# Automatic Gas Flow Control
# Flow Cryostat Temperature Controller

# Flow SHOGUN
# 流将軍

***A New Gas Controller Has Been Developed for USM1400!***

***Control the Flow, Move Forward***

Model Name: PVC100


- **Key Features**
  - ・Working Principle
  - ・PID-Controlled Flow Regulation
- **Data : Helium Flow Control Performance**
- **Data : Temperature Stability Comparison (LHe)**
- **Data : Temperature Control ($LN_2$)**
- **Comparison with Previous Model**
- **Components**
- **Setup Configurations**
- **Specifications**


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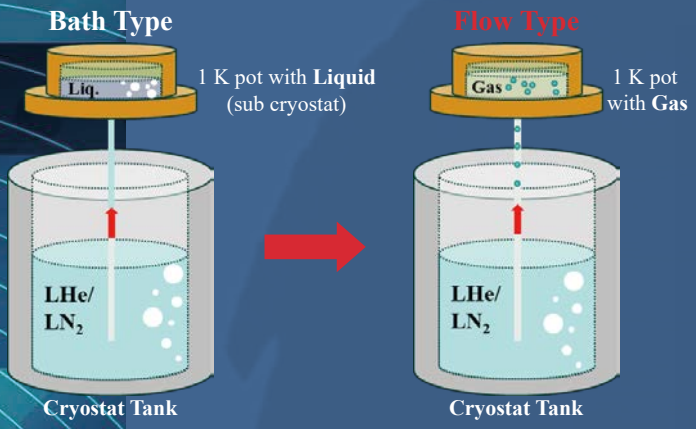
# Key Features

- **Linear flow valve control maintains a stable 1 K pot temperature**
- **PID feedback automatically regulates refrigerant flow to match the setpoint**
- **Optimized low flow operation extends cryogen holding time**
- **Excellent temperature stability ensures reliable STM performance**
- **Simple and flexible temperature control via setpoint adjustment**

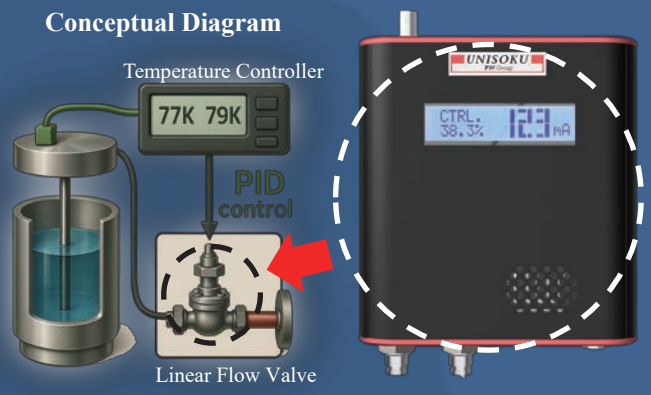
## Working Principle

The USM1400 is equipped with a main cryostat that stores liquid refrigerant internally.
The refrigerant is supplied to the 1 K pot (sub-cryostat) by gas pressure, cooling the STM stage as the 1 K pot temperature decreases.
When the refrigerant supply rate is increased, liquid accumulates in the 1 K pot, resulting in a cooling mode similar to a conventional bath cryostat (left figure).
In contrast, when the supply rate is reduced, the 1 K pot is filled with gas and operates as a flow cryostat (right figure).



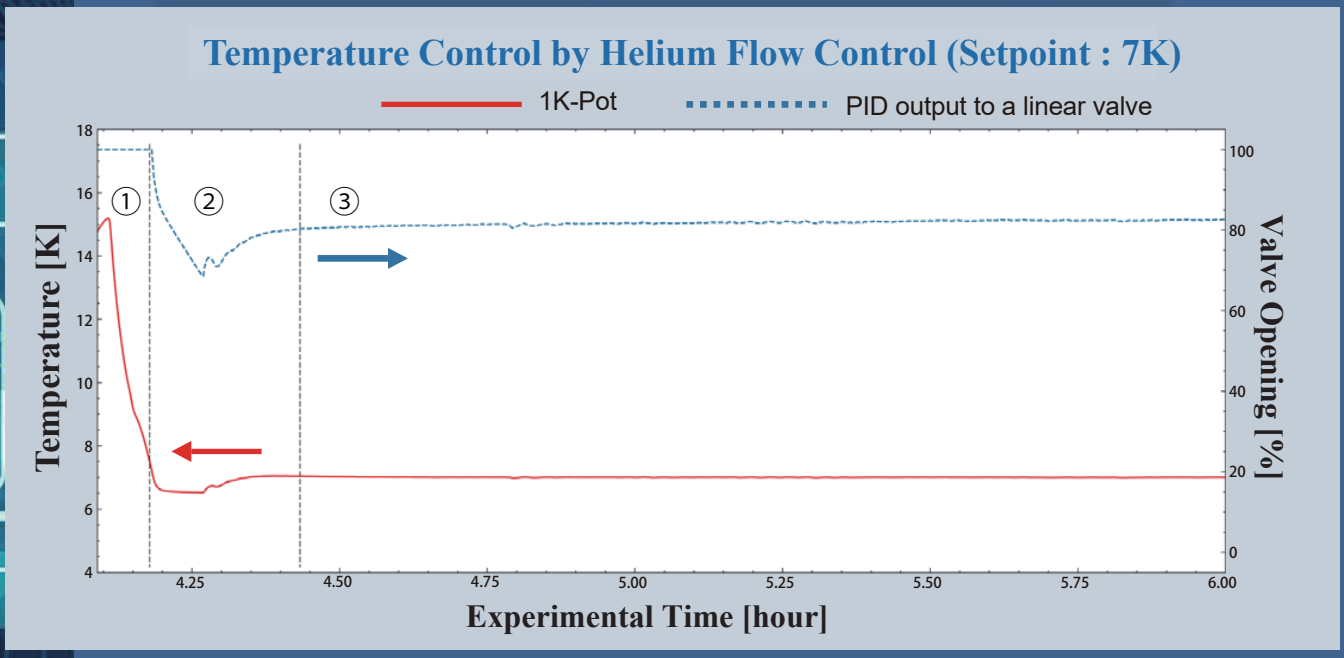

## PID-Controlled Flow Regulation

This flow cryostat controller is designed to precisely regulate temperature during gas cooling operation.
A proportional valve is integrated into the controller, with its opening controlled by an external analog voltage input.
As illustrated in the conceptual diagram, the controller functions like a faucet, regulating the gas flow rate to maintain a constant temperature.
In operation, the valve opening is driven by the PID output from the temperature controller, enabling automatic adjustment of the flow rate so that the 1 K Pot reaches and maintains the user-defined setpoint.

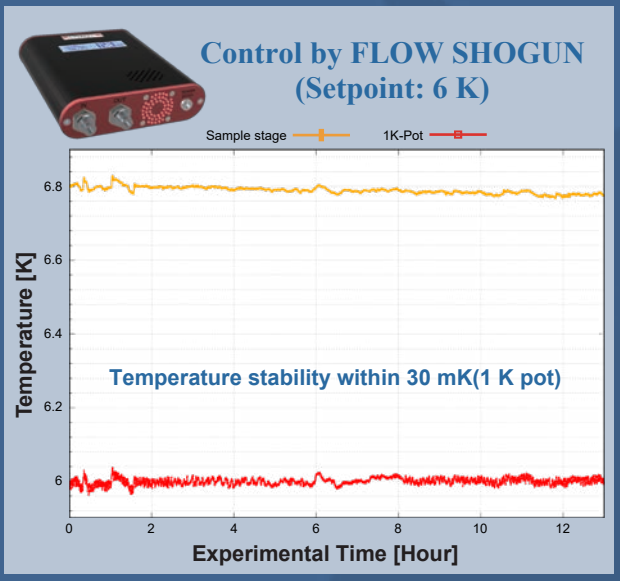


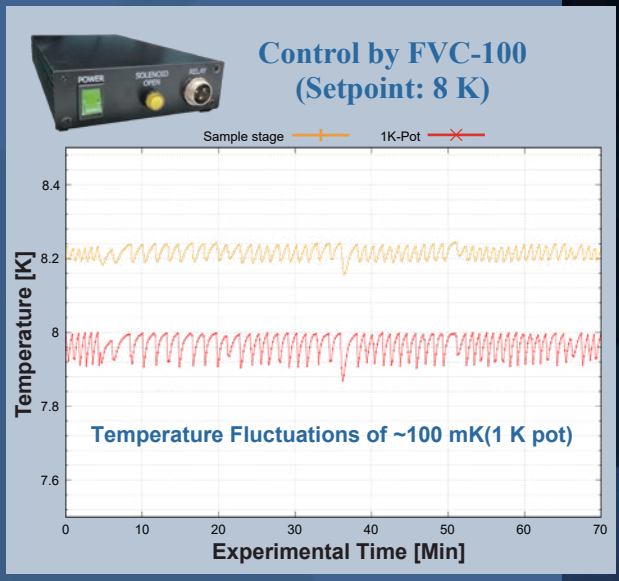

# Data: Helium Flow Control Performance

**①: Rapid cooling of the 1 K pot with 100% valve opening**
**②: Valve opening adjusted via PID control to reach 7 K at the 1 K pot**
**③: Stable maintenance of T1 K pot at 7 K as helium level decreases**



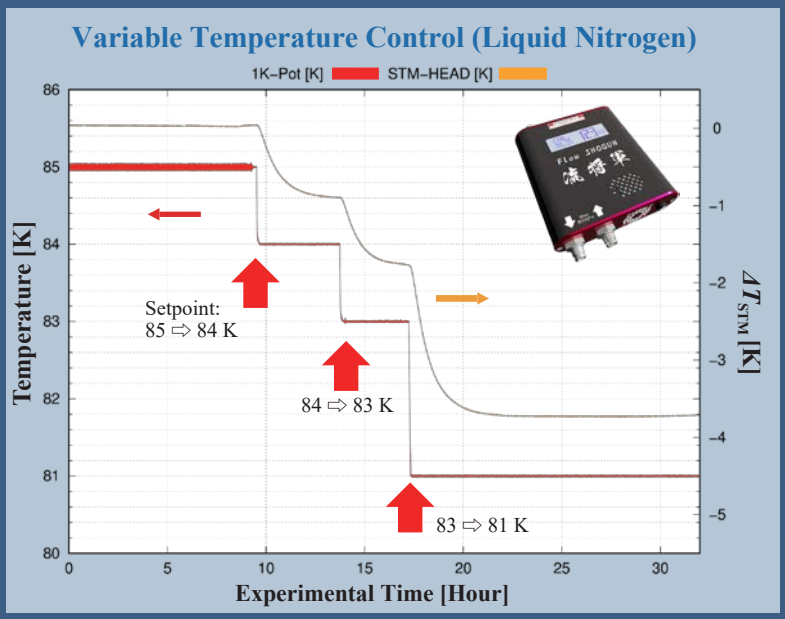
# Data: Temperature Stability Comparison (LHe)




# Data: Temperature Control ($LN_2$)

- Rapid response to setpoint changes, reaching target temperature within ~1 hour
- Stable temperature control even under low nitrogen gas flow conditions
- Reduced flow extends liquid nitrogen holding time, similar to helium operation
- No liquid nitrogen storage required, enabling quick transition to helium operation




# Comparison with Previous Model

| | PVC-100 /Flow SHOGUN (New Model) | FVC-100 (Previous Model) |
|---|---|---|
| Valve Control | 0 ~ 100 % (Continuously) | Digitally Open/Close (On/OFF) |
| Usability/Purpose | Fully Automated/Long Term STM | Manual Settings/ Temperature Maintained in Stand-by Mode |
| Temperature Stability | $\Delta T_{Fluctuation}$ < 30 mK | $\Delta T_{Fluctuation}$ ~ 100 mK |
| Helium Consumption from 1K pot | Automatically Minimized | Manual Control |

# Components

PVC-100

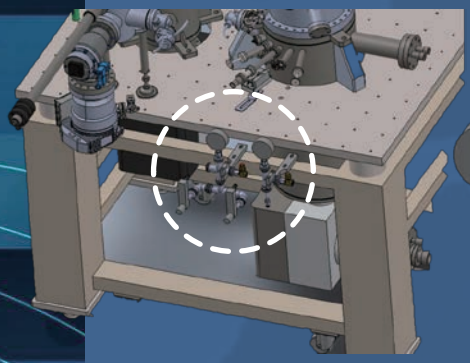
Power Supply Cable
(AC - DC Converter)

40 kPa Relief Valve

BNC Cable with Connector and
40 kPa Overpressure Valve
(From Temperature Controller to PVC-100)

* Please note that delivery and installation services are not included with the purchase.

# Setup Configuration



Tank Gas Manifold

Exchange The Relief valve
(7 kPa ⇒ 50 kPa)

Temperature Controller
(Lakeshore 335)

1K Pot Gas Manifold

Flow Meter

PID Output Signal
for Valve Control
(BNC Cable)

He/$N_2$ Gas In
(6 mm Tube)

He/$N_2$ Gas Out
(6 mm Tube)

He Recovery Line
or Air

# Specifications

| | |
|---|---|
| Product Name | Flow Cryostat Temperature Controller<br>(PVC-100, Flow SHOGUN) |
| Applicable System | USM1400*<br>* Not compatible with early USM1400 models without a 1 K pot |
| Controllable Temperature Range | 84 K ~ 100 K ($LN_2$)<br>6 K ~ 20 K (LHe)<br>* Lower temperature limit depends on thermal configuration (especially in LHe operation)<br>* Higher temperatures are possible with heater activation |
| Temperature Fluctuation | < 30 mK guaranteed * < 10 mK achievable |
| Temperature Controller | Cryocon22C / Lakeshore 335 |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