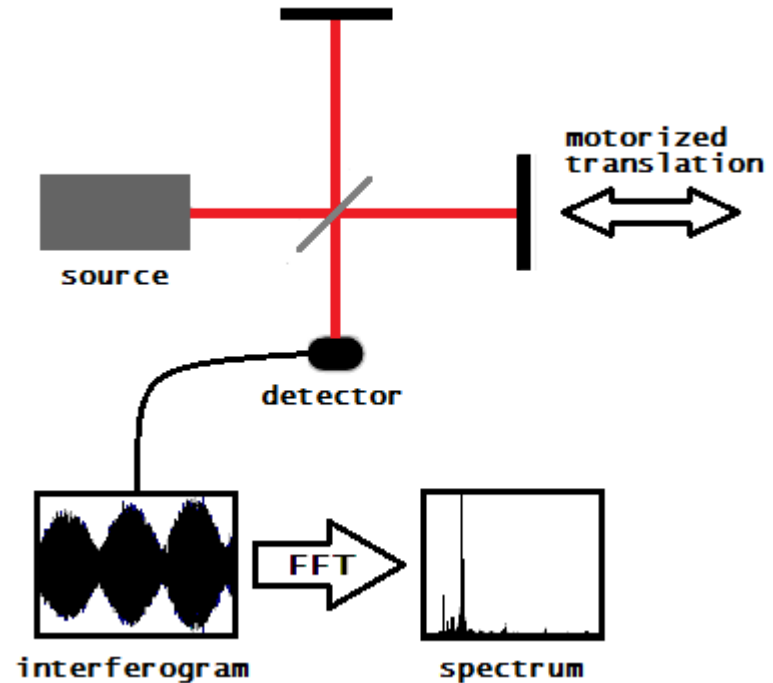


CMB summer school- FTS test

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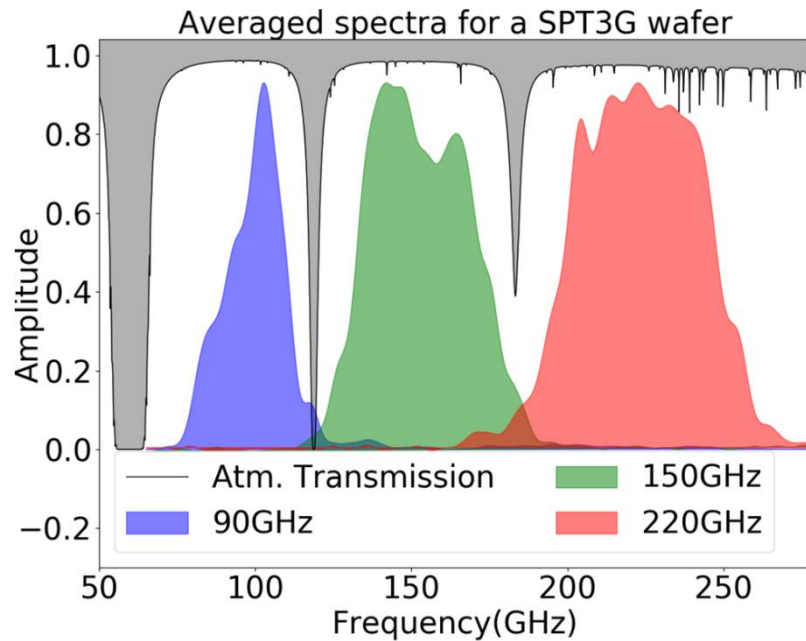


A PIXIE-style FTS that we developed for SPT3G. This FTS folds the input light rays many times so it still has enough resolution despite of its compact size.



This is a cartoon showing how the FTS works. Recap from the lecture: FFT of the auto-correlation gives you the power spectrum. (Credit: Wikipedia)

Measurements from this FTS



Left: we set up the FTS at the South Pole to test the deployed wafers for SPT.

Up: the measured spectral bands for one deployed SPT wafer.

Tasks for today

- Look at the structure of the FTS. How does it work?
- Do the optical coupling. How to maximize the signal?
- Set up the FTS driver software (optional). How does the control system work?
- Take some measurements. How to get the absolute transmission?
- Analyze the data. What's the algorithm? Why some filters are high-pass and some are low-pass?
- Measure the transmission of Fluorogold (Teflon, HDPE). How to reduce the S/N and nonlinearity?
- Fit for the dielectric constant and loss. Why there are band spectra?
- Measure the optical efficiency using the cold load (optional). How do we extract the optical efficiency?

The repository – 6 folders

- Data: where the ADC data and spectrum data are stored.
- Drivers: the driving software for the FTS.
- FTS_analysis: simple FTS analysis/plotting code and overplotting code.
- FTS_delectric: The code for analyzing multiple scans to average down the noise and the code for fitting the dielectric constant.
- Background_materials: papers about the instruments and materials.
- Optical_efficiency: codes for plotting the optical efficiency of SPT bolometers.

How to install the driver

- Installation guide available at:

https://github.com/panzhaodi/FTS_kicp_summer_school/blob/master/Drivers/SOFTWARE_INSTALL_INSTRUCTIONS.txt

Available for Linux/ Mac and Windows.

You will need to install libusb, pyserial, and pymodbus packages.

> sudo apt-get install libusb-1.0-0-dev

> Download the archive from <http://pypi.python.org/pypi/pyserial>.

Unpack the archive, enter the pyserial-x.y directory and run: python setup.py install

> easy_install -U pymodbus, or sudo pip install -U pymodbus

How to analyze the data

- Go to FTS_analysis folder
- Simply run `python BasicAnalysis.py`
- Enter the file name (`Example1.pkl`) following the prompts. The data should already exist in the Data folder.

How to overplot and compare the data

- Go to FTS_analysis folder
- Run `python BasicComparison.py`
- Enter the two file names (`Example1.pkl` twice for example) following the prompts. The data should already exist in the Data folder.
- Choose 'y' if you want to divide the two spectra following the prompts.

How to fit for the dielectric constant

- To resolve features for the fit, we need a more complex code to average over many scans and reduce the noise in data.
- Go to FTS_dielectric folder
- Edit the fts_multiple_scan.py file. Enter the data name you are going to analyze and the spectrum's name that you want to save as.
- Do `python FTS_multiple_scan.py` in your terminal to analyze the data.
- Repeat the measurements for the air transmission and air+material transmission, and put the two output spectra in the Data folder.
- Edit dielect_fit.py file. Enter the two output spectra's names in the beginning of the file.
- Do `python dielect_fit.py`.
- You will need to tune the range of parameters for the curve_fit function because there are local maxima for the likelihood.

How to analyze the optical efficiency data

- Install seaborn package by
`pip install git+https://github.com/mwaskom/seaborn.git`
- Put the generated data in the folder named `optical_efficiency`.
- Edit the file named `hkdata`. Enter the cold load temperature and the data location/name.
- In a ipython session or a python code, do: `import pickle, hkdata='your edited hkdata', pickle.dump(hkdata, open('hk_data.pkl', 'wb'))`
- Do `python fit_opticaleff.py hkdata.pkl`