The KHz Ranging Engine (KRE)

V1.2 Description

J Guilfoyle H Kunimori

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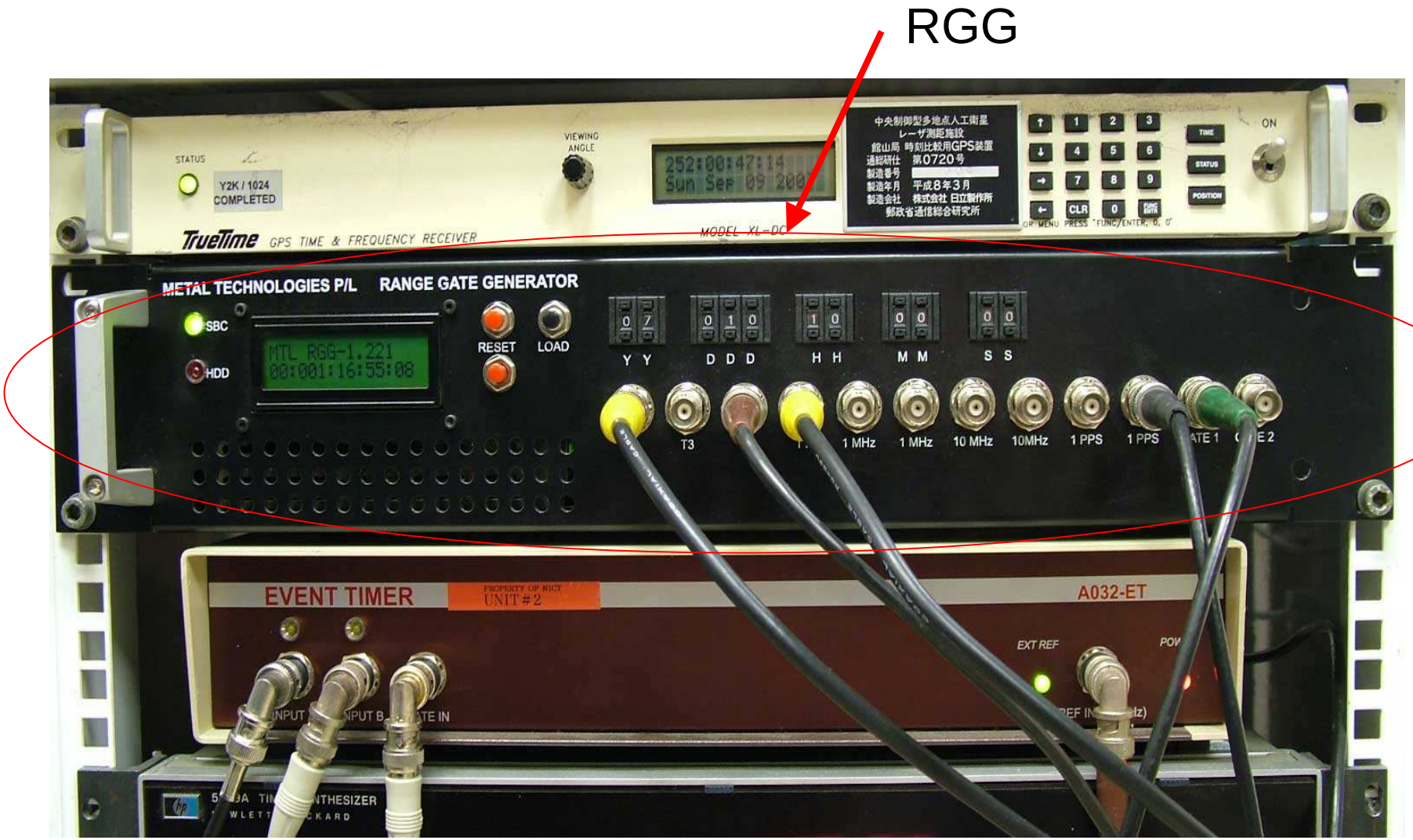
Introduction

Metal Tech and NiCT have developed a KHz-capable ranging controller, principally for upgrading the SLR systems at Koganei as future path.

Key Conceptual Features:

- **functionality in a variety of environments**
- **access to source**
- **modern and compact**
- **field upgradeable**

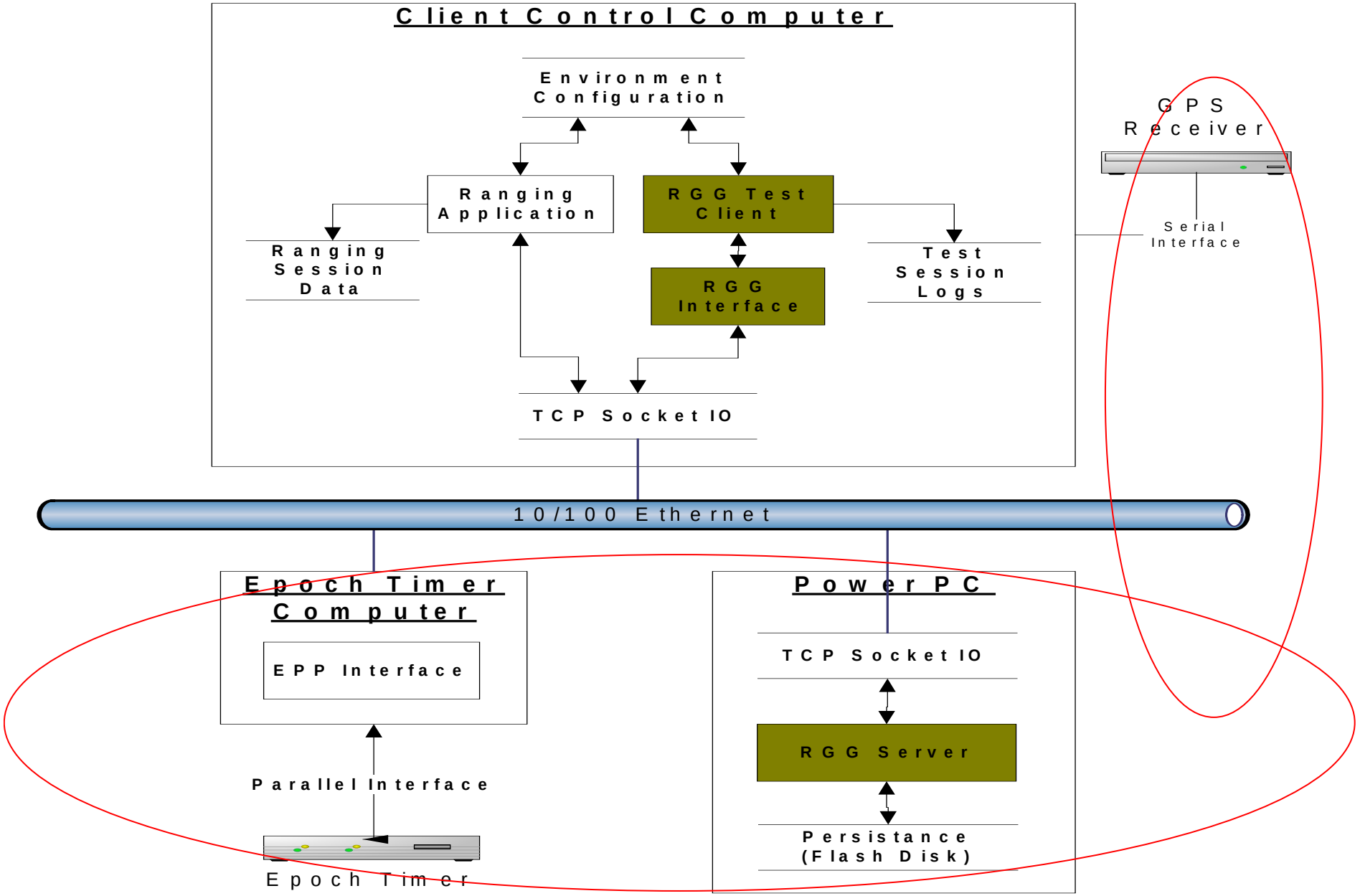
KRE Looks :


RGG
STATUS
Y2K / 1024
COMPLETED
VIEWING
ANGLE
TrueTime
GPS TIME & FREQUENCY RECEIVER
MODEL XL-DC
METAL TECHNOLOGIES P/L
RANGE GATE GENERATOR
SBC
HDD
MTL RGG-1.221
00:001:16:55:08
RESET
LOAD
Y Y
D D D
H H
M M
S S
T3
1 MHz
1 MHz
10 MHz
10MHz
1 PPS
1 PPS
EVENT TIMER
UNIT #2
A032-ET
EXT REF
ON

General Features

- **One box with RGG (range gate generator) and A032ET servers.**
- **Separate 100BaseT LAN communications to each server.**
- **2U high, 19” rack-mounting package.**
- **100~250VAC 45~65Hz, 1Φ.**
- **Warm reset functions.**
- **TCP/IP communications.**

Block diagram :Communications



RGG Server Features 1 of 4

- **Implementation platform XILINX V4Fx12, test C software implemented in Virtex Power PC**
- **On-board multipliers and dividers, 500MHz base frequency, 2ns granularity on all signals**
- **Precision frequency inputs:**
  - **10MHz**
  - **1pps**
- **Signal outputs:**
  - **buffered 10MHz, 1MHz, 1pps (square)**
  - **6 sequential triggers at laser fire time (TTL)**
  - **2 range gates, config. widths & delays (NIM)**

RGG Server Features 2 of 4

- **Epoch (1pps) outputs are synchronized to UTC independent of display time.**
- **On-board linear interpolation of blocks of range information.**
- **On-board collision avoidance via laser fire delay register.**
- **RS232 serial port for diagnostic data FIFO service task runs at 200Hz**

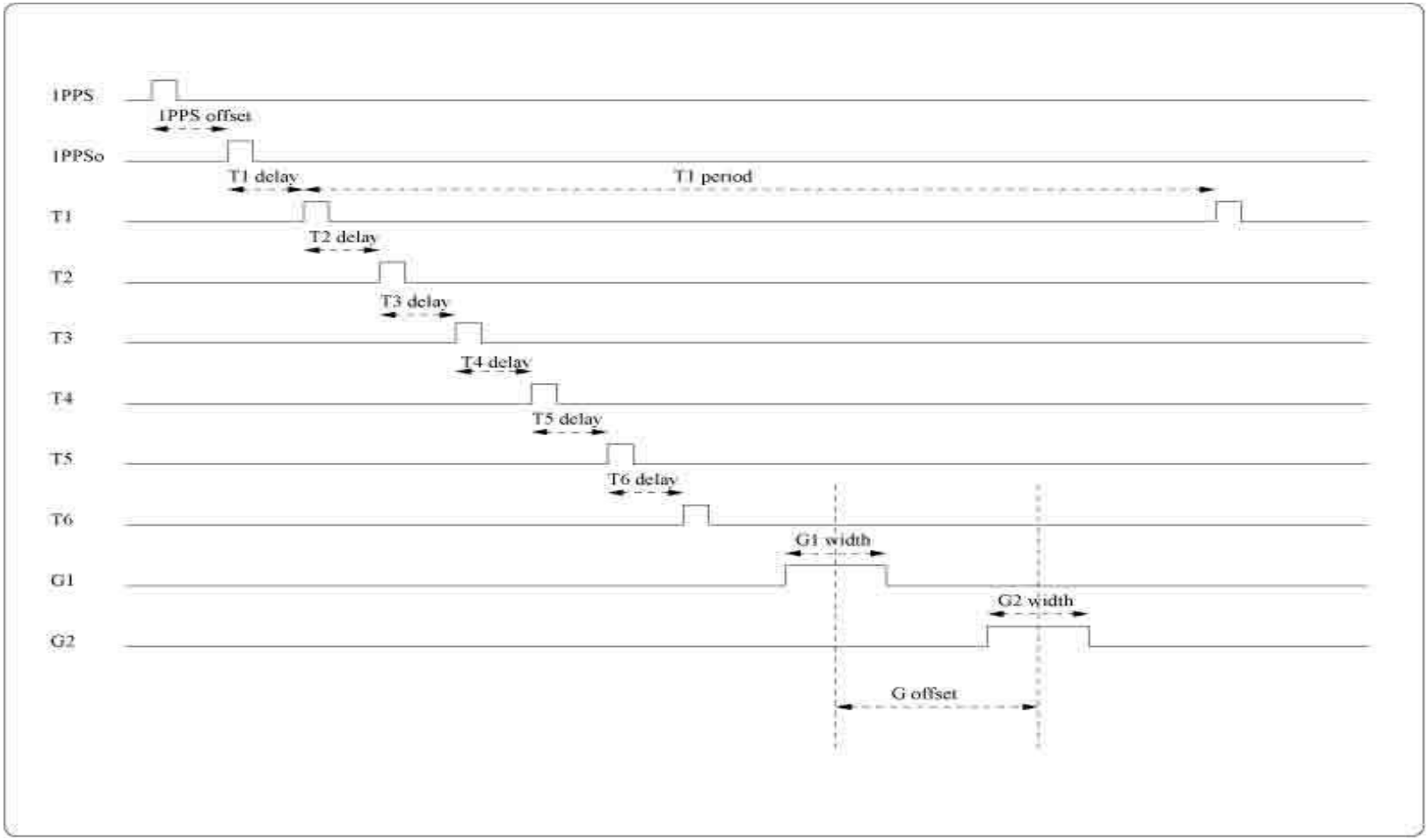
RGG Server Features 3 of 4

- **Range gates are epoch triggered**
- **The RGG is a sequential device, where randomness should enter via jitter in laser fire.**
- **No limitations to a multi-stop environment.**
- **Any PRF from 1Hz to 2KHz**

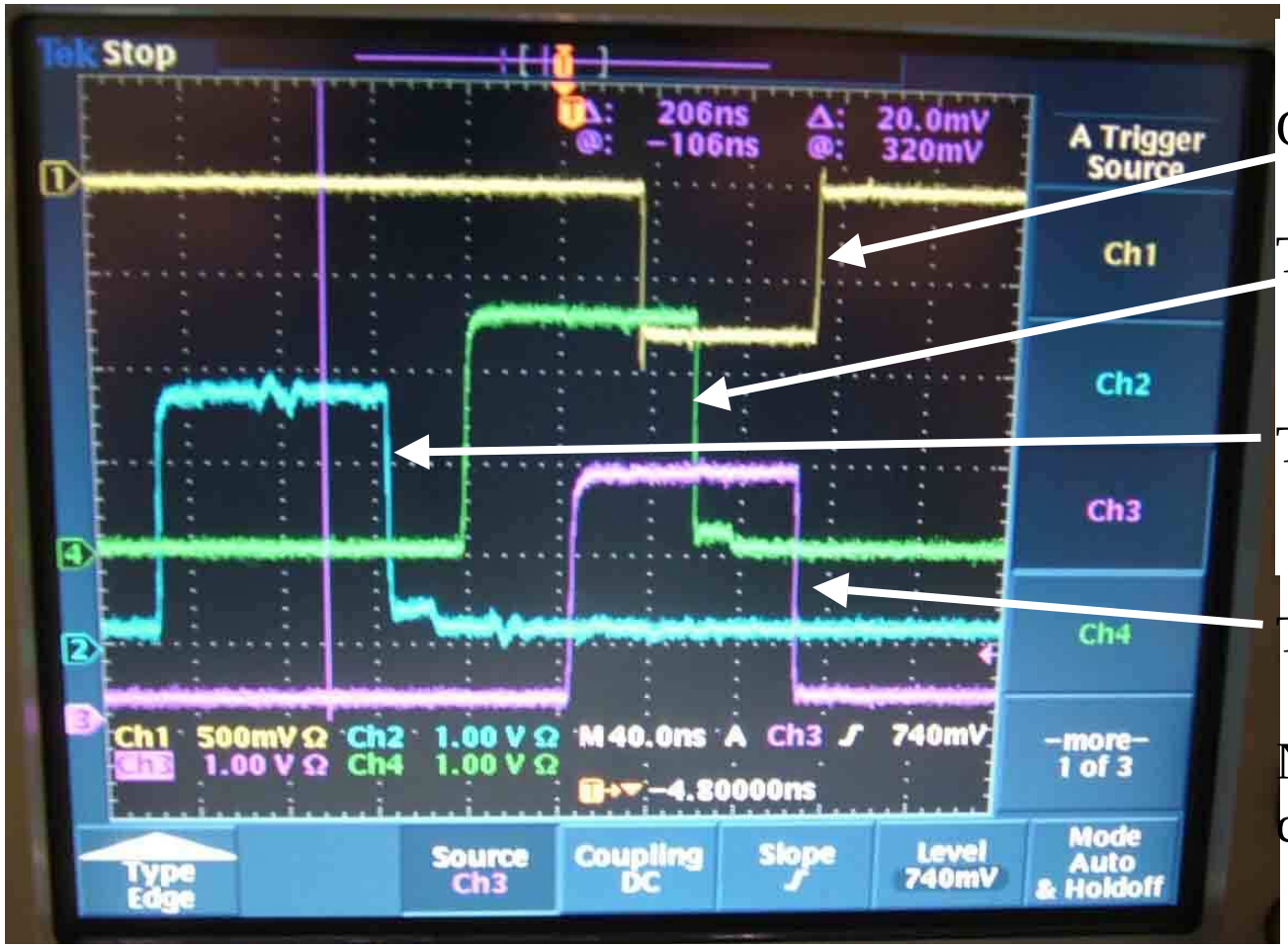
RGG Server Features 4 of 4

- **Interpolation is always on. Range rate is determined on board.**
- **Collision avoidance is always on.**
- **Gates are epoch triggered, no matter the range.**
- **The purpose of the two range gates is to deal with old style MCP detectors that require significant settle time after being gated on.**

Timing Chart: Triggers and Range Gate signals 1 of 1



Short, fixed range 1 of 1



Gate 1

Trigger 5

Trigger 1

Trigger 6

NB: triggers can overlap

Moving Target 1 of 1
Collision band handling

Top trace is Gate1

Bottom trace is laser fire

‘scope persistence is on

ET Server Features 1 of 1

- **Primary purpose is to handle the A032ET device**
- **Implemented on single-board PC under Linux, 60GB hard disk**
- **Bandwidth - can run Latvian demo mode 1 at ≥10KHz**
- **On-board USB2.0 port accessible via server software, used for Rx controls, such as:**
  - **shutters**
  - **OD LC filter**
- **H-Interface implemented on Java machine support DHCP, Ping, Telnet and FTP**

Collision Band handling : Efficiency

- **Collision zones are handled by a parameter controlling the allowable separation of laser fire and gate open. For the duration of the overlap, the laser fire signal is delayed, with the effect of reducing PRF.**

- **The following table show testing not exhaustive, but indicative of performance.**

Collision Band handling Efficiency

PRF Hz	*Range*	*Gate ns*	*Collision Deadband*	*%*
.1K	*1~42ms*	*76*	*30 µs*	*>97*
1K	*1~42ms*	*76*	*30 µs*	*>95*
2K	*1~42ms*	*500*	*65 µs*	*>90*
2K	*150ns*	*76*	*30 ns*	*99.9*
1K	*.1~1.09s*	*76*	*30 µs*	*>95*
2K	*.1~1.09s*	*500*	*65 µs*	*>90*
2K	*2.6~2.7s*	*500*	*65 µs*	*>90*

Limitations 1 of 2

- **FIFO depth is 6000 which limits the maximum range wrt PRF and gates:**

PRF	*Max Range with Gates*	
	1or 2	*1 & 2*
2KHz	*3 sec*	*1.5 sec*
1 KHz	*6 sec*	*3 sec*
500Hz	*12 sec*	*6 sec*

Limitations

- **Increasing FIFO size requires reorganization of internal Xilinx memory.**

  FIFO depth is 6000 which limits the maximum range wrt PRF and gates, can do 2kHz Lunar Ranging but not Planetary.

- **The RGG does not understand change of year.**
- **Range gate minimum width is 76ns.**
- **The Riga ET in Mode 1 can deal with one start and stop event. A multi-stop environment will require an ET server for each stop.**
- **Internal cals can only be done with fixed-range targets.**

Conclusions

- **We have created a very versatile device with few real limitations, off-loading many tedious functions from a client control computer.**
- **Only special PCB is for signal distribution, other devices are commercial products.**
- **The brains are in the VHDL firmware and software, so logic updates can be flexible for new requirement.**

Acknowledgements

- **The on-board hardware delay design for collision avoidance is based on ideas discussed at Graz in 2004.**
- **Clever contractors:**

  Leigh Dahl is responsible for creating the electronics and firmware.

  Yehia Ghonim is responsible for demo software development.