IAEA
International Atomic Energy Agency

"Atoms for Peace and Development"

FR22: IAEA Conference on
Fast Reactors and Related Fuel Cycles
19 – 22 April 2022
Vienna, IAEA

IAEA coordinated research projects on Neutronics Benchmark of CEFR Start-Up Tests and FFTF Loss of Flow Without Scram Test

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IAEA Coordinated Research Projects on FRs

The IAEA encourages and assists research on and development and practical use of atomic energy and its applications for peaceful purposes throughout the world. It brings together research institutions from its developing and developed Member States to collaborate on research projects of common interest, so-called **Coordinated Research Projects** (**CRPs**).

CRP completed in last decade

- **BN-600** MOX Core Benchmark
- **PHENIX** – EOL Tests
- **MONJU** – Na Natural Convection
- Analytical and Experimental Benchmark Analysis of **ADS**
- **EBR-II** Shutdown Heat Removal Tests

CRPs on Fast Reactors Technology

On-going CRPs

- **PSFR Source Term** – Radioactive Release Under Severe Accident Conditions
- Neutronics Benchmark of **CEFR** Start-Up Tests
- Benchmark Analysis of **FFTF** Loss of Flow Without Scram Test
- **NAPRO** – Na Properties and Safe Operations of Exp. Facilities
  Ended in Sept 2018
  2 TECDOCs in Publishing

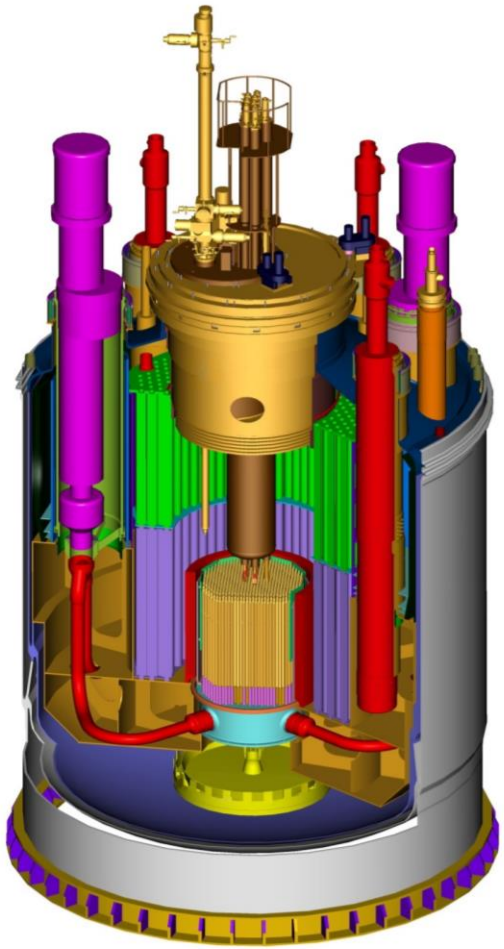
New Proposals

- Total Instantaneous Blockage of SFR Fuel Assembly
- Simulation of **CLEAR-S** Loss-of-Flow Experiment
- Benchmark Analysis of **STELLA-2** LOHS/LOF Tests
- Natural Circulation in LBE Sub/Assembly: **NACIE** Tests
- **PLANDTL**: Decay Heat Removal Thermal Hydraulics Tests

CRP: Neutronics Benchmark of CEFR Start-Up Tests

CEFR (China Experimental Fast Reactor)

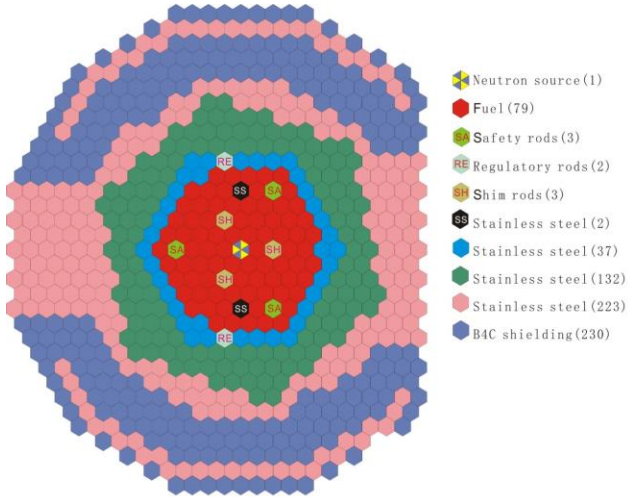
- Located in China Institute of Atomic Energy
- 65MWt (20MWe) sodium cooled fast reactor with a high neutron leakage core fuelled with uranium oxide and stainless-steel radial reflector.
- The primary system is a pool-type design, liquid sodium working fluid for the primary and secondary circuits.
- In 2010, CEFR went into first criticality.
- A series of start-up experiments were carried out to measure reactor physics and kinetics parameters.
- **6 experiments were selected for benchmark analysis**
  - evaluations of the criticality, control rod worth, sodium void worth, temperature effect reactivity, and various reaction rates.
- This CRP provides an excellent opportunity to the member states for validation of the physical models and neutronics simulation codes by comparing the calculated results to the recorded experimental data from the CEFR start-up tests.



CEFR Reactor Block

中国原子能科学研究院
中核集团 CHINA INSTITUTE OF ATOMIC ENERGY

China Experimental Fast Reactor Plant



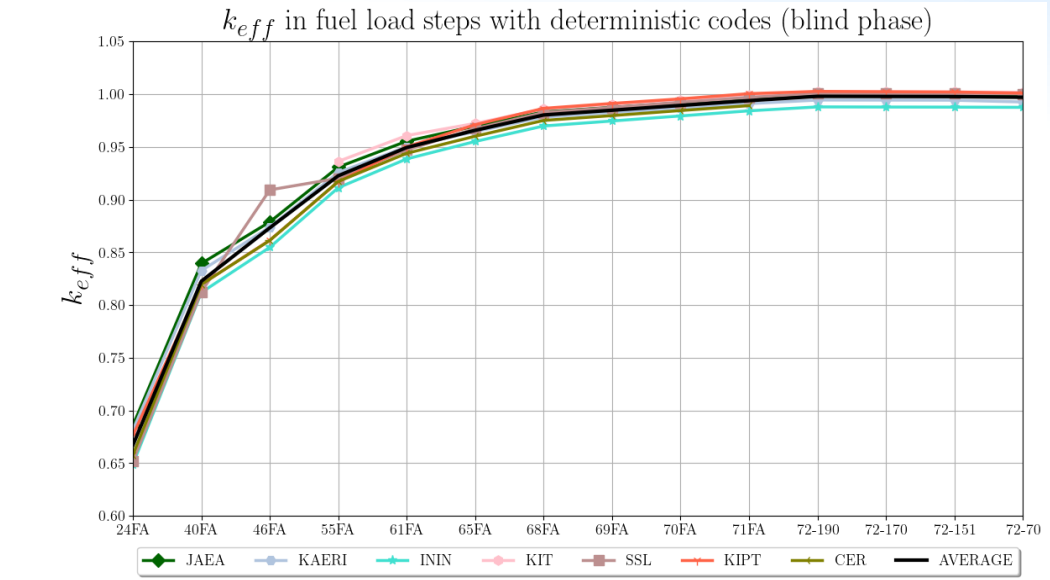
Core layout of the CEFR First Loading

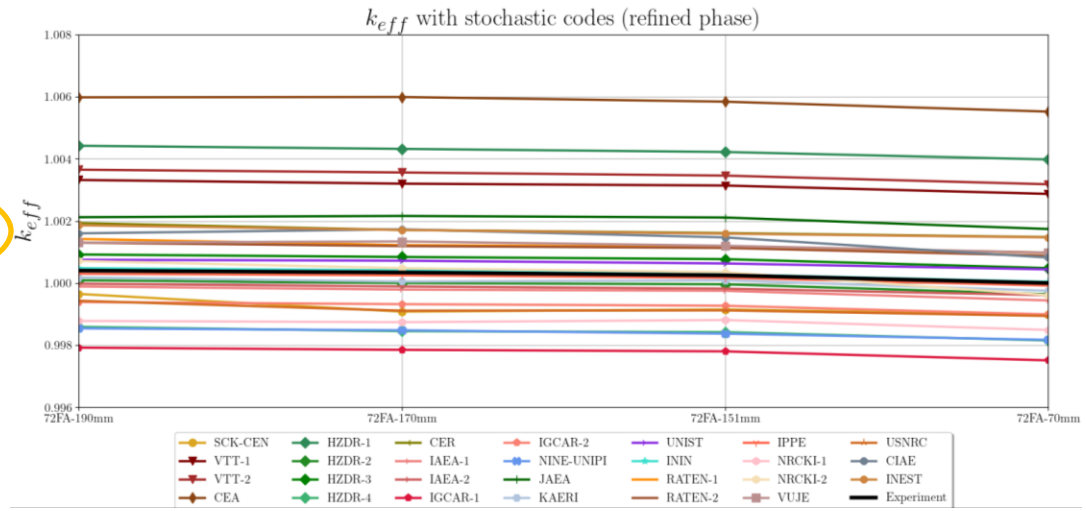
CRP: Neutronics Benchmark of CEFR Start-Up Tests

WP1	Net criticality
WP2	Control Rod Worth
WP3	Temperature reactivity coefficient
WP4	Sodium void reactivity effect
WP5	Core S/A exchange reactivity effect
WP6	Reaction rate distribution
WP7	Reactivity coefficients and kinetic parameter
WP8	Analysis of Uncertainties

Separate TECDOC

WP1. Net criticality

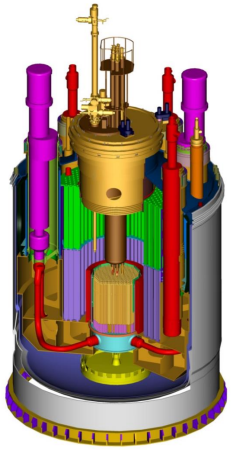




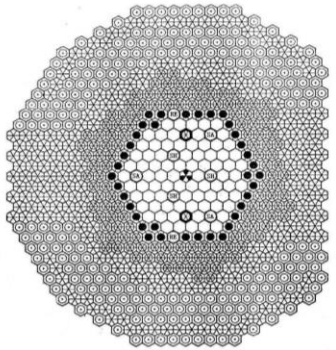
Country	Organization
Belgium	SCK•CEN
China	CIAE
China	INEST (FDS)
China	~~SNERDI~~
China	XJTU
Finland	VTT
France	CEA
Germany	HZDR
Germany	GRS
Germany	KIT
Hungary	~~BME~~
Hungary	CER
India	IGCAR
Italy	NINE
Italy	UNIPI
Japan	JAEA
Korea, Rep. of	KAERI
Korea, Rep. of	UNIST
Mexico	ININ
Romania	RATEN-ICN
Russia	~~IBRAE~~
Russia	IPPE
Russia	SSL
Russia	Kurchatov Ins. (NRCKI)
Slovakia	VUJE
Switzerland	PSI
Ukraine	KIPT
UK	Un. of Cambridge
United States	ANL
United States	NRC

30 Participating Organizations from 18 Countries

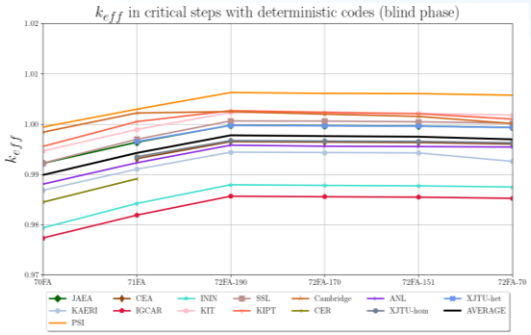
CRP: Neutronics Benchmark of CEFR Start-Up Tests



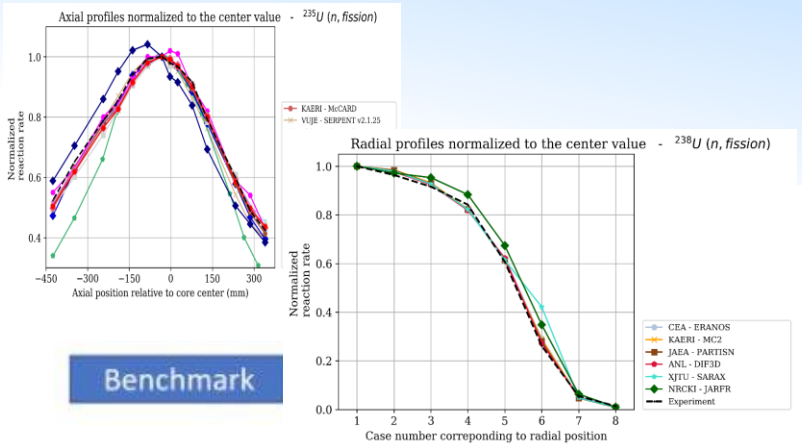
Plant Data



Modelling



Simulations



Benchmark

Kick Off: 1st RCM: June 2018, Vienna

2nd RCM: 28 October - 1 November 2019, Beijing *(Blind Phase* Results)

Refined Simulation Results, April 2021

IAEA TECDOC Draft November 2022

Benchmark Specifications → Individual Simulations → Sharing of results and comparison with Experimental Data → Publication

1st Online Update Meeting: June 2019, Vienna

2nd Online Update Meeting: November 2020, Vienna

3rd RCM: 6-9 April 2021 (Virtual)

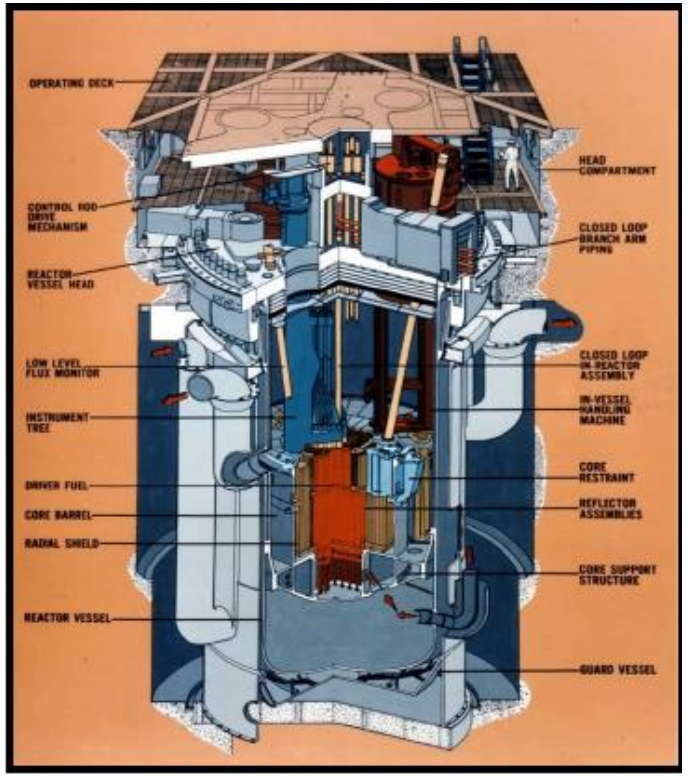
4th RCM: 7-11 November 2022, Vienna)

CRP: Benchmark Analysis of FFTF Loss of Flow Without Scram Test

FFTF (Fast Flux Test Facility) Reactor:

- 400 MW_{th} sodium cooled fast test reactor
- Mixed UO_2-PuO_2 (MOX) fuel
- Loop type plant, axial and radial reflectors
- Built to assist development and testing of advanced fuels and materials for fast breeder reactors
- Series of Passive Safety Tests performed in 1986
  - Unprotected transients including 13 Loss of Flow without scram tests
  - Demonstrated passive safety of SFRs
  - This Benchmark analysis is based on the Test number 13, which was initiated at 50 % power and 100 % flow.

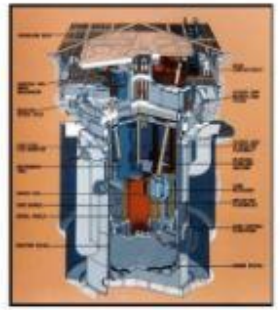
- These passive safety tests demonstrated the potential of FFTF to survive severe accident initiators with no core damage.
- The dynamics analysis of FFTF reactor core with complex reactivity feedback mechanisms and primary and secondary coolant loops using system codes provides an excellent opportunity for validation of the physical and mathematical models and reactor simulation codes using actual experimental data.



Country	Organization
China	CIAE
China	INEST
China	NCEPU
China	XJTU
France	CEA
Germany	HZDR
Germany	KIT
India	IGCAR
Italy	NINE
Italy	Sapienza Uni of Rome
Japan	JAEA
Korea, Rep. of	KAERI
Netherlands	NRG
Russia	IBRAE
Russia	IPPE
Spain	CIEMAT
Sweden	KTH
Switzerland	EPFL
Switzerland	PSI
United States	ANL
United States	NRC
United States	PNNL
United States	TAMU
United States	TerraPower

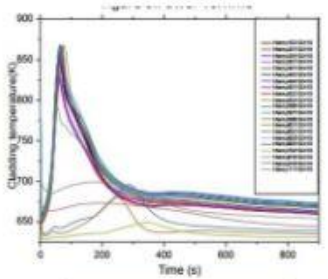
24 Participating Organizations from 13 Countries

CRP: Benchmark Analysis of FFTF Loss of Flow Without Scram Test

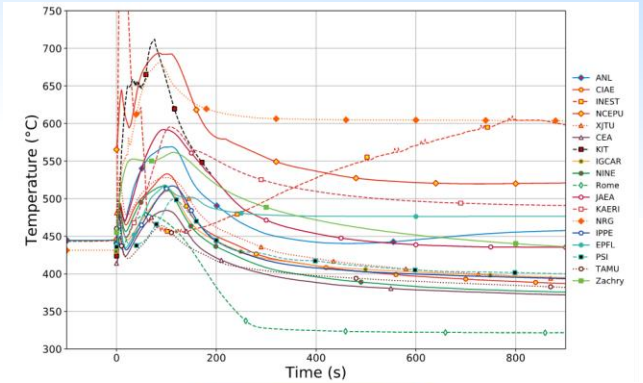


Plant Data

Modelling



Simulations



Benchmark

Kick Off: 1st RCM: October 2018, Vienna

Blind Phase Results Submissions, March 2020

Refined Simulation Submissions, November 2021

Final Simulation Results, June 2022

IAEA TECDOC Draft December 2022

Benchmark Specifications — Individual Simulations — Sharing of results and comparison with Experimental Data — Publication

1st Virtual Informal OM: October 2019, Vienna

2nd Virtual Informal OM: October 2020, Vienna

2nd RCM: December 2021, (virtual)

3rd RCM: November 2022, Italy

IAEA Special Session on CRPs

Time	Paper No.	Name	Designating Member State/Organization	Title of Paper
13:12–13:24	104	X. Huo	China	CEFR physical start-up tests: the core specifications and experiments
13:24–13:36	163	A. Gomez Torres	Mexico	Verification and validation of neutronic codes using the start-up fuel load and criticality tests performed in the China Experimental Fast Reactor
13:36–13:48	281	J. Choe	Korea	Neutronics Benchmark of CEFR Start-Up Tests: Temperature Coefficient, Sodium Void Worth, and Swap Reactivity
13:48–14:00	233	T. K. Kim	USA	Neutronics Benchmark of CEFR Start-Up Tests: Reaction Rates and Reactivity Coefficients
14:00–14:12	534	A. Moisseytsev	USA	Blind phase results for transient simulations of the FFTF Loss of Flow Without Scram test #13
14:12-14:24	536	N. Stauff	USA	Blind-Phase Results of the FFTF Neutronic Benchmark
14:24-15:00		All		Open Q&A

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Thank You!

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