

Neutron Activation Analysis: A novel in-situ method for CWA detection

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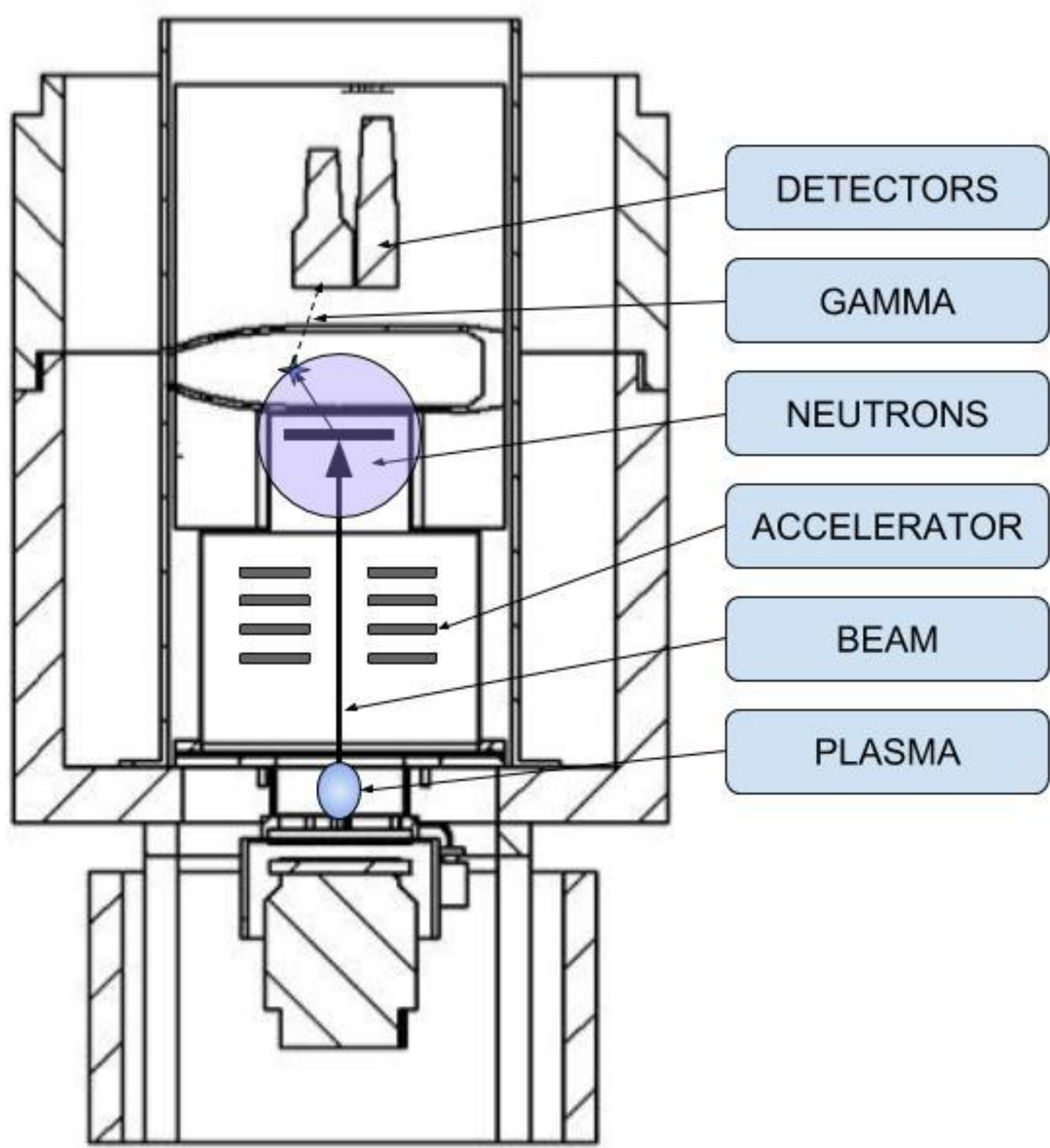


Fig. 1 - NeutronGate test station where experiments were performed. Deuterium beam is accelerated and collided to target where neutrons are produced via D-D nuclear fusion. Neutrons interact with munition producing gamma rays. Measured gamma spectrum is unique to the munition.

Key points:

- In situ characterization and evaluations of submerged munitions is a challenge.
- We have demonstrated our ability to distinguish between CWA- and HE -munitions using our novel method.
- Our technology may be attached to ROVs, which may provide an economical solution to the problem.
- Further R&D still required. Currently we are measuring and collecting characteristic spectrums for various ammunition types and conditions.
- Measurements of TNT and Mustard Gas surrogate munitions has been already demonstrated in laboratory conditions.

Problem: The general vicinity of a CWA - which is much of the Baltic sea - may be identified using collected sediment and water samples. However, no cost-effective method exists to identify and characterize individual munitions lying on the seabed. Identification and evaluation of individual munition' condition is crucial for economical decision making regarding the treatment and handling of said munitions.

Solution: We have demonstrated a novel method to solve this classification problem. Using our proprietary Elemental Analysis System (EAS) based in Neutron Activation Analysis (NAA), we are able to define the elemental composition of the munition in situ, without physically interfering with the object. We are able to identify the *type of a munition* fairly quickly, and with longer measurements it is possible to determine the *corrosion level* and possibly the *existence and amount of leakage*. This data is the information basis for deciding parties and allows decision making be based on facts. *When and what actions are required and which actions are reasonable and efficient?*

Desired requirements for an operational system were envisioned during DAIMON project.

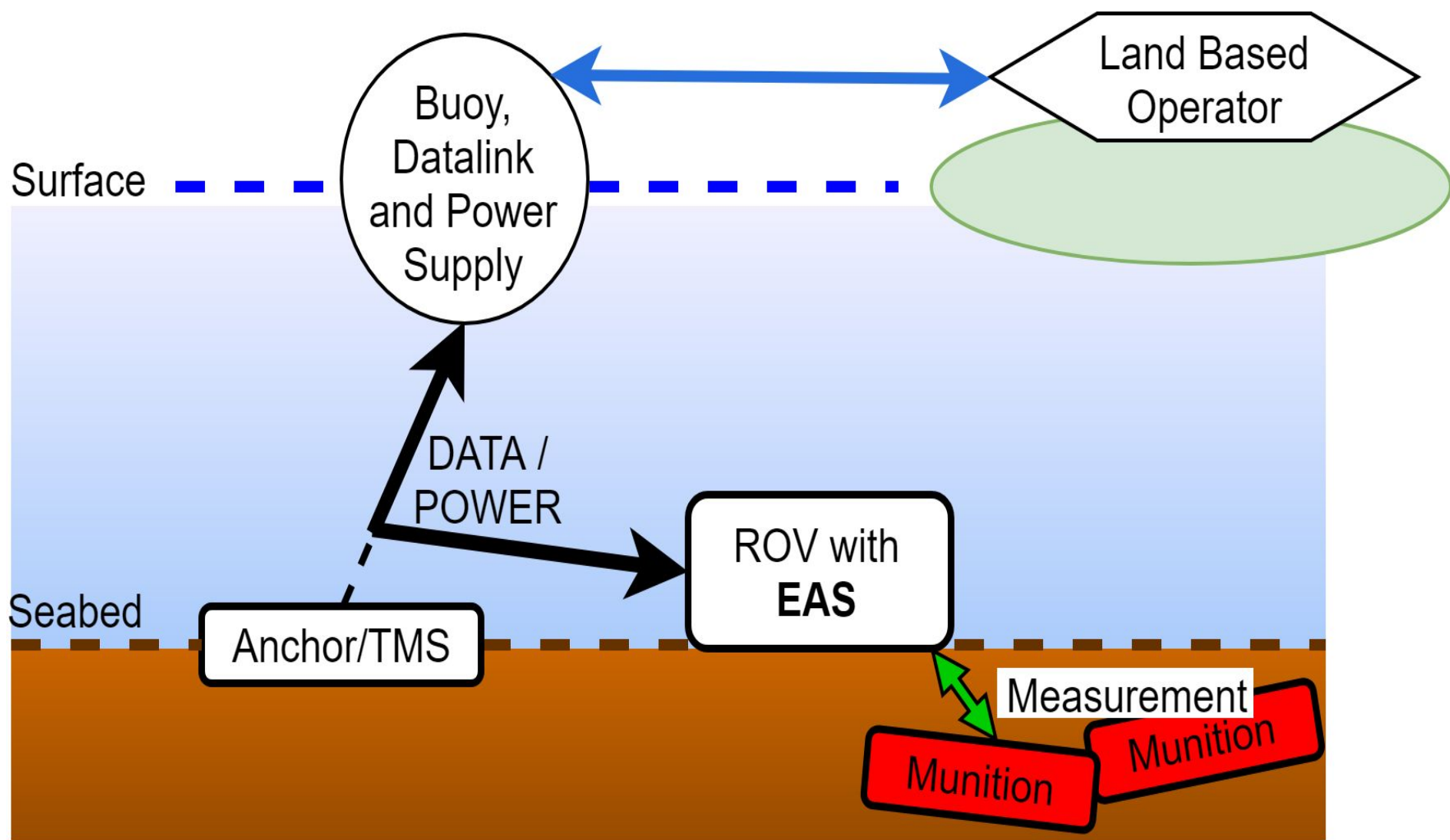


Fig. 2 - Concept of cost effective operative system consisting ROV mounted EAS and buoy providing power and datalink to the remote operator.

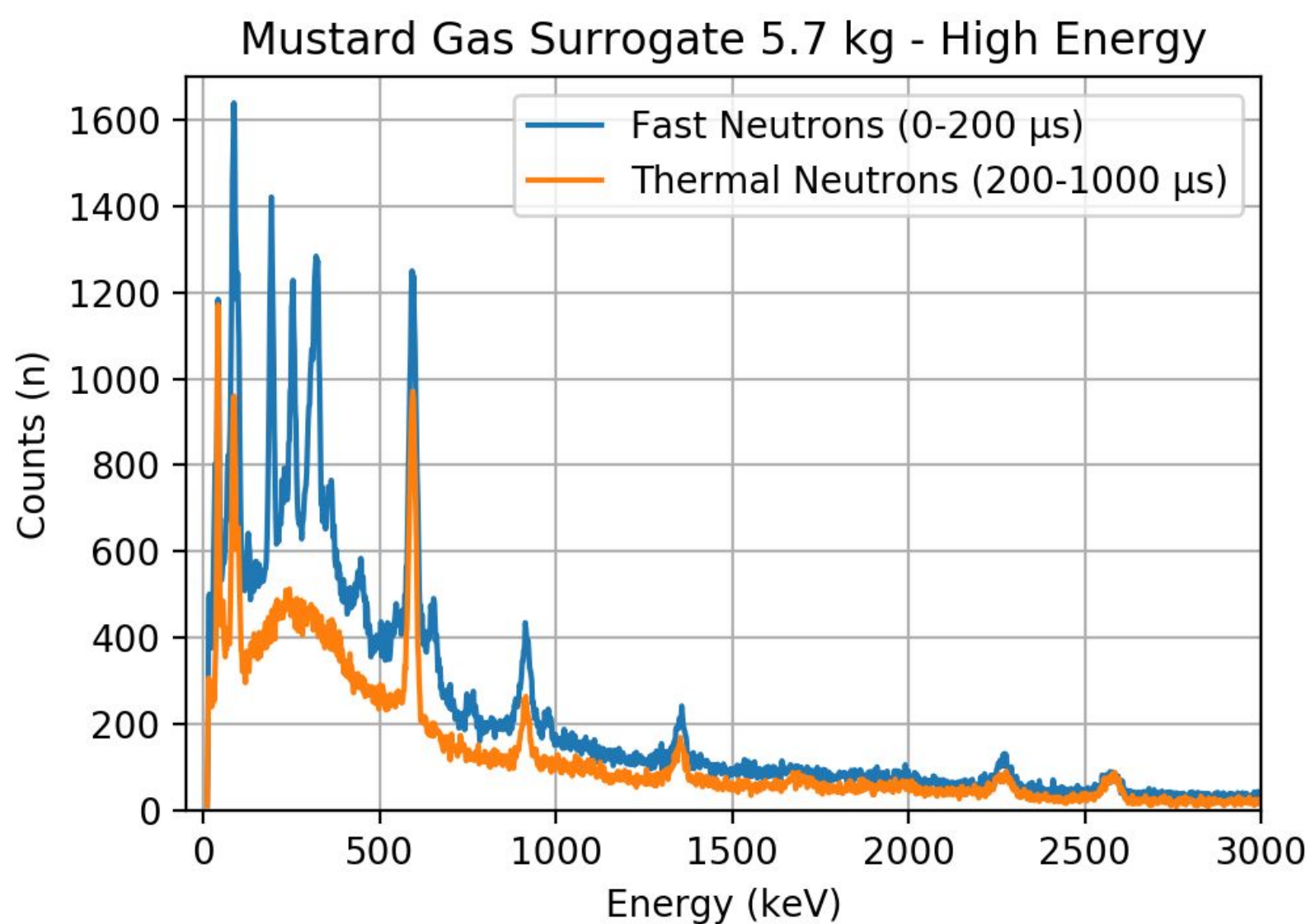


Fig. 3 - Measurement produces material-dependent spectrum, which allows us to make conclusions about the munitions' content and degradation level.

Common payloads	Element [w-%]						
	N	H	Cl	P	F	S	As
RDX	37	2,7	0	0	0	0	0
TNT	18,5	2,2	0	0	0	0	0
Mustard gas	0	5	44,7	0	0	20,1	0
Sarin	0	7,1	0	22,1	13,6	0	0
Lewsite	0	1	51	0	0	0	36,1

Table 1 - Some typical munition payloads and their relevant elemental mass percentages [w-%]. Most sensitive elements are marked with **Bold** Cl from mustard gas was measured in laboratory experiments. Due to our detector inefficiency at high gamma energies no considerable peak for N was detected from TNT.

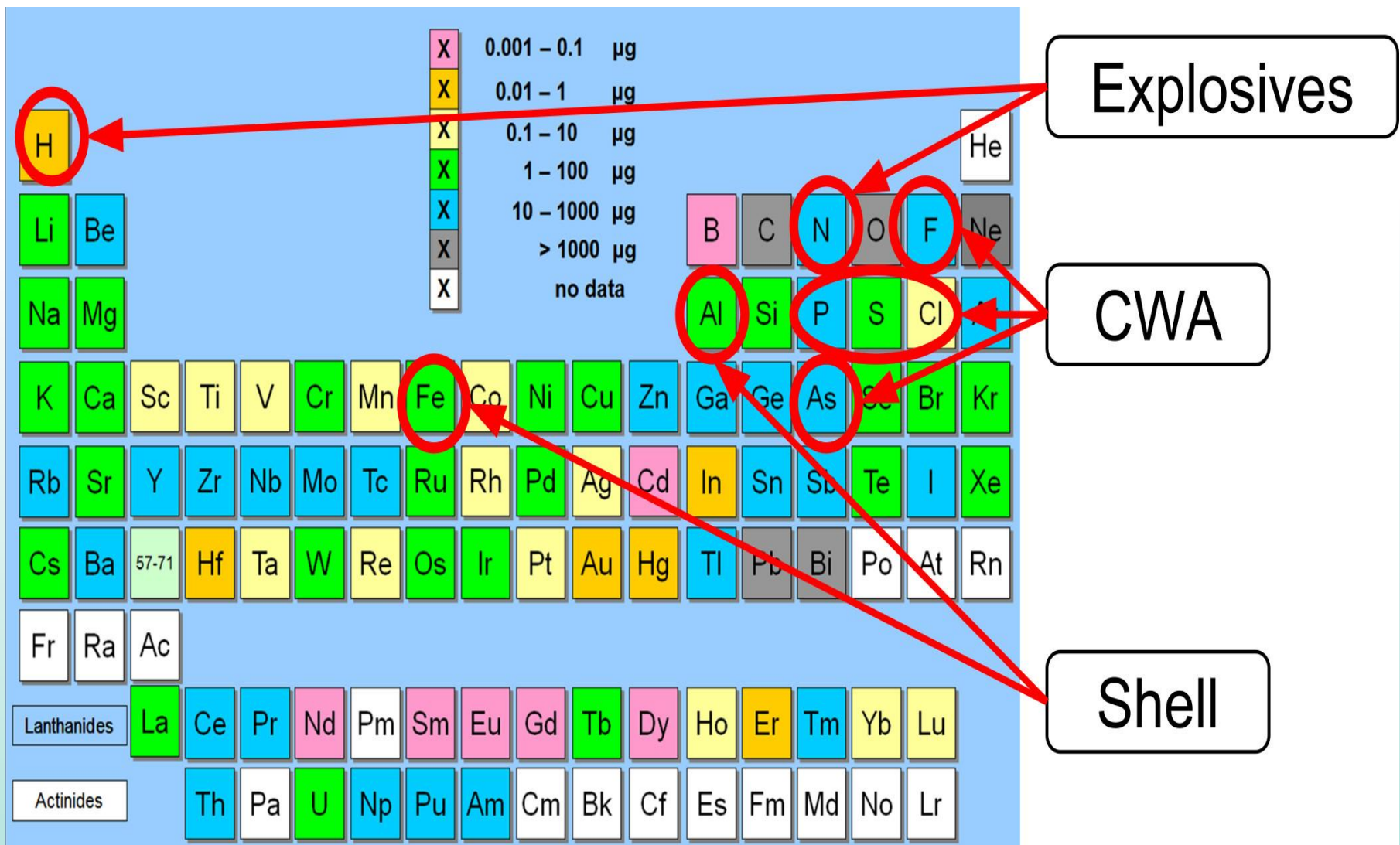


Fig. 4 - NAA method detects elements F,P,S,Cl and As which are present in most CWA munitions. Signal from N is common in explosive munitions. Shell material from most bombs and munitions contain Al or Fe.

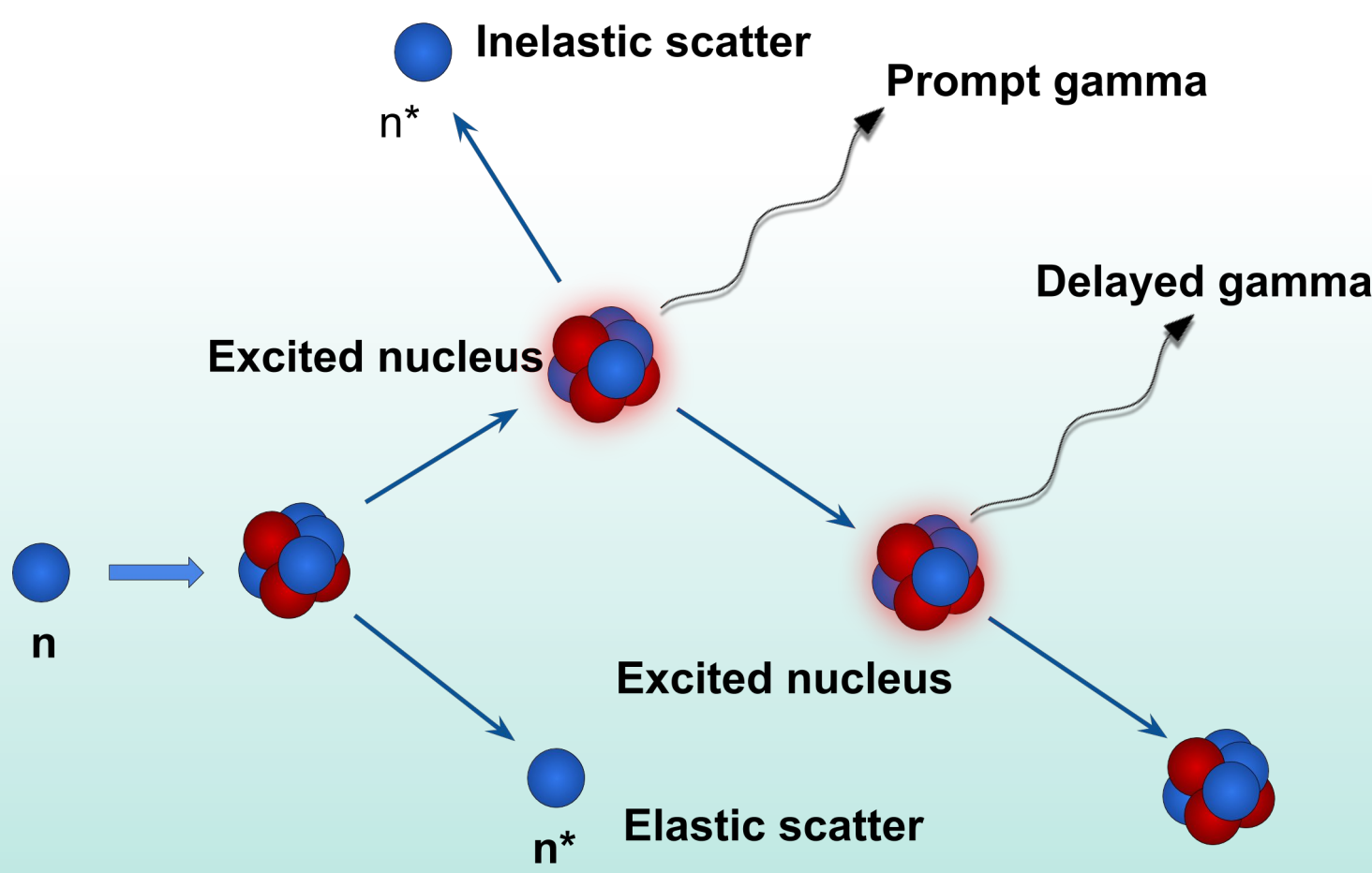


Fig. 5 - Neutron interacts with atom inside the MDM resulting in isotope specific gamma production via scattering and neutron capture. Measured gamma spectrum is specific to measured munition and payload.