

“AnGI”, the new Instrument for Prompt Gamma Neutron Activation Analysis (PGNAA) at the RA-6 Research Reactor (1 MW), Argentina

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Introduction

Prompt Gamma Neutron Activation Analysis (PGNAA) is a non-destructive elemental analysis technique useful for quantifying composition of mayor, minor and some trace level elements through the measurement of (n,g) reactions. It complements the very well known Neutron Activation Analysis (NAA), in which radioactive isotopes are measured following neutron irradiation.

Description

- A thermal neutron beam is extracted from reactor core through tube #2.
- Filters and shielding adjust the beam dimension and radiation components to ensure the optimum performance of the experimental facility.
- A high-resolution spectrometric system with Compton suppression, consisting of a n-type coaxial HPGe and NaI(Tl) annulus, measures the gamma spectrum between 100 keV and 8000 keV using a 16000 channel digital multichannel analyzer.

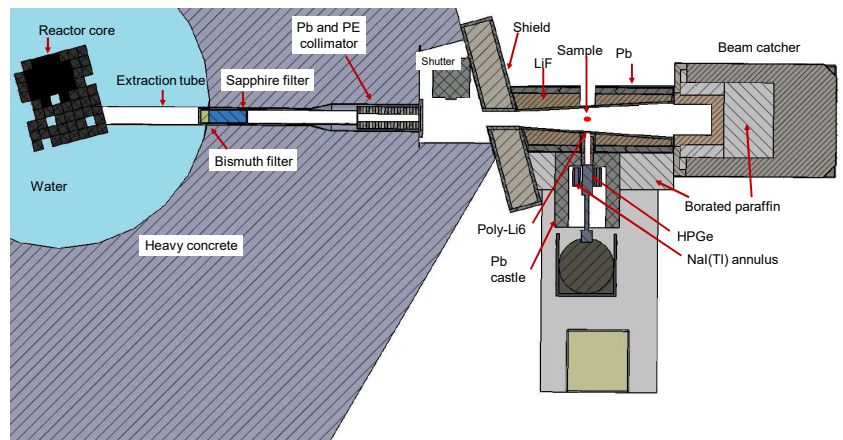


Figure 1: Schematic layout of the AnGI experimental set-up

Results

- The conventional thermal neutron flux is $9 \cdot 10^5$ n/(cm²s).
- The efficiency of the detector located 40 cm from the sample ranges between $3 \cdot 10^{-4}$ y 10^{-5} .
- The background count rate is about 150 cps in all spectrum.
- The count rate due to fast neutrons at 691 keV is 0,8 cps, which is equivalent to 3 n/(cm s) at HPGe detector.
- The total dose rate around facility is between 10 to 30 uSv/h.
- Figure 2 shows the highest Sensitivity Vs lowest Detection Limit for 69 elements for a measurement time of 16 hs.

$$S = \frac{c}{m t} = \frac{N_0}{M_{mol}} \phi \sigma \varepsilon$$

$$Ld \approx \frac{4,65\sqrt{B}}{S}$$

No: Avogadro constant,
Mmol: element molar mass
 ϕ : the conventional neutron flux
 σ : gamma cross section
 ε : detector efficiency in selected element energy
B: 16 hs background in selected element energy

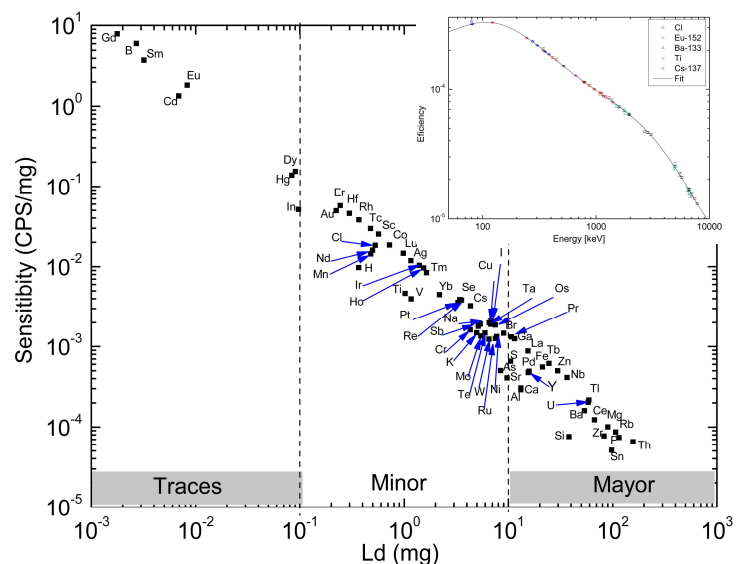


Figure 2: AnGI sensitivity and detection limits for different elements

Conclusions

- New PGNAA instrument with capabilities for elemental analysis of major components (Si, Fe, Al, Zr, Ca, S, U...), minor components (Fe, Mn, Cr, Na, Cu, Ni, Ag, Nd...), and trace elements (B, Cd, Sm, Gd, Eu, Dy...) for the development of new applications such as materials science, geology, and mining, among others.
- This new instrument enhances the engineering and design capabilities of neutron beamlines at CNEA.
- AnGI expands and complements the academic and scientific applications of nuclear analytical techniques at RA-6.