Ultra-High Precision Timing System for the CEA – Laser Megajoule

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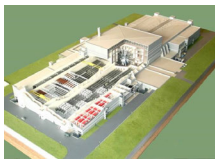
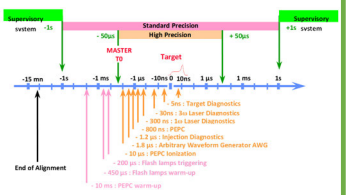
Laser MegaJoule Requirements

To control and set up all of the 176 laser beams and laser and plasma diagnostics, the timing system of the Laser MegaJoule (LMJ) must meet harsh requirements (See details on T. Somerlinck presentation). Timing system specifications are split into 2 performance categories : Standard and Ultra-High Precision Timing (SPT/HPT).



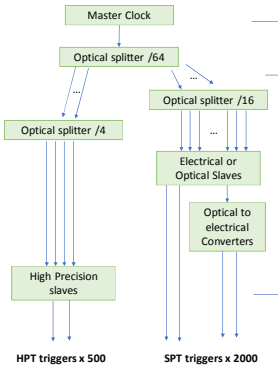


	Range	Jitter (RMS)	Thermal drift (peak-to-peak, over 1 week)	Quantity
SPT triggers	+/-1s	100 ps	< 2 ns	~ 2000
HPT triggers	+/-50µs	**5 ps**	**< 10 ps**	~ 500

Greenfield Technology specific Timing System

To give a global solution, Greenfield Technology (GFTy) has developped a specific timing system from the command-control software to the optical splitters in addition of the master-slave architecture

LMJ timing system architecture



GFTy Specific Products

GFT3013 : Master LMJ with a 12dBm laser diode

GFT4032 / GFT4016 :
- 64 outputs to reach more than 500 slaves
- 4 outputs 2ND stage to limit optical losses for HPT triggers and stay away from detection threshold and get optimized performances

GFT1018 – Low cost 8 channels slave
GFT1018-O : optical output version to reach long distance and harsh environment

GFT200 and GFT214 - 1 to 4 optical to electrical converters : Low cost solution to get 4 SPT triggers with close timing requirements

GFT1012 : 2 or 4 outputs high precision slave

GFT1012 : Ultra-High Precision Challenge

Power and system part — Box in the box : stabilized performance part

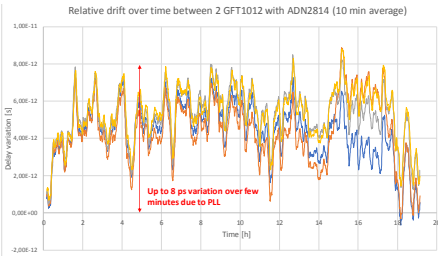
To conceive the ultimate precise slave, precautions have been taken to avoid noise and maintain stability.

Each function has been isolated to add a thermal control with a peltier cell. Metallic dissipators provide good thermal dissipation to stabililize the PCB and electronic devices.

Plastic box is used for mechanical consolidation. Air gap for thermal isolation.
Test with metal have been made : they have added an electronical shielding but prevent thermal transfers : stability with temperature was preferred.

Drawbacks of peltier cells : PWM control modules add noise due to high intensity variation. Electrical ground shielding between the function and the PWM part on every module has been added to minimize impact.

GFT1012 : Need for an all-new clock and data recovery system



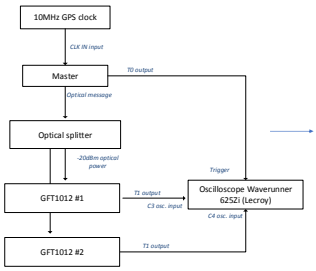
To guarantee the best performances, clock management is essential. Exchanges between master and slaves are made through an optical message @155,52MHz. To decode this message a clock and data recovery (CDR) function is necessary. PLL are used for years to achieve this function and are now more dedicated for higher frequencies : Stability over time and RMS jitter are not good enough for HPT specifications at 155.52MHz.

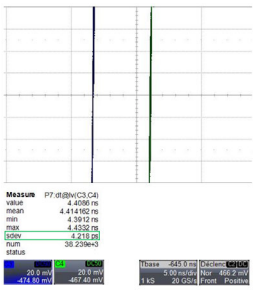
To get desired performances, GFTy decided then to design its own CDR function with discrete components at fixed frequency (adjustable in factory) that will bring less noise, be more stable and be a durable solution compared to obsolescent PLL components.
RMS jitter below 3ps has been measured before output drivers. Stability over time is presented below.

		IN/OUT RMS Jitter		
		ADN2817	ADN2814	GFTy solution
Specification		10 Mb/s ->2,7Gb/s	10 Mb/s ->675Mb/s	Fixed frequency
Frequency	155 MHz	**15 ps**	**8.2 ps**	**3ps**
	311 MHz	11,5 ps	3.2 ps	-
	622 MHz	5.7 ps	2.7 ps	-
	1,2 GHz	3.3 ps	-	-

GFT1012 : Ultra-High stability over time and temperature variation

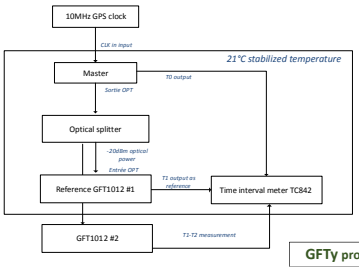
Jitter between 2 GFT1012

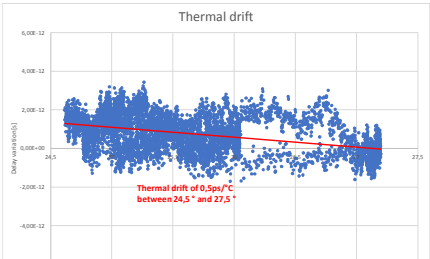




RMS jitter between 2 GFT1012 is 4ps RMS (typ.)

Stability over temperature

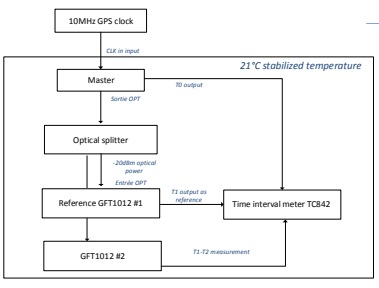


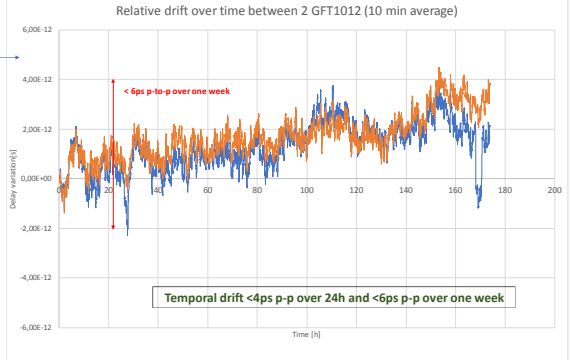


GFTy product comparison

Solution	GFTy product	Thermal drift ps/°C
Low-cost	GFT1018	~50ps
Standard	GFT1004	~15ps
Precise	**GFT1012**	<1ps

Stability over time





Summary

Thanks to CEA support and GFTy knowledge, GFT1012 meet the Laser MegaJoule requirements :
- **Jitter below 5ps RMS – 4ps typically**
- **Temporal drift below 10ps p-to-p over 1 week - <6 ps typically**

For further information, please see T. Somerlinck presentation or meet GFTy team at our booth during the conference.