Gerald Moore & John Icely

The Development of a Prototype Autonomous Optical Floating Profiler.

A.K.A Active Gimbal

Bio Optika

ARGANS

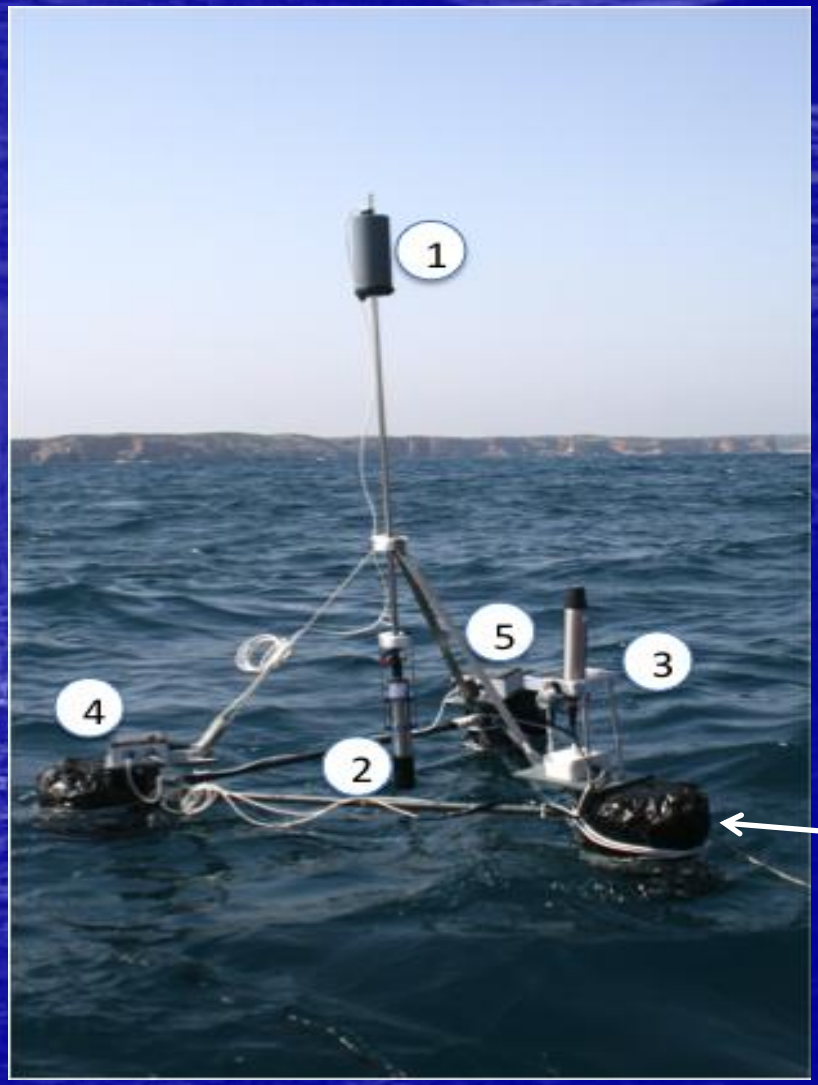
Design Goals:

- Launch & Go
  - Just PC (or possibly GSM transmission)
- Stable to Sea-State 3 or 4
- Determine Lu (K_{lu}) from '0' … 0.5m
- Remove tilt / roll bias from Irradiance Measurements

Ancillary Measurements:

- GPS = Time
- Press (depth) +/- 2mm
- Temperature +/- 1°
- Tilt / Roll / Compass
- Barometric pressure

Bio Optika ARGANS



Major Components:

1 the transmitter / profiler
2 the radiance sensor assembly
3 the active gimbal
4 the irradiance / GPS controller
5 battery pack.

NOT Forgetting Floats!
- main effort in stability.

Gerald Moore
MVT, Oct 2011 (3/15)

Bio Optika

ARGANS

Deployment:

Tripod design
Each Leg Balanced

Total Weight <15kg

Easily mounted on RIB

Bio Optika

ARGANS

Stability:

Gerald Moore
MVT, Oct 2011 (5/15)

Bio Optika

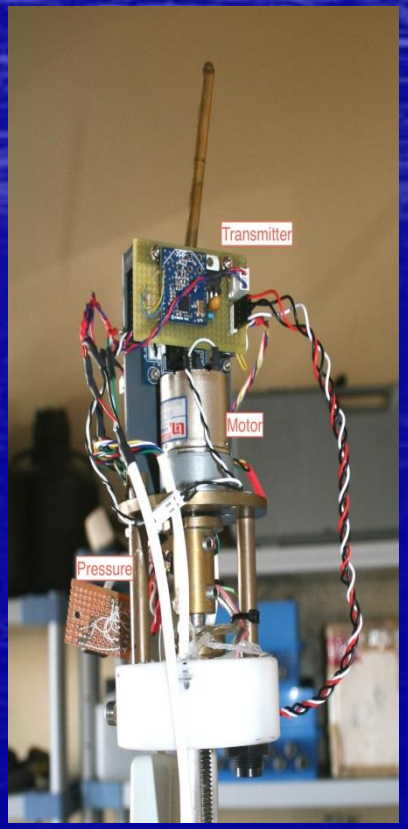
ARGANS

(1) Profiler

- Lead screw driven by motor
- Transmitter / Control Software
- Intelligent 900Mhz Transmitter
- All other units connected by

  (power & rs485) bus
- Pressure Sensor

  0-0.6 bar capillary from head
- (bucket calibration)
- Rate of descent of 0.12 cm/sec



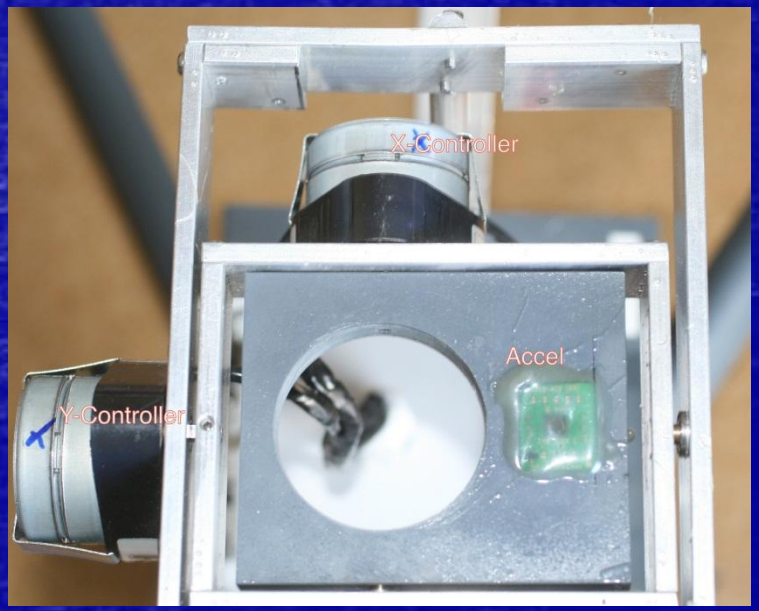
Gerald Moore
MVT, Oct 2011 (6/15)

Bio Optika

ARGANS

3 The Active Gimbal

- Measures average tilt / roll from accelerometer
- Corrects accordingly – simple feedback loop.
- Measures platform tilt / roll / compass
- Platform tilt limits the activity.



Gerald Moore
MVT, Oct 2011 (7/15)

Bio Optika

ARGANS

Sampling / Control

Communications using simple telnet console.
Command mode.

Any of the sensors could be queried and the motor operated, and a pre programmed measurement cycle could be started.

Measurement cycle
1) Measure GPS, Temperature, Barometric Pressure, Compass
2) Take *n* replicates of

accelerometer, Irradiance, Radiance

The irradiance / radiance were logged simultaneously by 2 processors

Profile Cycle

Descend k turns of motor

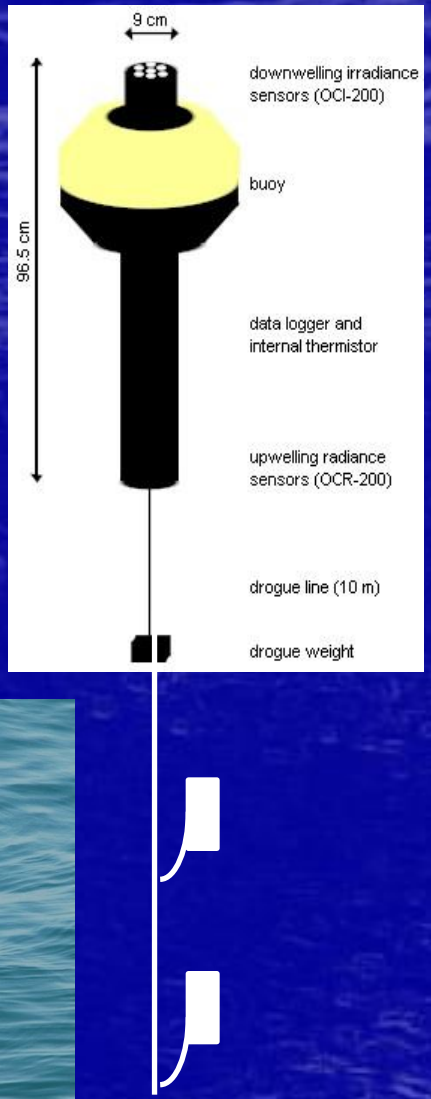
Check for limit switch and end profile

The number of measurements and inter-profile depth could be programmed.

The gimbal could be activated / deactivated by remote command

Performance and inter-comparision.

- Data from the Sagres TACCS and the Floating Rig
- Two Stations (unfortunately not matchups)
- Baseline calibration of the Trios Head and TACCS at ARC 2010
- Sagres TACCS processing / error budget validated at ARC 2010.



Gerald Moore
MVT, Oct 2011 (9/15)

Bio Optika

ARGANS

Active Gimbal

Compared the angle off vertical for the rig / active gimbal

Parameter	Platform	Active Gimbal
Min	2.1	0.5
Max	11.3	12.9
Mean	4.9	5.1
Median	4.2	3.7

Only a small improvement ; however the rig was well balanced

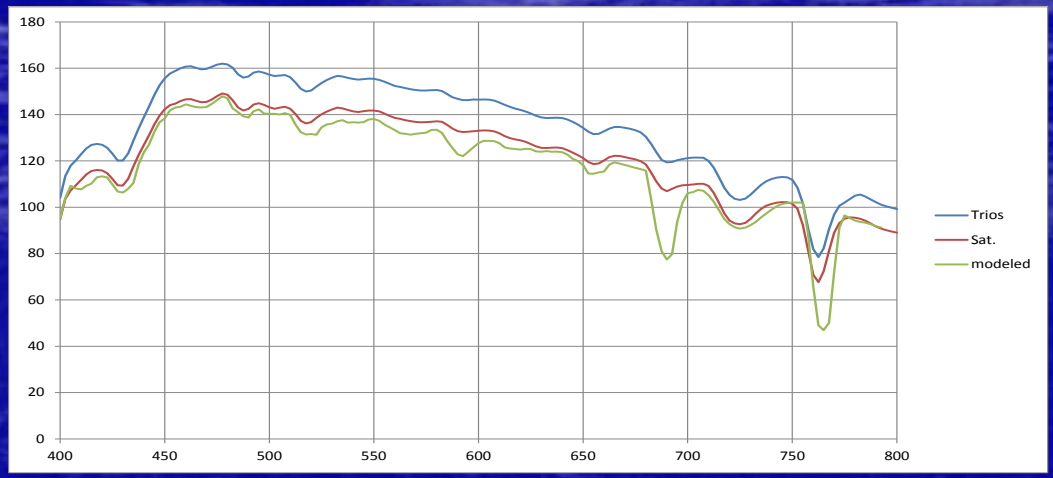
Considerable improvement in terms of number of 'good' readings.
3° off vertical >> 5% error.

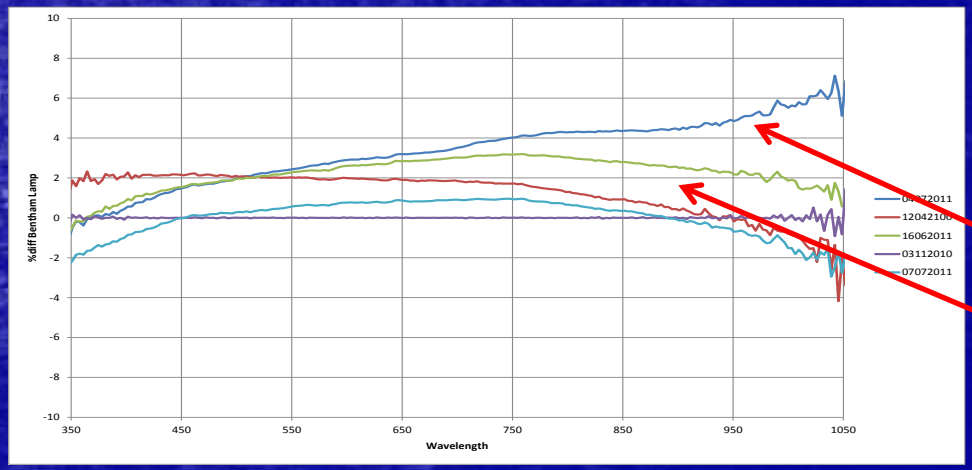
° Tilt Criteria	%Platform°	%Active Gimbal°
1	0.0	8.3
2	4.2	29.2
3	20.8	37.5

Bio Optika ARGANS

Irradiance

Modelled data from calculated with concurrent microtops AOT
Data screened for tilt / roll < 2° off vertical.
Offset between Trios / Satlantic identical a two stations.





Calibration:
ARC2010 baseline – tracked with NPL tertiary lamp.
3 days Post Deployment
7 days Post / Pre Deployment

Why – humidity – mechanical?

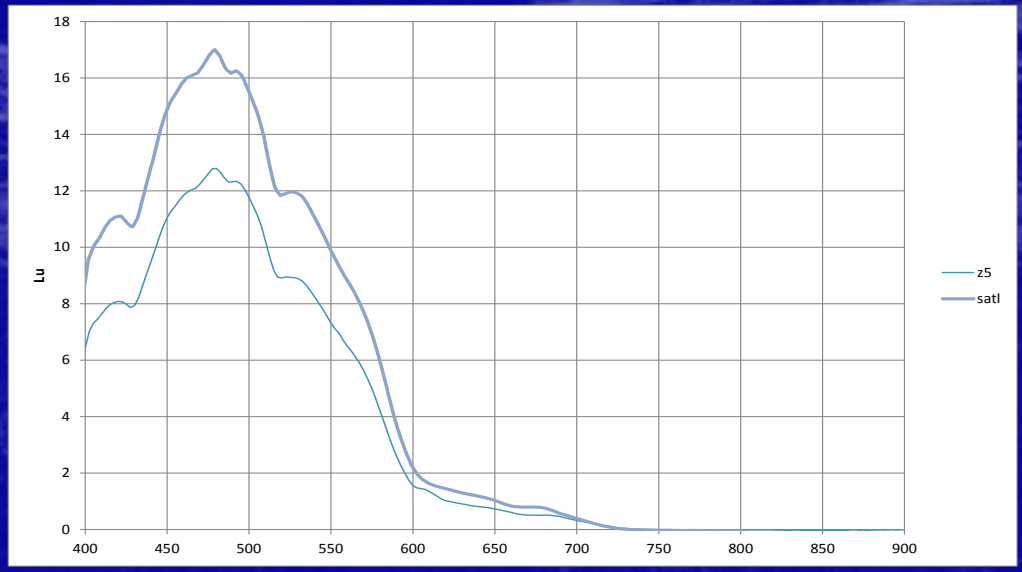
Gerald Moore
MVT, Oct 2011 (11/15)

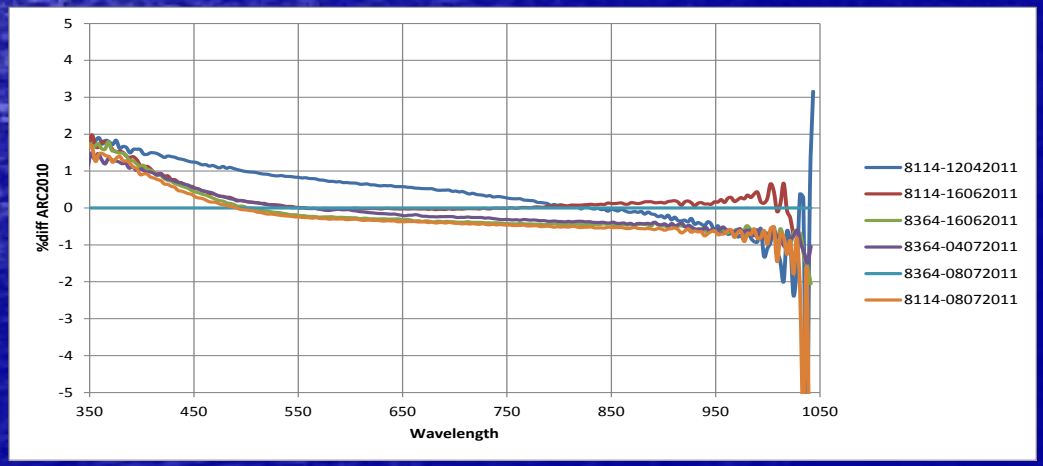
Bio Optika

ARGANS

Radiance

Compared the TACCS at 0.5m and the Trios.
Trios always underestimated 24.9% and 12.8% difference at the two stations.
Slight spectral effect.





Calibration not an issue
Stable +/- 2% pre / post deployment.

Why – float shading?

Gerald Moore
MVT, Oct 2011 (12/15)

Bio Optika

ARGANS

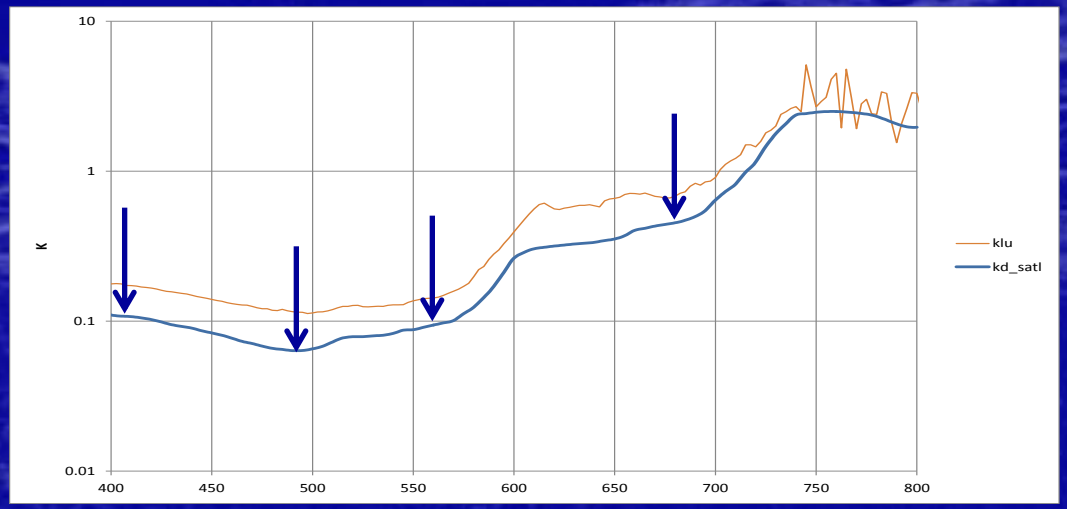
K_{lu} vs.. K_{ed}

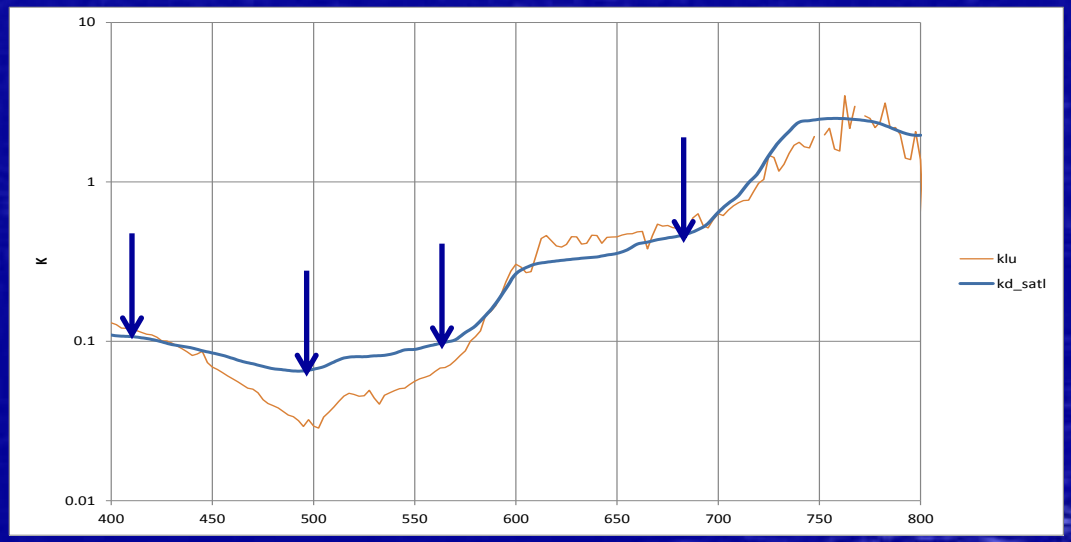
TACCS measures Ed(z) at 4 depths and 4 wavelengths.

K_{ed} calculated by log/linear regression. Spectrally interpolated by case 1 bio-optical model.

Profiler K_{lu} calculated by log/linear regression.

Results – may be affected by float shading, since better in NIR.





Gerald Moore
MVT, Oct 2011 (13/15)

Bio Optika

ARGANS

Conclusions

- **Rig**
  - **Stability good**
  - **Floats – problem with shading.**
- **Transmitter / Control**
  - **Functioned well – up to 400m / not problem with control**
- **Profiling Mechanism**
  - **Functioned – could have been faster.**
- **Active Gimbal**
  - **Functional – could have been faster.**
- **Optical Sensors**
  - **Real problems – Stability of Ed, NIR sensitivity**
- **Ancillary Sensors**
  - **Functioned well.**

N.B. ARC2010 – important for the proper evaluation – Thanks Giuseppe.

Future Developments

Major Problems

- **Rig - Need to improve floats**
  Transparent ?– difficult to model effect on light field.
  Toroidal ? – radially symmetric so 2d Monte-Carlo tractable.
- **Optical Sensors**
  Hyperspectral Ed (needed?) – for validation light weight 4 band sensor to constrain model.
  Hyperspectral Lu – upwelling light field does not match sensor sensitivity. Use two spectrometers / order sorting filter.

Simple design issue – 'cash'.

- **Transmitter / Control - ideally do more averaging.**
- **Profiling Mechanism – need better lead screw – budget.**
- **Active Gimbal – faster motor – better sensors – more robust.**
- **Ancillary Sensors – improve Tilt / Roll – better sensors available.**

Bio Optika

ARGANS