BrainRT for Routine EEG, LTM and Epilepsy monitoring

Table of Contents

Video-EEG for multiple purposes

Digital EEG is more than 20 years old and evolved from a rather fixed protocol of half an hour EEG registration into long term monitoring of patients.

The BrainRT software is suitable for different EEG applications. You can choose between **different recording devices** (all controlled with one single software) to meet the purpose of the EEG acquisition in an optimal way. The same goes for the type of camera: depending on the application, you might prefer a camera mounted in the ceiling to a camera mounted on a mobile cart. The BrainRT software lets you choose between a range of cameras to make sure that you have the best available set-up for recording the patient's actions.

To ensure a comfortable user experience, the BrainRT software is intuitive and easy to work with. One essential part of this philosophy is the use of measurement protocols, one for every type of measurement. This enables you to predefine the set-up for each type of acquisition and avoids the need to make manual adjustments each time you make a different type of acquisition.

Measuring protocols for different types of acquisition

In BrainRT, it is easy to define multiple measurement protocols. The correct protocol automatically activates the correct channels for acquisition. The measurement protocol not only defines the number of channels, but also the settings for signal display, the settings for analysis parameters and content of the report.

Some examples: in the IC monitoring protocol you can start the real time EEG analyses automatically to display a real time spectrogram. For the Baby EEG, you can activate a limited number of EEG channels and choose baby parameters for the ECG analysis.

You can even make a list of event buttons for each protocol, which makes it easy to enter events related to the measurement. For example, when performing a routine EEG, the list should contain events such as 'hyperventilation', 'make fist', 'eyes open', etc. For an EEG during surgery, the list will contain events like 'clamp', 'shunt' etc.

Some examples of protocols are:

- Routine EEG
- Baby EEG
- EEG after sleep deprivation
- Epilepsy monitoring

- 24 hour EEG
- EEG during surgery
- IC monitoring
- Neonatal monitoring

Routine EEG

The BrainRT software is perfectly applicable to routine EEG acquisitions with or without video. Thanks to a handy screen set-up with a selection of buttons to add notes and events, it is easy to perform all the necessary tasks related to a routine EEG.

Adding notes and events can be done in a very accurate way, because it is possible to adjust the initial position of the event by dragging it to the desired position. Switching between derivations during the acquisition is easy when using the predefined shortcut keys. Different sequences for flashing can be programmed into the BrainRT configuration for easy runs of flashing.

For excellent video quality, the BrainRT software offers several HD cameras which can be mounted in the ceiling or on a mobile cart.

Example of a routine EEG with HD video

Features for easy review

During the acquisition, you can already start to make a report which includes screenshots and notes related to the measurement.

Different tools are available to measure peak amplitude, frequency of waves and occurrence of asymmetry between left and right side. Very practical is the spectrogram, which you can create by dragging the cursor over rhythmic activity of interest. The spectrogram will automatically include the chosen electrode position AND the symmetrical electrode position on the other hemisphere (for example when you select T3-P3, T4-P4 is also included in the spectrogram).

EEG monitoring during surgery

The BrainRT equipment can be used for **EEG monitoring during surgery**. The EEG hardware is qualified for use in the operation room, suffering minimally from surrounding equipment. Thanks to real time automatic analysis of the EEG signals it becomes easy to spot asymmetries of the brain activity, which is a common problem during Carotid endarterectomy. By adding the **Brain Symmetry Index** to the trend overview, you get a valuable decision support tool for surgery related issues such as the necessity to place a shunt.
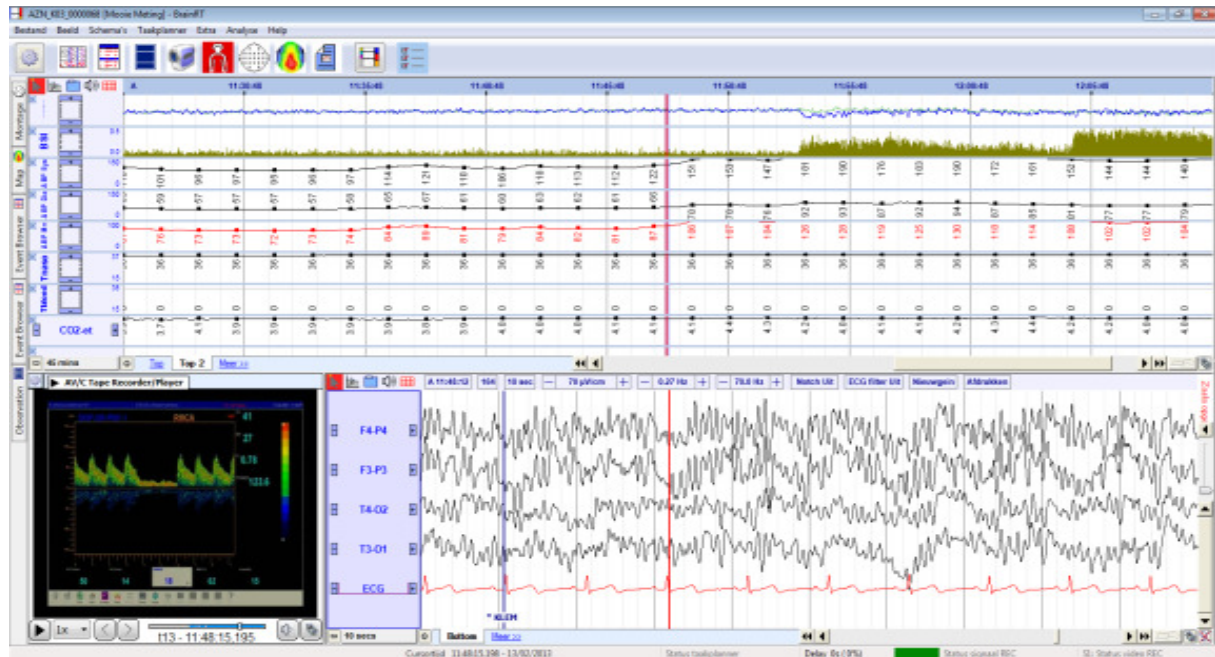
Example of EEG monitoring during carotid endarterectomy, with real time calculation of the Brain Symmetry Index and acquisition of EEG and other vital signals. Data from the Transcranial Doppler are included as well, by linking the analog output of the TCD device to the video input of the BrainRT acquisition station

INCLUDE PATIENT MONITOR DATA AND TCD DATA TO THE EEG RECORDING

In addition to the real time EEG analyses, BrainRT can include synchronized signals coming from the patient monitor (consult the chapter 'Philips IntelliVue interface' for more information). Also video images coming from the Transcranial Doppler device can be synchronized with the EEG acquisition.

INTERFACE WITH AIMS FOR NOTES, ALARMS AND EVENTS

BrainRT has an interface with the Anesthesia Information Management System (AIMS). Notes, alarms and events, entered by the surgeon in the AIMS, are inserted automatically in the BrainRT EEG registration. When reviewing the measurement afterwards, this feature enables you to evaluate better the effect of medication and other actions performed during the surgery.

Neonatal monitoring

Many neonates require specialized care during their first months of life. During this time, they are often connected to monitors to follow **vital signals** such as oxygen saturation, blood pressure, body temperature and respiration.

As many patients are monitored for days, weeks or even months, it is important to get a good interpretation of all this data. With the BrainRT software, it is possible to **record signals from the patient monitor (Philips IntelliVue)** and use the real time automatic analyses and review options of the BrainRT software for further interpretation.

For neonatal patients who require **brain monitoring**, the BrainRT equipment can be used as a CFM monitor. The raw EEG signals are recorded and can be reviewed in **synchrony** with the patient monitor data. Video recording can be added as well for optimal review options of the patient status.

Neonatal Intensive Care Monitoring with Real Time analysis of Cerebral Function Monitor (CFM) and cardiorespiratory activity

Real Time Brain**RT** analyses for neonatology

- **SpO$_2$ & CO$_2$**
  - Desaturations
  - Hypoxical state
  - End Tidal CO$_2$ levels
- **ECG**
  - Tachycardia, bradycardia
  - Heart rate
  - Ictal tachycardia
- **Blood pressure**
  - Baroreflex sensitivity
  - PTT

- **Respiration**
  - Apnea, hypopnea
  - Respiration rate and phase difference
- **EEG analyses**
  - CFM
  - Burst-Suppression
  - Entropy
  - Spectrogram
  - Sleep rhythms (spindles, alpha, delta, theta, beta)

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CFM analysis

The Cerebral Function Monitor (CFM) is often used as a visual interpretation of the EEG signals. The CFM trend is easy to interpret by non-neurologists and is particularly useful to detect seizures in neonatal patients. The BrainRT software calculates the Real Time CFM trend for one or more EEG derivations. This trend has been validated to give the same output as commercial CFM monitors.
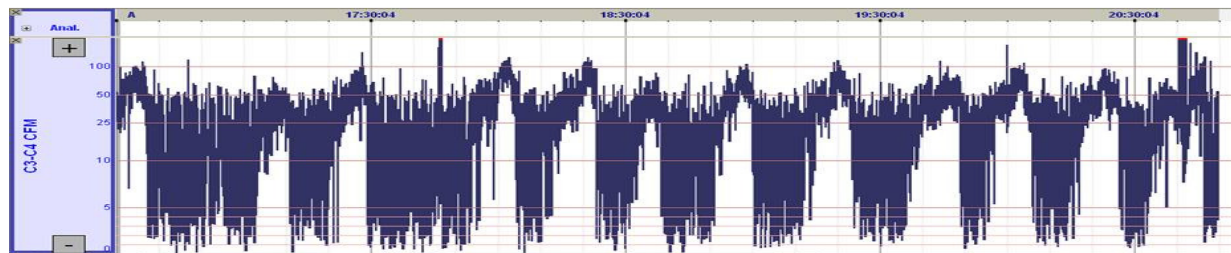
Example of automatic CFM trend in BrainRT

Burst suppression analysis

The burst suppression pattern of neonatal monitoring patients is an important indicator for brain development. In the BrainRT software, the real-time burst suppression analysis provides the burst count, inter burst interval, suppression duration and other parameters to analyze the burst suppression pattern.
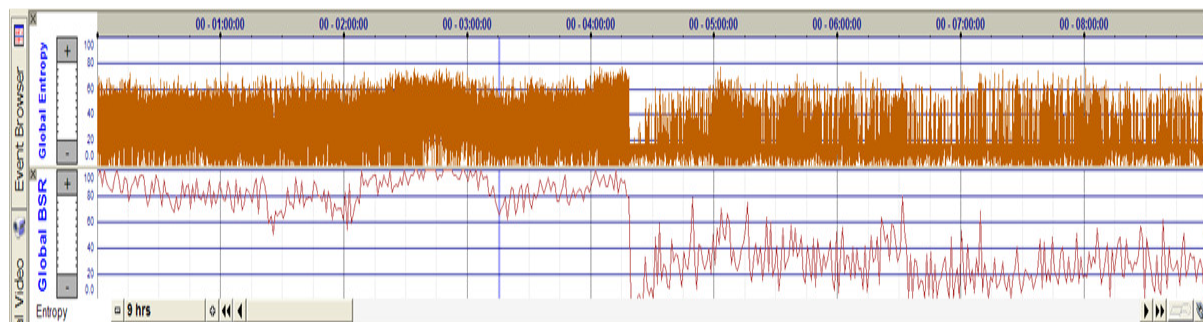
Example of Burst suppression analysis in BrainRT, with trends showing the global entropy and the global Burst Suppression Ratio

Sleep staging for neonates

Especially for sleep scoring in neonatal acquisitions, BrainRT includes the sleep stages 'Active Sleep' and 'Quiet Sleep'. In addition, the sleep stage N can be scored. When there is not yet a differentiation visible between NREM sleep stages, the sleep stage N can be used.

When you make a summary report of the acquisition, the report will automatically include information about the sleep stage distribution, of the respiratory events in each sleep stage etc.

Cardiorespiratory analysis and report

For preterm infants, **cardiorespiratory parameters** are a very important indicator of patient state. The occurrence of many cardiorespiratory events is an indicator that the neonatal patient requires further monitoring, possibly with a home monitoring device.

BrainRT automatically detects respiratory disturbances such as apneas and hypopneas. Related events such as oxygen desaturation and high CO2 values are also detected automatically in the BrainRT software. Manual corrections by the reviewer are possible.

To facilitate an easy interpretation of cardiorespiratory measurements in BrainRT, the results from the automatic cardiorespiratory analyses can be summarized into an **automatic overview table** of all cardiorespiratory related events. The following information is included (non-exhaustive):

- o Association between bradycardia, respiratory events and desaturations
- o Count and duration of bradycardia and related events

Cardiorespiratory events overview: Bradycardia and decelerations					
Bradycardia and decelerations	**< 5 sec**	**Total count**	**5-10 s**	**10-15 s**	**> 15 sec**
< 80 bpm (TST)	25	15	9	5	1
With respiratory event:	19	12	7	4	1
With oxygen desaturation:	19	10	5	3	1
< 60 bpm (TST)	15	5	5	0	0
With respiratory event:	10	5	5	0	0
With oxygen desaturation:	9	5	5	0	0

Autonomic Function Analysis

For neonatal patients with regulatory problems regarding blood pressure and cardiac rate, BrainRT provides a real time analysis of blood pressure signals and cardiac rhythm. The automatic analysis also detects episodes where the **baroreflex sensitivity** can be determined. Typically these episodes consist of a rising or falling blood pressure during at least three heartbeats. This results in multiple calculations of the baroreflex sensitivity, providing useful information about the autonomous nervous system of the patient. An example of such a trend and summary figure in the report is shown below.
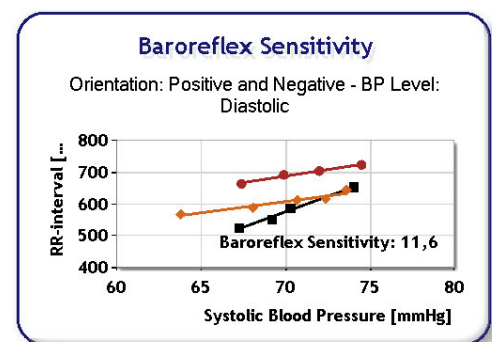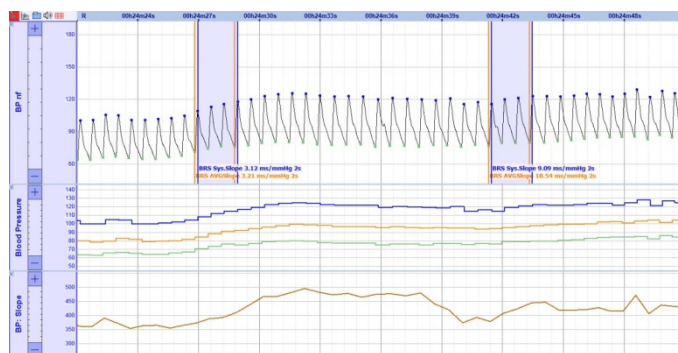
BrainRT example with blood pressure signal from a non invasive Nexfin cuff meter, with two episodes where the baroreflex sensitivity can be determined.

Noninvasive continuous blood pressure can be measured with devices such as the Nexfin or Finapress. The analogous signals of these devices can be recorded synchronously with the EEG signals by using one of the BrainRT amplifiers.

Epilepsy monitoring

For epilepsy monitoring from 32 to 256 EEG channels, BrainRT software uses the Brainbox 1166 amplifier.

Patient comfort is a key feature of the system: ultra light and small amplifiers maximize the mobility of the patient, even for a 256 EEG channels acquisition system.

With recorder and cameras communicating over the network, the BrainRT software provides a modern solution for epilepsy monitoring which is easy to set up and maintain.

The central BrainRT database provides an efficient platform for **real time monitoring**, giving unlimited access to the ongoing measurements from any review station in the network. Live monitoring of signals and video is a powerful tool in BrainRT. Each person monitoring the registrations can independently choose from the predefined screen set-ups. It is even possible to modify the monitoring set-up during the registration.

For effortless **software controlled stimulation**, the BrainRT equipment includes a switchbox to select the electrodes for stimulation.

Brainbox description

Produced by Braintronics, the Brainbox recorder is a compact EEG amplifier for High Density EEG recordings. Through daisy chaining of separate units, the amplifier offers up to 256 channels, including an optional SpO$_2$ channel and event button.
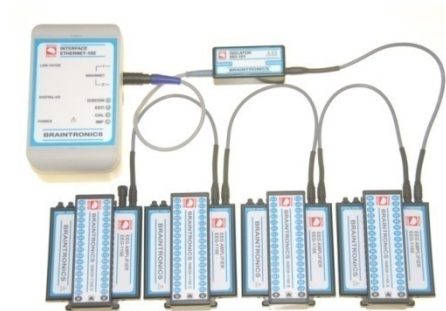

64 channel Brainbox Recorder

Brainbox design

- Small size (9.5 cm x 9 cm x 3 cm)
- Light Weight (150 grams for 64 channels)

Technical description

- 64 EEG channels per Brainbox unit
- Configurable sampling rate (256 Hz up to 4096 Hz)
- Optional channels: SpO$_2$, Event Button, DC channels
- Amplifier resolution: 16 bit
- Communication over IP: Ethernet connection to acquisition post
- Get a multiple room setup using multiple access points

256 channels Brainbox recorder with IP box and isolation box

Specialized BrainRT features for epilepsy monitoring

Intracranial measurements require patient specific measurement protocols. BrainRT provides **configuration features** to map needles and grids on the amplifier channels. When using special needles, BrainRT software provides the possibility to include 'customized needles/grids' in the acquisition protocol.

Display montages for the recorded channels can be added before, during or after the acquisition.

During stimulation, the electrodes can be chosen by using the BrainRT software interface connected to the **Digital Switch Matrix** manufactured by Braintronics.
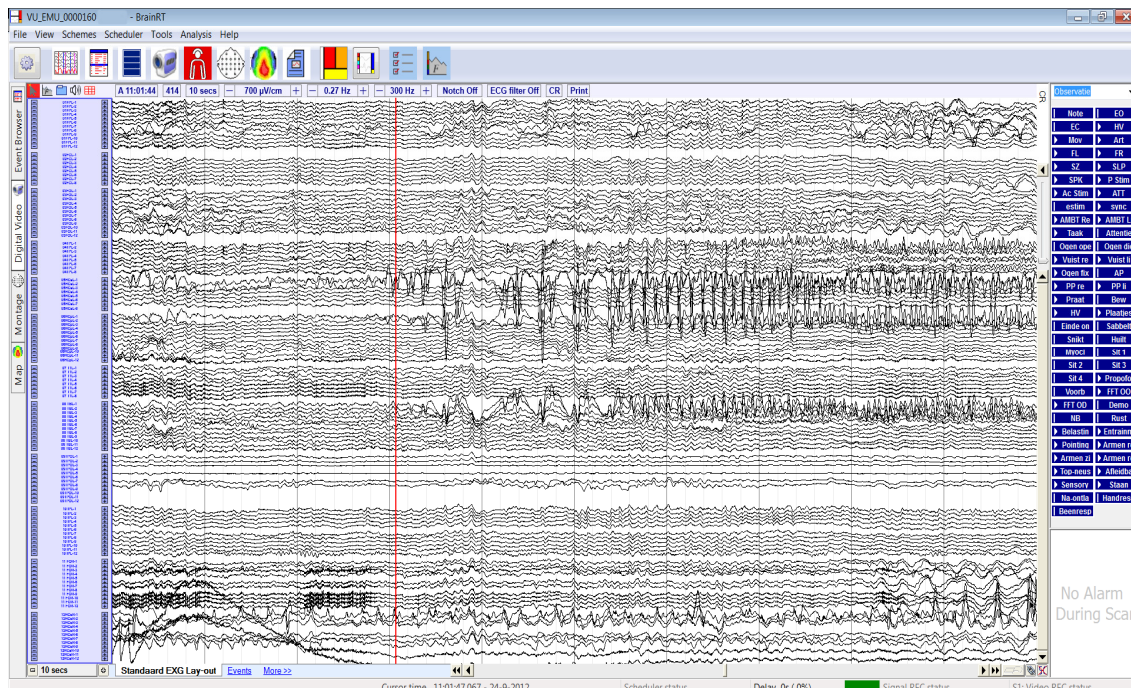
Example of Epilepsy Monitoring with 128 channels

BrainRT Configuration features

- Multiple predefined models of needles and grids for mapping channels to the amplifier, with the option to define a custom needle/grid

- Option to label each needle/grid for easy recognition

- One-click methods for making montages with referential, bipolar, common reference, average or source derivation channels during the acquisition

Measurement viewing features

- Split screen view for simultaneous view of real time data and recorded data

- Signals divided over one, two or more monitors for detailed view of real time data and recorded data, with synchronized video recordings

- Possibility to choose the number of channels on display (for example, 32 channels instead of 128 channels)

- **Real Time Analyses** during the acquisition of EEG and ECG signals: **spectrogram**, dominant frequency, mean phase coherence, **HRV**, **sleep rhythms** and sleep stage


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Video observation room for epilepsy monitoring

For optimal video recording of the epilepsy patient, the BrainRT software has the powerful option to measure up to **four video streams at the same time**.

With **Full HD network cameras** and camera control integrated in the BrainRT software for effortless Pan-Tilt-Zoom, the BrainRT facilitates HD recordings of seizures without limiting the patient's freedom.

In addition, **multi-camera views** are available in BrainRT: one up to four cameras in one window.
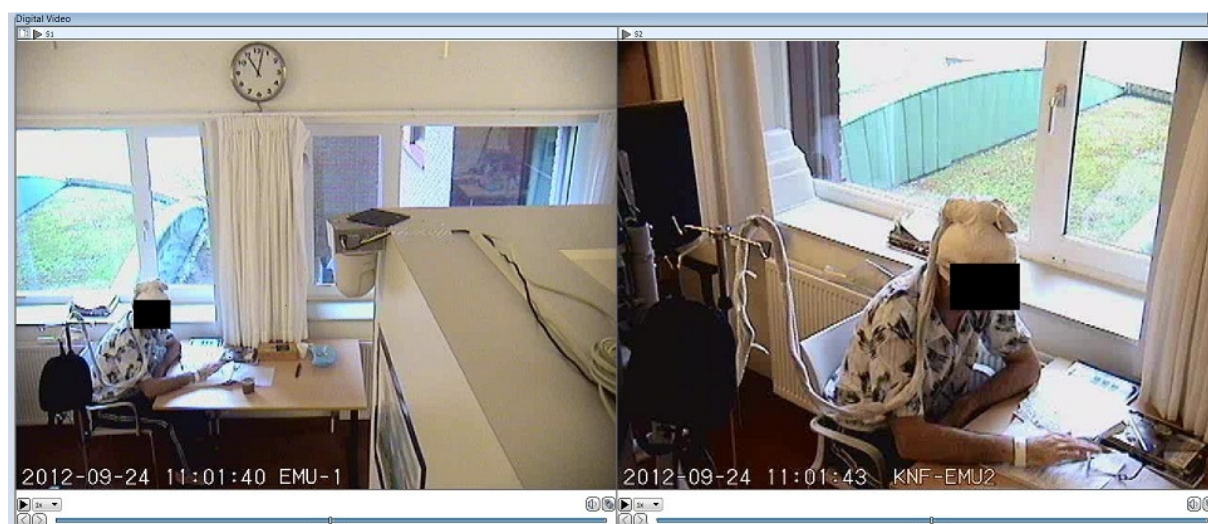
Long Term Epilepsy Monitoring Unit at VUmc with two cameras: one overview capture, one detailed patient capture

Camera features

- **HD (1280 x 720) and Full-HD (1920 x 1080) image resolution**

- **Max. frame rate:** 30 frames per second

- **Pan-Tilt-Zoom** functionality (camera control through BrainRT software)

- Possibility to **switch** between cameras during the acquisition. Storage continues automatically.

- **Automatic NightShot**

- **IP camera**: data transfer and camera control through Ethernet connection

- **H.264 protocol** for ultra-high compression:
    - 640 x 480 recordings: 450 MB/h
    - Full-HD recordings: 900 MB/h

Real Time video features

- During the acquisition, BrainRT sends signals and video to a central data share, allowing for **real time access to signals and video** from any BrainRT station

- In the ongoing recording, all completed video tracks are available for review in synchrony with the EEG signals

- Review and live images can be viewed at the same time with a dual video screen setup

- Multiple screen setups are available: large image with miniature images, two equal sized images etc.

IC monitoring

The BrainRT software includes many features for practical EEG monitoring on the **Intensive Care Unit**. An especially useful feature is the **real time analysis** of EEG signals, which produces overview trends for quick assessment of the patient's state. Some highly useful trends produced by the real time spectral analysis include the spectrogram (per hemisphere, per channel or a global spectrogram) and the Hilbert transform. This trend shows both the dominant frequency and the dominant amplitude in one single trend, to allow for a quick assessment of the EEG rhythm.

Thanks to the **live monitoring** feature, the physician can follow the complete recording from his office.

In addition, the interface to the "patient monitor" allows **including vital signals**, as for example cardiorespiratory parameters.
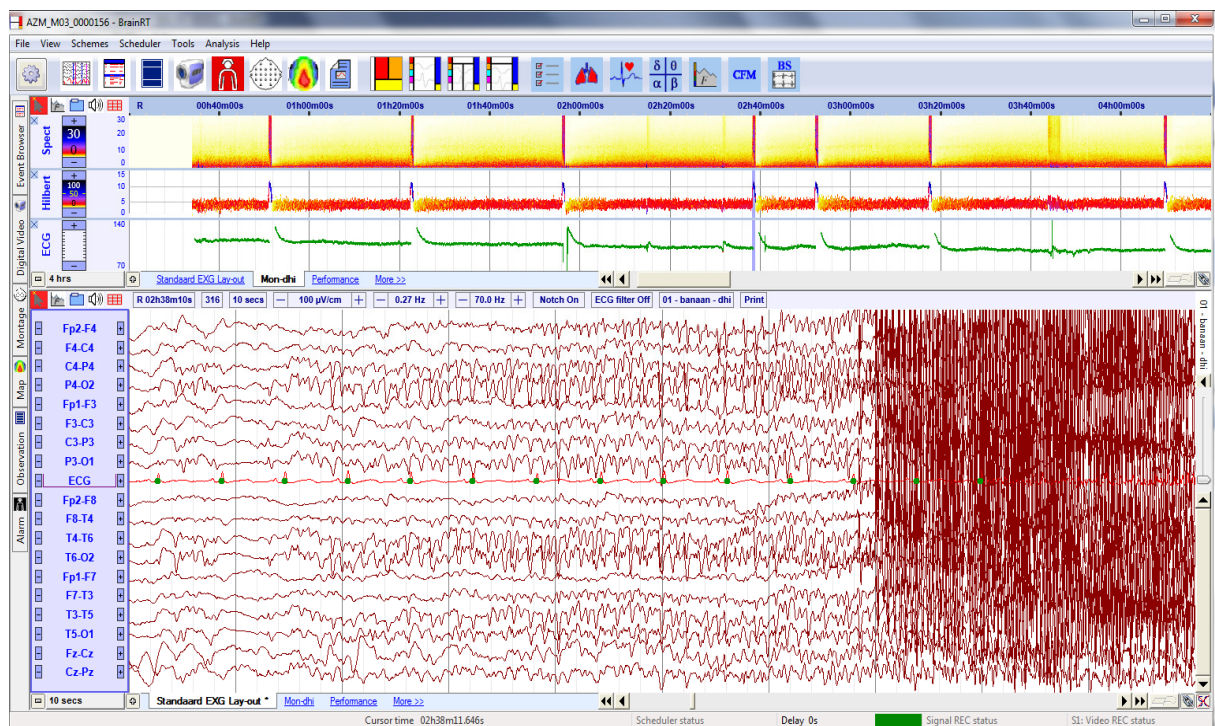
Example of Intensive Care Monitoring, with a very clear pattern of seizures visible on the spectrogram and Hilbert transform

ASSESSMENT OF THE SLEEP PATTERN OF THE CRITICAL CARE PATIENT

The sleep pattern of critical care patients plays an important role in the speed of recovery of an Intensive Care patient. The BrainRT software can be an important assistant in the assessment of the sleep quality of the patient: the software includes all the automatic analyses to create an automatic hypnogram, to detect respiratory events, PLMs, etc.

In order to get a quick overview of the patient's sleep, you can select the sleeping period of the patient and create a PSG report over this period.

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BrainRT

## AUTOMATIC RESPIRATORY ANALYSIS FOR THE CRITICAL CARE PATIENT

The BrainRT software includes automatic detection of apneas, hypopneas and desaturations. This can be particularly useful for patients who are suspected to require oxygen or other breathing aids.
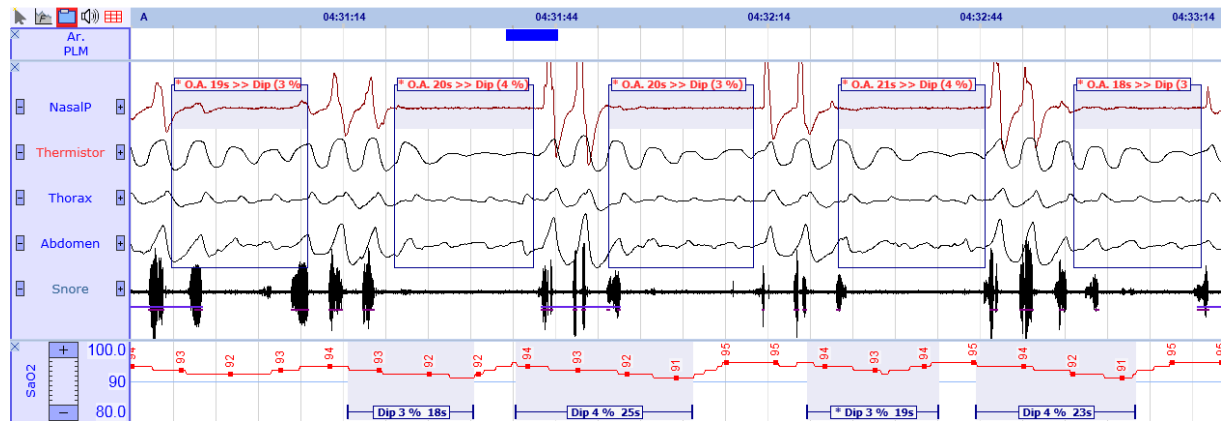
Respiratory analysis during IC monitoring

## AUTOMATIC SLEEP STAGING FOR THE CRITICAL CARE PATIENT

You can generate an automatic sleep hypnogram with the BrainRT software. The software combines information from the chin electrode, EEG and EOG channels to detect the correct sleep stages. Manual correction of the hypnogram is possible for optimal results.
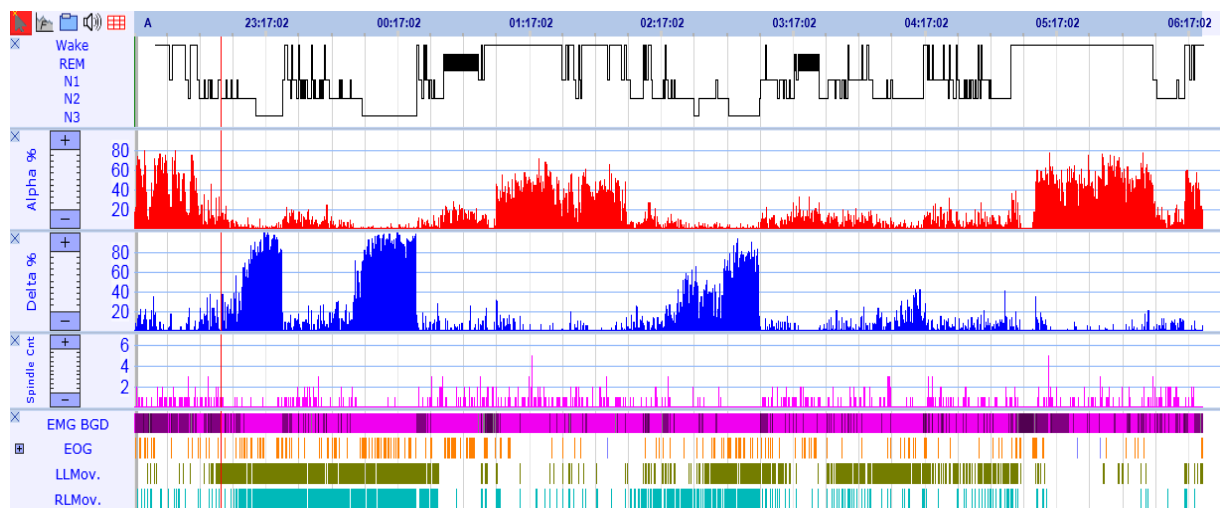
Automatic hypnogram in BrainRT

AUTOMATIC DETECTION OF PERIODIC LEG MOVEMENTS AND REM BEHAVIOR DISORDER

The BrainRT automatic EMG analysis can automatically detect PLMs and REM Sleep behavior disorder (both phasic and tonic activity are automatically detected - the automatic analysis was validated and approved at the Neurological Sleep Center of the University Hospital of Innsbruck). The figure on the right shows a very periodical movement of the leg(s), reoccurring in a very periodic way.
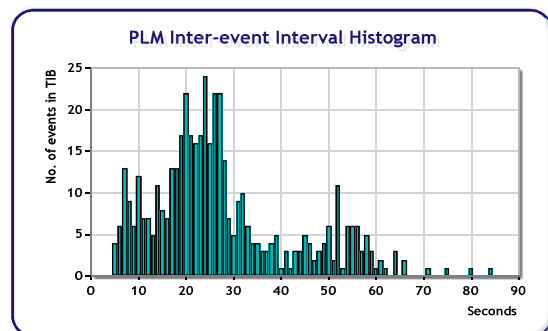
Real Time Monitoring

One of the key features of the BrainRT software is the possibility for **live monitoring**: all EEG acquisitions can be opened on any BrainRT review station for a live connection to the running signals and video images.

More than one BrainRT review station can monitor a running measurement at the same time.
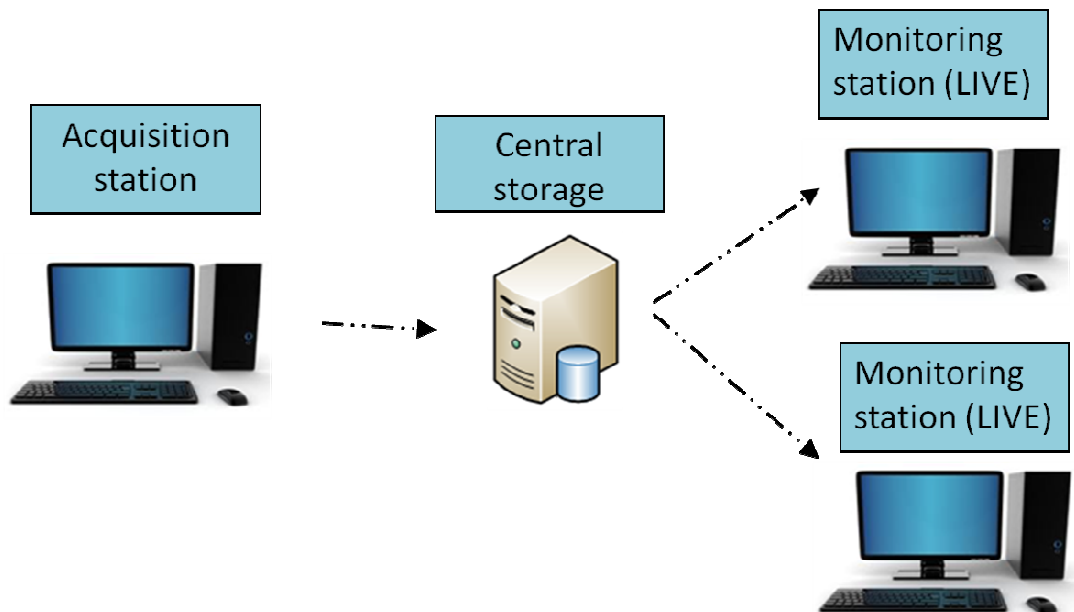
Principle of real time monitoring in the BrainRT software

ESSENTIAL FOR LONG TERM MONITORING

Live monitoring is essential when performing **long term monitoring**. It enables the physician to keep an eye on his patients from his office review station, without compromising the live surveillance of the local Intensive Care or other critical care unit where the EEG monitoring takes place.

NO NEED FOR EXTERNAL SOFTWARE TO PERFORM LIVE MONITORING

Live monitoring is **available to all users of the BrainRT software** and can even be used from a remote location (for example a physician's home). There is no need for external software packages to do this (such as VNC or remote desktop); the possibility for live monitoring is available within the BrainRT software. The only requirement is a network connection between the BrainRT acquisition station and the BrainRT review station.

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LIVE MONITORING EVEN DURING NETWORK CONNECTIVITY PROBLEMS

Thanks to the BrainRT unique monitoring software, temporary network connection dips are no problem for the live monitoring function. For network connection dips of up to 2 minutes, all data are buffered on the acquisition station for subsequent transferral after restore of the network connection. When the connectivity problem takes more than 2 minutes, the storage continues on the local hard drive and the two signal parts are merged after the acquisition.

## USE THE MONITORING STATION AS A CONTROL UNIT

Apart from live viewing and reviewing of running measurements, the monitoring station can perform the following actions on the running measurement: add notes and events, control IP camera, perform photo-stimulation and impedance checks and even stop the recording (only possible if function enabled on the acquisition station)

REAL TIME ALARMS FOR VITAL SIGNALS

The BrainRT software includes alarms for vital signals and other related events. These alarms can be programmed to produce sound or a flashing of the acquisition screen. It is even possible to transfer these alarms to the beeper of the attending physician or technician.

For example, if the SpO2 value of the patient goes below 85 %, the BrainRT software can generate an alarm.

Based on the real time respiratory analysis, BrainRT can also generate an alarm when no breathing activity was found in the last 2 minutes. Each of the alarm generators can be configured by the user.
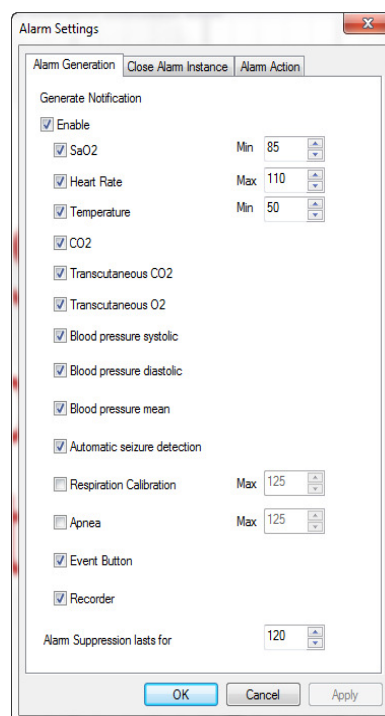
Alarms for different types of signals, also possible: alarm on event button

Real Time Analyses

During the acquisition with BrainRT software, it is possible to run automatic analyses in **real time**. That means that all data are analyzed at the exact moment that they are recorded, which gives the attending physician or technician an extremely useful **decision support tool** for patient care.

A list of automatic analyses for EEG signals is provided in the table below.

EEG ANALYSES & TRENDS	APPLICATIONS
Spectrogram	IC monitoring: seizure detection
Brain Symmetry Index	EEG during surgery: detection of asymmetry in brain activity
Sleep Rhythms (spindles, alpha, delta, theta, beta)	Automatic sleep staging during the EEG acquisition
Cerebral Function Monitor (CFM)	Neonatal monitoring: seizure detection
Burst-Suppression analysis	IC monitoring, Neonatal monitoring: detection of brain damage, brain development
Dominant frequency, spectral edge	IC monitoring, EEG during surgery: Detection of asymmetry in brain activity, brain damage

In addition to the EEG analyses, the BrainRT includes analysis of respiratory signals and other vital signals which are commonly included when monitoring a critical care patient. These analyses are available to use in every EEG acquisition made with the BrainRT software.

ANALYSIS OF VITAL SIGNALS	APPLICATION
Respiratory signals	IC monitoring, Neonatal monitoring, 24 hour EEG, EEG during surgery: detection of respiratory problems
Transcutaneous and expired O_2 & CO_2	IC monitoring, Neonatal monitoring, EEG during surgery: detection of respiratory problems
ECG signals	Routine EEG, 24 hour EEG, IC monitoring, Epilepsy monitoring, Neonatal monitoring: Cardiac rate and detection of ictal tachycardia events
Blood pressure	IC monitoring, Neonatal monitoring, EEG during surgery: analysis of correlation between EEG signals and changes in blood pressure
EMG signals	24 hour EEG, routine EEG, Tremor EEG: automatic detection of REM related sleep disorders (REM Sleep Behavior Disorder)

BrainRT

"PARAMETER SET" ADAPTABLE BY USER FOR OPTIMAL RESULTS

For optimal results, each analysis includes a "parameter set" which can be changed by the user. Changing the analysis parameters is even possible while the acquisition is running! Default parameter sets are available for adults, children and neonates.

EXAMPLE OF AN ECG ANALYSIS RESULT

Thanks to the automatic ECG analysis in BrainRT, tachycardiac events are detected. The tachycardia events are further evaluated, and if the tachycardia event complies with the conditions of an "Ictal Tachycardia event", the BrainRT software can generate an alarm. This allows for a quick intervention in case of a seizure.

SEIZURE CAUSING TACHYCARDIA EVENT
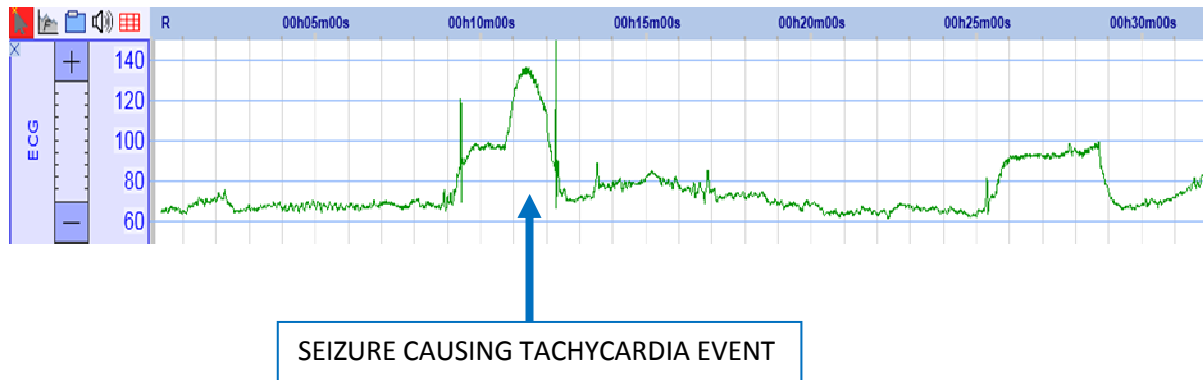
Example of an ECG trend for an EEG acquisition which includes a seizure

DISPLAY OPTIONS FOR TRENDS

The automatic analyses generate trends and events. For an optimal overview of all related trends, BrainRT software provides the possibility to make customized overviews. For example, the view below shows 12 hour trends of:

- SpO2 signals (red line)
- respiratory phase difference between abdominal band and thoracic band (red and purple line)
- respiratory rate (blue curve)
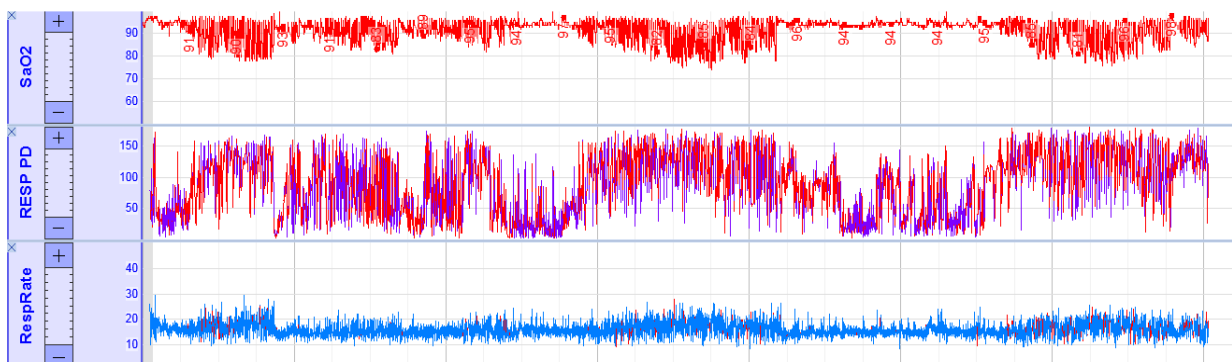
Trend overview for vital signals
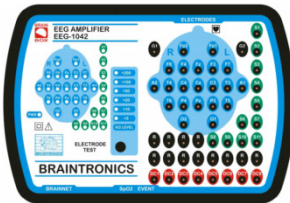
Amplifiers for online EEG

Schwarzer AHNS

Technical specifications

- Up to 44 channels (33 EEG channels)
- Maximum sampling rate: 2 kHz
- Schwarzer amplifier powered via USB cable
- Amplifier resolution: 20 bit
- Input impedance: 100 MΩ per channel
- Safety levels: IEC 601-1, IEC 601-1-1, IEC 601-1-2: "Safety of Medical Electrical Equipment"

Brainbox-1042

Technical specifications

- Up to 44 channels (32 EEG channels)
- Braintronics IP amplifier: Brainbox® connected to PC via **Ethernet cable**
- Maximum sampling rate: 1024 Hz for 32 EEG channels
- Amplifier resolution: 16 bit
- Input impedance: 10 MΩ ± 1 %

Brainbox-1166

Technical specifications

- Up to 256 channels (64 EEG channels per unit)
- Configurable sampling rate (256 Hz up to 4096 Hz)
- Optional channels: SpO_2, Event Button, DC channels
- Amplifier resolution: 16 bit
- Braintronics IP amplifier: Brainbox® connected to PC via **Ethernet cable**

Amplifiers for ambulatory EEG

Morpheus

Technical specifications

- Up to 34 channels (24 EEG channels)
- 1 Gb CF memory card
- 2 AA 1.5V batteries for power supply
- Max. recording time: 24 hours
- Internal Bluetooth® communication unit
- Size: 11 x 8 x 3 cm
- Weight: 250 grams (including batteries)

Vitaport 4 EEG

Technical specifications

- Up to 28 channels (25 EEG channels)
- Max. sampling rate: 512 Hz
- 4 Gb CF memory card
- Internal rechargeable battery
- Max. recording time: 24 hours
- Size: 12 x 5 x 3 cm
- Weight: 200 grams (including battery)

Other amplifiers:

Analysis of data from other amplifiers

The BrainRT software can be used for the analysis of other amplifiers:

- All Embla devices
- Philips Respironics Alice 6
- All Micromed devices

In addition, the BrainRT software can analyze data in the following formats:

- European data format (EDF and EDF+)
- **BrainlaB** format

Interface with Patient Monitor

Signals from the patient monitor can be recorded in real time with the BrainRT software interface. Suited for different applications, the BrainRT interface simplifies both clinical and research measuring methods.

Respiratory signals, SpO2, Transcutaneous CO2, intravenous blood pressure, Near Infrared Spectroscopy (NIRS) are some of the signals available from the Patient Monitor. An example of a patient monitor that provides signals to BrainRT is the Philips Intellivue.

ADD INTELLIVUE SIGNALS TO YOUR EEG RECORDINGS

When recording EEG signals with the BrainRT software, it is perfectly possible to add a synchronized recording of the patient monitor signals to your acquisition. This allows for a better insight into the relation between EEG activity, respiration, blood pressure, blood gases and other data from the monitor which was previously only available in a separate database.

SUPPORTED MODELS

BrainRT supports all models from the Philips IntelliVue **MP** and **MX** Series.

### COMMUNICATION INTERFACE

There are two methods of communication between BrainRT software and Philips IntelliVue: IP communication or serial link.

When using IP communication, there is no physical link between the monitor and the BrainRT acquisition station.

When using a serial link, the BrainRT acquisition station should be placed in proximity of the monitor for connecting both devices.
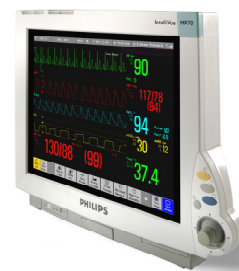
Philips IntelliVue monitor MP70

MEASUREMENT PROTOCOL

There are two options for acquisition with BrainRT: 'On the fly' signal selection when you start the measurement, or use of a preconfigured measurement protocol.

The 'On the fly' signal selection gives you an overview of all the available channels on the monitor. You make a selection of the signals you want to store and BrainRT automatically creates a measurement which includes these signals.

USE THE PHILIPS INTELLIVUE BUILT-IN COMPUTER AS BRAINRT STATION

Some models of the IntelliVue monitor include a complete computer which is connected to the back side of the monitor. This computer has been tested and approved to use as a BrainRT acquisition station. When using the built-in computer, you do not need a dedicated computer for the EEG + vital signals acquisition.

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Options for Video-EEG

Video acquisitions in synchrony with the EEG are particularly useful for distinguishing artefacts from real problems, and for an in-depth analysis of the patient's state.

High quality synchronized video acquisition is a key feature of the BrainRT software. Not only can you choose between different cameras for optimal ease of use, it is even possible to switch between cameras during the acquisition or to measure from two different cameras at the same time (for example an overview of the patient's room plus a detailed view of the patient's head).

Thanks to the efficient compression of the video files, the BrainRT software offers the right balance between high quality video files and compact video files. In addition, you can choose to keep only a few episodes of the entire video recording by clipping the video file.

SUPPORTED CAMERAS

- 30 frames per second
- Full HD resolution: 1920 x 1080
- Automatic NightShot
- Pan-Tilt-Zoom functionality (camera control through BrainRT software)
- Data transfer and camera control through Ethernet connection
- Suitable for mounting in ceiling

- 30 frames per second
- HD Resolution: 1280 x 720
- Automatic NightShot
- Lens type: fixed
- Data transfer and camera control through Ethernet connection
- Easy to mount on a mobile cart

- 30 frames per second
- HD resolution: 1280 x 720
- Built-in infrared (IR) illuminator
- Mini-dome camera
- Data transfer and camera control through Ethernet connection
- Suitable for mounting in ceiling

- 25 frames per second
- Resolution: 640 x 480
- USB connection
- Easy to mount on a mobile cart
- Exclusively recordings in colour

BrainRT for research

The BrainRT software is suited for research, both for acquisition of EEG data as for the analysis afterwards. By offering a wide range of export possibilities of the recorded data, BrainRT provides an ideal interface to external analysis programs.

RESEARCH WITH MICE

An application typically related to research is the acquisition of EEG recordings from mice. In order to guarantee easy sleep scoring and EEG analyses for these acquisitions, BrainRT includes the possibility to score sleep epochs of 4 seconds (required for scoring sleep stages for mice). In addition, you can export spectral analysis data to Excel for further analysis, in accordance with the sleep stages of the mouse.

BrainRT is often used for research, both with mice and with humans

Choice of durations of a sleep epoch for sleep scoring in BrainRT

EXPORT POSSIBILITIES IN BRAINRT

BrainRT offers the following export formats:

- Export to Matlab (signals and events): real time or offline
- Export to ASCII (available for raw data and RR intervals, possibility to select intervals of interest for export)
- Export to Excel for events and analysis results
- Export to XML for trends and analysis results
- Export to EDF and EDF+

ANALYSIS PARAMETERS IN BRAINRT

When using BrainRT for research, you can select your own analysis parameters. Each analysis has a default parameter set, and you can add a set of customized analysis settings for your particular research purpose.

A complete overview of the analyses and their parameters is provided in the BrainRT software manual.

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Integration in the hospital

The BrainRT software is designed with an effortless integration in the hospital in mind. To accomplish this, continuous development and upgrades of the software are made in order to keep compliant with the most recent **hospital infrastructure**.

Some of the most recent accomplishments of the BrainRT software:

- Database compatible with SQL Server 2008 and 2012
- Client installation compatible with Windows 7 and 8
- Report tool compatible with Office 2012
- Virtual software license for easy virtual installation on the license server

For the users of the BrainRT application, the **ShellPlus database** is an **efficient platform** where all users can access the measurements. Key features of the ShellPlus database are the central storage of the data (no local storage of data on the acquisition stations) and the central management of the software configuration.
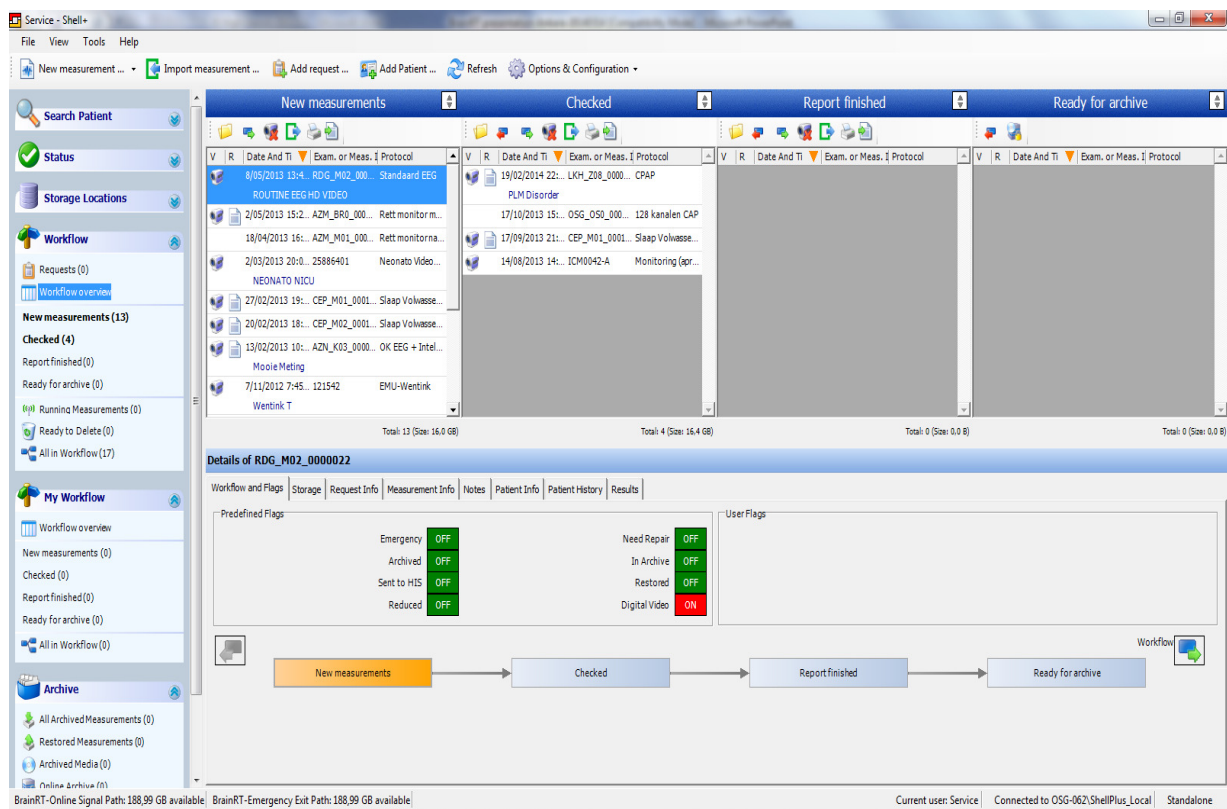
ShellPlus: Central database for management of all measurements and for centralized configuration of the program settings

The central configuration is automatically distributed to all stations in the network. The configuration can be changed on any acquisition or review station and is immediately distributed to all other stations (protected by a password).

Communication with the Hospital Information System

BrainRT guarantees correct patient information through communication with the Hospital Information System. The following functions are integrated in the BrainRT system:

• Automatic updates of the patient information
• Automatically generated list of appointments
• Automatic integration of the report to the patient's Electronic Medical Record

QUERY PATIENT INFO

This feature adds the possibility in the Shell+ client application to query for patient info based on the unique ID of the patient.
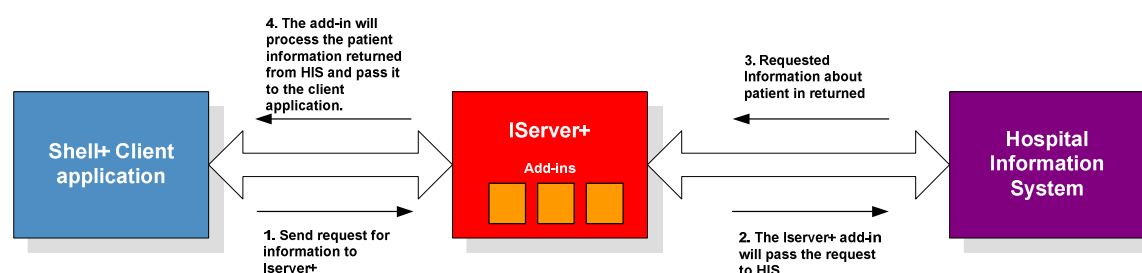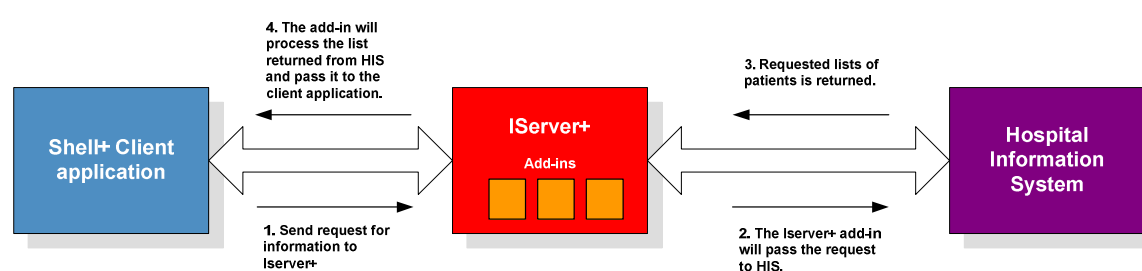

QUERY MEASUREMENT INFO

This feature adds the possibility in the Shell+ client application to query for measurement info based on the unique ID for the request.
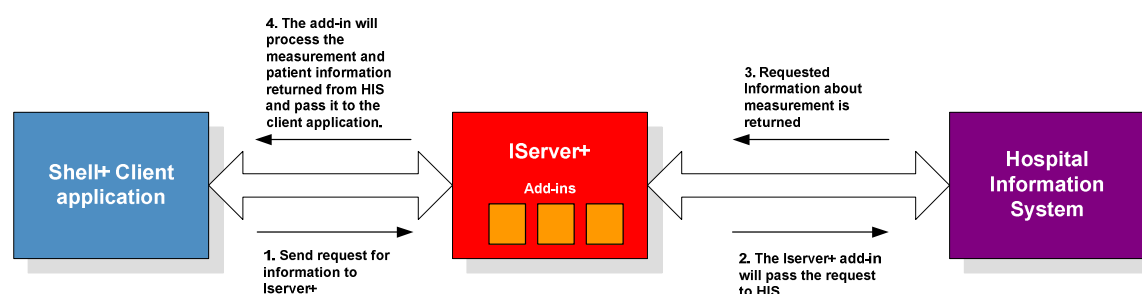
SEARCH PATIENT INFO

This feature adds the possibility in the Shell+ client application to search for patient information in the Hospital Information System.


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ADD, UPDATE OR DELETE REQUESTS UNSOLICITED

A request in Shell+ is defined as a demand for a new examination. A request contains following information:

- **Appointment ID**: Unique identifier for the request.
- **Patient ID**: Unique identifier that refers to the patient information of the patient for who the request is intended.
- **Patient Information**: Patient information to add or update in the patient list.
- **Date, time and location:** Information about where and when the examination is to be performed.

If this feature is implemented, the Hospital Information System can send unsolicited messages to add, update or delete a request in the Shell+ database.
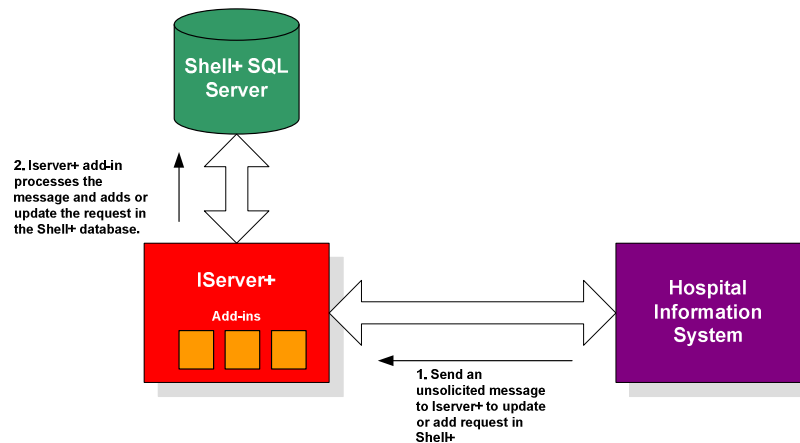

SEND REPORT TO HIS

Shell+ has the ability to send reports from BrainRT to the Hospital Information System.

BrainRT uses Microsoft Word to perform reporting of BrainRT registrations. OSG has developed an extension to Microsoft Word: the BrainRT Word add-in.

There are two options for the report: embedding the report in de HL7 message, or sending the report to a specified location with a unique predefined name. This option only applies the reports sent in Word or PDF.
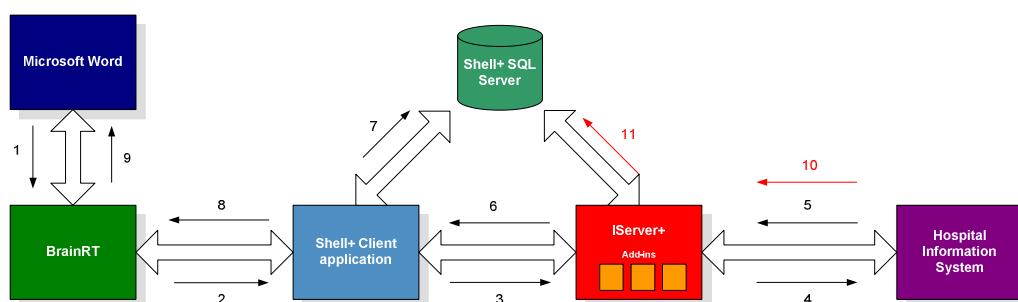
ADD, UPDATE OR DELETE PATIENT INFO UNSOLICITED

In opposite to the Query/Response implementation, patient information can also be updated, added or deleted in the Shell+ database by unsolicited messages sent by the Hospital Information System.

Query measurement information in the Shell+ database

HL7 clients can query the measurements in the database based on a patient ID.