The accuracy trend in your results—**decreasing for DMD but increasing for machine learning**—can be explained by how each method interacts with noise and anomalies.

**1️⃣ Why is Machine Learning Accuracy Increasing with SNR?**

Machine learning models typically **learn patterns from data** and **generalize well** when given cleaner inputs. As **SNR increases**, noise decreases, making it easier for the model to:

* Identify **underlying patterns** in normal and anomalous data.
* **Reduce misclassifications** caused by noisy features.
* **Improve feature separability**, leading to **higher accuracy**.

🔹 **Key Reason**: Machine learning benefits from cleaner data because its decision boundaries become more defined with lower noise.

**2️⃣ Why is DMD Accuracy Decreasing with SNR?**

Dynamic Mode Decomposition (DMD) relies on **low-rank approximations** of time-series data. As SNR increases:

* The **original signals are preserved**, but **fewer high-energy disturbances (noise) exist**.
* DMD mainly detects **large deviations** from expected dynamics.
* **Without noise-induced anomalies**, the DMD reconstruction error might become less sensitive, causing it to miss subtle anomalies.

🔹 **Key Reason**: DMD thrives when **there is noise**, since anomalies appear as deviations from normal dynamics. When noise decreases, subtle anomalies may not be detected as effectively.

**3️⃣ Core Differences Between the Two Approaches**

| **Method** | **Behavior at Low SNR** | **Behavior at High SNR** |
| --- | --- | --- |
| **Machine Learning** | Struggles with high noise, leading to misclassifications. | Learns clearer patterns, leading to **higher accuracy**. |
| **DMD** | Detects anomalies as deviations from the noisy signal. | Misses anomalies when noise is low, leading to **lower accuracy**. |

**4️⃣ Possible Fixes for DMD**

If you want **DMD to perform better at higher SNR levels**, consider:

* **Using a lower threshold** for anomaly detection (e.g., **90th percentile instead of 95th**).
* **Increasing the DMD rank** to capture finer details.
* **Combining DMD with another method** (hybrid approach).

**Final Takeaway**

* **Machine learning improves with cleaner data** because it learns structured patterns better.
* **DMD struggles at higher SNRs** since it depends on noise to amplify anomalies.