ARTHEMIS:
The Archive Project for the IPM and THEMIS

K. Reardon, G. Severino, G. Cauzzi, M.T. Gomez, T. Straus
Osservatorio Astronomico di Capodimonte, I-80131 Napoli, Italy

G. Russo
Dip. di Fisica, Università della Calabria, I-87036 Cosenza, Italy

G. Smaldone, C. Marmolino
Dip. di Scienze Fisiche, Università di Napoli Federico II, I-80125 Napoli, Italy

Abstract. We describe the plan for ARTHEMIS, the Italian archive for THEMIS, from the point of view of the prospective users of the archive. This archive is designed to store the data from the Italian Panoramic Monochromator (IPM) instrument installed on THEMIS as well as the full-disk images obtained by the telescope. We break the expected users down into seven categories: a) prospective IPM users; b) campaign planners; c) data analysts, d) external collaborators; e) instrument monitors, f) archival observers; and g) the general public.

1. Introduction

Solar data are somewhat particular with respect to their archival needs. The high photon flux of the sun means that solar data are limited primarily by the readout speed of the detectors used. Thus solar observations can produce a relatively larger data set each observing day when compared to most nighttime observations. As technology marches boldly onward creating ever faster detectors, the quantity of data produced will similarly increase. For example, the Italian Panoramic Monochromator (IPM) can currently produce a respectable 4 Gbytes of data per day, but that number could easily increase by a factor of ten within a few years. A solar data archive must be prepared to deal with such high expected data fluxes. The problem is not only the physical storage of such quantities of data, but finding a way to present the details of that data to the user in a synthesized and easily understandable way.

Moreover, a solar active region can be followed at most for two weeks, and even an “activity center” rarely lasts more than a few months, limiting the historical usefulness of the details of a particular observation. This is in contrast to an old photographic plate of a star field or galaxy which can be useful in establishing the variability of a particular star or the identification of a supernova precursor. However, because of the large numbers of active
regions and the regularity of the 11-year solar activity cycle, good statistics can be obtained in measuring general parameters of active regions or the global sun. Users of the archive are generally much more interested in these statistical parameters than in the details or full dataset from each observation.

These particular characteristics of solar data require some special considerations to be made in the planning of a solar database. See Messerotti (1997) in this proceedings for a discussion of the planning of solar archives. ARTHEMIS is being planned as an archive for the observations of the data from the IPM and the full-disk instruments on THEMIS. We have discussed some of the technical details of the planning of the ARTHEMIS archive in Reardon et al. (1997). In this paper, we will instead concentrate on the needs of an archive as seen from a user's point of view.

2. Archive Users

In order to plan the true requirements of the archive, we have considered the desired archive capabilities from the users' points of view. The ARTHEMIS archive aims to support a wide range of users, from those planning observations to those wanting to reduce already acquired data. We have broken down the projected primary users of the archive into seven different, but to some extent overlapping, groups and we discuss their needs and the intended services provided by the archive for each. The list is in rough order of importance for the initial stage of the instrument and archive.

A) Prospective IPM and THEMIS Users - These are users in the process of planning a set of observations. For these purposes, a complete manual detailing the use and capabilities of the instrument, including sample observations, will be made available online and in printed form. In addition, information on observing proposal procedures and archive of past accepted proposals, will be maintained. General solar resources such as spectral atlases and line formation information will also be made accessible online.

B) Campaign Planners, Observers - This group of users includes anyone who needs real time access to the current observations being made by THEMIS. For example, scientists planning any sort of observations with ground- or space-based instruments, will rely on the full-disk data from THEMIS in performing their target selection. In addition, for coordinated campaigns involving THEMIS, it will be important for the other involved parties to know, in "real time" the current target being observed at THEMIS. The high-resolution, full-disk images of magnetic field, velocity, and intensity will be an especially valuable resource for these two types of observers, who previously had to wait for the Kitt Peak observations to become available around 16 UT. To serve these purposes, the full-disk images, images of the current target, and the planned observing programs will be made available as soon as possible during each observing day via FTP or on the WWW site.

C) Data Analyzers - Once data has been obtained, either during an observing run or from the archived data, it will need to be reduced to produce
scientific-quality data. The standard reduction routines for the IPM will include dark-current, flat-field, and spectral-irregularity corrections, de-stretching corrections for seeing effects, velocity measurements, both horizontal and vertical, and fourier analysis techniques. These routines will be written in Interactive Data Language (IDL), the standard data reduction language for THEMIS. This full suite of reduction routines, derived from several years of use of similar instruments, will be made available for transfer to any user's home institution. User's will also be encouraged to come to the site of the archive itself at the Osservatorio Astronomico di Capodimonte in Naples to learn about the reduction of the IPM data. It may also be possible that a user will be able to have some basic reduction of the data performed before they are made available for downloading.

D) **External Collaborators** - Many users turn to data archives in the search for complementary observations for a dataset they already have on hand. This is often the case when analyzing flare observations, for which additional information is essential for full understanding. For these users, full searching capabilities of the complete observations catalog is essential. This catalog will include most of the information included in the FITS header of each image. In addition to the catalog data, at least one example observation from each observing day would allow a quick evaluation of the data without the need to load data from offline storage.

E) **Instrument Monitors** - Several groups of users will want to monitor the performance of the instrument over time. The technicians and resident scientists at the telescope need to be aware of any day to day variations in the instrument. A measure of instrument degradation over time will allow timely replacement of aging components. In order to correct for instrumental contributions, long term changes in the instrument will also be important to those attempting to measure the variation of solar parameters over the solar activity cycle. The measured instrumental parameters, including wavelength drift, CCD dark and read noise, shutter performance, and spectral transmission, will be derived from daily routine calibration procedures and stored in the online catalog.

F) **Archival Observers** - One of the main advantages of a data archive is the ability to measure certain solar parameters over a long time period, generally spanning a significant fraction of the solar cycle. The planned routine observations to be made at THEMIS and the integration of these data into the archives, makes this type of "archival science" particularly attractive. Currently it is planned that THEMIS will, weather permitting, make a full disk image each morning in several different solar parameters, Na D1 intensity, line-of-sight velocity, line-of-sight magnetic field, continuum intensity, and Hα intensity. As has been demonstrated in numerous papers by Howard (for an overview, see Howard, 1992), numerous interesting quantities, such as sunspot sizes, locations, motions, and field strengths, can be extracted from such a long time series of data. The simultaneous and strictly cospatial and cotemporal measurements of intensity and magnetic field strength with the same instrument should allow a good comparison of parameters derived from these two different types of data.
In addition, it is proposed that a set of standard observations of the quiet sun be made on a daily or nearly daily basis with the highest resolution of the telescope. Such a series of observations, taken over the solar cycle, would be a unique dataset for measuring variations of the “quiet-sun” with solar cycle. Such variations have been detected previously (for example, Muller and Roudier, 1994) and may play an important role in the perceived variation of magnetic flux with solar cycle. For example, the question remains whether the total magnetic flux at the solar surface changes significantly during the solar cycle, or whether it is merely redistributed into small-scale magnetic elements during the minimum. In addition, granular properties, such as mean size, fractal dimension, and separation, could be caused by cyclical changes in the underlying convection zone, which could in turn affect the propagation and reflection of p-mode waves. These changes could also influence more global properties, such as total solar irradiance. We plan to select a wide range of parameters to extract from the various types of data and perform reduction automatically on each image when it arrives at the archive.

G) General Public - An archive serves not only as a resource for the scientists using the instrument, but also as a source of information for anyone interested in solar physics in a more general way. It is always advantageous to engage the general public in the excitement and usefulness of doing scientific research. The archive will have an educational section with general descriptions of solar physics and the key research projects in which THEMIS is engaged. Such outreach programs will help THEMIS researchers address a larger audience.

3. Discussion

An archive, just like the telescope(s) it supports, benefits greatly by taking into account the needs of the prospective users in its planning. Solar data in particular, because of their great quantity and their statistical rather than detailed archival uses, need to be incorporated in a usable way into a database. Both ARTHEMIS, and the related French archive BASS-2000, are benefitting from being planned contemporaneously with the THEMIS telescope and its instruments. By planning an archive from a user's point of view, we hope to create a resource that is truly useful for the greatest number of researchers.

References

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Muller, R. and Roudier, T., 1994, Solar Physics, 152, pp. 131-137