Fujifilm Prescale® Film Software

Quantitative Analysis of Fujifilm Prescale® Film Samples

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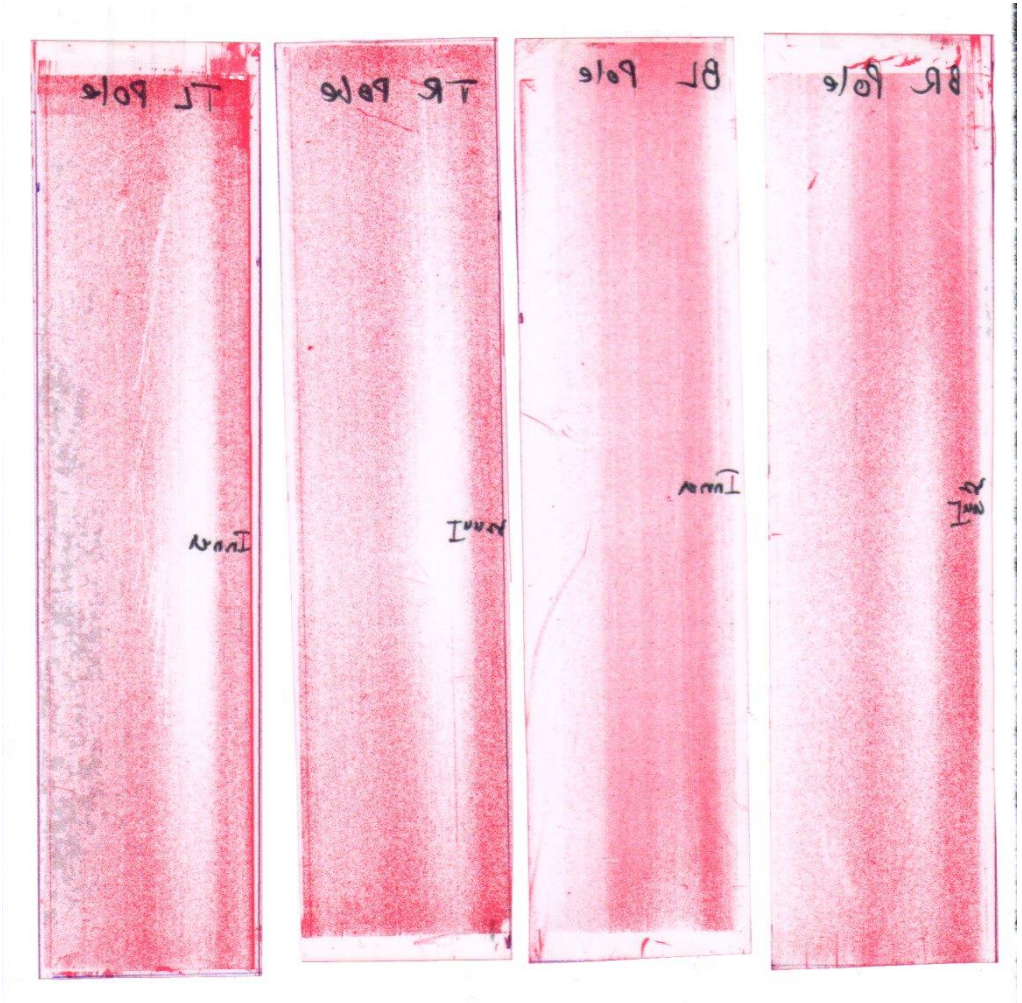
https://mechlab.web.cern.ch/

Overview

- Introduction
- Objectives and Software Criteria
- User Guide
- Behind the Code
- Conclusion and Next Steps



What Is Fujifilm Prescale® Film?

What Is Fujifilm Prescale® Film?

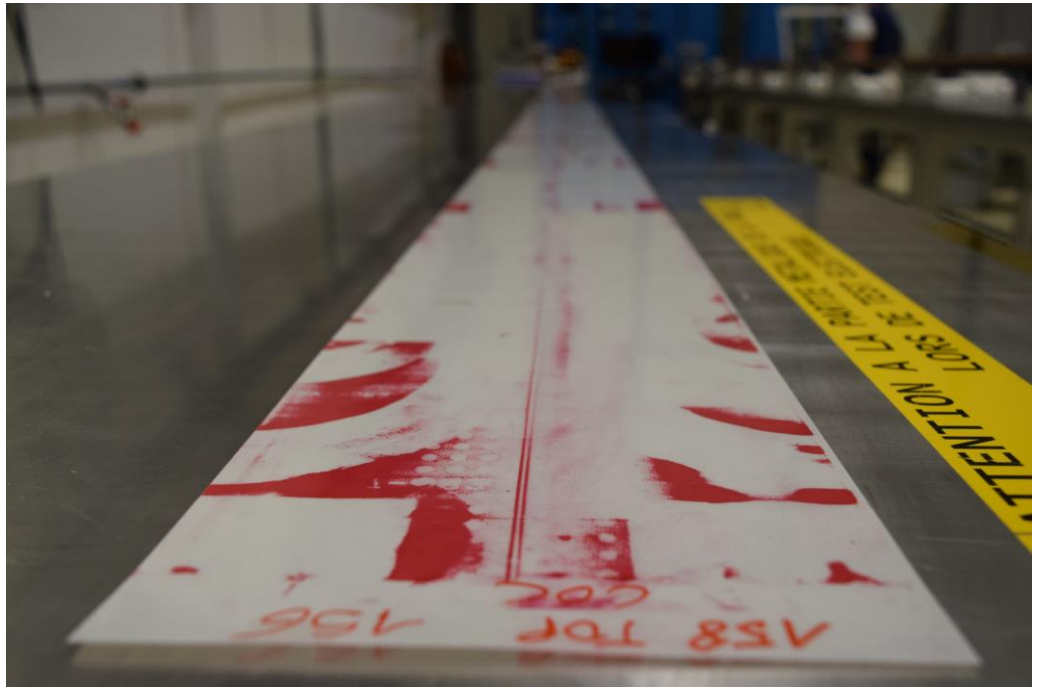
- Fujifilm Prescale® Film is a pressure sensitive film.
- Allows you to easily measure pressure distribution and range.
- When pressure is applied, small bubbles of ink in the film burst depending on pressure causing the colour of the film at this point to turn red.
- The colour density varies according to the amount of pressure applied.
- It is widely used at CERN for many applications.

Fujifilm Prescale® Film types

Types	Measurable pressure range [MPa] 1MPa≒10.2kgf/cm² (0.006 0.05 0.2 0.5 0.6 2.5 10 50 130 300)	Prescale Product size width(mm) x length(m)	Prescale Sheets Product size width(mm) x length(mm)	Classification
Ultra Extreme Low Pressure (5LW)		320 x 2	–	Two-Sheet Type
Extreme Low Pressure (4LW)		320 x 3	–	Two-Sheet Type
Ultra Super Low Pressure (LLLW)		270 x 5	270X200 (5 Sheets)	Two-Sheet Type
Super Low Pressure (LLW)		270 x 6	270X200 (5 Sheets)	Two-Sheet Type
Low Pressure (LW)		270 x 10	270X200 (5 Sheets)	Two-Sheet Type
Medium Pressure (MW)		270 x 10	–	Two-Sheet Type
Medium Pressure (MS)		270 x 10	270X200 (5 Sheets)	Mono-Sheet Type
High Pressure (HS)		270 x 10	270X200 (5 Sheets)	Mono-Sheet Type
Super High Pressure (HHS)		270 x 10	270X200 (5 Sheets)	Mono-Sheet Type

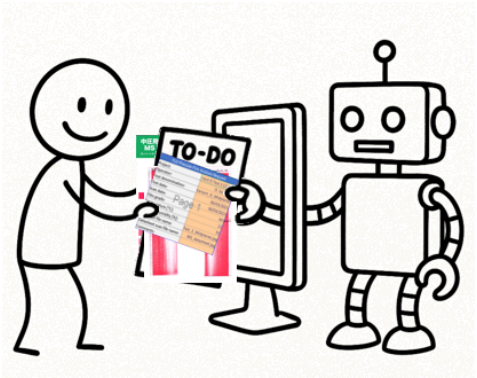
Applications At CERN

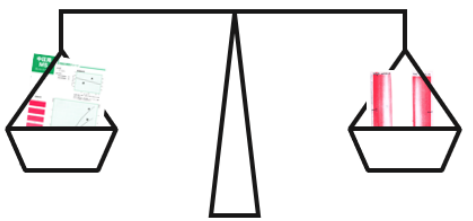
- Fujifilm Prescale® Film is widely used at CERN:
  - For detectors
  - Use in radiofrequency equipment
  - Magnet assembly
  - …& many more!



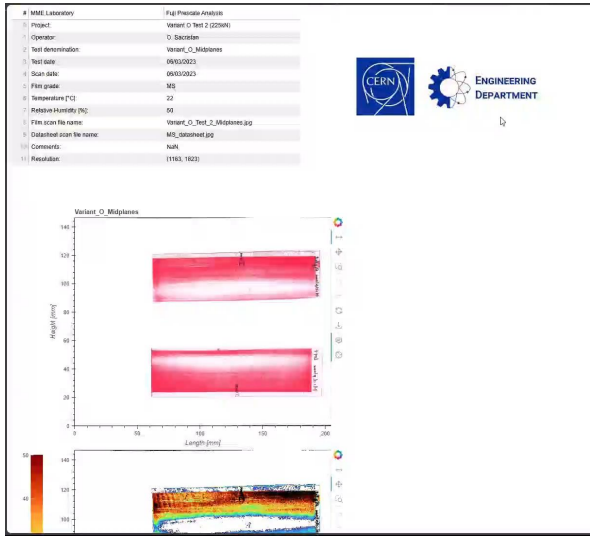
Project Goals

- Create Software to automate the analysis of Fujifilm Prescale® Film samples.





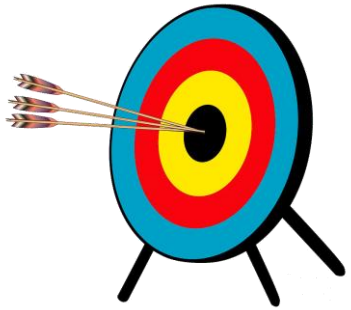
- Compares scans of Fujifilm Prescale® Film to the reference data sheet.



- Outputs an interactive pressure distribution image.

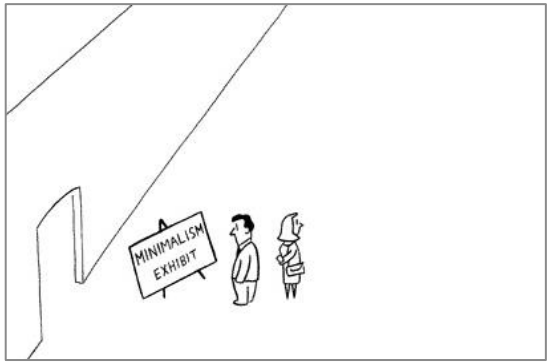
- Minimal user intervention required.

Software Criteria



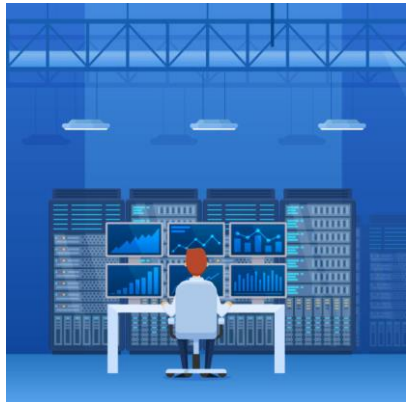
1. Accurate and efficient analysis.

2. Eliminate need for manual interpretation.



3. Minimal software/ hardware requirements.

4. Flexible.



5. Centrally Executed.

6. Shareable & interactive output.

7. Actively maintained.

8. Reliable and easy-to-use.

Hardware Requirements

1. Fujifilm Prescale® Film, and Fujifilm Prescale® Film Data Sheet (various film grades available).
2. White Backing Paper.
3. Humidity and Temperature Probe.
4. Scanner.
5. Computer with access to the MechLab Website (https://mechlab.web.cern.ch/) & CERNBox.

Best Practise

1. Fuji Paper should be stored in its packaging in a fridge without light.

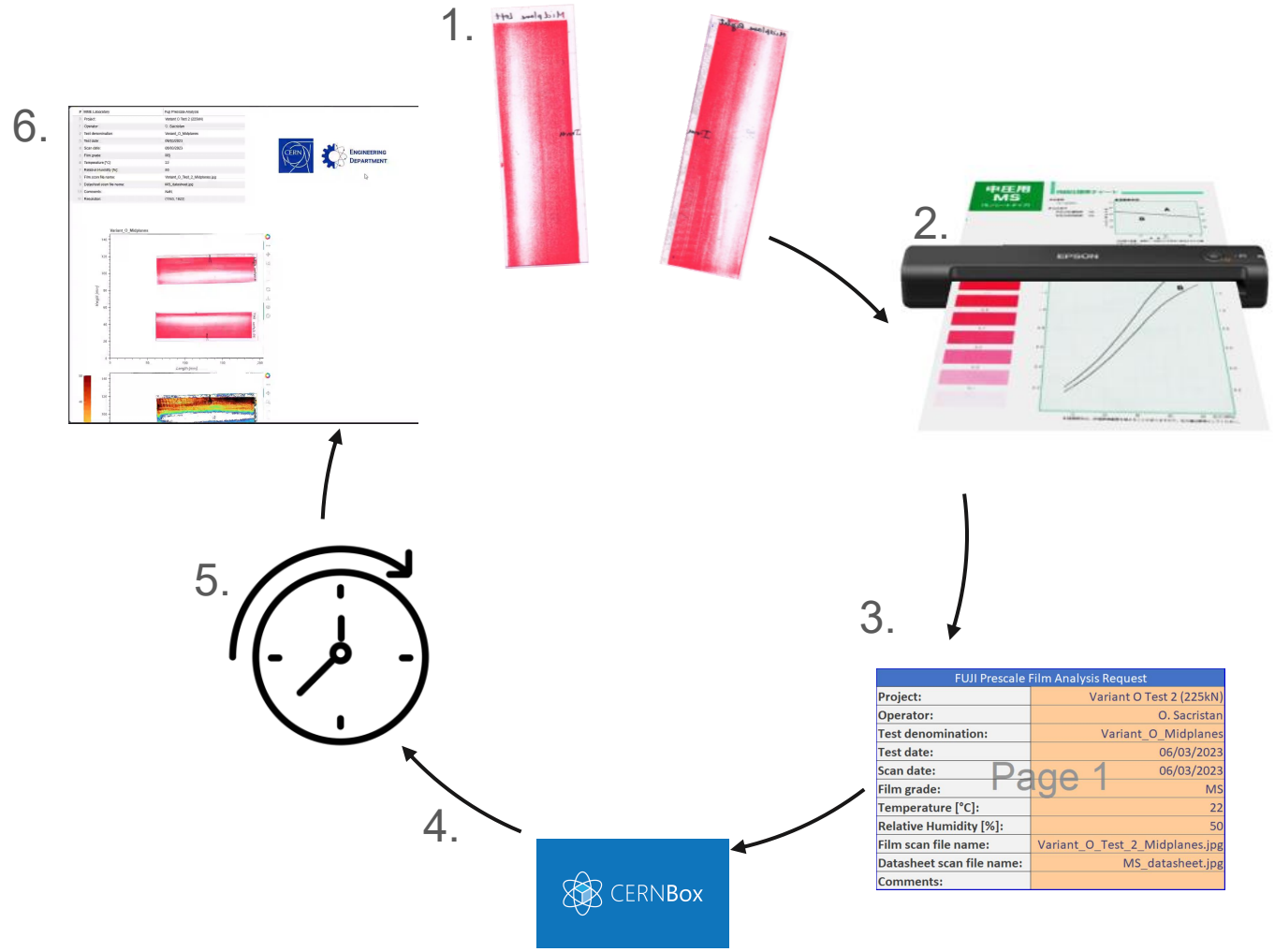
2. Should always measure humidity and temperature of room at time of use.
    - The film is sensitive to these variables, and they are important to accurately determine the pressure.

3. Scan within a few hours of creating the sample.

4. Scan datasheet with the same scanner at the same time.

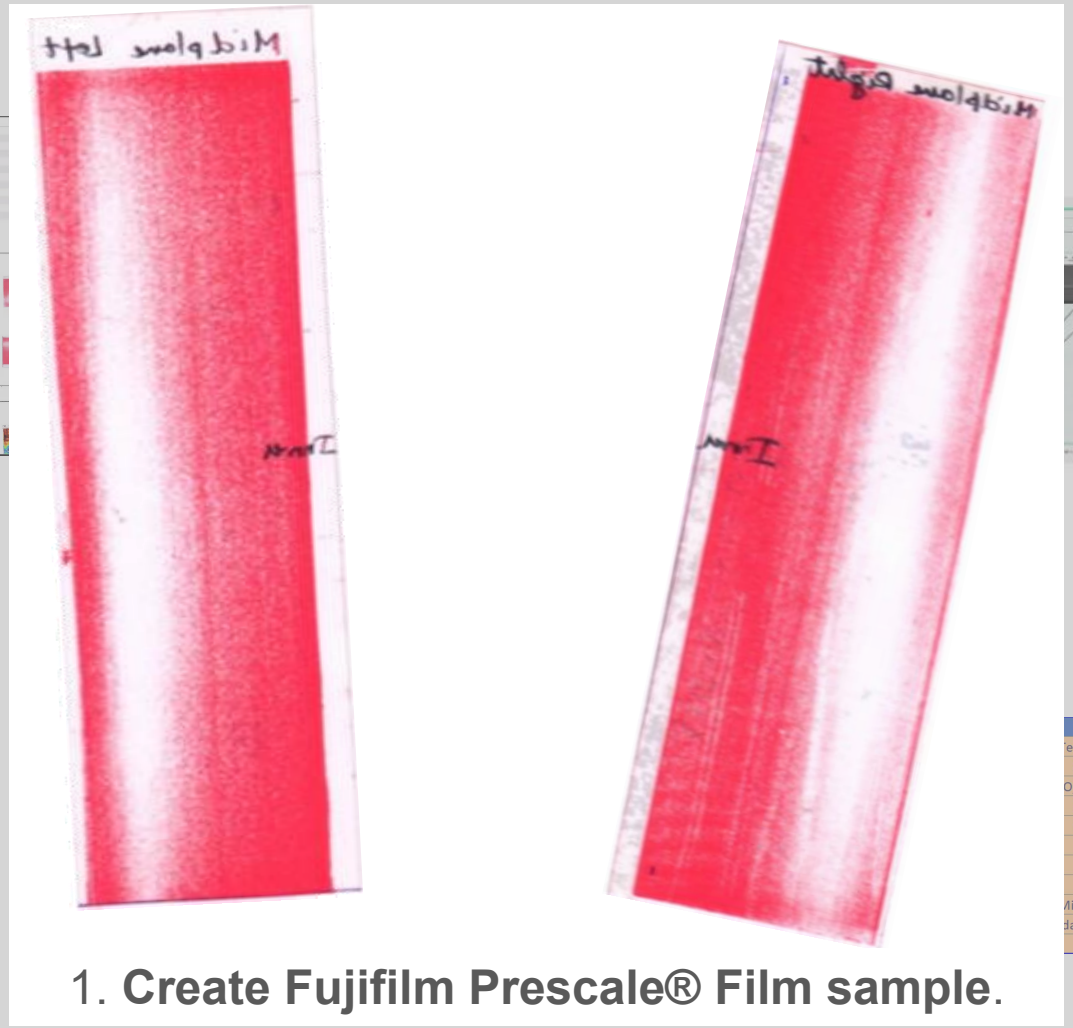
User Guide

User Guide


1.
2.
3.
4.
5.
6.
FUJI Prescale Film Analysis Request
Project: Variant O Test 2 (225kN)
Operator: O. Sacristan
Test denomination: Variant_O_Midplanes
Test date: 06/03/2023
Scan date: 06/03/2023
Film grade: MS
Temperature [°C]: 22
Relative Humidity [%]: 50
Film scan file name: Variant_O_Test_2_Midplanes.jpg
Datasheet scan file name: MS_datasheet.jpg
Comments:
Page 1
CERNBox

User Guide

6.



1. **Create Fujifilm Prescale® Film sample.**

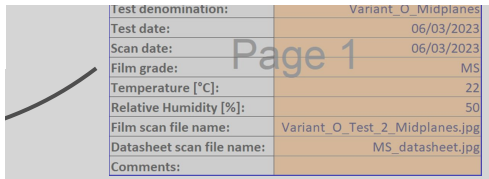
User Guide

1.

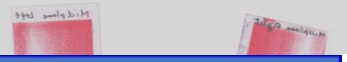
2. **Scan** the Fujifilm Prescale® Film and reference data sheet.

2.

- Backing paper required for scanning Fujifilm Prescale® Film due to it being translucent.
- Both files should be:
  - Scanned with the same device.
  - Saved as .jpg file.



User Guide

1. 

FUJI Prescale Film Analysis Request	
Project:	Variant O Test 2 (225kN)
Operator:	O. Sacristan
Test denomination:	Variant_O_Midplanes
Test date:	06/03/2023
Scan date:	06/03/2023
Film grade:	MS
Temperature [°C]:	22
Relative Humidity [%]:	50
Film scan file name:	Variant_O_Test_2_Midplanes.jpg
Datasheet scan file name:	MS_datasheet.jpg
Comments:	

Page 1

3. **Create a request** form using the provided template.

CERNBox

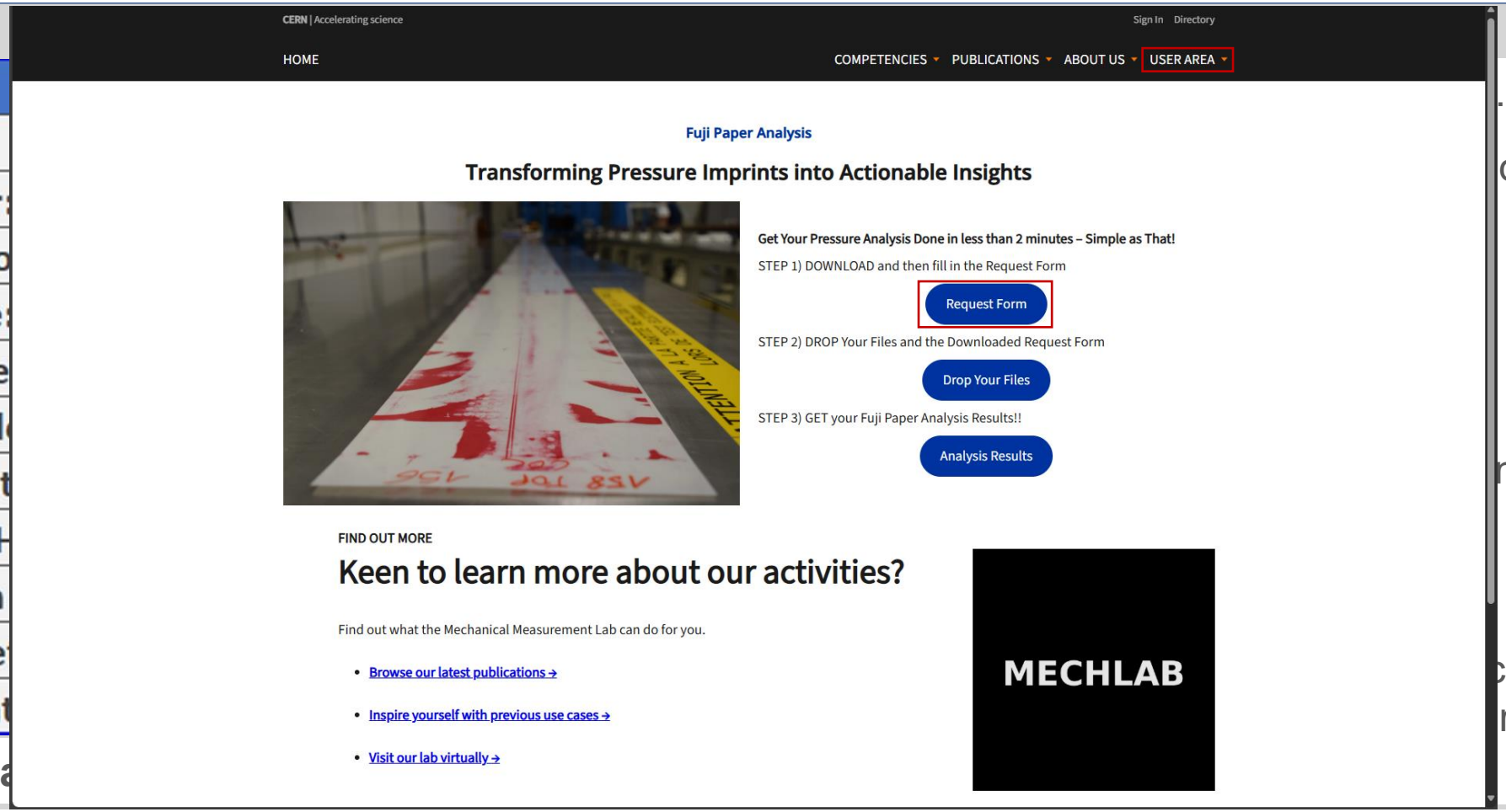
The request file is an excel form.

In the appropriate box you should list:

- project name
- your name
- test date and scan date
- the Fujifilm Prescale® Film film grade
- the temperature and humidity of the room during the test

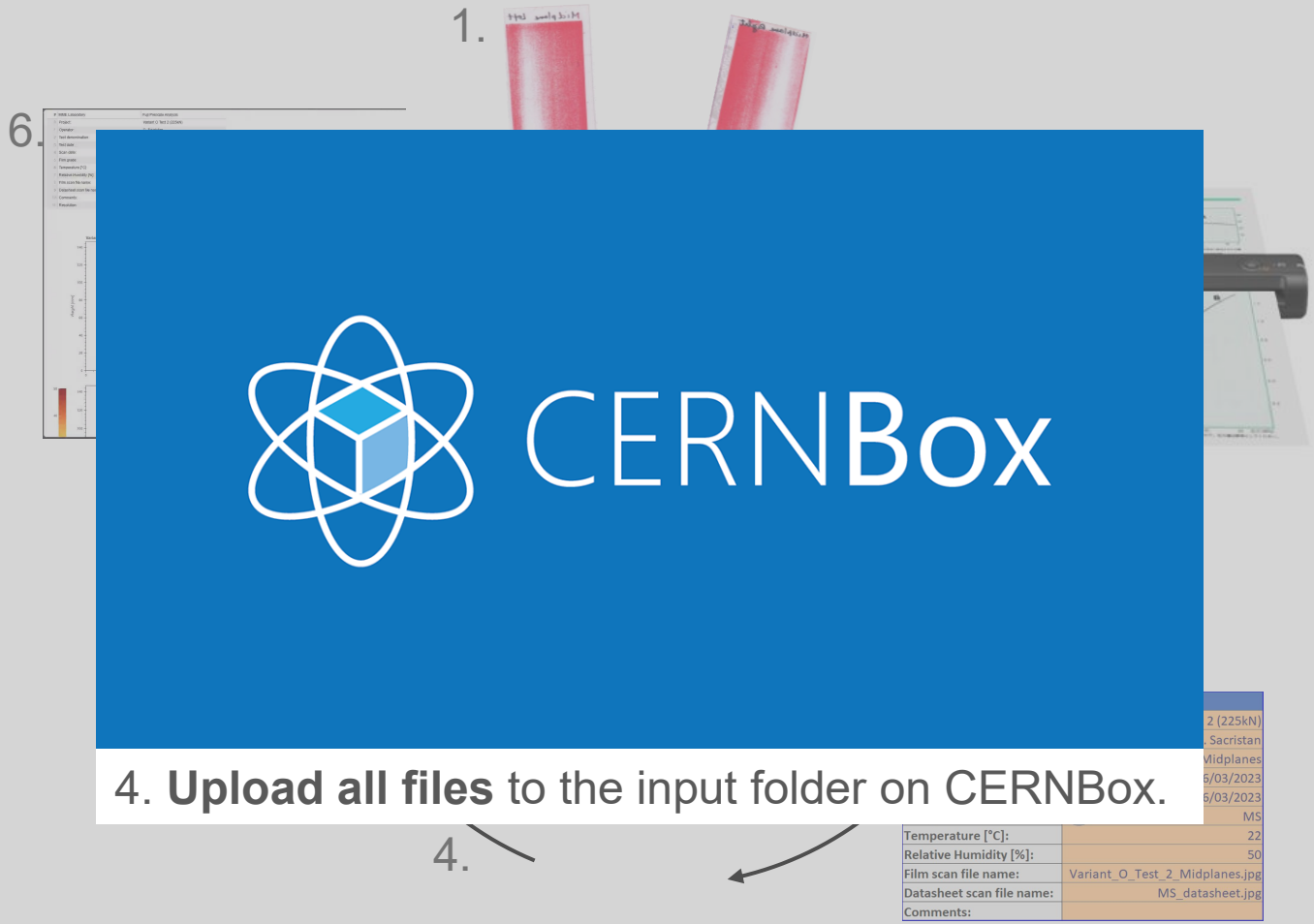
Finally ensure that the correct scan file name and datasheet file name are correct.

User Guide

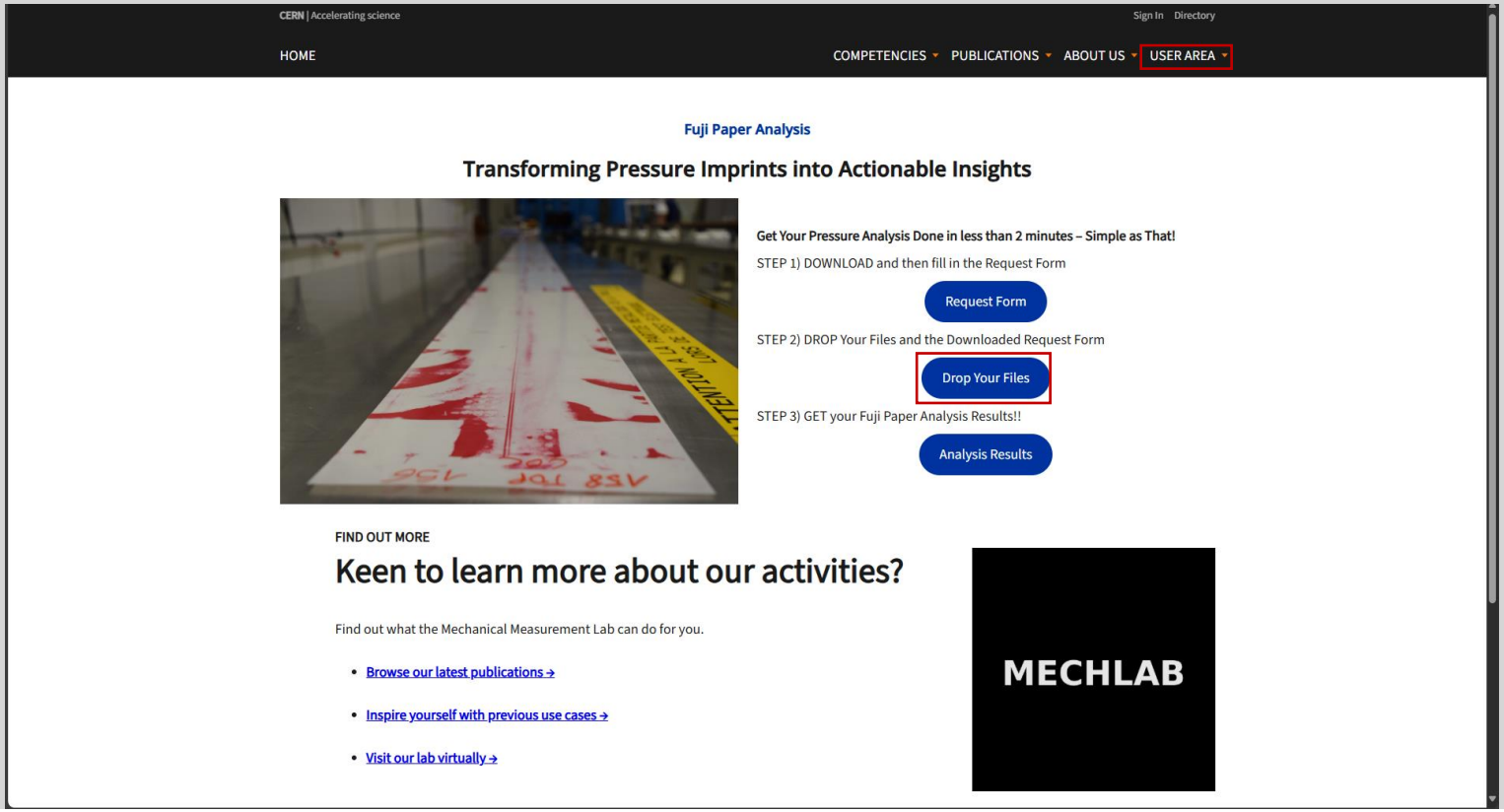


- The request form can be located via the MechLab Website (https://mechlab.web.cern.ch/).

User Guide

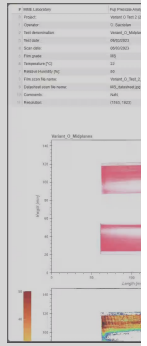

1.
6.
CERNBox
4. Upload all files to the input folder on CERNBox.
4.
Temperature [°C]: 22
Relative Humidity [%]: 50
Film scan file name: Variant_O_Test_2_Midplanes.jpg
Datasheet scan file name: MS_datasheet.jpg
Comments:

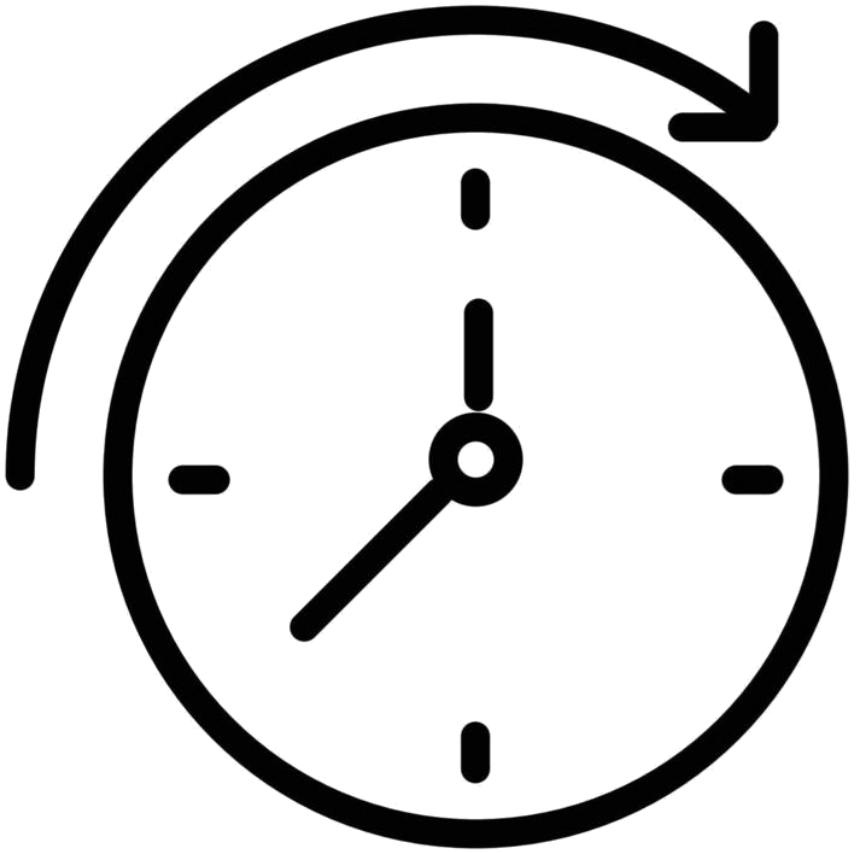
User Guide



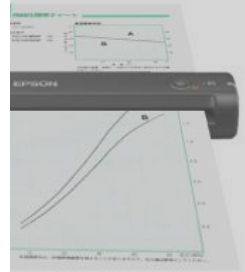
- The request form, Fujifilm Prescale® Film sample scan, and the Reference data sheet scan should all be uploaded into the Input folder on CERNBox.
- This folder can be located via the MechLab Website (https://mechlab.web.cern.ch/).

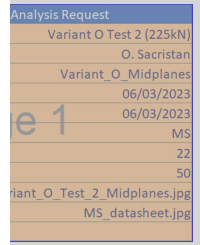
User Guide

6. 



5. **Wait for processing**; results appear in the output folder.





User Guide

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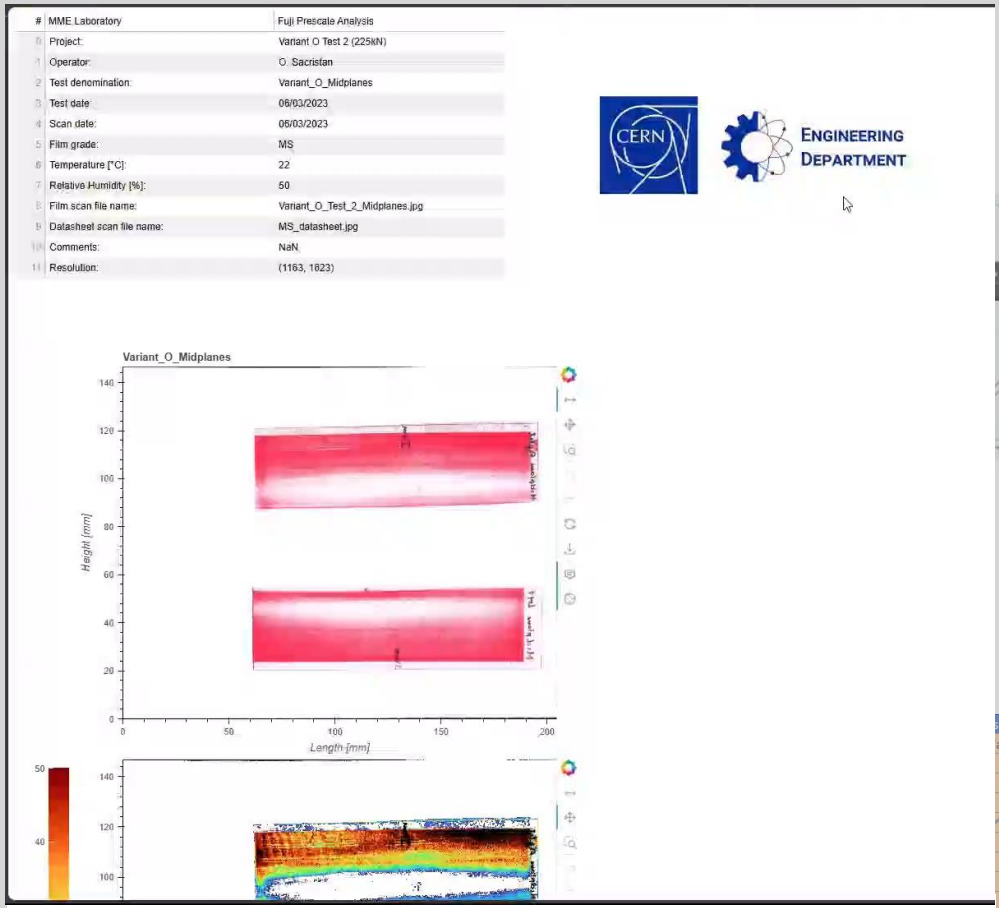
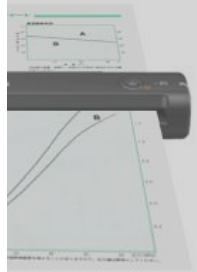
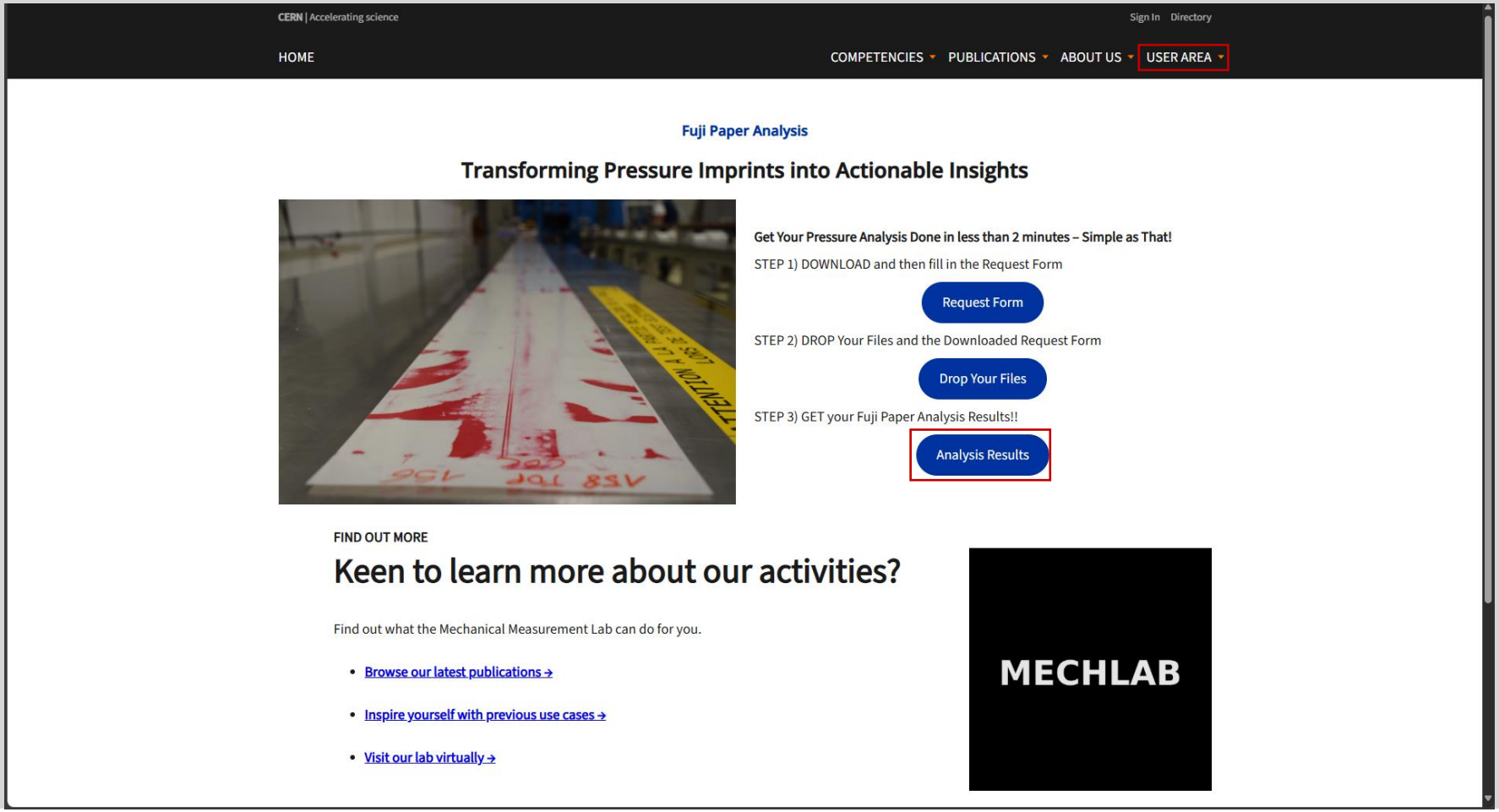




Request
ariant O Test 2 (225kN)
O. Sacristan
Variant_O_Midplanes
06/03/2023
1 06/03/2023
MS
22
50
Test_2_Midplanes.jpg
MS_datasheet.jpg

6. **Retrieve** interactive HTML, Original Input files and raw CSV file, from Output folder.

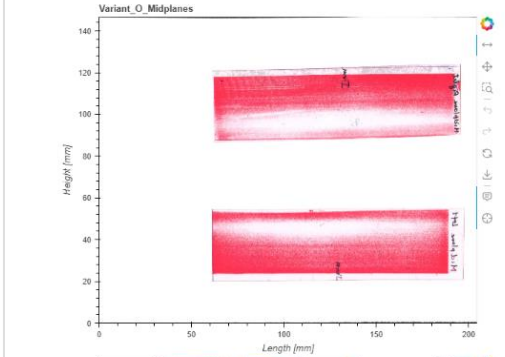
User Guide

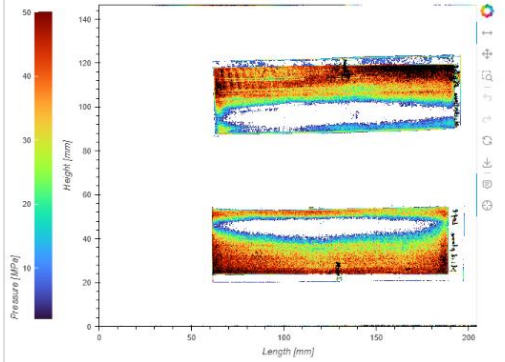


- The Output folder can also be located via the MechLab Website (https://mechlab.web.cern.ch/).

Our Service

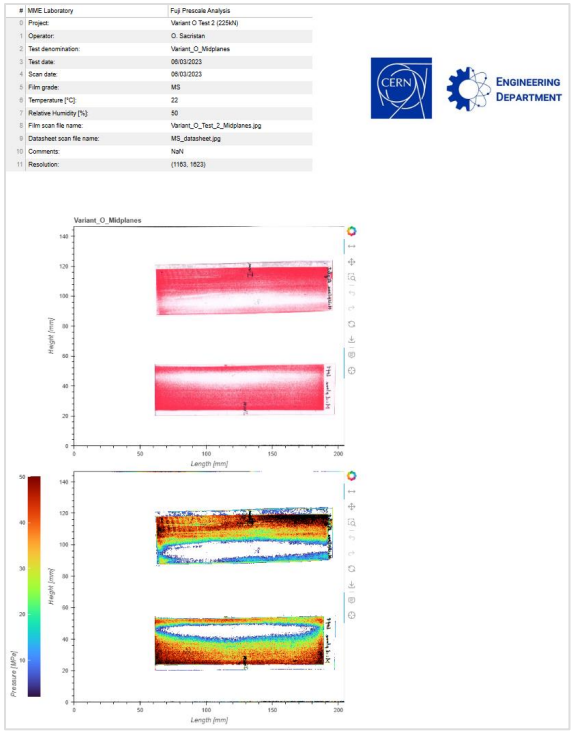
#	MME Laboratory	Fuji Prescale Analysis
0	Project:	Variant O Test 2 (225kN)
1	Operator:	O. Sacristan
2	Test denomination:	Variant_O_Midplanes
3	Test date:	06/03/2023
4	Scan date:	06/03/2023
5	Film grade:	MS
6	Temperature [°C]:	22
7	Relative Humidity [%]:	50
8	Film scan file name:	Variant_O_Test_2_Midplanes.jpg
9	Datasheet scan file name:	MS_datasheet.jpg
10	Comments:	NaN
11	Resolution:	(1183, 1623)

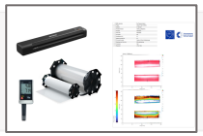




- Use of the software is 100% free CERN-wide and available to use anytime!
- Software is compatible with any scanner.

Our Service





Fujifilm Prescale® Film Software & Equipment

Equipment can be provided by EN-MME-MML on request.

Includes;

- Backing Paper
- Humidity & Temperature probe
- Epson ES-50 Scanner

⚠ Fujifilm Prescale® Film not included!

1000 CHF

Working Parameters & Constraints

- Scan size limitation: Maximum dimensions of 21.6 cm width × 1.8 m length.

- Spatial resolution limits:

  - Effective spatial resolution of Fujifilm Prescale® Film is lower than the scanner pixel resolution. (approx. 200 dpi Fujifilm Prescale® Film.)

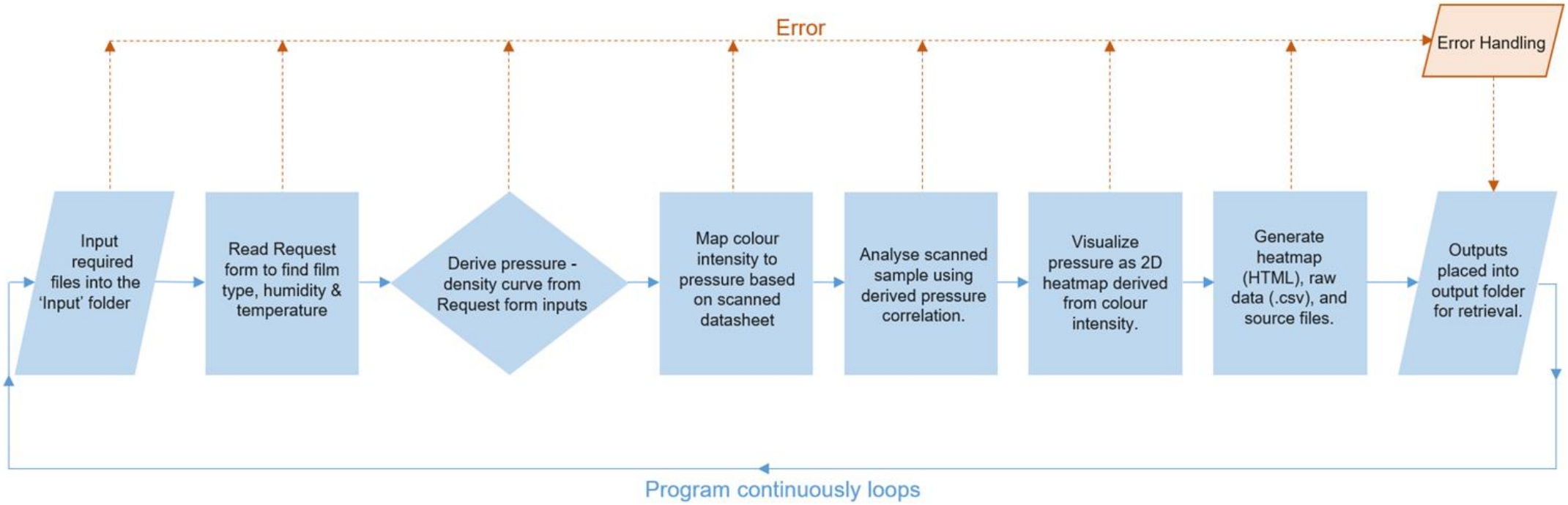
  - This is due to ink dispersion in the film, which blurs fine pressure details.

  - Overall spatial resolution is determined by the scanner's resolution. (Recommend 300dpi – Default for most scanners.)

  - Software processes colour intensity of each pixel. No averaging necessary.

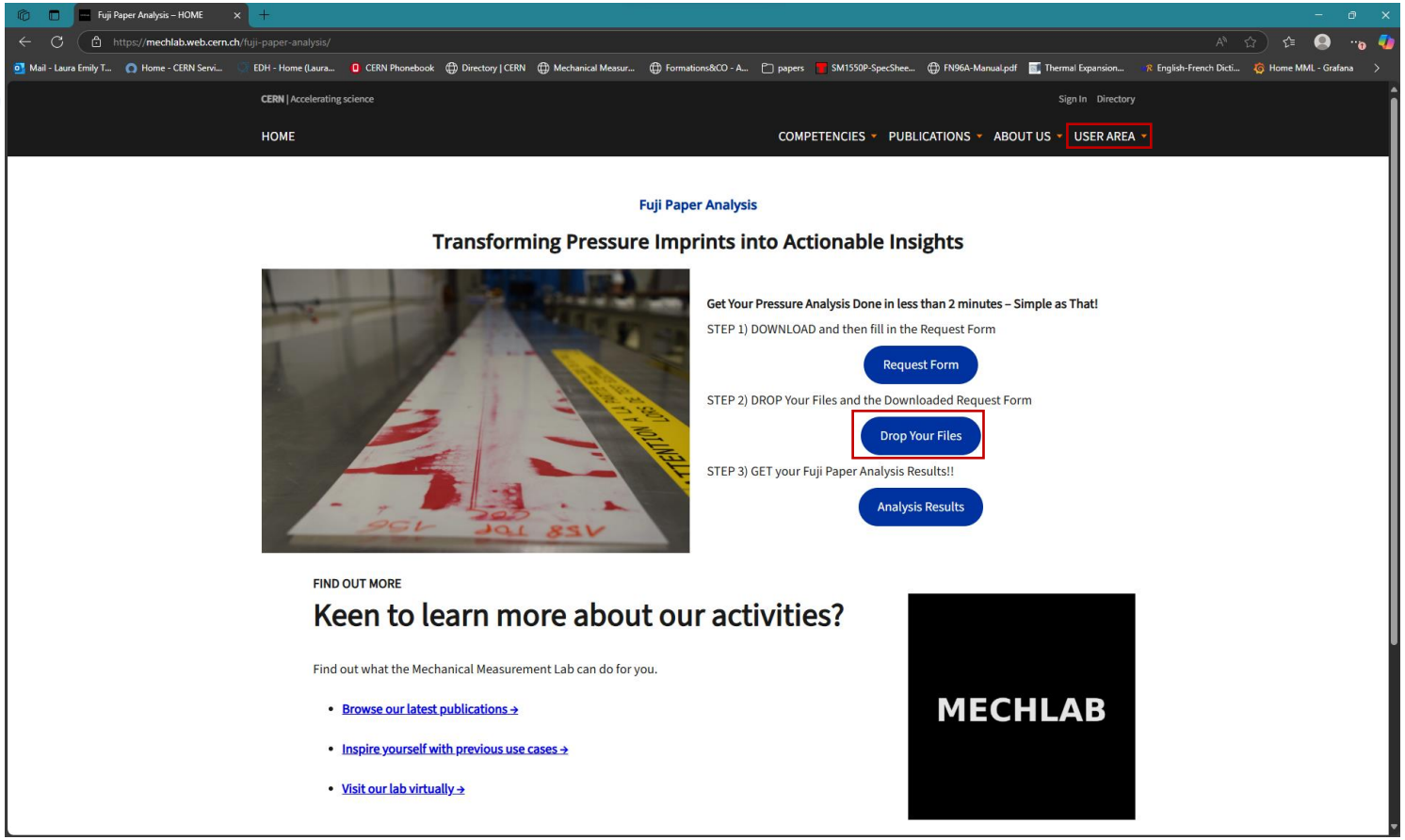
How Does It Work?

How Does It Work?



How Does It Work?

Input required files into the ‘Input’ folder



- Request form, Sample scan and Datasheet scan to be uploaded to the CERNBox Input folder accessed via the MechLab Website (https://mechlab.web.cern.ch/).

How Does It Work?

Read Request form to find film type, humidity & temperature

FUJI Prescale Film Analysis Request	
Project:	Variant O Test 2 (225kN)
Operator:	O. Sacristan
Test denomination:	Variant_O_Midplanes
Test date:	06/03/2023
Scan date:	06/03/2023
Film grade:	MS
Temperature [°C]:	22
Relative Humidity [%]:	50
Film scan file name:	Variant_O_Test_2_Midplanes.jpg
Datasheet scan file name:	MS_datasheet.jpg
Comments:	

How Does It Work?

Derive pressure - density curve from Request form inputs

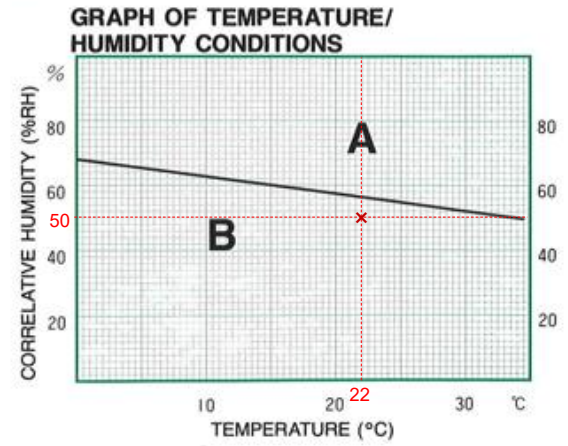
Film grade:	MS
Temperature [°C]:	22
Relative Humidity [%]:	50

MEDIUM PRESSURE
M S
(MONO-SHEET TYPE)

STANDARD CONTINUOUS PRESSURE CHART

Measurement pressure range: 10–50MPa
- Pressure application conditions
  Time to reach the pressure to be measured: 2 min.
  Time of retention at the pressure to be measured: 2 min.

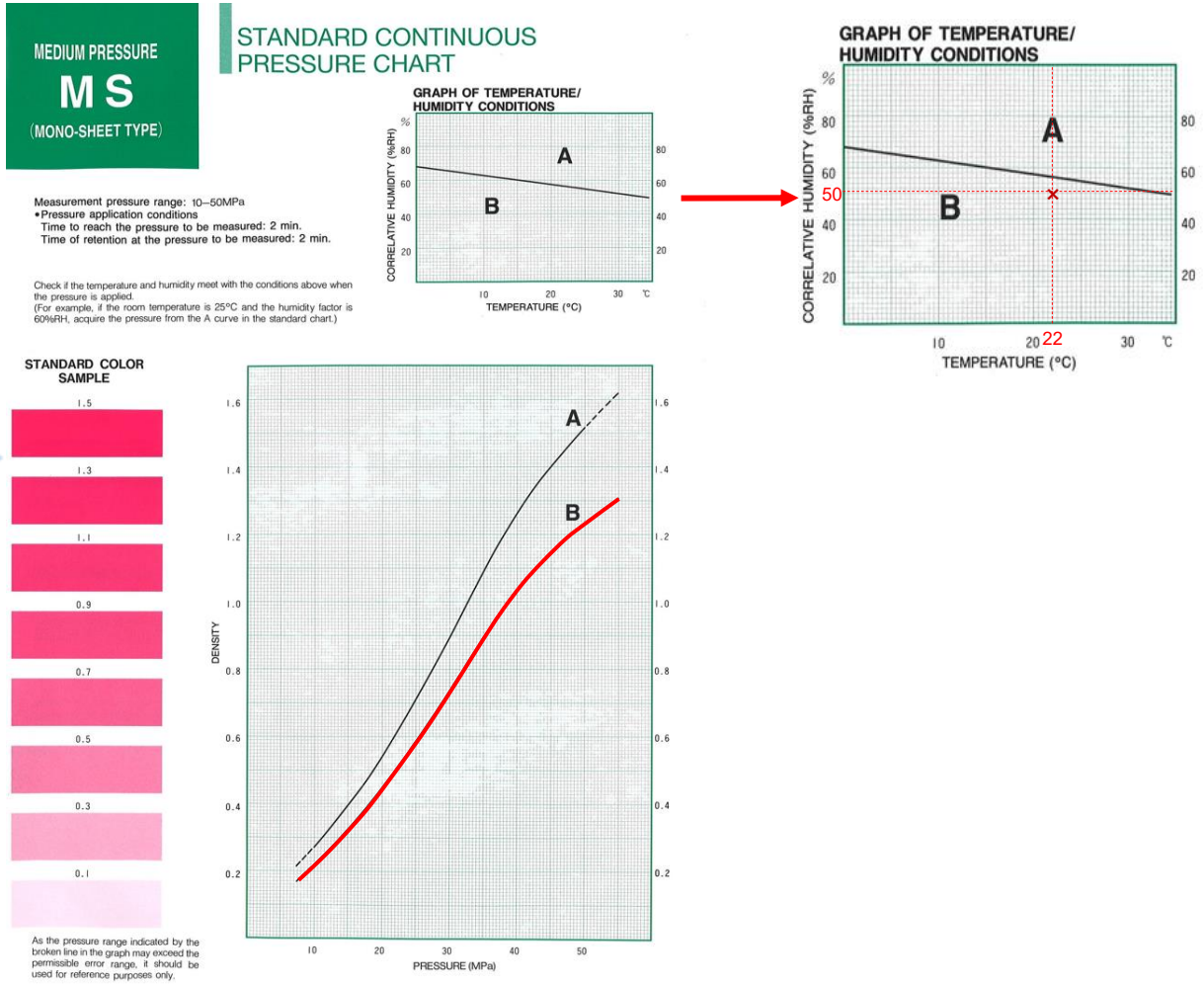
Check if the temperature and humidity meet with the conditions above when the pressure is applied.
(For example, if the room temperature is 25°C and the humidity factor is 60%RH, acquire the pressure from the A curve in the standard chart.)



- The temperature and humidity from the request form is used to find the appropriate pressure density curve. In this example, Film grade MS is used, and the inputs determine curve B is required.

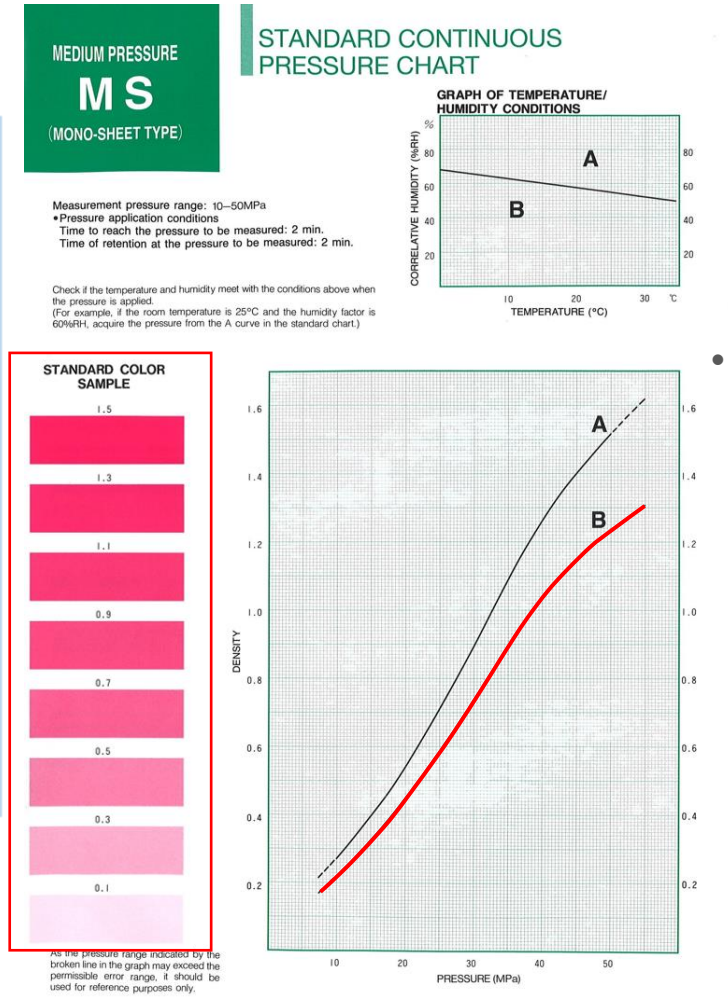
How Does It Work?

Derive pressure - density curve from Request form inputs



How Does It Work?

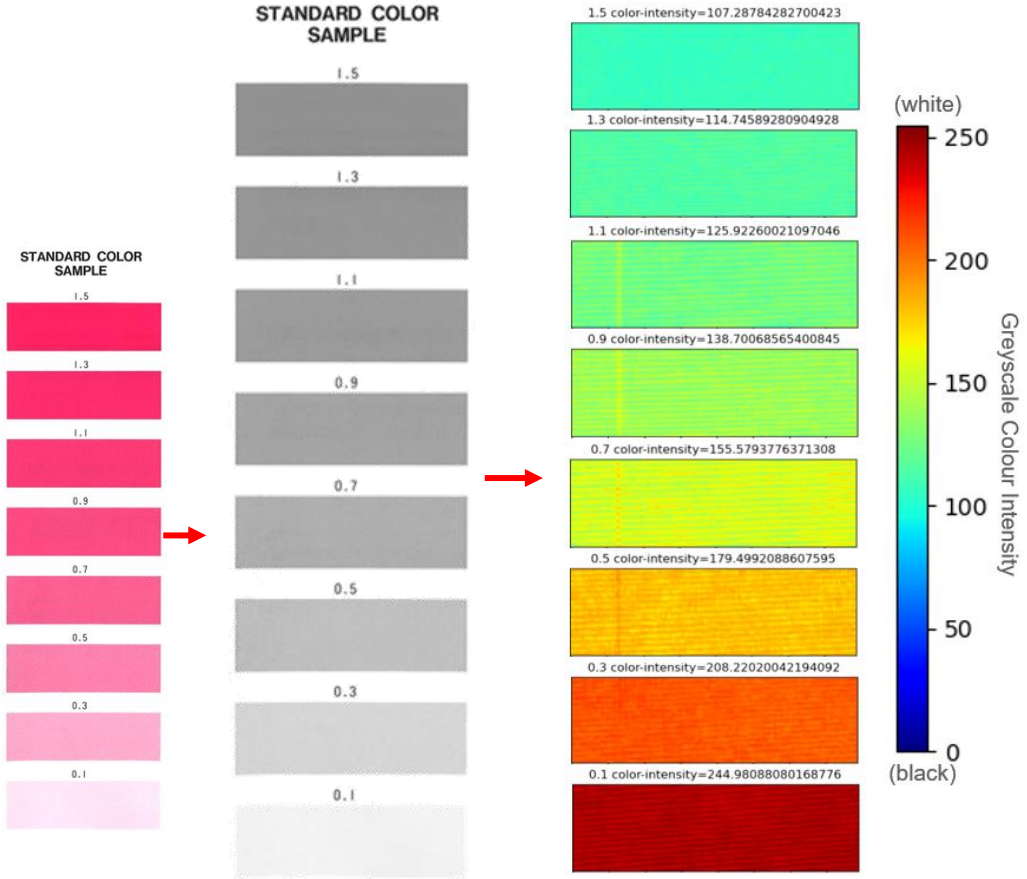
Map colour intensity to pressure based on scanned datasheet



- Next, Using the scanned reference data sheet, the intensity of the standard colour sample for each colour density is determined.

How Does It Work?

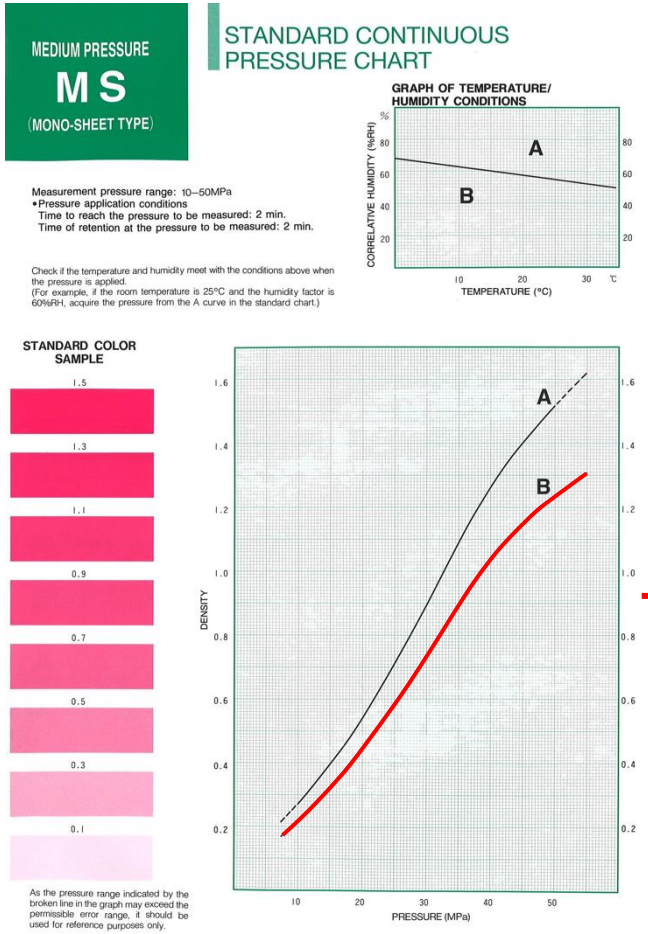
Map colour intensity to pressure based on scanned datasheet

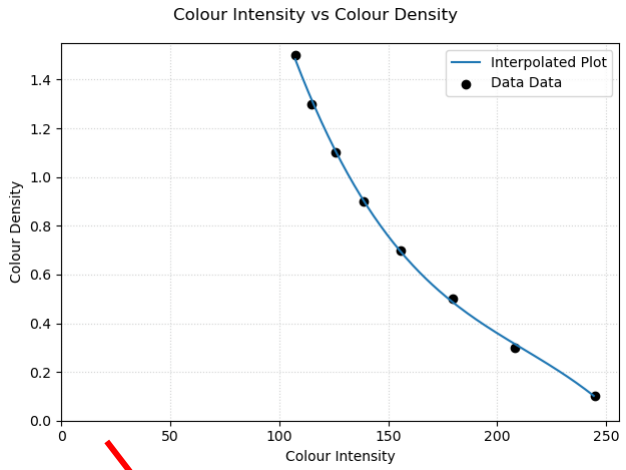


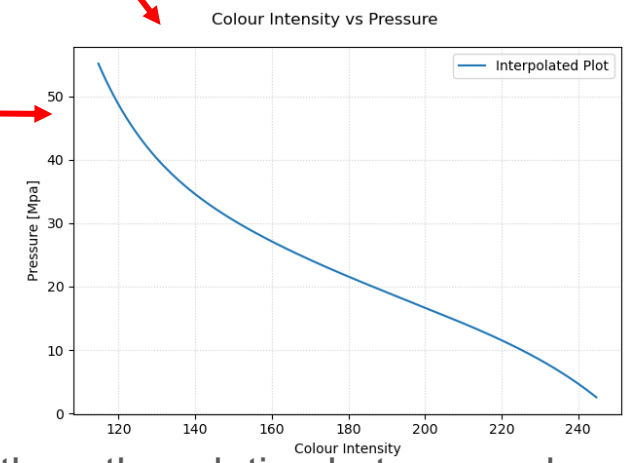
- Colour intensity of the standard colour sample is determined by converting the reference data sheet scan into greyscale and finding the average colour intensity for each section.
- Note: lighter intensities have a higher value while darker intensities have a lower value (White = 255, Black = 0).

How Does It Work?

Map colour intensity to pressure based on scanned datasheet



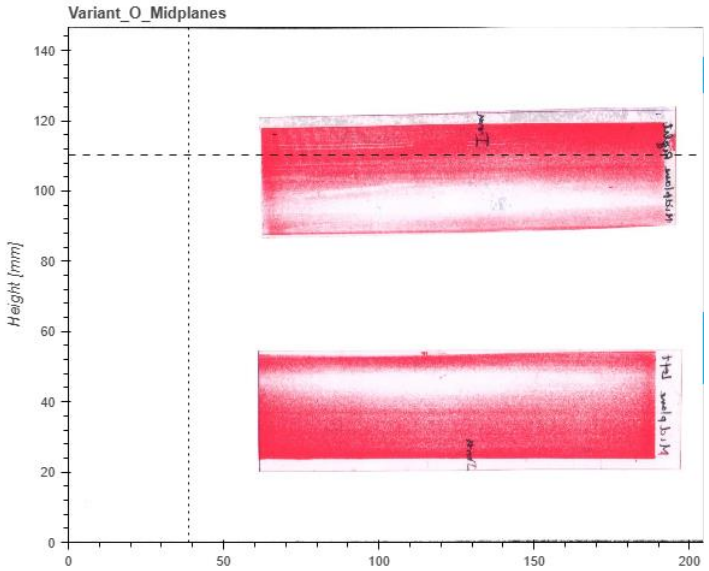


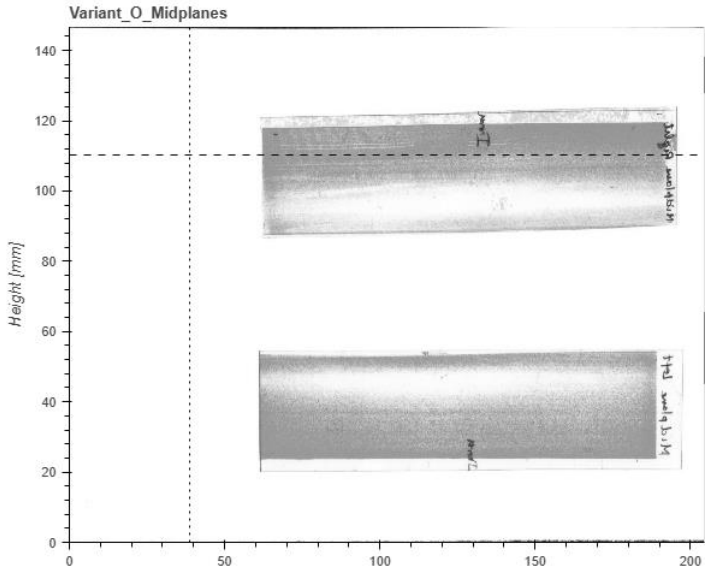


- The relation between colour intensity and colour density is then found and thus, the relation between colour intensity and pressure.

How Does It Work?

Analyse scanned sample using derived pressure correlation.

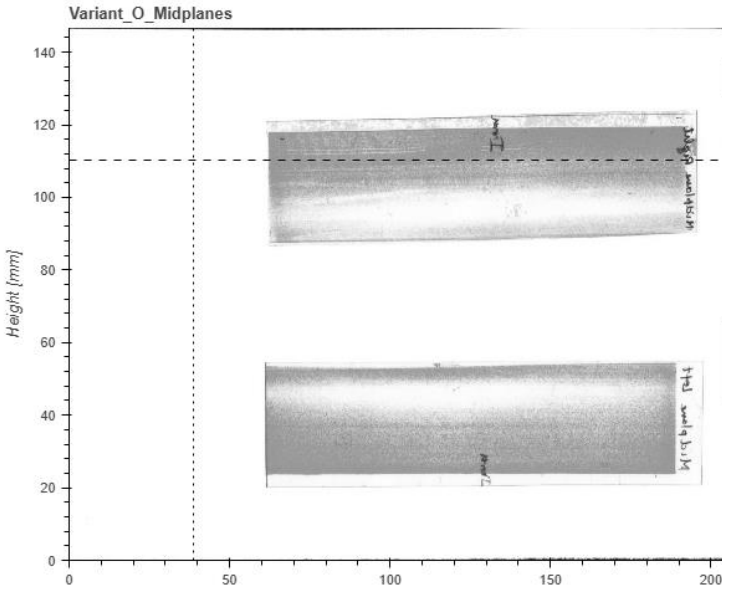


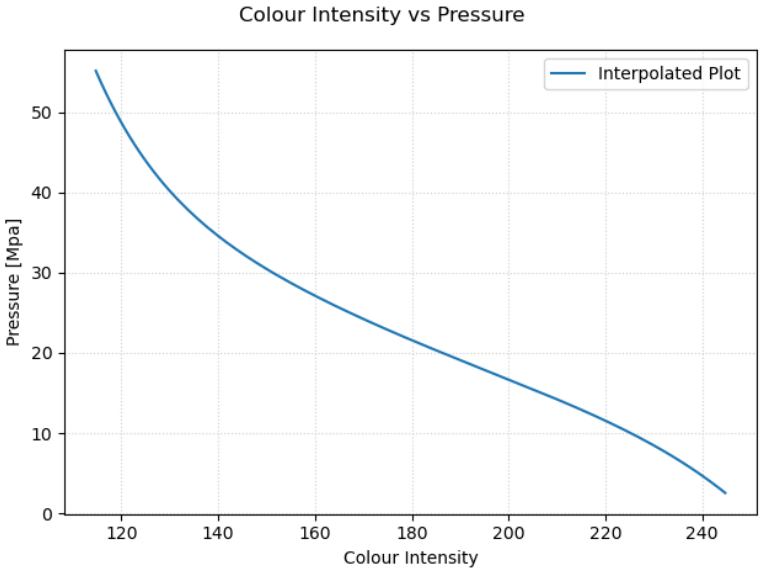


- To analyse the sample, the scan of the sample is also converted to grey scale

How Does It Work?

Analyse scanned sample using derived pressure correlation.

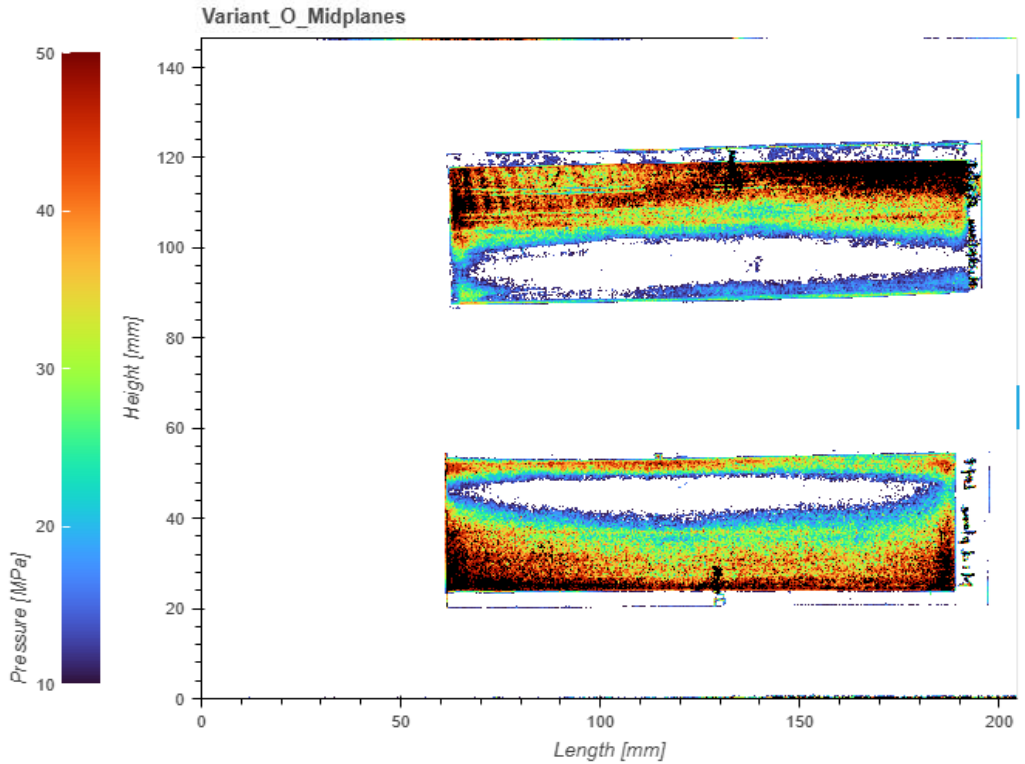




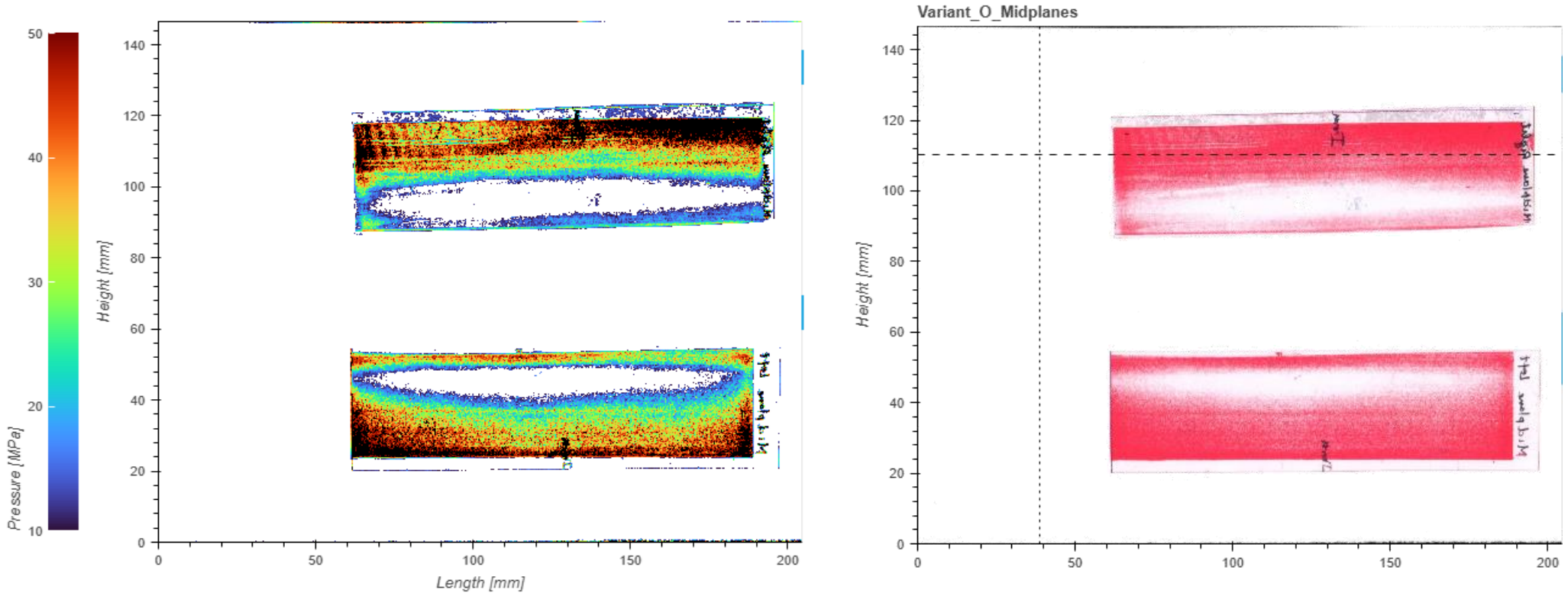
- The pressure distribution is then determined from the intensity of each pixel.

How Does It Work?

Visualize pressure as 2D heatmap derived from colour intensity.



How Does It Work?

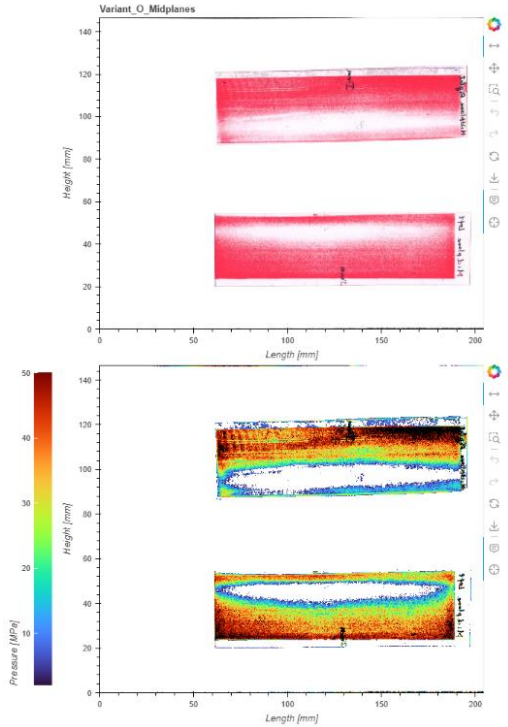


- If the Pressure < the minimum pressure specified on the data sheet, Pixel will be white.
- If the Pressure > the maximum pressure specified on the data sheet, Pixel will be Black.
- In both cases, Pressure will be displayed as NaN.

How Does It Work?

Generate heatmap (HTML), raw data (.csv), and source files.

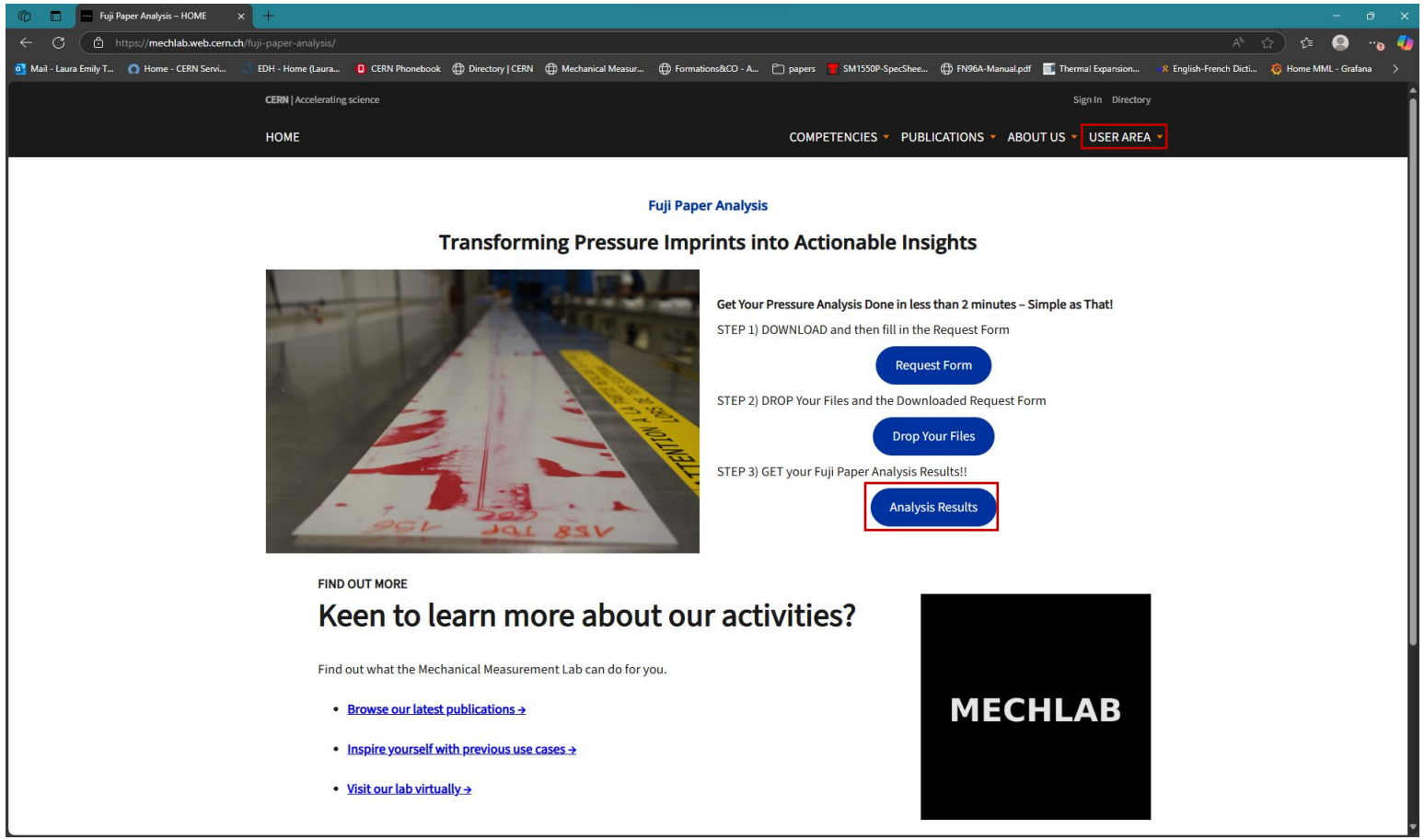
#	MME Laboratory	Fuji Prescale Analysis
0	Project:	Variant O Test 2 (225kN)
1	Operator:	O. Sacristan
2	Test denomination:	Variant_O_Midplanes
3	Test date:	06/03/2023
4	Scan date:	06/03/2023
5	Film grade:	MS
6	Temperature [°C]:	22
7	Relative Humidity [%]:	50
8	Film scan file name:	Variant_O_Test_2_Midplanes.jpg
9	Datasheet scan file name:	MS_datasheet.jpg
10	Comments:	NaN
11	Resolution:	(1183, 1823)



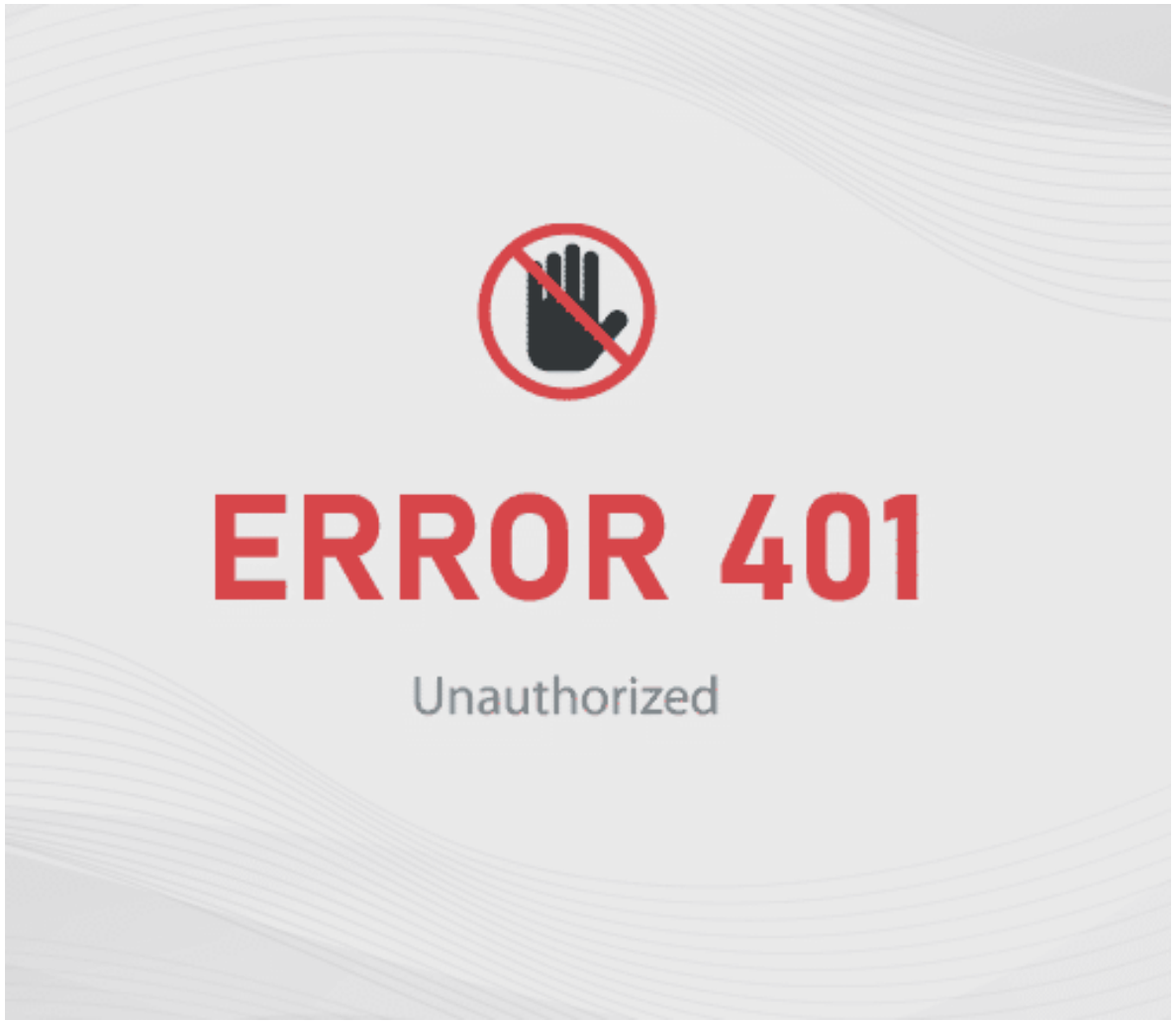
- The HTML contains the request form information + the image resolution and an interactive pressure distribution graph with the original scan as a reference.
- A .csv file with the raw pressure data for each pixel is also generated.

How Does It Work?

Outputs placed into output folder for retrieval.



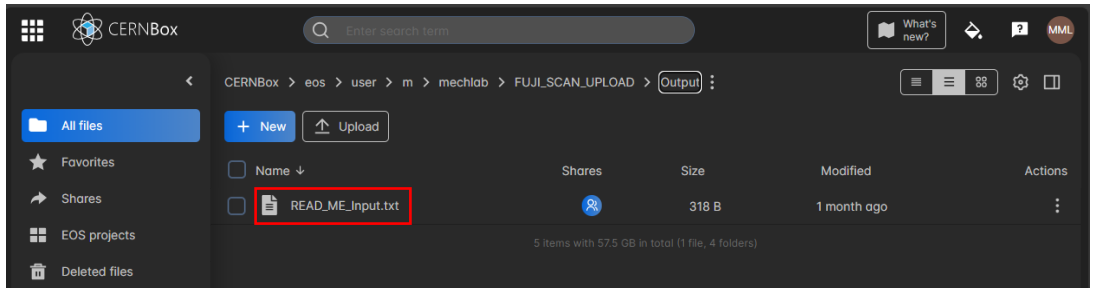
- The HTML file, CSV file and the original input files will be placed in the output folder accessible via the MechLab Website (https://mechlab.web.cern.ch/).


ERROR 401
Unauthorized

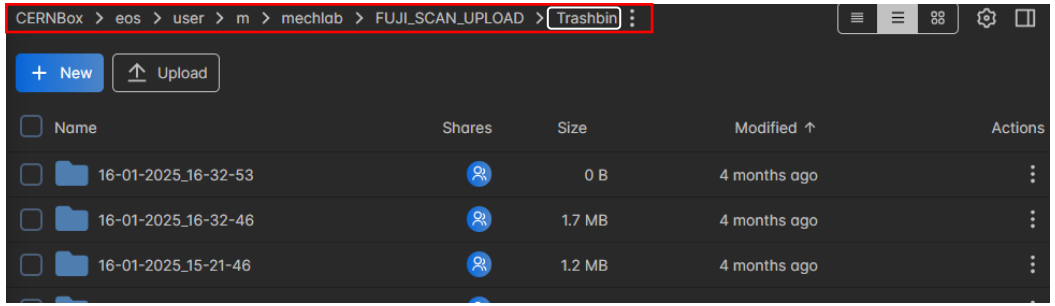
Error Handling

When an error occurs:

- The error is logged.
- A text file with error details appears in the output folder:



- Input files are moved to 'Trashbin' for review (placed inside folder with date and time of error as name):

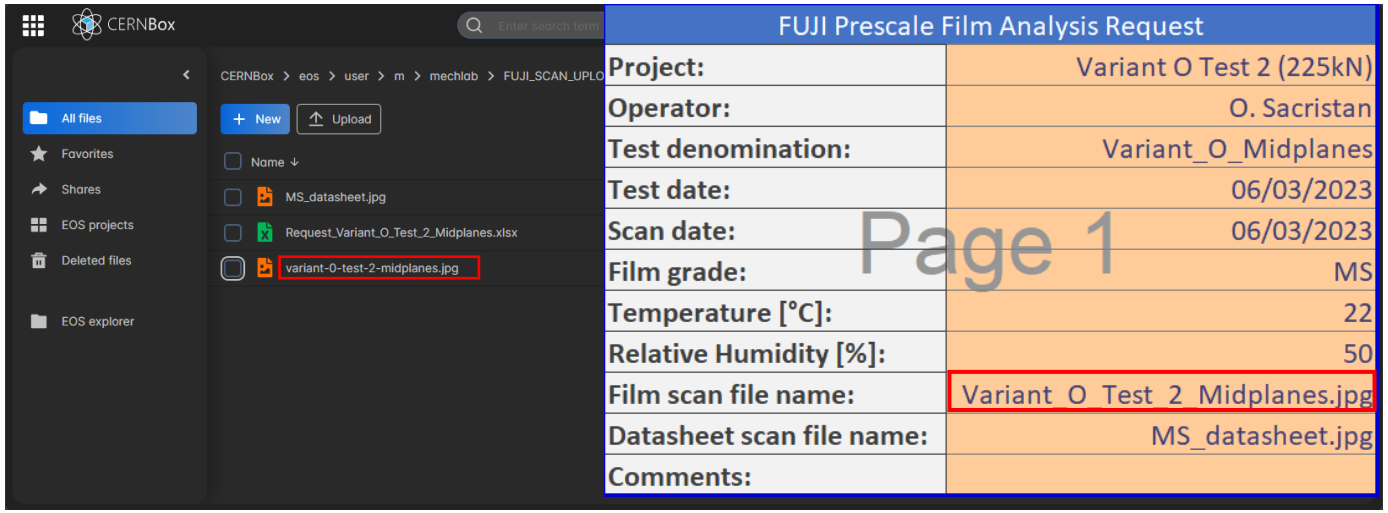


- An email is sent to EN-MME-MML.
- If the issue persists, users are advised to contact EN-MME-MML.

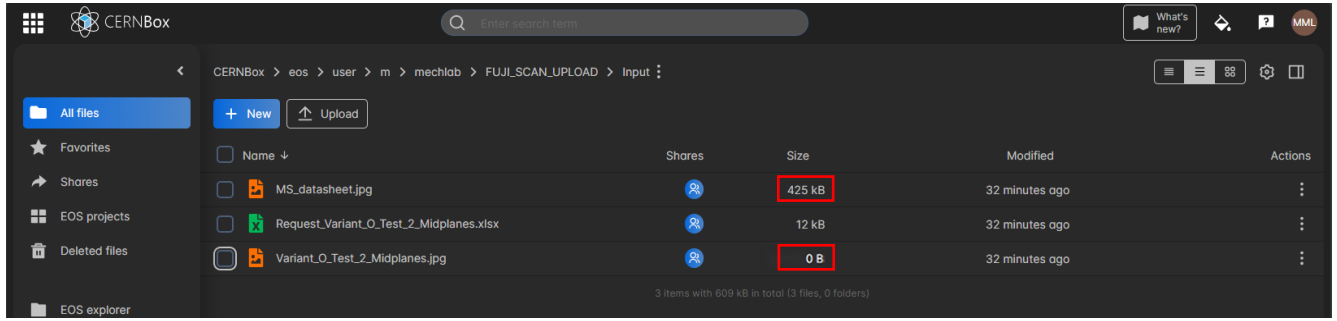
Error Handling

Most common errors include:

- Discrepancies in filenames:



- Error uploading file/corrupted file:



Conclusion

- Fully automated Fujifilm Prescale® Film analysis.
  - Reliable, repeatable pressure distribution processing.
  - Easy-to use and minimal requirements.
  - Centrally executed and reliably maintained.
  - Flexible – both dimensions of samples and operating hours (24/7!).
  - Creates an interactive, shareable output.
- Free use of software CERN wide.
- MML will provide necessary tools for 1000 CHF on request.

```
if film_type == '4LW': #finished, not validated
    tempAB = [15,30]
    humAB = [73,70]
    fit_AB_line= np.poly1d(np.polyfit(tempAB, humAB, 1))

    tempBC = [15,30]
    humBC = [63,60]
    fit_BC_line= np.poly1d(np.polyfit(tempBC, humBC, 1))

    tempCD = [15,30]
    humCD = [57,53]
    fit_CD_line= np.poly1d(np.polyfit(tempCD, humCD, 1))

    tempDE = [15,30]
    humDE = [41,37]
    fit_DE_line= np.poly1d(np.polyfit(tempDE, humDE, 1))


    if (fit_AB_line(temperature) <= humidity): #curve A
        print('I pick curve 4LW A')
        density=[0.116389960866333, 0.203111968693066, 0.330912815734428, 0.499792501990417, 0.721161788273393
        density_color = [1.5, 1.3, 1.1, 0.9, 0.7, 0.5, 0.3, 0.1]
        pressure=[0.0503529357631384, 0.0752941217526759, 0.100235281892031, 0.125176467881569, 0.150117628020

    elif (fit_AB_line(temperature) > humidity) and (fit_BC_line(temperature) <= humidity): #curve B
        print('I pick curve 4LW B')
        density=[0.116389960866333, 0.203111968693066, 0.330912815734428, 0.499792501990417, 0.721161788273393
        density_color = [1.5, 1.3, 1.1, 0.9, 0.7, 0.5, 0.3, 0.1]
        pressure=[0.0503529357631384, 0.0752941217526759, 0.100235281892031, 0.125176467881569, 0.150117628020

    elif (fit_BC_line(temperature) > humidity) and (fit_CD_line(temperature) <= humidity):
        print('I pick curve 4LW C')
        density=[0.114107858848929, 0.196265537278185, 0.2898339765198, 0.399377505971251, 0.529460580392686,
        density_color = [1.5, 1.3, 1.1, 0.9, 0.7, 0.5, 0.3, 0.1]
        pressure=[0.0503529357631384, 0.0752941217526759, 0.100235281892031, 0.125176467881569, 0.150117628020

    elif (fit_CD_line(temperature) > humidity) and (fit_DE_line(temperature) <= humidity):
        print('I pick curve 4LW D')
        density=[0.114107858848929, 0.193983309898112, 0.276140988327367, 0.362862996154101, 0.460995764793193
        density_color = [1.5, 1.3, 1.1, 0.9, 0.7, 0.5, 0.3, 0.1]
        pressure=[0.0503529357631384, 0.0752941217526759, 0.100235281892031, 0.125176467881569, 0.150117628020

    else:
        print('I pick curve 4LW E')
        density=[0.111825631468855, 0.189418980500634, 0.267012454895081, 0.335477145131905, 0.399377505971251
        density_color = [1.5, 1.3, 1.1, 0.9, 0.7, 0.5, 0.3, 0.1]
        pressure=[0.0503529357631384, 0.0752941217526759, 0.100235281892031, 0.125176467881569, 0.150117628020


if film_type == 'LLLW': #finished, not validated
    tempAB = [0,35]
    humAB = [91,70]
    fit_AB_line= np.poly1d(np.polyfit(tempAB, humAB, 1))

    tempBC = [0,35]
    humBC = [76,59.5]
    fit_BC_line= np.poly1d(np.polyfit(tempBC, humBC, 1))

    tempCD = [0,35]
    humCD = [61,50]
    fit_CD_line= np.poly1d(np.polyfit(tempCD, humCD, 1))

    tempDE = [0,35]
    humDE = [46,37]
    fit_DE_line= np.poly1d(np.polyfit(tempDE, humDE, 1))
```

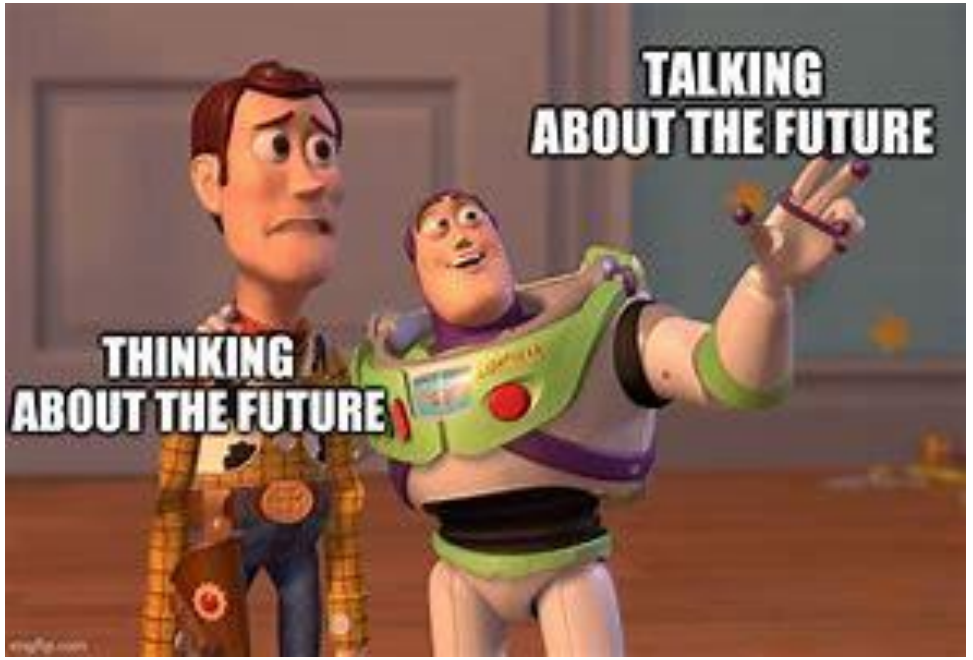
Next Steps/ Future Improvements

Next Steps:

- Ensure maintenance of code
- Improve error handling
- Produce EDMS Document, along side other outputs.

Future Improvements:

- Web-based deployment/GUI
  - Currently, not planned but potential to create this for a more finished product, if demand increases.



Questions?

Thank you for your attention!