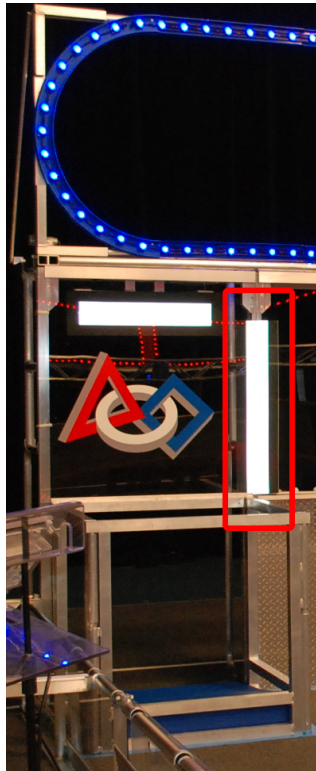


Target Info and Retroreflection

This document describes the Vision Targets from the 2014 FRC game and the visual properties of the material making up the targets. Note that for official dimensions and drawings of all field components, please see the [Official Field Drawings](#)

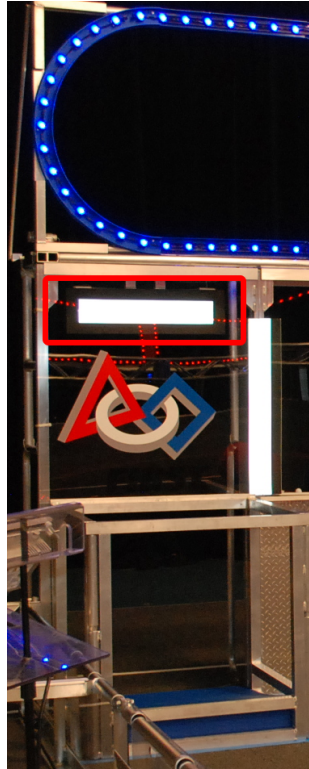
Vertical Targets



The Vertical Vision Target consists of 4" wide, 32" tall stripe of retroreflective material (3M 8830 Silver Marking Film) bordered by 2in. wide black gaffers tape on the left and right sides. The Vertical Targets are located behind the polycarbonate (above the low goal) and acrylic (in front of the Player Station) sheets above the inside edge of each Low Goal, approximately 37.5" above the carpet. When properly lit, the retroreflective tape produces a bright and/or color-saturated marker.

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Horizontal Targets



The Horizontal Target consists of a 23.5" long, 4" tall stripe of retroreflective material bordered on all sides by a 2" black ABS plastic frame. The Horizontal Targets are centered above the Low Goal, behind the polycarbonate sheet. The reflective material begins 68" above the carpet.

Horizontal Target Behavior

The Horizontal Target is a dynamic field element which is actuated during autonomous to indicate whether the corresponding High and Low goals are Hot or not. Before the match starts, both targets will have the reflective material showing out towards the field.

- When the match starts, one target will actuate to point the reflective material upwards, hiding it from view. The target which flips first will be randomly selected, but will always be the same for both alliances from the robot perspective. This means that the targets active at the same time will be located diagonally across the field from each other. The goal which has the reflective material showing is the Hot goal.
- Halfway through the autonomous period both targets will flip their state indicating that the other goal is now Hot.
- At the end of the autonomous period both targets will return to showing the material. The targets will remain in this state (both showing) for the duration of the Teleoperated period.

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The targets are actuated by an electric solenoid and have state transition times of ~?.? seconds.

Retroreflectivity vs. Reflectivity

Retroreflectivity vs. Reflectivity

Highly reflective materials are generally mirrored so that light “bounces off” at a supplementary angle. As shown above-left, the blue and red angles sum to 180 degrees. An equivalent explanation is that the light reflects about the surface normal the green line drawn perpendicular to the surface. Notice that a light pointed at the surface will return to the light source only if the blue angle is ~90 degrees.

Retro-reflective materials are not mirrored, but it will typically have either shiny facets across the surface, or it will have a pearl-like appearance. Not all faceted or pearl-like materials are retro-reflective, however. Retro-reflective materials return the majority of light back to the light source, and they do this for a wide range of angles between the surface and the light source, not just the 90 degree case. Retro-reflective materials accomplish this using small prisms, such as found on a bicycle or roadside reflector, or by using small spheres with the appropriate index of refraction that accomplish multiple internal reflections. In nature, the eyes of some animals, including house cats, also exhibit the retro-reflective effect typically referred to as night-shine. The Wikipedia articles on retro-reflection go into more detail on how retro-reflection is accomplished.

Examples of Retroreflection

Examples of Retroreflection

This material should be relatively familiar as it is often used to enhance nighttime visibility of road signs, bicycles, and pedestrians.

Initially, retro-reflection may not seem like a useful property for nighttime safety, but when the light and eye are near one another, as shown below, the reflected light returns to the eye, and the material shines brightly even at large distances. Due to the small angle between the driver's eyes and vehicle headlights, retro-reflective materials can greatly increase visibility of distant objects during nighttime driving.

Demonstration

To further explore retro-reflective material properties:

1. Place a piece of the material on a wall or vertical surface
2. Stand 10-20 feet away, and shine a small flashlight at the material.

Target Info and Retroreflection

3. Start with the light held at your belly button, and raise it slowly until it is between your eyes. As the light nears your eyes, the intensity of the returned light will increase rapidly.
4. Alter the angle by moving to other locations in the room and repeating. The bright reflection should occur over a wide range of viewing angles, but the angle from light source to eye is key and must be quite small.

Experiment with different light sources. The material is hundreds of times more reflective than white paint; so dim light sources will work fine. For example, a red bicycle safety light will demonstrate that the color of the light source determines the color of the reflected light. If possible, position several team members at different locations, each with their own light source. This will show that the effects are largely independent, and the material can simultaneously appear different colors to various team members. This also demonstrates that the material is largely immune to environmental lighting. The light returning to the viewer is almost entirely determined by a light source they control or one directly behind them. Using the flashlight, identify other retro-reflective articles already in your environment ... on clothing, backpacks, shoes, etc.

Lighting

Lighting

We have seen that the retro-reflective tape will not shine unless a light source is directed at it, and the light source must pass very near the camera lens or the observer's eyes. While there are a number of ways to accomplish this, a very useful type of light source to investigate is the ring flash, or ring light, shown above. It places the light source directly on or around the camera lens and provides very even lighting. Because of their bright output and small size, LEDs are particularly useful for constructing this type of device.

As shown above, inexpensive circular arrangements of LEDs are available in a variety of colors and sizes and are easy to attach to the Axis cameras. While not designed for diffuse even lighting, they work quite well for causing retro-reflective tape to shine. A small green LED ring is available through [FIRST Choice](#). Other similar LED rings are available from the supplier, [SuperBrightLEDs.com](#)

More Information

For more information on retroreflection including types of retroreflective materials, how retroreflective performance is characterized, and information on the 3M 8830 Silver Marking Film used on the 2014 field, see the documents linked from [this page](#).

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Sample Images

Sample Images are packaged with the examples for each language. The locations are described in the [LabVIEW Code](#) and [C++/Java Code](#) articles. The images included with the examples do not have the yellow LEDs lit on the goal above the target. Some images with the LEDs lit have been uploaded here: http://firstforge.wpi.edu/sf/frs/do/viewRelease/projects.wpilib/frs.2014_vision_images.2014_vision_images_supplement