Subjective Validation of Perception Properties in Binaural Sound Reproduction Systems

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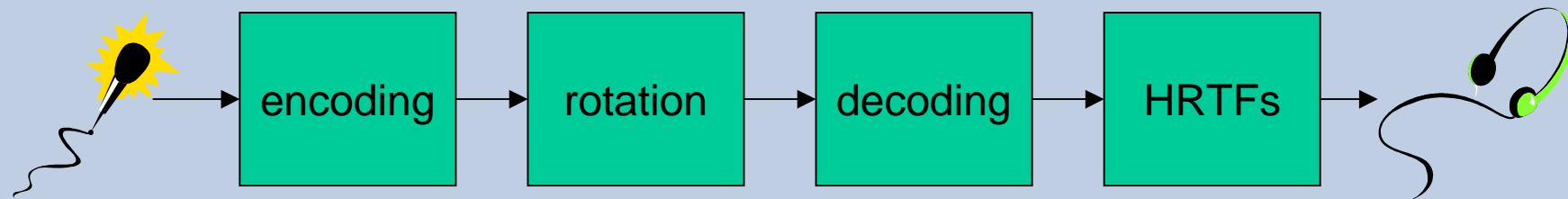

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Preceding projects:
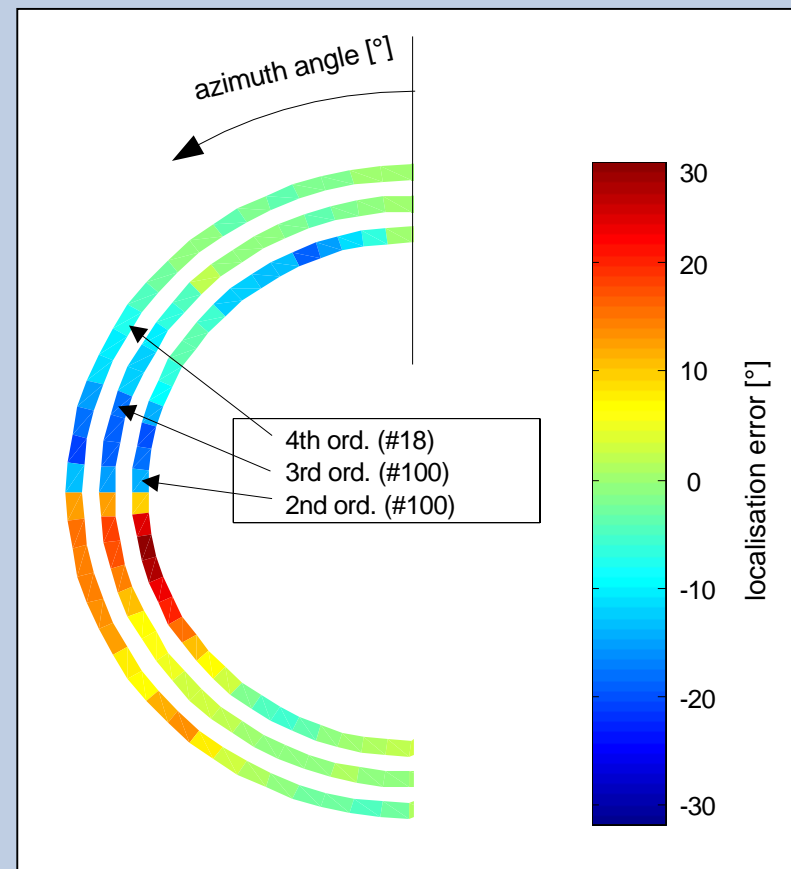
Binaural reproduction system for headphones:

- – real-time system based on DSP
- – tracking of head movement
- – rotation of audio sources based on ambisonic approach
- – binaural reproduction using a set of HRTFs

Preceding projects:

Objective model for localisation:

- prediction of localisation and blur
- based on distortion of HRTFs
- for 2D-systems
- preselection of parameter settings

Subjective Evaluation

Intentions:

- Validation of classified systems
- Verification of objective model
- Classification regarding coloration and externalisation
- Investigation of the influence of ambisonic
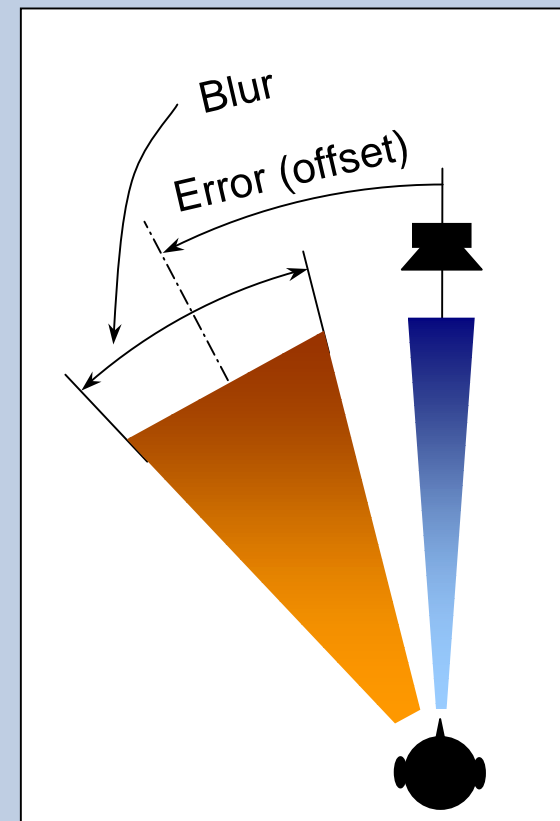- Determination of warping tables for further implementations

Interesting parameters:

Measuring:
- Localisation error
- Localisation blur

Verbal data:
- Coloration
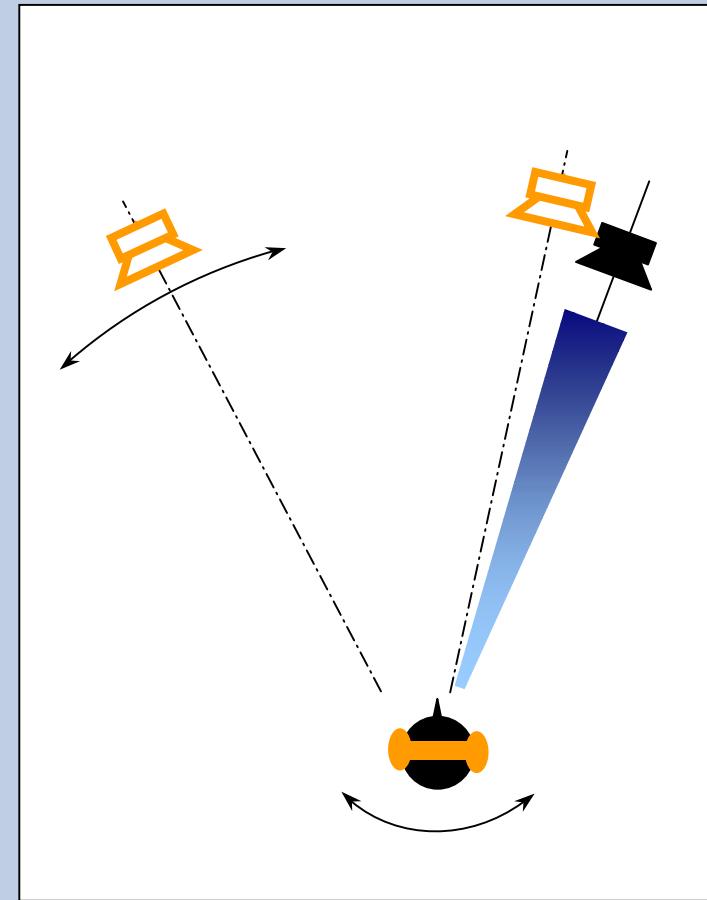- Externisation
- Consistency of movement

Investigating of localisation:

- Presented stimuli:
  - moved audio source
  - speaker array
- Determination of perceived positions:
  - entering/writing (input form)
  - showing/pointing (pointing device)

New evaluation approach:

– Stimuli over a real audio source at evaluated position

– Subject carring **open** headphones

– Virtual source presented over headphones - positioned by subject (360° range)

– Head movement allowed
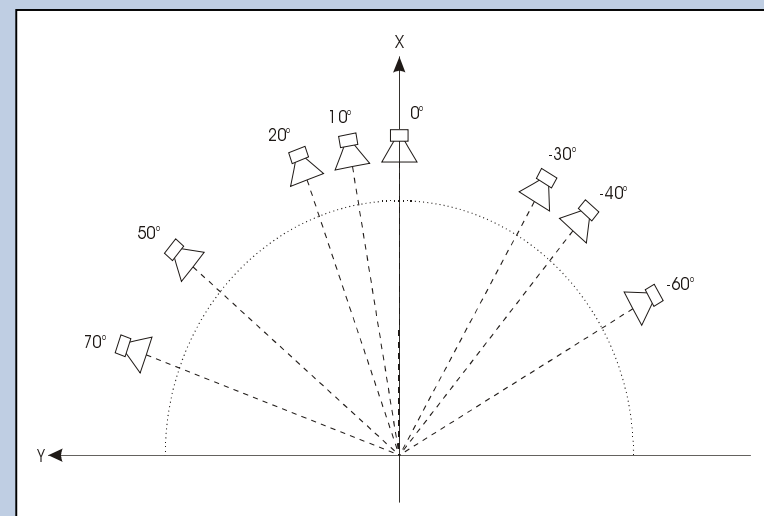 (limited to small range)

– Aim: match both sources

Used stimuli

Real sound stimuli:

– Resolution 10°, frontal part only

– speaker arrangment, taking advantage of symmetry of tested systems

– male speech

Virtual sound stimuli:

– female speech

– head movement

limited to 5°

Pilot test:

- Evaluation of the influence of open headphones
- Preselection of subjects
- Training of using the set-up
- Selected subjects:
  - 10 Subjects (4 female, 6 male)
  - aged 20 to 40

Evaluated systems:

Varied parameters:

- – Method of spatialisation: discrete and ambisonic
- – Length and kind of HRTFs
- – Ambisonic order
- – Weighting of ambisonic channels
- – Arrangment of ambisonic speakers

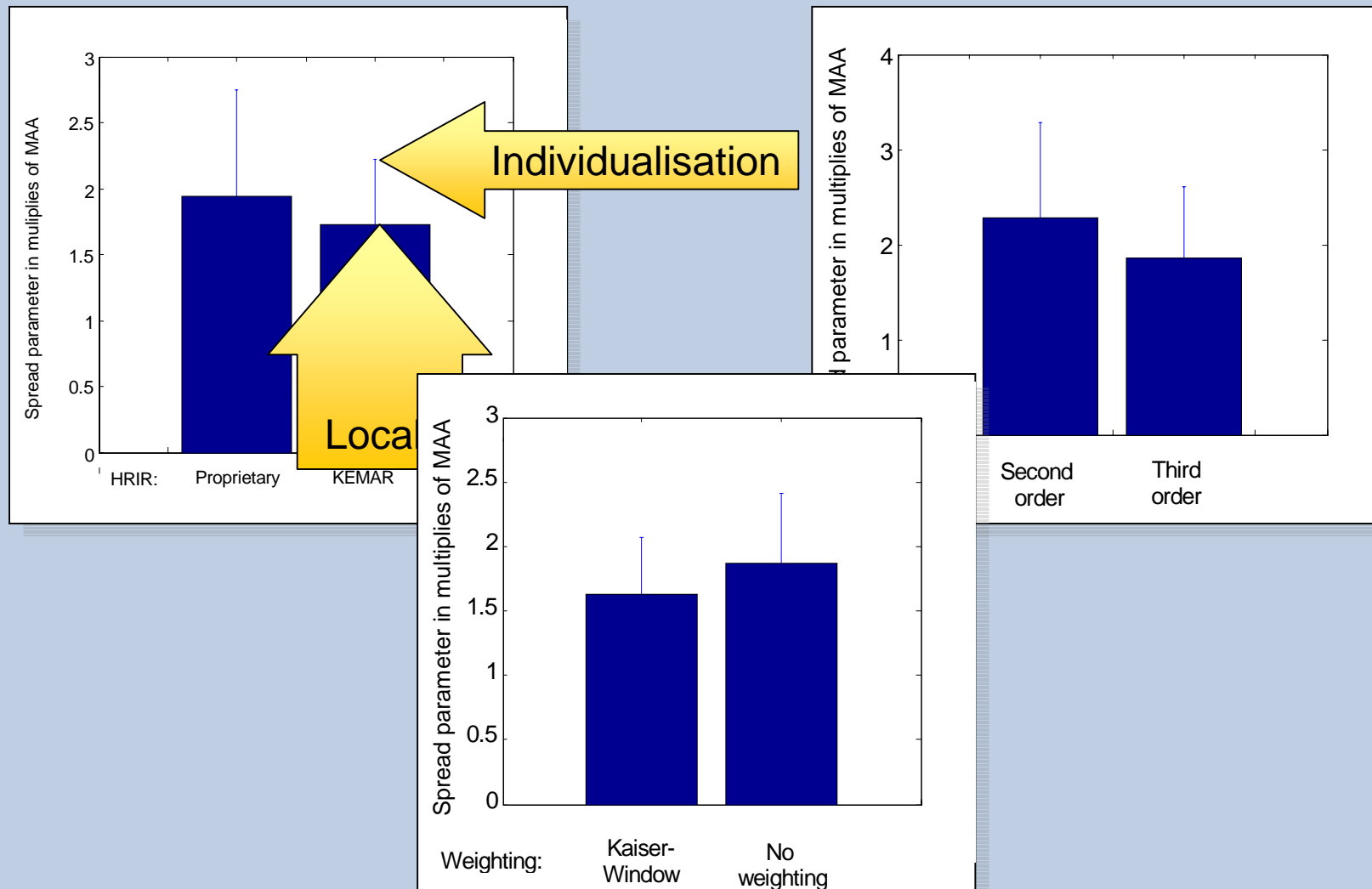11 different settings used

Physical set-up

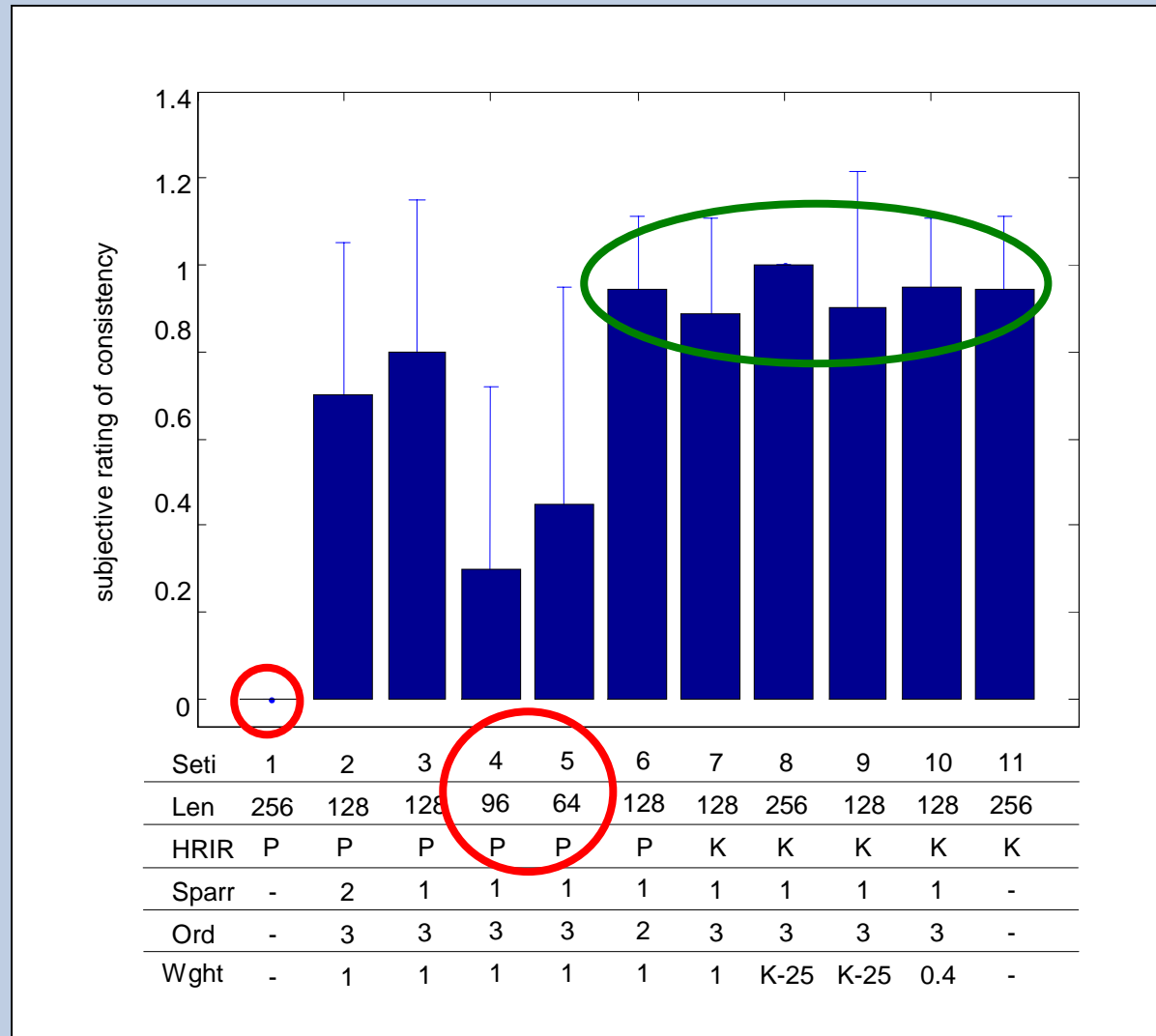measured reverberation time:

~230ms

Evaluation of data

- Localisation data : $L(sub, set, spk, no)$
  - Reversal error
  - Spread parameter: std. dev. normalised to MAA
  - Dependency on parameters: ANOVA
- Verbal data:
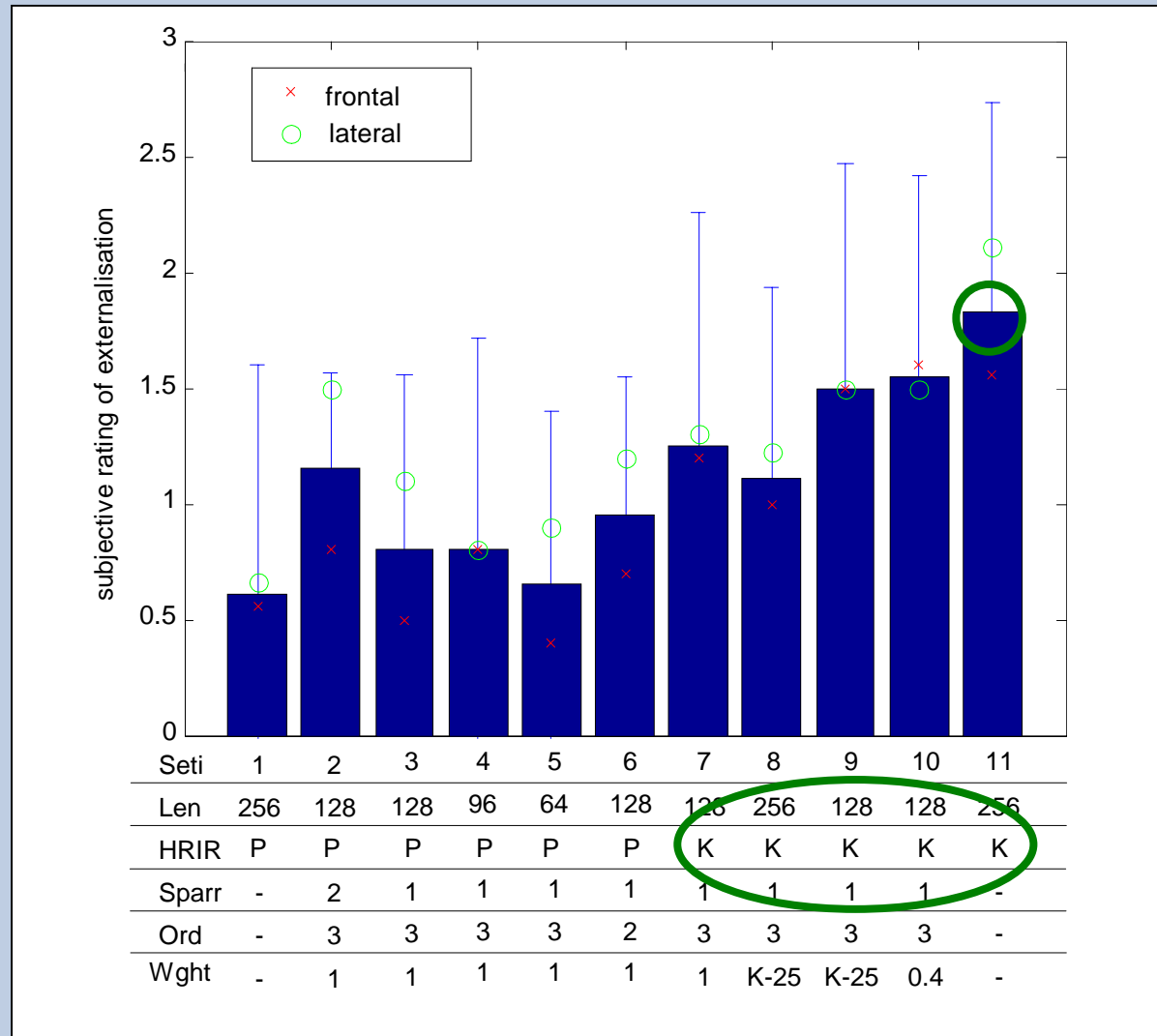 - Classification to quantize responses
  - Graphical comparisation
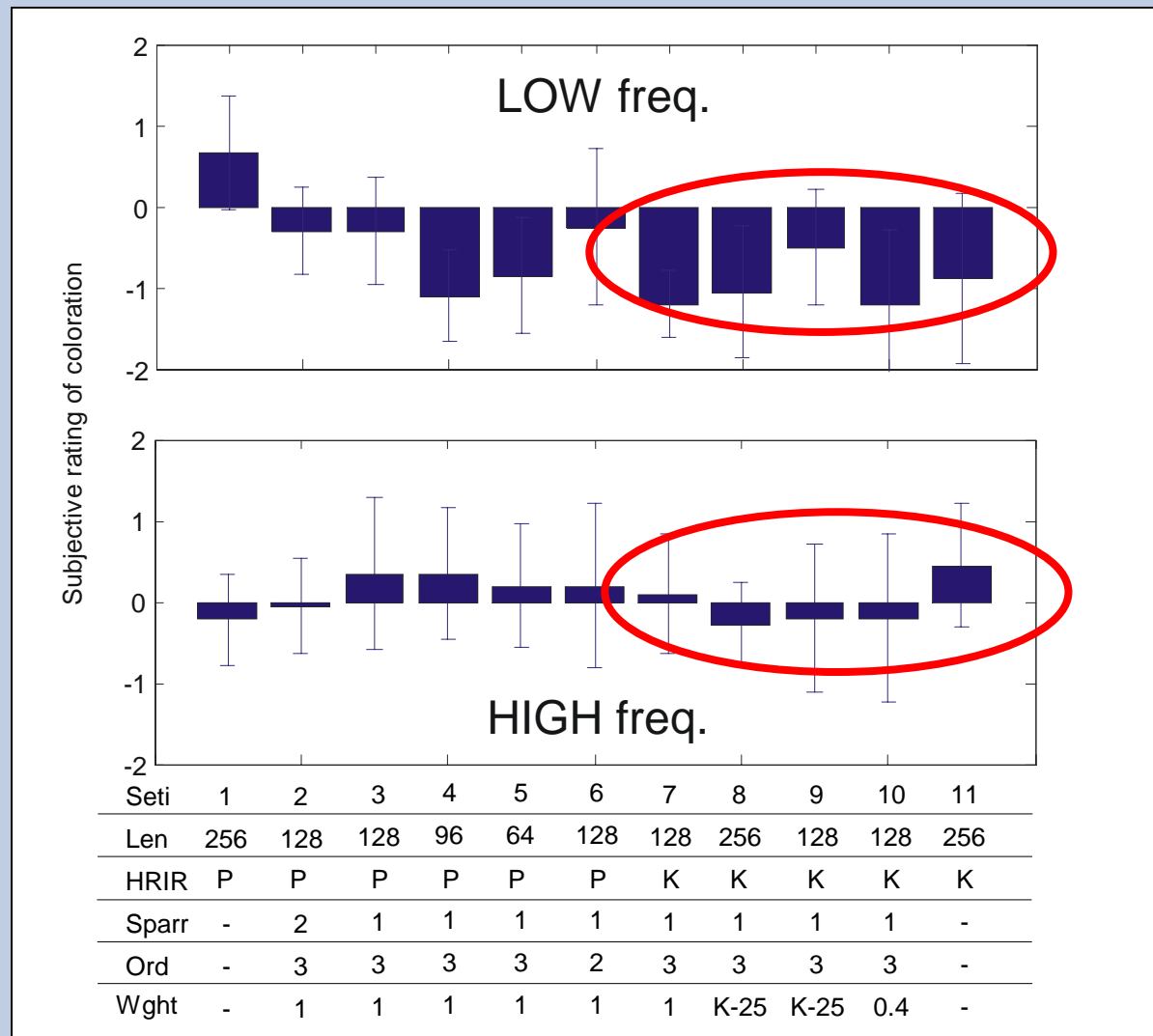
Reversal Error:

Results of ANOVA:

Verbal data: Consistency

Verbal data: Externalisation

Verbal data: Coloration

Conclusions:

- Evaluation subject dependent
- Ambisonic? Yes, 3th order at least
- Which HRTF?
  - KEMAR: better localisation and externalisation
  - Proprietary: better sound quality
- Weighting of channels using Kaiser-window
- Accordance with objective model verified

Outlook:

- – Warping tables to predict and minimise the localisation errors for further implementation
- – Measurement of localisation and localisation blur using narrow band stimuli
- – Determination of limits of used approach due to distorted localisation of real sounds

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Thank You!

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