SOLVING ENERGY CHALLENGES
THROUGH SCIENCE

Versatile Test Reactor (VTR) Experimental Capabilities

KEVAN D. WEAVER

NATIONAL ACADEMY OF SCIENCES

DECEMBER 7, 2020

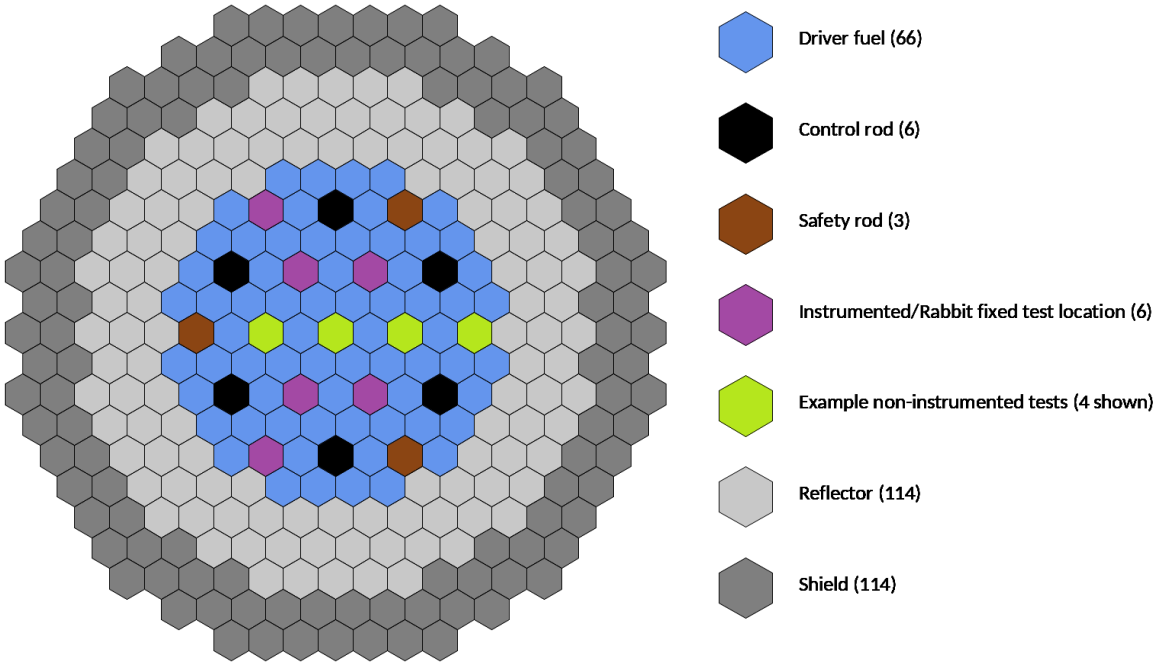
Note: Information regarding site location is **preliminary**. The decision for site location is determined via DOE acquisition processes that have not yet been completed.

VTR Core Face Map

SOLVING ENERGY CHALLENGES THROUGH SCIENCE

- Planned experimental devices/vehicles:
  - Dismountable Test Assembly (DTA)
  - Normal Test Assembly (NTA)
  - Extended Length Test Assembly (ELTA)
  - Rabbit Test Assembly (RTA)

- Based off experience from other fast test reactors:
  - EBR-II, FFTF, JOYO, BOR-60, etc.



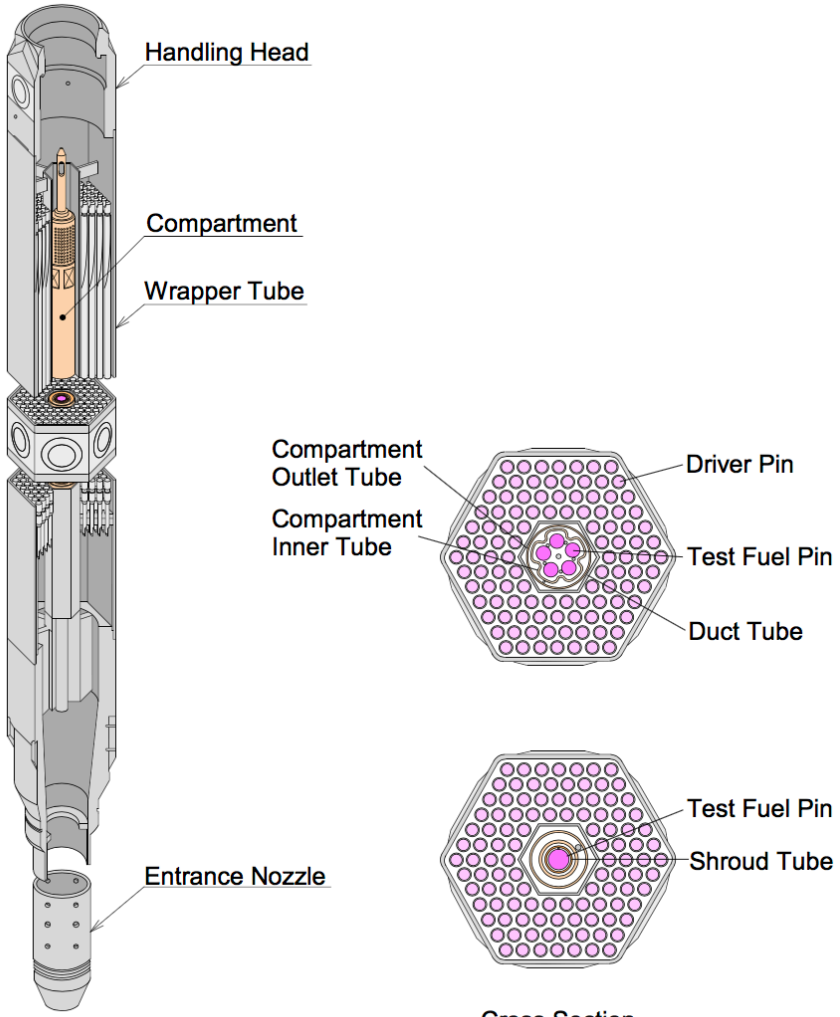
Preliminary

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. Includes cartridge loop experiments with separate coolants.
- 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
  - DE (VDC/BIM and M&S), I&C, Cross-cutting technologies

Dismountable Test Assembly (DTA)



Cross Section

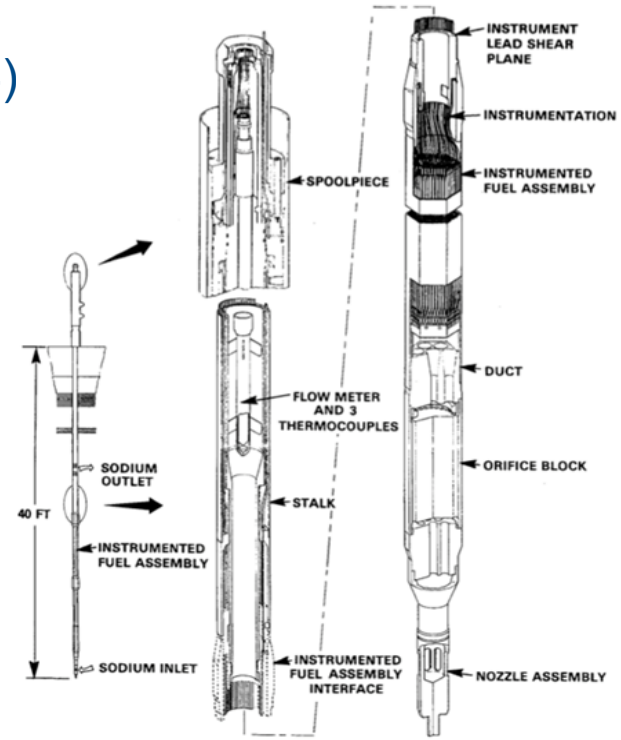
- JOYO experiment rig Type-A
  - (Figure courtesy JAEA)
- "Compartment" is equivalent to the DTA insert
- DTA insert can be removed during outage, and replaced with new insert
- Each DTA insert can contain fuel, capsules, and/or material specimens

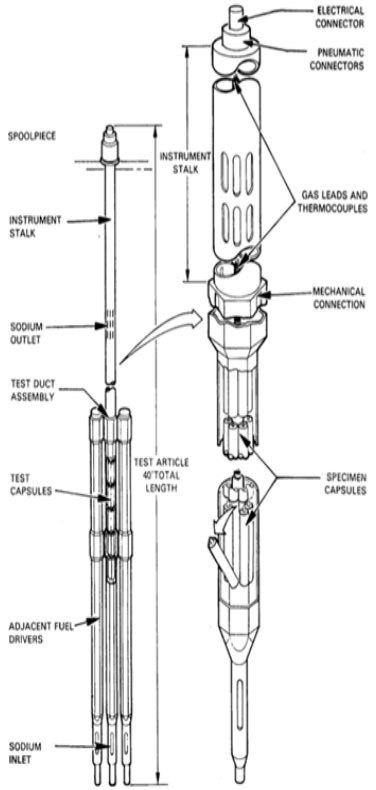
Preliminary

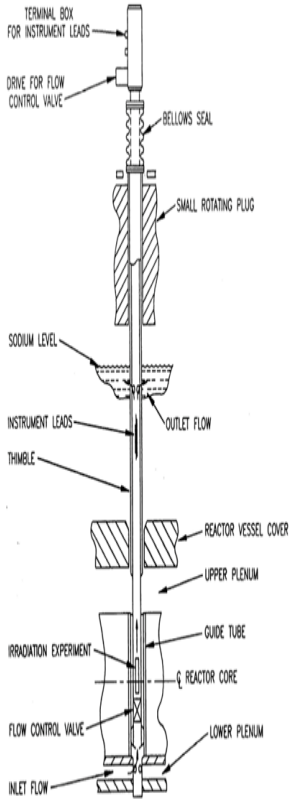
Extended Length Test Assembly (ELTA)

SOLVING ENERGY CHALLENGES THROUGH SCIENCE

- Contain various sensors to record the relevant physical conditions of the test article online, and may also manipulate the thermal-hydraulic environment during the test
  - Fuels
  - Materials
  - Cartridge loops (4)
    - Sodium
    - Pb/Pb-Bi
    - Molten salt
    - Gas



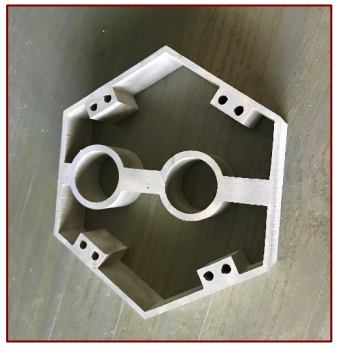


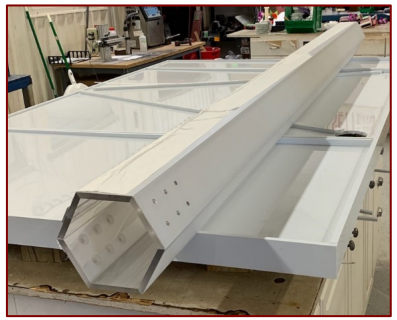


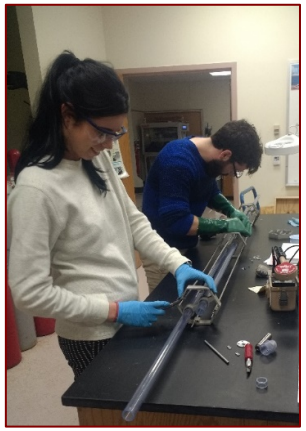
Preliminary

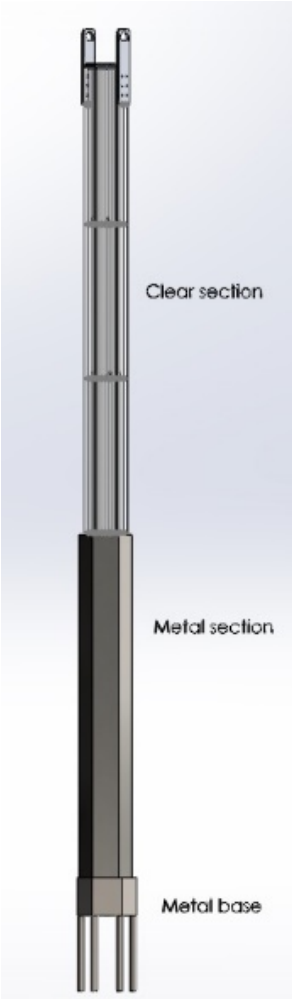
Rabbit Test Assembly (RTA)

- Rapid transfer system used for short-term irradiations
  - Design, modeling, and prototyping is being performed
  - Having discussions with DOE-SC and DOE-NNSA about requirements









Preliminary

VTR Experimental Capabilities Team

SOLVING ENERGY CHALLENGES THROUGH SCIENCE

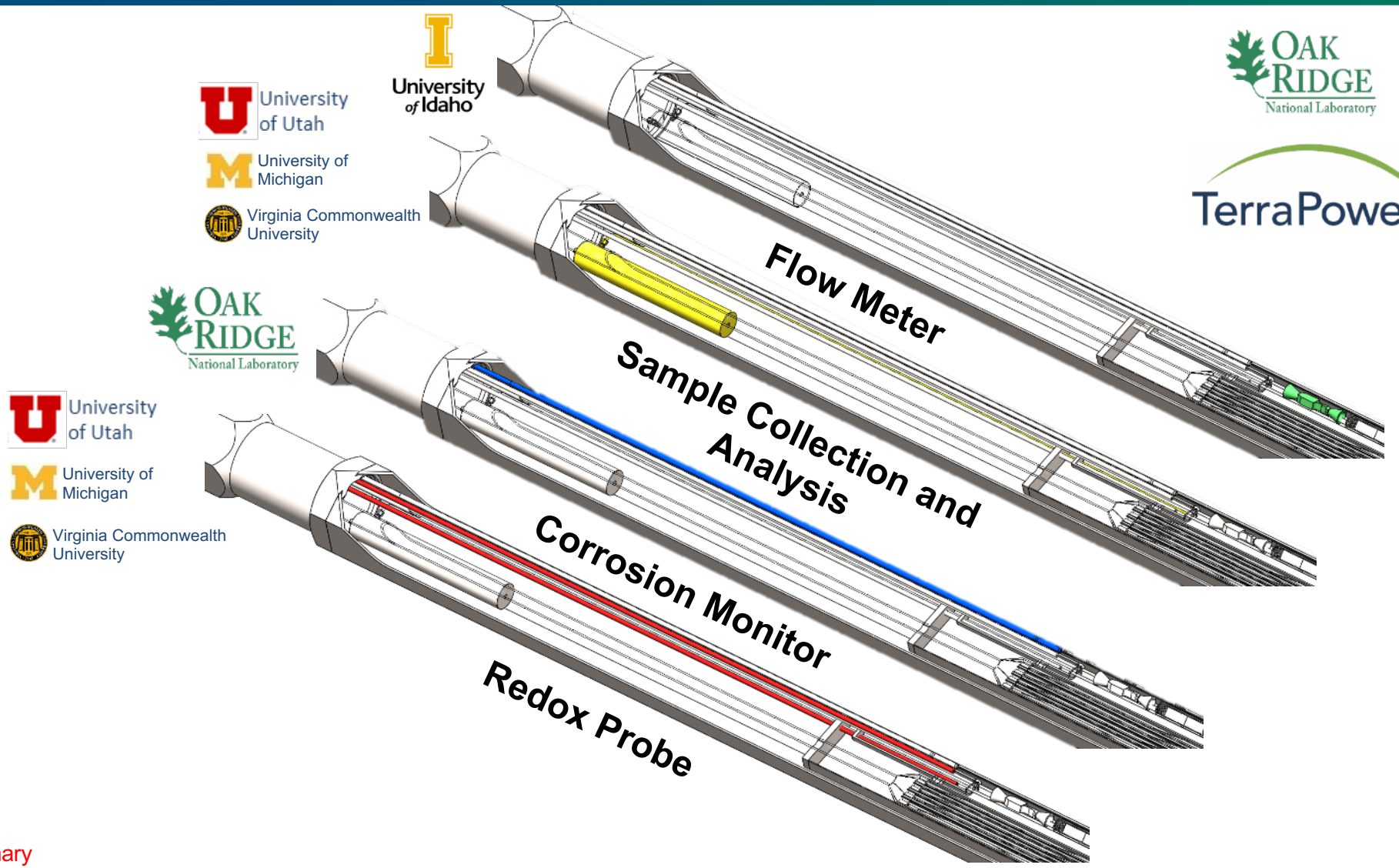
Experiment Vehicle or Area	Lead	Industry Partners	University Partners (does not include co-PI's)
VTR Experiments Integration	INL – Kevan Weaver	General Electric-Hitachi Cameron Group	n/a
NTA/DTA	INL – Nick Woolstenhulme	Cameron Group	n/a
ELTA – sodium cartridge loop	ANL – Mitch Farmer	Framatome	University of Wisconsin-Madison Purdue University
ELTA – lead/LBE cartridge loop	LANL – Cetin Unal	Westinghouse	University of New Mexico
ELTA – molten salt cartridge loop	ORNL – Joel McDuffee	TerraPower	University of Utah University of Idaho
ELTA – gas cartridge loop	INL – Piyush Sabharwall	General Atomics	Texas A&M University University of Michigan
ELTA – structural materials	LANL – Tarik Saleh	EPRI	Oregon State University Purdue University
RTA	PNNL – David Wootan	n/a	Texas A&M University
Digital Engineering (VDC/BIM and M&S)	INL – Chris Ritter	TerraPower	North Carolina State University Virginia Commonwealth University
Instrumentation & Controls	ORNL – Sacit Cetiner	Cosylab	Abilene Christian University Georgia Tech Massachusetts Institute of Technology University of Pittsburgh
Cross Cutting Technologies	INL – Dan Wachs	n/a	Oregon State University

Preliminary

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

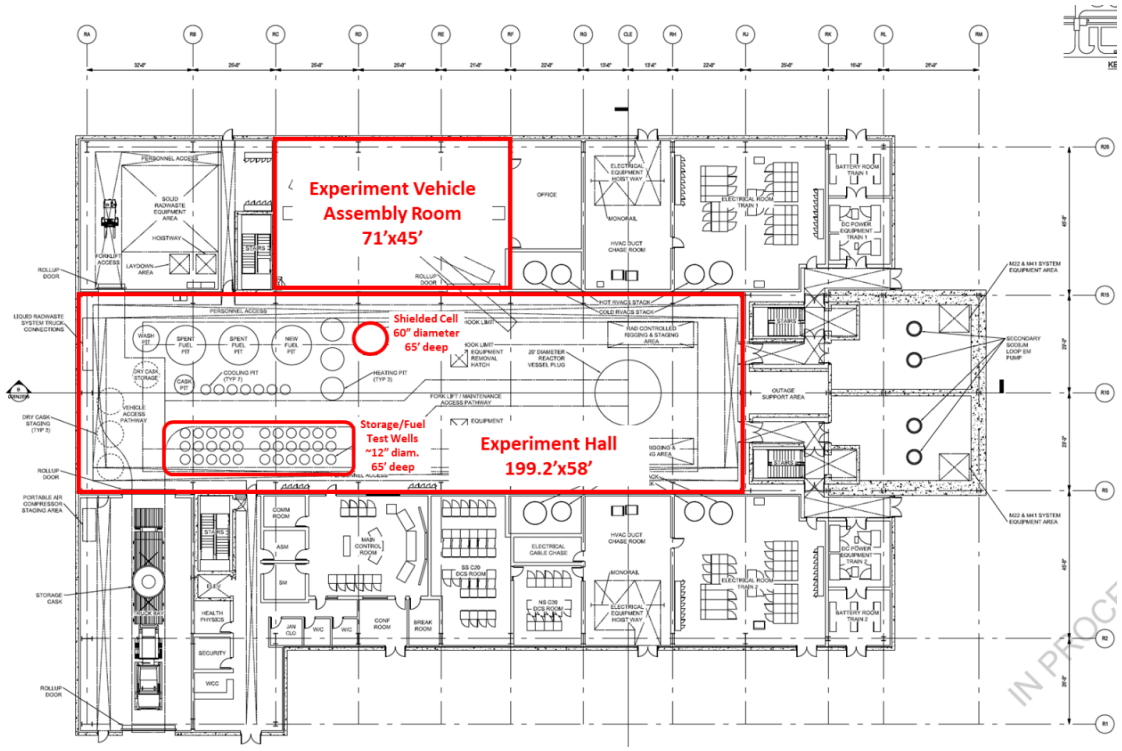


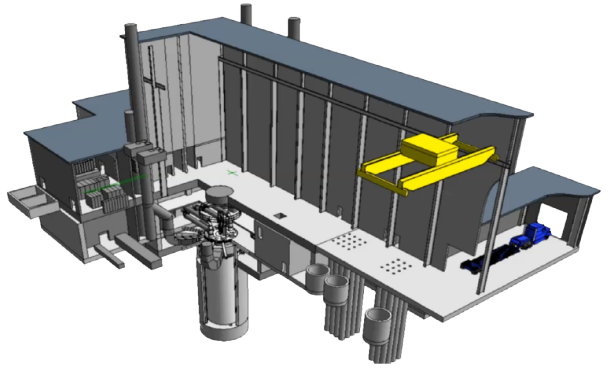
Overall Integration and Design

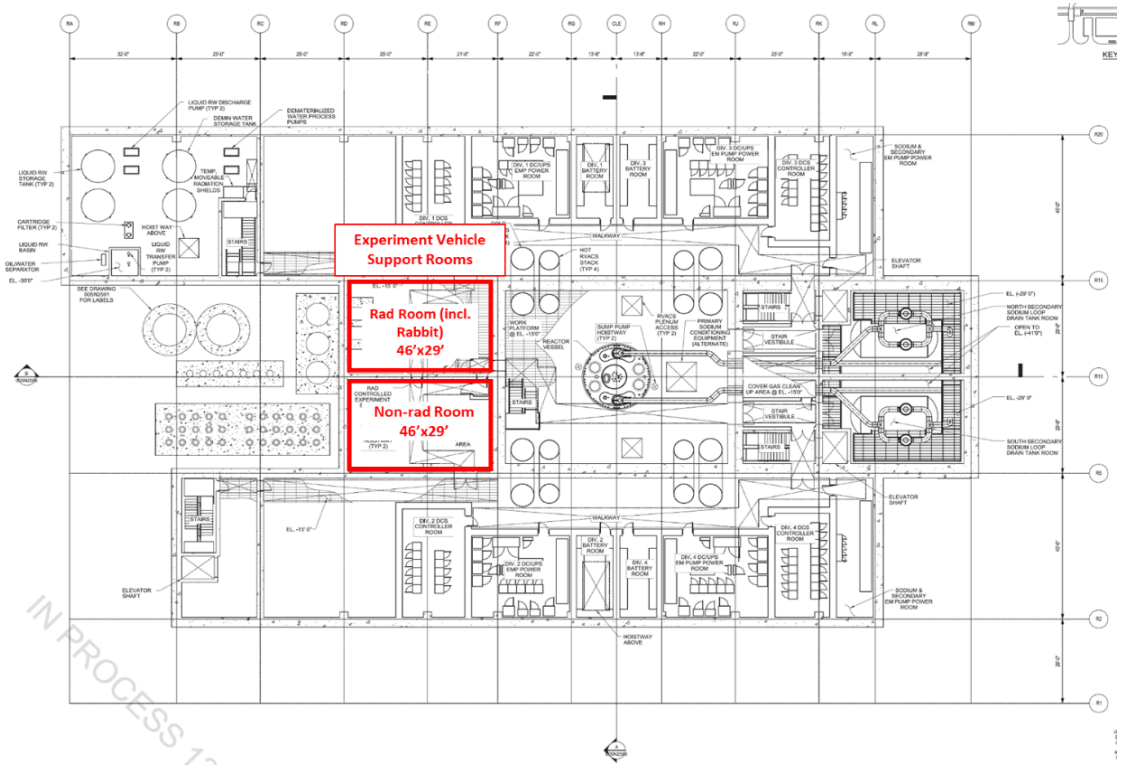
Preliminary

VTR – Designed for Testing

SOLVING ENERGY CHALLENGES THROUGH SCIENCE







- PIE will be performed at existing hot cells and support facilities at INL or ORNL

Preliminary

SOLVING ENERGY CHALLENGES
THROUGH SCIENCE

inl.gov/vtr | 208-526-1151 | vtr@inl.gov

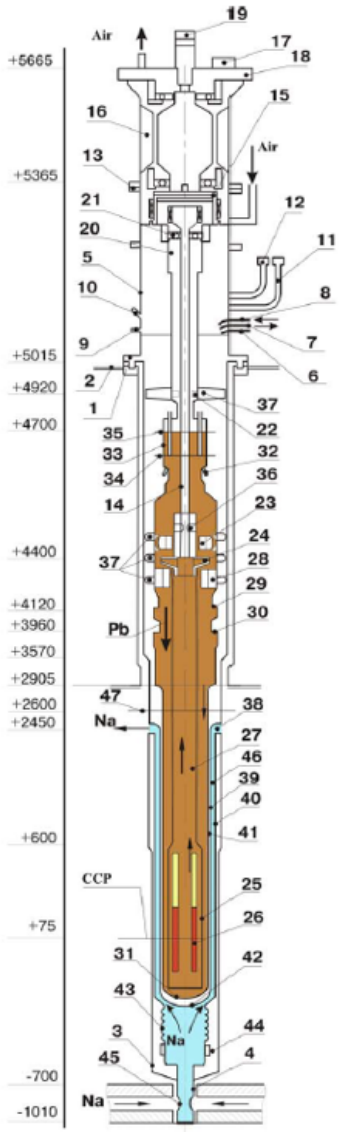
SOLVING ENERGY CHALLENGES
THROUGH SCIENCE

Backup Slides

National Academy of Sciences

Example Cartridge Loop:
The ILC (Independent Pb-Cooled Channel) in BOR-60

SOLVING ENERGY CHALLENGES THROUGH SCIENCE



CCP - central core plain

1 – flange;
2 – rotating plug upper plate;
3 – channel case;
4 – tail;
5 – window;
6 – filling pipe connection;
7 – gas outlet connection;
8 – immersible gas pipe connection;
9 – connection for gas supply to safeguard cavity;
10 – ORS terminal;
11 – electric heater terminal connector;
12 – measuring connector;
13 – flange of rotor lower bearing case;
14 – pump shaft;
15 – magnetic coupling;
16 – electric motor case;
17 – electric power connector;
18 – pump drive cap;
19 – eye bolt;
20 – upper gas volume of the lead chamber;
21 – ball bearing;
22 – intermediate shaft support;
23 – immersible self-aligning plain bearing;
24 – pump impeller;
25 – FA shroud;
26 – fuel element mock-ups;
27 – central tube;
28 – guide;
29 – thermal converter cables and bypass tubes outlets;
30 – electric heater cables and filling tube outlets;
31 – lead chamber bottom;
32 – bypass tubes inlets;
33 – oval tube;
34 – elevation of ORS element location;
35 – coolant level;
36 – side windows of the central shaft cavity;
37 – pylons;
38 – boss with side windows;
39 – internal tube;
40 – external tube;
41 – heat exchange zone;
42 – semi-spherical bottom;
43 – bellows compensator;
44 – sodium flow meters;
45 – side windows;
46 – annular gap for sodium pumping;
47 – sodium reactor level.