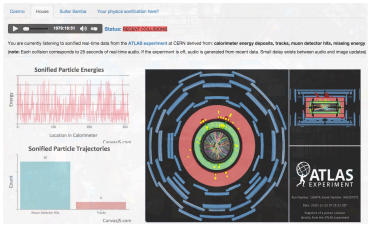
ATLAS data sonification : a new interface for musical expression and public interaction

Ewan Hill[1], Juliana Cherston[2], Steven Goldfarb[3], Joseph A. Paradiso[2]
[1]Dept. of Physics and Astronomy, University of Victoria; TRIUMF [2]Responsive Environments Group, MIT Media Lab
[3]Dept. Of Physics, University of Melbourne

Introduction

Quantizer is a project that transforms ***live*** collision data from the ATLAS Experiment at CERN into an audio stream. The project seeks to explore how creative musical pieces can educate and inspire artists and the general public. **An associated web page enables the public to listen to real-time experimental data.**

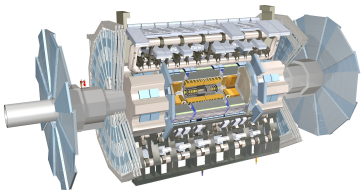
Quantizer website - www.quantizer.media.mit.edu



Music is a very popular medium, used by ATLAS for public outreach both as an explanatory tool, and as a means to reach new audiences. Quantizer specifically:

- **Who**: Targets members of the public with an interest in music or science, who might or might not already be familiar with the experiment;
- **When**: Provides continual music streams, either via the live transformation of LHC collisions or via pre-recorded data when the LHC is not in collision mode;
- **Where**: Engages a worldwide audience, requiring only access to the internet;
- **How**:
  - Encourages listeners to further explore ATLAS, the LHC, and particle physics, as well as the methods of sonification;
  - Invites the public to compose their own musical streams and learn more about ATLAS and the role of data in experimental physics in the process.

ATLAS



ATLAS is one of the main detectors at CERN's Large Hadron Collider (LHC). The ATLAS Collaboration uses the detector to probe some of the deepest questions of nature: "What is the nature of dark matter?", "What is the origin of mass?", and "Are there any deeper symmetries that govern the laws of our universe?". A tiny subset of particle collision event data is routed through a sonification engine designed to map incoming data to audio properties in real-time.

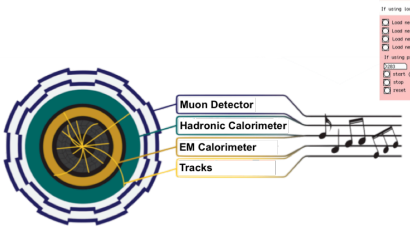
Data, Tools, and Sonification Methodology

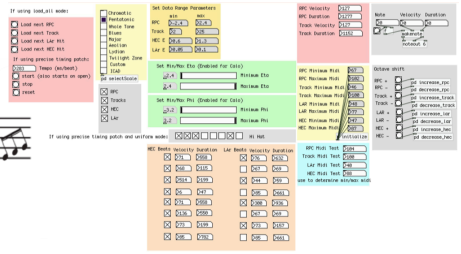
The Quantizer sonification platform was **designed so that anyone can compose music and learn about particle physics.**

The composition engine consists of two main interfaces that accommodate users of various levels of physics and music knowledge. The default Python interface filters data in accordance with basic approaches used by ATLAS to isolate useful information for an analysis. Physics enthusiasts can choose to write their own custom Python code to parse the data.

Composers can choose to integrate custom-built audio synthesis patches to create music driven by the Python filtered data streamed as OSC messages (an industry standard). The default OSC interface was designed to enable users to easily produce more traditional styles of music.

The default and custom interfaces have so far been use to create a variety of musical styles including: samba, blues, classical, pop-rock, electronic, and experimental.

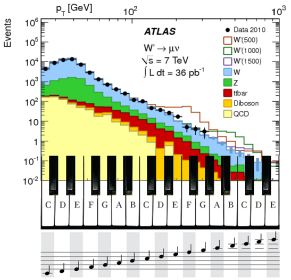




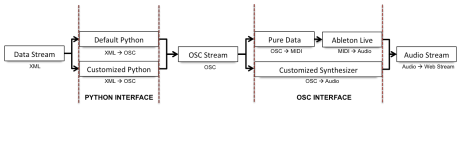
The default sonification engine takes data from the collision event, scales and shifts the data (to ensure that the output is in the audible frequency range) and maps the data to different musical scales. From there, a midi stream triggers sound samples according to the geometry and energy of the event properties. The data currently being streamed includes:

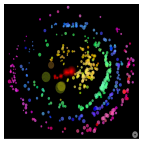
- energy deposit data from the hadronic endcap calorimeter,
- energy deposit data from the liquid argon electromagnetic calorimeter,
- momentum data for particle tracks, and
- location data from a muon trigger (RPC).

The default OSC interface translates energy and momentum information from the calorimeters and tracks into musical notes (MIDI notes). This mapping connects a particle's de Broglie wavelength to an audible sound wave.



Custom OSC interface by Akito Von Troyer





Events

Late 2014 – Project initiated
January 2015 – Started designing the sonification system and identifying the data to sonify.

ICAD 2015 Workshop – July 7 2015

A workshop was held at the International Conference on Auditory Display 2015 where many participants composed using custom OSC interfaces. At least one participant posted their musical composition online after the workshop.

Montreux Jazz Festival – July 9 2015

A live duet was performed at the Montreux Jazz Festival 2015 with jazz pianist Al Blatter as part of CERN's "The Physics of Music and the Music of Physics". Al Blatter and the Quantizer team improvised together a 10 minute musical piece based on only hours-old ATLAS data. The platform enabled the composers to customise the tempo, instrumentation, and musical scale to the preferences of the pianist.

Conferences – 2016

In early May a poster was presented at a conference for computer-human interaction held in San Jose – CHI 2016.

CHI paper reviewer comments: "Novelty and value of the work arise not just from using the LHC data source, but also in the demonstrated method of artistic engagement with the system and the description of the LHC data."

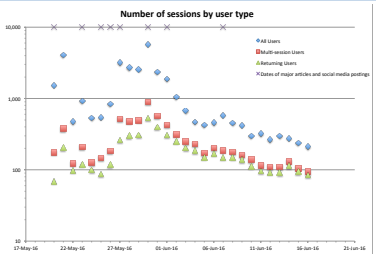
Quantizer's CHI paper is the 5th most downloaded Late-Breaking Work paper (out of 585) and in the top 100 most downloaded papers of all types of papers at CHI this year (out of 1131).

A paper was also accepted for a poster at the conference for "New Interfaces for Musical Expressions" 2016

Website Launch – May 20 2016

First month of website being public:

- >28 000 visitors.
- >2000 visitors returned.
- Visitors from ~150 countries from around the world.
- 33 visitors emailed the Quantizer group with positive comments and 23 requested to become composers.
- Email quote: "I myself am in love with this site, it is an amazing concept and I personally could listen to the Suitar Samba for hours!!!!"
- Unsolicited articles were written about Quantizer in at least 10 different languages.
- Two interviews were given for articles about Quantizer (3 including the one for the original ATLAS article).



Conclusions

The Quantizer platform is an interesting new tool that has been created that allows live ATLAS data to be transformed into music. It has strong outreach potential by attracting more and new interest in ATLAS and gives composers the chance to interact with the data in a different way. Several events have taken place that have received positive feedback.

Further work is required to improve the platform, share it more broadly, and to evaluate its outreach capabilities. The Quantizer team will work with more composers one-on-one to create more interesting audio.