Confey Community College

CanSat

Progress Report & Design Document

Team Name: **Confey Can**

Country: **Ireland**

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P.1 New Progress Statement for Team Profile:

While the National Final was a great success overall, it did highlight for us several areas in our project that can be improved upon. A couple of cords ripped on the parachute during ejection from the rocket. Also, our backup parachute, when tested travelled a considerable distance off course due to it's descent velocity not being large enough. Hence we are going to check on our maths to ensure our calculations for parachute area was correct, we are also going to investigate new materials for the parachute cords, experiment with shorter cord lengths and we will also investigate new parachute materials and the effects on stability and velocity of holes in the material. The National Final involved gathering wireless data from distances greater than we had experienced before and we had issues with corrupt/sporadic data which left us with less data than we intended and also caused issues with our data filtering program due to the GPS time data being corrupt in places. As a result, we are going to investigate at least two new types of antenna (Yagi and Parabolic) which we hope will be bigger and better than our previous 'pooper scooper' semi parabolic antenna. We will also edit our Python data filtering program so that it does not crash when the GPS time data appears in a strange format. Our flight video missed most of the parachute's flight so we could not display it running alongside the altitude graph. We are looking at ways to get a better fix on our parachute (better recorder possibly).

In addition, we feel that we will have the time to implement more of our bigger design plan test missions than we initially thought so we are going to add on flexible solar panels in order to evaluate the power available from the sun and whether this would be of use to us in future missions where we may want to have our Can become a planetary bot. We are also going to work on the transceiver and communication software to see if we can set up two way communication between the CanSat and the Ground station. We hope to use this to turn on/off power to devices and/or we may use it to demonstrate that the CanSat is a means of receiving and broadcasting messages.

Finally, one of the rocket men we met at the National Final has offered to do two 3D prints of the outer casing for us using what we hope will be stronger material which we intend to evaluate.

P.2 Task List:

Task:	Detail:	Status:
Brainstorm:	Discuss mission and options	Complete
Solar Panel Design Phase:	Order a variety of solar cells	Complete
	Test various configuations of Solar panels and select optimum configuration.	In progress
	Write Arduino software for solar panel evaluation	In progress
	Test software and hardware together	Not done
	Implement software and Hardware into Can structure and retest	Not done
	Calibrate	Not done
Two Way Comms	Agree specific comms tasks	In progress
	Physical adjustments	In progress
	Write program/code	In progress
Improve signal reception	Order new fully parabolic reflector	Complete
	Test parabolic reflector Vs Yagi antenna	In progress
Improve strength of parachute cord	Investigate new cord materials	In progress
	Purchase new cords	Not done
Investigate why decent velocity too low	Test new cords and select optimum	Not done
	Check maths for descent velocity	Not done
	Construct two more parachutes	In progress
	Determine optimum parachute design	Not done
Investigate 3D printing offer	Send in drawing	Complete
	Test can for suitability	Not done
Outreach	School visits to primary school 1	In progress
	School visits to primary school 2	In progress
Improve filtering of Python program	Edit program	In progress
Final test of hardware	Drone drop test	Not done
Analysis of data	Review data and verify results	Not done
FTR	Ensure draft FDR upto date	Not done
Address any arising issues	Final fix	Not done

Confey Community College

CanSat
CDR

Team Name: **Confey Can**

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INTRODUCTION:

1.1 Team organisation and roles

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

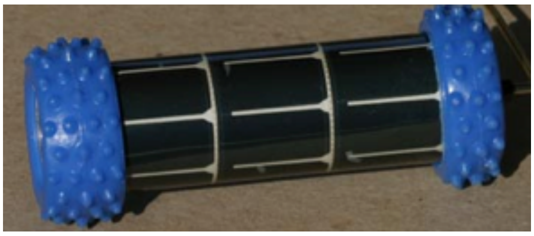
Team members:

Name:	Year of study:	Relevent Subjects:	Field of work in team:	Expected workload within team:	Project hours at school per wk	Hours per wk after school
Liam Murphy	5^{th} Year	Physics, Chemistry, Maths, Applied Maths, Engineering, Business	Outreach person and **Mission Manager**	Website design and management,of all e – communication, Coordination of primary school visits, Media contact, Pursuing sponsorship opportunities	Approx 1 hour	Appro x 3 hours
Conor Walsh	5^{th} Year	Physics, Maths, Engineering, Design and Communicati on Graphics	**Payload Manager** and Graphics Design, Test and Calibration	Test and Calibration of sensors, mechanical drawings for design and layout , electrical analysis	Approx 1 hour	Appro x 3 hours
Julia Waszkiewi cz	5^{th} Year	Physics, Biology, Chemistry, Maths, Applied Maths	Recovery System + **Safety Officer**	Parachute design, manufacture and test	Approx 1 hour	Appro x 3 hours
Gergely Gellert	5^{th} Year	Physics, Maths, Chemistry, Engineering, Applied	Software developer and **Flight Director**	Arduino programming, Python programming, testing of	Approx 1 hour	Appro x 3 hours

		Maths, Computer programming		sensors Excel graohical representations and powerpoint generation		
Alex Bourke	Transition Year	Sciences, Maths, Public speaking	Data analysis and media assistant	Excel presentation, incorporating video into graphs, data research and analysis, media assistant	Approx 1 hour	Approx 3 hours
Naoise Barry	5^{th} Year	Physics, Maths, Applied Maths, Engineering, Chemistry	mechanical design assistant	Mechanical design, Pursuing sponsorship opportunities	Approx 1 hour	Approx 3 hours
Denis Buhai	5^{th} Year	Physics, Maths, Biology, Chemistry, Business	Video of flight, outreach assistant	incorporating video into graphs, media assistant	Approx 1 hour	Approx 3 hours
Kieran Kilbane	5^{th} Year	Physics, Maths, Biology, Applied Maths, Geography	Outreach and media assistant,	general team assistance – testing and calibration, outreach	Approx 1 hour	Approx 3 hours

1.2 Mission objectives:

Our primary mission is to measure and record Pressure and Temperature as the Satellite decends to Earth and, from this data, to calculate it's Altitude and descent velocity.
We have a bigger plan involving planetary bots - thousands of which could be dropped onto a planet and, in addition to recording data during decent, they will also be able to land, move about, and record various pieces of information about the planet's surface and atmosphere (including topography, seismology, soil samples, video, weather..etc). The pictures below have been taken from websites just for illustration – we do not have a design for our 'planetary bot' yet.



http://www.smfr.org/robots/roller.html   https://www.youtube.com/watch?v=IwIRV_WmQ7A

They will be small, cheap and lightweight. For this, we will need to perform several test missions to investigate several aspects of this project.. This 2016 mission is the first of those test missions and it is hoped to demonstrate successful two way communication between 'Earth' and the CanSat/bot. In addition, the opportunity to have the CanSat act as a 'relay' for enhanced signaling and communication to extend the potential range of the devise and to allow for communication with any potential planetary inhabitants is also highly desirable. The CanSat/bot will also need a sustainable power source after it has landed – to allow it to move about and take measurements and this is why we would like to use this mission to investigate the capability of the power of a planet's sun. We also want to look at the forces experienced by the can especially during take off and landing so that we know what our future designs need to allow for and also to get an indication of the gravitational field of the planet and any variations in it. We want GPS in order to be able to locate the CanSat/bot and also to assist in mapping some of the data from it. In addition we have decided to measure relative humidity in this mission for reasons explained below.

Secondary Mission:	Reason:
Measure Relative Humidity of atmosphere	Inspired by the AIM mission which was to determine what factors – temperature, water vapour and dust particles lead to the formation of Noctilucent clouds. Also the fact that water is necessary for human life and therefore it's quantities in the atmosphere would be an important indicator of what might be available on land.
Measure forces/gforces on the can throughout it's flight	We would like to know the maximum gforce on the can especially during take off and landing so that we can make sure our can design/structure accounts for this – also we would like to know what the planet's gravitational gforce is for stability calculations, and movement calculations on the planet – as the gravitational force will affect power usage/mechanical operation on the ground.
Demonstrate two way communication by sending a message and getting the CanSat to relay the message back, also by varying the sensitivity on the accelerometer during flight and perhaps turning on/off the power/LED's	We will need to have two way communication to control our planetary bots in our future mission so we would like to be able to demonstrate this. Also, the CanSat could be used to broadcast messages to the planet and relay any messages received back. The CanSat could also be used as a relay to pass on messages received from distant Satellites. We also feel that there will be large forces experienced during take off and landing but we may need to change the sensitivity of the accelerometer once landed in order to measure the gravitational acceleration of the planet.
Evaluate the strength of the Solar radiation – voltage and current produced from flexible solar panels wrapped around the CanSat	As mentioned already, our CanSat could be one of a vast number of miniature devices all collecting data from different areas and relaying the data back to a controlling ground station - therefore it would need a rechargeable power source – we intend to measure the energy that is available from the Sun (using flexible solar panels) to see how much power we can get from it in order to figure out how many of a variety of sensors could be run using available solar power and therefore could continue/begin to function after landing. We also would want to measure the output of the solar panels over long periods of time in order to determine patterns showing when solar power is at it's maximum and minimum on the planet. We are trying out flexible panels wrapped around the exterior of the Can because we feel that this

	would provide the CanSat with an ability to absorb power from the sun no matter what way it was orientated.
Use GPS to track and locate the CanSat at all times	It is very important to have GPS communication in order to locate the CanSat at all times. In addition we would eventually want our 'bots' to map their own area of the planet providing various types of data – GPS location/tracking would be essential to relate the data to the particular region on the planet.

Which objectives should be reached in order for the CanSat launch to be considered successful:

Ideally, all of the above. We have already demonstrated that our primary mission works fully and, in addition, we have already successfully acquired gForce, GPS and Relative Humidity data during test launches and during the rocket launch in the National final. This data has been examined closely and appears to agree with what we expected. In addition to improving various aspects of our design (as a result of our experiences at the National final), we are now working on getting two way communication set up and we are also testing several flexible solar panels. Therefore the European final would be the third test mission for us and we would consider it to be successful if we could demonstrate some form of two way communication and record levels for the voltage and current produced from the flexible solar panels.

2 CANSAT DESCRIPTION

2.1 Mission overview

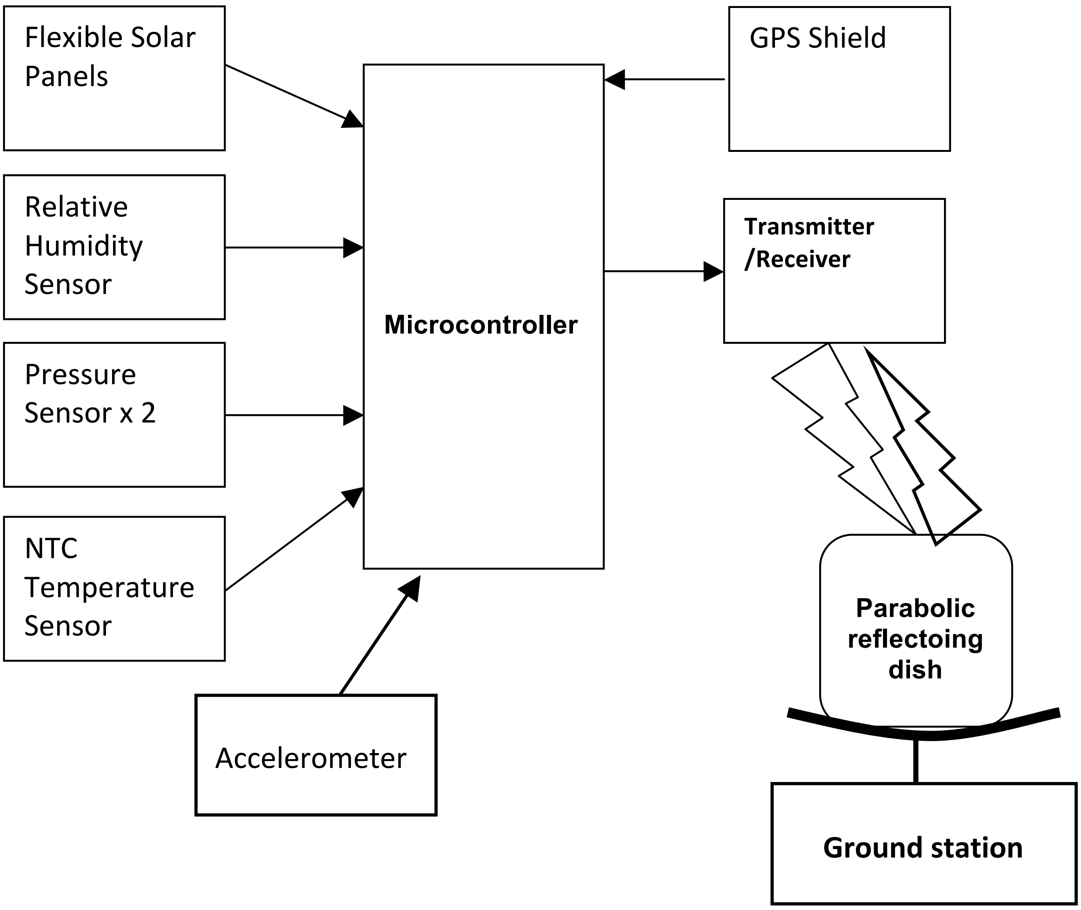
Design and build a CanSat to be launched and deployed from a rocket at an altitude of about 1000 meters. The CanSat is to descend no faster than 11 meters per second and no slower than 8m/s. It is to meet all requirements as laid down in Appendix 1. During it' s decent the CanSat will measure Temperature at the surface of the can, the temperature inside the can, pressure from two independent pressure sensors, relative humidity and gforce information in three directions. We will calculate from this data the altitude of the can as it falls and the resultant gForce on the can as it falls. We will also gather GPS data and map the trajectory of the can and we will evaluate the solar energy available from the Sun.

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

Element:	Product Name:	Usage:
Microcontroller board	Arduino Uno (based on ATMega328P)	To communicate with and acquire data from the sensors and other components and also to communicate with the ground station
Radio communications module	APC220	To wirelessly transmit /receive data to/from the ground station
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
Accelerometer	ADXL345	Measure gForce in X, Y, Z directions so resultant gForce can be measured
Relative Humidity Sensor	HIH4030	Measure relative Humidity
GPS Shield	DSS I2C GPS shield	Provide GPS data for location and trajectory mapping

Flexible Solar panels	4 products currently being tested:	Provide voltage and current measurements to reflect solar power available
Flat hexagonal parachute	Made by Julia	Provide the required decent rate and ensure a safe landing

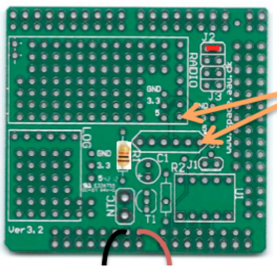
Block diagram:



2.2 Mechanical/structural design: (See Appendix 3 for mechanical drawings)

Our mechanical design has changed since our primary mission was completed and it is probably going to change again before the final (third mission). We decided to build our can out of a polymer called Polycarbonate which is a synthetic resin in which the polymer units are linked through carbonate groups. This means that it is flame retardant and has high heat resistance, has exceptional impact resistance and is RoHS (Restriction of Use of Hazardous Substances) compliant, which are all useful in the event of a mishap. In order to fit all the components inside the can we used a Printed Circuit Board (PCB) from AAU in Denmark. Onto this PCB we attached the sensors and transmitter as shown and labelled in the diagram overleaf. We found that our GPS shield would not work when connected below the AAU PCB so we added headers and placed it on top - we could instead have added an external shield but we felt this was unnecessary as the shield already contains an integrated patch antenna. This left us tight on space for our three extra secondary sensors but we managed to fit them all on our original shield below. We did have to solder our APC220 directly onto the board for space but we connected leads to all of it's pins so that the transmit/receive frequency can still be programmed. For our primary mission we created a metal spine that we plastic coated but we decided when manufacturing our secondary mission to also change the material of the spine from plastic coated metal to polycarbonate to reduce both the risk of short circuits and signal loss. We have not decided as yet how we intend to connect the solar panels as these are still under investigation. We have just been offered the chance to have a 3D printer generate a new outer casing for free and so we have organised the printing of two new outer casings which we will test to see if this will provide us with an even more robust can

AAU PCB



Power connection

Primary Mission Photos

Polycarbonate outer casing

AAU sits on top of Arduino

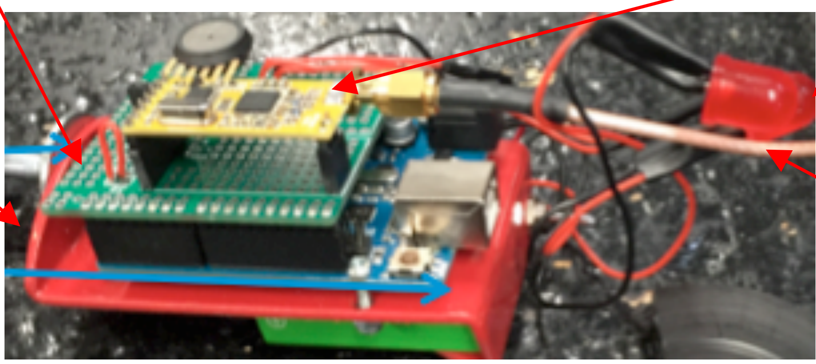
AAU PCB containing MPX4115A Pressure Sensor and NTC thermistor and circuitry

APC220 transciever

Our structure for the Primary mission

LED power indicator and locator for can

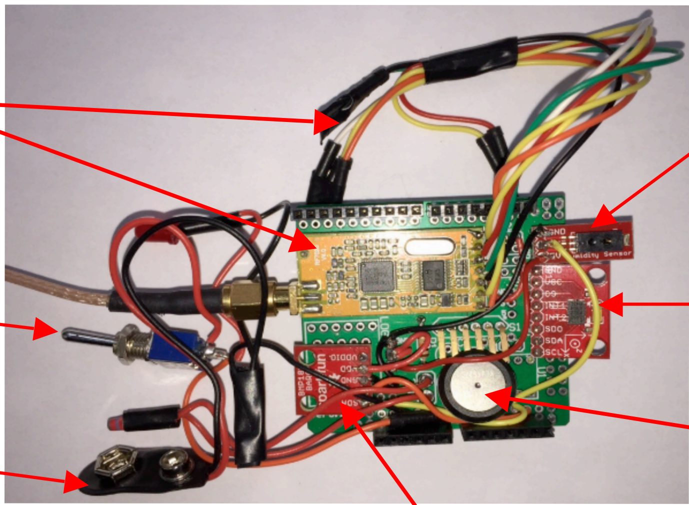
Plastic Coated Metal Spine



Antenna

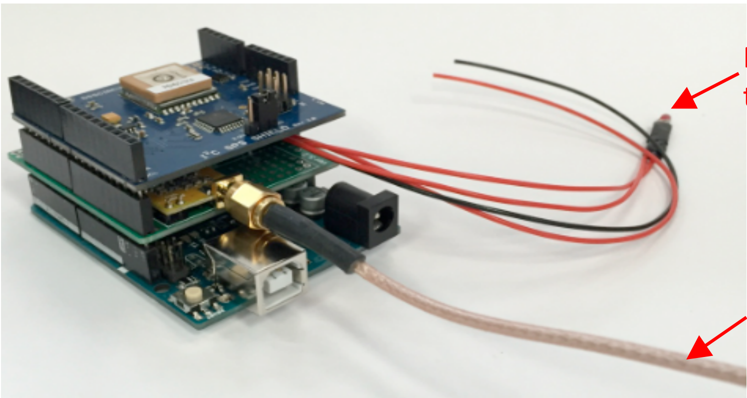
Secondary Mission Photos: (See Appendix 3 for mechanical drawings)

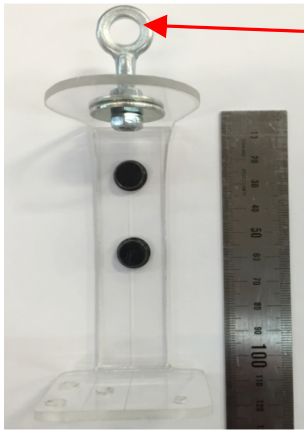
AAU with Secondary mission sensors included



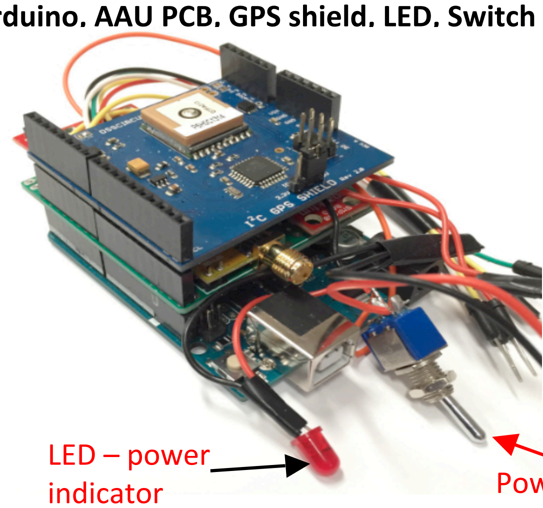
Polycarbonate spine:

Arduino. AAU and GPS shield

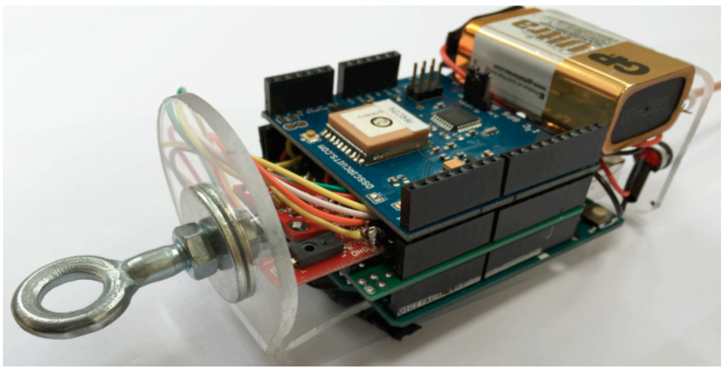




Arduino. AAU PCB. GPS shield. LED. Switch

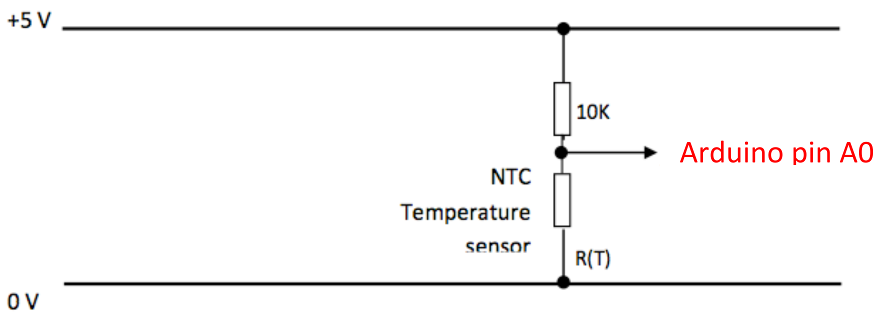


Everything connected and ready to put in can:

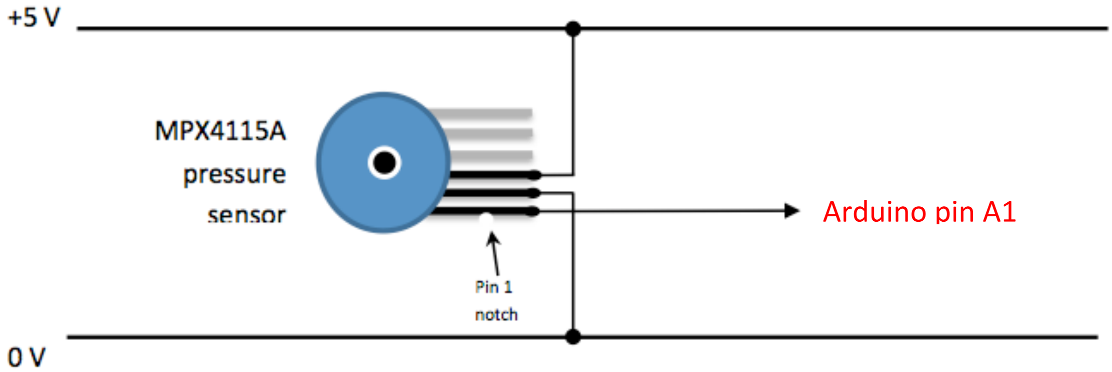


2.3 Electrical design:

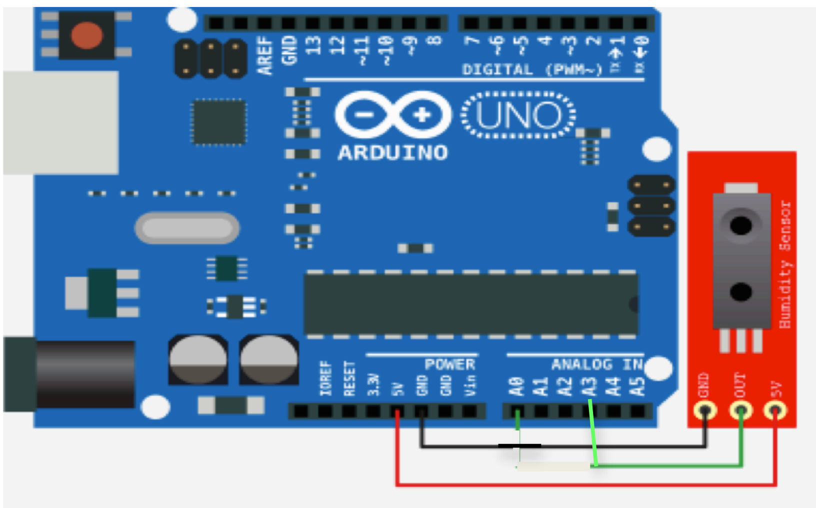
NTC Thermistor /Temperature Sensor



MPX4115A Pressure Sensor:

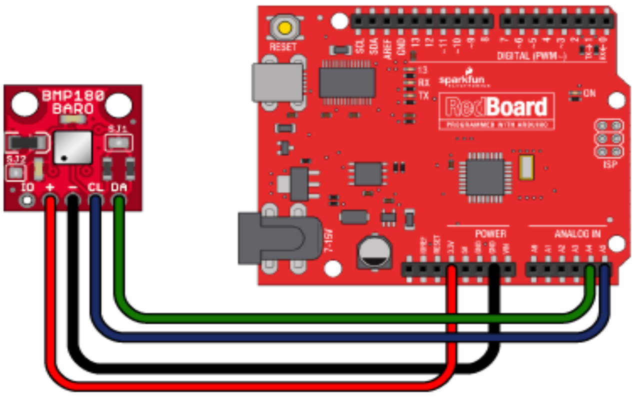


HIH4030 Humidity Sensor:

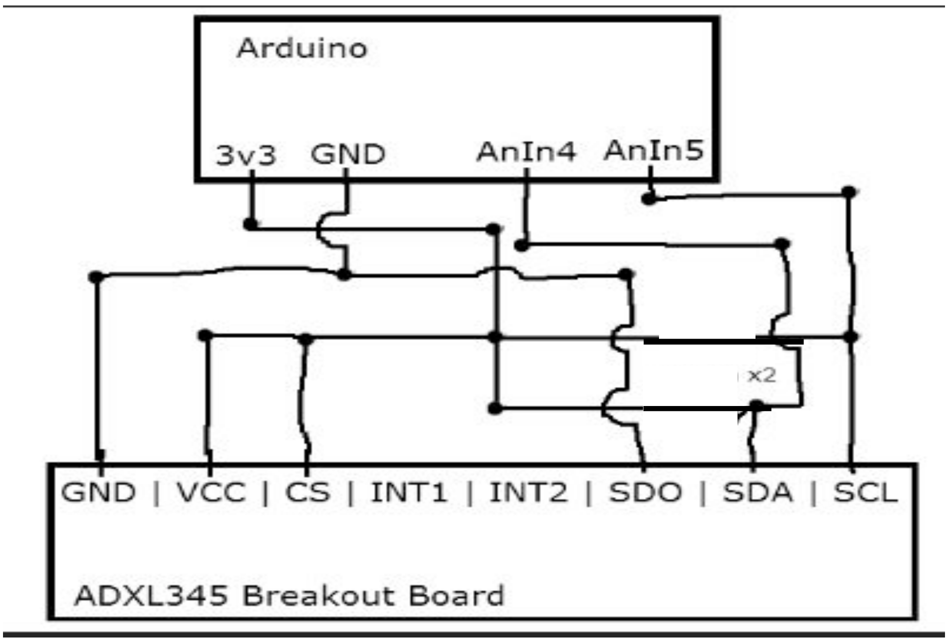


BMP180 Barometric Pressure Sensor:

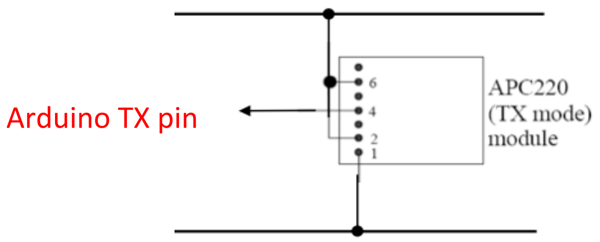
BMP180 label	Pin function	Arduino connection
DA (SDA)	I²C data	Any pin labeled SDA, or: Uno, Redboard, Pro / Pro Mini **A4** Mega, Due **20** Leonardo, Pro Micro **2**
CL (SCL)	I²C clock	Any pin labeled SCL, or: Uno, Redboard, Pro / Pro Mini **A5** Mega, Due **21** Leonardo, Pro Micro **3**
"-" (GND)	ground	**GND**
"+" (VDD)	3.3V power supply	**3.3V**
IO (VDDIO)	I/O voltage	Leave disconnected unless you're connecting to a lower-voltage microprocessor

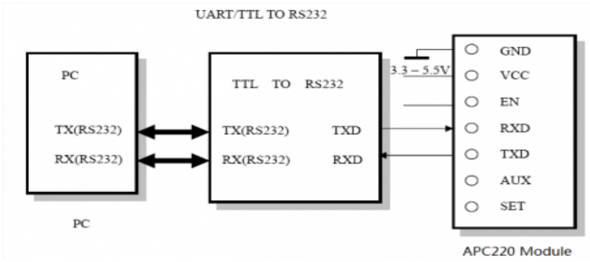


ADXL345 Accelerometer:



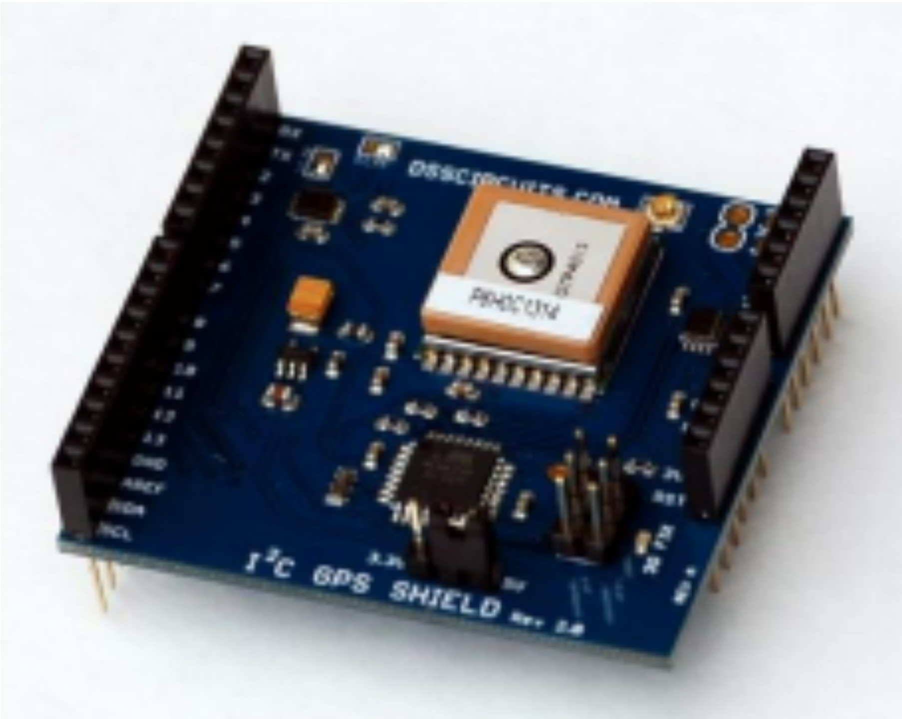
APC220 Transceiver (Interface: UART/TTL)





The software Rf Magic was used to set all parameters including frequency of operation, UART rate (9600bps uplink and downlink), air rate and check out mode. The ground station APC220 module is connected to the ground station (PC) via a UART/TTL to RS232 interface board.

DSS I2C GPS Shield:



The shield requires 3.3V default mode of operation on power up is I2C mode and can operate up to 400kHz. All level translation takes place on board so there is no need for external level translation. Unlike other I2Ccircuits, this shield does not require the use of external pull-up resistors. The shield uses specialized I2C translators that do not require pull-up resistors. Unlike most I2C circuits where the value of the pull-up resistor needs to be adjusted to the amount of I2C devices on the bus, this shield uses active I2C buffers that will maintain the “square” signal no matter how many external I2C devices are added.

Flexible Solar Panels: (possibly Powerfilm MP3-25)

We have not decided exactly how these are to be connected as yet – we are only just investigating four different types - full details will be included in the FDR:

Power/Batteries:

The battery we used in the CanSat National final was an industrial Duracell professional Alkaline battery (see Appendix). When we tested (multimeter between our 9V battery and fully operational Cansat) we found that our CanSat consumed 174 mA. Using a 9 volt battery at 550mAh, this allows us 3.16 hours (3 hrs 10 mins) which is tight – especially considering that larger currents lower capacity. We had the option of using six 1.5 volt AA batteries giving capacity of 2000mAh, but there wasn't enough room inside our can.
We also found, through reports on the internet, that the Arduino onboard voltage regulator (which maintains the constant 3.3v voltage needed by many of the sensors) was inefficient and wasted energy. If we had time and space, a way to improve this would be to bypass this regulator and use an external voltage regulator instead.
We are currently experimenting with different batteries and will investigate the possibility of perhaps trickle charging a battery with our solar panels and final details again will be included in the FDR. We are also going to try to measure consumption of the individual components as we are unsure as to where some of the power is being consumed.
In addition there is a small 3V coin cell battery located on the underside of the GPS shield. Normally, when a GPS is first powered up there is no information stored in memory and it needs to be downloaded from satellites – a process which can take upto 12 mins. This information would be lost every time power down happens so the GPS shield also carries a small 3v coin cell battery which supplies power to a battery backup circuit allowing the GPS to maintain the values stored in memory. This reduces the time to first fix to less than a minute usually.

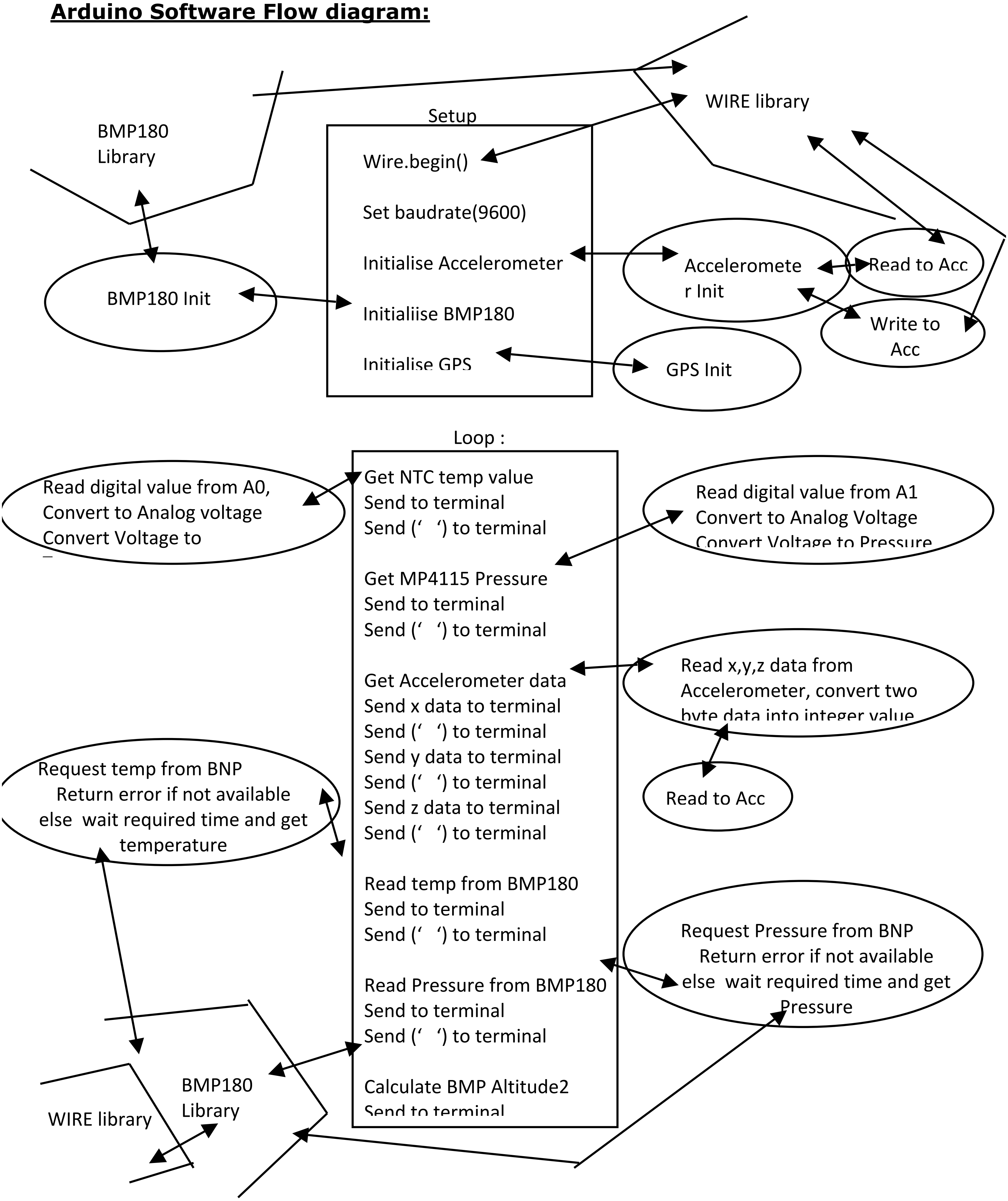
Component	Max Current
Arduino	45mA
Relative Humidity Sensor HIH4030	500uA
Accelerometer ADXL345	145 uA
DSS GPS shield	30mA
BMP180 Pressure sensor	10mA
MPX4115A	10mA
1 5mm flashing LED	20mA
APC220 transceiver	42mA

2.4 Software Design Overview:

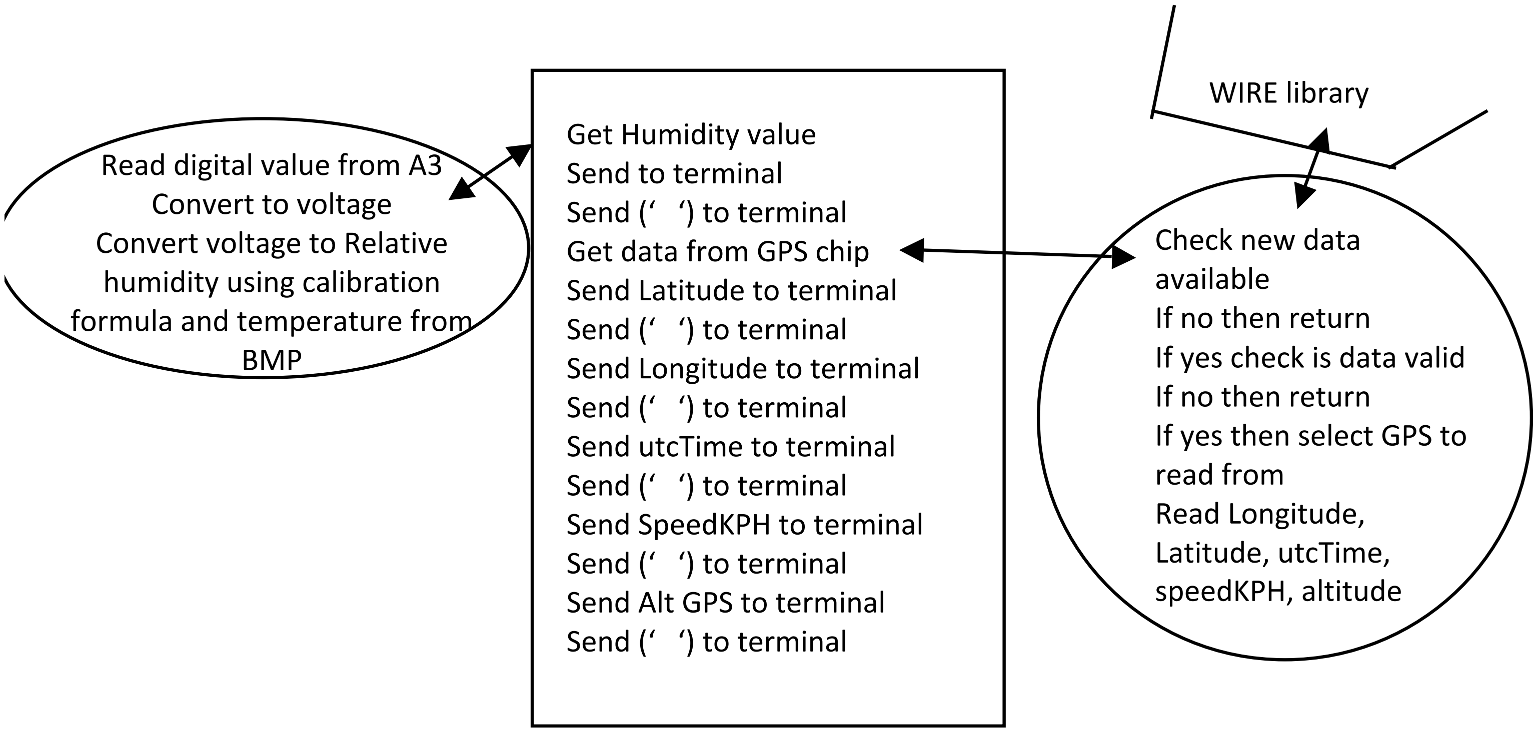
As can be seen from the diagrams of electrical comnnections, the ADXL345, BMP180 and DSS GPS shield all share pins A4 and A5 of the Arduino. This is due to the fact that communication with the ADXL345, DSS GPS shield and BMP180 is carried out via the I2C protocol as there would not be enough dedicated 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.
Because the I2C protocol allows for each enabled device to have it's own unique address, and as both master and slave devices to take turns communicating over a single line, it is possible for the Arduino board to communicate (in turn) with many devices while using just two pins (A4, A5) of the microcontroller. The wire library allows communication between Arduino and I2C devices. In addition, there is a BMP180 library which contains several functions written for this device when run in I2C mode.
The Relative Humidity sensor, NTC thermistor and MPX4115A are not I2C compatible and they have their own dedicated analog inputs. It is intended that the solar panel output will be connected to A2 and the software will be extended to collect/send this data to the terminal.

Please see overleaf for a software flow diagram:

Arduino Software Flow diagram:



Arduino Flow diagram(ctd)



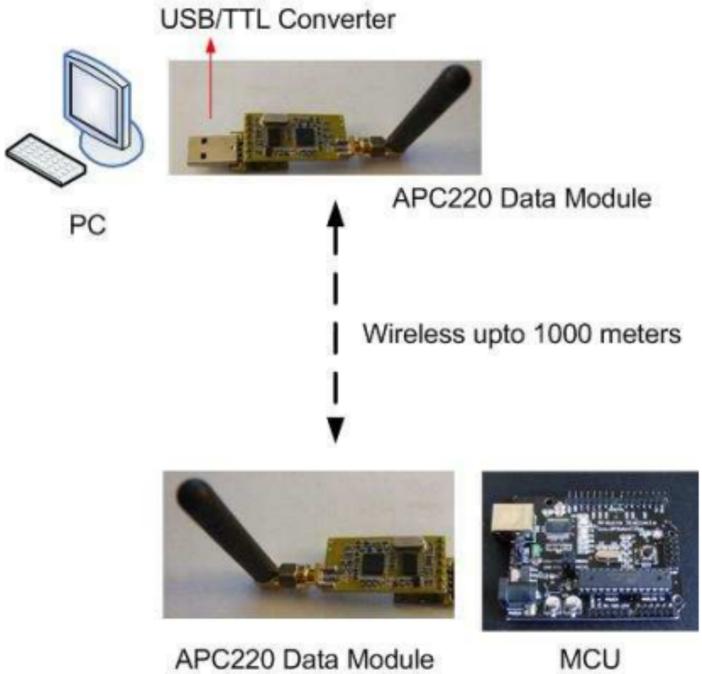
2.5 Recovery System:

We calculated the area required to give us a velocity of 8m/s. We then tested a variety of types (cross, hemispherical, flat) of parachute using a drone and found that our Octagonal one worked the best. We attached the flat Octagonal parachute to the spine of our can by means of a metal loop. The wind was so bad during the Regional final that we cut a hole in the top of our parachute for stability and this seemed to work on the day – however his was only a 150 foot drop.
We then decided to try out two types of material using the flat octagonal design. Both parachutes fell within the required speed limits and we brought both to the National final - but we selected the one that had given us the slightly faster velocity as we were concerned about drift as our can was on the light side (which we felt was advantageous as weight costs money in space). It was also of a more luminous colour and we felt it would be easier to track on video and to locate afterwards.

On the day we encountered a couple of problems: A couple of our cords were ripped during release from the rocket – but we were lucky (and surprised) that our parachute still fell at a speed below the required limits (actually slightly below the lower recommended limit). We managed to collect data and the can was unharmed. We also were able to send up our can again in the second rocket launch using the other parachute (just for experiment) and our can drifted several hundreds of meters off course (onto the roof of a house). We had GPS to locate it but this is still not desirable. We are now looking at improving our cord material, perhaps doubling up on cords, looking at better fixing of cords, rechecking our mathematical calculations for area Vs decent velocity and investigating the effects of holes of various sizes and numbers on stability/decent velocity. We are also going to reduce the length of our cords. We will run another drone test before the FDR is written up.
Our flight time for our National final Rocket mission was 39.1 secs to fall 256m (from drop to landing)– this was at a relatively constant speed of 6.6m/s. Our flight time for the National final Quadcopter mission was 5.8 secs to fall 31m – this was at a constant speed of 5.34 m/s. If we increase this speed to at least 8m/s we would expect a flight time of approximately 125secs (to fall 1000m) - but this really will depend also on the wind (will affect drag coefficient), pressure and temperature (will affect air density).

2.6 Ground Support:

On the ground we have a laptop which is connected to an APC220 transceiver via a USB/TTL converter as explained earlier. The APC220 uses the Frequency Shift Keying method to transmit signals. The carrier frequency we were given to use on the day of the National final was 434.3 MHz and both transeivers were set to transmit/receive at this frequency.



Ground antenna:
We decided to bring a semi parabolic reflecting dish with us on the day of the National final in order to focus the signal onto the antenna in order to ensure we did not lose signal. Without the reflecting dish we could not get a signal from 500m away and even with the signal we were struggling to maintain a signal. We lost a lot of data due to incomplete lines of data (our Python program currently filters out all incomplete lines of data but we may need to change this). We are currently testing a larger 40cm fully parabolic reflector for the European competition and also a Yagi antenna.

Left: Semi parabolic reflecting dish used in National Final
Below: possible Yagi/ Parabolic antenna

Data collection:
As mentioned earlier, the data is displayed using the terminal emulator program 'Terminal'. This program allows the user to log raw data to a file by clicking 'start log' and then 'stop log' after the required duration.

Python Program:

A python program written using the Python Integrated Development Environment IDLE then filters the raw data in the canLOG file.The program also calculates altitude and velocity from the pressure , temperature and time data.
We feel that the python program needs to be edited so that it better filters data. Before the National final it filtered data based on incomplete lines and Pressure and Temperature values outside 2 sigma. During the National Final, an erroneous piece of data from the GPS contained an unexpected decimal point and caused the program to exit from execution. This meant the Cleandata file was not closed and therefore was empty. We put in a fix for this problem on the day and then discovered some other erroneous data elsewhere. We were lucky and managed to edit the program to deal with these issues but we definitely need to do more work on the filtering capability before the European final.

Current flow diagram for Python Program:

Open canLOG file and store data into a file variable called 'Logfile'
Close canLOG
Copy data without headers and footers into new file called datafile

Read in the Pressure and Temperature data line by line and put into arrays but ignore all lines that are missing pieces of information (This is so the mean and standard deviation of Pressure and Temperature can be calculated

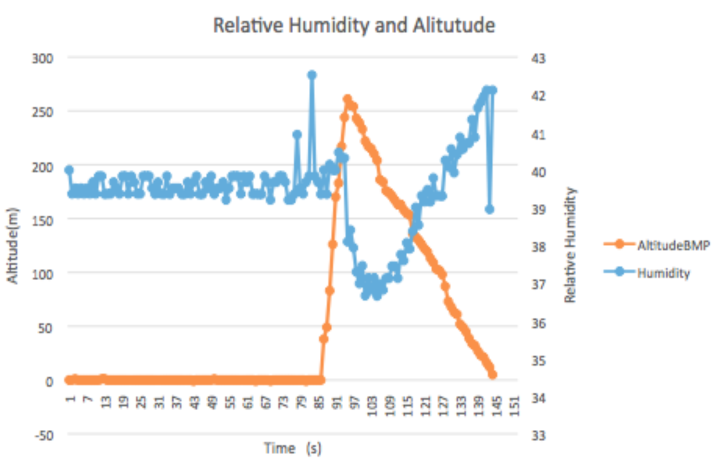
Start at top of the datafile
Look at each line one at a time
Read in one line at a time , split it (based on where there are spaces)
(Each individual piece of data is then one entry in an array)
If it is a full line (should have 35 entries) **and** the pressure and temperature are within 2 sigma of their means then
Store each piece of data in its own array
Calculate Altitude based on formula and MP4115A
Calculate Resultant gForceusing x,y,z data
Turn GPS time data into hours, mins and secs and total secs and store in individual arrays
Calculate num of secs between readings using GPS time data and store in array called deltatime (first deltatime is set = 0
Calculate Velocity based on BMP180(more accurate pressure sensor)
Timediff = time in secs – time in secs of first time data entry

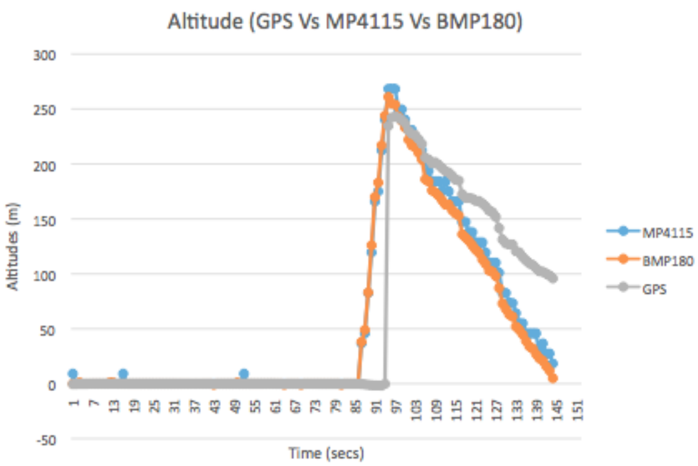
Open new file called 'Cleandata' and read in following data from the arrays one at a time separated by ' ' :
TimeDiff, NTCtemp,MPXPressure,AltMPX,
X,Y,Z,Resultant,BMPtemp,BMPpressure,BMPAlt,BMPVel,Humidity,Latitude,Longitude,Time,GPSvel,
GPSAlt,Hour, Mins, Secs,mSecs
close Cleandata

Excel Data file:

As previously mentioned, an Excel file has already been set up to source it's data from the Cleandata file. All graphs (scatter plots and line graphs) that we consider may be of interest have been pre prepared with labels, titles and data columns already selected(15+ graphs). When the user clicks 'data refresh' from within this file, the data is replaced with the data that currently resides in the Cleandata file.
We can then quickly examine all graphs to identify those we wish to include in our presentation, make any edits and copy them into our Powerpoint presentation. It is also possible to have the powerpoint presentation link directly to the Excel file but we will not have enough time to present all graphs and we will not know for sure exactly which ones we will want to include in the presentation.

Examples of our data graphs from National final: (Data in appendix 5)





Data gathered and storage/transfer:

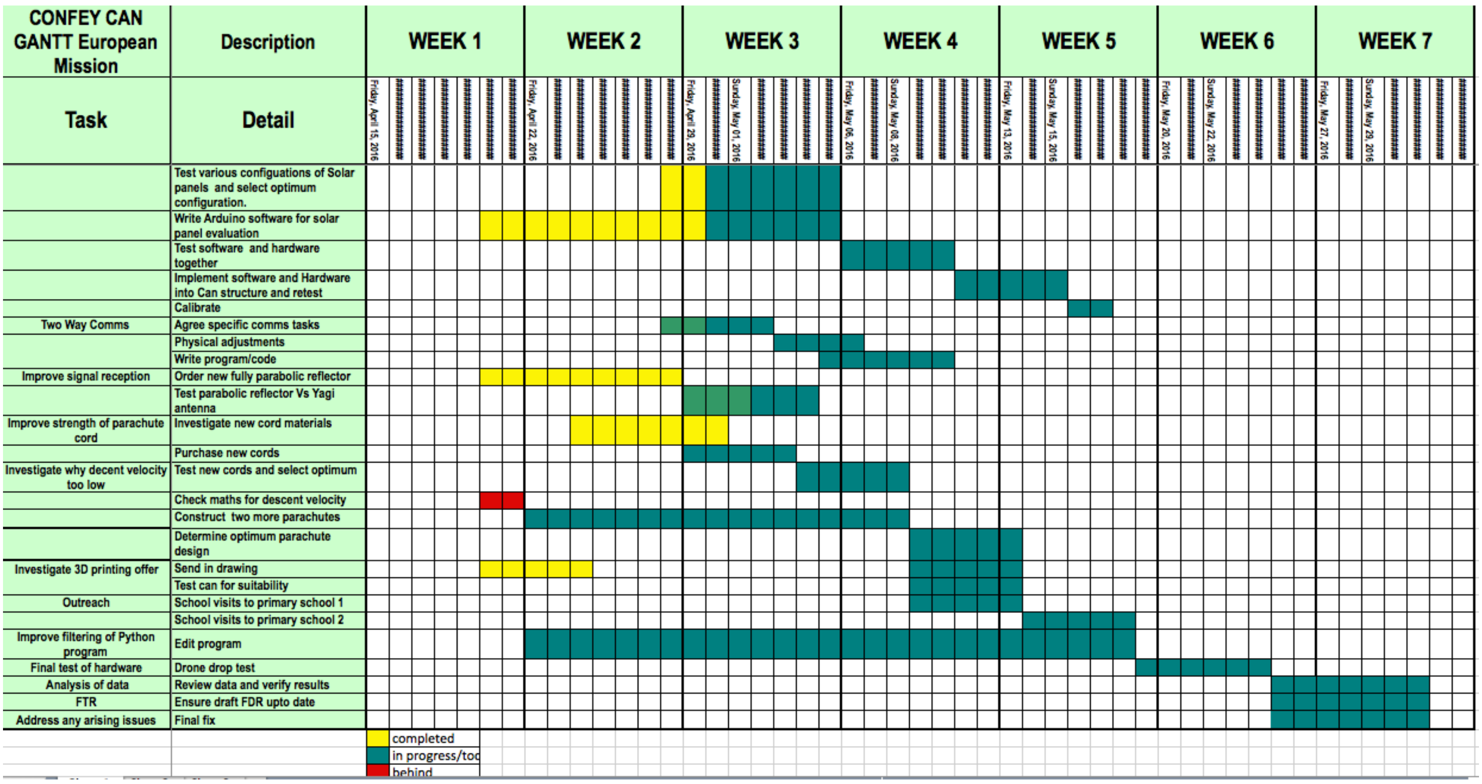
From looking at the time intervals on our previous missions it takes the Arduino 400 ms to collect each line of data (one per loop). From our quadcopter raw data file 76KB equates to approx 330 lines of raw data. This took 125.1 secs. This equates to 608 bytes per second or 4864 bits per second for raw data – slightly less for the filtered data. We get one data point on a graph for each line. At 330 lines per 125.1 secs this would mean we should get a data point (line) every 0.37sec or 370ms. This agrees closely with what we have seen in reality. The same calculations performed on the rocket data gave a data point (line)every 0.5secs but there were a lot of half lines in this data. There are some delays built into the Arduino program that may not be necessary but we feel that we would not like to fix something that works for us. We would appreciate feedback if we do need to change our data rate.
We do not store any data onboard the CanSat – mainly due to the fact that we are stuck for space. It is definitely something we would like to incorporate in a future mission as we definitely do see the relevance of having stored data in the event of a loss of signal. However, we felt from a priority point of view it was not very high due to the fact that satellites do not tend to return to earth under normal circumstances and hence the data stored on an SD card would never be accessed – unless it was made possible for the satellite to retransmit the lost data – something we would like to investigate further in future missions.

3 PROJECT PLANNING

3.1 Time schedule of the CanSat preparation

We feel that it took us too long to complete our primary mission and would definitely approach things differently next time around. We did not really know how to work as a team and did not really carry out a proper time schedule. It was all a bit of a rush in the days before the Regional final on 7th March. However, after the Regional final, having successfully secured a place in the National Final, we realised that we would have to work very hard in order to develop our secondary missions and encorporate any redesigns of the primary CanSat. We became far more aware of key dates and set ourselves specific targets. We allocated one team member (Naoise) to take minutes and to make sure that everyone received a copy of the minutes and was aware of the work they needed to carry out before the next meeting. Since the National Final we have been thinking about and planning for the European final. There are several adjustments/improvements we want to make to our CanSat and, in addition, we have decided to investigate two other missions as mentioned already – namely Two way communication and Solar cell evaluation. We have been busy preparing for and writing this report but we are aiming to have everything ready and evaluated by the due date our FDR. We have included a Gannt chart detailing our preparation for the European competition - it can be found in the appendices as it is too small to be read.

Time Schedule for preparation for Europe: (see Appendix 4 for larger detail)



3.2 Resource estimation

3.2.1 Budget

Part name:	Cost in Euros:
GPS DSS Circuits I2C GPS Shield	49.02
Accelerometer SparkFun Triple Axis Accelerometer Breakout - ADXL335	15.77
Pressure Sensor SparkFun BMP180 Barometric Pressure Sensor Breakout	14.90
Humidity Sensor SparkFun Humidity Sensor Breakout - HIH-4030	8.74
Flexible Solar Panels (approx as unsure which we will use)	40.00
Material for parachute and cords	20.00
Battery (Industrial Duracel) (testing - unsure as to which one we will use)	2.99
Cansat kit from DIT	150.00
Yagi antenna B&Q	19.00
Total:	320.42

3.2.2 External support

Support:

Cork EIectronics Industries Association provided us with a training manual with details of the CanSat primary missions

Dublin Institute of technology provided us with a soldering workshop and a primary mission training session for teachers

They also provided us with a mentor Damian Bourke who provided support throughout the project

Butler Transtest Ltd allowed us to use their equipment to calibrate our Primary mission Temperature and Pressure Sensors.

Darren ,Kinsella a local professional freelance photographer allowed us to use his drone on several occasions to carry out tests on our parachutes and sensors which was invaluable to us.

Kieran Sullivan as an independent sole trader is using his 3D printer to print off a couple of new outer shells for our can – we are hoping these will improve the strength/robustness of the can

Kieran Sullivan was also one of the Irish Rocketry representatives on the day of the National final and he provided us with the telemetry information/graphs from the National final rocket launch so we could compare with our own altitude, velocity, pressure and accelerometer data.

Ms. Reynolds (Confey college teacher) and Ms. Cullen gave constructive feedback to us during practice runs

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

Confirmed Sponsorship so far (there are also several more potential sponsors):

Manepa Medical (a market leader in the supply and service of specialised clinical decontamination equipment and products to the Healthcare, Pharmaceutical and Life-Science industries) donated €500 euros towards our trip to Europe.

We received a donation of two recycled Apple Mac books from a local company called Salesforce – these will be dedicated to work on future CanSat projects

3.3 Test plan

Calibration

For the calibration of our initial two sensors, we decided to contact Maynooth based calibration specialists, Butler Transtest Ltd., who are INAB (Irish National Accreditation Board) accredited, operating under the INAB scope of accreditation to ISO 17025. They are certified in calibrating electrical equipment, torque based equipment, pressure and temperature but we only needed the latter two. Our inquiry was accepted with open arms and they agreed to professionally calibrate our CanSat.

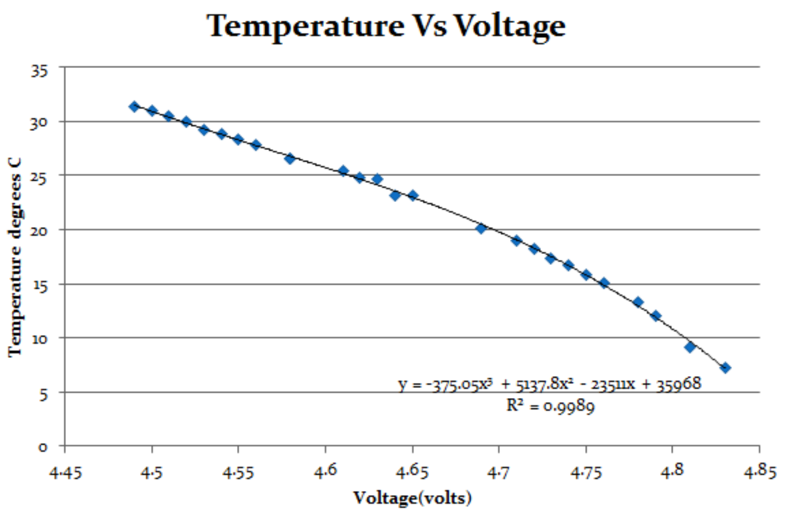
- ***Pressure Calibration***

  The staff at Butler Transtest used a simple but effective method of calibrating our pressure sensor. An airtight lunch-box had been bought in the local supermarket, and a hole was drilled into the side of it. They then got a pressure pump and pumped out some of the air from the lunch-box, with a functioning Arduino inside. Data was obtained and viewed on a nearby laptop, the results given were in millibars and they were compared to those given by the pressure pump. Using these, we were able to get accurate readings for air pressure.

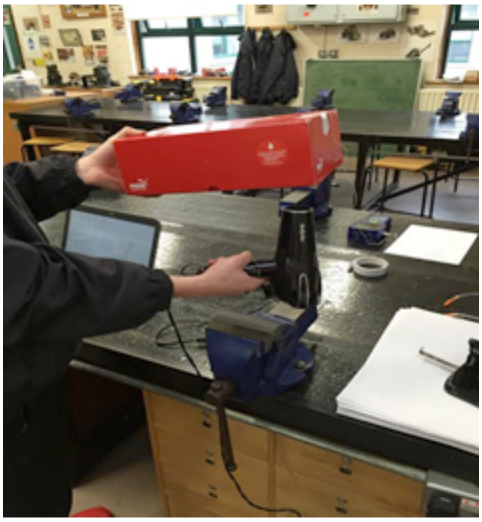
- ***Temperature Calibration***

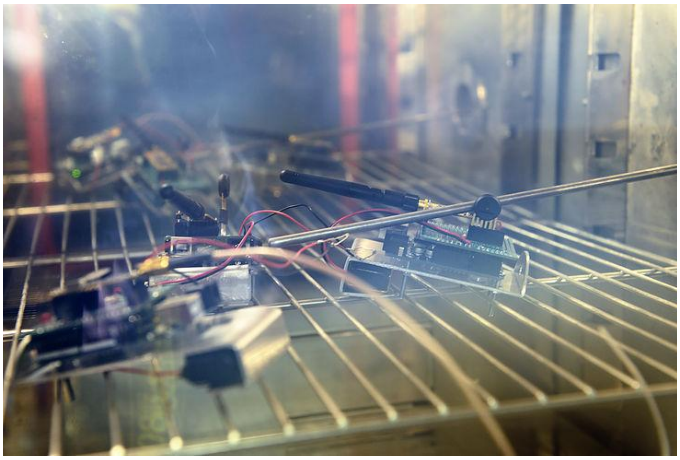
  After successfully calibrating the pressure sensor on the three CanSats, we moved on to temperature. This was done by placing the Arduinos inside an industrial temperature regulator (ITR) and adjusting the temperature accordingly. Unfortunately, this was not as successful as the previous calibration as we noticed faults with two of the thermistors. The standard issue thermistor only had a range of 0 - 70°C and the ITR was dropped to -10°C and thus we were given faulty readings. We had only been given two thermistors in our starting kit so we used a different model of thermistor for our third CanSat with a range of -20 - 70°C . We calibrated it using a hairdryer, temperature datalogger, fridge freezer and it produced excellent results. After going below freezing, the temperature was risen again up to 40°C. We then represented our results on an Excel x,y scatter plot which can be viewed overleaf. The best fit was to a cubic polynomial – and this is the formula we used in the arduino program to change voltage reading into temperature.

Calibration for primary Mission



Temperature calibration



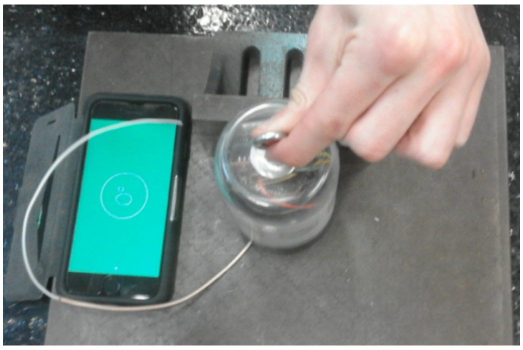


Arduinos inside Industrial Temperature Regulator

Confey Team and Butler Tech Employees

Accelerometer calibration

We calibrated the accelerometer when it was inside the can. We knew that there should be a force of + or -1g on the axis pointing towards the center of the earth. So we tilted the accelerometer so that each of the three axis were pointing in this direction (using a spirit level). We did this for both directions pointing up and down. We then added in the offsets from 1g into our Python program.



Relative Humidity Sensor:

We realised when we had the can assembled that to calibrate this sensor we would have to place it in a plastic bag with water and salt for 24 hours. We felt that this might affect other sensors so we decided we would just look at how relative humidity varied with temperature and pressure but we could not use the actual values. If we have time we may look into other ways of calibrating the sensor.

Calibration of Solar Panels:

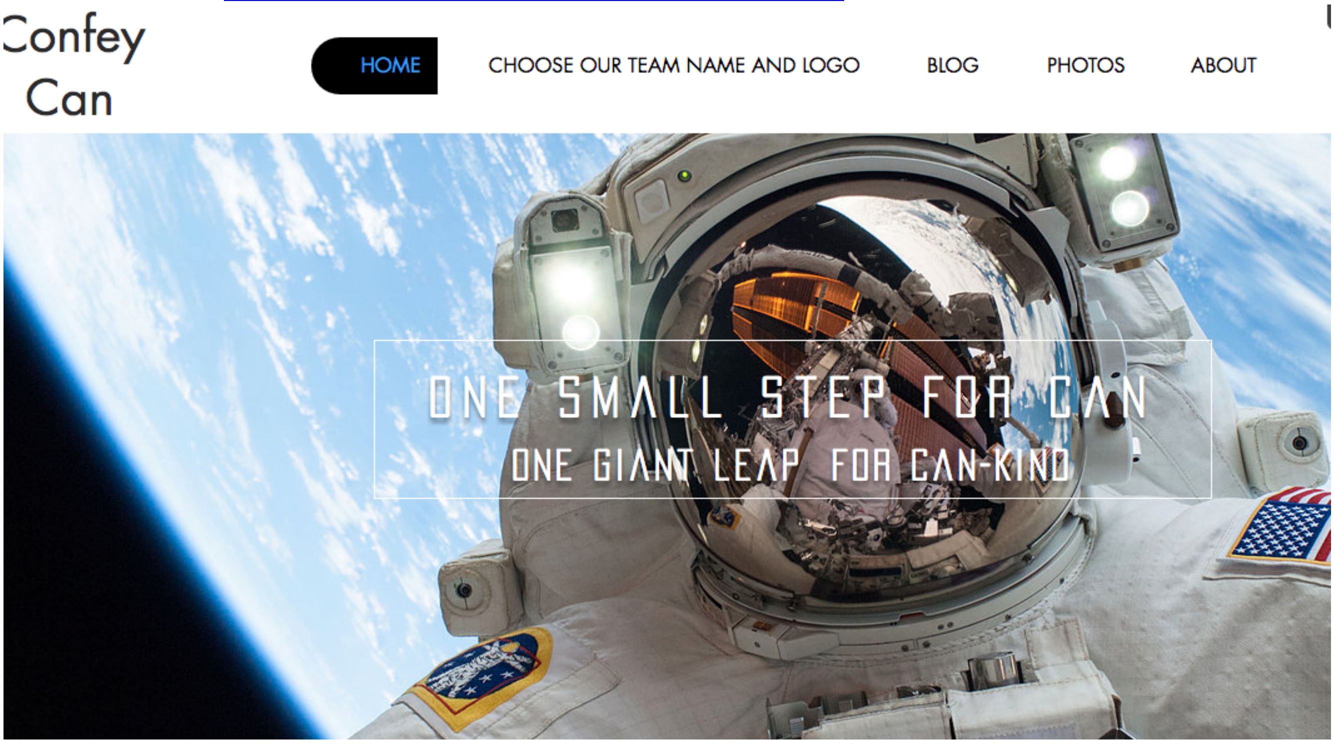
We have yet to decide exactly how we intend to do this – we will update for the FDR

4 OUTREACH PROGRAMME

School open night presentation:

Initially, the outreach programme began in our school. During a school Open Night the team presented their project proposals to 800 visiting parents and prospective parents. This met with wide acclaim.

Web Site: http://cansatconfey.wix.com/confey-can



Our website and blog is updated regularly so that students and other interested parties can keep up to date with what we are doing. (Facebook, Twitter and general social networks are being extensively used also.)

Infomercial video:

We are most proud of our infomercial video which features on the first page of the website and it is our way of explaining to the viewer how the CanSat project works. The Irish European Space Education Research Office representative and judge at the Regional final liked it so much she has had it put on to the ESERO website.

Online Survey

An online survey was launched from the newly created Confey Can website with the intention of finding a representative name for the project – 'ConfeyCan' won out.

Design a Logo competition:

An art competition was instigated by the Outreach manager to design a logo or moniker. This was open to all year groups in the school. A prize was awarded to the successful artist whose design was chosen. The logos are up on our website. A couple have been are included below:

Presentations to school year groups:

The project has been presented to 1st, 2nd and 3rd year students within the school with the express aim to encourage more students to engage with STEM in a fun, challenging and interesting fashion. It is also going to be presented to the senior students during their graduation night. In addition, many of our 6th and 5th Year students were allowed out of class to witness the test launches

Presentation to local Primary Schools including CanSat Scratch Game:

A digital 'CanSat game' has been developed by the teams' programmer using Scratch programming. Team members are going to local primary schools, giving a presentation on the Cansat project, running a video of our National final launch and then allowing the students to play the Cansat game in which they have to collect various pieces of data as the can falls. A small prize will be awardeded to the winner. The game has been provided free to these participating schools for use on their networks.

Media

Our outreach team member has also been busy contacting various local newspapers and, so far, we have featured in the most popular one (22,500 readers weekly). We also featured in IrishTechNews.net, online We have also written an article about Cansat for the Irish magazine ‘SCIENCE’. Article have also been written about the team in A national newspaper has also been contacted in addition to a National radio station and we are awaiting feedback.

Publication: Liffey Champion
Date: Saturday, April 23, 2016
Page: 7
Extract: 1 of 2
Circulation: 7500
Author: Laura Mc Loughlin
Headline: Confey College students win national space competition

Confey College students win national space competition

by Laura Mc Loughlin

STUDENTS from Confey College in Leixlip have won a competition to design, build and launch a mini satellite in the shape of a soft drink can.

The competition called CanSat is run by the European Space Agency and after winning the Regional Final, the Leixlip students will now represent Ireland in the Grand Final in Lisbon, Portugal in June.

A CanSat is a simulation of a real satellite in the size and shape of a soft drink can and is designed to inspire young people to pursue a career in the STEM (science, technology, engineering and mathematics) fields.

Eight students have been working on their design for the last six months Denis Buhai, Kieran Kilbane, Conor Walsh, Liam Murphy, Alex Bourke, Naoise Barry, Gergely Gellert and Julia Waszkiewicz along with the help of their psychics teacher Mary Selkirk and engineering teacher Philip Devereux.

22 teams from across Europe will compete to present the best satellite in a can the final which will run from 22nd to 26th June.

Every team that took part received a kit containing an arduino which is a mini computer, a thermostat to record temperature and air pressure sensor along with other items.

The catch is this all has to fit into a regular can from a soft drink.

The can is put into a rocket and shot a few hundred meters into the air.

It is released and a parachute deploys and while the can is descending it records temperature and air pressure.

The data is sent to a computer on the ground via antennae and this information is then displayed on graphs.

The teams are judged on the representation of data, community outreach, technical skills and can and parachute design.

The Regional Final was in Birr Castle, County Offaly where the students launched their rockets for the judging panel.

As part of the project the students had to get involved with the community as part of the outreach element.

“The students spoke to Intel and made a presentation at the school’s open night,” said Ms Selkirk.

“Liam made a website and Facebook Page.

“They also ran a competition in school to design a logo for the project.

“From this Confey Can became the name of the design.

“One of the student’s dad’s who lectures in DIT mentioned this competition to me last year and he acted as a mentor for us.”

Student Alex Bourke, who is in Transition Year, said he found the project very rewarding.

“It was all very good in different ways,” said Alex.

“It’s very rewarding when you get the rocket up in the air and you finish it.

“Also we had to overcome a lot of obstacles.”

Student Liam Murphy said working on the project helped him improve his presentation skills and gave him more confidence speaking in public.

“It helped the students to improve all round,” said Ms Selkirk.

“It helped them communicate with their teachers and helped with their presentation and design skills.”

Mr Devereux said he was very proud of what the group of students had achieved.

“I’m so proud of the students raising the bar with the STEM subjects,” said Mr Devereux

“It is a big feather in the Confey cap with regards to STEM and we are very proud to be associated with the competition.”

with the competition.

Deputy Principal of Confey College Mary Cullen said: “I would like to give huge recognition to the Ms Selkirk and Mr Devereux and to the students for their enthusiasm and the time that they have put into this.

“They have been exceptional and we are very proud of them.”

Stephanie O’Neill, ESERO Ireland Manager, Science Foundation Ireland also congratulated the students on their achievement.

“I would like to congratulate Confey College on their achievement, but I would also like to acknowledge the hard work and dedication shown by our other finalists, each team did a fantastic job, the quality of the work this year was incredible,” said Ms O’Neill.

“I would like to thank the individual team mentors who worked tirelessly with the teams in the run up to the final, and I would also like to thank our judges Neil Murray, Design Engineer at ESA/ESTEC, and Dr Niall Smith Cork Institute of Technology.”

18 APRIL, 2016 - 15:24

Confey College Team Wins National Leg Of CanSat Competition.

A team of secondary-level students from Confey College in Kildare has won the national leg of the CanSat competition which challenges future engineers to build miniature satellites for future space missions.

Silicon Republic reports that CanSat competition is a European Space Agency (ESA) competition for second-level students to develop a range of analytical equipment and place it into a container the size and shape of a soft drink can.

More specifically, each team had to fit all the major subsystems found in a satellite to their CanSat including power, sensors and communications – and provide a parachute to ensure the can had a gentle landing.

The Confey College team consists of Liam Murphy, Alex Bourke, Julia Waszkiewicz, Kieran Kilbane, Naoise Barry, Conor Walsh, Denis Buhai, Gergely Geller.

Silicon Republic reports that organised in Ireland by ESERO, the European final taking

TechCentral.ie

TechLife TechPro TechTrade TechRadio Downloads

Kildare team wins CanSat 2016 National Final

Confey college to represent Ireland in Portugal

Read It Later Print

Pictured: Confey College team Leader Liam Murphy (with cup), Alex Bourke, Julia Waszkiewicz, Kieran Kilbane, Naoise Barry, Conor Walsh, Denis Buhai, Gergely Geller

Home › Education

CONFEY COLLEGE WIN NATIONAL SPACE COMPETITION

JOHN • APRIL 18, 2016

by Colm Gorey

7 HOURS AGO 2 SHARES

Rocket launch of a CanSat at Birr, Co Offaly. Image via Barry Cronin/www.barrycronin.com

A team of second-level students from Confey College in Kild

LIFE BUSINESS DISCOVERY siliconrepublic PORTFOLIO PEOPLE

Kildare school wins CanSat competition with dramatic rocket launch

** **NB:** Web links to full articles can be found in APPENDIX 7 pg 42

5 REQUIREMENTS

In order to be able to launch the CanSat safely from the Rocket, the CanSat should meet the requirements listed in the competition guidelines available in APPENDIX 1.

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 the CanSat	115mm
Mass of the CanSat	240g at present
Diameter of the CanSat	66mm
Length of the recovery system	not sure yet
Flight time scheduled	125 – 155 secs
Calculated descent rate	6 – 8m/s
Radio frequency used	434.3
Power consumption	173mA (at present)
Total cost	€320.42

On behalf of the team I confirm that our CanSat complies with all the requirements established for the 2016 European CanSat competition in the official Guidelines, APPENDIX 1 of this document.

Signature, place and date: *M. Selkirk and P. Devereux*, Confey College School, Riverforest Leixlip, 30th April 2016

APPENDIX 1 - 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.

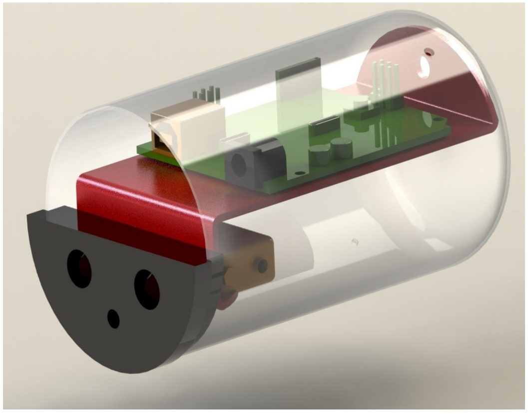
[15] In case of sponsorship, all the items obtained should be specified in the budget with the corresponding costs on the market at that moment.

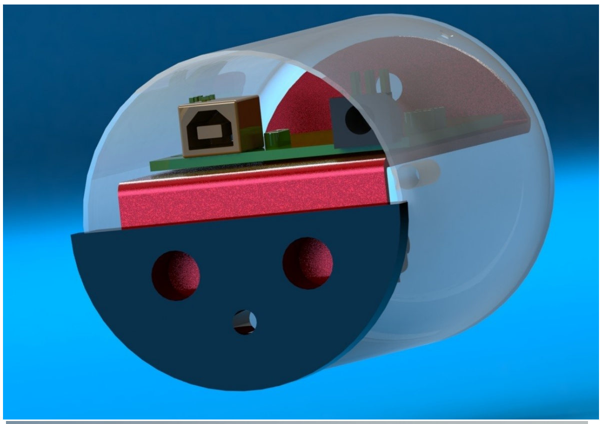
[16] The CanSat must be flight-ready upon arrival to the launch campaign. A final technical inspection of the CanSats will be done by authorised personnel before launch.

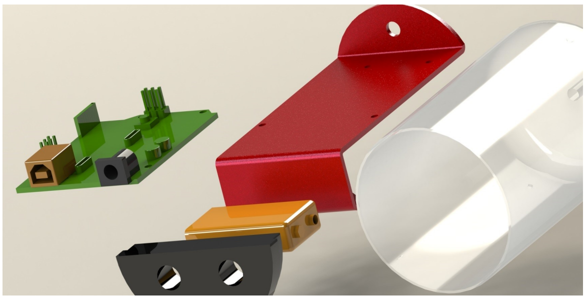
APPENDIX 2 – Mechanical Drawings:

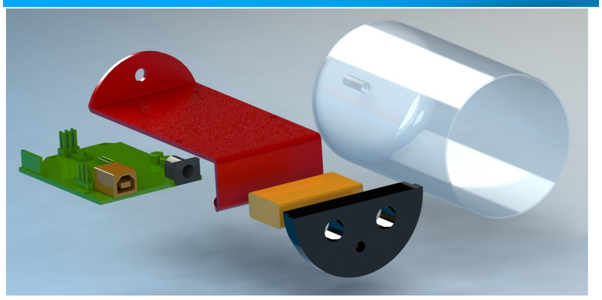
Phase 1 (Primary Mission)

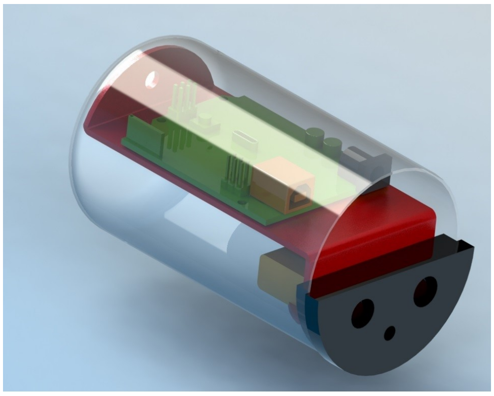
Using a computer program called "Solidworks", we were able to draw computer aided designs called 'Solidworks photo-realistic imagery' of our CanSat, which can be viewed below.

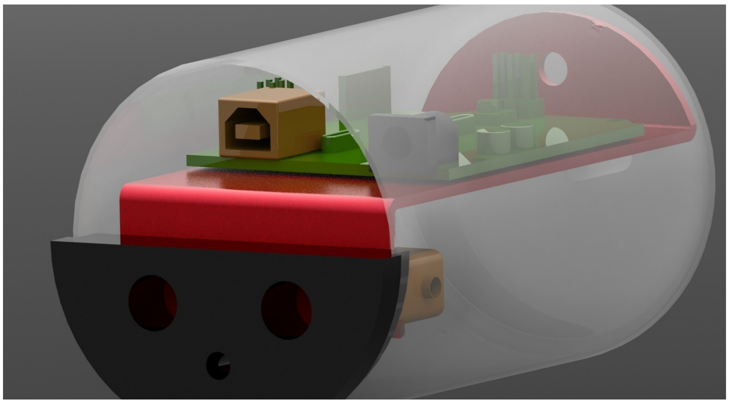




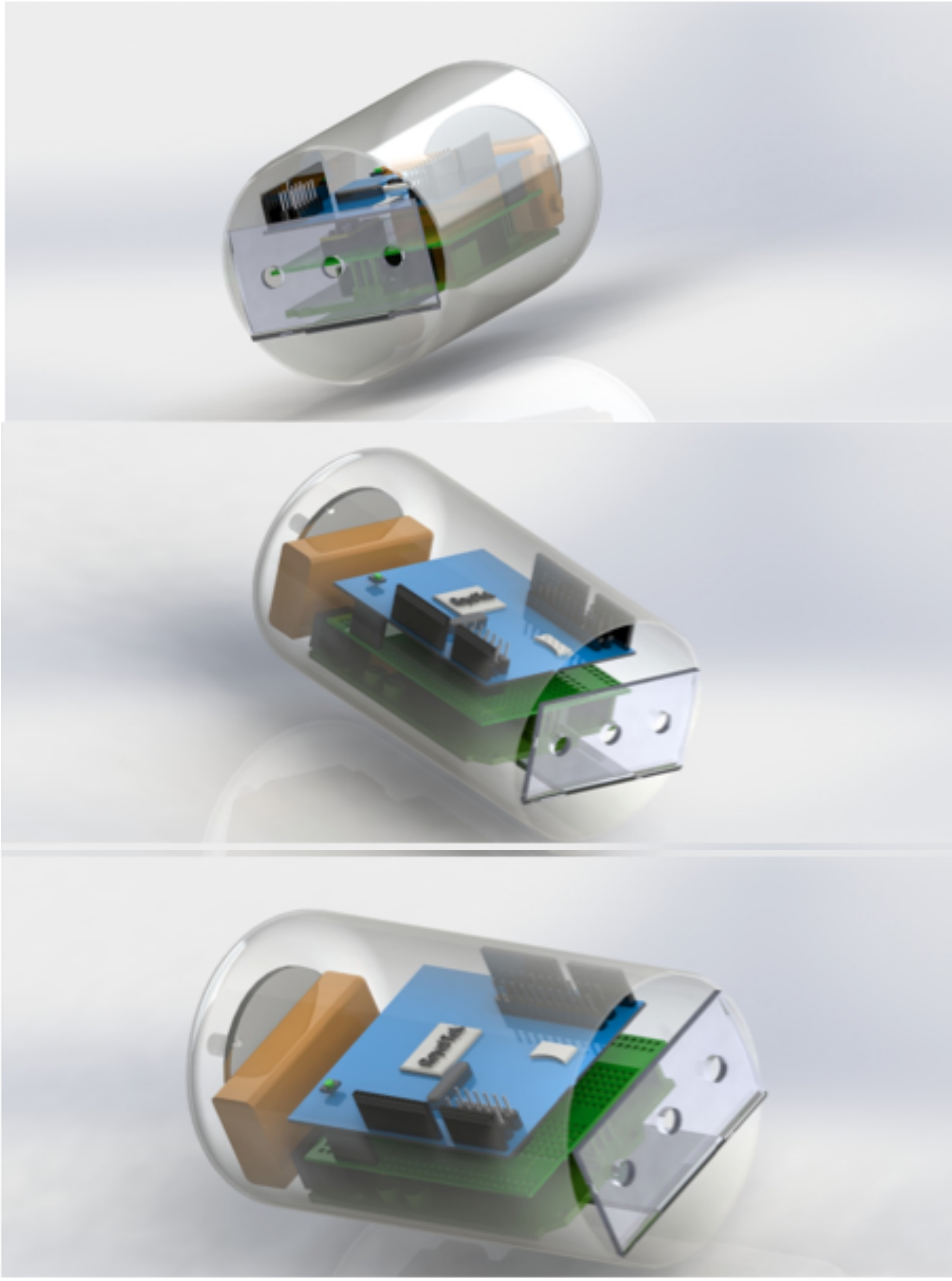


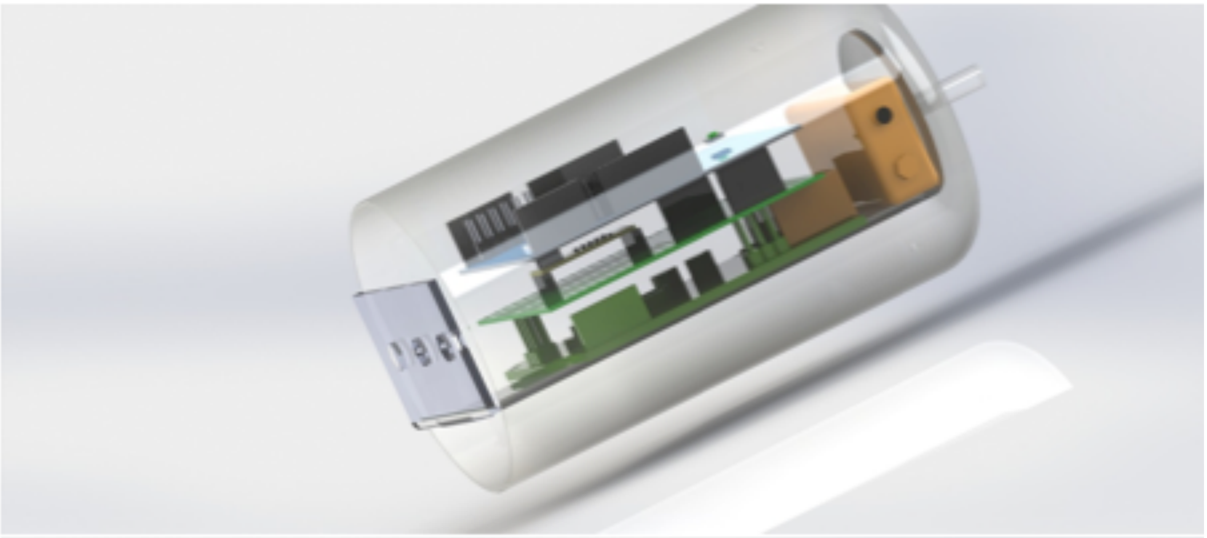


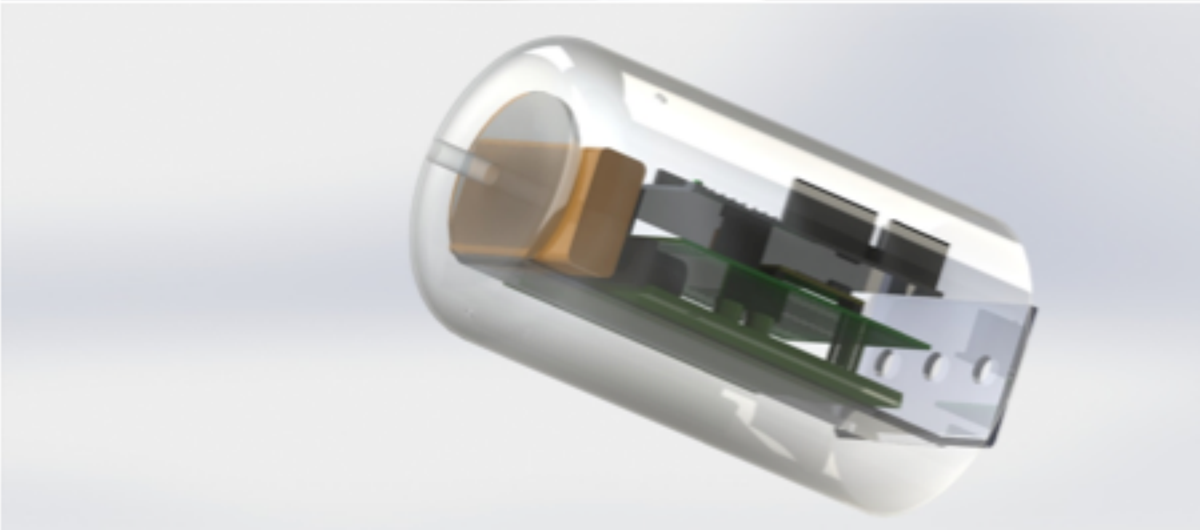


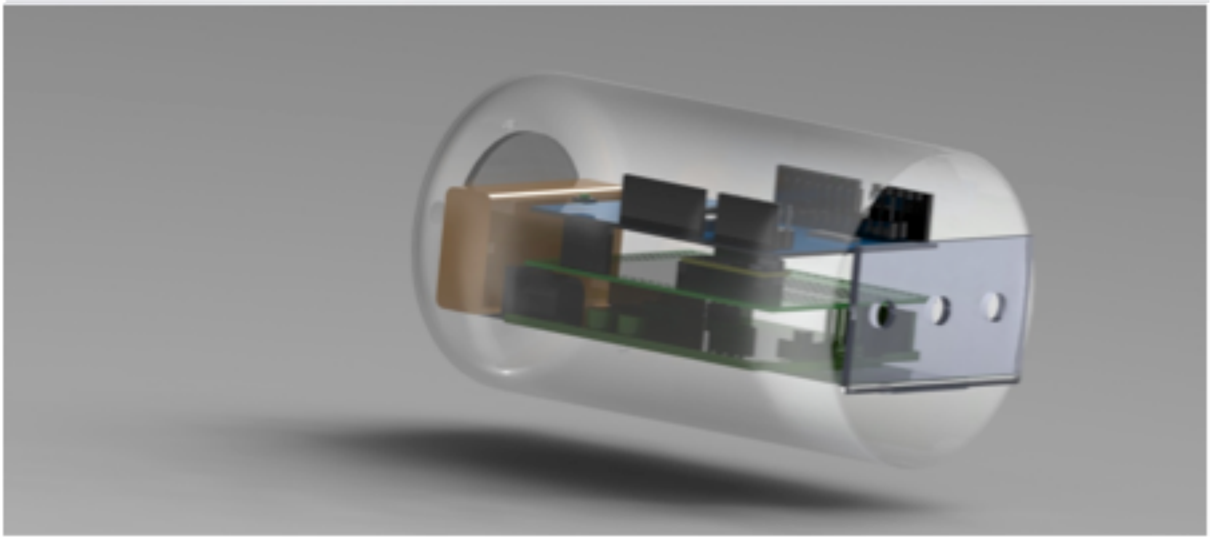


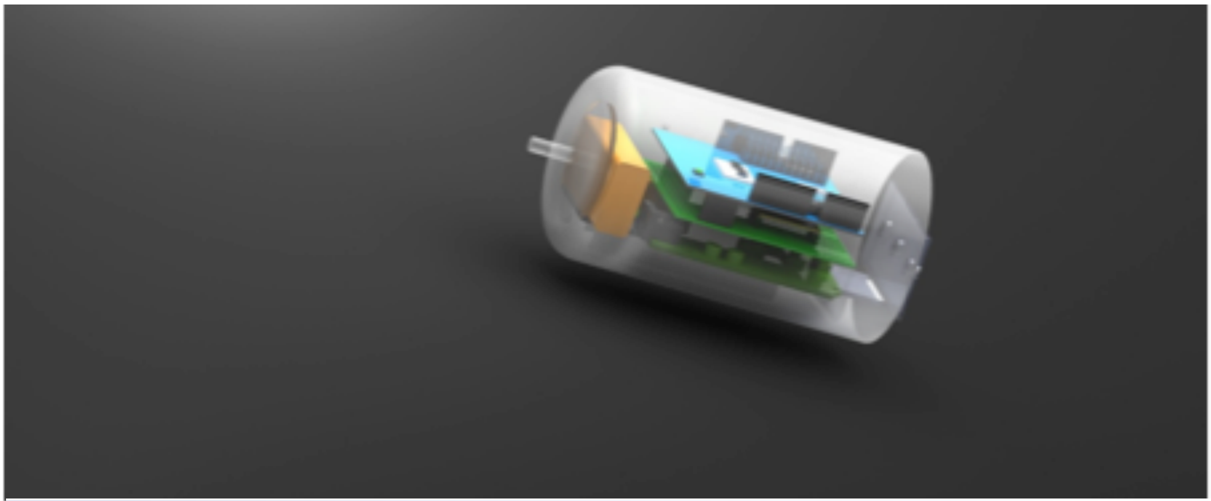
Phase 2.1: Secondary Mission

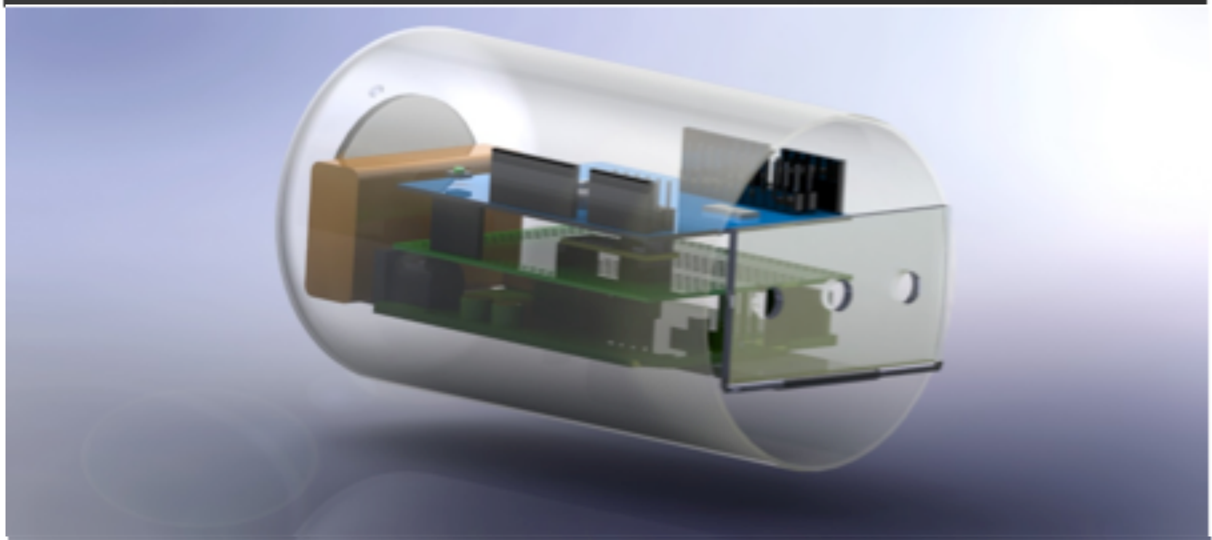


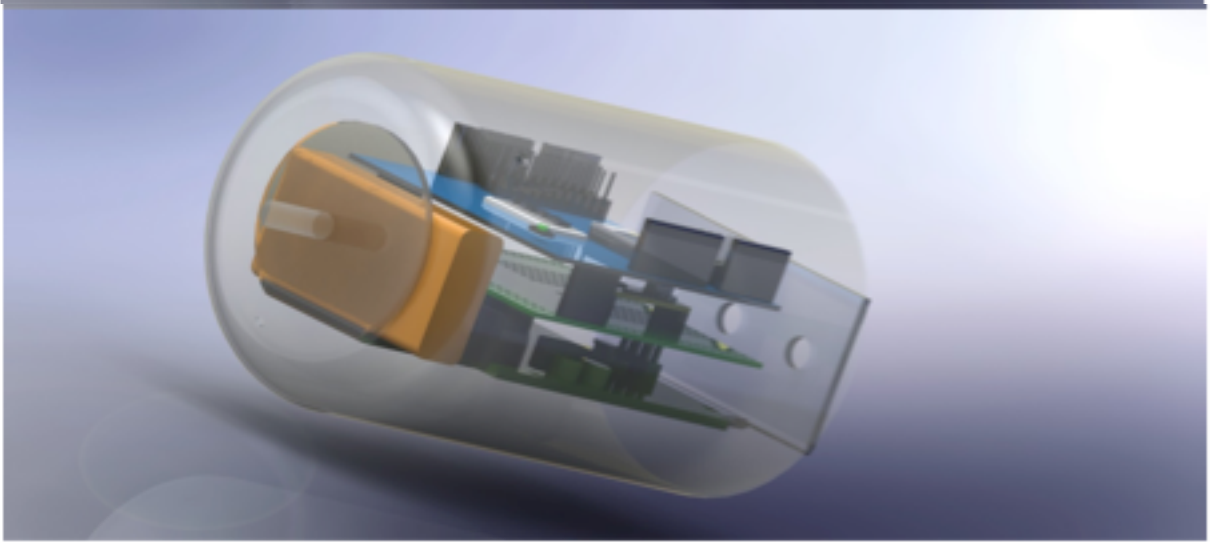












APPENDIX 3 – Battery Datasheet

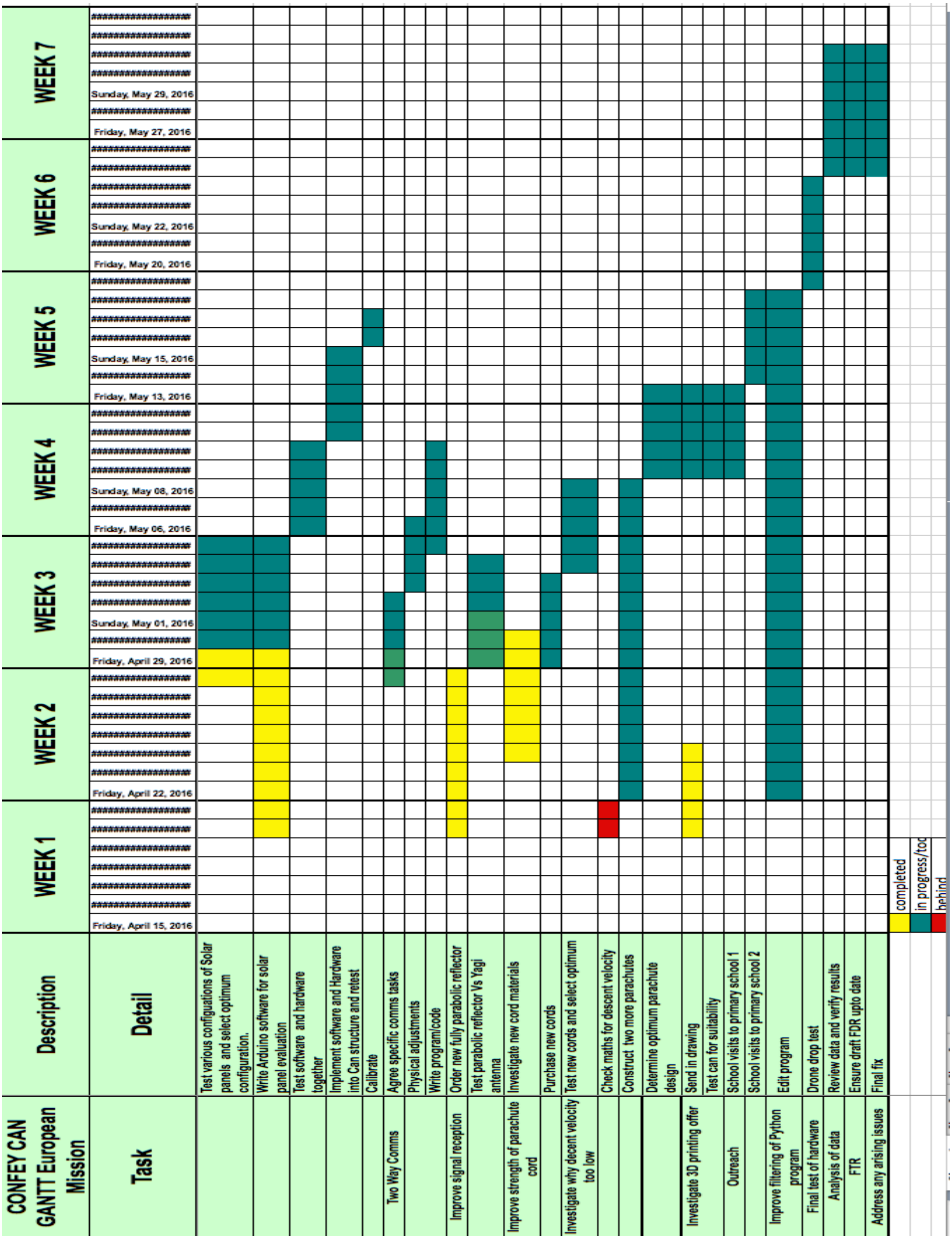
BATTERY

Technical Detail:

Individual Battery Details (9V Alkaline Battery)

Battery Capacity:	550.0mAh
Battery Technology:	Alkaline (Single Use)
Current:	2.1000A
Depth:	17.0mm
Height:	48.5mm
Voltage:	9.00V
Weight:	44.0g
Width:	26.2mm

APPENDIX 4 - Time Schedule for Europe



APPENDIX 5 – Excel Data from National Final Rocket Launch

SecondaryDataRocketBirr.xlsx

Time	XThermTmp1	MPXPress	Alt1Calc	Vel1Calc	Xg	Yg	Zg	RgForce	BMPTemp	BMPPres	Alt2	RelHumid	Lat	Long	TimeGPS	Vel2	Alt(GPS)	Hr	Min	Sec	mS
0	19.93	997.48	9.14	0	-0.06	0.43	-1	1.1	22.64	999.4	0	40	5305.6152	-755.0261	101117100	0	-0.4	10	11	17	100
0.2	19.93	998.57	0	-45.7	-0.06	0.43	-1	1.1	22.65	999.4	0	39.37	5305.6152	-755.0261	101117300	0	-0.4	10	11	17	300
0.9	19.93	998.57	0	0	-0.05	0.43	-1	1.1	22.63	999.3	1	39.52	5305.6152	-755.0261	101118000	0	-0.3	10	11	18	0
1.7	19.93	998.57	0	0	-0.06	0.43	-1	1.1	22.64	999.41	0	39.37	5305.6157	-755.0262	101118800	0	-0.3	10	11	18	800
1.9	19.93	998.57	0	0	-0.06	0.43	-1	1.1	22.63	999.36	0	39.52	5305.6157	-755.0262	101119000	0	-0.3	10	11	19	0
3.3	20.01	998.57	0	0	-0.05	0.43	-1.01	1.1	22.64	999.41	0	39.37	5305.6157	-755.0263	101120400	0	-0.1	10	11	20	400
10.1	19.93	998.57	0	0	-0.05	0.43	-1	1.1	22.65	999.4	0	39.52	5305.6162	-755.0266	101127200	0	0	10	11	27	200
16.8	19.93	998.57	0	0	-0.06	0.43	-1	1.1	22.64	999.39	0	39.37	5305.6162	-755.0266	101133900	0	0	10	11	33	900
17.6	19.93	998.57	0	0	-0.06	0.43	-1	1.1	22.65	999.44	0	39.68	5305.6162	-755.0266	101134700	0	0	10	11	34	700
18.3	19.93	998.57	0	0	-0.06	0.42	-1.01	1.1	22.64	999.41	0	39.37	5305.6162	-755.0266	101135400	0	0	10	11	35	400
18.5	19.93	998.57	0	0	-0.06	0.43	-1	1.1	22.63	999.37	0	39.84	5305.6162	-755.0266	101135600	0	0	10	11	35	600
19.2	19.93	998.57	0	0	-0.06	0.42	-1.01	1.1	22.63	999.33	1	39.84	5305.6162	-755.0266	101136300	0	0	10	11	36	300
20	19.93	998.57	0	0	-0.06	0.43	-1	1.1	22.61	999.32	1	39.36	5305.6162	-755.0267	101137100	0	0	10	11	37	100
20.9	19.93	998.57	0	0	-0.06	0.43	-1	1.1	22.63	999.45	0	39.37	5305.6162	-755.0267	101138000	0	0	10	11	38	0
22.6	19.93	998.57	0	0	-0.06	0.42	-1	1.09	22.64	999.42	0	39.37	5305.6162	-755.0267	101139700	0	0	10	11	39	700
25	19.93	997.48	9.14	3.81	-0.06	0.43	-1.01	1.1	22.63	999.44	0	39.68	5305.6162	-755.0266	101142100	0	0	10	11	42	100
25.7	19.93	998.57	0	-13.06	-0.06	0.43	-1	1.1	22.63	999.41	0	39.52	5305.6162	-755.0266	101142800	0	0	10	11	42	800
26.7	19.93	998.57	0	0	-0.07	0.43	-1	1.1	22.64	999.37	0	39.37	5305.6162	-755.0266	101143800	0	0	10	11	43	800
27.4	19.93	998.57	0	0	-0.06	0.43	-1	1.1	22.64	999.43	0	39.84	5305.6162	-755.0266	101144500	0	0	10	11	44	500
28.1	19.93	998.57	0	0	-0.06	0.43	-1	1.1	22.64	999.42	0	39.84	5305.6162	-755.0266	101145200	0	0	10	11	45	200
29.1	19.86	998.57	0	0	-0.06	0.43	-1	1.1	22.64	999.44	0	39.37	5305.6162	-755.0266	101146200	0	0	10	11	46	200
29.8	19.93	998.57	0	0	-0.07	0.43	-1	1.1	22.64	999.43	0	39.84	5305.6162	-755.0266	101146900	0	0	10	11	46	900
30.1	19.93	998.57	0	0	-0.05	0.43	-1	1.1	22.62	999.39	0	39.68	5305.6162	-755.0266	101147200	0	0	10	11	47	200
30.8	19.86	998.57	0	0	-0.06	0.43	-1	1.1	22.64	999.45	0	39.37	5305.6162	-755.0266	101147900	0	0	10	11	47	900
31.5	19.93	998.57	0	0	-0.05	0.43	-1.01	1.1	22.64	999.41	0	39.37	5305.6162	-755.0266	101148600	0	0	10	11	48	600
32.5	19.86	998.57	0	0	-0.06	0.43	-1.01	1.1	22.63	999.37	0	39.84	5305.6162	-755.0266	101149600	0	0	10	11	49	600
33.2	19.86	998.57	0	0	-0.06	0.43	-1	1.1	22.64	999.45	0	39.84	5305.6162	-755.0266	101150300	0	0	10	11	50	300
34.2	19.86	998.57	0	0	-0.06	0.43	-1	1.1	22.63	999.35	0	39.84	5305.6162	-755.0266	101151300	0	0	10	11	51	300
34.9	19.86	998.57	0	0	-0.06	0.43	-1	1.1	22.63	999.4	0	39.52	5305.6162	-755.0266	101152000	0	0	10	11	52	0
35.6	19.86	998.57	0	0	-0.06	0.42	-1	1.09	22.63	999.36	0	39.36	5305.6162	-755.0266	101152700	0	0	10	11	52	700
35.8	19.86	998.57	0	0	-0.06	0.43	-1	1.1	22.63	999.39	0	39.68	5305.6162	-755.0266	101152900	0	0	10	11	52	900
37.3	19.86	998.57	0	0	-0.06	0.43	-1.01	1.1	22.63	999.45	0	39.37	5305.6162	-755.0266	101154400	0	0	10	11	54	400
37.5	19.86	998.57	0	0	-0.06	0.43	-1	1.1	22.63	999.39	0	39.36	5305.6162	-755.0266	101154600	0	0	10	11	54	600
40.7	19.86	998.57	0	0	-0.06	0.43	-1	1.1	22.62	999.36	0	39.84	5305.6162	-755.0266	101157800	0	0	10	11	57	800
41.6	19.86	998.57	0	0	-0.06	0.43	-1.01	1.1	22.63	999.41	0	39.36	5305.6162	-755.0266	101158700	0	0	10	11	58	700
42.3	19.86	998.57	0	0	-0.06	0.43	-1	1.1	22.63	999.36	0	39.52	5305.6162	-755.0266	101159400	0	0	10	11	59	400
43.1	19.86	998.57	0	0	-0.06	0.43	-1	1.1	22.64	999.42	0	39.52	5305.6162	-755.0266	101200200	0	0	10	12	0	200
43.3	19.86	998.57	0	0	-0.06	0.43	-1.01	1.1	22.63	999.41	0	39.52	5305.6162	-755.0266	101200400	0	0	10	12	0	400
44	19.86	998.57	0	0	-0.06	0.43	-1	1.1	22.62	999.36	0	39.36	5305.6162	-755.0266	101201100	0	0	10	12	1	100

Data | Pressure1 Vs Pressure2 | Temp1Temp2 | Alt1Alt2Alt3 | TempPressureAlt1 | ResultantForce | gForceAlt1 | HumidityTime | VelocityTime | TempHumidity | PressureHumid | RForceVAlt

graphs

APPENDIX 6: - Datasheets for all sensors:

We have copies of all our datasheets in PDF format. Unfortunately the only way we seem to be able to put them into this file is one page at a time! But several of them are over 20 pages long. It may be our version of word (this file is currently running in compatibility mode as we used the template sent to us – has caused us a lot of difficulty and we wouldn't do that again). We have tried inserting the datasheets as objects but won't work, tried including as a file but will only do one page at a time) Finally, as a last option we are including links to the actual PDF's online :

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.) ADXL345 Accelerometer:

Breakout board:
https://www.sparkfun.com/products/9836

Datasheet:
https://www.sparkfun.com/datasheets/Sensors/Accelerometer/ADXL345.pdf

4.) BMP180 Pressure and Temperature Sensor:

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

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

5.) 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

6.) Flexible Solar Panels (not 100% sure if we will use these or another:
http://datasheet.octopart.com/MP3-25-PowerFilm-datasheet-8634848.pdf

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

8.) DSS I2C GPS Shield:
http://dsscircuits.com/images/datasheets/I2C%20GPS%20SHIELD%20REV2.0%20DATASHEET.pdf

APPENDIX 7:
Web sites containing articles/photos about Confey Can :

Irish Kildare Liffey Champion (readership 7500 weekly)
https://dub126.mail.live.com/mail/ViewOfficePreview.aspx?messageid=mgjvlyBS4N5hGFzQAiZMIHSg2&folderid=flinbox&attindex=0&cp=-1&attdepth=0&n=6866780

IrishTechNews.net, 18 April 2016 (readership: 65,000 monthly)
http://irishtechnews.net/ITN3/confey-college-win-national-space-competition/

KFMradio.ie, 18 April 2016
http://www.kfmradio.com/news/18042016-1524/confey-college-team-wins-national-leg-cansat-competition

SiliconRepublic.com, 18 April 2016 (readership: 260,000 monthly)
https://www.siliconrepublic.com/portfolio/2016/04/18/cansat-competition-ireland-confey-college

TechCentral.ie, 18 April 2016 (readership: 160,000 monthly)
http://www.techcentral.ie/kildare-team-wins-cansat-2016-national-final/