

# Implementation and Investigation of Multi-layer Insulation

Christian Robles, Physics Department, crobles@Princeton.edu

## Background

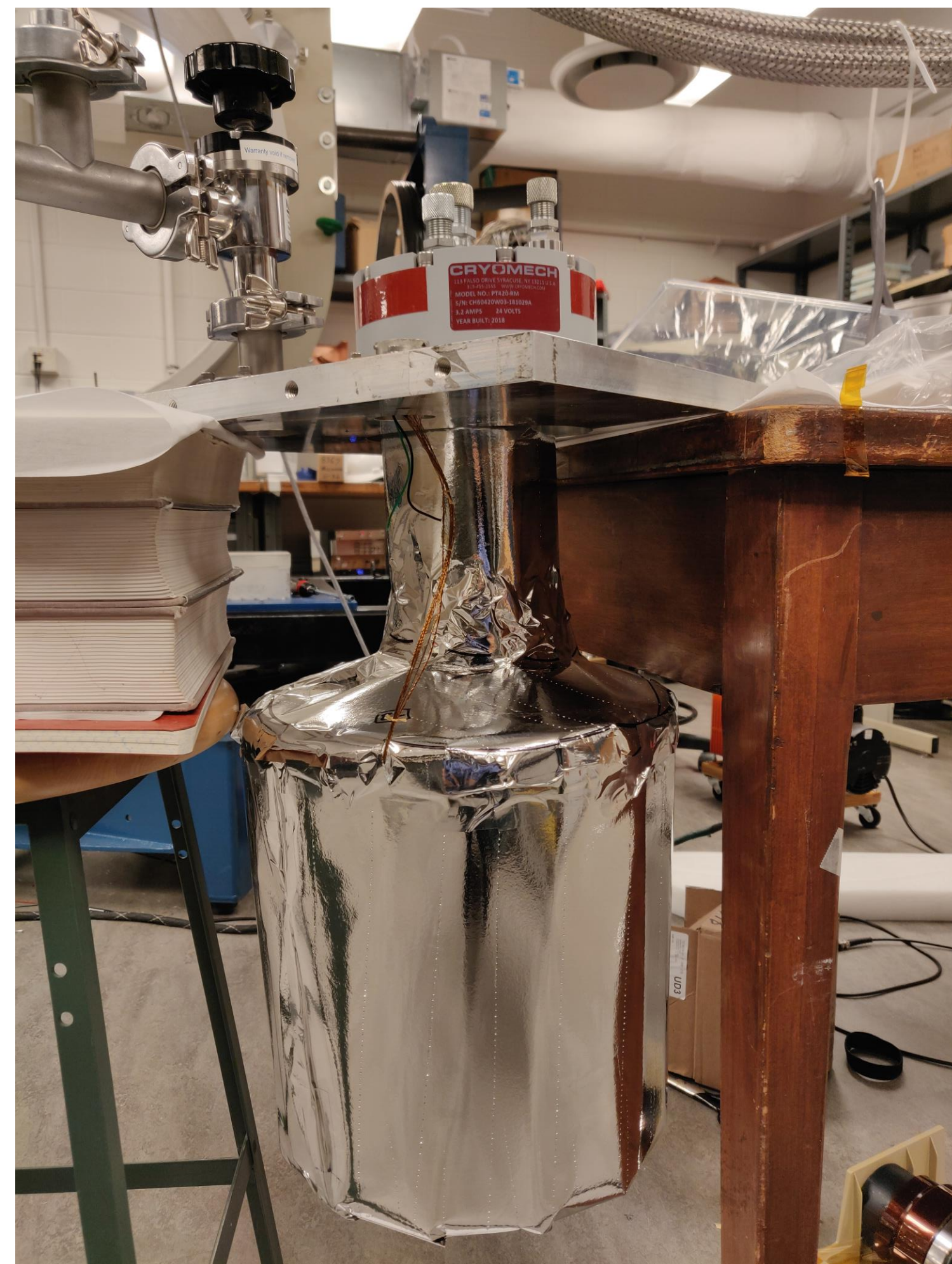
The installation of these multi-layer insulation or MLI for short is a necessity in telescopes with cryogenic chambers. The sensors used in telescopes such as The Small Aperture Telescope or TSAT need to be kept in a superconductive state which is achieved when the transition-edge sensors are at millikelvin. These TES are essential for the goal of the TSAT which is to detect gravitational B-modes in the CMB and will be deployed in Chile.

## Research Questions

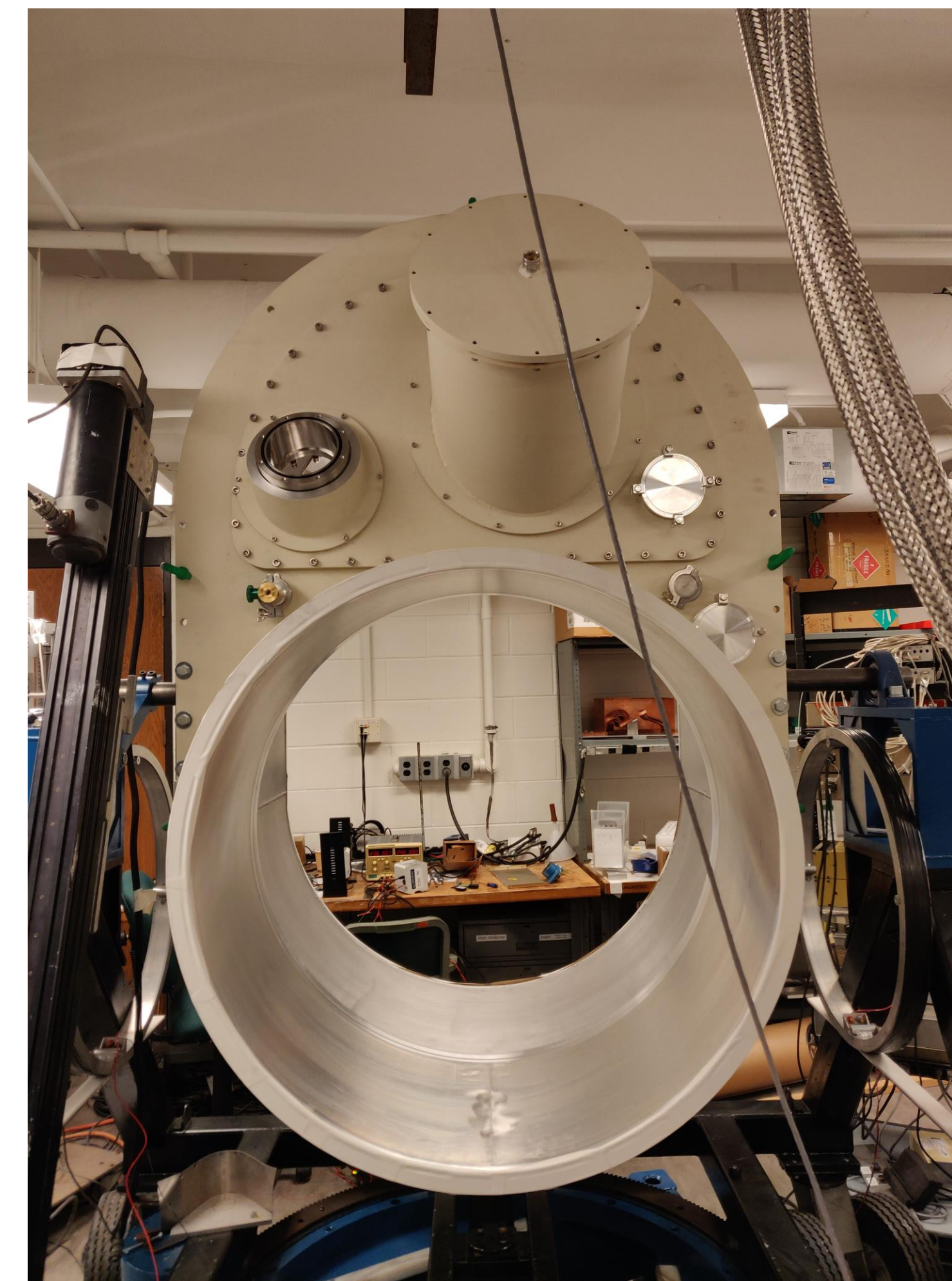
We worked to make and install MLI blankets inside the 40 Kelvin and 4 Kelvin stages of TSAT while also trying to improve and examine the properties of our specific MLI.

## Methods

For the implementation we constructed a 16ft wood table in order to lay out the blanket layers and used a razor to cut the layers. For the Examination we used a test cryostat sent from Penn with the pulse tube from TSAT. Using this test cryostat allowed us to test for the effect the blankets had on the cooldown.



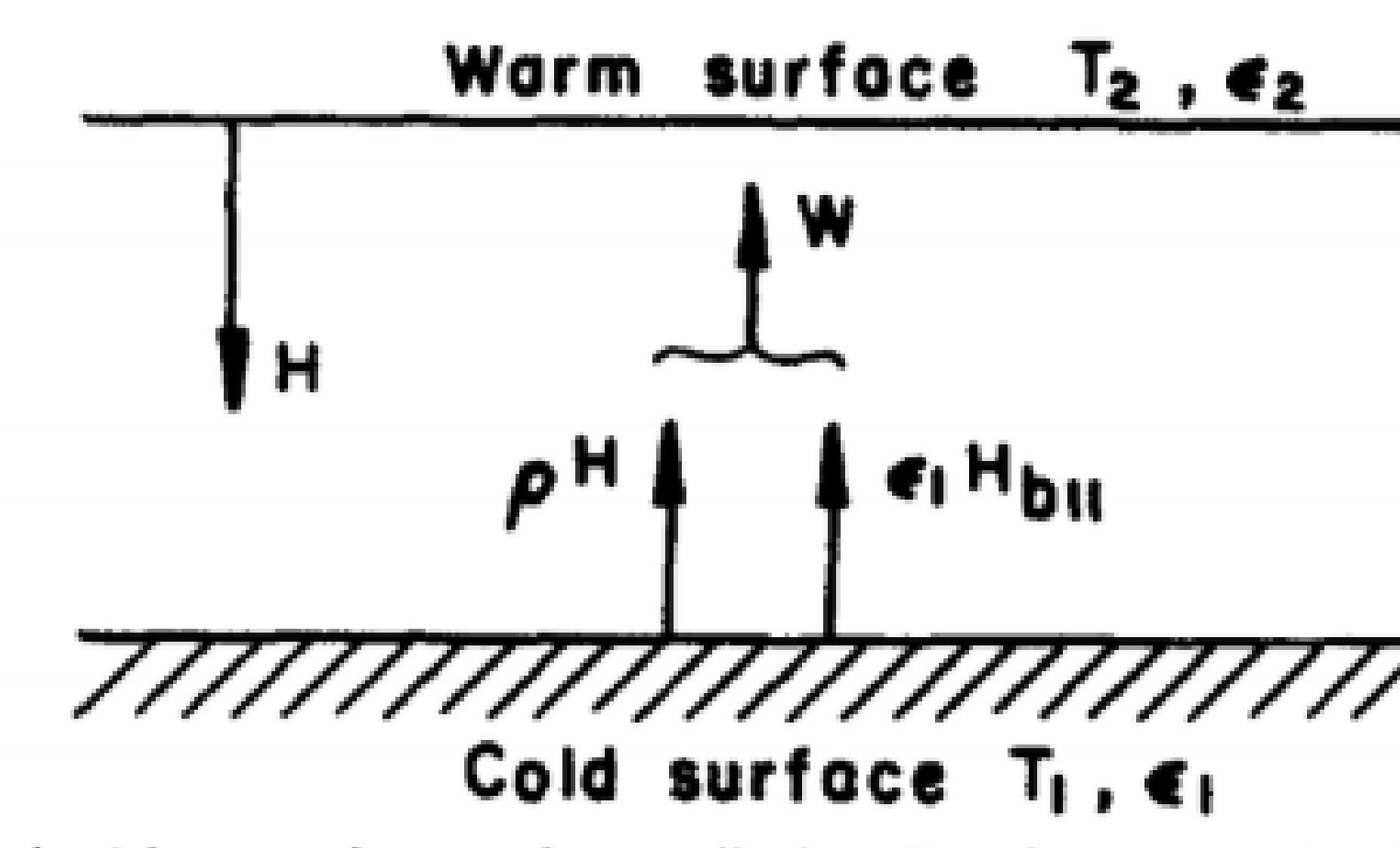
40 K stage of test cryostat with testing 30 layer MLI on pulse tube for TSAT.



TSAT- Outside vacuum shell which the MLI is being designed for.



A sample layer of MLI with 7 layers of aluminized mylar.



A diagram from Shu that provides the basis for the mathematical calculation of the heat transfer between the stages.

## Results

The results of this project currently are the production of most of the MLI for the TSAT with only a few more blankets left. Also in the examination into the MLI, the cooldown without the blankets stabilized at 30 Kelvin while with the MLI blankets at 27 Kelvin. It required around 2 watts in order to heat up the stage with the blankets to the temperature without the blankets.

## Conclusion

Discussion:

These findings show that the MLI blankets made in lab are effective and will provide adequate radiation shielding for TSAT.

Future Directions:

Although the effectiveness of the MLI was tested, more testing could be conducted changing different variables such as using just fiberglass as a spacer or also using netting. Testing like this could lead to an ideal "loft" or density of layers for the blankets.

## Acknowledgments

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## References

Shu, Q.S. Systematic study to reduce the effects of cracks in multilayer insulation. Part 1: theoretical model Cryogenics (1987) 27 249-256