

# Developing multitrack audio effect plugins for music production research

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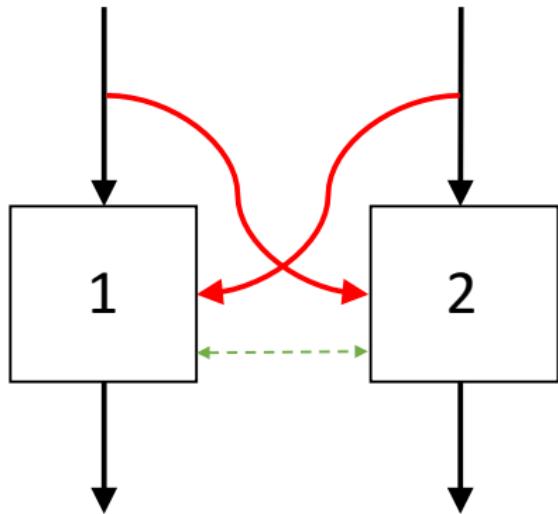
Research at the Centre for Digital Music (C4DM)  
60+ academics, post-docs, PhD students  
Area: audio engineering, intelligent music production

# Why a (JUCE) plugin?

- ▶ Rapid prototyping
  - Idea
  - Algorithm
  - Stand-alone software
  - Hardware
- ▶ Compatibility with existing audio production tools
- ▶ Focus on processing
  - Platform independence
  - Audio input and output taken care of (real time!)
  - Easy GUI
- ▶ JUCE '*encourages good coding practice*', '*made my life a lot easier*' is '*very well thought through*', '*well integrated*', and just '*Great!*'

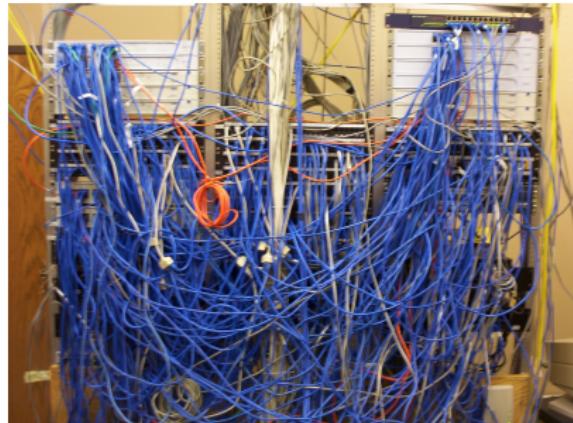
# Why multitrack?

- ▶ Cross-adaptive functionality
- ▶ Avoid sidechaining clutter
- ▶ Modelling of larger system
- ▶ Simple setup
- ▶ Spatial applications



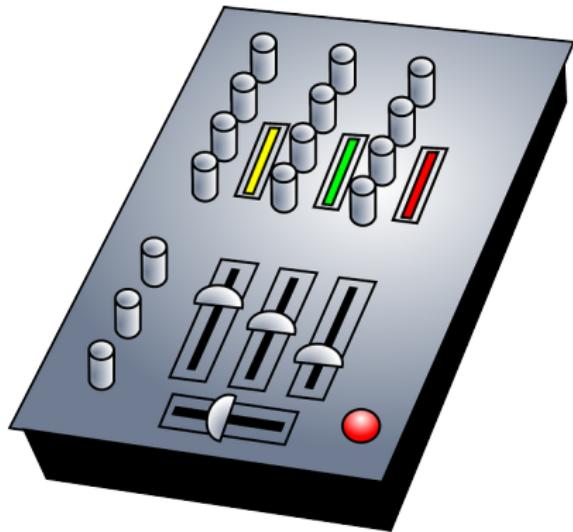
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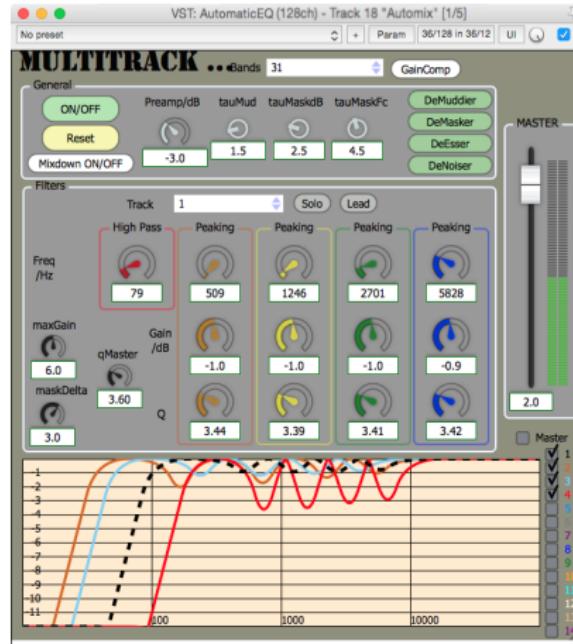
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Researchers, developers, artists, ...

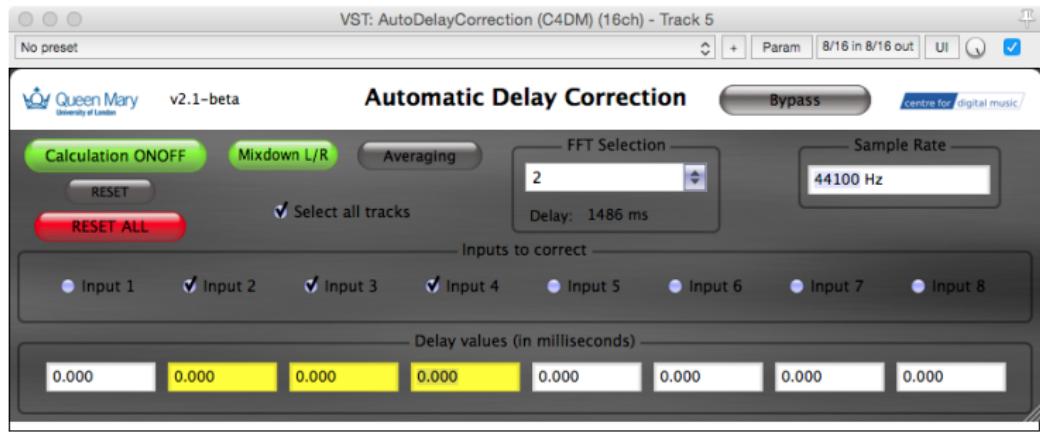
# Example: Automatic faders



# Example: Automatic EQ



# Example: Audio alignment



# Example: Listening test



# Example: Semantic compressor

Track 1 Track 2 Track 3 Track 4 Track 5 Track 6 Track 7 Track 8 Config

**Compressor**

Attack time (ms) 10.00  
Release time (ms) 90.00  
Threshold level (dB) -11.15  
Ratio (n:1) 7.00  
Knee radius 3.51  
Makeup Gain (dB) 0.00

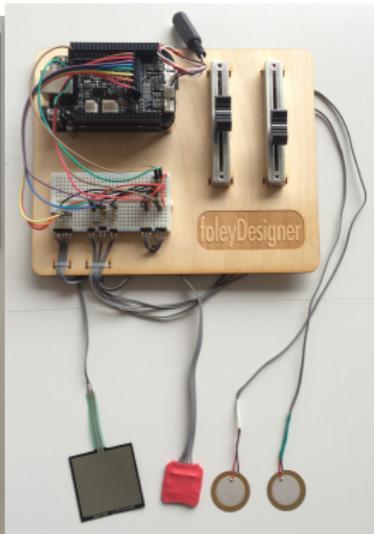
**Semantic Controls**

Instrument: Guitar  
Segments: C  
Chords: E major, E major, A major, C# major  
Onsets: transients, window (ms) 25.0

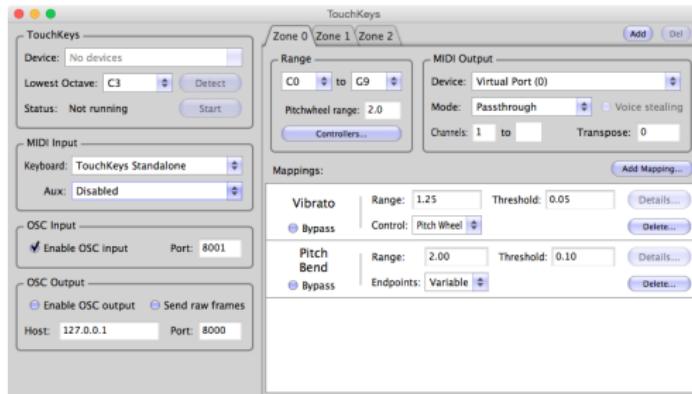
**semantiCompressor**

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# Others || Full applications



# Others || TouchKeys



# Others || Non-multitrack (<= 2) plugins

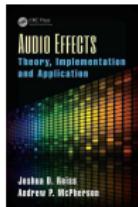


SAFE plugins ([semanticaudio.co.uk](http://semanticaudio.co.uk))

4:30pm today: '*The SAFE JUCE module: A System for Managing Music Production Metadata*' by Sean Enderby



iNtelligent Audio Switch Box



Audio Effects (Reiss & McPherson)

QMUL Digital Audio Effects course

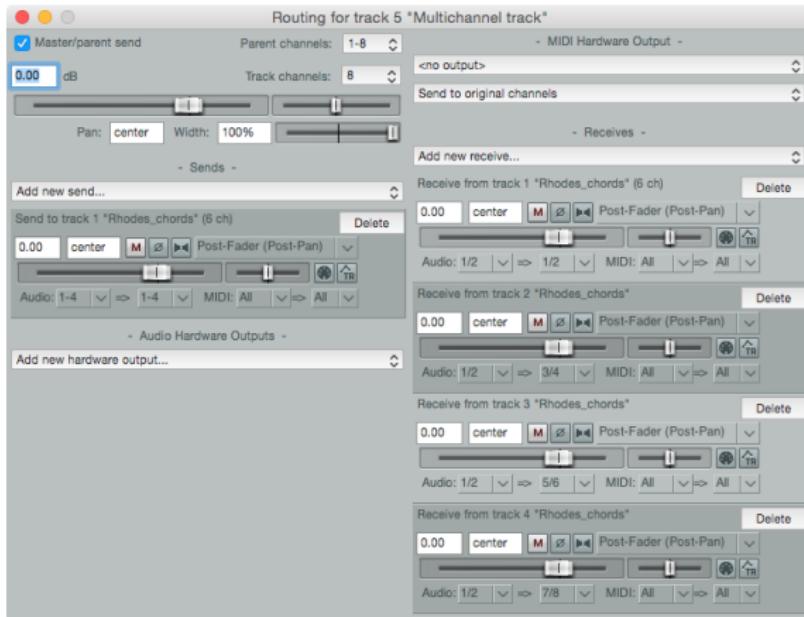
...

# DAW multitrack plugin support

Few DAWs support multitrack VSTs/AUs

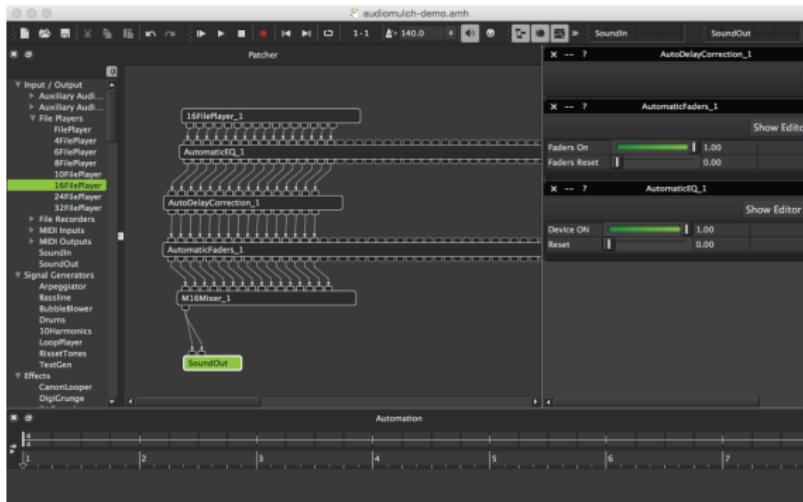
# DAW multitrack plugin support

## Cockos Reaper



# DAW multitrack plugin support

## AudioMulch



# Avid Pro Tools

AAX not accessible to us lowly researchers



*"You must be willing to make your product available for commercial sale to end-users. We don't offer our developer materials or services for academic use, experimentation, or 'just to check them out.' "*

(<https://www.avid.com/US/partners/audio-plugin-dev-program>)

# Complexity

- ▶ HeapBlock
- ▶ OwnedArray
- ▶ `for (int trk = 0; trk < numTracks; ++trk)`

# CPU

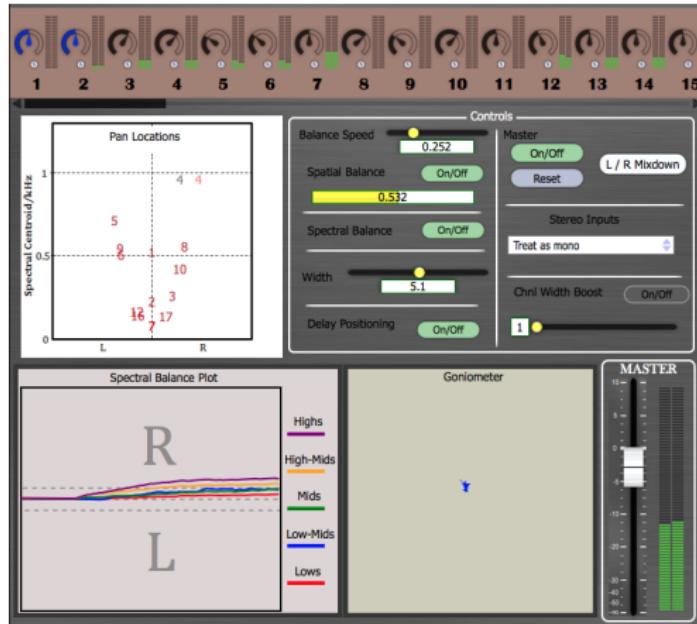
- ▶ Scaling factor
- ▶ Inter-dependencies, cross-adaptiveness, ...
- ▶  $\mathcal{O}(?)$
- ▶ Efficiency more critical

# CPU

```
1 int MultitrackEffectAudioProcessor::GetNumValidTracks( AudioSampleBuffer& buffer) {
2     int numActiveTracks;
3
4     for (int trk=0; trk<_numTracks ; ++trk) {
5         if (buffer.getMagnitude(trk,0,_numSamples)) {
6             numActiveTracks = trk+1;
7         }
8     }
9
10    return numActiveTracks;
11 }
12 }
```

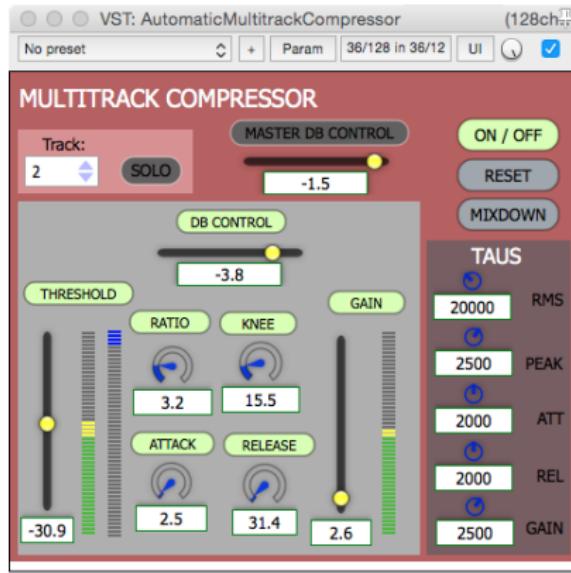
# Interfaces

## Large, complex



# Interfaces

## Pagination



# Concluding remarks

- ▶ Multitrack audio plugins provide unique opportunities and challenges
  - Cross-adaptive audio streams, complex architectures
  - Compatibility, complexity
- ▶ Academic focus ≠ industry focus
  - Prototyping, data collection
  - Computational efficiency, slick interfaces
- ▶ JUCE supports multitrack plugins and enables quick development

**Use cases for multitrack plugins are limited, but support could stimulate development**

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- E. Perez Gonzalez and J. D. Reiss, "A real-time semiautonomous audio panning system for music mixing," *EURASIP Journal on Advances in Signal Processing*, 2010.

# Q&A

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See also: 4:30pm today: '*The SAFE JUCE module: A System for Managing Music Production Metadata*' by Sean Enderby