



PPMS Application Note 1085-156

PPMS Vertical Puck

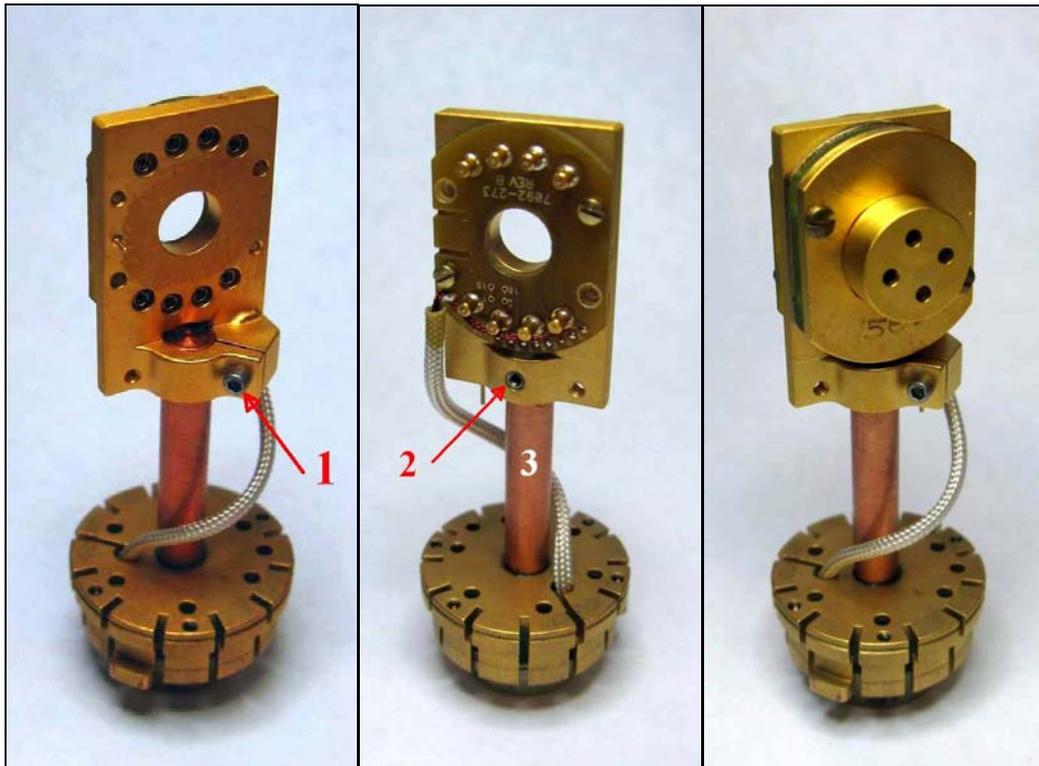


Figure 1. PPMS vertical puck showing the sample mount (left), the backside of the mount (middle), and a Heat Capacity frame mounted for measurements (right). **NOTE:** a Heat Capacity frame is NOT included in the vertical puck kit P111.

The vertical puck adapter for the PPMS places heat capacity or electrical transport pucks in the vertical orientation. This can be critical for heat capacity measurements of magnetically anisotropic materials performed in a magnetic field: putting a standard horizontal Heat Capacity platform holding a plate-like sample in a vertical magnetic field creates a large torque on the sample if there is both strong sample magnetism as well as an in-plane magnetic anisotropy (either due to shape or magneto-crystalline anisotropy). This torque can damage the delicate wires of the Heat Capacity puck frame. The additional feature of this puck is that the center of the sample is placed 4.0 cm above the puck surface which is in the uniform region of the magnetic field, thus greatly reducing the magnetic field gradients that the sample experiences. This is mainly important in the high field 16 tesla magnet system in which the uniform region of the field

is smaller (0.1% uniformity over a 1 cm diameter spherical volume that is centered 4.0 cm above the puck).

The new puck (see left panel of Figure 1) provides a vertical sample mount, as can be found on the Helium-3 option for the PPMS, atop a copper post standoff. Phosphor bronze twisted pair wiring runs up from the puck base to the circuit board (see middle panel). In the right panel of Figure 1 is shown a Heat Capacity frame in a Helium-3 Heat Capacity puck assembly. The vertical puck will accommodate all Heat Capacity puck types: standard (P107B), Helium-3 (P107E), and Dilution Refrigerator (P107H), although the latter is of little utility here as it is only usable up to 4 K. The Helium-3 Resistivity/ACT sample pucks (P104) can also be mounted here. **CAUTION: Due to the small gauge wiring used, we recommend not exceeding a current of 100 mA.**

To order the PPMS vertical puck kit (which includes the puck as well as tools and parts for mounting Heat Capacity frames) contact your local Quantum Design sales office and request sales number P111 . Note that any measurement platforms such as Heat Capacity frames or electrical transport pucks and cables must be provided separately and are not included in the P111 kit. If using the AC Transport Option with the vertical puck, the ACT/Helium-3 cable 3084-518 will be required. Other configurations do not require any special cables.

To understand the wiring configuration of the vertical puck, note that it is the same as the Helium-3 sample mount (see Table B-2 of the *Helium-3 User's Manual*). Consult the sections of Electrical Transport Option, AC Transport and Resistivity user's manuals that discuss measurements on the Helium-3 Refrigerator to help in sample mounting.

The data in Figure 2 demonstrate the ability of the vertical puck to measure the specific heat of a highly magnetic and anisotropic sample (a thin plate of pure gadolinium) in the vicinity of its Curie point $T_c = 293$ K and to do this in a magnetic field of 1 tesla. The sample was attached to the platform using Apiezon H grease (N grease is recommended for measurements below room temperature) and the sample did not move in the process of measuring it.

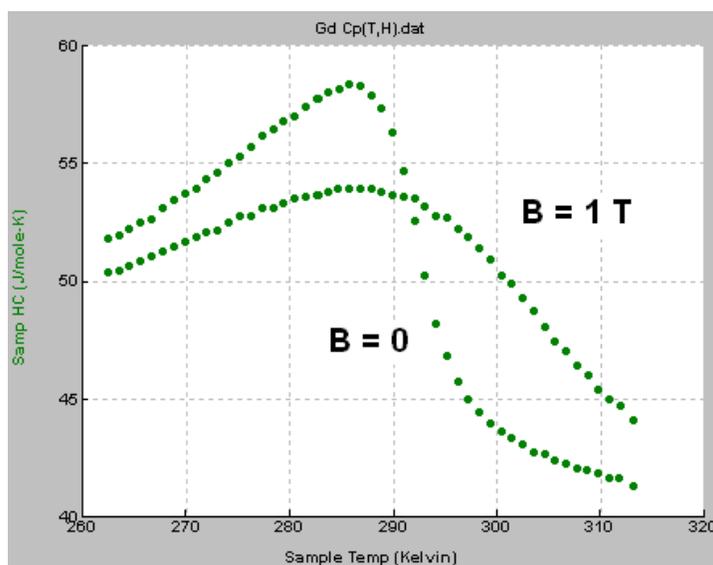


Figure 2. Specific heat of a vertically oriented thin gadolinium plate in vertical magnetic fields of 0 and 1 tesla.

Mounting a Heat Capacity Puck for Measurements on the Vertical Puck

(Items included in this vertical puck kit P111 are indicated in *italics*.)

- 1) The standard Heat Capacity frame (P107B) is recommended as the thermal conductance of the wires is higher than the other types and the measurements at high temperatures will thus be faster.
- 2) If using the P107B, remove the frame from the chuck and also from the wire guard (see Fig. 3-1 in the *Heat Capacity User's Manual*). **CAUTION:** The wire guard holds the circuit board onto the frame body so this should be done with the frame sitting on a table.
- 3) Put the *He-3 sample window lid (4092-622)* on the frame using the two *brass slotted screws (ZB-0FSM.19PS)* and put on the *protective cap (4092-623)*, so that it looks as shown in the upper left part of Fig. 8-1 of the *Heat Capacity User's Manual*.
- 4) Since the vertical puck does not use a puck thermometer (none is embedded in the sample mount), you should use a different .PKD file when creating new calibrations on it. We suggest creating a variant of the `standard.PKD` file (found in the `c:\QdPpms\Heat Capacity\TempCal\Standard` folder) in which the only difference is that the puck thermometer is turned off with the line `UsePuckThermometer=0` (usually this value is 1). Call this new file `vertical.pkd`. If using a previously calibrated Heat Capacity frame with a .CAL file that includes a puck thermometer calibration, edit the .CAL file to turn off the puck thermometer. This can be most easily done by changing `count` (i.e., the number of calibration temperatures) to zero for the puck thermometer table (see below), then saving this .CAL file with a new name.

```
[Temp_PuckRes]

XFuncCode=2
YFuncCode=2
XName=Temp
YName=PuckRes
Count=0
1.86788,6559.2947
2.0005579,5806.6467
...
```

- 5) To secure the Heat Capacity frame to the vertical puck, use 2 *stainless socket head screws (ZS-0FSM.19KH)* in the upper left and lower right holes shown in the middle panel of Figure 1 (these screws are absent in this photo). These should be tight in order to ensure good thermal contact between the frame and the puck.
- 6) Ensure that the standoff post (“3” in Figure 1) is screwed tightly onto the puck and also that the set screw (“2”) and collar screw (“1”) holding the standoff to the sample stage are tight.
- 7) Insert the vertical puck into the sample chamber using the standard puck extraction tool.
- 8) Mounting HC samples in the vacuum chuck mounting station is done using the plastic *Heat Capacity Sample Mount Adapter (4092-625)* see Fig. 8-1 of the *Heat Capacity User's Manual*. Earlier versions of the kit instead provided the *Helium-3 puck adapter assembly (4092-612)*, comprised of the lower two items from Fig. 3-1 of that same manual.