A Mass-Flow-Calorimetry System for Scaled-up Experiments on Anomalous Heat Evolution at Elevated Temperatures

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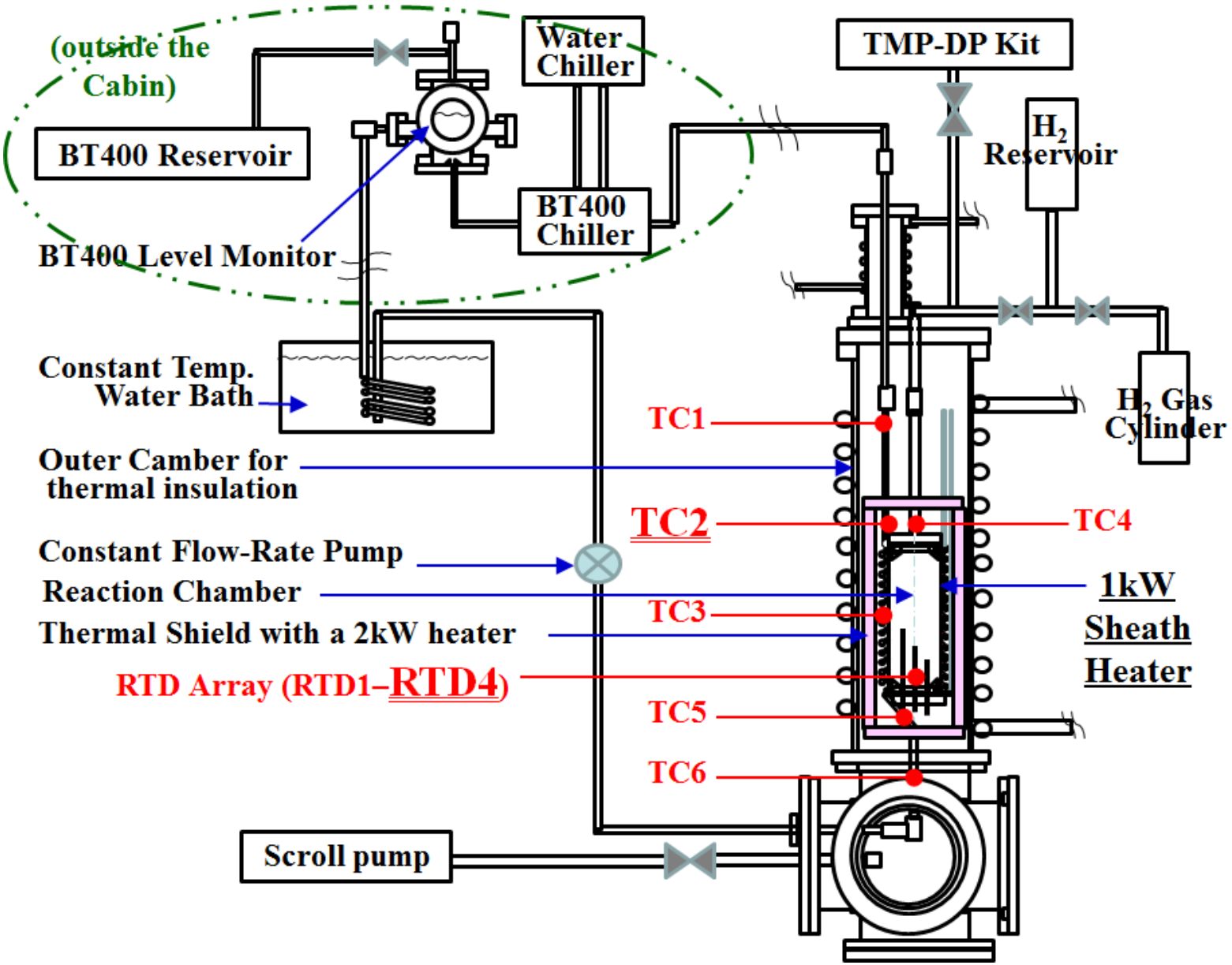
Aim and method

- A. Takahashi's poster summarizes in this Conference a lot of interesting, even astonishing, features during the D(H)-loading into the nanocomposite samples to speculate heat releasing mechanisms.
  - ➢ burst-like heat release with anomalously high values of differential heat of sorption, $\eta \approx 600$ eV/atom-H,
  - ➢ large values of integrated heat reaching ca. 800 eV/atom-Ni from a CNZ sample absorbing H,
  - ➢ abrupt desorption with 50 - 80 eV/atom-Ni absorbed almost exclusively in the first 573-K run for each sample.
- To confirm the interesting phenomena with improved signal-to-noise ratio, we have fabricated a reaction chamber with a ten-times-larger volume with a mass flow calorimetry using an oil coolant.

New scaled-up absorption system with oil-mass-flow calorimetry

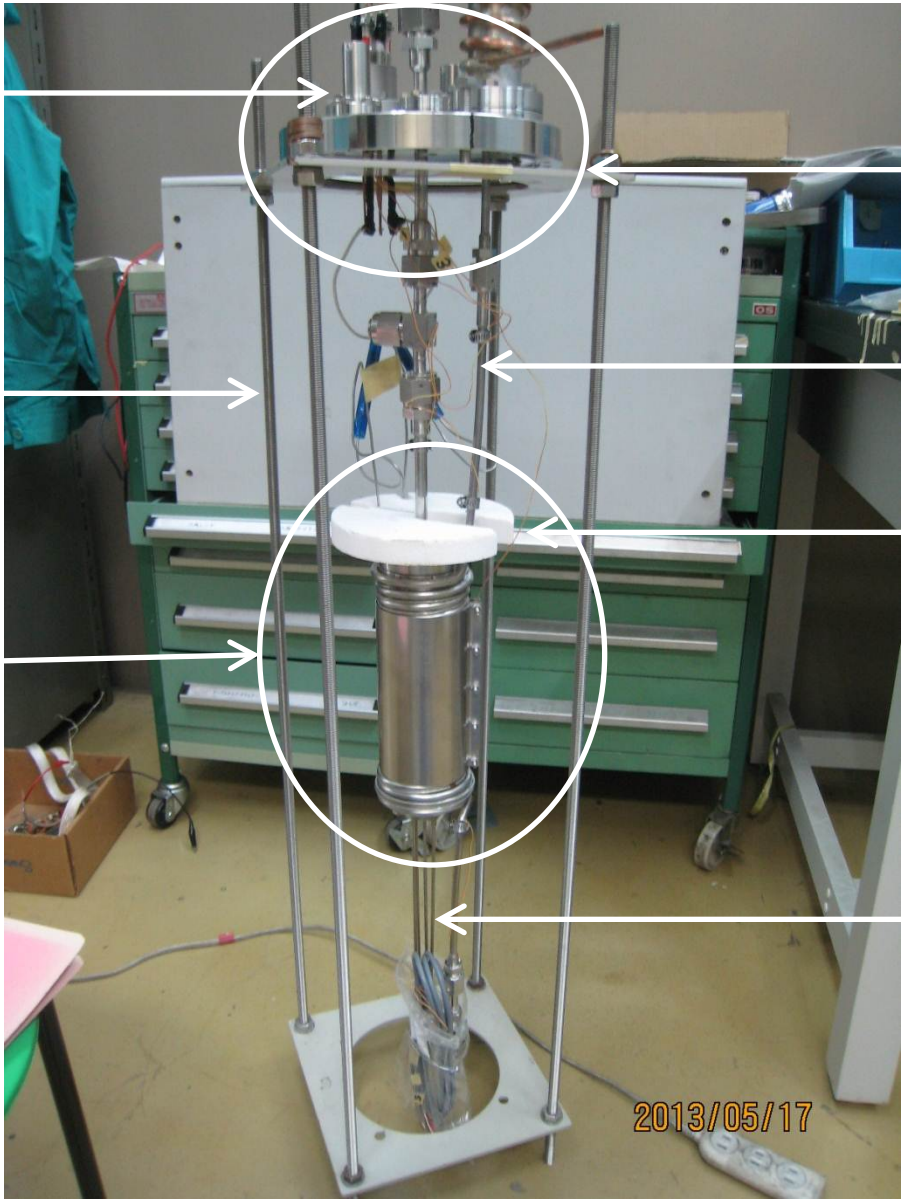


Reaction chamber of the C_1 system

Electrical and thermal feed-throughs

Tentative supporter for maintenance

Reaction chamber



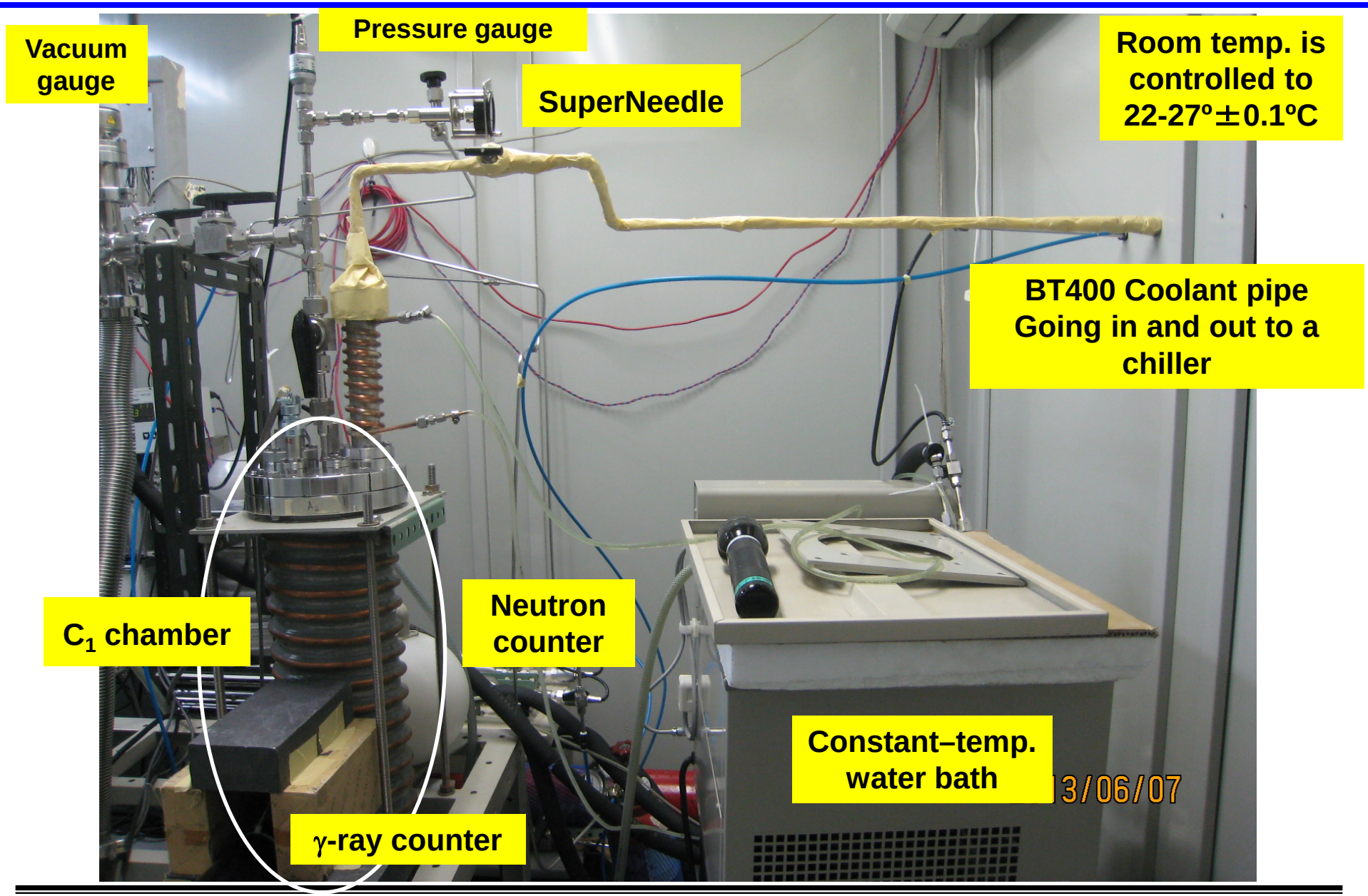
Top flange for outer chamber

Coolant pipe

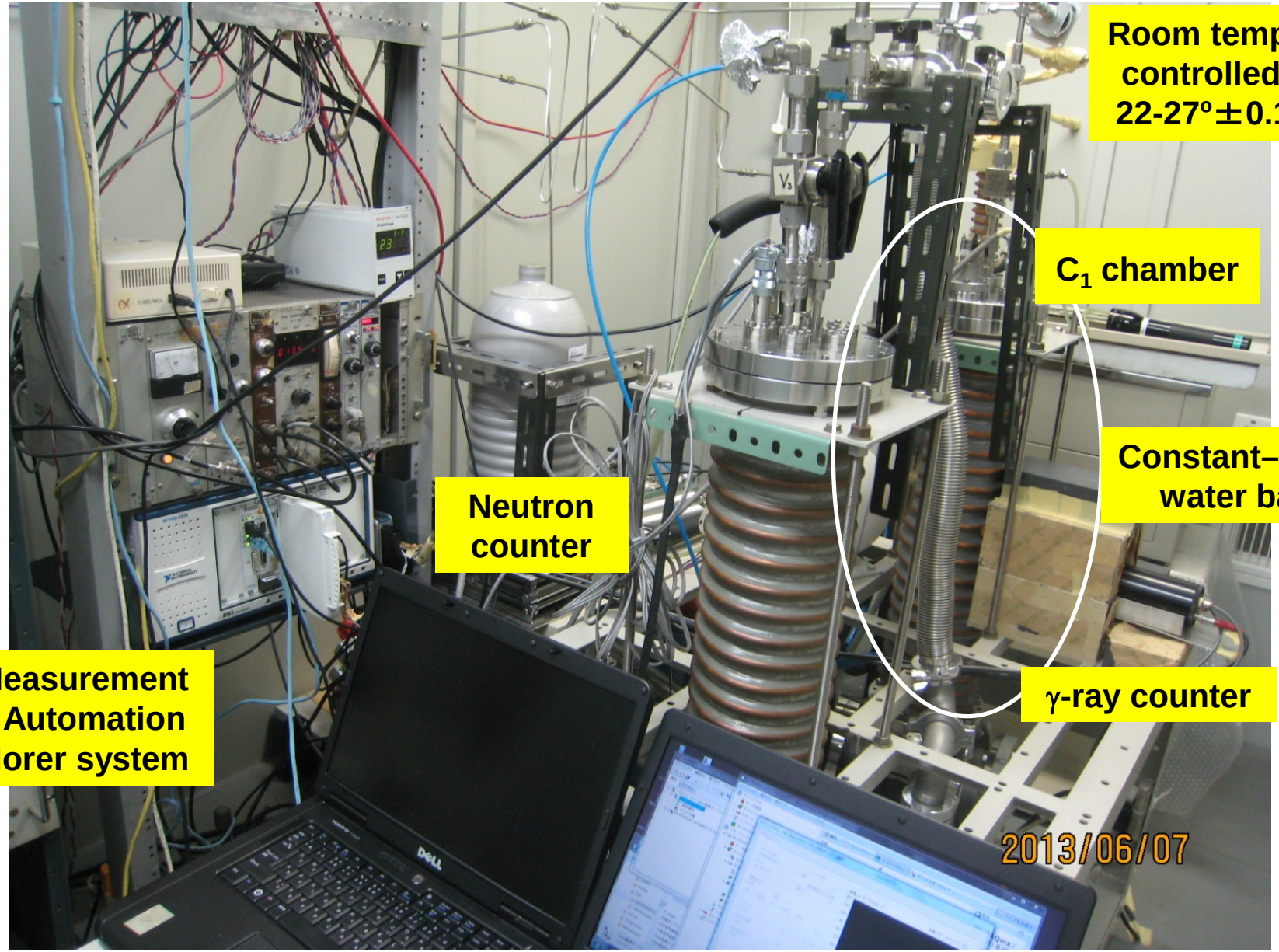
Upper radiation shield

Sheaths of RTD's

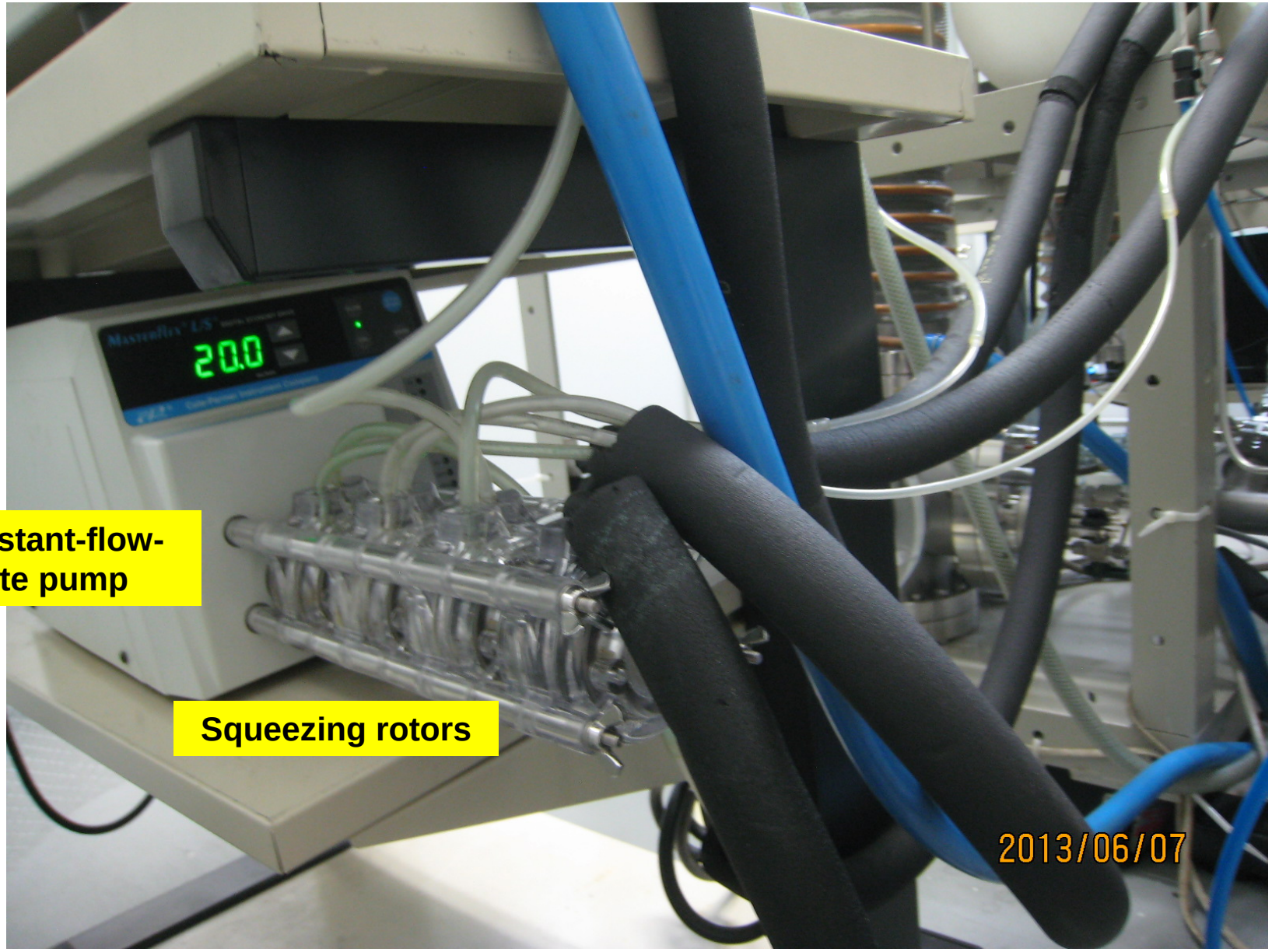
C_1 system for upgraded absorption experiments



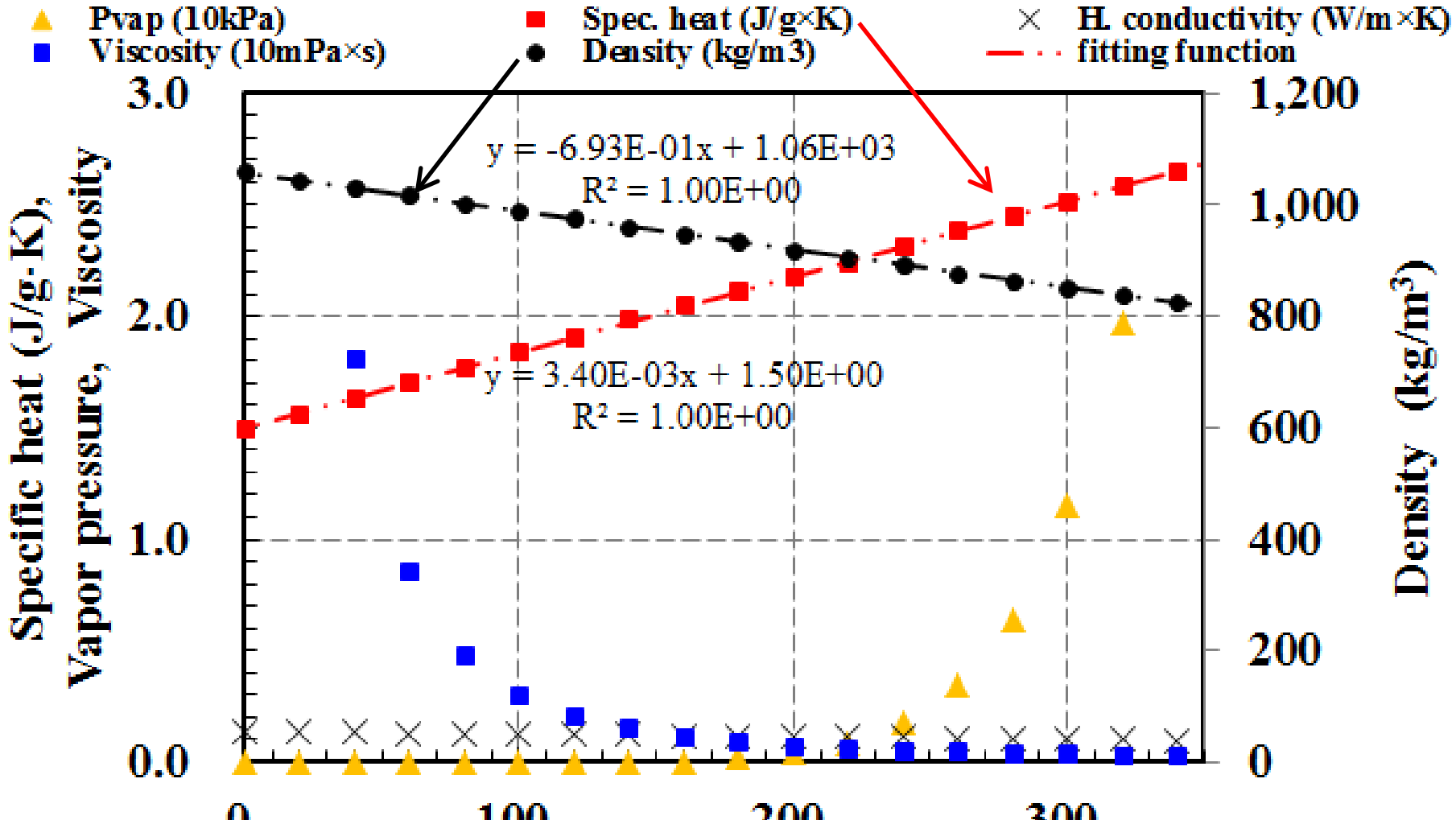
C_1 system for upgraded absorption experiments



C_1 system for upgraded absorption experiments

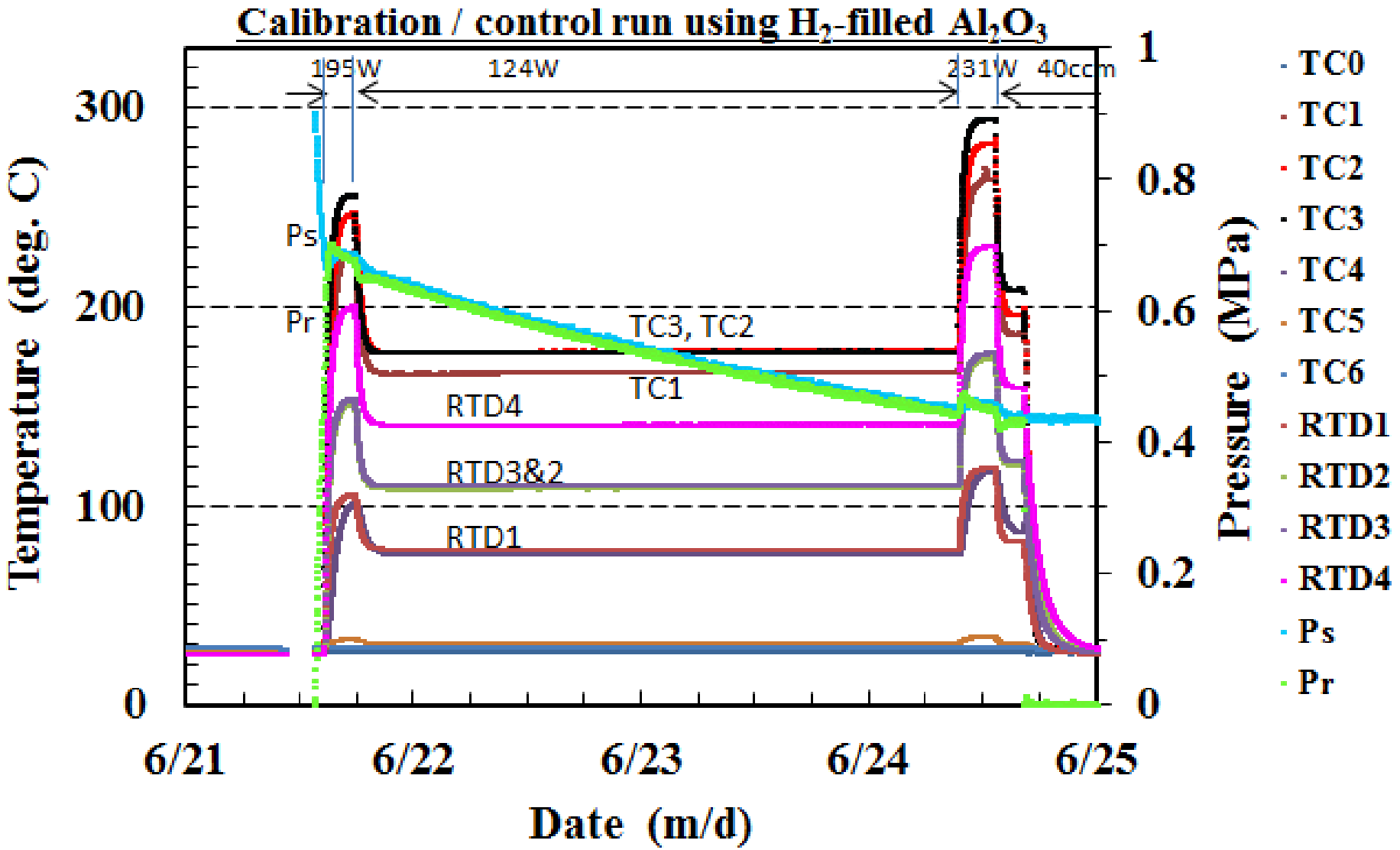


Heat transfer medium; BarrelTherm 400 (Matsumura Oil Co., Ltd.)

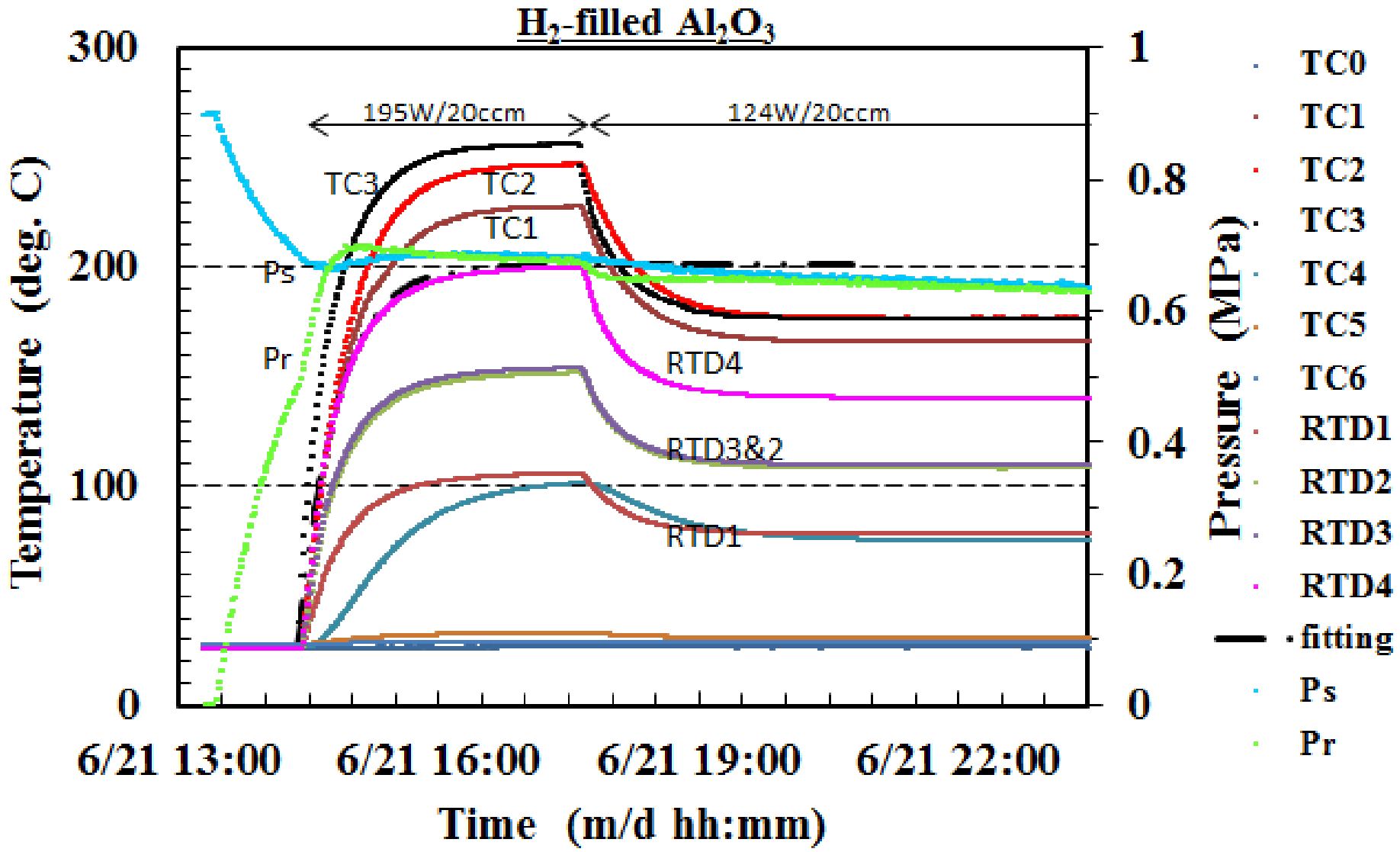


Technical info. JO1400001F
(Matsumura Oil Co., Ltd.)

Calibration using H-filled Al_2O_3 powder serves as a control run.



Calibration / control run using Al_2O_3 powder



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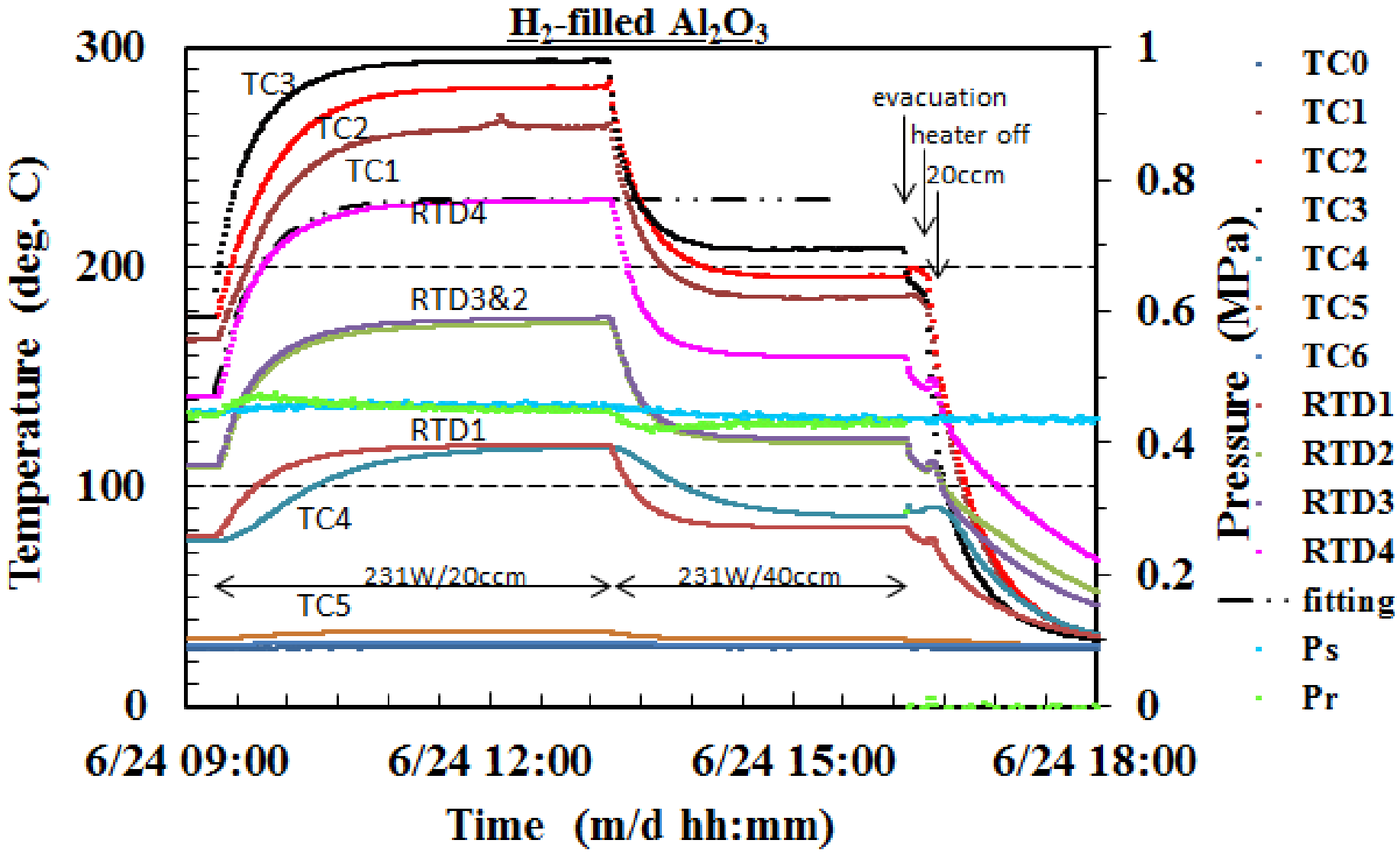
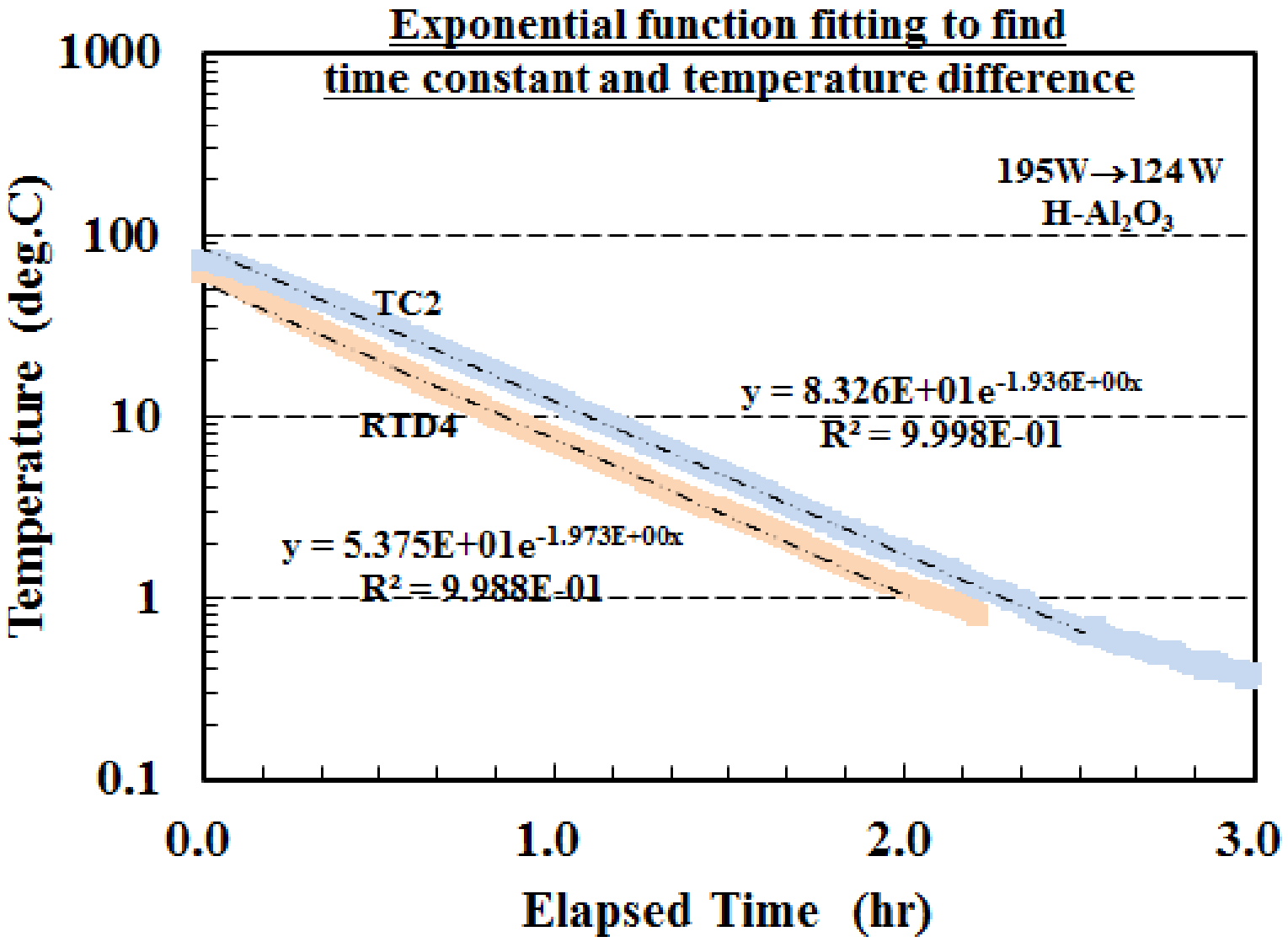


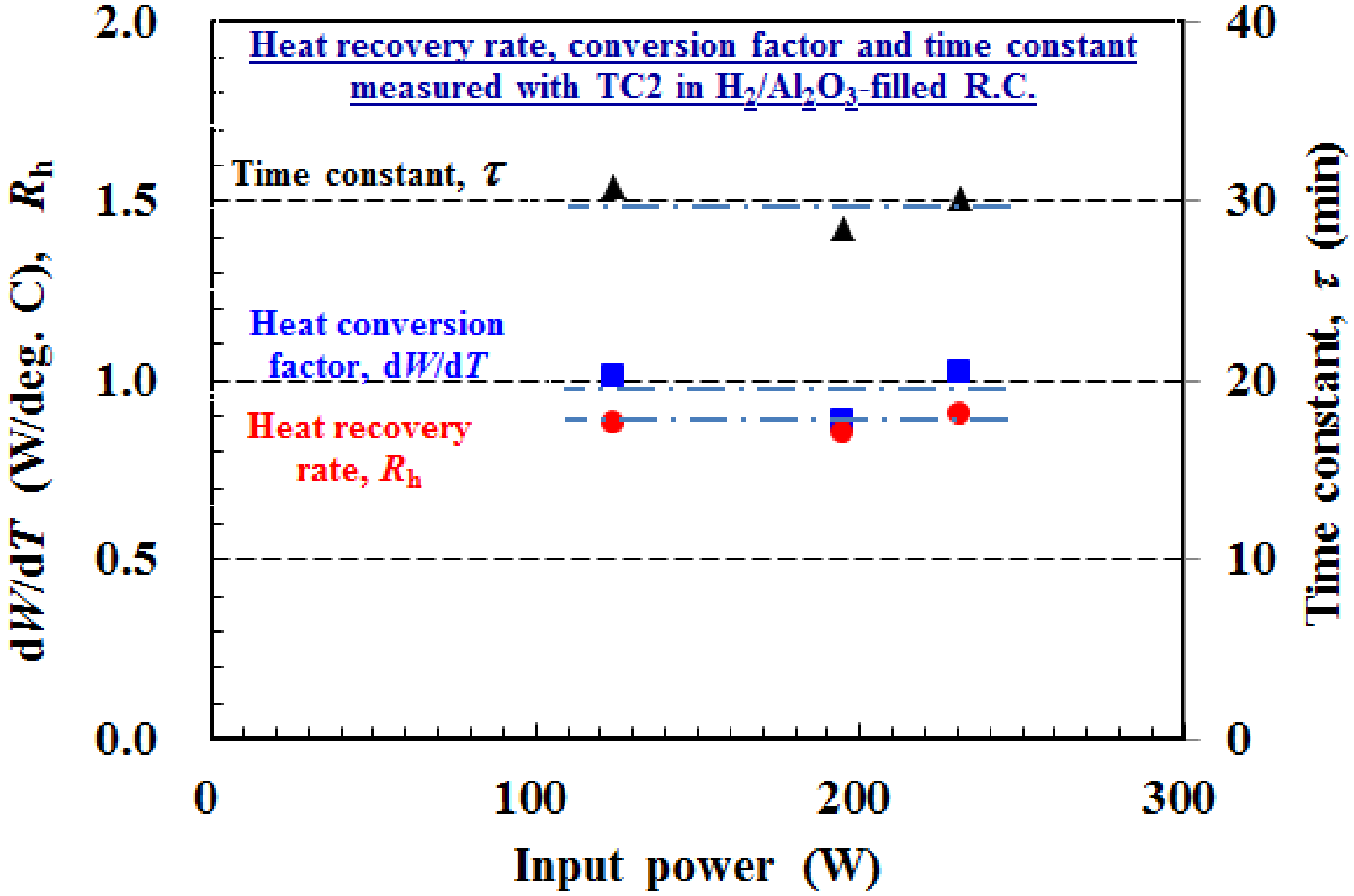
Calibration / control run using Al_2O_3 powder



Calibration of heat conversion factor ($\Delta W/\Delta T$), time constant (τ), and heat recovery rate for H_2-Al_2O_3 powder

TC2										
W_h (W)	ΔW_h (W)	F (ccm)	ΔT (°C)	$\Delta W/\Delta T$ (W/deg.C)	τ (min)		Tav (deg. C)	ρ (kg/m3) (=6.93e-1*T +1.06e3)	C (J/gK) (=3.4e-3*T +1.50)	heat recovery rate
195	195	20	2.20E+02	8.87E-01	28.4	heating phase	1.38E+02	1.16E+03	1.97E+00	8.55E-01
124	-71	20	-7.02E+01	1.01E+00	30.8	cooling phase	2.12E+02	1.21E+03	2.22E+00	8.84E-01
231	107	20	1.04E+02	1.02E+00	30.2	heating phase	2.30E+02	1.22E+03	2.28E+00	9.07E-01
			average	9.74E-01	2.98E+01					8.82E-01
			st.dev.	7.57E-02	1.24E+00					2.61E-02

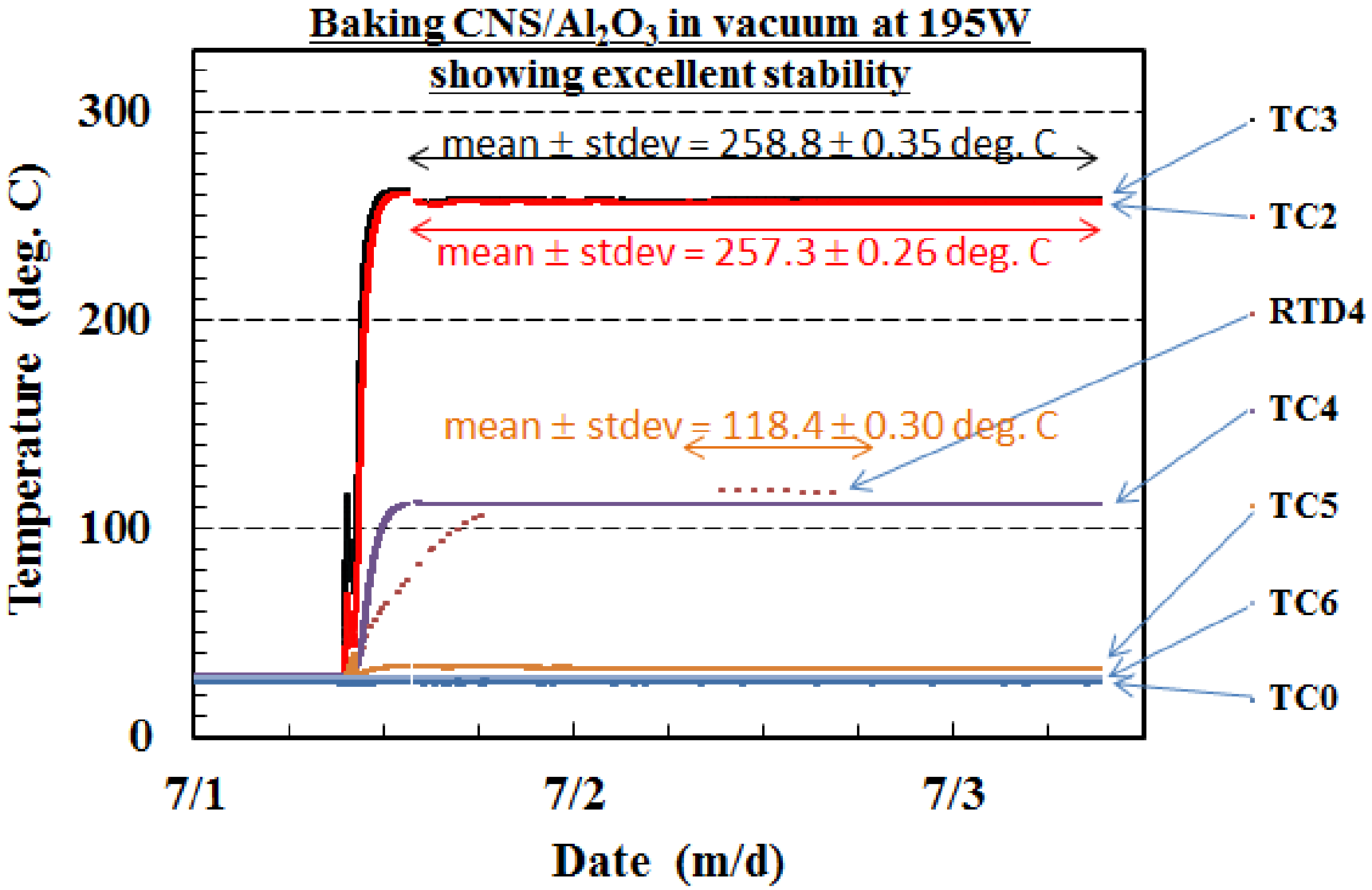
Results of calibration using Al_2O_3 powder



Preliminary runs using silica-included CNS/Al_2O_3 sample

	Molar ratio					Supplier	System
	Pd (Cu)	Ni	Zr	Si (Al)	O		Reference
Silica-included Pd; "PSII"	0.054 (2-10nmϕ)	---	---	0.946	1.95	Admatechs Co. Ltd.	A_1A_2 [5],[6],[7]
Silica-included Pd·Ni; "PNS"	0.011	0.062	---	0.927	1.92	Admatechs Co. Ltd.	A_1A_2 [6],[7]
Silica-included Cu·Ni; "CNS"	(Cu) 0.0071	0.030	---	0.321	0.64	Admatechs Co. Ltd.	C_1 Present work
(Filler) Al_2O_3 (60μmϕ)	---	---	---	(Al) 0.996	1.5	Showa Denko K.K.	C_1 As a filler and for calibration

Preliminary H-run using CNS/Al_2O_3 powder



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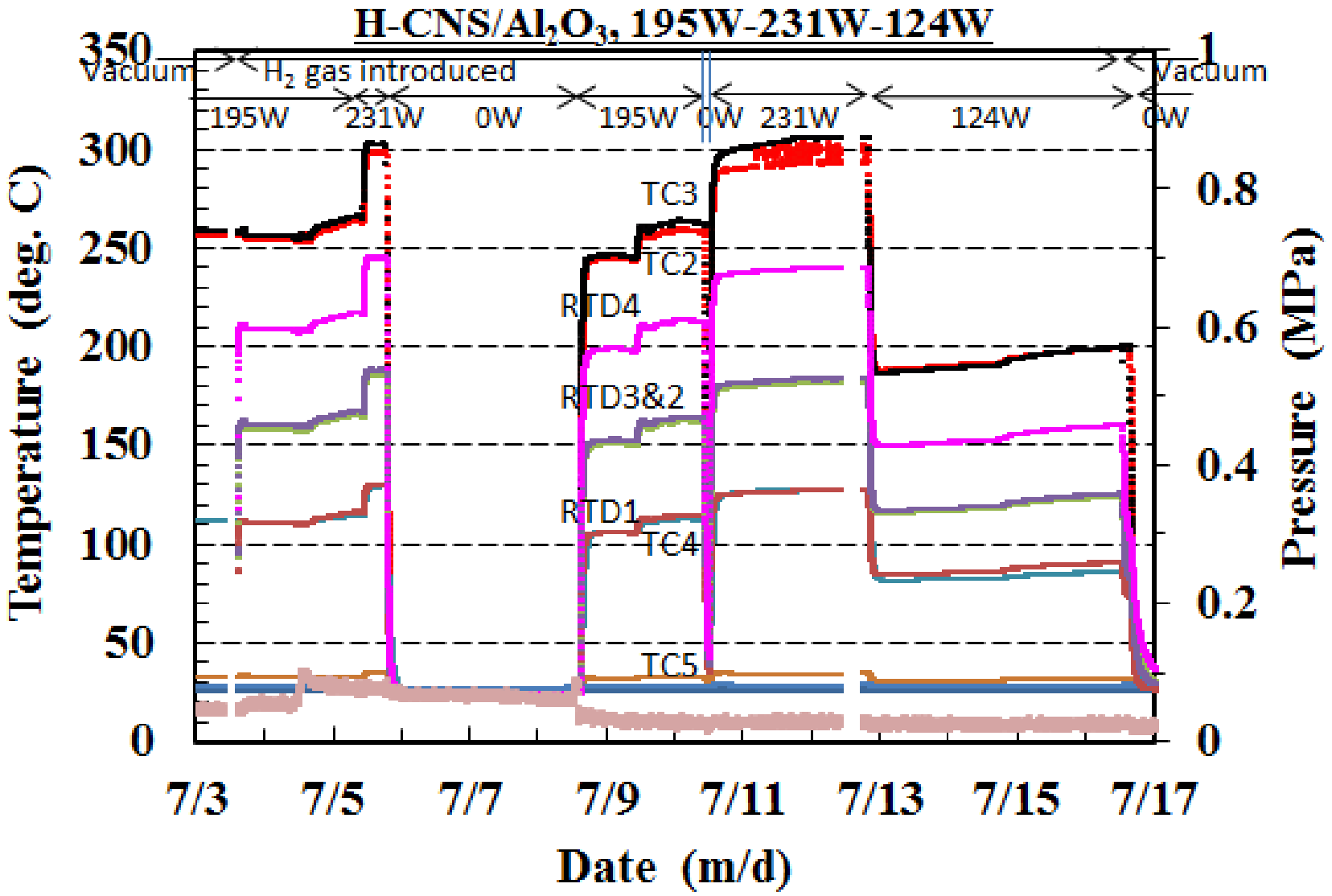

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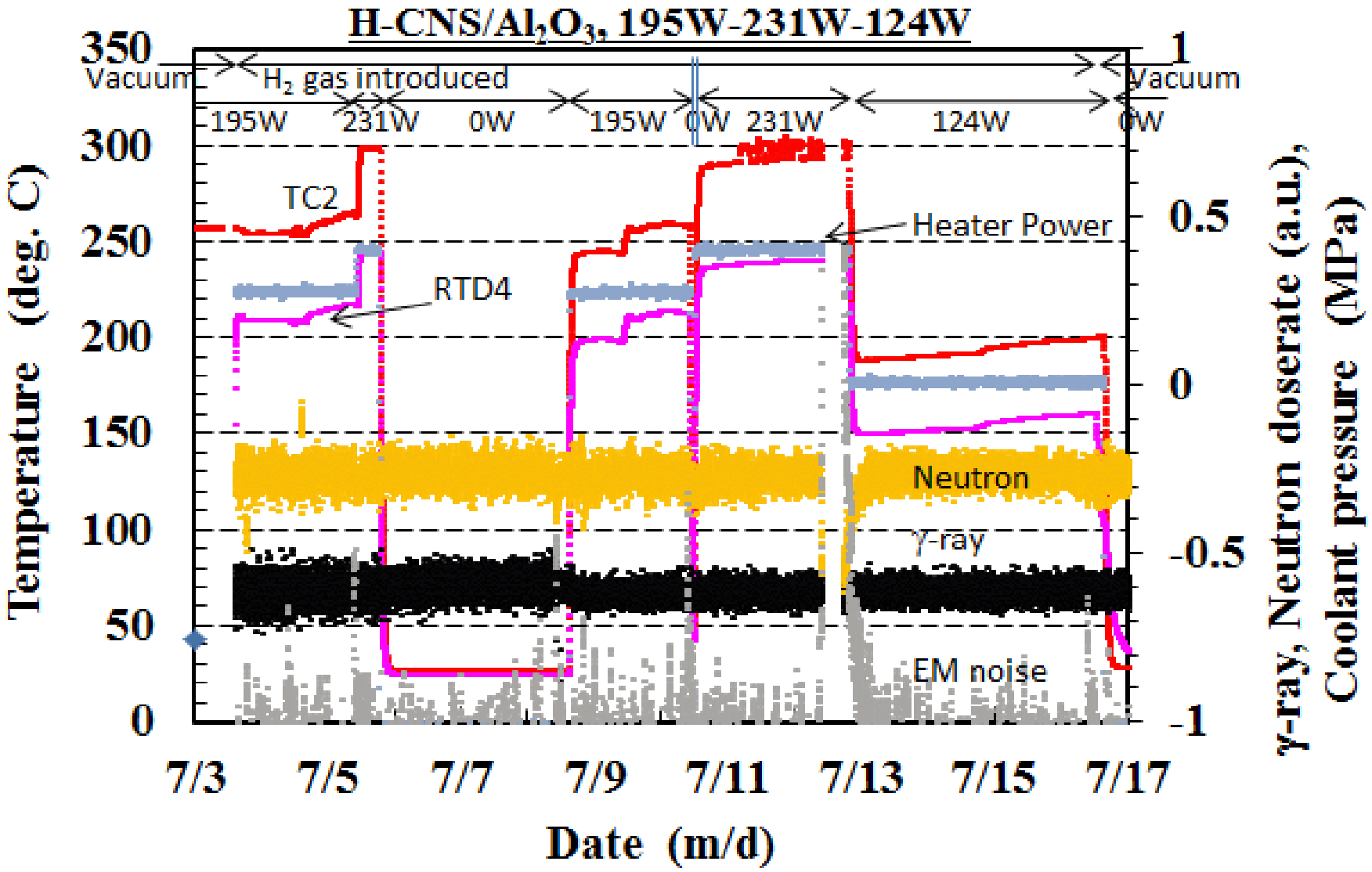

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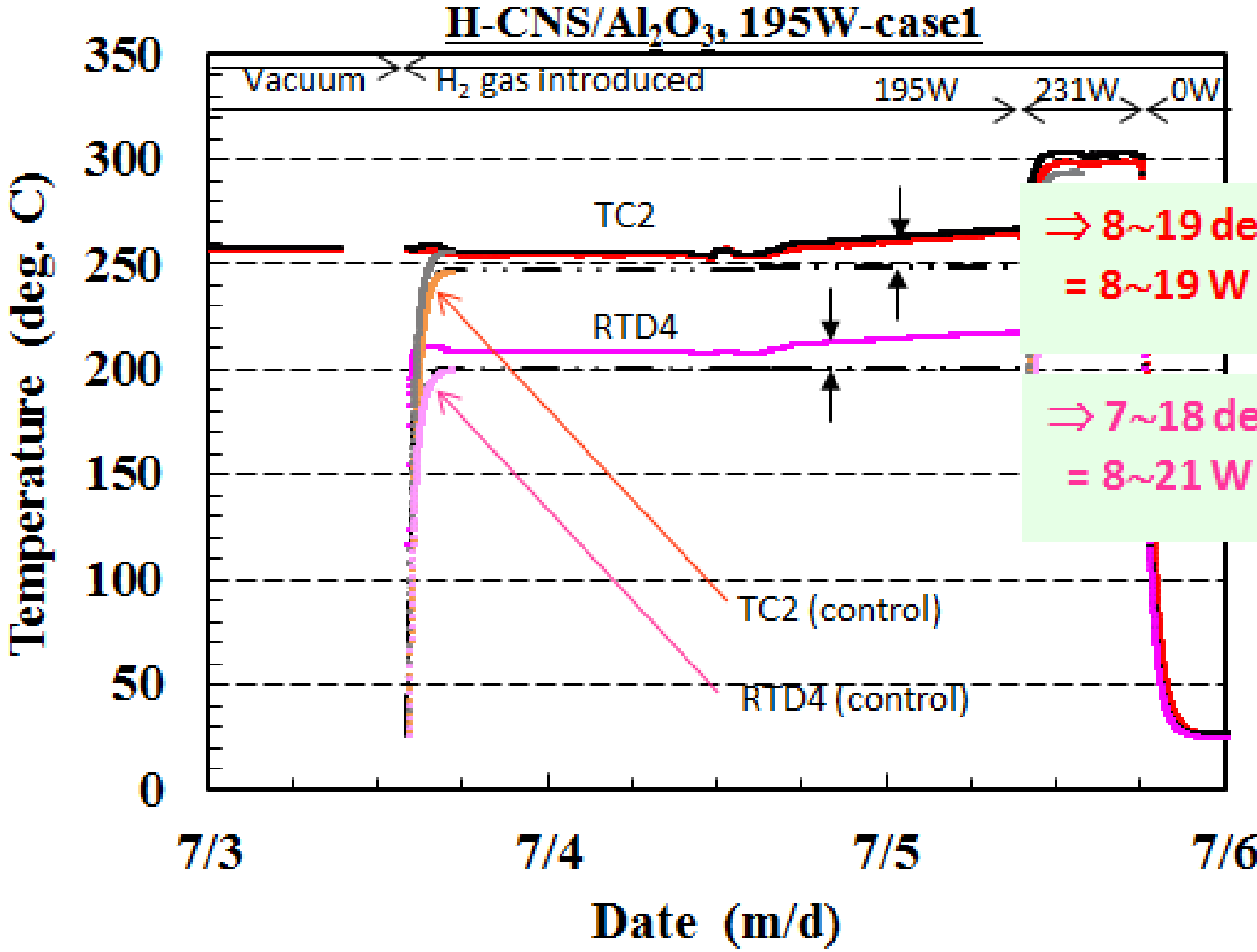
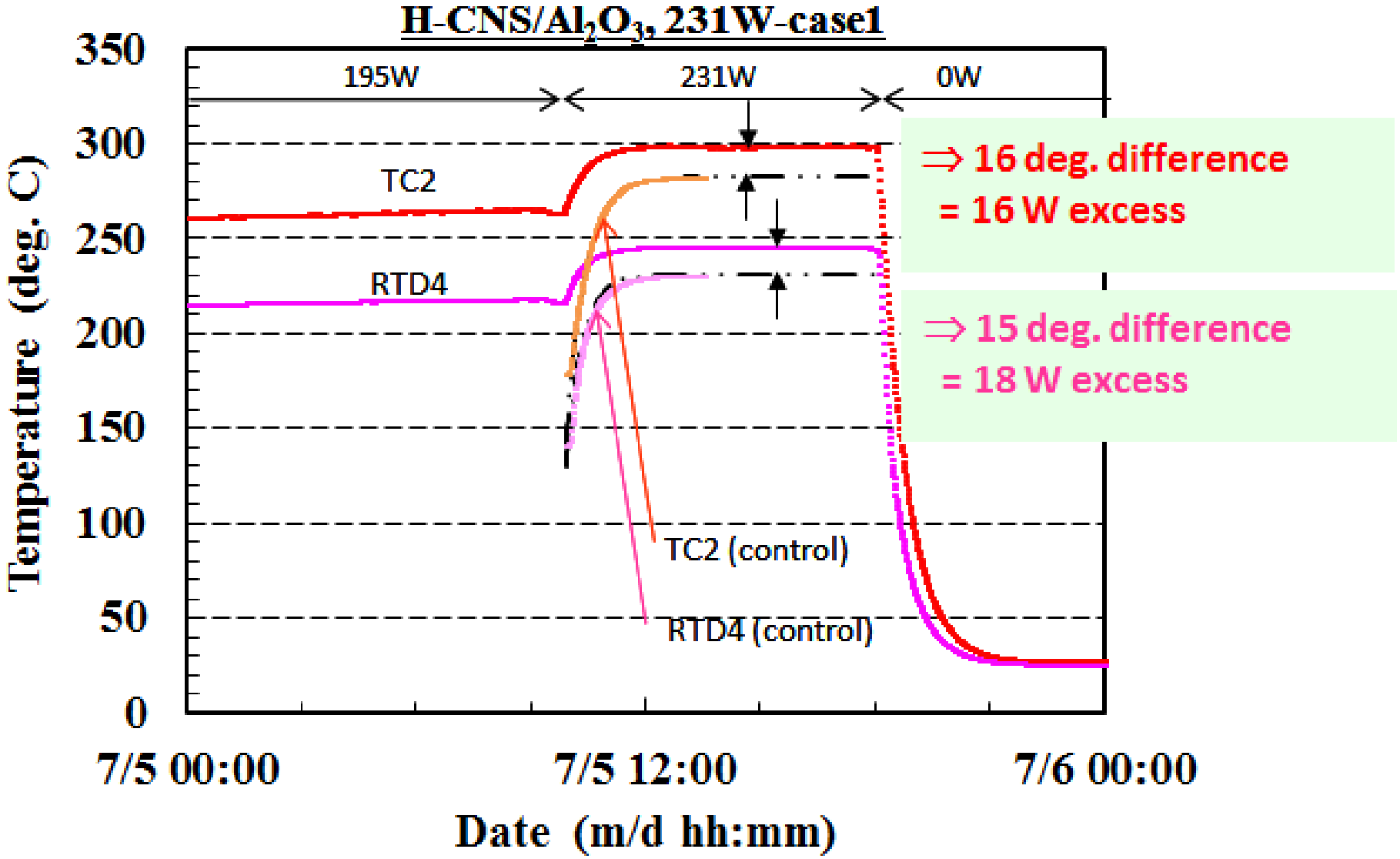


⇒ 8~19 deg. difference
= 8~19 W excess

⇒ 7~18 deg. difference
= 8~21 W excess

Preliminary runs using CNS/Al_2O_3 powder



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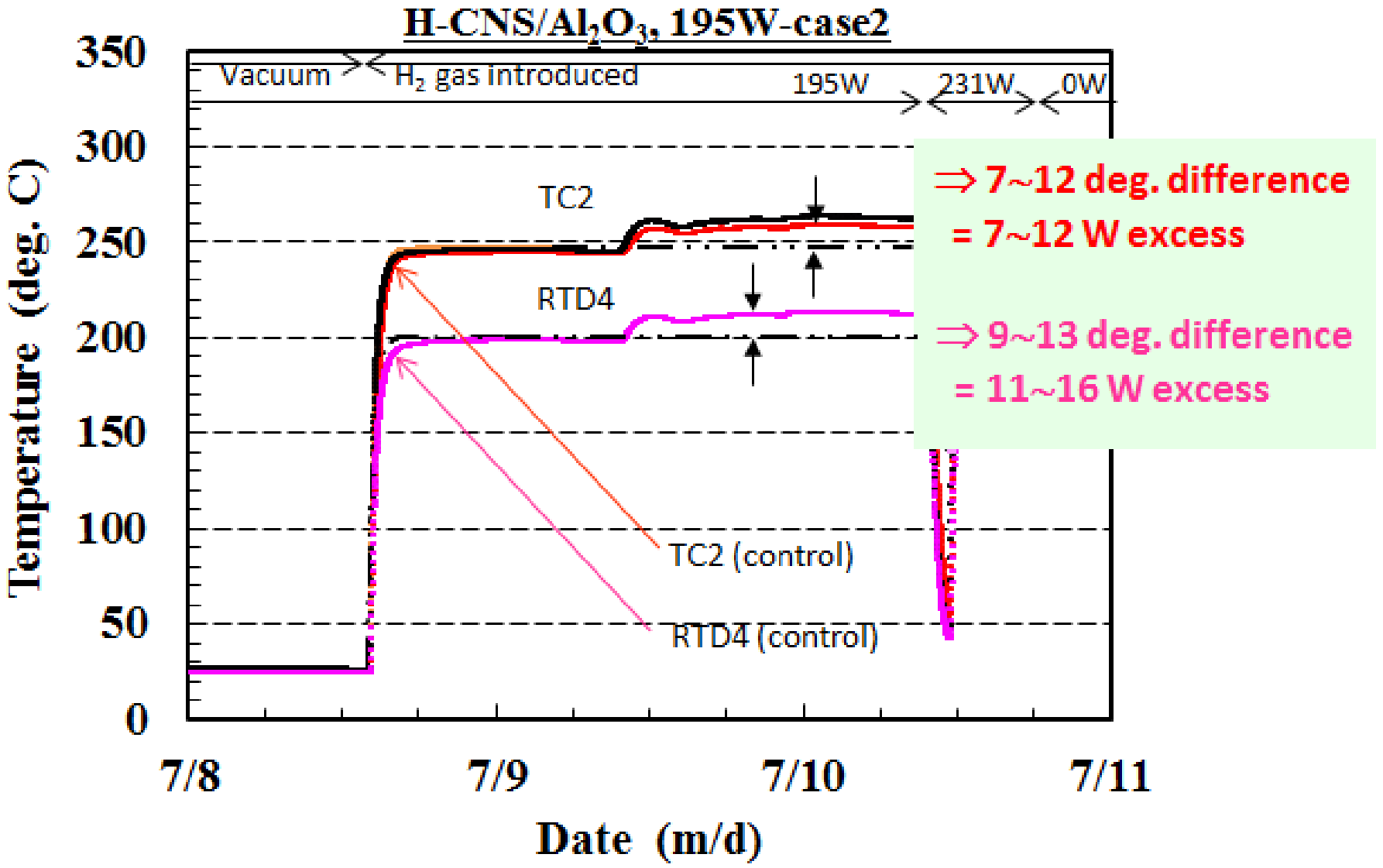

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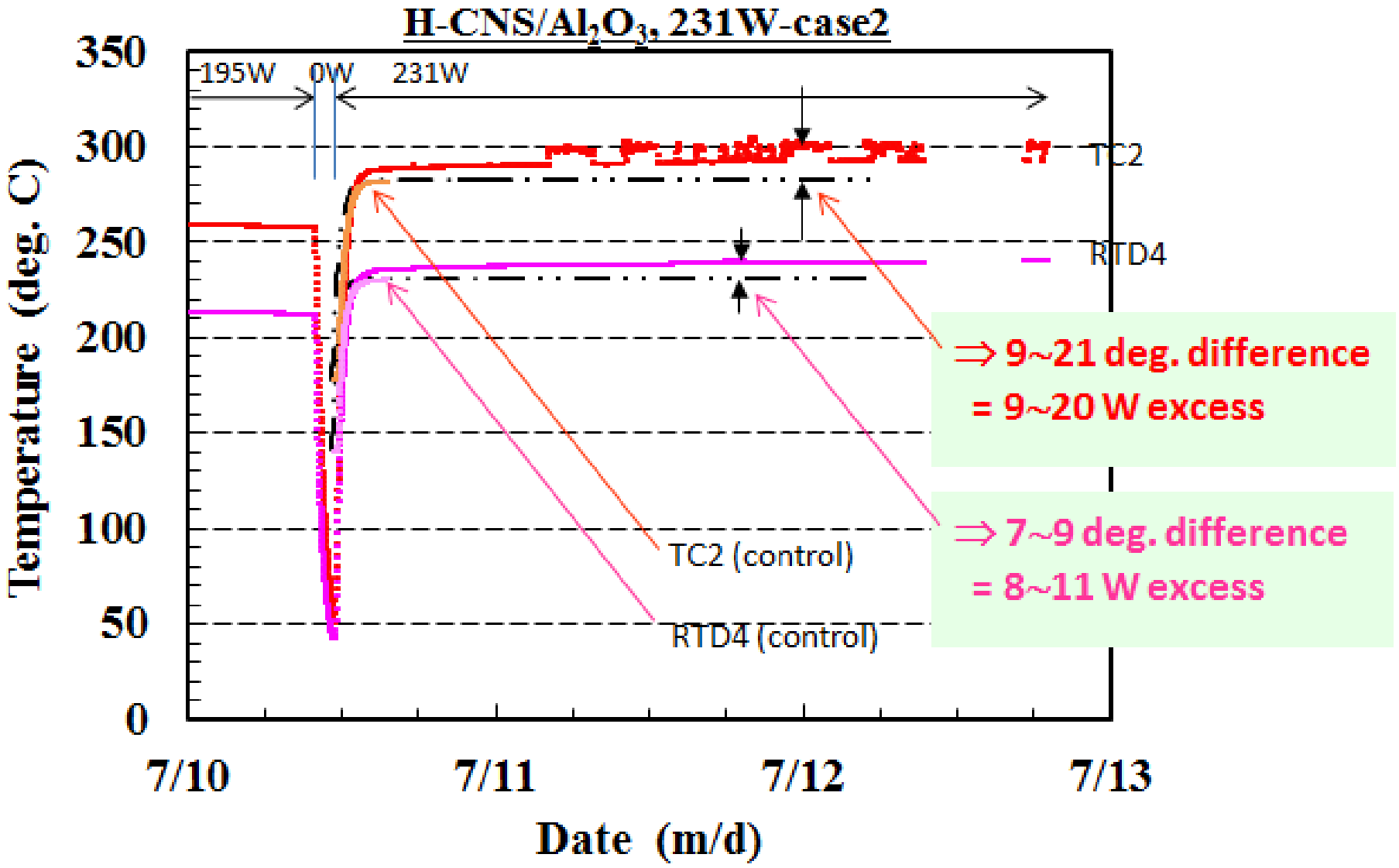

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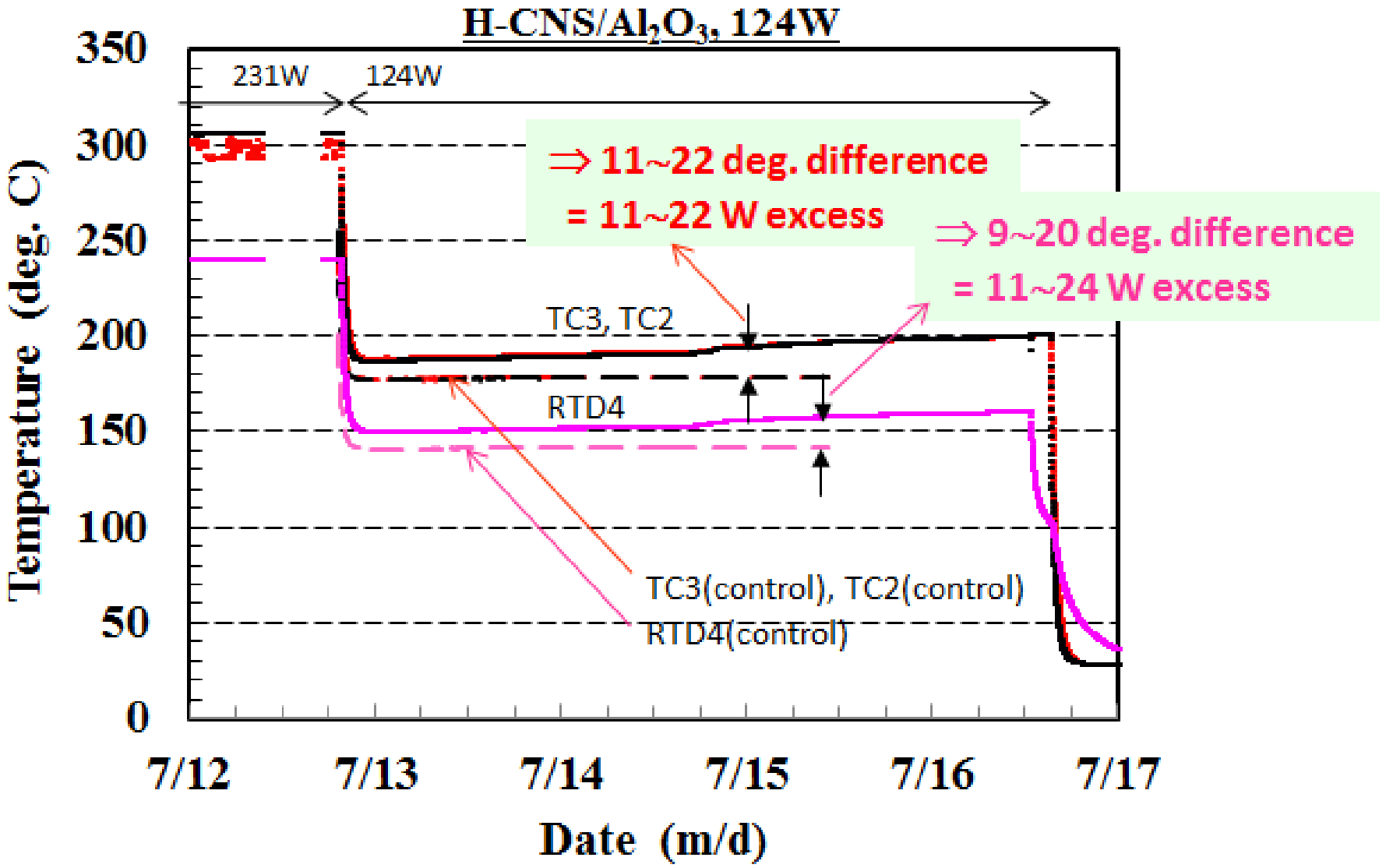

①Calibration of the oil-mass-flow calorimetry using a dummy Al_2O_3 powder:

- The coolant oil reached almost 300 deg. C at heater input of 231W.
- Long-term stability, or fluctuation in terms of standard deviation, is better than ±0.5 deg. C.
- Conversion factor, dW/dT = (0.97±0.08) W/deg with an oil-flow rate of 20 cc/min.
- Heat recovery efficiency is (0.88±0.03) with heat removal time constant of (30±1.2) min.

Conclusion

② The first trial run with a 50g CNS sample (silica-included Cu·Ni nano-compound containing 4g of Ni) mixed with 200g Al_2O_3:

- **Both TC2 at the oil outlet and RTD's inside the reaction chamber show higher temperatures than for the blank sample, which implies a long-lasting excess power of ~ 20 W (*i.e.*, 5 W/g-Ni).**
- **The assumed excess heat appears to be on the same order as that of the CNZ ($Cu·Ni/Zi_2O_3$) sample yielding 2 W/g-Ni excess power [5,6,7].**
- **Further measurements with more precise comparison are necessary to confirm the excess.**

Thank you for your attention.