Control, Monitoring and Analysis Software for the VERITAS Array

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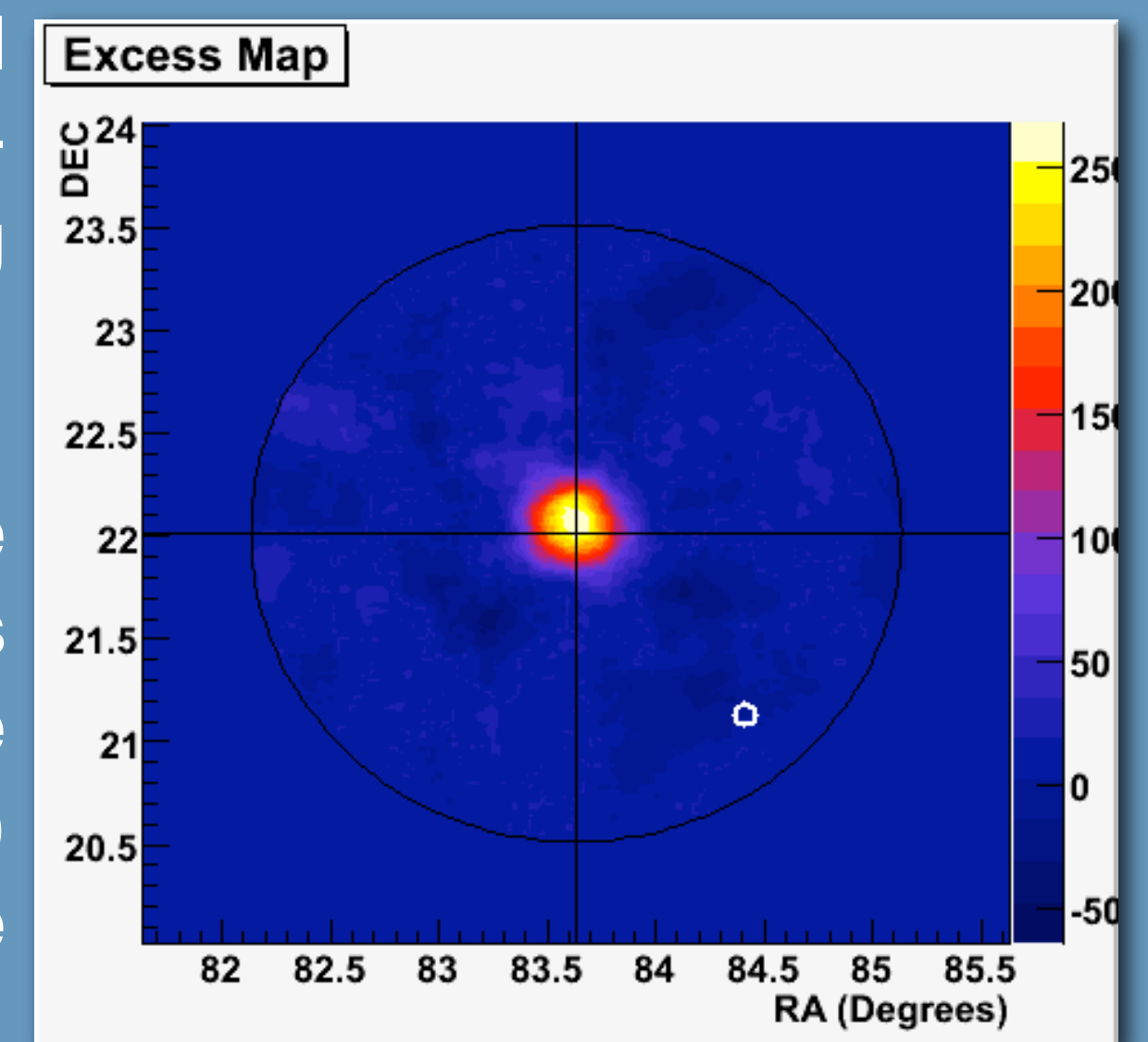for the VERITAS Collaboration[2]

ABSTRACT

VERITAS is an array of four 12 m diameter Atmospheric Cherenkov Telescopes located in southern Arizona operating since January 2007. In this contribution we discuss the various software systems needed to operate the array including the data acquisition, online analysis, real time hardware monitoring and offline analysis.

Data Acquisition

Inter-process communication is handled via a common Corba[3] interface. All code is developed using C++ and Zthreads[4] on top of customized versions of Linux.

Yellow indicates data flow while black indicates trigger/signal lines. The analog triggers are passed between L3 and L2 via fiber. Internal data transfer within telescopes is via an SCI bus while external data flow is via gigabit ethernet.

Once the data reaches the local archive, it is transfered to the UCLA archive via bbftp[5] over ssh. bbftp is an open source file transfer program optimized for large data files.

Online Analysis

The Harvester software contains an integrated online analysis that actively monitors the data stream to provide instant feedback to the observers. It reports preliminary results during data acquisition including the trigger rates at all Levels (1 - 3) as well as the Gamma-ray Rate and Significance. Since the analysis is built in to the Harvester code, it is very fast and stable. This code not only allows us to diagnose problems but informs us of any signal immediately. The online analysis is also used as a verification of the final detailed offline analysis.
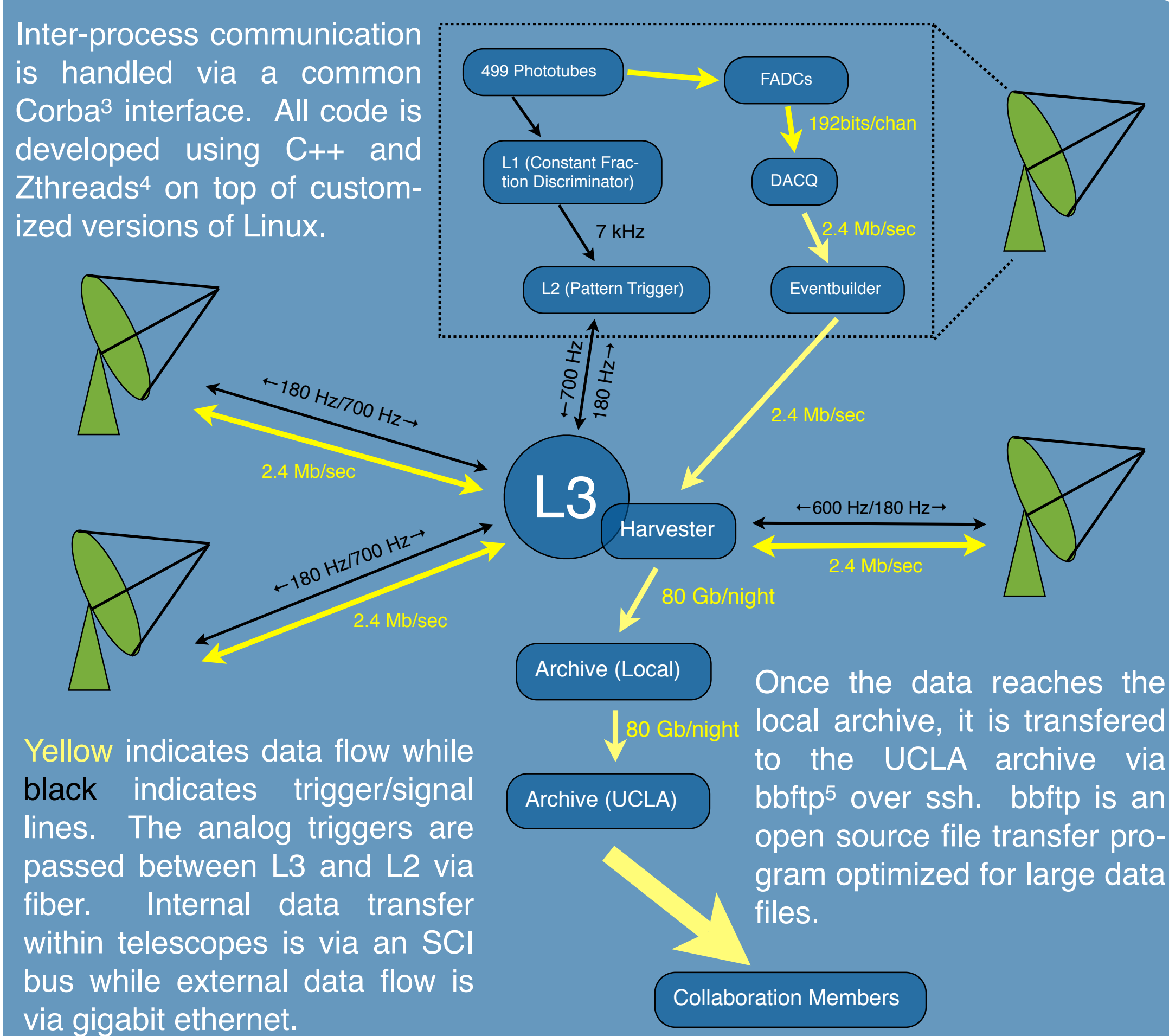
Offline Analysis

The VEritas Gamma-ray Analysis Suite (VEGAS) performs a detailed offline analysis of the data. VEGAS has over 70,000 lines of C++ code and is based on the Root data analysis framework[6]. The data are processed through six stages from calibration determination and application, single and array event parameterization, event selection and results, statistics and visualization. In addition to the standard VEGAS analysis package, several independent analysis systems are used to provide secondary platforms for cross-checking and development.

Detailed monte-carlo simulations (GrISU[7]) are used to calibrate VERITAS. The simulations model the shower (using CORSIKA[8]) all the way from the initial photon (or cosmic-ray) through the detector electronics and produce files readable by the analysis packages.

Quality Control and Real Time Monitoring

Variable	Records	Recording Rate
High Voltage	2000	Once a Minute
Currents	2000	Once a Minute
Tracking Information	4	4 Time a Second
Level 1 Trigger Rate	2000	Once a Minute
Level 2 Trigger Rate	4	Once a Minute
Level 3 Trigger Rate	1	Once a Minute

The data acquisition and online analysis records all observable quantities to a mysql[9] database. This detailed accounting allows for offline calibration and daily quality monitoring. There are two separate systems, one which focuses on the trigger rates and event distributions and another which details the status of the pixels. Both systems are web-based and automatic.

The Array systems (over 70 computers) are automatically backed up and restored upon failure using another open source package called BackupPC[10]. A recent snapshot of the system showed 69 full backups totaling 714.57 Gb and 204 incremental backups totaling 253.55 Gb but the actual drive space used is only 216.06 Gb due to pooling and compressing.
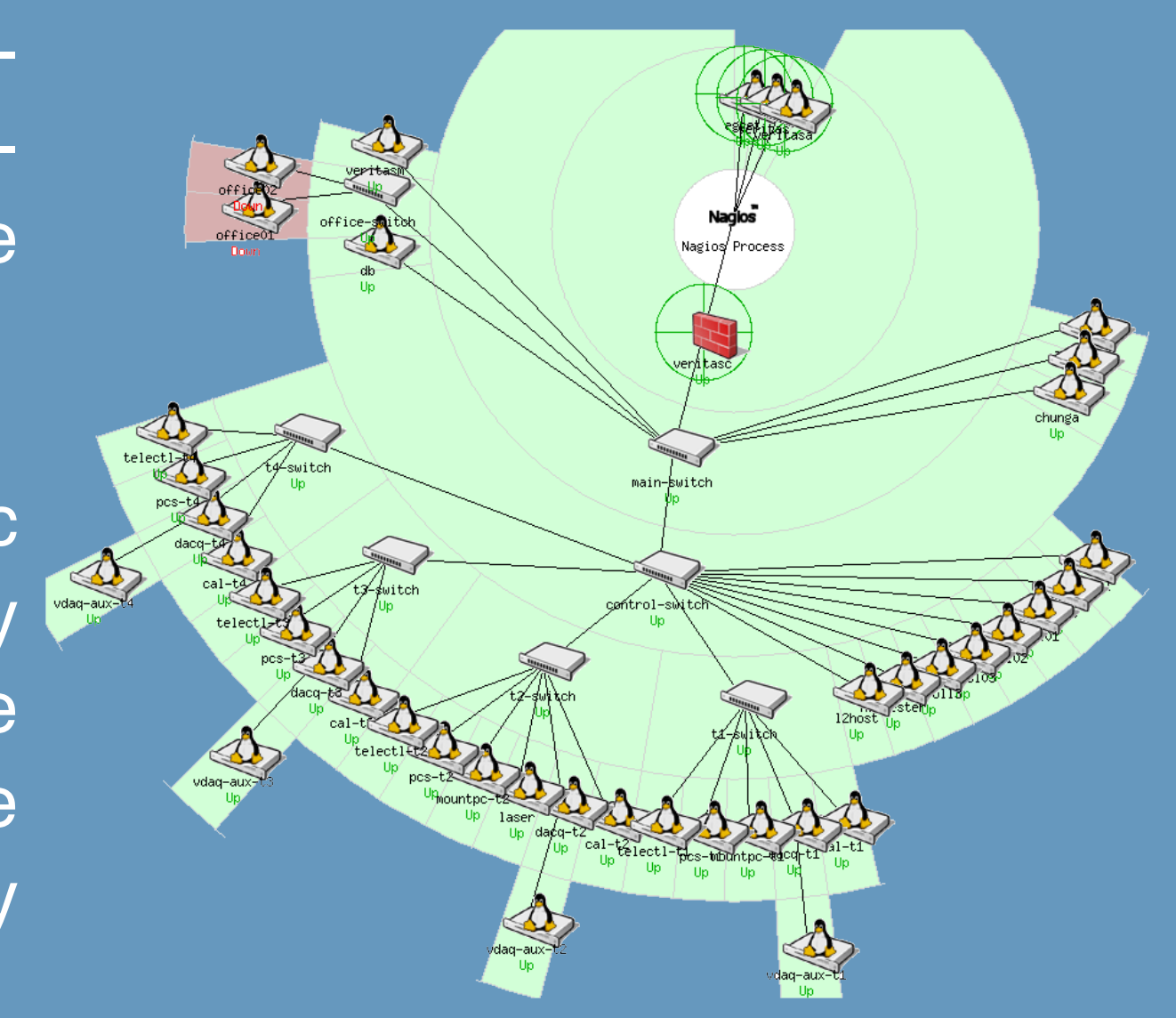
The status of the Array system (services, disc space and alive status) are continuously monitored using Nagios[11], an open source network monitoring package. This service automatically notifies the local staff of any failure via email and text messages.

Status and Outlook

Now complete, VERITAS is in year one of two scheduled operating years at the Whipple Observatory temporary site. The four key observing projects are a Galactic Plane Survey, Dark Matter search, SNRs and Blazars with additional time scheduled for individual group proposals and engineering. For more details on the performance and status of VERITAS, see D. Kieda's talk[12].

References and Acknowledgments

1. Fred Lawrence Whipple Observatory, Harvard-Smithsonian Center for Astrophysics, perkins@egret.sao.arizona.edu
2. VERITAS is supported by the U.S. Department of Energy, the National Science Foundations, the Smithsonian Institution, by NSERC in Canada, by Science Foundation Ireland and by PPARC in the U.K. For a full list of members, see http://veritas.sao.arizona.edu
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4. http://zthread.sourceforge.net
5. http://doc.in2p3.fr/bbftp/
6. http://root.cern.ch
7. http://www.physics.utah.edu/gammaray/GrISU/
8. http://www.ik.fzk.de/corsika/
9. http://www.mysql.org
10. http://backuppc.sourceforge.net
11. http://nagios.org
12. D. Kieda, "Status of the VERITAS Gamma-Ray Observatory." GLAST Symposium 5.2, Tuesday, February 6.