With the completely automated production analysis system, operating procedures are simple. The operator inspects and warms up the system in the morning, requiring perhaps 15 or 20 min. Thereafter, the computer controls all operations; the operator needs only to maintain a supply of samples in the magazine loader and to observe the system as a routine precaution.

The analytical results will emerge, and the samples will be processed in order, completely without operator interaction. Research applications allow and often require more operator interaction than routine analytical testing. We have developed software for both classes of operation.

When only one significantly active element is present, the sensitivity and precision achievable with fast neutron activation analysis can be predicted quite simply. Using a small accelerator-type generator, many elements can be detected at levels of 100 μg or less, and at a rate of about 100 samples per 8-hr day.

With the 14-MeV neutrons, we can detect directly 38 elements. These fast neutrons can be slowed to thermal energies, allowing detection of another dozen elements.

Detectability, as defined for the development of the tables, is based on a 100-count photopeak. This implies a statistical limit to the achievable precision that is about 10%.

Elements detectable with 14-MeV neutrons

Less than 3 μg	10 to 29 μg	30 to 100 μg
Aluminum	Chromium	Bromine
Antimony	Fluorine	Cobalt
Arsenic	Gallium	Hafnium
Barium	Mercury	Indium
Cerium	Oxygen	Iron
Copper	Scandium	Iodine
Germanium	Selenium	Magnesium
Palladium	Sodium	Manganese
Phosphorus	Tantalum	Molybdenum
Rubidium	Tungsten	Nitrogen
Silicon		Potassium
Strontium		Tellurium
Vanadium		Titanium
Zirconium		Zinc

Longer times of neutron bombardment or of counting, or larger sample quantities, generally result in larger counts and better precision—down to 1% in favorable cases. Absolute accuracy approaches the precision quite closely when the system is well calibrated and good flux data are available.

Interference effects

Most sample materials contain more than one element that can be activated significantly. One of the activities often tends to interfere with measurement of the other, thus degrading the achievable sensitivity or precision for measurement of one or more of the elements.

The interferences are of three types:

- Gamma rays of similar or identical energy may be emitted by different species.
- Compton scattering of high-energy gammas creates a high background against which lower energy photopeaks must be discriminated. (Compton scattering is the elastic scattering of photons by electrons.)
- In the case of fast neutron activation, two elements often can produce the identical radioisotope.

If the first type of interference is observed with a sodium iodide detector, the use of a solid-state detector often enables adequate improved energy resolution to solve the problem—but at the cost of lowering counting efficiency by a factor of 10. This translates into an order of magnitude loss of sensitivity at a fixed sample throughput rate, or to a three-fold loss of precision.

Alternatively, a second photopeak might be available for measuring one of the elements with a sodium iodide detector. We then can calculate that element's contribution to the originally chosen peak, again with some loss of sensitivity or precision.

The worst case of this kind of interference