# Laser Raman measurements on tritium mixtures and implications for the design of Systems for tritium accountancy or process control applications

M. Schlösser[a,*], S. Fischer[a], M. Sturm[a], B. Bornschein[a], R.J. Lewis[b], H.H. Telle[b]

[a]*Institute for Technical Physics, Tritium Laboratory Karlsruhe, Karlsruhe Institute of Technology (KIT), P.O. Box 3640, 76021 Karlsruhe, Germany*

[b]*Department of Physics, Swansea University, Singleton Park, Swansea, SA2 8PP, United Kingdom*

The compositional analysis of tritium-containing gases is a subject, which is of high importance in such diverse fields as, to name but two, in the fuel cycle of fusion power plants or in neutrino mass experiments making use of gaseous tritium beta decay (like KATRIN). For this task Laser Raman spectroscopy (LARA) has emerged as the method of choice, since it can be performed in-situ, in real-time, and without the generation of any waste.

In these and other, related fields mainly two application scenarios exist for Laser Raman spectroscopy: (i) process control on one hand (for which data has to be available within a few seconds); and (ii) tritium accountancy on the other hand (for which high precision is the key). An example for the latter is the LARA application for monitoring the KATRIN tritium source. The isotopic purity of the processed tritium gas (40 g/day) will be monitored continuously by a LARA system with a precision of 0.2% (95% C.L.) for measurement intervals of (currently) 250s.

Over the last five years two Laser Raman systems have been designed, constructed and operated at Tritium Laboratory Karlsruhe (TLK). We are able to perform measurements on static and circulating tritium mixtures, located inside a secondary containment (glove box), while all the optical setup is located outside and hence not exposed to radioactivity. Based on this experience we are now able to give proposals on how to design a suitable LARA system for the application scenarios highlighted above. In this context we will discuss the following aspects:

- We will suggest possible configurations of hardware components (e.g. laser, spectrometer, CCD, optical fibres) for systems being suitable for high-precision measurements or process-control applications. In addition, various concepts of coupling light from and to the tritium gas are compared.
- We will present multi-variate analysis (MVA) techniques associated with the so-called indirect hard modelling (IHM) approach as an advantageous methodology for rapid, online data analysis.