

High Precision Crystal Applications: the SABAT project

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Motivation

- Unknown amount of sunken chemical weapons is scattered across the Baltic Sea
- Serious threat for people and environment
- Detection methods for underwater hazardous materials: sonars / robots
- Recognition of shapes and density of objects ("chemically blind" methods)
- Need for rapid and noninvasive identification: Neutron Activation Techniques



Neutron Activation Techniques

- ❖ Novel methods of **non-destructive** chemical threat detection based on neutron activation:



Thermal neutron capture
(sources, D+D generators)



Neutron inelastic scattering
(D+D/D+T generator)

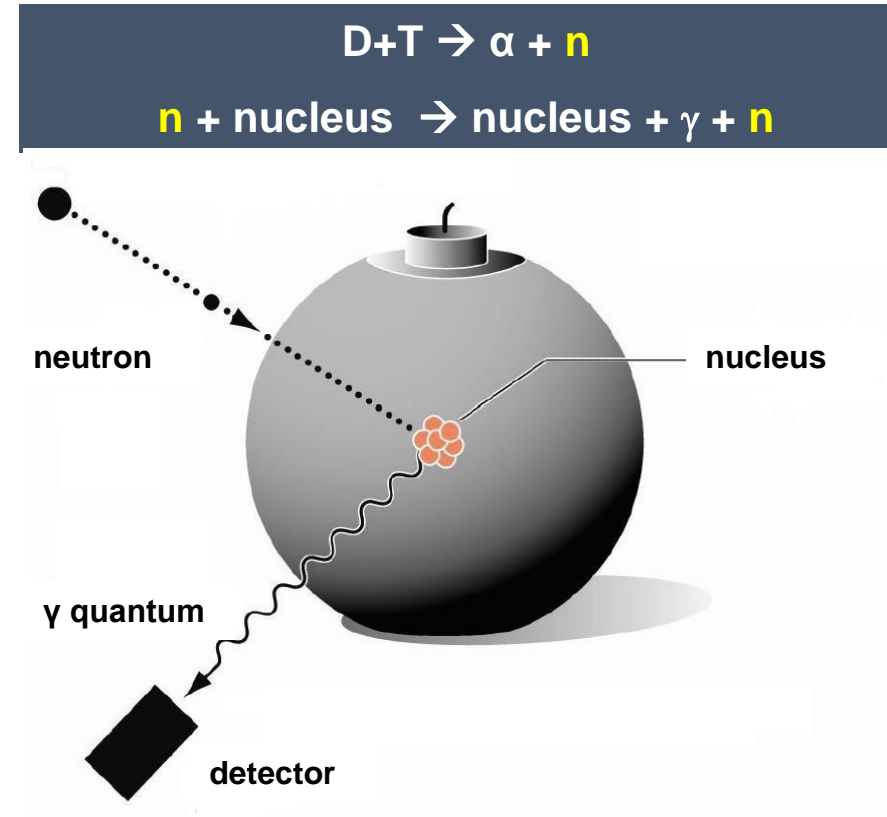
Excited nuclei emit gamma quanta of energy characteristic of the element



Relative content of elements \Leftrightarrow Stoichiometry



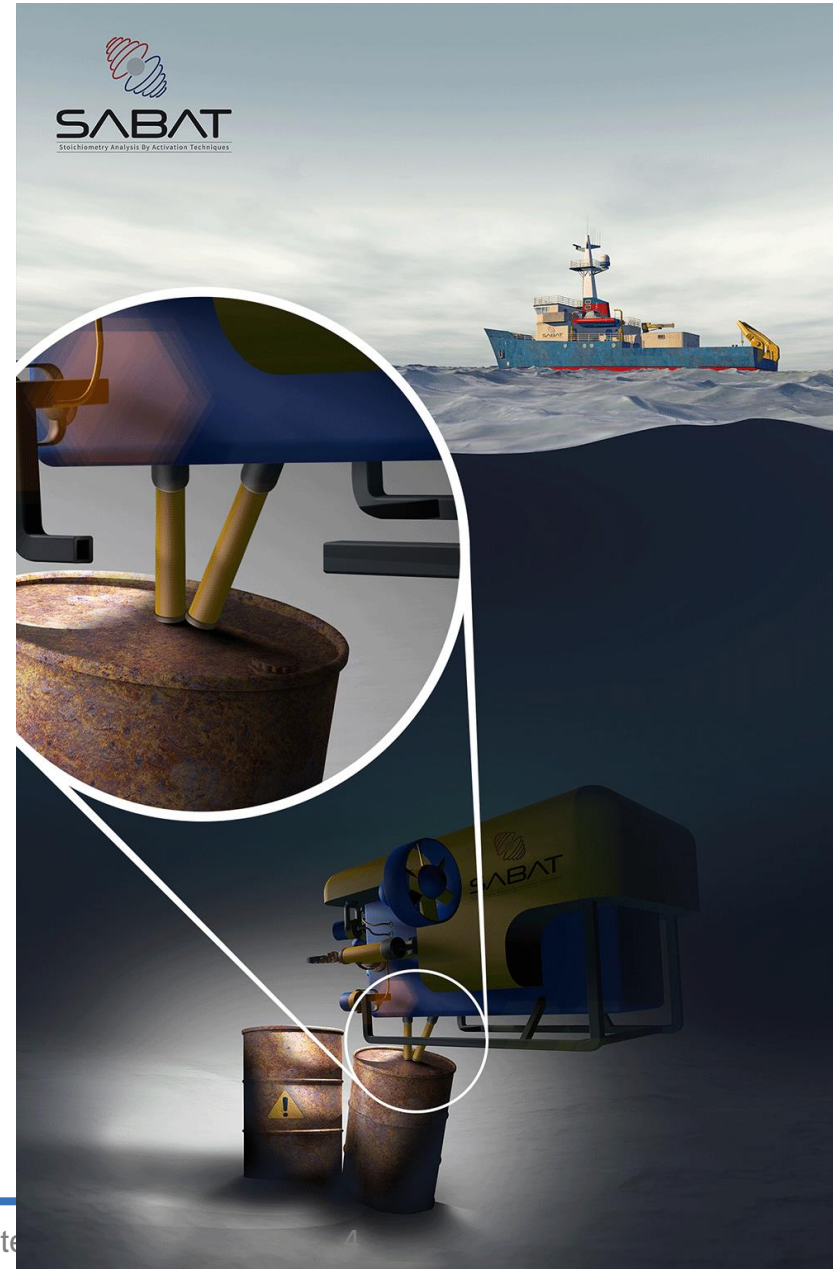
Identification



Non-invasive detection of hazardous materials using neutron beams

- ❖ **The SABAT project (Stoichiometry Analysis By Activation Techniques)**
- ❖ The 14.1 MeV neutron generator with α particle detection
- ❖ Neutron and γ quanta attenuation in water minimized by guides filled with air or some other gas
- ❖ Pulsed generator & correlated α particles detection \Leftrightarrow tomographical picture of the chemical composition
- ❖ Changeable position, length and orientation of guides
- ❖ Position sensitive detector (**scintillator**)

(M. Silarski, P. Moskal, Patent PL 223751; EP 15738491.8;US 15/509,013)



Status of the project

- ❖ **First measurements with the 14 MeV neutrons: data are being still analyzed**
- ❖ **Second γ quanta detector prototype: test to be done till the beginning of 2024**
 - LaBr₃:Ce crystal + SiMP readout
 - Anti-Compton shield to suppress background
 - Position reconstruction based on the distribution of optical photons (machine learning)
 - DAQ based on the CAEN Citiroc 1A
- ❖ **3"x3" LaBr₃:Ce,Sr crystal tests done in close collaboraton with Luxium Solutions**
- ❖ **First prototype of the sensor for underwater tests (to be done by the end of 2025)**



Status of the project

- ❖ Three recent papers published:
- ❖ M Silarski et al., *Radiation Protection Dosimetry* 199, 1932–1936; <https://doi.org/10.1093/rpd/ncac245>
- ❖ Silarski, M. et al. *Eur. Phys. J. Plus* **138**, 751 (2023); <https://doi.org/10.1140/epjp/s13360-023-04377-4>
- ❖ M. Silarski et al., *Sci Rep* **14**, 18584 (2024); <https://doi.org/10.1038/s41598-024-69290-x>

- ❖ Two grants for testing both types of sensors (with detector read out by SiMPs and PMT) received: Interreg South Baltic „BALTWRECK” and FNP FIRST TEAM FENG.

Neutron Activation Analysis Laboratory



Thank You for attention



Goya, *Witches sabbath*