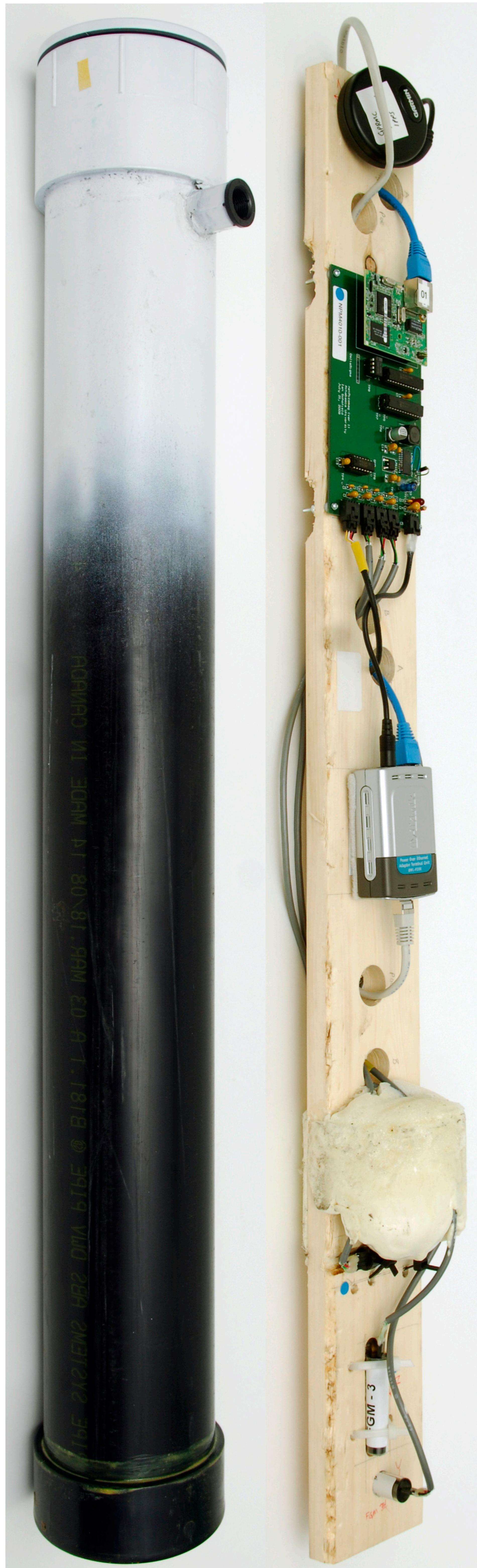

photos: Blaise MacMulin

netPICOMAG: a low-cost turn-key magnetometer for aurora detection

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netPICOMAG (or NPM) is the latest development in Athabasca University's ongoing low-cost magnetometer project, which aims to produce a 500 dollar magnetometer that can measure 1-nT magnetic perturbations at 1 Hz. NPM is a networked, self-contained, compact fluxgate magnetometer requiring zero maintenance and minimal installation skill. Although it has applications in research or industry, it is currently being targeted as a teaching tool for science education as an "aurora detector".

PHYSICAL DESIGN

NPM is a 4-foot by 4-inch ABS tube that is buried vertically into ground in order to thermally isolate the temperature-sensitive fluxgate magnetometer sensors located near the base of the tube. A polyurethane foam plug is formed directly above the sensors to further insulate the sensors from any heat generated by the electronics. The top of the tube is painted white to reflect solar radiation during the day that may cause internal heating.

Communication and power is carried over a single Cat 5E "Ethernet" cable configured for Power-over-Ethernet (PoE). The unit is partially buried, as shown below, in order to allow GPS signal reception (the black disk shown at the top of the mounting board on the left). A weatherproof RJ-45 connector connects the PoE cable to the NPM housing.

SENSORS AND ELECTRONICS

The heart of NPM is its three Speake and Company FGM-3 pulse count magnetic field sensors (www.speakesensors.com). Three sensors are oriented to measure magnetic field strength (in nT) of each of the field components (X, Y and Z) of the magnetic field. The FGM-3 emits a TTL-conformant (0-5V DC) digital pulse stream whose frequency is non-linearly proportional to field strength, and can detect field variations as small as 1 nT. The FGM-3h offers a 2.5x boost in sensitivity at the expense of dynamic range, thus the sensor can detect magnetic perturbations as small as 400 picoteslas. The NPM uses the less sensitive FGM-3 to measure the relatively strong Z component, while FGM-3h sensors are used for the X and Y components.

Frequency measurement is performed by two PIC 18F252 microcontrollers configured to perform pulse counting. A Garmin GPS 18 LVC GPS engine provides a precise 1 Hz signal used as the frequency time base as well as date and time data via its NMEA 0183 data stream.

A Rabbit Semiconductor RCM4010 core module (www.rabbit.com) serves as NPM's microcontroller as well as performing network communication via its on-board network controller. The microcontroller, frequency counters and associated electronics are mounted on a custom-built PCB designed to fit within the tight space requirements of the NPM's 4-inch diameter tube housing.

photo: Danny Ponomar

OPERATION

Once the NPM is buried and aligned, and the PoE cable is buried and connected to power and network, it can be powered up. After the GPS gets a satellite fix and produces the 1-pulse-per-second signal, data collection begins. The NPM sends buffered data every 10 seconds as UDP datagram packets to a data logging server, where it is archived and plotted nightly. Data can be viewed at:

http://autumn.athabascau.ca

The sample data shown below show data collected December 7, 2008 at the Athabasca University Geophysical Observatory (AUGO), in Athabasca, Alberta. The data has been scaled and offsetted in order to show how it correlates with data from a calibrated fluxgate 1-Hz magnetometer at AUGO.

FUTURE APPLICATIONS

Although science outreach is the primary goal of this project, it is hoped that future versions of NPM will find uses in research. NPM's exceptional price to performance ratio could encourage researchers to develop spatially dense magnetometer networks in regions that are currently sparsely covered.

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