

# Status of Irradiation Testing of ARAA Material in HANARO

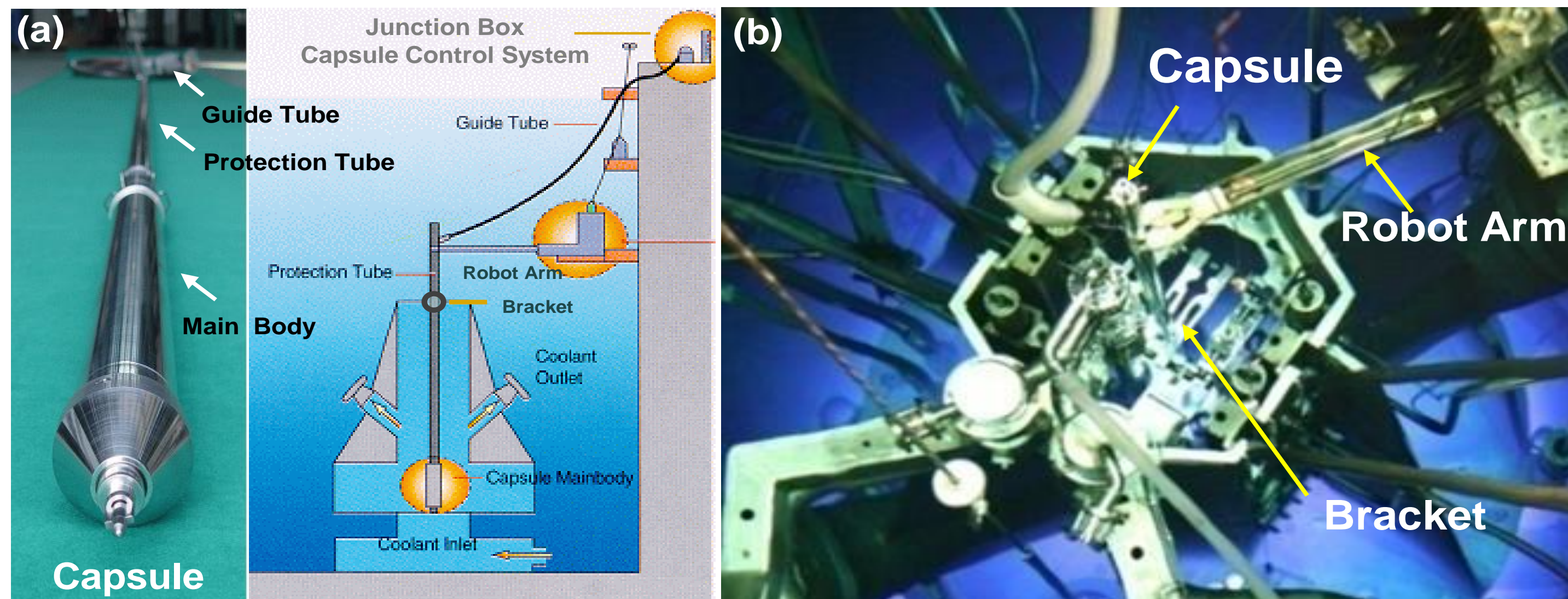
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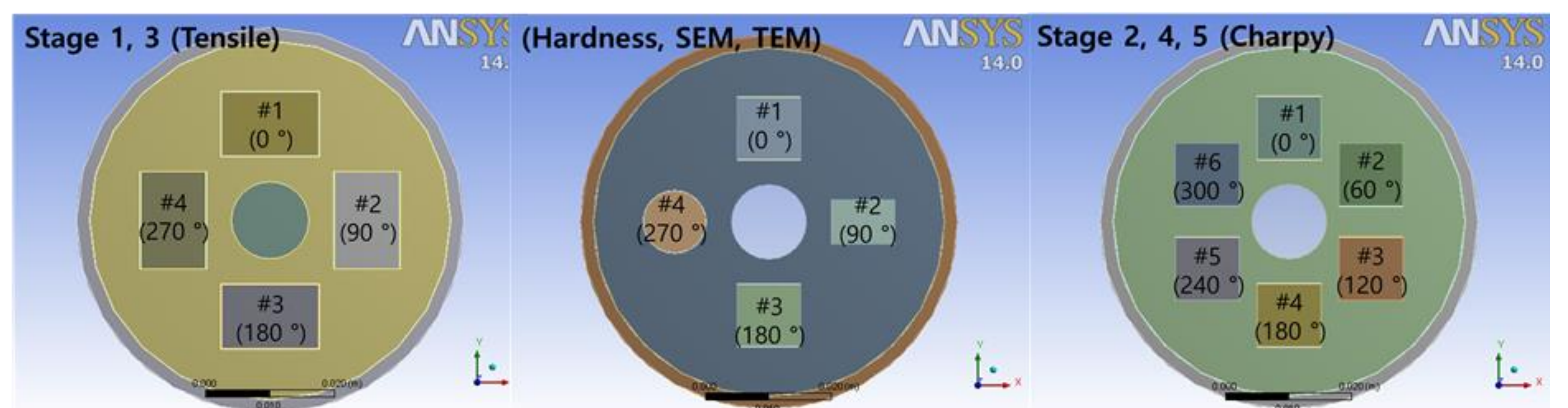
## ◆ Introduction

- ✓ **Advanced Reduced-Activation Alloy (ARAA)** as a structural material of fusion reactor has been required for an **irradiation testing** up to 3 dpa at about 330°C temperature.
- ✓ **16M-02K HANARO irradiation capsule** was designed and is being irradiated at HANARO. The progress and status of the **first irradiation testing of the ARAA material in HANARO** are described.

## ◆ HANARO Irradiation Capsule Systems



## ◆ Cross sections of the 16M-02K irradiation capsule having different specimen-hole designs



## ◆ ARAA specimens of the 16M-02K capsule

Specimen	Size (mm)	No (ea)	Location
Standard Charpy	10x10x55	42	Stage 2,4,5
Plate tensile	15x1x66	120	Stage 1,3
Hardness/Thermal Conductivity	φ10x2	32	Stage 1,3
SEM/EPMA	10x7x4	16	Stage 1,3
TEM	10x10x15	8	Stage 1,3

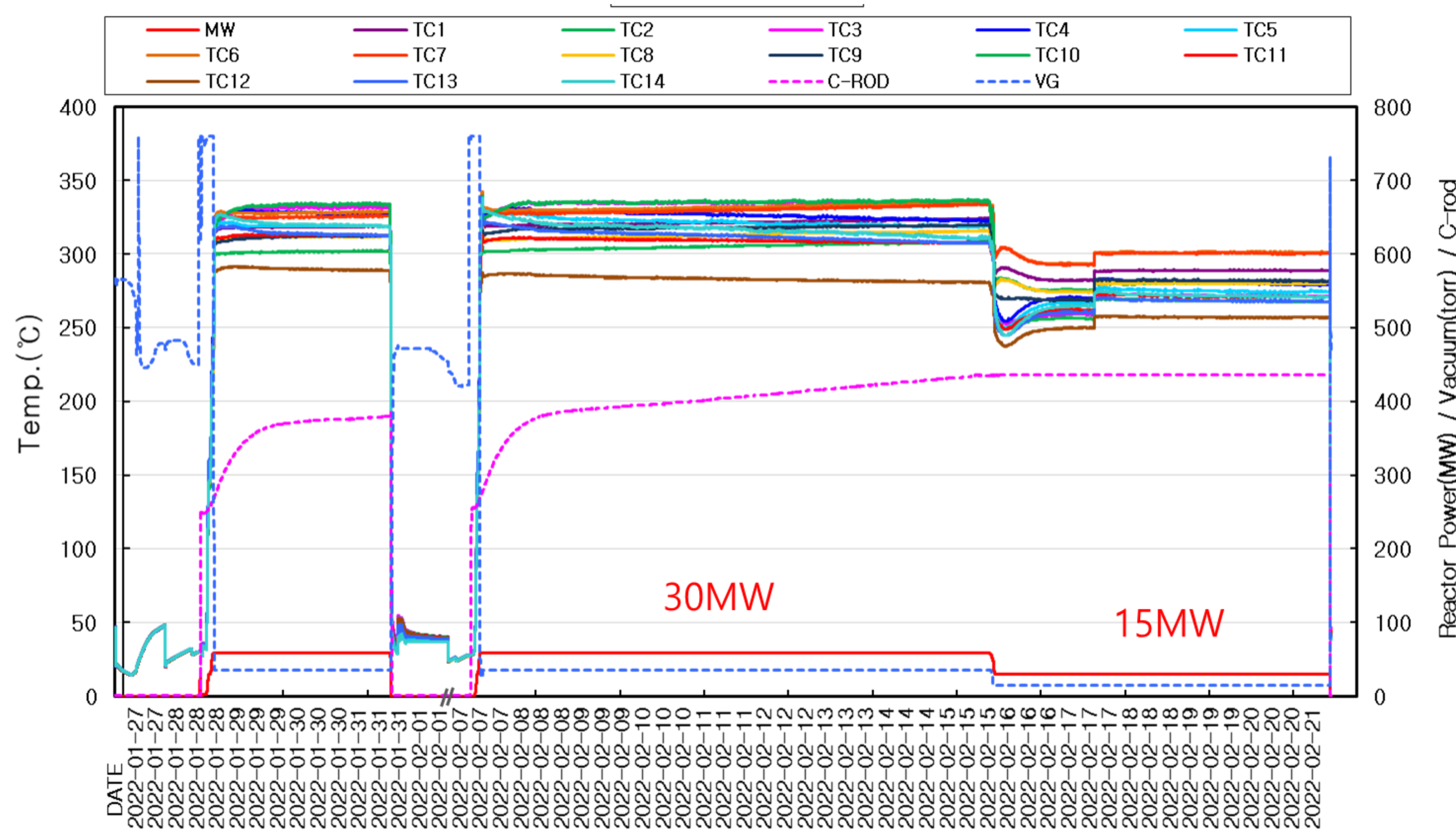
\* ARAA: Advanced Reduced-Activation Alloy

## ◆ Temperatures of the 16M-02K capsule at 30 MW power

Stage	TC	Calculated (GENGTC)		Calculated (ANSYS)		Measured*	
		He 1atm	0.4K He	He 1atm	0.4K He	He 1atm	He 40torr
1	TC1	201	281	198	<370	222	338
	TC2	201	281	198	<370	214	332
	TC3	230	312	204	<370	220	324
	TC4	230	312	204	<370	215	310
2	TC5	226	296	206	<441	218	312
	TC6	243	305	220	<441	224	313
3	TC7	245	303	282	369	230	334
	TC8	245	303	282	369	232	337
	TC9	265	329	274	369	231	311
	TC11	265	329	274	369	225	288
4	TC10	251	311	235	<369	242	315
	TC13	241	303	217	<370	239	299
5	TC12	233	300	211	<370	227	302
	TC14	206	282	187	<370	221	300

\* Heater power 0, control rod at 468mm

## ◆ Temp. variation of specimens during an irradiation of 16M-02K capsule (102-2 cycle)



## 1) Design & Irradiation of the ARAA specimens

- 1) **Multi-hole designs (4 and 6 holes)** of the specimens were adopted in the capsule to increase an economic efficiency of the volume and to improve the uniformity of specimen temperature at HANARO.
- 2) The specimens were designed that will be irradiated at **about 330°C in the CT test hole of HANARO at 30 MW** thermal output, using 1-dimensional code GENGTC, and 3-dimensional analysis program ANSYS 14.0.
- 3) The specimens will be irradiated in the CT test hole at 30MW thermal power for 8 irradiation cycles, at up to a **neutron fluence of  $2.5 \times 10^{21} (\text{n/cm}^2)$**  ( $E > 1 \text{MeV}$ ) equivalent to **3.0 dpa** of radiation damage.

## 2) Temperature analysis of the 16M-02K capsule

- 1) **A new capsule (16M-02K) having 4 and 6-hole specimen allocations** was designed, fabricated, and **successfully irradiated for the first evaluation of the neutron irradiation properties of the Advanced Reduced Activation Alloy (ARAA)** of a Fusion reactor **at HANARO**.
- 2) The **irradiation temperature of the ARAA specimens** was stably controlled in the range of **295-337°C** (satisfying user's requirement) during reactor operation cycles **at HANARO** of 30MW thermal power (aiming for 8 reactor operation cycles).
- 3) During the irradiation, **abnormal reactor power drop from 30MW to 15MW occurred**. It resulted in **a decrease of the specimen temp.(246-301°C)**. Considering a complicated recovery process of the irradiated materials, the effect of the temp. decrease on the irradiation properties should be carefully discussed later.

## ◆ Conclusion

- ✓ **The progress and status of the first irradiation testing of ARAA material at HANARO were summarized.**
- ✓ **The 4 and 6-hole structured capsule of the 16M-02K was designed, fabricated, and successfully irradiated for the first evaluation of the neutron irradiation properties of ARAA of a fusion reactor.**
- ✓ **During the irradiation testing, abnormal reactor power drop from 30MW to 15MW occurred and resulted in a decrease of the specimen temperature. The temperature of the specimen in the range of 295-337°C was changed to the range of 246-301°C. The effect of the temperature decrease on the irradiation properties of the ARAA should be carefully discussed later.**