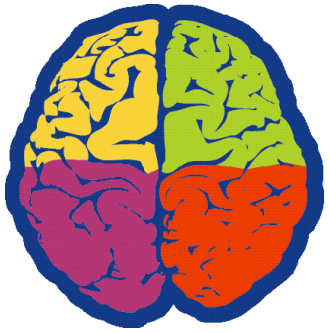
Operating ActiveTwo



CORTECH
SOLUTIONS

Innovative solutions for
research in electrophysiology
and behavior

ActiveTwo Background

- **ActiveTwo is a biopotential measurement system**
- Biopotentials are time-varying electrical potentials, measured on the scalp surface in the case of EEG
- Other biopotentials include:
  - Electrocariogram - ECG / EKG - heart
  - Electromyogram - EMG - muscle
  - Electrooculogram - EOG - eye
  - skin potential
- ActiveTwo can also measure other physiological signals, such as pulse (plethysmograph), respiration, temperature and skin conductance (GSR...not part of your system)

EEG Background

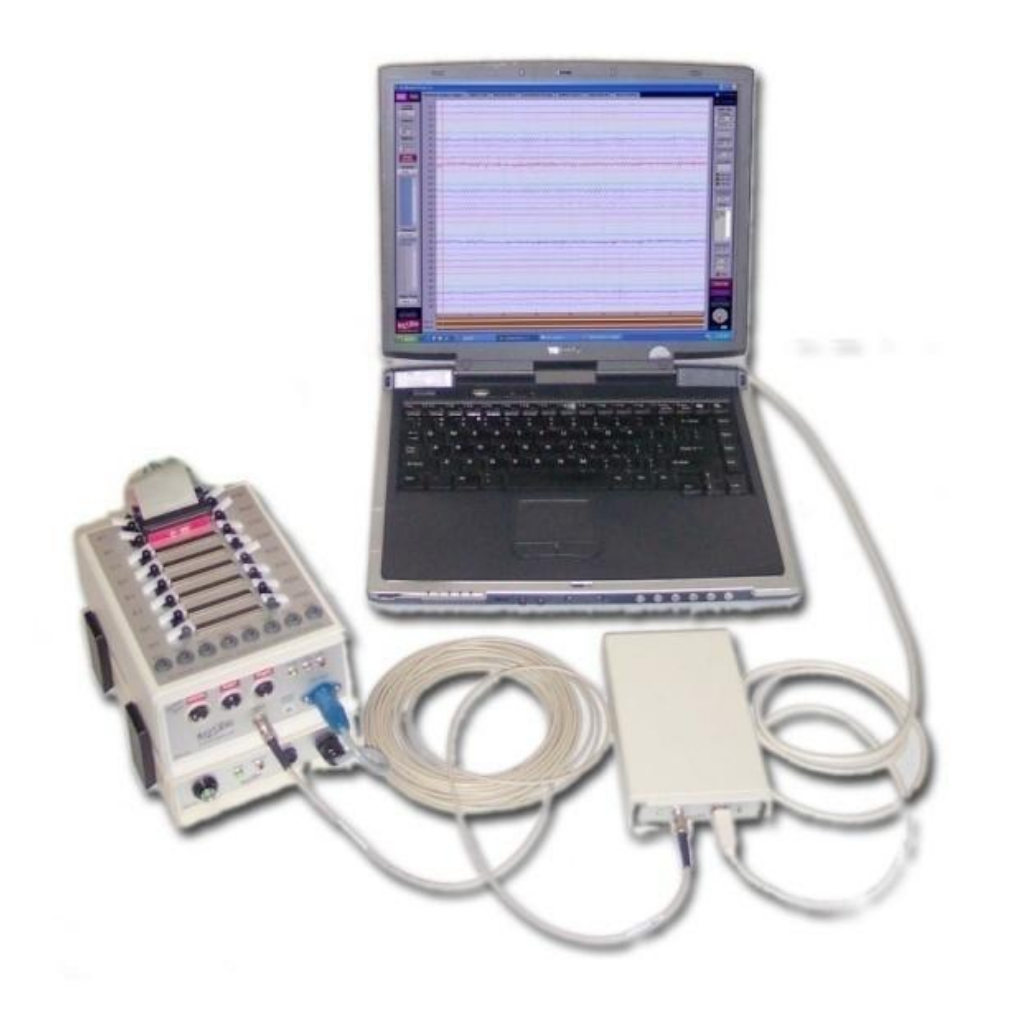
- Measured at the scalp surface
- Summed activity of sheets of mostly cortical pyramidal cells - neurons
- Stopwatch in balloon analogy
  - Some potentials are widely distributed - deep sources
  - Most potentials are represented more focally - superficial sources
- Historical view: the more electrodes you have, the better your ability to identify the source of scalp potential
- Modern view: The more electrodes you have, the better your ability to estimate the activity coming from one to a few regions of interest

Additional Resources

For additional information on ActiveTwo, check these resources:

- ActiveTwo Operating Guidelines booklet
- ActiveTwo User Manual
- groups.google.com/group/operatingactivetwo
- www.biosemi.com/faq.htm
- www.biosemi.nl/forum/
- www.cortechsolutions.com/Support/By-product/ActiveTwo.aspx
- support@cortechsolutions.com
- 910-362-1143

Setup and functional overview



Consumable supplies

- SignaGel - best for most labs
- Lectron III/Chloride 10 for more resistance to skin potentials and sweat
- Ten20 or Elefix for flat-type electrodes on scalp without cap
- Monoject or Luer-Lok syringes with blunt needles
- Double-sided adhesive rings
- Paper tape – 3M Micropore
- Disinfectant (not included)

Other supplies

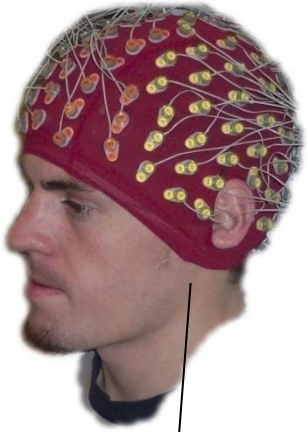
- Head measuring tape
- Velcro cable ties
- Two plastic buckets
- Non-iodized salt (NaCl)

Head cap styles

Standard

Chin strap

Surgical



Elastic border – no chin strap

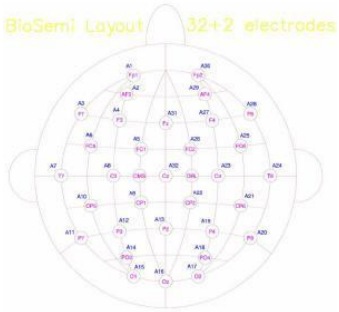
Custom

Head cap sizes

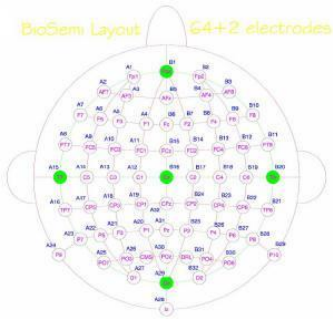
Size	Color	Head Circ.	# Sites	Std. Layout	Boys	Girls
Infa 6	Red	22-26 cm	32	10/20	premature infants	
Infa 5	Blue	26-30 cm	32	10/20	premature infants	
Infa 4	Yellow	30-34 cm	32	10/20	premature infants	
Infa 3	Brown	34-38 cm	64	10/20	0 - 1 mo.	0 - 1.5 mo.
Infa 2/3	Pink/Brown	36-40 cm	64	10/20	0 - 2 mo.	.5 - 3 mo.
Infa 2	Pink	38-42 cm	64	10/20	1 - 3.5 mo.	1.5 - 5.5 mo.
Infa 1/2	Lt Blue/Pink	40-44 cm	64	10/20	2 - 6.5 mo.	3 - 9 mo.
Infa 1	Light Blue	42-46 cm	64	10/20	3.5 - 10.5 mo.	5.5 - 15.5 mo.
X-Small/Infa 1	Green/ Light Blue	44-48 cm	64	10/20	6.5 - 19 mo.	9 - 28 mo.
X-Small	Green	46-50 cm	128	10/20 or ABC	10.5 - > 36 mo.	15.5 - > 36 mo.
Small/X-Small	Yellow/Green	48-52 cm	128	10/20 or ABC	19 - > 36 mo.	28 - > 36 mo.
Small	Yellow	50-54 cm	256	10/20 or ABC	toddlers / children	
Medium/Small	Red/Yellow	52-56 cm	256	10/20 or ABC	children / teens / small adults	
Medium	Red	54-58 cm	256	10/20 or ABC	teens / adults	
Large/Medium	Blue/Red	56-60 cm	256	10/20 or ABC	teens / adults	
Large	Blue	58-62 cm	256	10/20 or ABC	large teens / adults	
X-Large	Brown	62-66 cm	256	10/20 or ABC	exceptionally large adults	

Head cap layouts

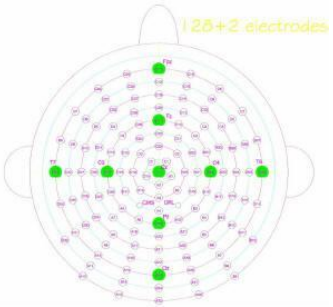
32 channels (10/20)



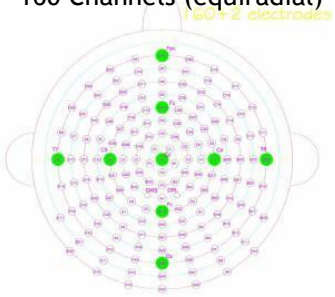
64 Channels (10/20)



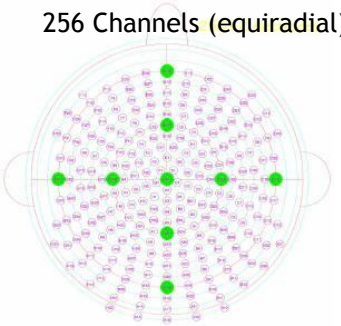
128 Channels (equiradial)



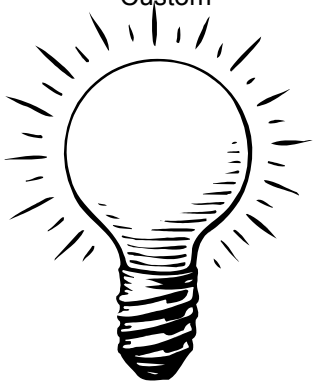
160 Channels (equiradial)



256 Channels (equiradial)



Custom



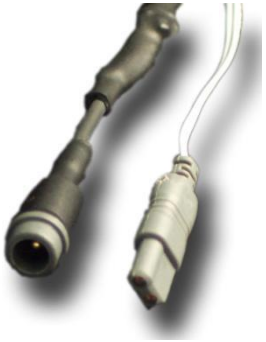
Active electrodes

Pin-type for head-cap

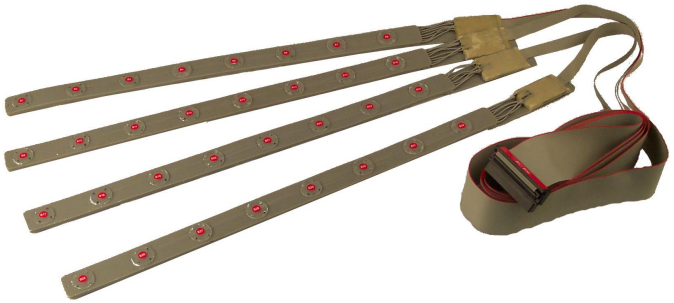
Flat-type

CMS/DRL

In-line buffer

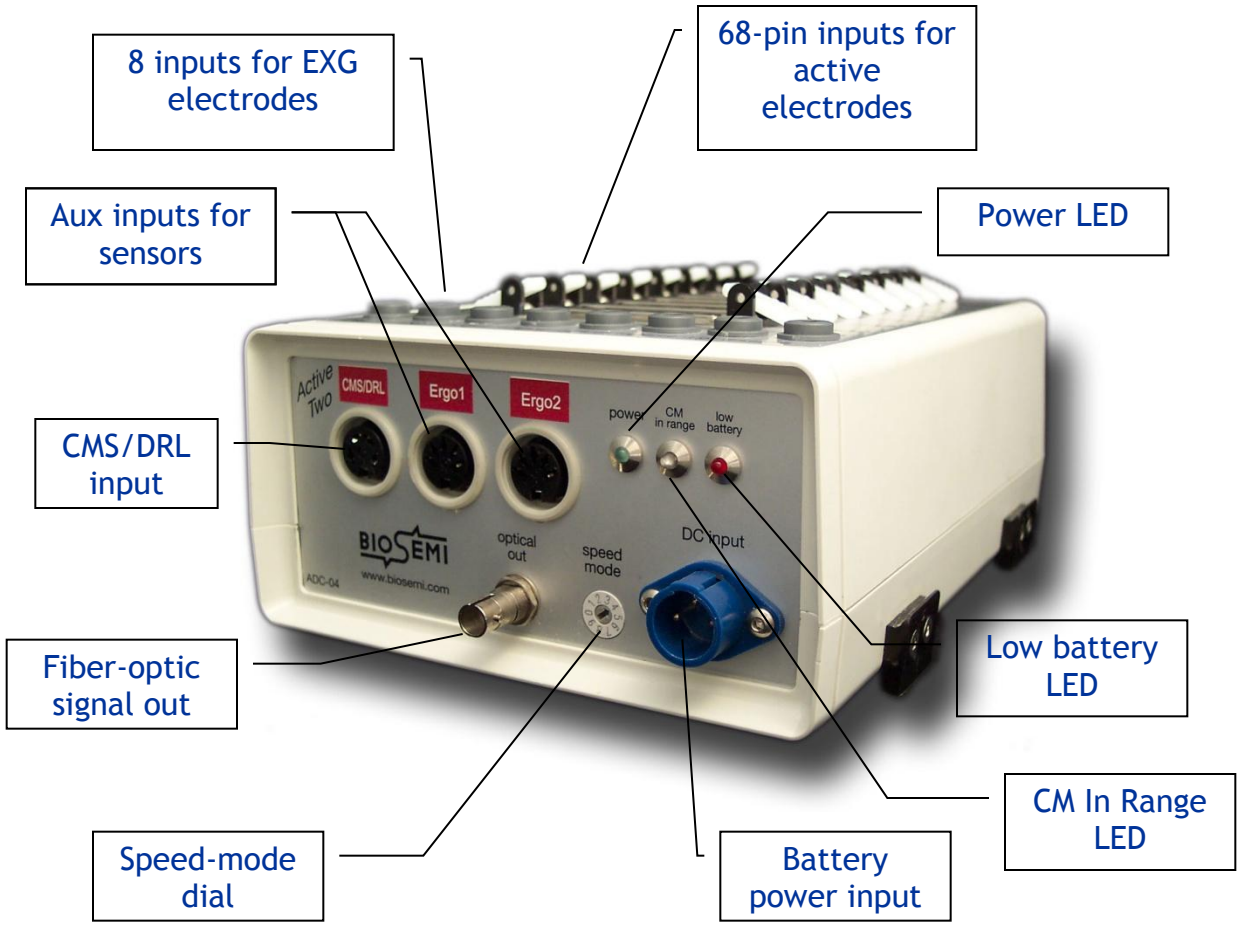


ECG strips



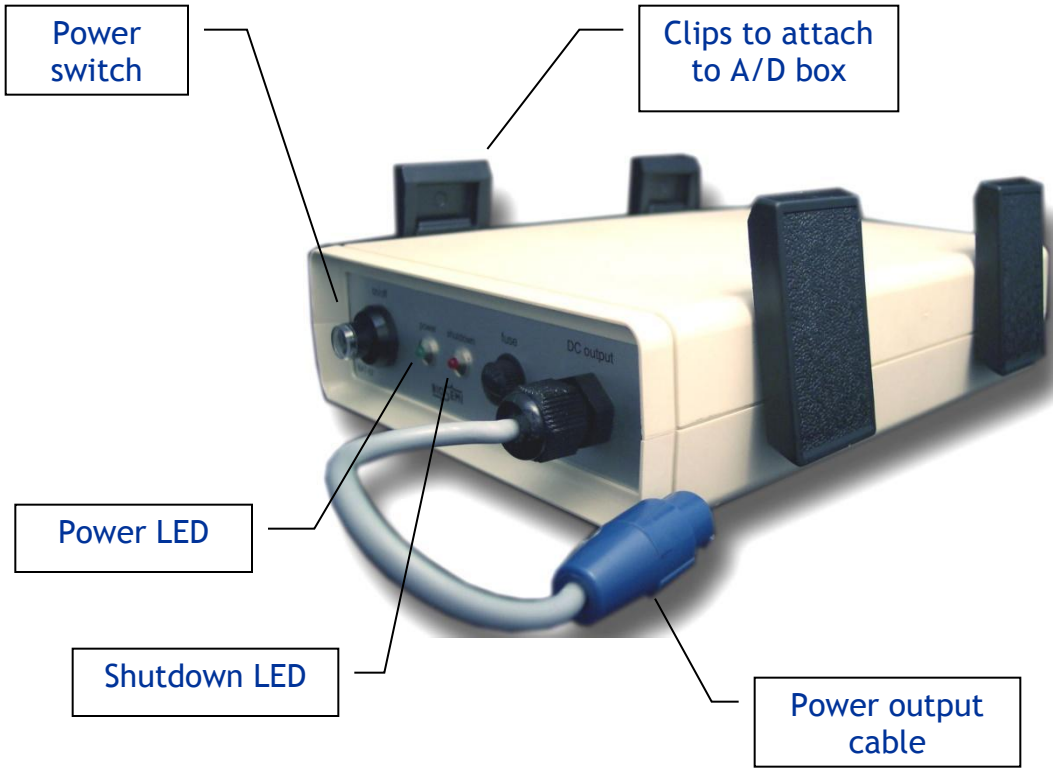
A/D box

- 8 – 280 channels
- Battery powered
- Fiber-optic out
- Battery-powered or self-powered aux inputs
- One 24-bit A/D per channel
- 2048 – 16384 Hz sampling
- +-262 mV range



Battery box

- Lead/acid chemistry
- 10-20 hours of operation, depending on # channels
- 3.5 hours to recharge after fully-depleted
- No memory effect
- “Shutdown” preserves minimum charge



Battery charger and AC adapter

- LED indicates charge state
- Intelligent charger
- OK to leave connected when powered
- Accepts 110-220 V

Fiber-optic cable

1. Perfect electrical isolation (safety)
2. No interference pickup (signal quality)
3. Length practically unlimited
4. Small diameter (~3/8”)
5. Inexpensive (<$30)
6. Type: ST-ST, 62.5/125 multimode, simplex

USB interface

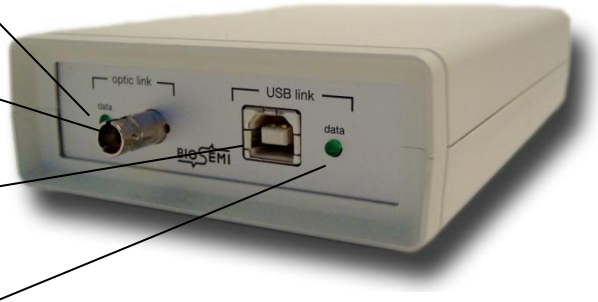
Input data LED

Fiber-optic input

USB output

Output data LED

Front



USB cable

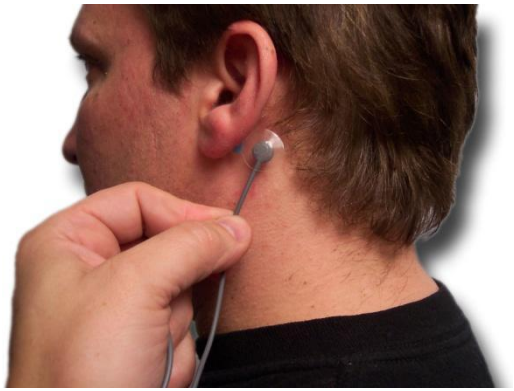
Rear

Trigger input/outputport

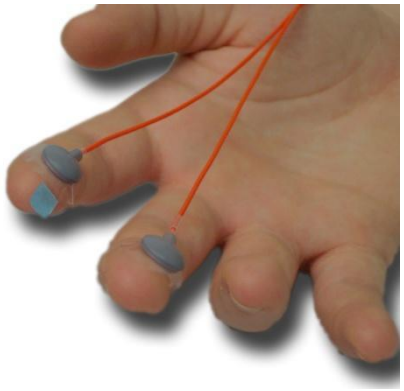
Non-EEG sensors

Respiration

Temperature

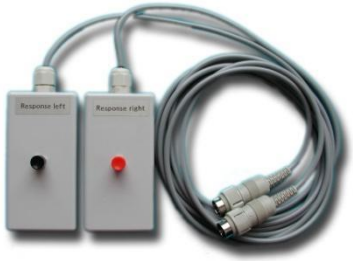


Skin conductance



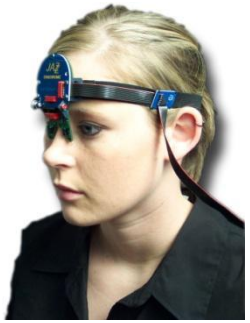
Microphone

Response buttons



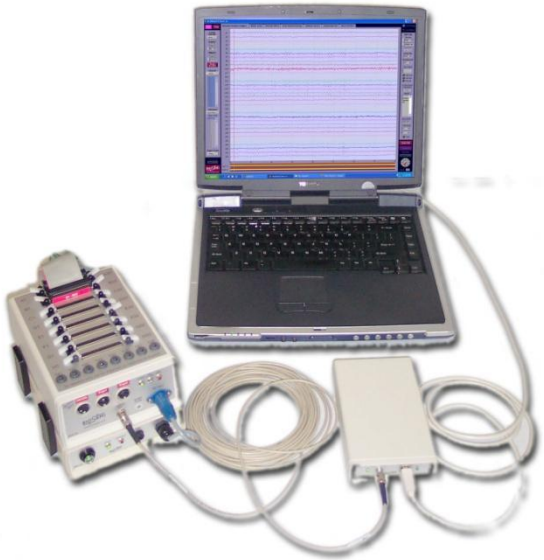
Strain gauge

Jazz

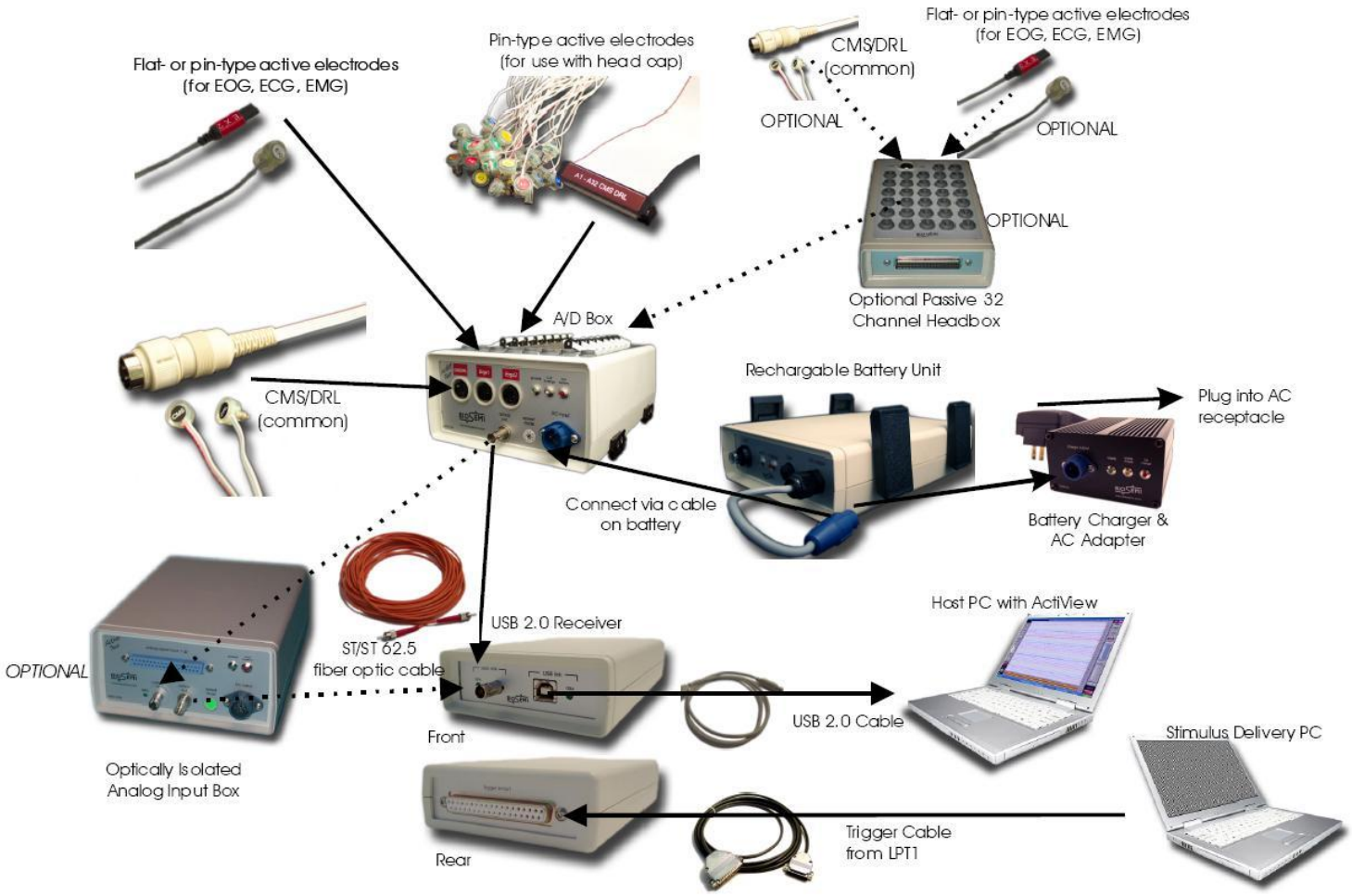


Basic assembly

1. Attach battery unit to A/D box.
2. Connect fiber optic cable between A/D box and USB interface.
3. Connect USB cable between USB interface and PC USB port.
4. Connect trigger cable between USB interface trigger port and stimulus computer's parallel port.
5. Select sensors, attach to subject and plug into system.

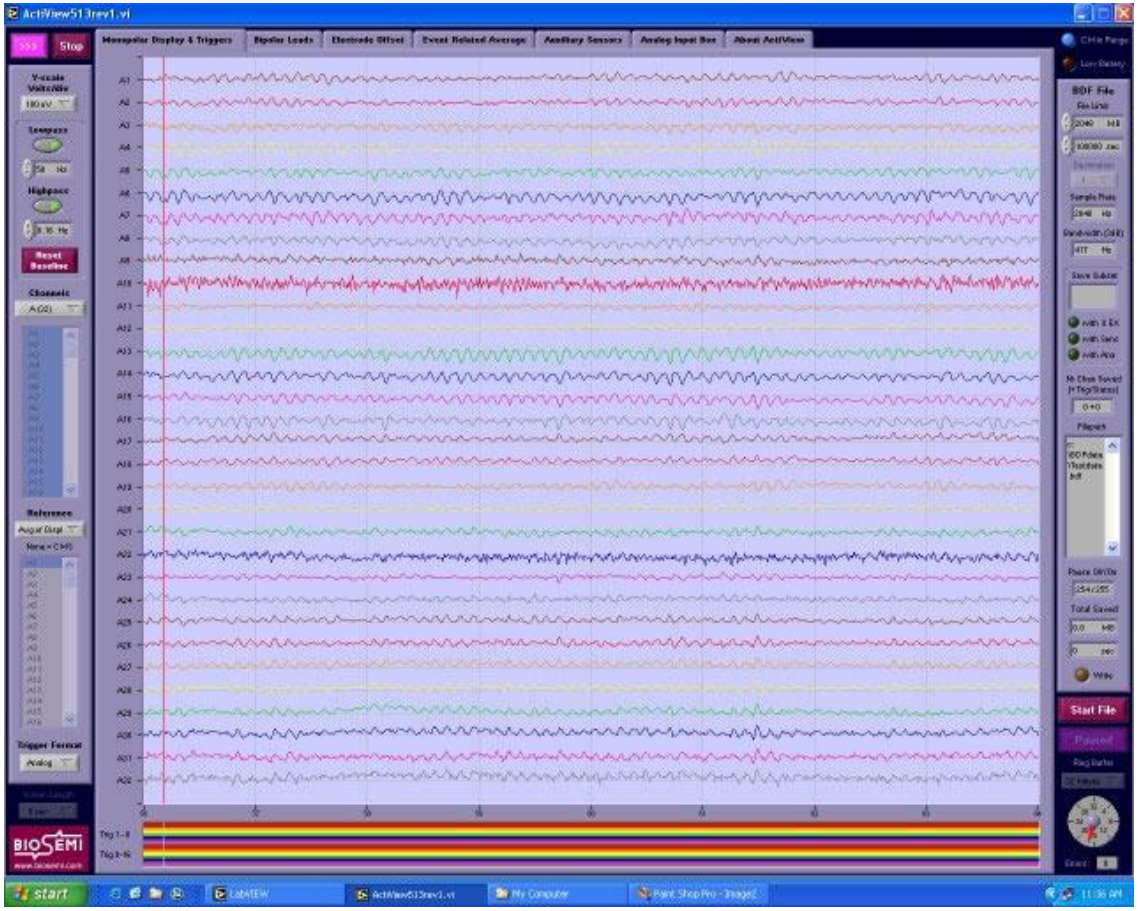


Cable connections



ActiView Software

- LabVIEW-based
- Continuous recording and display of signals with triggers
- Contact checking
- Open-source, in case you want to modify
- No programming required



Installing USB driver and software

1. Copy software from BioSemi web site, place BioSemi CD in drive or insert USB drive
2. Install USB driver
3. Install LabVIEW runtime engine
4. Copy ActiView application to local folder

Data acquisition best practices

Optimizing the laboratory environment

1. Allow plenty of space for participant and experimenter
2. Separate rooms for participant and experimenter
3. Shielding
   a. Faraday cage (RF shielding) – not required
   b. Mu metal enclosure (magnetic shielding) – required only in extreme cases
4. Lighting – low-voltage LED lighting is best as it generates less electrical noise and heat
5. Ventilation – air flow for participant area
6. Non-metallic furniture
7. Sink to wash electrodes and caps, private area for participant clean-up

Routine bench testing

1. Regular testing with one-bucket method to detect:
   a. Broken electrode pellets
   b. Broken wires
   c. Cracked wire insulation
2. Periodic two-bucket testing to monitor:
   a. Relative amount of environmental noise (with 10-100 kOhm resistor)
   b. Inter-channel gain accuracy (with signal generator)
   c. Absolute gain changes over time (should be none)

Electrode handling

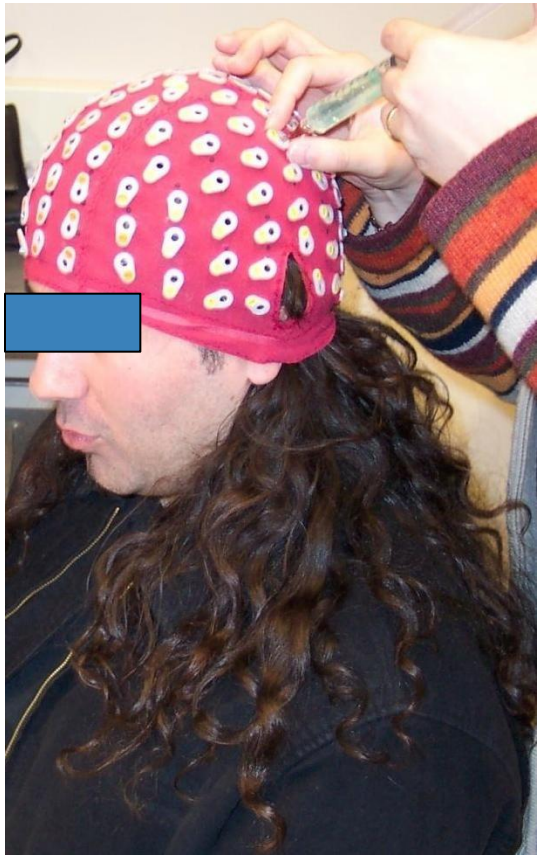
1. Use approved gel or paste for recording
2. Remove from cap gently – do not tug or kink wire
3. Use connector ejectors – do not pull on cable
4. Wash electrodes immediately after use (do not soak in water more than 10 minutes)
5. Wash with warm water, no detergent
6. Disinfect with the mildest product that meets your needs (not more than 10 minutes at a time)
7. Towel-off and hang or lay flat to dry
8. Store in a dark, dry place that is ventilated (not completely sealed)
9. Avoid contact with metal during handling and storage

Head cap maintenance

1. Wash with mild soap and warm water
2. Use sprayer to remove gel from electrode holders
3. Towel dry before disinfecting with the mildest product that meets your needs (not more than 10 minutes at a time)
4. Rinse with water after disinfecting
5. Towel-off and lay flat to dry
6. Avoid heat when drying – use a cool fan to accelerate

Participant selection & advance instructions

1. Participant selection
   a. Include hair style among exclusion criteria.
   b. Measure head before session of ask participant to do so.
2. Instructions to participants
   a. Minimize nicotine and caffeine use 2-3 hours before session.
   b. Arrive early, especially if a long walk or stairs will be required to reach the lab.
   c. Wash hair the morning of the session and avoid using hair products.
   d. Layer clothing (e.g. button or zip-up shirt over short-sleeve short) to allow participant to control body temperature.

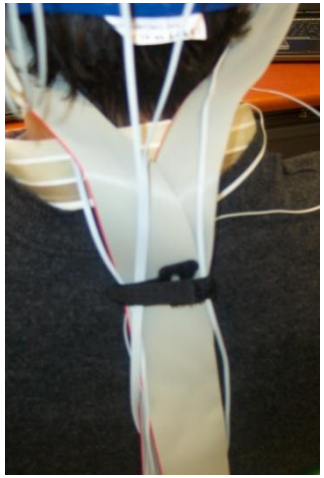


Electrode application and signal-quality checking

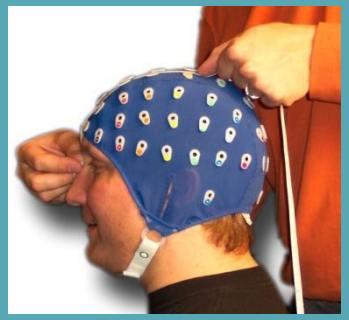
1. Err on the side of too little gel rather than too much.
2. Check the blue *CM In Range* light first.
3. Check *Electrode Offset* tab with these criteria in mind:
   a. Low: nothing above ±40 mV.
   b. Stable: unaffected by subject movement or touching electrodes or wires.
4. On *Monopolar Display* tab, disable filters and reference and observe signals with these criteria in mind:
   a. Signals should be < 100 uV amplitude
   b. Look for 60 Hz and manipulate power cables and furniture to minimize
   c. Look for low-frequency instability (drift) that may be associated with poor electrode contact quality

Positioning of A/D box, cables and participant

1. Follow the furniture recommendations
2. Position A/D box as close as practically possible to participant.
3. Keep the active electrode leads close together along the length of the run from participant to A/D box.
4. Wrap CMS/DRL around the other leads 3-5 times to minimize the loop pickup area.
5. Keep power cables, power supplies and cables carrying other high-level signals away from the participant

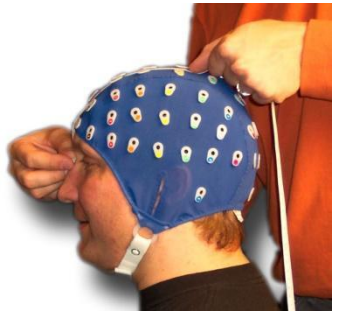


Data acquisition procedure



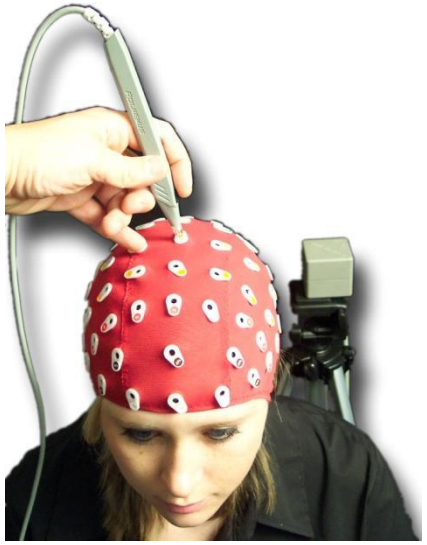
Position head cap

1. Measure head circumference to select cap size.
2. Measure nasion-inion distance before applying head cap and divide by two to locate vertex (Cz).
3. If participant has long hair, fix mastoid or earlobe electrodes before putting on the head-cap.
4. Put the cap on the participant's head.
5. Be sure label is out from under cap at IZ!
6. Measure nasion-to-vertex; adjust cap from front-to-back.
7. Measure LPA-to-RPA; adjust cap from left-to-right.
8. Visually inspect cap from the front to ensure cap is not rotated.
9. Repeat steps 6-8 to be sure that everything is in place.



Digitize electrode positions

1. Start Locator and use File->Open to select a sequence file.
2. Verify settings (Setup menu).
3. Select Digitize->Receivers on subject->One
4. Select Digitize->Electrodes, and wizard will begin.
5. Point to sites as prompted, and hold the stylus still as you press the button.
6. If Locator detects movement during measurement, it will ask you to repeat.
7. Recorded points will be displayed once complete; be sure to Accept.
8. Use File->Save and set “Files of type” parameter to save data.

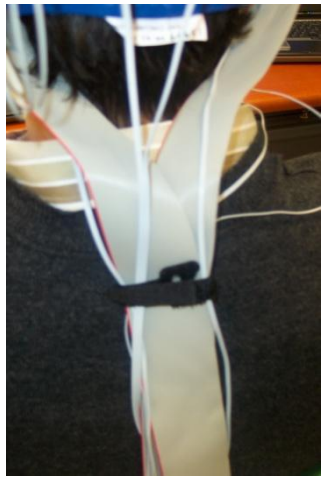


Apply gel

1. Fill syringe with gel – 10 cc should cover about 64 channels.
2. Inject gel into the first electrode holder, and ask if participant feels the gel on scalp. If not, then part the hair with syringe tip.
3. Fill the remaining electrode holders with gel, parting the hair as needed.

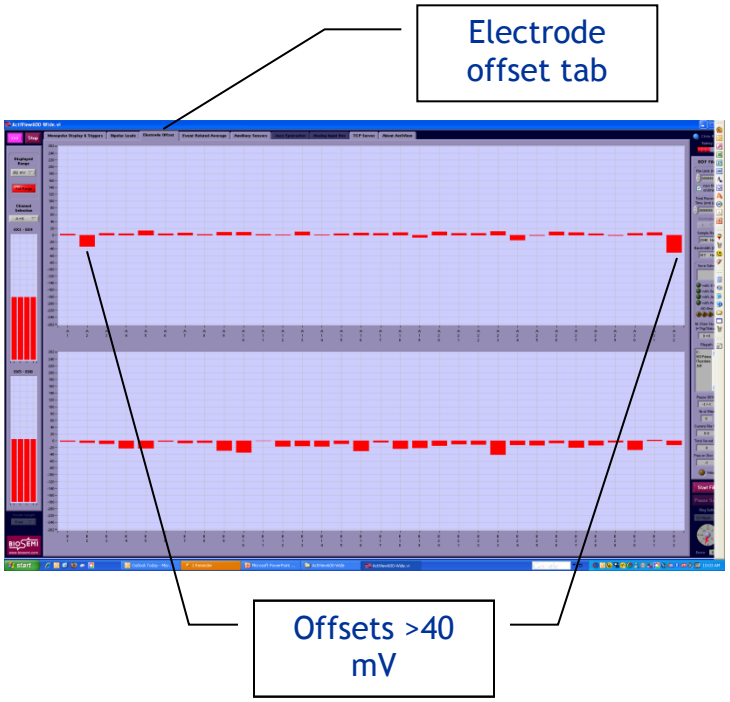
Insert / apply active electrodes

1. Apply flat-type active electrodes at mastoids or earlobes.
2. Insert the pin-type active electrodes into the electrode holders in cap.
3. Drape ribbon cables / connectors over the participant's shoulder.
4. Insert CMS and DRL electrodes.
5. Apply flat-type active electrodes for VEOG, HEOG, Nz, Nose etc.
6. Loop CMS/DRL around other leads, and Velcro-tie cables together.
7. Connect electrodes to A/D box.



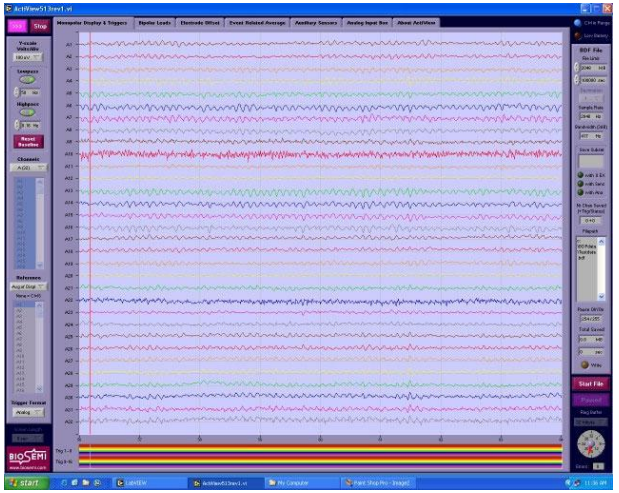
Check electrode contacts

1. Turn on A/D box power and verify CMS/DRL contacts: CM in range=solid blue=good.
2. Open ActiView, select CFG file, Start viewing data and switch to Electrode Offset tab.
3. Verify low, stable offsets across channels (< 40 mV). Address problem channels.
4. Select Monopolar Display tab, and observe signal quality at 100 uV/div. Address problem channels.



Collect EEG / ERP data

1. Select Start File on lower-right side of ActiView screen.
2. Specify header variables, which channels to save and path/name.
1. Be sure to “un-pause” manually or remotely via stimulus computer.
4. Select Pause (lower-right) to leave file open for further writing or Stop (upper-left) to close file.



Clean-up electrodes and head-cap

1. Remove electrodes from cap gently, and avoid kinking wire where it exits the electrode.
2. Clean immediately with warm water only; do not use detergent for cleaning electrodes. Mild detergent is OK for head-cap.
3. Towel dry to remove majority of water, then allow to air dry completely. Dry head-cap flat to avoid stretching
4. Disinfect, rinse with water and dry again.

Bench testing & maintenance

One-bucket test: leads together

Quantify internal noise sources

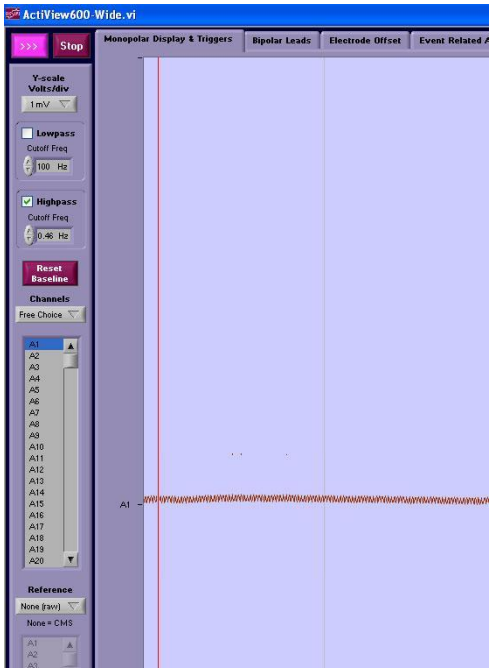
- Electrode noise
- Shorted noise (amplifier noise)

Diagnose system faults

- Corrosion of electrode contacts
- Damaged wire insulation
- Broken wires
- Bad connectors
- Internal faults

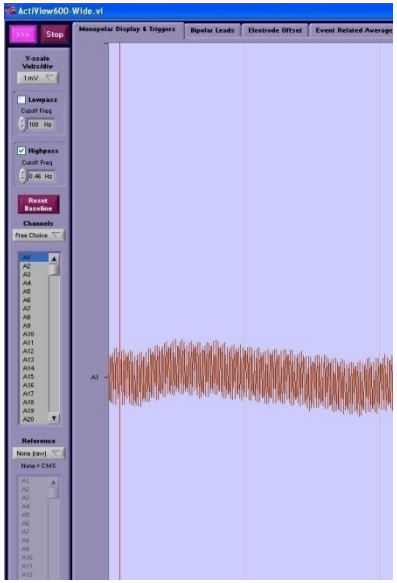
One-bucket test: leads separate

- Characterize environmental noise
- Relatively insensitive



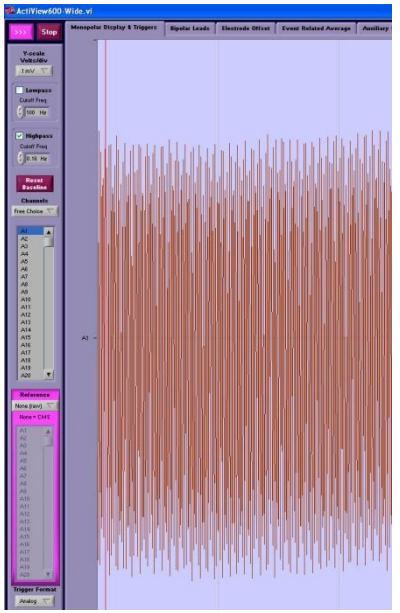
Two-bucket test: 10 k resistor

- Characterize environmental noise
- More sensitive



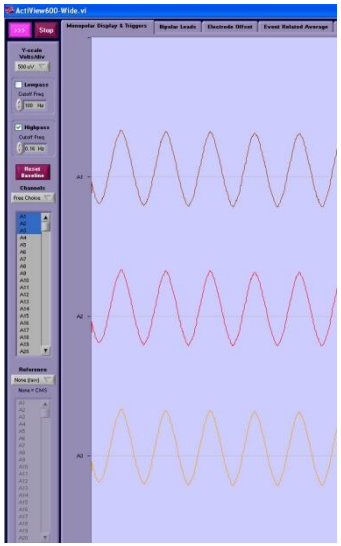
Two-bucket test: 100 k resistor

- Characterize environmental noise
- Very sensitive



Two-bucket test: signal generator

- Test calibration / gain accuracy per channel
- Test relative gain accuracy across channels
- Verify filter roll-off
- Quantify linearity of system
- Test relative timing of trigger port and EEG samples



Test and verify trigger interface

1. Connect the trigger cable between device / PC and Trigger Input port.
2. Open/start ActiView and select Analog trigger format and observe the state of the trigger input port.
3. Start the device/application that will send the trigger signals.
4. If trigger signals are visible and reliable…switch to Decimal mode.
5. If trigger signals are not visible/reliable…check pulse duration.
6. Save a short test data file with triggers, and verify they flow through to analysis software.
7. Separately test timing of stimulus/trigger at source using a two-channel oscilloscope!

Maintenance of active electrodes

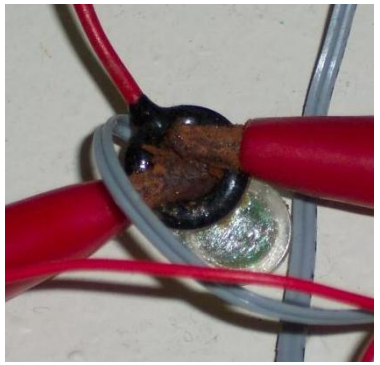
1. Clean immediately with warm water only; do not use detergent for cleaning.
2. Towel dry to remove majority of water, then allow to air dry completely.
3. Keep connector dry.
4. Do not allow electrode pellets to contact other metal objects/surfaces.
5. Store away from direct sunlight.
6. Soak in salt water once a week or before each use for up to 5 minutes at a time.
7. Remove from cap gently, and avoid kinking wire where it exits the electrode.

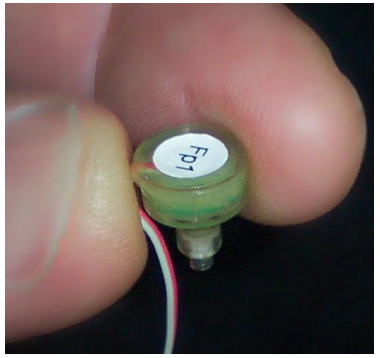
Maintenance of batteries

- Two battery units are supplied – use both.
- Useful life > 1000 discharge/recharge cycles.
- Recharge time of 3.5 hours (from fully depleted) reflects full capacity.
- Shorter recharge time reflects diminished capacity: cycle to refresh.
- Overcharging is not possible using supplied charger; OK to leave on charger if AC supply is assured.
- Never store a fully depleted battery.
- Recharge after Low-Battery indicator appears.

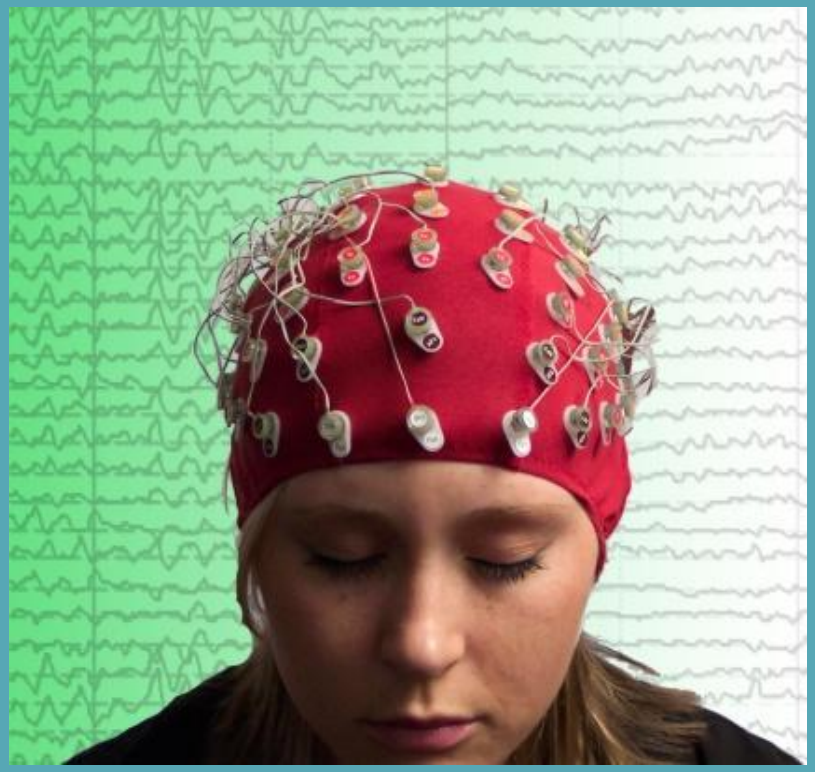
What not to do

1. Do not attempt to use the system before familiarizing yourself with the documentation.
2. Do not connect any AC powered device to the A/D box.
3. Do not allow active electrode tips to come into contact with any other metal.
4. Do not store a full-depleted battery.
5. Do not use soap to clean gel / paste from the electrodes.
6. Do not soak electrodes in any liquid for more than 10 minutes at a time.
7. Do not plug connectors into system in the wrong orientation.
8. Do not use alligator clips or other metal conductors to connect signal inputs to the active electrodes.
9. Do not kink electrode wires by pressing on them when removing from cap.
10. Do not position electrodes in cap so that the wire exits at an angle.

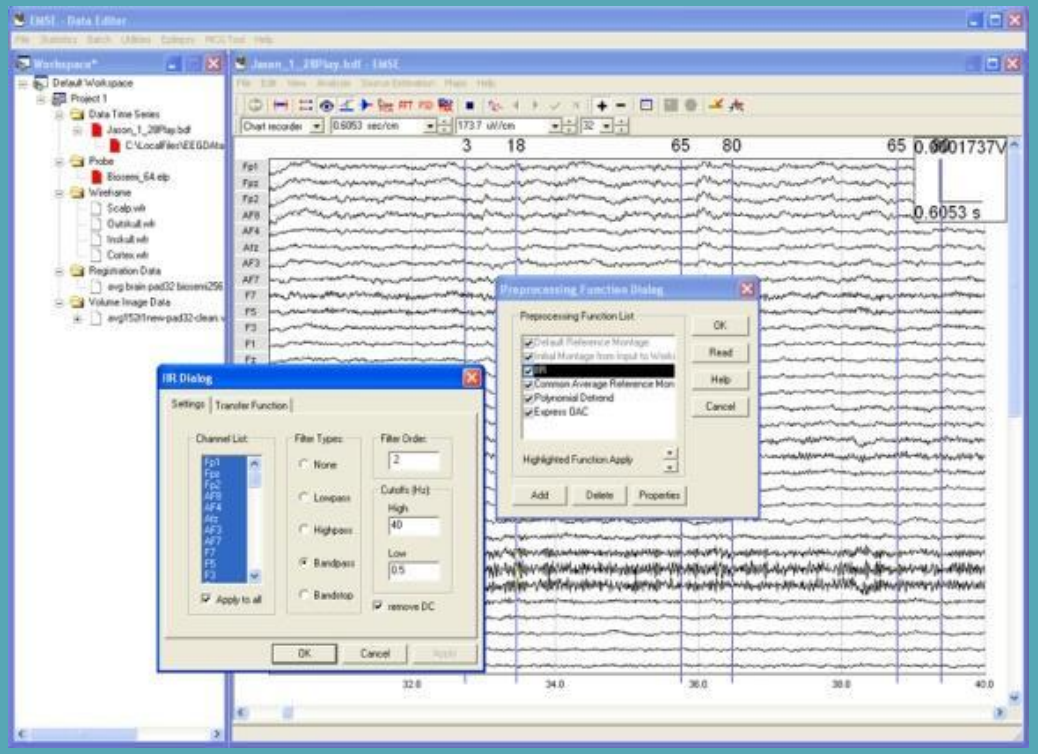




Data acquisition - actual recording

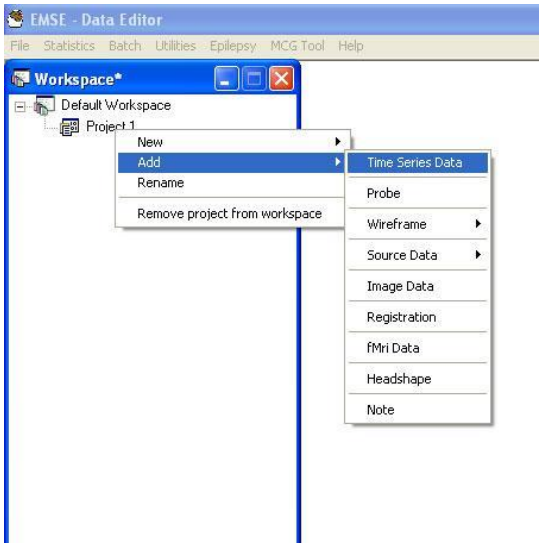


Data analysis: EMSE / BESA



EMSE - loading a data file

1. Select File->New Workspace.
2. Right-click Project 1, and select Add -> Time series data.
3. Browse to a data file and double click.
4. If you digitized electrode positions, right-click Project 1 and select Add->Probe.
5. Double-click on time-series name to load.
5. If you did not digitize electrode positions, EMSE chooses a suitable probe file for you.
6. Match channels to sensors dialog lets you identify any channels with unrecognized labels.
7. EMSE creates a table of trigger events.
8. Designate any non-EEG sensors as PassThrough.



EMSE - pre-processing

1. Reference: *Analysis->Filter Pipeline->Add->Montage-> select*
2. Filter: *Analysis->Filter Pipeline->Add->Temporal filter-> select*
3. Hand-editing / artifact rejection:

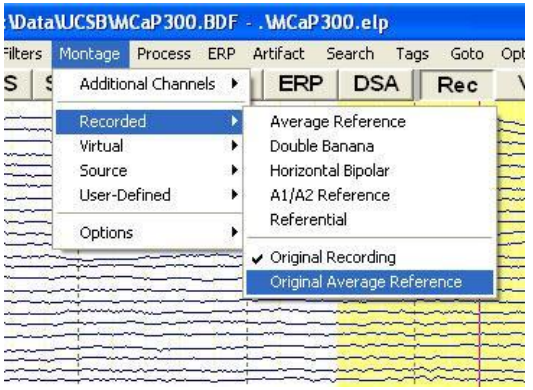
   Edit->Events->Segment Setup
4. Ocular artifact removal: *Analysis->Express ocular artifact correction*

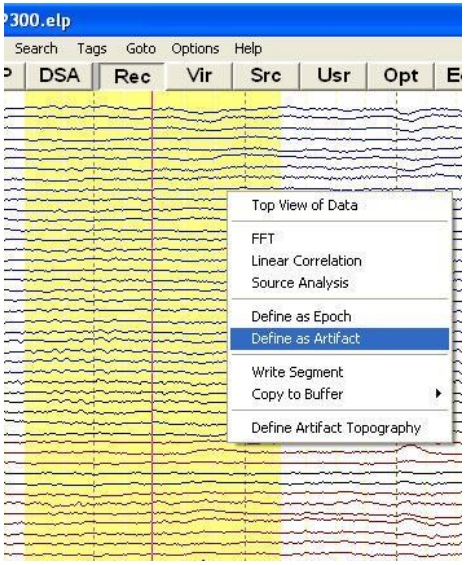
BESA – loading a data file

- File->Open
- Be sure Files of type is set to ERP
- ActiveTwo data files have BDF extension
- BDF files contain raw data
- Same File->Open operation used to load average data files

BESA – pre-processing

1. Reference: *Montage->Original Average Reference. BESA maintains original reference through all stages. User must select a montage for re-referencing at each stage.*
2. Filter: *EdF->Bandpass (e.g.). Filters can be applied before artifact rejection or after.*
3. Hand-editing / artifact rejection: *Left-click and drag to select, then select Define As Artifact.*
4. Ocular artifact removal: *Artifact->Automatic.*





BESA – ERP averaging

1. ERP->Edit Paradigm.
2. Assign attributes to triggers or go straight to defining conditions.
3. Define epoch lengths for each condition.
4. Set filters.
5. Automatic artifact scan or manual thresholds.
6. Average->Average.