Process monitoring and operational control in the flotation process supported by AI methods

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Task: „Process monitoring and operational control in the flotation process supported by AI methods"

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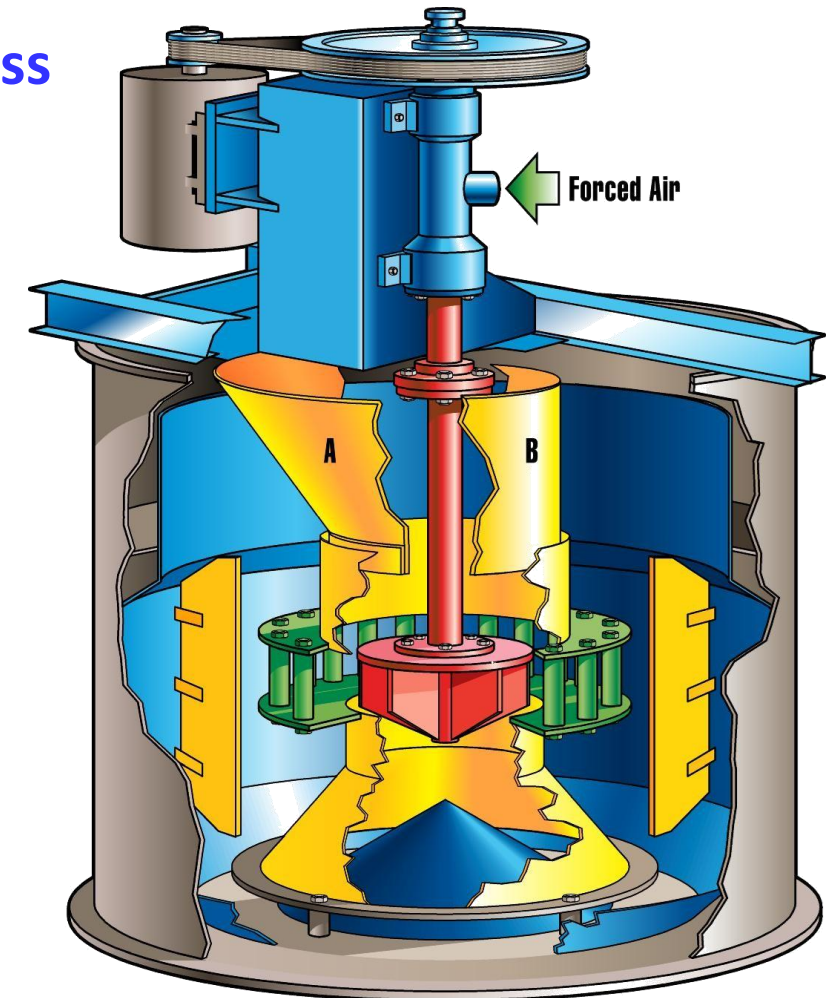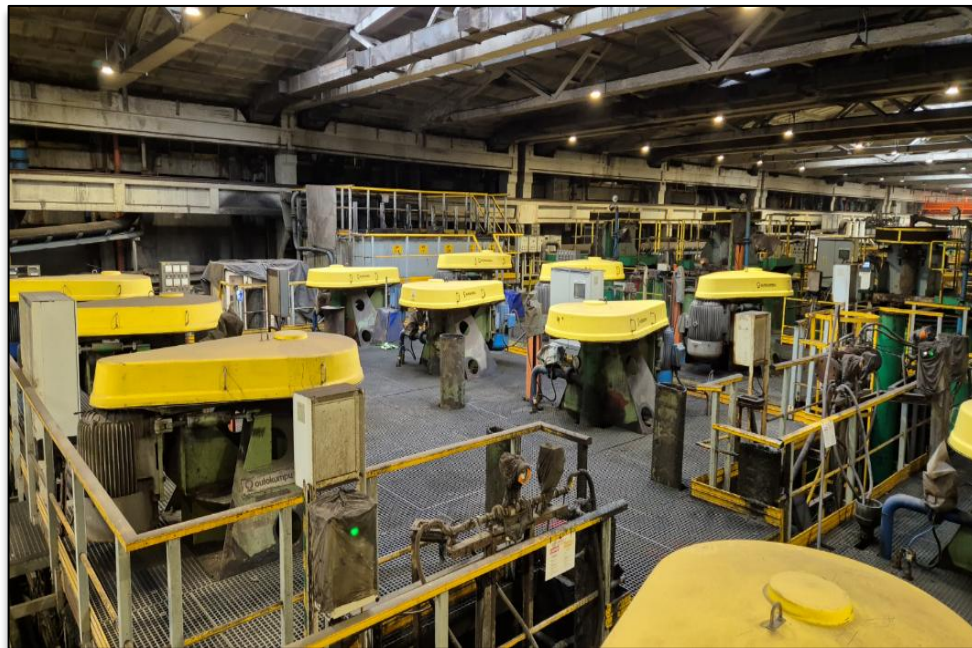Prof. Dariusz Daniel Saramak DSc, Eng.
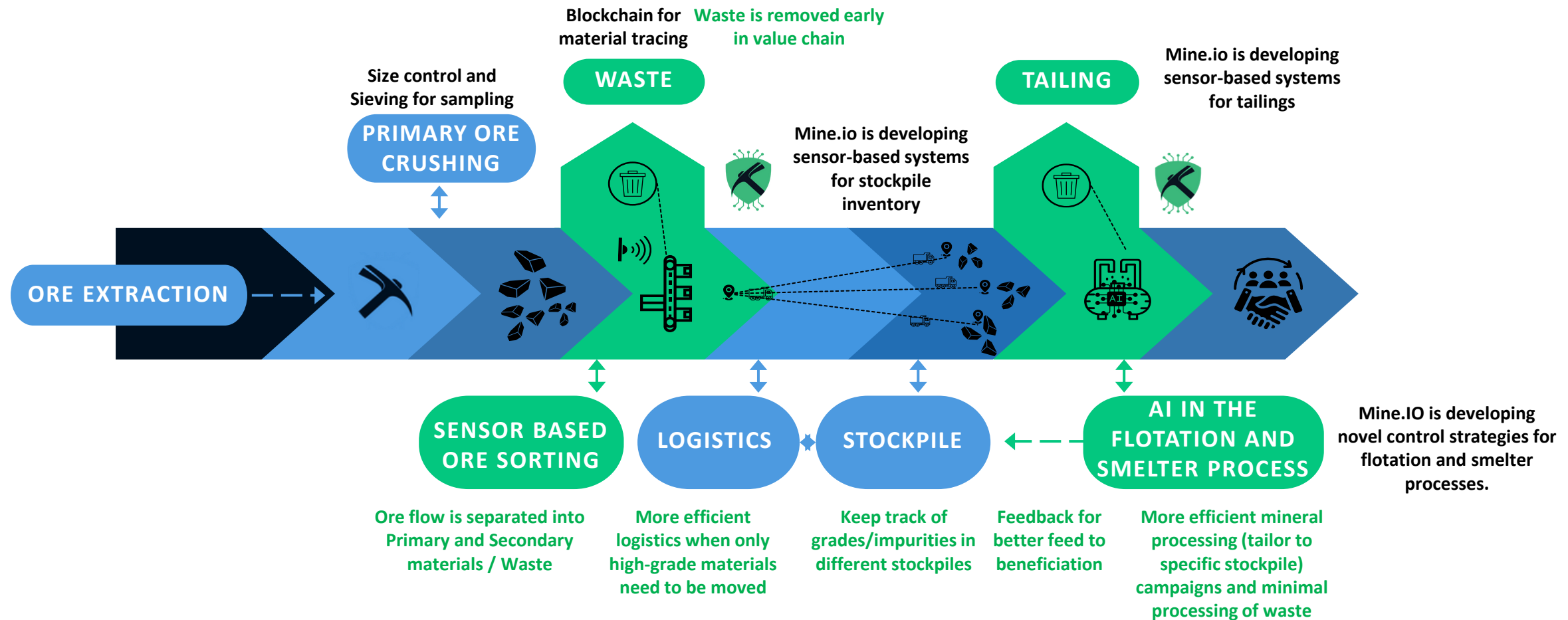
ENRICHMENT IN THE FLOTATION PROCES

- **Flotation process** – the most important **enrichment process** in the **Mineral Processing Plant**

- **Efficient processing** of the mined ore **before the next copper extraction process** in the smelter.

- **Enrichment** is carried out in **flotation machines** with the use of foaming and collecting reagents.

FLSmidth Minerals--Mechanical Product Line
(www.ffeminerals.com)

WHY THE AI TECHNOLOGY IS NEEDED IN THE FLOTATION PROCESS ?

- **Variability in ore quality**
  - **Copper ore** from different parts of the deposit **differs in mineralogical composition**.

- **Subjectivity of visual assessment**
  - **Observation of a froth** by the operator is a **method dependent** on **experience** and **individual interpretation** of the **process effectiveness**.

- **Limited response speed**
  - **Manual correction** of **process parameters delays the response** to dynamically changing conditions.

- **The need for process stabilization**
  - **Automatic control** based on image analysis allows you to **keep the process at an optimal level**.

- **Reduces the workload on the technical staff**
  - **Manual control**, even **supported by expert systems**, **requires constant observation** by the **operator**, which is almost impossible for a large number of machines.

MAIN AI APPLICATION IN THE FLOTATION PROCESS

- **Real-time flotation process monitoring and control**
  - **Automatic adjustment** of **process parameters**:
    - flotation **Pulp level**,
    - **amount** of **dispensed reagents** and **air** etc.

- **Concentrate quality prediction**.

- **Reduce raw material and energy consumption**

- **Modeling and simulation**
  - **Creating predictive models**
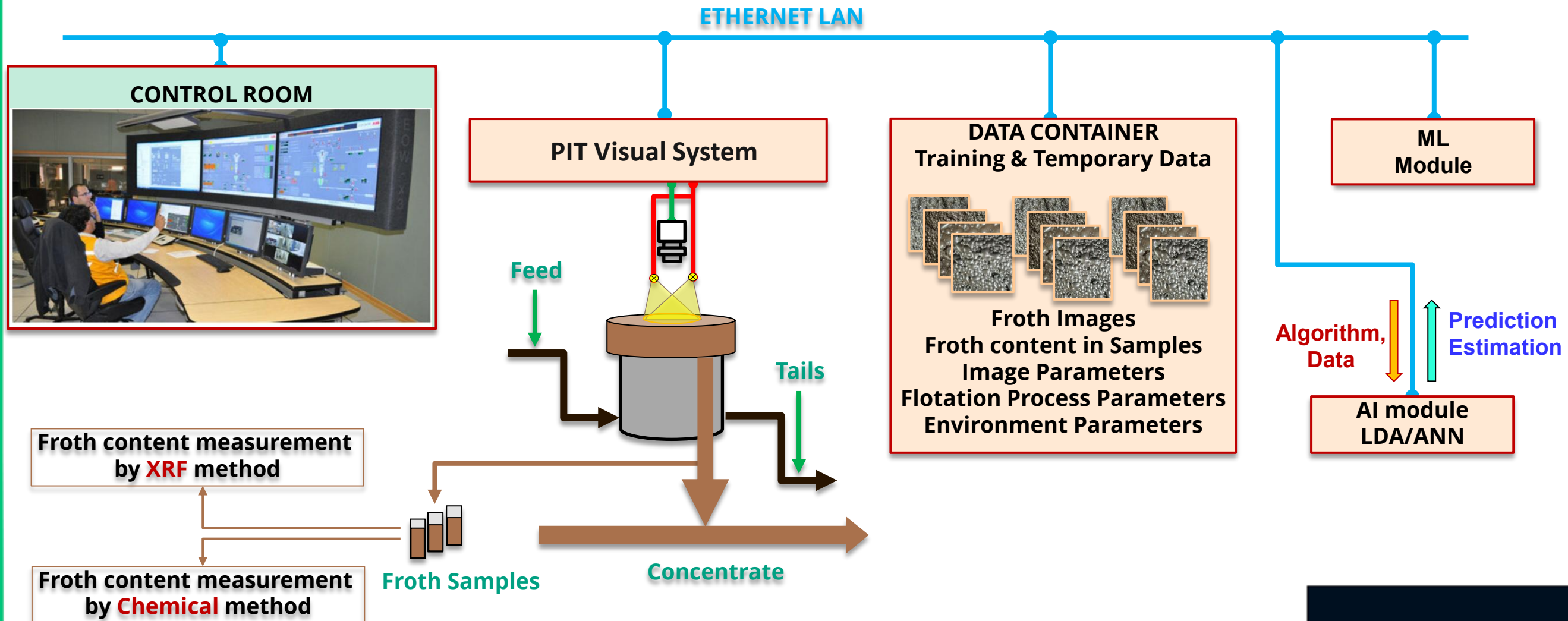   - Help **predict flotation efficiency** under **various conditions**.
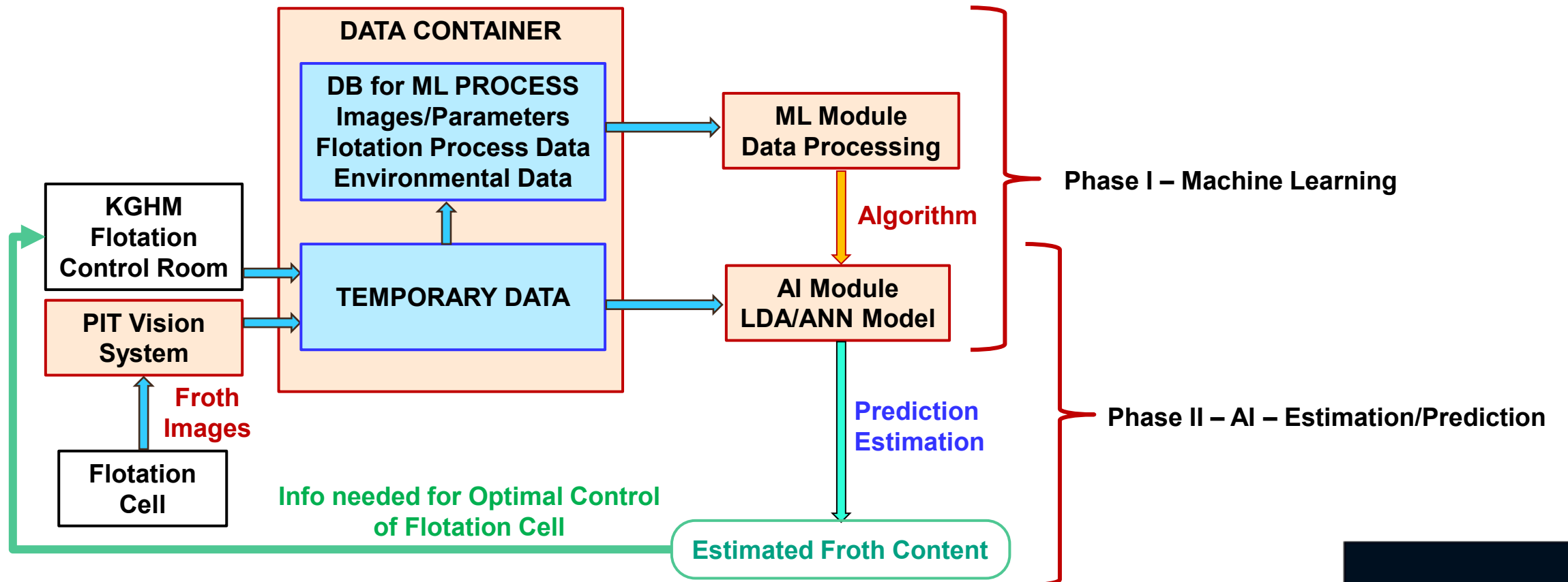
MACHINE LEARNING WITH THE PIT SYSTEM
DEFINITION of RELATION between IMAGE PARAMETERS and FROTH CONTENT

ETHERNET LAN

CONTROL ROOM

PIT Visual System

Feed

Tails

DATA CONTAINER
Training & Temporary Data

Froth Images
Froth content in Samples
Image Parameters
Flotation Process Parameters
Environment Parameters

ML Module

Algorithm, Data

Prediction Estimation

AI module LDA/ANN

Froth content measurement by XRF method

Froth content measurement by Chemical method

Froth Samples

Concentrate

IMAGE PROCESSING
INTELLIGENT COMPRESSION OF INFORMATION

- **Image Parametrization via Image Processing**
  - **Parameters** built on
    - **Image Structures, Color, Froth Texture** etc.
  - **Parameters** related to the **Flotation Process Parameters**
  - **Parameters** related to the **Environment Parameters**

- **Compression of information by parametrization process**
  - **Image** can be **described** by a **few hundreds** of parameters
    - **10 MB ↘ few hundreds of parameters**

PIT SYSTEM IN KGHM

- **Application of ML and AI technology in monitoring and control of   a flotation process:**
  - **Improvement** of
    - **Mining process**
    - **Mineral processing efficiency.**
  - **Better** process **selectivity,**
  - **Broader range** and **higher recovery rates** of valuable **raw materials**
  - **Higher economic efficiency** and **flexibility** in **minerals processing** and **recycling processes**

- **Photonic – IT system equipped with ML and AI algorithms and software**

- **Implementation in KGHM**

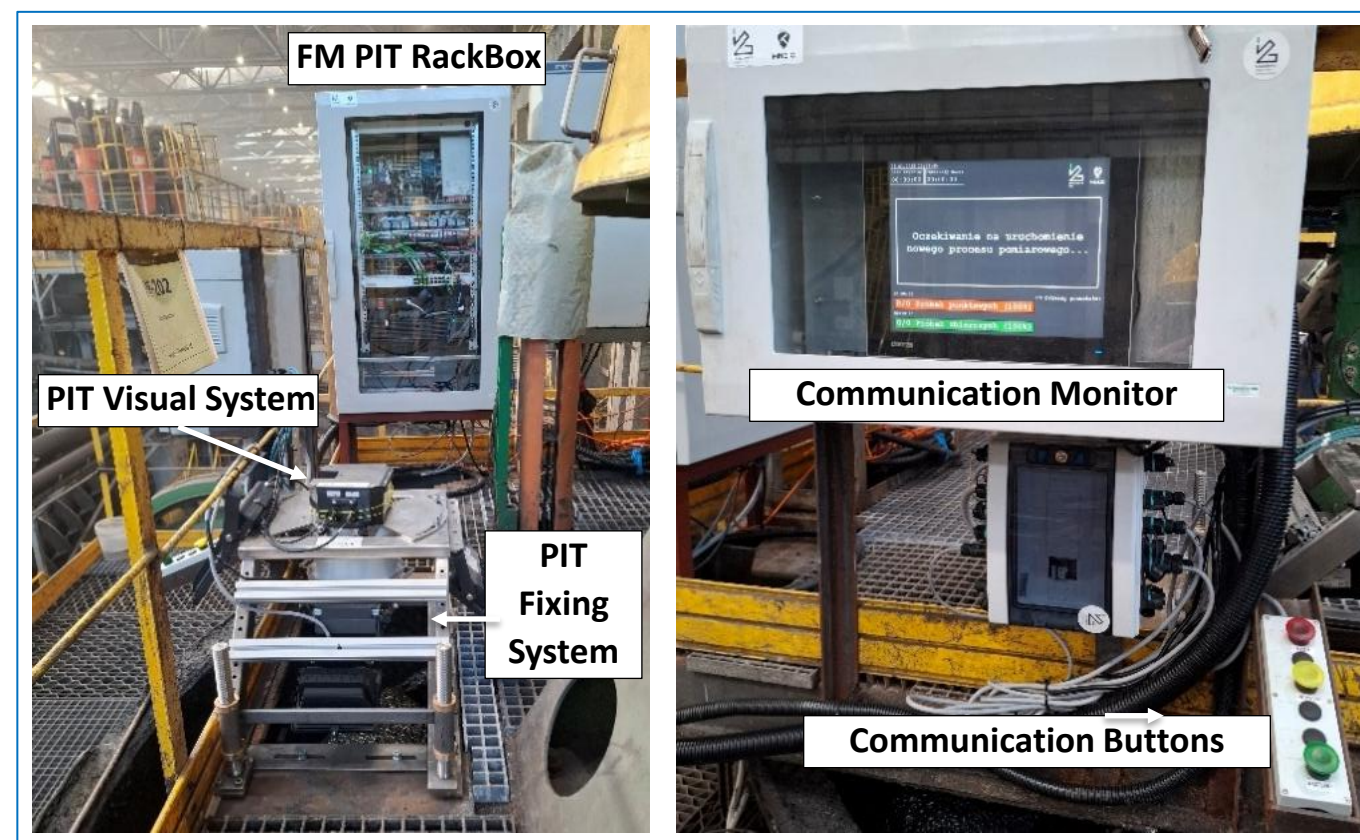**The Photonic – IT (PIT) System in KGHM**

FROTH IMAGE ANALYSIS in the PIT SYSTEM

- **Froth appearance is a key indicator of the flotation process**

  - **Information about**
    - **Process efficiency,**
    - **Process stability,**
    - **Concentrate quality.**

- **The PIT System:**

  - **Registers** the **high resolution images** of **various types**

  - **Analyses**
    - **Set** of **image features**,
    - **Information** about the **flotation process parameters**
    - **Environmental data**.

PIT VISION SYSTEM & FROTH SAMPLING TROUGH

FM PIT RackBox

PIT Visual System

PIT Fixing System

Communication Monitor
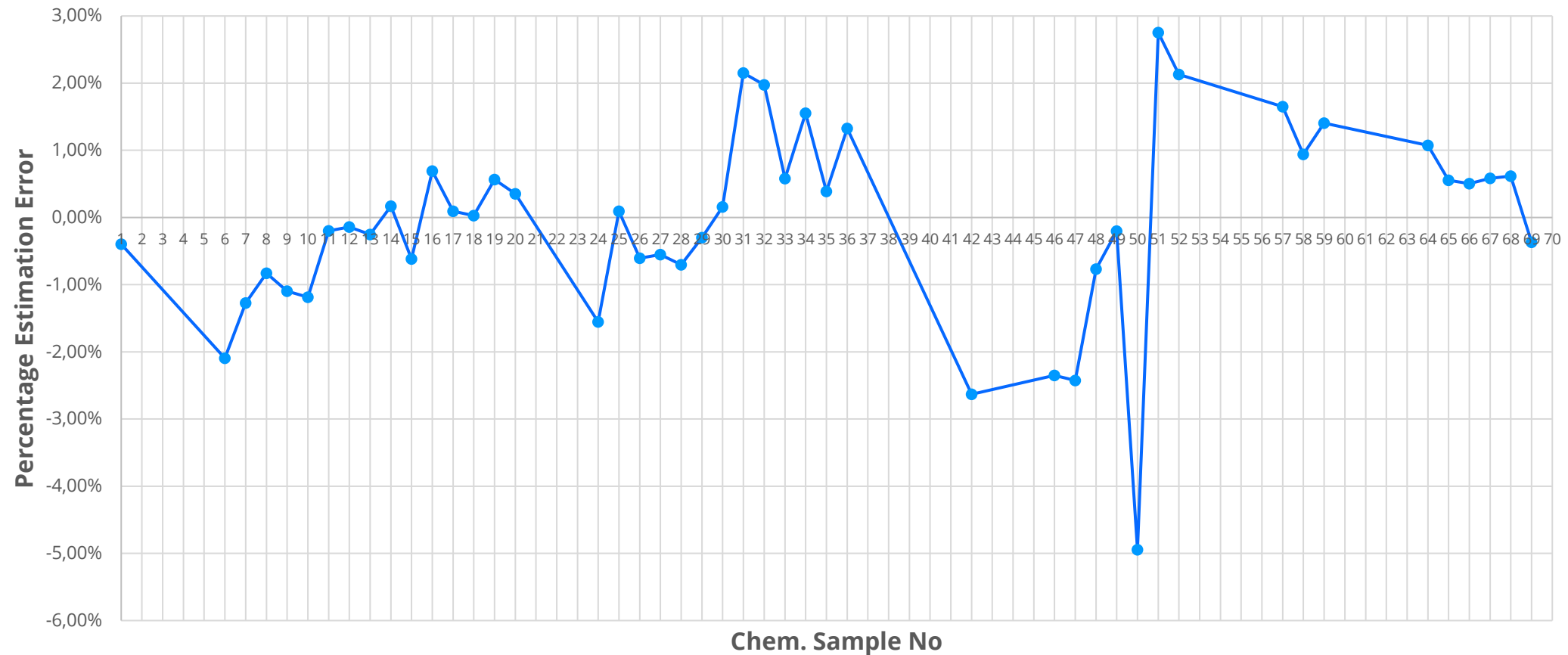
Communication Buttons

EXPECTED EFFECTS

- **Remote process monitoring**
- **Remote proces management.**
- **Flotation Process stabilization**
  - **less quality fluctuations.**
- **Improving** the **concentrate quality.**
- **Dynamic adjustment** of **process parameters.**
- **Reduction** of **chemical** and **energy consumption.**
- **Quick adaptation** to **variable transmission parameters.**
- **Collect** and **archive data** for **further analysis and optimization.**

ESTIMATION OF METAL CONTENT IN THE FROTH (AI ALGORITHM)

Measured and Estimated Metal Content for Chemical Groups
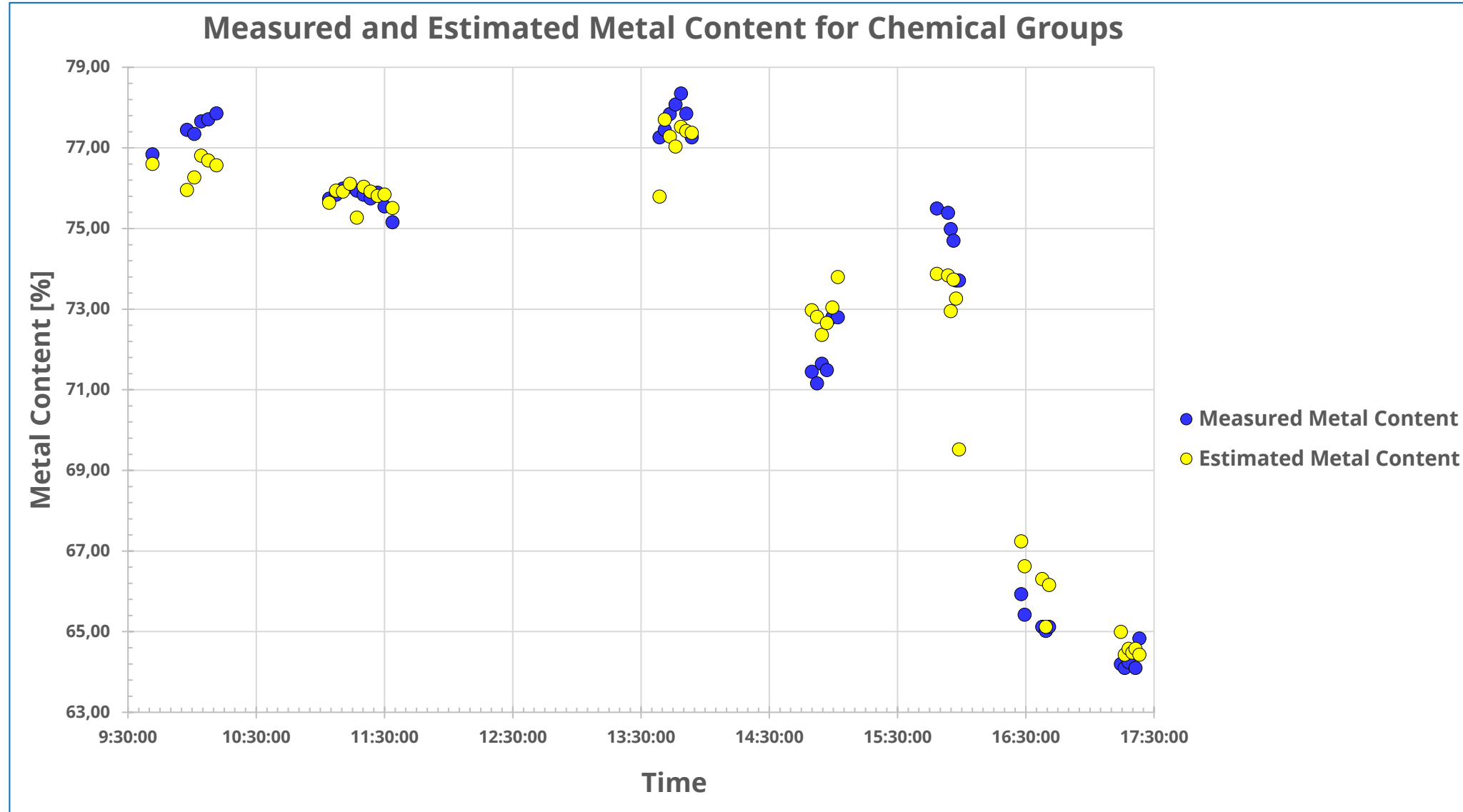
RELATIVE ESTIMATION ERROR FOR METAL CONTENT
IN THE FROTH (AI ALGORITHM)

Percentage Error of Metal Content Estimation in Chemical Groups

ACKNOWLEDGMENTS