2016 U.S. Safety Updates

Presented by
Rob Burk, USEA Chief Executive Officer

USEA Cross Country Design and Fence Construction Safety Task Force

- **Dr. Kathleen Becker,** *veterinarian, Masters in engineering, currently president of Häst PSC manufacturer of large animal rescue equipment*
- **Sarah Broussard,** *organizer of Rebecca Farm, former VP of safety for USEA, former Member of USEA Board of Governors, former Member of the USEF Eventing Technical Committee, eventer and Paramedic.*
- **Tremaine Cooper,** *competitor, 3*/4* FEI course designer, course builder*
- **Andy Griffiths,** *international FEI TD, Chairman IEOC, FEI Development Officer for the FEI, former international competitor*
- **Jay Hambly,** *FEI "I" international cross country course designer, International cross country course builder, Equine Canada course advisor and designer, Advanced level event rider, A level pony clubber*
- ***Continued…***

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USEA Cross Country Design and Fence Construction Safety Task Force

- **Malcolm Hook,** *FEI TD, Member USEF Technical committee, Member USEF Safety committee, FEI National safety officer*

- **Jonathan Holling**, *international competitor, ICP level 4 certified instructor, Member USEF Eventing Sport Committee, currently owns and operates Holling Eventing in Ocala, Florida*

- **Lesley Grant-Law,** *magna cume laude with honors degree in international relations and philosophy, summa cume laude with a masters in international relations (human rights), short listed for Canadian Event team multiple times, 4 star level rider, currently runs Law Eventing based in Ocala, Florida*

- **Doug Payne,** *USEF judge and TD, degree in mechanical engineering, member of USEA Board of Governors, international competitor, ICP certified instructor and trainer*

- ***Dave Voss**, holds engineering degrees from the Univ. of Stellenbosch and MIT. Previous CEO of Athena Technologies and former head of Project Wing at Alphabet (formerly Google) X. Holds multiple patents and has served on numerous committees with NASA and the U.S. Federal Aviation Administration.*

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2017 USEF Extraordinary Rule Change

9. ***FRANGIBLE FENCES***

Obstacles for which frangible technology is appropriate shall be constructed using this technology, or shall be retrofitted using this technology.

The Technical Delegate must communicate with the Ground Jury and Course Designer to confirm that Frangible Technology employed is consistent with the USEA Cross-Country Obstacle Design Guidelines. Information on the appropriate applications of Frangible Technology in cross-country fence construction is available in the USEA Cross-Country Obstacle Design Guidelines. Frangible Technology may be installed only by or under the supervision of Course Designers/course builders who have attended a USEA Seminar on Frangible fence construction.

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b. At the Modified Level and above, all oxers (both front and back top rails), must be built using frangible technology e.g. frangible pins, MIM Clips, or any other load relieving devices. In all cases, the front rail must be able to be activated by either combined horizontal and downward forces, or horizontal and upward forces.

The back rail must at a minimum be able to be activated by horizontal and downward forces.

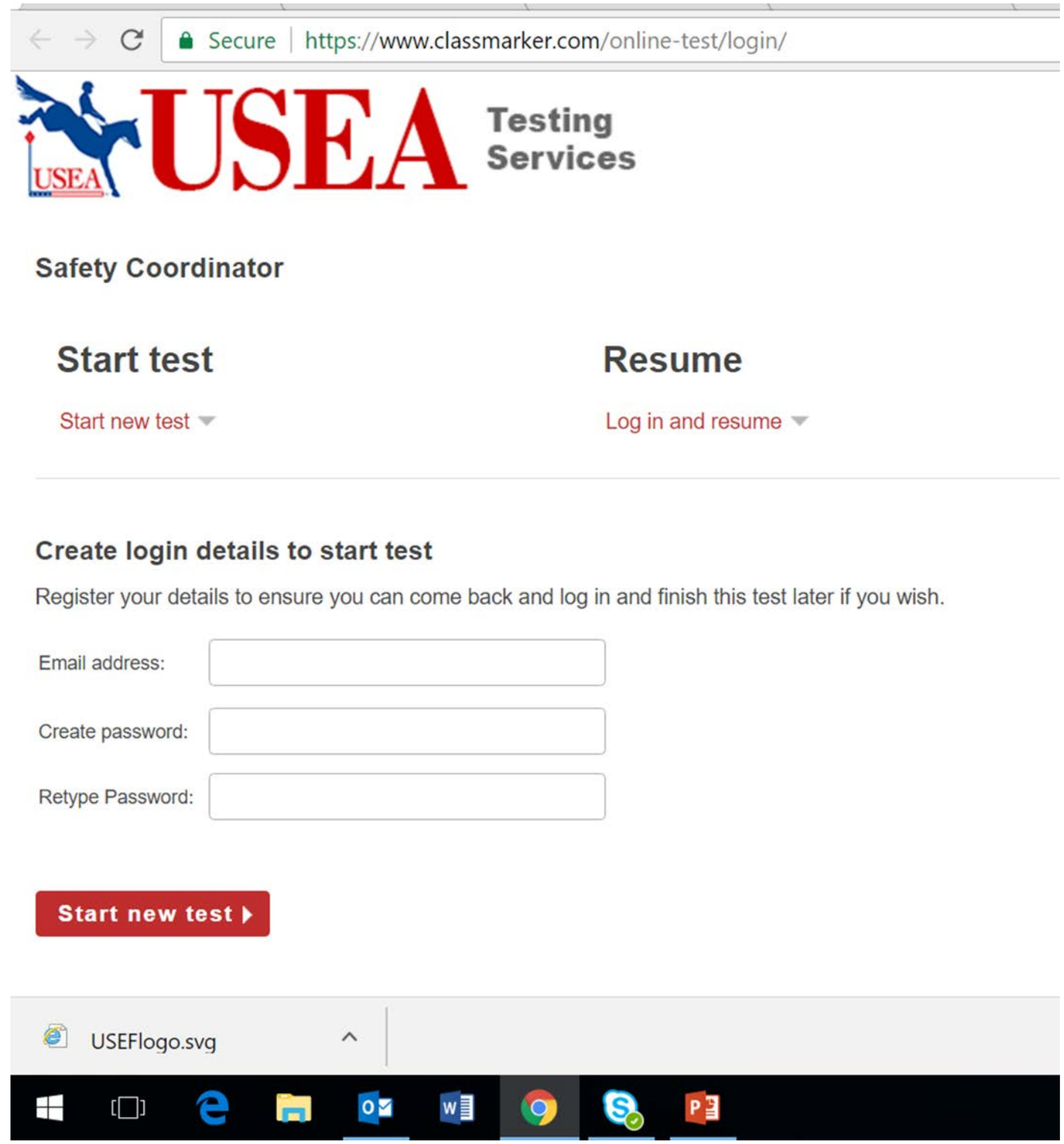
2017 Rule and Recommendation

- **<u>RULE:</u>**

SAFETY COORDINATOR. ***All competitions shall furnish a Safety Coordinator, who shall be responsible for the establishment and coordination of medical services. As this shall include the transportation of injured competitors, the Safety Coordinator should not have any other duties during any cross-country or jumping tests.***

- ***2011 USEA Safety Coordinator Manual Developed***

- ***2017 USEA Safety Coordinator Test and Cetification to be released***



Improved Eventing Safety: Horse/Fence Interaction in Rotational Fall Dynamics

Suzanne Weaver Smith, PhD
Donald and Gertrude Lester Professor of Mechanical Engineering

Gregorio Robles Vega (MS ME), Lange Ledbetter (BS ME)
University of Kentucky

and Shannon Wood (BS EP)
Murray State University

Thank you to all who have supported this effort to date.

USEA Board of Governors Presentation
December 11, 2016

2016-2017 Project Objectives

Filling in the Missing Pieces for Improved Eventing Safety: Horse/Fence Interaction in Rotational Fall Dynamics

- ***Task 1 – Phased Development of Validated Models***
  - Sequence of increasingly complex computer simulations
  - validated and developed with data from Tasks 2-4
  - To identify key parameters in frangible or deformable performance for design guidance
  - To reduce incidence and consequence of rotational falls
- ***Task 2 – Revisit BE Non-rotational Contact Forces***

  Sub-categorize contact force and impulse data
- ***Task 3 – Video Analysis of Rotational Falls***

  Extract approach speeds and rotational speeds
- ***Task 4 – Expanded Literature Review***

  Relevant sports safety, overturning analyses, inertia
- ***Task 5 – Review Safety Statistics***

  Compare original fall statistics to device activation counts

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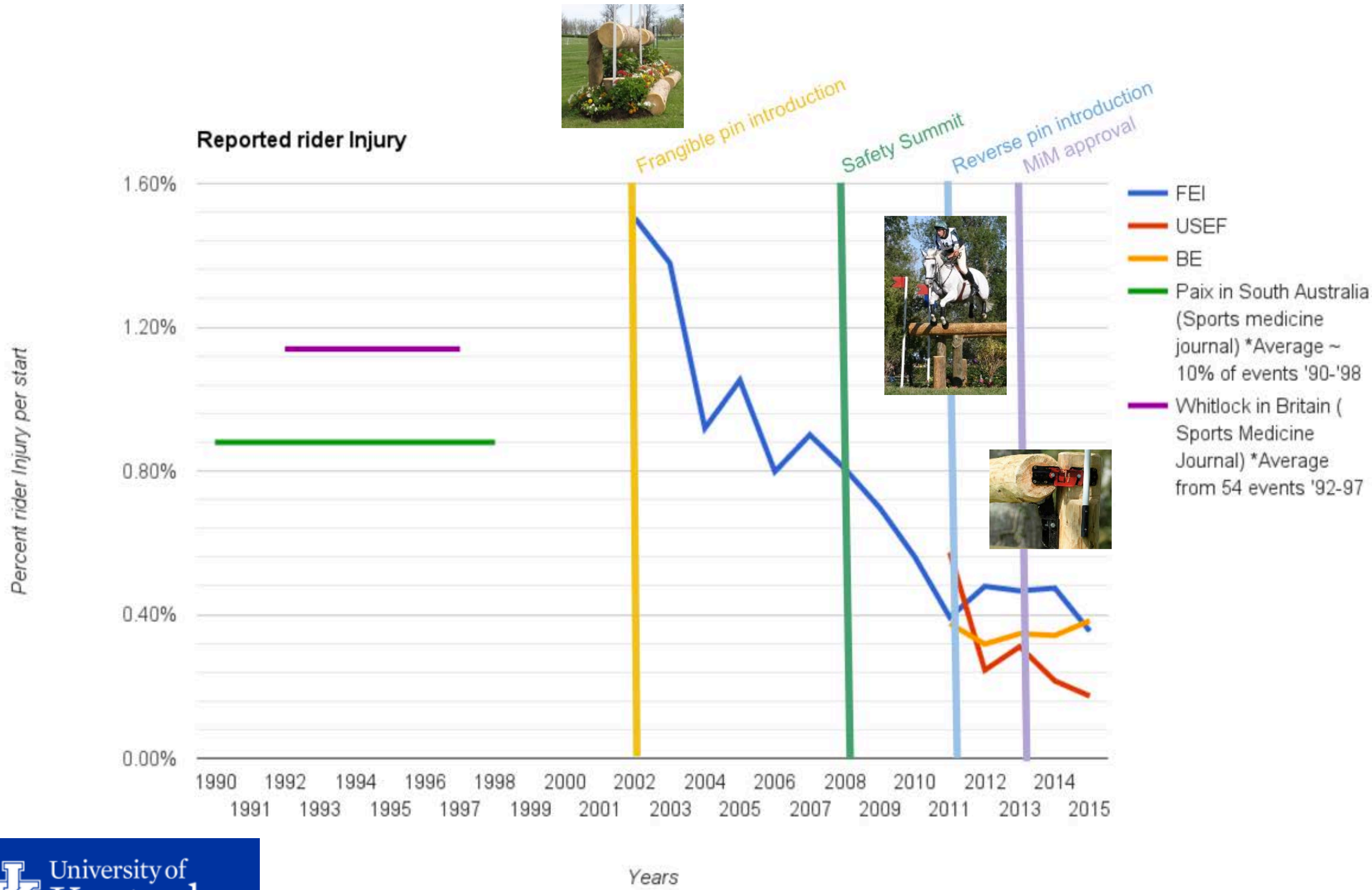
Serious Injuries Have Decreased Since Early 1990



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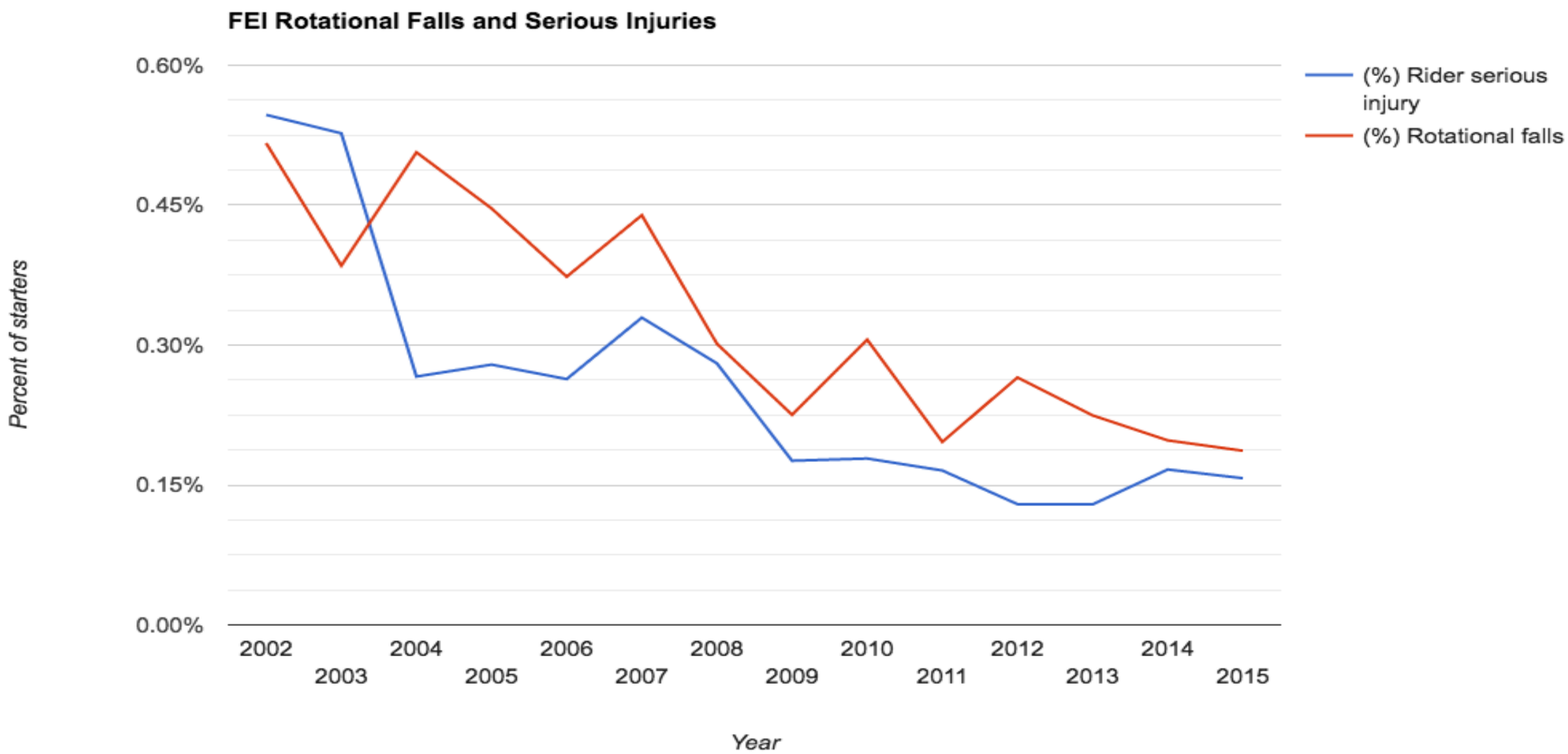
Almost No Data is Available for Modeling Because Rotational Falls Are Rare



In 2015, 1 in 536 (0.19%) starters on cross-country in an FEI Event had a rotational fall which is 1 in 16,080 jump approaches (with 30 jumps per start). In 2002, this was 1 in 6,000 approaches.

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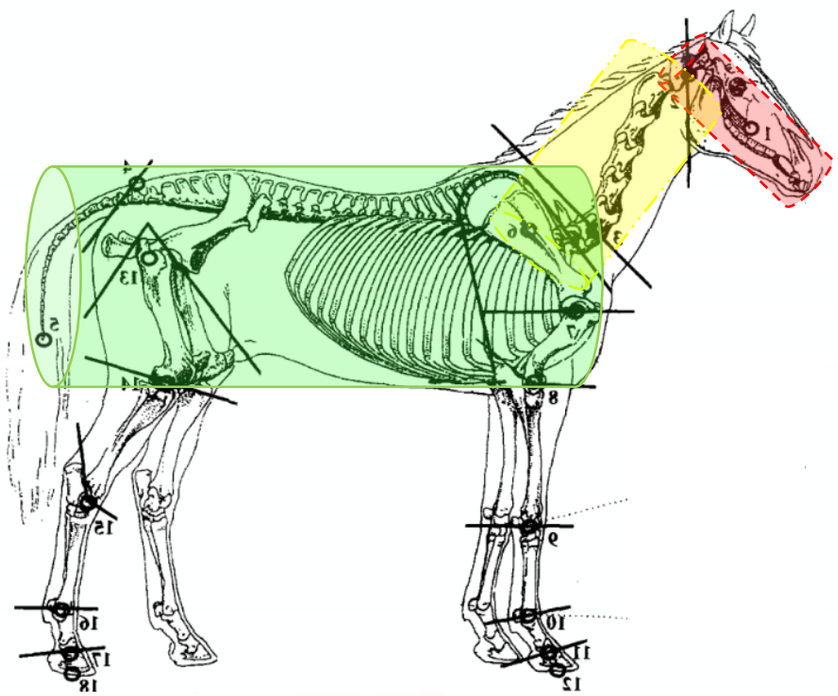
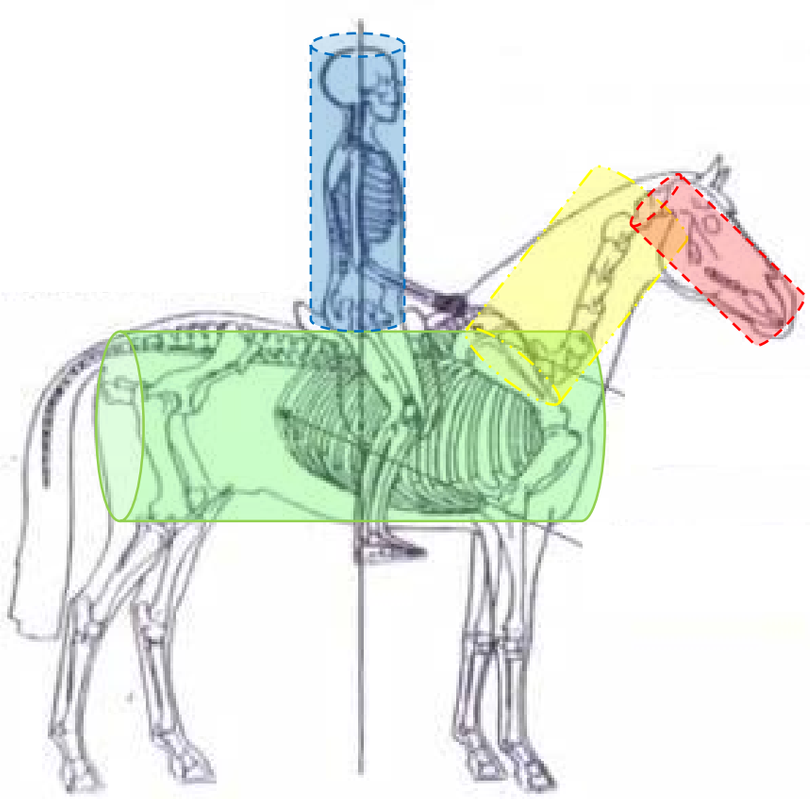
Three Cylinder Model for Inertia Plus Rider





Segment	Contact Inertia (kg m2)		Contact Inertia (%)	
Rider	109.6		6.5	
Trunk	906.3		53.7	
Head	97.1		5.8	
Neck	82.0		4.9	
Scapula	19.2	16.5	1.1	1.0
Brachium	6.1	5.0	0.4	0.3
Antebrachium	2.8	2.1	0.2	0.1
Metacarpus	0.1	0.0	0.0	0.0
Pastern Forelimb	0.0	0.0	0.0	0.0
Hoof Forelimb	0.0	0.0	0.0	0.0
Thigh	185.2	107.6	11.0	6.4
Crus	41.4	41.8	2.5	2.5
Metatarsus	21.1	21.8	1.3	1.3
Pastern Hind Limb	5.1	5.1	0.3	0.3
Hoof Hind Limb	6.0	6.5	0.4	0.4

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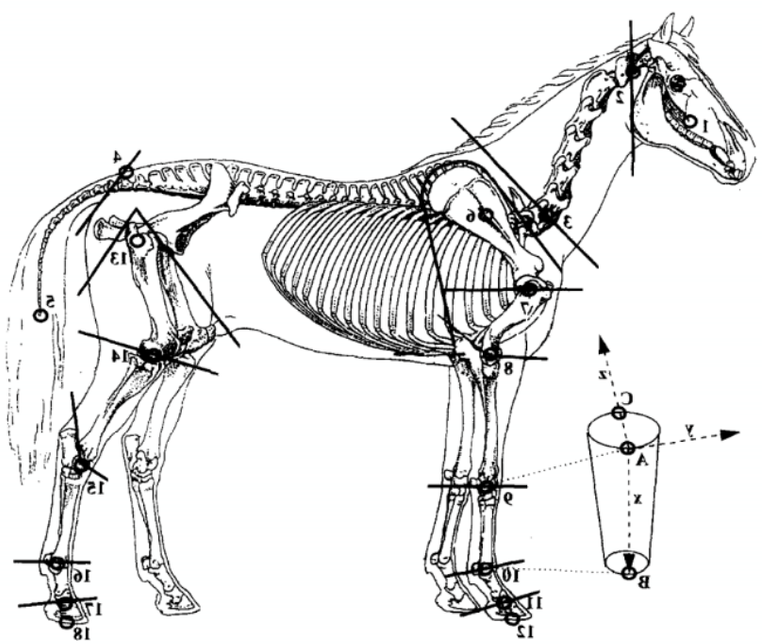
Key Variables - Inertia

Standing Inertia of the horse is the initial step for determining rotational inertia properties for use in simulations

26 Inertia segments of Dutch Warmblood cadavers



INERTIAL PROPERTIES OF DUTCH WARMBLOOD HORSES
by H.H. Buchner, et al

However, we need the rider in the equation

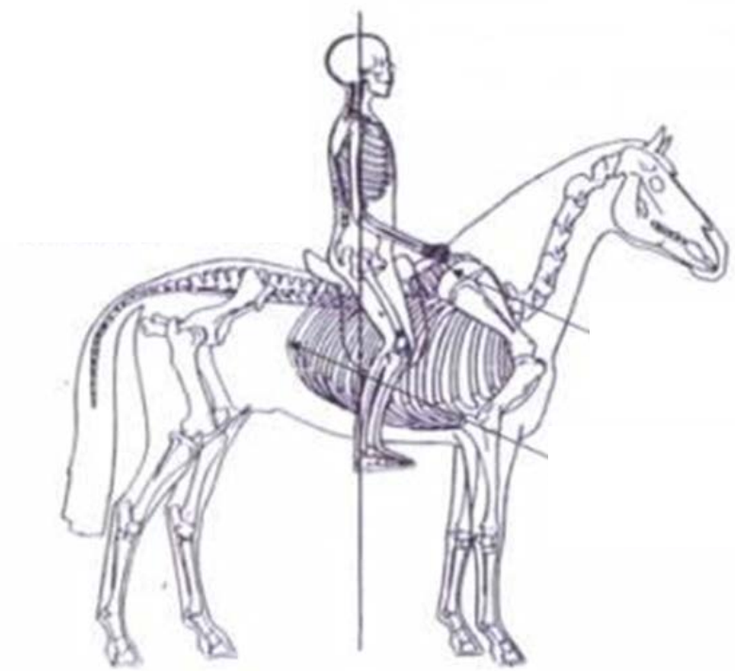


Photo from http://scienceofmotion.com/

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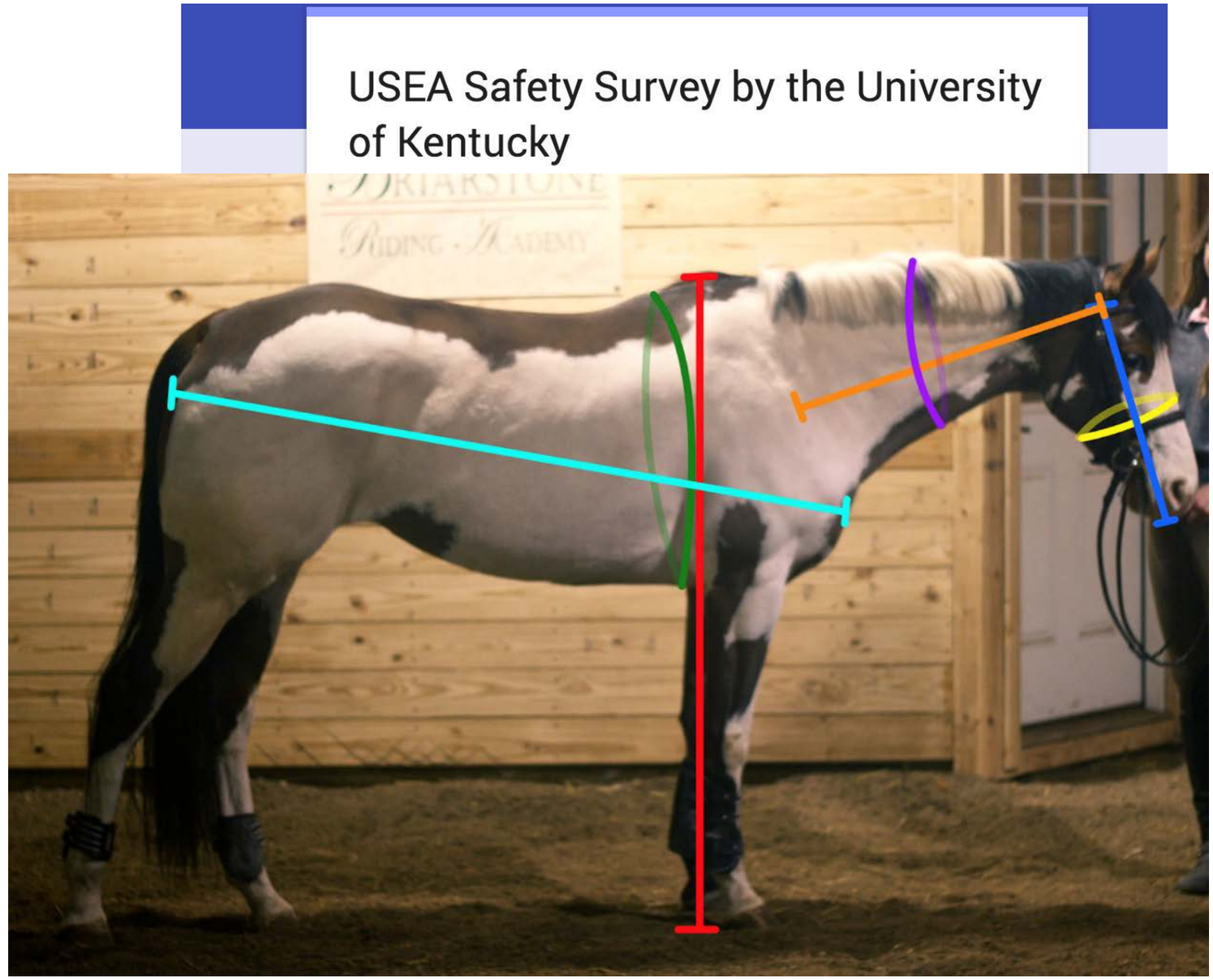
Three Cylinder Model of Working Event Horses and Rider Leads to “Citizen Science” Survey

Collected Data

- Measurements for horse
  - Length of body
  - Heart girth
  - Withers height
  - Neck length
  - Neck circumference
  - Head length
  - Head circumference
  - Horse weight
- Rider height and weight
- Level of competition
- Breed
- Location



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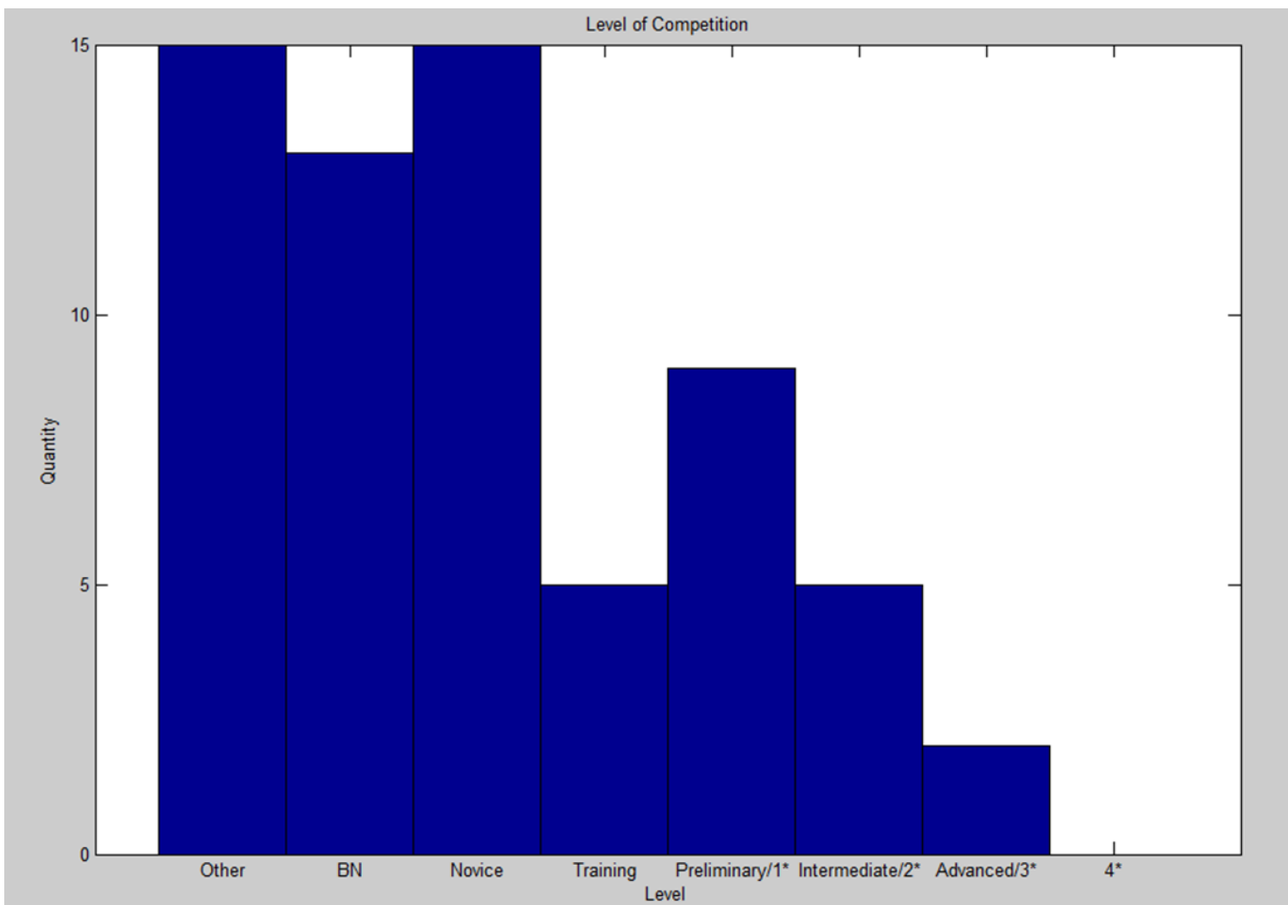
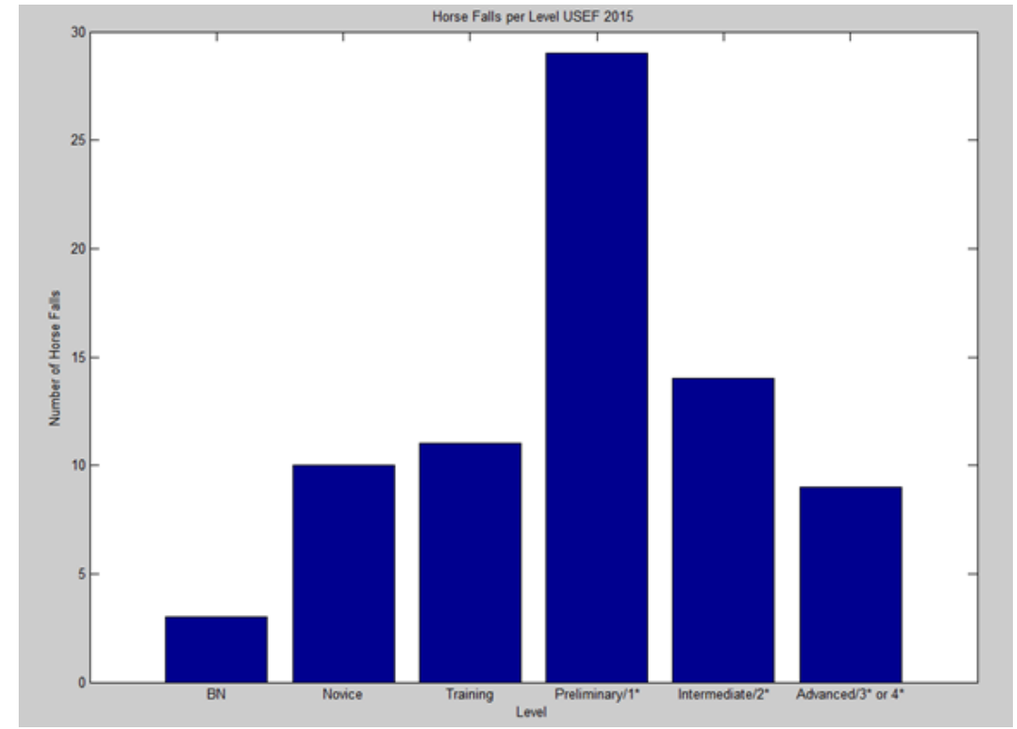
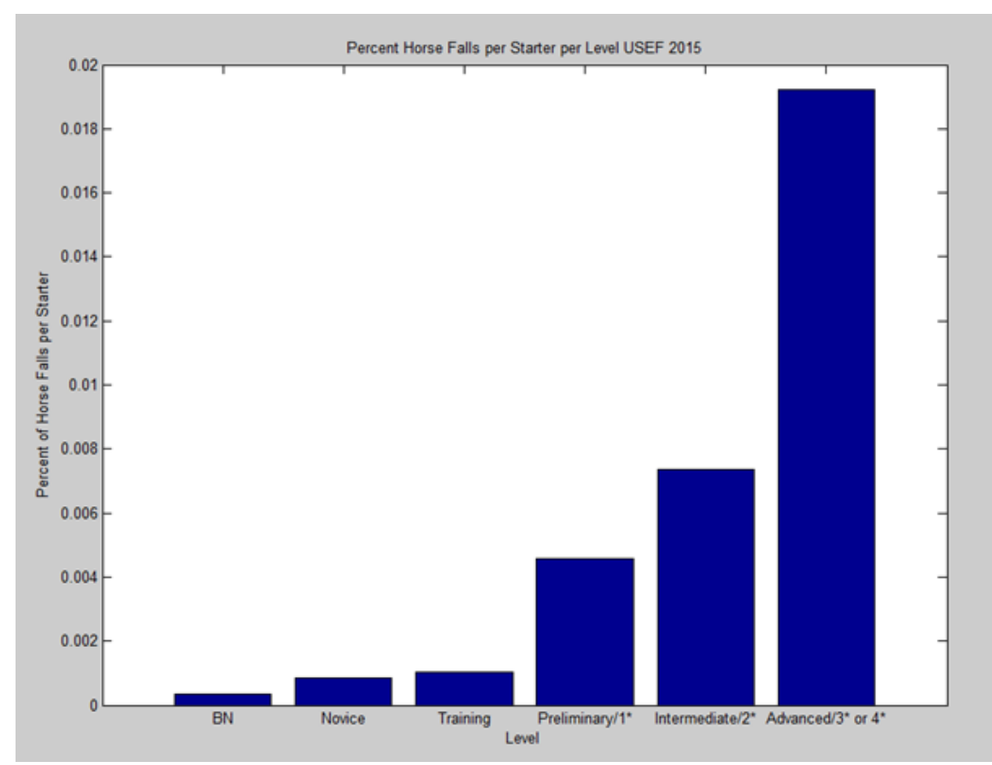
Survey Results

More upper level horses and riders are needed to accurately reflect populations of interest from the fall statistics.



U.S. 2015 Fall Statistics





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Key Variables – Contact Forces

- No rotational fall contact point force data is available
- Analysis of British Eventing instrumented fence data from 2008 and 2009
  - 32 days of competitions (Novice to CIC** in 2008; Novice to CIC**** in 2009)
  - 4352 horses; 1688 impacts recorded (38.8%)
- Data provided by Tim Deans and Martin Herbert, Competitive Measure Ltd

Single Rail, GoodYear 2008
Sample Size: 60 of 737
(4 front leg, 6.7%)

Oxer, British Eventing 2009
Sample Size: 229 of 952
(62 front leg contact; 27.1%)

Key Variables – Contact Velocity and Rotation Rate

- Video Analysis of Available Rotational Falls
  - Duration Of Rotation: 0.52 to 1.04 seconds
  - Rate of Rotation: 60-220 degrees per second
  - Sample Size: 6

Note: Rotation rates will be used to validate simulations

-16 Degrees 12 Degrees 70 Degrees

Trunk, rider, neck, and head angle ranges will also be extracted for simulation configurations, as well as contact velocity.

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2016-2017 Project Objectives

- ***Task 1 – Phased Development of Validated Models***
  - Sequence of increasingly complex models, validated with data from Tasks 2-4 to identify key parameters in device performance and for design guidance
  - ✓ Overturning block analysis
- ✓ ***Task 2 – Revisit BE Non-rotational Contact Forces***
  - ✓ Sub-categorize contact force and impulse data
- ***Task 3 – Video Analysis of Rotational Falls***
  - *Extract contact speeds, rotational speeds, key angles*
- ✓ ***Task 4 – Expanded Literature Review***
  - Relevant sports safety, overturning analyses
  - ✓ Inertia references identified
  - ✓ Develop and implement inertia survey
- ✓ ***Task 5 – Review Safety Statistics***
  - Compare original fall stats to device activation counts

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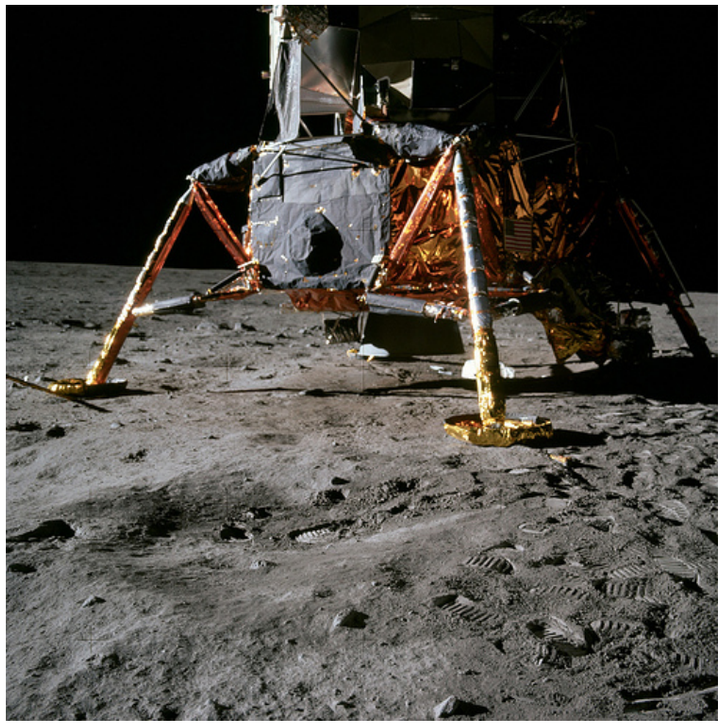
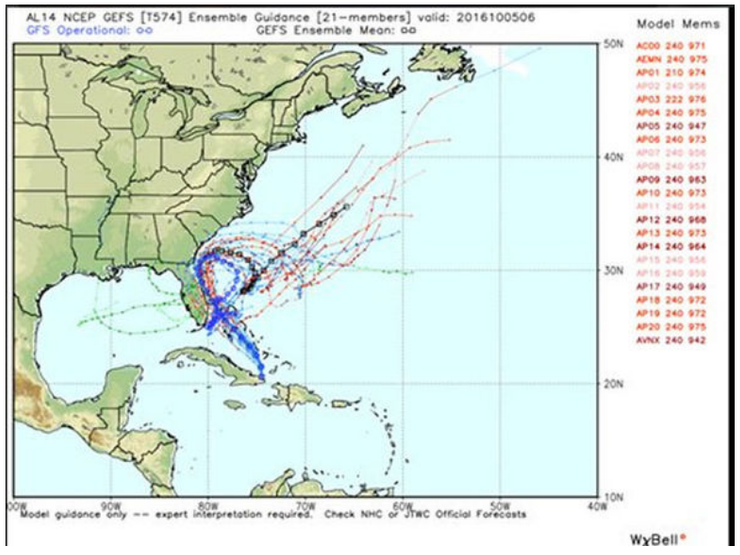
Approach - Monte Carlo Analyses

- The Monte Carlo method can be applied to a large number of problems in a wide range of disciplines.
- One early application for NASA was simulation of the lunar landing. Repeated computation of a large number of independent simulations revealed overall probabilities for successful landing without overturning.
- Weather forecasters use ensembles of simulations to evaluate the probability of rain or other weather phenomena. Monte Carlo simulations are used for weather forecasting and related interests such as economic risk management with respect to severe weather.



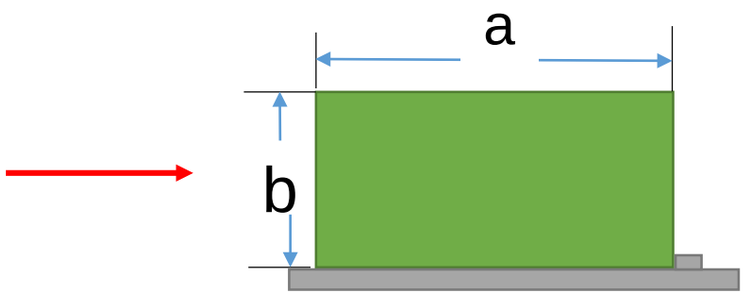
Apollo 11 - LM on the Moon

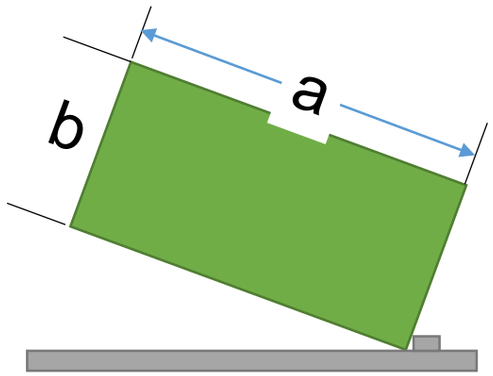


Hurricane Matthew Simulations

Overturning Block Analysis

- 2-D analysis of an overturning block
- Block of mass m strikes a bump
- Forward velocity converts to rotation
- The critical rotation rate is the maximum without going over - a point-of-no-return
- Monte Carlo methods used to generate 100 random values ranging over a non-dimensionalized geometry (a/b) value of 0 to 10





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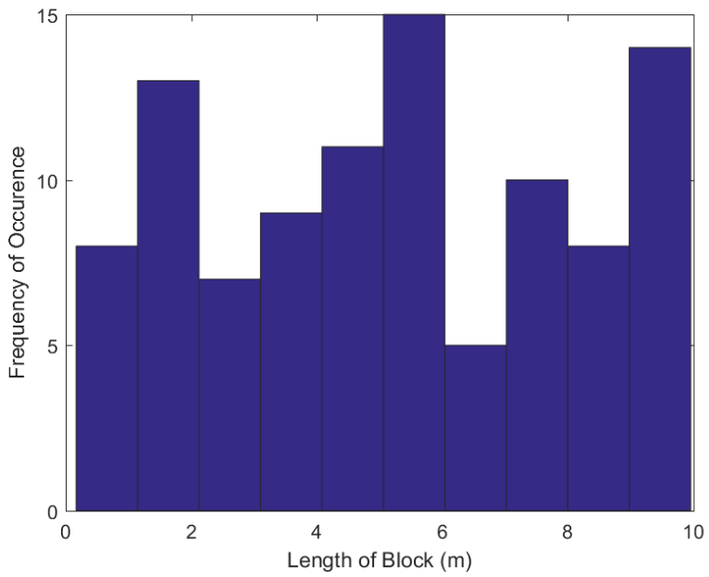
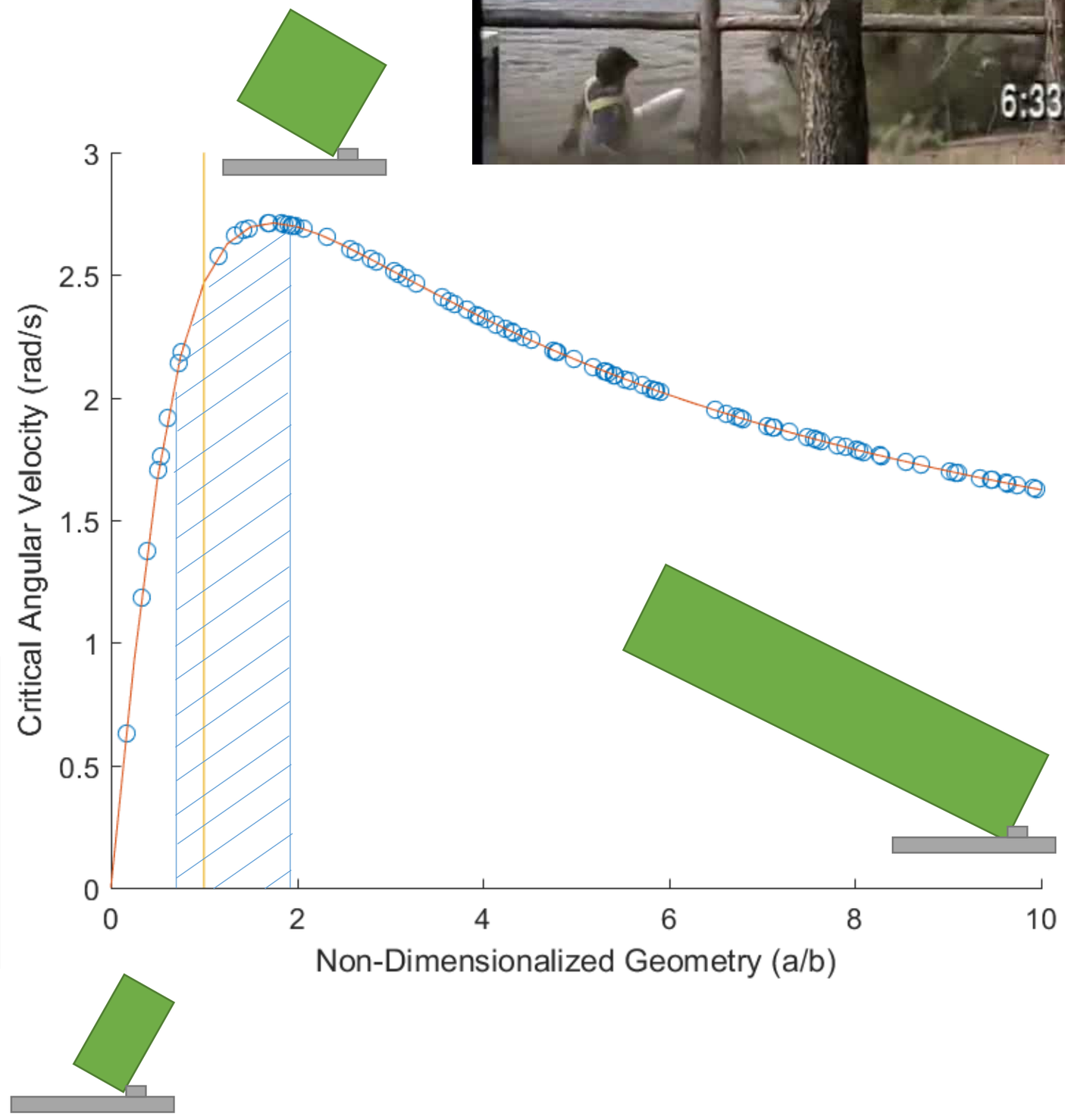
Overturning Block Analysis



Histogram of randomly generated block lengths for overturning analysis



Results are consistent with past observations that overturning can be avoided when the contact velocity is below a critical value.

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Monte Carlo Analyses

Each variable in turn is represented by a population that is statistically similar to that determined or estimated for

- Contact velocity
  - Speed and direction from fall video analysis and BE data respectively
- Horse and rider inertia
  - Sizes and weights from the survey
  - Configuration angles from fall video analysis
- Fence contact
  - Fixed: Forces and impulses from BE data
  - Face angles from builder interviews
  - Deformation rates/distances from previous device comparison testing or reasonable design ranges

→ How fast? How far? What direction?

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Needs

- **Citizen Science Data**
- **Share Video of Rotational Falls**
- **Visit www.useafoundation.org**

Follow-On Effort to Add Critical Information:
Contact Velocity Video Study for CIC**** Events

Objective:

- Develop a data set of non-rotational contact velocities for highest-level events where largest risk of rotational falls occurs

Approach:

- Triggered Video of Every Starter on Every Jump at All 6 Events
- 50 Starters; 40 Jumps; 6 Events = 12,000 data sets
- If ~9% have front-leg contact, 1,080 subset of data to analyze for contact velocity
- Could reduce overall effort by identifying 15-20 jumps/event

Justification:

- Technology exists for triggering, video and semi-automated analysis
- Enables evaluation of 3-d aspects, if needed, and other factors

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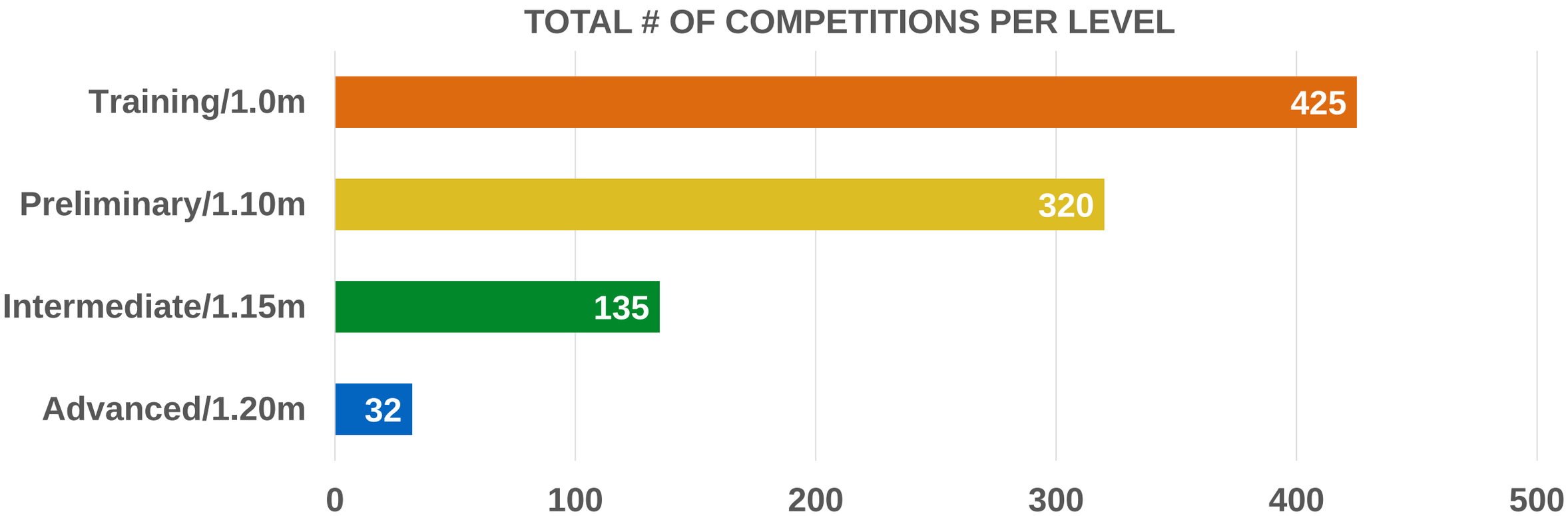
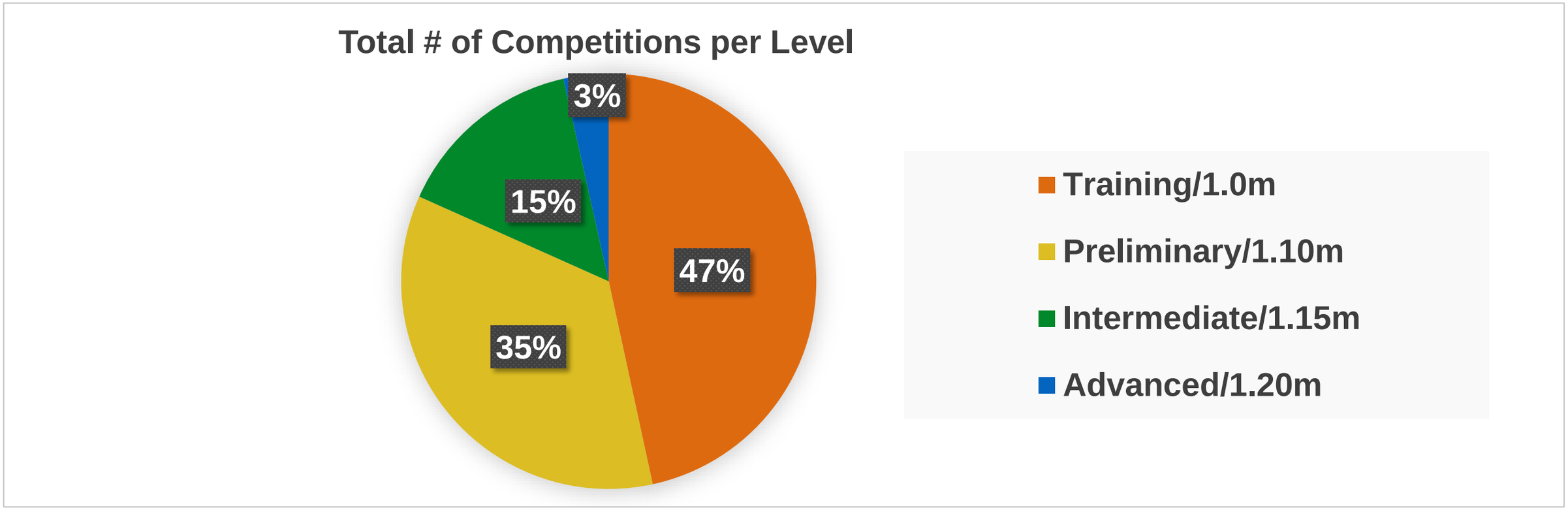
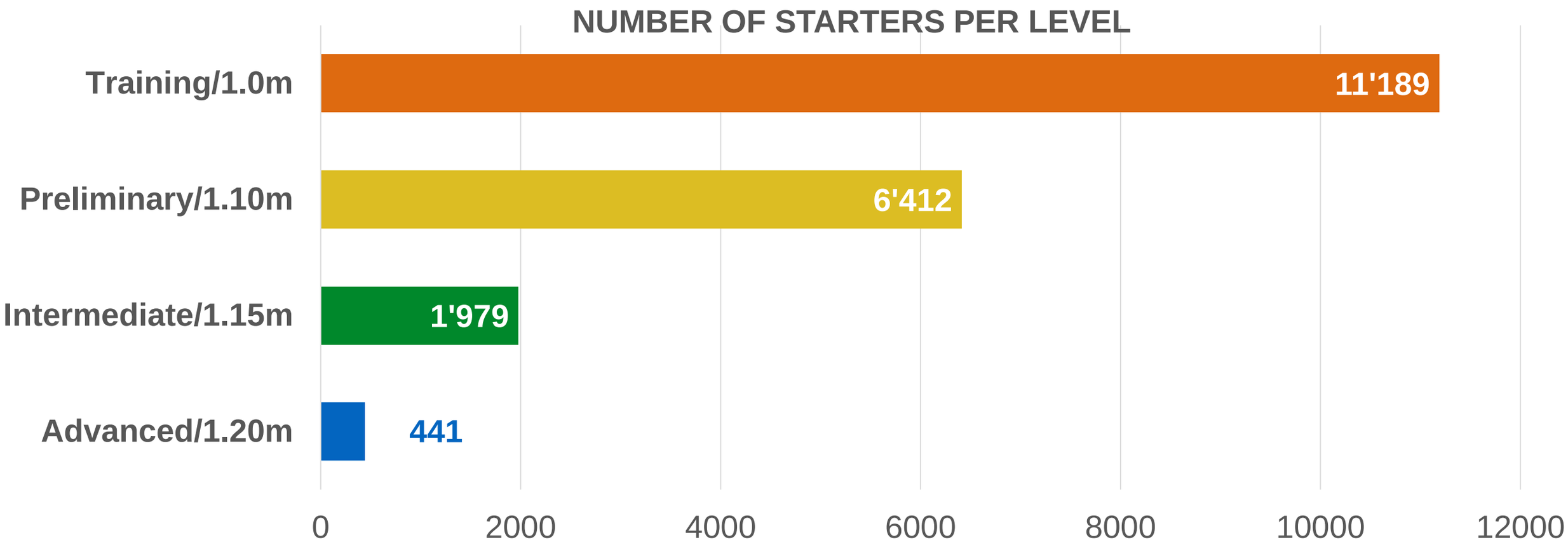
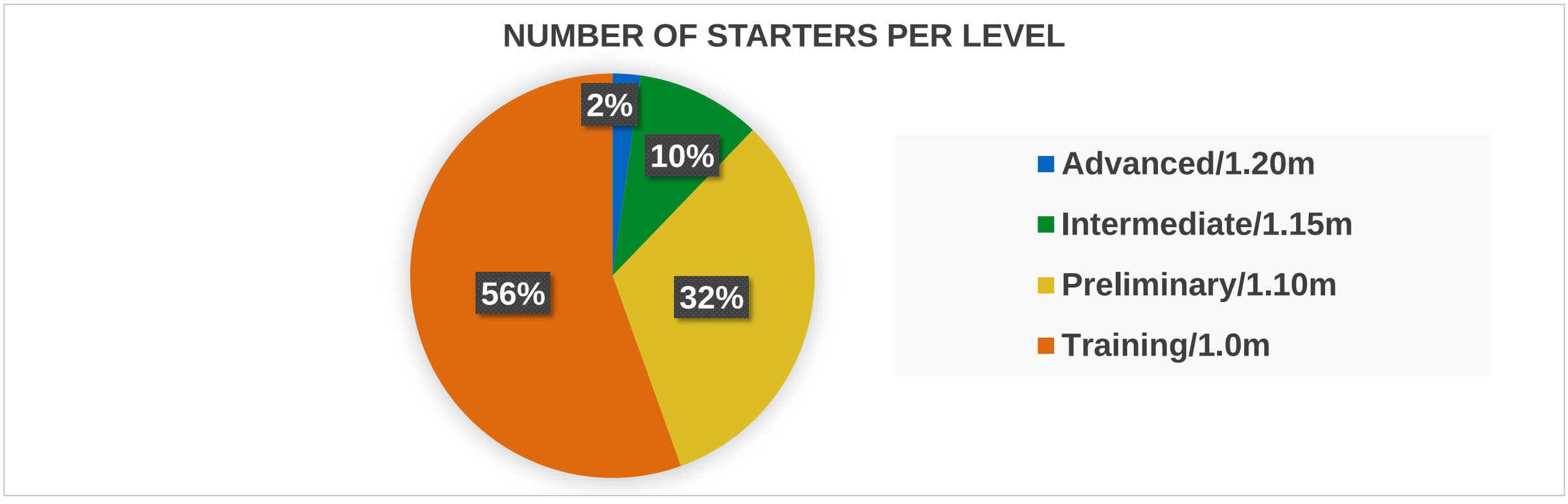
Number of National Eventing Competitions in 2016



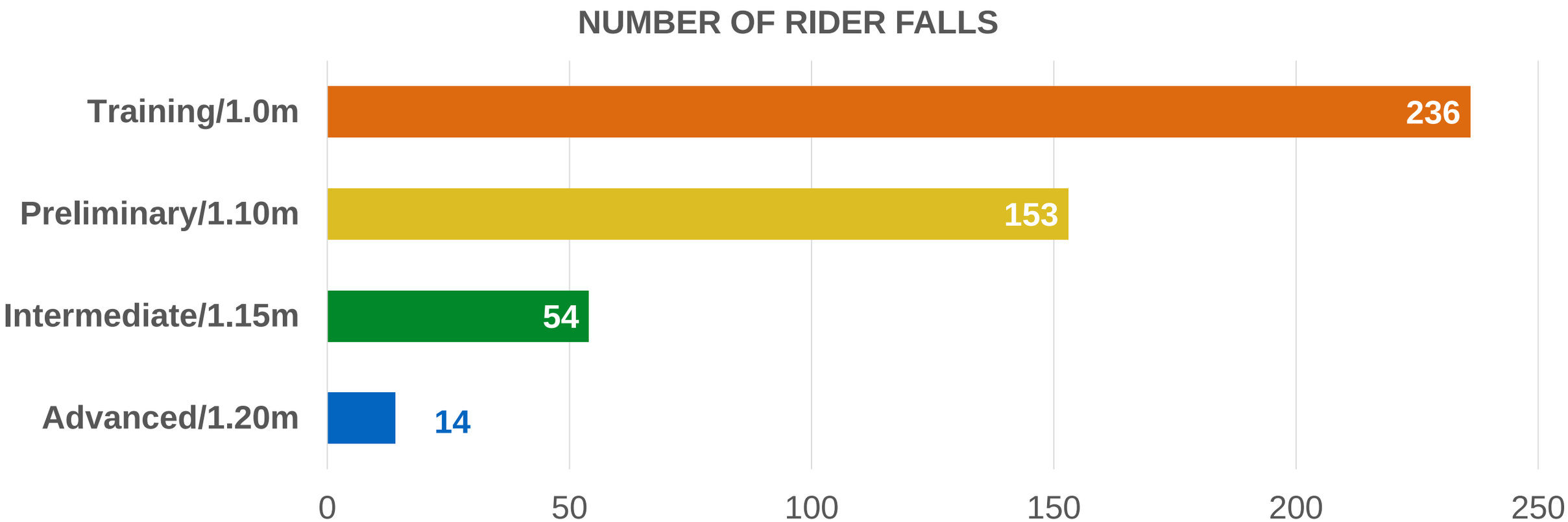


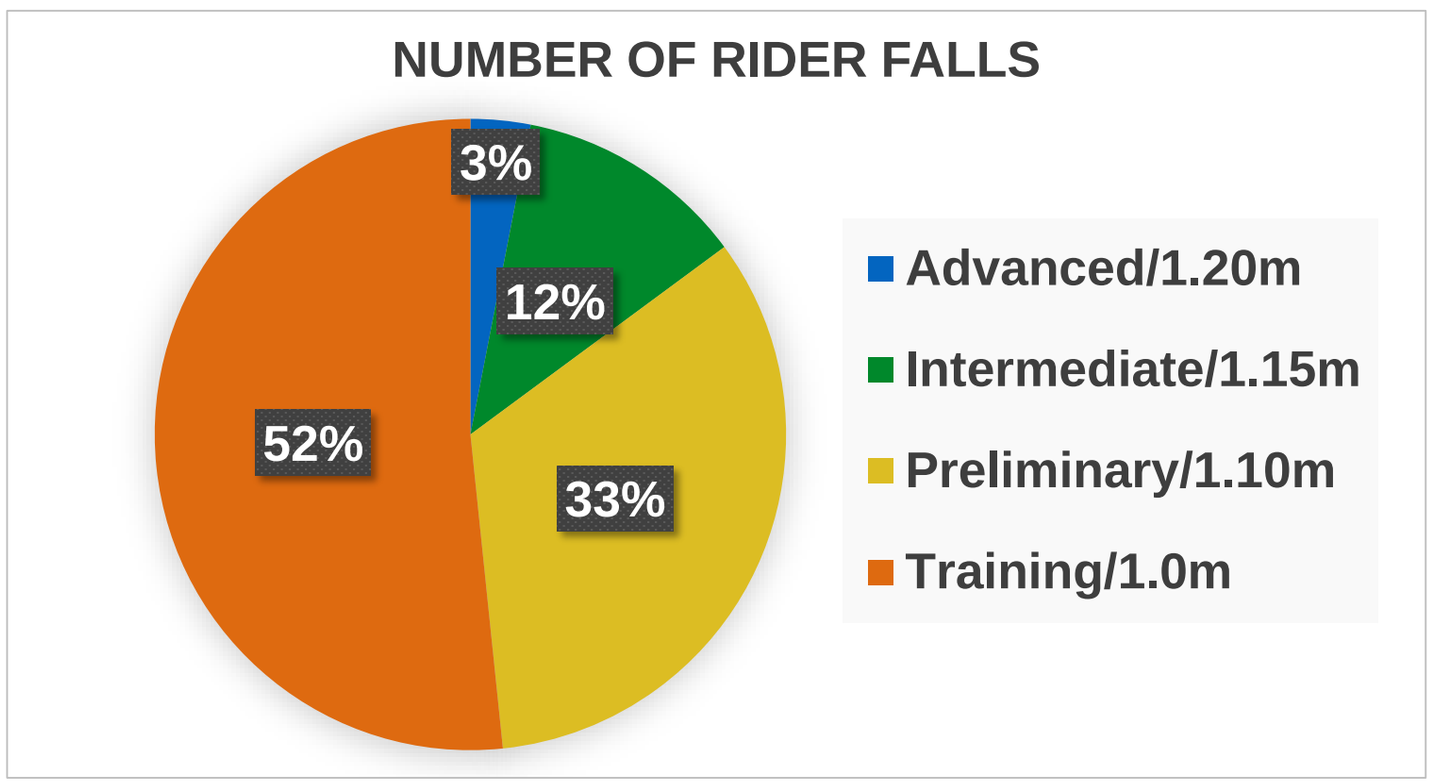
Number of Starters in National Horse Trials in 2016





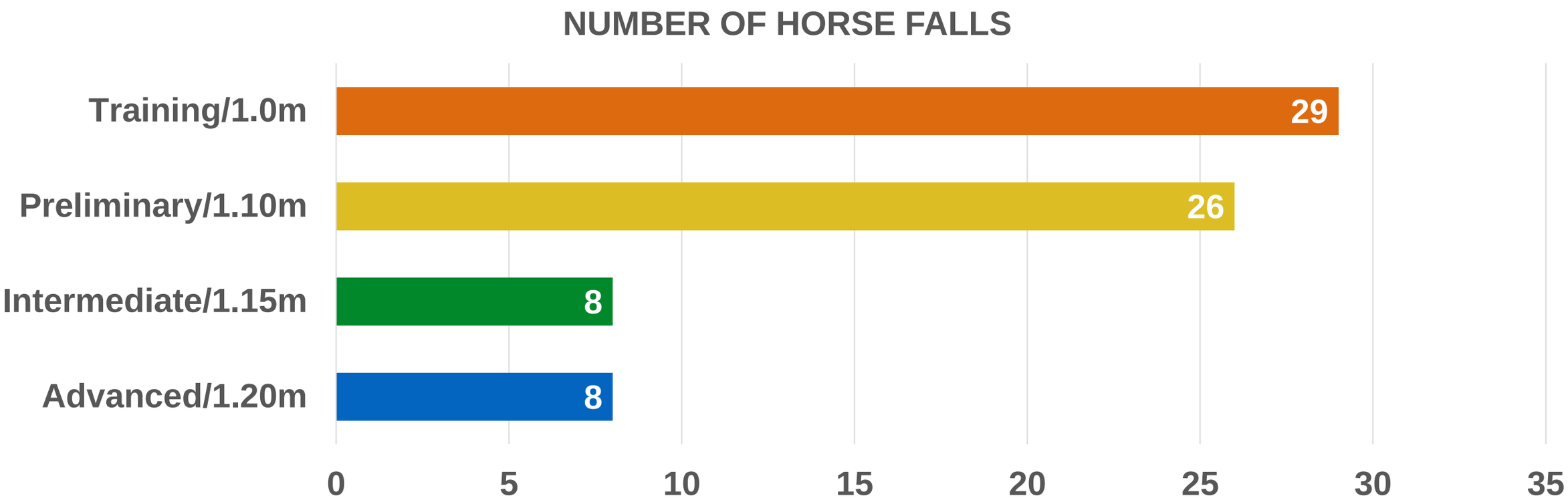
Number of Rider Falls per Level in National Horse Trials in 2016

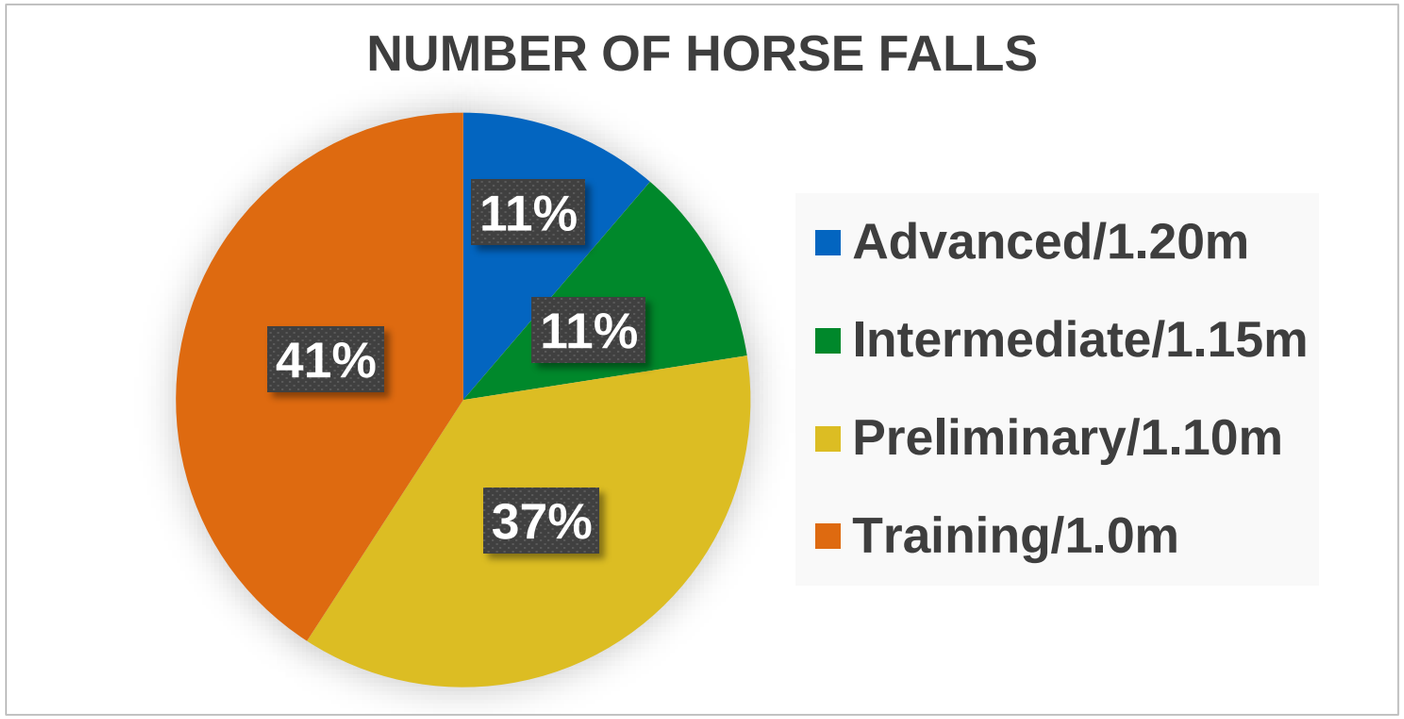




Rider Falls = 2.27%
or
1 every 44 starts

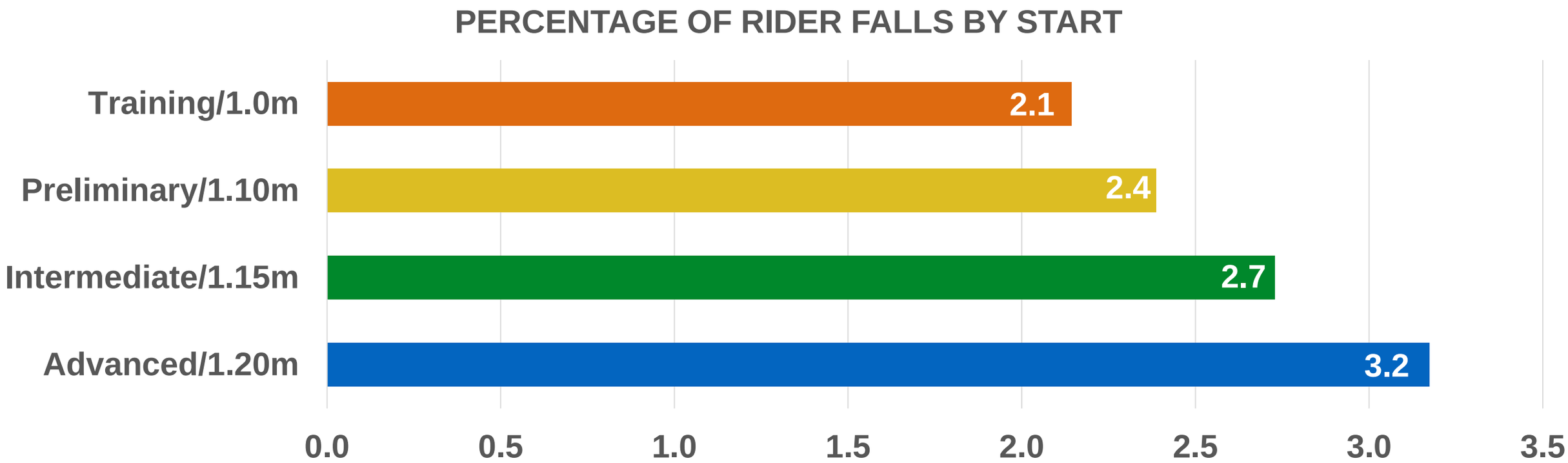
Number of Horse Falls per Level in National Horse Trials in 2016

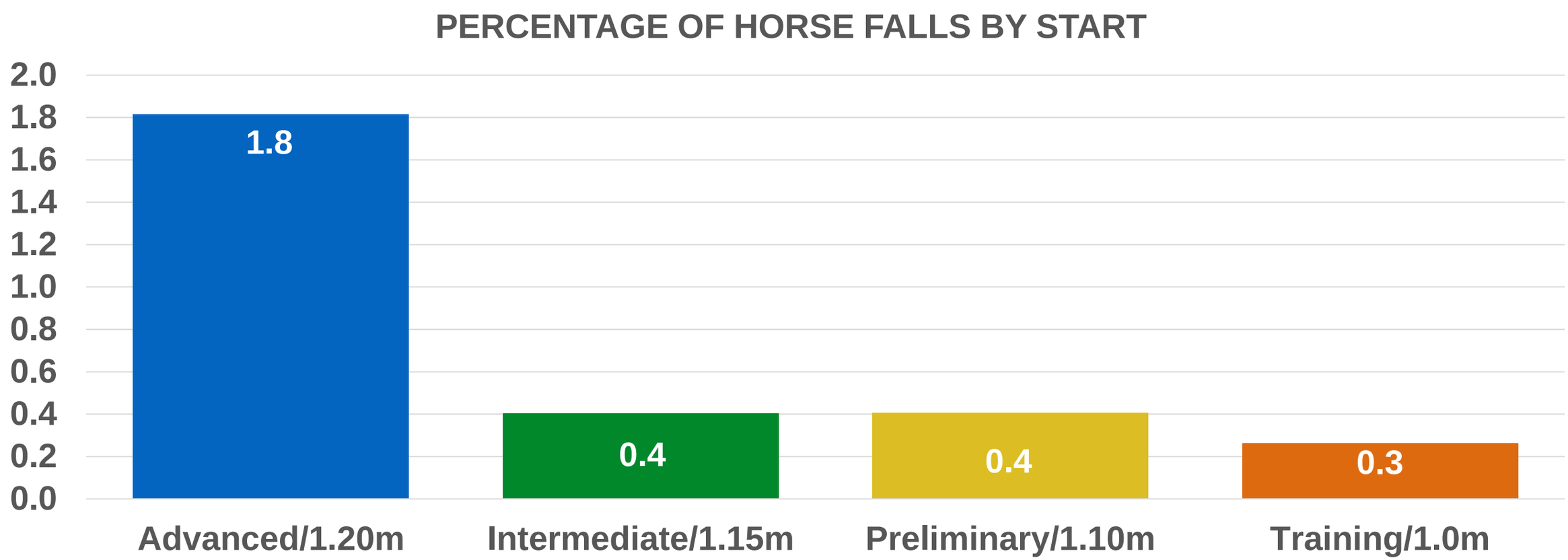




Horse Falls = 0.22%
or
1 every 446 starts

Percentage of Falls per Start by Level in National Horse Trials in 2016





Total Number of Rider Injuries at National Horse Trials in 2016

LEVEL	NUMBER OF SERIOUS RIDER INJURIES	NUMBER OF SLIGHT RIDER INJURIES
Advanced/1.20m	0	2
Intermediate/1.15m	0	7
Preliminary/1.10m	0	18
Training/1.0m	1	15
TOTAL	0.007% (1 every 13,676 starts)	0.214% (1 every 466 starts)

Total Number of Horse Injuries at National Horse Trials in 2016

LEVEL	NUMBER OF SERIOUS HORSE INJURIES	NUMBER OF SLIGHT HORSE INJURIES
Advanced/1.20m	0	3
Intermediate/1.15m	0	3
Preliminary/1.10m	0	8
Training/1.0m	0	5
TOTAL	0.002% (1 every 41,028 starts)	0.061% (1 every 1641 starts)