Replicable Model for Controlled Nuclear Reaction using Metal Nanoparticles

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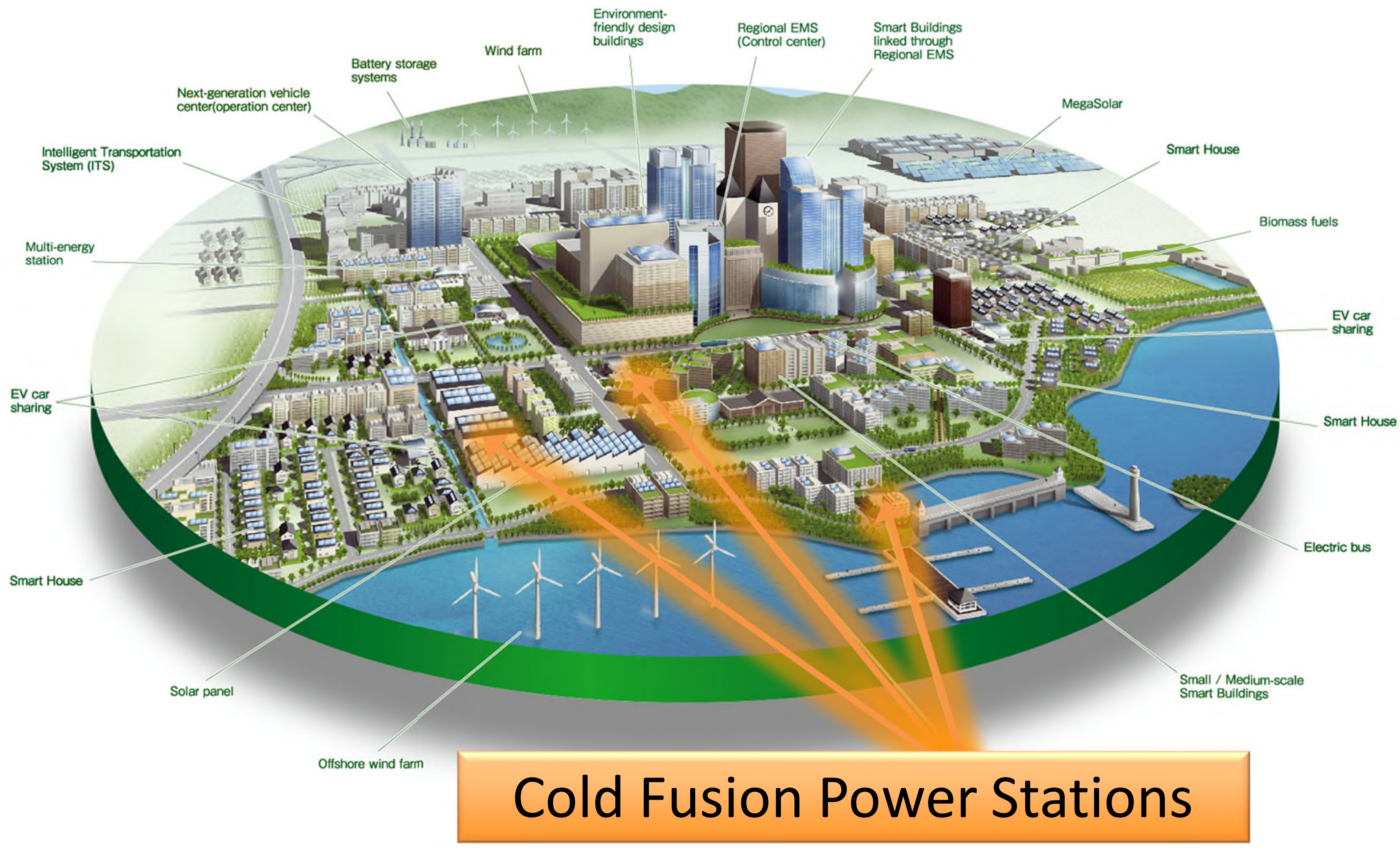
Fukushima

Effects of Fukushima

Cold Fusion Energy Solution



10 kW Domestic Home Units Design-Ideas

Building a Replicable Model

3 Purposes of this Report

1. **Formalize a replicable CF methodology with Ni and D_2 Gas:** Derive a formula based on test results only using **Ni** nanoparticles as metal and **D_2 gas**, which generated the best results.

2. **Analyze the Gas Composition during the Test:** Accurately analyzed the changes of gas composition during the test, which we believe hasn't been reported before.

3. **Find CF Reaction Kinetics:** Aim to find the reaction kinetics.

Testing with Various Metals and Gas

Metal:
Ni, Pd

Gas:
H_2, D_2, H_2O, D_2O

73 Test Results in total (Jan. – Dec. 2013)

No.	Gas		Power in/W				Time	Heat out/W		Hout/Hin	
	Component	Pressure	Heat Watt	Plasma		Total	ks	Estimated by Electrode temp.	Estimated by reactor temp.	Estimated by Electrode temp.	Estimated by reactor temp.
	Significant	Pa	W	V	W						
1	D_2O	70	30.7	0	0	30.7	7	51	33	1.65	1.08
2	D_2O	70	30.7	780	13.9	44.6	2.8	61	48	1.37	1.08
3	D_2O	275	31	0	0	31	58	58	35	1.87	1.13
4	D_2O	50	31	0	0	31	78	46	34	1.48	1.07
5	D_2O	50	31	0	0	31	13	43	31	1.38	0.997
6	D_2O	100	45.7	0	0	45.7	65	53	55	1.15	1.19
7	D_2O	20	44.6	0	0	44.6	1.2	36	50	0.82	1.13
8	D_2O	50	45.8	790	16.6	62.4	2.48	62	62	1	1.2
9	D_2O	50	46.6	772	14.6	61.2	1.44	60	60	1	1.3
10	D_2O	50	47	0	0	47	1.17	55	55	1.28	1.43
11	D_2O	145	45.9	0	0	45.9	150	67	60	1.3	1.31
12	D_2	330	45.8	0	0	45.8	62.5	68	69	1.48	1.51
13	H_2O	20	46	0	0	46	8.2	46	70	1	1.09
14	D_2	400	49	770	12	61	6.5	66	70	1.08	1.15
15	D_2	200	49	0	0	49	1.3	61	60	1.24	1.22
16	D_2	300	25	0	0	25	6.5	41	30	1.64	1.2
17	D_2	300	36	0	0	36	1.5	54	48	1.5	1.33
18	D_2	330	36	0	0	36	2.8	54	44	1.5	1.22
19	D_2	330	51.2	0	0	51.2	8	58	80	1.13	1.56
20	H_2O	20	35.5	0	0	35.5	60	42	42	1.18	1.18
21	H_2O	150	0	825	15.6	15.6	16	4.3	10.3	0.275	0.66
22	H_2O	145	0	800	16	16	9.4	3.1	10.4	0.192	0.655
23	H_2O	180	61.8	0	0	61.8	63.2	78	110	1.26	1.78
24	H_2O	25	61	0	0	61	64.3	45	78	0.73	1.28
25	D_2	140	61	0	0	61	18.2	70	110	1.15	1.8
26	D_2	200	61.3	0	0	61.3	143	85	111	1.39	1.81
27	D_2	300	62.4	0	0	62.4	11	100	65	1.6	1.04
28	D_2	370	62.4	821	22.7	85.1	4.5	120	95	1.41	1.12
29	D_2	365	62.4	846	22.7	85.1	3.6	120	105	1.41	1.23
30	D_2	310	0	852	24.4	24.4	4.2	9	24	0.37	1
31	D_2	430	81.5	0	0	81.5	22.5	100	91.5	1.22	1.12
32	D_2	260	80.5	0	0	80.5	2.08	105	87.5	1.3	1.09
33	D_2	140	0	0	0	0	2	0.04			
34	D_2	222	45	0	0	45	17.5	61	46	1.36	1.02
35	D_2	427	46.2	0	0	46.2	62	80	50	1.58	1.08
36	D_2	425	45.9	0	0	45.9	27	79	53.5	1.72	1.17
37	D_2	438	46.2	0	0	46.2	62	79	58	1.71	1.26
38	D_2	408	46.2	0	0	46.2	93.4	79	55	1.71	1.19
39	D_2	391	46	0	0	46	85.9	79	55	1.71	1.2
40	D_2	382	46	0	0	46	162	79	53	1.71	1.2
41	D_2	367	45.9	0	0	45.9	62	80	56.5	1.74	1.23
42	D_2	348	45.9	0	0	45.9	81.4	80	58.5	1.74	1.27
43	D_2	348	45.4	0	0	45.4	2.2	79	52.5	1.74	1.16
44	D_2	260	81	0	0	81	13.1	120	110	1.48	1.36
45	D_2	170	81	0	0	81	67	105	96	1.29	1.19

Testing with Various Metals and Gas

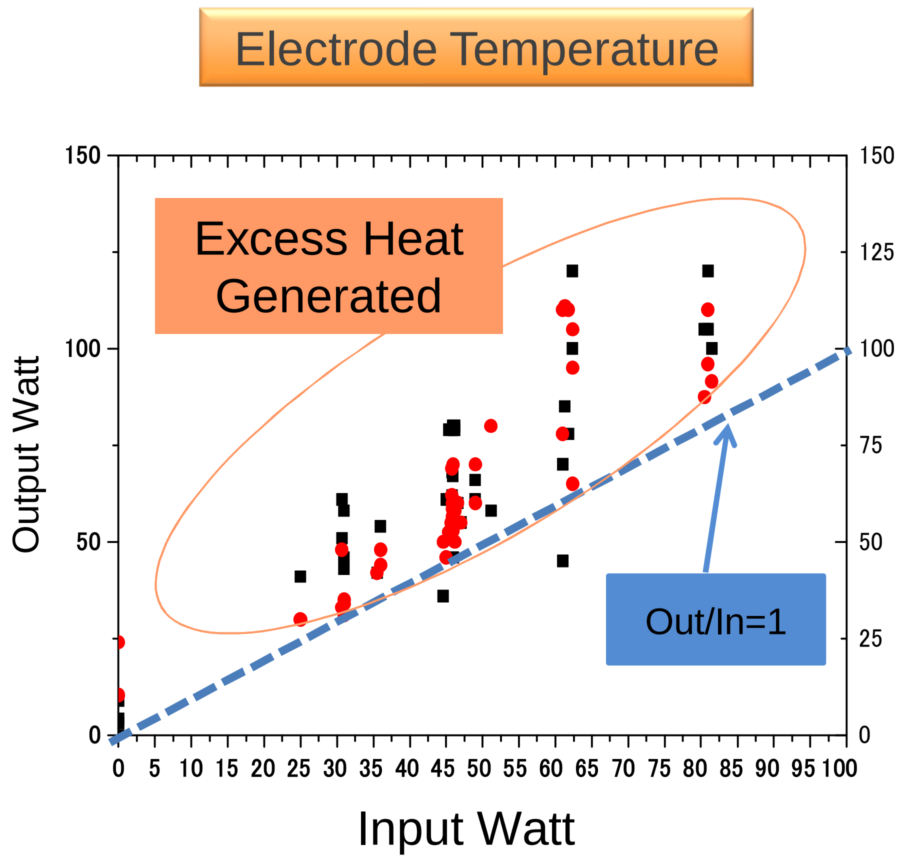
Some Test Results with Ni and H_2

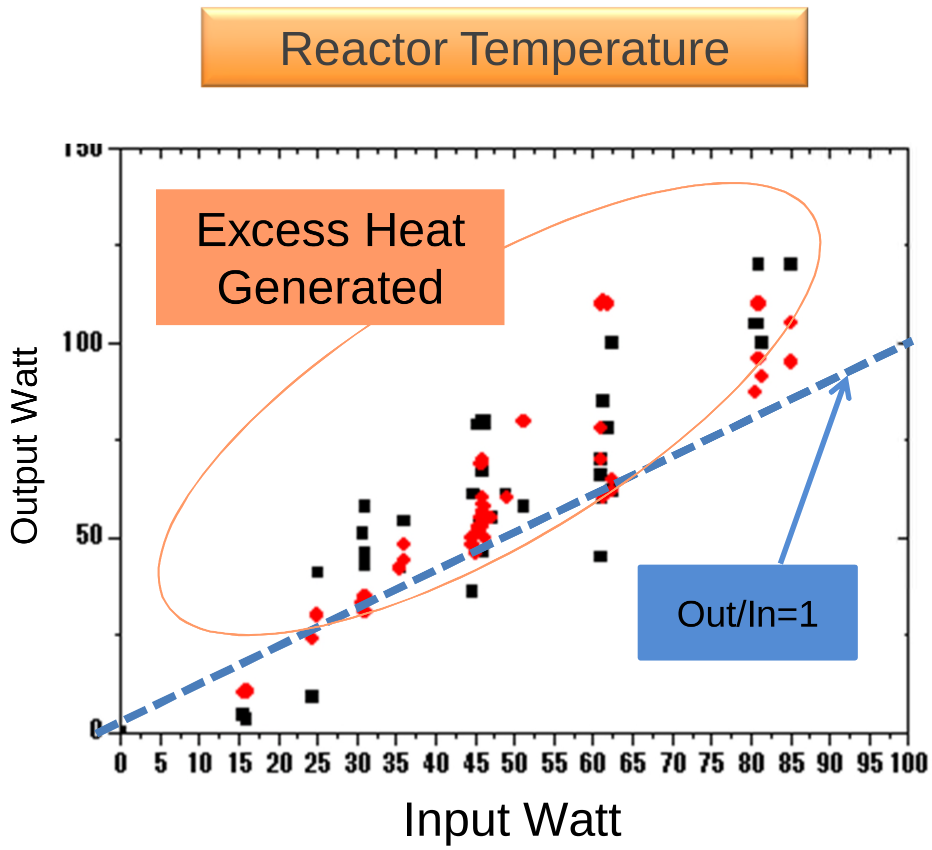
No.	Gas	Pressure (Pa)	Input Watt	Time/ks	Electrode Temperature	Reactor Temperature	COP (Electrode Temperature)	COP (Reactor Temperature)
1	H_2	20	44.6	1.2	36	50	0.82	1.1
2	H_2	20	46	8.2	46	70	1	1.1
3	H_2	20	35.5	60	42	42	1.2	1.2
4	H_2	25	61	64.3	45	78	0.73	1.3

Produced excess heat;

- Using **Nickel** Nano-particles and **D_2 gas**
- For over **1 month**
- Excess Heat = **75watt** (**COP = 1.9**)
- Excess Energy = **108MJ**

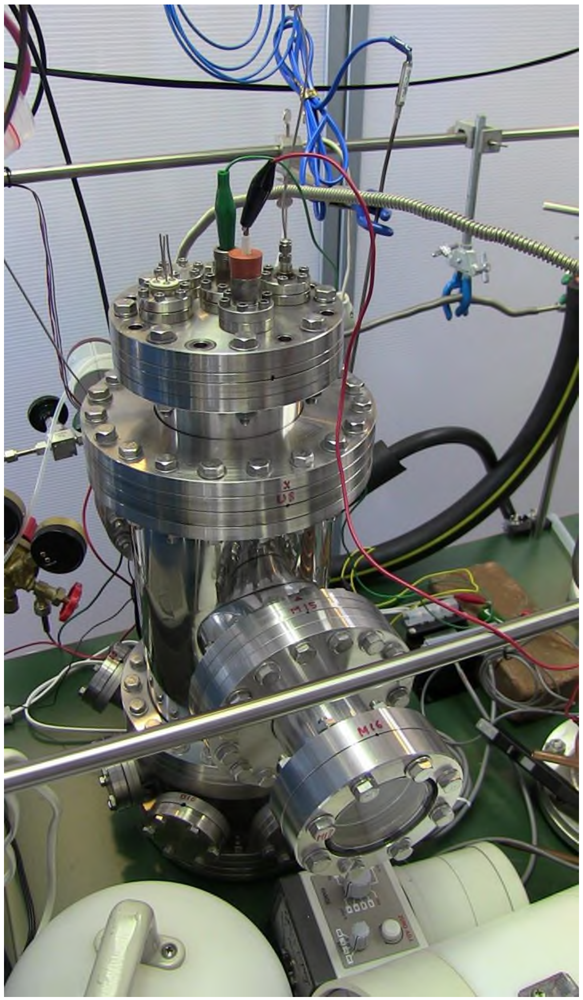
Input Dependence of Heat Generation (All the results; Ni with D_2, H_2, H_2O, D_2O)

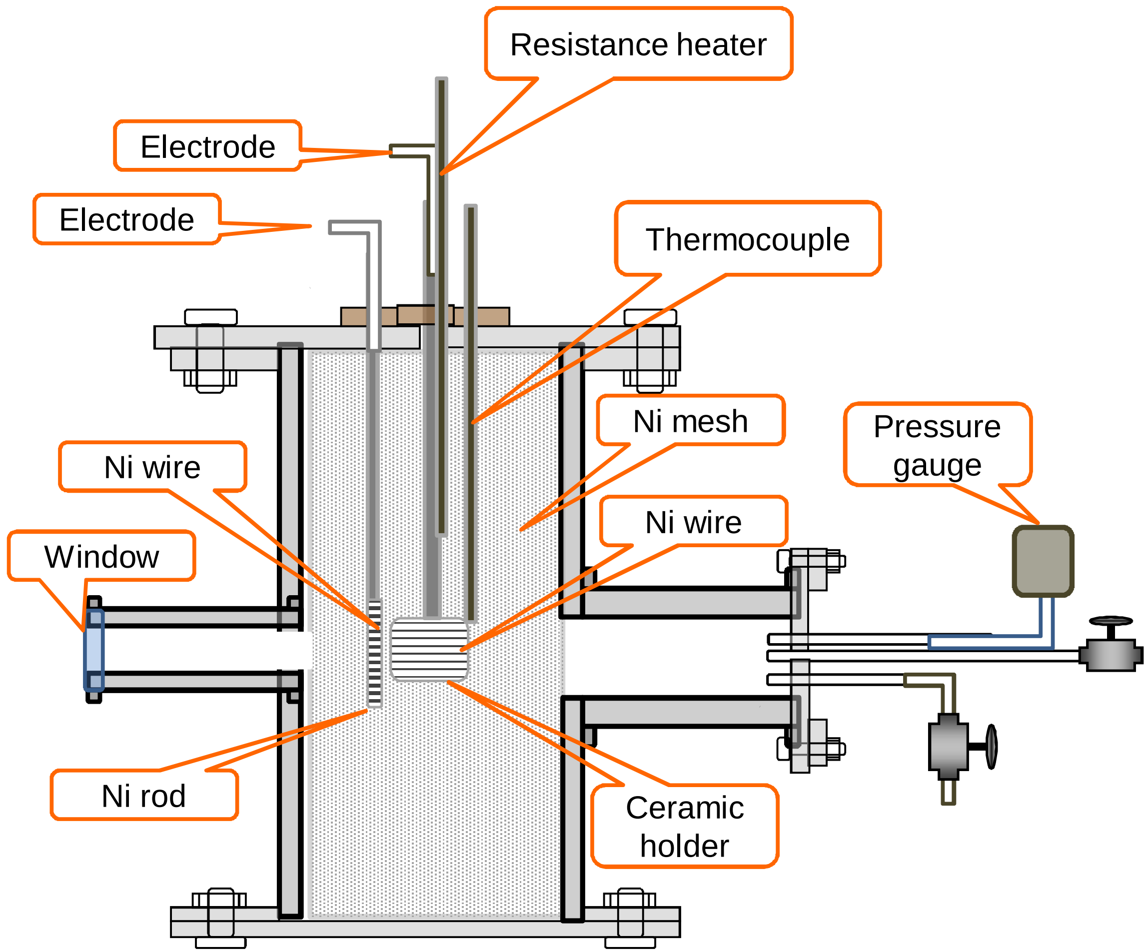




Set-up & Preparation

Reactor with Resistance Heater

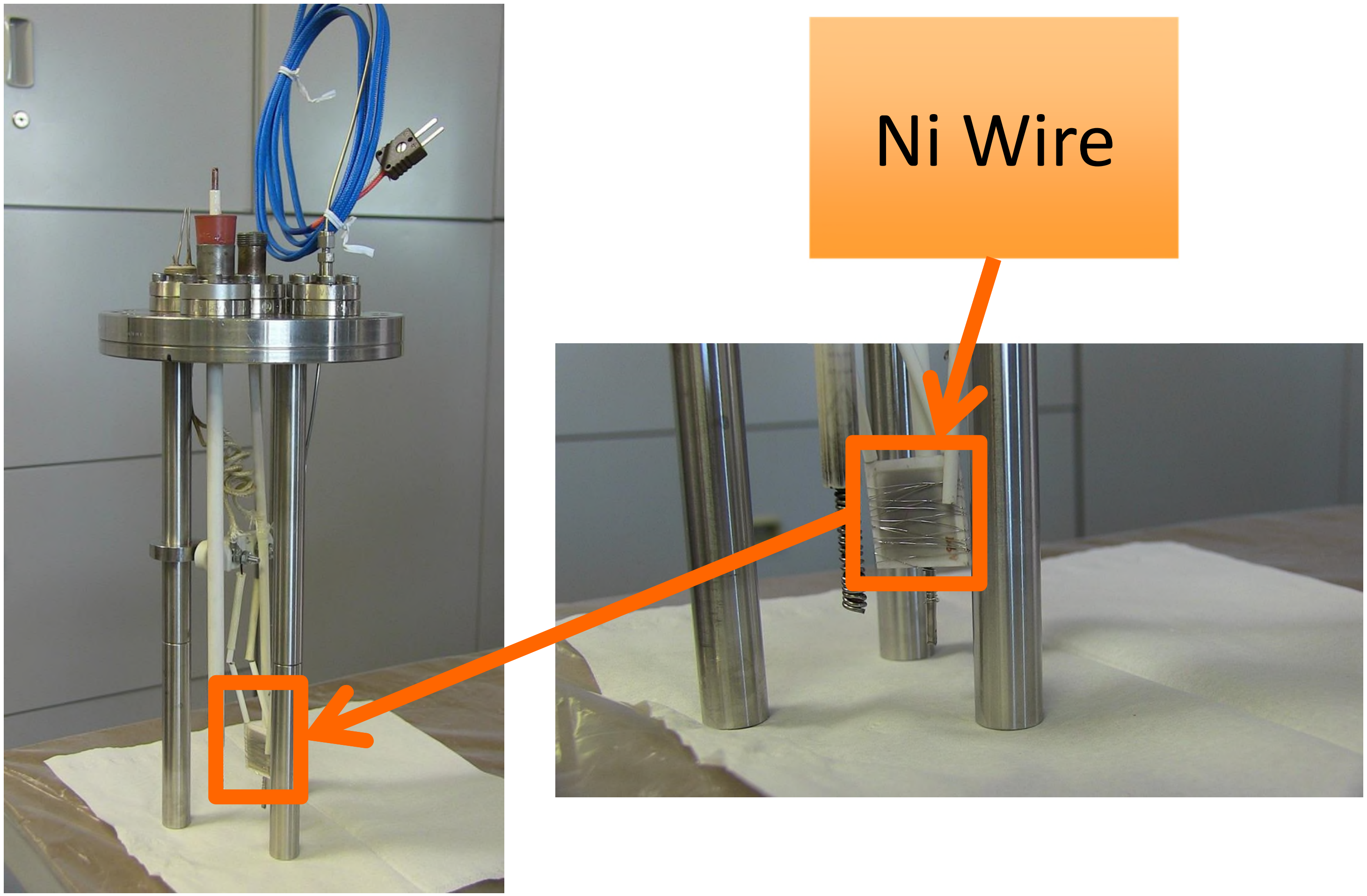




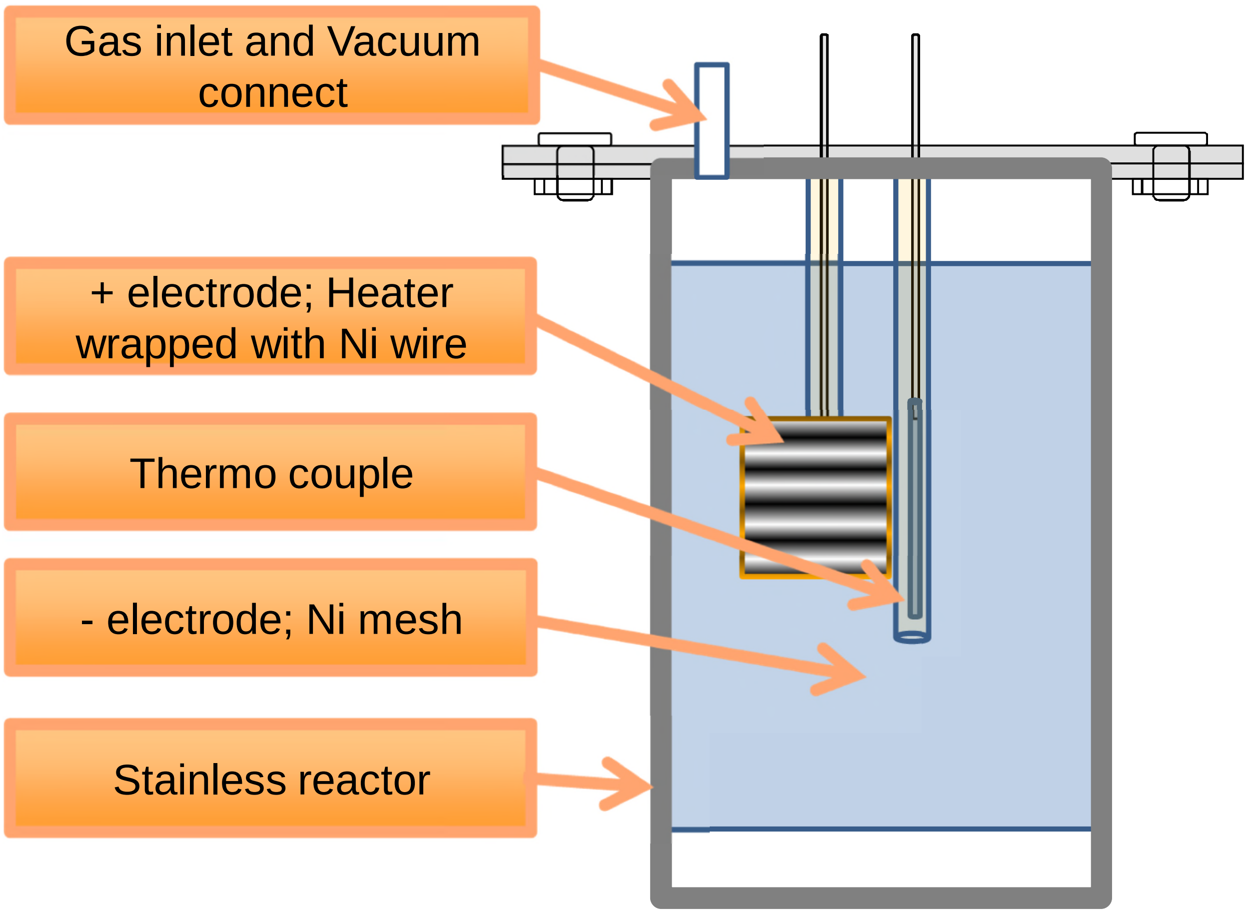
Key Components

■ Reactive metal	: Ni mesh
■ Reactant	: D_2 Gas
■ Temperature	: 200℃ +
■ Pressure	: 100~300 Pa

Reactor Lid with Electrode



Reactor Core (aka: Dorothy)

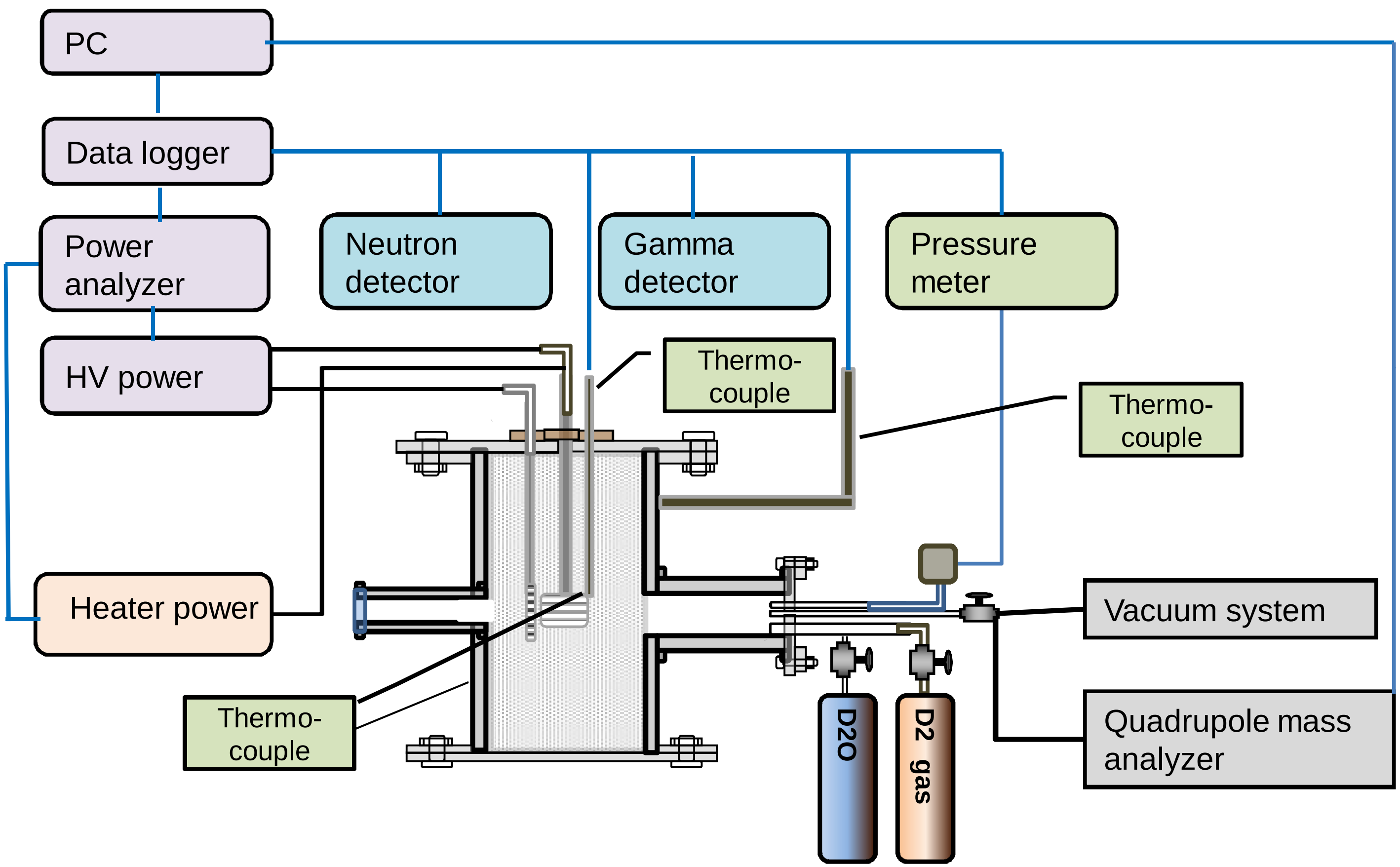


Measuring Data

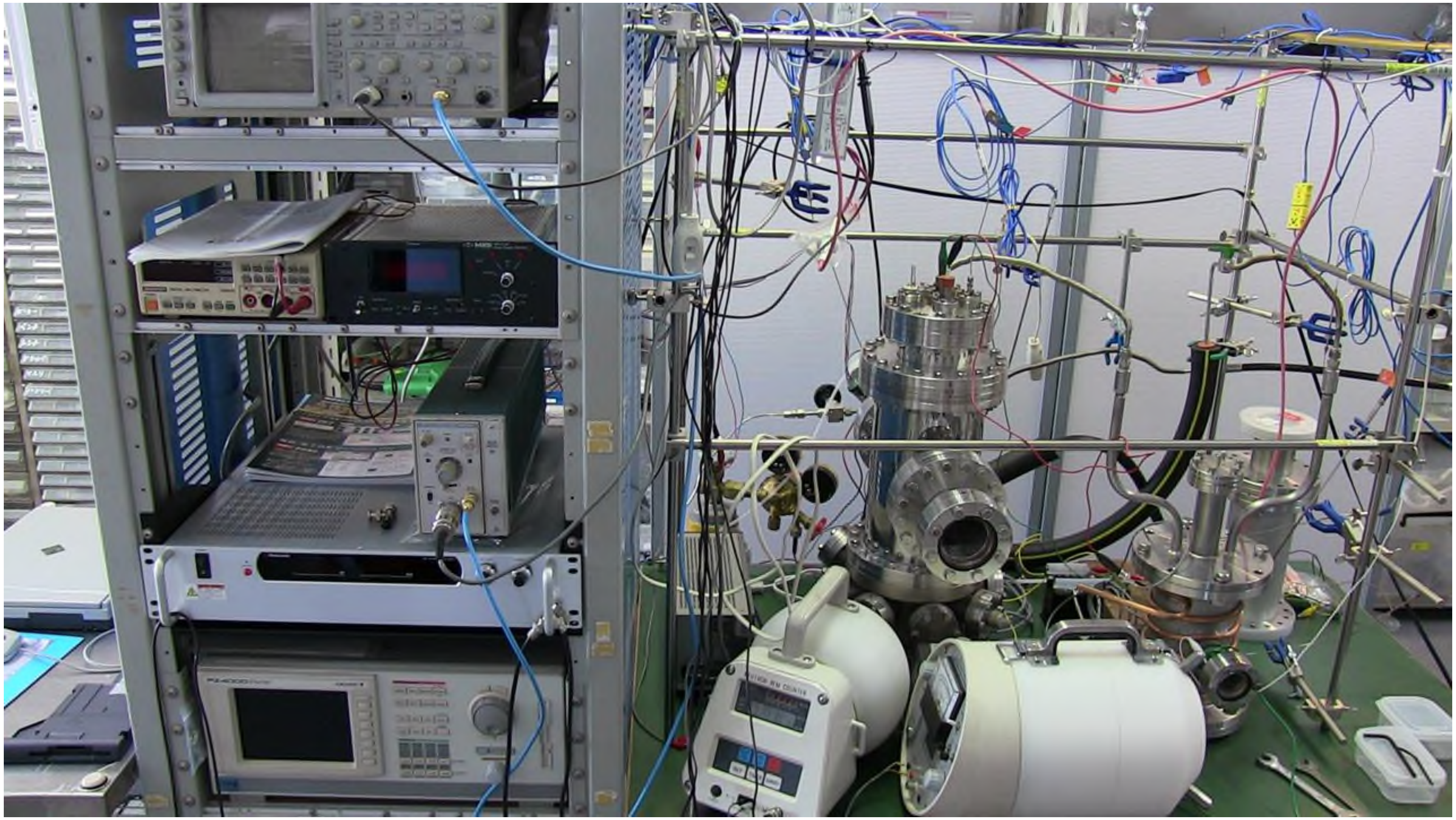
- Temperature
- Gas Pressure
- Gas Components
- Radiations; Neutron, γ-ray

Measurement Devices Configuration

Reactor is shown along with Vacuum system, Gas supply, and the Radiation detectors, etc.



Measuring Devices Setup

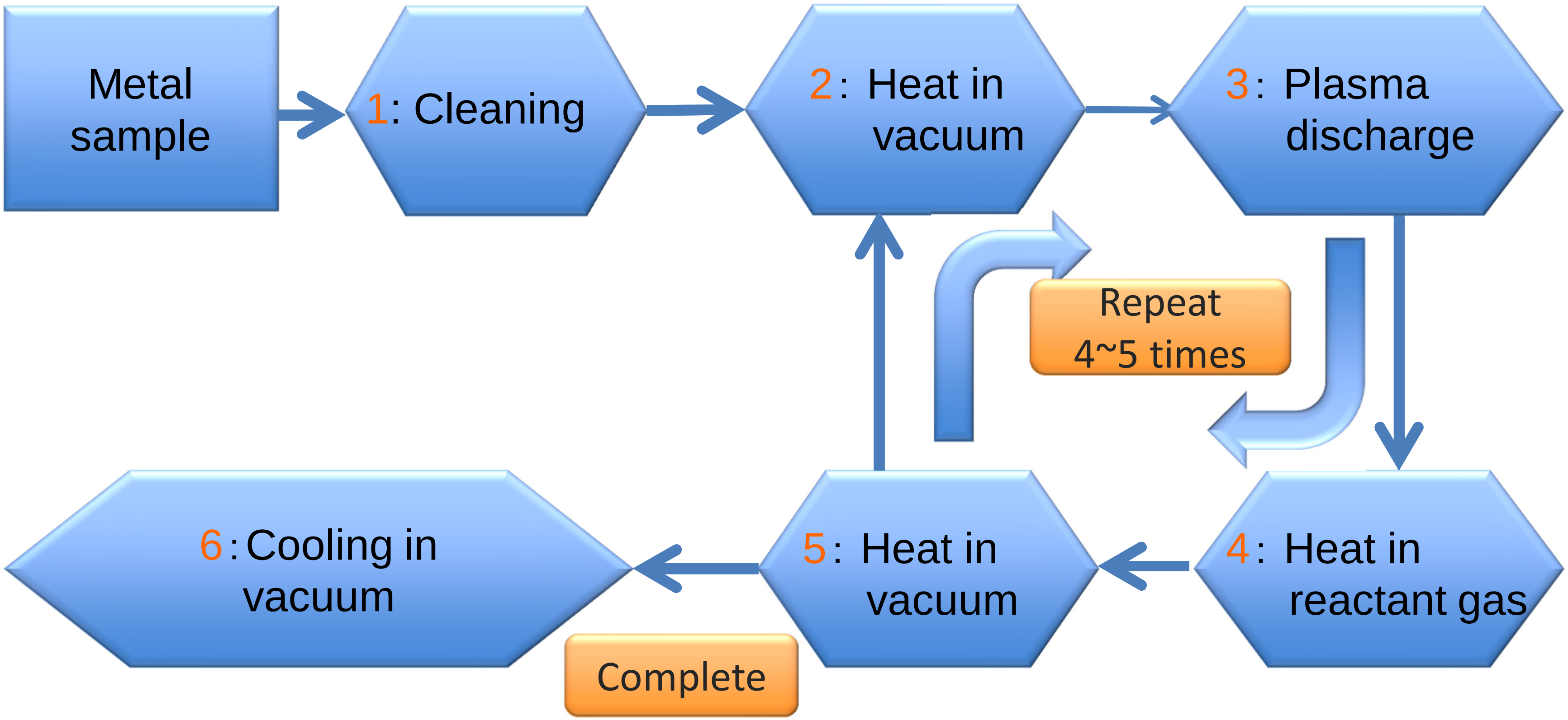


Measuring Devices Setup

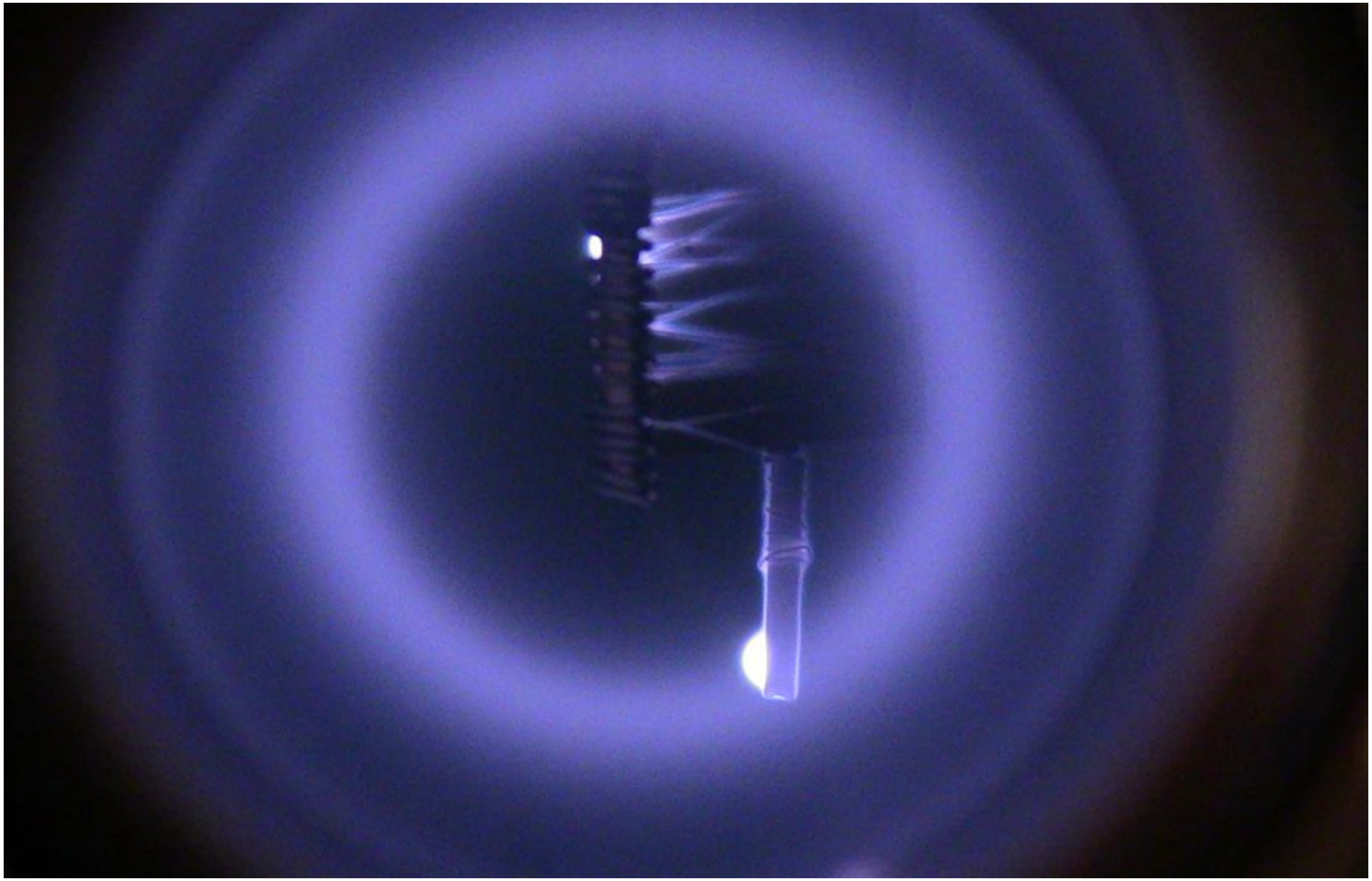
Radiation Detectors

Quadrupole Mass Analyzer

Preparation of the Reactant Metal

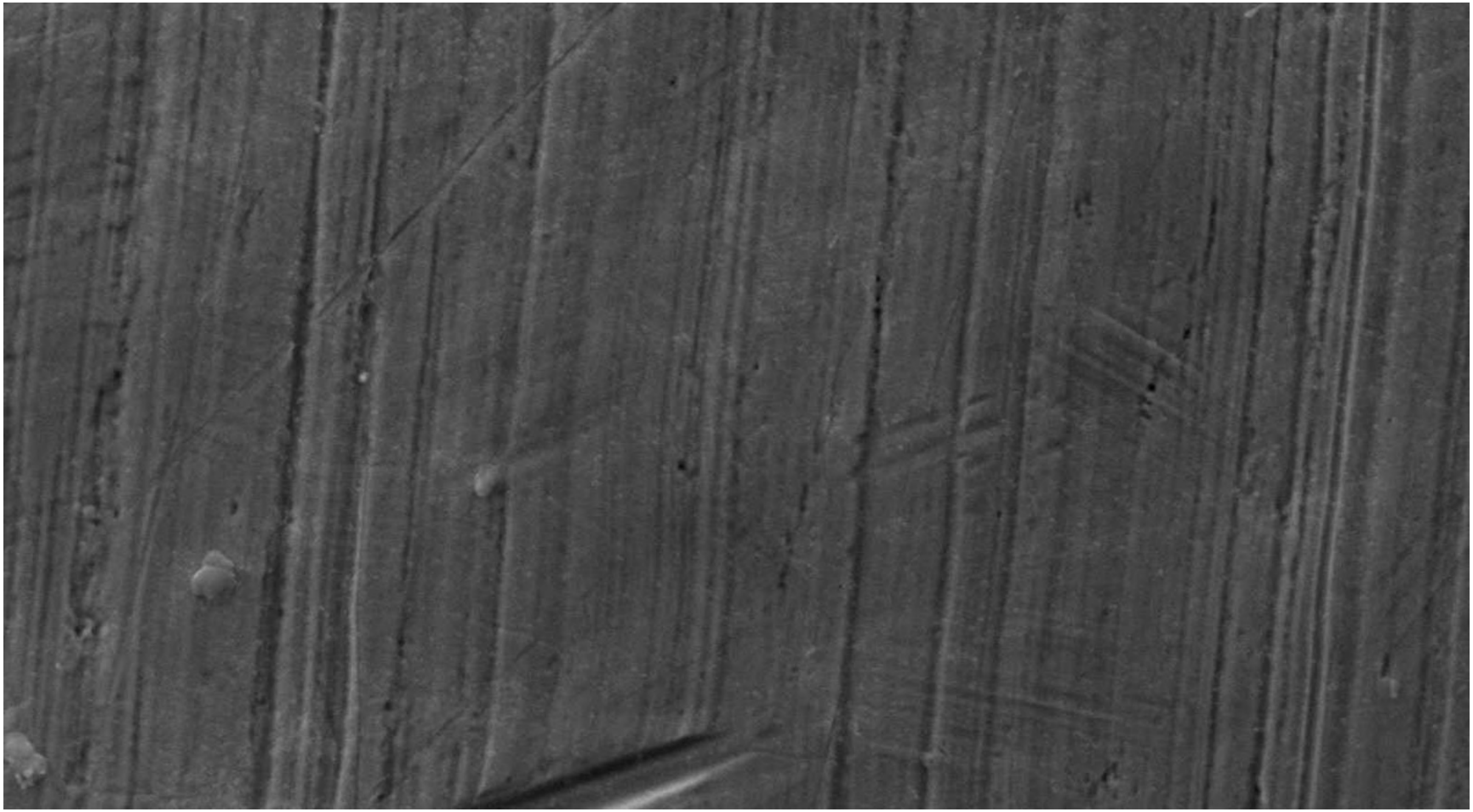


Activation with Plasma Discharge



Video Clip

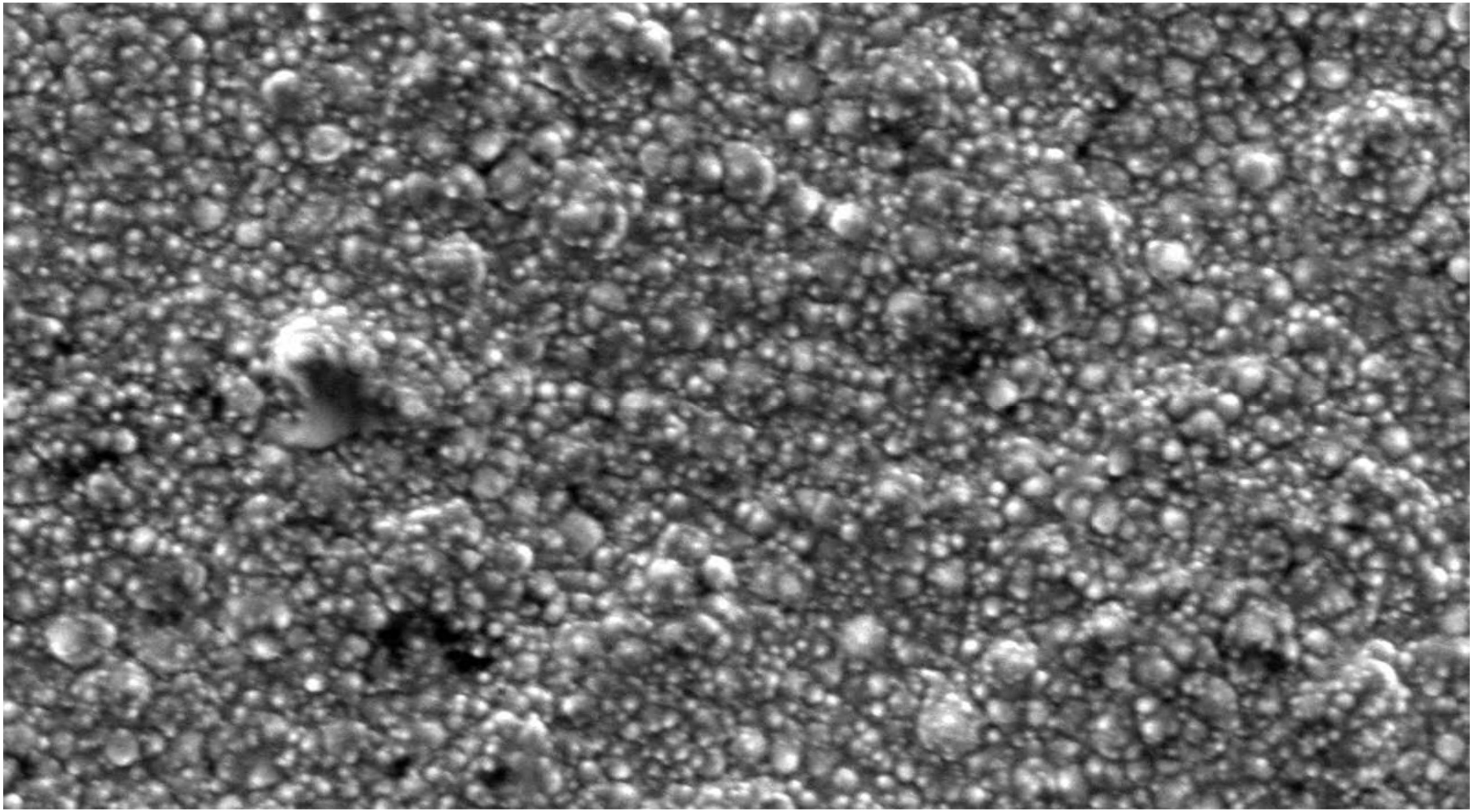
SEM of Ni Mesh **BEFORE** Activation



10 micron meter

x2000

SEM of the Ni Mesh **AFTER** Activation

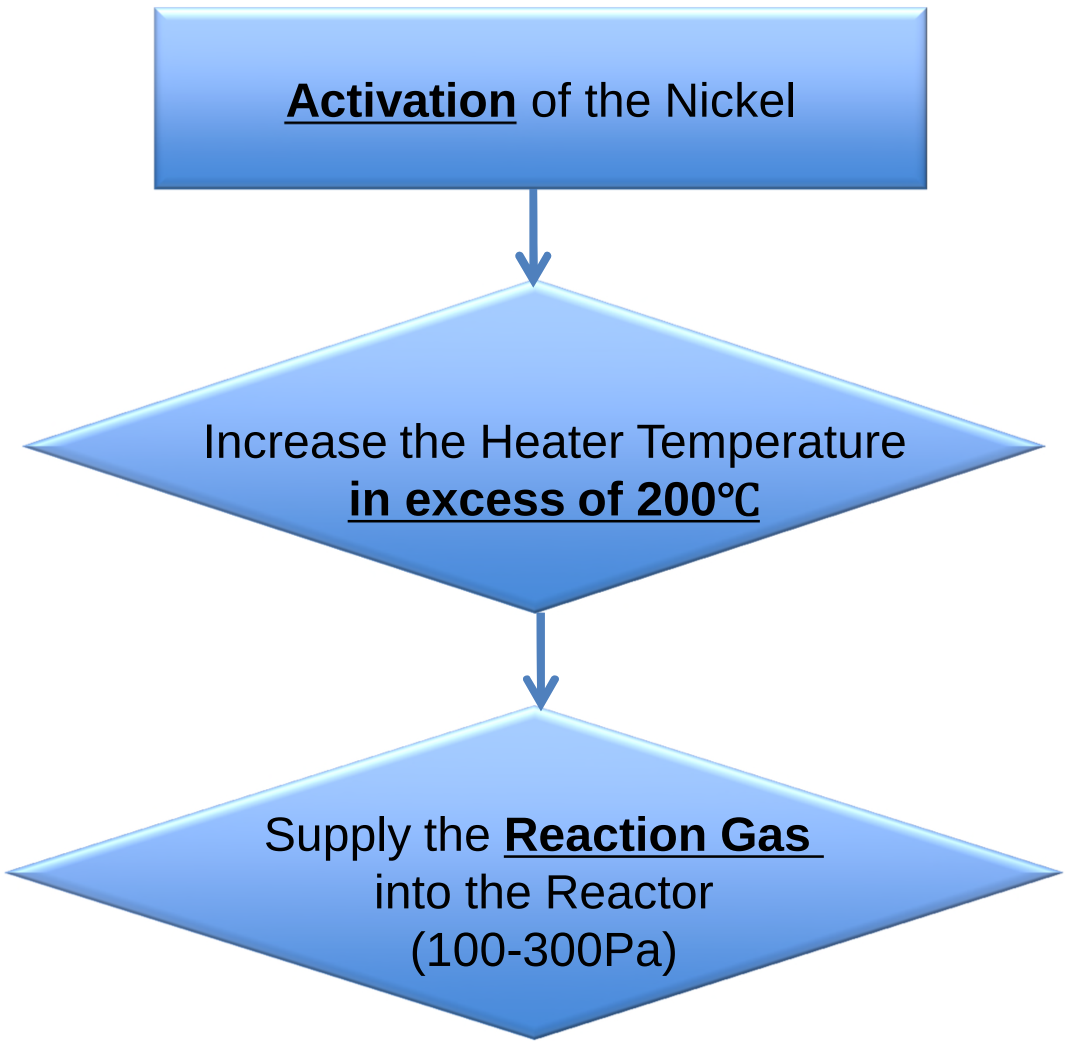


10 micron meter

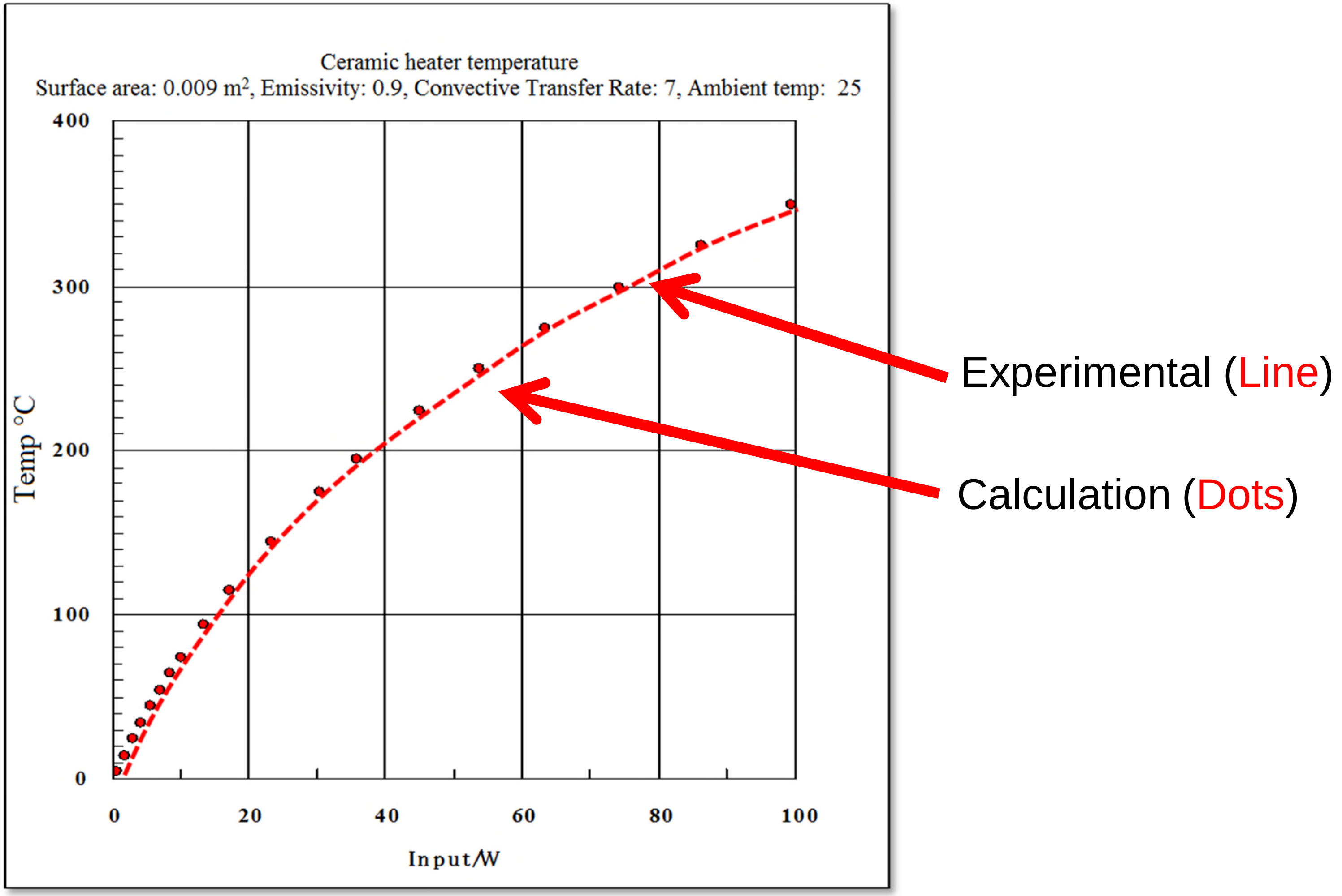
x2000

Excess Heat Generation

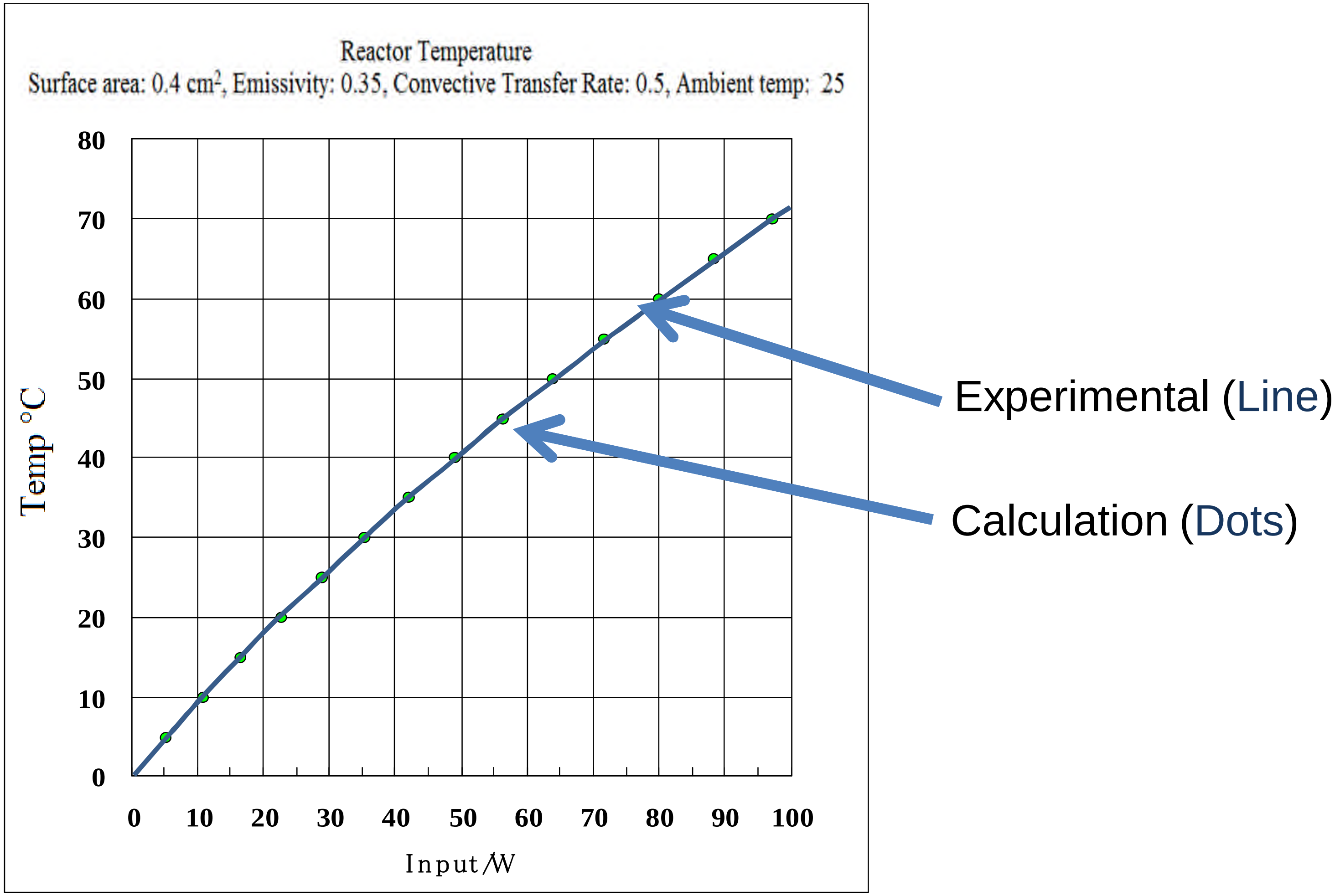
Method for Excess Heat Generation



Input Dependence for the **Electrode** Temperature (**Absent Reactant Gas and Metal**)

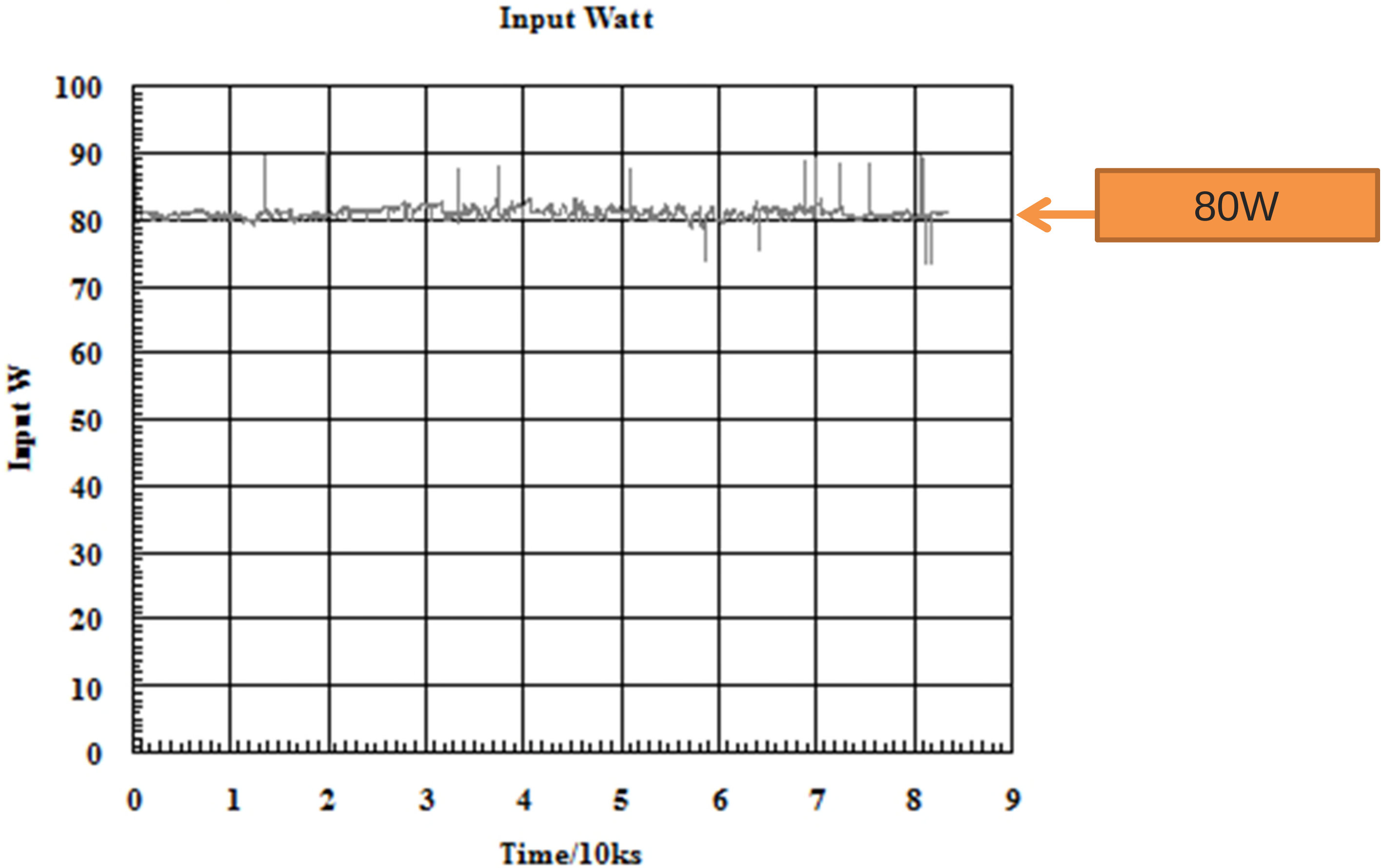


Input Dependence for the **Reactor** Temperature (**Absent Reactant Gas and Metal**)



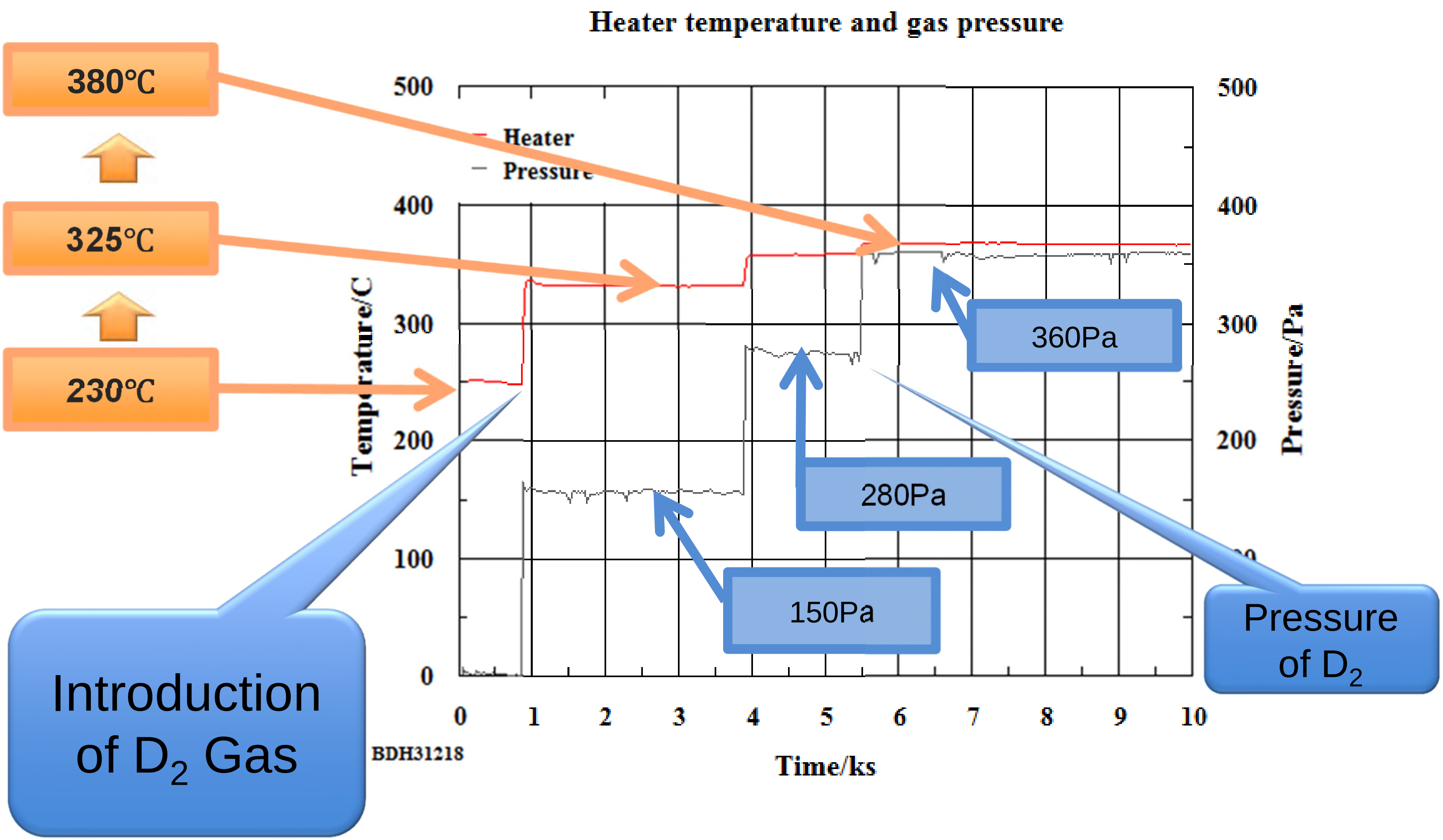
Example 1: Excess Heat Generation

Input power = 80W

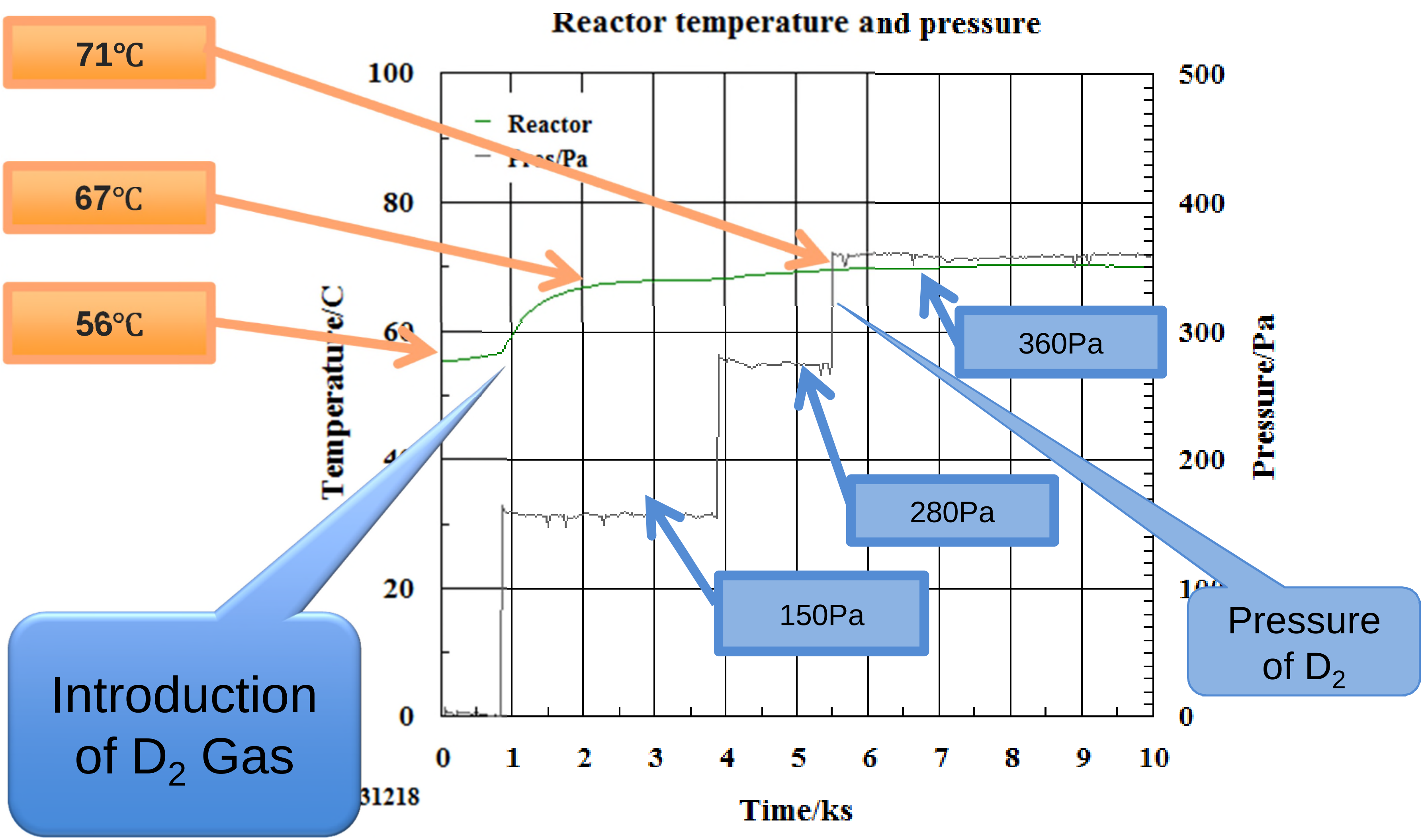


BDH31218

Example 1: Excess Heat Generation (**Electrode Temperature**)

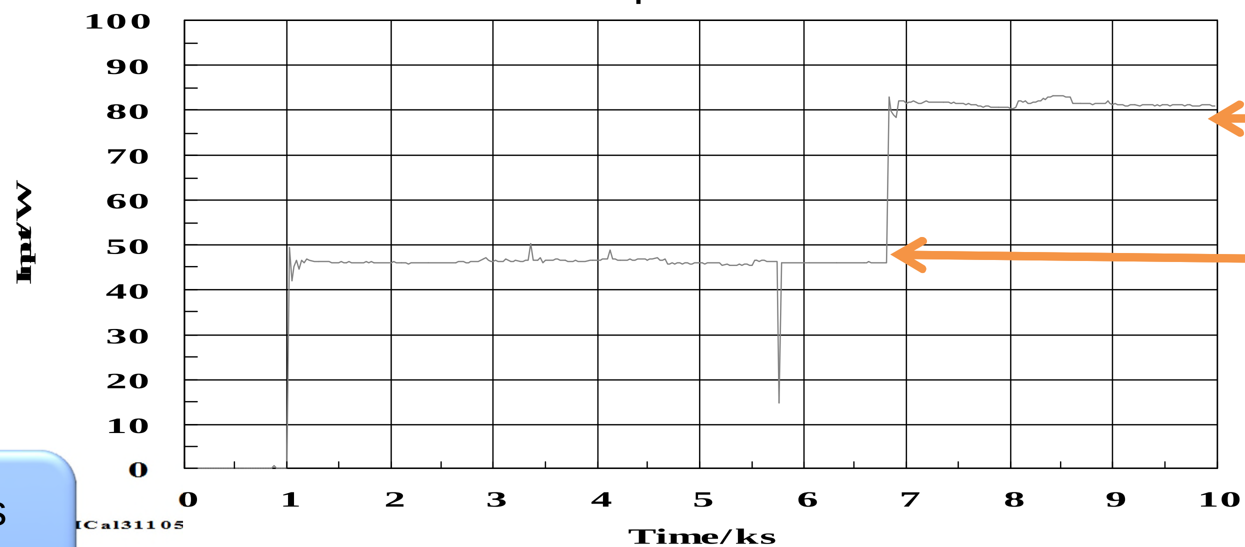


Example 1: Excess Heat Generation (**Reactor Temperature**)



Example 2: Excess Heat Generation

Input Watt

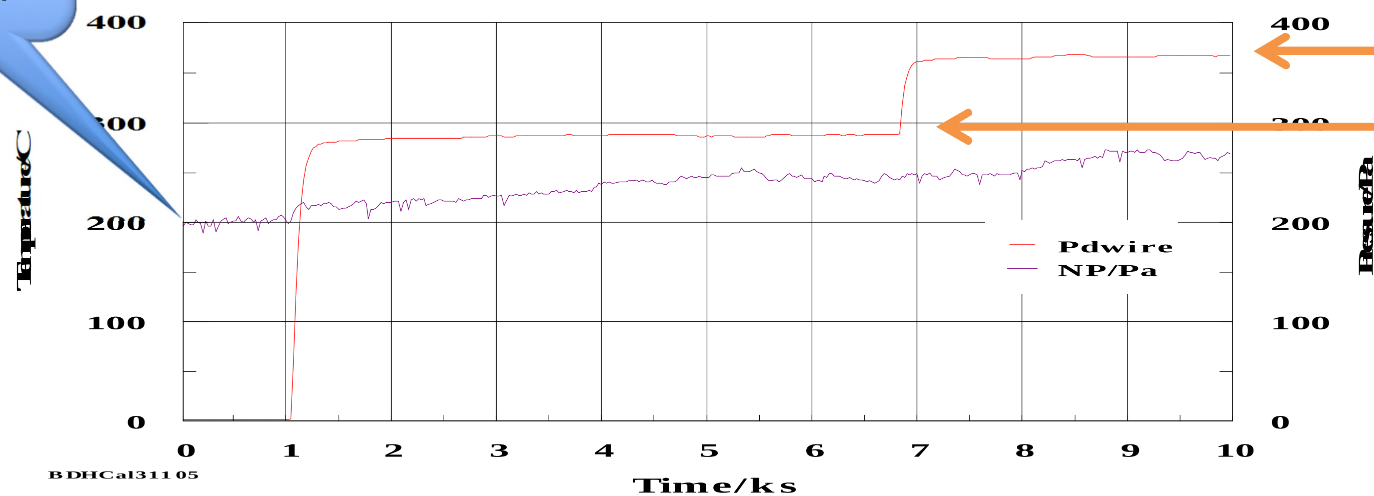


Input2=81W

Input1=46W

D$_2$ Gas Pressure = 200NPT

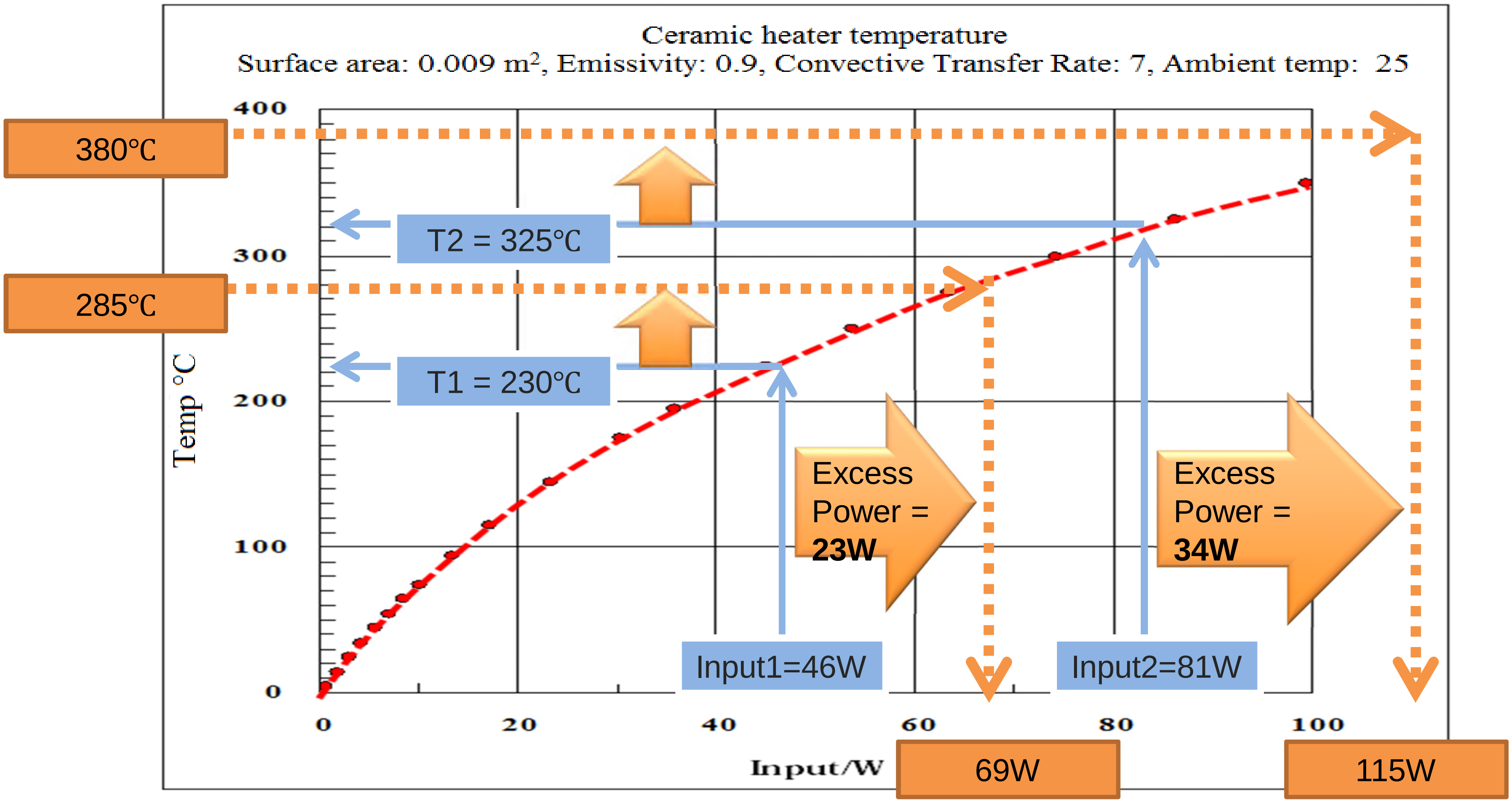
Electrode Temperature and Pressure



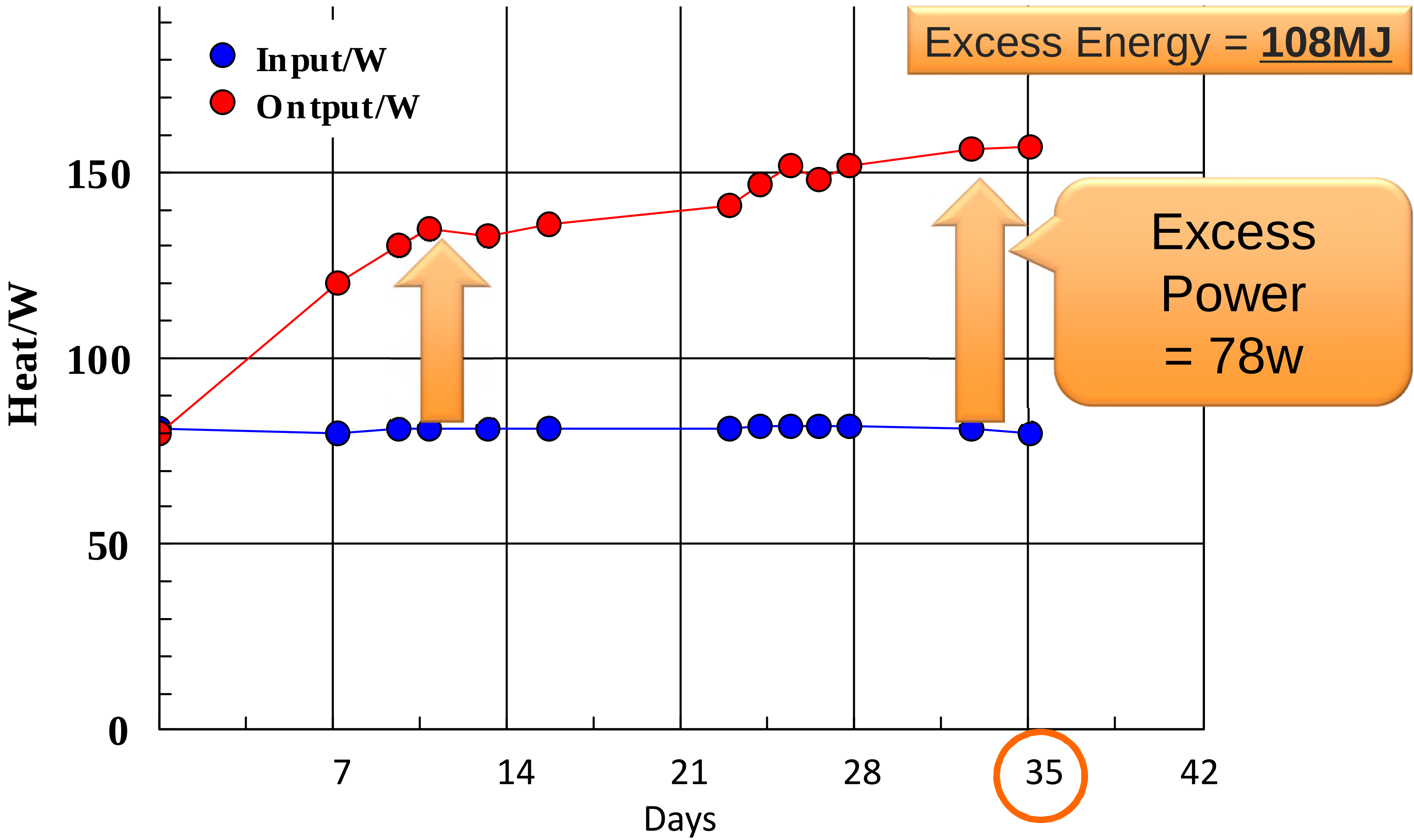
380℃

285℃

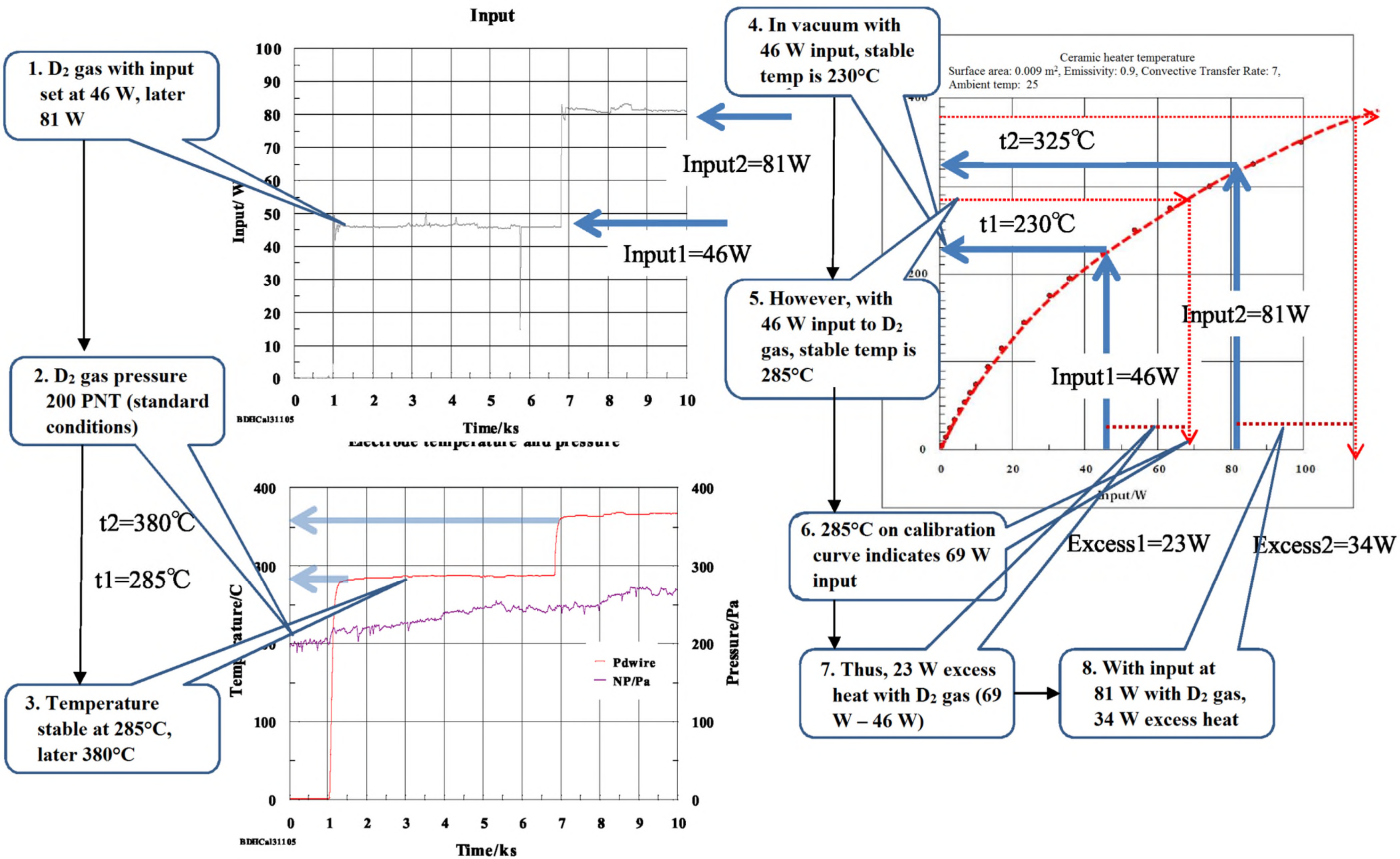
Example 2: Excess Heat Generation (**Electrode Temperature**)



Example 3: Input-Watts and Output-Watts during D_2 Gas Test



Example from Mizuno



Gas Analysis

Analyses of the Reaction Gas

Purpose:

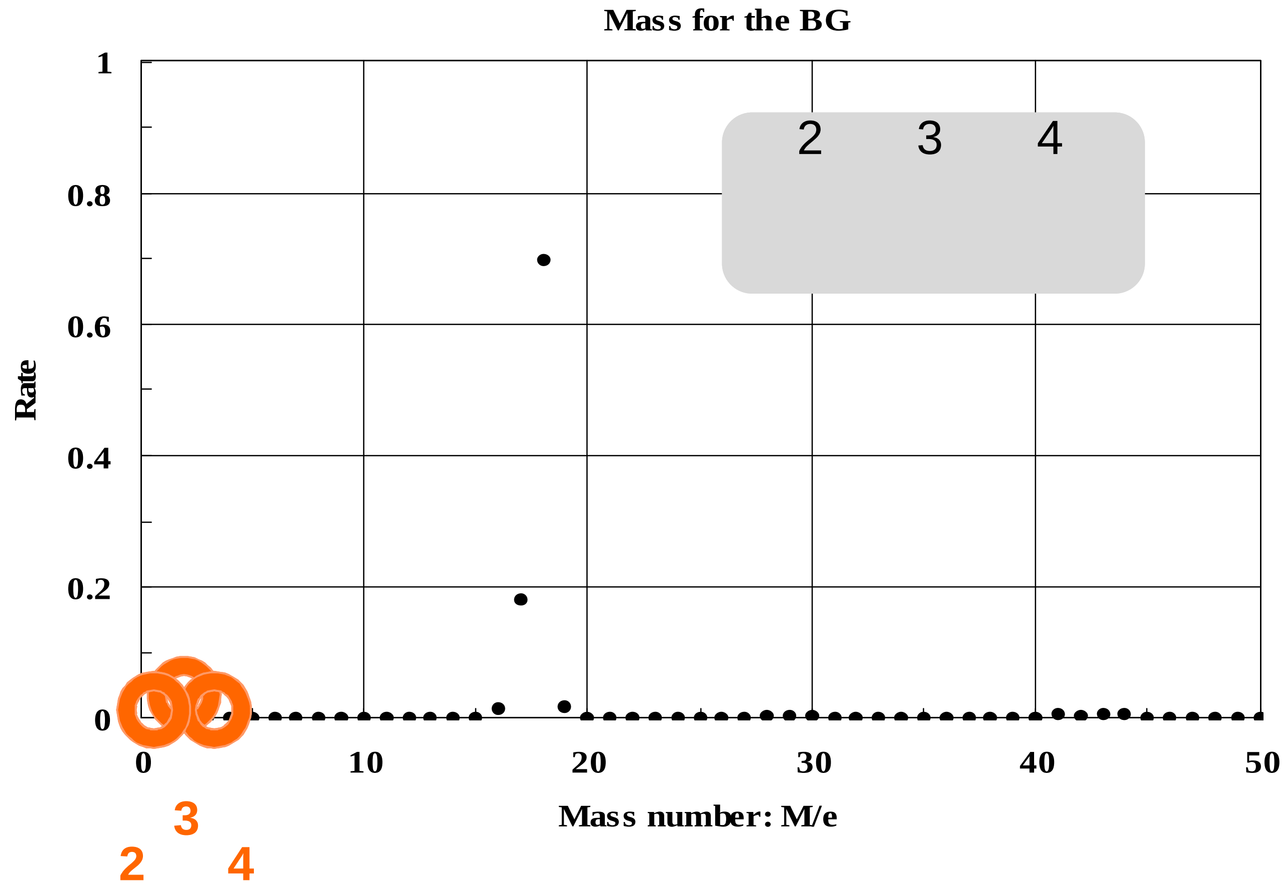
Estimation of the reaction kinetics.

Analyses:

1. The raw material gas.
2. Change of composition during test.
3. Gas in the reaction metal.

Gas Analysis during the Test with D_2O

1. Vacuum → 2. Introduction of D_2O Vapor → 3. After the Test



2 : D^+、H_2^+
3 : HD^+、$^3He^+$、H_3^+
4 : D_2^+, H_2D^+, ^4He
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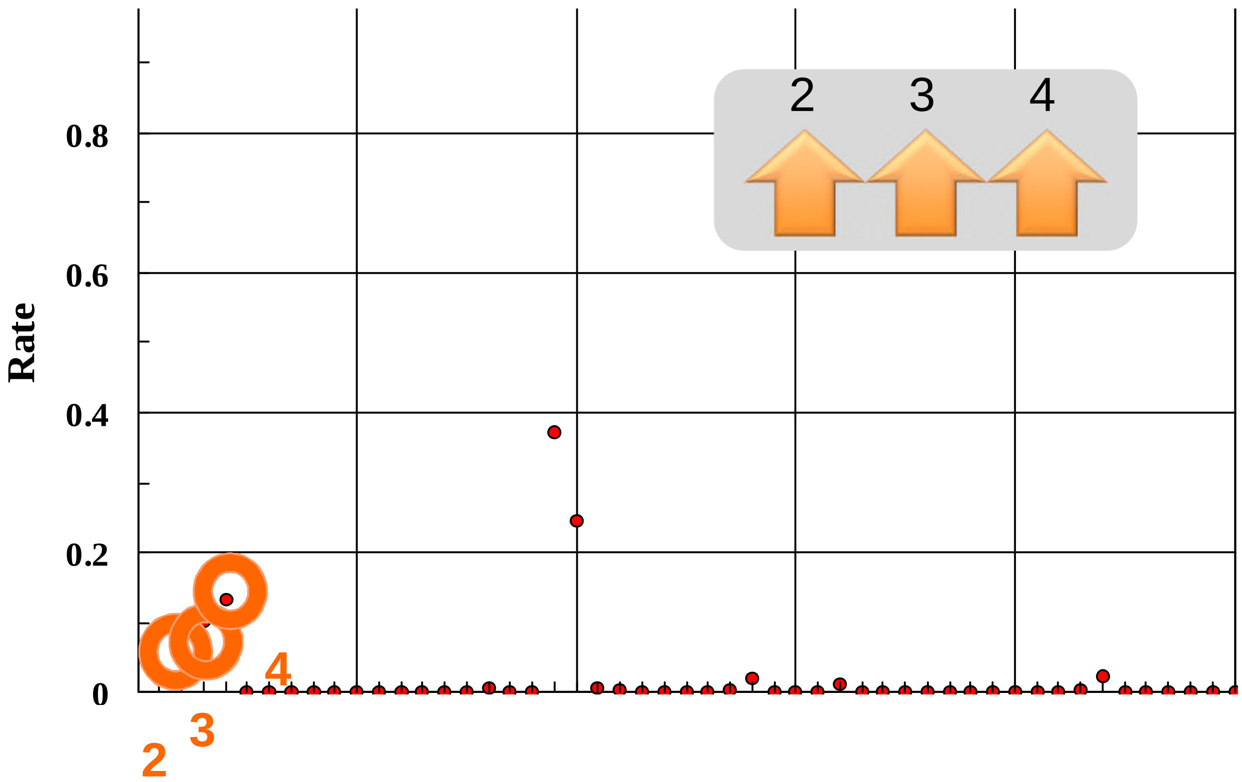

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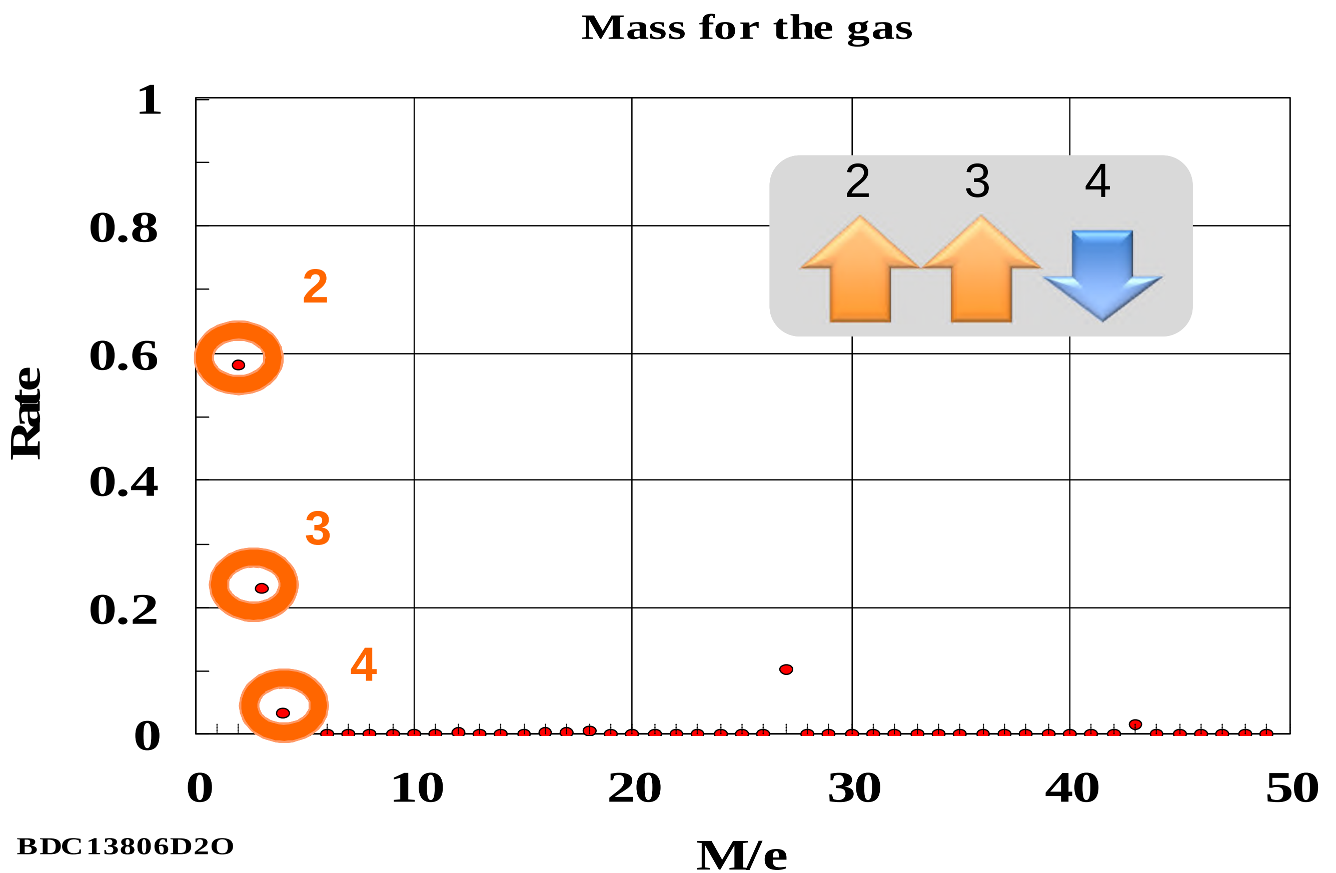

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Gas Analysis with $\underline{D_2}$ (Excess Heat Generated)

1. D_2 gas intro

2. 520ks after

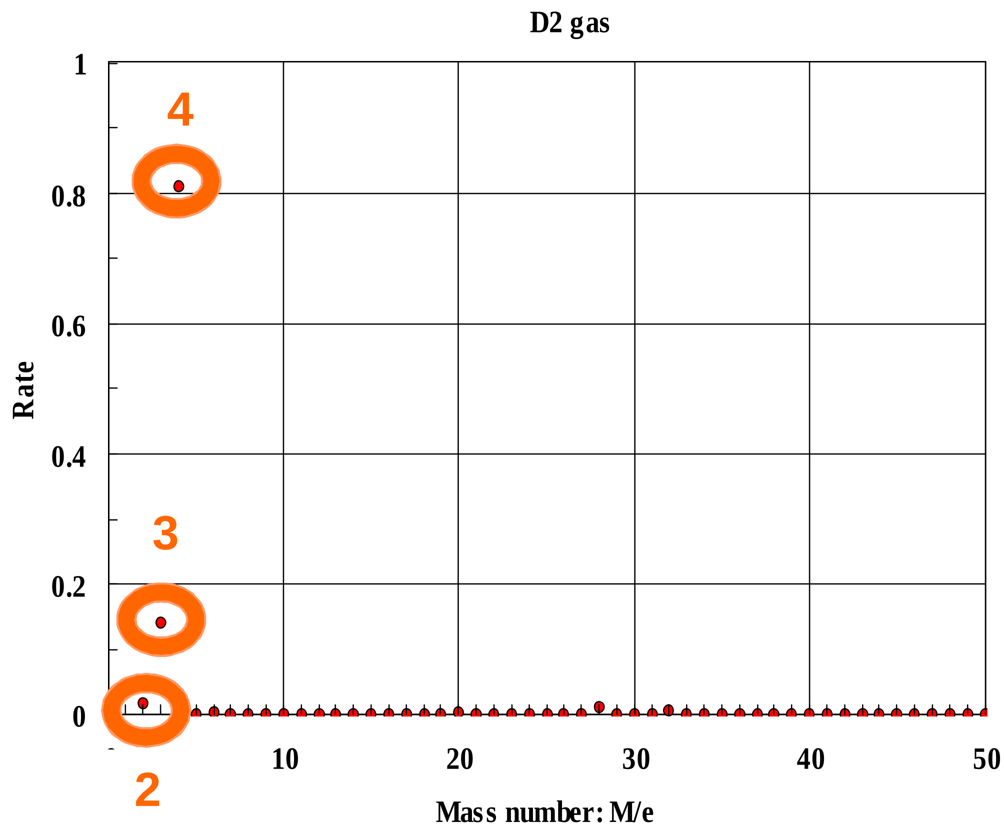
3. 700ks after

4. 770ks after

5. 1.6Ms after

6. 2.5Ms after

2 3 4



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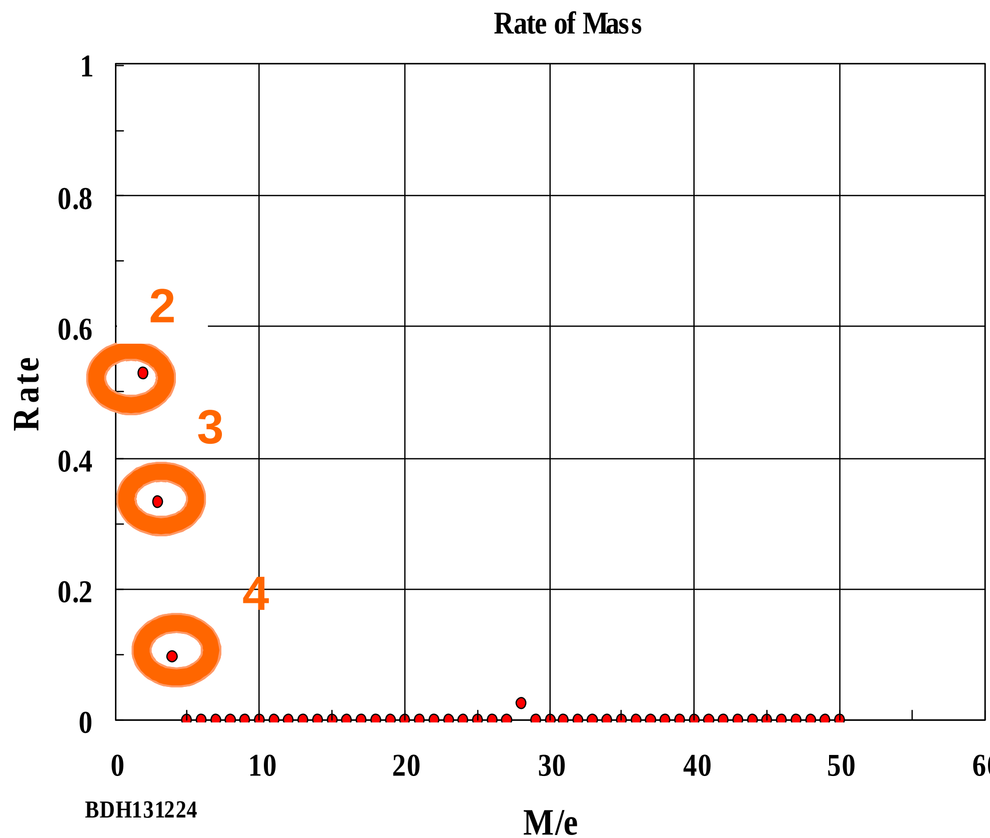

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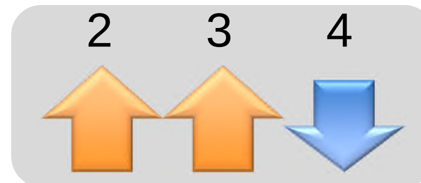

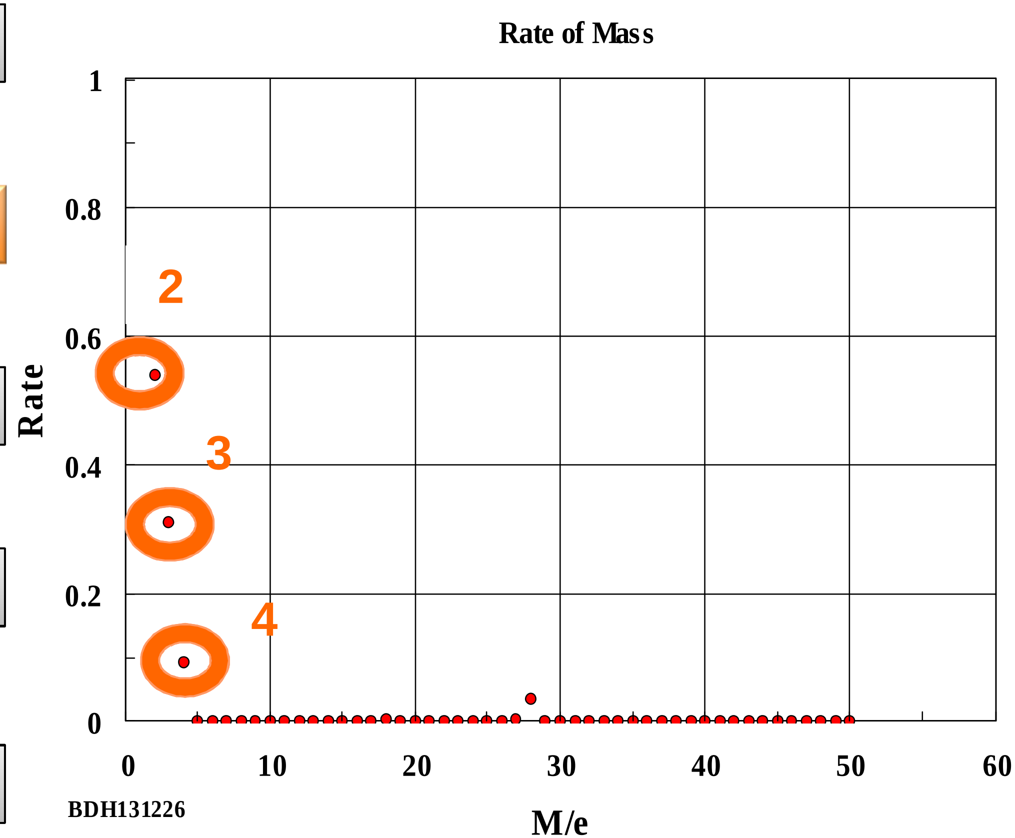

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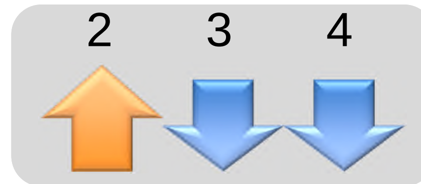

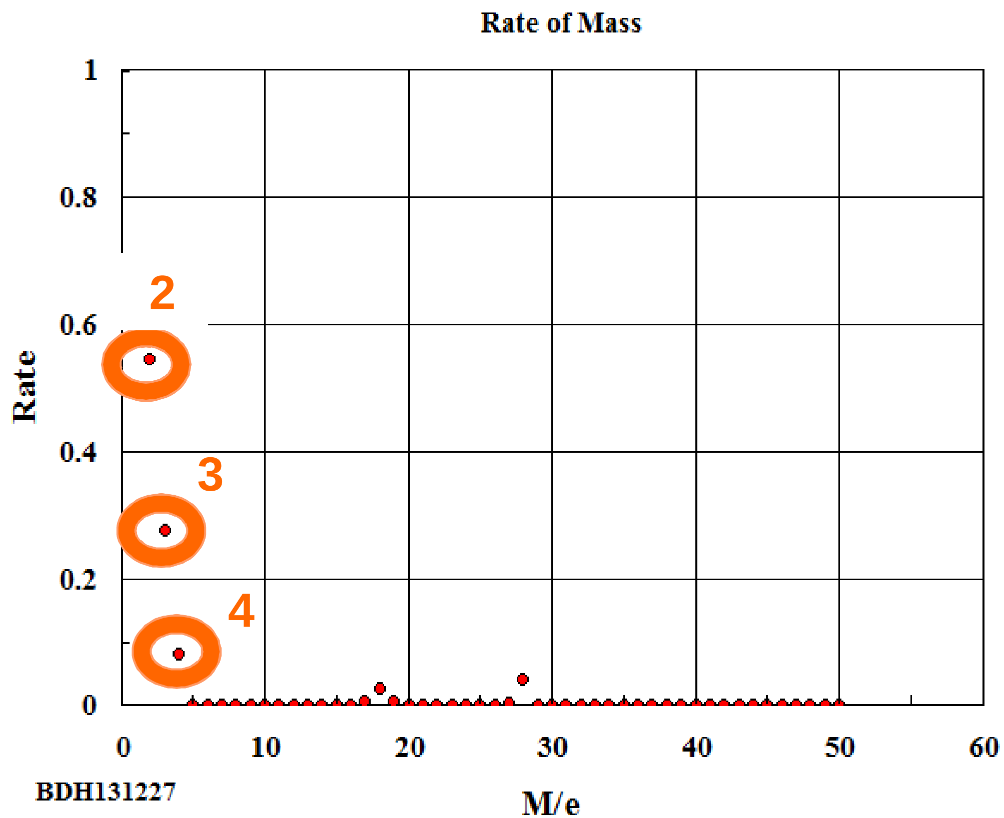

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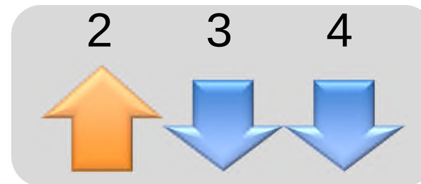

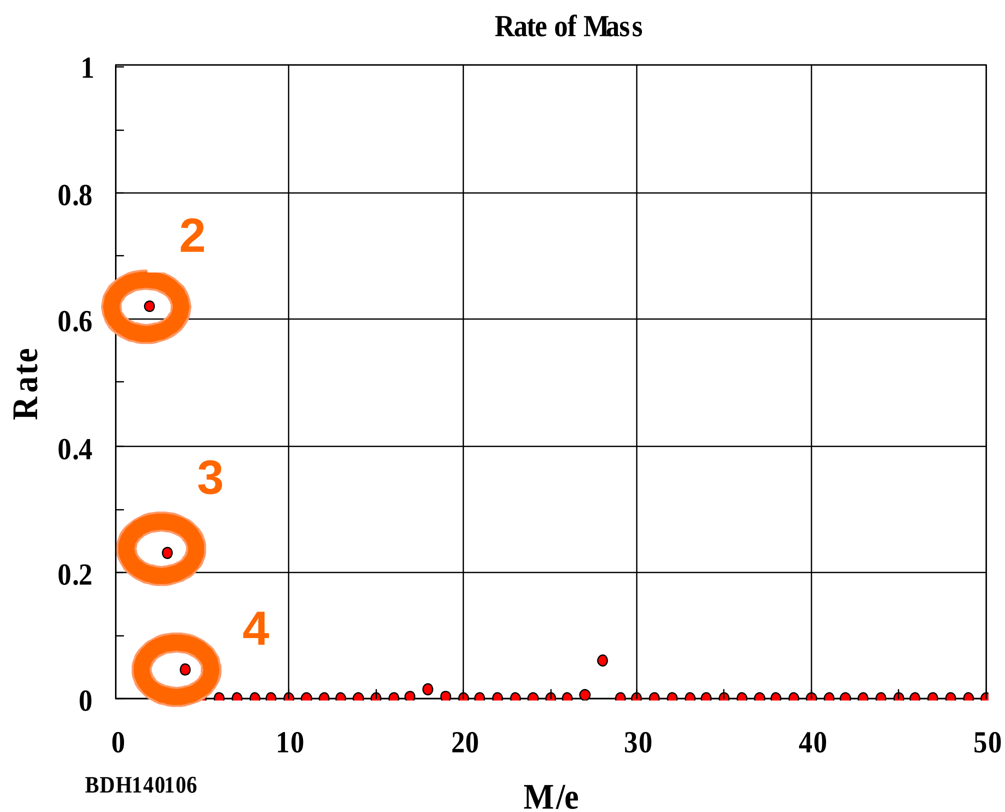

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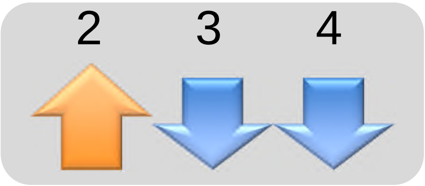

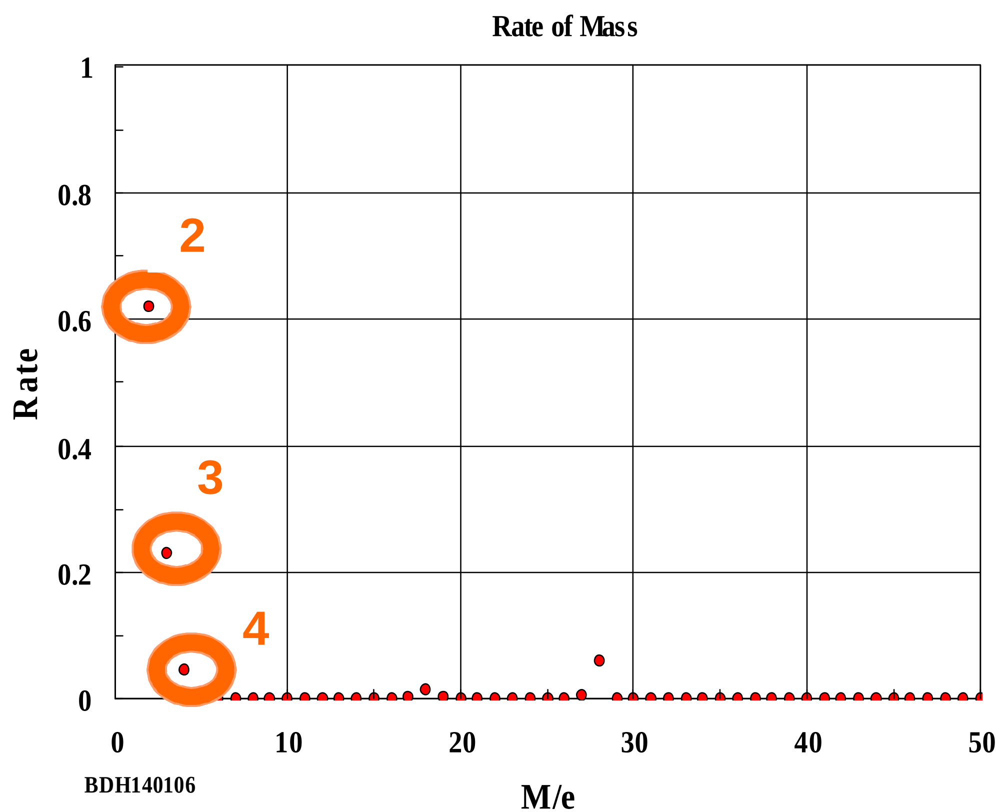

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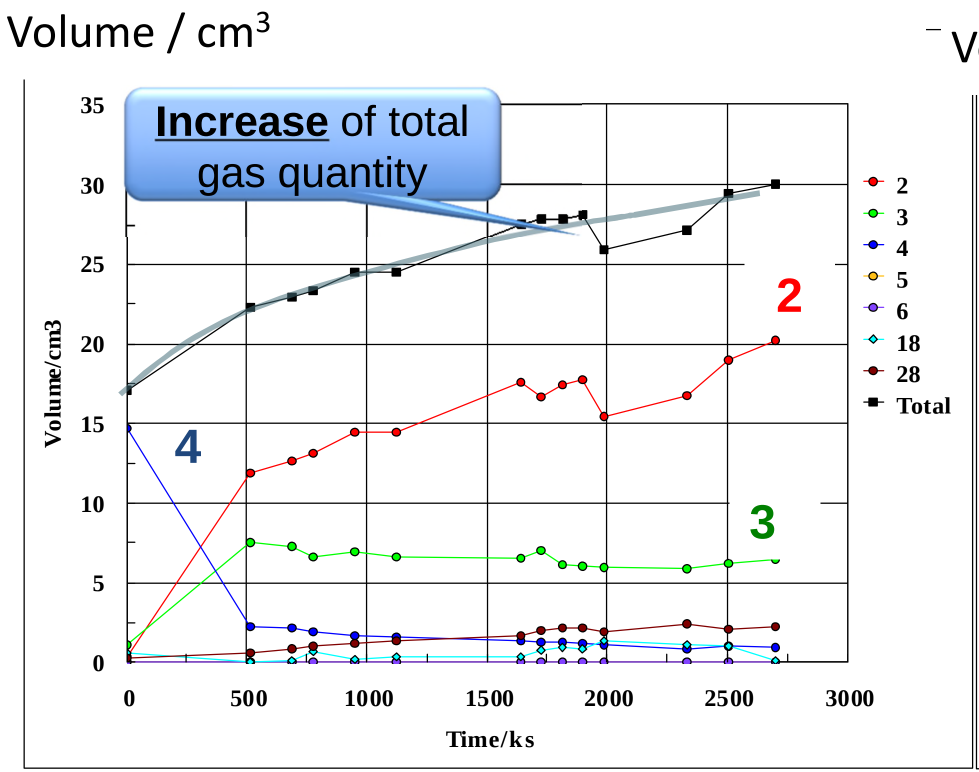
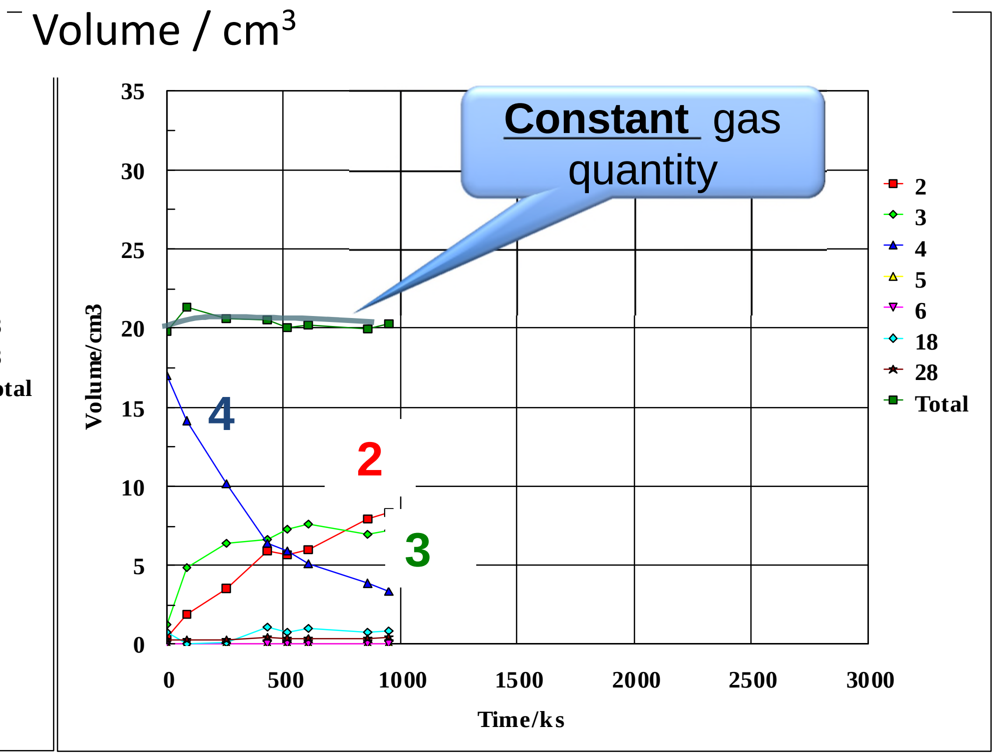
19 : OHD^+
20 : OD_2^+
27 : $C_2H_3^+$
28 : CO^+, N_2^+
44 : CO_2^+

Changes of Gas **Quantity**

Excess Heat Generation

Control (**NO** Excess Heat)

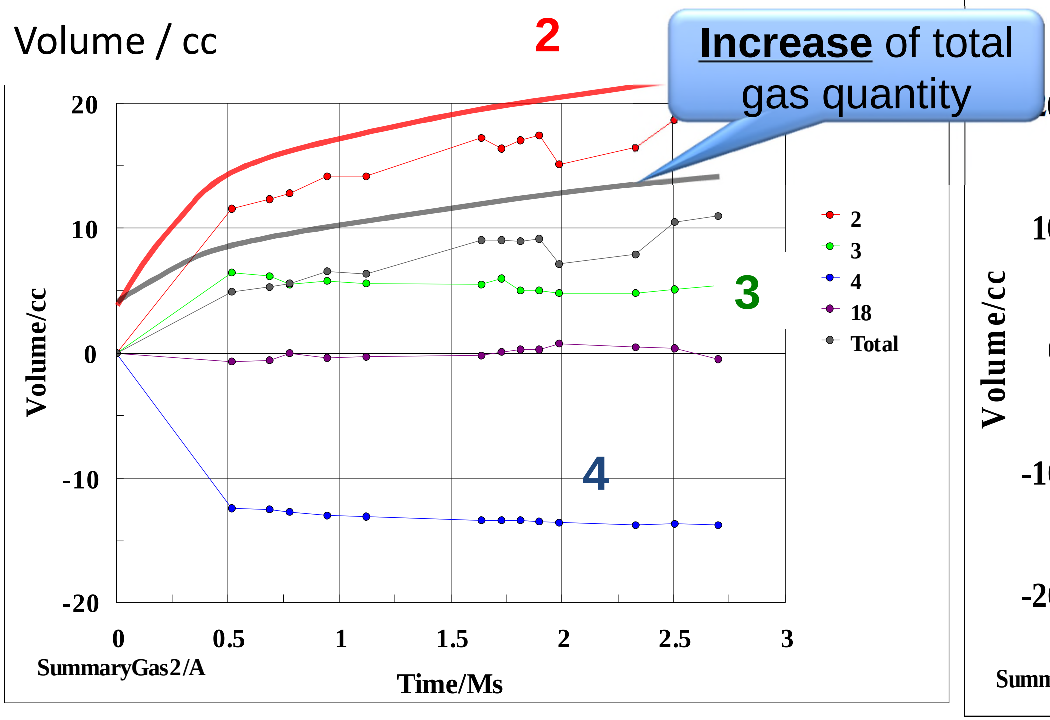


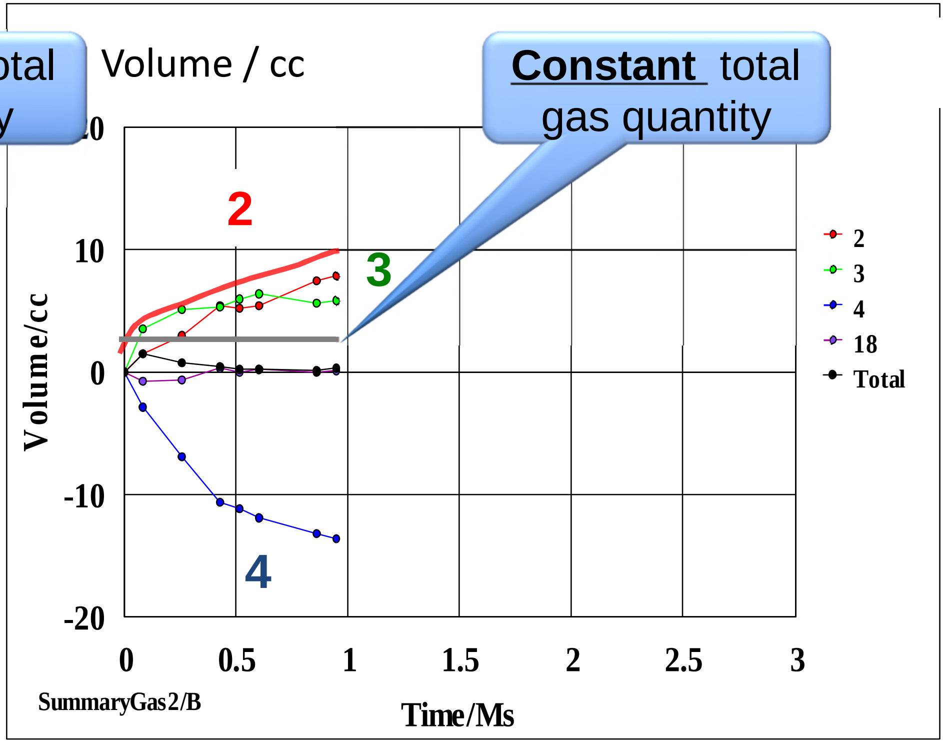


Change of Gas **Volume**

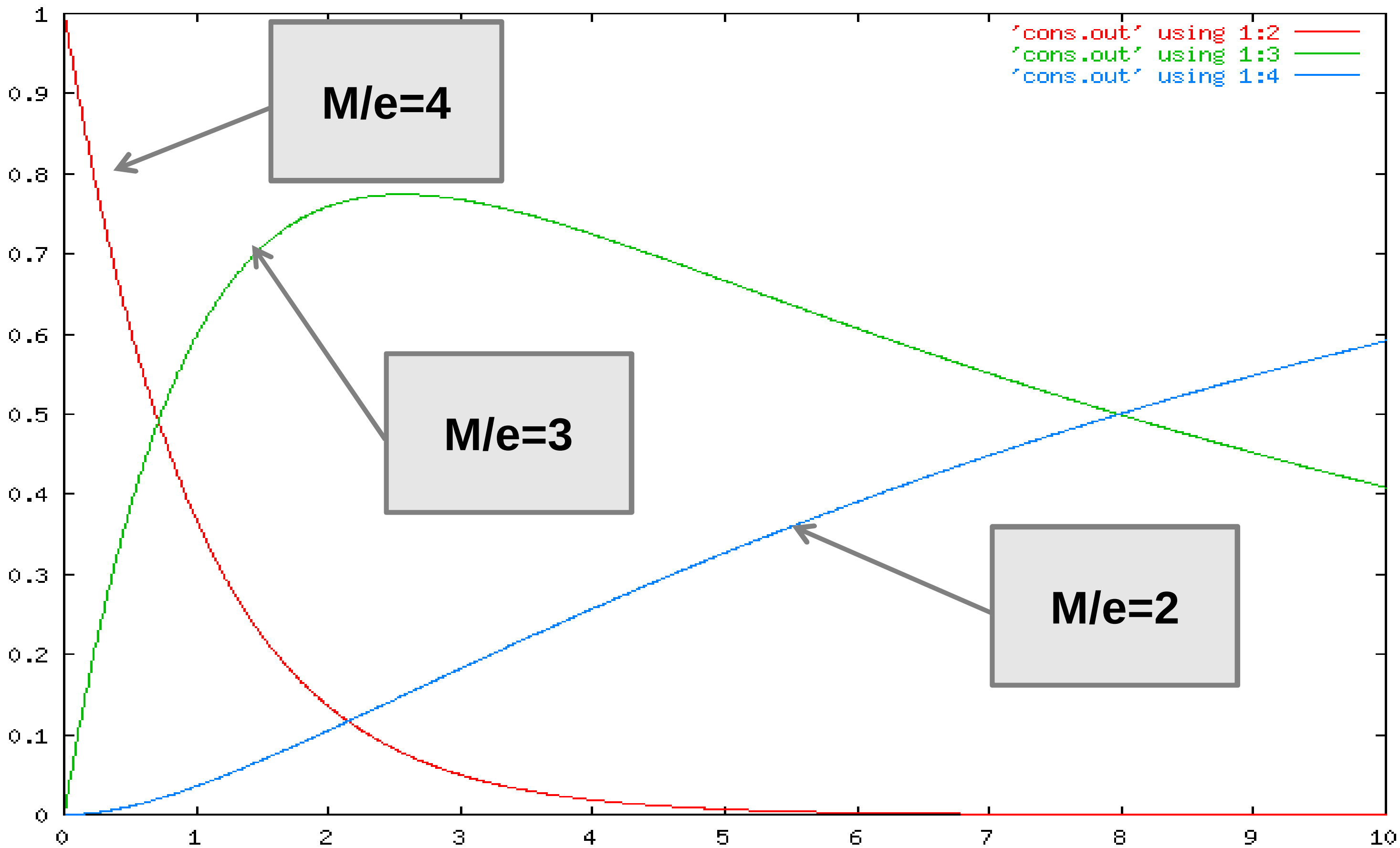
Excess Heat Generation

Control (**NO** Excess Heat)





Gas Calculation Result
(D2, Excess Heat Generated)



M/e=4 → M/e=3 → M/e=2

Estimation of Heat Generation with a Fusion Reaction Model (Our speculation)

Estimated reaction formulas from heat production and gas emission.

- $_1^2D + {_1^2D} \rightarrow {_1^3T}(1.01MeV) + P^+ (3.02MeV) \rightarrow 4.03MeV$
- $_1^2D + {_1^2D} \rightarrow {_2^3He}(0.82MeV) + n(2.45MeV) \rightarrow 3.27MeV$

←We will use these 2 initial reactions for argument sake.

Calculating the number of atoms of $T + {_2^3He}$ produced,

Assumption; the gas produced in the test are T and $_2^3He$.

The volume produced was ≒ **5cm³**

Hence, the number of atoms of ($T + {_2^3He}$) are;

$5/22{,}414\ cm^3 \rightarrow 2.23 \times 10^{-4} mol \rightarrow 2.23 \times 10^{-4} \times 6.022 \times 10^{23}$

= **1.34×10^{20} (the number of atoms of $T + {_2^3He}$)**

Estimation of Heat Generation with a Fusion Reaction Model (Our speculation)

The thermal calculation is as follows;

Assumptions;

- the gas produced in the test are T and $_2{}^3He$.
- $1MeV=1.602\times10^{-13}J$
- The average energy output of DD Reactions = 3.65MeV

Hence;

- If all the heat are from nuclear reactions: **78.35MJ** (Thermal energy generated when $T+{}_2{}^3He$ was produced is $3.65\times1.34\times10^{20}\times1.602\times10^{-13}J$ = 78.35MJ)
- Actual heat generated was $34\times3.6\times10^{3}\times881$ = **108MJ**. (Total energy produced in the test was 115W (Input = 81W, Excess Energy = 34W) The reactions lasted for 881hrs.)

108MJ is **137%** of the energy generation
when the reactions are to be **nuclear reactions**.

Summary

Summary: Excess Heat

Produced excess heat;

- Using **Nickel** Nano-particles and **D_2 gas**
- For over **1 month**
- Excess Heat = **75watt** (**COP = 1.9**)
- Excess Energy = **108MJ**

Summary: Gas

- The composites of the gas in the reactor changed during the reactions.
- Gas of **M/e=4: (D_2^+) decreased** in the tests when excess heat was generated.
- Gas of **M/e=3: (HD^+ or T^+ or $^3He^+$) increased** at the beginning of the reaction and decreased later.
- Gas of **M/e=2 (D^+ or H_2^+) increased** virtually consistently, in the tests when excess heat was generated.
- In the tests when excess heat was **NOT** produced, the increase of gas **M/e=2 (D^+ or H_2^+) was only 50%**.

Additional Research Required

- Gas of **M/e=3 (HD$^+$ or T$^+$ or ^{3}He$^+$)** appears to be the intermediate product.

→Gas analysis is required to identify.

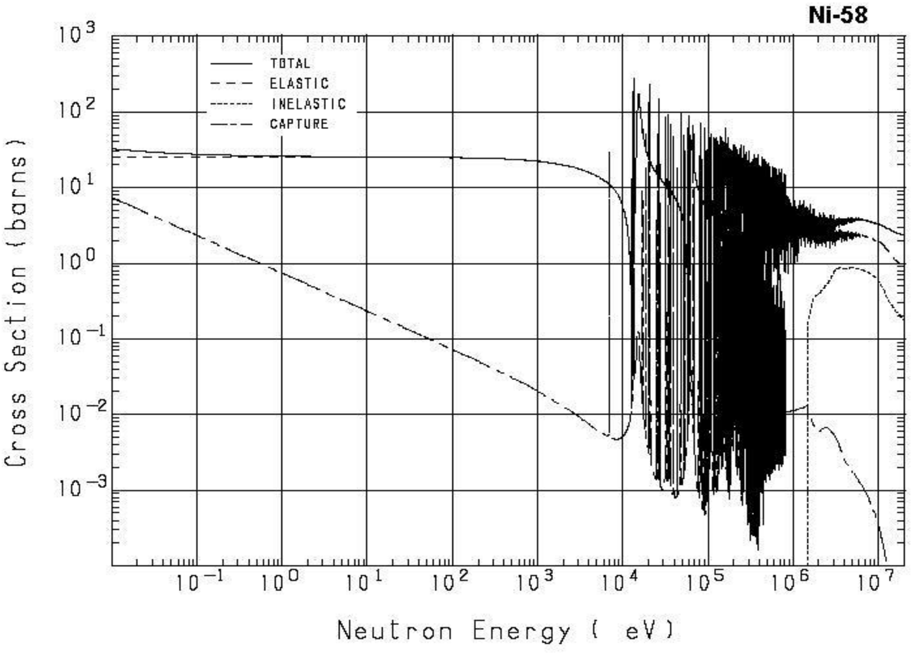
- Gas of **M/e=2 ($_1^2$D or H$_2^+$)** appears to be the final product.

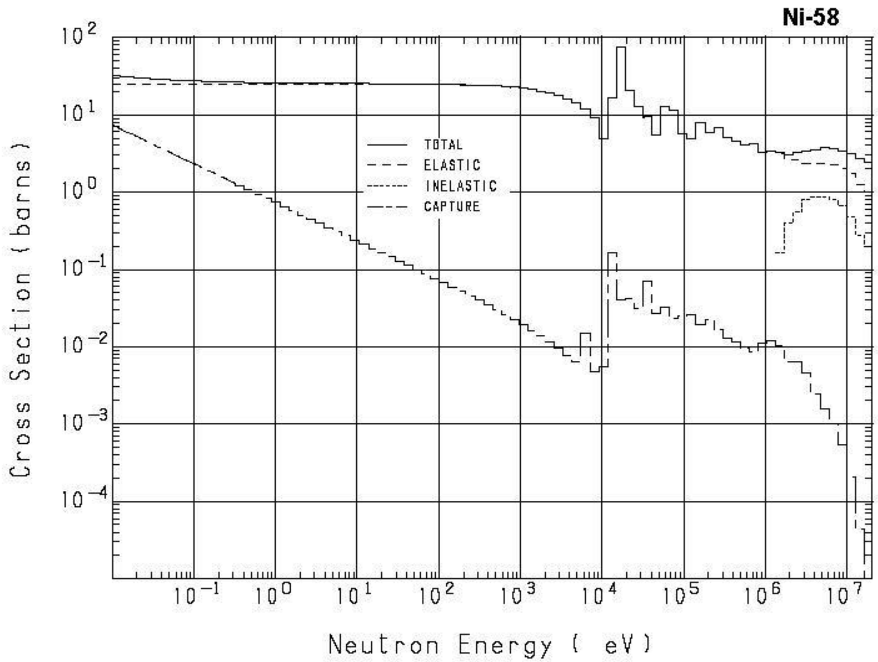
←This is inconsistent with the final product of fusion reactions, which is known to be $_2^4$He.

Additional Findings to be Presented

- Neutron Emission
- γ-ray Emission
- Transmutation Material

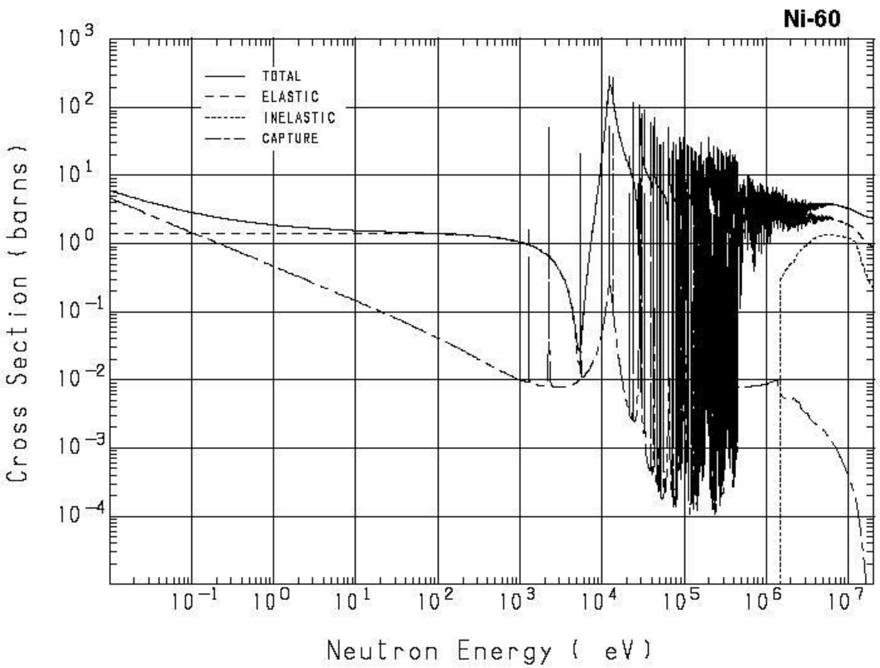
Neutron Reaction Cross Section: Ni58

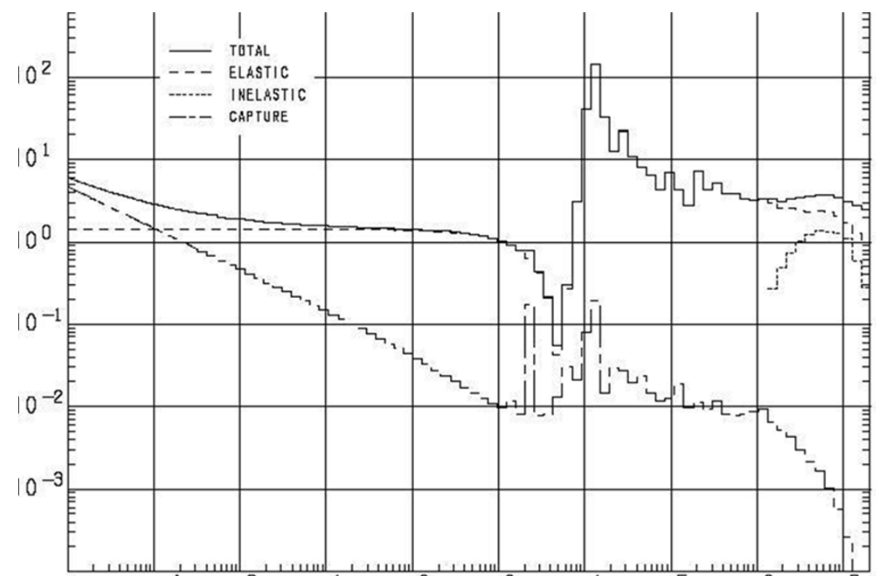




K. Shibata, T. Kawano, T. Nakagawa, O. Iwamoto, J. Katakura, T. Fukahori, S. Chiba, A. Hasegawa, T. Murata,H. Matsunobu, T. Ohsawa, Y. Nakajima, T. Yoshida, A. Zukeran, M. Kawai, M. Baba, M. Ishikawa, T. Asami, T. Watanabe, Y. Watanabe, M. Igashira, N. Yamamuro, H. Kitazawa, N. Yamano and H. Takano: "Japanese Evaluated Nuclear Data Library Version 3 Revision-3: JENDL-3.3," *J. Nucl. Sci. Technol.* **39**, 1125 (2002).

Neutron Reaction Cross Section: Ni60





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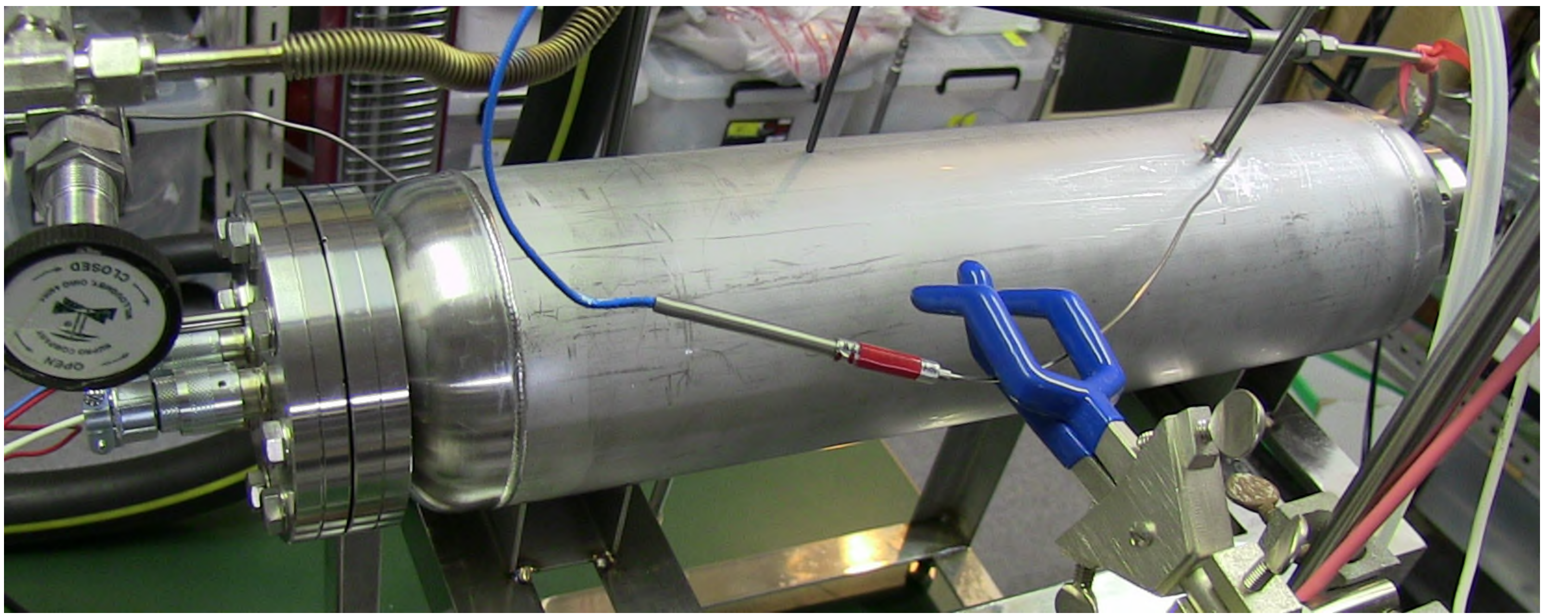
1 kW Output CF Reactor (aka: Scarlett)



10 kW Output CF Reactor (aka: Catherine)

Reactor Core

Cooling Water Jacket

How We See the Future

The 15th Japan Cold Fusion Research Conference in Sapporo, Japan on Nov. 1-2, 2014

Past Speakers:

Akito Takahashi, Yasuhiro Iwamura, Hideo Kojima,
Akira Kitamura, Tadahiko Mizuno, etc.