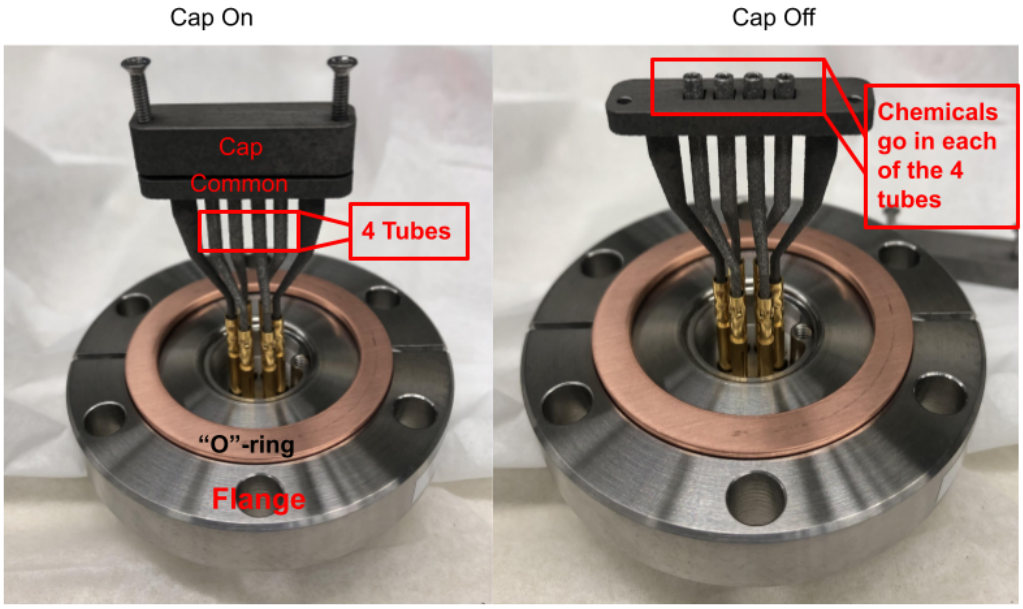
ORNL-UCSB Radium Oven Procedure

1) UCSB Part 1:

1.1) 2 complete ovens have been assembled under clean conditions on 2 seperate flanges. Each oven assembly consists of 4 oven tubes, 1 oven common, 2 2-56 screws, and 1 oven cap for shipping.



1.2) The 2 flanges with ovens will be bolted onto opposing sides of a 2.75CF "T" tube, with the third orthogonal end of the "T" tube sealed by a blank. Copper "O"-rings are used to seal each of the ports on the CF "T."

1.3) Pelican Case 2: The sealed “T” will be loaded into a secure Pelican brand case along with some extra things: a clean plastic bag containing a screwdriver for the 2-56 screws, a wrench for opening the 2.75CF “T,” clean plastic bags for storage, and a clean plastic bag containing extra tubes and 4 clean funnels and screws used for guiding Th and Zr solutions into the oven tubes.

1.4) Pelican Case 1: An additional Pelican case containing a bottle of Zr powder suspended in water, a bottle of dry BaCO3 powder, a Hamilton brand syringe for loading Zr into the oven tubes, a pair of tweezers for loading BaCO3 powder, and a poking tool for loading BaCO3 powder will be shipped separately.

2) Arrival at ORNL:

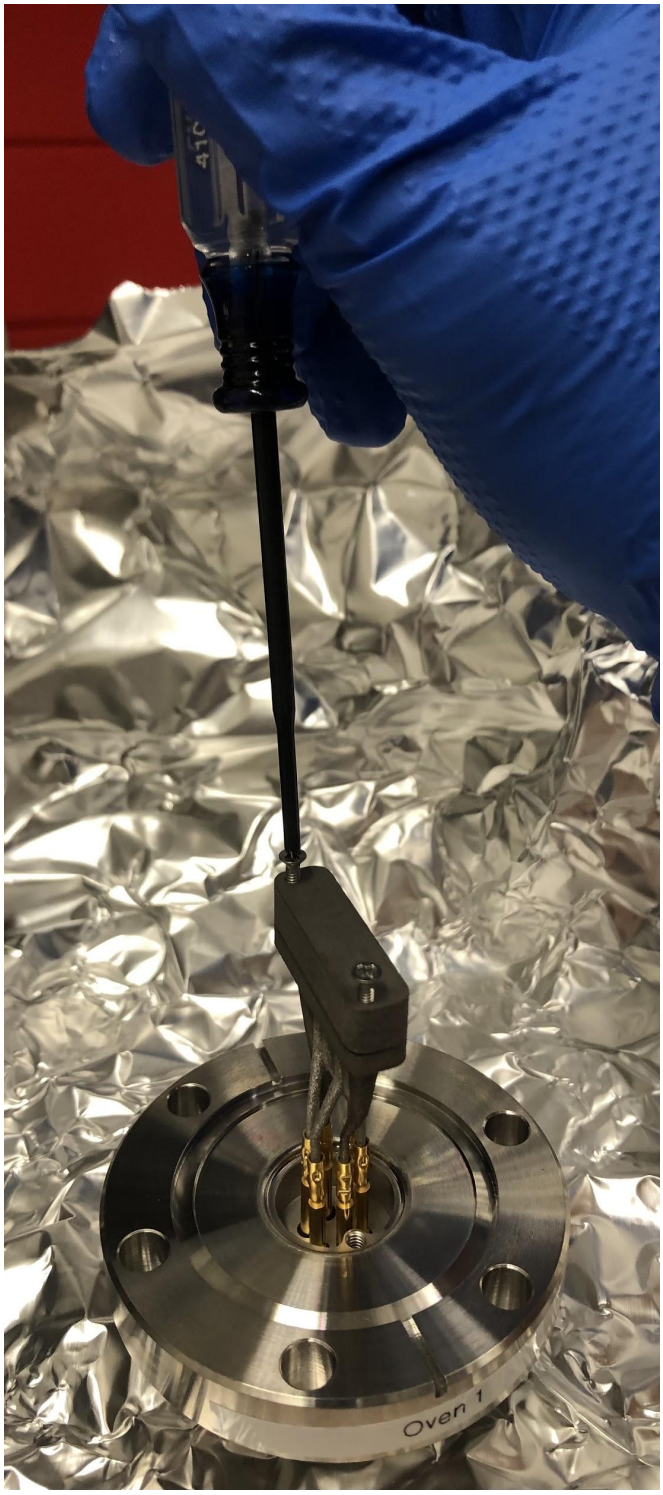
In a clean area, the cases should be opened and the contents disassembled as specified in the steps below.

2.1) Pelican Case 1:
No disassembly required. Open the case and check to see that the chemical bottles, the syringe, the poker tool, and the tweezers arrived safely.

2.2) Pelican Case 2:
Open the case. Wearing gloves, unbolt the ends of the 2.75CF “T” labeled “Oven 1” and “Oven 2” using the included socket wrench, (as shown in the picture below). The blank, (the end that has no label), should remain bolted.

2.3) After unbolting, place the copper “O”-rings in the clean plastic bag labeled “O-Rings.” Place the bolts, washers, and nuts in another bag labeled “UHV parts.” The two flanges should be inspected, making sure that the oven assemblies on each flange are secure. Store the “T” in a clean place.

2.4) Using the included screwdriver, unscrew the 2 small screws from the top of each oven assembly (as shown in the picture below). Remove the shipping caps and store the screws and the caps in the bag labeled “oven caps.”


Oven 1

3) Loading the ovens:

Prep:

Due to the fact that our zirconium source is stored as a heterogeneous mixture in water, we need to evaporate and re-mix the mixture in order to know roughly how much Zr is we are putting into each tube.

3.1) Use a pipette or syringe (NOT the syringe included in Pelican case 2) to collect a reasonable amount of Zr mixture from the Zr bottle. Spread the mixture onto a scrapable surface.

3.2) Place the surface with mixture under a heating lamp. Wait until the water has completely evaporated and you are left with only dried Zr powder. This should take ~1 hour.

3.3) By weight, measure 0.1g of the freshly dried Zr powder. By volume, measure 60uL of water (roughly a drop). Mix both quantities.

It is now time to load the ovens:

3.4) Take the oven assembly labeled “oven 1,” and place it into one of the milled aluminum blocks previously shipped from UCSB. The block is used to hold the flange in place.

3.5) Open the plastic bag containing 4 funnels (bag labeled “clean funnels and extra tubes”). Each funnel has a separate label: 224, 225, 226, and Sr. Each funnel already has the necessary screws screwed in.

3.6) Using the included screwdriver, screw the funnel labeled “224” onto the “oven 1” assembly (as shown in the picture below for funnel “225”). The funnel serves as a guide for the syringes and protects the other tubes from contamination. NOTE: It is not critical that the funnels are used for this test with Th-228. However, the funnels must be used for the final experiment, so it will be good practice to use them for this test.

3.7) Carefully mix the mixture from step 3.3 until it is as homogeneous as possible. Fill a 2uL Hamilton syringe (the syringe included in Pelican case 2) with 2uL of the Zr mixture. Insert the syringe through the funnel and into the available tube, and deposit the 2uL of mixture. Repeat this process until the tube is full.

3.8) After filling the first tube on the first assembly, unscrew the funnel and place it in a clean plastic bag labeled “dirty funnels.”

3.9) Now, take the funnel labeled “225.” Screw the funnel onto the first oven assembly. The funnel will only allow access to the second tube. Repeat step 3.7 until the second tube is full of Zr mixture.

3.10) After filling the second tube on the first assembly, unscrew the 225 funnel from oven assembly 1 and place it into the “dirty funnels” bag.

3.11) Take the funnel labeled “226.” Screw the funnel onto the first oven assembly. Again, the funnel will only allow access to the third. Repeat step 3.7 until the third tube is full of Zr mixture.

3.12) After filling the third tube on the first assembly, unscrew the 226 funnel from the oven assembly and place it into the “dirty funnels” bag.

3.13) Take the funnel labeled “Sr.” Screw the funnel onto the first oven assembly. Again, the funnel will only allow access to the fourth tube. Repeat step 3.7 until the fourth tube is full of Zr mixture. At this point, very little of the original Zr mixture should be left.

3.14) After filling the fourth tube on the first assembly, unscrew the Sr funnel from the oven assembly and place it into the “dirty funnels” bag.

3.15) By this step, all 4 tubes on the first oven assembly should be completely full with Zr mixture. Each oven should contain ~10uL of the mixture, corresponding to ~17ug of zirconium.

3.16) Leave the entire oven assembly, including the flange, out to dry under the heat lamp for ~45 minutes. The milled aluminum holders can be used to stabilize the flange while drying. The mixture must completely evaporate before we can proceed.

After Evaporation

3.17) Take the funnel labeled “224” from the bag. This funnel was already used in steps 3.6 and 3.7. Screw the funnel onto the first oven assembly. Again, the funnel will only allow access to the first tube on the oven assembly.

3.18) Fill a new Hamilton syringe (not used thus far) with 2uL of _____M thorium solution. Insert the syringe through the funnel and into the accessible tube, deposit the solution. Repeat until the tube is full.

3.19) After filling the first tube on the first assembly, unscrew the 224 funnel. Take the second oven assembly and place it into one of the milled aluminum blocks previously shipped from UCSB. Screw the 224 funnel onto the second oven assembly. Again, the funnel will only allow access to the first tube on the oven assembly.

3.20) Fill the thorium syringe with 2uL of _____M thorium solution. Insert the syringe through the funnel and into the accessible tube, deposit the solution. Repeat until the tube is full.

3.21) After filling the first tube on the second assembly, unscrew the 224 funnel from the oven assembly and dispose of it?

3.22) Take the funnel labeled “225” from the bag. This funnel was already used in steps 3.9 and 3.10. Screw the funnel onto the first oven assembly. Again, the funnel will only allow access to the second tube on the oven assembly.

3.23) Fill the thorium syringe with 2uL of _____M thorium solution. Insert the syringe through the funnel and into the accessible tube, deposit the solution. Repeat until the tube is full.

3.24) After filling the second tube on the first assembly, unscrew the 225 funnel. Now screw the 225 funnel onto the second oven assembly. Again, the funnel will only allow access to the second tube on the oven assembly.

3.25) Fill the thorium syringe with 2uL of _____M thorium solution. Insert the syringe through the funnel and into the accessible tube, deposit the solution. Repeat until the tube is full.

3.26) After filling the second tube on the second assembly, unscrew the 225 funnel from the oven assembly and dispose of it?

3.27) Take the funnel labeled “226” from the bag. This funnel was already used in steps 3.11 and 3.12. Screw the funnel onto the first oven assembly. Again, the funnel will only allow access to the third tube on the oven assembly.

3.28) Fill the thorium syringe with 2uL of _____M thorium solution. Insert the syringe through the funnel and into the accessible tube, deposit the solution. Repeat until the tube is full.

3.29) After filling the third tube on the first assembly, unscrew the 226 funnel. Now screw the 226 funnel onto the second oven assembly. Again, the funnel will only allow access to the third tube on the oven assembly.

3.30) Fill the thorium syringe with 2uL of _____M thorium solution. Insert the syringe through the funnel and into the accessible tube, deposit the solution. Repeat until the tube is full.

3.31) After filling the third tube on the second assembly, unscrew the 226 funnel from the oven assembly and dispose of it?

3.32) Take the funnel labeled “Sr” from the bag. This funnel was already used in steps 3.13 and 3.14. Screw the funnel onto the first oven assembly. Again, the funnel will only allow access to the fourth tube on the oven assembly.

3.33) Fill the thorium syringe with 2uL of _____M thorium solution. Insert the syringe through the funnel and into the accessible tube, deposit the solution. Repeat until the tube is full.

3.34) After filling the fourth tube on the first assembly, unscrew the Sr funnel. Now screw the Sr funnel onto the second oven assembly. Again, the funnel will only allow access to the fourth tube on the oven assembly.

3.35) Fill the thorium syringe with 2uL of _____M thorium solution. Insert the syringe through the funnel and into the accessible tube, deposit the solution. Repeat until the tube is full.

3.36) After filling the fourth tube on the second assembly, unscrew the Sr funnel from the oven assembly and dispose of it?.

3.37) All 4 tubes of each oven should now be completely filled with thorium-228 solution. Leave both oven assemblies out under the heat lamp until the thorium solution is dry.

After Evaporation 2

3.38) The ovens should now be completely dry. Take the oven caps and screws from step 2.4 and screw them back onto the complete assemblies. Place the screwdriver back in the screwdriver bag.

4) Shipping back to UCSB:

With all tubes on each oven loaded and shipping caps on, it is time to reassemble the 2.75CF “T.”

4.1) Take the copper “O”-rings, bolts, nuts, and washers from step 2.3. Sandwiching the “O”-ring between the flange and the “T,” carefully bolt the first flange with the included oven assembly onto the “T” using the included wrench. Tighten the bolts in a star formation (do not tighten adjacent bolts one after another). The bolts should be reasonably tight, but no need to go crazy. Repeat this process for the second flange. After the process is complete, the “T” should be in the same state as it was upon arrival.

4.2) Place the “T” (with included flanges and oven assemblies) into Pelican case 2. Place the included tools (wrench, screwdriver, funnels) back into their associated bags and into Pelican case 2.

4.3) Place the Zr bottle, $BaCO_3$ bottle, Syringe, and tweezers back into Pelican case 1.

4.4) Ship back to UCSB. Address:

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Thank you!!!