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Changing the World's Energy Future

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Overview

In support of nuclear safeguards and nonproliferation, this effort is leveraging acoustic and seismic sensors to advance detection of pyroprocessing activities. Pyroprocessing, or electrochemical processing, is a method of separating irradiated nuclear fuel into its actinide and fission product components, enabling the reuse of fuel materials and reducing the radiotoxicity of the remaining waste. Verification and accountability in the process poses several challenges because of the high radiation environment and the presence of material holdup through the facility. Irregular or unaccounted-for equipment operation can signify diversion or misuse of critical materials. Acoustic and seismic sensors offer the capability to identify periods of equipment operation and help verify adherence to accountancy records.

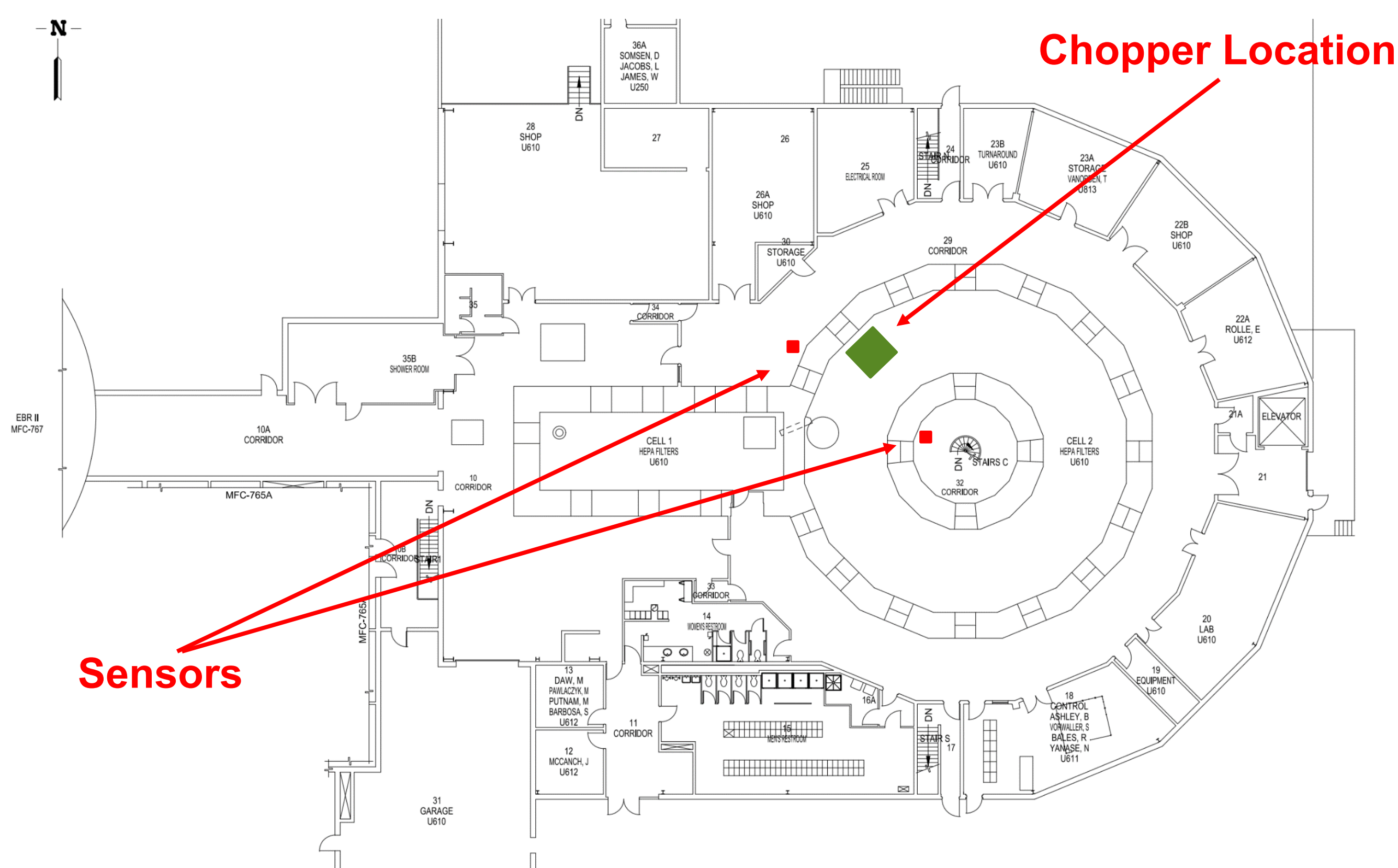
This research was funded through a Laboratory Directed Research and Development project under Battelle Energy Alliance, LLC contract number DE-AC07-05ID14517.

Treatment of Used EBR-II Fuel

In accordance with the Idaho Settlement Agreement, Idaho National Laboratory (INL) must manage, treat, and remove spent nuclear fuel stored at the laboratory to protect public health and the environment. To adhere to that agreement, INL is processing fuel used during operation of the Experimental Breeder Reactor II. The process recovers high-assay low-enriched uranium (HALEU) metal from spent nuclear fuel.

Pyroprocessing at the Fuel Conditioning Facility

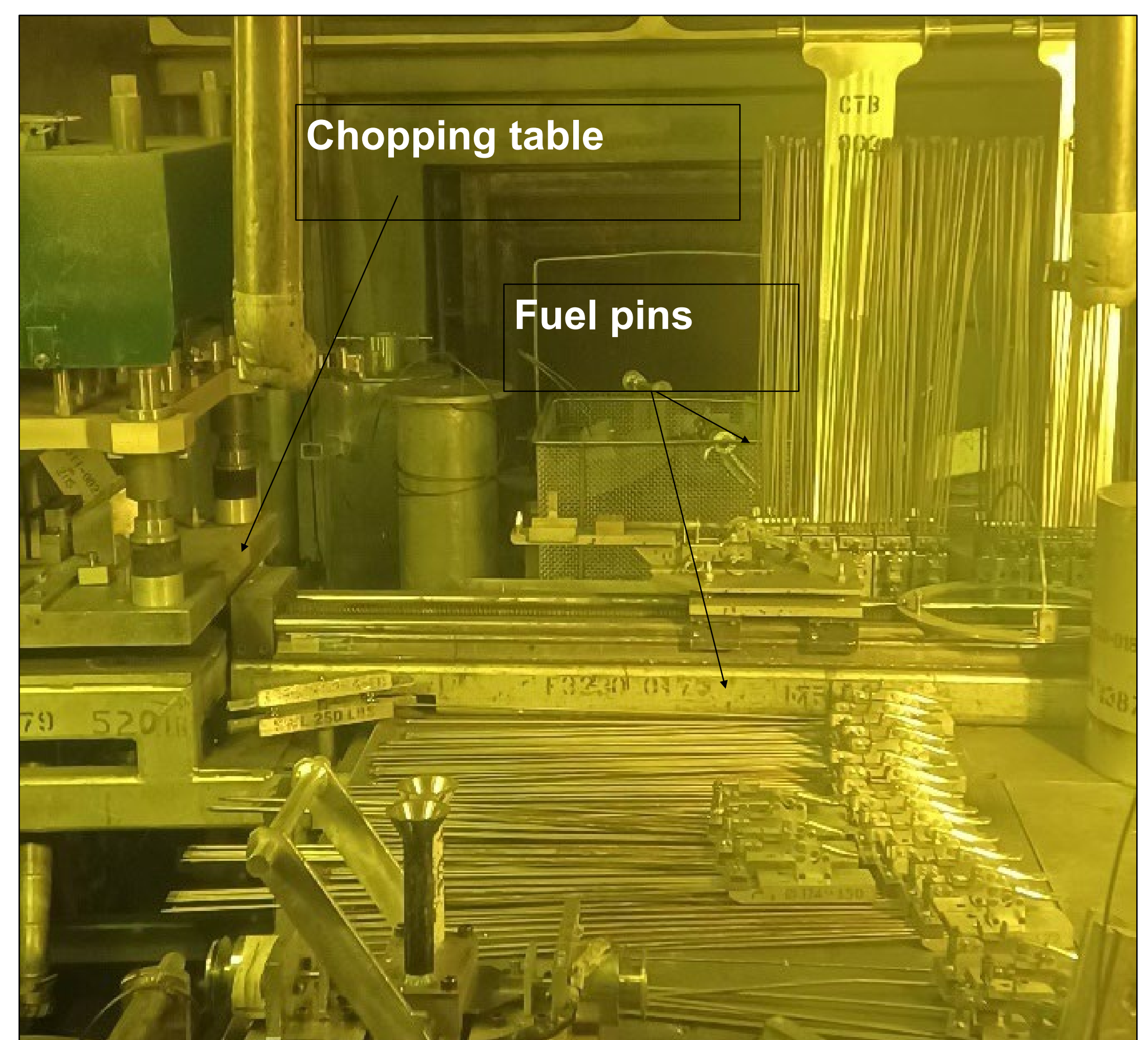
The primary mission of the Fuel Conditioning Facility (FCF) is to treat Department of Energy-owned sodium-bonded metal fuel. The facility houses a hot cell that includes pyroprocessing equipment such as an element chopper and an electrefiner. The hot cell has a circular shape with 5-foot-thick shielding walls.



Floor plan for the Fuel Conditioning Facility showing the circular shape of one of the hot cells, the position of the chopper inside the hot cell, and the position of the seismoacoustic sensors.

Element Chopper

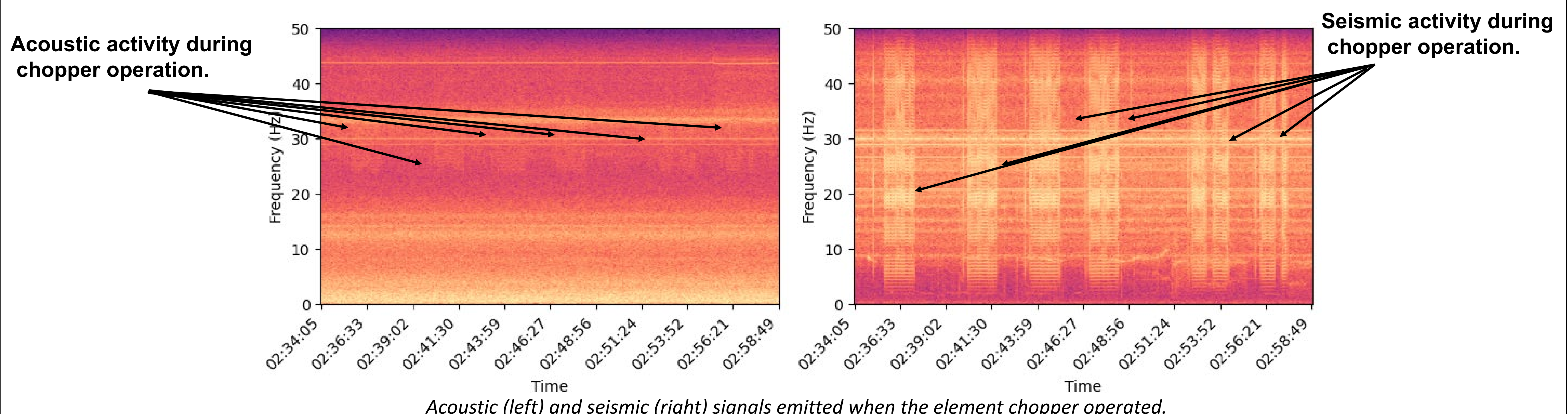
The element chopper cuts fuel into segments for processing in the electrorefiner. An assembly holds the fuel pins and continuously feeds them into the chopper.



Fuel pins arranged next to the element chopper, photographed through the window of the hot cell.

Acoustic & Seismic Monitoring

The initial research focused on monitoring for acoustic and seismic activity emitted during operation of the element chopper. Two Raspberry Shake and Boom sensors were placed inside the facility and outside of the circular hot cell. The sensors collected data during equipment operations. Both the seismic and acoustic signals were analyzed against operation logs. Signals were attributed to the chopper if they consistently lined up with equipment operation times reported in the logs. Raw waveforms, spectrograms, and power spectral density plots were generated and compared for all signals during each point of interest determined by the chopper logs. Results showed that seismic spectrograms gave the clearest indication of chopping events.



Acoustic (left) and seismic (right) signals emitted when the element chopper operated.