

PRACTICAL ECG

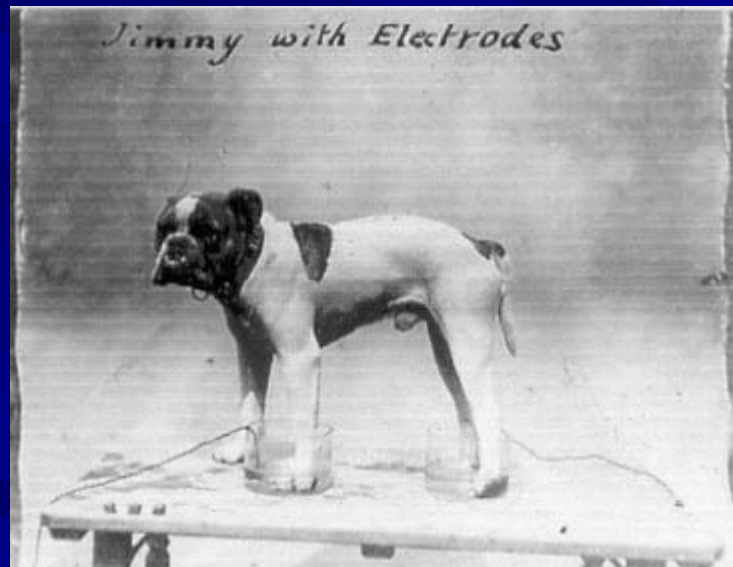
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MIET(Electronics)

Why Vetronic Services?

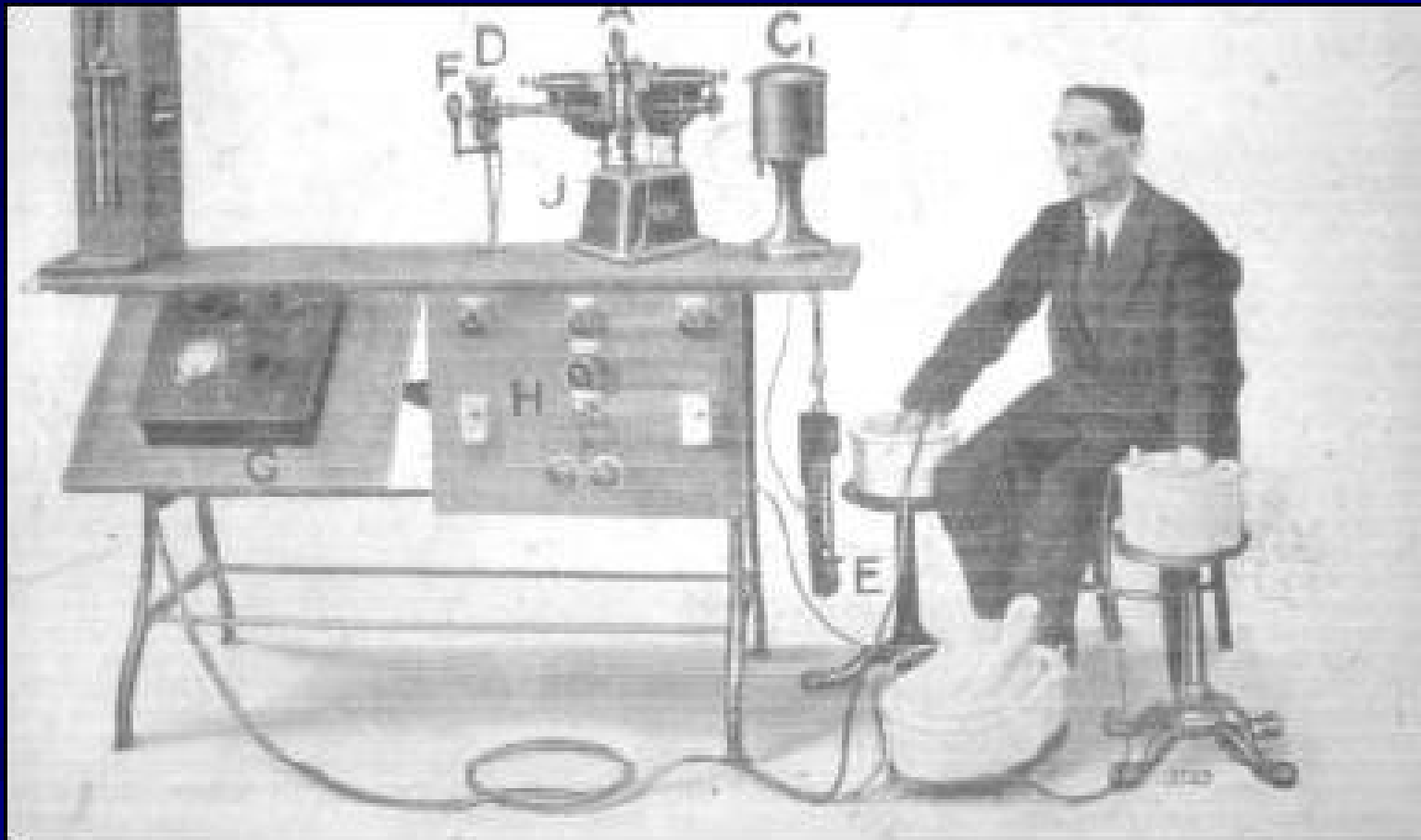
- Passion for electronics
- Wanted to produce products that would make my life easier in everyday practice life e.g.
 - Quick reliable ECG monitors
 - Simple to use ECG diagnostic equipment that could be used for monitoring as well as a full diagnostic ECG workup

We've come a long way

■ Augustus Desire Waller 1856 - 1922



Procedure for ECG 1920



Monitoring & Diagnostic ECG

- There are big differences between a monitoring ECG and a diagnostic ECG
 - Monitoring ECG's are heavily filtered
 - Lower sampling rate for monitoring ECG
 - Diagnostic ECG equipment can be used for monitoring but cannot use a monitor ECG for diagnostic work-up

Diagnostic ECG

- Three steps to performing a basic ECG investigation
 - Get a good clean tracing
 - Make rapid reliable measurements
 - Interpretation based on the trace and clinical observation

Getting a good clean ECG Trace

- The Equipment
- Methods of attachment
- Assessment

Equipment Selection

- Equipment needs no introduction
- Mains or battery?
- Some explanation needed regarding merits of single lead versus 6-lead
- ECG Cable selection
 - unshielded versus shielded
 - UK versus USA colour coding
- Analog versus digital – some analog machines are actually relatively poor digital types

Mains or Battery

- Both is ideal but Battery is the optimal option
- Biggest problem with ECG taking is mains interference.
- Even on some of the expensive ECG machines there are noticeably better results when run on the battery
- Invariably have cables running across the machine – susceptible to mains pick up

Single Lead Versus Six-lead

■ Nomenclature

- “Lead” refers to the Bipolar leads e.g. Lead II
- A “Lead” requires 2 connections and a reference connection
- A Single Lead machine has 3 cables
- A Six Lead machine has 4 cables

Single Lead versus Six Lead

- With a Single Lead machine you can only look at one Lead at a time
- You cannot therefore look at magnitudes of complexes in different leads at the same time
- This limits the clinical information that can be gained e.g. eliminating noise/movement, or calculating Mean Electrical Axis
- But a good quality single lead machine is still very useful

ECG Cable selection

- Shielded or unshielded
- Makes a lot of difference to the ability to obtain a good ECG
- Many medical ECG cables are shielded only as far as the split. After that the cable is unshielded
- Susceptibility to mains interference is greatly increased.

Colour conventions

- Different between UK and USA

UK Lead convention

- RED – Right Fore
- YELLOW – Left Fore
- GREEN – Left Hind
- BLACK – Right Hind (reference electrode)

USA Lead convention

- RED – Left Hind
- WHITE – Right Fore
- BLACK – Left Fore
- GREEN – Right Hind (reference electrode)

Equipment Types

- Analog
 - Digital
-
- Probably today there is very little difference between them
 - In fact most are now digital even though they are referred to as analog

Analog versus digital

- If it doesn't have an analog stylus it isn't truly an analog machine
- The rest are digital – thermal print heads that have a fixed resolution of around 200dpi

Analog??

- E.g. the Nihon Kohden 8400 series
 - Uses a 203 dpi thermal head
 - 203dpi gives 400 steps on standard ECG paper. This is only slightly better than the worst 8-bit 'digital' machines. 10 or 12-bit digital machines will have 4 or 8 x more resolution.

Analog ECG Machines

- True analog machines have a stylus
- They give good results with standard patients i.e. low heart rates
- Inertia of the stylus causes problems of overshoot and ringing with very fast heart rates – over 300 bpm – not suitable for exotic/avian work

Getting a good ECG Trace

- The Equipment ✓
- Methods of attachment
- Assessment

Methods of attachment

■ Primary aims

- Maximise the surface area of attachment
- Minimize the contact resistance
- Minimize noise pickup

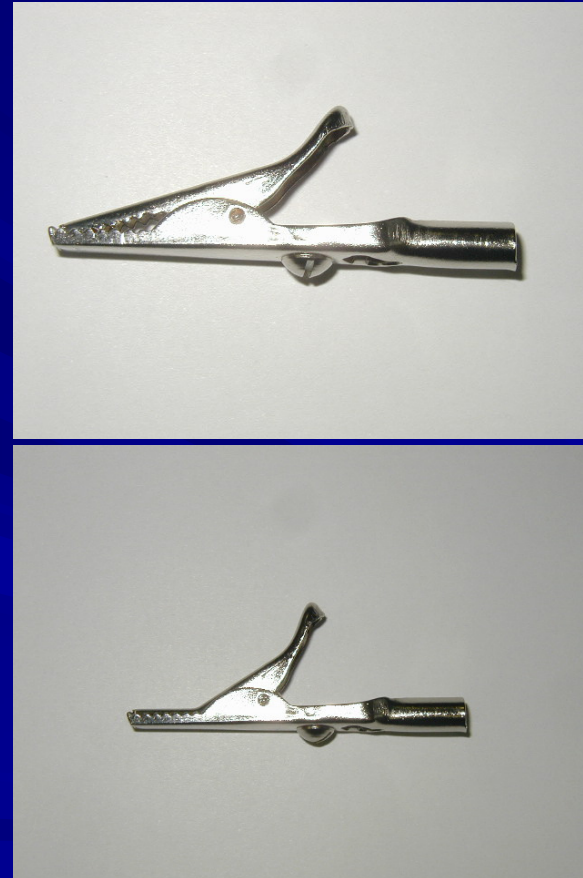
Maximise the surface area of attachment

■ Options

- Crocodile clips
- Sticky ECG electrodes
- Limb Plate Electrodes
- Hypodermic needles

Crocodile clips

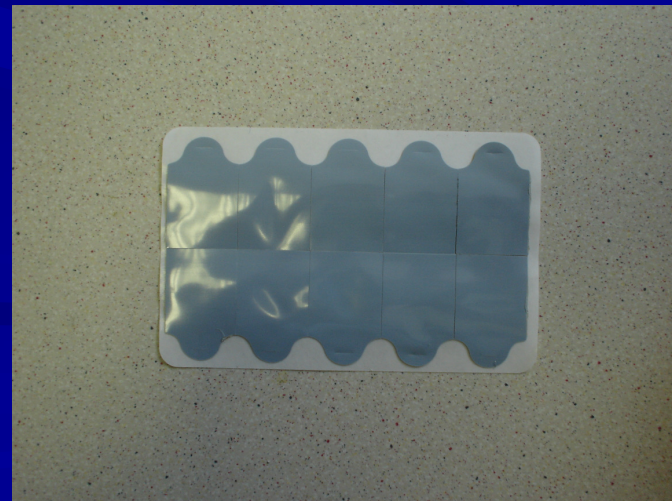
- Can be painful
 - Use modified clips
 - ‘Bite’ as much skin as possible
 - Spreads the load
 - Reduces pain
 - Maximises the contact
 - Need a conducting medium
 - Much better with shaved area



Sticky ECG Electrodes

- Variety of sizes but the contact area is essentially the same
- Need well prepared dry skin
 - Clip area larger than ECG pad
 - De-grease with surgical spirit
 - Allow to dry and then apply pad
- Takes time to apply so good for long ops or ambulatory monitoring
- Can get reasonable results from the pads of the feet but skin resistance is high so subject to noise and movement artefact
- Good preparation is imperative otherwise get mediocre results

ECG Pad Types



Limb Plate Electrodes

- Very easy to apply
- Non painful
- Large surface area so good signal pickup
- No need to clip hair
- Good long term results (hours)



Limb Plate Electrodes



Hypodermic needles

- Fairly well tolerated – 21g or 23g
- Bypasses skin resistance but small contact area so can produce unreliable results, particularly with movement
- Good for e.g. birds where skin is v fragile and cannot use pads or LPE
- Push needle under skin and out again, then attach crocodile clip to free end – picture.....

Minimise contact resistance

- Hair provides distinct barrier to contact, even when soaked in spirit
- Remove hair – pluck or shave
 - Anaesthetised dogs/cats: Pluck hair between pads and use modified crocodile clip for quick connection
- For crocodile clips and LPE apply contact medium *before* attaching electrode
- Use a conducting medium
 - Surgical spirit/isopropyl alcohol
 - Electrolyte solution/Saline
 - Cardiac gel/Ultrasound gel (remove after use)

<i>Agent</i>	<i>Pros</i>	<i>Cons</i>	<i>Contact Time</i>
Surgical Spirit	Promotes good contact. Cheap. Easily available	Smell. Irritant. Short contact time	10-15 minutes
Isopropyl Alcohol	Promotes good contact. Reasonably cheap	Smell. Irritant	30-40 minutes
Electrolyte Solution, e.g. Signa Spray by Parker	Non-irritant. Good contact. Low/zero odour	Less readily available. Increased cost	1 hour+
Cardiac Gel	Good sustained contact	Less easily available. Increased cost. Messy. Clogs up electrodes.	2 hours+
Self adhesive Electrodes	Clean. New contact every time. Simple to use	More expensive. Must prepare area. Not re-usable	2 hours+ Up to days in some cases

Remove outer layer of dead skin

- Common practice in human medicine to abrade skin with emery-paper prior to attaching ECG electrode.
- Removing some of outer keratinised skin markedly reduces skin resistance
- Last resort for that patient that will not give a good ECG

Minimise contact resistance

- Don't even try with a set of clips like this



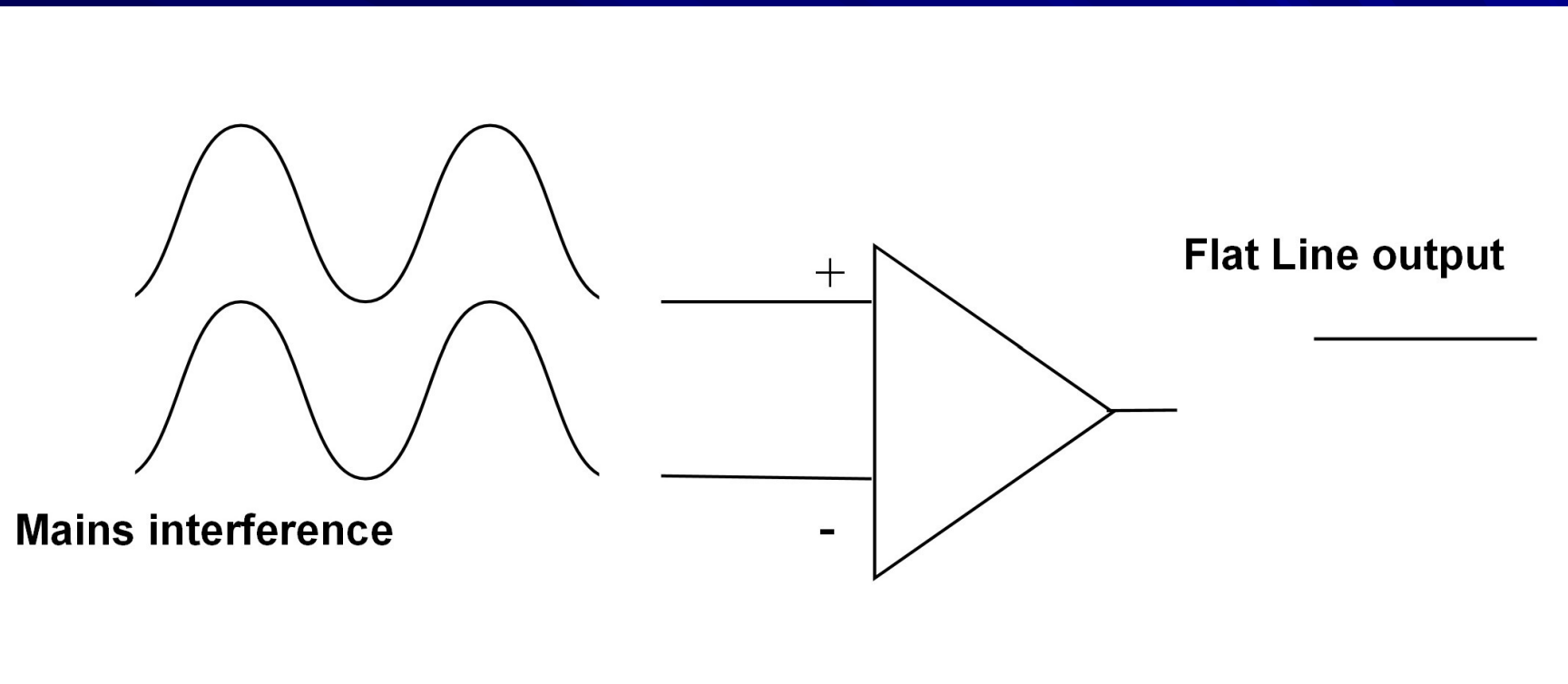
Minimise Noise Pickup

- So now you have a well attached ECG set of cables. Is that all you need for a good ECG?
- NO!
 - Must reduce noise pickup as well

Cable Position

- Cable position is extremely important
- Due to phenomenon of Common Mode Rejection
- Simply put – For best rejection of noise all leads must “see” the same interference

Common Mode Rejection



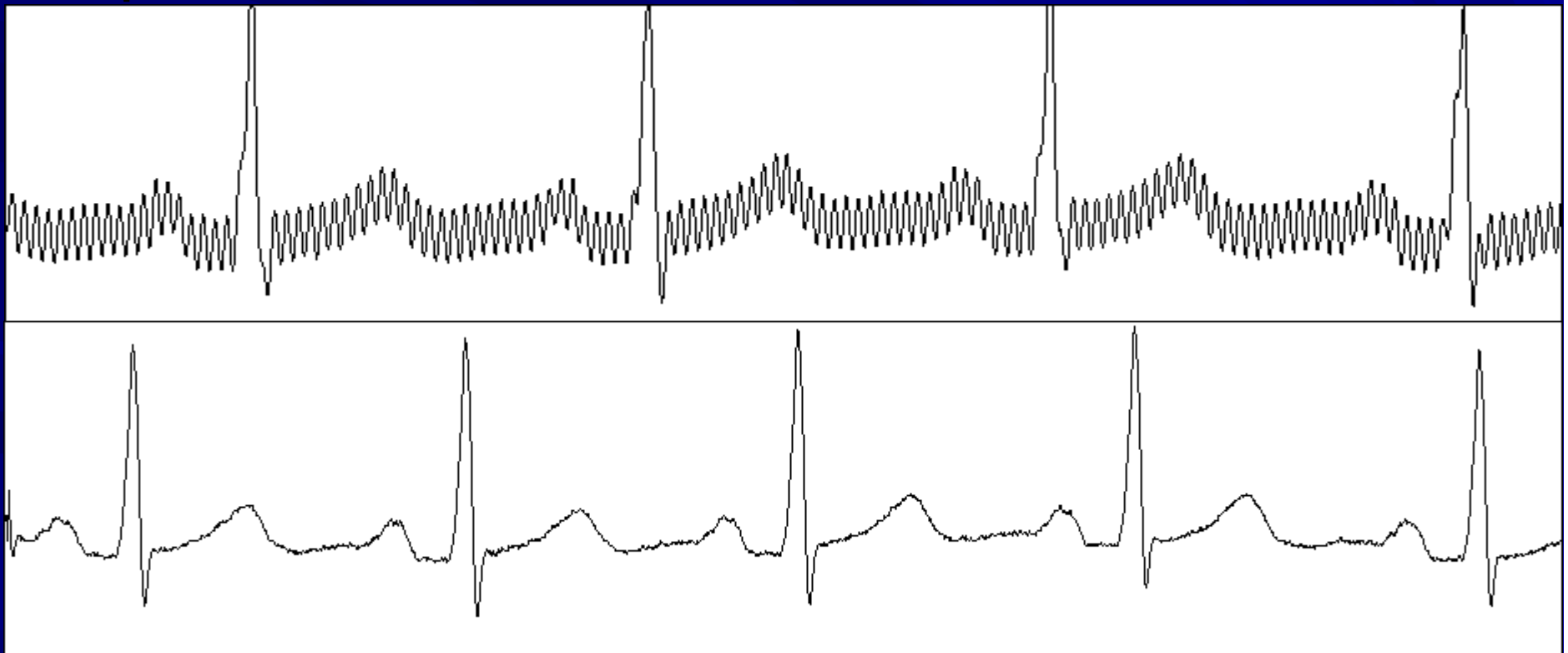
Improving Common Mode Rejection

- Minimise contact resistance
- All leads should be same length especially if unshielded
- All leads should run as close together as possible



Effect of cable spread

- The two pictures show the ECG of the patient with spread cables and with parallel cables



Demonstration of effect of Cable Spread

Getting a good ECG Trace

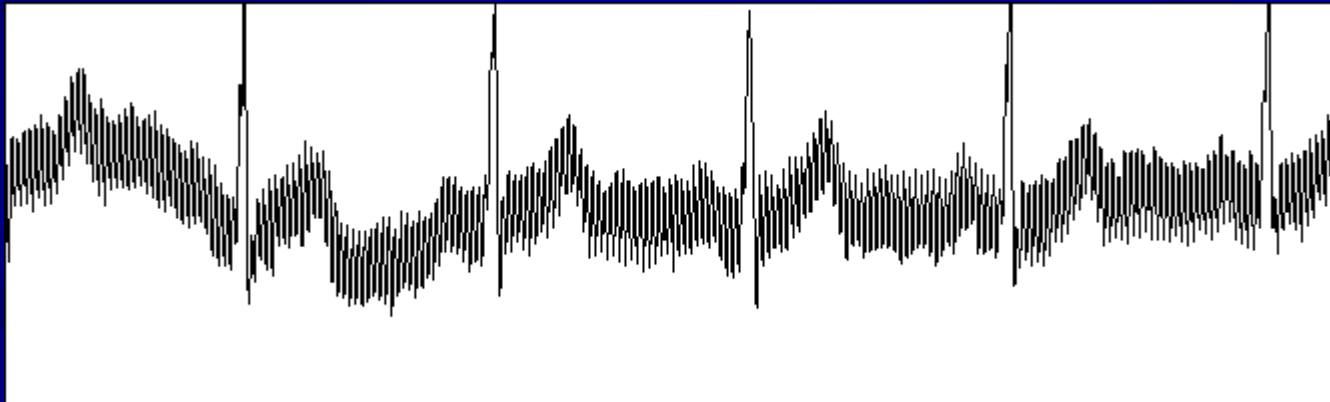
- The Equipment ✓
- Methods of attachment ✓
- Assessment
- What can go wrong
- How to remedy it

So you can't get anything but noise

What do you do?

Test the machine

Remove Causes of interference



Test the Machine

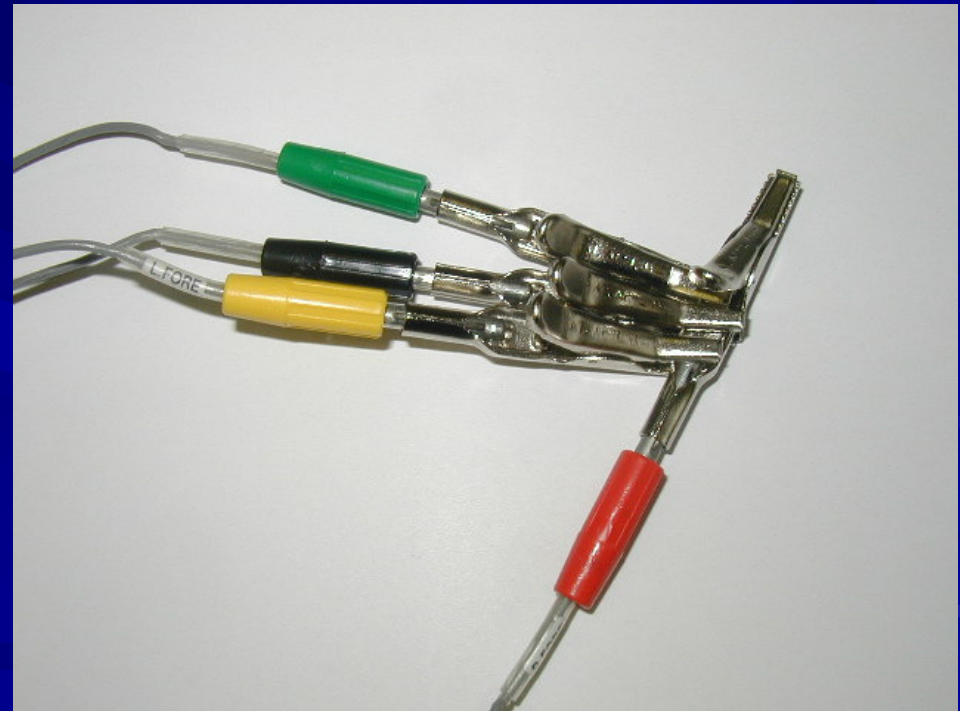
- Two very simple tests to assess the ECG machine
 - All Leads together
 - Individual Lead test

Test the Machine

- Two very simple tests to assess the ECG machine
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 - Individual Lead test

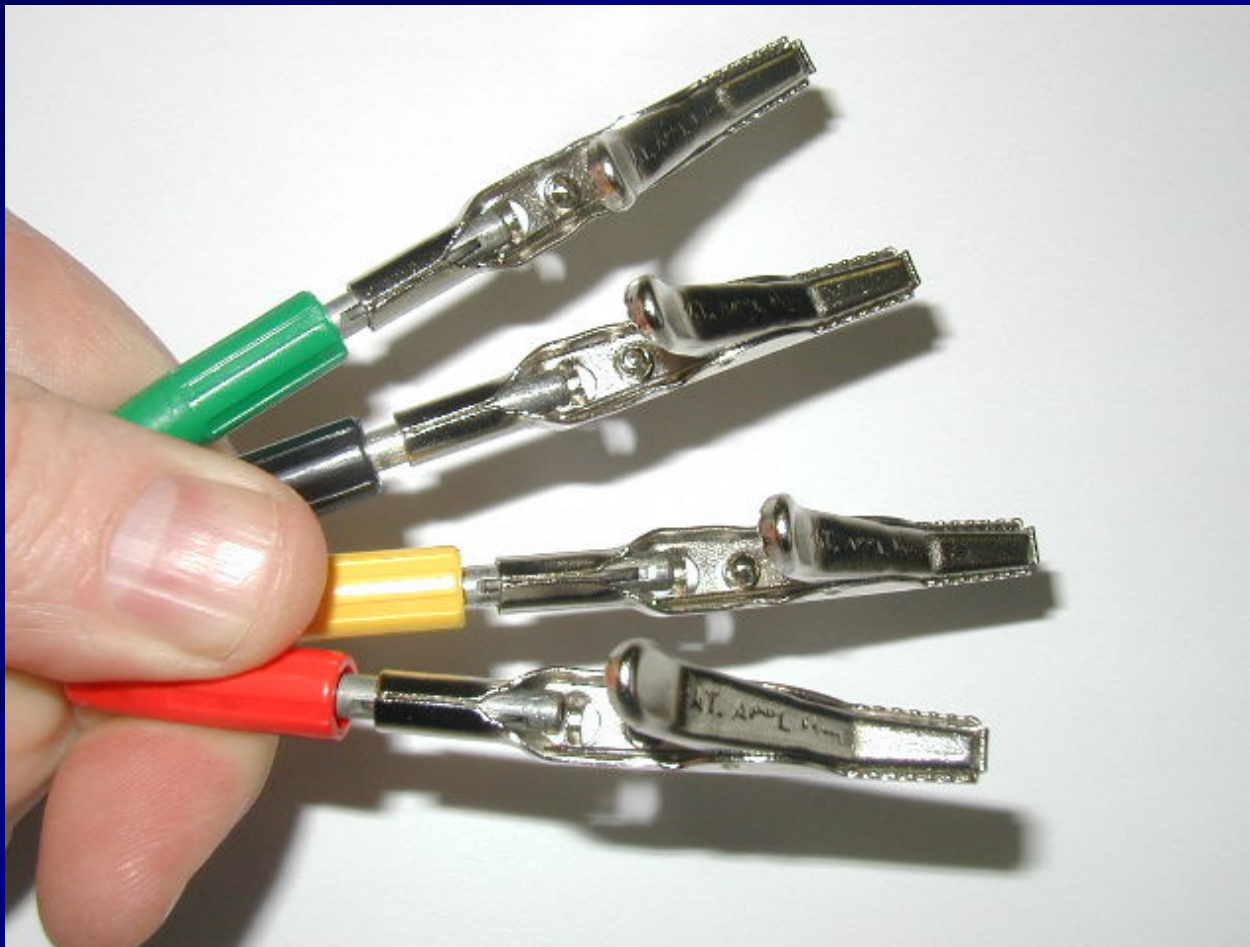
All Leads together

- On all Lead settings of the machine there should be a completely flat line. If not, there is a fault



Individual Lead Test

- Hold all four leads in one hand and fan out the clips



Individual Lead Test

- Touching any one of these leads (except Right Hind) should cause massive stylus movement or screen trace deflection.
- Touch each in turn. A properly functioning machine will have the following response

Individual Lead Test

■ Lead I

- Response with Right Fore and Left Fore
- No response with Left Hind or Right Hind

■ Lead II

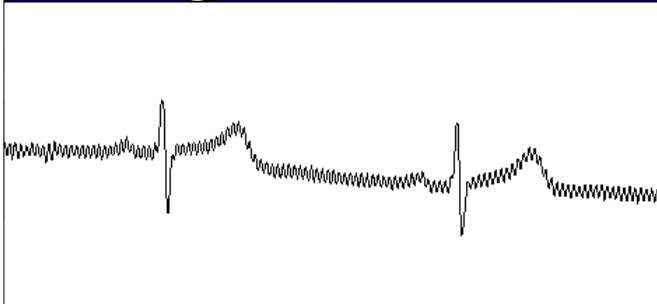
- Response with Right Fore and Left Hind
- No response with Left Fore or Right Hind

■ Lead III

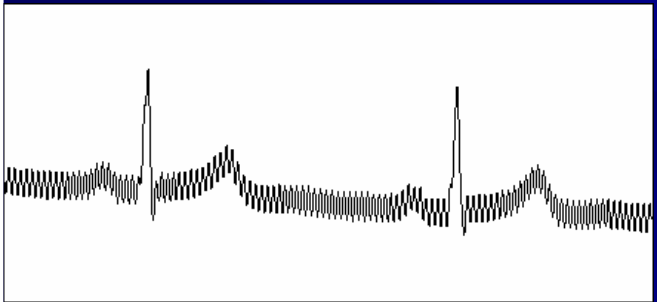
- Response with Left Fore and Left Hind
- No response with Right Fore or Right hind

Deducing a Lead problem from the ECG Result

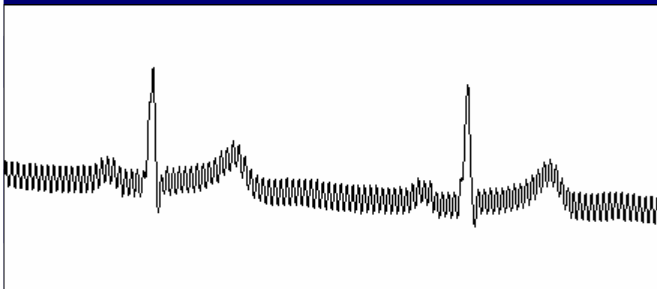
■ Right Hind contact problem



Lead I



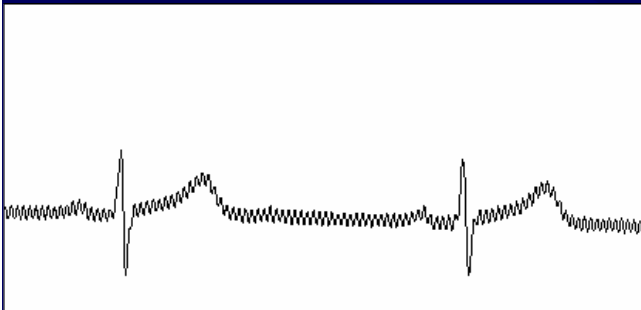
Lead II



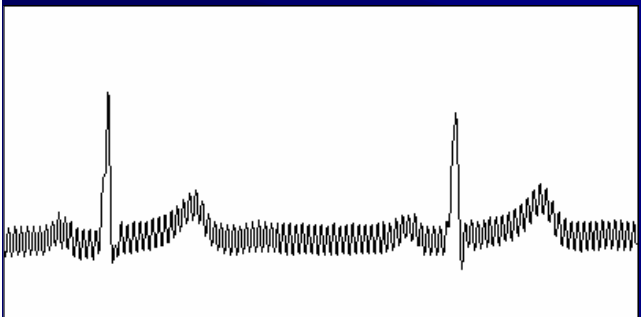
Lead III

Deducing a Lead problem from the ECG Result

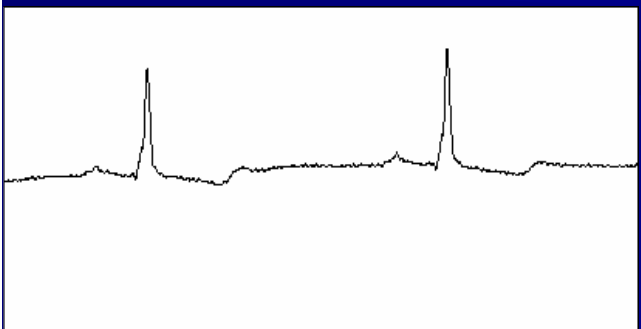
■ Right Fore contact problem



Lead I



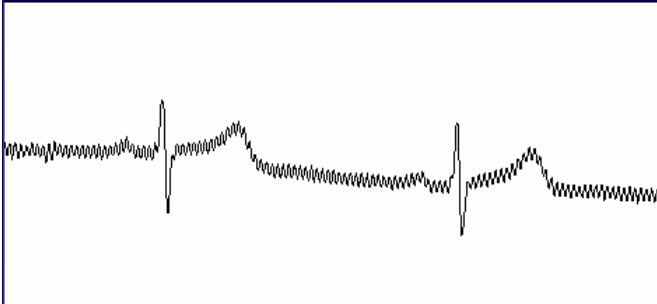
Lead II



Lead III (Does not involve RF)

Deducing a Lead problem from the ECG Result

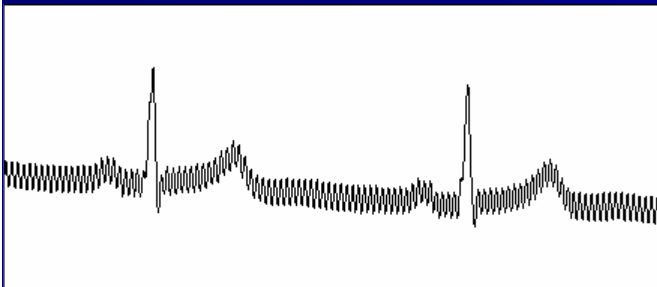
■ Left Fore contact problem



Lead I



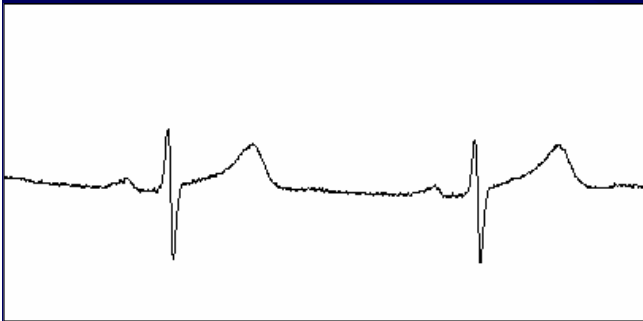
Lead II (Does not involve LF)



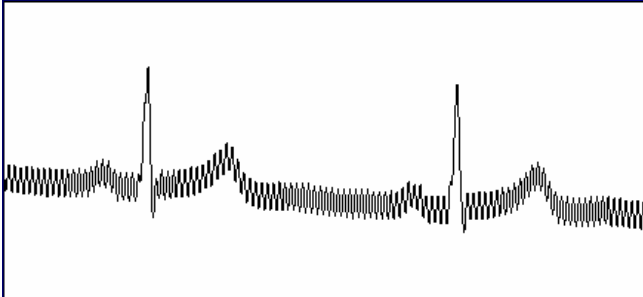
Lead III

Deducing a Lead problem from the ECG Result

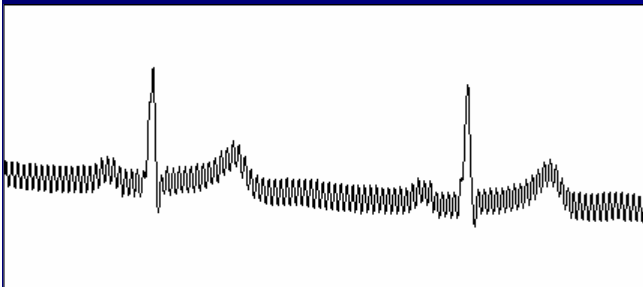
■ Left Hind contact problem



Lead I (Does not involve LH)



Lead II



Lead III

Sources of interference

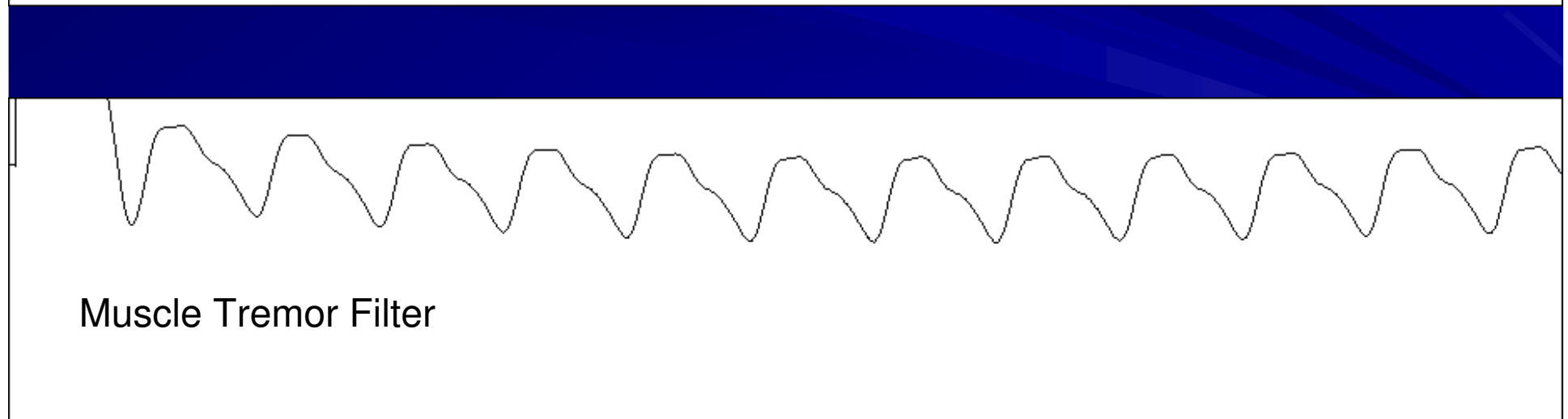
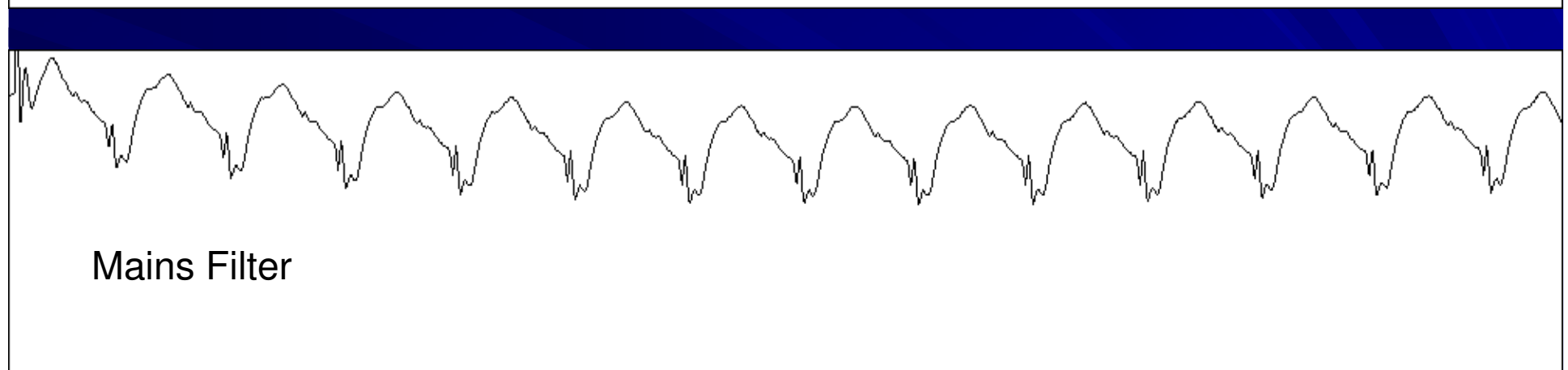
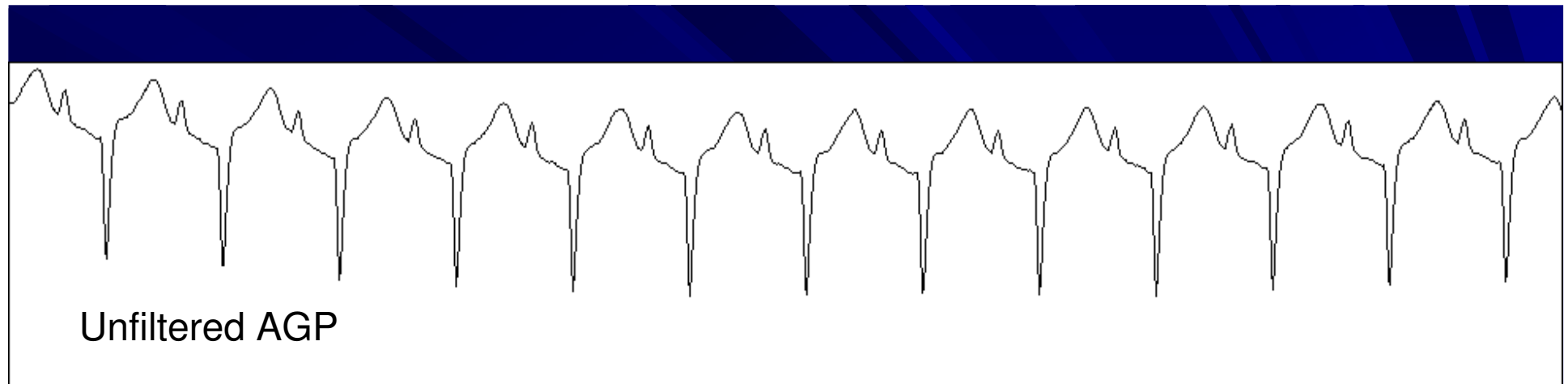
- Mains induced noise
- Movement
- Mobile phones
- Newer digital Cordless phones

Getting a good ECG Trace

- The Equipment ✓
- Methods of attachment ✓
- Assessment ✓

Dealing with Noise

- Try to avoid using filters whenever possible
- It will always alter the ECG to some extent. How much will depend on the filter and the characteristics of the ECG e.g. birds



Make rapid reliable measurements

- This is one area where digital technology takes over from older methods
- Measurements can be made very quickly and accurately on a digital system.

Parameter Measurement

- All our digital systems allow on-screen measurements with a mouse
- Produces more accurate and faster results
- All results are already on the computer, no need to add later. Simply save file with patient records

ECG interpretation

- Now armed with the array of measured ECG parameters you can begin the task of ECG interpretation

Some helpful tools

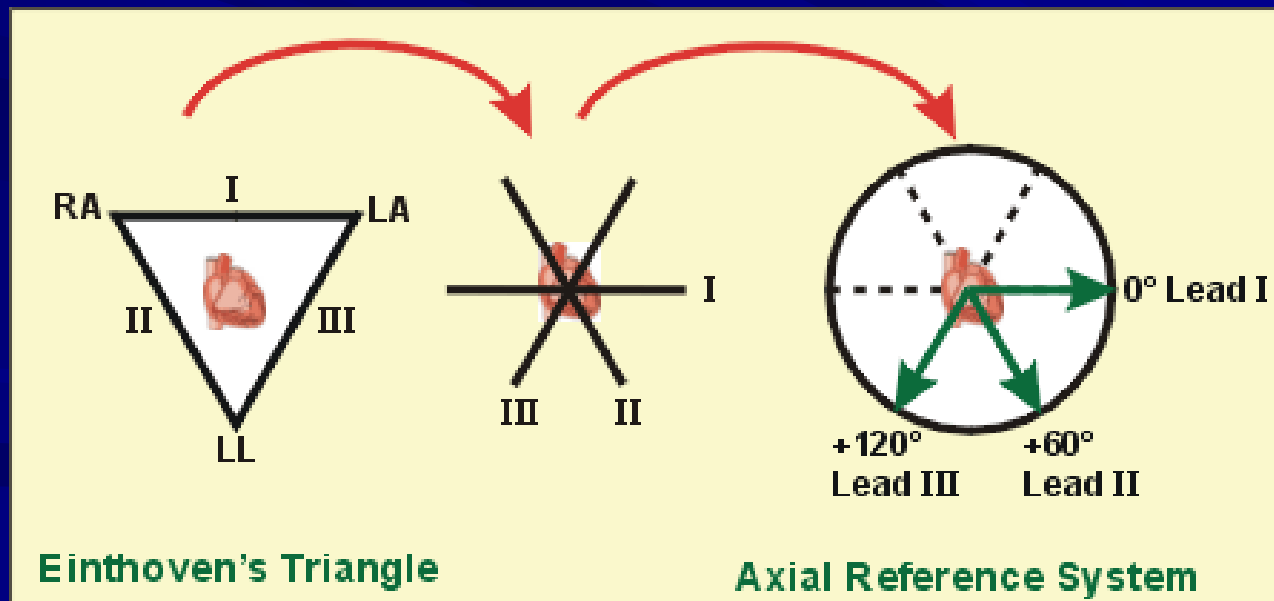
- From UC Davis web site
<http://vetpda.ucdavis.edu/Projects/VetPDA-Calcs.cfm>

LEAD I	4												
LEAD II	12												
LEAD III	12												
MEA													
Calculate													
	<table> <tr> <th></th> <th>Normal MEA</th> <th>RA Deviation</th> <th>LA Deviation</th> </tr> <tr> <td>DOG</td> <td>40-100</td> <td>> 100</td> <td>< 40</td> </tr> <tr> <td>CAT</td> <td>0-160</td> <td>> 160</td> <td>< 0</td> </tr> </table>		Normal MEA	RA Deviation	LA Deviation	DOG	40-100	> 100	< 40	CAT	0-160	> 160	< 0
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LEAD I	4												
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Calculate													
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- Extremely readable and informative text with excellent descriptions



The End

