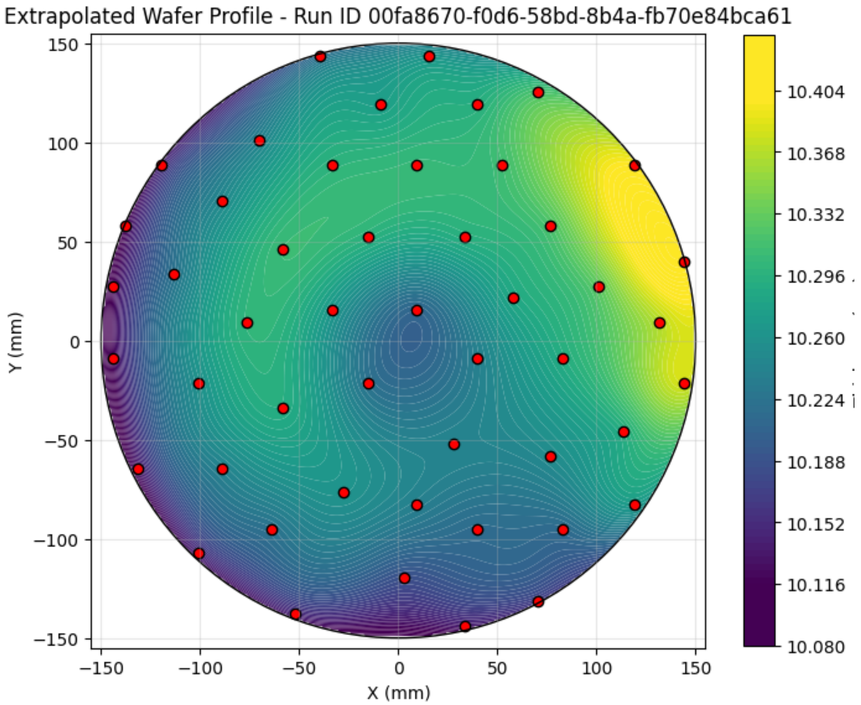
Data Science Competition

Semiconductor Process Performance Prediction

micron

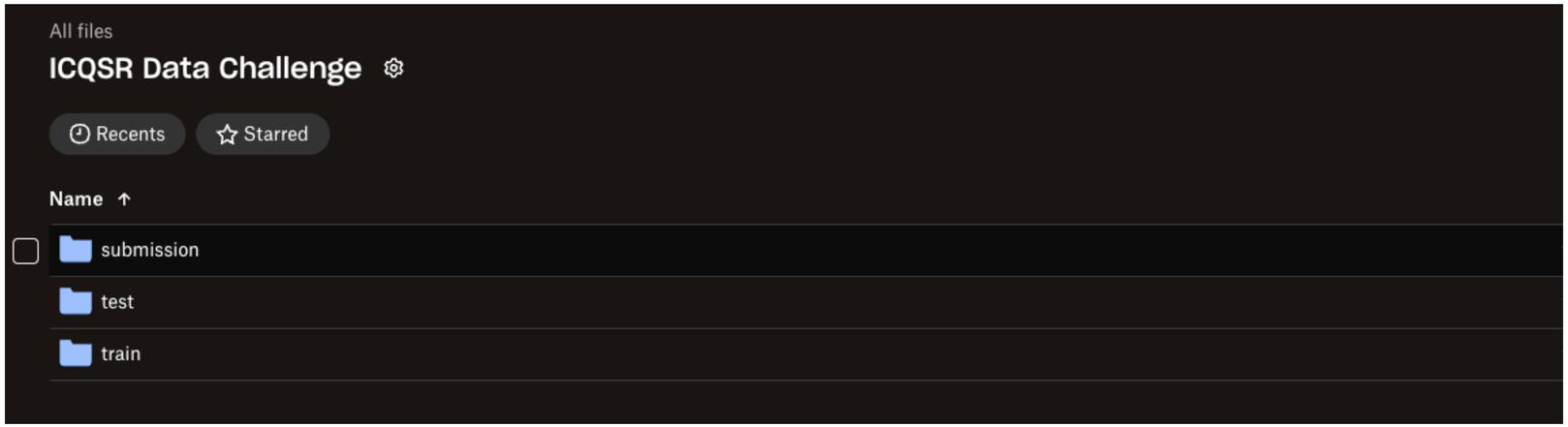
Competition Overview

- Objective:
  - Predict 49 measurement points on semiconductor wafers.
  - Use process data to improve efficiency and product quality.
- Key Focus Areas:
  - Real-world manufacturing data analysis.
  - Machine learning for process optimisation.



Dataset Structure

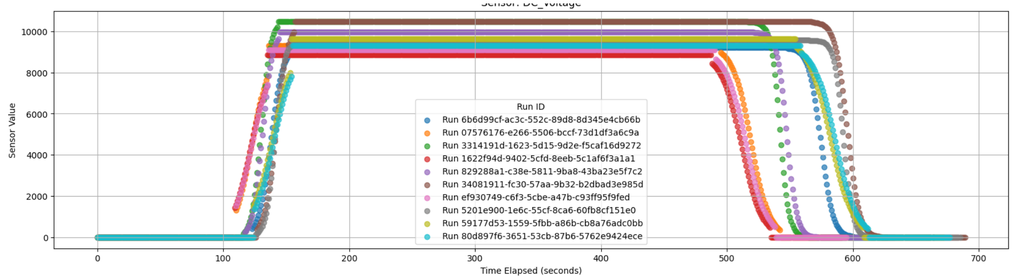
- Three Key Folders:
  - Train Data: Run Data + Incoming Run Data + Metrology Data (ground truth).
  - Test Data: Run Data + Incoming Run Data (no Metrology).
  - Submission: Metrology Data (Measurement column empty).

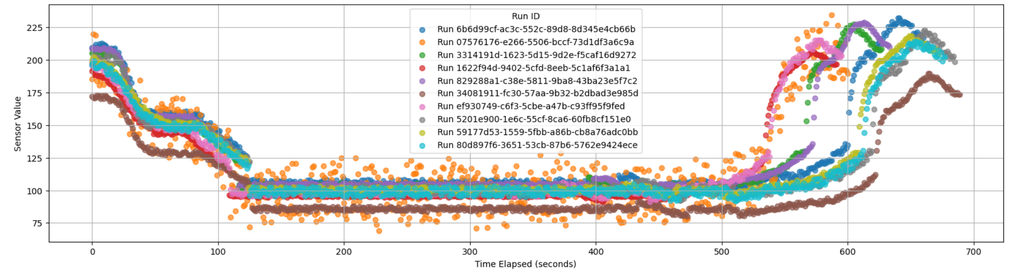


Data Description

Run Data - Overview

- Run Data (run_data_{file index}.parquet)
  - Represents: Current process sensor readings collected during the process step.
  - Location: Train & Test folders
  - Total Files: 20
  - Average Shape: (2,239,380 rows, 10 columns)
  - Use Case: Understanding real-time process conditions that impact measurements.





Data Description

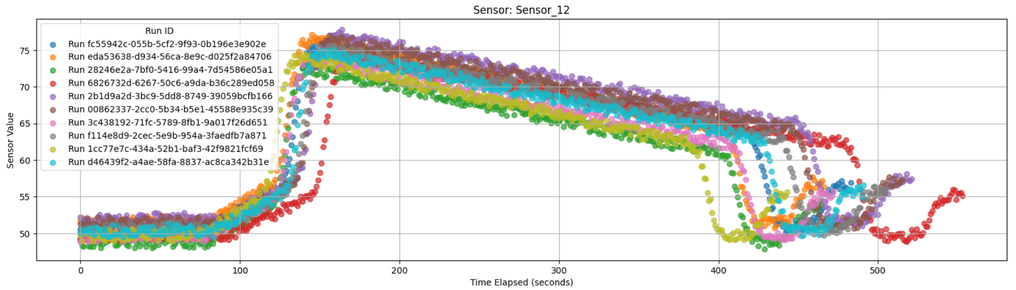
Run Data - Key columns

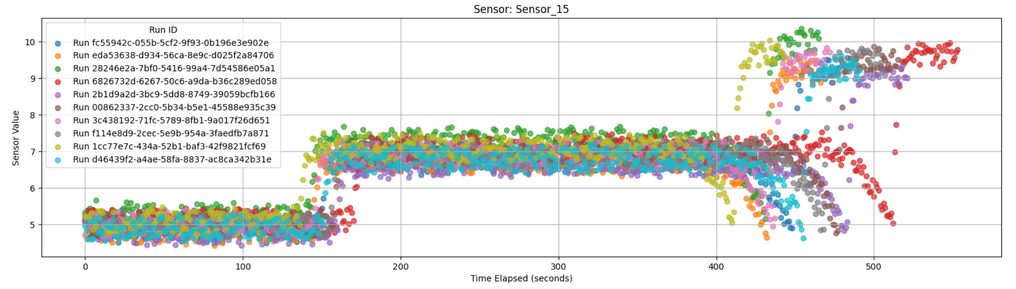
- **Tool ID:** Identifies the specific tool used for the process.
- **Run Start Time / Run End Time:** Timestamps indicating when a particular process run began and ended.
- **Run ID:** A unique identifier for each process run.
- **Process Step:** A unique identifier for the specific step within the process.
- **Consumable Life:** A numerical value representing the remaining or used life of a consumable component.
- **Step ID:** The identifier for a specific processing step within the run.
- **Time Stamp:** The exact time a specific sensor measurement was recorded.
- **Sensor Name:** The name of the sensor collecting the measurement (e.g., “Sensor_a”).
- **Sensor Value:** The numerical reading from the sensor.

Data Description

Incoming Run Data - Overview

- Incoming Run Data (incoming_run_data_{file index}.parquet)
  - Represents: Sensor readings from incoming process steps before the current process.
  - Location: Train & Test folders
  - Total Files: 20
  - Average Shape: (4,472,116 rows, 9 columns)
  - Similar to Run Data but does not include Consumable Life.
  - Use Case: Provides additional insights into the influence of prior processing steps on the current process.





Data Description

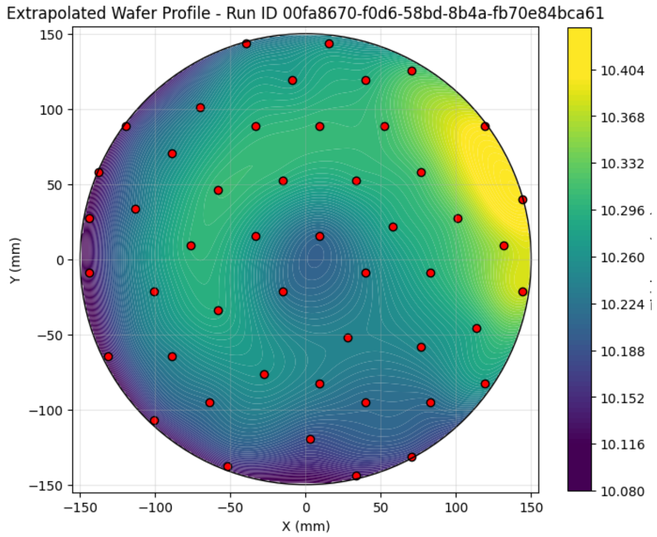
Incoming Run Data - Key columns

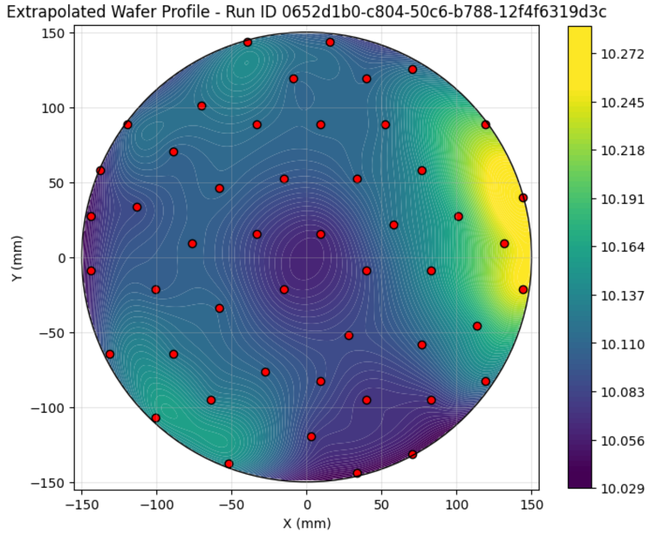
- **Tool ID:** Identifies the specific equipment used for the process.
- **Run Start Time / Run End Time:** Timestamps marking the beginning and end of a process run.
- **Run ID:** A unique identifier for each process run.
- **Process Step:** Identifies the process step within the run.
- **Step ID:** A specific identifier for a step in the process.
- **Time Stamp:** The exact time when a sensor measurement was recorded.
- **Sensor Name:** The name of the sensor collecting the measurement.
- **Sensor Value:** The numerical reading from the sensor.

Data Description

Metrology Data - Overview

- Metrology Data (metrology_data{file index}.parquet)
  - Represents: Performance measurement of the process (actual performed profile after processing).
  - Location: Train & Submission folders
  - Total Files: 20
  - Average Shape: (11,025 rows, 9 columns)
  - Use Case: Provides ground truth for training and serves as the target for submission.





Data Description

Metrology Data - Key columns

- **Run ID:** A unique identifier for each process run.
- **Run Start Time / Run End Time:** Timestamps marking the beginning and end of a process **run.**
- **X_index / Y_index:** Grid indices representing measurement locations on the wafer.
- **X / Y:** The actual spatial coordinates of the measurement points.
- **Point Index:** An identifier for each measurement point.
- **Measurement:** The measured process performance at the specified location.

Competition Goal

Your Challenge: Predict Process Resultant Profile for All 49 Points

- Use Train data to build a model that predicts the full perfomance profile at all 49 measurement locations.
- Apply the trained model to Test data to generate predictions.
- Fill the predicted values into the Submission folder’s Metrology Data, where the Measurement column is empty.
- Improve semiconductor manufacturing efficiency and yield.

Evaluation & Submission

- Model Performance Metrics:
    1. Point-wise Average RMSE (Root Mean Square Error) What is the best performance metric for this use case?
    2. Additional Metrics: MAE, R-squared, etc.
       Mean Absolute Error
- Submission Format:
    1. The Submission folder's Metrology Data must be filled with predicted Measurement values.
    2. Submit the updated Metrology Data file.
- Final Ranking: Based on prediction accuracy and robustness.
  Out of Sample Data Performance

Get Started!

Ready to Compete?

- Download the dataset.
- Train your model using the Train folder.
- Generate predictions using the Test folder.
- Fill in the missing measurement values in the Submission folder.
- Stay tuned for updates and discussions.