Themis, Engineering Peer Review – October 17, 2003 ‘Final 10/24’
Gary Swenson, U of Illinois
(Chair)

General. The review was conducted with quality information available in both overheads and had out format. The details of the system were well engineered with the experienced team at UCB including well calibrated and rugged all sky camera (ASC) and the UCLA magnetometer system, including detailed considerations of environmental accomodation.

Important comments:

1) The ASC data is planned for 1 s integration time (IT) taken at 5 s intervals. Running asynchronously would result in a +-5 s wash in composite images. ASC data should be synchronized to the GPS clocks which are relatively accurate to ~1 ms. In principal, the exposure should be synchronized to ~10% of the exposure time, or 100 ms. The only ‘wash’ in composite images would come from spatial assumptions rather than temporal sampling.
2) Keograms should be a daily data product. 1 min temporal accuracy should be adequate. The keograms can be used for star events. A pixel field of view (FOV) is ~.6o. At mid latitude, the starfield rotates through the field at a rate of ~ 2o per hour or .005 degrees in 10 secs, or .03 degrees in 1 minute. Since the pixel FOV>> star movement, 1 minute keograms will view all stars going through the field of view.
3) Image clarity information is important. Star presence, and better yet, transmission are invaluable. It is also notworthy that most all the cameras will view the same star field, and this may be used to cross calibrate relative sensitivity—even with just one start! It may be that rather than ‘machine vision’, a FFT of images or keograms would reveal clarity information.

Other minor comments are:

1) Operations. In accomplishment of the prime objective, the first ‘alignment’ of satellites combined with the occurrence of a substorm, and clear skies over Canada/Alaska will provide a key opportunity of analysis. Planning data gather and analysis for this event including the transfer of full resolution images back for the 1 hour substorm period will be important.

2). A lot of correlative information will also likely be available from radar’s etc. for a special, well observed event. An obvious way to bring this information together may be through a workshop.

3) EPO—Web pages are important and can reach a large number of people. But, we in experimental research have an opportunity to get youngsters involved-albeit maybe only few—in experimental operations. We should try—in the site schools to do this.

4) Mitigation of power loss risk. Thought has gone into this—and onsite people to call are in the plan. The insulated boxes are good solutions to environmental protection. One afterthought may be to include some vessels filled with ethelyne glycol as filler if there is room, to increase the thermal capacitance of a system with high likelihood of power interruption.

Hans Nielsen, University of Alaska

The Ground Based Observatories (GBO) planned for the THEMIS satellite mission represents an ambitious program. Success is likely given the proposers' excellent experience and track record. The documentation at the Review was good and we were presented with a well thought out experimental program that is likely to accomplish not only the THEMIS mission, but will also provide a wealth of data for auroral research in general. I applaud the team for their emphasis on a web based real time delivery of sufficient data to allow users to get an immediate impression of what is going on and what data will be available for a given event. The outreach effort is an important aspect of this effort. The equipment, based on years of experience, appears to be well designed.

Equipment:

1. Field testing of equipment important. The presented plan seems adequate.

Field installation:

1. At some sites (primarily high arctic) local animals will get so starved in winter that they will try to eat any exposed cables. Thoughts should be given to bury and shield external cables. There is also general safety precautions against animals (and, unfortunately, more often humans!).
2. All sky dome will collect snow and frost on the outside. At least the sites in Alaska are low wind sites and hence, the wind cannot be relied upon for keeping snow off the dome. Plans should be made for having a local caretaker on hand to check the site. Finding a caretaker can be difficult (and expensive).
3. Power at remote sites often of low quality. There are often frequent outages, and there are variations in voltage and frequency much beyond what is experience on large power grids. Power surges are frequent.

Data:

1. It was mentioned that sky quality can be assessed using the stars in the all sky (white light) images. I doubt that it is possible on the all sky image alone automatically to differentiate between say haze and auroral weil. It would be nice with an index giving sky conditions.
2. With the large number of stations in operation it would be desirable to have a formal log giving station status including equipment serial numbers, program version in use, upgrades installed, caretaker visit including what was done, etc. Such a log is important for both trouble analysis as well as an aid later in resolving critical data analysis issues. Archiving and updates to the log should be automatic (i.e. not rely on someone at home base).
3. 1 minute keograms and mag displays available and archived for all stations.

Operation and Archive:

1. The planned implementation of the station network over a few years prior to the actual mission will provide time for addressing all the issues that inevitably will come up.
2. Data should be synchronized if at all possible.

Rick Sterling, UCB

Following are my comments and suggestions from the Friday Themis GBO Review.

1. Overall.
The overall plan seems good. Ground based observatories will provide a powerful enhancement to the Themis multi-probe investigation.

Early deployment, beginning this coming winter, is good idea and will help greatly toward goal of reliable operation during the official Themis mission.

2. Data Acquisition.
I concur with suggestion to do synchronous sampling at the different observatories. If the observatories have common hardware and software, this should follow.

The "real-time" transfer of image "thumbnails" sounds fine and will provide valuable quicklook information and help encourage interest. However it will be important to aim for the capability to also transfer user defined science information (entire images). Ideally the data should be indexed by time and a user could log on and download images from a certain period of time. If this capability was included, it would allow scientists to select and quickly receive images to compare with an event seen at the satellite constellation. It will be less than optimal if the raw science data is only accessible by entire swap of hard disk.
Another exciting option is data characterization and transfer of this information in realtime data set.

3. Hardware and Deployment
Regarding computer hardware, good idea to find computer system with more durability. The testing of the "data brick" indicates this is being appropriately studied and tested. PC104 single board computers might be considered since they have proven capability in wide temperature conditions, are low power consumption and relatively reliable.

It may be worth considering a UPS with hard boot (hardware reset) capability.

If the thermal requirements in winter are 165W to maintain temperature in winter, I suggest trying to improve insulation.

4. Conclusion.
Overall plan and direction seems good. It is nice to be able to do field testing ahead of time. Its also good knowing that there are a variety of data transfer options.

NASA - Explorers Program Office, Bill Davis and Dennis Lee

Request for Action:
Establish GBO Systems level documents to include:
- System Requirements Specifications

Purpose -Flowdown level 1 and level 2 requirements
-identify verification and environmental test requirements
-identify timing, latency, power, data roles, communication performance requirements.
-identify reliability and quality control

-System Interface Requirements Document

Purpose -document major system interfaces with science data center
-identify component interface requirement
identify GBO and EPO interfaces

-System Test Plan

Purpose -identify system test requirements
-identify component test requirements