GMP
GENERAL MICROTECHNOLOGY & PHOTONICS

# NEAR-IR GRENOUILLES

## THE WORLD'S MOST POWERFUL AND EASIEST TO USE ULTRASHORT-LASER-PULSE MEASUREMENT DEVICE

As a **FROG** device, GRENOUILLE yields the pulse intensity and phase vs. time and spectrum and spectral phase with great accuracy and reliability, requiring no assumptions about the pulse. It measures the actual pulse, not the coherent artifact.

In addition, GRENOUILLE also measures the **beam spatial profile**.

What's more, it also simultaneously yields the otherwise-difficult-to-measure spatio-temporal distortions, **spatial chirp** and **pulse-front tilt**, which occur in most ultrashort pulses but are almost never measured. GRENOUILLE is the only commercially available device to measure these distortions and the most accurate diagnostic for pulse-front tilt ever developed.

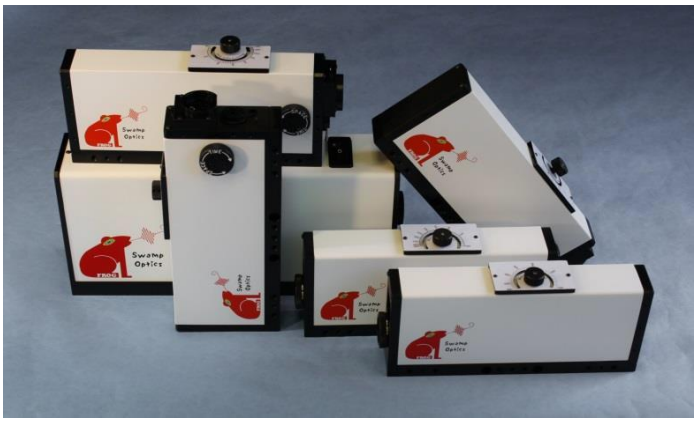
It yields the approximate pulse **absolute wavelength**, too.

Remarkably, GRENOUILLE **needs no alignment—ever!** Even placing it in the beam is amazingly easy.

GRENOUILLE tells you more about your pulse with less effort than ever imagined!

And weighing as little as 1 kg, it's light and compact, with a footprint smaller than a foot!

Note: currently, the Model 8-4-USB is only available as a kit.



## FROG/GRENOUILLE AT A GLANCE

- **The pulse intensity and phase vs. time**
- **The pulse spectrum and spectral phase vs. wavelength**
- **Measurements are of the actual pulse, not the coherent artifact**
- **The beam spatial profile**
- **The approximate spatial chirp**
- **The pulse-front tilt**
- **The autocorrelation**
- **No assumptions**
- **No alignment**
- **High sensitivity**
- **Real-time intensity and phase retrieval**
- **Minimal weight and size**
- **Laptop-friendly**

Swamp Optics FROG

A single GRENOUILLE can measure pulses from a wide variety of sources, from the lowest-energy oscillator to the highest-intensity amplifier.

Voted one of the 100 most important inventions of the year (across all fields) by R&D Magazine, and one of the top 25 optics inventions of the year by Photonics Spectra, GRENOUILLE represents a huge leap forward in ultrashort-pulse-measurement technology.

www.gmp.ch

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## NEAR-IR GRENOUILLE MODELS AND SPECIFICATIONS

| GRENOUILLE model | 8-4-breadboard | 8-9-USB | 8-20-USB | 8-50-USB |
|---|---|---|---|---|
| Center-wavelength range | 700 – 900 nm | 700 – 1100 nm | | |
| Pulse-length range @ 800 nm | ~4 – ~80 fs | ~10 – ~100 fs | ~20 – ~200 fs | ~50 – ~500 fs |
| Pulse-length range @ 1050 nm | NA | ~8 – ~80 fs | ~15 – ~80 fs | ~30 – ~100 fs |
| Delay increment | 0.4 fs/pixel | 0.95 fs/pixel | 0.85 fs/pixel | 1.15 fs/pixel |
| Temporal range[2] | 400 fs | 336 fs | 480 fs | 1.9 ps |
| Spectral resolution @ 800 nm | 2 nm | 2 nm | 1.5 nm | 0.7 nm |
| Spectral resolution @1050 nm | NA | 2.2 nm | 5 nm | 2 nm |
| Spectral range @ 800 nm[2] | 600 nm | 300 nm | 160 nm | 50 nm |
| Spectral range @1050 nm[2] | NA | 400 nm | 400 nm | 125 nm |
| Pulse complexity | < ~20 | Time-bandwidth product < ~10 | | |
| Intensity accuracy | 2% | | | |
| Phase accuracy | 0.01 rad (intensity-weighted phase error) | | | |
| Single-shot operation? | Yes | Optional[1] | Yes; both free-running mode & triggered single-shot mode are now standard. | |
| Sensitivity (single-shot) | 100 μJ | 0.1 mJ | 1 μJ | |
| Sensitivity (at $10^3$ pps) | 100 μJ | 500 μW (500 nJ) | 100 μW (100 nJ) | |
| Sensitivity (at $10^8$ pps) | 300 mW (3 nJ) | 50 mW (500 pJ) | 10 mW (100 pJ) | |
| Spatial profile accuracy | NA | < 0.2 % (Camera has true 8 bits and 480 x 640 pixels) | | |
| Spatial chirp accuracy (dx/dλ) | NA | 1 μm/nm | | |
| Pulse-front tilt accuracy (dt/dx) | NA | 0.05 fs/mm | | |
| Required input polarization | Vertical | Any (just rotate GRENOUILLE!) | | |
| Required input-beam diameter | 2 – 4 mm (collimated) | | | |
| Input-beam lateral-displacement tolerance | > 1 mm | | | |
| Number of alignment knobs | Several | Zero | | |
| Time to set up | ~ 1 week | ~ 10 minutes | | |
| Dimensions (L x W x H) w/camera | 45 cm x 45 cm x 15 cm | 33 cm x 7.5 cm x 16.5 cm | 33 cm x 7.5 cm x 16.5 cm | 26 cm x 4.5 cm x 11.5 cm |
| Weight | ~10 kg | 3 kg | 3 kg | 1.2 kg |

1. The Model 8-9-USB can be modified to allow single-shot measurement using a thinner crystal, but this reduces its sensitivity.
2. Temporal and spectral ranges are the full-scale ranges, not the pulse FWHM (which is typically a factor of ~3 smaller).

## ADDITIONAL NOTES

- Spatial chirp is easily revealed by tilt in the otherwise symmetrical measured trace.
- Pulse-front tilt is easily revealed by a displacement of the trace along the delay axis.
- Absolute wavelength is indicated to a few nm by the crystal-angle dial.
- FROG & GRENOUILLE have a (removable) ambiguity in the direction of time. (In contrast, other methods have infinitely many ambiguities.)
- Triggered single-shot operation is now standard on all models, except for the Models 8-4-USB and 8-9-USB, when using an angle-dithered crystal.
- Comparison of the retrieved and measured traces confirms the measurement.
- Input-beam mode quality should be good; GRENOUILLE's spatial-profile measurement helps to ensure this.
- Just connect to your computer's USB port; no power supply needed.
- The Model 8-50-USB has one camera, which is switchable between temporal and spatial profiles. All other Ti:Sapphire FROG and GRENOUILLE models use two cameras for simultaneous display of spatial and temporal profiles.
- Models 8-20-USB, 8-50-USB are GRENOUILLE designs. Models 8-4-USB and 8-9-USB are FROGs with a built-in spectrometer for spectral resolution.
- Model 8-4: The FROG algorithm to be used for this model requires an independent spectrum measurement, acquired with a response-calibrated spectrum.

**R&D 100 Award Winner**

**Circle of Excellence Award Winner**

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