A COMPACT WEATHER STATION FOR MONITORING ENVIRONMENTAL EFFECTS ON BEAM PROPERTIES AND EQUIPMENT

S. Cunningham#, R. Clarken, A.C. Starritt, Australian Synchrotron, Melbourne, Australia

Abstract

A compact and mobile weather station has been designed and integrated with EPICS (Experimental Physics an Industrial Control System) 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.

INTRODUCTION

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 [1] platform was chosen for the plug and play hardware, simple programming software and pre-existing code available online. The initial prototype utilised an Arduino Uno with an Arduino Ethernet Shield along with a DHT22 temperature-humidity sensor and a digital BMP085, 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 [2]

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

Table 2: DHT22 Technical Data [3]

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

Deployment

One practical concern when designing the final weather station device was the capability to isolate and therefore 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 allows 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 demonstrates the simplicity of this setup.

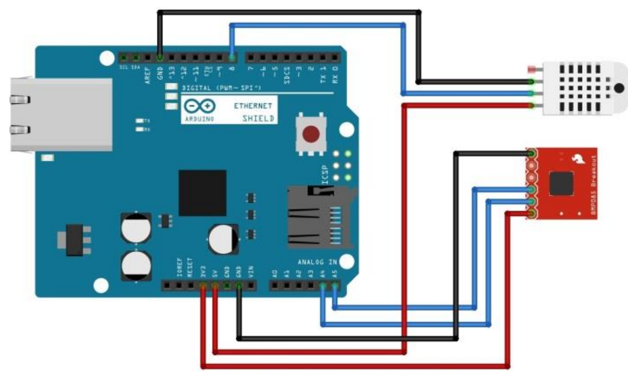

Figure 1: Weather station setup.

To assist with data storage and retrieval, the whole device was hosted on an Input-Output Controller (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.

CORRELATIONS DISCOVERED

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

Another correlation investigated was between the humidity and the vacuum in the linear accelerator (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 see (Fig. 3).

#Simon.Cunningham@synchrotron.org.au

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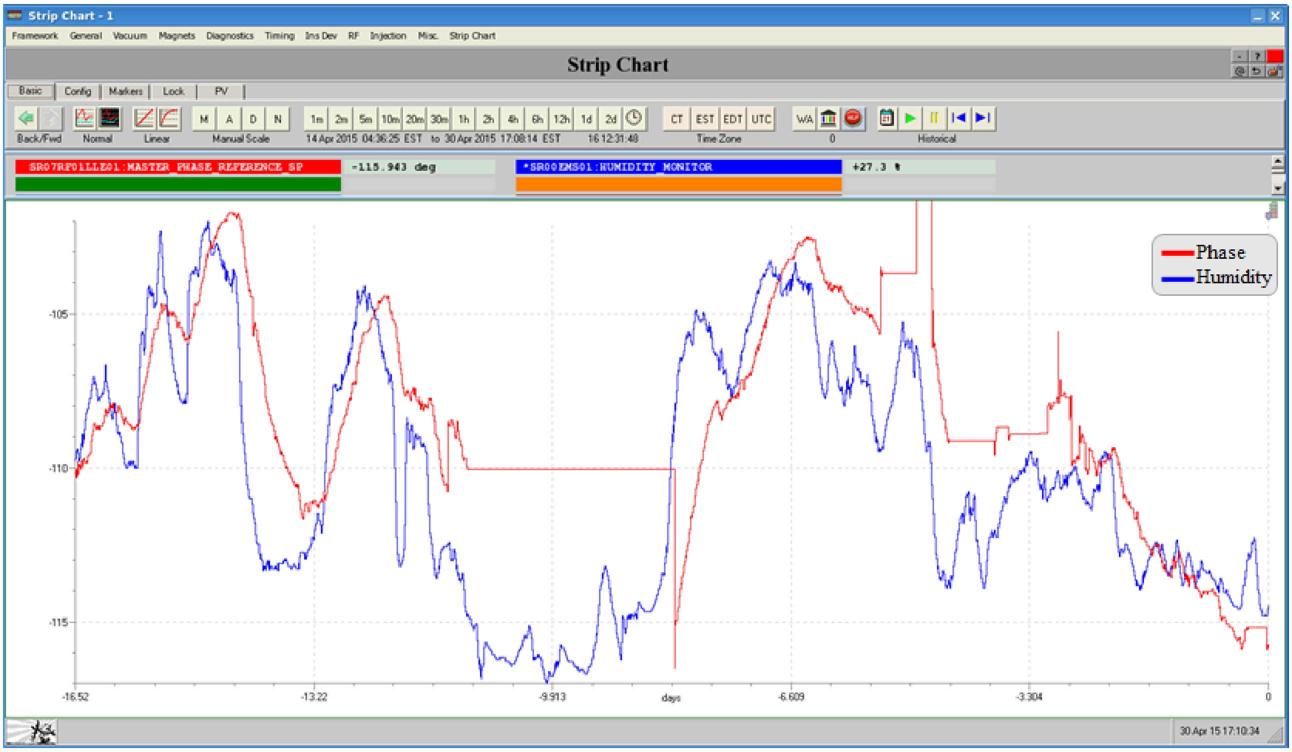

Figure 2: Humidity and phase vs. time.

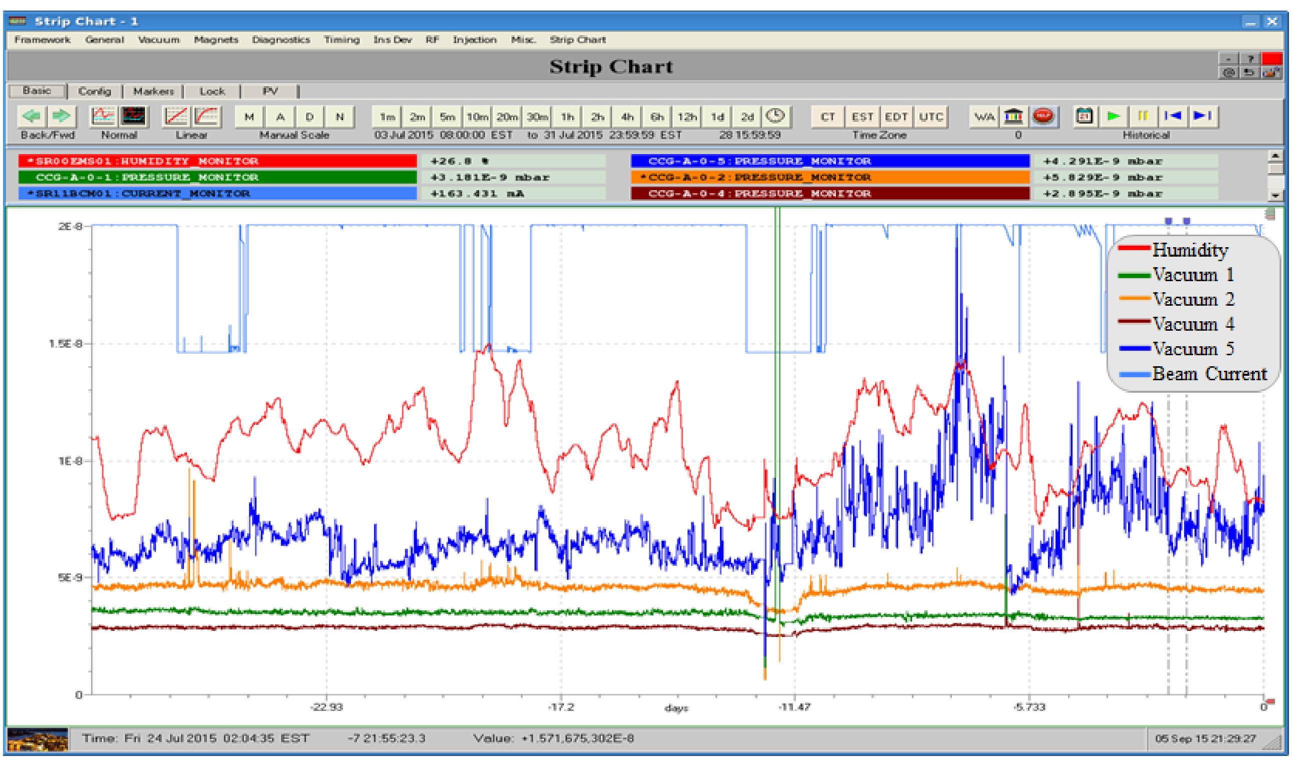

Figure 3: Humidity and LINAC vacuum vs. time.

SECOND GENERATION

The second generation of this device is currently being built with a Freetronics EtherTen module [4] 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 to maintain and distribute future devices.

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CONCLUSION

A first generation compact weather station has been built and used to discover atmospheric effects between the technical hall and the machine components. A second generation model is currently being developed with the capacity for power over Ethernet, allowing for greater mobility.

Work is also underway on developing code to allow existing and future models to be easily integrated into EPICS.

The correlations presented here show a need for further investigation into the links between atmospheric effects and beam characteristics.

REFERENCES

[1] Arduino website: https://www.arduino.cc/
[2] Bosch, BMP085 Digital pressure sensor data sheet, 15 October 2009
[3] Aosong Electronics Co. Ltd, DHT22 Datasheet
[4] Freetronics website: http://www.freetronics.com.au/

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