# Measurement of Pulsed Sources with the IDR300-PSL

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This guidance is provide to assist in the measurement of pulsed sources with the IDR300-PSL system. It should be noted that the measurement of pulsed sources is outwith the specification of the IDR300-PSL, yet in many cases a successful measurement result may be obtained. It is expected that the measurement of single pulse sources- particularly flash lamps such as those used in cameras and IPL devices - will not be possible in following this procedure.

**Overview**

In the measurement of light emission of pulsed sources, two types of instrument are generally used, filter radiometers (followed by sufficiently fast detection electronics) and CCD-array spectrometers. In general, however, neither technique provides the accuracy of a scanning spectroradiometer, as may be sought in the consideration of source photobiological safety within the context of IEC/EN62471.

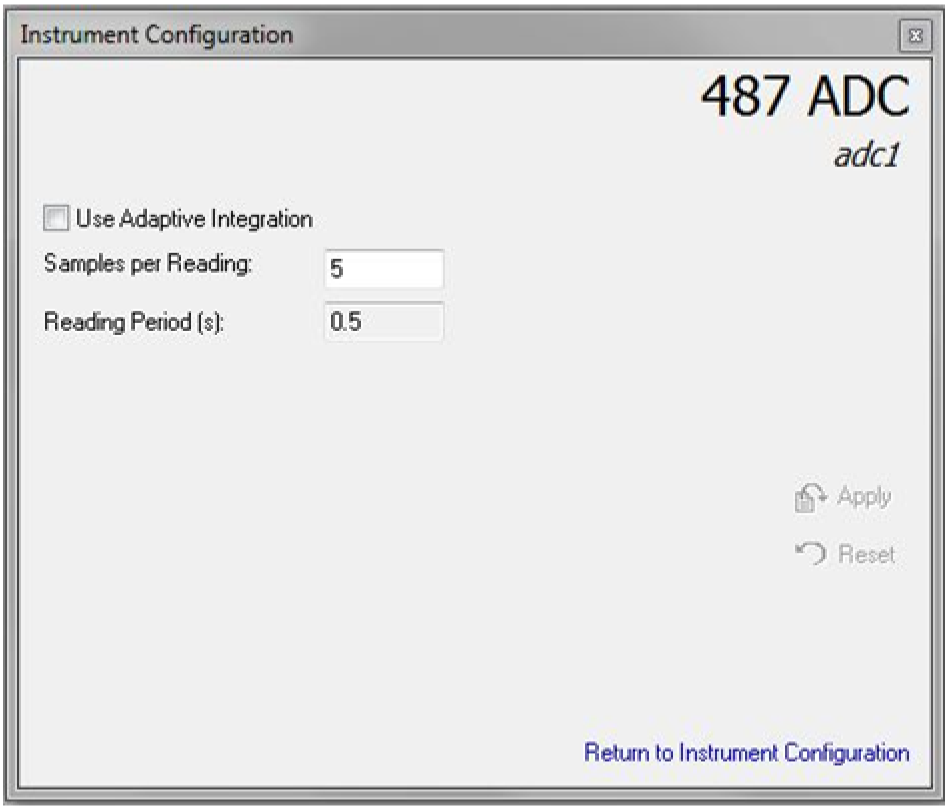
Currently under development at Bentham is a measurement solution based on IDR3000-PSL spectroradiometer with pulse detection electronics. In the meantime, in response to the numerous questions received on this matter, this note has been written to discuss the potential use of the IDR300-PSL system in the measurement of irradiance of pulsed sources.

**IDR300-PSL Detection Electronics**

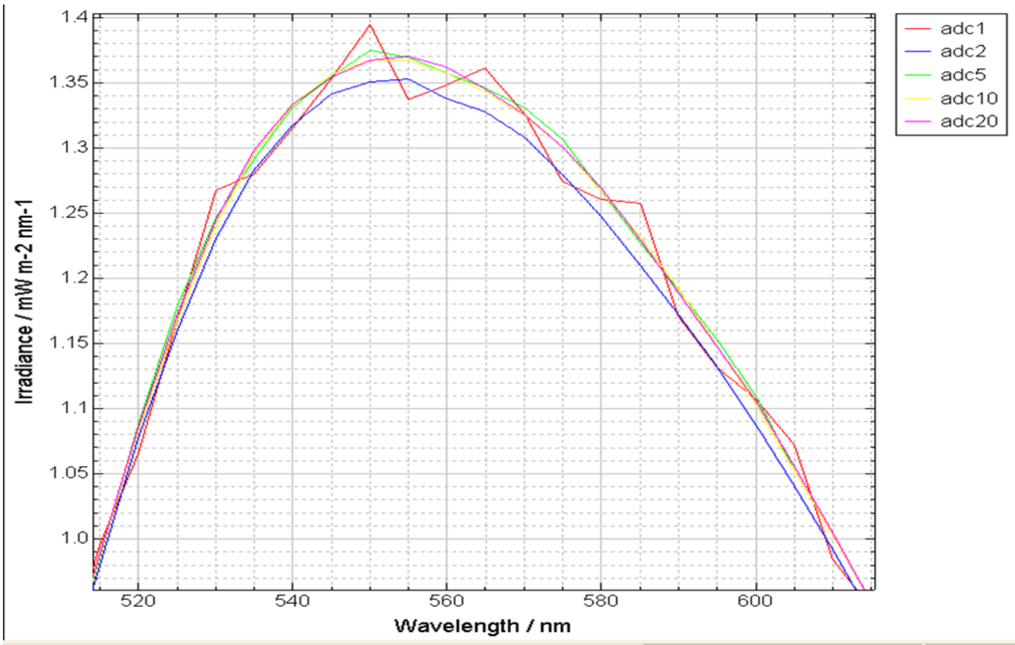
The detection electronics of the IDR300-PSL consists of two dual-channel trans-impedance amplifiers followed by analogue to digital convertors. The important consideration to make with regards the consideration of pulsed sources is the integration time of the ADC, 100ms. In normal operation, the photocurrent generated by the system detector is passed to the trans-impedance amplifier, the voltage output of which is integrated by the ADC. Depending on the result obtained, the measurement is either recorded or the gain range of the amplifier modified to increase or reduce the gain provided. In measuring pulsed sources with the IDR300-PSL, it is recommended to stop the ranging behaviour of the amplifier and to note that a time averaged result is obtained: it follows that this part of the procedure may only yield the relative spectral distribution of the source. It will be shown below how to obtain absolute values.

**Relative Spectra Distribution Measurement**

Given the 100ms integration period of the ADC and the synchronisation of the pulse and the time of integration, depending on the frequency and duty cycle of the pulsed source, may be measured anything from no pulse (integration time synchronised with off-time) to a whole train of pulses. Increasing the integration time will in most cases provide a more stable result by better sampling the data set. Integration time may be modified in Benwin+ through the instruments/ ADC 1 (2) menu item. ADC 1 is used in the spectral range 200-1050nm, and ADC 2 for longer wavlengths with the InGaAs detector.



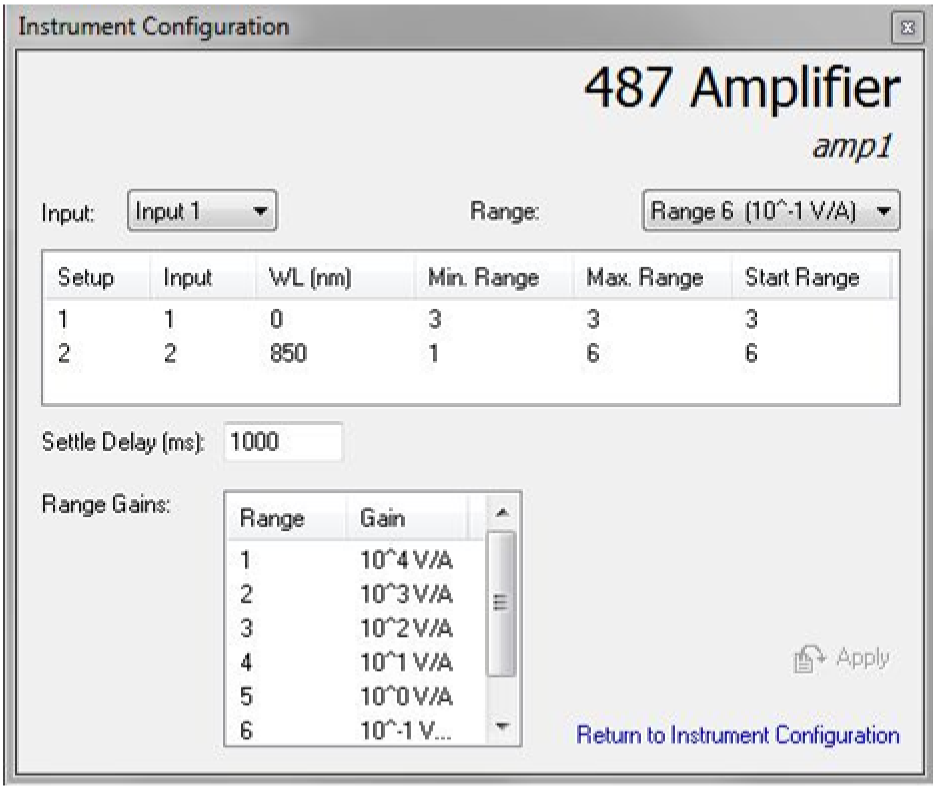

Ensuring that “use adaptive integration” is not selected, the number of samples taken per reading may be directly modified here. It is recommended to start with a low number of ADC reads, perform a measurement, and repeat the process with increasing number of ADC reads in seeking a reduction of noise, as seen above where the number of ADC readings is increased from 1 to 20.




Depending on the hazards considered, it is recommended to perform this relative spectral distribution measurement in both the irradiance and radiance configurations. Since the absolute measurement of radiance of pulsed sources should be performed with a 1.7mrad FOV, only this condition need e considered. Prior to performing the measurement of the pulsed sources, a system calibration with the CL6_H/CL7_H or SRS12 is required to provided a correct spectral result.

### Disabling Amplifier Auto-Range Function

In certain instances, it may be necessary to stop the amplifier from auto-ranging, which may otherwise fall into an endless loop of gain-range change as pulses are measured or not in the integration time. This can be implemented in Benwin+ through the instruments menu/ amplifier 1 (2).




For the detector in consideration, change the min, max and start ranges to the same number, starting from 6 (maximum gain) prior to performing a scan. Where Benwin+ returns ADC overload errors, the gain range should be decreased and the scan repeated. There is no easy way to determine which is the optimum gain range to apply other than by trial and error.

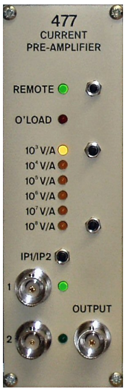
**Determination of  Pulsed Source Temporal Profile and Absolute Irradiance/ Radiance**
Rather than use the detection electronics integrated to the IDR300, use of the 477 pre-amplifier (part of AC detection electronics) and an oscilloscope will allow determination of the temporal evolution of irradiance / radiance from the source under test.

Light emitted from the source can be detected by one of two means. The IDR300-PSL can be set, using scan/ signal setup, to a wavelength at which the source emits light (determined from the relative spectral distribution measurement). The signal output of the corresponding detector should then be coupled to the 477 pre-amplifier input 1.

In the case of irradiance measurements, and only for "white" sources of light emitting, the DH400_VL photometric detector can be used to measure the illuminance of the pulsed source as a function of time, in which case this detector should be coupled to the 477 pre-amplifier input 1. This technique could be used in the measurement of radiance, but the TEL309-photometric detector ensemble would have to be re-calibrated against the SRS12.

The output of the 477 pre-amplifier should be coupled to an oscilloscope.

The sources under test should be set up as normal, 200mm from the input optic (D7 diffuser, TEL309 or photometric detector). The 477 gain range should be adjusted manually using the black buttons to the right side of the 477 gain range indicators. Increase the gain range (toward $10^{8}$ V/A range) to the maximum gain at which the red overload light does not illuminate. The output of the 477 should be coupled to an oscilloscope and the pulse profile obtained thereon.




The peak voltage on the oscilloscope should be monitored and the  alignment source- input optic adjusted to obtain a maximum.

Given that the definition of a pulsed source in IEC 62471 is one for which it delvers energy in the form of a single pulse or train of pulses where each pulse is assumed to have a duration less than 0.25s, the time base of the oscilloscope should be adjusted to obtain for example a total period of 0.5s. In this manner the temporal resolution of the pulses in 0.25s is not compromise. The temporal measurement result should be saved.

Given the system calibration factor obtained in the relative spectral distribution measurement (or the illuminance meter calibration factor, provided in the DH400_VL certificate where this detector is used), the selected gain range of the 477 pre-amplifier (V/A) and the relative spectral distribution result, the radiant exposure or radiance dose can be calculated, limiting the integration to 0.25s.

The resulting radiant exposure and radiance dose can be compared with the exposure limits for each hazard considered.

A lamp that exceeds the exposure limit of a given hazard will be classified as RG3
A single pulsed lamp whose radiant exposure / radiance dose is below the exposuire limit of a given hazard will be classified as exempt.
For repetitively pulsed lamps, whose radiant expsoure/ radiance dose is below the exposure limit of a given hazard shall be classified against continuous wave lamp criteria shall be based on time-averaged pulsed emission.

The attached spreadsheet provides a template for the analysis of the results of applying this method.