My Experiences
Quantifying My Sleep States

Informal Seminar

de la Iglesia and Opp Labs

University of Washington

Seattle, WA

April 17, 2012

Dr. Larry Smarr

Director, California Institute for Telecommunications and Information Technology

Harry E. Gruber Professor,

Dept. of Computer Science and Engineering

Jacobs School of Engineering, UCSD

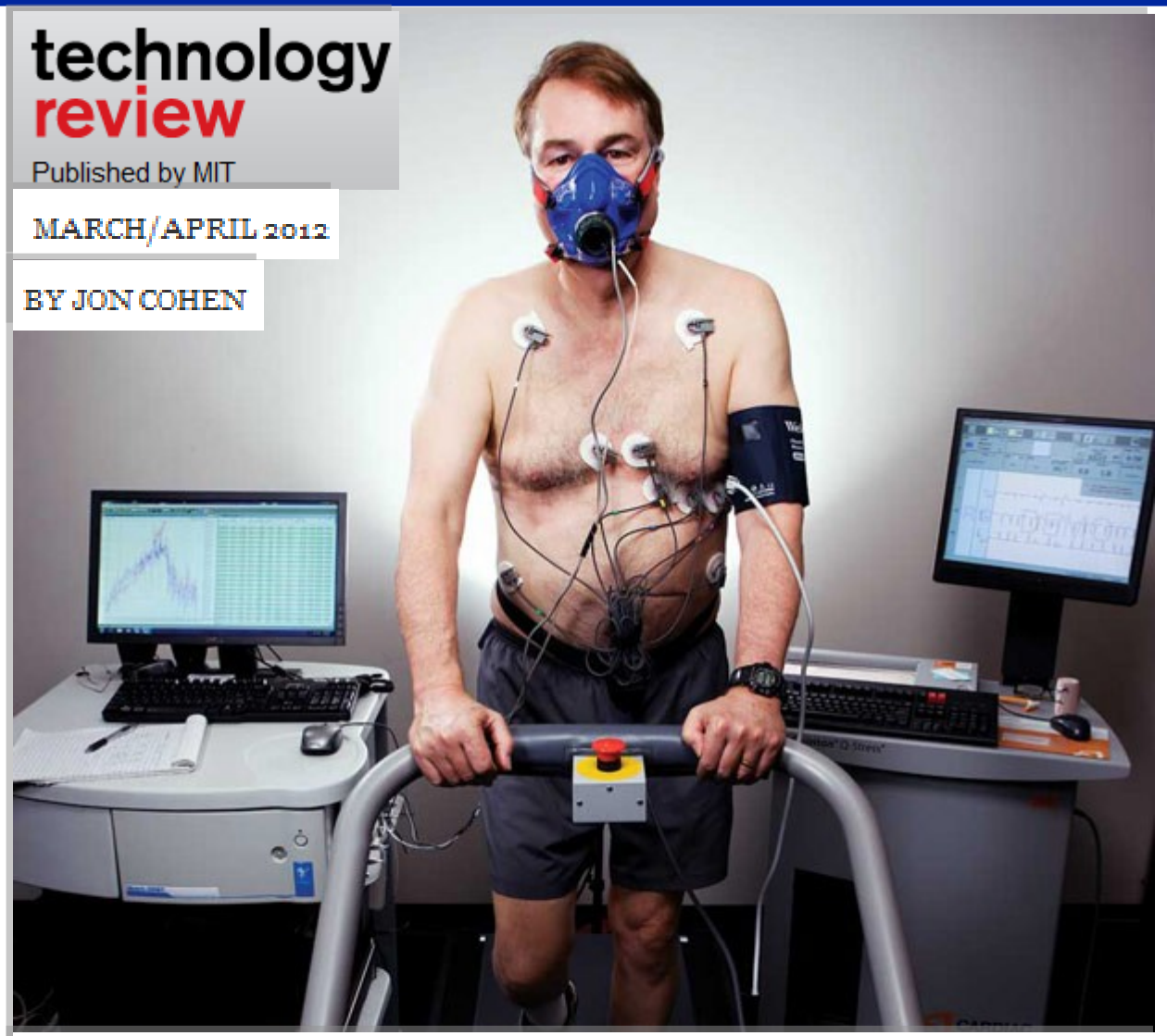
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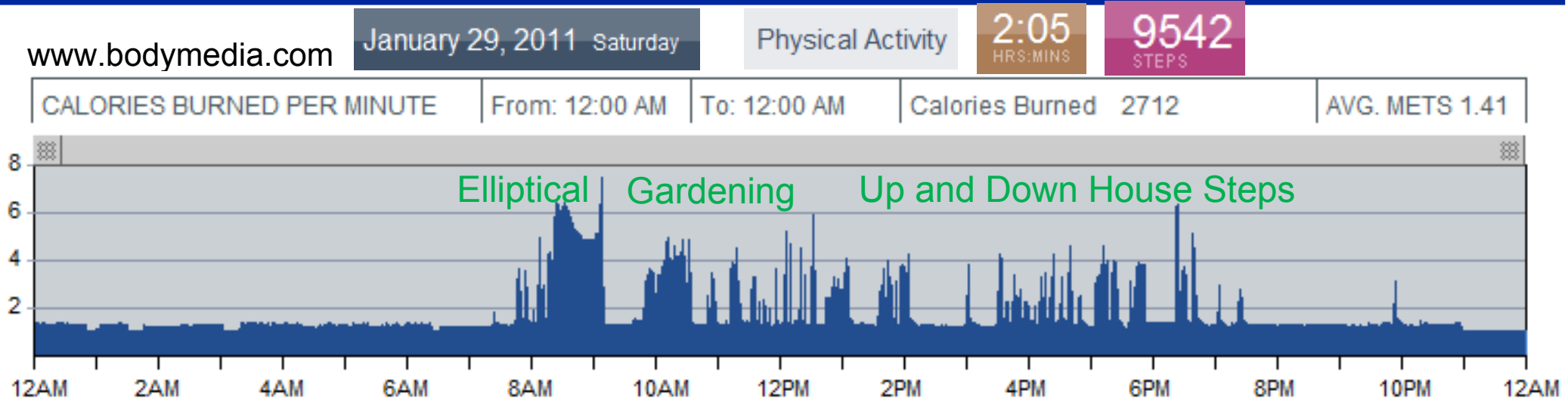
I Have Spent Ten Years Quantifying My Body



www.technologyreview.com/biomedicine/39636

BodyMedia Sensors Measures Acceleration, Skin Temperature, Skin Heat Flux, and Galvanic Skin Response

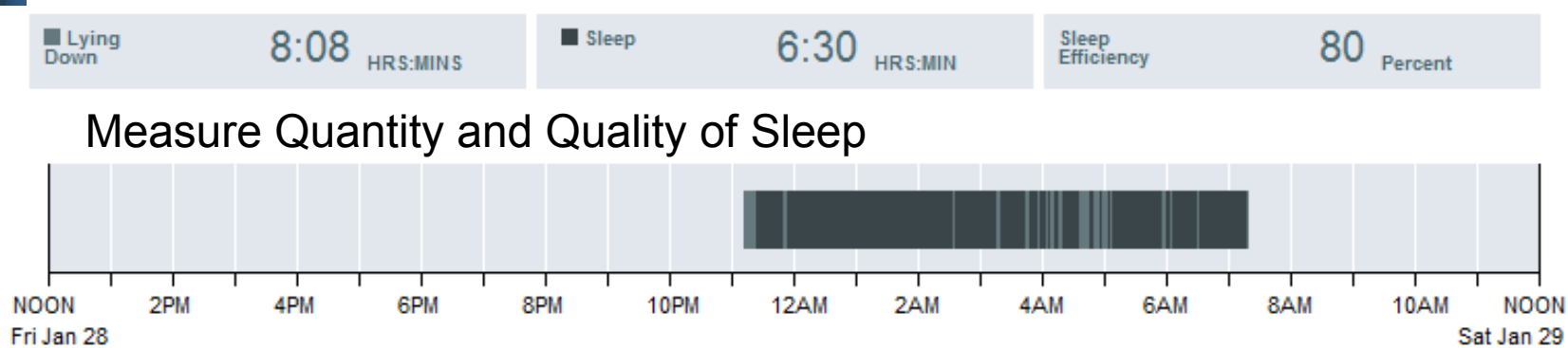
www.bodymedia.com





BODYMEDIA®
Know your Body. Change your life

25 Week Average:
2473 Calories Burned/Day
1:19 hr Physical Activity/Day (>3 METs)
6887 Steps/Day (~3.4 Miles)



25 Week Ave: 6:51 hrs with 81% Efficiency

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Published Comparison of BodyMedia with Sleep Lab Polysomnography (PSG)

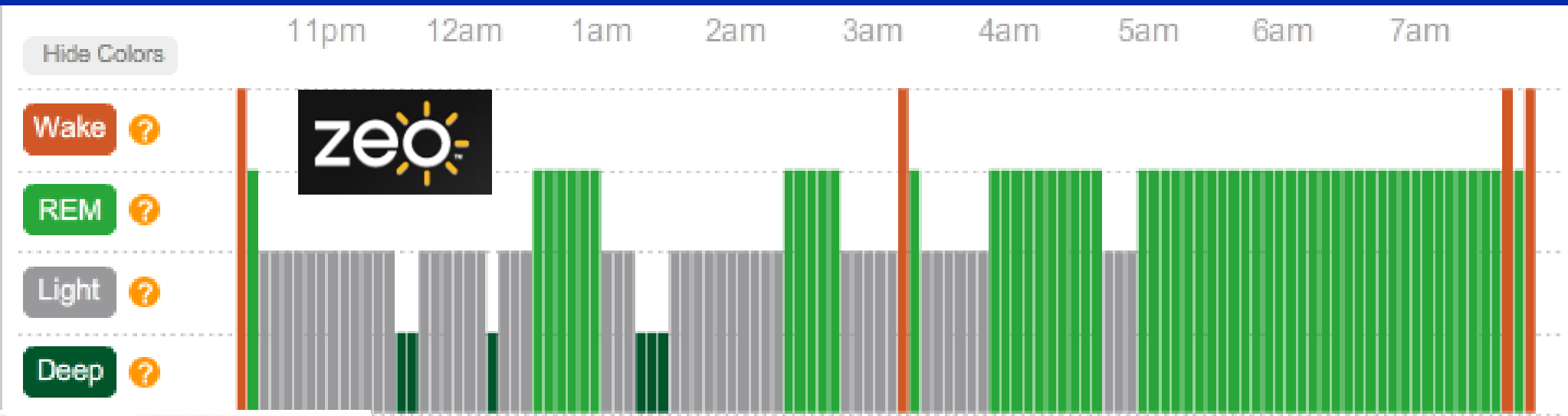
- 27 participants (Mean age = 28.7 years, 16 women) underwent PSG recordings while wearing the armband.
- PSG and armband data were scored in 20-second epochs.
- BodyMedia's sleep algorithm was developed using techniques from statistical machine learning.
- The algorithm correctly identified 93% of all sleep epochs, and 83% of all wakefulness epochs, for an overall epoch-by-epoch accuracy of 89%.
- The algorithm correctly identified 65% of all NREM sleep epochs (vs. 43.9% by chance), and 45.6% of all REM sleep epochs (vs.13.9% by chance), for an epoch-by-epoch accuracy of 70% (vs. 39% by chance).

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www.bodymedia.com/Professionals/Key-Publications/Abstract-presented-at-SLEEP-2006-20th-Anniversary-Meeting-of-the-AOSS-2006

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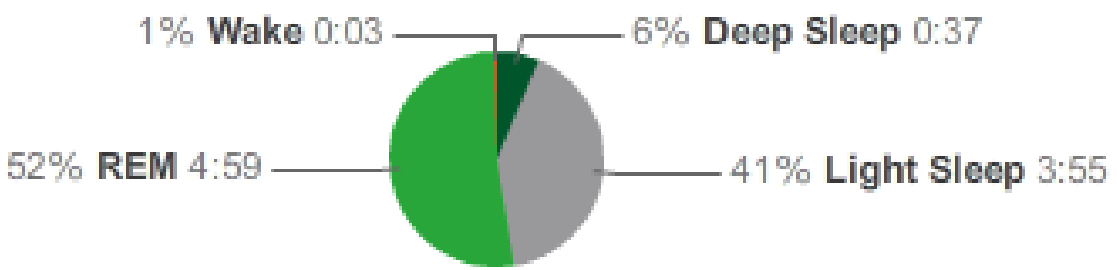
Quantifying My Sleep Pattern Using Zeo - Surprisingly About Half My Sleep is REM!





Total Z: 9 hr 31 min

Time to Z: 0 hr 2 min



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REM is Normally 20% of Sleep
Mine is Between 45-65% of Sleep

An Infant Typically
Has 50% REM

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I Have Worn A Zeo for 400 Nights

The Measured Life

Do you know how much REM sleep you got last night? New types of devices that monitor activity, sleep, diet, and even mood could make us healthier and more productive.

JULY/AUGUST 2011 | BY EMILY SINGER



MIT Graduate student Ian Eslick

technology review
Published by MIT

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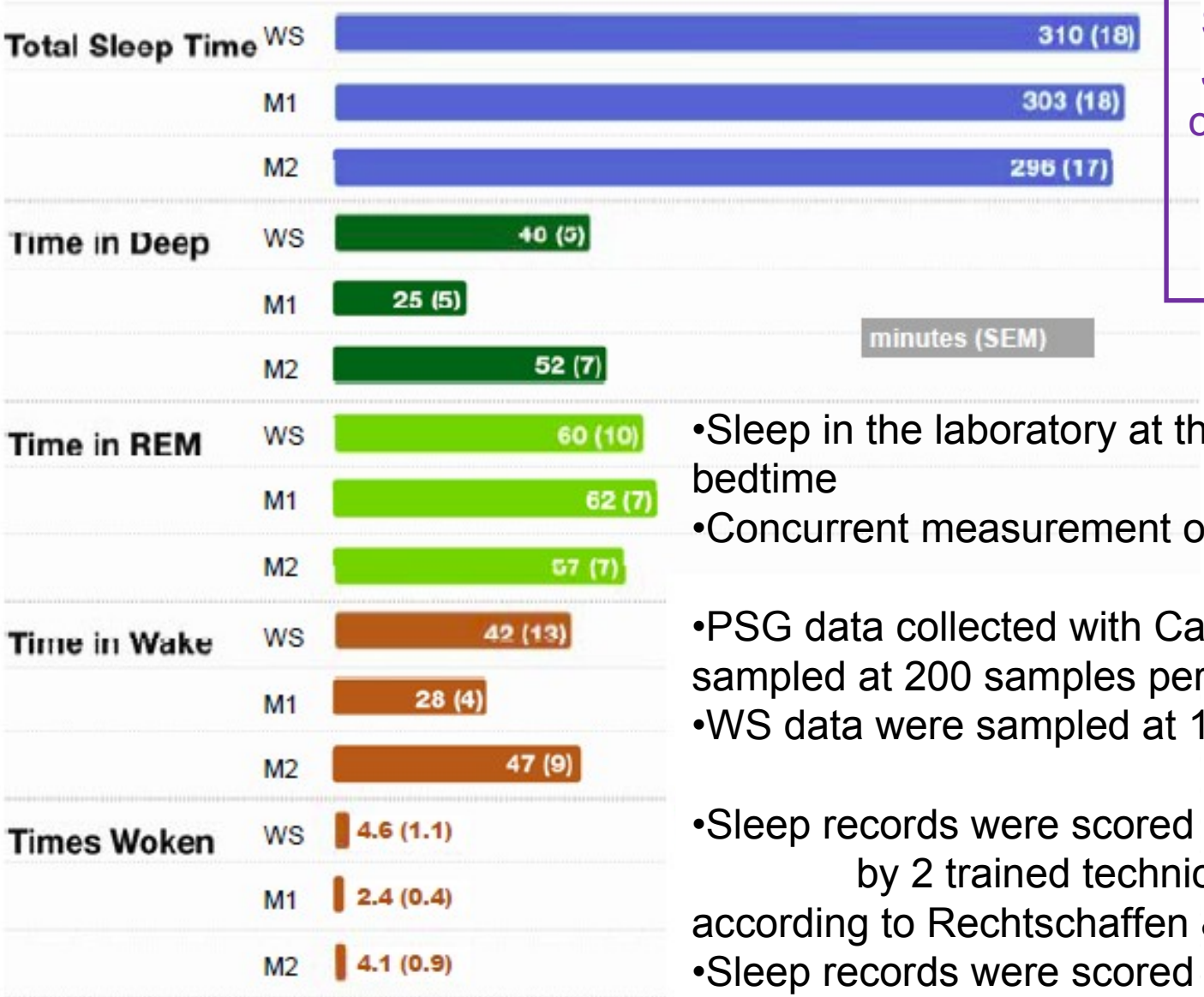
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On the Road Zeo Solution: Link Headband to Android Smartphone



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Published Comparison of Zeo with Sleep Lab Polysomnography (PSG)



Shambroom JR, Johnstone J, Fabregas SE. Evaluation of Portable Monitor for Sleep Staging. Sleep. 2009;32 (Suppl.): A386. Abstract 1182.

- Sleep in the laboratory at the participant's habitual bedtime
- Concurrent measurement of PSG and WS

- PSG data collected with Cadwell Easy II PSG, sampled at 200 samples per second
- WS data were sampled at 128 samples per second

- Sleep records were scored blinded to WS by 2 trained technicians (M1 and M2) according to Rechtschaffen & Kales
- Sleep records were scored automatically by the WS

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www.myzeo.com/sleep/sites/default/files/Shambroom%2C%20Johnstone%2C%20Fabregas_Validation_2009_APSS_poster.pdf

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Recent Paper Details Comparing Zeo Accuracy vs. Sleeplab and Actigraphy

J. Sleep Res. (2012) 21, 221–230

Wireless system to monitor sleep

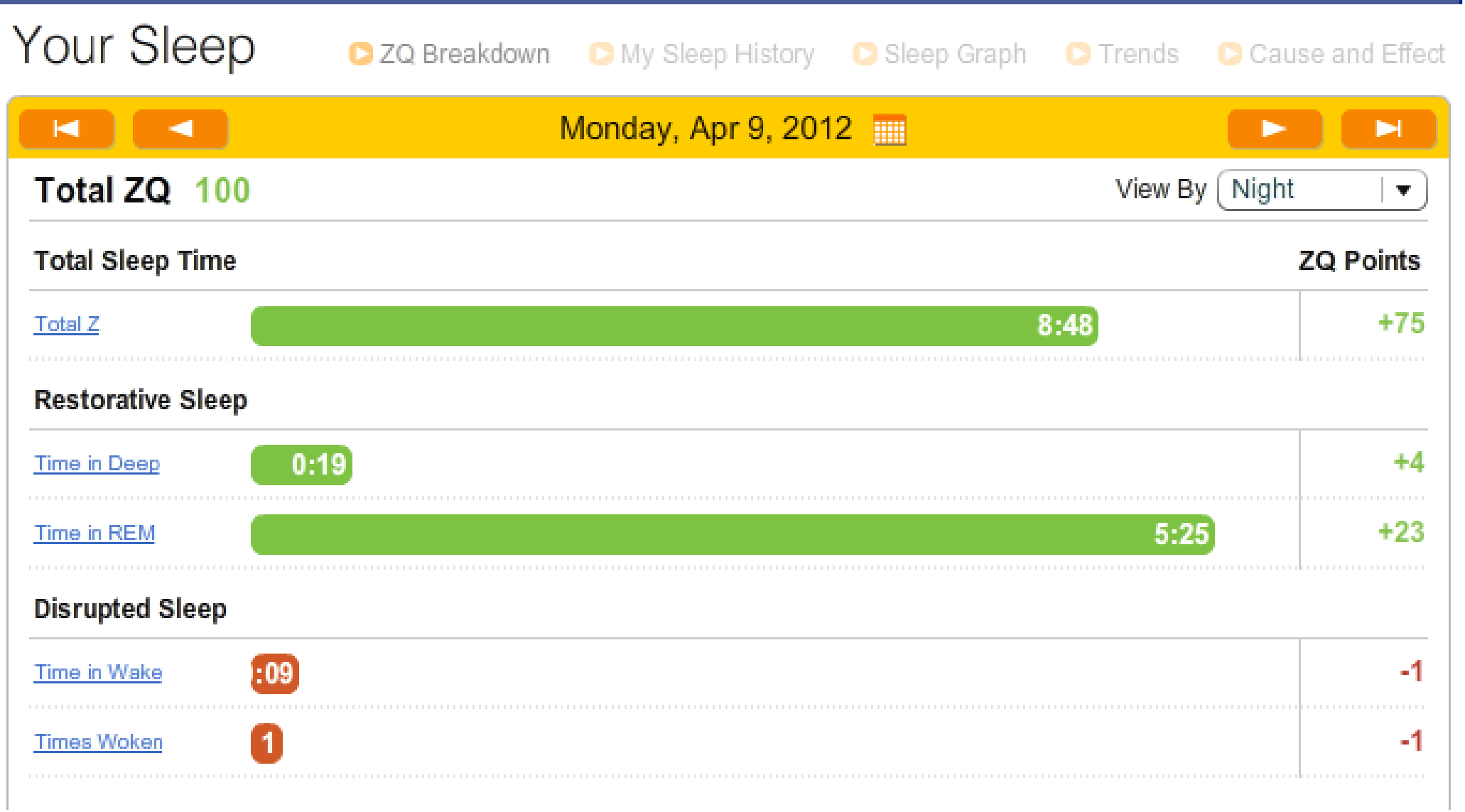
Validation of an automated wireless system to monitor sleep in healthy adults

JOHN R. SHAMBROOM[1], STEPHAN E. FÁBREGAS[1] and JACK JOHNSTONE[2]

[1]Zeo Sleep Research Center, Zeo, Inc., Newton, MA, USA and [2]Valley Sleep Center, Burbank, CA, USA

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How the ZQ is Computed: A Typical Night with ZQ=100

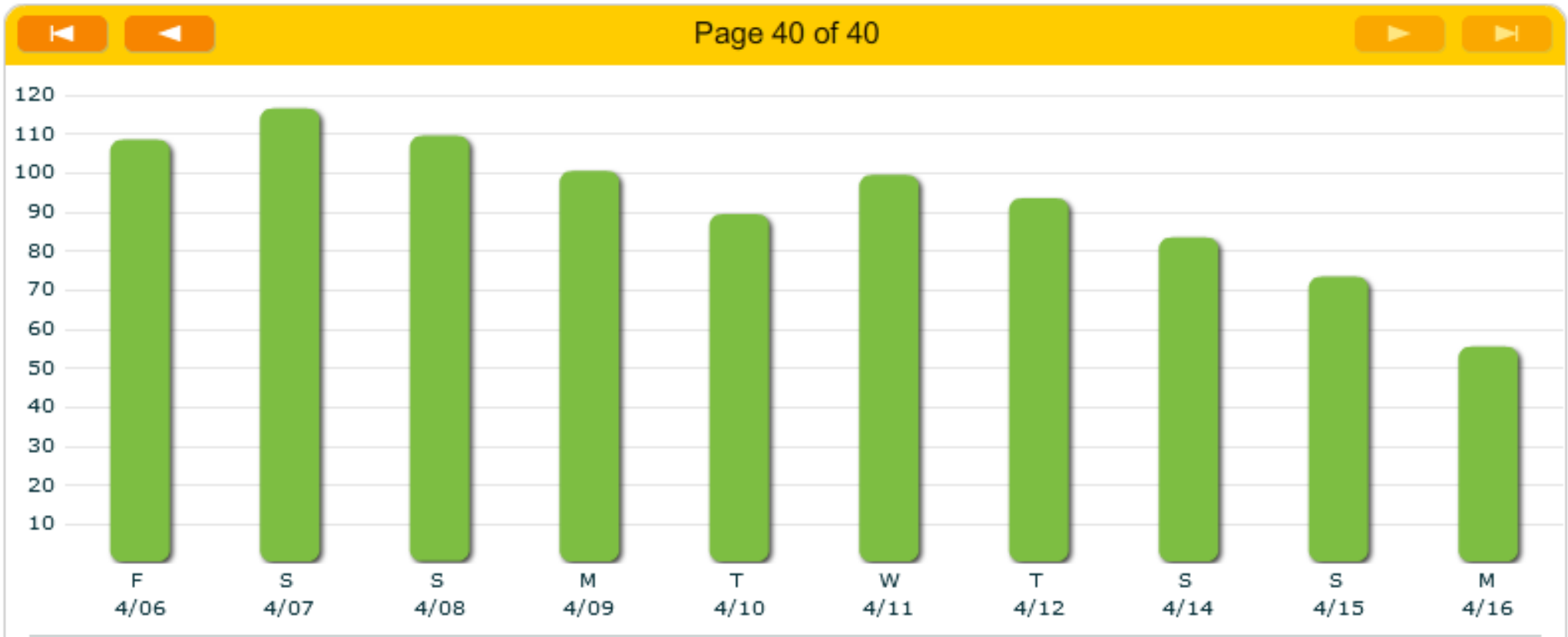


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My ZQ Can Vary By a Factor of Two

There are **400 nights of sleep** in your account. Uncheck a night to delete it.



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My Total Sleep Can Vary by a Factor of 2



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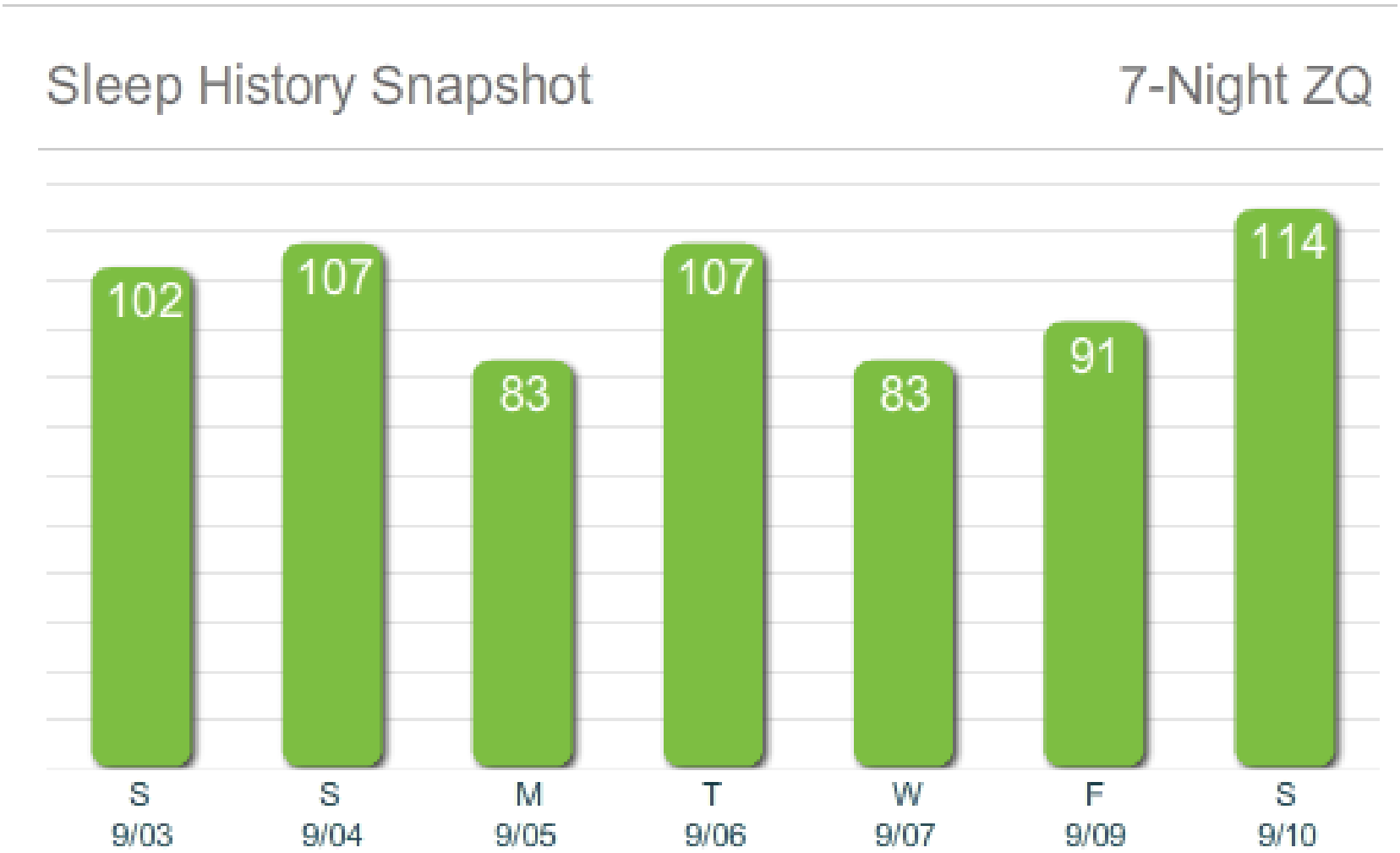
My Deep Sleep Duration Can Vary by a Factor of 3



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My Average ZQ is About 100 -- ZQ Average is 66 for Males in Their 60s



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I Have Over Twice the REM Sleep of a Normal Male in Their 60s

Average	Normal Person In Their 60s	Me Age 62
ZQ	66	100
Total Sleep	6.3 hrs	8.5 hrs
REM	1.9 hrs	4.5 hrs
Deep	41 min	40 min
Wake	40 min	15 min

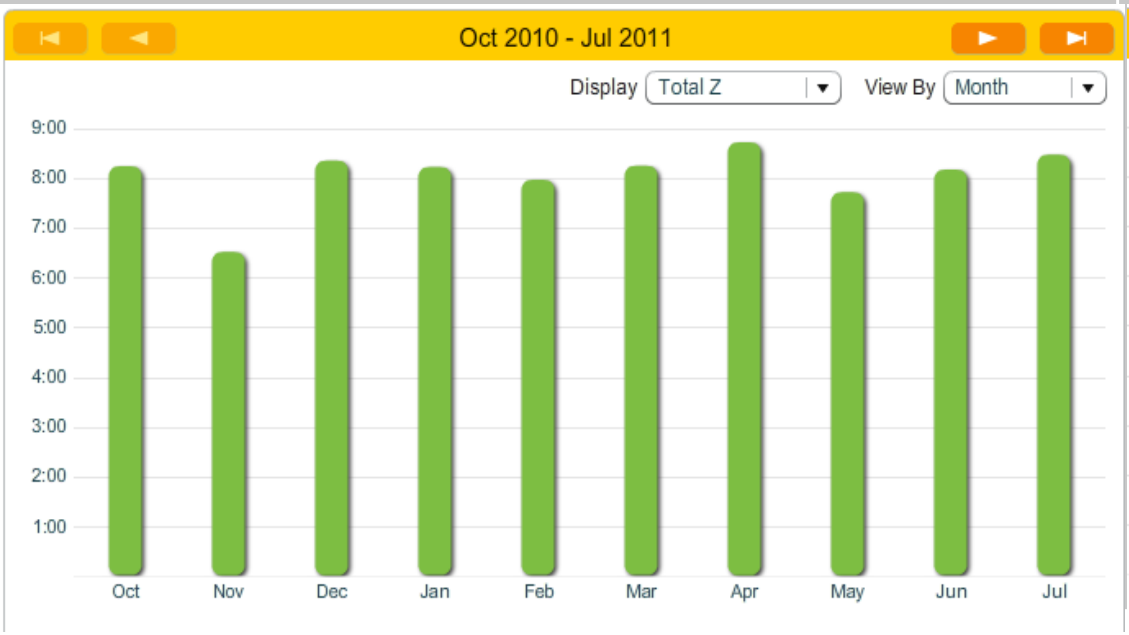
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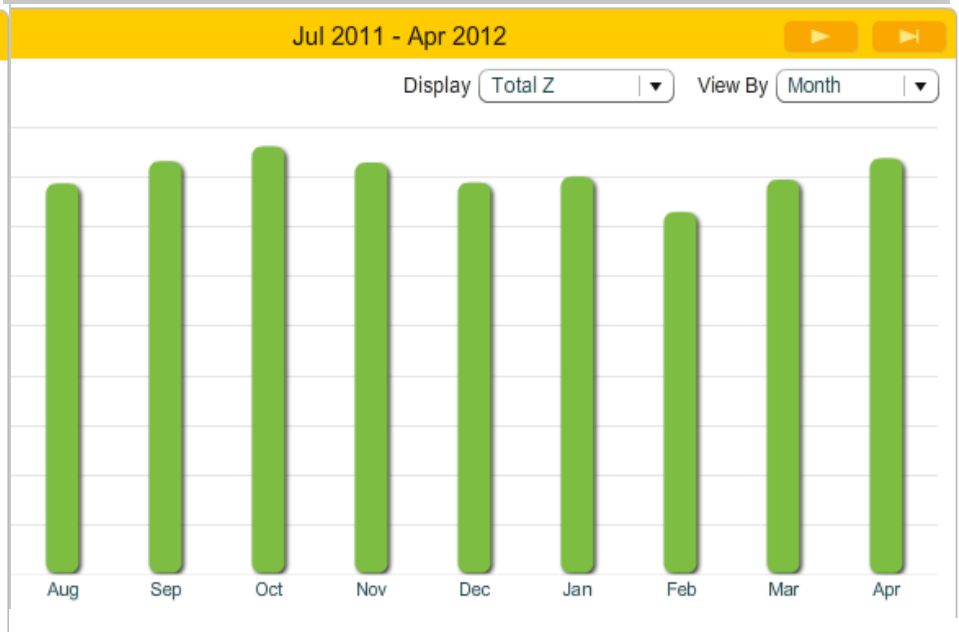
LS Values From Ten Days 8/31/11 to 9/10/11

Source: Zeo.com

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I Have a Fairly Stable Amount of Sleep: Monthly Averages

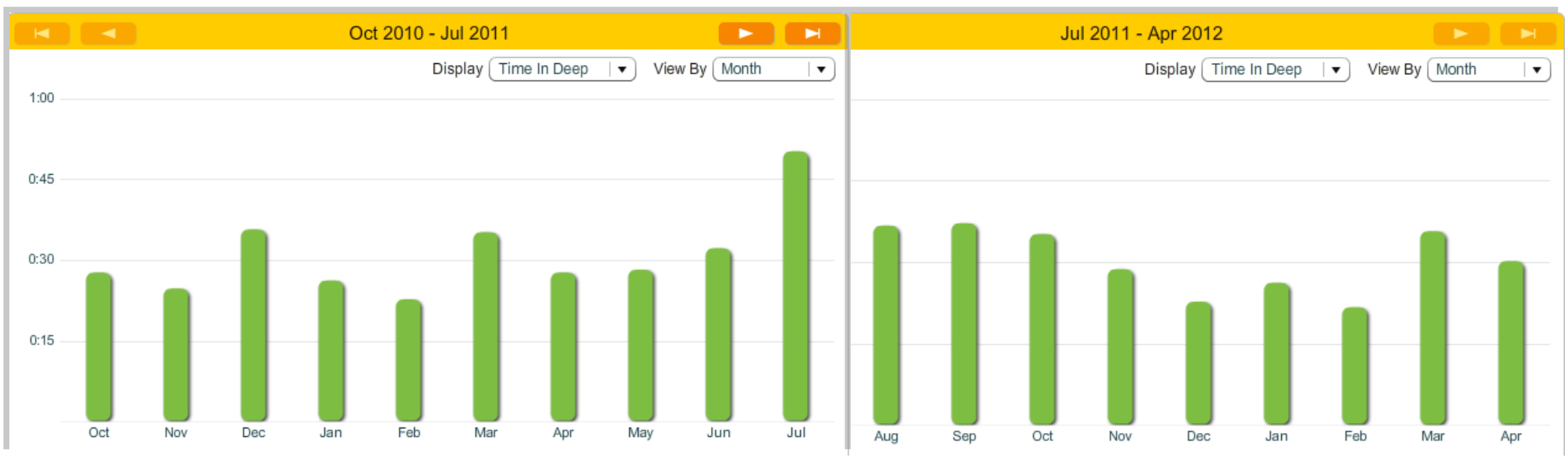




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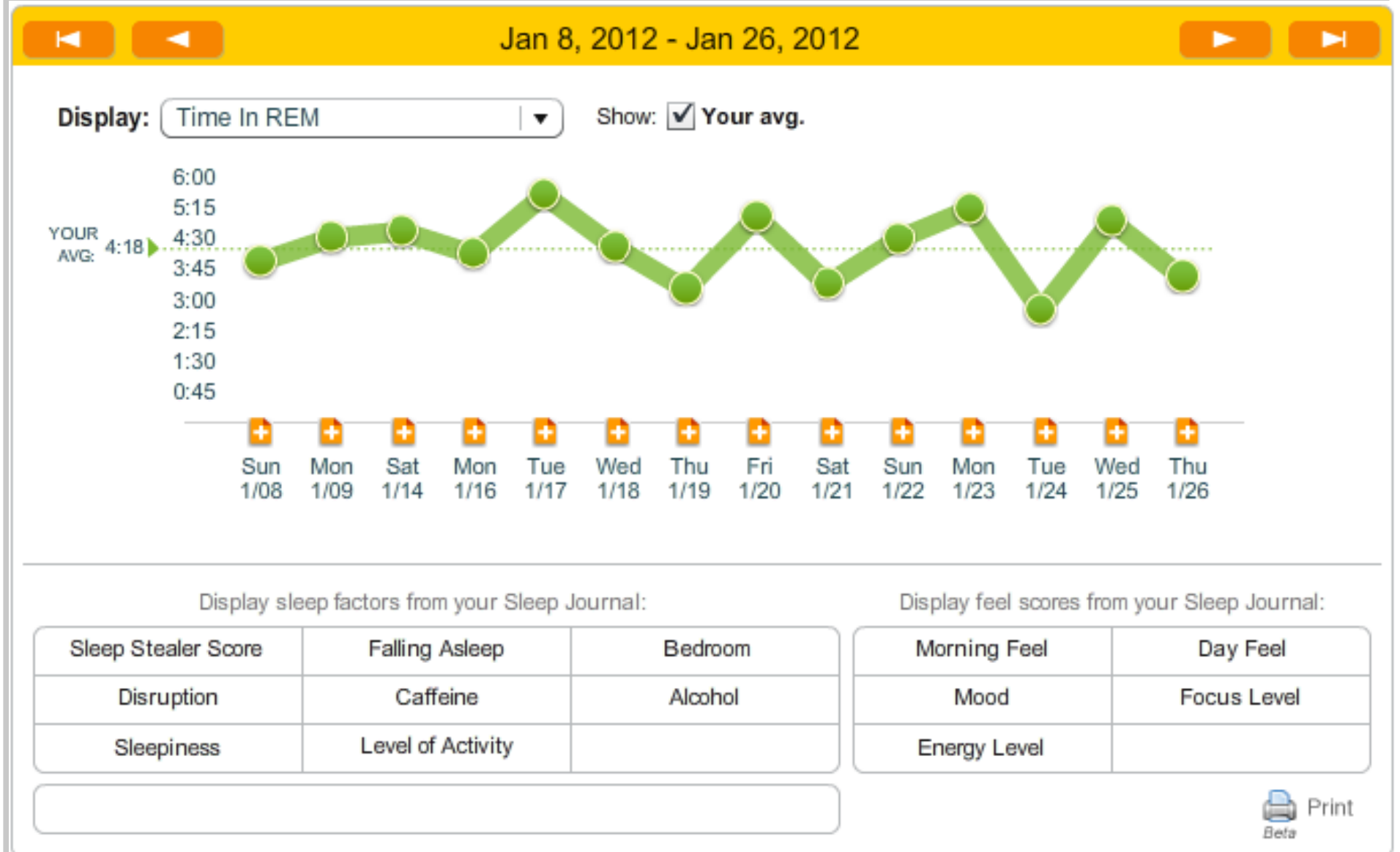
Possible Weak Seasonal Effect On Quantity of Deep Sleep



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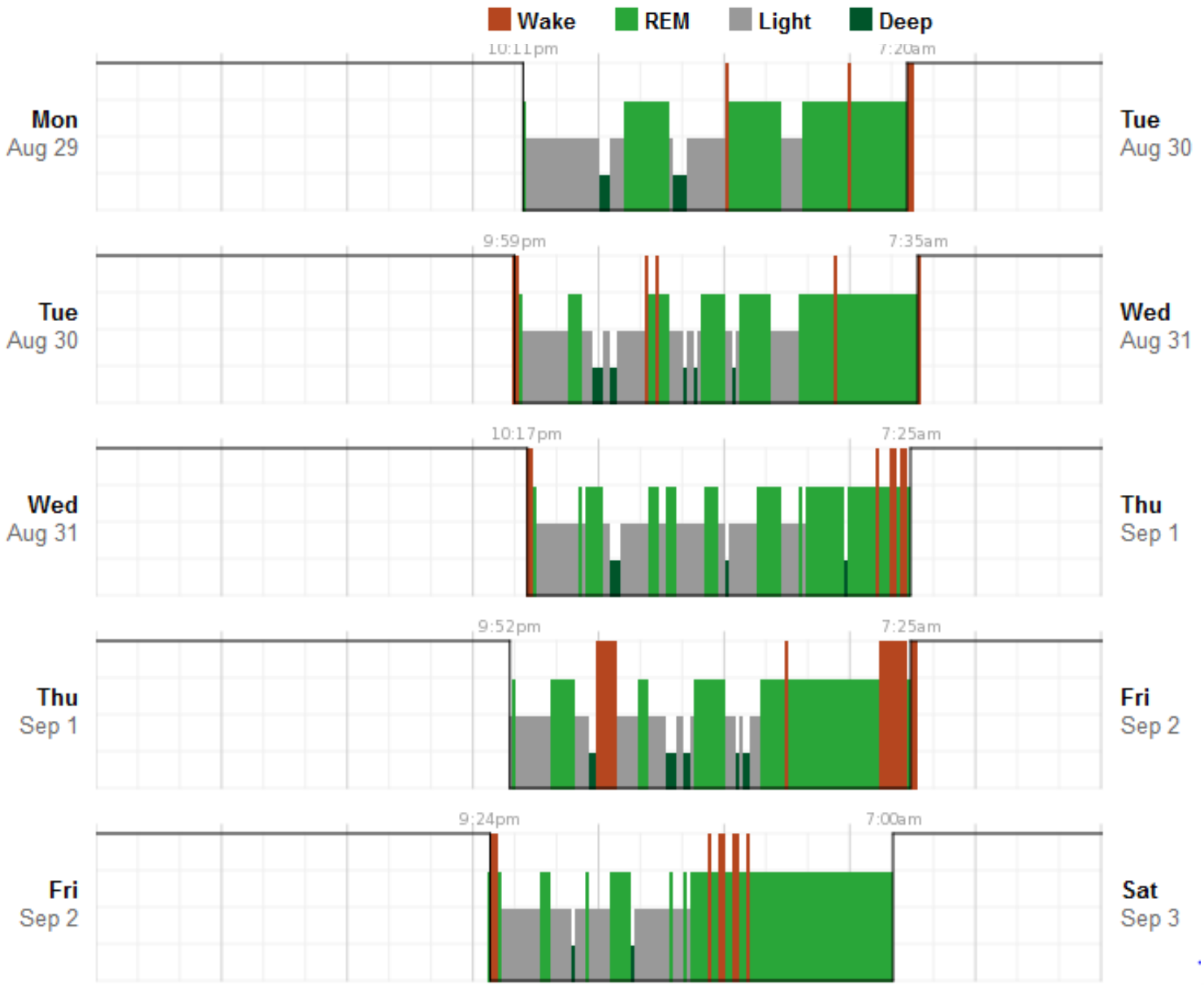
Zeo Lets One Couple Sleep Journal Entries to Sleep Data



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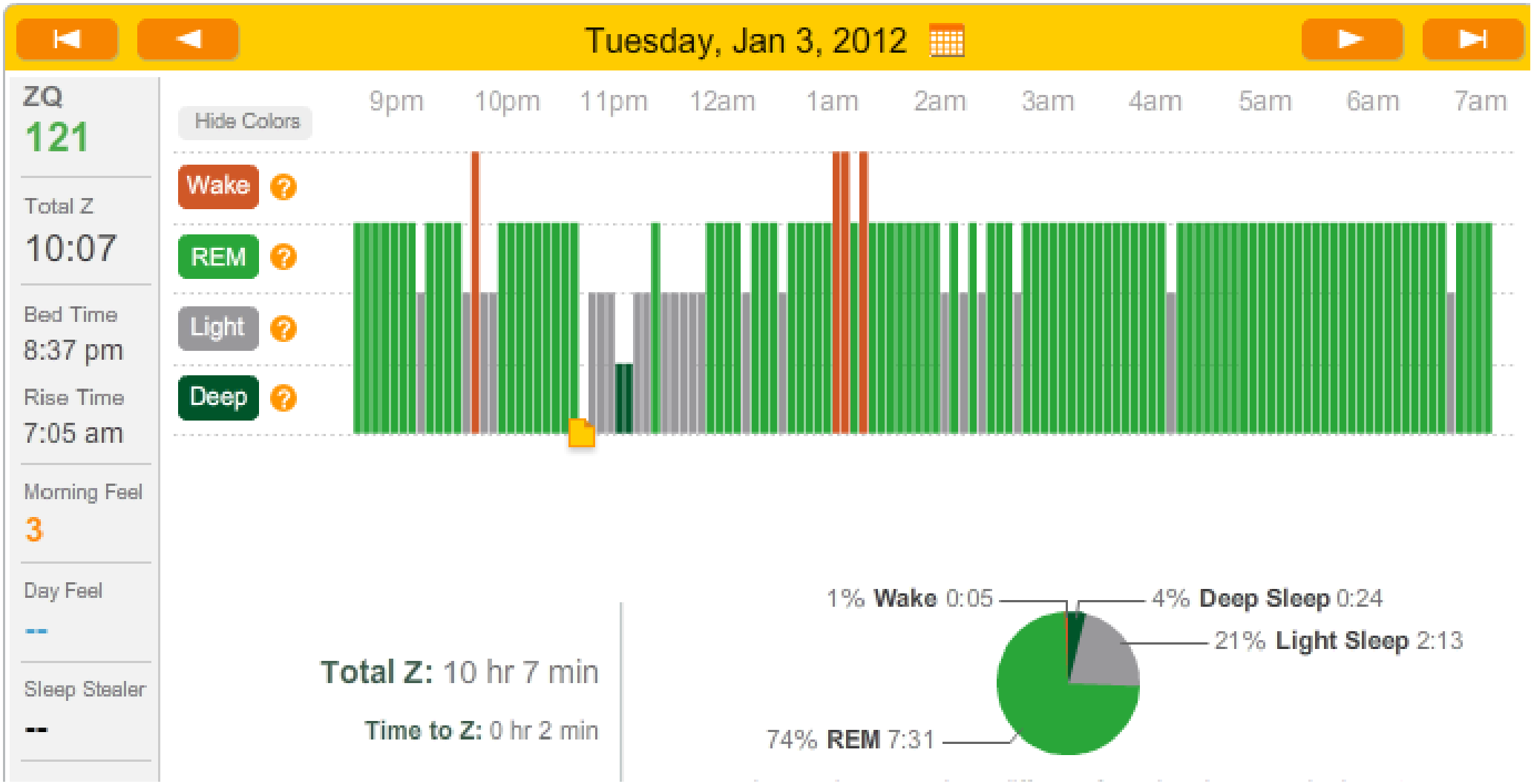
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I Have a Fairly Consistent Sleep Architecture: A Few REM Blocks Early, Then a "Wall of REM"



Source: Zeo 2011

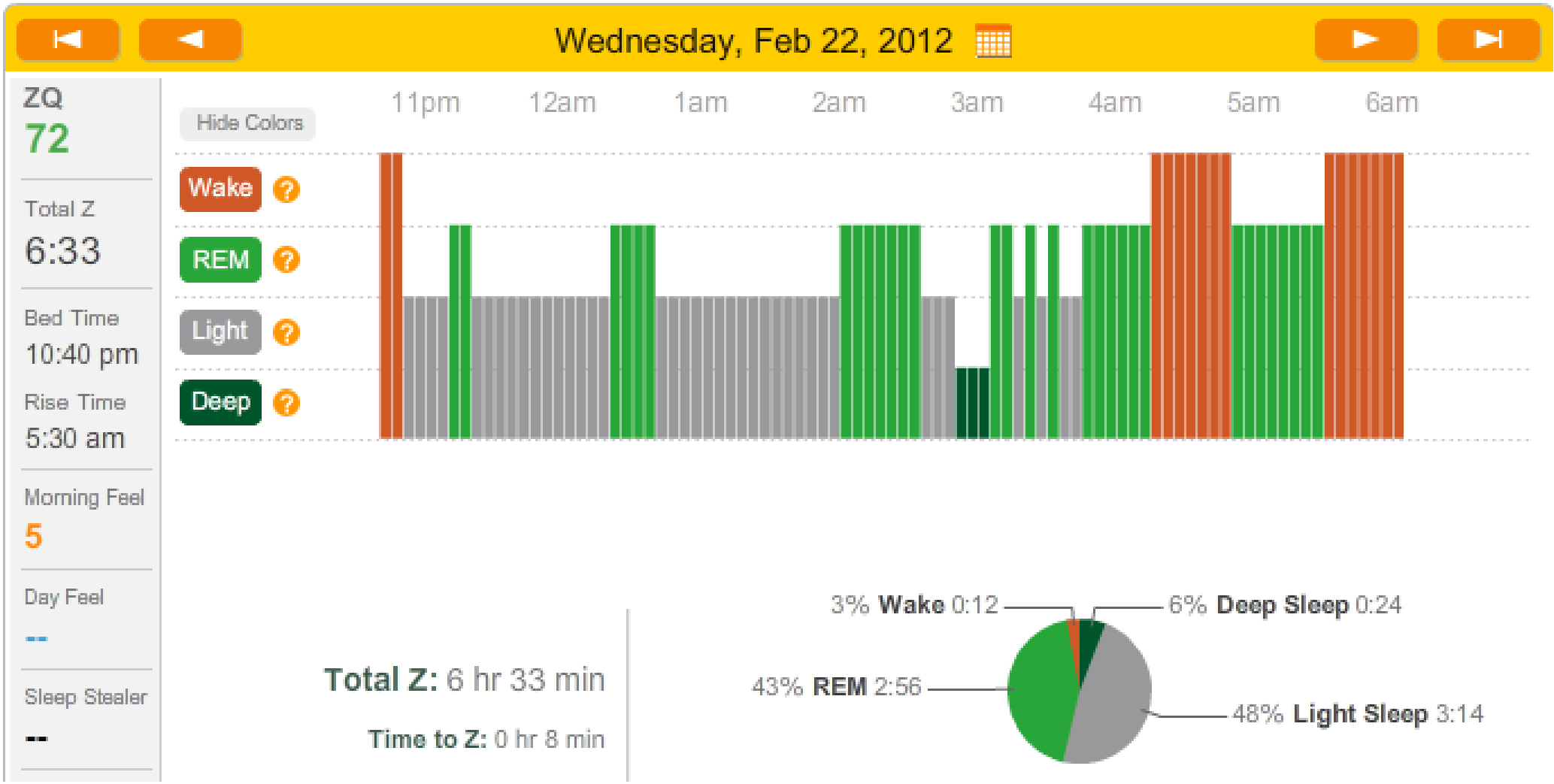
One of My Highest ZQ and % REM: Night After Colonoscopy



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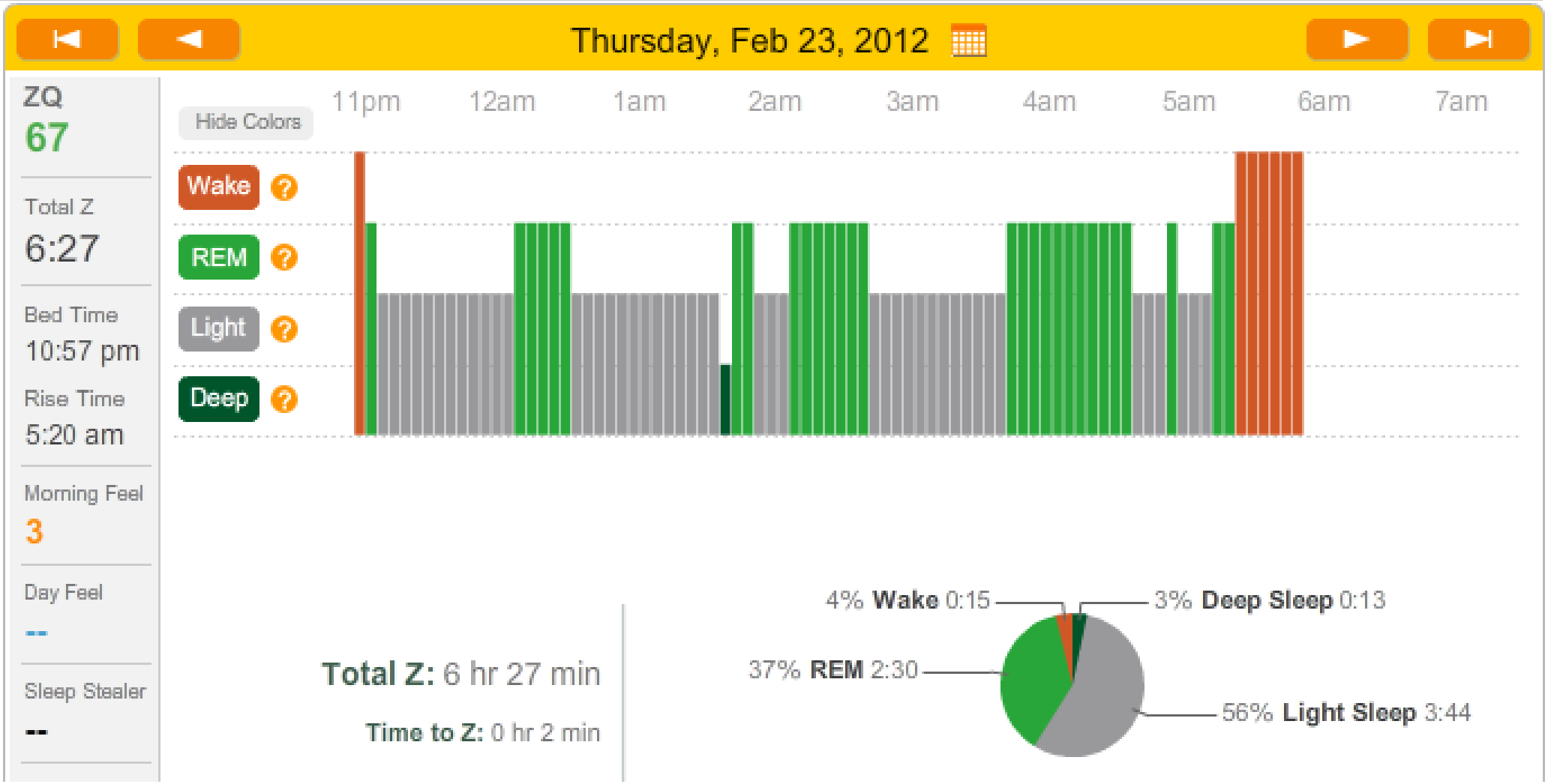
Five Nights in a Row with Low REM 36-43% Three Weeks After Starting Prednisone



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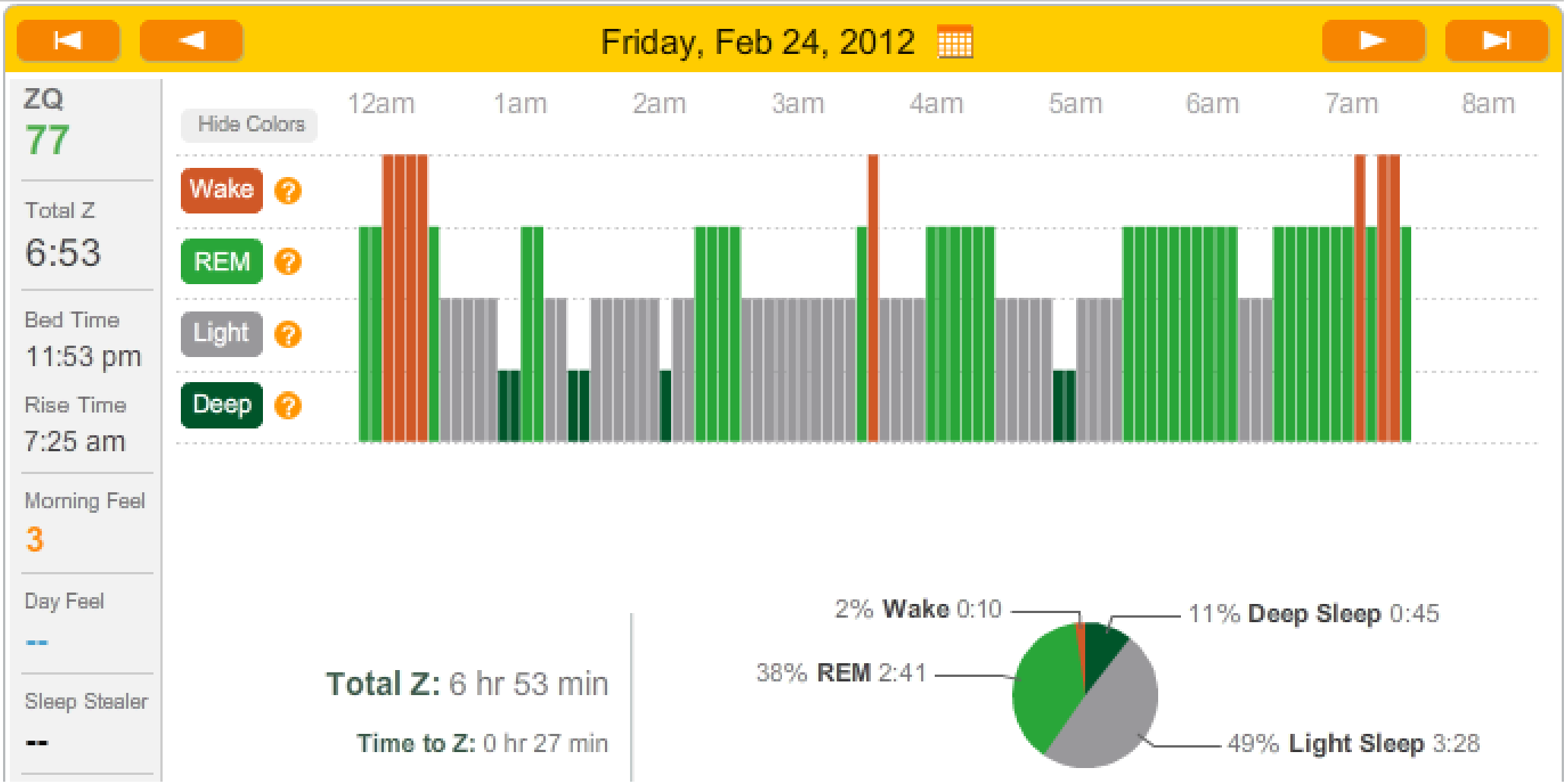
Night #2 With Low REM



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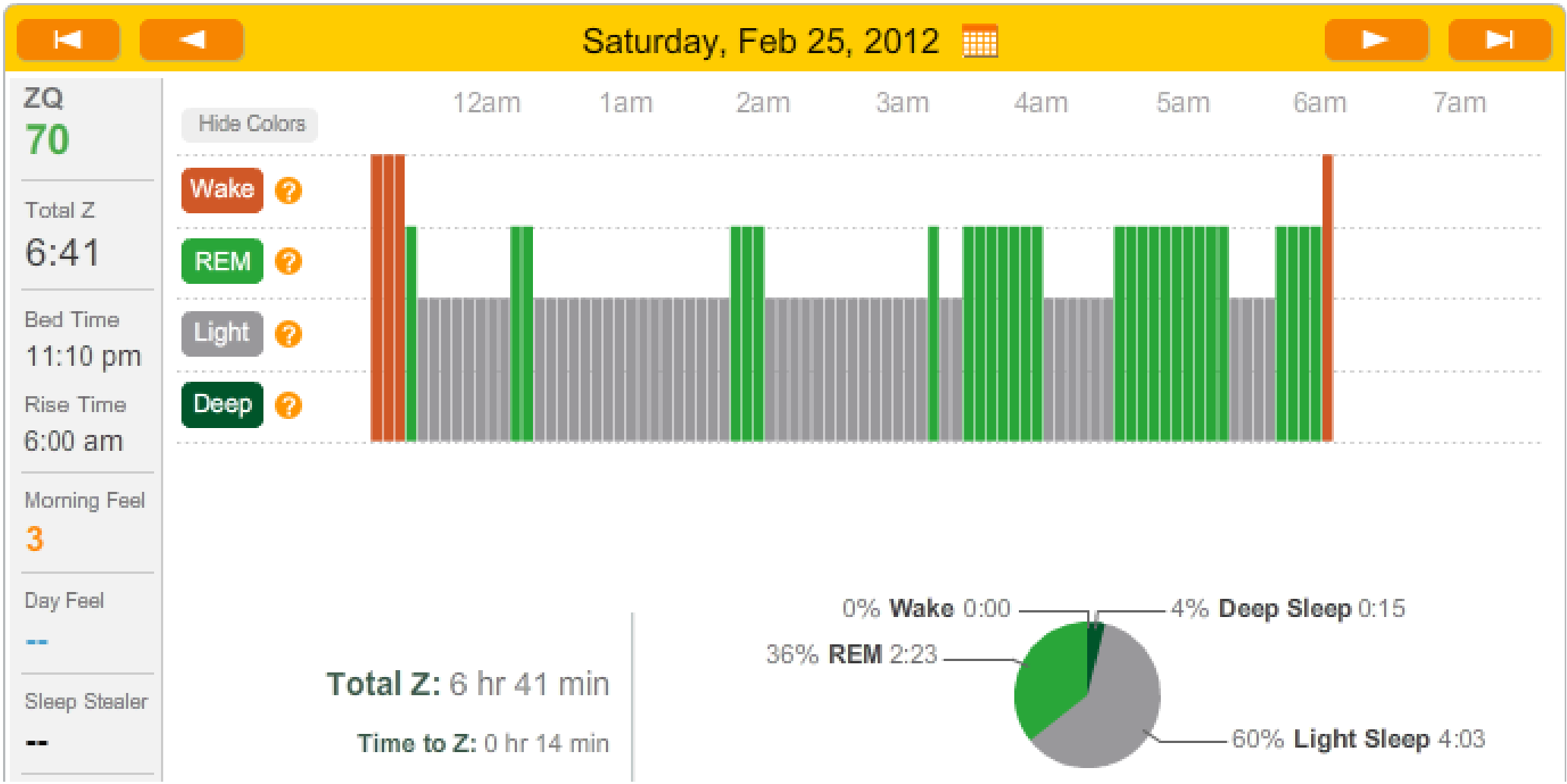
Night #3 With Low REM



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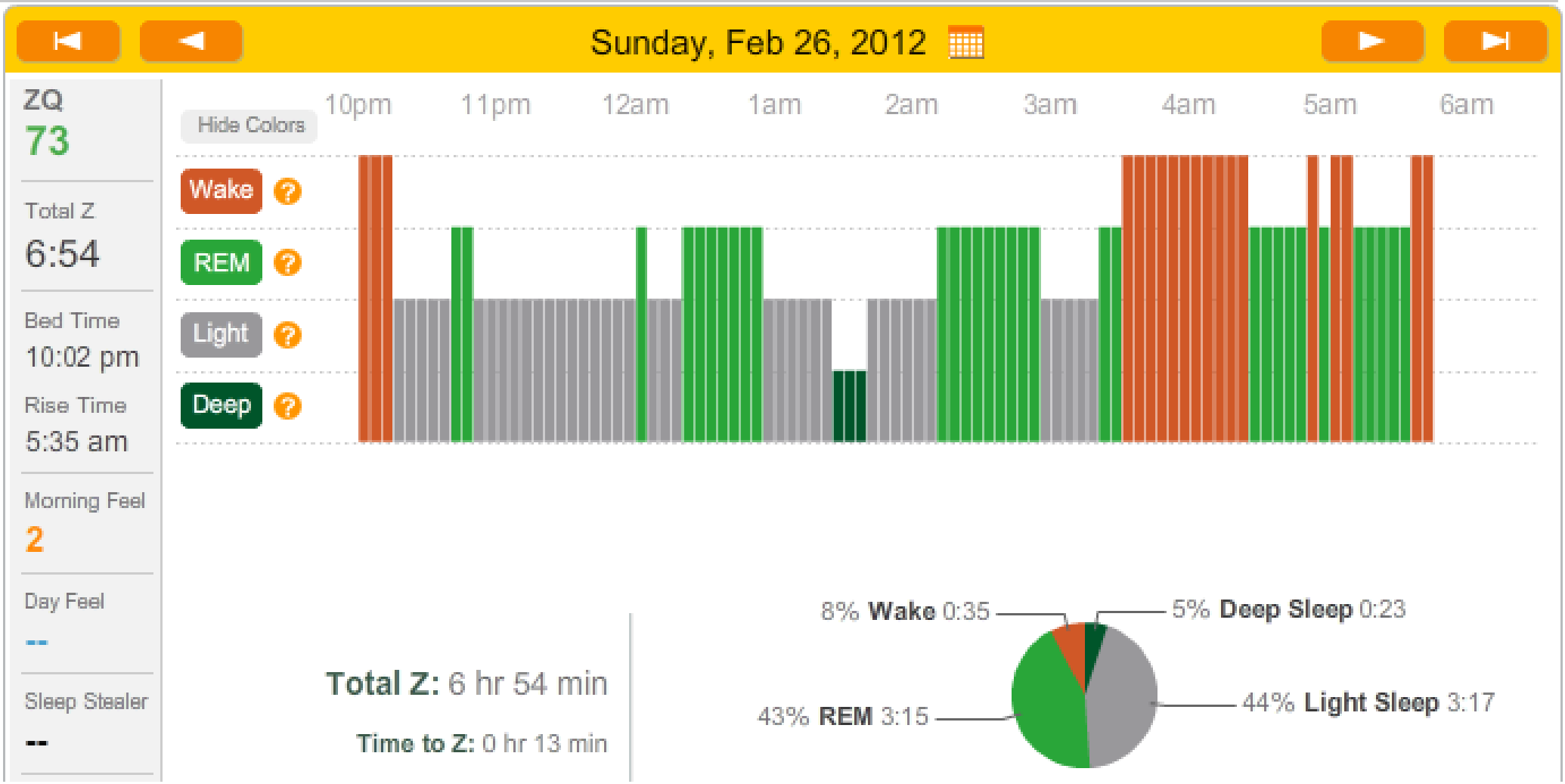
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Night #4 With Low REM



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Night #5 With Low REM

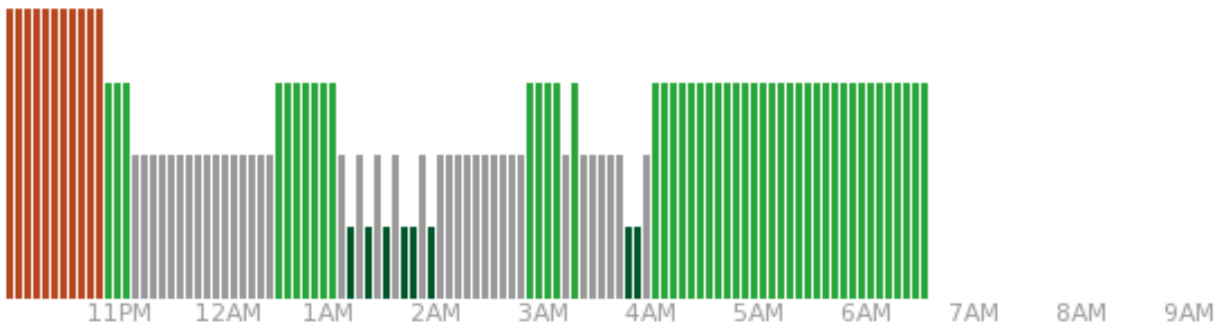


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Trip La Jolla to Perth, Australia Takes Roughly 4 Days for REM to Re-adjust to ~50%

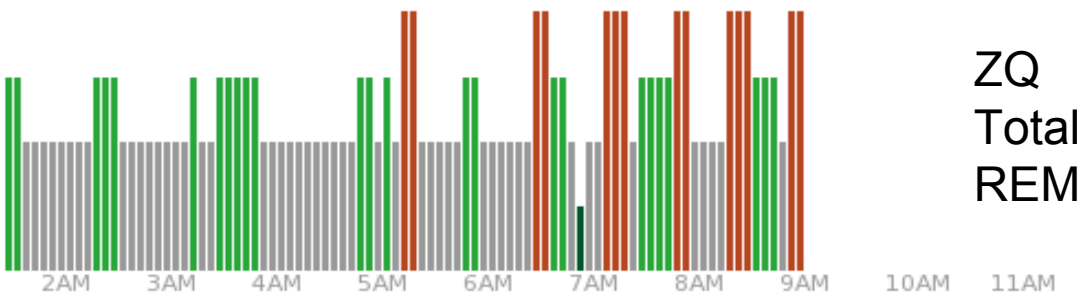
All Graphs Are Aligned to La Jolla Pacific Time Zone

8/2/11
La Jolla



ZQ	89
Total Z	7:35
REM	50%

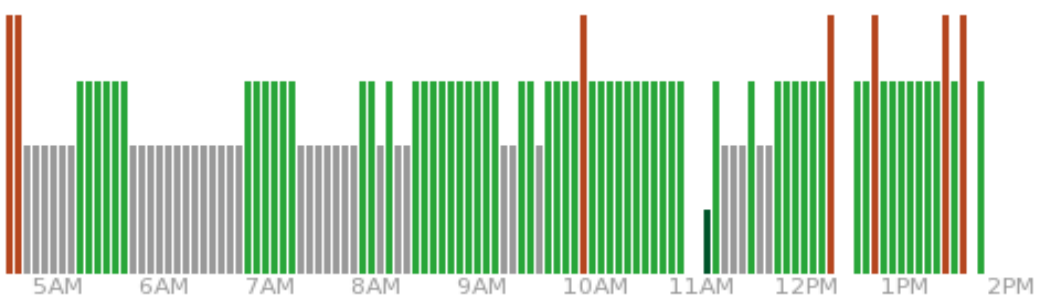
8/6/11
Qantas LAX-Brisbane



ZQ	71
Total Z	7:16
REM	29%

8/9/11
Perth

ZQ	91
Total Z	8:12
REM	61%



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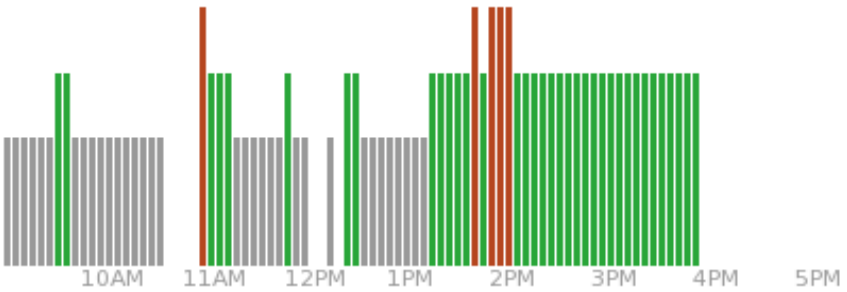
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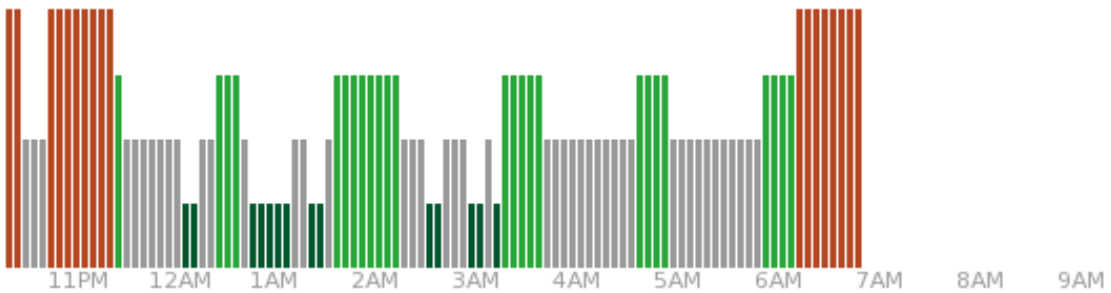
Return Trip Perth to La Jolla
Takes 4 Days for REM to Re-establish ~50%

All Graphs Are Aligned to La Jolla Pacific Time Zone

8/13/11
Perth

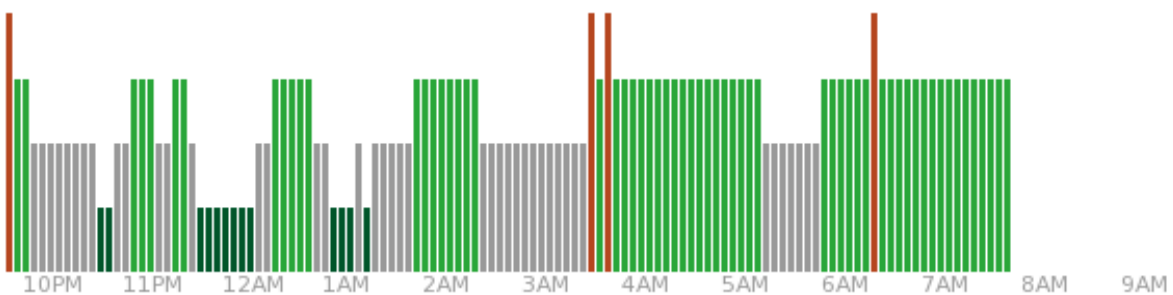
ZQ	63
Total Z	5:54
REM	47%





8/16/11
La Jolla

ZQ	83
Total Z	7:09
REM	28%



8/19/11
La Jolla

ZQ	117
Total Z	9:52
REM	51%

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Zeo Does Work With Researchers and Educators

We recognize the incredible importance of researchers and educators, and also the challenges that they face in continuing their work.

In order to do our part, we often support and provide special pricing for vital research and education efforts.

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www.myzeo.com/sleep/additional-research

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Zeo Supports Open Platform Developers: Android Mobile API

1 Open Zeo - Android Mobile API

author:	Zeo Inc.
date:	2011-11-28

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- 1 Open Zeo - Android Mobile API
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  - 1.10 AlarmSnoozeEvent
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[1]	http://developer.android.com/guide/developing/projects/projects-eclipse.html#ReferencingLibraryProject
[2]	http://developer.android.com/guide/developing/projects/projects-cmdline.html#ReferencingLibraryProject

https://github.com/zeoeng/zeo-android-api

Zeo Has a Developer API

Zeo Developer Interfaces Welcome

Welcome to the Zeo Developers site. We have a number of projects available that allow developers to build their own applications using the Zeo platform. Example projects include:

- Integrate Zeo sleep data into a website that tracks your weight, nutrition, and exercise.
- Create a desktop application to view and process Zeo sleep data.
- Build a lucid dreaming system to notify you when you are in REM sleep and alert you using a sound.
- Use Zeo while you are awake to measure meditation.
- Build custom Android apps that interface with Zeo sleep data.

More information can be found on each developer interface here:

- Zeo Web API - A set of web services that allow third parties to develop applications that allow users full access to their individual sleep records.
- Zeo Data Decoder Library - A version of software and a library that enables a user to decode Zeo sleep data stored on a memory card without uploading data to mySleep.myZeo.com.
- Zeo Raw Data Library - A version of software and a library that enables a user to decode Zeo sleep data and raw signal data in real time using the auxiliary serial port located on the back of Zeo.
- Zeo Android API - A collection of documentation, an API contract (in Java), and example apps demonstrating interfacing with Zeo data stored on an Android device.

http://developers.myzeo.com/