Timing system for the HALPS/L3 ELI project

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GFTy Electronic Timing system

GFTy involved in several TS for big physic instruments

- **France:**
  - SOLEIL synchrotron (cPCI solution)
  - LULI (1U, 19 inches)
  - APOLLON (1U, 19 inches)
  - LMJ (1U/2U, 19 inches)
  - RX (detonic application – cPCI solution)

- **Europe**
  - AWE
  - Aldermaston

- **USA**
  - Jupiter (1U, 19 inches)
  - NIF (FTT) (1U, 19 inches)
HALPS Generality

- The High Repetition-Rate Advanced Petawatt Laser System

- Synchronization pump laser beam/short pulse laser beam
  => several precisely timed triggers needed
- Master oscillator common to the 4 lasers
HALPS Timing System

- Common reference CLK + precisely timed triggers
- Require a low jitter high precision ETS, independent or synchronous to the ELI’s TS
  - Master Timing Generator (MTG) optically linked to local multi channel delay generators
  - 1ps delay resolution
  - MTG phase locked to the 80MHz system clock, jitter <10ps rms
- Greenfield Technology ETS selected
  - Customized its ETS
HALPS Timing System
Low jitter – 1ps ETS

- **Master Timing Generator**/Multichannel Delay Generators / Time Interval Meter

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**Master Timing Generator**/Multichannel Delay Generators / Time Interval Meter

- 5
- www.greenfieldtechnology.com
- ICALEPCS 2015 – 21/10/2015
4 main blocks

- CLK Manager: ensure phase lock to the ref. CLK (80MHz) and low jitter btw ref clk and optical output (<10ps rms)
- MSG encoding: 6 Epochs and 4 Keys coincident to ref. clk
- Data frame generation: 1B/2B encoded @160MS/s
- Optical transmitter: 6dBm @ 1550nm
GFTy ETS components
Master Timing Generator 2/2

- Encoded message
  - 3 fixed (1kHz, 100Hz, 10Hz) and 3 user specified Epochs (F1>F2>F3)

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<th>F1</th>
<th>500</th>
<th>200</th>
<th>100</th>
<th>50</th>
<th>20</th>
<th>10</th>
<th>5</th>
<th>3.3</th>
<th>2</th>
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<tbody>
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<td>1000</td>
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- 2 pairs of keys (SShot) + Burst mode on SS1/SS2 pair

- 1 inhibit key (soft/hard) : data frame generation inhibition
HALPS Timing System
Low jitter – 1ps ETS

- Master Timing Generator/Multichannel Delay Generators / Time Interval Meter

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ICALEPCS 2015 – 21/10/2015
GFTy ETS components
Multichannel Delay Generators

- MTG => Data pattern distributed to multiple zones
- 3 main delay generator blocks
  - Data stream decoding: MTG triggers and ref. clock recovering
  - Clock controller: clock selection
  - Delay generation: digital (6.25ns) + analog (1ps).
HALPS Timing System
Low jitter – 1ps ETS

- Master Timing Generator/ Multichannel Delay Generators / Time Interval Meter

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GFTy ETS components
Time Interval Meter

- 2 main blocks
  - Timing controller / CLK mux
  - Time counter + linear interpolators => 1ps meas. resolution
  
  Note: Arming mode: Start, Stop, Gate, Optical input

- Enable 2 independent high precision TS to operate as a single time coordinate TS
GFTy ETS
Results

● Achieved by GFTy ETS
  - Runs @ 160MHz
  - Phase locked to the 80MHz reference clock
  - < 10ps rms jitter: ref. CLK ⇔ optical data stream
  - Trigger frequency range : 1000 – 0.1 Hz
  - 2 Single Shot pairs + Burst mode
  - 0 to 10s delay range with 1ps res., jitter < 15ps rms (T0-channel)
  - acc. < 250ps + delay * t_c (rubidium t_c~10^{-12})

● Under test at the LLNL Facility

● GFTy proposed a customized ETS
  - controlled via front panel, web browser or ethernet link (simple cmds, LXI std)
  - Upgrade up to 256 channels
GFTy Devices

● Products
  - Timing system (Master unit + slave units, Opt-Elec)
  - Delay generator (up to 20 chan./20V)
  - Time interval Meter
  - Signal generator
  - Opt ⇔ Elec converters
  - Digitizer (10GHz – 8/10/12bits – 3GHz BW)
  - Streak camera
  - High BW scope (FTD10000 – 7GHz)

● Form factor
  - PXI, cPCI
  - Benchtop, OEM
  - rack