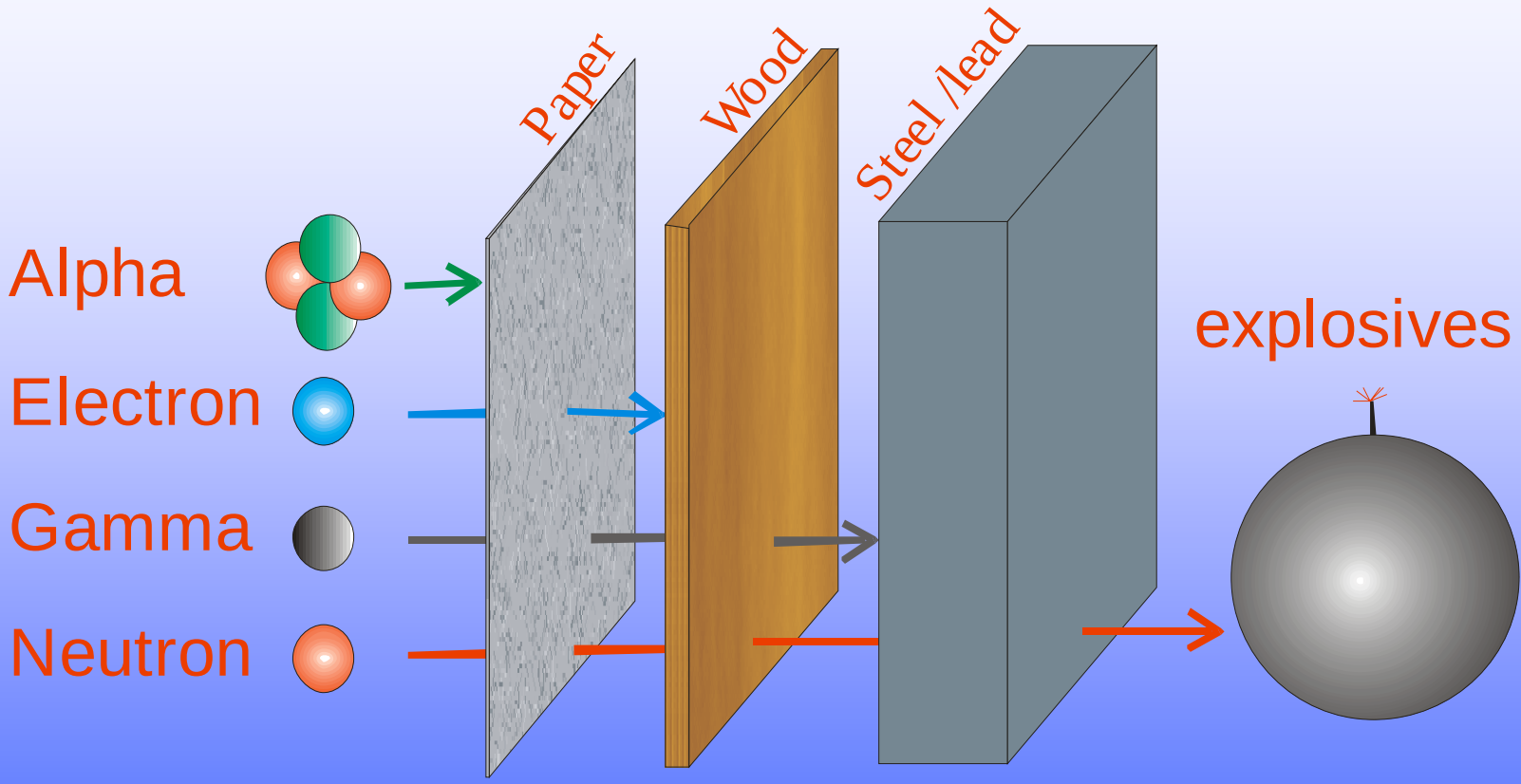
Advantage of neutrons



Since neutrons are able to penetrate several mm of steel and lead, they are particularly suitable for the detection of hidden materials.

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NeutroTest: The principle

- Explosives and drugs consist of light elements like:
  - **hydrogen (H)**
  - **carbon (C)**
  - **oxygen (O)**
  - **nitrogen (N)**

- → **hydrogen** is able to thermalize and backscatter fast neutrons

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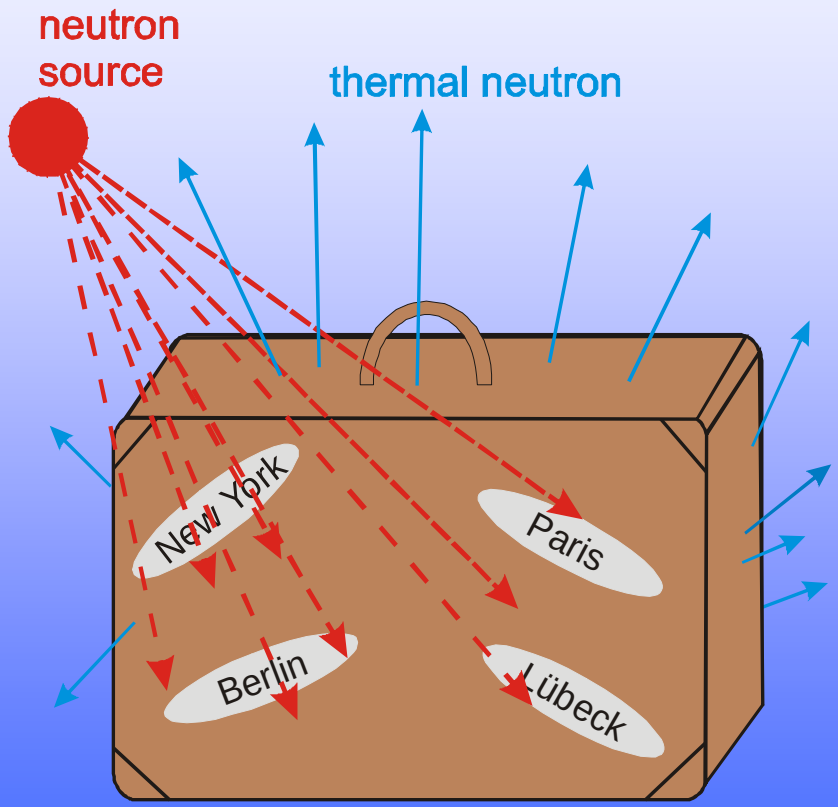
NeutroTest: The principle



Fast neutrons generated by the neutron source irradiate the object, where they are slowed down (thermalized) and backscattered by the light elements.

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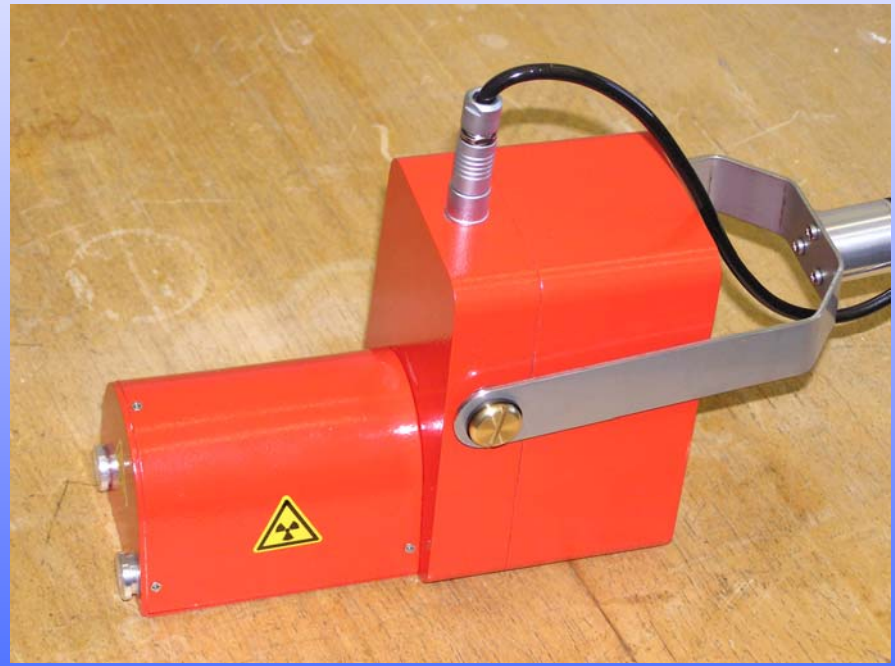
NeutroTest

NeutroTest 0



NeutroTest 1

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A suitcase filled with lab coats (cotton), Pb tube and pieces of paraffin and TNT

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The paraffin and TNT have different hydrogen contents, Pb tube has no H

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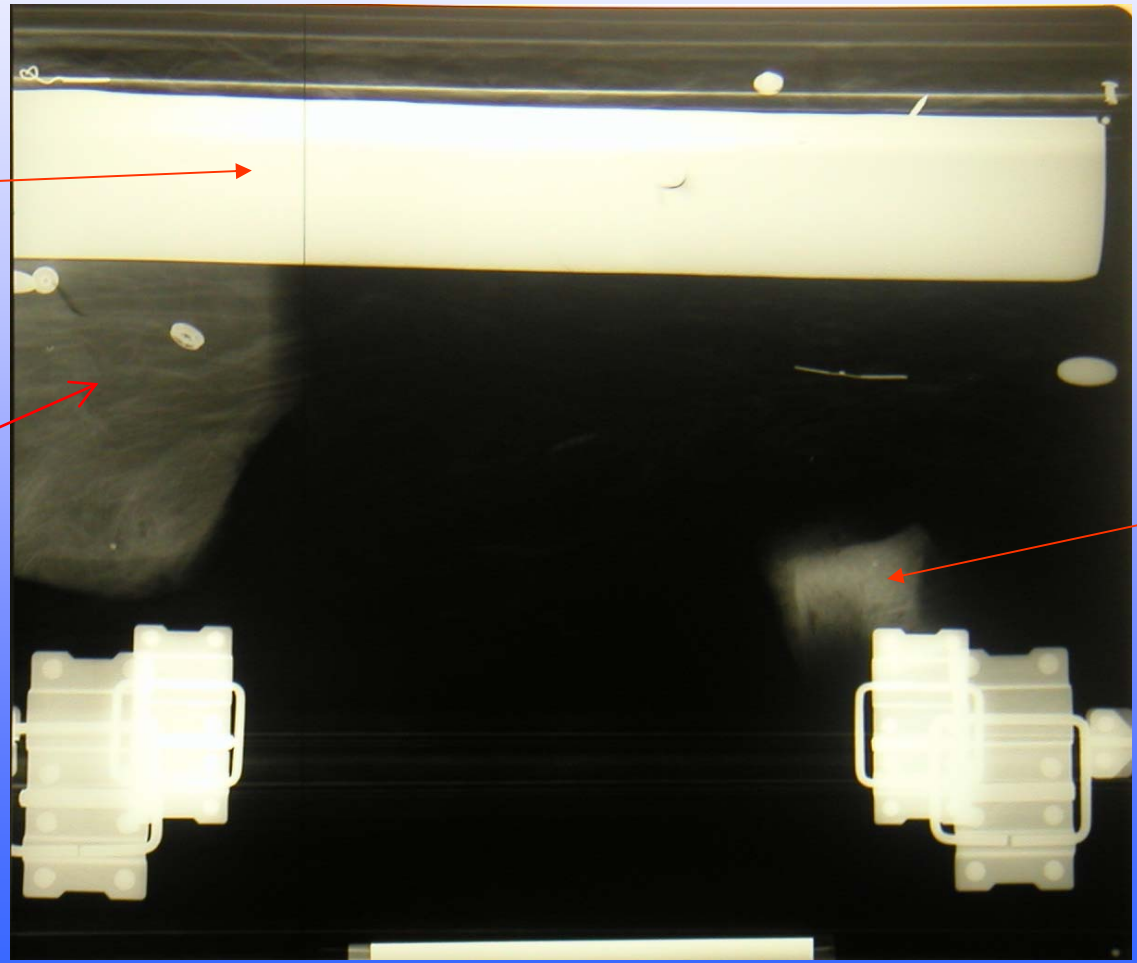
The X-ray of the suitcase shows a density distribution, TNT is difficult to identify



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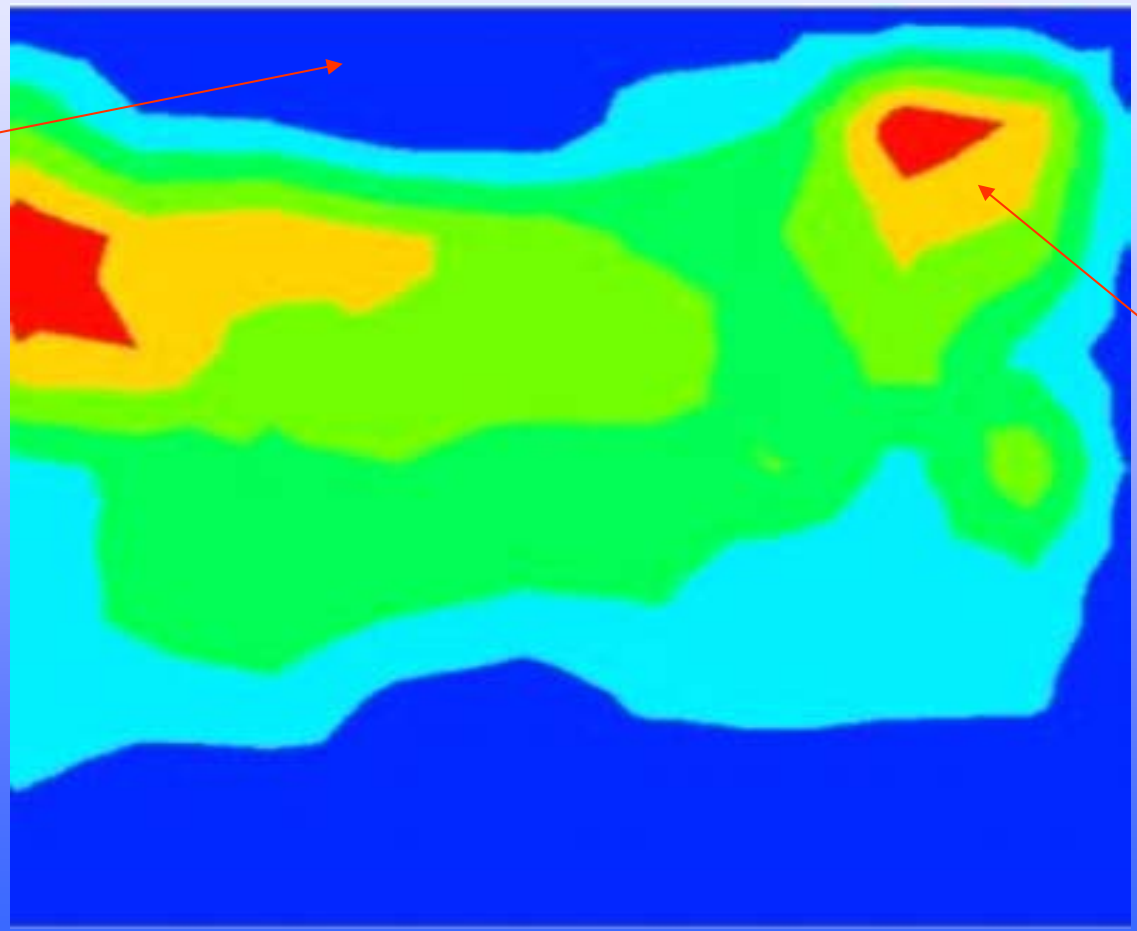
Protonogramm of the suitcase

produced by thermalized neutrons-backscattered



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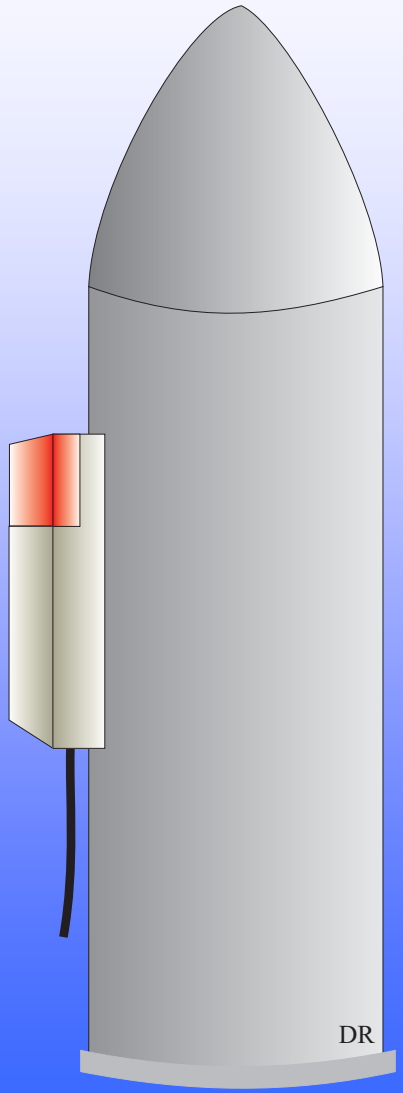
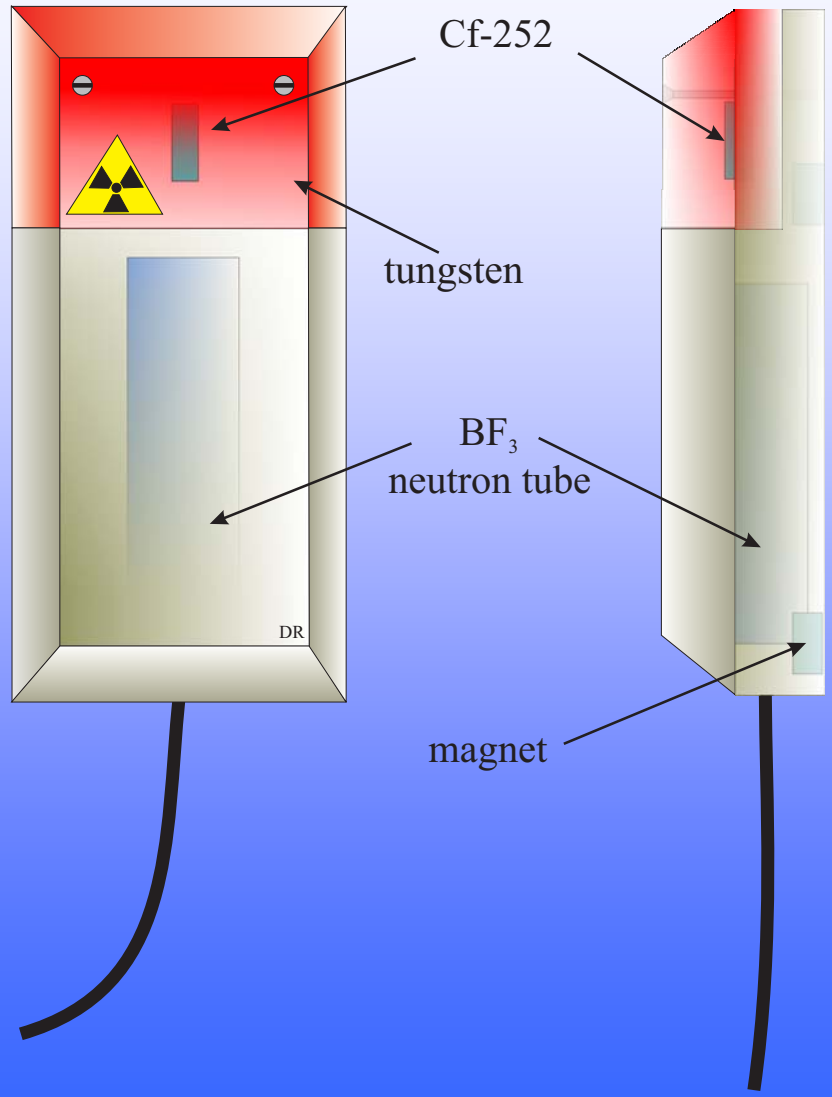
NeutroTest
shell/bomb identifier





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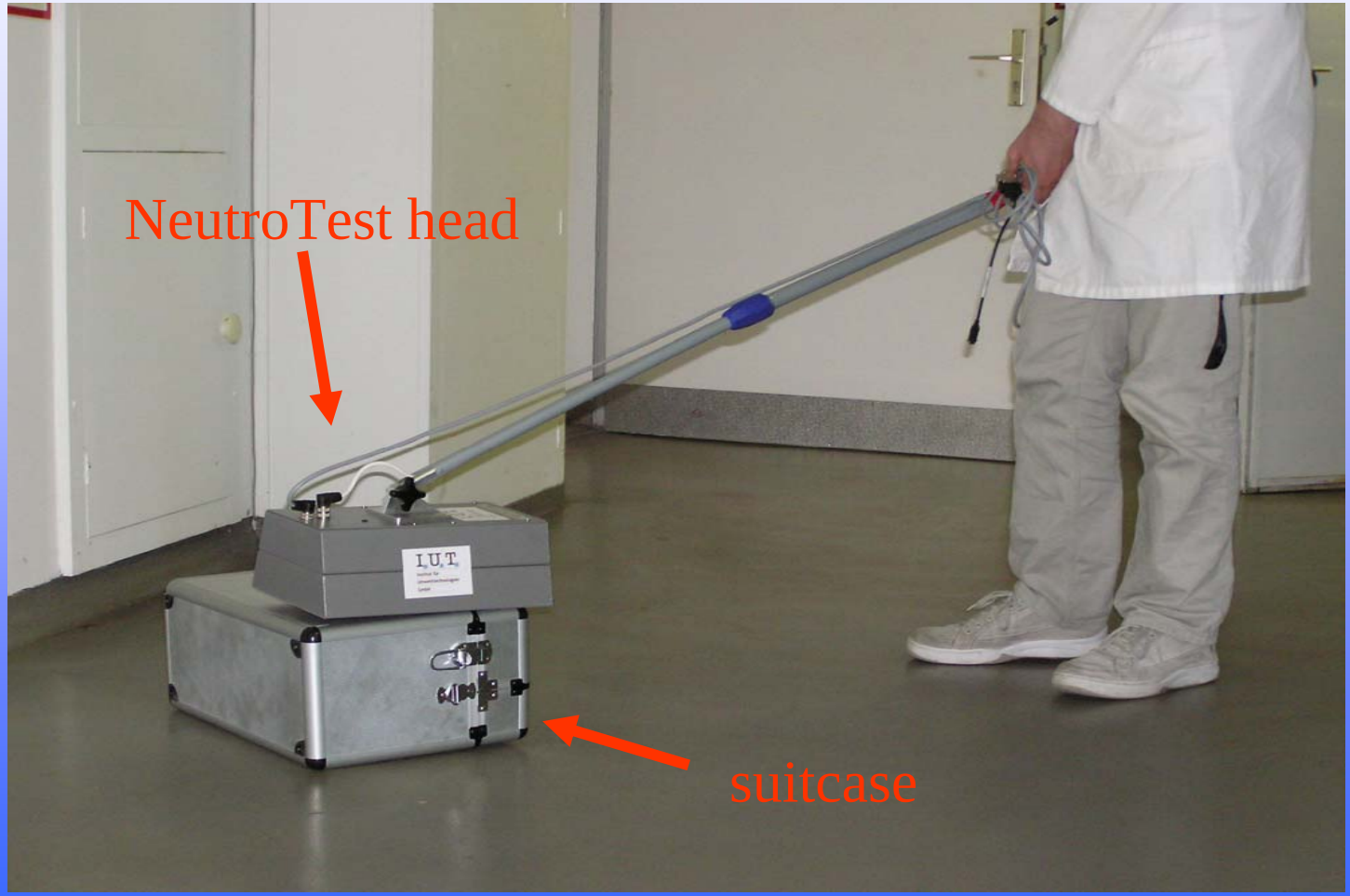
NeutroTest 0 Prototype



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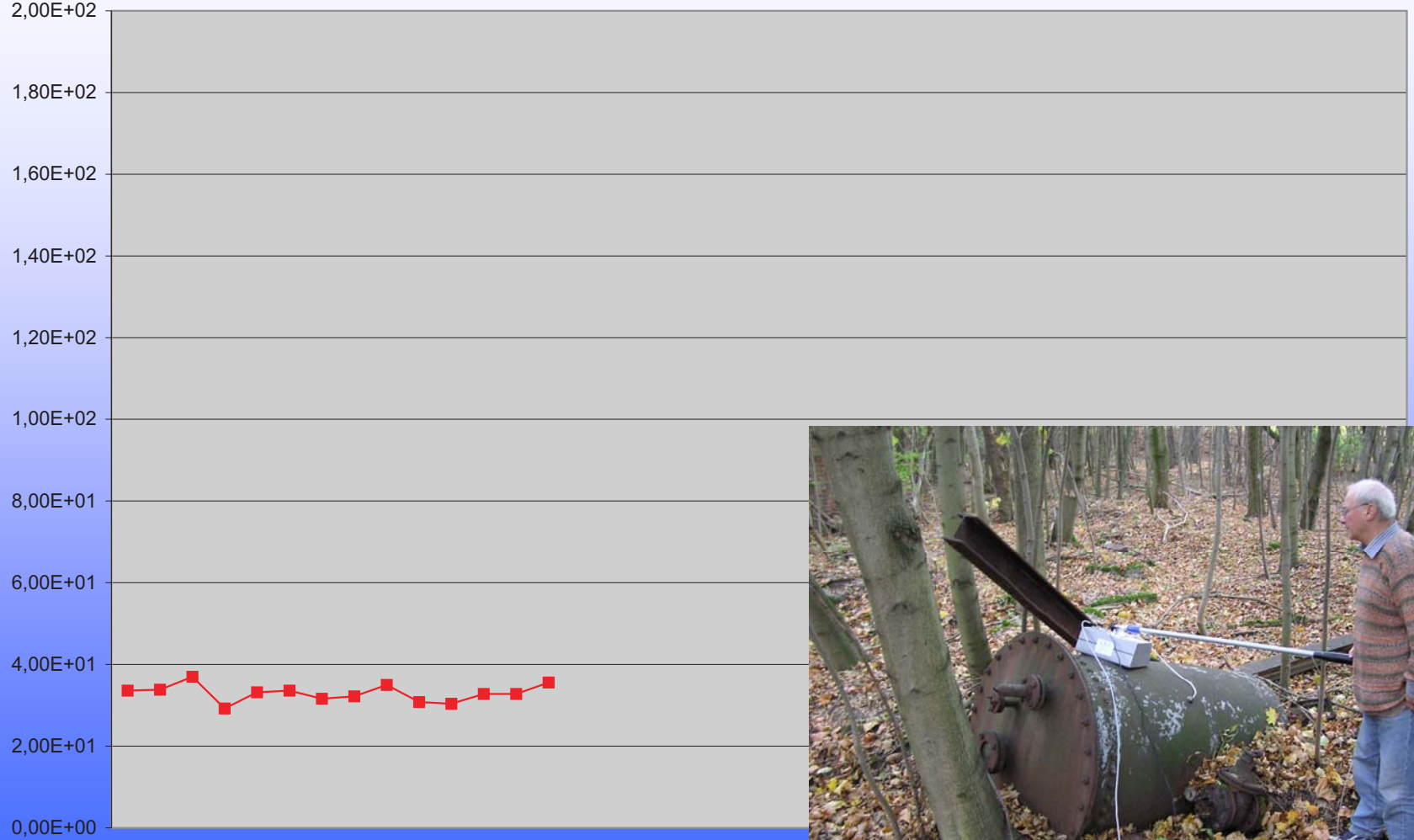
Field trial NT 0: melting kettle for TNT (WW2)



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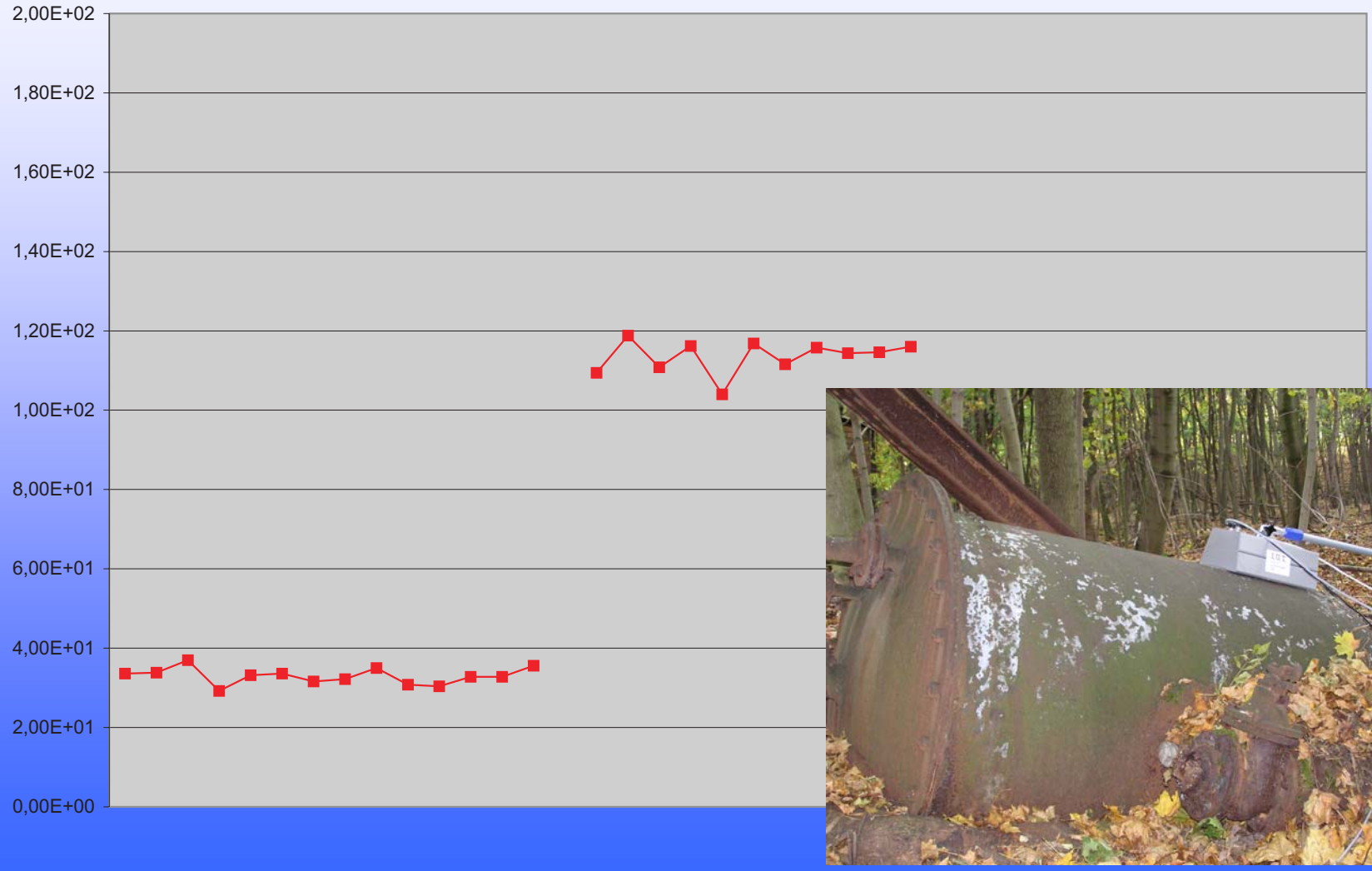

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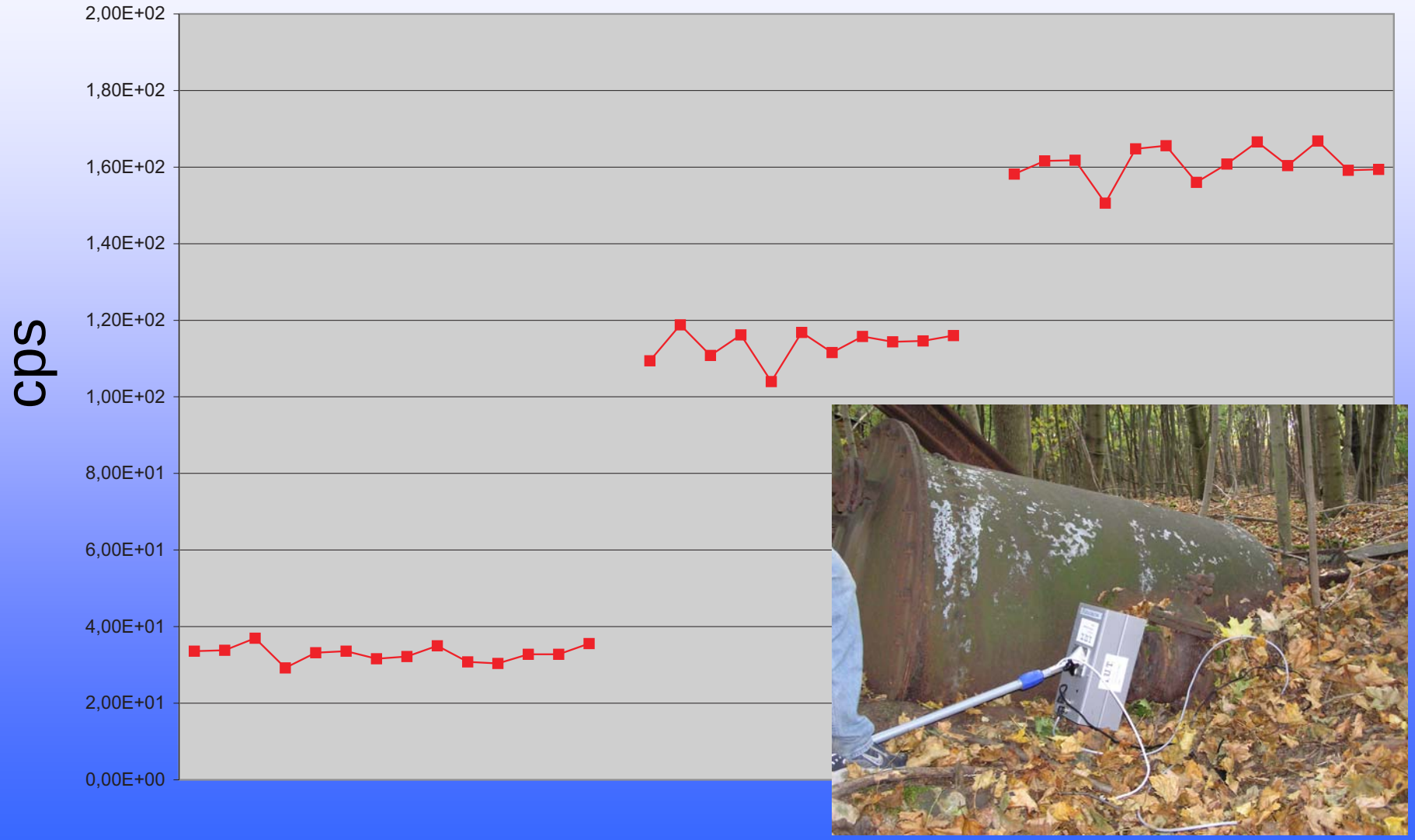

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Valve filled with TNT (WW2)

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Scanning of a box with NT 0

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Box filled with DNT (WW2)

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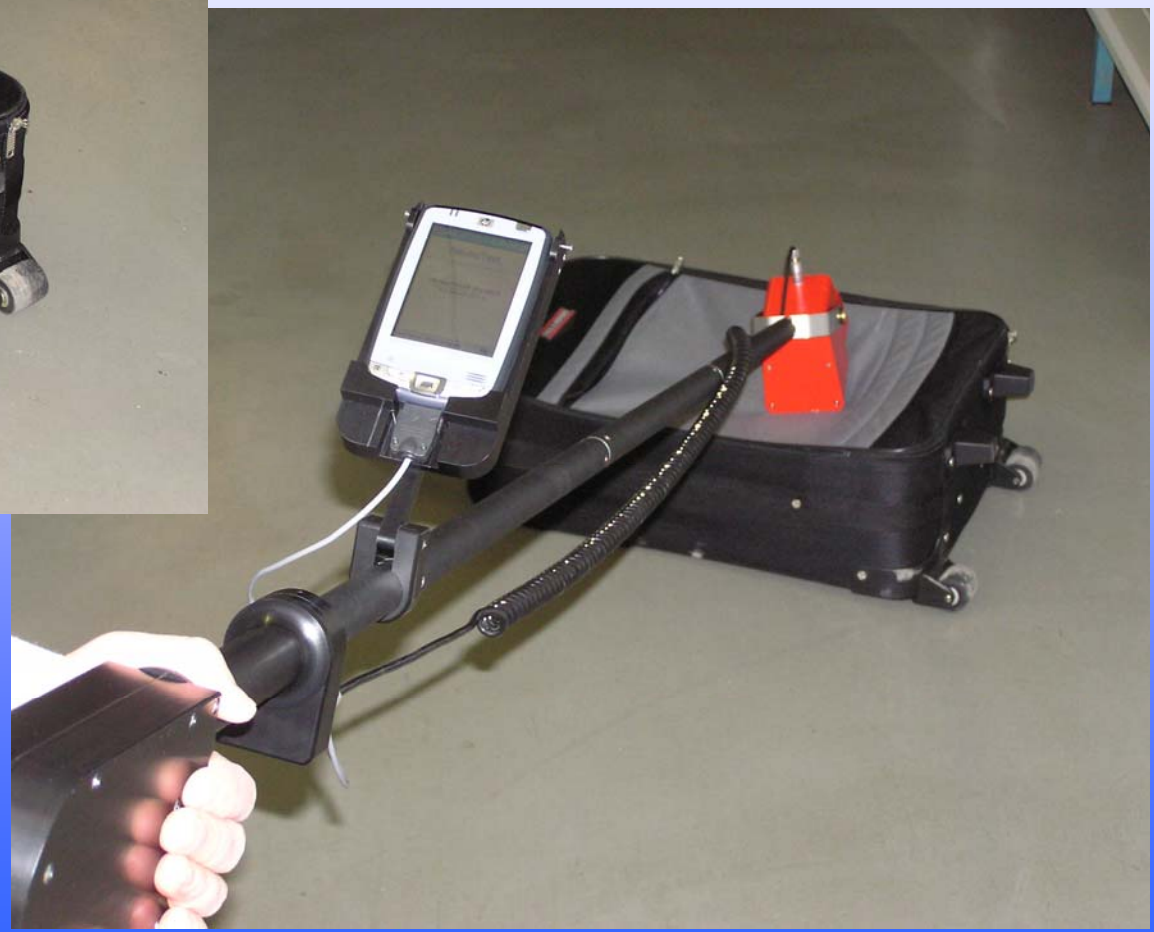
Suitcase scan with NeutroTest 1



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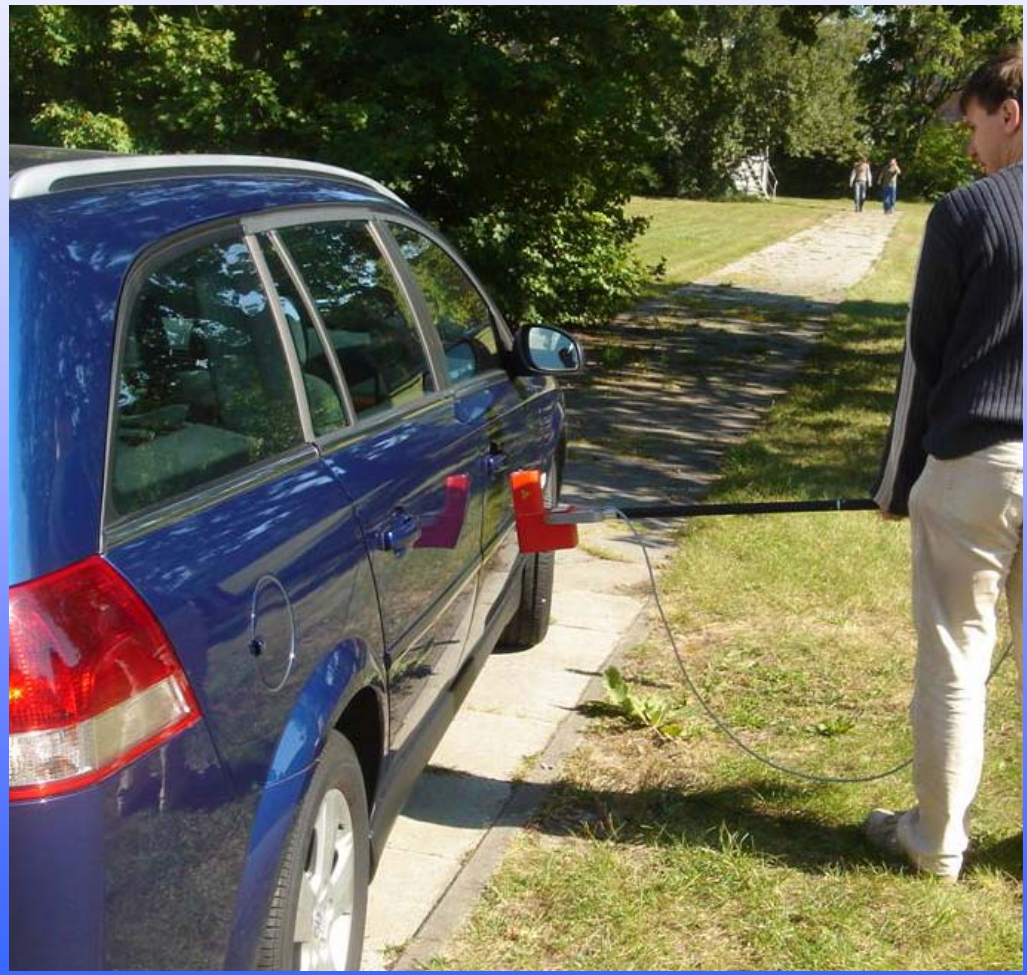
CAR INSPECTION BY NT1



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Identification of booby traps by NT1

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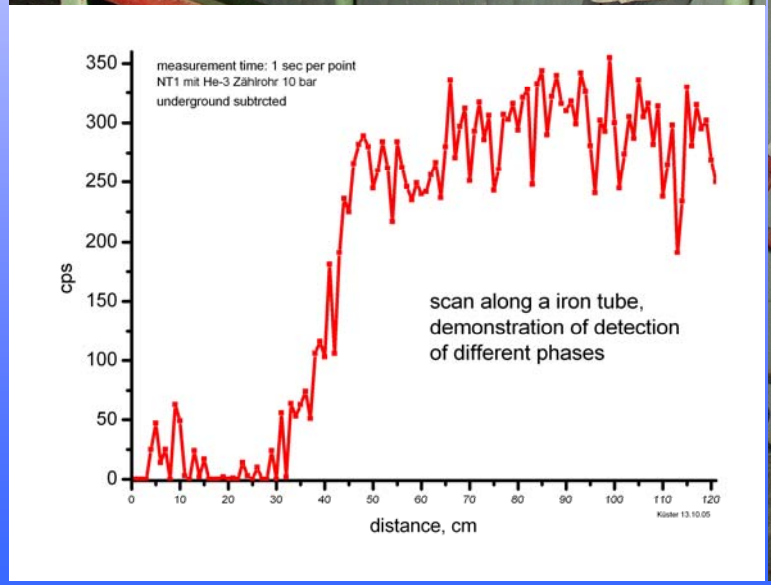
DETERMINATION OF FILLING HEIGHT IN TUBES



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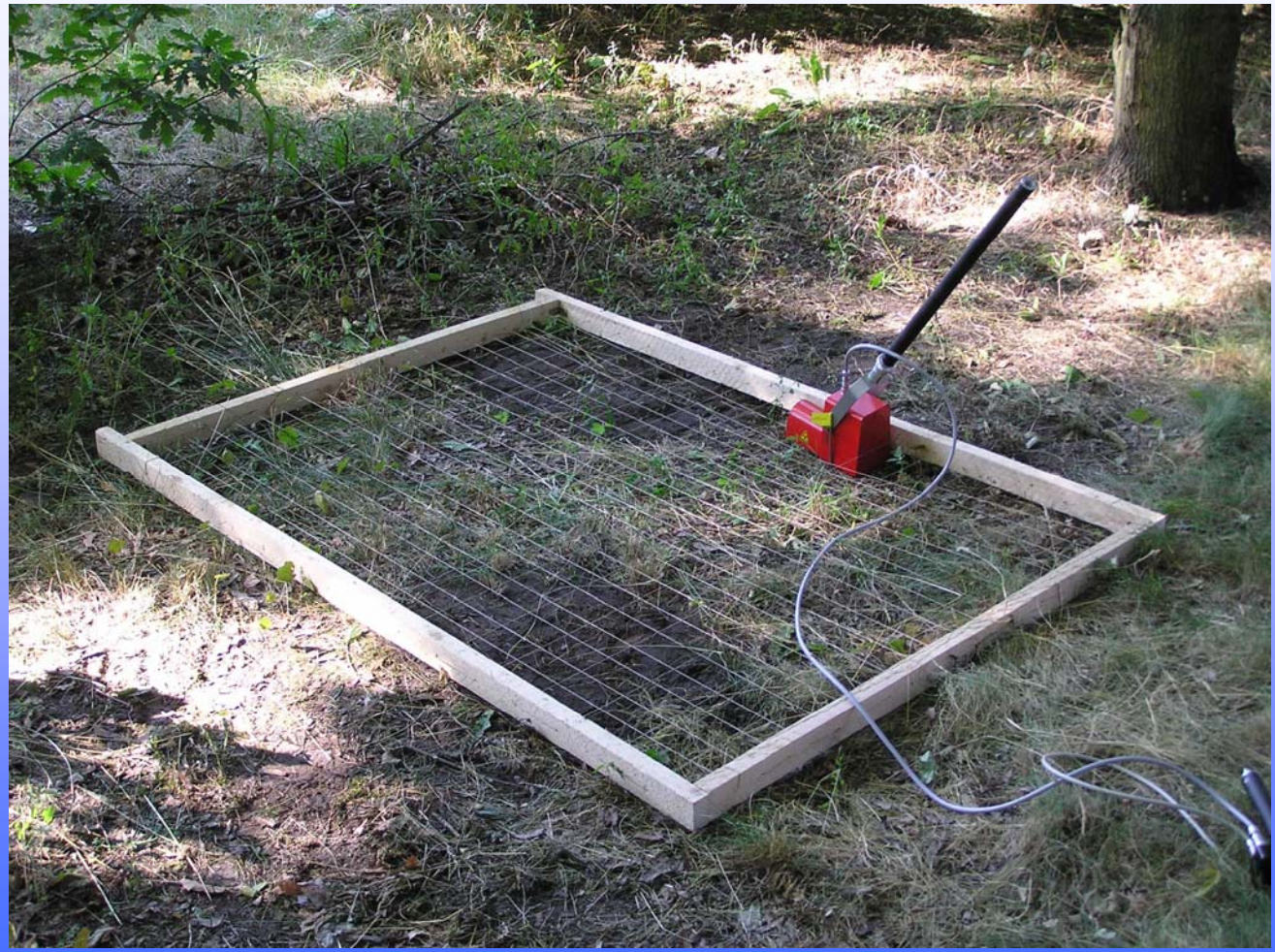
Field scanning with NeutroTest 1



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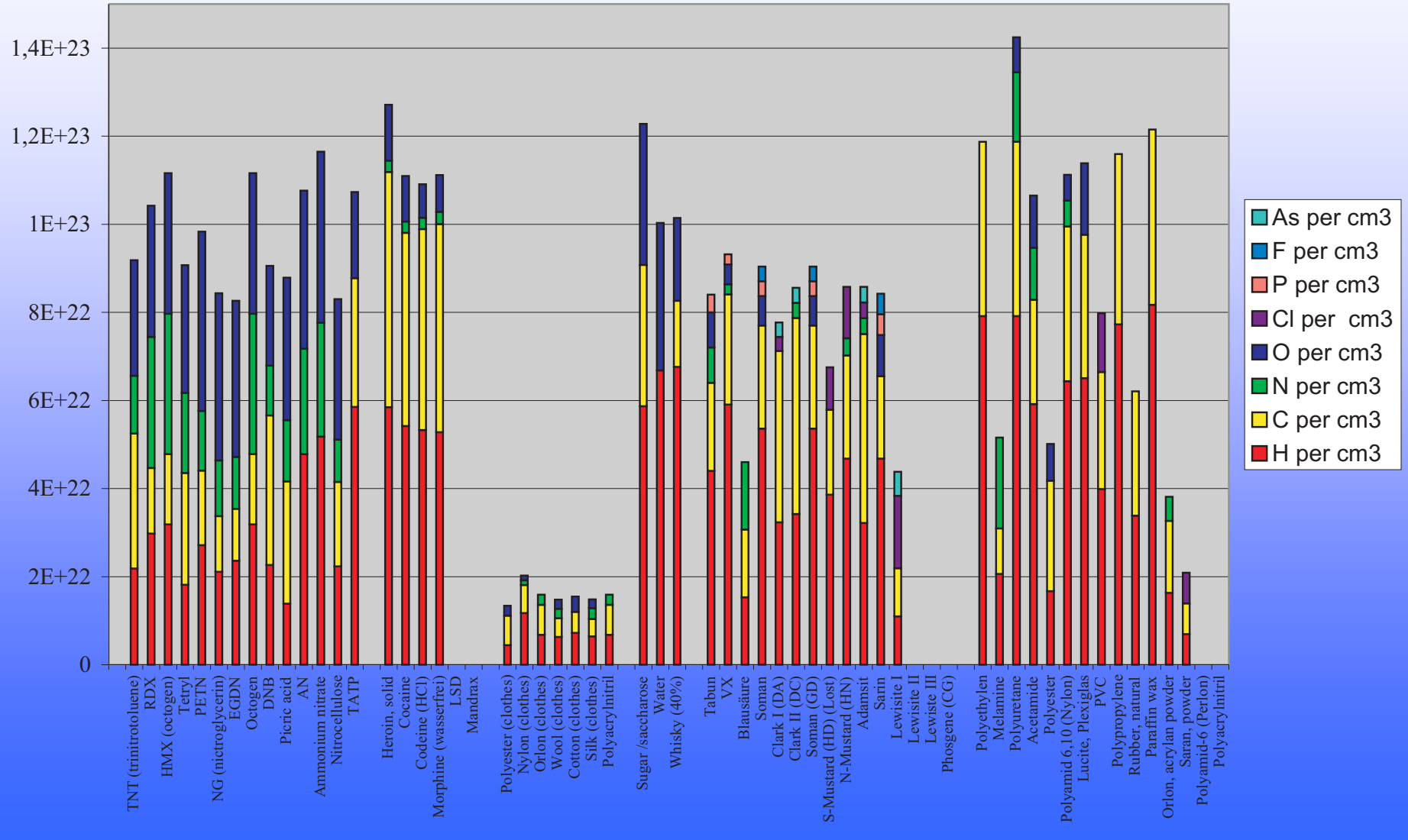
Element density (total)



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Problem of a counting rate based system

Problem:

counting rate dependes on: distance source-object $1/r^2$
distance object-detector $1/r^2$
weight of the object
density of the object

Based on cps:

A piece of TNT in the top part of a suitcase gives the same signal as a much bigger piece of water in the bottom.

The geometry factors have to be cancelled out

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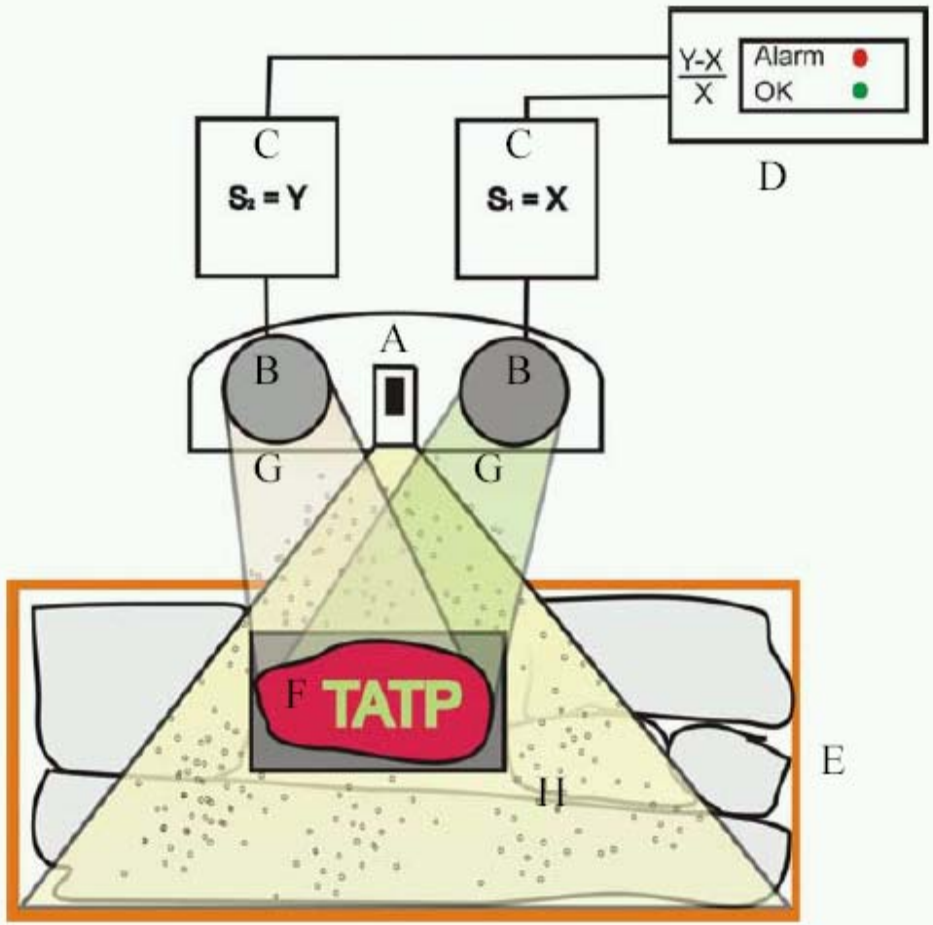
SCHEME OF NEUTROTEST2



A) Neutron source / Cf-252 - 10^6n/sec
B) Neutron gauges
C) Electronic unit
D) Microcontroller, display
E) Hand luggage
F) Explosive in steel container
G) Backscattered neutrons
H) Flux of fast neutrons

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Ratio method

Ratio = n(without Cd) / n(with Cd)
= thermal / fast neutrons

$$Ratio \sim \frac{N0(source) \cdot G1\_th \cdot G2\_th \cdot H\_th(Objekt)}{N0(source) \cdot G1\_fast \cdot G2\_fast \cdot H\_fast(Objekt)}$$

$$Ratio \sim \frac{H\_th(Objekt)}{H\_fast(Objekt)}$$

N0	Activity of the source
G1	Geometry factor source-object
G2	Geometry factor object-detector
H	object factor

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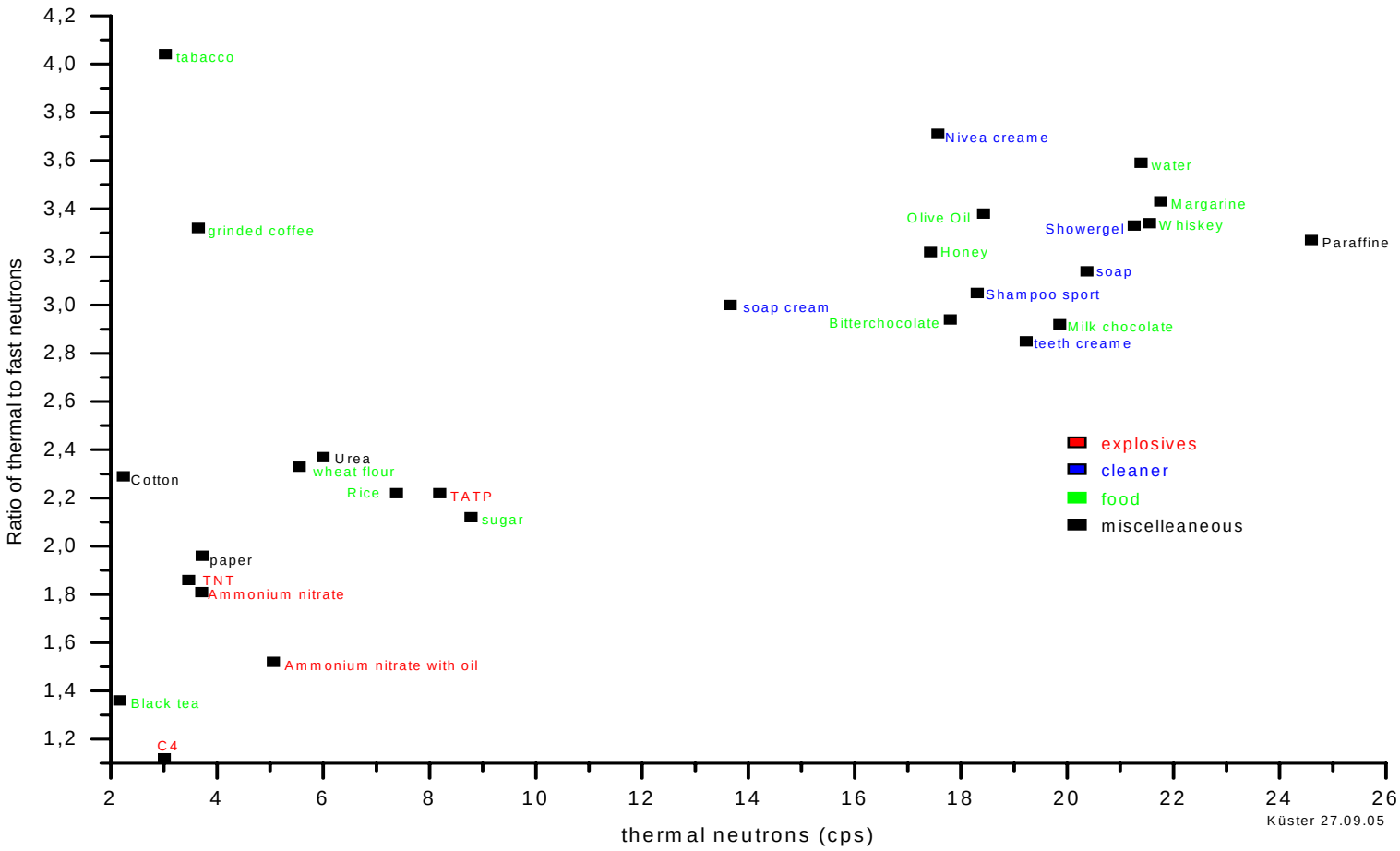
IDENTIFICATION OF EXPLOSIVES BY MEANS OF THERMAL/FAST NEUTRON RATIOS



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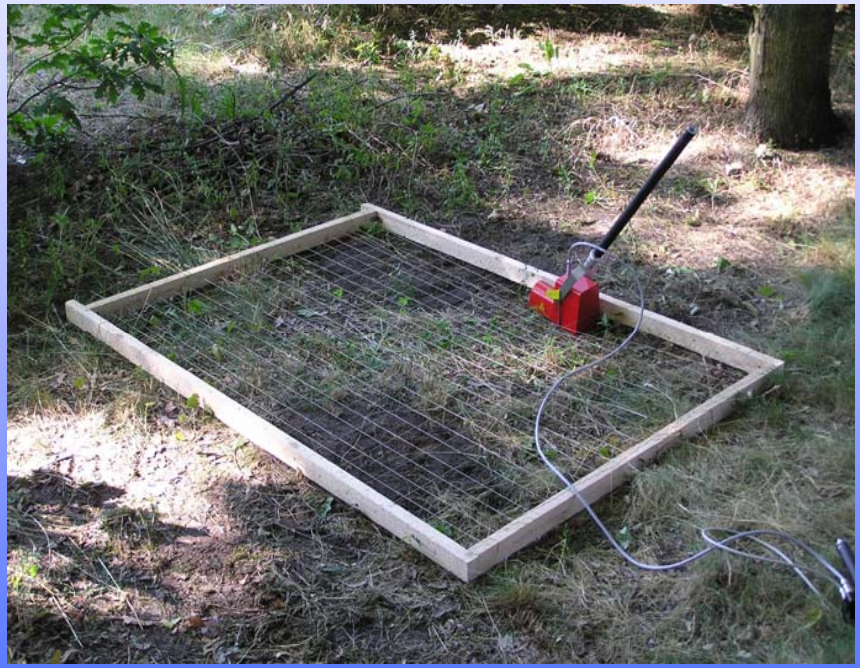
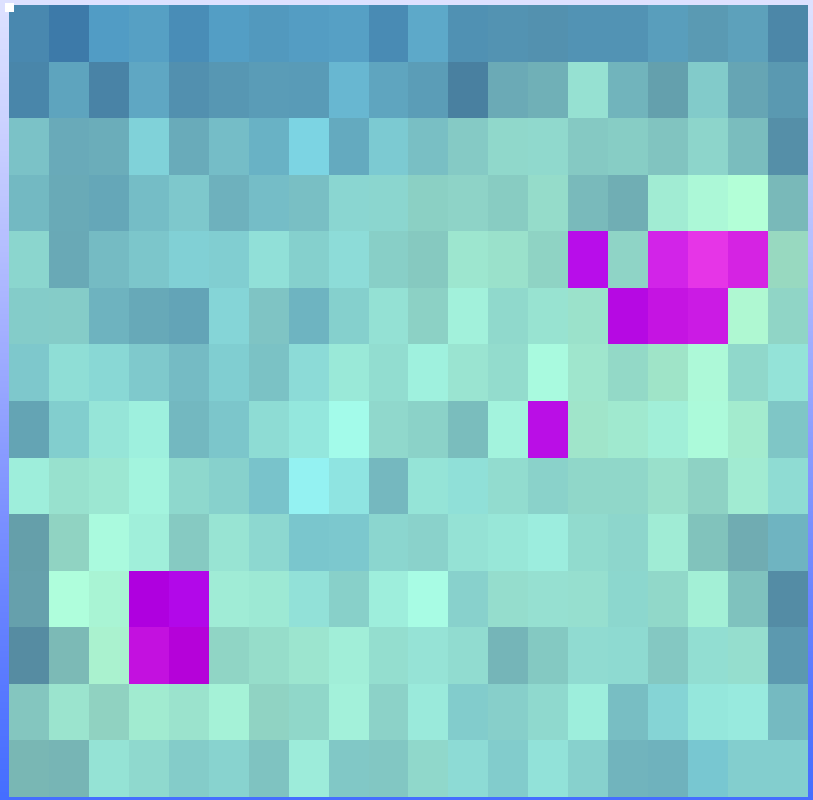
SEARCH OF EXPLOSIVE 5cm IN GROUND BY NT2





rMtf, bMff, gMqf

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NeutroTest 2

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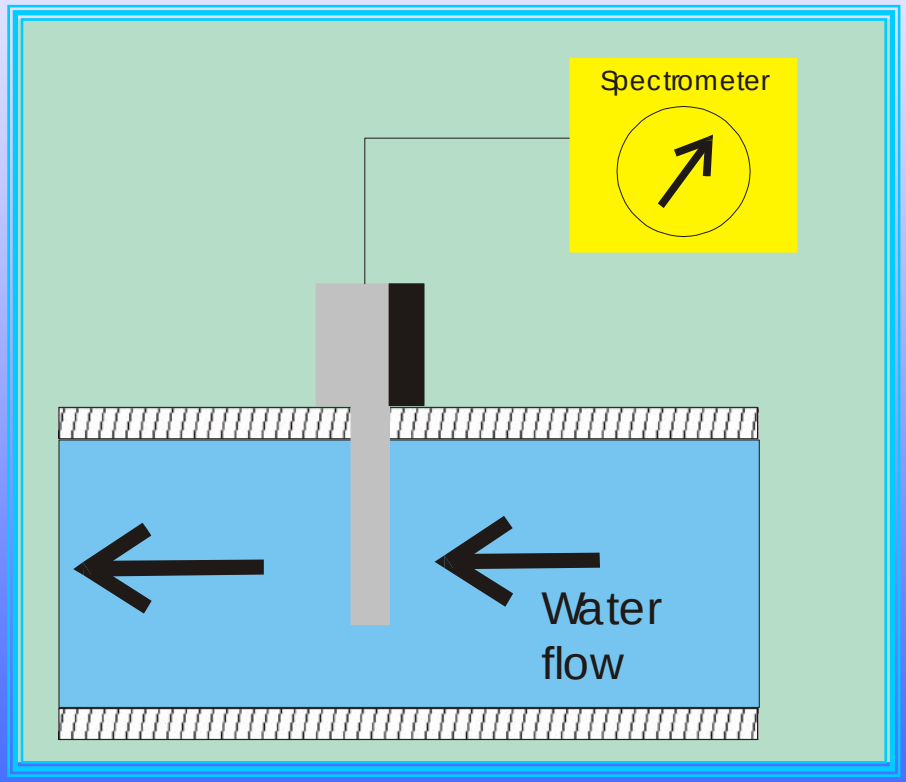
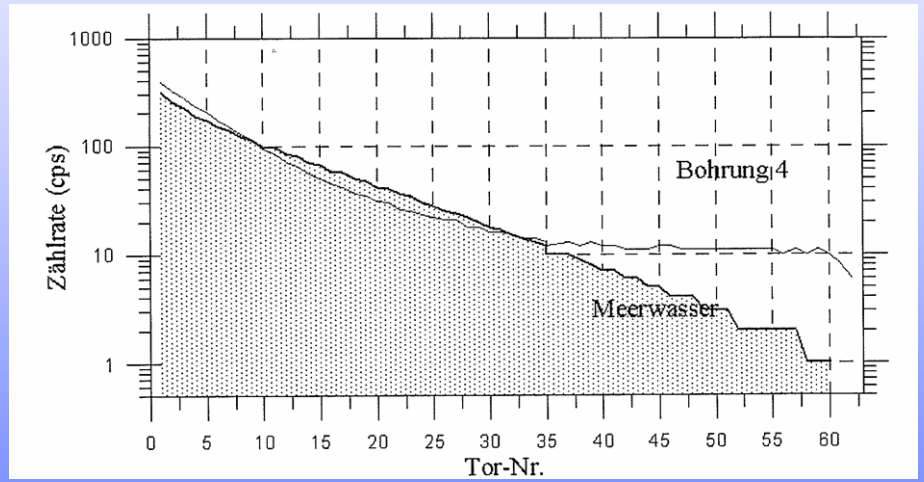
Application example

Online determination of toxic compounds in drinking water
- in boreholes - in wells - in water pipes

Scheme of the Neutroscan.



Experimental results of aromates (bencene) in seawater



Time resolved spectrum of thermal neutrons in a borhole with sea water + 6 µg Bencene per liter. Sensitive against heavy metals, organic and biological compounds.

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NEUTROSCAN EQUIPMENT

NEUTRON GENERATOR

NEUTRON GAUGE.

TUBE OF NEUTROSCAN

PRINCIPLE

Fast neutrons are produced by means of a miniaturized generator. Thermalized neutrons are detected by means of the neutron gauge. Electronic part analyze the life time distribution of thermal neutrons, which give information about toxic compounds.

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NeutroScan