RRCAT THz FTS - TES detector

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The Terahertz FTS for low temperature and high magnetic field environment was installed at RRCAT, India (Raja Ramanna Centre for Advanced Technology). This custom spectrometer is a combination of polarizing Martin-Puplett type and Michelson type FTS.

The dual-channel cryogenic detector system consists of an Indium Antimonide (InSb) HEB and a Transition-Edge Sensor (TES) mounted at 90° to each other inside the cryostat. This detector system was designed to mount at both reflection port and transmission port, as required. The top view of the complete assembly shows the reflection and the transmission port. FTS was designed to interface with an Oxford Instruments Magneto-Optical Cryostat (MOC) capable of producing fields upto 7 T.

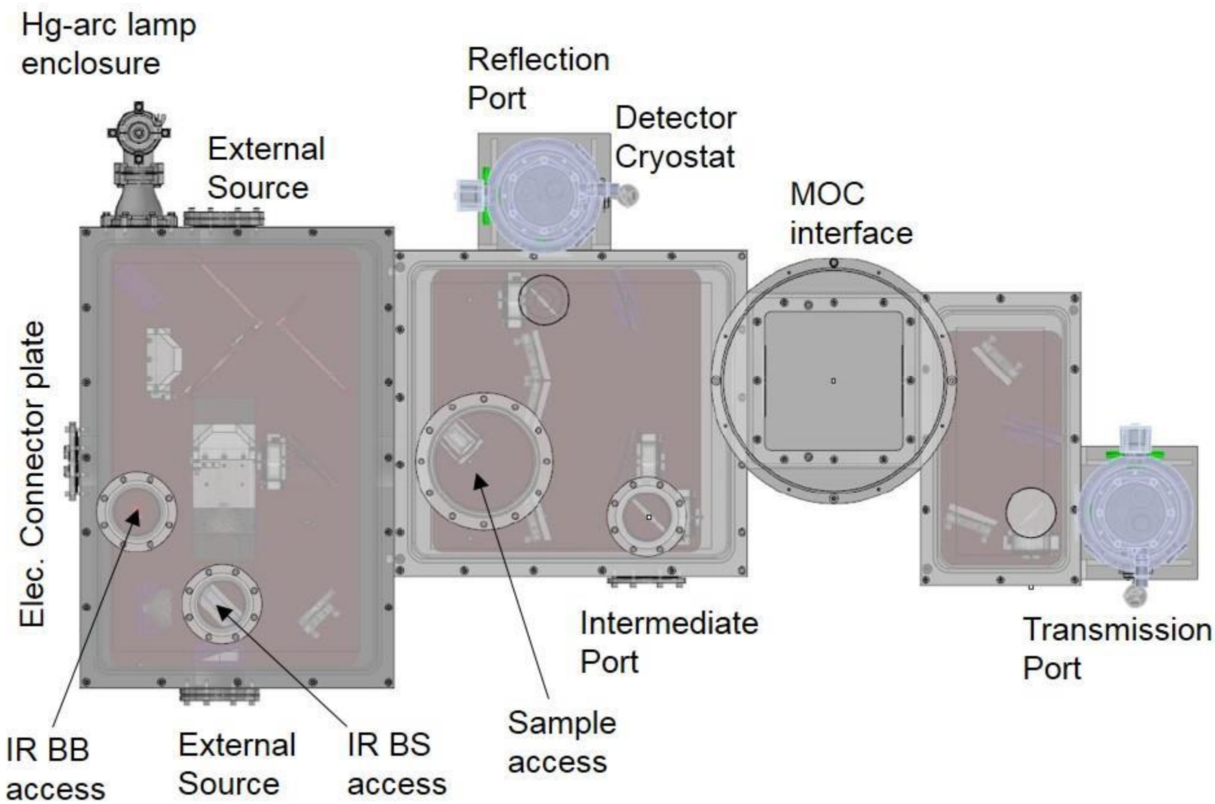

Figure 1 CAD rendering of the THz FTS showing the detector mounting locations at reflection and transmission ports.

Figure 2 THz FTS at RRCAT, India with TES detector system connected at the reflection port.

Figure 3 Magneto-Optical Cryostat connected to the THz FTS at the MOC interface (as shown in Figure 1)

Recently RRCAT has mentioned about the following issues they have encountered during the FTS measurements.

1. The performance of the TES deteriorates with increasing magnetic field and the detector signal becomes negligible once the magnetic field in their magneto-optical cryostat reaches 5 T. They are not sure whether the signal is being affected by the stray magnetic field from their cryostat. According to Oxford, the stray magnetic field should be around 100 Gauss and 200 Gauss at the reflection and transmission port of the TES respectively.
2. Another issue they are having is with the detector ranges. HEB provides data until 65 cm^{-1} and TES is not providing them with good data below 100 cm^{-1}. The observed power below 100 cm^{-1} is low with gold mirror and it might be even lower when they are measuring the samples. They are looking to address the issue with the gap in their data between 60 and 100 cm^{-1}.

TES Transmission (Reference) measurements at RRCAT in Magnetic Field (O to 4.9 Tesla)

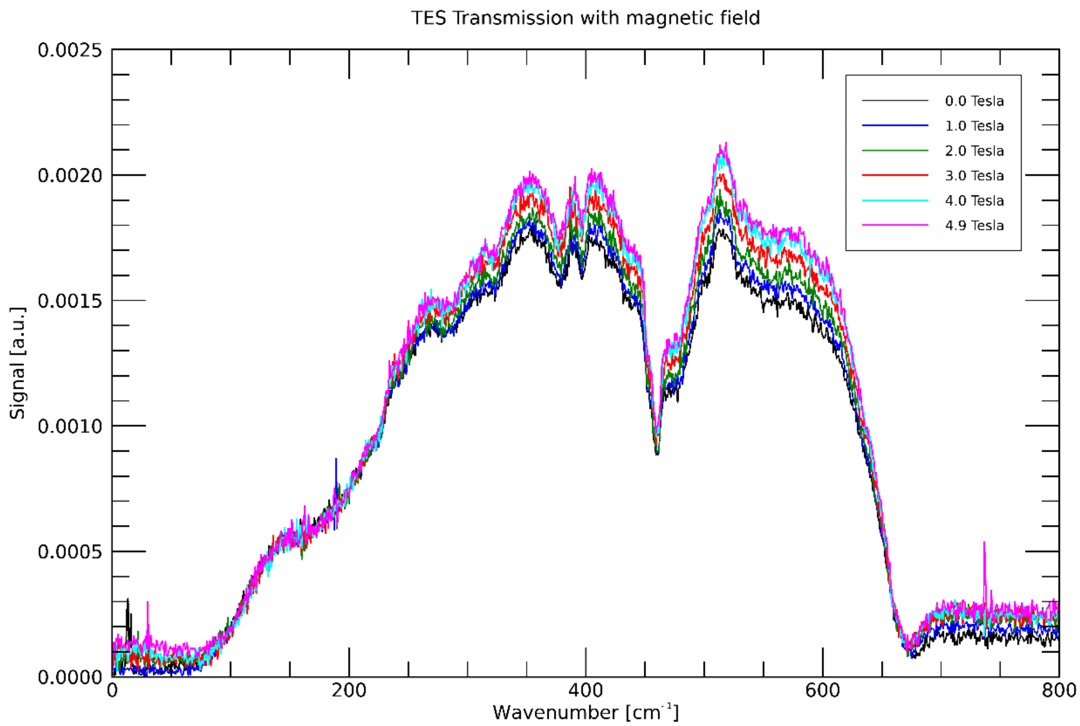

Figure 4 Spectra measured using TES detector system at transmission port at different MOC magnetic fields.

There was no indication of systematic decrease in the spectral power with magnetic field until 4.9 Tesla. RRCAT mentioned that they can see the signal until MOC is at 4.94 T and then it completely disappears at 4.96 T.

Stray Magnetic Field at the flange of TES detector system due to MOC Magnetic field

RRCAT has measured stray magnetic field near the detector flange and it is about 210 Gauss when the MOC is at 5 T near the transmission port. These numbers are in line with the Oxford Instruments stray magnetic field specifications. At the reflection port, the stray magnetic is about 100 Gauss.

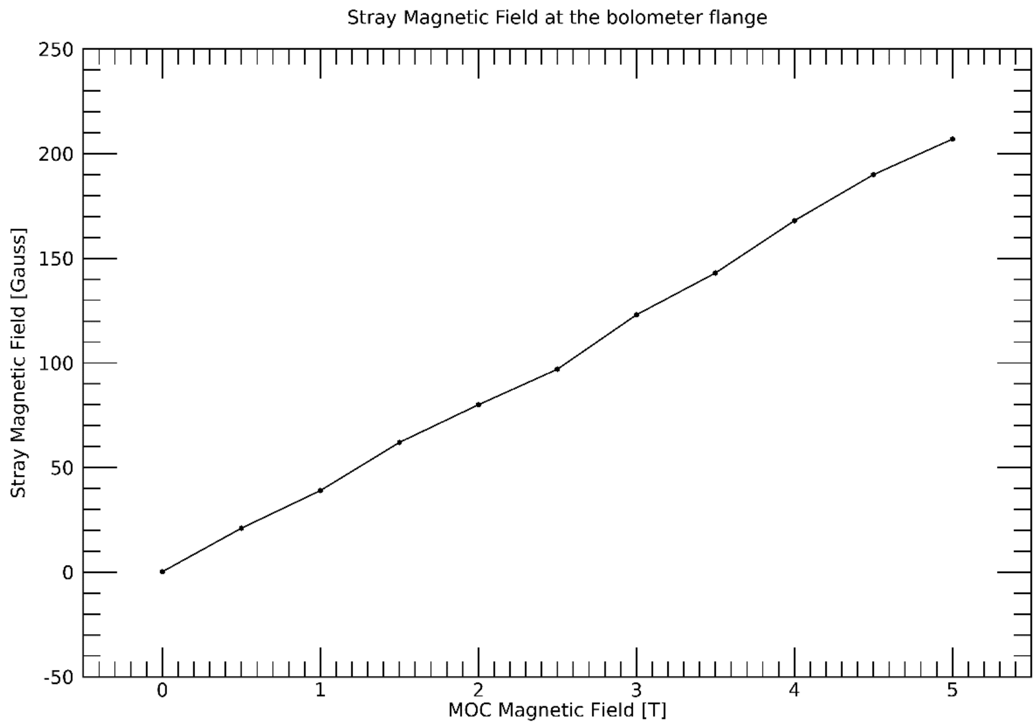

Figure 5 Stray magnetic field near the detector flange due to the MOC magnetic field.

TES Transmission (Reference) measurements at RRCAT in 5 T field

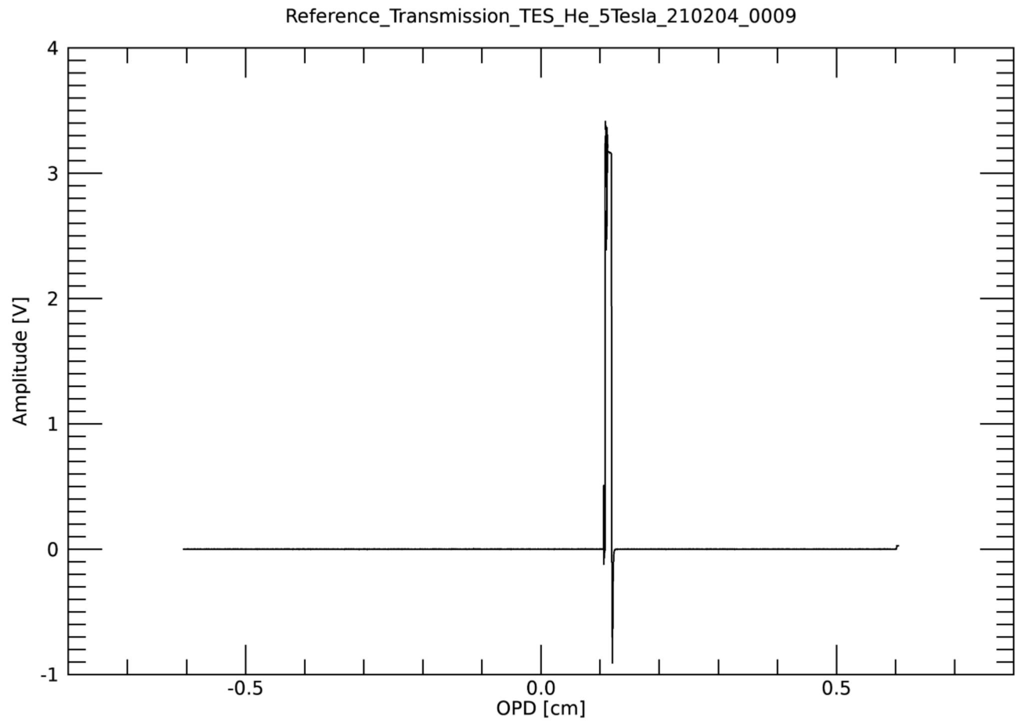

Figure 6 Typical interferogram when the MOC magnetic field at 5 T.

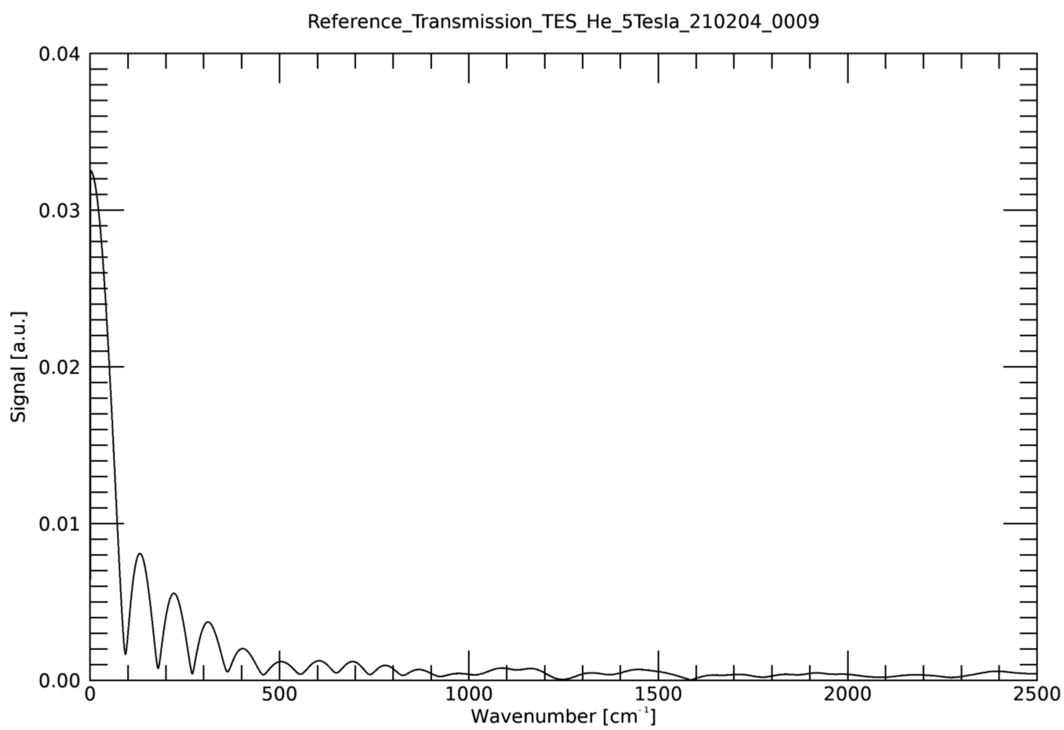

Figure 7 Typical spectrum when the MOC magnetic field at 5 T.

Zero Signal noise measurements in presence of magnetic field using TES detector system

RRCAT has used a 200 KHz DAQ card to perform the zero signal noise measurements in the presence of different magnetic fields near the detector flange. The TES detector system is at the transmission port.

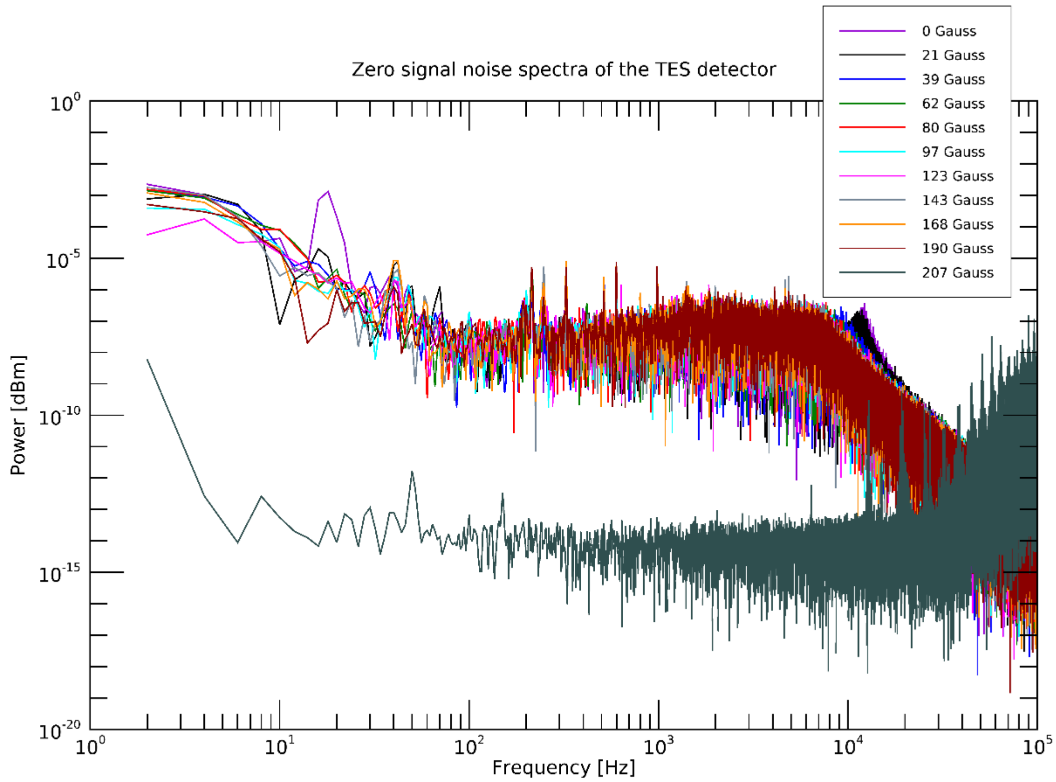

Figure 8 Zero signal noise of the TES detector in the presence of stray magnetic fields due to the MOC magnetic field. The dark grey curve shows the field effect on the detector system once the stray magnetic field is above 200 Gauss.