



μ METOS Training

Session 1: Hardware

μMETOS Features

Main Unit

- 16 Bit μProcessor
- 512 kB Flash Memory on μMETOS ag
- 1 MB Flash Memory on μMETOS sm
- 5 minute measurement interval
- Logging of hourly averages
- Minimum 12 Month data capacity
- Display
- Build in disease and evapotranspiration models
- Infrared interface for data download to printer, PC Windows CE Palmtop
- Brightness Sensor on PCB
- Optional sensors for temperature and relative humidity and global radiation
- Interface to sensor box RS 485 on μMETOS sm, power supply and sensor input on μMETOS ag
- Interface to programming unit

Extension Unit μMETOS ag

PCB with connectors for

- Rain gauge
- Leaf wetness sensor
- Wind speed sensor
- Soil temperature sensor

Extension Unit μMETOS sm

PCB with

- 8 bit μcontroller
- 2 RS485 interfaces
- Connectors for
 - Rain gauge
 - Leaf wetness sensor
 - Wind speed sensor
 - Soil temperature sensor
 - 6 Watermark sensors

Available Models of μ METOS

μ METOS ag

MCR 100 with sensors for

- Air temperature
- Relative Humidity
- Brightness

MCR 200 with sensors like MCR 100 plus

- Rain gauge
- Leaf wetness

MCR 250 with sensors like MCR 200 plus

- Global radiation

MCR 300 with sensors like MCR 250 plus

- Wind speed

Optional for MCR 200, MCR 250 and MCR 300

- Soil temperature sensor

μ METOS sm

SMR 50 with sensors for

- Brightness
- Soil temperature

SMR 100 with sensors like SMR 50 plus

- Air temperature
- Relative humidity

SMR 200 with sensors like SMR 100 plus

- Rain gauge
- Leaf wetness

SMR 250 with sensors like SMR 200 plus

- Global radiation

SMR 300 with sensors like SMR 250 plus

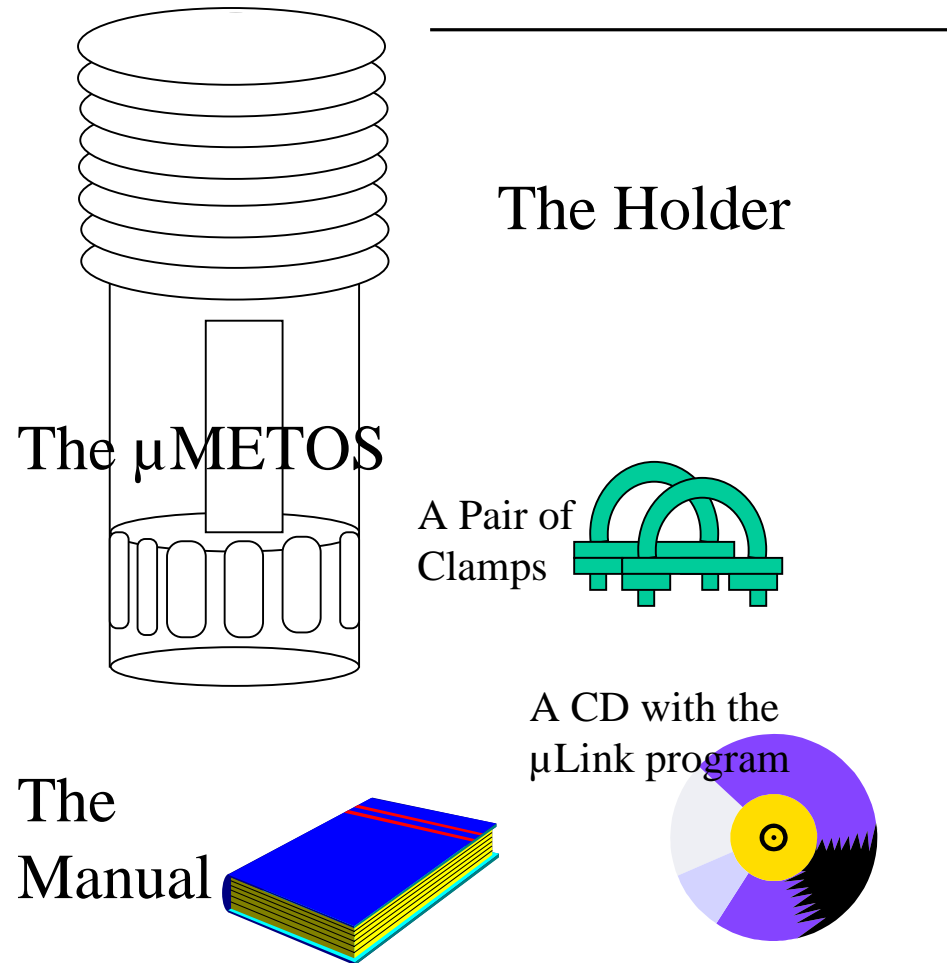
- Wind speed

Optional for all μ METOS sm

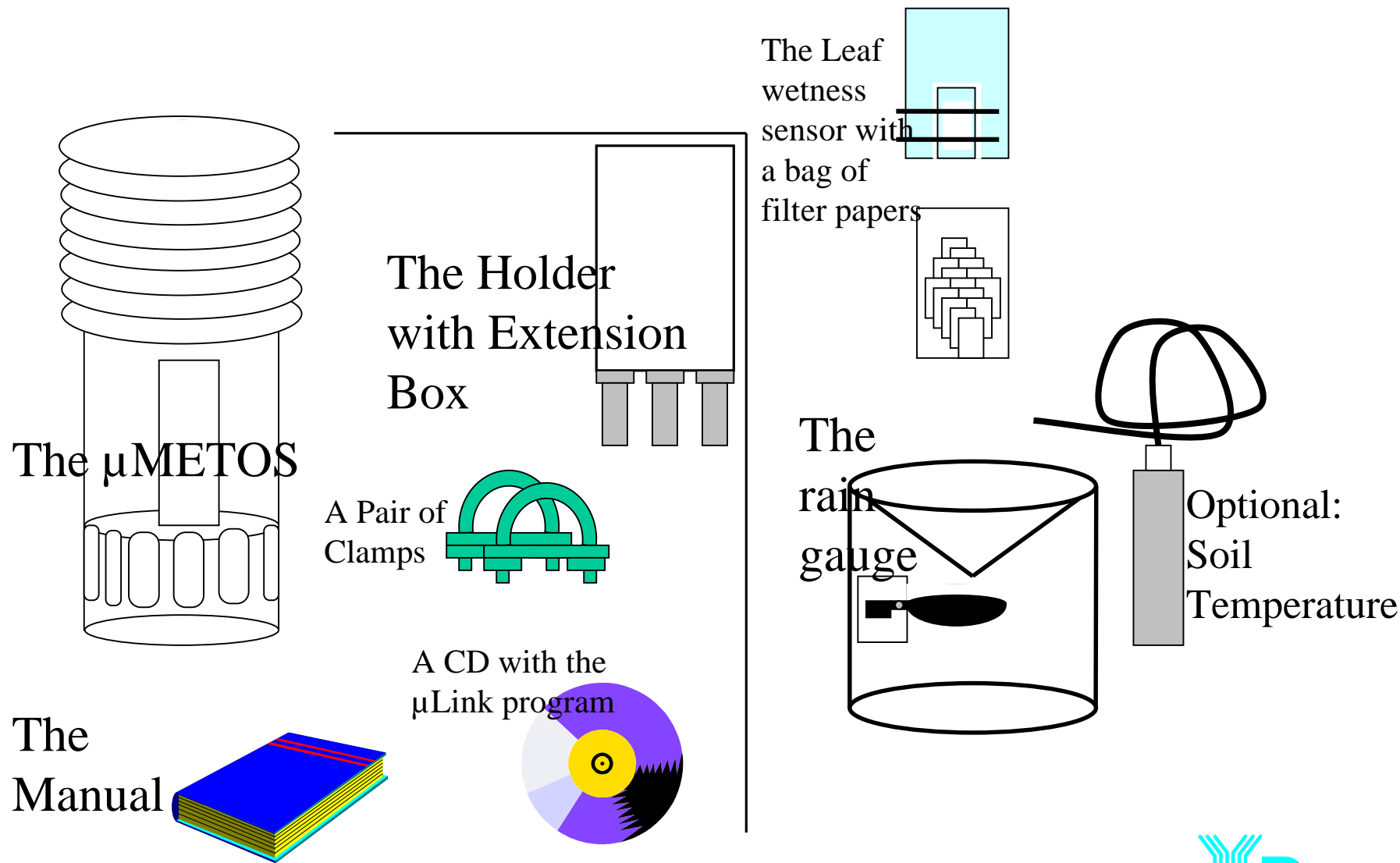
- 6 Watermark sensors



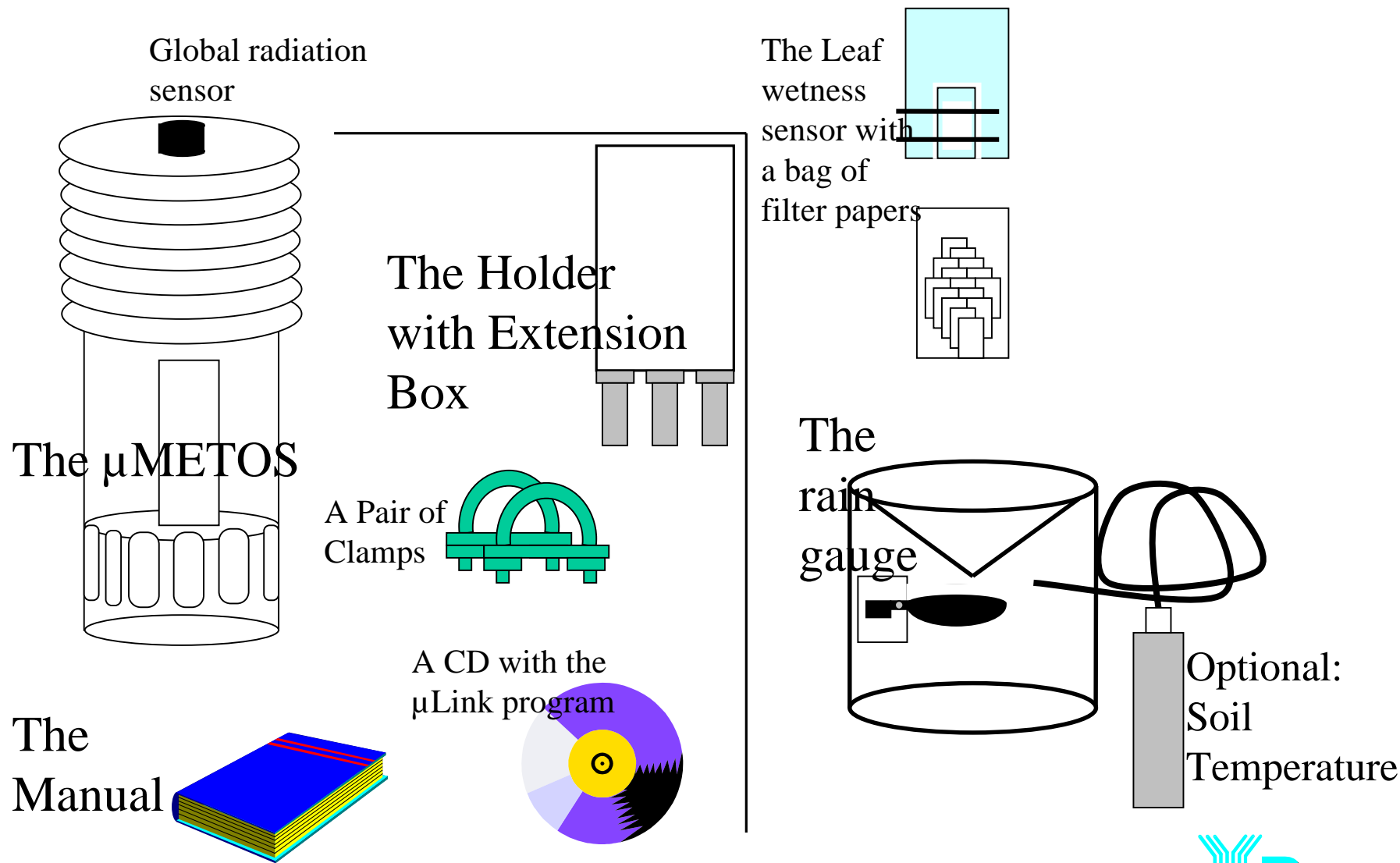
Parts of a complete μ METOS MCR 100



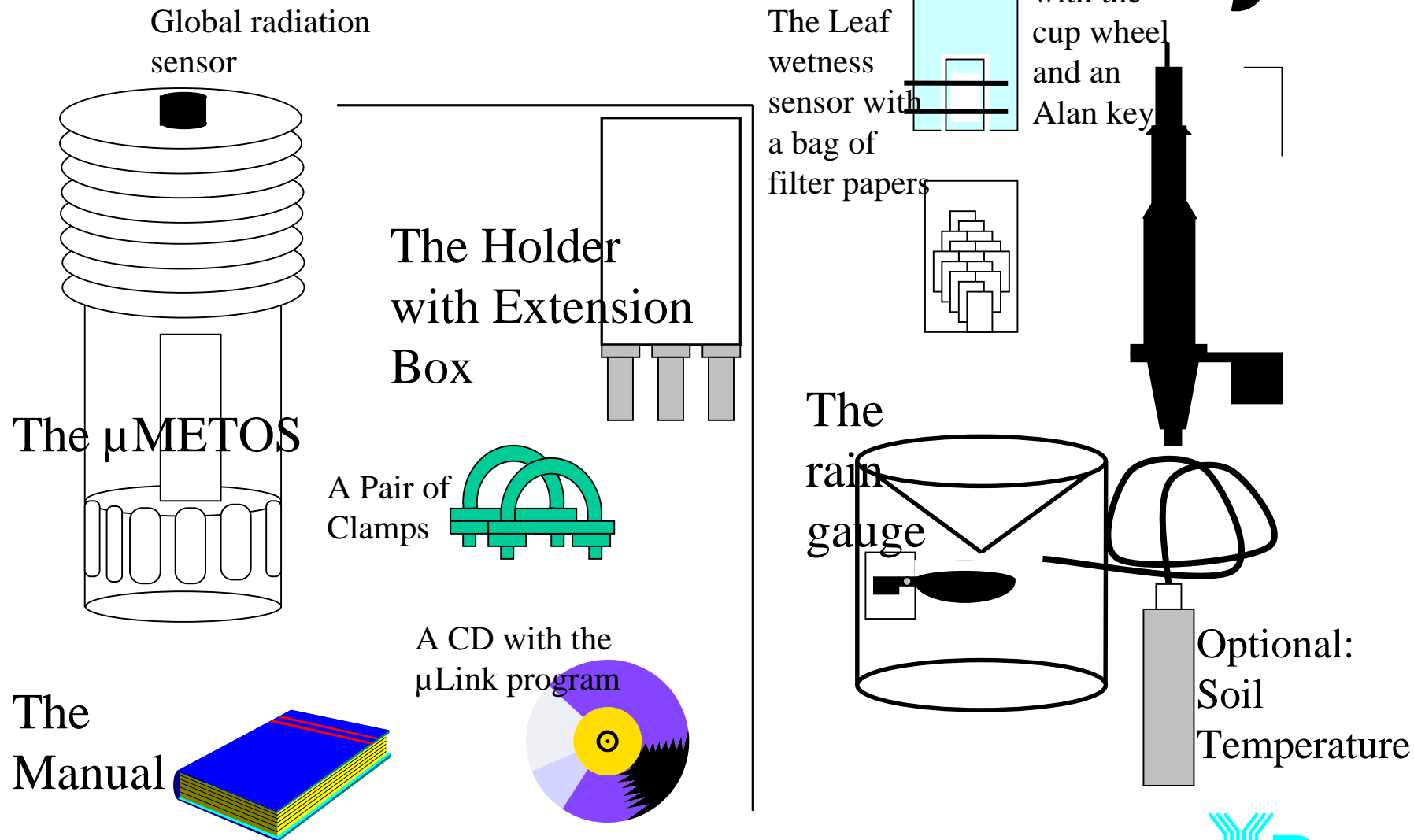
Parts of a complete μ METOS MCR 200



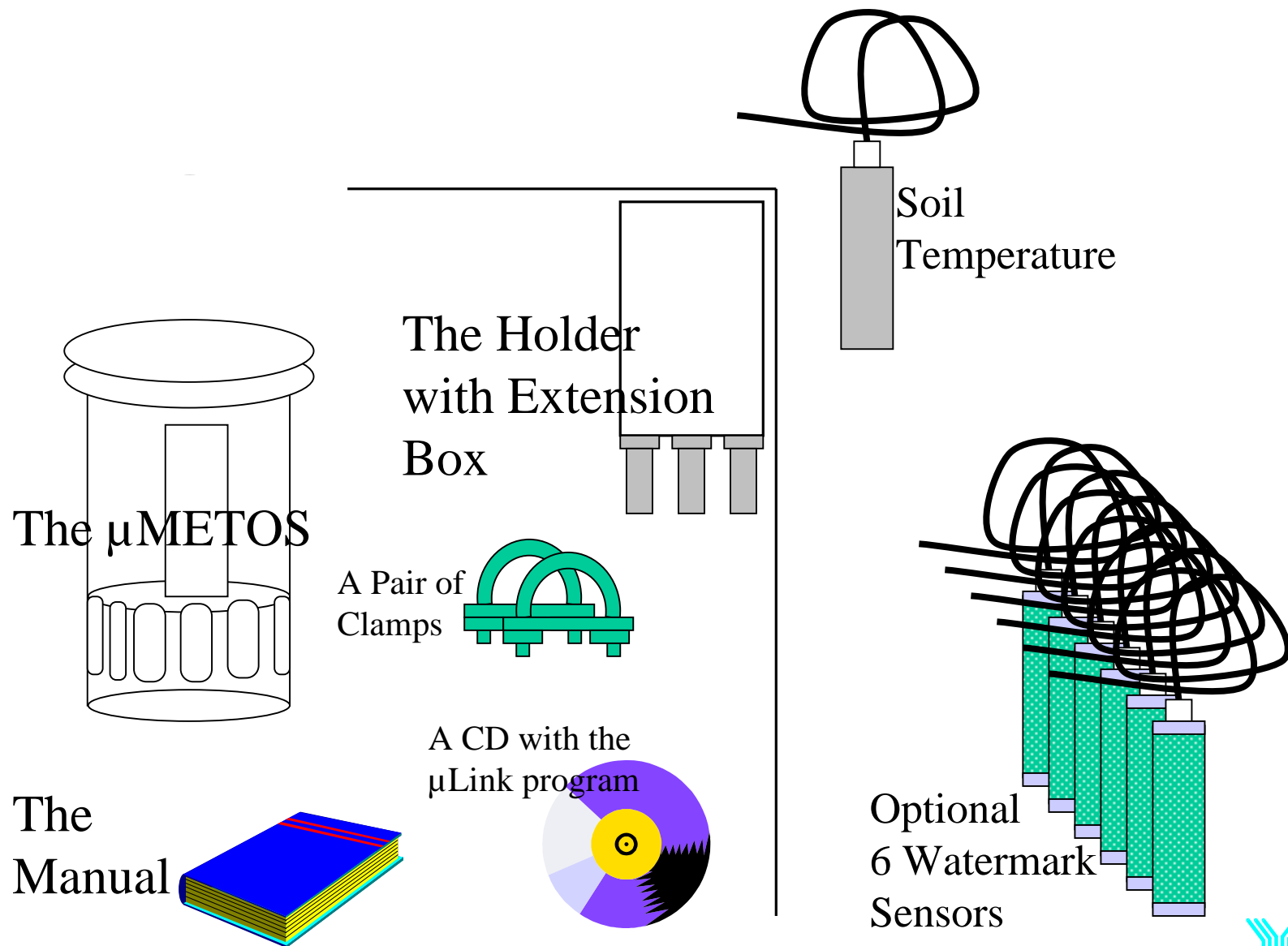
Parts of a complete μ METOS MCR 250



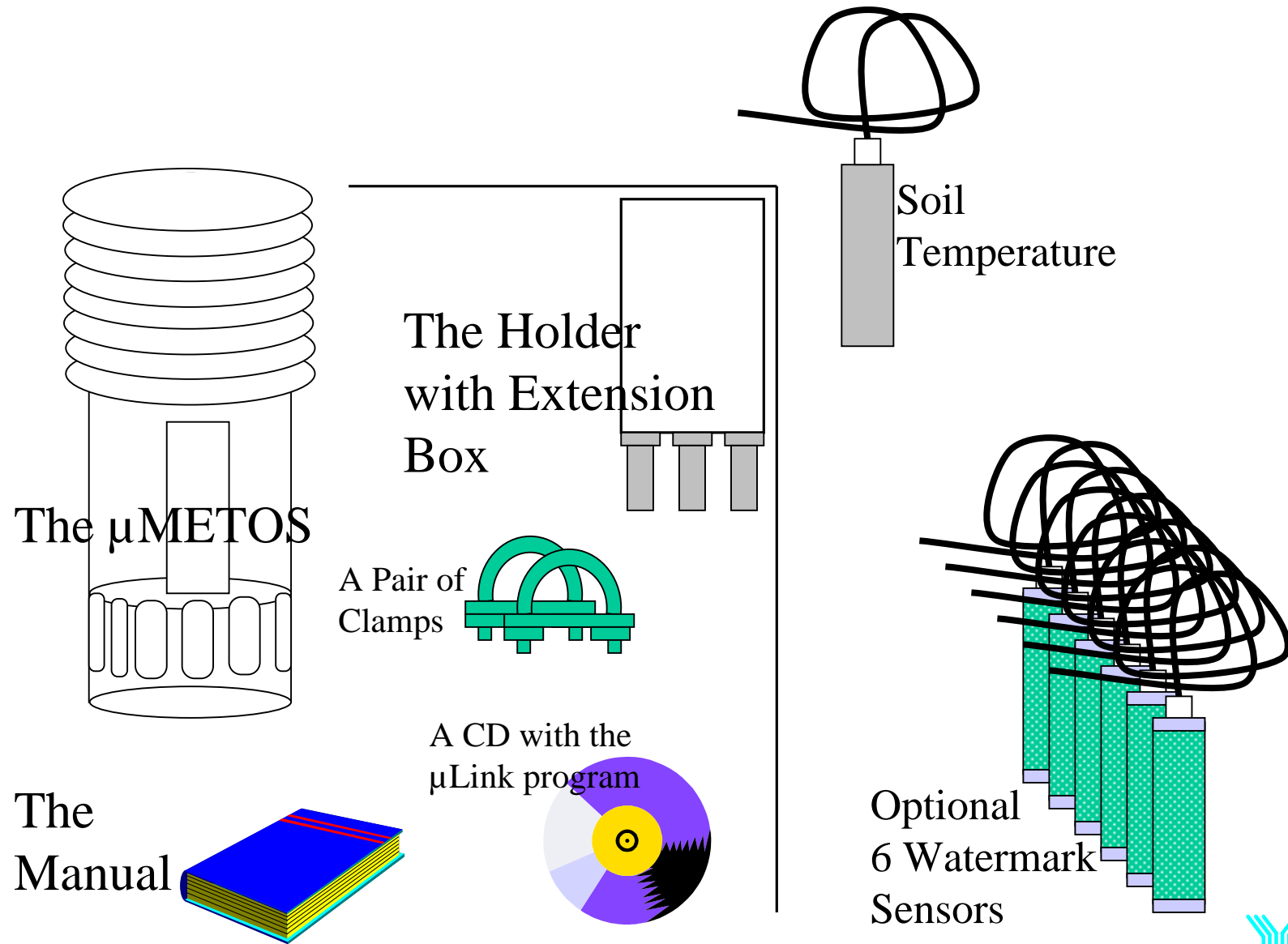
Parts of a complete μ METOS MCR 300



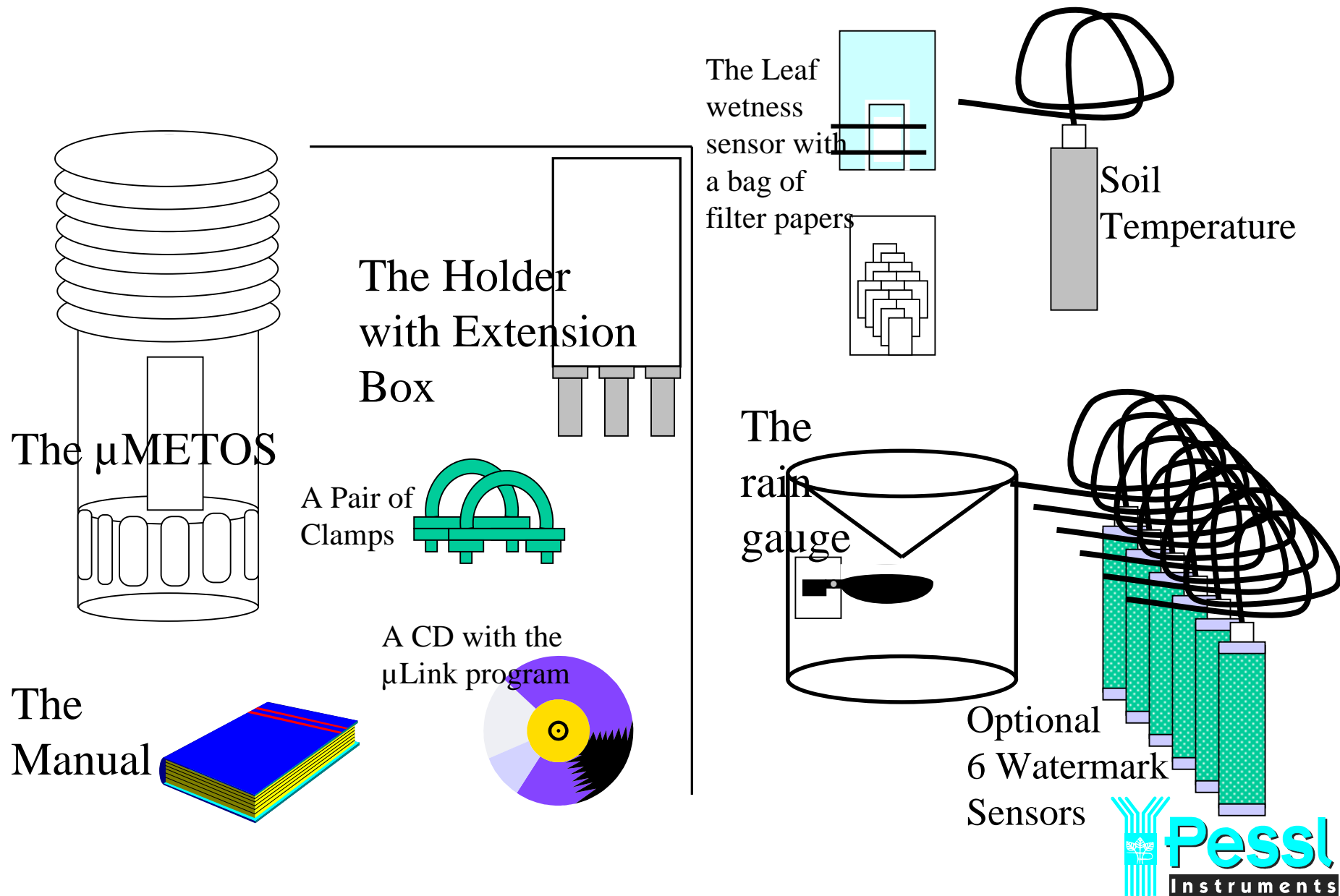
Parts of a complete μ METOS SMR 50



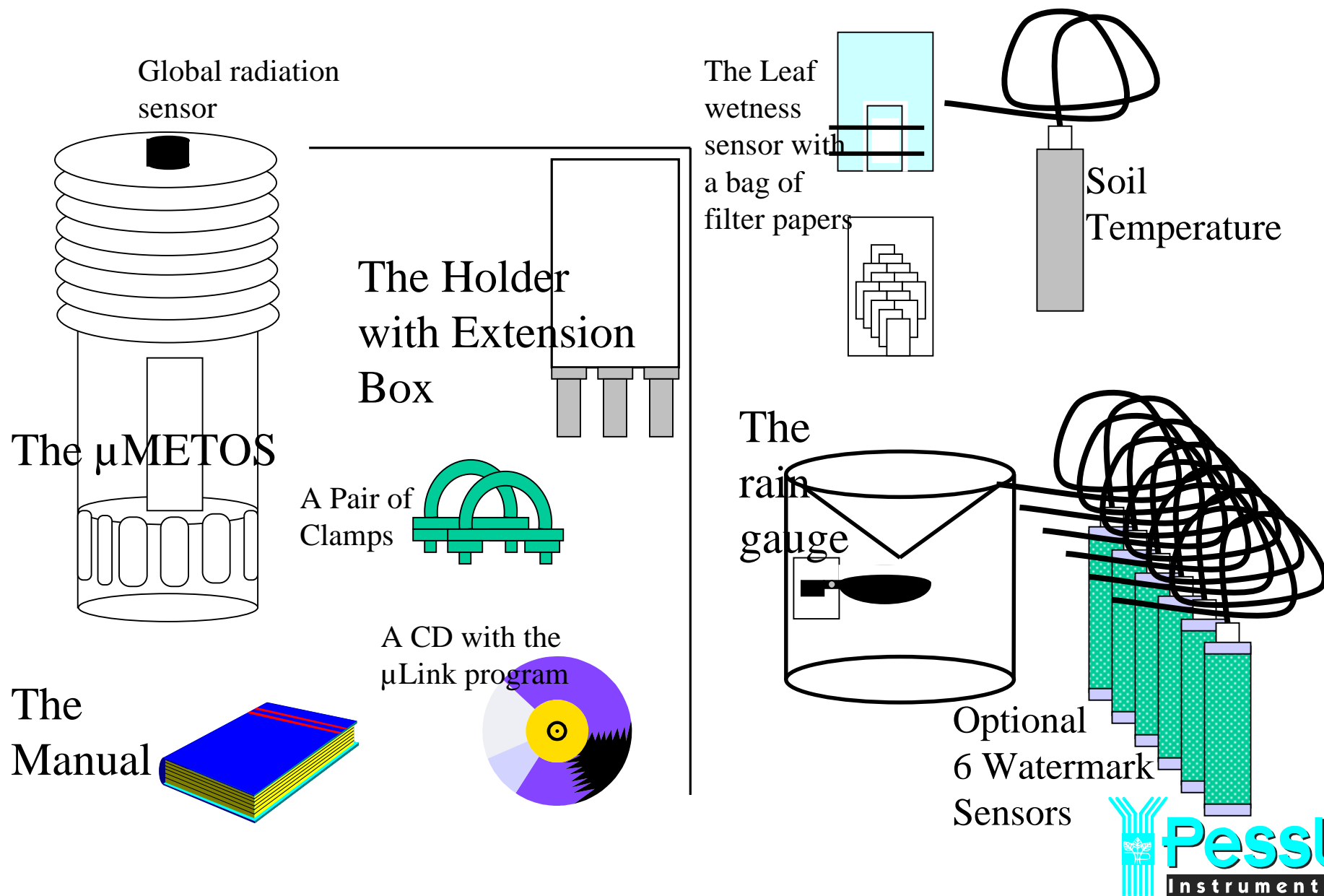
Parts of a complete μ METOS SMR 100



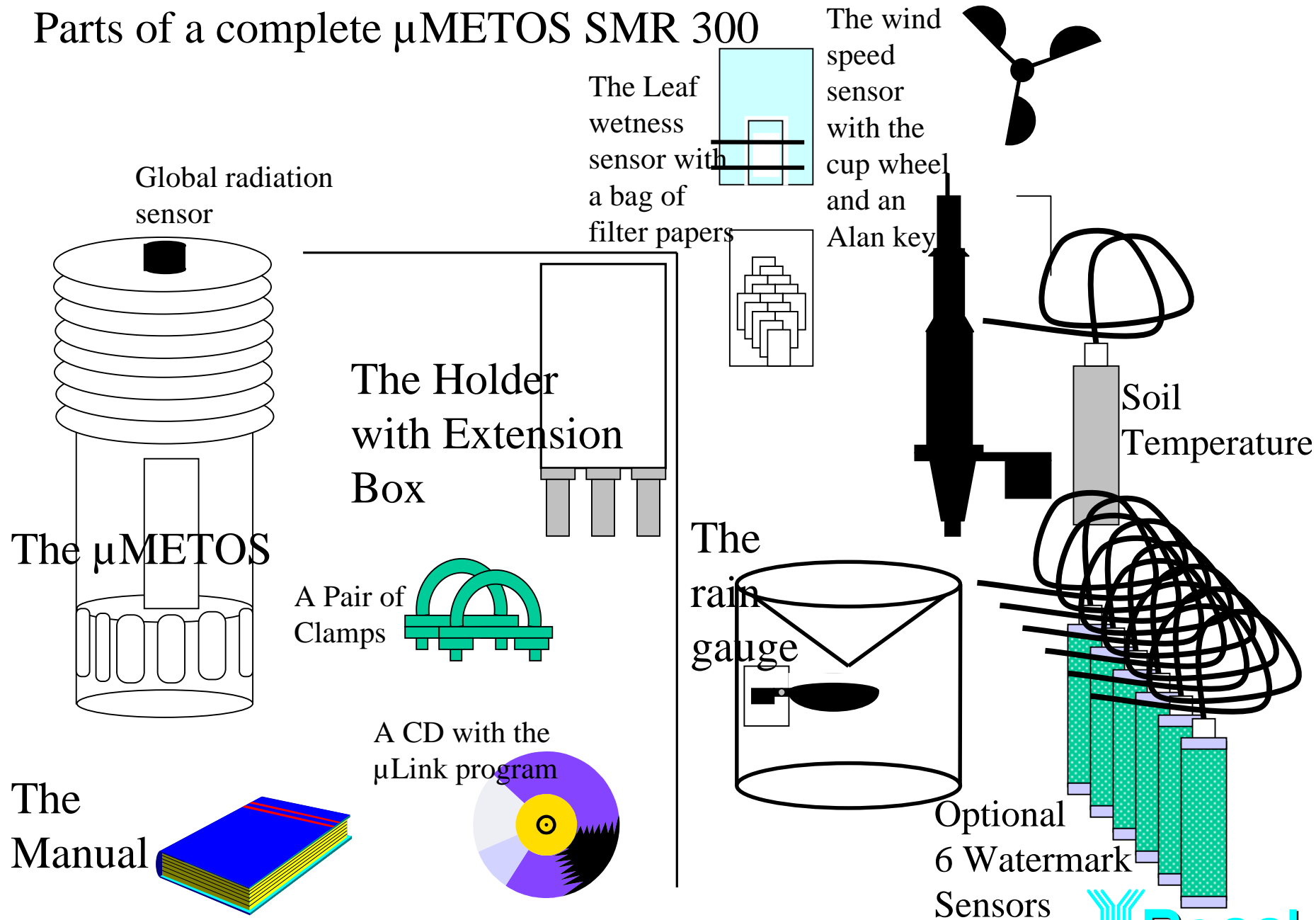
Parts of a complete μ METOS SMR 200



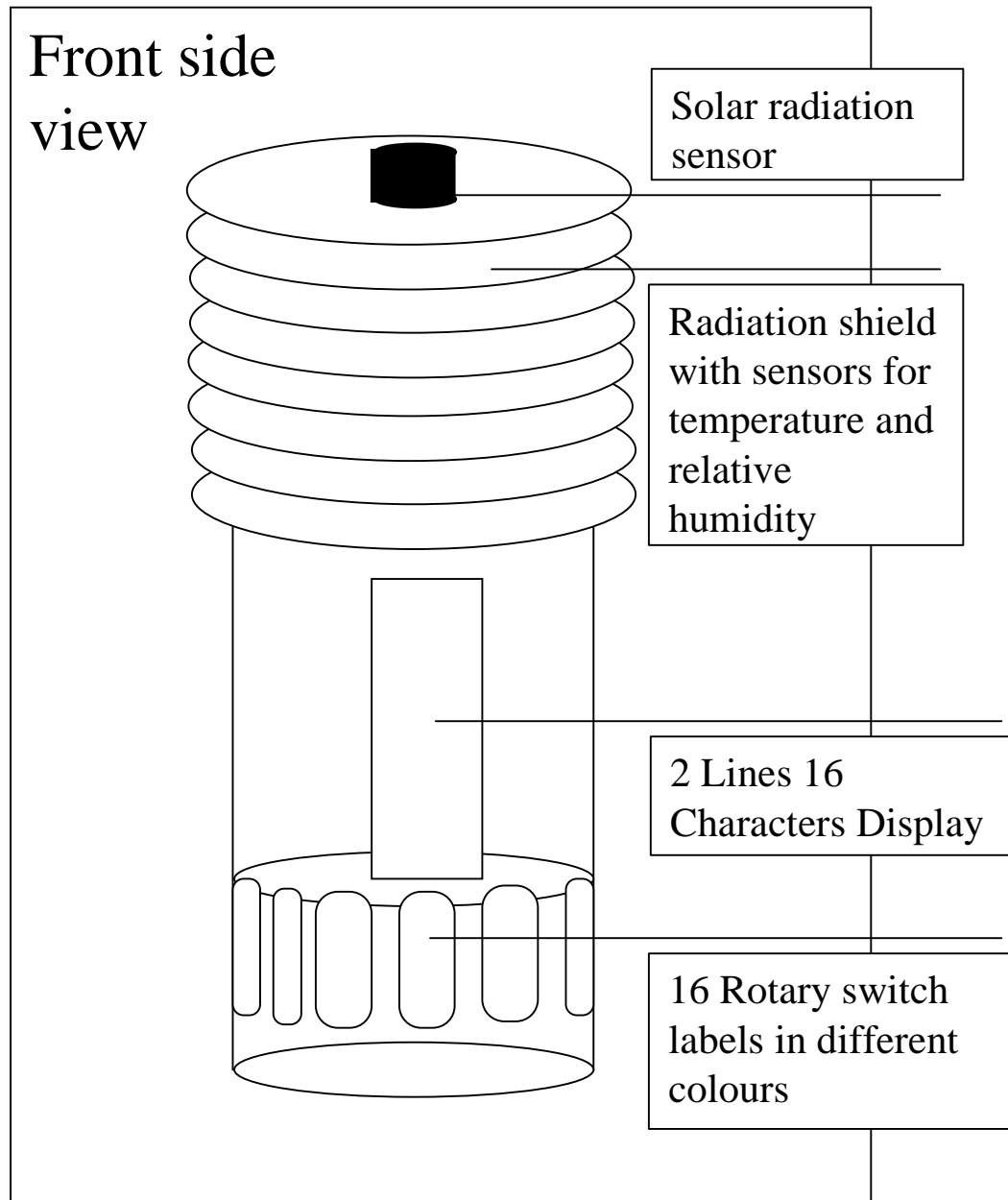
Parts of a complete μ METOS SMR 250



Parts of a complete μ METOS SMR 300



The μ METOS Main Unit:

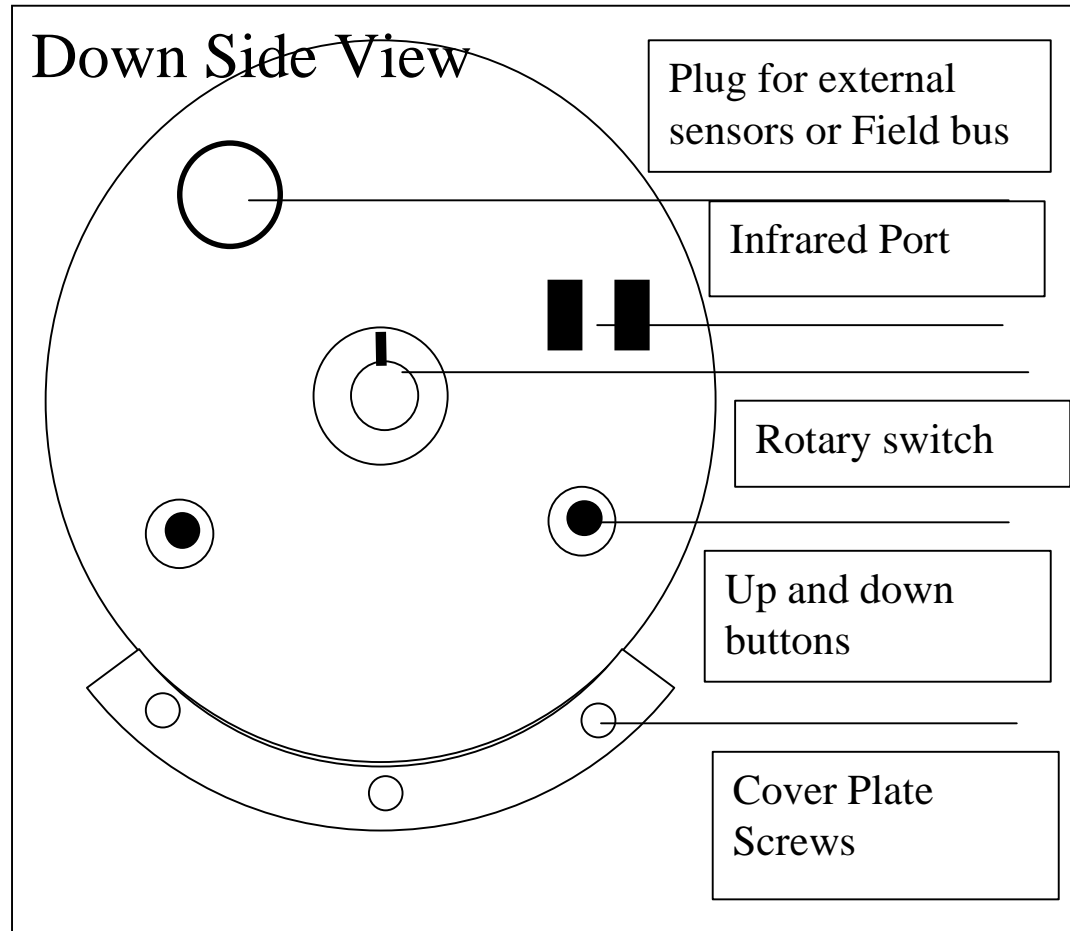


The μ METOS Main Unit is the electronic climate data logger connected with the sensors for temperature, relative humidity, brightness and global radiation (at MCR300 only).

Electronically it consists of a single PCB with a 16 bit Hitachi microprocessor, 512 kB or 2MB flash memory, digital inputs for temperature and relative humidity, analogous inputs for brightness, global radiation and leaf wetness, counters for wind speed and rain and an infrared interface.

It is powered by 6 mignon cells visible on the backside of the unit. Capacity of this mignon cells is lasting for more than 6 month (more than one season).

The μ METOS Main Unit:

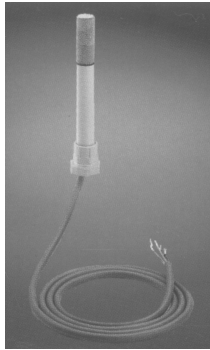


On the μ METOS ag external Sensors like leaf wetness, rain gauge and wind speed are connected by one single plug. On the μ METOS sm the same plug is used for the field bus connecting the sensor box. This makes it easy to remove the system from field and carry it to the office for data downloading.

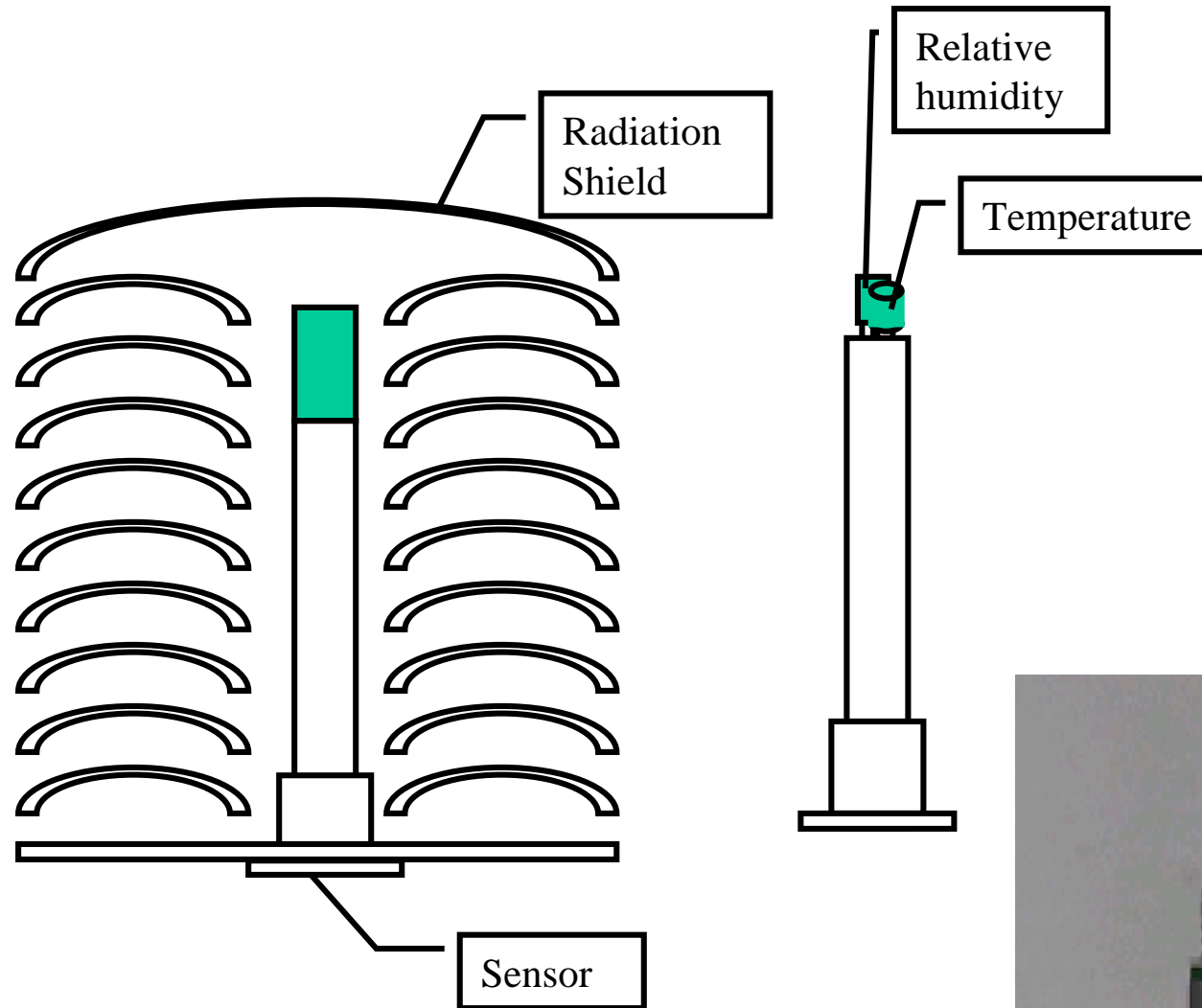
The infrared port is to communicate with PC, hand held Windows CE computers or Cannon portable printers.

The μ METOS is operated by rotary switch and up and down button. The 16 labels are describing the function of the different rotary switch positions.

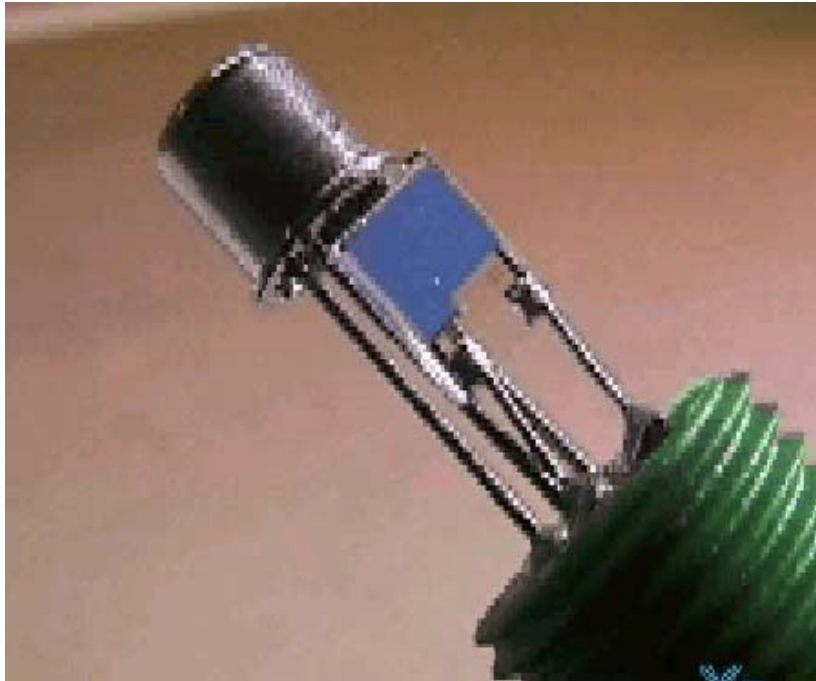
8 screws are fixing the cover plate to make the unit water tight.



The temperature and relative humidity sensor

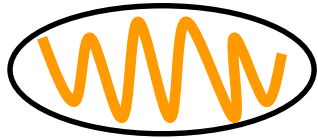


Temperature and relative humidity



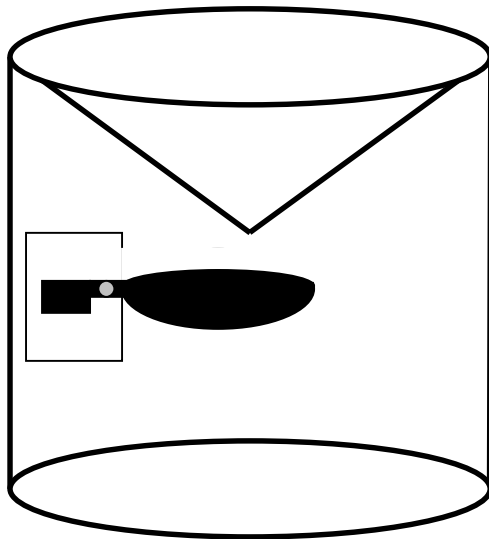
... are measured with a sensor unit that combines an SMT 160-30 sensor for temperature and a HC 200 sensor for relative humidity. The temperature sensor has an operating range from -30°C to $+90^{\circ}\text{C}$ with an accuracy of 0.5°C . Because of the mode of operation used by the μMETOS (five repeated measurements each time) the actual accuracy within the μMETOS measuring range will be better than this value. The sensor output is a duty-cycle signal. The relative humidity sensor has an operating range from 10% to 95% relative humidity. In the range between 30% to 90%, the accuracy is 3% and in the range between 25% to 95%, the accuracy is 4%. The sensor output is a frequency-based signal. Pollution is damaging the relative humidity sensor. For this reason this sensor should be changed every 2 or 3 years.

The Daylight Sensor

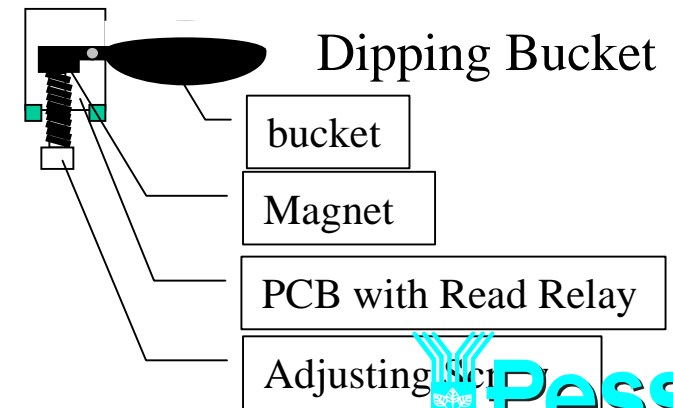
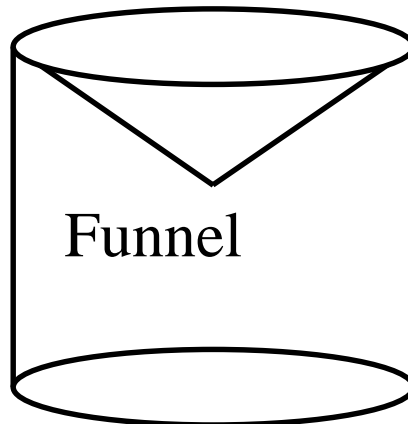


Photoresistor mounted on PCB, Daylight Threshold is 300 Lux.

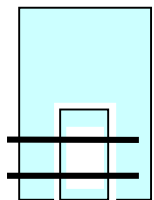
The Rain Gauge (Precipitation Sensor)



The **precipitation** sensor (rain gauge) is a tipping bucket with a resolution of 0.2 mm (0.01-inch). The maximum rain intensity recorded is 24 millimetres (mm) per minute. This sensor comes with 5-meter (15-ft.) cable.



The Leaf Wetness Sensor

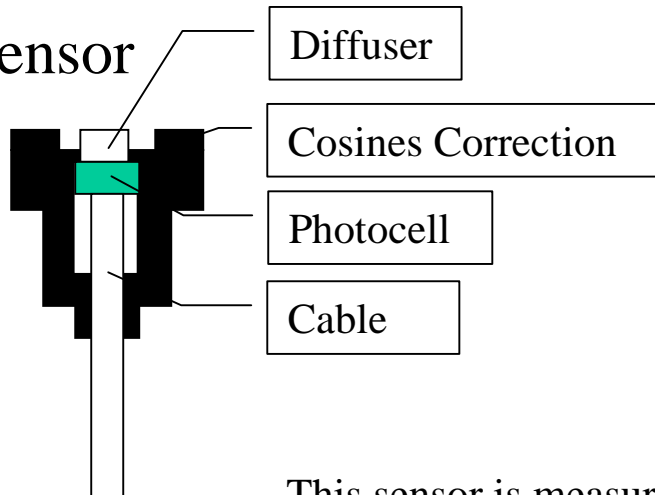
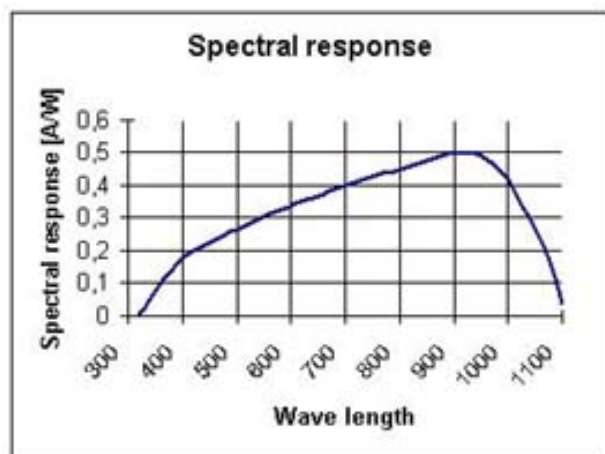


... works by measuring the conductivity in a filter paper. The filter paper is held by two stainless steel electrodes in a transparent holder. The use of transparent Lucite plastic as a holder reduces the warm up of the sensor when it is exposed to direct sunlight.



Maintenance: The sensing element should be checked periodically. If the sensing element is dirty, soiled by bird droppings, coated by spray materials (copper fungicide, etc.), physically damaged, or worn out, it should be replaced. The sensing element will eventually dissolve after long exposure.

The Global Radiation Sensor



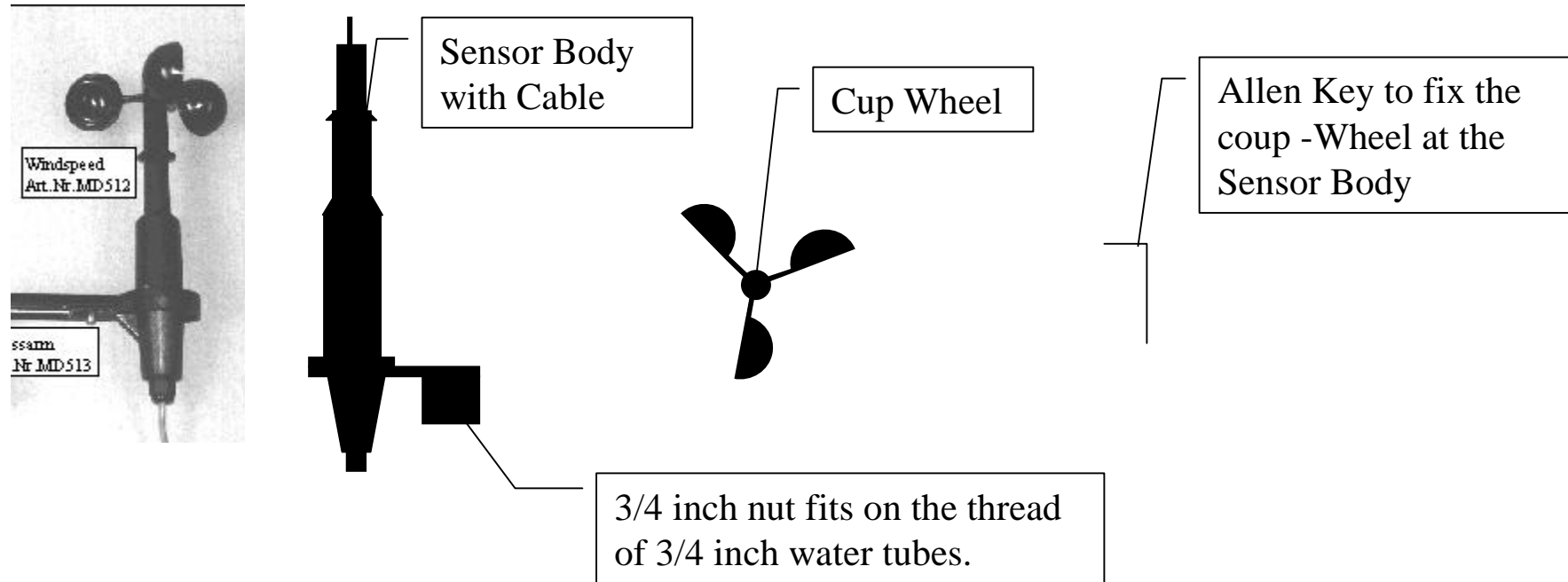
Maintenance: Keep the top edges of the plastic housing and the semitransparent cap clean.

... is a photocell absorbing light in the range from 360 nanometers to 1100 nanometers wavelength.

This sensor is measuring solar radiation in Watt per square meter. The sensor comes calibrated with the μ METOS. A zero correction is done every night at midnight during normal operation.

The Wind Speed Sensor

... consists of three parts:



... operates in a range from 0.5 m per second to 40 meters per second. This sensor comes with 3 meter cable.

... is measuring total wind run. Every turn increases a counter. Wind speed is calculated by numbers of turns * 0.75 m / time interval in seconds.

The Soil Temperature Sensor

... is a SMT 160-30 in a water prove stainless steel housing. The temperature sensor has an operating range from -30°C to $+90^{\circ}\text{C}$ with an accuracy of 0.5°C . Because of the mode of operation used by the μMETOS (five repeated measurements each time) the actual accuracy within the μMETOS measuring range will be better than this value. The sensor output is a duty-cycle signal.



The Watermark Soil Moisture Sensor

The Watermark Sensor consist of two concentric electrodes buried in a special reference matrix material that held in place by a synthetic membrane. The matrix material has been selected to reflect the maximum change of electrical resistance over the growth range of production crops as well as neutralise the effect of soil salinity. In operation, soil moisture is constantly being absorbed or released and the electrical resistance between the electrodes is increased. This resistance is read by the weather station. The sensor is manufactured from non-corrosive parts and lasts for years.



The μ METOS ag sensor box



puts all external sensor together into one single cable. It has inputs for the rain gauge, the leaf wetness sensor, the wind speed sensor and the soil temperature sensor. Rain, leaf wetness, wind and soil temperature are three pin Panduit connectors. The cable to the μ METOS min unit goes on a 7 pin Panduit connector. This Sensors are delivered with water prove PG-connector by Pessl Instruments. They can be changed easily without using a special tool. The seven pin connector for the cable to the main unit does not fit trough the hole in the housing. If it needs to be replaced it is delivered with the box itself but without the PCB. In this case replace the PCB and the sensors to the new box and replace the old box on the holder.



The μ METOS sm sensor box

...differs totaly from the sensor box above. It is ist own little climate station. We call it intelligent sensor box do to ist own μ processor doing the measurement and talking with the main unit via field bus interface. It has a 8 bit μ processor and all the electronic needed to evaluate the sensor signals. It reports to the main unit in $^{\circ}$ C for soil temperature, in mm for rain, in m/sec for wind speed, in true or false for leaf wetness and in hPa for watermark soil moisture.

Weather Data Presentation at The μ METOS Display

First \downarrow Yellow Label Temperature and Relative Humidity



1. Turn the rotary switch that the pointer points toward the first yellow label below the display. Click on the down button to wake the μ METOS. Data format is: M-DD HH temp RH
2. Click on the Up and Down button simultaneously to change from hourly values to daily average values. Data format is: M-DD AV temp RH
3. Click again on the Up and Down button simultaneously to change to daily minimum values. Data format is: M-DD MN temp RH
4. Click again on the Up and Down button simultaneously to change to daily maximum values. Data format is: M-DD MX temp RH
5. Click again on the Up and Down button simultaneously to change back to hourly values.

Compare actual, yesterday average, minimum and maximum of temperature and relative humidity on all μ METOS systems in the seminar.

Weather Data Presentation at The μ METOS Display

Second \downarrow Yellow Labels Soil Temperature and Leaf Wetness

1. Turn the rotary switch that the pointer points toward the second yellow label below the display. Click on the down button to wake the μ METOS. Leaf wetness is displayed in minutes per hour. Data format is: M-DD HH soilT LW

2. Click on the Up and Down button simultaneously to change from hourly values to daily average values of soil temperature and total leaf wetness duration in hours.

Data format is: M-DD X soilT RH

3. Click on the Up and Down button simultaneously to change from hourly values to daily minimum values of soil temperature and total leaf wetness duration in hours.

Data format is: M-DD X soilT RH

4. Click on the Up and Down button simultaneously to change from hourly values to daily maximum values of soil temperature and total leaf wetness duration in hours.

Data format is: M-DD X soilT RH

5. Click again on the Up and Down button simultaneously to change back to hourly values.

Weather Data Presentation at The μ METOS Display

Third \downarrow Yellow Labels Solar Radiation and Wind Speed

1. Turn the rotary switch that the pointer points toward the third yellow label below the display. Click on the down button to wake the μ METOS. Data format is: M-DD HH Srad WS
2. Click on the Up and Down button simultaneously to change from hourly values to daily average values. Data format is: M-DD AV Srad WS
3. Click on the Up and Down button simultaneously to change from hourly values to daily maximum values. Data format is: M-DD MX Srad WS
4. Click again on the Up and Down button simultaneously to change back to hourly values.

Weather Data Presentation at The μ METOS Display

Fourth \downarrow Yellow Labels Precipitation and Evapotranspiration for short cut gras (ET_0)

1. Turn the rotary switch that the pointer points toward the fourth yellow label below the display. Click on the down button to wake the μ METOS. Data format is: M-DD HH Rain
2. Click on the Up and Down button simultaneously to change from hourly values to daily average values. Data format is: M-DD AV Rain ET
4. Click again on the Up and Down button simultaneously to change back to hourly values.

Evapotranspiration

- μ METOS always calculates evapotranspiration
- With sensors for temperature, relative humidity, global radiation and wind speed it calculates a modified Penmann Montheith ET
- With sensors for temperature, relative humidity and global radiation it calculates a modified Penman Montheith ET for an average wind speed of 0.7 m/sec
- With sensors for temperature and relative humidity it calculates Et following the Haude formula.

Please refer to the manual for the exact calculation formula.

Crop Factor

- Evapotranspiration values displayed in this screen are calculated for short cut gras (cropfactor = 1)
- Evapotranspiration values used by the accumulation screen are corrected by the selected crop factor.

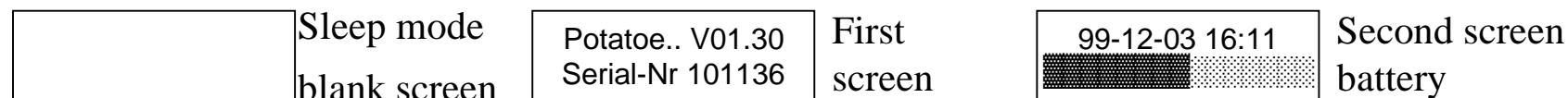
Soil Moisture Data Presentation at The μ METOS sm Display

First, Second and Third \uparrow Yellow Label

Every display shows two watermark sensors.

1. Turn the rotary switch that the pointer points toward the first, second or third yellow label above the display. Click on the down button to wake the μ METOS. Data format is: M-DD HH WM1 WM2
2. Click on the Up and Down button simultaneously to change from hourly values to daily average values. Data format is: M-DD AV WM1 WM2
3. Click on the Up and Down button simultaneously to change from hourly values to daily maximum values. Data format is: M-DD MX WM1 WM2
4. Click on the Up and Down button simultaneously to change from hourly values to daily maximum values. Data format is: M-DD MN WM1 WM2
5. Click again on the Up and Down button simultaneously to change back to hourly values.

The Log Data Display



Press the down button to wake up your μ METOS

Sensor and System Test and System Configuration!!!!

μ METOS offers a simple possibility to test all sensors, to test the system and to change the disease models calculated. Turn the rotary switch into position “Log Data”.

- Press the up and the down button for 7 seconds. First display shows: “temp RH Srad” (in the first line) and “wet/dry bright/dark rain WS” (in the second line).
- Pressing the Up button goes to the second display which shows: “SoilTemp and Watermark1, 2” (in the first line) and “Watermark3, 4, 5, and 6” (in the second line).
- After pressing the Up button again μ METOS sm gives the serial number and the hardware and software version of the sensor box.
- By Pressing both buttons μ METOS displays the CRC check sum over the Program memory. This is needed to check the success of a reprogramming.
- By pressing the Down button for 7 seconds μ METOS enters the mode to change the calculated disease models.

Exercise

Sensors in the first Window:

- Try to change the temperature and relative humidity by breathing onto the sensor
- Try to change the solar radiation by exposing the μ METOS toward a light
- Try to change the leaf wetness by connecting the two electrodes on the sensor with your finger
- Simulate 1 mm of rain by tipping the bucket 5 times with 1 second interval
- Simulate wind by turning the wind speed sensor

Sensors in the second window

- If there try to change the Soil Temp by warming up the sensor with your hand
- If there try to change the watermark result by putting them in to a glass of water (it takes a long while before a result is visible)

Please repeat sensor testing until everybody feels comfortable with the different sensors!

Temperature and relative humidity sensor: In meteorology this sensor is normally mounted in 2 m height. On the μ METOS it can be mounted in two meter height too. The plant disease models and the evapotranspiration models are designed like this. Some growers like to have this sensor inside the canopy. There is no reason why not. But note: It can be that the plant disease models will indicate a higher disease pressure.

Solar Radiation: To expose this sensor correctly the μ METOS should be on the sun side of the mounting pole. The sensor on top of the μ METOS should be in correct horizontal position. This is possible when the pole is straight to ground.

Leaf Wetness: This sensor should reflect canopy climate. On trees or vines it is easiest to mount it on a brunch. In potato or tomato it is best to use an L-formed pece of wood or metal where the sensor is mounted on the horizontal part.

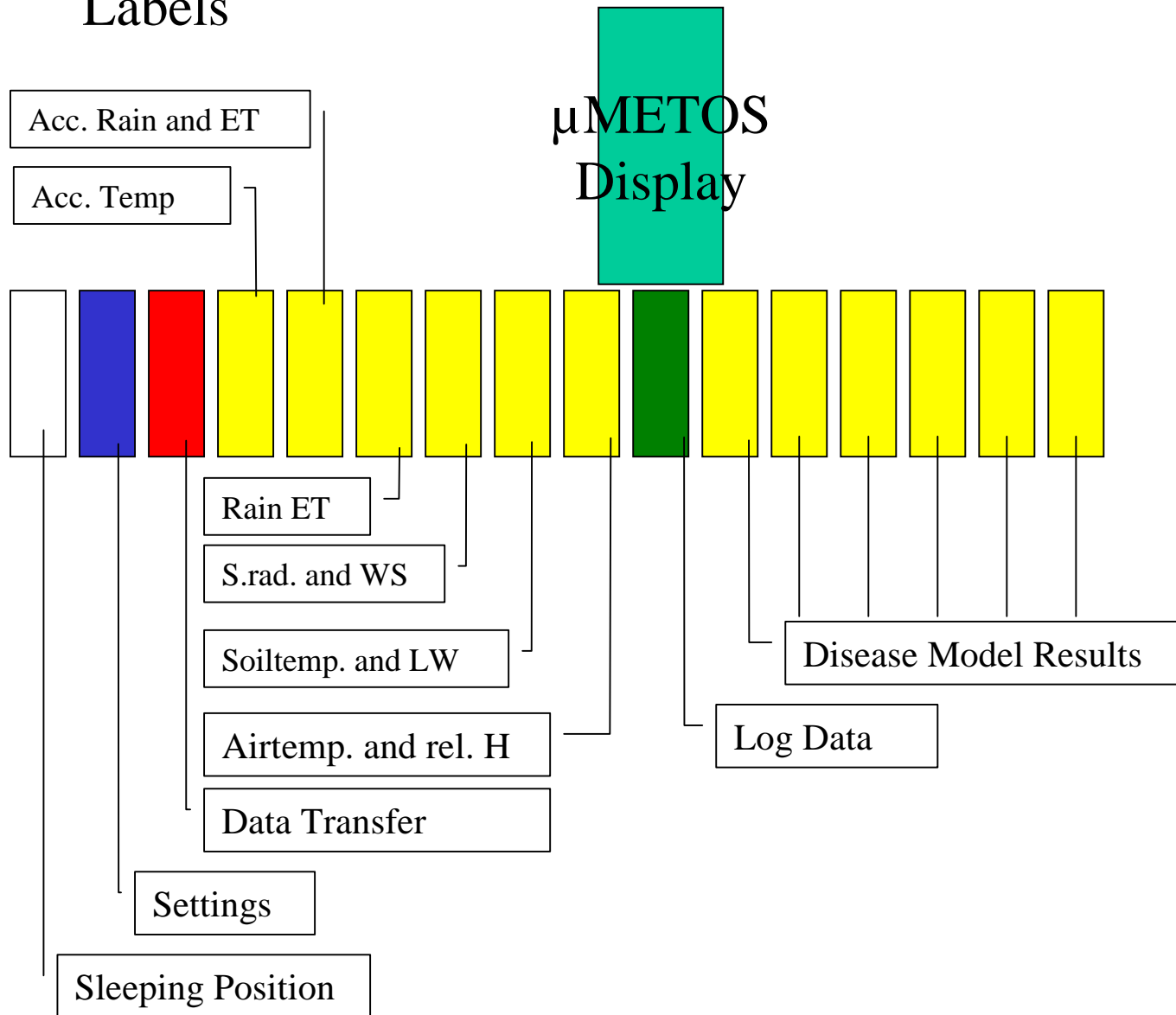
Daylight: This sensor is mounted direct on PCB. As long as sunlight can come to the μ METOS main unit this sensor will work.

Precipitation: This sensor should be mounted on a separate pole. Top of the sensor should be in 1 m height. It can be mounted on a pece of wood or on a metal pole. If it is a metal pole it needs two holes in 5 cm distance at the top end of the pole. The sensor should be in some distance to the μ METOS to avoid a rain shadow. The cable should be buried to avoid cable damages by wind wiping.

Wind Speed: The sensor fits on the thread of a 3/4 inch water tube. It should be 75 cm or 1m higher than the crop. The μ METOS holder can be mounted on the same tube. This saves a separate tube for the wind speed sensor. Don't forget to fix the allen screw on the cup wheel.

Soil Temperature: The Sensor is in a water prove stainless steel block. This sensor should be buried in the soil. Be aware that it should be protected from cutting by gras cutting machines. Please protect the cable by burying it.

μMETOS ag Rotary Switch Positions with Transparent, Red and Blue Labels



Transparent: Stand By Mode of the μMETOS. No measurements and no data logging in stand by mode.

Blue: To enter “Time Setting” click on both buttons. To enter “Date Setting” click on both buttons again. Use up and down buttons to decrease or increase time and date.

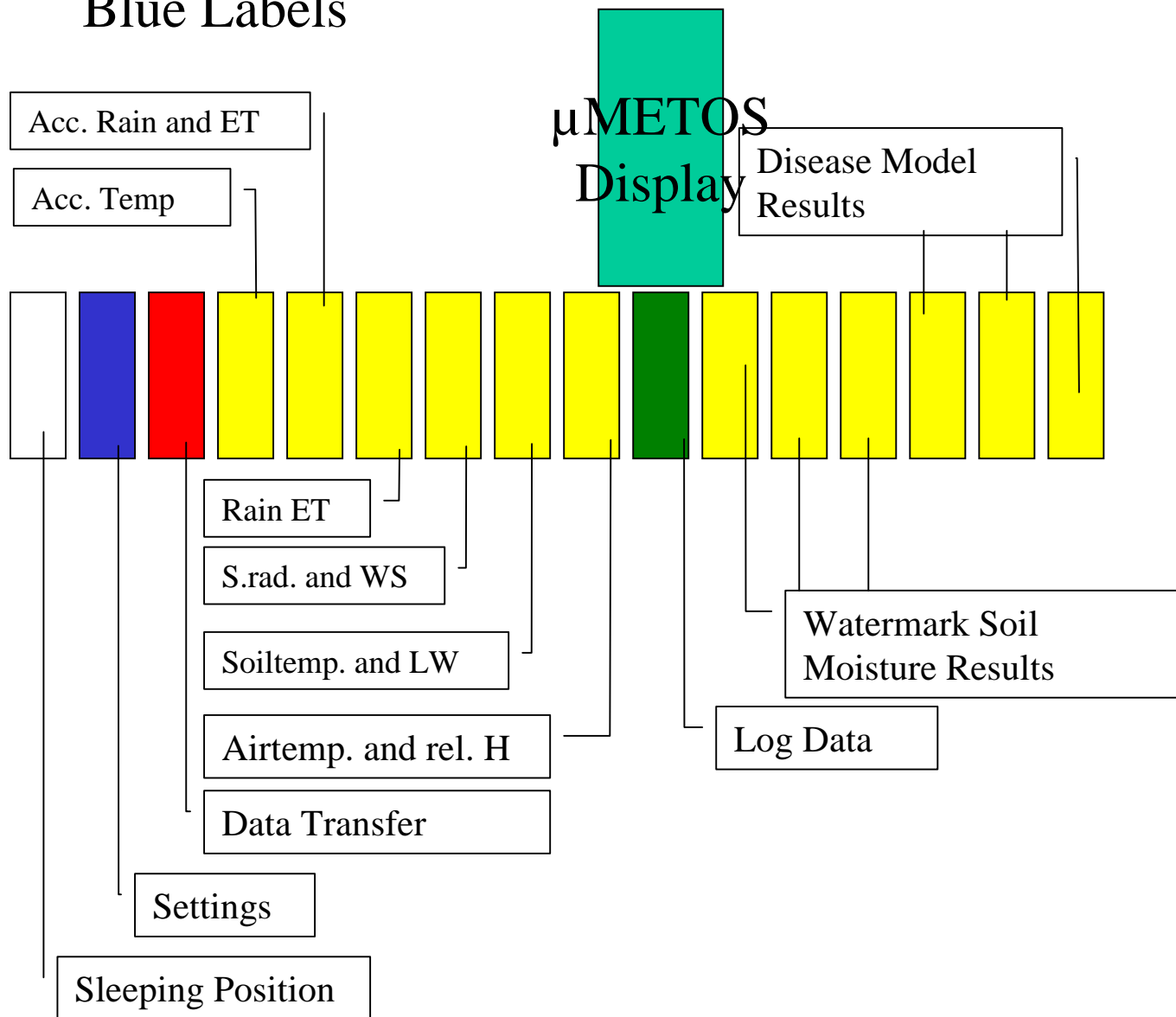
Red: Data transfer to PC, Windows CE Handhold Computer and Canon BJC80 Printer. (3 Labels on actual firm ware will be only one label in future.)

Yellow: Data presentation shows climate data and simulation model results.

Green: Log Data



μMETOS sm Rotary Switch Positions with Transparent, Red and Blue Labels



Transparent: Stand By Mode of the μMETOS. No measurements and no data logging in stand by mode.

Blue: To enter “Time Setting” click on both buttons. To enter “Date Setting” click on both buttons again. Use up and down buttons to decrease or increase time and date.

Red: Data transfer to PC, Windows CE Handhold Computer and Canon BJC80 Printer. (3 Labels on actual firm ware will be only one label in future.)

Yellow: Data presentation shows climate data and simulation model results.

Green: Log Data



The Evapotranspiration Accumulation Displays

Acc.Rain, Etc.[mm] Cropf.
Click both to set Cropfactor
Rain E.T C.F

The fifth yellow label gives the opportunity to accumulate Rain and Et_{crop} over a selected period. Use the up or the down button to select a period. One line shows the results and the other line shows the selected period of time.

Cropfactor: 1.00

To set the Crop factor press both buttons simultaneously. The screen shown on the left side occurs. Use up and down button to select the desired crop factor. After 10 seconds the system falls back into ET accumulation or you can press both buttons simultaneously to go back.

5-22 5-31
65.0 72.0 0.95

Use the up and down button to select the desired period. By pressing the up button the period is displayed in the second line. By pressing the down button the period is displayed in the first line. The other line displays accumulated rain, accumulated Et_{crop} and the selected crop factor.

Please use your μ METOS to accumulate Rain and Et_{crop} for a specific period and compare the influence of changes in the cropfactor.

The Temperature Accumulation Display

Accumulated temperatures are a good tool to access the development of pests or plants. Most organisms do have a minimum temperature where the development starts. Most do have a optimum temperature. Temperatures higher than this optimum temperatures will not speed up the development.

Accumulated negative temperatures are a tool to test for the fulfilling of chill needs of different crops. To calculate chilling units we need the upper treshold and the lower threshold.

Before starting to accumulate temperatures we need:

- Base and Limit for positive degree day accumulation

or

- Base and Limit for negative degree day accumulation

Pos.Neg.Degree Days
Click on both to Set Base/Limit
B<deg.d B>deg.d

5< 7.0 2> 0.0
12-05 12-06

Accumulator Display

Pos 5 ← 40
Neg 2 -40

Setting Display

Please use your μ METOS to accumulate Temperatures and compare the influence of changes in the Base and Limit settings.