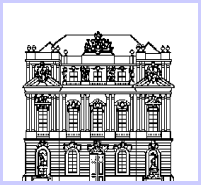

Austrian Academy of Sciences

Acoustics Research Institute – ARI

Effects of interaural time differences in fine structure and envelope on lateral discrimination

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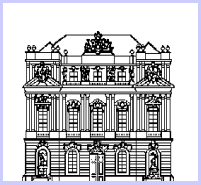
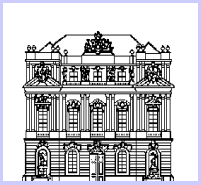


State of research

- CI listeners show sensitivity to ITD

  Lawson et al. (1998), van Hoesel and Clark (1997), Laback et al. (2004)

- Lateralization discrimination (LD) upon ITD depends on the stimulus parameters:
  - Pulse rate
  - Type of ITD:
    - Fine Structure (ITD_{FS})
    - Envelope (ITD_{ENV})
- Current bilateral cochlear implant systems:
  - Two independently working devices
  - Uncontrolled change of fine structure ITD (ITD_{FS})

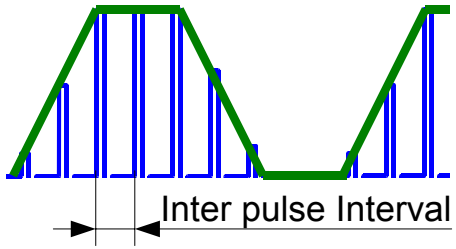


Objectives

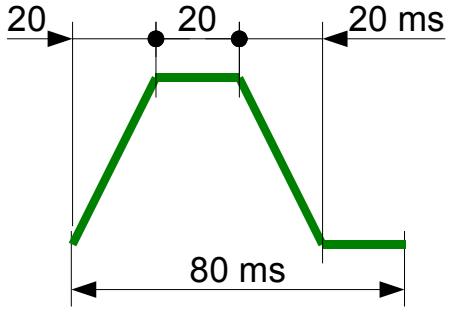
- Do we need a bilateral synchronization of:
  - speech processors to each other ($ITD_{FS} = 0$)?
  - fine structure to ITD_{ENV} ($ITD_{FS} = ITD_{ENV}$)?

Stimuli & Subjects

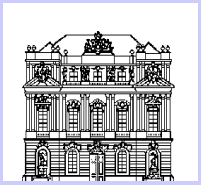
- Lateralization discrimination (LD):
  - Pitch matched electrode pair
  - Binaurally balanced loudness



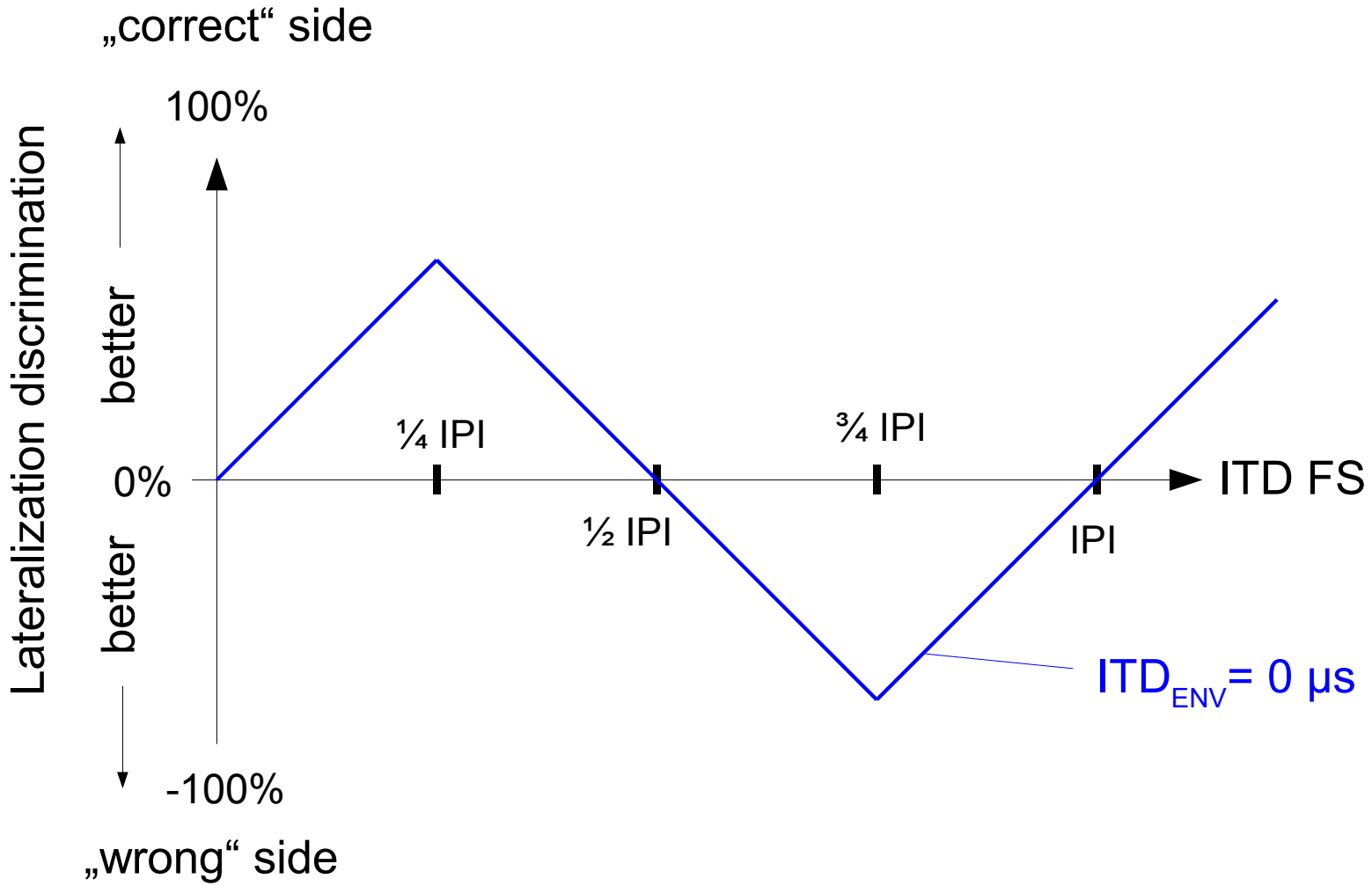
- Amplitude modulated pulse trains:
  - ITD_{FS}-Information (FS)
  - ITD_{ENV}-Information (ENV)
  - 4 Trapezoids, 300 ms total duration

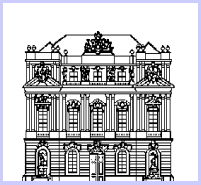


- Pulse Rates: 100...1600 pps (IPI: 0.6 ... 10 ms)
- 4 CI listeners (most of them used: C40+/C40+)



Expected results





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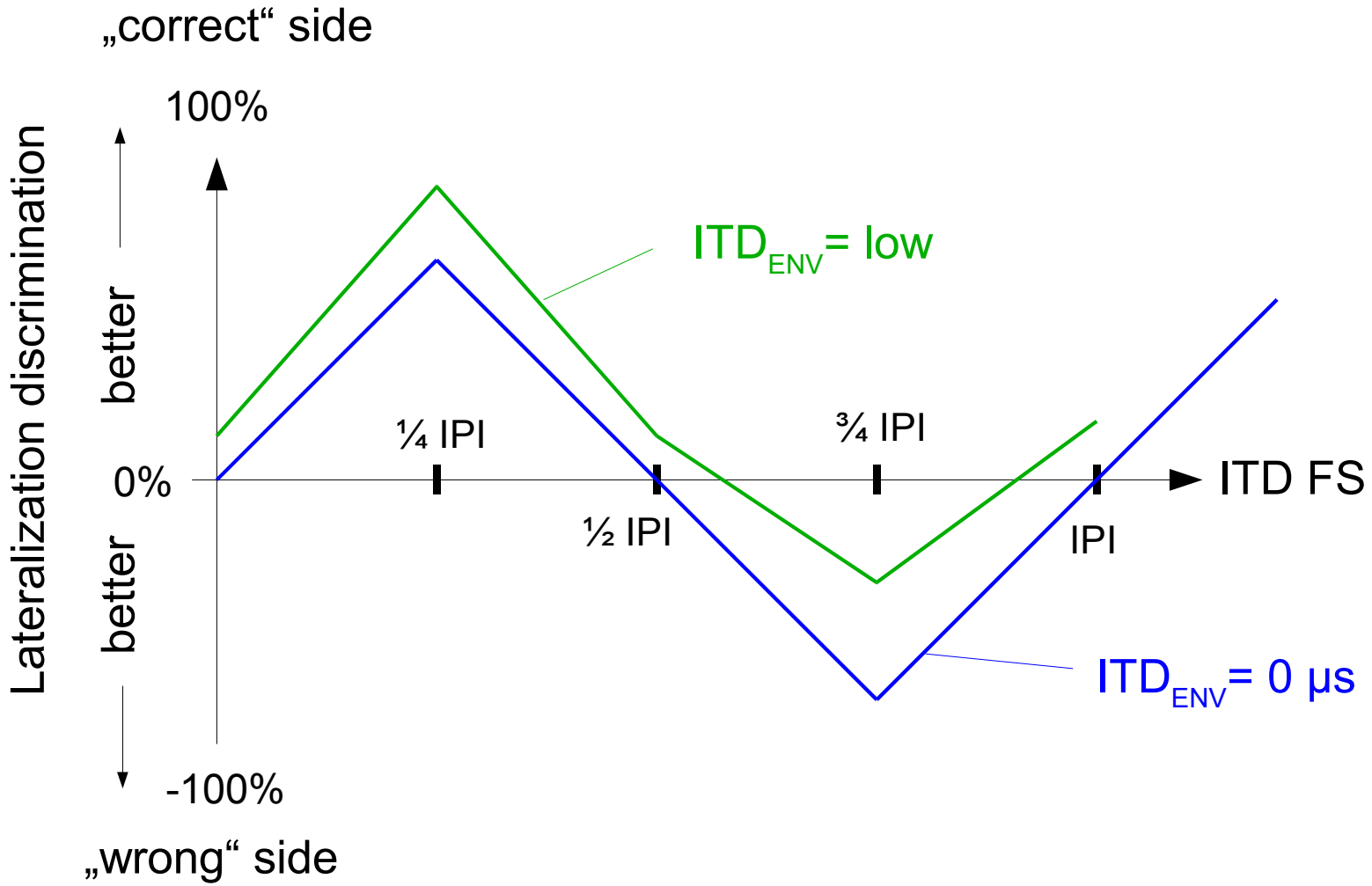

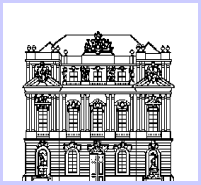

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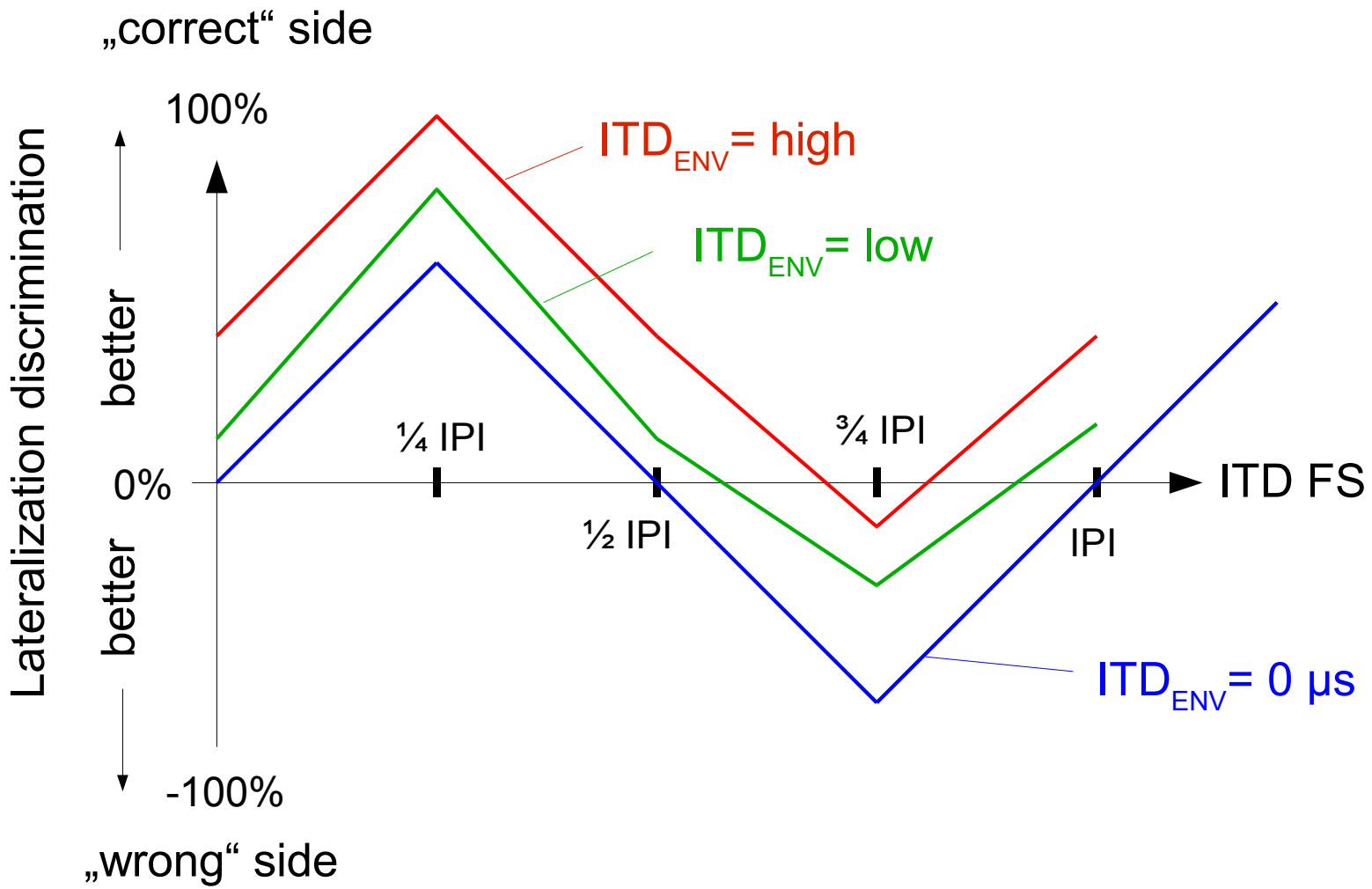
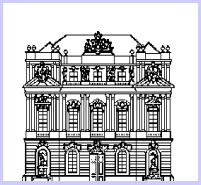
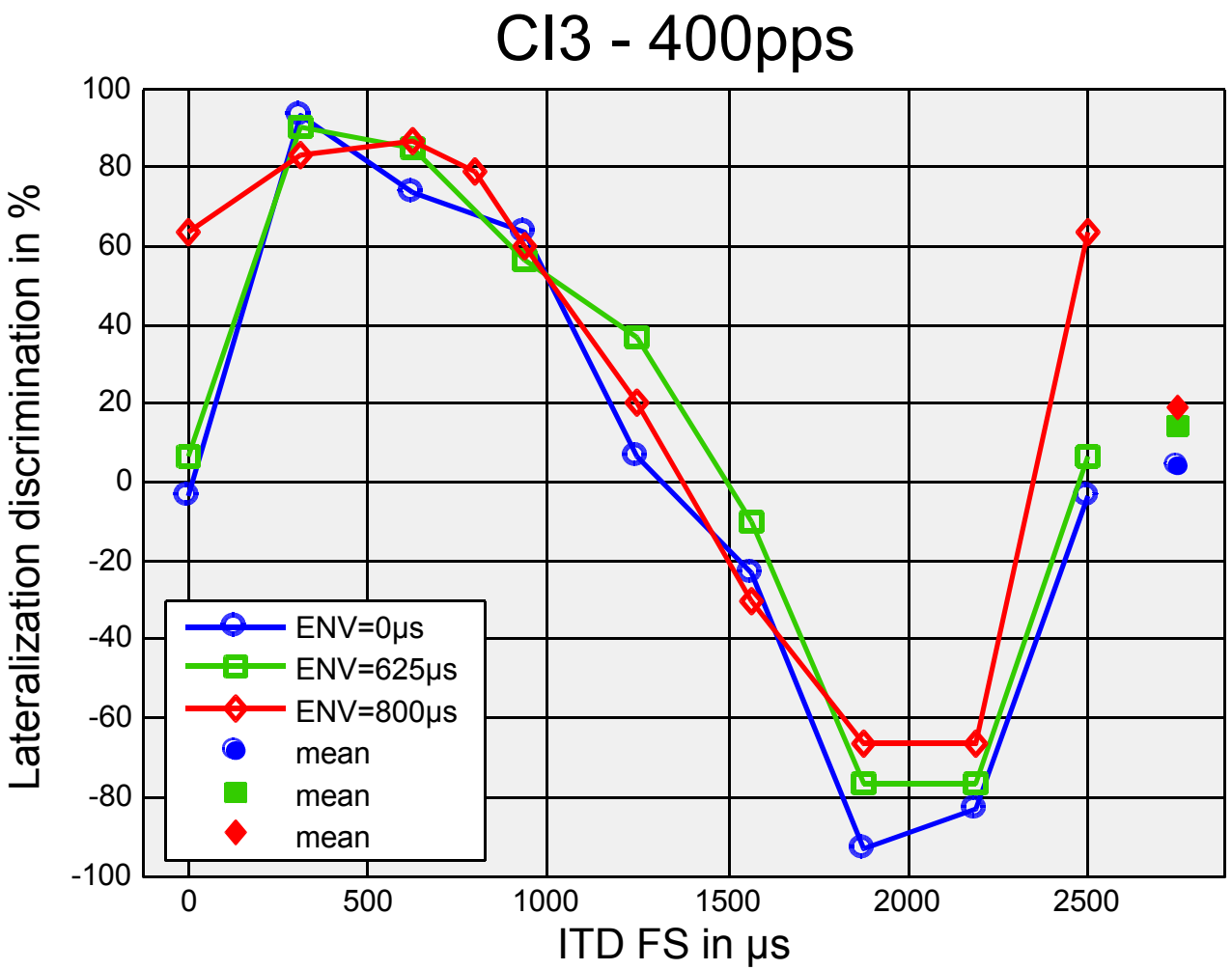




Results for lower pulse rates



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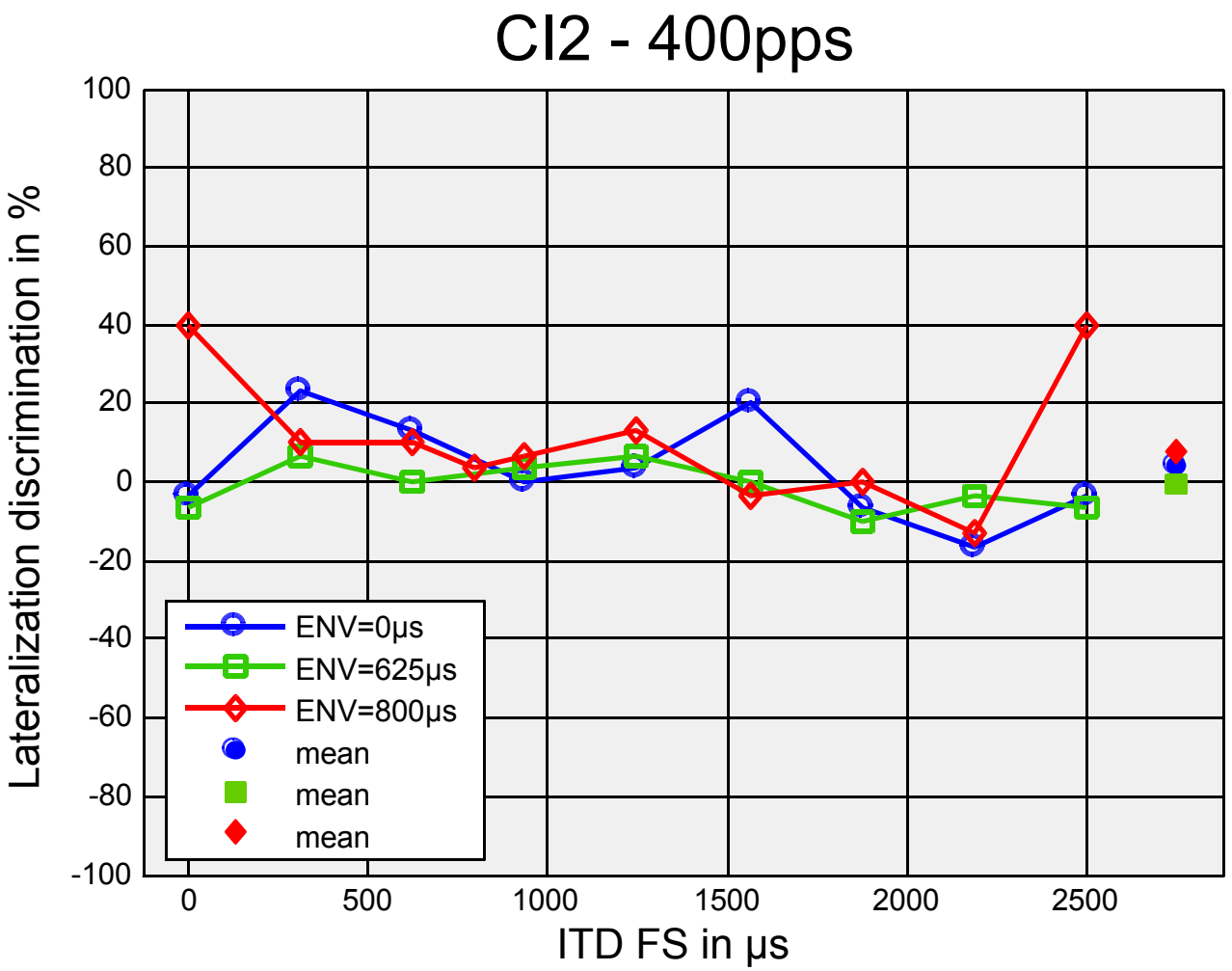

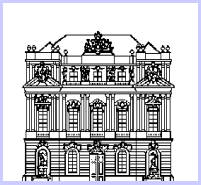

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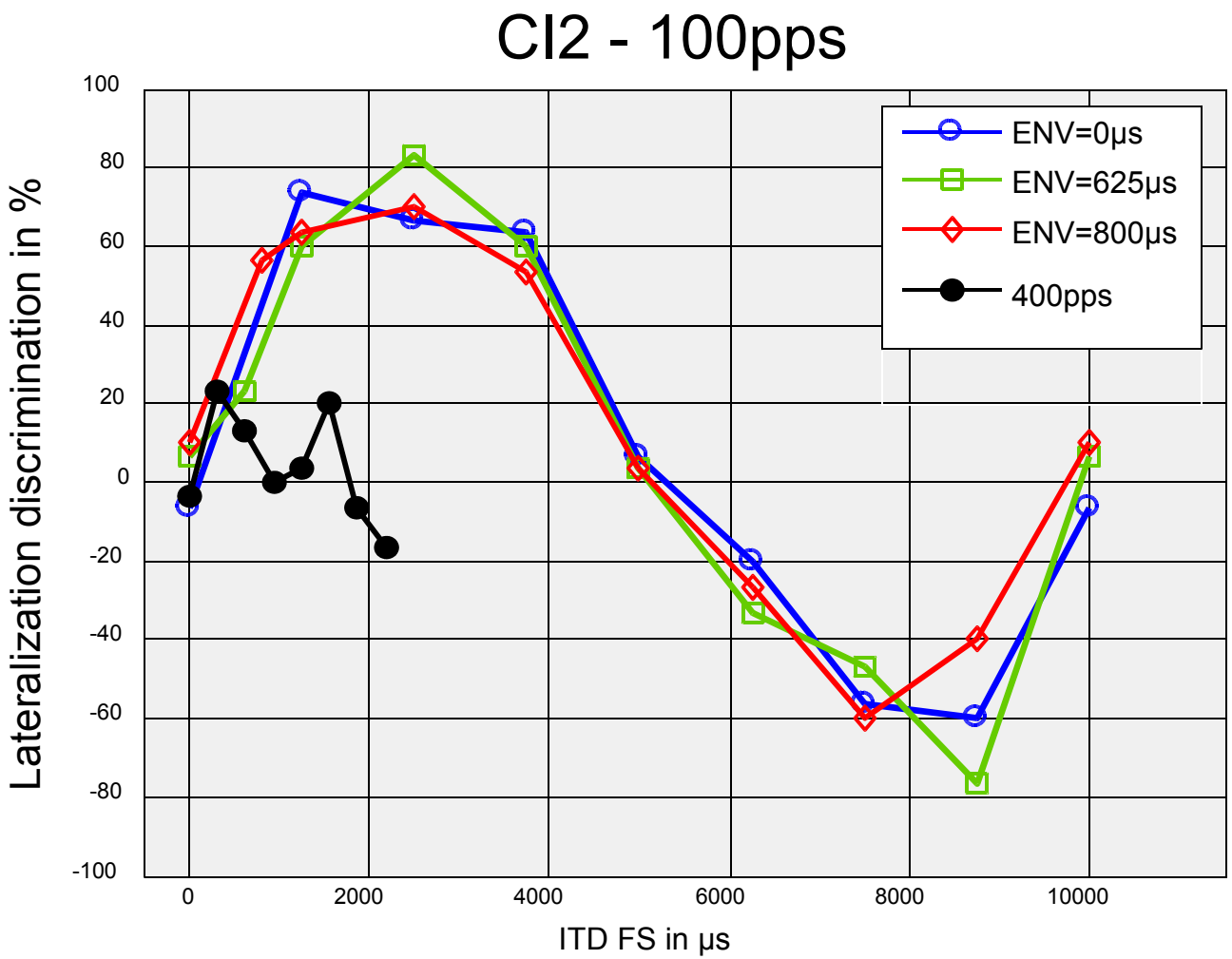
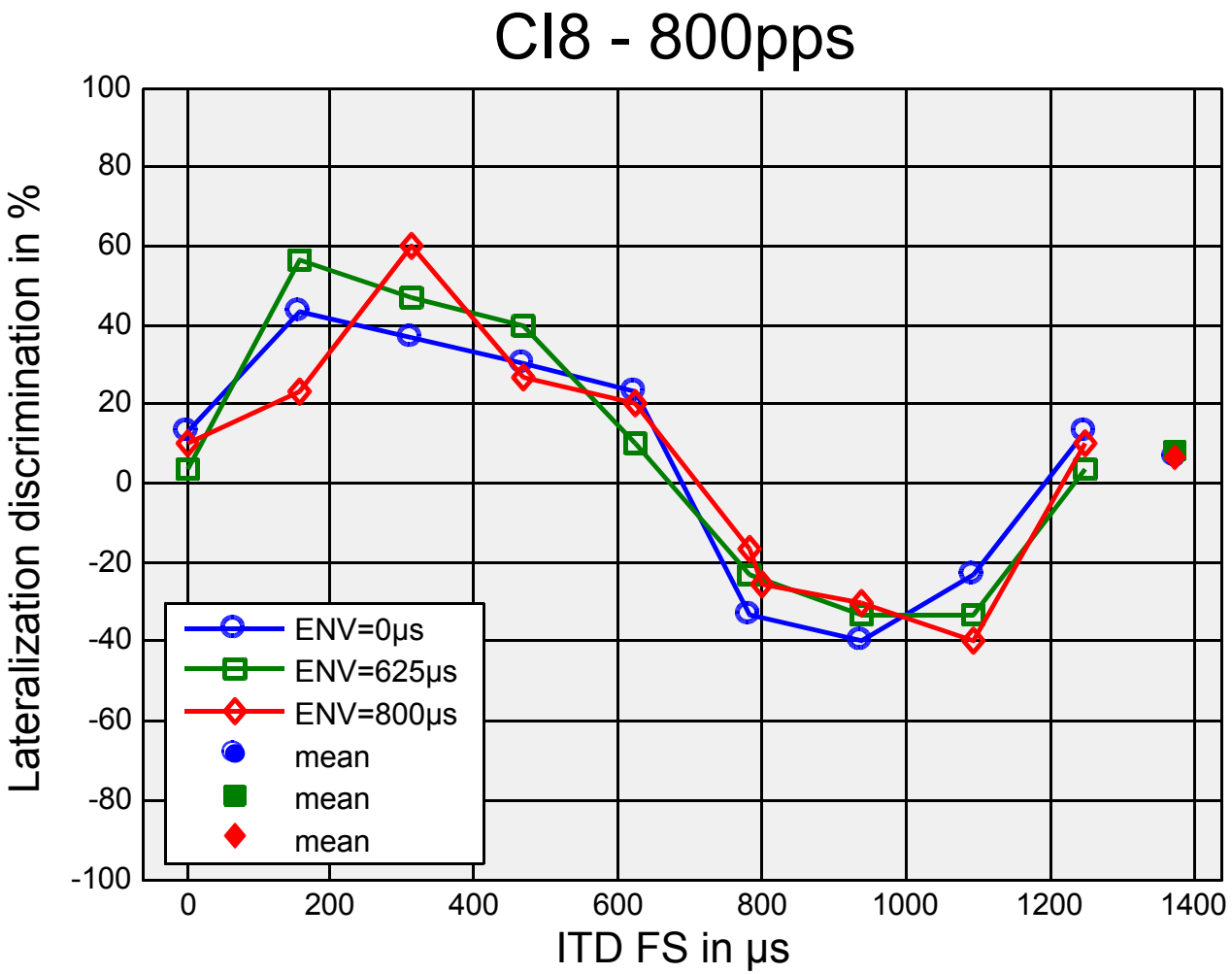
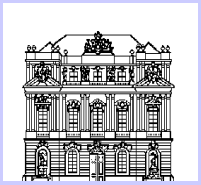


Results for higher pulse rates





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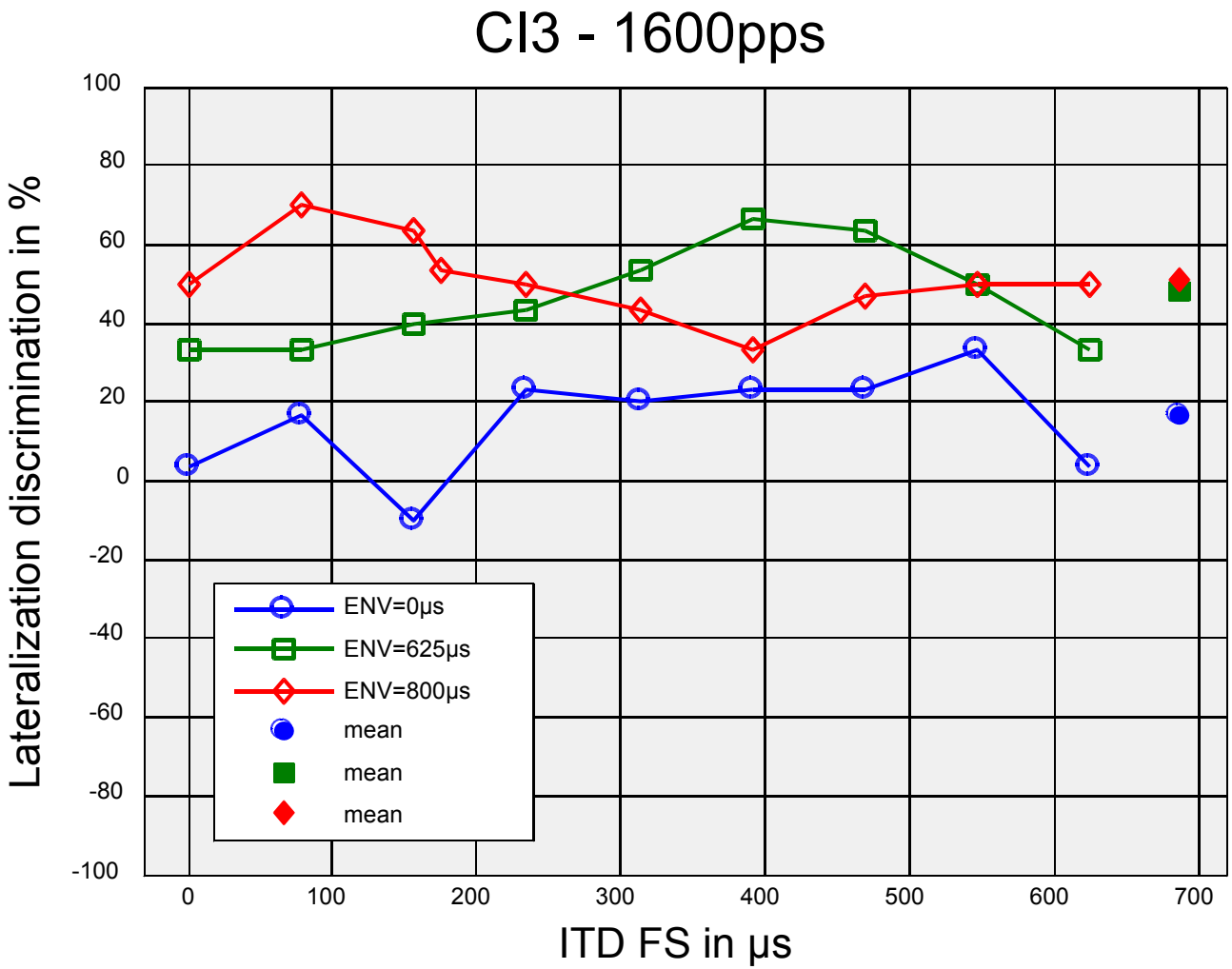
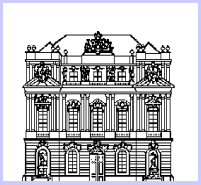
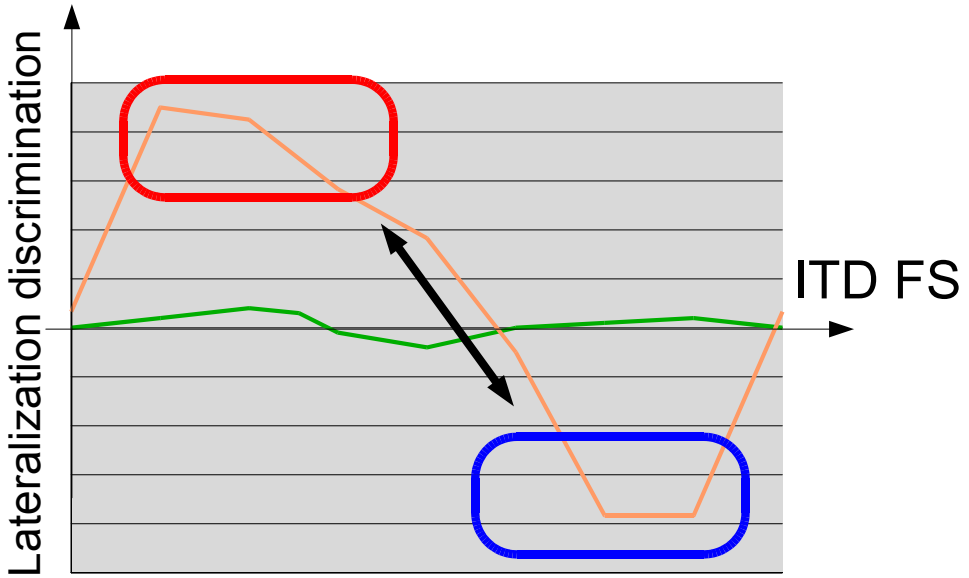


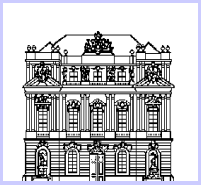


Synchronization of fine structure

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



Pulse rate	CI1	CI2	CI3	CI8
100		< 0.001	-	-
150		< 0.001	-	-
200	< 0.001	0.01	-	-
400	0.75	0.21	< 0.001	< 0.001
600	-	-	-	-
800	-	-	<0.001	<0.001
938	-	-	-	0.45
1600	0.46	-	0.11	-

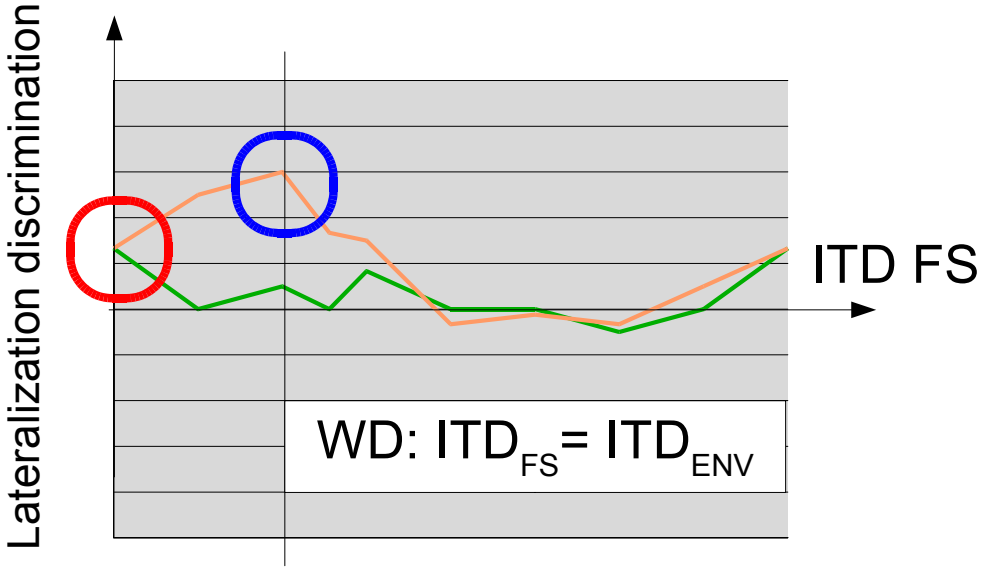


Synchronization to the envelope

- Relevant, if

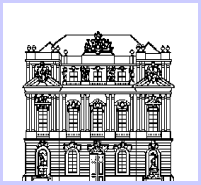
  LD(*ITD*$_{FS}$= *ITD*$_{ENV}$)

  > LD(*ITD*$_{FS}$= *0*)

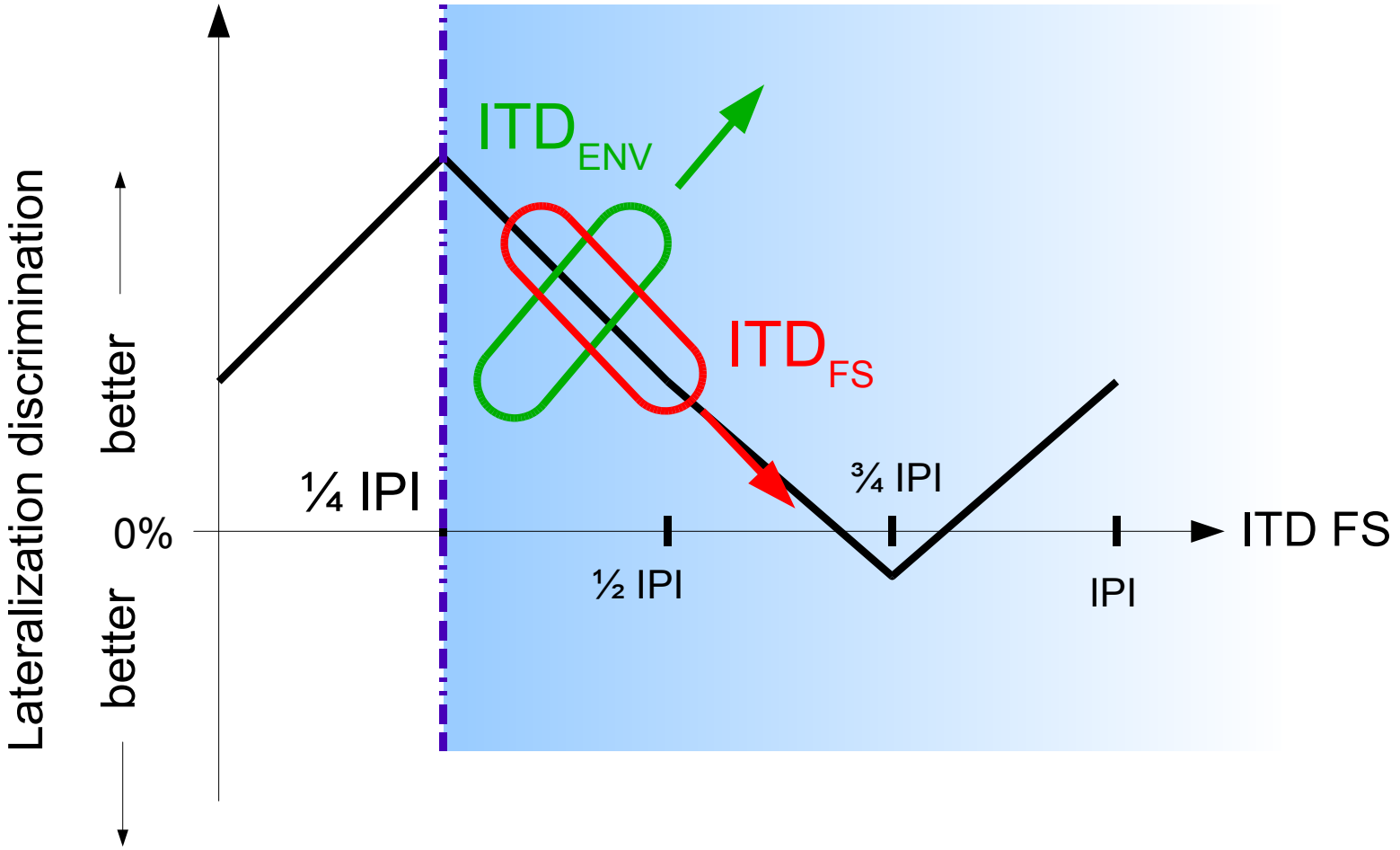


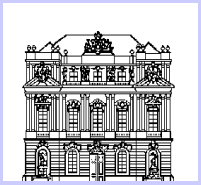
- ITD$_{ENV}$ = 625 µs:

Pulse rate	CI1	CI2	CI3	CI8
100		0.36	-	-
150		0.68	-	-
200	< 0.001	0.14	-	-
400	-	-	< 0.001	< 0.001
600	-	-	-	-
800	-	-	0.27	0.17



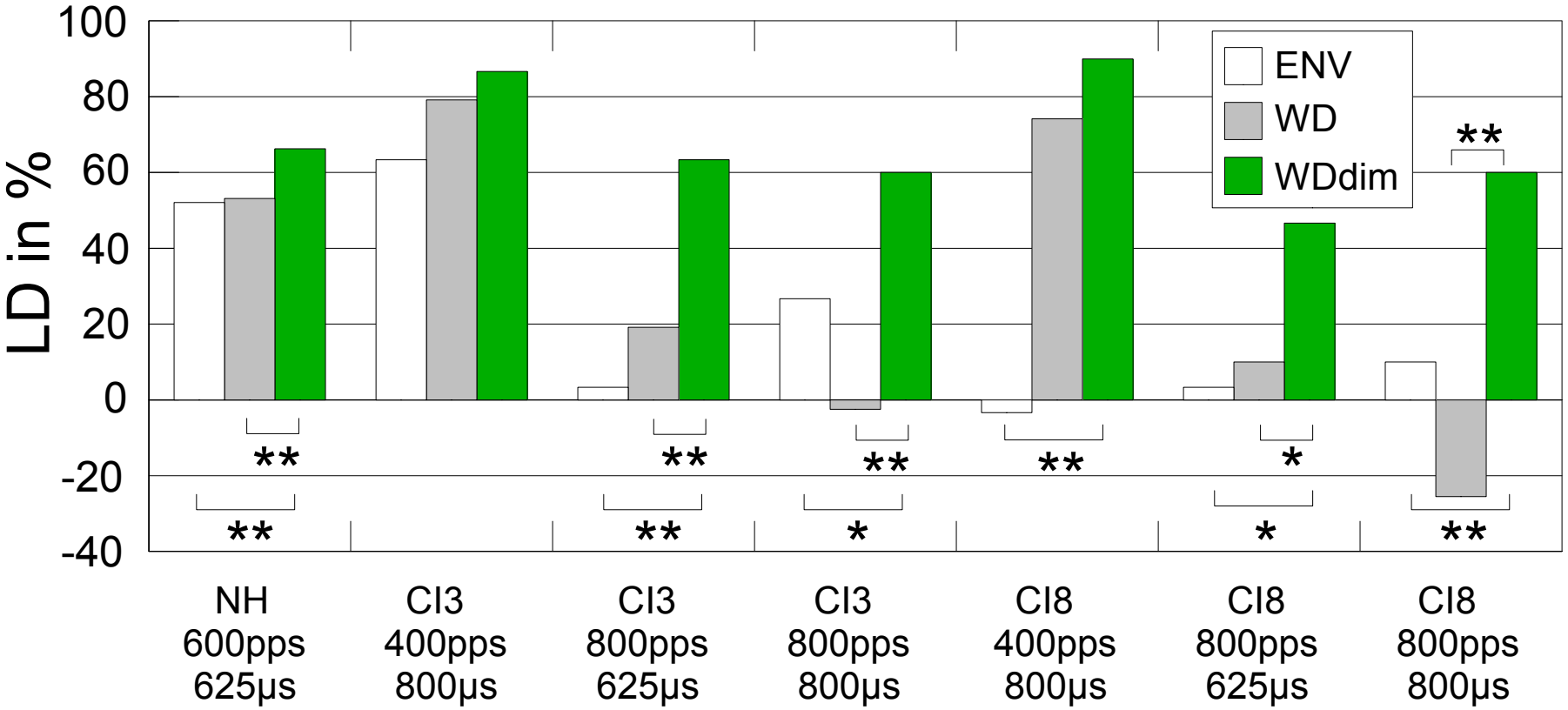
Interaction of ITD cues

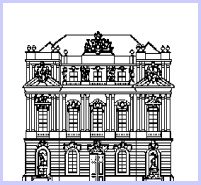




Diminished Waveform Delay WD_{DIM}

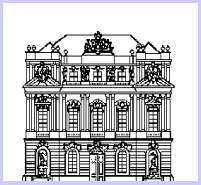
- Coding rule: $ITD_{FS} = min\left(ITD_{ENV}, \frac{1}{4} IPI\right)$
- Results:





Summary

- High sensitivity to ITD_{FS} – low to ITD_{ENV}
- High variability of performance
- Synchronisation of speech processors:
  - Appears to be necessary up to about 800 pps
- Synchronisation of ITD_{FS} to ITD_{ENV}:
  - Improvement of performance up to about 400 pps



Summary

- High sensitivity to ITD_{FS} – low to ITD_{ENV}
- High variability of performance
- Synchronisation of speech processors:
  - Appears to be necessary up to about 800 pps
- Synchronisation of ITD_{FS} to ITD_{ENV}:
  - Improvement of performance up to about 400 pps
- Diminished Waveform Delay (WD_{DIM}):
  - Improved the lateralization discrimination for:
    - Pulse rates up to 800 pps
    - Higher ITD values than 0.25 inter pulse interval