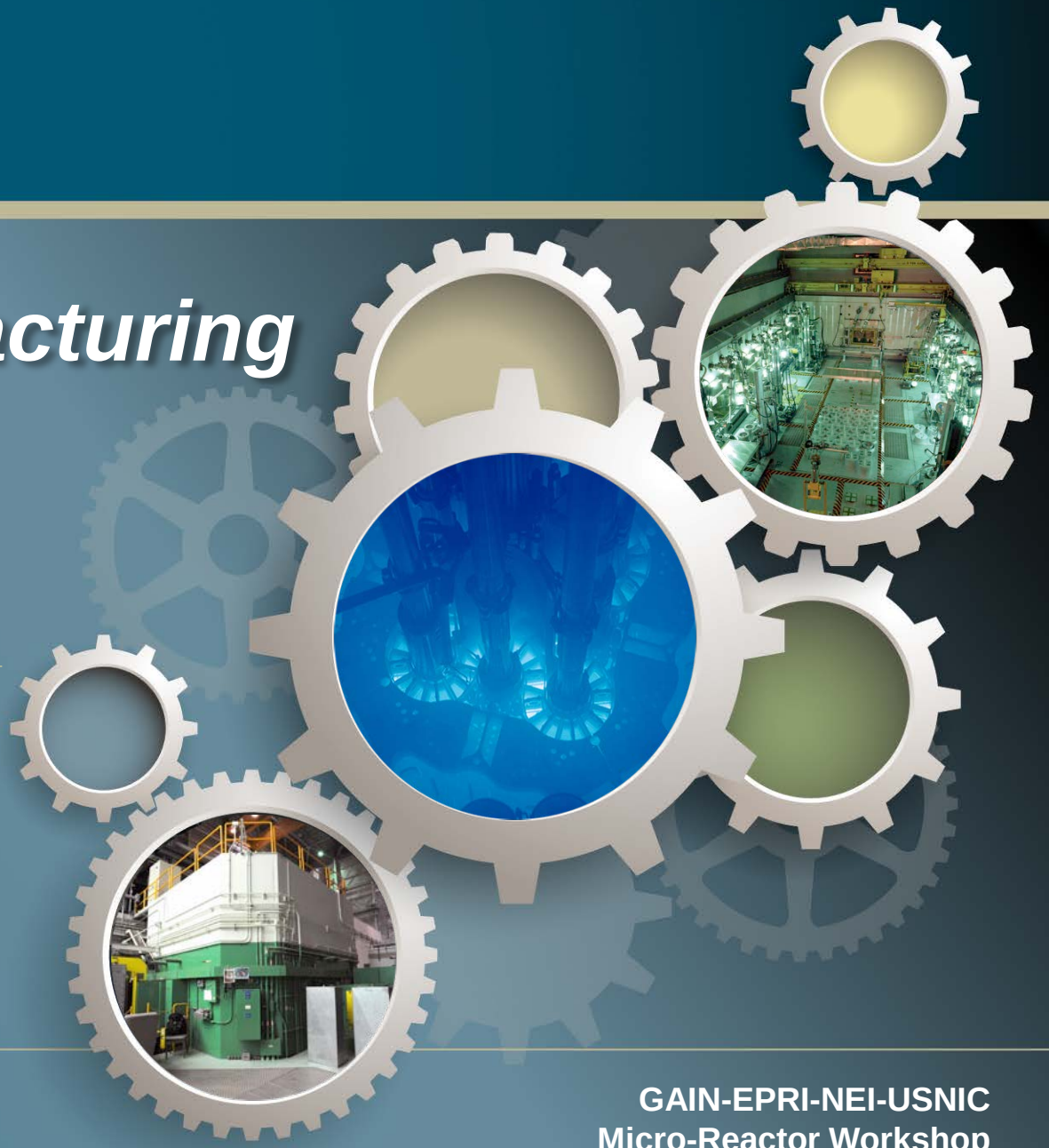
HALEU Fuel Manufacturing



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GAIN-EPRI-NEI-USNIC
Micro-Reactor Workshop
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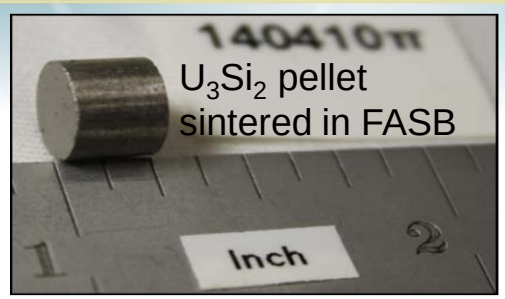
INL Fuel Fabrication

- **Pu and minor actinides**
  - Fuel Manufacturing Facility (FMF)
  - Casting Laboratory (Analytical Laboratory)
- **Uranium**
  - Fuels and Applied Science Building (FASB)
  - Experimental Fuels Facility (EFF)

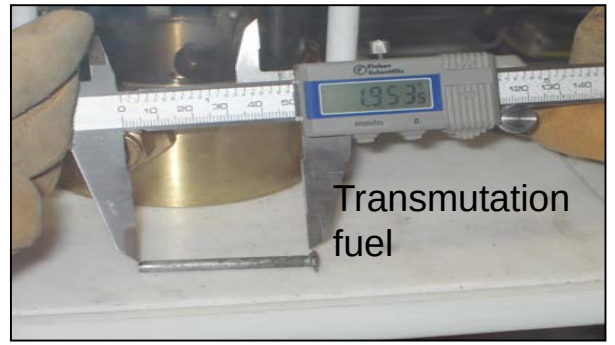
Advanced Fuels Campaign



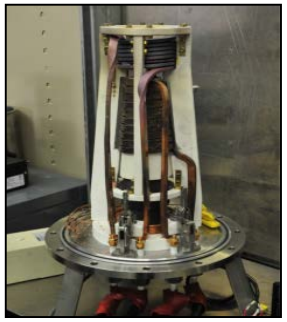
Fabrication development of accident tolerant fuel (U_3Si_2)

TerraPower

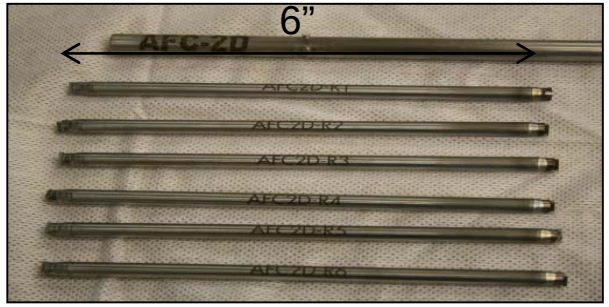
Metallic fuel extrusion line in EFF



Fabrication process development – casting of metal fuel



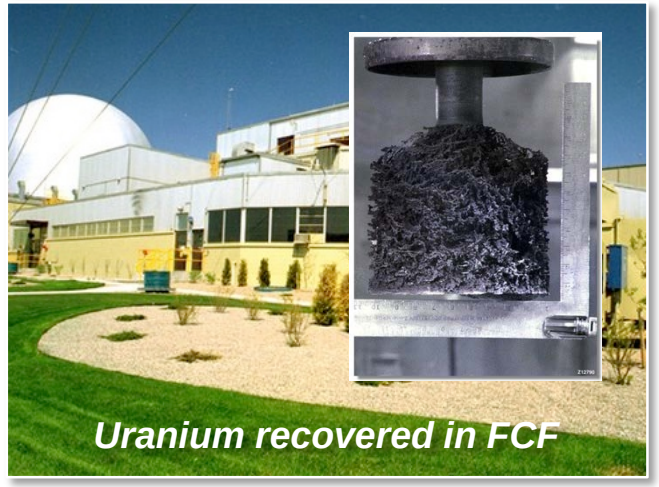
Fuel casting furnace in FASB (U capability in EFF)



Fuel experiment capsule (top) and rodlets ready for irradiation testing

Advanced Nuclear Needs Near-term HALEU Fuel for Demonstration

- **Several new reactor and fuel concepts call for use of high-assay low-enriched uranium (HALEU) fuel (U-235 enrichment from 5% to 20%)**
  - Regulatory approval may be facilitated by demonstration
  - But – no commercial HALEU supply of or capability
  - DOE and INL asked to help provide HALEU fuel
- **Insufficient DOE uranium inventory available for this purpose, so ~10 MT of HALEU from FCF spent fuel treatment to be made available**
- **DOE-funded study at INL-MFC**
  - HALEU recovery using the FCF process
  - Fuel fabrication in INL facility using gloveboxes, rather than in shielded hot cells
  - Consider generically metallic fuel and pellet-type fuel engineering-scale fuel manufacturing campaigns



Green and sintered U_3Si_2 fuel pellets

Facility Options

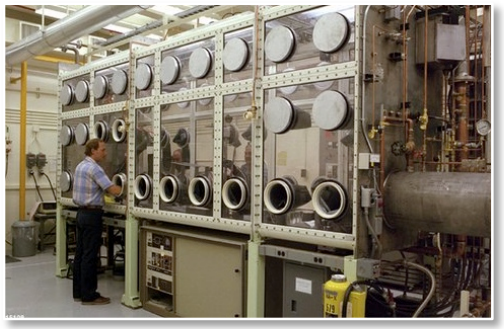
- **Targeting Haz Cat 2 authorization**
- **MFC-798 (RLWTF)**
  - Available in late 2019
  - Need to remove contaminated piping and equipment
- **FCF Mockup Shop Area**
  - Need to first relocate current mission
  - Access restricted by security requirements
- **ZPPR Reactor Cell & Workroom**
  - Available now
  - Limited ventilation capacity and floor space
- **EBR-II Dome**
  - Best used for reactor demo?
  - Need to repair Dome & Shell and install reinforced concrete floor
- **All need HVAC work and other system mods/installs**

For Quickest-possible HALEU Fuel Delivery We Propose

- **DOE fund accelerated FCF treatment rate of EBR-II spent fuel**
  - FCF transitioned from 4x10 operation to 7x12 in April
  - Improved process to reduce radioactive contaminants in product
- **Private sector partners fund**
  - Procurement of glovebox and equipment design, build, testing, and installation
  - INL engineering and quality personnel to be engaged
  - INL preparation of process design and requirements
- **Funding source TBD, INL to execute**
  - Safety design strategy, hazard analysis, safety analysis
  - Preparation of building, including relocating current mission, building mods, HVAC design and installation

U metal recovered during fuel treatment

HALEU metallic ingots



Inert-atmosphere glovebox

Arc-melter for alloy/compound preparation

HALEU Fuel Fabrication – Current Estimates

- **Facility Preparation Cost Estimate: $39M (-10%/+30%)**
  - Facility cleanout: $2M
  - Facility modifications and operational readiness: $19M
  - Equipment: $18M
- **Operations Cost Estimate: $106M (-10%/+30%)**
  - FCF HALEU production (increment to accelerate EBR-II fuel treatment): $35M
  - Fuel fabrication: $71M
- **Schedule:**
  - At 7x12 FCF operation
    - 5 MT HALEU feedstock completed in FCF: Dec. 2023
    - 5 MT fuel fabrication complete: ~ Dec. 2023
  - If FCF accelerated to 7x24 by June 2022, little no improvement
    - Little to no improvement in schedule to 5 MT fuel
    - Would be needed to maintain 1 MT/yr feedstock rate in later years

Open Issues and Concerns for HALEU Fuel Plan

- **DOE decisions are pending and funding availability has been uncertain**
  - Mitigated by
    - Current focus on facility preparation; not mission-specific
    - Initial engineering and contracting supported by available DOE funds
- **Uncertainty in specific designs and fabrication processes to be supported introduce project and schedule risk**
  - Mitigated by
    - Generic approach to fabrication process
    - INL fuel and process expertise anticipating requirements, to some extent
    - Clear communication to private partner regarding risk and uncertainty
- **Private-partner schedule uncertainty**
  - Mitigated by near-term focus on ASAP provision of fabricated fuel
    - Should meet schedule objectives for all inquirers to date, with one exception

INL Idaho National Laboratory