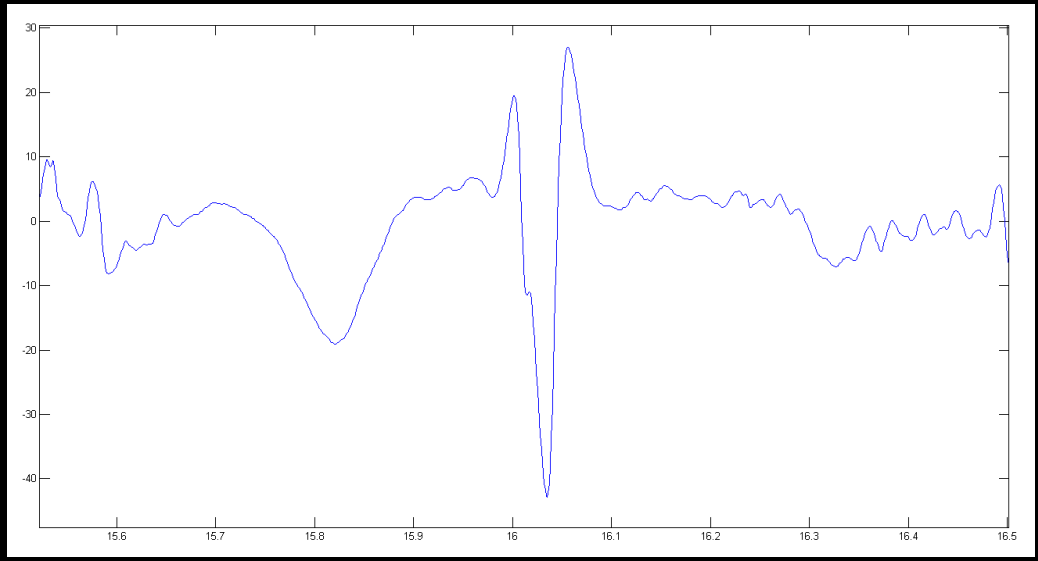
Basic ECG Waveform Annotations

Parsing
Extractor
Segmentor



Abhejit Rajagopal with Fabien Scalzo

May 14, 2013

UCLA : CSm299s

A call to code!

Need:

- Robust way to extract fetal Q-S data
- Non-intrusive method to record

Proposed solutions:

- Perform signal analysis on maternal ECG
- Extract relevant features
- Implement machine learning to improve accuracy with real data

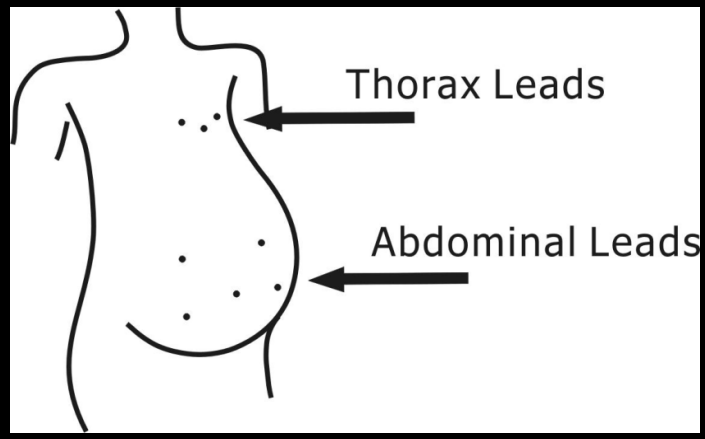


Hi,
I am the Cheese Shogun.
My wife is pregnant, and her family has a history of arrhythmia. How can we find out if my son has a problem before he is born?
I demand a solution!

Phase 0: Measuring the ECG

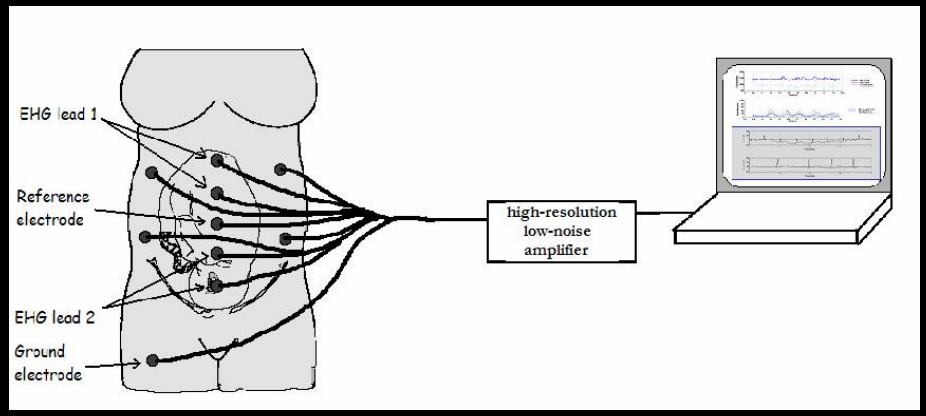
Non-instrusive methods!

(Abdomincal ECG)



Previously...

direct fetal electrocardiography (FECG) possible only during labor



Phase 1: Parsing

First step: parse data and store in appropriate form.

- Use Matlab to import data from txt/csv (csvimport)
- Store in Matlab arrays (trivial)



Choose a standard format for importing ECG data!

Phase 2: Extractor

Interesting Point extraction

- R-peaks (nqrsdetect)
- Alternate R-peaks (qrsdetect1/2)
- Plot data



Cheese Shogun advises you to use mature algorithms instead of *Reinventing the Horse*.

e.g. NSDL Toolbox!

Phase 2: Extractor

segmentor.m | main_script.m | extractor.m

```
1   %pre-defining matrix to length of ecg in question
2   newQRS=zeros(length(ekg1),1);
3
4   %% Finding R-peaks
5   nQRS = nqrsdetect(ekg1,1000);
6   HDR1 = qrsdetect(ekg1,1000,1);
7   h1QRS = HDR1.EVENT.POS;
8   HDR2 = qrsdetect(ekg1,1000,2);
9   h2QRS = HDR2.EVENT.POS;
10
11  [newQRS] = plotPOS(ekg1,nQRS,newQRS);
12  [newQRS] = plotPOS(ekg1,h1QRS,newQRS);
13  [newQRS] = plotPOS(ekg1,h2QRS,newQRS);
14
15  % plot em
16  figure;
17  plot(time,ekg1)
18  hold all;
19  plot(time,newQRS, 'o')
20  title('Various R-Peak Locations', 'FontWeight','bold')
21
```

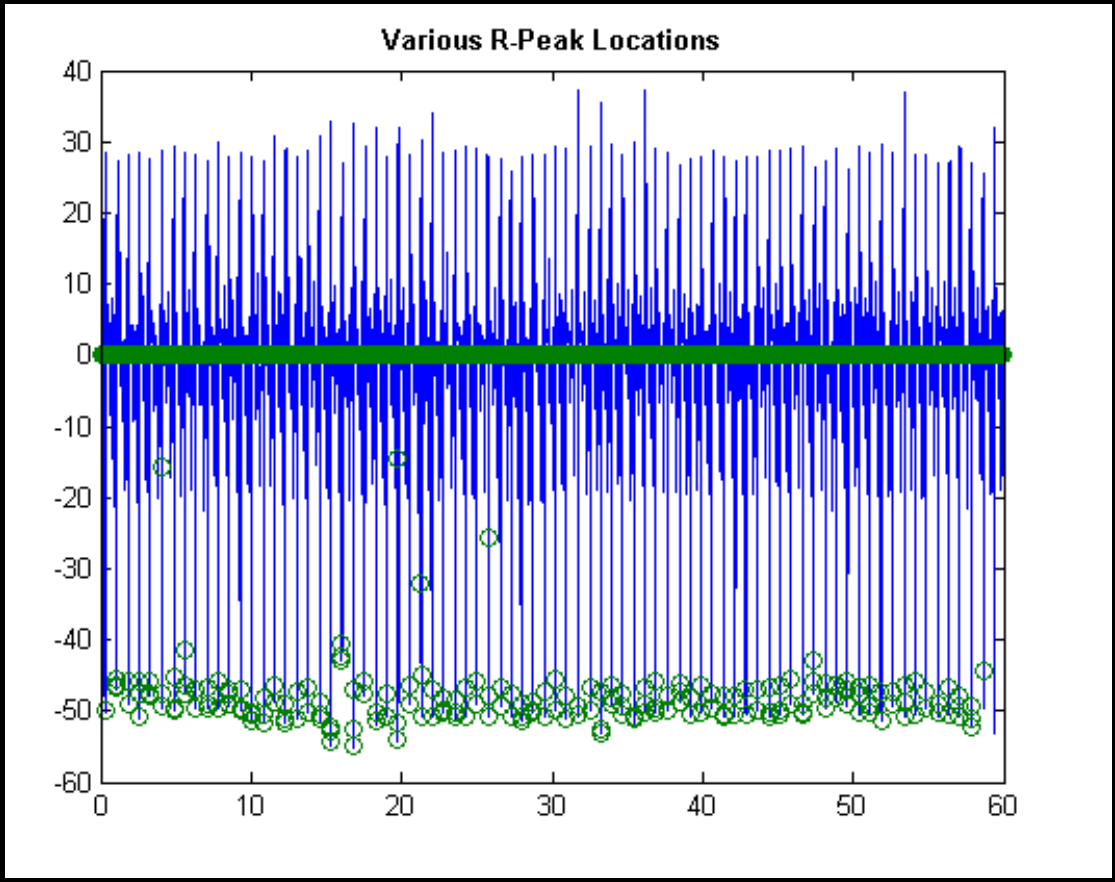
nqrsdetect algorithm for detecting R-peaks

plotPOS plots relevant points from original ecg

"hold all;" is a useful technique to auto plot multiple colors



Phase 2: Extractor



Noisy ECG data, 1 minute stream

Three different algorithms used to detect R-peaks.

Not 100% accurate,
but we have found so-called "peak candidates"

This is the super-position of the three vectors of points.

Phase 3: Segmentor

Segment beats according to rule

- Given R-peak locations
- Segment beats at midpoint
- Very-basic solution, may result in non-uniform results (OK for now)



Cheese Shogun figures that thresholding is a very *subjective* transform method. I'd like much better some rules that work for almost any input.

Phase 3: Segmentor

segmentor.m | main_script.m | extractor.m

```
1   %pre-defining matrix to length of ecg in question
2   % newQRS=zeros(length(ekg1),1);
3
4   %% Finding R-peaks
5   nQRS = nqrsdetect(ekg1,1000);
6   % HDR1 = qrsdetect(ekg1,1000,1);
7   % h1QRS = HDR1.EVENT.POS;
8   % HDR2 = qrsdetect(ekg1,1000,2);
9   % h2QRS = HDR2.EVENT.POS;
10
11  %% Segmentation
12
13  % [newQRS] = plotPOS(ekg1,nQRS,newQRS);
14  % [newQRS] = plotPOS(ekg1,h1QRS,newQRS);
15  % [newQRS] = plotPOS(ekg1,h2QRS,newQRS);
16
17  edges_locs = generate_edges_from_locs(nQRS);
18  segmented = segment_by_edge(time, ekg1,edges_locs);
19
20
21  % plot em
22  figure;
23  plot(time,ekg1)
24  for j=1:length(segmented)
25      hold all;
26      plot(segmented{j}(:,1),segmented{j}(:,2))
27  end
```

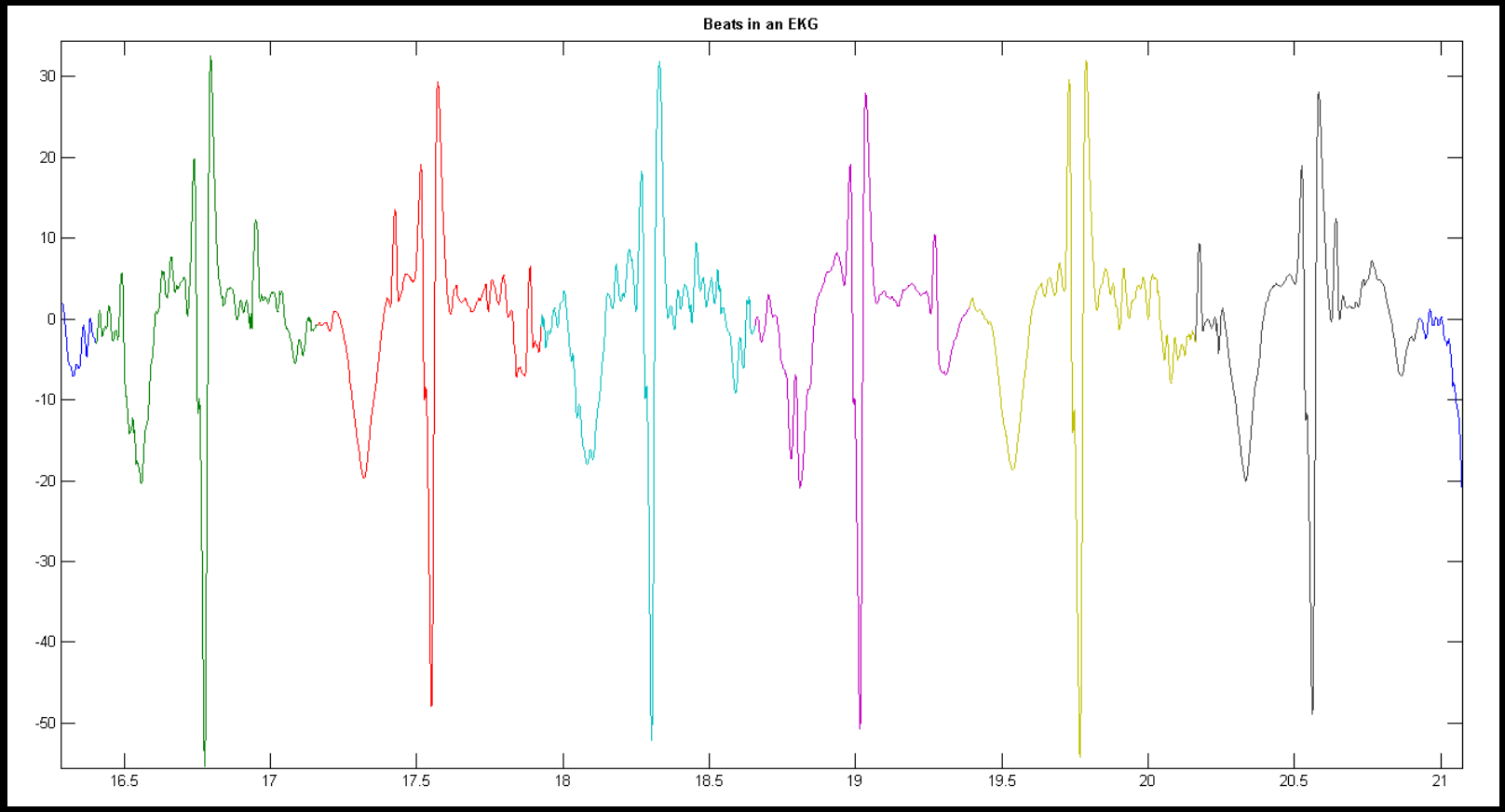
nqrsdetect algorithm for detecting R-peaks

dictates edge points as midpoint of two peaks

segments beats according to the rule (points)



Phase 3: Segmentor



Besides a few initial/final beats, the beat segmentor seems to work pretty well. However, this is subjective, so we'll need to verify its accuracy with a robust algorithm.

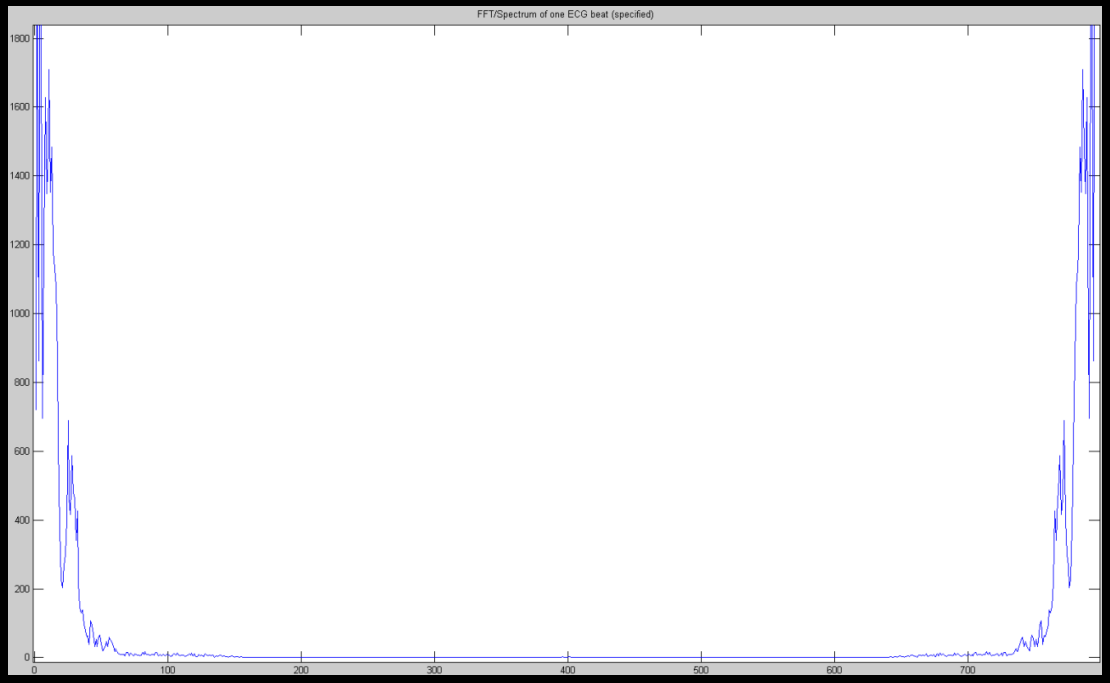
Next Steps?

- Verify segmentation (groundtruths)
- Large features analysis (maternal Q-R-S)
- Small feature analysis (fetal Q-S interval)

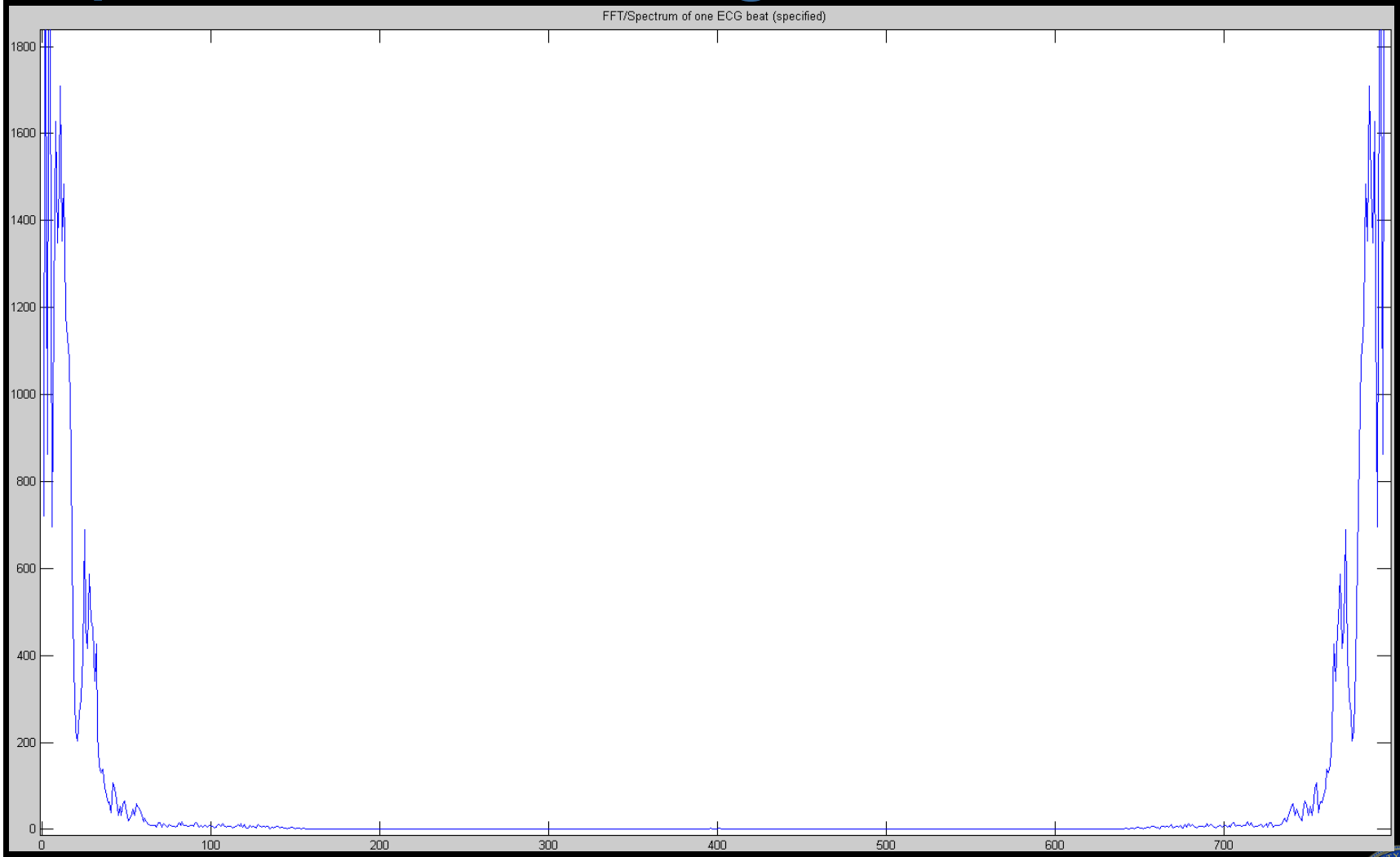


Messing around with Filters

- Take a given ECG beat and look at frequency spectrum
- Apply some rough filtering to see what happens



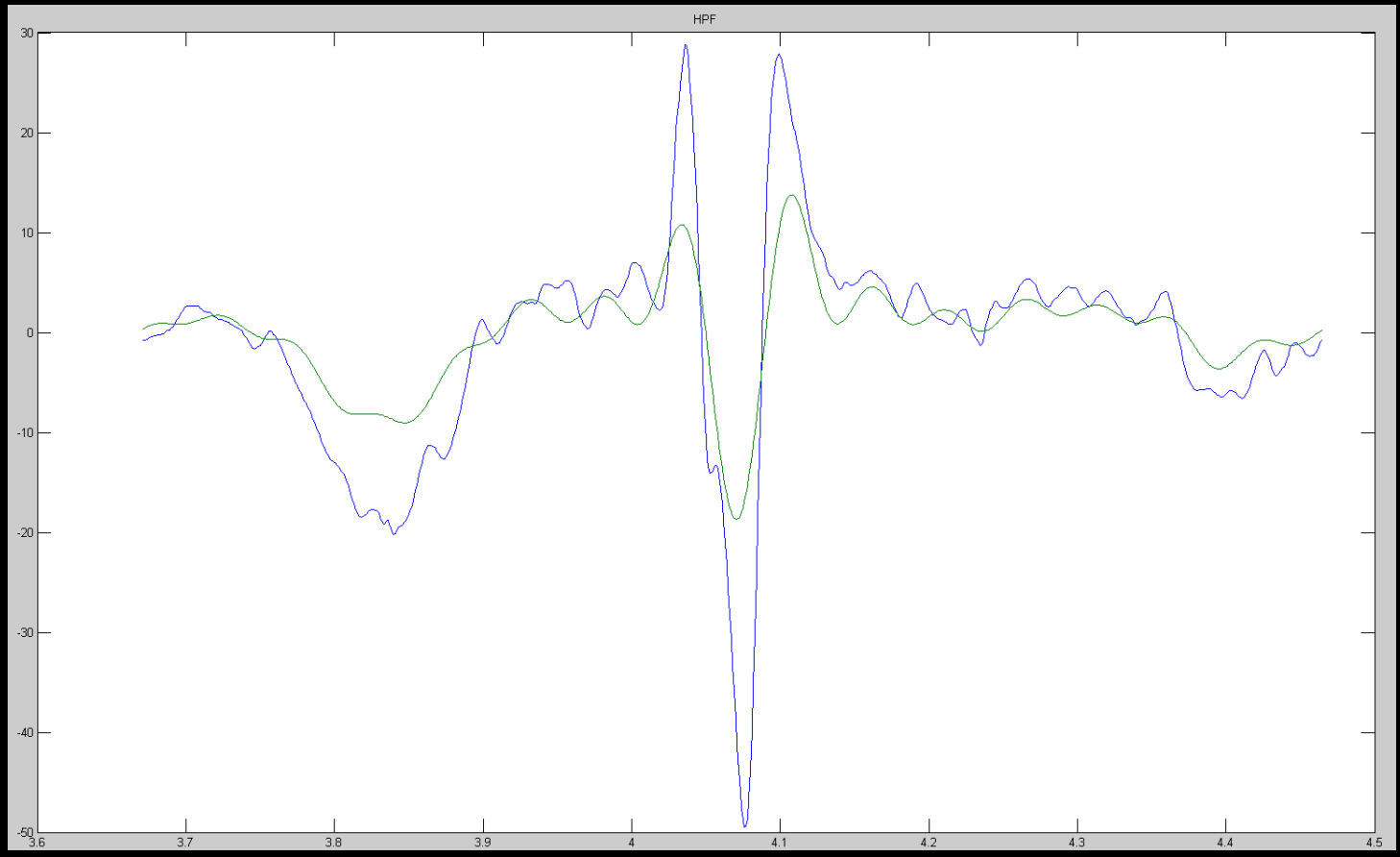
Spectrum of a single ECG beat



Length(fft) = 795

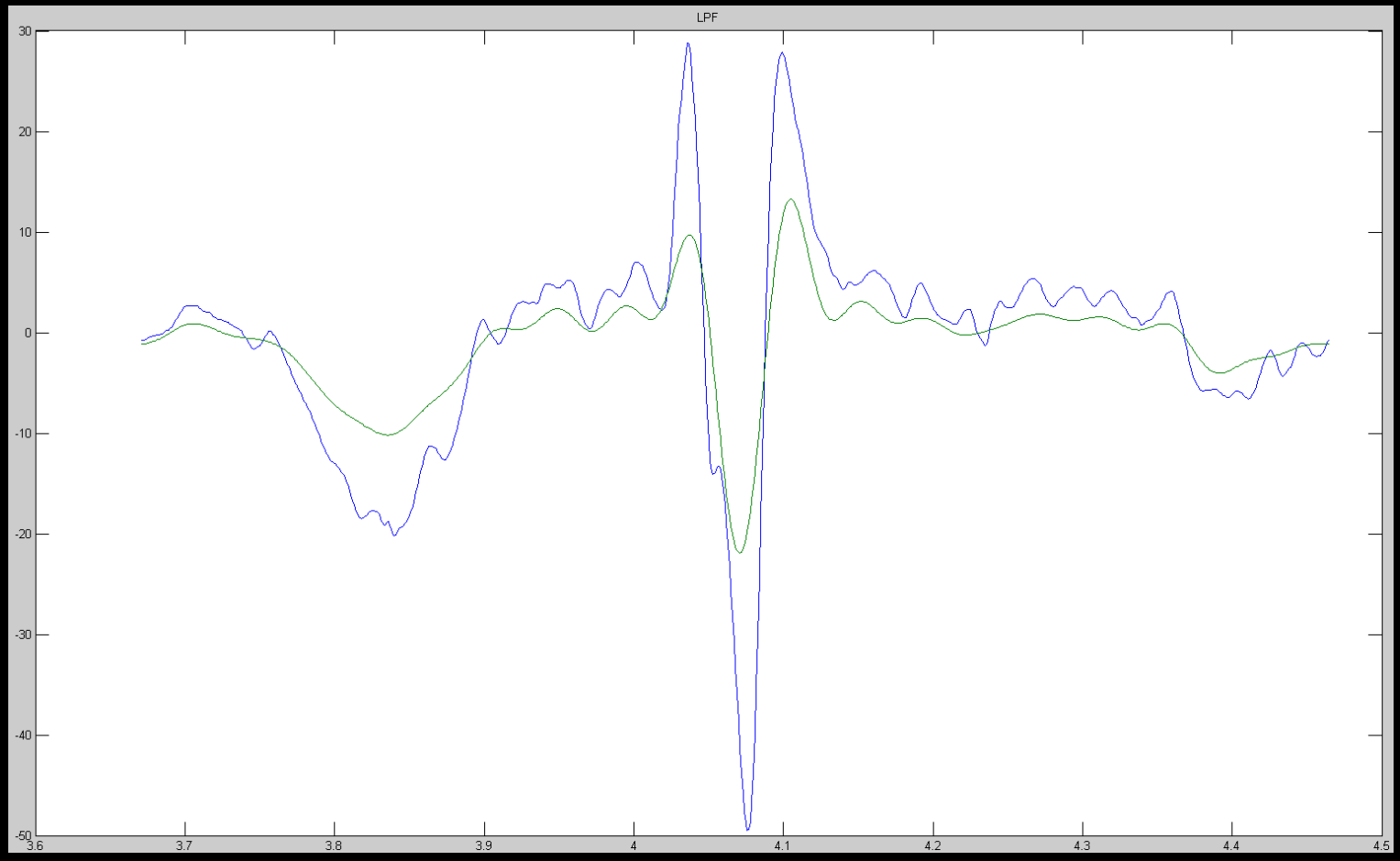
Messing around with Filters

- HPF |780Hz→|



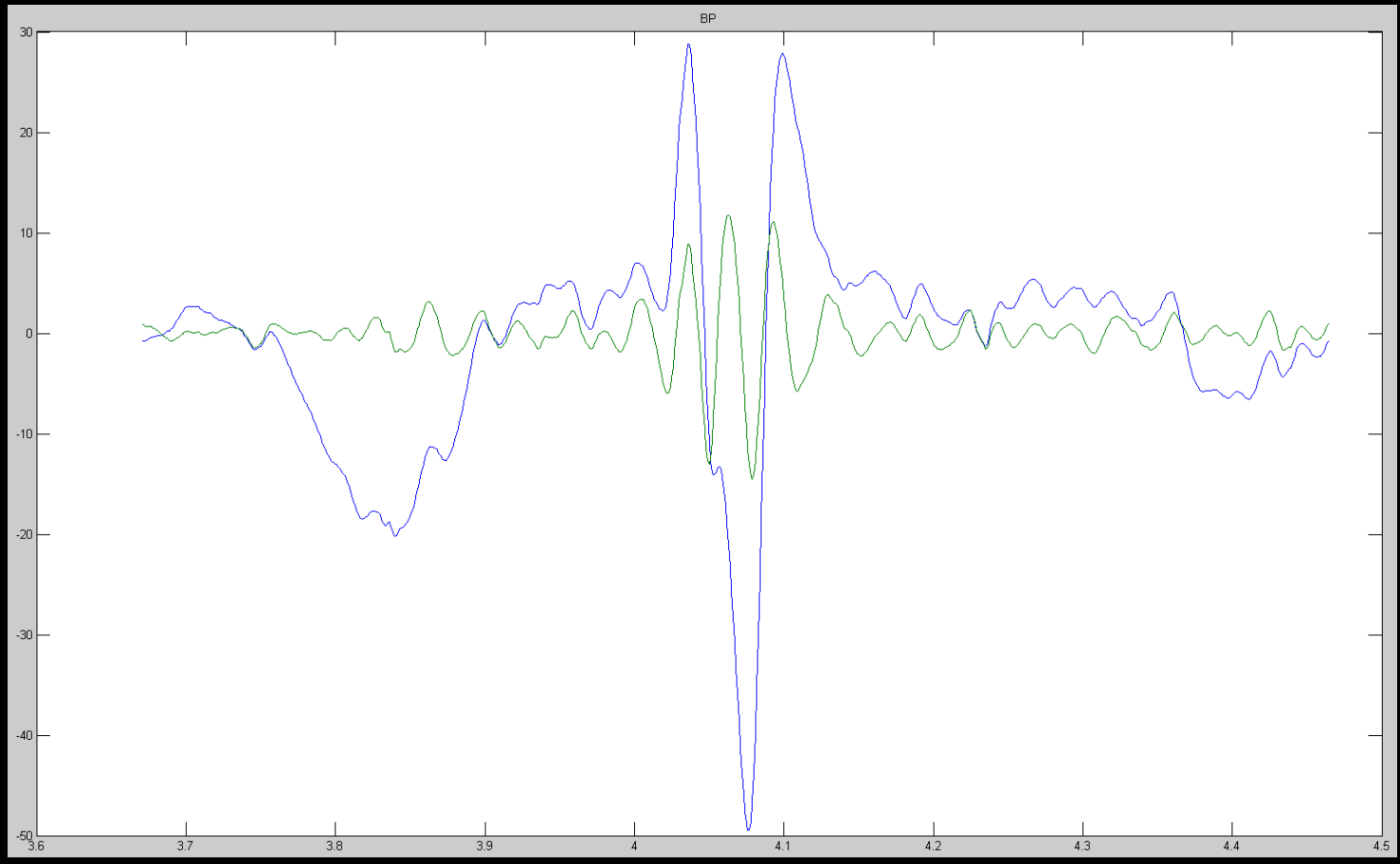
Messing around with Filters

- LPF |20Hz←|



Messing around with Filters

- BPF |20Hz←→780Hz|



Questions/Discussion



I command you to inquire about stuff!