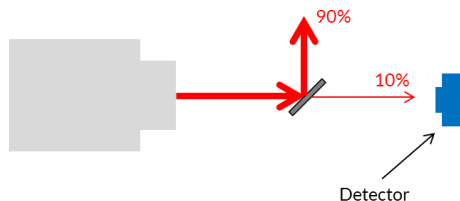
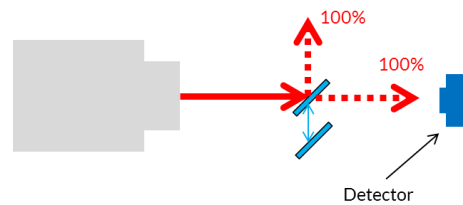


## Latest applications of gRAY detectors

### Medical laser systems:

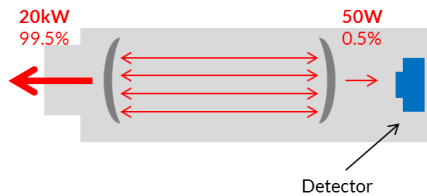
- Case 1:** Process stability is crucial for the customer - a European laser system manufacturer specialized on powerful surgical lasers for precise tissue cutting and ablation. The **CO<sub>2</sub> laser (CW)** for powers up to **60 W** needs to be measured **sporadically for 1-2 s** before a surgery. With a beam-diameter of 6-8 mm the power density is much below the threshold value  $1.5 \text{ kW/cm}^2$  for gRAY detectors. To save both costs and space, the customer uses a **gRAY C50-MC** combined with an **AMP 2050**. The module is integrated into the beam path **behind a tiltable mirror**, which is flipped only during the short measurement periods to let the beam hit the detector. For the surgery, the complete beam is used.



- Case 2:** Due to EU regulations, every medical laser system needs to be equipped with a redundant power measurement unit. The customer integrates the **gRAY B01-SC** into a **3  $\mu\text{m}$  laser (CW)** of max. **10 W**. In order to save space, the detector is soldered directly onto the electronics board (like the B01-SMC) with a reflow process. This makes the whole unit very compact and ensures good thermal and electric coupling. To monitor the power **continuously**, the board is mounted **behind a beam splitter (90:10)**, meaning that max. 1 W hits the detector. The main beam is coupled into an optical fiber behind the beam splitter and used for micro surgical tissue cutting.

### Industrial laser systems:

- Case 3:** Marking lasers start to have high requirements for precision e.g. for the manufacturing of decorative elements on consumer electronics like the Apple on each iPhone. The customer needs a continuous power monitor for the **5 W (CW)** laser systems with wavelengths **1064 nm or 532 nm**. Since space is limited, the **gRAY B05-SC** was chosen and integrated into the processing head **behind a beam splitter** (see graph above). The measured signal is directly fed into a power control loop to stabilize the output power. The thermal and electronic integration is done by the customer.



- **Case 4:** For high power **CO<sub>2</sub> (CW)** cutting lasers, the power needs to be monitored **continuously** to ensure reproducible production results. The **gRAY C50-HW** is placed behind the laser cavity to measure the light transmitted through the back mirror – typically <50 W. This light is only a small fraction of the front output but is directly proportional to the main beam. It can therefore be used for a closed loop control of the laser power. The **low rise time** of the detector fulfills the customer's requirement of  $\ll 1$  s. With the thermal, mechanical and electronic integration provided with the housed detector, the assembly of the measurement unit is straightforward.

**Case 5:** The customer builds **CO<sub>2</sub> (CW)** laser systems for fusion splicing of optical fibers where the beam position is crucial for high production yield. Space is limited in the system and we therefore develop a customized positioning device for this application. A laser beam of ca. 5 mm diameter is measured at 2 positions inside the system. The **measurement** is carried out **during ca. 2 s** while the new fibers are loaded to the machine. The customer builds the read-out electronics and provides the thermal integration. With the new detector, the measurement unit gets much more compact and cost-efficient.

#### Power meters:

- **Case 6:** To build a compact and highly sensitive power meter, the customer chose the **gRAY B05-SC** for integration into a power measurement head. The measurement head is only 30x40x18.5 mm<sup>3</sup> in size and can resolve **powers down to 10 uW**. In order to achieve this high resolution, a second B05-SC detector is placed next to the main detector for compensation of thermal fluctuations in the environment. Compared to the previous models, the customer could achieve lower rise times as well, which is attractive for retail customers.
- **Case 7:** Compact and precise power meters are demanded in industry for maintenance purposes. The customer therefore develops a high power hand held measurement device, which can be used for powers up to **100 W**. Any commercially available detector is too bulky for the application at hand. In order to make a compact detector, the **gRAY C50-MC** is slightly modified and integrated into a housing provided by the customer. The temperature is measured with a T-sensor and a compensation of the temperature dependence is done inside the meter.

#### Research:

- **Case 8:** Until now, the customer has used a fast and precise power meter to measure a **1064 nm** pulsed laser. Since this product was discontinued by the manufacturer, the **gRAY C10-HC** is a well suitable replacement. The rise time of only 200 ms allows for fast measurements and the coating withstand even the irradiation with a **short pulse laser** of **880 fs**, **3.9 MHz** and up to **8 W**. With a voltmeter the signal can be measured and easily converted into power with the **conversion factor 1 V/W**, which is calibrated at greenTEG.

### Summary of described applications:

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
<b>Application</b>	Medical laser	Medical laser	Marking laser	Cutting laser	Splicing laser	Power meter	Power meter	Research
<b>Integration</b>	in system	in system	in system	in system	in system	in head	in head	stand alone
<b>Mode of use</b>	sporadic	continuous	continuous	continuous	sporadic	sporadic	sporadic	sporadic
<b>Max. Power</b>	60 W	1 W	5 W	50 W	20 W	3 W	50 W	8 W
<b>Min. Power</b>	10 mW	100 uW	100 uW	50 mW	100 uW	10 uW	50 mW	10 mW
<b>Wavelength range</b>	10.6 um	3 um	532 & 1064 nm	10.6 um	10.6 um	190 nm - 15 um	190 nm - 15 um	1064 nm
<b>Beam diameter</b>	6-8 mm	ca. 4 mm	ca. 5 mm	ca. 20 mm	ca. 5 mm	ca. 5 mm	ca. 15 mm	ca. 3 mm
<b>Operation mode</b>	CW	CW	CW	CW	CW	CW	CW	pulsed
<b>Pulse length</b>	-	-	-	-	-	-	-	0.9 ps
<b>Peak power</b>	-	-	-	-	-	-	-	1.5 MW
<b>Pulse energy</b>	-	-	-	-	-	-	-	2uJ
<b>Repetition rate</b>	-	-	-	-	-	-	-	3.9 MHz
<b>Space in system</b>	not limited	not limited	limited	not limited	limited	limited	limited	not limited
<b>Electrical integration</b>	greenTEG electronics	own electronics	own electronics	greenTEG electronics	own electronics	own electronics	own electronics	greenTEG electronics
<b>Mechanical integration</b>	own heat sink	integrated in own amplifier PCB	own heat sink	greenTEG housing	own heat sink	own housing	own housing	greenTEG housing
<b>Used gRAY detector</b>	C50-MC & AMP 2050	B01-SC	B05-SC	C50-HW	customized position detector	B05-SC	C50-MC	C10-HC
<b>Location of integration</b>	behind flip mirror	behind beam splitter	behind beam splitter	behind back mirror	below work piece (only illuminated during exchange)	with compensation sensor	with T-sensor	-
<b>USPs of gRAY</b>	modular system, price, compactness	precision, price, compactness	precision, available as component	measurement speed	customized design, compactness, price	precision, sensitivity, compactness	compactness, available as component	precision, measurement speed