In any practical application the main task is composition analyses. There is no single detection technique that can by itself provide a 100% probability of different minerals detection combined with a low false alarm rate. We suggest system approach, which combines different laser-based technologies having orthogonal detection and identification capabilities. In such a way the strength of one technique may compensate for the weaknesses of the others, and the vulnerability of one detection device could be compensated for by another detection device. Clever combination of the detection techniques may achieve detection probabilities and false alarm rates that are more acceptable than those of systems based on one method only.

The apparatus includes impulse laser excitation sources, spectrograph, gated detector and computer with specific software. The following spectroscopic techniques are used, individually or in different combinations: Luminescence, Breakdown, Raman and Second Harmonic Generation. Prototype system is developed for real time identification of minerals as they are conveyed on a fast moving conveyor belt. Combined with corresponding feeders and ejectors, the machine may be used for radiometric sorting of minerals with resulting separation, using an applied force, into different products in accordance with measured properties. Spectroscopic data bank was developed for main technological minerals, which enables to select the mostly suitable technique for specific mineral assemblage. Apparatus based on breakdown spectroscopy was successfully tested on conveyor belt of Four Corners Mine, Florida, for Mg contents evaluation in phosphate ore.

Gemology is the study of gemstones. At the heart of gemology is gem identification. A method needed to be devised where natural and cut gems could be identified without damage. We propose to use for this aim laser-based time-resolved spectroscopic complex enabling to measure luminescence, Raman and Breakdown spectra. Additional techniques include Diffuse reflectance FTIR and NIR spectroscopy, which are especially effective for differentiation between natural and synthetic gem stones.

Combined luminescence, Raman and LIBS detection of minerals may be used for remote sensing of deposits on Earth and planetary surfaces.