



Playing Back the 1878 St. Louis Edison Tinfoil Recording

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Lawrence Berkeley National Lab

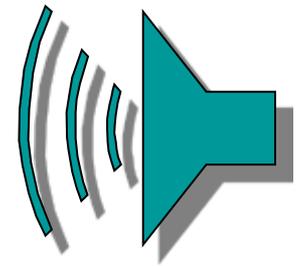
- In 1877 Thomas Alva Edison invents the “Phonograph”
- While others had already recorded sound, Edison was the first to record and reproduce the human voice.
- This was a transformative invention.
- It enabled the commercial sound recording industry.
- It provided new research tools.
- It was the basis of a variety of signal recording methods which underlie science and technology.

- Today we will hear the oldest Edison recording yet reproduced. It was recorded in 1878 and recently restored.
- Due to its age and fragility that recording could only be played digitally, using this century's technology.
- Most early recorded sound artifacts would not survive invasive playback or are in obsolete formats.
 - Optically measure the detailed structure of the record.
 - Use computer analysis to determine the audio content
- An example of "Preservation Science".

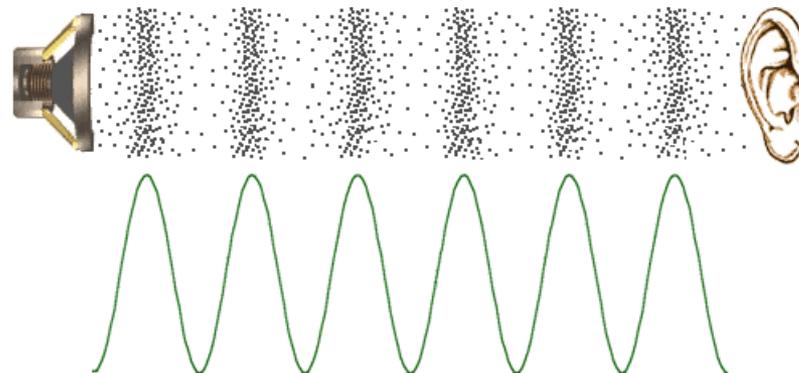
- The 1878 St. Louis tinfoil was restored at Lawrence Berkeley National Laboratory.
- The restoration occurred as part of a larger project to address the needs of digital preservation and access using non-invasive methods.
 - Create tools to massively digitize collections.
 - Systematically address the earliest recordings and other collections with special needs
 - A collaboration with the Library of Congress + others



What is sound?



- Matter = gas, liquid, and solid
- Matter can be compressed by exerting pressure
- Sound = a pressure wave in matter
 - Compression = increased density
 - Rarefaction = decreased density
 - Period = pitch; Amplitude = loudness
- We experience the sensation of sound when our ears respond to periodic compressions and rarefactions of the atmosphere.



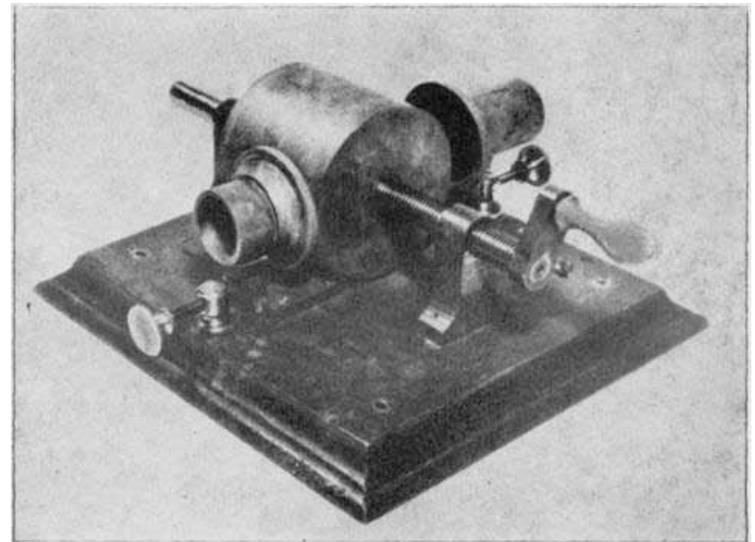
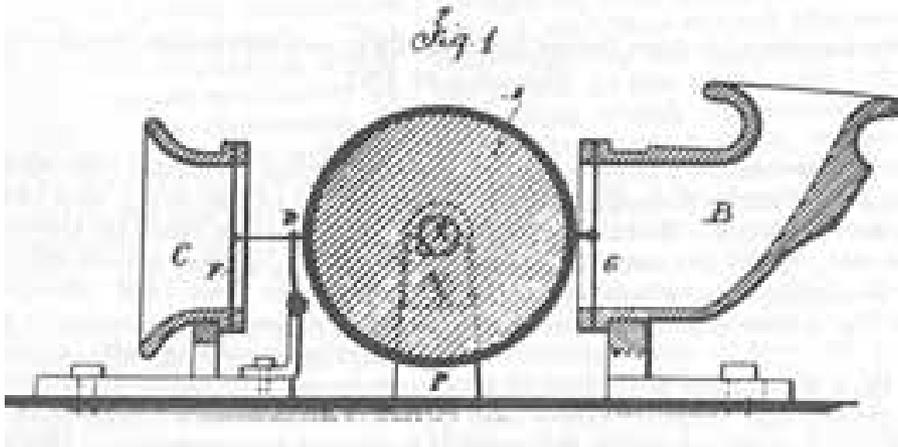
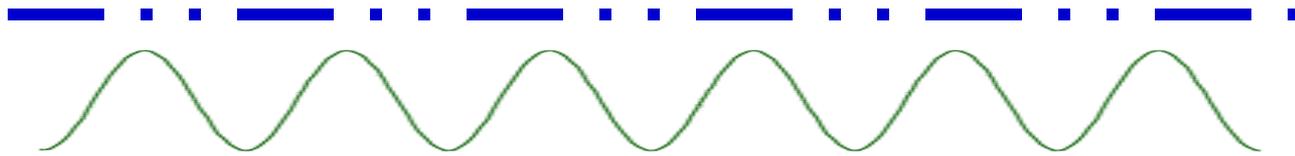
How is sound recorded?

- Sound energy can be transferred from one material to another
 - Beat a drum
 - Pluck a string
 - Stand near a speaker
 - Speak into a paper cup and feel the bottom vibrate
- Sound can be directly recorded by capturing this mechanical effect permanently in material.



Edison's Invention

In 1877 Edison was experimenting with methods to record discrete telegraph impulses on paper discs. This led him to this idea of recording the continuous impulses of the voice also in a material.



“...I designed a little machine using a cylinder provided with grooves around the surface. Over this was to be placed tinfoil, which easily received and recorded the movements of the diaphragm...Kruesi (the machinist), when he had nearly finished it, asked what it was for. I told him I was going to record talking, and then have the machine talk back. He thought it absurd. However, it was finished, the foil was put on; I then shouted 'Mary had a little lamb', etc. I adjusted the reproducer, and the machine reproduced it perfectly. I was never so taken aback in my life. Everybody was astonished. I was always afraid of things that worked the first time....”

Thomas Edison

“I was never so taken aback in my life.”



Photograph of the 1878 St. Louis Foil

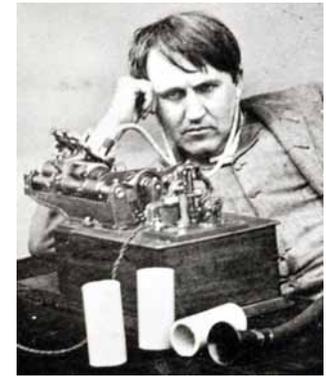




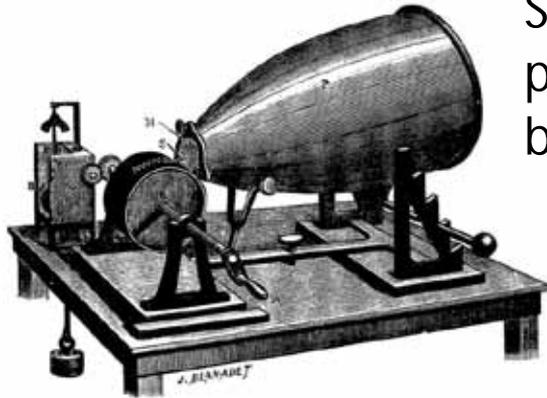
Phonautograph
Leon Scott
1853-60

Two Inventions!

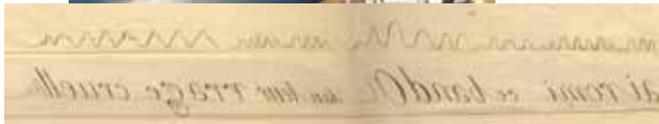
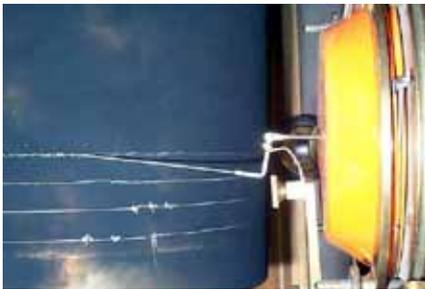
Phonograph
Thomas Edison
1877



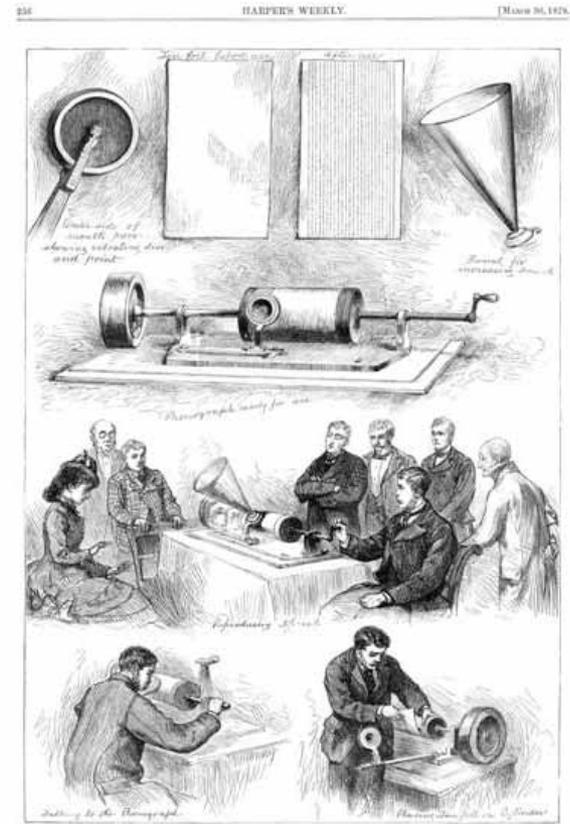
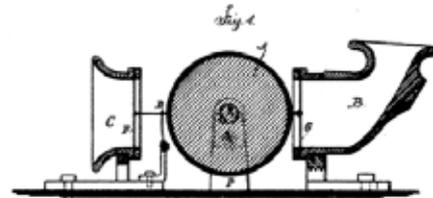
Scott enscribed sound on paper and could not play it back



Edison embossed sound on foil and was therefore the first to reproduce it.



T. A. EDISON.
Phonograph or Speaking Machine.
No. 200,521. Patented Feb. 19, 1878.

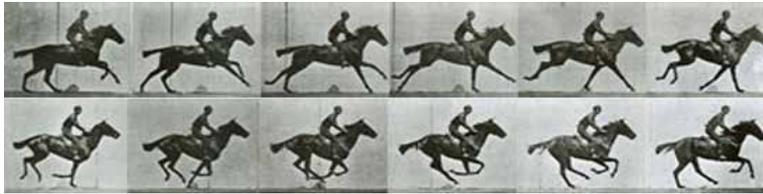


A Greater Significance

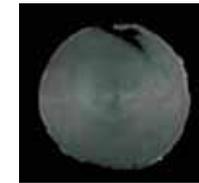
- More than a tool to record sound, we should view Edison's invention in the broader technological context of the time.
- The 1800's were a period of heroic innovation and invention.
- These developments underlie our entire information and communication age.
- Edison's work on sound recording sits squarely in this context.

19th Century Context

- 1820's-30's Niepce and Daguerre: Photography
- 1837 Samuel Morse (+others): Telegraph
- 1853-60 Leon Scott: *Phonograph*
- 1876 A.G. Bell: Telephone
- 1876 E. Muybridge: Motion capture



- 1877 Thomas Edison: tin foil *Phonograph*
- 1880-5 Bell and Tainter, research audio formats, practical system introduced
- 1896: G. Marconi: Wireless transmission
- 1900's: A. Fleming and L. De Forest: Vacuum tube rectifiers and amplifiers

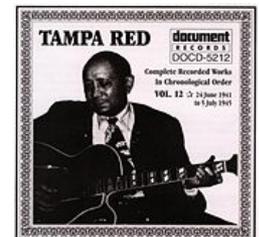


Transformation

- From Edison onwards the field of sound recording took off.
- Tinfoil was soon abandoned as fragile.
- A.G.Bell was an early adapter and in fact made the first practical systems using wax.
- Academic researchers were among the first to embrace recording as a tool for fieldwork.

Now Recorded Sound is Valuable

- Technical tests and experiments...
- Field recordings of linguistic, cultural, and anthropological materials...
- Field recordings of sources which underlie much of modern music, American and European folk traditions...
- Speeches & spoken words of historical figures, primary recordings of writers and performers
- Early radio broadcasts (lacquers)...
- Live performances, events,....
- Public and private dictation and monitoring records, intelligence, Presidential sources,...
- Commercial record releases...



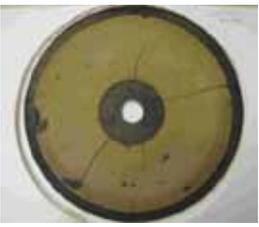
This is a record of our culture



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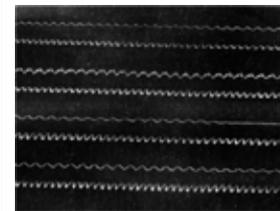
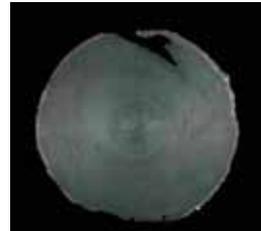
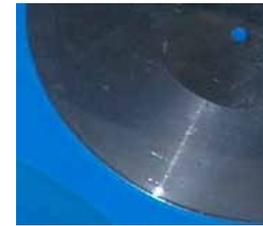
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Preservation and Access

- Archivists want to copy all pre-digital media into modern forms.
- It's a big project.
- Much of the media is in unknown condition.
- Some materials are damaged or too delicate to "play".
- The formats are diverse and sometimes obsolete

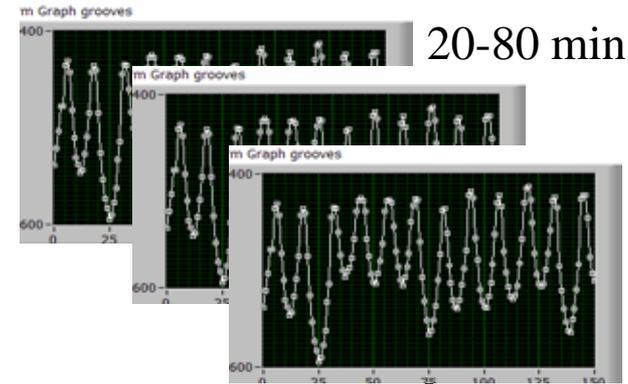
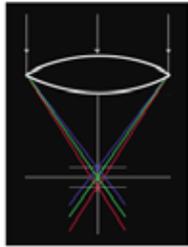


Berkeley Optical Sound Restoration Project

- Light reflected off a surface carries information.
- Use light to create a detailed digital image of the surface of the record.
- Analyze that image to calculate how a playback stylus would move.
- That motion determines the audio content.
- Embed this is a modern analysis, control, and data collection framework.

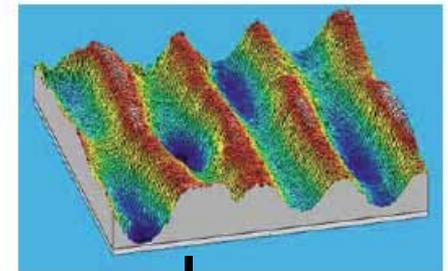
A Basic Optical Process

High resolution optical probe...creates a series of depth/intensity profiles of the surface



20-80 mins

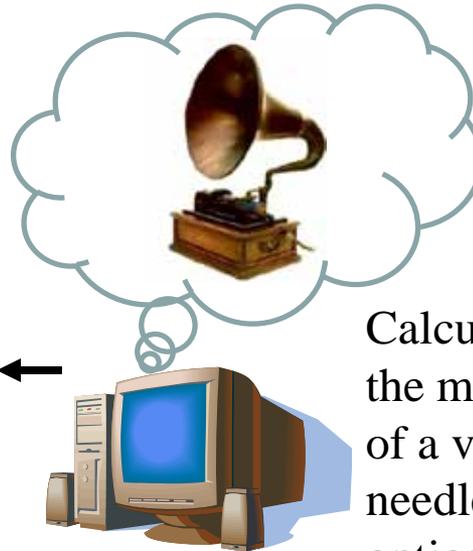
These are merged into a surface map



Map is archived



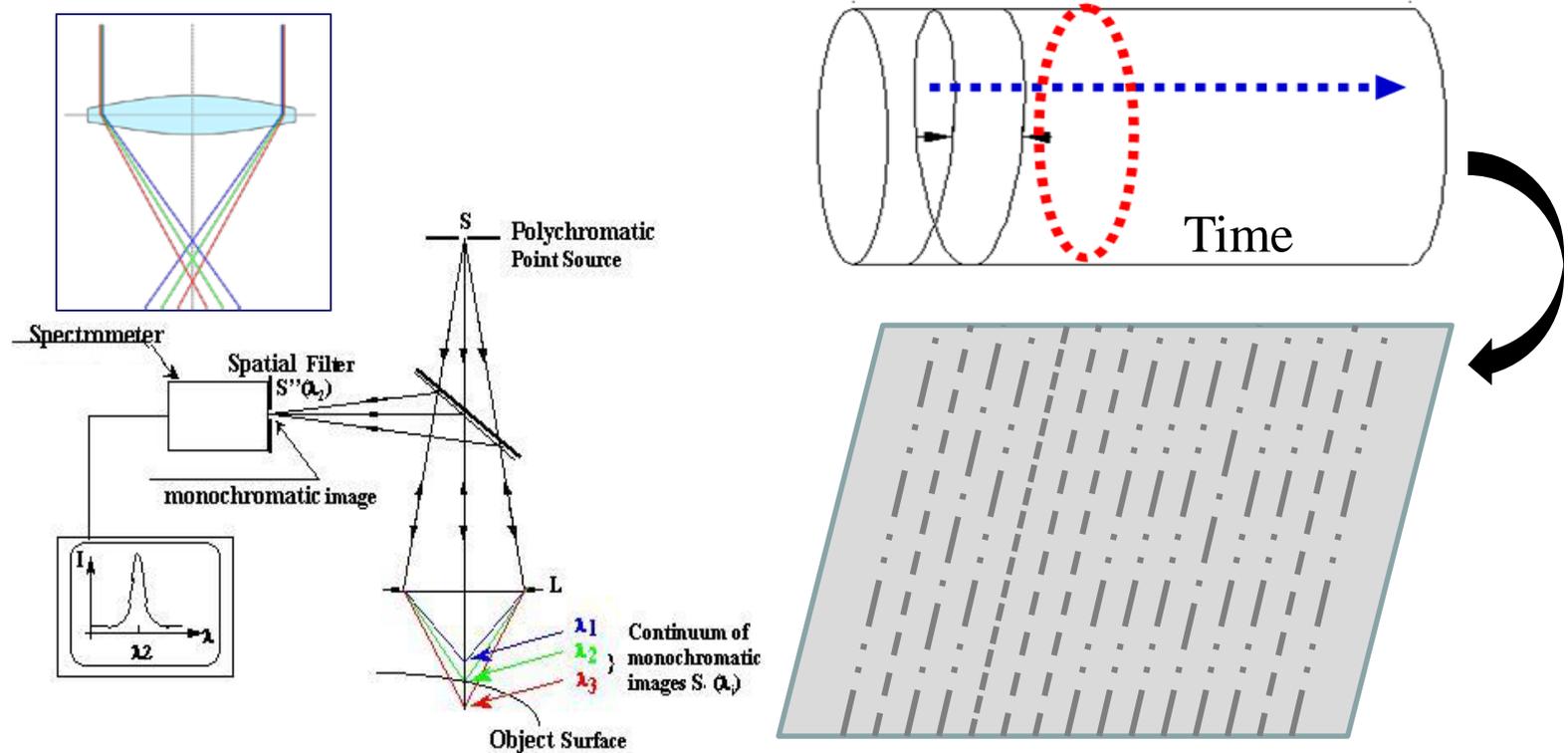
Calculate the motion of a virtual needle, apply optional restoration



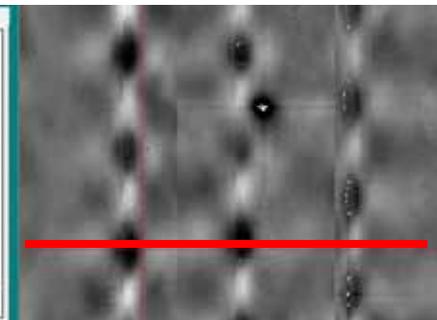
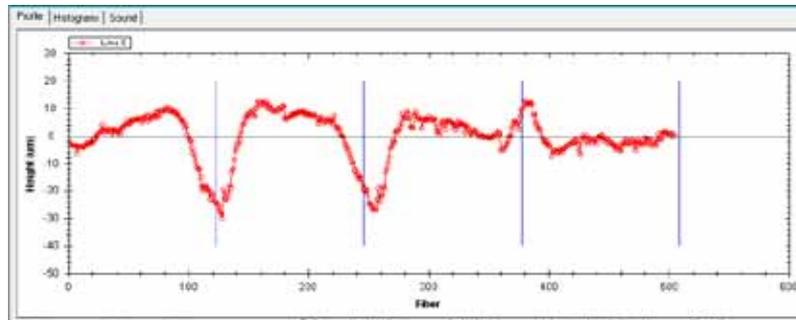
Create audio waveform



3D Imaging: Confocal Microscope



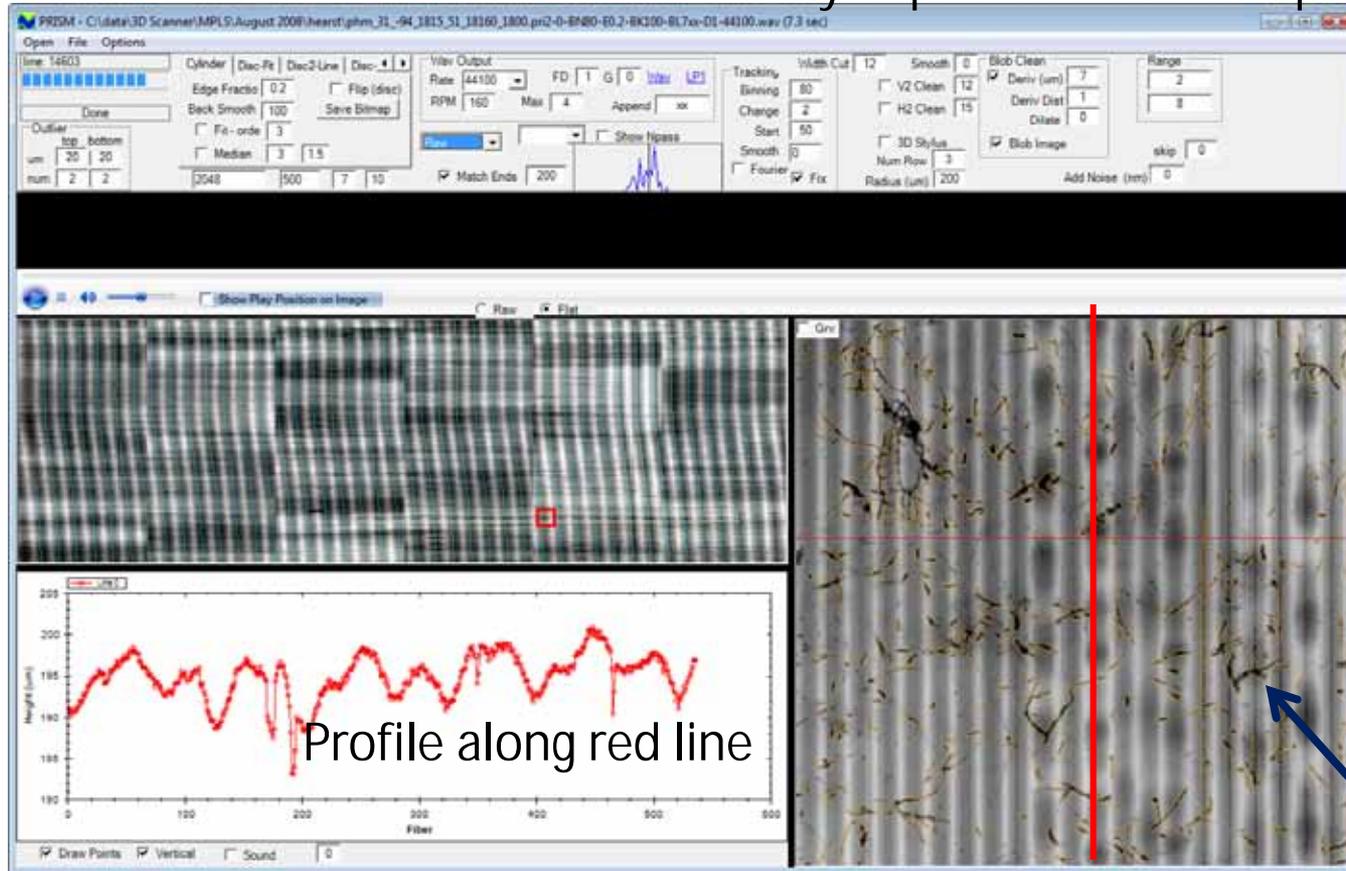
0.05 mm



Analysis Software Example

Analysis parameters and options

Overview
of full
data set



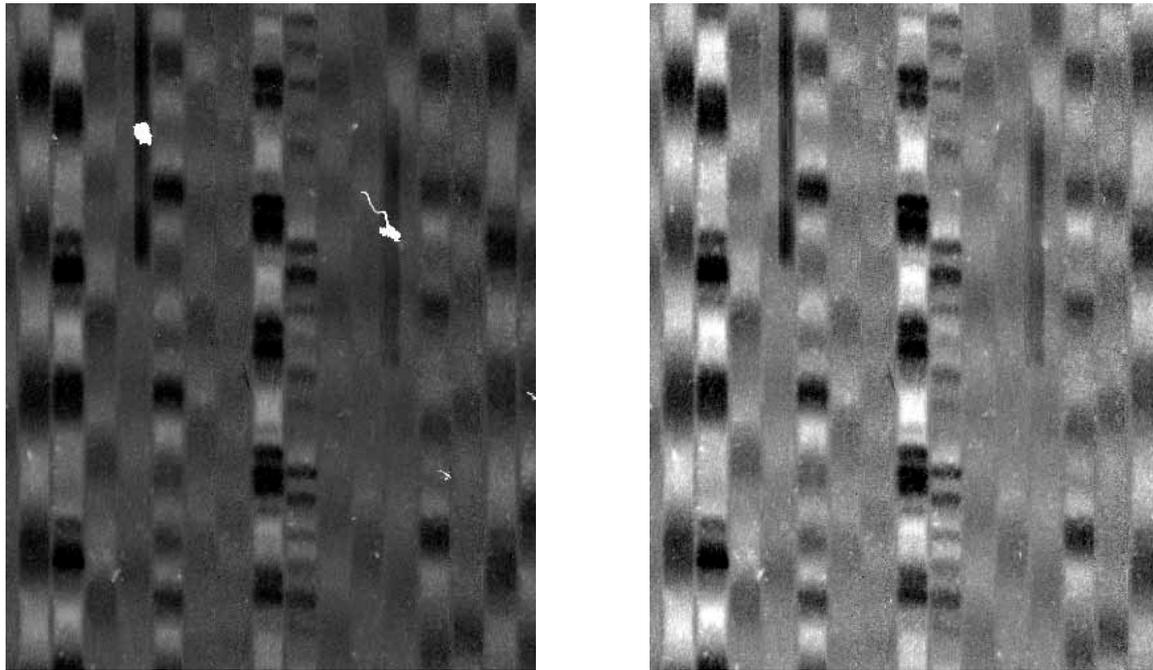
Zoomed
in view

Depth
image,
black is
deepest

Surface
damage

The analysis codes include powerful tools and options for access to data and image processing to remove defects and damage.

Example of Dust Removal



Dust particles appear WHITE because they are above the surface

Applications

- Transfer large or important collections systematically
 - Work underway with Library of Congress, Smithsonian, Indiana, UC Berkeley, Harvard,...
- Special materials
- Follow the timeline back through the early history of recorded sound – Edison tinfoil...

- A recent pristine test disc 📢
- 1950's: "Johnny" Les Paul 📢
- 1940's: "Goodnight Irene" 📢 WWII radio 📢
- 1930's: "Iolanthe" (broken), 📢 Milman Parry 📢
- 1920's: "Let's Get Drunk and Truck" 📢
- 1910's: Ishi, "The Wood Duck" 📢
- 1900's: Gypsy Fortune Teller
- 1887's: Edison Talking Doll
- Early 1880's: Bell and Tainter
- **1878: Edison tinfoil**



Gypsy Fortune Teller

cracked wax cylinder, circa 1906



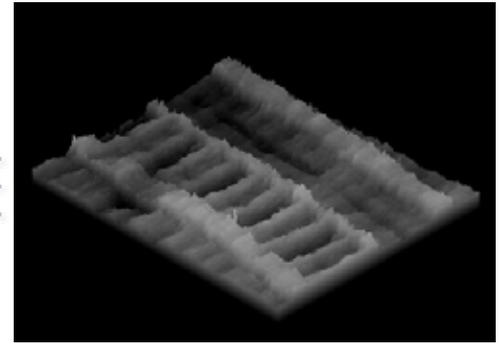
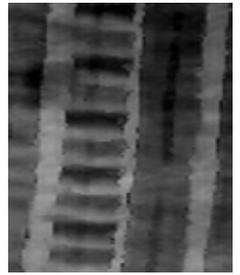
Montana
State Hist.
Commission



- You will soon go to a ball or large gathering and meet a new friend.
- A sincere friend seeks to help you in matters of importance to you.
- Your troubles can be avoided by changing your attitude towards them.
- You will have unexpected good fortune in a letter.
- The first years of your life will be the unhappiest.
- You will be married three times, each time more happily.
- A person who has made trouble for you in the past will become your friend.

Edison Talking Doll ~1887 (ENHS)

"Twinkle twinkle little star...."



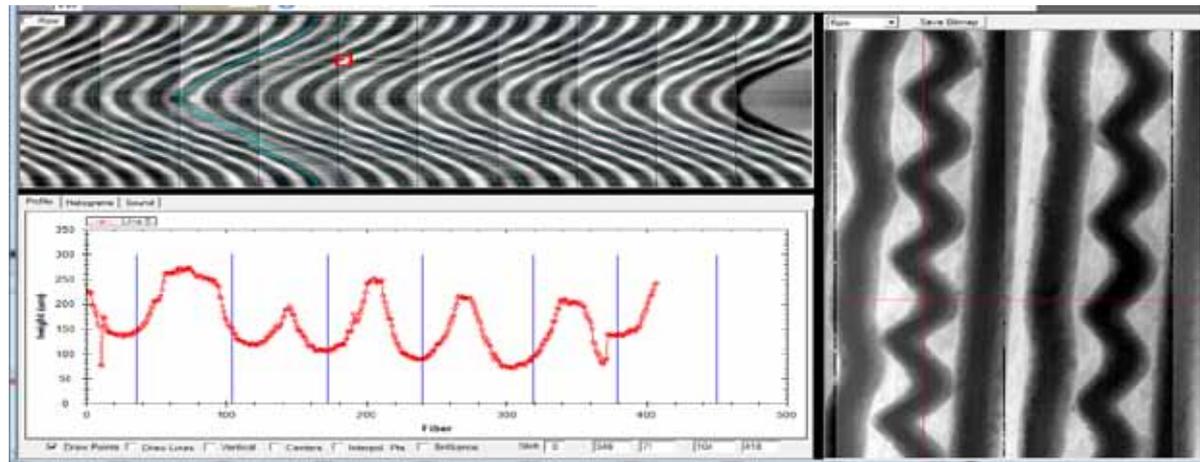
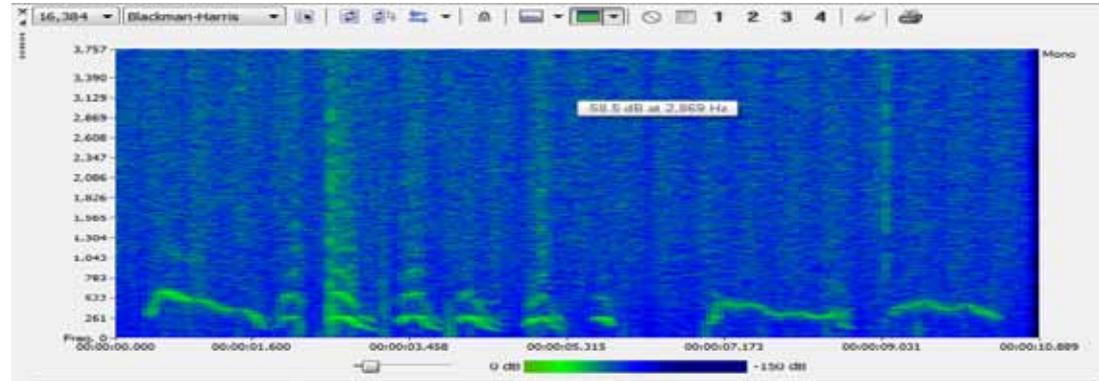
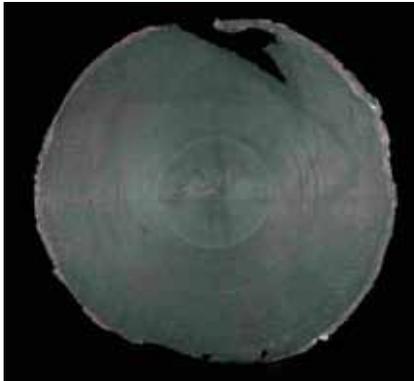
- This item was an experimental prototype for product sold by Edison some years later
- It is believed to be the first known recording of a woman and the first recording made for commercial purposes
- The product was a flop and Edison referred to the dolls as "little monsters", he had the remainder buried.
- One site notes, "a complete disaster, terrifying children and costing their parents nearly a month's pay."

Electroformed Copper Stamper (1881)

prob. earliest example of a lateral cut disc record!

Restored in 2011 using 3D optical scan

Trrrrrr 1 2 3 4 5 6 trrrr trrrrr

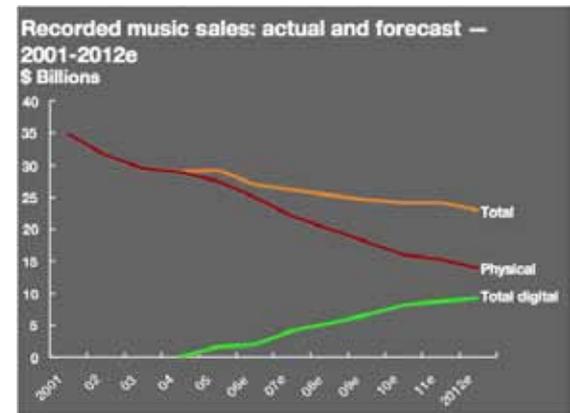
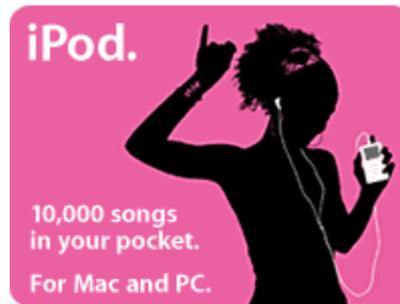


Accompanying Notes

Charles Sumner Tainter, Home Notes Oct. 17, 1881

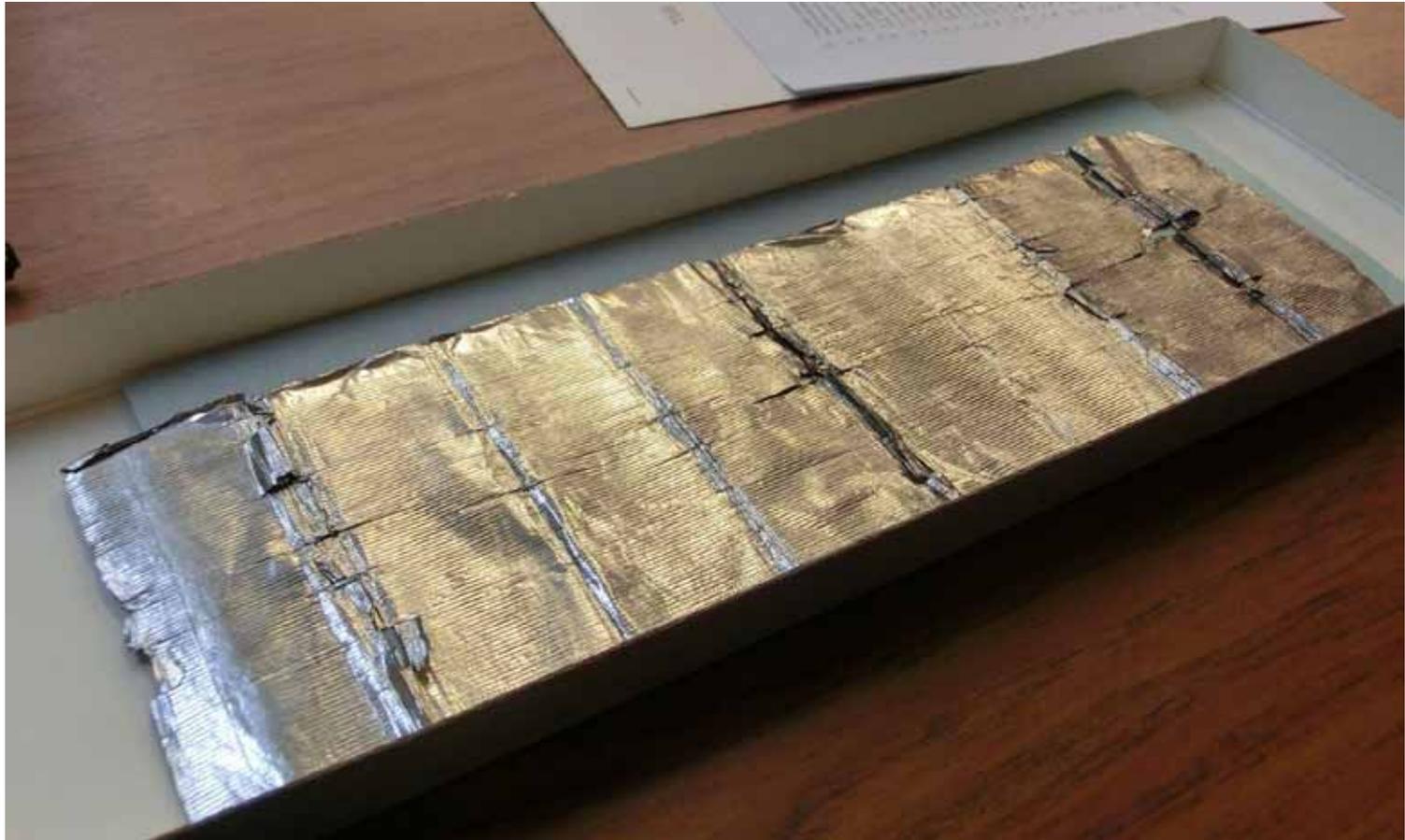
“Our object is to use the copper electro-type for the purpose of forming records or phonograms in other substances by stamping, or printing, and to use these stamped copies for reproducing the sounds originally recorded in the composition.

In this way a piece of music, for instance, can be recorded once, and any number of copies made from this original record, and the music reproduced from any each of the copies.”

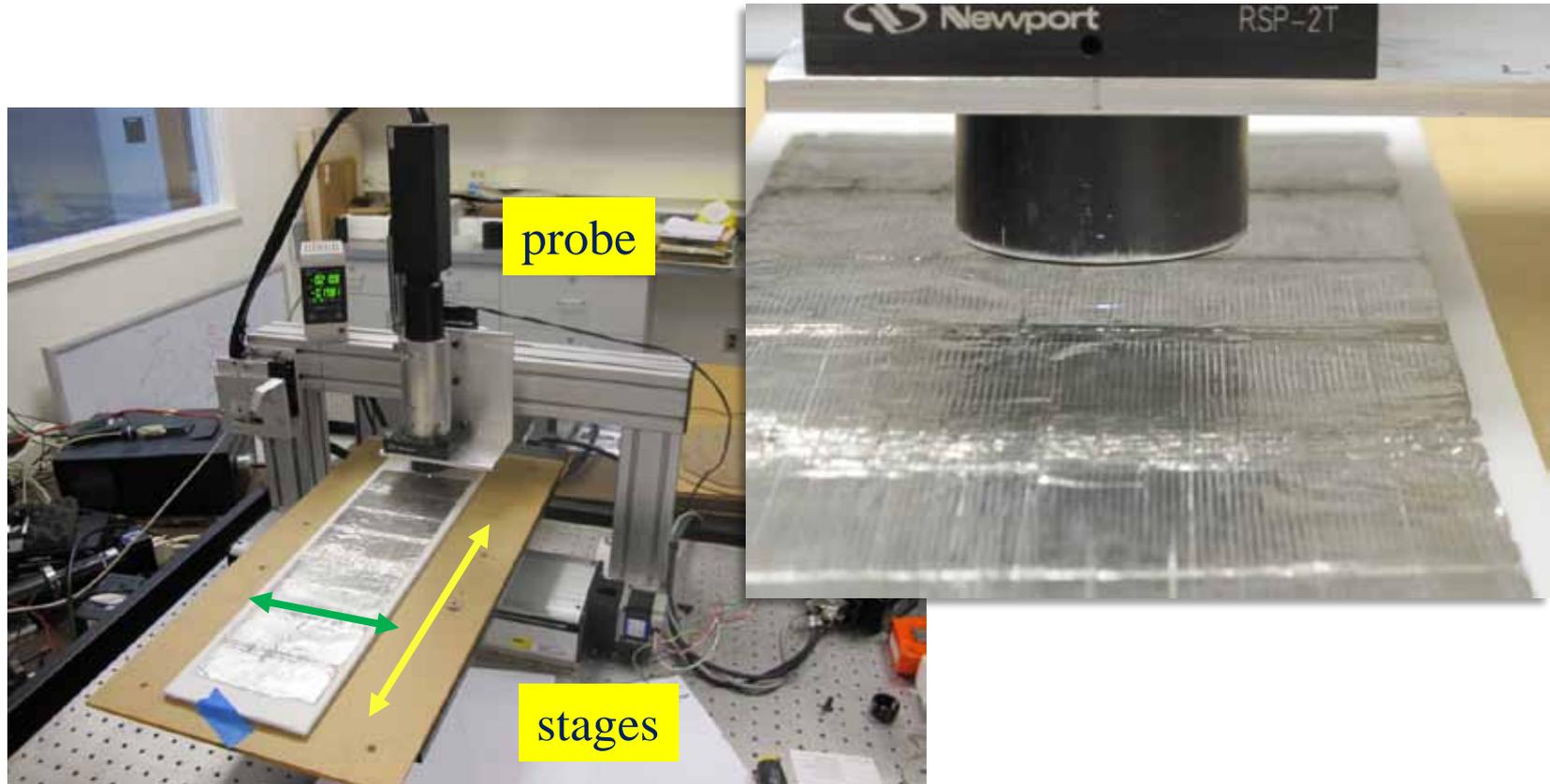


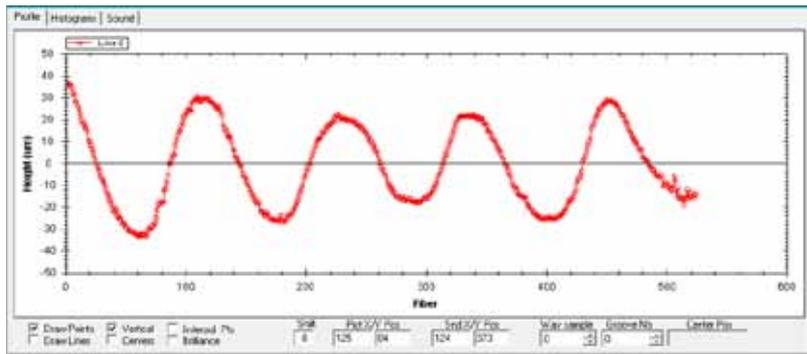
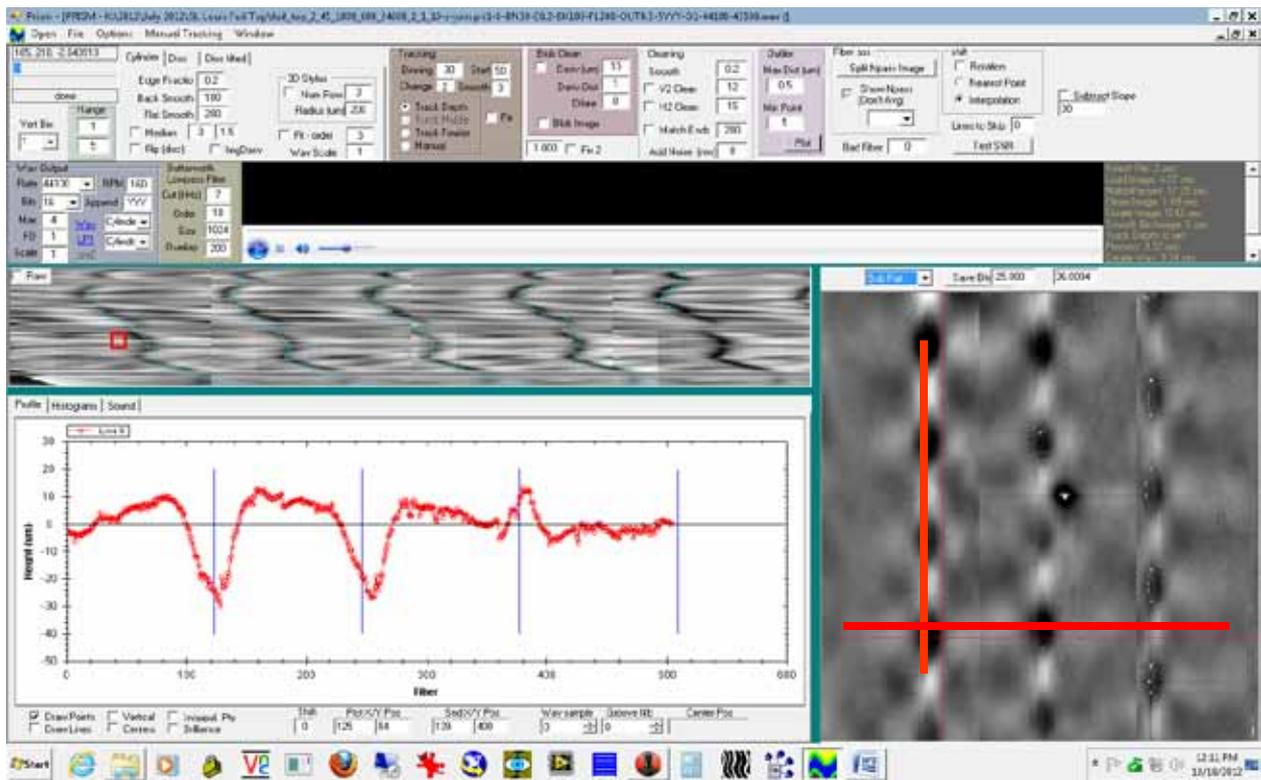
The St. Louis Tinfoil

- The St. Louis Edison tinfoil was brought to Lawrence Berkeley National Lab in July 2012
- We considered wrapping it around a cylinder but soon rejected that due to its condition.
- The foil had been folded with 7 distinct creases and the ends were delicate as well.

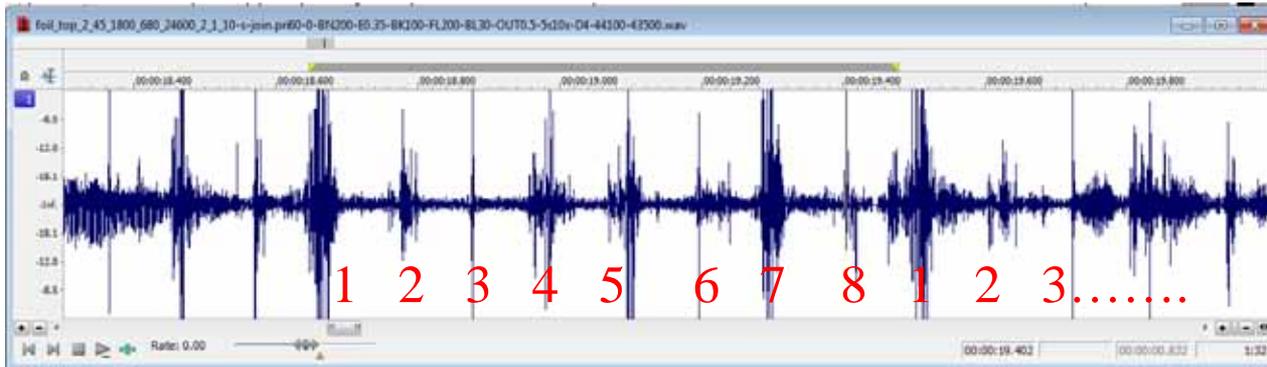


Optical Scanner with Tinfoil





Audio Restoration and Sound Quality



- This tinfoil is an artifact with significant wear and damage
- Fortunately most of the damage is confined to the 7 folds and the ends

Content

- Duration is ~1 minute, 10 seconds
- 0-3 s: no recorded audio
- 3-27 s: brass instrumental music
- 27-37 s: "Mary had a little lamb...".
- 37-46 s: laughter
- 46-57 s: "Old Mother Hubbard..."
- -1 min, 10 s: laughter and inaudible speech

Video of the Process

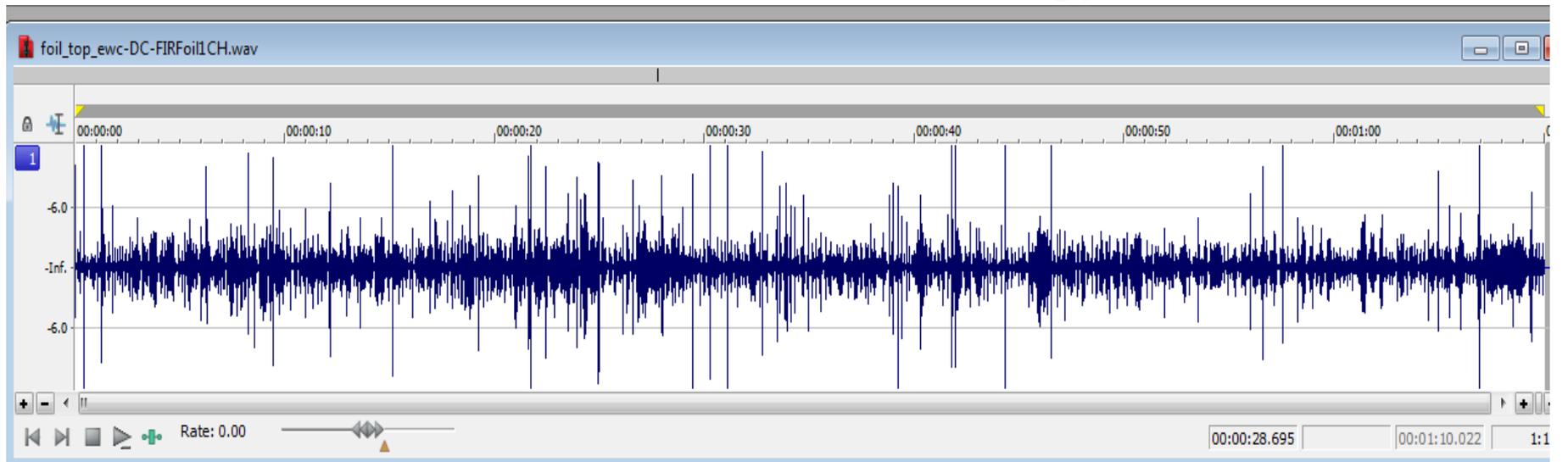
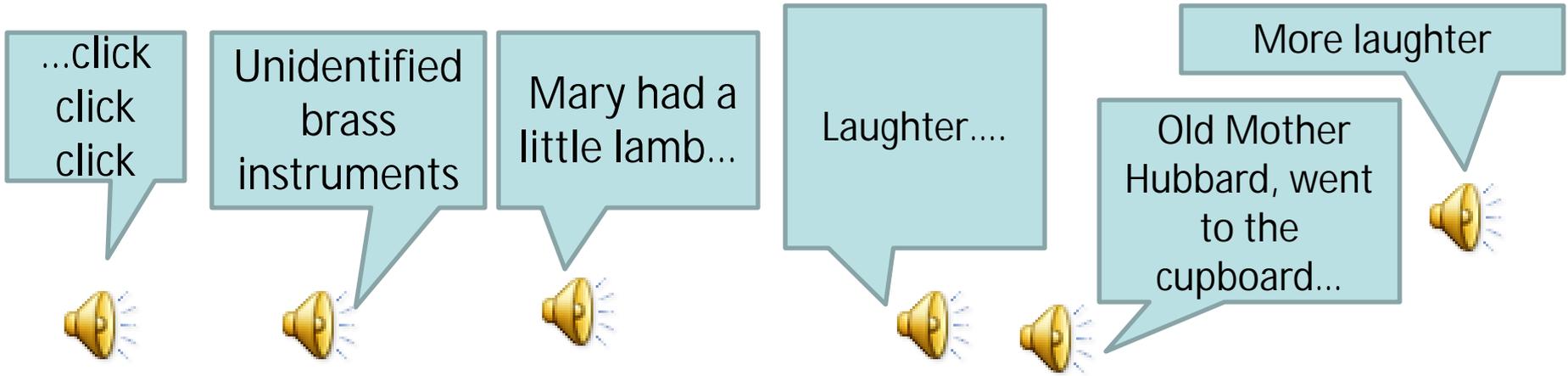
<https://www.youtube.com/watch?v=B-Ix0rHBDzw>



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Full raw

<https://www.youtube.com/watch?v=B-Ix0rHBDzw>



Full filtered = remove extra frequencies

Optical Scanning Collaboration and Support

Tinfoil project: Earl Cornell, Mark Guadagni, Chris Hunter, CH

Lawrence Berkeley National Lab

The Library of Congress

Univ. of Appl. Sciences, Fribourg, Switzerland

The Smithsonian Institution



INSTITUTE of
Museum and Library
SERVICES



Smithsonian
Institution



NATIONAL
ENDOWMENT
FOR THE
HUMANITIES

THE ANDREW W. MELLON FOUNDATION

John Simon Guggenheim Memorial Foundation

Fellowships to Assist Research and Artistic Creation



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Conclusions

- Edison's contributions to information technology were a transformative link in the 19th century chain of innovation and invention.
- The St. Louis tinfoil is our “point of closest approach” to the beginning of recorded sound as we have come to know it in our culture.
- Today's digital technology provides a window on the entire early period of sound recording and the research, artistic, historical, and commercial legacies.
- More info? irene.lbl.gov and links there-in...