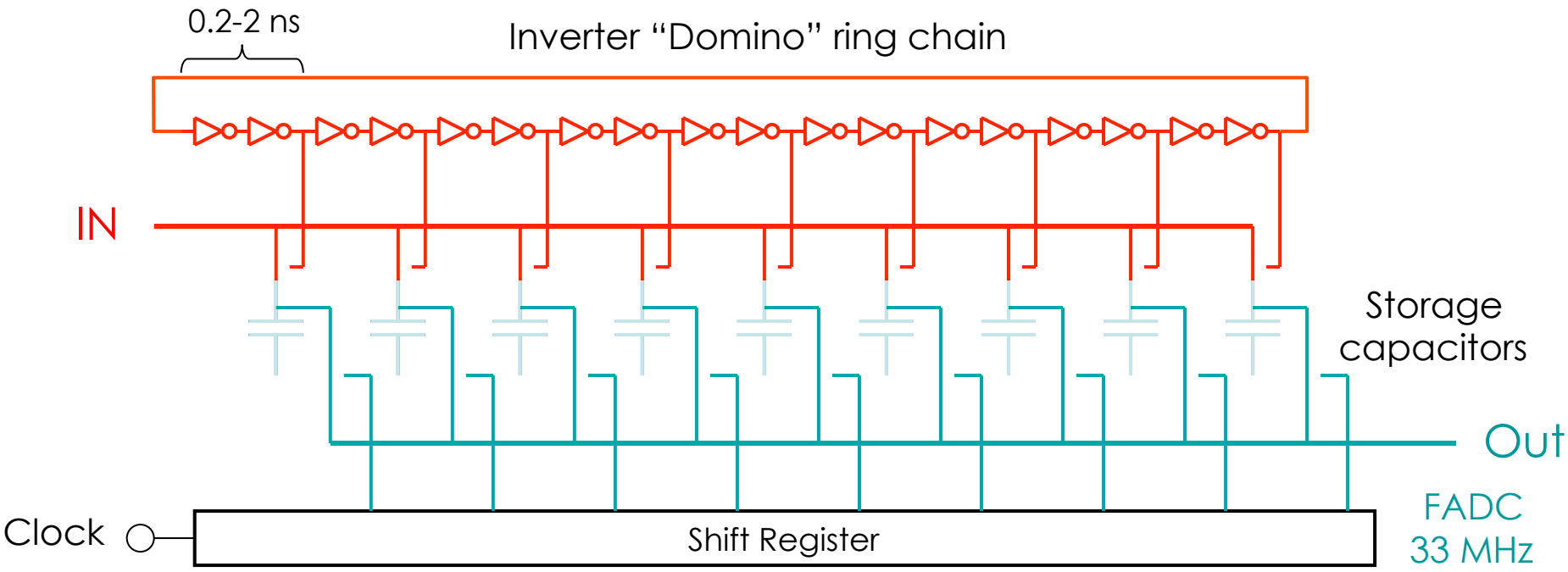
Stefan Ritt, Paul Scherrer Institute, Switzerland

Luca Galli, Fabio Morsani, Donato Nicolò, INFN Pisa, Italy

THE WaveDAQ SYSTEM FOR THE MEG II UPGRADE

DRS4 Chip



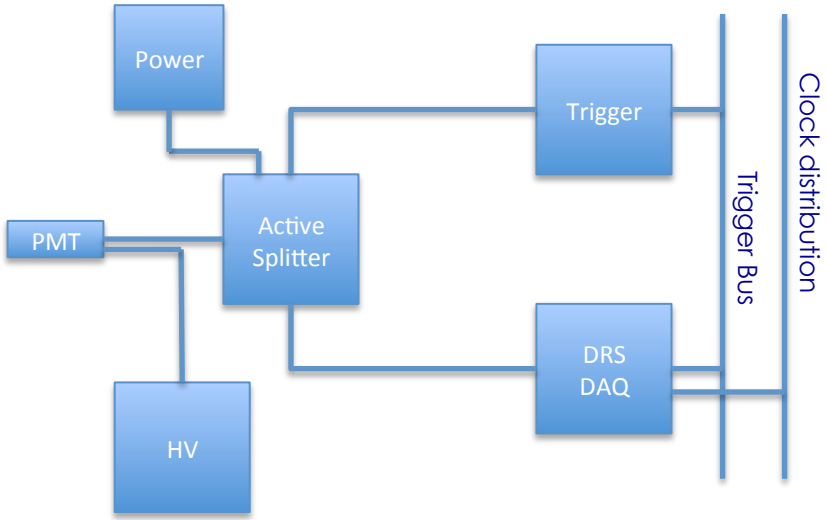
- Switched Capacitor Array (Analog Memory) developed at PSI
- 5 GSPS / 11.5 bits SNR, 9 channels on 5 mm x 5 mm chip, 40 mW / chn.
- Used at ~200 locations worldwide
- 2012: "Gigahertz Waveform Sampling: An Overview and Outlook"

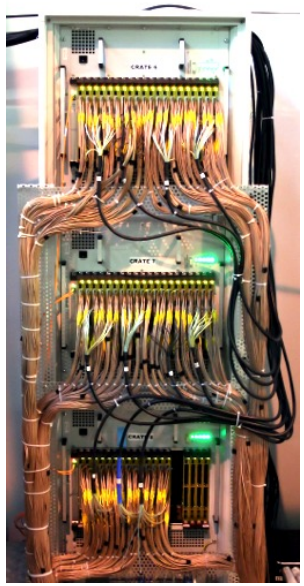
- Pile-up rejection O(~10 ns)
- Time measurement O(10 ps)
- Charge measurement O(0.1%)

MEG & MEG II

MEG Experiment 1999-2013

- Separated DAQ & Trigger
- 3000 Channels DRS4 (0.8 GSPS / 1.6 GSPS)
- 1000 Channels Trigger (100 MSPS)
- 5 Racks





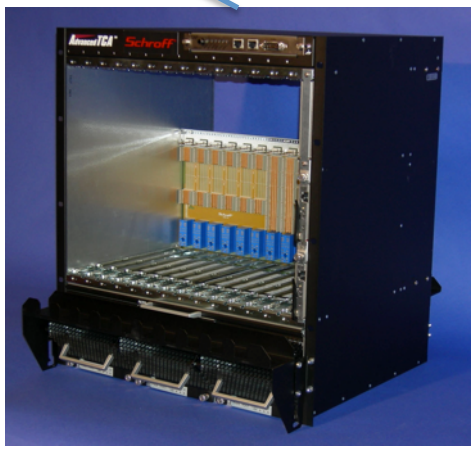
MEG II Experiment 2014-

- 9000 Channels
- Same rack space ➔Combine DAQ & Trigger

S2: M. de Gerone: An extreme high resolution Timing Counter for the MEG II Experiment
S2P: M. Simonetta: Test and characterization of SiPMs intended as detector for the MEG timing counter
S5P: D. Nicolò: An FPGA-based trigger for the MEG II Experiment
S5P: A. Pepino: A high performance Front End Electronics for Drift Chamber readout in the MEG II Experiment
S7P: M. Grassi: A new cylindrical drift chamber for the MEG II Experiment
S7P: G. Rutar: A Dedicated Calibration Tool for the MEG and MEG II Positron Spectrometer
S7P: L. Galli: MEG II drift chamber prototype characterization with the silicon based cosmic ray tracker at INFN Pisa
S7P: M. Venturini: Ageing tests for the MEG II drift chamber
S9P: D. Nicolò: A liquid hydrogen target for the calibration of the MEG and MEG II liquid xenon calorimeter
S9P: K. Ieki: Upgrade of the MEG liquid xenon calorimeter with VUV-light sensitive large area SiPMs

Crate Options

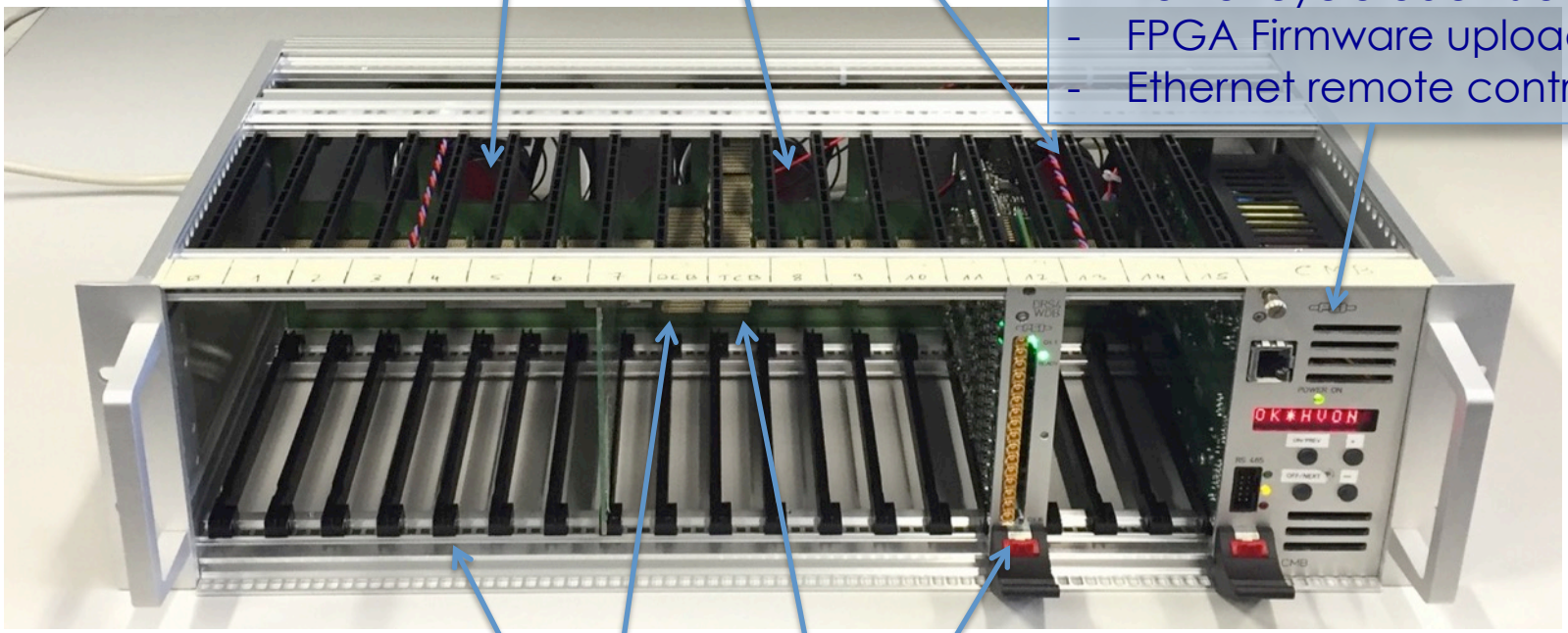
Feature	VME	ATCA	???
Transfer speed O(100 MB/s)	✔	✔	✔
Dual-Star Topology with Gbit links	✗	✔	✔
Shelf management	✗	✔	✔
Fast trigger distribution	✗	✗	✔
Low-jitter precision clock O(ps)	✗	✗	✔
200 V SiPM biasing	✗	✗	✔
< 2000 EUR per crate including power	✗	✗	✔



WaveDAQ System

Fans blow from back to front

Crate **M**anagement **B**oard
- Power supply 24V / 300W
- Fan / Temp. control
- Power cycle each slot
- FPGA Firmware upload
- Ethernet remote control

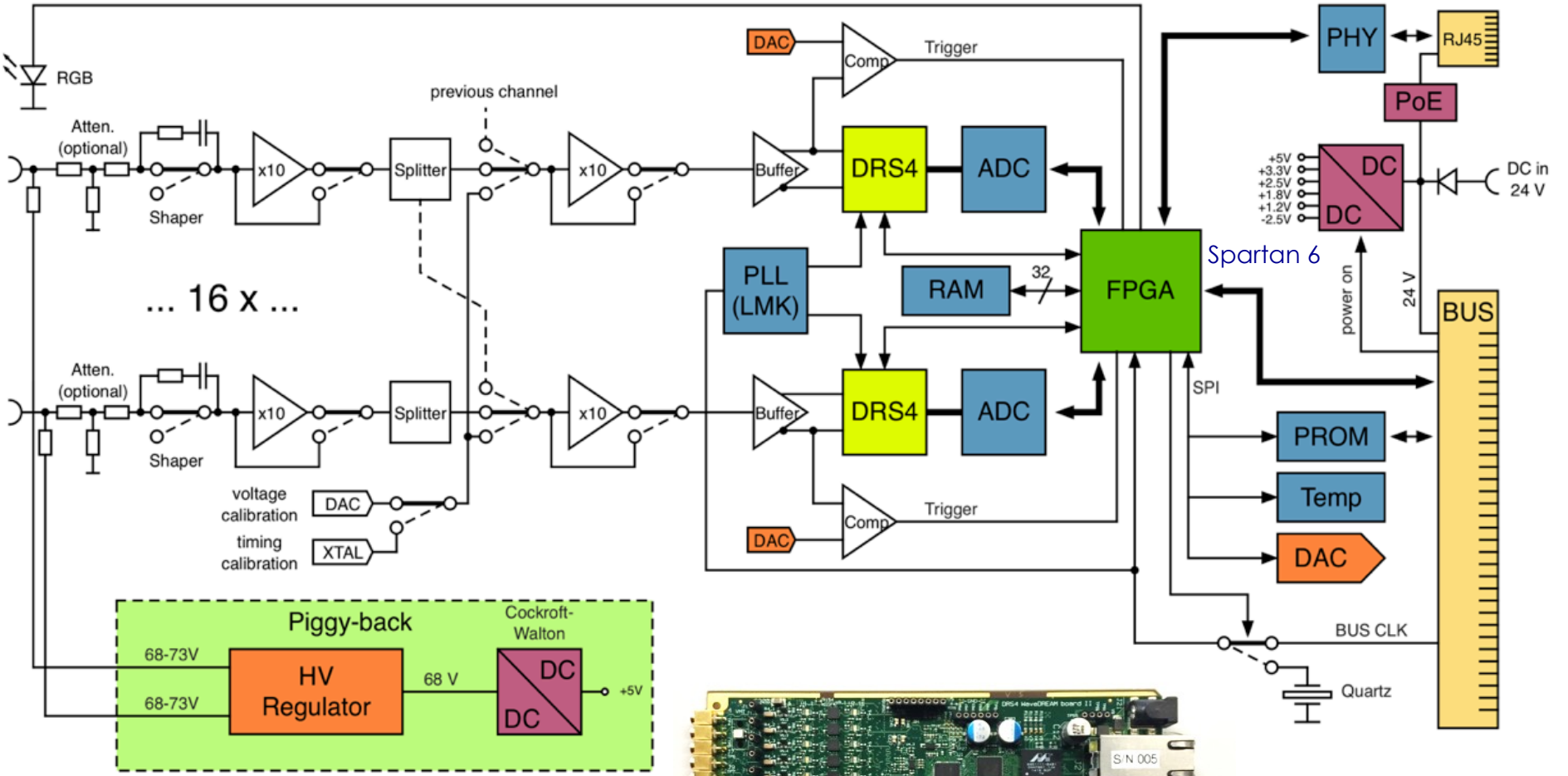


Data **C**oncentrator **B**oard

Trigger **C**oncentrator **B**oard

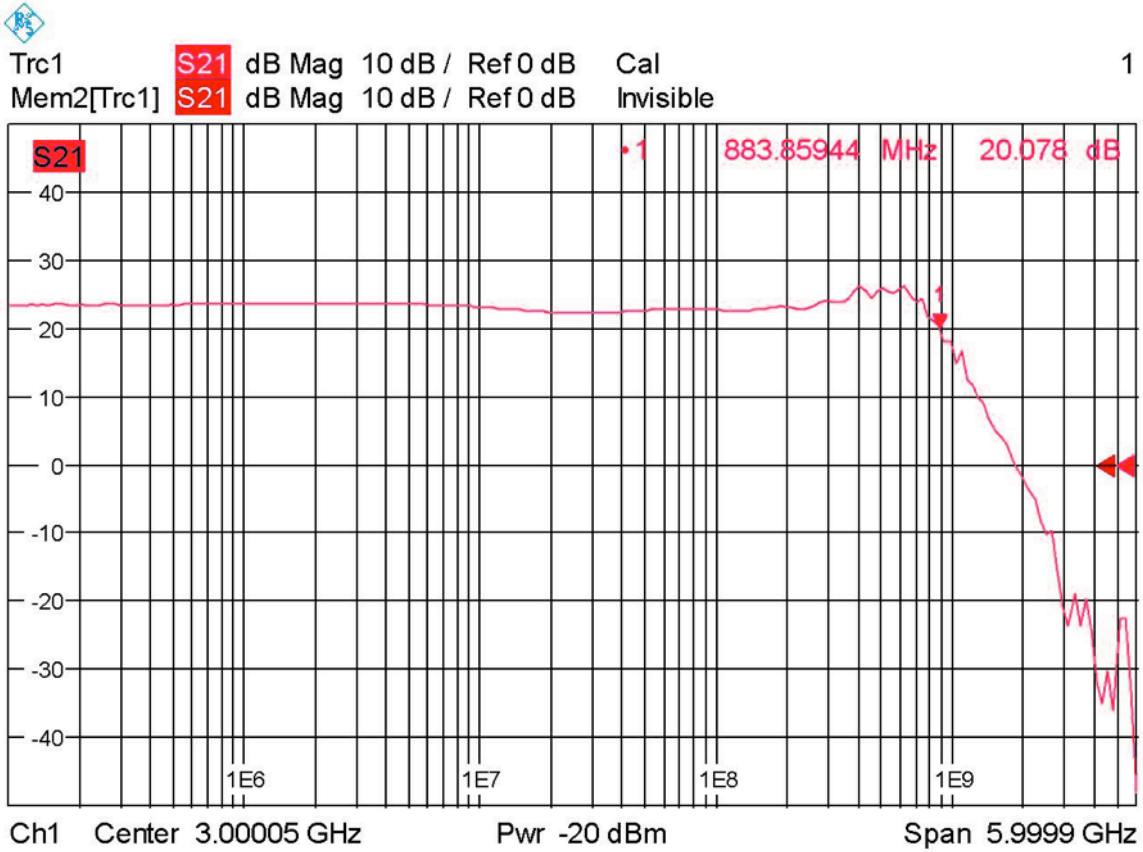
16 WaveDREAM boards
(256 channels)

WaveDREAM Board (WDB)



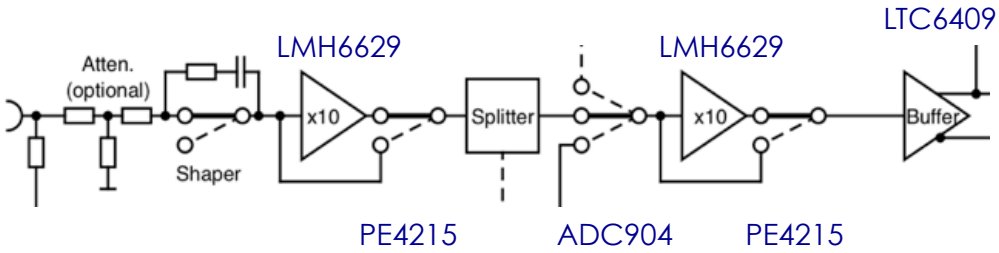
Drs4 based **REA**dout **M**odule

Preamp



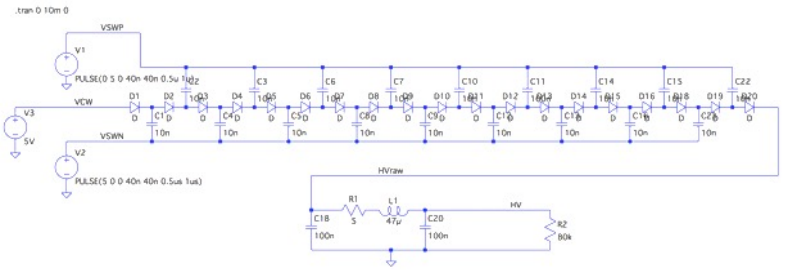
Gain	BW_{3db} (MHz)	Noise (mV)
1	940	0.37
10	880	0.40
100	300	1.2
100	500	1.7
100	800	3.3

Different compensations

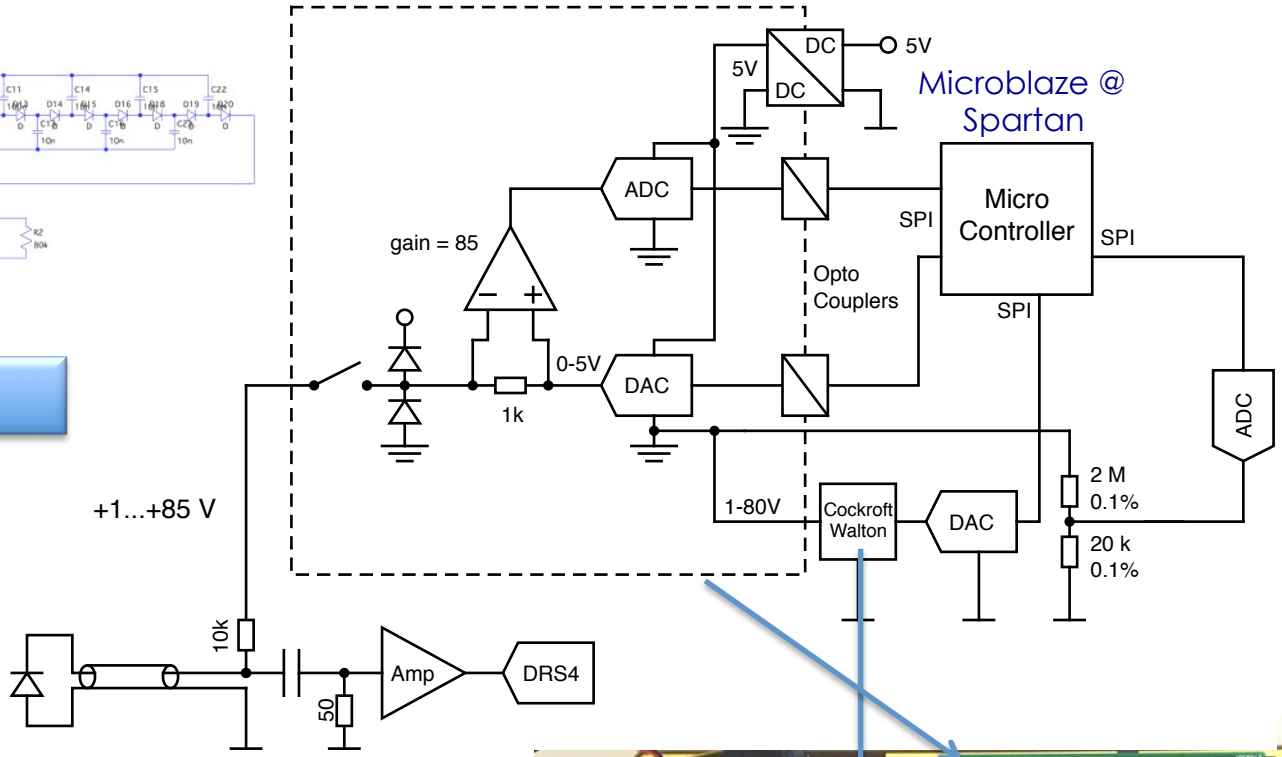


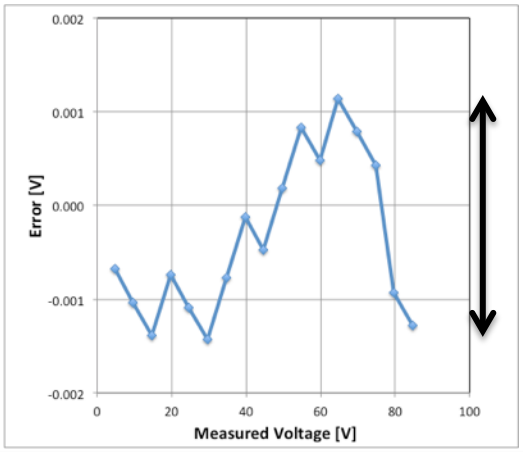
3.3 mV at output =
33 μV at input

WaveDREAM2 HV



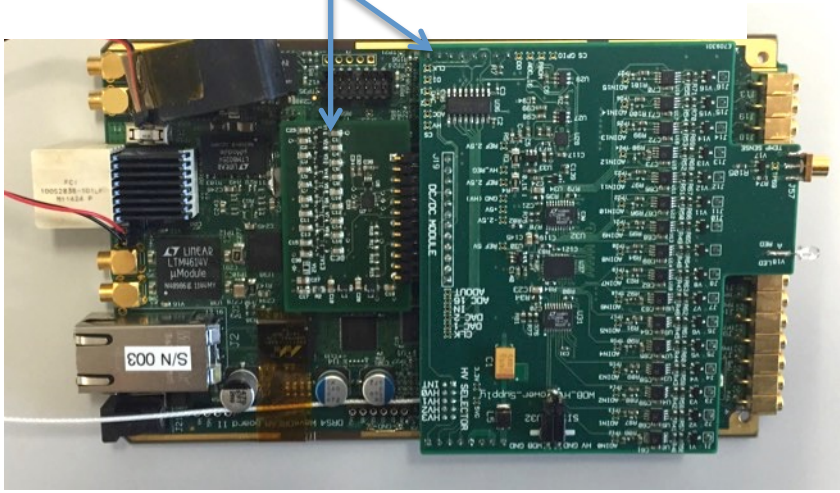
~ 5 EUR / channel





+/- 1mV

Ripple < 10 μV



Temperature Sensor Extension

maxim integrated™

DS18B20
Programmable Resolution
1-Wire Digital Thermometer

- User-Definable Nonvolatile (NV) Alarm Settings
- Alarm Search Command Identifies and Addresses Devices Whose Temperature is Outside Programmed Limits (Temperature Alarm Condition)
- Available in 8-Pin SO (150 mils), 8-Pin µSOP, and 3-Pin TO-92 Packages
- Software Compatible with the DS1822
- Applications Include Thermostatic Controls, Industrial Systems, Consumer Products, Thermometers, or Any Thermally Sensitive System

DESCRIPTION

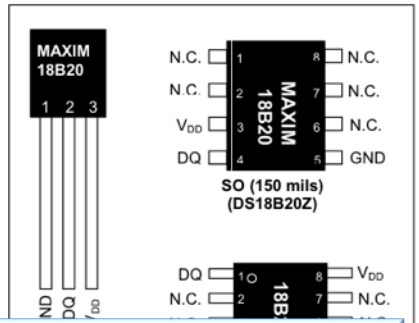
The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central microprocessor. It has an operating temperature range of -55°C to +125°C and is accurate to ±0.5°C over the range of -10°C to +85°C. In addition, the DS18B20 can derive power directly from the data line ("parasite power"), eliminating the need for an external power supply.

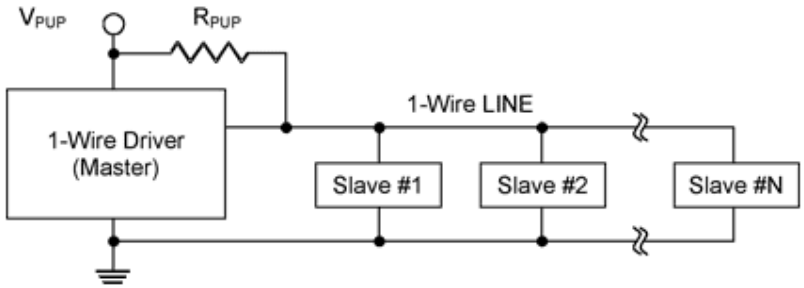
Each DS18B20 has a unique 64-bit serial code, which allows multiple DS18B20s to function on the same 1-Wire bus. Thus, it is simple to use one microprocessor to control many DS18B20s distributed over a large area. Applications that can benefit from this feature include HVAC environmental controls, temperature monitoring systems inside buildings, equipment, or machinery, and process monitoring and control systems.

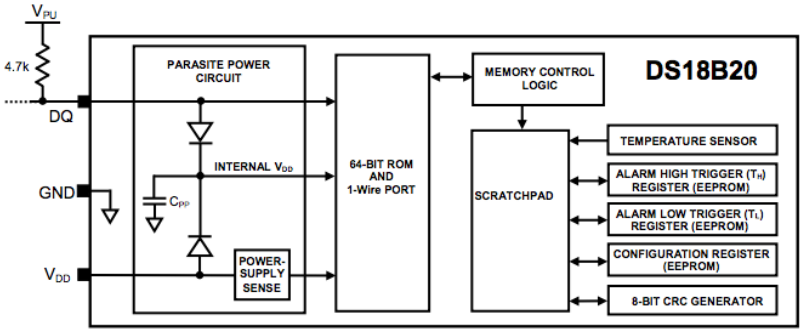
FEATURES

- Unique 1-Wire® Interface Requires Only One Port Pin for Communication
- Each Device has a Unique 64-Bit Serial Code

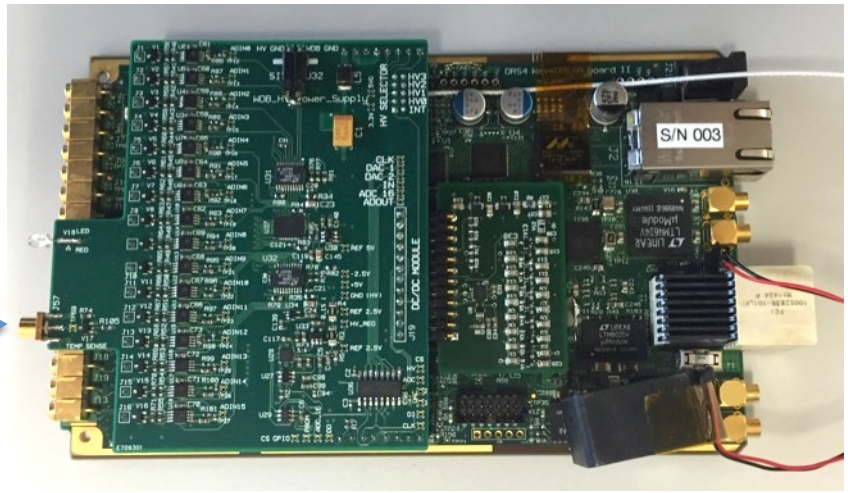
PIN CONFIGURATIONS



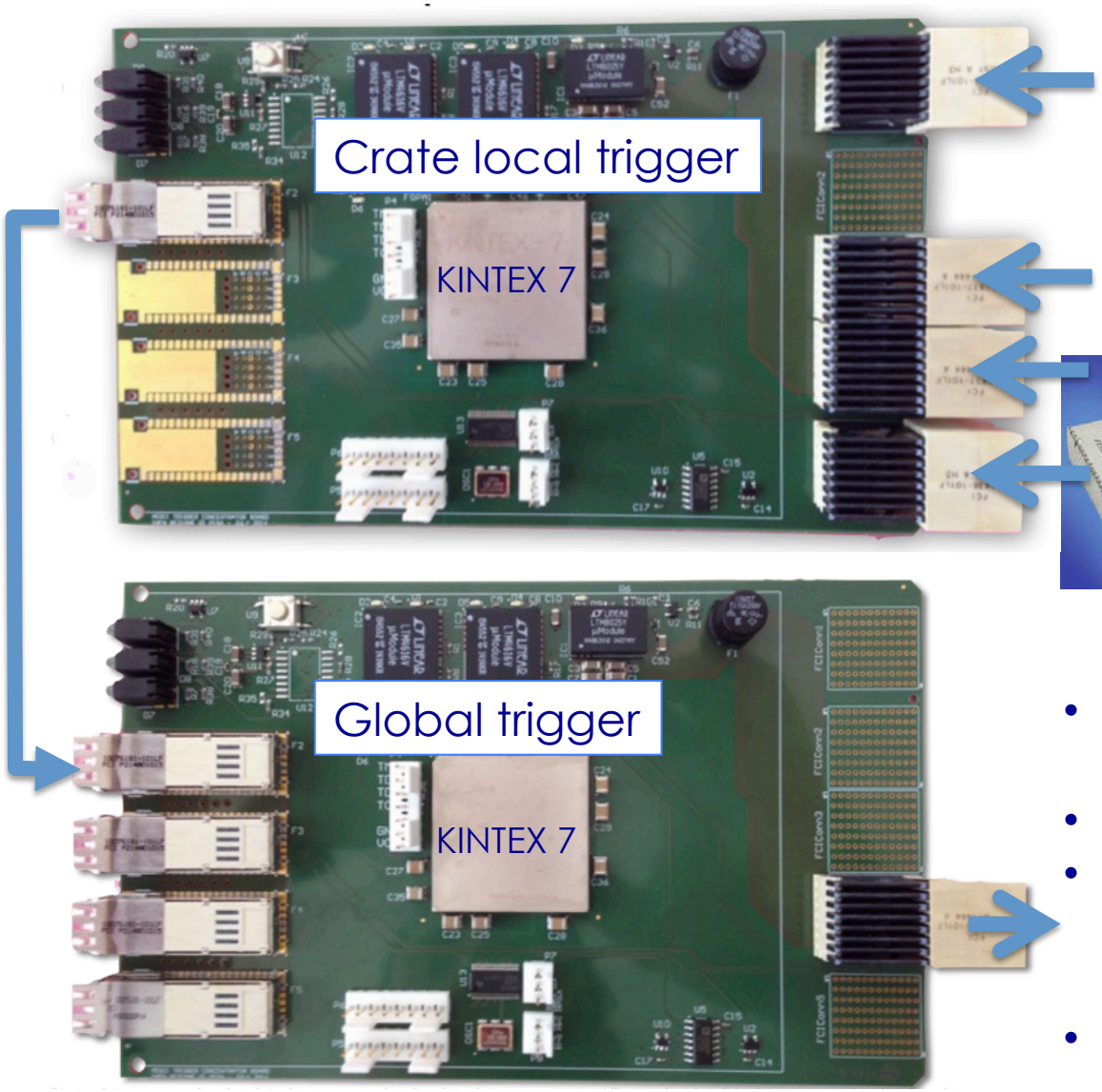


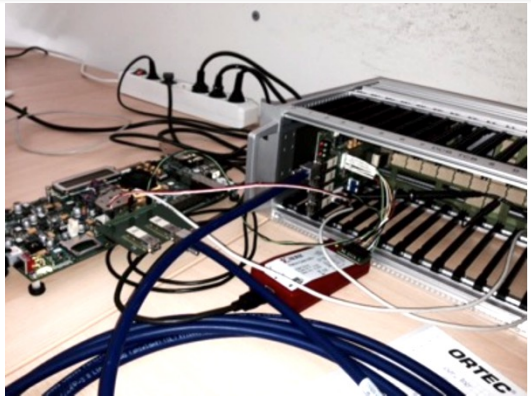


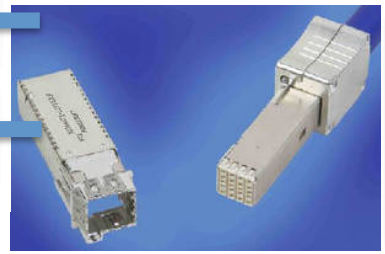
- accuracy ±0.5°, 3 EUR / sensor
- 1-16 sensors per WD2 board with only one coaxial cable
- Automatic HV adjustments with temperature changes

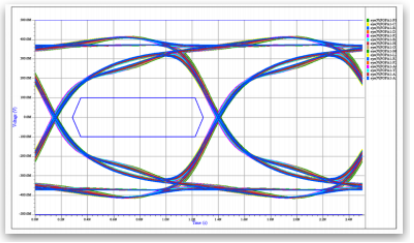


Trigger Concentrator Board (TCB)





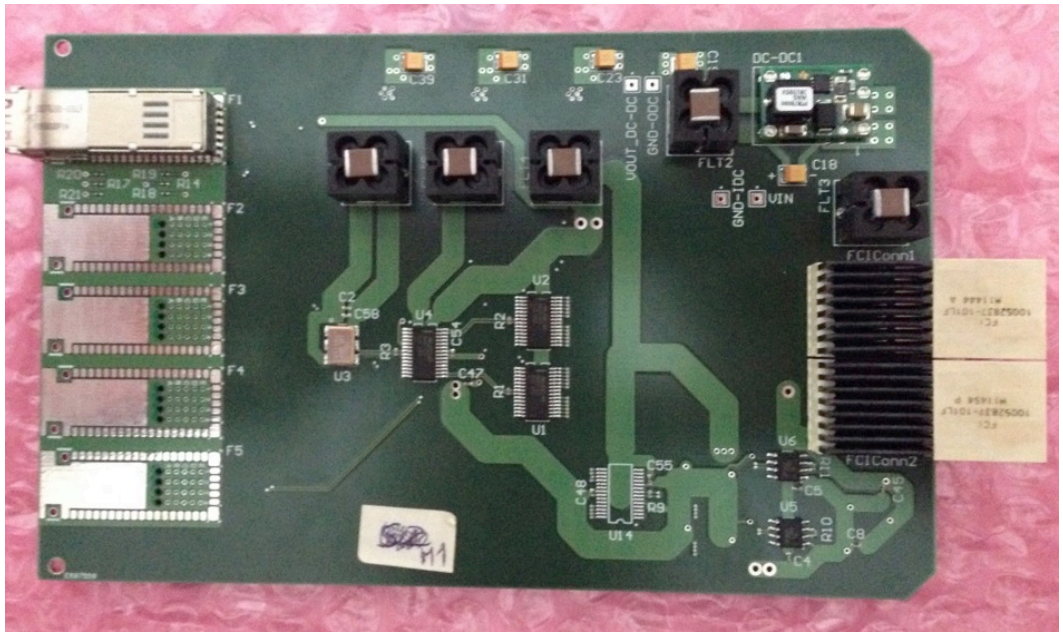


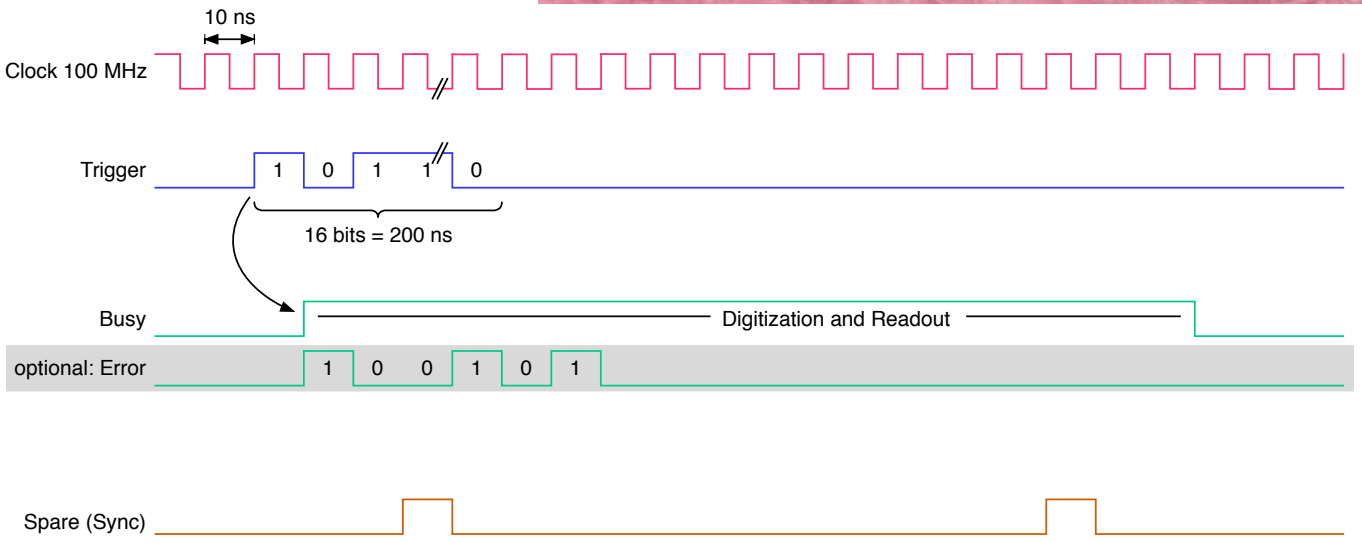


- Receives serial links (SERDES) from WD boards
- Computes crate local trigger
- Send trigger via serial links to global trigger in dedicated crate
- FCI Densishield cables

Ancillary system

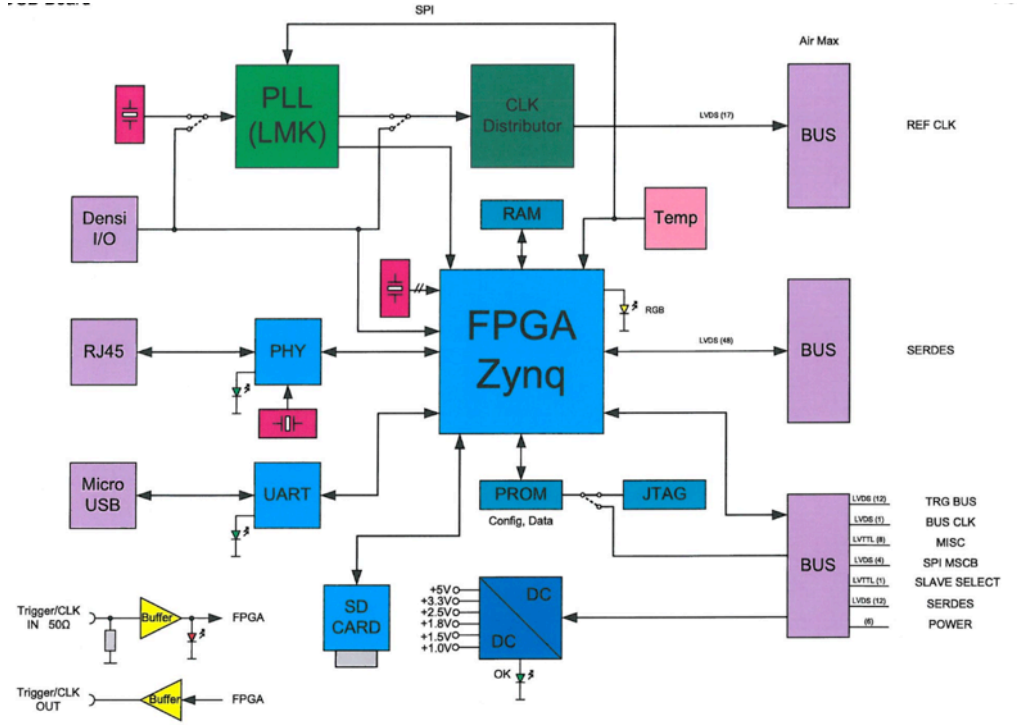
- Contains master clock
- Distribute clock
  (jitter < 12 ps measured)
- Distribute trigger
- 4 diff. pairs for
  - Clock
  - Trigger
  - Busy
  - (Sync)

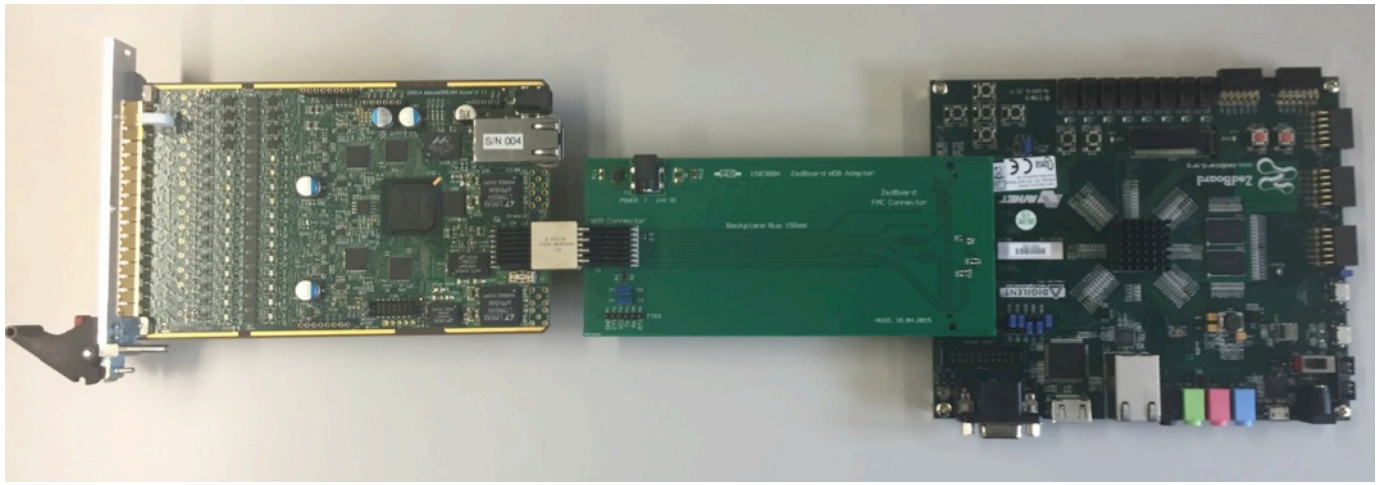




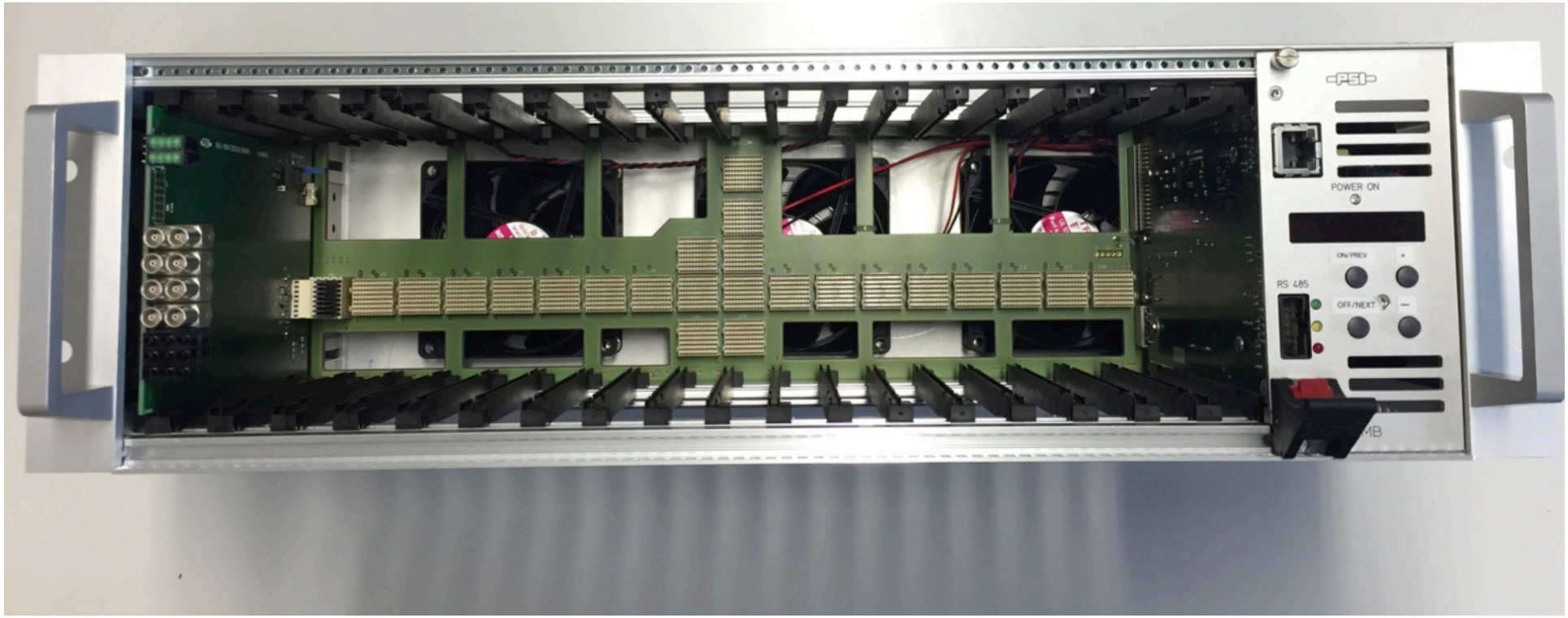
DAQ Concentrator Board (DCB)

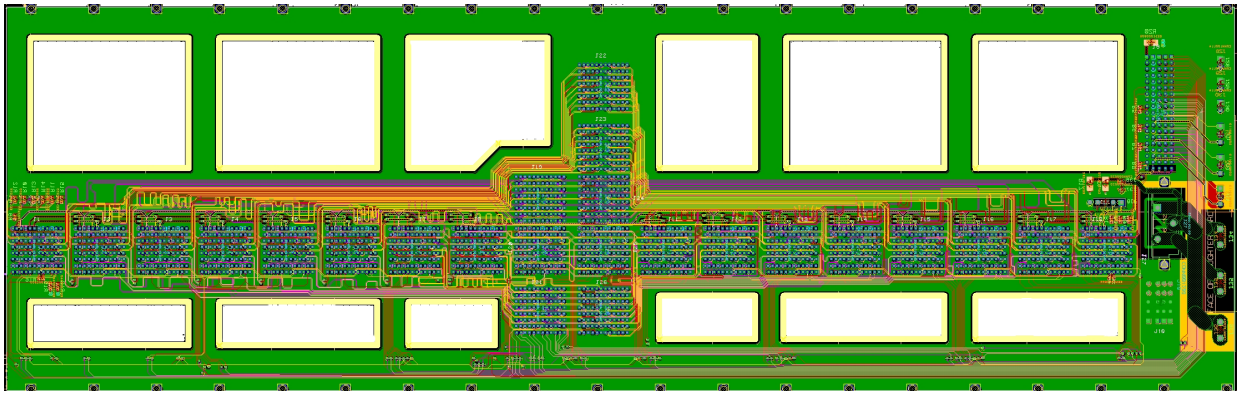
- Receive Gbit links from WDB
- Use SERDES instead GTX (lower latency)
- Waveform preprocessing in Zynq CPU
- Output via Gbit Ethernet (10 Gbit optional)
- Board under design
- Tests with Zed-Board and "Backplane Simulator"



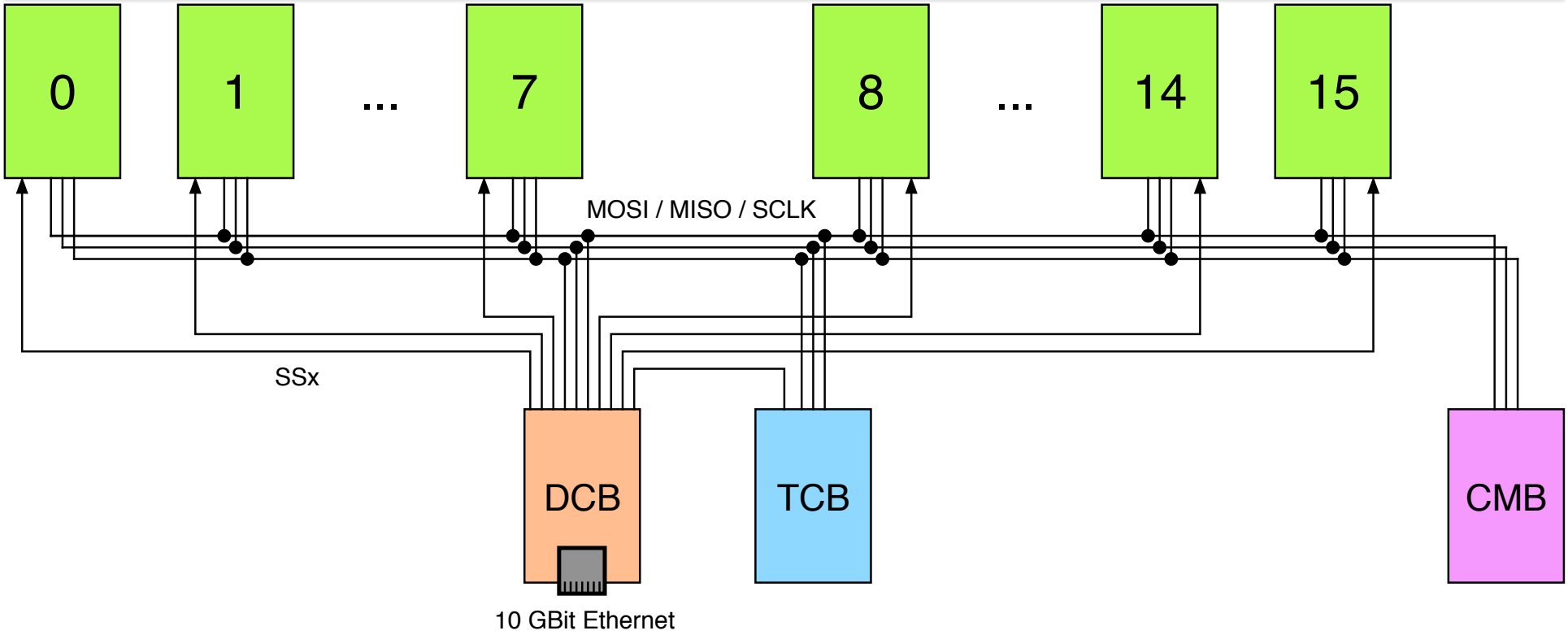


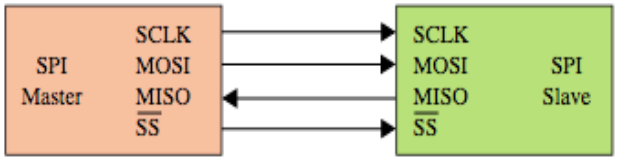
Half Height Backplane

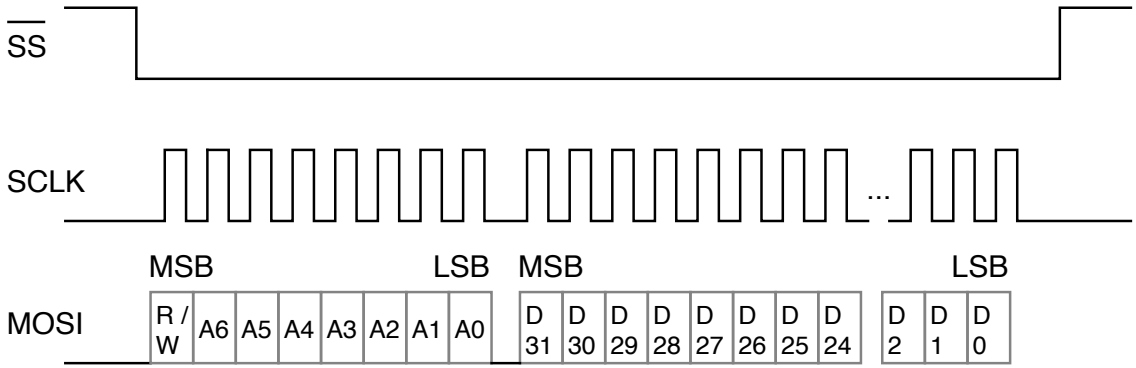




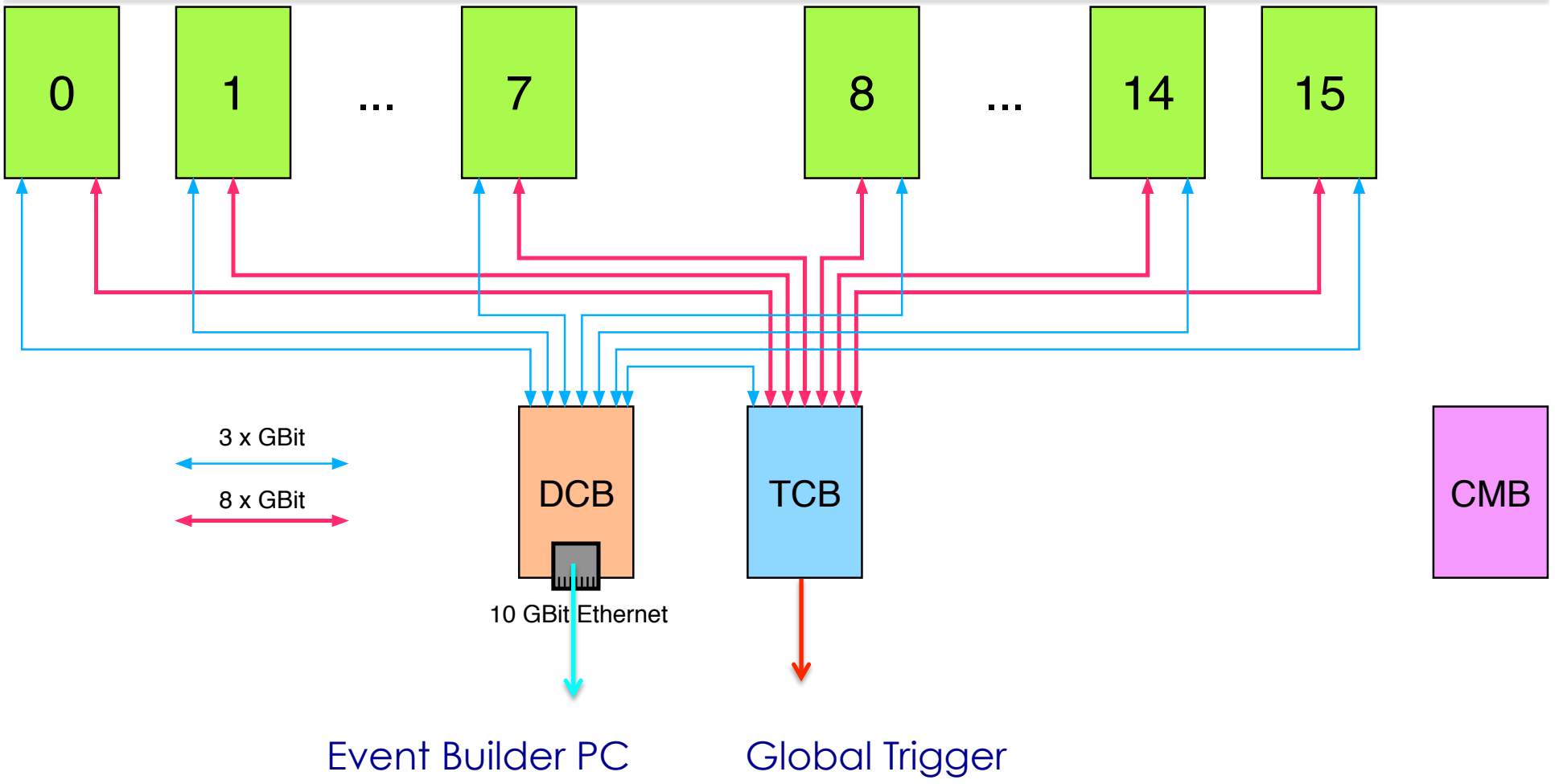
SPI configuration



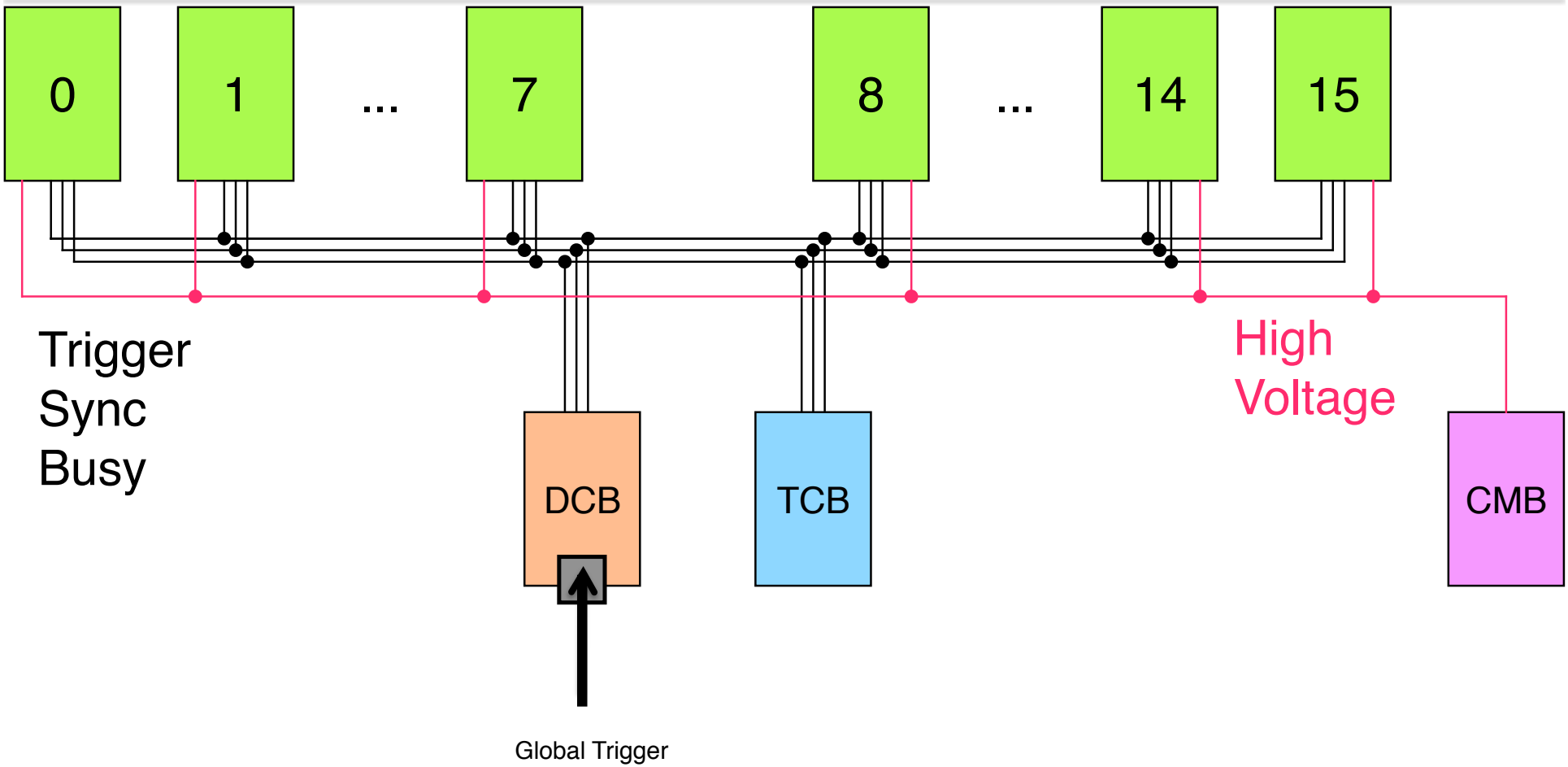




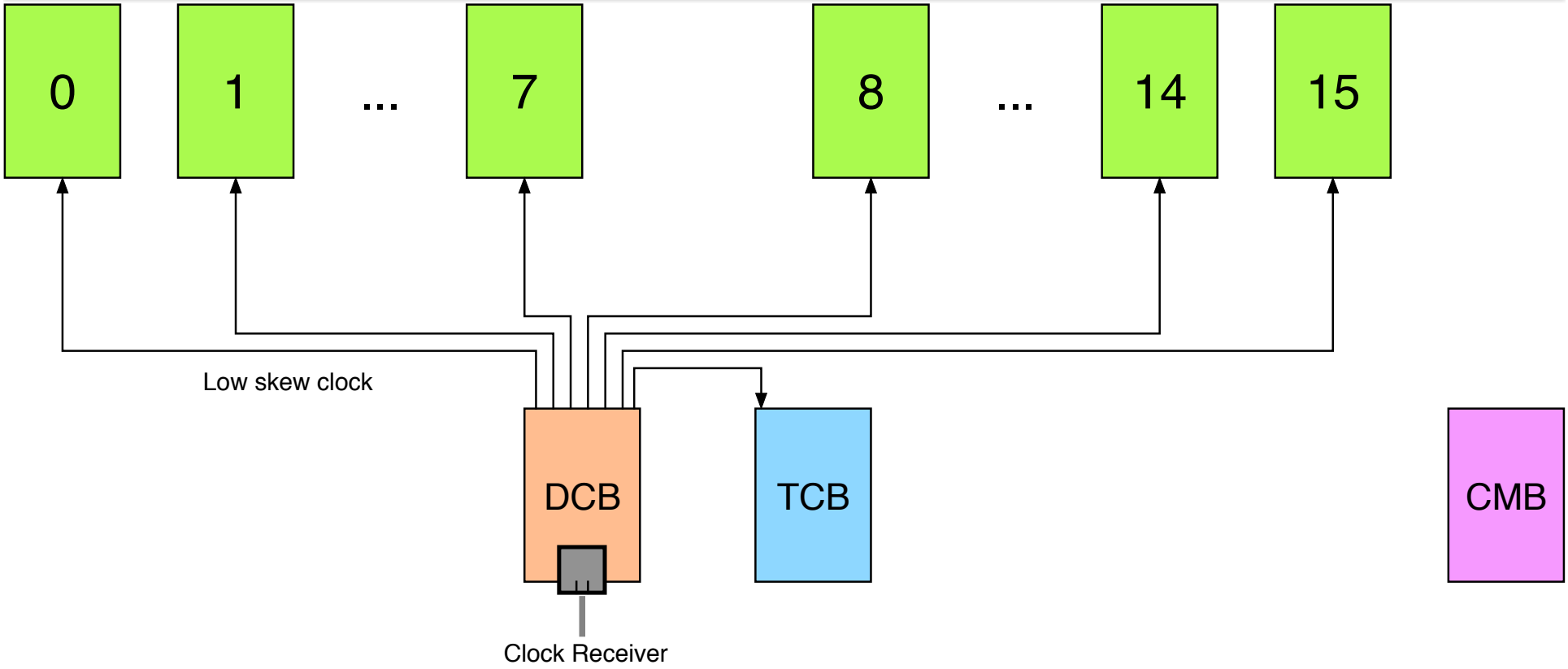
Gbit links for DAQ & Trigger



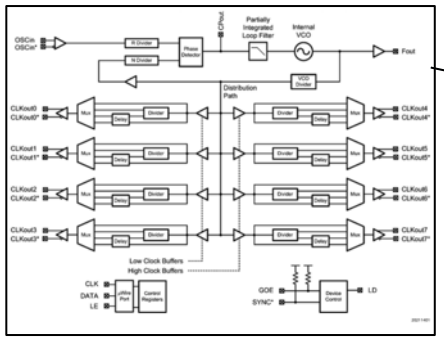
Trigger Bus & HV



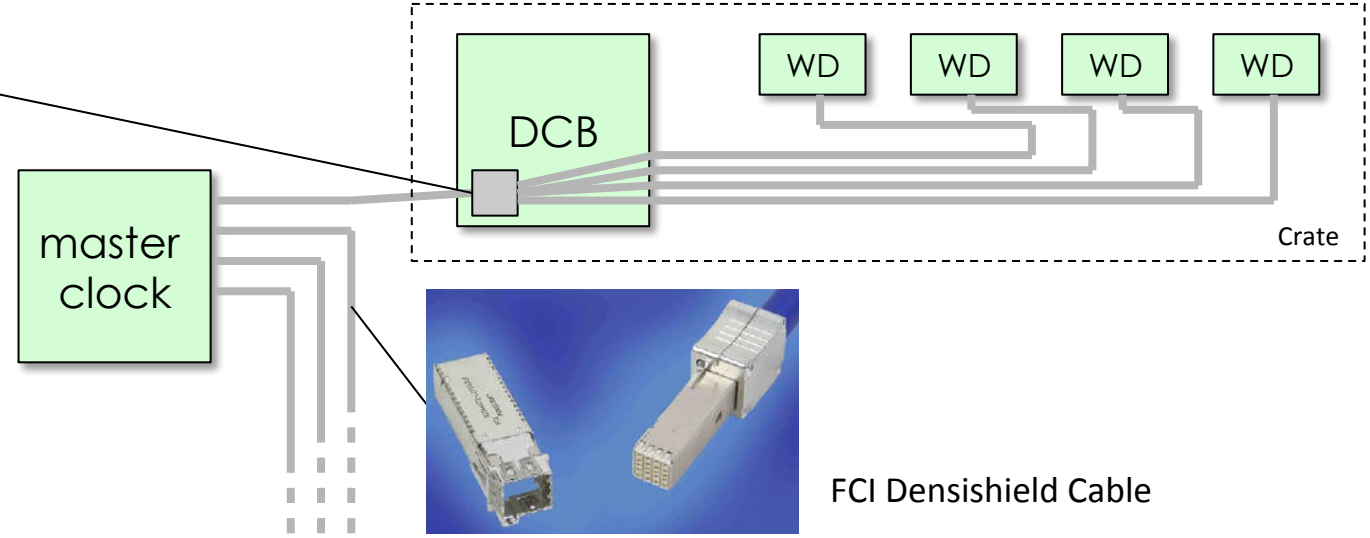
Clock Distribution



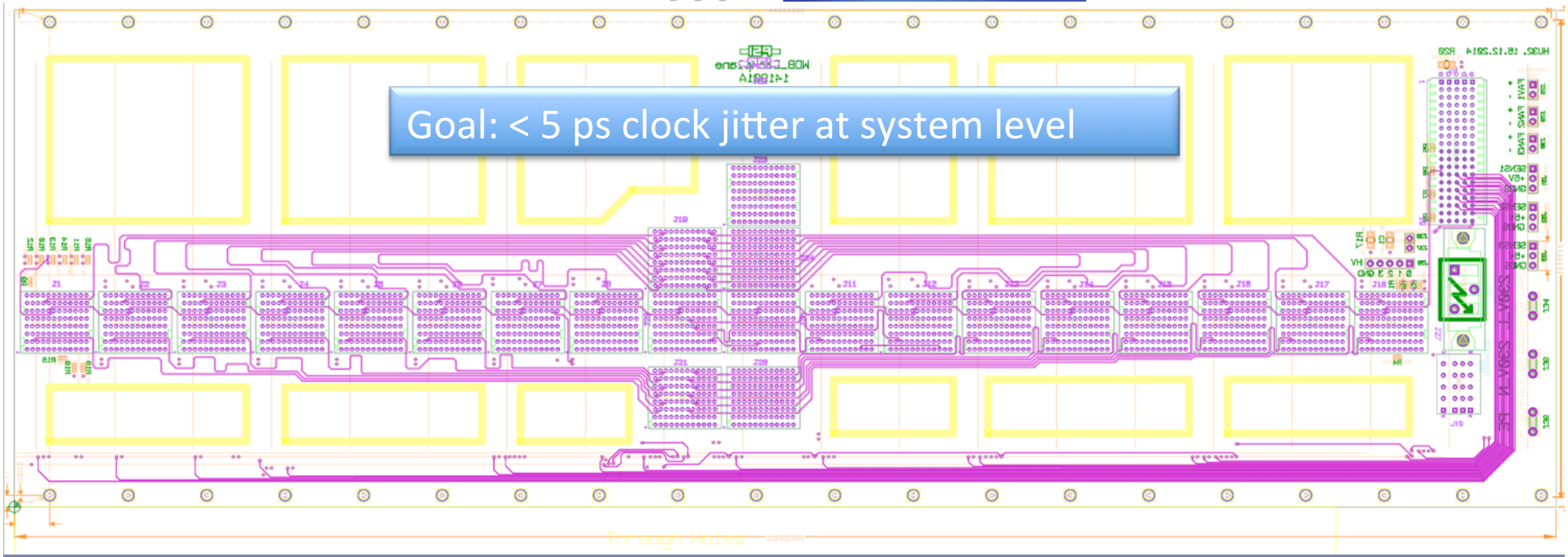
WaveDAQ Clock Distribution



LMK03000 Jitter Cleaner



FCI Densishield Cable



Pin Assignment

Data Concentrator Board (DCB)

C2	A	B	C	D	E	F	G	H	I	J	K	L	
8	GND	LSK0_CLK_P	LSK0_CLK_N	GND	SD0_D1_P	SD0_D1_N	GND	SD15_D1_P	SD15_D1_N	GND	LSK15_CLK_P	LSK15_CLK_N	LSK_CLK 0/15
7	LSK1_CLK_P	LSK1_CLK_N	GND	SD1_D1_P	SD1_D1_N	GND	SD14_D1_P	SD14_D1_N	GND	LSK14_CLK_P	LSK14_CLK_N	GND	LSK_CLK 1/14
6	GND	LSK2_CLK_P	LSK2_CLK_N	GND	SD2_D1_P	SD2_D1_N	GND	SD13_D1_P	SD13_D1_N	GND	LSK13_CLK_P	LSK13_CLK_N	LSK_CLK 2/13
5	LSK3_CLK_P	LSK3_CLK_N	GND	SD3_D1_P	SD3_D1_N	GND	SD12_D1_P	SD12_D1_N	GND	LSK12_CLK_P	LSK12_CLK_N	GND	LSK_CLK 3/12
4	GND	LSK4_CLK_P	LSK4_CLK_N	GND	SD4_D1_P	SD4_D1_N	GND	SD11_D1_P	SD11_D1_N	GND	LSK11_CLK_P	LSK11_CLK_N	LSK_CLK 4/11
3	LSK5_CLK_P	LSK5_CLK_N	GND	SD5_D1_P	SD5_D1_N	GND	SD10_D1_P	SD10_D1_N	GND	LSK10_CLK_P	LSK10_CLK_N	GND	LSK_CLK 5/10
2	GND	LSK6_CLK_P	LSK6_CLK_N	GND	SD6_D1_P	SD6_D1_N	GND	SD9_D1_P	SD9_D1_N	GND	LSK9_CLK_P	LSK9_CLK_N	LSK_CLK 6/9
1	LSK7_CLK_P	LSK7_CLK_N	GND	SD7_D1_P	SD7_D1_N	GND	SD8_D1_P	SD8_D1_N	GND	LSK8_CLK_P	LSK8_CLK_N	GND	LSK_CLK 7/8

C3	A	B	C	D	E	F	G	H	I	J	K	L	
8	24V	don't connect	don't connect	24V	don't connect	don't connect	3.3V	don't connect	don't connect	3.3V	don't connect	don't connect	POWER
7	TRIGGER_P	TRIGGER_N	GND			GND	TR_BUSY_P	TR_BUSY_N	GND	TR_SYNC_P	TR_SYNC_N	GND	TRIGGER
6	GND	SPI_CLK_P	SPI_CLK_N	GND	SPI_MOSI_P	SPI_MOSI_N	GND	SPI_MISO_P	SPI_MISO_N	GND	MSCB_P	MSCB_N	SPI/MSCB
5	SD8_D0_P	SD8_D0_N	GND	SD8_CLK_P	SD8_CLK_N	GND	SD9_D0_P	SD9_D0_N	GND	SD9_CLK_P	SD9_CLK_N	GND	SERDES WD6/9
4	GND	SD7_D0_P	SD7_D0_N	GND	SD7_CLK_P	SD7_CLK_N	GND	SD8_D0_P	SD8_D0_N	GND	SD8_CLK_P	SD8_CLK_N	SERDES WD7/8
3	SELECT_TCB		GND	LSK_TCB_CLK_P	LSK_TCB_CLK_N	GND			GND			GND	SELECT/LSK TCB
2	24V	SD_RX_D_P	SD_RX_D_N	24V	SD_RX_CLK_P	SD_RX_CLK_N	24V	SD_TX_D_P	SD_TX_D_N	24V	SD_TX_CLK_P	SD_TX_CLK_N	SEDES TCB
1	POWER_ON	/INIT	GND/SENSE	/BOARD_SELECT	/FLASH_SELECT		CLK_P	CLK_N	GND	DATA	/ATTENTION	GND	CONTROL

C4	A	B	C	D	E	F	G	H	I	J	K	L	
8	GND	SD5_D0_P	SD5_D0_N	GND	SD5_CLK_P	SD5_CLK_N	GND	SD10_D0_P	SD10_D0_N	GND	SD10_CLK_P	SD10_CLK_N	SERDES WD5/10
7	SD4_D0_P	SD4_D0_N	GND	SD4_CLK_P	SD4_CLK_N	GND	SD11_D0_P	SD11_D0_N	GND	SD11_CLK_P	SD11_CLK_N	GND	SERDES WD4/11
6	GND	SD3_D0_P	SD3_D0_N	GND	SD3_CLK_P	SD3_CLK_N	GND	SD12_D0_P	SD13_D0_N	GND	SD12_CLK_P	SD12_CLK_N	SERDES WD3/12
5	SD2_D0_P	SD2_D0_N	GND	SD2_CLK_P	SD2_CLK_N	GND	SD13_D0_P	SD13_D0_N	GND	SD13_CLK_P	SD13_CLK_N	GND	SERDES WD2/13
4	GND	SD1_D0_P	SD1_D0_N	GND	SD1_CLK_P	SD1_CLK_N	GND	SD14_D0_P	SD14_D0_N	GND	SD14_CLK_P	SD14_CLK_N	SERDES WD1/14
3	SD0_D0_P	SD0_D0_N	GND	SD0_CLK_P	SD0_CLK_N	GND	SD15_D0_P	SD15_D0_N	GND	SD15_CLK_P	SD15_CLK_N	GND	SERDES WD0/15
2	GND	/SELECT 0	/SELECT 1	GND	/SELECT 2	/SELECT 3	GND	/SELECT 12	/SELECT 13	GND	/SELECT 14	/SELECT 15	SELECT
1	/SELECT 4	/SELECT 5	GND	/SELECT 6	/SELECT 7		/SELECT 8	/SELECT 9	GND	/SELECT 10	/SELECT 11	GND	SELECT

C3	A	B	C	D	E	F	G	H	I	J	K	L	
8	24V	HV0	HV1	24V	HV2	HV3	3.3V	spare	spare	3.3V	spare	spare	POWER
7	TRIGGER_P	TRIGGER_N	GND	LSK_CLK_P	LSK_CLK_N	GND	TR_BUSY_P	TR_BUSY_N	GND	TR_SYNC_P	TR_SYNC_N	GND	TRIGGER/CLK
6	GND	SPI_CLK_P	SPI_CLK_N	GND	SPI_MOSI_P	SPI_MOSI_N	GND	SPI_MISO_P	SPI_MISO_N	GND	MSCB_P	MSCB_N	SPI/MSCB
5	SDx_D4_P	SDx_D4_N	GND	SDx_D0_P	SDx_D5_P	SDx_D5_N	GND	SDx_D6_P	SDx_D6_N	GND	SDx_CLK_P	SDx_CLK_N	GND	to TCB
4	GND	SDx_D0_P	SDx_D0_N	GND	SDx_D1_P	SDx_D1_N	GND	SDx_D2_P	SDx_D2_N	GND	SDx_D3_P	SDx_D3_N	to TCB
3	SDx_D4_P	SDx_D4_N	GND	SDx_D5_P	SDx_D5_N	GND	SDx_D6_P	SDx_D6_N	GND	SDx_CLK_P	SDx_CLK_N	GND	to DCB
2	24V	SDx_D0_P	SDx_D0_N	24V	SDx_D1_P	SDx_D1_N	24V	SDx_D2_P	SDx_D2_N	24V	SDx_D3_P	SDx_D3_N	to DCB
1	POWER_ON	/INIT	GND/SENSE	/BOARD_SELECT	/FLASH_SELECT		CLK_P	CLK_N	GND	DATA	/ATTENTION	GND	CONTROL

GND	SERDES_2-7 not connected at backplane, possible use in future extensions
POWER	
LVDS	
LVDS	unconnected at backplane
LVTTL	
LVTTL	

Trigger Concentrator Board (TCB)

8 SERDES connections to each WaveDREAM board

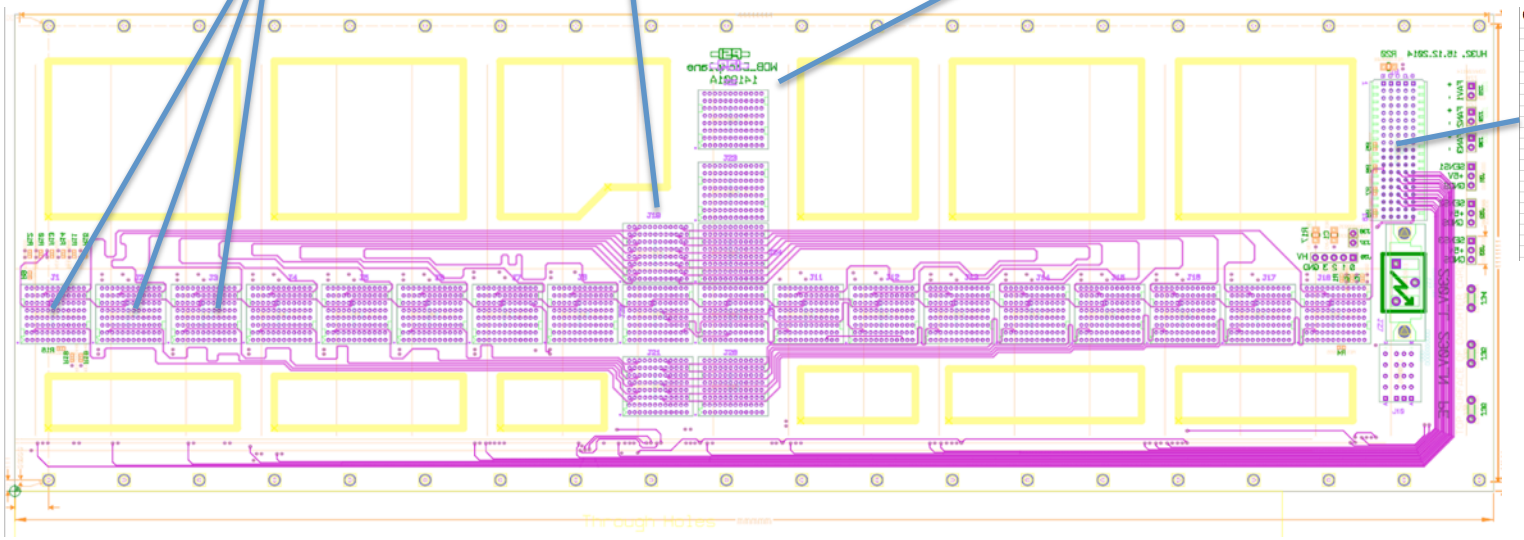
C0	A	B	C	D	E	F	G	H	I	J	K	L	
8	GND	SD0_D5_P	SD0_D5_N	GND	SD0_D6_P	SD0_D6_N	GND	SD15_D5_P	SD15_D5_N	GND	SD15_D6_P	SD15_D6_N	SERDES WD0/15
7	SD0_CLK_P	SD0_CLK_N	GND	SD0_D4_P	SD0_D4_N	GND	SD15_CLK_P	SD15_CLK_N	GND	SD15_D4_P	SD15_D4_N	GND	SERDES WD0/15
6	GND	SD0_D1_P	SD0_D1_N	GND	SD0_D2_P	SD0_D2_N	GND	SD15_D1_P	SD15_D1_N	GND	SD15_D2_P	SD15_D2_N	SERDES WD0/15
5	SD0_D3_P	SD0_D3_N	GND	SD0_D0_P	SD0_D0_N	GND	SD15_D3_P	SD15_D3_N	GND	SD15_D0_P	SD15_D0_N	GND	SERDES WD0/15
4	GND	SD1_D5_P	SD1_D5_N	GND	SD1_D6_P	SD1_D6_N	GND	SD14_D5_P	SD14_D5_N	GND	SD14_D6_P	SD14_D6_N	SERDES WD1/14
3	SD1_CLK_P	SD1_CLK_N	GND	SD1_D4_P	SD1_D4_N	GND	SD14_CLK_P	SD14_CLK_N	GND	SD14_D4_P	SD14_D4_N	GND	SERDES WD1/14
2	GND	SD1_D1_P	SD1_D1_N	GND	SD1_D2_P	SD1_D2_N	GND	SD14_D1_P	SD14_D1_N	GND	SD14_D2_P	SD14_D2_N	SERDES WD1/14
1	SD1_D3_P	SD1_D3_N	GND	SD1_D0_P	SD1_D0_N	GND	SD14_D3_P	SD14_D3_N	GND	SD14_D0_P	SD14_D0_N	GND	SERDES WD1/14

C1	A	B	C	D	E	F	G	H	I	J	K	L	
8	GND	SD2_D5_P	SD2_D5_N	GND	SD2_D6_P	SD2_D6_N	GND	SD13_D5_P	SD13_D5_N	GND	SD13_D6_P	SD13_D6_N	SERDES WD2/13
7	SD2_CLK_P	SD2_CLK_N	GND	SD2_D4_P	SD2_D4_N	GND	SD13_CLK_P	SD13_CLK_N	GND	SD13_D4_P	SD13_D4_N	GND	SERDES WD2/13
6	GND	SD2_D1_P	SD2_D1_N	GND	SD2_D2_P	SD2_D2_N	GND	SD13_D1_P	SD13_D1_N	GND	SD13_D2_P	SD13_D2_N	SERDES WD2/13
5	SD2_D3_P	SD2_D3_N	GND	SD2_D0_P	SD2_D0_N	GND	SD13_D3_P	SD13_D3_N	GND	SD13_D0_P	SD13_D0_N	GND	SERDES WD2/13
4	GND	SD3_D5_P	SD3_D5_N	GND	SD3_D6_P	SD3_D6_N	GND	SD12_D5_P	SD12_D5_N	GND	SD12_D6_P	SD12_D6_N	SERDES WD3/12
3	SD3_CLK_P	SD3_CLK_N	GND	SD3_D4_P	SD3_D4_N	GND	SD12_CLK_P	SD12_CLK_N	GND	SD12_D4_P	SD12_D4_N	GND	SERDES WD3/12
2	GND	SD3_D1_P	SD3_D1_N	GND	SD3_D2_P	SD3_D2_N	GND	SD12_D1_P	SD12_D1_N	GND	SD12_D2_P	SD12_D2_N	SERDES WD3/12
1	SD3_D3_P	SD3_D3_N	GND	SD3_D0_P	SD3_D0_N	GND	SD12_D3_P	SD12_D3_N	GND	SD12_D0_P	SD12_D0_N	GND	SERDES WD3/12

C2	A	B	C	D	E	F	G	H	I	J	K	L	
8	GND	SD4_D5_P	SD4_D5_N	GND	SD4_D6_P	SD4_D6_N	GND	SD11_D5_P	SD11_D5_N	GND	SD11_D6_P	SD11_D6_N	SERDES WD4/11
7	SD4_CLK_P	SD4_CLK_N	GND	SD4_D4_P	SD4_D4_N	GND	SD11_CLK_P	SD11_CLK_N	GND	SD11_D4_P	SD11_D4_N	GND	SERDES WD4/11
6	GND	SD4_D1_P	SD4_D1_N	GND	SD4_D2_P	SD4_D2_N	GND	SD11_D1_P	SD11_D1_N	GND	SD11_D2_P	SD11_D2_N	SERDES WD4/11
5	SD4_D3_P	SD4_D3_N	GND	SD4_D0_P	SD4_D0_N	GND	SD11_D3_P	SD11_D3_N	GND	SD11_D0_P	SD11_D0_N	GND	SERDES WD4/11
4	GND	SD5_D5_P	SD5_D5_N	GND	SD5_D6_P	SD5_D6_N	GND	SD10_D5_P	SD10_D5_N	GND	SD10_D6_P	SD10_D6_N	SERDES WD5/10
3	SD5_CLK_P	SD5_CLK_N	GND	SD5_D4_P	SD5_D4_N	GND	SD10_CLK_P	SD10_CLK_N	GND	SD10_D4_P	SD10_D4_N	GND	SERDES WD5/10
2	GND	SD5_D1_P	SD5_D1_N	GND	SD5_D2_P	SD5_D2_N	GND	SD10_D1_P	SD10_D1_N	GND	SD10_D2_P	SD10_D2_N	SERDES WD5/10
1	SD5_D3_P	SD5_D3_N	GND	SD5_D0_P	SD5_D0_N	GND	SD10_D3_P	SD10_D3_N	GND	SD10_D0_P	SD10_D0_N	GND	SERDES WD5/10

C3	A	B	C	D	E	F	G	H	I	J	K	L	
8	24V	don't connect	don't connect	24V	don't connect	don't connect	3.3V	don't connect	don't connect	3.3V	don't connect	don't connect	POWER
7	TRIGGER_P	TRIGGER_N	GND	LSK_TCB_CLK_P	LSK_TCB_CLK_N	GND	TR_BUSY_P	TR_BUSY_N	GND	TR_SYNC_P	TR_SYNC_N	GND	TRIGGER/CLK
6	GND	SPI_CLK_P	SPI_CLK_N	GND	SPI_MOSI_P	SPI_MOSI_N	GND	SPI_MISO_P	SPI_MISO_N	GND	MSCB_P	MSCB_N	SPI/MSCB
5			GND			GND			GND			GND	
4	GND			GND			GND						
3			GND			GND			GND			GND	
2	24V	SD_TX_D_P	SD_TX_D_N	24V	SD_TX_CLK_P	SD_TX_CLK_N	24V	SD_RX_D_P	SD_RX_D_N	24V	SD_RX_CLK_P	SD_RX_CLK_N	SERDES DCB
1	POWER_ON	/INIT	GND/SENSE	/BOARD_SELECT	/FLASH_SELECT		CLK_P	CLK_N	GND	DATA	/ATTENTION	GND	CONTROL

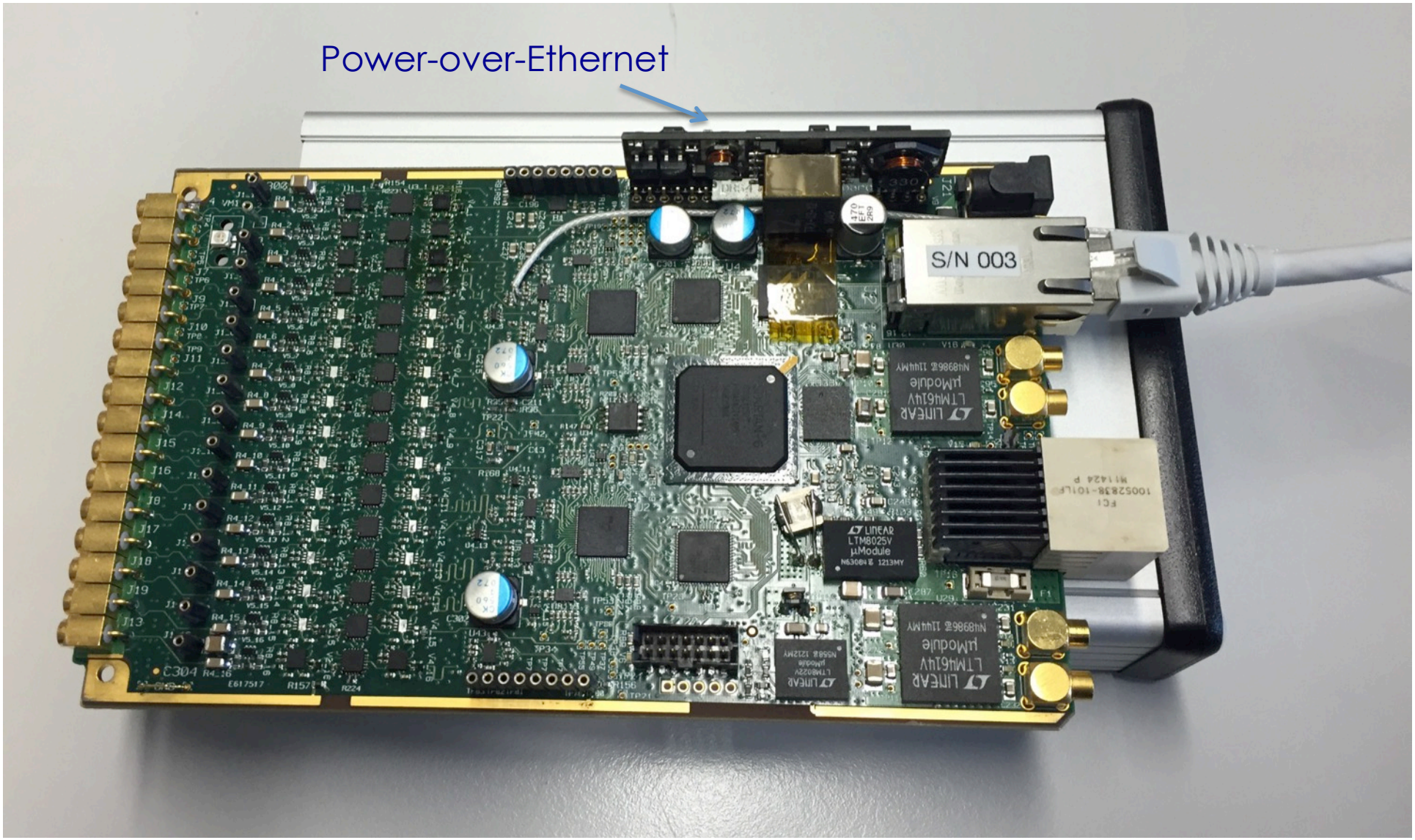
C4	A	B	C	D	E	F	G	H	I	J	K	L	
8	GND	SD7_D5_P	SD7_D5_N	GND	SD7_D6_P	SD7_D6_N	GND	SD8_D5_P	SD8_D5_N	GND	SD8_D6_P	SD8_D6_N	SERDES WD7/8
7	SD7_CLK_P	SD7_CLK_N	GND	SD7_D4_P	SD7_D4_N	GND	SD8_CLK_P	SD8_CLK_N	GND	SD8_D4_P	SD8_D4_N	GND	SERDES WD7/8
6	GND	SD7_D1_P	SD7_D1_N	GND	SD7_D2_P	SD7_D2_N	GND	SD8_D1_P	SD8_D1_N	GND	SD8_D2_P	SD8_D2_N	SERDES WD7/8
5	SD7_D3_P	SD7_D3_N	GND	SD7_D0_P	SD7_D0_N	GND	SD8_D3_P	SD8_D3_N	GND	SD8_D0_P	SD8_D0_N	GND	SERDES WD7/8
4	GND	SD6_D5_P	SD6_D5_N	GND	SD6_D6_P	SD6_D6_N	GND	SD9_D5_P	SD9_D5_N	GND	SD9_D6_P	SD9_D6_N	SERDES WD6/9
3	SD6_CLK_P	SD6_CLK_N	GND	SD6_D4_P	SD6_D4_N	GND	SD9_CLK_P	SD9_CLK_N	GND	SD9_D4_P	SD9_D4_N	GND	SERDES WD6/9
2	GND	SD6_D1_P	SD6_D1_N	GND	SD6_D2_P	SD6_D2_N	GND	SD9_D1_P	SD9_D1_N	GND	SD9_D2_P	SD9_D2_N	SERDES WD6/9
1	SD6_D3_P	SD6_D3_N	GND	SD6_D0_P	SD6_D0_N	GND	SD9_D3_P	SD9_D3_N	GND	SD9_D0_P	SD9_D0_N	GND	SERDES WD6/9



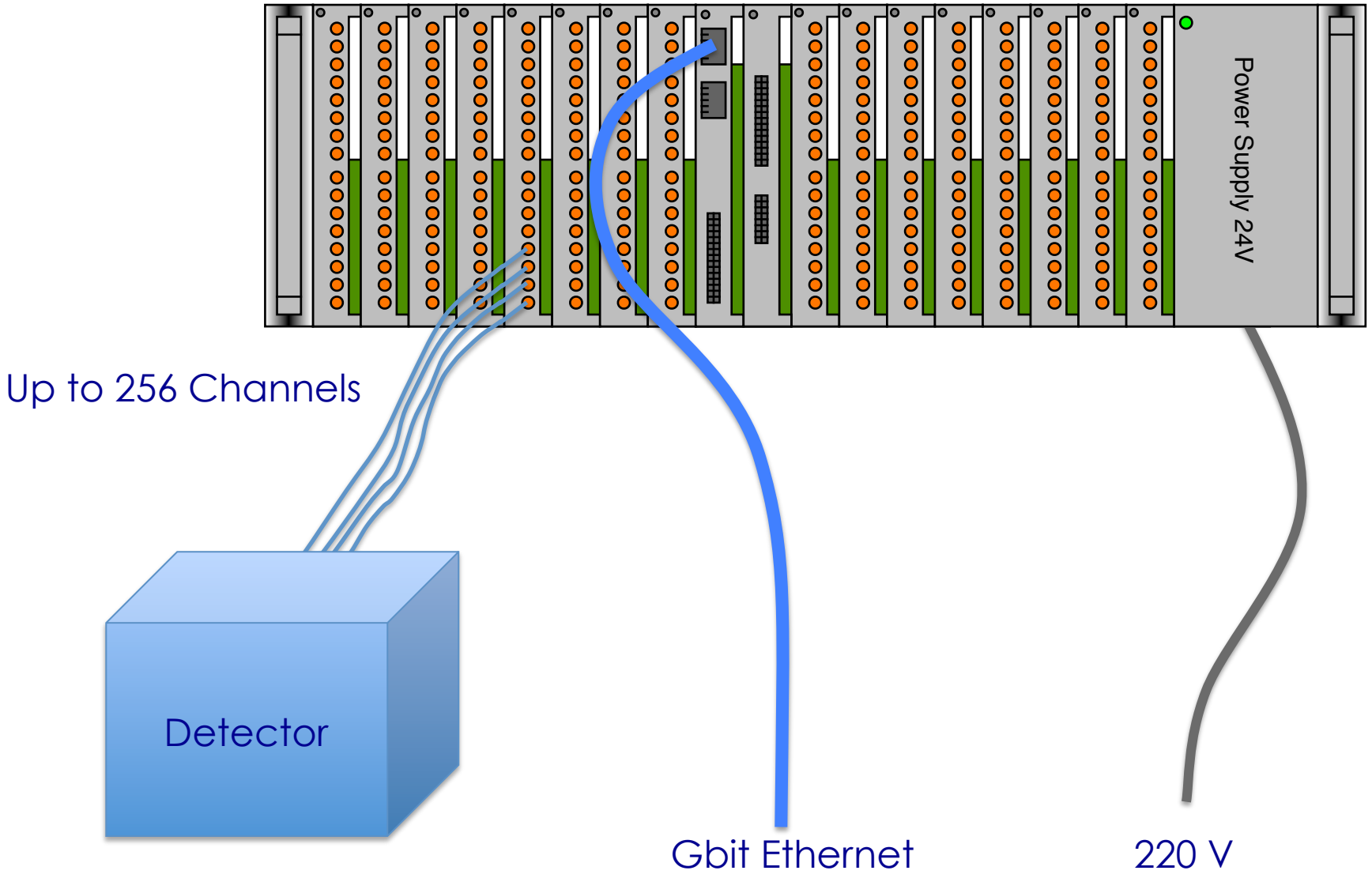
Crate Management Board (CMB)

C1	A	B	C	D	E
1	3.3V	FAN_1	POWER_ON_S2	POWER_ON_S1	POWER_ON_S0
2	spare	FAN_1	POWER_ON_S5	POWER_ON_S4	POWER_ON_S3
3	spare	FAN_1	POWER_ON_DCB	POWER_ON_S7	POWER_ON_S6
4	spare	FAN_2	POWER_ON_S9	POWER_ON_S8	POWER_ON_TCB
5	spare	FAN_2	POWER_ON_S12	POWER_ON_S11	POWER_ON_S10
6	/INIT	FAN_2	POWER_ON_S15	POWER_ON_S14	POWER_ON_S13
7	/FLASH_SELECT	FAN_3	/SELECT 2	/SELECT 1	/SELECT 0
8	GND	FAN_3	/SELECT 5	/SELECT 4	/SELECT 3
9	SPI_CLK_P	FAN_3	/SELECT DCB	/SELECT 7	/SELECT 6
10	SPI_CLK_N	5V	/SELECT 9	/SELECT 8	/SELECT TCB
11	GND	TEMP_SENSE_1	/SELECT 12	/SELECT 11	/SELECT 10
12	SPI_MOSI_P	GND	/SELECT 15	/SELECT 14	/SELECT 13
13	SPI_MOSI_N	5V	PLUGIN S2	PLUGIN S1	PLUGIN S0
14	GND	TEMP_SENSE_2	PLUGIN S5	PLUGIN S4	PLUGIN S3
15	SPI_MISO_P	GND	PLUGIN DCB	PLUGIN S7	PLUGIN S6
16	SPI_MISO_N	5V	PLUGIN S9	PLUGIN S8	PLUGIN TCB
17	GND	TEMP_SENSE_3	PLUGIN S12	PLUGIN S11	PLUGIN S10
18	MSCB_P	GND	PLUGIN S15	PLUGIN S14	PLUGIN S13
19	MSCB_N	HV3	HV2	HV1	HV0

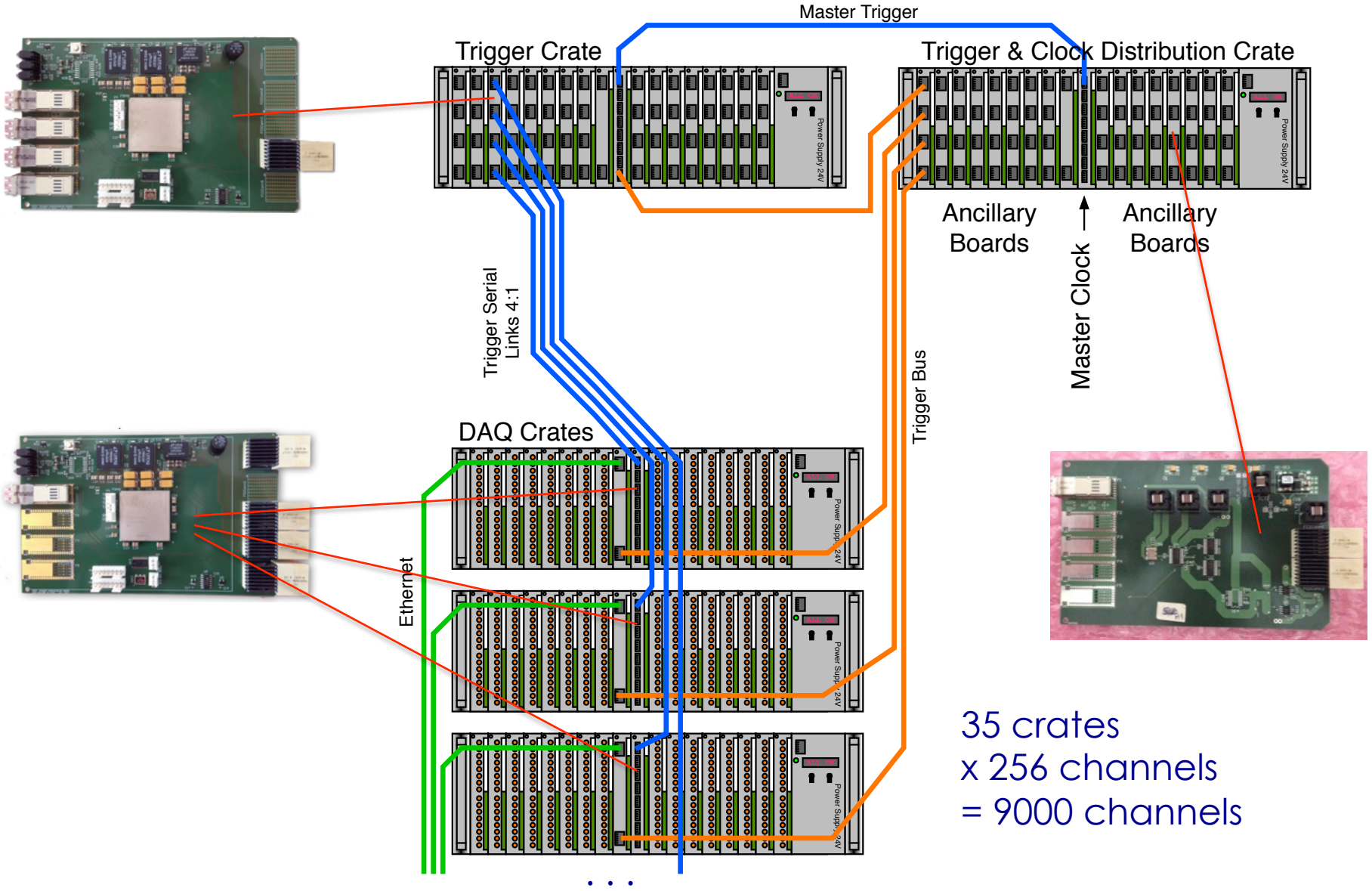
Minimal System



One-crate system



MEG II System



WaveDAQ Performance

- Trigger resolution 10 ns (100 MHz clock)
- Trigger bandwidth 8 Gbit / s
- Trigger latency <380 ns *) (9000 channels)

- DAQ bandwidth 2 Gbit / s
- DAQ time measurement 10 ps *)
- DAQ dead time 3 - 35 μs / event

- MEG II: 7 x 10^7 μ/s, DAQ eff. > 95% @ 30 Hz *)

*) projected

Conclusions

- WaveDAQ system has been designed to fulfill needs of MEG II experiment
- System has huge potential for many others (costs: ~130 EUR / channel)
- Status: Crate fully working, trigger board and WaveDREAM board successfully tested, firmware to be finished, DCB under design
- First full crate test end of 2015, full system (35 crates) in 2016
- DRS5 chip (no dead-time) planned for 2017+