User manual

V1.0

FASTLITE

Table des matières

I.   Discovering your Fringeezz

The Fringeezz is a fast integrated Carrier-Envelope Phase (CEP) detector. As its name suggests, it is detecting fringes at the output of an f-to-2f setup, and extracts the encoded CEP value using embedded electronics.

The Fringeezz is an ideal tool for fast phase tagging, up to 15 kHz, or to implement a high-bandwidth CEP stabilization loop using the Dazzler CEP control module, or any other control device.

We hope this user manual will give you the necessary insights to allow you to take full advantage of the Fringeezz astonishing capabilities.

A.   Configurations and options

Fringeezz are factory set to detect light on a relative bandwidth of about 10% of the central wavelength. This central wavelength has to be specified at the time of purchase, and changing this wavelength requires the Fringeezz to be sent back to Fastlite.

Available detection range is indicated on the graph below.
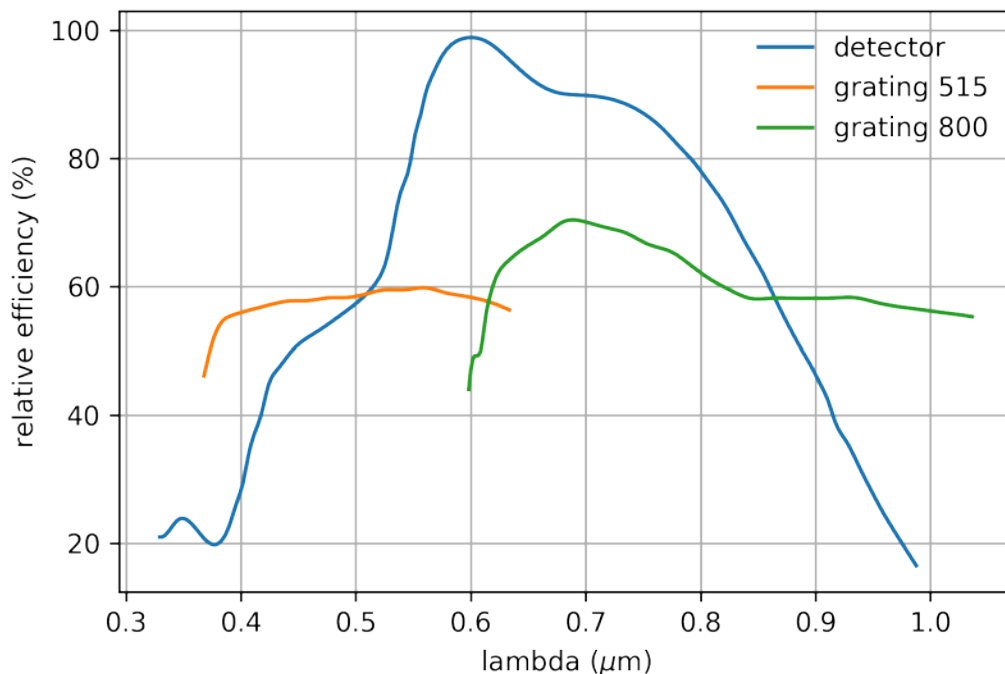
A complete f-to-2f optical setup is available as an option. It is designed the match the optical input requirements of the Fringeezz, and easily integrates the Fringeezz module.
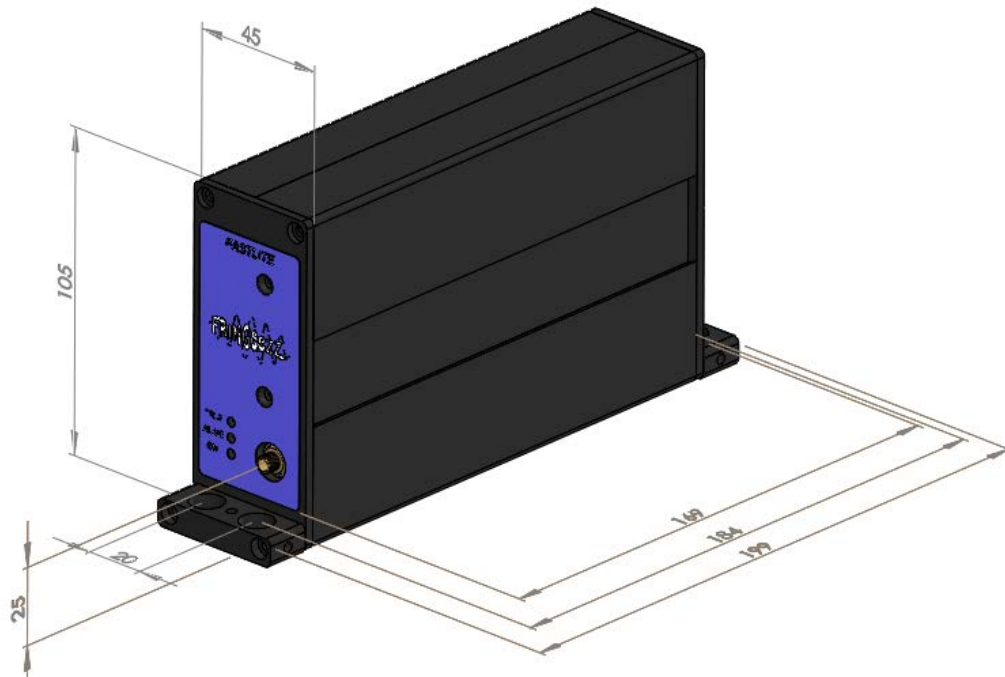
B.   Packing list

The Fringeezz package contains:

- The Fringeezz module
- The analog feedback module
- A 9V DC power supply
- A USB drive with user software and user manual
- A USB cable
- A DB25 cable (type IEEE 1284)
- Four SMB-SMB 1m cables

- Four SMB-BNC adapters
- A factory test sheet

- An f-to-2f module (optional)

C.   Hardware description

Dimensions are in mm.

TRIG: Blinks when a proper trigger signal is detected. Continuously lit when fringes are detected.

ALIVE: Blinks when device is operational

ON: The device is powered

Optical input: horizontal 50 µm slit

SC: TTL output SMB connector displaying the start and stop of the video signal (convenient to trig an oscilloscope)

DBG: TTL output SMB connector for alignment purpose; Allows to verify that fringes are correctly processed by the instrument, it also help to choose which fringe is used for measurement.

ALT: TTL input SMB connector to toggle between target and alternate target CEP setting.

TRIG: Trigger input SMB connector. Requires TTL signal (0-5V). The measured trigger rate is displayed in the *info area* as described in section III.D.

VID: allows to visualize the fringes detection, once connected to an oscilloscope. Should be used for alignment.

FEEDBACK OUT: DB25 (IEEE1284) connector for digital feedback. CEP error data is continuously streamed as soon as the Fringeezz device is powered and communication with the software is initialized.
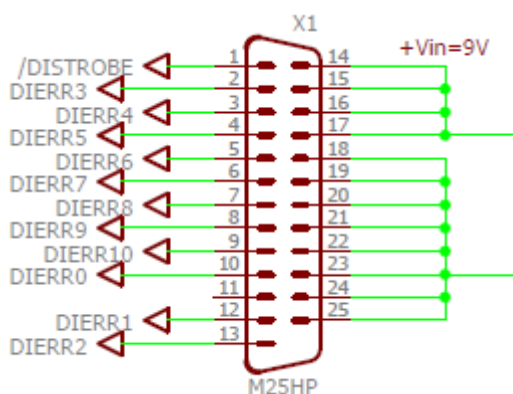
Pins assignment: 1- Strobe / trigger
2 to 9: Digital error signal for Dazzler
10-12-13: LSBs Digital error signal
11- Unused
14 to 17- 9 V DC
18-25- Ground

**USB:** USB 2.0 connector for PC/Fringeezz communication and data transfer

9V DC+: Power supply input. Please use the provided 9V adapter.
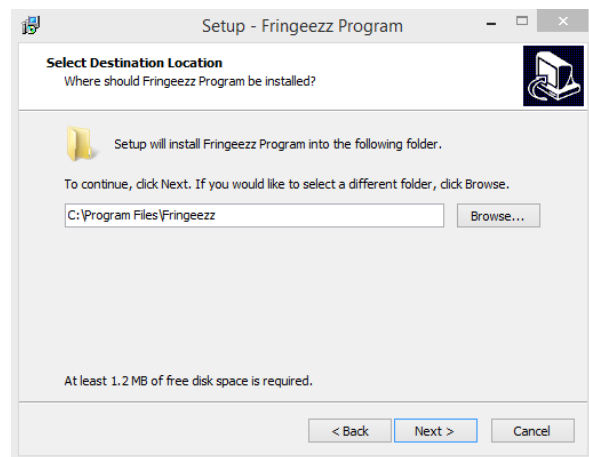
II.   Setting up your Fringeezz

A.   Software installation

The application program installer is found on the USB drive delivered with the Fringeezz. The program is compatible with Windows 7 to 10.
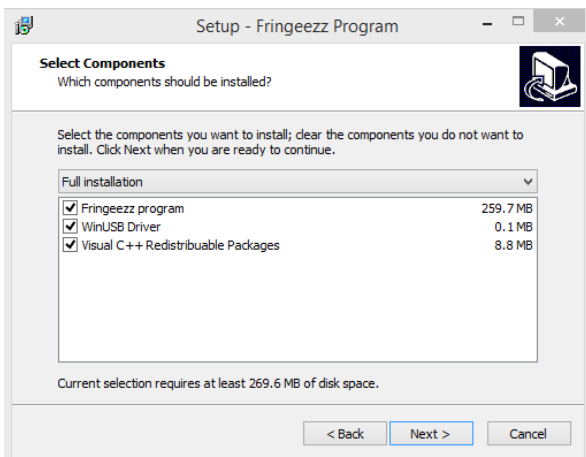
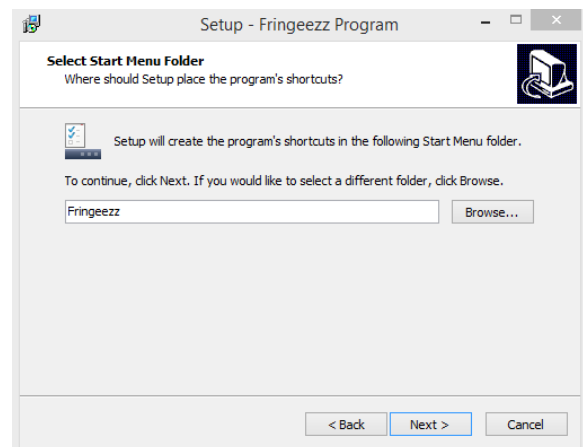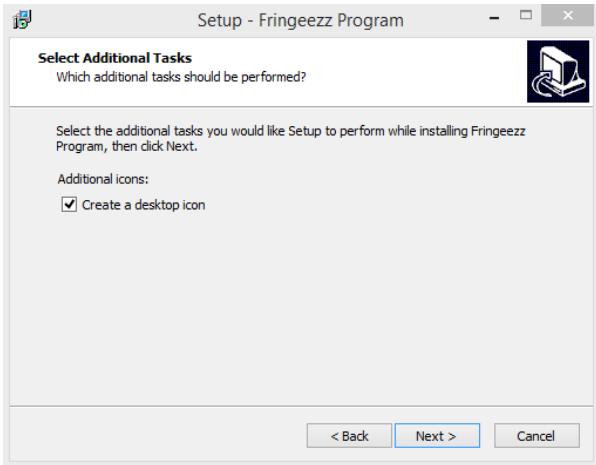Double click on "setup-fringeezz-xxx-rxxx.exe" and follow instructions.

Click "Next"

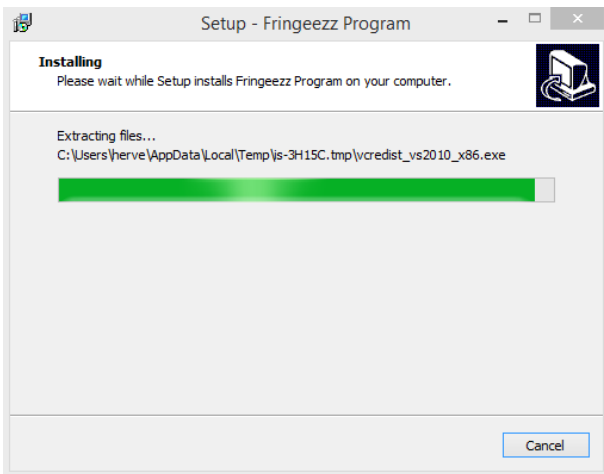Click "Next"

Click "Next"

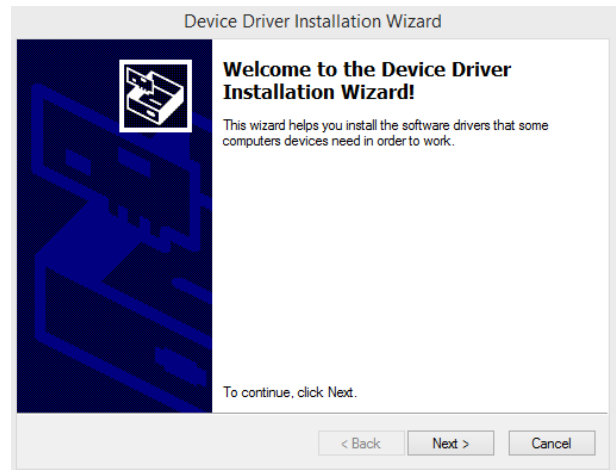Click "Next"

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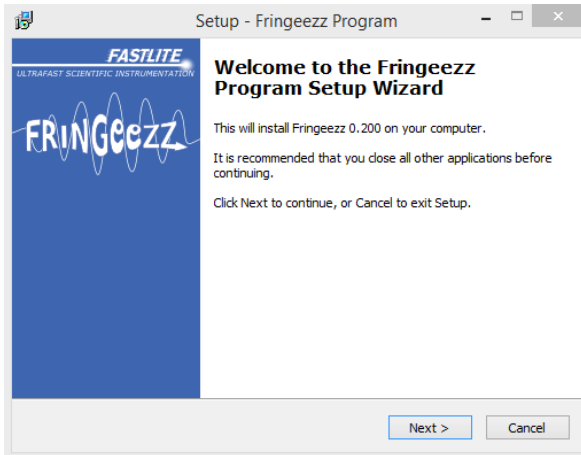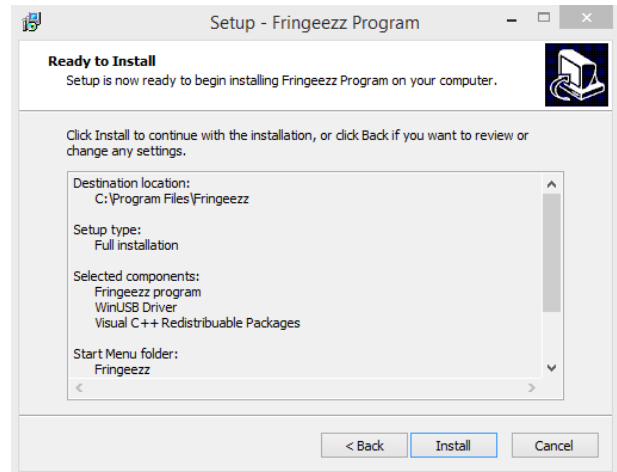
Click "Next"

Click "Install"

Wait until next step

Click "Next"
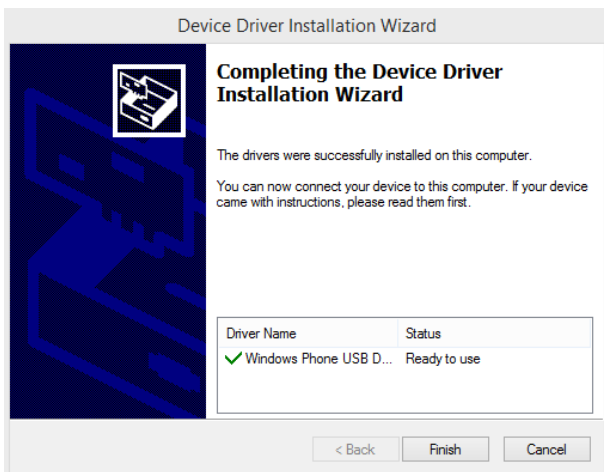
Click "Finish"

B. Connections

Connect trigger (see section IV.A), USB and 9V DC supply.

III. Software guide

When starting the Fringeezz software, the following window appears.
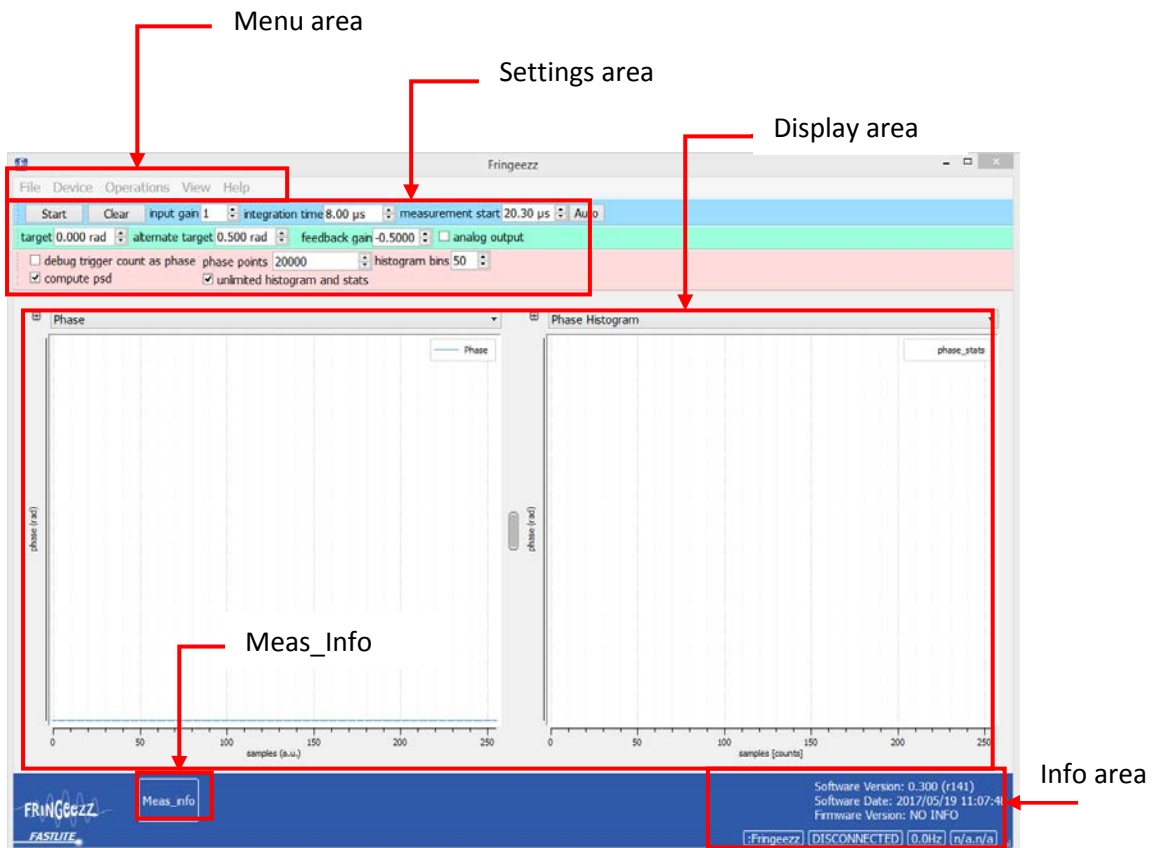
Menu area gives access to *File, Device, Operations, View and Help* sub-menus, as described in section III.A.

Settings area gives access to all parameters to configure the Fringeezz acquisition, as described in section III.B.

Display area consists of selectable displays as describes in section III.C.

Info area provides information of the device status as described in section III.D.

Meas_info provides phase measurement values (number of measured shots, phase value, mean value and standard deviation value).

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A. Menu

1.   File menu

Clear history resets data displayed in left graph (see section III.C)

Data logger enables data logging, and allows to select a log directory. This functionality is described in details in section VI.
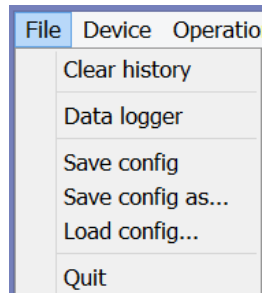
Save config: saves current settings in the default location. (.cfg file)

Save config as: saves current settings and opens a browser to select location.

Load config: opens a browser to select the .cfg file location.

Quit exits software.

2.   Device menu
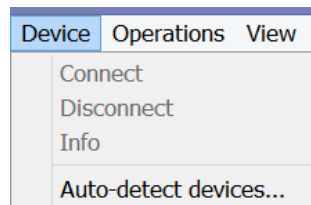
Connect sets communication with a Fringeezz module connected to the computer via USB

Disconnect stops communication with the connected device.

Info provides information on the connected hardware.

Auto-detect devices… finds all connected and compatible devices.

3.   Operations menu

Alignment mode disables warnings for an easier alignment and optimization.

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4. View menu

Accessibility increases text size for a better visibility.

Single plot sets the *display area* as a single display, while **Dual plot** allows to display two graphs simultaneously.

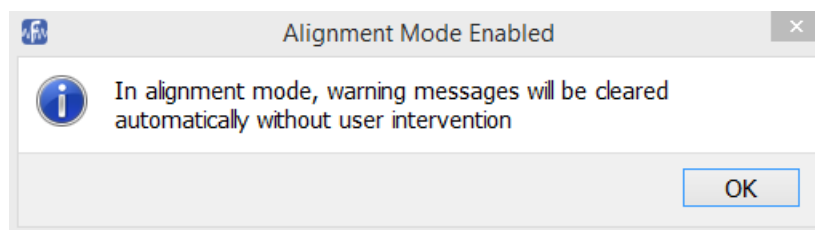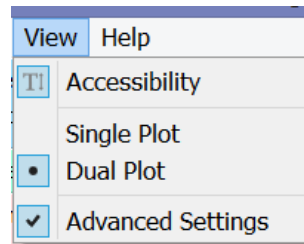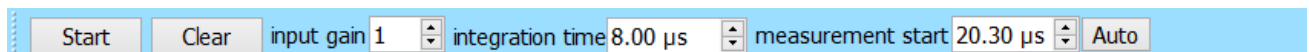**Advanced settings** hides or shows the settings described in part B.3.

B.   Settings

1.   Acquisition

Start Toggles the acquisition and data logging between active and inactive.

Clear resets all displayed data and statistics (does not affect data logging).

Input gain is the electronic gain applied to the detector signal before filtering, it should be kept as low as possible to keep a good signal to noise ratio (SNR).

Integration time can be tuned from 1 to 25.5us, and is equivalent to the *integration time* of a spectrometer. Adjust this setting to make sure acquisition is single-shot, depending on your trigger repetition rate and arrival time.

Measurement start allows to choose wich fringe is used for the measurement.

Auto automatically selects a fringe for the measurement.

2.   Feedback
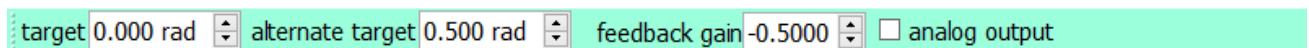
Target sets the target CEP value for feedback.

Alternate target sets an alternate target CEP value. When a high level TTL signal is applied to the ALT connector, this alternate target becomes the feedback target.

Feedback gain selects negative or positive feedback depending on feedback loop specs. Gain goes from -1 to +1.

Analog output is to be used with the analog module for feedback, uncheck to use the digital output.

3. Advanced settings

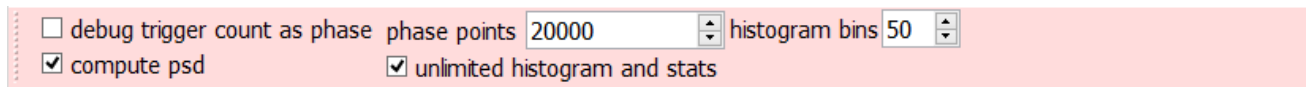**Debug trigger count as phase** replaces the CEP error output signal by an incremental trigger count. For debug and test purpose only.

Phase points sets the number of phase points used for display and data logging interval.

Histogram bins sets the resolution of the histogram.

Compute PSD. By default, Fringeezz software always computes the PSD, which may slow down the software at high repetition rates. Uncheck if PSD calculation is not necessary.

Unlimited histogram and stats allows to extend the amount of data used for statistics above the *phase points* value. Activated by default.

C. Displays

Depending on *View* settings described in section III.A.4, one or two graph areas are available.

The left graph allows to select:

Phase: displays phase (rad) versus shot number.

Phase history: displays phase data of the current day, with basic statistic information.
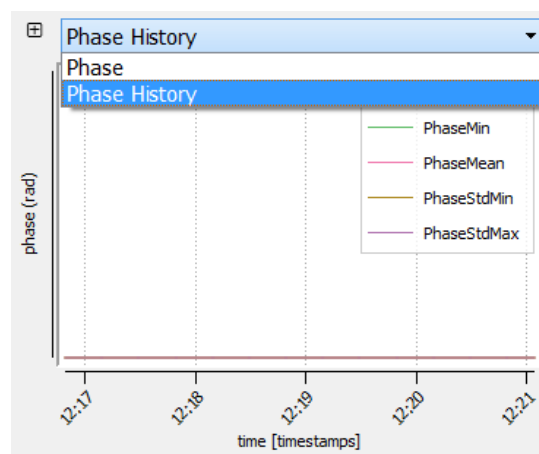
The right graph allows to select:

Phase histogram displays a histogram showing the statistic repartition of CEP data (rad) versus number of events. Number of data points set in *advanced mode* (section II.B.3).

Power spectral density (PSD) displays the Power Spectral Density, i.e. phase noise (A.U.) versus frequency (Hz – Log scale), as well as integrated phase noise.

Feedback output displays the CEP error value sent through the *Feedback out* connector.
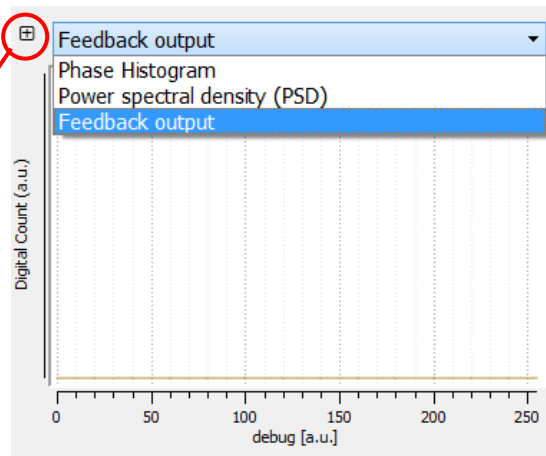
The + mark gives access to additional graph display options.

D. Info

Displays diagnostic data for maintenance purpose.

IV.   Alignment

Alignment is done using the Fringeezz software, a spectrometer compatible with the Fringeezz spectral range, and an oscilloscope with a bandwidth better than 20MHz.

Start the Fringeezz software. Default, or last stored configuration is automatically loaded.

Most of the optimization is done using the output signals available from SMB connectors on the Fringeezz back panel.

A "NO FRINGES" warning is displayed as long as any of the optimizations described in this chapter is not satisfying. Select the *alignment mode* in the *operation menu* (see section III.A.3) to disable this warning during the alignment.

A.   Trigger

The Fringeezz requires a TTL trigger, synchronized with the laser, and arriving between 25 and 1 µs before the laser pulse. Connect the *VID* output of the Fringeezz and a copy of the trigger signal to the oscilloscope, and check the absence of jitter.

The VID signal lasts 50 µs and exhibits a positive overshoot at the beginning and a negative overshoot at the end. Set the Fringeezz *integration time* (section III.B.1) so that the delay between trigger and first overshoot is less than 25 µs.

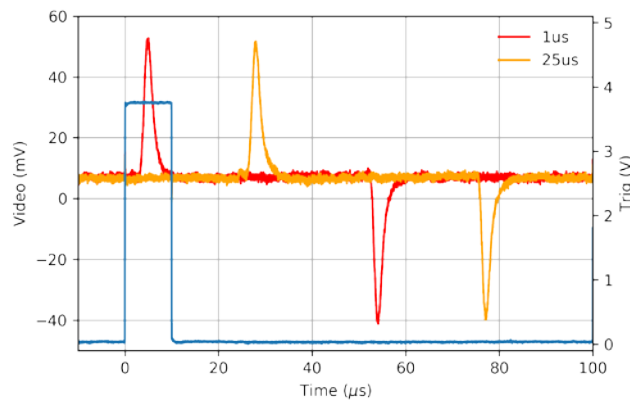*Figure 1 : Trigger signal (blue), VID output with 1µs integration time (red), VID output with 25 µs integration time (orange)*

SC output is a convenient signal synchronized with the VID output. It can thus be used to trigger the oscilloscope, as done for the rest of this alignment procedure.
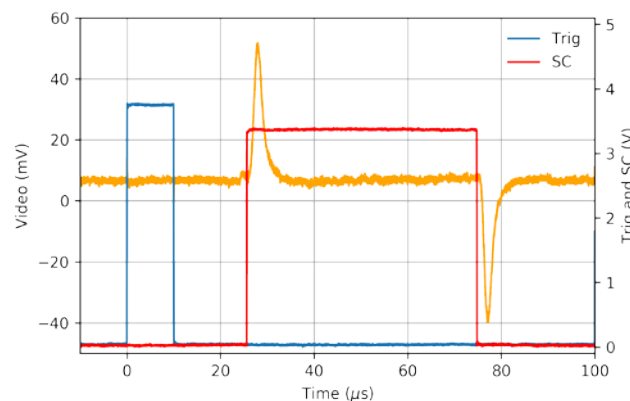

Figure 2 : Trigger signal (blue), VID output (orange), SC output (red)

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B.   Spectral range

Verify with a spectrometer that the fringes out of the f-to-2f setup are compatible with your Fringeezz device (central wavelength, number of fringes, fringe contrast). Tweak the f-to-2f to optimize the output spectrum.

The Fringeezz is as sensitive as a standard spectrometer, but has a very short integration time to allow single-shot detection. Setting the integration time of your standard spectrometer as short as possible for this preliminary check will thus give a good indication of the potentially detectable signal by the Fringeezz.

C.   Optical alignment

Set the *input gain* (section III.B.1) at maximum and optimize light coupling conditions to the Fringeezz. Besides basic alignment, remember the Fringeezz has a very short integration time to allow single shot detection, so a careful optimization of the focus position and size on the entrance slit is necessary to get a good signal. Once a signal is detected, set the *input gain* as low as possible to reduce electronic noise.

VID signal should display about 10 fringes with an amplitude of at least 100mV and a contrast of about 50% with the lowest possible gain.
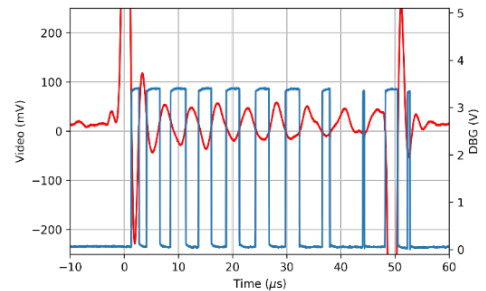
The *DBG output* monitors the fringes location as measured by the Fringeezz. A good light coupling in the Fringeezz leads to a DBG signal duty cycle of about 50%.
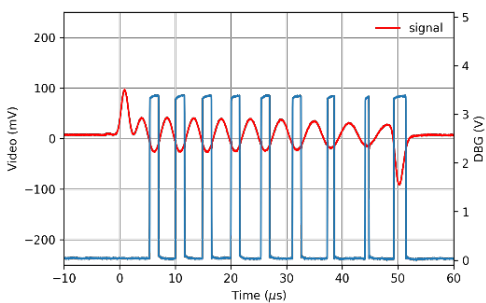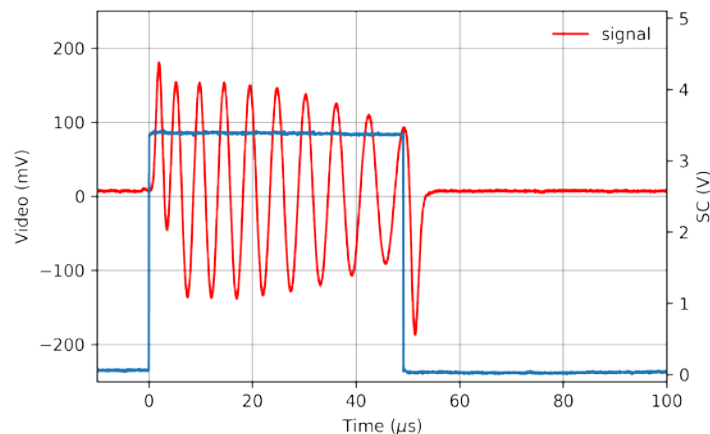

Typical too low signal. The DBG signal duty cycle is not close to 50%.

The same signal compensated by a high *Input gain* setting.

Electronic noise will affect the CEP measurement.

The signal on the figure below is a typical signal, obtained from *VID output*. It shows the fringes alone, while the background and envelope of the original spectrum are removed.

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The signal on the figure is still a relatively low signal since the start and end overshoots are still visible. But we will use this signal as it is enough for CEP measurement and is a good example for the fine tuning part of the alignment process.
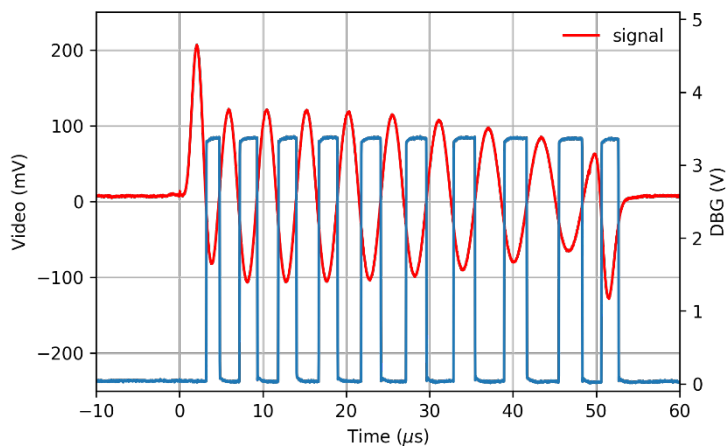

*Figure 3 : VID output (red), DBG signal (blue)*

V.   Measuring CEP

The Fringeezz computes the CEP shot to shot variation using a single fringe. Fringe selection is done using the *measurement start* setting (section III.B.1).

The right fringe is the one with the largest amplitude near the center of the *VID signal*, and where the *DBG signal* duty cycle is close to 50%. The start and end overshoots of the *VID signal* may affect the CEP measurement, so one should avoid to select a fringe too close from the edges of the *VID signal*.

Adjust *measurement start* delay just before the selected fringe.

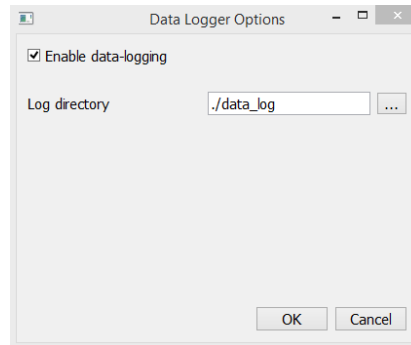In most cases, the *Auto* button will be able to select the right fringe automatically.

Selected fringe for a *measurement start* delay set at 15µs
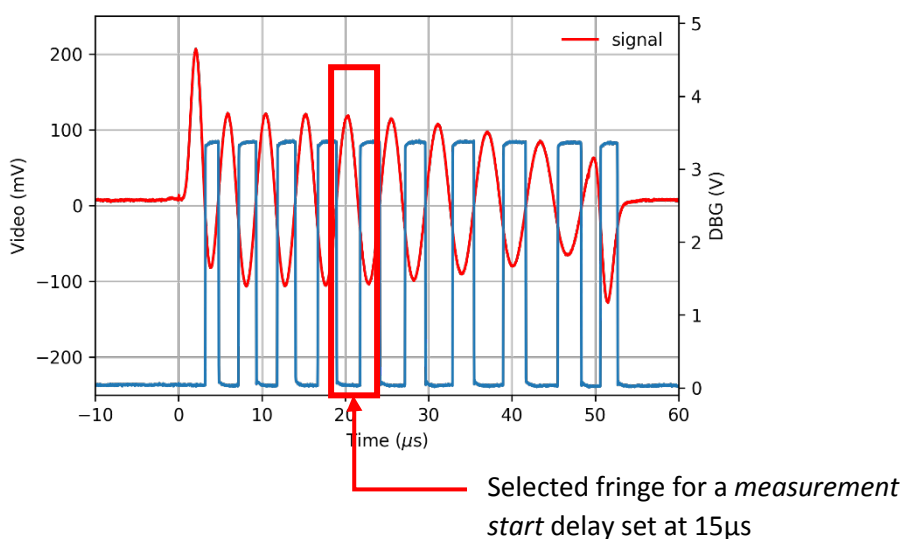
Press the *Start* button. CEP phase values are then streamed from the Fringeezz device to the computer.

VI. Data logging

Data logging can be activated from the *file* menu (see section III.A.1)

When data logging is enabled, a new log file is created each time the *Start* button is clicked.

To sustain up to 15 kHz repetition rate data logging, The Fringeezz software is using HDF5 file format. This format allows for fast access for writing and reading data. It is recognized by all programming languages and many software (Python ,C, C++, Fortran, LISP, Labview, Mathematica, Matlab, Octave and scilab, R, but also Origins, Igor, GNUplot…)

The data log files are by default located in a folder: C:\Program Files\Fringeezz\data_log

Each file has a unique name including the date and time of the file creation. For example, a file named "phase_log_20161205_163025.hdf5" has been created on the 5th of December 2016 at 16h30mn and 25s.

This HDF5 file contain 3 sets of data:

- Configuration
  - Data type: string (can be converted to UTF8)
  - Provides information on the Fringeezz configuration
    - integration_time_us
    - input_gain
    - measurement_start_us
    - target
    - alt_target
    - feedback_gain
- Timestamps
  - Data type: integer
  - Array of time stamps (UNIX format)
    The Fringeezz software writes CEP phase values once it has acquired the amount of *phase points* (20000 by default, see section III.B.3). It then writes the date and time of writing. *Timestamps* data set thus contains a vector of times corresponding to the logging times
- Phases
  - Data type: integer
  - Matrix of phase (1E4rad)
    Phases data set is a matrix of CEP values with each line corresponding to one logging time (number of points set by the *phase points* setting).

The USB-drive delivered with your Fringeezz contains a Python example of how to use HDF5 log files.

This file format is optimized to enable long term CEP logging without overcrowding your hard drive.