FEMTOCHROME®
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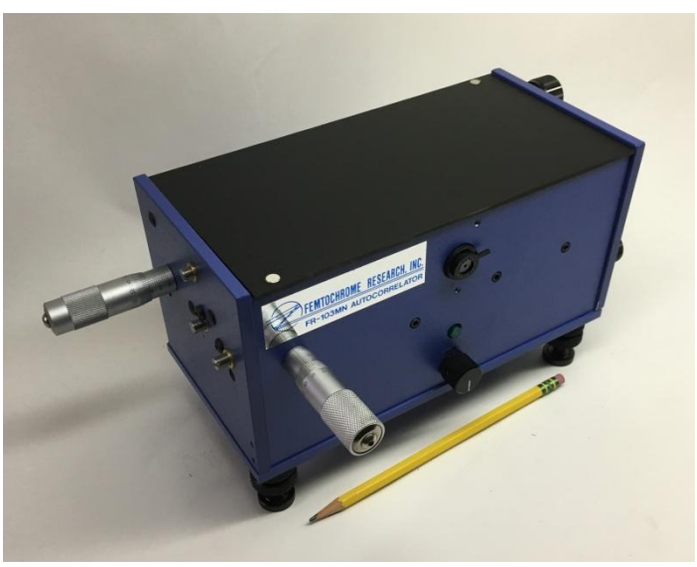
FR-103MN AUTOCORRELATOR



Specifications:

* Pulsewidth Resolution: <1fs
* Minimum Pulsewidth: ~ 4fs
* Maximum Pulsewidth: ~ 40ps '
* Scan Range: > 75ps '
* Sensitivity: $[P_{av}P_{pk}]_{min}=10^{-6}W^2$ "
* Wavelength Range: 410-5000nm
* Interferometric/Background-free
* Crosscorrelation Option
* Fiber Coupled/ Free Space
* Low Rep Rate Option (> 4Hz)
* Computer Data Acqusition Option

" $10^{-7}W^2$ w/**HS** version. w/ PMT [550-1700nm]

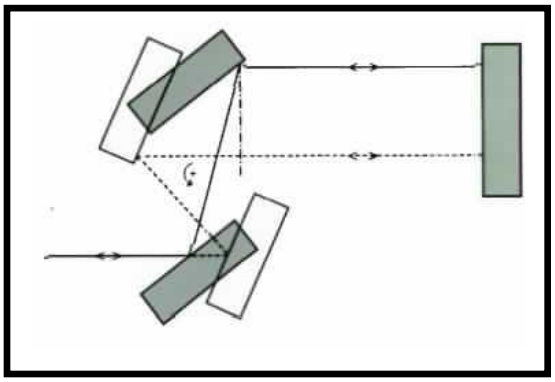
The **FR-103MN** is a compact, dispersion-free, 'real-time' NL crystal autocorrelator for the measurement of temporal width of ultrashort laser pulses. Offering unsurpassed sensitivity, resolution and dynamic range, it is easy to operate. The **FR-103MN** is perfectly suited for the monitoring of low power lasers as encountered in optical communications, as well as ultrashort (fs/ps) pulses from any mode-locked laser over UV-5000nm spectral range.

DISPERSION-FREE, HIGH RESOLUTION

Dispersion is negligible in the **FR-103MN** for pulsewidths down to ~5fs. Using high reflective metallic-coated optics [the only transmissive element is an ultrathin (<<1um) pellicle beamsplitter], an unprecedented resolution approaching 1fs [limited only by the NL crystal thickness] is attained.

ROTATING PARALLEL (//) MIRROR ASSEMBLY

Rapid scan, periodic optical delay is introduced by means of a parallel (//) mirror assembly.* This unique mechanism results in uniform and error-free delay generation. Large delays are easily generated, with dispersion-free interferometric resolution.



LINEARITY

The delay generated by the // mirror assembly is an exact sinusoidal function of time. The entire scan range occurring within small angles, linear approximation is excellent. [The error in the measured FWHM autocorrelation is < 0.5%, even for a pulsewidth as long as 40ps]. Optical delay generation is uniform, devoid of errors (position uncertainty) that can be encountered in other delay methods. Furthermore, the autocorrelation delay axis can be linearized precisely by the numerical application of the exact sine function.

The theoretical calibration factor (CF) of the **FR-103MN** is not prone to any change since the uniform rotation rate of the // mirrors is crystal locked. Additionally, a translation stage w/micrometer featured on the fixed arm of the Michelson Interferometer set-up allows the user to experimentally check and verify the CF.

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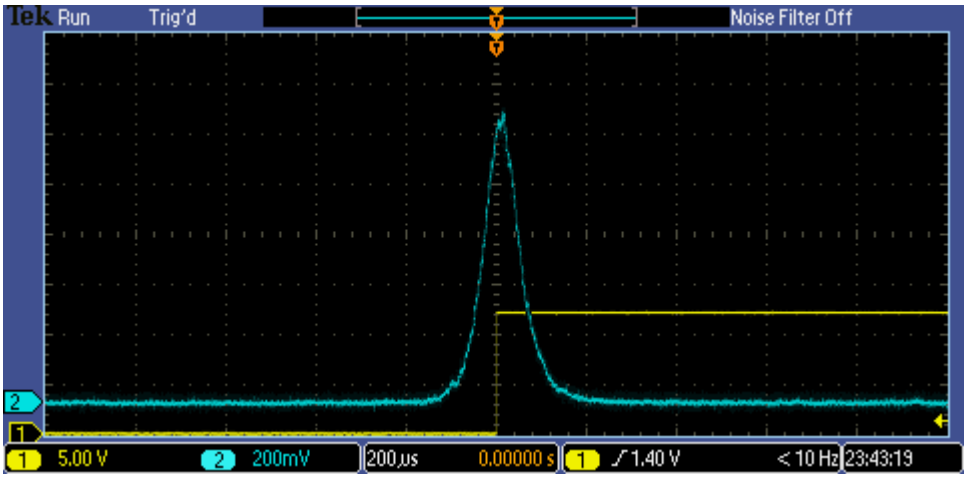
* Z.A.Yasa and N.M.Amer, Optics Commun., V36, 406 (1981)

HIGH SENSITIVITY & DYNAMIC RANGE

The unmatched sensitivity of the **FR-103MN** is demonstrated by its noise equivalent signal level of $[P_{av}P_{pk}]_{min} = 10^{-7}W^{2}$ *. This is further augmented by a dynamic range of ~10^{4}.



Commercial fiber laser (1552nm) pulse [450fs/ 1mW avg. power], measured by the **FR-103MN**.

WAVELENGTH RANGES (/BBO/KDP/IR/xxxx)

Three optimal **NL crystals** provide operation to ~ 5000nm. The standard unit comes with one NL crystal, customer specified:

/BBO → 410-600nm
/KDP → 510-1100nm
/IR → 850-5000nm.

These NL crystals accept **vertically** polarized input beams, they are BBAR coated and fundamental blocking filters are provided for their operational range. For long term reliability, a desiccators is provided to protect the crystal when not in use. The standard NL crystal thickness is customer specified (0.1mm/0.3mm/1mm), with attention to the trade-off between resolution (thinner NL crystal) and sensitivity (thicker NL crystal).
Typically, a 0.3mm crystal thickness can be considered sufficient for pulsewidths down to ~30fs. With shorter pulses, a thinner crystal is necessary. For sub 10fs pulsewidths, a custom (<25µm) NL crystal thickness will need to be specified.

/xxxx PD modules for extended IR wavelengths

The photomultiplier (PMT) in the standard **FR-103MN** covers the 410-1800nm operation. This range can be extended in the IR, by plug-in photodiode (PD) modules (/xxxx) which mount in front of the PMT enclosure. The PD module selections are:

/1300 → 1300-2200nm
/2200 → 2200-3400nm
/3000 → 3000-5000nm

Sensitivity is greatly reduced when operating with these PD modules since they lack the gain as provided by a PMT. Typically, a minimum of ~ 5mW avg. power is needed for a subpicosecond modelocked pulse, over the wavelengths covered by these modules.

OPTIONS:

CROSSCORRELATION (/CC)

The **FR-103MN** has a built-in auxiliary port for crosscorrelation of two spatially separate synchronized beams. A fiber adapter can be installed also at the CC port [/FA(CC)].

INTERFEROMETRIC OPERATION (/IO)

Standard (Michelson Interferometer) configuration of **FR-103MN** utilizes non-collinear (background-free) SHGmethod.* Optionally, it can be converted to provide collinear (interferometric) SHG. Using the highest resolution setting (<1fs) of its integration-time switch, fringe resolved autocorrelation is obtained. [This setting is of lowest gain, for which higher input power levels may be necessary].

FIBER ADAPTER OPTION (/FA)

An optional gimbal mount with a collimator is installed over the variable input aperture of the **FR-103MN**, for easy connection of fiber-coupled beams. Factory aligned, repeated connections with no need for realignment is facilitated. The /FA is easily removable for a free-space input beam. Its standard adapter is FC [FC/PC or FC/APC]. For operation at 1550nm, a PM-DSF patchcord can be attached to the /FA. The collimator of the /FA is focus adjustable to obtain good collimation if necessary to use over a significantly wide wavelength range. A $\lambda/2$ plate holder is also provided within the /FA assembly, for the user to install one for their wavelength of operation, if needed for polarization control.

The /FA option can also be applied to the CC port [/FA(CC)].

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* E.P.Ippen, C.V.Shank and A.Dienes, APL, V.21, p.348(1972

LOW REP RATE OPTION (/LRR)

The rotation rate of the // mirrors is locked (phase locked loop) to the repetition rate (submultiple) of the input beam. With a linear phase modulation superimposed on the rotation rate, autocorrelation traces are readily accumulated (~ 15secs) and **continuously monitored** for any rep rate (> 4Hz) laser. This mode is particularly useful for < 100Hz rep. rate lasers.

(HS) VERSION

The standard uniform rotation of the // mirrors is modified in this version of the **FR-103MN**, by means of a control mechanism. When this version **(HS)** is selected, two modes of operation are available:

1. Uniform rotation (as in the standard **FR-103MN**, but with a lower refresh rate (typically 2Hz))
2. Controlled movement such that the // mirrors slow down greatly (4 selectable speeds) over a period when the pulses on the two arms of the Michelson Interferometer set up are overlapping. The // mirrors speed up outside this range, to return quickly for a repetition of the cycle.

Whereas the standard **FR-103MN** (w/o LRR) provides 'real-time' autocorrelation for typically > 100kHz lasers, this version (**FR-103MN(HS))** renders the unit suitable for 'real-time' autocorrelation of lasers with any rep rate > 100Hz. This is particularly useful for kHz amplified lasers. Higher sensitivity is attained in this version, with its longer integration times available.

COMPUTER DATA ACQUISITION OPTION (CDA)

A data acquisition board is installed in the **FR-103MN**/CDA, providing an interface (USB) with any PC w/ Windows OS. Its associated software allows traces to be displayed, analyzed [averaged and/or fit with typical pulseshapes (Gaussian and $Sech^2$)] or saved.

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* Wavelength Range: 410-5000nm
* Interferometric/Noncollinear
* Fiber Coupled/ Free Space
* Crosscorrelation Option
* Low Rep Rate Option (any rep rate > 4Hz)
* Computer Data Acqusition Option
* (/HS)...High Sensitivity Version ('real-time' autocorrelation for >500Hz input rep rates)

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