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Lineup of High Capacity 4K JT Cryocoolers

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Introduction

We released 4K GM-JT Cryocooler system (RJT-100), with a capacity of 10W class at 4.2K.

Concepts

- Achieve the world's largest cooling capacity at 4.2K and COP with mechanical small cryocooler.
- Contribute to the development of science and technology by saving energy and reducing CO2.

Contributing to the SDGs

GM-JT Cryocooler system

●GM-JT Cryocooler

RJT-100 4K GM-JT Cryocooler

●Compressors

J117V Indoor Water Cooled Compressor for the JT

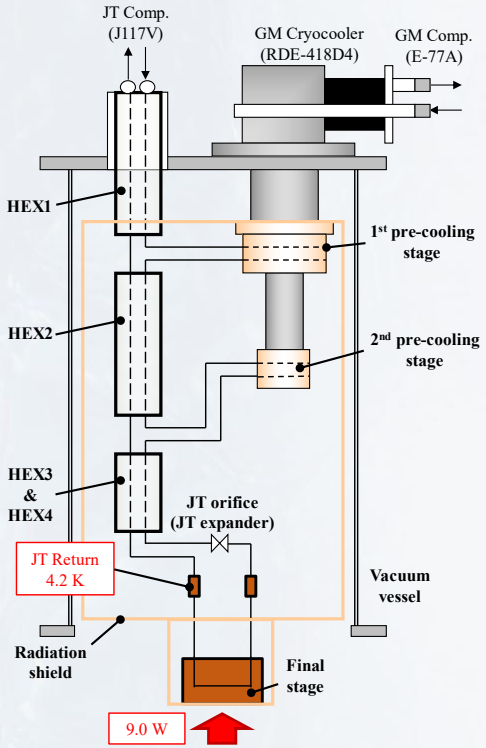
E-77A Indoor Water Cooled Compressor for the GM

This system consists of the GM-JT cryocooler and two water-cooled helium compressors for the JT(J117V) and the GM(E-77A).

Principle of RJT-100

Principle

- The RJT-100 4KGM-JT cryocooler is Joule-Thomson (JT) cryocooler using the RDE-418D4 two-stage Gifford-McMahon (GM) cryocooler as pre-cooler of gas helium (GHe).
- High pressure GHe supplied from J117V is pre-cooled by RDE-418D4 and four heat exchangers (HEX). The pre-cooled GHe is expanded by fixed orifice (JT expander) and part of GHe is liquified at cooling interface.
- The 4K cooling capacity utilize the latent heat of liquid helium (LHe), and its features are high capacity and high efficiency compared to GM and Pulse Tube Cryocoolers. (9.0W at 4.2K / Power consumption: 14.1kW)
- Due to the high capacity, the number of Cryocoolers can be reduced at customer's system, it's leading to reduction in maintenance costs.



Schematic of RJT-100 GM-JT Cryocooler

Features of RJT-100

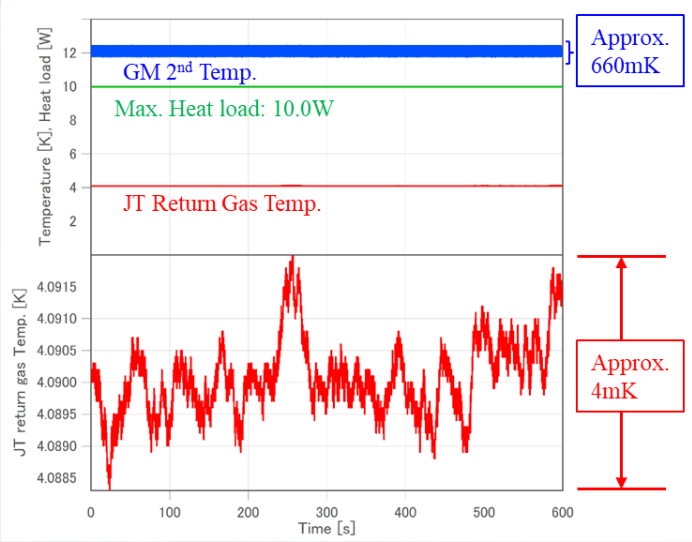
Small temperature amplitude

- The temperature fluctuation's amplitude of GM-JT was about 4 mKp-p and 1/165 smaller than that of our GM because it uses latent heat of helium and there is no pressure pulsation.

Capacity control function ('Save mode')

Capacity control according to usage to reduce the power consumption

- By changing the operating frequency of the E-77A and the supply pressure of the J117V to adjust to the required cooling capacity, the power consumption can be reduced.
- In 'save mode', the cooling capacity was reduced by 38% while power consumption was reduced by 53%.



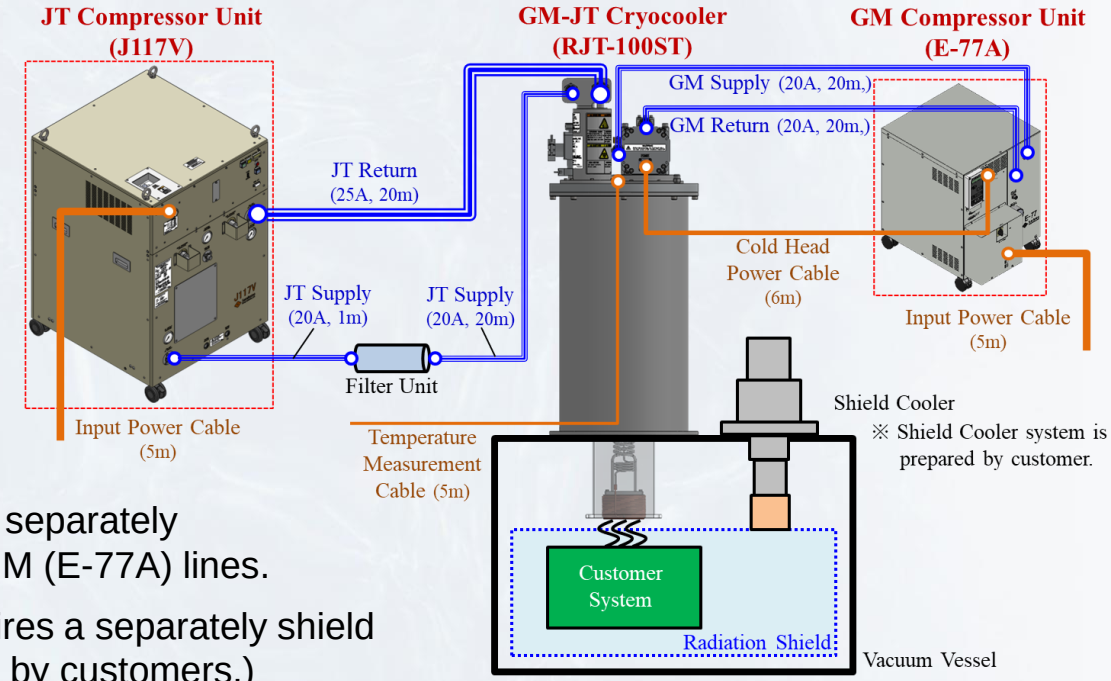
Temperature fluctuation's amplitude of GM-JT

Cooling Capacity	Power Consumption	E-77A Comp. Frequency	J117V Operation Mode
100% (9.0W)	100% (14.1kW)	60Hz	Standard
56% ~ 100%	67% ~ 100%	**30Hz ~ 60Hz**	Standard
38%	53%	**30Hz**	**Save mode**

System Configuration

	Specification
Cooling Capacity	**9.0W @4.2K**
Power Consumption	14.1kW or less※ (GM:7.5+JT:6.6)

※Except for shield cooler system.



- GM-JT cryocooler (RJT-100) requires two separately compressors for the JT (J117V) and the GM (E-77A) lines.
- Shield cooling against radiation heat requires a separately shield cooler. (Shield cooling system is prepared by customers.)

Main Performance Specifications

SHI Cryogenics Group

●GM-JT Cryocooler

RJT-100 4K GM-JT Cryocooler

●Compressors

J117V Indoor Water Cooled Compressor for the JT

E-77A Indoor Water Cooled Compressor for the GM

	Specification
Cooling Capacity	RJT-100ST(Stage type): 9.0W@4.2K
Power Consumption	• J117V：Less than 6.6kW • E-77A：Less than 7.5kW
Compressors Input power	• LV ：AC200V class at 50/60Hz, 3 phase or • HV：AC400V class at 50/60Hz, 3 phase
Compressors Cooling System	Water cooling (Both J117V and E-77A)
Environmental Conditions	Indoors (without dew) Ambient temperature: 5 ~ 28deg.C, Humidity: 25~85%RH
Outside Dimensions, Mass	• RJT-100ST：Φ350mm H: 1040mm (60kg) • J117V：W:690mm D:800mm H:1070mm (340kg) • E-77A：W:450mm D:485mm H:601mm (120kg)
Standards	• UL：UL 60335-2-89 • CE Machinery Directive ：2006/42/EC • CE EMC Directive：2014/30/EU • CE RoHS Directive：2011/65/EU+2015/863/EU • UKCA
Maintenance Interval	10,000h (※This interval is the shortest object)

JT Cooler Line-up

SHI Cryogenics Group

（Catalog spec）

※Under development

	GM RDE-418D4	PT RP-182B2S	RJT-100ST (Stage)	RJT-100RC (Recondensation)	RJT-100TE (Open) ※T.B.D.	PT-JT ※T.B.D. (Prototype)
Cooling capacity (at 4.2 K)	2.0 W	1.5 W	**9.0 W**	**8.5 W**	**9.0 W**	**9.0 W**
Power consumption ※1	7.5 kW	14.5 kW	14.1 kW	14.1 kW	14.1 kW	21.1 kW
COP	2.7×10^{-4}	1.0×10^{-4}	**6.4×10^{-4}**	**6.0×10^{-4}**	**6.4×10^{-4}**	**4.3×10^{-4}**
Reaching temperature	<3.5 K	<2.8 K	4.2 K			

※1：Except for shield cooling system

Test result for one sample

- PT-JT is under development to be a lower vibration cryocooler than GM-JT.
- 4K cooling capacity and COP of JT cryocoolers is better than GM and PT.
- GM-JT with reaching temperatures below 4.2 K is under development.

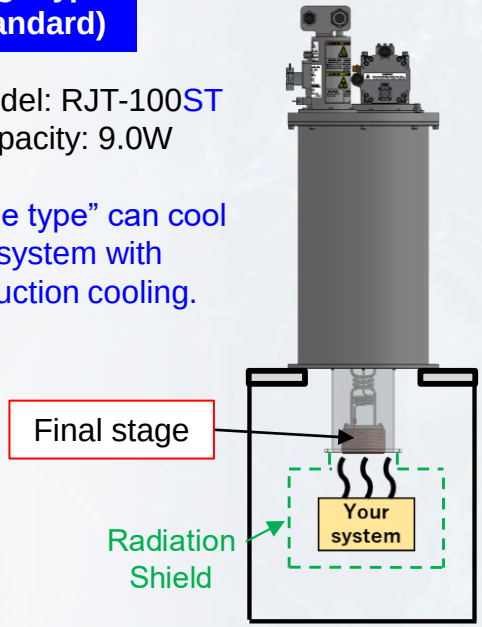
Cooling Interface of RJT-100

You could select the cooling interface not only “Stage type” (standard) but also other type (optional).

Stage type (Standard)

- Model: RJT-100ST
- Capacity: 9.0W

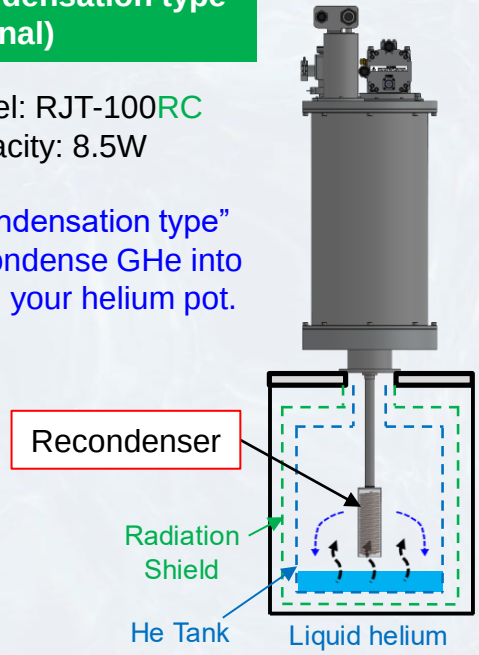
“Stage type” can cool your system with conduction cooling.



Recondensation type (Optional)

- Model: RJT-100RC
- Capacity: 8.5W

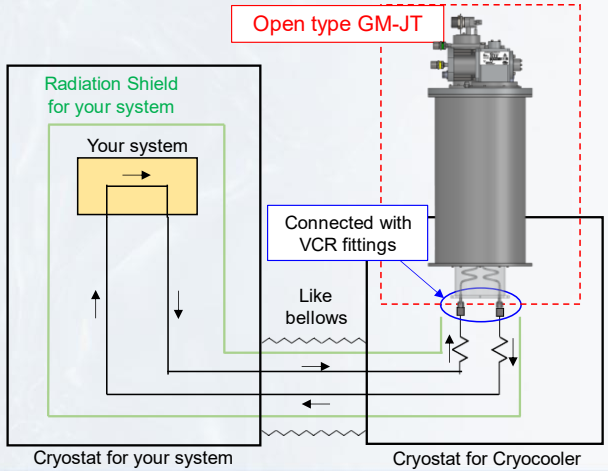
“Recondensation type” can condense GHe into LHe in your helium pot.



Open type (Optional)

- Model: RJT-100TE
- Capacity: 9.0W

By connecting the VCR fitting to your system, “Open type” can supply helium directly to the cooling lines of your system.



Introduction of PT-JT

PT-JT (Prototype)

※Under development
●Capacity : 9.0 W
(Test result for one sample)

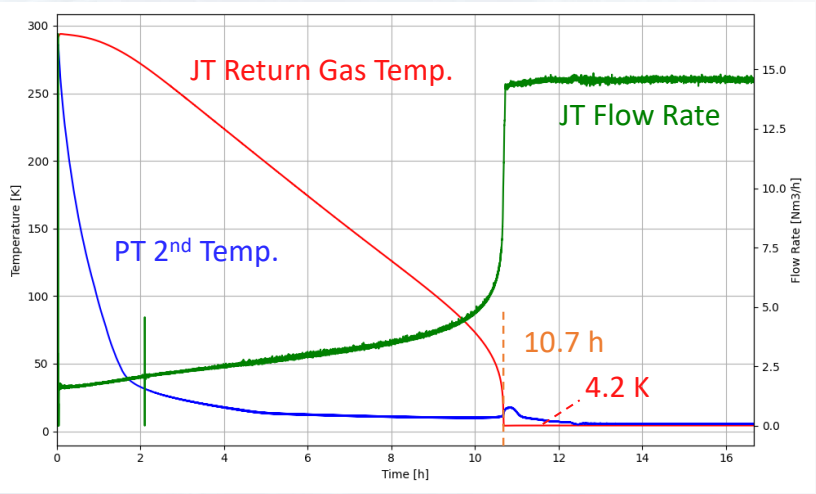
PT-JT uses PT cooler (RP-182C2S) as a pre-cooler.
PT-JT can cool the system by conduction cooling as well as "stage type".

PT Cryocooler (RP-182C2S)

※PT-JT vibration is expected to be smaller than that of GM-JT and comparable to that of PT cryocoolers.

Cool down test result

- Reaching temperature: 4.2 K
- Cool down time: 10.7 h (Without heat load)



Due to JT expansion, JT return gas temperature decreased rapidly to 4.2 K.

Conclusion

We have released RJT-100ST.

- The cooling capacity of RJT-100ST achieved 9.0 W at 4.2 K
- RJT-100ST has the features of the small temperature fluctuation about 4 mKp-p, and ‘save mode’.
- The prototype PT-JT was developed to realize a high-capacity (9.0 W), low-vibration cryocooler.

Future Works

- To study to shorten the cool down time.
- To investigate the effect of GM-JT and PT-JT vibrations on the customer system.

Thank you for your attention.

END