MPEG-D SPATIAL AUDIO OBJECT CODING FOR DIALOGUE ENHANCEMENT (SAOC-DE)

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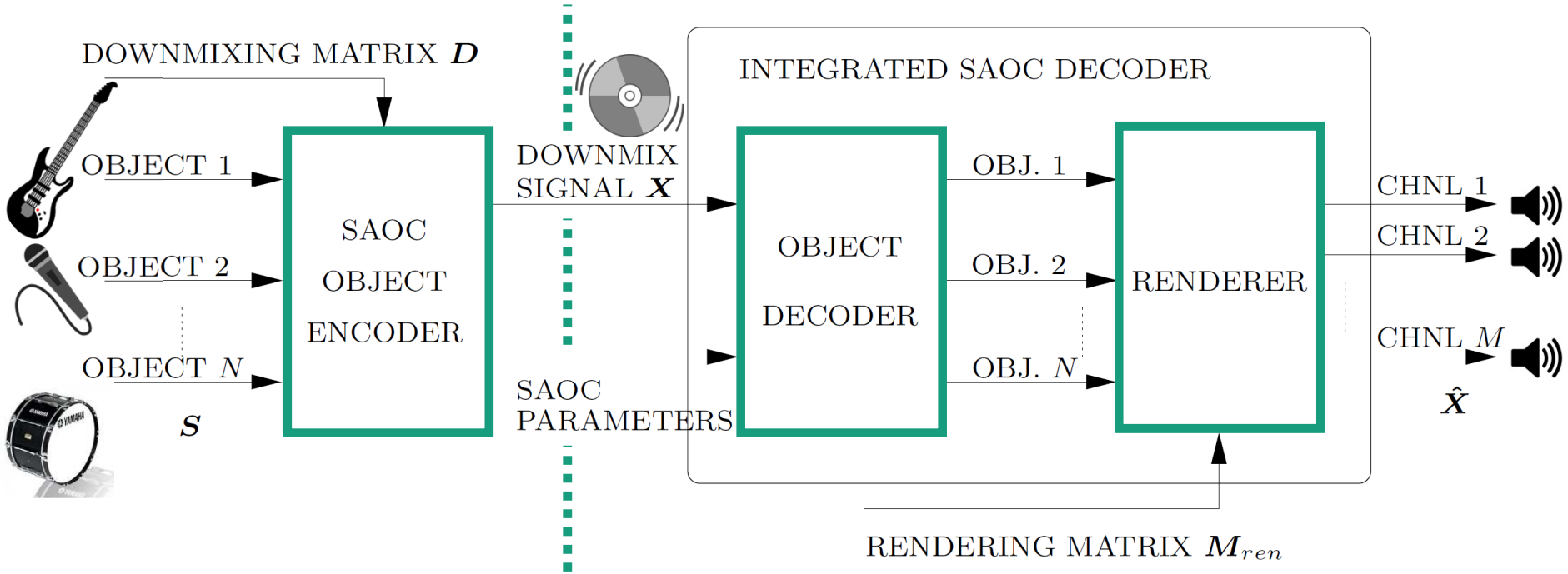
OUTLINE

- Introduction to Spatial Audio Object Coding
- Dialogue enhancement
  - Concept
  - Technical solution
- Evaluation: subjective listening test
- Demonstration
- Conclusions

Spatial Audio Object Coding (SAOC)

- SAOC is an efficient way for coding audio objects
- A semantic pre-/post-processor to other audio codecs



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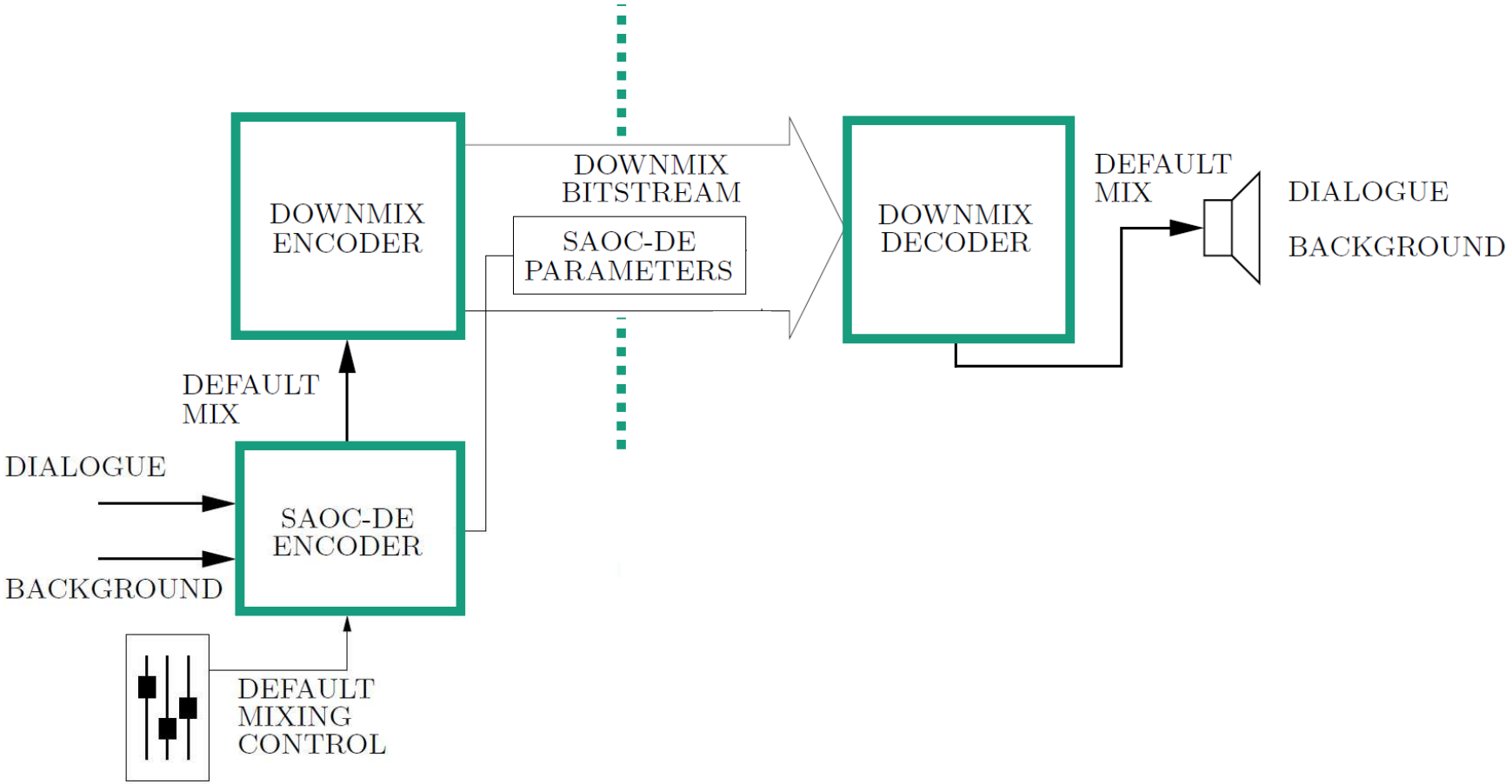
Dialogue Enhancement (DE) – Legacy decoder



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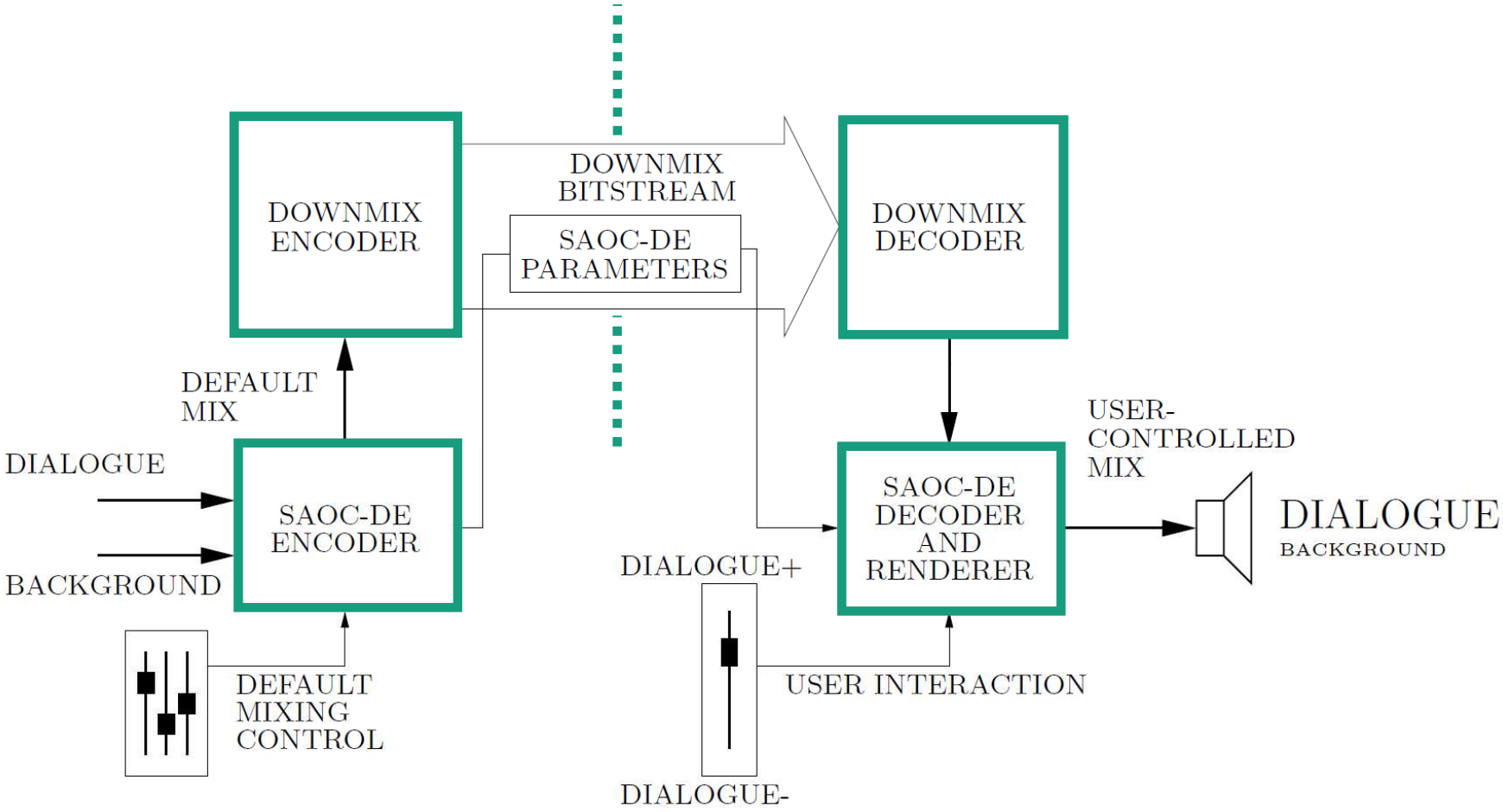
Dialogue Enhancement (DE) – SAOC-DE decoder



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Wimbledon 2011 experiment with BBC

- Public test during Tennis Grand Slam Championships 2011 in Wimbledon
- Player provided on BBC website
- User control for dialogue vs. background balance
- Well-received: >80% of people answering the questionnaire indicated the effect of this functionality to be positive

Dialogue enhancement functionality benefits

- Improving intelligibility of dialogue by background attenuation
  - Hearing-impaired audience
  - Non-native audience
  - Noisy listening environments
- Reducing dialogue level
  - Custom mixture, e.g., focusing on sports event atmosphere sounds

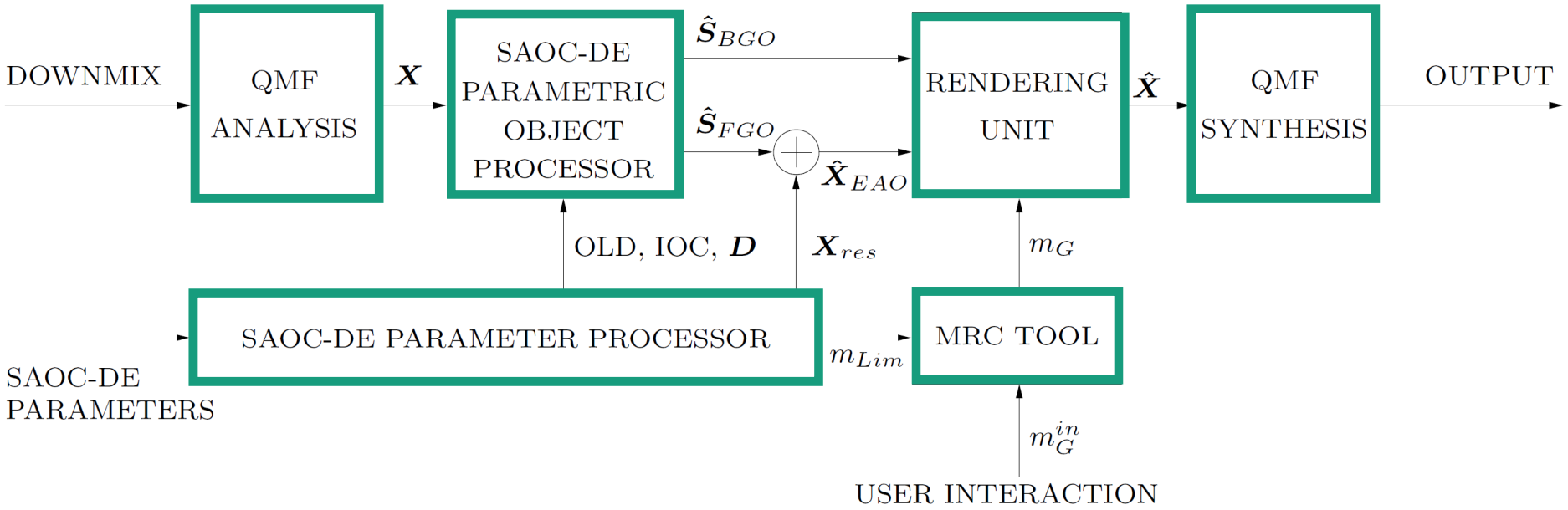
- Allows addressing complaints in broadcast regarding dialogue mixing levels

Adapting MPEG-D SAOC for DE-application needs

- Adding support for more than 2 downmix channels
  - In 5.1, dialogue is normally present in the 3 front channels
- Disable functionality not needed by the application
  - Reduction in engineering and computational complexity

- 2 meta-objects: foreground (FGO), background (BGO)
- Restrict rendering functionality to in-place re-balancing of FGO and BGO
  - Number of output channels = number of downmix channels
  - No object re-panning

SAOC-DE decoder overview



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Signal model

- Downmix signal obtained with instantaneous linear mixing

$$\mathbf{X} = \mathbf{DS}$$
$$= \mathbf{X}_{BGO} + \mathbf{X}_{FGO}$$

- Target output signal: re-balanced mix of partial downmixes

$$\hat{\mathbf{X}} \approx m_{BGO}\mathbf{X}_{BGO} + m_{FGO}\mathbf{X}_{FGO}$$

- The gains determined from single user input m_G
  - The re-balancing gain to be applied to FGO (dialogue)
  - Applied as attenuation only to avoid clipping

Object reconstruction

- Parametric object reconstruction

$$\hat{\mathbf{S}} = \mathbf{G}\mathbf{X} \approx \mathbf{S}$$

- Un-mixing matrix

$$\mathbf{G} = \mathbf{E}\mathbf{D}^{*}\left(\mathbf{D}\mathbf{E}\mathbf{D}^{*}\right)^{-1}$$

- Object covariance $\mathbf{E}$ and downmixing matrix $\mathbf{D}$ obtained from SAOC side information (object level differences, inter-object correlations, etc.)
- Enhanced Audio Object (EAO) reconstruction
  - Include waveform residual signal(s) for improving perceptual quality of output
  - Residual signals focused on FGO (i.e., dialogue signal)

$$\mathbf{X}_{res} = \mathbf{S}_{FGO} - \hat{\mathbf{S}}_{FGO}$$

Modification Range Control (MRC)

- Rendering gain interface allows full separation of partial downmixes of FGO and BGO
  - Rights-management issues
  - Quality control concerns
- MRC values in bitstream restrict the range of the user input gain
- Content-provider retains control over the allowed modifications
  - Keep modification in a safe region

Main differences from classic MPEG-D SAOC

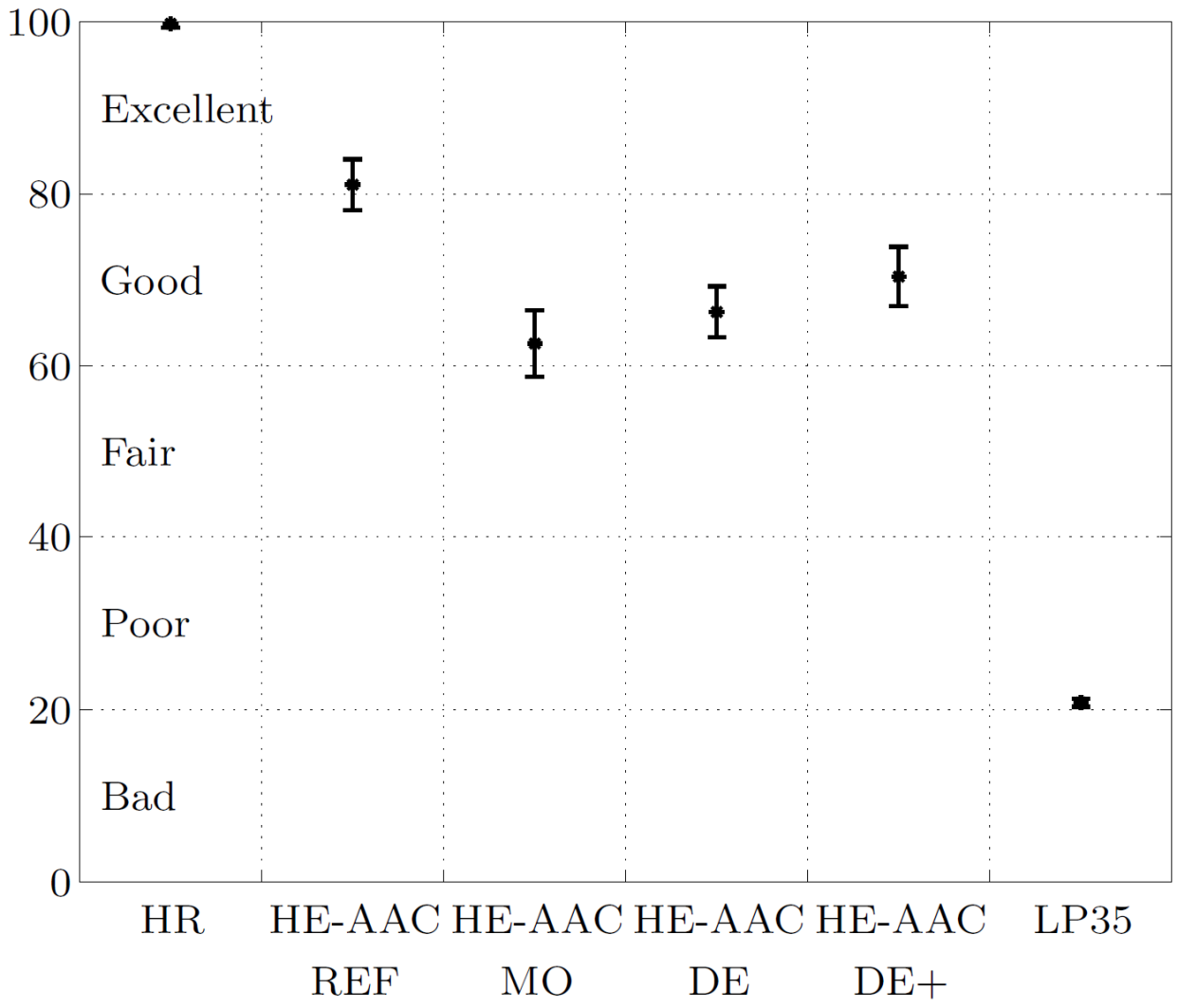
- Increased maximum number of downmix channels to 3 (from 2)
  - Generalized object reconstruction algorithms to support higher number of downmix channels
- Simplified rendering interface
  - In-place gain change of two meta-objects
  - Single gain rendering control input instead of a full rendering matrix
- Significant complexity reduction
  - Disabled un-used tools and modes (e.g., decorrelators)
  - Limited number of objects to 6 (from 32)
- Replaced DCU with MRC
- Removed MPEG Surround transcoding

Subjective listening test with MUSHRA

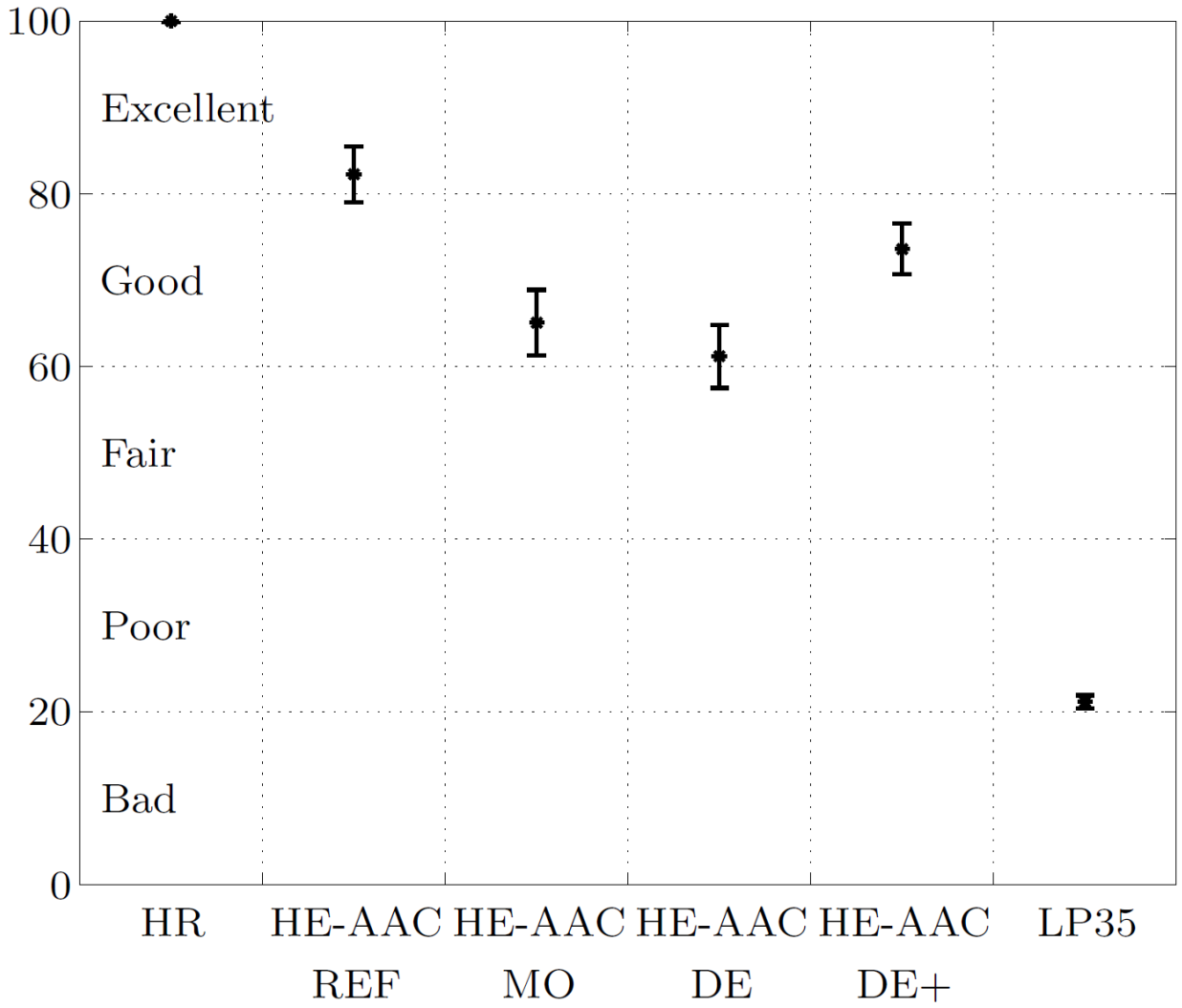
- Material similar to broadcast content
  - Stereo background (music, sound effects, audience noise)
  - Mono dialogue foreground panned to center
  - Downmix (stereo) SNR 1.5 – 7.5 dB

Conditions	
HR	Original objects mixed with target gains
HE-AAC REF	”HR” encoded with HE-AAC at 64 kbps
HE-AAC MO	Multi-Object transmission (discrete objects, 43+21=64 kbps)
HE-AAC DE	SAOC-DE and HE-AAC encoded downmix (64 kbps)
HE-AAC DE+	SAOC-DE bitrate on top of dmx bitrate (64+SAOC kbps)
LP35	3.5 kHz low-pass anchor

FGO +6 dB (parametric-only, 10 listeners, 64 kbps)



FGO +12 dB (with EAO processing, 10 listeners, 64 kbps)



Demonstration

Conclusions

- SAOC-DE extends MPEG-D SAOC for dialogue enhancement applications
- It is answering the request from broadcasting industry
  - Providing a backward compatible extension to existing services
- Good performance in subjective evaluations
- Technical solution standardized as an amendment to MPEG-D SAOC
  - ISO/IEC 23003-2:2010/Amd.3:2015
- Included as “Advanced Clean Audio“ solution in DVB
  - ETSI TS 101 154 v2.2.1