SOLVING ENERGY CHALLENGES
THROUGH SCIENCE

Versatile Test Reactor: Missing Piece of Nuclear Energy Innovation Infrastructure in the U.S.

Kemal Pasamehmetoglu

VTR Executive Director

IANS – Lunch & Learn Webinar

January 26, 2021

There is a Clear and Compelling Mission for VTR

SOLVING ENERGY CHALLENGES THROUGH SCIENCE

COMMERCIAL

- Accelerated testing for fuels, materials & sensors for advanced reactors: Na, Pb, LBE, MS, He
- Accelerated testing for materials
- Clean energy market share

NATIONAL SECURITY

- Safeguard detectors/safeguards by design
- Global safety and security policies
- Export of reactors and reactor services

VTR

SCIENCE & TECHNOLOGY

(High-Energy Neutrons over Large Volumes)

- Fast reactor physics
- Materials in extreme environments
- Neutrino science

VTR is a state-of-the-art TEST REACTOR to enable continuous innovation in advanced nuclear energy technologies during its 60 years lifetime.

VTR Major Milestones to Date

SOLVING ENERGY CHALLENGES THROUGH SCIENCE

1st Major Milestone

Critical Decision 0 achieved in 2019, focused on needs of:

- Commercial developers of advanced nuclear energy technologies
- National security interests
- Scientific community

2nd Major Milestone

Critical Decision 1 achieved in September 2020, focused on:

- Analysis of alternatives
- Conceptual design and conceptual safety design
- Cost and schedule ranges

National Environmental Policy Act

SOLVING ENERGY CHALLENGES THROUGH SCIENCE

Notice of Intent published in the Federal Register

Aug. 5 2019

DOE hosts public scoping meetings via webinar

Aug. 27-28 2019

Draft Environmental Impact Statement (EIS) undergoing DOE review

EIS will look at:

- No Action Alternative, Build VTR at INL and Build VTR at Oak Ridge National Lab
- Will also look at fuel fabrication at INL and Savannah River Site

Aug. 17 2020

Draft EIS will be published and public review begins Public Review of Draft EIS

- At least 45-day comment period
- At least one public (via Webinar) meeting required with 15 days advanced notice

Nov. 2020

DOE releases final EIS

- Respond to oral and written comments on the Draft EIS
- 30 day waiting period (after EPA Notice of Availability is published)

Spring 2021

DOE issues record of decision

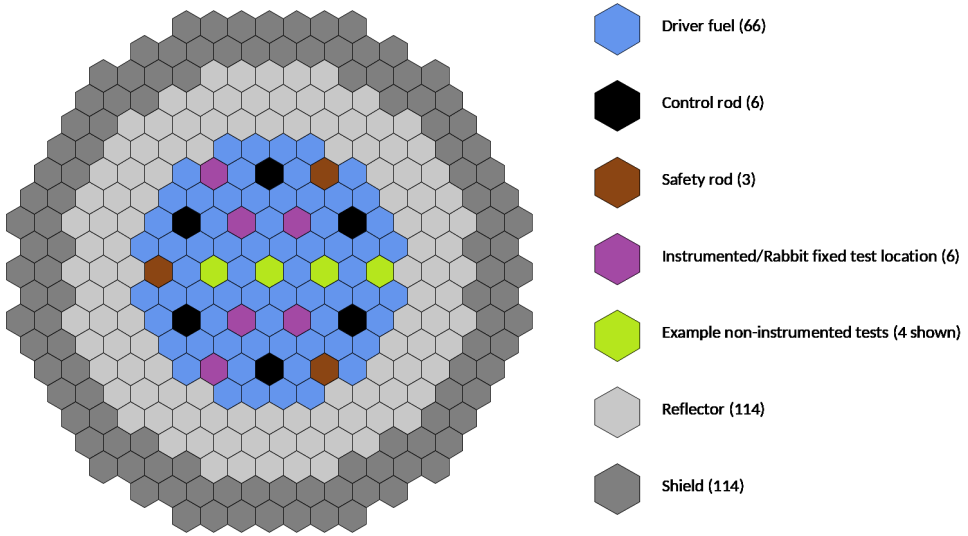
- Reactor site
- Fuel fabrication site

Summer 2021

Conceptual Design Approved at CD-1

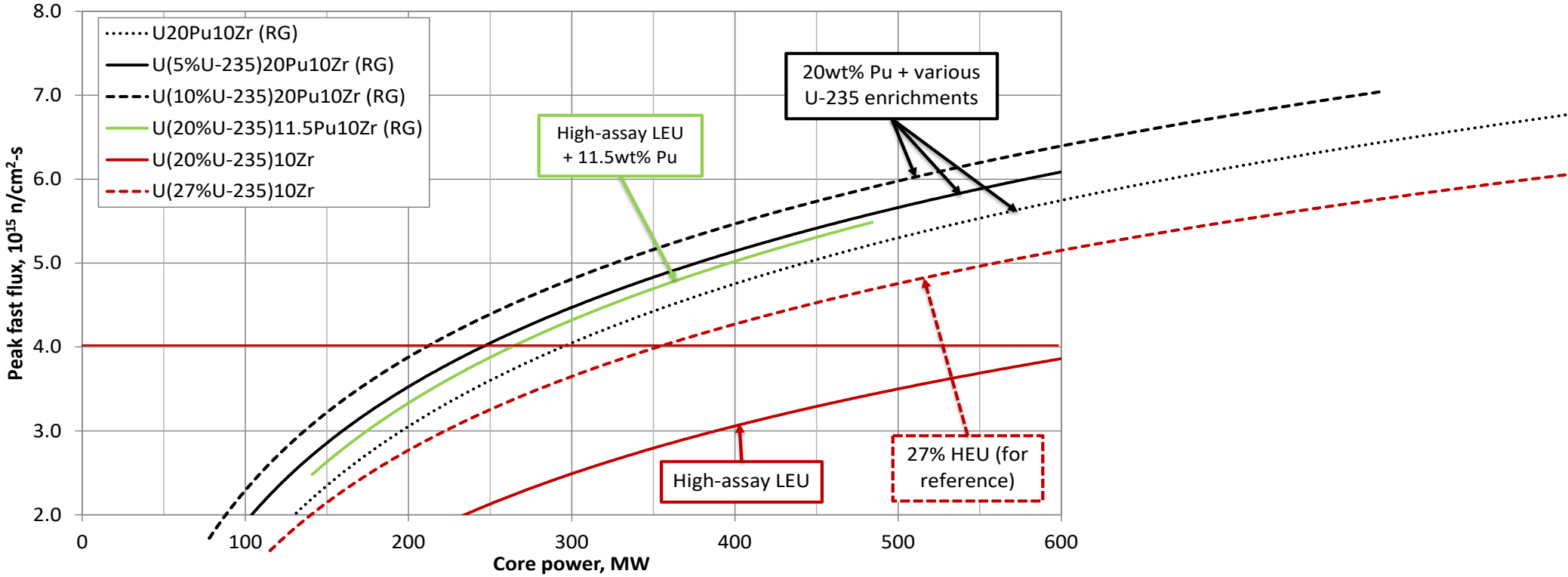
SOLVING ENERGY CHALLENGES THROUGH SCIENCE

Parameter	Target
High fast neutron flux (>0.1 MeV)	≥ 4 x 10^{15} n/cm^2-s
High fluence	≥ 30 dpa/yr
High test volume in the core	≥ 7 L/test location (multiple locations)
Representative testing height	≥ 0.6 m
Flexible test environment	Loops (Na, Pb, LBE, He, Salt) Rabbit
Driver fuel life cycle management	Existing facilities as much as possible
Schedule: Available ASAP	Target Date: 2026
COST(capital + operating):	Minimal



- 300 MWth pool-typed sodium cooled reactor
- Core design optimized for meeting testing requirements (National Laboratories)
  - ➢ Driver Fuel: U-20Pu-10Zr
- GEH PRISM A for the balance of the reactor (GEH-Bechtel subcontract)
- Innovative experimental vehicle designs (National Labs, Universities, Industry)

Sizing Studies Using Different Fuel Compositions



Fuel Composition	Reactor Size (MWth)
U-20Pu-10Zr (0-5% U235, RG Pu)	300
HALEU-10Zr (20% U235)	~750

VTR Experiment Vehicles

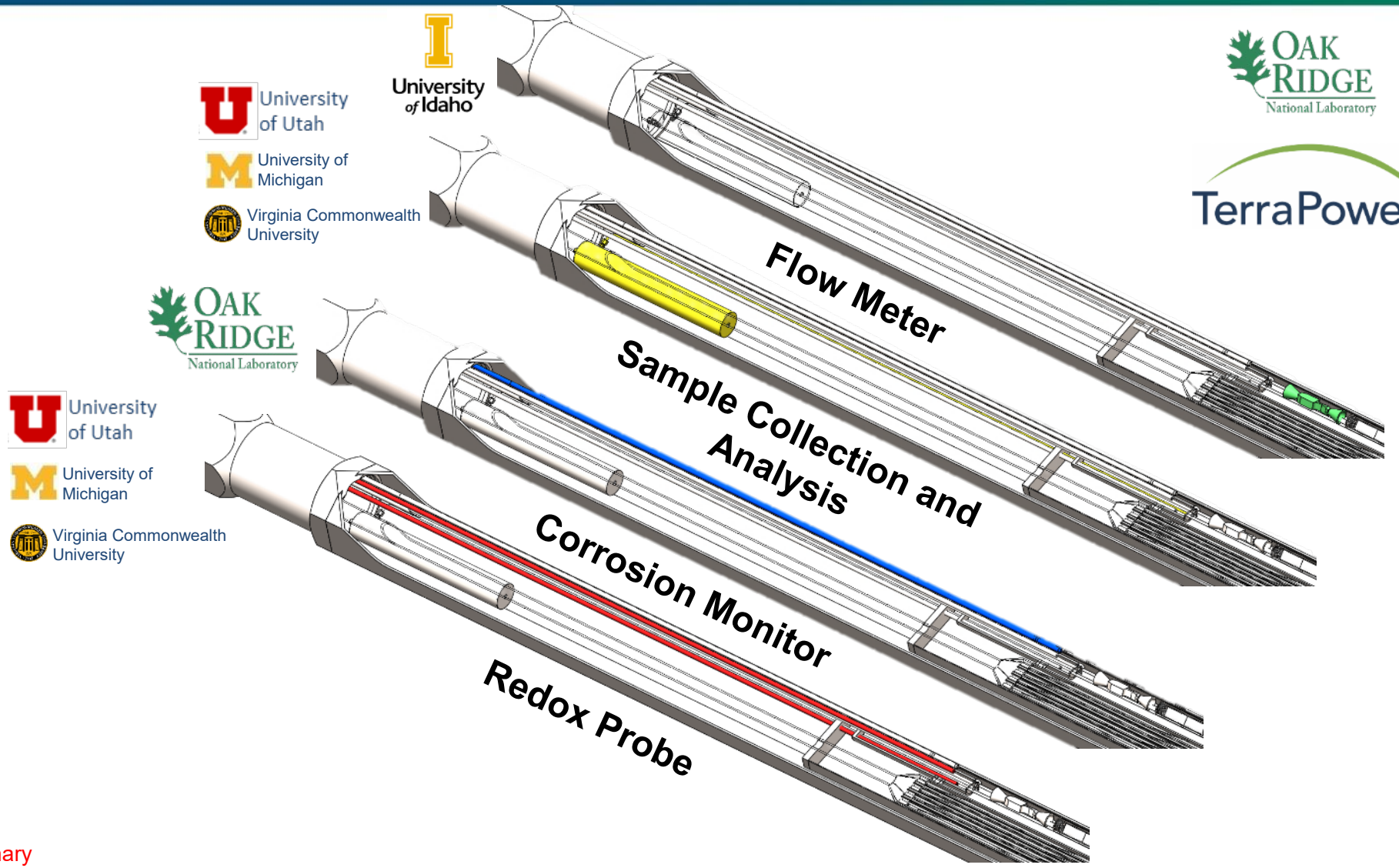
SOLVING ENERGY CHALLENGES THROUGH SCIENCE

- Dismountable Test Assembly (DTA)
  - A modified driver fuel assembly that will have an insert (DTA insert) that replaces 7-19 pins of the driver fuel. The DTA insert can remain for one cycle, or for as many cycles as the material limits of the insert allow. DTAs are non-instrumented or passively instrumented.
- Normal Test Assembly (NTA)
  - Standard non-instrumented or passively instrumented open test assemblies that are the same size, flat-to-flat, as the driver fuel assemblies.
- Extended Length Test Assembly (ELTA)
  - Test assemblies that have a long ”stalk” that extends through the reactor head, and typically have various instrumentation leads, etc., for monitoring and controlling thermal-hydraulic conditions.
- Rabbit Test Assembly (RTA)
  - Special test assembly for rapid transfer of capsules that contain experiment specimens, which are propelled down a rabbit tube into a rabbit thimble, irradiated, and recovered intra-cycle or inter-cycle.
- Support Areas
  - VDC/BIM/DE, I&C, Cross-cutting technologies

ELTA example – Molten Salt Cartridge Loop

SOLVING ENERGY CHALLENGES THROUGH SCIENCE

University of Utah
University of Michigan
Virginia Commonwealth University
University of Idaho
OAK RIDGE National Laboratory
TerraPower



Overall Integration and Design

Preliminary

CD-1 Cost and Schedule Range

	Project Cost Range ($B)
Point Estimate	3.6
Upper Bound	5.8
Lower Bound	2.6

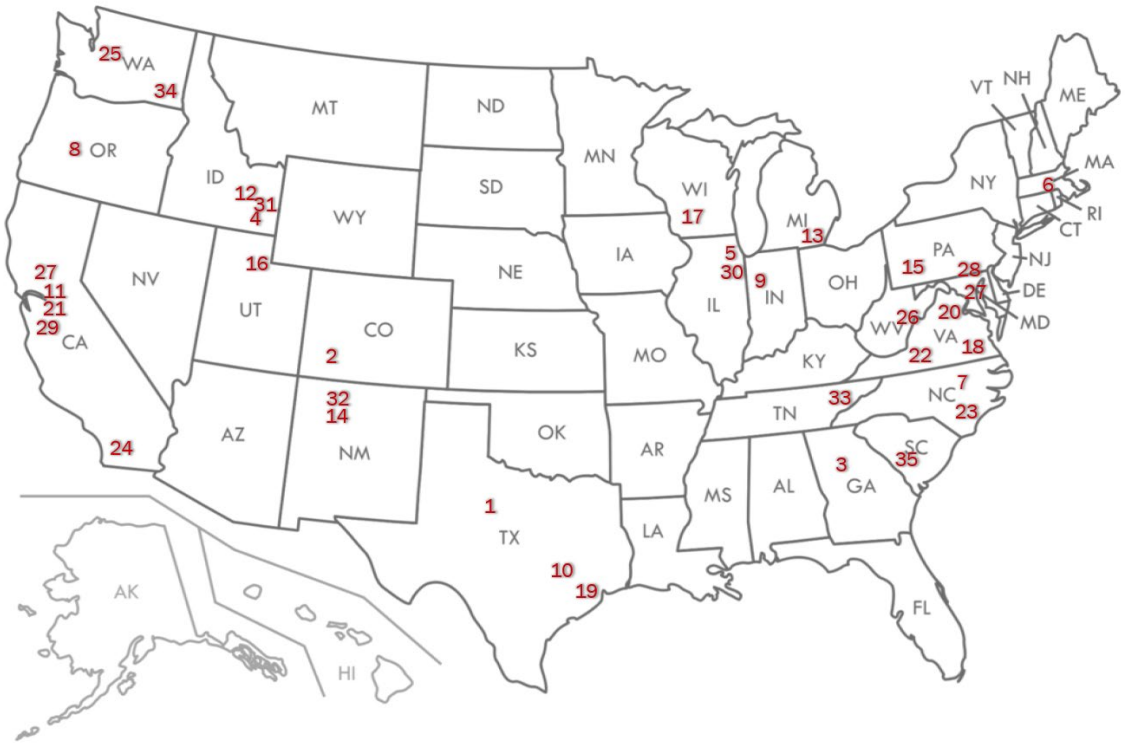
Milestone	Fiscal Year
CD-0	FY 2019, Q2
CD-1	FY 2020, Q4
CD-2/3	FY 2023 Q2 (target)
CD-4	FY 2026, Q4 – FY 2031, Q4

- Point estimate includes ~20% contingency and management reserve
- Cost range includes +60% and -30% for uncertainty range

VTR Partnership

SOLVING ENERGY CHALLENGES THROUGH SCIENCE

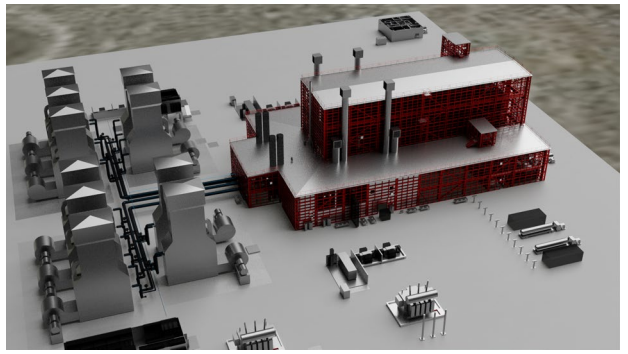
- 2018 –Department of Energy establishes VTR program after several studies highlight need.
- 6 national labs, 19 universities & 10 industry partners
- DOE 413.3B – Process for development of major systems projects.

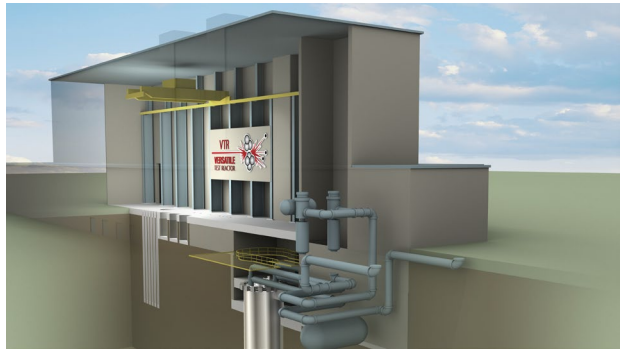


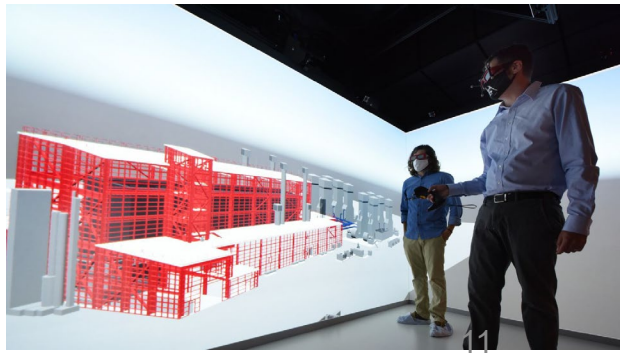
The Blanket Master Contract for the Engineering Design and Construction phase of the project is being negotiated with Bechtel National, Inc (TerraPower and GE-Hitachi partners)

Summary & Conclusions

- When operational, VTR will be the world's premier fast spectrum test reactor allowing technology developers and scientists access to state-of-the-art capabilities.
- VTR will provide the missing piece of research and development infrastructure and will help re-establish U.S. as the global leader in nuclear energy innovation.
- Even in the early design phase, VTR already is making an impact on nuclear energy innovation.
  - e.g. Integrated Digital Engineering framework
- VTR will be authorized and operated under the DOE authority, working closely with the Nuclear Regulatory Commission (NRC).
  - MOU signed in September 2019
- There is considerable international interest among our nuclear energy allies.
  - France, Japan collaborations







inl.gov/vtr