CONTRACT NASW 4699 -- FINAL REPORT

User Friendly Database for Neptune Planetary Radio Astronomy Observations

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ABSTRACT

Planetary Radio Astronomy ("PRA") data from the Voyager Neptune encounter have been cleaned and reformatted in a variety of formats. Most of these formats are new and have been specifically designed to provide easy access and use of the data without the need to understand esoteric characteristics of the PRA instrument or the Voyager spacecraft. Several datasets have been submitted to the Planetary Data System ("PDS") and have either appeared already on peer reviewed CD-ROMs or are in the process of being reviewed for inclusion in forthcoming CD-ROMs. Many of the datasets are also available online electronically through computer networks; it is anticipated that as time permits, the PDS will make all the datasets that were a part of this contract available both online and on CD-ROMs.

1. HISTORY

During the course of the Voyager mission to the outer planets, PRA data have been sent from the Voyager Project at JPL to the PRA Project Office in Boulder in a wide variety of formats, on the medium of half inch magnetic tape. Unfortunately, the correct reading of the data frequently required detailed knowledge not only of the data format used on a given tape (and how to circumvent the frequent errors and lack of adhesion to the published data format specifications) but also a detailed knowledge of the working of both the PRA instrument and the Voyager Flight Data System ("FDS"). Although many of the data are archived with the National Space Science Data Center ("NSSDC"), the use of these data by third parties is often difficult or impossible. The following are typical problems that a third party investigator might find when trying to use PRA data from NSSDC:

1) The physical medium on which data are supplied (1/2 inch magnetic tape) may be formatted in a density unreadable by the investigator;

2) The printed description of the layout of the data on the physical tape may be difficult to understand, obscure, or lacking in precision;

3) The data may contain binary floating point numbers in a format which is not compatible with the investigator's computing equipment;

4) Binary integer numbers may be packed differently from the way that the investigator's computing equipment expects;

5) EBCDIC may be used;

6) The data may be one of:

   a) Too "raw" for use by an investigator who has no detailed knowledge of the instrument concerned;

   b) Uncalibrated;

   c) Of insufficient resolution;

   d) Incomplete;

   e) Missing necessary ancillary information (e.g. frequency settings);

   f) Contain unflagged bad or suspect data.

Under the terms of this contract, the author has made

available a number of datasets that reduce or eliminate entirely these difficulties. In particular:

1) The data are available electronically and on standard, state of the art, media; i.e. CD-ROMs;

2) The description of the data format is both simple and precise;

3) The data contain no floating point numbers, all numbers are provided as integers, with the byte order clearly specified;

4) Binary integer numbers may still be packed differently from the way that an investigator's computing equipment naturally operates. However, the datasets have been provided in both binary and ASCII format, so that, as a last resort, an investigator can use the (slower, larger but universal) ASCII formatted data;

5) EBCDIC is never used;

6) With regard to the data themselves:

   a) The data are well documented, with spacecraft and instrument idiosynchracies removed insofar as is possible;

   b) The data are calibrated;

   c) Data at both browse and full resolution are available;

   d) The data are as complete as the original raw dataset downlinked from the spacecraft;

   e) Ancillary information needed to interpret the data are now contained within the datasets themselves;

   f) All bad data are clearly marked.

Before it will make data sets available to the public, sets submitted to the PDS must undergo rigourous peer review. This process includes requirements that the data set be fully documented and usable by third parties, as well as complete documentation of the instrument characteristics and modes of operation. Such documentation for the PRA instrument and the submitted datasets described herein has been submitted to the PDS and is available from their online catalogue.

2. DATA SETS

Four data sets have been produced.

2.1. BROWSE

The browse data set confines itself to scanning mode data, in the lower frequency band of the PRA instrument only, and limiting itself to 48 second "averages" of the fundamental six second cycle of the instrument. (The term "averages" needs to be more clearly defined: a given record on a tape contains eight six second scans, four in each of two senses of circular polarisation. Browse data records comprise the calibrated mean of each set of four scans, separated out into the distinct polarisation states.) Any data that are suspect have been removed prior to inclusion in this dataset, so that the user of this set is guaranteed that no signal seen in the set is an artifact of the downlink or computer processing. It is intended that this data set be used for the study of gross polarisation and frequency characteristics of the neptunian radio emission.

The browse data set has undergone the usual peer review process at the PDS, and has already been published on CD-ROM. It is also available for direct electronic access in the particles and fields catalogue of the PDS.

Figure 1 shows a typical plot obtained from PDS browse data.

2.2. Modified EDR

Low rate data are provided to the PRA project office in a format known as Experimenter Data Record, or "EDR". Unfortunately, these EDRs, apart from being impossible to interpret without access to a several-inch-thick document from JPL, frequently contain corrupt data, errors in timing and other, similar hurdles to their correct interpretation. We have produced a data set at the same resolution as the original EDR data, but containing much simpler headers and from which the obvious contamination and corruption has been removed.

This data set is useful for the detailed examination of the various radio emissions detected by PRA at Neptune. In particular, the bursty radio emissions are present and

recognisable in this dataset (see Figure 2).

2.3. Fixed frequency

Throughout the Neptune encounter, the PRA instrument was placed periodically into a fixed frequency mode. This mode is incompatible with the more common scanning mode which is contained in the Browse data set. There is insufficient information in the original EDR records to determine the characteristics of this mode, although its presence can be clearly detected. We have produced a data set containing only the fixed frequency data and with all the information required to extract the data correctly contained within the dataset.

Figure 3 is an example of a plot from this dataset.

2.4. High rate

During the encounter, a number of 48 second frames were acquired when the instrument was in a mode of rapid data acquisition. These frames are in a format completely unlike the low rate data. Additionally, because the permitted error rate in these frames is much higher than for lower rate data, several copies of each frame were returned to Earth. We have almagamated all the copies of each frame to produce a single, combined "best" frame which in most cases is realtively noise free.

The original format of the frames is, like that of EDRs, arcane and incomplete (for example, the frequency being sampled is nowhere contained in the dataset). We have produced a simpler format which contains within it sufficient information to extract the high rate data correctly. The data set we have produced contains calibrated data organised simply in terms of frequency and polarisation. This data set is most useful for examining the dynamics of dust impacts on the spacecraft during the encounter period. These data have been reviewed and made public by the PDS and are available both online and on CD-ROM.

Figures 4 and 5 are examples of data obtained from this data set.

3. Hard copy

PostScript format files of the entire encounter data have been produced. These are available at the author's institution and will be submitted to PDS. The Figures contained herein are examples of these files.

4.

Although it formed no part of this contract, software written by the author and which is capable of manipulating the data formats produced under this contract will shortly be made available to the PDS. This will further reduce the necessity for understanding instrument and spacecraft operation before the data can be usefully used by third parties.

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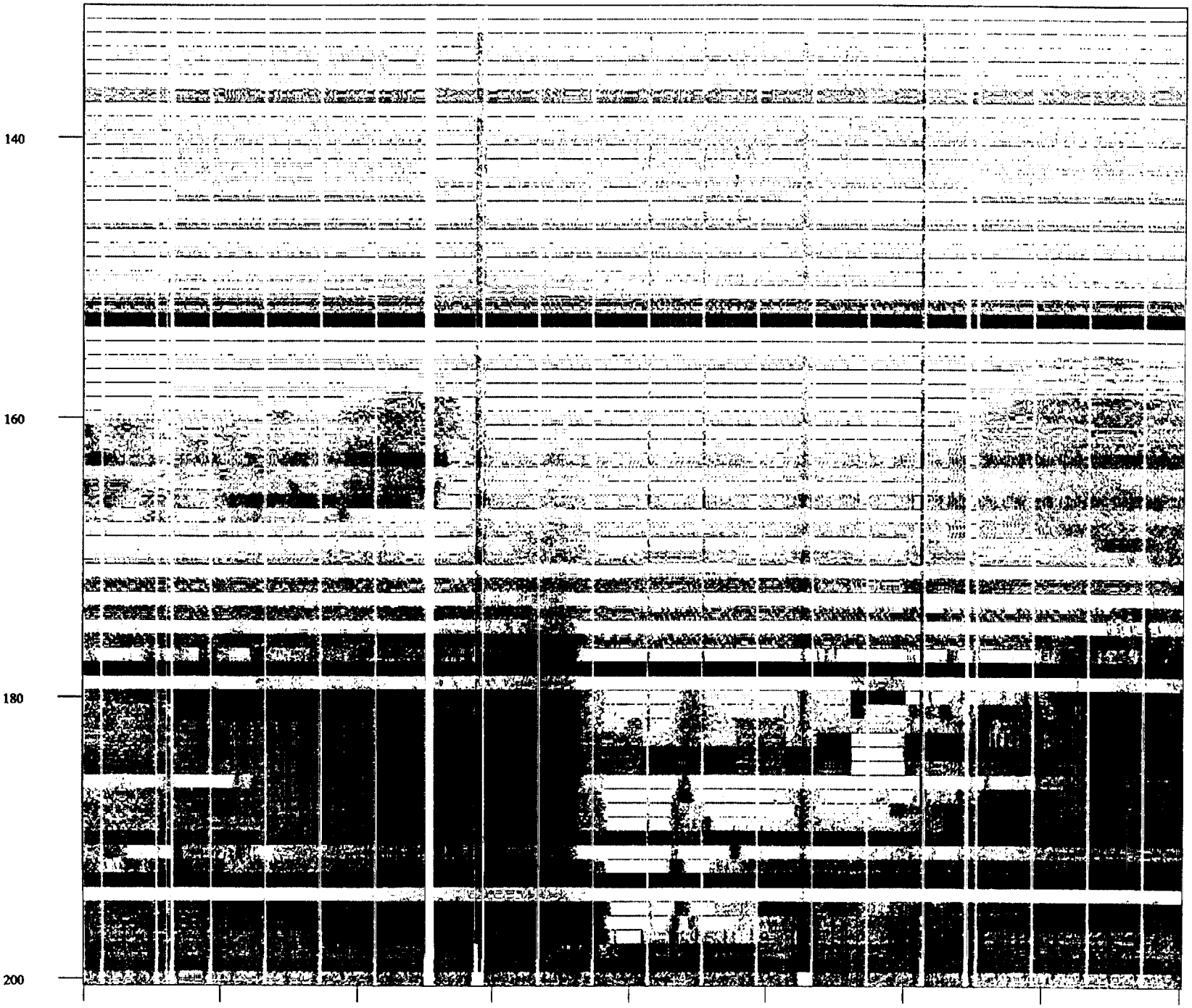

Figure 1

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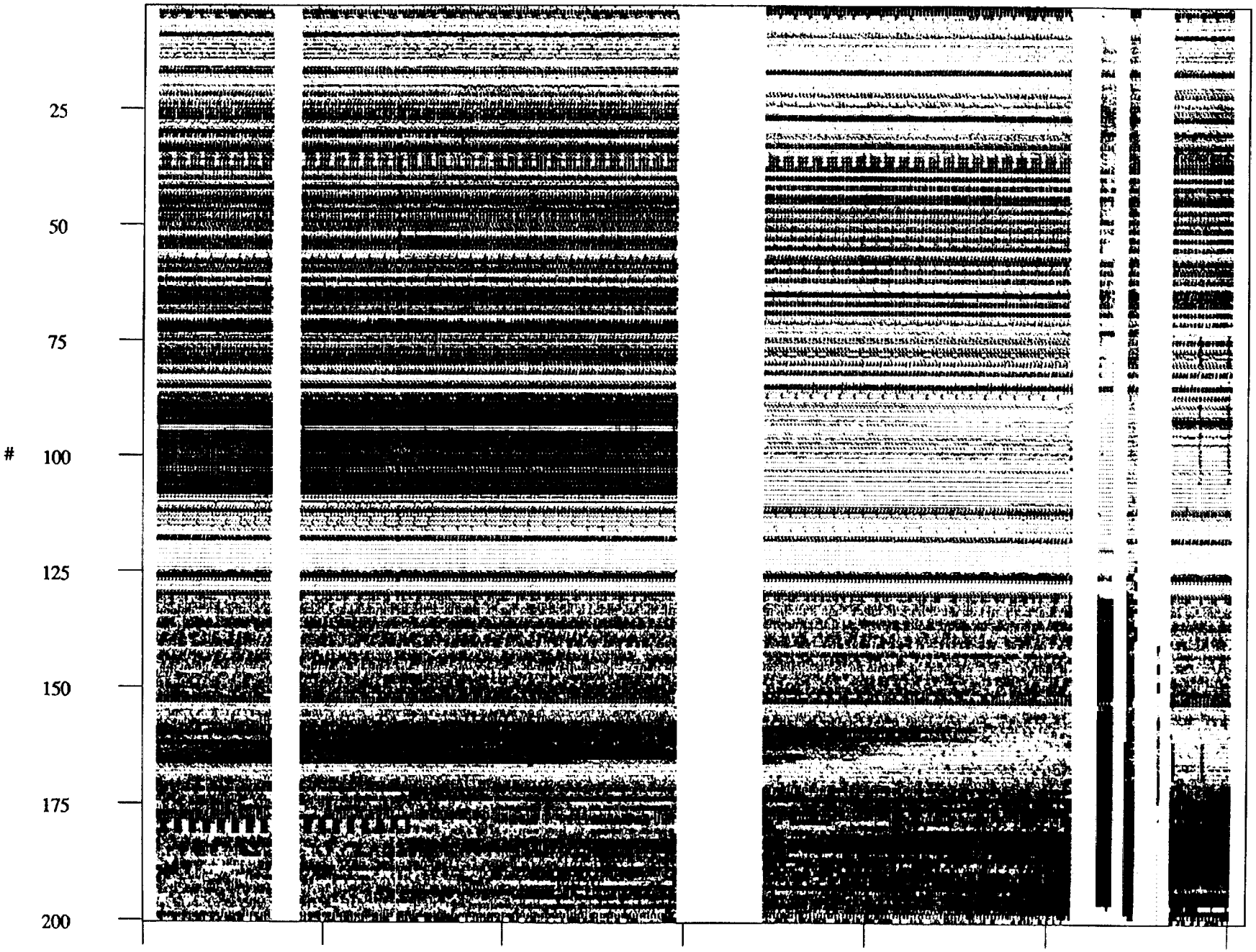
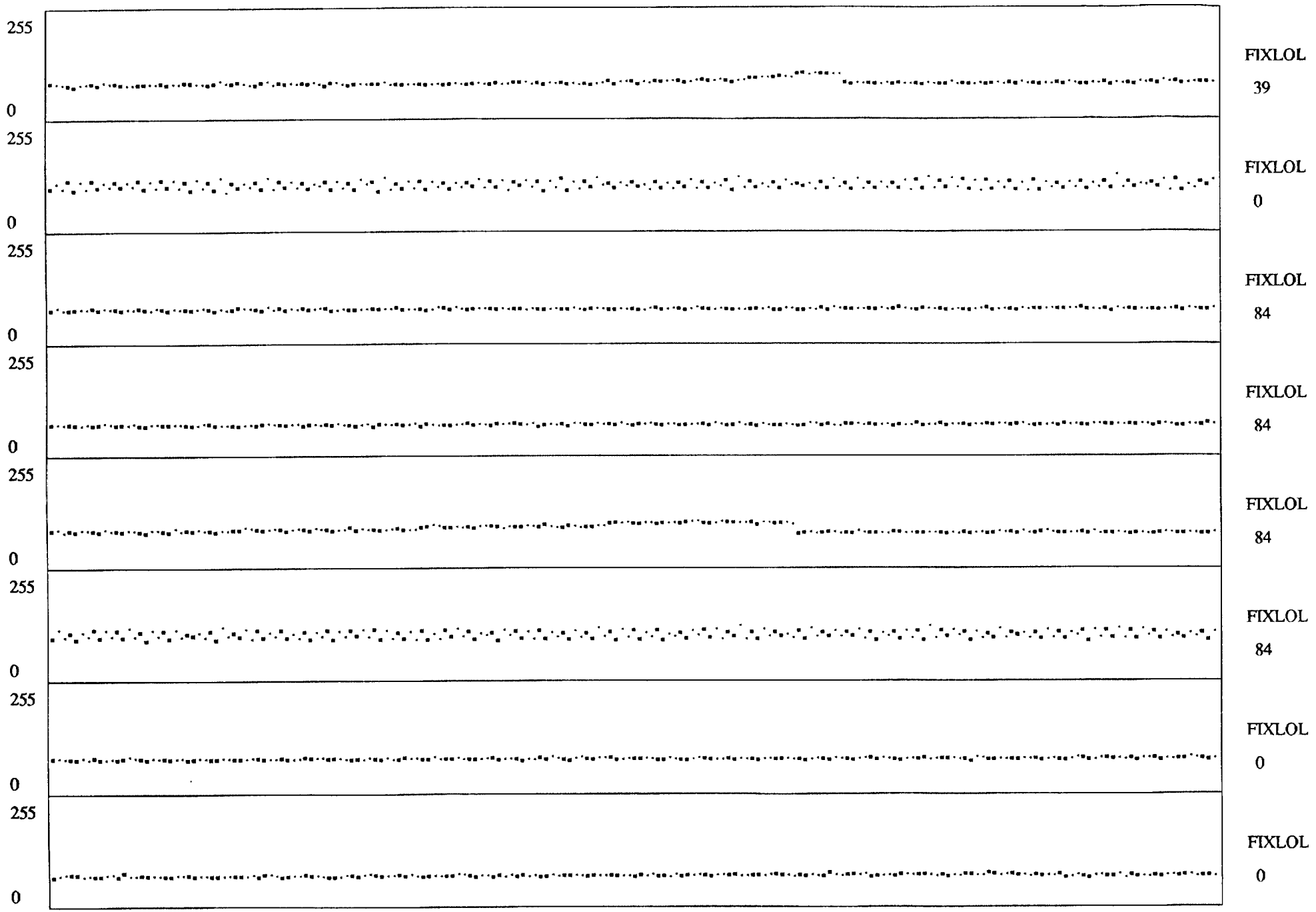


Figure 2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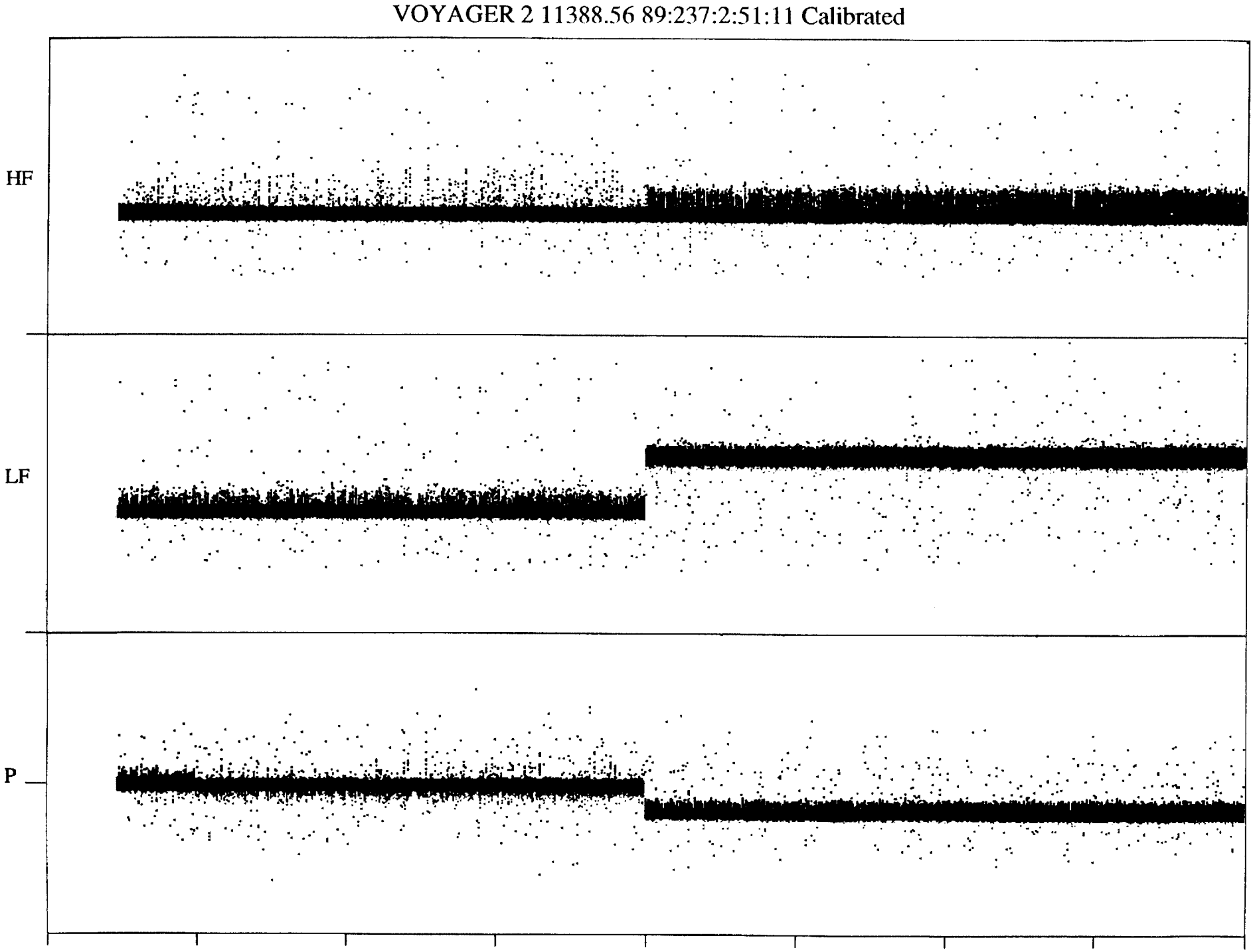

Figure 4

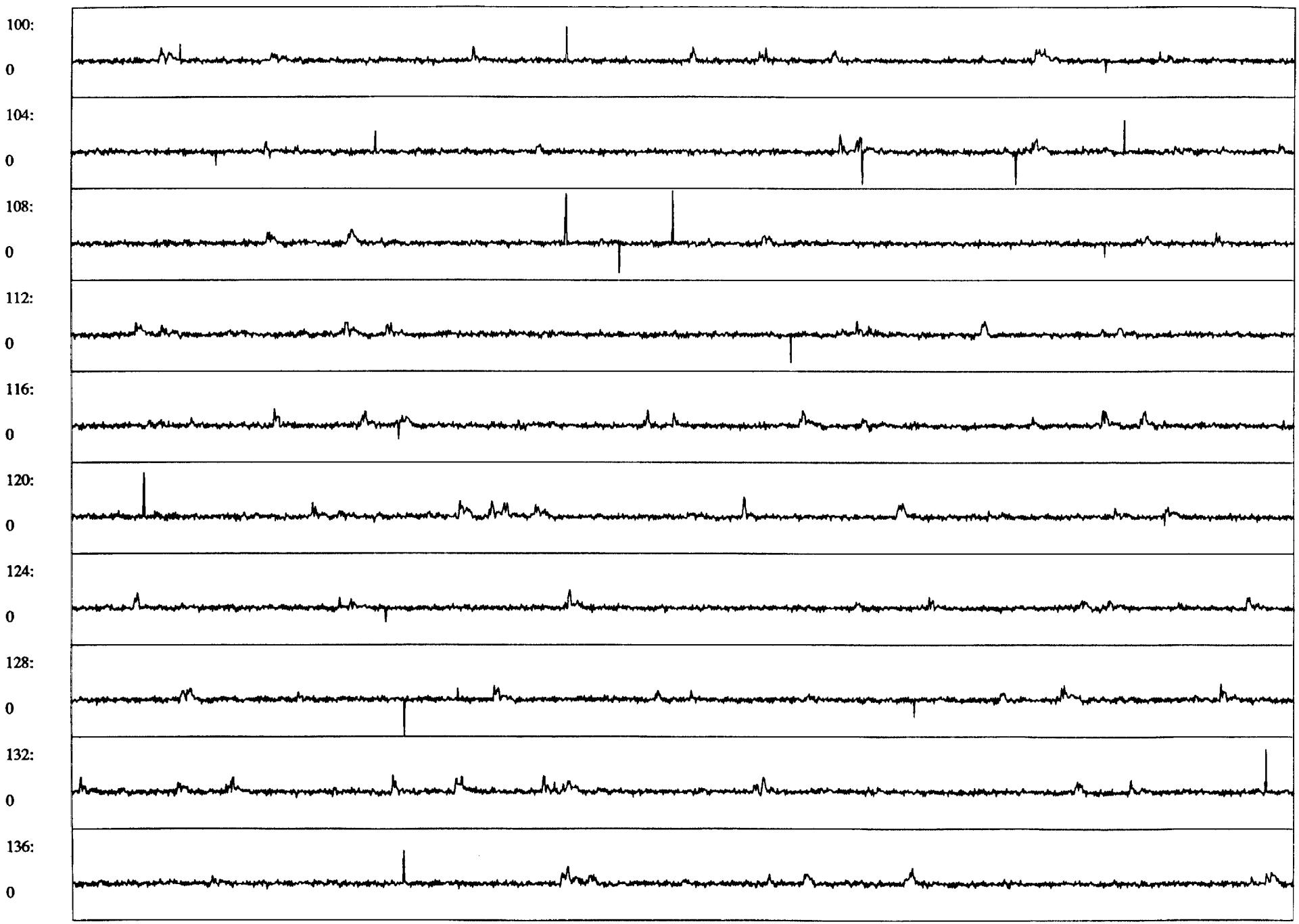
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Figure 5

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