

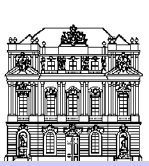


## **Interaural time differences in fine structure and envelope in bilateral electrical hearing**

**P. Majdak, B. Laback, W. D. Baumgartner**

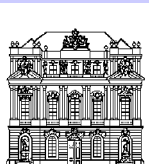
<http://www.kfs.oeaw.ac.at>

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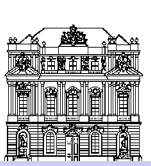
# State of research & questions

- CI listeners are sensitive to ITD in fine structure (Laback, Majdak and Baumgartner, 2004)
- Lateralisation discrimination (LD) depends on the pulse rate, duration and stimulation level
- Current bilateral cochlear implant system:
  - Two independently working systems
  - Uncontrolled change of fine structure ITD ( $ITD_{FS}$ )
- Question: Bilateral synchronization of:
  - speech processors to each other ( $ITD_{FS} = 0$ )?
  - fine structure to  $ITD_{ENV}$  ( $ITD_{FS} = ITD_{ENV}$ )?



# Method & Parameters

- Lateralisation discrimination (LD):
  - 2-interval, 2 AFC
  - 60 repetitions for each item
- Binaurally balanced, pitch matched electrode pair
- Pulse Rates: 100...1600pps
  - Inter Pulse Intervals (IPI): 625 $\mu$ s...10ms
  - Preselected in pretests for each subject
- $ITD_{FS}$ : 0...800 $\mu$ s, 0...IPI
- $ITD_{ENV}$ : 0...800 $\mu$ s, IPI/4 (max. sensitivity)

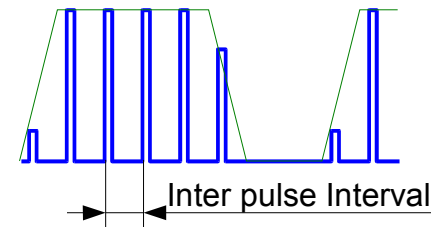


# Stimuli & Subjects

- Amplitude modulated pulse trains

- $ITD_{FS}$ -Information (FS):

- Delay of each pulse for one ear

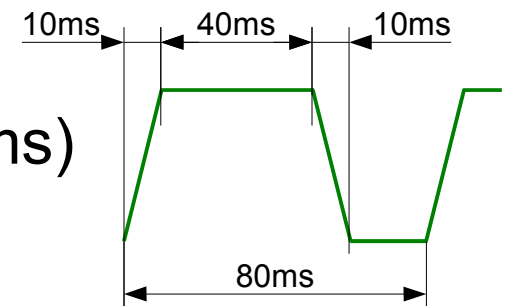


- $ITD_{ENV}$ -Information (ENV):

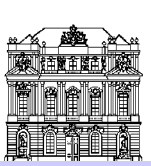
- 4 Trapezoids (Total duration: 300ms)

- Fast rising/falling edges

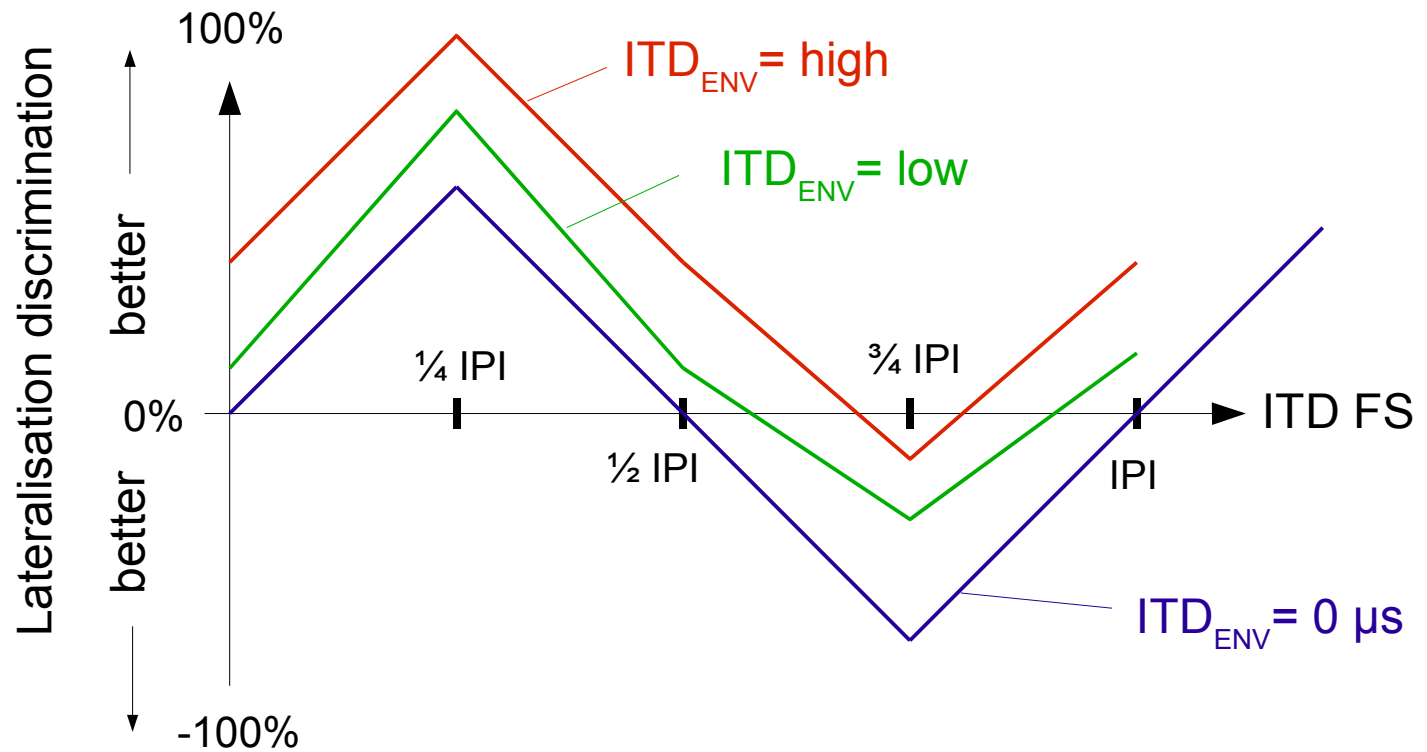
- Gaps between trapezoids



- 4 CI listeners (most of them used: C40+/C40+)
- 4 NH subjects with a simulation of CI stimulation



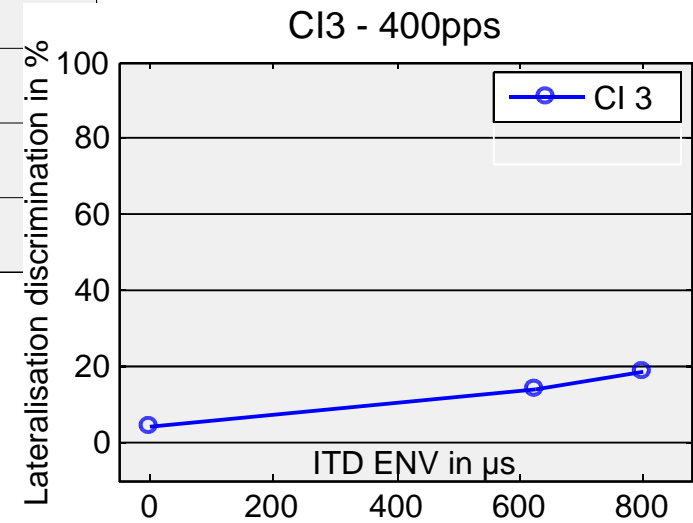
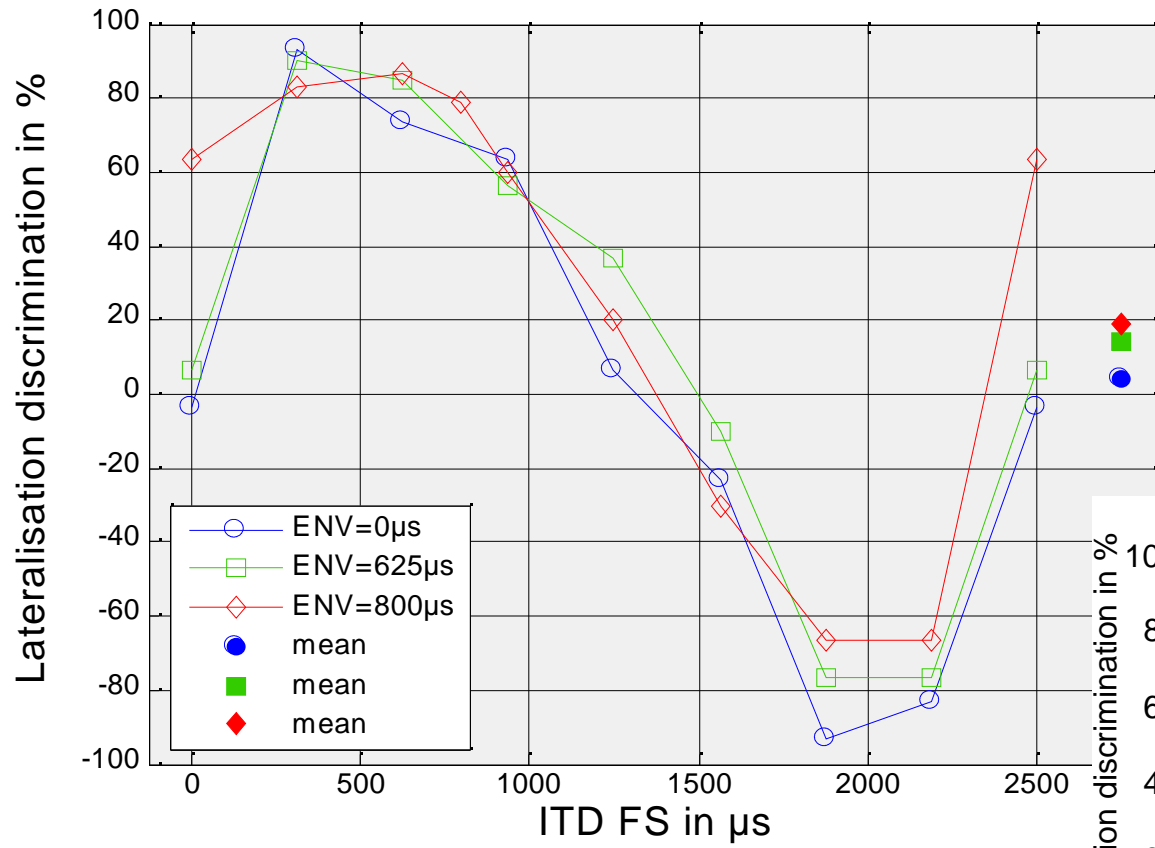
# Expected results

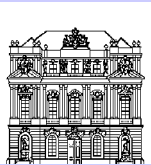




# Results for lower pulse rates

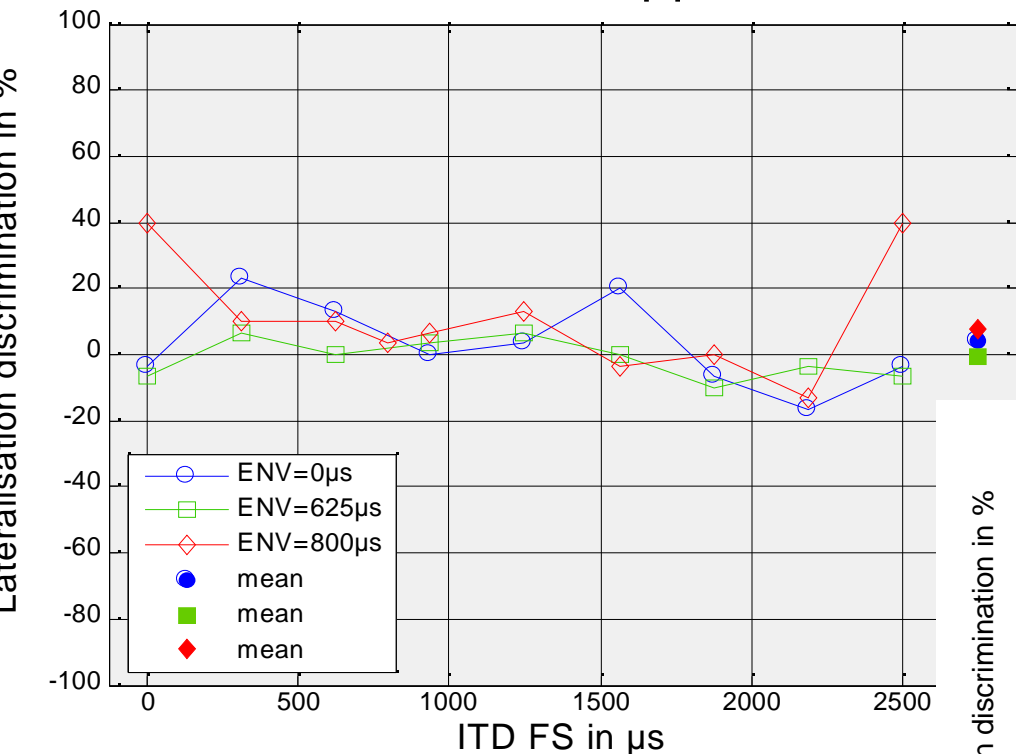
## CI3 - 400pps



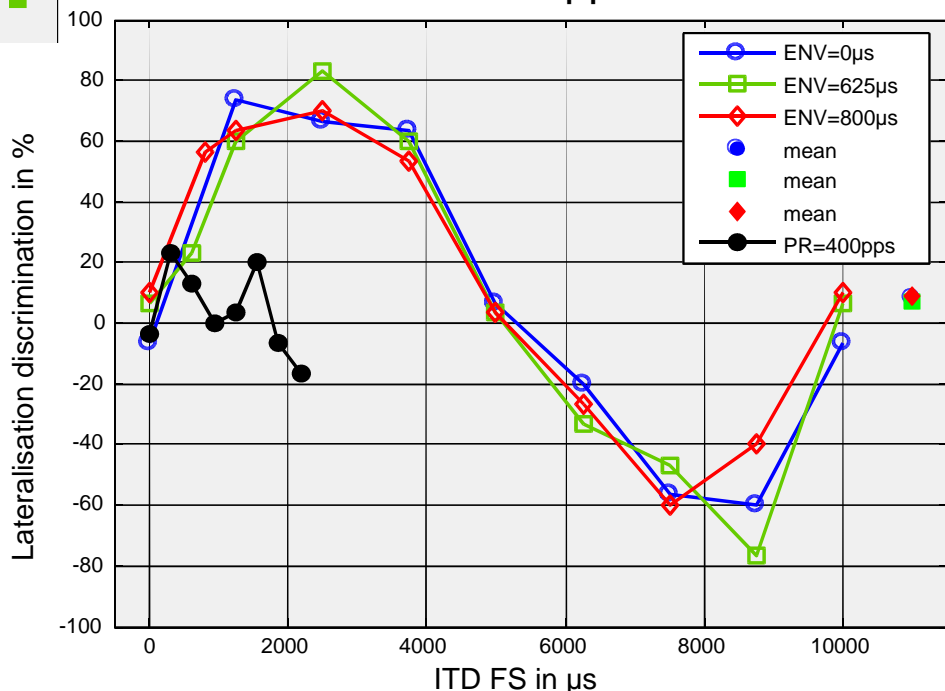


# Results for lower pulse rates

## CI2 - 400pps



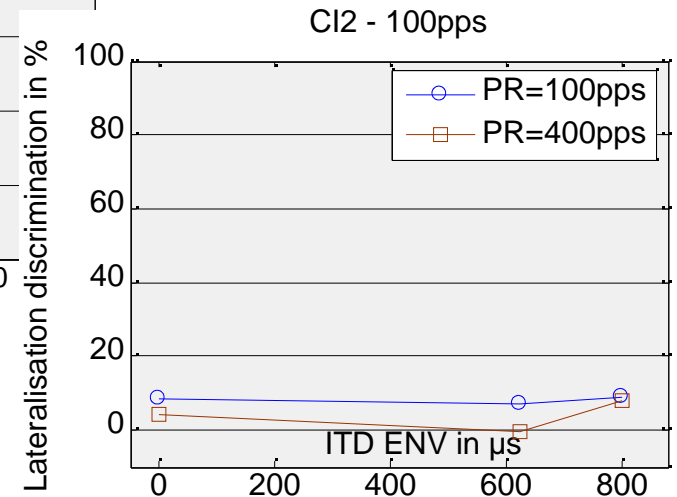
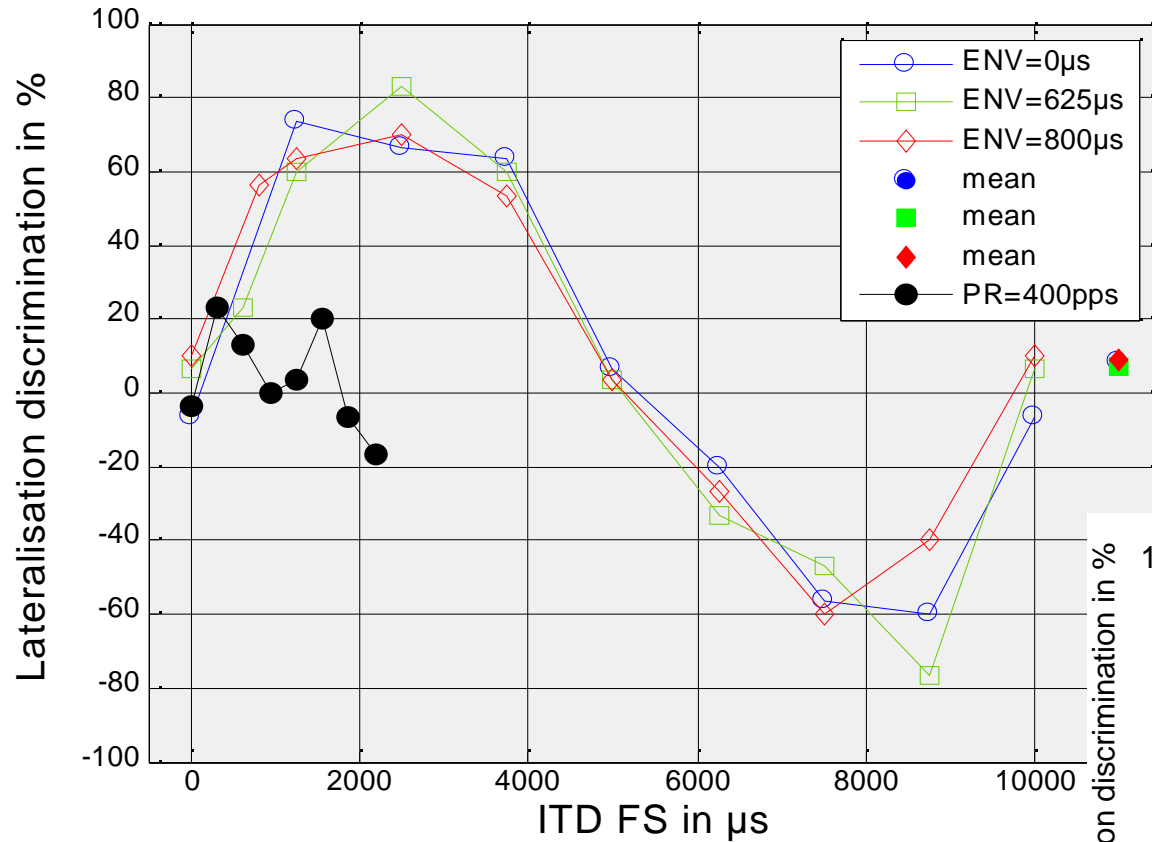
## CI2 - 100pps





# Results for lower pulse rates

## CI2 - 100pps

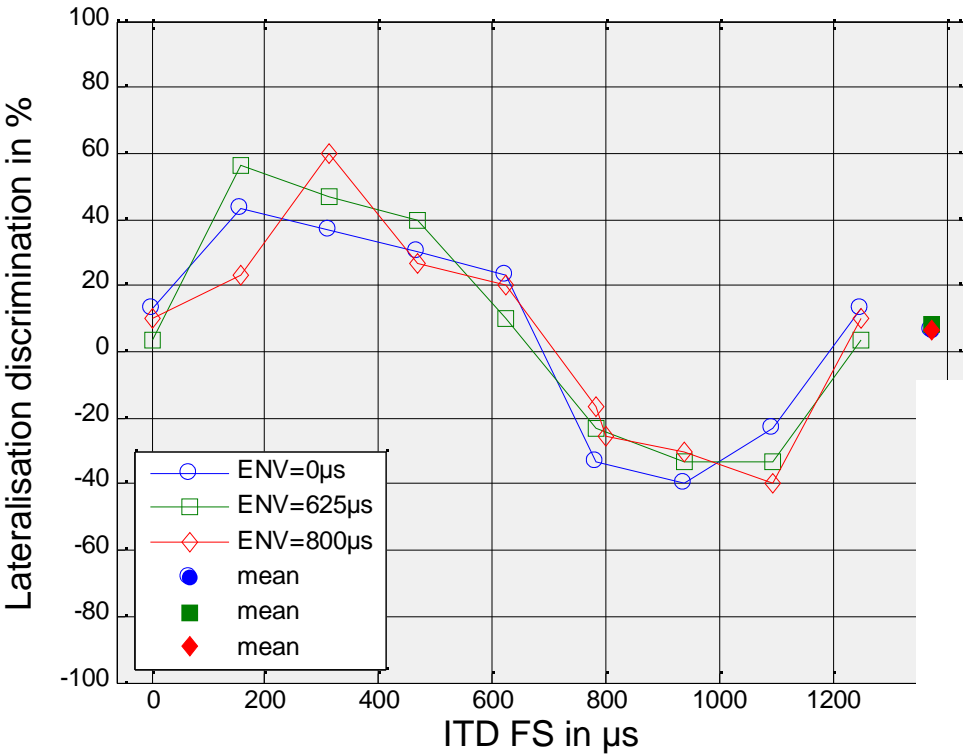




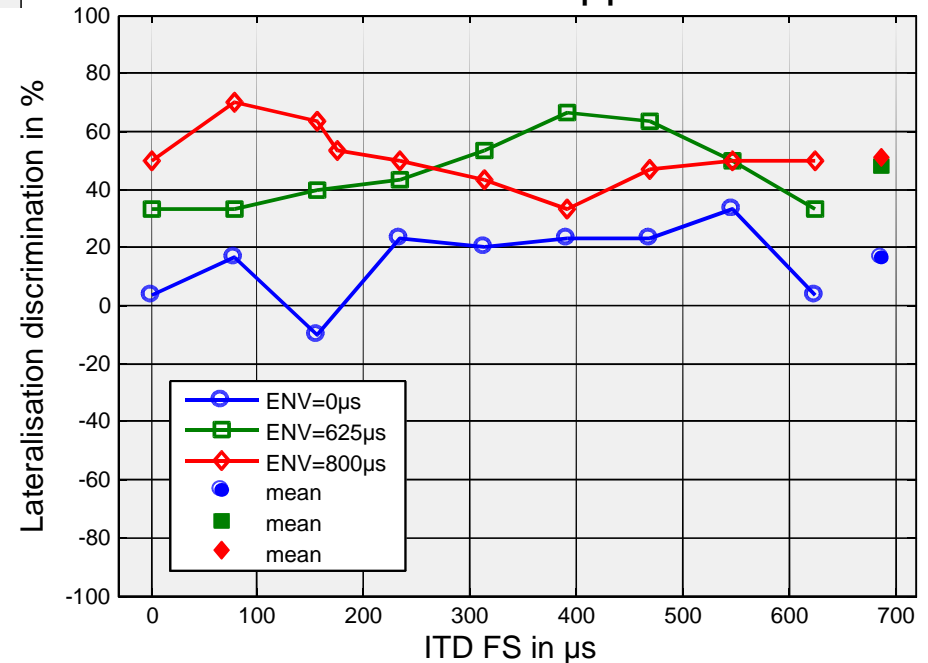


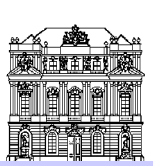
# Results for higher pulse rates

## CI8 - 800pps



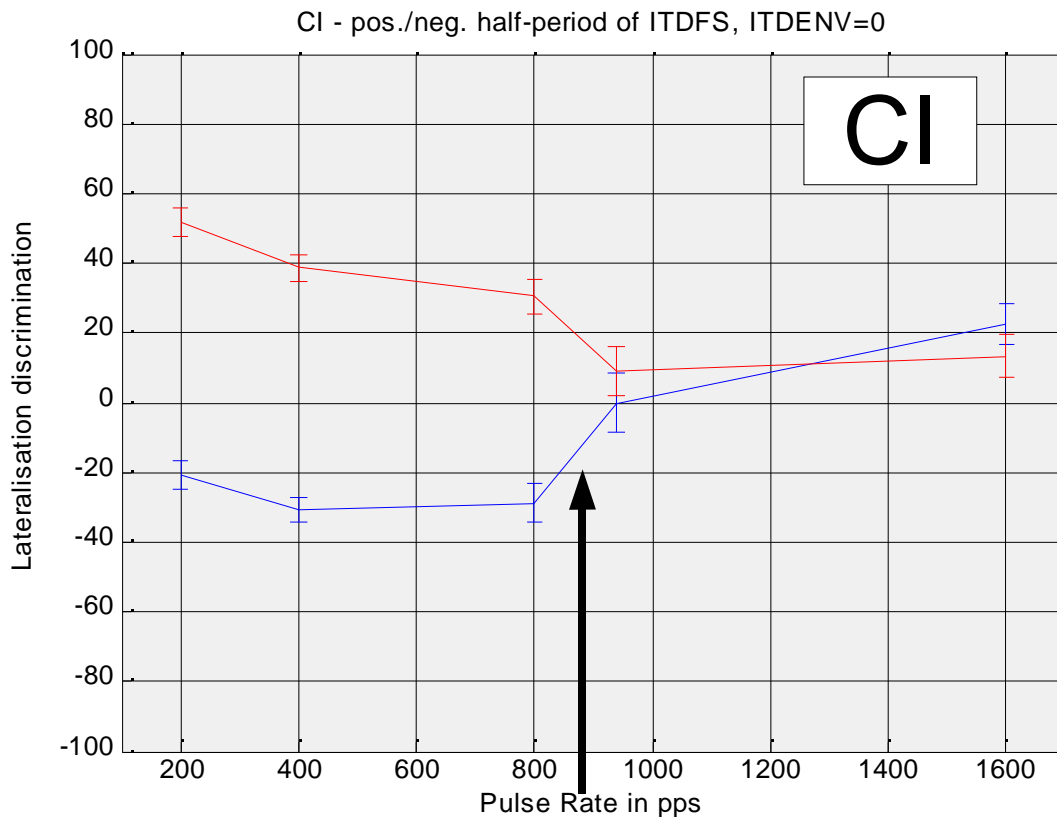
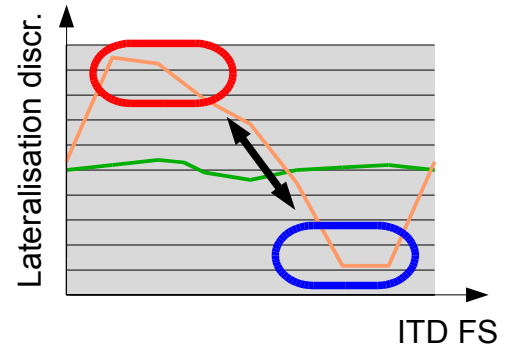
## CI3 - 1600pps



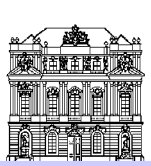


# Synchronization of fine structure

- Relevant, if lateralisation discrimination **depends** on  $ITD_{FS}$



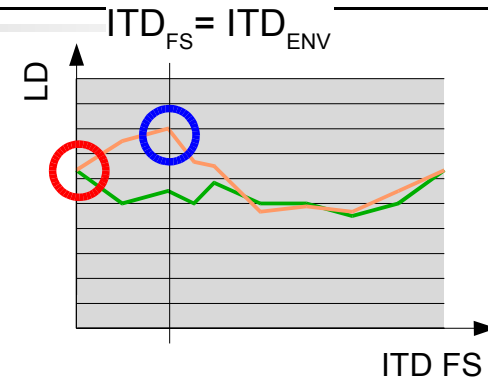
Pulse Rate	p
400pps	0,0001
600pps	-
800pps	0,0001
938pps	0,45
1600pps	0,31



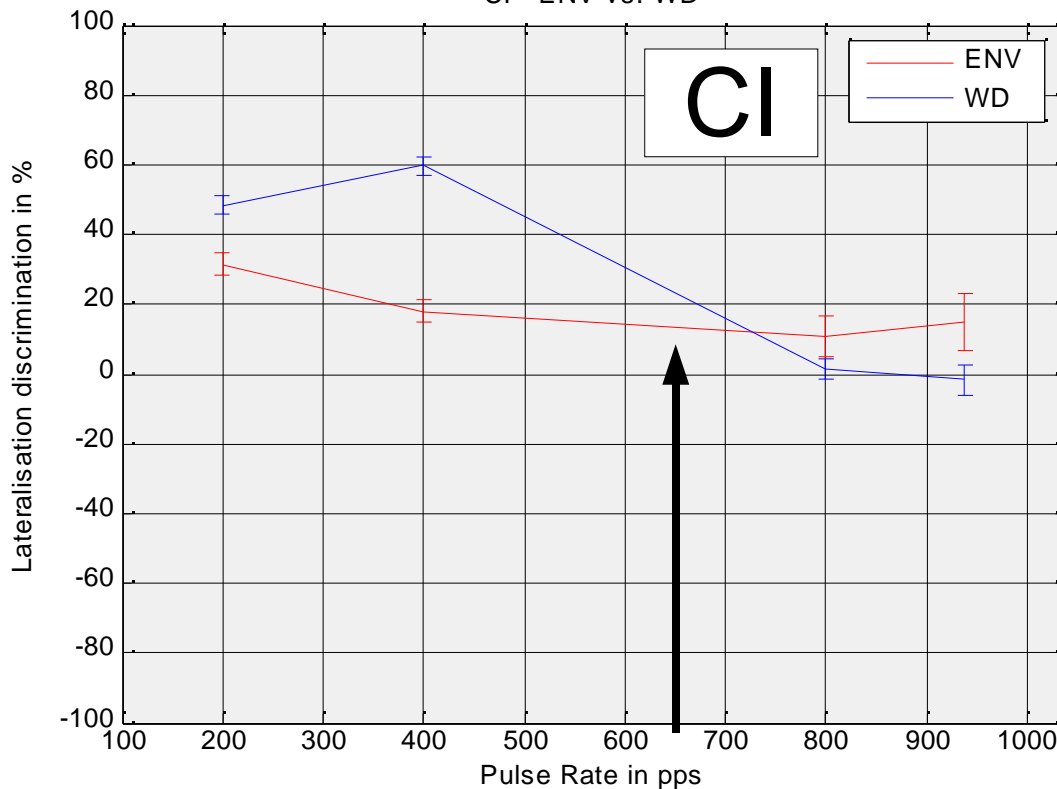
# Synchronization to the envelope

- Relevant, if:

$$\mathbf{LD(ITD_{FS} = ITD_{ENV})} > \mathbf{LD(ITD_{FS} = 0)}$$



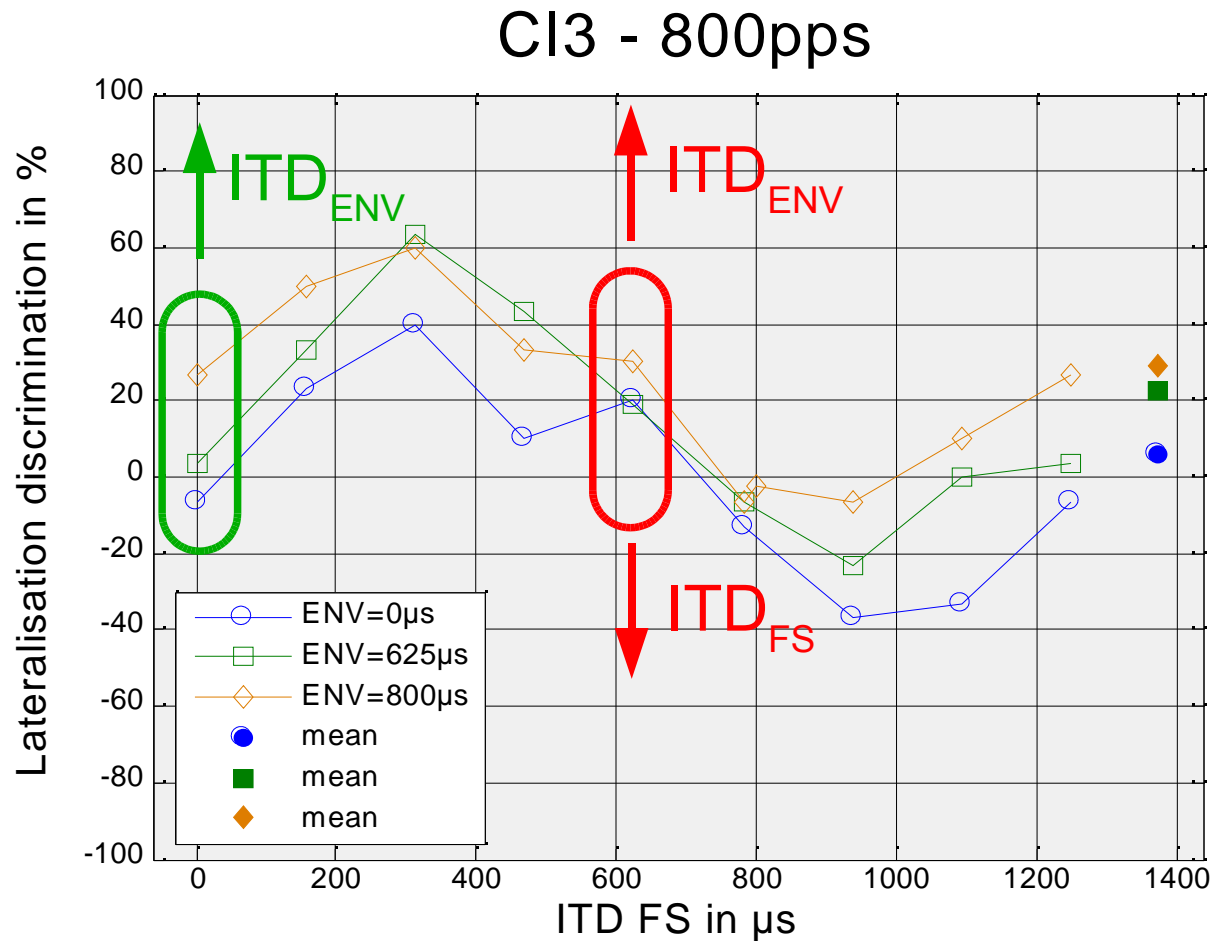
CI - ENV vs. WD



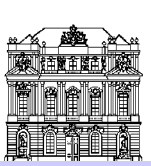
Pulse Rate	p
200pps	0,0001
400pps	0,0001
600pps	-
800pps	0,2
938pps	0,1



# Synchronization to the envelope



- Interaction between  $\text{ITD}_{\text{FS}}$  and  $\text{ITD}_{\text{ENV}}$ !



# Summary for CI listeners

- High sensitivity to  $ITD_{FS}$  – low to  $ITD_{ENV}$
- Strong variability of performance
- Synchronisation of speech processors:
  - appears to be necessary up to  $\sim 800$ pps
- Synchronisation of  $ITD_{FS}$  to  $ITD_{ENV}$ :
  - Improvement of performance up to  $\sim 600$ pps
- Open questions:
  - Effect of artificial stimuli? Broadband stimuli?
  - Lateralisation? Binaural unmasking?