

Optical Scanning Applied to Recorded Sound Preservation and Access: Status and Prospects

Carl Haber

Lawrence Berkeley National Lab



4-Oct-2010

Library of Congress TOPS
C.Haber

Collaboration and Support

Lawrence Berkeley National Lab: Earl Cornell, CH, Vitaliy Fadeyev, Robert Nordmeyer, Mitch Golden + students: Maryrose Barrios, Nicolas Scozzoro, Wei Zhou (2010)

Library of Congress: Peter Alyea, Larry Appelbaum, Dianne van der Reyden, Elmer Eusman, Eric Hansen, Gene DeAnna

EIF Fribourg – Switzerland: Ottar Johnsen + students: Adrian Nicolet, Tobias Mueller (2010)



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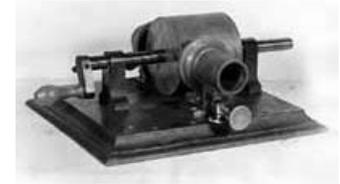
Outline

- Background
- Projects and History
- IRENE aspects
- Special studies
- Disc scanning
- Education
- Conclusion

History



- 1853 Leon Scott: *Phonoautograph* paper recorder
- 1877 Thomas Edison invents sound reproduction on tin foil *Phonograph*
- 1880-5 Bell(s) and Tainter, Volta Lab research into audio formats, finally introduce wax cylinder
- 1887 Emile Berliner invents disc *Gramophone*
- 1925 Western Electric *Orthophonic* (electrical) system
end of the “Acoustic Era”
- 1929 Edison production ends, lacquer transcription disc introduced
- 1947 Magnetic tape in production use, Ampex 200A
- 1948 33 1/3 rpm LP introduced
- 1958 Stereophonic LP on sale, uses 45/45 system
- 1963 Cassette magnetic tapes
- 1982 Compact Disc (CD)
end of the “Analog Era”
- 2001 Apple *IPOD*
- Late 2000's Massive online access to digital sound files

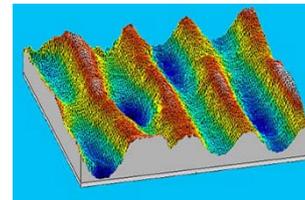
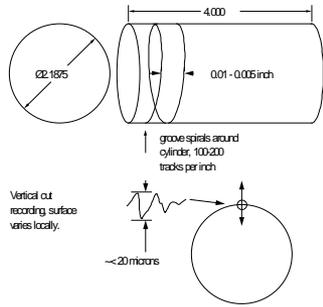


Discos fonográficos Pathe
Caras y Caretas (7/7/1906)



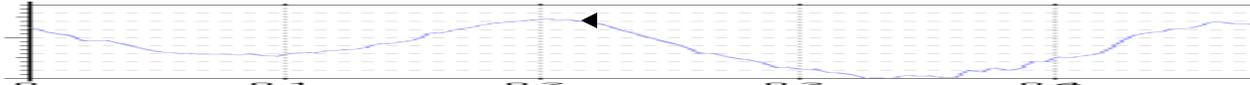
The Berkeley Optical Sound Restoration Project

- Develop methods to optically restoring mechanical sound recordings **without contact** to the medium – **like text scanning**
- Address concerns of the preservation, archive, and research communities:
 - Preservation: Restore or stabilize delicate or damaged media
 - Access: Mass digitization of diverse media, automation
 - Assessment
 - Diverse, obsolete formats and legacy playback systems
- The approach evolved naturally out of methods of optical metrology, pattern recognition, image processing, and data analysis we use for physics research.



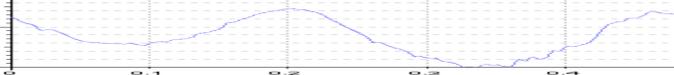
254 microns

Black 2 minute cylinder



Vertical cut

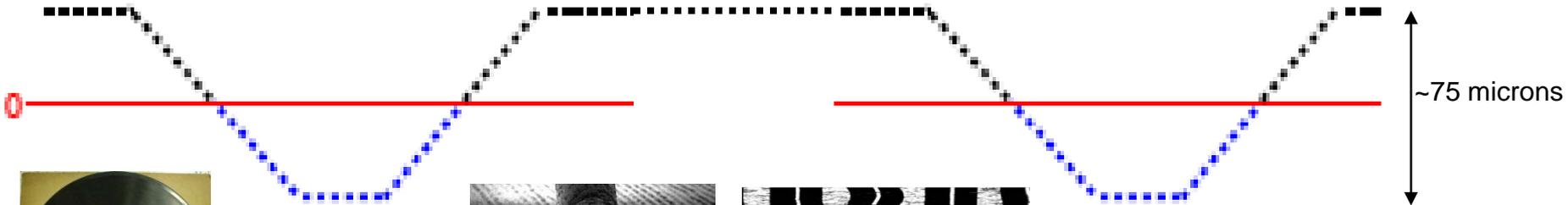
Blue 4 minute cylinder



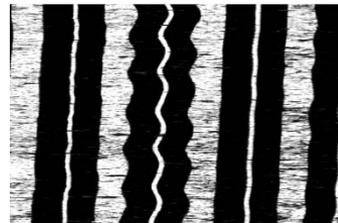
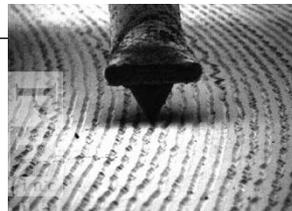
$\sim 20\text{ microns}$

Shellac disc

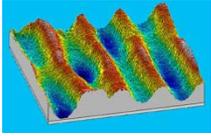
400 microns



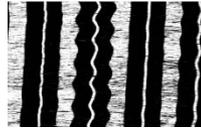
Lateral cut



Audio is encoded in micron scale features which are >100 meters long.



Non-Contact Digital Imaging



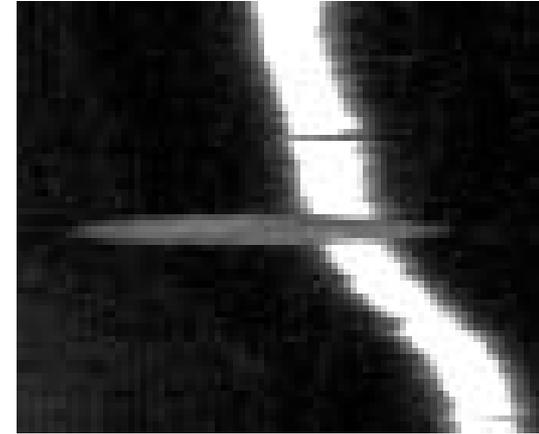
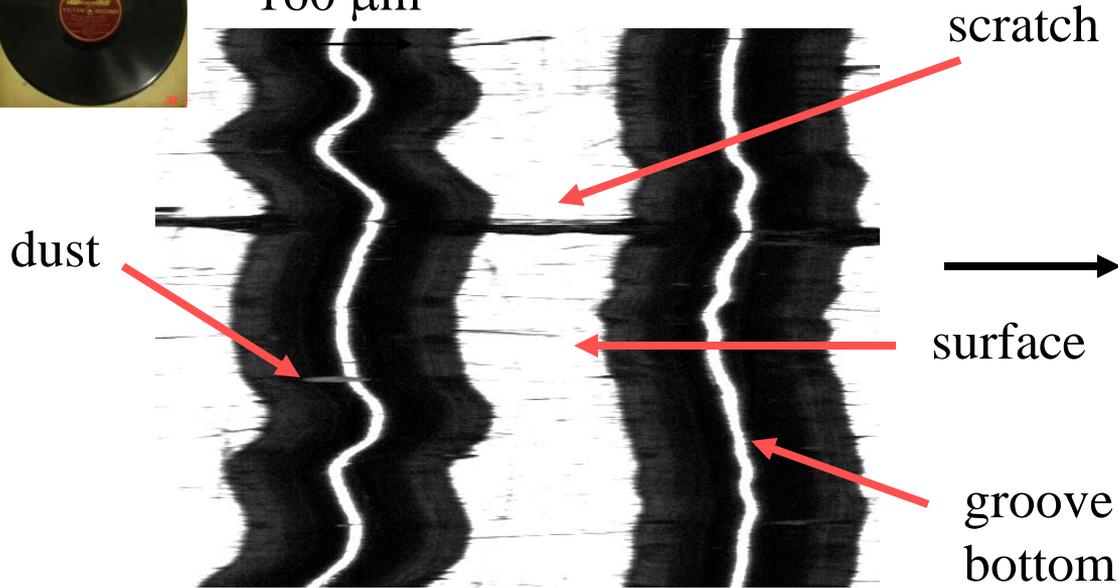
- Create a high resolution digital map of entire surface
- Computer plays record (image) with a virtual stylus
- Product
 - Standard digital sound files (ie .wav)
 - High resolution digital images which may be reanalyzed later as well
- Protects samples from further damage
- Repair existing damage through “touch-up”
- Reconstruct broken records
- Offload aspects of restoration to automated software

A “smart” copying machine for records

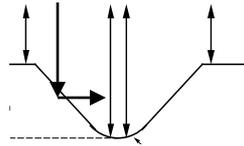
2D Imaging: Electronic Camera



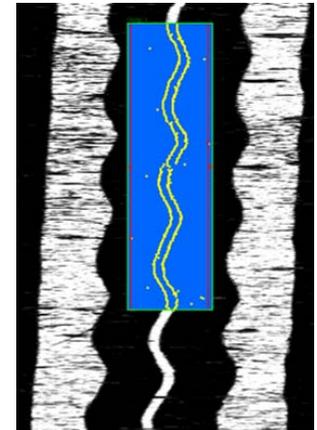
160 μm



Coaxial illumination

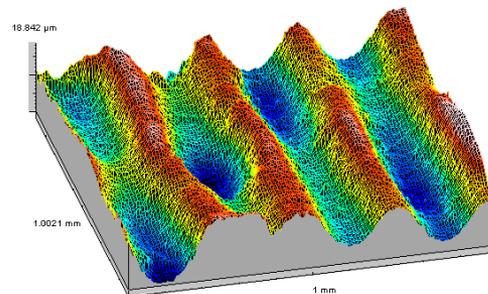
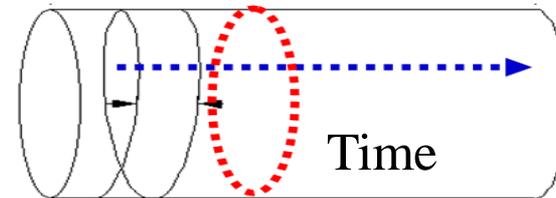
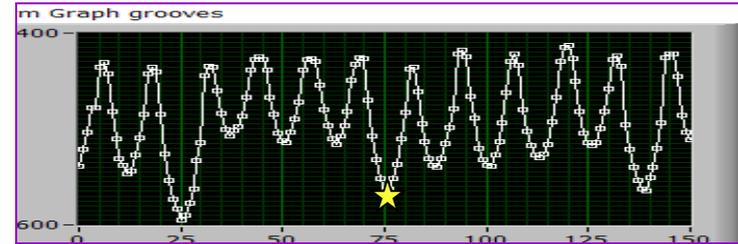
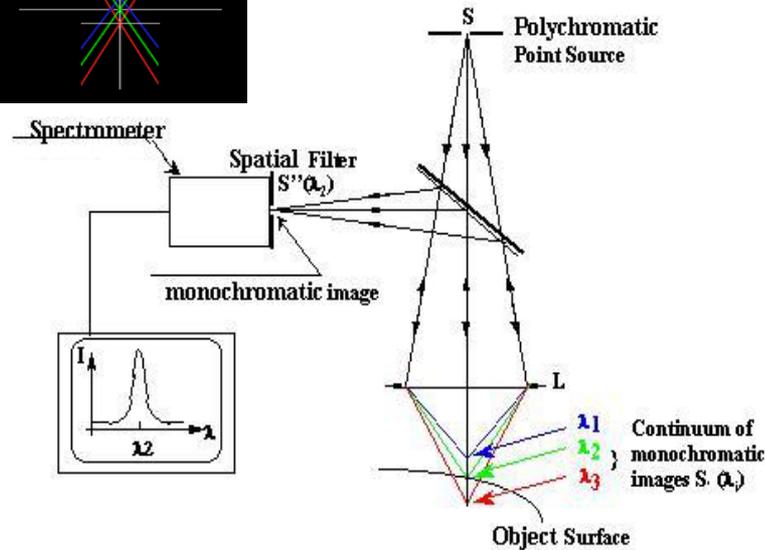
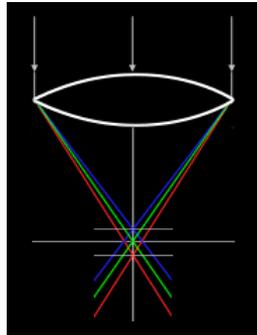
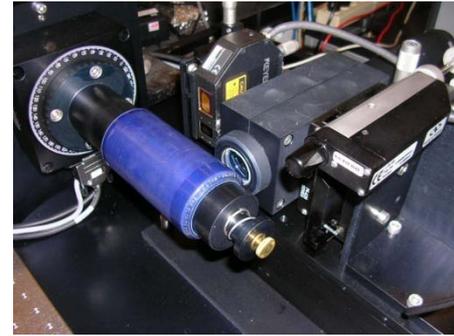


- Suitable for disc with lateral groove
- Require 1 pixel = ~ 1 micron on the disc surface
- High resolution yields narrow depth of field, 10 – 20 microns
- High speed cameras allow near “real-time” imaging
- Extract groove information from high contrast edge transitions



3D Imaging: Confocal Scanning Probe

Required for cylinder with vertical groove modulation.



1 point at 2 KHz vs. 180 points at 1.8 KHz
3 days 30 minutes



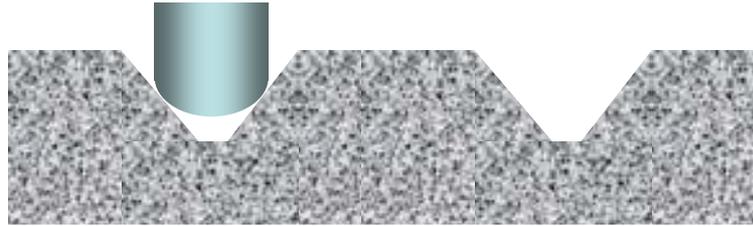
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Redundancy

Audio stored in entire profile, signal averaging

Stylus



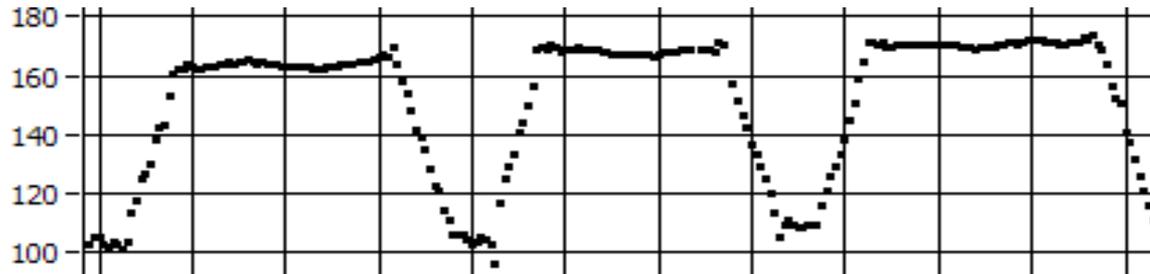
Stylus comes into contact at 2 points

2D



Measure the groove bottom with 2 points/slice

3D



Measure the entire groove with ~30 points/slice



Developments

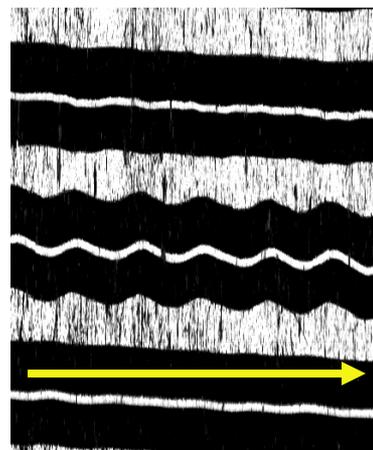
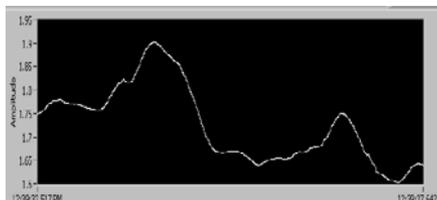
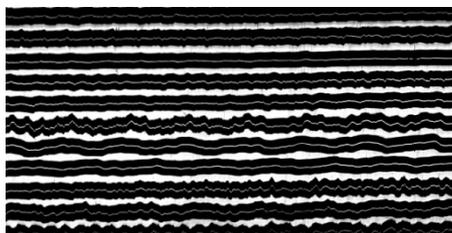
- Concept was tested 2002-2003 leading to interest and support from the Library of Congress and others.
- IRENE: a fast 2D optical scanner for disc records 2006-7 (NEH)
 - Digital access to the most common media + special formats
 - Installed 2006 at Library of Congress, evaluation, upgrade
- 3D: a fast 3D scanner for cylinders and discs 2008-9 (IMLS)
 - Preservation and restoration of early and damaged recordings
 - Benefit from recent improvements in 3D probe technology
- Connecting to Collections: 2010-12 (IMLS)
 - Migration of technology into use at multiple collection sites
 - Special Studies:
 - Wax field recorded and dictation cylinders
 - Damaged broken, unplayable, or tare recordings
 - Early experimental recordings
 - Cylinder molds and disc stampers



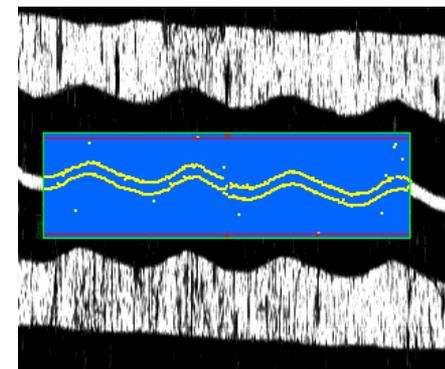
I.R.E.N.E



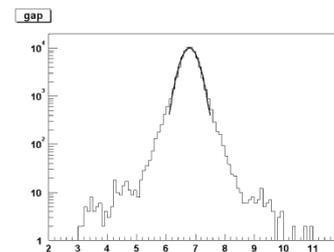
Line scan



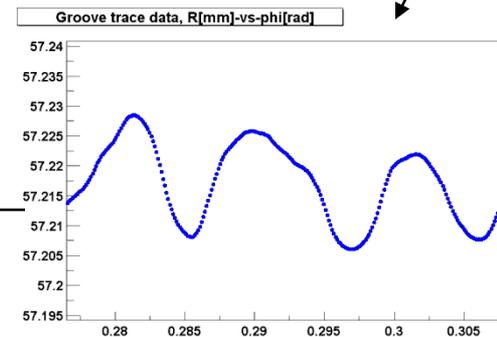
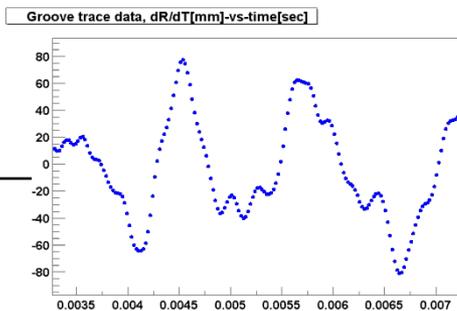
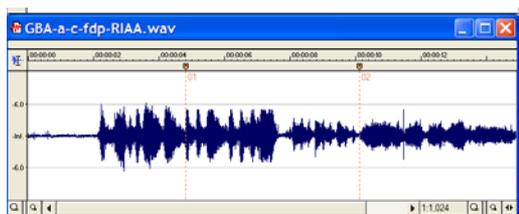
Time
Pixels = 104 KHz



Width across
groove bottom



Measure slope
at each point
(stylus velocity)



Average
Filter using width cut



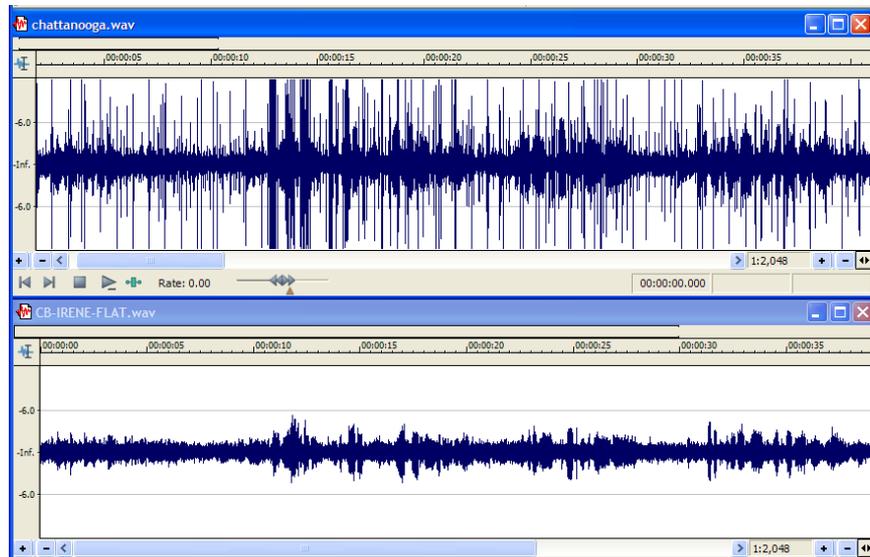
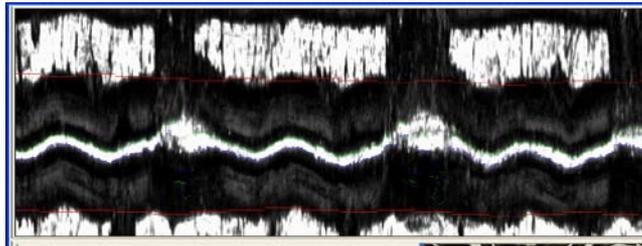
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Chattanooga Blues 1923

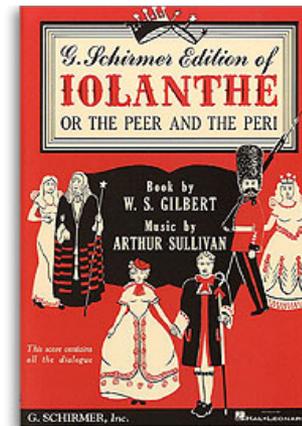
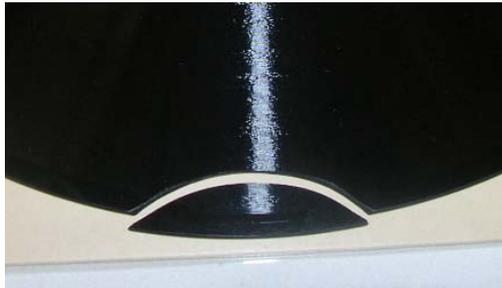
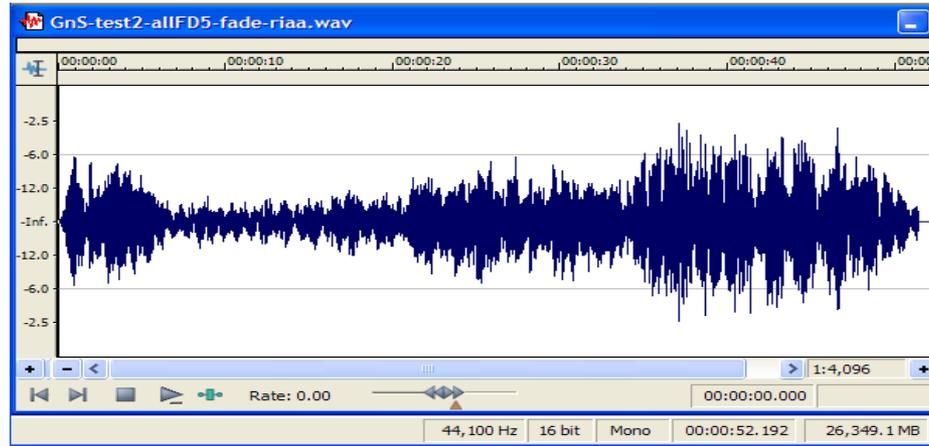
Ida Cox, Paramount 12063

Acoustic recording, heavily worn, cracked, with significant stylus damage and distortion



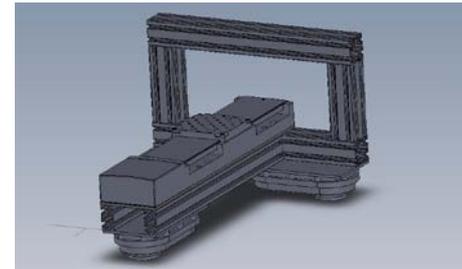
Broken Record

Gilbert and Sullivan "Iolanthe" 1930 Victor 9708

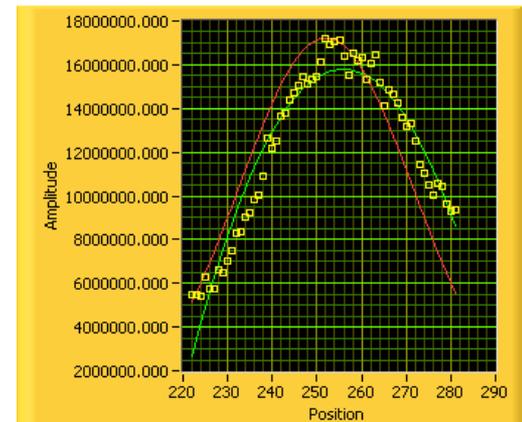
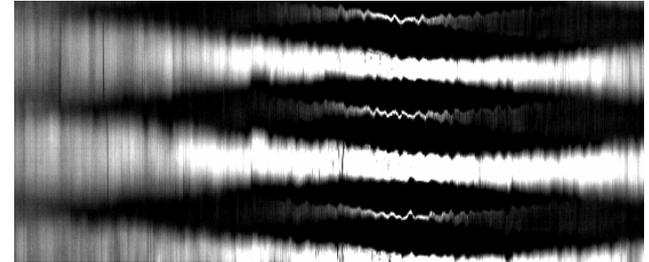
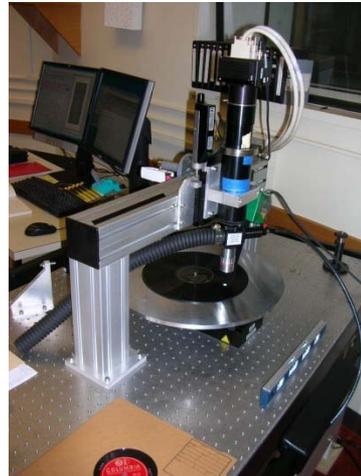
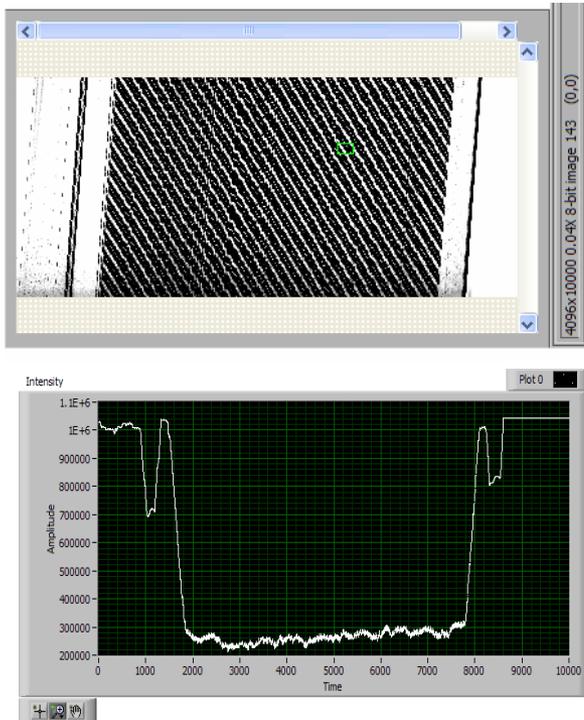


Collection Scanning

- Packard Campus: simple interface, fast setup, robust, fast data logging
- U Chicago South Asia Library, Chennai, India: portable system
- Software enhancements
 - Setup, calibration
 - Automatic parameter setting
- Hardware
 - Lamps: smaller, lower power
 - Optics: efficiency
 - Tracking: reduce clearance
 - Lightweight support and isolation



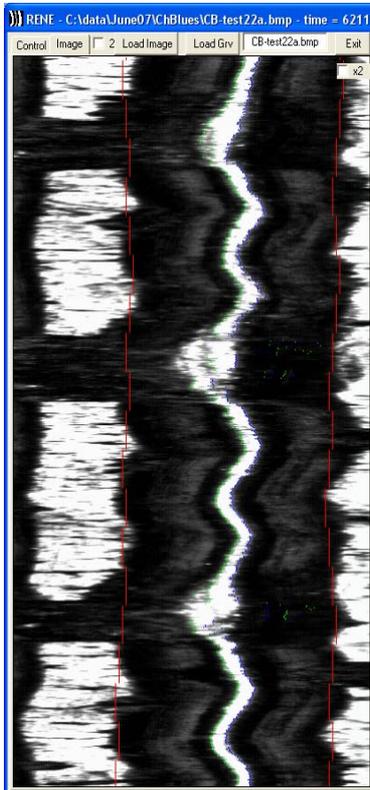
IRENE Control Software for Production



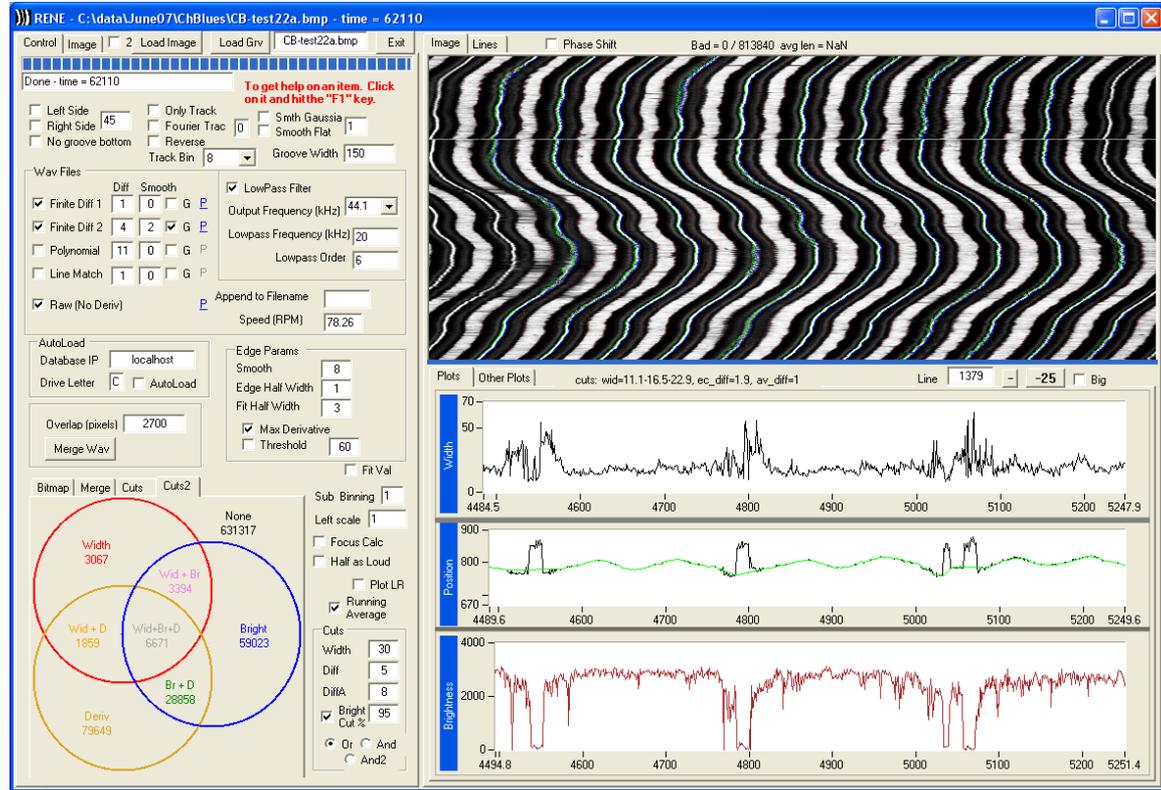
- Evolving towards a fully automated system
- Exposure, focus, start/stop, parameters, selection
- Determine using image processing and analysis tools during setup

IRENE Analysis Software

Image View



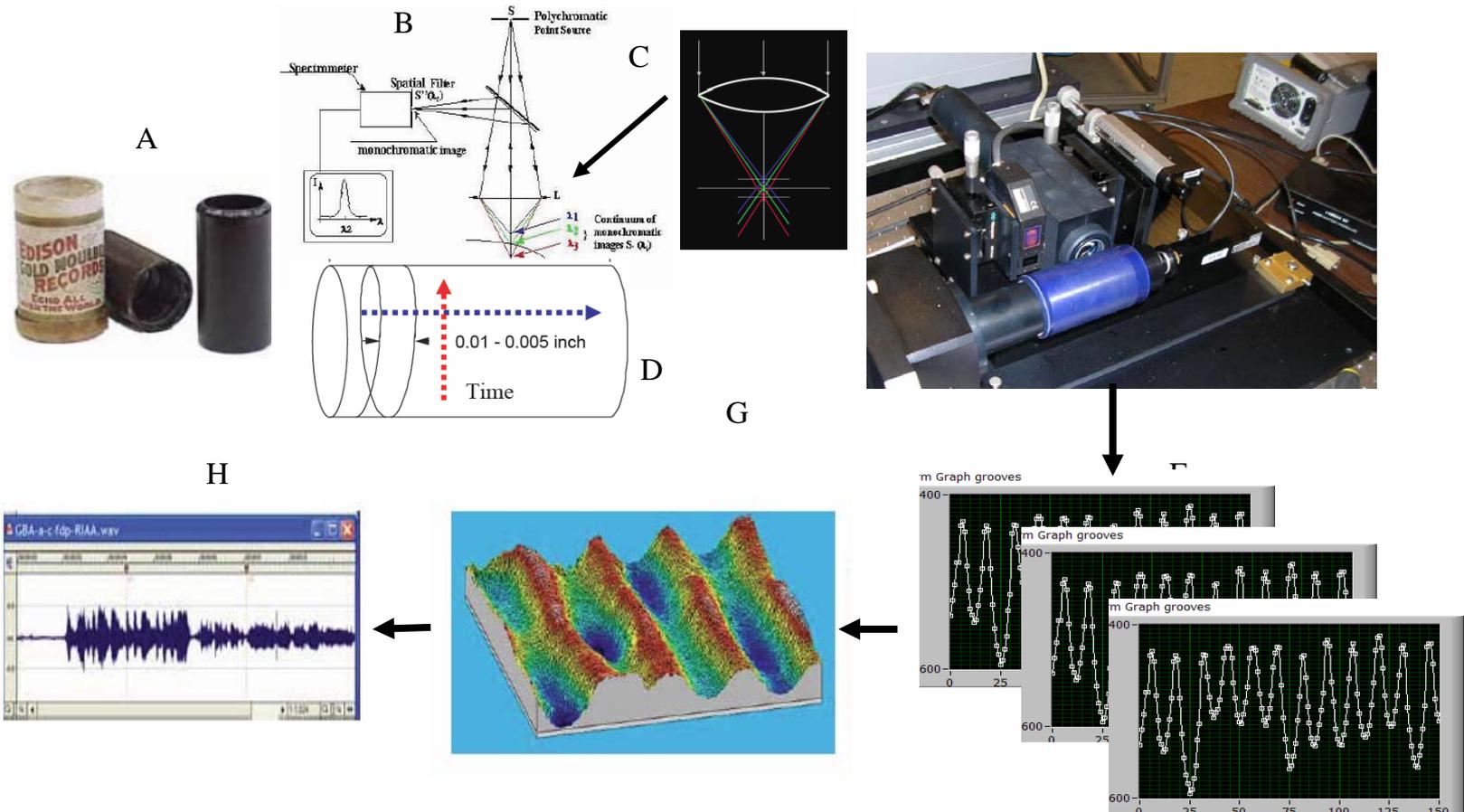
Control View



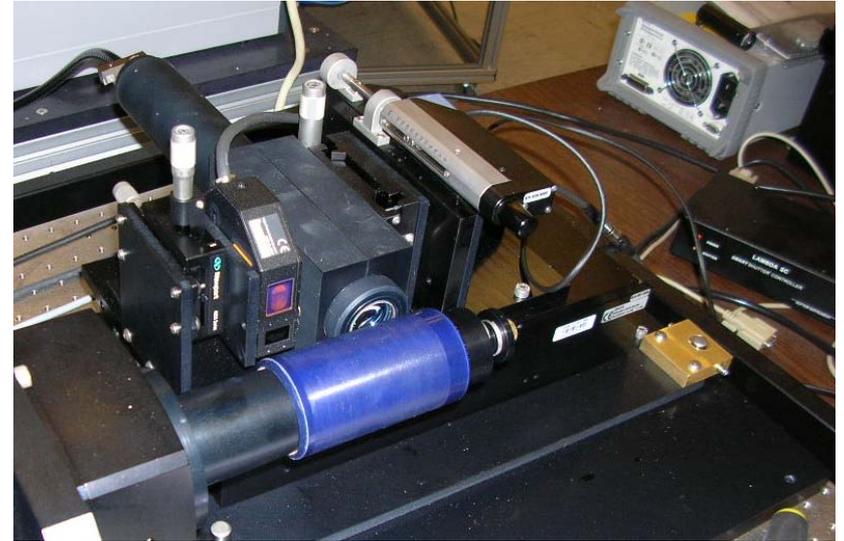
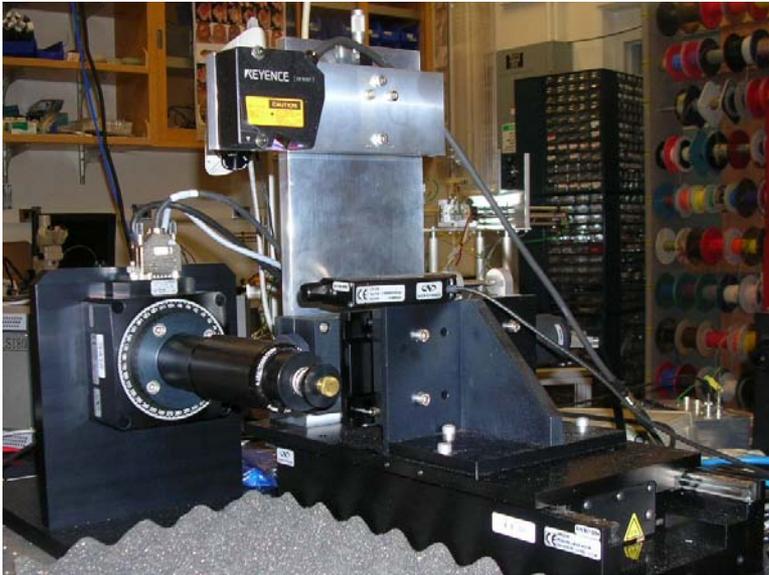
IRENE Details

- <http://irene.lbl.gov/> recent pdf's posted
- <http://irene.lbl.gov/examples.html>

Basic 3D Scanning Process



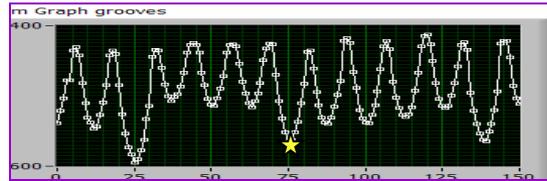
Fast 3D Scanner Project



- Funded 10/07 by IMLS
- Build fast scanner using new 180 point confocal probes
- Integrate into simple and robust control and analysis system.
- Installed at the Library of Congress in 2010

Development of 3D Sensors

Single point



Multiple points



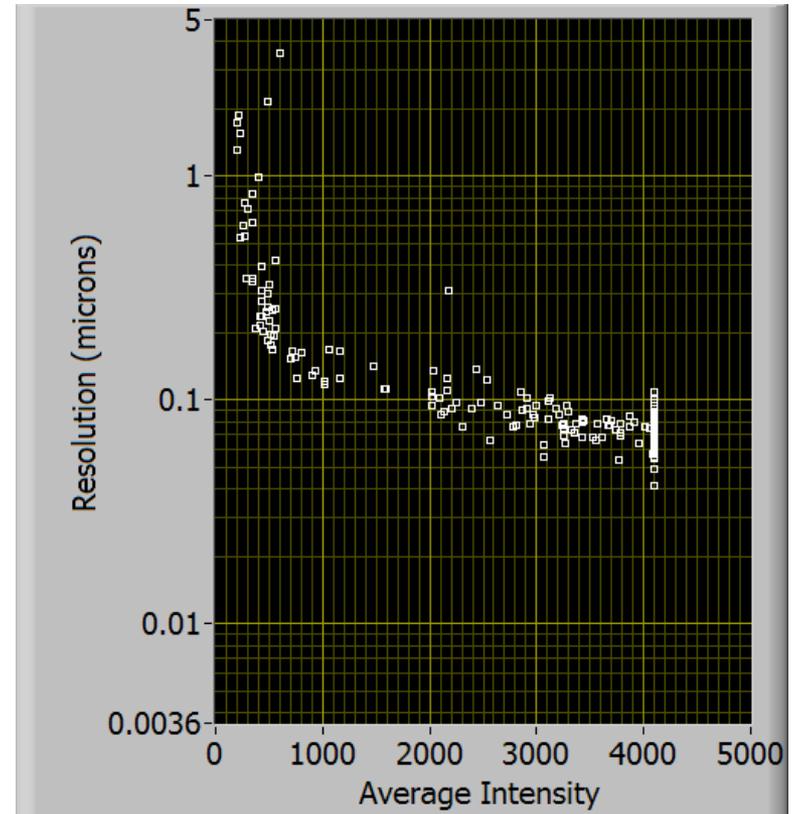
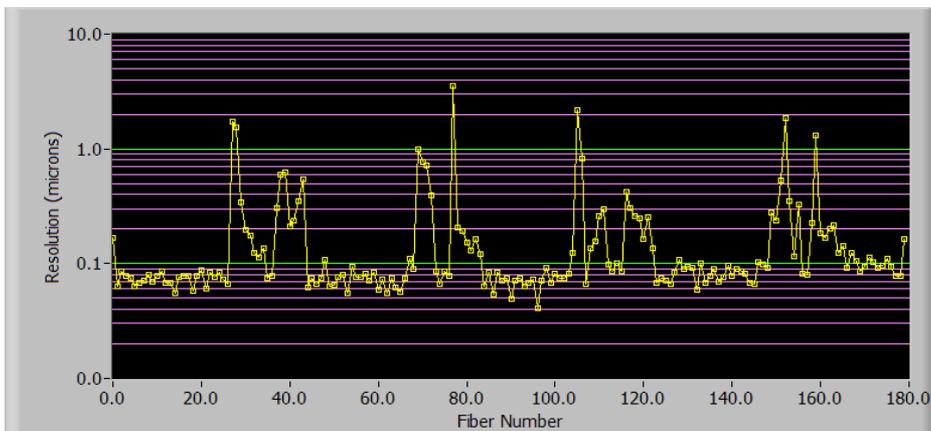
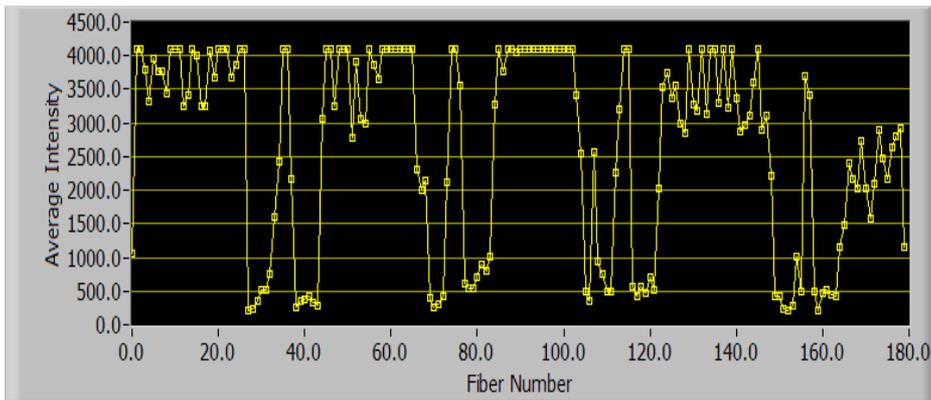
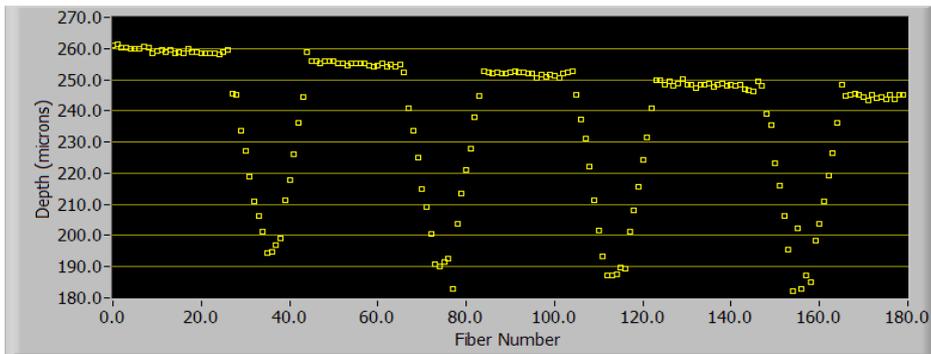
single	Parameter	MP V1	MP V2
1	Number of points	180	180
10 nm	Depth resolution	120 nm	90 nm
330 μm	Depth of field	400 μm	350 μm
1	Measurement rate [KHz]	0.6-1.4	0.6-1.4
7 μm	Spot size	3.5 μm	2.5 μm

This evolution continues with 1000 point sensors, issue may be illumination

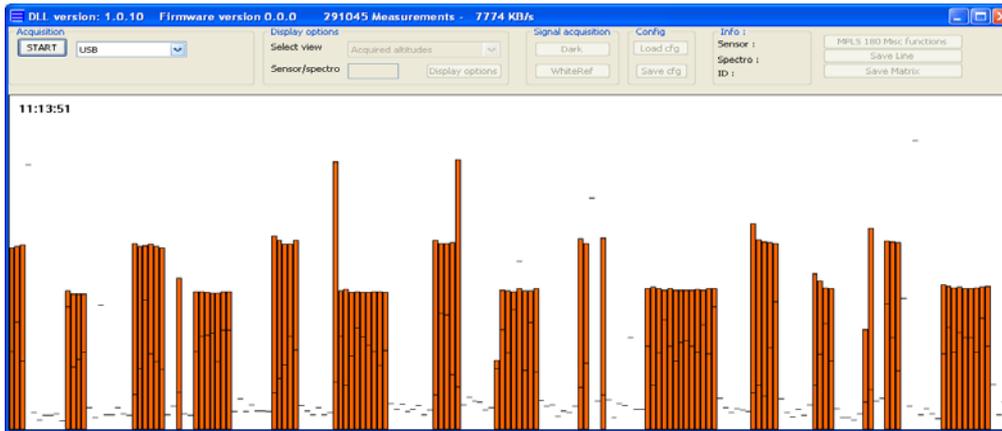
Technical Issues for 3D Probes

- Depth resolution: \ll feature size
 - Best on single point probe but continues to improve
- Spot size: smaller is better on slopes
- Scan time: dramatic improvement 180:1
- Focal range: addressed using laser tracking
- Illumination: Xe arc lamps
- Surface slope: considerable improvement between MPLS V1 and V2 due to NA and spot size
- Crosstalk: surface topography may lead to spurious light paths, addressed by probe orientation and data processing

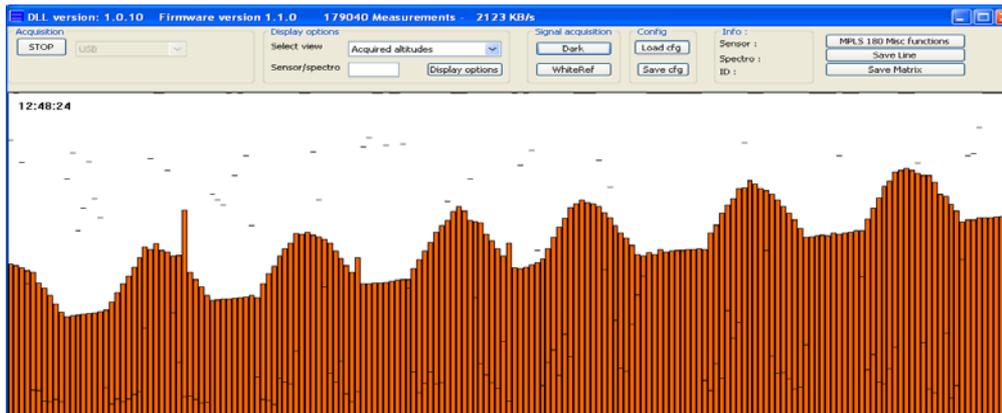
3D V2 vertical resolution study



3D Disc Reflectivity



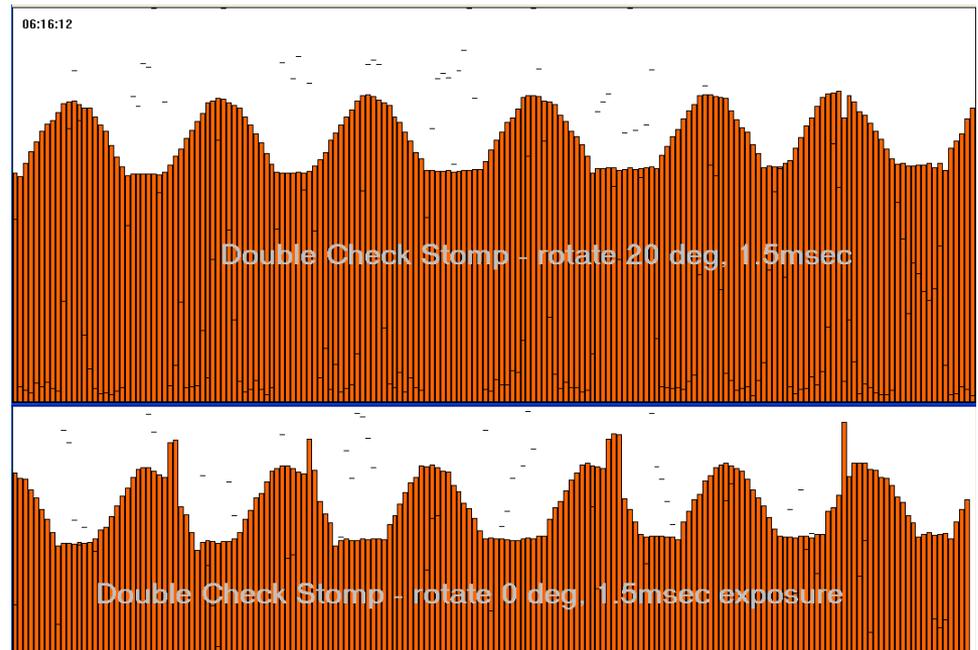
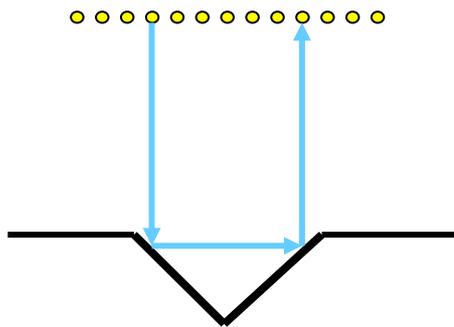
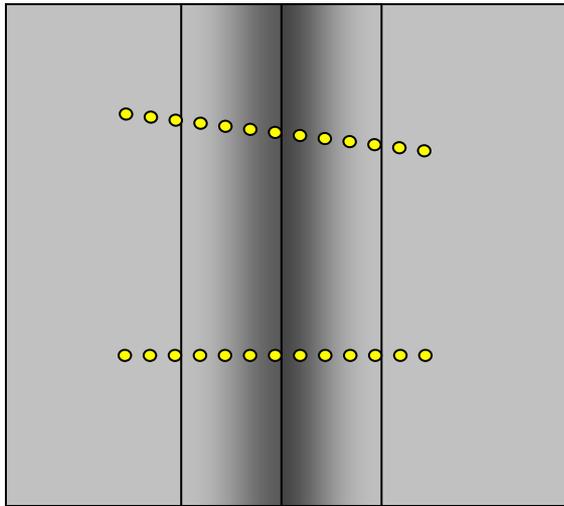
V1



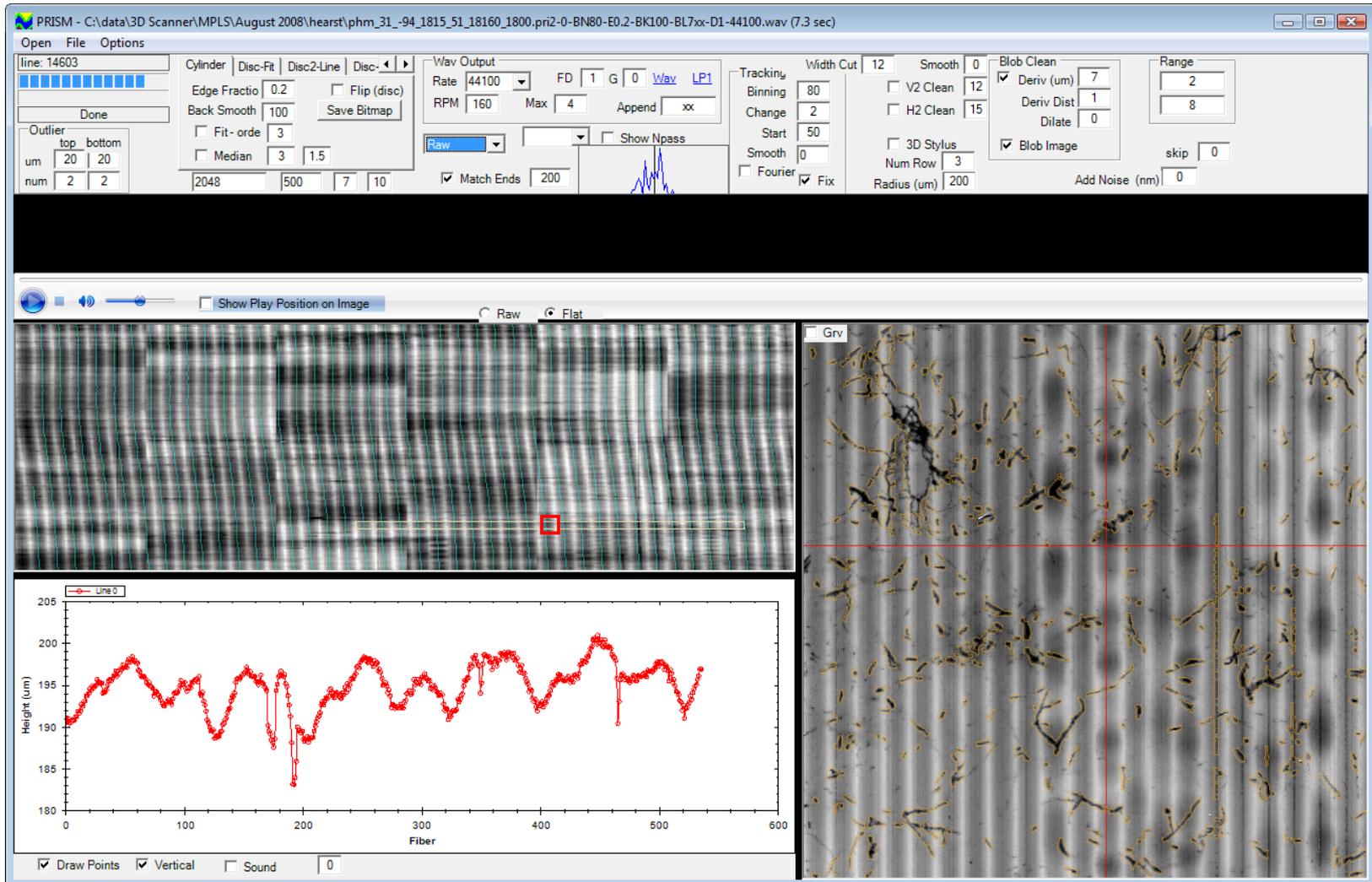
V2

3D Crosstalk and Rotation

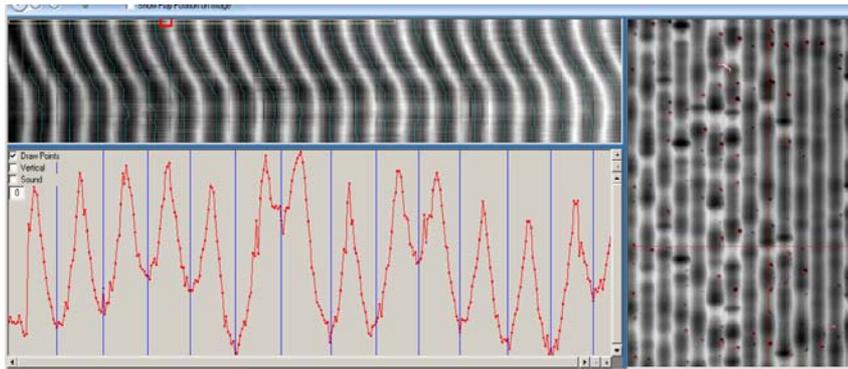
Requires point-to-point phase shift during
Data processing to re-align timing



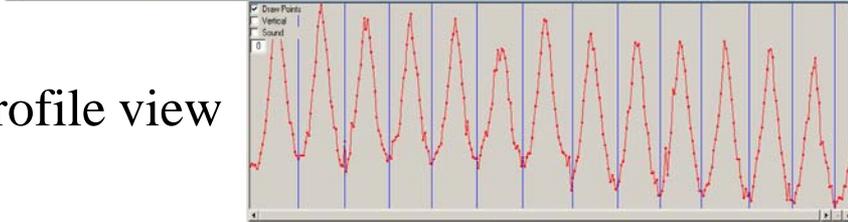
3D Analysis Software



3D Analysis Tools

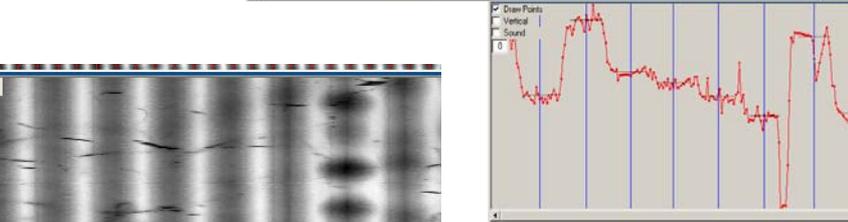


Raw image, greyscale = depth

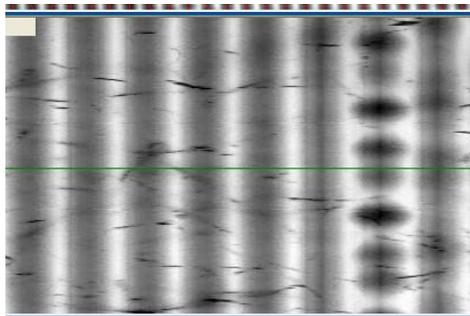


Spatial average to determine local shape

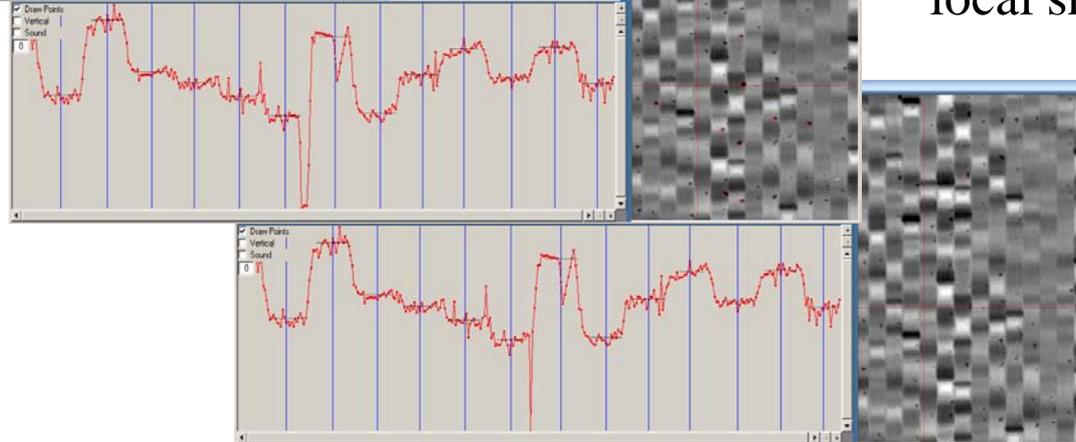
Profile view



Subtract local shape



Condition assessment



“blobs” removed

Special Studies

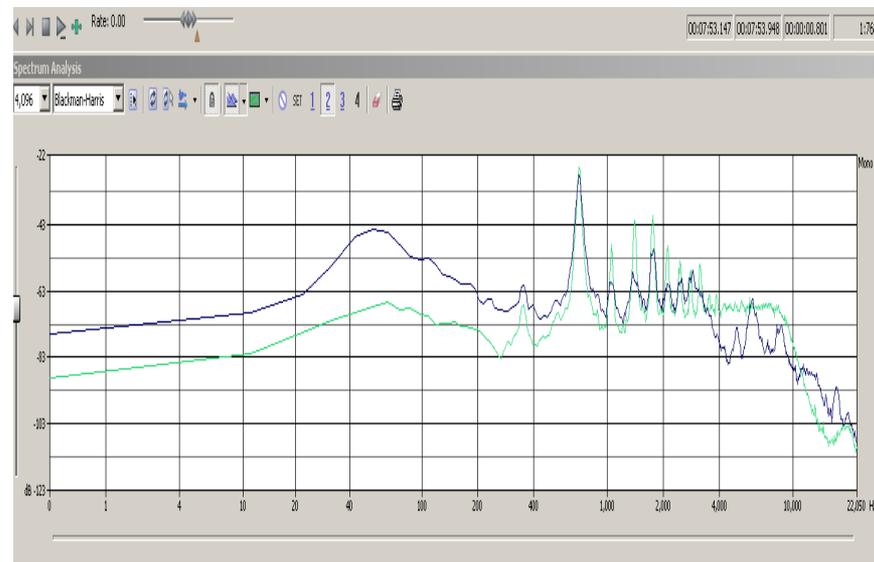
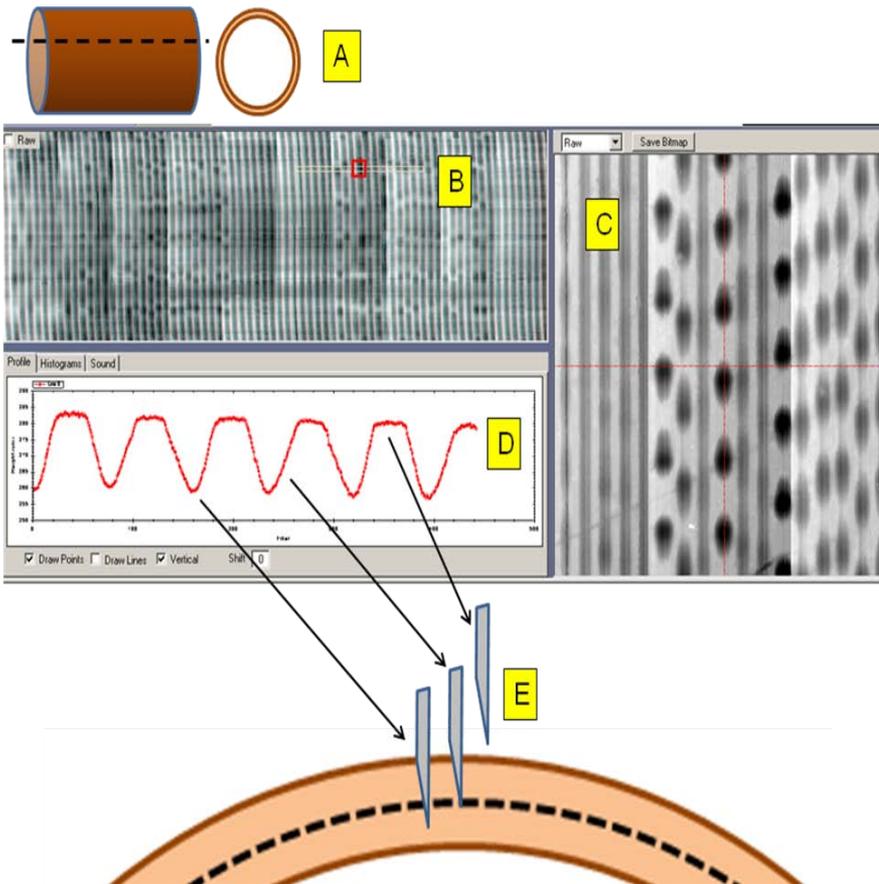


- Examples which challenge the technology
- Expanded study on wax field cylinders from ethnographic collections
 - Lots of surface defects due to fibers, cutting process, filtering and cleanup
- Early experimental recordings
 - A range of unusual materials, formats, and methods
- Berliner discs
- Copper galvanos at the Berlin Phonogramm Archive
 - Key international collection, unique application of confocal scanning
- Broken cylinders and discs
 - Fixture and s/w development with EIF Fribourg, ENHS Dickson
- Rare transcription media
 - Lacquer, aluminum, plastic (recording sessions, fieldwork, novelty, Presidential)

Field Recordings Pilot Study

- 1930 Vancouver Island, Franz Boas, audio+film
- UW Burke Museum, IU-Archive of Trad. Music, AMNH
- Systematic scan of 12 cylinders in a variety of conditions
- Reconstruction using PRISM with derived parameters
- Compare one and four pass, stylus (1959, 1984)





Stylus version (black)



3D version (blue)



Since optical scanning is free from the real-time dynamic effects inherent in stylus playback certain types of distortion can be reduced

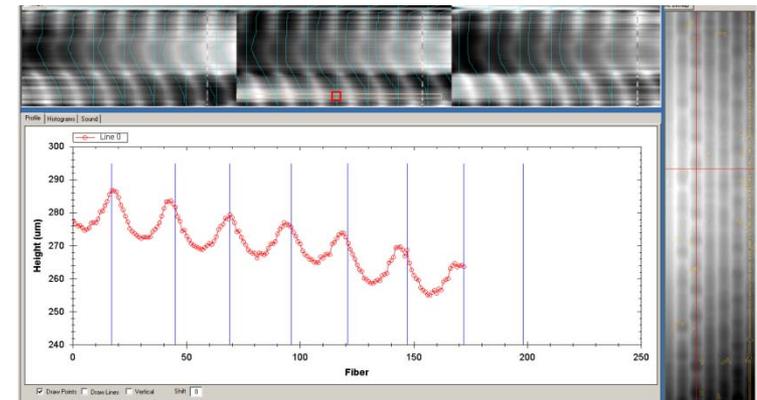
Galvano Study



- Berlin Phonogramm Archive, large scale conversion of field recordings to galvanos as a means for preservation and access
- Many casts have not been made, old technology
- Earlier attempts to scan with 2D video
- Proposal to make a thin probe to fit inside galvano
- Proof of principle using sacrificial sample

Stylus 

3D 



Vertical Cut Disc Study

- Edison Diamond Discs and Pathe vertical discs
- ENHS has a significant collection of wax masters, some are broken
- Opportunity to further experience with broken media



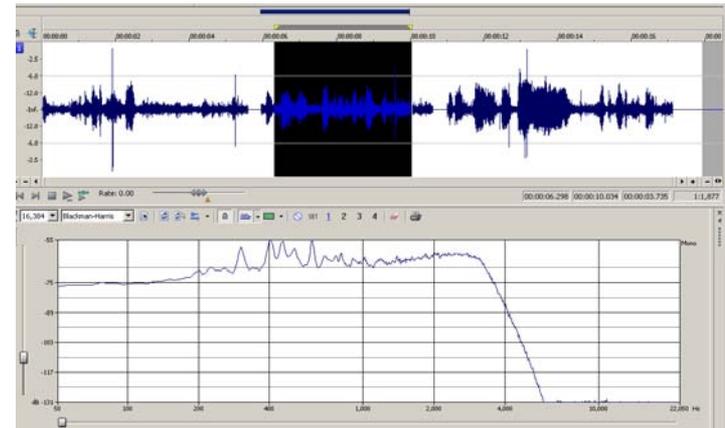
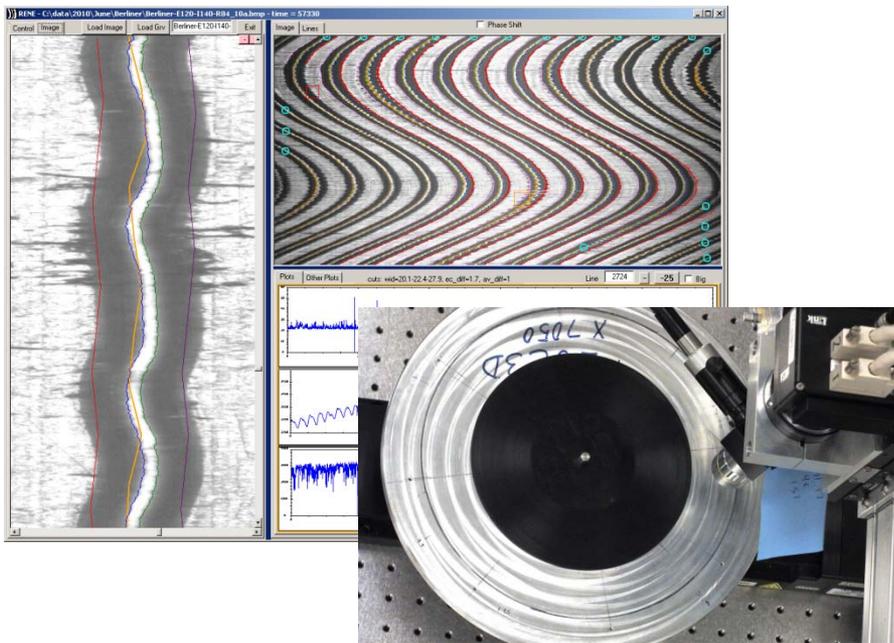
Edison



Pathe

Berliner Discs

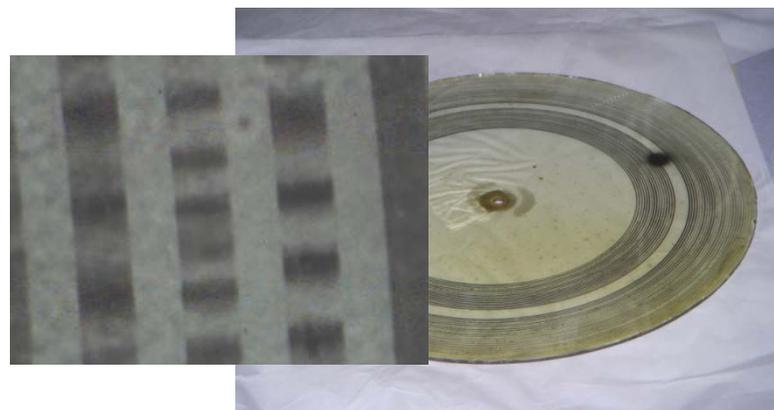
- Very early commercial disc production
- Significant collections at the Library, EMI Archives (UK)
- Small study done on 1 item with 3D and IRENE
- Initial results with IRENE were easy to obtain



Note: offensive content

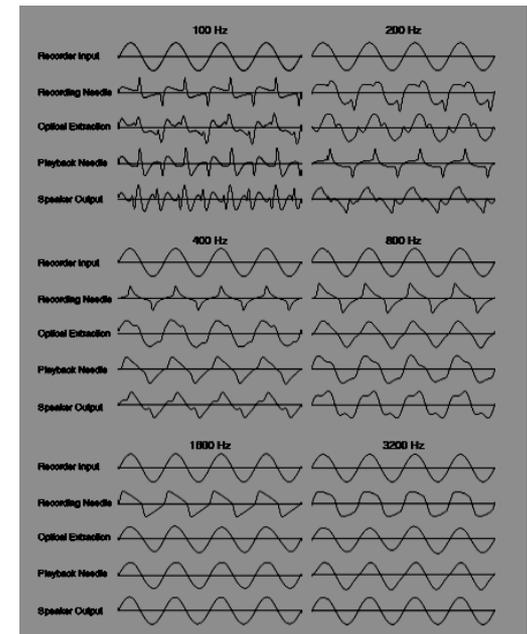
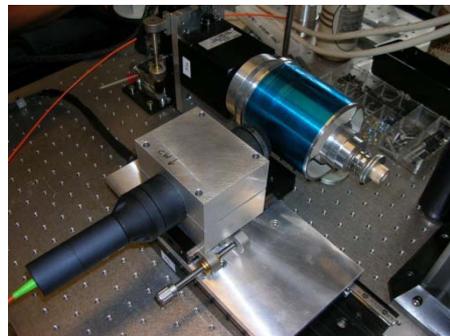
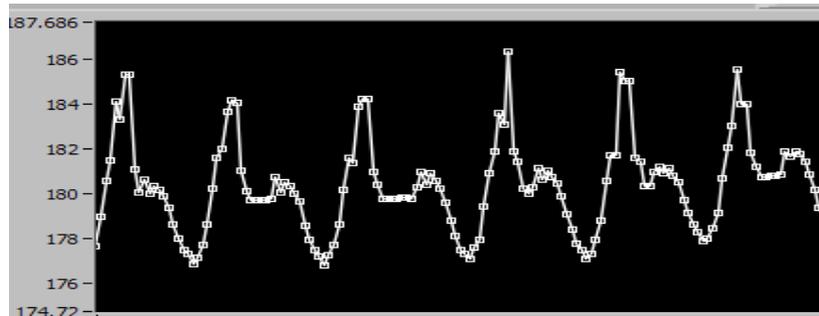
Experimental Recordings

- Diverse media from the development of audio recording technology
- Leon Scott phonoautograms ~1860, restored with IRENE analysis methods
- A.G. Bell, C.S. Tainter, C.Bell, 1880-1888, Volta Lab – SI NMAH collection, a broad R&D study which led to the adoption of wax as a recording medium
- Both cylindrical and disc formats were studied before Berliner, using mechanical and photographic sound carriers
- Near term goal is to scan sample of the Bell collection as a pilot study



Plastic Dictation Belts

- Dictation, telephone and radio monitoring 1940's-1970's
 - US Presidential phone conversations
- Groove is embossed, lateral modulation, shallow
- Never meant as an archival medium, poor storage



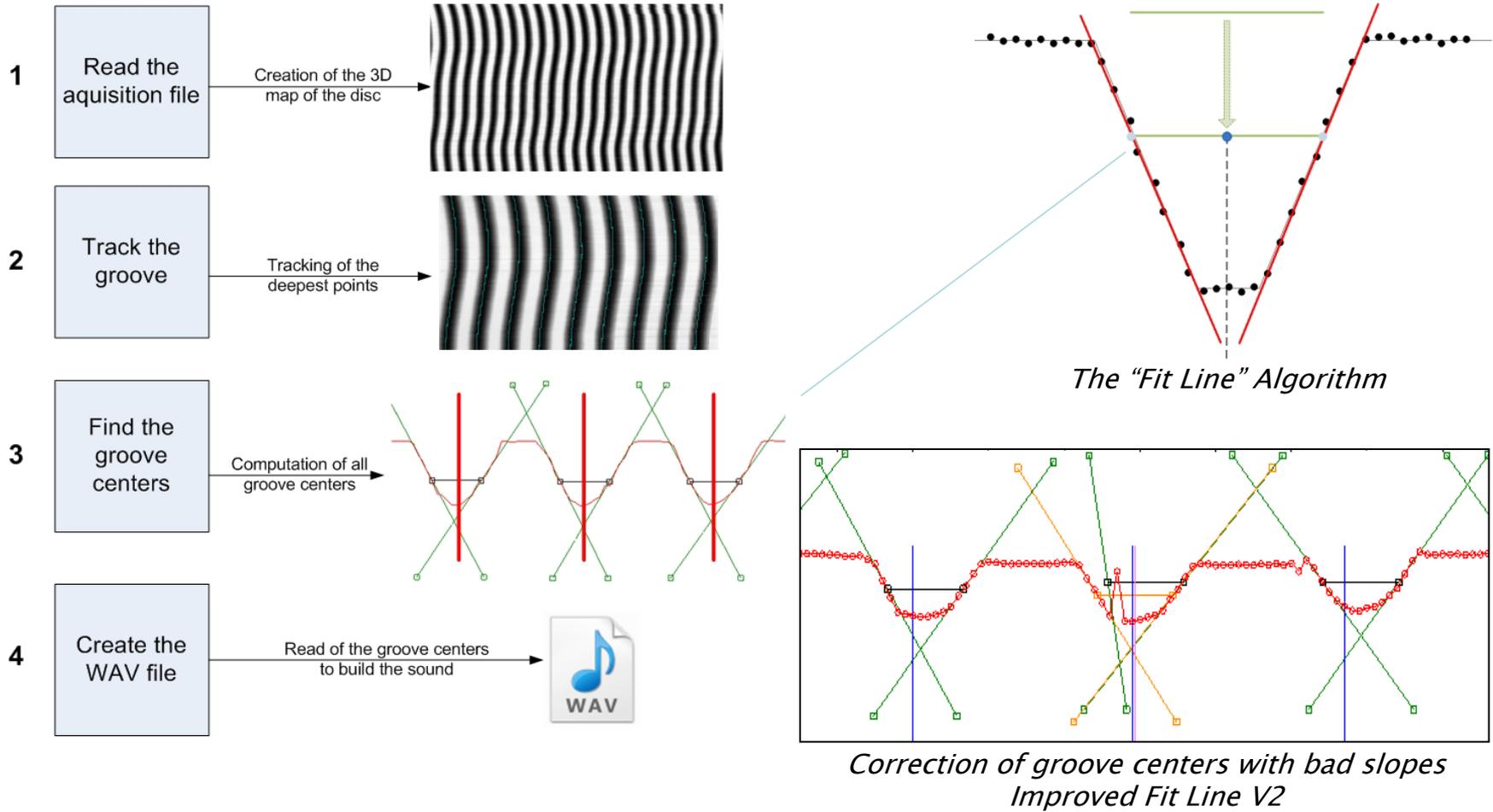
Development of 3D Disc Scanning

- Disc scanning is the most difficult aspect due to steep groove wall slopes
- Expectation has been that this would surpass IRENE due to greater redundancy
- First study of lateral grooves was on dictabelts with gentle slopes, worked well
- For discs early measurements with single point probe showed promise but were impractical due to scan time
- MPLS V1 had insufficient sensitivity for all but “dullest” disc
- MPLS V2 can image most discs and is the basis for the present campaign

Subtleties

- The power of 3D is based upon redundancy and averaging
- But all those points must now be used or rejected properly
 - Fitting algorithms
 - Outlier rejection
 - Adaptive parameters
- Measurement on steep slopes is a challenge
 - Reflected light intensity
 - Degraded resolution
 - Crosstalk
- All this has required us to develop many more tools and techniques

3D Groove Center Algorithm



Effect of Profile Corrections

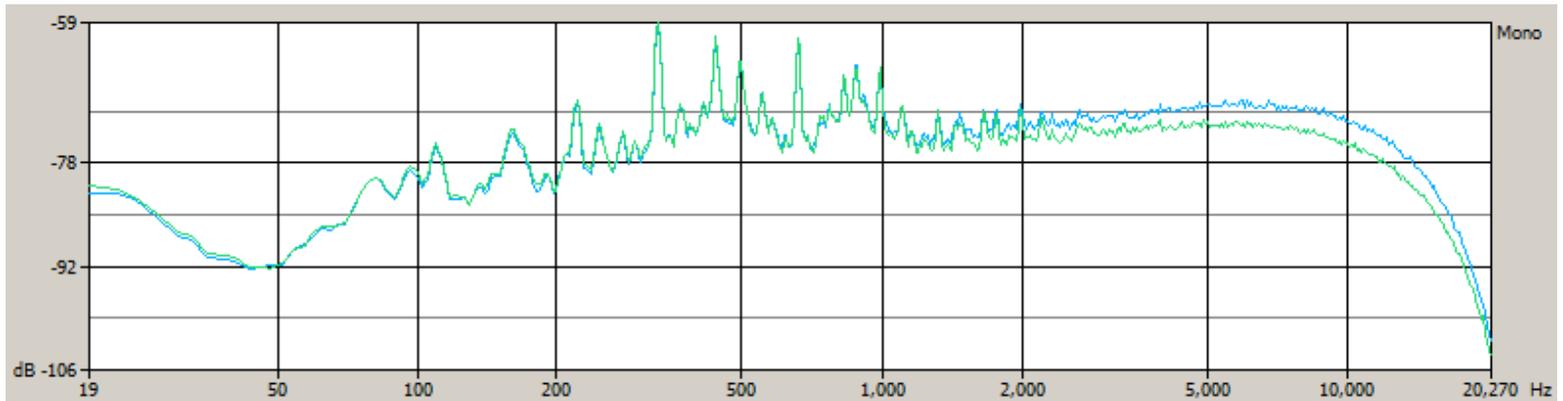
- Overall better sound quality
 - Less clicks
 - Lower noise
- Example with “Wabash”
Old shiny disc, in bad condition



Basic Fit



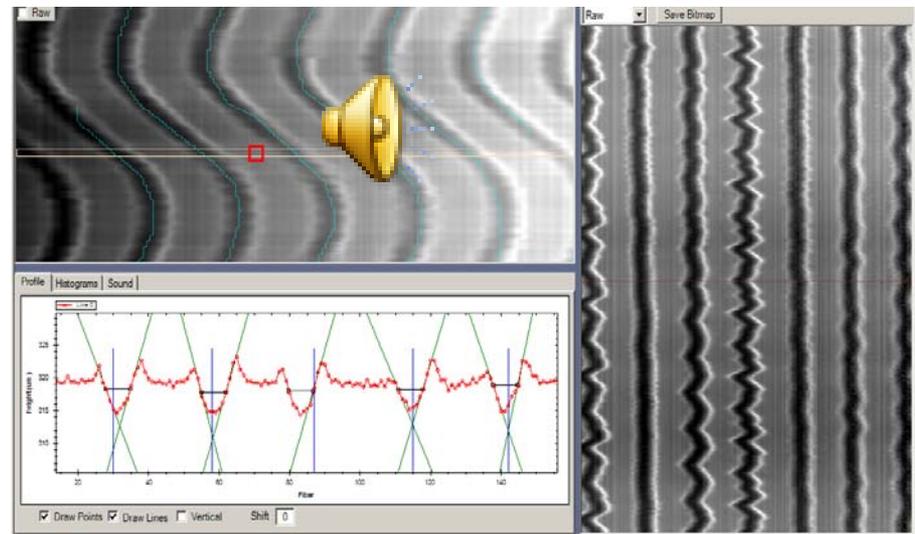
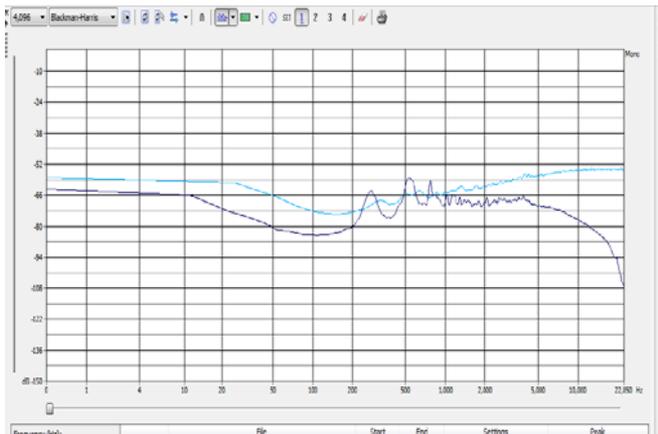
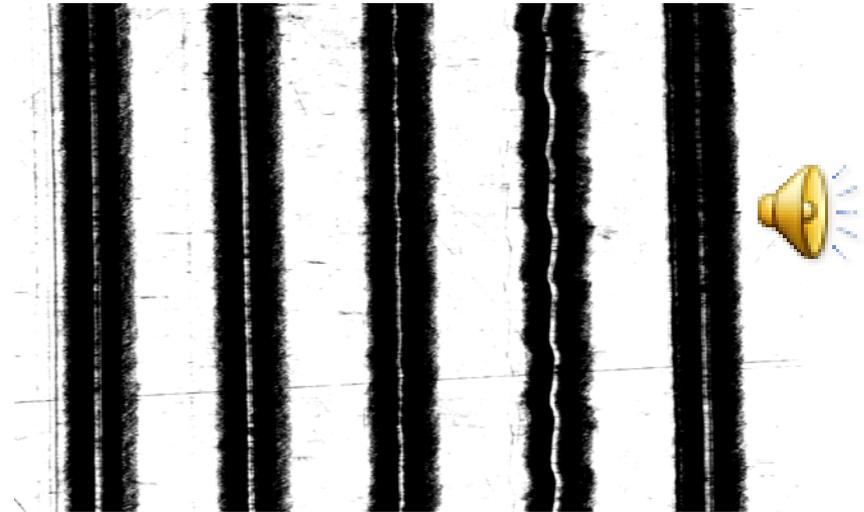
Improved Fit



Frequency spectrum analysis of the two files

Aluminum Disc Records

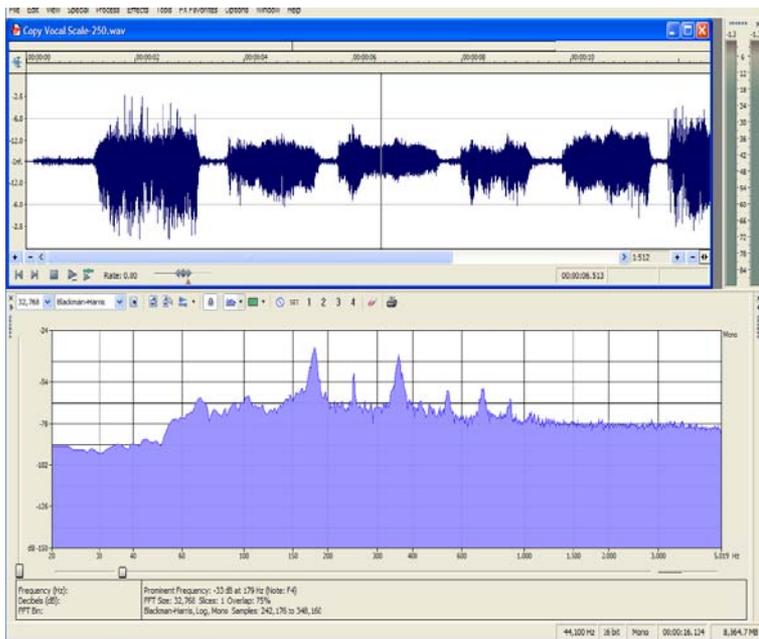
- Study on discs from Harvard Millman Parry South Slavic fieldwork collection
- Comparison of IRENE and 3D imaging



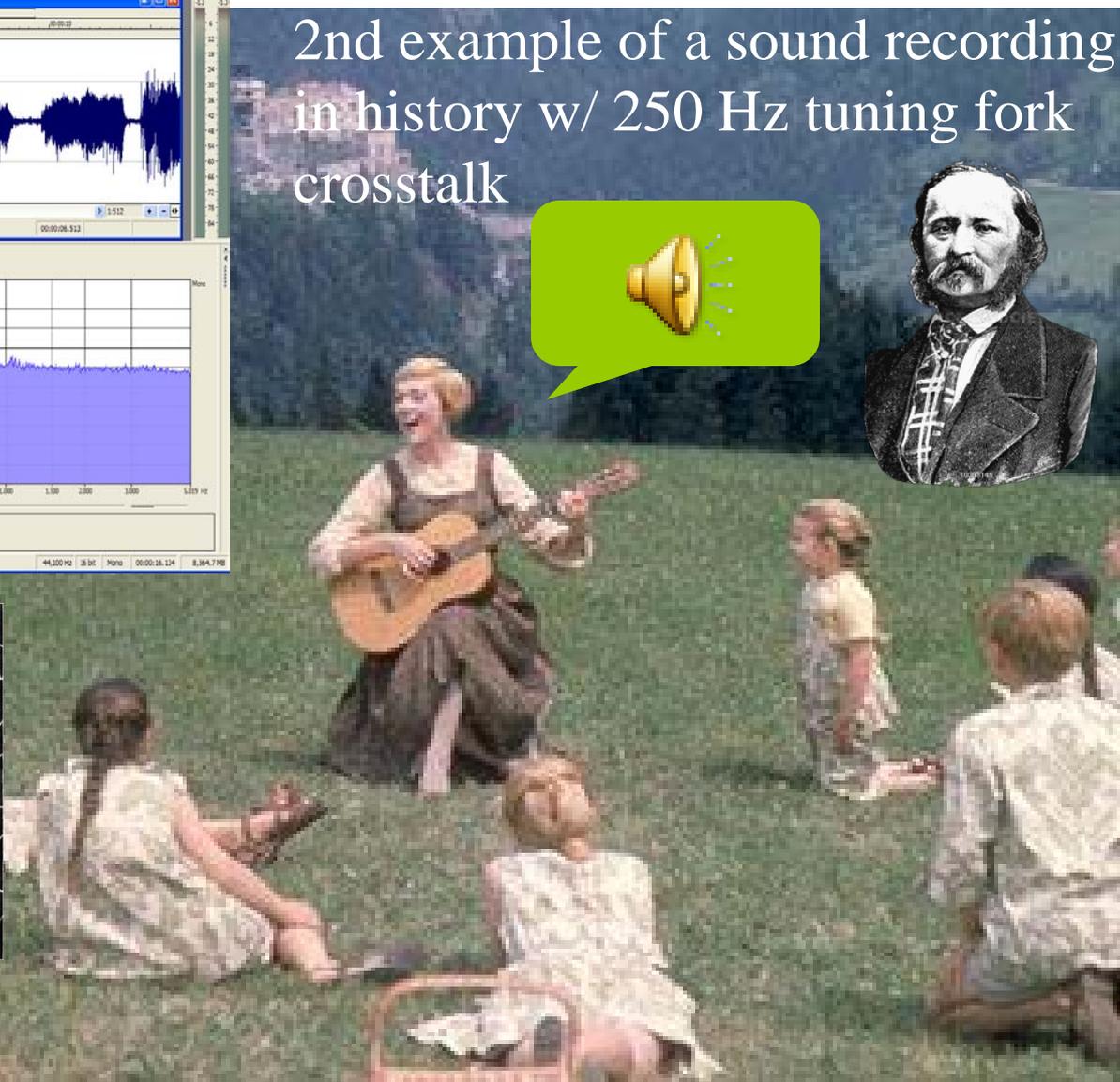
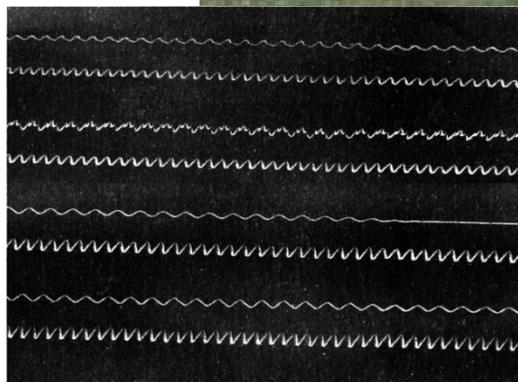
Education and Training

- At Berkeley we have developed a significant student participation
- ~10 UCB undergraduate internships
- 8 thesis students (3 months FT) from the University of Applied Science EIF Fribourg, Switzerland
- Subjects: EE, CS, Physics
- Students have participated in measurements, data analysis, code development, algorithms
- Opportunity to expose students in engineering and physical science to problems in preservation/conservation





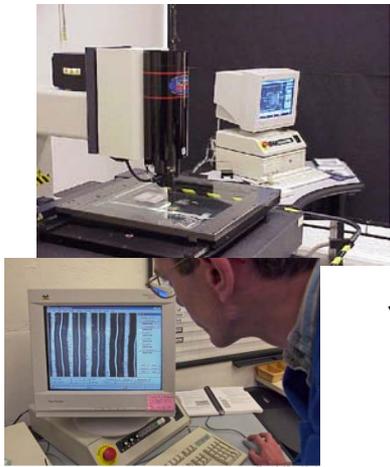
2nd example of a sound recording in history w/ 250 Hz tuning fork crosstalk



Do Re Mi Fa So La Ti# Do

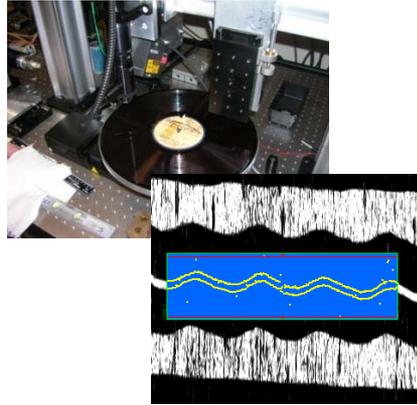
Optical Scanning: Technology Roadmap

Basic 2D concept demonstration
40 min / 1 sec

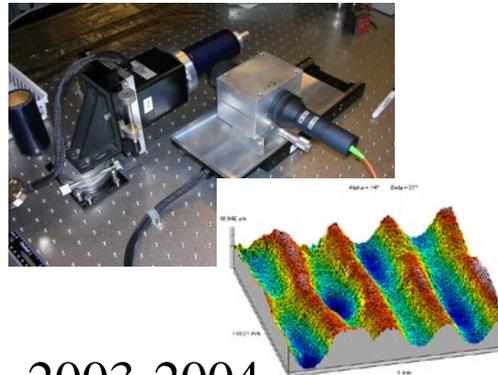


2002

2D disc R&D
4 sec / 1 sec



3D cylinder R&D
20 hr / 1 min



2003-2004

IRENE
System eval



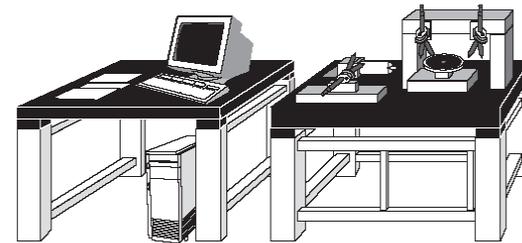
2006-2007

Production mode discs



2009-10

3D System
10 min / 1 min



2008-20....



Special studies



4-Oct-2010

Library of Congress TOPS
C.Haber

Web site: <http://irene.lbl.gov/>

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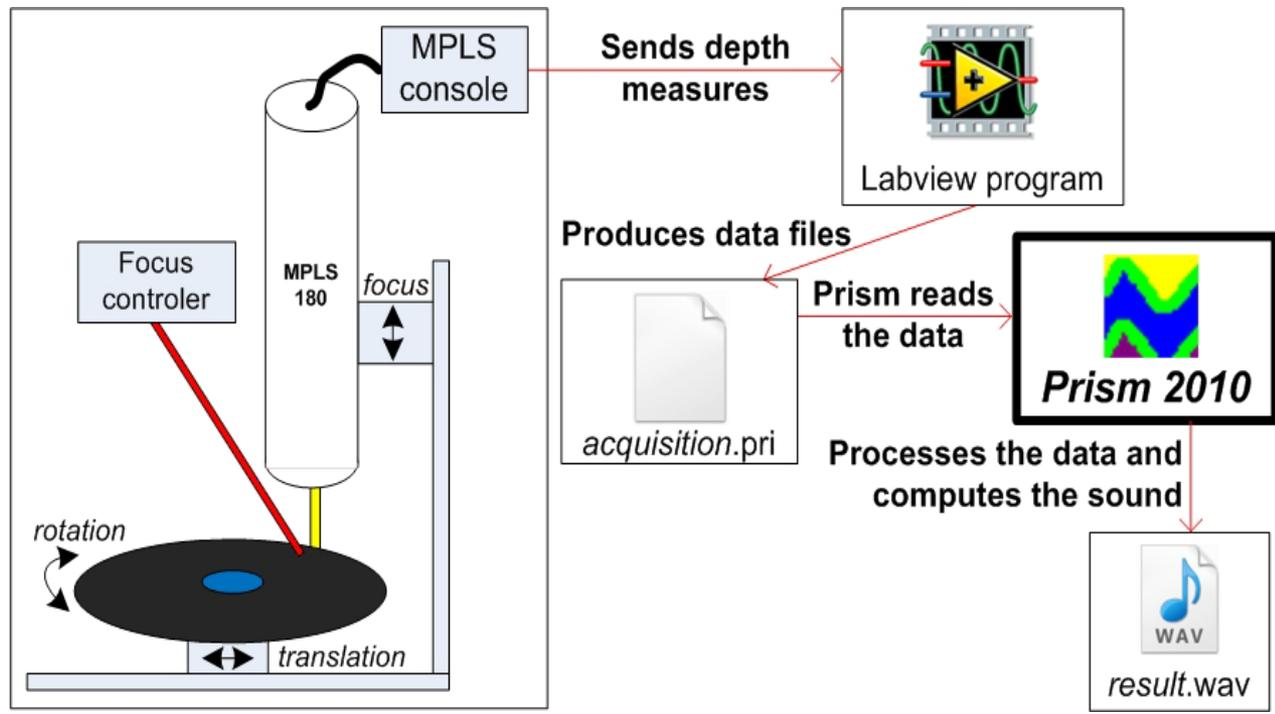
Extra Slides

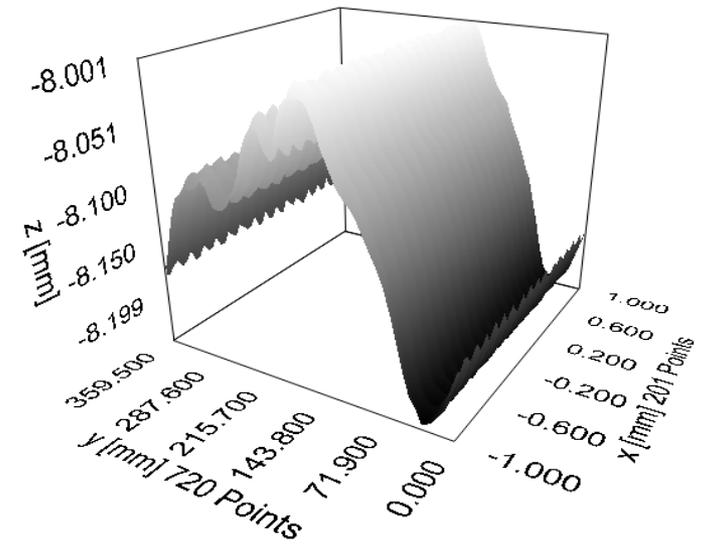
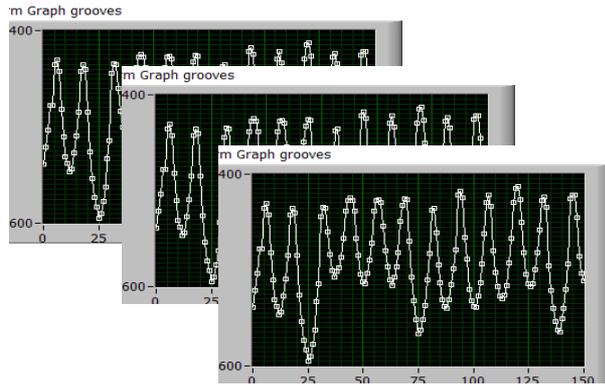
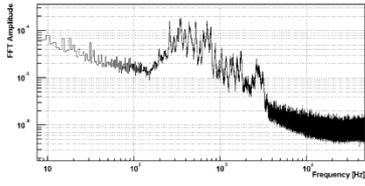


4-Oct-2010

Library of Congress TOPS
C.Haber

45





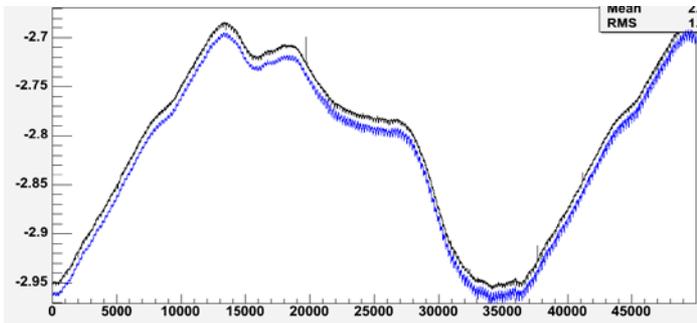
Sample at 96KHz to minimize effect of aliasing

Sequential axial scans

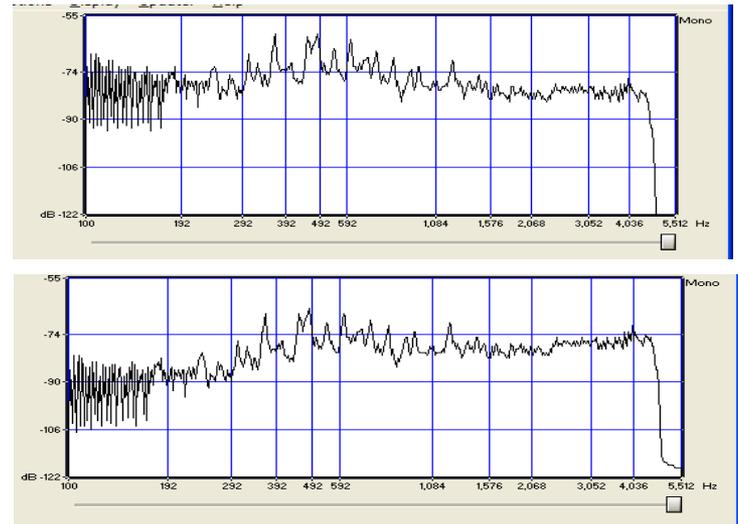
Subtract valleys from ridges to correct for overall shape

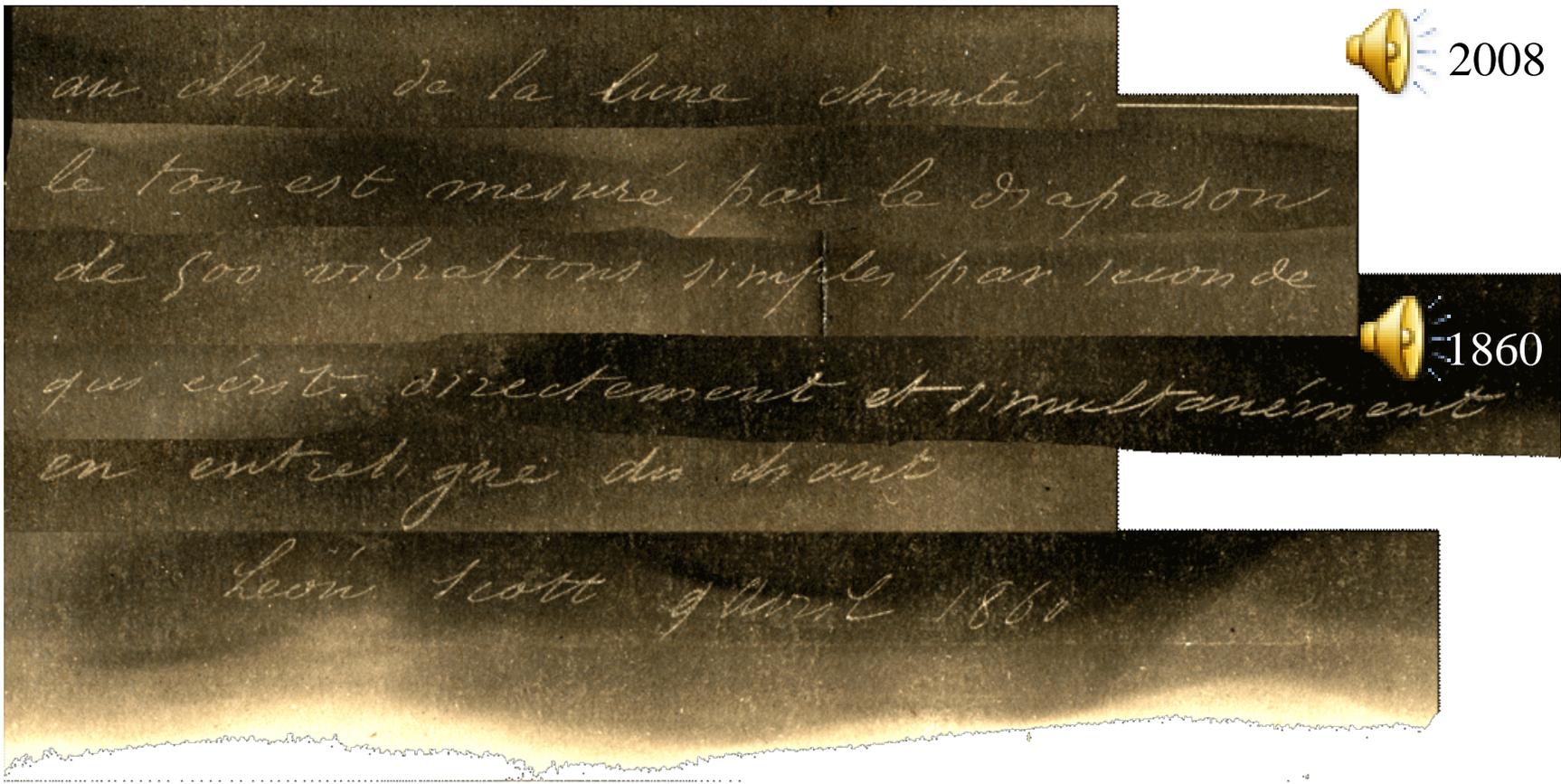
Overall cylinder shape due to off-center, deformation, heard as low freq rumble

(Ridges provide (approx), geometrical reference)



d/dt





"Au Clair de la Lune" ["By the Light of the Moon"] sung;
“...the pitch is measured by the tuning fork of 500 simple vibrations per second
which writes directly and simultaneously in interlinear space of the song”

Léon Scott 9 April 1860

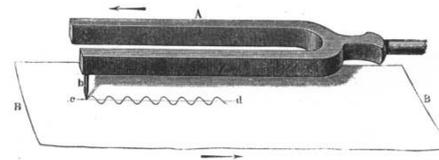
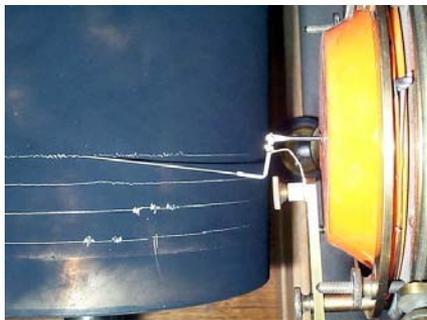
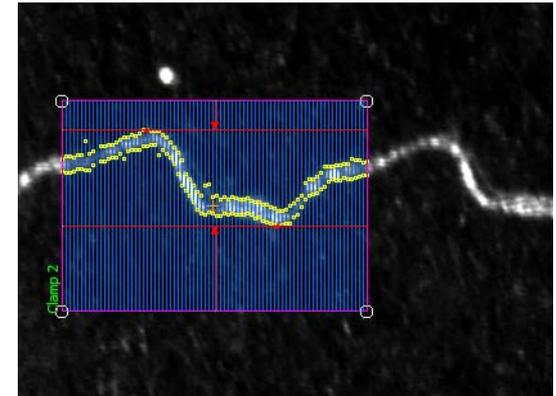
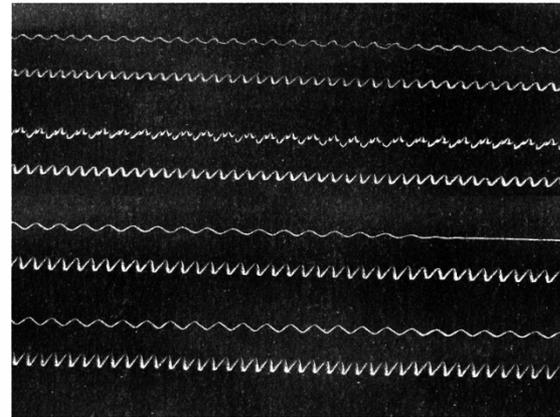
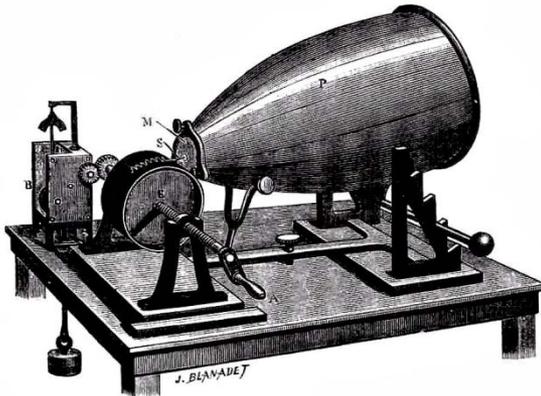
Early Recorded Sound



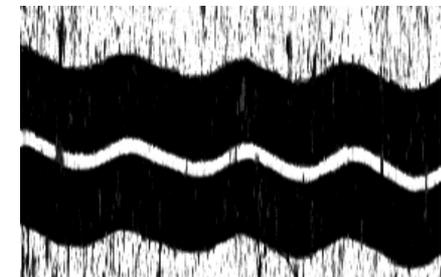
Phonautograph
Leon Scott
1853

Scott enscribed sound on paper and could not play it back

...visually similar to "IRENE" 2D scans, can processed and analyzed by the same tools...



Recorded April 9, 1860
Deposited in the French
Academy of Sciences

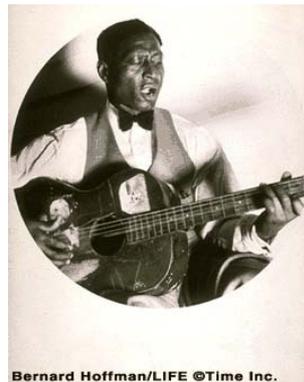
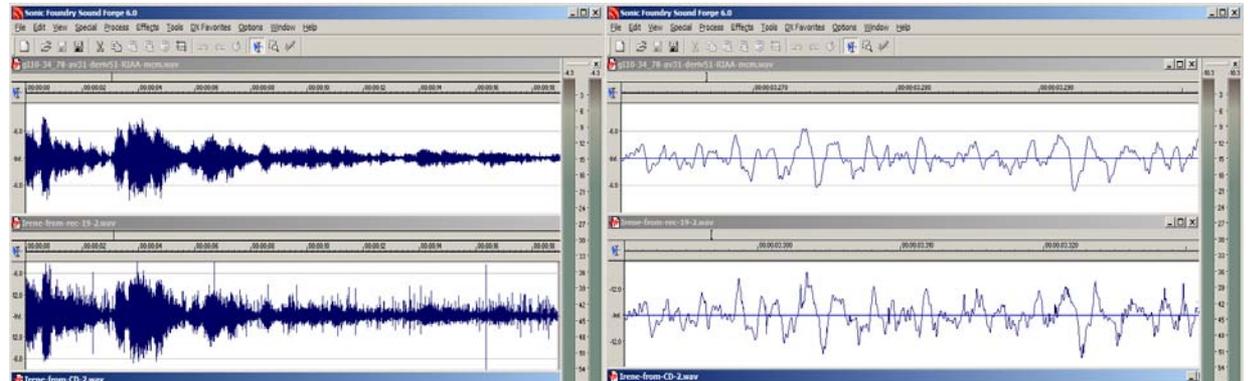


Early Sound Comparison 2002

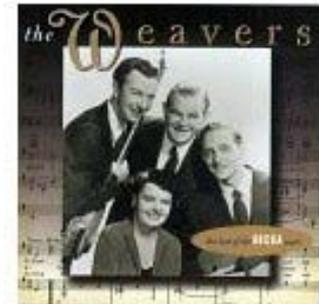
“Goodnight Irene” by H. Ledbetter (Leadbelly) and J.Lomax,
performed by The Weavers
with Gordon Jenkins and His Orchestra ~1950

 *optical* readout.

 *mechanical (stylus)*



Bernard Hoffman/LIFE ©Time Inc.



4-Oct-2010

Library of Congress TOPS
C.Haber

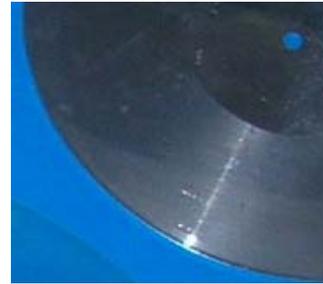
50



Sound Carrier Diversity and Condition



Wax cylinders
Fungus
Wax bloom



Al disc: oxidation



Acetate: flaking



exudation



Plastic belts
breakage

dirt

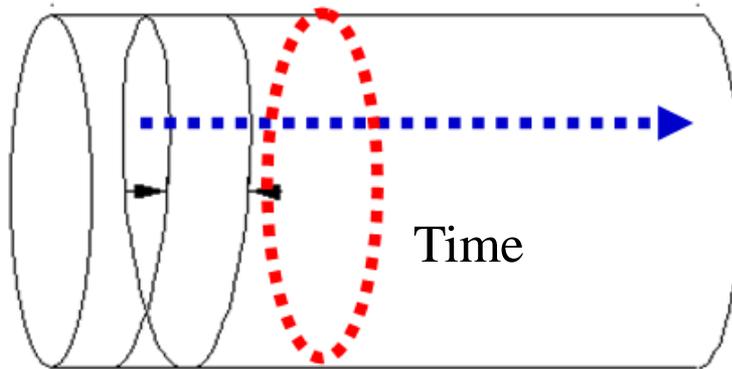


warpage

The Method

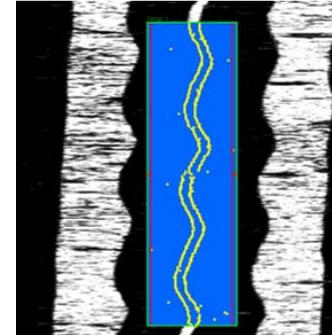
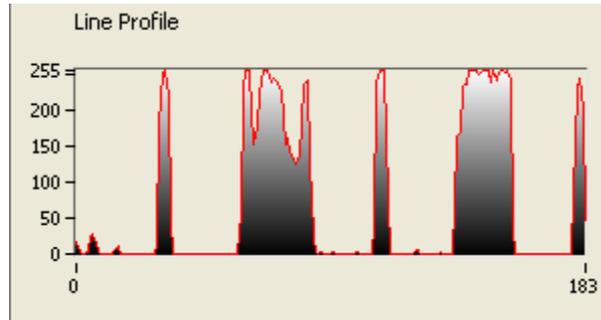
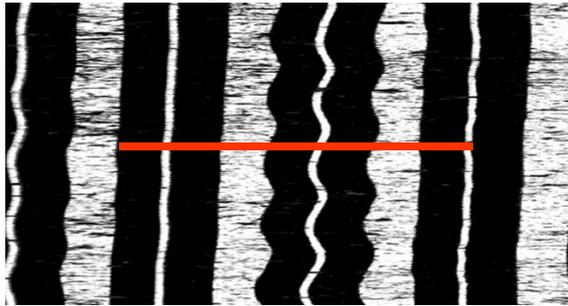
- Digitally **image** the surface
- Cover with sequential **views** or **grid**.
- Stitched together: **surface map**
- **Process image** to remove defects
- **Analyze shape** to **model** stylus motion.
- **Sample** at standard frequency
- **Convert** to digital sound format.
- Real time playback is **not required**
- Store results as **standard digital sound files** (.wav) and high resolution **digital images**

Speed and Data

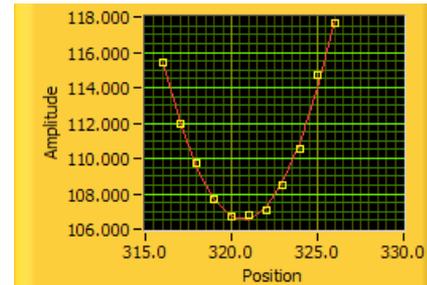
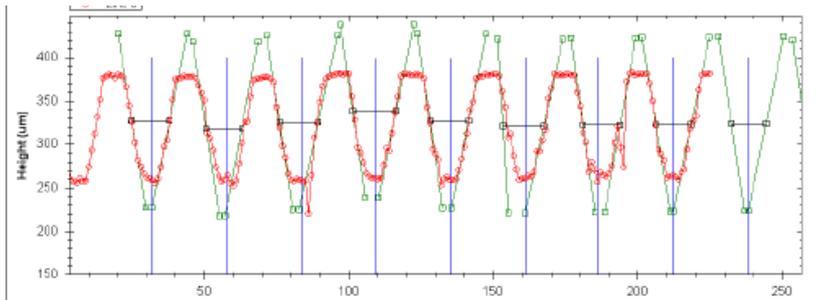


- Point by point measurement
- Exposure time per point
- Grid along time direction (red) = digital sampling
 - 0.02 degree = 18,000 samples = 48 KHz
- Grid along axis direction (blue) = points per profile
 - Typically 5 – 10 microns
- 1 probe: ~ 80 hours for 2-4 minutes of audio (2003)
- 180 probes: ~ 20 minutes (new multi-fiber probes 2008)

Image Analysis



Edge
detection

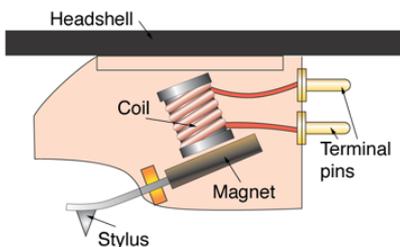


Surface
parameterized by
functions

- Feature extraction and measurement
 - Importance of characteristics and algorithms
 - Control of data quality: DOF, focus, intensity, bad points
- Measured characteristics of features provide a natural noise detection and removal tool

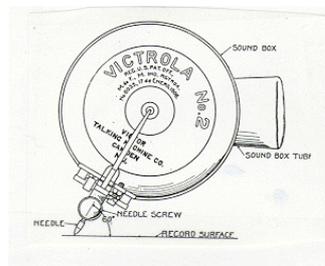
What is the relationship between “groove” and sound?

Electro-magnetic case

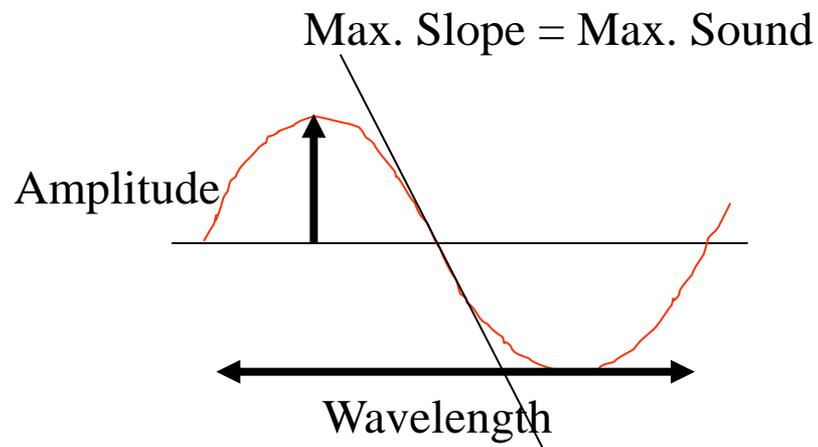


induction

Acoustic case



Diaphragm is over-damped to provide flat response



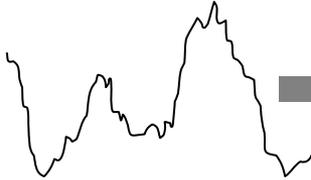
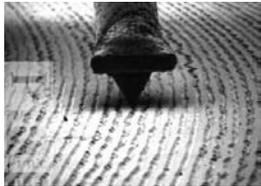
$$\text{Sound} = \text{Stylus Velocity}$$

$$A_p = \frac{v_p}{2\pi f}$$

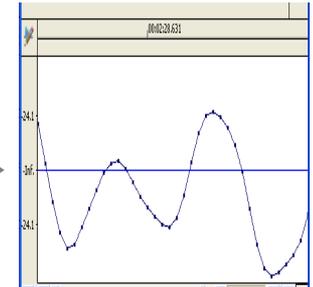
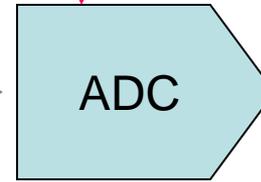
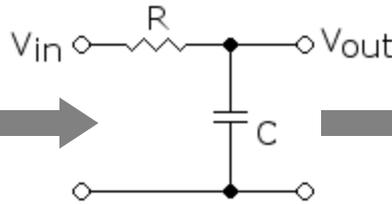
(“constant velocity condition”)

Digitization

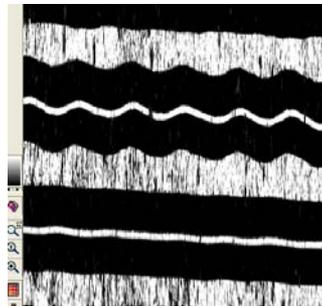
Analog waveform



Low-pass filter
 $f_0 < f_{\text{sample}}/2$



Commercial CD: 16 bits, 44.1 KHz
Archive spec: 24 bits, 96 KHz



Amplitude

Time



Pixel: 100-400 KHz

Comparison

- ✘ Data intensive
- ✘ Cost
- ✘ Scanning speed
- ✘ Is fidelity sufficient?
- ✘ Powerful restoration methods for audio already available
- ♪ Non-contact
- ♪ Robust – wax, metal, shellac, acetates...
- ♪ Effects of damage and debris reduced by image processing and geometry
- ♪ Re-assemble broken media
- ♪ Resolve noise in the “spatial domain” where it originates.
- ♪ Effects of skips are reduced or eliminated.
- ♪ Distortions (wow, tracking errors, etc) absent or geometrical corrections.
- ♪ Operator intervention during transcription is reduced, mass digitization.
- ♪ Produce standard audio output data format (.wav)
- ♪ Can archive images for future re-analysis with new algorithms.

2D Scanner: Goals and Features

- Understand limits and capabilities of this approach
 - Noise, Frequency response, Linearity, Sampling
- 2D imaging of groove bottom and/or top.
- Emphasize throughput: scan 3 min record in 10-15 minutes
- Encompass as much variation in media as possible.
- Handle broken discs.
- User friendly interface.
- Commercial off-the-shelf components.
- Provide a test bed for the mass digitization application.
- Provide detailed statistical information about media condition.
- Do no harm.
- Include a detailed evaluation phase at the Library of Congress

Milestones

- 2002: first demonstration of 2D method
- 2003: First 3D scans with single point probe
- 2004: Begin the development of a fast 2D scanner IRENE
3D scans of dictabelts demonstrated
- 2006: IRENE installed at the Library of Congress for testing
- 2007: 3D scans of unique Jack London dictation recordings
First 3D studies of Native American field recordings
- 2008: First high speed 3D probe acquired
Restoration of Scott phonograph, earliest sound recording using IRENE codes
Begin to convert IRENE control system to express GUI and tools
- 2009: V2 3D probe acquired, enables efficient disc scanning for the first time
Scan of Bishop Museum Kalakaua cylinder – nothing audible found
IRENE moved to Packard Campus
- 2010: 3D installed at Library of Congress
Systematic 3D study of F.Boas field recordings
3D demonstrated on Galvanos
3D disc measurement advances

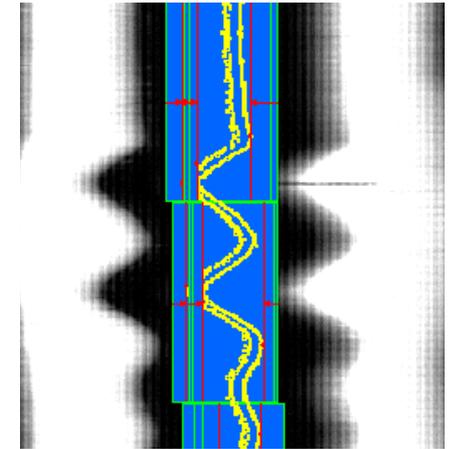
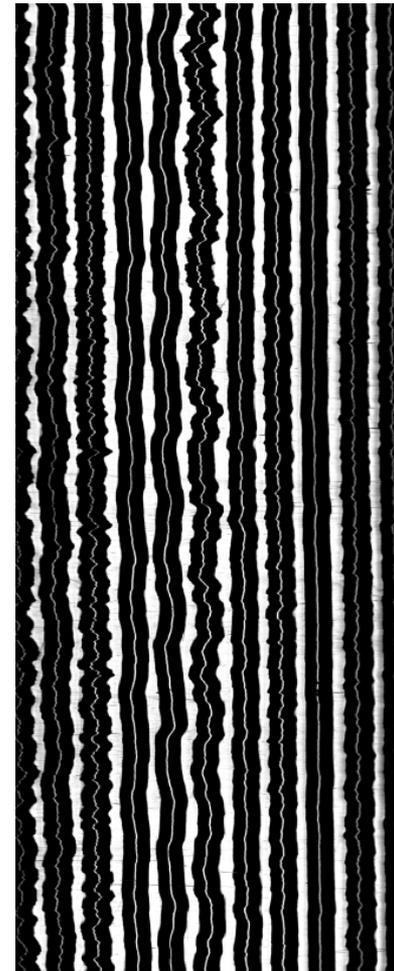
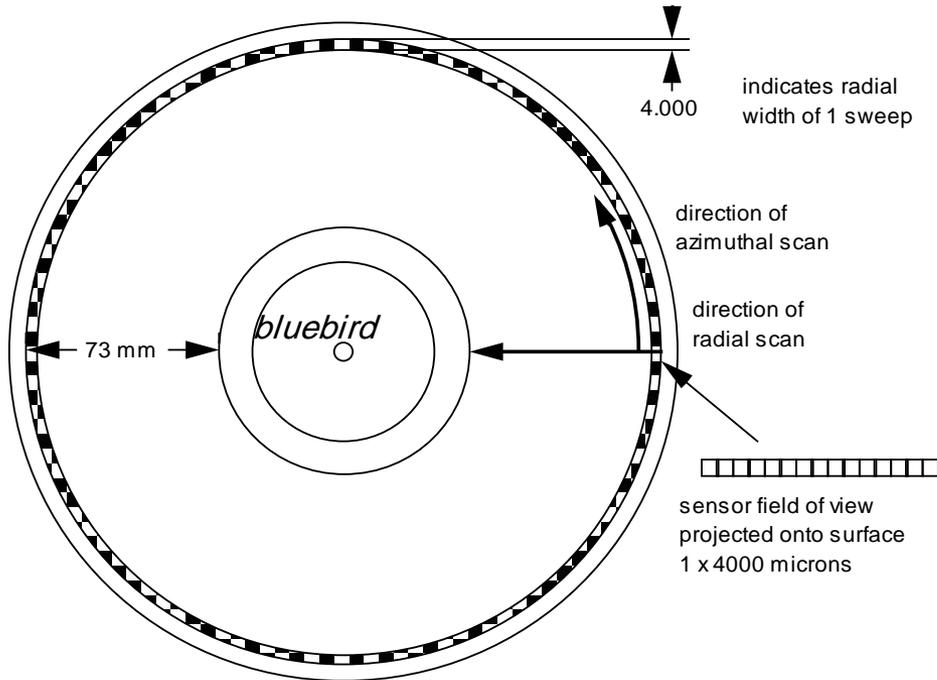


Present Research Program

- IMLS is supporting this with a grant which covers 2010-2012
 “Advancing Optical Scanning of Mechanical Sound Carriers:
 Connecting to Collections and Collaboration”
- Migration of technology into use at multiple collection sites
 - Test, and operation of IRENE at the LC Packard Campus
 - A “portable” IRENE for U Chicago South Asia Library in Chennai, India
- Special Studies:
 - Wax field recordings (Berkeley, UI-ATM, Burke Museum UW)
 - Damaged, broken, unplayable, or rare recordings (ENHS, EIF, NARA, MSHC)
 - Early experimental recordings (SI NMAH)
 - Cylinder molds and disc stampers (Berlin Phonogramm Archiv)



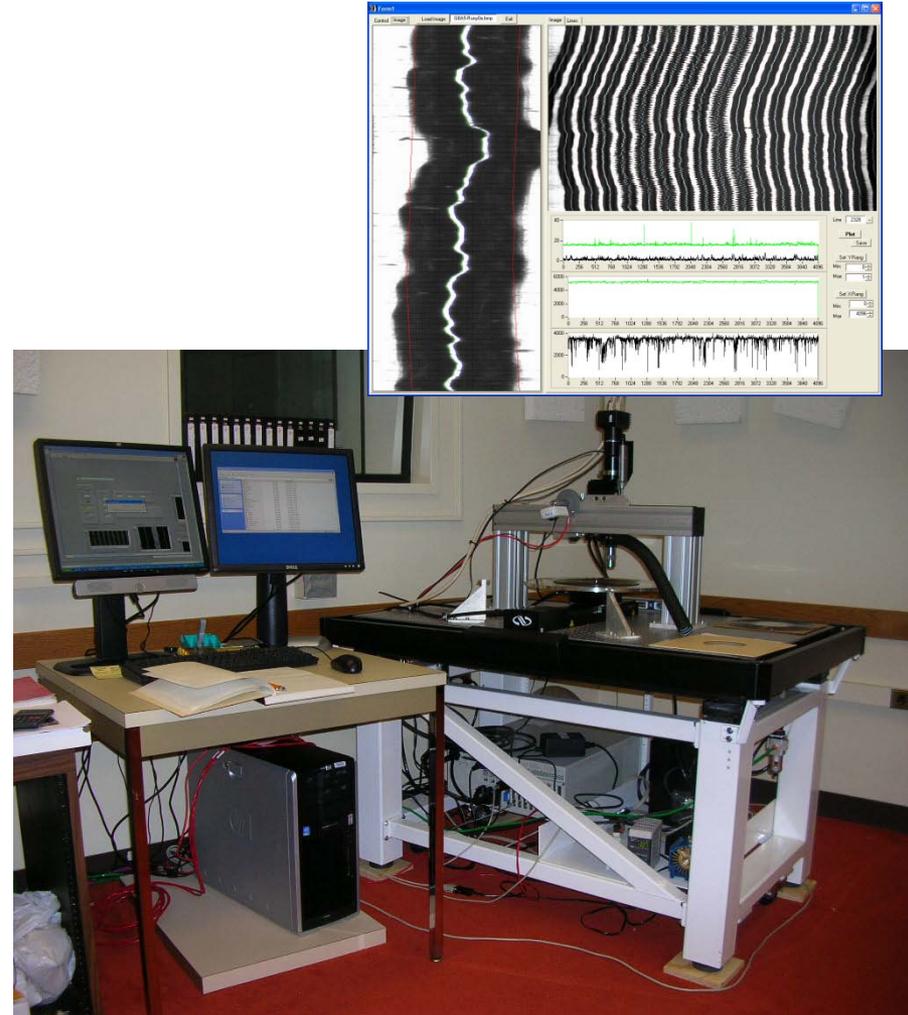
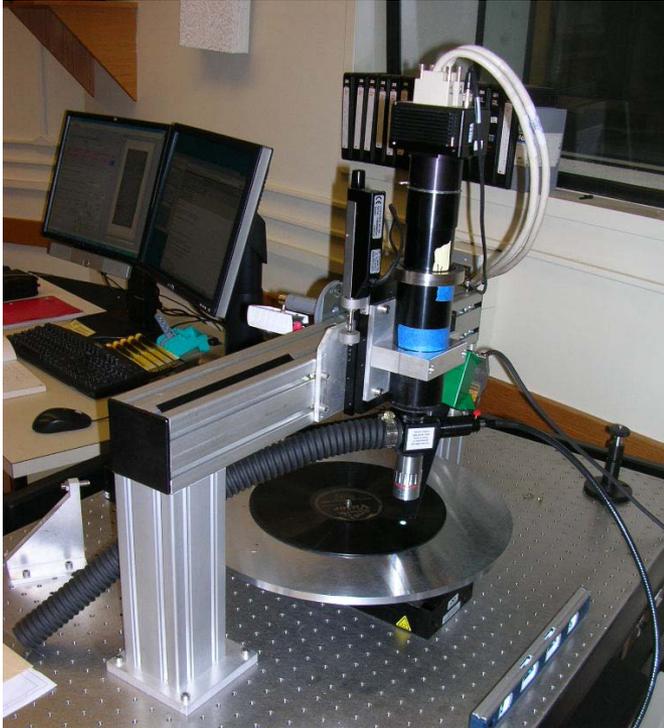
Line Scanning: disc is in motion



- 4000 pixels @ $\sim 5 \times 10^3$ lines/s
- Requires bright illumination
- 7.6×10^5 lines/outer ring
 - **390 KHz max sampling**
- Scans @ a few x real time
- Scan time decreases linearly with sampling!!!

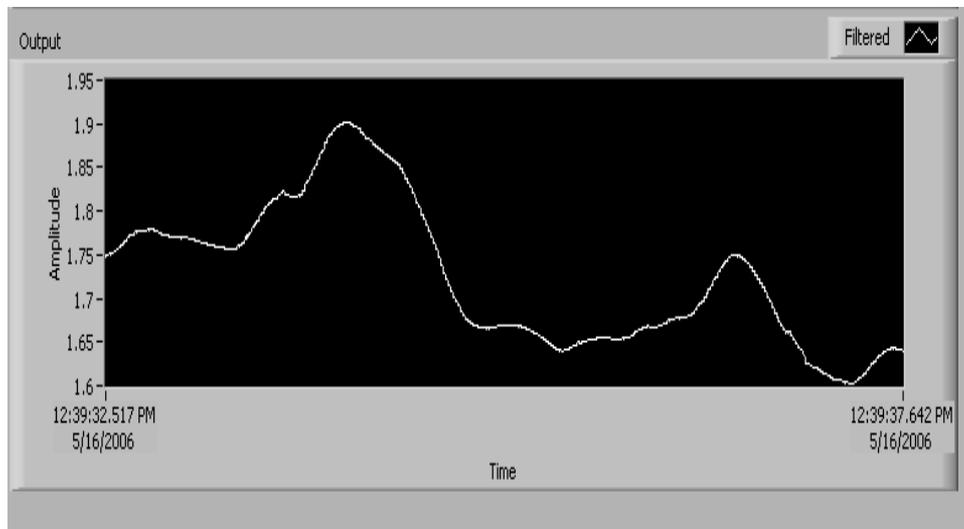
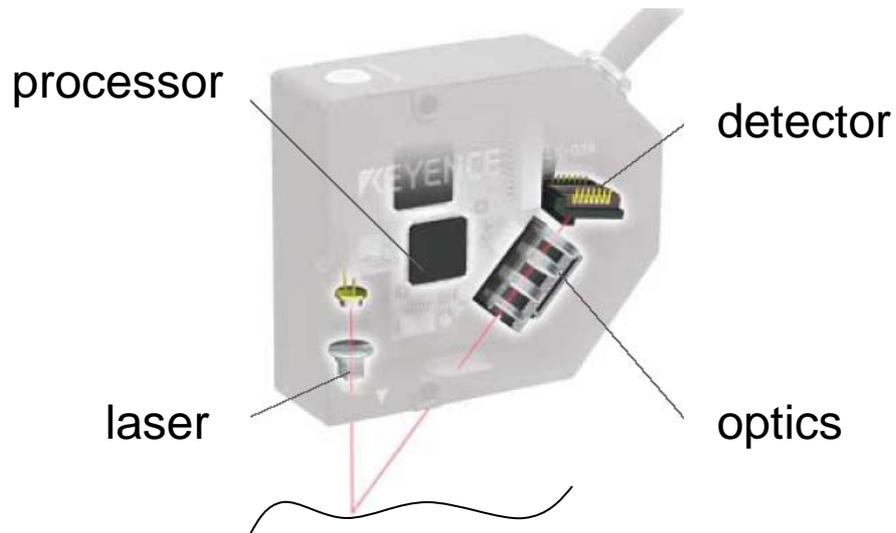
I.R.E.N.E.

Image, Reconstruct, Erase Noise, Etc

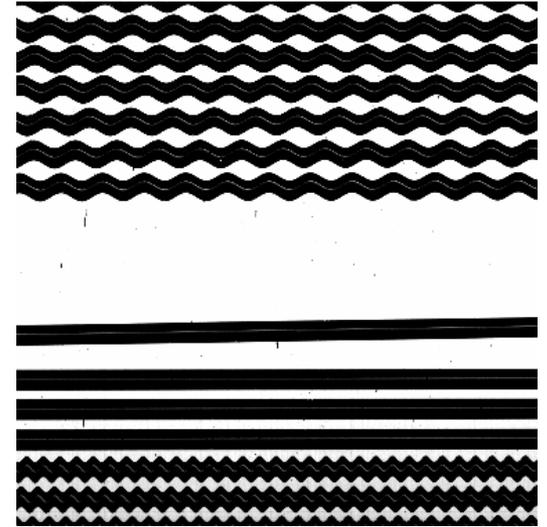
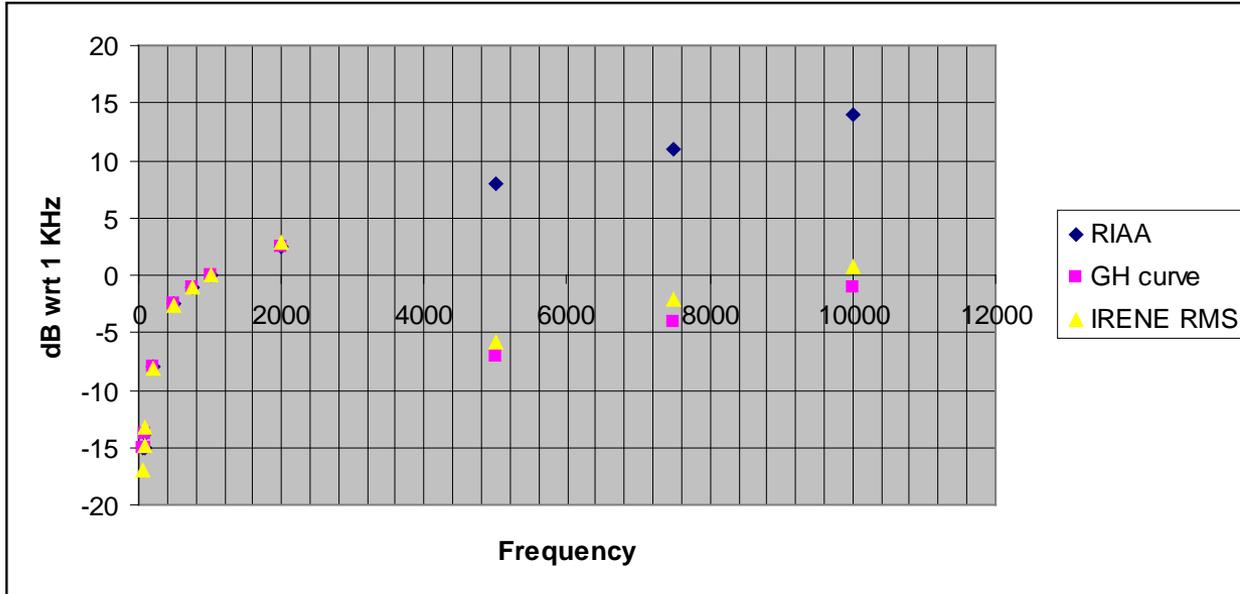


Key Technical Issues

- Fast camera
- Illumination
 - Intensity, Stability, Heat
- Wide field of view optics
- Active focusing system
- Vibration Control
- Motion Control
- Image capture and processing: parameters
- Performance
 - Robustness, Frequency response, Noise, Speed



Test Discs

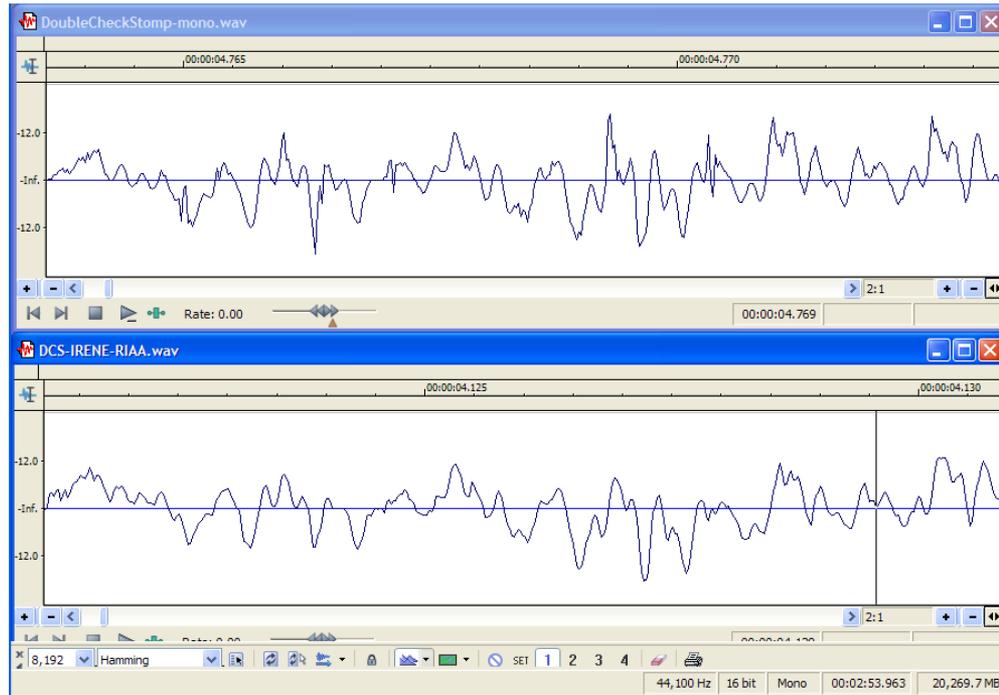


Pristine new acetate disc scanned by IRENE

Double Check Stomp

Duke Ellington, 1930

Comparison: Shellac disc in good condition, disc cleaned before stylus transfer, IRENE transfer before cleaning



Stylus, optimized, cleaned

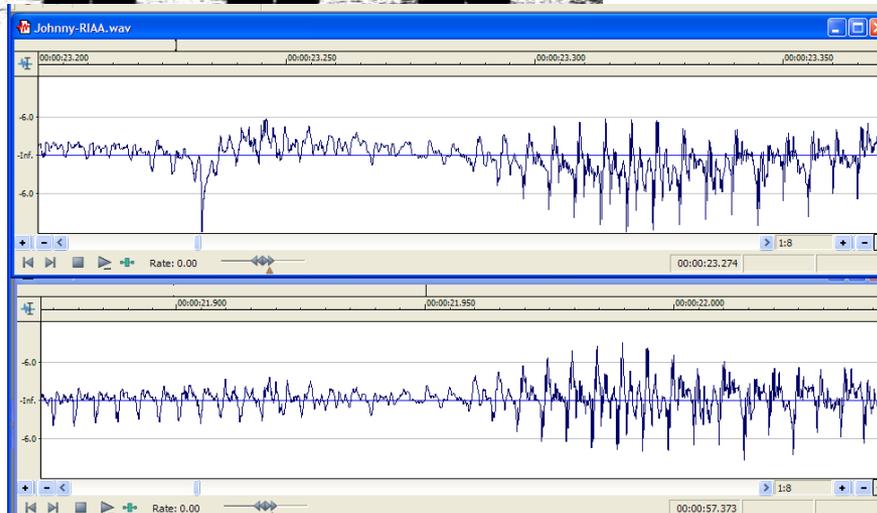


IRENE
Not cleaned



“Johnny”: Les Paul and Mary Ford

1953 recording, shellac 78 rpm disc is worn and scratched, distorted



Stylus version
has a clear skip
due to scratch



IRENE

Lacquer Transcription Discs

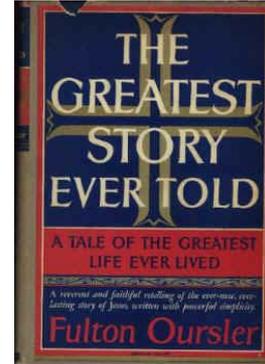
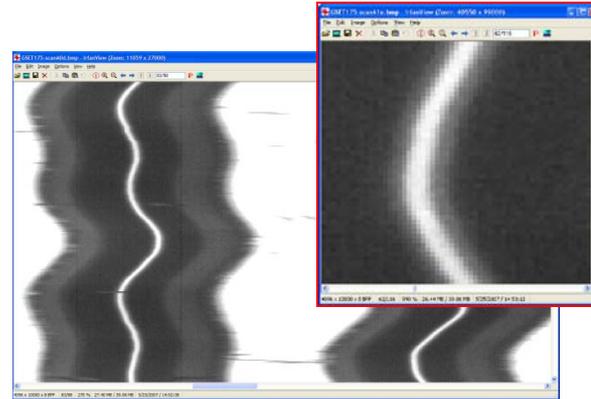
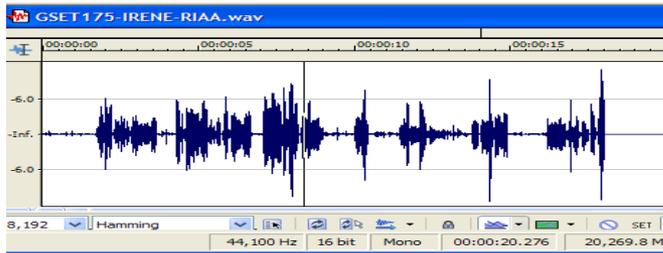


Stylus

33 1/3 rpm, 16 inch radio transcription discs ~1950



IRENE

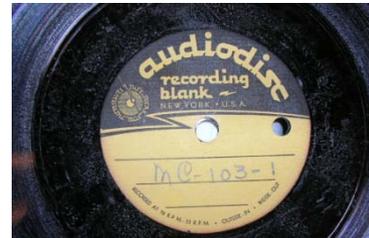


Stylus

1947 Studio “take”
Mutt Carey and his NY’rs
Shim-Me-Sha-Wabble



IRENE



Sound effects

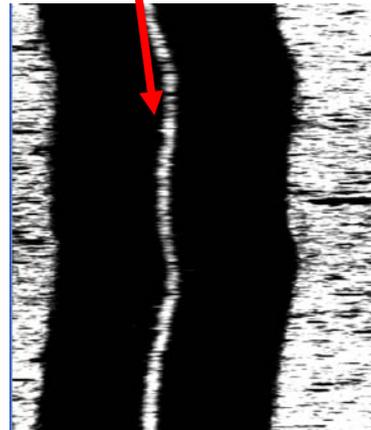
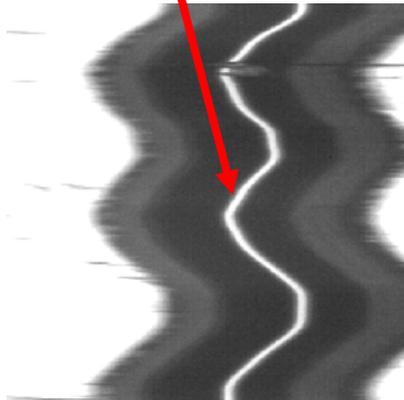
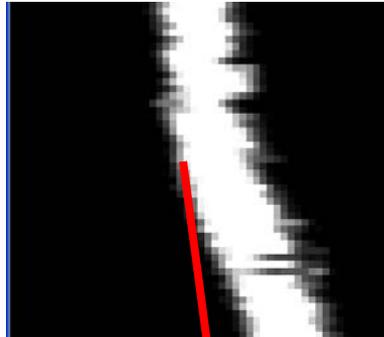
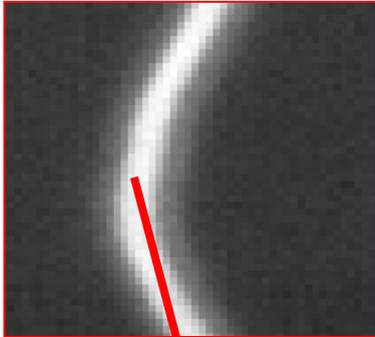


Media Characteristics

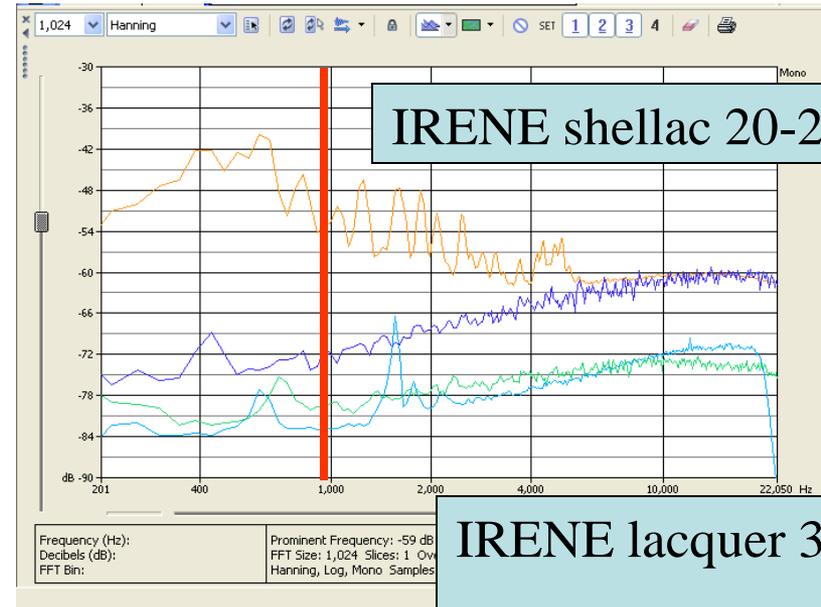
lacquer

shellac

Signal and noise @ 1 KHz



IRENE audio



IRENE shellac 20-25 dB

IRENE lacquer 34 dB

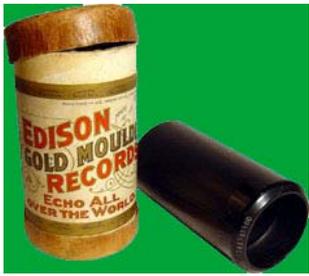
Stylus shellac 30 dB

IRENE: Outlook

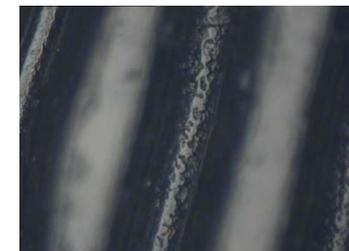
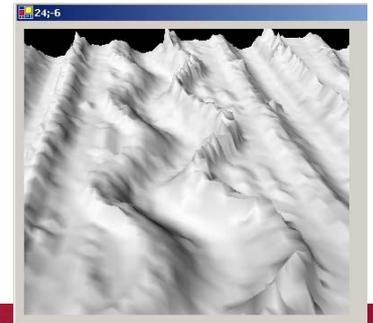
- Considerable insight into 2D optical scanning on a wide range of materials
- Particular performance on damaged media
- Good frequency response
- Broad band noise on shellac greater than lacquer, and stylus version, due to imaging response of the media
- 3D scanning will lead to greater redundancy and lower noise levels may be expected
- Moved system to Library of Congress NAVCC site in October 2009
- IMLS: plan to deploy a “portable” version remotely as part of the 2010-12 effort



3D Media



- Wax field cylinders
 - Damaged, Mold
- Commercial cylinders
- Diamond Discs
- Tin Foil
- Dictation belts
- Discs which image poorly in 2D
- Experimental recordings

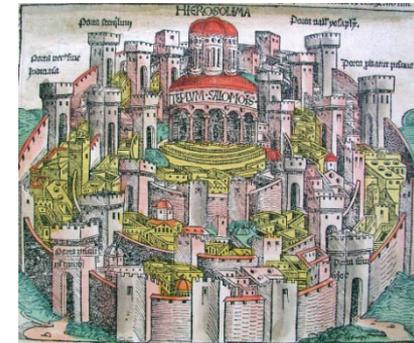
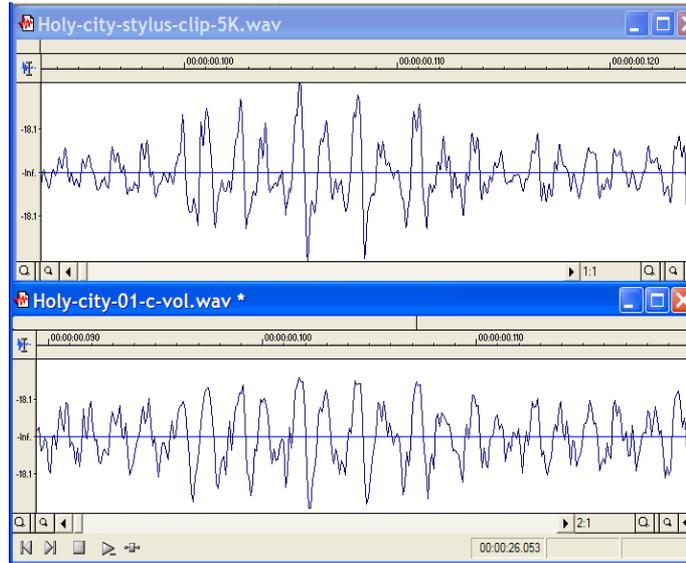


Sound Comparison

- The Holy City, composed by Stephen Adams,
The Edison and Skedden Mixed Quartet, Amberol 1601
Commercial cellulose release



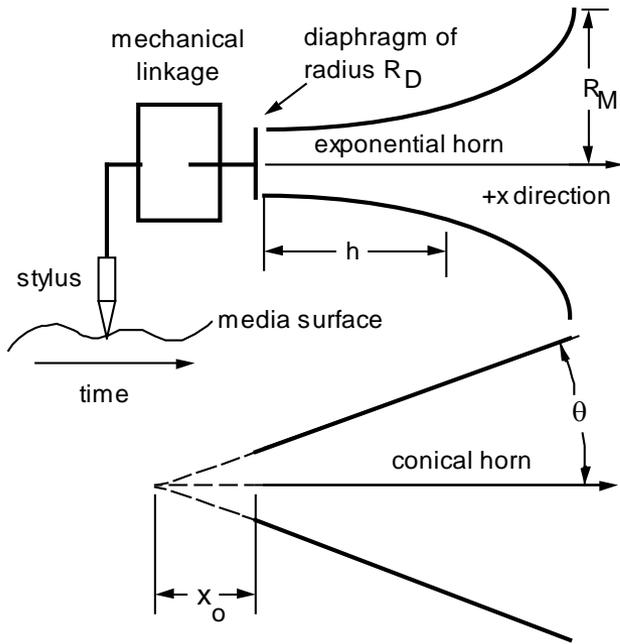
- 🔊 • Stylus
- 🔊 • Optical
- 🔊 • Optical + filter + EQ



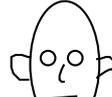
Library of Congress TOPS
C.Haber



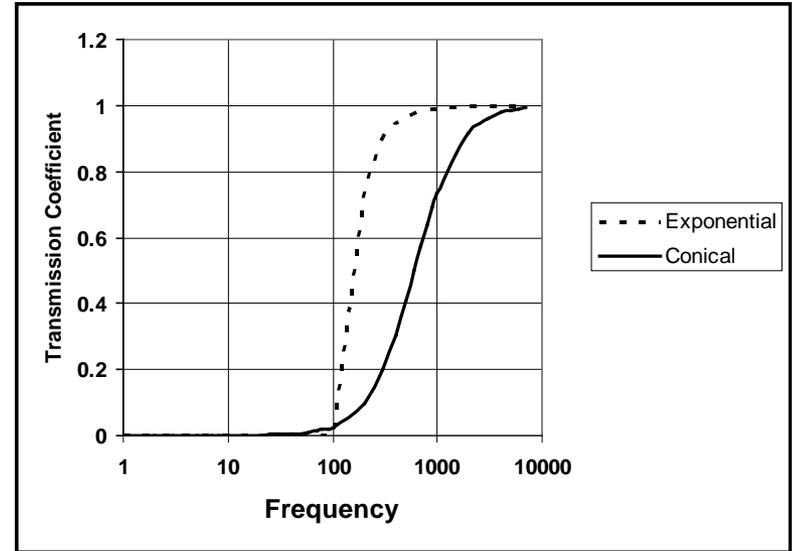
Optical + EQ + filter



listener



source



Response of horn and diaphragm at low frequency can modify response and deviations from “constant velocity” characteristic.



U.S. DEPARTMENT OF THE INTERIOR, NATIONAL PARK SERVICE, EDISON NATIONAL HISTORIC SITE

Special Studies

- Boas pilot program
- Copper Galvanos
- Berliner discs
- Vertically cut discs
- AG Bell materials
- Broken cylinders
- Dictation Belts

Rare Lacquer Transcription Discs

Typically these are one-of-a-kind and considered delicate. Archivists may prefer a non-invasive approach to playback and/or evaluation.



78 rpm acetate
Theos Bernard, interview,
1929



78 rpm nitrate on glass
Label: Howard Hughes,
Collier Award 1939



Personal messages....vending machines



Hearst Collection Pilot Study

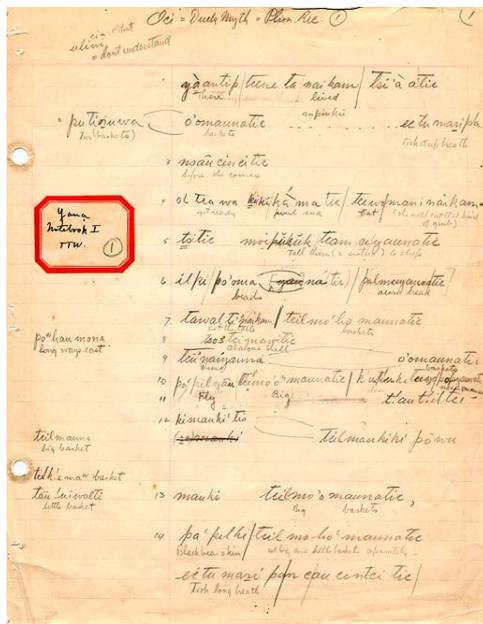
- Wax cylinders from fieldwork collections are a good example of 3D media
 - Collaborate with UC Berkeley, Phoebe Hearst Museum and Dept. of Linguistics: California Indian recordings
- Scan a range of samples to:
 - Bracket the performance of the process
 - Assess the realistic throughput for a larger project
- Practicalities
 - Software and hardware development to enable efficient data taking and analysis.
- 2007-8: 12 cylinder sample, 2010-11: 100 cylinders

Ishi Recordings: The Story of Wood Duck



Sam Batwai, Alfred L. Kroeber, and Ishi

Duck



This narrative is ~2.5 hours long and is contained upon 51 wax cylinders



Recorded and translated by Prof. T.T. Waterman

Clip from 3D pilot study



4-Oct-2010

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