IMG INDUSTRIAL MOISTURE GATE

IMG-S · STRAW BALES

Industrial Moisture Gate for Straw Bales

Real-time, precise moisture data from within all the bales — within one minute.

DUNAKONTROLL
MOISTURE INTELLIGENCE



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- 3.3 Measurement Process
- 3.4 Installation & Calibration
- 3.5 Handover Acceptance Criteria
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01

About Dunakontroll

Moisture measurement solutions for fibrous materials — born in the paper industry.

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01 · ABOUT DUNAKONTROLL

Rooted in the paper industry

1994

Born in Hungary, within the grounds of one of Central Europe’s largest paper mills.

2013

Launch of the first generation of HPNAs.

Global

Strong international presence.

Ownership

Austrian ownership with a lifelong career in the paper industry.

Management

Hungarian management.

Team

Professionals, engineers, mathematicians, physicists and an emeritus professor.

Brand

Rebranding activities.

Industries & product family

Depending on the client's needs, **Dunakontroll** can develop additional moisture content measuring equipment for other fibrous materials and grains.

Pulp and Paper

IMG-P

Industrial Moisture Gate for Waste Paper Bales

Wood

IMG-W

Industrial Moisture Gate for Wood Logs

Wood

Chips

Wood Chip Moisture Gate on Conveyor Belt

Pulp & Biomass

IMG-S

Industrial Moisture Gate for Straw

01 · IMG WORLD MAP

IMG installations worldwide



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02

The challenge

Measuring moisture content in the processing industry.

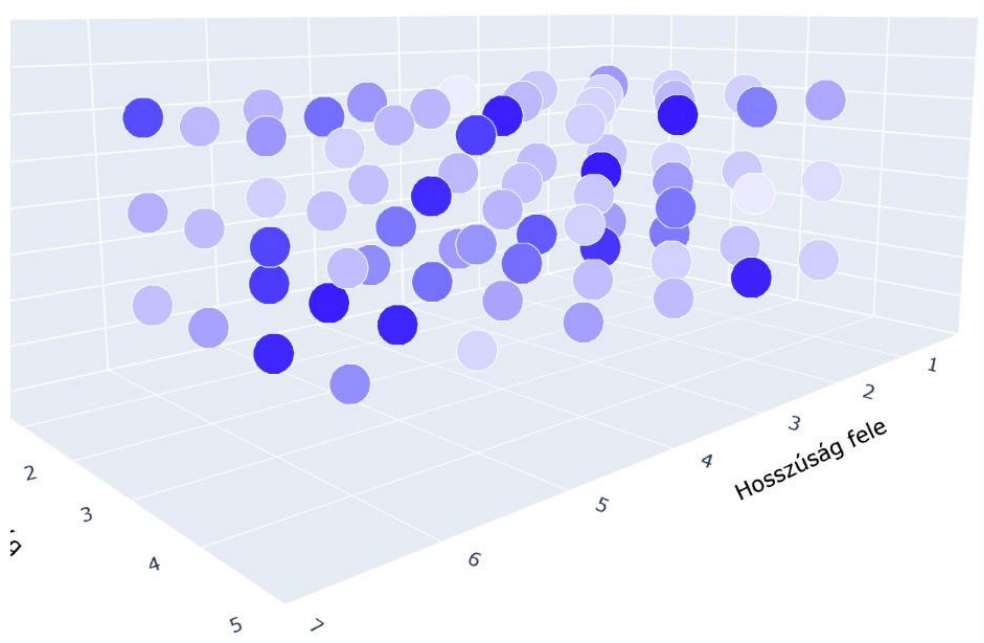


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02 · THE CHALLENGE

Highly inhomogeneous moisture

EXAMPLE OF MOISTURE DISTRIBUTION INSIDE A BALE

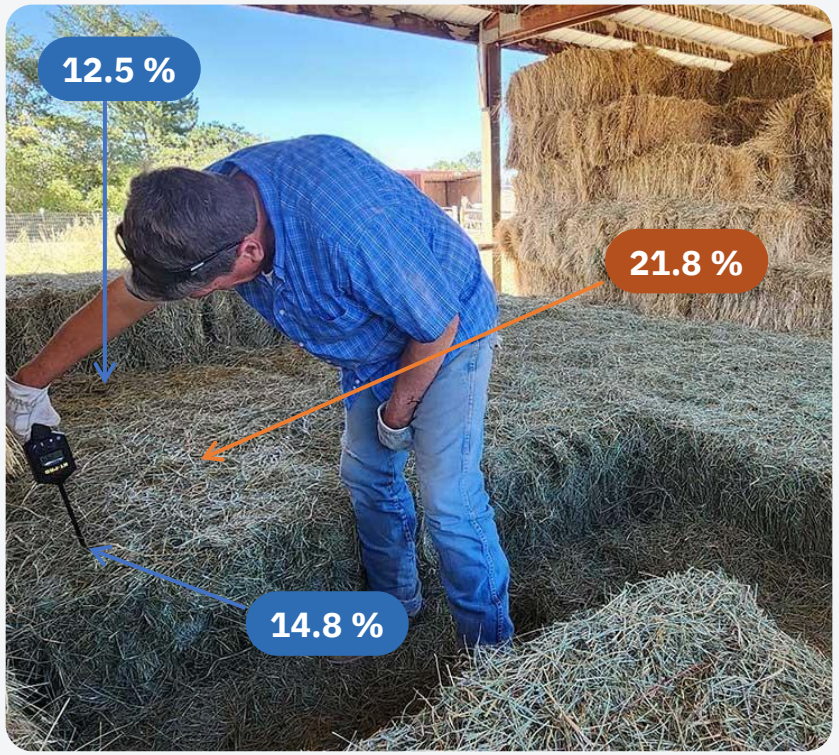


Wetter and drier spots are scattered unpredictably through the whole bale.

A single reading — or even a handful — cannot describe the bale as a whole.

02 · THE CHALLENGE

The surface does not tell the truth



By taking readings only outside the bale, you will NOT get even an indication of the overall moisture inside it.



Surface — extremely wet outside



Inside — dry

Hand-held methods only measure:

- at selected spots and at a certain depth
- a very limited portion of the total volume
- without proper calibration

The readings do not represent the moisture of the whole bale

02 · THE CHALLENGE

What precise measurement demands

How to accurately measure the moisture content of the raw material...

1. in a representative manner
2. in large quantities
3. in a short time
4. without any human intervention
5. and provide decision-makers with transparent, real-time data?



03

IMG-S

Industrial Moisture Gate for Straw Bales — the system, requirements, process, installation, acceptance criteria and benefits.



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3 · INDUSTRIAL MOISTURE GATE FOR STRAW BALES

The whole load, in one minute



A moisture measurement system for fibrous materials, using microwave technology to determine the average moisture content of entire loads.

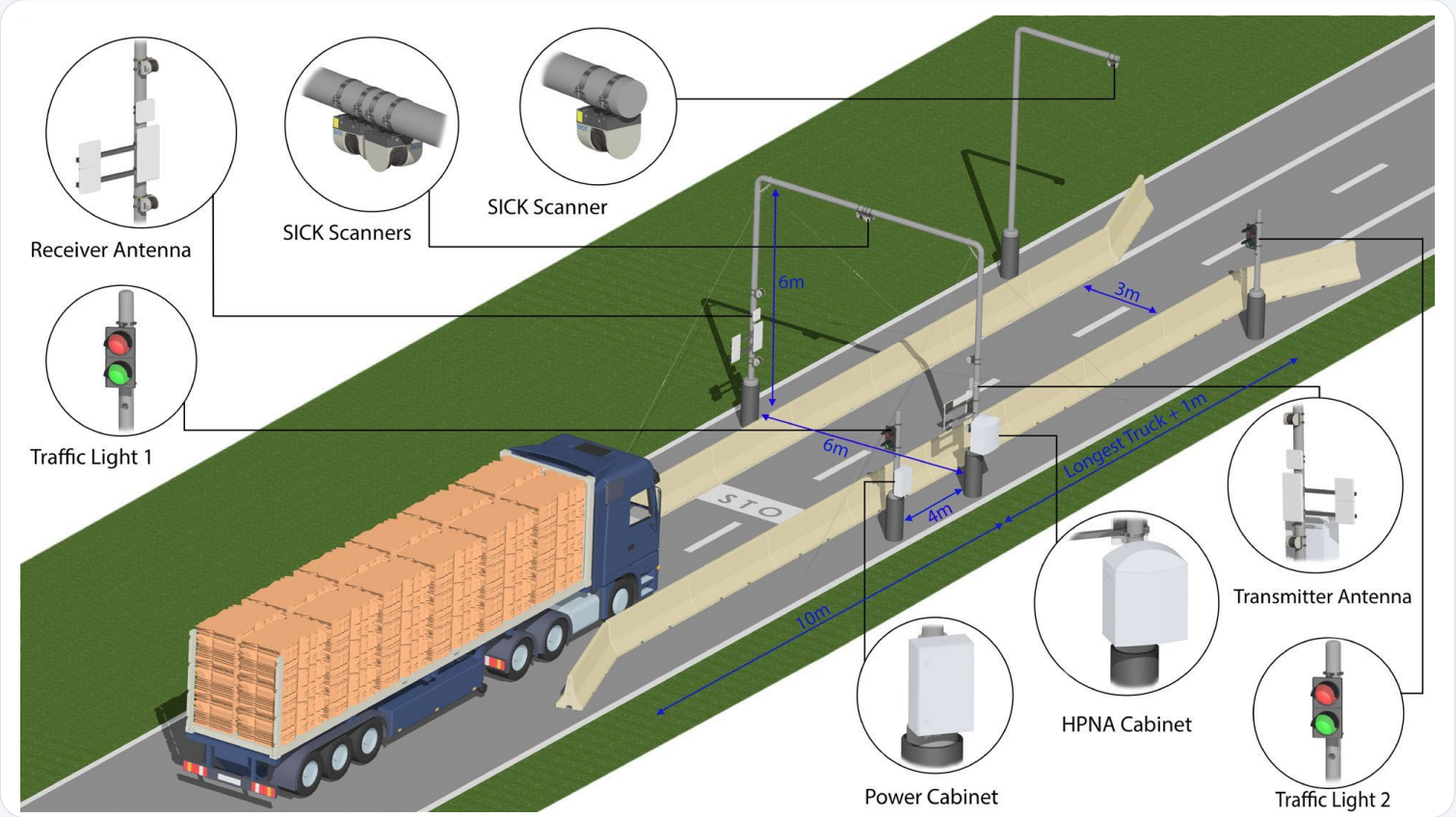
< 1 min
per load

100 %
of the bales measured, from within

Real-time, precise moisture data from within all the bales.

3.1 · THE SYSTEM

The gate at a glance

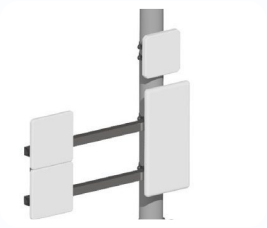


MAIN COMPONENTS

- Receiver & transmitter antennas
- SICK 3D scanners
- Traffic lights 1 & 2
- IMG cabinet
- Power cabinet

3.1 · THE SYSTEM

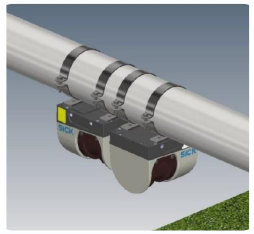
Two systems collect the data



MEASURES WATER

Microwave system

Generates multiple polarised, low-power electromagnetic fields. Variations in these fields, caused by the presence of water, provide information about the water content of the load.



MEASURES GEOMETRY

3D optical system

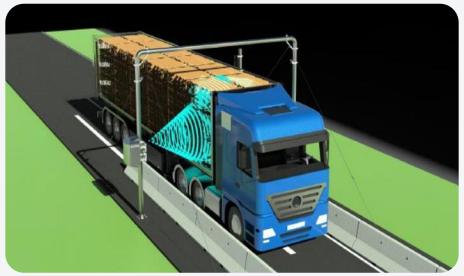
Collects physical data on the load — width, length, speed, and the start and end points of the load. This data controls the microwave system and is used to calculate the load parameters.

3.1 · THE SYSTEM

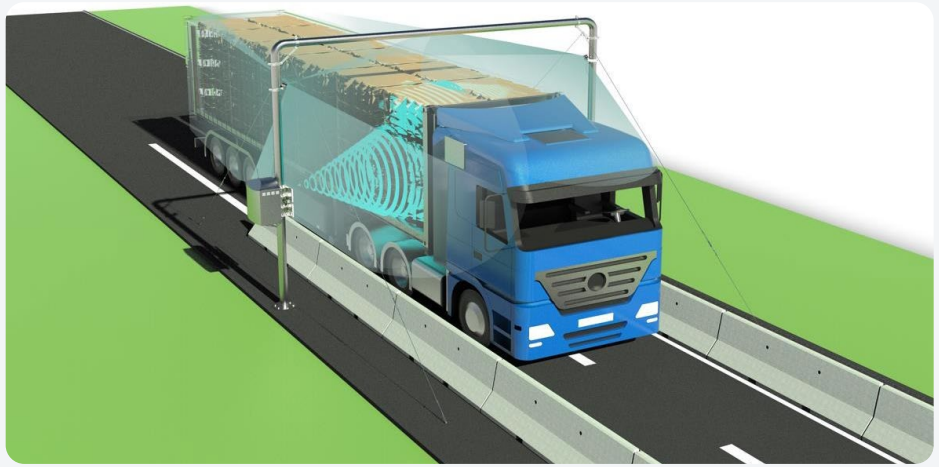
One integrated measuring unit



Microwave unit



Optical system



The microwave unit and the optical system work as one integrated unit.

PARAMETERS OF THE MEASURING SYSTEM

6 – 50 %
measuring range, gross moisture content

max. 930 MHz
signal frequency fk (ISM band)

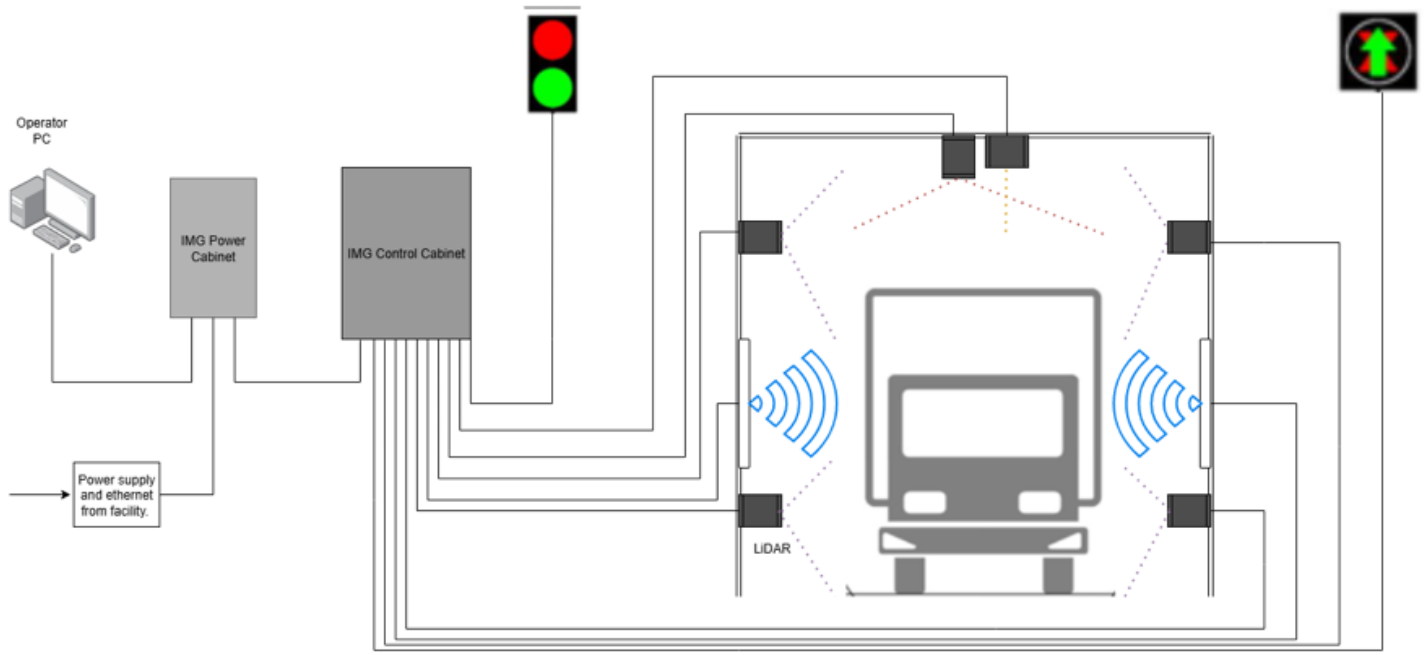
10 mW
signal power

≈ 6 m
distance sender – receiver

≈ 70 dB
microwave dynamics

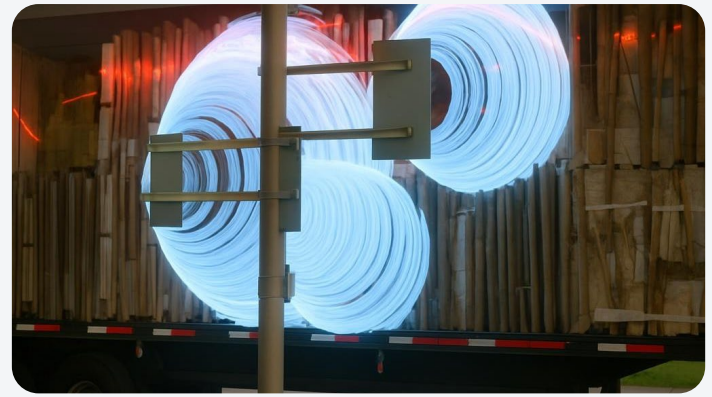
3.1 · THE SYSTEM

Circuit diagram



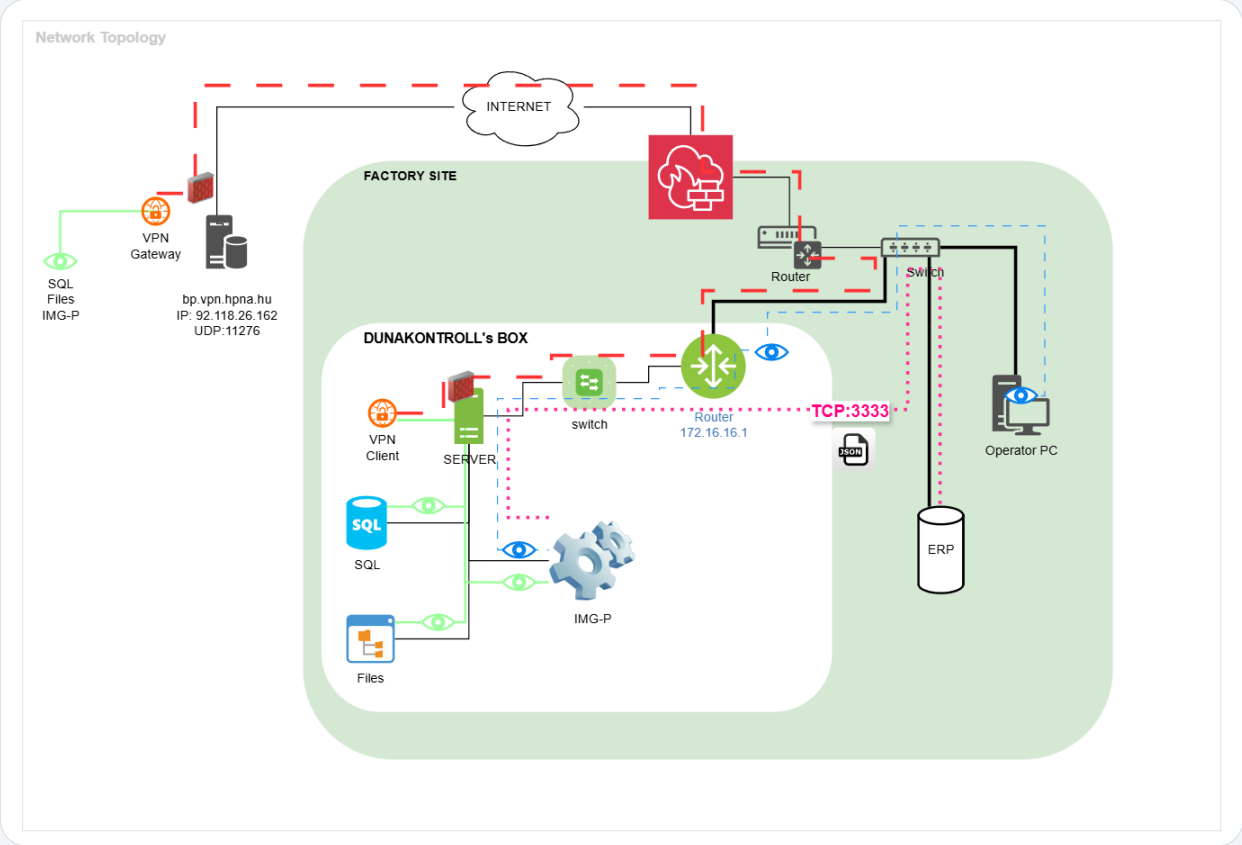
Note: All 6 scanners are installed at the 1st gate, and Scanner #7 is installed at the 2nd gate.





3.1 · THE SYSTEM

IT communication scheme



Dunakontroll's box on site

Server, SQL database, file storage and the IMG software behind its own router and firewall.

ERP integration

Results are passed to the mill's ERP as JSON over TCP (port 3333).

Operator PC

Connected through the factory switch.

Secure VPN link

Encrypted connection between the site and Dunakontroll.

3.2 · MEASUREMENT REQUIREMENTS

What the load needs

1.6 m
minimum load height (excluding metal gates or similar) — no maximum

1.7 m
minimum load width

≤ 5 km/h
truck speed passing the antennas

- **Minimal space** between the bales in the lengthwise direction.
- The scanners **must "see" the entire load**: remove tarpaulins on open deliveries; on closed deliveries pull the side curtains back — towards the cabin on one side, towards the rear on the other.
- **Horizontal metal bars** securing the load must be removed before measurement.
- Loads in **metal containers cannot** be measured.





3.3 · MEASUREMENT PROCESS

Manual or automatic, in five steps

1

Data entry

Manual: entered through the Dashboard.
Automatic: sourced from the ERP system.

2

Start measurement

Manual: operator clicks START.
Automatic: triggered by the ERP, card-reader kiosk, ANPR camera, etc.

3

Measurement

Fully autonomous. Traffic lights direct the truck; the 3D optical system tracks its position in the zone.

4

Data processing

When the truck leaves the zone, the system calculates the average moisture content of the load.

5

Display & send

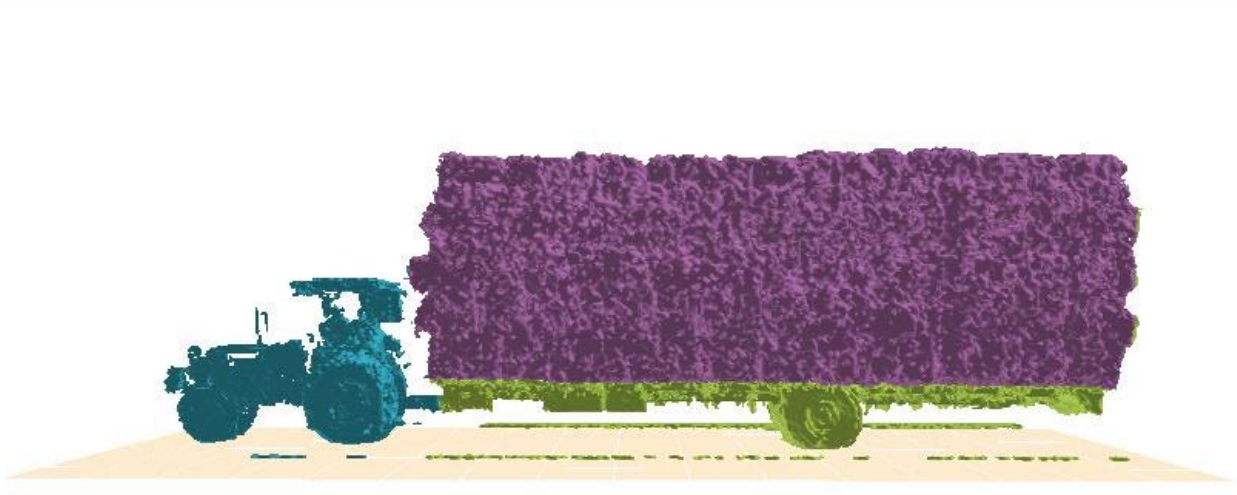
The result is shown on the Dashboard and sent to the ERP system if connected.

CORE DATA **Truck ID · Net weight · Paper type**

Automatic mode integrates with the mill's ERP (e.g. SAP) for greater efficiency.

3.3 · MEASUREMENT PROCESS

3D optical load detection



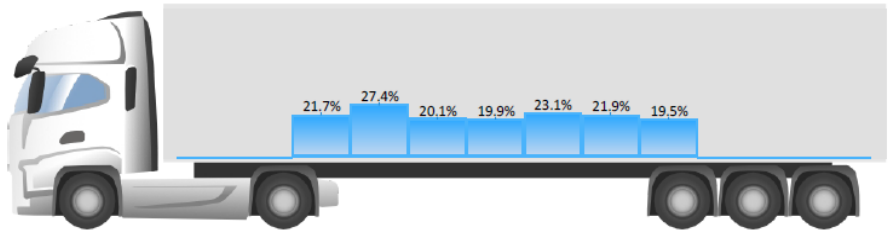
POINT CLOUD MODEL

An open truck loaded with straw, reconstructed in 3D as it passes the gate.

A report for every truck

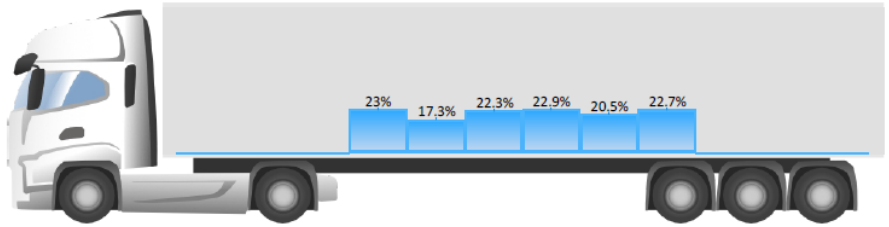
Measurement		
	Date/Time:	x/x/2026 11:15:06 PM
	Ticket Number:	12345
	Plate No.:	ABCDE 12
	Paper Grade	Big Bale
	Supplier:	xxx
	Weight:	11190
	Moisture Average:	22.0 %

Profile:



Measurement		
	Date/Time:	x/x/2026 9:44:47 AM
	Ticket Number:	12345
	Plate No.:	ABCDE 12
	Paper Grade	Big Bale
	Supplier:	xxx
	Weight:	11630
	Moisture Average:	21.4 %

Profile:

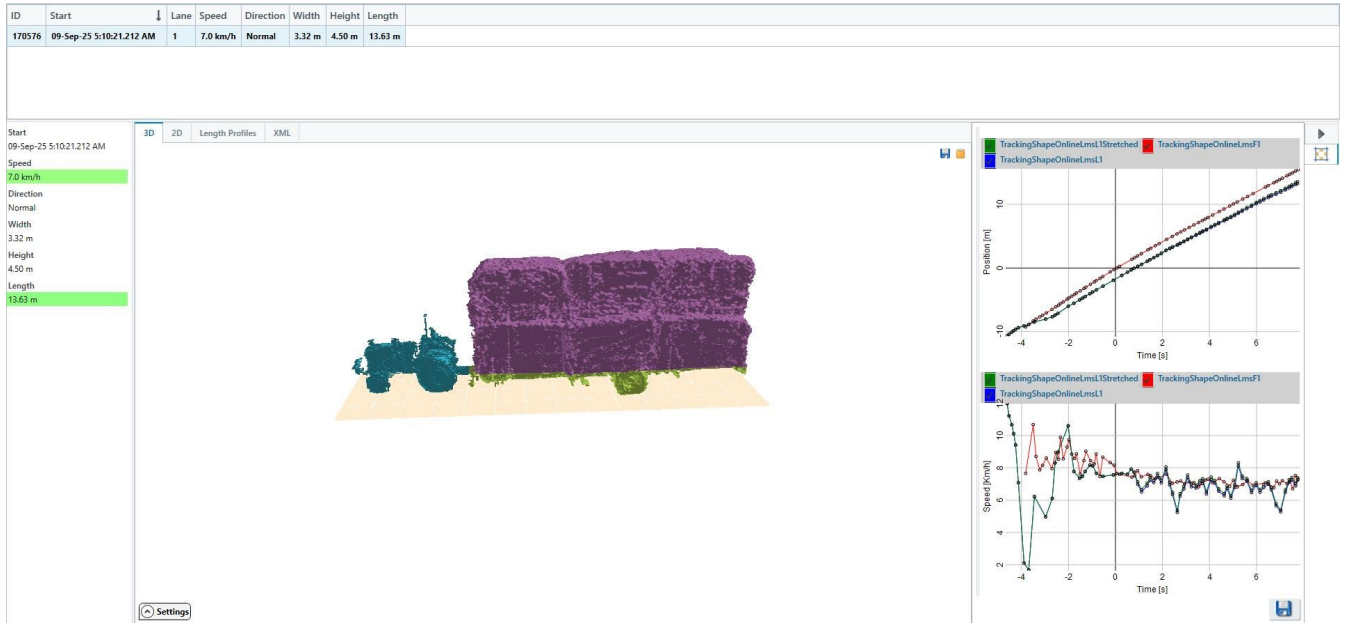


3.3 · MEASUREMENT PROCESS

Internal truck report

A truck report with the 3D detection model, for Dunakontroll's internal use and analysis.

Not provided to the client



3.4 · INSTALLATION & CALIBRATION

Site preparation

≈ 4 months

On average, installation is scheduled four months after the first instalment is paid under the contract.

During this period Dunakontroll works in close partnership with the client, to a predefined schedule, to prepare the site, logistics processes, IT connections, etc. for optimal operation of the IMG.

THE CLIENT COMPLETES, BASED ON DUNAKONTROLL'S DRAWINGS

- Groundworks — foundation for the gate structure and trenches for underground cables and conduits
- Manufacture (or arrange) and install the gate frame structure
- Data and power cables from the mill's termination point to the IMG
- Build the truck guide



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3.4 · INSTALLATION & CALIBRATION

From installation to calibrated

1

2 weeks

The Dunakontroll team completes installation and start-up of the IMG at the client's site.

2

3–5 days

Calibration — programming the calibration algorithms — in the case of standard deliveries.

3

Jointly agreed

The parties agree on the measuring tool and methodology used as the calibration baseline.



3.5 · HANDOVER ACCEPTANCE CRITERIA

Accuracy verified at handover

3 × 3 The IMG is tested on **three different paper grades**, with **three trucks per grade**. Allowed deviation against the control system, at a **95% confidence level**:

MOISTURE CONTENT	MOISTURE CONTENT	MOISTURE CONTENT	MOISTURE CONTENT
up to 20%	**20% – 30%**	**30% – 40%**	**above 40%**
±1.4%	**±1.7%**	**±2.0%**	**N.A.**
max. allowed deviation	max. allowed deviation	max. allowed deviation	uncertainty of the counter-measurement method

Values are stated under ISO 5725-1:1994 reproducibility and repeatability conditions and characterise the empirical uncertainty of the entire measurement chain (sensor + sampling + laboratory reference); the relative standard deviation (±5%) expresses its variability across a shipment population. The sensor's intrinsic contribution to the combined uncertainty — per the **GUM (JCGM 100:2008) uncertainty budget** — is below 7% at 20% MC and below 2% at 40% MC. Detailed uncertainty budget available on request.

3.5 · HANDOVER ACCEPTANCE CRITERIA

The reference measurement

If comparative measurements cannot be carried out with an IMG-compatible measuring system — a mutually agreed-upon base — another control moisture measurement tool or method shall be chosen by prior agreement.

Dunakontroll accepts the **Delmhorst RDMP-3** hand-held moisture meter. Flat-electrode hand-held instruments are **NOT** accepted.

The IMG's **average moisture content of the whole truck** is compared with the average of a manual measurement of **at least 200 measuring points**.

Any sampling method carries inherent weaknesses: limited sample size, uneven moisture distribution, potential human error in collecting and handling samples.

Manual sampling is not an absolute "gold standard", but a reference subject to improvement.

3.5 · HANDOVER ACCEPTANCE CRITERIA

How manual sampling is done

- Manual sampling is done by **unloading the truck and opening the bales** to take a representative number of spot measurements throughout the entire load — not just the surface.
- For moisture contents **above 30%**, the IMG's measured values are **considered the standard** and are not compared: the control meters' displayed values are only a guideline due to their measurement uncertainties.

WEAKNESSES OF HAND-HELD CONTROL METERS

- sampling error
- considerable variation in the results measured by the instrument
- insensitivity to the density and type of material
- temperature dependence of the resistance measurement
- significant influence of human error



3.5 · HANDOVER ACCEPTANCE CRITERIA

Consistency over time

Measurement **consistency** refers to the **precision** and **repeatability** of the measurements taken over time.

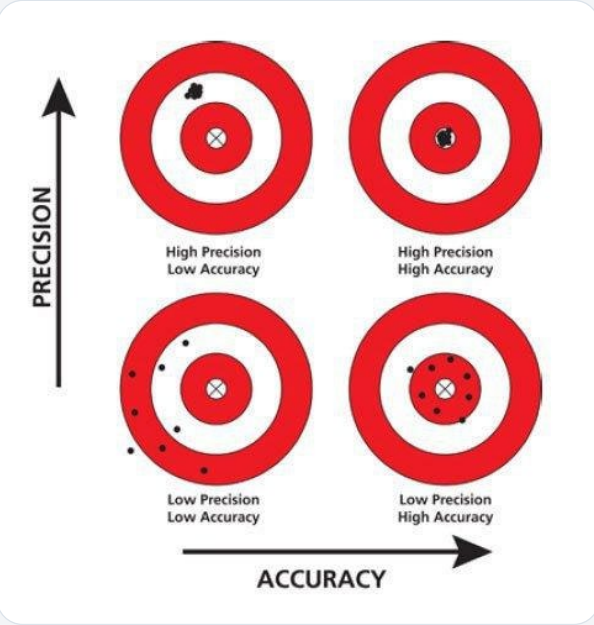
6×

The same truck drives through the gate six times.

- The average moisture content is calculated.
- The highest and lowest values are excluded for a more accurate central tendency.
- The ±6% relative range of the average is compared with the measured values.

±6%

max. relative deviation of each passage from the average



3.6 · ADVANTAGES & BENEFITS

Gate vs. hand-held methods

Industrial Moisture Gate — closed, automated process	Hand-held moisture meters & methods
✓ Automated measurement system	– Manual or laboratory based
✓ Non-destructive	– Invasive
✓ Measures large quantities — the entire load at once	– Measures at selected points or a very limited quantity
✓ Measures in a representative manner	– Is NOT representative
✓ Fast — measures in less than 1 minute	– Time-consuming
✓ Each delivery can be measured	– Based on sampling
✓ Does not require human intervention	– Requires dedicated staff, leaving room for human error
✓ Instant data exchange with the mill’s ERP system	– Stand-alone measurement, no data integration possible

3.6 · KEY BENEFITS FOR PULP & BIOMASS COMPANIES

Yield, energy value, storage safety

Maximise yield

- ✓ Transparent procurement — pay for usable fibre, not hidden water
- ✓ Reliable pulp yield prediction for smarter production planning
- ✓ Consistent raw material quality for stable operations

Optimise energy value

- ✓ Accurate calorific value (kJ/t) calculation for fair biomass settlements
- ✓ Fewer disputes with suppliers through verifiable, digitalised reporting
- ✓ Stronger profitability with data-driven energy input management

Ensure storage safety

- ✓ Detect dangerous moisture levels before storage
- ✓ Prevent rot, mould and spontaneous combustion — protecting assets and supply security
- ✓ Reduce operational risks and insurance costs with verifiable safety data

By improving measures of incoming Paper for Recycling our mills could see increased manufacturing yields. Not only this, but our transparent reporting system will provide clear communications to customers.

Nuno Messias

Paper for Recycling Purchasing Director, DS Smith Recycling Division, Iberia

One gate, three materials



IMG-P · waste paper bales



IMG-W · wood logs

Proving its versatility, the IMG-S can be rapidly adapted to additionally measure waste paper bales and wood logs.

The IMG-W also provides **density data**.

DUNAKONTROLL
MOISTURE INTELLIGENCE

Know the moisture inside every bale.

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IMG INDUSTRIAL MOISTURE GATE

