TAPPI WEBINARS

## Second of a Five-Part Series

# Use of a Laser to Measure Dust Generated off a PM

## April 22, 2025, 10:00 – 11:00 AM

## Defining Best Available Technology to Deal with Paper Dust Generated off Tissue Paper Machines and Converting Assets


**Welcome and Statement of Antitrust Compliance**

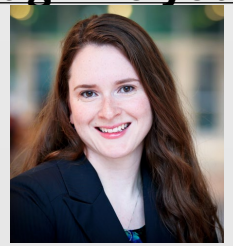
This meeting will be held in accordance with TAPPI's Antitrust Policy and Procedures.

*TAPPI's aim is to promote research and education and to arrange for the collection, dissemination and interchange of technical concepts and information in fields of interest to its members. TAPPI is not intended to, and may not, play any role in the competitive decisions of its members or their employers, or in any way restrict competition among companies.*

TAPPI WEBINARS

**This webinar is brought to you by TAPPI Tissue Division Leadership Team**

Jessica Carette
Cascades Tissue
Dir. Projects R&D



Gary Furman
Nalco - Ecolab
Sr. Corporate Scientist

**TAPPI Tissue Dust Mitigation Committee Leadership Team**

Alfredo Sarli
Valmet Ltd.
Air Systems Applications Specialist

Jeff Peters
BTG – Voith
Tissue Application Manager

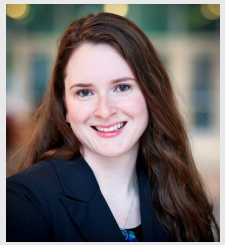
Bud Chase
EDT- Enzymes
Vice President - Tissue

**TAPPI's Tissue Leadership Team**

Robert Davis
TAPPI
Div. Manager for Nanotechnology, Process Control and Tissue

Hannah Peterson
TAPPI
Tissue Division Manager, Awards & Webinars Coordinator

TAPPI WEBINARS



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Jessica Carette, Cascades Tissue and

Gary Furman, Nalco - Ecolab

## TAPPI Tissue Division Activities:

**1- TappiCon 2025 in Minneapolis (May 4th)**
**2- Tissue 101 course (on site at TAPPICon, Full Day on May 4 and 8am to 12 on May 5th & 6th)**
**3- Tissue 201 course (May 13 and 14 at Neenah's Bridgewood Resort)**
**4- TappiSafe Course on Dust Mitigation (online)**
**5- Yankee Dryer Safety and Reliability Committee***
**6- Dust Mitigation Committee***

*To join, or for more info, please contact Robert Davis at: RDavis@tappi.org

# Bio for presenter today

## David Zerr – Host

- BSME from Purdue University
- Paper industry professional having worked at Procter & Gamble, Georgia-Pacific, and now Pulmac Systems International as their VP of Innovation
- Developed and presented over 20 peer-reviewed TAPPICon / PEERS / PaperCon papers.
- Active in TAPPI Tissue, Tissue's Dust Mitigation Committee, and Process Control Group
- Considerable experience within manufacturing, troubleshooting, R&D, QC, Finance and Project Management.
- Awards / TAPPI Involvement:
  - TAPPI Tissue Co-Chair 2018-2019
  - 2020 PIMA Technologist of the Year
  - TAPPI's Top 50 Power List
  - 2025 PIMA Innovator of the Year
  - To be inducted as a TAPPI Fellow at TAPPICon 2025

- 1st - First webinar was a foundational one that introduces use of chemicals to not only reduce dust but leads to enhanced handfeel (Feb 18, 2025)
- 2nd - Use of a laser to measure dust generated off a PM (Apr 22, 2025)
- 3rd - Review Yankee coating packages and doctor blades (TBD)
- 4th - Review use of enzymes (TBD)
- 5th - Use of nanocellulose fibers to help capture paper dust (TBD)

Webinar attendees can earn 1 Hour Credit towards Professional Engineer's Continuing Education. Please email Robert Davis (rdavis@tappi.org) for this certification.

Please ask questions in the Q&A box. These will be addressed in the Q&A.

# Key Learnings from Session I

- **Kemira's Lucyna Pawlowska presentation focused on:**
  - Use of dry strength resins (DSR) coupled with reduction in refining is the most impactful way to reduce dust levels and improve sheet quality.
  - 7-case studies reviewed in depth.

- **Emtec's Eric Haagen presented:**
  - How an Emtec Tissue Softness Analyzer (TSA) works, and use of this tool to categorize handfeel differences.
  - TSA unit utilized to track improvements cited.

- **Link to Session One** - *How Chemistry to Contain Dust on Tissue Paper Machines Affects Handfeel*: **Access the Webinar Recording Here**

# Background: Why focus on dust now?

- Over the last decade, Retail customers have demanded softer bath & towel.

- Regardless of PM technology (Conventional / TAD), manufacturers of premium products have reduced moisture off the Yankee (from ~5% to ~3% moisture levels), substantially increased use of Eucalyptus HW fibers and used softeners to improve handfeel. This drove higher dust levels.

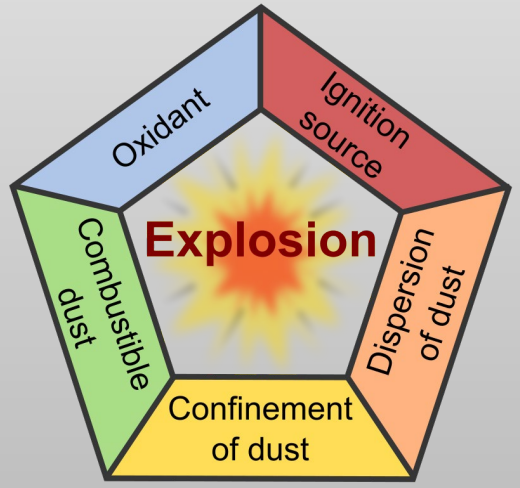
- As products became softer, Retail customers started to complain about excessive dust, particularly in premium bath.

# Why focus on dust now (Continued)

- In turn, tissue producers drove chemical, doctor blade and equipment suppliers to develop cost effective solutions to reduce dust levels.

- How to track progress? That's the challenge. How to determine if changes in pulp furnish, refining, chemistry, doctor blades, enzymes and other technologies are increasing or decreasing the level of fugitive paper dust.

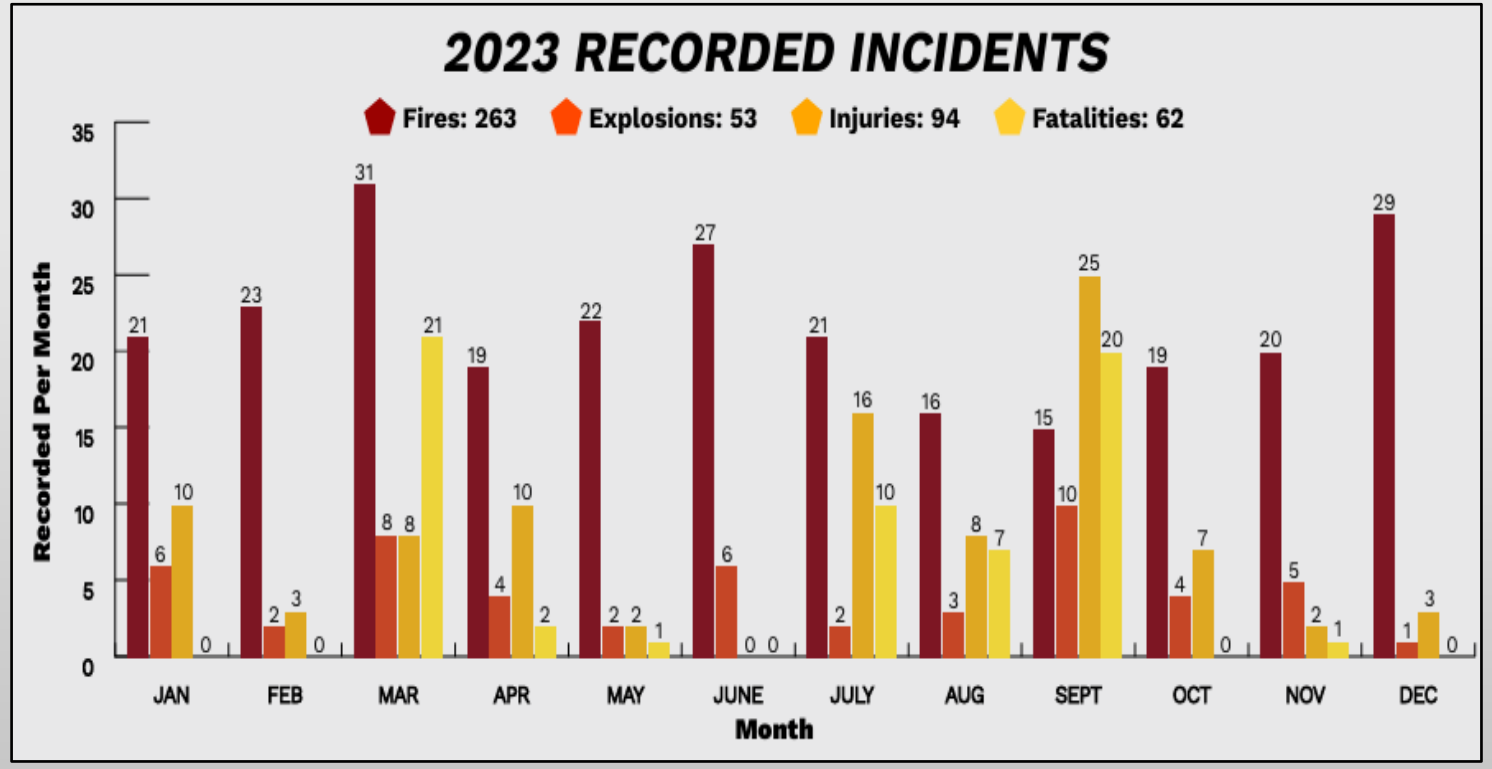
- Further, with more dust, comes a greater risk of fires & explosions in tissue mills.




- *When a dust fire ignites, it is called deflagration. Then, a shockwave is sent around the process equipment, causing accumulated dust in the room to go into suspension.*
- *Once the fire escapes from the process, it creates a source of ignition for the now looming dust cloud in the area. This is secondary deflagration.*
- *Dust fires and explosions are triggered by five events happening simultaneously, this is called the Dust Pentagon*

# Why focus on dust now? Safety Concerns

*Global Incident Overview from P&P Canada article by Dr. Chris Cloney, Jan 16, 2025*




## LOSS HISTORY - UNITED STATES

Loss history from dust explosions in the United States over the last eight years is given in the following table. This data has been collected in the incident database and reported in the 2016 to 2023 combustible dust incident reports.

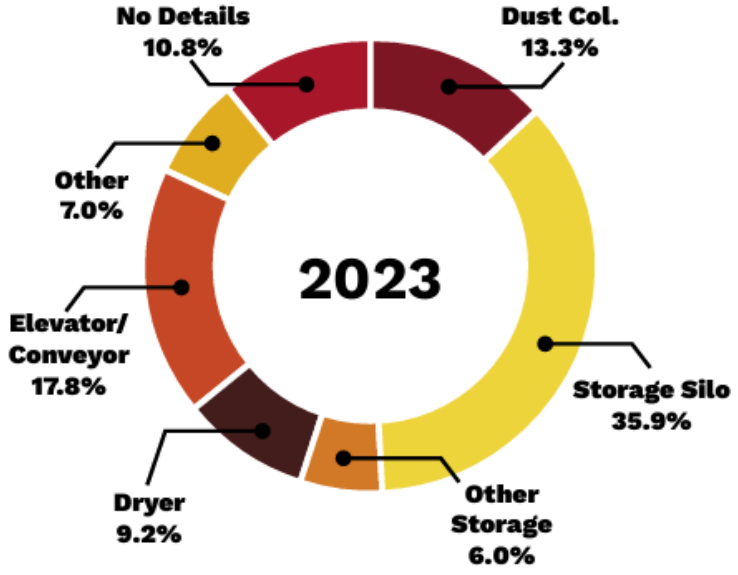
| YEAR | EXP./YEAR | INJ./YEAR | FAT./YEAR |
|---|---|---|---|
| 2016 | 31 | 22 | 3 |
| 2017 | 28 | 43 | 6 |
| 2018 | 37 | 30 | 2 |
| 2019 | 37 | 27 | 1 |
| 2020 | 26 | 23 | 1 |
| 2021 | 19 | 19 | 1 |
| 2022 | 26 | 21 | 1 |
| 2023 | 17 | 16 | 0 |
| 8 year average | 27.6 | 25.1 | 1.9 |

This data gives an average of 28 dust explosions per year, 25 injuries and a range from one to six yearly fatalities over the last eight years. Note that dust fires are excluded in this analysis.

2023-Combustible_Dust_Incident_Report-Version_1.pdf

# Why focus on dust? Safety

## *Global Incident Overview from P&P Canada article by Dr. Chris Cloney, Jan 16, 2025*




### DISCUSSION POINTS

In 2023, storage silos demonstrated the highest percentage (36%) of combustible dust incidents with 93 fires and 20 explosions reported. Dryers and dust collectors were the next biggest sources of incidents, accounting for 18% and 13% each.

Only three dust collector explosions were recorded in 2023 compared to 10 in 2022. These included a flash fire which occurred during a filter change at a 3D printing facility in Shanghai that killed two workers and injured two more, and a dust collector explosion in Wismar,

Germany that injured two. A full breakdown of fires, explosions, and loss can be seen in the table below:

| | FIRES | EXP. | INJ. | FAT. |
|---|---|---|---|---|
| DUST COLLECTOR | 39 | 3 | 8 | 2 |
| STORAGE SILO | 93 | 20 | 35 | 12 |
| OTHER STORAGE | 17 | 2 | 1 | 0 |
| DRYER | 52 | 4 | 6 | 21 |
| ELEV./CONV. | 24 | 5 | 9 | 0 |
| OTHER | 17 | 5 | 16 | 2 |
| NO DETAILS | 21 | 13 | 19 | 25 |
| **TOTAL** | **263** | **53** | **94** | **62** |

Of the incidents where the equipment is known, 21 fatalities came from elevators/conveyors, 10 from storage silos, two from dust collectors and two from an aluminum melting furnace explosion. The 21 fatalities from conveyor belt systems are attributed to two coal mine fires in Panguan, China and Karaganda, Kazakhstan, respectively.

Incidents where no details were provided for the equipment made up only 11% of the total reported. However, these incidents made up 20% of the reported injuries and 40% of the reported fatalities. These incidents included a coal dust explosion in a mine in Columbia, a sugar facility explosion in Tanzania, a housing materials facility explosion in Japan, a battery manufacturer explosion in Sweden, a grain dust explosion in Decatur, Illinois and a sawdust explosion at a molding manufacturer in the UK.

It has been estimated that the *unreported* incident rate on fires and injuries is over 90% worldwide.

As in safety incidences, there are numerous near misses or injuries that go unreported.

# Why focus on dust? Safety

## *Global Incident Overview from P&P Canada article by Dr. Chris Cloney, Jan 16, 2025*

2023 COMBUSTIBLE DUST INCIDENT REPORT

**INCIDENT DATA**

***INCIDENT DATA OVERVIEW***

| | UNITED STATES | | | | | CANADA | | | | | INTERNATIONAL | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2021 | 2022 | 2023 | 2019 | 2020 | 2021 | 2022 | 2023 | 2019 | 2020 | 2021 | 2022 | 2023 |
| Fires | 175 | 116 | 98 | 79 | 75 | 22 | 14 | 8 | 9 | 14 | 53 | 35 | 57 | 75 | 174 |
| Explosions | 37 | 26 | 19 | 26 | 17 | 1 | 7 | 3 | 0 | 2 | 37 | 27 | 30 | 24 | 34 |
| Injuries | 42 | 35 | 26 | 24 | 21 | 4 | 2 | 9 | 0 | 0 | 72 | 51 | 180 | 65 | 73 |
| Fatalities | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 7 | 9 | 64 | 48 | 62 |

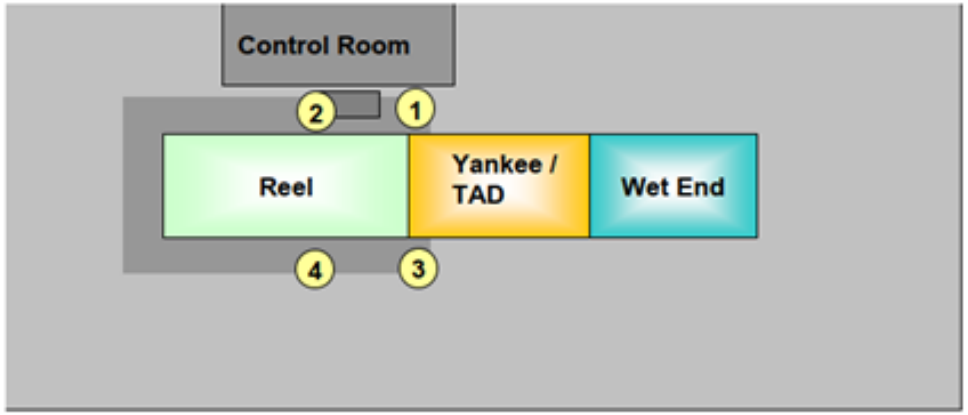
Combustible dust incidents remain a global challenge in facilities that process fine, flammable particles like wood, grain, and coal. **In 2023, fires accounted for most incidents and injuries, while explosions were responsible for most fatalities (66%).**

2023 is the latest available data on the Combustible Dust Incident Report.

# Use of a Laser to Measure Fugitive Paper Dust on a PM

Intent is to provide a hands-free measurement tool that will automatically read and record fugitive paper dust on a paper machine or converting asset. This will be the hard-wired version. A Mobile-version will be described late.

Figure 1 – Dust Mapping Locations




Test procedure

Dust levels will be measured according to NIOSH Methods 0500 (gravimetric sampling at fixed locations within the machine room). A description of the sampling locations is included below.

Location 1 – T/S Creping Doctor, 1m outside dust enclosure.

Location 2 – T/S at control panel, 1m (location of the panel is approximately 1 m away) outside dust enclosure.

Location 3 – D/S at Creping Doctor, 1m outside dust enclosure.

Location 4 – D/S at reel, 1m outside dust enclosure.

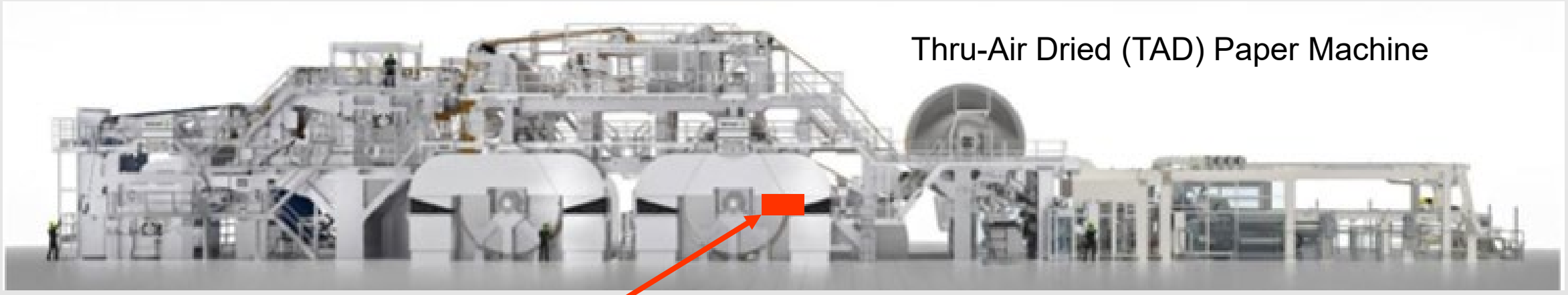
For this initial dust mapping location, intent is to place the laser on the drive side by the creping doctor (Location # 3).

The laser can be placed between 24” to 36” away and still have an accurate measurement.

# Details on the Laser to Measure Fugitive Paper Dust off a PM

Intent is to configure the laser to measure paper dust height on a flat surface near / on the paper machine. This is the hard-wired unit.

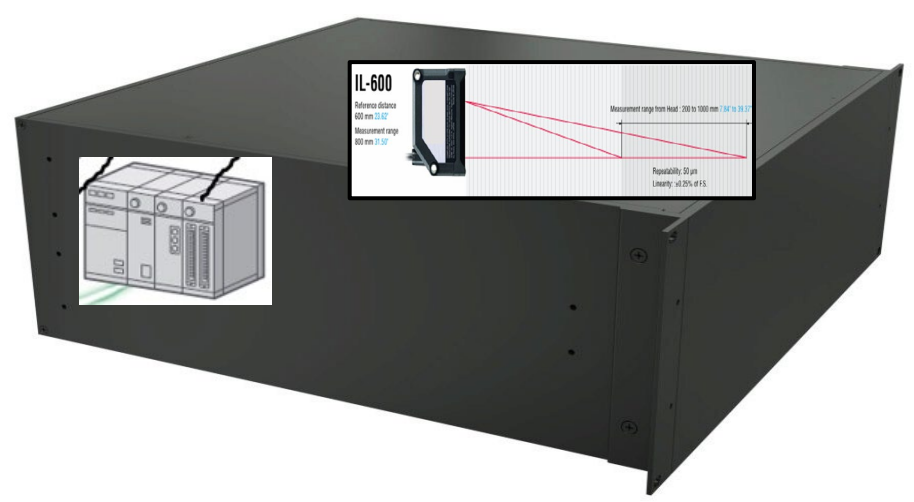

- **Measure distance** range for this laser series is 7.8” to 39.4” (200 mm to 1000 mm)
- **Repeatability** is 0.002 inches (50 um = 0.0005 mm = 0.002 inches)
- **Thickness accuracy** is roughly the cross-section thickness of a human hair.
- **Longer distance lasers (up to 11.5 LF) available,** but this unit was chosen as a practical distance from the head to the surface being measured.
- **Unit has a dedicated calibration mode** to allow calibration in 3 easy steps.
- **Ambient light elimination function** is included.
- **Distance from PLC to DCS 300 LF Max**





Red box represents where the Laser would be placed, but on drive side

# Components added to ensure reliability and repeatability



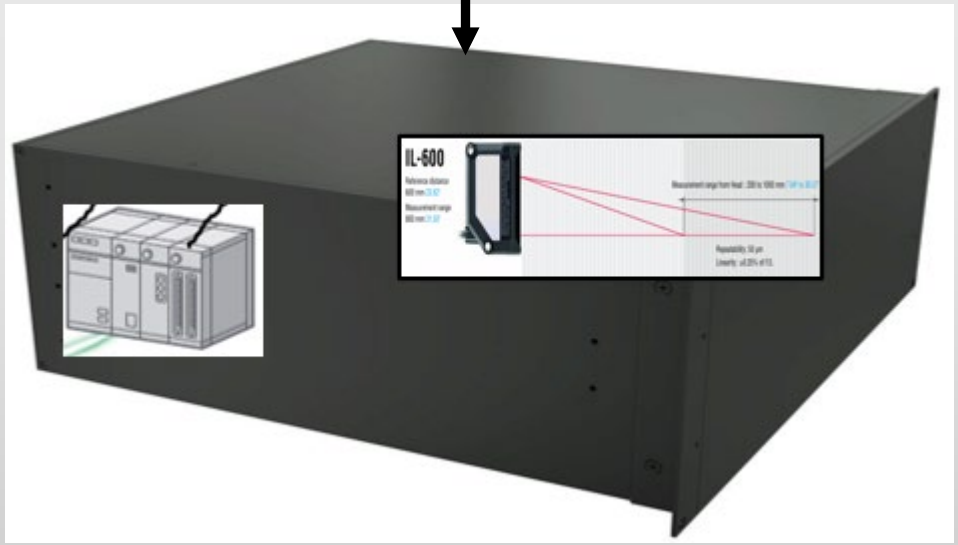

Climate Control Unit for the NEMA 4 enclosure; Blower to remove fugitive dust at observation site & in front of laser window; Vibration isolation pads included for electronics and junction box.

NEMA 4 Junction Box, carbon steel, powder coat finish. Houses the Din Rail Mount Amplifier, PLC, Ethernet (TCP / IP) Network Unit, Cables, misc. parts. PLC can handle up to 8 lasers per paper machine / converting asset.

Laser* Reference distance: 600 mm (23.6”), red semiconductor laser, Wavelength 655 nm (visible light, Class 2 Laser Class, 560 uW Output, Operating Temp Range 14F to 122F. Laser will be flush against the polycarbonate window.

*The Class 2 Laser deployed is a low-powered, visible-light laser that is generally safe if you don't stare into the beam. Our laser has a 655 nm wavelength. The main safety requirement is to avoid intentionally looking into the laser for more than a quarter of a second. Per OSHA, Class 2 lasers emit in the visible wavelength range 400 – 700 nm and have sufficient power output to cause damage to the eyes if viewed continuously. However, their outputs are low enough where eye protection is afforded by the blinking reflex. Additional hazard control measures take the form of cautionary signs or labels.

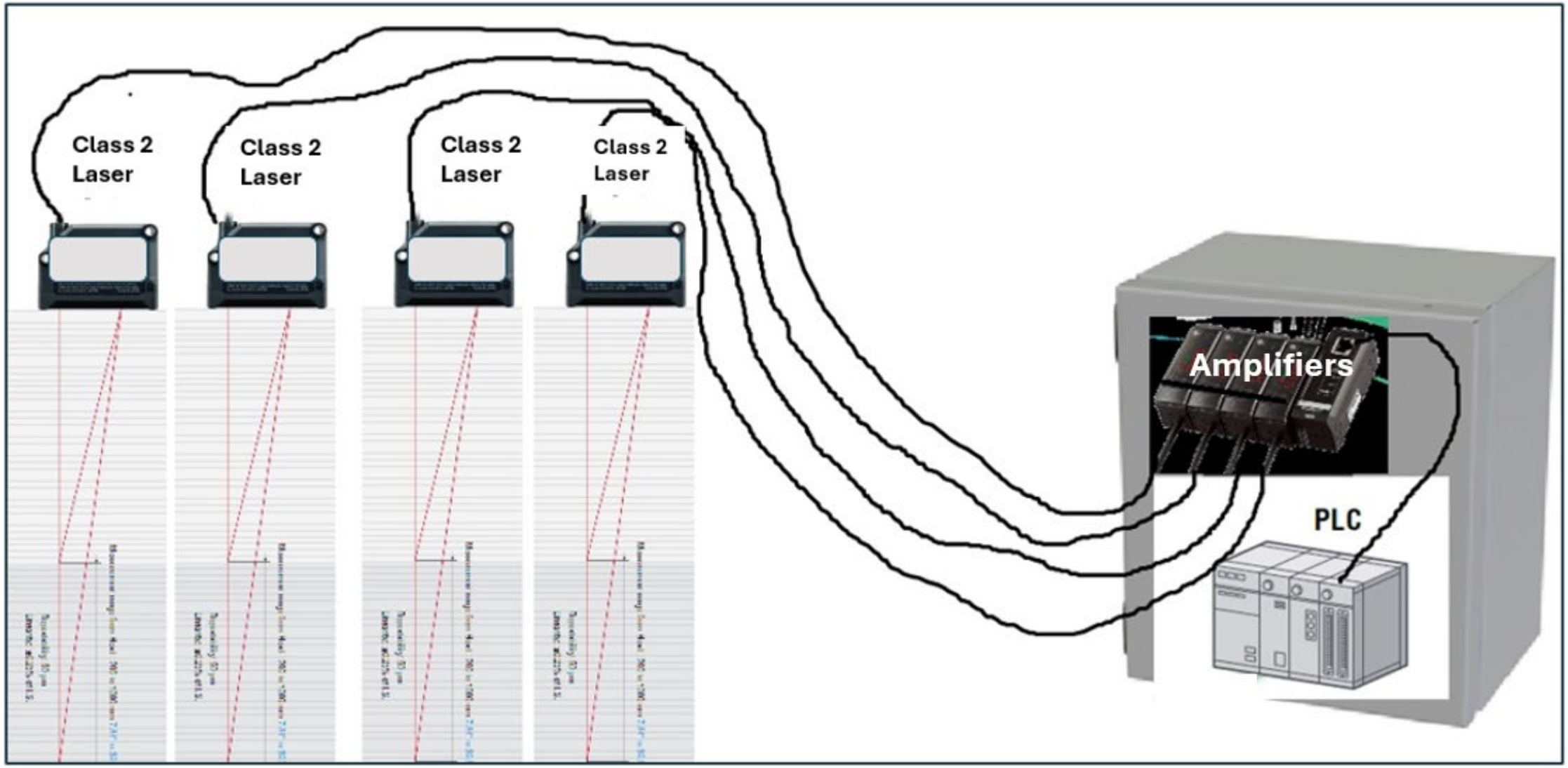
# Overall Layout of the Laser, Amplifier, PLC and Connection to DCS / HMI




NEMA 4 Junction Box, carbon steel, powder coat finish. Houses the Din Rail Mount Amplifier, PLC, Ethernet (TCP / IP) Network Unit, Cables, misc. parts. PLC can handle up to 8 lasers per paper machine / converting asset.

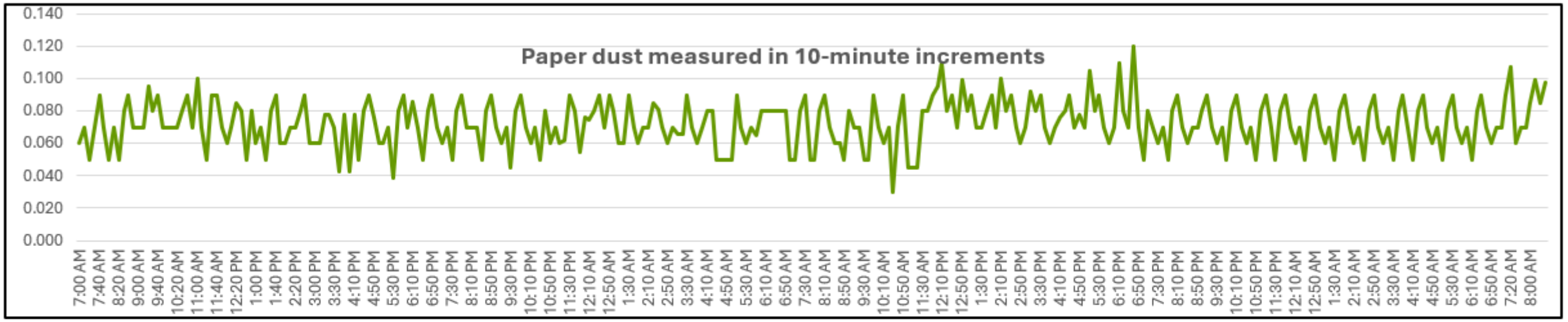
Connects to the Paper Machine's DCS or to an HMI in Converting

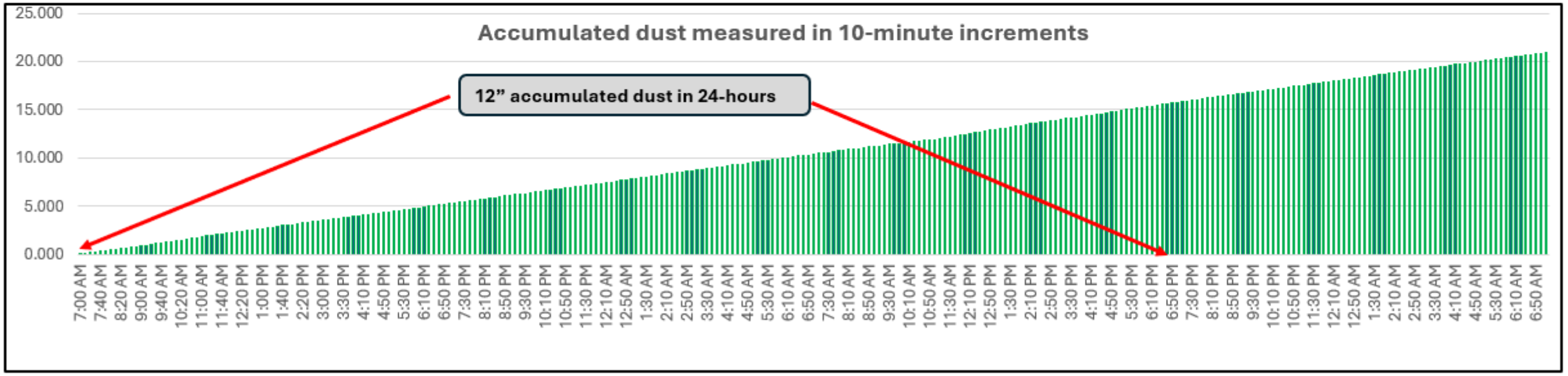
# Each laser requires an amplifier. One PLC can handle up to 8 Lasers



# Expected Operational Performance

- Height measurement is taken every 10-minutes (adjustable)
- After measurement taken, a blast of air will clear off the test surface & the polycarbonate window to ensure clear visibility for the laser.
- Height measurement then fed to amplifier and then into the PLC.
- Communication from PLC to PM's DCS can be in several protocols, Modbus TCP/IP will likely be used.
- Height data will be time stamped to correlate with grade running, trials, etc.
- Built in histograms will be available in the DCS, and would be capable of displaying current histograms, and past runs by grade, previous trials and downloadable to authorized personnel for report writing, comparisons between grades and other graphs.
- Provides dust rates per hour, per shift, per day, etc. and being time stamped will be able to compare past runs by grade, trials, etc.


Paper dust measured in 10-minute increments
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000


Accumulated dust measured in 10-minute increments
12” accumulated dust in 24-hours
25.000
20.000
15.000
10.000
5.000
0.000

# Mobile Laser Unit to Measure Fugitive Dust

- Mobile unit allows easy movement from one PM to another or Converting Assets.
- Key functionality - Determine if changes in pulp furnish, refining, chemistry, doctor blades, enzymes and other technologies are increasing or decreasing the level of fugitive paper dust. This allows a scientific method to quantify progress.
- Differences on the mobile unit to the hard-wired unit:
  - Essentially, the only difference between the two is the mobile cart with lockable wheels.
  - Only 120 VAC Power is required.
  - Communications can be either wirelessly reported or by plugging a laptop into available ports on the NEMA 4 enclosure.

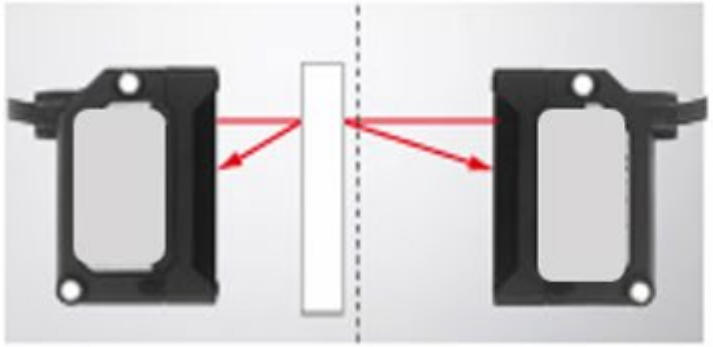
# Key Benefits to Customer / User

- Once a baseline is established, this provides a definitive fugitive dust measurement:
  - By grade
  - By hour / shift / day
  - By trial – Can measure effectiveness of trials (e.g., less refining, more dry strength resins; New Doctor Blades; Use of Enzymes, etc.
- Being time stamped and in the DCS/ HMI/ PLC, this allows data to be reviewed as needed to view past grade measurements vs. current.

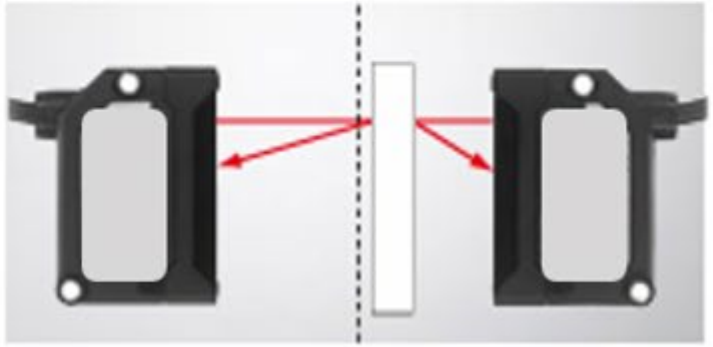
# Thickness calibration function included

**3-step easy calibration** With conventional devices, calibration had to be conducted on each and every individual sensor head, however, as the IL Series has a dedicated mode that allows calibration to be completed in 3 simple steps.

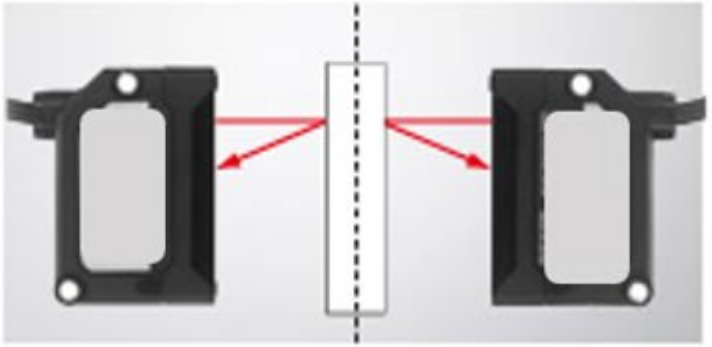
*Step 1* Bring the target close to one sensor head and input the thickness data, then push the set button.



*Step 2* Bring the same target used in Step 1 close to the opposing sensor head and push the set button.



*Step 3* Insert a target thicker than the target used in Step 2. Input the thickness data. Then pushing the set button completes calibration.

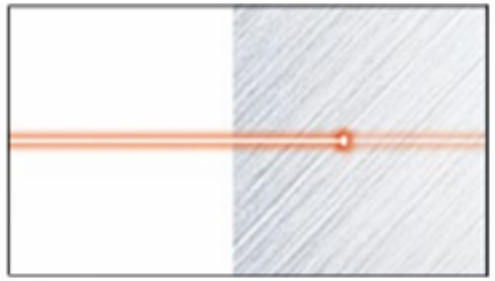


When bringing the target closer to the sensor head in Steps 1 and 2, you are compensating for the misalignments that occur during installation. To set, you can begin with either one of the sensor heads.

# Different measurement backgrounds can be dealt with

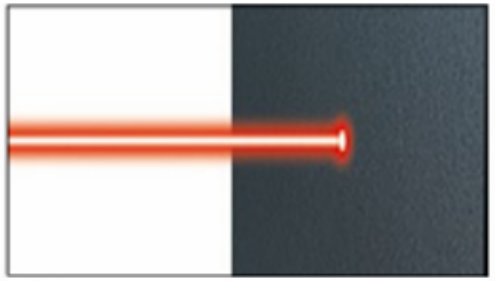
## Laser and amplifier adjust automatically to different backgrounds

Based on where the dust is being measure, system automatically adjusts required power for the laser to effectively read dust levels. With this design, both mobile & hard-wired units will have a consistent background to read against.



**Reduced power**

When the workpiece is highly reflective



**Increased power**

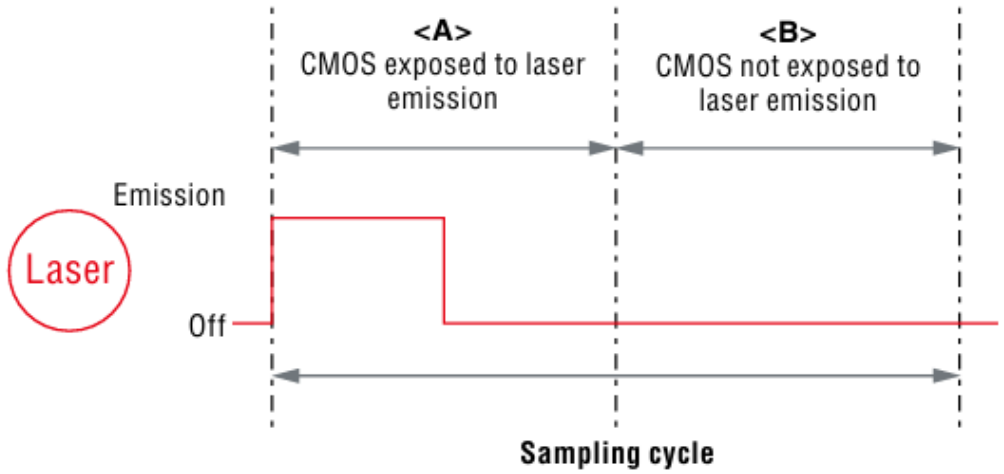
When the workpiece is dark

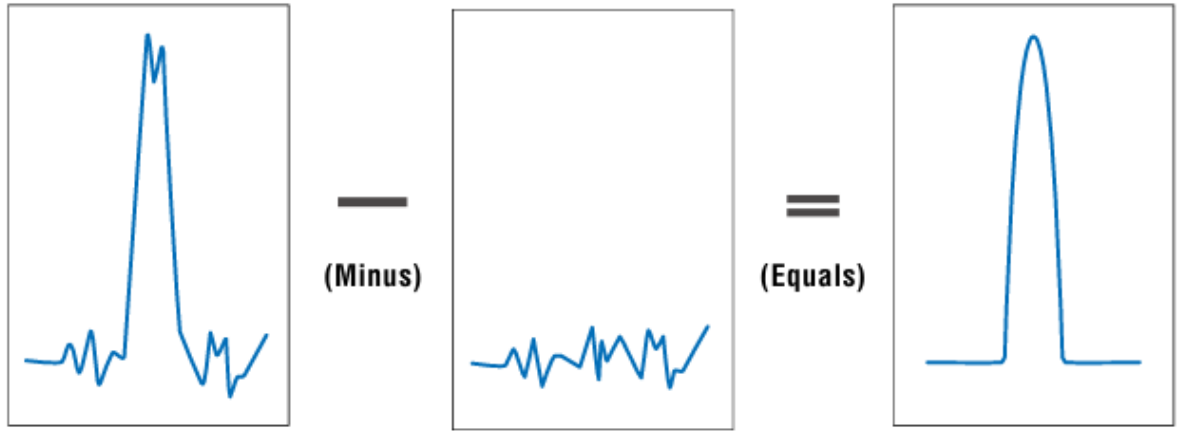
## Laser has a rugged head structure

**Laser structure was designed to make it withstand almost any environment. The optical base uses die cast 304SS for added strength and protection.**

# Ambient light can present an issue unless it's accounted for

Variations in ambient lighting can interfere with a laser's measurement capabilities. This laser proactively adjusts to variations in ambient lighting automatically by setting the sampling rate to 2 or 5 milliseconds, thus reducing effects of ambient lighting.




** CMOS Laser displacement sensors are advanced sensing devices that utilize Complementary Metal-Oxide-Semiconductor (CMOS) technology to measure the distance, thickness, and position of objects with exceptional precision.*

# In Summary:

- This laser tool provides a definitive means to track fugitive paper dust generated on paper machines and converting assets.
- Being time stamped, allows tracking by grade, shift, past runs and provides built in graphics to plot progress.
- Once baselines are set, provides an in-depth determination if changes in pulp furnish, refining, chemistry, doctor blades, enzymes and other technologies are increasing or decreasing the level of fugitive paper dust.
- Technology is built to withstand the hot, humid, and dusty environments of Tissue Paper Machines and Converting.


Thank you.

Let’s open this up to questions from the audience

David Zerr, Pulmac’s VP of Innovation
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