**🧠 BONUS STATION: "Target Tracker" – Design for Precision**

1. **NGSS Connection: HS-ETS1 (Engineering Design)**
**Set up 3 targets** at different distances:
	* Close (0.5–1 meter)
	* Medium (1.5 meters)
	* Far (2+ meters)
	You can use cups, boxes, paper targets, or chalk circles.
2. Use your existing **launcher** (from previous stations) or make small changes (change rubber band tension, angle, base stability, etc.).

**📏 Test and Collect Data:**

1. For each distance, **launch 3 times**.
2. **Record hits vs. misses** for each target.
3. Track:
	* **Angle of spoon or arm** (estimate in degrees)
	* **Pull-back distance**
	* **Launcher design version (Original, Modified 1, Modified 2)**

**📊 Data Table Example:**

| **Target Distance** | **Launcher Version** | **Angle** | **Pull-Back (cm)** | **Hits** | **Misses** | **Notes** |
| --- | --- | --- | --- | --- | --- | --- |
| Close | Original | 45° | 3 | 2 | 1 |  |
| Medium | Modified 1 | 60° | 4 | 1 | 2 |  |
| Far | Modified 2 | 75° | 6 | 3 | 0 |  |

**🔁 Redesign and Improve:**

1. Use your results to **modify your launcher**:
	* Change angle
	* Add a stopper for consistency
	* Adjust base support
	* Change rubber band or pull-back length
2. **Test again** to see if your accuracy improves!

**💬 Target Tracker Reflection Prompts:**

**1. What changed between your first and final designs?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**2. What worked best for hitting targets accurately?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3. Which design choices helped transfer energy more efficiently?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**4. What real-world machines use similar energy and motion concepts?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**5. How did measuring and data collection help you improve?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

🧠 **Bonus Station: "Target Tracker" – Design for Precision**
**NGSS Connection:**

* **HS-ETS1-2** – Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems.
* **HS-ETS1-3** – Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs.
* **HS-ETS1-4** – Use a computer simulation or mathematical model to generate data for iterative testing and refinement of a design.

✅ **ITEEA STEL Standards – High School**

* **STEL 1G** – *Technological systems use inputs, processes, and outputs.*
 → Students explore how changes in pull-back distance, angle, and materials affect the performance (output) of the launcher.
* **STEL 2G** – *Systems thinking helps analyze how different components influence outcomes.*
 → Learners analyze how modifications in launcher design improve precision and target accuracy.
* **STEL 3I** – *Design and research in technology and engineering contexts use models and simulations.*
 → Students treat the launcher as a model system and test variables like angle, tension, and stability to simulate real-world projectile systems.
* **STEL 4H** – *The engineering design process includes defining problems, generating ideas, testing solutions, and communicating results.*
 → Students cycle through design-redesign-test phases, using collected data to inform improvements.
* **STEL 5F** – *Data is critical to understanding problems and informing design decisions.*
 → By tracking hits, angles, and modifications, students gather evidence to make decisions about what changes lead to better precision.

✅ **Common Core Math Standards – High School**

* **HSS.ID.A.1** – Represent data with plots on the real number line (dot plots, histograms, and box plots).
 → Students can graph hits vs. misses or compare performance across launcher versions.
* **HSS.ID.B.5** – Summarize categorical data for two categories using two-way frequency tables.
 → Learners compare launcher design (Original vs. Modified) with success rates across distances.
* **HSN.Q.A.1** – Use units as a way to understand problems and guide the solution of multi-step problems.
 → Students measure angles in degrees, distances in meters or centimeters, and use this data consistently to draw conclusions.
* **HSA.CED.A.2** – Create equations in two or more variables to represent relationships between quantities.
 → Learners may model the relationship between angle and distance to optimize performance.
* **F.IF.B.4** – Interpret key features of functions in terms of the quantities they represent.
 → Students can explore how variables like pull-back distance affect precision, potentially identifying ideal configurations for accuracy.

💡 **Summary:**
This station integrates **engineering design, physics, and data analysis**. Students apply math to quantify design decisions, test hypotheses about motion and accuracy, and refine their launchers for precision — just like engineers improving real-world targeting systems.