



Piccolo spectrometer system for reflectance and fluorescence measurement from mobile and fixed platforms

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Plus work by Andrew Revill (U of E) and Anna Florence (SRUC) on BBSRC ATEC precision farming project

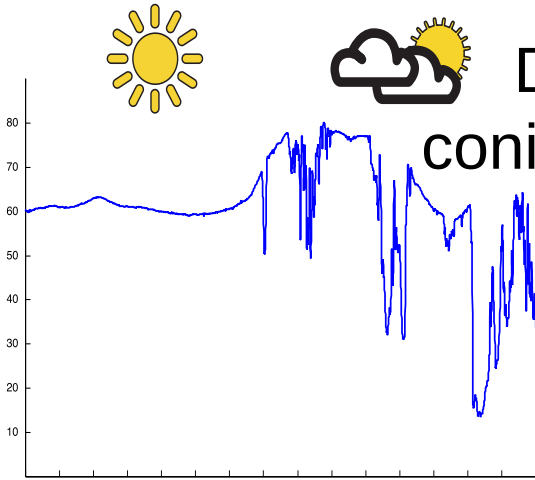


COST is supported by the
EU Framework Programme
Horizon 2020



Piccolo doppio DFOV multi-spectrometer system

Design brief: DFOV and cos-conical for variable illumination



DFOV and cos-conical for variable illumination

Use existing OEM optical benches



Ethernet or Wirelessly controlled'



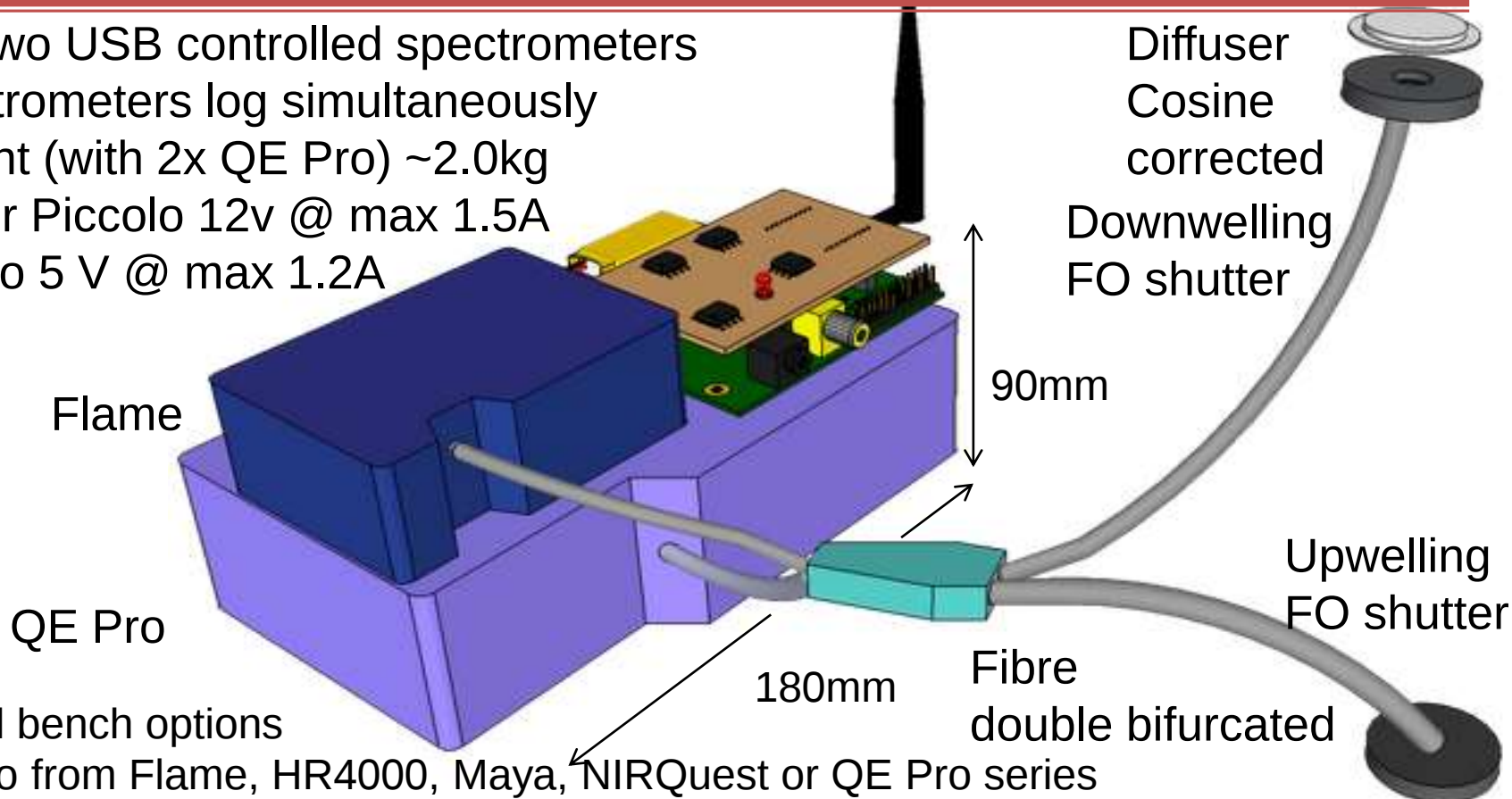
Light weight < 2kg to deploy on UAVs

Affordable!



Piccolo doppio DFOV multi-spectrometer system

- Any two USB controlled spectrometers
- Spectrometers log simultaneously
- Weight (with 2x QE Pro) ~2.0kg
- Power Piccolo 12v @ max 1.5A
- QEPro 5 V @ max 1.2A



Down welling	Up welling
☐	☒ 1. Acquire downwelling
☒	☐ 2. Acquire upwelling
☒	☒ 3. Acquire dark

Ocean Optics Flame 25 μ m slit		QE Pro (cooled) 10 μ m slit)	
Range	~400 – 950nm	Range	~650 – 800nm
Sampling int.	~ 0.4nm	Sampling int.	~ 0.1nm
FWHM	1.3nm	FWHM	~0.31nm
Digitisation	16-bit ?!?	Digitisation	18-bit

Piccolo doppio DFOV multi-spectrometer system

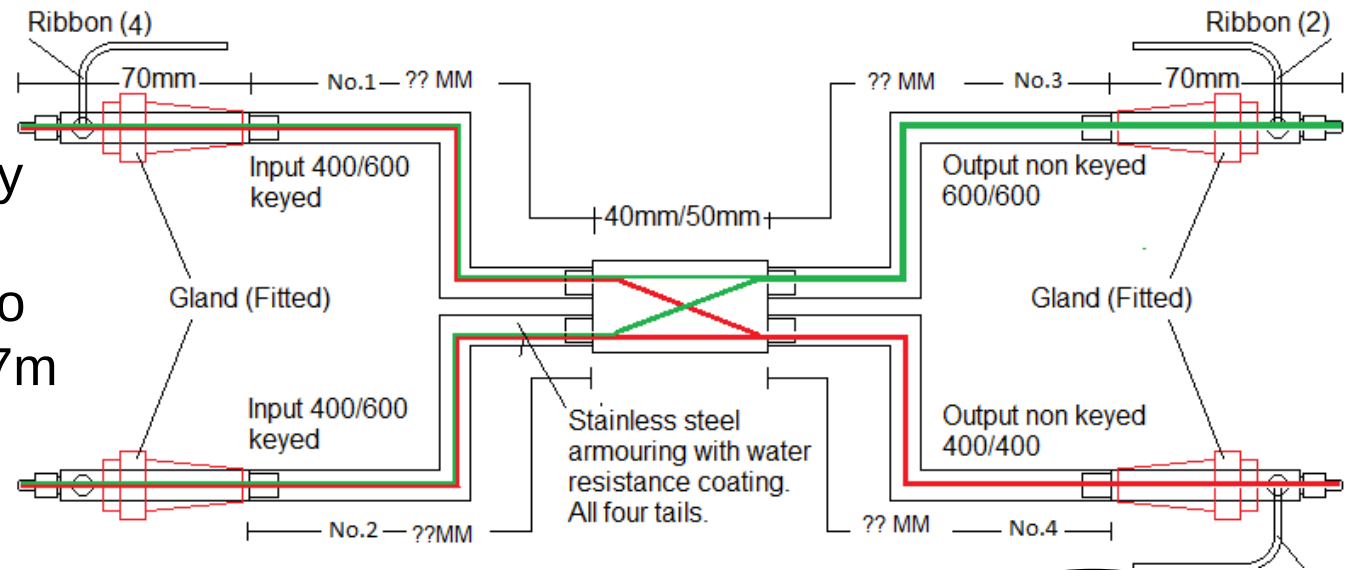
Title :- 2 by 2 Stainless steel 400/600 water resistant

Date :- 11/04/2017

Author:- Sharon Rogers

Authorised by:- Richard Kershaw

Double bifurcated
fibre optic assembly
Developed by
Alker Ltd for Piccolo
So far max length 7m



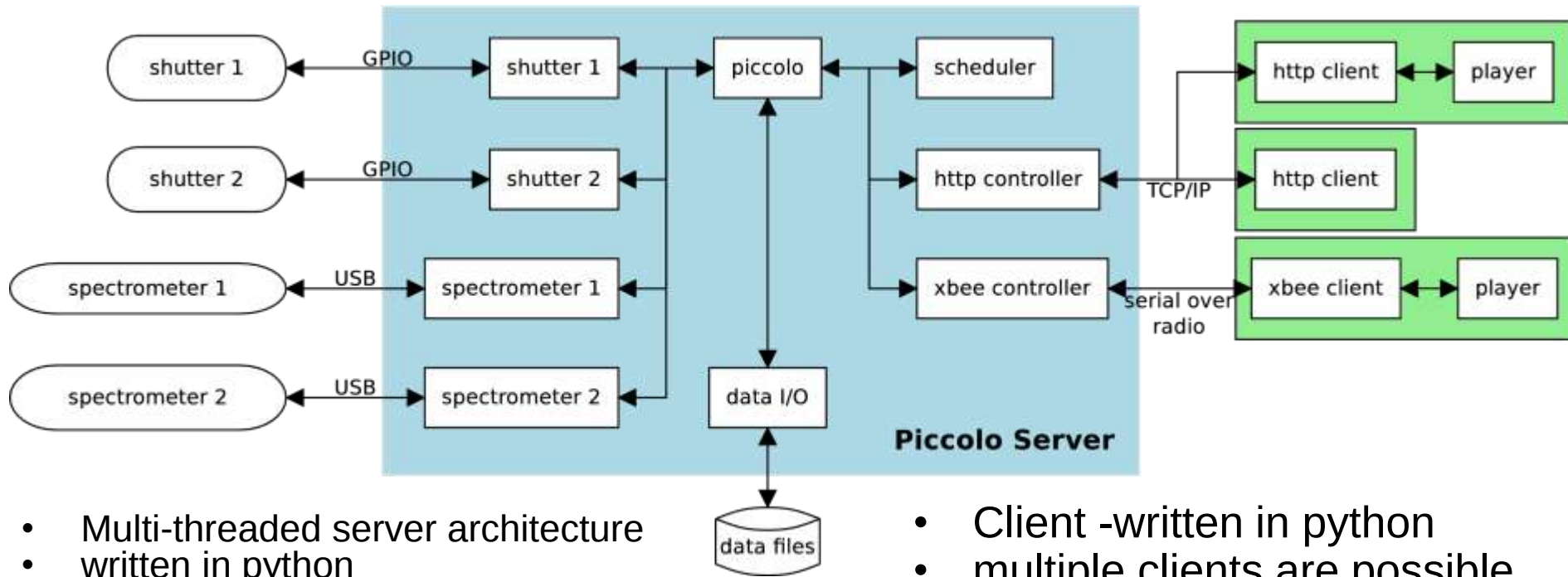
optical bench slit

400µm fibre 600µm fibre

Upwelling fibres

Downwelling fibres

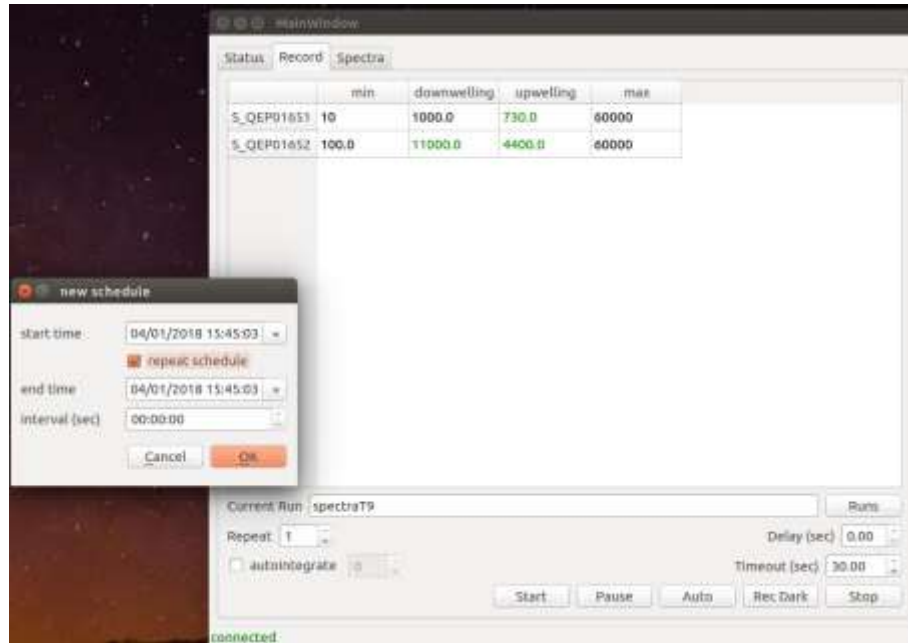
Piccolo doppio DFOV multi-spectrometer system



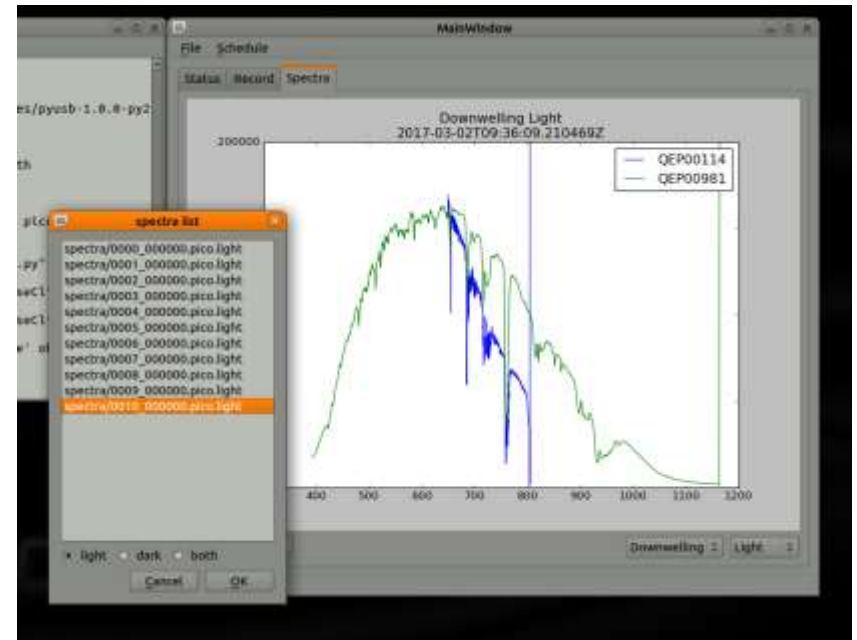
- Multi-threaded server architecture
- written in python
- runs on raspberry pi 2
- controls up to 3 spectrometers
- Controls 2 shutters
- listens to instructions over http/serial commands and can be scheduled
- Data in json files

- Client -written in python
- multiple clients are possible
- connect via http or serial over radio
- command line client
- graphical interface (player)
- Client library can be used for custom clients

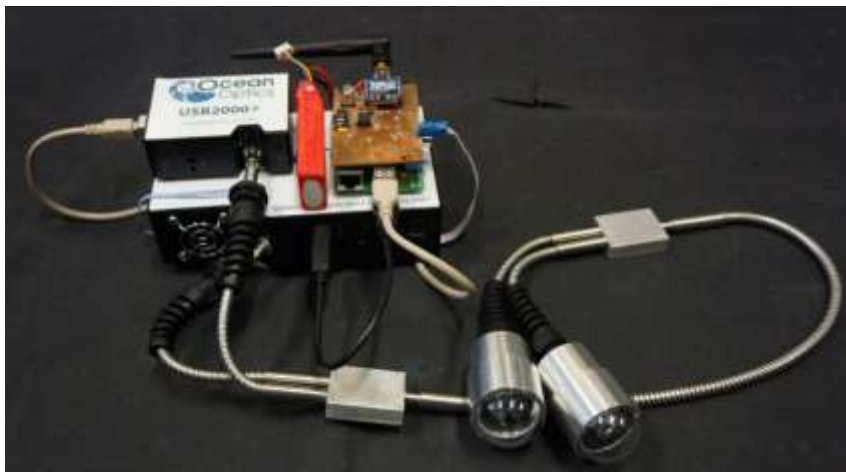
Piccolo doppio DFOV multi-spectrometer system



Control GUI or command line



Select and view data



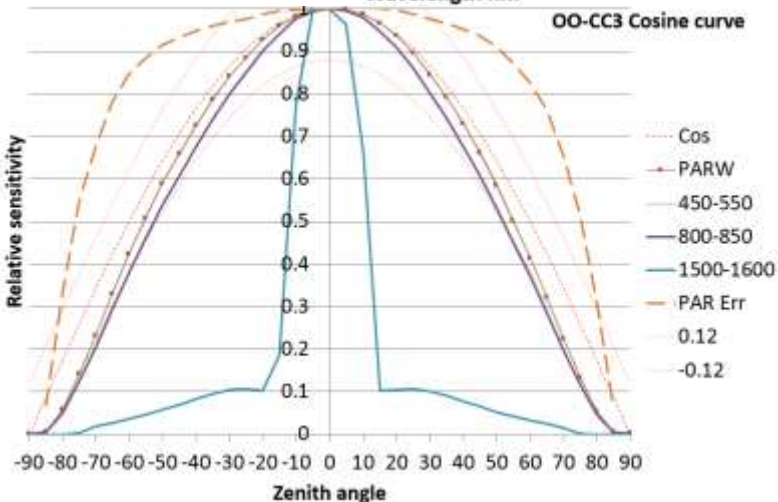
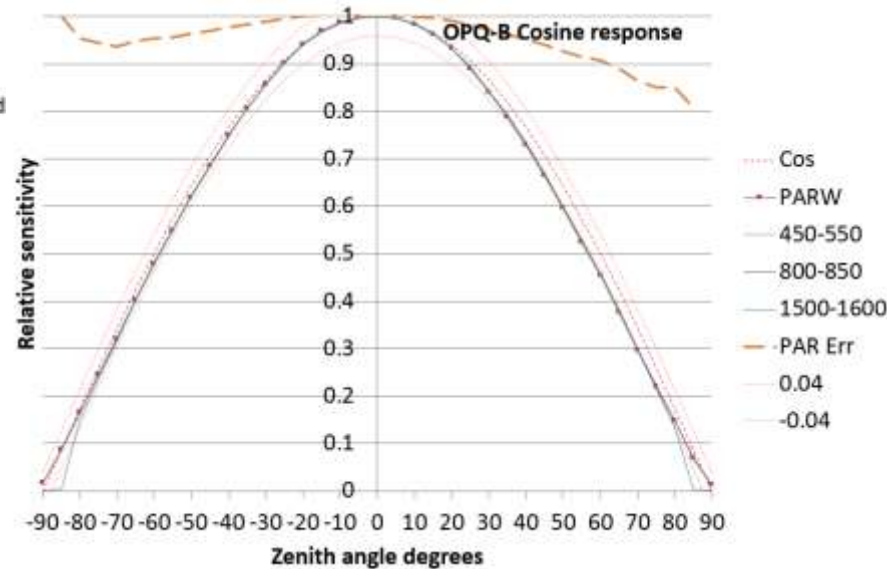
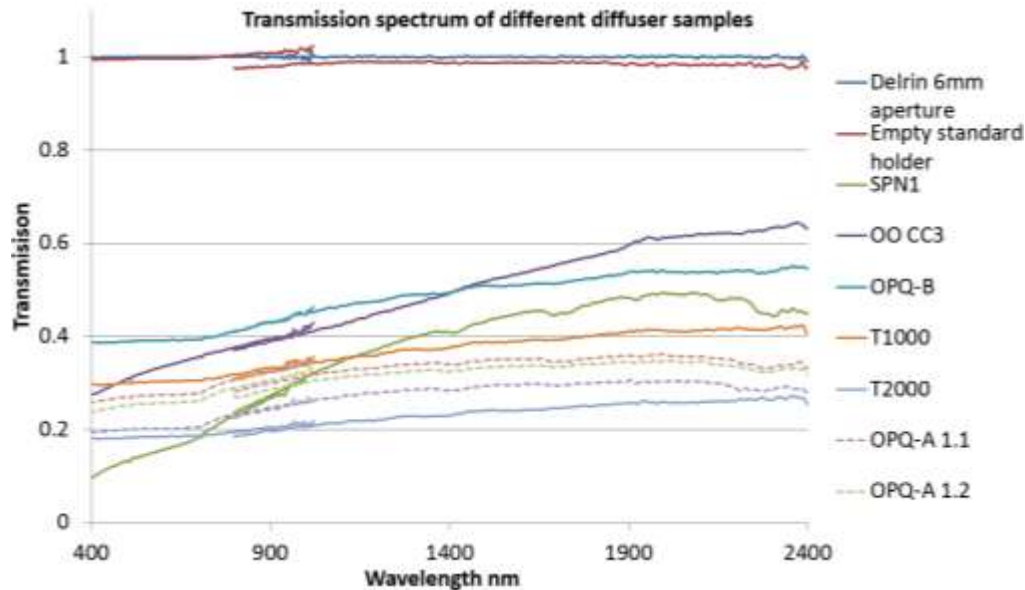
DFOV dual
optical
bench
system



Fore optics from
Peak Designs Ltd

Piccolo doppio DFOV multi-spectrometer system

Transmission & cosine response of diffuser developed by Peak Designs Ltd for Piccolo and test of others



Piccolo
diffuser



OO-CC3 (opaline)
diffuser -other materials
also available

Piccolo doppio DFOV multi-spectrometer system

Development and testing of a field portable radiometric and spectral calibration validation system in progress (now 2nd year)

So far validation source precision of $\pm 1\%$ has been achieved.

Has photodiode and spectrometer monitoring options

Can have multi line lamp emission sources

(Ne, Hg-Ar

re Mihai et al 2018 RS, 10, 289)



Piccolo doppio DFOV multi-spectrometer system

Field deployment

Townsend & Kingdon,
U. of Wisconsin
summer 2015
publication
due 2018



Mac Arthur,
U. of Edinburgh
Iceland
Summer
2015



Porcar-Castell & Atherton,
U. of Helsinki, Hyytiälä Nov. 2017



Porcar-Castell &
Atherton, reflectance
and fluorescence
from UAV
Hyytiälä 23/03/2017
& 19/04/2017

Piccolo doppio DFOV multi-spectrometer

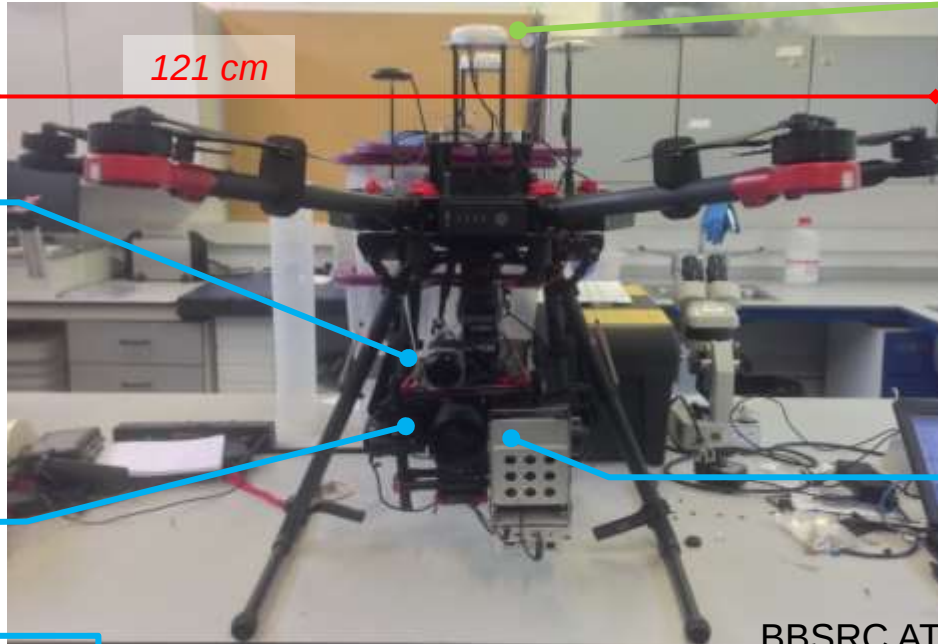
DJI M600-RTK Take off weight max. 15kg flight time 13 minutes (safely)

RTK GPS



121 cm

Thermal imager



RGB Optical Camera

MAIA Multispectral imager

Piccolo DFOV system + RGB or thermal imager on interchangeable gimbal



BBSRC ATEC project. Work by Andrew Revill (UofE) and Anna Florence (SRUC)

DETAILS.updateTime	OSD.longitude	OSD.latitude	OSD.height	OSD.pitch	OSD.roll	OSD.yaw	OSD.flycSta+GIMBAL.pitch	GIMBAL.roll	GIMBAL.yaw
2017-02-09 12:51:10.079000	-1.5386014861	55.0151738273	34.4	0.4	3.4	5.5GPS_Att	-66.6	0	7.2
2017-02-09 12:51:10.079000	-1.5385999591	55.0151735025	34.4	0.4	3.6	5.5GPS_Att	-55.3	0	7.2
2017-02-09 12:51:10.079000	-1.5385983536	55.0151731295	34.3	0.2	3.8	5.5GPS_Att	-44.1	0	7.2
2017-02-09 12:51:10.079000	-1.538596876	55.0151728522	34.2	0	4	5.4GPS_Att	-32.8	0	7.2
2017-02-09 12:51:10.079000	-1.5385953281	55.0151725368	34.2	-0.1	4.3	5.4GPS_Att	-21.5	0	7.2
2017-02-09 12:51:10.079000	-1.538593883	55.0151722797	34.1	0	4.6	5.4GPS_Att	-10.2	0	7.2
2017-02-09 12:51:10.079000	-1.5385923516	55.0151719583	34	0.1	4.9	5.4GPS_Att	1	0	7.2
2017-02-09 12:51:10.079000	-1.5385908117	55.0151716765	34	0.1	5.2	5.4GPS_Att	12.3	0	7.2
2017-02-09 12:51:10.079000	-1.5385892028	55.0151713533	33.9	0.1	5.3	5.4GPS_Att	23.6	0	7.2
2017-02-09 12:51:10.079000	-1.5385875875	55.0151710942	33.8	0.1	5.4	5.4GPS_Att	29.9	0	7.2
2017-02-09 12:51:10.079000	-1.5385859439	55.015170794	33.7	0.1	5.3	5.4GPS_Att	29.9	0	7.2
2017-02-09 12:51:10.079000	-1.5385842986	55.015170519	33.6	0.1	5.4	5.4GPS_Att	29.9	0	7.2
2017-02-09 12:51:10.079000	-1.5385826243	55.0151702151	33.6	0.1	5.4	5.4GPS_Att	29.9	0	7.2
2017-02-09 12:51:10.079000	-1.5385809555	55.0151699913	33.5	0.1	5.5	5.3GPS_Att	29.9	0	7.2
2017-02-09 12:51:10.079000	-1.5385792552	55.0151697376	33.4	0.1	5.5	5.3GPS_Att	28.5	0	7.2
2017-02-09 12:51:10.079000	-1.5385775954	55.0151695561	33.4	0.2	5.6	5.3GPS_Att	19.1	0	7.2
2017-02-09 12:51:10.079000	-1.5385759036	55.0151693242	33.3	0.3	5.6	5.4GPS_Att	7.9	0	7.2

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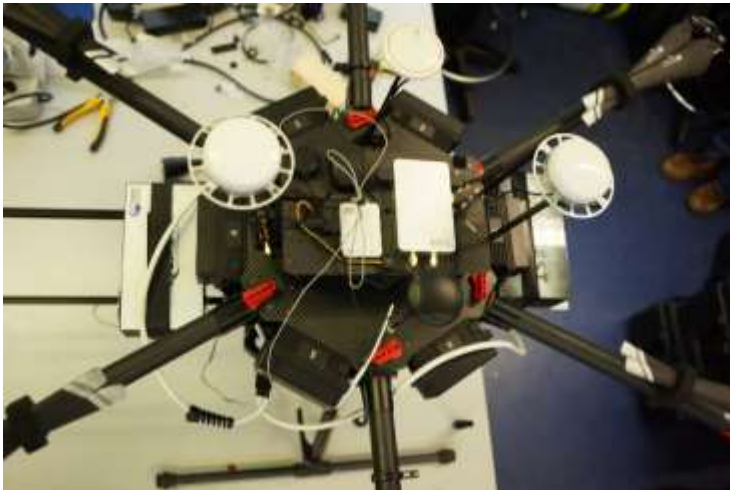
Mounting options



Mount spectrometers on gimbal



RCR fixed above platform

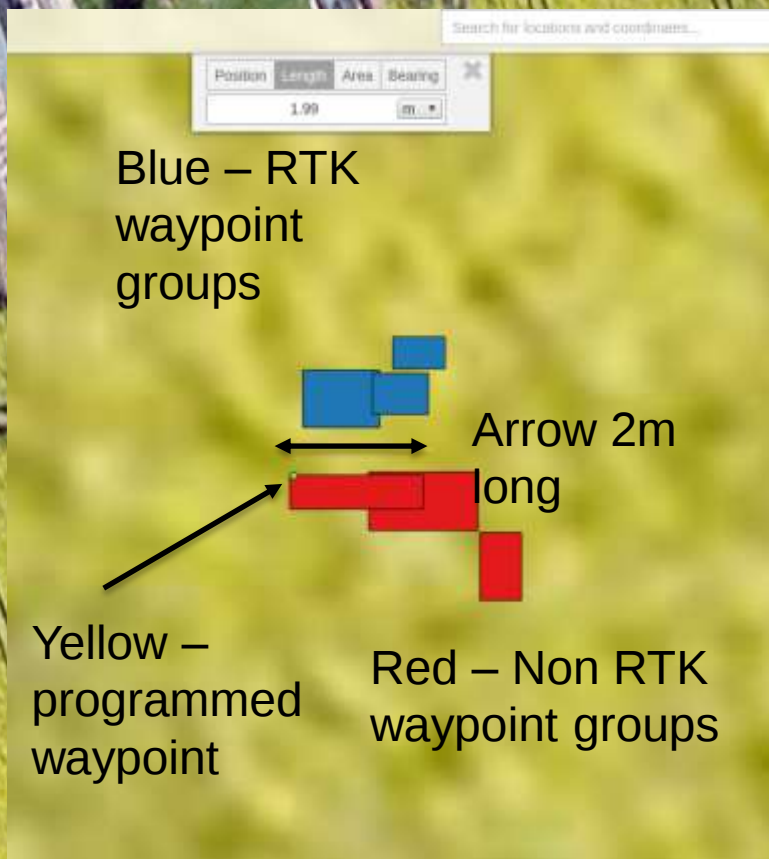


Mount spectrometers platform



Space for FO and other sensors on gimbal

GPS



Piccolo doppio DFOV spectrometer system

Conclusions

- A light weight (<3.5kg) DFOV spectrometer system has been developed and tested
- Can be deployed on UAVs or at fixed locations
- Logging sequences can be scheduled
- Can measure reflectance and fluorescence (near) simultaneously through same fibre optic based fore optic = same support for both measurements
- QE Pro offers a step-change in OEM spectrometer dynamic range
- A calibration field verification system has been developed and 1st tested during late 2017
- Some UAV operation issues to be resolved but RTK positioning of ~1m and PPK of <10cm possible



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Piccolo DFOV spectrometer system



European Association of Remote
Sensing Laboratories

10th EARSeL SIG

Imaging Spectroscopy

Workshop



University of
Zurich ^{UZH}



Photo: © JiSign / Fotolia

19-21 April 2017

University of Zurich

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