A Compact Weather Station for Monitoring Environmental Effects on Beam Properties and Equipment

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ABSTRACT

A compact and mobile weather station has been designed and integrated with EPICS to assist with environmental monitoring at the Australian Synchrotron. This proved invaluable in correlating the dependence of the Storage Ring RF phase with humidity.

The device is based on Arduino technology and consists entirely of substitutable parts allowing for easy repair and maintenance by people with any degree of technical skill. The project aim is to deploy several of these devices throughout the facility to enhance the understanding of environmental effects on beam properties and equipment.

BACKGROUND

When considering how to design the weather station, it was essential to try and make it as simple and functional as possible while being low-cost. For this reason the Arduino open-source electronics platform was chosen for the plug and play hardware, simplicity of programming software and pre-existing code availability. The initial prototype utilised an Arduino Uno with an Arduino Ethernet Shield along with a DHT22 temperature-humidity sensor and a BMP085 digital, barometric pressure sensor. When choosing these sensors, it was important to take into consideration the operational specifications which are outlined in Table 1 and Table 2 below.

Table 1: BMP085 Technical Data

Pressure Range	300 – 1100 hPa
Pressure Accuracy	± 2.5 hPa, max
Temperature Range	-40°C - +85°C
Temperature Accuracy	±2°C

Table 2: DHT22 Technical Data

Humidity Range	0 – 100%RH
Humidity Accuracy	± 5%RH
Temperature Range	-40°C - +125°C
Temperature Accuracy	±0.2°C

One practical concern when designing the final weather station device was the capability to isolate/minimise radiation damage. To this end the sensors are housed in their own case separated by a cable from the Arduino and its housing unit. This will allow the sensors to be placed near and/or within the plane of radiation of the beam inside the tunnels while potentially minimising the damage to the Arduino itself. Any faulty sensors will therefore be easily replaceable, restoring functionality to the whole module with minimal effort due to the plug and play nature of the device.

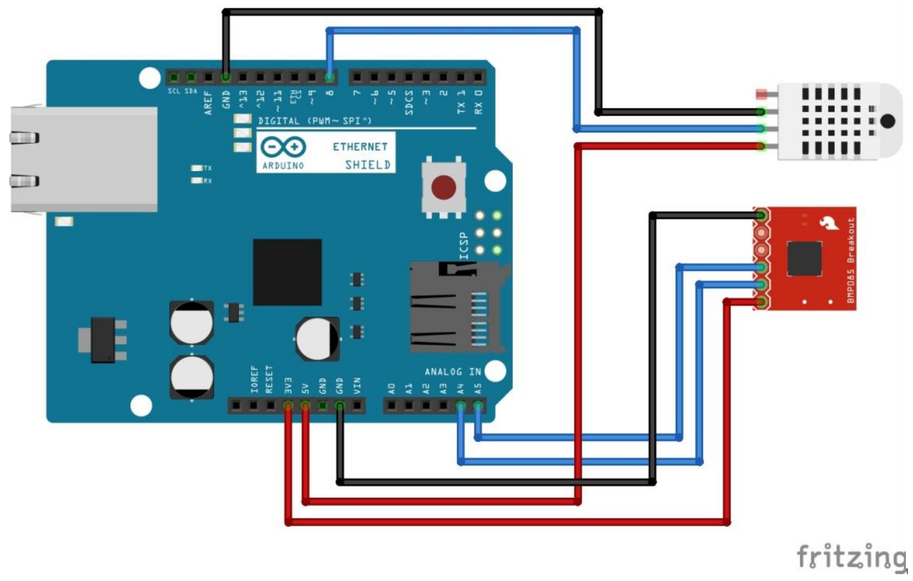

Figure 1:Circuit Diagram

To assist with data storage and retrieval, the whole device was hosted on an IOC to allow integration with EPICS. This removed the need for a real time clock from the device as all data is now saved with a time stamp, as well as enhancing diagnostic capabilities as demonstrated by the correlations in this presentation.

APPLICATIONS

One of the first correlations discovered was the relationship between beam phase and humidity in the technical hall. It can be clearly seen in Figure 2 below that there is a direct relationship with the humidity leading the phase of the beam.

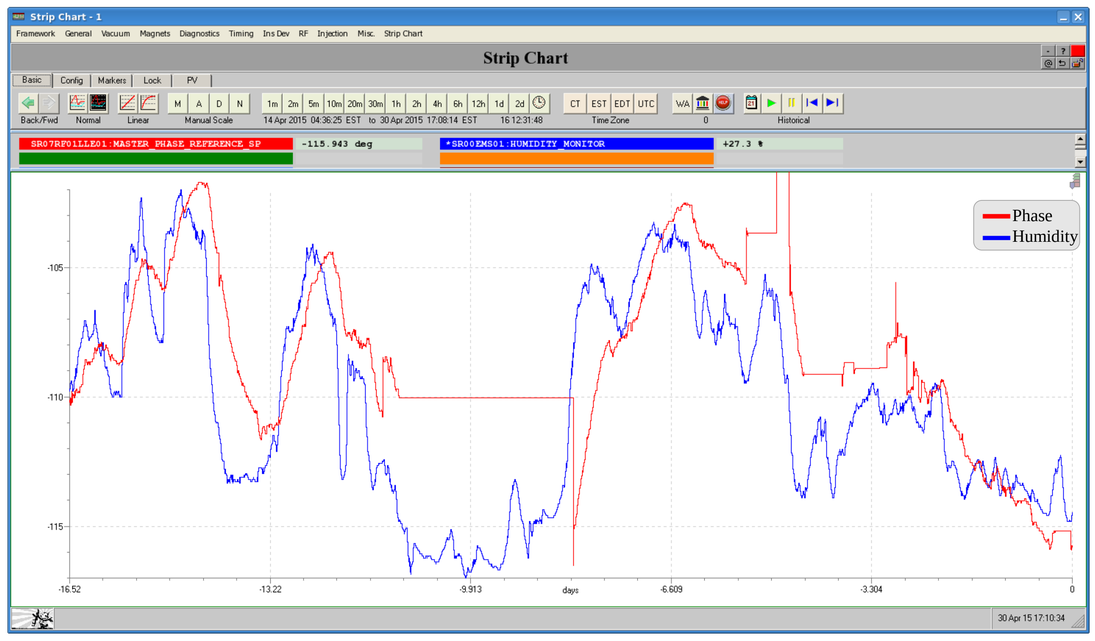

Figure 2: Humidity and Phase vs Time

Another correlation discovered was between the humidity and the vacuum in the LINAC. Although this has been a known issue for some time, until the development and deployment of the weather station module there has been no way to determine the extent to which this correlation occurs, as shown below in Figure 3.

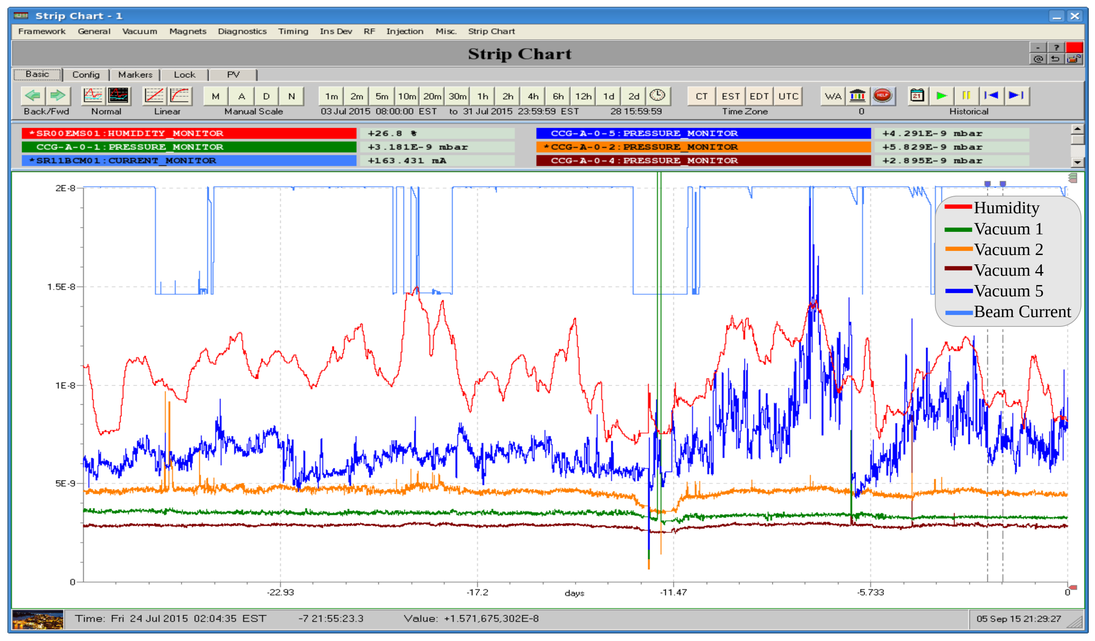

Figure 3: Humidity and LINAC Vacuum vs Time

FUTURE DEVELOPMENT

The correlations presented here show the need for further investigation into the links between atmospheric effects and beam characteristics. The second generation of this device is currently being built with a Freetronics EtherTen module which has power over Ethernet capabilities, eliminating the need for plug packs and proximity to power outlets once deployed. There is also development underway on some in-house support software. The software being developed will allow for future devices to be distributed and integrated into EPICS with ease, in line with the plug and play intent of the overall project. This has the benefit of enabling personnel with any technical skill or knowledge level of to maintain and distribute any future devices.