



The DFI[®] V3

The most powerful instrument for detecting colourless synthetic diamonds and simulants in melee batches or for centre stones; which also allows the analysis of coloured gems, in batches or individual stones.

The DFI[®] is the most powerful, reliable and effective instrument for analysing colourless 'melee' diamonds and single stones using photoluminescence. Diamond photoluminescence analysis is a robust scientific technique that reveals the subtle atomic-level defects that all diamonds possess; by analogy, one could say that it is their DNA. Since its introduction 10 years ago, this instrument has been continuously improved and allows routine analysis of colourless diamonds at room temperature or low temperature.

We are pleased to present the third version of the DFI[®], which has required nearly two years of research and development. This new version is faster, more powerful, more compact and more user-friendly.

The DFI[®] V3 is equipped with the new GEM10[®] spectrometer, specially produced for the DFI[®] and D-Tect[®]. This spectrometer, calibrated for absolute irradiance, is equipped with a new high-performance cooled CCD detector. It is highly sensitive and fast, enabling a higher production rate. For most diamonds, an acquisition time of 300 to 400 milliseconds per stone is now sufficient. For research, it allows long acquisition spectra with a very good signal-to-noise ratio. The DFI[®] V3

can be equipped with one or two spectrometers. The single spectrometer option offers a resolution of 1.3 nm, while the dual spectrometer option offers a resolution of 0.3 nm for one (UV-Vis) and 0.7 nm for the other (Vis-NIR). For professional use in sorting melee diamond batches or individual stones, the single spectrometer version is sufficient.



Software

The work is made easier by version 1.3 of our Spect-Ident[®] software, which provides effective real-time assistance to technicians, enabling them to work quickly and without risk of error. When it comes to sorting colourless 'melee' diamonds, with the help of Spect-Ident[®], an experienced technician can sort

between 1,500 and 3,000 diamonds per hour, regardless of their size (from $\varnothing$ 0.4 mm or less, the instrument has no size limitations).

And just like D-Tect[®], the DFI[®] V3 gives only two answers, 'natural' or 'synthetic', with no 'refers' to send to a laboratory: you are the laboratory.

The DFI[®] V3 and the D-Tect[®] V2 are the only instruments on the market to offer complete autonomy in determining the naturalness of colourless diamonds.

UV source

We replaced the UV sources of the DFI[®] V2, which were recognized and high-performance scientific sources, but fragile and difficult (or impossible) to repair. The new UV source of the DFI[®] V3 is entirely designed and assembled by us, and is more efficient and brighter than the old one. Its design facilitates maintenance and servicing. The effective spectral range always starts from the far UV at 185-190 nm. The UV beam is filtered and offers six excitation wavelengths from 220 nm to 400 nm. The operator can easily change filters using a joystick, and the selected excitation wavelength is displayed on the screen. This configuration makes it very efficient and easy to observe luminescence under different UV wavelengths.

Optics

We have designed a new optical path that reduces energy loss. In this new path, the UV and laser beams now follow the same final optical path in a perfectly parallel manner, one in the centre of the other. They excite the samples from the same and unique final optic, which maintains the same focal distance for both exciters. This allows switching from one excitation to the other without moving or repositioning the stone being analysed, as the focal point always remains in the same position. In addition to the convenience this offers, this design provides real safety in use, as both beams are contained up to 35 mm from the sample. Observer safety is reinforced by a protective shield that blocks any reflections from the sample surface.

The new lenses have been specially machined from ultra-pure silica glass (Transmission $\geq$ 99.50 %/cm à 193 nm) and are coated with an exceptional UV anti-reflection coating (residual reflection of $\approx$ 1.2% from 200 nm to visible light). These high-performance lenses, combined with the shorter optical path, provide a power gain of nearly 2, which users appreciate because it substantially increases the luminescence of diamonds and other coloured gemstones.

Sample holder

We have created a new ergonomic sample holder for analysis at room temperature. It can be quickly adapted for right-handed or left-handed users. It allows diamonds to be sorted while controlling both excitation sources (laser and UV) via two controls directly installed on the sample holder's holding bracket. This configuration saves time, as it is no longer necessary to look up and control the beams using controls located away from the work area. The time savings and increased comfort are considerable.

Raman spectrometry

The DFI[®] V3 laser and its filter are of very high quality and spectrally perfectly aligned (Δ of $\pm$ 0.05 nm), a precision that allows Raman diffusion spectrometry. This means that it is possible to identify mineral materials, and of course diamonds first and foremost. This means that the Raman spectrum tells you that the gemstone analysed is indeed a diamond, to the exclusion of any other mineral species. This function allows you to formally identify any simulants encountered, such as moissanite, cubic zirconia, YAG, synthetic rutile, etc.



Upgrading DFI[®] V2 to V3

Upgrading is possible while retaining the following components from version V2: the microscope, the spectrometer, the filter wheel (with its filters) and the laser. The following will be replaced: the structure and all its components, the UV source, the optics (lenses, filters) and the following will be added: new connectors, the new UV and laser beam shutter system, the computer (built-in) and various other components.

Imaging

The DFI[®] V3 is equipped with a high-performance 20-megapixel (5496 x 3672) Sony[®] camera with 2.4/2.4µm pixels and a highly sensitive CMOS detector. The images have no electronic noise (full black), allowing for long acquisition times, and the associated software offers all the settings necessary to collect high-quality luminescence images.

Database

Like the D-Tect[®], the DFI[®] V3 has a dynamic database integrated into Spect-Ident[®] that allows the emission spectra displayed on the screen to be identified. The software has reference spectra (diamond, HPHT & CVD synthetic diamond, simulants) that can be superimposed on that of the gem being analysed simply from a drop-down list. This configuration is very useful for technicians who are starting to work with the instrument, allowing them to quickly become independent and work with greater autonomy.

An extensive database is also provided with the instrument in the form of a displayable table for interpreting spectra. It includes all the ZPLs (emission bands at the exact frequency of a transition) commonly found in colourless diamonds, each with a brief description. The structure of each centre is detailed and a link is available to display a text describing in detail the centre producing this ZPL. For each centre, it allows you to open an image of the spectrum or open a window that allows you to drag a spectrum onto the one that has been collected. This comprehensive document (84 centres, artefacts or Raman bands) for colourless diamonds allows novice technicians to progress very quickly and become autonomous and therefore quickly productive.

Training

Like with the D-Tect® V2, the DFI® V3 requires training as it is a scientific instrument. The training (maximum 2 people) takes place over two days, consisting of approximately 6-8 hours of theory and approximately 8-10 hours of practical training with a qualified trainer. It is very comprehensive and does not require any prior scientific knowledge.

During the training, a document summarising all the points covered in the theory and practical sessions is given to the trainees. At the end of the course, not only will they know how to use the instrument, but will also have gained fascinating scientific knowledge and will have learned more about diamonds and their (atomic) defects than most gemmologists learn during their gemmology training.

Remote support is available for the first three months after the instrument is put into service. This support provides educational assistance during the technicians' first steps.

Beyond its ability to analyse colourless diamonds of all shapes and sizes, the main difference between the DFI® and existing instruments is that it requires an operator, which has always been an obvious choice for GGTL Laboratories. A well-trained and vigilant technician will be able to detect subtle anomalies, which may be clues to new production methods or new treatments applied to synthetic diamonds.

This is a significant safety advantage that no automated system can ever offer.

Summary of the characteristics of DFI® V3

- Allows analysis of all colourless diamonds (from D to Z) that are faceted and rough, of all sizes, even very small or very large ($\varnothing$ 0.40 mm and less, up to 100 carats and more) at room temperature (20 °C, $\approx$ 293 K) and at low temperature (- 196 °C, 77 K).
- Quick and effective identification of colourless CVD and HPHT synthetic diamonds.
- Allows analysis of all shapes (baguettes, ovals, trilliants, princesses, etc.).
- Capacity for sorting colourless melee diamonds: 1,500 to 3,000 stones per hour.
- Give two answers: 'natural' or "synthetic", no 'refers' to send to a laboratory.
- Allows Raman diffusion spectrometry, enabling the identification of any simulants (moissanite, CZ, synthetic rutile, etc.).
- It is also an effective aid in analysing certain coloured stones: rubies, spinels, sapphires, tsavorites, etc.

Additional information

- Information and quotes can be requested at switzerland@ggtl-lab.org.
- DFI® is a technology developed in Switzerland and Liechtenstein since the 2000s by GGTL Laboratories Switzerland and Liechtenstein.
- The DFI® V3 is designed, developed and manufactured in Switzerland.
- It is sold and distributed exclusively by the three laboratories of the GGTL Laboratories group, namely: Switzerland, Liechtenstein and Antwerp.
- Dimensions: L 670, W 340, H 580 mm, maximum power consumption: $\approx$ 400 W (measured).
- The DFI® V3 cannot be sold in the following countries: United States, Russia, China, and India.
- Sales of instruments produced by GGTL Laboratories are invoiced in Swiss francs (CHF). US dollars (USD) are not accepted.

DFI luminescence of colourless diamonds

