NEXT

A university molten salt research reactor

Dr. Jonathan Scherr jbs19b@acu.edu

Conceptual Design Lead MSRR, Abilene Christian University

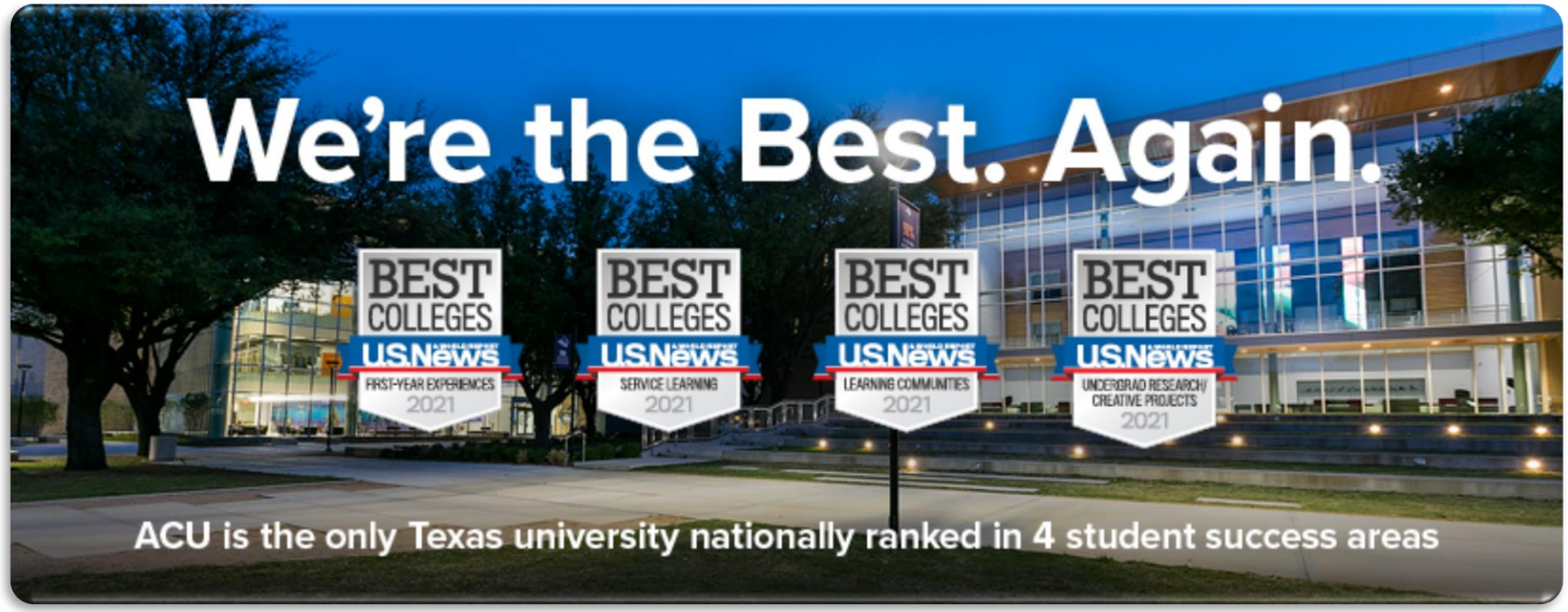
October 29, 2020

ABILENE CHRISTIAN UNIVERSITY

Abilene Christian University

NEXT
Nuclear Energy eXperimental Testing

- Main Campus in Abilene, Texas - population 123,000
- Fall 2020 marks the third consecutive year for a record number of students enrolling at ACU - 5,293 students.
  - Main campus is in Abilene Texas - 3,675 students
  - ACU Dallas - 1,618 students

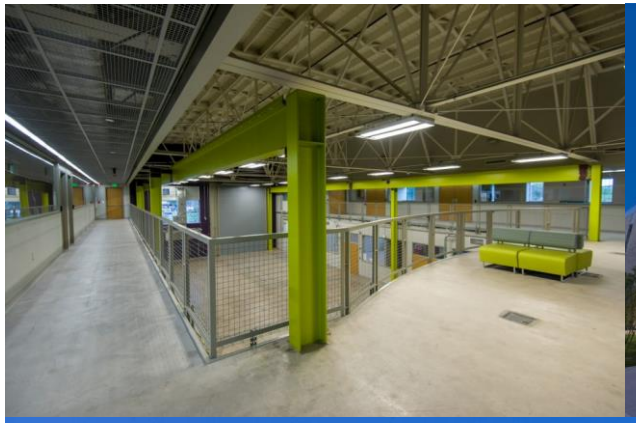


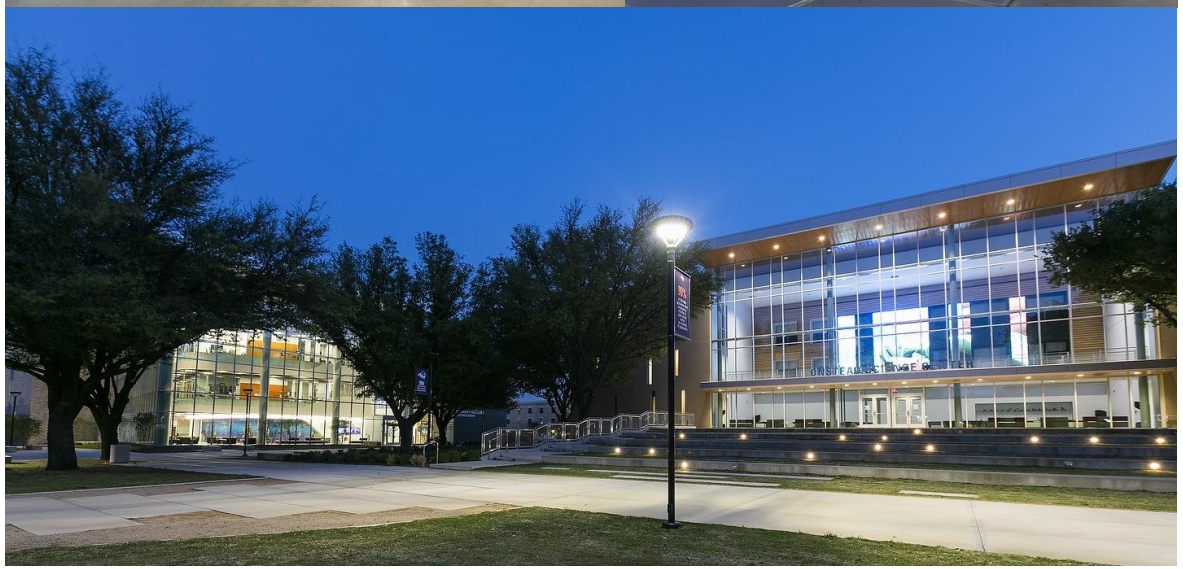
ACU

ACU Commitment to Research

NEXT
Nuclear Energy eXperimental Testing

- Physics program started in 1969 focused on research
- ABET accredited engineering program started in 2012
  - 19 faculty, 174 undergraduate students
- $50M+ invested in science and engineering infrastructure
- Hired Vice President of Research to incentivize research and technology invention, and corporate engagement activities
- Planning a new $15M Science and Engineering Research facility
- Administrative and financial support of NEXT Lab vision





ACU

ACU History of Research

NEXT
Nuclear Energy eXperimental Testing

- 60 years of continuously funded research through the Robert A. Welch Foundation, NIH, the Petroleum Research Fund, and others.
- 40 years of continuous DOE funded nuclear research
- ACU research successes
  - Old Model
    Take students to world-class facilities
  - New model
    Bring world-class facilities to ACU
    Bring the world to ACU

U.S. DEPARTMENT OF ENERGY

VTR VERSATILE TEST REACTOR

NSF

NIH

GAIN Gateway for Accelerated Innovation in Nuclear

INL Idaho National Laboratory 70 YEARS OF SCIENCE & INNOVATION

Fermilab

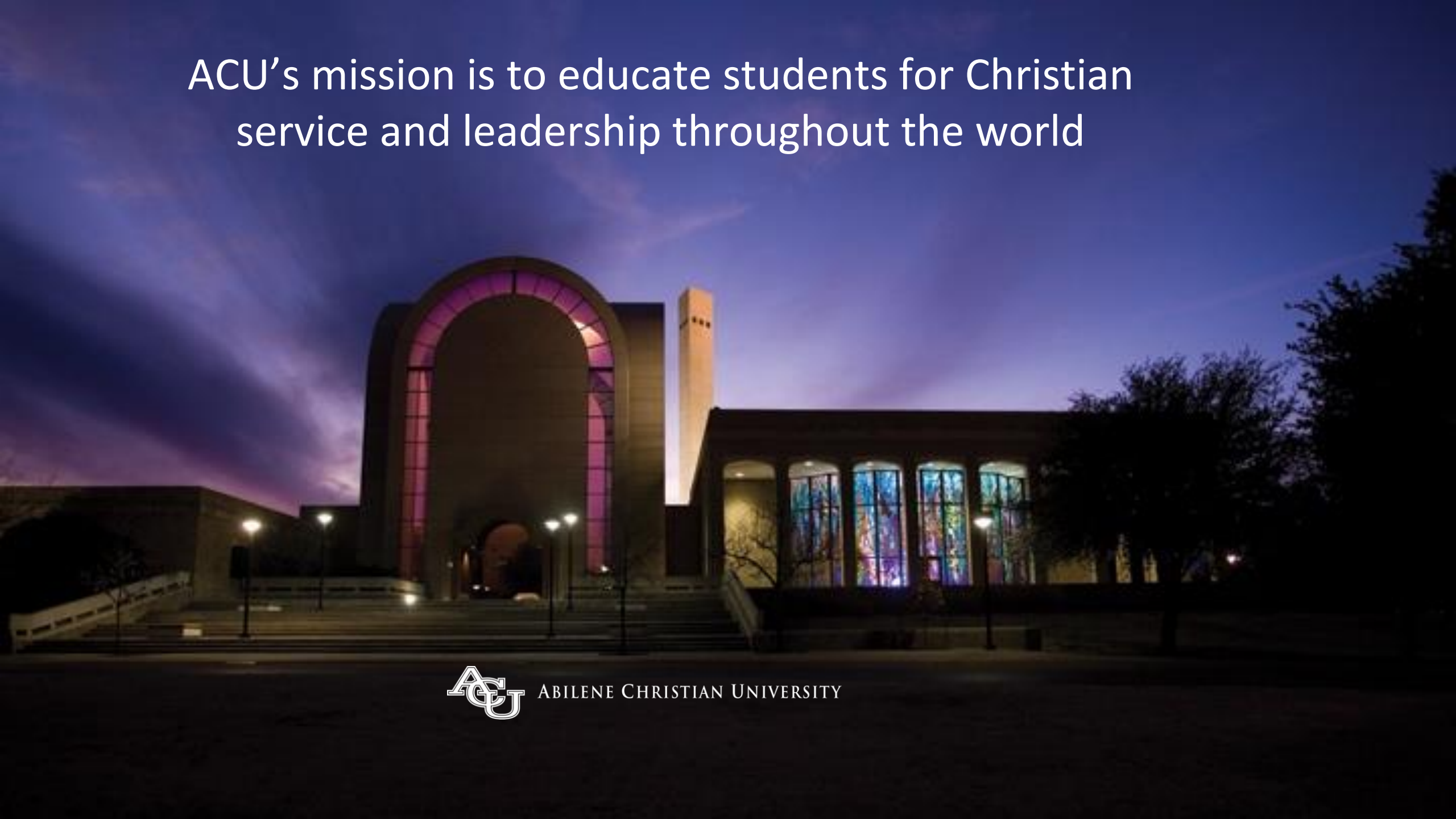
Los Alamos NATIONAL LABORATORY EST. 1943

BROOKHAVEN NATIONAL LABORATORY

Lawrence Livermore National Laboratory

ACU

ACU's mission is to educate students for Christian service and leadership throughout the world



Nuclear Energy eXperimental Testing Lab

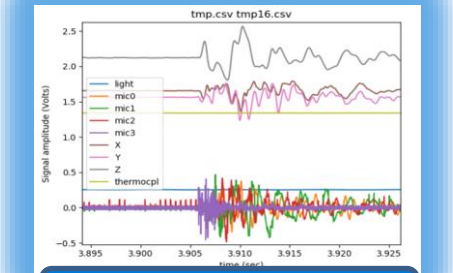
Finding global solutions to the world's critical needs

NEXT Lab Research Projects

NEXT
Nuclear Energy eXperimental Testing

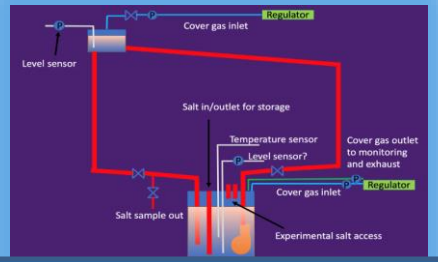
Molten Salt Test Loop

Fission Fragment Removal



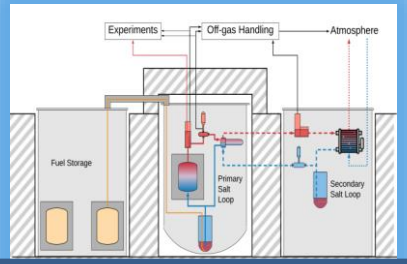
Instrumentation

Data Acquisition

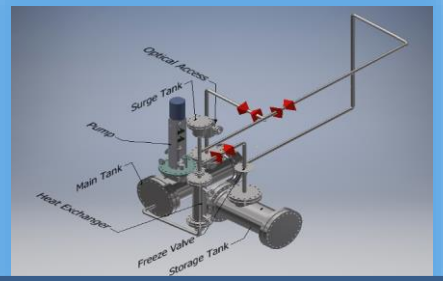


Fluoride Molten Salt Test Loop

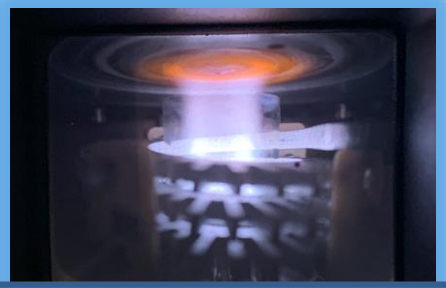
Salt Purification System



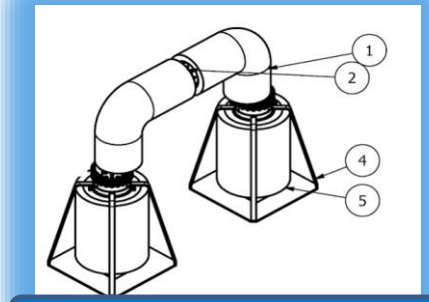
Molten Salt Research Reactor



Molten Salt Test System



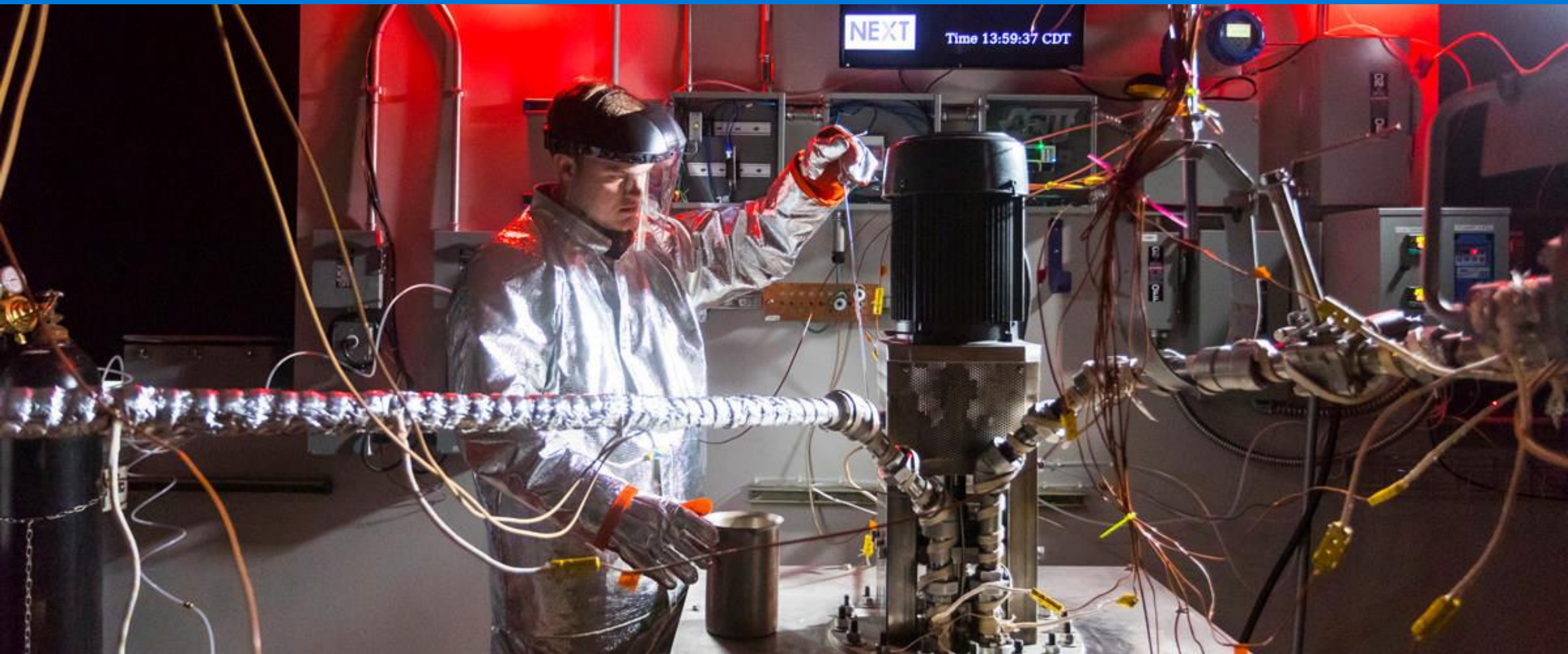
Chemical Analysis System



Molten Salt Filters

The NEXT Lab mission is to provide global solutions to the world's need for:

- energy that is less expensive and safer
- water that is pure and abundant
- medical isotopes to diagnose and treat cancer



NEXT Research Alliance

NEXT
perimental Testing

Georgia Tech

NATURA RESOURCES ∘ ABILENE CHRISTIAN UNIVERSITY ∘ GEORGIA TECH ∘ TEXAS A&M UNIVERSITY ∘ UNIVERSITY OF TEXAS ∘
NEXTRA
From Doubt to Astonishment
- Galilieo

TEXAS A&M UNIVERSITY

TEXAS
The University of Texas at Austin

ACU ABILENE CHRISTIAN UNIVERSITY

MSRR in the news

- Screen capture from www.ans.org/news/article-458/four-universities-team-up-to-design-molten-salt-research-reactor/

- We have also given talks at various conferences and workshops

Four universities team up to design molten salt research reactor

August 21, 2020, 12:11PM | Nuclear News Staff

Nuclear News | Research & Applications

Undergraduate students work on the molten salt test loop at Abilene Christian University's NEXT Lab. Photo: Jeremy Enlow/Steel Shutter Photography

Abilene Christian University (ACU) is leading a consortium called NEXTRA—the Nuclear Energy eXperimental Testing Research Alliance—with the Georgia Institute of Technology, Texas A&M University, and the University of Texas at Austin. NEXTRA was formed in spring 2019 to design, license, and commission a molten salt–fueled research reactor to be hosted on ACU's campus in the central Texas city of Abilene. ACU and its partners recently announced funding of $30.5 million over the next three years from Abilene-based Natura Resources.

Focus on ACU: ACU's Nuclear Energy eXperimental Testing Laboratory, or NEXT Lab, is leading the project, and ACU is set to receive the lion's share of the funding, at $21.5 million.

MSRR Schedule

ACU submittals will be separate Construction Permit (CP) and Operating License (OL) applications.

Operational activities are subject to other NRC regulations which will be incorporated into the Part 50 license for the facility:

- 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material," license to receive, possess, and use special nuclear material
  - Receiving LEU from U.S. Department of Energy (DOE) Research Reactor Infrastructure program (have received letter of support from DOE-NE)
- 10 CFR Part 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material," license to receive, possess and use byproduct material produced by operation of the reactor and from other licensees

ACU Science & Engineering Research Center

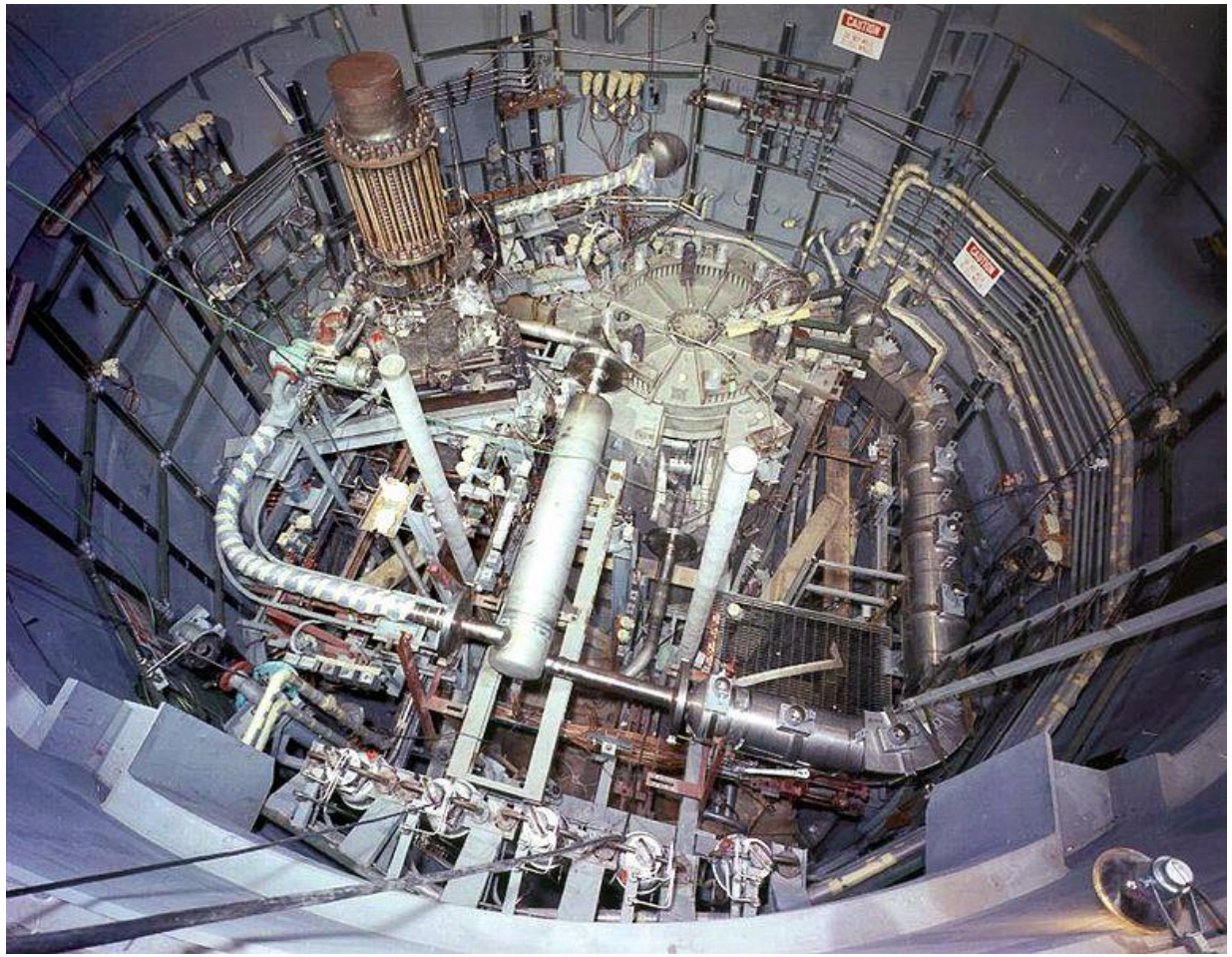
NEXT
Nuclear Energy eXperimental Testing

This research and education facility includes:

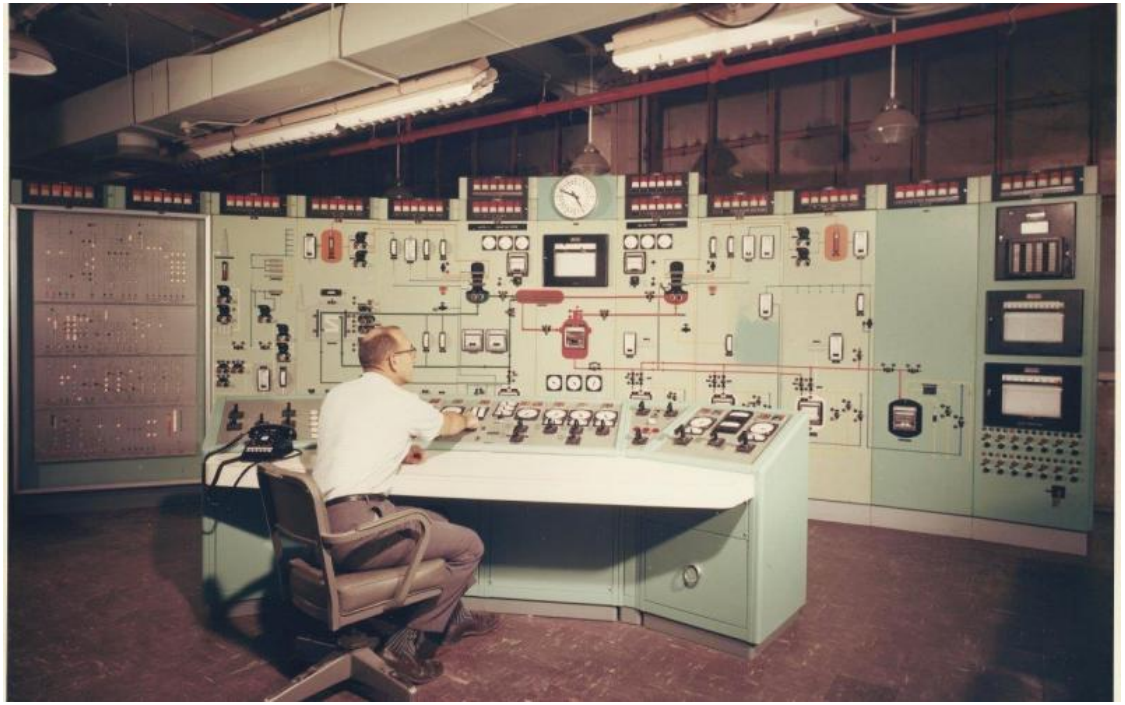
- radiochemistry labs
- molten salt systems labs
- instrumentation lab
- flexible research bay
- office space
- training room.

MSRR is based on the MSRE

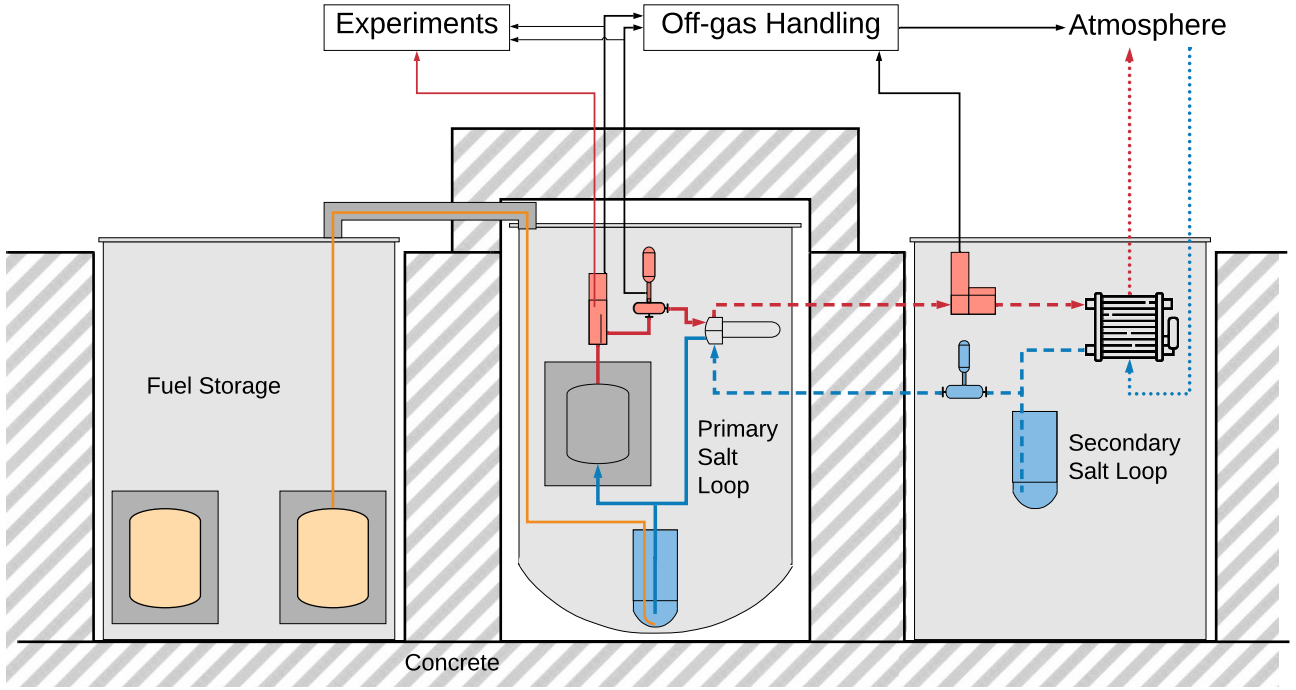
NEXT
Nuclear Energy eXperimental Testing



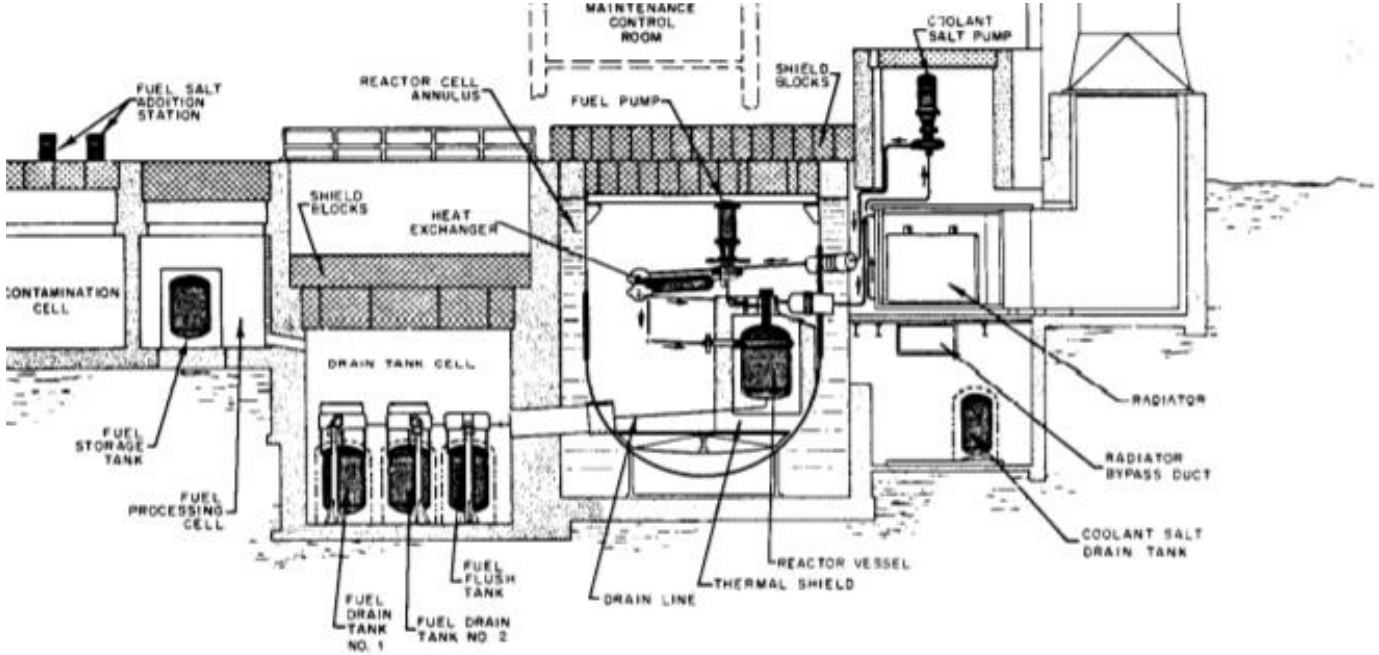
MSRR design and licensing will leverage experience gained with the MSRE
There are some key differences between the two systems



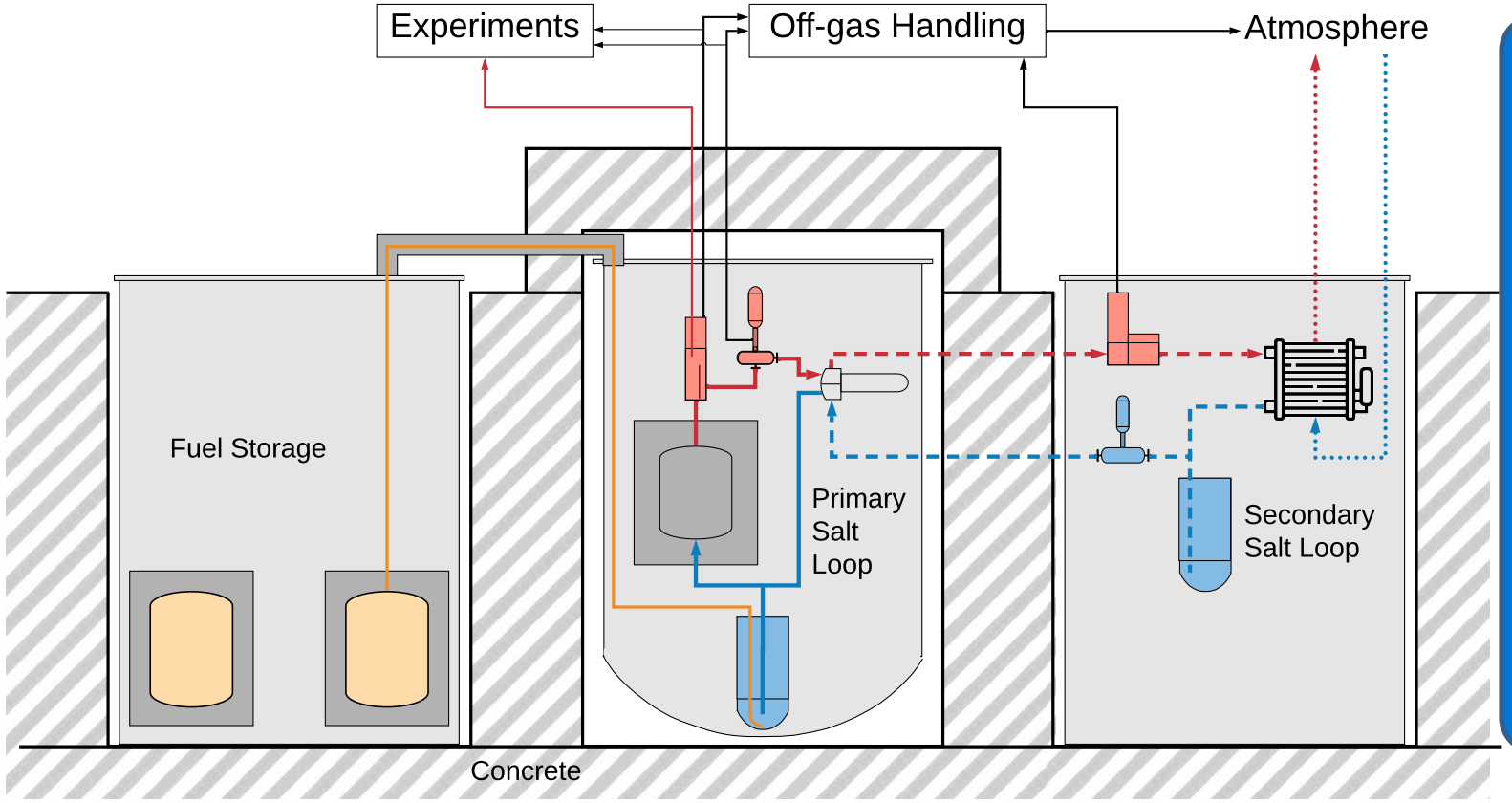
MSRR


Experiments
Off-gas Handling
Atmosphere
Fuel Storage
Primary
Salt
Loop
Secondary
Salt Loop
Concrete

MSRE


MAINTENANCE CONTROL ROOM
COOLANT SALT PUMP
FUEL SALT ADDITION STATION
REACTOR CELL ANNULUS
FUEL PUMP
SHIELD BLOCKS
SHIELD BLOCKS
HEAT EXCHANGER
CONTAMINATION CELL
DRAIN TANK CELL
RADIATOR
FUEL STORAGE TANK
FUEL PROCESSING CELL
RADIATOR BYPASS DUCT
COOLANT SALT DRAIN TANK
REACTOR VESSEL
THERMAL SHIELD
DRAIN LINE
FUEL FLUSH TANK
FUEL DRAIN TANK NO. 1
FUEL DRAIN TANK NO. 2

Overview of Conceptual Design



Reactor Parameters:

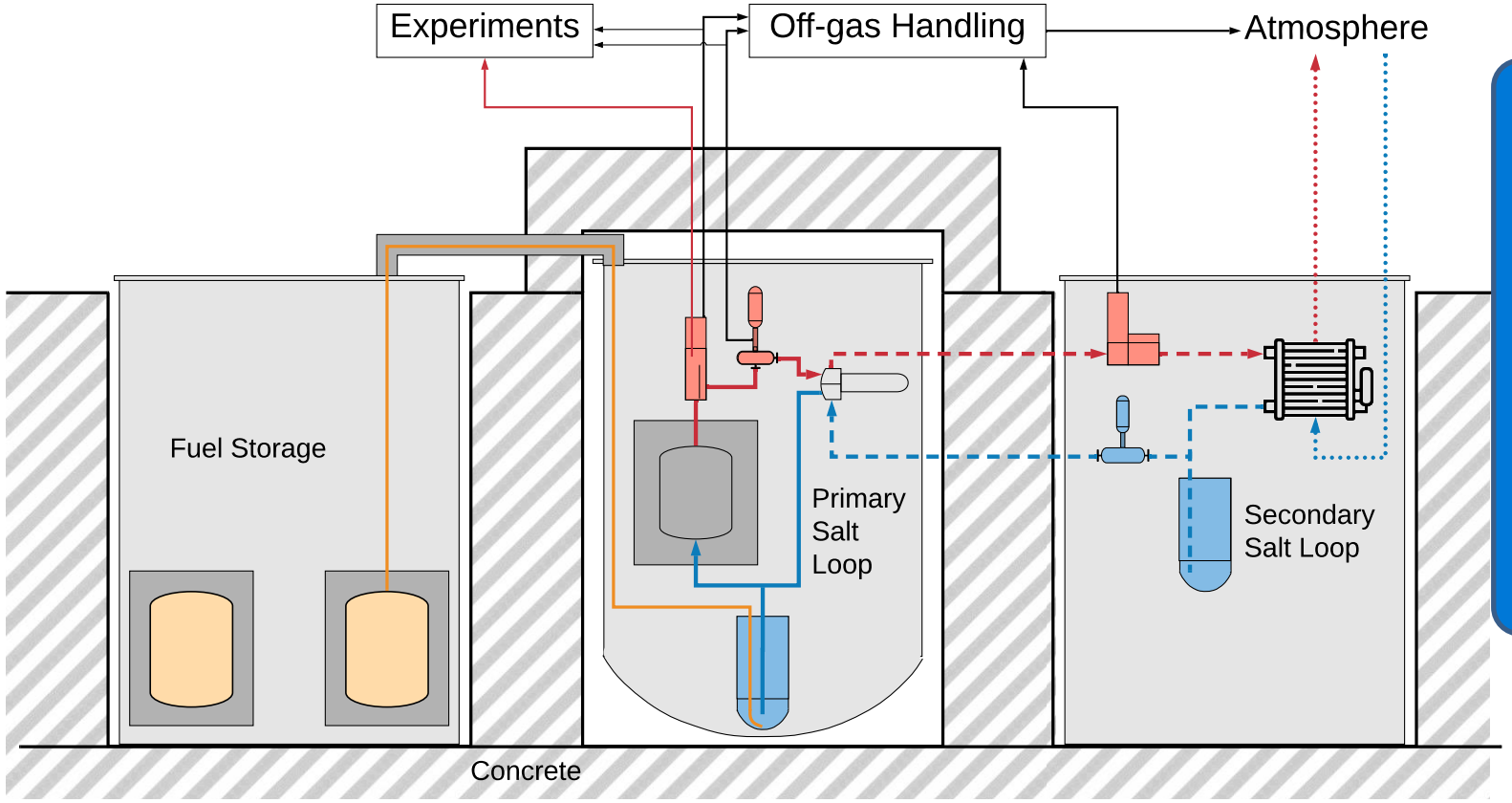
The MSRR design will employ

- Lower power
- Lower power density
- Lower pressure drop

Size:

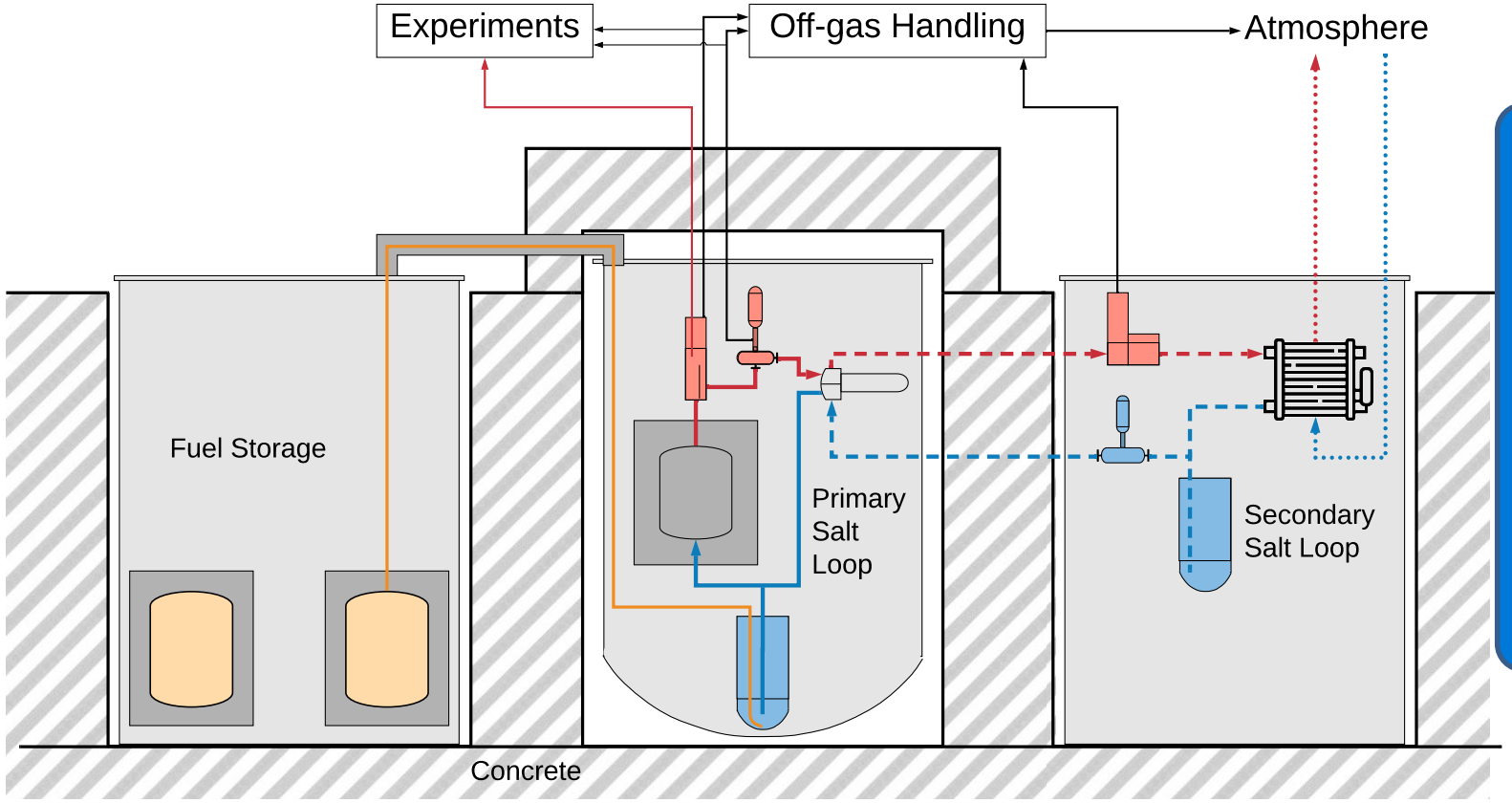
- 1 MW_{th}
- Reactor vessel is 6 feet tall and 4.5 feet in diameter

MSRR is a Loop-type Design



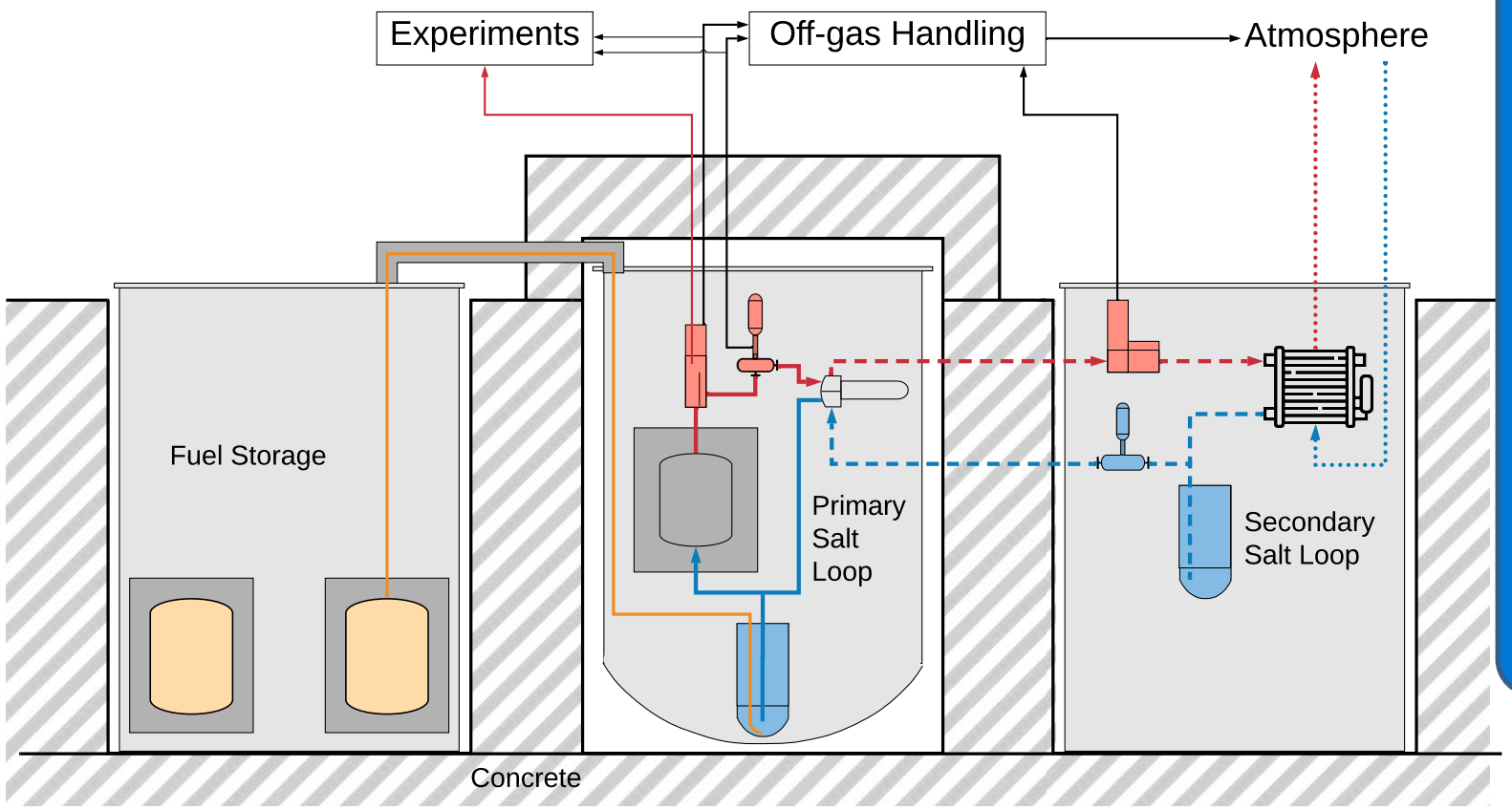
- The MSRR will have forced primary flow for full power operations.
- A secondary loop will be used to remove the reactor thermal power.
- The ultimate heat sink will be air.

Fuel Characteristics



- $LiF\text{-}BeF_2\text{-}UF_4$ is the anticipated fuel
- HALEU (~19.5%) will be used.
- Lithium enrichment greater than 99.99%.

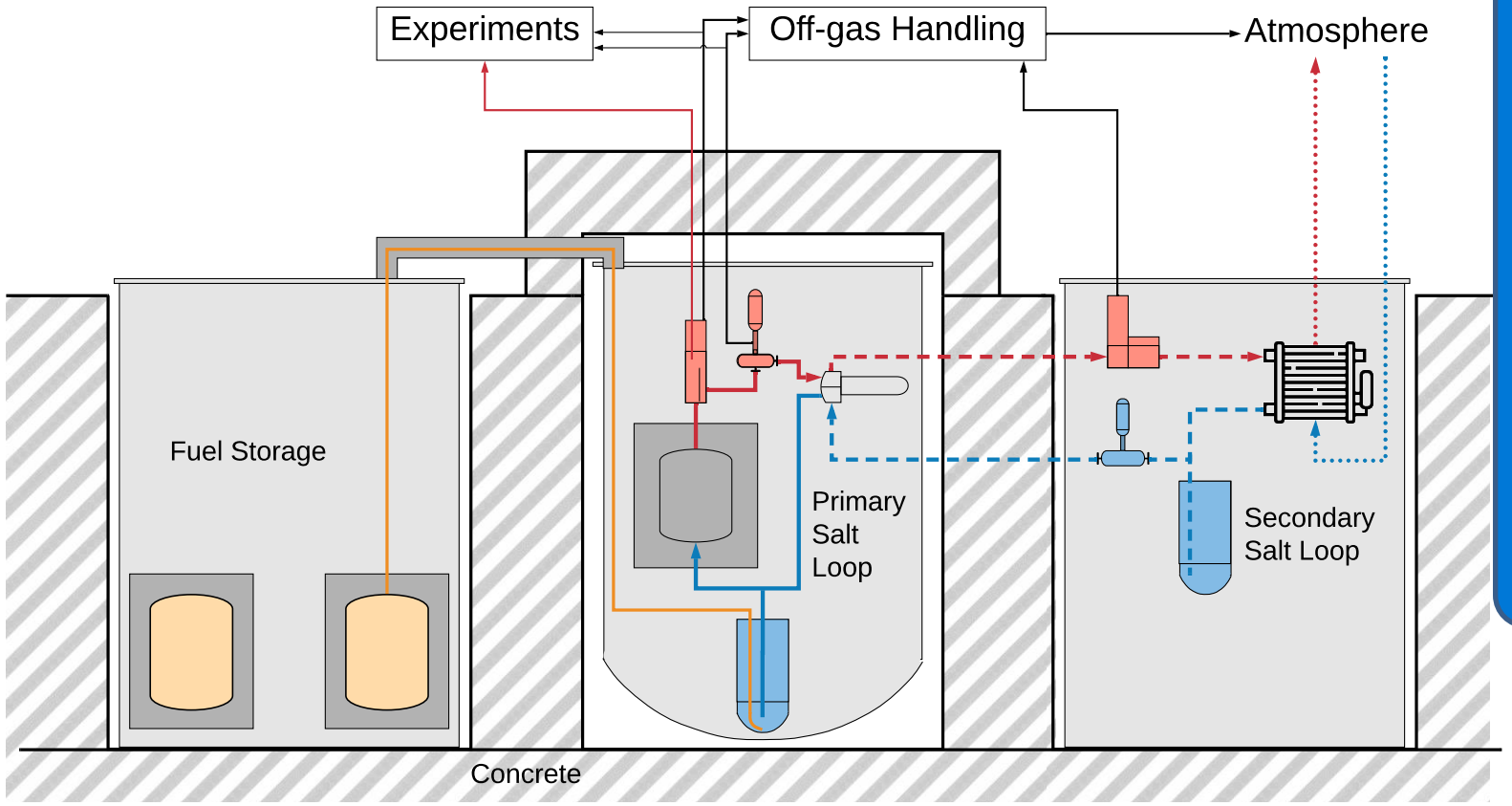
Fuel Handling System (FHS)



- The MSRR design employs Defense-In-Depth (DID) approach. The FHS will be designed with multiple physical barriers.
- The fuel handling system is connected to the reactor subsystem through the drain tank.
- Because the FHS is a supporting auxiliary system located external to the MSRR reactor containment vessel, the FHS will need its own suitably designed containment.

Heat Removal and Experimental Planning

NEXT
Nuclear Energy eXperimental Testing



- Outer wall of containment vessel is actively cooled with air.
- Cooling during an accident or power outage will be completely passive.
- We are planning a wide variety of experimental systems

Thank you for your time

jbs19b@acu.edu

acunextlab.org

ABILENE CHRISTIAN UNIVERSITY

NATURA RESOURCES ◦ ABILENE CHRISTIAN UNIVERSITY ◦ GEORGIA TECH ◦ TEXAS A&M UNIVERSITY ◦ UNIVERSITY OF TEXAS

NEXTRA

From Doubt to Astonishment
- Galilieo

Natura Resources SUSTAINABLE ENERGY

Develop Abilene
Development Corporation of Abilene

Excelsior

U.S. DEPARTMENT OF ENERGY