

Accuracy of Hartmann-Shack aberrometry for eye dynamics measurement

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Objective

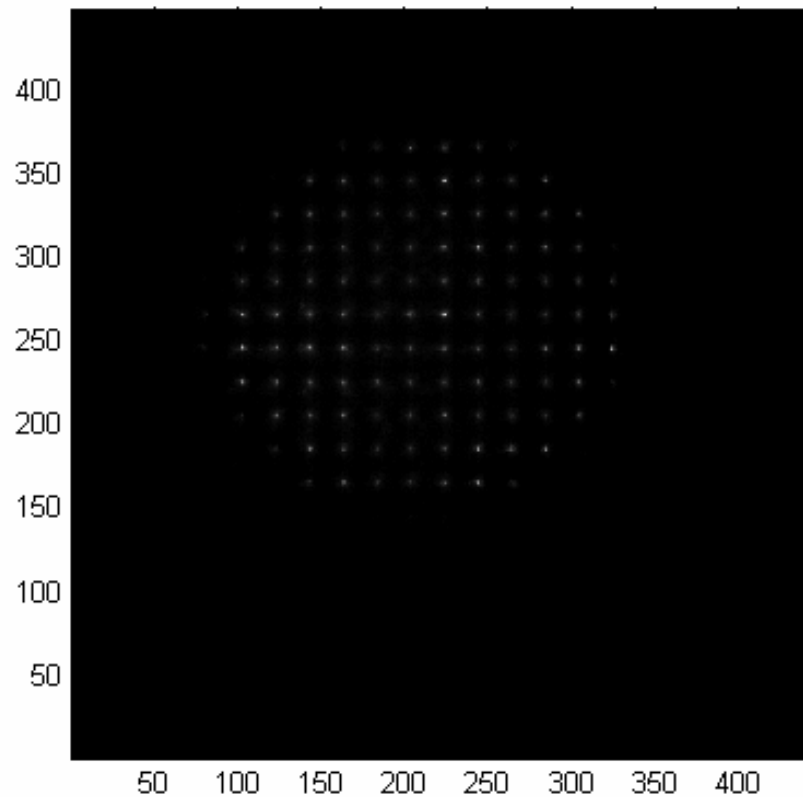
- To find coherence of wavefront aberrations with blood pulse

Justification

- Wavefront aberrations of the human eye fluctuate in time
- Pulse and heart rate variability have been linked to microfluctuations in accommodation, changes in optical aberrations and longitudinal eye movements

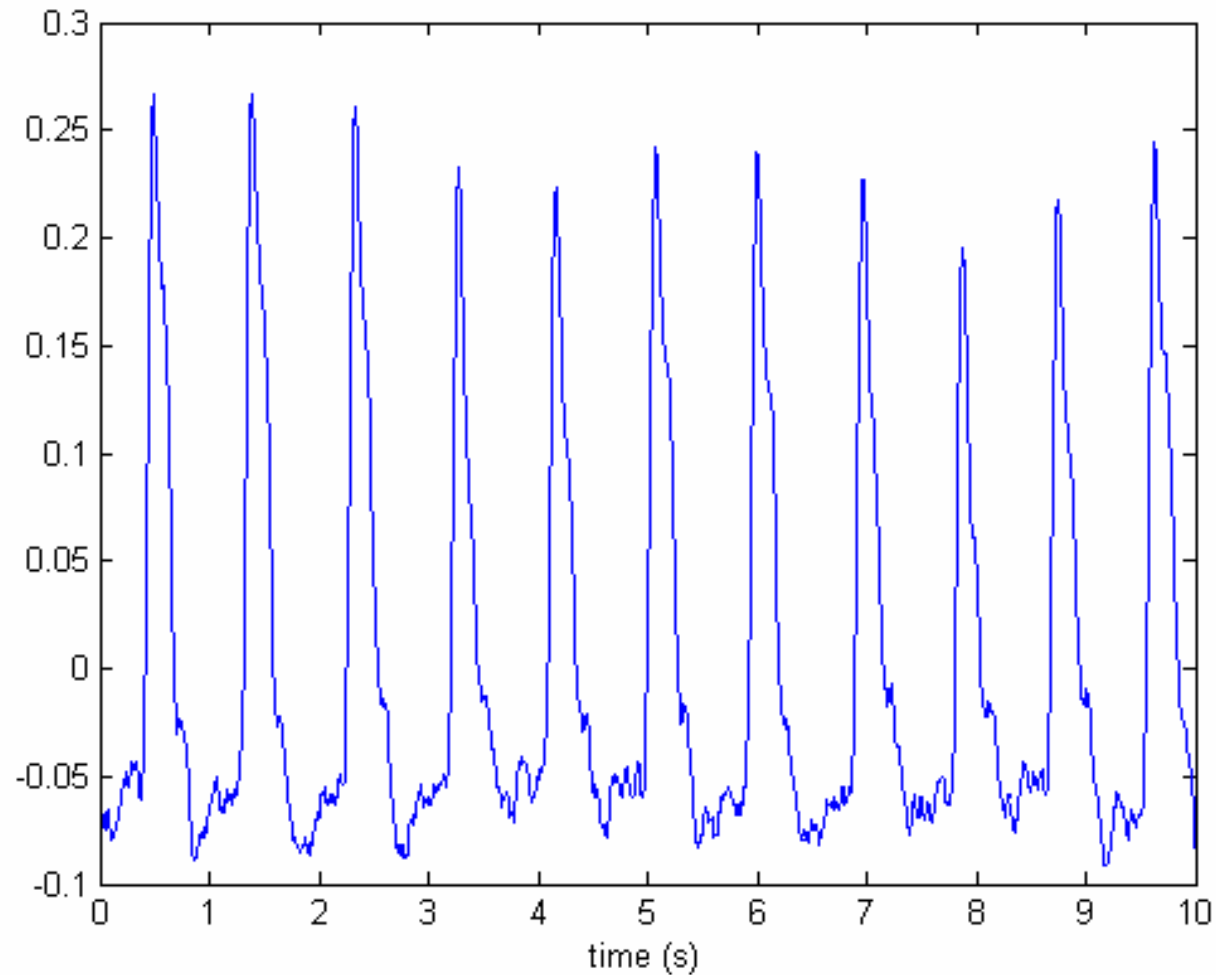
Measures. Aberrations

- Hartmann-Shack wavefront sensor. 2000 frames in 10 seconds (200 Hz)
 - *.bmp files
 - Coordinates of Centers of Gravity (COG)
 - First 15 Zernike coefficients of wavefront



Measures. Pulse

- Blood pulse registered at 100 Hz in 10 seconds

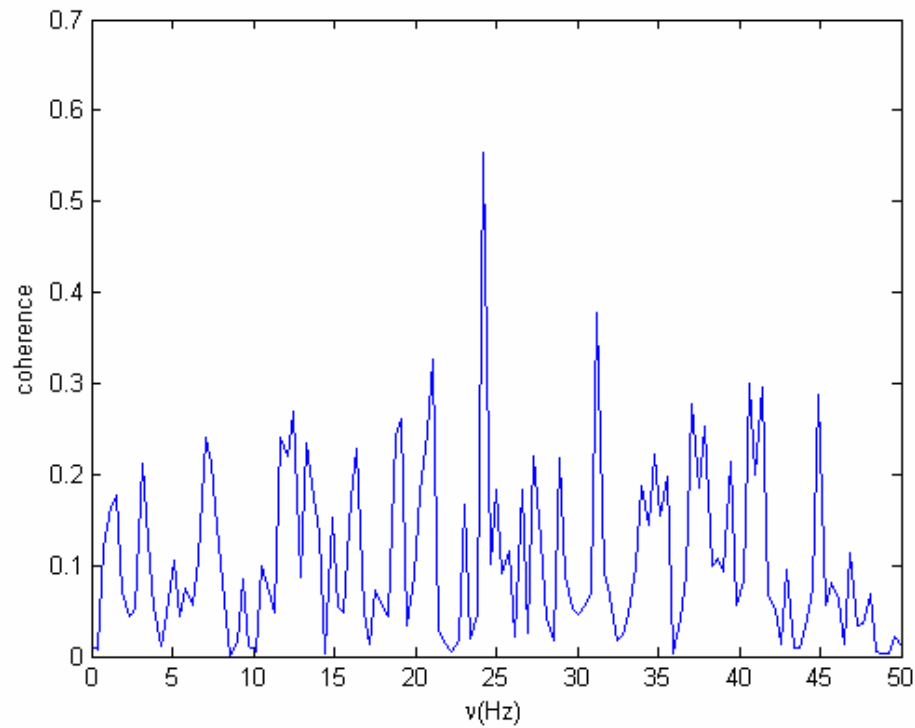


Results

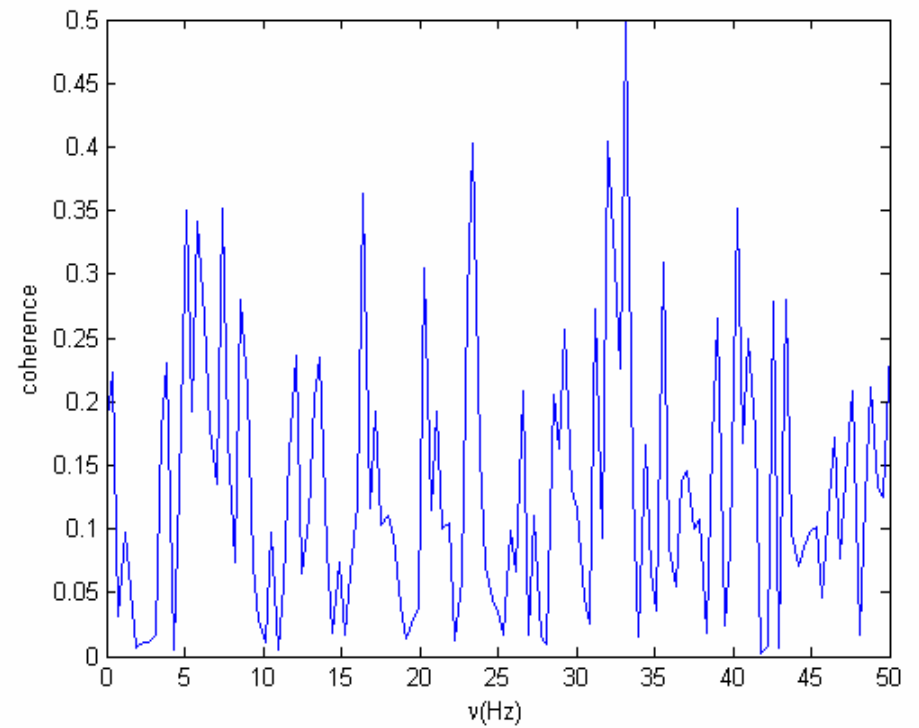
Coherence of Zernike coefficients with blood pulse

Pulse-tilt coherence?

Vertical tilt

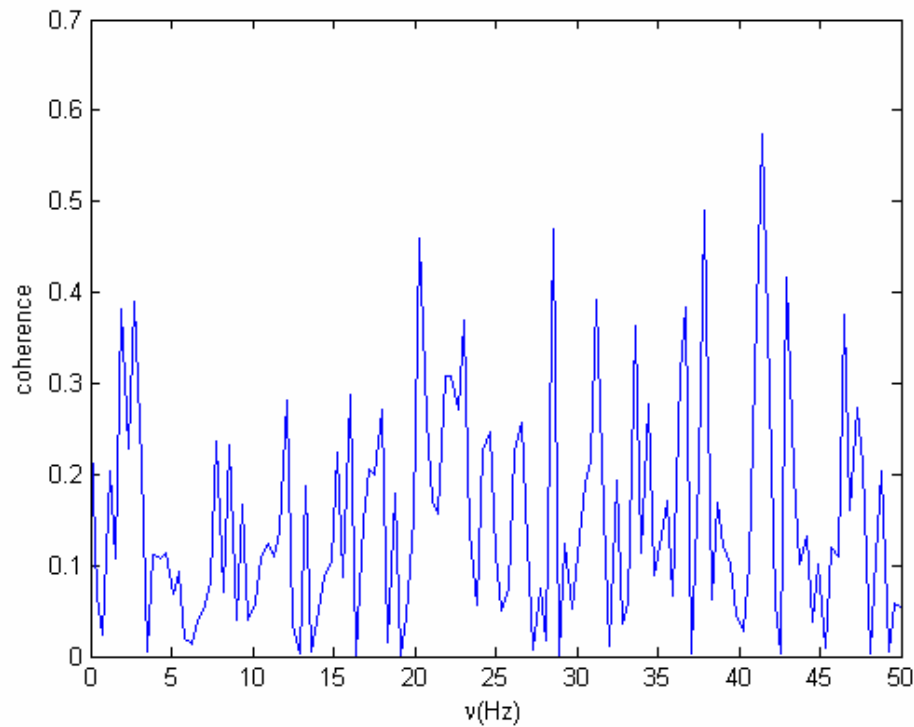


Horizontal tilt

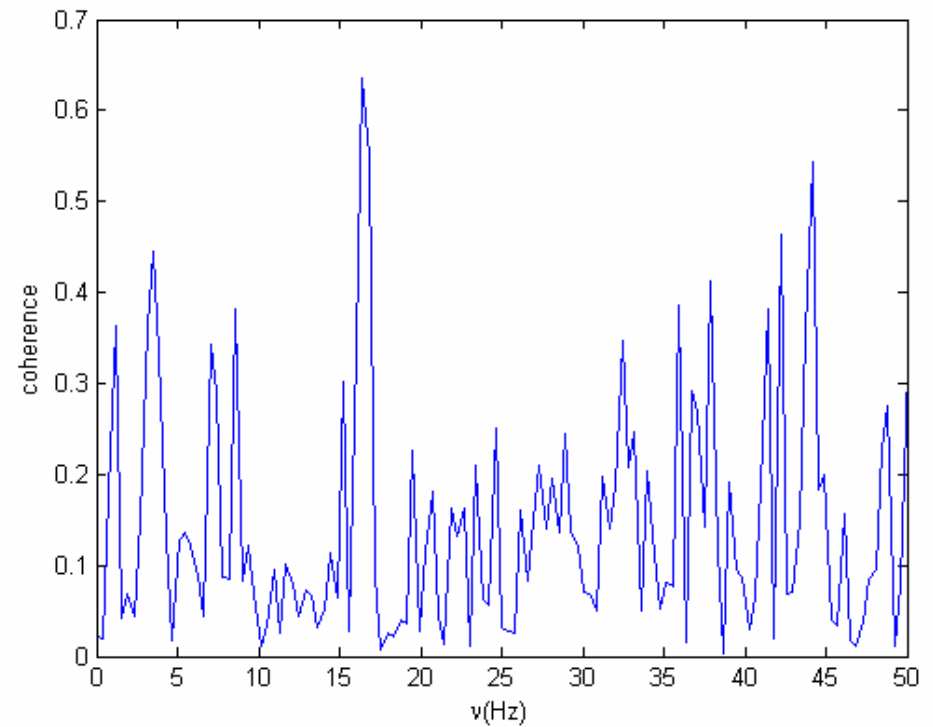


Pulse-astigmatism coherence?

45°/135° astigmatism

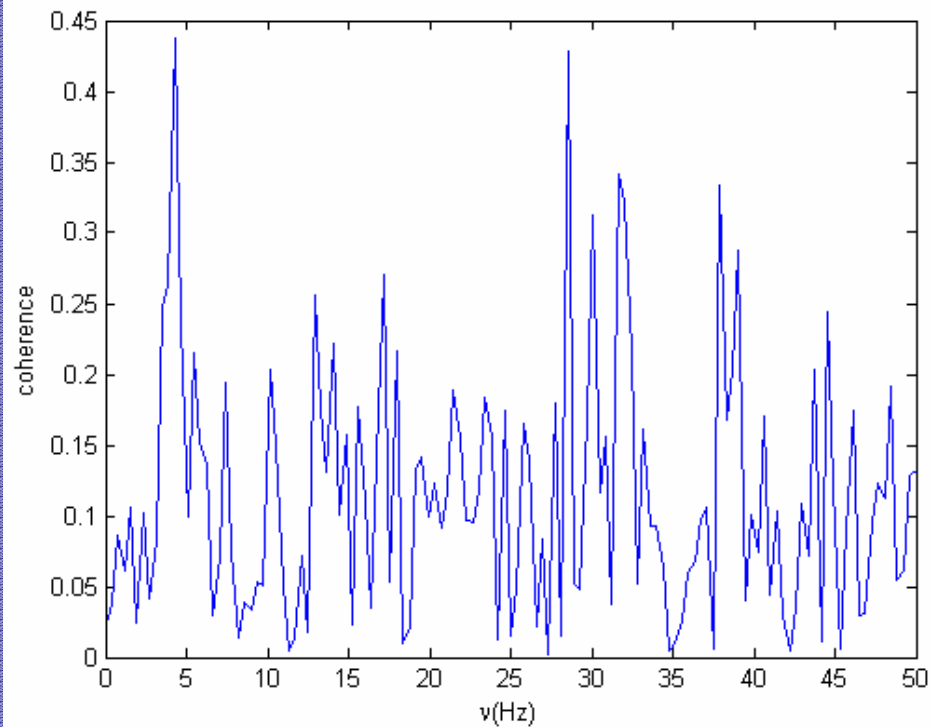


0°/180° astigmatism

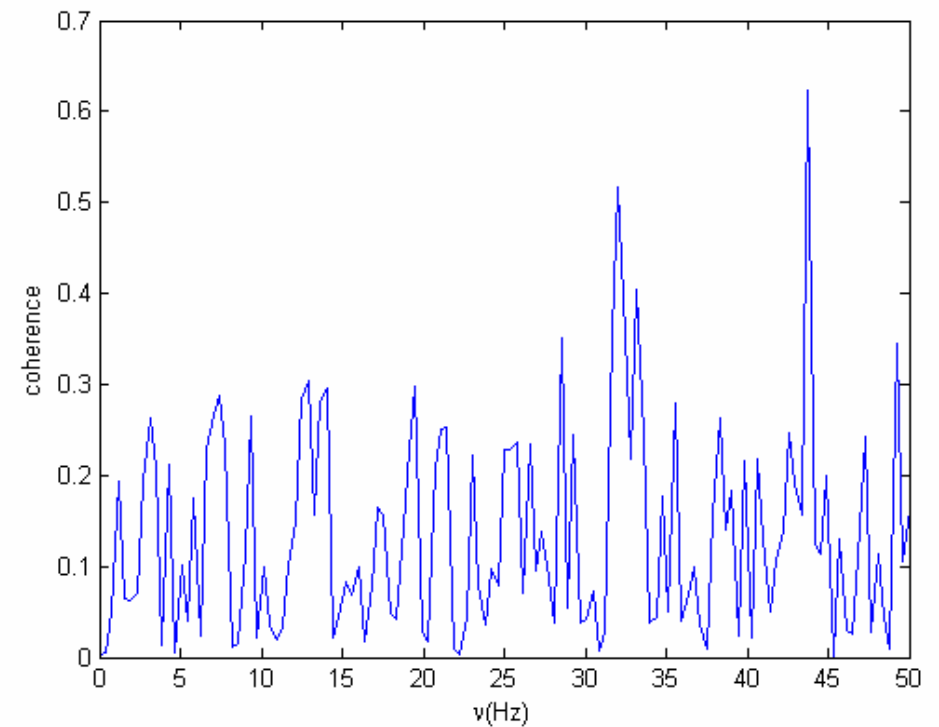


Pulse-sphere coherence?

Defocus



Spherical aberration

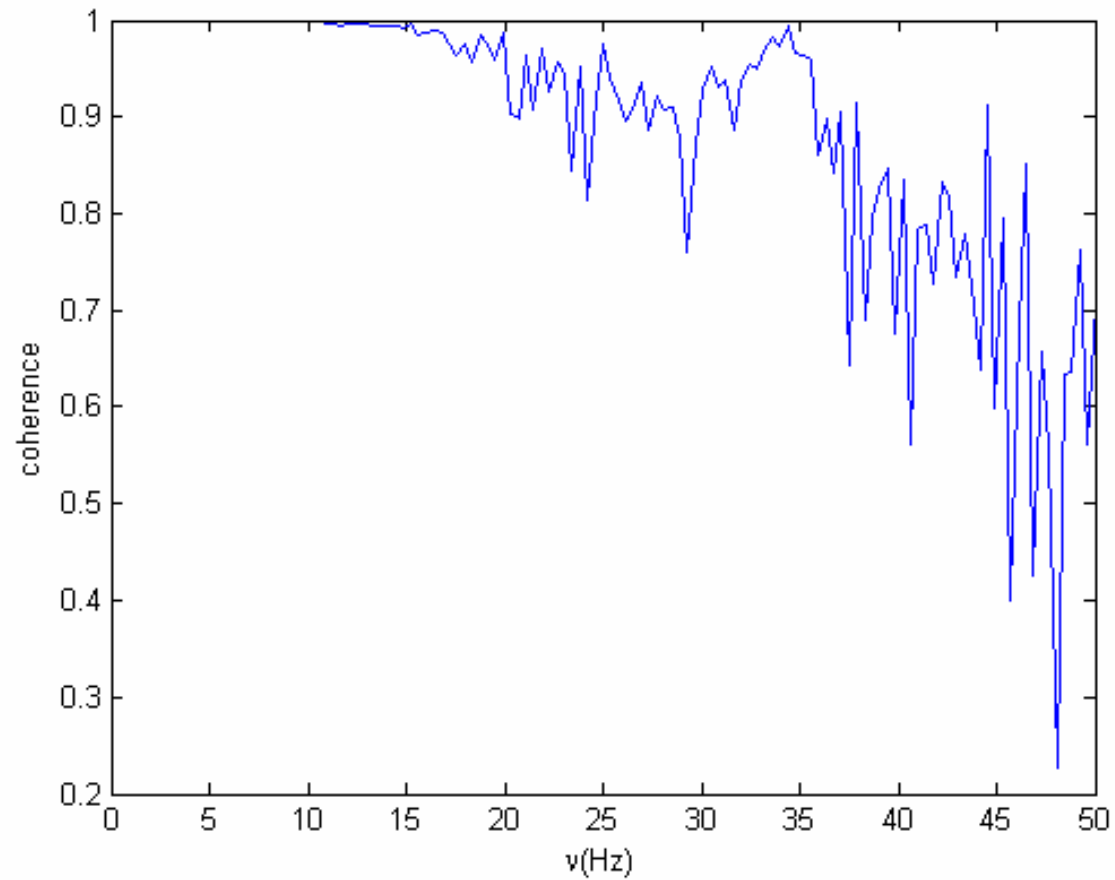


Results

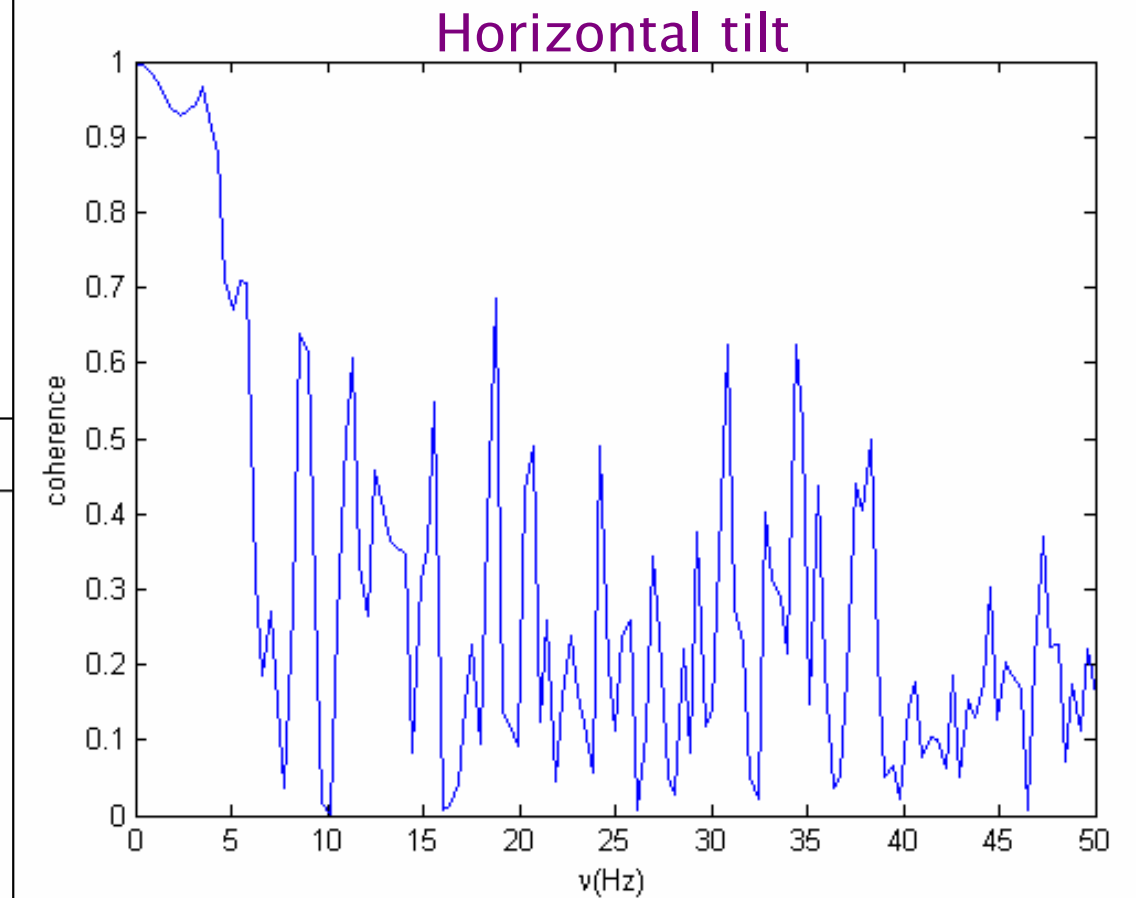
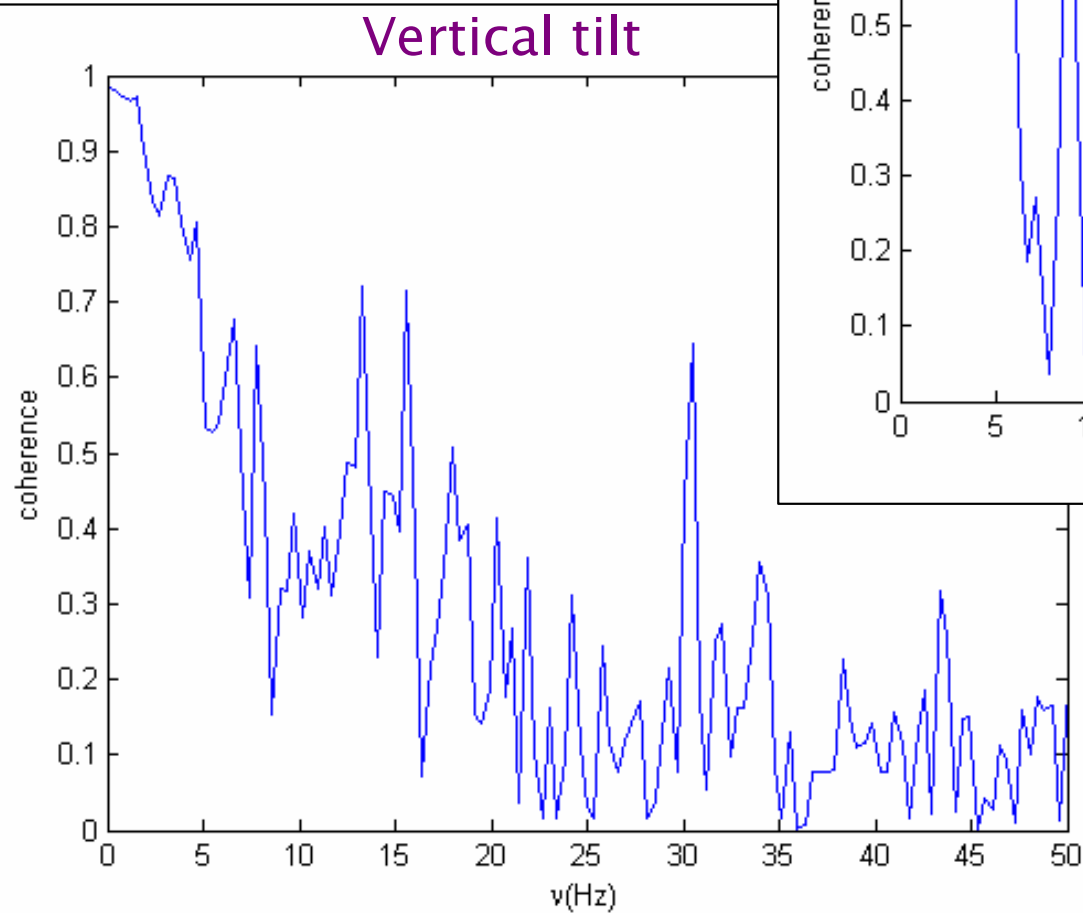
Coherence of signals themselves?
Odd-even samples analysis

Signal? Odd-even samples coherence

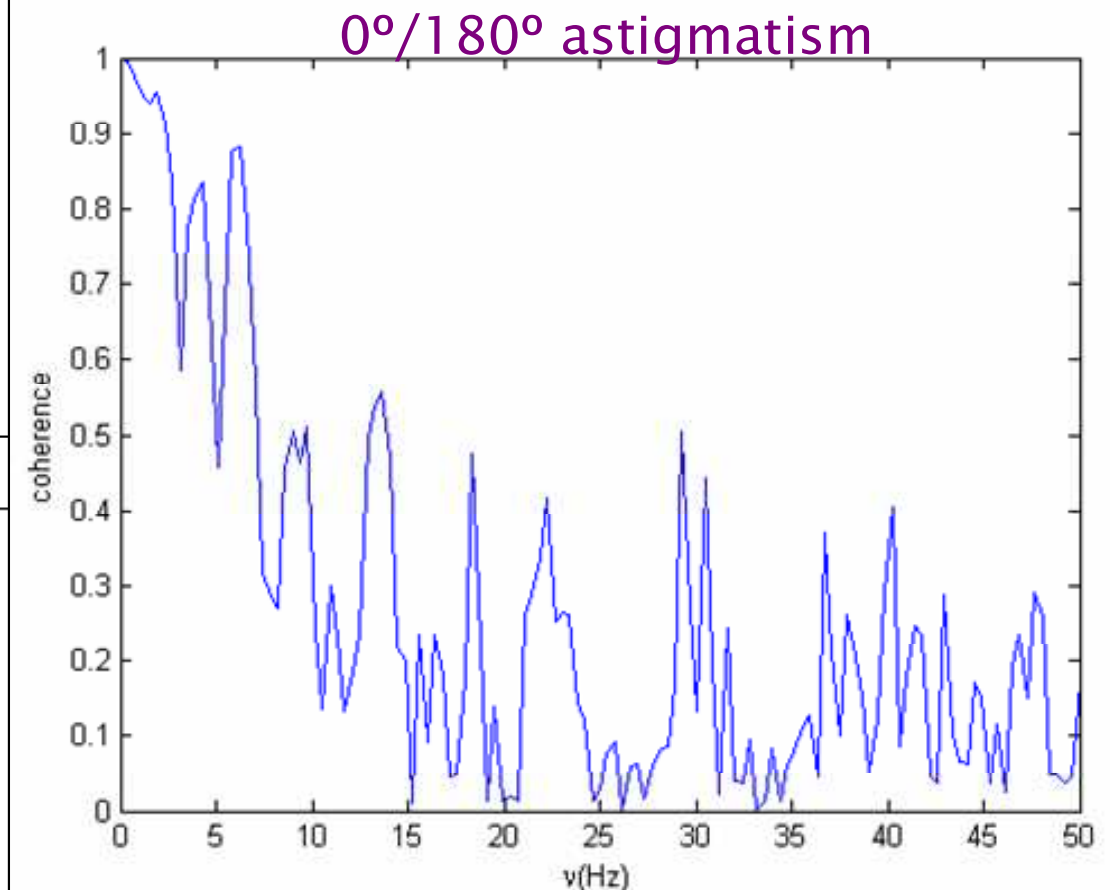
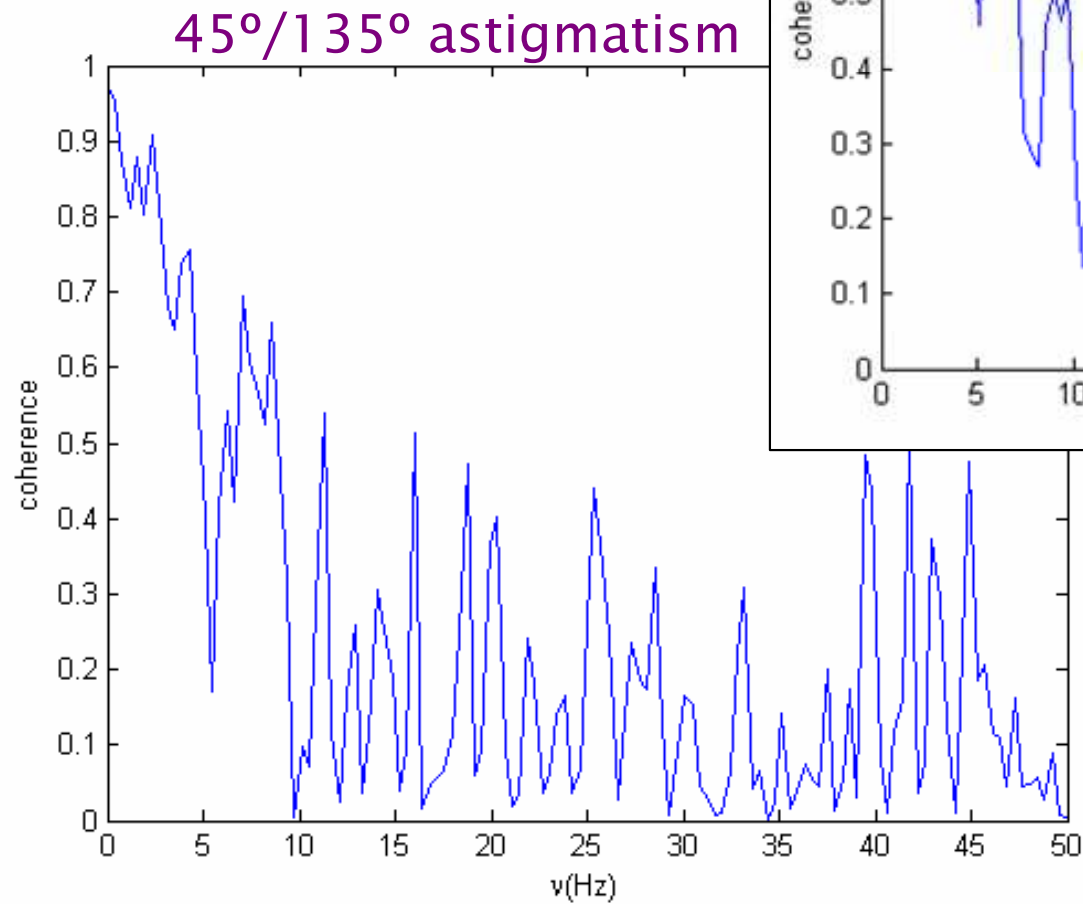
Pulse



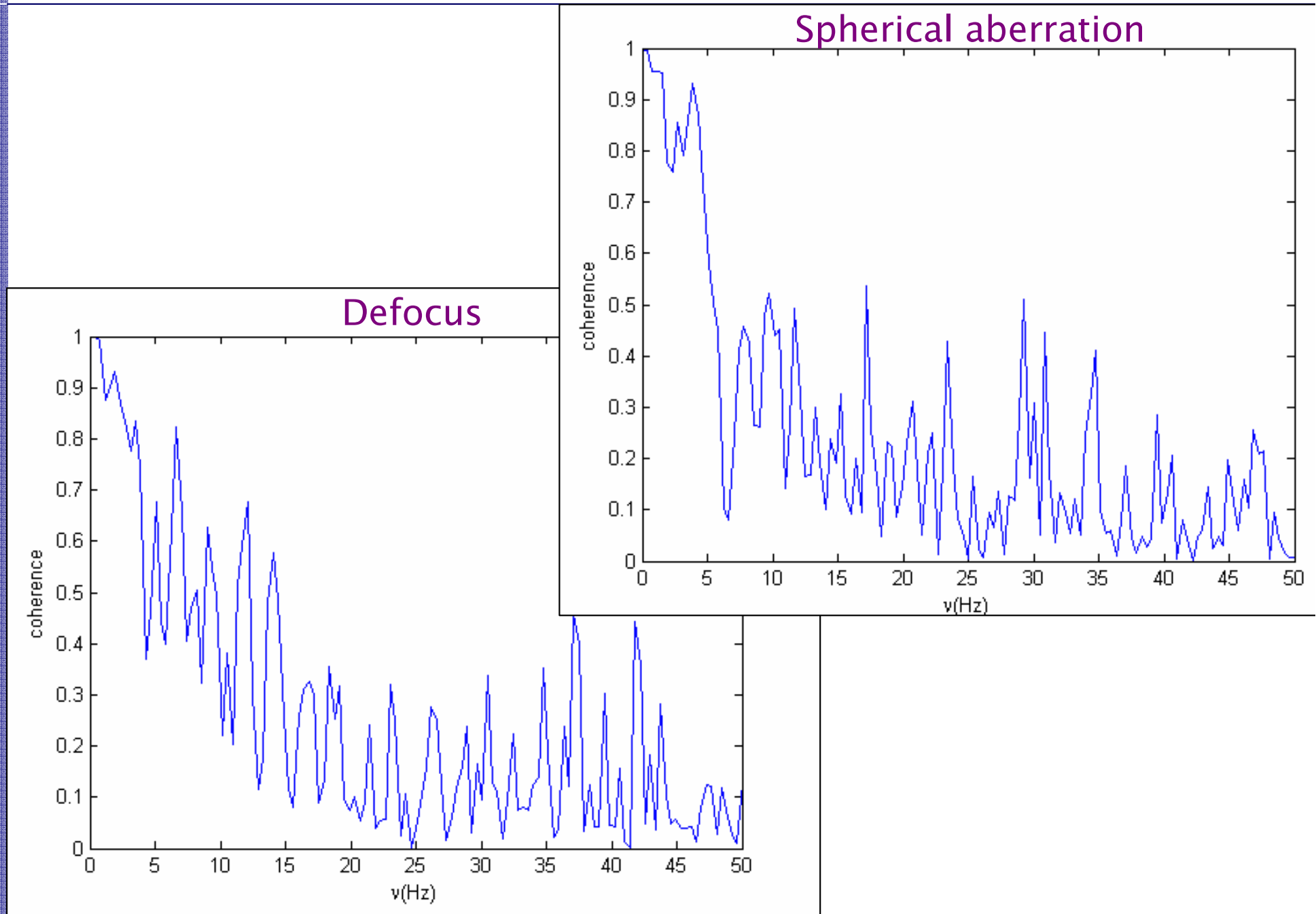
Signal? Odd-even samples coherence



Signal? Odd-even samples coherence



Signal? Odd-even samples coherence



Conclusion

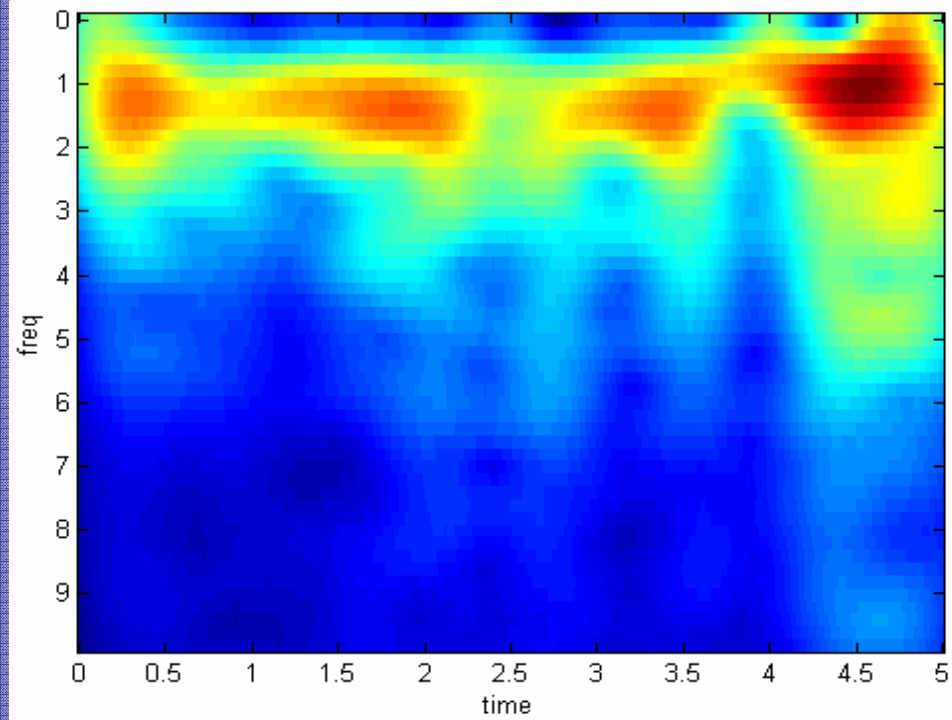
- No coherence of Zernike coefficients signals themselves for frequencies over 5 Hz

Alternative

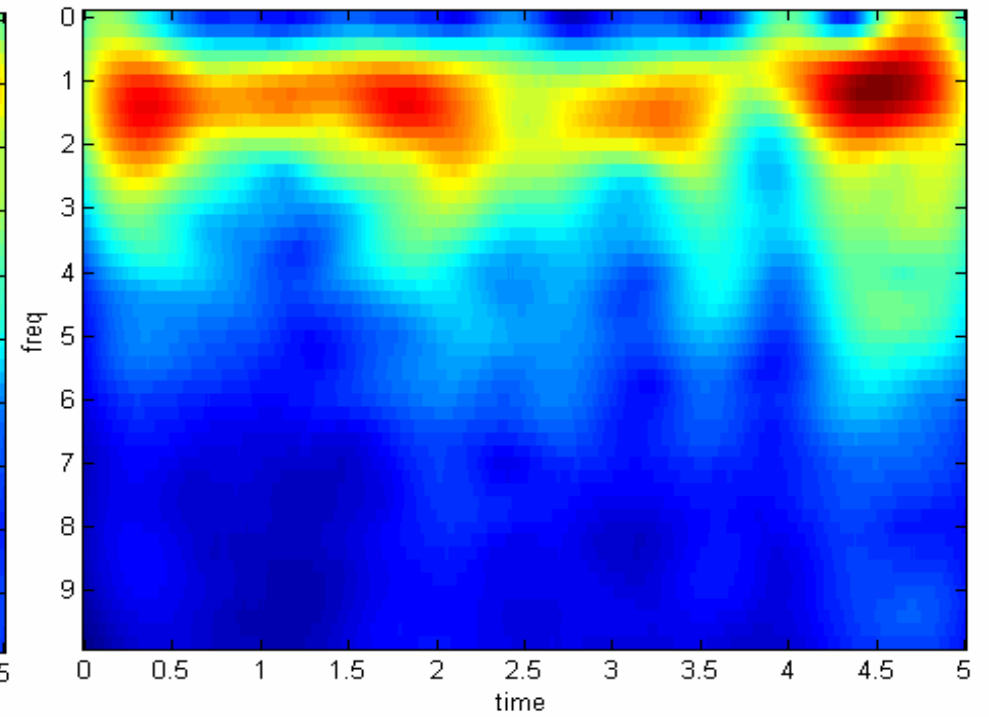
- Dynamic analysis of the movement of the COGs of the spots
 - Analysis of time-frequency representations of the blood pulse and the movement in X and Y direction of the COG of the central spot
 - Coherence of the movement in X and Y direction of the COGs of all spots with blood pulse

Central COG analysis

X COG

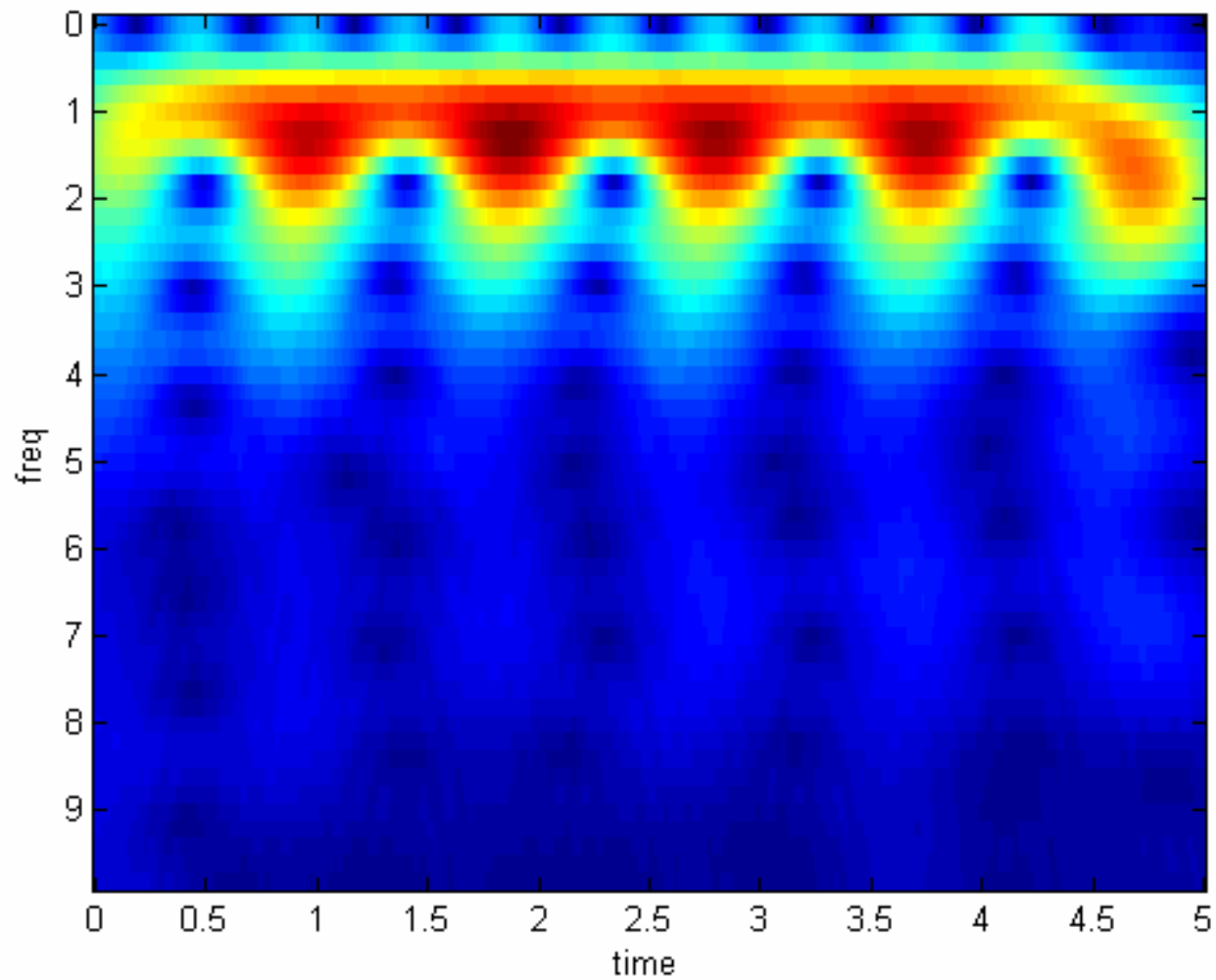


Y COG

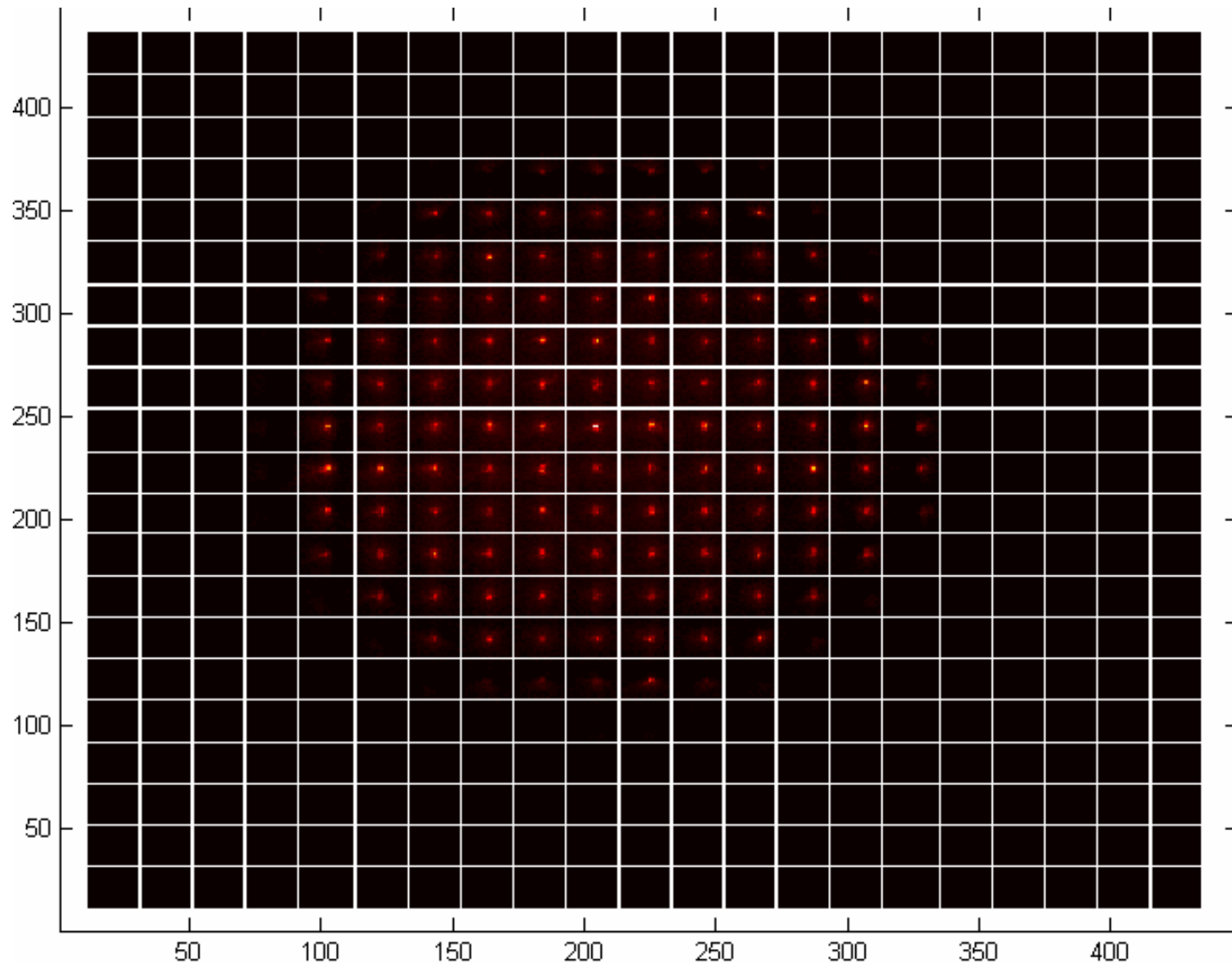


Central COG analysis

Pulse

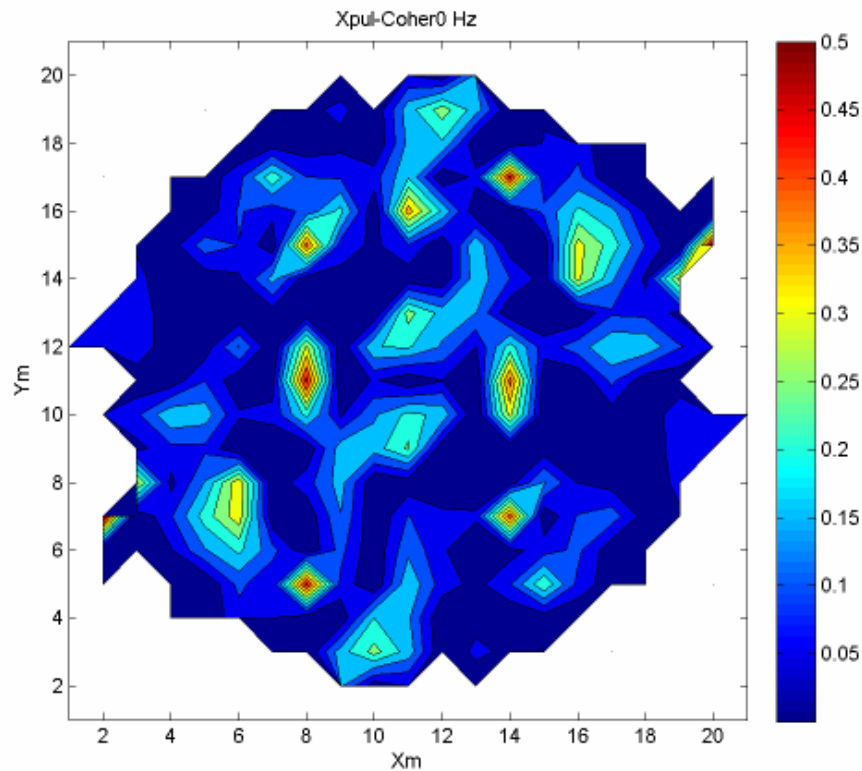


COGs movement analysis

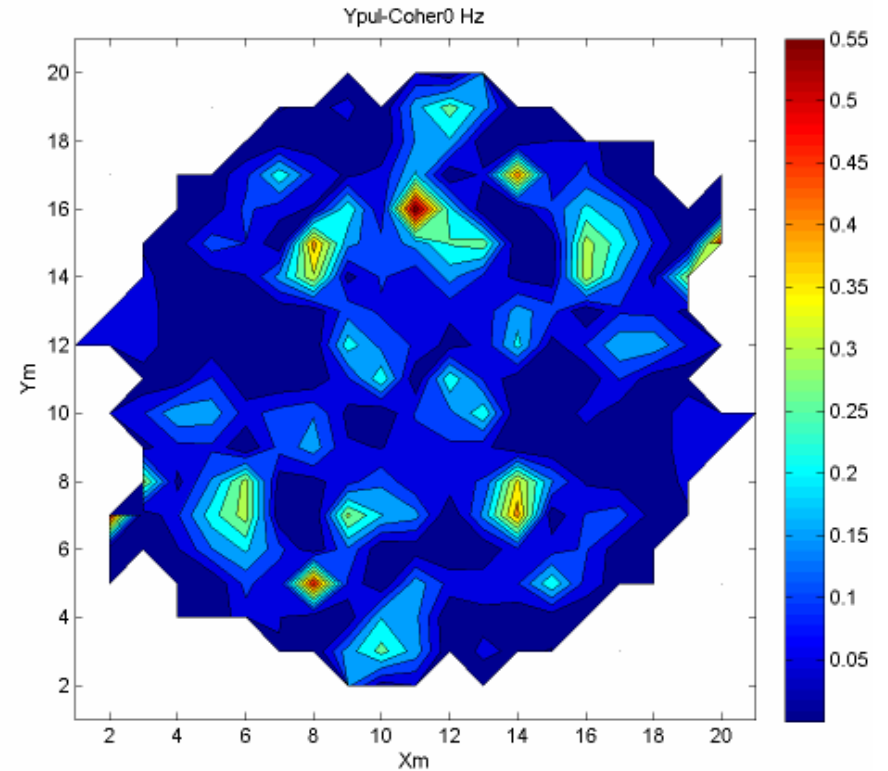


COG movement-pulse coherence

X COG

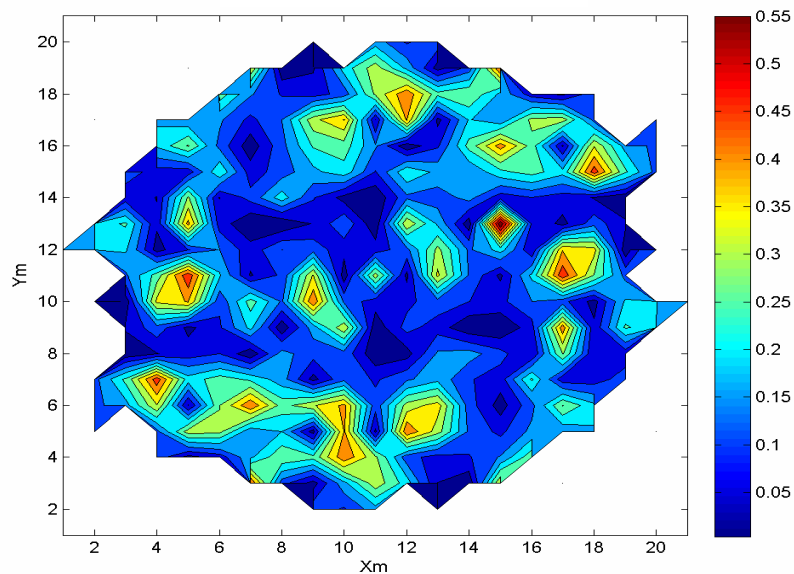


Y COG

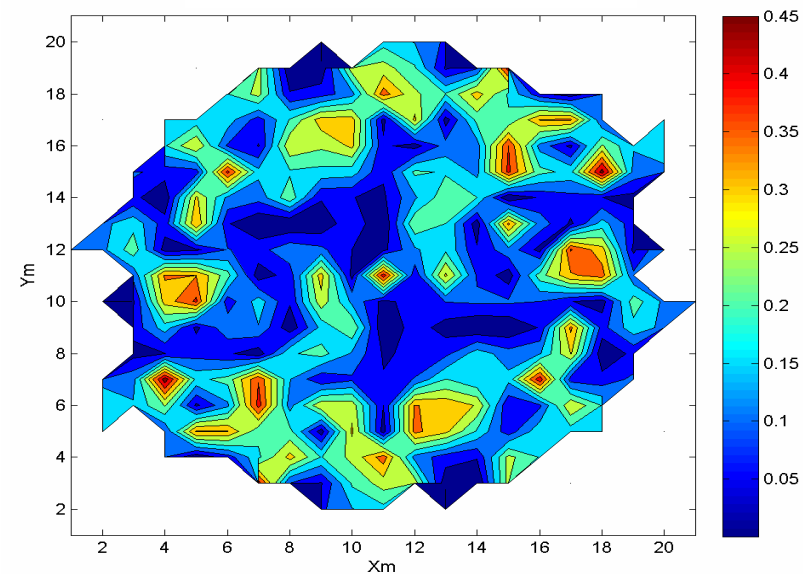


COG movement-pulse coherence

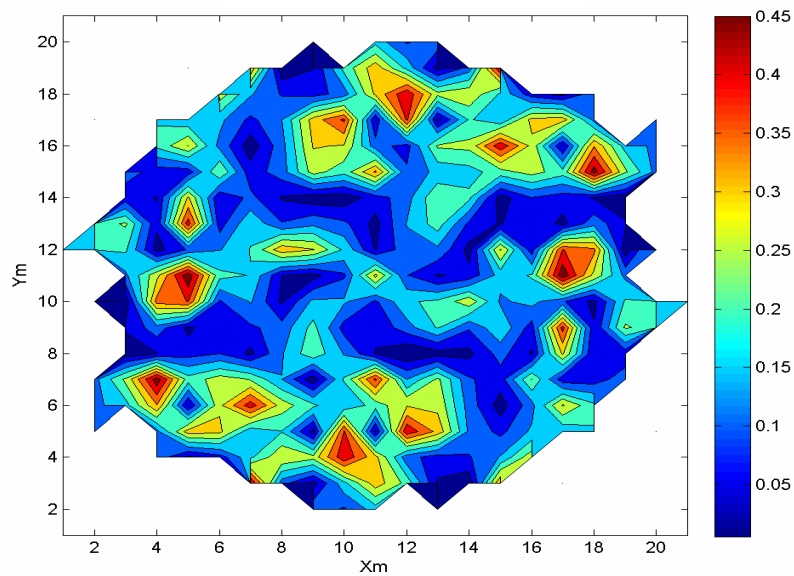
X-pulse 1 Hz



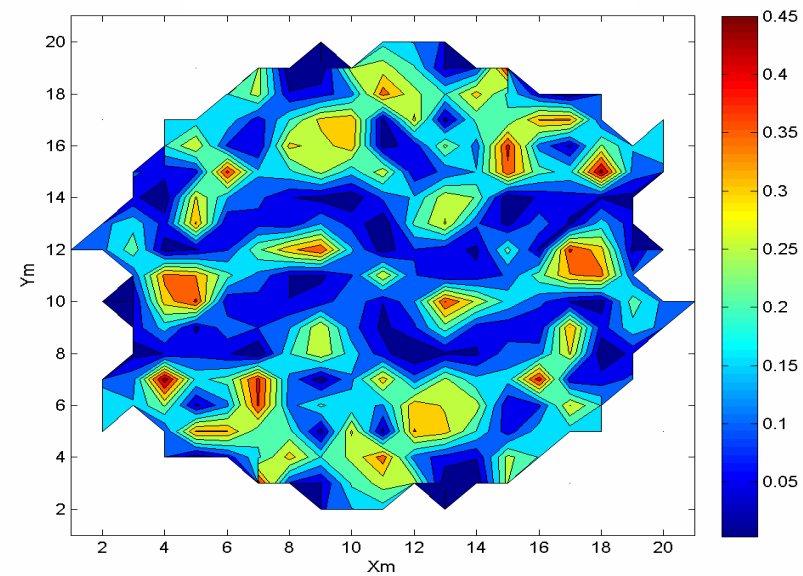
X-pulse 1.25 Hz



Y-pulse 1 Hz



Y-pulse 1.25 Hz

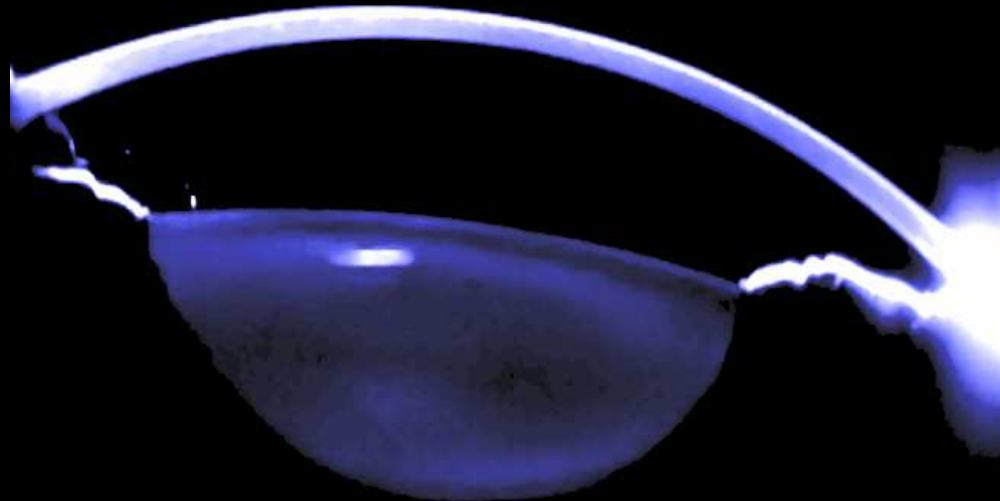


Conclusions

- No coherence into Zernike coefficients signals themselves for frequencies over 5 Hz. Noise?
- No homogeneous coherence between pulse and COGs movement
- No high coherence of pulse with aberration. Maximum around 0.5
- Is it the appropriate system?
- Saccadic movement?



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