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FINAL REPORT

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1.0 General

- 1.1 Date of Report : 3 December 1997
- 1.2 Period Covered : 1 August 1994 through
31 July 1995
- 1.3 Grantee : The University of Iowa
Dept. of Physics and
Astronomy
Iowa City, IA 52242
- 1.4 Title of Grant : Archiving of Wideband Plasma Wave Data
- 1.5 Grant Number : NAG 5-2669
- 1.6 Signature : Submitted by:



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2.0 Preceding Work

The first two years of this effort were funded as part of Prof. Donald Gurnett's Dynamics Explorer Plasma Wave Investigation (PWI) data analysis effort. During these two-plus years of effort, we developed a very reliable system which provides data in digital form, provides access via the internet including a browse function using Netscape or other web browsers, and analysis software for both personal computers (IBM-compatibles running windows) and unix workstations with which to analyze the archived data.

In the first year of effort, we procured a 486 personal computer system with a fast, multiport analog-to-digital conversion board with institutional funding. During this year we developed the procedures and software to digitize the wideband plasma wave signals up to a bandwidth of 40 kHz, depending on the bandwidth of the particular wideband receiver producing the data. We also wrote software to decode the time code channel on the analog tapes so that time tags could be attached to the data every 10 msec. We developed a self-describing format for the data based on the successful Planetary Data System's standards, and produced files of the fully digitized signals complete with time tags.

In the second year of effort, we began to use the system developed during the first year to do production on what we considered to be the highest priority wideband plasma wave data in our holdings. These high priority data are those which have been published or, in some cases, the data which formed the basis for published studies. These data span a wide range of Earth orbiting missions including Dynamics Explorer 1, ISEE 1 and 2, Spacelab 2/PDP, AMPTE, S³, Hawkeye, Injun 5, and IMP 6. The published data were considered high priority since the examples included represent a set of "typical" or "good" examples of a wide variety of plasma wave phenomena. It is also thought that the events found in the literature might be reasonable events for additional study. While these data were archived in a "production" mode, the volume of data archived in this second year of the effort was relatively small, due partly to inefficiencies associated with starting up a new system and also to the fact that significant time is spent in finding short segments of published data on long analog tapes.

Also during this second year, a limited data analysis tool was completed which allows access to the wideband data and basic Fourier transform and frequency-time spectrogram display capabilities. This tool was designed to run on an PC under DOS with Windows. Part of the motivation for this software is to show that wideband data is now accessible to scientists with even minimal computational resources. Prior to this effort, all of the Earth-based wideband plasma wave data were in analog form and required a rather sophisticated spectrum analysis laboratory for even basic analyses. The number of labs suitably equipped for such analyses are extremely limited, and are certainly out of the reach of the casual potential user of these data. Furthermore, the analog nature of the data virtually ruled out any correlative studies with the other digital data obtained from even the same spacecraft except by plotting data on a common scale and using photographic techniques to juxtapose the wave data with the relevant correlative data sets. The PC software coupled with the digitized data eliminate all of these disadvantages of

the analog data.

Obviously, a PC environment is a rather limited platform, especially in its lack of capability to access the large quantities of data involved in the digitized wideband data. Hence, the development of a unix tool was begun during the second year to provide a full-featured analysis tool which would meet the requirements of virtually any user. We currently have such a unix tool running at Iowa which can access any of the wideband data online, utilizes special browse files which allow a user to rapidly locate data of interest and then graphically interact with the program to do detailed studies. For example, a browse file might show several minutes to an hour of archived data in the form of a frequency-time spectrogram. The user can use a mouse to open an analysis rectangle encompassing the feature of interest, limiting the analysis range in both frequency and time. The software will then utilize the raw, full resolution waveform data to re-compute Fourier transforms on appropriately-sized data blocks to provide full-resolution spectra of the desired feature. The process can be repeated to focus in on successively greater detail. The color bar used to represent intensities can also be varied interactively, allowing a user to experiment with the stretch in order to bring out the feature of interest or to switch to a grey scale, if desired. This version of the software is stable enough that remote users can make arrangements to run it remotely over the internet on a workstation which has X- windows capability. We have further developments to this package running in a test environment which also allows spectral slices at a specified time to be displayed, or even the raw waveform, itself.

3.0 Summary of Work Performed Under the Current Grant

Beginning with the third year of funding, under Grant NAG 5-2669, we began a more ambitious archiving production effort, minimizing work on new software and concentrating on building representative archives of the missions mentioned above, recognizing that only a small percentage of the data from any one mission can be archived with reasonable effort. We concentrated on data from Dynamics Explorer and ISEE 1, archiving orbits or significant fractions of orbits which attempt to capture the essence of the mission and provide data which will hopefully be sufficient for ongoing and new research as well as to provide a reference to upcoming and current ISTP missions which will not fly in the same regions of space as the older missions and which will not have continuous wideband data.

We archived approximately 181 Gigabytes of data, accounting for some 1582 hours of data. Included in these data are all of the AMPTE chemical releases, all of the Spacelab 2/PDP data obtained during the free-flight portion of its mission, as well as significant portions of the S³, DE-1, Imp-6, Hawkeye, Injun 5, and ISEE 1 and 2 data sets. Table 1 summarizes these data. All of the data archived are summarized in gif-formatted images of frequency-time spectrograms which are directly accessible via the internet with common Web browsers at <http://www-pw.physics.uiowa.edu/spds/home.html>. Each of the gif files are identified by year, day, and time as described in the Web page. This provides a user with a specific date/time in mind a way of determining very quickly if there is data for the interval in question and, by clicking on the file name, browsing the data. Alternately, a user can browse the data for interesting features and

events simply by viewing each of the gif files. When a user finds data of interest, he/she can notify us by email of the time period involved. Based on the user's needs, we can provide data on a convenient medium or by ftp, or we can mount the appropriate data and provide access to our analysis tools via the network. We can even produce products such as plots or spectrograms in hardcopy form based on the specific request of the user.

Table 1
Minutes of Data Archive at Given Bandwidths

Spacecraft	40 kHz	10 kHz	1 kHz
PDP/SL2	N/A	1,113	968
S ³	N/A	815	846
DE-1	13,781	28,634	28,332
Imp 6	N/A	1,492	1,371
Hawkeye	245	366	320
Injun 5	N/A	426	478
AMPTE	N/A	117	N/A
ISEE 1	1,946	5,505	3,884
ISEE 2	N/A	2,905	1,361
Totals	15,972	41,373	37,560

The archived data reside on 8mm Exabyte tapes at The University of Iowa.