

Status of the Tunable Diode Laser Spectroscopy Contribution to International Safeguards Verifications

³G. Grigoriev, ¹A. Lebrun, ⁶A. Mantz, ⁴L. Mechold, ²A. Nadezhdinskii, ⁵N. Peter – Stein,
¹V. Ryzhikov, ⁷F. Tittel, ¹M. Zendel

¹ International Atomic Energy Agency, Wagrammerstrasse 5, A1400 Vienna, Austria,
a.lebrun@iaea.org

² General Physics Institute, Moscow, Russia; ³ Kurchatov Institute, Moscow, Russia; ⁴ Laser Components GmbH, Olching, Germany; ⁵ Canberra Albuquerque, Inc., Albuquerque, USA;

⁶ Connecticut College, New London, USA; ⁷ Rice University, Houston, USA

The IAEA has the responsibility to carry out the verification of the correctness of the declarations of the state nuclear material involved in peaceful applications, and to substantiate the completeness of the declaration thus ensuring the absence of undeclared nuclear material and activities. Therefore the IAEA has a need for accurately assaying both the nature and quantity of the declared nuclear material in bulk quantities but also to detect minute traces of nuclear material or related indicators in case of undeclared activities. A working group of international experts advises the IAEA on TDLS for safeguards applications and formulate recommendations on further developments. Within this framework, the IAEA in partnership with the General Physics Institute in Russia and Canberra Albuquerque, Inc. in the USA developed a portable instrument able to detect hydrofluoric acid (HF) in air at ppb levels which is indicative of operations using UF₆, e.g. enrichment activities. This instrument is now in the final phase of validation before use as a detection tool for routine inspections. The second TDLS application envisaged for safeguards is the accurate determination of uranium enrichment as an alternative to destructive analysis (DA). In 2007, an experimental TDLS measurement system dedicated to the determination of uranium enrichment in UF₆ gas was proven to be capable of achieving levels of accuracy comparable to DA. General Physics and Kurchatov Institutes in Moscow have identified avenues for improvement of the existing experimental system. Laser Component GmbH supported by the German Support Program to the IAEA safeguards is developing improved, high precision lead salt lasers with extended tuning ranges and a new dewar vessel to achieve better temperature control. Kurchatov institute worked in 2008 to improve the UF₆ gas handling technology and in particular to minimize the spurious memory effects detected during the 2007 measurement campaigns. As soon as available, General Physics Institute will integrate the improved components into a compact optical path immune to perturbations such as presence of humidity or temperature fluctuations. Once the technology has matured sufficiently, the manufacturing will be undertaken to industrial standards with the aim of installing these systems at enrichment plants under IAEA safeguards as soon as possible. The IAEA has also started to investigate Quantum Cascade Lasers (QCL) as an alternative to the lead salt lasers. GPI will test a QCL from Laser Components in 2009.

The paper describes the progress of TDLS applications for safeguards applications as recommended by the IAEA TDLS working group and explores future development needs such as the use of TDLS for detection of tritium traces and use of high UF₆ absorption cross section at 16 μm. These applications are still investigated but completion of the ongoing development project remains the IAEA priority.