

# BEUMER Group - Port Zone: a conversation about Dry Bulk



## Advanced Collision Prevention Systems for Ship Loaders

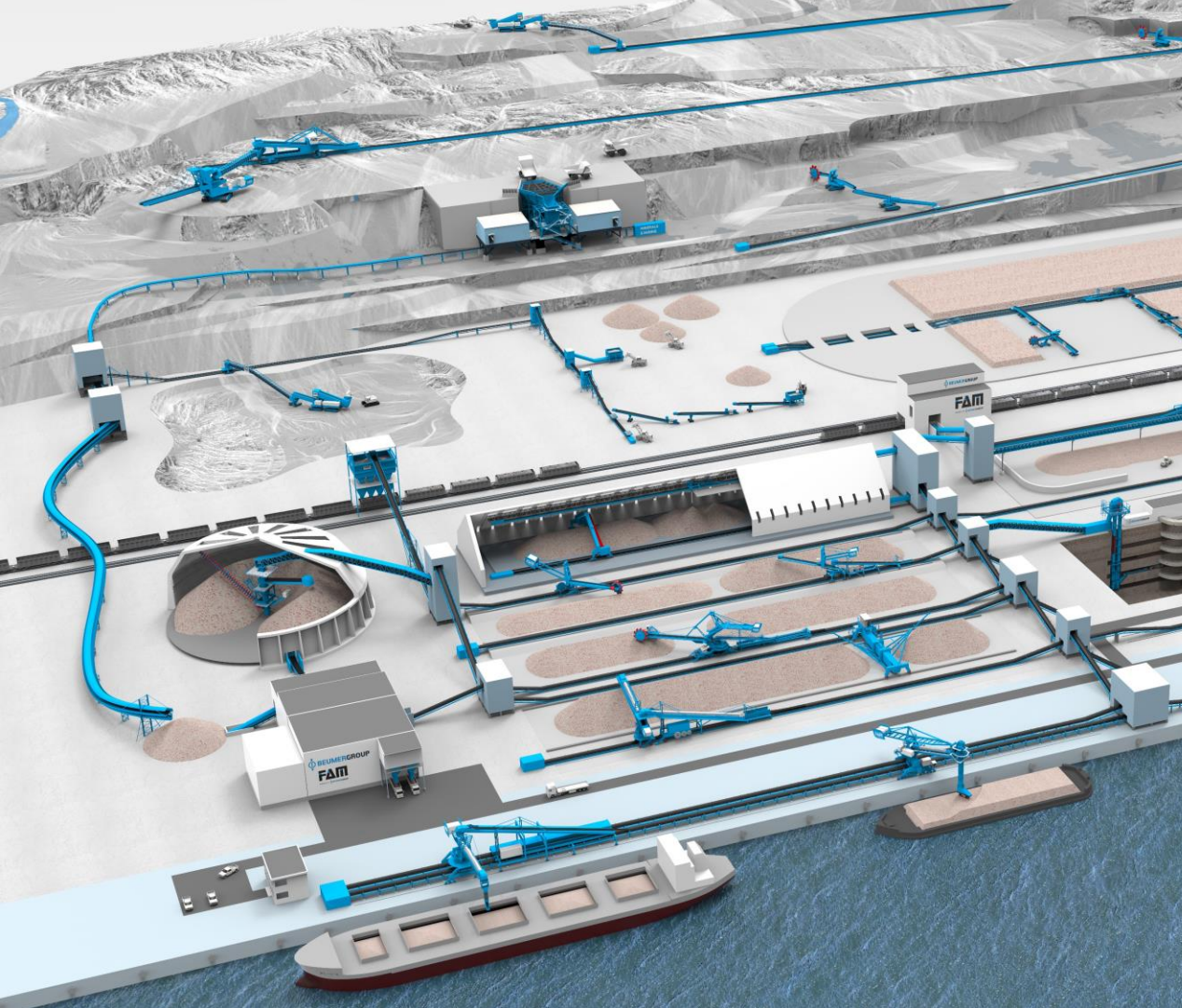
FAM Minerals & Mining GmbH - Member of BEUMER Group  
Port Zone presentation, 19.04.2023



## The Global Bulk Materials Expert

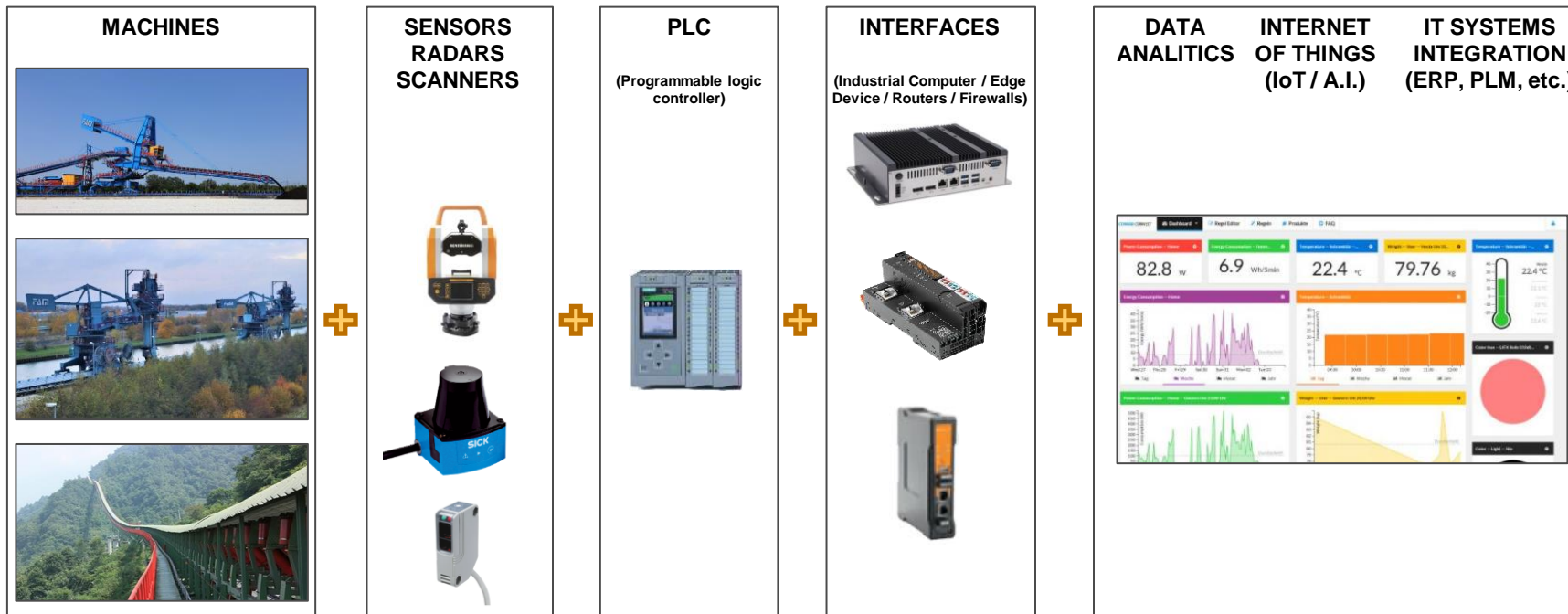
## From the Pit to the Port, your Partner of Choice!





- **Digitalization and adv. automation**
- **Sensor-based collision avoidance**
- **Unmanned operation**
- **Stockpile management**
- **Condition monitoring**
- **Predictive maintenance**
- **Digital dashboards and data analytics**


## “Automation and Digitalization” according to FAM Minerals and Mining concept



Automation

Digitalization

- **Anti** collision systems
- Collision **prevention** systems
- Collision **avoidance** systems
- Collision **mitigation** systems
- Collision **detection** systems
- Collision **warning** systems
- ....



A system that is intended to detect, avoid and prevent collisions.

It can alarm an imminent collision and/or take actions by interfering or paralyzing the operation of a machine, thus **preventing** the collision.

# Unique solution to each plant

## Some general facts:

- **FAM consulting** – Which systems are suitable for the requirements?
- **Process analysis** – Which collision hazards exist?
- The solution may be a **combination of several methods**.



Powerplant Walsum Germany – 2 CSU with Level 1 and 2 FAM ACS

- When FAM **sells new equipment, collision prevention systems** are part of the scope and included in the alignments with customers. Usually, basic systems are always included in the machine package and advanced systems are offered as optional.
- FAM collision protection systems also have **open interfaces**, extending the protection to plant components from third-party manufacturers, **making its solutions “multi-brand machines”**.
- FAM has numerous **experiences and references** in hardware and software based anti collision systems.

# Defining possible collisions to be avoided

## For instance:

- Hazard 1 – Collision detection between the chute with the vertical bunker walls
- Hazard 2 – Collision detection between the chute and the hatch bottom
- Hazard 3 – Collision detection between the chute and the hatch covers
- Hazard 4 – Collision detection between the chute and the ship superstructures
- Hazard 5 – Collision between the telescopic boom and the ship superstructure
- Hazard 6 – Collision between the ship loader and moveable objects on the ground
- ... and more ...



Ship loader in South America – Level 3 FAM ACS under engineering phase

## Level 1 ACS

Implemented on the PLC\* level only, with mathematical models, and/or with the usage of sensor-based solutions (interlocks).

Automation

## Level 2 ACS

System oriented solution, collecting information from more than one machine.

Automation

Digitalization

## Level 3 ACS

Intelligent solution, combining adv. scanners (i.e., Laser, Radar, Cameras), Software and Advanced Automation.

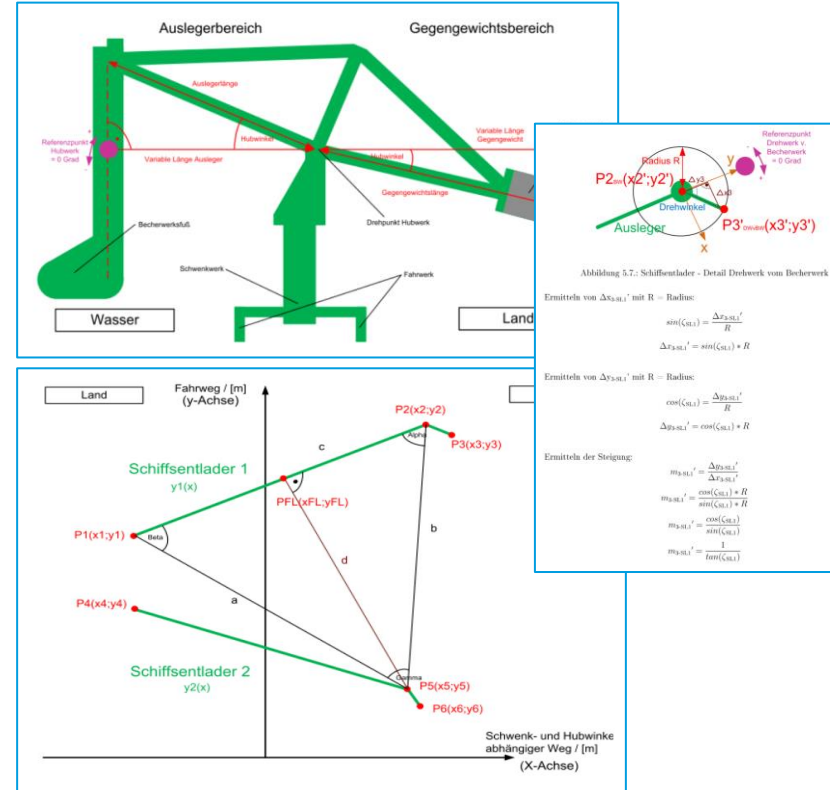
Automation

Digitalization



# Level 1 – ACS (mathematical)

- Level 1 anti collision systems **are located at the machine control level (PLC\* level)**.
- Usually part of each PLC software for moving machines.
- The **machines exchange their positions** by using safe data communication technology.
- **Mathematical models** are used to calculate the own position and the positions of the other machines with a collision risk.
- **Each machine has an own level 1 collision evaluation and stops its own drives**, if of collision detection takes place.



# Level 1 – ACS (sensor based)

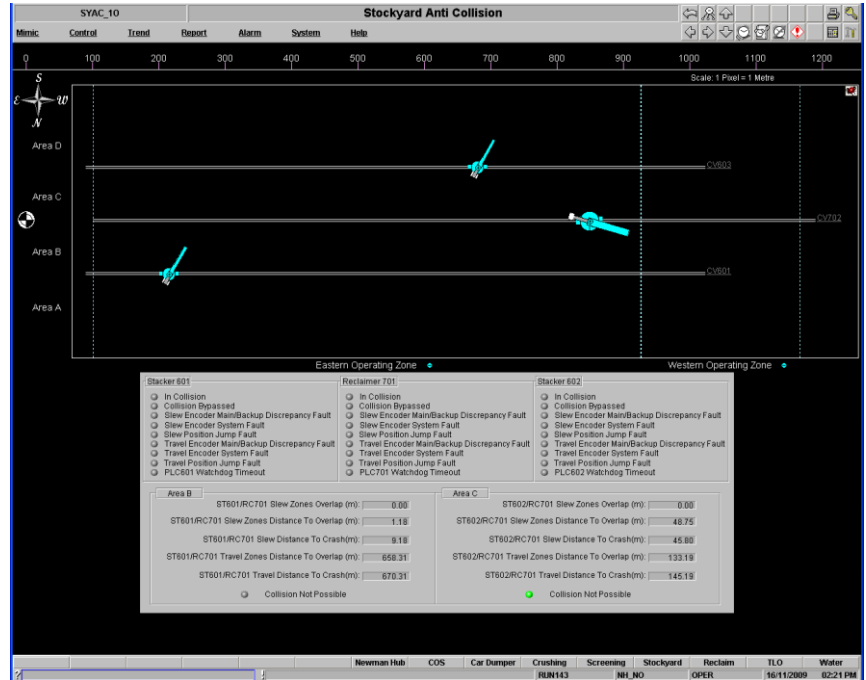
- Suitable for machines with defined linear movement (**most cases on rails**).
- The distance to the next machine with collision risk is determined by using special sensor technology (**basic laser or ultrasonic linear distance sensors**).
- If the distance reaches a critical value the correspondent **drives will stop via the interlocks\***.
- The used sensor technology **depends on the site condition and the technological requirements**.
- **Each machine has an own level 1 collision evaluation and stops its own drives** if a collision detection takes place.



Ship loader Onne Port (Nigeria) – Level 1 (sensor based) FAM ACS

# Level 2 – ACS (system oriented)

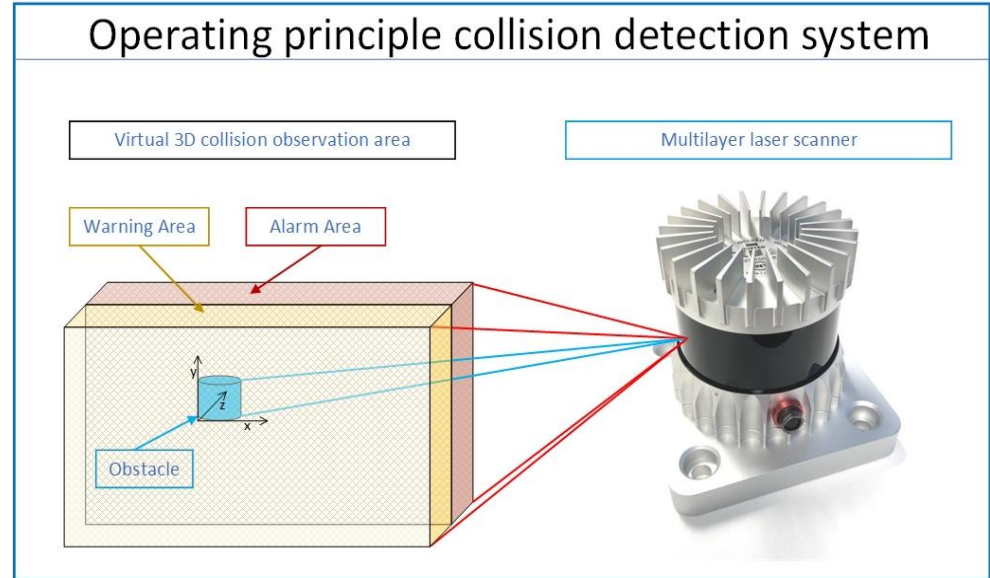
- A central system collects all positioning data from the individual machines.
- In the most cases a level 2 anti collision system has its own HMI\* screen.
- **Model based evaluation of positioning** for each individual machine, thus enabling the determination of possible collision risks.
- **The system creates the releases and interlocks** for all drives for the individual machines.
- In normal operations **the machines may only start their drives if a valid release command is received** in the PLC.
- A level 2 anti collision system **can be coupled with additional software solutions**, i.e., stockpile management systems (SMS).
- Limited use for ship loaders application.



Level 2 FAM ACS installed in a stockyard (it could be combined with the Harbor)

## Recognition of objects through 3D collision pre-defined areas

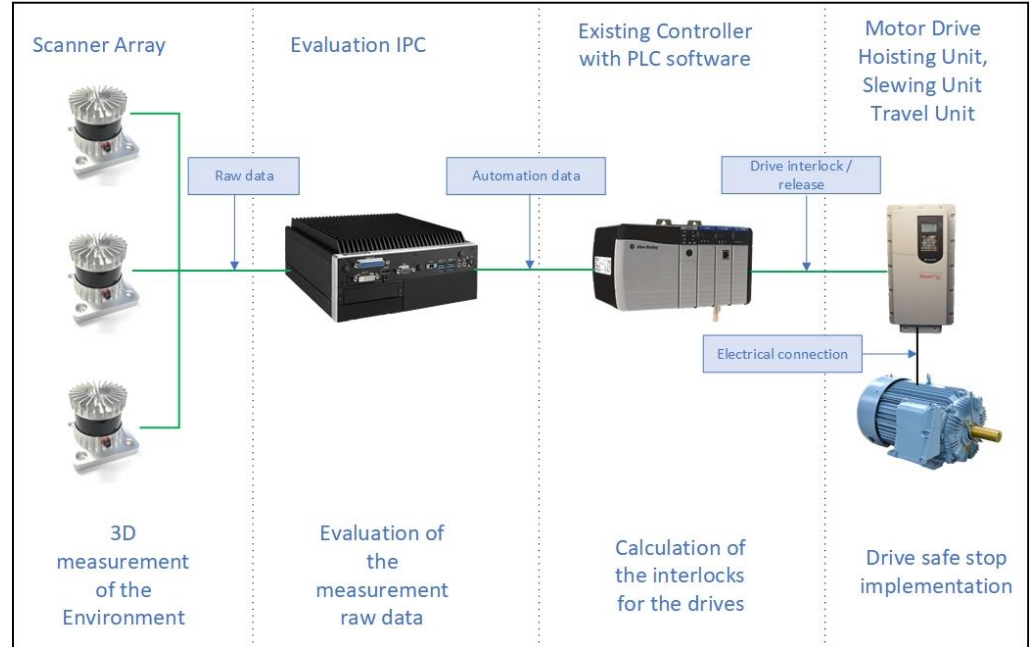
- The system **creates an adjustable 3D collision observation area**.
- The observation area enables the detection of obstacles and **identifies dimension, shape and distance from the obstacle**.
- This system is also **able to distinguish between several types of obstacles**.
- One single system can define several observation areas – **for instance one area for warnings and another one for alarms**.



# Level 3 – ACS (intelligent system)

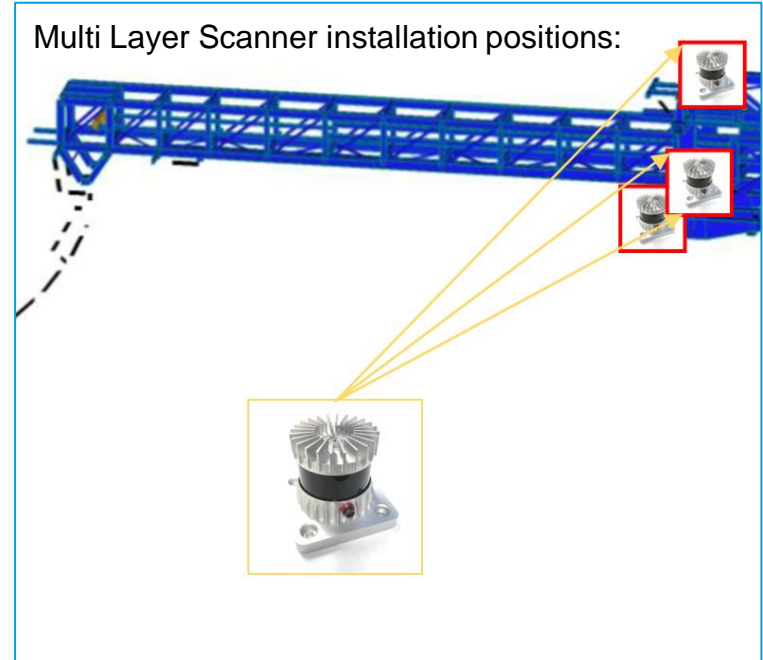
## Components of the level 3 ACS

- **Laser Scanner Array** – Observation of the environment and arrangement of the raw data.
- **Evaluation IPC\*** – Software for evaluation of the raw data and calculation of alarm and warning cases.
- **Local PLC (existing)** – Implementation of the additional interlocks to the drive control logic.
- **Motor Drive (existing)** – Command control and interlock processing.

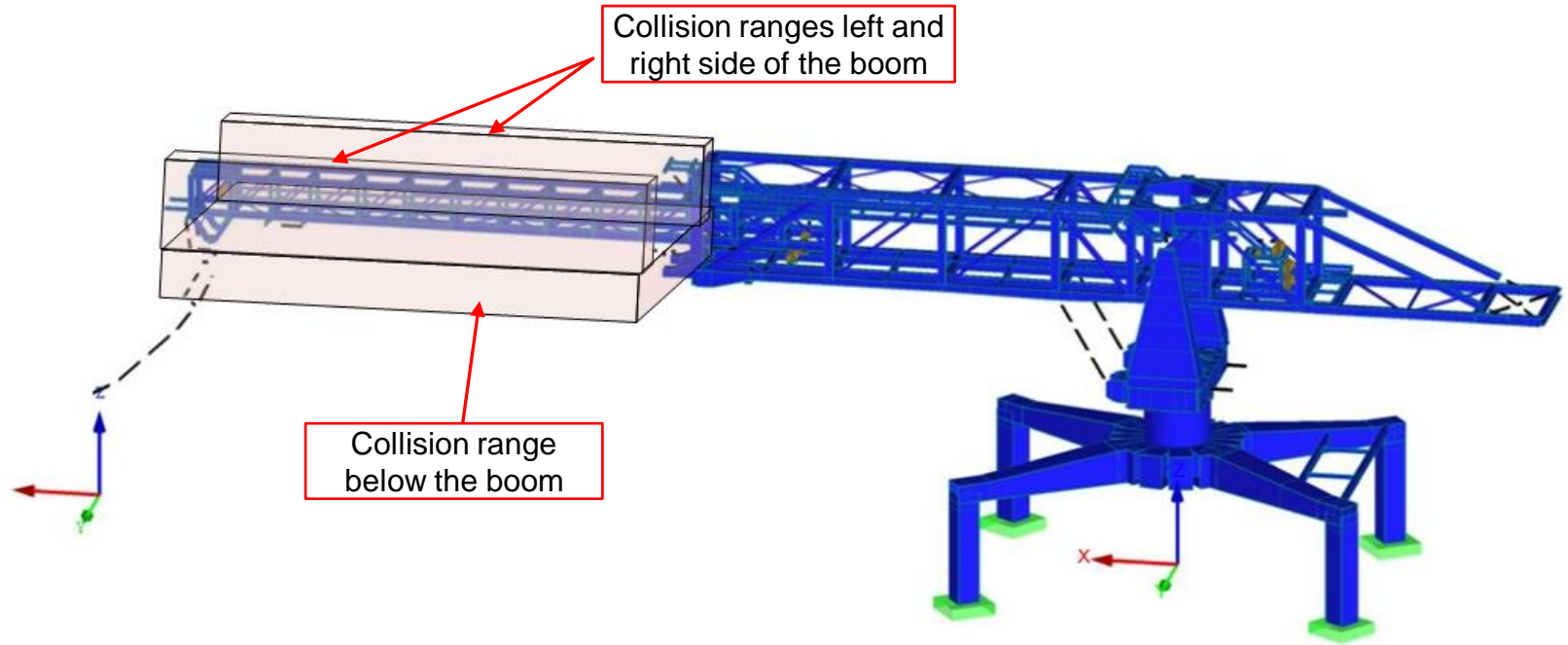


## Independent system for the collision ranges monitoring

- Installation of **one or more multilayer laser scanners on the boom frame.**
- Installing a third multilayer scanner for the range below the boom enables more flexibility and precision and might be optional depending on the use case.
- The **system can detect the approach of ship superstructures or other obstacles from virtually all directions.**
- The **ACS sends detected collision hazards** to the PLC.
- Optical and acoustical **alarms are installed, allowing operators to react** in case of imminent collision.

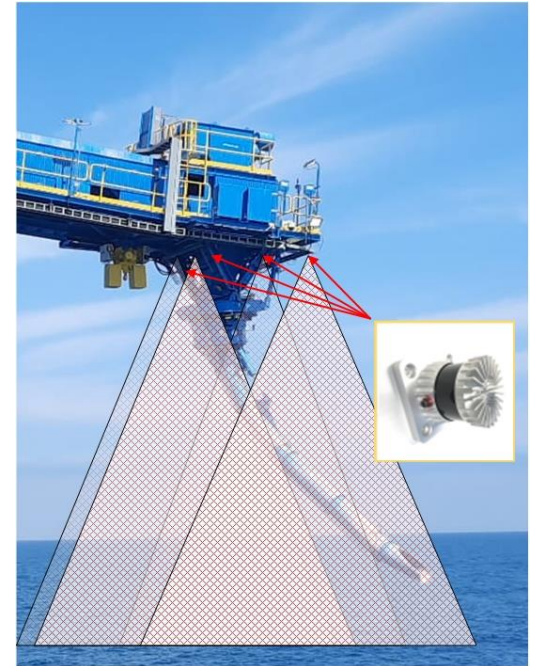


# Level 3 – ACS (intelligent system)



## Independent system for monitoring of the dynamic collision range around the “banana chute”

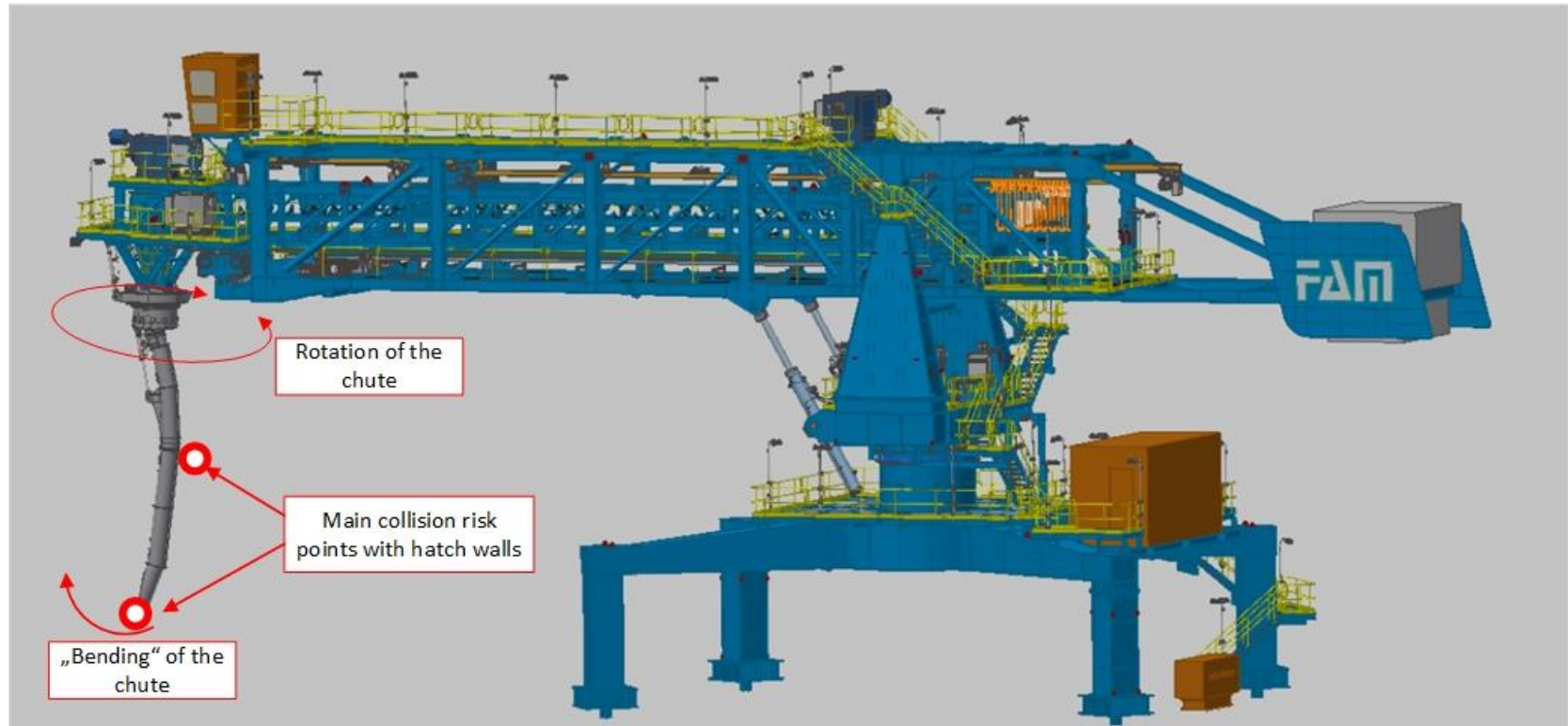
- Installation of four **multilayer laser scanners** on the boom tip around the moveable chute platform.
- The **system can detect the chute edges and the position of the chute** in the 3D environments
- The system can detect the approach of the chute to the hatch wall or to other obstacles on the ship in all directions.
- The **ACS sends detected collision hazards** to the PLC.
- Optical and **acoustical alarms are installed, allowing operators to react** in case of imminent collision.



Multi Layer Scanner installation positions for collision protection from the ship hatch



# Level 3 – ACS (intelligent system)



## Collision protection against moving objects in the travel drive range

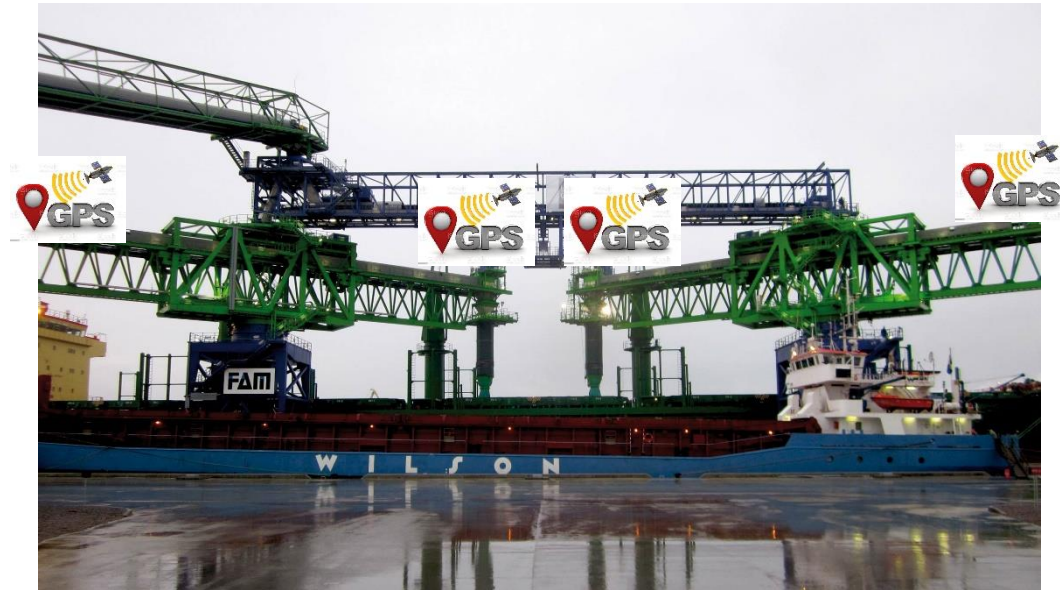
- Installation of multilayer laser scanners on machine frame in both travel directions.
- The **system can detect several kinds of obstacles in the defined range.**
- The **definition of different collision zones** is possible (only range on the rails, different zones depending on distance...).
- **Definition of different actions and interlocks** for different zones are possible.
- The ACS can **recognize different object sizes and shapes.**
- Definition of different actions and interlocks for the single obstacle types are possible.



Multi Layer Scanner position for collision protection against obstacles in travel range

## Collision protection against other machines with a common collision range - GPS

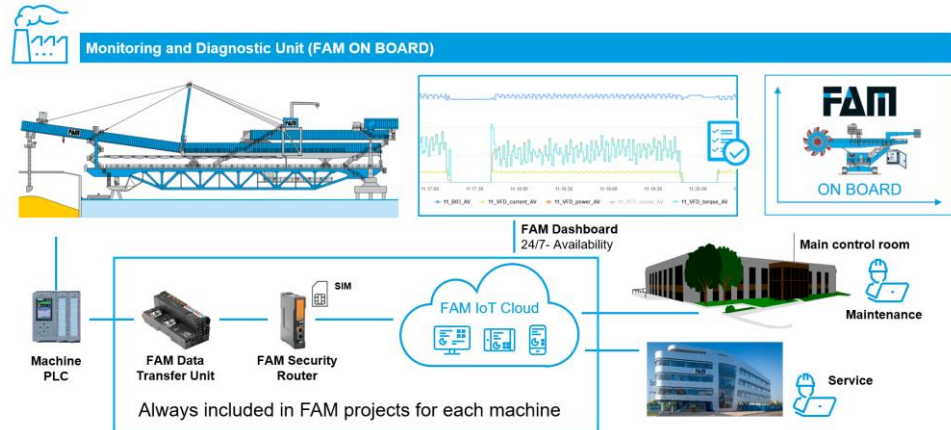
- Installation of **professional GPS receivers on each machine** (minimum two).
- With this technology it is possible to **precisely detect machine positioning in the 3D space**.
- With the usage of RTK\* technology the **precision can be increased up to 2cm**.
- FAM recommends to also consolidate positioning in a central system.
- The interlocks of the drives in collision case are realized by using safe communication protocols.



GPS antenna installation positioning for collision protection against other machines.

## ACS enhanced by Data Driven solutions

- Improves the level of accuracy and intelligence through operational data analysis.
- Operational data is collected and analyzed via IoT interfaces and secure Cloud environment.
- It uses **Machine Learning\*** algorithms.
- The more data is stored, the more accurate the inputs will be for **machine operation without collision alarms**.
- **Data Analytics reports** including ACS information and operational accuracy are shared with the end user.



When installing Collision Prevention Systems,  
the **specialized consulting from a bulk material expert** is a no-brainer!

Before defining a Collision Prevention solution,  
**process analysis should be conducted together with the end user**,  
identifying modus operandi and potential collision risks.

The implemented solution will often be a **combination of several methods**,  
aiming for safety and the most efficient operation.

A complete and safe solution needs to consider:

- Operational Know-How,
- Mechanical and Electrical Engineering expertise,
- Automation and PLC/HMI programming Know-How,
- Correctly specified Sensors/Scanners/Positioning Systems,
- Proper IT Software and Hardware implementation.

**Collision Prevention Systems are “Must Have” technologies  
for Bulk Material Ship Loaders –  
protecting People and Assets!**



# Thank you!

**Bruno Castro**  
Head of Digitalization  
Tel.: +49 391 6380 10190  
Mail: [bruno.castro@fam.de](mailto:bruno.castro@fam.de)

**FAM Minerals & Mining GmbH**  
Sudenburger Wuhne 47  
39112 Magdeburg  
Germany

 [www.fam.de](http://www.fam.de)  
 [FAM-GMBH](#)  
 [FAM\\_MAGDEBURG](#)

**FAM**  
MEMBER OF  **BEUMERGROUP**