

# Welcome!

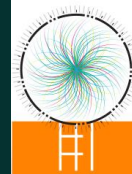
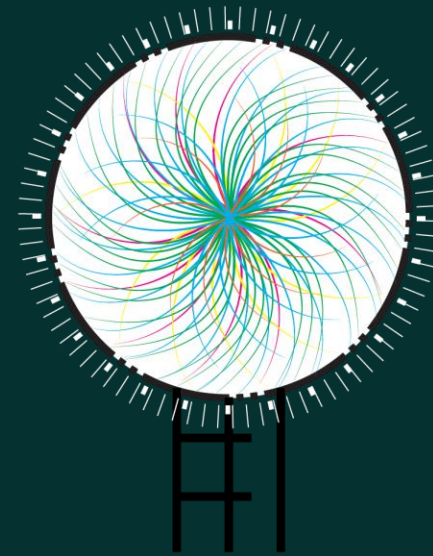
## Vertex 2025!

Marcel Demarteau  
Physics Division

[demarteau@ornl.gov](mailto:demarteau@ornl.gov)

August 25, 2025

ORNL is managed by UT-Battelle, LLC for the US Department of Energy



25<sup>th</sup> – 29<sup>th</sup> August

# VERTEX25

The 33<sup>rd</sup> International Workshop on Vertex Detectors



U.S. DEPARTMENT OF  
**ENERGY**

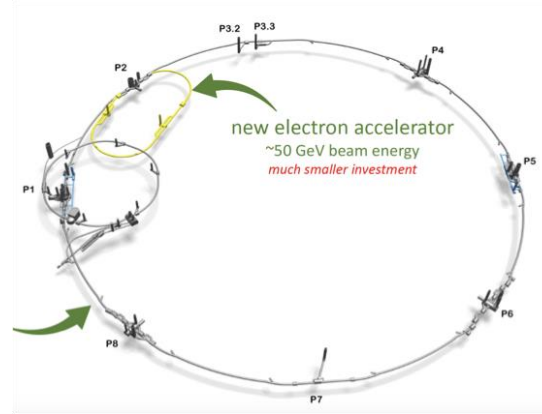
# A Bright and Challenging Future



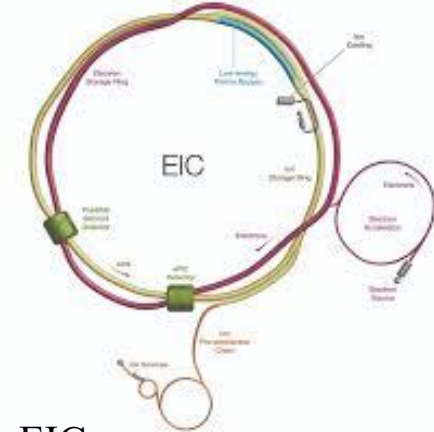
FCC-ee



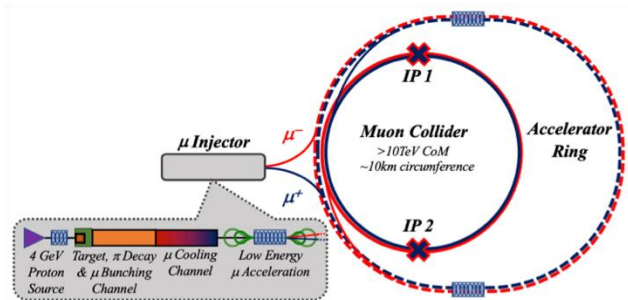
LEP-3



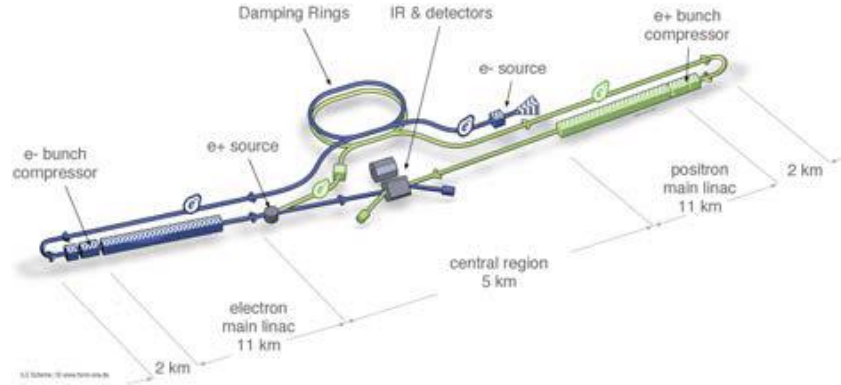
LHeC



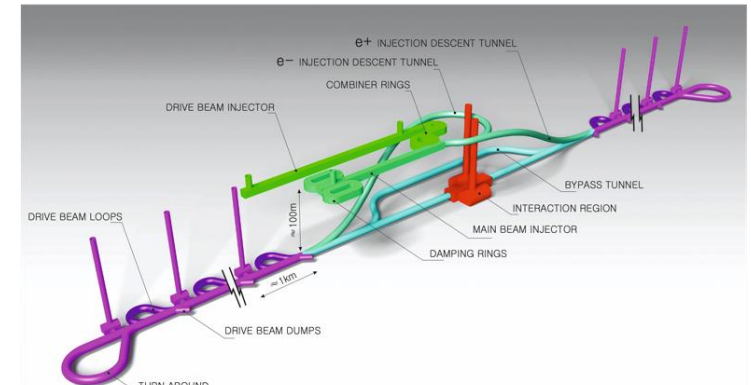
EIC



MuC

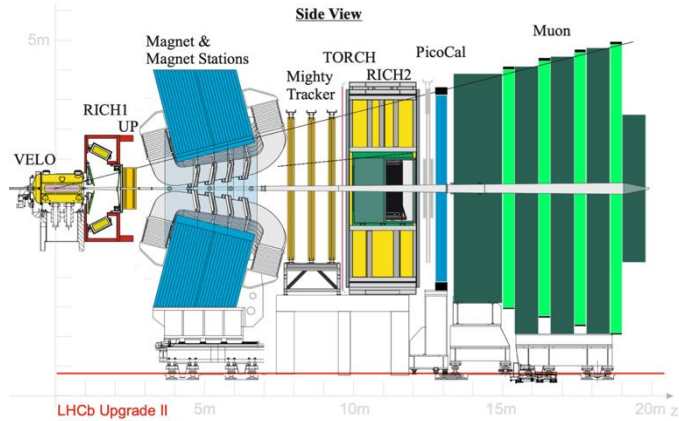


ILC

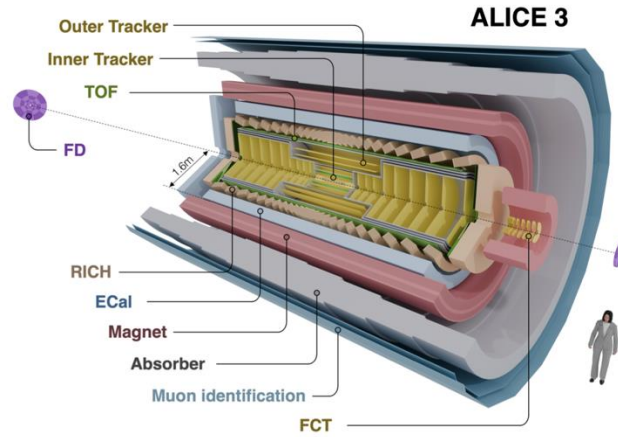


CLIC

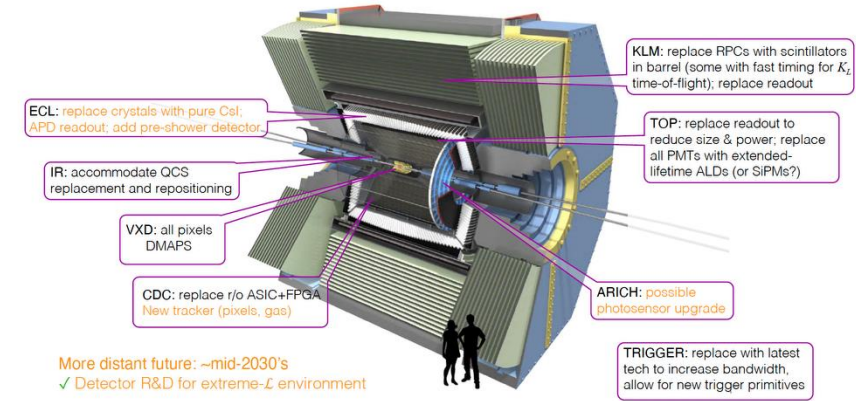
# A Bright and Challenging Future



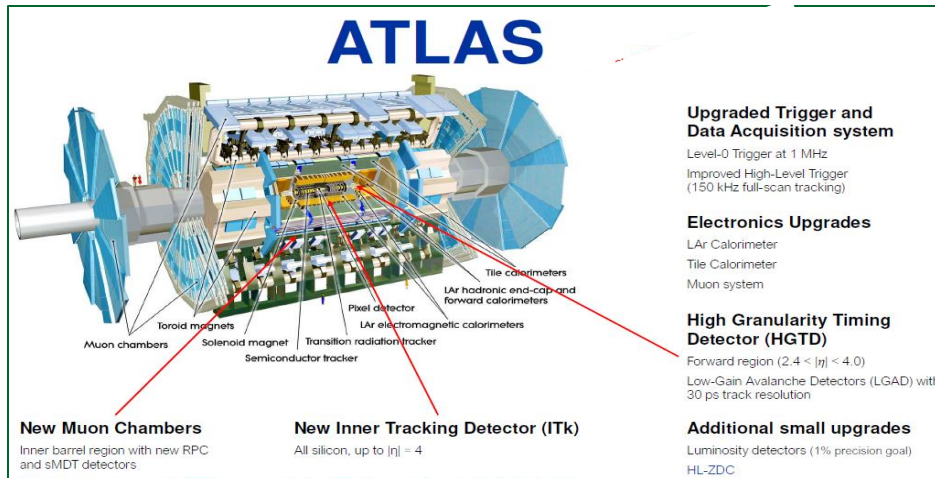
LHCb Upgrade



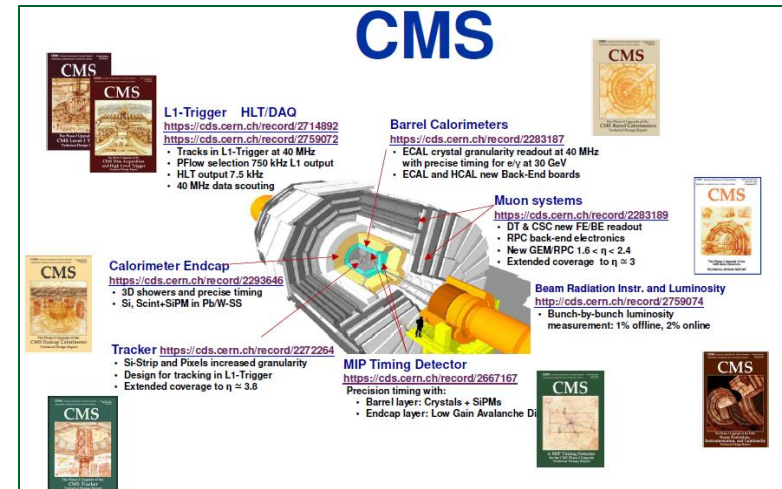
ALICE Upgrade and ITS3



Belle-II Upgrade

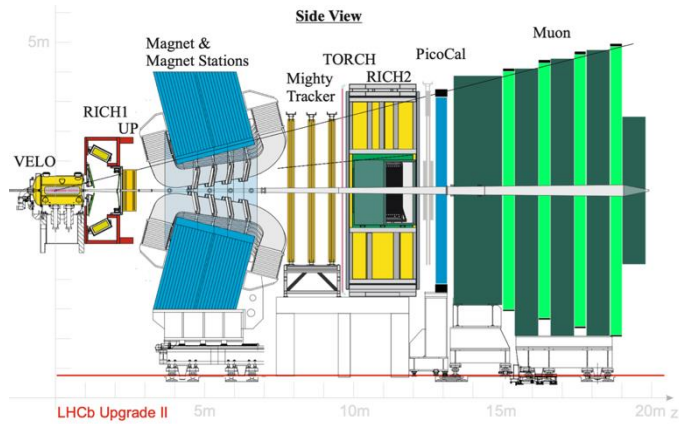


Phase-II ATLAS Upgrade

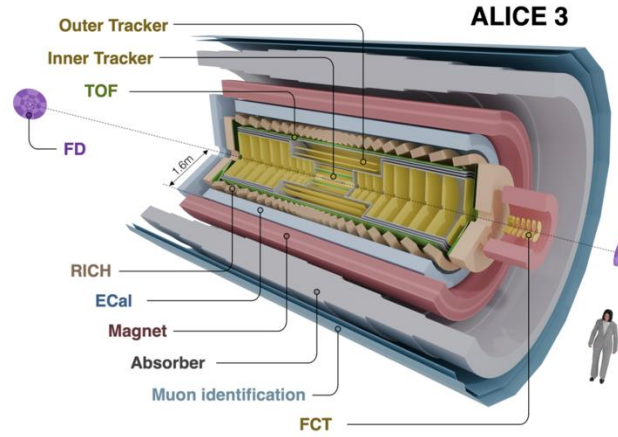


Phase-II CMS Upgrade

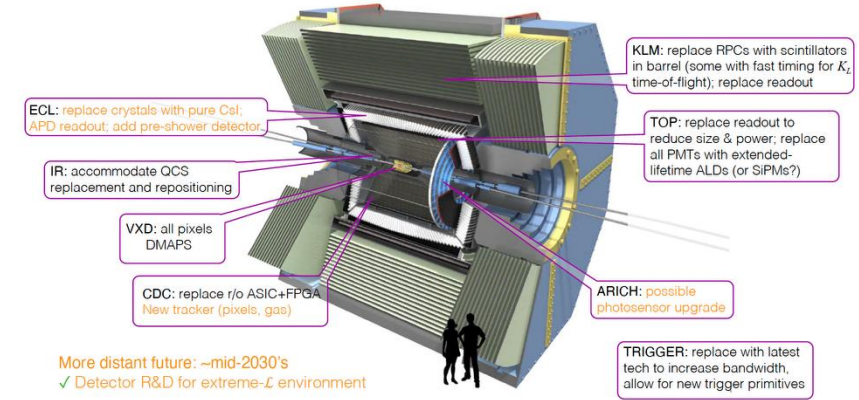
# A Bright and Challenging Future



LHCb Upgrade



ALICE Upgrade and ITS3



Belle-II Upgrade

## Vertex and Tracking Detectors are at the Centre !

### ATLAS

**Upgraded Trigger and Data Acquisition system**

- Level-0 Trigger at 1 MHz
- Improved High-Level Trigger (150 kHz full-scan tracking)

**Electronics Upgrades**

- LAr Calorimeter
- Tile Calorimeter
- Muon system

**High Granularity Timing Detector (HGTD)**

- Forward region ( $2.4 < |\eta| < 4.0$ )
- Low-Gain Avalanche Detectors (LGAD) with 30 ps track resolution

**Additional small upgrades**

- Luminosity detectors (1% precision goal)
- HL-ZDC

**New Muon Chambers**

- Inner barrel region with new RPC and sMDT detectors

**New Inner Tracking Detector (ITk)**

- All silicon, up to  $|\eta| = 4$

- Tile calorimeters
- LAr hadronic end-cap and forward calorimeters
- Pixel detector
- LAr electromagnetic calorimeters
- Toroid magnets
- Solenoid magnet
- Transition radiation tracker
- Semiconductor tracker
- Muon chambers

Phase-II ATLAS Upgrade

### CMS

**L1-Trigger HLT/DAQ**

- <https://cds.cern.ch/record/2714892>
- <https://cds.cern.ch/record/2759072>
- Tracks in L1-Trigger at 40 MHz
- PFlow selection 750 kHz L1 output
- HLT output 7.5 kHz
- 40 MHz data scouting

**Calorimeter Endcap**

- <https://cds.cern.ch/record/2283646>
- 3D showers and precise timing
- Si, Scint-SiPM in Pb-W-SS

**Tracker**

- <https://cds.cern.ch/record/2272264>
- Si-Strip and Pixels increased granularity
- Design for tracking in L1-Trigger
- Extended coverage to  $\eta = 3.8$

**Barrel Calorimeters**

- <https://cds.cern.ch/record/2283187>
- ECAL crystal granularity readout at 40 MHz with precise timing for  $e/\gamma$  at 30 GeV
- RPC back-end electronics
- ECAL and HCAL new Back-End boards

**Muon systems**

- <https://cds.cern.ch/record/2283189>
- DT & CSC new FE/BE readout
- RPC back-end electronics
- New GEM/RPC  $1.6 < \eta < 2.4$
- Extended coverage to  $\eta \geq 3$

**Beam Radiation Instr. and Luminosity**

- <http://cds.cern.ch/record/2759074>
- Bunch-by-bunch luminosity measurement: 1% offline, 2% online

**MIP Timing Detector**

- <https://cds.cern.ch/record/2667167>
- Precision timing with:
  - Barrel layer: Crystals + SiPMs
  - Endcap layer: Low Gain Avalanche Detectors

- Tile Calorimeter
- LAr hadronic end-cap and forward calorimeters
- Pixel detector
- LAr electromagnetic calorimeters
- Toroid magnets
- Solenoid magnet
- Transition radiation tracker
- Semiconductor tracker
- Muon chambers

Phase-II CMS Upgrade

# Workshop a partnership between UT Knoxville and ORNL



Mathieu Benoit (ORNL)

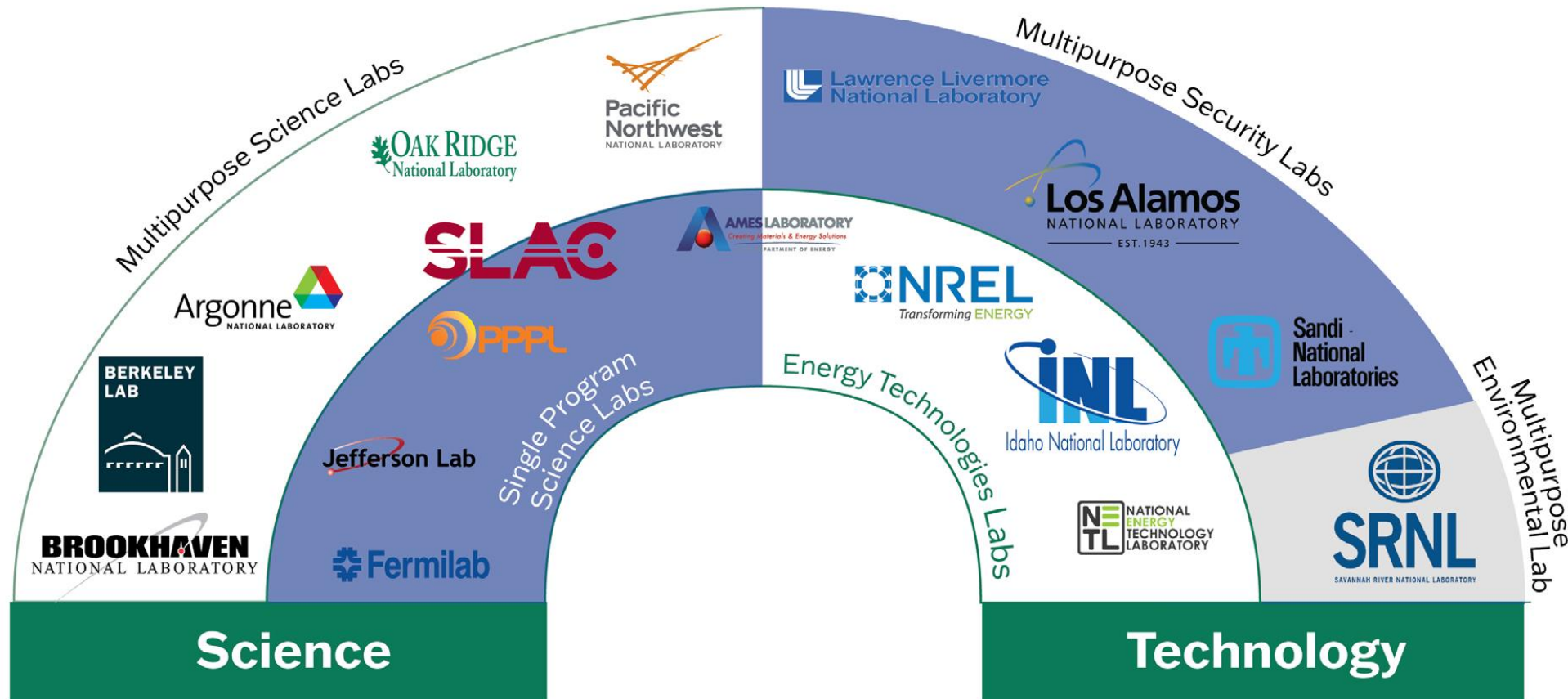
Marcel Demarteau (ORNL)

Oskar Hartbrich (ORNL)

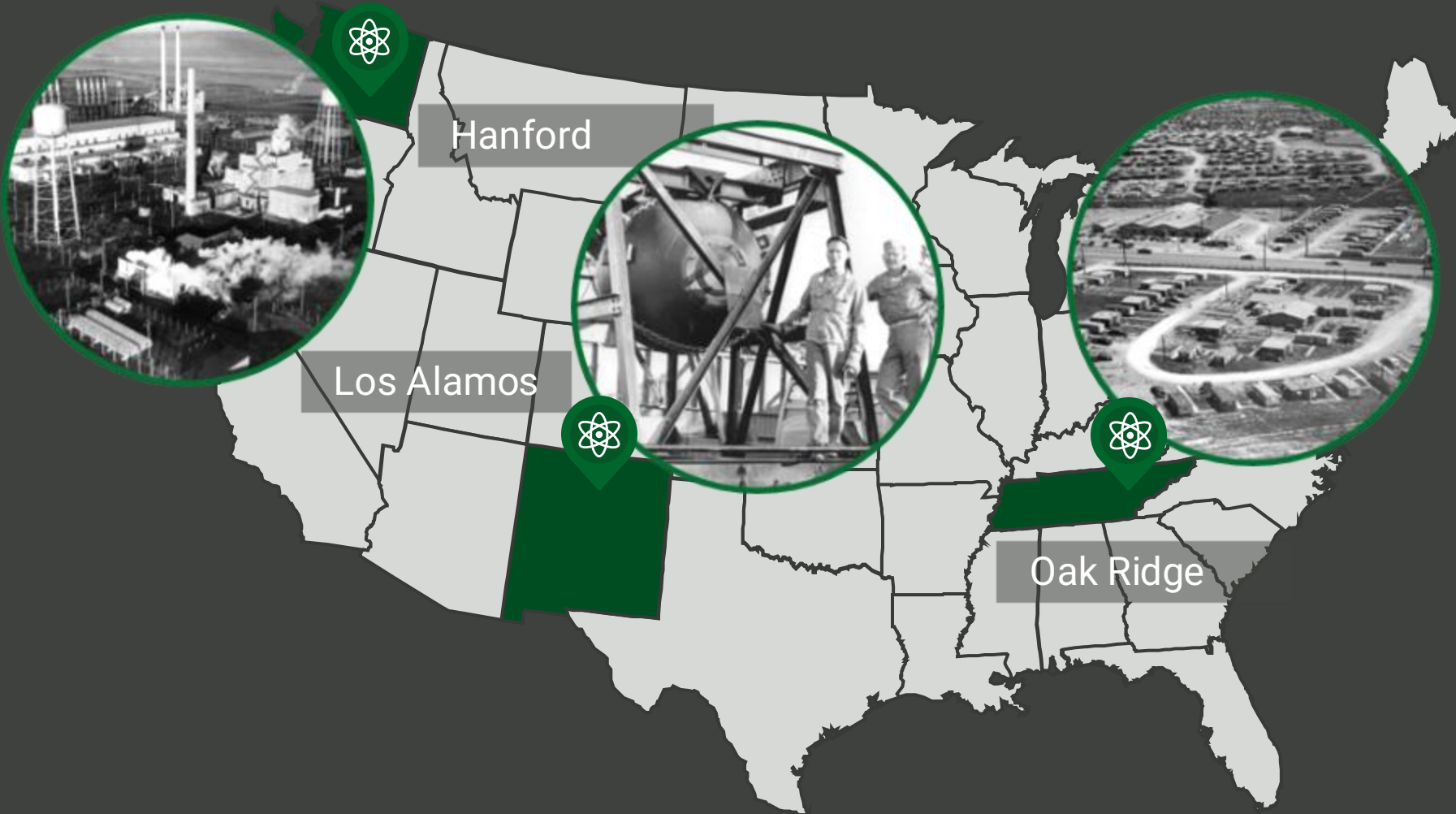
Stefan Spanier (UTK)



# DOE EXECUTES ITS MISSIONS THROUGH DIVERSE NATIONAL LABS



# The Manhattan Project built and operated labs, plants, and towns at 3 primary sites



# Most of the Manhattan Project was carried out in Tennessee

Harriman



Southern RR

Kingston

Watts Bar Lake



58



Valley



95

Bethesda Road



Oak Ridge



62

Southern RR



25W

Knoxville >>>



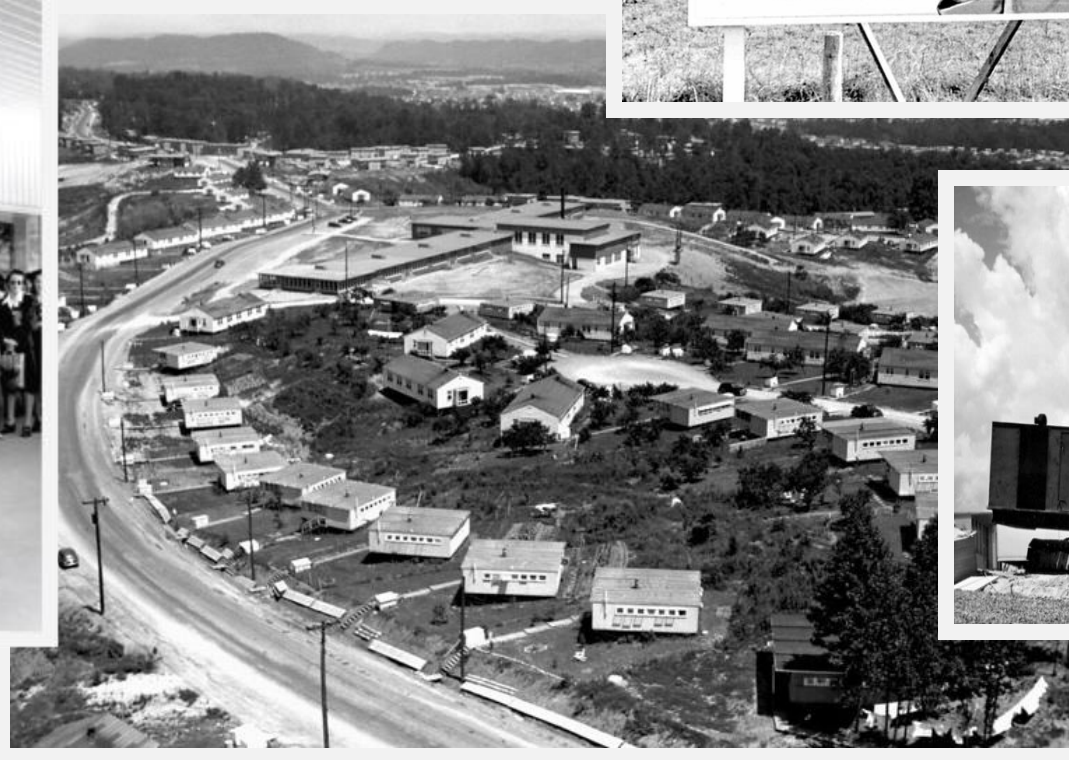
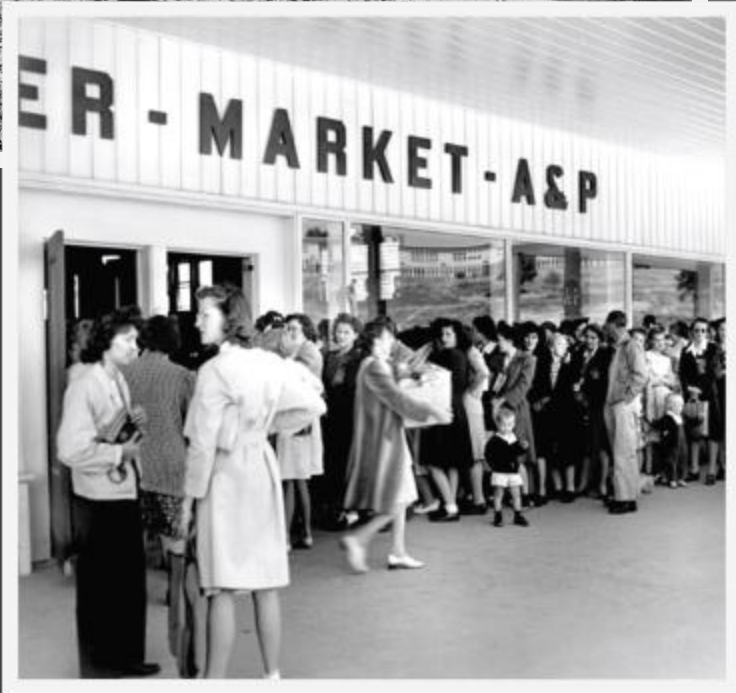
62

Louisville and Nashville RR



70

Southern RR



# Tennessee Eastman recruited thousands of local women to work at the Y-12 Plant



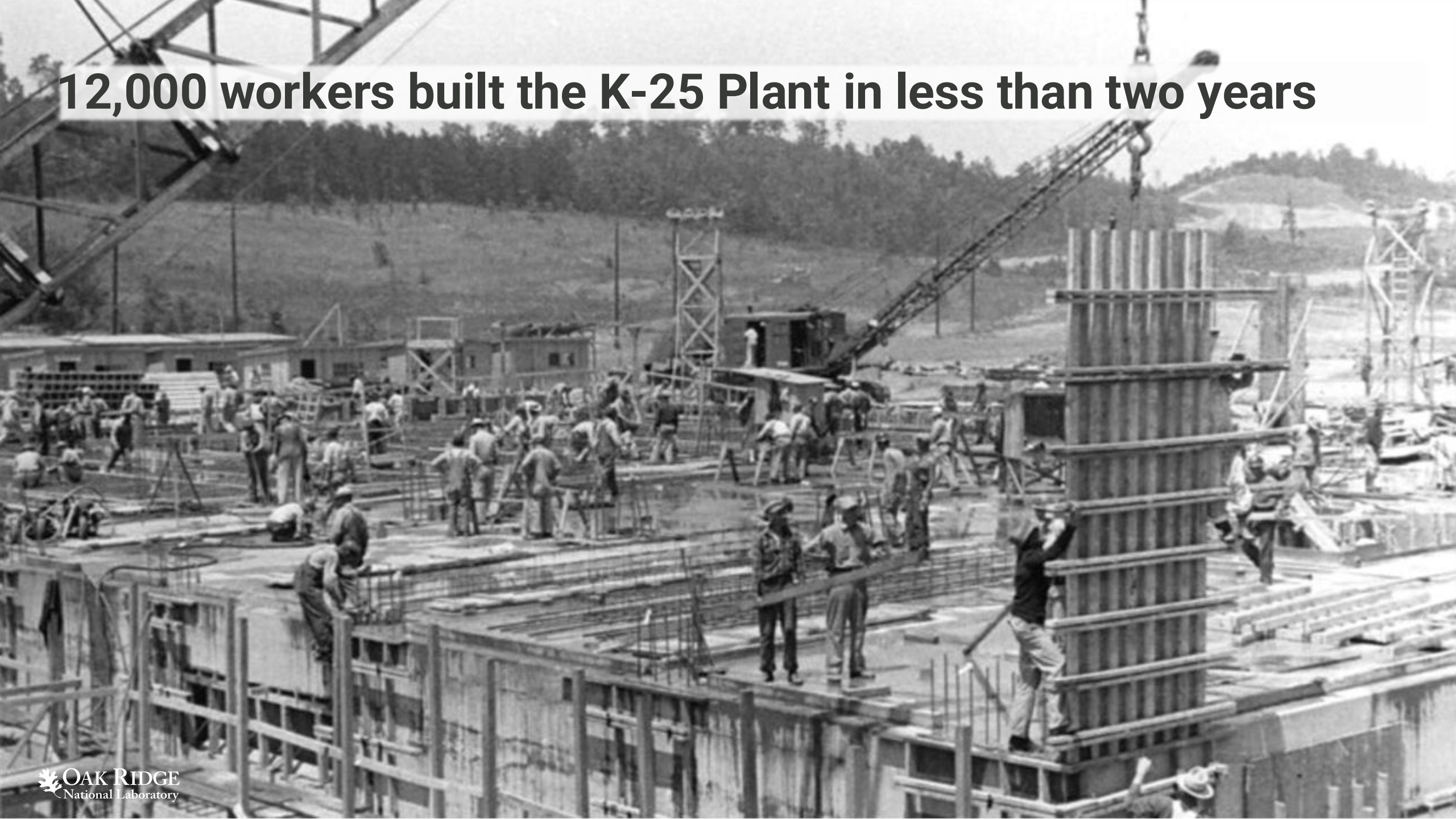
# The “Calutron Girls” operated machines that separated uranium via massive electromagnets



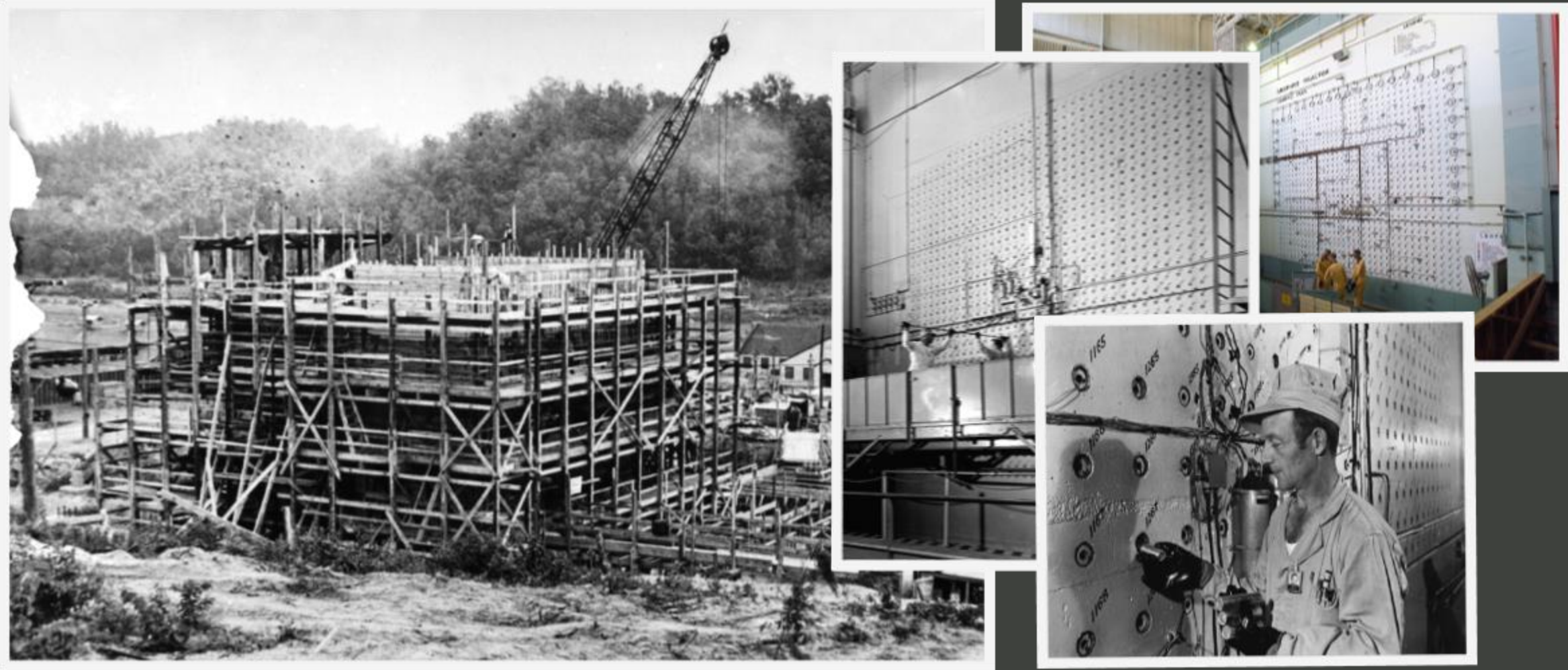
Ernest O.  
Lawrence



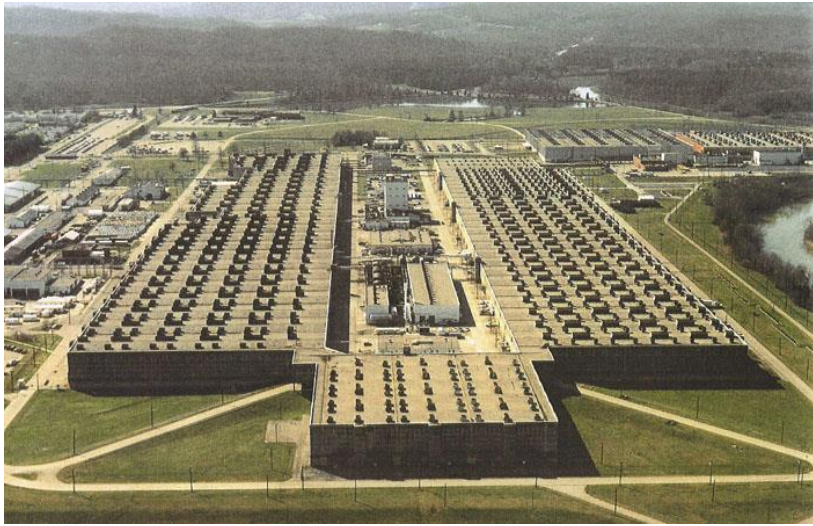
**12,000 workers built the K-25 Plant in less than two years**



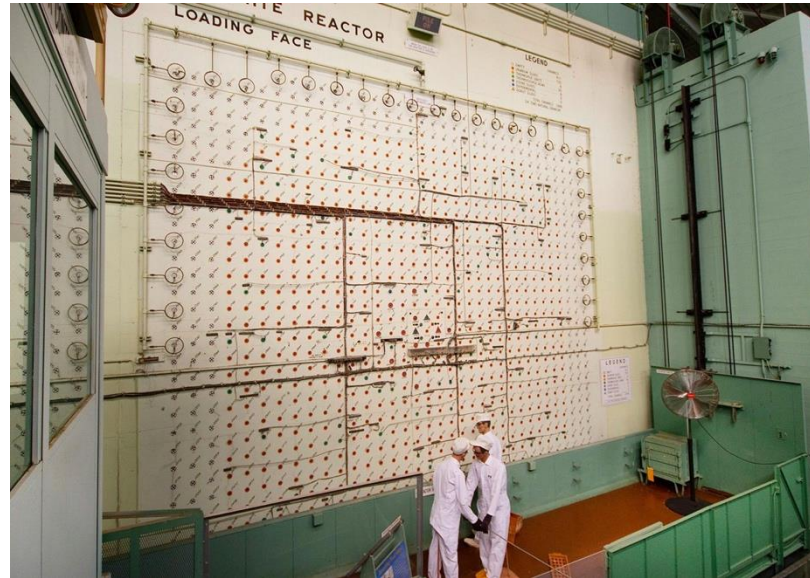
# The X-10 Graphite Reactor broke ground two months after the Chicago Pile



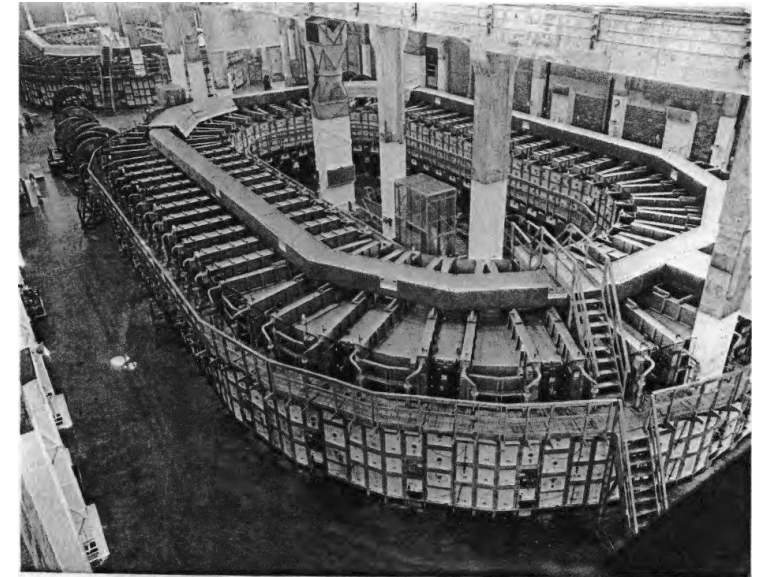
# Oak Ridge National Laboratory evolved from the Manhattan Project (Clinton Laboratories)



**K25** – Gaseous Diffusion Plant for U-235 enrichment



**X10** – Graphite Reactor; first production of gram-sized samples of Plutonium



**Y12** – Electromagnetic Isotope enrichment through Calutrons

X10 became Oak Ridge National Laboratory (1947)

# UT professors were central to establishing a national laboratory at Oak Ridge



Katharine  
Way



William  
Pollard





# Oak Ridge trained many of the first nuclear engineers



# ORNL by the numbers



# ORNL delivers translational research for national priorities

We apply our signature strengths to the most compelling S&T challenges



Lead the world in **neutron sciences**



Deliver **exascale computing** from system to ecosystem



Discover and design next-gen **materials and chemical processes for clean energy**



Accelerate deployment of **fusion and advanced fission energy**

**DISCOVERY SCIENCE**



Transform integrated **energy systems** to accelerate decarbonization



Unlock complexity in **biological and environmental systems**



Provide strategic **isotope R&D and production**



Address pressing **national security challenges**

**DEVELOP AND DEPLOY**

# ORNL's distinctive user facilities enable breakthroughs that can't be made anywhere else



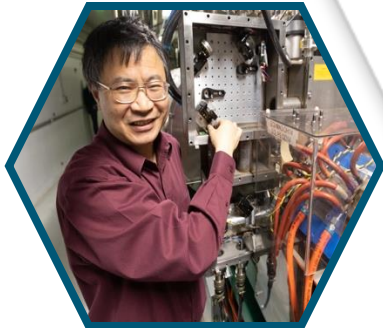
# Neutrons

Lead the world in neutron sciences

World's most powerful proton accelerator

Second Target Station

World-leading reactor-based neutron source



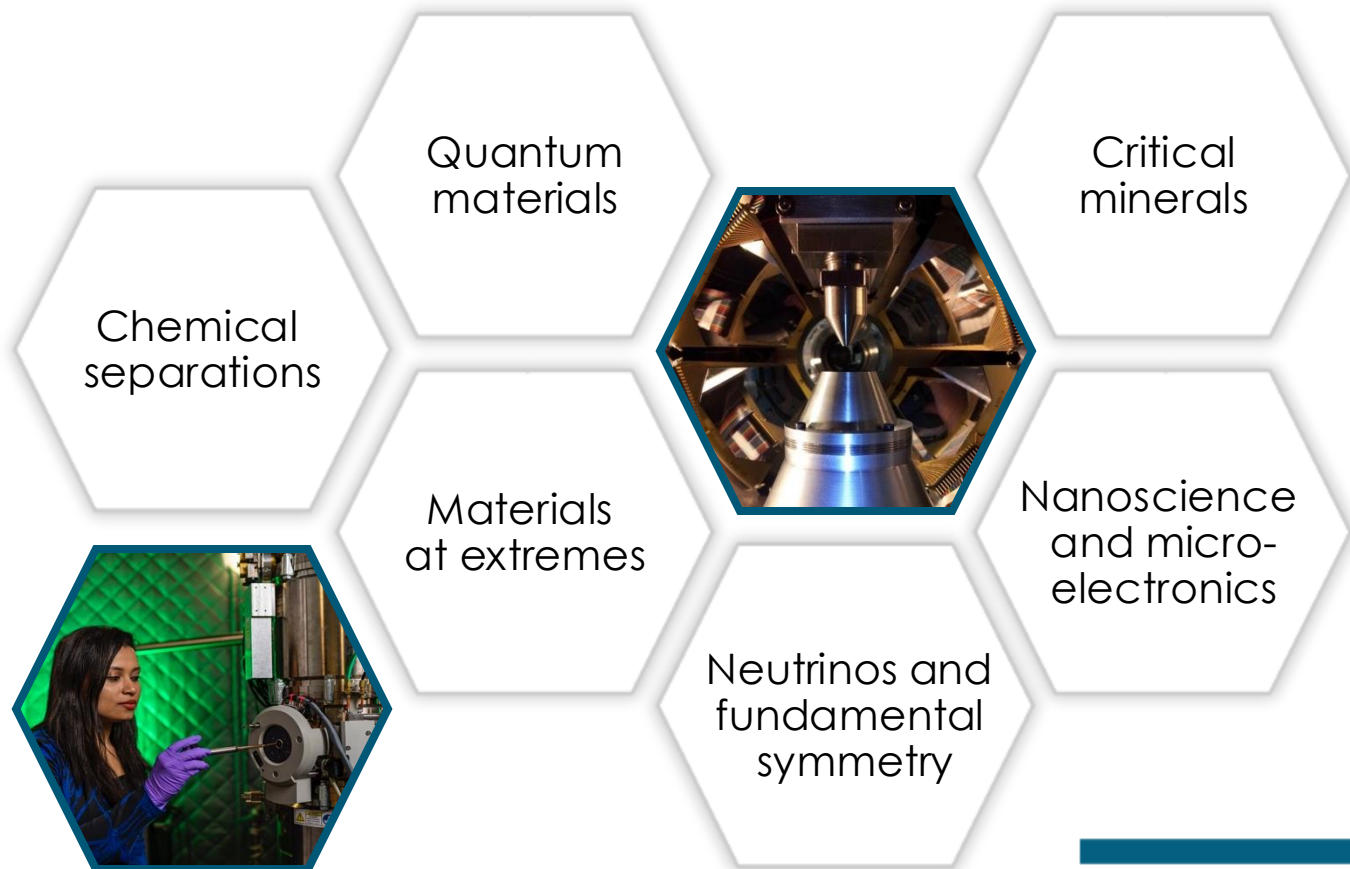
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Candice Halbert  
Spallation Neutron Source  
(SNS) Scientific Associate



# Materials science

Discover and design next-generation materials and chemical processes for clean energy



Radu Custelcean  
Research Staff,  
Structural Chemist



# Fusion and fission energy

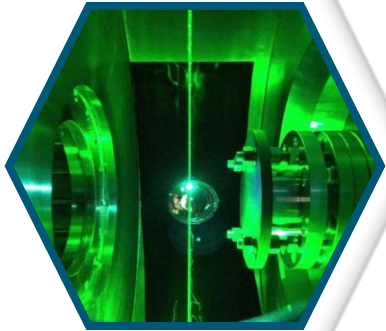
## Accelerate deployment of fusion and advanced fission energy

Manage US contributions to ITER

Support commercial needs for fusion test facilities + pilot plant

Develop advanced reactors

Sustain today's nuclear power plants



US ITER Project  
1 of 6 central solenoid  
modules being raised  
and prepared  
for assembly



# Isotopes

Provide strategic isotope R&D  
and production for US and allies



Stable and  
radioactive  
isotopes



Medicine,  
industry,  
research,  
security

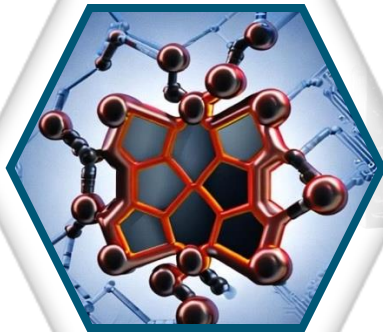
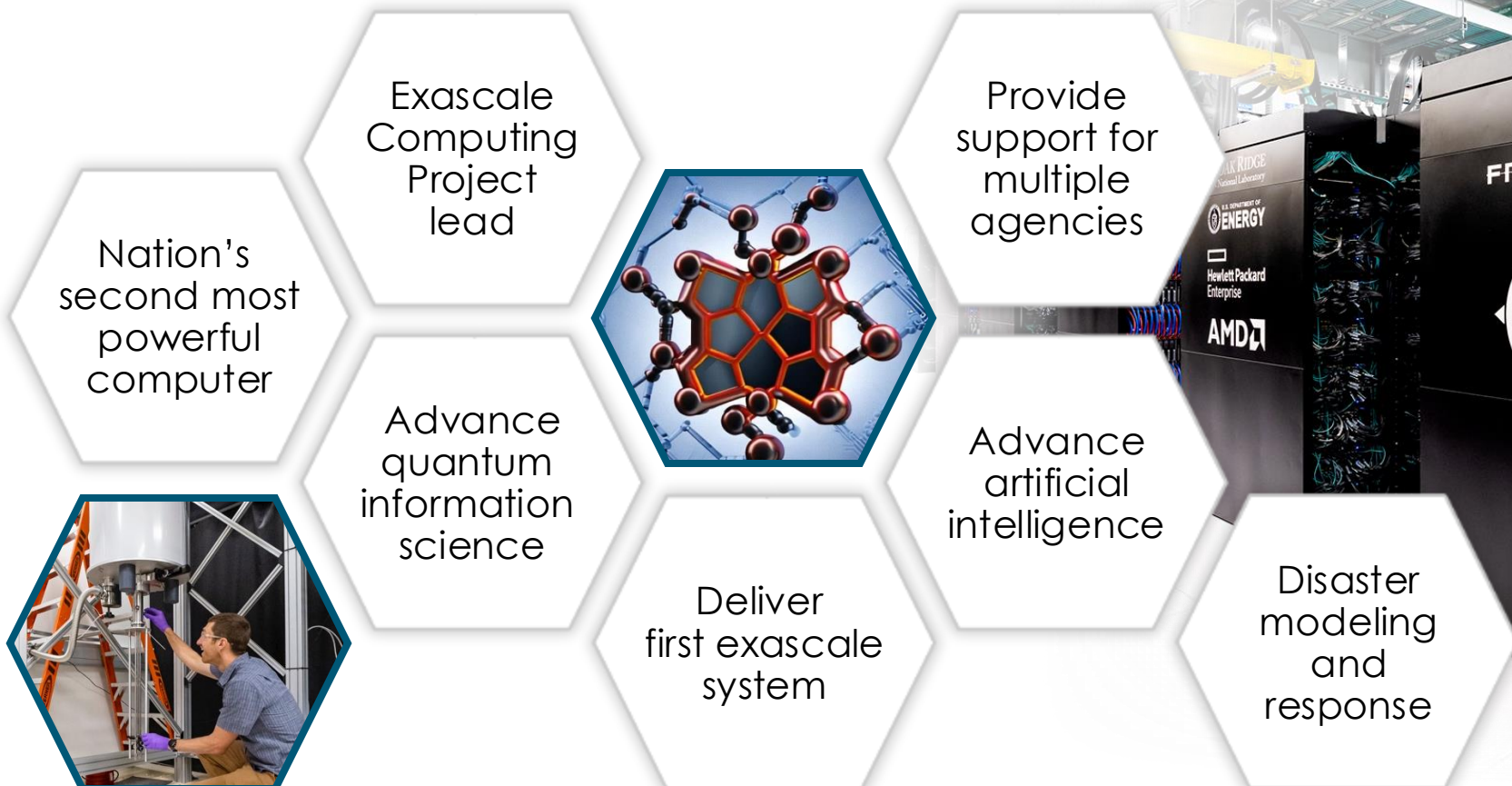


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Jillene Sennon-Greene  
Radioisotope  
Manufacturing Coordinator

# Computing

## Deliver Exascale computing from system to ecosystem



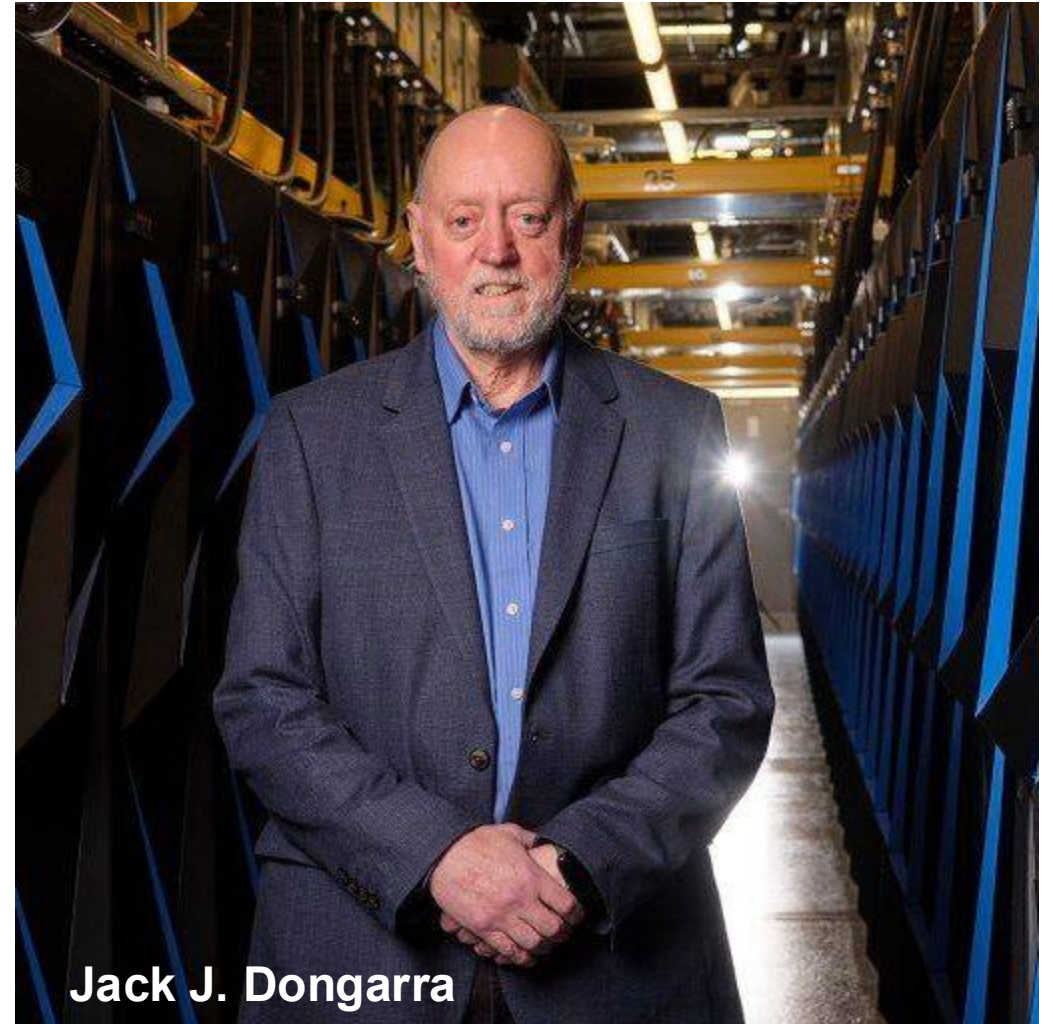
Frontier  
Supercomputer

# 2021 Alan Turing Award

- The 2021 Alan Turing award (the Nobel prize for computing) was awarded to Jack Dongarra, joint appointment between ORNL and UTK

*“for pioneering contributions to numerical algorithms and libraries that enabled high performance computational software to keep pace with exponential hardware improvements for over four decades.”*

- Dongarra’s major contribution was in creating open-source software libraries and standards which employ linear algebra as an intermediate language.

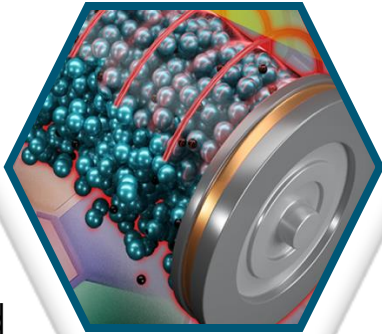


**Jack J. Dongarra**

# Clean energy

## Transform integrated energy systems to accelerate decarbonization

Efficient buildings and sustainable transportation



Reliable, resilient electricity grid

Energy transitions



Advanced manufacturing



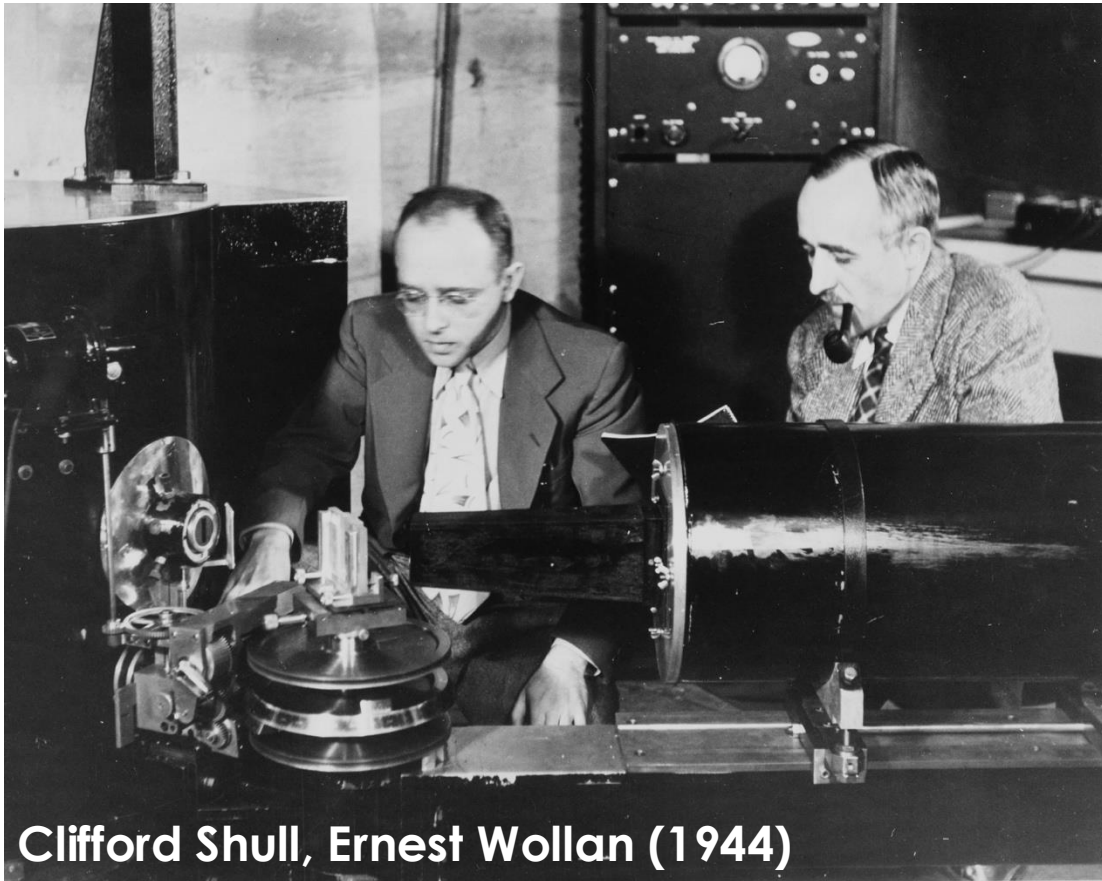
GRID-C  
Polyphase magnetic coil

# The Physics Division

- The Physics Division was one of the first Divisions at the laboratory and has been an incubator of new Divisions and Directorates at the laboratory.
- The Division has been at the core of the evolution of the laboratory.
- Its origin is, of course, in the development of the nuclear technology for peaceful purposes.



# The Birth of Neutron Scattering



Clifford Shull, Ernest Wollan (1944)

File Neutron  
Date 5-25-44  
Subject DIFFRACTION OF NEUTRON  
By E. O. Wollan  
To Doan  
Those Eligible  
To Read the  
Attached  
Copy 1 Doan

I would like to attempt to measure the diffraction of neutrons by single crystals. I have brought some equipment with me from Chicago, and Dr. Borst has shown me an opening in the pile at which this work could be done.

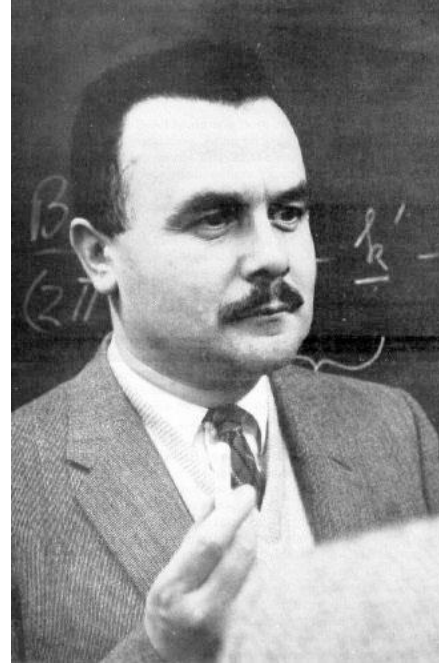
I would appreciate obtaining approval to go ahead with this

Wollan made the original request to the head of the reactor to say: "Can I have a beam port here? I want to try neutron diffraction."

# 1994 Nobel Prize in Physics



Clifford G. Shull  
*“For the development of the  
neutron diffraction technique”*



Bertram N. Brockhouse  
*“For the development of  
neutron spectroscopy”*

Ernest Wollan had passed away and the Nobel prize is not awarded posthumously

# The First Ever Search for a Neutron EDM

**THE NEWS**  
OAK RIDGE NATIONAL LABORATORY

A Publication by and for the ORNL Employees of Carbide and Carbon Chemicals Division, Union Carbide and Carbon Corporation

Vol. 3—No. 13 OAK RIDGE, TENNESSEE Friday, September 29, 1950



### Harvard University Conducts Important Research at ORNL

The growing importance of Oak Ridge National Laboratory as a research center is manifested particularly in its assistance to universities and technical schools on various projects in which nuclear research is involved. An example of such relationship is its present collaboration with Harvard University in an investigation to determine if neutrons have permanent electric dipole moments.

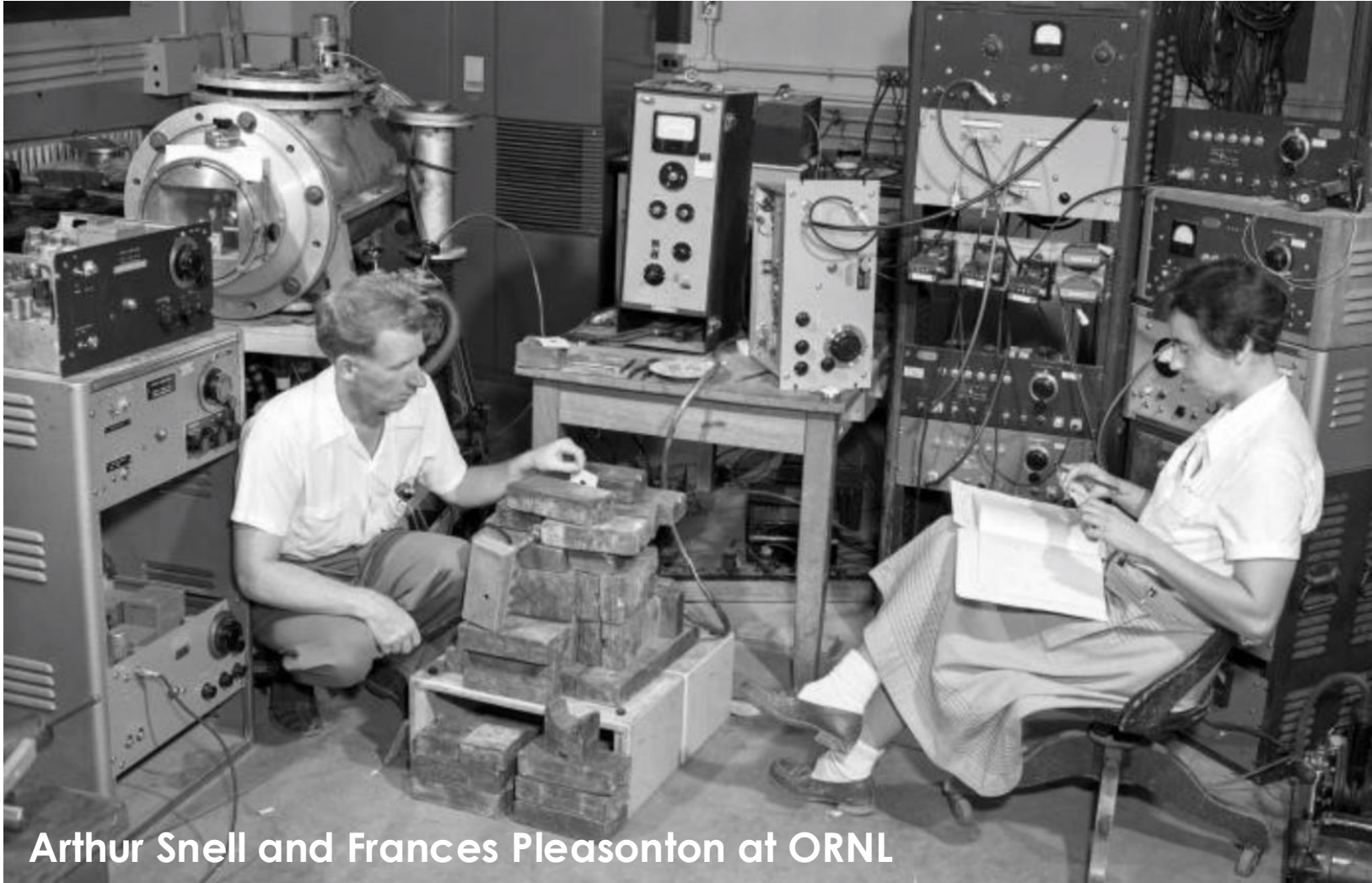
The work of the project is under the direction of Professors E. M. Purcell and Norman F. Ramsey of the Harvard University Physics Department and is being conducted on the Laboratory area by James H. Smith, a graduate student at Harvard. Dur-



Led by Edward Purcell and Norman Ramsey

**HARVARD UNIVERSITY SPONSORS PROGRAM HERE** — James H. Smith, Harvard University graduate student in physics, is shown as he adjusts a neutron beam apparatus at the south face of the Oak Ridge Pile. Using the Pile as a source of neutrons, Mr. Smith is engaged in a project jointly sponsored by Harvard University and Oak Ridge National Laboratory for the purpose of determining if neutrons have permanent electric dipole moments.

# The First Measurement of the Neutron Lifetime



Arthur Snell and Frances Pleasonton at ORNL

A.H. Snell, F. Pleasonton, R.V. McCord, "Radioactive Decay of the Neutron", [Phys. Rev 78 \(1950\)](#).

# Oak Ridge Physics Division: Home to Two Historic Sites

*Holifield Radioactive Ion Beam Facility*



**APS Historic Site (2016)**

*HRIBF carried out pioneering experiments using accelerated beams of radioactive nuclei (1963 – 2012)*

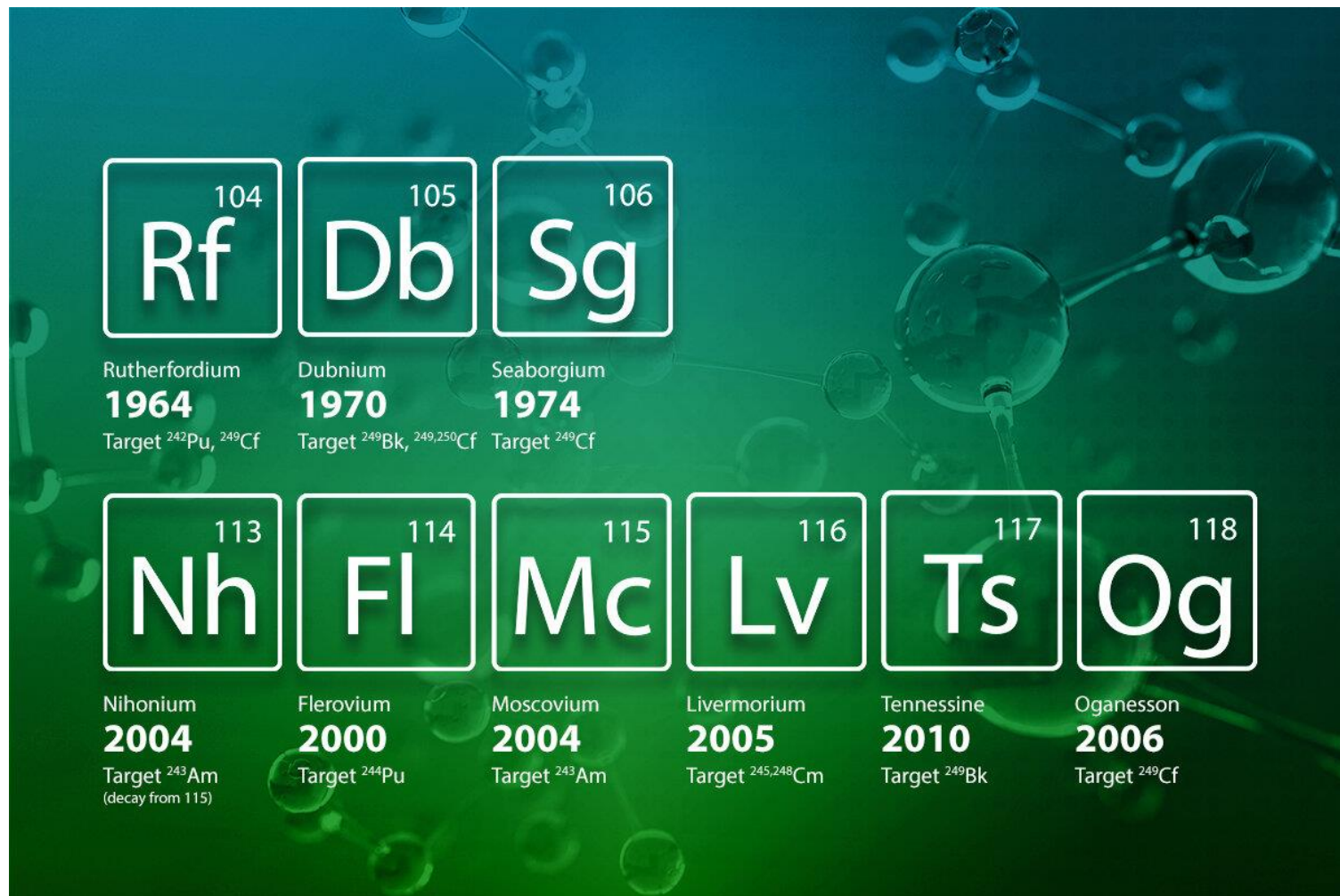
*Oak Ridge Electron Linear Accelerator*



**ANS Historic Site (2006)**

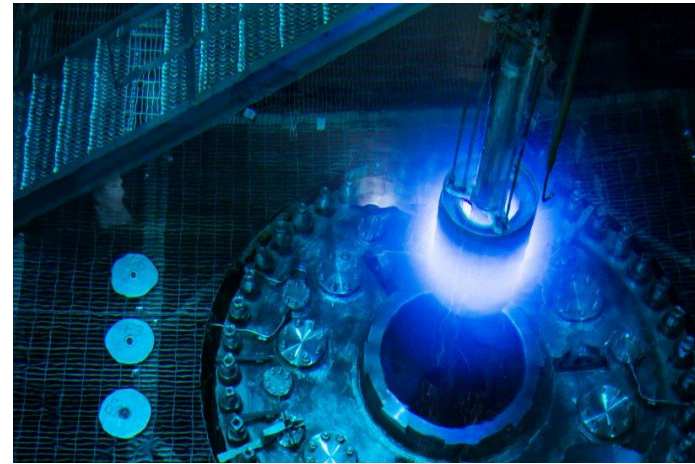
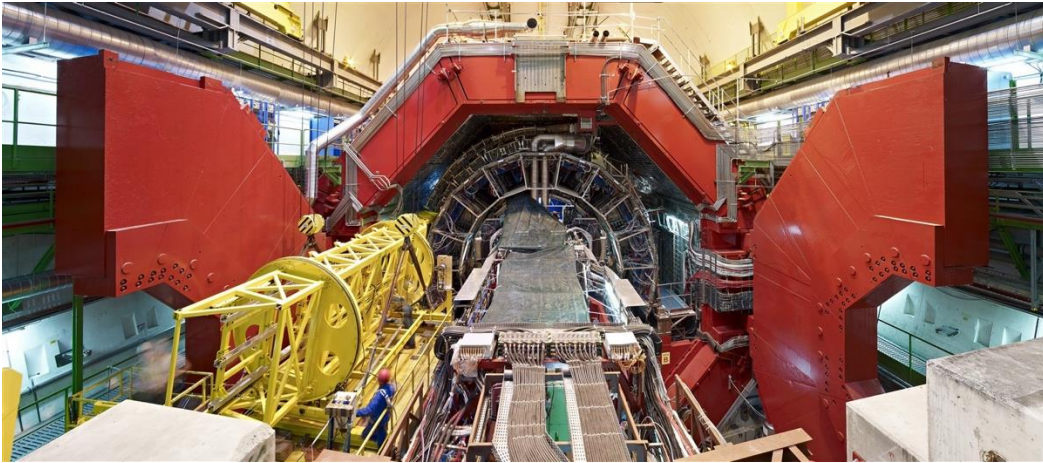
*ORELA's linear accelerator became the world's leading facility for producing nuclear data (1969 – 2015)*

# Oak Ridge Physics Division



- Oak Ridge contributed to and participated in the discovery of nine superheavy elements.
- Element 117 named after the state.

# Oak Ridge Physics Division



- Hosting only reactor neutrino experiment in US (HFIR)

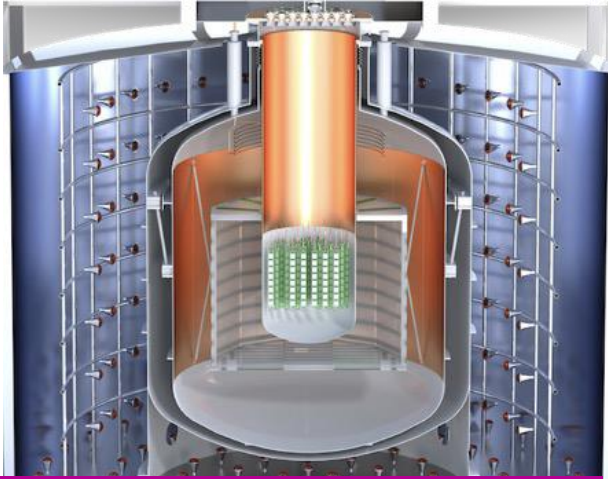


- Built the lead-scintillator shashlik electromagnetic calorimeter for ALICE (LHC)
- Lead lab for the Majorana Demonstrator  $0\nu\beta\beta$ -decay experiment (SURF)



- Discovered coherent elastic neutrino nucleus scattering (SNS)

# Three Science Thrusts

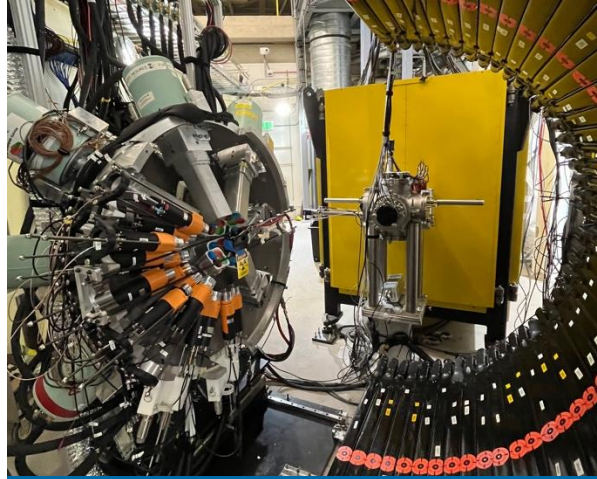


## Revealing Broken Symmetries in Nature with Neutrinos and Neutrons

A Search for neutrinoless double beta decay

Search for broken FS using neutrons

Low-Energy neutrinos as a new probe of Fundamental Symm.

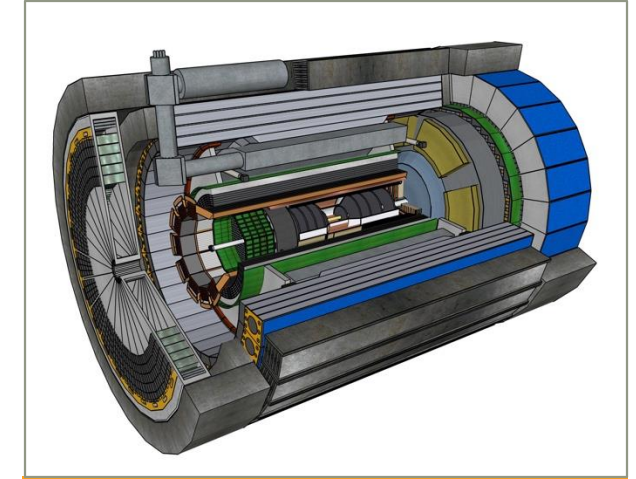


## Examining the Limits of the Nuclear Chart

Understand the structure of nuclei

Build a comprehensive picture of nucleosynthesis

Understand the fundamental properties of nuclear isomers



## Unraveling the Quantum Structure of Matter

Understand gluon and quark fragmentation

Investigate gluon dynamics using ultra-peripheral collisions

Map the internal quantum structure of the nucleon and nuclei

An aerial photograph of the Oak Ridge National Laboratory campus, showing various buildings, parking lots, and a central pond, surrounded by dense green forest. The text "Thank you and have a great conference" is overlaid in white on the left side of the image, with a vertical green bar to its left.

Thank you and have  
a great conference