Module Construction at Pusan

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Pusan National University (PNU)

ALICE ITS upgrade, MFT and O2 Asian Meeting 2014@Pusan
2014.12.15.

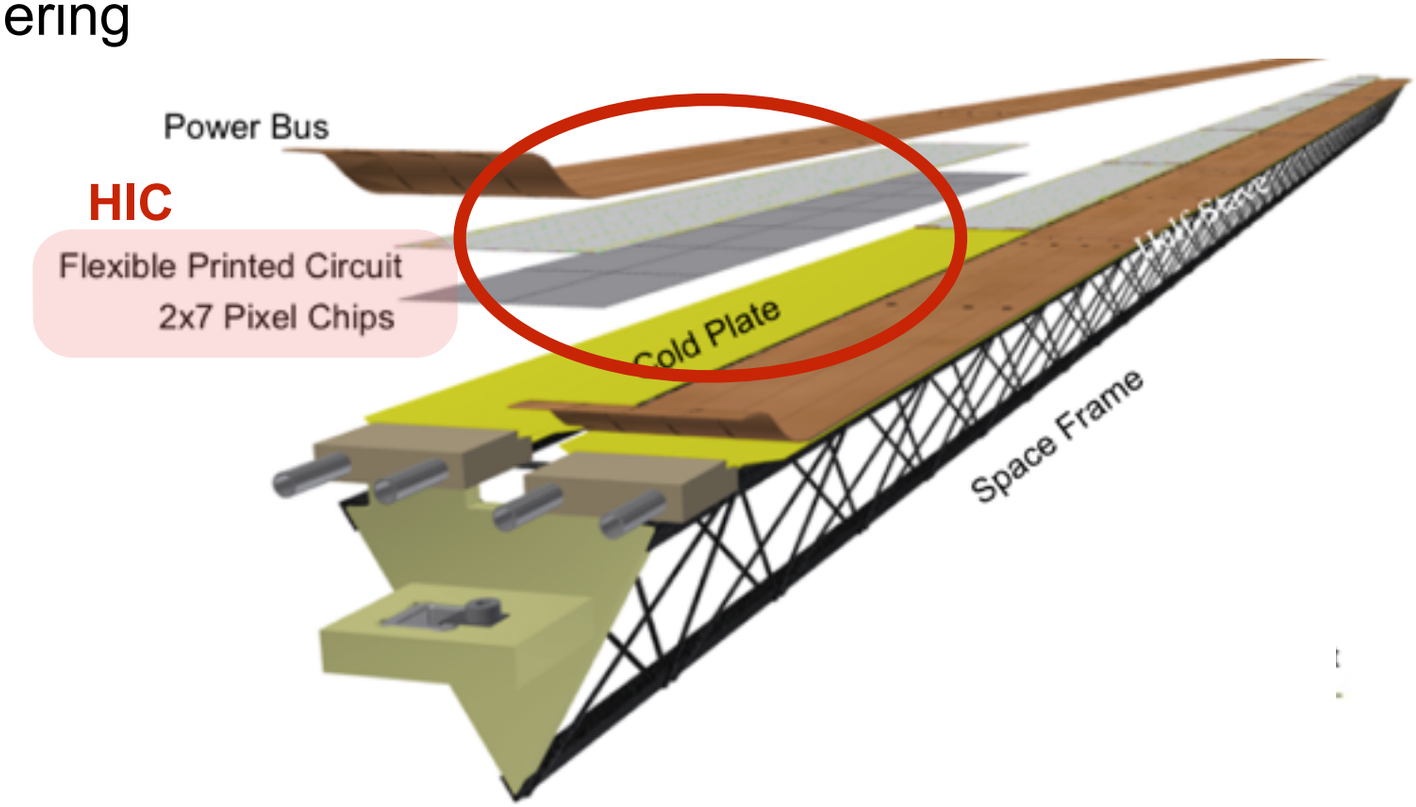
Preparation for HIC Assembly

Infrastructure

Transportation Test

Training Local Expert

- Visit CERN for Training Laser Soldering
- Laser Soldering Data Analysis



HIC: Hybrid Integrated Circuit

Infrastructure for HIC Assembly

Infrastructure for HIC Assembly

New room & Clean booth(Planed)

Pixel chip Characterization System

- **Infrastructure**
  - **20m² of <u>Clean booth</u> (**100,000 Level)*(Planned)*
- **Equipments**
  - Microscope(SZX7)
  - Further will be informed by WP4 Group

    (**Desiccator** for Silicon Chips, **Storage** for modules)
- **Misc.**
  - Further will be informed by WP4 Group

    (Gloves, Air spray, Alcohol so on..)

- **Will be delivered**
  - **Baseline System for HIC Assembly**
    - contains mass test system & HIC Assembly System

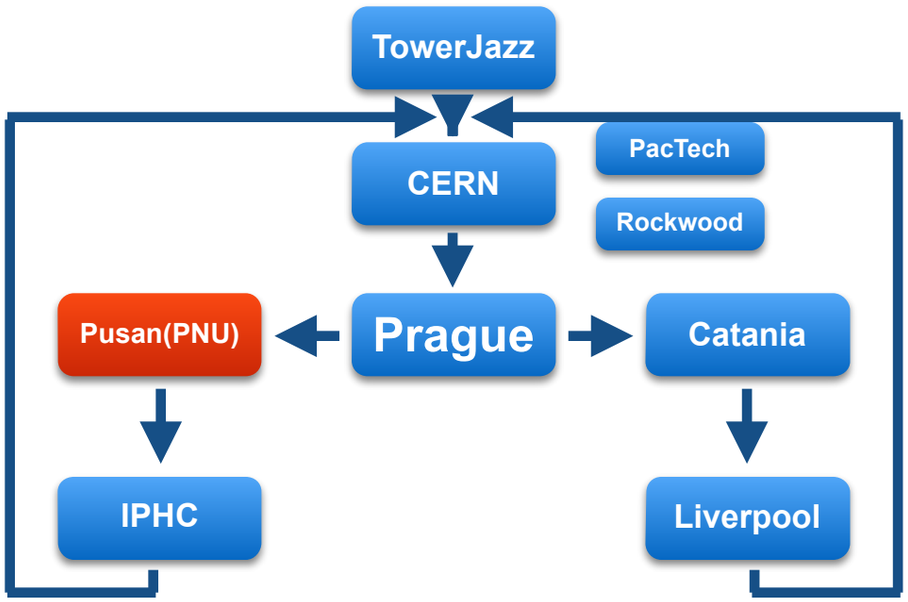
Transportation Test

Transportation Test

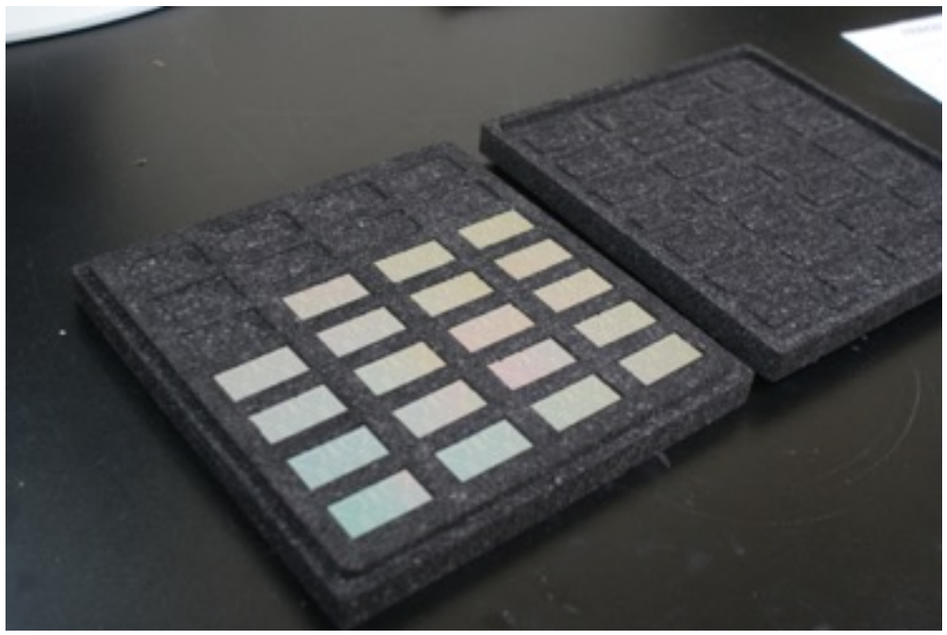
- **Purpose:** confirm the transportation of Chips before start the Mass-Production
- **<u>PNU is most distant site of overall test sites → Transportation test is necessary</u>**
- **Test Procedure:**

1. Take a package and check the damage of Foam box
2. Open the box carefully, check for broken chips or any small fragments of chips in the box
   - Pick out some chips with using Chip Lifting Tool to check with microscope.
3. Put back all chips to box and pack the package and send to next test site.

- **Document any damages by taking pictures, and send mail to next site**



Route of Transportation Test



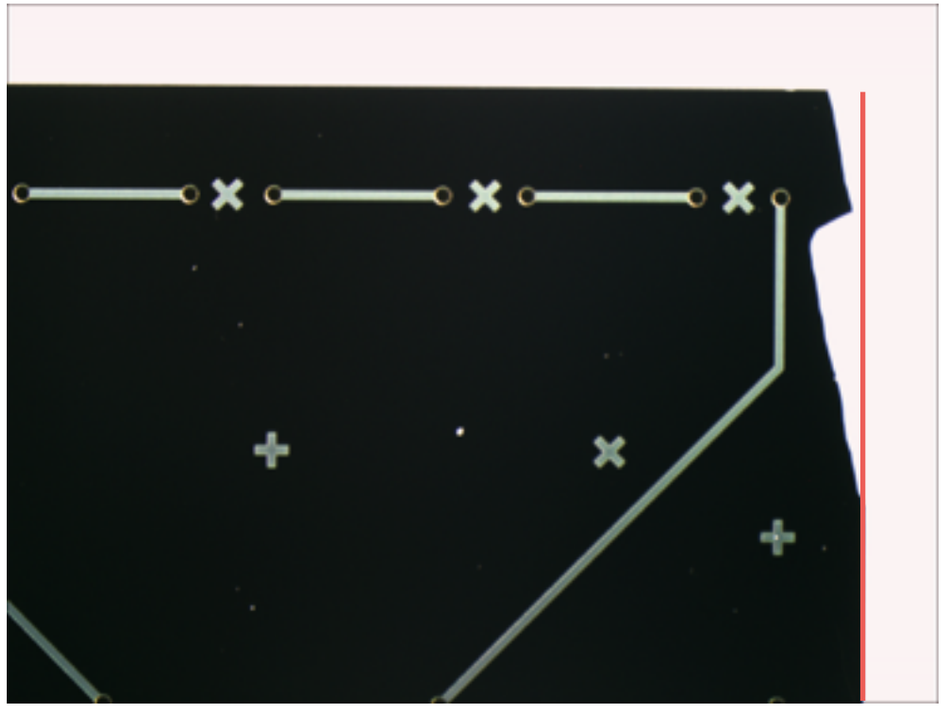
Foam Box & Test Dummy Chips

Chip Lifting Tool

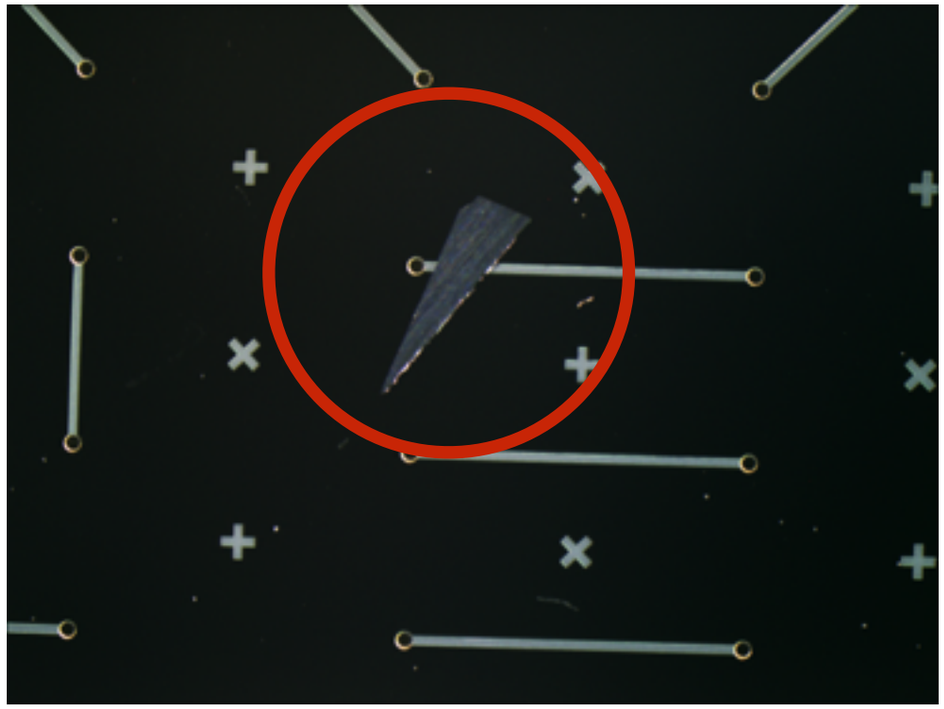
Transportation Test Result

- **Result:**
  - No damage on the box
  - 1 Small fragment of chip is found
    - but, don't know where it comes from.
    - Size of fragment is different with broken edge of same chip.
  - Some chips are damaged.
- This problem is reported to WP4 group.

- **Waiting for next Transportation Test.**



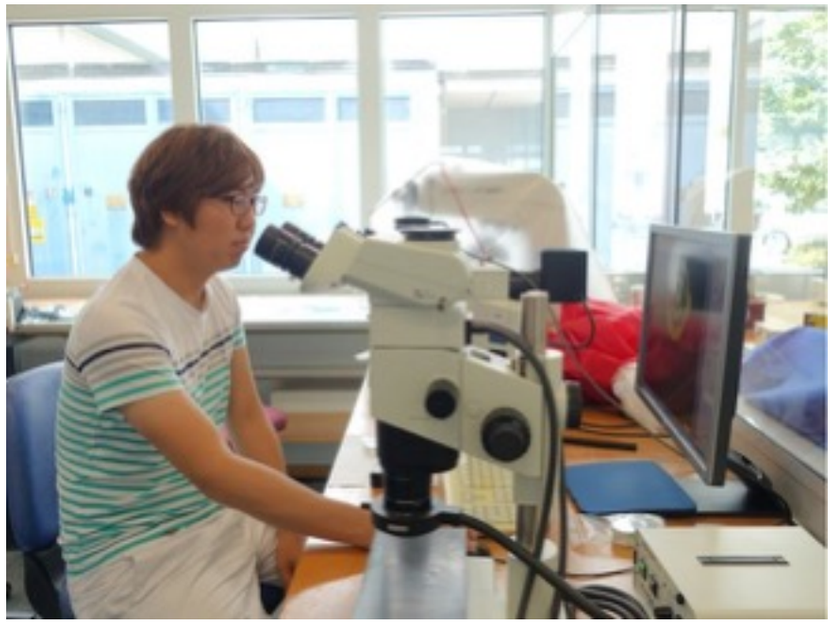
Chip Edge



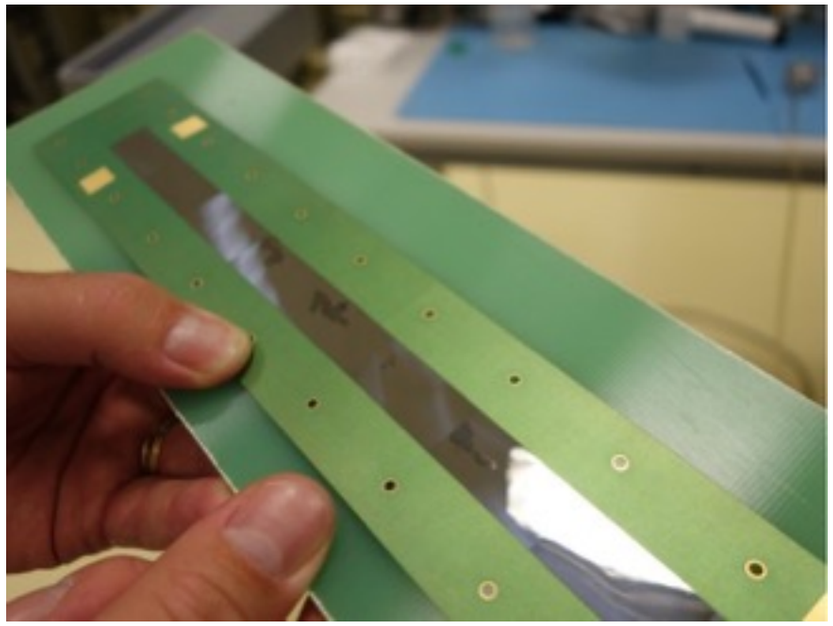
Fragment of Chip

Training Local Expert

Visiting CERN & Laser Soldering



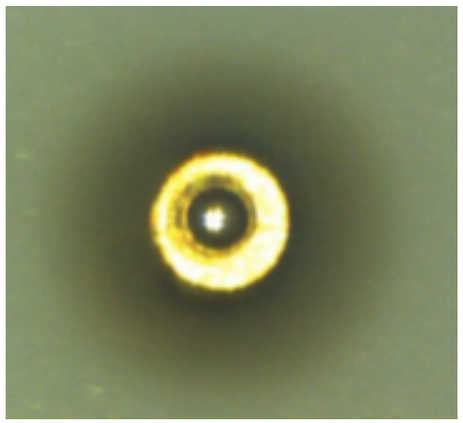
Checking Cross-Section



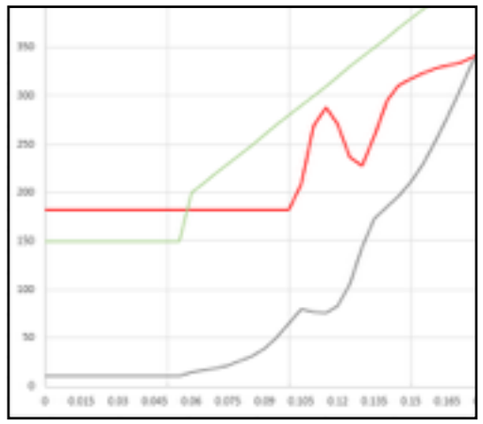
9 Chips Soldering

- **Purpose**: Training local expert for operating HIC Assembly
- **Training R&D of Laser Soldering** with Antoine. (4 + 4 wks)
  - 50, 103 Pads Chip, 9 Chips Soldering
  - Simple Check of the quality of Soldering
- **Task in Korea: Laser Soldering Data Analysis**
  - **Purpose** : Quality Assurance of Laser Soldering with non-destructive method.
  - Furthermore, Find optimal Laser Soldering Profile

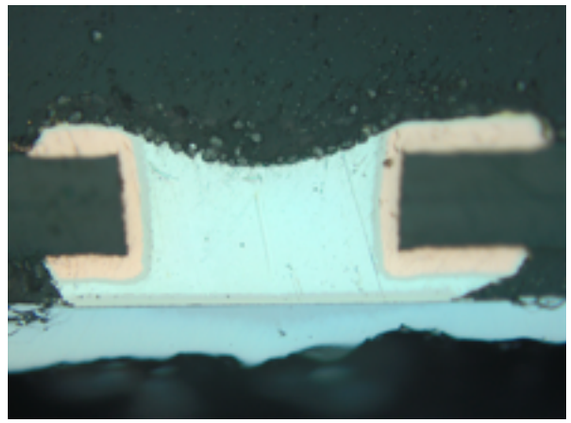
Available Data to Analysis



Soldering Video



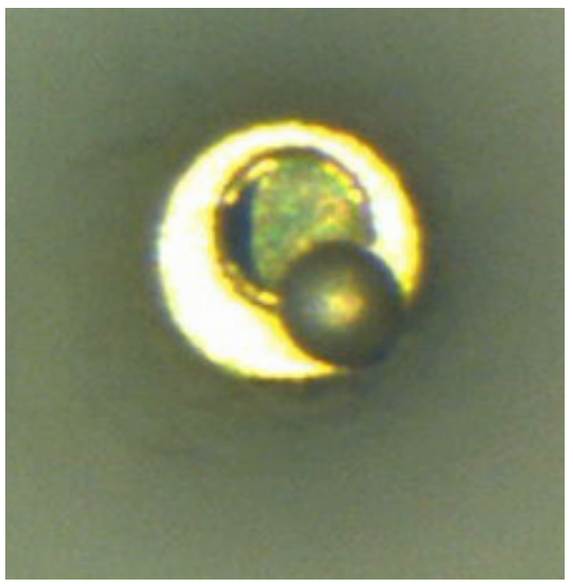
Measured Laser Power, Temp.



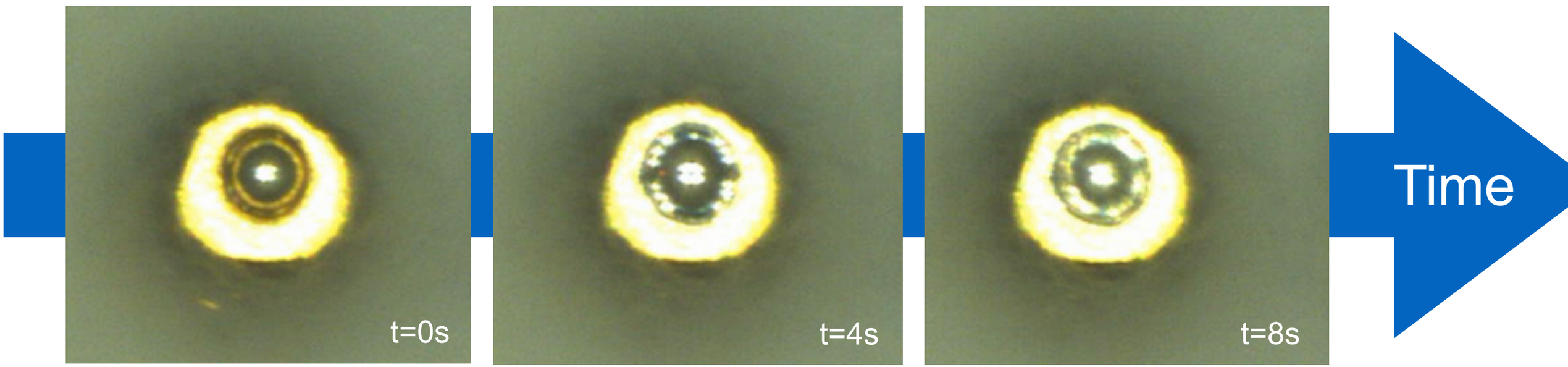
Cross-Section Picture

Soldering Video

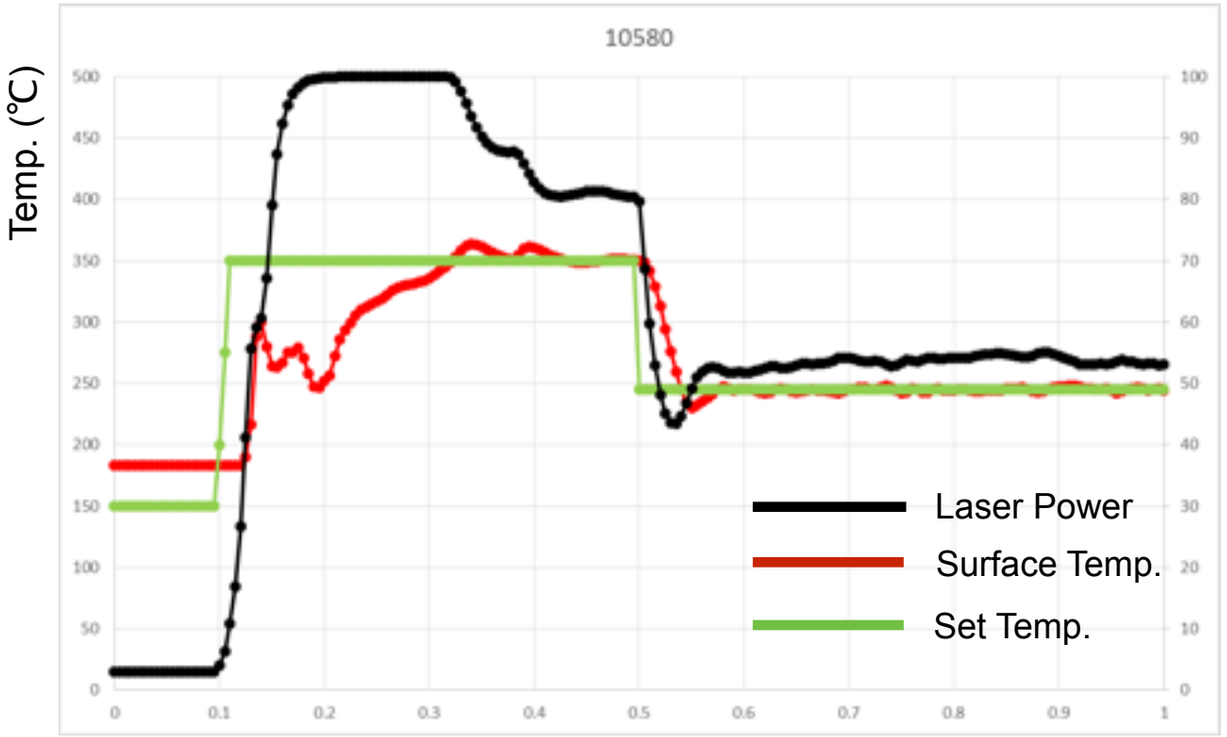
- **Take a video during the soldering.**
  - Frame rate: 15 FPS
  - Camera is placed on next to Laser
- Basically, we can see the time evolution of soldering spot.
- We can see the position of Soldering ball also.

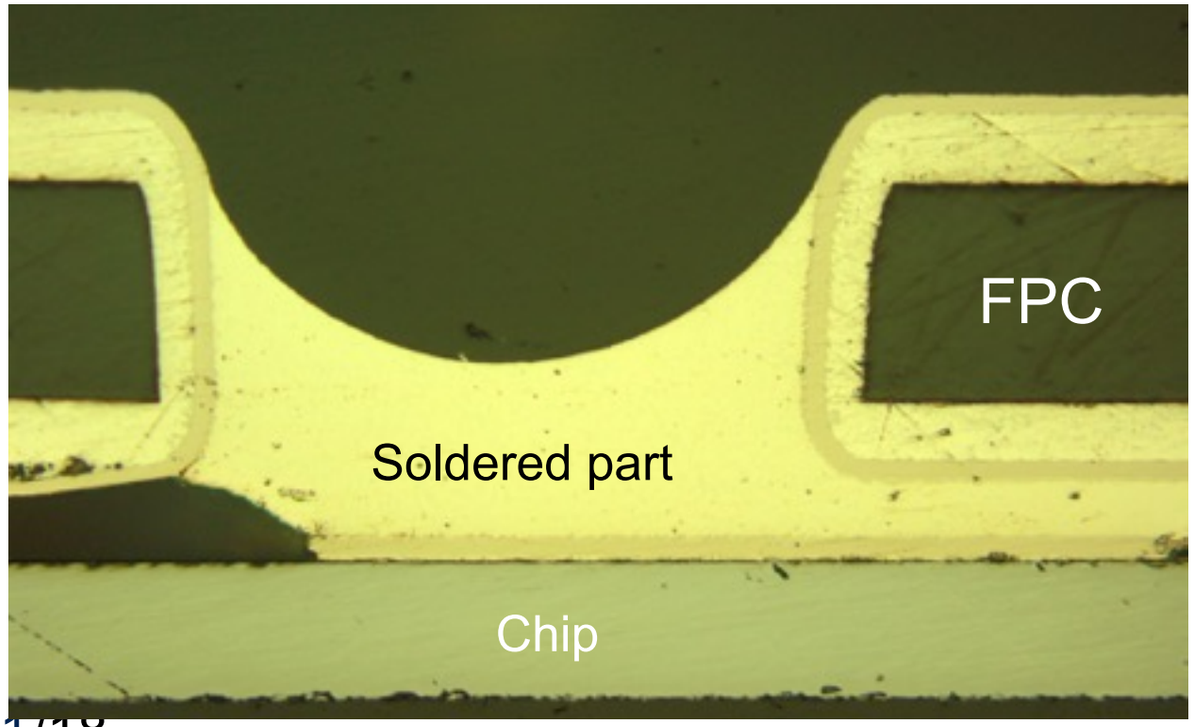


Bad position



Measured Data & Cross-Section





Measured Laser Power & Surface Temperature

- Record a Surface Temperature & Laser Power during the soldering.
- Laser Power controlled by combination of Set Temp. and Surface Temp.
- This data is related in status of Soldering Process

Cross-Section Picture

- Cross-section Picture is absolute standard to judge soldering quality.
- We should start analysis from here.

Procedure of Laser Soldering Data Analysis

1. Categorize soldering type

Categorize with using Cross-section picture,
Is it good? or bad?

2. Check the Measured value

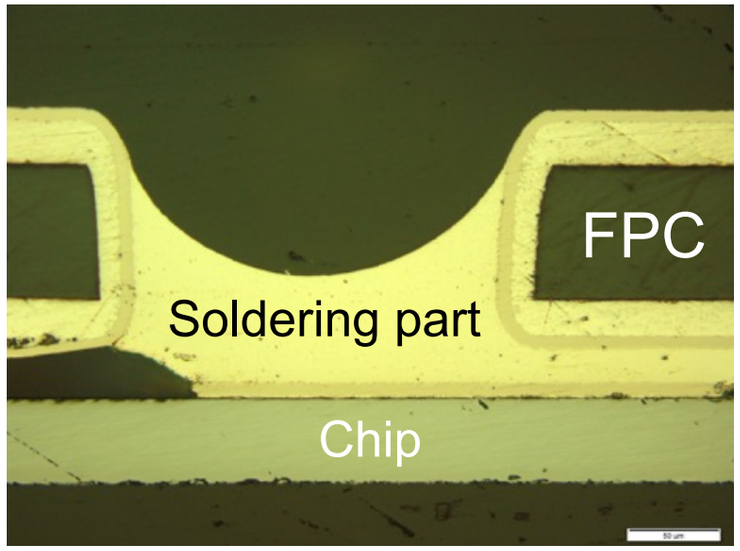
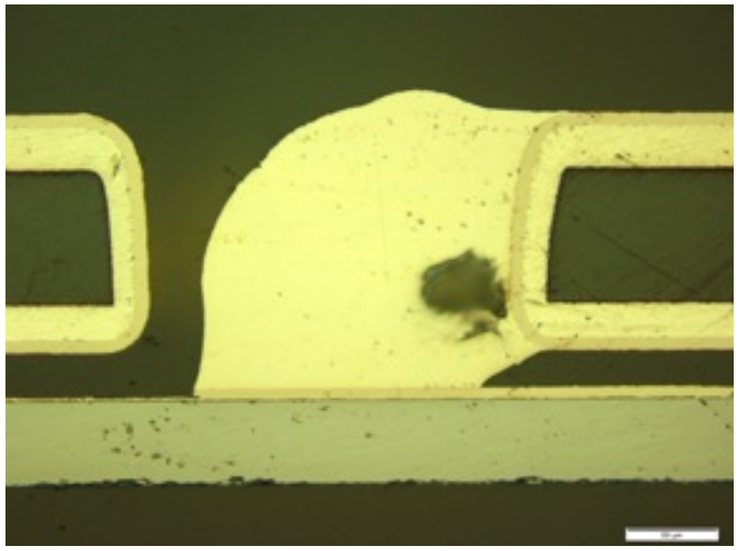
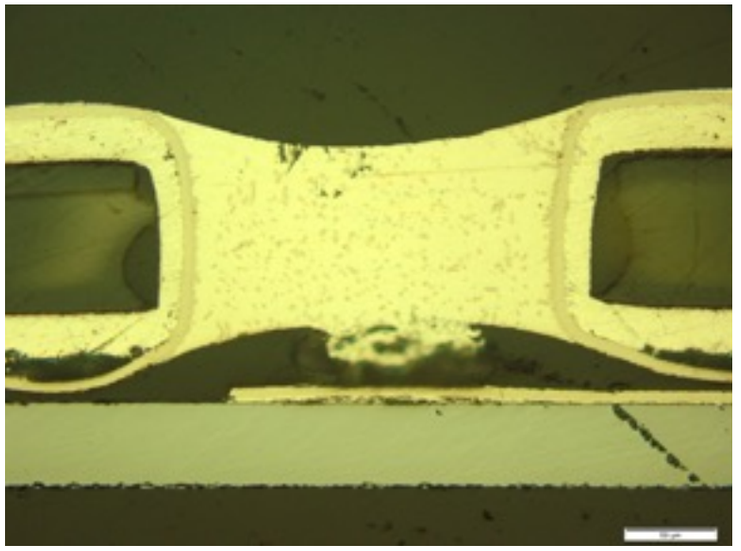
See the Surface Temp. and Laser Power, and time evolution of Video of each soldering type.

3. Check with another Data

Assume the type of each soldering point with basis of previous check.

Check the Cross-section

- **Used 100 Sample data with 18 Cross-section picture.**
- **Categorized the Cross-section shape.**
  - I have 1 bad case, and 3 Worst case of 18 Cross-section picture.

14/18	1/18	3/18
		
Good Connection case	Bad Connection case	Worst Connection case

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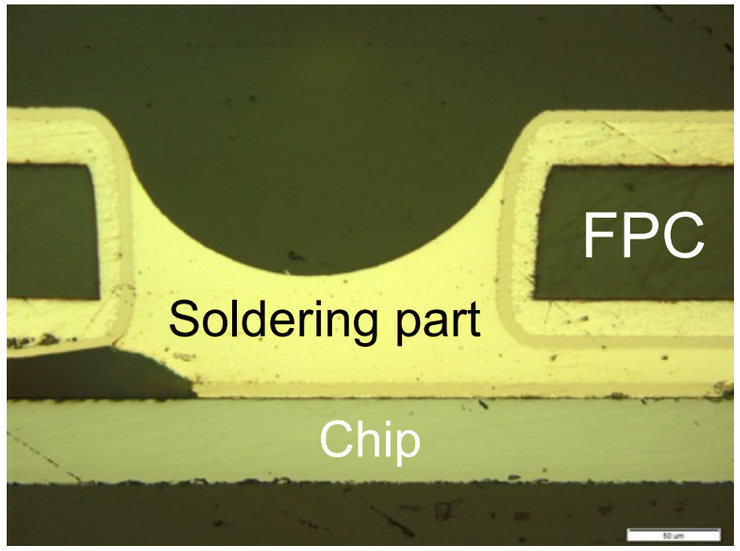
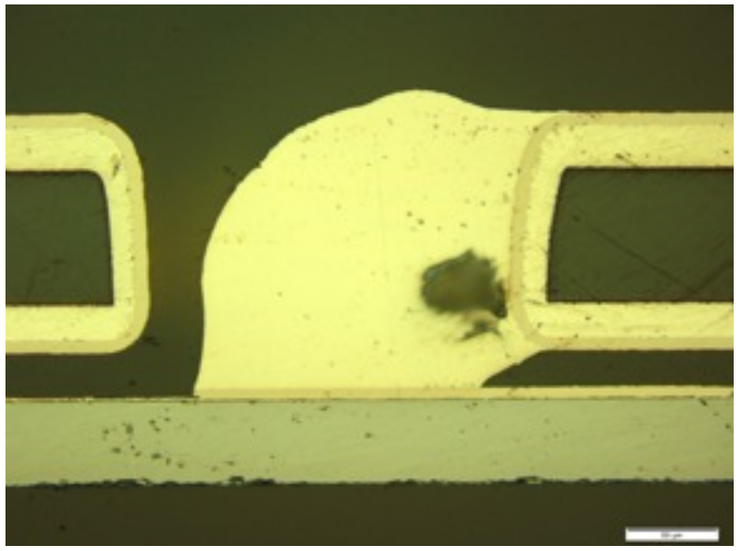


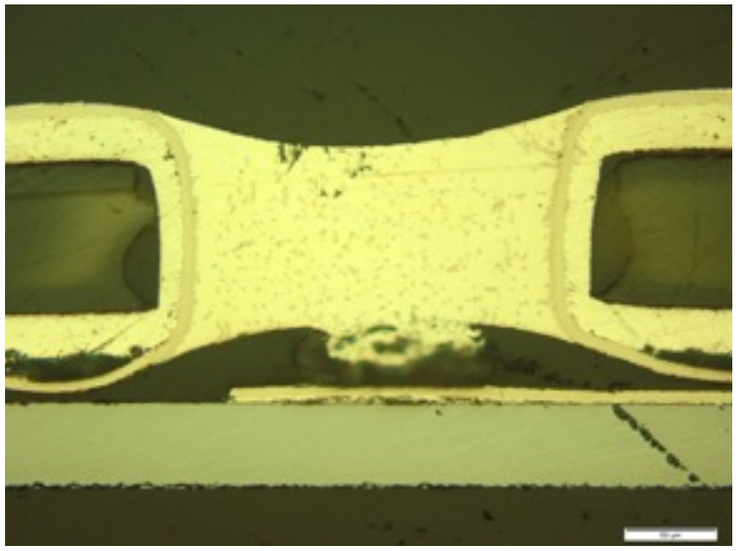
Good Connection case

1/18



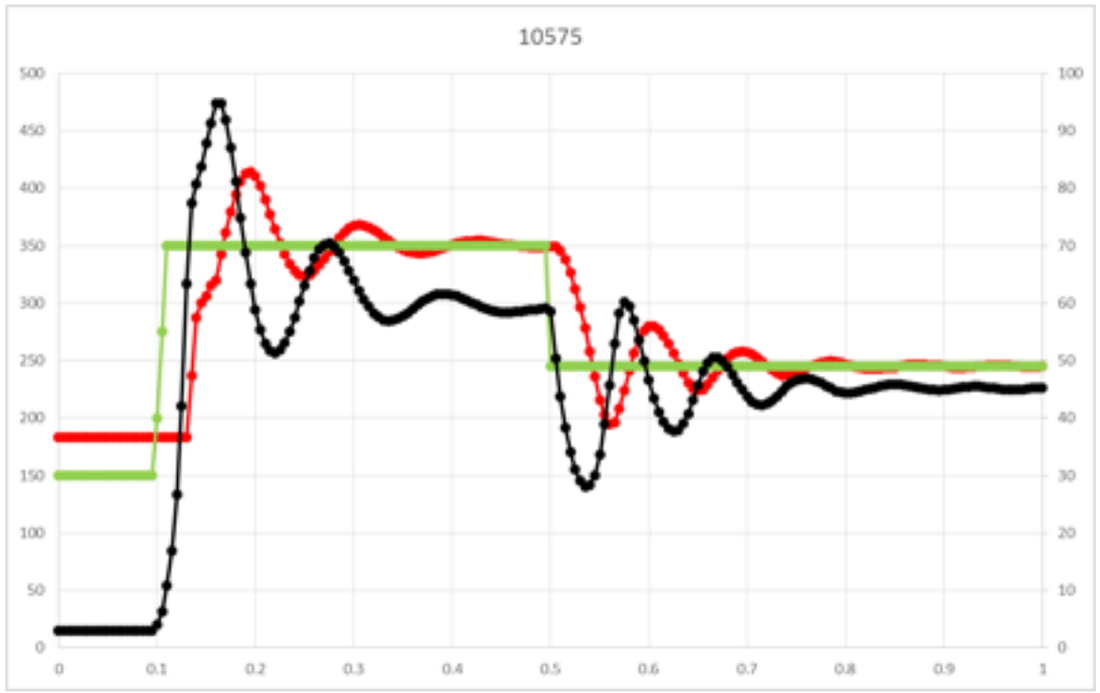
Bad Connection case

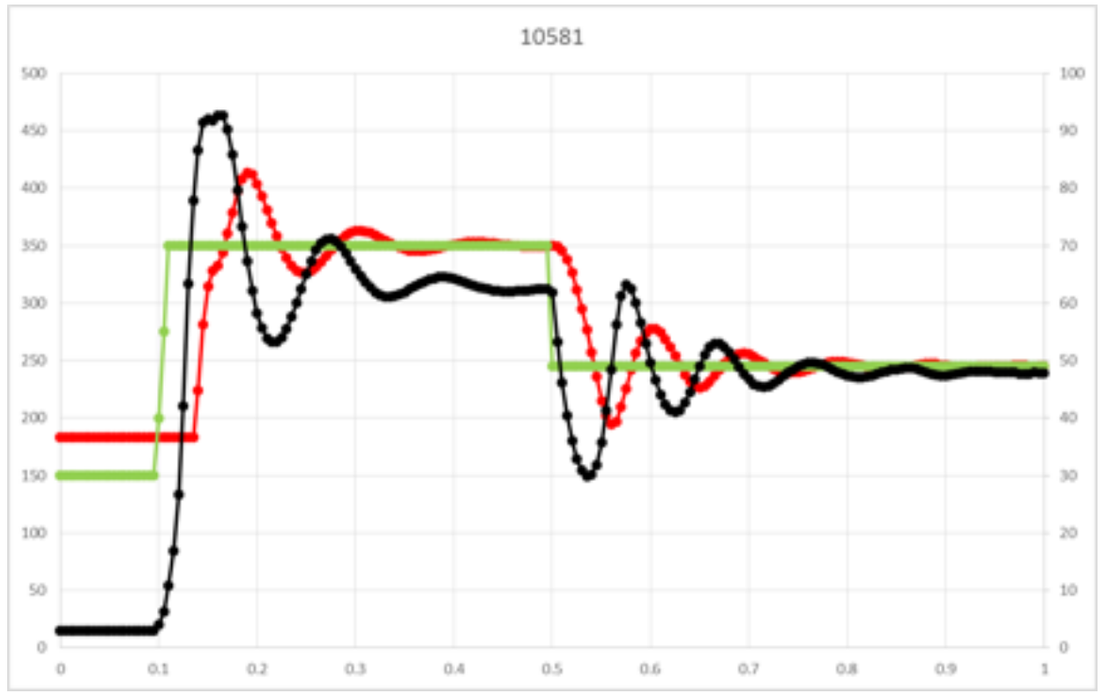
3/18

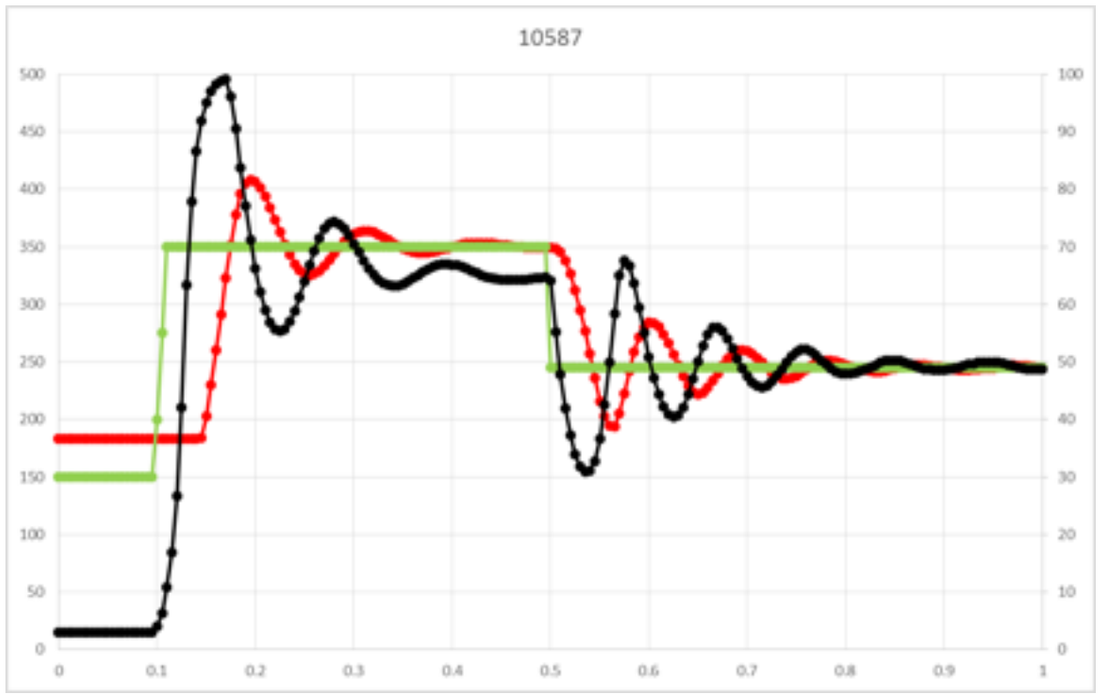


Worst Connection case

Check the Surface Temp. and Laser Power





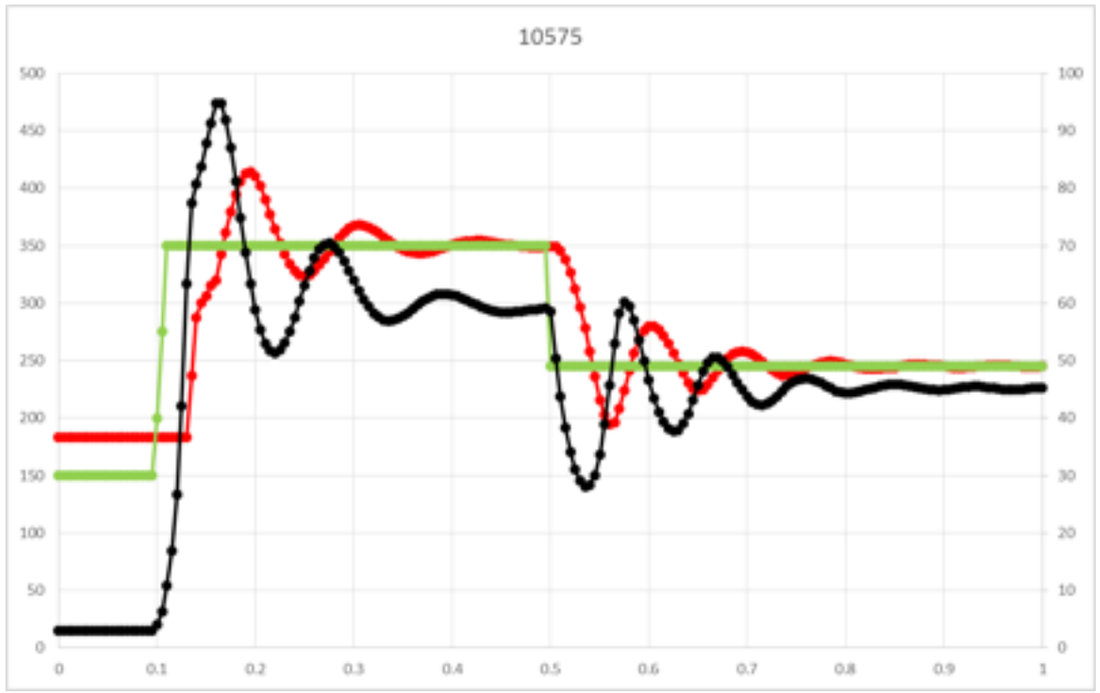


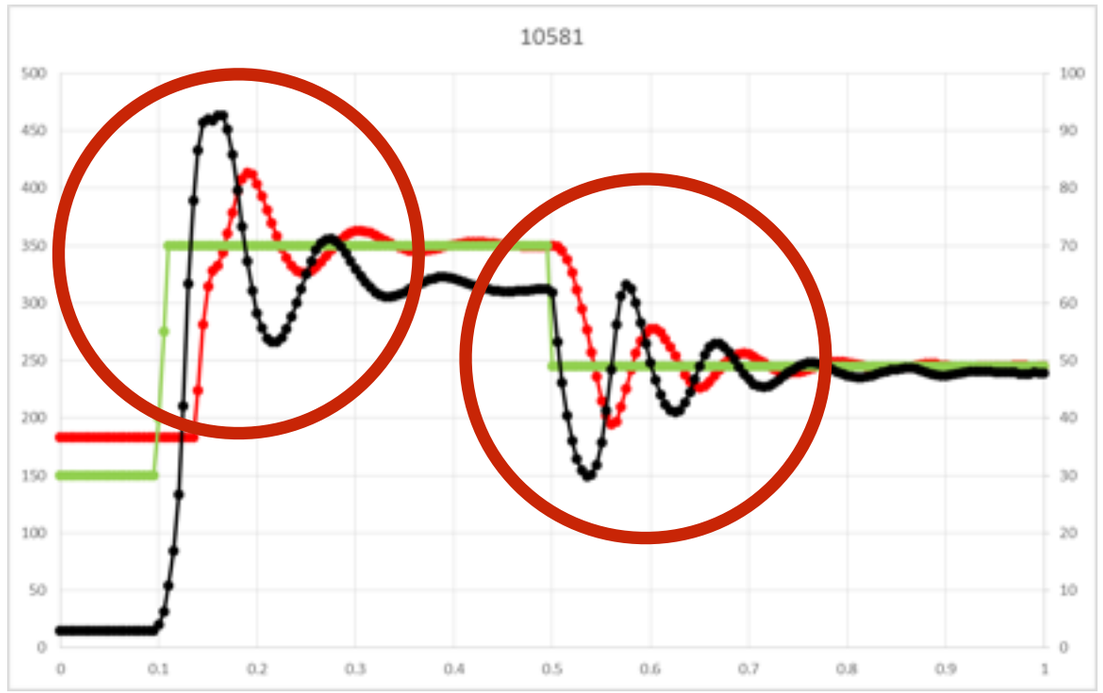
Worst Case

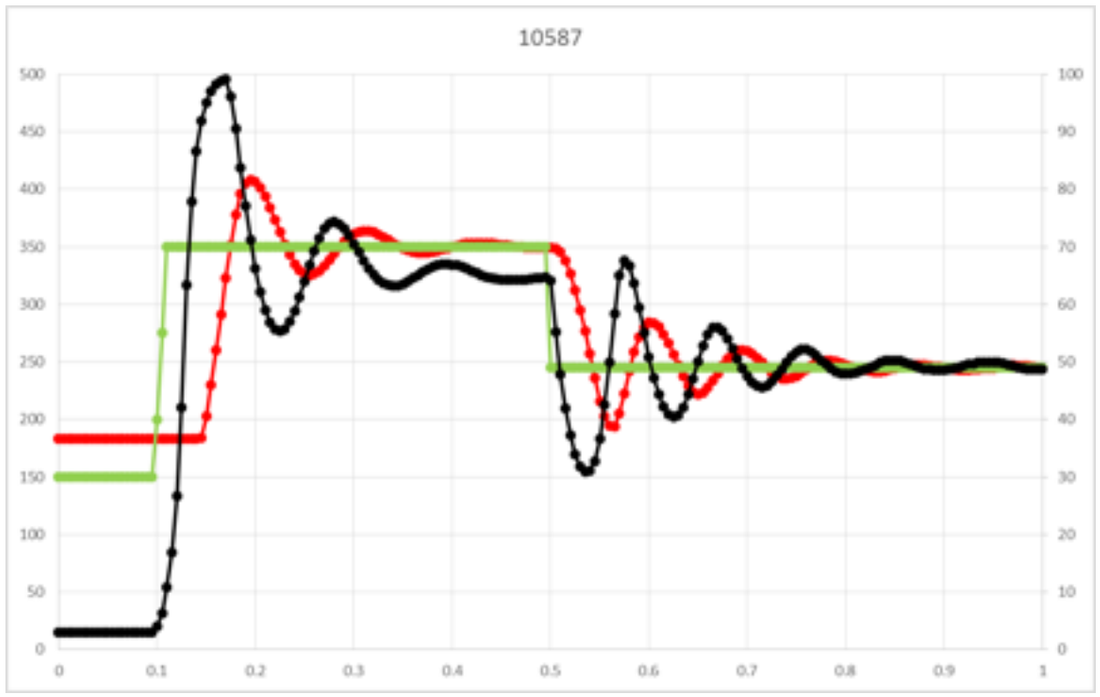
- **Checked the Surface Temp. and Laser Power curve.**
- The Worst Case,

  they show almost perfectly similar curve shape.

Check the Surface Temp. and Laser Power







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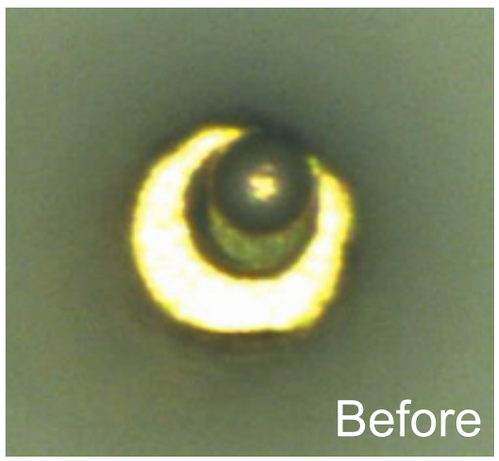
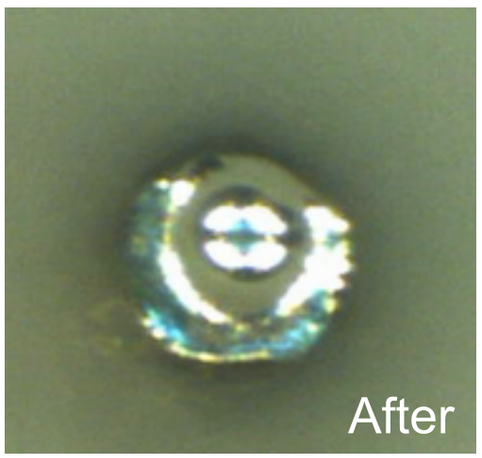
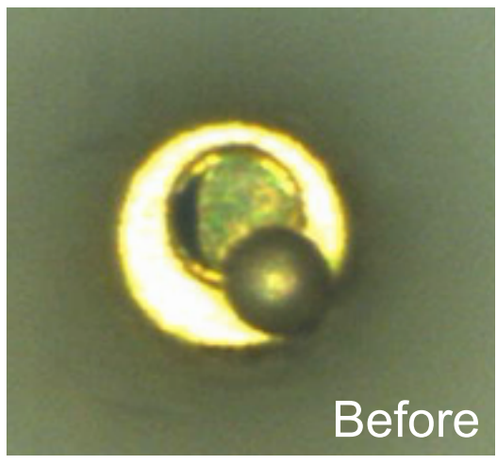
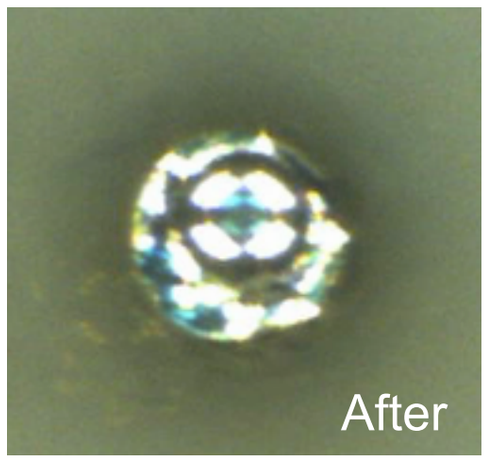
Soldering Video



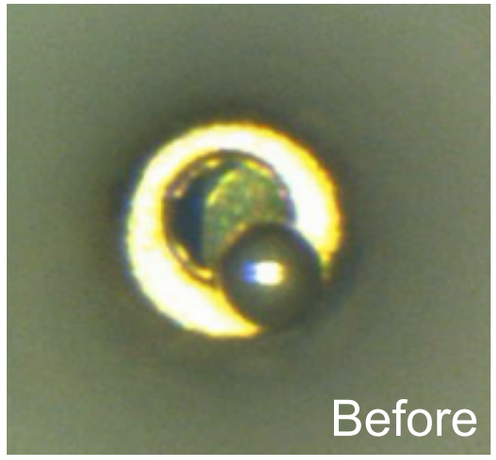


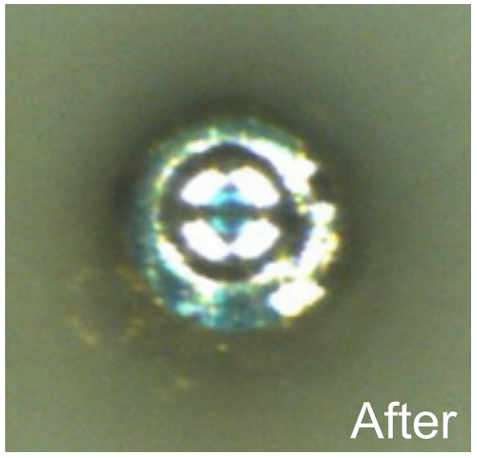
Case1(10575)





Case2(10581)

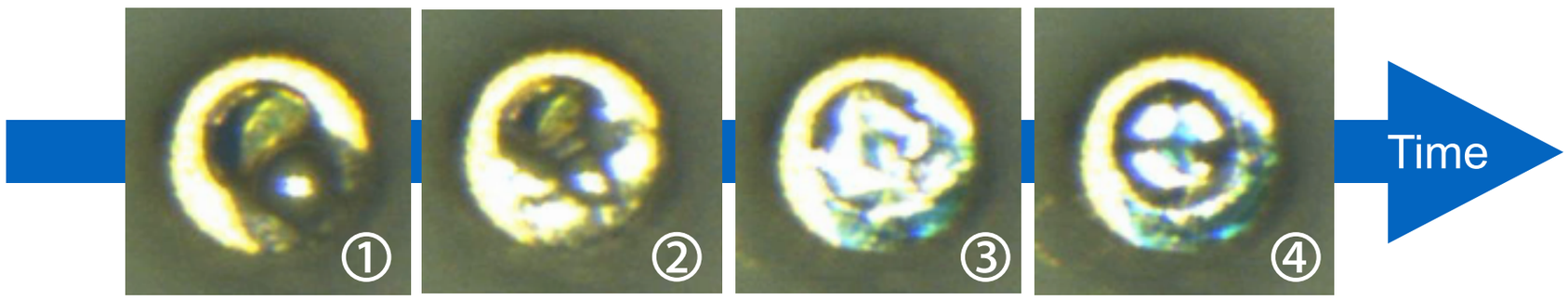




Case3(10587)

Worst Case

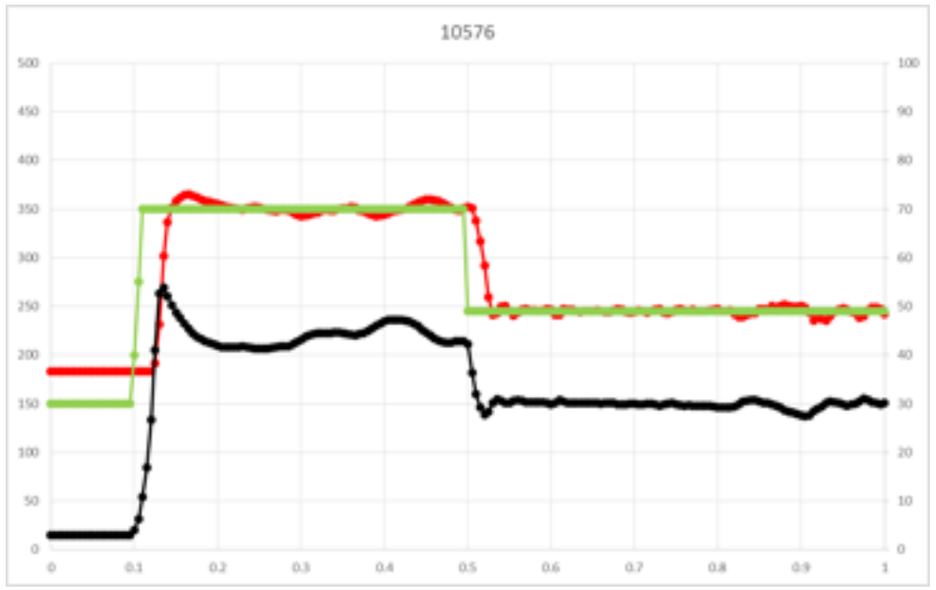
- **All of them start soldering in bad position of Soldering ball.**
- **It is melted through the circle line of hole**



Classification of Soldering Type

Type (from Cross-Section)	Measured Value (Temp. & Laser Power)	Position of Soldering Ball (Video)
Good	Various (but different with Worst)	Center
Bad	Suppressed	Center
Worst	Unique	bad Position

Good case(10579)



Bad case(10576)

Black line(Laser power) is decreased in Bad case.

Check the another data

- **Check with measured value**
  - Below is some soldering data in same sample.
  - There is no cross-section picture yet.

    but, we can assume the cross-section image with previous data.

This Soldering data should be

‘Worst’ case

This Soldering data should be

‘Bad’ case

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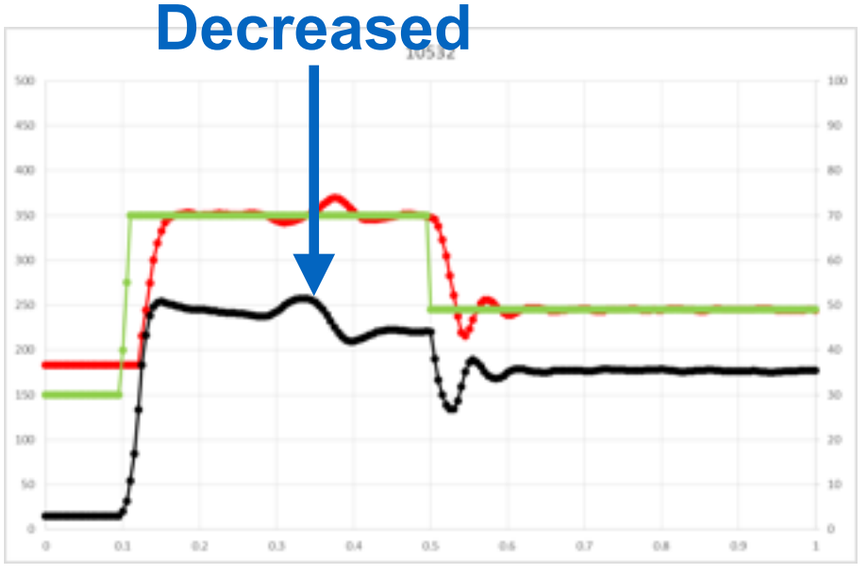


This Soldering data should be

‘Bad’ case

Summary & Outlook

- PNU is preparing both Infrastructure and Local Expert for HIC Assembly.
- We took part in Transportation Test, and waiting for next test
- Training Local Expert
  - Visit CERN to learn Laser Soldering
  - Task: Laser Soldering Data Analysis in on going now.

Summary

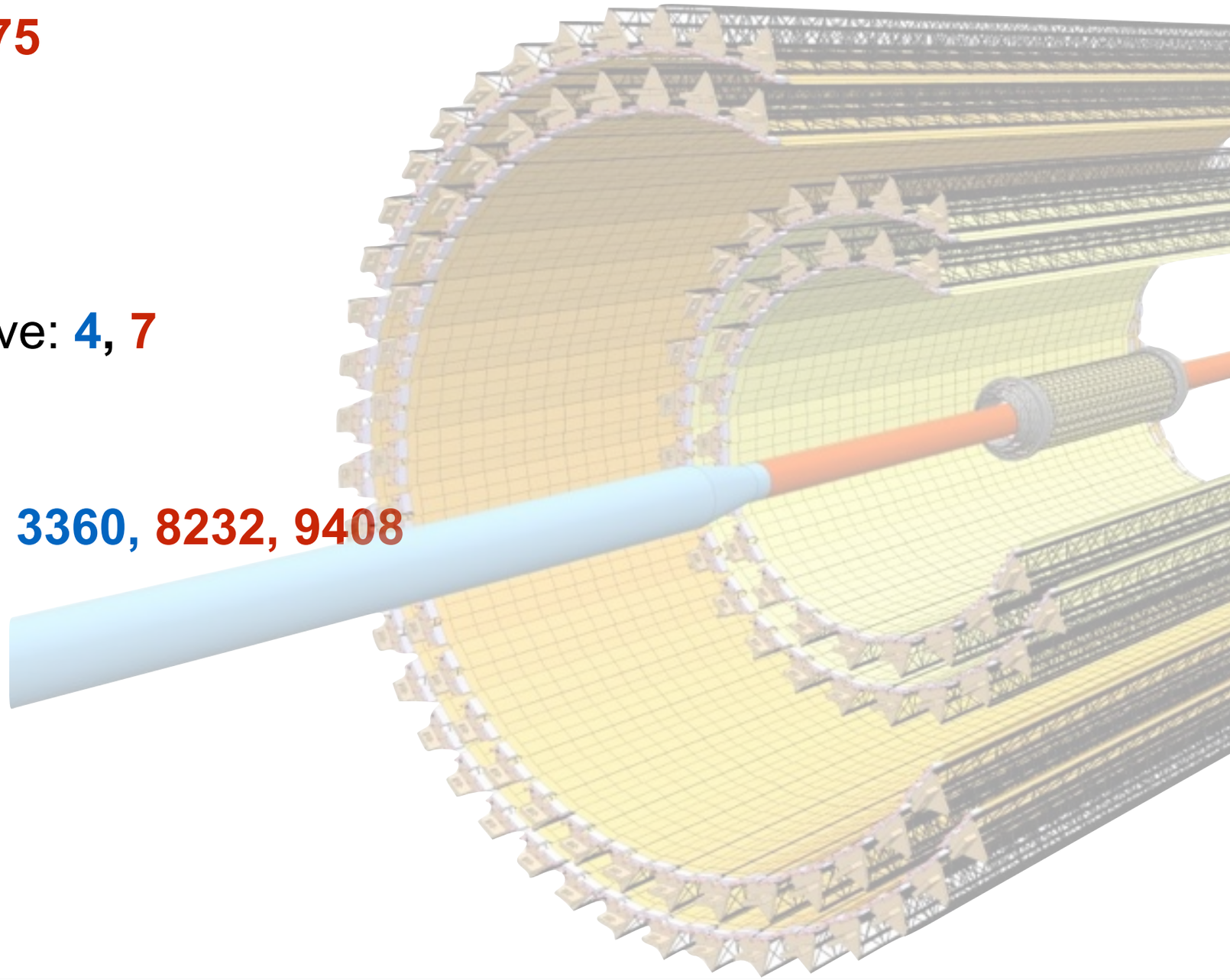
- **CERN Visit**
  - Date: Jan.2015
  - Period: 4 wks
  - Purpose: participate in R&D process of Laser Soldering
- Baseline system for HIC Assembly will be delivered next year.

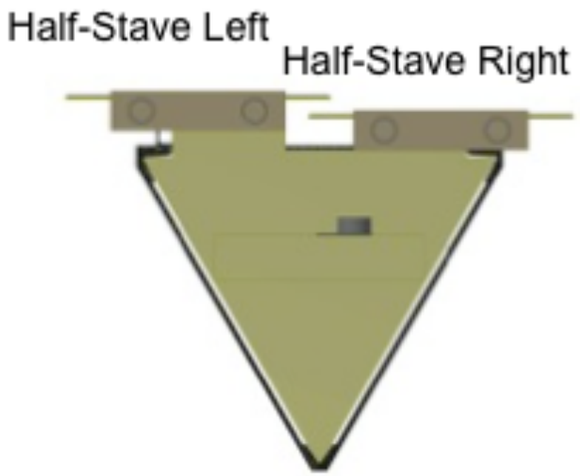
Outlook

Back up

Outer Barrel Specification

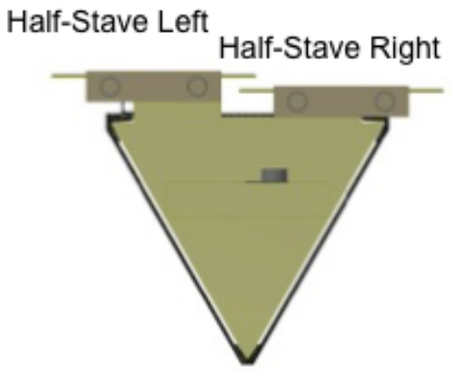
- Outer Barrel: 2 **Middle layer** + 2 **Outer layer**
- Radial Position(mm) : **196, 245, 344, 393**
- Length in z(mm) : **843, 1475**
- # of Staves: **24, 30, 42, 48**
  - # of half-Staves: 2
- # of moudules per half-stave: **4**, **7**
- # of Chips per module: 14
- # of Chips per layer: **2688, 3360, 8232, 9408**





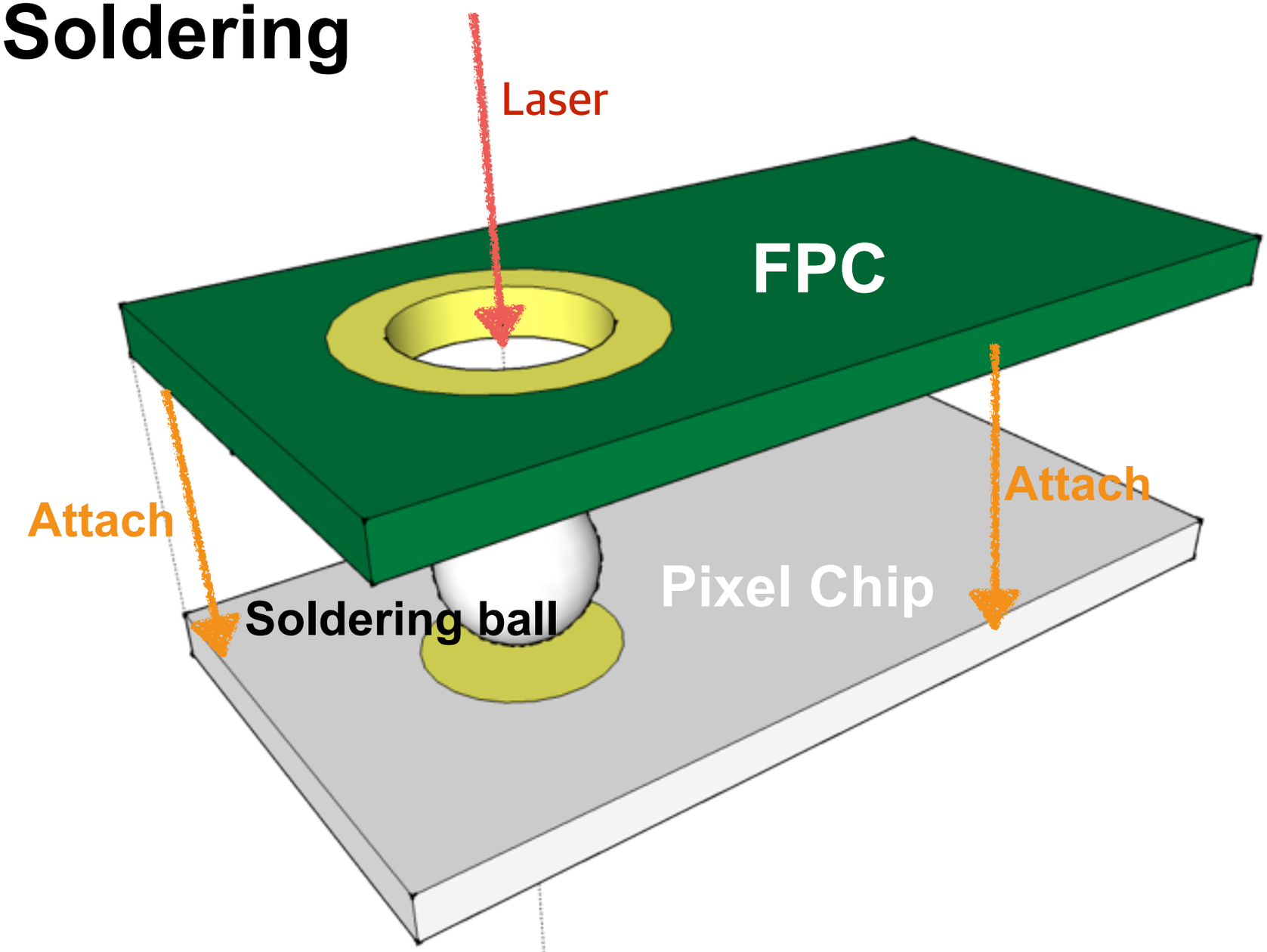
Amount of needed HIC

Layer	Stave	Half-stave	Module	Chip
L3	24	48	192	2688
L4	30	60	240	3360
L5	42	84	588	8232
L6	48	96	672	9408
Spares(20%)	11(ML) 18(OL)	22(ML) 36(OL)	340	4760
Total	65(ML) 108(OL)	130(ML) 216(OL)	2032	28448



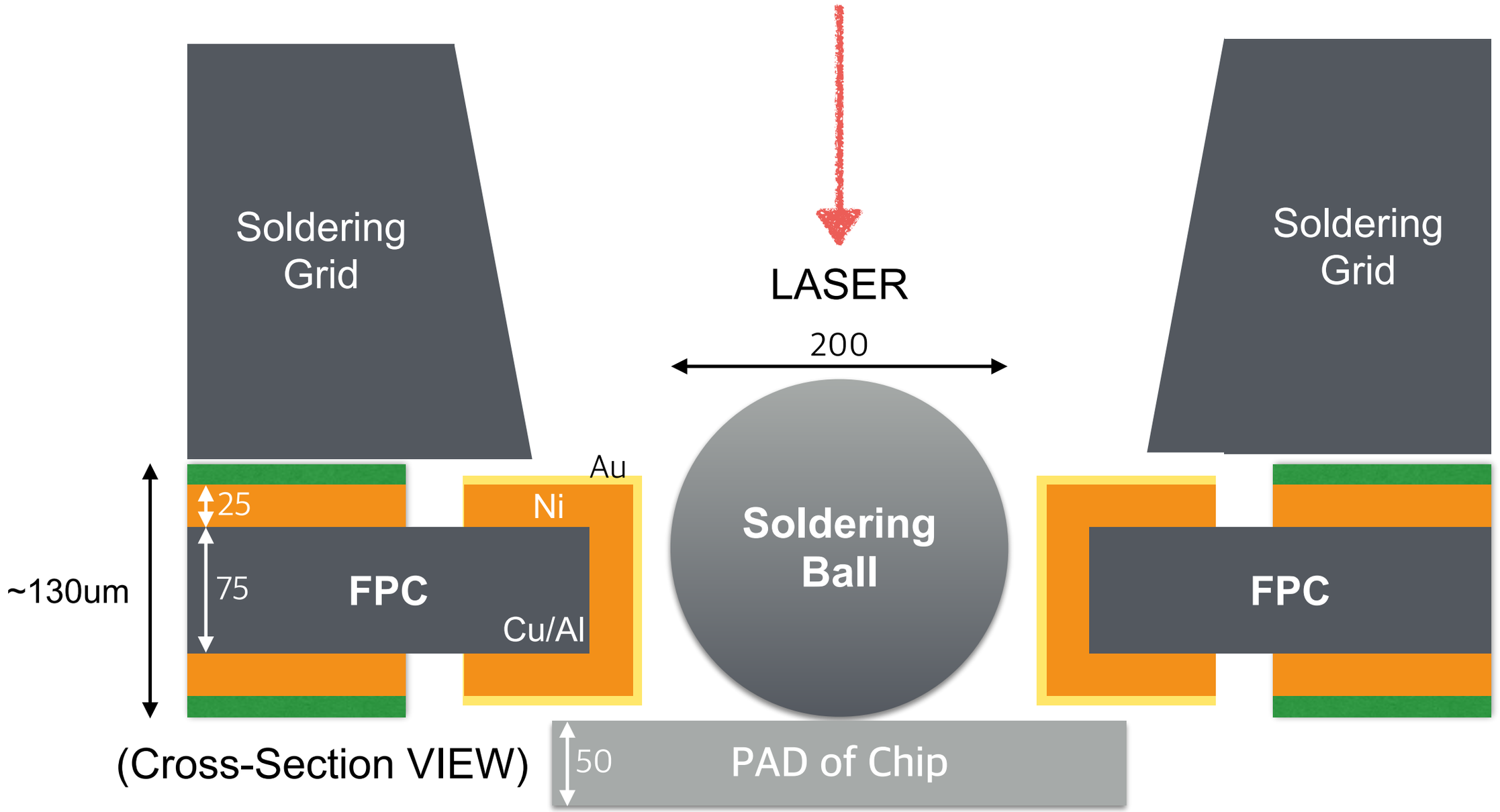
Each site would manufacture the 1 module per day for 1 ~ 2 years

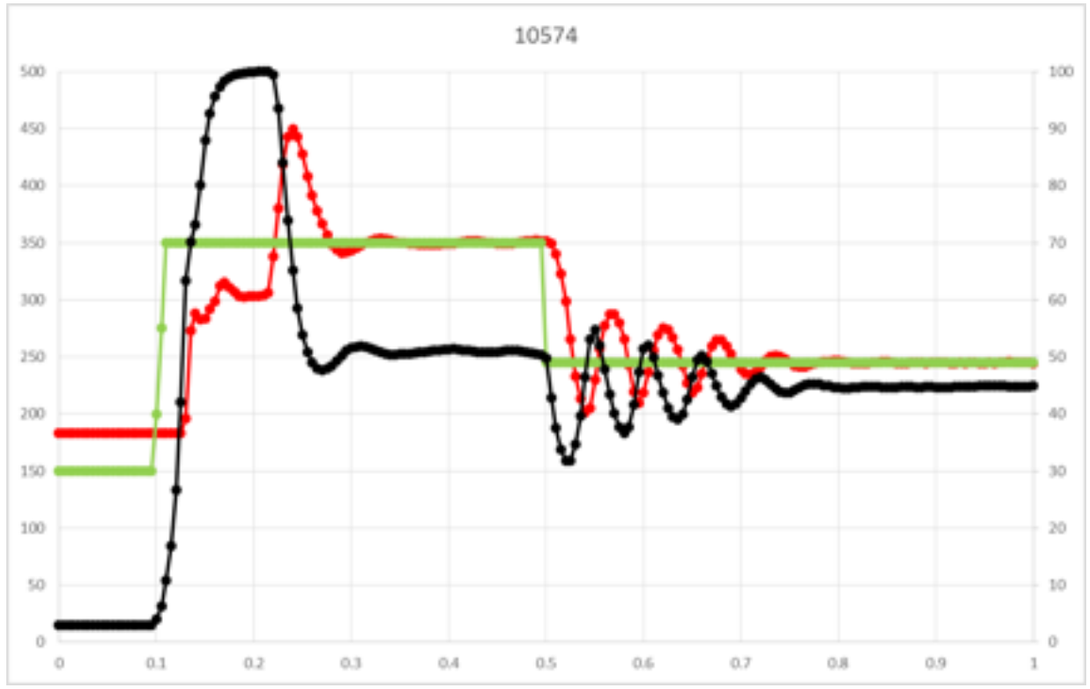
Laser Soldering

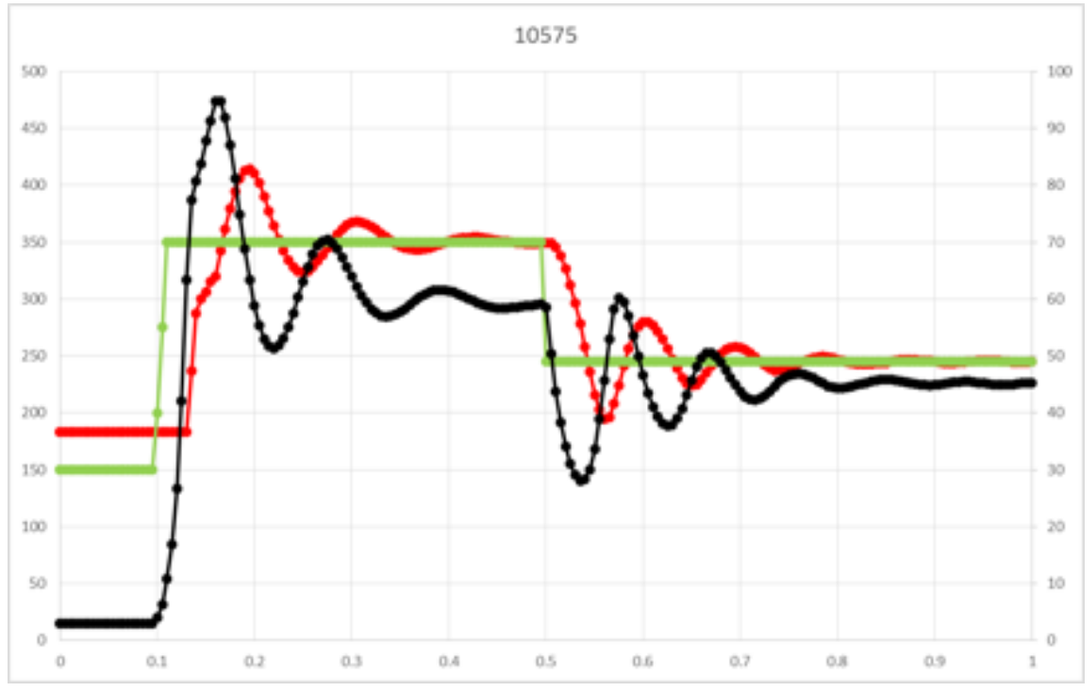


- **Pixel chips are soldered to FPC by <u>Laser soldering technique</u>**
- It can avoid thermal stress on the full HIC Structure
  - The hit is only generated in the small local area of the size of connection pad

Cartoon of Cross-Section view




10574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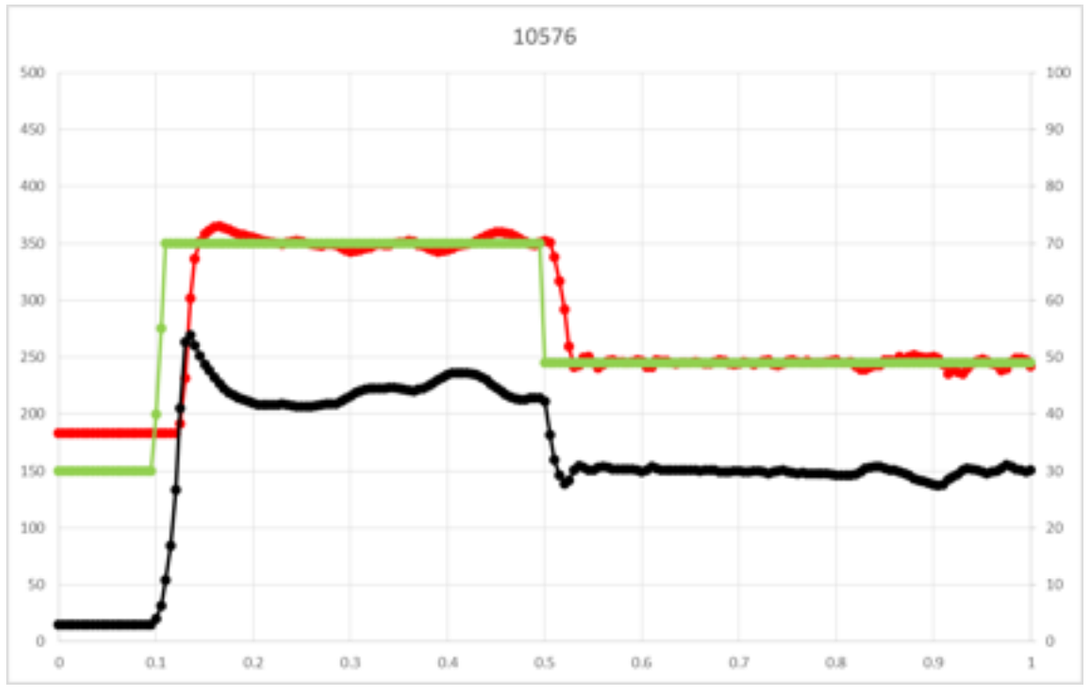
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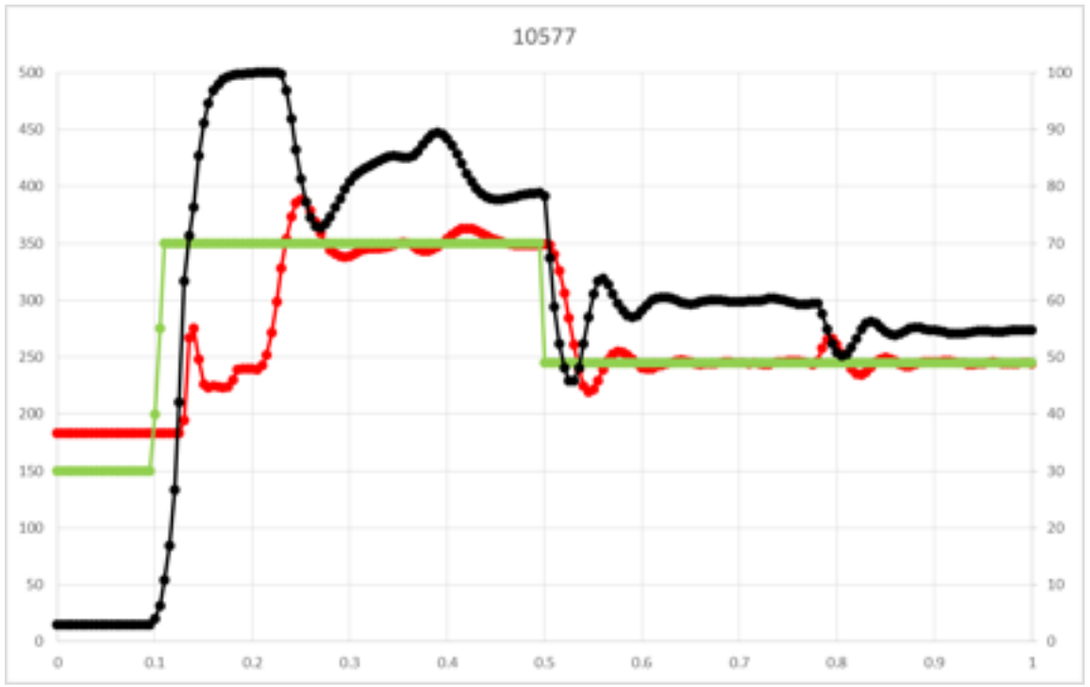
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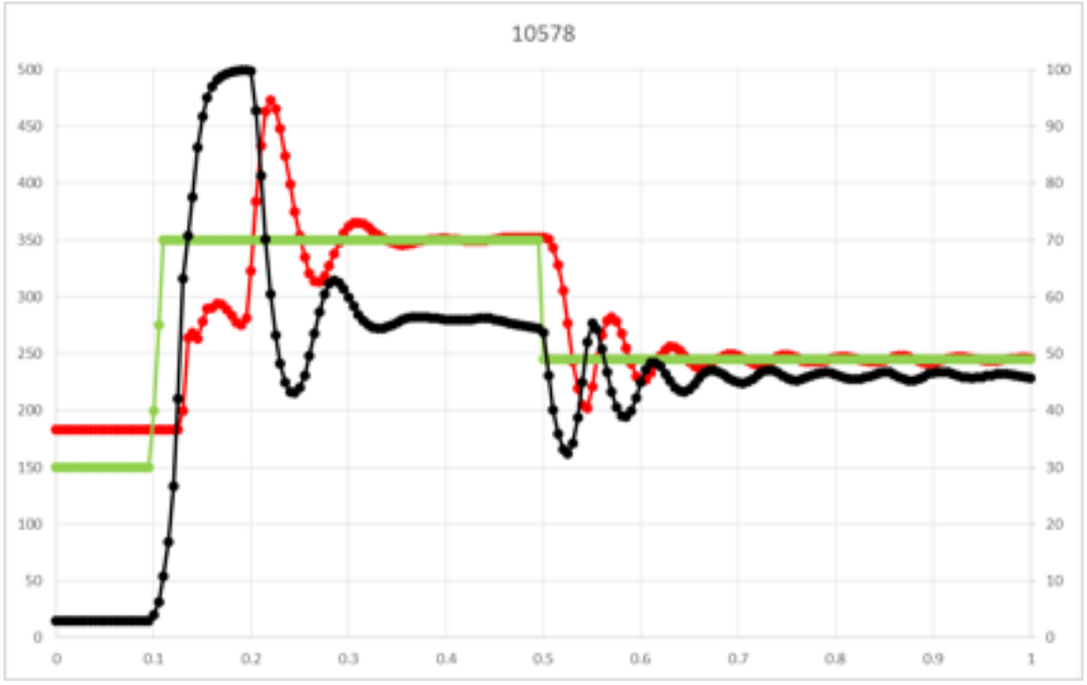
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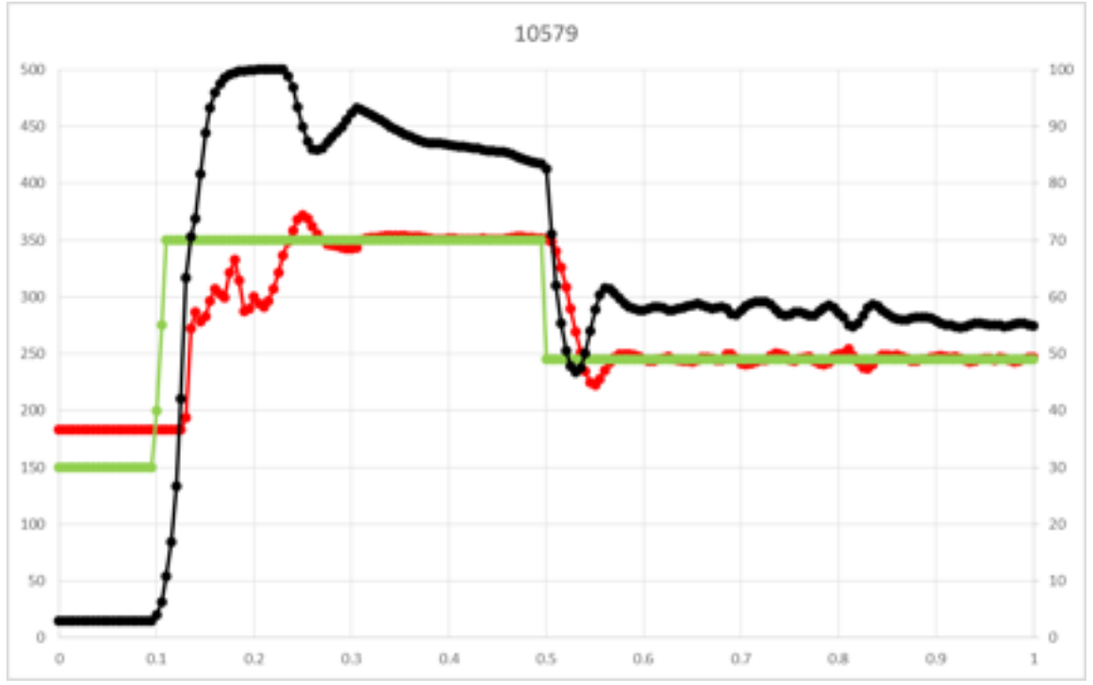
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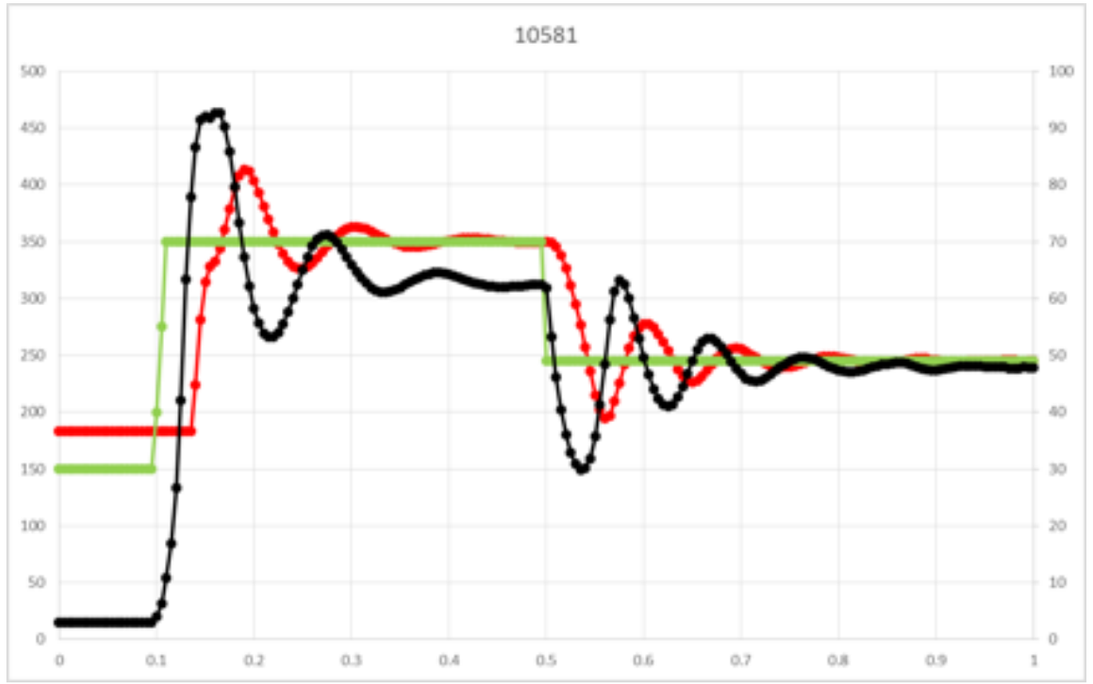
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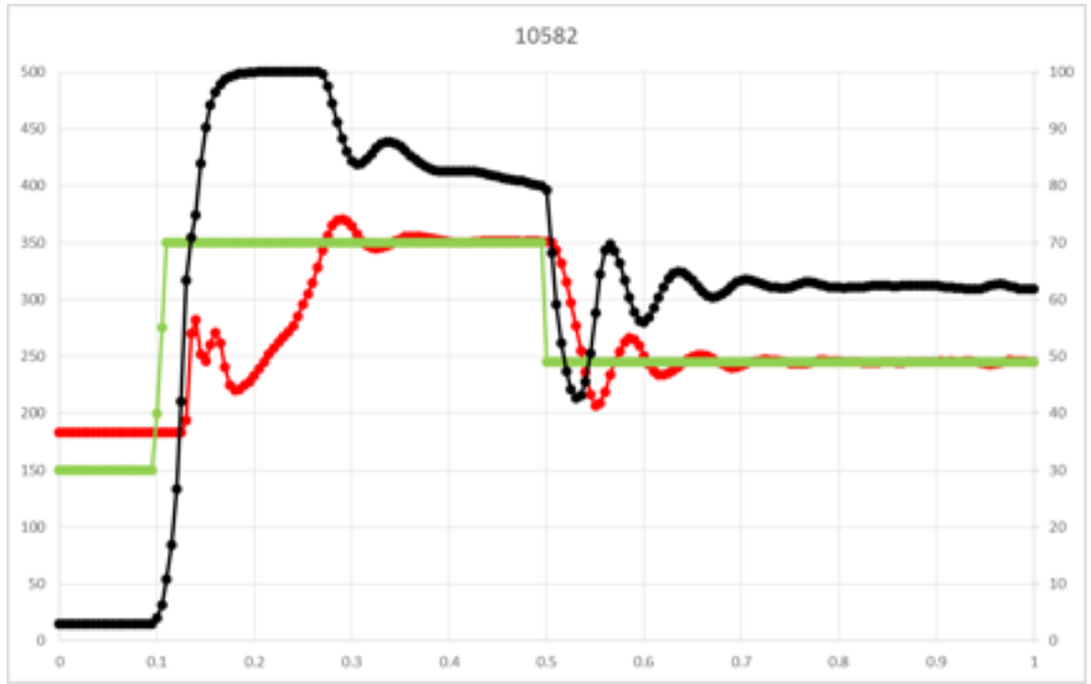
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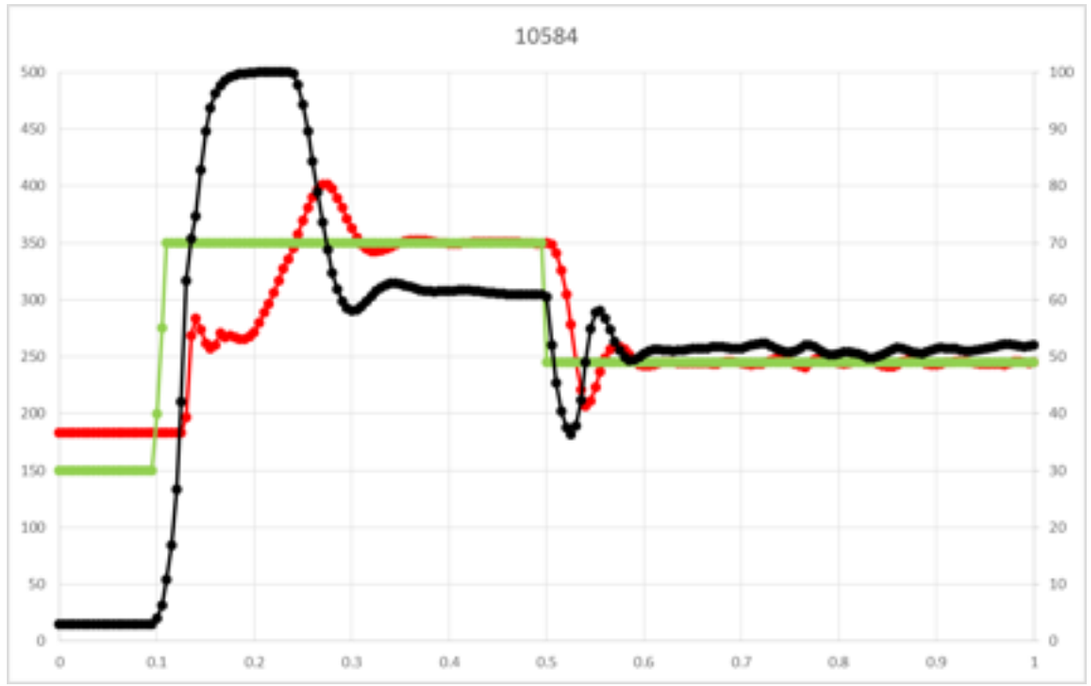
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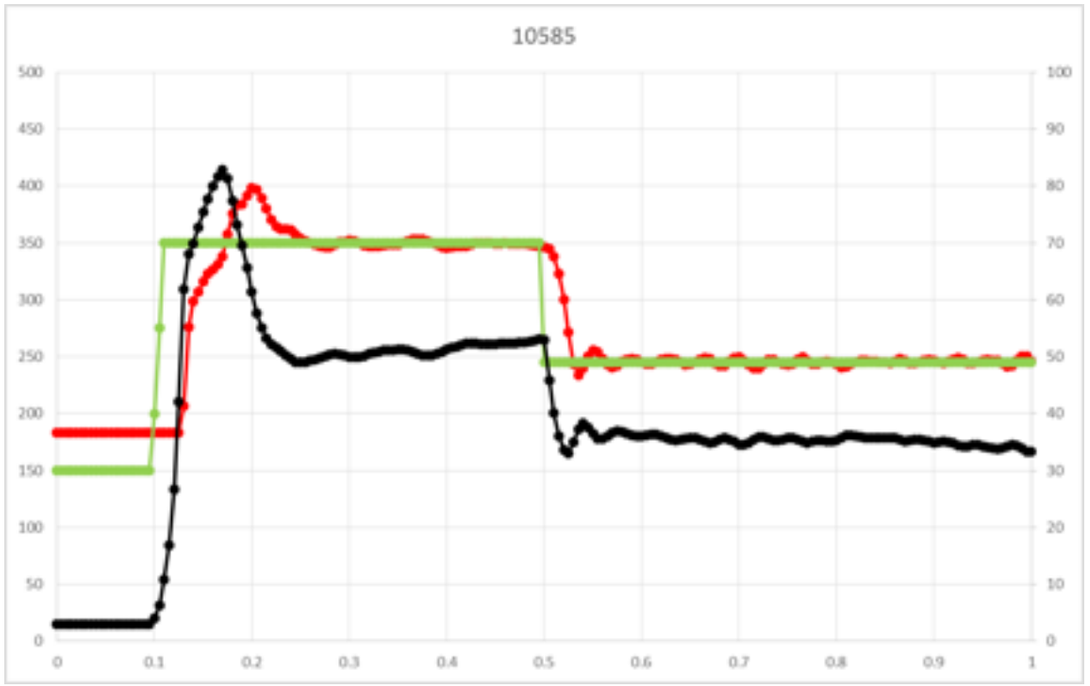
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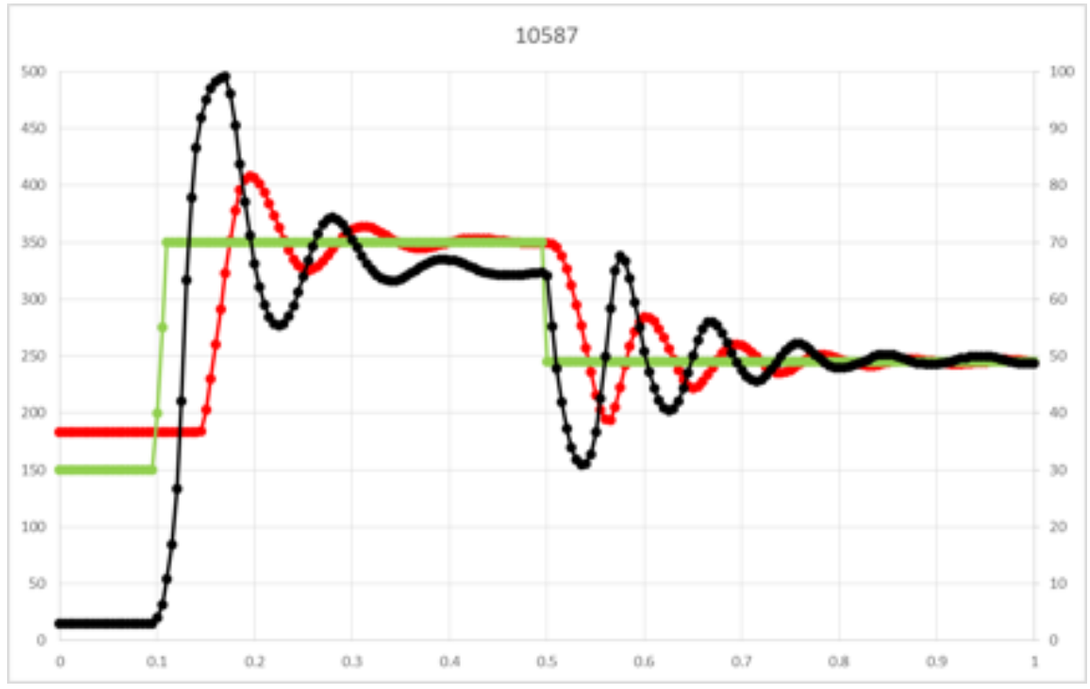
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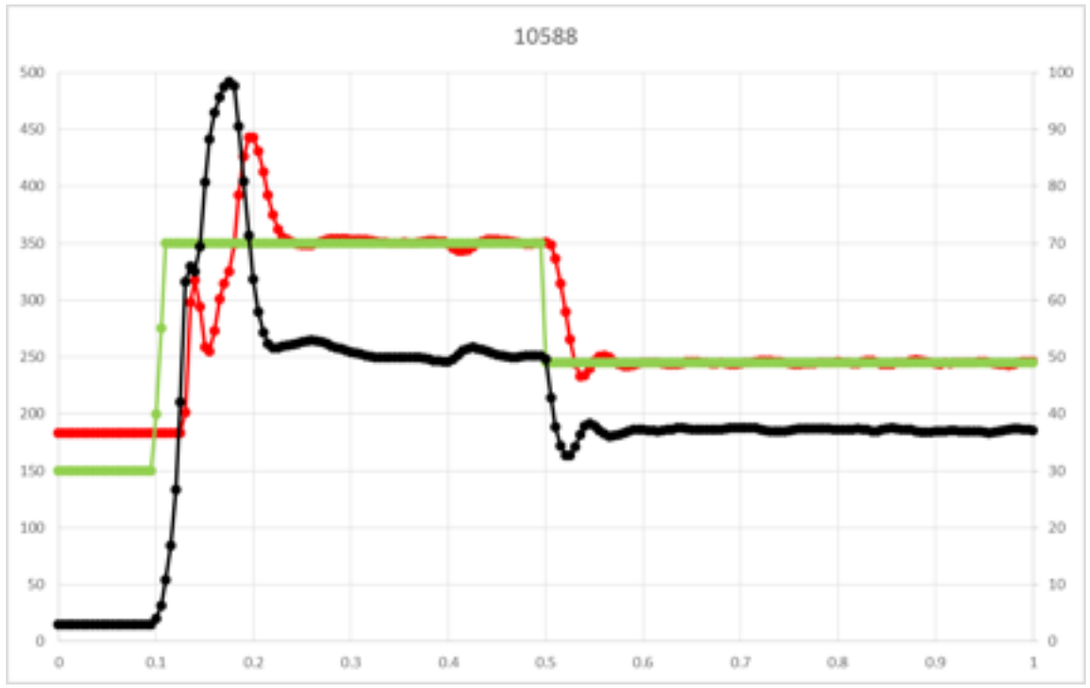
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