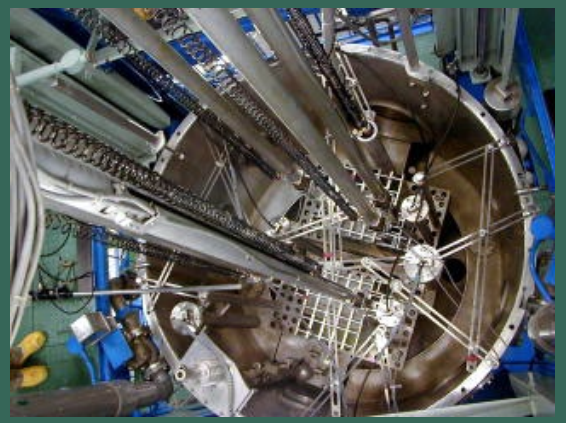
京都大学
KYOTO UNIVERSITY

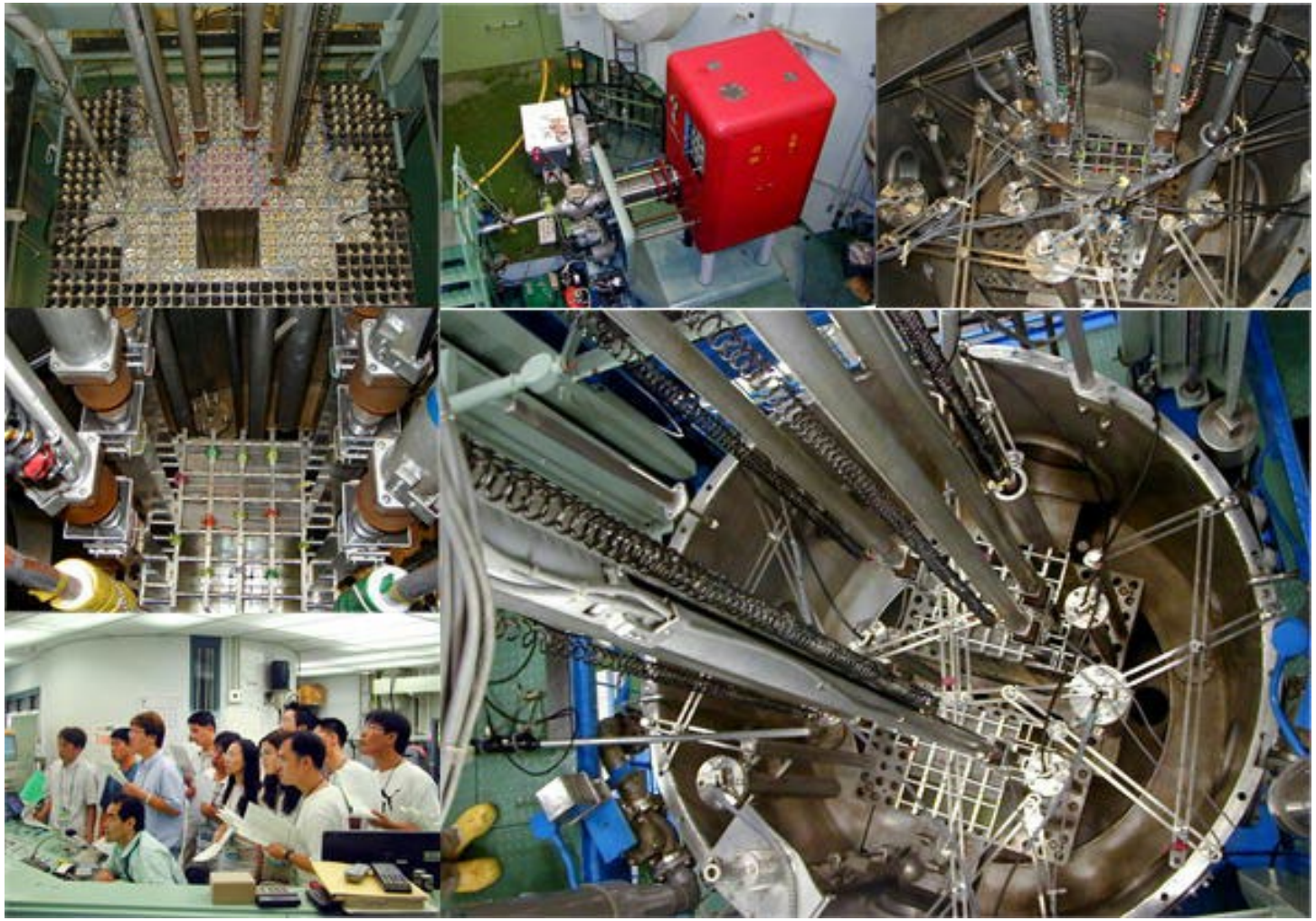
IGORR22ND & IAEA TM
JUNE 15-19, MITO, JAPAN

CONVERSION OF KYOTO UNIVERSITY CRITICAL ASSEMBLY (KUCA) TO LOW-ENRICHED URANIUM FUEL: STATUS AND FUTURE PLANS

HIRONOBU UNESAKI, YOSHIYUKI TAKAHASHI, YASUNORI KITAMURA AND TSUYOSHI MISAWA
INSTITUTE FOR INTEGRATED RADIATION AND NUCLEAR SCIENCE, KYOTO UNIVERSITY (KURNS), JAPAN



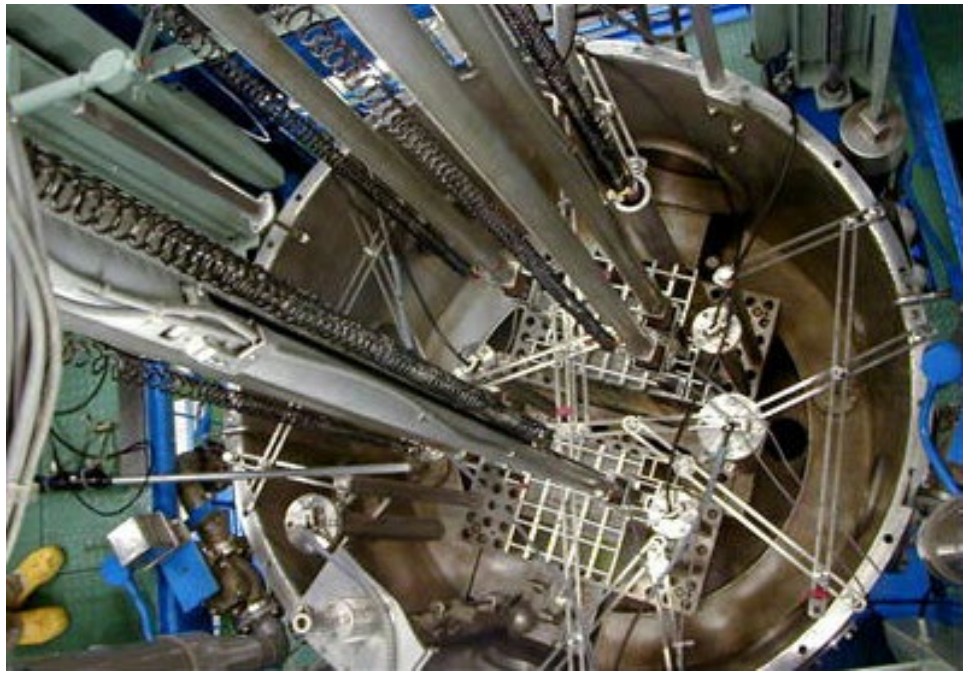
KUCA: THE FACILITY AND ITS UNIQUENESS



- Multi-core critical assembly
- High flexibility of reactor fuel composition and core configuration
- Wide variety of detectors and measuring devices
- Widely used for reactor physics, critical safety, detector development and human resource development / education
- Original design using 93% and 45% HEU
- All HEU returned to US by 2022; completion officially announced on Aug 2022 by US DOE and Japan MEXT

京都大学 KYOTO UNIVERSITY

KUCA: THE "WET" CORE



- Light water moderated/reflected core
- Originally operated using 93% HEU flat plate fuel and 93% & 45% HEUl curved plate fuel
- Wide variety of detectors and measuring devices
- Widely used for reactor physics, critical safety, detector development and human resource development / education
- Longest running reactor physics experimental course for graduate level students; over 5000 particitipants since 1975
- All HEU returned to US by 2022; completion officially announced on Aug 2022 by US DOE and Japan MEXT

京都大学
KYOTO UNIVERSITY

KUCA: THE "DRY" CORE

- Solid (polyethylene or graphite) moderated/reflected core
- Originally operated using 93% HEU U-Al coupon fuel (2" square x 1/16" thick)
- Natural Uranium metal plates and Thorium metal plates used with U fuel plates to simulate various fuel composition
- Enables wide variety of fuel composition and neutron spectrum
- Wide variety of detectors and measuring devices
- Widely used for reactor physics, critical safety, detector development and human resource development / education
- All HEU returned to US by 2022; completion officially announced on Aug 2022 by US DOE and Japan MEXT

京都大学 KYOTO UNIVERSITY

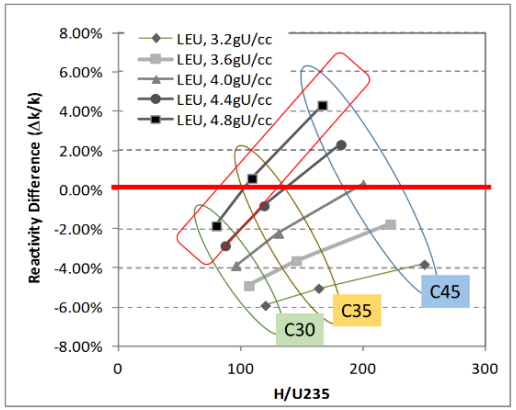
KUCA CONVERSION: HISTORY AND STATUS

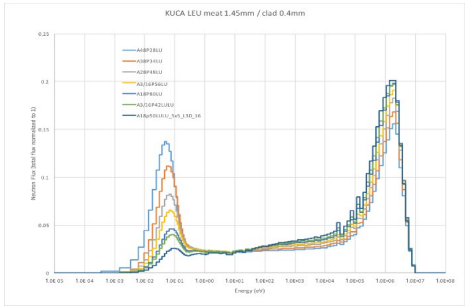
- *August 2023: NRA approval for fuel fabrication*
- *September 2023: Fuel fabrication commenced @ Framatome CERCA ROMANS*
- March 2024: Wet LEU Fuel fabrication completed
- April 2024: Wet LEU Fuel inspection by KURNS staff successfully completed @ Framatome CERCA ROMANS
- May 2024 – June 2024: First batch of Wet LEU fuel transported to Y-12 facility for repacking (from TNBGC-1 to ES-3100)
- July 2024: First batch of Wet LEU fuel - NRA pre-shipment inspection (at Y-12) successfully completed, NRA approval obtained

京都大学
KYOTO UNIVERSITY

KUCA CONVERSION: HISTORY AND STATUS

- *Early 2000s: initiation of KUCA conversion project*
- *Mid 2000s- : Feasibility study for KUCA conversion – "Can KUCA operate and maintain its capability after LEU conversion?" – "YES"*
- *2016: Official announcement of KUCA HEU return and LEU conversion @ 4th Nuclear Security Summit as US-JAPAN bilateral project*
- *2016- : Fuel fabrication technology development for KUCA Dry LEU fuel*
- *2016-2022: KUCA HEU return (completetion officially announced August 2022)*
- *September 2023: Fuel fabrication commenced @ Framatome CERCA ROMANS*





京都大学
KYOTO UNIVERSITY

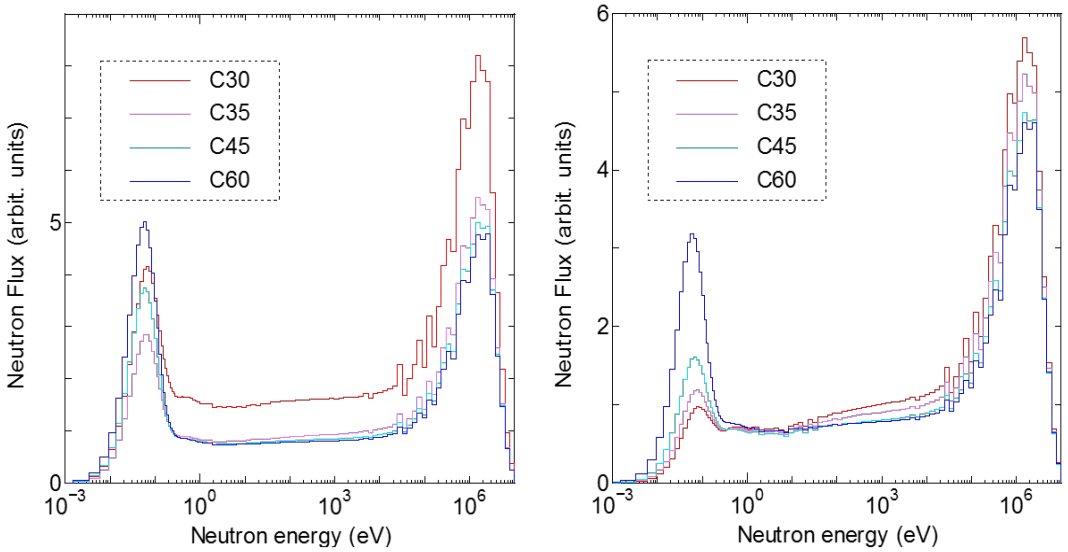
KUCA CONVERSION: GOALS

- maintain compatibility with HEU cores capability,
- achieve extended capability with more “hard” spectrum (e.g., rich with high-energy neutrons), improved simulation capability of PWR/BWR core spectrum, including HALEU application,
- maintain full capability for the human resource development program (inter-university reactor physics experimental course), and
- ensure that no modification/alteration of reactor components (e.g., control rods, core tank, fuel frame) is required.

京都大学
KYOTO UNIVERSITY

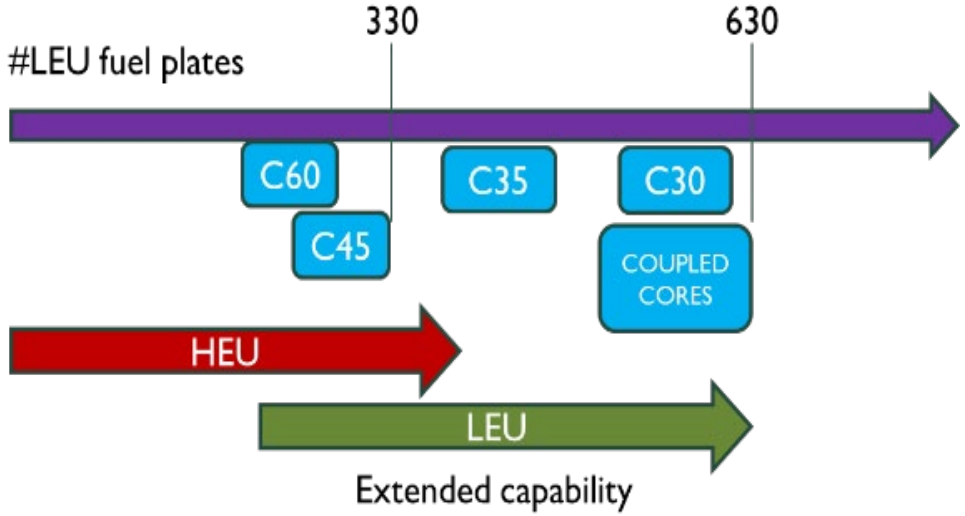
KUCA CONVERSION: WET CORE

- 4.8gU/cc, U3Si2-Al dispersion type, Al cladded flat plate
- No change in dimension



HEU (U-Al) Fuel

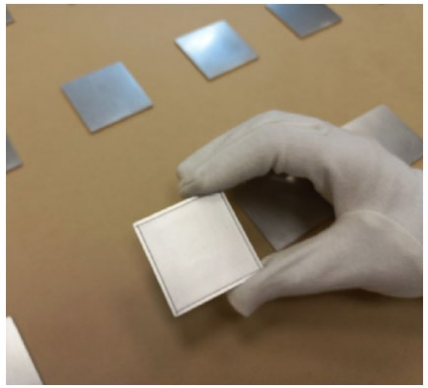
LEU (U_3Si_2-Al) Fuel
4.8gU/cc
Meat thickness : 0.74mm
Clad thickness : 0.38mm

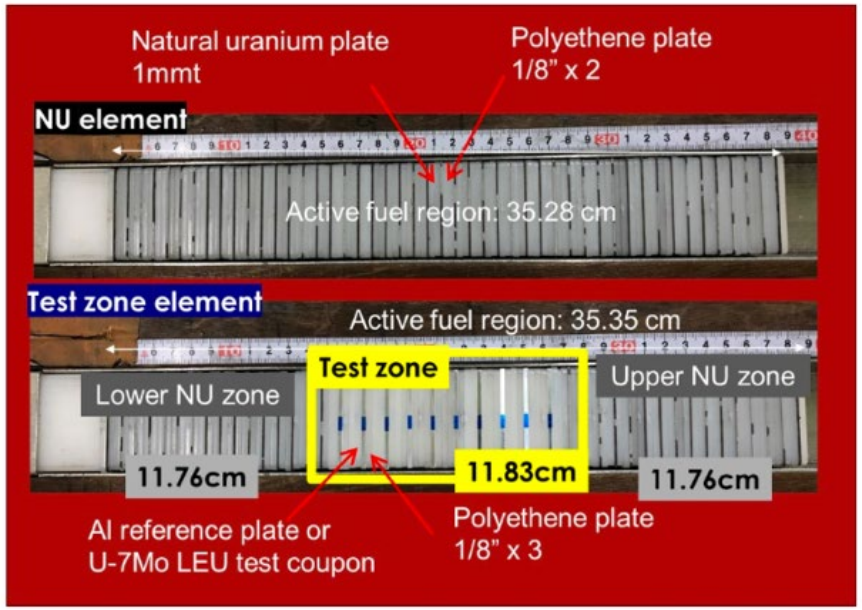


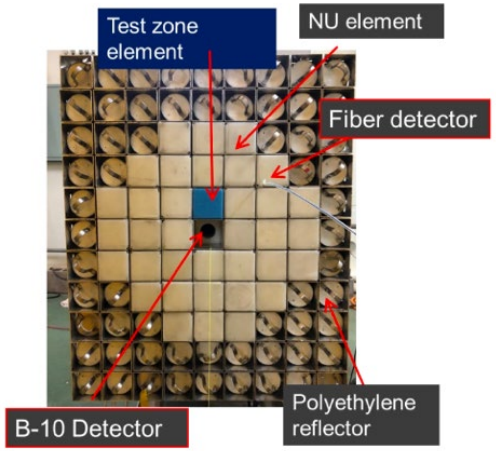
京都大学 KYOTO UNIVERSITY

KUCA CONVERSION: DRY CORE

- U7-Mo, AL dispersion type, Al cased coupon: need for fuel fabrication technology
- Test/sample LEU coupons fabricated and used at KUCA for subcritical experiment – confirmation of fabrication technology



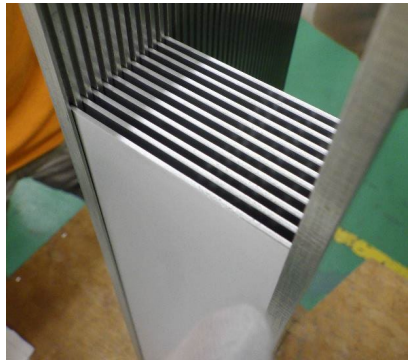


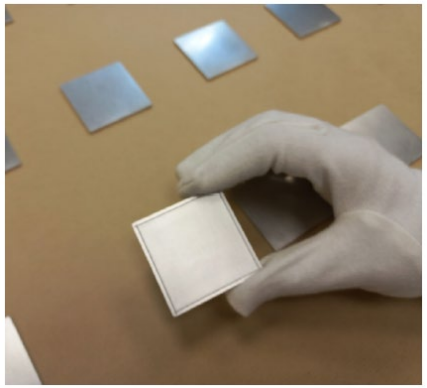


京都大学
KYOTO UNIVERSITY

KUCA CONVERSION: CURRENT STATUS

- First batch of Wet LEU fuel received at KUCA @ October 2024, official announcement of KUCA Wet core conversion
- Second batch of Wet LEU fuel to be received at KUCA in 4Q of 2025
- First batch of Dry LEU fuel successfully fabricated and awaiting for transport; to be received at KUCA in 3Q of 2025





京都大学
KYOTO UNIVERSITY

KUCA CONVERSION: FORTHCOMING PLAN AND FUTURE

- Restart operation using LEU in FY2025
- Commence with the reactor physics experiment required as part of the regulatory process for the full operational license.
- A wide variety of core configurations will be developed, and the basic neutronic characteristics—such as critical mass, control Rod worth and neutron flux distribution will be measured, expected to provide systematic reactor physics data for LEU-loaded critical cores
- Could be regarded as the first systematic series of critical experiments using LEU fuel (20% enrichment) that covers a wide variety of neutron spectra.
- KUCA Dry Core conversion: the first critical system to achieve criticality and operate with a full core of U7Mo fuel

KUCA CONVERSION: CONTRIBUTIONS

- The first critical assembly to be fully converted
- The first reactor to achieve criticality and operated with U7Mo fuel full core
- The first systematic series of critical experiment using LEU fuel (20% enrichment) covering wide variety of neutron spectra

Conversion itself is expected to contribute to :

- Reactor physics / neutronic design
- Nuclear data V&V for >5% enriched U fuel including HALEU
- Reactor conversion science & technology

- KUCA operation capability to fulfil various needs from nuclear / radiation science & technology academia
- Continue to provide platform for human resource development

京都大学 KYOTO UNIVERSITY

CONCLUSION

KUCA Conversion project is:

- A quest for scientific interest in neutronics and fuel development
- An ambitious challenge to simultaneously fulfill the HEU minimization requirement and achieve extended reactor performance after conversion
- An important step for the reactor conversion community

KUCA conversion will enable continued contribution to nuclear engineering & science and human resource development

京都大学
KYOTO UNIVERSITY