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

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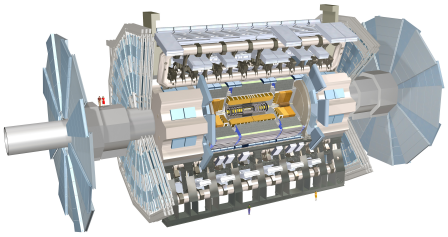
Introduction

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. **This analysis measures the level of success of the project as an outreach tool.**



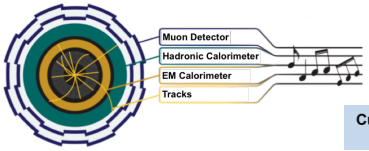
ATLAS is one of the main detectors at CERN's Large Hadron Collider (LHC). The ATLAS Collaboration uses the detector to probe some of the deepest questions of nature: "What is the nature of dark matter?", "What is the origin of mass?", and "Are there any deeper symmetries that govern the laws of our universe?". 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. **An associated web page then enables the public to listen to real-time experimental data.**

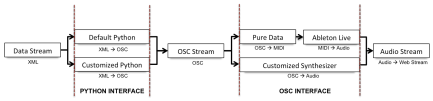
Data, Tools, and Sonification Methodology

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.

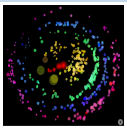
Composers can choose to integrate custom-built audio synthesis patches to create music driven by the Python filtered data streamed as OSC messages (an industry standard). The default OSC interface translates energy and momentum information from the calorimeters and tracks into musical notes (MIDI notes). This mapping connects a particle's de Broglie wavelength to an audible sound wave. The default OSC interface was designed to enable users to easily produce more traditional styles of music.

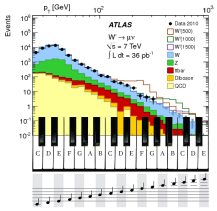
Several mappings are automatically applied to the data taken live by ATLAS and streamed to a dedicated website, where listeners can learn more about the audio, the data, the Quantizer project, and the ATLAS Experiment.





Custom OSC interface by Akito Von Troyer



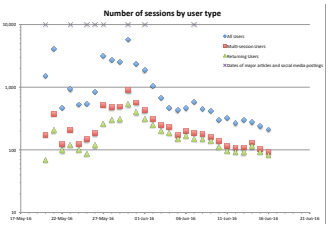


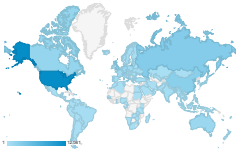
Quantizer website - www.quantizer.media.mit.edu

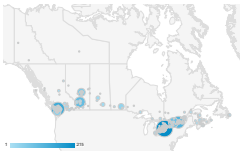
Data - Main Quantizer Website

Between May 20 and June 16:
- 33 785 sessions and 28 812 visitors (=> 1029 visitors / day)
- Over 2000 visitors returned to the website.
- 2211 visitors from Canada

Benchmark: In May www.atlas.cern had 28 255 visitors (= 911.5 visitors / day).





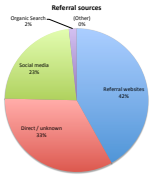


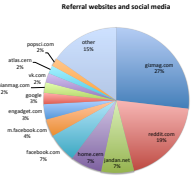
Visitors to the website come from around the world and not just from countries or cities that are affiliated with ATLAS or CERN.

In May:
- 363 referrals to www.atlas.cern from the Quantizer website.
- 215 referrals to the Quantizer website from www.atlas.cern.

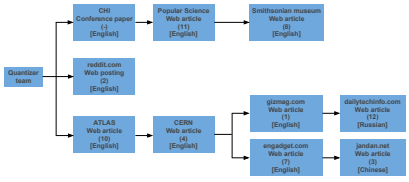
Benchmarks: In May, www.atlas.cern received referrals from:
- Facebook: 10 495
- Atlas-live (live event displays): 1704
- ATLAS Masterclass: 638
- AMELIA (a multimedia educational interactive analysis lab): 492

ATLAS article about Quantizer had 10 686 views in May.
Benchmark: The next most popular ATLAS article in May (a press-statement) had 3129 views.





Map of article sources (referral ranking) [language]



Between May 20 and June 16:
- 161 websites resulted in referrals to the Quantizer website (not all unique, e.g. facebook.com v.s. m.facebook.com)
- Articles about Quantizer that referred readers to the Quantizer website were written in 10 languages: Bulgarian, Chinese, English, French, German, Greek, Japanese, Portuguese, Russian, and Spanish
- Two interviews were given for articles about Quantizer (3 including the one for the original ATLAS article).

Data – Other Media

Emails from website visitors

Best quotes:
- "What you did is really cool and … it helps me concentrate at work."
- "Thanks for doing the things that keeps science refreshing and fun."
- "I myself am in love with this site, it is an amazing concept and I personally could listen to the Suitar Samba for hours!!!!"
- "A real gift to all sonic and soft-synth nerds like me!"

Statistics for between May 20 and June 16:
- 36 emails received (ignoring friends and colleagues etc.)

- 23 individuals asked to compose with Quantizer platform or asked for permission to use Quantizer audio clips in their music production.
- 1 individual wants to integrate Quantizer into an undergraduate course they teach.
- 1 artist has an IMDB entry as an actress and filmmaker.
- 15 individuals stated or implied that they are musicians.
- 3 individuals mentioned having at least part of an undergraduate physics education.

When these emails started to arrive, the following were partially incomplete:
- Install and usage instructions across all platforms for non-experts
- User Agreements for composers to use ATLAS data.

Music and computer-human interaction conferences

The Quantizer group submitted papers to two conferences:
- CHI : The top conference for Computer-Human Interaction
- NIME : International conference on New Interfaces for Musical Expression

Best CHI and NIME reviewer quotes:
- "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."
- "This is a very interesting project due to the many interdisciplinary elements that came together, and the general challenge of understanding complex datasets with auditory representations is also quite challenging."

CHI and NIME criticisms:
- Reviewers for both conferences accepted the papers but would like to see more complex synthesizers to create richer audio (less traditional styles of music) and more detailed evaluations of the work. These are reasonable comments but may have been inevitable considering the project was still fairly new and under development at the time of the paper submissions.

CHI paper downloads (linked from the Quantizer website):
- 23 downloads around the time of the conference
- 138 downloads total as of July 3
- Benchmarking: 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).

Analysis and Conclusions

Website visitors and referrals
- The number of visitors to the Quantizer website is good compared to the benchmark and many returned.
- More people were referred from the Quantizer website to the ATLAS website than the other way around.
- The number of people referred to the ATLAS website is relatively small compared to the benchmarks but that number could reasonably increase to levels similar to the atlas-live website numbers.
- The number of views of the ATLAS article about Quantizer did well compared to benchmark.
- Referrals came from a variety of sources. Only a minority were directly referred from ATLAS or CERN.
- Several unsolicited articles about Quantizer were written in a variety of languages and were derived from both the original ATLAS article and the CHI paper.

Emails
- Most of the emails gave positive feedback.
- Quantizer is attracting musicians (and artists) to engage with ATLAS, a group that was likely less well engaged previously.
- Better planning would have allowed the public to immediately and easily start composing using Quantizer.

Conferences
- Papers were accepted for both conferences but the reviewers thought the music styles were too traditional.
- The number of downloads of the CHI paper is large relative to benchmarks.

Conclusions

Quantizer has performed well at attracting the attention of the public and has performed okay at getting them to engage ATLAS directly or through Quantizer. The Quantizer website received over 28 000 visitors in a single month with over 20 people requesting permission to compose with Quantizer. Further work is required to get more people actively engaged partly through further developing the synthesizers.