<table>
<thead>
<tr>
<th>Hazard Class Category Containment #</th>
<th>3 Layer containment for Very High and High Radiotoxicity (Group 1 and 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.a</td>
<td>LBNL Lexan or aluminum sample holder with kapton tape surrounded by 2 each individual heat sealed plastic bag.</td>
</tr>
<tr>
<td></td>
<td>Layer 1- Kapton Tape, sealed Layer 2- Heat sealed plastic bag Layer 3- Heat sealed plastic bag</td>
</tr>
<tr>
<td></td>
<td>Physical Approvals: Ambient temperature</td>
</tr>
<tr>
<td>1.b</td>
<td>LANL cryostat sample holder Sample holder with kapton windows and indium seam Layer 1- kapton window with indium seal Layer 2- Aluminum with Kapton tape, screws Layer 3- durable plastic bag or BL11-2 prep room tent inside prep room. Cryostat S Steel housing assembly with kapton windows and bolting rings outside of BL 11-2 prep room.</td>
</tr>
<tr>
<td>1.c</td>
<td>LANL cryostat sample holder with kapton window and indium seal. Layer 1- Aluminum holder with solid sample and kapton windows. Layer 2- Sample bolted on aluminum holder with kapton windows. Layer 3- durable plastic bag or BL11-2 prep room tent inside prep room. Cryostat S Steel housing</td>
</tr>
<tr>
<td>Assembly</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
</tr>
</tbody>
</table>
| 1.d      | USGS cryostat holder  
Layer 1-  
Layer 2-  
Layer 3-  

**Physical Approvals:**  
G-XAS cell One sample per cell $=^{231}$Pa sorbed onto TiO$_2$ single crystal.  
Maximum activity : 15000Bq  
- Doubly contained crystal in two sealed polyethylene envelopes. Check for no contamination of each envelope.  
- External envelope glued onto the cell surface.  
- Cell cap (polyamide 0.7 mm thick) sealed with Viton o-ring.  
- Additional glue in the thread.  
Layer 1-polyethylene  
Layer 2-  
Layer 3- Cell cap (polyamide 0.7 mm thick) sealed with Viton o-ring.  

**Physical Approvals:**  
Nominal operating conditions of BL 11-2 at 17 keV (focused beam). |
| 1.e      | Diamond anvil cell  
Layer 1  
Layer 2-  
Layer 3-  

**Physical Approval:**  
Pressure |
| 1.g      | LBNL  
Triple contained aluminum holders with Kapton or Mylar windows.  
Fit into cryostats.  
Layer 1-nested, 1 side is epoxied |
<table>
<thead>
<tr>
<th>Layer 1</th>
<th>Layer 2</th>
<th>Layer 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>window, other side is indium wire pressed with lid and cap screws.</td>
<td>nested, 1 side is epoxied window, other side is indium wire pressed with lid and cap screws.</td>
<td>Outer 1 side is epoxied window, other side is indium wire pressed with lid and cap screws.</td>
</tr>
<tr>
<td><strong>Physical Approvals:</strong></td>
<td></td>
<td><strong>Physical Approvals:</strong></td>
</tr>
<tr>
<td>Ambient temp, Cold</td>
<td></td>
<td>Ambient temp, Cold</td>
</tr>
</tbody>
</table>

1h. **LANL Conradson**

Layer 1 polystyrene
Layer 2 Stainless Steel Chamber
Layer 3 Glovebag

1i **LANL Sample holder with kapton windows and indium seam**

Layer 1-liquid cells with Kapton in aluminum cell with indium seal and cap screws
Layer 2-Kapton window with indium seal, cap screws
Layer 3-Aluminum with Kapton tape, screws

**Physical Approvals:**
Ambient temp liquids
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
</table>
| lj   | Epi tube, screw top  
Layer 1-plastic vial, screw top  
with rubber gasket.  
Layer 2-Plastic heat sealed bag  
secondary.  
Layer 3-Plastic heat sealed bag |
| k    | PE Tube  
Layer 1-plastic vial, screw top  
with rubber gasket.  
Layer 2-Plastic heat sealed bag  
secondary.  
Layer 3-Plastic heat sealed bag |
| l    | Reserved Conradson, LANL  
BL 10-1, 8-2  
Layer 1- polystyrene  
Layer 2-Stainless Steel vacuum  
structure  
Layer 3- glovebag |
| m    | LBNL, Hu Containment  
Pu239 wet paste  
Layer 1-Scotch Tape  
Layer 2- 1.5 mil polyethylene heat  
sealed bag  
Layer 3-.5 mil polyethylene heat  
sealed bag |

**Physical approvals**  
Ambient
LANL Layers
1 - polystyrene film with sample deposited on its surface
2 - Kapton windows between aluminum clamps with cap screws and indium wire.
3 - Vacuum shroud cryostat with kapton windows with torr seal, o-ring on stem of cold fingers (cannot use in cold environment).

Approved to run in BL2-3 only

Physical approvals
Ambient temp and pressure

LANL Holder
The primary consists of Pu coupons clamped or glued to an aluminum holder. This fits inside a cylindrical tube with a circumferential cutout (over the samples) that is just over 180 degrees in length. A Kapton window is glued over the cutouts with Torr Seal. The ends are sealed with indium or gold wire.

The secondary is identical to the primary, except larger, so that the primary is nested inside it.

The tertiary is our standard one for diffraction. An aluminum container with two Kapton windows sealed with elastomer o-
rings. The secondary mounts on the cold finger of an open cycle liquid He refrigerator. The end of the container and its mount on the refrigerator head are sealed with o-rings.

**Physical approvals**
Ambient temp and pressure

| 1p  | LANL Holder  
| A detailed description of the sample containment. The primary Layer 1 polystyrene.  
Layer 2- The secondary containment system an aluminum holder assembled with screws and elastomer o-rings and equipped with Kapton windows (fixed with Torr Seal),  
Layer 3- housing the first aluminum holder in a second aluminum holder assembled with screws and elastomer o-rings and equipped with Kapton windows (fixed with Torr Seal),  
Physical properties: ambient pressure and temperature |
|-----|---|
| 1q  | Primary containment:  
primary will contain solid samples mounted between two Kapton windows that are sealed to an aluminum holder with Torr Seal. The dimensions of the aluminum holder are 1”x 3”  
Secondary Containment:  
The primary is housed within a secondary that consists of two Kapton windows sealed to an aluminum holder with In wire. The dimensions of the secondary aluminum holder are: 4”x2”.  
Tertiary Containment  
the secondary is mounted within |
The tertiary containment, which also consists of two Kapton windows sealed to an aluminum holder with In wire. The three Kapton windows are identical and the kapton thickness will be of 2 mil. The dimensions of the secondary aluminum holder are: 5”x3”.

The experiment will be conducted at ambient pressure and temperature in the hutch at beam line 6-2.

<p>| | |</p>
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<tbody>
<tr>
<td>1r</td>
<td>University of Clemson, Th232. Limited to 0.2mg</td>
</tr>
<tr>
<td></td>
<td>Primary containment- Epo-tek 301 Epoxy covered by 0.001 in thick Kapton tape (layer 1). Secondary Heat sealed plastic bag 0.0015 in thick. Tertiary-heat sealed plastic bag</td>
</tr>
</tbody>
</table>

| 2 Layers containment for Low Radiotoxicity (Group 3) |
|---|---|
| 3a | LBNL |
|   | Lexan or aluminum sample holder with kapton tape. |
|   | Layer 1- Kapton Tape, sealed Layer 2- sealed plastic bag |
3c  LBNL (Tc99)
Layer 1-Kapton film with indium seal and cap screws. Mylar film may only be used for ambient conditions.
Layer 2- cryostat holder with kapton

Physical approvals
Ambient, vacuum, cold

3d  2 Layers
Primary containment: Plexiglass (Lexan) holder with sample set into a window, sealed with adhesive tape with the following specifications:
Adhesive tape: ISC Helicopter-IG Surface Guard Tape (Indoor Grade) (J" wide) with the following properties:
Adhesive: rubber Carrierl Backing: polyurethane film Thickness: 4.5 mils
Adhesion: 40 ounces per inch (to stainless steel) Tensile Strength: 48 pounds per inch (longitudinal).

Secondary containment: Heat sealed linear low density polyethylene bag, with thickness of 2 mil.

3e  2 layers
Tc99
Two layers of containment for moderate toxicity radioisotope. First containment is polystyrene, the sample is embedded in polystyrene pellets that are cast in 0.1” by 0.5” slots in a 0.1” thick aluminum plate containing 14 of these slots. This is identical to holder 4b for U. The second containment will be to encase the aluminum plate in 5 micron thick polypropylene film. This will be held in place with adhesive.

At the beam line this wrapped plate will be installed into a sealed aluminum box that includes the detector system that is also fastened to the beam port and will
be filled with 1 atm of helium.

**Physical approvals**
Ambient temperature and pressure.

<table>
<thead>
<tr>
<th>Layer 1</th>
<th>Epi tube, screw top</th>
<th>Layer 2</th>
<th>Heat sealed Plastic bag</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>plastic vial, screw top or pop top with glue with rubber gasket.</td>
<td>Uses-Liquid sample in 2 mL, screw-top, polypropylene centrifuge tube inside three layers of heat-sealed plastic.</td>
<td></td>
</tr>
</tbody>
</table>

**Physical approvals:**
Room temperature
| 3g | Uses: Lukins, LBNL  
Layer 1-Sample polyethylene tube with gasket epoxy glue.  
Layer 2 in heat sealed plastic bag.  
Powder sample in heat-sealed plastic tube (actually a plastic pipette in this case although I also use heat sealed Epi tubes) inside three layers of heat-sealed plastic. |
<table>
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<tbody>
<tr>
<td><strong>1 Layer containment for Low Radiotoxicity (Group 4)</strong></td>
<td></td>
</tr>
</tbody>
</table>
| 4.a | LBNL  
Lexan or aluminum sample holder with kapton tape.  
Layer 1- Kapton Tape, sealed |
| 4.b | Slotted metal sample holder with unpolished polystyrene sample material  
Layer 1-polystyrene |
| 4.c | Slotted metal Al sample holder with kapton tape and bolting ring  
Layer 1-Epoxied sealed kapton tape 1 side, indium sealed cap screw inside bolting ring, cap screws on kapton tape other side.  
**Physical approvals:** |
| 4.d | Ambient, Cold, vacuum with rubber gasket. Plastic seal bag secondary. Uses: Liquid sample in 2 mL, screw-top, polypropylene centrifuge tube inside three layers of heat-sealed plastic. **Physical approvals:** Room temperature |
| 4.e | Epi tube, heat sealed Layer 1-sample polyethylene tube with glue sealed cap in plastic bag. Uses: Lukins, LBNL Powder sample in heat-sealed plastic tube (actually a plastic pipette in this case although I also use heat sealed Epi tubes) inside three layers of heat-sealed plastic. **Physical approvals:** Room temperature |
| 4.f | Layer 1-quartz capillaries with flame sealed ends or epoxy. Mounted with double back tape X-ray scattering. Layer 2-Must be used with a secondary protective containment cylinder. **Physical approvals:** Room temperature Ambient pressure |
### 4.g

John Barger Holder
kapton (polyimide) or mylar (PET, polyester) or mica window adhesive-backed film with thickness .0025 to .010 in. Windows will be self-secured (via adhesive backing) to sample holders. A layer of window material will be applied to overlap around the margins of the sample holder to reinforce the seal provided by the adhesive of the primary tape layer.

Layer 1 – Capton, Mylar Mica window
Al gasket ID of bolting ring

### 4.h

Bolted Aluminum Holder
Layer 1- Kapton Tape
Aluminum gasket or indium gasket.

**Physical approvals:**
- Room temperature
- Cold in cryostat under vacuum.

### 4.i

Carbon Films, LANL loaded inside vacuum chamber device
Uranium
Layer 1-Polished polystyrene inside plastic. (polished polystyrene alone is not approved as primary containment)

**Physical Approvals:**
| 4j | LBNL  
Kapton film with indium seal and cap screws. Mylar film may also be used.  
**Physical approvals**  
Ambient, Cold, vacuum |
|---|---|
| 4k | SLAC, Uranium capillary  
Kapton film with plexiglass and aluminum/plastic caps. cap screws and O-ring on ends. |
| 4l | Containment for transport to Campus  
Container is stainless steel with installed gasket sealing lid to container in order to maintain anaerobic environment inside. This vessel is placed in a PG 1 package. **Inner package of radioactive Uranium is contained in a sealed plastic bag.** |
| 4m | LBNL, Singer Containment  
**Aneropak Box**  
**Primary Containment**- The lid of the Anaeropak box locks down, and tape will be wrapped around the lid for additional sealing and to prevent the locks from opening. On the side of the sample box, two windows will be made of Kapton film, which will be taped 2X on both sides with Kapton tape.  
The base and top part of the sample cell are connected by screws, with an O-ring seal. The top part of the sample cell has a window made of Kapton film, that will be 2X taped on both sides with a single piece. The sample cell will be housed within a modified Aneropak Box:  
**Physical approvals**  
Ambient |
<table>
<thead>
<tr>
<th>SSRL Radioactive Material sample holder catalog</th>
<th>01/05/2015</th>
</tr>
</thead>
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<table>
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<tr>
<th>4n</th>
<th>LANL containment Conradson</th>
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<tbody>
<tr>
<td></td>
<td><strong>Physical approvals</strong></td>
</tr>
<tr>
<td></td>
<td>Ambient</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4o</th>
<th>Dave Singer, LBNL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Magnetite dipped in U238</td>
</tr>
<tr>
<td></td>
<td>Primary Containment-Kapton, on steel housing with cap screws and o-ring between platform and window ring. Particulate filter on inlet and outlet of gas flow tubing. Relief valve before inlet filter to avoid kapton window from over pressurization</td>
</tr>
</tbody>
</table>

| 4p | Sample holder is machined from polycarbonate sheet (see dimensions in Figure 1). The sample is packed in the recess, then capped with 0.2 mil (6 um) polypropylene (PP) film attached via a piece of double sided tape (Figure 2). The tape has an opening removed to allow beam impingement on the sample after passing through the PP window. The film and the holder serve as primary containment of the sample material. Samples will be packed as a wet paste, then the tape will be applied, followed by the first layer of PP film. Once the holder |

Figure 2. A schematic of a loaded sample holder complete with sample, PP film, and adhesive tape.
is prepared it will then be placed inside a PP film pouch which will be sealed with tape (Figure 3).

**Figure 3.** Showing second layer of PP film as an envelope (secondary containment) with a folded and taped tab for closure.

| 4q | **Primary containment:** The sample holder is constructed from clear polycarbonate. The space for the sample is a channel 3 cm long, 1 cm wide, and 1 cm deep. See attachment A. The sidewalls are 5 mm thick, and the rear wall is 2.5 mm thick (Figure 1). End-caps of 5 mm thick polycarbonate (Figure 1) are secured with cyanoacrylate adhesive (LocTite formula 401 super glue).  
**Secondary containment:** Kapton film is secured to the fourth side using LocTite formula 401 super glue to form a watertight seal. A second layer of Kapton (0.3 mm or greater) tape over the Kapton film provides an additional layer of containment.  

**Physical approvals**  
Ambient |

| 4r | **LANL**  
Primary Containment  
Uranium 238 and Unat only |
- During shipping is a stainless steel coffin, see Scheme 1.
- During chamber loading is a glovebag over the chamber opening.
- During the experiment is the chamber.

**Physical approvals**

**Ambient**

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**LANL- Stosh**

**BL 6-2**

1st layer – Polystyrene (not the primary containment) in a containment is a cylinder aluminum holder with a top cap made of polycarbonate and bottom cap made of aluminum which is assembled with elastomer o-rings in the groove and screws on top and bottom. On the front window of the cylinder Kapton is adhered to the surface with Torr seal to the aluminum holder.

2nd Layer-

Kapton and plexiglass

U-238, U-nat only

Uranium is Powder

Room temperature and ambient pressures
Thin sections
The thin sections will be epoxied/glued to a standard glass/plastic microscope slide.

U-nat

Primary Containment: The epoxy will be the containment for the thin section.

Monochromatic beam
2 to 38 keV

Physical approvals
Ambient

Sediments will be adhered to sample holders in one of three manners. Samples cannot be covered with any material because of the low energies of x-rays at the carbon K-edge and the low penetration ability of electrons to be detected.

a. Sediments will be deposited onto a clean silicon wafer in water or an organic solvent and allowed to dry in place.
b. Sediments will be deposited onto carbon tape. c. Sediments will be pressed into a metal foil such as indium or copper.

Primary Containment:
| 4v          | Samples are uranyl fluoride microparticles (~ 1 micron diameter) sealed between two silicon nitride windows with epoxy.  
|            | 14 µg of UO$_2$F limit.  
|            | Window frames are 3 mm in diameter, and 200 microns thick, while the windows are 1 mm x 1 mm square, and 50 nanometers thick.  
|            | Only approved for BL 13-1 for PNNL |
| 4w          | The primary containment is a Teflon or aluminum block, which is compatible with the solvents. Within the block a sample well has been milled. The window is equipped with at two polypropylene windows and a Viton gasket held in place by a stainless steel plate. There are two ports for sample loading on top, which are closed with screw type plugs.  
|            | • The holder is only approved for less than 0.1 molar solutions of uranium with a total volume of 1 mL (24 mg U-238; 3.0E+02Bq).  
|            | • The holder is only approved for room temperature measurements at ambient pressure.  
<p>|            | • Upstream facing (beam side) windows are 4 µm thick and composed of polypropylene. |</p>
<table>
<thead>
<tr>
<th><strong>LANL</strong></th>
<th></th>
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</thead>
</table>
| **4x** | Kristin Boye- **Stanford University**  
The sediments will contain U-nat \( \leq 13\text{mg} \), in a total of 100 mg of sediments.  
The sample pellets will be inserted into circular slots in an aluminum holder and sealed with a single layer of Kapton. Dimensions of holder 2.5 cmx 5.0 cm.  
Layer 1-single layer of Kapton self-adhesive tape on both front and back. |