

Background

- Iron Will Outfitters is a leader in premium archery equipment
- Experiencing broadhead failure while on the hunt inspired a desire to improve and quantify broadhead performance
- 3-blade broadheads increase cutting area but are limited by tip sharpness and penetration force

Objective

- Design and optimize a 3-blade broadhead
- Benchmark competitor broadheads
- Quantify broadhead performance for the following characteristics
 - Strength and durability
 - Penetration Force
 - Flight characteristics

Key Requirements

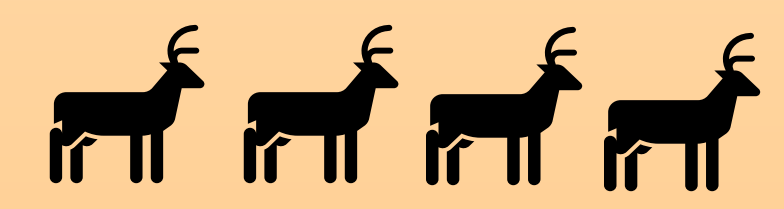
- Broadhead weight is 100 grains $\pm$ 3 grains (~6.48 grams)
- Broadhead blades are removable
- Broadhead has no loose parts when fully assembled
- Blades do not bend, break or come loose from ferrule during its lifetime
 - Lifetime is defined as 5 impacts
- Broadhead has a maximum force to penetrate hide of 20lbs

CU 3-Blade Final Design Overview

Image Removed for Intellectual Property Considerations

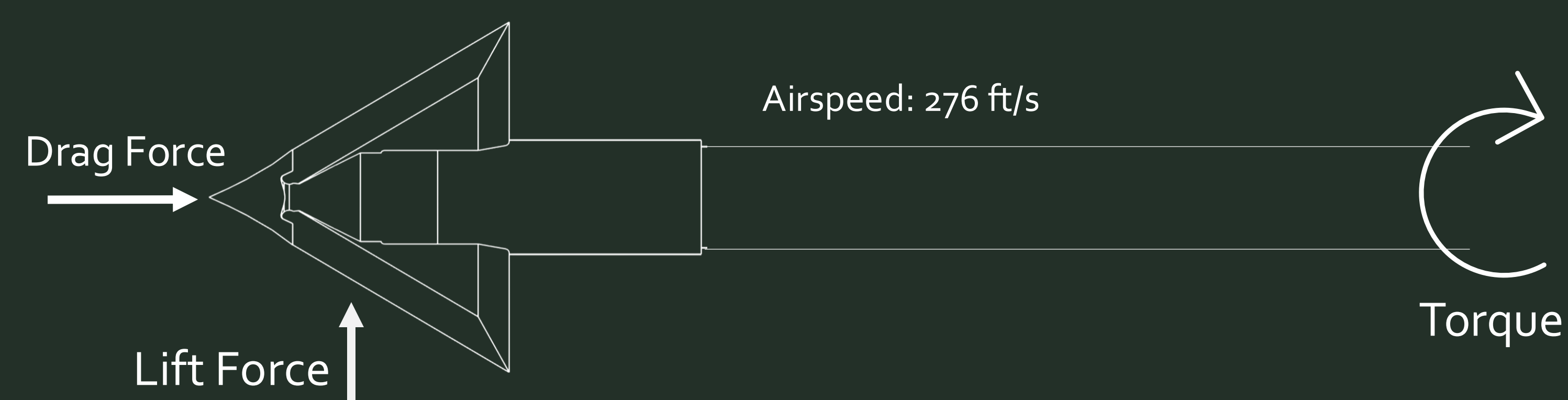
Conclusion and Next Steps

- Final design outperformed prototype 1, passing the 5-impact lifetime requirement
- Final design exceeds penetration force requirement and exceeds sharpness of all 3-blade competitors
- Improved performance is due to A2 Tool Steel replacing the stainless-steel blades in prototype 1
- Next design iteration will incorporate tooling to tighten the collar to simplify assembly
- Next design will incorporate design changed to increase weight ~ 7 grains



Flight Characteristics Determined By CFD

- Flight characteristics determine the stability and accuracy of flight
- Decreasing lift and drag reduces the overall aerodynamics forces on the arrow, allowing for stable and accurate shots
- Achieved a **34% decrease** in required restoring torque and **3.3% decrease** in drag over Iron Will S Series



Special thanks to Bill Vanderheyden, John Gordon, No Limits Archery, and the ME Senior Design Staff

Sharpness Testing

- Sharpness is measured in grams required to cut a wire
- Smaller value corresponds to sharper edge
- Sharpness is measured before and after durability testing

3-Blade Broadhead	Before (g)	After (g)	% Change
Prototype 1	464.4	504.4	8.6%
Final Design	342.0	368.8	7.3%
Iron Will S Series (Single Bevel)	142.3	164.7	15.7%
Competitor 1	556.7	773.5	38.9%
Competitor 2	679.6	716.5	5.4%

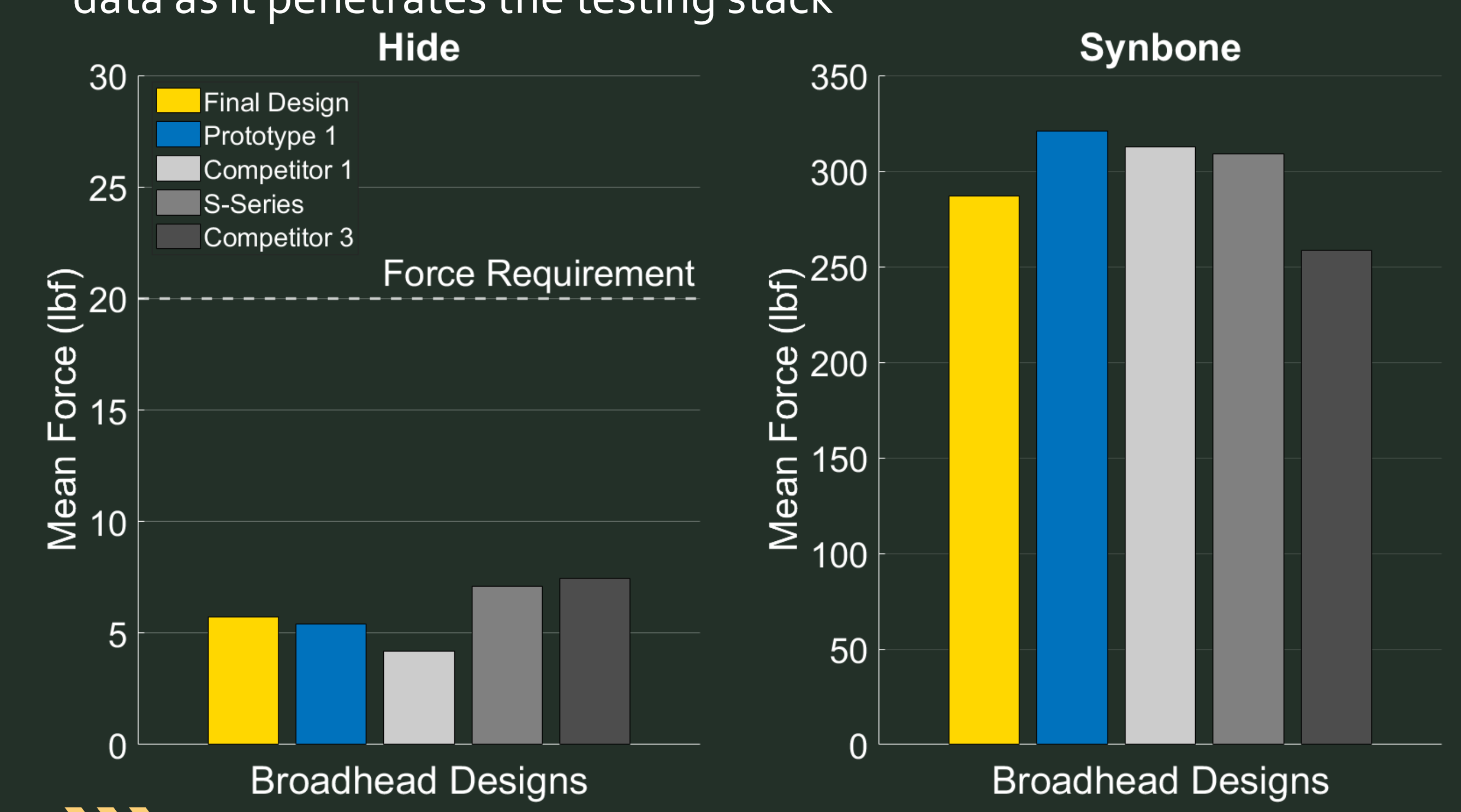
Simulating Large Game

The following materials were layered to simulate the broadhead impacting large game for testing

- Ballistics gel to mimic muscle and organs
- Synthetic bone
- Real deer hide

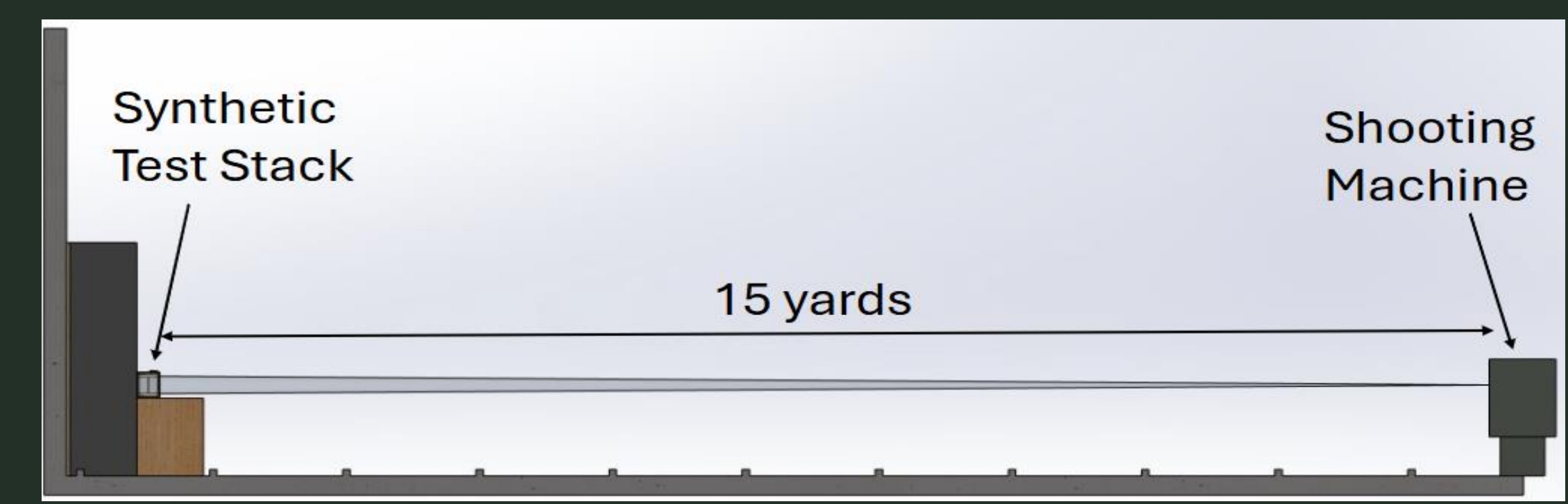
Penetration Force Test

MTS pushes broadhead through the test stack to collect force data as it penetrates the testing stack



Durability Testing

- Broadhead lifetime is defined as **5 impacts without blades bending, breaking or coming loose from the ferrule**
- Broadhead is shot with 60-pound draw weight
- After each shot into test set up broadheads are inspected for
 - Visual deformation
 - Blade movement



Broadhead	Pass/Fail
Prototype 1	Fail
Final Design	Pass
Competitor 1	Pass
Competitor 2	Pass