# ECG Derived Respiration

## Using Spatial Information in the VCG

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# Goals of Presentation

- Some Cardiology
- Some Math
- What is EDR ?
- Various methods
- Our Implementation
- Results

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# Electrocardiography

## Bio Medical Signal Processing

- ECG Lead Positions
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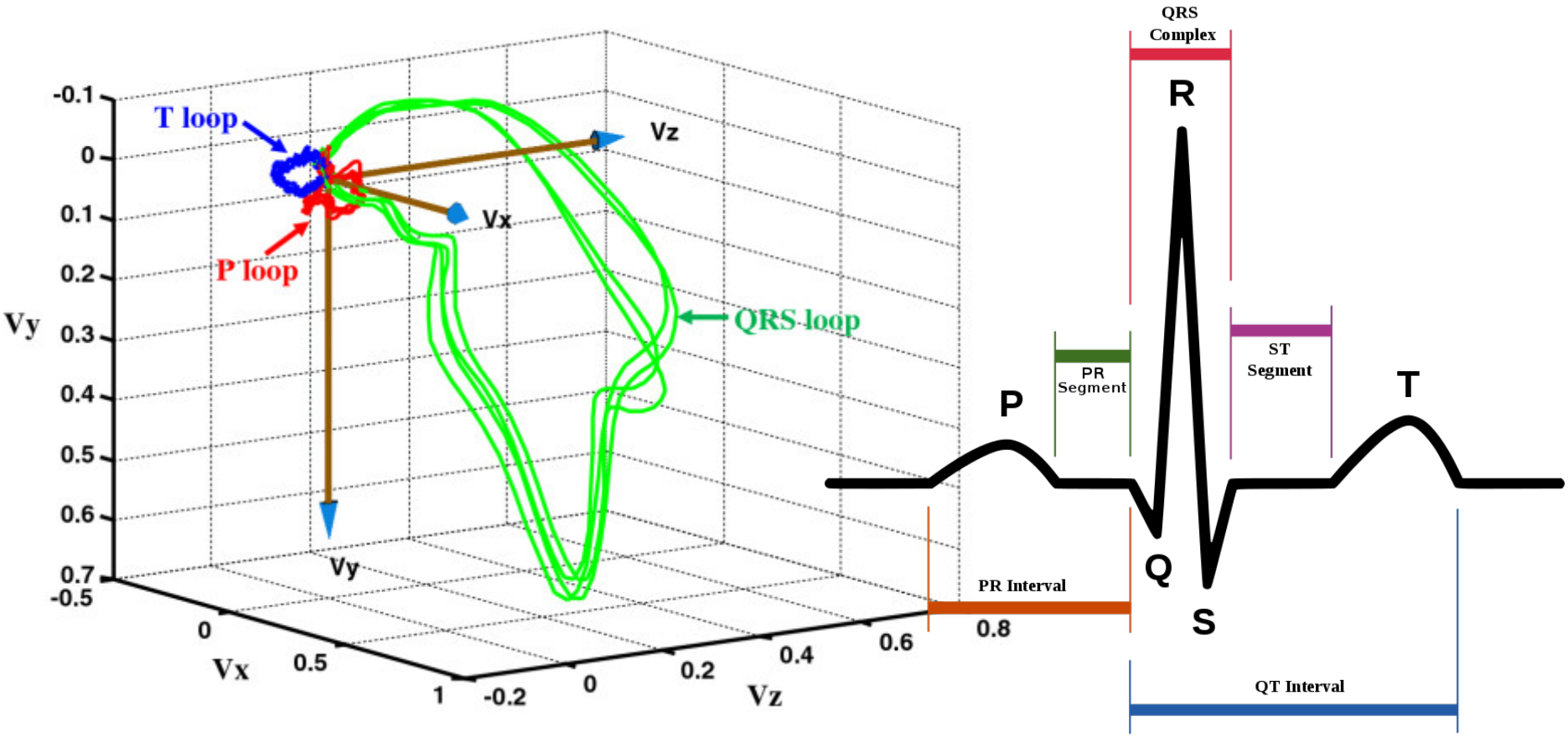

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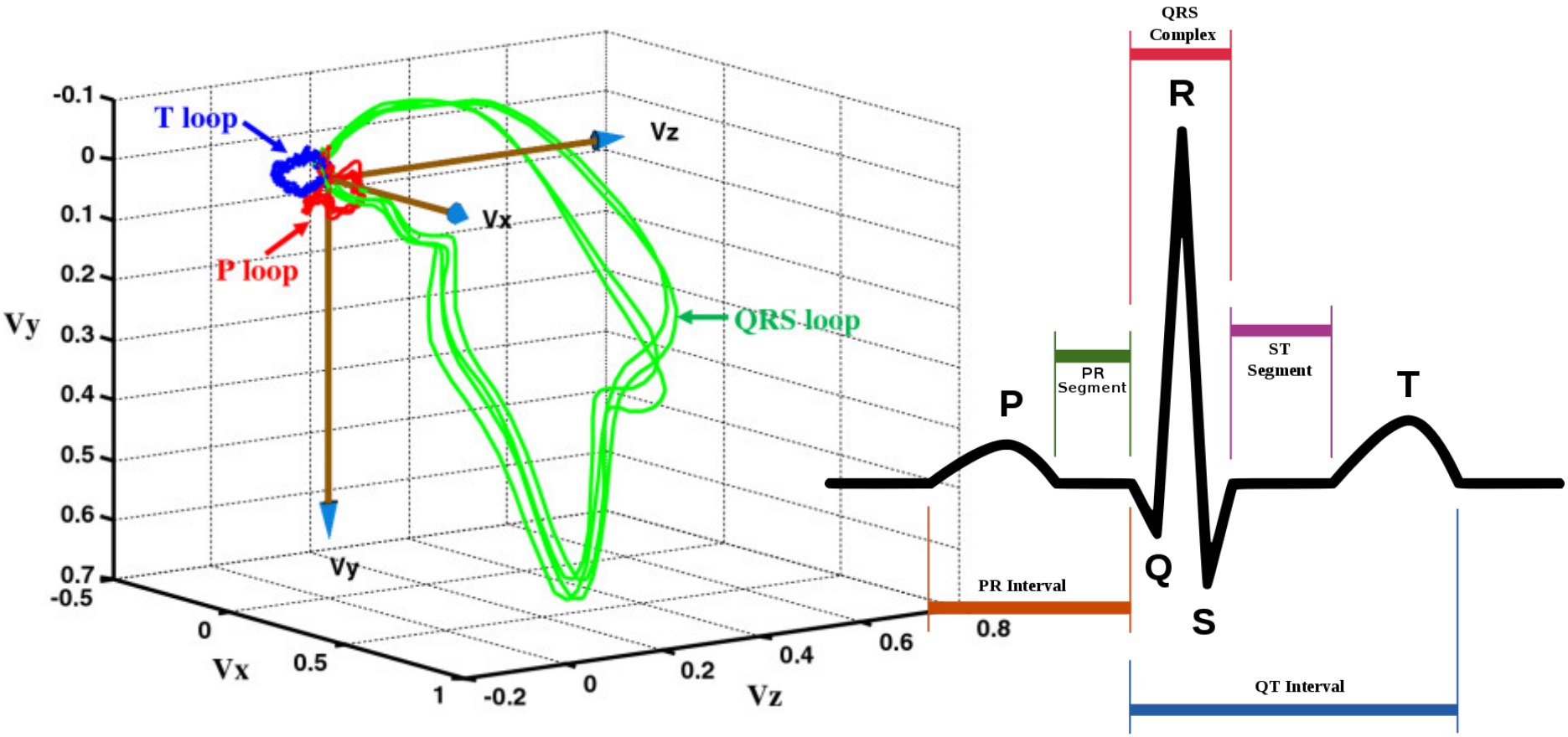

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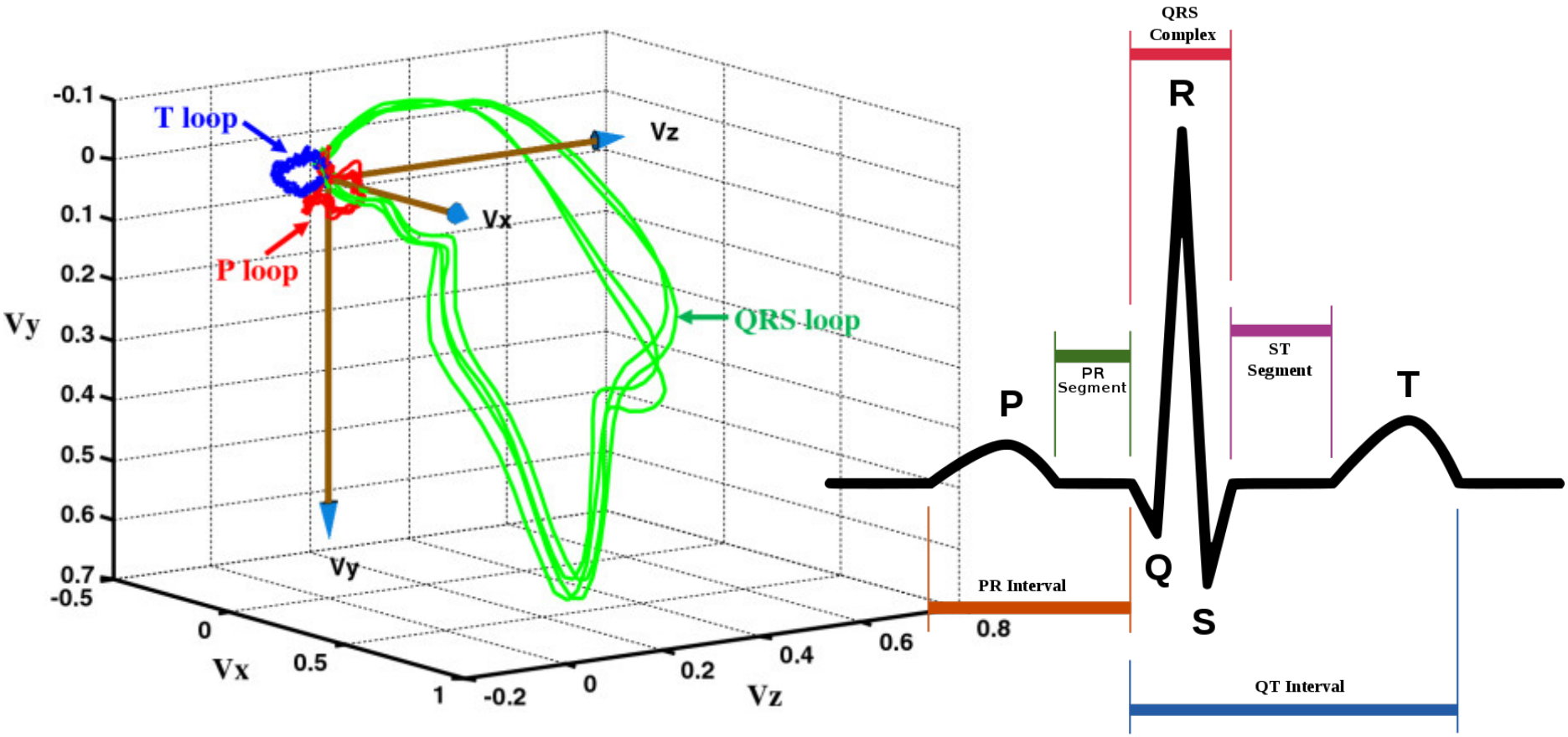

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## Since 1967

- What is EDR ?
- Significance
- Different Methods
  - Ratio of Area on two leads - Moody et al.
  - Ratio of amplitudes R and S on a Single Lead - Maxson et al.
  - Using Spatial Information in the VCG - Leanderson et al.

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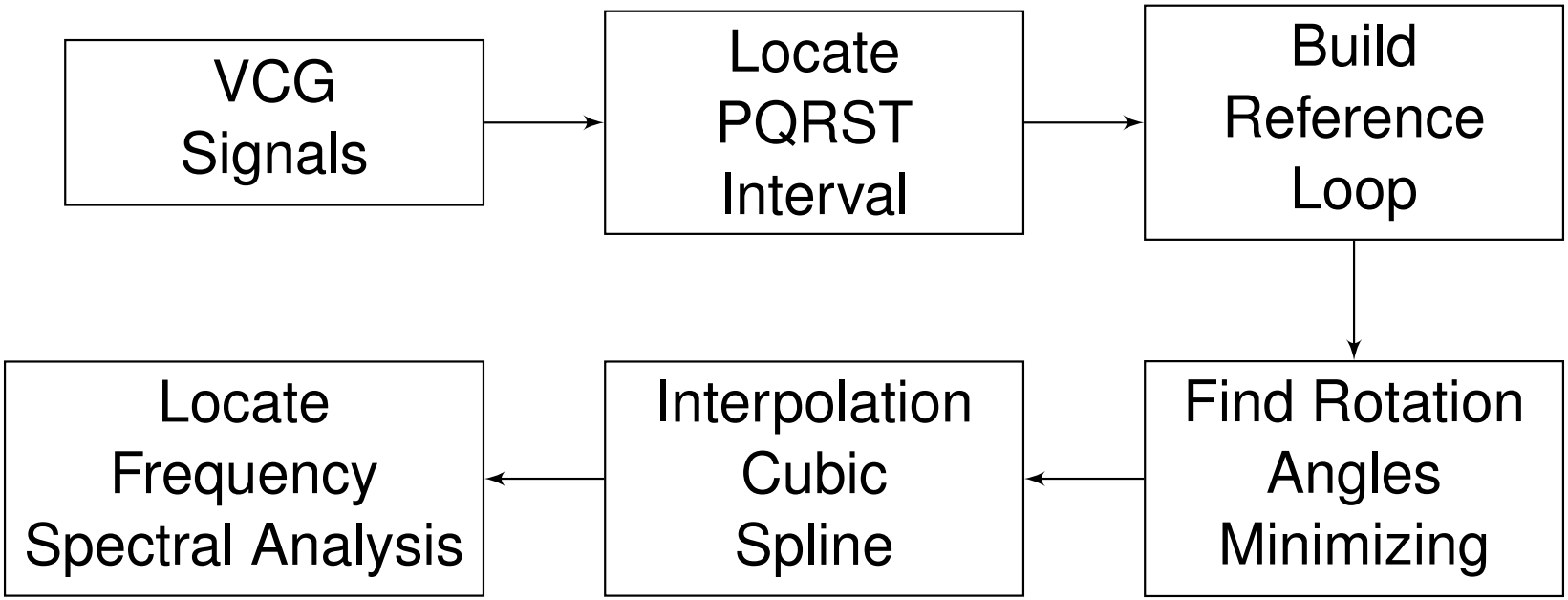
# Using Spatial Information in the VCG

## S.Leanderson et al



# Maximum Likelihood VCG Loop Alignment

Leif Sornomo

- Transformations
  - Translation
  - Rotation
  - Scaling
  - Time Synchronization

$$J_T = \begin{bmatrix} 0_{\delta+\tau} \\ I \\ 0_{\delta-\tau} \end{bmatrix}$$

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Estimate Q using SVD

$$Z = YJ^T_\tau Y^T_R$$

- Finding angles -

$$Q = \begin{bmatrix} * & sin\varphi_z cos\varphi_y & sin\varphi_y \\ * & * & sin\varphi_x cos\varphi_y \\ * & * & * \end{bmatrix}$$

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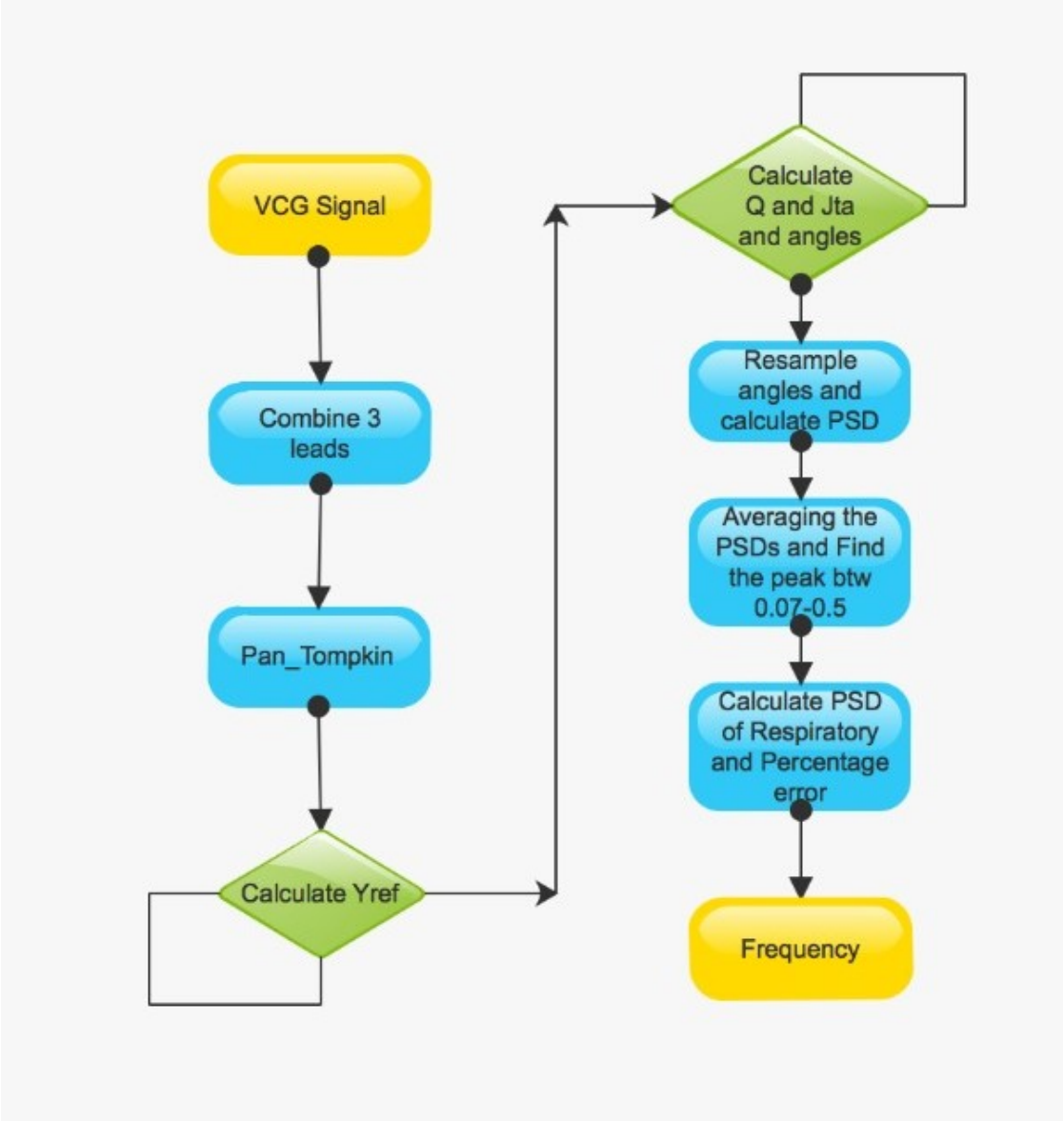
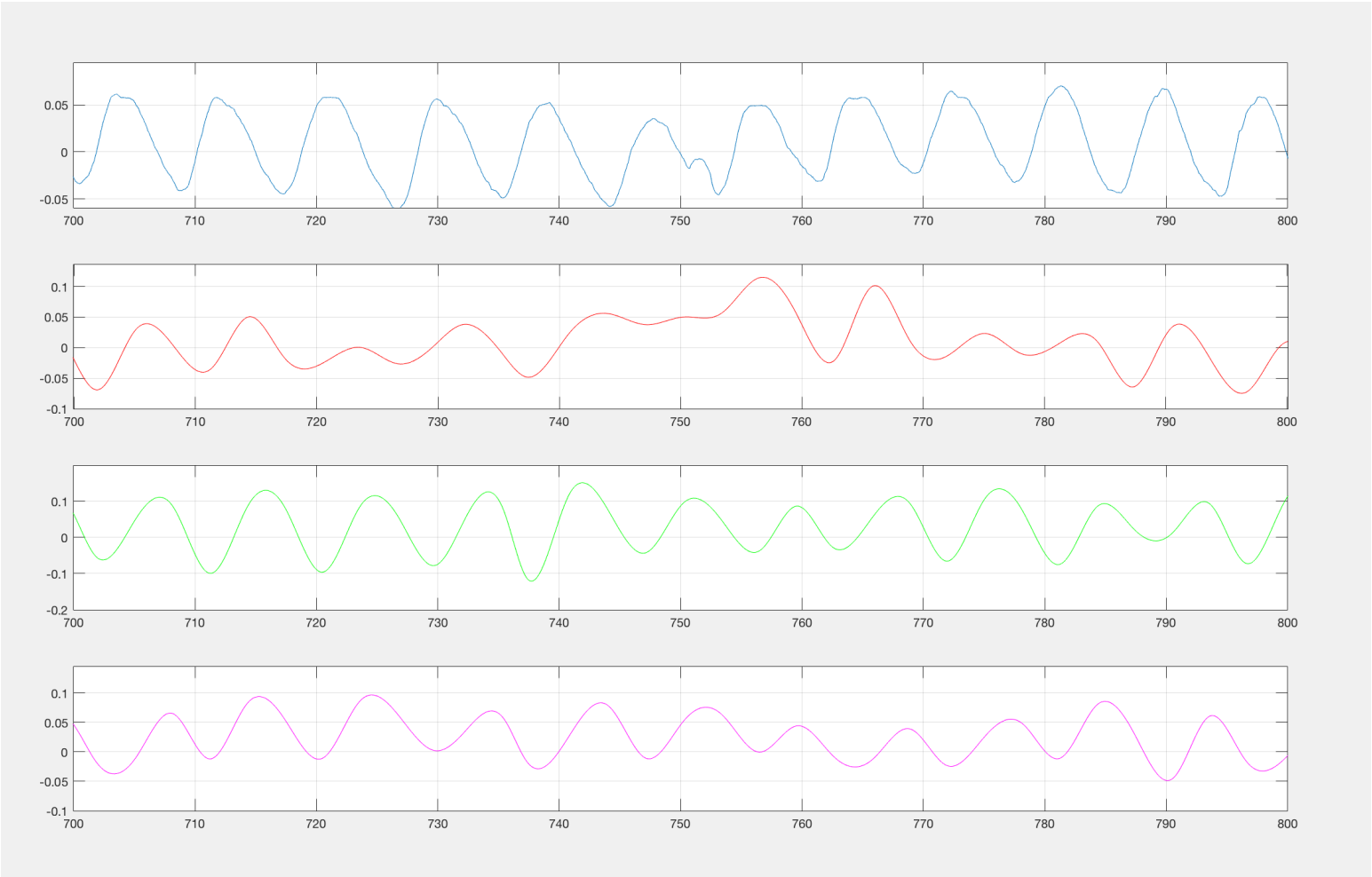
# Flowchart


VCG Signal
Combine 3 leads
Pan_Tompkin
Calculate Yref
Calculate Q and Jta and angles
Resample angles and calculate PSD
Averaging the PSDs and Find the peak btw 0.07-0.5
Calculate PSD of Respiratory and Percentage error
Frequency

# Results

| Input Signal | Actual Frequency | Spatial Info | | EDR +HR | QRS Area |
|---|---|---|---|---|---|
| | | W Opt | W/O Opt | | |
| 1 | 23 | 23 | 23 | 24 | 23 |
| 2 | 15 | 15 | 15 | 15 | 24 |
| 3 | 15 | 10 | 10 | 5 | 13 |
| 4 | 17 | 21 | 17 | 21 | 18 |

# EDR With Operator Splinting



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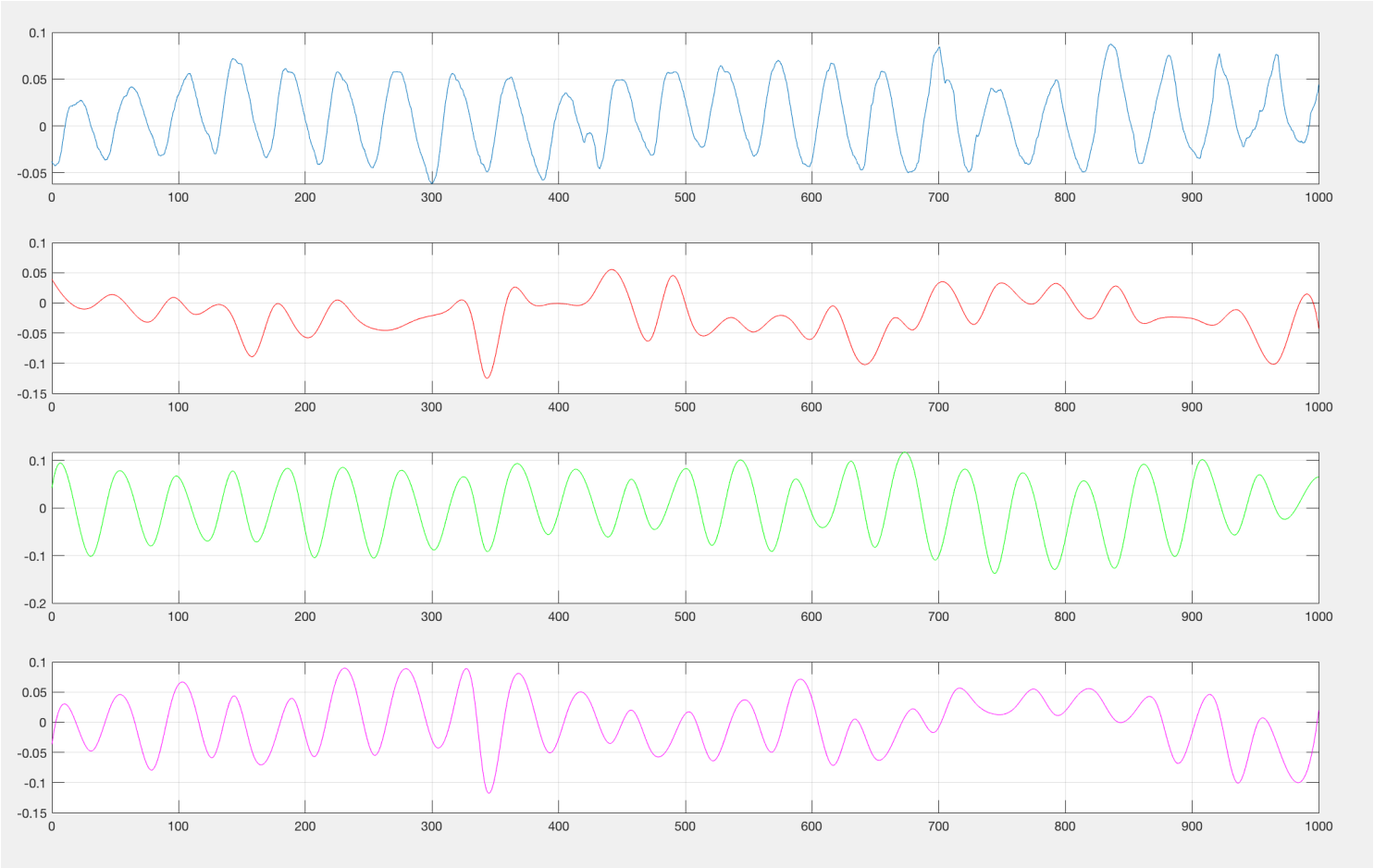

# Thank you