

A photograph of a golf course green with a sand trap and trees in the background. The text is overlaid on the image.

Surface Firmness: Can we Manage it?

Clint Waltz, Ph.D.

Turfgrass Specialist

Measuring Playability

What affects play on a golf green?



Speed

- ✓ Stimpmeter
- ✓ Long history
- ✓ Easily understandable units (feet)
- ✓ Management – fertility, mowing, rolling, irrigation, etc.



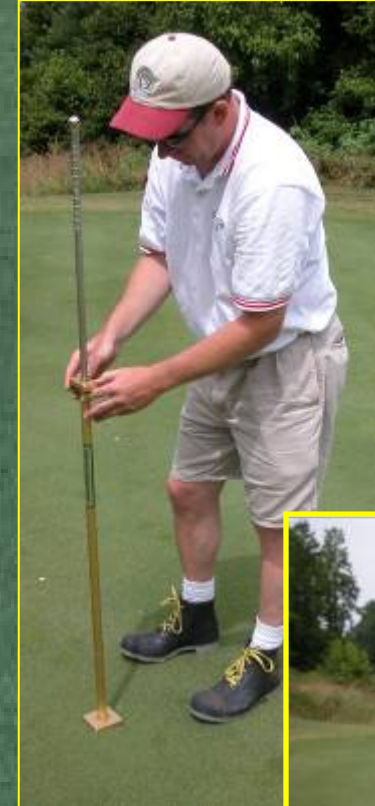
Firmness

Measuring Playability

How is firmness measured?

Turf Tec

- ✓ Soil strength
- ✓ Penetrometer
- ✓ Instrument scale (1 to 10)
- ✓ Simple / minimal technology
- ✓ Inexpensive



**Turf Tec
Penetrometer**



Measuring Playability

How is firmness measured?

Clegg Impact Soil Tester

- ✓ Originally designed for road construction
- ? Hammer size, number of drops
- ✗ Green injury - depression
- ✓ Measures deceleration
- ✓ g_{max} (70 -120)
- ? Relative to what on a green



Clegg Impact
Soil Tester



USGA TruFirm

USGA TruFirm

Developed

USGA's Research & Test Center

- ✓ Dr. Matt Pringle
- ✓ Engineer
- ✓ First used for 2005 U.S. Open

Need

- ✓ For ball & club testing
- ✓ Predict bounce & roll characteristics
- ✓ Compare various championship courses



USGA TruFirm

USGA's Research & Test Center

**Objective is to maintain the rules of golf
pertaining to clubs and balls.**

USGA TruFirm

Possible Means of Testing

- ✓ **Ball launcher & high speed video**
 - Time & labor intensive
 - Equipment
 - Costly
 - heavy
 - cumbersome
 - damages greens



USGA TruFirm

Equipment Needed

- ★ Simple & easy to use
- ★ Highly portable / lightweight
- ★ No damage to greens
- ★ Data
 - 👍 Logged
 - 👍 Easy to read
 - 👍 Understandable units (inch)
- ★ Applied to all areas of the golf course

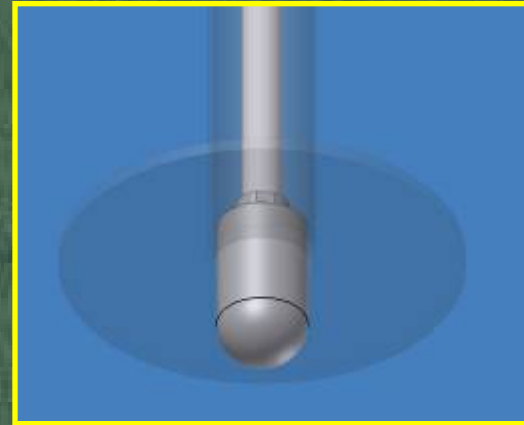


\$7,200

USGA TruFirm

Design Concepts

- 🏌️ Considering a full swing golf shot & ball
 - ★ Energy & momentum can not be replicated
 - ✓ TurFirm is a compromise between both
 - ★ Land with approx. the same speed in the direction normal to the turf (16 m/s)
 - ★ Replicate size of golf ball
 - ✓ 1.68" diameter hemispherical face

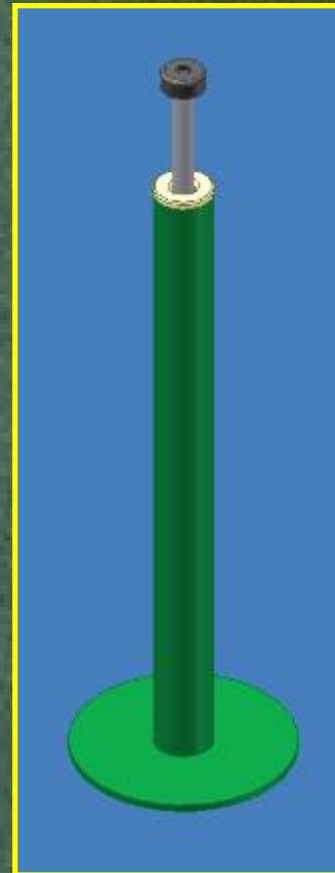


Clegg – similar in principle & technology

USGA TruFirm

The TruFirm

- ★ Hammer & guide tube
 - ✓ equipped with accelerometer
 - ✓ measures force time history of the impact
- ★ Connected to handheld PC
- ★ GPS receiver
- ★ Patent # 7,243,526 B2

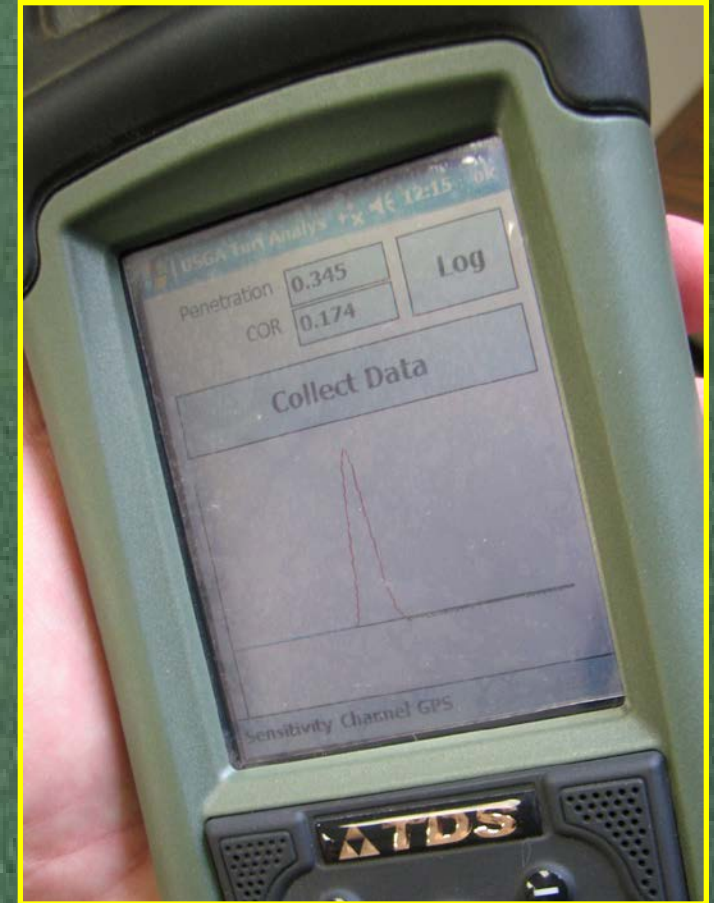




USGA TruFirm

Operation

1. Simple, fast & easy
2. Punch some buttons
3. Raise hammer to top
4. Release hammer
 - ✓ acceleration is recorded
5. Move to next location



Handheld PC

USGA TruFirm

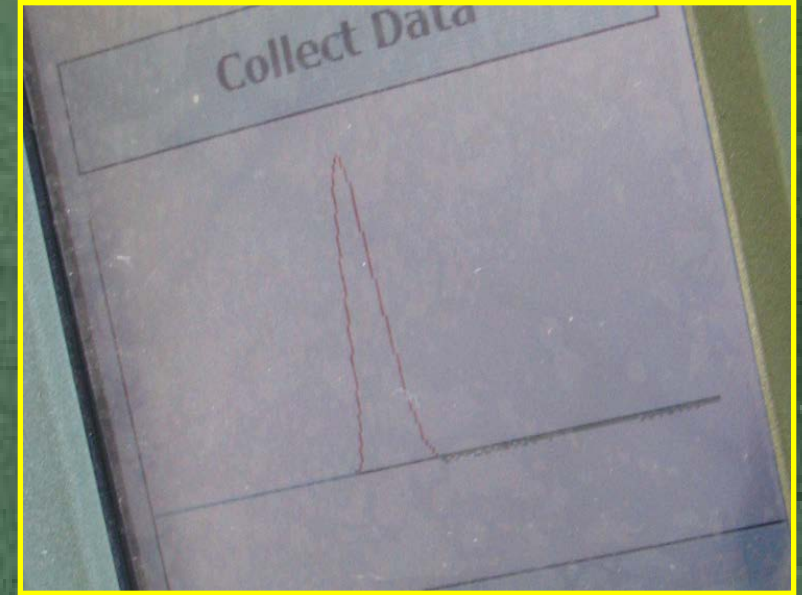
Operation (Cont.)

6. Download to computer

7. Analyze data & interrupt

Data

- ★ Raw signal saved for each impact
- ★ Acceleration is integrated to calculate velocity & penetration depth
- ★ GPS location saved for each impact



USGA TruFirm

Where used?







USGA Championships

- ✓ 2005 US Open
- ✓ 2007 Men's Sr. Open
- ✓ Various other championships

PGA Tour

USGA TruFirm

Where used?

-  Masters Tournament – since 2008
-  The Tour Championship – since 2008
-  The PGA Championship – 2011
-  The Greater Gwinnett Championship – since 2013
-  Liz Murphy Championship – 2010
-  Nationwide Event – 2010

USGA TruFirm

Where used?

★ Turner Field – since 2008

★ Research Trials

- ✓ UGA – Griffin & Tifton
- ✓ Clemson University
- ✓ Auburn University



USGA TruFirm

Testing Protocol

Greens

- ★ Before & after play each day of tournament
- ★ following all maintenance practices
- ★ Nine locations within quadrants
- ★ Masters – based on landing areas & pin placement

Fairway landing zones & approaches

- ★ USGA events

USGA TruFirm

Data

Daily Data

Date Time	Average	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	PG
5/31/13 10:00 AM	0.385	0.387	0.381	0.380	0.363	0.373	0.375	0.379	0.387	0.387	0.381	0.382	0.395	0.398	0.402	0.385	0.400	0.382	0.397	0.417
8/26/13 10:00 AM	0.402	0.410	0.405	0.398	0.385	0.403	0.417	0.397	0.406	0.391	0.406	0.405	0.408	0.407	0.417	0.402	0.399	0.393	0.392	0.438
9/9/13 9:45 AM	0.407	0.412	0.406	0.413	0.389	0.410	0.428	0.407	0.414	0.410	0.402	0.408	0.401	0.415	0.417	0.402	0.410	0.378	0.400	0.452
9/16/13 9:45 AM	0.380	0.389	0.376	0.383	0.366	0.383	0.389	0.387	0.390	0.383	0.368	0.385	0.382	0.386	0.388	0.369	0.376	0.370	0.370	0.407
9/17/13 8:45 AM	0.371	0.373	0.367	0.374	0.359	0.372	0.382	0.383	0.372	0.378	0.371	0.376	0.371	0.375	0.373	0.363	0.363	0.352	0.376	0.392
9/18/13 9:45 AM	0.371	0.366	0.360	0.363	0.356	0.370	0.378	0.378	0.374	0.377	0.371	0.376	0.381	0.382	0.369	0.370	0.372	0.366	0.377	0.401
9/18/13 5:30 PM	0.379	0.373	0.367	0.376	0.363	0.383	0.388	0.384	0.385	0.386	0.379	0.390	0.381	0.386	0.386	0.367	0.376	0.378	0.378	
9/19/13 9:00 AM	0.372	0.379	0.375	0.378	0.362	0.376	0.380	0.372	0.377	0.379	0.367	0.370	0.370	0.371	0.370	0.363	0.373	0.365	0.372	0.390
9/19/13 6:00 PM	0.374	0.376	0.372	0.376	0.365	0.385	0.379	0.376	0.380	0.381	0.367	0.379	0.373	0.377	0.382	0.363	0.368	0.370	0.364	
9/20/13 9:00 AM	0.361	0.368	0.355	0.362	0.345	0.362	0.371	0.380	0.365	0.367	0.365	0.368	0.356	0.364	0.360	0.344	0.354	0.354	0.360	0.373
9/20/13 6:15 PM	0.357	0.364	0.356	0.368	0.351	0.360	0.348	0.356	0.358	0.368	0.351	0.367	0.357	0.354	0.361	0.357	0.342	0.352	0.353	0.384
9/21/13 7:55 AM	0.345	0.355	0.346	0.340	0.341	0.346	0.341	0.353	0.347	0.344	0.343	0.350	0.353	0.346	0.355	0.338	0.338	0.334	0.339	0.376
9/21/13 1:54 PM	0.358	0.353	0.343	0.343	0.337	0.346	0.344	0.349	0.350	0.359	0.366	0.367	0.363	0.363	0.371	0.366	0.369	0.367	0.379	0.377
9/22/13 9:23 AM	0.361	0.370	0.354	0.371	0.348	0.366	0.369	0.361	0.367	0.359	0.360	0.361	0.364	0.369	0.370	0.351	0.354	0.353	0.355	0.385
Pre-Tournament	0.398	0.403	0.397	0.397	0.379	0.395	0.407	0.394	0.402	0.396	0.396	0.398	0.401	0.407	0.412	0.396	0.403	0.384	0.396	0.436
2013 Weekly Average	0.366	0.370	0.361	0.367	0.354	0.368	0.370	0.371	0.370	0.371	0.364	0.372	0.368	0.370	0.371	0.359	0.362	0.360	0.366	0.387
2012 Weekly Average	0.361	0.359	0.350	0.364	0.341	0.362	0.361	0.363	0.361	0.362	0.361	0.362	0.366	0.364	0.366	0.359	0.369	0.366	0.367	0.411
2011 Weekly Average	0.383	0.372	0.377	0.377	0.366	0.384	0.384	0.379	0.384	0.379	0.381	0.384	0.393	0.394	0.397	0.388	0.389	0.385	0.389	0.408
2010 Weekly Average	0.362	0.357	0.357	0.363	0.342	0.359	0.369	0.360	0.362	0.352	0.362	0.363	0.367	0.366	0.372	0.367	0.372	0.360	0.365	0.379
2009 Weekly Average	0.336	0.333	0.333	0.332	0.316	0.332	0.337	0.335	0.341	0.330	0.334	0.341	0.335	0.335	0.347	0.336	0.344	0.341	0.344	0.406
2008 Weekly Average	0.298	0.302	0.300	0.295	0.278	0.299	0.302	0.297	0.305	0.297	0.300	0.304	0.298	0.299	0.297	0.294	0.300	0.298	0.300	0.360

Daily Data: Statistics

Date Time	StdDev	CoV	LPI	UPI	Min	Max	CI
5/31/13 10:00 AM	0.010	2.7%	0.365	0.406	0.363	0.402	0.005
8/26/13 10:00 AM	0.009	2.1%	0.385	0.420	0.385	0.417	0.004
9/9/13 9:45 AM	0.011	2.7%	0.385	0.429	0.378	0.428	0.005
9/16/13 9:45 AM	0.008	2.2%	0.363	0.397	0.366	0.390	0.004
9/17/13 8:45 AM	0.008	2.1%	0.355	0.387	0.352	0.383	0.004
9/18/13 9:45 AM	0.007	1.9%	0.357	0.386	0.356	0.382	0.003
9/18/13 5:30 PM	0.008	2.1%	0.364	0.395	0.363	0.390	0.004
9/19/13 9:00 AM	0.006	1.5%	0.361	0.383	0.362	0.380	0.003
9/19/13 6:00 PM	0.007	1.8%	0.361	0.387	0.363	0.385	0.003
9/20/13 9:00 AM	0.009	2.5%	0.343	0.379	0.344	0.380	0.004
9/20/13 6:15 PM	0.007	2.0%	0.343	0.371	0.342	0.368	0.003
9/21/13 7:55 AM	0.006	1.8%	0.332	0.358	0.334	0.355	0.003
9/21/13 1:54 PM	0.012	3.4%	0.333	0.382	0.337	0.379	0.006
9/22/13 9:23 AM	0.007	2.0%	0.346	0.376	0.348	0.371	0.003

Pre-Tournament	0.010	2.4%	0.375	0.413	0.373	0.409	0.004
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2013 Weekly Average	0.008	2.1%	0.351	0.382	0.352	0.378	0.004
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2012 Weekly Average	0.008	2.2%	0.345	0.377	0.341	0.372	0.004
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2011 Weekly Average	0.009	2.4%	0.365	0.402	0.366	0.399	0.004
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2010 Weekly Average	0.008	2.3%	0.345	0.379	0.342	0.375	0.004
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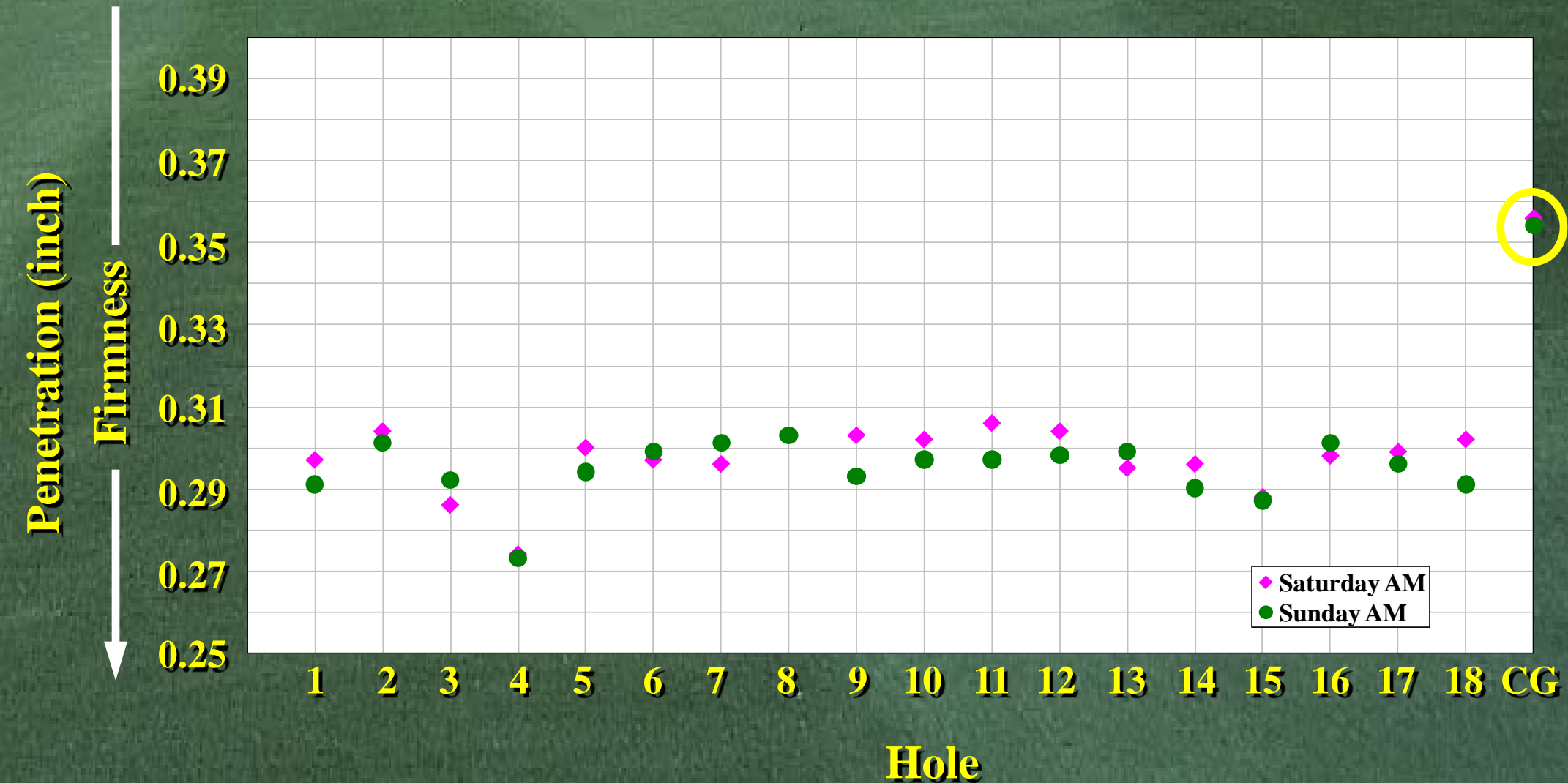
2009 Weekly Average	0.009	2.8%	0.318	0.355	0.316	0.349	0.005
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2008 Weekly Average	0.007	2.3%	0.284	0.312	0.278	0.308	0.003
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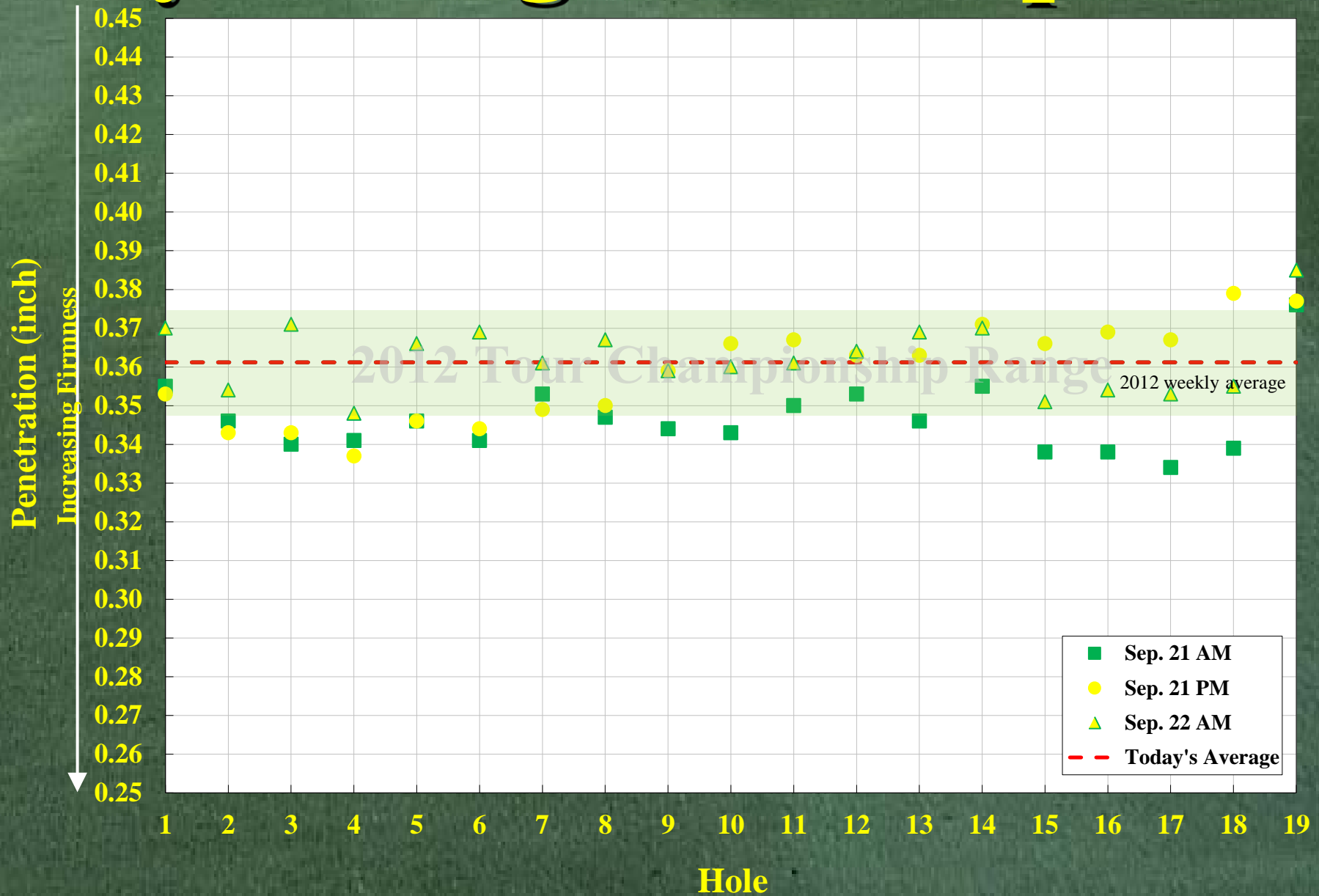
Daily Data: Rankings

Date Time	Rank																		PG
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
5/31/13 10:00 AM	11	6	5	1	2	3	4	11	11	6	8	14	16	18	10	17	8	15	
8/26/13 10:00 AM	16	10	6	1	9	17	5	12	2	12	10	15	14	17	8	7	4	3	
9/9/13 9:45 AM	13	7	14	2	10	18	8	15	10	5	9	4	16	17	5	10	1	3	
9/16/13 9:45 AM	16	6	9	1	9	16	14	18	9	2	12	8	13	15	3	6	4	4	
9/17/13 8:45 AM	10	5	12	2	8	17	18	8	16	6	14	6	13	10	3	3	1	14	
9/18/13 9:45 AM	4	2	3	1	7	15	15	11	13	9	12	17	18	6	7	10	4	13	
9/18/13 5:30 PM	4	2	5	1	11	17	12	13	14	9	18	10	14	14	2	5	7	7	
9/19/13 9:00 AM	16	12	15	1	13	18	9	14	16	4	5	5	8	5	2	11	3	9	
9/19/13 6:00 PM	9	7	9	3	18	13	9	15	16	4	13	8	12	17	1	5	6	2	
9/20/13 9:00 AM	15	5	9	2	9	17	18	12	14	12	15	6	11	7	1	3	3	7	
9/20/13 6:15 PM	15	8	17	3	13	2	8	12	17	3	16	10	7	14	10	1	5	6	
9/21/13 7:55 AM	17	10	5	6	10	6	15	13	9	8	14	15	10	17	2	2	1	4	
9/21/13 1:54 PM	8	2	2	1	5	4	6	7	9	12	14	10	10	17	12	16	14	18	
9/22/13 9:23 AM	16	4	18	1	12	14	9	13	7	8	9	11	14	16	2	4	3	6	
Pre-Tournament	14	10	9	1	4	16	3	13	5	6	11	12	16	18	6	15	2	6	
2013 Weekly Average	12	4	8	1	9	13	15	11	16	6	18	10	14	17	2	5	3	7	
2012 Weekly Average	4	2	12	1	10	6	11	7	9	5	8	15	13	16	3	18	14	17	
2011 Weekly Average	2	3	4	1	9	9	5	9	6	7	8	16	17	18	13	14	12	14	
2010 Weekly Average	4	3	11	1	5	16	6	8	2	9	10	14	13	18	15	17	7	12	
2009 Weekly Average	5	6	4	1	3	12	10	14	2	7	14	8	9	18	11	16	13	16	
2008 Weekly Average	15	11	3	1	9	15	4	18	4	11	17	7	9	4	2	11	7	11	

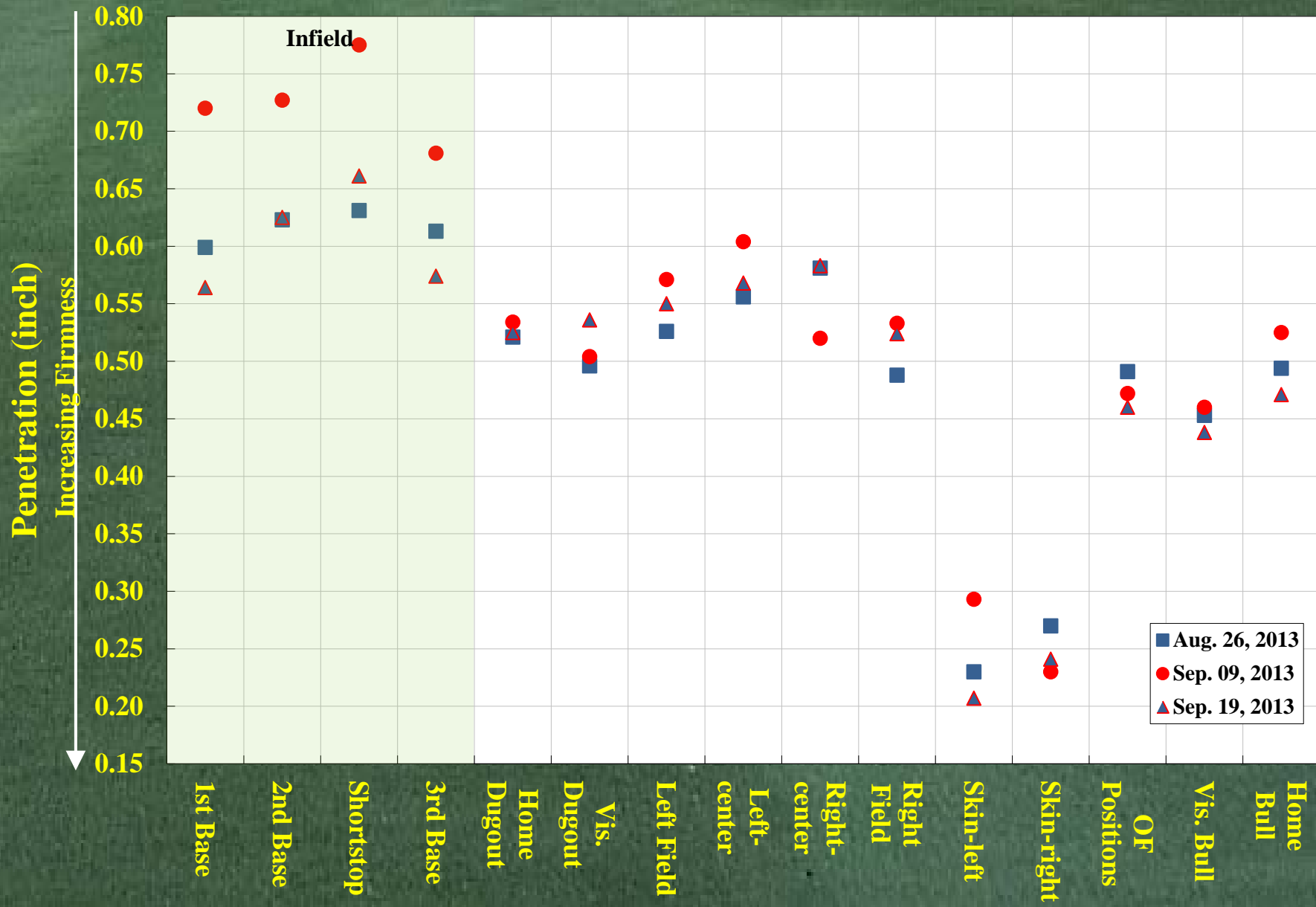
Daily Change & Comparison



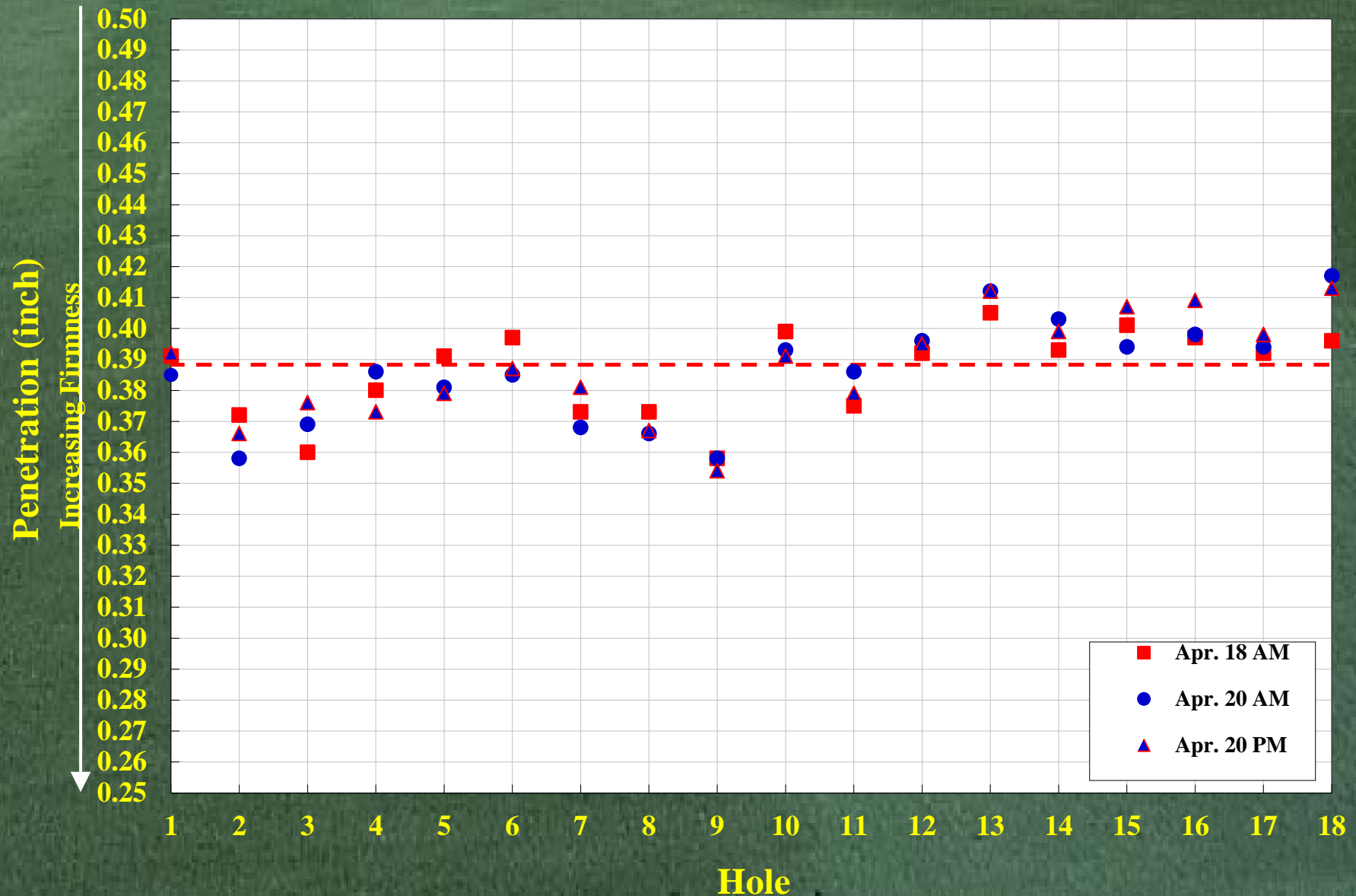
Daily Change & Comparison



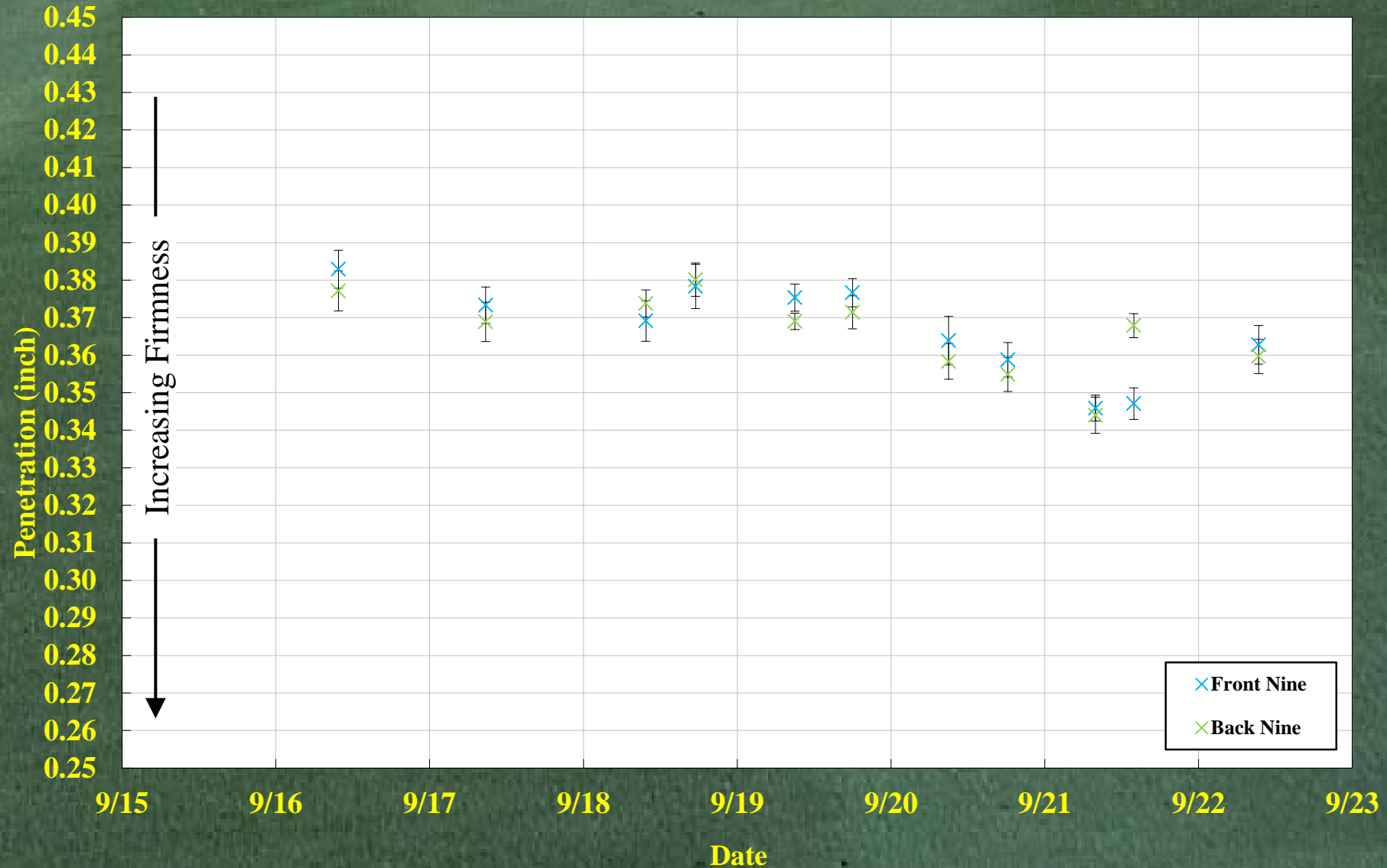
Daily Change & Comparison



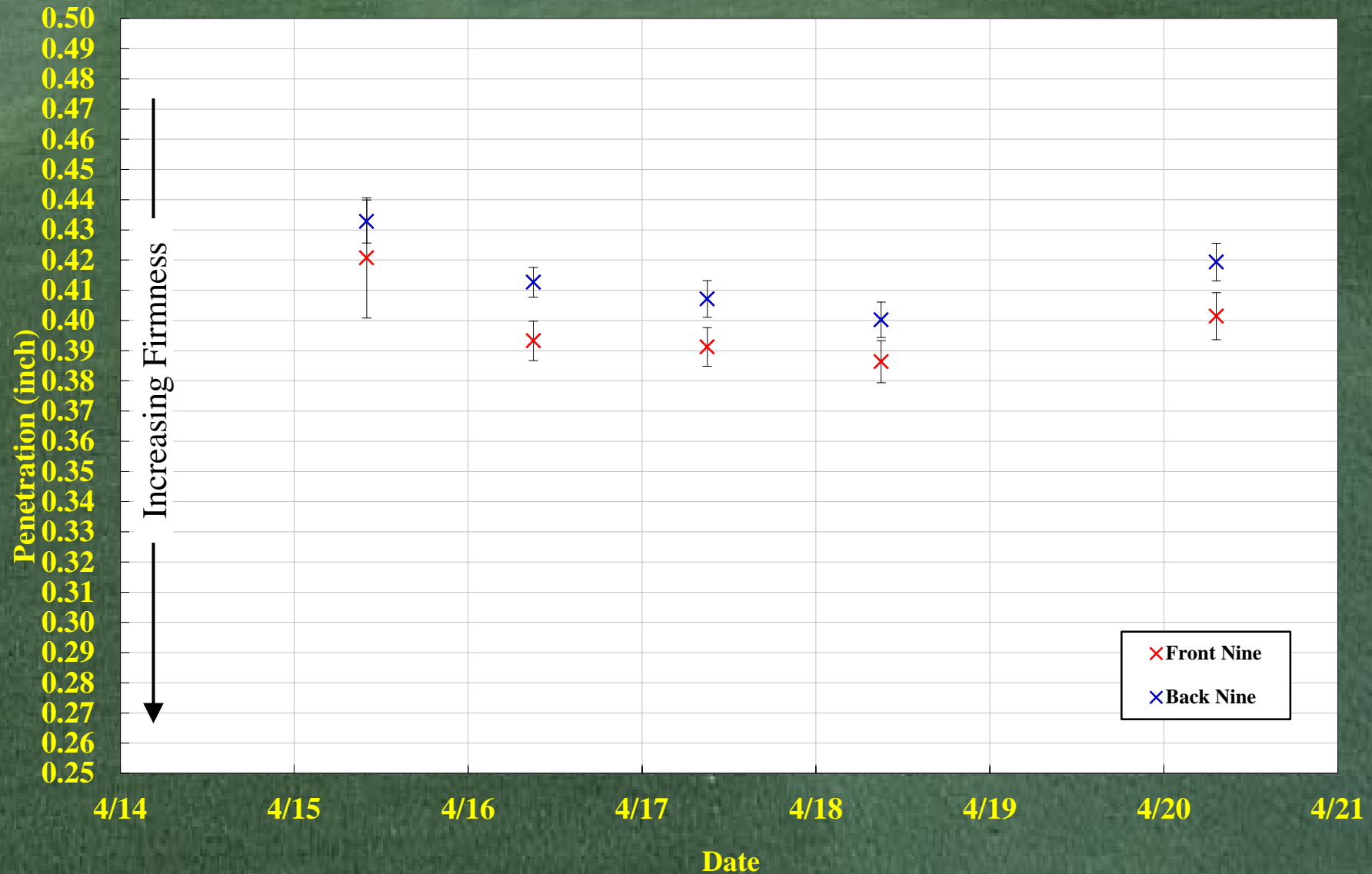
Daily Change & Comparison



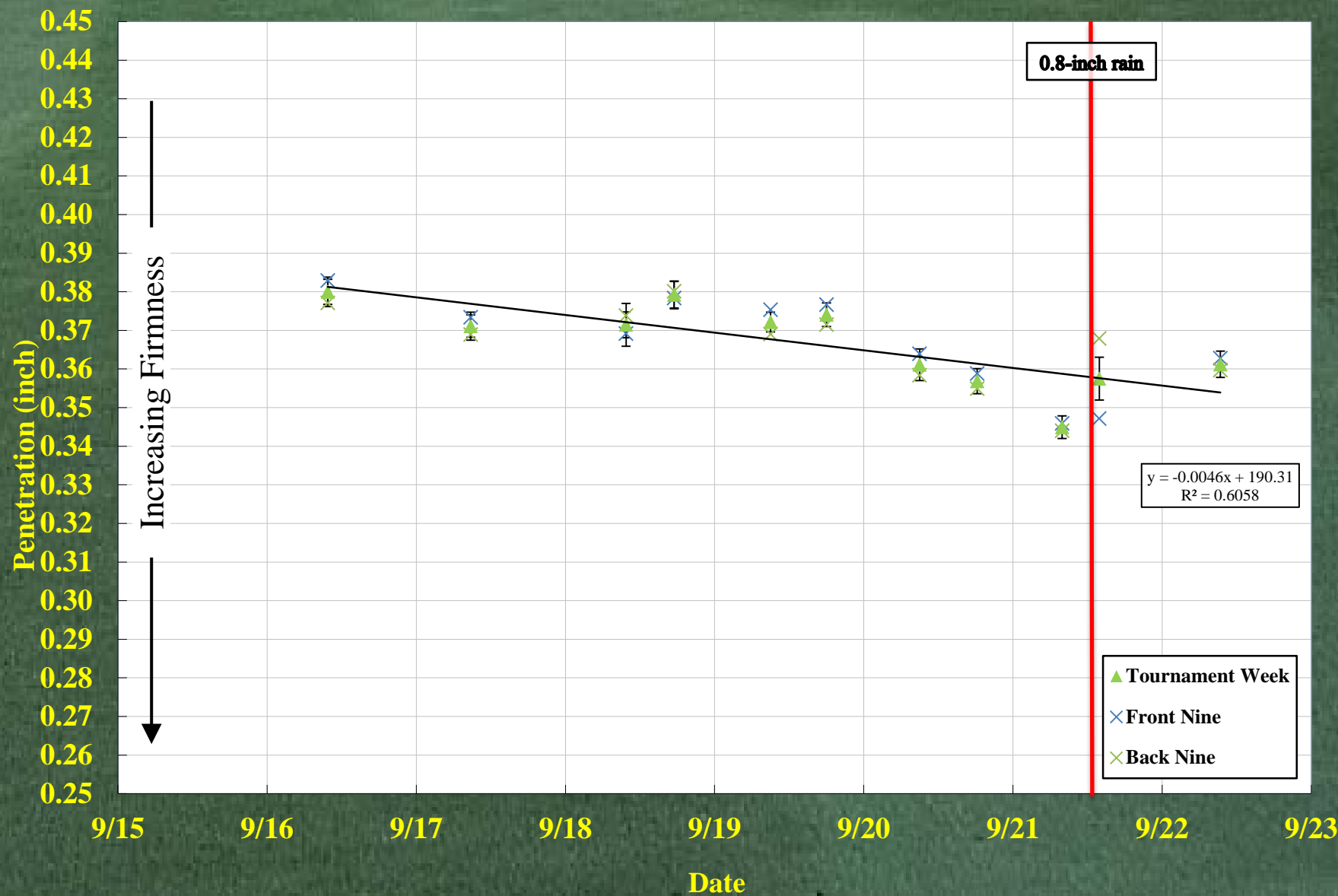
F9 & B9 Comparison



F9 & B9 Comparison



Summary



USGA TruFirm

What we've learned

- ★ Speed and firmness are independent
- ★ Manage softness, not firmness
 - ✓ Change in paradigm
 - ✓ Mowing – HOC, multiple
 - ✓ Rolling
 - ✓ SubAir
- ★ Climatic conditions greatly influence
 - ✓ Rain, sunshine, humidity, cloud cover, etc.



USGA TruFirm

What we've learned

- ★ Construction may make a difference
- ★ Traffic patterns are detectable
- ★ Thatch affects firmness
 - ✓ 3 yrs for a green to “standardize”
- ★ Spot checks
 - ✓ Questionable
 - ✓ Look for trends
 - ✓ Consecutive days on all greens



USGA TruFirm

Role in Turfgrass Management

- ★ Mapping
- ★ Irrigation
- ★ Consistency
- ★ Construction
- ★ Measurement of thatch
- ★ Timing cultivation practices



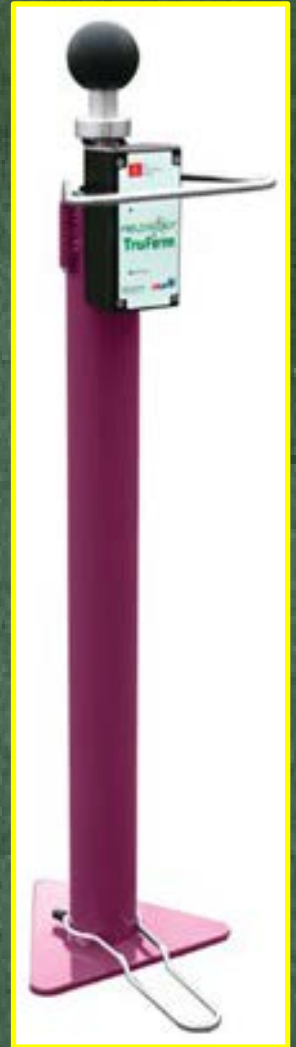
FieldScout TruFirm

**Spectrum Technologies
with cooperation from USGA**

FieldScout TruFirm

Equipment Needed

- ★ Simple & easy to use
- ★ Highly portable / lightweight
- ★ No damage to greens
- ★ Data
 - 👍 Logged
 - 👍 Easy to read
 - 👍 Understandable units (inch)
- ★ Applied to all areas of the golf course



\$899

Precision Firmness Meter

Precision Firmness Meter

Equipment Needed

- ★ Simple & easy to use
- ★ Highly portable
- ★ Data
 - 👉 Understandable units (inch)



\$595

Important Dates in 2014

A group of people, including men and women, are standing on a grassy field. Some are wearing polo shirts and khaki shorts, while others are in more casual attire. They appear to be engaged in a field activity, possibly a research field day. In the foreground, there are two green metal stands, likely for holding papers or books. The background shows a line of trees under a clear sky.

UGA Turfgrass Research Field Day – August 6

For other local programs contact your CEA

Thank You

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