

iSPEX 2

INTRODUCTION

iSPEX 2 is a combination of an add-on and an app, which turns the smartphone camera into a spectropolarimeter.

A grating projects a spectrum of incoming light onto the smartphone camera. This spectrum is modulated by a highly chromatic retarder to include dark bands that contain information on the linear polarisation of the incoming light. This provides a full linear polarimetric and spectrometric measurement.

HARDWARE

The iSPEX 2 add-on consists of three parts as shown in figure 1:

1. The universal optical tube (left), containing polarisation optics and grating
2. A universal clip to clamp iSPEX 2 onto a smartphone (middle).
3. A positioner (right), tailored to a specific smartphone model, to centre the iSPEX2 in front of the camera.

Note: The positioner acts as a guide to align the iSPEX2 with the camera of the mobile phone. It is not essential to position the iSPEX2. With some training and practice a user is also able to position the iSPEX correctly on most phone cameras with just the optical tube and the clip.

Figure 1



ASSEMBLY

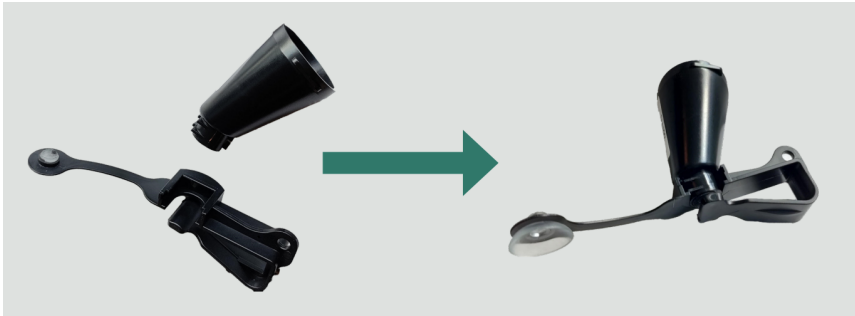
The iSPEX 2 add-on is assembled by combining the optical tube, smartphone clip, and the positioner.

Commented [1]: A faire apres chaque repas, car pas d'activité à ce moment là (et passage des satellites... ajouter les heures)

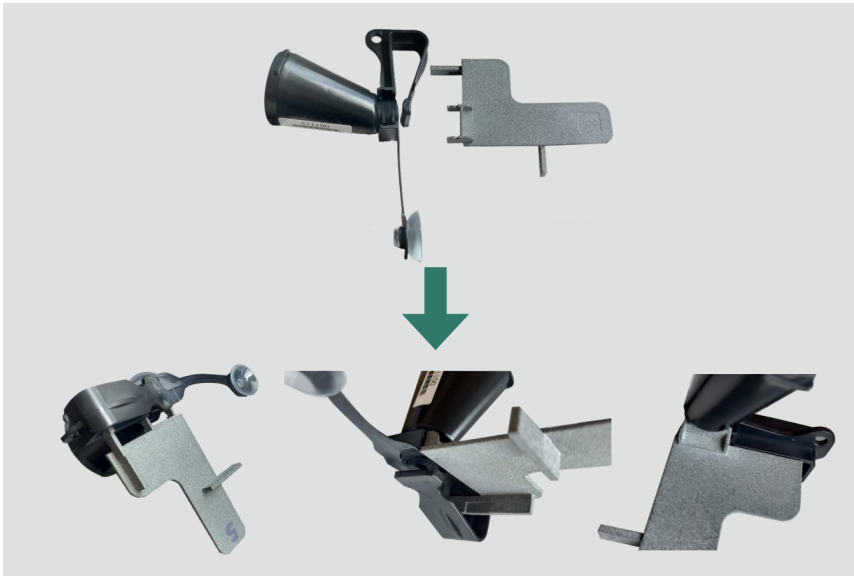
Commented [2R1]: Je suis 100% d'accord. Est ce que ça se rajoute sur ce protocole?

Commented [3R1]: I will, yes

Combining the tube + clip



Adding the positioner to the assembled tube + clip



View this video to see the assembly: [iSPEX Assembling the iSPEX](#)

Once you have the unit assembled (with or without positioner) place the unit over the main camera (with 1x optical zoom) of your smartphone. The positioner should help you align the iSPEX tube with the camera.

See the video on placement of the iSPEX: [iSPEX Positioning the iSPEX](#)

Note: the iSPEX2 unit is not waterproof, so please be careful while near the water. If you drop the unit in the water, water will enter between the foils and distort the path of the light making the unit unusable.

SOFTWARE

To use the iSPEX and make measurements you need the app installed on your phone.

INSTALLATION

IOS

Install the IOS app for iSPEX from the App Store:
<https://apps.apple.com/us/app/ispex-water/id6503945440>

When you first start the app grant the app all requested permissions:

- camera: to take pictures
- location/gps(to determine position, sun position and correct angles),
- photo album (to store photos)
- mobile data: to upload pictures to our servers

Android

Still under construction. You can use the play store version [here](#), but it does not contain pointing information like GPS. But is usable alongside the iOS or Hydrocolor apps.

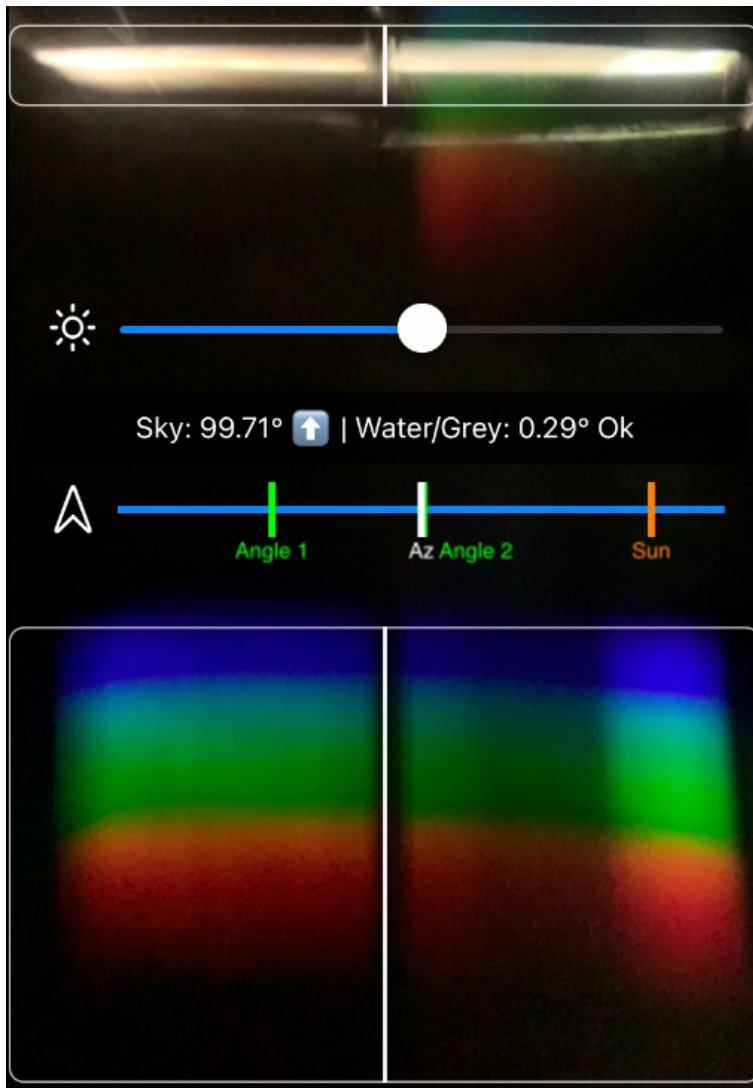
PLACEMENT OF THE ISPEX

The positioner will help placing the iSPEX correctly on your mobile phone camera. However, it's required to verify the correct placement before every measurement.

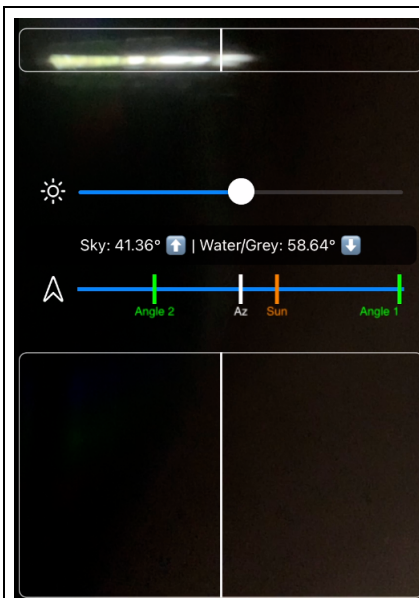
Correctly placed iSPEX

The iSPEX is placed correctly when:

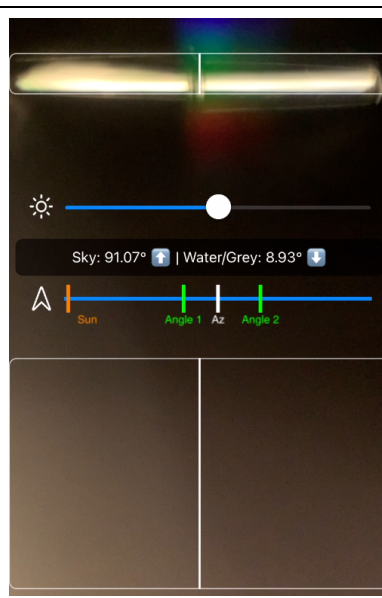
1. The background is black across the whole image
2. The slit is visible in both sides (L+R) and not overexposed
3. The spectrum is visible on both sides and equally lit (L+R)
4. The slit and spectrum are positioned so that the vertical divider line is in the middle between them and the left and right sides of both the slit and the spectrum are aligned with it.
 - a. If you are unable to position the ispex perfectly centered this is not a problem as we use a decent margin cutting out both sides of the spectrum.
5. The spectrum is clearly but not brightly visible in the bottom part.
6. The image is not grainy which would mean the gain is too high



Examples of incorrectly placed iSPEX



No spectrum visible / slit not fully lit



No spectrum visible, light leaking into bottom part

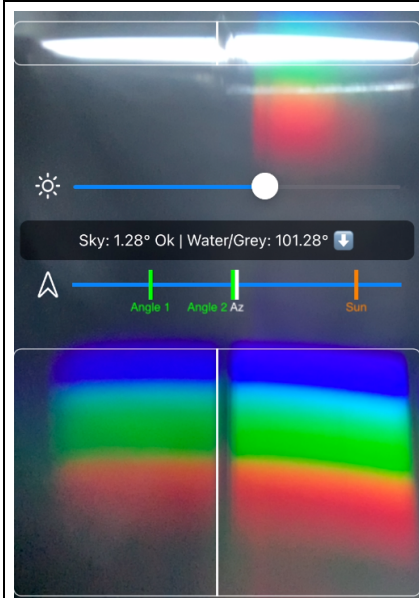


Image overexposed

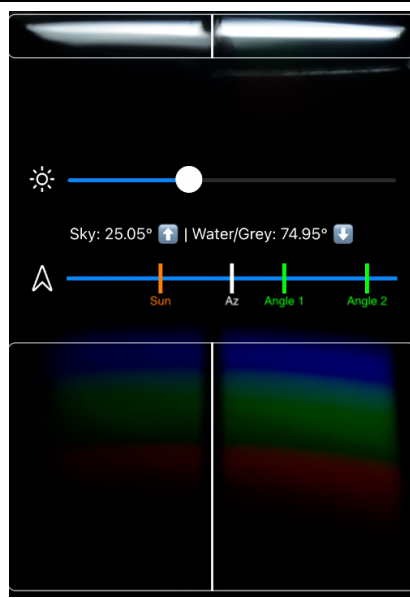
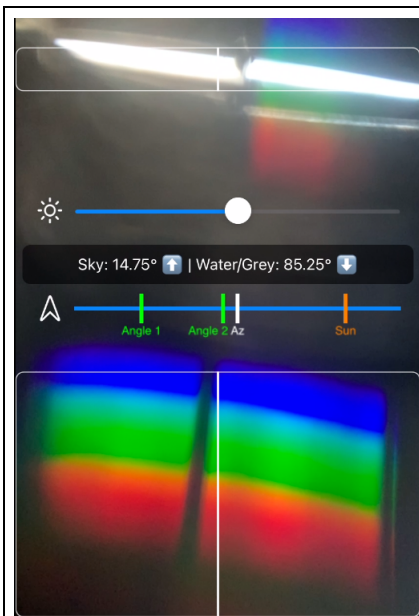
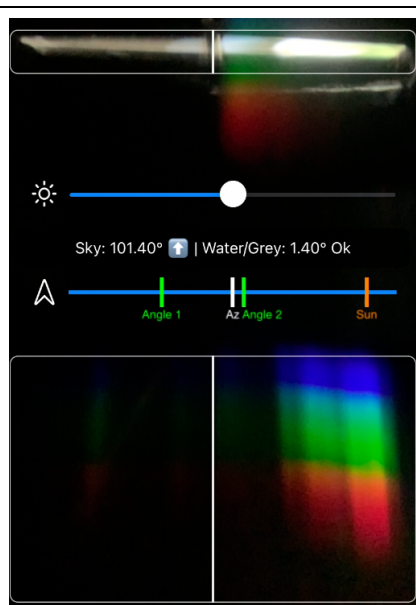


Image underexposed



iSPEX rotated + overexposed image



Spectrum only visible on 1 side

PROCEDURE

Preparation

- Practice assembly and correct placement of the iSPEX
 - After you get familiar with assembly you can leave the iSPEX assembled for transport to the measurement location. Best to use a plastic bag to prevent dust and other particles from entering.
 - Make sure you practice the placement procedure before taking the iSPEX into the field and get thoroughly familiar with it.
- Make some test measurements while you are ashore and get familiar with the app and procedure.
- Make sure your mobile phone is charged and has enough battery to make several measurements and/or bring a charger/battery pack.
- Remove any phone covers/protective case from your mobile phone
- Optional: Check your phone compass to see if it's calibrated. If not, calibrate the compass.

Material needed

- A clean microfiber cloth to clean the camera lens before installing the iSPEX
- A mobile phone with the iOS or Android app installed and sufficient battery charge
- An assembled iSPEX2 (at least the tube + clip)
- A grey card (if you are conducting water reflectance measurements). A standard 18% grey card, which is readily available online or from photography stores, should be used. A card the size of a postcard or bigger is sufficient. Ideally you have one that has a keychain and you put it around your neck.

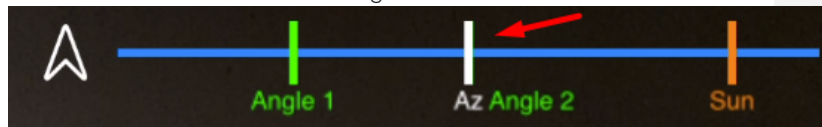
Protocol

1. Find an unshaded patch of water, where you cannot see the bottom. There should be a clear view of the water itself and the sky above it. Measurements are best done on a fully clear or fully overcast day.
2. Orient yourself so the sun is behind you and the water roughly in front of you.
3. Remove any phone covers/protective cases from your mobile phone
4. Clean the camera lenses with the microfiber cloth and verify there are no smudges or fingerprints on the lens.
5. Place the assembled iSPEX on the phone camera so that the image looks like the correct example image shown in the previous section.
6. Press down on the suction cup to make sure the iSPEX is fixated.
 - a. Note that it's still possible to move the iSPEX and suction cup once it is pushed down. Be careful not to touch the iSPEX unit from this point onward.
7. Lower the brightness of the spectrum so that it is only moderately visible on the screen

8. Verify that the phone has GPS and shows the position of the sun and measurement angles

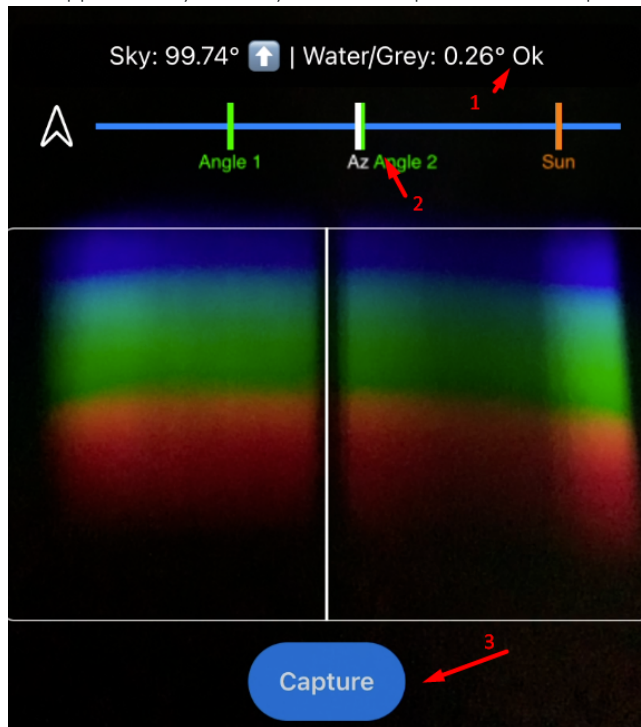


- a. Rotate and check that the Angle1 and Angle 2 are moving.
9. Depending on your position relative to the water, pick either Angle 1 or Angle 2 that has the best view of the water (without reflections or shade)
10. Align the white Az line with Angle 1 or Angle 2.
- a. In this case Angle 2 was chosen

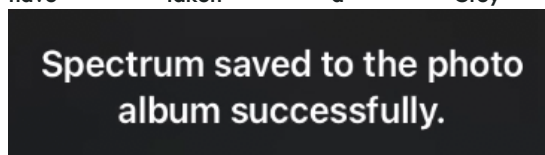


11. Next look at the Water/Grey value. Point the phone down so that the angle shows approximately 0 degrees and Ok. You will also hear a beeping sound that the correct angle was found, and you will feel haptic feedback signaling the same.
12. Take your grey card and position it in front of the iSPEX. You will see the spectrum image change as now light from the sky is reflected into the iSPEX.

13. When you see the spectrum, Angle 1 or 2 is aligned with Az and the Water/Grey angle is approximately 0, you can press the capture button below.

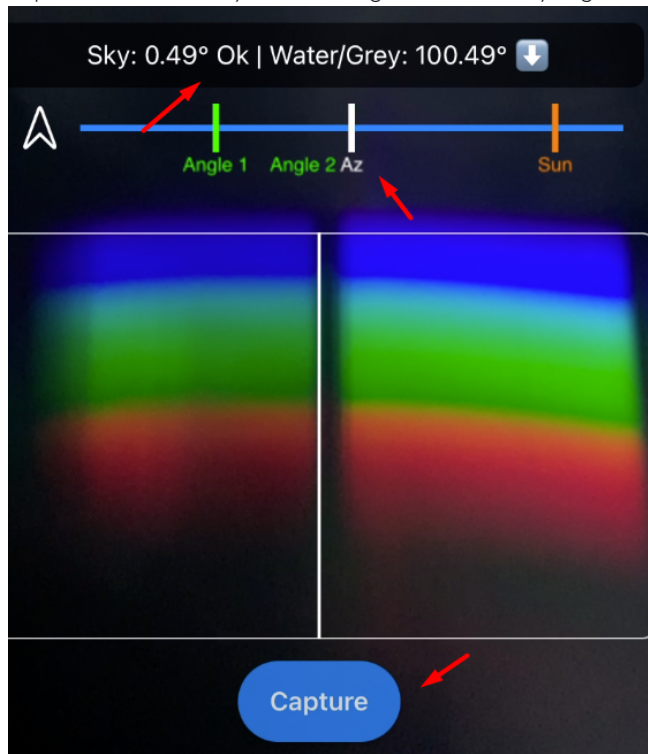


14. You will see a message that the photo was stored to the internal memory. **You now have taken a Grey card image.**



15. Put away your grey card and try to keep your phone as stable as possible in the current position and make sure the angle you picked and the Water/Grey position is correct and press Capture one more time. **You have taken a water image.**
16. Finally, keep the phone at the same horizontal angle. Now start rotating the phone up so that the Sky value goes down towards 0.

17. Once the value for Sky is approaching zero you will hear a beeping sound and feel haptic feedback. Verify that the Angle is still correctly aligned and press Capture.



You have now taken a Sky image. The measurement is complete

You can take the images in any order, but for processing purposes it's best to follow the same procedure every time. We suggest the following:

- 1) the **gray sheet** image
- 2) the **water** image
- 3) the **sky** image

PROCESSING

If you have a data connection the images will be uploaded to our backend. We process images in RAW and they are quite large: normally between 10-20MB. Uploading the images can take a bit of time depending on the quality of the internet connection and the amount of measurements you took.

If you have no data connection available, verify that the images were taken in your phone photo album.

Then go to a location with a data connection (wifi or mobile data) and open the app. Keep the app open. The app will now sync your data in the background. Depending on the number of measurements this might take a long time.

VIEWING AND EDITING YOUR SPECTRA

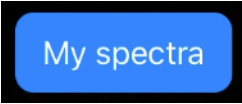
In the app we have the option to view your measurements and once the images are processed you will also see the spectra.

Click

on

the

button



My spectra

You will see a list with all measurements (details), the image and the processed spectrum



MySPEX



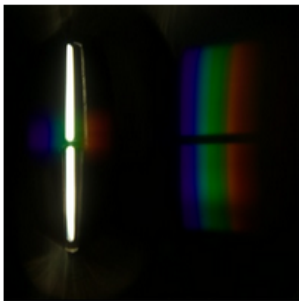
⏮ ⏪ Page 1 of 2 ⏩ ⏭ Total Records: 20

Date & Time: Jul 6, 2024, 2:14:31 PM

Device Model: iPhone SE (GSM)

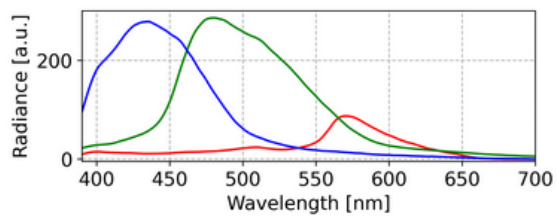
Lat: 45.28 Lon: 24.31 Country: Romania

Angle: 62° Azimuth: 284°

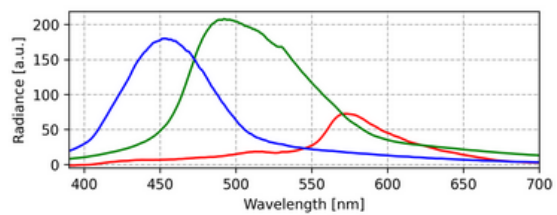


Spectral Data

[Left side](#)



[Right side](#)



Editing the details of the measurement

In the list of images/spectra click on the button:

EDIT RECORD

CANCEL

Edit Measurement

CONFIRM

Measurement Type

SKY

WATER

GREY

Cloud Cover 50%

☀

☁

Comment

Water at lake

Latitude:

44.43905039926563

Longitude:

26.198809146881107

Here you can:

1. Set the type of measurement
2. Use the slider to indicate the cloud cover during the measurement
3. Put a comment related to the measurement
4. View the location of the measurement on the map
5. Drag the marker to correct the GPS position of the measurement

If you don't want to change anything click cancel on the top left corner.
If you did make changes press Confirm to store the changes

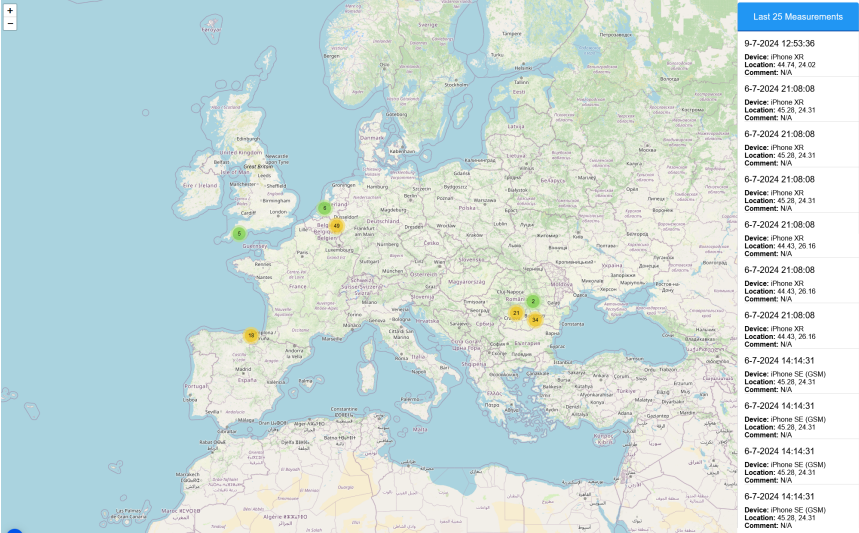
Deleting a record

To Delete a record from the list click the button



iSPEX Map

We also have a general map available where you can see all measurements. This can be useful for larger projects.
<https://map.ispex.org/home>. Currently it only shows the images, not the spectra.
On the right you will find the last 25 measurements added to the database.



MAINTENANCE

The iSPEX doesn't require any specific maintenance. You can keep it assembled in a plastic bag or cardboard box for storage.

TROUBLESHOOTING

Problem		Solution
AZ line not visible	Phone has no GPS	Enable GPS and give the app the correct permissions or wait for the phone to acquire location
My Spectra record list shows processing	Images were not uploaded (completely) yet	Leave the app open for a longer period of time with a data connection and check later