Mark III Tape-Labelling and Handling Procedures

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1 Introduction

Since now seems to be the time that VLBA tape management procedures are firming up, I would like to review the procedures that have been used for some time with Mark III tapes worldwide. These procedures were developed over a period of several years to deal with various problems that occurred. The system that has evolved has proven to be both practical and highly reliable. Since the institution of the present procedures, almost no problems (i.e. mislabelled tapes, lost tapes at correlator, premature release or degaussing) have occurred, despite literally hundreds of thousands of tape-transactions that have taken place in the field and at the correlators.

The Mark III tape labelling system is based on one simple philosophy: **The status and identity of any tape at any time must be instantly recognizable simply by examining the labels on the tape.** Furthermore, a system of check and cross-checks at virtually every stage of tape handling minimizes the possibilities for errors. We feel adherence to this philosophy is particularly important at the correlator, where a single shipping room may contain 1) incoming tapes from the field, 2) tapes released and ready for degaussing, 3) degaussed tapes ready for shipment, and 4) newly purchased tapes.

2 The Mark III Tape Labels

The Mark III labelling system is based on an integrated system of four labels, each applied at a different phase of the tape cycle. These labels are:

1. **Permanent VSN label:** This label carries an 8-character volume serial number (VSN) unique for each physical tape. By convention, the first 3 or 4 characters identify the purchasing institution or project, and the last 4 or 5 characters are simply a serial number (i.e. 'VLBA0023'). Printed on the label is the VSN, a 4-digit hex CRC code derived from the VSN, and a Code 39 bar code representing the VSN. In addition, there is included some information about the tape type, lot number, etc. Of course, all of this information, as well as other information relating to this tape (purchase date, performance history, current location) is maintained in a computer database as well. Figure 1 shows an example of a VSN label.

2. **Temporary label carrier:** The *label carrier* is a specially-printed large label that is applied when a tape is degaussed. It is designed with reserved spaces for all temporary labels that will be applied during a 'tape cycle' (i.e. from recording to re-recording), and has an adhesive that is specially designed for easy removal. All temporary labels are applied to this label carrier, so that all temporary labels are removed simply by removing this single label carrier. In addition, the carrier label has a pre-printed green dot that indicates an unrecorded tape;

this dot is covered successively by red and yellow adhesive dots to indicate the current tape status. Figure 2 shows an example of the pre-printed label carrier.

3. **Field label:** The *field label* is applied in the field when the tape is recorded. Printed information includes the recording station, and the start and end times of the recording. In addition, a bar code identifying the station and tape start time is printed on the label. The field label is applied to the carrier label in its reserved position. The field label may be either pre-printed or printed at the field station. Figure 3 shows an example of a field label.

4. **Library label:** The *library label* is printed when a recorded tape has arrives at the correlator and is assigned to a slot in the correlator tape library. Printed on this label is the assigned library slot number, as well as the VSN, recording station, and tape start time. The latter provides valuable cross-checking information that is easily checked without reference to any computer data base. The library label is applied to the carrier label in its reserved position. Each Mark III library slot is assigned a 5-character code identifying the section, bay, shelf, and position on the shelf (e.g. 'AD312'). Figure 4 shows an example of a library label.

3 The Mark III Tape-Handling Cycle

For purposes of instruction, let us follow a Mark III tape through one entire recording and processing cycle, detailing the steps of labelling and label usage at each step along the way. We will start with a degaussed tape arriving in the field ready for recording:

1. **Field-station procedures:**

   (a) Each tape is inspected for obvious damage when it arrives and set aside for environmental stabilization. At this point the only labels on the tape are the permanent VSN label and an empty pre-printed label carrier with a green dot (indicating a degaussed tape).

   (b) After stabilization, and before actual recording, the tape is pre-passed, with head cleaning, following normal procedures.

   (c) When the tape is mounted for recording, the *VSN label* is either scanned by a handheld bar-code reader or entered manually through a keyboard. To avoid errors, keyboard entry requires entering both the VSN and the accompanying 4-digit hex CRC check code for verification.

   (d) A bar-coded *field label*, either supplied to the station or printed at the station, is applied to the designated position on the label carrier. The field label, along with the green dot, indicates the tape is in the process of being recorded.

   (e) At the conclusion of recording, an adhesive *red dot* is placed over the pre-printed green dot on the label carrier. This red dot indicates that the tape is recorded and acts as pseudo-write-protection.

   (f) The tape is removed from the drive, packed for shipping in an appropriate container, and shipped to the correlator. No content-specific labels are used on the tape-shipping container.

2. **On arrival at the correlator:**

   (a) The tape is unpacked and examined for obvious damage.

(b) A handheld bar-code scanner is used to scan both the *VSN label* and the *field label*, and the tape is assigned to a slot in the tape library either by the computer or by the operator. A *library label* is immediately printed and applied to the reserved location on the label carrier. If either of the bar codes is either unreadable or missing, the corresponding VSN and field-label information is hand entered; hand-entered VSN's must be verified by the accompanying 4-digit hex check code. Damaged VSN labels can be reprinted and replaced on the spot, if necessary. Note at this point that the tape-library database knows the VSN, recording station, and tape-start time from the label information alone.

(c) The tape is placed on a cart along with other incoming tapes, which are then subsequently distributed to the assigned slots in the tape library by simply reading the *library label*.

3. **Preparation for processing:**

(a) Logs are collected from participating stations.

(b) A cross-check is done between the information contained in the logs and the library database. This allows the identification of any missing tapes, or any inconsistencies between log information and tape-library database information, which of course must be resolved.

4. **Correlation processing:**

(a) When the correlator is ready for a tape, the operator is informed of the VSN (but not the VSN check code) and library slot number.

(b) The operator retrieves the tape from the library and mounts and loads it on any available drive.

(c) The operator enters the drive number and 4-digit hex VSN *check code* (not the VSN itself) into the operator's keyboard. Software then attempts to make a match between a requested tape and the entered check code. This procedure requires a minimum of information from the operator and virtually guarantees that the proper tape is mounted.

(d) A standard tape-conditioning pass, with head cleaning, is automatically initiated.

(e) When the correlator reads the tape, both the data time and hardware serial code of the recording system are checked for correctness before the data is judged valid.

(f) At the conclusion of processing the tape is dismounted, and the tape is either returned immediately to the library or placed on a cart for later distribution to the proper library locations (using the information on the library label).

5. **Tape-release procedures:**

(a) When correlation processing is complete and the tape is ready for release, the correlator manager or responsible person first makes a notation (including his or her initials) in the database that the tape is authorized for release (usually a whole group of tapes is covered by such an authorization).

(b) A list of tapes authorized for release, and their positions in the library, is given to the tape shipper.

(c) The tape shipper removes tapes from the library, immediately places a yellow dot over the red dot on the carrier label to indicate that the tape is in the release process, and loads released tapes onto a cart. The yellow dot prevents potential confusion with other tapes in the shipping room.

(d) In the shipping room, the VSN bar code is scanned to request release of the tape. The request will be honored only if the necessary release authorization exists in the database — a crucial safeguard to prevent accidental release and degaussing of data tapes. The operator then marks an 'X' across the carrier label with a felt-tip pen to indicate the tape has been released.

(e) Once the tape has been released, it moves to the degaussing station. There the carrier label, containing all temporary labels, is removed, the tape is degaussed, and a new blank carrier label is applied, and the tape is set aside for shipping.

(f) When ready for shipping, the VSN bar code is scanned and the destination is entered into the database, and the tape is packaged and shipped.

Table I summarizes all the valid labelling states for Mark III tapes and the corresponding implied tape status. Figure 5 shows an example of a fully-labelled Mark III tape as it appears at the correlator.

4 Schedules, Logs, etc.

In an ideal world the Mark III correlators would receive not only data tapes but also a full set of schedules and logs from each station in a timely manner. The real world is much less ideal, particularly when dealing with stations worldwide, over many of which we exercise virtually no control. Sometimes logs, particularly, are delayed or lost, and we were therefore forced to develop procedures to deal with these cases as gracefully and painlessly as possible; the cost of redoing experiments simply because log files are delayed, missing, or incomplete is too high. The procedures that have been developed work as follows:

1. When the observing schedule for an experiment is created, a machine-readable copy of that schedule is sent to every station. The schedule includes all information necessary to take data, including observing frequencies, recording modes, and a detailed schedule of observing times and sources covering *all* stations. In addition, SNAP command files to drive the Mark III field system for that particular station may be sent, or may be generated at the station from the schedule file. Transmission of information and files to the field is done either electronically or on floppy discs.

2. At the conclusion of an experiment, each station is asked to send all relevant material to the correlator, including data tapes, logs, *and the original schedule file.*

3. At the correlator, the first-received *a priori* schedule file (from *any* of the participating stations or often directly from the investigator) is used to create a skeleton correlator control file for the experiment. The information in this control file is sufficient to process the data from *any* station so long as that station adhered to the *a priori* schedule. Generally, only a fringe search will need to be done to pin down the clock.

4. Log information from a station is used to *customize* the control of the correlator for that station for more efficient correlator operation, particularly with respect to scan start times

and footages, and missed observations. The log also provides a valuable cross-check on the information entered into the tape-library database when the tapes arrive at the correlator; missing tapes or inconsistent entries are easily identified and investigated.

5. In the case of missing logs, *a priori* schedule information is used to process the tapes. *The field labels on the tapes provide sufficient information to the tape-library database for the correlator software to request the proper tapes without actually reading the data on them.*

These procedures allow the Mark III correlators to process most of the data most of the time, even in relatively adverse circumstances, and without absolutely requiring that logs be supplied, although the information they supply is very useful if available (particularly tape start times and footages).

5 How Does All This Relate to the VLBA?

As I indicated, the procedures discussed here were developed over a period of years in learning to deal with the various types of failures that can occur. And, although not optimal, these procedures have served the Mark III community very well over the years.

For at least the next couple of years, some data taken at VLBA sites will be correlated on Mark III processors; and for many years, presumably, Mark III data will be correlated on the VLBA processor. Such being the case, I would think it advantageous to adopt a universal labelling system for Mark III and VLBA sites. Procedures and labelling within the correlator centers may differ, but labelling at recording sites should be compatible. I believe this can be accomplished if the following guidelines are followed:

1. All tapes will carry a compatible permanent bar-coded VSN label. Each tape-procuring institution will choose a unique identifier of 3 or 4 characters and will be responsible for assigning VSN's and applying VSN labels to new tapes entering the system. All relevant information about the tape will be entered into one of the correlator-library databases. If it is decided to use embedded bar-code scanners on VLBA drives, duplicate VSN labels will need to be applied to the backside of the tape reels in the proper positions.

2. Field labels with at least a station identifier and tape start time will be applied to a standard label-carrier label. Bar-coded labels are very useful, but not mandatory.

3. A standardized color-dot system will be adopted. It has been suggested that yet another-colored dot be applied during the recording process to properly identify tapes that may have to be dismounted and remounted during the data-taking process (for Mark III, this condition is indicated by the presence of a field label with a green dot on the carrier label).

4. Labelling and handling procedures at correlators are at the discretion of the individual correlators.

5. Procedures for exchange of information between correlator tape-library databases should be developed.

Appendix I

Mark III Tape Label Details

1 Code 39 Bar Code

The bar-code used on all Mark III tape labels is Code 39 (sometimes called 3 of 9). The Code 39 bar code is a variable length, discrete, self-checking, bidirectional, alphanumeric code. Its character set contains 43 meaningful characters: 0-9, A-Z, '-.$/+%' and space. Each character is composed of nine elements: five bars and fours spaces. Three of the nine (hence '3 of 9') elements are wide (binary value 1), and six elements are narrow (binary value 0). An additional special character (often designated as '*') is used for both start and stop delimiters.

Code 39 is self-checking, but the option is present to add a checksum character for each message. The checksum character is the modulo 43 sum of all the character values in a given message and is printed as the last character.

2 The VSN Label

The VSN is an 8-character identifier chosen as descibed earlier in this memo. The VSN label contains the following information:

1. Printed block characters of the 8-character VSN
2. Printed 4-digit hex CRC check code generated as follows:
   (a) In the VSN, modify all 'O's to '0's (zeroes)
   (b) From the binary representation of the modified VSN, compute the polynomial $x^{16} + x^{15} + x^2 + 1$.
3. A Code 39 bar code containing the following 10 characters (excluding the start and stop delimiters), in order:
   - 8-character VSN
   - A space character
   - A Code 39 check character
4. Some auxiliary information about tape type, etc, printed in small characters

The space following the VSN in the bar-code is used to distinguish data originating from the keyboard versus the barcode reader in a system where the barcode reader is interposed between the a standard terminal and the host computer. If the software receives 8-characters followed by a trailing space, it assumes the data is coming from the barcode reader and does not require the 4-char check code as verification. If there is no trailing space, the entry of the 4-char check code

is required for verification. (This is, of course, a closely-held secret!) Furthermore, for operational convenience, the characters 'O' and '0' are considered identical in all VSN-label-verification testing.

Most bar-code readers can be set to use the Code 39 check character for verification only; the check character is not transmitted to the host. Even if check character is transmitted to the host, it can be easily recognized, checked, and discarded.

3 The Field Label

The Mark III field label contains the following information:

1. Plain printed information on the recording station, the experiment name, and the tape start and stop times.
2. An 11-character bar code containing the following characters, in order –
   - A single-character station identifier
   - An 8-character field of the form DDD-HHMM identifying the tape start time, where 'DDD' is the day of year, and 'HHMM' is the UT hour and minute.
   - A space character.
   - A Code 39 check character.

Again, the trailing space in the bar-code allows the correlator software to determine that it has received input from the bar code reader vs. keyboard input, but no attempt is made to verify keyboard input, except for validity of the station code and range checks on the time code. The difference in the length of the VSN (8 significant characters) versus the field-label (9 significant characters) allows software to distinguish one from the other.

4 The Library Label

The library label is simply a printed label containing the following information:

- The library to which this label applies (e.g. 'Haystack Mark III Tape Library')
- The library slot number to which the tape is assigned
- The station code and tape start time (same as bar code on field label). This is followed by an Haystack internally-assigned experiment number corresponding to this data.
- The tape VSN and 4-digit hex check code

Although some of the information on the library label is redundant, it provides an instant cross-check among the other labels on the tape.

5 Label Printing

All Mark III tape labels, except for the commercially-printed carrier label, are standard $1\frac{7}{16}$"x4" paper adhesive labels printed on an inexpensive dot-matrix printers (one at the correlator shipping/receiving area and one at each field site). We have found the low-density bar code labels printed on dot-matrix printers to be highly reliable, and the convenience of on-demand single-label printing that they offer is highly desirable. Although the bar-code printing software for the Mark III was developed in-house, many commercial packages are now available at reasonable cost.

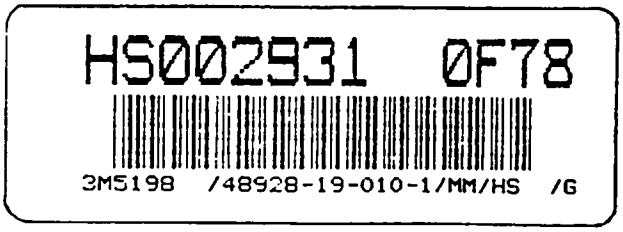

Figure 1. VSN Label Example

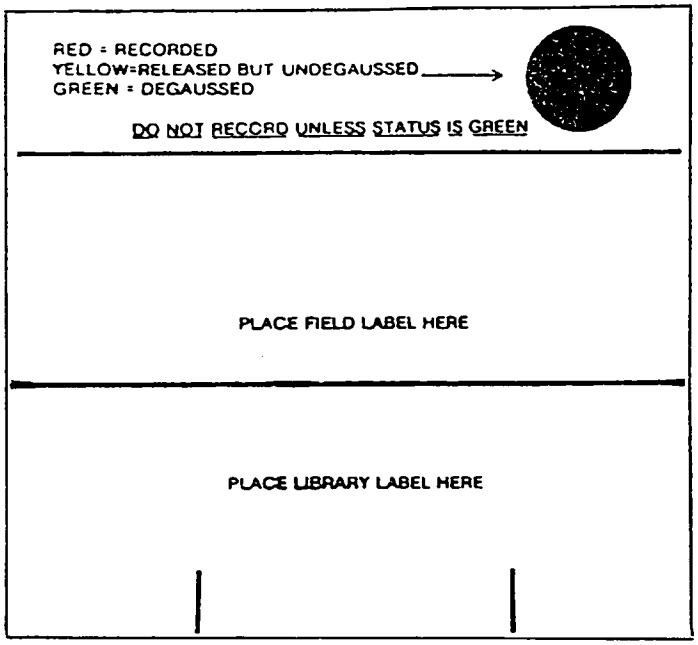

Figure 2. Pre-printed Label Carrier

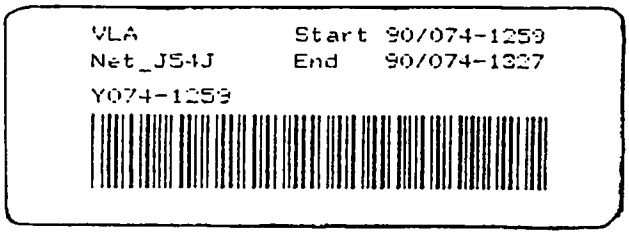

Figure 3. Field Label Example

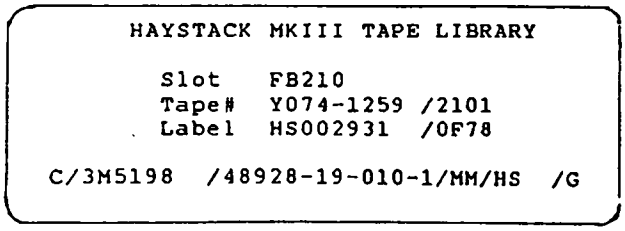

Figure 4. Library Label Example

VSN Label	Field Label	Library Label	Dot Color	Tape Status
X			Green	Degaussed
X	X		Green	Recording in Progress
X	X		Red	Recording Complete
X	X	X	Red	Assigned to Correlator Library
X	X	X	Yellow	In Release Processing

Table 1. Mark III Tape-Label Status

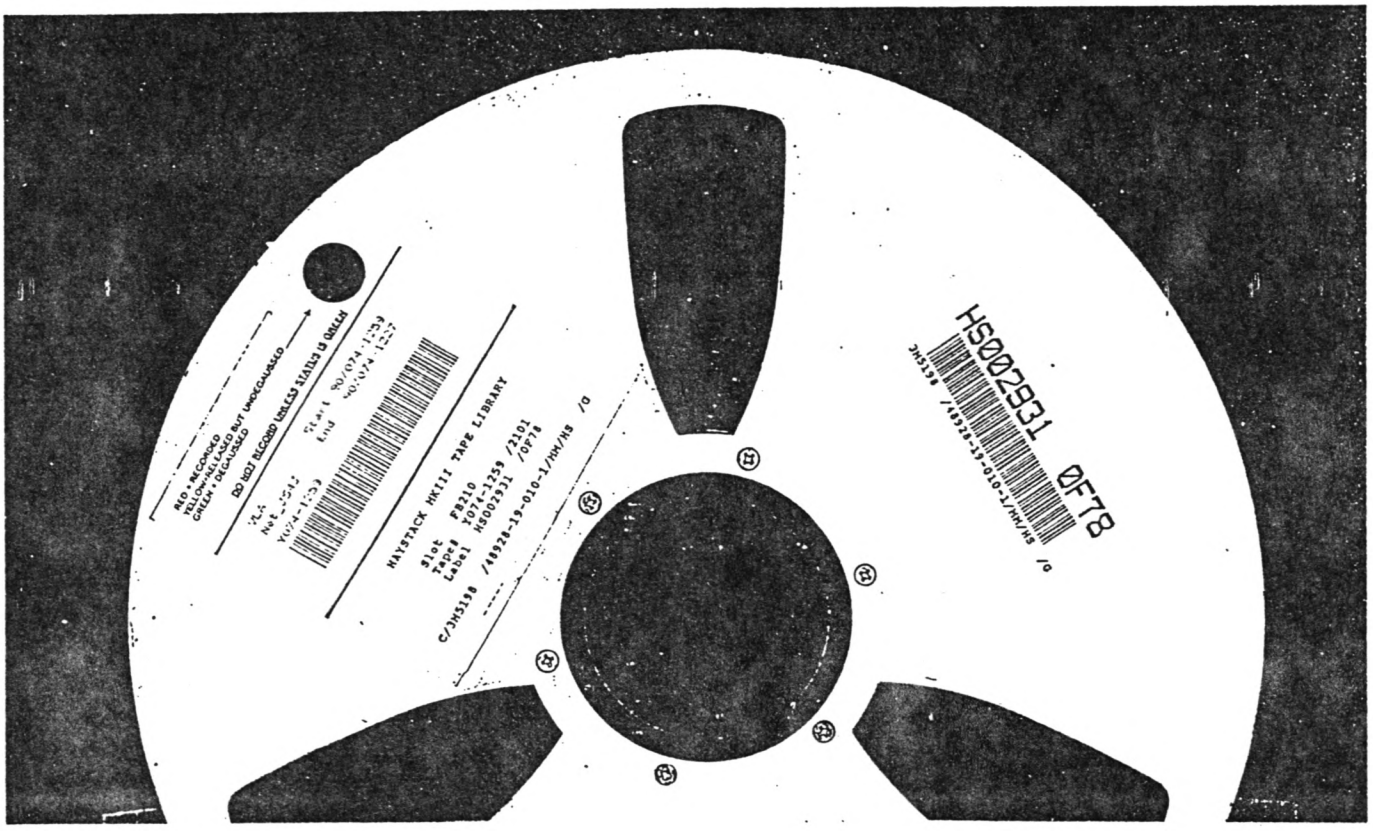

Figure 5. Fully-Labelled Tape at Correlator