FAR INFRARED TRANSMISSION MEASUREMENT ON THE HYBRID

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Introduction

Our aim was to measure far-infrared (FIR) spectra above 33 T in order to confirm a possible enhancement of the singlet to triplet transition by the 101.7 cm^{-1} phonon in a quasi-1D spin gap system α'-NaV_2O_5. We estimated that the absorption line areas must be measured with a 2% precision. This margin is would be met by one hour signal averaging on the 33 T resistive magnet in Cell 12. In this report we compare the experimental setup on the Hybrid magnet in cell 15 to the previously used setup in cell 12, and also to the TeslaFIR setup with a 12 T SC magnet and 0.3 K bolometers in Tallinn.

Experimental

We used the standard FIR probe for transmission measurements and Bruker IFS66/vs. The signal from the 4 K bolometer in the Janis cryostat was amplified by the Princeton preamplifier and filtered by the Krohn-Hite filters. A SR760 spectrum analyzer was used to monitor the noise level. An electrical touch indicator consisting of six stripes of copper tape was mounted on the tail of the cryostat. Different setups have different noise sources. On the resistive magnet the largest noise comes from the magnet cooling water turbulences, which tend to create vibrations of the cryostat and of the bolometer. We estimate the relative noise level for a set of N spectra $T_i(\omega)$ taken under similar conditions by calculating the relative sigma of the average spectrum:

$$\sigma(\omega) = \sqrt{\left(\frac{1}{N}\sum_{i=1}^{N} T_i^2(\omega)\right)\left(\sum_{i=1}^{N} T_i(\omega)\right)^{-2} - \frac{1}{N^2}} \qquad [1]$$

As the random noise in the average spectrum is reduced proportionally to the square root of integration time per data point the relative sigmas must be scaled by a factor $k = \sqrt{t\,\Delta\omega}$, where t is the total measurement time of all the averaged spectra and $\Delta\omega$ is the spectral resolution. Thus, by plotting the scaled sigmas, $k\sigma(\omega)$, on a common graph we can directly compare different experimental setups.

Results and Discussion

We see from the Figure that the noise level on the Hybrid without cooling water running was about the same as it was in Cell 12. Mechanical noise from the cooling water on Hybrid increased the sigma of the averaged spectrum by a factor of 10. The noise was transferred to the bolometer through the body of the cryostat. Later it was found that the platform supporting experimental setup was not isolated mechanically from the magnet housing. The magnet housing and the platform were bolted together via a walking platform around the magnet housing. With such noise level we were unable to perform planned experiment.

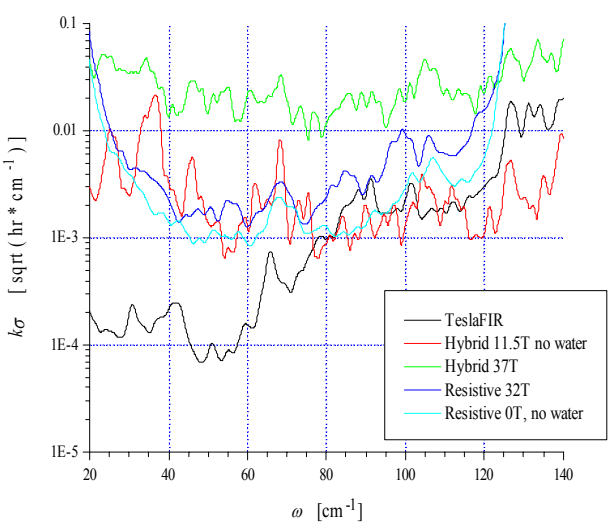

Figure. Spectra of scaled sigmas measured on different magnet systems with and without cooling water running.

Conclusions

Further tests are needed to see if by breaking the mechanical connection between the platform and the magnet keeps the noise at acceptable level when cooling water is running.

Acknowledgements

Estonian Science Foundation grants 6138 and 5553 and a U.S. – Estonia Scientist Travel Grant 1/2005 are acknowledged.