CHARA TECHNICAL REPORT

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Vacuum Access Procedures

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ABSTRACT: It will always be necessary to open the CHARA vacuum system from time to time. This report describes procedures and protocols for such access.

1. INTRODUCTION

The CHARA vacuum system is designed to keep pressures in the beam transport tubes and the segmented delay lines (the POPs) sufficiently low that seeing and alignment are not disturbed by turbulence or stratification, and that fringe contrast is not reduced by chromatic optical path differences. The latter requirement, in the visible, is the most stringent, requiring pressures of about .001 atm. This is not a low pressure, and is easily achieved with the vacuum pump system. A more demanding requirement is for the vacuum system to maintain a pressure of this level when the pump is not operational. Even rather modest leaks, due to poor handling procedures or lack of regular maintenance, will compromise pressures of this level within an hour or less.

The CHARA operating concept, and implementation, will provide for a remotely operated and aligned opto-mechanical system which ultimately can be maintained and used for extended periods without breaking the vacuum integrity. Until that stage is fully achieved, it will be necessary to open the vacuum system for regular operational reasons. It is important to follow appropriate guidelines in these activities.

2. MONITORING VACUUM STATUS AND REPORTING

As of this writing, 6 of the telescope beams are holding vacuum adequately for current night-time operations. It is now important to keep track of work carried out on the vacuum lines, so that when they begin to leak seriously (as will happen from time to time) we can trace back

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recent activity and identify the inspections and tests needed to diagnose deficiencies. If we do not have this information, we will have to debug the system from scratch, which is tedious and time consuming.

Therefore, it is important that every time a vacuum box is opened, this fact is recorded. As a temporary procedure, we ask that every time a box is opened, an email be sent to ridgway@noao.edu identifying the box and whether or not the o-ring was processed at level 1, 2 or 3, described below. This information will be kept for future reference as needed.

3. INTRODUCING AIR

It is necessary to choose an opportunity when all manifold valves can be closed for about 30 minutes. Close all valves, including the pump valve in the Pump House. Then open the pressure release valve and the flow valve at the south end of the manifold. This configuration allows introduction of clean air into the system in a controlled manner. (However, note that at this writing, there is a leak in the charcoal filter unit which partially defeats the filtering.)

Open the manifold valve to the line that is to be brought back to atmosphere. Set the flow rate at 10 SCFM. Within about 30 minutes, the pressure will be sensibly equalized. Close the manifold valve to again isolate the line.

4. OPENING VACUUM BOXES

Be aware of the weight of the vacuum box ports. The POP box ports weigh about 60 pounds and the Turning box covers about 150. Avoid handling them in a way that will result in scratches on the o-ring surface.

Leave the o-ring in place unless you plan to clean it thoroughly.

5. ABOUT THE VACUUM REQUIREMENTS

The CHARA vacuum system operates in the pressure range 100-1000 microbars. By most laboratory vacuum system standards, this is a very high pressure. A benefit is that simple and inexpensive components and techniques have been used, saving project costs. A disadvantage is that common vacuum equipment and techniques are often not well matched to the CHARA requirements. Some of the advice given below would be quite unsuitable for higher performance vacuum systems.

6. VACUUM GREASE

First, some general information. The standard silicone o-ring grease is only slightly soluble in alcohol. Nevertheless, alcohol, augmented with mechanical effort, can be used effectively to clean the flat surface that mates against the o-rings, for example, or to clean the o-ring grooves.

An o-ring can be cleaned purely mechanically, with a clean wipe. Alcohol can be used to clean an o-ring, but it should be understood that this does not remove the grease chemically,

but removes it (and hopefully impurities and contaminates) mechanically with a modest benefit of the partial solubility. However, generally alcohol is not ideal for o-rings – extended contact may cause some deterioration. The Dow-Corning vacuum grease is soluble in kerosene and mineral spirits (as well as in more offensive materials such as stoddard solvent, benzene, toluene, ethyl ether or petroleum ether).

After removing grease, the o-ring can be washed with warm soapy water, and then thoroughly dried (optimally, drying in an oven at about 100 C, although this is not strictly necessary for CHARA vacuum levels).

Be careful in the choice of wipe or towel. Anything that releases lint is not useable. Kimwipes seem to be OK. A well laundered towel would be OK. The ubiquitous blue paper shop towels are not.

7. O-RING PROCEDURES

An o-ring does not need much grease, but ensuring that it is completely greased requires a fair amount as it is quite stiff and does not spread thinly. I find it convenient to rub small amount of grease from the tube onto the o-ring at intervals around the circumference and then to use the fingers to knead and spread thoroughly. In high-vacuum situations, it is wise to avoid excessive grease, but at CHARA tolerances it probably doesn't matter much. Plan on several minutes of work here. When you grease the o-ring, your fingers will be sensitive to irregularities on the surface. Some are normal, such as a fabrication seam, which is located at 90 degrees to the working surfaces. If you feel something strange, check it out.

The o-rings have a mind of their own. Don't try to install them cold. If they are cold, try warming them in the sun on a warm day, or with a heat gun - don't over do it. If they have been wrapped up in a bundle, let them hang out for a day or so to relax.

As the CHARA vacuum requirements (and performance) are moderate, rigorous o-ring procedures are not always necessary. Particularly when there is some urgency it is possible to use shortcuts. Let's call the o-ring handling procedures levels 1 through 3.

A. Level 1

If the port has been removed briefly, the following may be satisfactory. With alcohol and a towel, clean the flat o-ring mating surface on the removable port - this surface will almost always be contaminated with obvious dried and darkened grease – repeat until the wipe comes away clean. Then, with a clean and dry or greased finger, run your finger around the full circumference of the o-ring. The purpose of this move is to remove any lint or hairs that fell onto it while exposed. Then promptly install the port. If repeated a number of times, this shortcut will be less and less satisfactory as the grease becomes thinner and more contaminated.

B. Level 2

A more satisfactory approach will follow Level 1, but in addition remove the o-ring. Use alcohol and wipes to clean out the o-ring groove. Use a clean wipe to clean the o-ring. This

will not remove all of the grease, but will remove macroscopic particles nicely. For high quality vacuum systems, it is normal to use grease in moderation. For CHARA, it may be safer to grease generously; the o-ring grooves are actually not very smooth, owing to irregularities introduced in the plating process, and excess grease seems to have no disadvantages at our vacuum levels.

C. Level 3

In case of problems, check the groove and port for scratches. Both can be smoothed by hand. There are stones of various grit in the shop that fit into the groove. Steel wool or fine abrasive paper can be used on the port cover plate.

Because the grease is quite thick, the only way to carefully check an o-ring for damage, and the only way to remove fine grit, is to clean it off completely - use kerosene or mineral spirits, followed by soap and water, then dry completely and re-grease.