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Keep Our Sounds Alive: Principles and Practical Aspects of Sustainable Audio Preservation

(including a glance on video)

Part 2

Signal Extraction from Original Carriers

Based on IASA-TC 04

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Workshop at Inforum 2016

Prague 23 May

Generally accepted principle for audio preservation since 1990, upcoming for video:

- all audiovisual carriers are prone to decay
- all audiovisual systems are threatened by obsolescence
- long term preservation can only be achieved in the digital domain by subsequent migration
- analogue and digital contents must be extracted from originals, analogue converted to digital, and both to file formats
- transfer is time consuming and expensive, and unlikely to be done again

consequently:

- original signals must be extracted and transferred in the best possible quality

Extraction/transfer parameters

- selection of carrier
- cleaning, carrier restoration
- replay equipment
- speed
- replay equalisation
- correction for errors caused by misaligned recording equipment
- removal of storage related signal artefacts
- time factor

Audio

- **Historical mechanical formats**
- **Standard coarse groove discs**
- **Microgroove discs**
- **Magnetic tapes**
- **Digital magnetic carriers**
- **Optical carriers**

Summarising comments on video

Historic mechanical and other obsolete formats

- cylinders
- **coarse groove replicated discs**
- all instantaneous discs
- selenophon
- magnetic wire

Except for standard coarse groove replicated discs seek expert's advise - contact IASA Technical Committee: http://www.iasa-web.org/

Consult: Guidelines on the Production and Preservation of Digital Audio Objects (IASA-TC 04), 2nd Edition 2009

Coarse groove replicated discs (“shellacs”, 78 rpms, pre 1900 - ~mid1950s)

Acoustically recorded: contact experts
Electrically recorded (=standard): from ~1925

Electrically recorded (standard) coarse groove discs

Selection: find best copy – also outside own collection

Cleaning: ultrasonic vs. “Keith Monks“ et al.
cleaning agents: distilled water plus wettning agent – **NO** alcohol

Restoration: no chemical, many mechanical problems

Replay equipment: professional /Hi-Fi equipment
market stable

Pick-up systems: magnetic (stylus selection crucial), laser (upcoming), imaging (experimental)

Speed: correct in the analogue domain

Equalisation: recording frequency response is not flat on discs – many different equalisations needed
Consult IASA-TC 04

Correction for objective errors, and
Removal of storage related signal artefacts: do not apply

Time factor: 3-5x and more, depending on record condition and need for cleaning

Microgroove discs (LPs, vinyls)

Selection: find best copy – also outside own collection

Cleaning: ultrasonic vs. “Keith Monks“ et al.
cleaning agents: distilled water plus wetting agent, isopropyl alcohol

Restoration: few chemical, (possible interaction with plastic bags): many mechanical problems

Replay equipment: professional /Hi-Fi equipment, market stable

Pick-up systems: magnetic, dynamic, laser (exotic)

Speed: correct in the analogue domain

Equalisation: RIAA – check pre-amplifier for accuracy
NB: pre1960 LPs may need different equalisation – consult IASA TC-04

Correction for objective errors, and
Removal of storage related signal artefacts: do not apply

Time factor: 2-3x and more, depending on record condition and need for cleaning

Magnetic tape

Selection

- applies to replicated cassettes and tapes (rare) only

Cleaning

- removal of dirt: dry, water, solvents
- removal of dry and bleeding splices
- replacement of leader tapes

Carrier restoration

- partly successful: curing tapes suffering from pigment binder breakdown
- available soon: re-conditioning of brittle acetate tapes

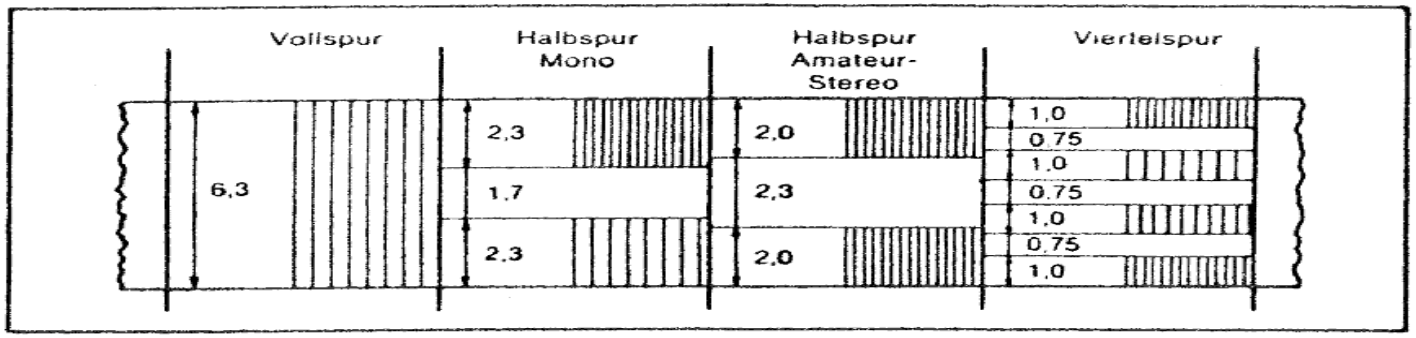
Do NOT lubricate tapes without special advice

Replay equipment

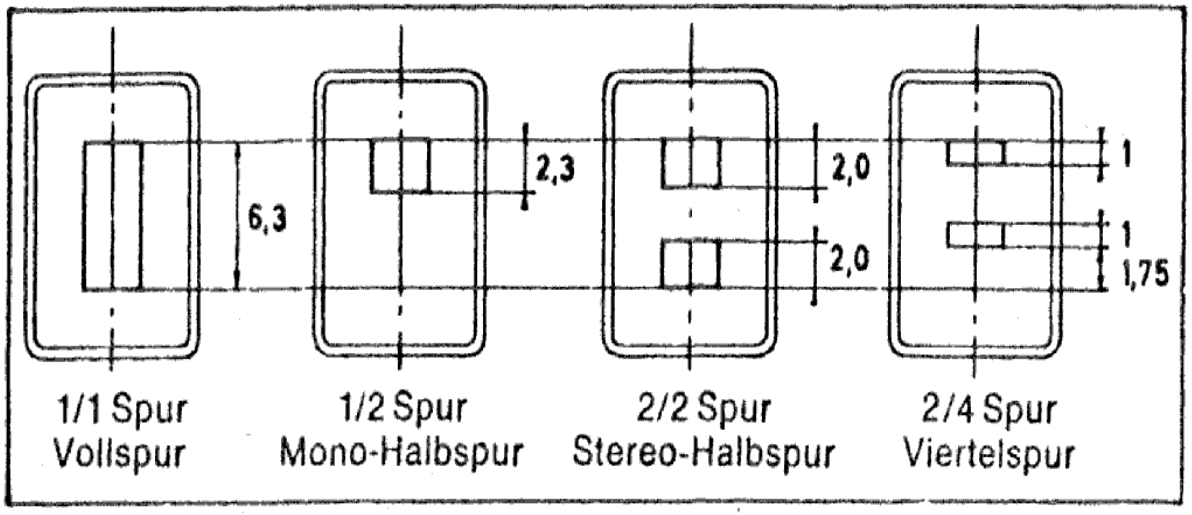
- recording and replay distortions do not compensate, but multiply each other
- choose equipment of latest generation to minimise replay distortions
- equipment must fully comply with format specific parameters: speed
  track width
  equalisation (EQ)
  noise reduction system (NR)

Problem of ever increasing dimension:
Availability of high quality equipment and spare parts

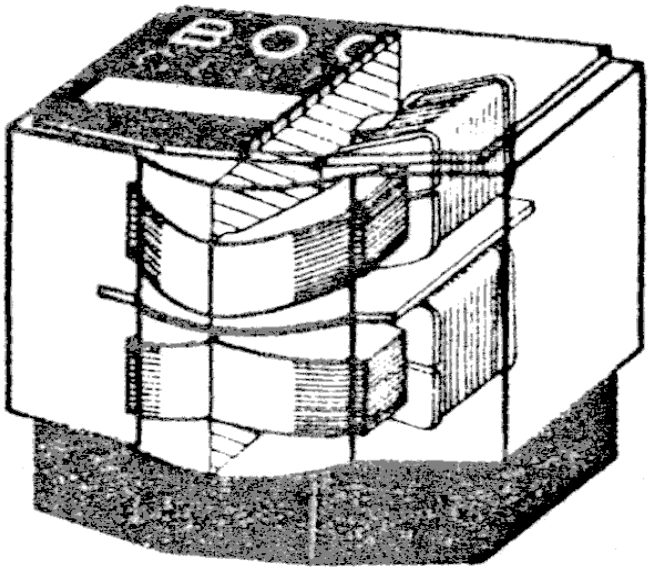
Various quarter inch tape track formats:

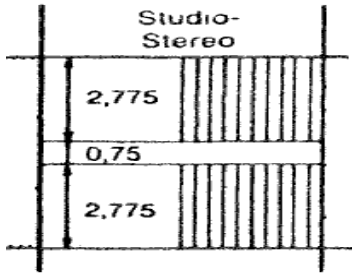


full mono half stereo 2mm quarter



Butterfly head – professional stereo 2 x 2.775mm



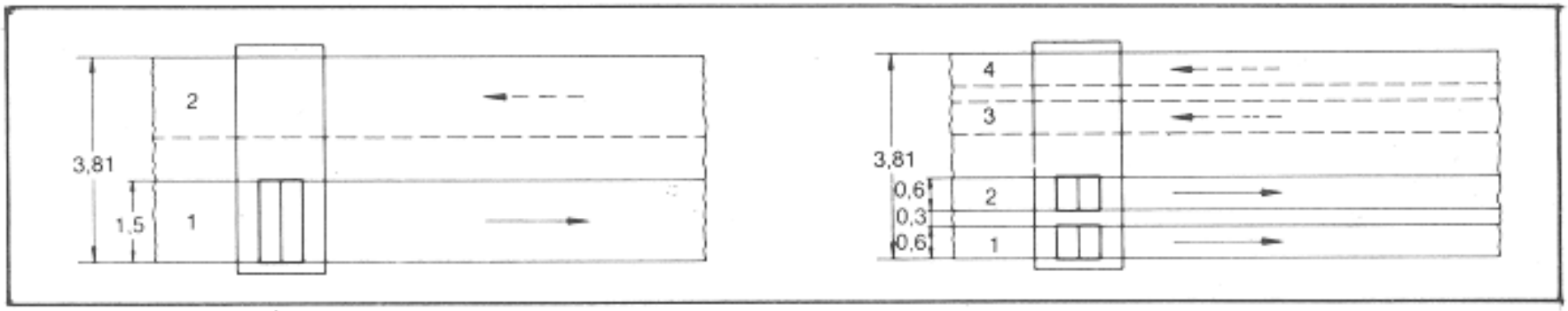


Recording and replay heads must have the same track width. Any differences cause losses in signal-to-noise ratio, if not an inseparable mix of unrelated signals

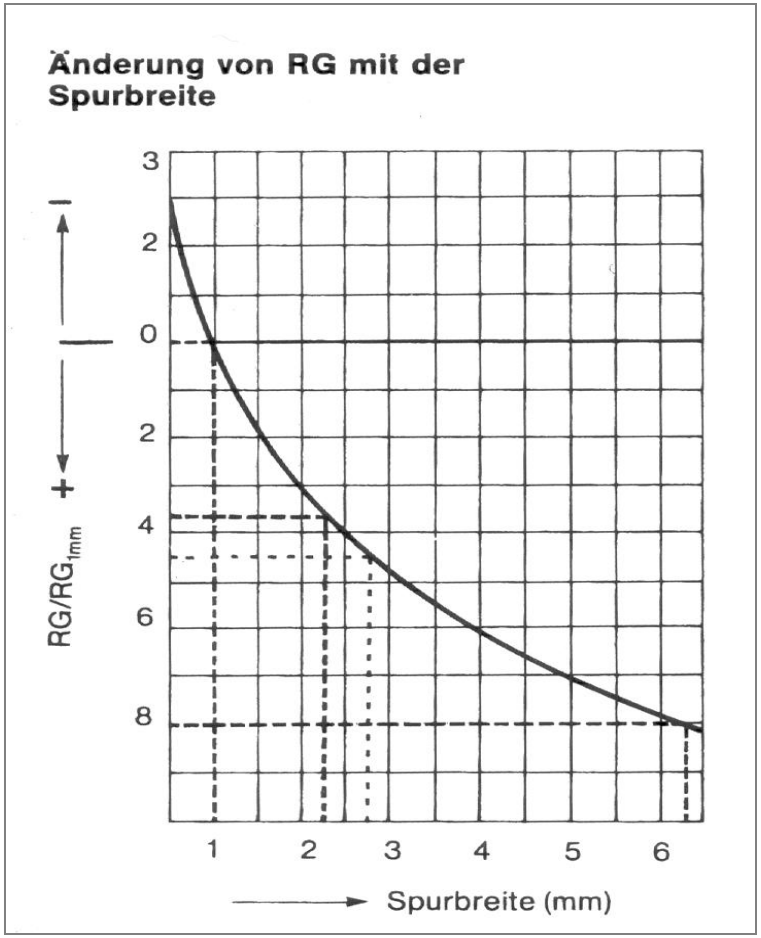
Compact cassette formats

mono

stereo



S/N vs track width

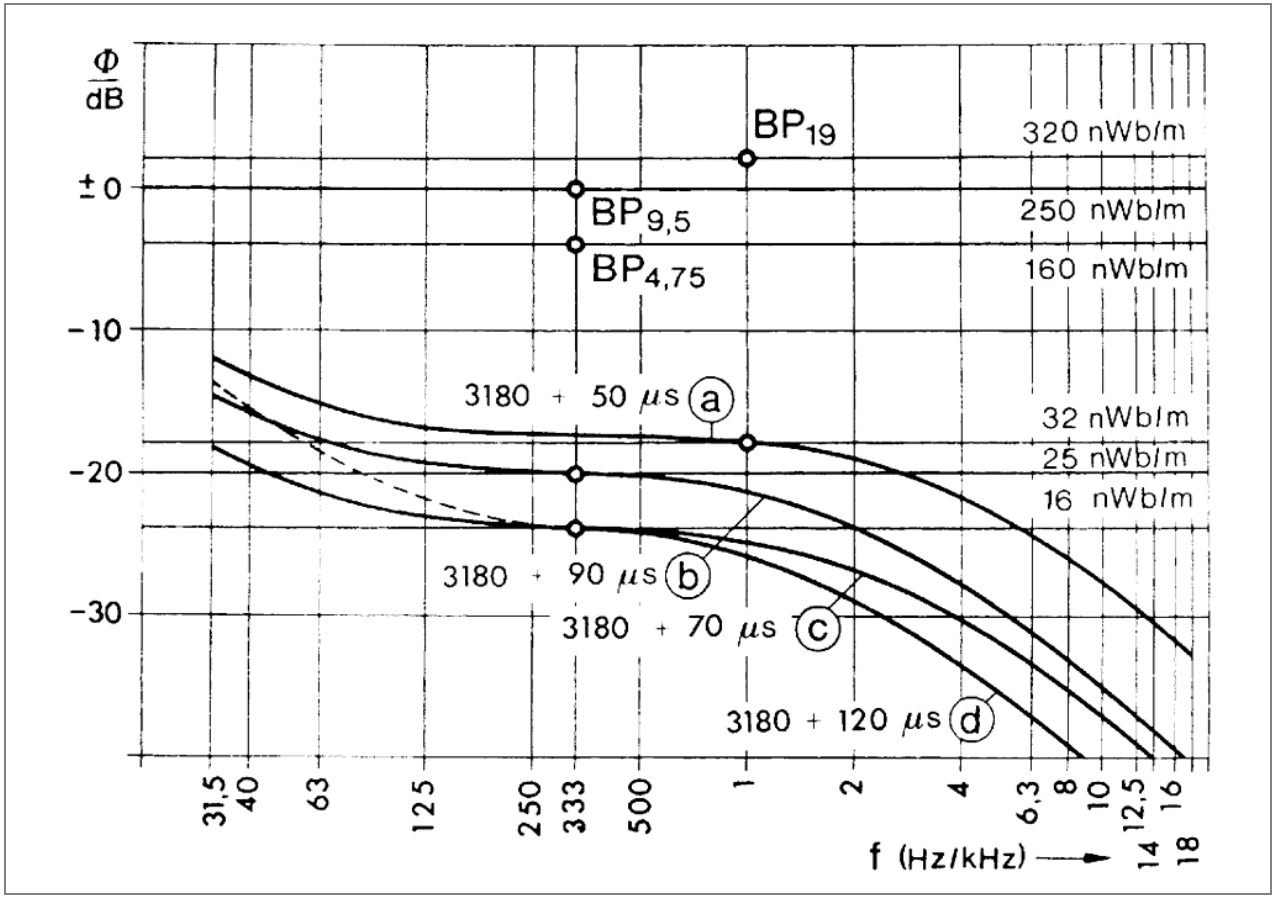


Equalisation

Recording frequency response is not “flat” on tapes
- different norms CCIR (IEC) vs NAB
- different for speeds
- historical EQs

Replay frequency response must compensate recording curve
Correct equalisation difficult to assess if unknown

Equalisation curves for various consumer tape formats



Tape equalisations including historical EQs 1

Tape Speed	Standards Organisation	Year of Publication	Time Constants	
30 ips, 76 cm/s	**IEC2 AES**	**(1981) current standard**	∞	**17.5 µs**
30 ips, 76 cm/s	CCIR IEC1 DIN	(1953-1966) (1968) (1962)	∞	35 µs
15 ips. 38 cm/s	**IEC1** CCIR DIN BS	**(1968) current standard** (1953) (1962)	∞	**35 µs**
15 ips. 38 cm/s	**NAB** EIA	**(1953) current standard** 1963	**3180 µs**	**50 µs**

Tape equalisations including historical EQs 2

7 1/2 ips, 19 cm/s	**IEC1** DIN(studio) CCIR	**(1968) current standard** 1965 1966	∞	**70 µs**
7 1/2 ips, 19 cm/s	**IEC 2** **NAB** DIN(home) EIA RIAA	**(1965) current standard** (1966) (1963) (1968)	**3180 µs**	**50 µs**
7 1/2 ips, 19 cm/s	Ampex (home) EIA (proposed)	(1967)	∞	50 µs
7 1/2 ips, 19 cm/s	CCIR IEC DIN BS	(up to 1966) (up to 1968) (up to 1965)	∞	100 µs

Tape equalisations including historical EQs 3

$3^3/_4$ ips 9.5 cm/s	**IEC2** **NAB** RIAA	**(1968) current standard** **(1965)** (1968)	**3180 µs**	**90 µs**
$3^3/_4$ ips 9.5 cm/s	DIN	(1962)	3180 µs	120 µs
$3^3/_4$ ips 9.5 cm/s	DIN	(1955-1961)	∞	200 µs
$3^3/_4$ ips 9.5 cm/s	Ampex (home) EIA (proposed)	(1967)	∞	100 µs
$3^3/_4$ ips 9.5 cm/s	IEC	(1962-1968)	3180 µs	140 µs
$3^3/_4$ ips 9.5 cm/s	Ampex	(1953-1958)	3180 µs	200 µs

Tape equalisations including historical EQs 4

1 7/8 ips 4.75 cm/s	**IEC** DIN	**(1971) current standard** (1971)	**3180 µs**	**120 µs**
1 7/8 ips 4.75 cm/s	IEC DIN RIAA	(1968-1971) (1966-1971) (1968)	1590 µs	120 µs
1 7/8 ips 4.75 cm/s cassette	**IEC Type I**	**1974 current standard**	**3180 µs**	**120 µs**
1 7/8 ips 4.75 cm/s cassette	DIN Type I	(1968-1974)	1590 µs	120 µs
1 7/8 ips 4.75 cm/s cassette	**Type II and IV**	**(1970) current standard**	**3180 µs**	**70 µs**
15/16 ips 2.38 cm/s	undefined			

Noise reduction systems

- Dolby A - professional
- Dolby SR - professional
- Dolby B consumer - Compact Cassettes
- Dolby C consumer - Compact Cassettes
- Telcom C4 - professional
- Hicom consumer – Compact Cassette
- dBX – (semi) professional

Encoded tapes must be appropriately decoded –
Problem: Noise reduction system difficult to determine if unknown – best indicator: *steady background hiss*

Imperative *before* replay of originals

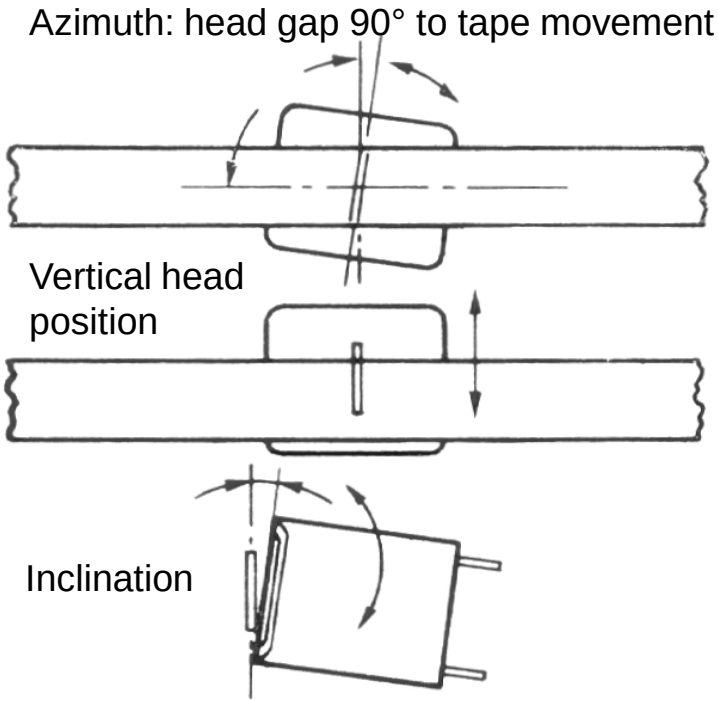
- compensation for misaligned recording heads - azimuth error, vertical head position

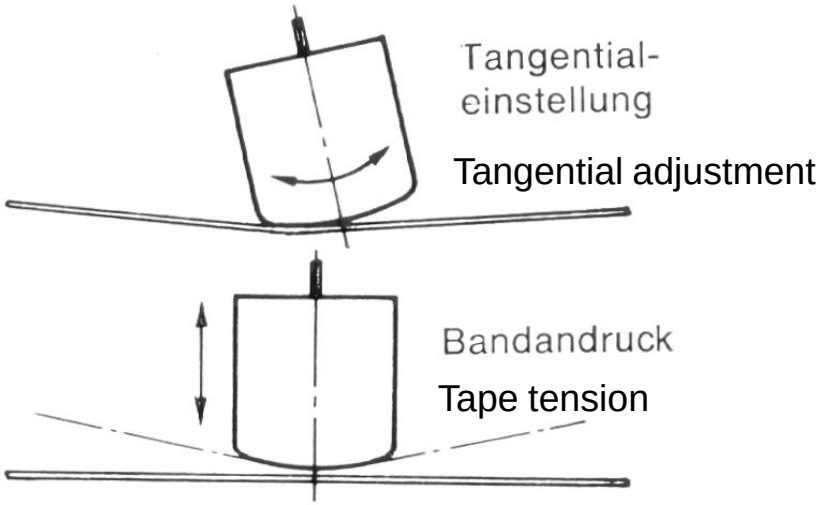
  use magnetic suspension to check track width and vertical head position
- removal of storage related signal artefacts - print through

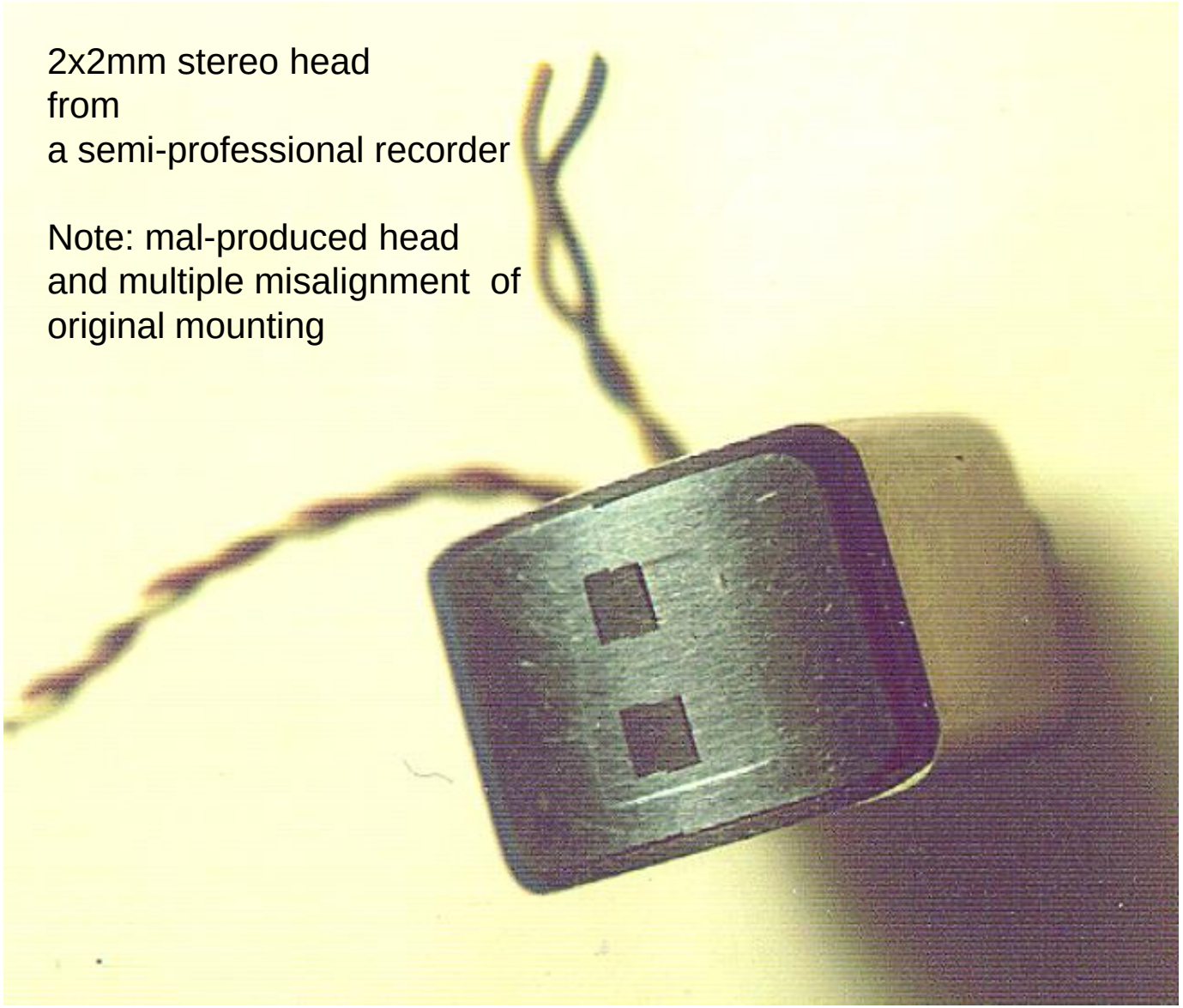
  wind tapes in the fast wind mode 3 or more times to minimise print through

Both corrections impossible once signal has been transferred to another carrier!

Head and tape path adjustments



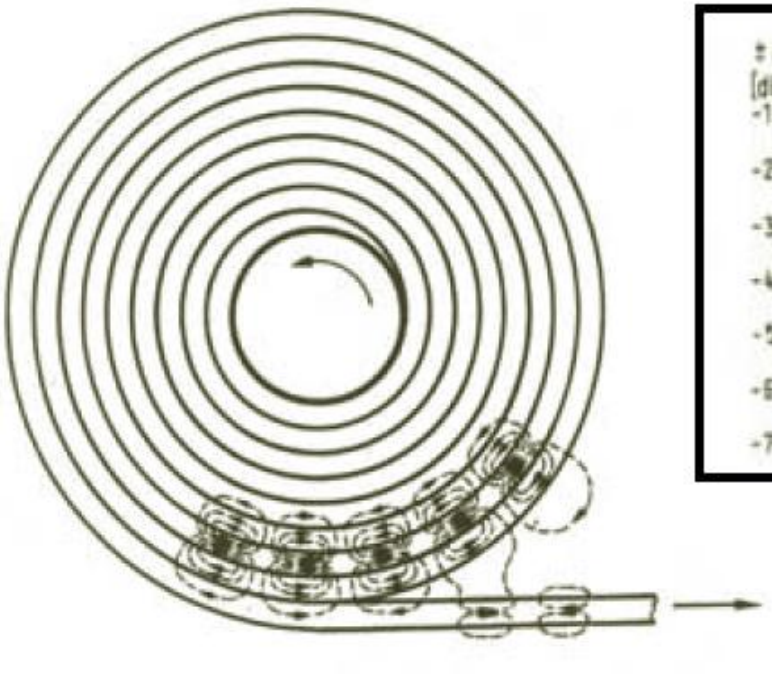


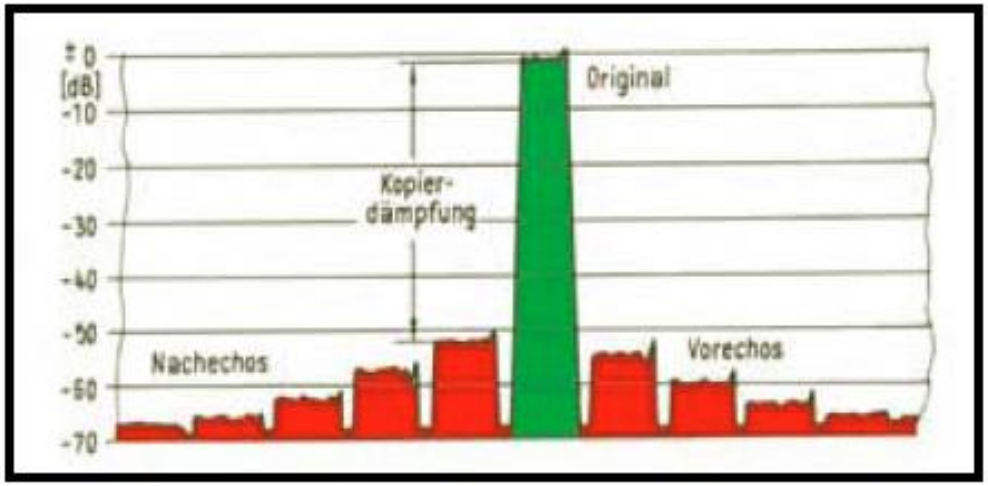

2x2mm stereo head
from
a semi-professional recorder
Note: mal-produced head
and multiple misalignment of
original mounting

Magnetic powder to make tracks visible

Minimisation of print through

Rewind tape in fast wind mode at least 3 times before reply





Print through also affects linear audio tracks of video tapes, but not the video signal or any digital signals

Transfer of digital audio contents from streaming (EIAJ, R-DAT) to file formats

- 3-tier error correction: *full – interpolation – muting*
- transferred signals must (should) be free of interpolated errors
- tape path adjustment and/or cleaning may considerably improve error rate
- check error status and keep a record of unavoidable interpolations

Time factor (technical transfer only) for one operator:

Classical scenario for magnetic tape - fairly uniform and technically regular holdings: 3x
(1 hour of analogue original needs 3 hours of work)

“Factory” transfer in broadcast archives: much faster – 1 operator runs 3-4 transfer stations
• high investment in equipment, for highly uniform holdings only
• generally unsuitable for heritage collections

3x and more for:

- analogue tape (heritage) holdings in NSAs and ResSA
- historical digital formats (EIAJ)

Additional time element: transfer of metadata

Optical carriers

Selection for replicated CDs/DVDs as for LPs

Cleaning and restoration with greatest care only, accompanied by error testing before and after work

Selection of replay equipment less important than with analogue originals, may, however, influence retrievability of –R and –RW disks

Speed, equalisation, correction for errors caused by misaligned recording equipment, and removal of storage related signal artefacts do not apply

Time factor

CDs and DVDs can be transferred at higher speeds than real time

Be **careful,** however: check consistency of error correction at higher transfer speed

Video signal extraction: specific problems 1

Tape cleaning: crucial element for heavily used tapes – cleaning machines for several formats available

Replay equipment:

- variety of television standards: SD: Historical b/w, NTSC, Secam, PAL – variety of HD standards
- vast number of historical obsolete formats
- variety of different versions within one format, e.g. U-Matic: LB, HB, SP
- variety of different sound representations within one format
- rapidly shrinking market

Video signal extraction: specific problems 2

High level technical expertise needed to maintain and adjust replay equipment – hire retired television engineers as consultants

Improved signal retrieval from composite formats by direct component extraction possible – implementation, however, not yet available for all formats

Digital video target formats: Televison archives practice vs *archival* principles:

In the past, TV-archives generally transferred analogue and linear digital holdings to data reduced (“compressed”) production formats, eg. DigiBeta or MPEG-50 formats

Since ~ 2002 upcoming: uncompromising linear video file archiving: digital signals linear of losslessly compressed in (MJPEG 2000) stored in IT environment
Research archives pioneered, followed by national and television archives

Outsourcing

• originating from North America, outsourcing of archival services has become widespread standard
• commercial companies must comply with archival standards, such as IASA-TC 03, 04, etc.
• general problem of commercial services: professional control

Summary general

• signal retrieval from original carriers determines the quality for the rest of a document's life
• employ all skills at a given time to retrieve signals at best possible quality
• transfer technology may improve, digital storage capacities will increase, and expectations will rise accordingly, therefore….

…keep the originals whenever possible – you may wish to come back!

IASA Technical Committee
Standards, Recommended Practices and Strategies

IASA-TC 04: Guidelines on the Production and Preservation of Digital Audio Objects, ed. by Kevin Bradley 2nd edition 2009
http://www.iasa-web.org/

Juha Henriksson & Nadja Wallaszkovits:
Digitisation workflow for analogue open reel tapes
http://www.jazzpoparkisto.net/audio

Franz Pavuza: Short Guidelines for Video Digitisation, 2008
http://www.tape-online.net/Short_Guidelines_Video_Digitisation.pdf

IASA-TC 06 : Guidelines on the Production and Preservation of Digital Audio Objects, ed. by Kevin Bradley (forthcoming)

Thank you!

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