Accomplishments of the International Criticality Safety Benchmark Evaluation Project (ICSBEP) During 2010

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Idaho National Laboratory (INL)

Nuclear Criticality Safety Program Symposium
Oak Ridge National Laboratory
1 – 2 March 2011

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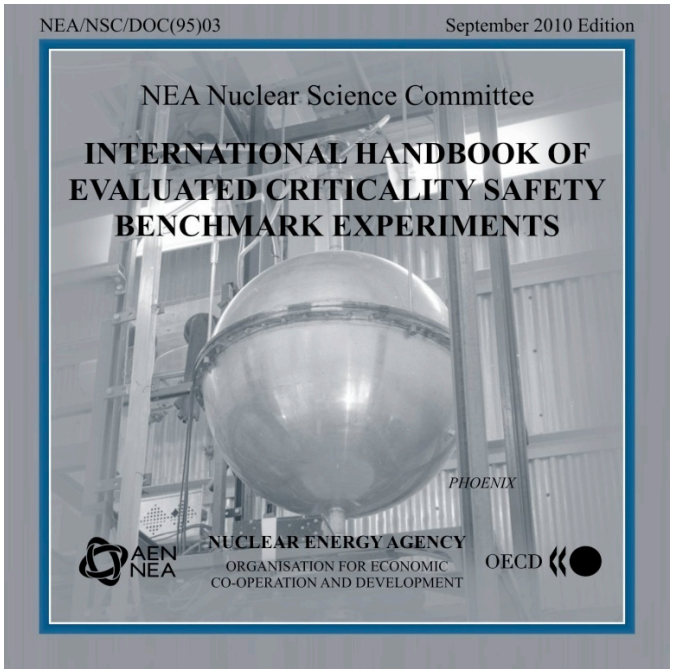
Outline

- Publication of the 2010 Edition of the ICSBEP Handbook
- 25 newly approved benchmark evaluations
  - 12 from the United States
  - 13 from outside the United States
- Upgrades to ICSBEP database and user interface, DICE

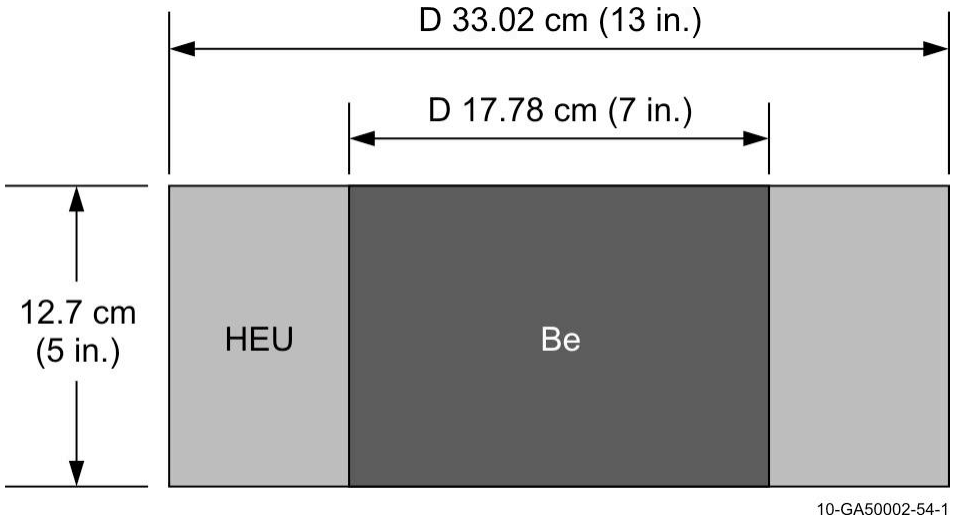
International Handbook of Evaluated Criticality Safety Benchmark Experiments

- **September 2010 Edition**
  - 20 Contributing Countries
  - Spans nearly 55,000 Pages
  - Evaluation of 516 Experimental Series
  - 4,405Critical or Subcritical Configurations
  - 24 Criticality-Alarm/Shielding Benchmark Configurations – numerous dose points each
  - 155 fission rate and transmission measurements and reaction rate ratios for 45 different materials
  - 25 New Evaluations in 2010

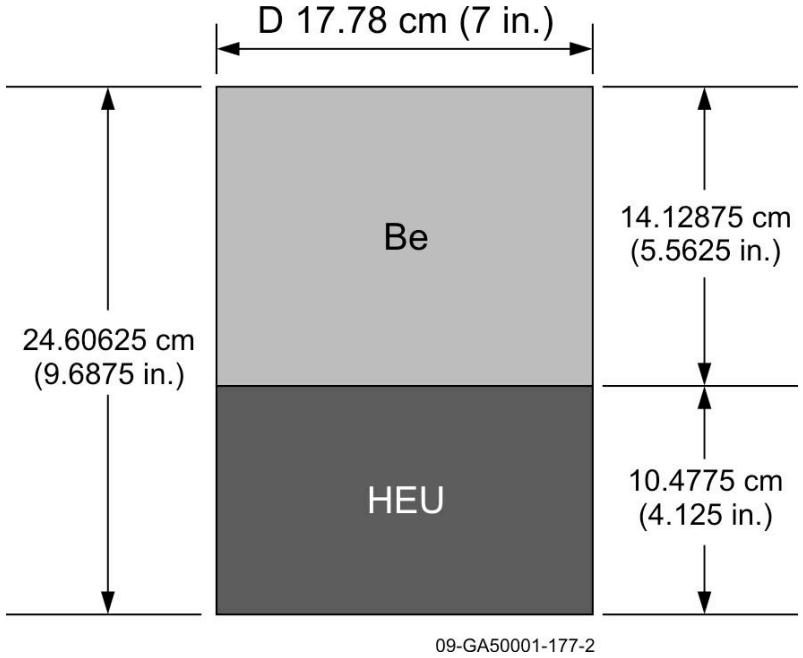
  - http://icsbep.inl.gov



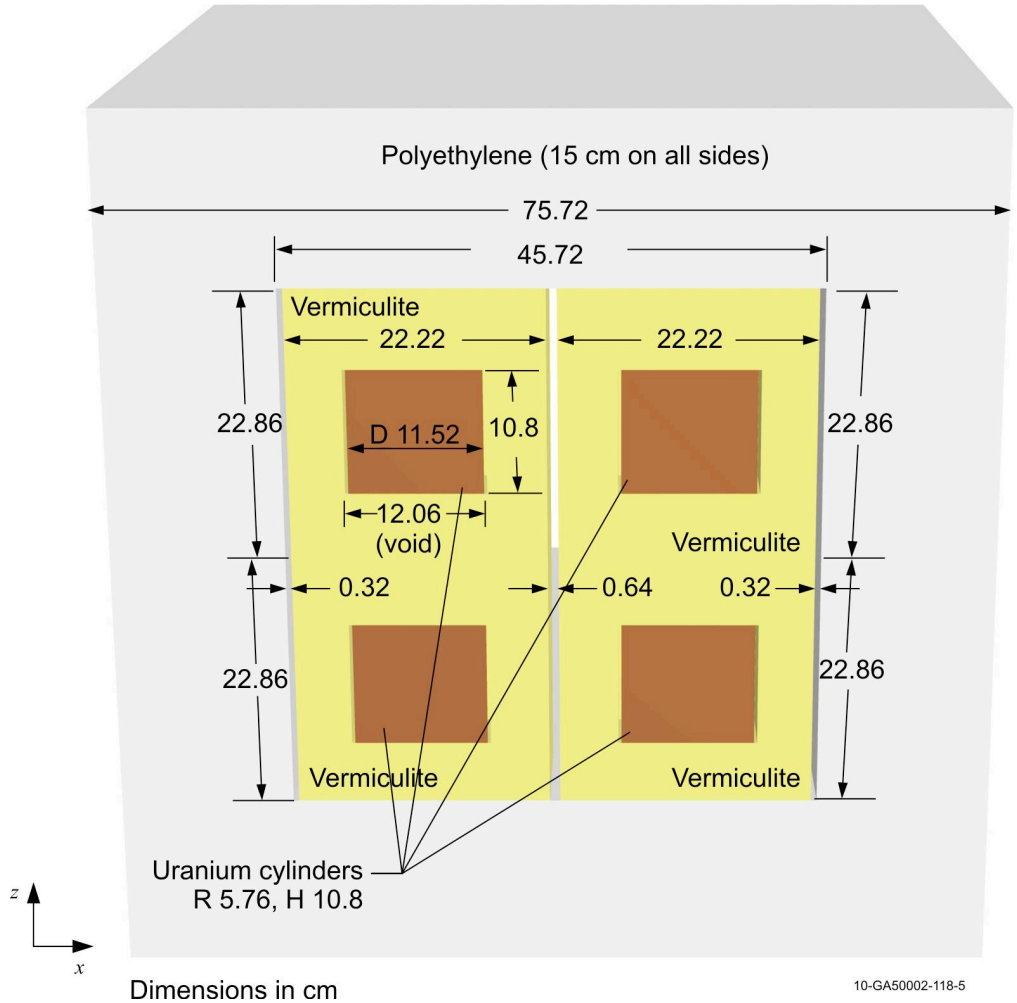
ORALLOY (93.15 ^{235}U) Metal Annuli with Beryllium Core (HEU-MET-FAST-059) – INL



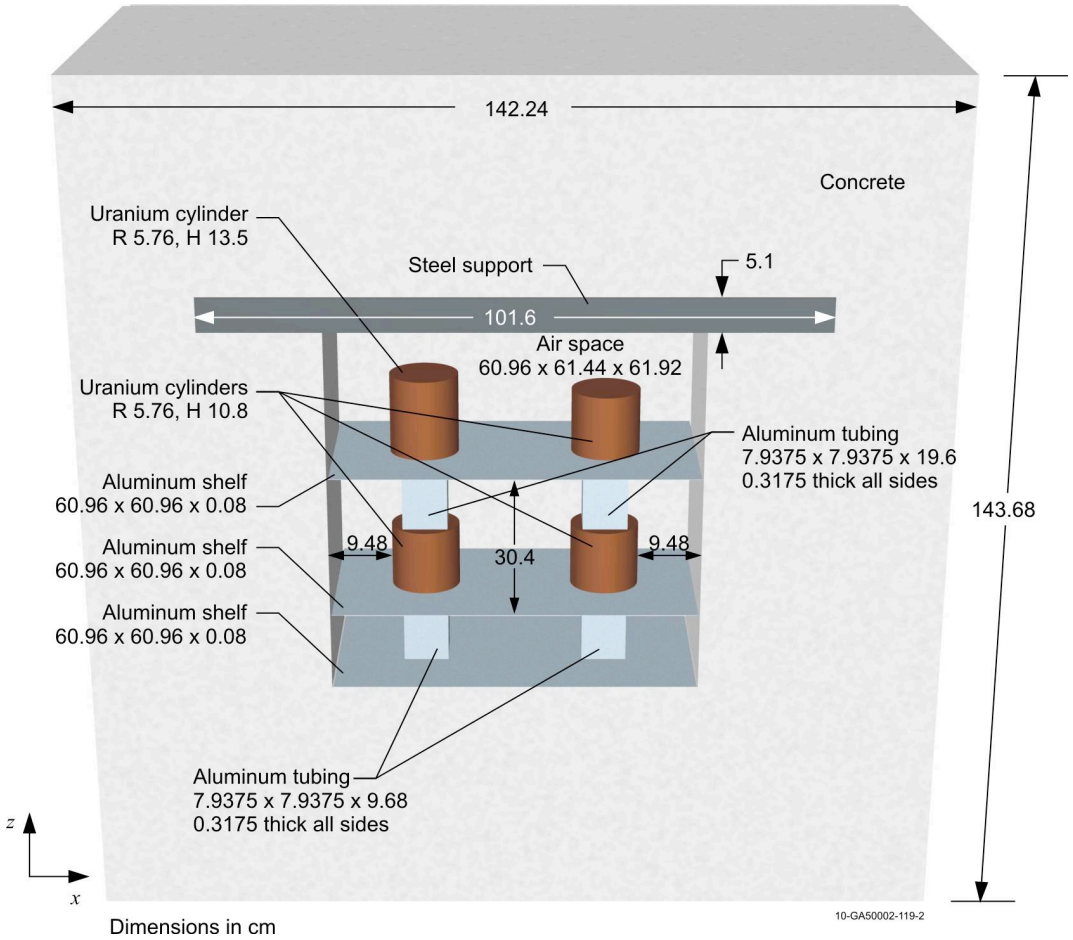
ORALLOY (93.2 ^{235}U) Metal Cylinder with Beryllium Top Reflector (HEU-MET-FAST-069) – INL



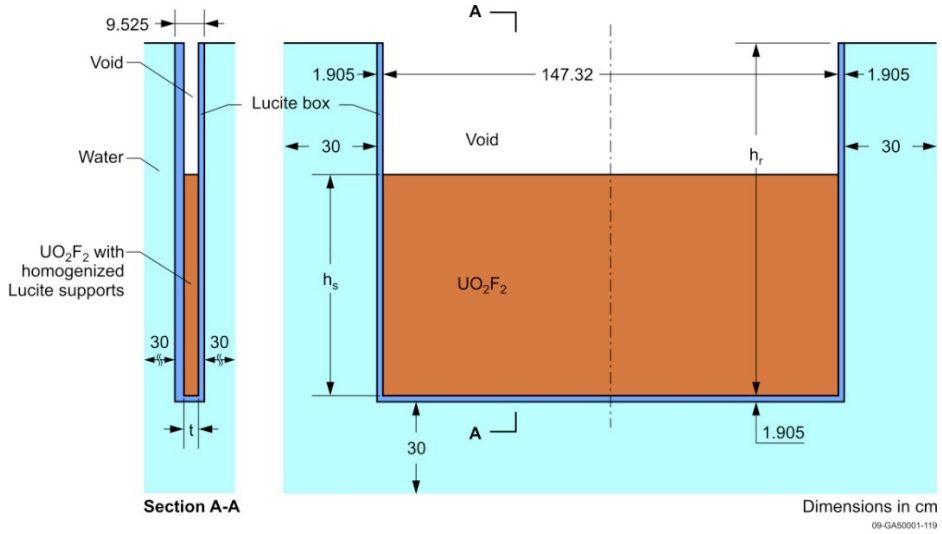
Polyethylene-Reflected Arrays of HEU(93.2) Metal Units Separated by Vermiculite (HEU-MET-FAST-056) – INL / ISU

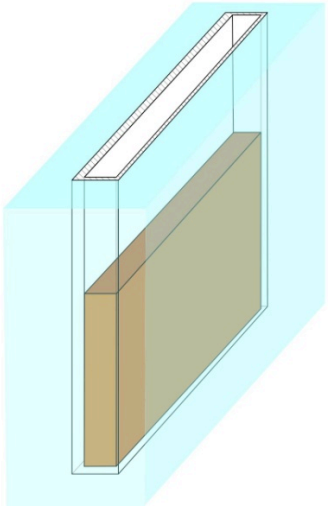


Concrete Reflected Arrays of U(93.2) Metal (HEU-MET-FAST-054) – INL / ISU



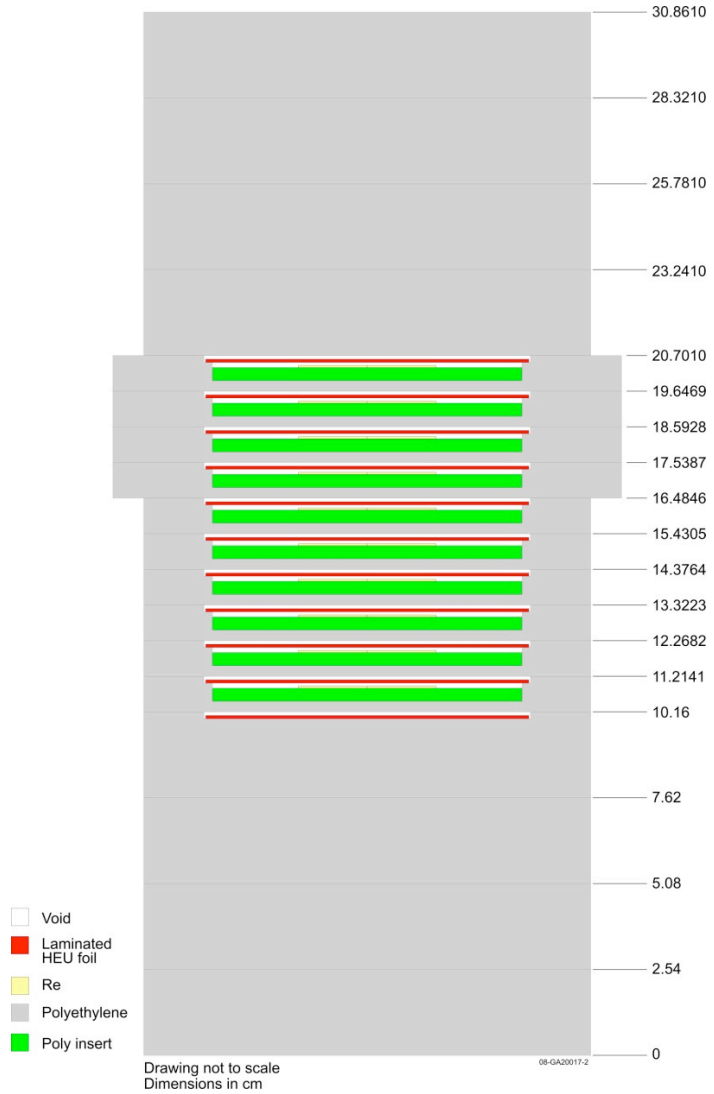
Water-Moderated and -Reflected Slabs of Uranium Oxyfluoride (HEU-SOL-THERM-034) – INL / University of Utah



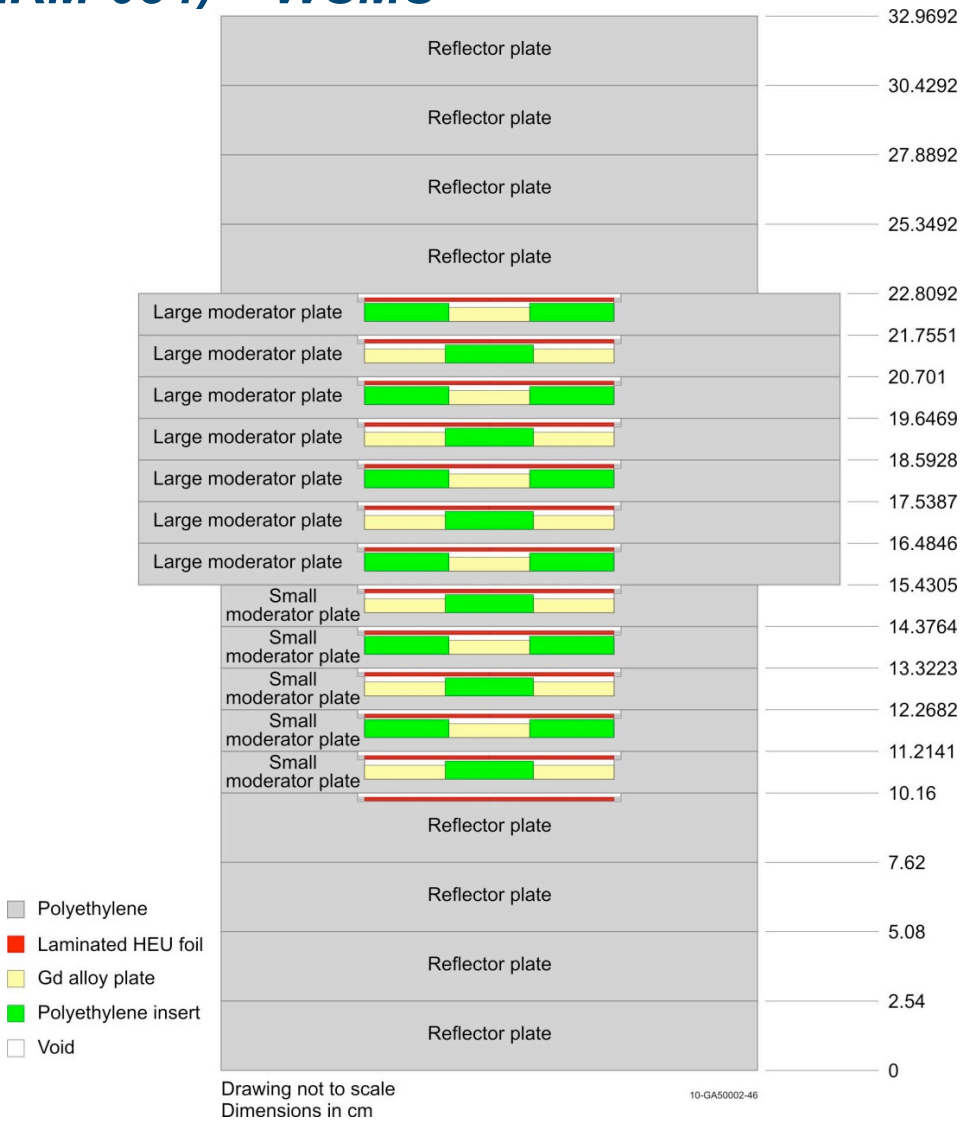


Perspective view
(Not to scale)

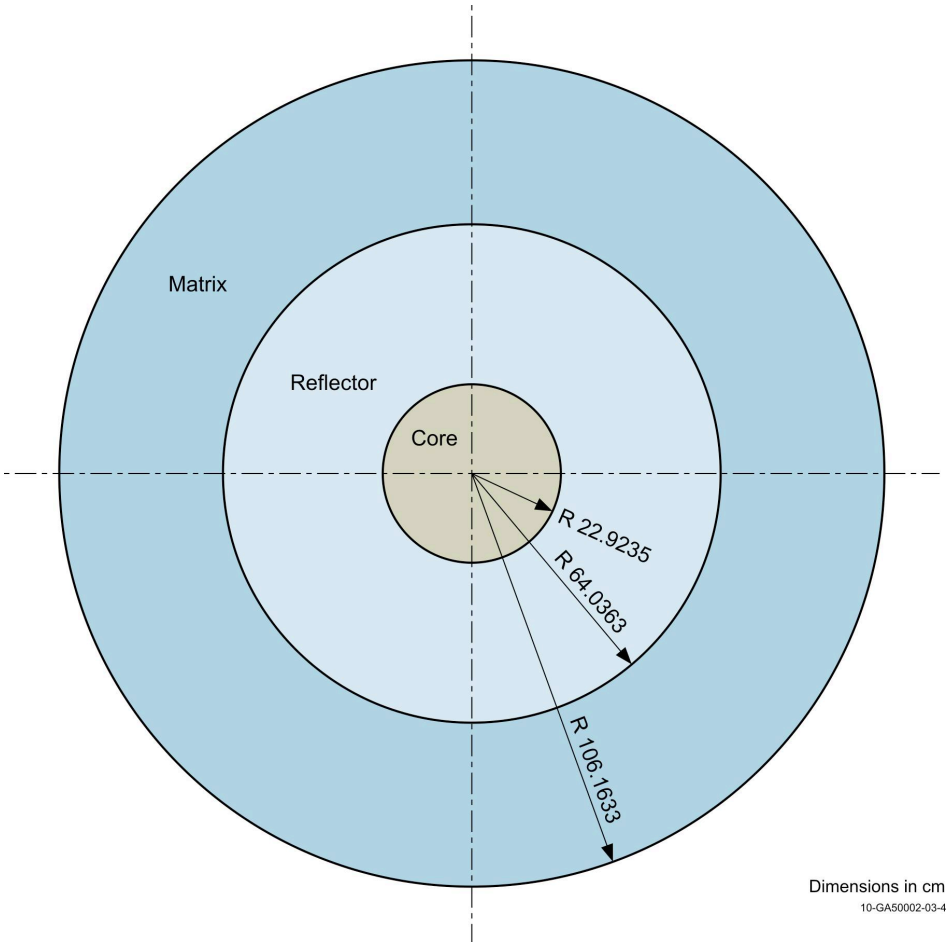
2 x 2 Polyethylene Reflected and Moderated Highly Enriched Uranium System with Rhenium (HEU-MET-THERM-033) – ENE



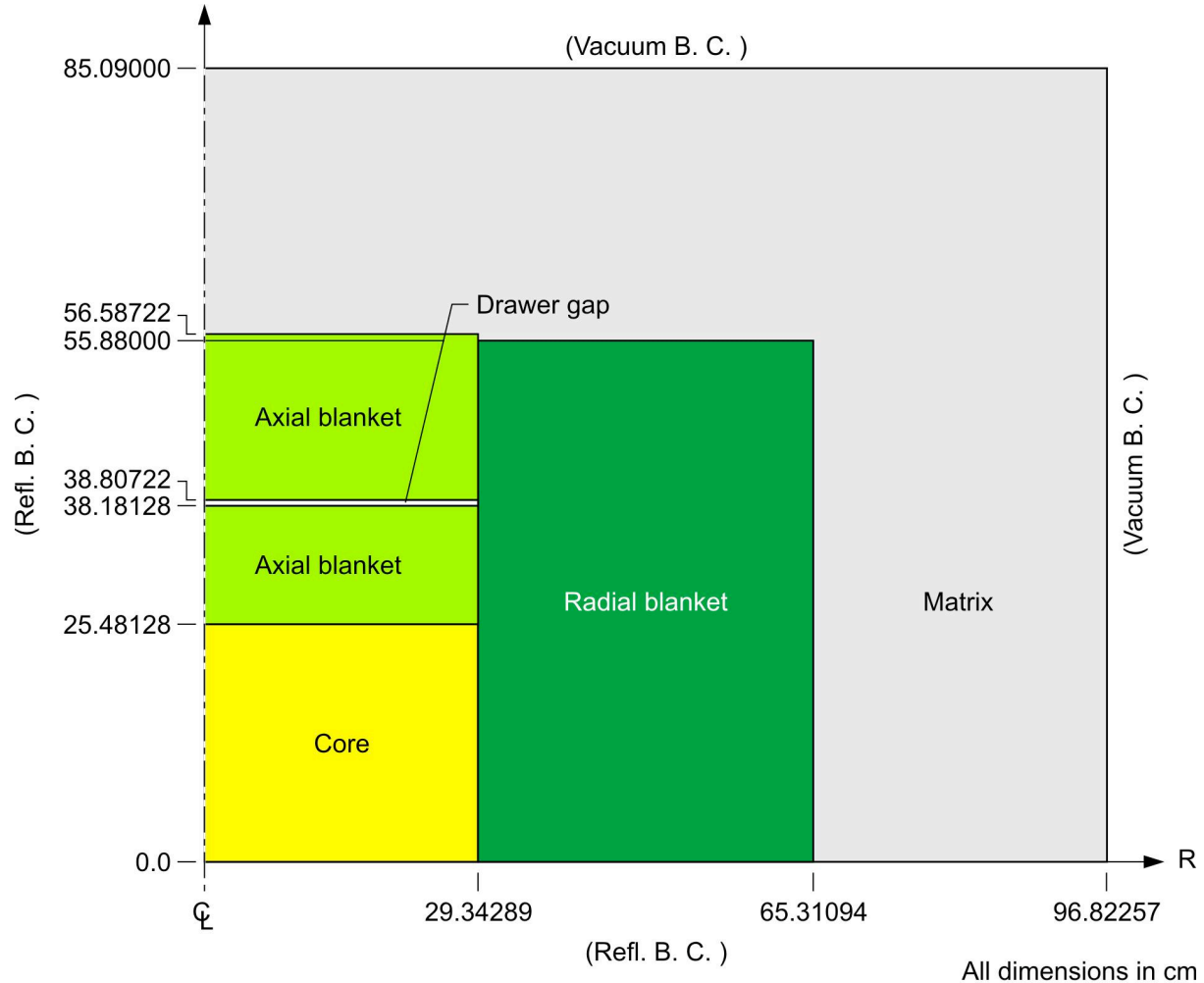
2 x 2 x 13 Array of Highly Enriched Uranium with NI-CR-MO-GD Alloy, Moderated and Reflected by Polyethylene (HEU-MET-THERM-034) – WSMS



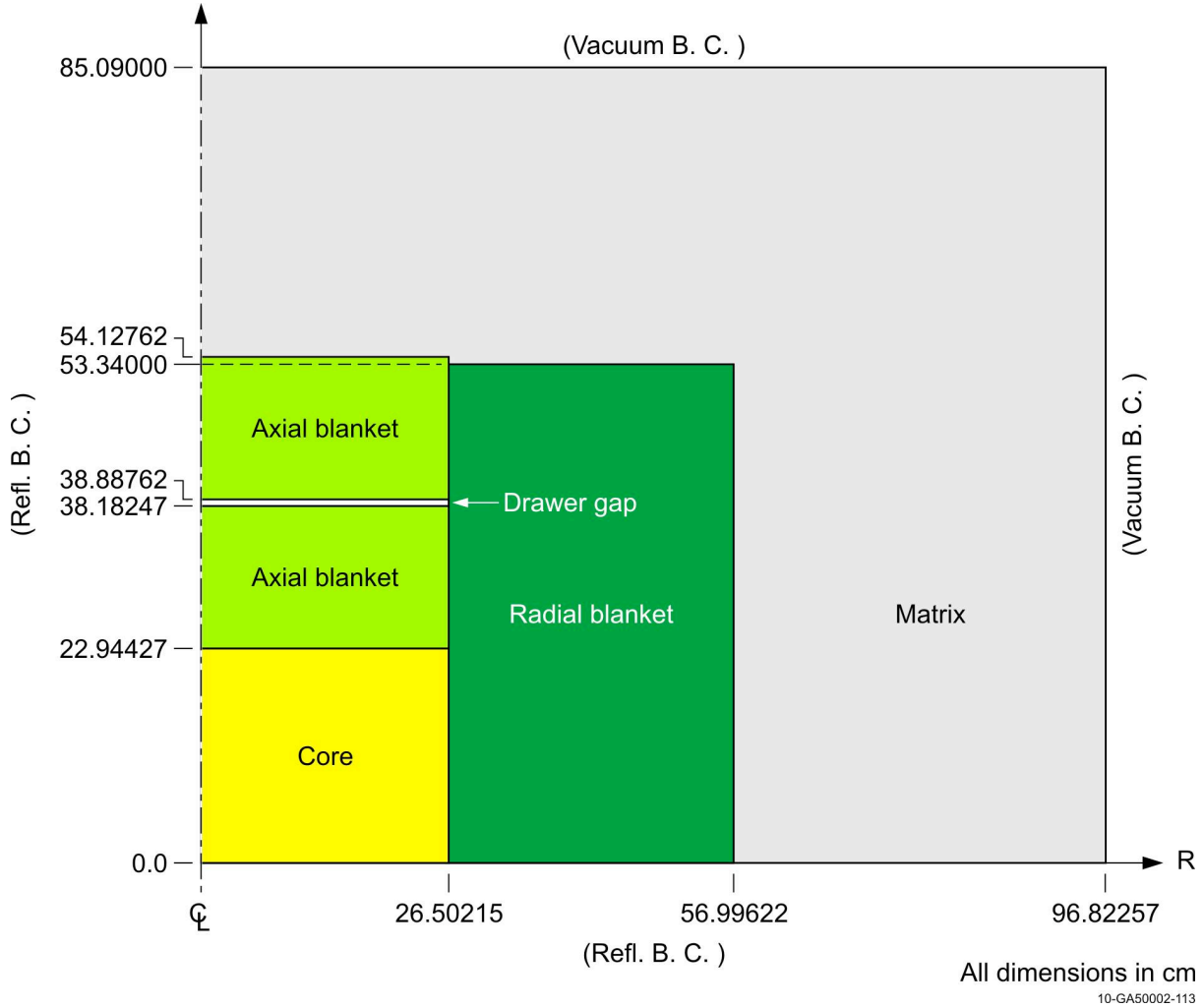
ZPR-3 Assembly 6F: A Spherical Assembly of Highly Enriched Uranium, Depleted Uranium, Aluminum and Steel with an Average ^{235}U Enrichment of 47 Atom % (IEU-MET-FAST-015) – ANL



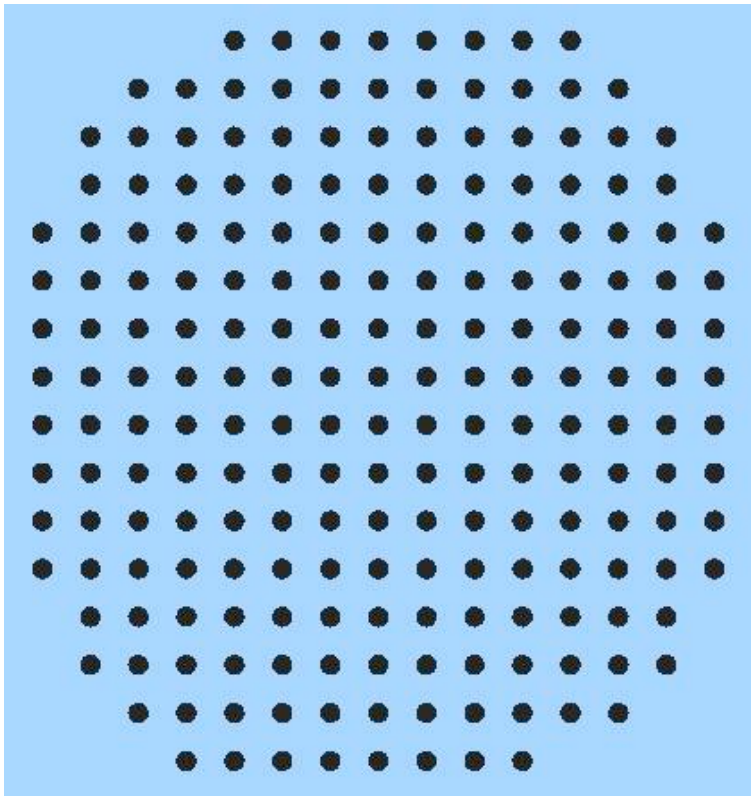
ZPR-3 Assembly 11: A Cylindrical Assembly of Highly Enriched Uranium and Depleted Uranium with an Average ^{235}U Enrichment of 12 Atom % and a Depleted Uranium Reflector (IEU-MET-FAST-016) – ANL



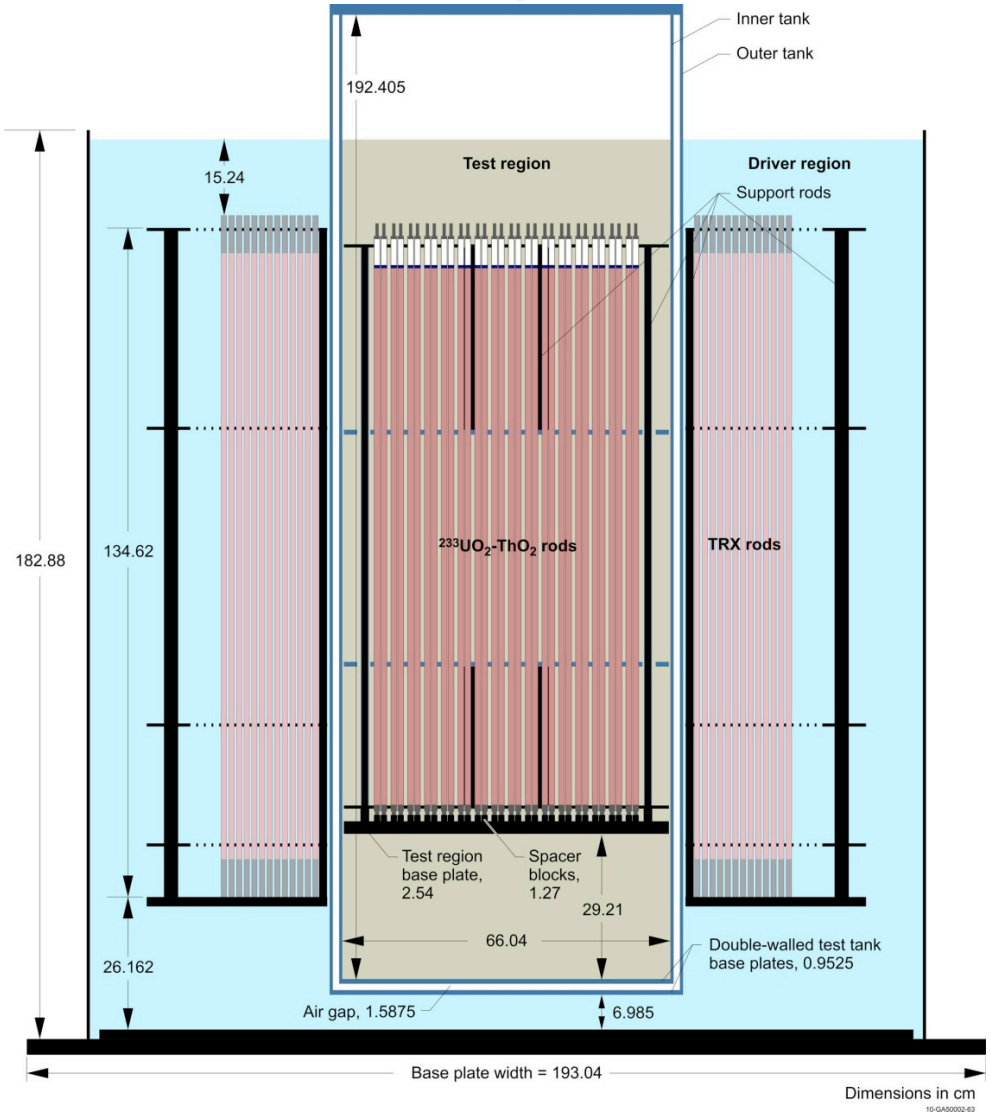
ZPR-3 Assembly 12: A Cylindrical Assembly of Highly Enriched Uranium, Depleted Uranium and Graphite with an Average ^{235}U Enrichment of 21 Atom % (IEU-COMP-FAST-004) – ANL



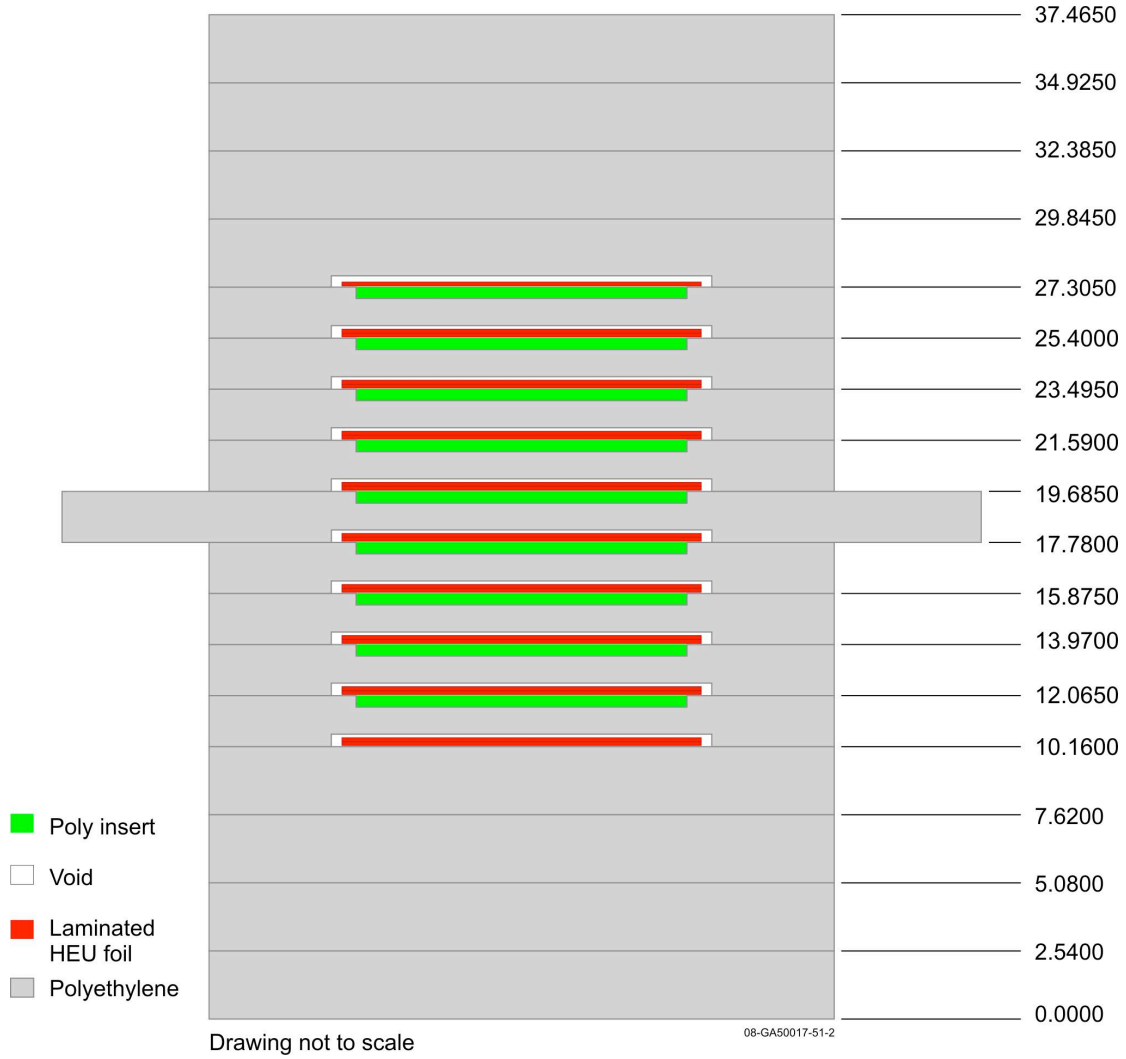
U(4.89) Metal Rods in Water or Uranyl Fluoride Solution (LEU-MET-THERM-007) – DOE-OR / ORNL / University of Tennessee



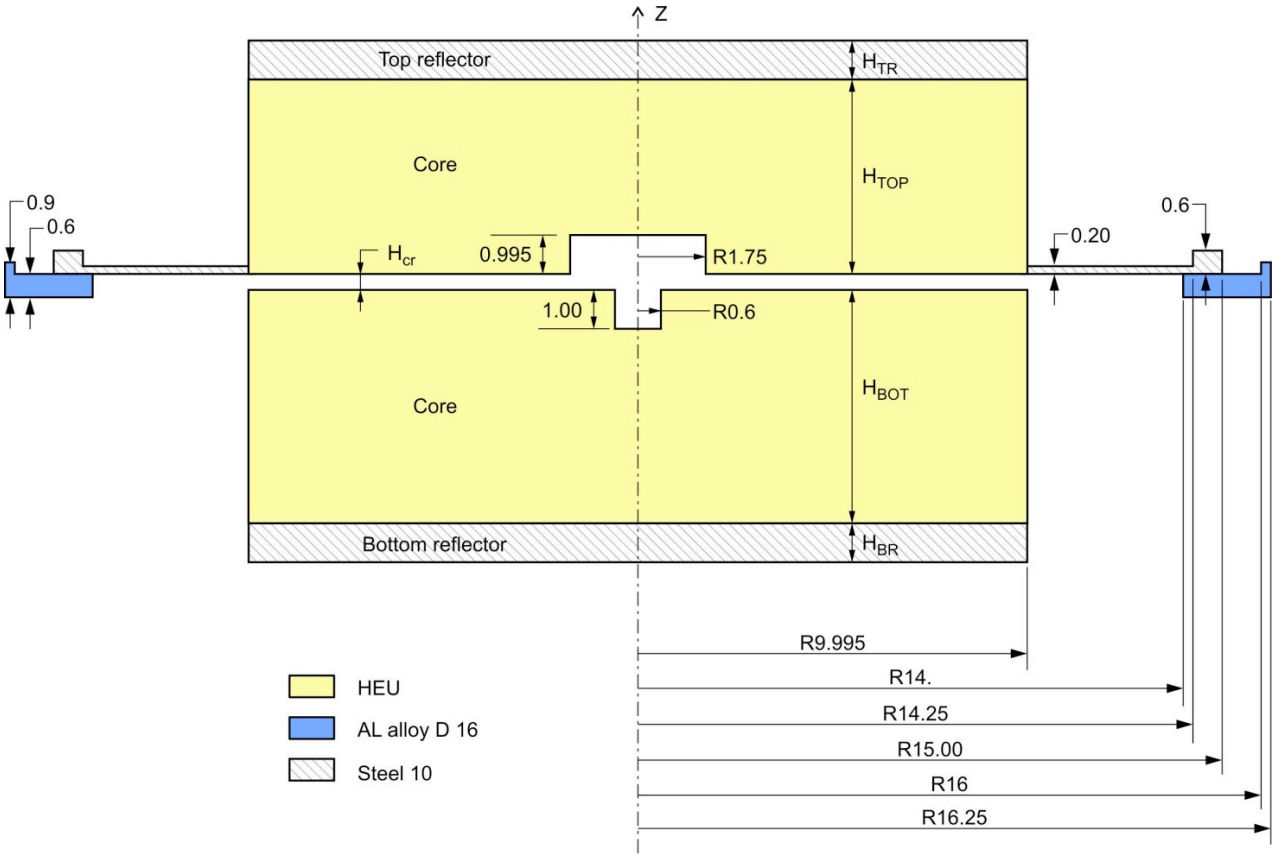
D_2O MODERATED LATTICE of $^{233}UO_2$-$^{232}ThO_2$ (U233-COMP-THERM-004) – WSMS



One Dimensional Array of Highly Enriched Uranium, Moderated and Reflected by Polyethylene (HEU-MET-THERM-032) – JSI, Slovenia



HEU Cylinders Axially Reflected by Steel (HEU-MET-FAST-043) or Aluminum (HEU-MET-FAST-044) – VNIITF, Russia

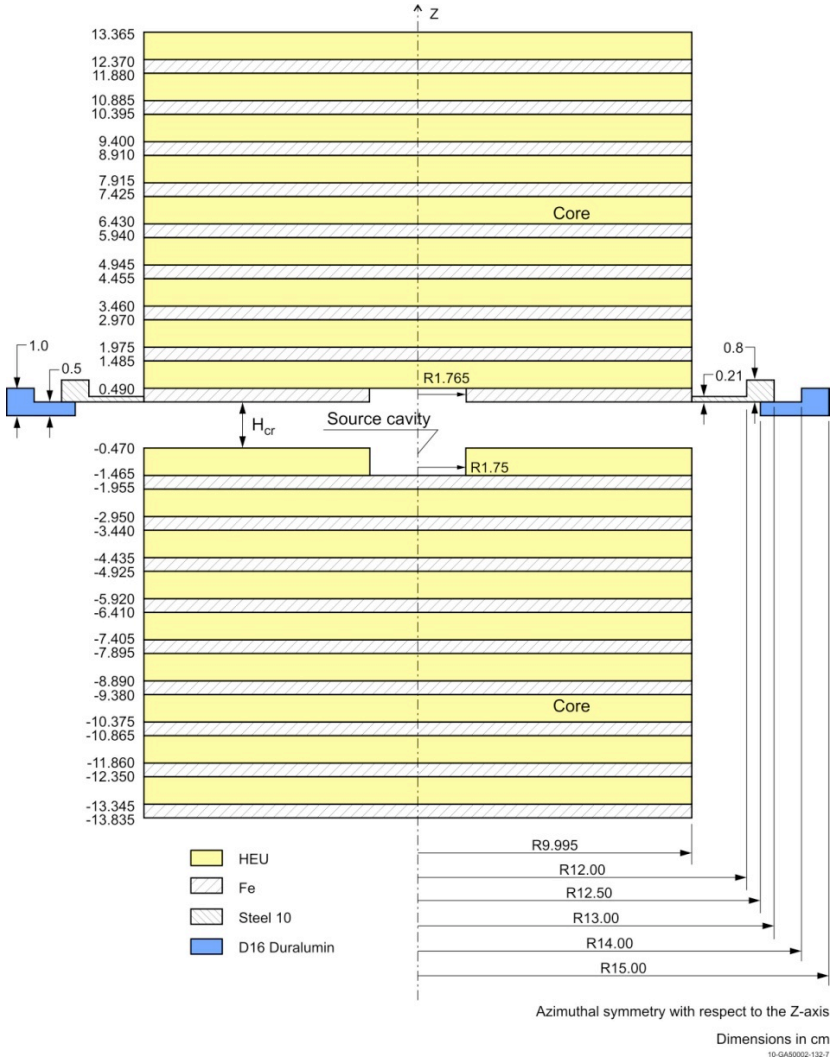


Azimuthal symmetry with respect to the Z-axis

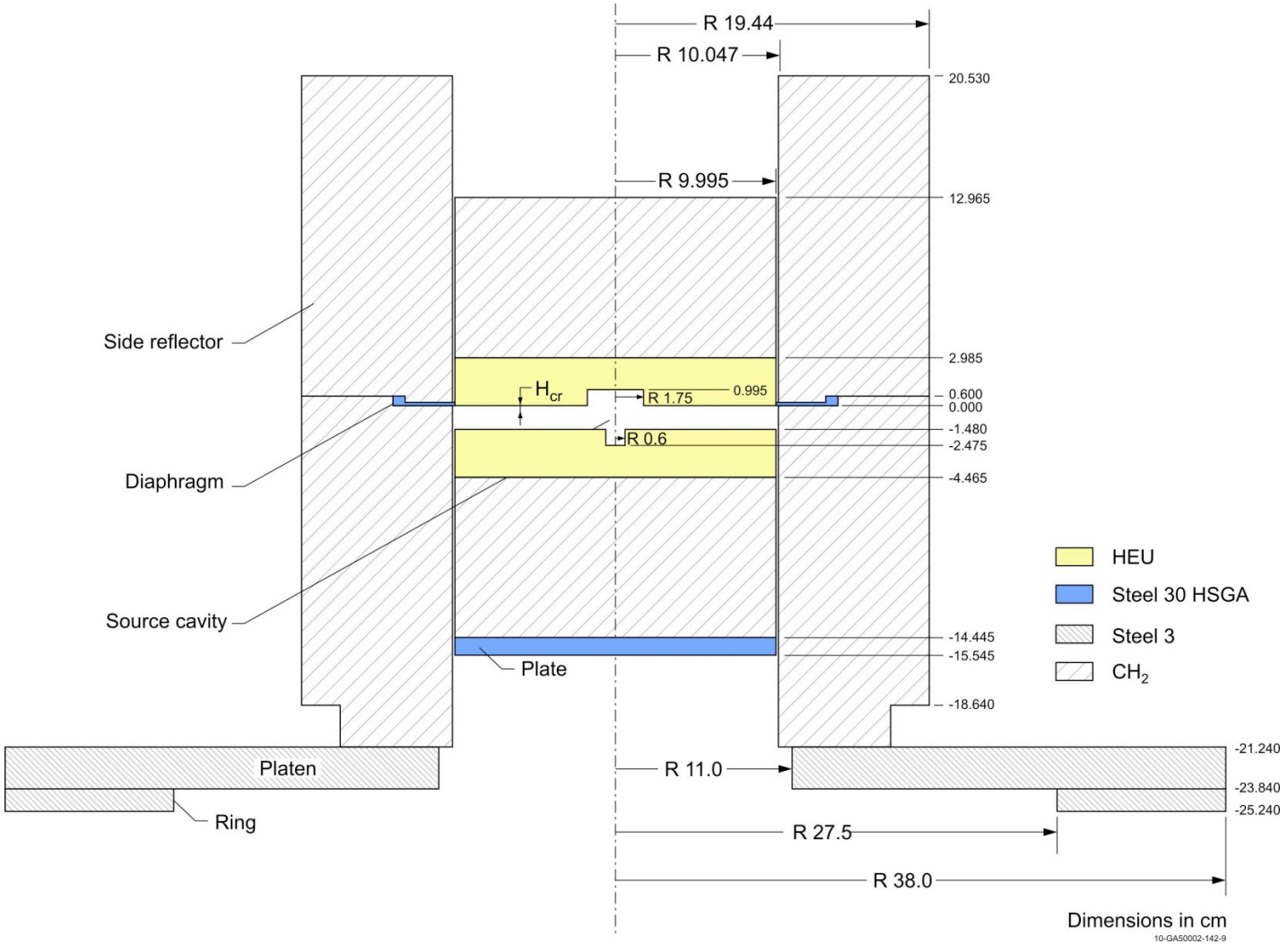
Dimensions in cm

10-GA50002-131-6

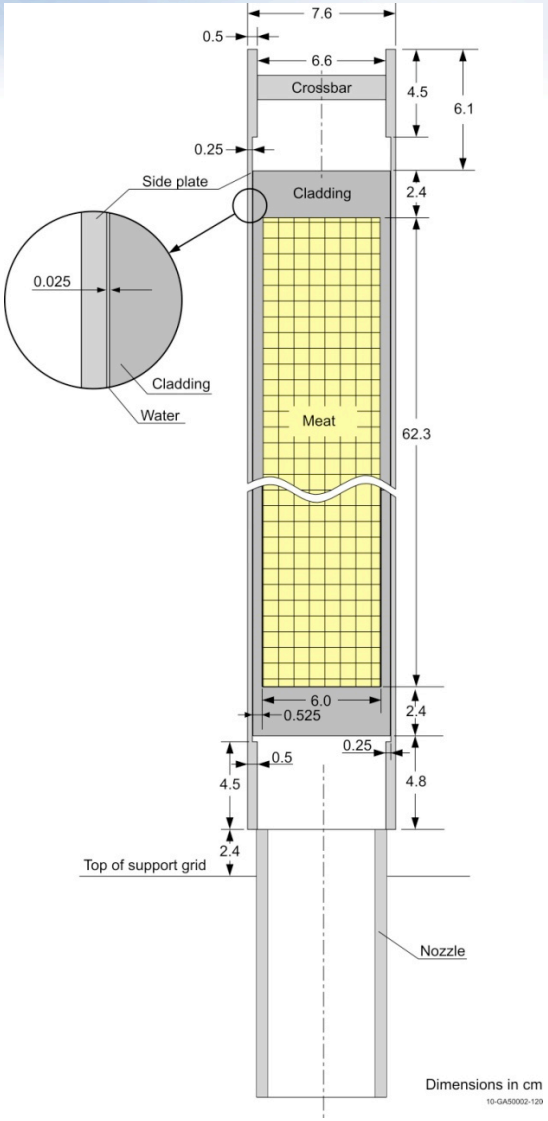
Heterogeneous Iron-Diluted (HEU-MET-FAST-087) or Aluminum-Diluted (HEU-MET-FAST-089) HEU Cylinder – VNIITF, Russia



Highly Enriched Uranium Cylinder Reflected by Polyethylene (HEU-MET-FAST-091) – VNIITF, Russia



RA-6 Reactor: Water Reflected, Water Moderated U(19.77)3Si2-Al Fuel Plates (IEU-COMP-THERM-014) – CNEA, Argentina



Bare and Water-Reflected Spheres and Hemispheres of Aqueous Uranyl Fluoride Solutions (30.45% ^{235}U) (IEU-SOL-THERM-002) – AWE, United Kingdom

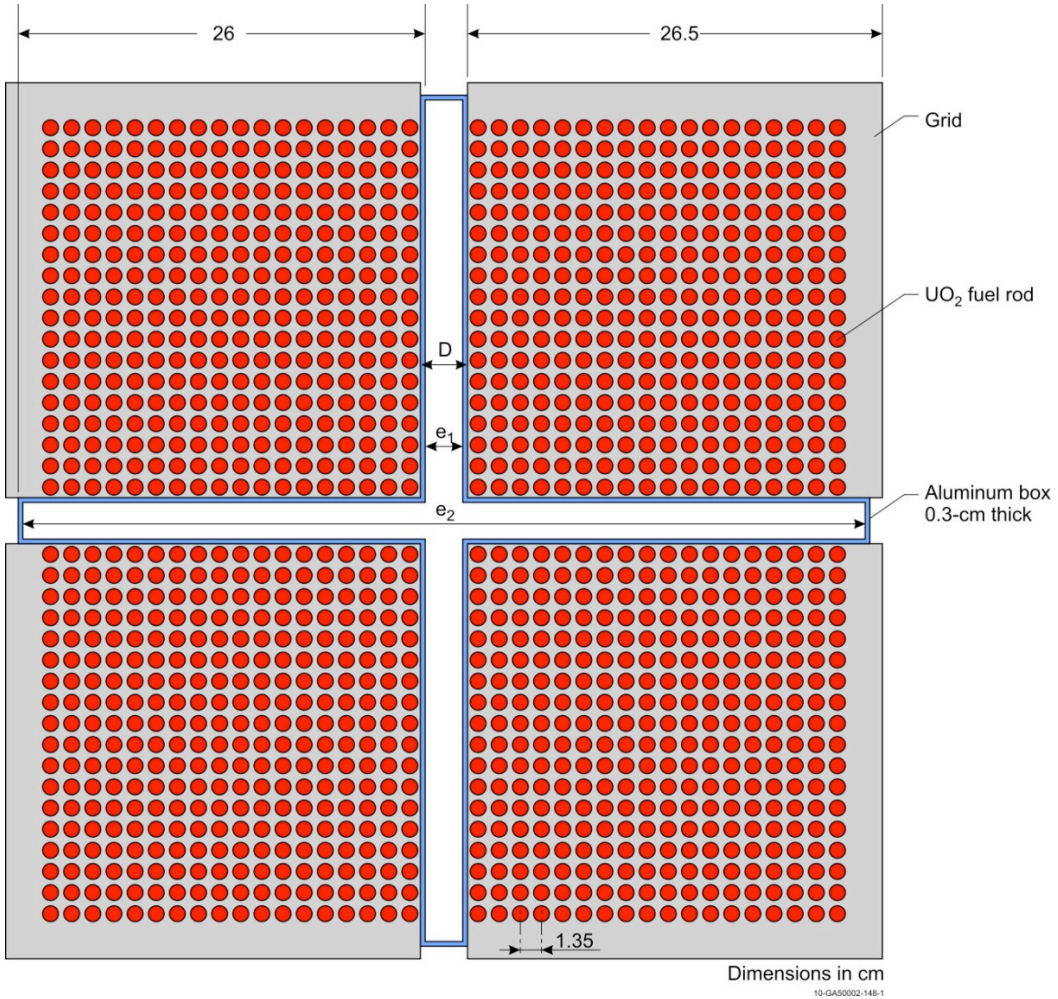
Early Pioneers

Members of the Dounreay criticality team in front of Cell 1 (with US visitors) – May 1959.
From left: Vic Parker, Eric Thornthwaite, Alan Bray, J. C. Smith, Gordon Hansen, Hugh Paxton, John Walford, Roy Reider, Jimmy Lyons, Bob Hack, George White.
(Hansen, Paxton and Reider were visiting from LASL.)

4.738-WT.%-Enriched Uranium Dioxide Fuel Rod Arrays Reflected by Water in a Dry Storage Configuration (IEU-COMP-THERM-057) – IRSN, France

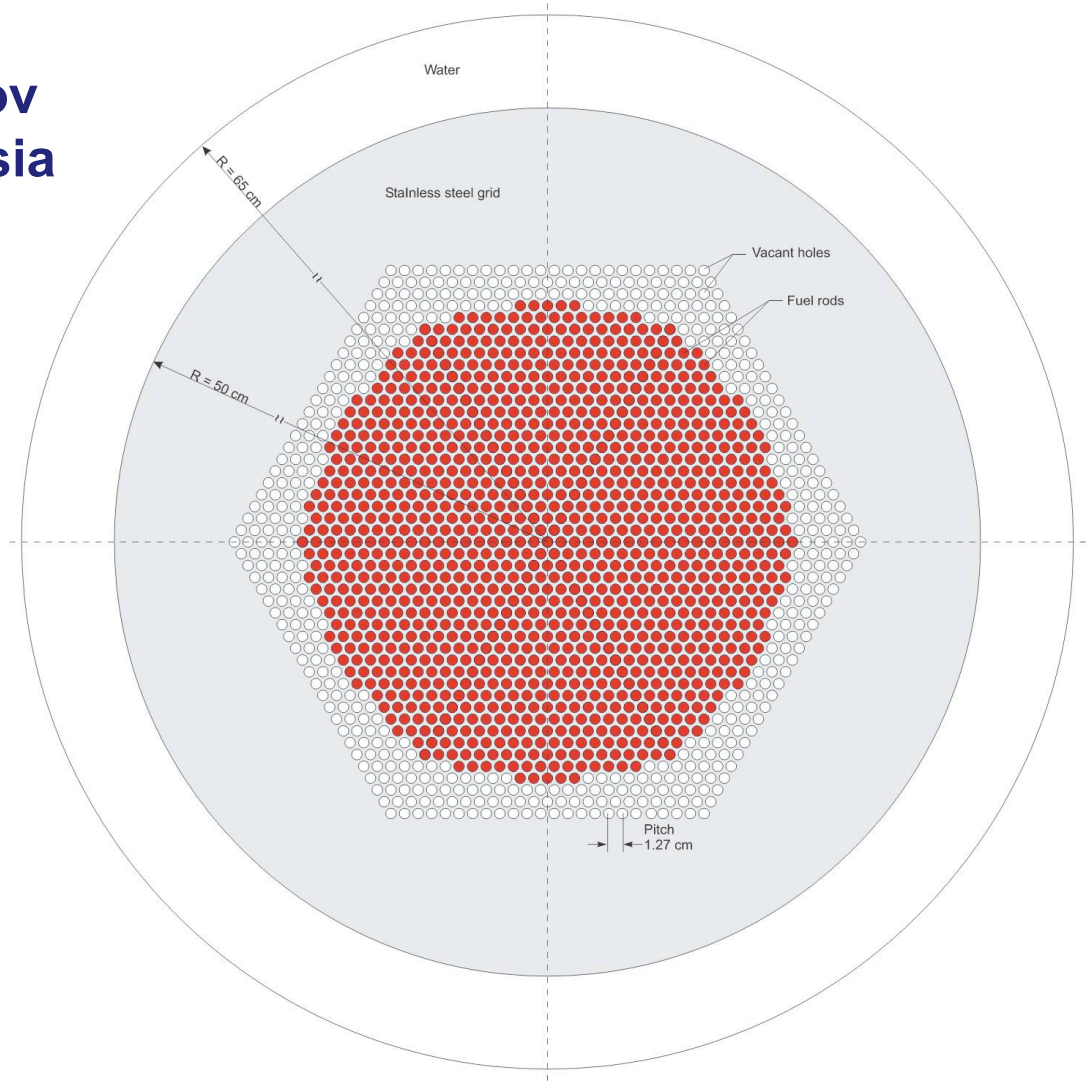
Aluminum Box Contains

- Air
- Water
- Polystyrene
- Polyethylene

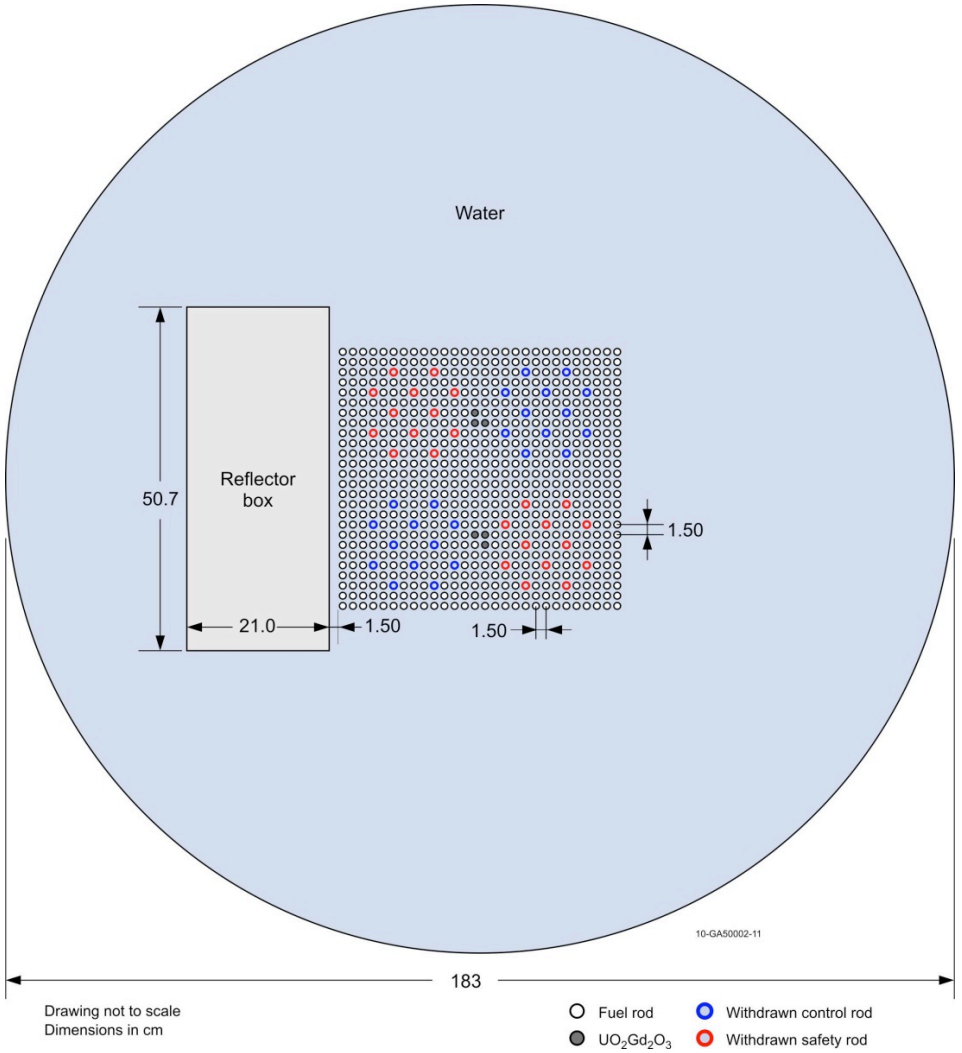


VVER Physics Experiments: Regular Hexagonal (1.27 cm Pitch) Lattices of Low-Enriched U(3.5 WT.% $^{235}U)O_2$ Fuel Rods in Light Water at Different Core Critical Dimensions (LEU-COMP-THERM-030) –

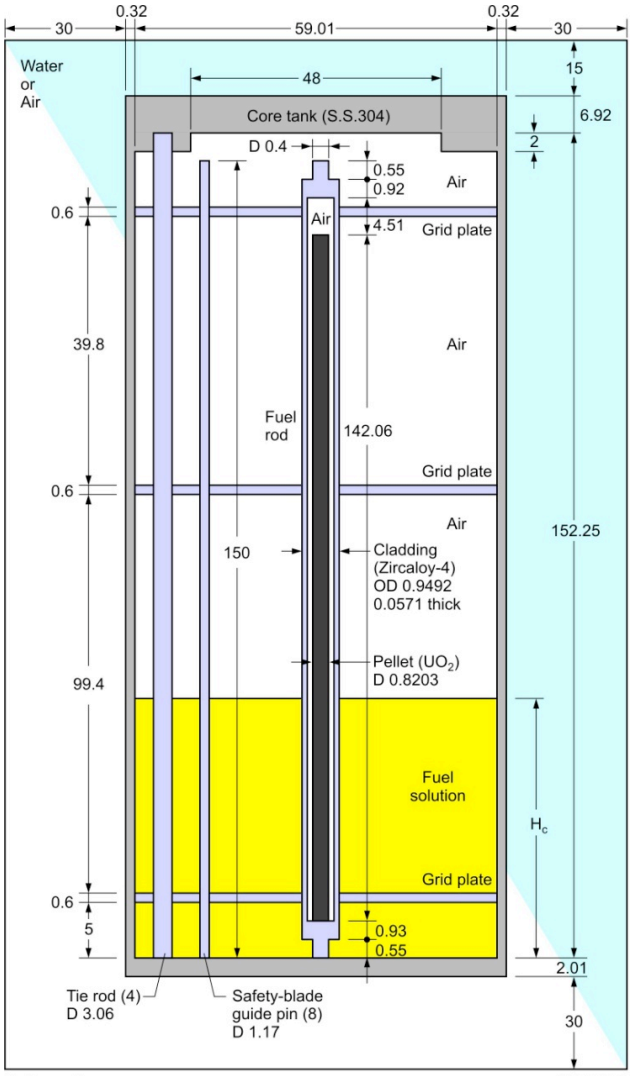
RRC Kurchatov Institute, Russia



Critical Loading Configurations of the IPEN/MB-01 Reactor with Large Void in the Reflector (LEU-COMP-THERM-058) – IPEN, Argentina

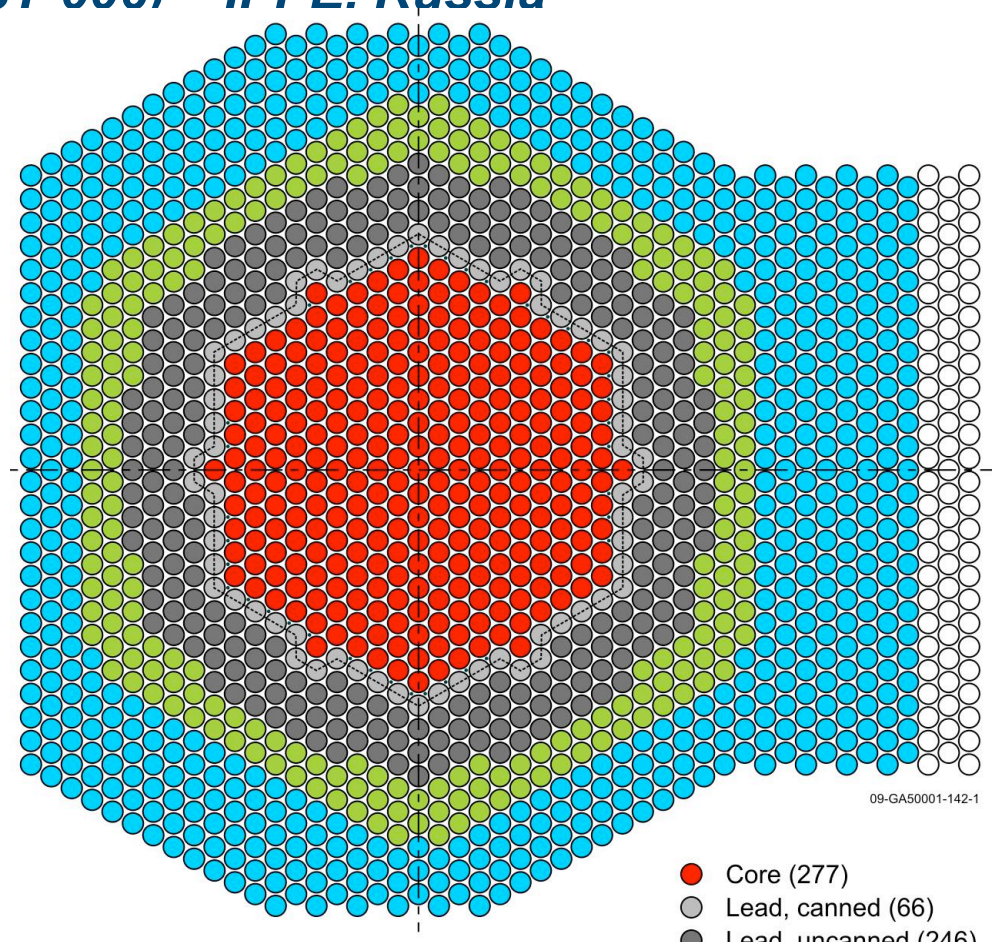


STACY: A 60-CM-Diameter Tank Containing 5%-Enriched UO_2 Fuel Rods (2.5-cm Square Lattice Pitch) in 6%-Enriched Uranyl Nitrate Solutions, Unreflected and Water-Reflected (LEU-MISC-THERM-007) – JAEA, Japan



Not to scale
Dimensions in cm

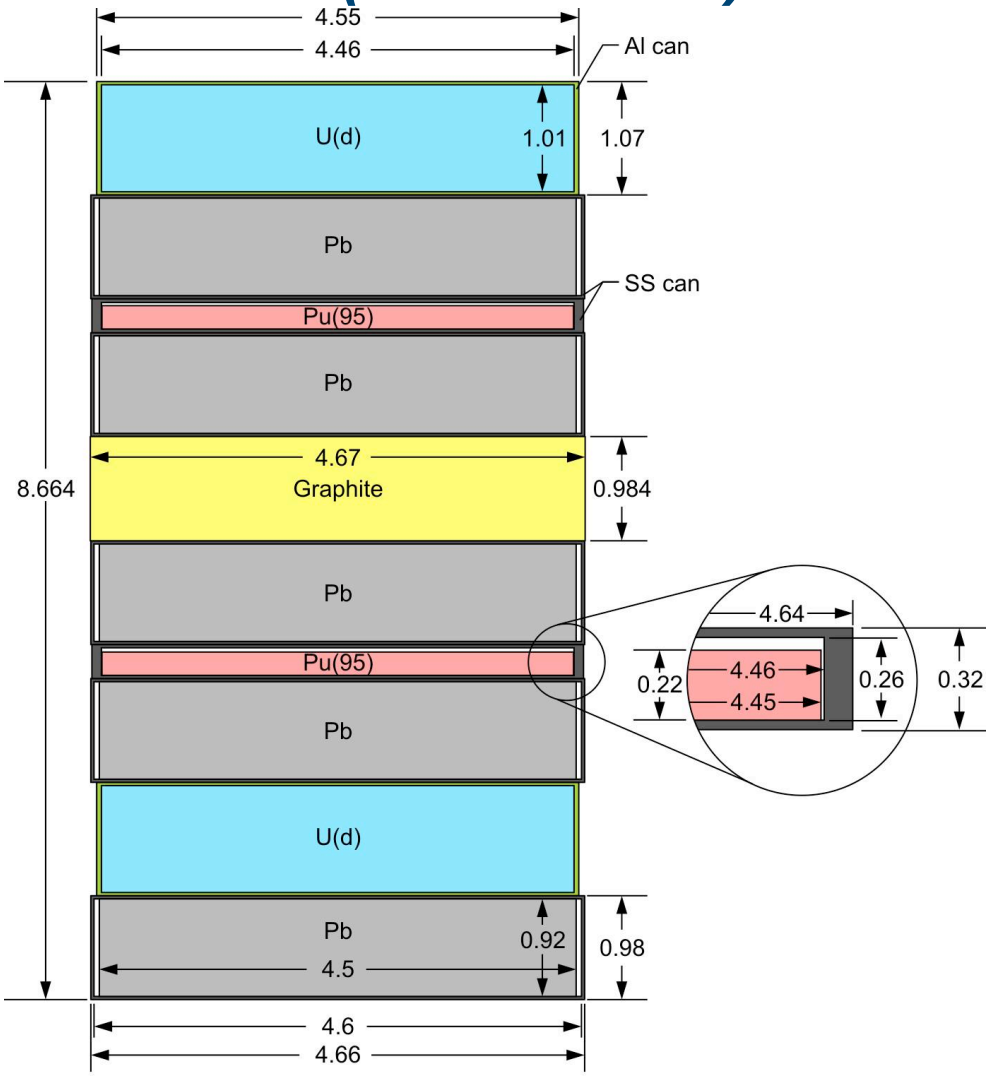
BFS-61 Assemblies: Critical Experiments of Mixed Plutonium, Depleted Uranium, Graphite and Lead with Different Reflectors (MIX-MET-FAST-006) – IPPE. Russia



All intertubular gaps in the reflector outside the dotted line were filled with stainless steel bars

- Core (277)
- Lead, canned (66)
- Lead, uncanned (246)
- Stainless steel (222)
- $U(d)O_2$ (587)
- Empty tube (77)
- SS bar

MIX-MET-FAST-006 (Continued) – Unit Fuel Cell



Dimensions in cm

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Database for the International Criticality Safety Benchmark Evaluation Project (DICE)

- Upgrades and Corrections
- Data Verification Efforts
- Workshop Planned for ICNC-2011