Spinning Pinhole for the Cloud Droplet Probe (CDP)

Operator Manual

DOC-0176 Rev C

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WARNING:

The Cloud Droplet Probe houses a Class 3-B laser. Lasers pose dangers due to both visible and invisible radiation. Use appropriate precautions to avoid laser exposure. Never operate the spinning pinhole without the protective shroud and cover in place. Do not operate above the specified 5000 rpm.
Operate both devices at your own risk: DMT is not responsible for damage or injury due to improper use.

General Information

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The seller warrants that the equipment supplied will be free from defects in material and workmanship for a period of eighteen months from date of shipment or 12 months from the date of either installation or first use whichever comes first. When returning the equipment to DMT for warranty or service procedures, the equipment owner will pay for shipping to DMT, while DMT will pay the return shipping expense. Consumable components, such as tubing, filters, pump diaphragms, and Nafion humidifiers and dehumidifiers are not covered by this warranty.

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The CDP uses two optical detectors to accurately sense and size particles passing through the CDP sample volume. These detectors are called the **sizer** and the **qualifier**. The CDP uses these detectors to determine whether particles fall within the instrument's **depth of field**. The depth of field is the region of the sample where the laser is uniformly illuminating particles, and the CDP typically only sizes particles that fall within this region. The sizer and qualifier must be aligned both spatially and temporally, or else particles will generate non-concurrent electrical signals which will be rejected as noise or improperly sized. For more details on the CDP's design and operation, consult the *CDP Operator Manual*.

1.2 Spinning Pinhole Operation

The CDP spinning pinhole is one of several tools that, in concert, validate the performance of the CDP. The spinning pinhole test aims to place the pinhole in the CDP laser's path such that light pulses similar to those created by a particle reach the sizer and qualifier concurrently and in magnitudes representative of actual particles. In particular, the spinning pinhole should generate light pulses that mimic those from particles that are within the CDP's depth of field.

Under ideal conditions, when the CDP is properly aligned, the pinhole's signals will reach the sizer and qualifier in sufficient focus so that all signals will be classified as particles and properly sized. When the CDP is out of alignment, the qualifier will not receive sufficient signals at the correct time, and particles will be rejected for sizing because they are considered to be outside the CDP's depth of field. The strategy when using the spinning pinhole, then, is first to turn off depth-of-field rejection, meaning the CDP sizes all particle events it detects. Then depth-of-field is turned back on, so that particles deemed outside the depth of field are rejected for counting. The particle number concentrations from both tests should be equal, since the CDP should deem all signals generated by the spinning pinhole as depth-of-field-qualified particles. Furthermore, PADS should not have classified any particles as depth-of-field rejects (i.e., Dof_Reject_Cnt should be zero).

Warning: Successful CDP calibration testing can only occur when the spinning pinhole is properly aligned and carefully positioned in the laser path. If the pinhole itself is out of alignment, the CDP may erroneously appear out of alignment when it is not. Other calibration tools such as glass beads can help verify spinning pinhole results. See below for tips on aligning the pinhole.

Mounting

The spinning pinhole is attached to the wing section of the CDP using a clamping foot that is specially designed to mount the CDP wing (see Figures 1 and 2). Unscrew the clamp, place the spinning pinhole assembly on the wing, and gently tighten the clamping mechanism. This will not require torque beyond what you can apply with your fingers.

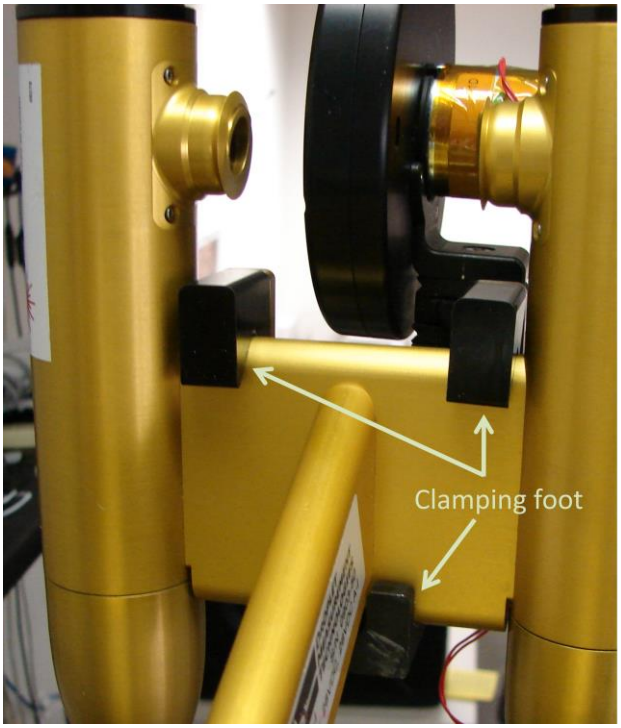

Figure 1: Spinning Pinhole Mounting Clamp

Instructions for Use

1.) Turn on the CDP's system power and start the PADS data acquisition system. Align the spinning pinhole using the three-axis stage such that the pinhole is nominally centered between the CDP arms and the CDP laser is entering the opening on the side of the spinning pinhole cover. (See Figure 2.)
2.) Power on the CDP Spinning Pinhole and ensure that the CDP and data system are connected and communicating properly.

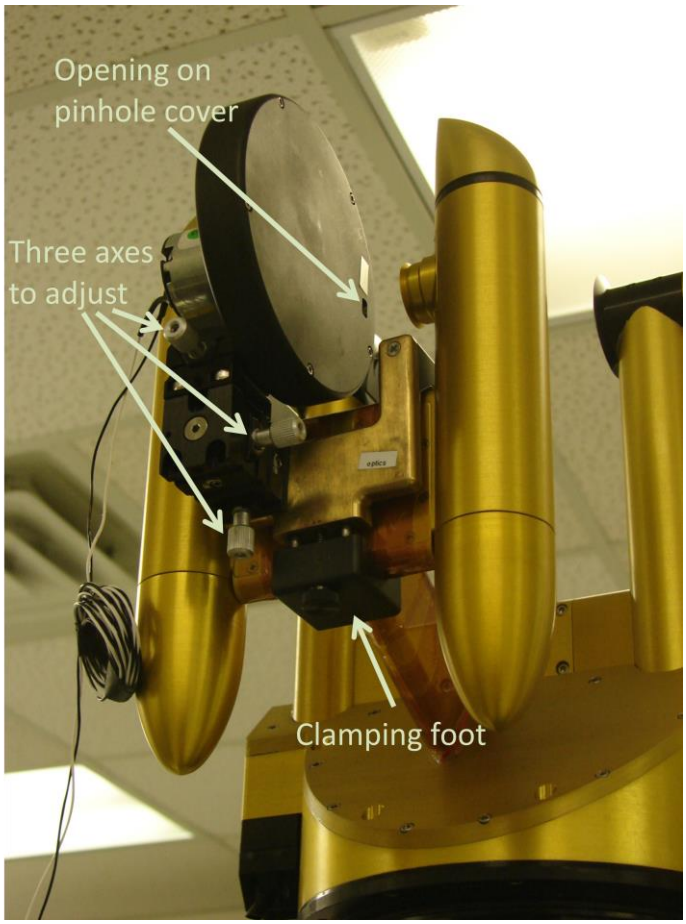

Figure 2: Spinning Pinhole

3.) In PADS, select the CDP tab and from the Configure menu select Configure Instrument. Click on the **Dof Reject** button, which should toggle to false. Click **Save**, and then click **Reset Program**. This step disables the CDP's qualifier from rejecting particles.
4.) Click the **Setup** tab, toggle the **True Air Speed Source** to "Manual," and enter a Manual Air Speed of 4 m/sec. This ensures that the CDP number concentration output is scaled to particles per second.
5.) Adjust the spinning pinhole vertically and forward/aft in an effort maximize the number of particle counts. The CDP spinning disk rotation rate ranges between 20 and 30 Hz, so the maximum particle number concentration will be between 20 and 30 particles/cm^3. The particles should size between 18 and 22 µm. When the number concentration is between 20 and 30 particles/cm^3, the spinning pinhole is roughly aligned. At this point, note the number concentration.
6.) Now turn off depth-of-field rejection. From the Configure Menu, select Configure Instrument. Click **Dof Reject** again, so the button will toggles to "True." Click **Save** and then **Reset Program**.

7.) Ideally the number concentrations after steps 5 and 6 should remain the same, indicating that the CDP is aligned and also that the spinning pinhole is aligned with the CDP. More likely, however, all CDP counts will be rejected on depth-of-field criterion and will be included in the Dof_Reject_Cnt.
8.) If the CDP has rejected particles for being outside the depth of field, the goal is to move the spinning pinhole such that all of the particle counts meet depth-of-field requirements. The spinning pinhole disk will typically need adjustment in all three axes. (See Figure 2.) Start by adjusting along a single axis, then change the axis, and repeat as necessary. Watch the Dof_Reject_Cnt and the particle number concentration. When the former goes to zero and the latter returns to the value it was prior to turning on depth-of-field rejection, both the CDP and the spinning pinhole are properly aligned. Note that this adjustment process may take up to an hour.
9.) If numerous attempts to align the spinning pinhole fail to yield the desired results, perform a glass-bead test or another calibration check to determine whether the problem is with the spinning pinhole or the CDP.

If the problem appears to be with the spinning disk and repeated alignment attempts have failed, contact DMT for assistance.