

METALLIC: The Minerals to Materials Supply Chain Research Facility

Center 3: Refinery



METALLIC Industry Event
July 27-28, 2026

Meet the Team: METALLIC Center 3 - Refinery



Ryan Ott
Center 3 Lead



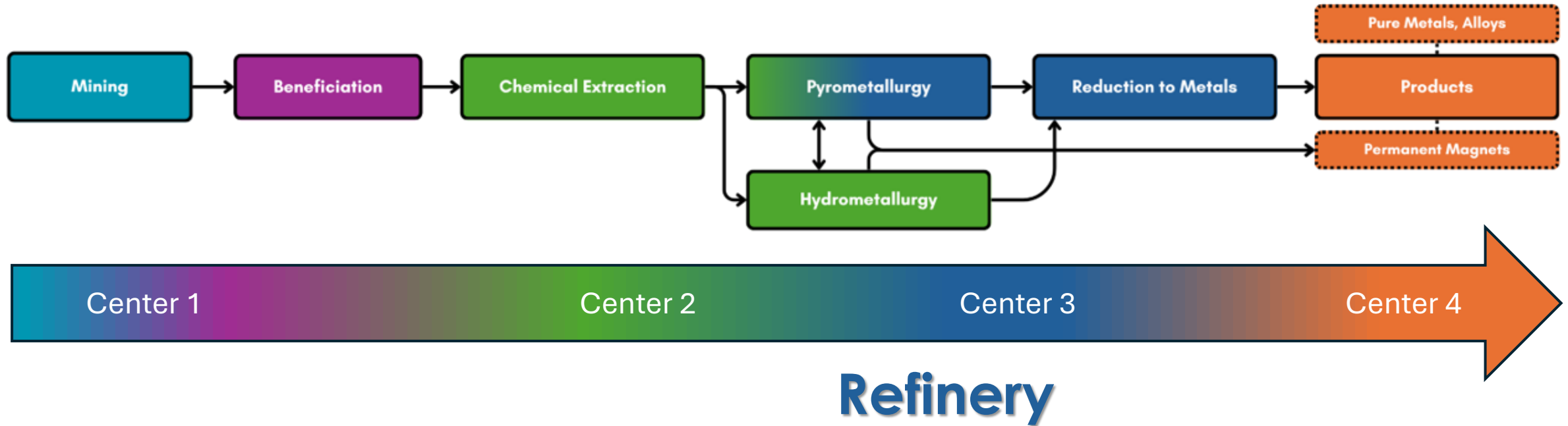
David Alman
Center 3 Co-Lead



Wyatt Du Frane
Center 3 Co-Lead

How Center 3 (Refinery) fits into METALLIC structure

Building collaborations and workflow across teams



Stakeholders can work with METALLIC to perform mid-scale processing work using advanced equipment and collaborate with world-leading experts

Center 3: Critical Materials Refinery

Refinery Flagship Activities

1. Pyrometallurgical
2. Electrochemical
3. Advanced Reduction Technologies
4. Metals Purification

National Resource for Industrial Partners

- *Validating new materials and technologies*
- *De-risking commercial adoption*
- *Workforce development*



Flagship # 1: Pyrometallurgical

What METALLIC Offers

- Advanced melt processing lab- to pilot-scale
- Addresses large gap at the “mid-scale” (1-50 kg) – provides commercially relevant melt technologies

Existing Capabilities:

- Vacuum induction, plasma arc melting/casting
- Gas atomization, electric arc furnace (EAF), vacuum arc remelt (VAR), electroslag remelt (ESR)
- Carbonization, graphitization, single crystal growth

New Capabilities:

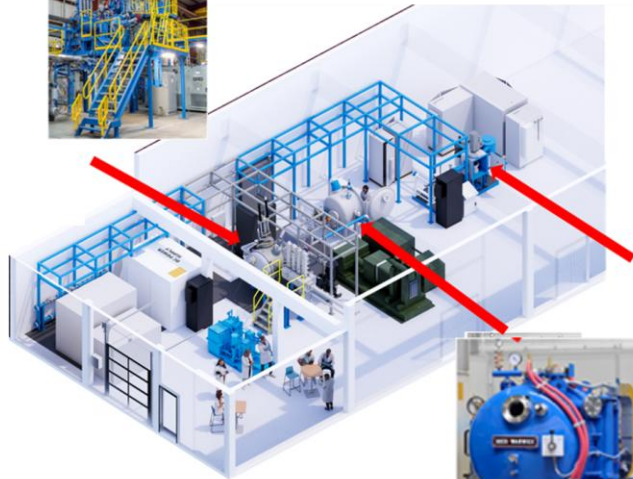
- **Plasma melt system** (450 kW torch) heated billet withdrawal
- **Electron beam** (150 kW) system for ultra-high purification
- **Cold wall vacuum induction** (350 kW) system + strip casting
- **Carbonization** furnace (1100°C, 120L chamber)
- **Graphitization** furnace (2600°C, 80 L chamber)



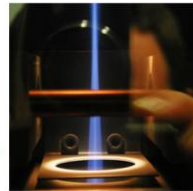
New Pyrometallurgy Capabilities Coming Online



**Plasma Melt System
450 kW Torch**



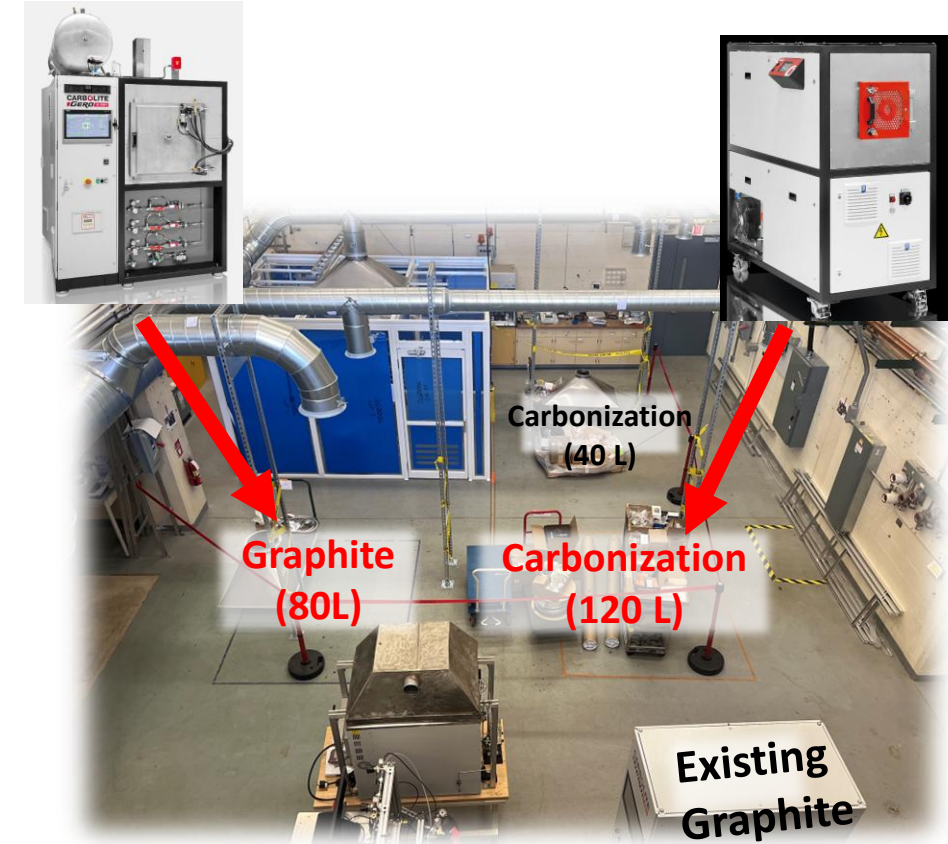
**Electron Beam System
150 kW**



**Cold Wall VIM
+ Strip Casting
350 kW**



New Melt Capabilities – December 2026



**Graphitization Capabilities –
October 2026**

Flagship #2: Electrochemical

What METALLIC Offers

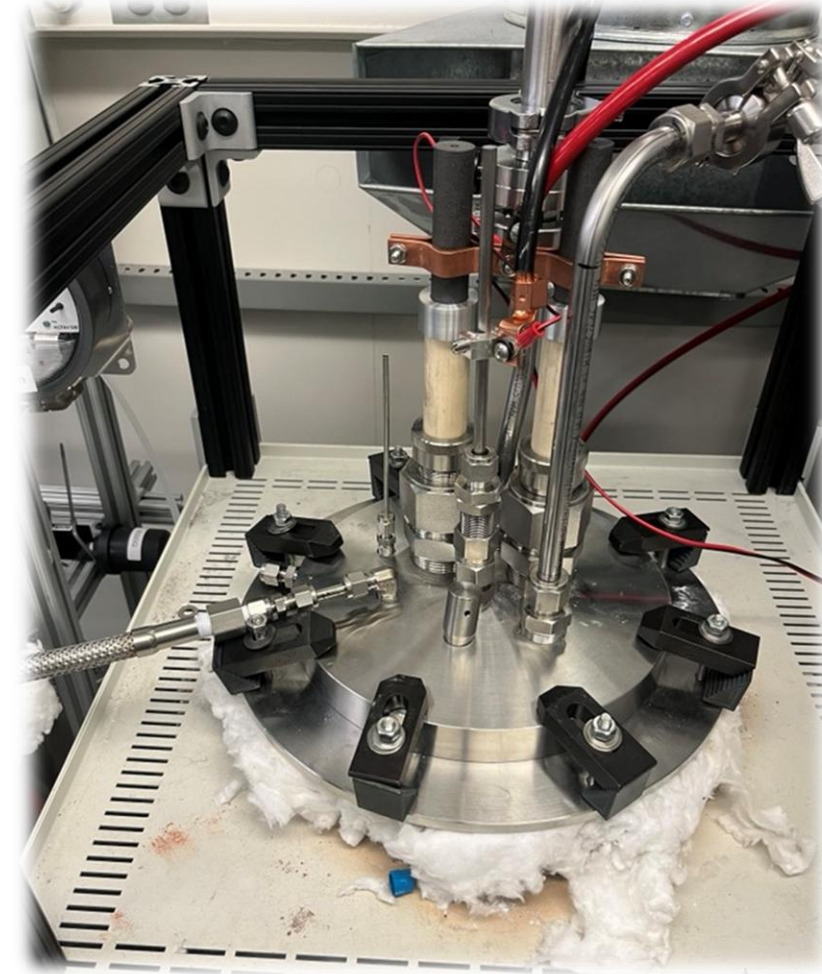
- Validate various feedstocks (oxides and salts)
- Test conventional and unconventional feedstocks

Existing Capabilities:

- 60 ampere electrowinning cell with extensive instrumentation, ~100 grams/hr Nd metal
- ICP OES for analysis of rare earth samples with auto titration and auto sampling
- FTIR for analysis of anode gas for CO, CO₂ and CF₄

New Capabilities:

- **150 A Cell** for electrorefining swarf in a molten salt
- **500 A Cell** for REM and graphite (65 kg capacity)
- **3000 A Cell** for electrowinning Nd metal (4 kg/hr), auto weight feeder control



3000 A cell for commercially relevant reductions – Feedstock flexibility

Key Features:

- Output of 4 kg/hr
- Advanced process control and data collection
- PC for FTIR operation to measure and monitor CO_2 , CO & CF_4
- Oxygen Sensor (anode gas)



Flagship # 3: Advanced Reductions

What METALLIC Offers

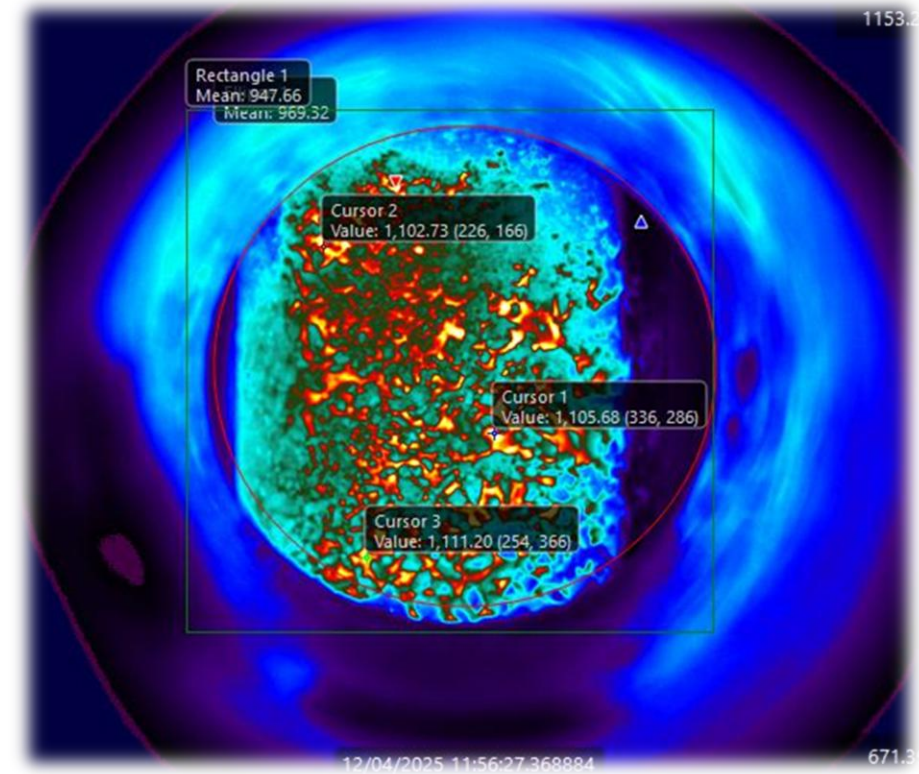
- De-risking advanced technologies like microwave processing
- Testing technologies on wide-range of feedstocks

Existing Capabilities:

5 lab-scale batch and continuous feed type microwave reactors, reaction temperatures up to 1500°C, liquid and gas atmospheric processing (solvent, CO₂, Inert, Air), EM material characterization, reactor modeling capabilities

New Capabilities:

- **Microwave reduction system** with continuous feed
- Over 100 kg/hr feed rates– up to 1000x current capacity
- Ability to change gas environment
- Test various feedstocks at commercially relevant-scales

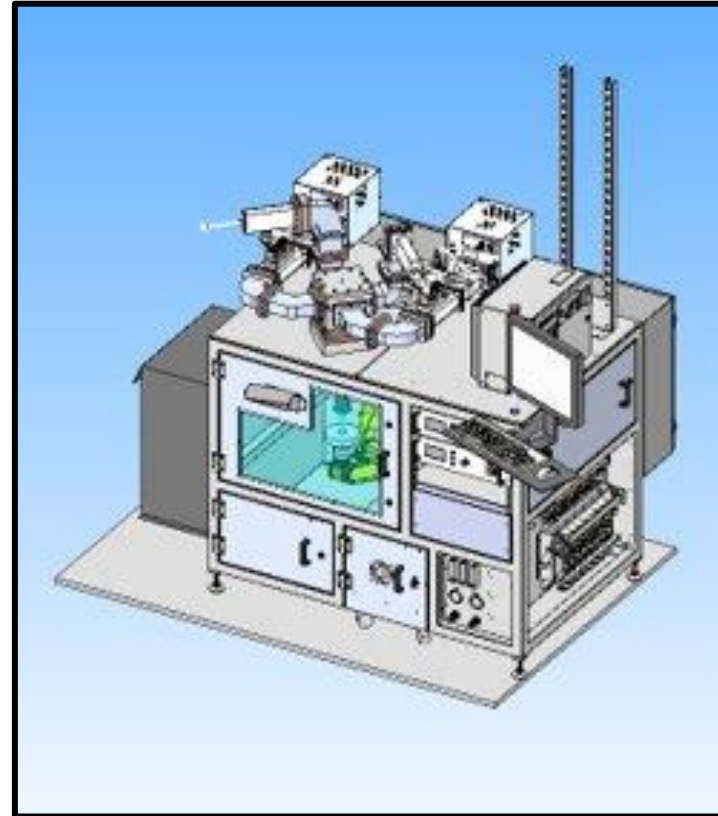


New Advanced Reduction Capabilities Coming Online



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- Flexible, large-scale MW reactor for process optimization
- Continuous feed processing for 10-100 kg/hr
- Coupled with the state-of-the-art characterization equipment, the reactor will bridge the gap from lab-to-commercial scale
- Facilitates optimization of critical mineral recovery, ore reduction, drying, and comminution



New Microwave Capabilities– December 2026

Flagship # 4: Metal Purification

What METALLIC Offers

- Melt column separation of precipitates in Li, Ca, Ga, Ge
- Resonant isotope laser separation/purification for high-value targets: ^6Li , ^7Li , HALEU, ^{28}Si , Ru, Pd
- Vacuum distillation (Ca, Mg, Mn, Dy)

Existing Capabilities:

Inert atmosphere glove box lines with box and vertical tube furnaces, vacuum distillation

New Capabilities:

- **Laser isotope separation test suite** with combination laser and custom spectrometer
- Sample digestions for analytical chemistry



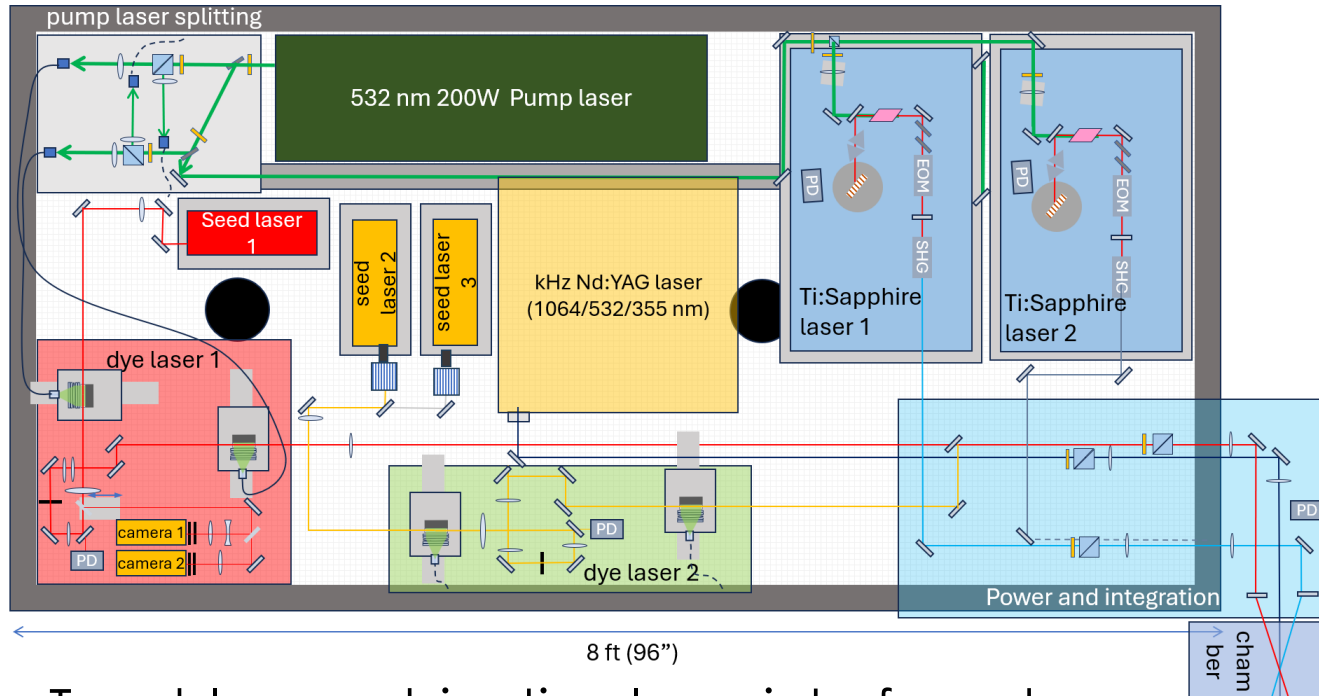
Flagship # 4: Metal Purification



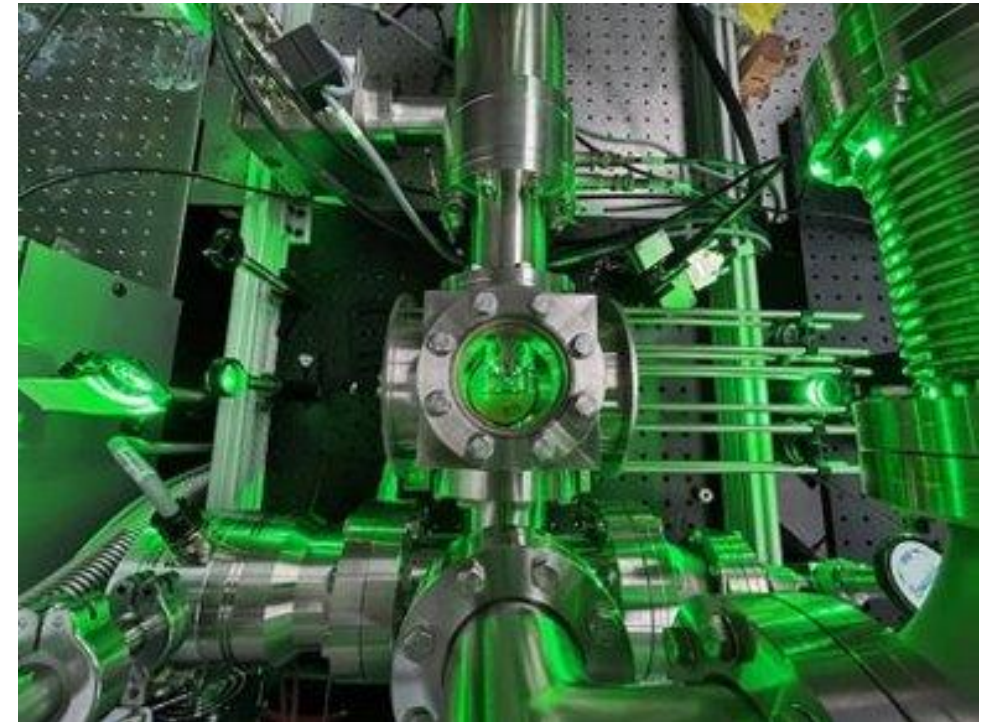
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Advanced processing techniques

Tunable, combination laser for resonant ion separation – June 2026



- Tunable, combination laser interfaced with a custom designed spectrometer
- Selectively ionize and remove impurities or separate high value targets.



SCAR: Spectroscopic Characterization of Atomic Resonances – March 2026

Existing Capabilities and Expertise

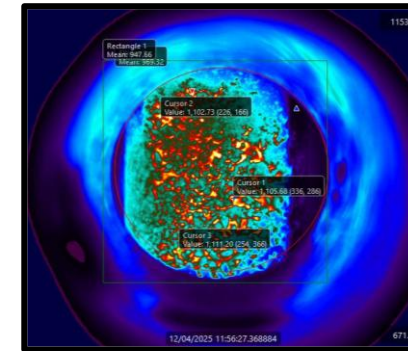
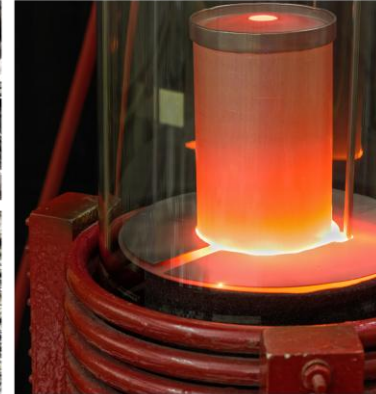


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METALLIC will leverage existing capabilities and expertise across Labs:

- Advanced Magnet Facility (AMF)
- Materials Preparation Center (MPC)
- Advanced Alloy Signature Center (AASC)
- REACT Facility
- Center of Microwave Chemistry
- Carbon Materials Manufacturing Facility (CaMMF) for graphite
- Materials Engineering Research Facility (MERF)

**Existing capabilities not funded by METALLIC*



Expertise and capabilities to work with industrial partners on mid-scale refining

Working with the Refinery Flagships

Work Pyrometallurgical can support:

- Graphitization
- Rare earth metal making
- Reactive and refractory materials
- Battery and magnet feedstocks
- Platinum group metals

Scale: 1-50 kg

Work Adv. Reductions can support:

- Comminution reduction/fracturing
- Drying
- Roasting
- Reductions
- High temperature/rapid heating

Scale: 10-100+ kg/hr

Work Electrochemical can support:

- Test various feedstocks (oxides and salts)
- Commercially relevant (kgs/hr) molten salt electrolysis

Scale: 0.1– 5 kg/hr

Work Metals Purification can support:

- Advanced refinement and isotope separation of high value targets
- UHP alkali metals (Mg, Ca)
- UHP RE metals (Yb, Dy)

Scale: 0.1 – 10 kg

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