Monitoring of Tritium Purity during Long-term Circulation in the KATRIN Test Experiment LOOPINO using Laser Raman Spectroscopy

S. Fischer[a,*], M. Sturm[b], M. Schlösser[a], B. Bornschein[b], G. Drexlin[a], F. Priester[a], R.J. Lewis[c], H.H. Telle[c]

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

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

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

The aim of the Karlsruhe Tritium Neutrino experiment, KATRIN, is the direct (model-independent) measurement of the mass of the electron anti-neutrino. For that purpose a windowless gaseous tritium source – WGTS – is used, with a tritium throughput of 40g/day. In order to reach the design sensitivity of 0.2 eV/c^2 (90% C.L.) the key parameters of the tritium source, i.e. the gas inlet rate and the gas composition, have to be stabilized and monitored at the 0.2% level (2σ).

Any small change of the tritium gas composition will manifest itself in non-negligible effects on the KATRIN measurements; therefore, precise methods to specifically monitor the gas composition have to be implemented.

One source of compositional change is associated with the production of methane isotopologues due to interactions of tritium with the pipe walls made of stainless steel. To investigate these effects, long-term measurements have been performed in the tritium test circulation loop LOOPINO [1].

We present the first results of Laser Raman measurements in LOOPINO, in which hydrogen isotopologue mixtures were circulated continuously for several weeks. The total pressure of the mixtures was typically of the order of 10-20 kPa; the relative concentration of T_2 varied from less than 1% to more than 95%. During the measurement periods, changes of the gas composition due to hydrogen-isotope gas exchange reactions and gas – wall interactions were observed. In this context, we will discuss investigations on the influence of the tritium concentration on the production of methane isotopologues $C(H,D,T)_4$.

Finally, we show that the relative concentration of T_2 in an almost pure-T_2 mixture can be monitored by LARA within time interval s of 250s, with a precision of better than 0.2% (2σ).

[1] M. Sturm et al., published at the same conference.