Using a Raspberry Pi for Environmental Monitoring

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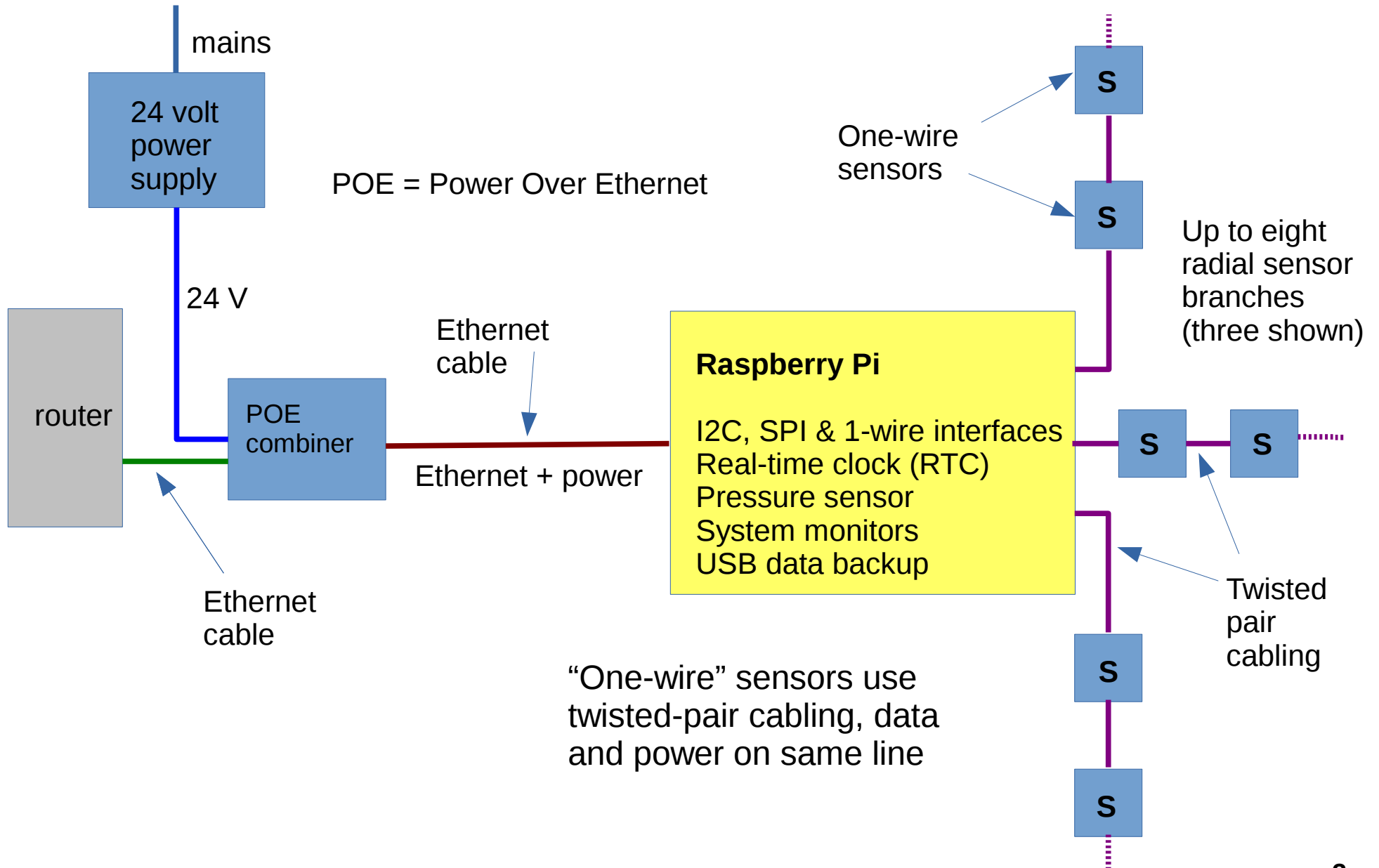Raspberry Pi Day

University of Strathclyde, January 17th 2015

Motivation and Aims

- Need for a robust, economical and extendable system for measuring temperature, humidity, light, etc. in small-scale commercial horticulture, where system cost is an issue.

- Significant running-cost savings by monitoring and controlling temperature in winter – heating is expensive!

- Needs accurate (to within 1°C) and re-configurable temperature sensors, with lots of sensors distributed over a wide area.

- Data needs to be fully accessible remotely anywhere as a web page.

- **The Raspberry Pi has proved to be ideal as the core of such a system.**

System outline

mains

24 volt power supply

POE = Power Over Ethernet

One-wire sensors

S

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Up to eight radial sensor branches (three shown)

router

24 V

Ethernet cable

POE combiner

Ethernet cable

Ethernet + power

Raspberry Pi

I2C, SPI & 1-wire interfaces
Real-time clock (RTC)
Pressure sensor
System monitors
USB data backup

S   **S**

Twisted pair cabling

"One-wire" sensors use twisted-pair cabling, data and power on same line

S

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And the hardware...

Need to keep water out!

IP65 enclosure, lid removed

R Pi and interface circuitry

ESD and RFI protection

24 volt supply

Sensor terminals

Power over Ethernet injector

Cable glands or conduit fittings for sensor wiring

IP67 ethernet connector

IP66 porous vent plug (for humidity control & pressure equalisation)

Up to 20m of Ethernet cable

The Raspberry Pi and its interfaces

Die-cast box

PoE power supply (LM2596)

I^{2}C, SPI and 1-wire interfaces on top.

Raspberry Pi is underneath.

BMP085 sensor for barometric pressure

Real-time clock (DS1307)

8 channels for 1-wire sensors
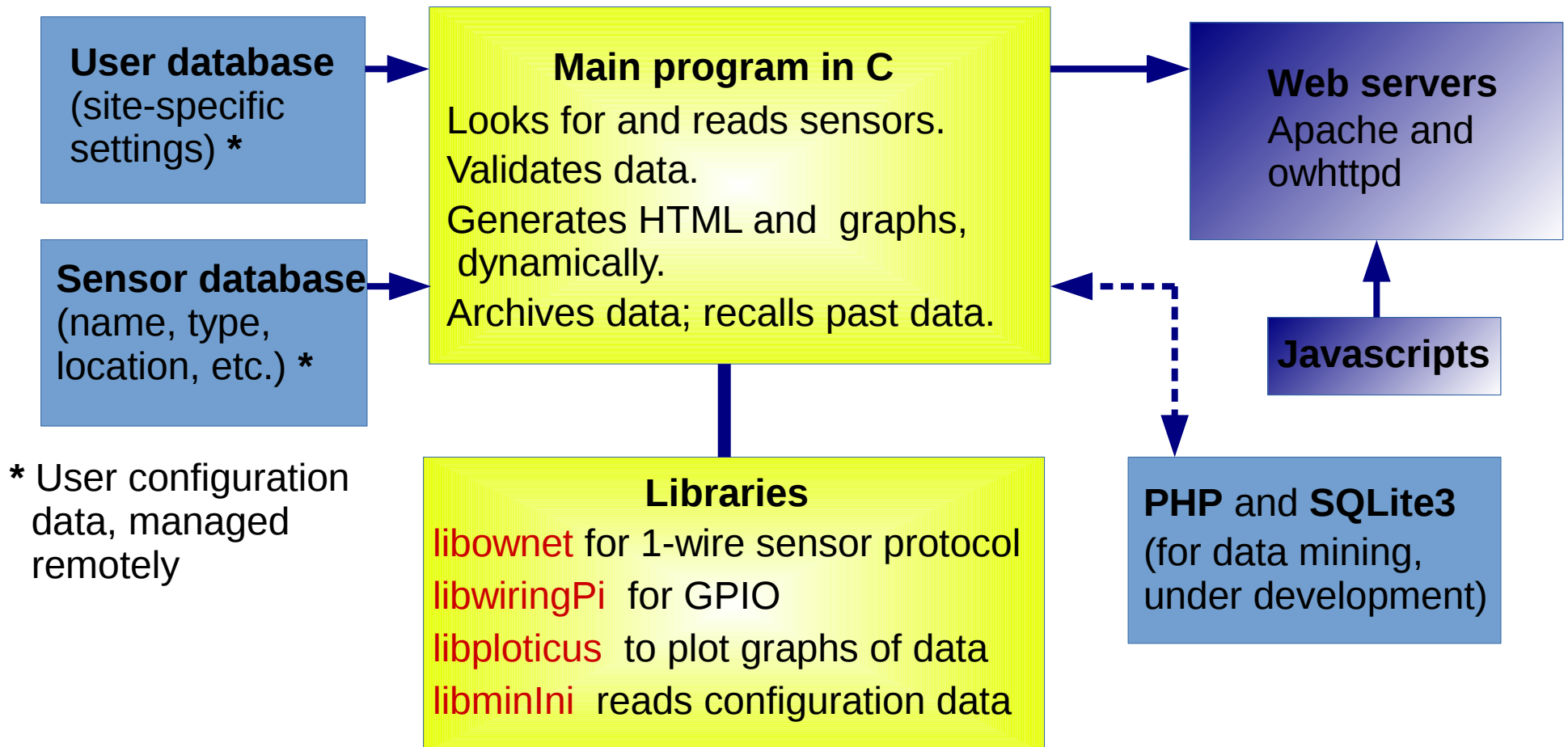
Raspberry Pi Day
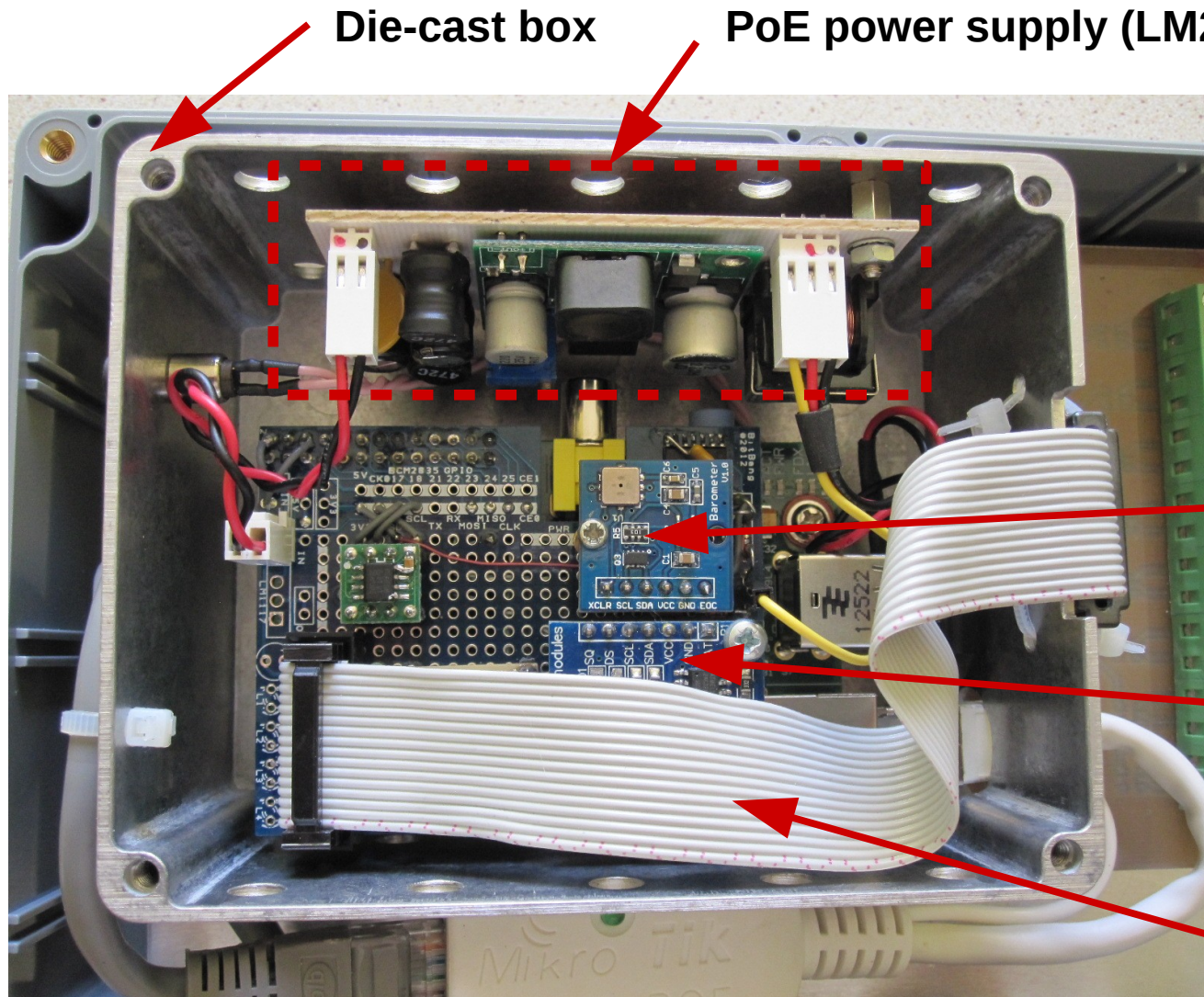
Software overview

- Supports live addition or removal of sensors at any time
- Handles missing or corrupt data; tolerates power outages and other upsets
- Readings and 24-hour plots are updated every 10 minutes

User database
(site-specific settings) *

Sensor database
(name, type, location, etc.) *

* User configuration data, managed remotely

Main program in C
Looks for and reads sensors.
Validates data.
Generates HTML and graphs, dynamically.
Archives data; recalls past data.

Libraries
libownet for 1-wire sensor protocol
libwiringPi for GPIO
libploticus to plot graphs of data
libminIni reads configuration data

Web servers
Apache and owhttpd

Javascripts

PHP and **SQLite3**
(for data mining, under development)

Some measurements ...

Station height 70 m asl. Air temperature 6.4 °C

Readings on Tue 13 Jan 2015 at 11:30			
Local pressure		Sea-level pressure	
hPa	in Hg	hPa	in Hg
992.5	29.3	1001.1	29.6

DigiBaro

Atmospheric pressure over the last 24 hours

Local pressure for last 24hrs 13 Jan 2015

Pressure (hPa)
1025
1015
1005
995
985
975
11 13 15 17 19 21 23 01 03 05 07 09 11
13 Jan
Time (hrs)

Sensor DigiBaro: Digital BMP085

See
   www.shrublandparknurseries.co.uk
   and
spnelmsett.plus.com

Temperature

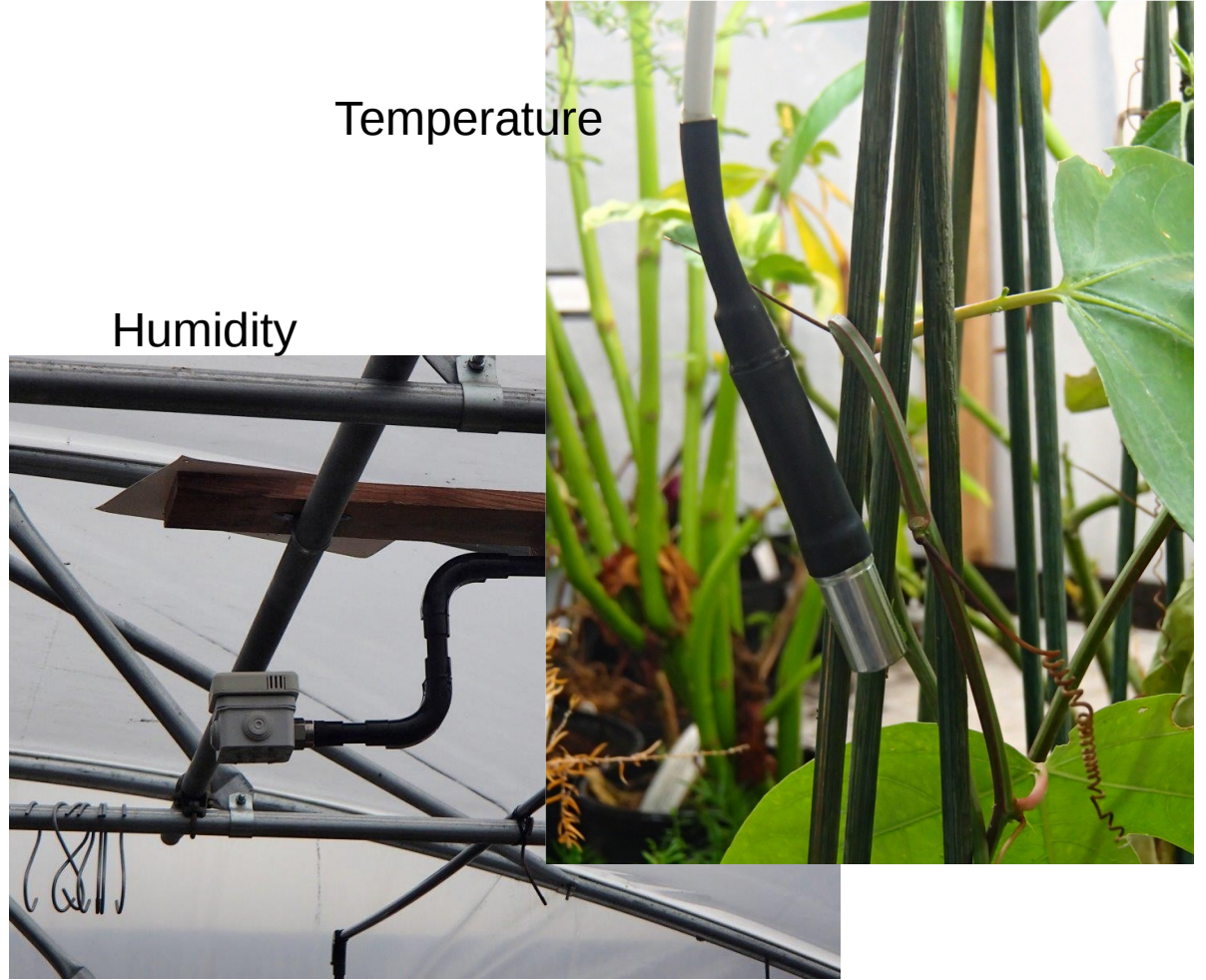| Readings on Tue 13 Jan 2015 at 11:30			
Sensor	° C	° F	Location
piggy_in	8.1	46.5	piggery_in
office	14.8	58.7	office
piggy_out	6.4	43.5	piggery_out
poly_lh	10.4	50.7	Polytunnel Left
propagator	8.5	47.3	propagator
poly_rh	10.8	51.5	Polytunnel Right
Humid01	15.6	60.1	Humidity test
p_house_r	19.1	66.4	Polhouse R
p_house_cr	17.8	64.1	Polhouse CR
p_house_cl	15.6	60.0	Polhouse CL
p_house_l	18.1	64.5	Polhouse L
Openbarn	8.4	47.1	Open Barn
Mainbarn	8.9	48.1	Main Barn

piggy_in   office   piggy_out   poly_lh   propagator   poly_rh
Humid01   p_house_r   p_house_cr   p_house_cl   p_house_l
Openbarn   Mainbarn

Temperature over the last 24 hours

Temperature for last 24hrs 13 Jan 2015

Temperature (°C)
15
13
11
9
7
5
11 13 15 17 19 21 23 01 03 05 07 09 11
13 Jan
Time (hrs)

Sensor poly_rh: Polytunnel Right
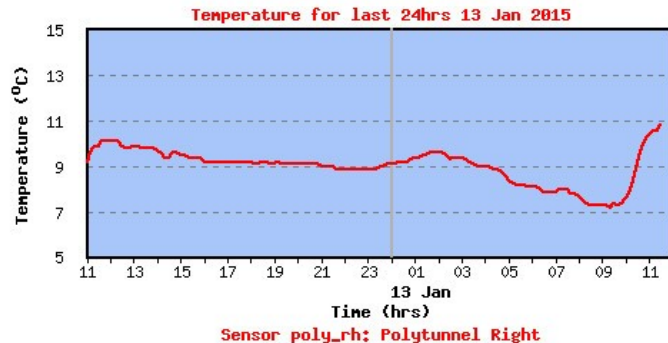
Greenhouse installation

Temperature

Humidity