

# Comparison UVT sensors

To compare the performance of a WTW UVT sensor and a UVT sensor from a market companion, tests were performed in the laboratory using artificial samples that mimic a variable turbidity effect. A RealTech Lab UVT instrument was used as the reference instrument.

In contrast to e.g. turbidity measurements no definition for the optics exists for UVT measurements. But the used optic has an influence on the UVT measurement. Therefore it was important that for this test a lab reference instrument is used that gives the same UVT readings as the lab UVT instrument Wedeco used in the past to develop, dimension and control their UVT disinfection units.

Wedeco stated that the used RealTech lab UVT instrument is giving the same UVT readings also under varying turbidity conditions as the UVT5 lab instrument which was used by Wedeco in the past.

## Test equipment

As test equipment a RealTech Lab UVT instrument (provided by Wedeco Herford, Germany), a WTW UV 705 IQ SAC sensor as well as a UVT sensor with 50 mm gap size of a market companion were used.

Sensors were checked first with deionized water, the RealTech lab instrument was calibrated every day using deionized water. Both online sensors were set to similar settings:

- WTW Sensor: Signal averaging 10 min, ultrasonic cleaning
- Sensor market companion: Signal averaging 10 min, wiper cleaning every minute

The general laboratory experimental set-up is shown in figure 1.



Fig. 1) The online sensors were placed in an acrylic-cylinder in a way that the measuring windows of both sensors were located at the same level. Turbidity standard was added in 6 steps

## Test Results

### Stability Test

First tests using standard settings of the online sensors were done in deionized water to check if stable conditions could be achieved in the used set-up (fig 2). The market companion's sensor measured values of approx. 100 UVT %  $\text{cm}^{-1}$ , the WTW sensor measured values in the range of 98,3 to 99 UVT %  $\text{cm}^{-1}$ . Grab samples taken out of the acryl cylinder were used for the reference measurements with the RealTech lab instrument.

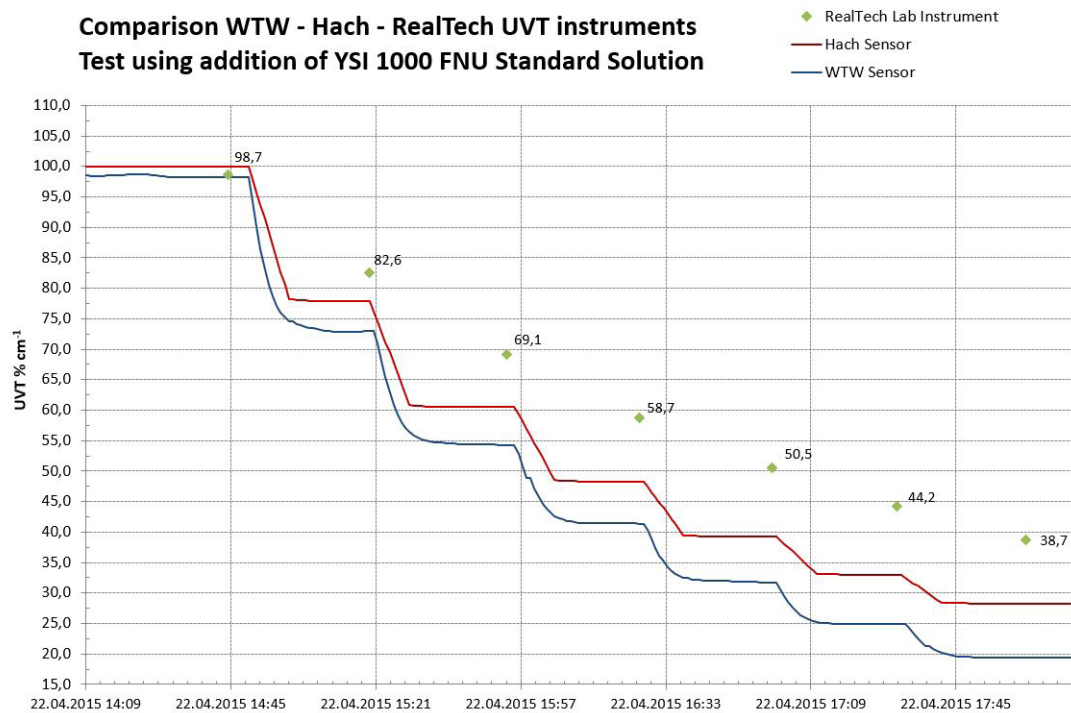


Fig. 2) For first UVT instrument comparison tests deionized water was used, to check if stable conditions can be achieved in the set-up

### Turbidity influence test

In 6 steps YSI 6047 turbidity standard was added to the deionized water in the acryl cylinder to increase turbidity. Increased turbidity shows for both sensors the already known decrease in the UVT value compared to the RealTech lab Instrument, underestimating the UVT values (fig. 3).

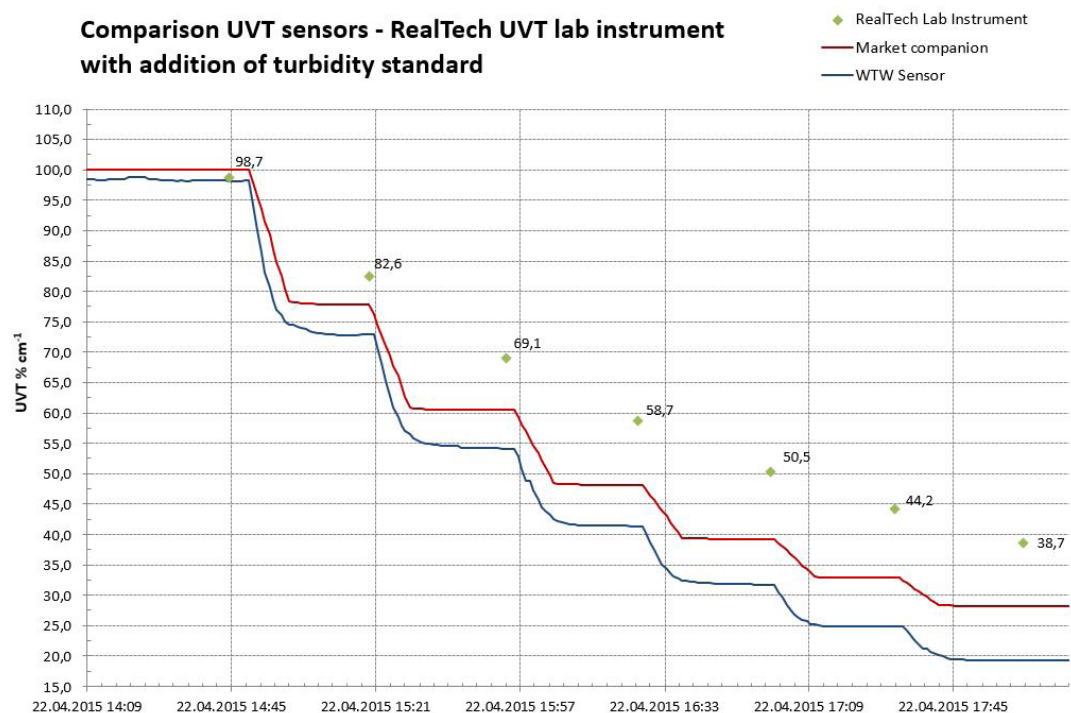


Fig. 3) Addition of turbidity standard in 6 steps and the corresponding UVT value changes of the two sensors (continuous measurements, blue and red line) and of the lab instrument (grab samples, green rhomb)

## Sensor adjustment - WTW

Adjustments/user calibrations of the sensors were done on the computer using the online values of both used sensors and the values of the RealTech instrument for reference values.

	# Raw Sensor Data UVT % $\text{cm}^{-1}$	Lab reference Data UVT % $\text{cm}^{-1}$
value pair 1	15	37
value pair 2	98	100

Table1): Calculated value pairs for the user calibration of the WTW sensor

Using these two value pairs the WTW sensors online values were re-calculated showing then a good match with the lab reference values (fig. 4).

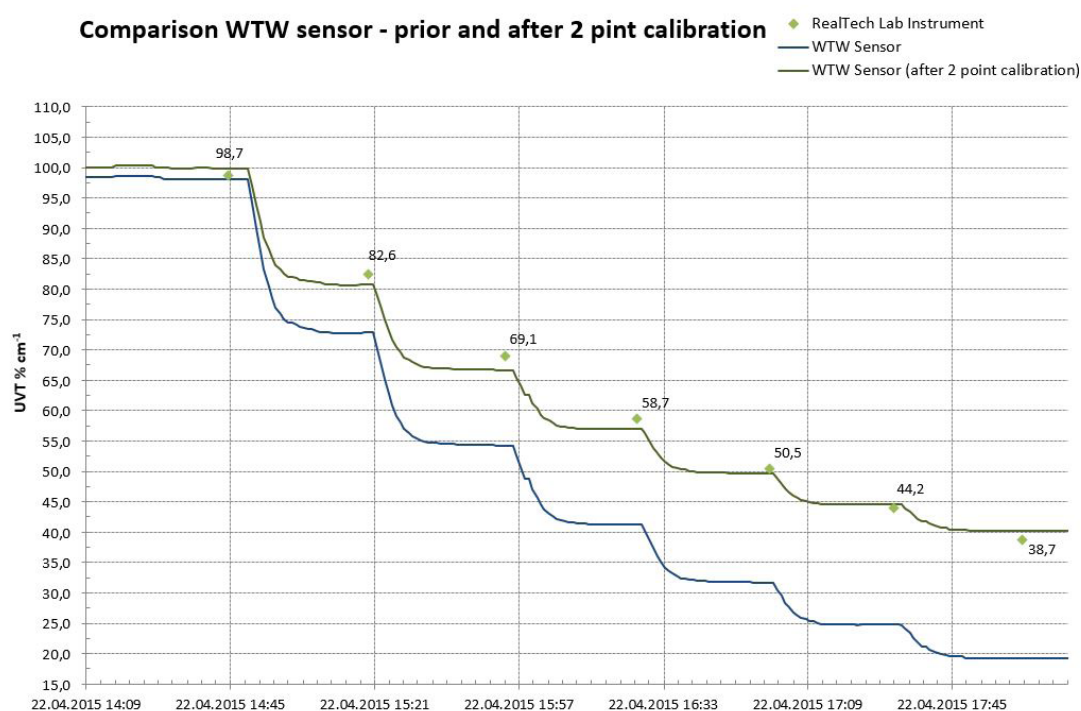


Fig. 4) Raw and corrected UVT values of the WTW sensor values using a 2-Point User Calibration (the standard adjustment procedures of the WTW sensor)

Maximum deviation of corrected WTW sensor values and lab values were between -2.4 and 1.7 UVT %  $\text{cm}^{-1}$ , see table 1.

	RealTech UVT % $\text{cm}^{-1}$	WTW UVT % $\text{cm}^{-1}$	WTW UVT % $\text{cm}^{-1}$ <small>corrected</small>	Difference WTW UVT % $\text{cm}^{-1}$ <small>corrected</small> - RealTech
22.04.2015 10:00	99.0	98.6	100.3	1.3
22.04.2015 14:45	98.7	98.3	100.1	1.4
22.04.2015 15:20	82.6	73.0	81.0	-1.6
22.04.2015 15:54	69.1	54.2	66.7	-2.4
22.04.2015 16:27	58.7	41.4	57.0	-1.7
22.04.2015 17:00	50.5	31.7	49.7	-0.8
22.04.2015 17:31	44.2	24.9	44.6	0.4
22.04.2015 18:03	38.7	19.4	40.4	1.7

Table 1: Comparison of lab, WTW and corrected WTW sensor UVT data

## Sensor adjustment - market companion

For the market companion's sensor it is only possible to use a factor in the range of 0.8 - 1.2 to adjust the sensor. In principal it is also possible to do an offset adjustment, but this is only possible in very limited mE settings corresponding to approx. +/- 2,5 UVT % cm<sup>-1</sup> values. By using a single factor to adjust the sensor it is not possible to achieve good matching results with the lab instrument over the whole measuring range (fig. 5).

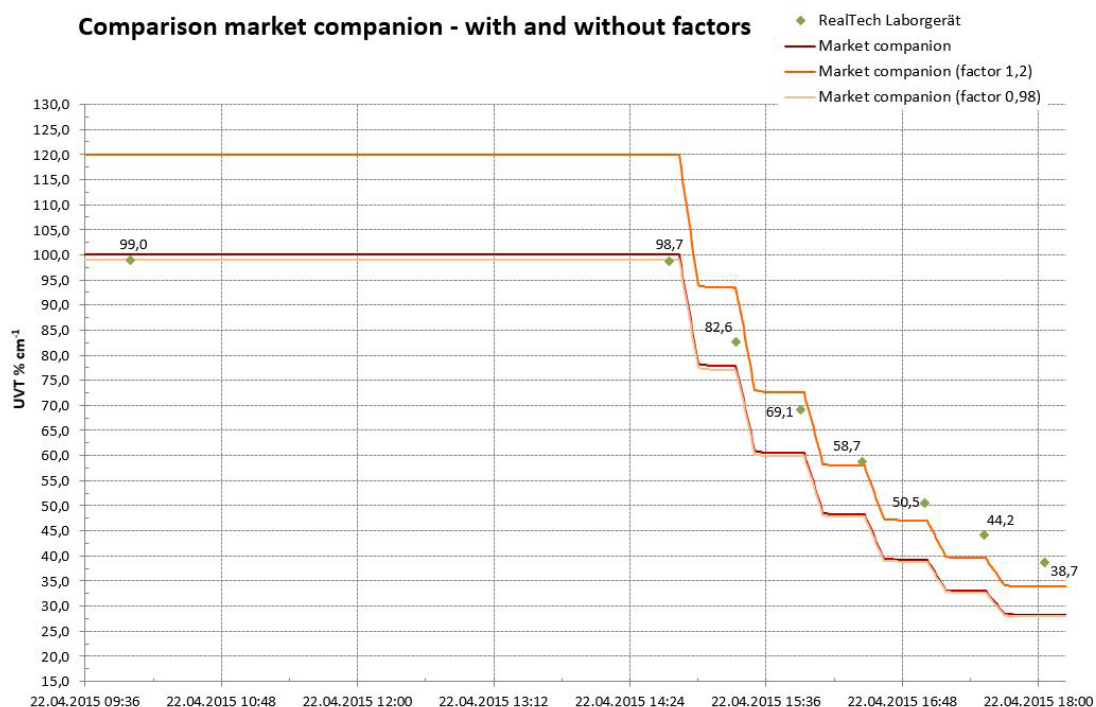


Fig. 5) Raw and corrected UVT values of the sensor of the market companion using 2 different factors (the standard adjustment procedures of the online instruments)

To ideally match all lab UVT values in this experiment the sensor would need different correction factors for the high, the middle and the low UVT range, respectively. But only one factor can be used in the sensor settings. Deviations of not corrected as well as corrected sensor values compared to the lab measurements as well as lab UVT values are summarized in table 2.

	RealTech UVT % cm <sup>-1</sup>	Sensor UVT % cm <sup>-1</sup>	Difference Sensor - RealTech UVT % cm <sup>-1</sup>	Difference Sensor <sub>corrected</sub> - RealTech using factor 0.99 UVT % cm <sup>-1</sup>	Difference Sensor <sub>corrected</sub> - RealTech using factor 1.20 UVT % cm <sup>-1</sup>
22.04.2015 10:00	99.0	100.0	1.0	0.0	21.0
22.04.2015 14:45	98.7	100	1.3	0.3	21.3
22.04.2015 15:20	82.6	77.9	-4.7	-5.5	10.9
22.04.2015 15:54	69.1	60.5	-8.6	-9.2	3.5
22.04.2015 16:27	58.7	48.3	-10.6	-10.9	-0.7
22.04.2015 17:00	50.5	39.2	-11.3	-11.7	-3.5
22.04.2015 17:31	44.2	33.0	-11.2	-11.5	-4.6
22.04.2015 18:03	38.7	28.3	-10.4	-10.7	-4.7

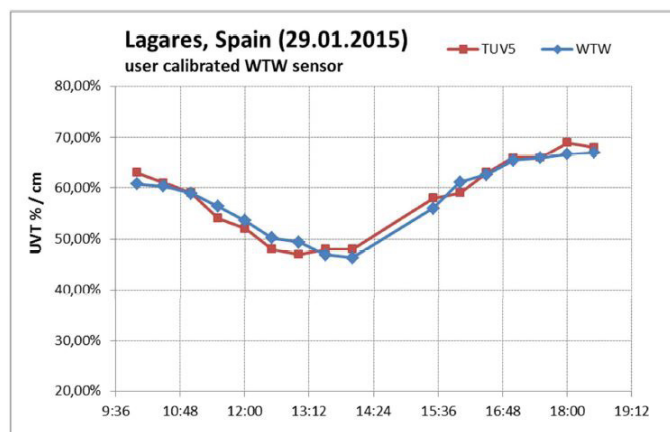
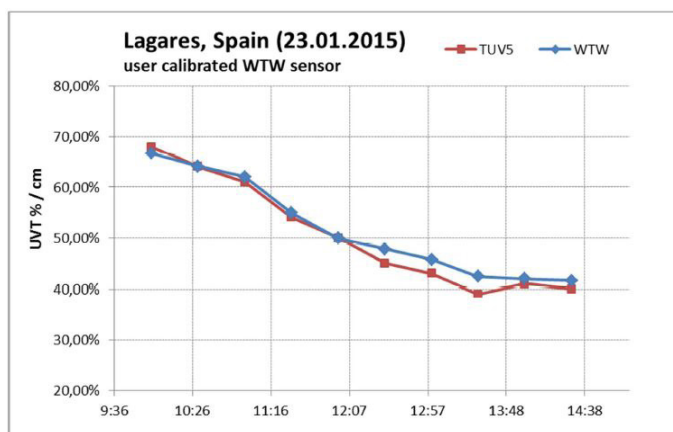
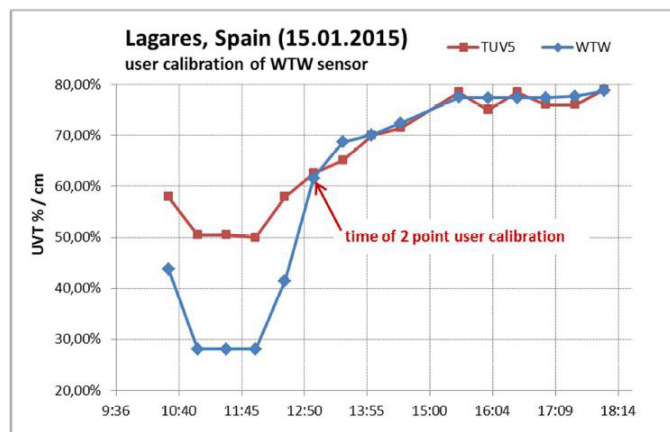
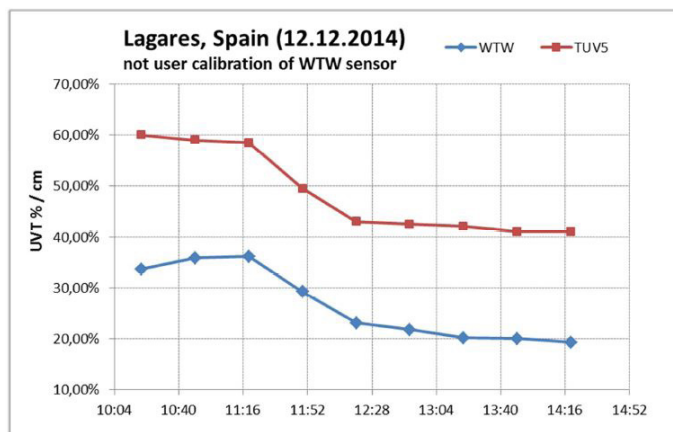
Table 2): Comparison of lab, sensor market companion and differences of this sensor and lab UVT data

## Conclusion

Both used online sensors showed large UVT value differences compared to the lab UVT instrument when turbidity was present. Therefore both sensors have to be adjusted to match with the lab UVT measurements. As the Wedeco UVT5 or the RealTech lab instruments were used to design the control strategy as well as to dimension the Wedeco UV disinfection units, the UVT online sensors have to match well with the lab instrument UVT readings over a wide turbidity range. This lab test as well as findings at a real plant in Lagares, Spain (see appendix), showed that the WTW UV 705 IQ SAC sensor (as well as other WTW spectral sensors which are able to measure the parameter UVT) can be adjusted via a two point user calibration in an easy way to match with the readings of a RealTech lab UVT instrument over large turbidity ranges. For the UVT sensor of the market companion used in this test, a match could only be achieved for a very small range.

## Appendix

Comparison of lab TUV5 and not adjusted as well as 2 point adjusted (user calibrated) WTW UVT Online data:



Do you have further questions?  
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