

Development of a Data Acquisition System for the CM of a wind turbine

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Summary:

- Background and motivation for research.
- Overview of system design
- Update on the progress of the Data Acquisition Platform.

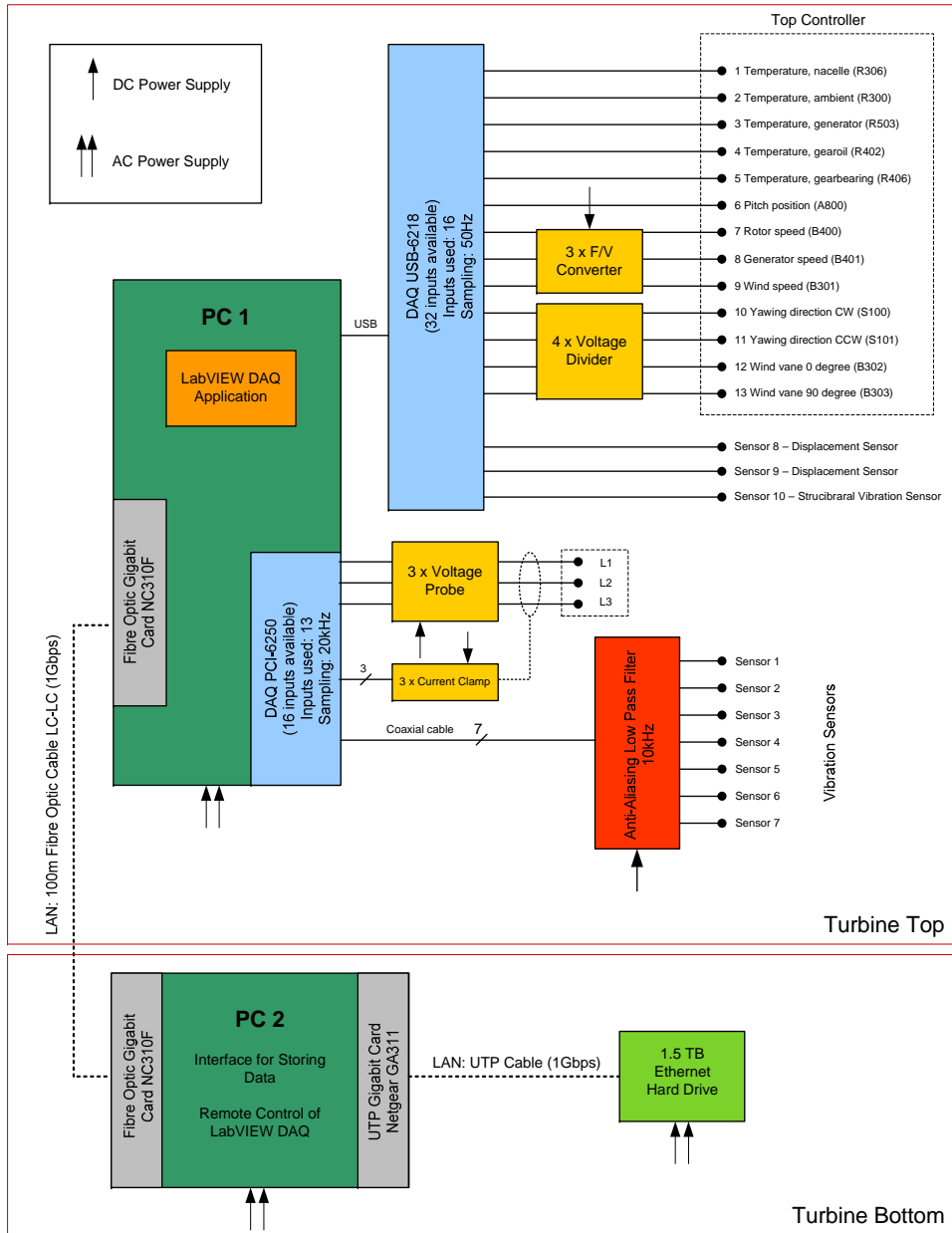


Background

- CM for wind turbines is becoming increasingly popular in industry.
 - Allows operators to plan effective maintenance schemes and maximise profits
- CM for wind turbines is yet to mature
 - There is no definitive standard for wind turbine CM system yet.
 - Wind farm operators do not use the output of their CM systems
- Purpose of this research is explore this avenue by developing a CM system that monitors as many parameters as possible at a high frequency to decide what should be monitored.

Data Acquisition Platform Requirements

- Should not affect normal operation of the turbine
- Should enable easy access to the machinery and pose no danger to maintenance engineers
- No electrical connections between top and bottom DAQ devices
- Isolation barrier for direct connections to the controller?
- Data Acquisition control and data collection at the bottom of the wind turbine
- Compact and easy to analyse data format
- Hot-swapping hard drives for data collection



Data Acquisition Platform Layout

To be installed on a Vestas V47 (660kW) WT at Harehill

Building the DAQ Platform:

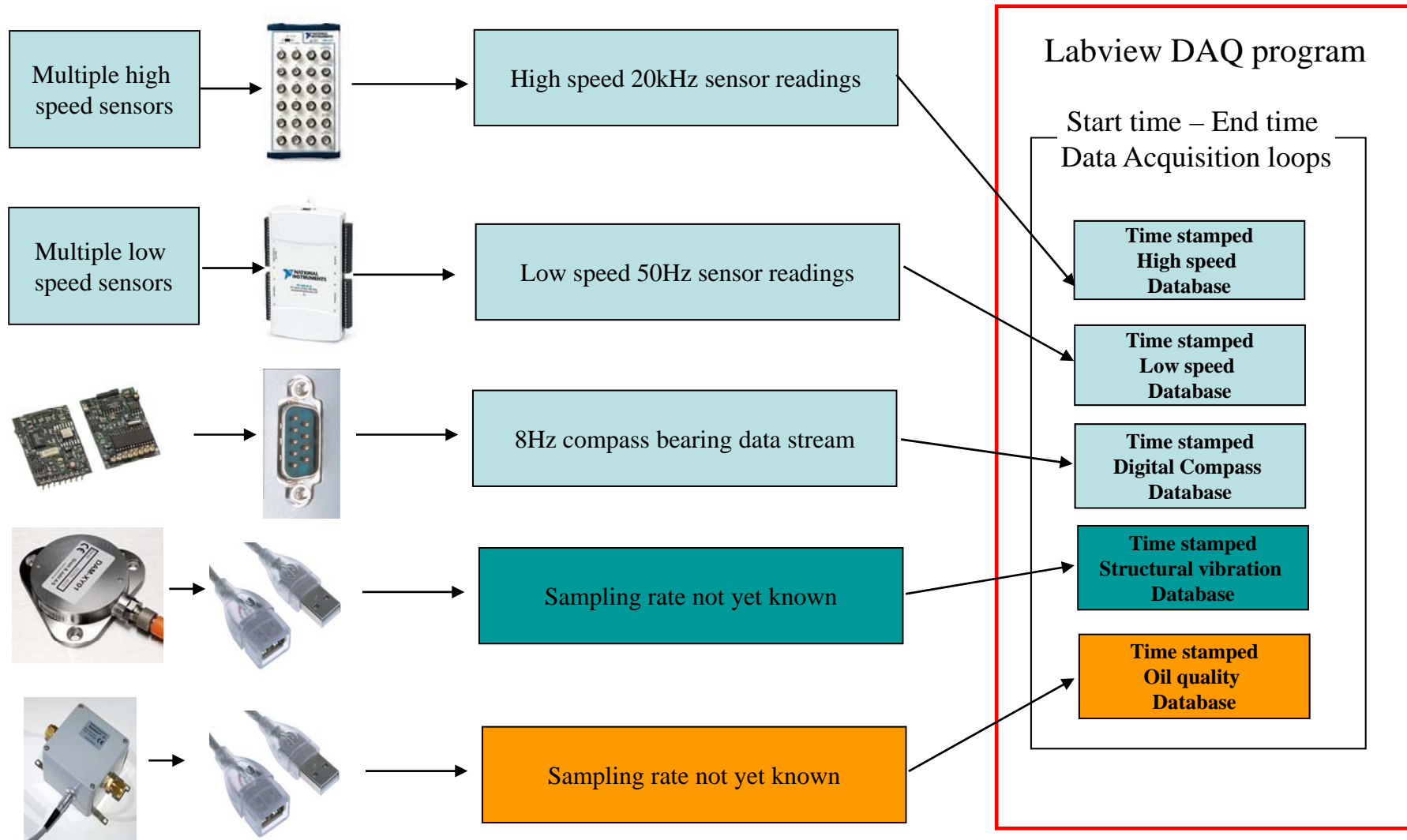
- Design of physical setup so that it conforms to operational and safety regulations.
- In order to do this we must anticipate conditions and scenarios the system may be exposed to and must be capable of handling
- The aim is to put together a working prototype in the lab as a demonstrator for Scottish Power to gain their approval.



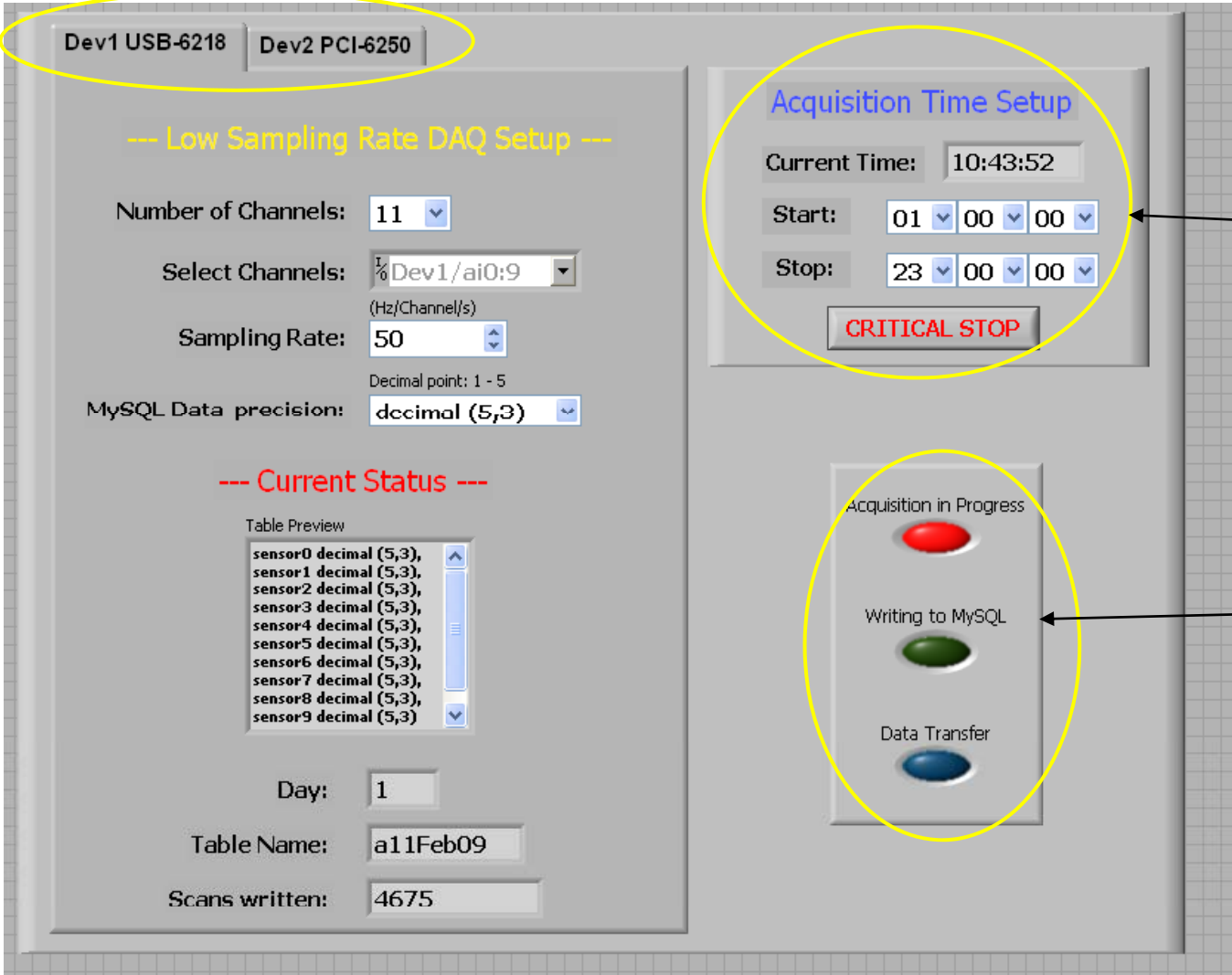
Sensors

No	Parameter	Signal Output	Interface	Sampling Rate	Supply voltage	Power Consumption
1.	Temperature, gear bearing	0-5V	Sig. Conditioner	50Hz	24Vdc	500mW
2.	Temperature, generator	0-5V	Sig. Conditioner	50Hz	24Vdc	500mW
3.	External Air Temperature,	0-5V	Sig. Conditioner	50Hz	24Vdc	500mW
4.	Temperature Nacelle	0-5V	Sig. Conditioner	50Hz	24Vdc	500mW
5.	Temperature gear oil	0-5V	Sig. Conditioner	50Hz	24Vdc	500mW
6.	Rotor speed (Hall effect gear tooth sensors)	0-5V	V/D & Labview	50Hz	12Vdc	Na
7.	Generator speed (Hall effect gear tooth sensors)	0-5V	V/D & Labview	50Hz	12Vdc	Na
8.	Pitch position (linear actuator)	0-10V?	Direct	50Hz	Na	Na
9.	Atmospheric Pressure Baro sensor	0-5V	Direct	50Hz	24V	70mW
10.	Humidity Sensor P14 SMD	0-5V	Direct	50Hz	0-32V Rec9V	Na
11.	Wind speed (nacelle mounted wind anemometer)	0-5V?	F/V Converter	50Hz	4.75-28V DC	1mA-1.3mA
12.	Wind direction (wind vane)	0-5V	Voltage divider	50Hz	1-5V (20V absolute max)	0.5W
13.	Digital compass (nacelle direction)	Compass Bearing	RS232	8Hz	6Vdc	Na
14.	Structural Vibration - XY	±5V	RS 485-USB	?	24V	1.5W(3.6PK)
15.	7 Hansford vibration sensors	±5V	Filtered	20kHz	24V	0.1W (?)
16.	3 Phase Currents	±5V	Direct	20kHz	?	?
17.	3 Phase Voltages	±5V	Direct	20kHz	?	?

Labview software DAQ architecture



Labview Software Interface



The screenshot displays the Labview Software Interface with several key components highlighted by yellow circles and annotated with arrows:

- Top Left:** Two buttons labeled "Dev1 USB-6218" and "Dev2 PCI-6250" are circled in yellow. An arrow points to them with the text "Controls each DAQ device".
- Top Right:** The "Acquisition Time Setup" panel is circled in yellow. It includes a "Current Time" display showing "10:43:52", "Start" and "Stop" time pickers (01:00:00 and 23:00:00), and a red "CRITICAL STOP" button. An arrow points to the time pickers with the text "Start and stop DAQ loops".
- Bottom Right:** A vertical stack of three LED indicators is circled in yellow. From top to bottom, they are labeled "Acquisition in Progress" (red), "Writing to MySQL" (green), and "Data Transfer" (blue). An arrow points to the green LED with the text "LED indicators For current task in operation".

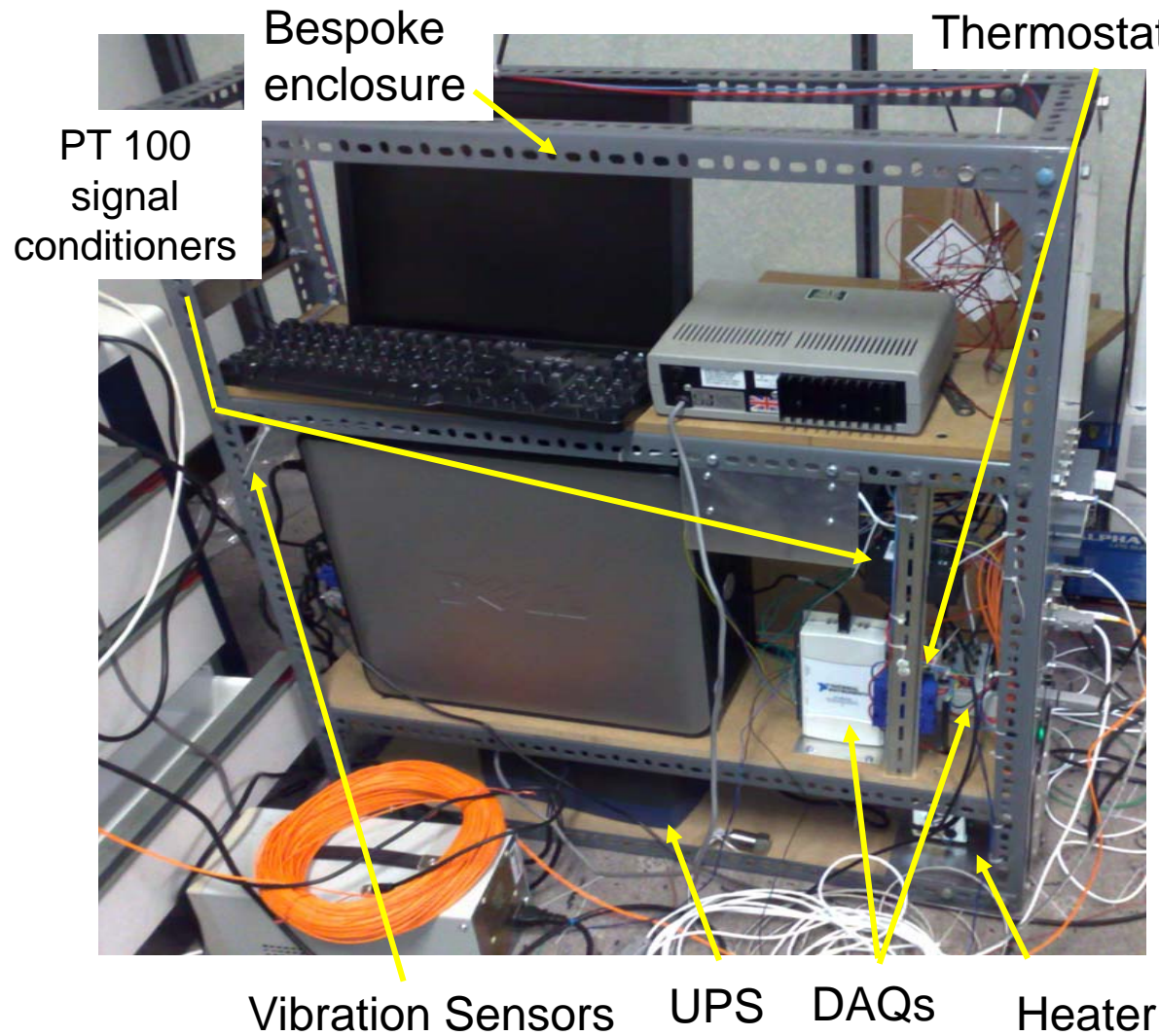
The main interface area contains the following settings and status information:

- Low Sampling Rate DAQ Setup ---**
 - Number of Channels: 11
 - Select Channels: Dev1/ai0:9 (Hz/Channel/s)
 - Sampling Rate: 50
 - Decimal point: 1 - 5
 - MySQL Data precision: decimal (5,3)
- Current Status ---**
 - Table Preview:

sensor0	decimal (5,3),
sensor1	decimal (5,3),
sensor2	decimal (5,3),
sensor3	decimal (5,3),
sensor4	decimal (5,3),
sensor5	decimal (5,3),
sensor6	decimal (5,3),
sensor7	decimal (5,3),
sensor8	decimal (5,3),
sensor9	decimal (5,3),
 - Day: 1
 - Table Name: a11Feb09
 - Scans written: 4675

- Automatically loaded when pc loads
- Automatic run on program start-up
- Can be completely controlled through remote desktop

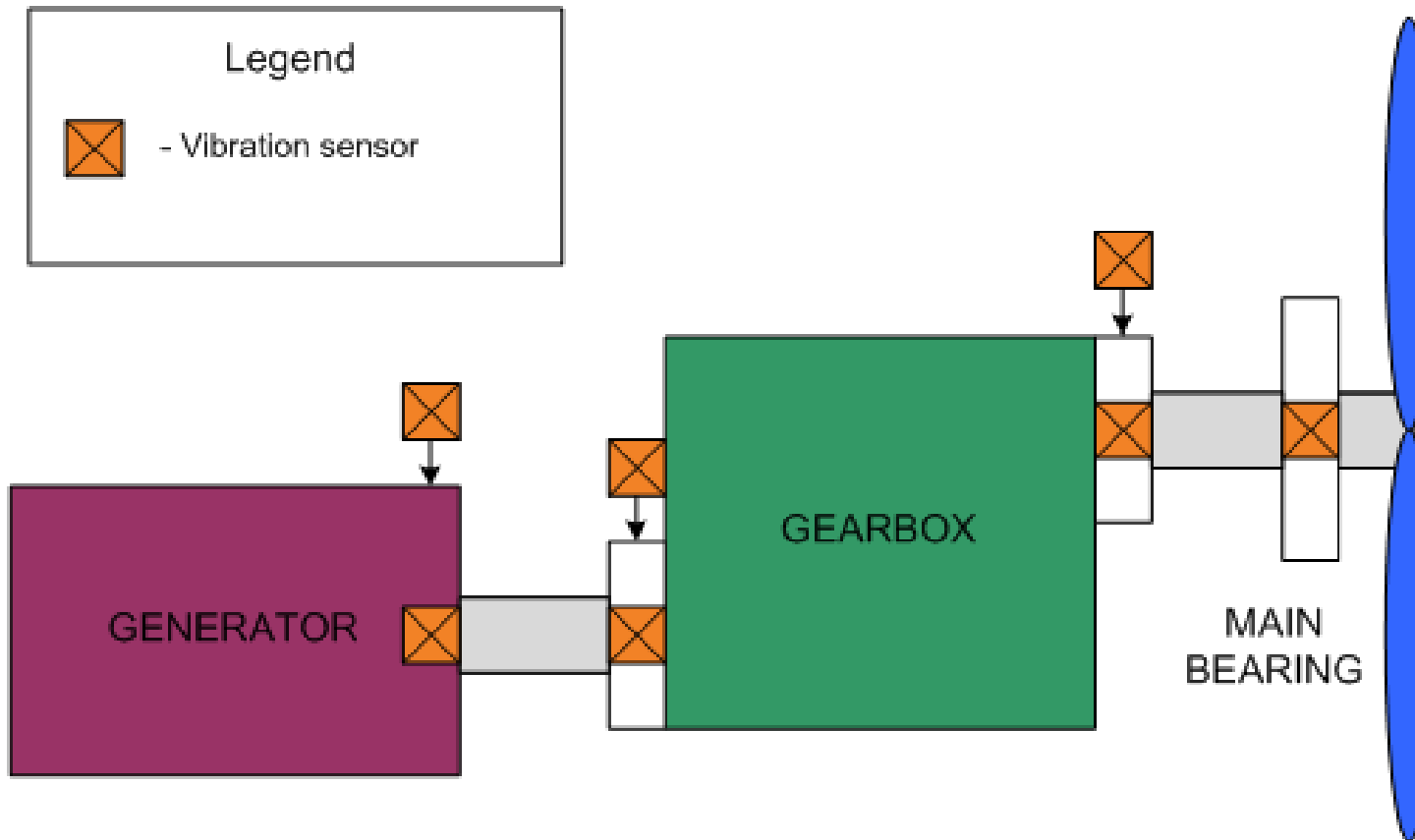
Nacelle enclosure and test rig:



Anemometer, wind vane, air temperature and humidity



Hansford HS-100 Vibration Sensor Layout



Bottom enclosure:



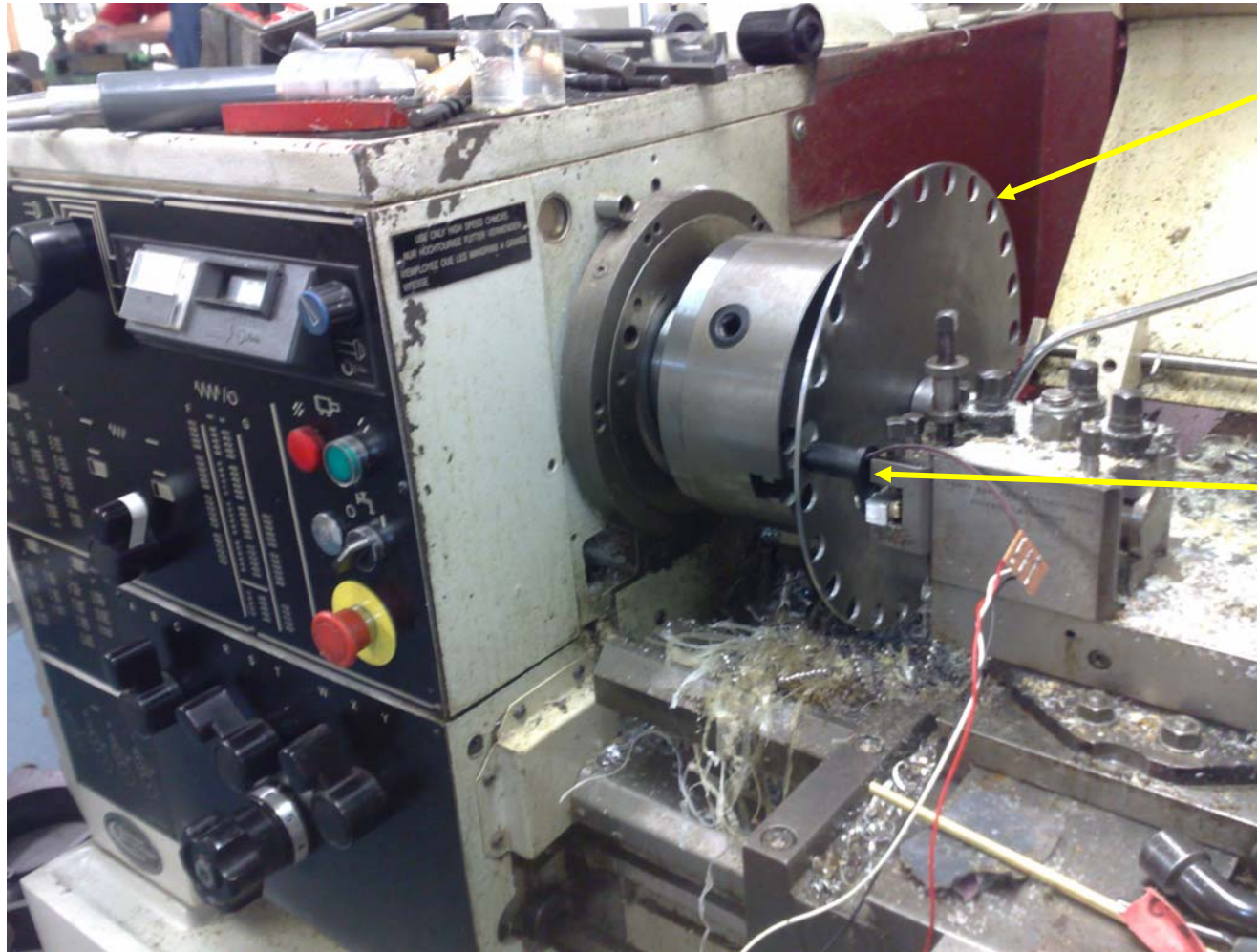
Off the shelf
enclosure

2 x HDD

UPS



Rotor RPM low speed shaft sensor test



Steel disk with 24 equidistant holes

Hall effect gear tooth sensor

Future Work

- Test remainder of sensors:
 - Gram & Juhl two axis vibration sensor
 - Humidity and Barometric pressure sensor
 - Wind vane & Anemometer
- Purchase current and voltage sensors
- Purchase sensor power supply
- Internal Wiring of sensors to power supplies and DAQ units
- Mains & reset switches, enclosure fuse's, and power LED's
- Design and build PCB sensor interface board.
- Overall system test.
- Invite SP for a demo.

- Phase 2 of the project will begin to look at analysing the data.

Published Publications

- Swiszczy G., Cruden A., Booth C., Leithead W., “A Data Acquisition Platform for the Development of a Wind Turbine Condition Monitoring System”, International Conference on Condition Monitoring and Diagnosis 21-24 April 2008, pp 1358-1361.

Submitted Abstracts

- Zaher A., Cruden A., Booth C., Leithead W., “High Resolution Wind Turbine Condition Monitoring”, 3rd International Conference on Sustainable Energy and Environment SEE(2009) 19-22 May.
- Zaher A., Cruden A., Booth C., Leithead W., “Database management for high resolution condition monitoring of wind turbines”, 44th Universities’ Power Engineering Conference (UPEC) 1-4 September 2009.