Confey Community College

CanSat CDR

Team Name: Confey Vulcan

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1. INTRODUCTION

1.1 Team organisation and roles

Teachers:
Ms. M. Selkirk (Physics, Maths and Applied Maths), Mr. J. Dinneen (Engineering, Technical Graphics)

Name:	Year of Study:	Relevant Subjects:	Area of Work Within the Team:	Expected workload	Project hours at school per week:	Project hours per week after school:
Adam Walsh	Transition Year	Engineering, Sciences, Business, Maths	Outreach person and Project Manager	Website design, social media management, coordination of primary school visits, CanSat information video, organization of meetings and distribution of	Approximately 1.5 hours.	Approximately 4 hours
Brendan Alinquant	Transition Year	Engineering, Sciences, Technical Graphics, Maths	Software Developer	Wireless data transmission, graph generator, Arduino programming, Python programming and testing of sensors	Approximately 1.5 hours.	Approximately 4 hours
Ugo Uzoukwu	5th Year	Engineering, Physics,DCG, Maths	Parachute Design and Manufacturer	Parachute research, design, manufacturing and testing	Approximately 1.5 hours.	Approximately 4 hours
Ademide Oyeyemi	5th Year	Engineering, Physics, Maths	Electronics Manufacturer	Soldering of electrical components, electrical analysis and testing and calibration of sensors.	Approximately 1.5 hours.	Approximately 4 hours
Erik Ryan	5th Year	Engineering, Physics, DCG, Maths	Can Design and Manufacturer	Mechanical CAD designs for the layout and manufacturing of the can.	Approximately 1.5 hours.	Approximately 4 hours
AnnaMei Chan Kinsella	5th Year	Applied Maths, Physics, Maths,	Outreach and Project Manager	Social media management, pursuing sponsorship oppurtunities, youtube page management and meeting	Approximately 1.5 hours.	Approximately 4 hours

1.2 Mission Objectives:

Our primary mission :
To measure and record air pressure and external temperature as our Vulcan descends and use this data to then calculate the can's altitude and descent velocity.

Our secondary missions:
We found that the pressure sensor that came with our kit was not very accurate so we added another, more accurate, pressure sensor. This also measured temperature so we can now compare the internal and external temperature. Also, we can then use a more accurate temperature reading when calculating the Relative Humidity because the thermistor was reading the outside temperature – not the inside.

We have added a relative humidity sensor to measure relative humidity of the atmosphere, due to the fact that water is a requirement for life and this could indicate the possible existence of life on a planet.

To improve the efficiency of the can we also changed from our 9v battery to two 1.2v rechargeable batteries and a step-up voltage regulator. This meant we bypassed the Arduino's inefficient voltage regulator.

We also intend to add a power switch and LED strips to indicate power is on and also for locating the can.

If we get through to the European finals we want to explore the option of guided landing. We had two Confey College teams who entered the Leinster finals and the other team were working on guided landing. They had two servos which could steer a parafoil that they had designed. They also had a motor but this was not fully ready for the Leinster final. We are hoping to use some of their parts and design to try to get this working. They have offered us the parts and have been helping us consistently with the bulid/design of our can for the National finals. They also made an excellent infomercial video explaining how their can and the guided landing system works. Please have a look at this excellent video HERE.
As a result, some of our secondary missions for the National final have been chosen to be of use for guided landing.

We have added a GPS shield which we will use for location of the can and for possible use of guided landing for the European final. The shield also has the capability to store data on a micro SD card which could be used as a backup if there is loss of data via the wireless communication.

We intend to demonstrate that we have set up two way communication in the form of a buzzer that can be turned on/off wirelessly to locate the can. We will also have the option

of asking the can to perform a calculation and return the answer and also of getting the can to ‘broadcast’ a message. We would also need two way communication for Europe as it would be needed for guided landing.
We have added an IMU which contains an accelerometer which can measure the g-forces on the can in the X, Y, and Z direction. The IMU also contains a Gyroscope which measures angular velocity in all three X,Y,Z directions – it basically tells us how fast along which axis the can is rotating in deg/s. A Magnetometer measures the power and direction of the magnetic fields in Gauss. From this information we can approximate heading. These three/nine pieces of information will give us a great deal of information about an objects movement and orientation. It allows us to calculate tilt and roll. We feel that information will be needed for guided landing.

In addition, the gForce information but is also useful to evaluate the forces experienced by the can at the various stages of flight – so adjustments can be made for later designs.
It also would tell us about the acceleration due to gravity on the planet being explored.

The Magnetometer data is also very important because having information about a Planet’s magnetic field power and direction tells us about how well equipped it is to deal with solar radiation and also gives information about the weather systems.

We also have a new wirelessly controlled flip up can surface and intend to add flexible solar panels onto the flip lid to allow for trickle charging of the can’s batteries.

2. CANSAT DESCRIPTION

2.1 Mission Overview

We had to design and build a CanSat to be launched and deployed from a rocket at an altitude of approximately 1000 metres. The CanSat, ideally, must descend at a speed no faster than 11 metres per second and no slower than 8 metres per second. During its descent our CanSat will measure the temperature from the inside and the outside of the can and pressure from two independent pressure sensors.

We will use this data to calculate the altitude and descent velocity of our can as it falls.

We will also measure Relative Humidity to determine the presence of water and, if it is present, to determine it's abundance.

We will measure gForce, Angular velocity and the strength and direction of the Earth's magnetic field. From this data we will calculate tilt, roll and header. We will also be able to identify the forces experienced by the can during it's mission from launch to landing. The information about the Magnetic field will allow us to evaluate how effective the field is at protecting the planet from dangerous solar radiation.

We will demonstrate two way communication in the form of a buzzer that we can turn on and off. We also demonstrate that we can get the Arduino to perform a mathematical operation wirelessly.

We also hope to use our two way communication to allow wireless control of a servo motor which will control our can's flip open lid. This lid will eventually have flexible solar panel's on it's surface to trickle charge the can's batteries.

We also have GPS location which will help us to locate our can and we have the capability to store our sensor data on a micro SD card in case data transmission/receipt is unsuccessful.

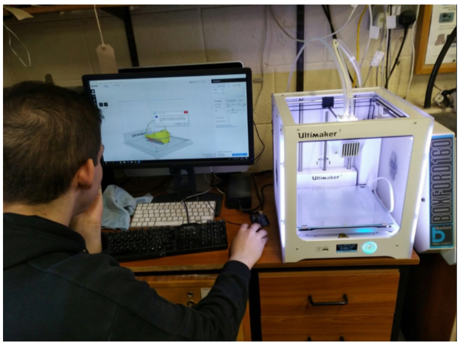
Our can will also have flashing LED's to show that power is on and to help in the location of the can.

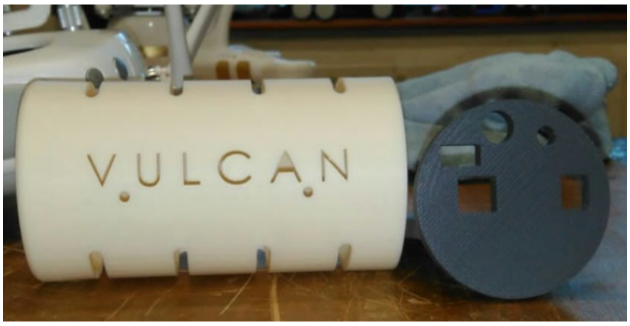
The key elements we will use to accomplish these missions are:

Element:	Product Name:	Usage:
Microcontroller board	Arduino Uno	Allows us to communicate with and acquire data from the sensors and other components and also to communicate with the ground station
Radio communications module	APC220	Allows us to wirelessly transmit AND receive data to/ from the ground station
Arduino Custom Shield	AAU Sensor Board	Allows us to add sensors, exra power/ground points, specifically designed slots for Thermistor and Pressure Sensor circuitry
Pressure sensor	MPX4115A	Measure pressure for primary mission
Pressure and Temperature sensor	BMP180	Measure temperature internally for use with pressure reading to calculate altitude and also for use with relative humidity sensor
Temperature sensor	NTC Thermistor	Measure temperature at the surface of the can
IMU unit	LSM9DS1 3axis Accelerometer, Gyroscope, Magnetometer	Allows us to measure the magnetic field strength and direction, acceleration and angular velocity in three dimensions
Flat octagonal parachute	Made by Ugo	Provide the required decent rate and ensure a safe landing
GPS shield	Adafruit Ultimate GPS Logger shield	Measures GPS data, calculates Altitude, Time, logs data on microSD card, holds most of our sensors as it sits on top rather than having them sandwiched.
External Antenna	Slim Sticker Quad Band Antenna	GPS has problems with receiving satellite signals at times due to being covered - antenna is external and allows better receiving of signal
Relative humidity sensor	HIH4030	Measure relative humidity
2 x 1.2V AA rechargeable batteries	2850mAH Ansmann AA Batteries	Better efficiency of power than 9v batteries
Piezo Buzzer	Piezzo Buzzer B 10N	For location and also to demonstrate 2-way communication

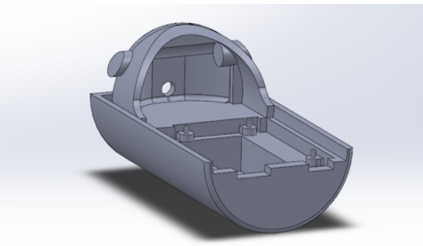
2.2 MECHANICAL DESIGN

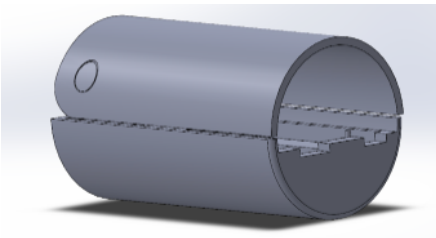
We chose to 3d print the can due to the unparalleled accuracy that we would not be able to obtain by using any other method accessible to us such as a milling machine, hand tools or a lathe. Our local tech giant INTEL kindly allowed us to use their facilities and expertise to 3D print our can for the Leinsters. In the Leinster finals, we designed a can which consisted of a spine and an outer shell. We found this to be inefficient for conserving space as the spine took up too much of the volume.

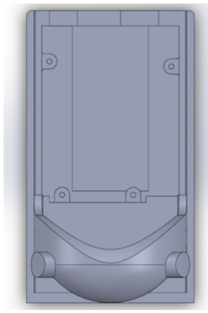




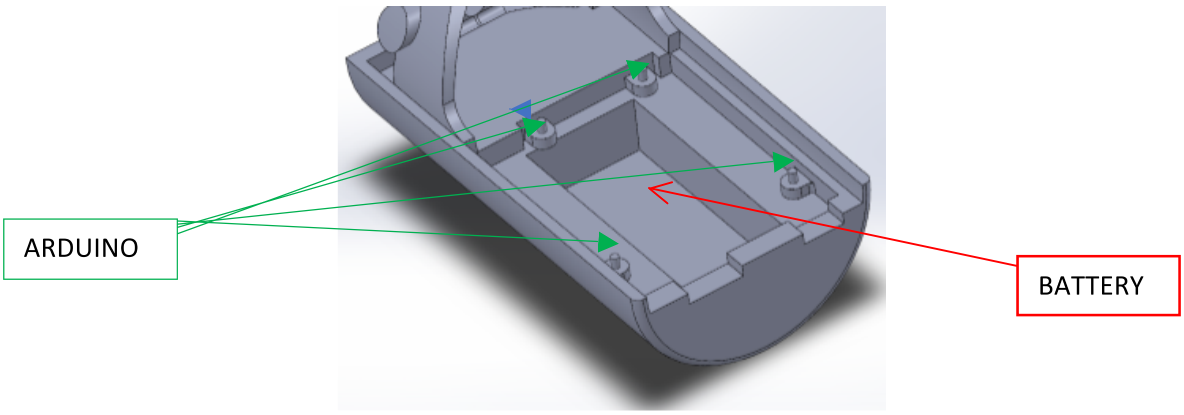
For the Nationals, we have solved this volume issue by splitting our can in half and having the spine built into the can. We decided to use a hinged flap for the other side because this meant that our Arduino and all of the electronics were accessible. The hinged design could also be used in a real satellite to house a solar panel and move the panel so it is best in line with the sun, in order to receive maximum sunlight.



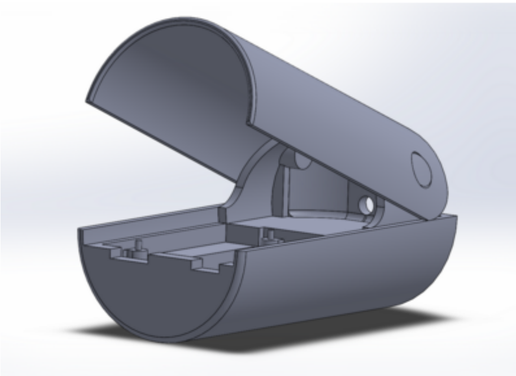
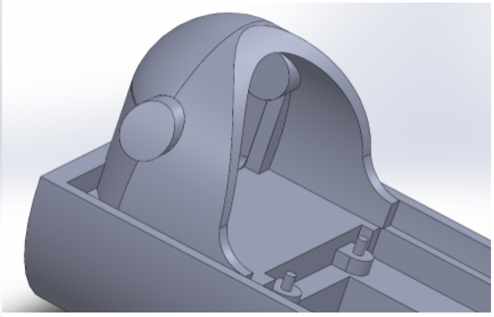
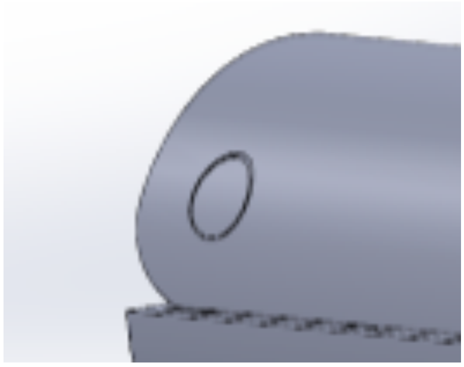




We felt that not having a spine would also increase the toughness of our can, instead of having a spine that was held in place by friction like lots of other teams we saw. The Arduino is securely attached to the body, ensuring that it won’t fall out and lessening the likelihood of damage to the electronics or to the can. We were also able to implement an area for the battery holder in our design. This means that we can be extremely efficient in our use of space. Our battery will be secured in place which solves a problem we found during flight testing as our battery clip disconnected from our battery on hitting the ground.

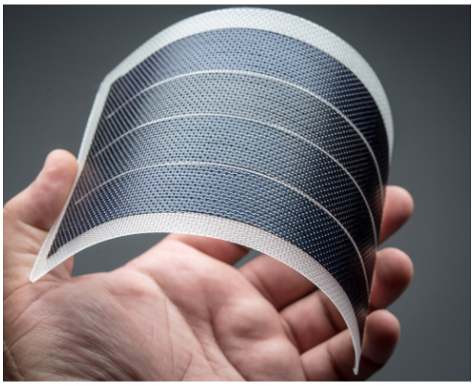


The hinged design consists of two cylinders, flush with the perimeter of the can with a radius of 33mm. The flap has two corresponding holes that mate with the two cylinders in order to allow rotation about the cylinders. We used our schools 3d printer and printed our can out of Ultimaker polycarbonate filament. We chose this because polycarbonate is an extremely tough material that will be able to withstand the extreme forces exerted on the can throughout its mission. We printed the can using 70% infill which is the percentage of the can filled and 0.1mm layer height which is the thickness of each layer placed down by the 3d printer.

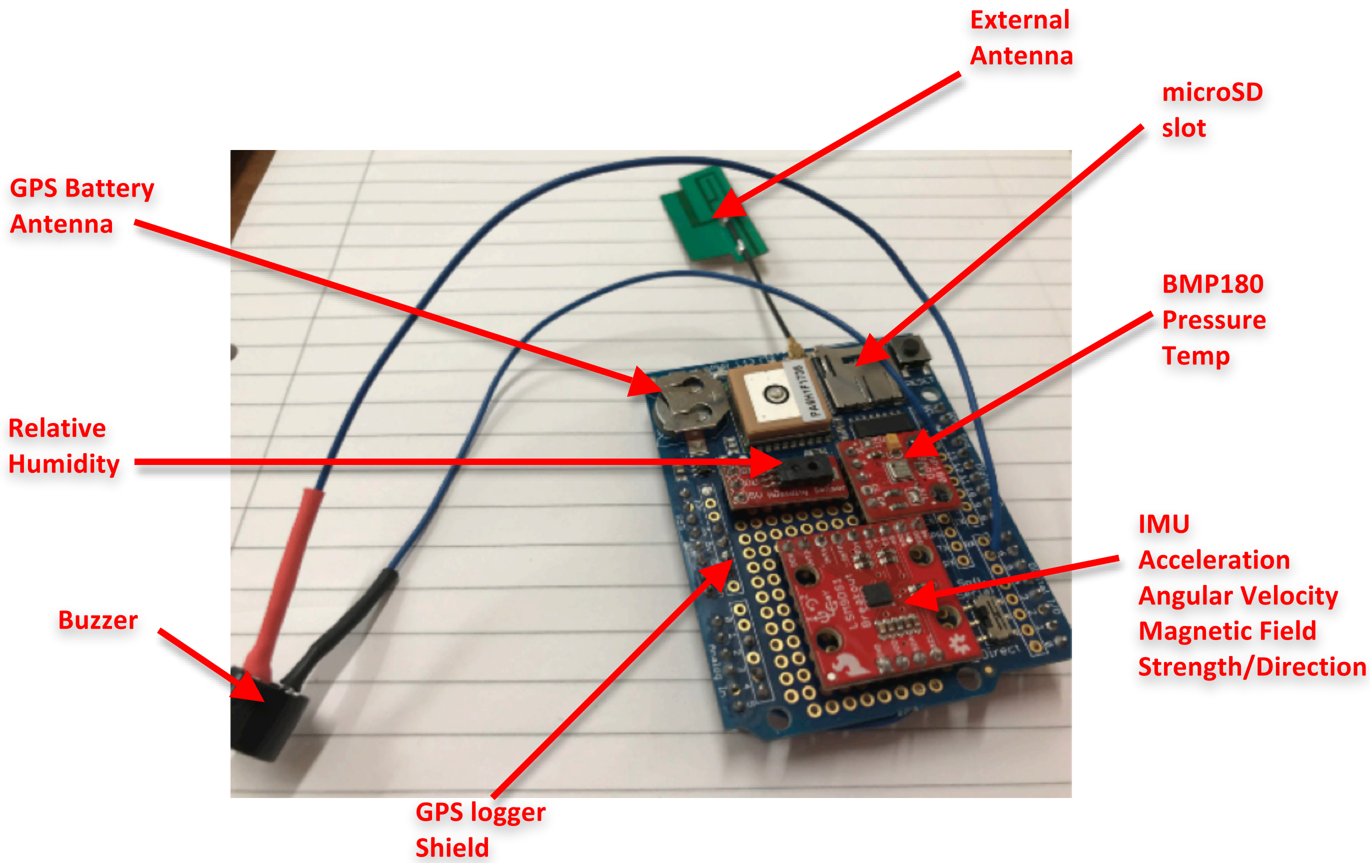




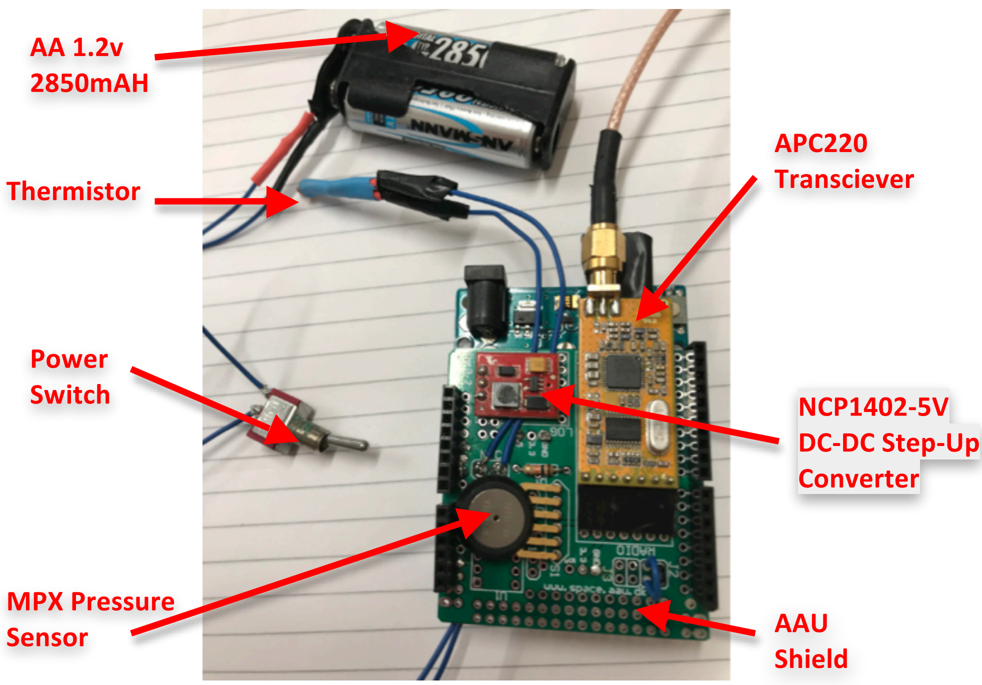
For Europe:

For the European final we would like to automate the opening of the can by using a servo and the two way communications system we have already developed. We would use a linkage mechanism between the servo horn and a bracket on the flap. We intend to cover the flap with a flexible solar panel (Previous Confey College teams have used these in Cansat competitions). The idea is that ultimately the solar panel will orient itself so that the can is receiving the most sunlight and this can trickle charge it's batteries.



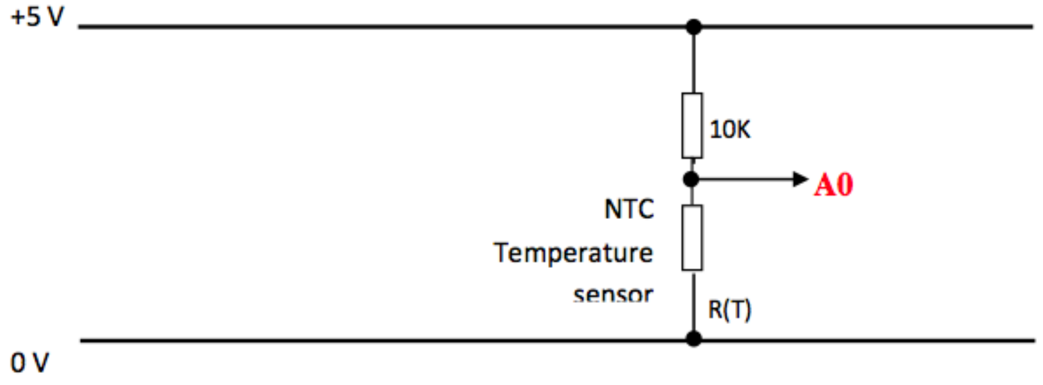
Secondary Mission Photos:



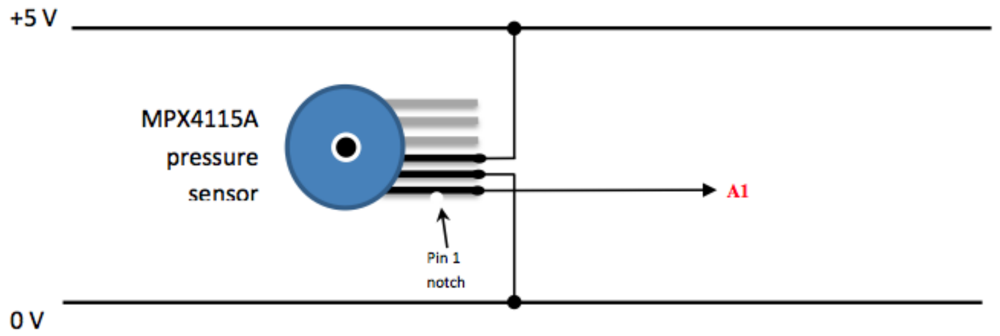


2.3 Electrical design:

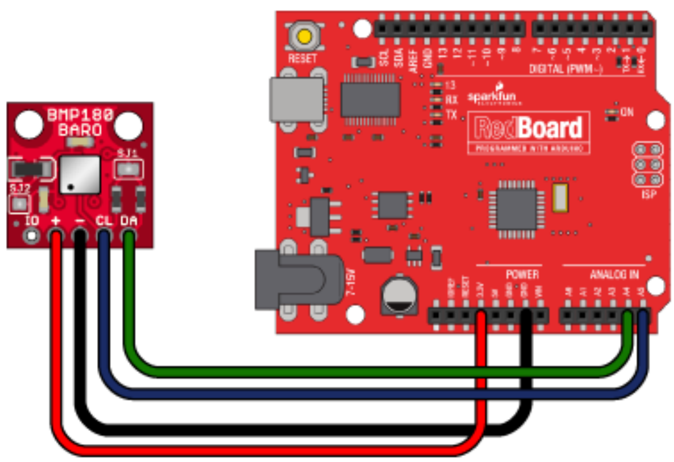
NTC Thermistor/Temperature Sensor:



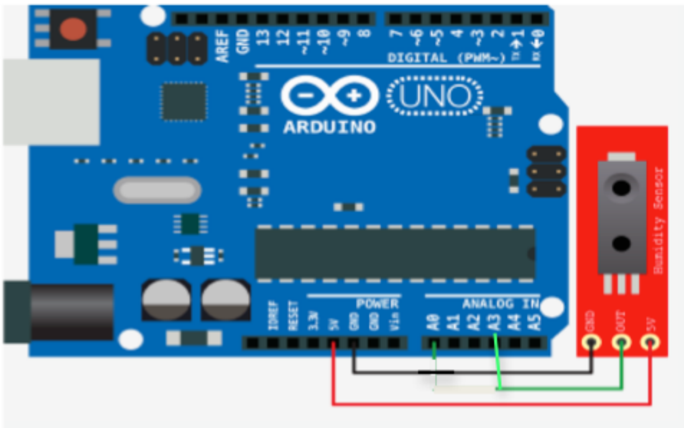
MPX4115A Pressure Sensor:



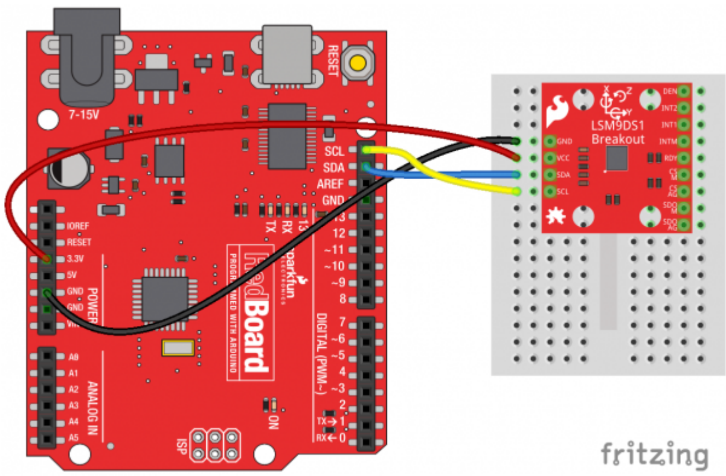
BMP 180 Barometric Pressure and Temperature Sensor:



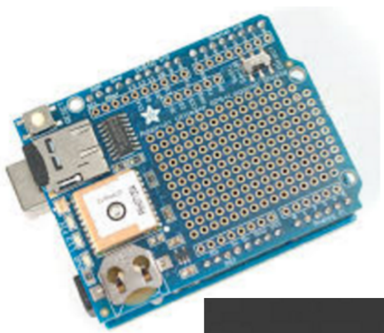
HIH4030 Relative Humidity Sensor:

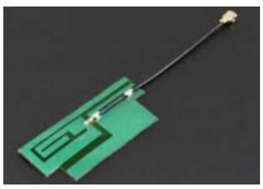


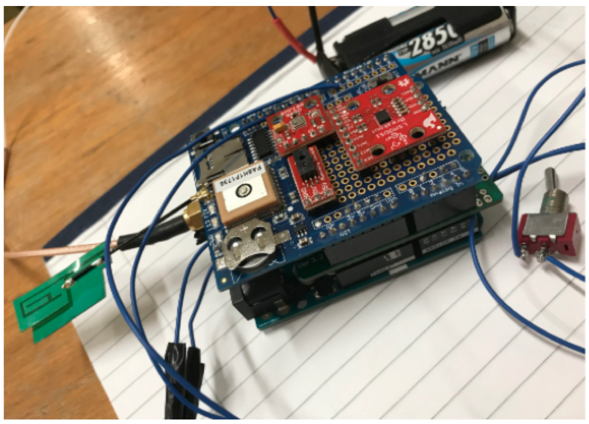
LSM9DS1 – 3 Axis Accelerometer, Gyroscope, Magnetometer:



Adafruit Ultimate GPS Logger Shield and Quad band Antenna



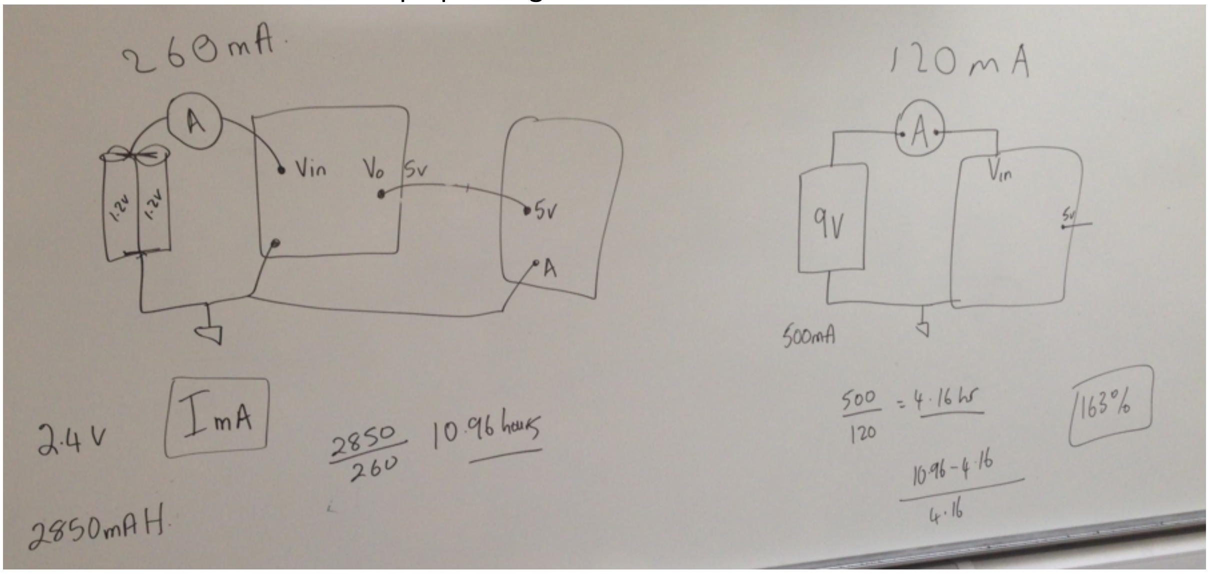




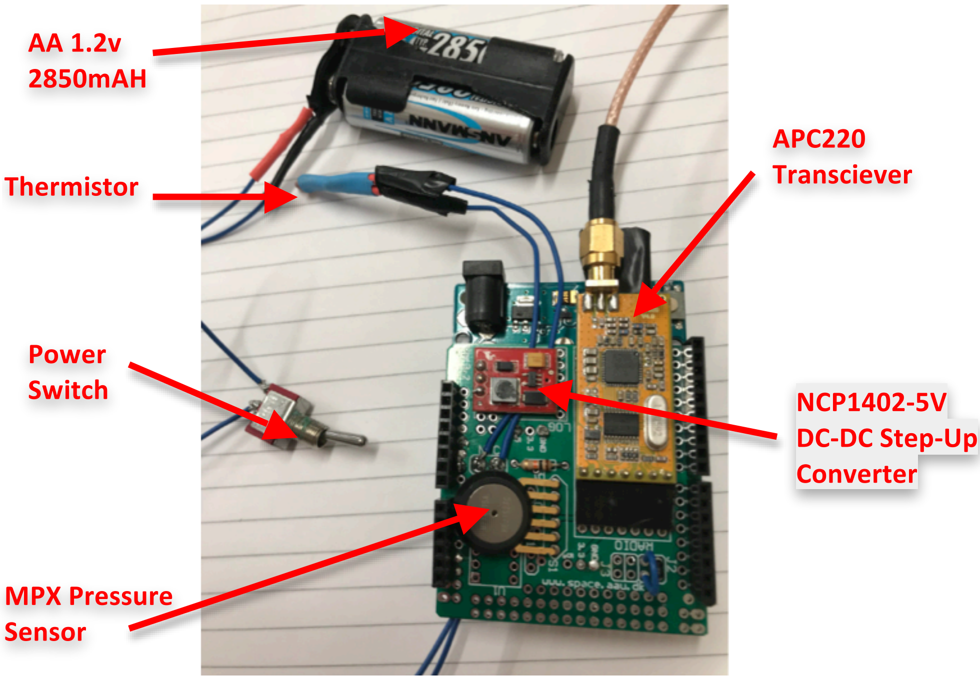
Power/Batteries

We undertook research on Arduino power and found that our 9V battery was being converted down to 5v by the Arduino using a step down voltage regulator and that this was not efficient. So we decided to use two rechargeable 1.2v batteries and a more efficient step up voltage regulator instead. This meant that our battery life was longer and also we did not have to keep buying new batteries.

We then measured the input current to our running Arduino setup when using the 9V battery and Arduino step down regulator versus the input current when running on the 2.4V batteries and the NPC1402 step up voltage convertor. Below are the calculations we made:



As can be seen, the new arrangement should mean that batteries should last almost 11 hrs versus just over 4 hrs.

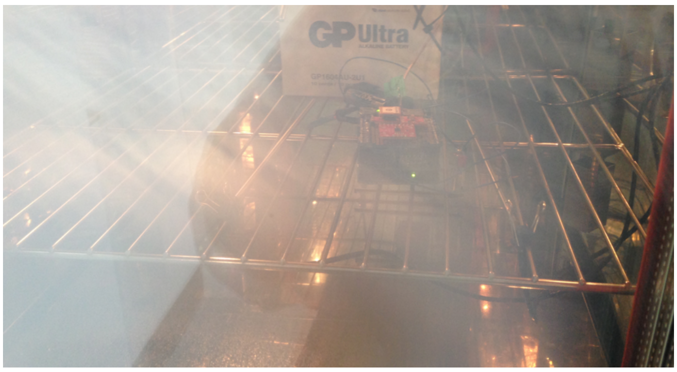


Calibration:

For our calibration, we contacted the NSAI(National Standards Authority of Ireland) and ButlerTech to calibrate our sensors. We originally contacted ButlerTech to calibrate our temperature sensors. They told us that they got their equipment calibrated at the NSAI so we contacted them to calibrate our pressure and relative humidity sensors.

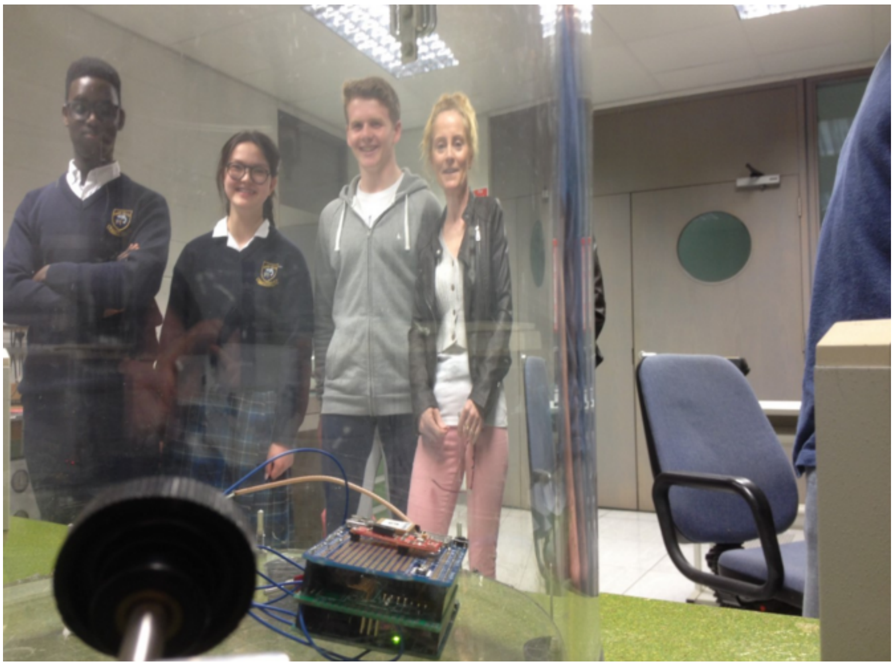
Temperature:

Originally, we used a hairdryer and a freezer to calibrate our temperature sensors but we felt that the sensors we used to calibrate were inaccurate so we contacted Butler Tech. They agreed to do so. Our Arduino was placed in a chamber where they were able to control the temperature. The data was transmitted via the radios. They used platinum resistance thermometers to measure the temperature in the chamber. We recorded the values our sensors were sending and the value on their sensors. The process was repeated with different temperatures. The values were then but into excel and the best fit graph was found along with the equation to change the value to the correct one. This equation was also added to the Arduino program.



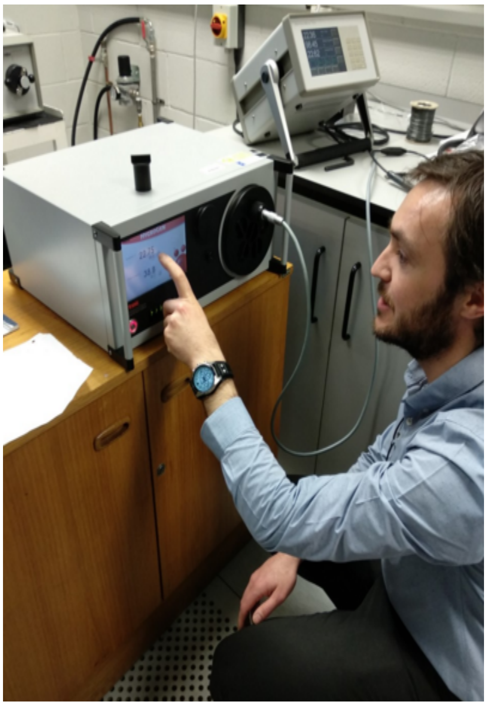
Pressure:

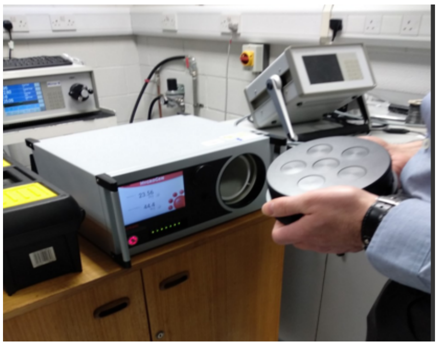
Originally to calibrate our pressure sensors, we went up the mountains to different areas of pressure. We got the pressure with an app on an iPhone and the values from our sensors. We felt that this was inaccurate so we contacted the NSAI. They also agreed to do our calibration for us. The Arduino was placed in a vacuum chamber. The air was sucked out to change the pressure in the chamber. The pressure from our sensors and their setup were recorded. We changed the pressure to record different values. They were then put into excel to get the best fit graph and the equation. The equation was put into the Arduino program.

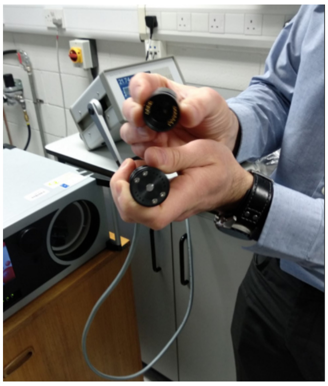


Relative Humidity:

For relative humidity the Arduino was placed into a humidity chamber. The air was sucked out. Air was passed through and passed through a water saturator and pumped into the chamber. They measured the humidity in the chamber with a chilled mirror probe. This was colder than the temperature in the chamber therefore the water vapour condensed and formed a dew on the mirror. Then they shone a light to measure the amount of dew. They used the mount of light lost to calculate the humidity in the chamber. The temperature was also varied as we were recording relative humidity. We recorded the values on our sensor and the value on their equipment. We then put this into the best fit graph on excel. The equation for converting it into the correct value was also found. This equation was added into the Arduino program

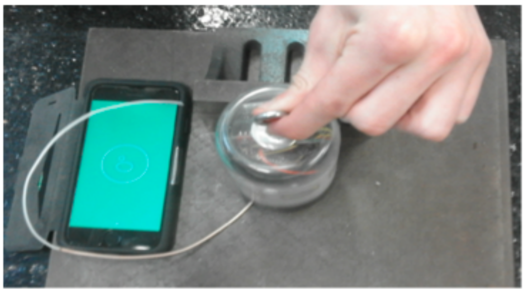




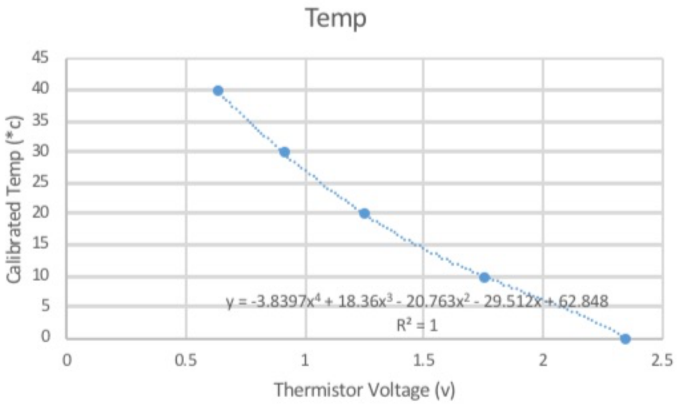


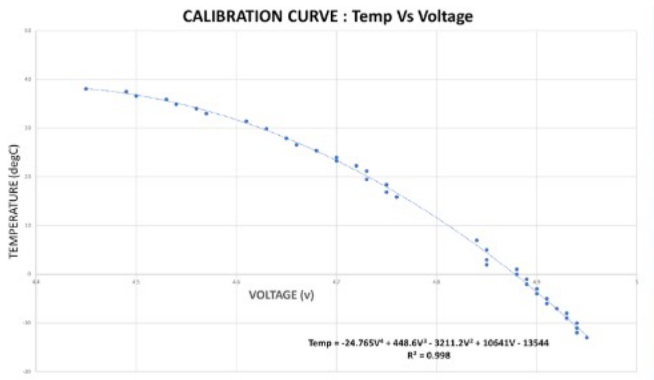
Accelerometer Calibration:

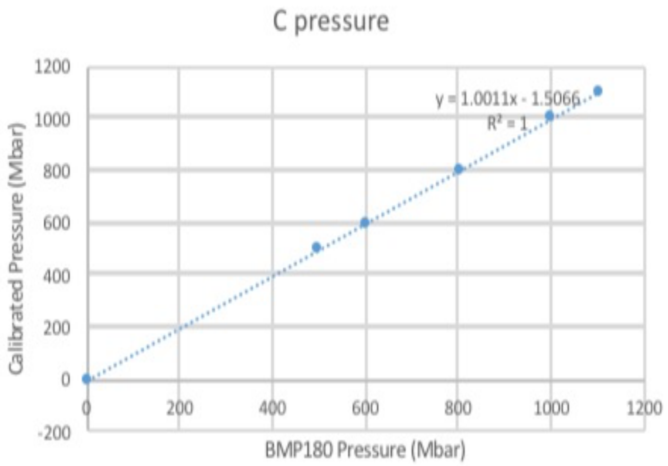
We knew that there should be a force of + or -1g on the axis pointing towards the centre of the Earth and zero on the other two. So we tilted the accelerometer so that each of the three axis were pointing in this direction using a spirit level (on iPhone). We did this for all directions pointing up and down. The offsets were then added into our Python program.

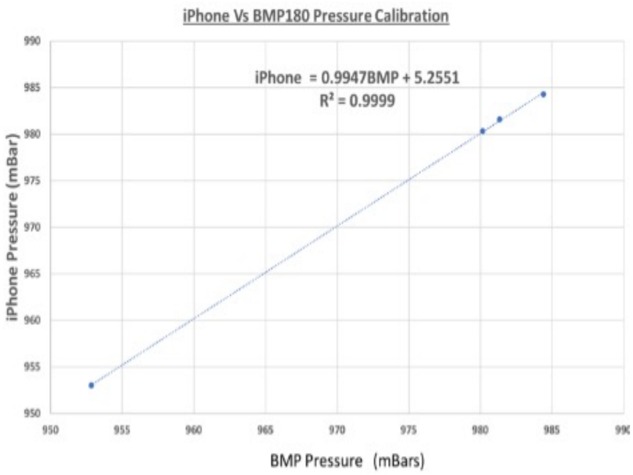


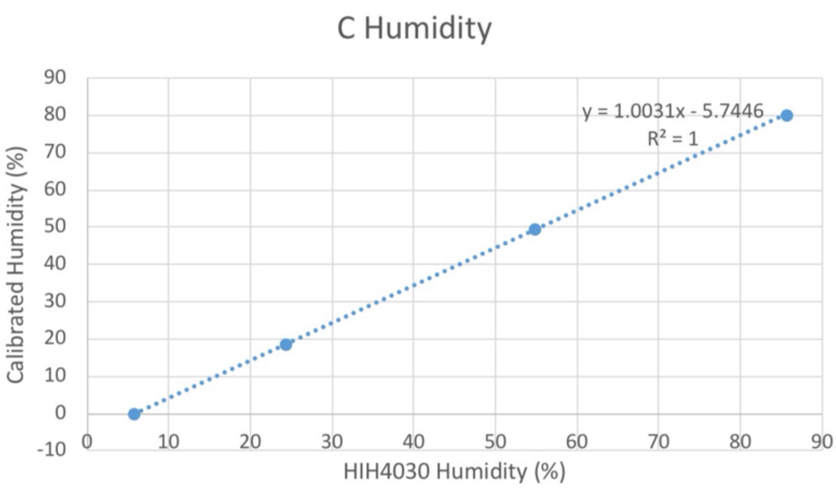
Calibration Curves:











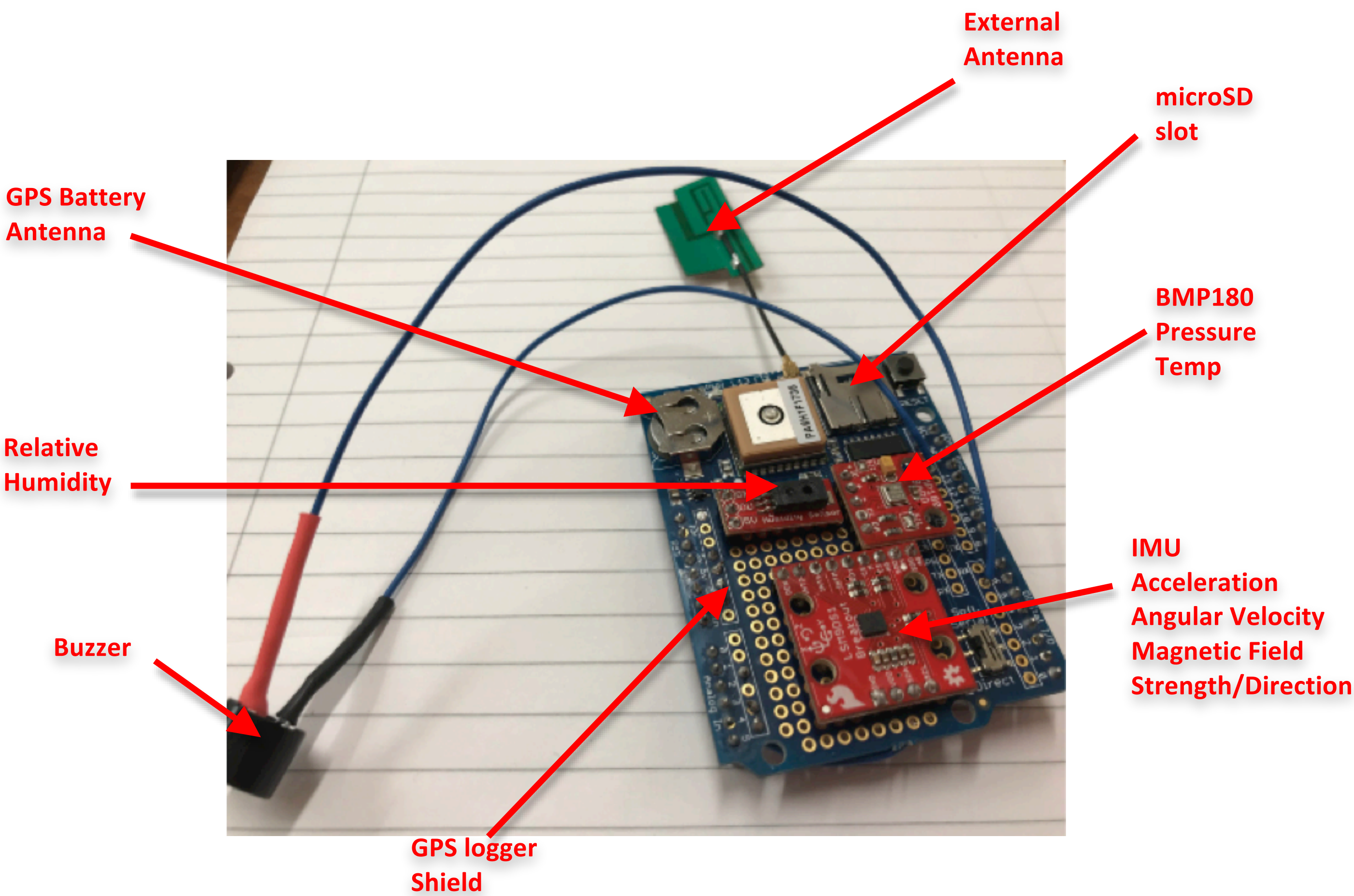
2.4 Software Design Overview:

Connection to Arduino:
The LSM9DS1, BMP180 and DSS GPS shield all share pins A4 and A5 of the Arduino. This is due to the fact that communication with the LSM9DS1, DSS GPS shield and BMP180 is carried out via the I2C protocol as there would not be enough dedicated analog inputs available for all of our different data sources.

The I2C protocol involves using two lines to send and receive data: a serial clock pin (SCL) that the Arduino Master board pulses at a regular interval, and a serial data pin (SDA) over which data is sent between the two devices. As the clock line changes from low to high (known as the rising edge of the clock pulse), a single bit of information - that will form in sequence the address of a specific device and a command or data - is transferred from the board to the I2C device over the SDA line. When this information is sent - bit after bit -, the called upon device executes the request and transmits it's data back - if required - to the board over the same line using the clock signal still generated by the Master on SCL as timing.

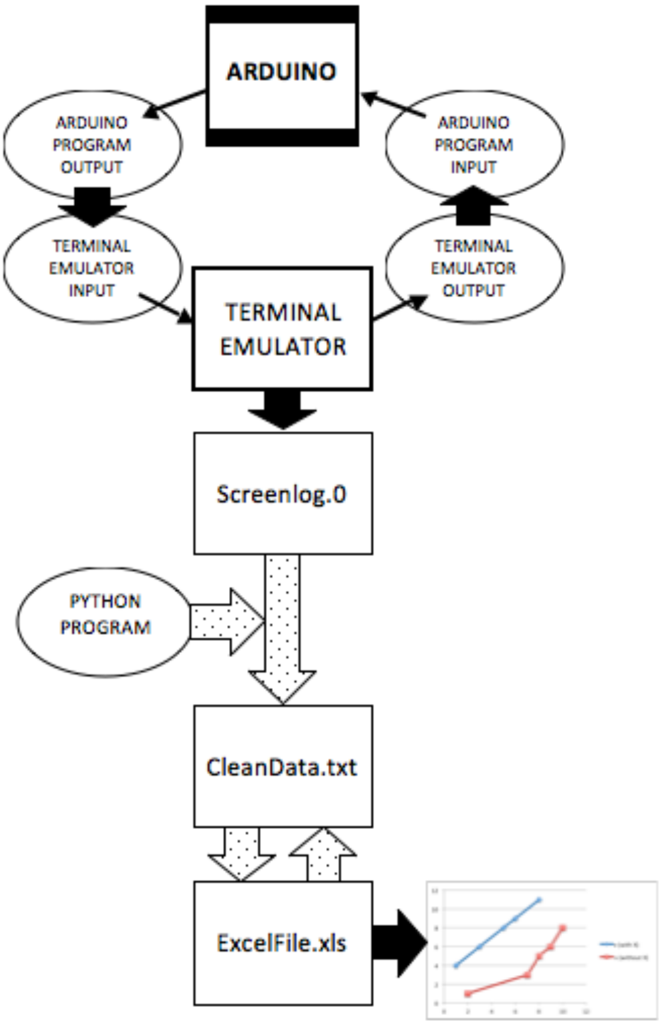
The NTC thermistor, MPX4115A and Relative Humidity sensor are not I2C compatible and they have their own dedicated analog inputs A0, A1 and A2 respectively.

Digital pin 6 (D6) is used to control the Piezo Buzzer. This allows us to more easily locate the can and show two way communication.



Arduino program:

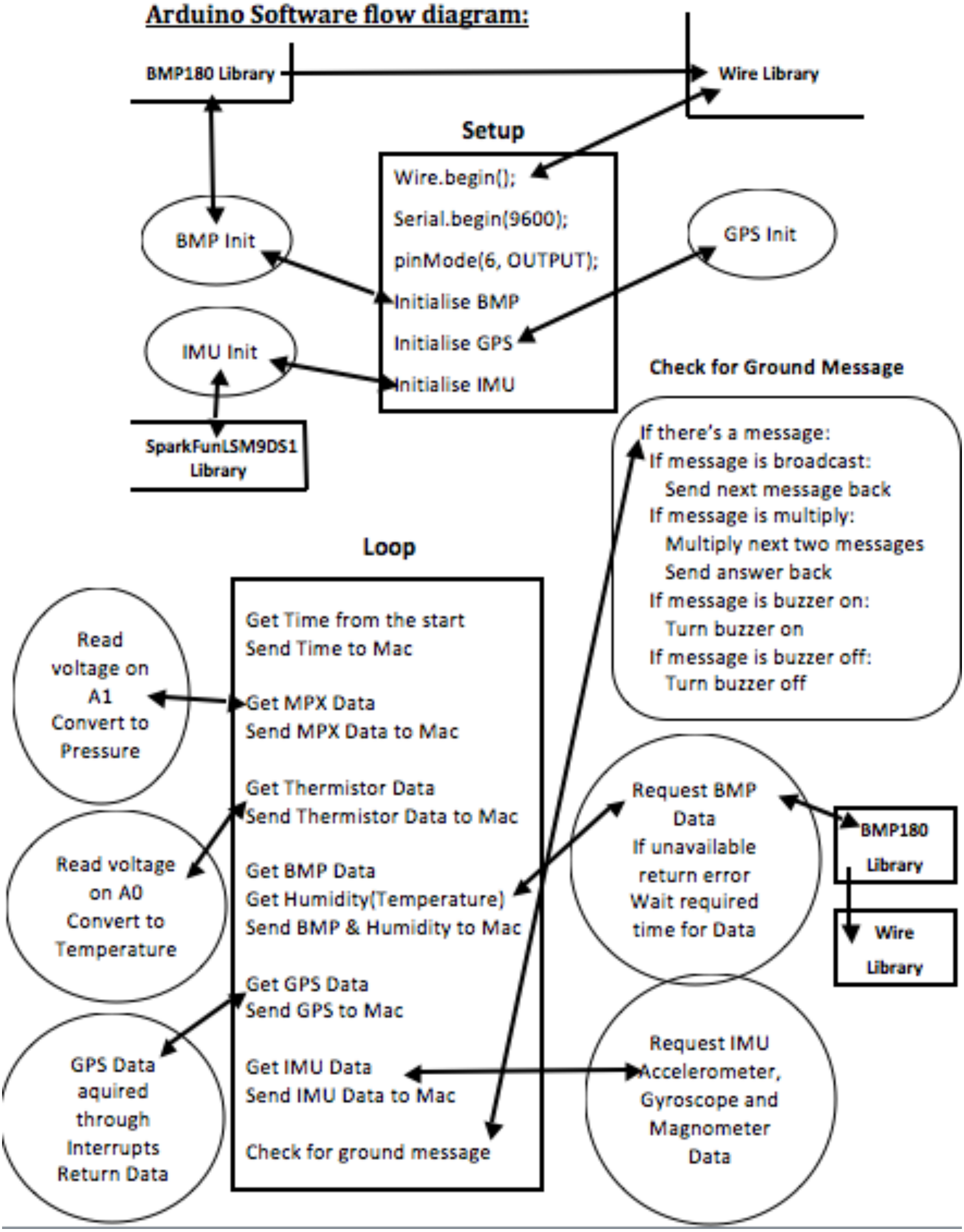
Much of the code we are using was downloaded from the sparkfun website which contains example code for all of the breakout boards we are using (see Appendices). We made sure that each sensor worked individually using the example code and then we tidied the code and added it into our main Arduino program. We put most of the main code into functions to make it easier to figure out what was going on. We tried to keep calculations to a minimum in the Arduino code so there was less time delay between measurements. We have two Python programs that run on the Arduino data, tidying it up and performing any extra calculations that are needed.



Python program:

We used a Python program to analyse the data output from the Arduino and to tidy it up. We have two ways of looking at the data. We can run one python program that reads in the wireless data, tidies it as it reads it in, stores it in a clean file and also generates real time graphs. We have a backup option where the transmitted data goes straight into a file and, after the can has landed, another Python program works on the data from this raw data file, tidies it and places it into a 'cleandata' file. An excel worksheet has been set up to get data from the clean data file on refresh. The excel file has pre prepared graphs that update automatically on refresh and can be analysed immediately. We hope to use both systems on the launch day.

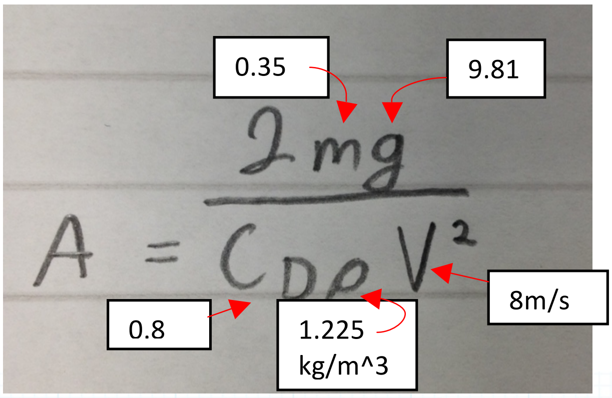
Arduino Software flow diagram:



2.5 Recovery System

Parachute Physics

The main purpose of the parachute is to make sure that the Cansat has a stable and controlled decent and is not damaged upon impact. To get the correct area we used this formula



$$\sqrt{\left(\frac{2\times0.350\times9.8}{1.225\times0.10949\times0.8}\right)} = 7.99579\ldots$$

The formula re-arranged and used to calculate terminal velocity (**A** is rounded to 5 digits)

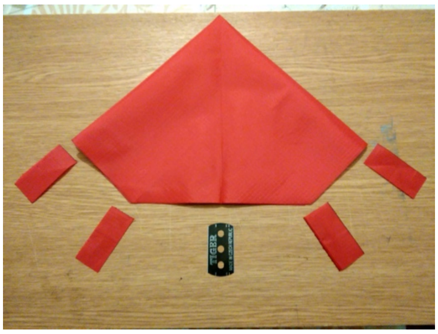
Terminal velocity (V)is the point at which the force of drag and the force of gravity **(mg)** on the can are equal and cancel each other out, this means that while the can still falls thought the air, it no longer accelerates and has reached its maximum speed.

Coefficient of drag (C_D) Is a value that is determined though testing an object in a wind tunnel. The C_D of a flat parachute is known to be **0.8.**

Air density (ρ) is the mass of the air per cubic metre this is given to be 1.225 at sea level but varies with altitude.

Parachute manufacturing

We manufactured the parachute out of ripstop nylon cut into and octagonal shape and kite strings. Ripstop nylon is extremely light and durable it can also be waterproofed with an impermeable coating if required, these are the properties of our parachute. The should lines are made of polyester kite strings which have a high tensile strength to withstand the forces of deployment. To make sure that can decent is as stable as possible we added a swivel hook to the parachute, this made sure that if the parachute spins the can itself stays stationary reducing the stress on the can. We have also tested the parachute with a spill hole in it this makes sure that parachute oscillation is down to a minimum and any oscillation that does occur is quickly corrected. One consequence of having a spill hole is that it can reduce the effective parachute area if added after manufacturing leading to a faster decent however we compensated for this by making the parachute larger to keep the same effective area once the hole is added.



Folded up parachute and unstitched loops

Swivel hook

National parachute

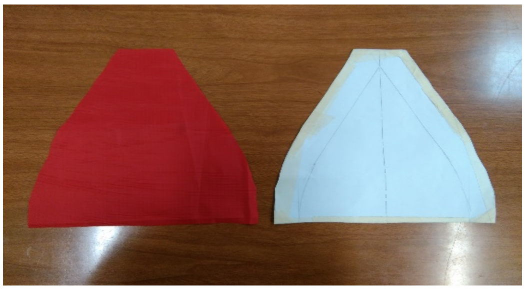
For the national competition we plan to use a parachute in the shape of a semi-ellipsoid, this type of parachute offers more stability than a standard flat parachute due to the way air flows through it.

The parachute is made up of several different pieces called **<u>gores</u>,** these are truncated, triangular shapes with curved sides and when they are sewn together the form the shape of the parachute.

N. Parachute Manufacturing

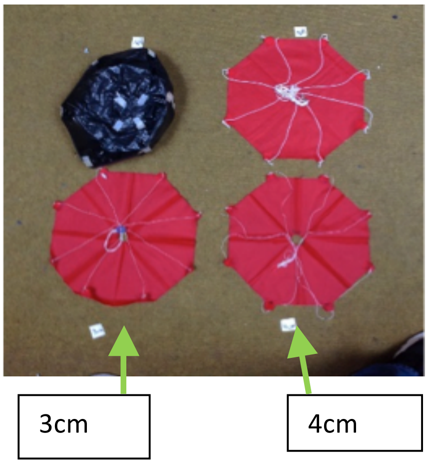
The manufacturing process for the semi-ellipsoid parachute was similar to that of the flat parachute, mainly involving cutting parts out and sewing them together. It was made of ripstop nylon like the precious parachute but involved much more sewing due to being made up of multiple parts. We used kite string again for the shroud lines although we would like to use Para cord later on but due to time constrains this was not possible.

Parachute gore and paper template.



Parachute testing:

To test the parachute, we used the drone our school bought after coming 3rd place in the EU Cansat competition 2016. The weight was simulated using a bottle of water and combined with the weight of the parachute it amounted to 300g or 350g. The drone was then raised to a height of 30m and the bottle was then dropped while someone on the ground recorded the decent. This allowed us to get the average decent speed for each parachute as well as observe each parachutes stability.



Parachutes with spill hole size

Prototype parachutes

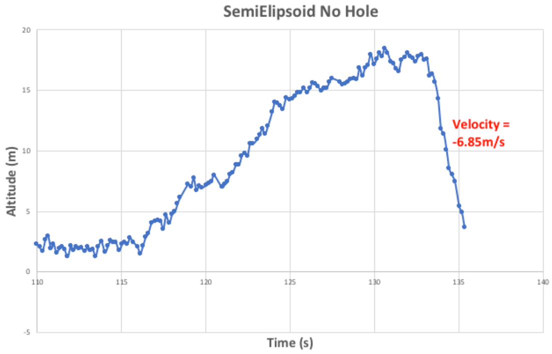
We created a structure to help drop the parachute from the drone more reliably, as shown in the middle image above, the can would be attached to the hook at the centre by the I-bolt of the can and the parachute would be stuffed into the black container. Once the drone is at the desired height it is given a slight shake causing the can to fall from the hook and bring the parachute out of the container to be deployed. We found that our can spun as it fell so we added a swivel hook to prevent this.

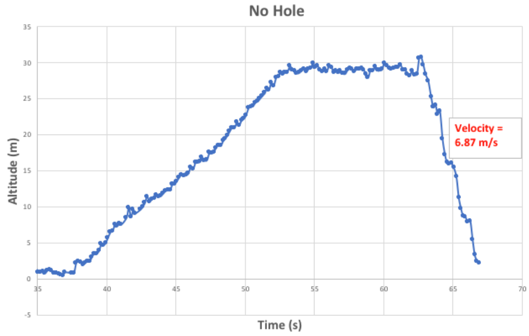
Parachute drop mechanism

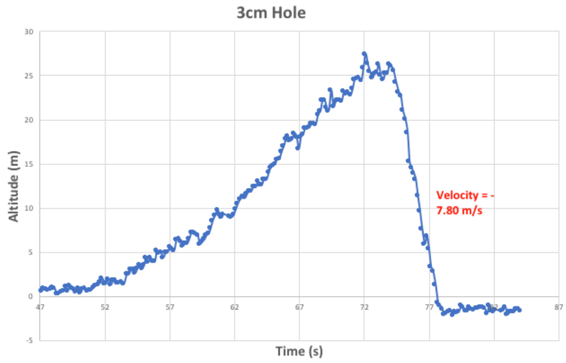
Swivel hook

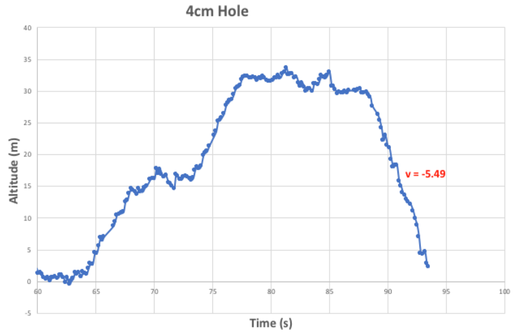
Testing:

We also tested parachutes with different sized spill holes, no holes and a prototype for the semi ellipsoid parachute made from a bin bag. We did this to evaluate the stability of each parachute depending on the size of the spill hole and also to try and find a correlation between stability and spill hole size.









Test results

The graphs are plotted with altitude against time, a bump in the decending line indicates the parachute falling to the left or right making it stay in the air longer and show up in the graph as a more horizontal line signifying the parachute is less stable.

Semi-ellipsoid: This parachute is the most stable out of all of them, as expected, there is virtuallty no kinks in the decending line. This parachute is also not too far off the minimum decent speed (8m/s) at approximatly 7m/s.

No hole: This may have been the least stable parachute of the four there are 3 prominent kinks in the line showing that this parachute drifted quite a lot. This parachute is also not too far off the minimum decent speed (8m/s) at approximatly 7m/s.

3cm hole: This parachute is very stable showing just one prominent area where it could be observed drifting. This parachute is also the closest to the required 8m/s decent speed.

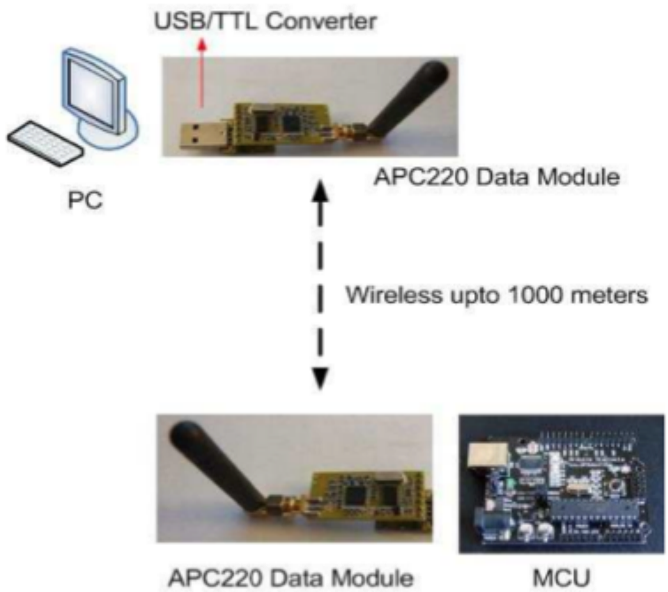
4cm hole: This parachute was not the best in terms of stability it shows at least two prominent moments of it drifting. Due to the parachute drifting quite a lot it has the slowest terminal velocity of all of them which is not ideal for locating the can(5.49m/s).

Parafoil for Europe:

If we get through to the European finals we would like to explore the option of guided landing. We had two Confey College teams who entered the Leinster finals and the other team were working on guided landing. They had two servos which could steer a parafoil that they had designed. They also had a motor but this was not fully ready for the Leinster final. We are hoping to use some of their parts and design to try to get this working. They have offered us the parts and have been helping us consistently with the bulid/design of our can for the National finals. They also made an excellent infomercial video explaining how their can and the guided landing system works. Please have a look at this excellent video HERE.

2.6 Ground Support:

We have two Apple Mac Book Pro's that were donated to one of our past Cansat teams . These laptops on the ground are connected to APC220 transceivers via a UART to TTL converter. Our Arduino also uses an APC220 to transmit the data. The APC220 uses the frequency shift keying method to transmit and receive signals. We can program our APC220's frequency via RF Magic or via a spare Arduino that has been set up to do this. Our baudrate is 9600 as we found this to work the best.



We felt that the range of the duckbill antenna might not be enough for the 1000m transmission distance. We tested to 500m using a drone and did not have a problem. We did not get time to test the full 1000m. We decided to use a Yagi antenna as a guarantee. We purchased the LPRS Yagi 434Hz – 7 element. This is specifically designed to receive signals between 390MHz-480MHz range.

LPRS

Manufacturer:	LPRS
Manufacturer Part No:	YAGI-434A
Order Code:	2096215
Technical Datasheet:	(EN)

Data Collection and Display:

We are using two Apple Mac Book Pro’s that were donated to our 2014 Cansat team. It took a while for us to figure out how to use the Apple PC’s to read in the data. Eventually we located a USB to UART driver (SILABS_USB_Driver), downloaded it and it worked. On one lap top we are using the terminal emulator function SCREEN to read our data into a raw data file. SCREEN is a full-screen window manager that multiplexes a physical terminal between several processes

We can then run a Python program to tidy up the data to make it ready for making graphs. The Python program also performs some of the calculationsOn the other laptop we are using a python program to read in the data and tidy it as it comes in and display realtime graphs. This also puts the data into a file ready for extra graphing if needed.

An excel worksheet has been set up to get data from the any clean data file on refresh. The excel file has pre prepared graphs that update automatically on refresh and can be analysed immediately. We hope to use both systems on the launch day.

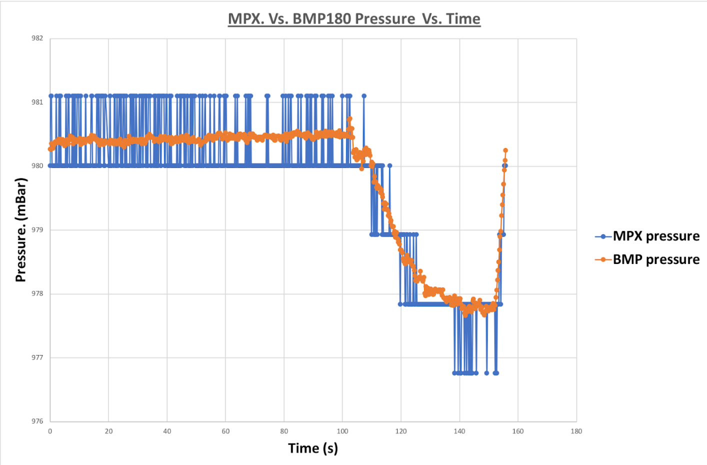
Example of Excel Data File:

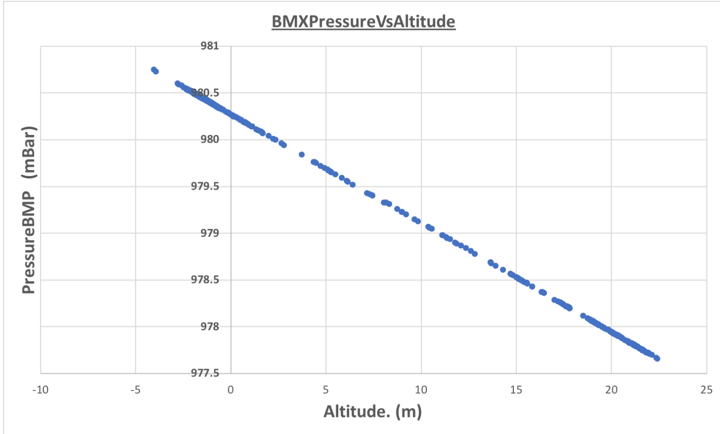
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1																					
2	Time(s)	TmpEx(DegC)	PressMP(mB)	Alt1(m)	Vel(m/s)	BMPp	BMPt	BMPa	RelHumid	GyroX	GyroY	GyroZ	AccX	AccY	AccZ	MagX	MagY	MagZ	Pich	Roll	Header
3	0	7.81	1006.05	0	-227.58	1008.59	25.39	0	40.77	-0.83	1.18	-2.67	0.18	-0.04	0.97	0.21	-0.33	-1.83	-10.53	-2.56	131.6
4	0.24	7.81	1012.56	-54.62	-227.58	1008.55	25.38	0.38	41.24	-1.24	1.04	-2.51	0.18	-0.04	0.97	0.22	-0.33	-1.83	-10.31	-2.38	131.7
5	0.48	7.79	1004.97	9.09	265.46	1008.57	25.39	0.19	41.56	-1.25	0.88	-2.67	0.18	-0.04	0.97	0.22	-0.33	-1.83	-10.36	-2.39	131.62
6	0.72	7.81	1004.97	9.09	0	1008.57	25.39	0.19	40.29	-1.19	1.01	-2.7	0.18	-0.04	0.95	0.22	-0.33	-1.82	-10.58	-2.29	132.18
7	0.96	7.83	1007.14	-9.16	-76.04	1008.63	25.4	-0.32	39.65	-1.24	1.06	-2.64	0.18	-0.04	0.97	0.22	-0.33	-1.82	-10.43	-2.51	132.36
8	1.2	7.81	1010.39	-36.44	-113.67	1008.62	25.41	-0.18	40.45	-0.83	1.02	-2.7	0.18	-0.04	0.97	0.23	-0.33	-1.82	-10.31	-2.31	132.91
9	2.17	7.79	1007.14	-9.16	28.12	1008.64	25.4	-0.42	40.45	-1.21	0.97	-2.74	0.18	-0.04	0.97	0.21	-0.33	-1.82	-10.52	-2.36	131.25
10	2.41	7.79	1008.22	-18.24	-37.83	1008.6	25.4	-0.07	39.81	-1.24	0.92	-2.77	0.18	-0.04	0.97	0.22	-0.34	-1.83	-10.38	-2.38	131.41
11	2.65	7.82	1010.39	-36.44	-75.83	1008.62	25.41	-0.18	39.81	-1.24	0.86	-2.84	0.18	-0.04	0.97	0.22	-0.33	-1.83	-10.3	-2.49	131.85
12	2.89	7.78	1004.97	9.09	189.71	1008.66	25.43	-0.55	39.97	-1.03	0.97	-2.79	0.17	-0.04	0.97	0.22	-0.33	-1.83	-10.26	-2.32	131.95
13	3.16	7.81	1004.97	9.09	0	1008.7	25.42	-0.87	41.09	-0.95	0.82	-2.64	0.18	-0.04	0.97	0.22	-0.33	-1.82	-10.46	-2.26	132.06
14	3.4	7.81	1007.14	-9.16	-76.04	1008.62	25.42	-0.23	40.61	-1.15	0.86	-2.7	0.18	-0.04	0.96	0.22	-0.33	-1.82	-10.38	-2.35	131.95
15	3.64	7.83	1004.97	9.09	76.04	1008.64	25.42	-0.39	39.02	-1.41	0.77	-2.83	0.18	-0.04	0.97	0.22	-0.33	-1.83	-10.41	-2.3	132.42
16	3.88	7.77	1012.56	-54.62	-265.46	1008.59	25.42	0.02	40.77	-1.16	1.05	-2.82	0.18	-0.04	0.97	0.22	-0.33	-1.83	-10.31	-2.36	131.78
17	4.87	7.82	1009.31	-27.39	27.51	1008.64	25.43	-0.4	39.65	-1.2	0.77	-2.64	0.18	-0.04	0.95	0.22	-0.33	-1.83	-10.5	-2.44	132.22
18	5.15	7.77	1010.39	-36.44	-32.32	1008.66	25.44	-0.54	40.77	-1.13	1.33	-2.6	0.18	-0.04	0.97	0.22	-0.33	-1.83	-10.31	-2.39	131.81
19	5.39	7.82	1009.31	-27.39	37.71	1008.64	25.42	-0.41	40.29	-1.29	1.16	-2.69	0.18	-0.04	0.97	0.22	-0.33	-1.82	-10.39	-2.16	132.2
20	5.63	7.77	1007.14	-9.16	75.96	1008.63	25.43	-0.3	40.45	-1.13	0.97	-2.65	0.18	-0.04	0.97	0.22	-0.33	-1.83	-10.26	-2.34	132.46
21	5.87	7.79	1004.97	9.09	76.04	1008.68	25.44	-0.73	41.57	-0.98	1.15	-2.69	0.18	-0.04	0.97	0.21	-0.32	-1.82	-10.34	-2.34	132.22
22	6.14	7.82	1004.97	9.09	0	1008.64	25.43	-0.4	40.13	-1.27	0.81	-2.78	0.18	-0.04	0.97	0.22	-0.33	-1.83	-10.32	-2.34	132.16
23	6.38	7.81	1007.14	-9.16	-76.04	1008.64	25.43	-0.43	40.61	-0.77	1.04	-2.67	0.18	-0.04	0.97	0.22	-0.33	-1.83	-10.43	-2.44	131.89
24	6.62	7.82	1007.14	-9.16	0	1008.67	25.44	-0.63	40.29	-1.18	1.21	-2.59	0.18	-0.04	0.96	0.22	-0.33	-1.83	-10.34	-2.35	131.67
25	7.61	7.77	1010.39	-36.44	-27.56	1008.67	25.44	-0.6	40.77	-1.07	1.16	-2.73	0.18	-0.04	0.97	0.22	-0.34	-1.83	-10.3	-2.41	131.78
26	7.85	7.82	1004.97	9.09	189.71	1008.7	25.44	-0.88	40.61	-1.18	0.98	-2.66	0.18	-0.04	0.97	0.22	-0.33	-1.83	-10.4	-2.35	132.04
27	8.13	7.81	1010.39	-36.44	-162.61	1008.61	25.44	-0.18	41.09	-0.92	1.19	-2.55	0.18	-0.04	0.97	0.22	-0.34	-1.82	-10.27	-2.46	131.54
28	8.36	7.77	1007.14	-9.16	118.61	1008.62	25.44	-0.21	39.97	-1.16	0.9	-2.61	0.18	-0.04	0.96	0.22	-0.33	-1.83	-10.43	-2.34	132.24
29	8.6	7.81	1006.05	0	38.17	1008.63	25.45	-0.32	41.25	-1.11	0.94	-2.69	0.18	-0.04	0.97	0.21	-0.34	-1.83	-10.37	-2.26	131.15
30	8.84	7.81	1004.97	9.09	37.88	1008.69	25.45	-0.82	41.09	-1.26	1.09	-2.66	0.18	-0.04	0.95	0.21	-0.33	-1.82	-10.58	-2.4	131.46
31	9.12	7.79	1010.39	-36.44	-162.61	1008.7	25.47	-0.92	41.09	-1.21	0.79	-2.63	0.18	-0.04	0.96	0.22	-0.33	-1.83	-10.4	-2.39	131.52
32	9.36	7.81	1010.39	-36.44	0	1008.69	25.46	-0.8	40.93	-1.09	0.76	-2.7	0.18	-0.04	0.97	0.22	-0.33	-1.82	-10.55	-2.43	132.41

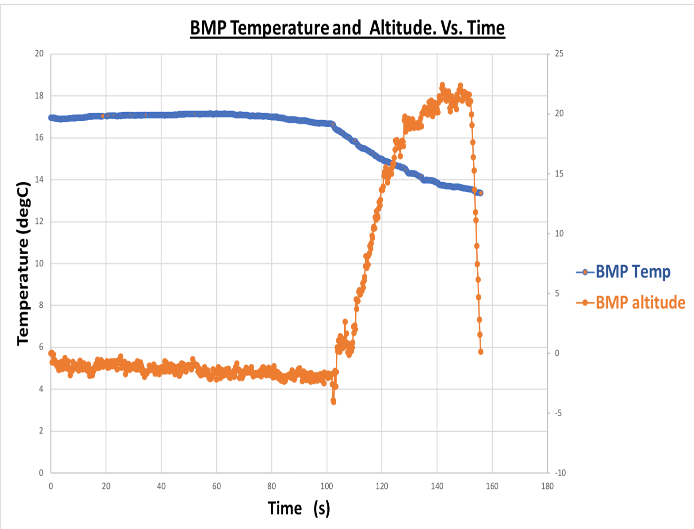
For Europe:

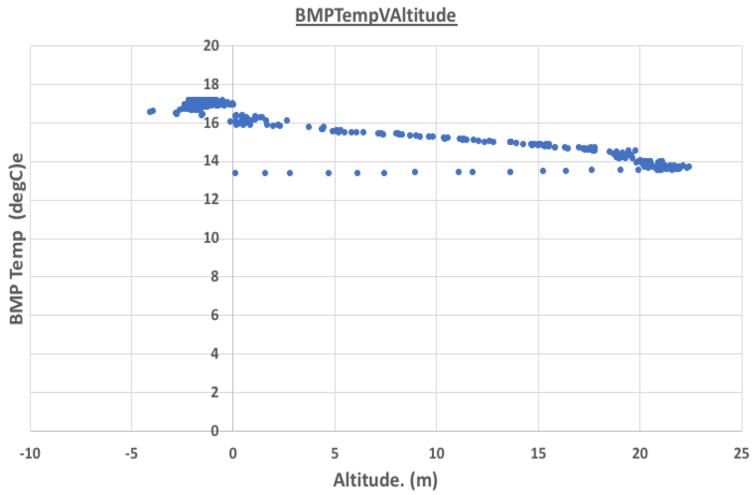
For Europe we would like to tidy up the Arduino code and put everything into functions. We would like to remove as much of the calculations from the Arduino program as possible and use the Python program instead. This would mean that the Arduino program would spend less time doing calculations during the loop it is executing – this would mean we would have a higher data sampling rate as each loop would execute faster.

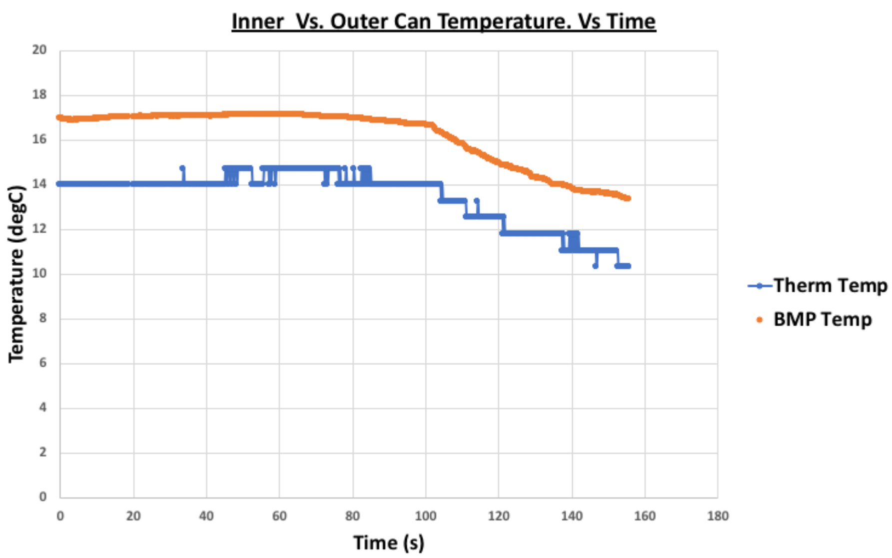
Examples of graphs from the Regional final:











3. PROJECT PLANNING

3.1 Time Schedule of the CanSat preparation

We feel that while our timing and project planning for the regional final was good, we can still improve a lot. We worked well as a team and had good communication, however due to complications and leaving some parts of the CanSat until the last minute we ended up rushing to get our CanSat completed on time for the regional competition. As a result of what we learned from our time keeping in the regional competition, for the national competition we have gone through what needs to be done, designated our various different tasks to be completed and got started early so that we will have our CanSat completed in time. We have specific dates and deadlines set and we have weekly meetings to ensure that we don’t fall behind schedule for the national competition. There have still been delays however and we are still learning about the best way to keep things and team members on task.

3.2 Resource Estimation

3.2.1 Budget

Low Loss WIFI Antenna Cable 2M SMA Male to SMA Female RG58 50 ohm Coaxial Pigtail For LTE MIMO Directional 3G 4G LTE Ham ADS-B GPS £6.43
Sold by onelinkmore

Order #203-8506488-7539558
Placed on April 17, 2018

SEN-13284 SparkFun 9DoF IMU Breakout - LSM9DS1 /fba £26.50
Condition: New
Sold by: V&U Electronic Components Ltd
Fulfilled by Amazon

Adafruit Slim Sticker-type GSM/Cellular Quad-Band Antenna - 3dBi uFL [ADA1991] £5.97
Sold by The Pi Hut

ANSMANN Photocam IV Battery Charger for AA/AAA Battery - "UK Only" Plug - with 4 x AA 2850mAh rechargeable batteries £32.95
Sold by Amazon EU S.a.r.L.

Adafruit Ultimate GPS Logger Shield - Includes GPS Module [ADA1272] £44.19
Sold by kjdElectronics EU

Humidity Sensor - HIH-4030 Breakout	HIH4030	£10.00	1	£10.00

Product	Model	Price	Quantity	Total
NCP1402-5V DC-DC Step-Up Converter Breakout	PRT-10968	£3.33	2	£6.66

----

1 x Barometric Pressure Sensor - BMP180 Breakout (BMP180-BRK) = £6.90

Order Code	Qty Ordered	Mftr. Part No	Manufacturer / Description	
2096215	1	YAGI-434A	LPRS YAGI-434A Antenna, YAGI, 7 Element, 9dBi, 434MHz	€40.71

Material for parachute and cords : €20.00
Cansat kit from DIT (Arduino, Shield, antennax2, APC220x2, thermistor, pressure sensor) €150.00

TOTAL for flying related parts: (£90.73+€210.71) €313.45

3.2.2 External support

<u>Support</u>

Dublin Institute of Technology provided us with a soldering and coding workshop.

Butler Transtest Ltd allowed us to use their equipment to calibrate our primary mission temperature and pressure sensors.

NSAI also very kindly helped us to calibrate our Relative Humidity sensor and pressure sensors. In addition they gave us a tour of their facilities and the visit was extremely informative.

Intel allowed us to use their 3D printer to print several versions of our can for the regional final and also gave us very good advice.

Ms. Power (Confey College media person) helped to put us in touch with reporters from local newspapers.

Fergus and Fran our caretakers who kept the school open late for us on several nights.

The Liffey Champion who have helped us to get local recognition and sponsorship for our project.

3.2.3 Confirmed sponsorship to date:

Manepa Medical (a market leader in the supply and service of specialised decontamination equipment to the Health Care industry) donated €500 towards our costs.

The Courtyard Hotel, Leixlip donated €200 and promised us a further €800 if we manage to go to Europe

Bernard Owens Menswear, Leixlip donated €200.

Leixlip Credit Union donated €250.

SuperValu Riverforest, Leixlip donated prizes for a school competition to name our can.

John Dooley donated prizes for a competition we held in school

Macaris Italian takeaway donated a voucher for a competition we held in school

The Courtyard Hotel, Leixlip donated €200 and have promised to further support us if we get through to the European finals.

Watkins Tile Centre, Leixlip donated €20

4. OUTREACH PROGRAMME

Name and Logo Competition:

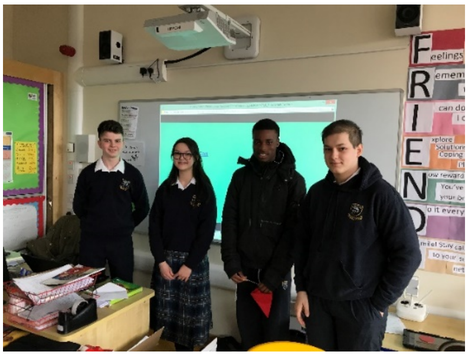
We held a competition to design a logo and name our can. The competition was open to the entire school and we received lots of entries. The four winners received prizes which were provided to us by some local business sponsors. The top three entries can be seen below:

Presentation to First Year Groups:

We presented our CanSat project to all of the first year classes in an attempt to get the students more involved in the STEM subjects as well as the CanSat project in years to come. The students were interested in what we had to say and enjoyed the presentation.

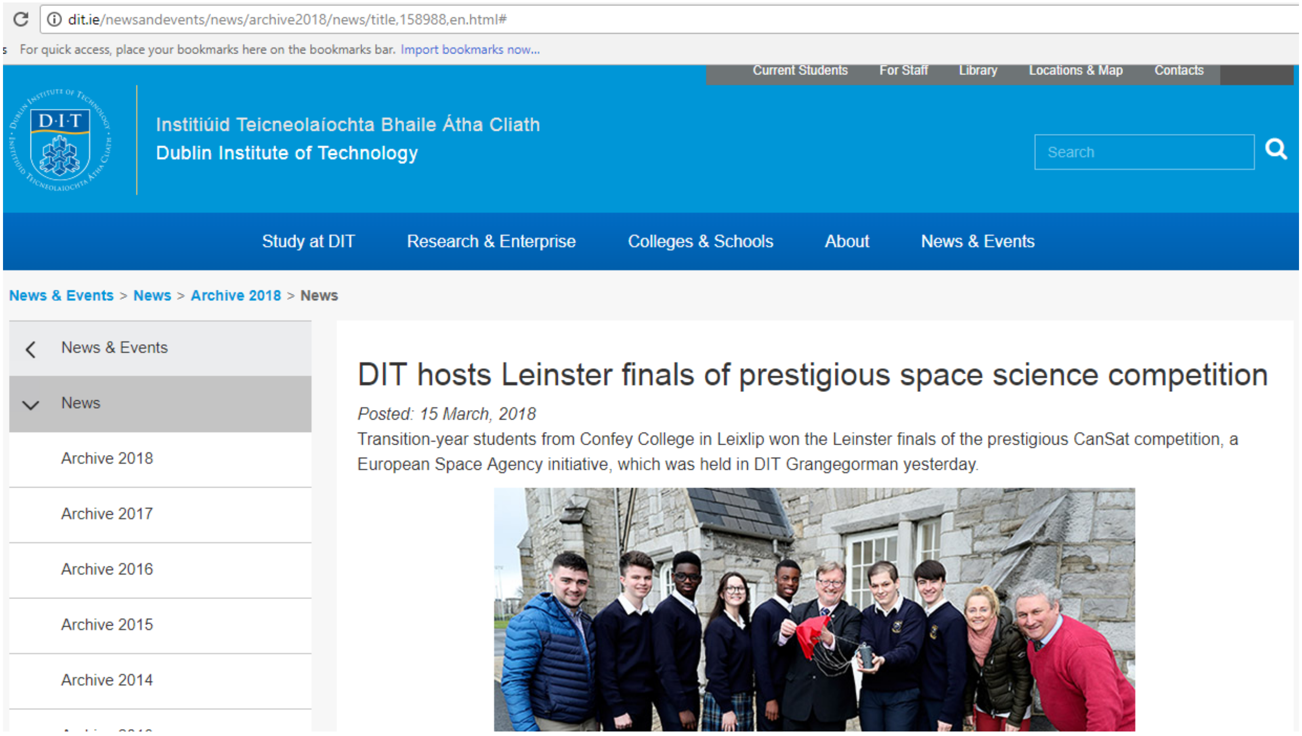
Visits to Primary Schools:

We visited three of our local primary schools recently to present CanSat to some of the senior classes and to involve them in a CanSat game that we developed in order to promote the STEM subjects and the CanSat project in the schools. The students enjoyed our visits and we could see each time that the students were more inclined to choose the STEM subjects after our visit than they had been before our visit.



Media

As part of our outreach programme we have been in contact with some of our local newspapers and recently we had an article published about our CanSat team in the "Liffey Champion", the most popular newspaper in our local area. We also had a number of articles published online which can be seen below.



dit.ie/newsandevents/news/archive2018/news/title,158988,en.html#

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DIT hosts Leinster finals of prestigious space science competition

Posted: 15 March, 2018

Transition-year students from Confey College in Leixlip won the Leinster finals of the prestigious CanSat competition, a European Space Agency initiative, which was held in DIT Grangegorman yesterday.

24 March 2018 • Liffey Champion

Confey College students win CanSat space competition Leinster final

(l-r) Jason Dineen (Teacher), Adam Walsh, Adenide Oyeyemi, Annamel Chan Kinsella, Ugo Uzoukwu, Professor Brian Norton (President, DIT), Erik Ryan, Brendan Alinquaint, Mary Selkirk (Teacher), Dr Mick McKeever (DIT) {Photo by Mark Maxwell Photography}

TRANSITION- year students from Confey College won the Leinster finals of the prestigious CanSat competition, a European Space Agency initiative held in DIT Grangegorman last week.

The Confey College team beat five other teams for the coveted prize of Leinster champions and will go on to the national finals in Portlaoise in April.

A CanSat is a simulation of a satellite built inside an empty soft drink can. The challenge for the students is to fit all the major subsystems found in a satellite, such as power, sensors and a communication system, into this minimal volume.

The CanSat is then launched to an altitude of 100 metres using a drone – its mission is to measure weather data, speed and acceleration and to make a safe landing using a parachute designed by the students.

Dr Mick McKeever, a Lecturer in the School of Electrical and Electronic Engineering coordinated the competition in DIT.

"The goal of CanSat is to encourage school students to consider careers in science and engineering," he said.

"The competition engages students in a real space project in a fun and exciting way.

"It builds life skills such as teamwork, presentation and communication skills, and industry skills such as computer programming, radio communications, data analysis and soldering electronics."

The CanSat Ireland competition is run by ESERO Ireland in collaboration with CIT Blackrock Castle Observatory and the Institutes of Technology and is co-funded by the European Space Agency and Science Foundation Ireland.

https://www.kildarenow.com/news/confey-college-win-leinster-finals-cansat-space-competition/214097

KildareNow | News | Sport | Features

Confey College win the Leinster finals of the CanSat space competition

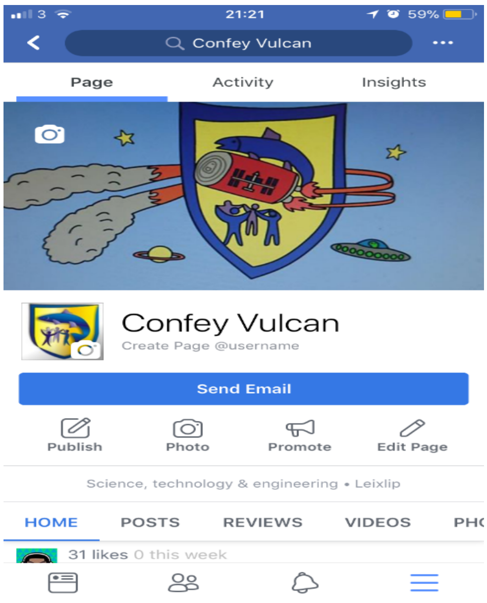
Website Design

Https://17chankinsella.wixsite.com/confeycansat2018

Our website is a very successful part of our outreach programme. Our website has several pages, one for each part of CanSat that we work on, as well as a blog which is updated regularly to keep our readers updated.

Social Media

We have two social media pages, one on Instagram and one on Facebook. Our pages are updated regularly so our followers can be kept updated on our progress. Each of our pages are very successful, with our videos reaching over 100 views.



5. REQUIREMENTS

In order to be able to launch our CanSat safely from the rocket, it should meet the requirements listed in the competition guidelines.

Complete the following table by specifying the exact characteristics of your CanSat. Please make sure that the figures indicated here correspond to the same figures in other sections of the document.

Characteristics:	Figure (units)
Height of Cansat	115mm
Mass of Cansat	319g
Diameter of Cansat	66mm
Length of the Recovery system	35cm
Flight time schedule	125 - 155 s
Calculated decent rate	6.6m/s
Radio Frequency	437MHz
Power Consumption	0.624W (260mA)
Total Cost	€313.45

On behalf of the team I can confirm that our CanSat complies with all of the requirements established for the 2018 CanSat competition in the official guidelines.

Signature, place and date:

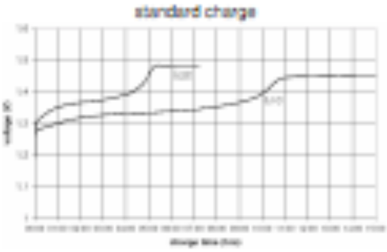
Appendix 1 – Battery Datasheet

ANSMANN 2850mAH Battery

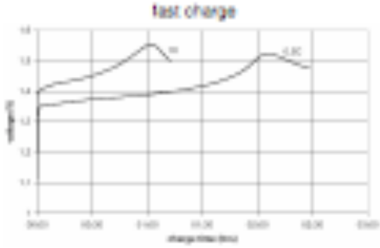
			Conditions
cell type:		NiMH	
cell size:		AA	
nominal voltage:	1.2	V	
max. charge voltage:	1.45	V	at standard charge (0.1C / 20°C)
capacity			
nominal:	2850	mAh	discharge at 0.2C
minimum:	2500	mAh	discharge at 0.2C
	2300	mAh	discharge at 1C
			1.0V end discharge voltage ta: 20°C
max. continuous discharge current:	5400	mA	ta: 0....45°C
charge	current		time
standard charge:	270	mA	14....16hrs
quick charge:	725	mA	4hrs
fast charge:	2700	mA	1.1hrs
recommended charge	5...10	mV	- delta V
termination control	0.8...1	°C	temp. increase per minute
parameters:	45...50	°C	TCO (temperature cut off)
trickle charge current:	25...90	mA	(recommended)
continuous overcharge: (less than 1 year)	≤ 200	mA	no conspicuous deformation no leakage
internal resistance: (impedance)	≤ 30	mΩ	at 1KHz battery fully charged
life expectance:	≥ 500	cycles	acc. IEC standard
self discharge			
charge retention:	≥ 60	%	after 28 days storage at 20°C
ambient temperature range:	0...45	°C	standard charge
	10...40	°C	fast charge
	- 20...65	°C	discharge (≤1.0C)
	0...45	°C	discharge (>1.0C)
	- 20...50	°C	storage (≤1month)
	- 20...40	°C	storage (≤3months)
	- 20...30	°C	storage (≤12months)

Diagrams

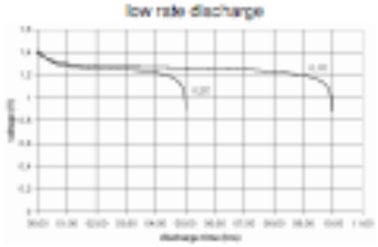
standard charge



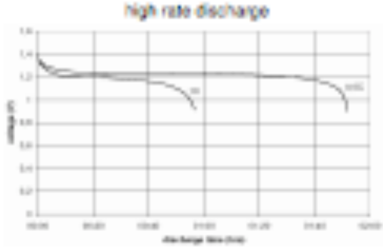
fast charge



low rate discharge



high rate discharge

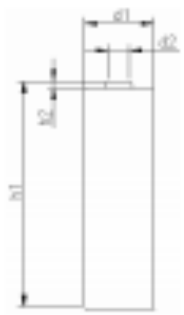


QCT1: 20/2400/35
QCT2: 30/2200/40

mechanical specifications

cell dimensions (incl.label)

diameter d1:		14.3	- 0.5	mm
diameter d2:	max.	5.5		mm
height h1:		50.3	- 0.5	mm
height h2:	min.	1.2		mm
weight:		30	± 2	g



ANSMANN	ANSMANN Specifications for model:	AA - 2850mAh Digital bulk package
	data sheet no. / part no.	5035021
	version no.	0
	author / date	Gramlich / 30.06.2009

Manufacturer reserves the right to alter or amend the design, model and specification without prior notice

ne: +44 (0)191 498 9999
atteries@cellpacksolutions.co.uk
www.cellpacksolutions.co.uk
CELL PACK SOLUTIONS

APPENDIX 2: Datasheets for All Sensors

Below are copies of our datasheets for all of our sensors

1.) NTC thermistor Temperature Sensor:
http://dsp.rice.edu/sites/dsp.rice.edu/files/ntcle100.pdf

2.) MPX4115A Pressure Sensor:
http://www.farnell.com/datasheets/8723.pdf

3.) BMP180 Pressure and Temperature Sensor:

Breakout board:

https://www.sparkfun.com/products/11824

Datasheet:

http://cdn.sparkfun.com/datasheets/Sensors/Pressure/BMP180.pdf

4.) HIH4030 Relative Humidity Sensor:

Breakout board:

https://www.sparkfun.com/products/9569

Datasheet:

https://www.sparkfun.com/datasheets/Sensors/Weather/SEN-09569-HIH-4030-datasheet.pdf

5.) APC220 Transceiver:
http://www.robotshop.com/media/files/PDF/dfrobot-apc220-manual.pdf

APPENDIX 3 - CANSAT REQUIREMENTS

The CanSat hardware and mission must be designed to the following requirements and constraints:

[1] All the components of the CanSat must fit inside a standard soda can (115 mm height and 66 mm diameter), with the exception of the parachute. An exemption can be made for radio antennas and GPS antennas, which can be mounted externally (on the top or bottom of the can, not on the sides), based on the design. N.B. The rocket payload area has 4.5 cm of space available per CanSat, along the can's axial dimension (i.e. height), which must accommodate all external elements including: parachute, parachute attachment hardware, and any antennas.

[2] The antennas, transducers and other elements of the CanSat cannot extend beyond the can's diameter until it has left the launch vehicle.

[3] The mass of the CanSat must be between 300 grams and 350 grams. CanSats that are lighter must take additional ballast with them to reach the 300 grams minimum mass limit required.

[4] Explosives, detonators, pyrotechnics, and flammable or dangerous materials are strictly forbidden. All materials used must be safe for the personnel, the equipment and the environment. Material Safety Data Sheets (MSDS) will be requested in case of doubt.

[5] The CanSat must be powered by a battery and/or solar panels. It must be possible for the systems to be switched on for four continuous hours.

[6] The battery must be easily accessible in case it has to be replaced/recharged.

[7] The CanSat must have an easily accessible master power switch.

[8] Inclusion of a retrieval system (beeper, radio beacon, GPS, etc.) is recommended.

[9] The CanSat should have a recovery system, such as a parachute, capable of being reused after launch. It is recommended to use bright coloured fabric, which will facilitate recovery of the CanSat after landing.

[10] The parachute connection must be able to withstand up to 1000 N of force. The strength of the parachute must be tested, to give confidence that the system will operate nominally.

[11] For recovery reasons, a maximum flight time of 120 seconds is recommended. If attempting a directed landing then a maximum of 170 seconds flight time is recommended.

[12] A descent rate between 8 m/s and 11 m/s is recommended for recovery reasons. In case of attempting a directed landing, a lower descent rate of 6m/s is recommended.

[13] The CanSat must be able to withstand an acceleration of up to 20 g.

[14] The total budget of the final CanSat model should not exceed 500€. Ground Stations (GS) and any related non-flying item will not be considered in the budget. More information regarding the penalties in case of exceeding the stated budget can be found in the next section.

[15] In case of sponsorship, all the items obtained should be specified in the budget with the corresponding costs on the market at that moment.

[16] The CanSat must be flight-ready upon arrival to the launch campaign. A final technical inspection of the CanSats will be done by authorised personnel before launch.

APPENDIX 4 –
Websites Containing Articles about Confey Vulcan

Liffey Champion – 7500 readers weekly

Kildare Now
https://www.kildarenow.com/news/confey-college-win-leinster-finals-cansat-space-competition/214097

DIT website
http://dit.ie/newsandevents/news/archive2018/news/title,158988,en.html

Confey Vulcan website
https://17chankinsellaa.wixsite.com/confeycansat2018