

# Wireless Sleep Devices for Insomnias, Parasomnias, and Other Sleep Disorders

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# Agenda

- Background, Insomnias and Parasomnias
- Needs for New Sleep Testing Devices
- Some New Wireless Products to Meet Those Needs
- A Few More Ideas for Sleep Research

# Background, Insomnias and Parasomnias

# Insomnia

- **Insomnia** is a sleeping disorder characterized by persistent difficulty **falling asleep or staying asleep** despite the opportunity.
- Approximately **64 million Americans** suffer from insomnia each year.
- Insomnia tends to increase with age and affects about **40 percent of women and 30 percent of men.**

U.S. Dept. of Health and Human Services, 2007

<http://india.smashits.com/wikipedia/Insomnia>

Roth, Thomas; Timothy Roehrs (2004-02-25). "Insomnia: Epidemiology, characteristics, and consequences". *Clinical Cornerstone* **5** (3): 5-15.

# What are Parasomnias?

- A parasomnia is a **partial arousal**, meaning that the person exhibits **symptoms of being both asleep and awake at the same time.**
- Most parasomnias include **physical or verbal behaviors** that are considered undesirable and sometimes even dangerous.

<http://www.clevelandclinic.org/health/health-info/docs/3700/3728.asp?index=12133>

<http://www.webmd.com/content/article/105/107673.htm>

# What Causes Parasomnias and When Do they Occur?

- Parasomnias can be caused by
  - Biological factors,
  - Stress, and
  - Depression.
- The **causes of some types of parasomnias are not well know.**
- Parasomnias tend to be **more common in children** than adults, and in some cases, **parasomnias run in families.**
- A parasomnia activates one or more physiological systems during the sleeping and waking cycle at an inappropriate time.
- Parasomnias can occur during REM (rapid-eye movement) sleep or NREM (non rapid eye-movement) stages of sleep.

<http://www.sleep-deprivation.com/articles/types-of-sleep-disorder/disrupted-sleep/parasomnias.php>

# Prevalence of Insomnias and Parasomnias

Epidemiologic studies have found that:

- 4% of adults engage in Sleepwalking,
- 3% in Nocturnal Eating,
- 2% with Night Terrors,
- 1% with acting-out dreams (including REM Sleep Behavior Disorder, RBD),
- 3-4% with serious Restless Legs Syndrome

<http://www.parasomnias-rbd.com/newsletter/index.php?date=20071128>

# Types of Parasomnias

- **Confusional Arousals**
- **Sleep Bruxism**
- **Sleep Paralysis**
- **Sleep Talking**
- **Sleep Terrors**
- **Nocturnal Paroxysmal Dystonia (NPD)**
- **Night Seizures**

## **Parasomnias where a wireless device can help**

- **Sleepwalking**
- **Nocturnal Leg Cramps- get out of bed to stretch leg**
- **REM Sleep Behavior Disorder-act out violent dreams**
- **Nightmares-hard to go back to sleep**
- **Sleep Enuresis- get up**

# Needs for New Sleep Testing Devices

# Insomnias and Parasomnias

**Both Insomnias and Parasomnias frequently are characterized by patients being out of bed.**

**Therefore, a wireless device allows continuous monitoring without an attendant.**

# What Sleep Researchers May Want

- Need for sleep diagnostic systems that are:
  - **Simple** to use
  - Wireless for most **flexibility** for patient and technician to evaluate insomnias and parasomnias
  - Useable in traditional sleep labs, hospitals, long-term care facilities, **at home, or other locations**
- Desired Characteristics
  - Usable in the US, Western Hemisphere, or around the world.
  - FDA cleared to market
  - Meet all requirements of a full sleep diagnostic device
  - Provide maximum reimbursement

# Some New Wireless Products to Meet Sleep Research Needs

# CleveMed-More than a Decade of Wireless EEG

1994



1996



1997



1999



Auditory Evoked Response Epilepsy

Sleep

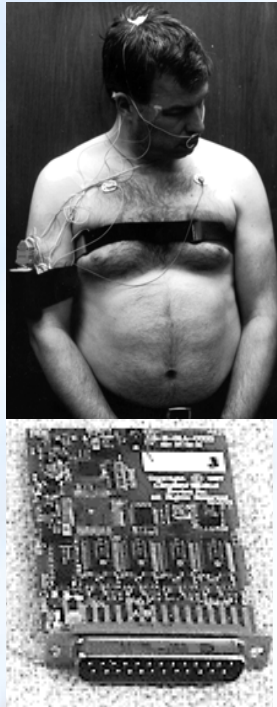
Non-Convulsive Seizures

**CleveMed**

Cleveland Medical Devices Inc.

# CleveMed-A Decade of Wireless Sleep Experience

1997



2002



2004



Research Sleep Device Crystal Monitor 16

Crystal Monitor 16-S

# Crystal Monitor<sup>®</sup> Model 20-S Wireless Sleep Diagnostic Monitor



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# Crystal Monitor Model 20-S Wireless Sleep Monitoring System

- Lightweight, wireless physiological monitor
- Viewing and recording
  - 2-EEG, Central and Occipital
  - ECG,
  - 2-EMG, Chin and Leg
  - 2-EOG, Left and Right Eye
  - Airflow, pressure
  - 2-Respiratory Effort, Thoracic and Abdominal
  - Body Position
  - Pulse Oximetry, pulse rate and SpO2
  - Snore (derived)
  - Auxiliary DC input
- 2- way, 900 MHz. radio with robust radio link (ack-nak) and retransmission of packets



# Crystal Monitor Model 20-S Specifications

- Dimensions: 135 mm x 63 mm x 25 mm (5.3" x 2.5" x 1")
- Weight: 210 grams (7.3 oz.) with batteries
- Radio Range: ~ 33 meters (~100 feet)
- Filter Input bandwidth 0.5 Hz - 250 Hz. 960 sps (-3dB attenuation); CMRR 100 dB
- Noise: < 1  $\mu$ V RMS (0.5 Hz – 100 Hz)
- Input Impedance > 20 M $\Omega$  @ 10 Hz
- Input Interface Standard no-touch 1.5 mm connectors
- **SD Memory Card that can record a week of data**
- Power Supply 2 AA batteries, Battery Life >12 hours continuous use with commercial batteries



# Crystal Monitor<sup>®</sup> Model 20-B

- The Crystal 20-B has all the same sensors as the Crystal 20-S.
- The Crystal 20-B uses a 2,400-2,483 MHz. ISM band radio. It has the advantage of being usable in any country around the world.



# SleepScout Specifications

- 9-channel device monitors: ECG, leg EMG, pulse oximetry, airflow, snore, thoracic and abdominal effort, body position and an auxiliary DC input.
- Its memory card stores the data from sleep studies, allowing the device to be sent home with the patient without the need of a PC.
- Because data is stored on a removable SD memory card, long-term ambulatory studies can be performed over several days/weeks without requiring the patient to return to the sleep lab until the end of the study.
  - A 1 GB memory card stores 60 hours of data.
- An optional radio provides real-time data.
- The sleep scout weighs less than 190 grams
- 2AA batteries power the device for over 12 hours.



# Sapphire Specifications

- 22-channel device monitors:
  - 6-EEG channels
  - 2 EOG,
  - 4 EMG,
  - ECG,
  - auxiliary DC input.
  - pulse oximetry
  - airflow and snore
  - thermistor
  - thoracic and abdominal effort
  - body position
- Available with either 900MHz or 2400 MHz radio.
- SD memory card stores the data from sleep studies, allowing the device to be sent home with the patient without the need of a PC.
- The Sapphire weighs 538 grams
- 4-AA batteries power the device for 12 hours.



# iPSG

- iPSG provides a remotely attended study.
- iPSG Includes:
  - 15" touch screen computer
  - Microsoft Windows® XP Pro
  - Intel Pentium M Processor LV
  - 1 GB memory
  - 80 GB hard drive
  - IV pole
  - Video camera, infrared
  - Medical-grade power supply
- Works with the Crystal Monitor, Sapphire, or Sleep Scout
- Provides live data and video through a **wired or wireless LAN** and then the **Internet**.
- HIPAA and HL7 compliant.

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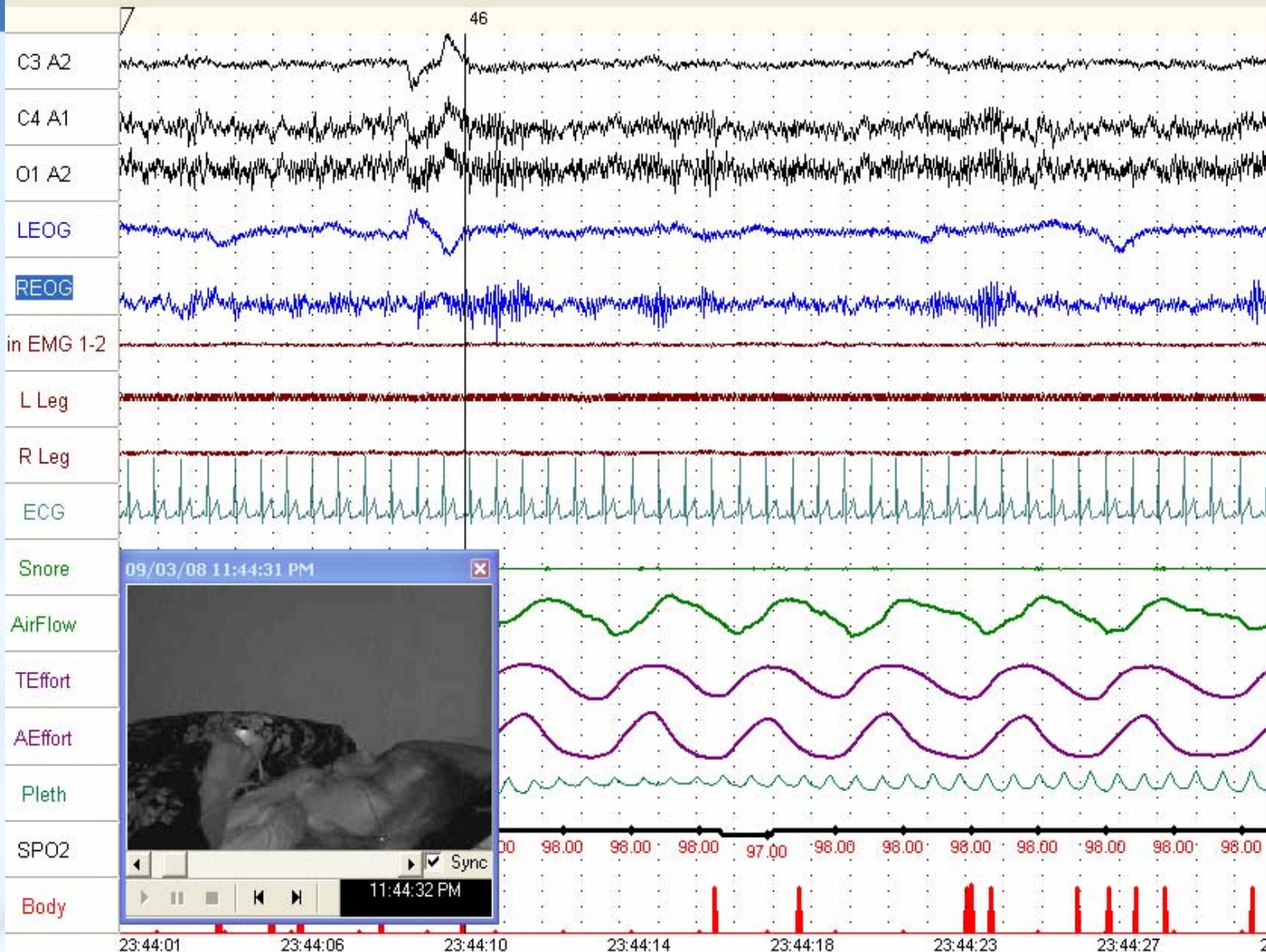


# PSG@Home

- [PSG@Home](#) provides a remotely attended study.
- Works particularly well for pediatrics and home bound patients
- Works with the Crystal Monitor, Sapphire, or SleepScout
- Provides live data and video through the **cellular phone** network **and Internet**.
- Won the “Stevie” award for Best Product Designer in 2008 (American Business Awards- 'Business Oscar')
- **Video pan, tilt, and zoom.**



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- C.Apnea
- M.Apnea
- O.Apnea
- C.Hypopnea
- M.Hypopnea
- O.Hypopnea
- Arousal
- PLM
- DSAT
- LightsOn
- LightsOut

Add Remove

- eyes open
- eyes closed
- look left
- look right
- look up
- look down
- clench teeth
- hold breath
- cough
- flex left leg
- flex right leg
- ARRHYTHMIA
- HEART RATE ACCELER

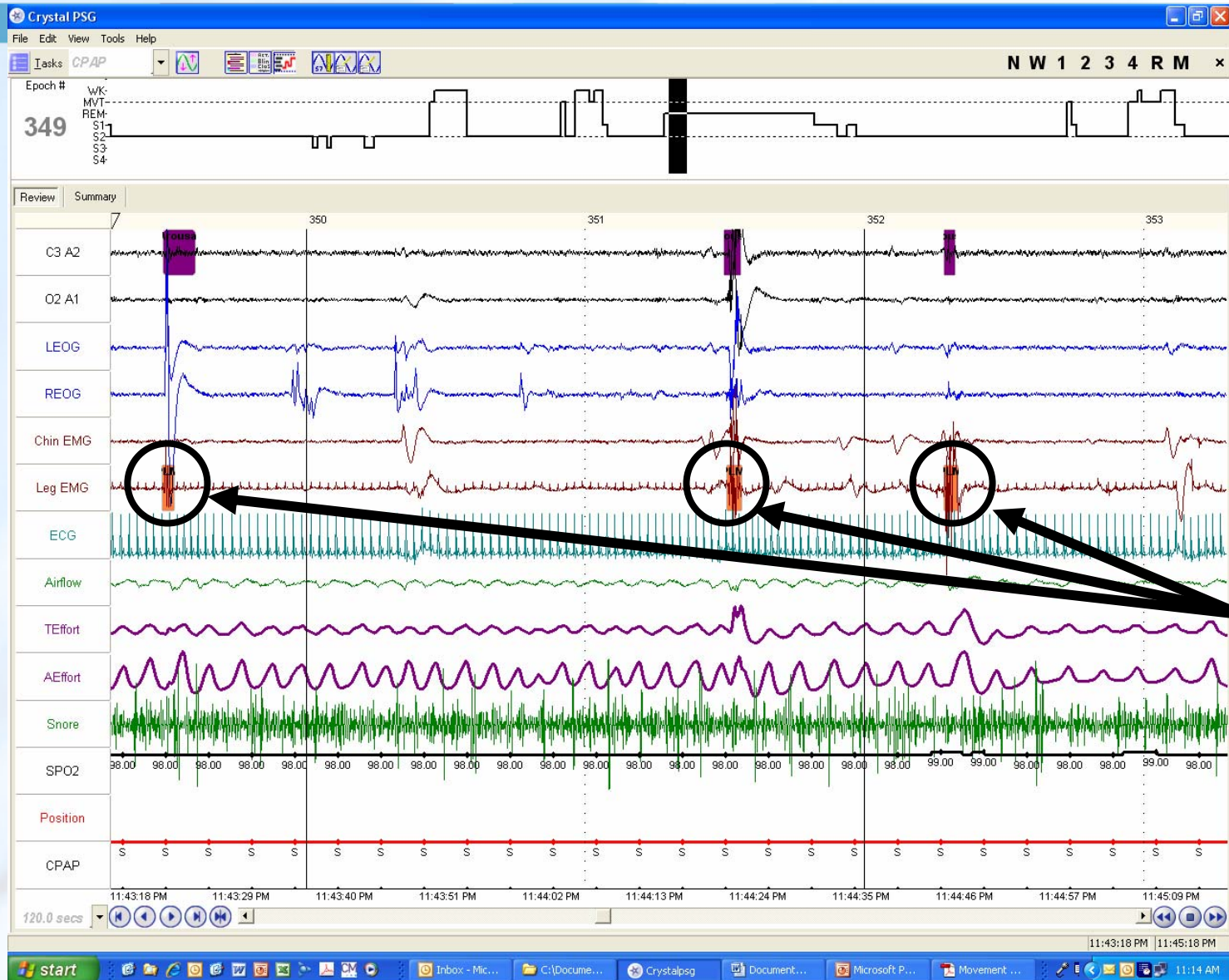
# Periodic Limb Movement



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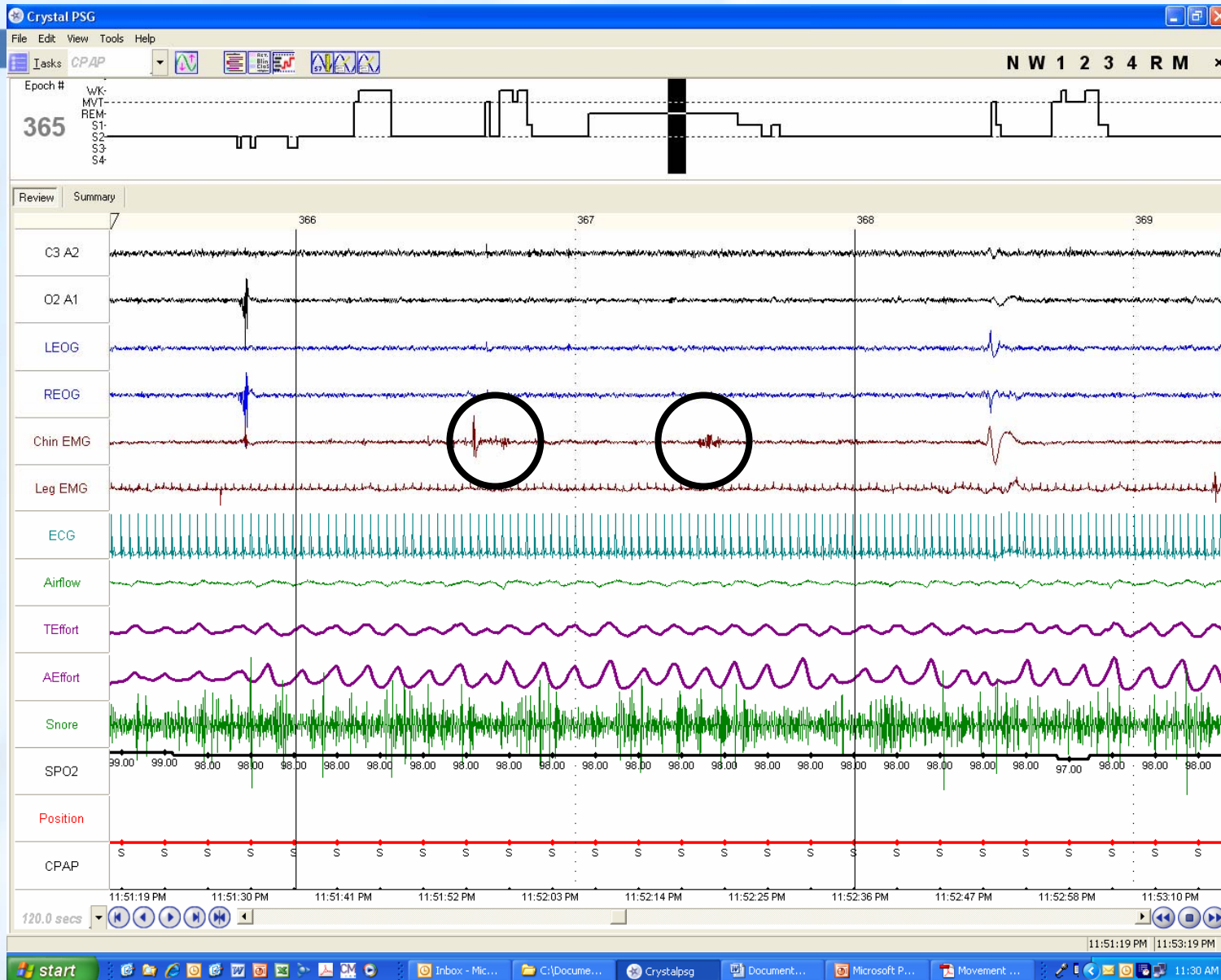


# Restless Legs Syndrome (RLS)



PLM Series  
3 PLMs in  
90 sec.

# Bruxism



# A Few More Ideas for Sleep Research

# Applications for Sleep Studies

- Aging and Sleep
- Drug Studies
  - New Drugs
  - Efficacy of Drugs
- Sleep abnormalities (insomnia and parasomnia effects)
- REM Sleep and Learning
- New Sleep Therapies
- Circadian Rhythm Studies
- Neurotransmitter studies, larger animals

# Why Home Studies

- Doesn't require "all night technician"
- Lower Cost
- Easier to get Patients
- Longitudinal Studies
  - Multiple nights
  - Over time
- Minimizing First Night Effects
- EEG available at home (and in real-time)
- Video is now feasible for home studies

# Conclusion

- Four sleep diagnostic systems (20-S, 20-B, SleepScout, and Sapphire ) are available to provide wireless and remote polysomnography diagnostic studies or screenings in sleep labs, hospitals, homes, or any location around the world.
- iPSG and [PSG@Home](#) provide remote monitoring and video.
- Computer assisted scoring and reporting makes the post-study paperwork easy for sleep professionals.

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