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# Data of cryocooler temperature dynamical response to time-varying power inputs at 4 K

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Data Article

# Data of cryocooler temperature dynamical response to time-varying power inputs at 4 K

Andrea Sosso *, Paolo Durandetto

*INRiM – Istituto Nazionale di Ricerca Metrologica, Torino, Italy*

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ABSTRACT

Data presented here deal with the measurement of a two-stage Gifford-McMahon cryocooler dynamical thermal response to programmed square wave and sine wave power inputs around 4 K. Square response data report the raw temperature data points measured by the sensor. Properly filtered data are also presented and results of exponential decays fitting analyses are shown as well. Sine response data were acquired with two different experimental setups and at several frequencies; data report the frequencies of the input stimulus, the measured temperature variation and the phase between input and output signals for both setups. More details about the experimental background can be found in the related research article, "Experimental analysis of the thermal behavior of a GM cryocooler based on linear system theory" (Sosso and Durandetto, in press).

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**Specifications table**

| | |
|---|---|
| Subject area | Engineering, Physics |
| More specific subject Area | Cryogenics |
| Type of data | Excel files, Scilab script |

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* Corresponding author.
*E-mail address:* a.sosso@inrim.it (A. Sosso).

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| | |
|---|---|
| How data was acquired | The voltage drop across the temperature sensor is measured with a digital storage oscilloscope Teledyne LeCroy HDO6034A and with a lock-in amplifier EG&G 7265. The power is dissipated by a resistor properly biased by an arbitrary function generator Keysight 33250A |
| Data format | Raw, filtered and analyzed data |
| Experimental factors | See the related research article [1] |
| Experimental features | A cryocooler with a resistor for generating heat and sensor for measuring consequent temperature variations, both appropriately tightened to the cryocooler cold region |
| Data source location | Torino (Italy) |
| Data accessibility | Data provided in the article are publicly available on Mendeley Data: https://data.mendeley.com/datasets/bsby4dhjy5/draft?a=e75eb7c5–53c0–46bc-afc6–43a77b94f933 doi:10.17632/bsby4dhjy5.1 |
| Related research article | A. Sosso and P. Durandetto, "Experimental analysis of the thermal behavior of a GM cryocooler based on linear system theory," International Journal of Refrigeration, in press [1] |

**Value of the data**

- Square wave response data provides insights about possible differences between increasing and decreasing temperature trends and thus to detect possible asymmetries.
- Sine wave response data provides a comparison between data acquired with two different techniques: the differences can be investigated for detecting any pros and cons of each method.
- Data results from similar measurements at different temperatures or with another cryostat, e.g., a pulse-tube cooler, can be compared to our data and to investigate on possible differences.

## 1. Data

Data presented here include the measured temperature variation of a Gifford-McMahon cryocooler around 4 K in response to programmed time-varying power inputs. In particular, step and sine wave power functions were used and the subsequent cryocooler temperature datapoints were acquired, processed and shared in the repository.

## 2. Experimental design, materials, and methods

The main component of the experimental setup is the Gifford-McMahon cryocooler (Leybold Coolpower 4.2), together with a temperature sensor and a heating resistor appropriately tightened to its cold region. A programmed heat variation is generated through the resistor with the use of an arbitrary function generator and the cryocooler response is measured by means of a proper sensor. A detailed description of the employed procedures and techniques can be found in [1,2].

Data are subdivided into two Excel files, one for square wave and the other for sine wave power input responses.

The file "Square wave input.xlsx" includes the cryocooler temperature response to a 10 mHz square wave power input. Two periods (200 s) of the input signal were stored. The file is divided in two sheets named "Sampled data" and "Skimmed data". "Sampled data" contains raw data acquired by the digital oscilloscope organized in a three columns table with N rows, where N is the total number of sampled points. First and second column are time and averaged sensor voltage as sampled by the oscilloscope. The third column is obtained by converting the measured voltage into a temperature value according to the sensor calibration curve, that was linearized around 4 K. Raw data were divided into four monotonic transitions (one ascending and one descending transition for each

period), each of which has been suitably skimmed [2] using the algorithm “skim_data.sce”. Each skimmed transition was separately fitted with both second and third order exponential decays. Skimmed data points and best fit parameters are listed in “Skimmed data” sheet.

The file “Sinewave input.xlsx” includes the cryocooler temperature variation in response to sine wave power inputs of several frequencies. Data were acquired using both the digital oscilloscope and the lock-in amplifier. The file summarizes the measurement results in two tables, one for each method. Both tables contain the frequency of the input sinewave, the measured peak-to-peak voltage variation of the temperature sensor, the peak-to-peak temperature variation as obtained via the sensor calibration curve and the phase difference between input and output sinewave. The phase was directly measured by the lock-in amplifier, while it was calculated from a time delay measurement when the oscilloscope was used.

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## Transparency document. Supporting information

Transparency data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.dib.2018.08.211.

## References

[1] A. Sosso, P. Durandetto, Experimental analysis of the thermal behavior of a GM cryocooler based on linear system theory, International Journal of Refrigeration, 92, 2018, 125–132, ISSN 0140–7007, http://dx.doi.org/10.1016/j.ijrefrig.2018.04.016.

[2] Andrea Sosso, Paolo Durandetto, Determination of the temperature vs power dynamic behavior of a cryocooler via two independent methods in time and frequency domain, MethodsX, 5, 2018, 841–847, ISSN 2215–0161, http://dx.doi.org/10.1016/j.mex.2018.06.013.