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Title: (U) TA-55 and Sigma Overview

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(U) TA-55 & Sigma Overview

Los Alamos
NATIONAL LABORATORY
EST. 1943

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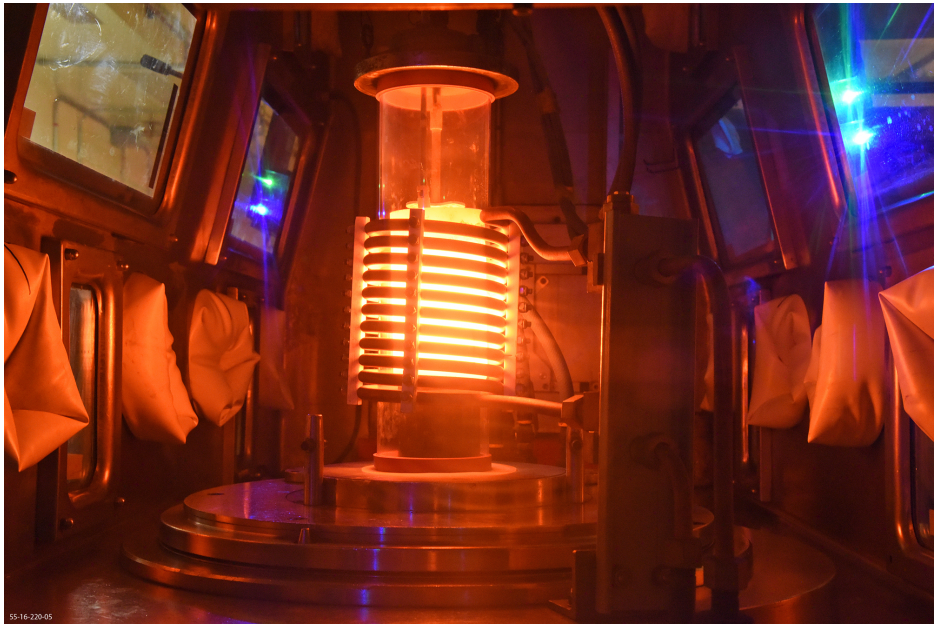
December 7, 2016

Reviewed by: Dane Spearing, NEN-1
Date: 29 November 2016

National Nuclear Security Administration
Operated by Los Alamos National Security, LLC for the U.S. Department of Energy's NNSA

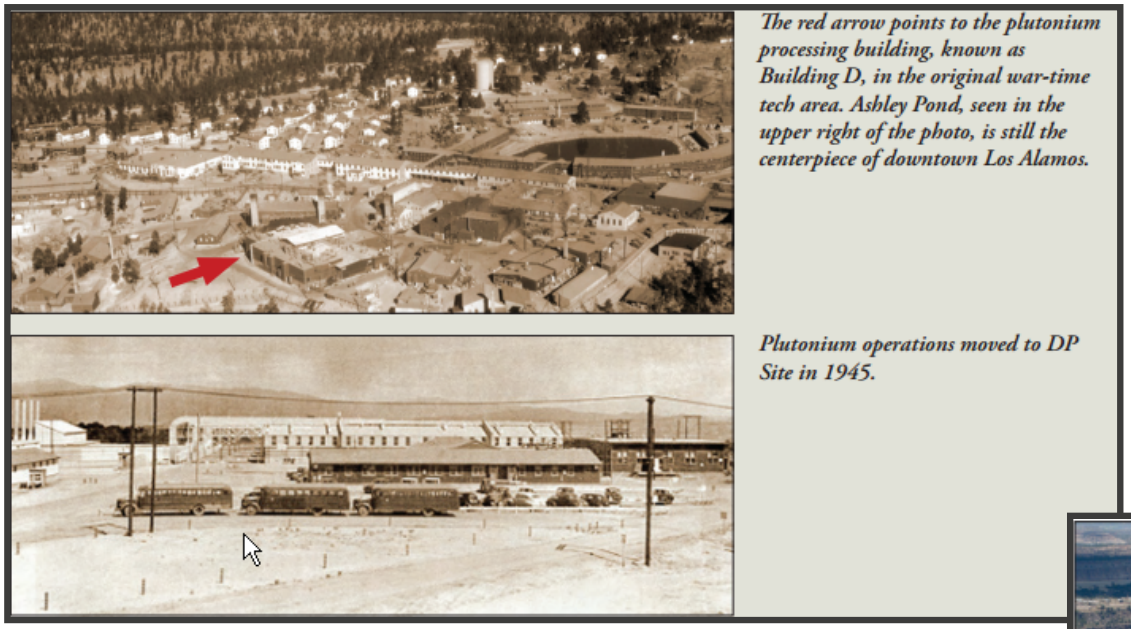
TA-55 – Plutonium Facility (PF-4)



Mission Statement

Managed by the Plutonium Science and Manufacturing Directorate (AD-PSM), the TA-55 Plutonium Facility (PF-4) provides world-class, safe, secure, and reliable special nuclear material (SNM) research, process development, technology demonstration, and manufacturing capabilities that support the nation's defense, energy, and environmental needs.

TA-55 History



The red arrow points to the plutonium processing building, known as Building D, in the original war-time tech area. Ashley Pond, seen in the upper right of the photo, is still the centerpiece of downtown Los Alamos.

Plutonium operations moved to DP Site in 1945.

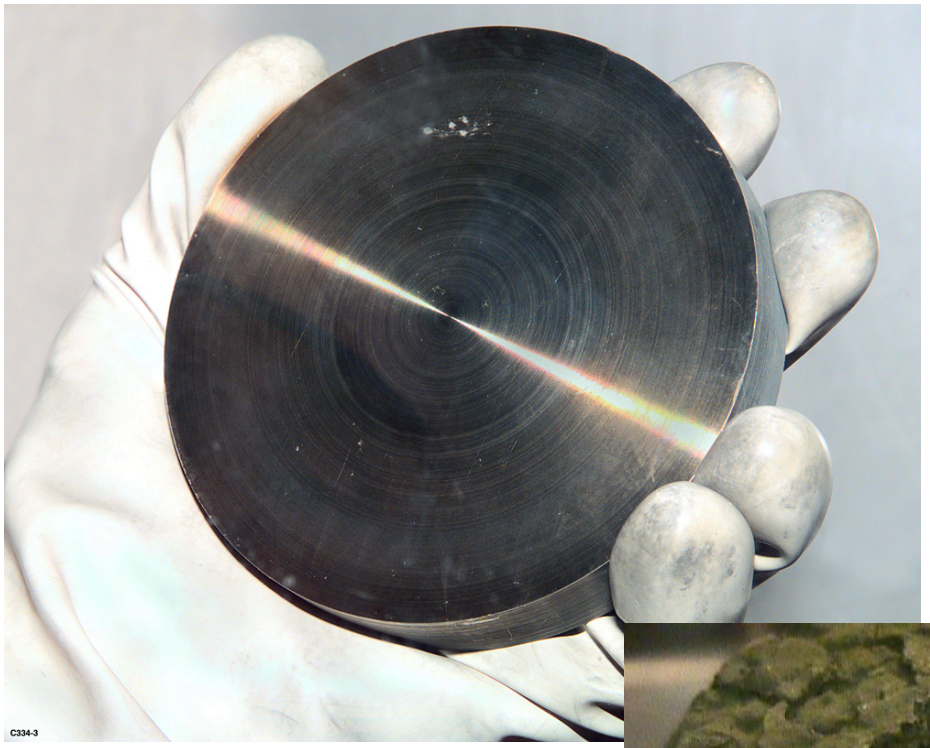
1943 – 1945: Pu Processing Building (Building D) near downtown Los Alamos

1945 – 1978: Pu operations were housed at DP-Site on Los Alamos mesa.

1978 - Present: The Plutonium Facility at TA-55

PF-4 is the “youngest” plutonium facility in the US, and is currently the only active Category I Pu processing facility in the nation.

Plutonium



Pu metal

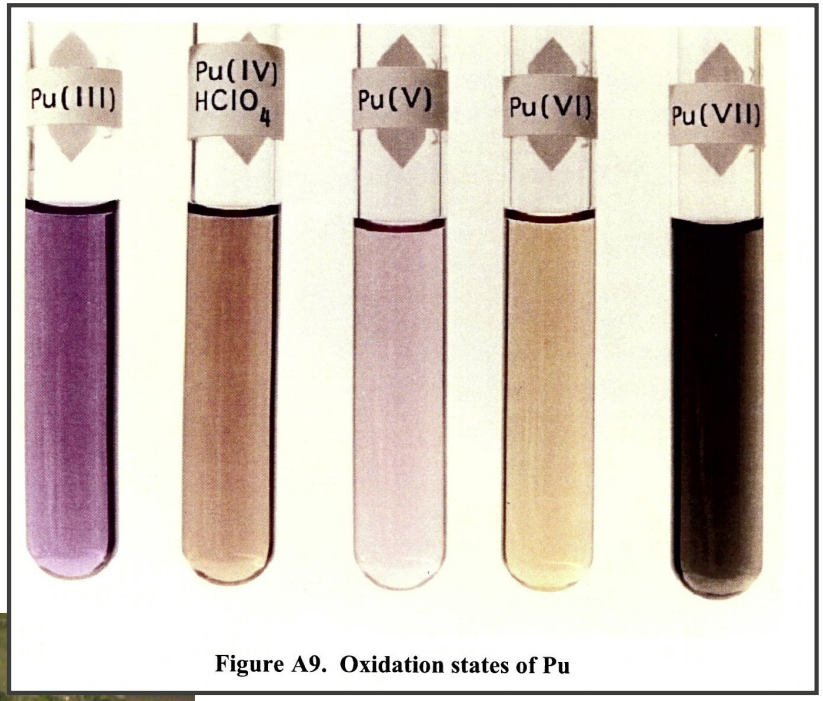
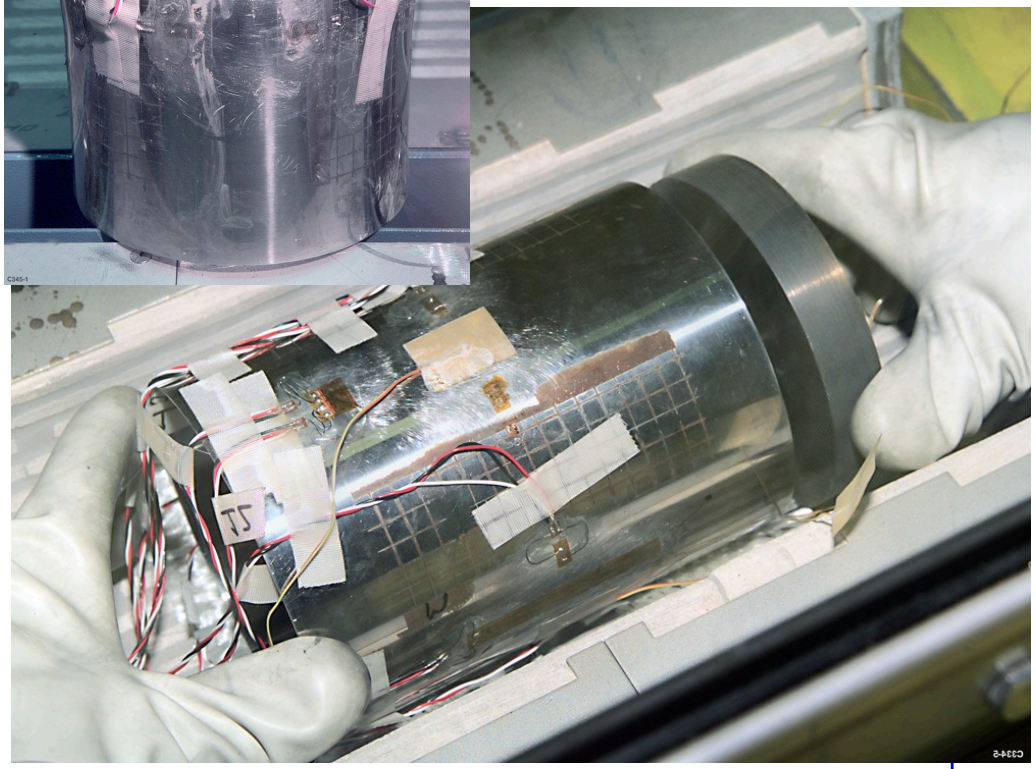


Figure A9. Oxidation states of Pu

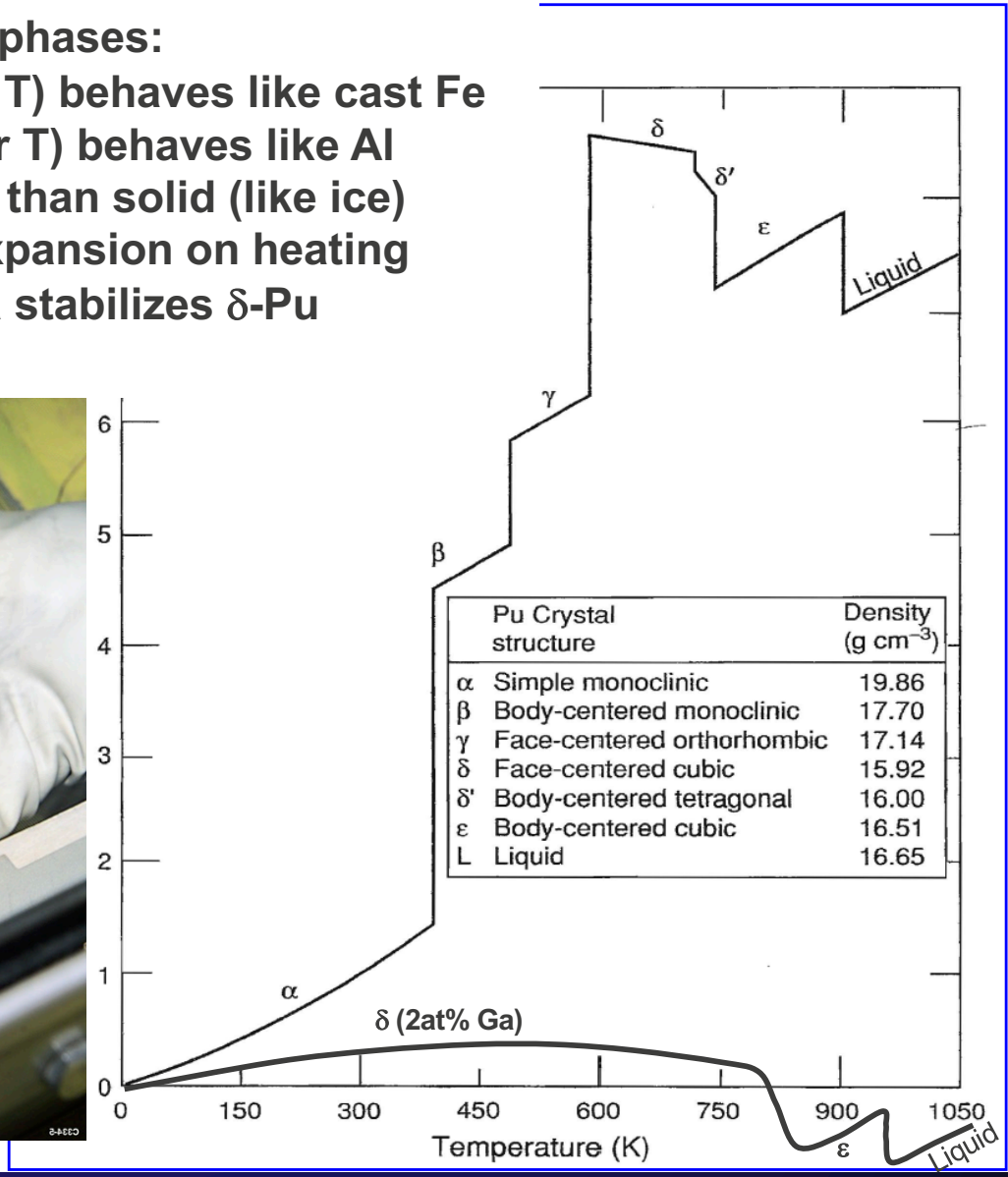
Pu in solution

Pu oxide

Plutonium – a strange material indeed



- 5 different solid phases:
  - α-Pu (room T) behaves like cast Fe
  - δ-Pu (higher T) behaves like Al
- Liquid is denser than solid (like ice)
- Large volume expansion on heating
- Alloying with Ga stabilizes δ-Pu

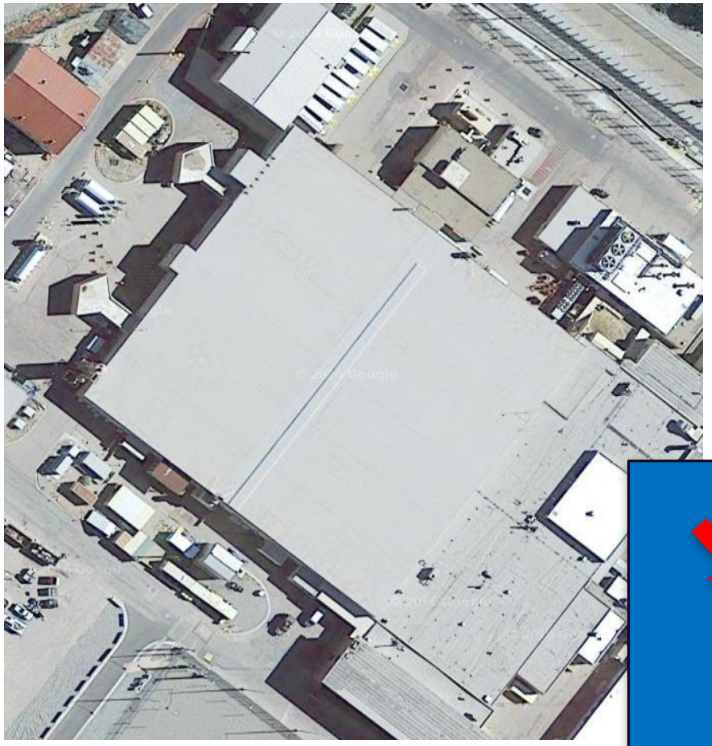


Pu Crystal structure		Density (g cm^{-3})
α	Simple monoclinic	19.86
β	Body-centered monoclinic	17.70
γ	Face-centered orthorhombic	17.14
δ	Face-centered cubic	15.92
δ'	Body-centered tetragonal	16.00
ε	Body-centered cubic	16.51
L	Liquid	16.65

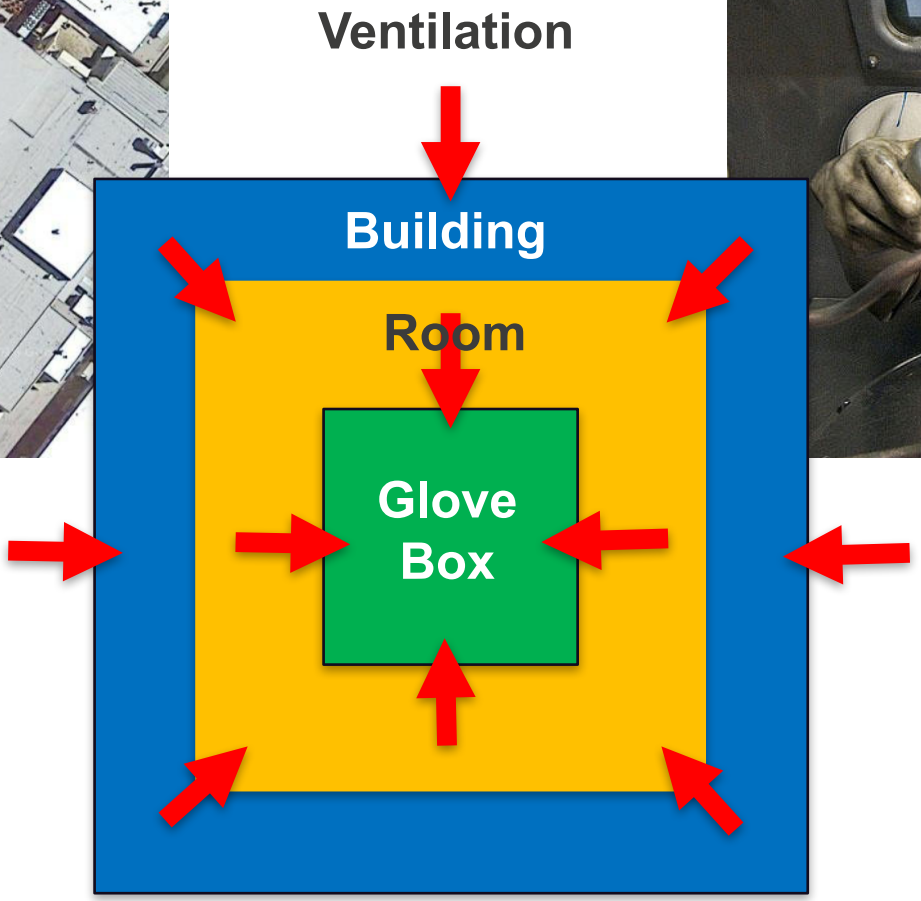
Plutonium: “Most Toxic Substance Known to Man”???

	Substance	Lethal Dose (mg)	Death In
Ingested	botulism toxin	0.00005	hours to days
	nicotine	60-100	seconds to days
	aflatoxin (in mushrooms)	0.01	hours to days
	aconitin (in flowers)	1-2	hours
	strychnine	100-200	hours
	cyanide	200	minutes
	plutonium	6000	> 15 years
Injected	snake poison	0.005-1	hours to days
	plutonium	2	> 15 years
Inhaled	Nerve gas	1	hours
	Cadmium vapors	90	hours
	plutonium	5	> 15 years

Pu Safety: Defense in Depth

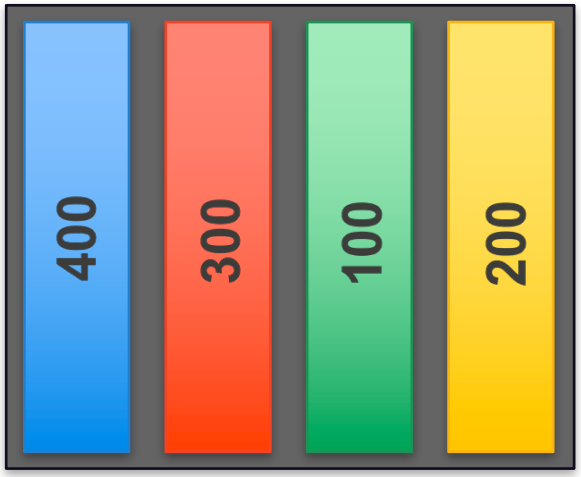


Building Shell



Gloveboxes

PF-4 Functional Areas



PF-4 is organized into 4 functional areas:

400 Wing: Aqueous Processing

300 Wing: Casting and Machining

100 Wing: Pu-Oxide Production & Materials Science

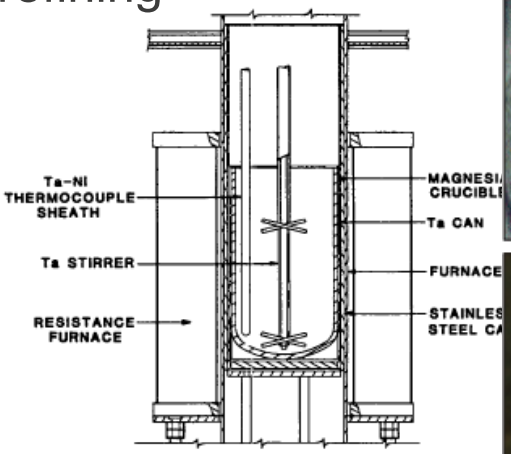
200 Wing: Heat Source Production

Fact Sheet

Opened in 1978
160,000 sq ft (three floors)
70,000 sq ft processing space
~450 gloveboxes/hoods

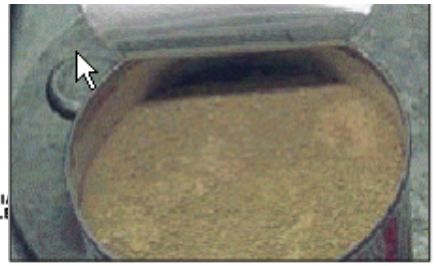
400 Wing: Aqueous Processing

- Purpose:
  Pu recovery, reprocessing, & refining
- Capabilities:
  - Nitric acid dissolution
  - Cl-based recovery
  - Direct oxide reduction
  - Am removal
  - Electrorefining

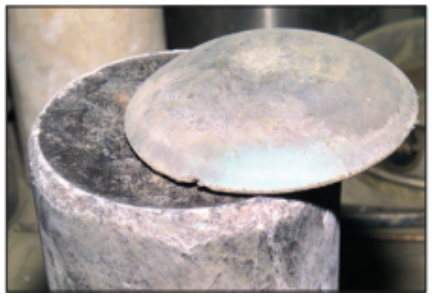


DOR process equipment.

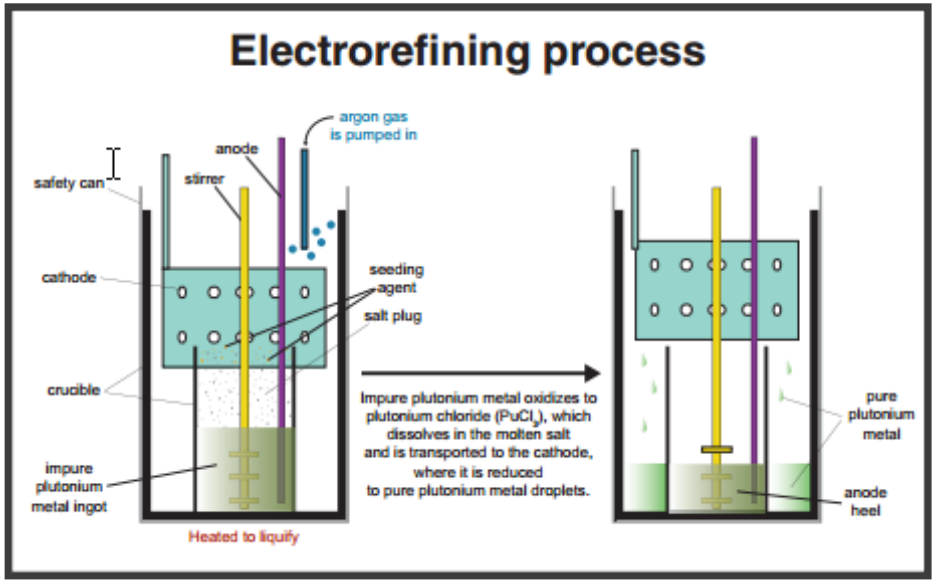
Direct Oxide Reduction



Pu Oxide



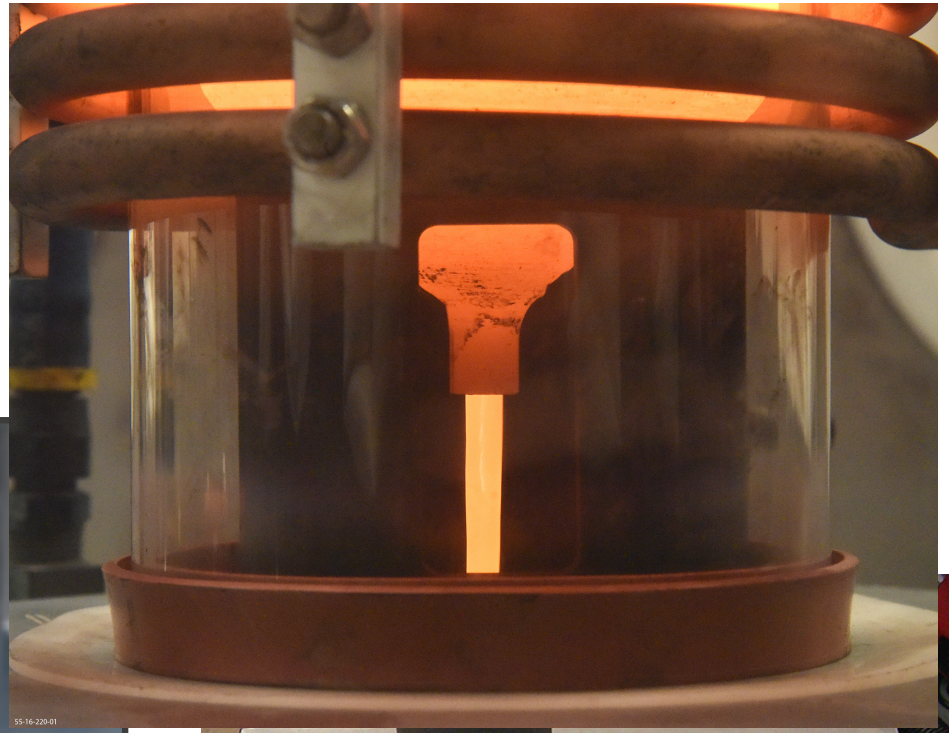
Pu metal



300 Wing: Pu Casting and Machining

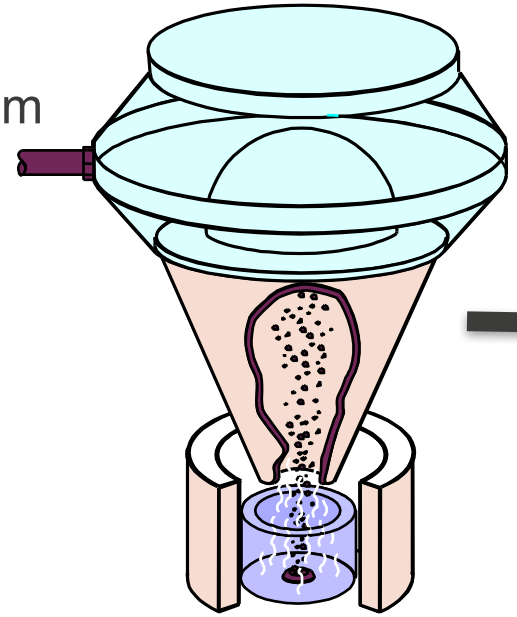
Dedicated to:

- Pu Casting
- Pu Machining
- Pit Fabrication
- Pit Surveillance



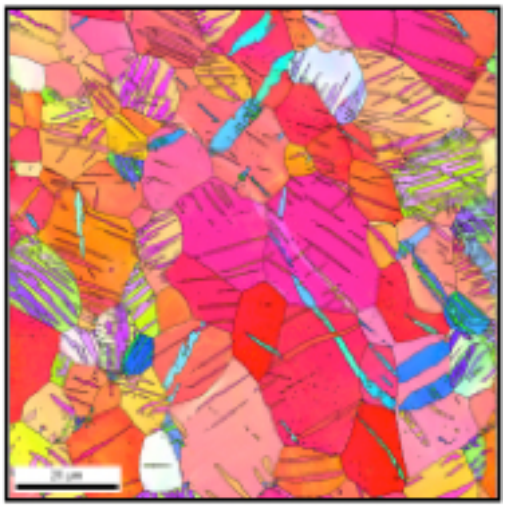
100 Wing: Oxide Production and Materials Science

- Advanced Recovery and Integrated Extraction System (ARIES) – “swords to plowshares”
- MOX fuel pellet research
- Pu metallography
- Pu materials science



Pu hydride/de-hydride

PuO_2 storage can



Plutonium metallograpy, microscopy, and metallographic analysis

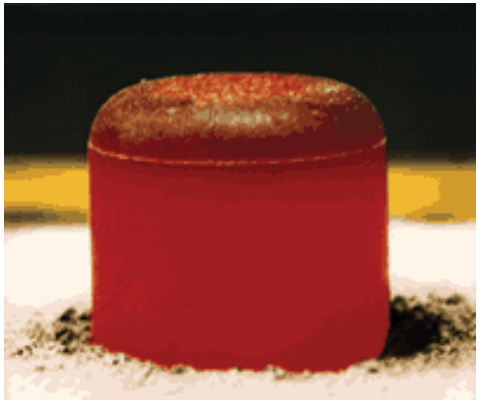
MOX Fuel Pellets

200 Wing: ^{238}Pu Heat Source Production

- Started ^{238}Pu for artificial heart program
- Missions include:
  - Cassini mission to Saturn
  - Martian rovers

Curiosity Rover

Isotopic Fuels
Impact Tester (IFIT)



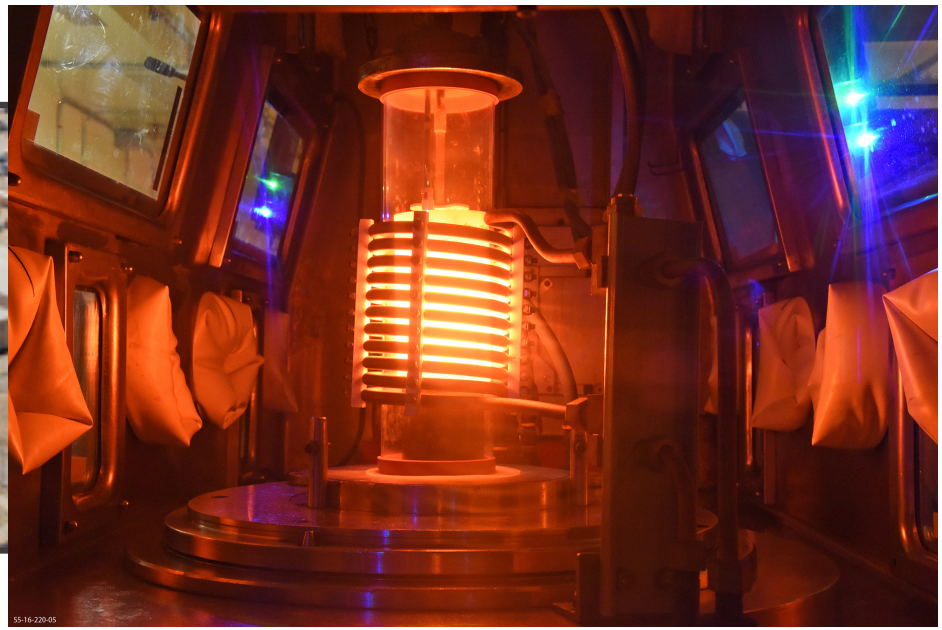
$^{238}PuO_2$ pellet

Radioisotope Thermoelectric Generator (RTG)

TA-55 Summary

PF-4 is a unique resource for US plutonium programs:

- **Basic design is flexible and has adapted to changing national needs**
- **Robust facility with strong safety and security implementation**
- **Supports a variety of national programs**
- **Will continue for many years into the future**



Sigma Overview

Handling everything from
Hydrogen to Uranium

Los Alamos
NATIONAL LABORATORY
EST. 1943

NNSA
National Nuclear Security Administration

Operated by Los Alamos National Security, LLC for the U.S. Department of Energy's NNSA

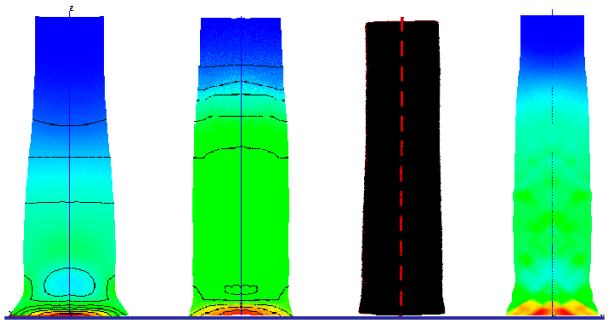
Sigma Fact Sheet

- Opened and in continuous operation since 1958.
- Handle all elements between hydrogen and uranium on the periodic chart, in many forms (e.g. - metals, ceramics, solutions)
- Prototyping and characterization facility with a full suite of capabilities including:
  - Foundry
  - Forming- Powder Metallurgy
  - Welding and Joining
  - Chemical Analysis
  - Microstructural Characterization
  - Corrosion
  - Electrochemistry/Electroplating

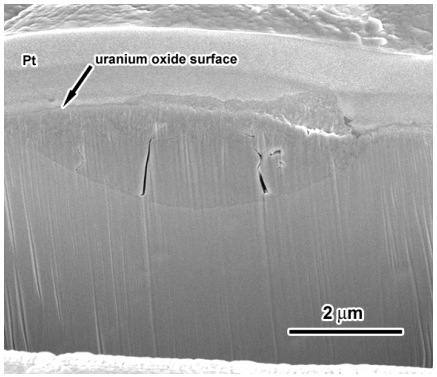
- 200,000 sq ft integrated prototyping, testing and characterization facility

Sigma Division – Core Uranium Capabilities

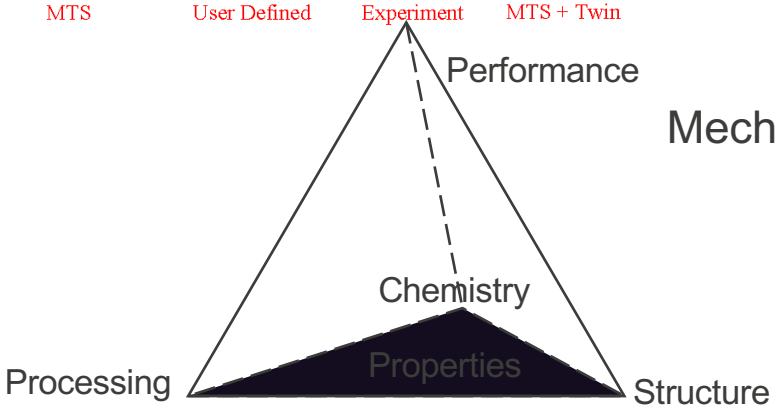
Modeling and Validating Performance:
Constitutive Mech. Prop.



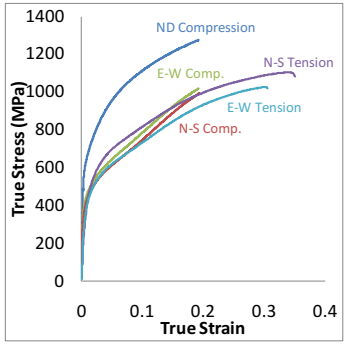
Environmental Performance:
Hydride Corrosion of Uranium



Fabrication:
Uranium Components for Hydrodynamic Experiments

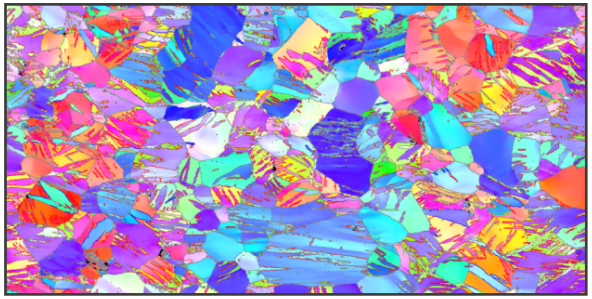


Mechanical properties:

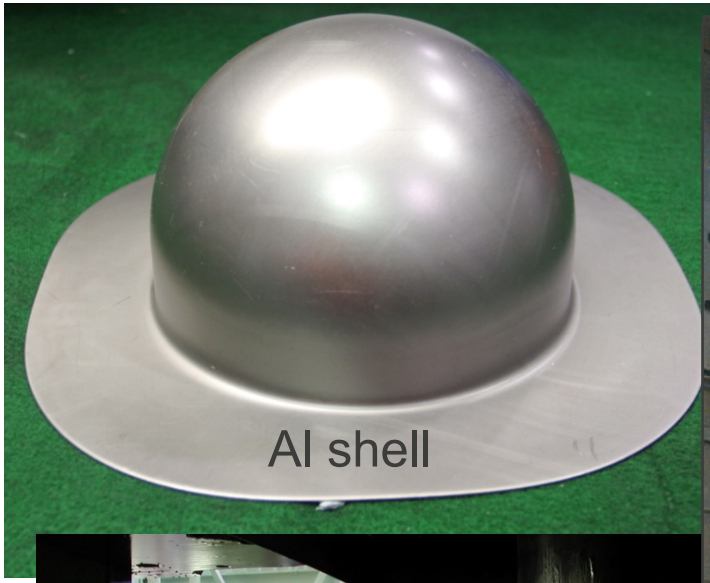


Synthesis:
Uranium Foundry

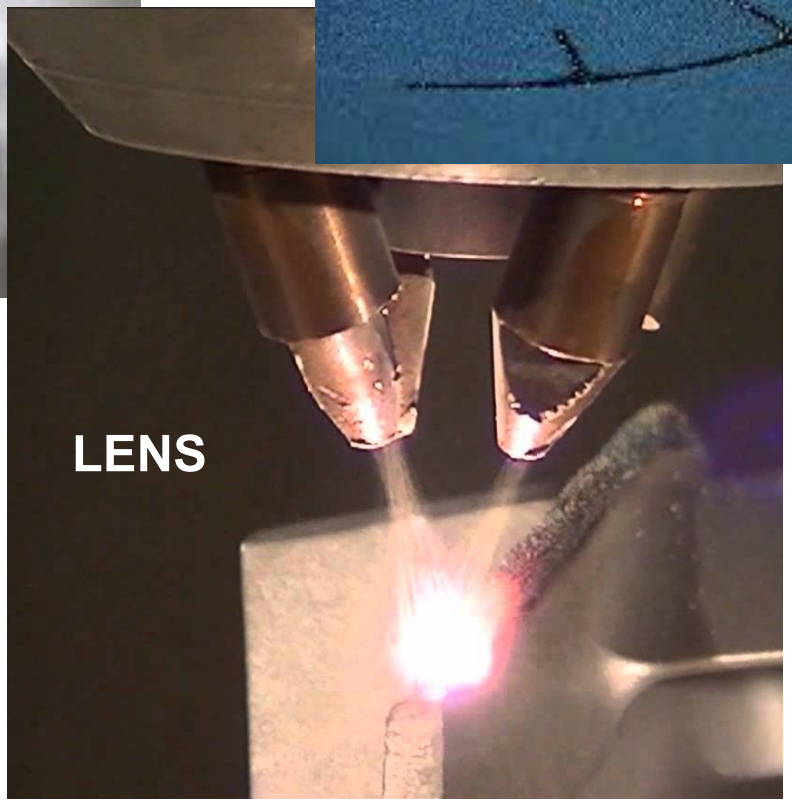
Characterization:
Twinning in U



Metals Forming and Process

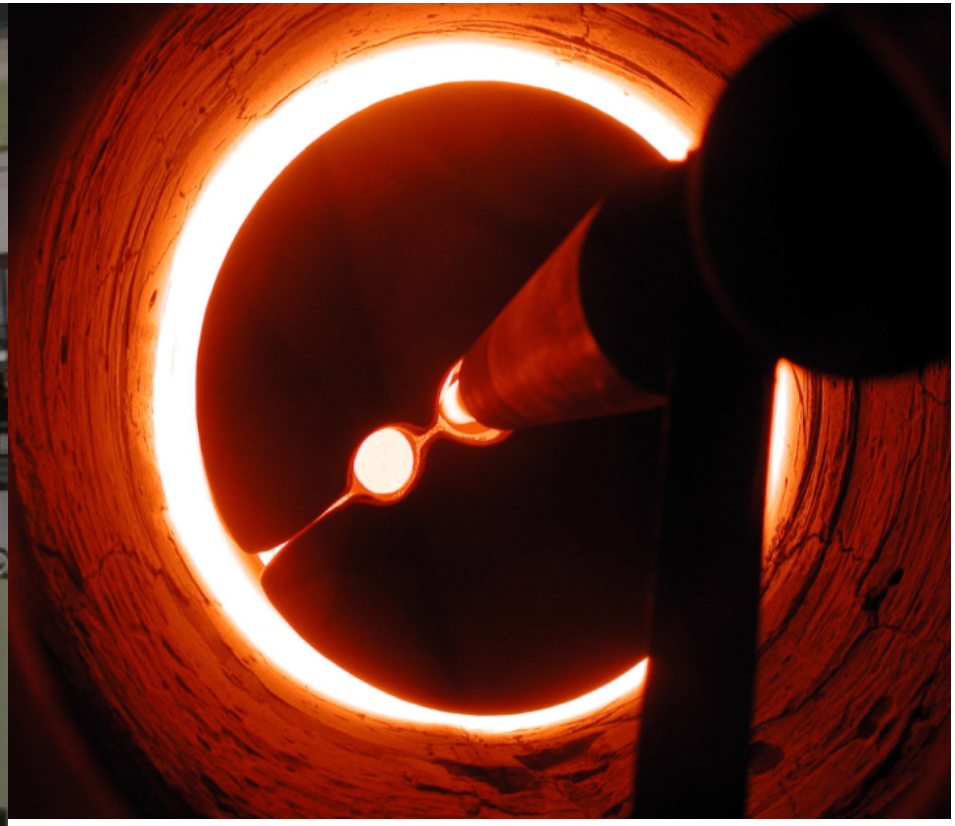


Metals Additive Manufacturing



Full suite of metals additive manufacturing capabilities for exploring and developing state-of-the-art part fabrication.

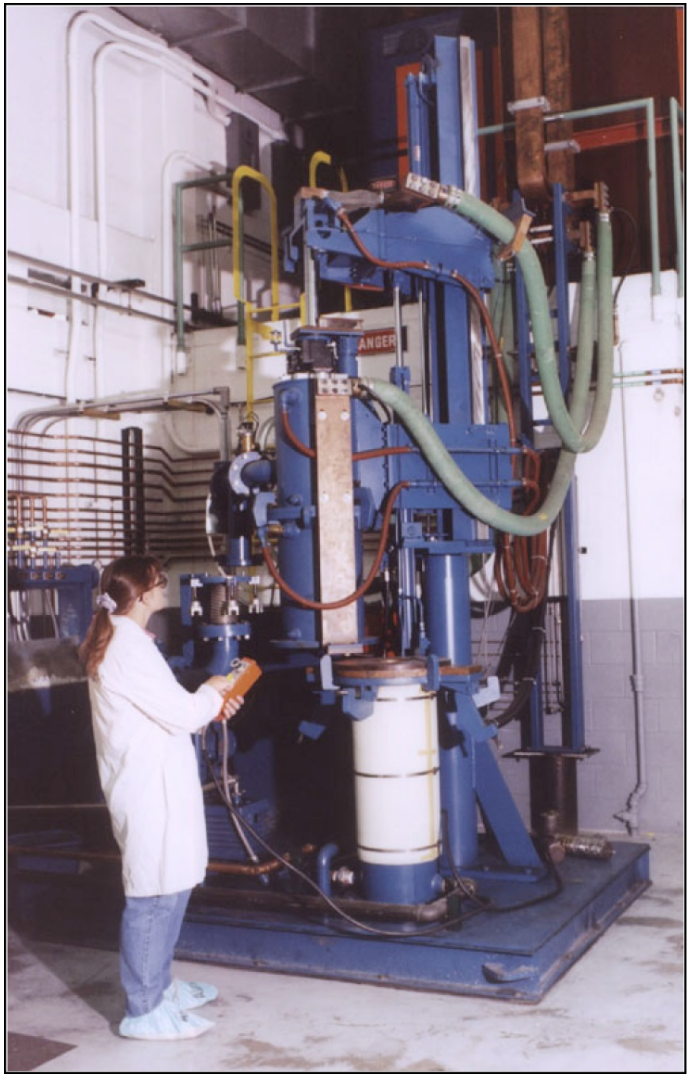
Casting



Vacuum induction melting

Vacuum Arc Remelt

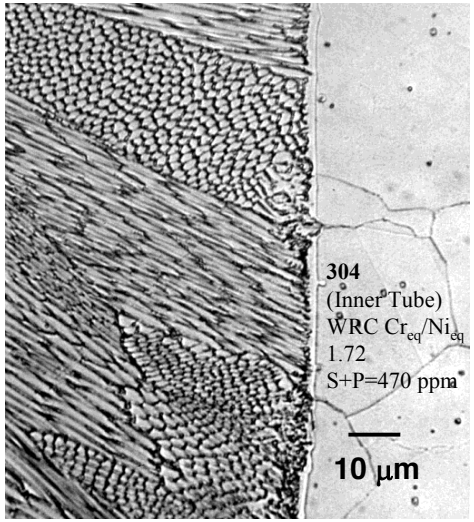
- Configured for melting reactive metals
- Designed and build by Retech, installed in 1983
- 10 kA power supply
- 2.5", 3.5", 5", 6", 6.25" and 8.5" Ø x 24” crucibles; limited to 400 kg
- Magnetic stirring up to 90 G
- Highly instrumented including load cell and video recording; instrumented crucibles (temperature and current partitioning)



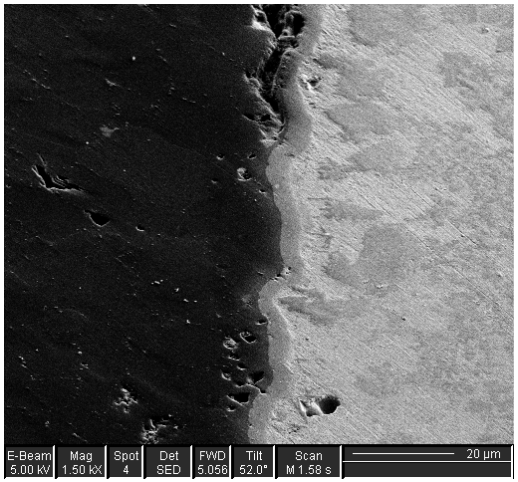
Welding and Joining

Expertise Welding and Brazing:

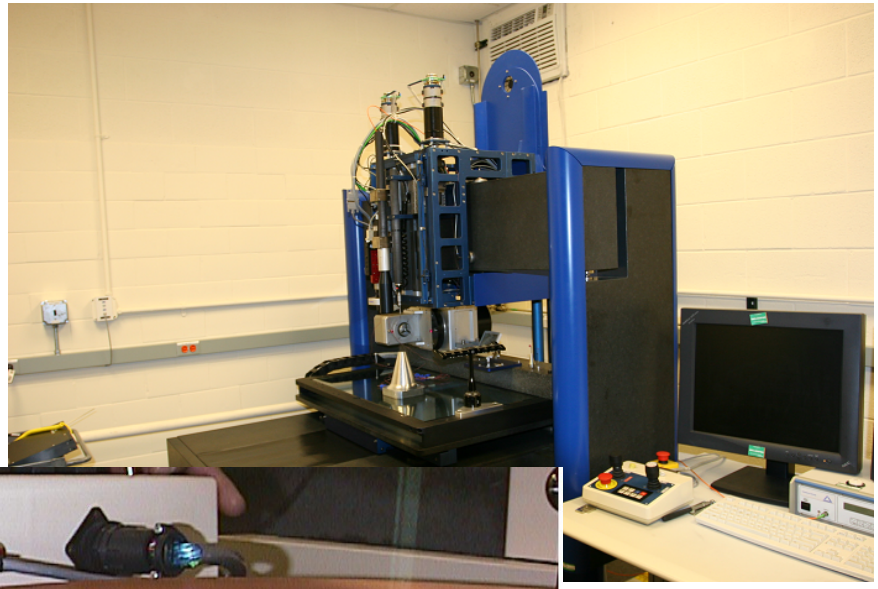
- Plutonium and Uranium
- Beryllium
- Copper and copper alloys
- High and Low Alloy Steel
- Tool Steel
- Stainless Steel (ferritic, austenitic, duplex, super duplex)
- Refractory Metals (W, Mo, Ta)
- Titanium, Vanadium, Niobium, Aluminum

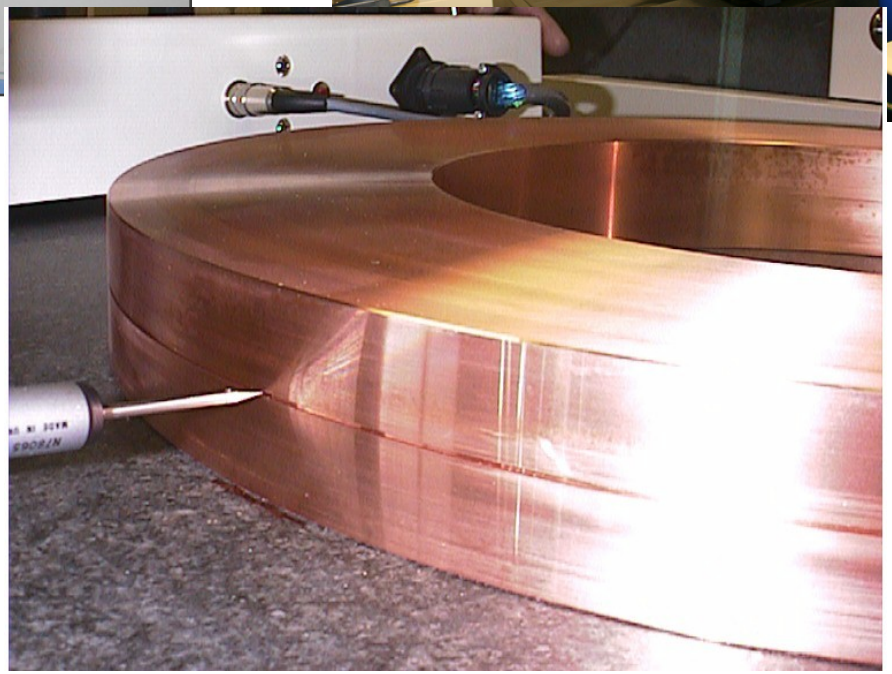


Stainless Steel
Pulsed Laser Weld



Machining & Inspection

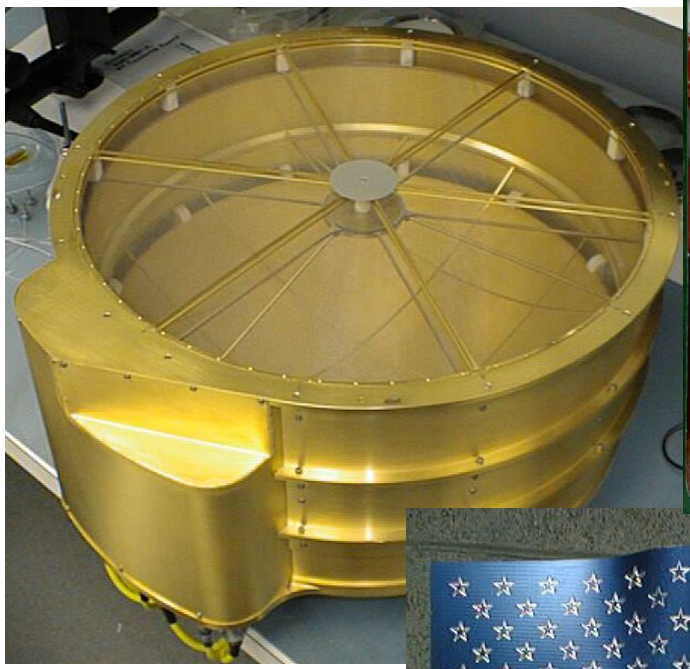




Machining Expertise:

- **Metals**
- **Ceramics**
- **Graphite**

Plating and Cleaning



The only large volume plating baths in the DOE complex.

Sigma Summary

- Long term service to the Nation (nearly 60 years!)
- Flexible authorization basis to handle almost the entire periodic table
- Wide breadth of prototyping and characterization capabilities
- Integrated program and line management