



Hands-on Training (Cryogenics)

Pulse Tube Refrigerator

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What is a pulse tube refrigerator?

- The refrigerator consists of a regenerator, a pulse tube, a valve rack, etc.
- Unlike mechanically driven GM refrigerators, the displacer does not move back and forth within the cylinder, resulting in less vibration during operation.
- Furthermore, the regenerator material is fixed and there are no moving parts in the low-temperature area, resulting in a long life.
- It is primarily used in highly sensitive analytical equipment that is sensitive to vibration.



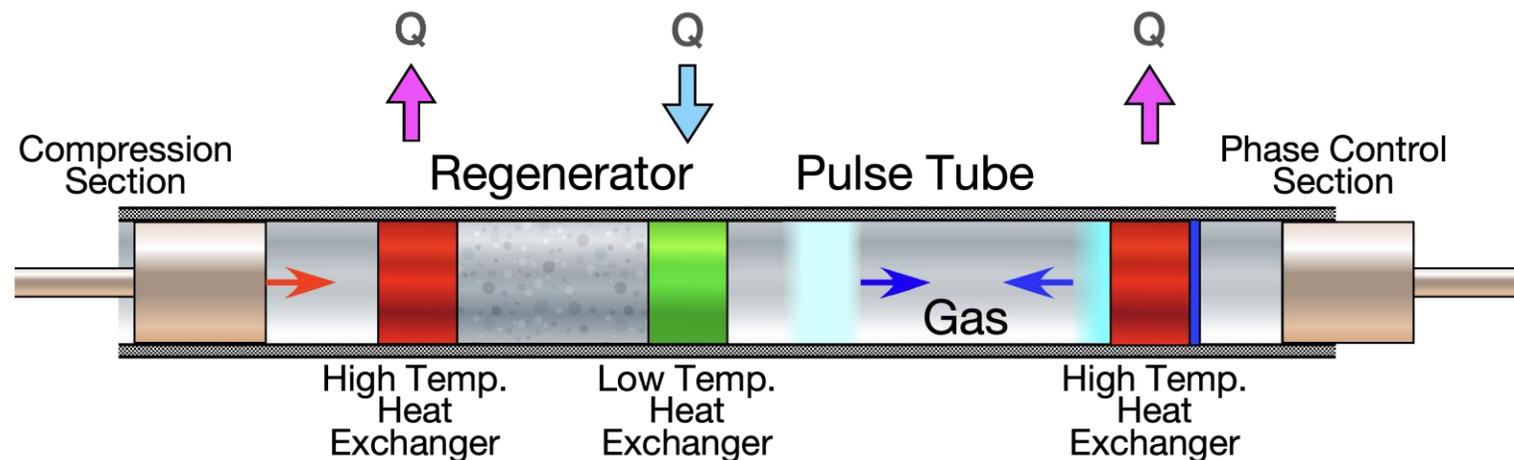
<https://www.shi.co.jp/>
Sumitomo Heavy
Industries, Ltd.

Achieved
temperature 3K or
less

1. Low vibration
2. Long life
3. Room temperature moving parts (valve unit) can be operated separately

Cooling mechanism

- When gas is moved back and forth, pressure and phase are generated.
- The phase difference between pressure and phase changes is important in heat transport
- When the phase difference is 90 degrees, it is called a traveling wave mode, and when it is 0 degree, it is called a standing wave mode.
- In the regenerator tube, heat is transferred to the high temperature side in the traveling wave mode.
- In the pulse tube, standing wave modes transport heat to the ends.
- It is important to adjust the phase difference



Equipment employed today

This is the model known as the first generation.

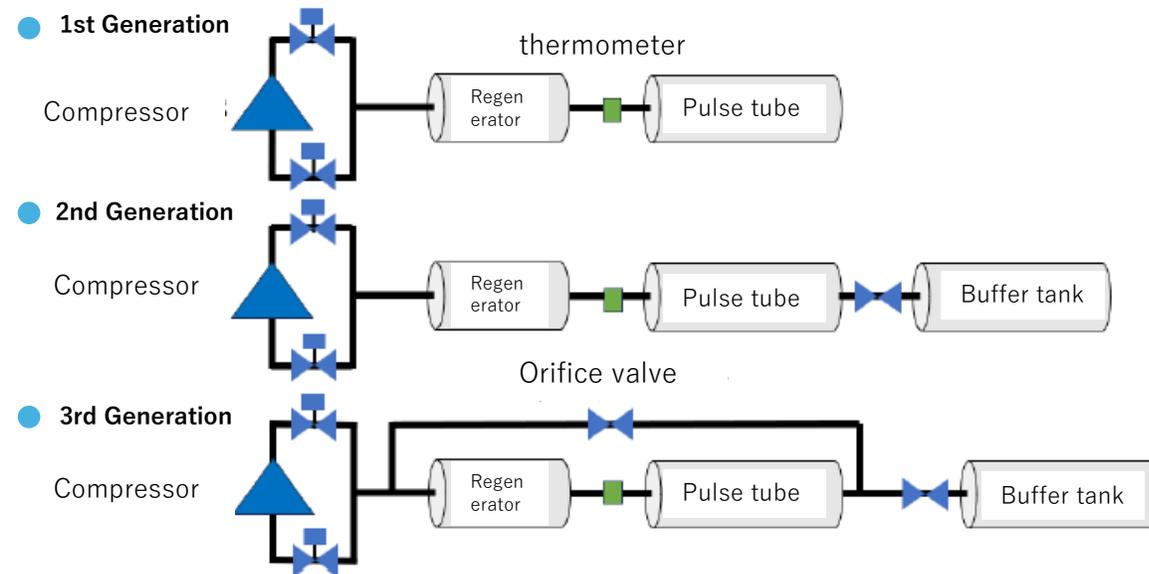


Evolution of pulse tube refrigerators

1st generation (Basic type)
No buffer tank connected

2nd generation (Basic type)
A buffer tank connected

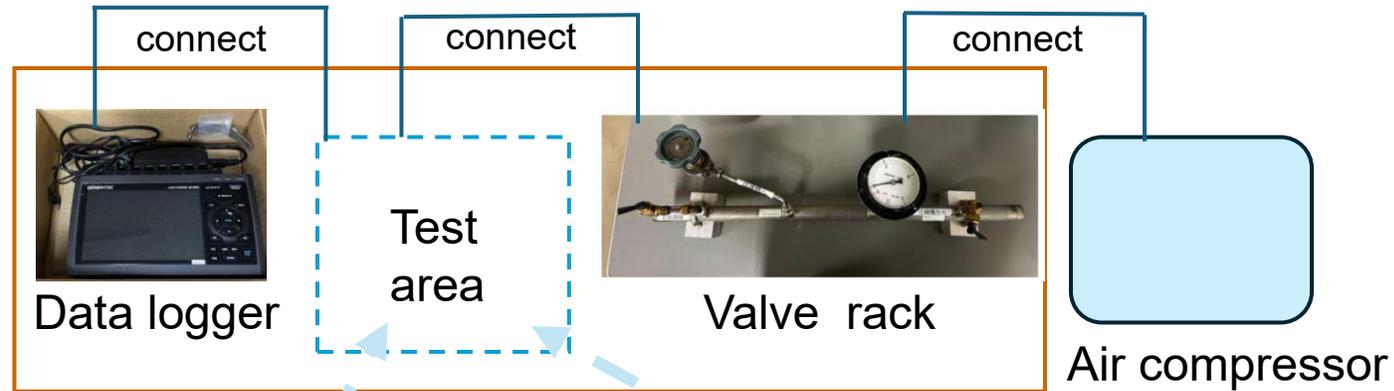
3rd generation (Basic type)
A buffer tank connected, and
bypass thru an orifice valve



Experiment Room Layout

Please separate into
groups A and B.

Working Desk



Desk A



Pulse tube refrigerator



mesh

Group A

Desk B



Pulse tube refrigerator



Acrylic pipe Φ 20
Acrylic pipe Φ 30

Group B

Working Desk Setup

Supply compressed air



Air Compressor

Let air in and out



Valve rack



Pulse tube and Regenerator



Data logger

Measuring the temperature

Working Desk Setup (Connection)

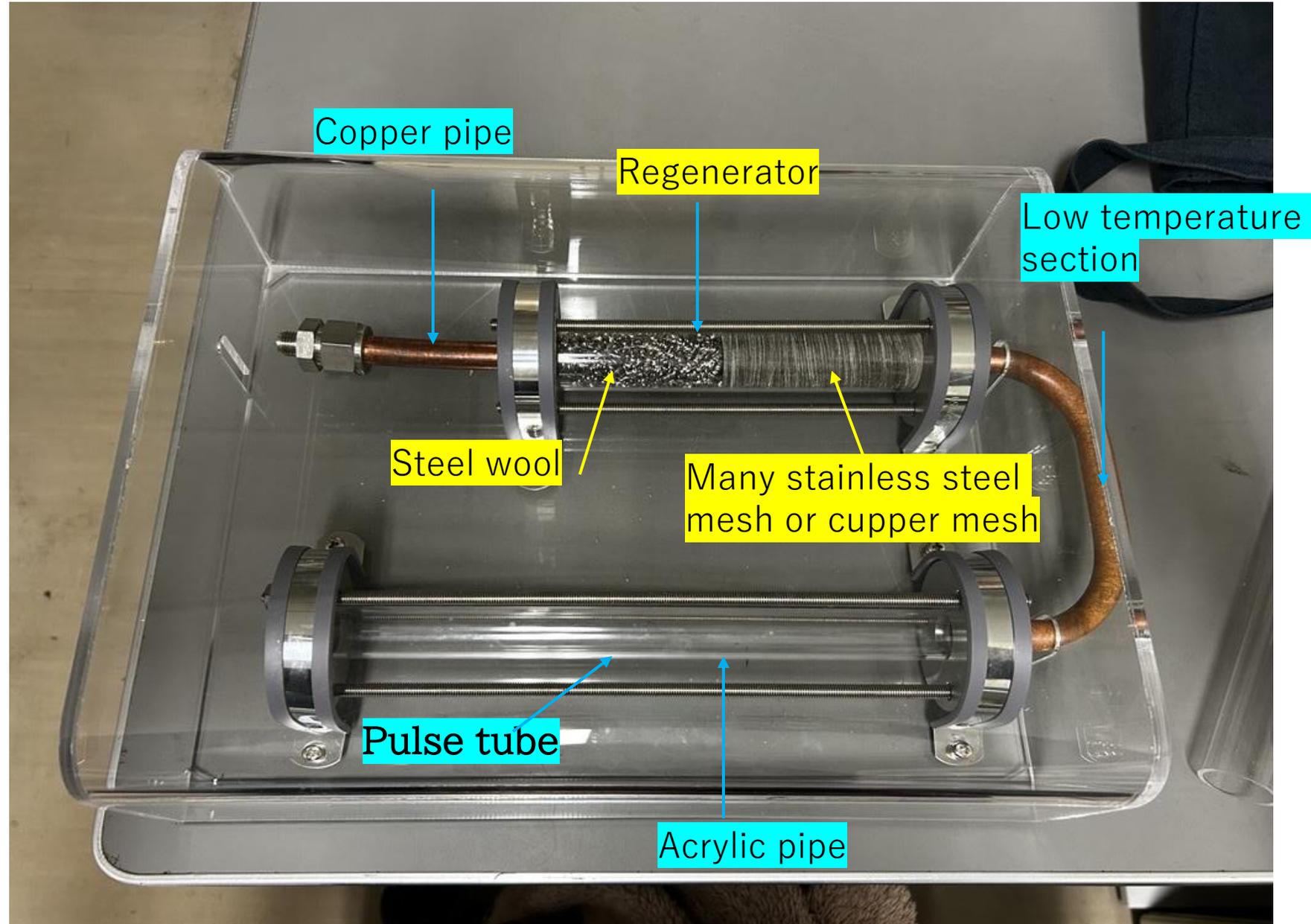


Please operate these two valves

Group A
Main Unit
Configuration

Please select the material for the
Regenerator.

Regenerator material :
Stainless steel mesh
or
Copper mesh

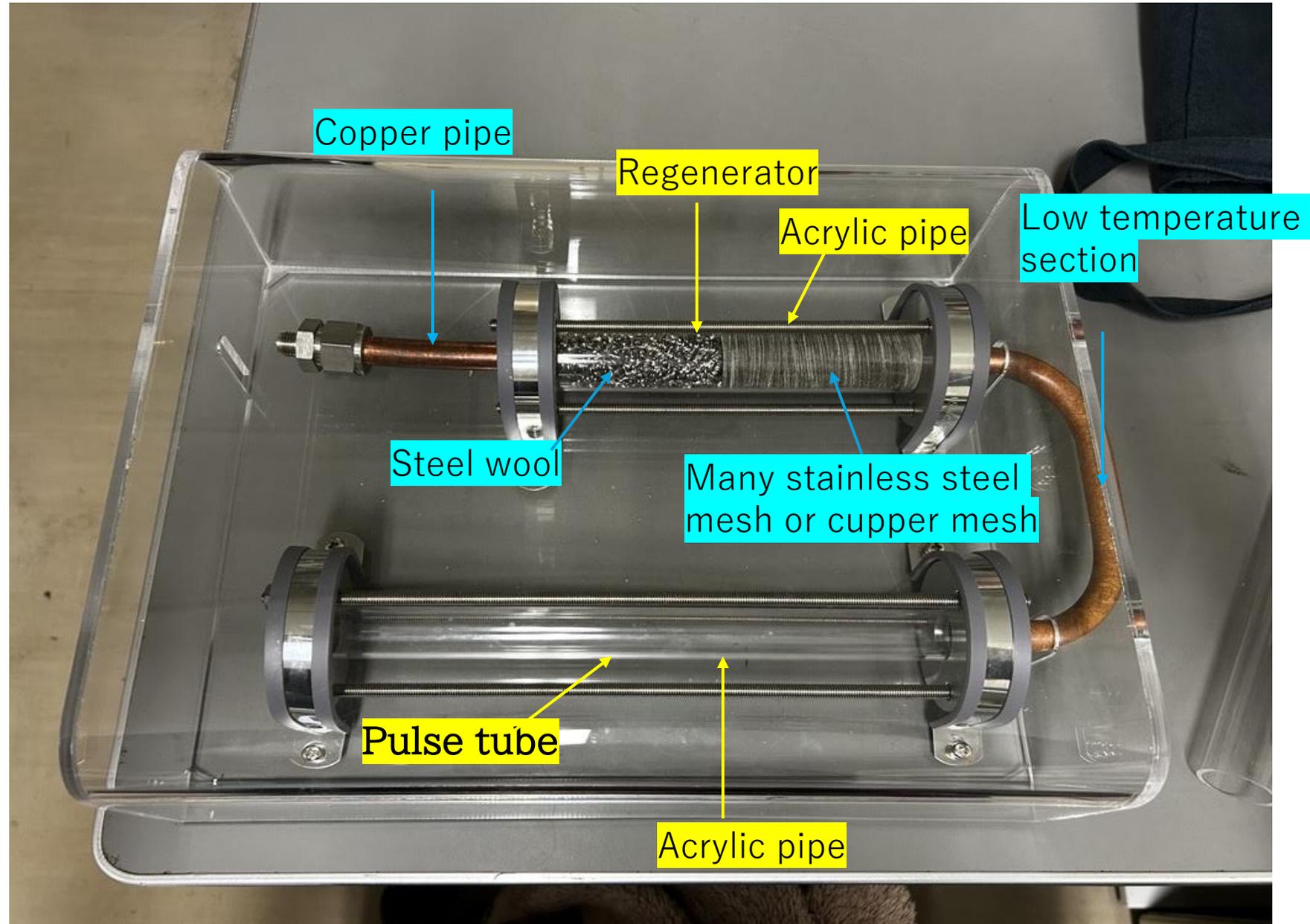


Group B
Main Unit
Configuration

Please change the length of
the pulse tube and
Regenerator.
(The mesh is stainless steel)



Acrylic pipe $\Phi 20$
Acrylic pipe $\Phi 30$



Seeking maximum cooling capacity

Let's find the maximum capacity setup!

Group A

- ① Select a regenerator material.

Thermal conductivity

- Copper about 400 [W/(m·K)]
- Stainless steel about 20 [W/(m·K)]



If insufficient, please
add more scouring
pads.

Group B

- ① Select the length (3 types)

Use $\Phi 20$ pipe for pulse tube
250, 150, 50 [mm]

Use $\Phi 30$ pipe for regenerator
170, 250, 100 [mm]



Assemble your refrigerator with your choice of materials

- ② Connect the manifold valve unit to the compressor and test it.
You need to operate the valves by yourself.(Center Desk)

Let's try changing the combination!

Goals of training

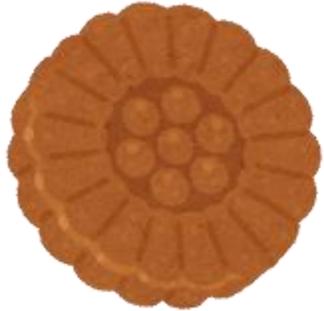
- Have it assembled...Letting people understand how pulse tube refrigerators work
- Have it changed...Find something better by changing the conditions

**Packing regenerator
material**



Using a stick

Cover it temporarily with tape



**Thank you for your attention
Enjoy pulse tube refrigerators !**



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