Engineering Project 4: Vacuum Pumpdown Estimator + Outgassing/Leak Modeling

Problem statement

- Develop a physics-based vacuum pumpdown analysis tool that estimates effective pumping speed and outgassing/leak rate from pressure–time data and predicts time-to-target pressure for vacuum systems.

The problem this project solves

- Pumpdown behavior is often monitored qualitatively, making it difficult to detect subtle degradation from leaks, valve issues, or increased outgassing.
- Raw pressure logs do not directly reveal the underlying physical parameters that control vacuum performance.
- This project converts pressure–time traces into quantitative, interpretable parameters through model fitting and data-driven prediction.

Applications

- Vacuum system health monitoring for semiconductor process tools and test chambers.
- Early detection of leak formation, seal degradation, or conductance loss.
- Pumpdown time forecasting to support scheduling, throughput planning, and tool utilization analysis.
- Diagnostic comparison of pump and chamber configurations across tools or maintenance states.

Why it's important

- Enables proactive maintenance by identifying performance drift before it impacts yield or uptime.
- Provides physics-grounded insight rather than threshold-only alarms, improving root-cause analysis.

- Scales to fleet-level monitoring and supports data-driven decisions for vacuum system optimization.