Lessons Learned from the Virginia Tech Helmet Ratings

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Virginia Tech Helmet Ratings

- **Virginia Tech Helmet Lab**
  - Injury biomechanics research
  - Research funding: NIH, NOCSAE, IIHS, NCAA, DOD

“What helmets should we buy?”

- Lester Karlin, VT Equipment Manager

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  - Injury biomechanics research
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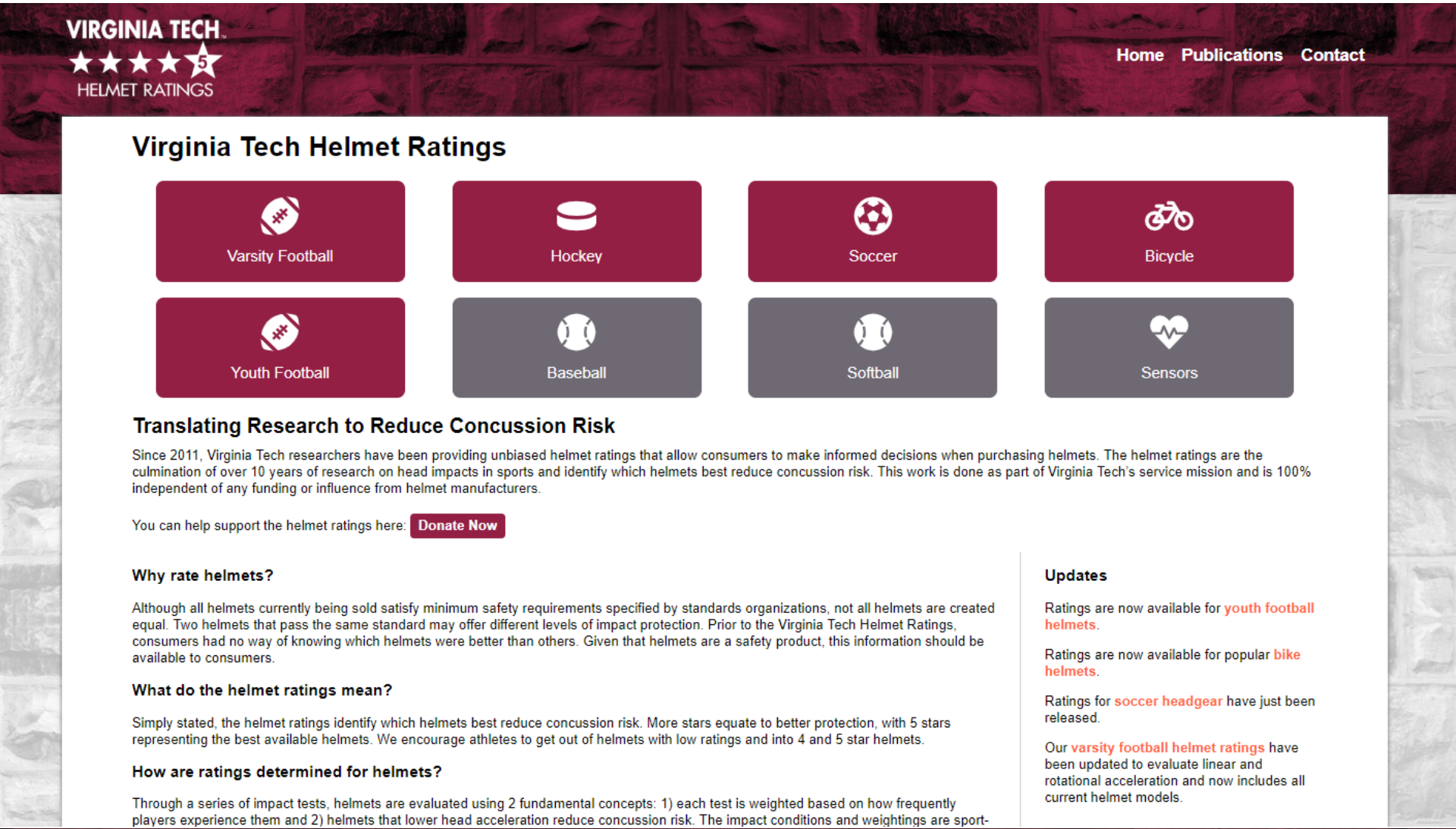
- **Virginia Tech Helmet Ratings**
  - Translational outcome of research to meet public need
  - Initially released in 2011
  - Independent of manufacturer funding
  - Supplemental testing to NOCSAE, only tests certified helmets

www.vt.edu/helmet

Virginia Tech Helmet Ratings



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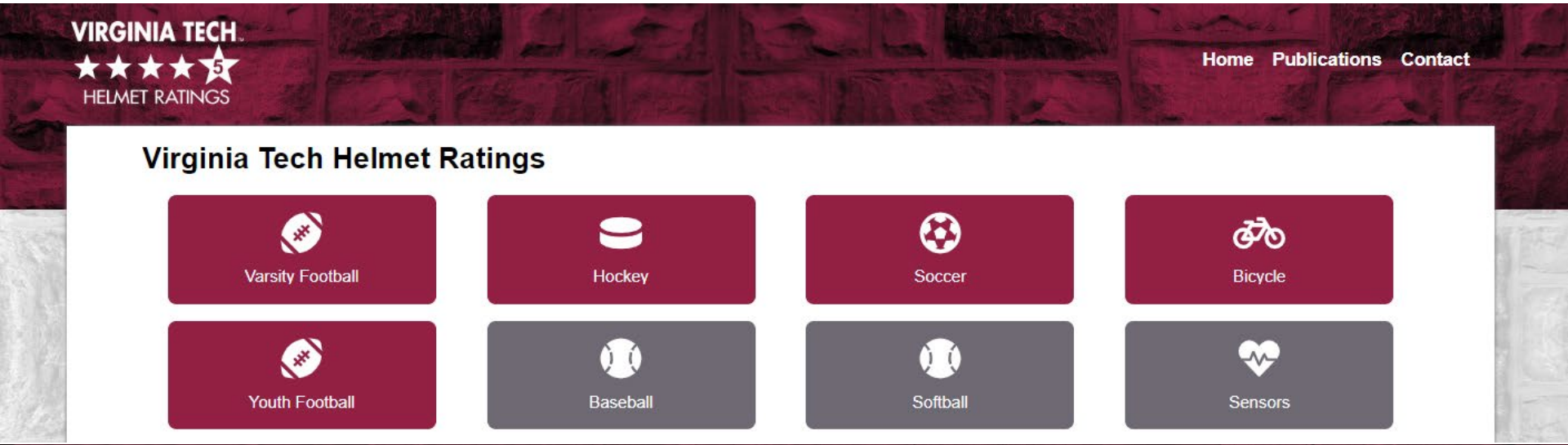
Virginia Tech Helmet Ratings

The helmet ratings program has 2 primary objectives

1. Inform consumers of relative differences between helmets in the context of concussion risk reduction
2. Provide manufacturers with a design tool to optimize helmet design to best reduce concussion risk in the real world



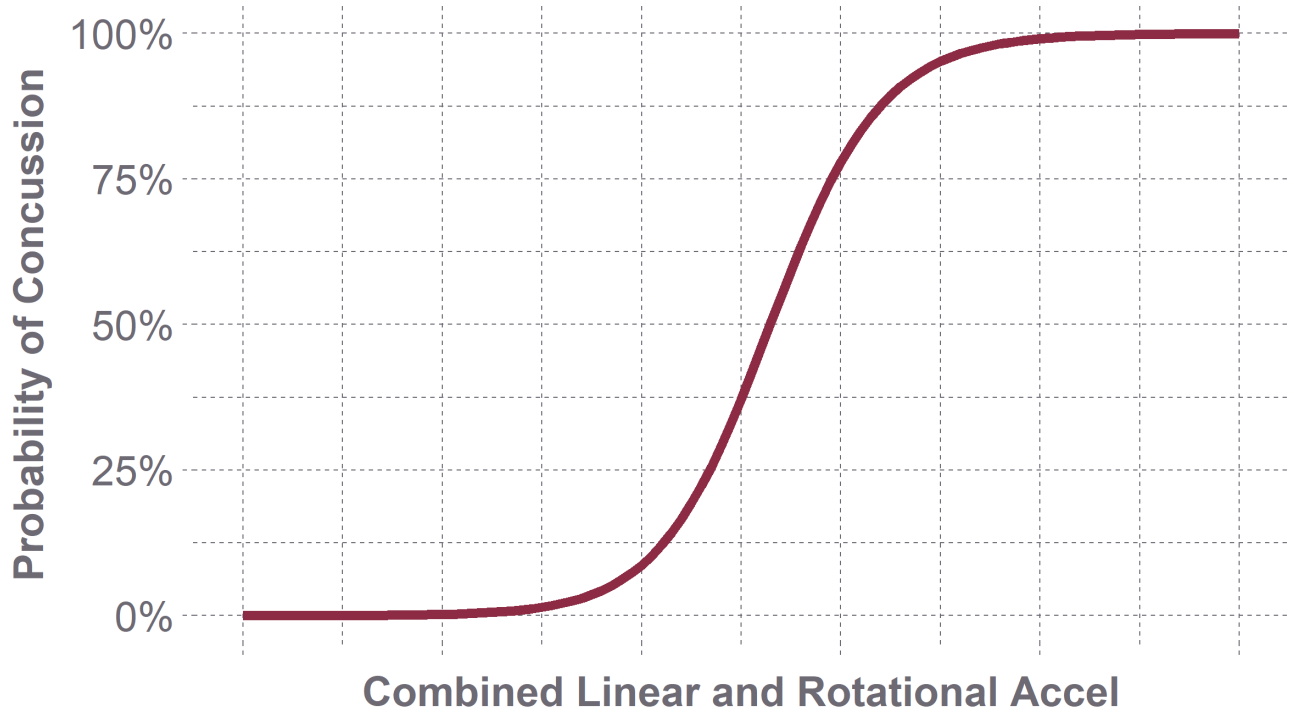
General STAR Evaluation Approach

- Characterize sport-specific head impact exposure and concussion risk in the real-world
- Translate and map impact scenarios to sport-specific impact test equipment in the lab
- Evaluate helmets over range of impact locations and severities; summarize results into an overall rating

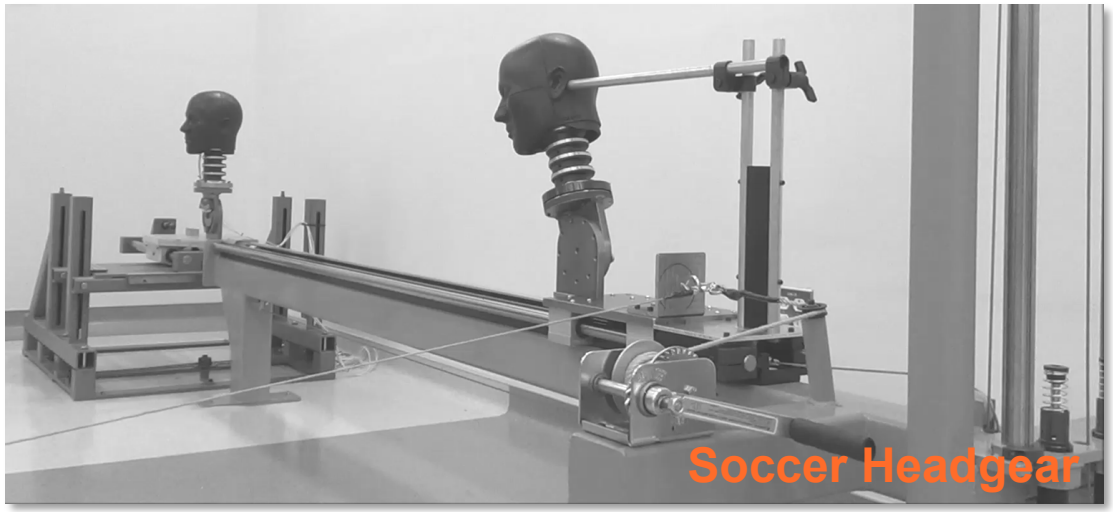
General STAR Evaluation Approach

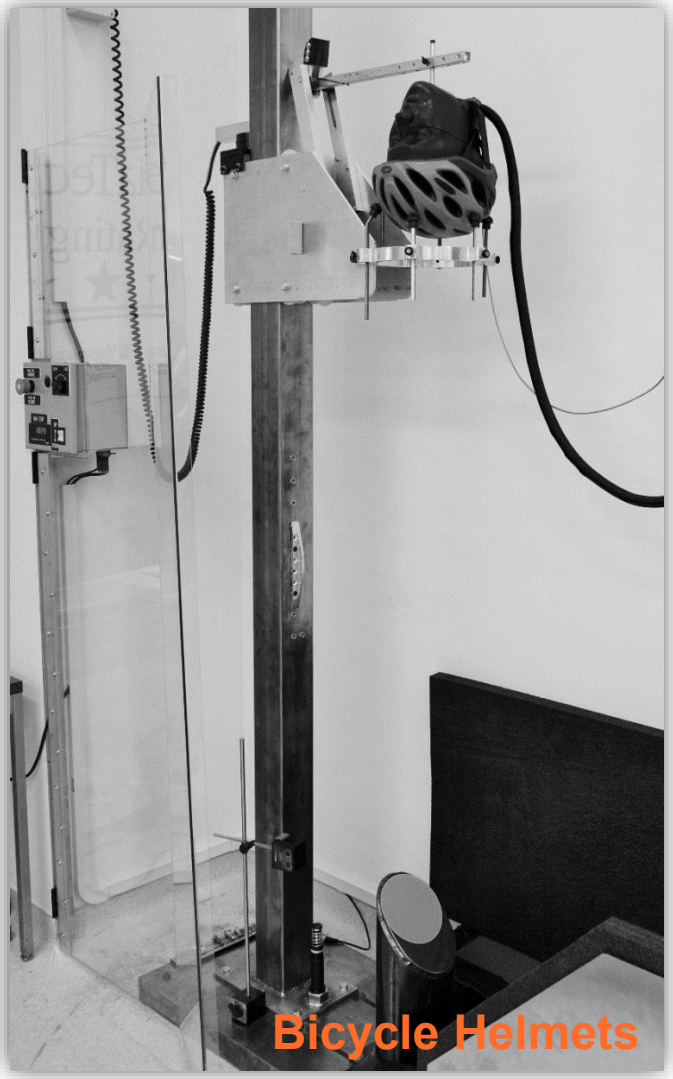
Fundamental concepts of STAR Evaluation System

1. Tests are weighted based on how often they occur
2. Helmets that lower head acceleration reduce risk



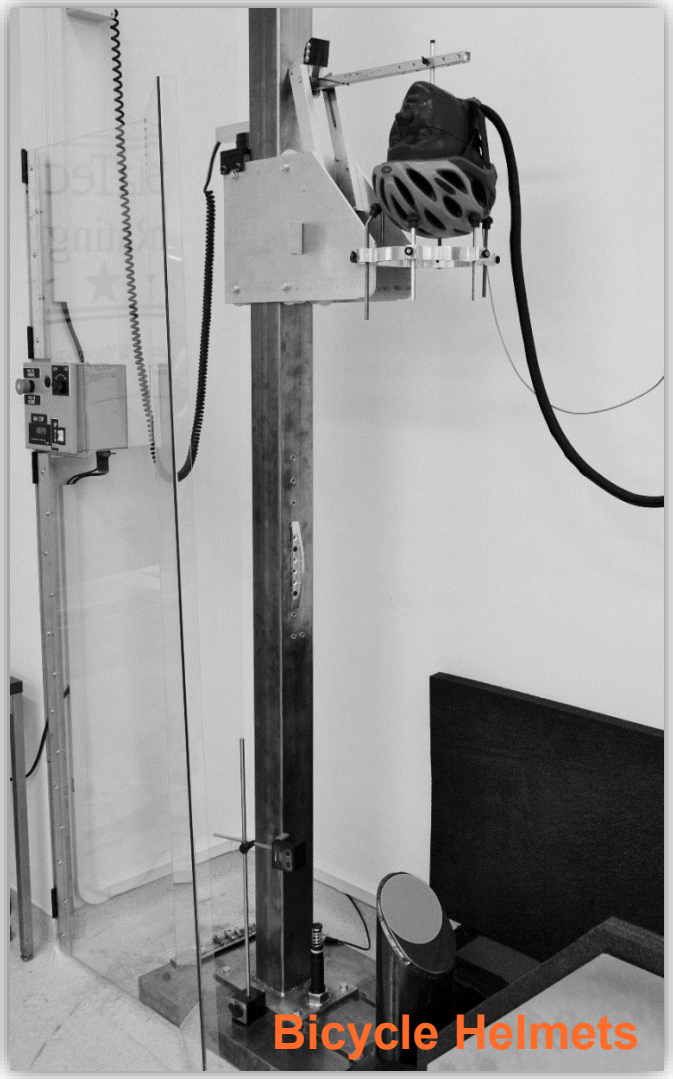
Application-Specific Test Methodologies





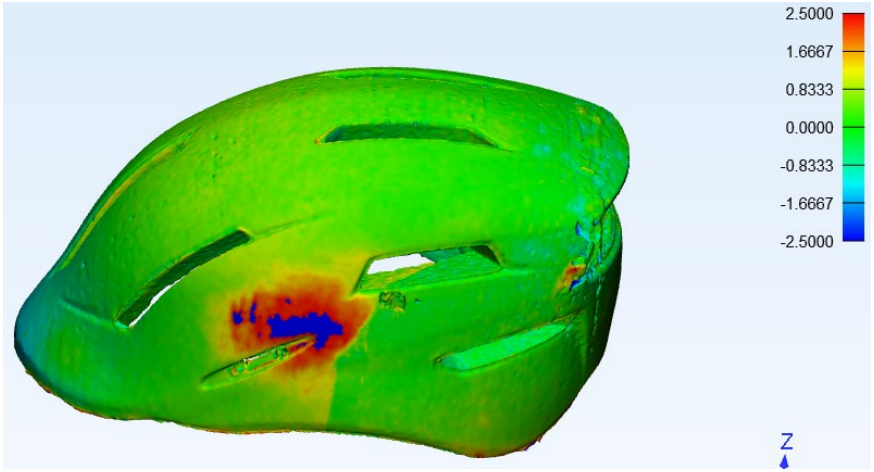
Evaluating Bicycle Helmets

- Oblique impact rig with 45 degree anvil
  - Sandpaper coated (80 grit)
- NOCSAE headforms Three linear accelerometers, tri-axis angular rate sensor at head CG
- No neck – head support ring and lever arm, dual axis inclinometer
- Velocity light gate



Damage Reconstructions

Real-world head impact characterization



- **Accident description:** “biking very fast, potentially hit a pothole, fell off bike”
- **Impact surface:** Road, pavement holes/bumps
- **Helmet surface:** large scrapes (~4.0-5.0 cm long) and slightly pockmarked anterior to max crush
- **Max crush:** 3.9 mm temporal/parietal left

Bicycle STAR: Exposure Locations

Equal weighting for all locations (1-time events)

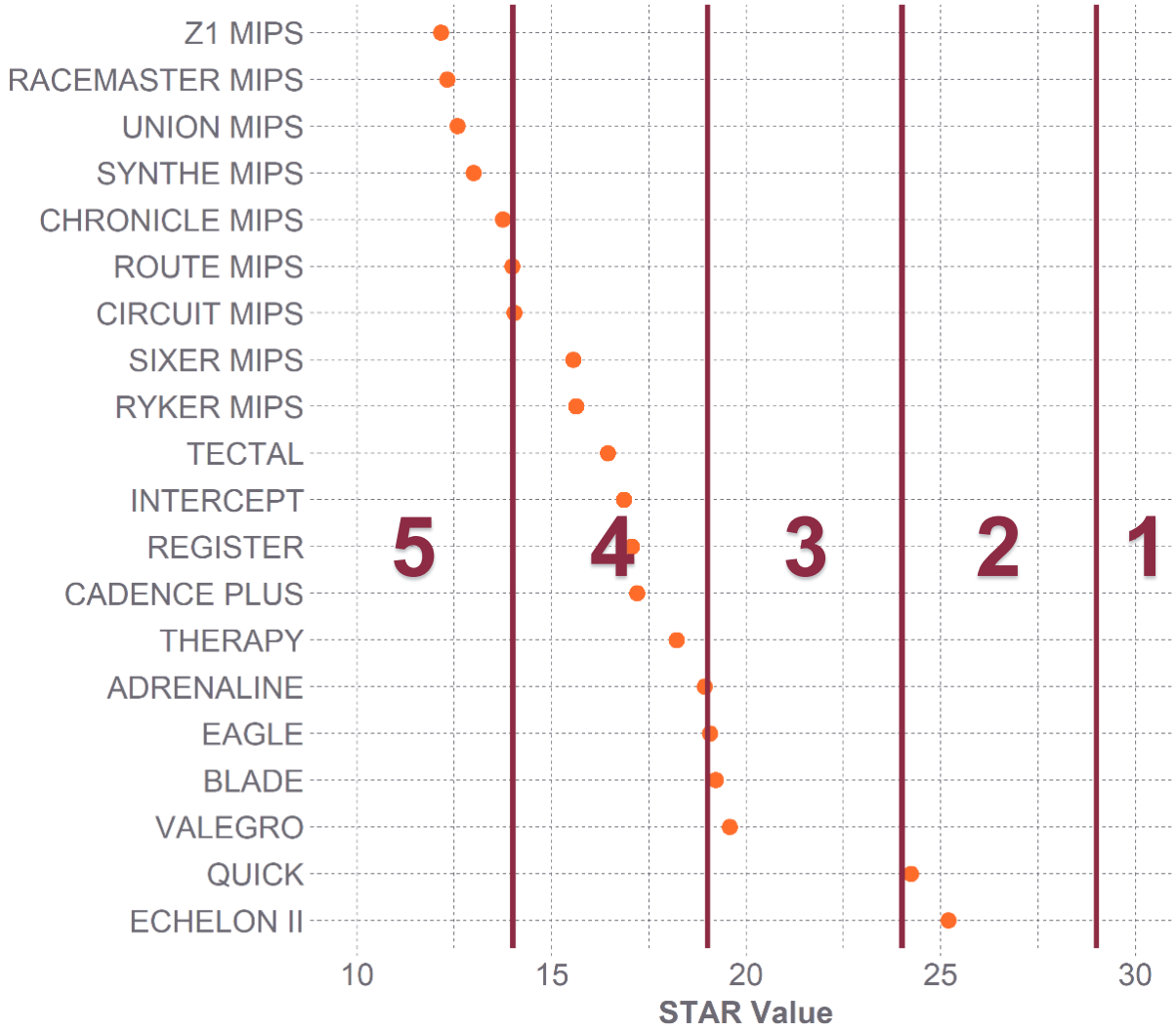
$$Bicycle\ STAR = \sum_{L=1}^{6} \sum_{V=1}^{2} \boldsymbol{E(L,V)} * R(a,\omega)$$

Six impact locations:

- 1 and 4 at helmet rim
  - Commonly impacted location in cyclist accidents
- Each sample impacted once per location
- Minimum spacing: 12 cm

Bicycle STAR: Example Test

Bicycle Helmet STAR Results



115 Bicycle Helmet Models Rated

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Bicycle Helmet Ratings

In collaboration with the Insurance Institute for Highway Safety, we have rated a total of 115 bike helmets using the STAR evaluation system. Our bicycle helmet impact tests evaluate a helmet's ability to reduce ***linear acceleration and rotational velocity*** of the head resulting from a range of impacts a cyclist might experience. Helmets with more stars provide a reduction in concussion risk for these impacts compared to helmets with less stars.

Wearing a helmet is most important and can be the difference between life and death in the event of a crash. These ratings supplement standards by providing additional information on which helmets best reduce concussion risk. For bike helmets, we recommend any 4 or 5 star helmet. While there are some differences in impact performance within these groups, other factors such as cost, fit, and comfort should be considered when purchasing a helmet.

Share this page on social media: Tweet

You can help support the helmet ratings here: **Donate Now**

★★★★★ : Best Available
★★★★☆ : Very Good
★★★☆☆ : Good
★★☆☆☆ : Adequate
★☆☆☆☆ : Marginal
☆☆☆☆☆ : Not Recommended

Only show helmets that are:

Show All	Road Style	Urban Style	Mountain Style
Skate Certified	Snow Certified	Under $100	

Search for helmets...

Fox Dropframe Pro (MIPS)

★★★★★

Cost: $200
Certifications: CPSC

Style: Mountain
Score: 8.9

Lazer G1 MIPS

★★★★★

Cost: $240
Certifications: CPSC

Style: Road
Score: 9.2

Bontrager Rally MIPS

★★★★★

Notes

A ***lower score*** offers ***better protection***.

Cost shown is MSRP for the helmets at the time of testing.

For proper fit, cyclists should position the helmet rim ***1-2 fingers' width above the browline*** and ***tighten the fit system*** to minimize movement of the helmet on the head.

All helmets sold in the US must be ***CPSC***-certified. This standard requires protection against catastrophic injuries in extremely severe impacts, which are rare. Several helmets are certified by additional US standards. The ratings indicate helmets that pass standards for ***snow*** sports (ASTM F2040) or ***skate*** sports (ASTM F1492).

Documents

See our test methodology.

My Takeaways / Lessons Learned

- **Manufacturer Buy-In**
  - While not a standard, we've had an open process
  - Responsive to input, questions, and concerns
  - Decisions and methods backed by research, representative of real-world events
  - Accessible methods
  - Resonates with consumers

- **Consumer Buy-In**
  - Independent / no conflict of interest
  - Easily accessible and points to the research
  - Publicizing the ratings

Harmonization vs. Competing Methods

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Varsity Football Helmet Ratings

A total of 26 varsity football helmets have been rated using the STAR evaluation system. Our impact tests evaluate a helmet's ability to reduce ***linear and rotational acceleration*** of the head resulting from a range of head impacts a football player might see on the field. Helmets with more stars provide a reduction in concussion risk for these impacts compared to helmets with less stars.

Don't see your helmet listed below? Check out our legacy football helmet ratings for older models that are no longer produced.

For varsity football helmets, we recommend any 5 star helmet. While there are some differences in impact performance within this group, other factors such as cost, fit, and comfort should be considered when purchasing a helmet.

Share this page on social media: Tweet

You can help support the helmet ratings here: Donate Now

★★★★★ : Best Available
★★★★☆ : Very Good
★★★☆☆ : Good
★★☆☆☆ : Adequate
★☆☆☆☆ : Marginal
☆☆☆☆☆ : Not Recommended

Search for helmets...

VICIS ZERO2 TRENCH ★★★★★
Cost: $859.00 Weight: 4.7 lb
Score: 0.52

VICIS ZERO2 ★★★★★
Cost: $759.00 Weight: 4.3 lb
Score: 0.73

Schutt F7 LTD ★★★★★
Cost: $975.00 Weight: 5.1 lb
Score: 0.75

Riddell SpeedFlex Diamond ★★★★★
Cost: $499.99 Weight: 4.8 lb
Score: 1.69

Notes

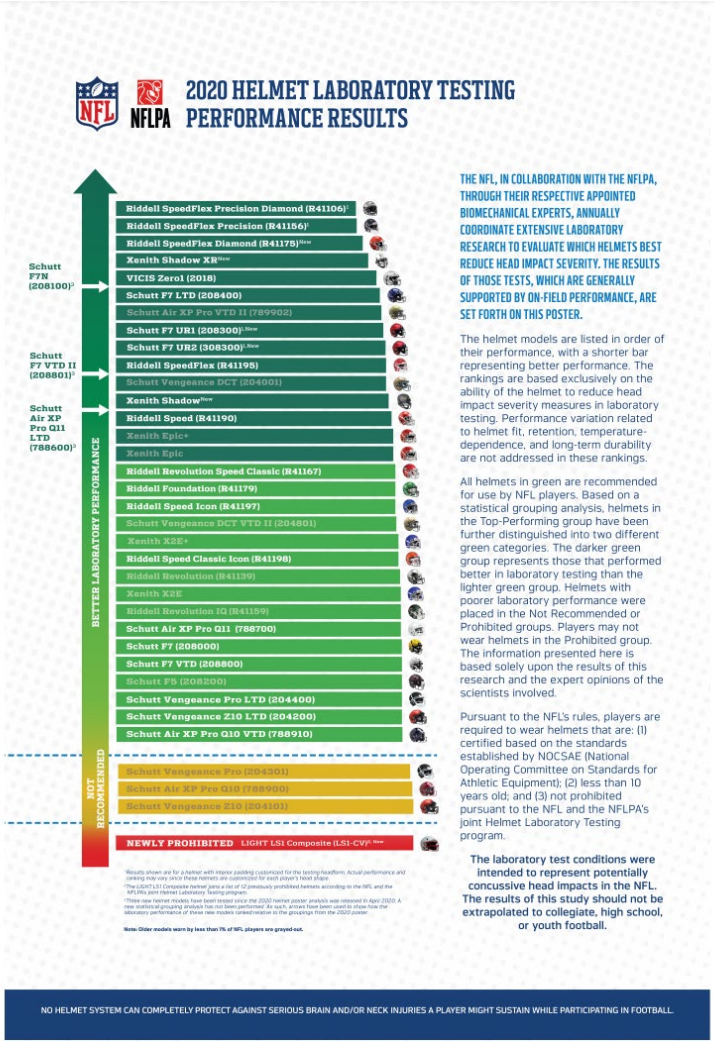
A ***lower score*** offers ***better protection***.

Cost shown is what ***we paid*** for the helmet at the time of testing.

Weight includes the helmet shell and facemask tested. We chose the ***lightest standard facemask*** for each helmet.

Documents

See our test methodology.



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