

# MEMORANDUM OF UNDERSTANDING

## I. PURPOSE

The purpose of this Memorandum of Understanding (MOU) is to provide information about the relationship among the various parties to this MOU regarding their respective roles, duties, obligations and responsibilities for implementation of the archiving of the high resolution data obtained by the Cluster Wideband (WBD) Plasma Wave Receiver. Parties to this document propose to coordinate and perform the functions described herein within the scope of their various governmental mandates, contracts and grants.

## II. PERIOD OF RELEVANCE

This MOU is designed to serve as a record of the relationship of the signatories from the date of its execution until the end of active Cluster WBD operations unless modified by all the parties to the MOU. The Period of Relevance will commence upon the date that all parties have signed the MOU. A review may be conducted annually for modification and/or amendment.

## III PARTIES TO THE MEMORANDUM OF UNDERSTANDING

The parties to this MOU and their primary roles are delineated below:

- NASA HEADQUARTERS (NASA HQ), Washington, D.C.: NASA HQ will provide oversight to ensure that the Cluster WBD data are archived to their satisfaction.
- NASA GODDARD SPACE FLIGHT CENTER (GSFC), Greenbelt, MD: GSFC will ensure that that all of the parties to this MOU carry out their respective responsibilities.
- NATIONAL SPACE SCIENCE DATA CENTER (NSSDC), Greenbelt, MD: NSSDC will monitor the archival process and ensure that the data are being archived in a manner that will benefit the science community at large.
- THE UNIVERSITY OF IOWA (Iowa), Iowa City, Iowa: Iowa will prepare all of the Cluster WBD data obtained during the mission operations phase for archiving, including validation of same and accompanying documentation.
- SOUTHWEST RESEARCH INSTITUTE (SwRI), San Antonio, Texas:

SwRI will act as the repository for the data and as the distributor of same to the science community.

#### **IV BACKGROUND**

The European Space Agency (ESA) Cluster spacecraft were launched in July and August 2000, with commissioning of the scientific payload on all four satellites taking place from September 2000 through January 2001. The official mission operations phase (MOP) began on February 1, 2001. The only scientific instrument on that payload that was funded solely by the National Aeronautics and Space Administration (NASA) was the Cluster WBD plasma wave receiver. A WBD instrument was mounted on each of the four Cluster spacecraft. Virtually all of the WBD data obtained during the Cluster mission up to the date of execution of this MOU have been obtained by direct downlink to the Deep Space Network (DSN) ground stations at Goldstone and Canberra and this is expected to remain the case for the duration of the mission. The WBD data can also be recorded onboard in a mode called Burst Mode 2, but this mode has been used only once in the mission because it prohibits one of the other wave instruments from taking data due to memory and processing considerations, and because Burst Mode 2 reduces the WBD resolution to 1/3 of its capability. Furthermore, Burst Mode 2 is allowed by the other instrument teams to occur only one hour per month.

Because WBD data are transmitted to the DSN ground stations at a very high bit rate of 220 kbits/s, and because the Cluster spacecraft are not always visible at Goldstone or Canberra, WBD data are obtained on a limited basis only. The NASA requirement of DSN since the start of the MOP phase has been to acquire two hours per spacecraft per 57-hour orbit, or approximately 24 hours of WBD data per week. A modification of this requirement in FY02 stated that these data were to be obtained simultaneously from as many of the four spacecraft as possible, on a best efforts basis. In addition, NASA requires DSN to perform at least one guaranteed multi-spacecraft operation (MSO) per month, or two MSOs on a best efforts basis. An MSO is a special operation that requires that WBD data be acquired from at least three or four spacecraft simultaneously for one hour with a pre- or post-operation calibration lasting 10 minutes being performed. The calibration consists of the WBD transmission from only one spacecraft being picked up by the three or four ground antennas that are being used in the MSO. The purpose of this calibration is to provide greater timing accuracy than can be achieved with a normal DSN support (10 microseconds).

Based on the above data retrieval requirements, approximately 0.2 TBytes of level 1 processed WBD data are produced each year. WBD data consist of one-axis ac electric or magnetic field time series in the range 50 Hz to 577 kHz with 5 to 35 microsecond time resolution depending on the mode. Information on the instrument and its various capabilities can be found in "The Wide-Band Plasma Wave Investigation", by D. A. Gurnett, R. L. Huff and D. L. Kirchner, *Space*

*Science Reviews*, 79, 195-208, 1997. Level 1 processing consists of the following for each WBD transfer frame (1096 bytes): unpacking the WBD status bytes, byte aligning the science data, and determining the time of measurement based on the onboard clock and on the DSN ground receive time stamp. Two time determinations for the start time of each WBD transfer frame are made for the following reason: the onboard clock time has an accuracy no better than 2 ms. Since the time resolution of the WBD data can vary anywhere from 5 to 35  $\mu$ s, the onboard time clocks are not sufficient when performing cross-spacecraft correlations, although they are sufficient for doing large-time scale science or when comparing WBD data to data from other Cluster instruments. When greater time accuracy is required, the 10  $\mu$ s accuracy afforded by the DSN ground receive time tags must be used. In obtaining the onboard clock time of measurement, only internal delays on the spacecraft from actual time of measurement to the time that a time stamp is applied by the onboard data handler are accounted for. When applying the DSN ground receive time tags, the time of flight as well as the spacecraft internal delays are taken into account. Information on internal DSN delays, which are very small, can only be accounted for during the MSOs when the special calibration is carried out. Iowa does not make compensation for these DSN internal delays during MSOs, but rather provides these data for anyone to analyze and apply the appropriate time correction. In addition, separate “WEC time correction files” will be made available by Sheffield University through the Cluster Active Archive. These files provide time corrections, based on data supplied by ESOC (European Space Operations Centre), which can be applied to the onboard time tags provided in WBD’s level 1 files that will allow for 10  $\mu$ s accuracy of these onboard time tags.

Once Iowa has created a level 1 data set described above, these data are validated through various tools developed at Iowa, and then the data are written to DVDs. In addition to the level 1 WBD data, these DVDs also contain documentation about the WBD instrument, example software to read the level 1 data files, sample calibration routines, and information on known problems. Since Iowa’s current NASA grant, NNG04GB98G, and its predecessor grant and contract did not provide for the archiving of Cluster WBD data, the level 1 WBD DVDs are currently only disbursed to the WBD Co-Investigators in the U.S. and to the Cluster data centers in France, Sweden and the U.K., where the Principal Investigators of other Cluster wave instruments reside.

## **V RESPONSIBILITIES**

The responsibilities and agreements of each of the parties to this MOU are set forth below.

NASA HQ: NASA HQ will agree that once Iowa has archived the Cluster WBD data obtained during the MOP phase of the Cluster mission in accordance with this MOU, Iowa will not be held responsible under any of its past, current or future grants for the archiving of the Cluster WBD data in any other form or at

any other location, unless agreed to advance with Iowa.

NASA GSFC: GSFC will ensure that all of the parties to this agreement are carrying out their responsibilities in accordance with this MOU. GSFC may request periodic written updates on the progress of the archival progress from Iowa and SwRI.

NSSDC: NSSDC will ensure, on behalf of NASA, that the data are being archived in a fashion consistent with NASA and scientific standards and that links to the data are provided through the NSSDC web site.

IOWA: Iowa, under its current NASA grant, NNG04GB98G, and any future related grants, agrees to send a copy of the Cluster WBD DVDs, as described in Section IV, to SwRI, for the period from the beginning of the MOP phase through the end of active operations of Cluster WBD. DVD shipments will contain one entire month's worth of data. Iowa will also provide assistance and information to SwRI in order for them to carry out their role as described below. Iowa accepts these responsibilities for as long as they are carrying out active Cluster WBD operations and processing new data. Completion of the delivery of these DVDs will relieve Iowa of any other responsibility for archiving the Cluster WBD data in any form at any other facility unless specifically funded to do so.

SwRI: SwRI will have the responsibility of ingesting the Cluster WBD data obtained on the Iowa DVDs into their IDFS database. These data, in calibrated or raw data number form, will then be made accessible and downloadable to the science community in ASCII or CDF format through a web interface. These data will become publicly accessible after Iowa has insured that the validations are good. Iowa will have at most six months for this validation activity after which time the data will be publicly available. Validation primarily concerns the time tagging of the WBD data as occasionally Iowa receives information from either ESOC or DSN that certain timing problems exist in the data during certain time periods, or Iowa uncovers systematic problems that are not apparent from a single data set, but from several data sets spread out over several months. Until the data are opened up to general access, SwRI will provide the capability for the Iowa Cluster WBD Principal Investigator, or his designee, to approve specific requests from scientists to access the data during the restricted access phase of any data set. SwRI will carry out these responsibilities under a NASA grant or contract. Proper execution of the MOU assumes that both Iowa and SwRI will be funded by NASA for performance of their respective duties. A lapse in funding to either Iowa or SwRI will require that the parties renegotiate this MOU. It is expected that the MOU will remain in force for as long as Iowa is still carrying out active Cluster WBD operations and obtaining new data.

## **VI GENERAL PROVISIONS**

PERFORMANCE GOALS: All parties to this MOU have agreed to work together

to provide an acceptable means of archiving the Cluster WBD data, as described in Section V. Within one year of the date of execution of this MOU, Iowa should have delivered to SwRI all WBD data obtained during the Cluster MOP phase up to the current time. After that current data will be delivered by Iowa to SwRI with a one- to two-month lag from receipt of current data to time of delivery to SwRI. During the first year after execution of this MOU, SwRI will write and implement the necessary software to provide raw or calibrated data through its web site. Thus by one year after the execution of this MOU, WBD data should be routinely available for the entire Cluster mission through SwRI, with new data being made available on a restricted basis within one to two months after data capture and on a general basis within six months.

PERFORMANCE REPORTING: GSFC may require Iowa and SwRI to report on their progress and performance, in writing, not more often than twice per year. If GSFC intends to request written reports, they will inform all parties of their intention and provide the details of the expected content of these reports.

CONTINUOUS IMPROVEMENT: All parties to this MOU will work to improve the processes being carried out so as to reduce the time needed for the archival work.

AMENDMENTS: Should amendments to this MOU be desirable or necessary, all parties should be informed by the initiating party of their desire to amend the MOU and the reasons for requesting an amendment. The amendment will need to be agreed to by all parties.

LONG TERM ARCHIVING SOLUTIONS: The parties agree to work together to find a long term solution to the problem of getting the WBD high resolution calibrated waveform data into the Cluster Active Archive (CAA), which is an archive of the highest resolution data from all Cluster instruments. Iowa has received funding from the Living with a Star Targeted Research and Technology Program to meet a small part of this objective. The funding will allow Iowa to archive all of its documentation on the instrument and its operations as carried out, as well as the overview spectrograms (typical WBD operations are 2-3 hours each) and full time resolution spectrograms (30 seconds each) in the CAA. The CAA, which contains all of the Cluster data, will eventually become a part of the ILWS program. The graphical WBD data, together with its documentation, will thus be available. It is Iowa's desire that the WBD data archived at SwRI be made available to the CAA and the ILWS program in the form of raw and calibrated waveforms. The possibilities for how SwRI will accomplish this needs to be explored with NASA HQ and NASA GSFC, with one possibility being that the SwRI web site act as a mirror site for the CAA web site. The long term goal is to provide a means for the high resolution WBD data to be available in both digital waveform and graphical form throughout the lifetime of the Cluster mission and for many years to follow as a part of NASA's Living With a Star Program.

**VI SIGNATURE**

By signing this Memorandum of Understanding, all parties have reviewed the MOU and find it accurately reflects a general understanding of their involvement in the archiving of the Cluster WBD high resolution data.

NASA Headquarters

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NASA Goddard Space Flight Center

Date

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National Space Science Data Center

Date:

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The University of Iowa

Date:

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Southwest Research Center

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