

The (virtual IKOsahedral loudspeaker array) vIKO

Markus Zaunschirm (zaunschirm@iem.at) Nov. 29th 2016.

Introduction

The interactive virtualization of the *IKO* for different playback/recording positions at various venues is intended to be used on a laptop equipped with a spatial audio workstation (e.g. *Reaper* with *ambix* plugin suite) and headphones. The *vIKO* employs multiple input multiple output (MIMO) convolutions comprising measured room impulse responses (RIRs), impulse responses (IRs) controlling the *IKO* and the higher-order microphone array (eigenmike *EM32*), and individual head-related IRs (HRIRs) used for dynamic binaural *Ambisonic* rendering. Please find more information as well as a perceptual evaluation of the *vIKO* here [1].

In-depth information on the *IKO* and the PEEK project **Orchestrating Space by Icosahedral Loudspeaker** (*OSIL*) can be found on the project homepage [2].

What is in the box

- presets for *mxfx_convolver* - multichannel audio plug-in suite (folder: *mcfx_vIKO*)
- presets for the *ambiX* - ambisonic plug-in suite (folder: *ambix_BinauralDec*)
- default *Reaper* projects as starting point for compositions involving the *IKO* (in folder: *vIKO_default*)

Getting started

In order to use the *vIKO* environment you have to install:

- *Reaper* (<http://www.reaper.fm/download.php>)
- *ambiX* - Ambisonic plug-in suite (<http://www.matthiaskronlachner.com/?p=2015>)
- *mcfx* - multichannel audio plug-in-suite (<http://www.matthiaskronlachner.com/?p=1910>)

After installing the above mentioned mandatory components:

- copy the folder *mcfx_vIKO* in the *mcfx*-preset folder (on windows the default is: `C:/Users/xxx/AppData/Roaming/mcfx/convolver_presets/`).
- copy the folder *ambix_BinauralDec* in the *ambix*-binaural default folder (`C:/Users/xxx/AppData/Roaming/ambix/binaural_presets/`).

How to use *vIKO_default* project

Open *vIKO_Default.rpp* in *Reaper*. The project consists of 4 tracks (see fig. 1):

- ***encode signal 1***: put the source signal (mono) that is intended to be spatialized in this track. The mono source signal is encoded in 3-rd order *Ambisonics* using the *ambix_encoder_o3* plug-in, see fig. 2(a). Please note that the track needs to have at least 16-channels (number of *Ambisonics* channels). The channels of the *encode signal 1* track are routed to the *vIKO to ambi* track, see fig. 2(b).
- ***encode signal 2***: different source signal but same inserts and routing as *encode signal 1*.

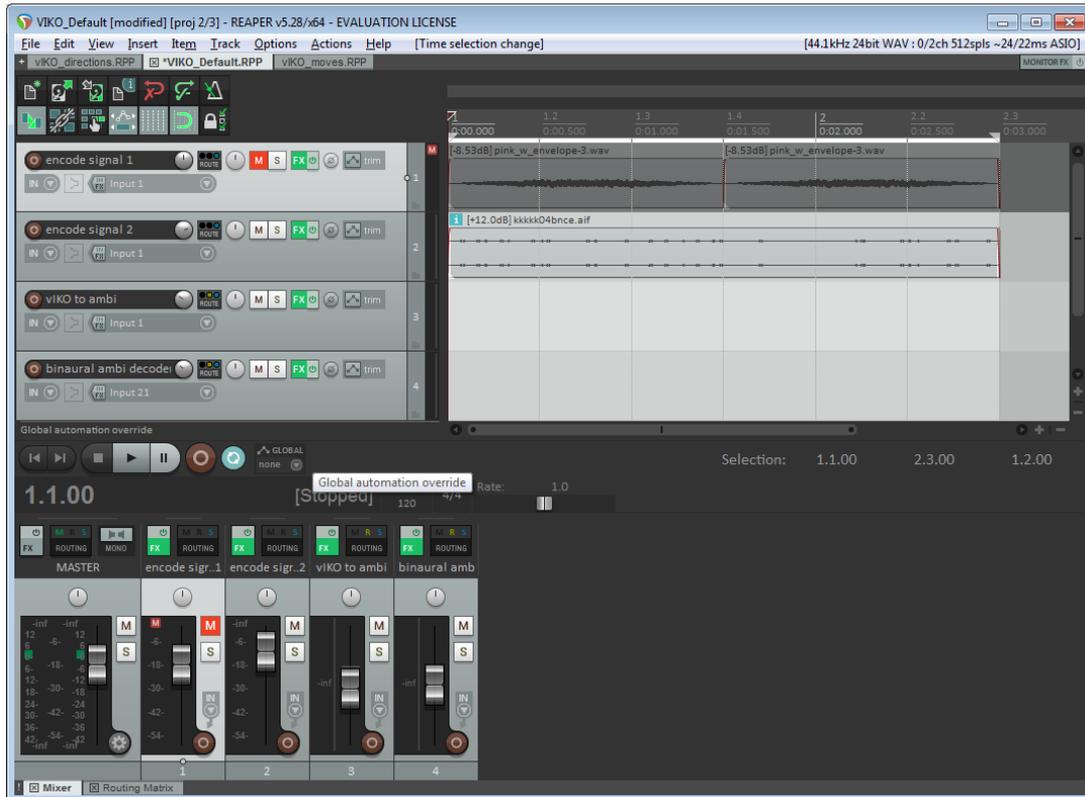
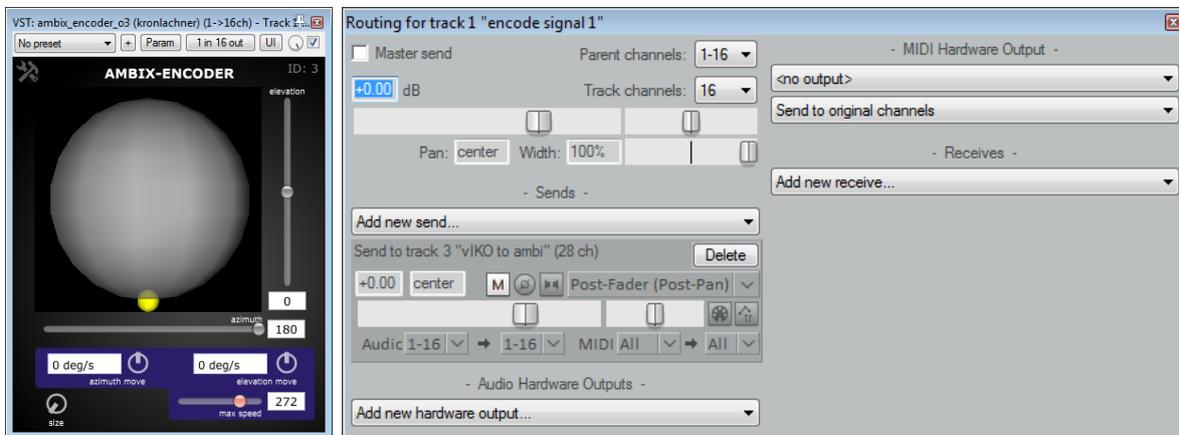


Figure 1: Screenshot of the default *Reaper* session consisting of 4 tracks: *encode signal 1*, *encode signal 2*, *vIKO to ambi*, and *binaural ambi decoder*.



(a) 3-rd order *Ambisonic* encoder. Adjust direction using the sliders or an automation track. (b) Routing of track *encode signal 1*. Note that the track has 16 channels and that all channels are routed to the *vIKO to ambi* track.

Figure 2: Insert and routing of track *encode signal 1*.

- *vIKO to ambi*: this track contains the core part of the *vIKO* condensed into a preset for the *mcfx-convolver*. The preset contains the *IKO* decoder (16 *Ambisonic* channels to 20 loudspeaker channels), a room impulse response (RIR) filter matrix between the 20 loudspeaker channels and the 32 microphones of the *eigenmike (em32)*, and an *em32* encoder. In the *mcfx_vIKO* folder you find the presets to be use for this track, see fig. 3. For further reading and references see [1]. The output channels of the *vIKO to ambi* track

(25 *Ambisonic* channels obtained from the *em32*) are routed to the *binaural ambi decoder*.

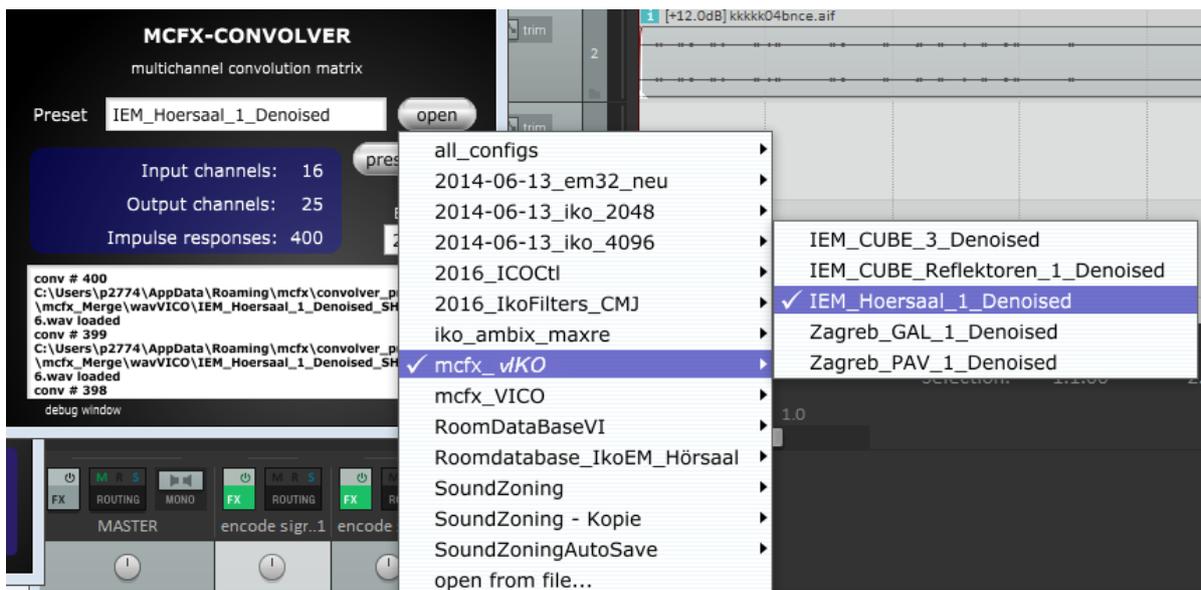


Figure 3: Choose one of the provided presets from the *mcfx_vIKO* folder by clicking on open and navigating to the desired preset folder. Note: folder *mcfx_vIKO* has to be copied in the *mcfx* preset folder.

- ***binaural ambi decoder***: the 4-th order *Ambisonic* channels (output from *vIKO* to *ambi* track) are rendered to binaural signals (2 channels as output) using *Ambisonic* based binaural synthesis. To allow for dynamic binaural synthesis (follow head movements of listener) the *Ambisonic* channels are rotated using an *ambix_rotator*. In order to use that feature, a headtracker is mandatory and you need to setup the *ambix_rotator* using the *Fx-paramter* learn functionality within *Reaper*. Note that the latency settings (render-ahead, buffer sizes) should be as low as possible to get the best possible listening experience when using the dynamic binaural synthesis (rotator). To interface your headtracking data into *Reaper* check Options → Preferences → Control Surfaces and add your device (e.g. OSC/MIDI controls). Please set the yaw/pitch/roll sliders to 0 if you do not intend to use dynamic rendering.

vIKO_directions project

This *Reaper* project incorporates four basic *IKO* beam directions (180° towards the listener, 0° to the back, 270° right, 90° left, see fig. 5) using the *encoder* plugin with pink noise in the track *encode signal 1* and fine grains in the track *encode signal 2*. Playing around with the azimuth automation will steer the beam on the horizontal axis.

vIKO_moves project

Overall there are 5 different moves (change beam direction and gain of *IKO* over time) presented in this project (numbered according to markers).

1. azimuth angle (using *ambix_encoder*) moves in clockwise motion covering 180°
2. azimuth angle moves in counter-clockwise motion covering 180°
3. azimuth angle moves in clockwise motion covering 360°

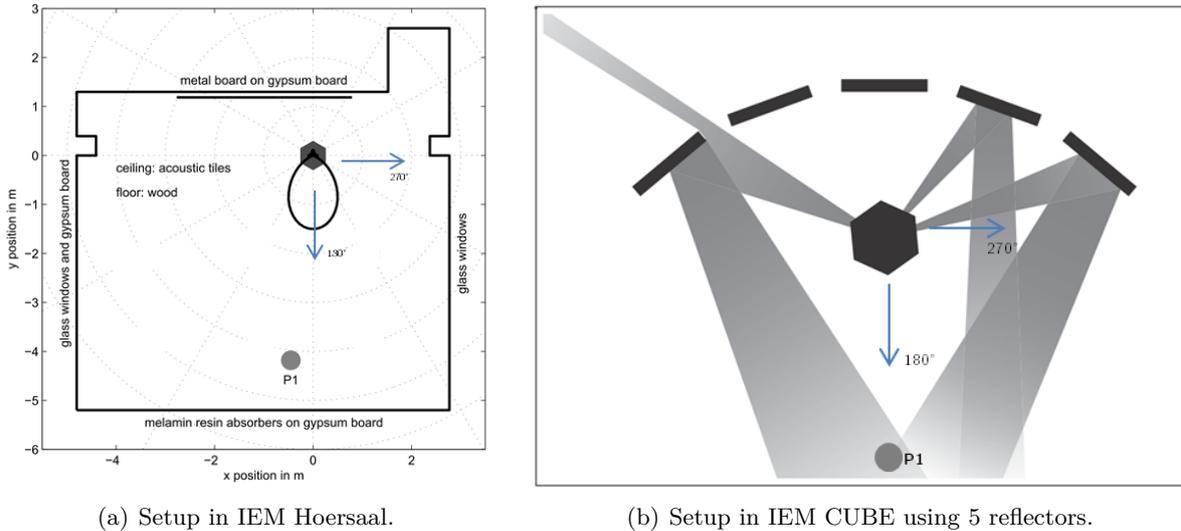


(a) GUI of *ambix_rotator*. Assignment of headtracker output to yaw/pitch/roll is achieved via OSC/MIDI control. (b) *Ambix-binaural-decoder*. Choose a preset by clicking on open. Note: the *ambix_BinauralDec* folder should be copied to the *ambix* default folder.

Figure 4: Inserts of track *binaural ambi decoder*.

4. amplitude-panning (left-right)
5. distant-panning (front-back-front) using the size-control of the *ambix_encoder* (change from 3-rd order to 0-th order and back) combined with amplitude-fading

If you play around with the automation graphs and the *ambix_encoder* you will get an idea of the spatial behaviour of the *IKO* beams.



(a) Setup in IEM Hoersaal.

(b) Setup in IEM CUBE using 5 reflectors.

Figure 5: Placement of *IKO* and *eigenmike*.

Rooms and setup

A typical setup of the *IKO* in a room is shown in fig.5 where the *IKO* is either placed in the corner of room (fig. 5(a)) or reflectors are placed around the *IKO* (fig. 5(b)). In both scenarios the audience and also the *eigenmike* is placed in front of the *IKO* (corresponds to an azimuth angle of 180° in the *ambix_encoder*). The *mcfx* preset corresponding to the setup depicted in fig. 5(a) can be found in the *mcfx_vIKO* folder under *IEM_Hoersaal_1_Denoised.conf* the one corresponding to fig. 5(b) is named *IEM_CUBE_Reflektoren_1_Denoised.conf*.

Contact

For comments and question please contact:

Markus Zaunschirm (zaunschirm@iem.at) - technical
Gerriet Sharma (sharma@iem.at) - artistic

References

- [1] M. Zaunschirm, M. Frank, and F. Zotter, “An interactive virtual icosahedral loudspeaker array,” http://ambisonics.iem.at/Members/zotter/2016_zaunschirm_virtualico_daga.pdf.
- [2] “Orchestrating Space by Icosahedral Loudspeaker (OSIL),” <http://iem.kug.ac.at/projects/osil/osil.html>, 2016, [Online; accessed 29-November-2016].