

# Development of a pneumatic GM cryocooler with dual-displacer

Qian Bao, Mingyao Xu

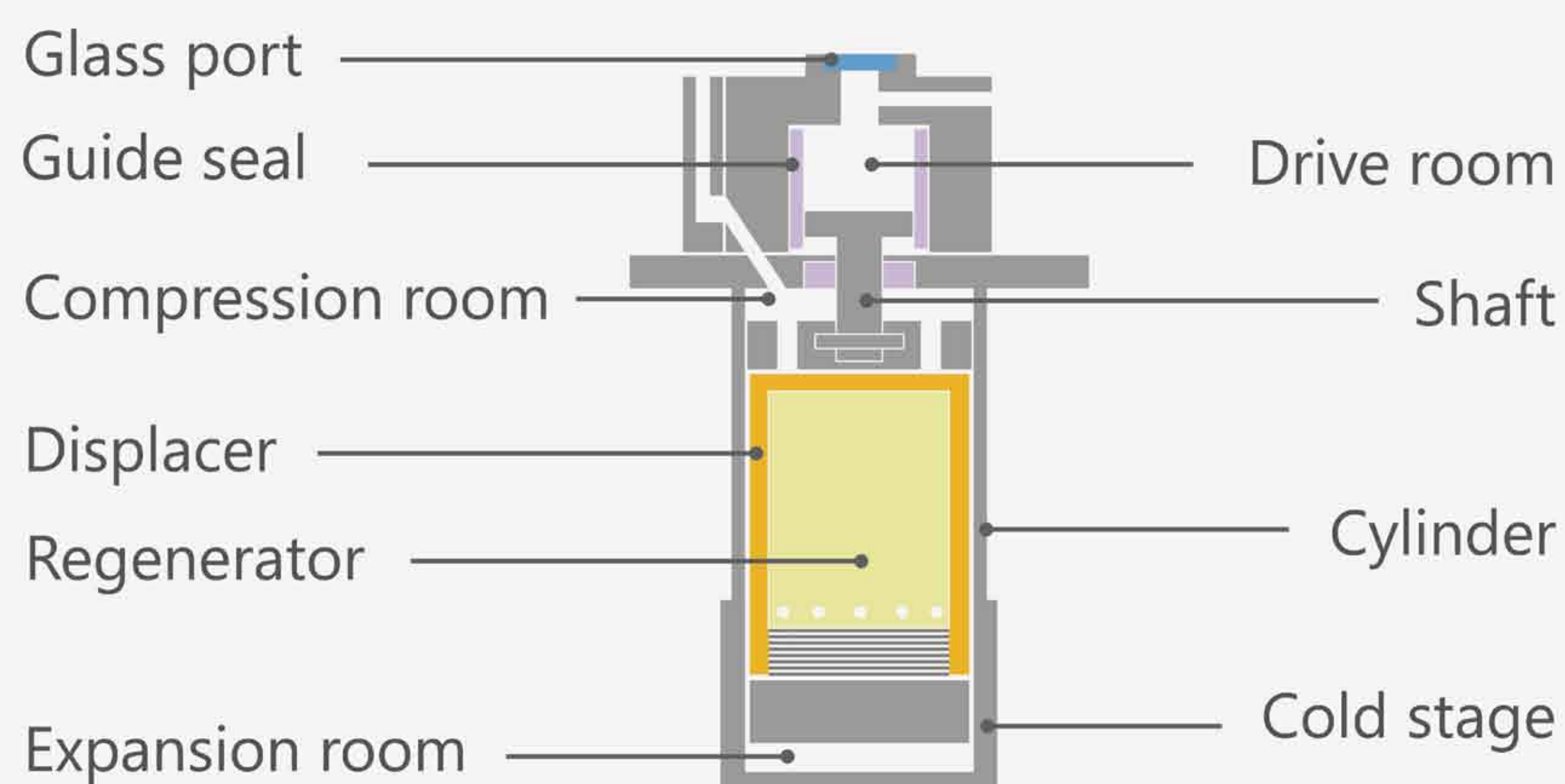
Technology Research Center, Sumitomo Heavy Industries, Ltd., Nishitokyo-city, Tokyo, Japan 188-8585

## Background

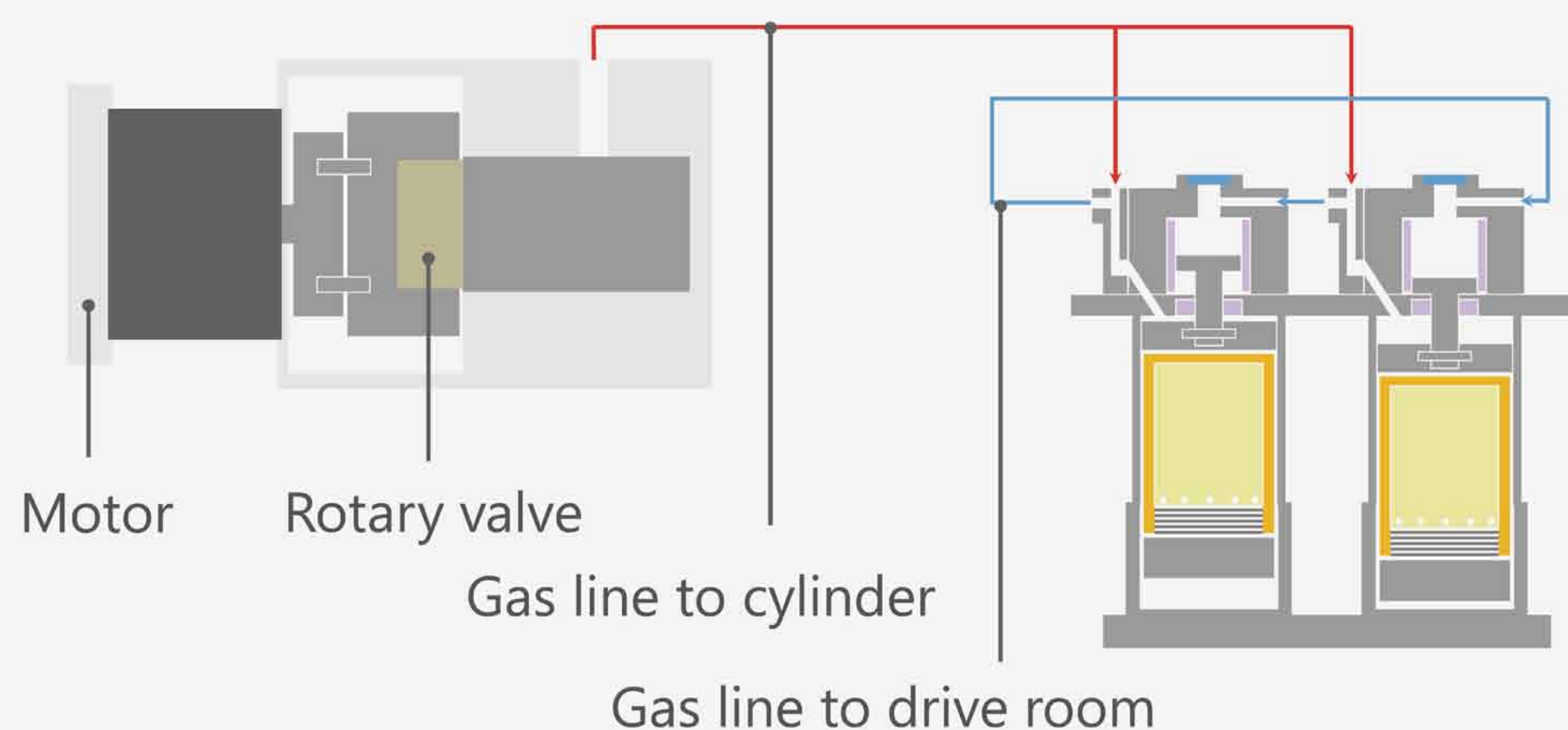
- **High Temperature Superconductive (HTS)** applications often require  $10^2 \sim 10^4$  W of cooling capacity at  $60 \sim 80$  K.
- The motor torque requirement becomes unrealistic when the displacer continuously increase in size.
- A prototype **pneumatic GM cryocooler** was designed and built to overcome the lack of torque of current motor.
- A new **dual-displacer scheme** was designed to further improve the efficiency of the prototype unit.
- Parameters including **valve timing** and **regenerator material arrangement** were optimized by experiments.

## Design concept

- Displacers are fully driven by the **pressure difference**.

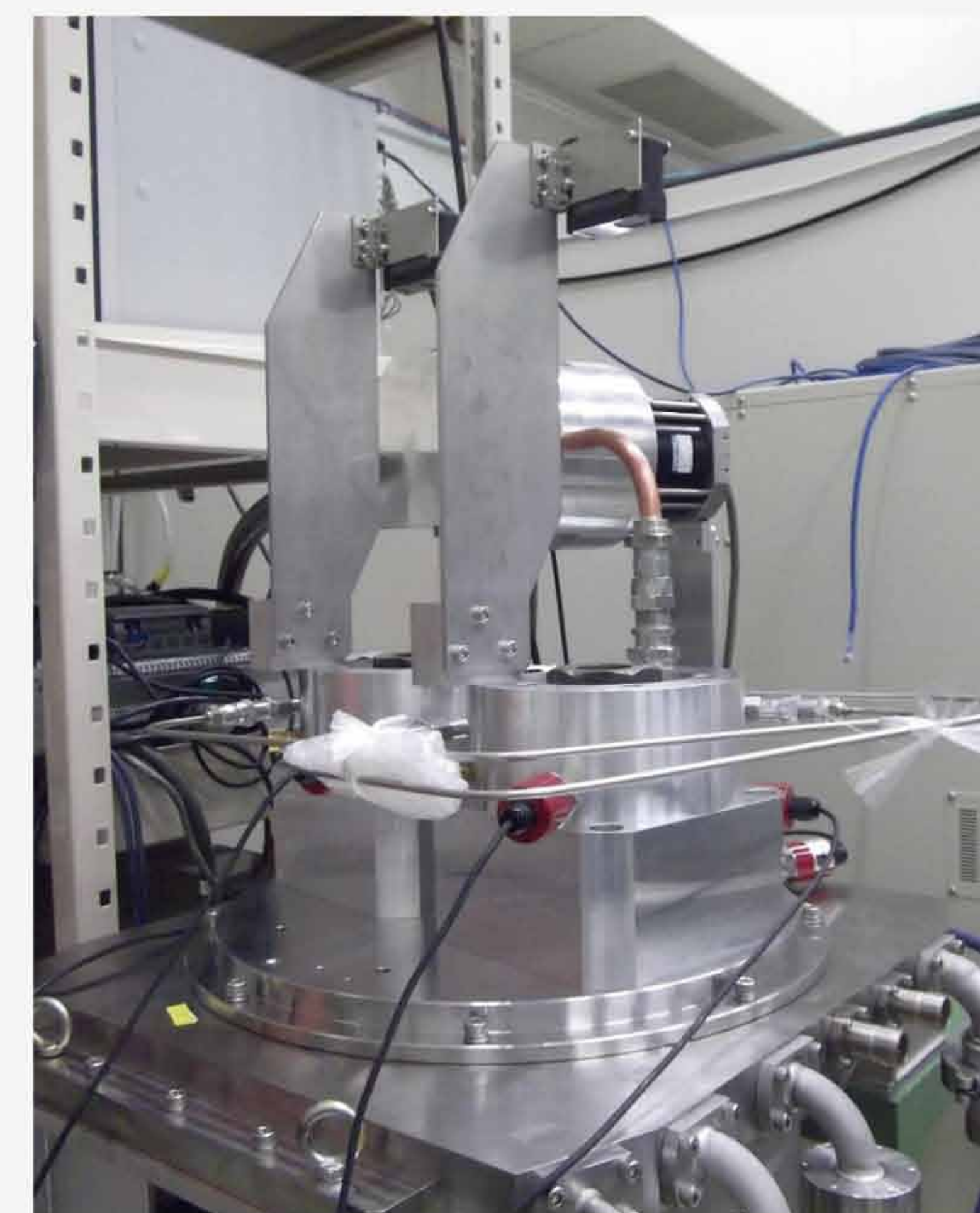
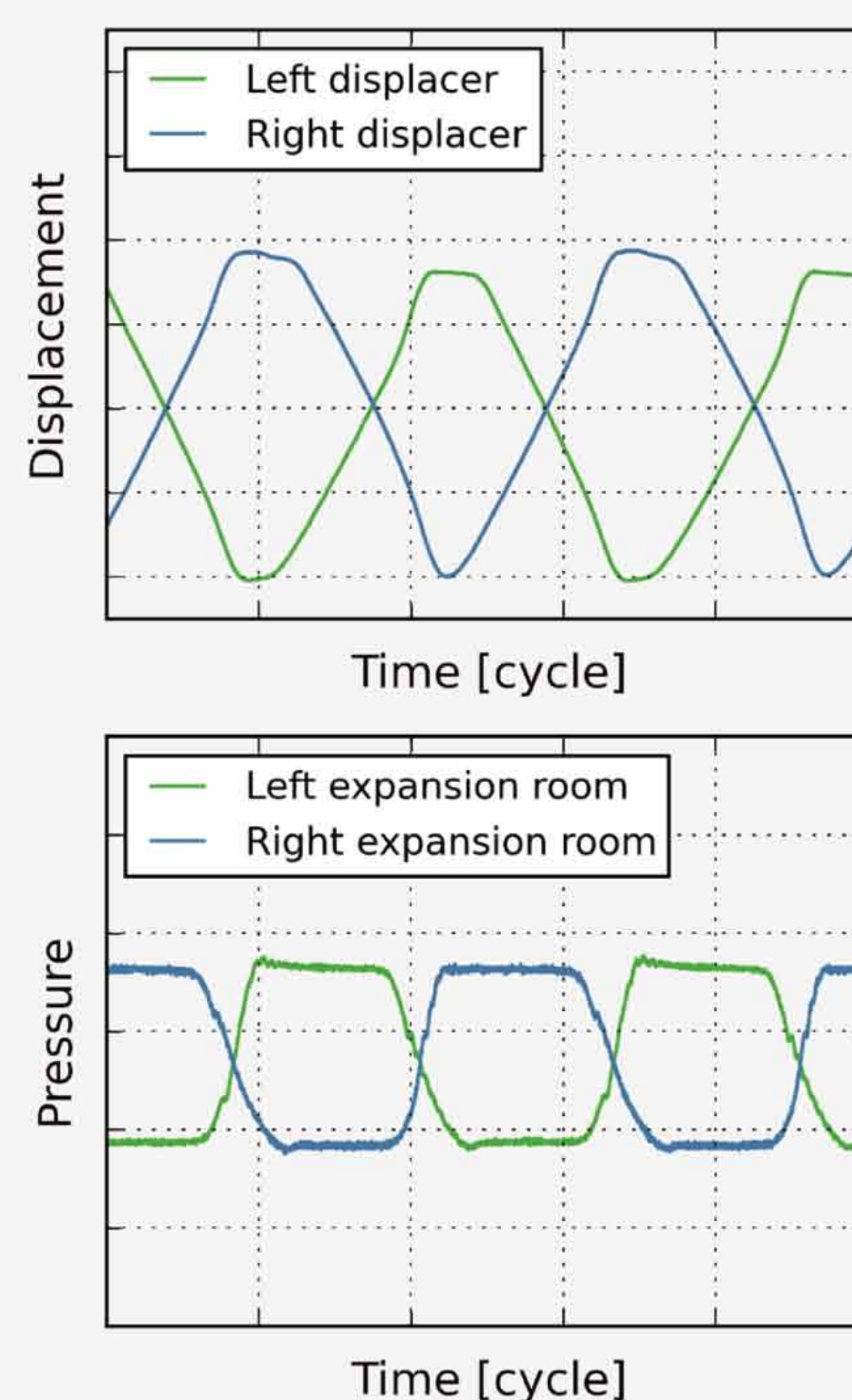


- Rotary valve is solely controlled by the motor.
- Drive pressure is **alternatively supplied** to the two cylinders.



## Experimental results

- A prototype unit of 751 mm height was built.
- Dual-displacer's movement was measured by laser vibrometer.
- Pressure waves in cylinder were mutually reversed, thus the **pressure oscillation on compressor side was reduced**.
- Displacer's movement was optimized by modifying the diameter of shaft and fine-tuning of gas seal, which led to +200W in cooling power compared with initial result.
- Conventional regenerator materials were used and the regenerator length was optimized.
- Highest cooling power was **550W @ 80K** with an input of about 13.0kW. Lowest temperature under no-load condition was 22K.



## Conclusions and future work

- A pneumatic, dual-displacer GM cryocooler prototype unit which can provide **550 W cooling power at 80K** was developed.
- Although the pressure oscillation was reduced on compressor side, the overall efficiency still needs further improvement.
- Future work includes the optimization of the operating frequency, driving component and heat exchanger.