

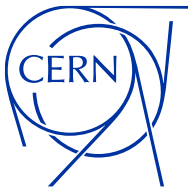
Fujifilm Prescale® Film Software

Quantitative Analysis of Fujifilm Prescale® Film Samples

Laura Thackray

Mechanical Measurement Lab / EN-MME

<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.

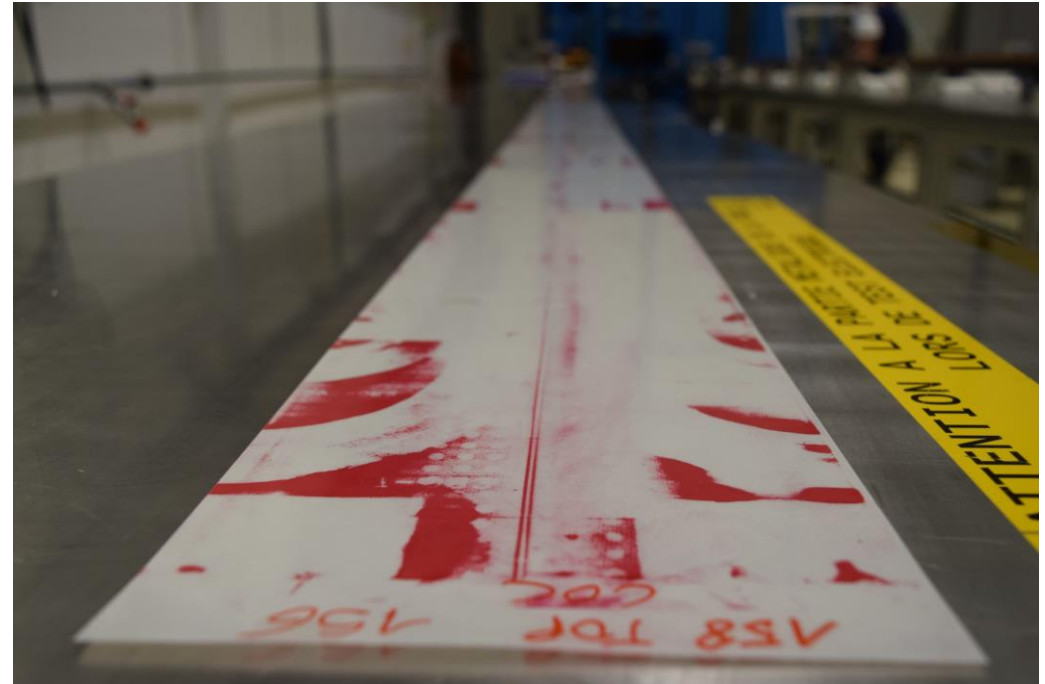


Fujifilm Prescale® Film types

Types	Measurable pressure range [MPa] $1\text{MPa} \doteq 10.2\text{kgf/cm}^2$	Prescale	Prescale Sheets	Classification
		Product size width(mm) x length(m)	Product size width(mm) x length(mm)	
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

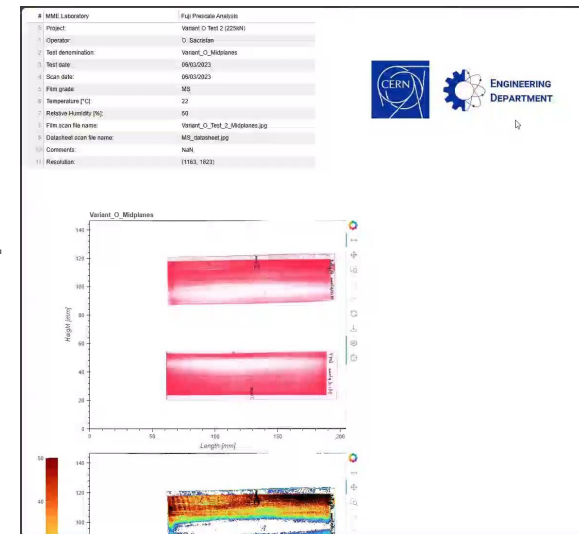
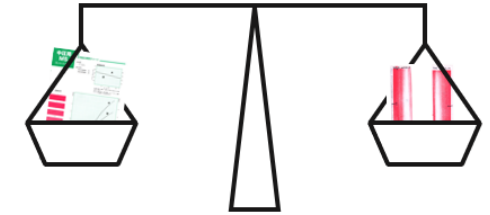
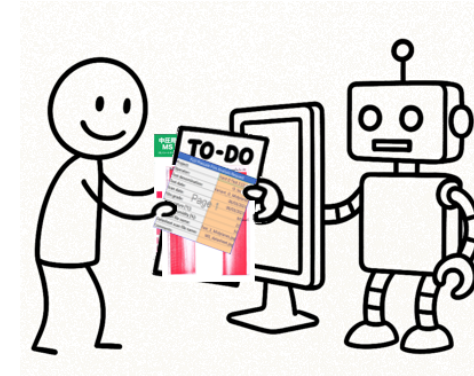
Applications At CERN

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



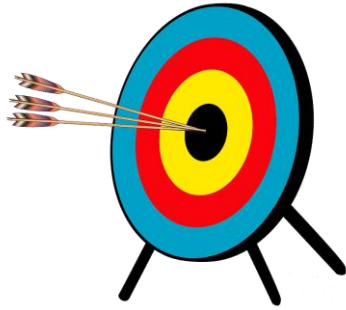
Project Goals

- 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.



**DO NOT
TOUCH**

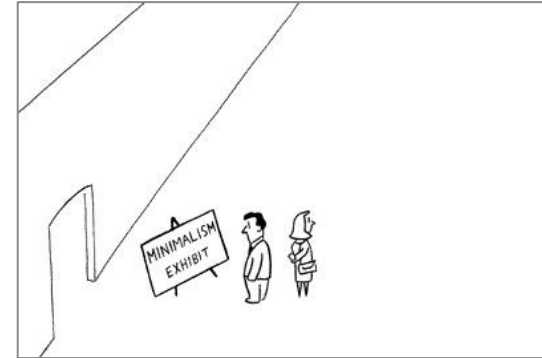
Software Criteria



1. Accurate and efficient analysis.



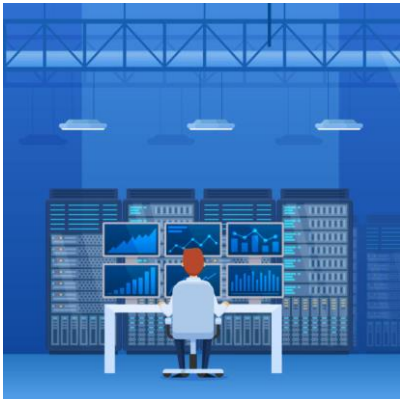
2. Eliminate need for manual interpretation.



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.

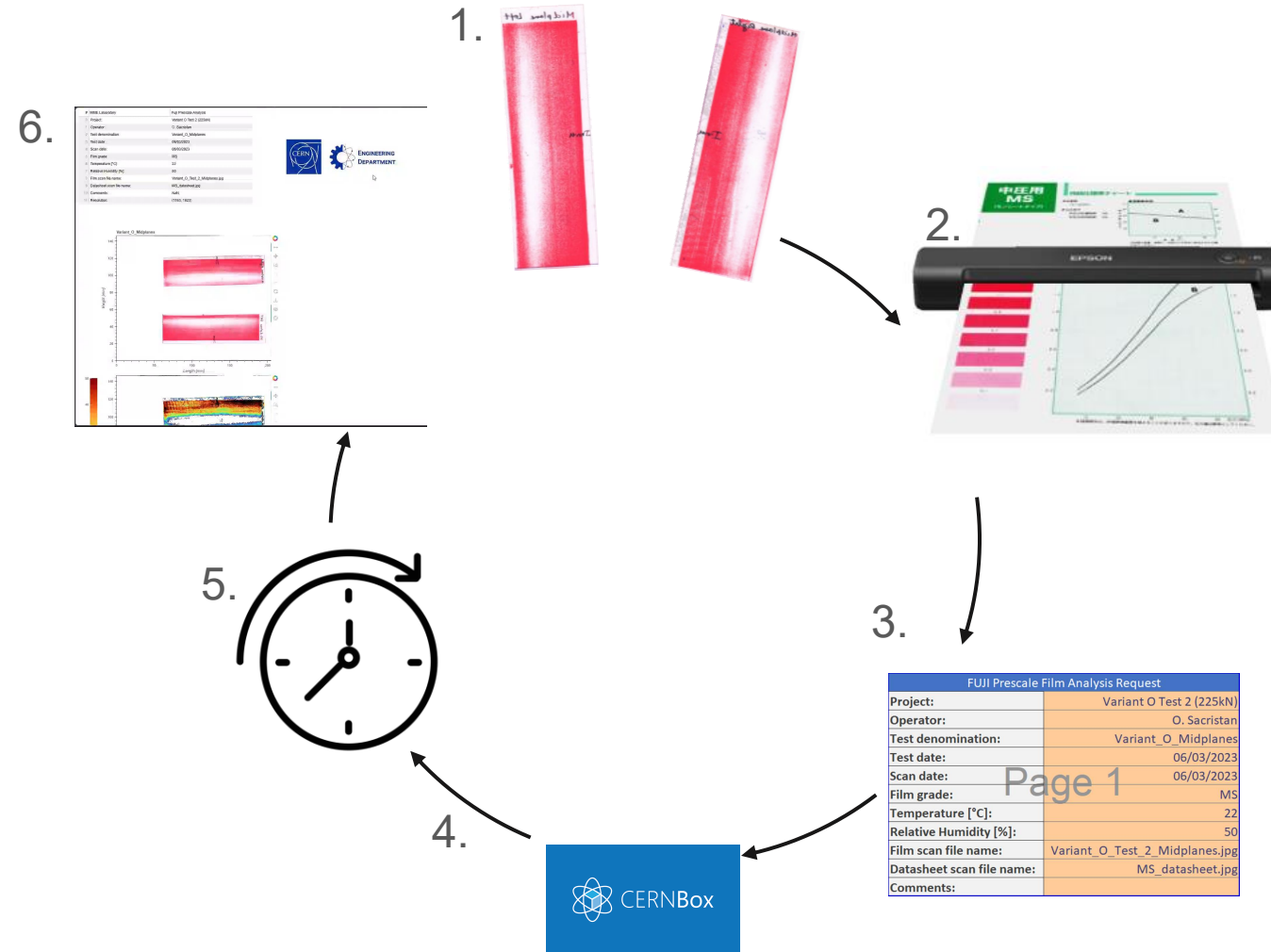


Best Practise

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.

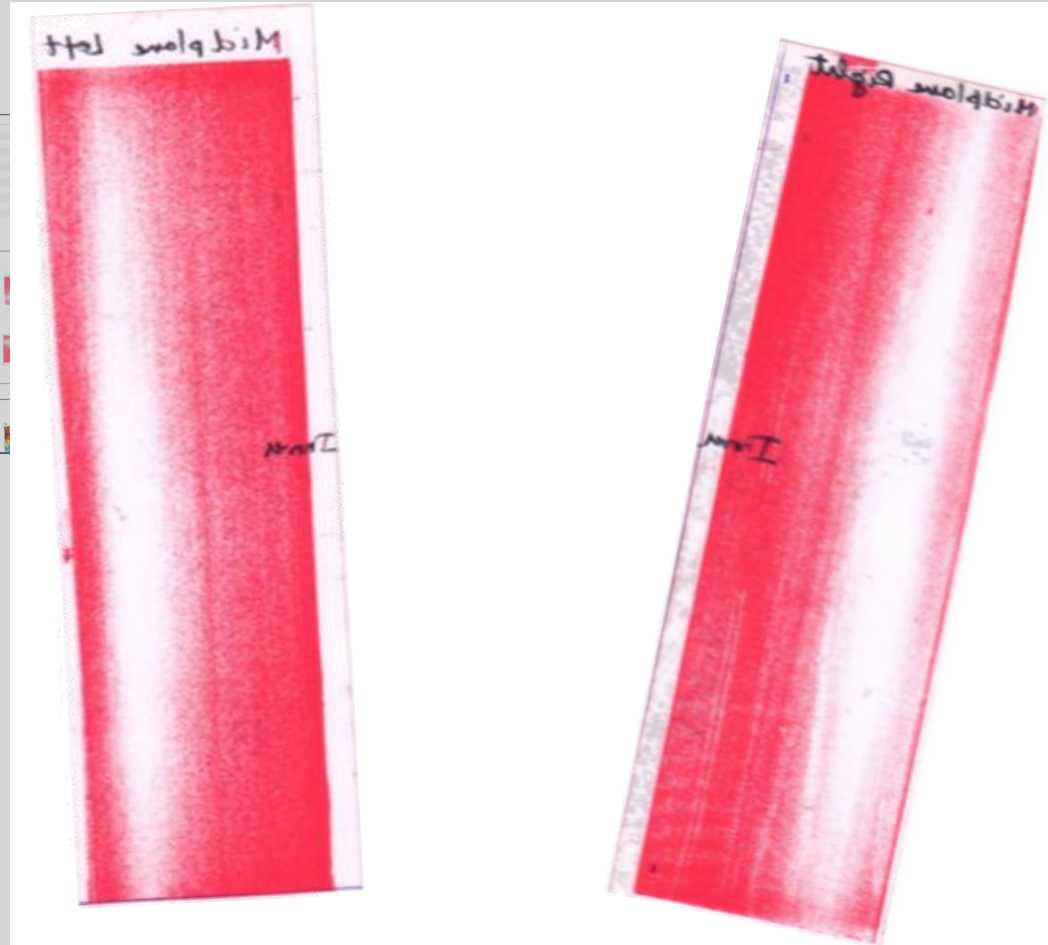
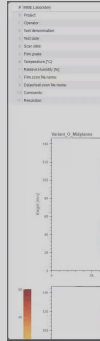
User Guide

User Guide



User Guide

6.



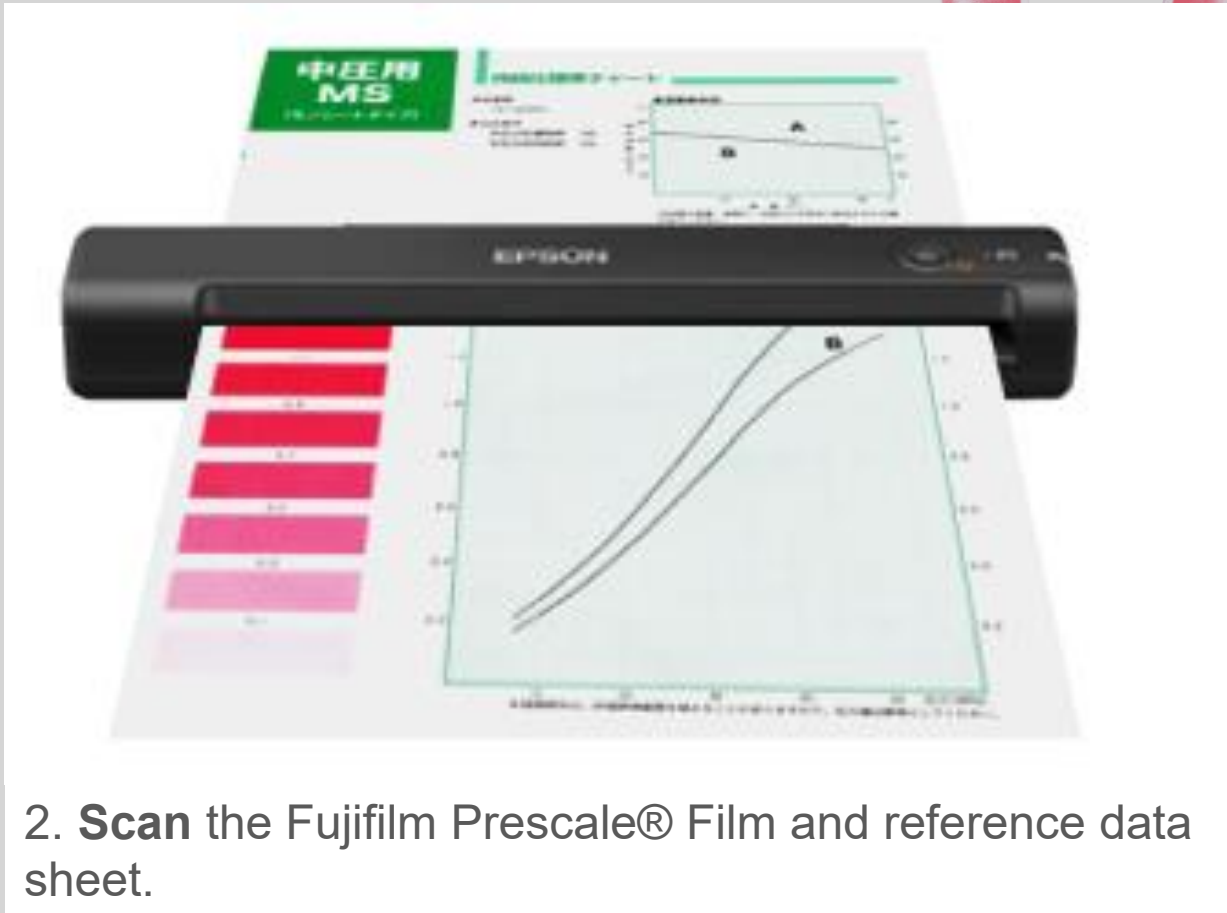
1. Create Fujifilm Prescale® Film sample.



Test 2 (225kN)
O. Sacristan
O. Midplanes
06/03/2023
06/03/2023
MS
22
50
Midplanes.jpg
datasheet.jpg

User Guide

1.



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.

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:	

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:	

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.

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



User Guide

Project:
Operator:
Test deno
Test date:
Scan date:
Film grade:
Temperat
Relative H
Film scan
Datashee
Comment
3. Crea

CERN | Accelerating science

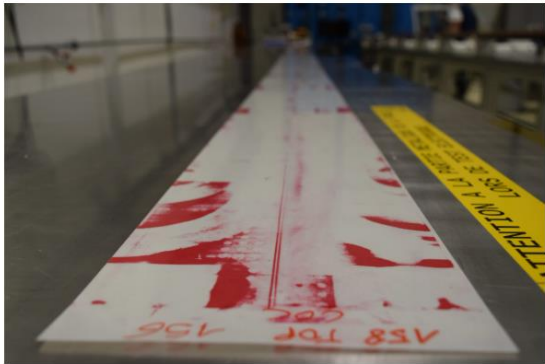
Sign In Directory

HOME

COMPETENCIES ▾ PUBLICATIONS ▾ ABOUT US ▾ **USER AREA ▾**

Fuji Paper Analysis

Transforming Pressure Imprints into Actionable Insights



Get Your Pressure Analysis Done in less than 2 minutes – Simple as That!

STEP 1) DOWNLOAD and then fill in the Request Form

Request Form

STEP 2) DROP Your Files and the Downloaded Request Form

Drop Your Files

STEP 3) GET your Fuji Paper Analysis Results!!


Analysis Results

FIND OUT MORE

Keen to learn more about our activities?

Find out what the Mechanical Measurement Lab can do for you.

- [Browse our latest publications →](#)
- [Inspire yourself with previous use cases →](#)
- [Visit our lab virtually →](#)



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

User Guide

1.

6.



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:	

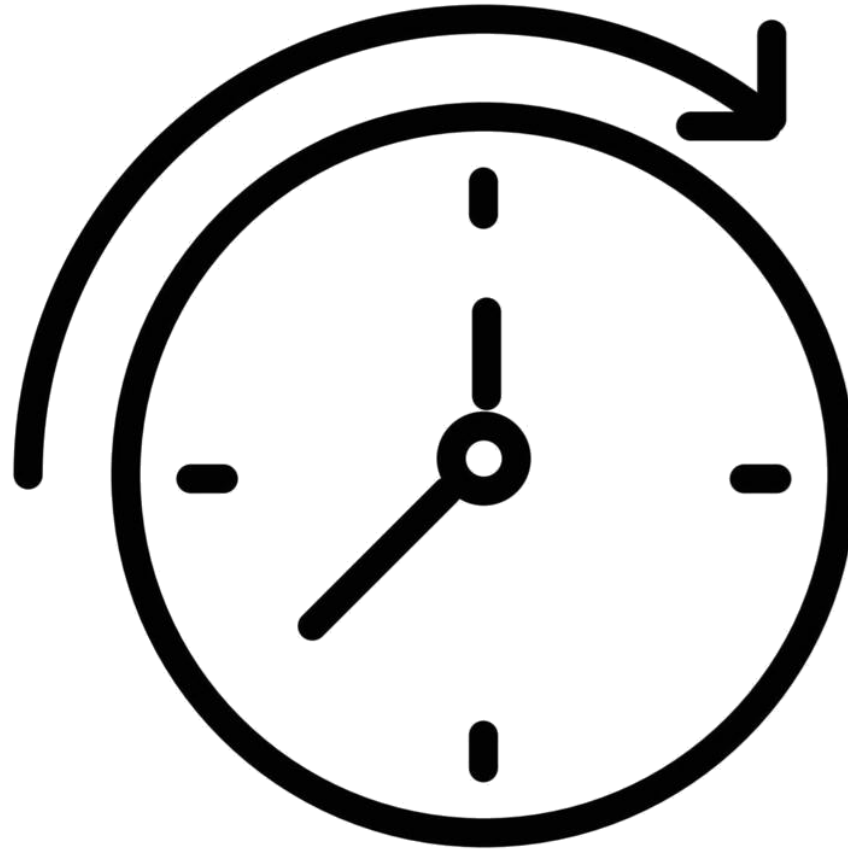
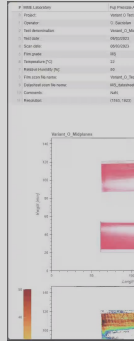
User Guide

The screenshot displays the MechLab website interface. At the top, a dark navigation bar includes the CERN logo, the tagline 'Accelerating science', and links for 'Sign In' and 'Directory'. Below this, a secondary bar contains 'HOME', 'COMPETENCIES', 'PUBLICATIONS', 'ABOUT US', and a highlighted 'USER AREA' dropdown menu. The main content area features a section titled 'Fuji Paper Analysis' with the subtitle 'Transforming Pressure Imprints into Actionable Insights'. On the left, there is a photograph of a white strip of film with red pressure imprints. To the right, a three-step process is outlined: 'STEP 1) DOWNLOAD and then fill in the Request Form' with a 'Request Form' button; 'STEP 2) DROP Your Files and the Downloaded Request Form' with a 'Drop Your Files' button (highlighted with a red box); and 'STEP 3) GET your Fuji Paper Analysis Results!!' with an 'Analysis Results' button. Below this, a section titled 'FIND OUT MORE' asks 'Keen to learn more about our activities?' and provides three links: 'Browse our latest publications →', 'Inspire yourself with previous use cases →', and 'Visit our lab virtually →'. On the right side of this section is a large black square with the text 'MECHLAB' in white.

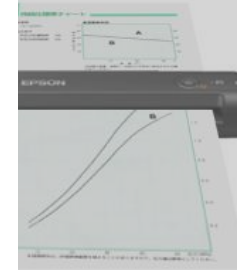
- The request form, Fujifilm Prescale® Film sample scan, and the Reference data sheet scan should all be uploaded into the Input folder on CERNBox.
- This folder can be located via the MechLab Website (<https://mechlab.web.cern.ch/>).

User Guide

6.



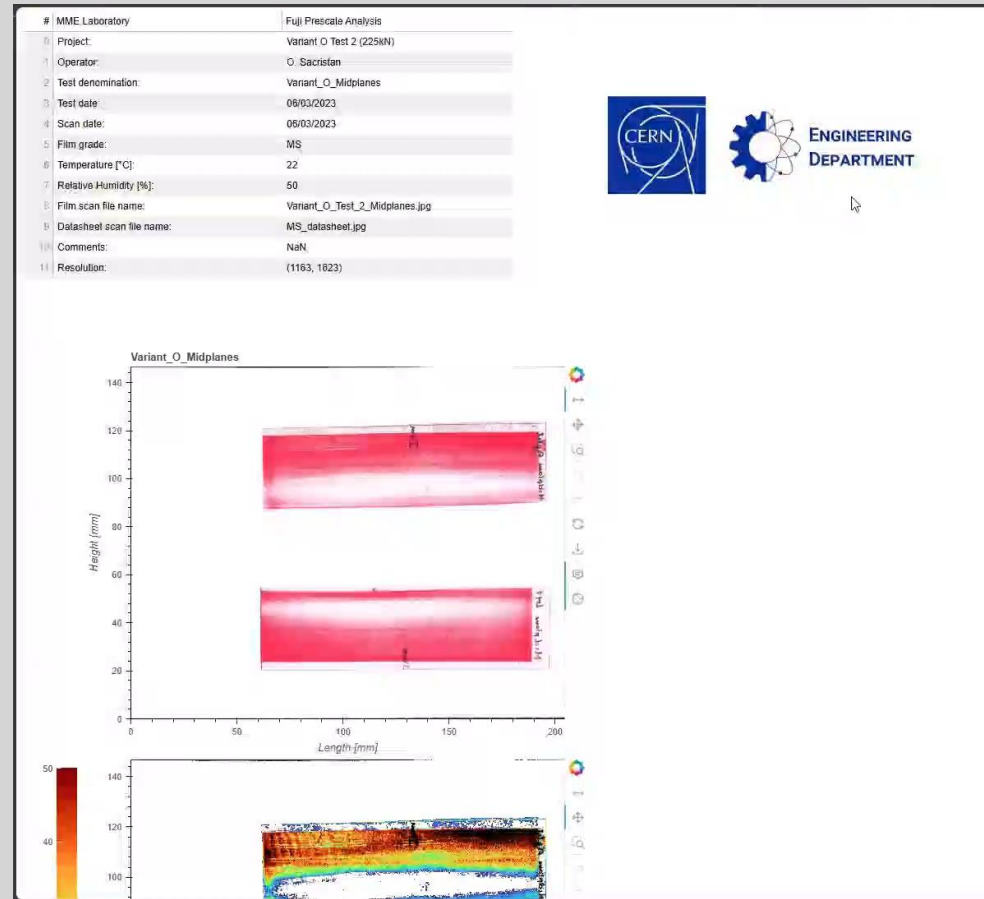
5. **Wait for processing;** results appear in the output folder.



Analysis Request									
Variant O Test 2 (225kN)									
O. Sacristan									
Variant_O_Midplanes									
06/03/2023									
e 1 06/03/2023									
MS									
22									
50									
Variant_O_Test_2_Midplanes.jpg									
MS_datasheet.jpg									

User Guide

6.



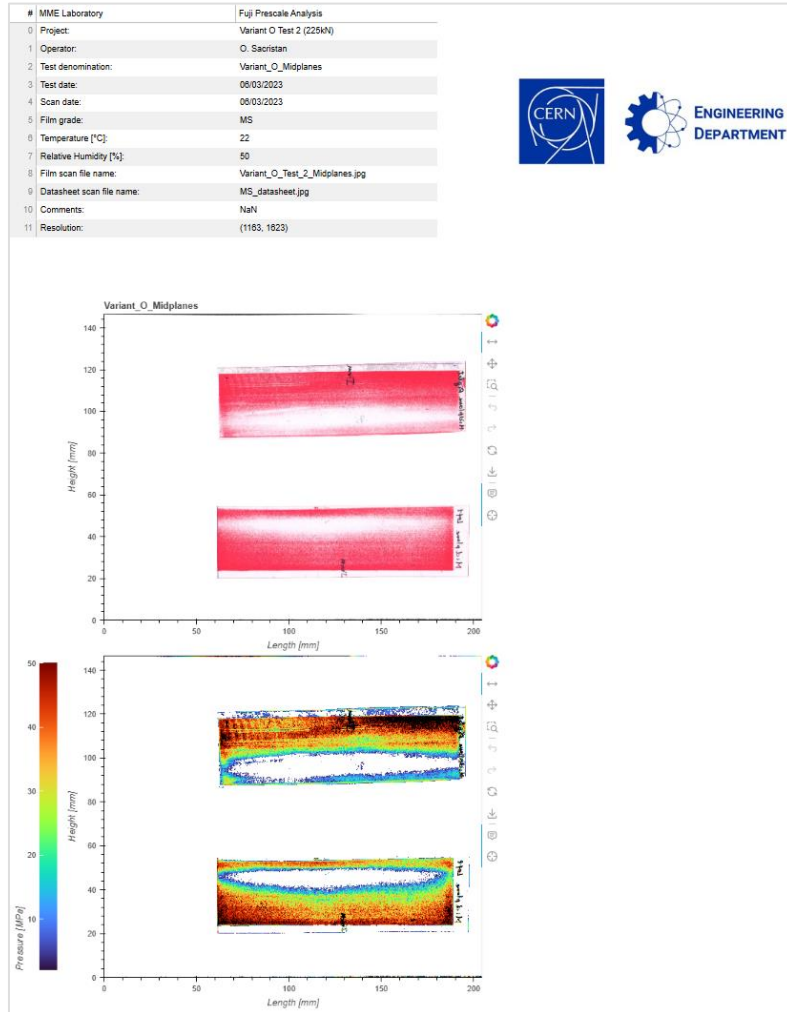
6. **Retrieve** interactive HTML, Original Input files and raw CSV file, from Output folder.

User Guide

The screenshot displays the MechLab website interface. At the top, a dark navigation bar includes the CERN logo and text 'CERN | Accelerating science' on the left, and 'Sign In' and 'Directory' on the right. Below this, a secondary bar contains 'HOME', 'COMPETENCIES', 'PUBLICATIONS', 'ABOUT US', and a highlighted 'USER AREA' dropdown menu. The main content area features a section titled 'Fuji Paper Analysis' with the subtitle 'Transforming Pressure Imprints into Actionable Insights'. To the left is a photograph of a white paper strip with red pressure imprints. To the right, a three-step process is outlined: 'STEP 1) DOWNLOAD and then fill in the Request Form' with a 'Request Form' button; 'STEP 2) DROP Your Files and the Downloaded Request Form' with a 'Drop Your Files' button; and 'STEP 3) GET your Fuji Paper Analysis Results!!' with an 'Analysis Results' button. Below this, a section titled 'FIND OUT MORE' asks 'Keen to learn more about our activities?' and provides three links: 'Browse our latest publications ->', 'Inspire yourself with previous use cases ->', and 'Visit our lab virtually ->'. On the right side of this section is a large black square with the white text 'MECHLAB'.

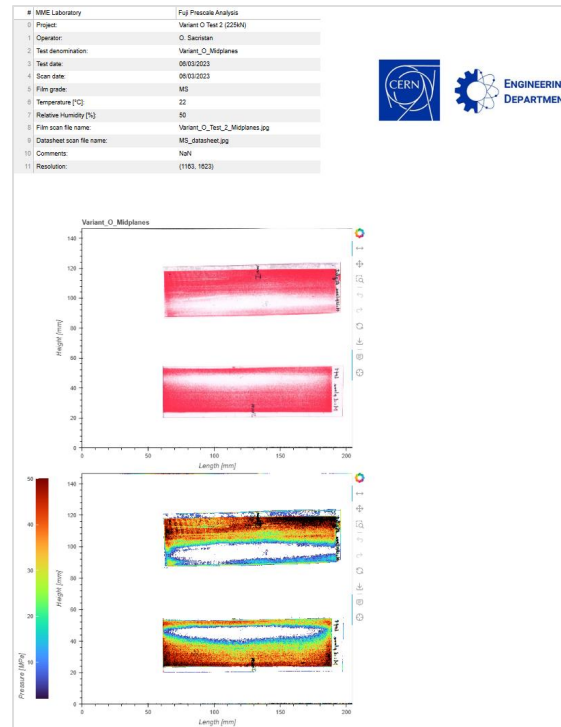
- The Output folder can also be located via the MechLab Website (<https://mechlab.web.cern.ch/>).

Our Service



- 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



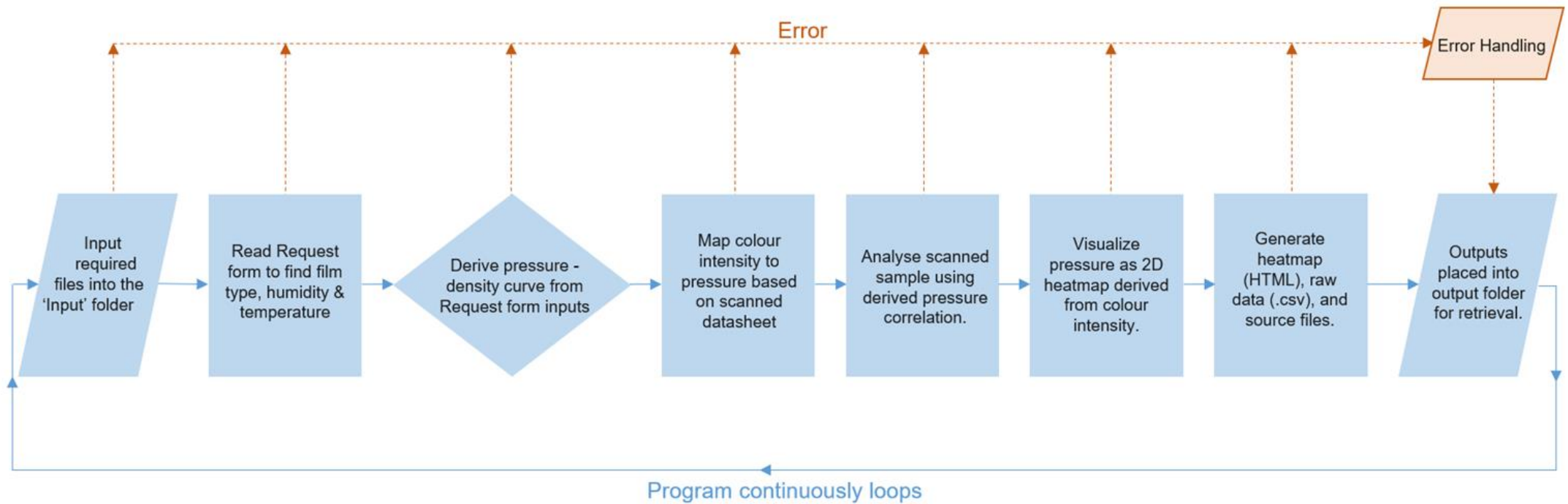
Working Parameters & Constraints

- 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.



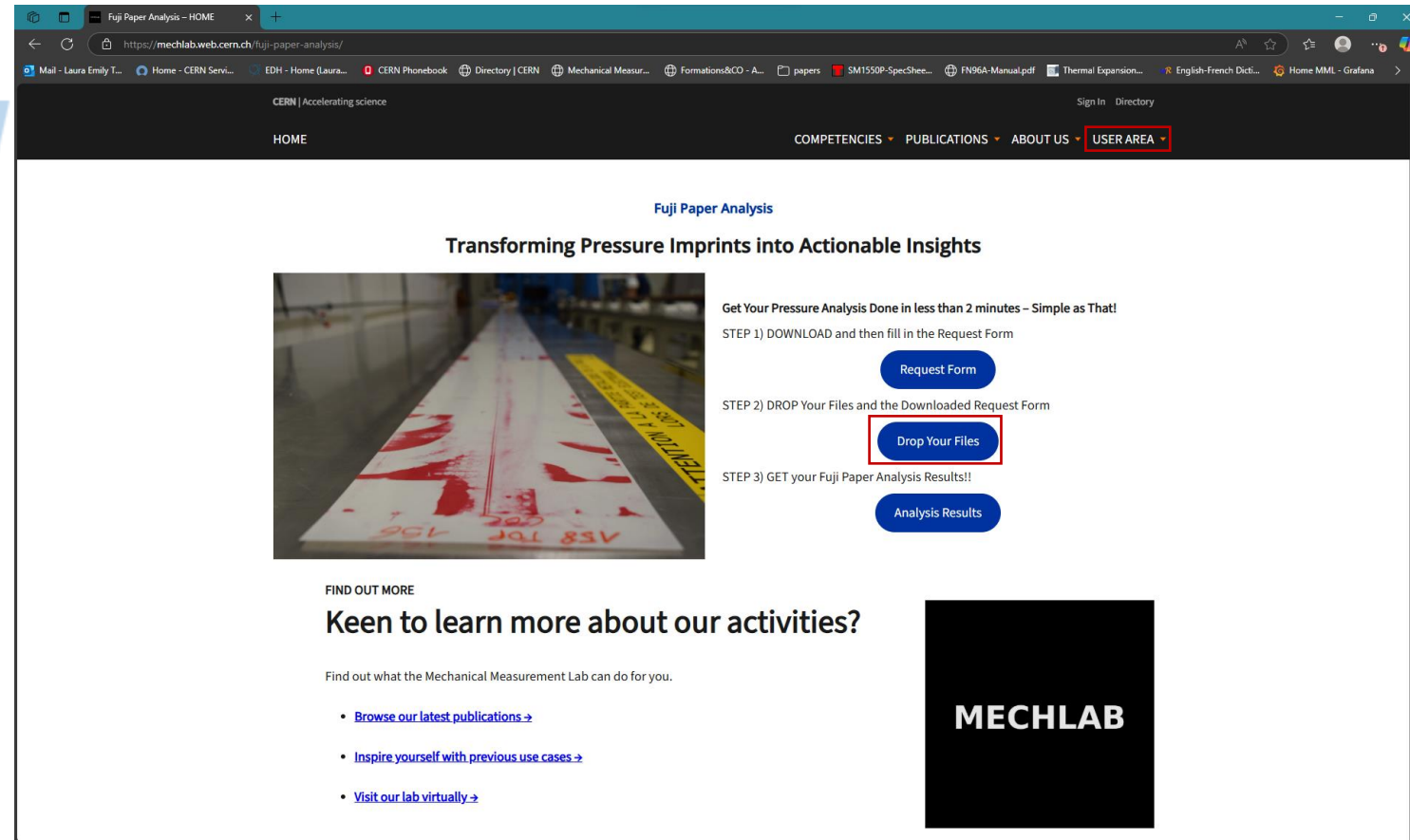
How Does It Work?

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

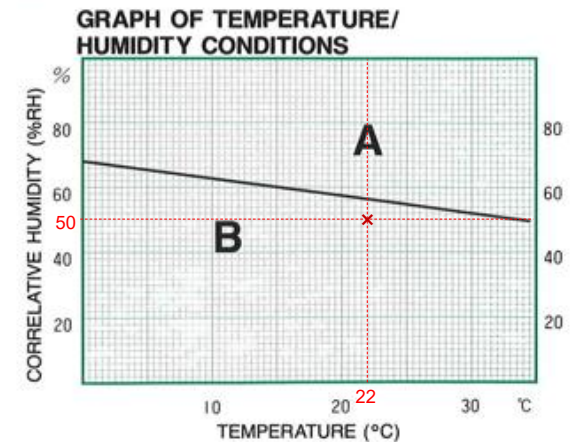
Film grade:	MS
Temperature [°C]:	22
Relative Humidity [%]:	50



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?

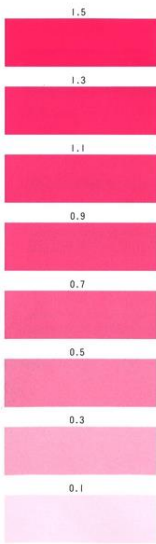
Derive pressure - density curve from Request form inputs

MEDIUM PRESSURE
MS
(MONO-SHEET TYPE)

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.

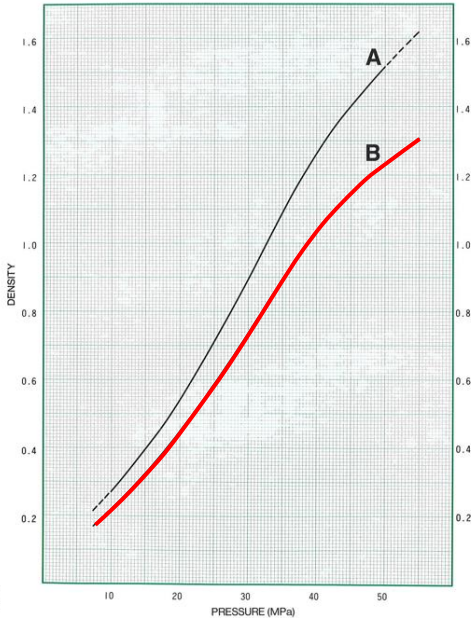
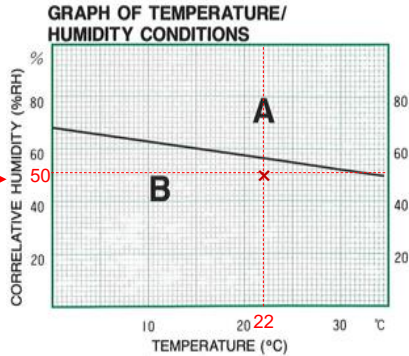
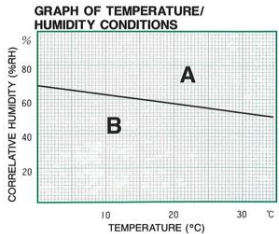
Check if the temperature and humidity meet with the conditions above when the pressure is applied.
(For example, if the room temperature is 25°C and the humidity factor is 60%RH, acquire the pressure from the A curve in the standard chart.)

STANDARD COLOR
SAMPLE



As the pressure range indicated by the broken line in the graph may exceed the permissible error range, it should be used for reference purposes only.

STANDARD CONTINUOUS PRESSURE CHART



How Does It Work?

Map colour
intensity to
pressure based
on scanned
datasheet

MEDIUM PRESSURE
MS
(MONO-SHEET TYPE)

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

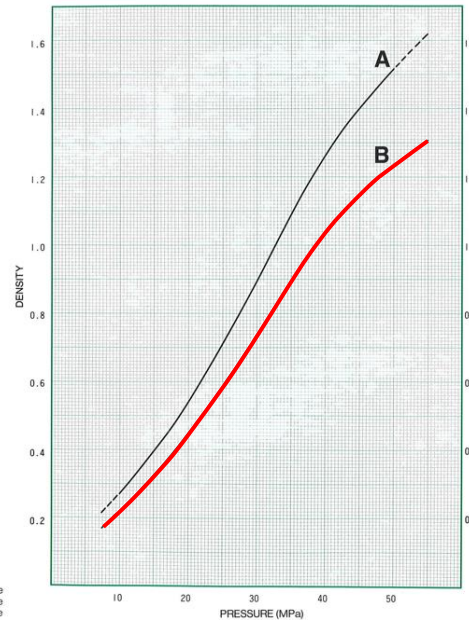
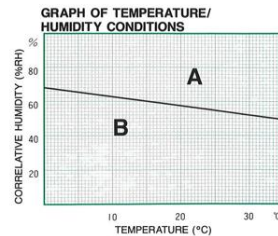
Check if the temperature and humidity meet with the conditions above when the pressure is applied.
(For example, if the room temperature is 25°C and the humidity factor is 60%RH, acquire the pressure from the A curve in the standard chart.)

STANDARD COLOR
SAMPLE



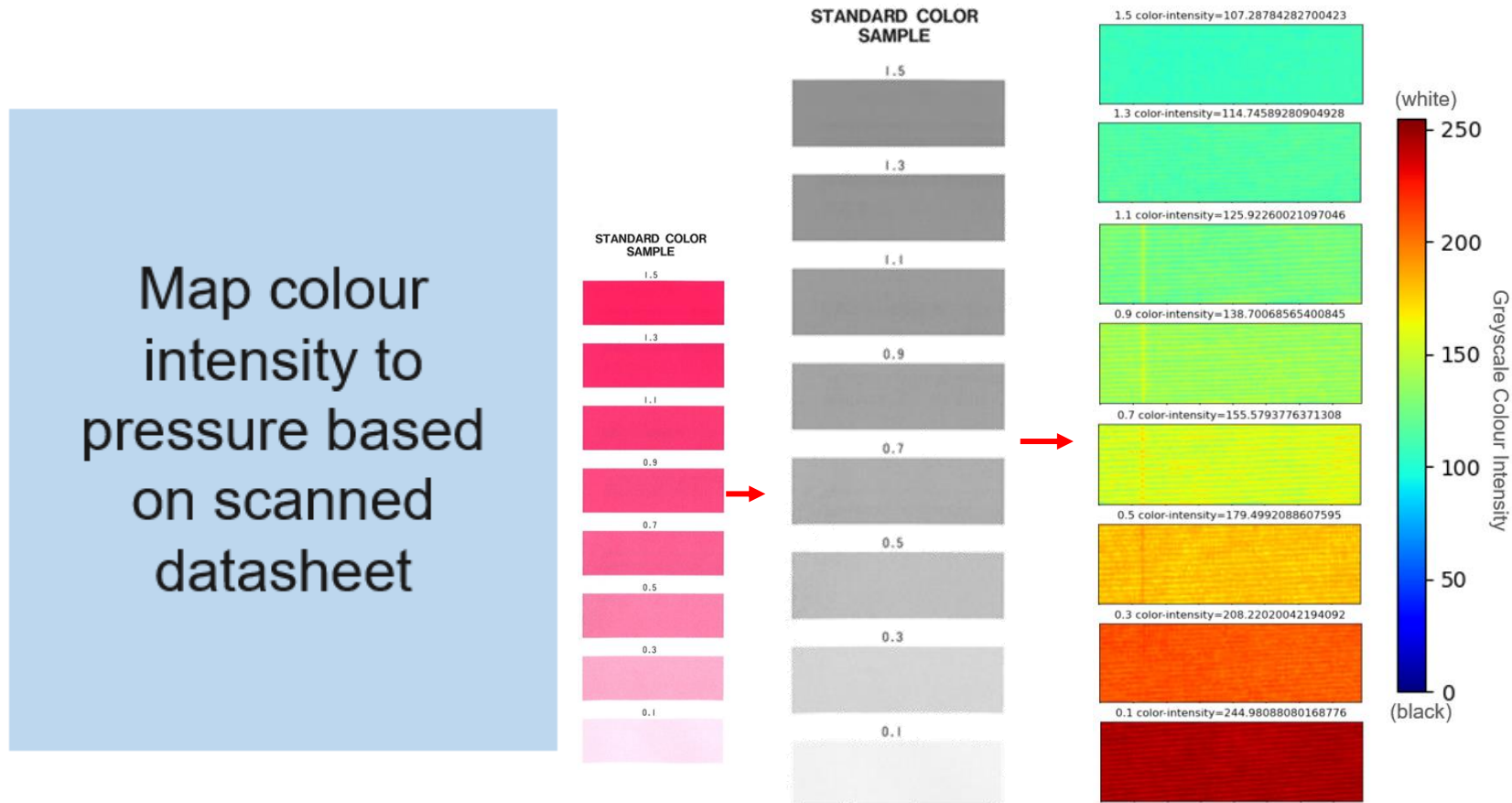
As the pressure range indicated by the broken line in the graph may exceed the permissible error range, it should be used for reference purposes only.

STANDARD CONTINUOUS
PRESSURE CHART



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

How Does It Work?



- 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?

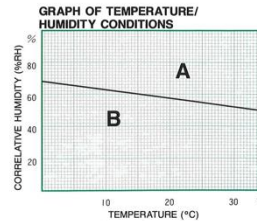
Map colour intensity to pressure based on scanned datasheet

MEDIUM PRESSURE
MS
(MONO-SHEET TYPE)

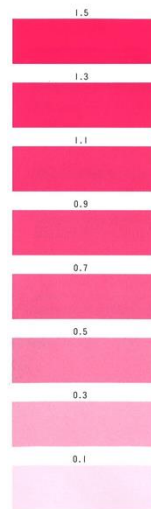
Measurement pressure range: 10–50 MPa
• Pressure application conditions
• Time to reach the pressure to be measured: 2 min.
• Time of retention at the pressure to be measured: 2 min.

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.)

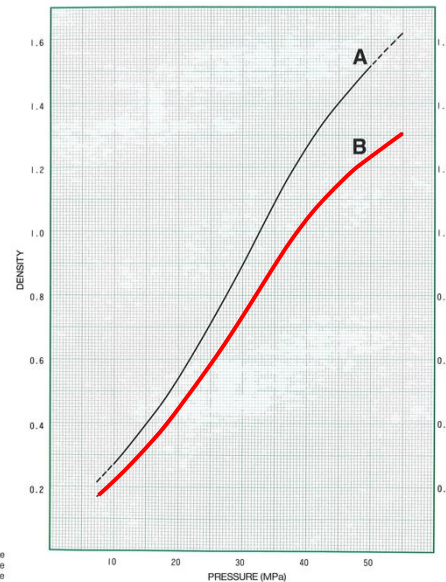
STANDARD CONTINUOUS
PRESSURE CHART



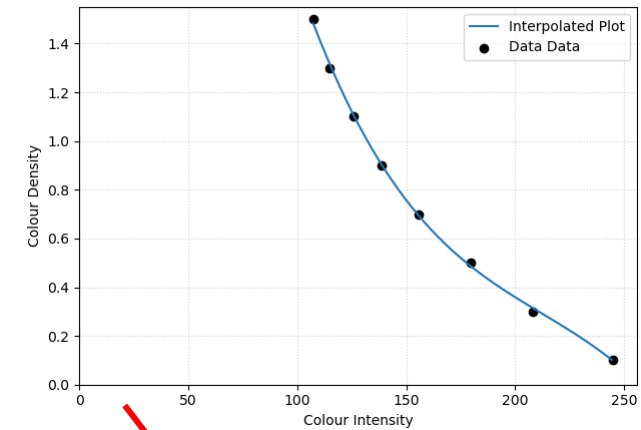
STANDARD COLOR
SAMPLE



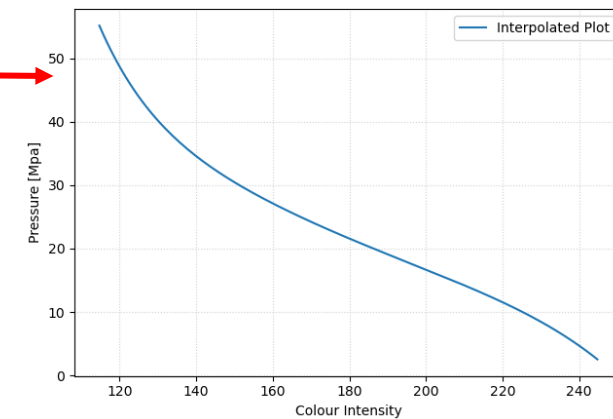
As the pressure range indicated by the broken line in the graph may exceed the permissible error range, it should be used for reference purposes only.



Colour Intensity vs Colour Density



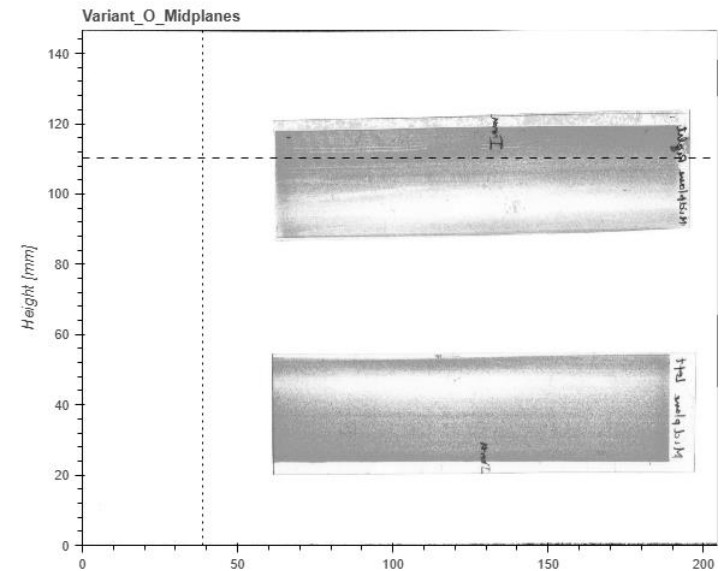
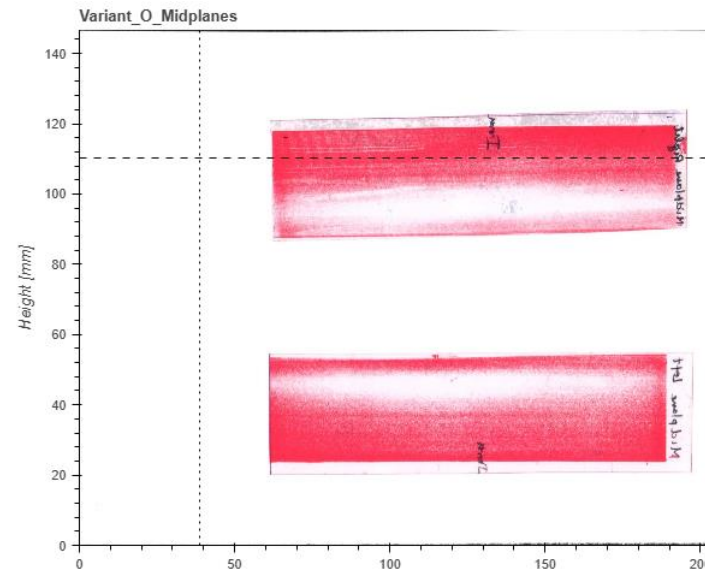
Colour Intensity vs Pressure



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

How Does It Work?

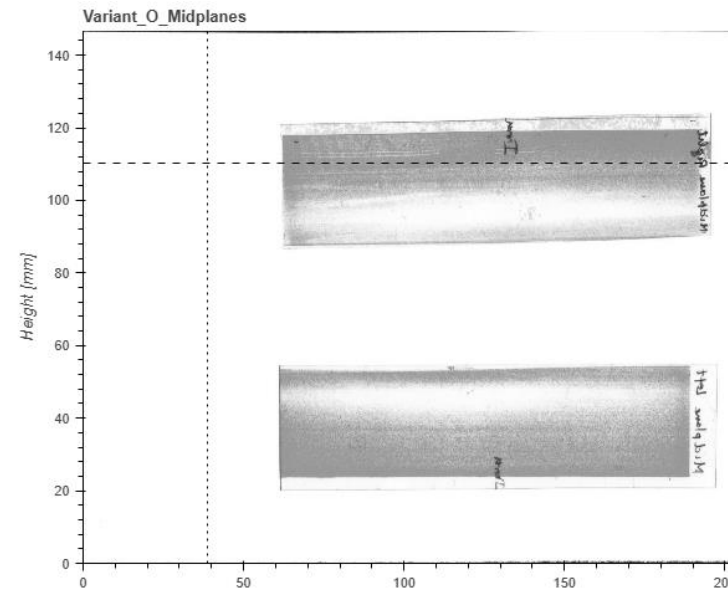
Analyse scanned sample using derived pressure correlation.



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

How Does It Work?

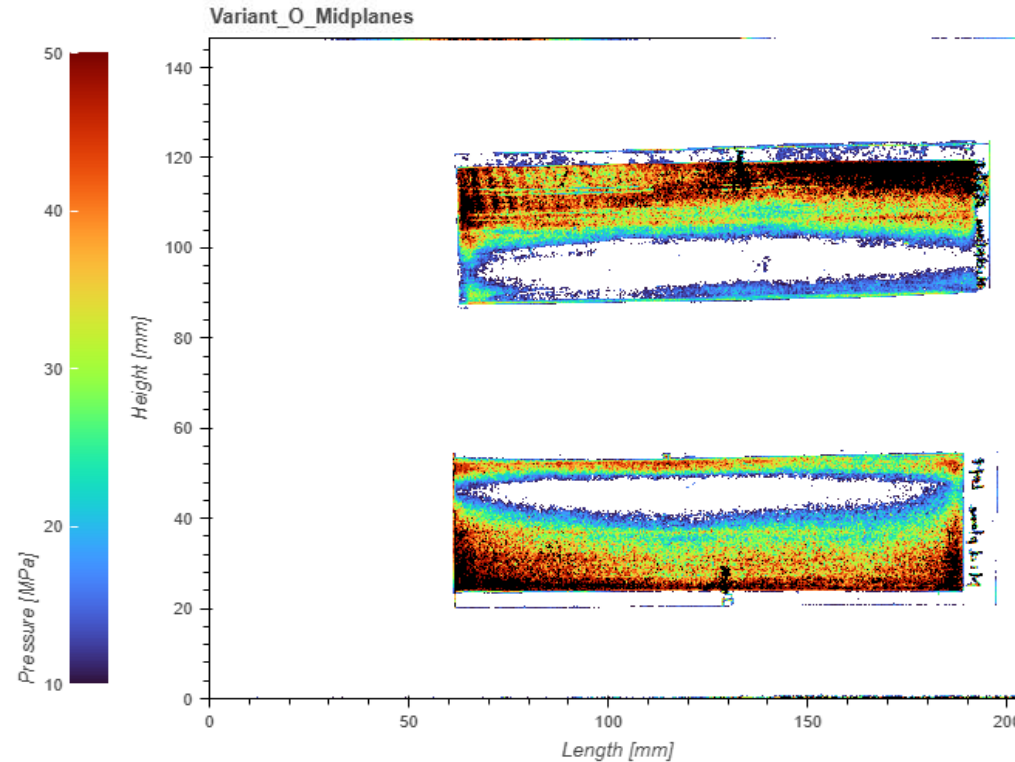
Analyse scanned sample using derived pressure correlation.



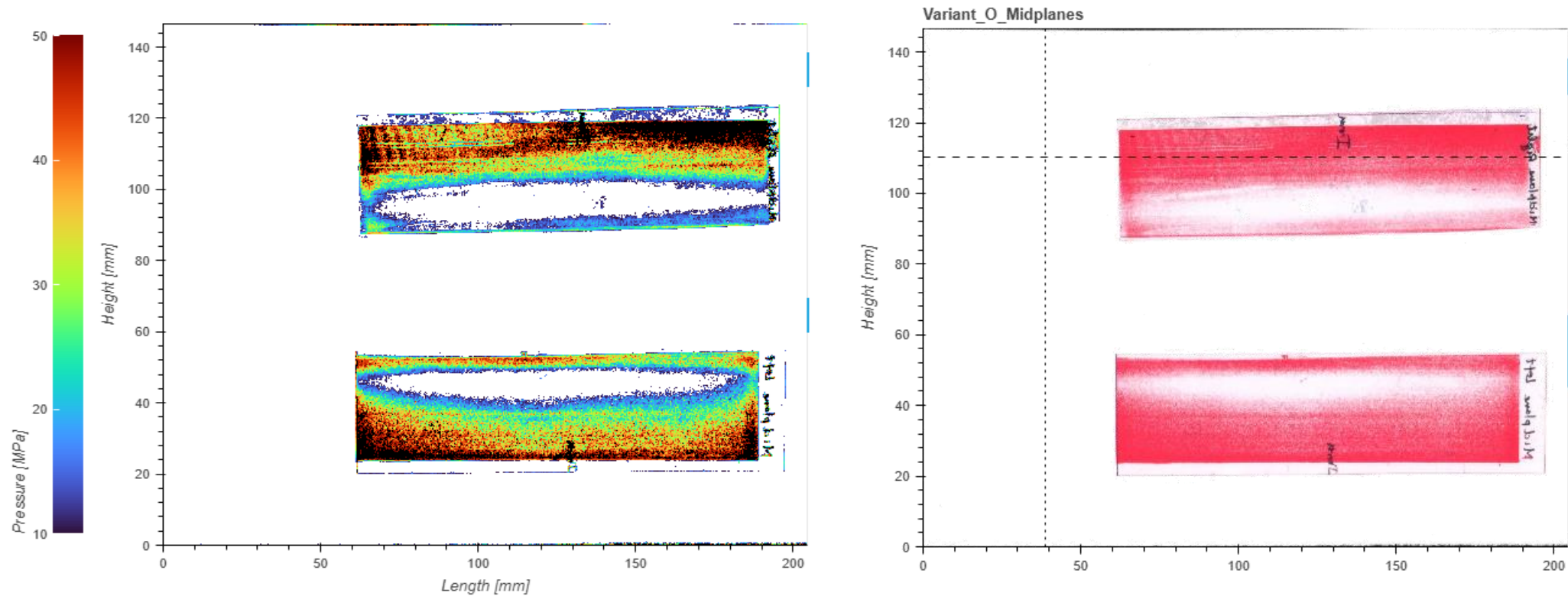
- The pressure distribution is then determined from the intensity of each pixel.

How Does It Work?

Visualize
pressure as 2D
heatmap derived
from colour
intensity.



How Does It Work?

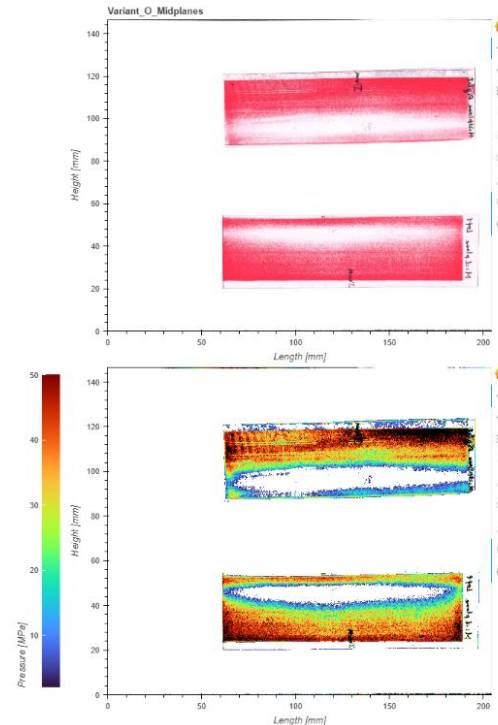


- If the Pressure < the minimum pressure specified on the data sheet, Pixel will be white.
- If the Pressure > the maximum pressure specified on the data sheet, Pixel will be Black.
- In both cases, Pressure will be displayed as NaN.

How Does It Work?

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

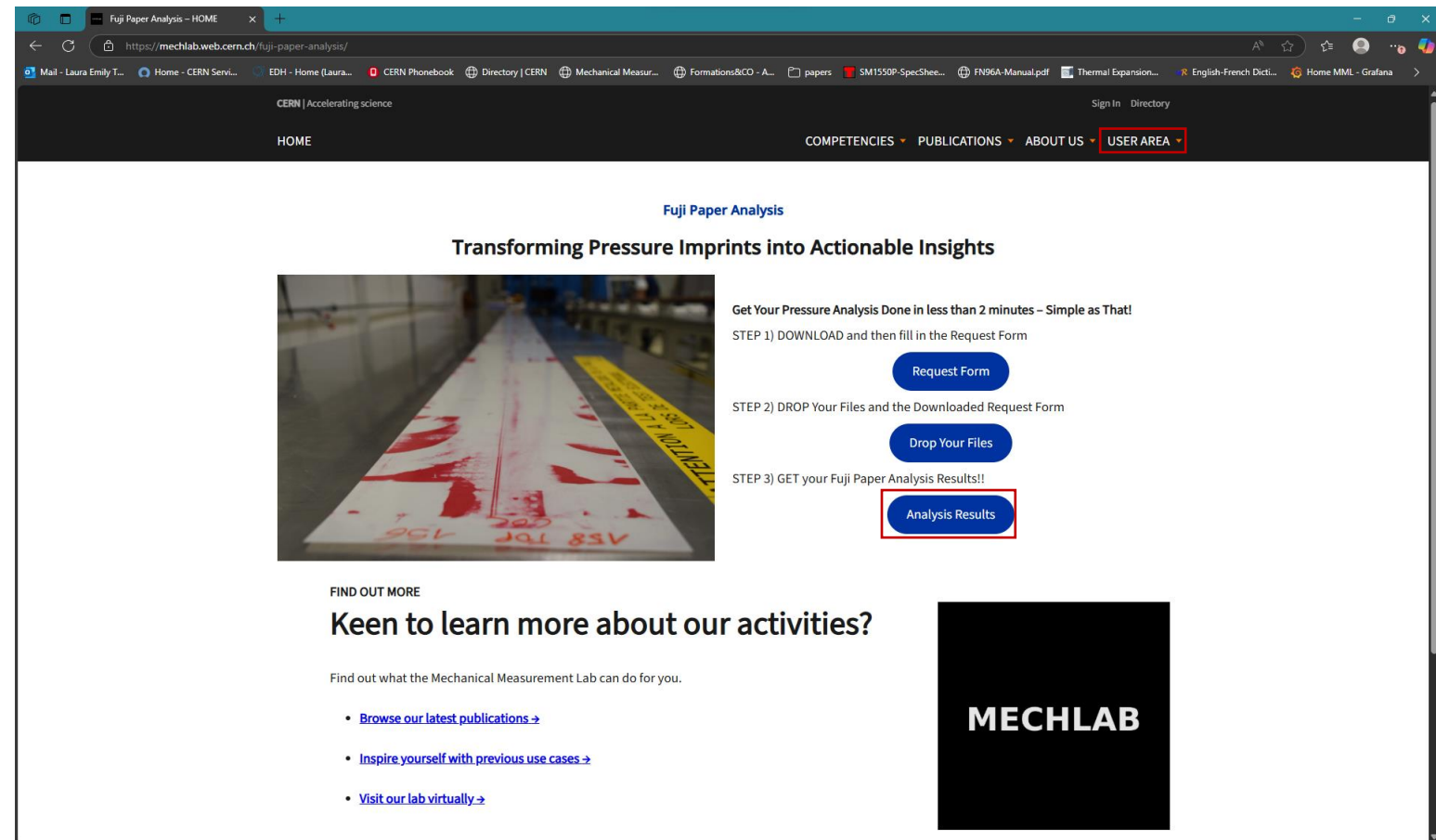
#	MME Laboratory	Fuji Prescale Analysis
0	Project:	Variant O Test 2 (225kN)
1	Operator:	O. Saoristan
2	Test denomination:	Variant_O_Midplanes
3	Test date:	06/03/2023
4	Scan date:	06/03/2023
5	Film grade:	MS
6	Temperature [°C]:	22
7	Relative Humidity [%]:	50
8	Film scan file name:	Variant_O_Test_2_Midplanes.jpg
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/>).



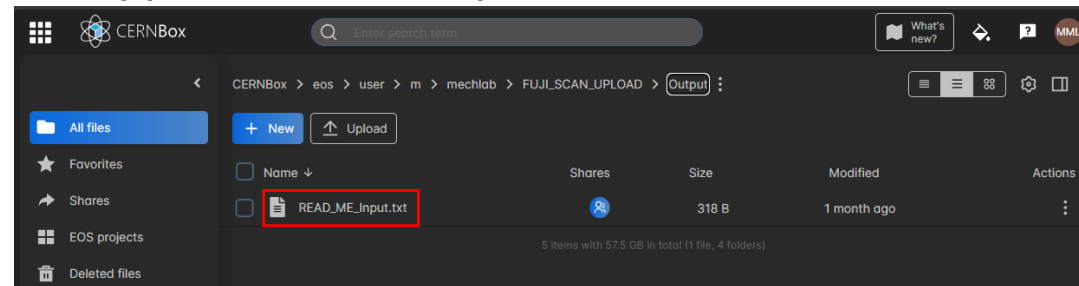
ERROR 401

Unauthorized

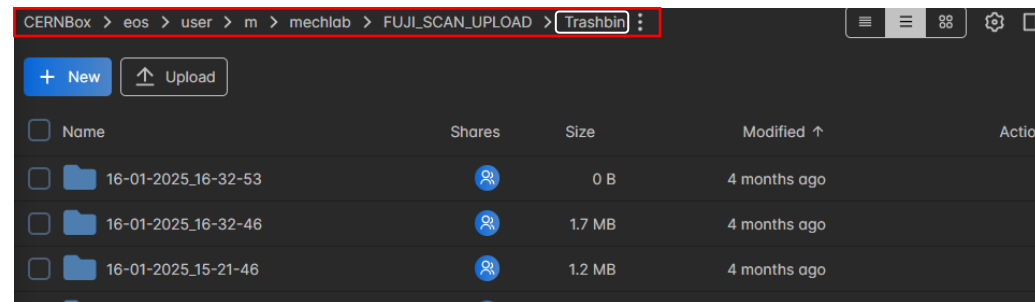
Error Handling

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):

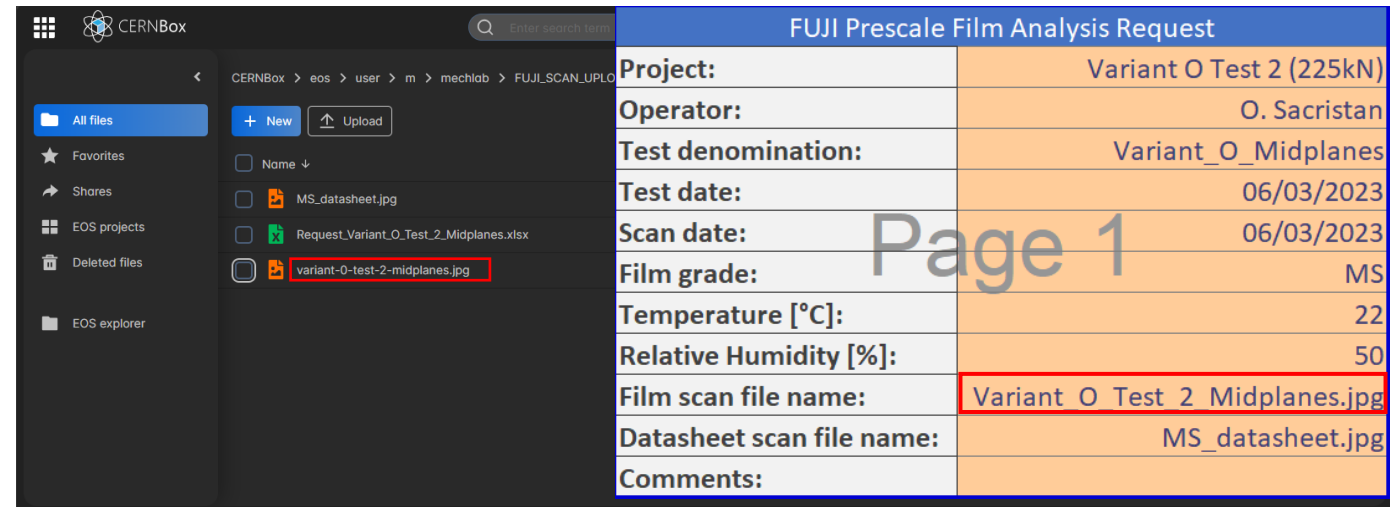


- An email is sent to EN-MME-MML.
- If the issue persists, users are advised to contact EN-MME-MML.

Error Handling

Most common errors include:

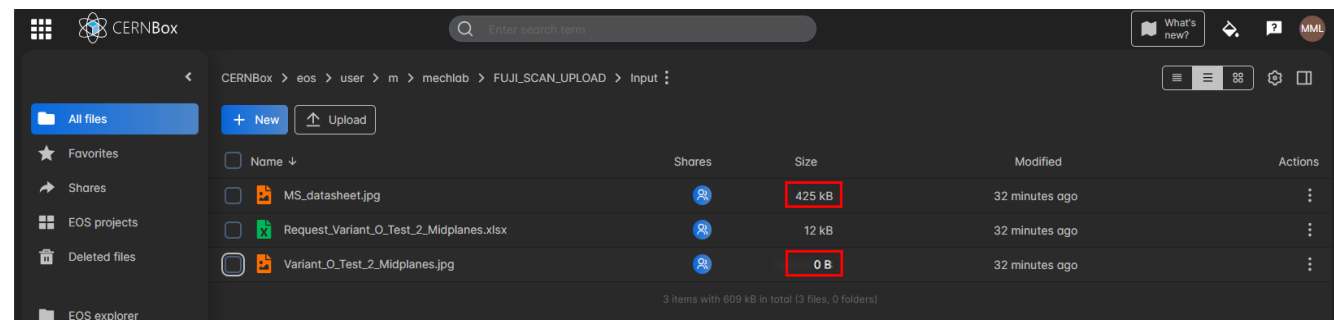
- Discrepancies in filenames:



The screenshot shows the CERNBox interface with a file upload error. The file list shows three files: MS_datasheet.jpg, Request_Variant_O_Test_2_Midplanes.xlsx, and variant-0-test-2-midplanes.jpg. The file variant-0-test-2-midplanes.jpg is highlighted with a red box. To the right, a form titled 'FUJI Prescale Film Analysis Request' contains the following data:

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:	

- Error uploading file/corrupted file:



The screenshot shows the CERNBox interface with a file upload error. The file list shows three files: MS_datasheet.jpg, Request_Variant_O_Test_2_Midplanes.xlsx, and Variant_O_Test_2_Midplanes.jpg. The file Variant_O_Test_2_Midplanes.jpg is highlighted with a red box, and its size is listed as 0 B. The file MS_datasheet.jpg is also highlighted with a red box, and its size is listed as 425 kB. The file Request_Variant_O_Test_2_Midplanes.xlsx is listed with a size of 12 kB. The interface shows a message at the bottom: '3 items with 609 kB in total (3 files, 0 folders)'.

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.

```
283 if film_type == '4LW': #finished, not validated
284     tempAB = [15,30]
285     humAB = [73,70]
286     fit_AB_line= np.poly1d(np.polyfit(tempAB, humAB, 1))
287
288     tempBC = [15,30]
289     humBC = [63,60]
290     fit_BC_line= np.poly1d(np.polyfit(tempBC, humBC, 1))
291
292     tempCD = [15,30]
293     humCD = [57,53]
294     fit_CD_line= np.poly1d(np.polyfit(tempCD, humCD, 1))
295
296     tempDE = [15,30]
297     humDE = [41,37]
298     fit_DE_line= np.poly1d(np.polyfit(tempDE, humDE, 1))
299
300
301 if (fit_AB_line(temperature) <= humidity): #curve A
302     print('I pick curve 4LW A')
303     density=[0.116389960866333, 0.20311968693066, 0.330912815734428, 0.499792501990417, 0.721161788273393]
304     density_color = [1.5, 1.3, 1.1, 0.9, 0.7, 0.5, 0.3, 0.1]
305     pressure=[0.0503529357631384, 0.0752941217526759, 0.100235281892031, 0.125176467881569, 0.150117628026]
306
307 elif (fit_AB_line(temperature) > humidity) and (fit_BC_line(temperature) <= humidity): #curve B
308     print('I pick curve 4LW B')
309     density=[0.116389960866333, 0.20311968693066, 0.330912815734428, 0.499792501990417, 0.721161788273393]
310     density_color = [1.5, 1.3, 1.1, 0.9, 0.7, 0.5, 0.3, 0.1]
311     pressure=[0.0503529357631384, 0.0752941217526759, 0.100235281892031, 0.125176467881569, 0.150117628026]
312
313 elif (fit_BC_line(temperature) > humidity) and (fit_CD_line(temperature) <= humidity):
314     print('I pick curve 4LW C')
315     density=[0.114107858848929, 0.196265537278185, 0.2898339765198, 0.399377505971251, 0.529460580392686,
316     density_color = [1.5, 1.3, 1.1, 0.9, 0.7, 0.5, 0.3, 0.1]
317     pressure=[0.0503529357631384, 0.0752941217526759, 0.100235281892031, 0.125176467881569, 0.150117628026]
318
319 elif (fit_CD_line(temperature) > humidity) and (fit_DE_line(temperature) <= humidity):
320     print('I pick curve 4LW D')
321     density=[0.114107858848929, 0.193983309898112, 0.276140988327367, 0.362862996154101, 0.460995764793193]
322     density_color = [1.5, 1.3, 1.1, 0.9, 0.7, 0.5, 0.3, 0.1]
323     pressure=[0.0503529357631384, 0.0752941217526759, 0.100235281892031, 0.125176467881569, 0.150117628026]
324
325 else:
326     print('I pick curve 4LW E')
327     density=[0.111825631468855, 0.189418980500634, 0.267012454895081, 0.335477145131905, 0.399377505971251]
328     density_color = [1.5, 1.3, 1.1, 0.9, 0.7, 0.5, 0.3, 0.1]
329     pressure=[0.0503529357631384, 0.0752941217526759, 0.100235281892031, 0.125176467881569, 0.150117628026]
330
331
332 if film_type == 'LLLW': #finished, not validated
333     tempAB = [0,35]
334     humAB = [91,70]
335     fit_AB_line= np.poly1d(np.polyfit(tempAB, humAB, 1))
336
337     tempBC = [0,35]
338     humBC = [76,59.5]
339     fit_BC_line= np.poly1d(np.polyfit(tempBC, humBC, 1))
340
341     tempCD = [0,35]
342     humCD = [61,50]
343     fit_CD_line= np.poly1d(np.polyfit(tempCD, humCD, 1))
344
345     tempDE = [0,35]
346     humDE = [46,37]
347     fit_DE_line= np.poly1d(np.polyfit(tempDE, humDE, 1))
```

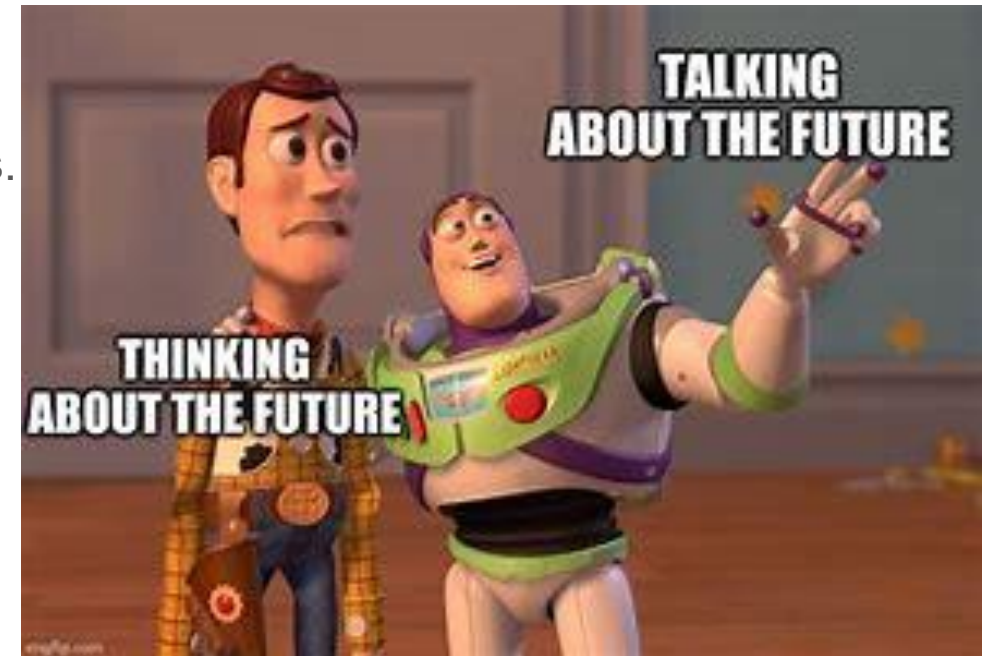
Next Steps/ Future Improvements

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.



The left side of the slide features a dark blue background with a faint pattern of interlocking gears. Overlaid on this is a complex network graph with numerous nodes and connecting lines in a lighter blue color.

Questions?



Thank you for your attention!