TWR-2050 Deployment Planning in *Ruskin.*

The RBR Software (known as “Ruskin”) enables the user to establish a coherent deployment for a TWR-2050 logger. Figure 1 shows a typical window for a TWR-2050 deployment configuration. The configuration tab is selectable in the right hand panel once the instrument is connected.

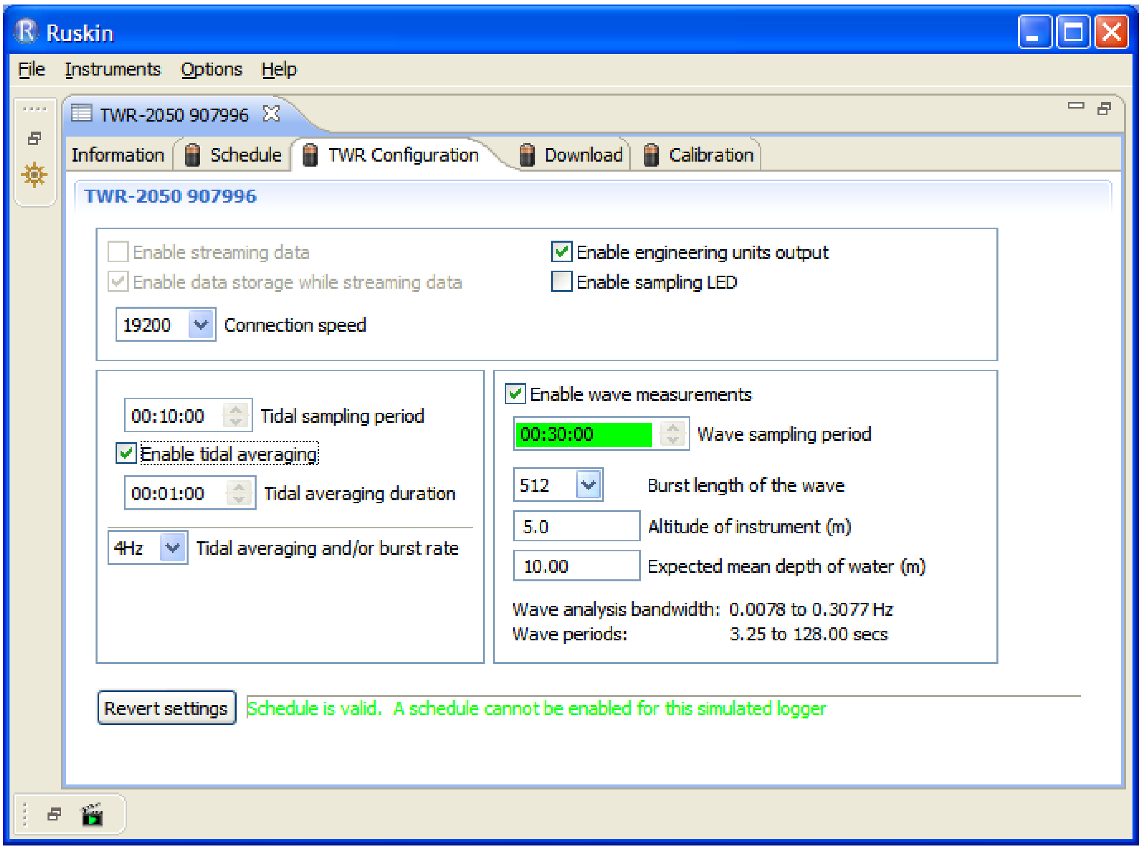

Figure 1. Typical TWR deployment configuration window

We will now walk through the setup step by step in the best way to establish a good deployment.

1. <u>Deployment plan</u>

The TWR-2050 will be fixed to a suitable support below the surface of the water, a dock or other rigid mooring. The TWR-2050 must not be able to move in the water. Figure 2 offers a view of the logger fixed to a dock with a definition of the different water heights.

• *Expected mean depth of water*: an estimate of the average water depth, used for the initial prediction of expected wave frequencies that can be detected. Ruskin will use the actual depth measured by the logger for its calculations
• *Altitude of instrument:* The actual height of the logger above the seabed. This is defined by the deployment, the logger will probably be fixed to the dock by a diver and the diver must be instructed on the precise placement of the logger
• *Total depth of water*: at any one time
total depth of water = measured *depth of logger* + *height (altitude) of logger above seabed*

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Hence knowing the height of the logger above seabed as defined by the placement of the logger and the depth of logger as measured by the logger, the total depth of water can be calculated.

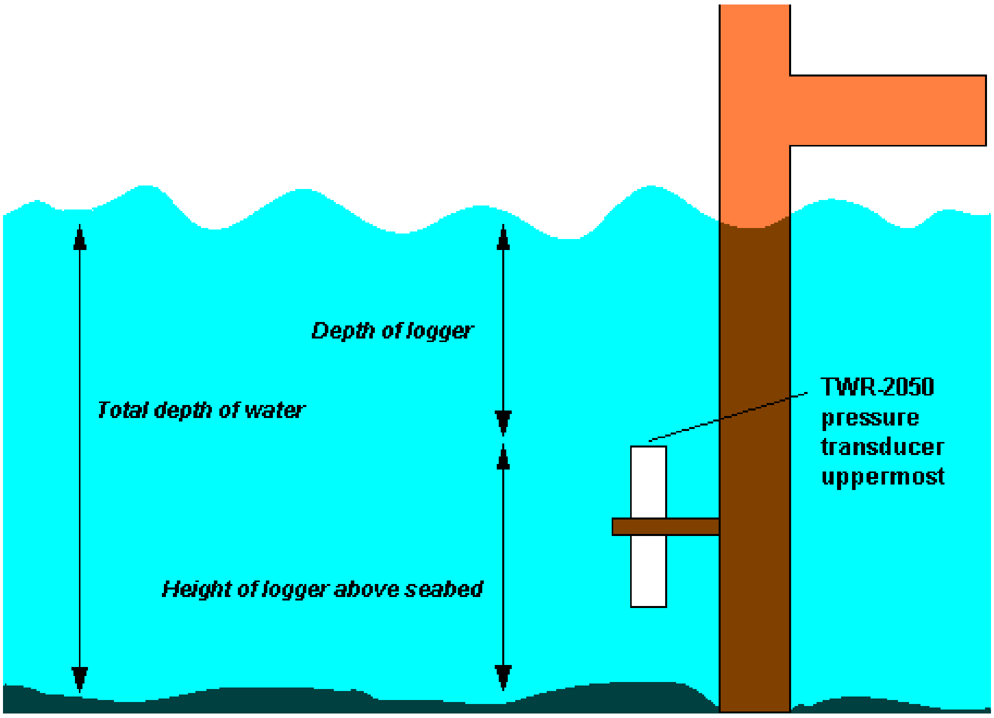

Figure 2. Schematic representation of the fixing of a TWR-2050 to a dock.

For deployment planning, the software needs to know the expected mean depth of water (in metres) and the expected altitude of the logger above the seabed to provide estimates of what the logger will be able to measure about the surface waves. The TWR-2050 measures water depth by means of a pressure transducer. The physics of what a pressure transducer can 'see' at depth depends on the height of water above the transducer *as well as* the amount of water below the transducer. High frequencies attenuate quickly with depth. Figure 3 shows the attenuation with depth as a function of wave frequency expressed as the wave period in seconds.
(*period* = *1/frequency*). What Figure 3 demonstrates is that the placement of the TWR-2050 is critical in defining the nature of the wave data to be captured by the logger.

The basic rule is to place the logger as close to the surface of the water without the possibility that the logger will emerge from the water either because of high waves or low tides.

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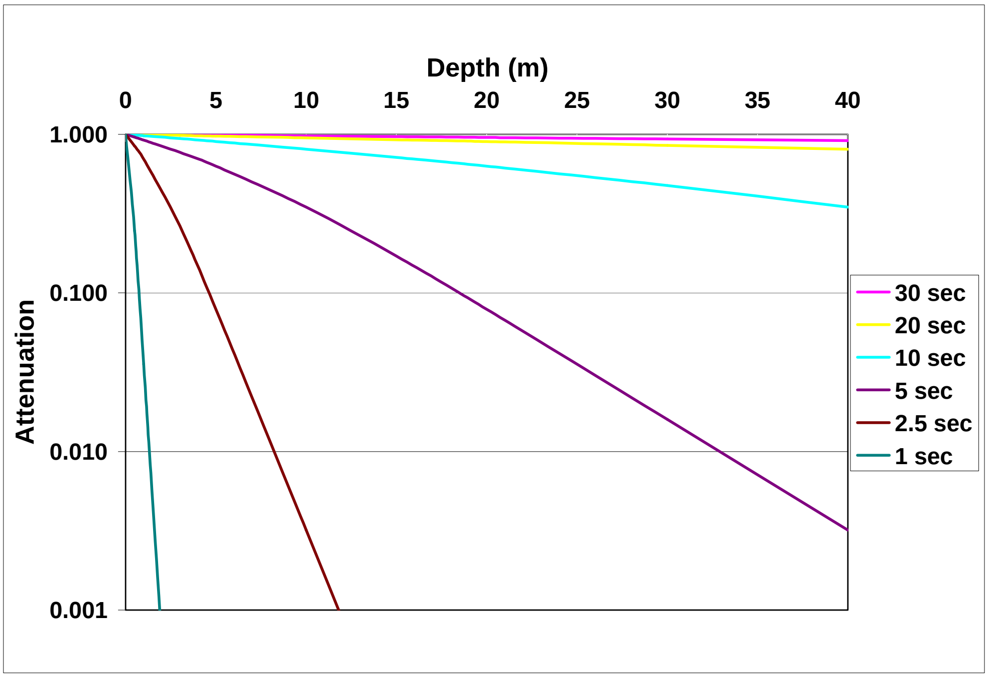

Figure 3. Wave attenuation as a function of depth for various wave periods.

This step in the deployment configuration requires that the 'expected mean depth of water', that is the total depth of water known from experience with the measurement site, and the 'expected altitude of the logger above seabed', a definition to be given to the diver, be entered. Note that on data retrieval the second value will be added to the measured depth of water above the logger when performing all wave calculations. (Figure 4).

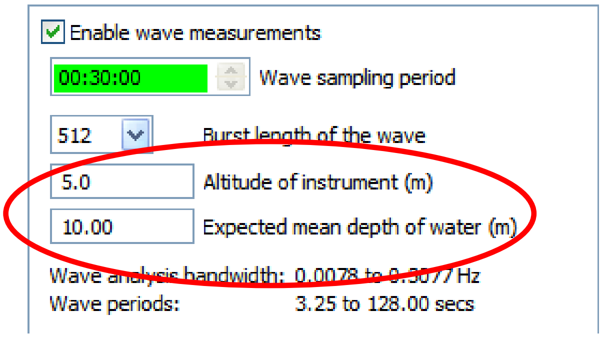

Figure 4. First step in the TWR-2050 deployment plan.

2. Tide Data

The next step of the configuration is to define the sampling period and averaging for the tides. The period between tides is 12 hours and 25 minutes. If we wish to reconstruct the tide signal with some precision, we need to sample the tide several times an hour. The typical rate is to sample the tide every 10 minutes. The TWR-2050 measures the tide as the height above the logger using the pressure transducer. However, all high frequency signals are removed by averaging the signal. Typically the tide pressure signal is averaged over a one minute interval. Longer intervals will reduce the noise on the tide signal but will increase the power consumption of the logger. Figures 5a & 5b show a typical setting of the tide parameters. Try changing the tide data parameters and notice the estimates of memory and battery usage on the left of the window.

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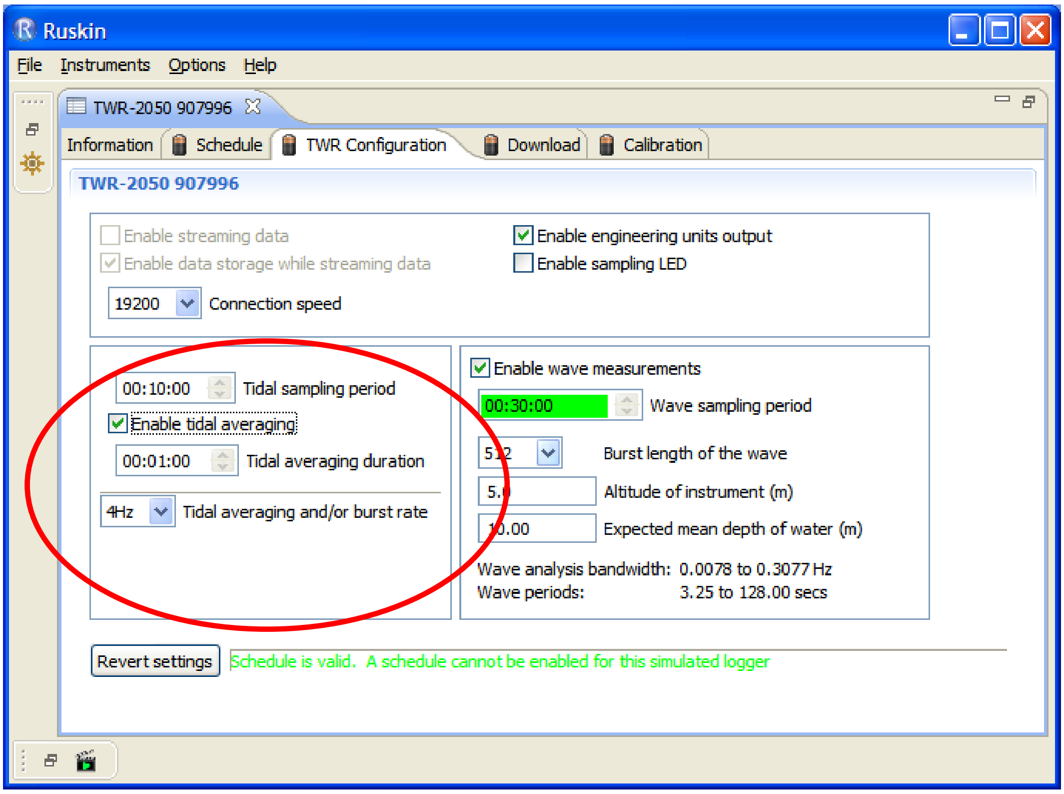

Figure 5a. Tide data parameters and usage estimates

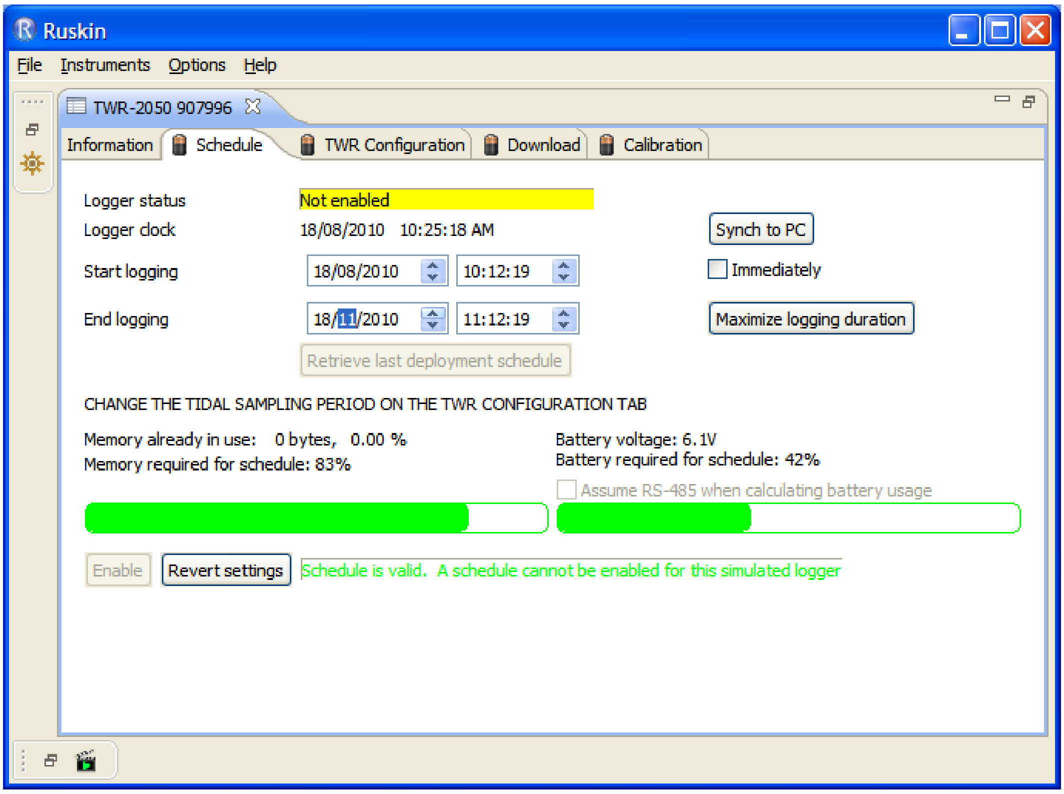

Figure 5b. Usage estimates (schedule tab).

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3. Wave Data

When waves are enabled, the TWR-2050 takes multiple pressure readings in a burst which allows for the reconstruction of the surface wave time series. There are three parameters which define the wave data:

- *Rate for both Tide and Wave data*: this defines the sampling rate for individual pressure readings used in both Tide and Wave calculations. The possibilities are 1Hz, 2Hz and 4Hz. The sampling rate defines several elements of the data capture:
  i. Firstly, the highest possible frequency visible in the data is limited to ½ the sampling frequency. However, this mathematical limit can not usually be achieved because of the attenuation characteristics shown in Figure 3.
  ii. Secondly, the sampling frequency defines the resolution of the frequency spectrum which can be calculated from the wave data;
  iii. Thirdly, the sampling frequency, together with the burst length, define the lowest frequency which can be assessed in a wave burst. (see below)

- *Tidal averaging and/or burst rate*: this defines how often wave bursts are collected. Storms take many hours to move into an area and a one hour period for sampling waves is usually adequate. In the TWR-2050 there is an implicit requirement that the Wave Period be an integer multiple of the Tide Period and so the up/down arrows add or subtract one Tide Period to the Wave Period.

  Furthermore, tidal averaging can proceed during the collection of a wave burst, however, the result must be queued for storage until the end of the wave burst. The design decision defined a maximum queue length of 4 tide results. When a configuration would require a longer queue, the error message of Figure 7 is displayed.

- *Burst Length*: this defines the number of samples in a wave burst. It must be a power of 2 and is chosen from the list: 512, 1024, 2048 and 4096. The longest wave period to be assessed is defined by: *burst length/sampling frequency*

The wave parameters work together to define the range of wave information which can be calculated as well as the memory and battery usage. As the parameters are varied, you will see changes to the estimates at the bottom of the window.

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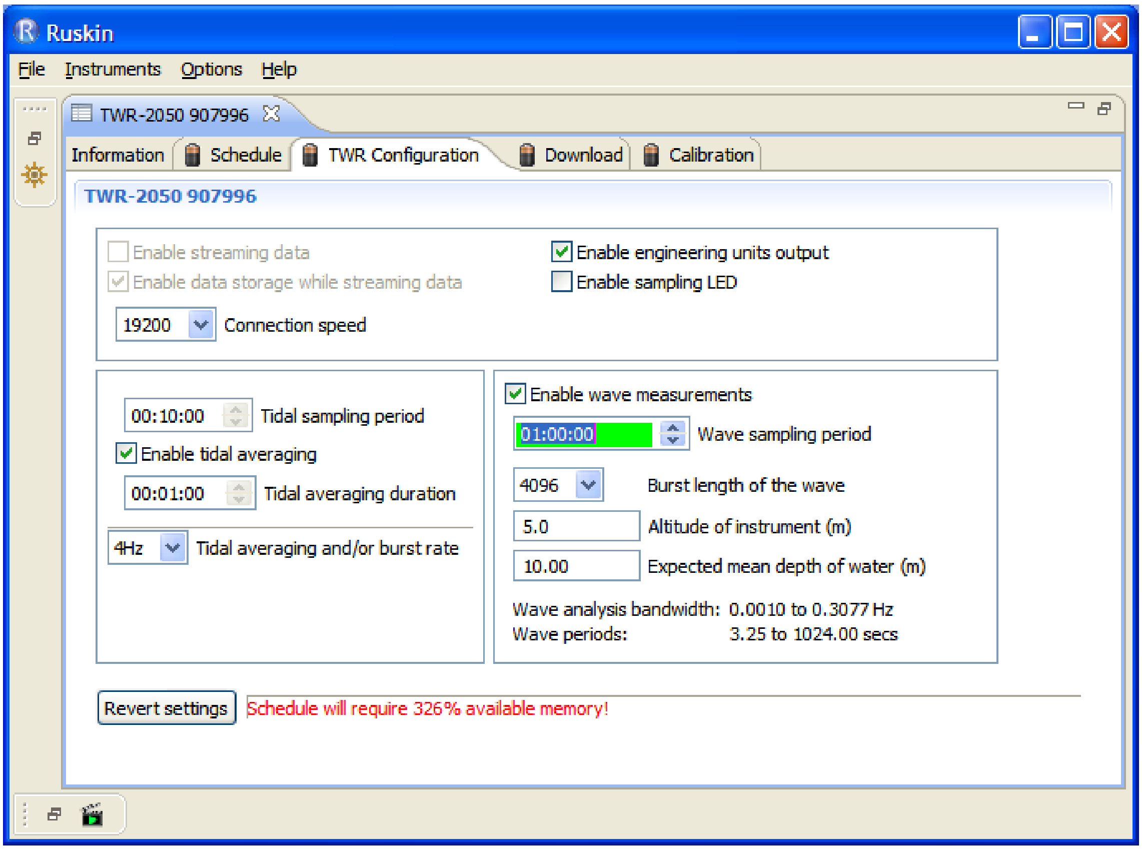

Figure 6a. Configuration window showing error reporting.

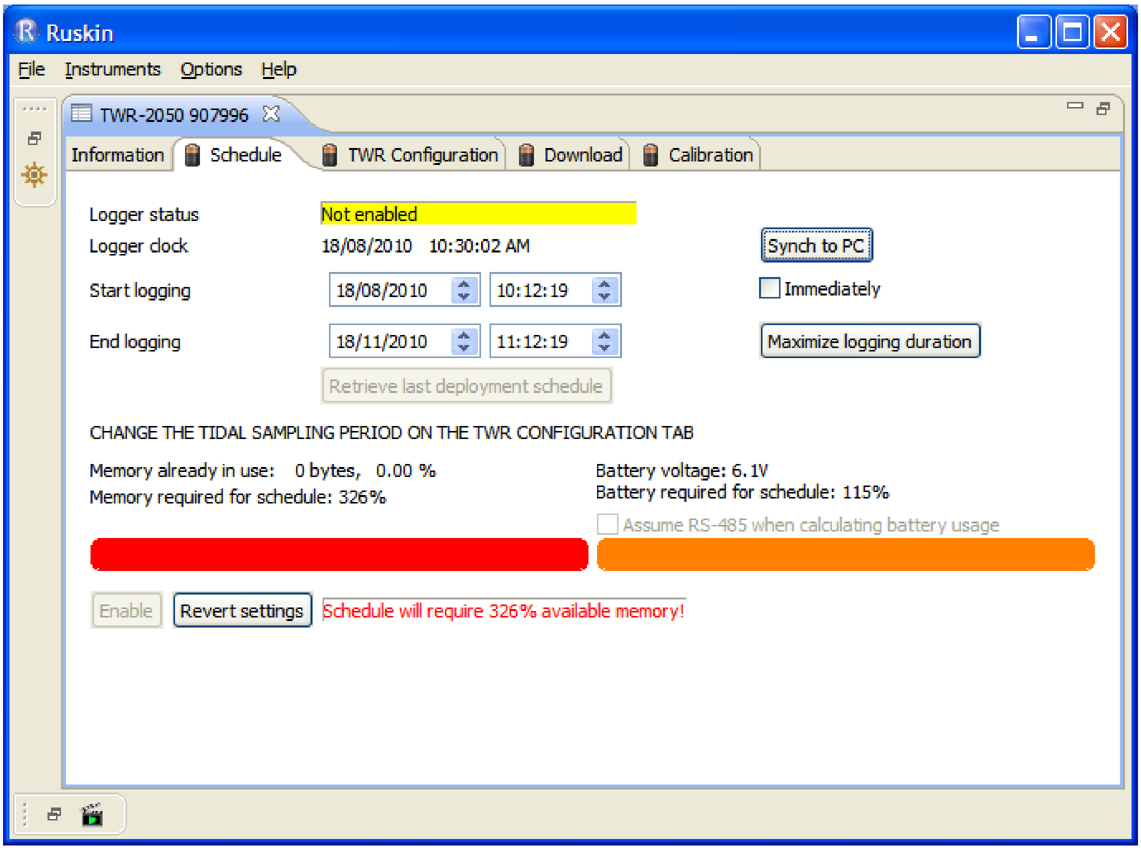

Figure 6b. Schedule tab

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4. Error Removal

In the example configuration window of Figure 6a & 6b, an error is indicated in the lower left corner. The proposed deployment would require a memory usage of 326% and a battery usage of 115% (1150 mAh). The TWR-2050 configuration window allows the user to try out various parameter settings and does not force the 100% memory usage limit on the configuration. Perhaps the user wants wave bursts of 4096 samples in length and would accept changing the deployment dates to allow for this. Or maybe the 3 month deployment defined by the dates is required and so the user would have to change the wave burst length or wave period to reduce the memory usage. 100% normal battery usage is defined at 1000mAh. It is for the user to adjust the configuration.

The wave and tide sampling regimens are interlinked – no more than 4 tide readings may be taken during a wave burst. If more frequent readings are attempted, a warning is shown (see figure 7.). Also, if a wave sampling interval is attempted that doesn't allow the burst to complete before restarting, a warning is given.

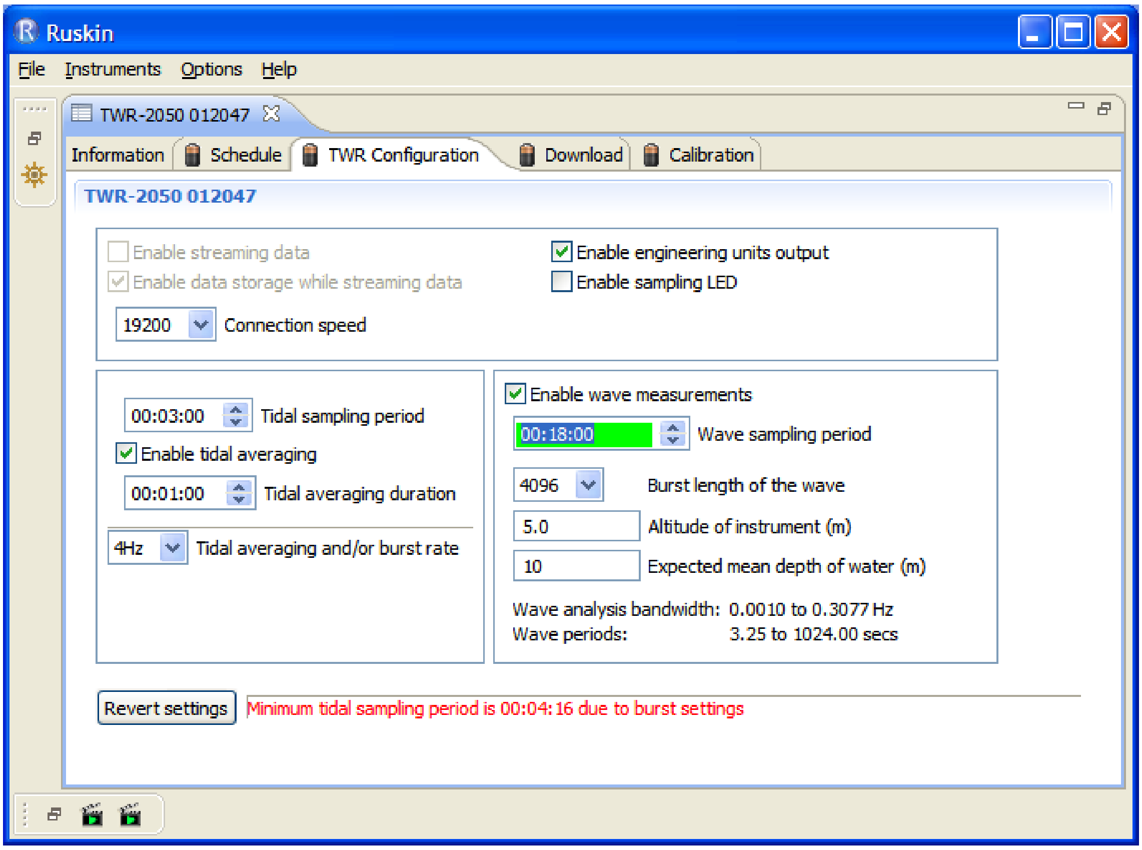

Figure 7. Error message when the required length of the embedded tide result queue exceeds 4 items.

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