Underwater Spectrometer System 2006 (UWSS04)
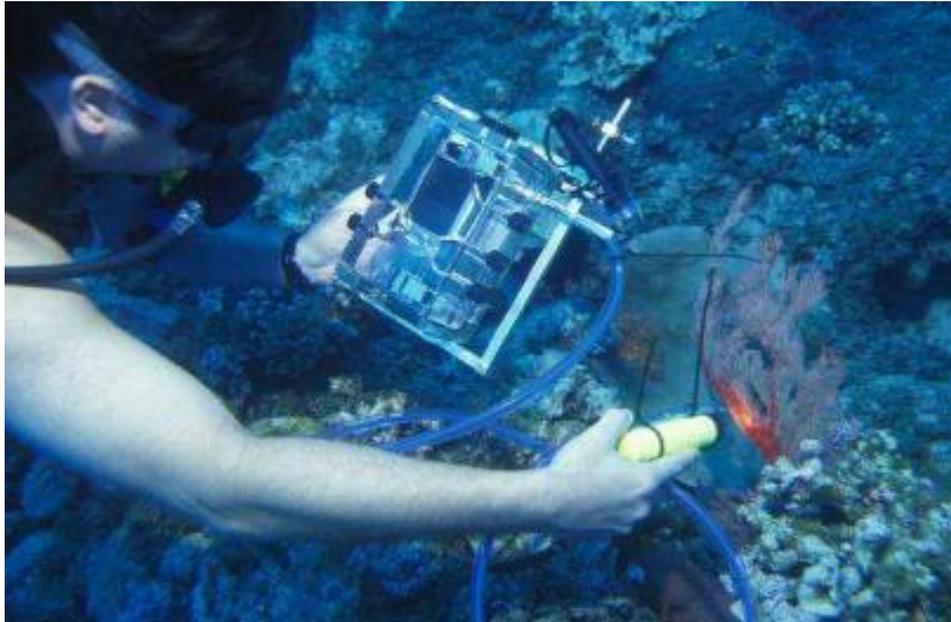
29 August 2006

System developed by: C.Roelfsema, J.Marshall, E.Hochberg, S.Phinn, A.Goldizen and K.Joyce.

Funded from Proposals Written by: S. Phinn

Software Developed by: D. Landis, Ocean Optics Inc., G-C Esarello, P.Scarth and T. Gill

Housing Built by: Murray Wills of Wills Camera Housings

Initial design resulting from the Collaborative Coral Reef Remote Sensing Workshop in 2004 at Heron Island, Australia, organised by Karen Joyce and Chris Roelfsema.

Joyce K.E., Roelfsema C.M. , Atkinson M.J. ,Cochrane K., Goodman J.A., Hochberg E.J., Marshall J., Palandro D. (2002) Collaborative Coral Reef Remote Sensing Workshop Summary: Heron Island, In: Proceedings of the 11th Australasian Remote Sensing and Photogrammetry Conference, Brisbane, 2-6 September, CD-Rom, Causal Publications.

Table of contents:

List of Figures and Tables:

1 Introduction

The miniature underwater spectrometer system we are now using, and still refining, was built out of a long-understood need in our research on marine remote sensing, coral reef ecology, and the ecology and physiology of animal colour vision. The construction of a small, easily used spectrometer operated entirely underwater was recommended by the participants of the Collaborative Coral Reef Remote Sensing Workshop in 2002 at Heron Island, Australia. During that workshop the advantages and disadvantages of several spectrometer setups were compared. Previous systems were large, heavy, and had become dated or were limited by length of optical cable and communication between researchers in boats and underwater. This comparison led to the basis of the design work, by the authors, for the system presented in this manual (Figure 1).

Figure 1 Underwater USB 2000 Spectrometer System being used in a coral reef environment.

This document was written in response to the enthusiastic interest shown by colleagues who have heard about the spec or seen the first version. "Where can I order one?" has been heard more than once. We considered putting systems together as a sideline, but quickly realised that coordinating the supply of rapidly evolving components and providing support were beyond our resources. Instead we are providing details of what we have done to anyone who wants to assemble an underwater spectrometer of their own. We take no responsibility for how your rig turns out. What you see here has worked for us; we hope it works for you.

The body of this document consists of two sections. The first (chapter 2 - Components and Sources) gives details of parts, where they can be gotten and how we have put them together. The second (chapters 3 & 4 - Instructions) is a manual we have written for our own use. Please keep in mind that many details are still changing.

We would particularly like to thank Dr. David Landis of Ocean Optics Inc. for his continuing help in software development, finding pieces, and support; and Murray Wills of Wills Camera Housings for his very kind and experienced help in optimising the housing design.

2 Components and Sources

Version 4: 18 July 2005   By: Chris Roelfsema
Version 3: 4 feb 2005   By: A. Goldizen, C.Roelfsema, S.Phinn and J. Marshall

2.1 Spectrometer USB 2000

Figure 2 USB 2000 Spec with iPAQ

Most components (Figure 2) are bought from Ocean Optics, Inc. in Dunedin, Florida. Their catalogue and website are extremely useful when deciding on specifications. All components listed below will be referenced to page numbers in the 2004 catalogue wherever possible.

Our primary contact for this system has been Dave Landis:

Dr. David Landis
Vice President, Science and Technology
Ocean Optics, Inc.
830 Douglas Avenue
Dunedin, FL 34698
(P.O. Box 2249
Dunedin, FL 34697-2249)
Phone +1-727-733-2447
Fax +1-727-733-3962
Dave.Landis@OceanOptics.com
http://www.OceanOptics.com

Dave supplied the programming needed for button-only use of the handheld PC that drives the spec and logs data. Dave has also had the complete original system in hand and has helped with troubleshooting.

A problem has arisen recently that may make future systems difficult to assemble. We understand from Dave that the mass-market handheld manufacturers are dropping serial port capability from all their PDAs. The USB-2000 spec, in common with most handhelds, is a USB slave device. Since a USB slave cannot run another, the serial port is crucial at this point in time. As of September 2004, OOI is scrambling to find stocks of serial-capable handhelds to fill the orders they have in hand. There is not a long-term solution currently in sight, so OOI is planning to drop their Palm-SPEC system (catalogue p. 28) at the end of the year.

In any case, rapid turnover in the HP iPAQ models available to OOI means that there will shortly be at least two different handhelds being used in our own systems. This will require some custom housing work for each set-up.

A possible, though expensive, alternative may be a handheld designed for running other gear, so likely to be available with a serial port for some time. The Trimble Recon (www.trimble.com) is one. This has yet to be tried.

1.1.1 System Details

Table 1 Components of spectrometer – from 2004 Ocean Optics catalog

Order Code	Item	Catalogue page	Price USD
USB2000	Spectrometer	38	2199.00
Grating #3	VIS-Color, 350-850nm	36-37	included
USB-BP	Li-ion battery pack	39	499.00
USB-ADP-H	Adapter pkg. – USB2000 to handheld PC	38	75.00
VFT-1000-UV	1000µm vacuum feed-through, UV	134	299.00
228-11110-000	Palm-SPEC Computer – Compq/HP iPAQ	28	500.00
QP-1000-2-UV/VIS	1000µm Premium fiber, UV/Vis, 2m	123	359.00

The most recently ordered system includes the following to give coverage further into the UV.

Table 2 Additional parts for UV-sensitive system

Grating #2	UV-VIS, 250-800nm	36-37	included
OFLV-200-850	Order-sorting detector filter, UV	35	150.00
UV2	UV detector upgrade	35	150.00

- Note that a fixed entrance slit (catalogue p.34) is not necessary. The end of the fiber, or the end of the VFT in this case, acts as a slit and determines the entrance aperture.
- We like the premium fibers (catalogue p.123) for their extra tough jacketing and connectors, and use them in several diameters. The lab-grade assemblies (catalogue p.124) work fine.
- The vacuum feed-through serves as the through-wall spec to external fiber port (Figure 3).

Figure 3 Vacuum feed-through for optical cable.

- We modified the spec-iPAC cable to be more compact and enable a smaller housing (see below). Ordering two is a good idea: one to modify and a backup.

1.1.2   Cable Modification

Figure 4   Data cable modification (a) Standard cable   (b) Modified cable

The cable has been cut to shorten it as needed, leaving the iPAQ connector intact (Figure 4). The serial connector is replaced with a standard, side-lead, D-type serial terminal available from Radio Shack. Wiring diagram? The reinforcing boot of the handheld connector is then carefully pared back to allow more flexibility inside the housing. Both are reinforced with electronics grade silicone.

2.2 Housing
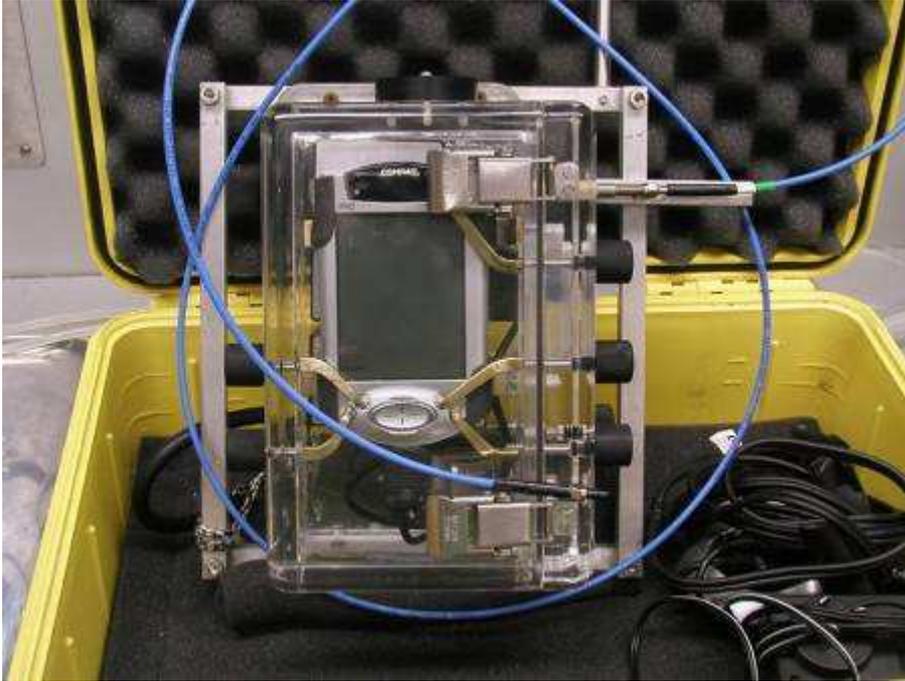
Figure 5 Field-ready Underwater Spectrometer System

Our housing (Figure 5) builder is Murray Wills in Victoria:

Wills Camera Housings
46 Commercial Street
Kaniva Vic 3419
Australia
ph +61-3-5392-2294
fax +61-3-5392-2294
willscam@wimmera.com.au

Murray has been very helpful and a real pleasure to work with. Our first housing is solid, well made, and excellent value at AUD600.00. Cost will vary with modifications and the number of knobs and buttons your housing requires. Turn-around time for an order depends on Murray's work load, but was 2-3 months in September 2004.

1.1.3 Control Knobs

Computer
On / Off

Delete

Software
On

Integration Time

Save

Top
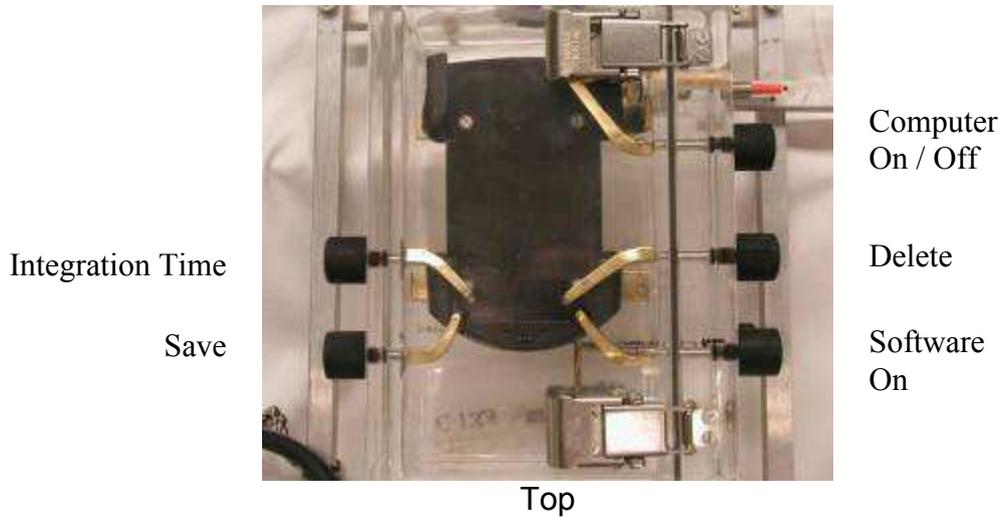
Figure 6 Front view of underwater housing with explanation of knob functions.

Computer On / Off

Delete

Software On

Spec On / Off
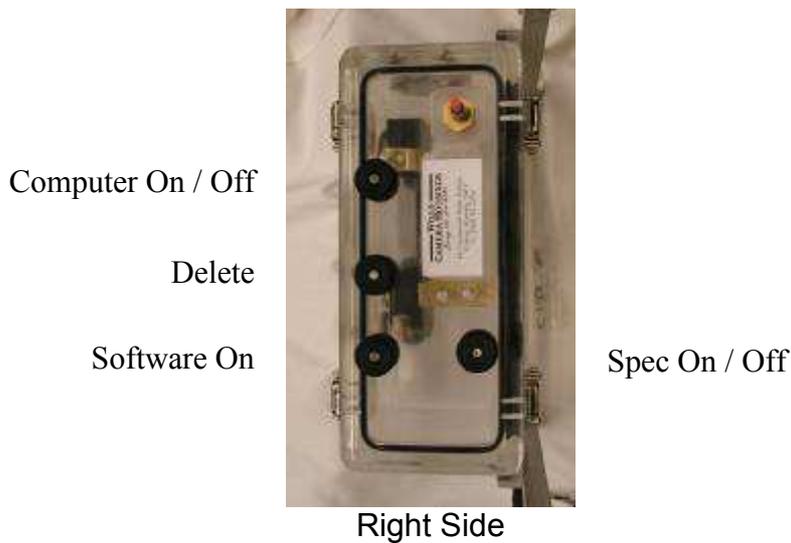
Right Side

Figure 7 Right side view of underwater housing with explanation of knob functions

- Our current iPAQ needs a soft reset in some circumstances (see below). As built with six knobs the rig must be removed from the housing to be reset. We have asked Murray to add an external reset knob (Figure 6 and Figure 7).
- The computer function knobs, in particular, can be hard to twist with gloves on. Murray will add short levers to each.
- These modifications add AUD100.00 to the cost of the housing.

Figure 8 The spectrometer and iPAQ are fixed in brackets which are connected to the right side of the housing.

The iPAQ 3950 we have came with a slip-on hard plastic case that modified perfectly as a mount in the housing (Figure 8). No telling if future models will be so accommodating. Murray can design what is needed.

Our housing came with one cover o-ring; good idea to order a spare.

1.1.4 Handle
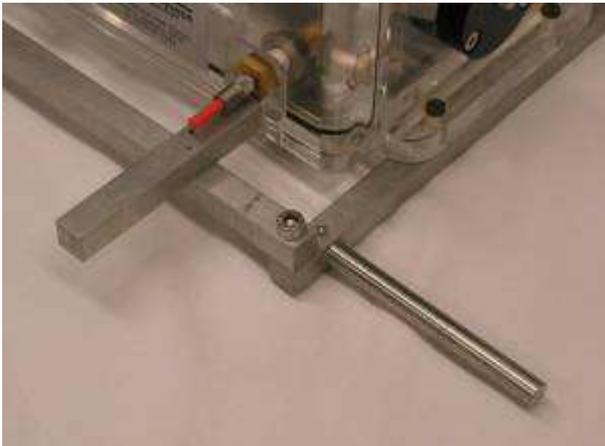
Figure 9 Close up of frame around housing and guide rod for optical cable and for laser pointer.

We added a simple frame handle of 12mm square-section aluminium, assembled and attached to the housing flanges with stainless machine screws (Figure 9). A guard bar was added to the right side to protect the VFT to external fiber connector. A 9mm stainless rod is mounted vertically to the top rail for fixing the working end of the fiber and holding the laser (Figure 9). The right side of the handle needs to be removed to open the housing.

2.3 Camera

Figure 10 (a) Mount with standard camera connector for positioning camera on underwater housing. (b) Camera housing

The housing has a camera mount on top so that the spec target can be photographed as it is being analysed (Figure 10).

We use a Sony Cybershot DSC-P9 or DSC-P10 in their Marine Pack housings. Any small sized digital camera with its own underwater housing and a standard baseplate screw can be mounted on the spectrometer housing. We have been using the Sony for several years and have found the camera and housing highly suited to underwater survey work in coral reef and seagrass environments.

2.4 Laser Pointer

Figure 11 Laser pointer

We use a AA-powered, waterproof laser pointers (Figure 11) mounted on the handle to help aim the rig (Title photo). The final plan is to fix the fiber to allow the target end of the fiber and the camera to focus on the same spot. The laser spots will be adjusted to converge at the focal distance and be visible through the camera to allow easy point and shoot data gathering.

Our pointers are Apollo details, available from details, for price.

2.5 Dive torch

We use a standard dive torch when collecting spectra from benthic targets. The dive torch is connected to the optical cable with ziptys (Figure 12).

Figure 12 Dive torch attached to fibre optic cable

The optical cable is directed to ensure it is pointing at the middle of the light bundle at about 5 cm distance from torch.

3 Software CD for Underwater Spectrometer software

Version 2: 20 July 2004, By: S.Phinn, C.Roelfsema, J. Marshall, E.Hochberg and D.Landis
Version 3: 24 April 2006, By: S.Phinn and C.Roelfsema

Note that the CD is not included here and we recommend that once you have all your hardware and software that a similar CD is set-up for your system.

This document contains a record of the instructions sets developed for use of the UW-Spec, which includes a customized version pf the OOIPS2000 software.

3.1 Files on CD:

3.1.1 UW Spec Manual.doc – The document you are reading now

3.1.2 IPAQ Communication Software
Contains series of files to install on laptop and iPAQ and to manage iPAQ

3.1.3 OOI manuals – Directory
Palm-SPEC_Operating_Manual.pdf   manuals for the USB2000
usb2000.pdf   manuals for the battery pack
usbbp.pdf   manuals for the iPAQ

3.1.4 OOI programs for iPAQ – Directory

OOIPS2000 version 1
Setup.exe –   Setup Ocean Optics software on iPAQ
Setup.W02 –   Unknown
Test1.IntTime –   Integration time example list software
Test2.IntTime –   Integration time example list software
Test3.IntTime –   Integration time example list software
Websetup –   Unknown

OOIPS2000 version 2
OOIFunctionsCE.dlll –   File for re-assignment of iPAQ buttons for spectrometer, to
                                         be placed in \Program Files\OOIPS2000 directory on iPAQ
OOIPS2000.exe –   Ocean Optics custom software with no-warm-up time for
                                         use of the USB2000 with iPAQ

3.1.5 Upload Download programs - Directory

USBProgrammer-   Ocean Optics utility for updating spectrometer
                                        configuration

Palm-SPEC Conversion Utility Setup.exe –
                                        Program for reading binary USB200 files from
                                        spectrometer to PC and converting to ASCII delimited Files
Read_oo_spec.sav -   IDL program for reading multiple USB2000 binary files to
                                        ENVI spectral library files (by P.Scarth)

3.1.6 Processing downloaded spectra with Excel - Directory

UW-USB-compiler.xls-   Excel macro which places the from the palm downloaded
                                          spectral text files in one excel spread sheet. Written by GC
                                          Esarello, University of Waterloo

UW-USB-standard.xls -   If the spectra are collected the following sequence: dark
                                          reading, white panel, 8 x object then this file excel will
                                          organise and analyse the data.

4 Current Operating Instructions
Version 5: 3 May 2006 by S.Phinn and .Roelfsema

Version 4: 18 July 2005 By: Chris Roelfsema
Version 3: 4 Feb 2005
By: S.Phinn, C.Roelfsema, J. Marshall, E.Hochberg and D.Landis

4.1 Equipment Needs

4.1.1 Underwater Housing
- Housing
- O ring grease
- Cable to connect iPAQ to Ocean Optics spectrometer
- 400 micron fibre Optical Cable for collecting target spectra
- Transparent tubing to protect Optical Cable
- Threaded connection between optical cable and housing
- Cable tie to connect protective tubing to optical cable
- Allen Key (to attach handles)
- Cable to connect housing to diver
- Dive Torch

4.1.2 Ocean Optics Spectrometer
- Ocean Optics Spectrometer
- Ocean Optics Spectrometer Battery
- Ocean Optics serial/RS-233 port adapter to connect spectrometer to iPAQ cable
- Ocean Optics Spectrometer Charger

4.1.3 iPAQ
- iPAQ
- Charger iPAQ
- Download module iPAQ

4.1.4 Camera
- Camera housing
- O ring grease
- Wide Angle lens

4.1.5 General
- Slate
- Pencil
- Dry cloth
- U/W Spectralon

4.2 Preparation:
-
- Check O-ring seal and grease when necessary

4.2.1 Pre-closure of housing
- Turn on battery pack
- Turn on iPAQ
- Start OOIPS2000 with stylus

           - Check that SAM mode is enabled
           - Check that spectrometer configuration file is valid
           - Check the autosave filenames are set up to the correct directory
- Check UWspec battery pack is fully charged and mounted correctly.
- Check iPAQ battery is fully charged and mounted correctly.
- Turn-off OOPIS2000 using the right button
- Turn off the iPAQ
- Turn off the USB battery pack

4.2.2 Close housing and check seal
- Check O-ring seal and grease when necessary
- Check for hair or other material on o-ring or on seating in house
- Before diving submerge housing and check for major leaks, preferably in fresh water.

4.2.3 Assemble fibre-optic-cable and other materials
- Connect fibre cable in transport tube to UWspec housing
- Attach zip-tie to fibre cable and housing to ensure that tubing those not move
- Attach dive torch to other end of fibre cable with zip-tie.
- Check if optical cable is aimed at centre of light bundle from torch. If not adjust.

"Do not bend the fibre optic cable!"

4.3 Preparation for Fieldwork

4.3.1 Calibration of Spectralon panel

- Clean the field panel as per the instructions in the CRSSIS field spectrometry guide and **http://www.labsphere.com/data/userFiles/SRS%20Care%20and%20Handling%20Guidelines.pdf**
- Calibrate the field panel against the pristine reference panel which is kept in Stuart Phinn's office to work out spectral conversion factors for panel based reflectance measurements to the reference panel.

4.3.2 Travel to and between field site

- When travelling to field site keep UW spec supported so that it is not bumping around.

- Keep the Spectralon panel covered and dry and do not let it get dirty or scratched – any small scratches or dirt will make your measurements useless.

- Preferably keep UW spec in container with fresh water

- Keep UW spec out of the sun

- If no water or shade is available put UW spec in wet towel to keep moist.

4.3.3 Before entering water test UW spectrometer, dive torch and camera

In housing using this EXACT sequence:
- Turn on battery pack
- Turn on iPAQ
- Start OOIPS2000 using Right button
        - Check that the appropriate file-name appears on the screen
        - Check that the file-save(left button), integration time (left middle button) and
           file un-save (right middle button) all work
- Turn-off OOPIS2000 using the right button
- Turn off the iPAQ
- Turn off the USB battery pack
- Turn on/off torch
- Turn on camera
- check if date and time is recorded on image
- check memory and battery
- Turn of camera

Place in housing in freshwater and check for leakage (bubbles) from UW spec, camera or torch.

4.4 Underwater spectral measurements.

Step 1   Diver enters
Step 2   Boat person gives UW spec to diver and is now equipped with:
- Underwater spectrometer with iPAQ charged
- Underwater Spectralon panel or equivalent and a
- Dive slate to note the sample number and target details.
- Digital Camera charged and enough memory space
- Dive torch with enough batteries

Step 3   Diver descends
Step 4   Diver checks for leaking regularly while descending.

Dive safety warning "Assent slow when leakage is discover."

Step 5   Look for target
Step 6   Turn on battery pack
Step 7   Turn on iPAQ
Step 8   Start OOIPS2000 using Right button
Step 9   Check:
                - appropriate file-name appears on the screen
                - file-save(left button), integration time (left middle button) and file
                   un-save (right middle button) all work

Step 10   Collecting spectra

Step 10.1	Ideal Allow 5 minute warm-up
Step 10.2	Record dark-measurement by covering optics with dark subject
Step 10.3	Record Spectralon have fibre at 5 cm distance of spectralon and adjust integration time if needed and repeat step 10.3
Step 10.4	Record target and repeat 8 times have fibre at 5 cm distance of target
Step 10.5	Write on slate target name, date, time, start & end file no.,
Step 10.6	Take picture of target
Step 10.7	Take picture of slate with notes

Step 11	Find new target and repeat step 10
Step 12	When done turn all instruments off
Step 13	Ascend
Step 14	Hand UW spec to boat person
Step 15	Place UW spec in wet shaded area.

Tips
- Shade target or spectralon to create uniform light environment.
- Have optic fibre under the same angle and distance when collecting spectra from spectralon or target.
- Check for leaking regular
- Do not forget to not file rec and the target name

4.5 Post-sampling

4.5.1 General
- **"Ensure housing is rinsed in freshwater and dried thoroughly"**
- Submerge housing in freshwater basin for at least 15 min (take all parts off which can be removed without flooding the housing.)
- Take optical cable out of transparent protective hosing and have streaming water flush transparent hose. Submerge optical cable in fresh water for at least 15 min.
- Dry all parts after freshwater rinse and store in dry/ventilated case with silica dry packs

4.5.2 Data download
- Remove iPAQ from housing
- Place iPAQ in cradle attached to a PC with Active-Sync software installed (for PC-PDA link)
- Use the or:
    - Palm-Spec conversion software to copy and convert OOIPS2000 spectra to ASCII files
    OR
    - Copy files to OPC and use read_oo_spec.sav to convert all files to an ENVI spectral library

4.5.3 Data processing
- Input measurements =   dark current (d)
                           panel (p)

<div align="center">target (t)</div>

i)   Dark current correction = (p – d) and (t - d)
ii)   Averaging
iii)   Reflectance = (t - d)/ (p - d)
iv)   Output file format =
           Col 1= wavelength (nm) Col 2 = target (reflectance)

4.5.4 Data processing and analysing using Excel

Refer to the appendix for instructions on how to use MS-Excel to analyse the data.

4.6 Operational Tips

4.6.1 What to do after discharge of HP palm battery.(Giancarlo Cesarello)

When experiencing battery shutdown conduct following step.
- Remove battery completely from its location.
- Let it out 5 minutes (actual 5 minutes)
- Remount the battery
- Apply a soft reset.

This will not take result in to problems which are apparently due to a varition of Voltage/Current between the pocket PC and the battery. This peak of Voltage may have being caused by static electricity.

4.6.2 Creating integration time file

Create in a ASCII file in text program
List the integration time in single column as follow (example):
e.g.
1
2
5
10
20
etc

Then upload it into the appropriate directory on the palm top.

5 Instructions for Custom Version of OOIPS2000

Version 5: 3 May 2006   By: C.Roelfsema and S.Phinn
Version 4: 18 July 2005   By: Chris Roelfsema
Version 3: 4 feb 2005   By: D.Landis and edited by C.Roelfsema,

5.1 Install software on IPAQ (version 4 feb 2005)

Step 1)   Install ActiveSynch on your pc or laptop, if not there yet. Use the setup
               files in "*IPAQ Communication Software directory*" on the CD
Step 2)   Install the Ocean Optics software, OOI2000 using "*Setup.exe*" from the
               "*OOIPS2000 version 1*" directory on the CD.
               Installation **password is (caSe sEnsitive) dia96DGag2**
               Copy "*Test1.IntTime*" (Integration time example list) from the
               "*OOIPS2000 version 1*" directory on the CD to the "*my documents*"
               directory on the iPAQ.
Step 3)   Install "*OOIFunctionsCE.dll and OOIPS2000.exe*" in "*OOI2000 version
               2*" directory on CD (This is a newer software version)
               • Delete "*OOIFunctionsCE.dll and OOIPS2000.exe*" on the iPaq first
               • Copy "*OOIFunctionsCE.dll and OOIPS2000.exe*" from "*OOIPS2000
                 version 2*" directory on the CD to the directory "/*program/
                 OOIPS2000*" on iPAQ
               • **RENAME** "*OOIFunctionsCE.dlll*" with "OOIFunctionsCE.dll" (only two
                 ll at the end). Be aware that the dll files are sometimes hidden files.
Step 4)   Go iPAQ, go to settings, select buttons
               Change buttons assignment,
               • Button 1, 2, 3 and 5 are <none>
               • Button 4 will be OOIP2000
Step 6)   Turn iPAQ off and installation succeeded.

5.2 Uninstall software on IPAQ

Step 1)   Go to start go to setting go uninstall programs and select OOPI2000
program

Step 2)   Go to explorer and delete in \Program Files\OOIPS2000 the following
files:
               • *OOIPS2000.exe*
               • *OOIFunctionCE.DLL*
Step 3)   Reboot the iPAQ

Alternative one could do a hard reboot on iPAQ (hold button 1 and 4 and push reset
button in for four seconds). The iPAQ then needs to be reset by quick push of reset
button.

5.3 Stylus handling

When operating the software using the stylus close the software by going to "file" and select "exit" instead of conducting hard closure by selecting the cross in the top right corner.

5.4 Button assignment on iPAQ:

Note button assignment on iPAQ for OOIPS2000 operation, going from left to right is:

Button 1   **Left**:   File save
Button 2   **Left-middle**:   Change integration time by one step (as listed in Integration time file)
Button 3   **Right-middle**:   Undo last file save
Button 4   **Righ**t: OOIPS2000 ON/OFF

At the main Windows CE screen, the Left, Left Middle and Right Middle buttons don't do anything.

5.5 Main Screen:

The last saved filename is displayed. The current integration time is also displayed in the lower-right corner of the screen.

SAM menu:
All custom functions are accessed under the SAM menu

SAM Mode Enabled
– checked if the application is in the SAM mode, unchecked if it is not. Select this menu item to change the SAM state of OOIPS2000.

Choose Int. Time File…
- presents a dialog box allowing you to select the active file with the list of integration times. This file must:
•   Have the extension .inttime
•   Be placed in \My Documents or a sub-folder of \My Documents
•   These files must be created on the PC using a raw text editor (like Notepad) and saved on the PC using the .inttime extension. Use Windows Explorer to copy the files to the right directory.

Display Int. Time File…
- presents a dialog box showing all *.inttime files. Selecting one shows all of the integration times stored in that file. You can not edit this file, it is for display only.

Configure AutoInc. Names…

- presents a dialog box allowing you to:

    Enable – enables autoincrement filenames. This option must be enabled for the SAM mode to work properly. Entering SAM mode automatically sets this to enabled.

    Base Filename (and Path) – allows you to manually enter the file name a path

    Browse for Filename – [[Preferred option]] allows you to browse for a file path and name for the autoincrement filenames. Browse to "\Storage Card" to save files on the CF card.

    Starting Index – specifies the starting number for the AutoIncrement filenames

    Next Filename – displays the full path and filename to be used

Configure Display Delay

– presents a dialog box allowing you to specify the number of seconds a stored spectrum is displayed. After this delay, real-time data will be shown. If you check the box "Permanent Display", the stored spectra will be shown always, and live data will not be displayed. When you click the Undo button, this delay also sets how long the previous spectrum is displayed.

Trigger Now

– Same functionality as pressing the Left application button. A file is saved using the displayed filename. The display is paused for the specified interval.

Undo Last Save

– Same functionality as the Left Middle button. The last saved file is erased. The next to last stored spectra is displayed and the AutoIncrement file index is decremented.

You can change the graph colours by selecting Spec | Graph Colours.

6 Appendices

6.1 Appendix 1 Tips for software (Eric Hochberg email)

Provided by E. Hochberg, September 2003

From: "Eric Hochberg" <hochberg@hawaii.edu>
To: "Stuart Phinn" <S.Phinn@uq.edu.au>
Cc: "Justin Marshall" <justin.marshall@uq.edu.au>
Sent: Tuesday, September 16, 2003 11:38 AM
Subject: Re: palm questions

> Hi Stuart,
>
> OK, sorry for the delay. Anyway, this is how my system seems to work:
>
> 1. charge up both the iPAQ and the USB-BP
> 2. unplug both from their chargers
> 3. plug the spectrometer into the iPAQ
> 4. turn on the USB-BP
> 5. turn on the iPAQ
> 6. start OOIPS with stylus
> 7. choose SAM integration time file
> 8. set up SAM autosave file namd & number
> 9. set up SAM display delay
> 10. enable SAM with stylus
> 11. after taking some spectra, to make sure it works, quit OOIPS using
> button
> 12. turn off iPAQ
> 13. wait several seconds (simulate travel to pretty reef)
> 14. turn on iPAQ
> 15. start OOIPS using button
> 16. take spectra (simulate pretty corals)
> 17. repeat 10-15 as needed (simulate swimming/boating around in hot
> tropical sun)
> 18. use stylus to disable SAM (back in the lab)
> 19. quit OOIPS with sylus
>
> Sometimes, doing #6 doesn't get the spectrometer working for me. When
> that happens, I quit OOIPS with the stylus and turn off the iPAQ. Then
> I unplug the spec from the iPAQ and turn off the USB-BP. Then I wait
> several seconds, then try again. It seems that there is something about
> shutting down the USB-BP power and restarting that lets the spec work
> properly. I've noticed that the system on occasion doesn't like to work
> with the USB-BP power source plugged in. So, it's easy enough to just
> unplug it - it's supposed to work the whole day, right?
>
> Well, that's pretty much it. When my life calms down a bit, I'll make

> better documentation. Of course, I hope this system works for you. If
> not let me know and I'll be more diligent.
>
> Something to think about is that the iPAQ can take an extended life
> battery, which I think is bigger than the one that comes with the unit.
> We may want to allow space for this in the housing.
>
> Aloha,
> Eric
>

6.2 Appendix 2 How to process and analyse spectra using MS-Excel

Provided by C.Roelfsema, April 2006

UW-USB-compiler.xls-   Excel macro which places the from the palm downloaded
spectral text files in one excel spread sheet. Written by GC
Esarello, University of Waterloo

1. Place spectra and UW-USB-compiler.xls in one directory

2. Start UW-USB-compiler.xls
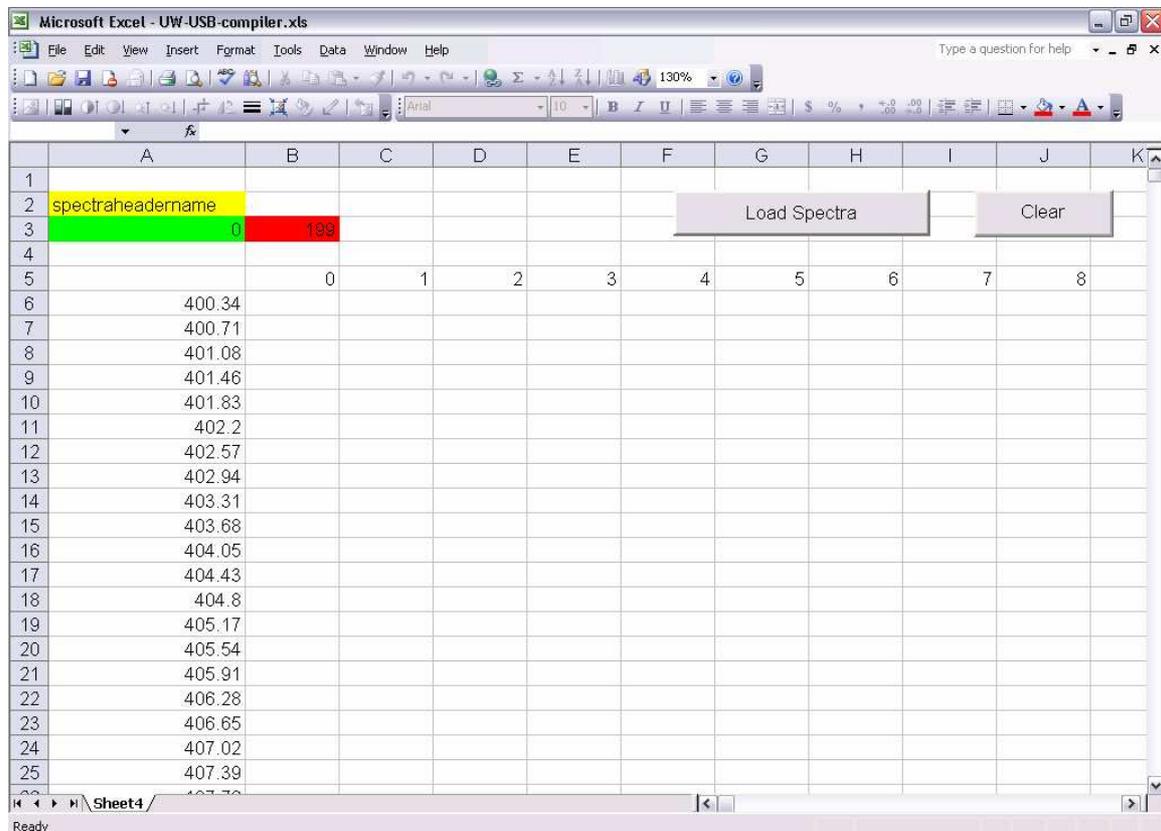
Figure 13 UW-USB compiler excel macro

3. Change the name (yellow box) to the name to code/name the spectra has before
    the sequential number (Figure 13).

4. Change the start number (green box) to the number of the first spectra you want to have in your excel file (Figure 13).

5. Change the end number (red box) to the number of the last spectra you want to have in your excel file (Figure 13)

6. Select Load spectra and the following window occurs (Figure 14).
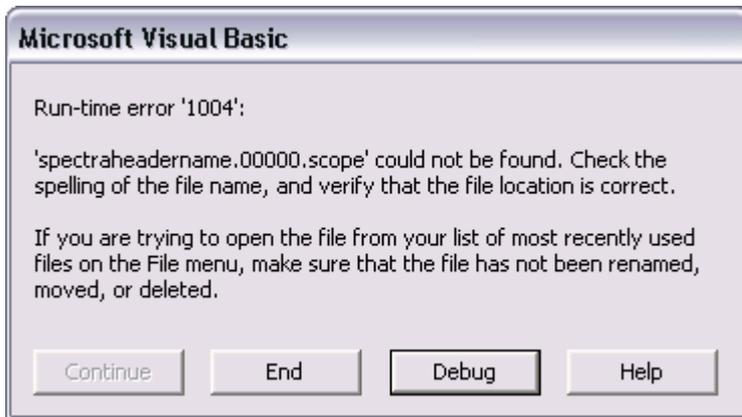
Figure 14 Debug window

7. Select Debug (Figure 14) and the following excel macro editor will occur.
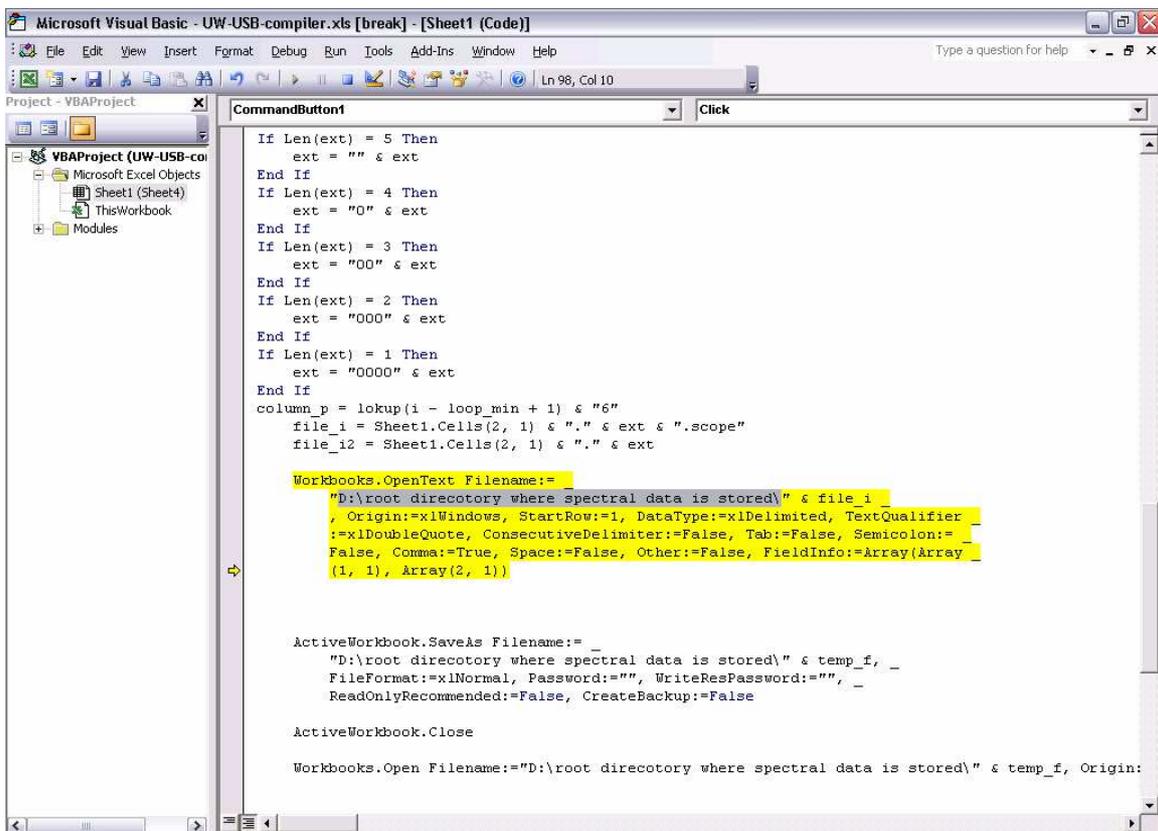
Figure 15 Macro editor

8. See Figure 15 and Figure 16, Replace the sentence "D:\root directory where spectral data is stored\" with the data directory where the spectra is stored. This should happen on three places.
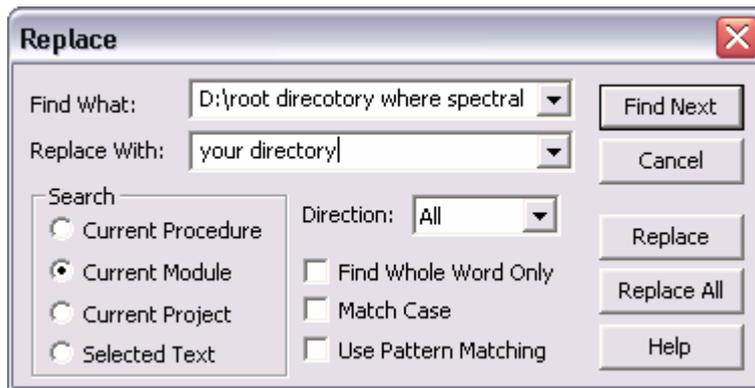
Figure 16 Replace root directory

9. Save the macro and leave the macro editor

10. Select Load spectra and the spectral text files in the specific directory will be copied in to one sheet of the excel file. For this process it will create excel file for every spectral text file which can be deleted after all spectra is placed in the excel file.

If you collected the spectra as described in the paragraph: "Underwater spectral measurements." then the following excel can be used organize the results.

UW-USB-standard.xls - If the spectra are collected the following sequence: dark reading, white panel, 8 x objet then this file excel will organise and analyse the data.

1. Copy the spectra which is gathered with the excel macro compiler (Figure 17).
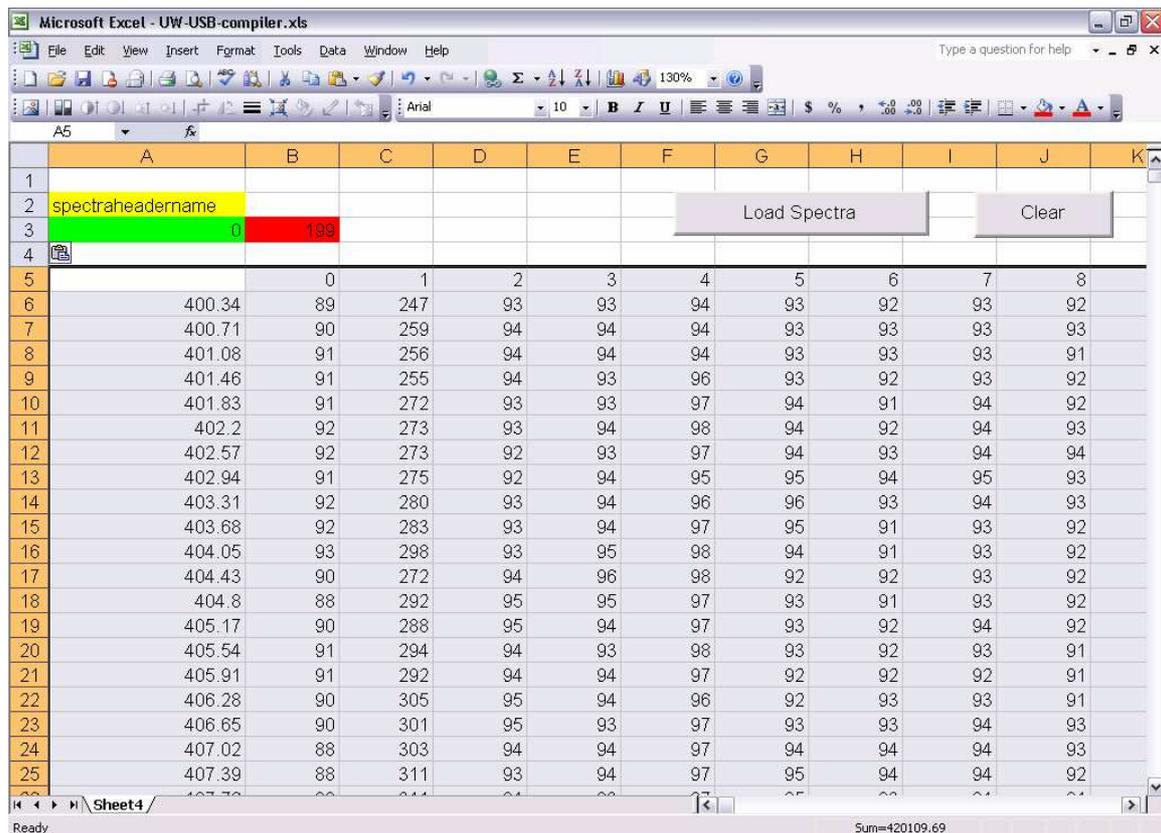
Figure 17 UW-USB compiler with spectra

2. Open up the UW-USB-standard.xls and disable macros.

3. Use paste special (as values) to place the the spectra (which has been copied in step 1) into the excel worksheet "sheet4". After this the dark reading, white panel reading, average spectra and final spectra will automatically calculated and placed in different worksheets (Figure 18).
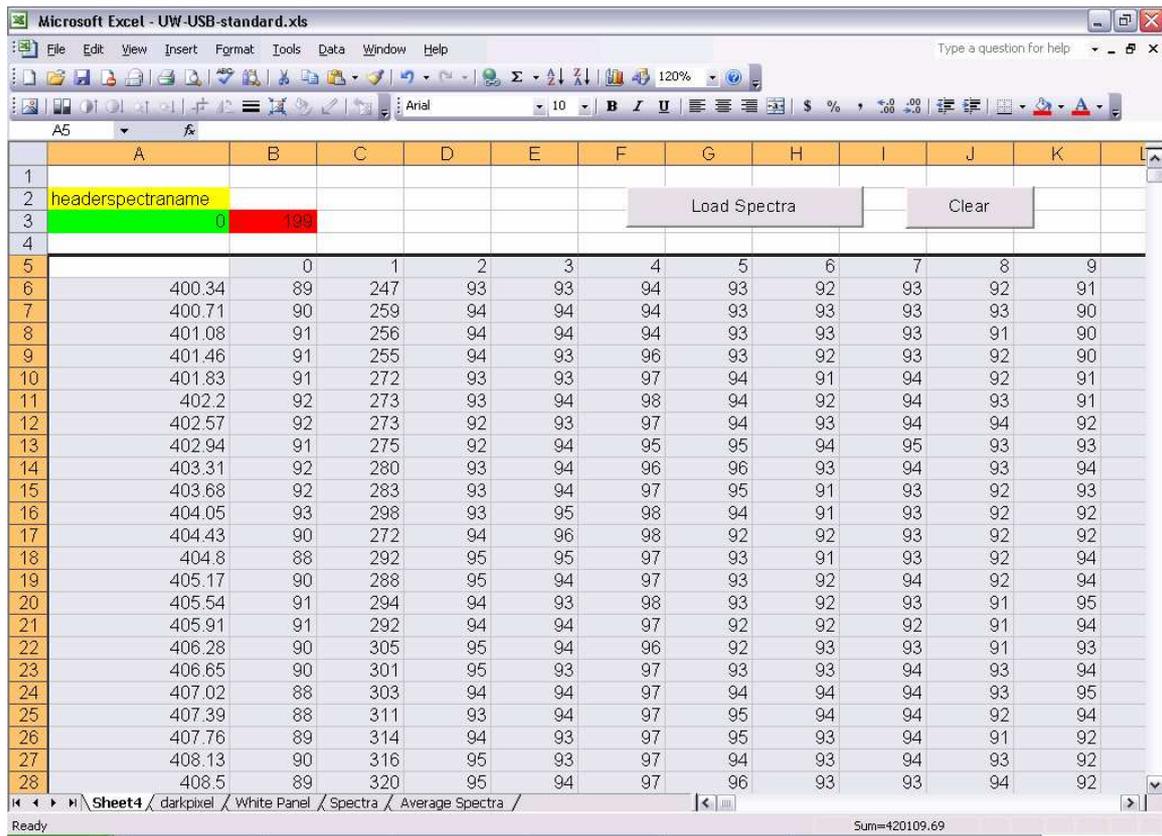
Figure 18 UW-USB-standard with spectra

4. Save the spectra library under a new name and analyse the spectra and/or delete outliers and add meta data.