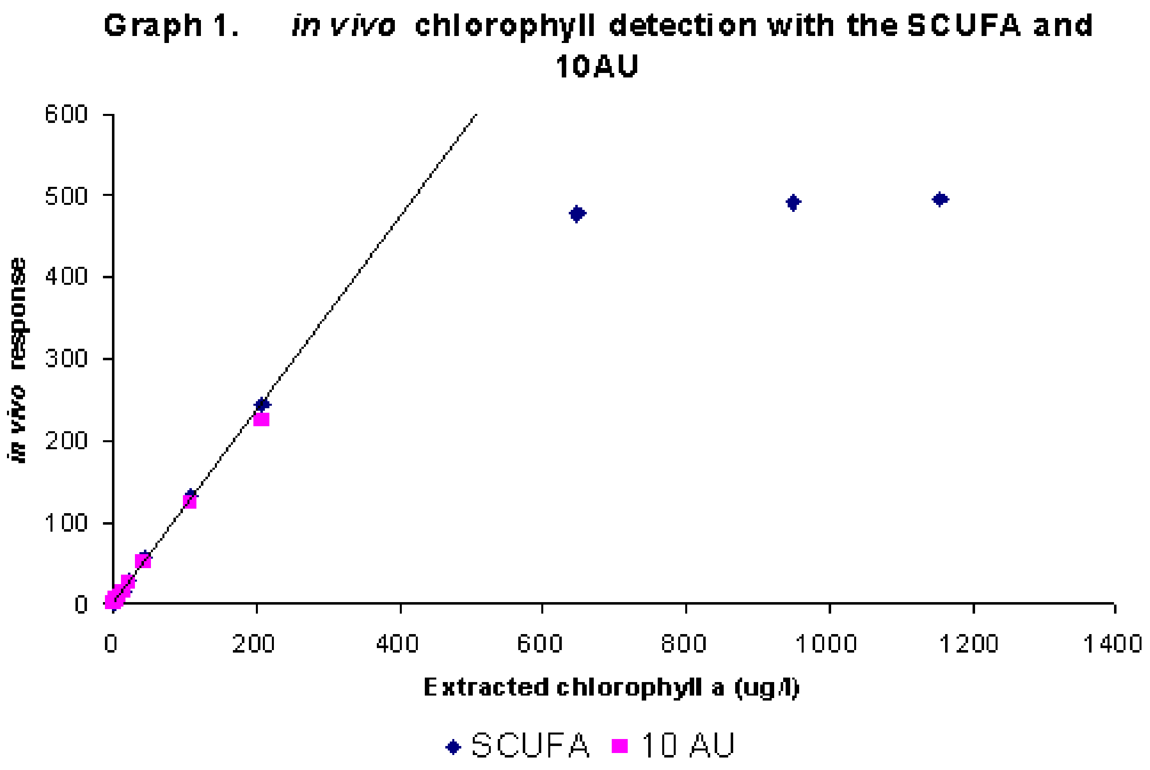
A Turner Designs Product Update

SCUFA® Submersible Fluorometer Performance Testing

1.0 Chlorophyll:

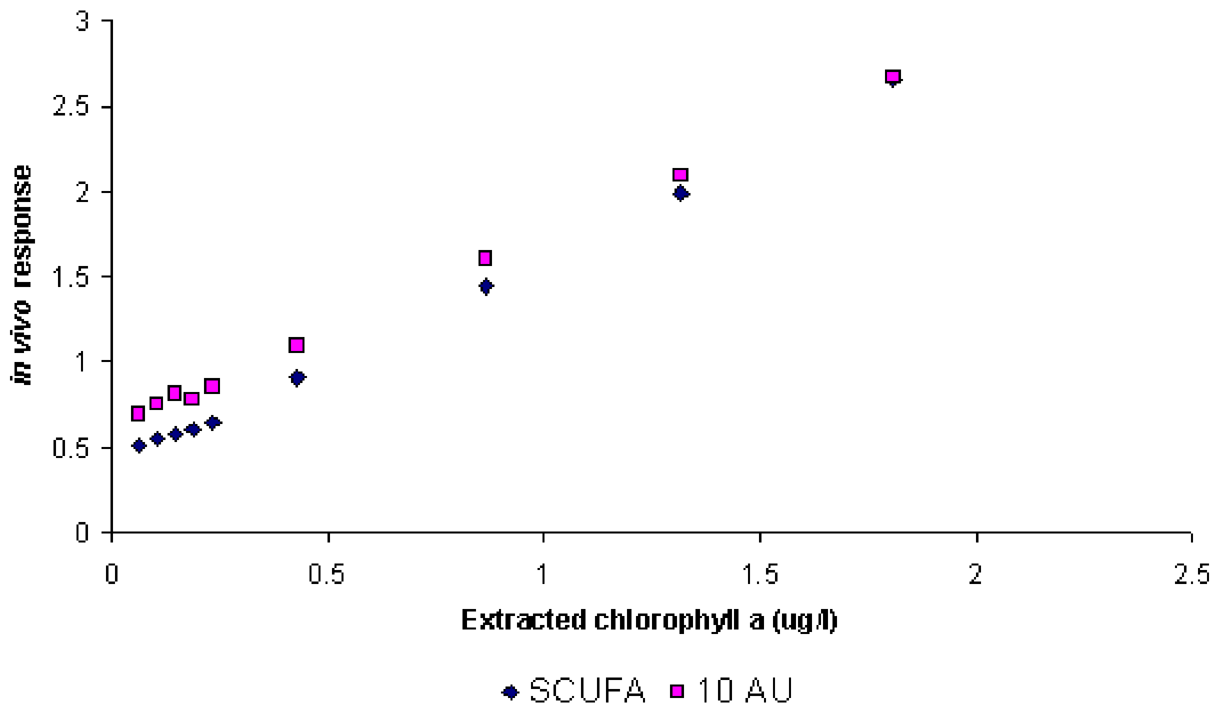
1.1 Range and Linearity:

The SCUFA® submersible fluorometer was calibrated in conjunction with Turner Designs' 10AU field fluorometer to measure in vivo chlorophyll. Dilutions of an Isochrysis sp. algal culture were used to span the range of both instruments. A sample of each dilution was immediately filtered and prepared for later extractive chlorophyll analysis. Analysis was performed on a separate 10AU configured with the 10-040 chlorophyll a optical kit.



The SCUFA® and 10AU both performed well in terms of linear range and detection limit. The in vivo chlorophyll samples spanned a concentration range of 0.05ug/l - 200ug/l (Graphs 1 &2). Both instruments were blanked with DI instead of seawater, which accounts for the slight baseline shift at the detection limit. Results remained linear through 200ug/l. Above that level, the signal response of the SCUFA® becomes nonlinear and plateaus at a relative value of 500FUs. The 10AU was calibrated in such a fashion that all samples above 300FUs were off scale.

Graph 2. Close up of the *in vivo* chlorophyll response



1.2 Response with interfering pigments

We also tested the SCUFA's® performance where other chlorophylls - b and c's- were at significant levels. These accessory chlorophylls historically interfere with the in vivo chlorophyll a signal. The SCUFA's® optics were specifically designed to minimize this type of interference. Three algal monocultures, Chroomonas sp. - a cryptophyte, Phaeodactylum sp. - a diatom, and Pycnococcus sp. - a chlorophyte, were used to test SCUFA's® response in environments with high chlorophyll b or c content. The first 2 cultures characteristically have significant levels of chlorophyll c1 and/or c2, whereas Pycnococcus sp. contains significant levels of chlorophyll b. In vivo response was then compared to extracted chlorophyll a content (Graph 3). For all 3 cultures, the SCUFA® responded linearly to the chlorophyll a content of each culture.
Graph 3. in vivo response with 3 species of algae SCUFA®fluorometer

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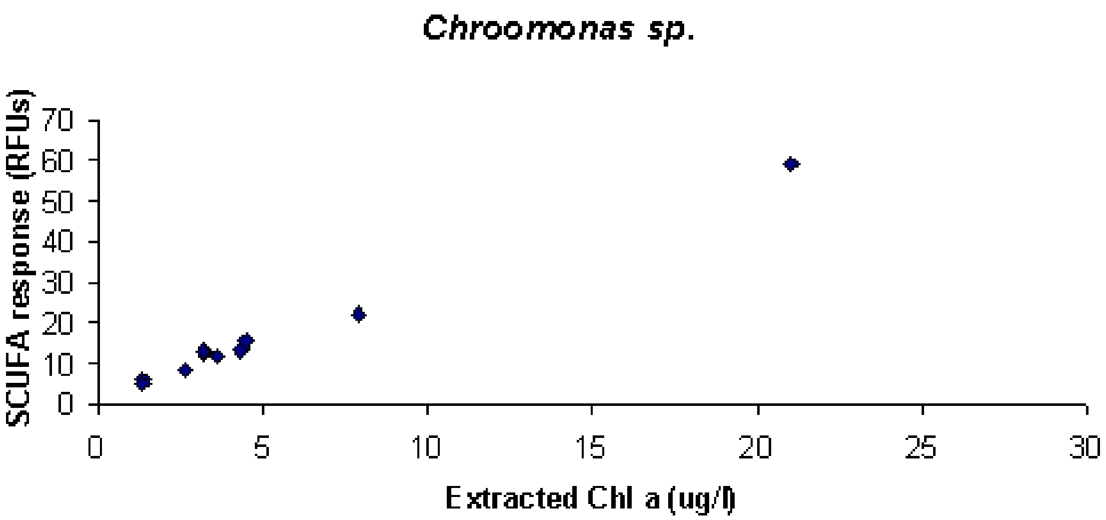
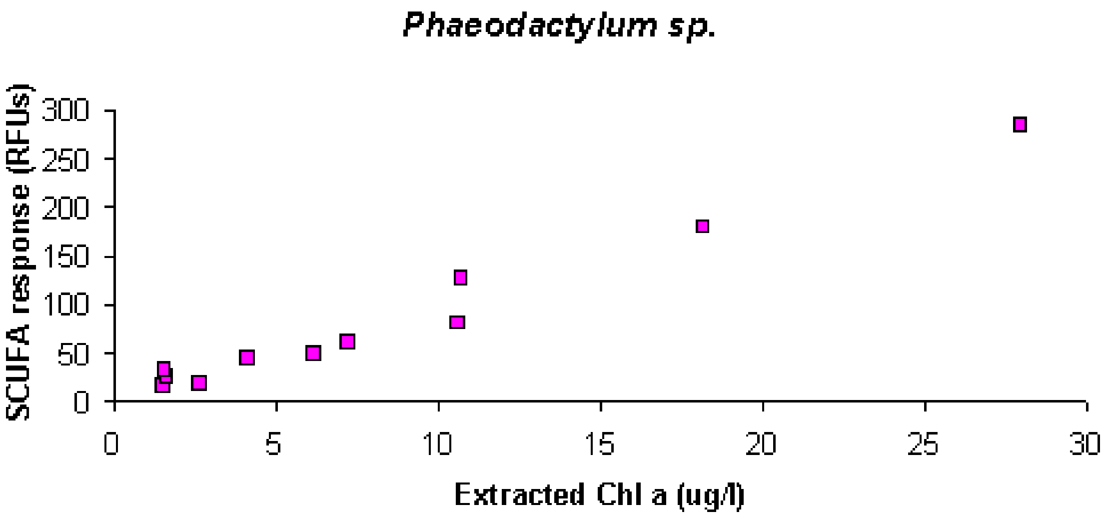
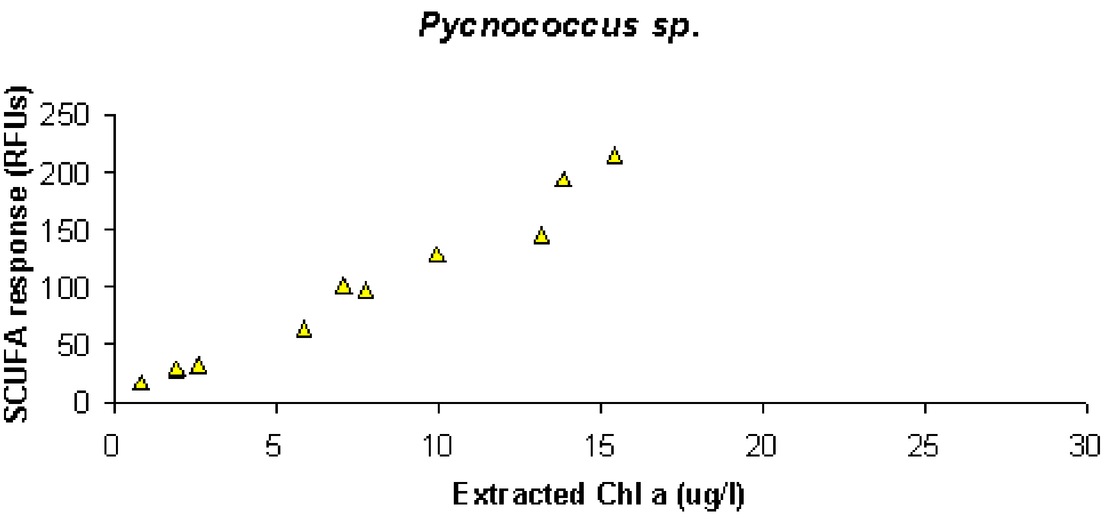
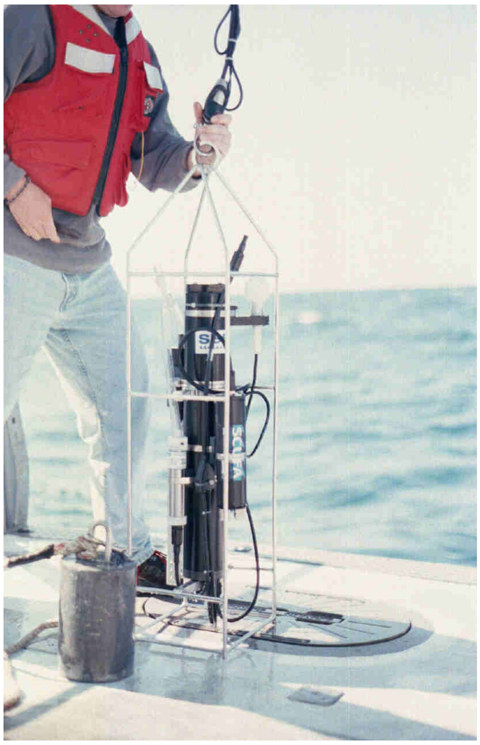






1.3 Comparisons to other submersibles

We compared the SCUFA® fluorometer to three fluorometers from other manufacturers in a field setting. On 2 separate occasions, the SCUFA® was deployed for vertical profiles, interfaced with a Seabird CTD. On the first date, the SCUFA® was paired with a Chelsea Aquatracka submersible fluorometer for comparison. On the second date, the SCUFA® was paired with a Sea Tech and a WETStar submersible fluorometer.



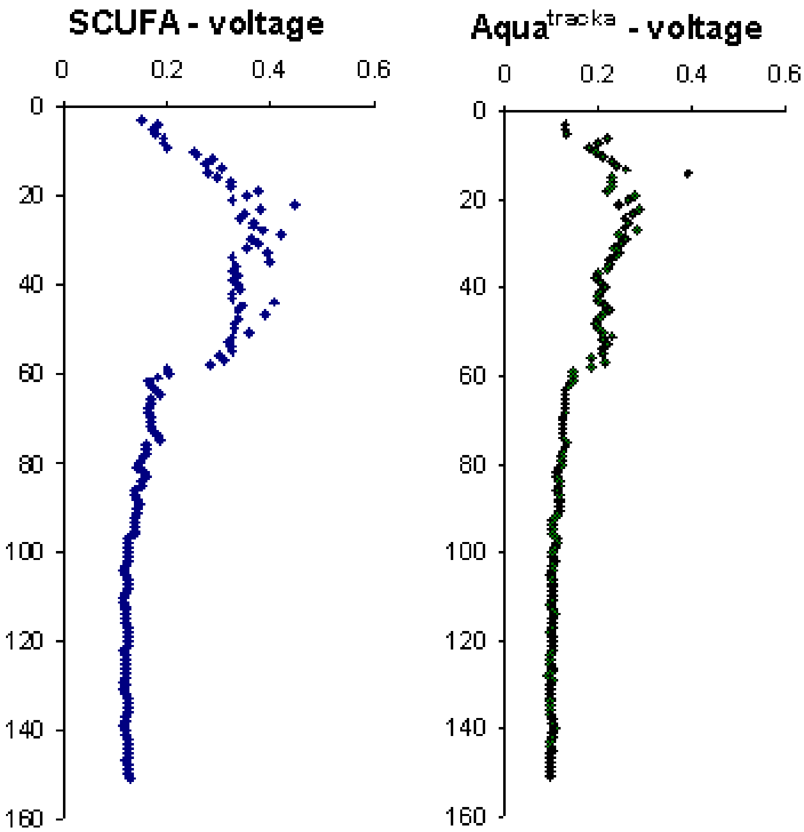
On the following page are Graphs 4 and 5 of vertical profiles using the SCUFA® in comparison to the Sea Tech, WETStar, and Aquatracka fluorometers. Note that results are not necessarily in the same units or ranges. Voltage output between instruments can vary greatly, and the output of the WETStar in this example is in relative fluorescence units, and not voltage. No instrument's output is in direct chlorophyll concentration.

On both days, basic trends in the chlorophyll profile were consistent across all instruments. The SCUFA® with its ability to tailor the 0-5V analog output provided better resolved data. This is most apparent on the second cruise, between the Sea Tech and the SCUFA® (Note the range differences in the x-axes). A surface grab sample was collected and later analyzed for actual chlorophyll concentration. Surface waters had a chlorophyll concentration of 1.06 ug/l. In this environment, the Sea Tech's output utilized only 1% of its 0-5V range. In contrast, the SCUFA®, which was calibrated in the lab before deployment specifically for the levels expected in Monterey Bay, utilized the full 0-5V range of the analog output over the day. This allowed for better resolution of the SCUFA's® analog data.

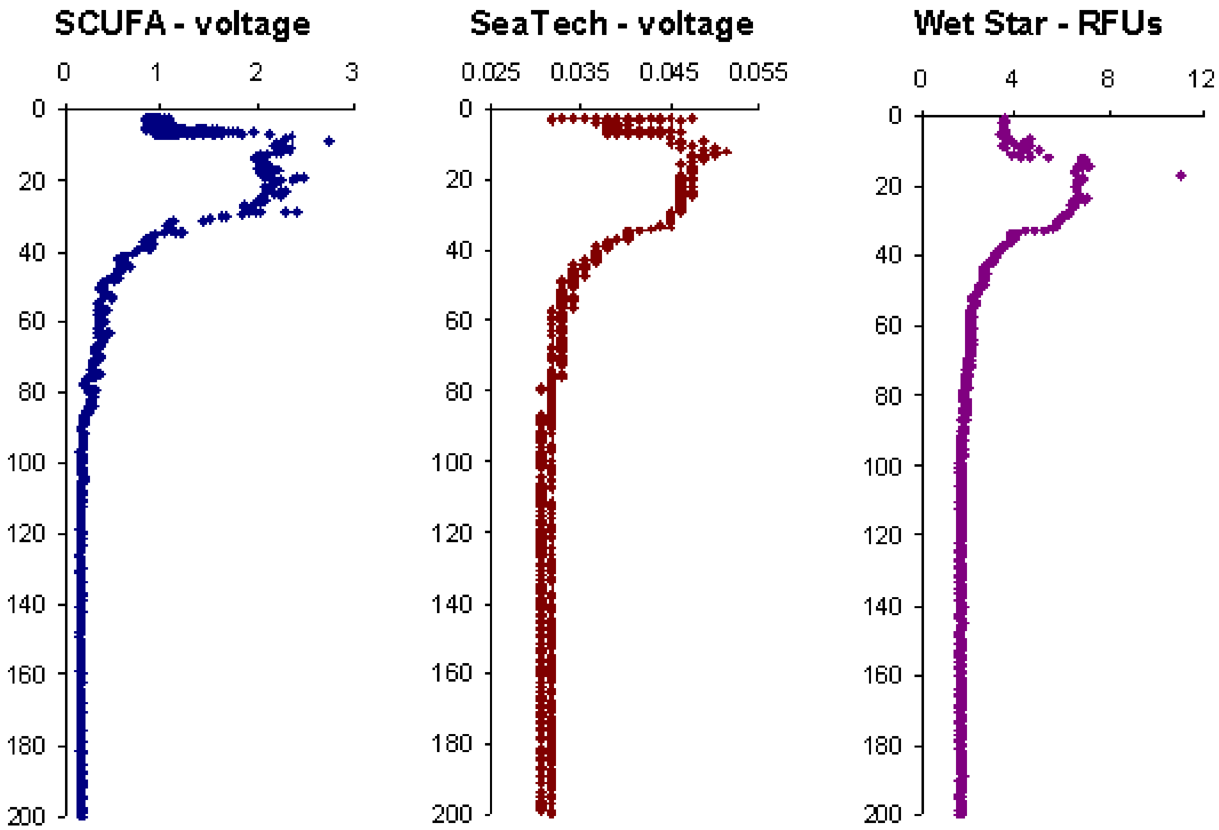
2.0 Rhodamine WT:

The Rhodamine model of the SCUFA® fluorometer (SCUFA® III) was tested against a Model 10 Field Fluorometer in a dye tracer experiment in a wastewater treatment plant. In Graph 7, the data was corrected for any temperature and time differences between the two instruments.

Graph 4. Comparison of the SCUFA® and Chelsea fluorometers on cruise #1

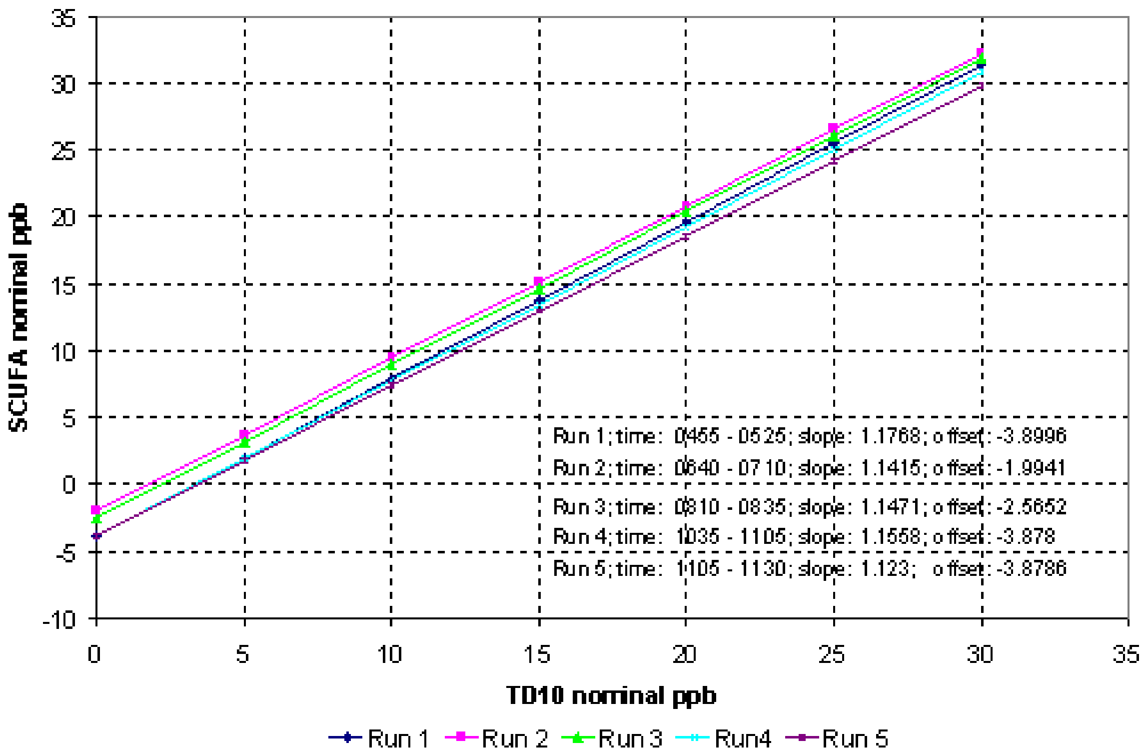


Graph 5. Comparison of the SCUFA®, Sea Tech, and WETStar on cruise #2

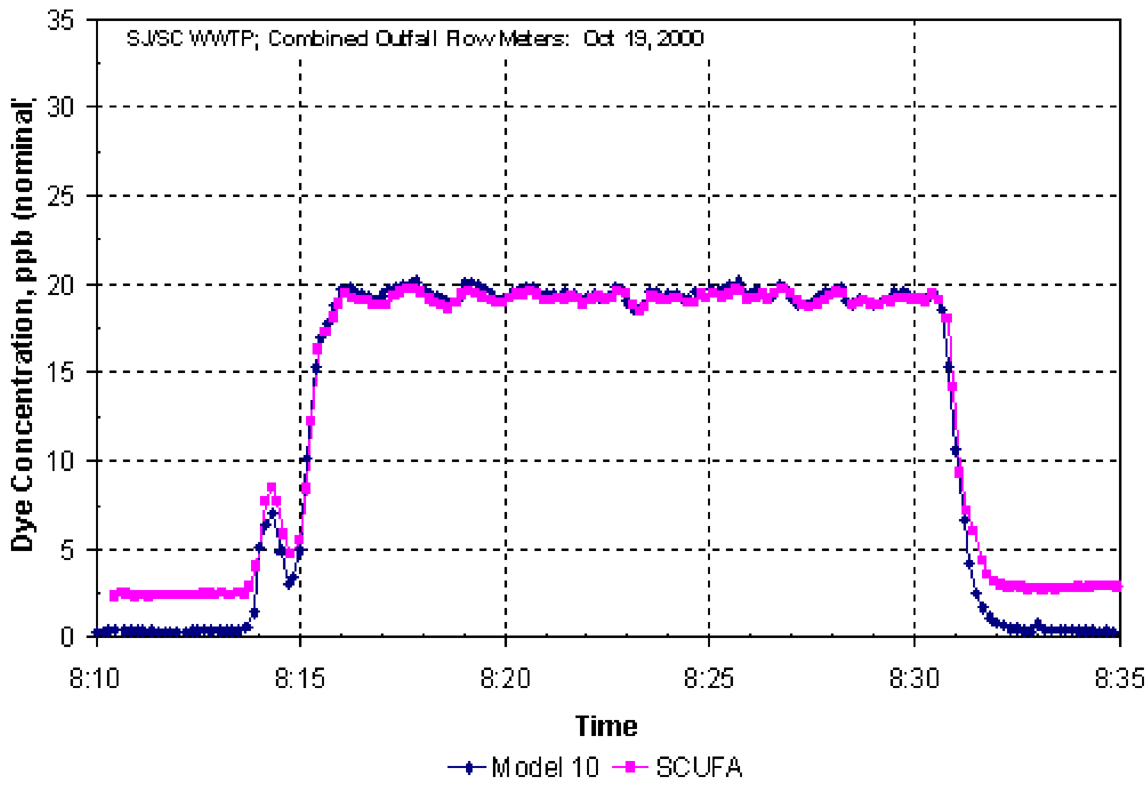


Graph 6 shows the very good correlation between the responses of the Model 10 and the SCUFA® III. The blank offset option of the SCUFA® was not used during the calibration and accounts for the baseline differences seen in Graph 7.

Graph 6. Slope and offset Comparison of Model 10 and SCUFA® over 5 test runs

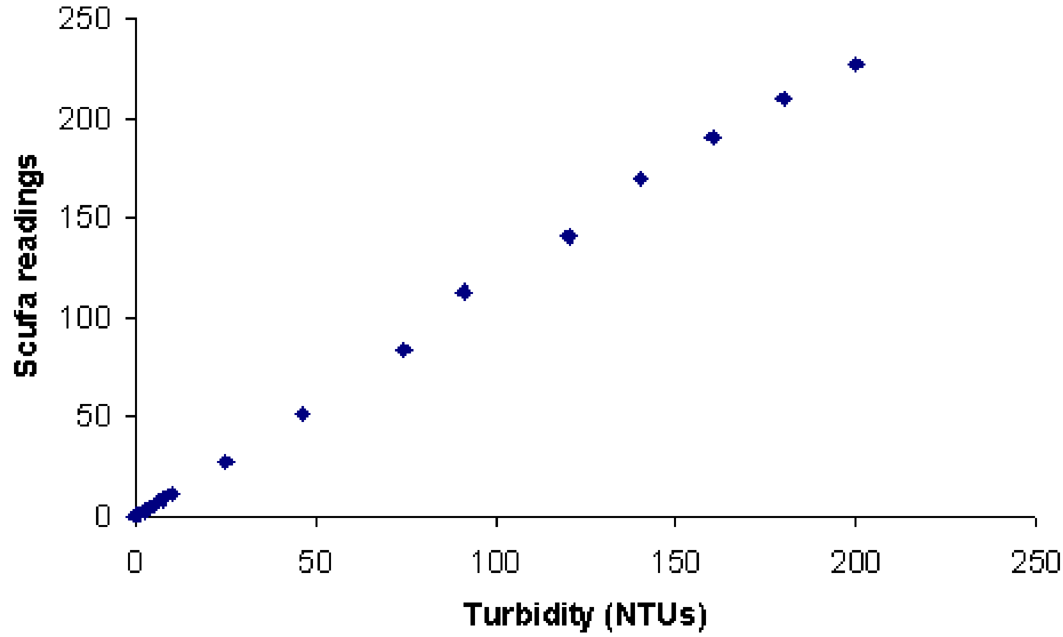


Graph 7. Real time comparison of Model 10 and SCUFA® RWT response
3.0 Turbidity:

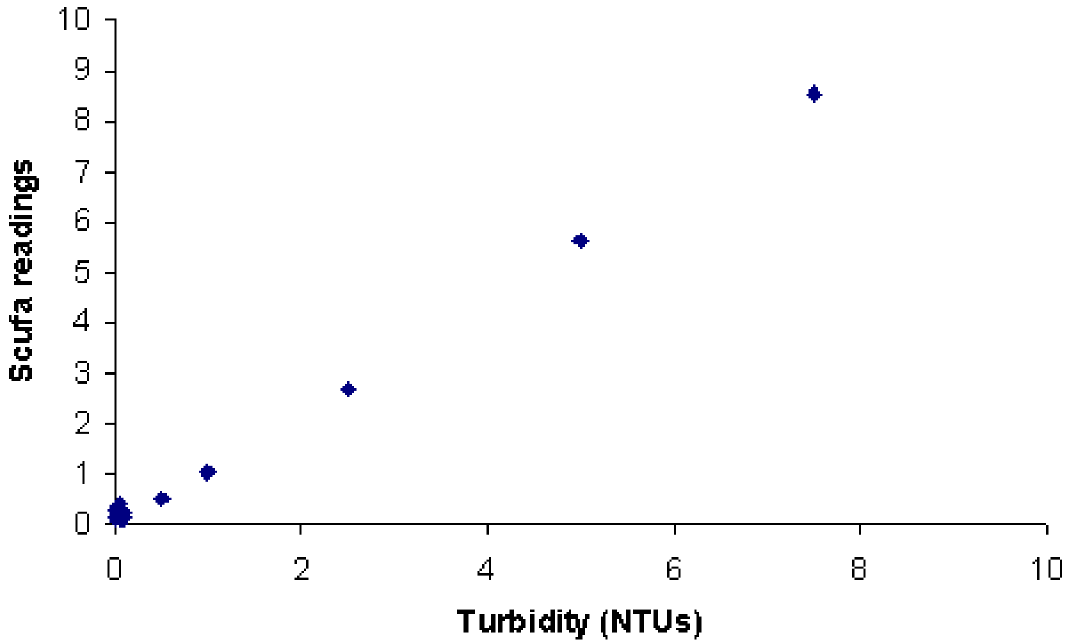


Turbidity performance and linearity was tested with APS microsphere turbidity standards from 200NTU down to 0.05NTU with the SCUFA®. The response was linear over the entire range. At detection limits, the quality of the source DI water greatly affected the resulting signal from the SCUFA®. We recommend for the very best blanking of the instrument to use DI water that has been allowed to sit in a clean bottle for at least 10 minutes to allow for all microbubbles to dissipate.

Graph 8. Turbidity response of the SCUFA® from 0 - 200NTUs



Graph 9. Turbidity response of the SCUFA® from 0-10NTUs



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APS Analytical Standards Inc.
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Deployment cables:

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P: 800-327-0971
F: 858-565-1649
Email: impluse@impulse-ent.com