CFD Accuracy Enhancement of Electronic System

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Product Line

Electronic System (3C)

- Notebook
  - Thin & Light
  - High Performance

- Tablet
  - Thin & Light

Mobile

- Phone
  - Communication
  - Middle size

Hand-Held

- DT/AIO
  - High Performance

PC

Skin

Component

Component

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Skin Temperature Accuracy Improvement

Improvement check
(Introduction on last page)

Heat transfer

$Q_{conduction} = kA(\Delta T/\Delta x)$

- W, K

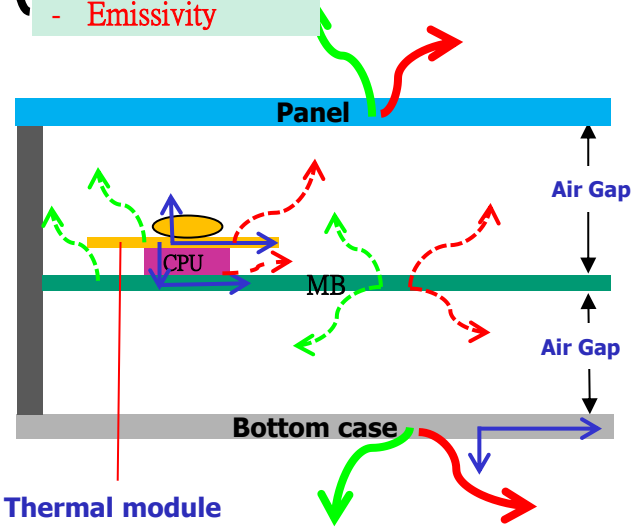
$Q_{convention} = hA(T_s - T_\infty)$

- Impedance

$Q_{radiation} = \varepsilon\sigma A(T_s^4 - T_\infty^4)$

- Emissivity

往系統外熱傳
往系統內熱傳
往系統外熱傳
往系統內熱傳



Skin Temperature Accuracy

Library

Database Collection

- NB/DT/AIO/Tablet.
  - Parts parameters (W, K)

System Impedance

Calibration & fine-tune

- Flow resistance study.
  - P-Q calibration.
  - Add extra flow resistance.
- Opening calibration.

Radiation

Study & ε collection

- NB/DT/AIO/Table
  - Collect ε

Mesh Quality

Study & SOP

- Setting for boundary layer.
- Optimum between Accuracy & Solving time.

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Library Collection(I)

- Wistron_Library_20140923
  - DT_AIO_RPOS
  - NoteBook Library
  - Tablet Library

- DT_AIO_RPOS
  - CPU
  - HDD
  - MB
  - Memory
  - PCH
  - PSU

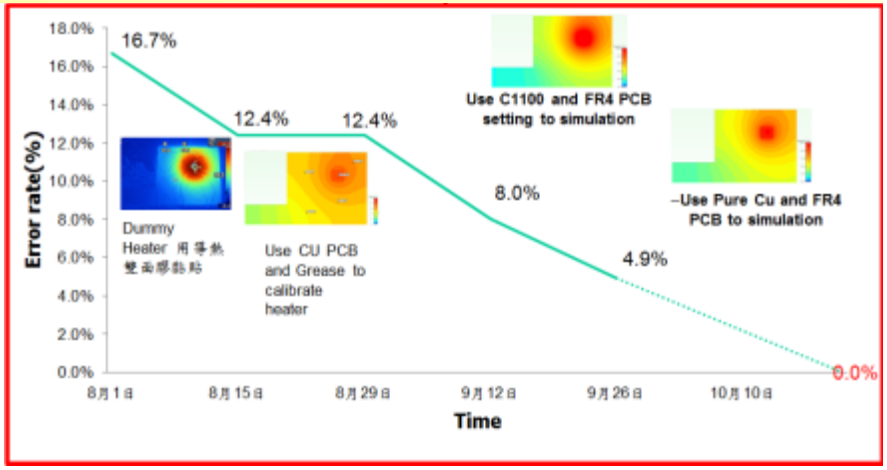
- NoteBook Library
  - CPU
  - Camera
  - GPU
  - HDD
  - MB
  - Memory
  - Mini PCI Card
  - North Bridage
  - PCH
  - Second Part
  - South Bridage
  - System resistance
  - Thermal Module

- Tablet Library
  - CPU
  - EE component
  - External Card
  - LCD
  - MB

Library Collection(II)

PCB

1. The temperature distribution of MB will impact distribution of skin temperature.
2. Estimated Kz from Theory & Experiment(Follow ASTM 5470測試規範)



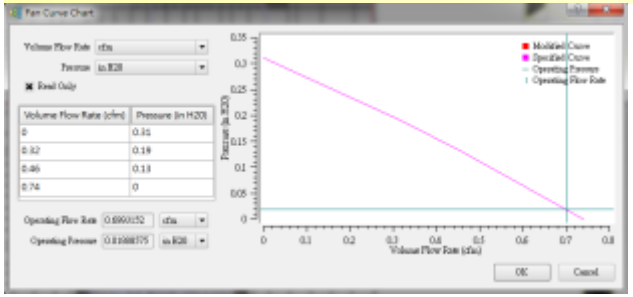
Error rate decrease from 16.7% to 4.9%

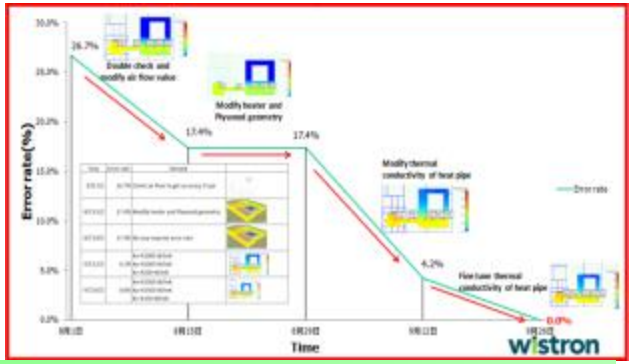
Thermal Module

Heat-Pipe

Fan PQ

1. Modified PQ Curve in free air condition. (Refer Intel's document)
2. Calibrated conductivity of heat pipe
   a. The error come form soldering &different structure(Powder/composite/groove)



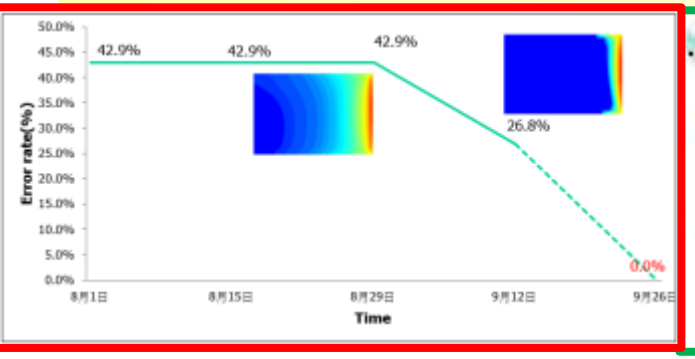


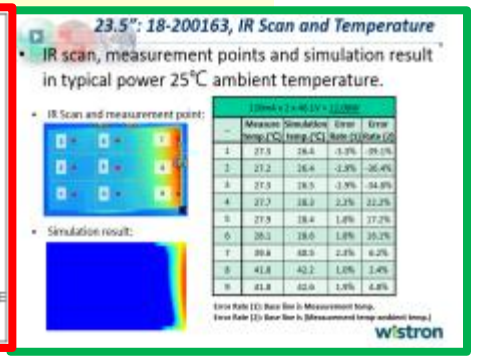
Error rate decrease from 26.7% to 4.2%

Library Collection(III)

Panel

1. Decompose
   a. confirm Z-stacking of different vendor
   b. backlight power & LCD power
2. Calibrate conductivity of LCM

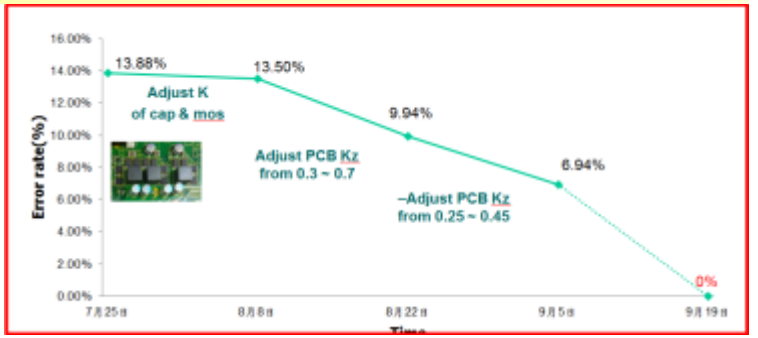




Error rate decrease from 42.9% to 20% (Still on-going)

VRM

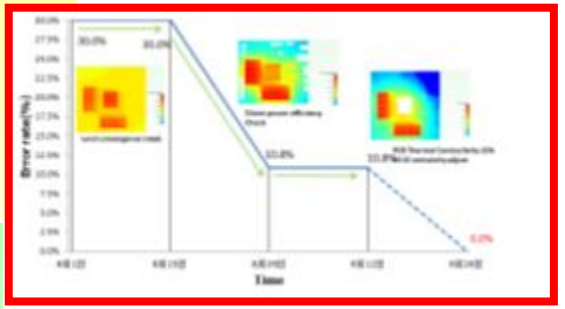
1. Decompose
   a. Calibrated conductivity of chock/mos
   b. Analyzed by "Taguchi-method"



Error rate decrease from 13.8% to 6.9%

Memory

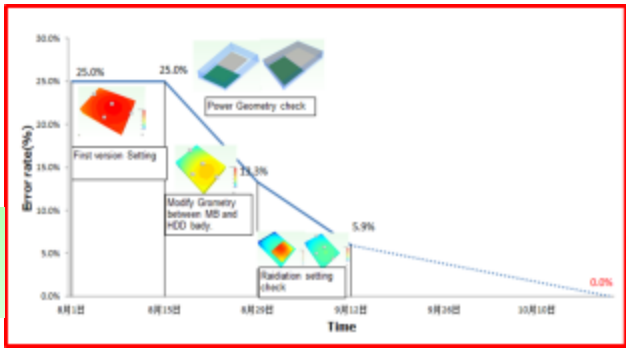
1. Confirm Input power
   a. different vendor & capacity
   b. different stacking type
   c. UMA/DIS
   d. different scenario



Error rate decrease from 30.0% to 10.8% (Still on-going)

HDD

1. Confirm Input power
   a. different vendor & capacity
   b. different scenario
   c. UMA/DIS

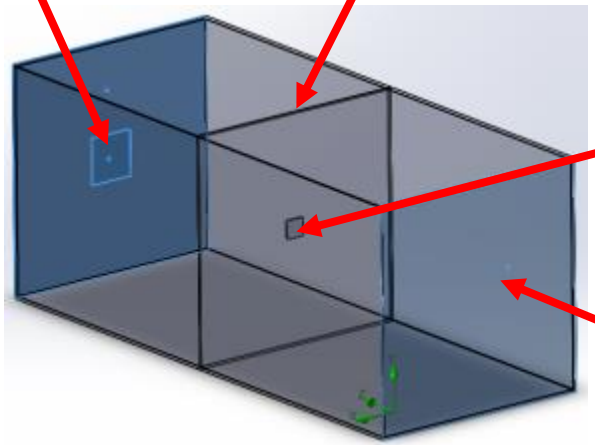


Error rate decrease from 25.0% to 5.9%

System Impedance

Negative Pressure

Enclosure
500Wx500Hx600Lmm
Thickness 5mm
No slip Wall, roughness = 0



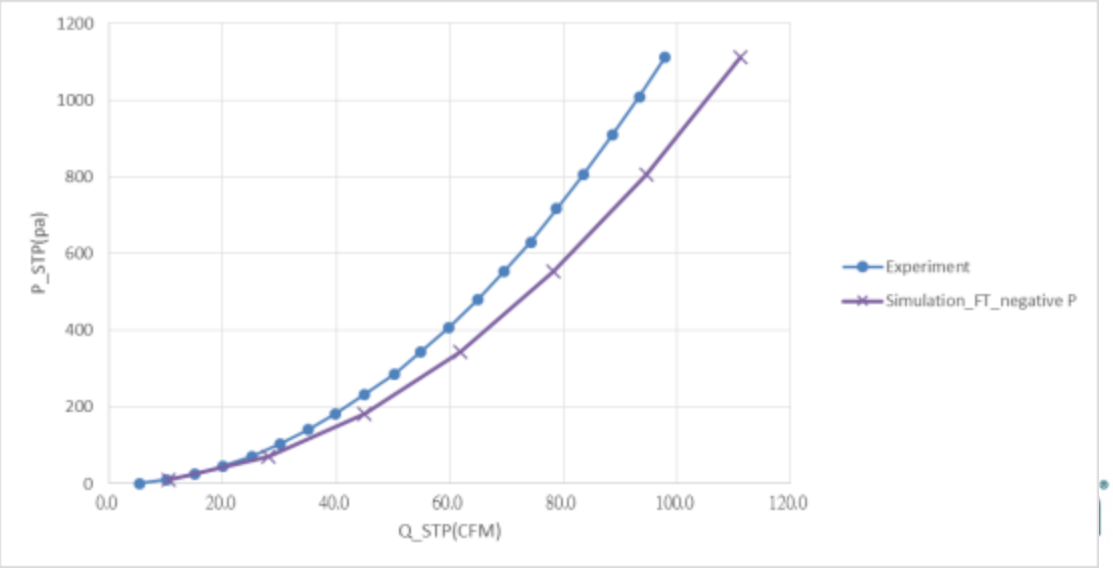
Square Hole
40Wx40Hmm

Environment Pressure
1atm

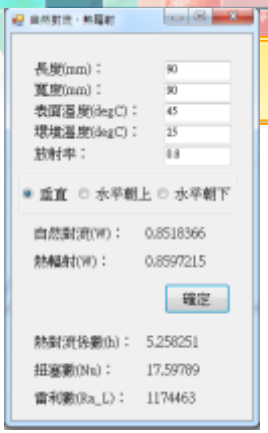
Solution Domain: 500Wx500Hx1000L mm
Symmetry Boundary set on $\pm Y$ and $\pm X$

Study items:

1. **Check Setting of Numerical tunnel**
2. **Studying outlet vent**
3. **Studying inlet vent**
4. **Studying whole thermal module.**



Radiation –Calibrate emissivity



★試算表

Theory

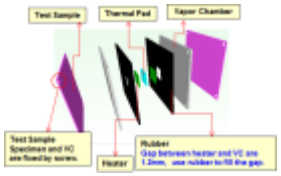
$Q_{total} = Q_{conduction} + Q_{convention} + Q_{radiaion}$

【$Q_{rad}=\varepsilon\ \sigma\ A(T_s^4-T_a^4)$】

【$Q_{conv}=hA(T_s-T_a)$】

(Ta:室溫 Ts:試片溫度)

理論公式整理成的試算表做分析



由理論公式及概念設計實驗治具

分析Convection & Radiation各面熱傳量(Q)並理論分析結果比較

目標
求得未知試片放射率?

Experiment

Step1

【輸入固定功率, 量測試片表面溫度】

建立CFD model

Numerical(FT)

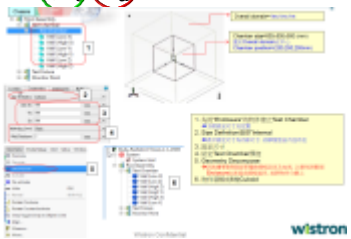
Step2

1. 輸入w, Ta.
2. Tuning ε直到實驗的試片表面溫度與模擬結果一致.

$Q_{total}=\varepsilon\sigma A(T_s^4-T_a^4)+hA(T_s-T_a)$

★SOP

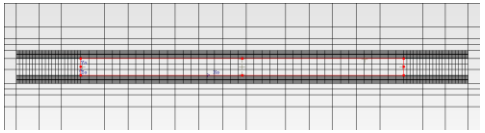
★SOP
★Golden model

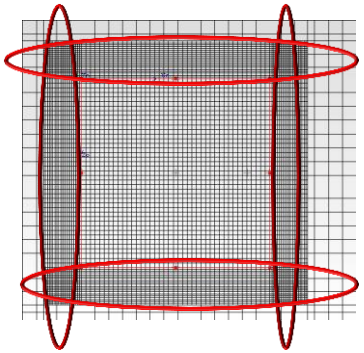


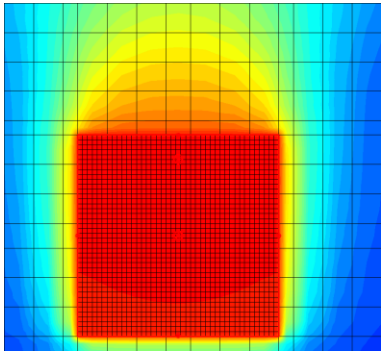
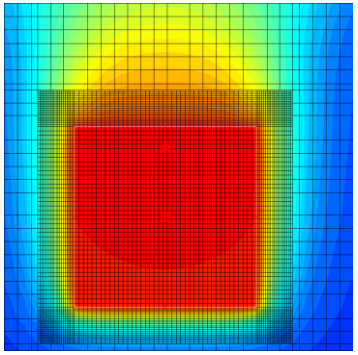
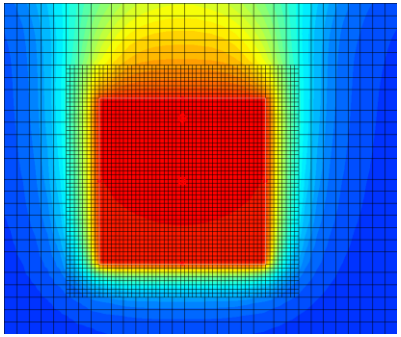
Mesh quality

Mesh quality

It will help to show boundary effect, if make suitable grid setting on boundary of object or heat source.

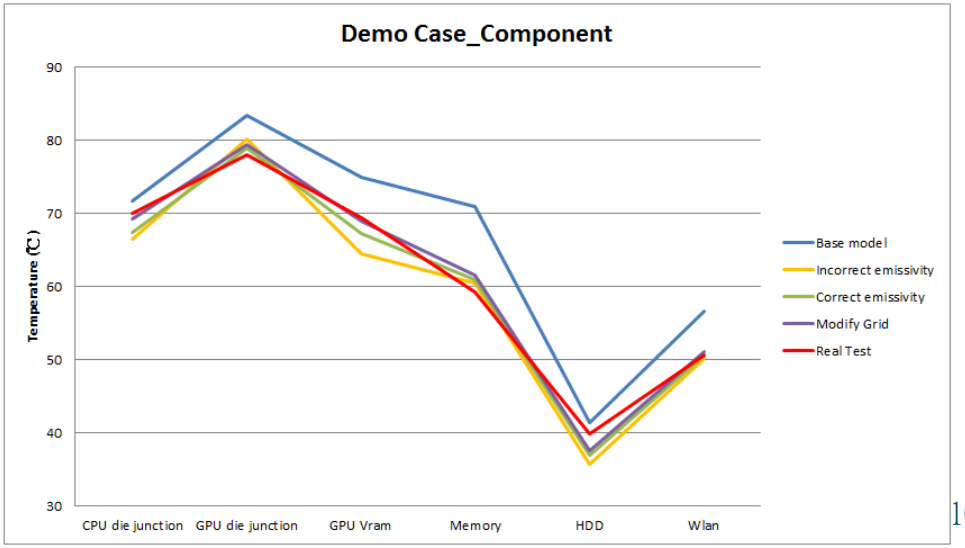


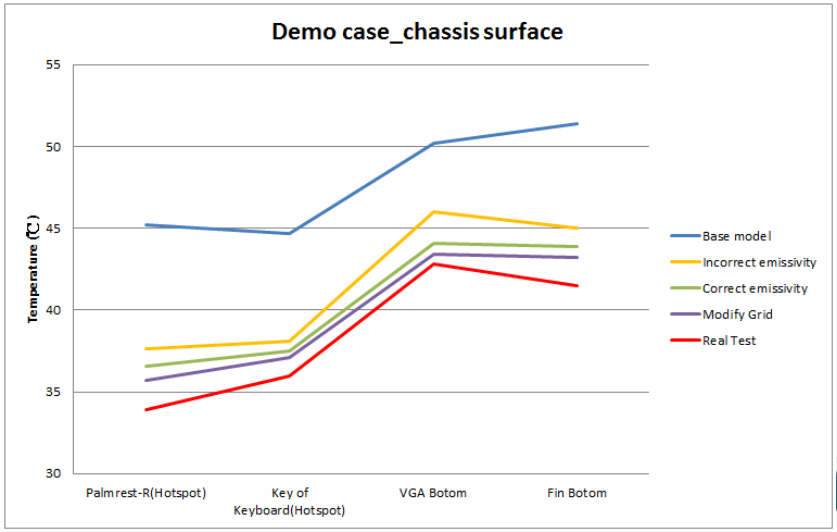


Heater Calibration: Real test=103.6℃					
1		2		3	
No boundary mesh	Error rate(%)	Boundary mesh (0.2 mesh size)	Error rate(%)	Boundary mesh (0.5 mesh size)	Error rate(%)
106.2℃	*2.5%*	103.9℃	0.2%	104.3℃	0.8%
					

Demo Case

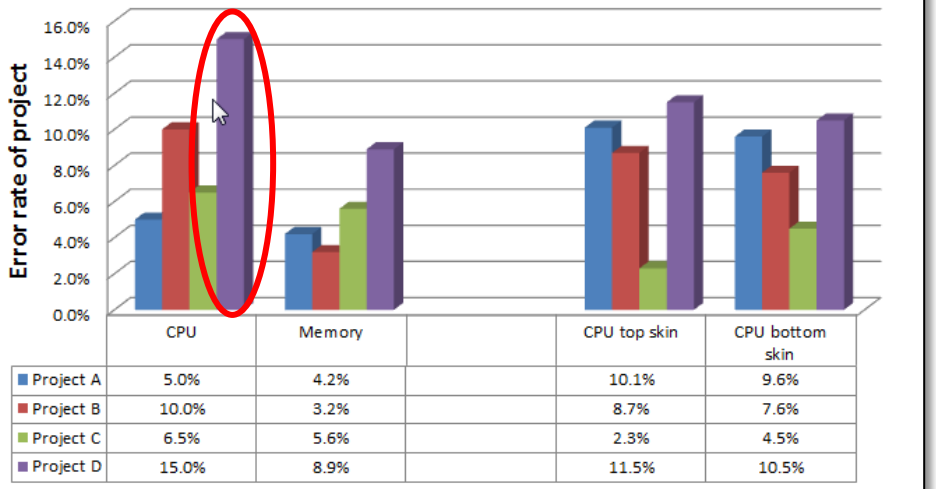
		Base model		Incorrect emissivity		Correct emissivity		Modify Grid		Real Test
System Radiation		OFF		ON		ON		ON		-
Power	System total	36.65		36.5		36.65		36.65		36.3
Component	Scenario	3DMark13	Error	3DMark13	Error (%)	3DMark13	Error (%)	3DMark13	Error (%)	
	CPU die junction	71.6	2.3%	66.4	-5.1%	67.4	-3.7%	69.2	-1.1%	70.0
	GPU die junction	83.3	6.8%	80.1	2.7%	78.8	1.0%	79.3	1.7%	78
	GPU Vram	74.9	8.1%	64.4	-7.1%	67.1	-3.2%	68.9	-0.6%	69.3
	Memory	70.8	**19.8%**	60.4	2.2%	60.9	3.0%	61.5	4.1%	59.1
	HDD	41.3	3.8%	35.7	**-10.3%**	36.9	-7.3%	37.4	-6.0%	39.8
	Wlan	56.6	**12.1%**	50.1	-0.8%	50.5	0.0%	51.0	1.0%	50.5
Skin	Palmrest-R(Hotspot)	45.2	**33.3%**	37.6	**10.9%**	36.6	8.0%	35.7	5.3%	33.9
	Key of Keyboard(Hotspot)	44.7	24.2%	38.1	5.8%	37.5	4.2%	37.1	3.1%	37.9
	VGA Botom	47.8	17.3%	44.0	7.5%	43.5	3.0%	43.0	1.4%	44.6
	Fin Botom	51.4	23.9%	45.0	8.4%	43.9	5.8%	43.2	4.1%	41.5





Process about improving accuracy

Model Checklist → *Input data* → *Compare error rate (%)* → *Analyzing* → *Recheck library & database*



	CPU	Memory		CPU top skin	CPU bottom skin
Project A	5.0%	4.2%		10.1%	9.6%
Project B	10.0%	3.2%		8.7%	7.6%
Project C	6.5%	5.6%		2.3%	4.5%
Project D	15.0%	8.9%		11.5%	10.5%

Ex: CPU temp. have larger error rate occurs on project D

Analyzing: CPU (new platform) in project-D & crate by CPU spec.
Recheck: According calibration SOP & build new CPU model in library

Parameters (ProjectD)

Keycomponent	Conductivity(k)	Emissivity(ε)	選擇New Create & others請註明
CPU	New create	Library	MTK CPU(create by CPU spec.)
Memory	Library	Library	
UCASE	New create	Database	Specical ID
LCASE	New create	Database	Specical ID

Refer to "Calibration SOP" → *Create new CPU model in library*

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