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Product Introduction

Model P850:
PPMS® Dilution Refrigerator System (DR)

(Preliminary Product Description)

Model P850 Dilution Refrigerator System is a novel, continuously circulating ^{3}He/^{4}He-refrigerator system for the popular Physical Property Measurement System (PPMS). This fully automated, valveless dilution refrigerator installs easily into the sample space of the PPMS to provide temperature control from 4 K to 50 milliKelvin (mK). The DR option can be ordered with new systems or as an upgrade to existing systems. In this initial introduction, the DR will provide lower temperatures for heat capacity measurements performed on the PPMS.

The P850 Dilution Refrigerator System is a new concept in refrigeration design developed in cooperation with Oxford Instruments. The valveless control is achieved by utilizing a specially designed turbo pumping system. The turbo pump and its controller function together as a virtual gate valve. Varying the speed of the turbo pump controls the circulation rate of the gas mixture. This technique also accommodates changes in the helium vapor pressure in the pumping lines.

To simplify operation, the system comes from the factory as a sealed unit ready to use without the need for any assembly or the connection of any pumping line. The system is incorporated into a cart that can be rolled out of the way when not in use, enabling safe storage of the cryogenic probe. When needed, only electrical cable connections are required to make the system active.

Sample mounting has been simplified by providing plug-in sample mounts. Once a sample is mounted on these easy-to-handle platforms, it is plugged into the receptacle on the mixing chamber of the refrigerator. Since the dilution refrigerator is inserted directly into the sealed sample chamber of the PPMS, there are no additional vacuum seals or electrical contacts to make to the probe. This makes the entire process of mounting samples very fast, convenient, and user-friendly.

Combined with the P650 Heat Capacity Measurement System, the P850 Dilution Refrigerator System can extend the low temperature end of this measurement to 50 mK. This allows users to make fully automated heat capacity measurements from 50 mK to 4 K. This requires the purchase of the **P856A DR/Heat Capacity Compatibility Kit**.

Features:

- *Continuously* circulating dilution refrigerator extends the PPMS's lowest temperature to 50 mK
- Factory sealed for fast connection to the PPMS
- Valveless, fully automated operation
- Simple plug-in sample mounting
- No low-temperature (indium) vacuum seal
- Integrated nitrogen coldtrap for thorough gas cleaning
- System is supplied with a special adaptor to allow the user to remove the sample mount from the DR and, without disturbing the sample, install it into the PPMS sample chamber. Then, using the standard P650 Heat Capacity system, perform measurements up to 10 K.

Benefits:

High measurement throughput with no limit on measurement time (1 week hold time)
No system leak checking required
Safe, unattended sample measuring

System Requirements:

Model 1000 Modular Control System is required for the DR Temperature Module to measure and control the sample temperature.

P640B Cryopump High-Vacuum System is required.

When upgrading existing Heat Capacity equipped systems the P856A DR/Heat Capacity Compatibility Kit is required.

P800 Continuous Low-Temperature Control provides extended low temperature operation required by the dilution refrigerator (this is a standard feature on all new PPMS systems).

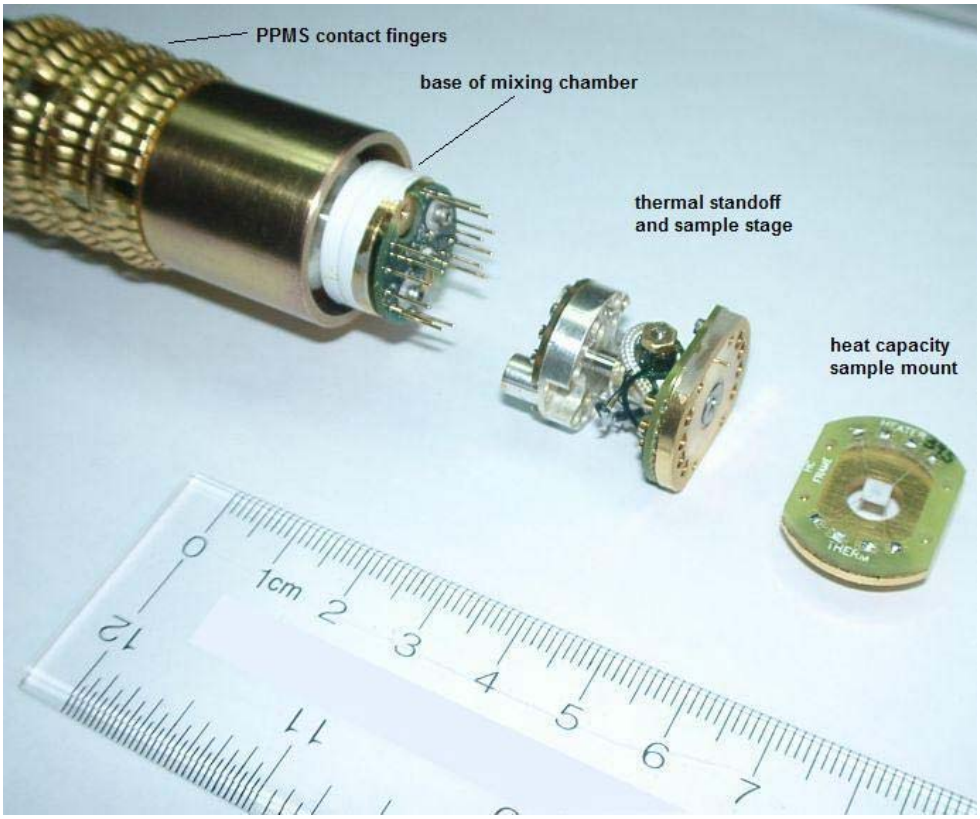
P850 Dilution Refrigerator is not currently available for PPMS EverCool (Model P930) equipped systems.

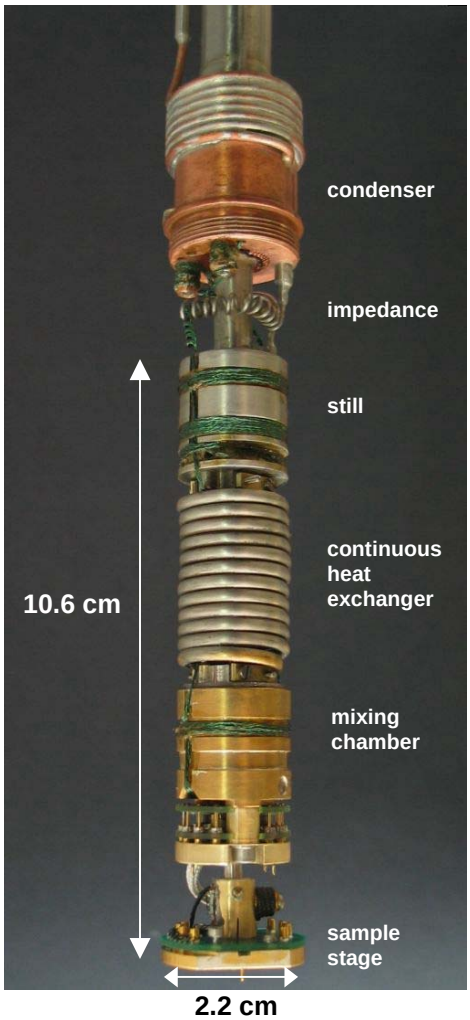
System Availability:

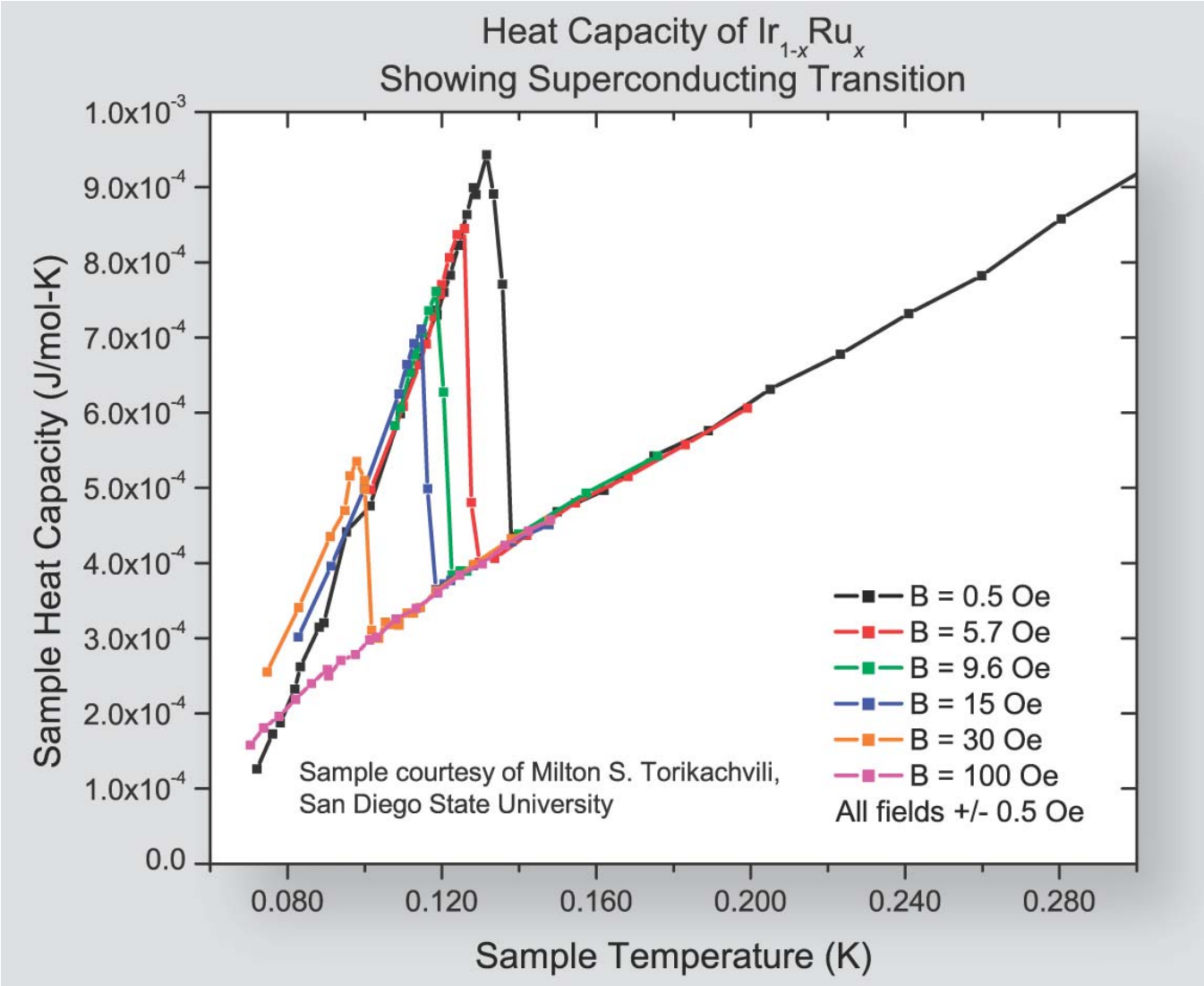
Estimated delivery of the P850 Dilution Refrigerator System is 8 months after receipt of purchase order.

Design Specifications: (Technical specifications are subject to change without notice.)

DR Temperature Range:	50 mK to 4 K with stability of better than ±0.2%
Magnetic Field Range:	Up to 14 tesla (performance at 16 tesla needs to be verified)
Cooling Power at 100 mK:	0.25 μW at sample stage 2 μW at mixing chamber
Cooling-Down Time:	300 K to 100 mK in under 8 hours (5 hours typ.)
User Experiments:	Each system ships with the P856B User Experimental Compatibility Kit
Space for User Experiments:	22 mm (0.88”) diameter × 35 mm (1.4”) long cylindrical space
Heat Capacity Addenda: included in P856A	< 10 nJ/K at 100 mK (resolution: 0.1 nJ/K) < 15 nJ/K at 500 mK


PPMS contact fingers
base of mixing chamber
thermal standoff
and sample stage
heat capacity
sample mount
1cm


condenser
impedance
still
continuous
heat
exchanger
mixing
chamber
sample
stage
10.6 cm
2.2 cm


Heat Capacity of Ir1-xRux
Showing Superconducting Transition
Sample Heat Capacity (J/mol-K)
1.0x10-3
9.0x10-4
8.0x10-4
7.0x10-4
6.0x10-4
5.0x10-4
4.0x10-4
3.0x10-4
2.0x10-4
1.0x10-4
0.0
0.080
0.120
0.160
0.200
0.240
0.280
Sample Temperature (K)
B = 0.5 Oe
B = 5.7 Oe
B = 9.6 Oe
B = 15 Oe
B = 30 Oe
B = 100 Oe
All fields +/- 0.5 Oe
Sample courtesy of Milton S. Torikachvili,
San Diego State University