



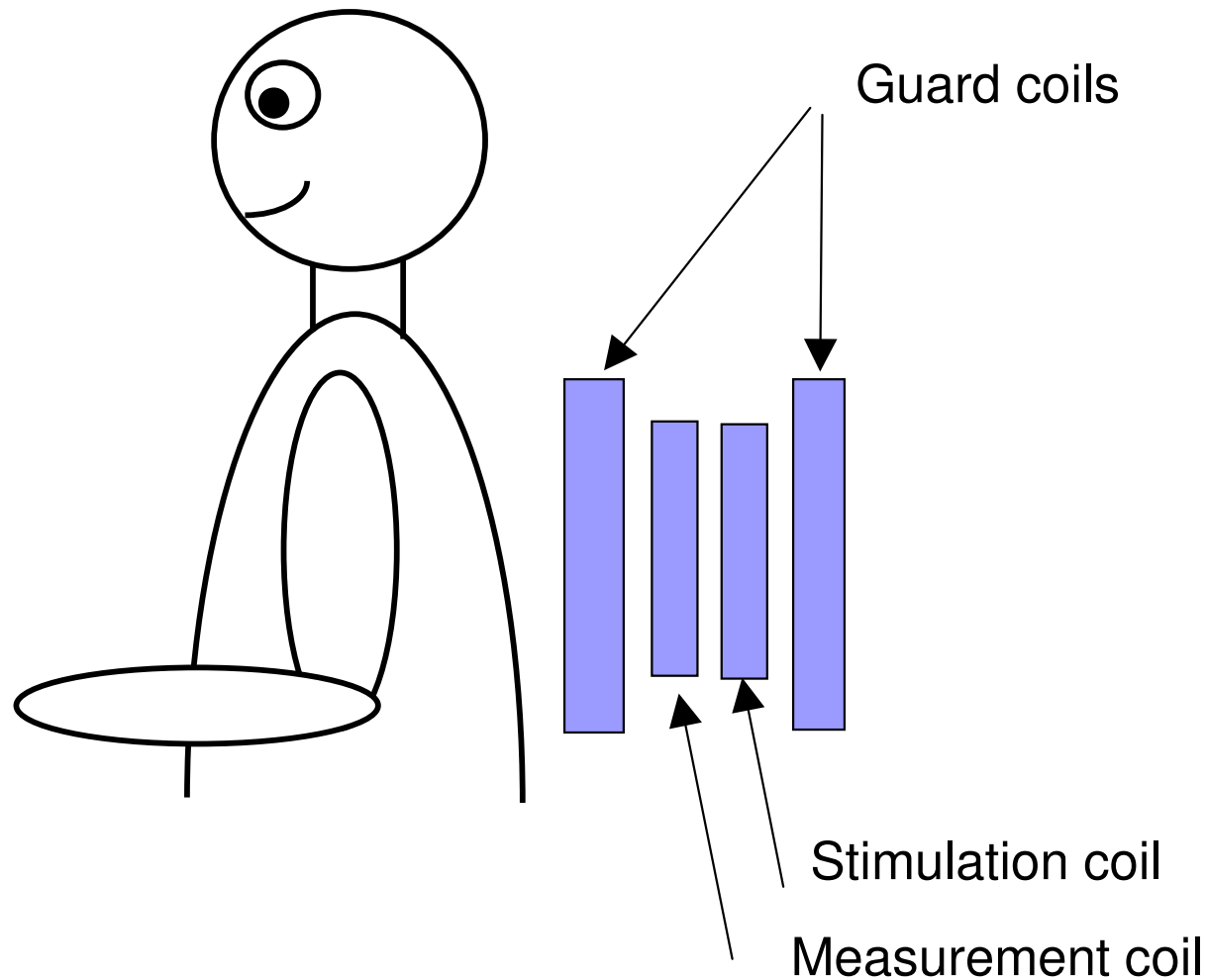
# Eddy Current Based Flexible Sensor for Contactless Measurement of Breathing

Alex Richer, Andy Adler  
SITE, uOttawa

# Eddy current monitoring

- Apply RF energy to body
- Energy induces *Eddy currents* in conductive tissues at signal frequency
- Eddy currents can be measured
  - With separate receive coil
  - With transmit coil, during or after signal

# Typical configuration

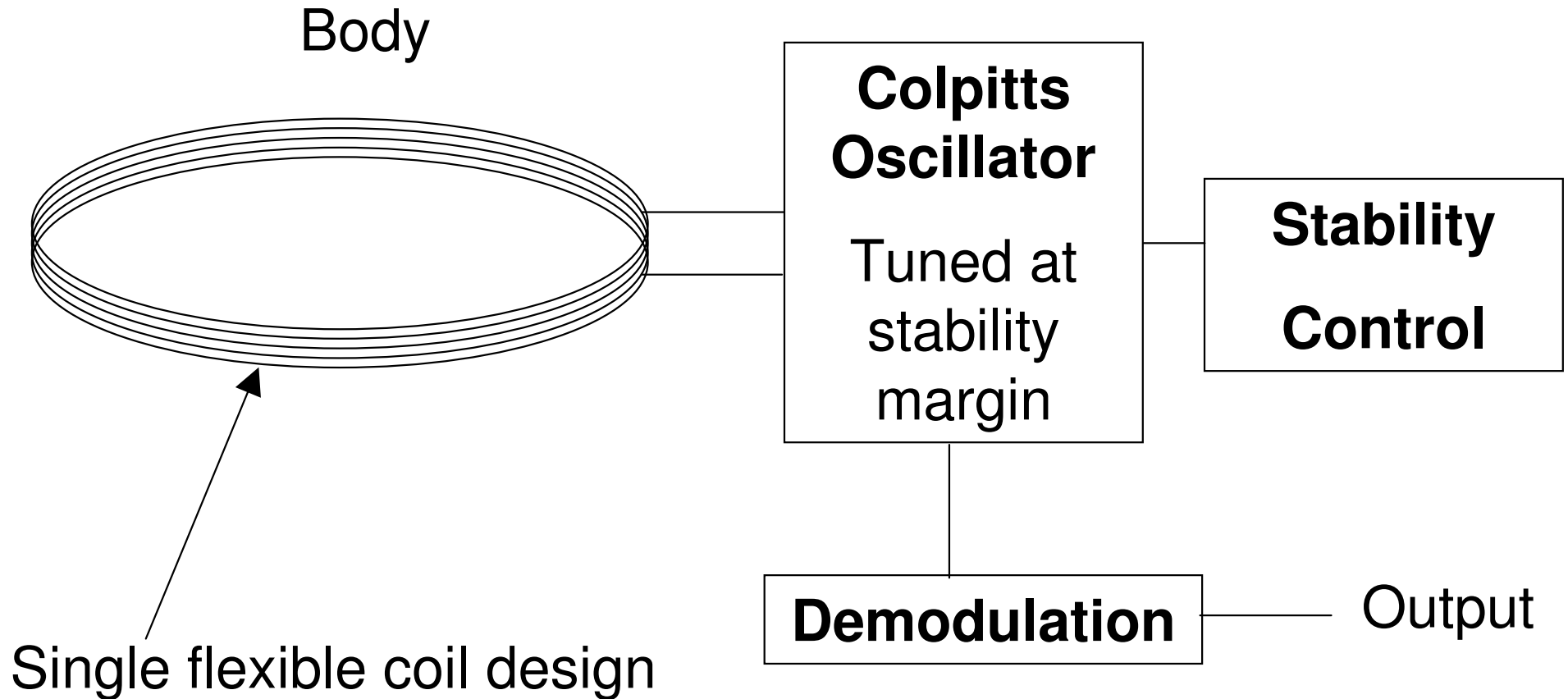


Measurement coil  
Can be at 90° to  
Stimulation to reduce  
interference

# Challenges

- Small signals from biological tissue
- Higher frequencies used (10MHz) to increase signal
- Sensitive to interference
- Sensitive to movement artefacts

# Our Design



coil used for both stimulation and measurement

# Electronics Designs

## Design #1 (1995):

- AM demodulator measures signal

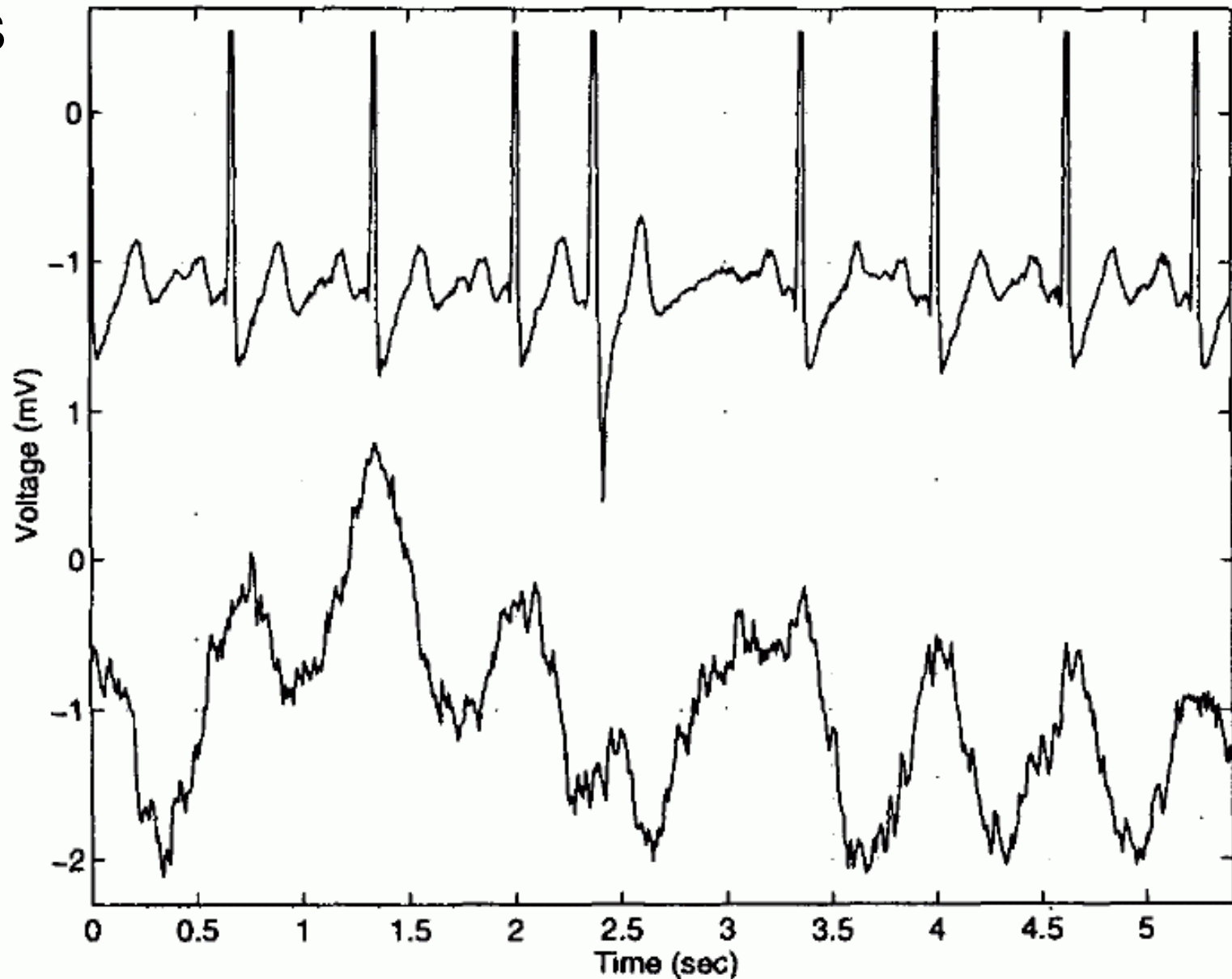
## Design #2 (1997):

- Amplitude of oscillation is maintained with feedback loop.
- Output signal is feedback control signal

## Advantages

- Improved Linearity, Stability

# Results



**figure 5:** Simultaneous record of an electrocardiogram and the signal from the EM sensor (lower trace), showing changes in thoracic conductivity produced by normal, extrasystolic and compensatory beats.

# Performance

## Good:

- Sensitive to heart and lung activity
- Can detect rhythms
- Can detect relative amplitude of activities

## Bad:

- Large motion artefacts
- Sensitive to movement nearby
- Not suitable for quantitative measurement

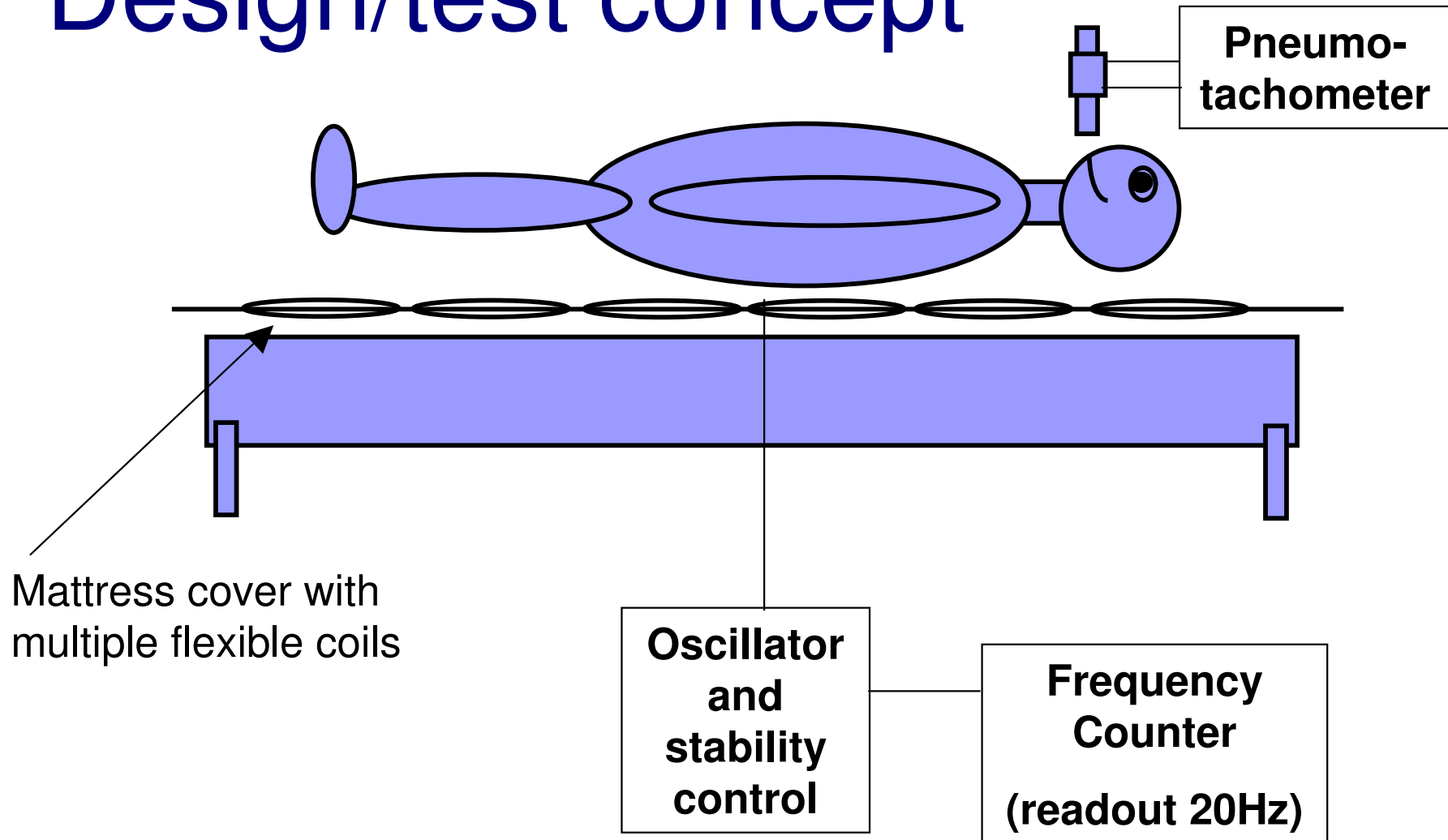


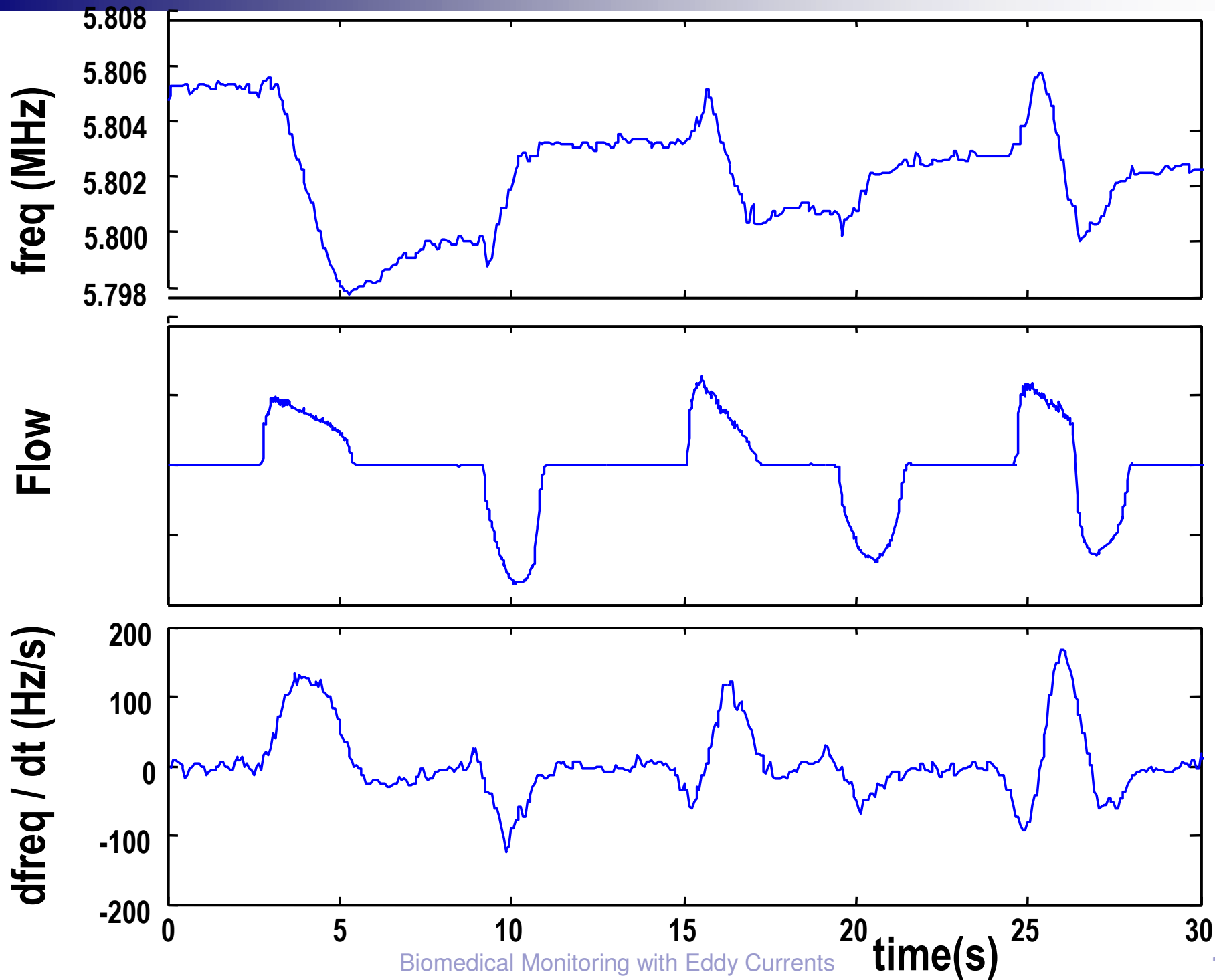
# Current work:

## Sleep monitoring application

- Flexible coils
  - Possible due to Single send/receive coil
- Frequency counter to demodulate signal
  - Demodulation of DC component
- Movement artefact is occasional, and can be detected

# Design/test concept





# Technology: *Applications*

- Infant Apnea Monitoring:
  - significant concern regarding *infant apnea* and *SIDS*.
- Adult sleep monitoring:
  - Obstructive sleep apnea measurement
  - 12x increase in reported cases 1990 – 1998

# Technology: *Advantages*

- *Lung volume measurement:*
  - measurement of volume and breath timing
- *Safe:*
  - Radio energy far below standards.
  - Non-contact operation and design
- *Inexpensive:* Commodity Electronics components and techniques.

# Technology: *Issues*

- *Movement artefacts:*
- *Calibration:*
  - Need calibration to relate  $\Delta\text{freq}$  to Volume
- *Accuracy and stability:*
  - Small signal levels make accuracy difficult