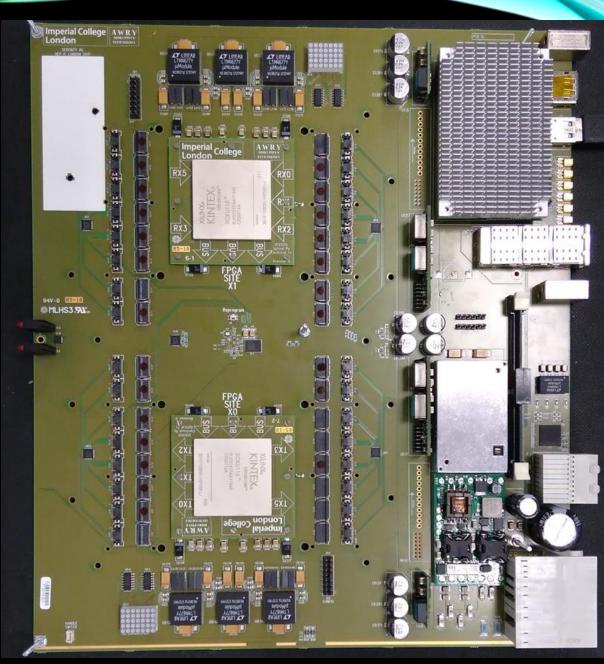
## SERENITY Andy Rose, Imperial College, London



### WHAT IS SERENITY?

- ATCA Development Platform
- Carrier Card
  - Services Power, Clocks, Optics, Interconnects, IPMC & CPU
- Daughter Cards
  - Data Processing FPGAs
- Firmware & Software
  - Generic, Flexible Infrastructure



### AN ASIDE: COTS COMPONENTS

#### ATCA low level control – IPMC

- Available from CERN
- Runs the commercial standard software





#### Ethernet

- Switch with integrated Gigabit Ethernet Phys
- AC coupled via capacitors
- Small form factor 1cm<sup>2</sup>
- VLAN capable

#### Standard Intel x86 COM-Express Type 10 CPU

- Running standard Centos Linux
- What sys-admins want, not necessarily what hardware engineers want!
- PCIe interface to FPGAs
- Clean separation of hardware, firmware and software

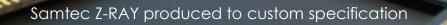


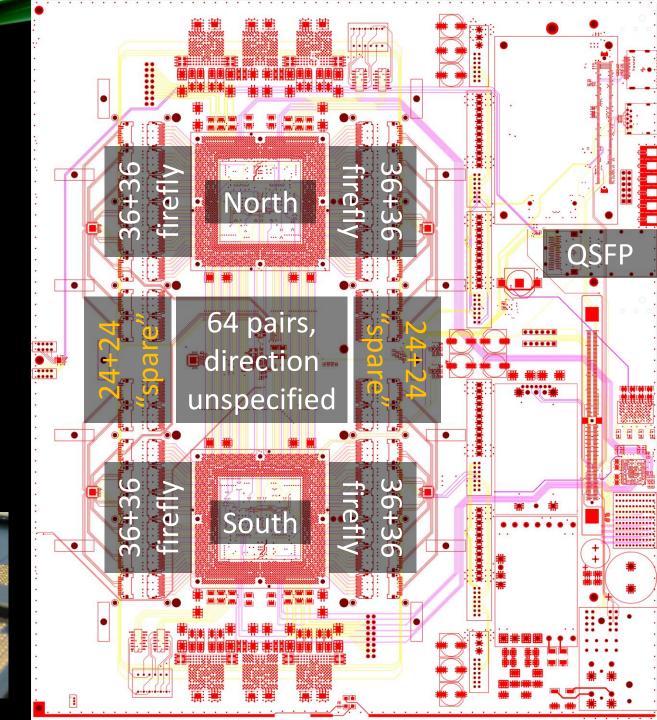
#### WHICH PROBLEMS IS SERENITY MEANT TO SOLVE?

- Different projects want different FPGAs, different optical and electrical connectivity
  - Can one board make everyone happy?
  - If not, can we at least provide a rapid-prototyping platform for ATCA?
- Bulk of cost concentrated in FPGAs, bulk of potential failure modes in carrier
  - Can we decouple financial risk from production risk?

### HOMŠ

- FPGAs on Daughter-cards:
  - Freedom to choose your preferred family, package, generation, (vendor?)
- Freedom to choose your balance of optical and electrical connectivity
- Carrier testing done with FPGAs safely in their static-bags



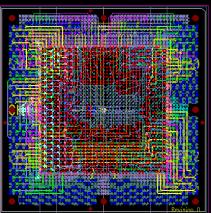


### WHAT WERE THE CONCERNS?

- We started the project with serious concerns over choice of ATCA, particularly:
  - Thermal management
    - Optics must be kept below 50C or longevity drops at shocking rate
  - Acoustic noise
- Others expressed concern over
  - Interposer signal integrity
  - Supplying power to FPGAs
  - Cooling FPGAs on daughter-cards
  - Limited prior experience with 16 or 25G links
  - Whether different institutes could really produce their own daughter-cards?

#### CAN DIFFERENT GROUPS PRODUCE DAUGHTER-CARDS?

- IC Xilinx KU115: Symmetric & Daisy Chained
- KIT Xilinx KU15P
- TIFR Xilinx VU9P
- Saclay a clock-network analysis daughter card



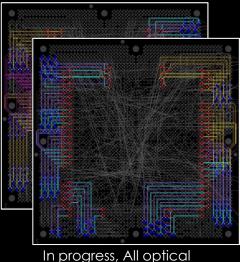
All optical KU115, Imperial



Mixed optical/electrical KU15P, KIT

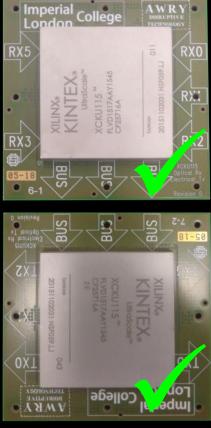


Clock-performance analyzer CEA Saclay

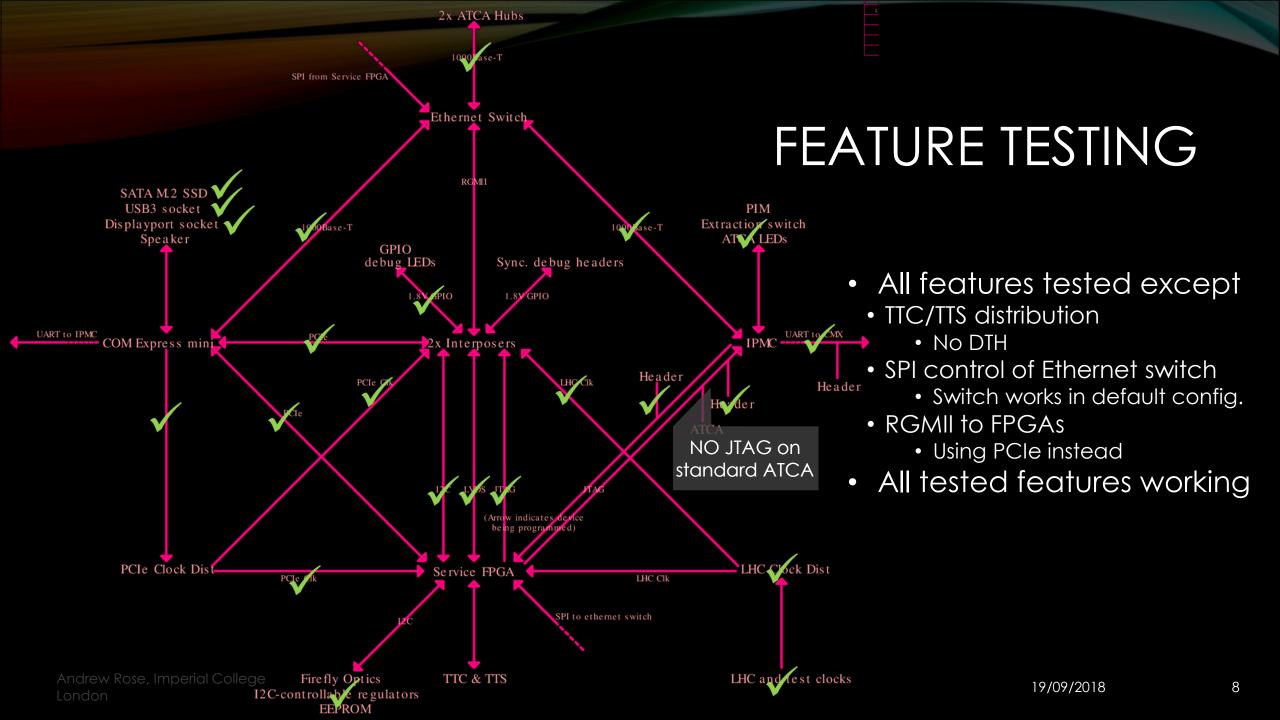


In progress, All optico VU9P, TIFR

Daisy-chain, optical in KU115, Imperial



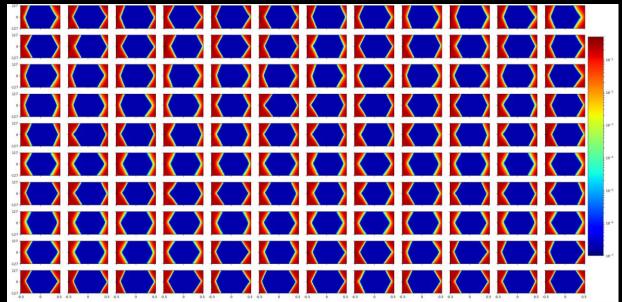
Daisy-chain, optical out 19/0%(2011&, Imperial 7



Seri	ial I/O Links																					
9																						
Nar	The	TX ^1 RX	Status	Drts E	Irrors BER	DERT Reset	TX Pattern	RXPatern	TXP	te-Cursor	T	DL Post-Cursor		TX Diff Swing	DFE	Inabled	Inject Error	TX Reset	RX Reset	RX PLL Status	TX PLL Status	Loopback Mor
	<ul> <li>Ungrouped Links (0)</li> </ul>																					
÷ 1	Unk Group 0 (120) S Link 0	MGT X0YB/TX MGT X0YB/RX	16.000 Gbps	1.001E15	0E0 9.994E-	Reset Reset	PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	~ 0.00 ~ 0.00	dB (00000) dB (00000)	~ 0 ~ 0	1.00 dB (00000) 1.00 dB (00000)	v	950 mV (1100) 950 mV (1100)	~	N N	Inject	Reset	Reset	Locked	Locked	Near-End PM Near-End PM
	% Link 1	MGT_X0YBTX MGT_X0YBRX	16.028 Gbps	1.001E15	0E0 9.994E-	6 Reset	PRBS 7-bit	<ul> <li>PRBS 7-bit</li> </ul>	~ 0.00	dB (00000)	~ 0	0.00 dB (00000)	×	950 mV (1100)	~	×	inject Inject	Reset Reset	Reset Reset	Locked	Locked	Near-End PM
	N Link 2 N Link 3	MGT_X0YB/TX MGT_X0YB/RX MGT_X0YB/TX MGT_X0YB/RX	16.010 Gbps	1.001E15	0E0 9.994E- 0E0 9.994E-	6 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>		dB (00000) dB (00000)		0.00 dB (00000) 0.00 dB (00000)	~	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked Locked	Near-End PM/
	% Link4	MGT_X0Y10/TX MGT_X0Y10/RX		1.001E15	GED 9.994E-	16 Reset	PRBS 7-bit	✓ PR057-bit	~ 0.00	(00000) Bb	~ 0	(00000) Bb 00.0	v	950 mV (1100)	v	2	inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 5	MGT_X0Y10/TX MGT_X0Y10/RX	15.990 Gbps	1E15	0E0 1E-	15 Reset	PRBS 7-bit	<ul> <li>PRBS 7-bit</li> </ul>	~ 0.00	dB (00000)		0.00 dB (00000)	~	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 6 % Link 7	MGT_X0Y11/TX MGT_X0Y11/R0 MGT_X0Y11/TX MGT_X0Y11/R0	15.992 Gbps	1E15	0E0 9.995E-	6 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	~ 0.00 ~ 0.00	dB (00000) dB (00000)	× 0 × 0	0.00 dB (00000)	×	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM/
	N Link 8	MGT_X0Y12/TX MGT_X0Y12/R0	16.000 Gbps	1615	0E0 9.997E-	16 Reset	PRBS 7-64	Y PR857-bit	~ 0.00	dB (00000)	~ 0	(00000) Bb 00.0	v	950 mV (1100)	v	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	N Link 9 N Link 10	MGT_X0Y12/TX MGT_X0Y12/R0 MGT_X0Y13/TX MGT_X0Y13/R0	16.000 Gbps	1E15	0E0 9.995E- 0E0 9.994E-	16 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	✓ 0.00	dB (00000) dB (00000)	~ 0	0.00 dB (00000)	~	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM/
	% Link 10 % Link 11	MGT_X0Y13/TX MGT_X0Y13R0	16.000 Gbps	1.001E15	0E0 9.994E-		PRBS 7-64	<ul> <li>PR05 7-bit</li> <li>PR05 7-bit</li> </ul>		dB (00000) dB (00000)		1.00 dB (00000)	v	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	N Link 12	MGT_X0Y14/TX MGT_X0Y14/R0	16.000 Gbps	1.001E15	0E0 9.994E-	6 Reset	PRBS 7-bit	Y PRBS 7-bit	✓ 0.00	dB (00000)	~ 0	(00000) Bb 00.0	~	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 13 % Link 14	MGT_X0Y14/TX MGT_X0Y14/RX MGT_X0Y15/TX MGT_X0Y15/RX	16.000 Gbps	1.001E15 1.001E15	0E0 9.994E- 0E0 9.994E-	16 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PR85 7-bit</li> <li>PR85 7-bit</li> </ul>		dB (00000) dB (00000)	× 0	0.00 dB (00000) 0.00 dB (00000)	v	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset Reset	Locked	Locked Locked	Near-End PM/ Near-End PM/
	N Link 15	MGT_X0Y15/TX MGT_X0Y15/R0	16.000 Gbps	1.001E15	GE0 9.994E-	E Denet	PR857-bit	✓ PRBS 7-bit	~ 0.00	(00000) Bb	¥ 0	(00000) Bb 00.0	~	950 mV (1100)	~	2	Inject	Reset	Repet	Locked	Locked	Near-End PM
	% Link 16	MGT_X0Y16/TX MGT_X0Y16/RX	16.000 Gbps	1.001E15	0E0 9.994E-		PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>		dB (00000) Bb		0.00 dB (00000)	×	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 17 % Link 18	MGT_X0Y16/TX MGT_X0Y16/R0 MGT_X0Y17/TX MGT_X0Y17/R0	15 998 Ghes	1.001E15 1.001E15	0E0 9.994E- 0E0 9.994E-	6 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	~ 0.00 ~ 0.00	dB (00000) dB (00000)	× 0 × 0	0.00 dB (00000) 0.00 dB (00000)	v	950 mV (1100) 950 mV (1100)	~	8	Inject	Reset	Reset	Locked	Locked Locked	Near-End PM/
	N Link 19 N Link 20	MGT_X0Y17/TX MGT_X0Y17/R0 MGT_X0Y18/TX MGT_X0Y18/R0	15.981 Gbps	1.001E15	050 9.9945-	6 Reset	PRBS 7-bit	✓ PRBS7-bit	~ 0.00	(00000) 80	¥ 0	(00000) Rb 000	v	950 mV (1100)	~	2	Inject	Reset	Reset Reset	Locked	Locked Locked	Near-End PM
	N Link 20 N Link 21	MGT_X0Y18/TX MGT_X0Y18/KX MGT_X0Y18/TX MGT_X0Y18/KX	16.000 Gbps	1.001E15 1.001E15	0E0 9.994E- 0E0 9.994E-	6 Reset	PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>		(00000) Bb (00000) Bb	~ 0	0.00 dB (00000)	v	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PMA
	N Link 21	MGT_X0Y18TX MGT_X0Y18R0	16.000 Gbps	1.001E15	050 9.9945-	6 Reset	PR897-bit	✓ PRBS 7-bit	~ 0.00	(00000) 8b		0.00 dB (00000)	v	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 22 % Link 23	MGT_X0Y18/TX MGT_X0Y18/R0 MGT_X0Y18/TX MGT_X0Y18/R0	15.990 Gbps	1.001E15	0E0 9.994E-	6 Reset	PRBS 7-bit	✓ PRBS 7-bit	~ 0.00	(00000) Bb		(00000) Bb 00.0	×	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 24	MGT_X0Y28/TX MGT_X0Y28/R0	15.991 Gbps	1.001E15	0E0 9.994E- 0E0 9.994E-	6 Reset	PRBS 7-bit PBBS 7-bit	V PRBS 7-bit	✓ 0.00	dB (00000) dB (00000)	× 0	0.00 48 (00000)	~	950 mV (1100) 950 mV (1100)	~	2	Inject Inject	Reset Reset	Reset	Locked	Locked	Near-End PM
	% Link 26 % Link 26		16.000 Gbps	1.001E15	0E0 9.994E-	6 Reset	PRBS 7-bit	✓ PRBS 7-bit	~ 0.00	dB (00000)	~ 0	0.00 dB (00000) 0.00 dB (00000)	~	950 mV (1100)	~	2	Inject	Reset	Reset Reset Reset	Locked	Locked	Near-End PM/ Near-End PM/
				1.001E15 1.001E15	000 99946-		PRBS 7-bit	<ul> <li>PR85 7-bit</li> <li>PR85 7-bit</li> </ul>	~ 0.00	(00000) (8)	~ 0	0.00 dB (00000) 0.00 dB (00000)	~	950 mV (1100)	~	2	Inject	Reset	Report	Locked	Locked	
	© Link 28 © Link 29	MGT_X0Y30/TX MGT_X0Y30/R0 MGT_X0Y30/TX MGT_X0Y30/R0	15.991 Gbps	1.001E15	0E0 9.994E- 0E0 9.994E-	6 Reset	PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	~ 0.00 ~ 0.00	dB (00000) dB (00000) Bb	× 0 × 0	1.00 dB (00000) 1.00 dB (00000)	v	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked Locked	Near-End PM/
				1.001E15			PRBS 7-bit	Y PR05 7-bit	~ 0.00	dB (00000) Bb	× 0	0.00 48 (00.000)	~	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	
	% Link 31 % Link 32	MGT_X0Y31/TX MGT_X0Y31/R0 MGT_X0Y32/TX MGT_X0Y32/R0	16.000 Gbps	1.001E15 1.001E15	0E0 9.994E- 0E0 9.994E-	6 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	✓ 0.00	dB (00000) Bb dB (00000) Bb	¥ 0	0.00 dB (00000) 0.00 dB (00000)	~	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM/ Near-End PM/
	% Link 33			1.001E15			PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	~ 0.00	dB (00000) dB (00000)	~ 0	000 dB (00000)	v	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	
	% Link 34	MGT_X0Y33/TX MGT_X0Y33/R0 MGT_X0Y33/TX MGT_X0Y33/R0	16.020 Gbps	1.001E15	0E0 9.994E- 0E0 9.994E-	6 Reset	PRBS 7-bit	V PRBS 7-bit	~ 0.00	dB (00000)	~ 0	0.00 dB (00000)	v	950 mV (1100)	v	2	Inject	Reset	Reset	Locked	Locked	Near-End PM/
	N Link 35 N Link 36			1.001E15		6 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PR857-bit</li> <li>PR857-bit</li> </ul>	~ 0.00 ~ 0.00	(00000) Bb (00000) Bb	¥ 0	0.00 dB (00000) 0.00 dB (00000)	ž	950 mV (1100) 950 mV (1100)	v	2	Inject	Reset	Reset	Locked	Locked	
	% Link 37	MGT_X0Y34/TX MGT_X0Y34/R0 MGT_X0Y34/TX MGT_X0Y34/R0 MGT_X0Y35/TX MGT_X0Y35/R0	16.000 Gbps	1.001E15	0E0 9.994E-	16 Reset 16 Reset 16 Reset	PRBS 7-bit	Y PRBS 7-bit	~ 0.00	dB (00000)	~ 0	0.00 dB (00000)	~	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM/
	N Link 38 N Link 39	MGT_X0Y35/TX MGT_X0Y35/R0 MGT_X0Y35/TX MGT_X0Y35/R0	15.994 Gbps	1.001E15 1.001E15	0E0 9.994E- 0E0 9.994E-	6 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PR85 7-bit</li> <li>PR85 7-bit</li> </ul>	~ 0.00	dB (00000) dB (00000)	~ 0	0.00 dB (00000) 0.00 dB (00000)	v	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked Locked	Near-End PM/
	% Link 39 % Link 40	MGT_X0Y35/TX MGT_X0Y35/K0 MGT_X0Y35/TX MGT_X0Y35/K0	16.000 Gops	1.001E15	0E0 9.991E-	6 Reset	PRBS 7-bit	<ul> <li>PRBS 7-bit</li> </ul>	V 0.00 V 0.00	dB (00000)	~ 0	0.00 dB (00000)	~	950 mV (1100) 950 mV (1100)	~	× ×	Inject	Reset	Reset	Locked	Locked	Near-End PMJ
	% Link 40 % Link 41	MGT_X0Y36/TX MGT_X0Y36/RX MGT_X0Y36/TX MGT_X0Y36/RX	16.000 Gbps	1.001E15	0E0 9.991E-	6 Reset	PRBS 7-bit	Y PRBS 7-bit	~ 0.00	dB (00000) dB (00000)	~ 0	(0000) B (0000) 0.00 B (0000)	v	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM/ Near-End PM/
				1.001E15	0E0 9.991E- 0E0 9.991E-	6 Reset 6 Reset	PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>EBBS 7-bit</li> </ul>	~ 0.00	dE (00000) dB (00000)	~ 0	0.00 dB (00000) 0.00 dB (00000)	~	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset Reset	Reset Reset	Locked	Locked Locked	
	% Link 43 % Link 44	MGT_X0Y37/TX MGT_X0Y37/R0 MGT_X0Y38/TX MGT_X0Y38/R0	16.000 Gbps	1.001E15	0E0 9.991E-	15 Reset	PRBS 7-bit	✓ PRBS 7-bit	~ 0.00	dB (00000)	~ 0	0.00 dB (00000)	v	950 mV (1100)	~	×.	Inject	Reset	Reset	Locked	Locked	Near-End PM/
	S. Link 45	NACE NOVERTX NEED NOVERED	15 000 Ches	1.001E15	050 9 9915-	E Denet	PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	~ 0.00	(00000) (8)	~ 0	0.00 dB (00000)	~	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Nam-End PM
	% Link 46 % Link 47	MGT_X0Y39/TX MGT_X0Y39/RX MGT_X0Y39/TX MGT_X0Y39/RX	16.000 Gbps	1.001E15 1.001E15	0E0 9.991E- 0E0 9.991E-	15 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	✓ 0.00	dB (00000) dB (00000)		0.00 dB (00000) 0.00 dB (00000)	×	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM/
			16.000 Gbps	1.001E15			PRBS 7-bit	<ul> <li>PRBS 7-bit</li> </ul>	~ 0.00	dB (00000) Bb	~ 0	00.00.00.000	~	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	
	% Link 49 % Link 50	MGT_X1Y4/TX MGT_X1Y4/RX MGT_X1Y5/TX MGT_X1Y5/RX	16.042 Gbps	1.001E15 1.001E15	0E0 9.991E- 0E0 9.991E-	6 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	~ 0.00	dB (00000)	¥ 0	0.00 dB (00000) 0.00 dB (00000)	~	950 mV (1100) 950 mV (1100)	*	2	Inject	Reset	Reset	Locked	Locked	Near-End PM/
	% Link 50 % Link 51	MGT YENSTY MGT YENSTY.	16.000 Gbps 16.010 Gbps	1.001E15	0E0 0.001E-	R Denet	PRBS 7-bit PRBS 7-bit	Y PRRS 7-bit	~ 0.00 ~ 0.00	dB (00000) Bb (00000) Bb	v 0 v 0	0.00 dB (00000)	~	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked Locked	Nasr-End PM
	N Link 52	MGT_X1Y6/TX MGT_X1Y6/RX MGT_X1Y6/TX MGT_X1Y6/RX	16.000 Gbps	1.001E15	GE0 9.991E-	6 Reset	PR89.7-bit	<ul> <li>PR95 7-bit</li> <li>PR95 7-bit</li> </ul>	~ 0.00	(00000) 8b	~ 0	0.00 dB (00000)	v	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM/
	N Link 53 N Link 54	MGT_X1Y6/TX MGT_X1Y6/RX MGT_X1Y7/TX MGT_X1Y7/RX	16.000 Gbps	1.001E15	0E0 9.991E- 0E0 9.991E-	6 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	~ 0.00	(00000) Bb (00000) Bb	~ 0	0.00 dB (00000)	~	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PMA
	N Link 55	MGT_X1Y7/TX MGT_X1Y7/RX	16.000 Gbps	1.001E15	0E0 9.991E-	16 Reset 16 Reset	PRBS 7-bit	<ul> <li>PRBS 7-bit</li> </ul>		dB (00000)	~ 0	1.00 dB (00000)	v	950 mV (1100)	v	2	inject	Reset	Reset	Locked	Locked	Near-End PM
	N Link 56	MGT_X1YB/TX_MGT_X1YB/RX	16.000 Gbps	1.001E15	0E0 9.991E-	6 Reset	PRBS 7-bit	✓ PRBS 7-bit	✓ 0.00	dB (00000)	~ 0	(00000) Bb 00.0		950 mV (1100)	~	×.	Inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 57 % Link 58	MGT_X1YBTX MGT_X1YBRX	16.000 Gbps	1.001E15 1.001E15	0E0 9.991E- 0E0 9.991E-		PRBS 7-bit PRBS 7-bit	<ul> <li>PR85 7-bit</li> <li>PR85 7-bit</li> </ul>		dB (00000) dB (00000)		0.00 dB (00000) 0.00 dB (00000)	~	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked Locked	Near-End PM/ Near-End PM/
	% Link 50		16.008 Gbps	1.001E15	0E0 9.991E-	6 Reset	PR8S 7-bit	<ul> <li>PR00.7-bit</li> </ul>	~ 0.00	dB (00000)	~ 0	(00000) Bb 00.0	v	950 mV (1100)	v	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 60	MGT_X1Y10/TX MGT_X1Y10/RX	16.000 Gbps	1.001E15	0E0 9.991E-		PRBS 7-bit	✓ PRBS 7-bit		dB (00000)		0.00 dB (00000)	×	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	N Link 61 N Link 62	MGT_X1Y10/TX MGT_X1Y10/R0 MGT_X1Y11/TX MGT_X1Y11/R0	16.009 Gbps	1.001E15 1.001E15	0E0 9.991E- 0E0 9.991E-	16 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-68</li> <li>PRBS 7-68</li> </ul>		dB (00000) dB (00000)	~ 0 ~ 0	0.00 dB (00000)	v	950 mV (1100) 950 mV (1100)	~	N N	Inject	Reset	Reset	Locked	Locked Locked	Near-End PM/
	% Link 63	MGT_X1Y11/TX MGT_X1Y11/RX	16.010 Gbps	1.001E15	0E0 9.991E-	16 Reset	PRBS 7-bit	✓ PRBS 7-bit	~ 0.00	dB (00000) Bb	~ 0	(00000) Bb 00.0		950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	N Link 64 N Link 65	MGT_X1Y12/TX MGT_X1Y12/R0 MGT_X1Y12/TX MGT_X1Y12/R0	16.000 Gbps	1.001E15 1.001E15	0E0 9.99E- 0E0 9.99E-	15 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	v 0.00	dB (00000) dB (00000)	¥ 0	0.00 dB (00000) 0.00 dB (00000)	~	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked Locked	Near-End PM/
	S. Link 66	NGT X1Y13/TX NGT X1Y13/RX	16.000 Gbee	1.001E15	050 9.995-	6 Reset	PRBS 7-bit	✓ PR057-bit	~ 0.00	(00000) Bb	~ 0	(00000) Bb 00.0	v	950 mV (1100)	~	2	inject	Reset	Reset	Locked	Locked	Naac-End PM
	% Link 67	MGT_X1Y13/TX MGT_X1Y13/RX	16.000 Gbps	1.001E15	0E0 9.99E-	15 Reset	PRBS 7-bit	✓ PR8S 7-bit		dB (00000)		0.00 dB (00000)	×	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PMA
	N Link 68 N Link 69	MGT_X1Y14/TX MGT_X1Y14/RX MGT_X1Y14/TX MGT_X1Y14/RX		1.001E15	0E0 9.99E- 0E0 9.99E-		PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>		dB (00000) dB (00000)		0.00 dB (00000)		950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM/
	% Link 70	MGT_X1Y15/TX MGT_X1Y15/R0	16.001 Gbps	1.001E15	0E0 9.996-	16 Reset	PR0S 7-64	Y PR857-bit	~ 0.00	dB (00000)	~ 0	(00000) Bb 00.0	v	950 mV (1100)	~	×.	Inject	Reset	Reset	Locked	Locked	Near-End PM
	S Link 71 S Link 72	MGT_X1Y15/TX MGT_X1Y15/RX MGT_X1Y16/TX MGT_X1Y16/RX	15.975 Gbps	1.001E15	0E0 9.99E- 0E0 9.99E-	6 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	✓ 0.00	dB (00000) B	~ 0	0.00 dB (00000)	v	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM/
	% Link 72 % Link 73	MGT_X1Y16/TX MGT_X1Y16/K	16.000 Gbps	1.001E15	0E0 9.996-	16 Reset	PR85 7-64	<ul> <li>PR05 7-bit</li> <li>PR05 7-bit</li> </ul>		dB (00000)		0.00 dB (00000)	v	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	S Link 74	MGT_X1Y17/TX MGT_X1Y17/RX	16.045 Gbps	1.001E15	0E0 9.99E-	6 Reset	PRBS 7-bit	Y PRBS 7-bit	~ 0.00	dB (00000)	~ 0	(00000) Bb 00.0	~	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 76 % Link 76	MGT_X1Y17/TX MGT_X1Y17/R0 MGT_X1Y18/TX MGT_X1Y18/R0	16.000 Gbps	1.001E15 1.001E15	0E0 9.99E-	16 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PR85 7-bit</li> <li>PR85 7-bit</li> </ul>		dB (00000) dB (00000)		0.00 dB (00000) 0.00 dB (00000)	×	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset Reset	Locked	Locked Locked	Near-End PM/ Near-End PM/
	S. Link 77	NAME AND DESCRIPTION OF A DESCRIPTION OF	15 020 Ches	1.001E15	050 9.995	E Denet	PR857-bit	✓ PRBS 7-bit	~ 0.00	dB (00000)	× 0	0.00 48 (00000)	~	950 mV (1100)	v	2	Inject	Reset	Repet	Locked	Locked	Nam-End PM
	% Link 78 % Link 79	NGT_X1Y19/TX NGT_X1Y19/R0 NGT_X1Y19/TX NGT_X1Y19/R0	16.000 Gbps	1.001E15 1.001E15	0E0 9.99E- 0E0 9.99E-	16 Reset 16 Reset 16 Reset	PRBS 7-bit PRBS 7-bit	Y PRBS 7-bit		dB (00000) Bb	~ 0	0.00 dB (00000)	×	950 mV (1100)	~	2	inject	Reset	Reset Reset Reset	Locked	Locked Locked	Near-End PM/
	S. Link 80	MOT X1Y20/TX MOT X1Y20/RX	16 010 Ghes	1.001E15 1.001E15	0E0 9.99E-	6 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	V 0.00	dB (00000) dB (00000) Bb	× 0 × 0	0.00 dB (00000)	v	950 mV (1100) 950 mV (1100)	~	8	Inject	Reset	Reset	Locked	Locked	Next-End PM
	S Link 81 S Link 82	MGT_X1Y20TX MGT_X1Y20R0 MGT_X1Y21/TX MGT_X1Y21/R0	16.000 Gbps	1.001E15	050 9.995.	6 Reset	PRBS 7-bit	Y PRBS 7-bit	~ 0.00	(00000) 80	× 0	00000186.0000	~	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM/
				1.001E15 1.001E15			PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	v 0.00	(00000) Bb (00000) Bb	× 0	(00000) Bb 00 0	~	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked Locked	
	% Link 84 % Link 85	MGT_X1Y20TX MGT_X1Y20R0 MGT_X1Y20TX MGT_X1Y20R0 MGT_X1Y20TX MGT_X1Y20R0	15.900 Gbps	1.001E15	0E0 9.99E- 0E0 9.99E-	16 Reset 16 Reset	PR897-bit	Y PRBS 7-bit	~ 0.00	dR (00000)	v 0	0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000)	~	950 mV (1100)	v	2	Inject	Reset	Reset Reset	Locked	Locked	Near-End PM/ Near-End PM/
	% Link 85	MGT_X1Y22/TX MGT_X1Y22/R0	15.973 Gbps	1.001E15	0E0 9.90E- 0E0 9.90E-	16 Reset	PRBS 7-bit	Y PRBS 7-bit	~ 0.00	(00000) Bb	~ 0	(00000) Bb 00.0	~	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	N Link 86 N Link 87	MGT_X1Y23/TX MGT_X1Y23/RX MGT_X1Y23/TX MGT_X1Y23/RX	16.000 Gbps	1.001E15 1.001E15	0E0 9.99E- 0E0 9.99E-	15 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PR85 7-bit</li> <li>PR85 7-bit</li> </ul>	~ 0.00	dB (00000) dB (00000)	~ 0	0.00 dB (00000) 0.00 dB (00000)			~	N N	Inject	Reset	Reset	Locked	Locked Locked	Near-End PM/
	S Link 87 S Link 88	MGT_X1Y25/TX MGT_X1Y25/RX MGT_X1Y24/TX MGT_X1Y24/RX	16.000 Gbps	1.001E15	0E0 9.99E-	16 Reset	PRBS 7-bit	✓ PRBS 7-bit	✓ 0.00	dB (00000)	~ 0	(00000) Bb 00.0	~	950 mV (1100) 950 mV (1100)	~	Z	Inject	Reset	Reset	Locked	Locked Locked	Near-End PM/ Near-End PM/
				1.001E15 1.001E15			PRBS 7-64	<ul> <li>PR85 7-bit</li> <li>PR85 7-bit</li> </ul>	~ 0.00	dB (00000) Bb	× 0	00.00.00.0000			~	2	Inject	Reset	Reset	Locked	Locked Locked	
	S Link 90 S Link 91	MGT_X1Y25/TX MGT_X1Y25/RX MGT_X1Y25/TX MGT_X1Y25/RX	16.000 Gbps	1.001E15	0E0 9.99E- 0E0 9.99E-	6 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	- 0.00 - 0.00	dE (00000) dB (00000)	- 0 - 0	0.00 dB (00000) 0.00 dB (00000)	v	950 mV (1100) 950 mV (1100)	v	2	inject	Reset	Reset	Locked	Locked	Near-End PM/
	% Link 92	INGT X1Y25/TX INGT X1Y25/RX	16.000 Gbos	1.001E15	0E0 9.99E-	6 Reset	PRBS 7-bit	Y PRBS 7-bit	~ 0.00	dB (00000) Bb	~ 0	0.00 dB (00000)	~	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PMA
	N Link 93 N Link 94	MGT_X1Y25/TX MGT_X1Y25/R0 MGT_X1Y27/TX MGT_X1Y27/R0	16.018 Gbps	1.001E15 1.001E15	0E0 9.99E-	15 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	· 0.00	dB (00000) dB (00000)	~ 0	0.00 dB (00000)	×	950 mV (1100) 950 mV (1100)	×	2	Inject	Reset	Reset	Locked	Locked Locked	Near-End PM/ Near-End PM/
	S Link 95	MGT_X1Y27/TX MGT_X1Y27/RX	16.000 Gbps	1.001E15 1.001E15	0E0 9.99E-	16 Reset	PRBS 7-bit	<ul> <li>PRBS 7-bit</li> </ul>	~ 0.00	dB (00000) Bb	¥ 0	0.00 dB (00000)	~	950 mV (1100)	~	×	inject	Reset	Reset	Locked	Locked	Near-End PM
	N Link 96	MGT_X1Y28/TX MGT_X1Y28/RX	16.000 Gbps	1.001E15	0E0 9.996-	6 Reset	PRBS 7-bit	Y PRBS 7-bit	~ 0.00	dB (00000)	~ 0	0.00 dB (00000)	v	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End Phil
	N Link 97 N Link 98	MGT_X1Y28/TX MGT_X1Y28/R0 MGT_X1Y28/TX MGT_X1Y28/R0	16.000 Gbps	1.001E15	0E0 9:99E- 0E0 9:99E-	6 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>		dB (00000) Bb (00000) Bb		0.00 dB (00000) 0.00 dB (00000)		950 mV (1100) 950 mV (1100)	v	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	N Link 99	MGT_X1Y29/TX MGT_X1Y29/RX	16.017 Gbps	1.001E15	0E0 9.99E-	15 Reset	PRBS 7-bit	Y PRBS 7-bit	~ 0.00	dB (00000)	~ 0	(00000) Bb 00.0	Ý	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 100	MGT_X1Y30/TX MGT_X1Y30/RX	16.000 Gbps	1E15	0E0 9.995E-	6 Reset	PRBS 7-bit	<ul> <li>PRBS 7-bit</li> </ul>	~ 0.00	dB (00000)	~ 0	(00000) Bb 00.0	v	950 mV (1100)	v	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 101 % Link 102	NGT_X1Y30TX NGT_X1Y30R0 NGT_X1Y31/TX NGT_X1Y31R0		1E15	0E0 9.996E-		PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>		dB (00000) dB (00000)		0.00 dB (00000) 0.00 dB (00000)	ž	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked Locked	Near-End PM/
	% Link 103	MGT_X1Y31/TX MGT_X1Y31/R0	16.000 Gbps	1E15	0E0 9.996E-	6 Reset	PRBS 7-bit	<ul> <li>PRBS 7-bit</li> </ul>	~ 0.00	dB (00000) Bb	~ 0	0.00 dB (00000)	~	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 104	MGT, X1Y32/TX MGT, X1Y32/RX	16.000 Gbps	1E15	0E0 9.995E-	6 Reset	PRBS 7-bit	✓ PRBS 7-bit	✓ 0.00	dB (00000)	~ 0	0.00 dB (00000)	~	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	N Link 105 N Link 105	MGT_X1Y32/TX MGT_X1Y32/R0 MGT_X1Y33/TX MGT_X1Y33/R0	16.000 Gbps	1E15	060 9.9966-	6 Reset	PRBS 7-bit	<ul> <li>PR05 7-bit</li> <li>PR85 7-bit</li> </ul>	✓ 0.00	dB (00000) Bb	~ 0	0.00 dB (00000) 0.00 dB (00000)	v	950 mV (1100) 950 mV (1100)	~	8	Inject	Reset	Reset	Locked	Locked Locked	Near-End PM/
	S Link 107	MOT NEEDEN MOT NEEDEN	10.000 Ches	1E15	050 9.9955	6 Reset	PRBS 7-bit	<ul> <li>PRBS 7-bit</li> </ul>	~ 0.00	dB (00000) Bb	Y O	0.00 dR (00000)	v	950 mV (1100)	~	Ĩ.	Inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 108 % Link 109	MGT_X1Y34/TX MGT_X1Y34/R0 MGT_X1Y34/TX MGT_X1Y34/R0	16.000 Gbps	1E15 1E15	0E0 9.995E-	16 Reset	PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>		dB (00000) dB (00000)	× 0	0.00 dB (00000)	×	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked Locked	Locked Locked	Near-End PMA
	% Link 110	MGT X1Y35/TX MGT X1Y35/RX	16.000 Gbps	1E15	0E0 9.995E-	6 Reset	PRBS 7-bit	<ul> <li>PRBS 7-bit</li> </ul>	~ 0.00	(00000) Bb	~ 0	0.00 dB (00000)	Ý	950 mV (1100)	v	8	inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 111	MGT_X1Y35/TX MGT_X1Y35/RX	16.000 Gbps	1E15	0E0 9.995E-	16 Reset	PRBS 7-bit	Y PRBS 7-bit	~ 0.00	dB (00000)	~ 0	(00000) Bb 00.0	~	950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 112 % Link 113	MGT_X1Y36/TX MGT_X1Y36/R0 MGT_X1Y36/TX MGT_X1Y36/R0	16.005 Gbps	1615	0E0 9.995E-	6 Renet	PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>	~ 0.00	(00000) B	~ 0	0.00 dB (00000)	~	950 mV (1100) 950 mV (1100)	~	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 113 % Link 114	MGT_X1Y36/TX MGT_X1Y36/R0 MGT_X1Y37/TX MGT_X1Y37/R0	16.000 Gops	1E15	0E0 9.995E- 0E0 9.995E-		PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>		dB (00000) dB (00000)		0.00 dB (00000) 0.00 dB (00000)	v	950 mV (1100) 950 mV (1100)	~	×.	inject	Reset	Reset	Locked	Locked	Near-End PM/
	S Link 115	MGT_X1Y37/TX MGT_X1Y37/RX	16.003 Gbps	1E15	0E0 9.995E-	6 Reset	PRBS 7-bit	Y PRBS 7-bit	~ 0.00	dB (00000)	~ 0	(00000) Bb 00.0	~	950 mV (1100)	*	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 116 % Link 117	MGT_X1Y38/TX MGT_X1Y38/RX MGT_X1Y38/TX MGT_X1Y38/RX	16.005 Gbps	1E15 1E15	0E0 9.995E- 0E0 9.995E-		PRBS 7-bit PRBS 7-bit	<ul> <li>PRBS 7-bit</li> <li>PRBS 7-bit</li> </ul>		dB (00000) dB (00000)		0.00 dB (00000) 0.00 dB (00000)	~	950 mV (1100) 950 mV (1100)	×	2	Inject	Reset	Reset	Locked	Locked Locked	Near-End PM/ Near-End PM/
	% Link 118	MGT_X1Y38/TX MGT_X1Y38/RX	16.000 Gbps	1615	GE0 9.995E-	16 Reset	PRBS 7-bit	✓ PRSS 7-bit	~ 0.00	(00000) 85	× 0	0.00 48 (00000)	~	950 mV (1100)	v	2	Inject	Reset	Reset	Locked	Locked	Near-End PM
	% Link 119	MGT_X1Y3B/TX MGT_X1Y3B/R0	15.995 Gbps	1E15	0E0 9.995E-	6 Reset	PRBS 7-bit	✓ PRBS 7-bit	✓ 0.00	dB (00000)	~ 0	0.00 dB (00000)	×	950 mV (1100)	~	2	Inject Inject	Reset Reset	Reset Reset	Locked	Locked	Near-End PM
			_	_			_		_	_	-	_	-		_	_	_	_	_			_

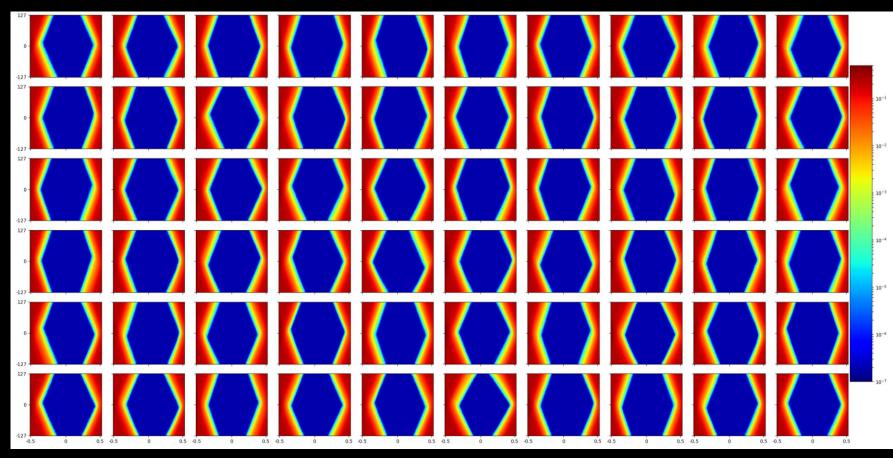
### LINKS - INTERNAL LOOP

- 120 simultaneous IBERTs
  - 16Gbps, Near-end PMA loopback. Default settings
- Each link passed 1e15 bits No errors
- 120Pb of data through silicon
- Indicated good clock and power stability



### COPPER LINKS – EYE DIAGRAMS

- Inter-interposer bus
- Two independent FPGAs
- 16Gbps, DFE disabled, No Preor Post-Cursor
- Each link passed
   8e14 bits No errors



### OPTICAL LINKS – EYE DIAGRAMS

- Firefly optics
- Two independent FPGAs
- 16Gbps, DFE disabled, No Preor Post-Cursor
- <u>Default optical</u> <u>module settings</u>
- 10m optical fibre
- Each link passed 8e14 bits – No errors

No optical module present

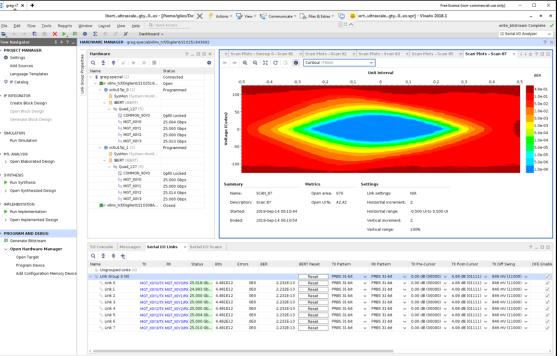
 $FPGA \ 1 \rightarrow daughter-card \rightarrow interposer \rightarrow motherboard \rightarrow firefly \rightarrow MTP \rightarrow 10M optical cable \rightarrow MTP \rightarrow firefly \rightarrow motherboard \rightarrow interposer \rightarrow daughter-card \rightarrow FPGA 2$   $\frac{19/09/2018}{11}$ 

#### 25GBPS INITIAL RESULTS

#### Firefly over copper 25Gbps PRBS31

#### 😋 greg-i7 🗙 🕂 -commercial use only) ibert\_uitrascale\_gty\_0\_ex - [/home/giles/Development/p2-serenity-ibert-ku15p/gty\_ibert\_1\_ex4/ibert\_uitrascale\_gt - write hitstream Complete . 🖘 🖉 🖩 🗙 🕨 👫 🕸 Σ 🖄 🖉 Dashboard 📰 Serial VO Analızer area-special/xilinx tcf/Digilent/210251843992 Scan Plots - Scan 82 x Scan Plots - Scan 83 x Scan Plots - Scan 85 x Scan Plots - Scan 87 x Scan Plots - Scan 88 x Scan P 📕 Scan 91 🔍 Q 💥 C 📴 🚺 Contour (Filed Unit Interva Name: SCAN 9 BER Description General 1.0e-01 5.0e-02 Hardware ? \_ D 🛙 × 1.0e-02 5.0e-03 Name 1.0e-03 e sckul5p\_0 (2) Programmed T SueMon (S 5.0e-04 IBERT (IBERT 1.0e-04 No Quad\_127 (5) 5.0e-05 COMMON X0YO **QpII0** Locked 1.0e-05 IN MGT X0Y0 25.000 Gbps MGT\_X0Y1 25.000 Gbps 5.0e-06 D: MGT X0Y2 25.000 Gbps Re MGT X0Y3 25.000 Gbps xcku15p\_1 (2) Programmed SysMon (Syst Metrics Settinas Summary IBERT (IBERT) • Ry Quad\_127 (5 Name: SCAN 91 Open area: 977 Link settings: COMMON X0Y Open UI %: 40.00 Dr MGT X0Y0 24 985 Ghos Started: 2018-Sep-14 11:44:07 -0.500 UI to 0.500 U MGT\_X0Y1 25.000 Gbps NGT\_X0Y2 Ended 2018-Sep-14 11:44:45 Vertical increment 25.000 Gbps MGT X0Y3 25.000 Gbps Vertical range 1009 losed Serial I/O Links Vame Inject Error Ungrouped Links Link Group 0 ( PBRS 31-bit PRRS 31-bit 0.00 dB (00000) × 4.08 dB (01111) × Inject S Link 0 GT X0Y0/TX MGT X0Y0/RX 24.994 Gb... 1.044E15 0E0 9.583E-16 Reset PRBS 31-bit PR8S 31-bit ∨ 0.00 dB (00000) ∨ 4.08 dB (01111) ∨ 846 mV (11000) ∨ None Inject MGT X0Y0/TX MGT X0Y0/RX 25.000 Gb... 1.044E15 0E0 9.582E-16 PRBS 31-bit PRBS 31-bit 0.00 dB (00000) v 4.08 dB (01111) v 846 mV (11000) v Inject 📎 Link I Reset MGT X0Y1/TX MGT X0Y1/RX 25.000 Gb... 1.044E15 Unk 2 3.2E1 3.066E-14 PRRS 31.bit PRRS 31-bit 0.00 dB (00000) 😼 4.08 dB (011111) 846 mV(11000) > Inject S Link 3 MGT X0Y1/TX MGT X0Y1/RX 25,000 Gb., 1.044E15 3.5E1 3.354E-14 PRBS 31-bit PRBS 31-bit 0.00 dB (00000) v 4.08 dB (01111) v 846 mV (11000) v None Inject % Link 4 MGT X0Y2/TX MGT X0Y2/RX 25.000 Gb... 1.044E15 0E0 9.583E-16 Reset PRBS 31-bit PRBS 31-bit 0.00 dB (00000) v 4.08 dB (01111) v 846 mV (11000) v None Inject Unk 5 MGT X0Y2/TX MGT X0Y2/RX 25.000 Gb... 1.044E15 0E0 9.582E-16 Reset PRBS 31-bit PRBS 31-bit 0.00 dB (00000) ~ 4.08 dB (01111) ~ 846 mV (11000) · Inject

#### Inter-interposer bus 25Gbps PRBS31



#### Using the deprecated 14Gbps-rated Firefly connector

PBBS 31-bit

PRBS 31-bit

0.00 dB (00000) < 4.08 dB (01111) < 846 mV (11000) </p>

v 0.00 dB (00000) 
 v 4.08 dB (01111) 
 v 846 mV (11000) 
 ·

None

Inject

Inject

PRRS 31-bit

PRBS 31-bit

S Link 6

Unk 7

MGT X0Y3/TX MGT X0Y3/RX 25,000 Gb., 1,044E15

MGT X0Y3/TX MGT X0Y3/RX 25.006 Gb... 1.044E15

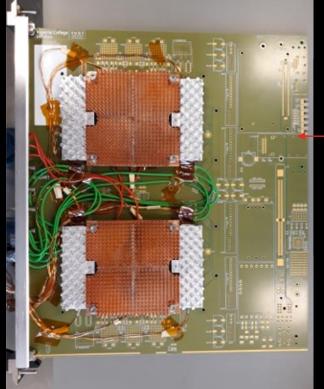
0E0

2.1E1

9.583E-16 Reset

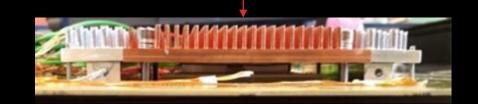
2.012E-14 Reset

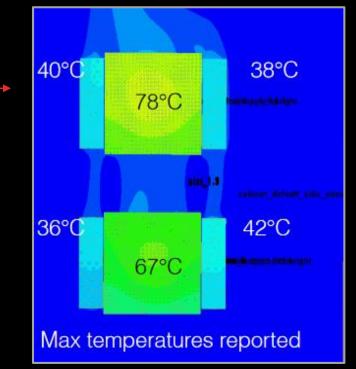
#### THERMAL & MECHANICAL TESTS



Thermal simulations

- Physical thermal studies at CERN
- Mechanical component design, studies into stress on FPGA solder balls and stress on PCBs under way at IC



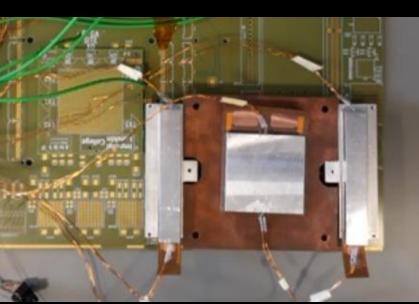


#### TEST STAND AT CERN

- Kapton heaters
- Comtel Crate

Piso

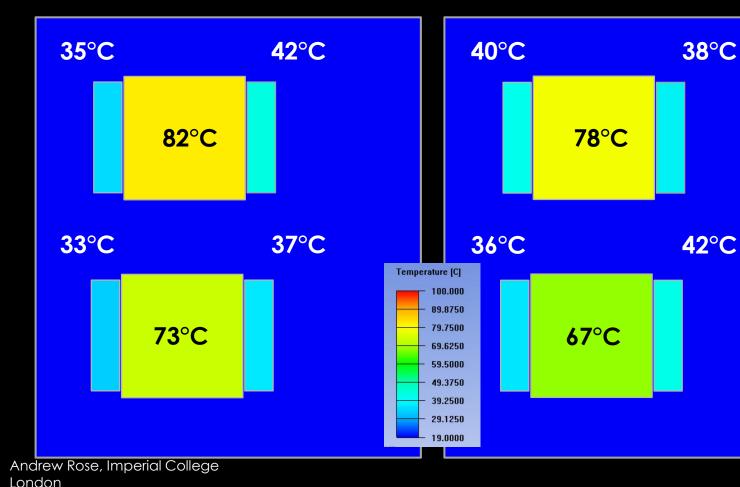
Front-Back Airflow





#### Measurement, Fan Speed 15

PISO



Simulation, Fan Speed 15

### THERMAL TEST RESULTS

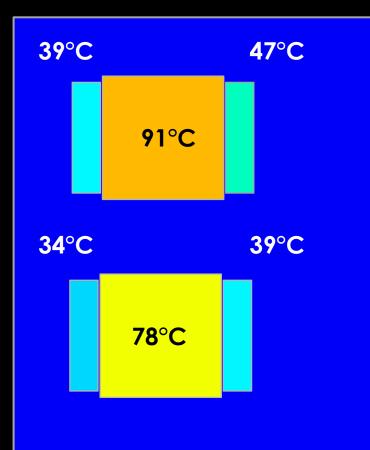
- Standard CERN crate made by Schroff, Vertical Airflow
  - FPGAs @ 90W each
  - Max temperature 100 °C
  - Optics @ 10W each
  - Max temperature **50** °C
  - May increase to 20W so need margin
- Simulation by Ansys
- KIT also running simulations with Mentor FloTHERM for comparison

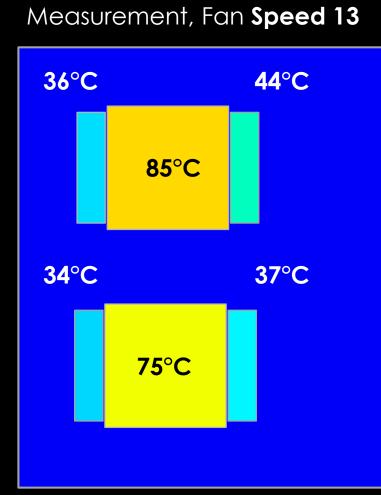
15

#### FAN SPEED

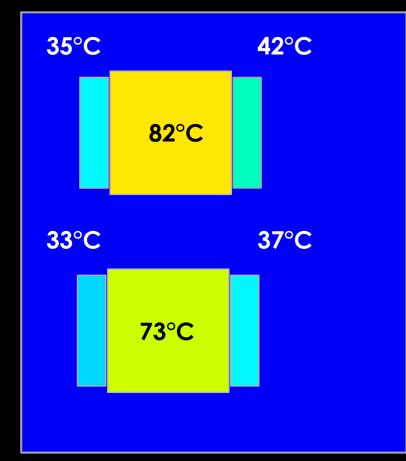
#### Measurement, Fan **Speed 10**

PISO





#### Measurement, Fan Speed 15

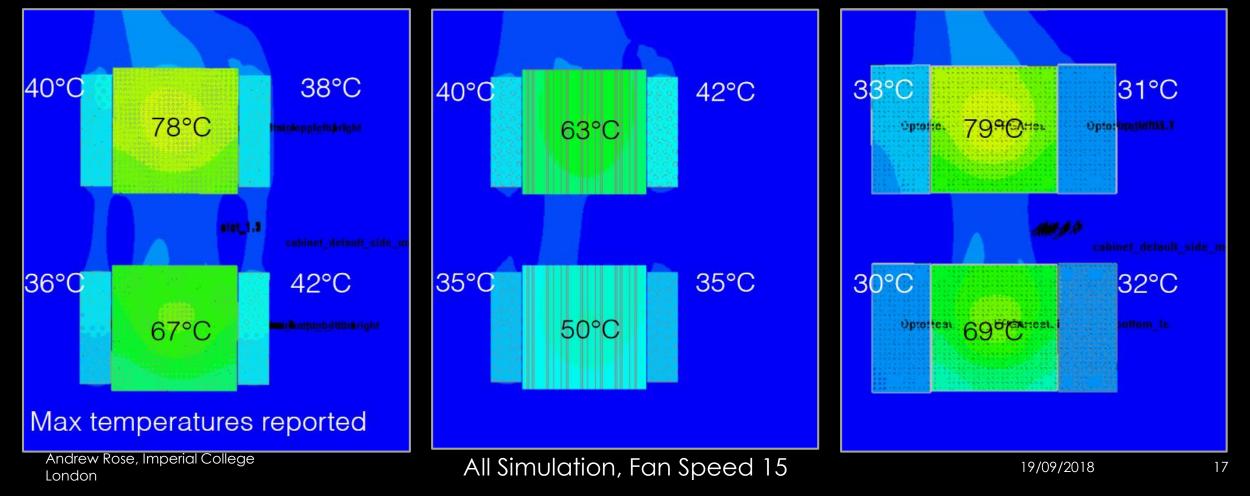


• Simulations suggest significant improvement with custom heatsink.

piso.

### HEATSINK TYPE

• Validation of simulation with measurement under way



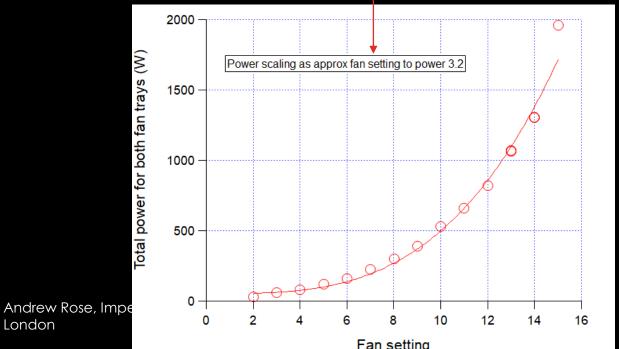
#### CRATE NOISE & POWER

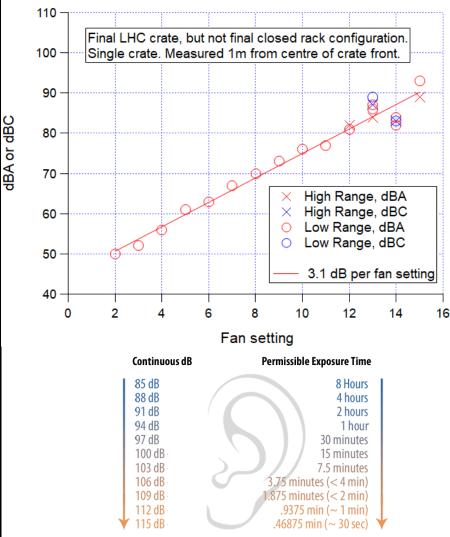
- Measurements of the running ATCA system still a cause for concern regarding
  - Aural (acoustic) health and safety

PISO.IC

London

Power-consumption required to cool system ullet





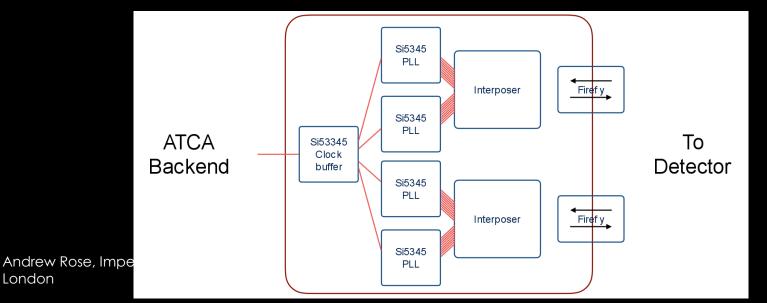
### **CLOCK-DISTRIBUTION TESTS**

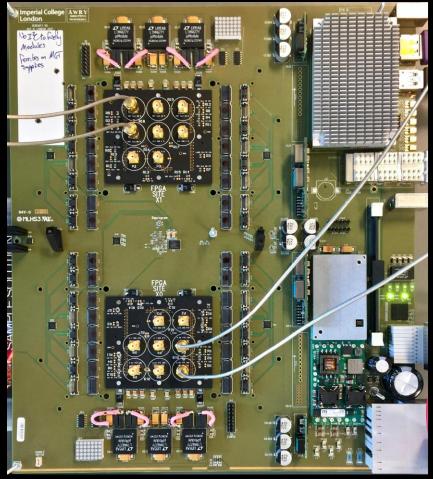
- Serenity is TDR proposal for CMS HGC DAQ, trigger, clocking and control board.
- HGC requires precision timing distribution

SOCION

London

• CEA Saclay have been testing whether Serenity's clocking performance meets HGC requirements





### **CLOCK-DISTRIBUTION TESTS**

- 320.624MHz test clock (HGC precision-timing frequency)
- External clock-source, RMS = 1.3ps
- Serenity tested at 20GS/s (Eval board at 40GS/s)

Measurements by CEA Saclay	SI5444 Eval board for comparison (4 outputs)	Serenity North LHC clock (9 outputs)	Serenity South LHC clock (9 outputs)	Serenity Overall			
Random Jitter	0.9ps	1.6ps	1.4ps	1.8ps			
Deterministic Jitter	1.9ps	3.2ps	3.1ps	4.2ps			
RMS	1.3ps	2.3ps	2.1ps	2.8ps			

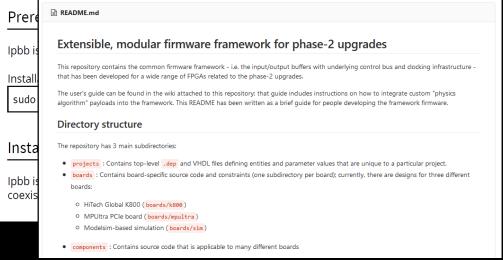
• Based on these results, Serenity's contribution to system jitter is minimal and it can be considered a "pure clock distribution" node

SOCION

- Ipbus-over-PCIe worked out-of-the-box
- Have built upon the success we had with MP7 model in Phase-1 upgrades
  - Infrastructure firmware EMP
  - Build Tool IPBB

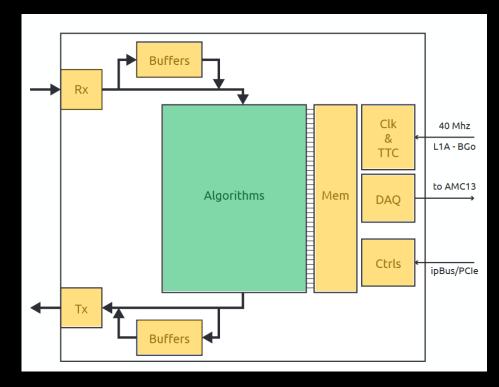
#### Ipbb walkthrough

RUTHR



### FIRMWARE

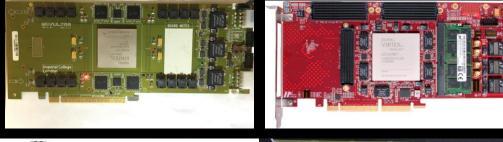
 Infrastructure separated from payload for algorithms



#### EMP FIRMWARE

#### • Different boards

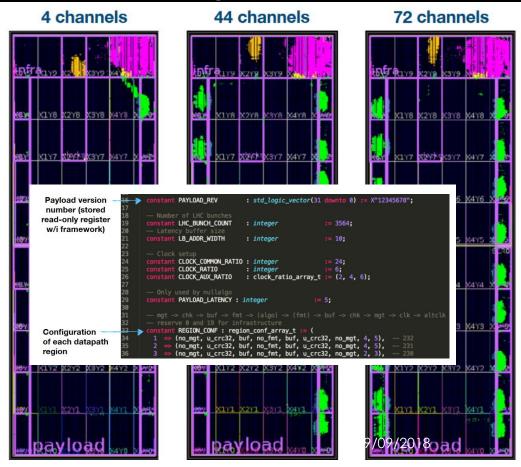
2 ALTIFR







#### • Different configurations



### CONCLUSIONS

- Serenity has succeeded in its initial aims of allowing multiple types of FPGA and user-specified connectivity, and also in mitigating risk
  - Different institutes have successfully produced their own daughter-cards, each with different generations & models of FPGAs
- Concerns over interposer signal integrity and supplying power to FPGAs seem unfounded
- Performance at both 16G and 25G looks good
- Cooling of both optics and FPGAs on daughter-cards looks manageable
  - General concerns over power and noise of LHC-scale systems built using ATCA remain

#### WHAT NEXTS

- 20 Revision 1.1 cards in assembly now
- A number of cards destined for "time-share test-stands" at CERN
  - Allow systems to test "full-stack" algorithms from source to sink
  - Also, horizontal integration with CERN DTH & online software when they become available
- Remaining cards destined for collaborating institutes

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## THANKS FOR LISTENING! ANY QUESTIONS?

## SERENITY

CEA Saclay: Ozgur Sahin, Pierre-Anne Bausson IC: Andrew Rose, Duncan Parker, Greg Iles INFN Pisa: Giacomo Fedi, Piero Giorgio Verdini, Andromachi Tsirou KIT: Luis Ardila, Matthias Balzer, Thomas Schuh RAL: Tom Williams, Alessandro Thea, Kristian Harder TIFR: Shashi Dugad, Raghu Shukla, Irfan Mirza University of Ioannina: Stavros Mallios





Science & Technology Facilities Council







# SERENITY 静

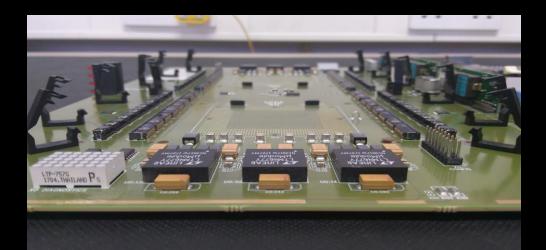
I do not own, nor do I assert any right of ownership over, the Serenity logo. It is just a cool logo from a cool TV series (Firefly) and subsequent film (Serenity). I urge you to go and buy them both: They're a lot of fun.

#### SPARES & BACKUP

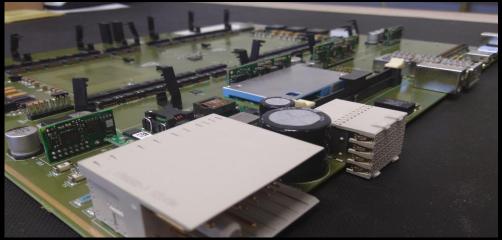
Andrew Rose, Imperial College London

19/09/2018

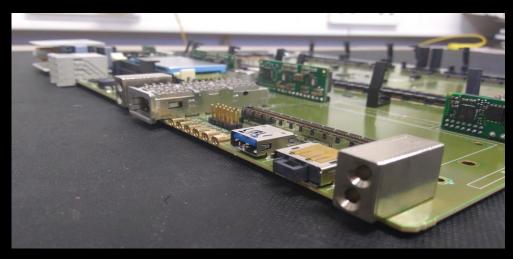
27



#### HARDWARE IN HAND



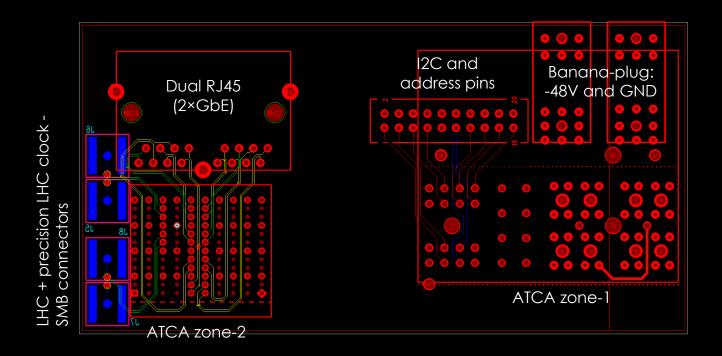




#### MICRO-BACKPLANE







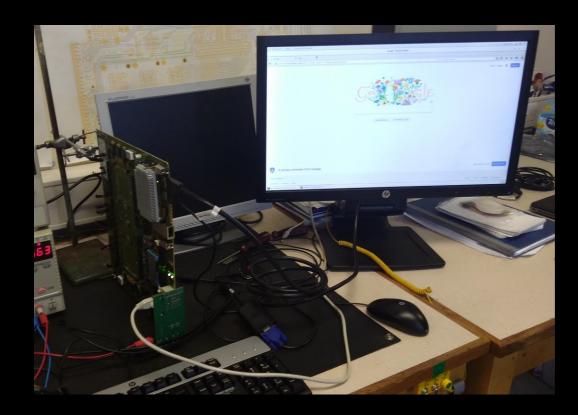
localhost3121/xilinx_tdfDigitent/210251843992/0_1_0_0/IBERT/Quad_126/IL	MGT_X0Y&RX_MGT_X0Y8/TX_15.015 Gbps	7.912E14	0E0	1.264E-15	Reset	PRBS 7-bit	~	PRBS 7-bit	~	0.00 dB (00000)	~	(00000) Bb 00.0		950 mi/ (1100	
localhost.3121/xilinx_tcfDigilent/210251843992/0_1_0_0/IBERT/Quad_126/M.	MGT_X0YB/RX MGT_X0YB/TX 15.000 Gbps	7.912E14	0E0	1.264E-15	Reset	PRBS 7-bit		PRBS 7-bit	~	0.00 dB (00000)	~	(00000) Bb 00.0	~	950 mV (1100	1.00
localhost3121/xlinx_tdfDigilent/210251843992/0_1_0_0/IBERT/Quad_128/N	MGT_X0Y18/RX MGT_X0Y18/TX 15.000 Gbps	7.912E14	0E0	1.264E-15	Reset	PRBS 7-bit		PRBS 7-bit	~	0.00 dB (00000) 0.00 dB (00000)	~	0.00 dB (00000)	~	950 mV (1100 950 mV (1100	
localhost.3121kilinx_htlDigilent/210251843992/0_1_0_048ERT/Quad_12844 localhost.3121kilinx_htlDigilent/210251843992/0_1_0_048ERT/Quad_13144	MGT_X0Y19/RX MGT_X0Y19/TX 15.000 Gbps MGT_X0Y28/RX MGT_X0Y28/TX 15.971 Gbps	7.912E14 7.912E14	0E0 0E0	1.264E-15	Reset	PRBS 7-bit PRBS 7-bit	~	PRBS 7-bit PRBS 7-bit		0.00 dB (00000)		0.00 dB (00000) 0.00 dB (00000)		950 mV (1100 950 mV (1100	
localhost3121/dlinx_tdfDiglett/210251843992/0_1_0_0fBERT/Quad_131ML	MGT_X0Y29/RX MGT_X0Y29/TX 15.000 Gbps	7.912E14	OEO	1.264E-15	Reset	PRBS 7-bit	v	PRBS 7-bit	~	0.00 dB (00000)	~	0.00 dB (00000)	~	950 ml/ (1100	
localhost3121/kilm_tdfDigilent/210251843992/0_1_0_0/IBERT/Quad_1314L	MGT_X0Y30/RX MGT_X0Y30/TX 15.991 Gbps	7.912E14	0E0	1.264E-15	Reset	PRBS 7-bit		PRBS 7-bit	~	0.00 dB (00000)	v	0.00 dB (00000)	~	950 ml/ (1100	
localhost.3121/xilinx_tdfDigient/210251843992/0_1_0_0/IBERT/Quad_131/M.	MGT_X0Y31/RX MGT_X0Y31/TX 15.983 Gbps	7.912E14	OEO	1.264E-15	Reset	PRBS 7-bit		PRBS 7-bit	~	0.00 dB (00000)	~	0.00 dB (00000)	~	950 mV (1100	
localhost.3121/sllinx_tdfDigilent/210251843992/0_1_0_04BERT/Quad_1324L	MGT_X0Y32/RX MGT_X0Y32/TX 15.000 Gbps	7.912E14 7.912E14	0E0 0E0	1.264E-15	Reset	PRBS 7-bit		PRBS 7-bit	~	0.00 dB (00000)	~	0.00 dB (00000)	~	950 mV (1100	
Iocalhost.3121/elime_tdDigitent/2102518439920_1_0_0/IBERT/Quad_132M Iocalhost.3121/elime_tdDigitent/210251843992/0_1_0_0/IBERT/Quad_132M.	MGT_X0Y33/RX MGT_X0Y33/TX 15.982 Gbps MGT_X0Y34/RX MGT_X0Y34/TX 16.000 Gbps	7.912E14 7.912E14	OEO	1.264E-15	Reset	PRBS 7-bit PRBS 7-bit		PRBS 7-bit PRBS 7-bit	č	0.00 dB (00000) 0.00 dB (00000)	č	0.00 dB (00000) 0.00 dB (00000)	÷	950 mV (1100 950 mV (1100	
localhost.3121/nlini_totDiglent/2102518439920_1_0_01BERT/Quad_132M	MGT_X0Y35/RX MGT_X0Y35/TX 16.000 Gbps	7.912E14	OEO	1.264E-15	Reset	PRBS 7-bit		PRBS 7-bit	~	0.00 dB (00000)	~	0.00 dB (00000)	~	950 ml/ (1100	
localhost3121xilinx_tdfDigilent/2102518439920_1_0_0/IBERT/Quad_1204L	MGT_X0Y10/RX MGT_X0Y10/TX 16:000 Gbps	7.912E14	0E0	1.264E-15	Reset	PRBS 7-bit	~	PRBS 7-bit	¥	0.00 dB (00000)	¥	0.00 dB (00000)	~	950 mV (1100	
localhost.3121/xlim_tdfDigilent/210251843992/0_1_0_0/IBERT/Quad_133/H.	MGT_X0Y36/RX MGT_X0Y36/TX 16.023 Gbps	7.912E14	0E0	1.264E-15	Reset	PRBS 7-bit		PRBS 7-bit	×	0.00 dB (00000)	~	0.00 dB (00000)	v	950 mV (1100	
localhost3121/vilini_tdDigilent210251843992/0_1_0_0/IBERT/Quad_133/M	MGT_X0Y37/RX MGT_X0Y37/TX 16.000 Gbps	7.912E14	0E0	1.264E-15	Reset	PRBS 7-bit	~	PRBS 7-bit	~	0.00 dB (00000)	~	0.00 dB (00000)	~	950 mV (1100	
localhost.3121/kilinx_tdfDigilent/210251843992/0_1_0_0/BERT/Quad_133/M. localhost.3121/kilinx_tdfDigilent/210251843992/0_1_0_0/BERT/Quad_133/M.	MGT_X0Y38RX MGT_X0Y38/TX 15.000 Gbps MGT_X0Y39RX MGT_X0Y39/TX 15.000 Gbps	7.912E14	0E0	1.264E-15	Reset Reset	PRBS 7-bit PRBS 7-bit	v u	PRBS 7-bit PRBS 7-bit	~	0.00 dB (00000) 0.00 dB (00000)	č	0.00 dB (00000)	~	950 mV (1100	
localhost3121/dim_tdfDigitett210251843992/0_1_0_0/IBERT/Quad_225/II	MGT_X1Y4RX MGT_X1Y4/TX 15.000 Gbps	7.912E14	OEO	1.264E-15	Reset	PRBS 7-bit	v	PRBS 7-bit	~	0.00 dB (00000)	v	0.00 dB (00000)	~	950 mV (1100	
localhost3121/nimr_tdlDigilent/210251843992/0_1_0_0/IBERT/Quad_2254L	MGT_X1Y5/RX MGT_X1Y5/TX 15.019 Gbps	7.912E14	0E0	1.264E-15	Reset	PRBS 7-bit	×	PRBS 7-bit	v	0.00 dB (00000)	~	0.00 dB (00000)	~	950 ml/ (1100	
localhost.3121/xilinx_tdfDigient/210251843992/0_1_0_0/IBERT/Quad_225/H.	MGT_X1Y6/RX MGT_X1Y6/TX 15:000 Gbps	7.912E14	0E0	1.264E-15	Reset	PRBS 7-bit		PRBS 7-bit	×	0.00 dB (00000)	~	0.00 dB (00000)	.~	950 mV (1100	
localhost.3121/xilinx_tdfDigilent/210251843992/0_1_0_0fBERT/Quad_2254L	MGT_X1Y7/RX MGT_X1Y7/TX 16.024 Gbps	7.912E14	0E0	1.264E-15	Reset	PRBS 7-bit		PRBS 7-bit	~	0.00 dB (00000)	~	0.00 dB (00000)	~	950 mV (1100	
localhost3121kilinx_tdfDigilent/2102518439920_1_0_0/IBERT/Quad_226/M	MGT_X1YB/RX_MGT_X1YB/TX_No Link MGT_X1YB/RX_MGT_X1YB/TX_16.000 Gbps	7.912E1	0E0	1.264E-15	Reset	PRBS 7-bit PRBS 7-bit		PRBS 7-bit PRBS 7-bit	÷	0.00 dB (00000) 0.00 dB (00000)	č	0.00 dB (00000) 0.00 dB (00000)	ž	950 mV (1100 950 mV (1100	
ocalhost 3121/cline_td/Digter/2102518439920_1_0_04ERT/Quad_1264L	MGT X0Y11/RX MGT X0Y11/TX 16.000 Gtps	7.912E14	OEO	1.264E-15	Reset	PRBS 7-bit		PRBS 7-bit	~	0.00 dB (00000)	~	0.00 dB (00000)	~	950 mV (1100	
	MGT_X1Y10/RX MGT_X1Y10/TX 15.982 Gbps	7.912E14	0E0	1.264E-15	Reset	PRBS 7-bit	×	PRBS 7-bit	v	0.00 dB (00000)	¥	0.00 dB (00000)	~	950 mV (1100	
X1 to X0	MGT_X1Y11/RX MGT_X1Y11/TX 15.000 Gbps	7.912E14	0E0	1.264E-15	Reset	PRBS 7-bit	~	PRBS 7-bit	٠	0.00 dB (00000)	~	0.00 dB (00000)	~	950 mV (1100	
	MGT_X1Y12/RX MGT_X1Y12/TX 15:009 Gtps MGT_X1Y13/RX MGT_X1Y13/TX 15:991 Gtps	7.912E14 7.912E14	0E0	12645-15	Reset	PRBS 7-58		PR837-58	ž	0.00 dB (00000)	X	0.00 08 (00000)	~	950 m/ (1100	
positiost 3121/vinit_totOgient/2102518439920_1_U_oleERT/Guad_2274L	MGT_X1Y14/RX MGT_X1Y14/TX 15.010 Gbps	7.912E14 7.912E14	0E0	1.264E-15		PRBS 7-08	٦Ľ-	PRES 7-DE		0.00 dB (00000)				\$50 mV (1100	
over	MGT_X1Y15/RX MGT_X1Y15/TX 16.000 Gbps	7.912E14	OEO	1.264E-15		PRBS 7-bit	יר	blar	1	TV/mon				\$50 mV (1100	
Incalheed 3121 wine_berDing Cost 930 Cost Incent Young 22040.	MGT_X1Y16/RX MGT_X1Y16/TX 16.035 Gbps	7.912E14	0E0	1.264E-15		PRBS 7-bit-	C	JUI		00 (00100)		0.00 dB (00000)		950 m// (1100	
localhost3121mlinx_ttfDiglent210251843992/0_1_0_0/IBERT/Quad_228/H.	MGT_X1Y17/RX MGT_X1Y17/TX 16.018 Gbps	7.912E14	0E0	1.264E-15		PRBS 7-bit	×	PRBS 7-bit		0.00 dB (00000)		0.00 dB (00000)		\$50 mV (1100	
aanaar	MGT_X1Y18RX MGT_X1Y18/TX 15.010 Gbps MGT_X1Y19RX MGT_X1Y19/TX 15.000 Gbps	7.912E14 7.912E14	0E0	1.2646-15		on	∖£ï.		ř,	atic	5			950 m// (1100 950 m// (1100	
copper	MGT_X0Y12/RX MGT_X0Y12/TX 16.000 Gbps	7.924E14	OEO	12625-15		OI		au			)	100 B(00000)		950 mV (1100	
pcalhost3121mins_tcfDigle+t210_5184395_0_1_0_018ERT/Ouad_2294L	MC _X1Y20/RX MGT_X1Y20/TX 16:000 Gbps	7.924E14	0E0	1.262E-16		PRBS 7-bit				0.00 dB (00000)		0.00 08 (00000)		950 m// (1100	
scalhost3121/kins_tdDiglant210251843992/0_1_0_019ERT/Quat_22041-	MGT_X1Y21/RX MGT_X1Y21/TX 15:001 Gbps	7.924E14	0E0	1.262E-15		PRBS 7-bit	*	PRBS 7-bit	× .	0.00 dB (00000)		0.00 dB (00000)		950 m// (1100	
localhost.3121/xiimx_tdfDigilent/210251843992/0_1_0_040ERT/Quad_22944.	MGT_X1Y22/RX MGT_X1Y22/TX 16.000 Gbps	7.924E14	0E0	1.262E-15		PRBS 7-bit		errc	١ľ	0.00 dB (00000)		0.00 dB (00000)		\$50 mW (1100	
localhost3121kilinx_tdDigilent/2102518439920_1_0_01BERT/Quad_22914. localhost3121kilinx_tdDigilent/210251843992/0_1_0_01BERT/Quad_23014.	MGT_X1Y23/RX MGT_X1Y23/TX 16:000 Gbps MGT_X1Y24/RX MGT_X1Y24/TX 15:044 Gbps	7.924E14 7.924E14	0E0 0E0	1.262E-15			~		~					950 ml/ (1100	
localhost 3121/vilinx_tctDigitent/210251843992/0_1_0_0/BERT/Quad_230M	MGT_X1Y25/RX MGT_X1Y25/TX 16:000 Gbps	7.924E14	OEO	12025-15	Read	PRES 7-58		PR057-18				0.00 00 000000		250 10 (1100	
localhost3121/nlinx_tdDigitent/2102518439920_1_0_0/IBERT/Quad_230/M	MGT_X1Y26/RX MGT_X1Y26/TX 18.000 Gbps	7.924E14	0E0	1.262E-15	Reset	PRBS 7-bit	~	PRBS 7-bit	~	0.00 dB (00000)	~	0.00 dB (00000)	~	950 ml/ (1100	
localhost3121/nlinx_tcfDiglent/210251843992/0_1_0_0/IBERT/Quad_230/IL.	MGT_X1Y27/RX MGT_X1Y27/TX 15.983 Gbps	7.924E14	0E0	1.262E-15	Reset	PRBS 7-bit		PRBS 7-bit	¥	0.00 dB (00000)	~	0.00 dB (00000)	~	950 mV (1100	
localhost3121/kilinx_tdfDigilent210251843992/0_1_0_0/IBERT/Quad_231/M.	MGT_X1V28/RX MGT_X1V28/TX 15.009 Gbps	7.924E14	0E0	1.262E-15	Reset	PRBS 7-bit		PRBS 7-bit	~	0.00 dB (00000)	~	0.00 dB (00000)	~	950 ml/ (1100	
Iocalhost.3121/elim_tclDigilent/210251843992/0_1_0_04BERT/Quad_2314L. Iocalhost.3121/elim_tclDigilent/210251843992/0_1_0_04BERT/Quad_1274L.	MGT_X1Y29/RX MGT_X1Y29/TX 15.091 Gbps MGT_X0Y13/RX MGT_X0Y13/TX No Link	7.924E14 7.924E14	0E0	1.262E-15	Reset	PRBS 7-bit PRBS 7-bit		PRBS 7-bit PRBS 7-bit	~	0.00 dB (00000) 0.00 dB (00000)	~	0.00 dB (00000)	~	950 ml/ (1100	
localhost 3121/vilini_ctclpient/210251843992/0_1_0_0/BERT/Cuad_12/ML	MGT_X1Y30/RX MGT_X1Y30/TX 15.003 Gbps	7.924E14	0E0	1.262E-15	Reset	PRBS 7-bit		PRBS 7-bit		0.00 dB (00000)	~	0.00 dB (00000)	~	950 ml/ (1100	
localhost.3121/vilinx_tdDigitent/210251843992/0_1_0_0/IBERT/Quad_231/M	MGT_X1Y31/RX MGT_X1Y31/TX 16.000 Gbps	7.924E14	0E0	1.262E-15	Reset	PRBS 7-bit	v	PR8S 7-bit	*	0.00 dB (00000)	~	0.00 dB (00000)	~	950 ml/ (1100	
localhost3121/ulinx_tcfDiglent/210251843992/0_1_0_0/IBERT/Quad_232/IL.	MGT_X1Y32/RX MGT_X1Y32/TX 15.003 Gbps	7.924E14	0E0	1.262E-15	Reset	PRBS 7-bit		PRBS 7-bit	~	0.00 dB (00000)	~	0.00 dB (00000)	~	950 mV (1100	
localhost 3121/silins_tdlDigilent/210251843992/0_1_0_048ERT/Quad_232M	MGT_X1Y33/RX MGT_X1Y33/TX 16.000 Gbps MGT_X1Y34/RX MGT_X1Y34/TX 16.000 Gbps	7.924E14 7.924E14	0E0	1.262E-15	Reset	PRBS 7-bit PRBS 7-bit		PRBS 7-bit PRBS 7-bit	*	0.00 dB (00000)	~	0.00 dB (00000)	×	950 mV (1100 950 mV (1100	
localhost.3121/klinx_htlDigitent/210251843992/0_1_0_048ERT/Quad_232/M localhost.3121/klinx_htlDigitent/210251843992/0_1_0_048ERT/Quad_232/M	MGT_X1Y35/RX MGT_X1Y35/TX 15:000 Gbps	7.924E14	0E0 0E0	1.262E-15	Reset Reset	PRBS 7-68		PRBS 7-bit	~	0.00 dB (00000)	~	0.00 dB (00000)	~	950 mV (1100	
localhost 3121/vilinx_tdDigitent/210251843992/0_1_0_0/IBERT/Quad_233/M	MGT_X1Y36/RX MGT_X1Y36/TX 16.000 Gbps	7.924E14	OEO	1.262E-15	Reset	PRBS 7-bit		PRBS 7-bit	~	0.00 dB (00000)	v	(00000) Bb 00.0	~	950 ml/ (1100	
localhost.3121/niinu_tcfDigilent/210251843992/0_1_0_0/IBERT/Quad_233/M.	MGT_X1Y37/RX MGT_X1Y37/TX 16.027 Gbps	7.924E14	0E0	1.262E-15	Reset	PRBS 7-bit		PR8S 7-bit	×	0.00 dB (00000)	~	0.00 dB (00000)	~	950 mV (1100	
localhost3121mlms_tdfDiglent/2102518439920_1_0_048ERT/Quad_2334L	MGT_X1Y38/RX MGT_X1Y38/TX 16.009 Gbps	7.924E14	0E0	1.262E-15	Reset	PRBS 7-bit		PRBS 7-bit	٠	0.00 dB (00000)	~	0.00 dB (00000)	×	950 mV (1100	
localhost 3121/kilinx_tdtDigiten/210251843992/0_1_0_018ERT/Quad_233M localhost 3121/kilinx_tdtDigiten/210251843992/0_1_0_018ERT/Quad_127M	MGT_X1Y39RX MGT_X1Y39TX 15.952 Gbps MGT_X0Y14RX MGT_X0Y14TX 15.000 Gbps	7.924E14 7.924E14	0E0 0E0	1.262E-15	Reset	PRBS 7-bit PRBS 7-bit		PRBS 7-bit PRBS 7-bit	~	0.00 dB (00000) 0.00 dB (00000)	~	0.00 dB (00000) 0.00 dB (00000)	~	950 mV (1100 950 mV (1100	
localhost.3121xilinr_tdtDigilent/210251843992/0_1_0_018ERT/Quad_127/M	MGT_X0Y15/RX MGT_X0Y15/TX 16 000 Gbps	7.924E14	OEO	1.262E-15	Reset	PRBS 7-bit		PRBS 7-bit	~	0.00 dB (00000)	v	0.00 dB (00000)	~	950 mV (1100	
localhost 3121/vilinx_tdfDigitent/210251843992/0_1_0_0/IBERT/Quad_128/M	MGT_X0Y16/RX MGT_X0Y16/TX 16.003 Gbps	7.924E14	OEO	1.262E-15	Reset	PRBS 7-bit		PRBS 7-bit	~	0.00 dB (00000)	~	0.00 dB (00000)	~	950 ml/ (1100	
localhost3121/elinx td/Digitent/210251843992/0_1_0_0/BERT/Quad_128/M	MGT X0Y17/RX MGT X0Y17/TX 16 000 Gbps	7.924E14	OEO	1.262E-15	Reset	PRBS 7-bit	~	PRBS 7-bit	~	0.00 dB (00000)	~	0.00 dB (00000)		950 mi/ (1100	
inclaiments in initial coordigations for states of a constrained and include				L'EDER-10 [	PODAR								-		
HIP_1 (60)				ĺ	Reset	PRBS 7-bit	Ý	PRBS 7-bit	v	0.00 dB (00000)	v	0.00 dB (00000)	~	850 mV (1100	
HIP_1 (60) localhost.3121xilinx_tdfDigilent/210251843992/1_1_0_0/IBERT/Quad_120/H	MGT_X0YBRX MGT_X0YB/TX 16.000 Gbps	7.922E14	OEO	1.262E-15	Reset Reset	PRBS 7-bit PRBS 7-bit	* *	PRBS 7-bit PRBS 7-bit	¥	0.00 dB (00000) 0.00 dB (00000)	~ ~	0.00 dB (00000)	2 2 3	950 mV (1100 950 mV (1100	
HB <sup>*</sup> _1 (50) localhost 3121 Milini_totDigitent/21025184399211_1_0_04BERT/Quad_12641 localhost 3121 Milini_totDigitent/21025184399211_1_0_04BERT/Quad_12641	MGT_X0YB/RX MGT_X0Y9/TX 15.009 Gbps	7.922E14	0E0 0E0	1.262E-15 [ 1.262E-15 [	Reset Reset Reset	PRBS 7-bit PRBS 7-bit PRBS 7-bit	* *	PR85 7-bit PR85 7-bit PR85 7-bit	¥	0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000)		0.00 dB (00000) 0.00 dB (00000)		950 mV (1100 950 mV (1100 950 mV (1100	
HIP_1 (60) Isoathad 121 kikins_iddDigHent210251843982/1_1_0_0HBERT/Duiad_126M. Isoathad13121 kikins_iddDigHent210251843982/1_1_0_0HBERT/Duiad_126M. Isoathad13121 kikins_iddDigHent210251843982/1_1_0_0HBERT/Duiad_126M.			OEO	1.262E-15	Reset Reset	PRBS 7-bit PRBS 7-bit		PRBS 7-bit PRBS 7-bit	> > >	0.00 dB (00000) 0.00 dB (00000)		0.00 dB (00000)		950 mV (1100 950 mV (1100	
HB <sup>*</sup> _1 (50) localhost 3121 Milini_totDigitent/21025184399211_1_0_04BERT/Quad_12641 localhost 3121 Milini_totDigitent/21025184399211_1_0_04BERT/Quad_12641	MGT_X0Y8RX_MGT_X0Y9RX_16.009 Gbps MGT_X0Y18RX_MGT_X0Y18RX_16.009 Gbps MGT_X0Y19RX_MGT_X0Y19RX_16.008 Gbps MGT_X0Y28RX_MGT_X0Y28RX_16.014 Gbps	7.922E14 7.922E14	0E0 0E0 0E0	1.262E-15 [ 1.262E-15 [ 1.262E-15 [ 1.262E-15 [ 1.262E-15 ]	Reset Reset Reset	PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit		PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit	> > >	0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000)		0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000)		950 mV (1100 950 mV (1100 950 mV (1100 950 mV (1100	
(#):100         (#):100           (#):100         (#):000           (added)1210000         (#):000           (#):000         (#):000           (#):000         (#):000           (#):000         (#):000           (#):000         (#):000           (#):000         (#):000           (#):000         (#):000           (#):000         (#):000           (#):000         (#):000           (#):000         (#):000           (#):000         (#):000           (#):000         (#):000           (#):000         (#):000           (#):000         (#):000           (#):000         (#):000           (#):000         (#):000           (#):0000	MGT_X019/RX         MGT_X019/RX         16.009 Geps           MGT_X0119/RX         MGT_X0119/RX         16.009 Geps           MGT_X0119/RX         MGT_X0119/RX         16.009 Geps           MGT_X0119/RX         MGT_X0119/RX         16.009 Geps           MGT_X0119/RX         MGT_X0119/RX         16.014 Geps           MGT_X0129/RX         MGT_X0129/RX         16.014 Geps           MGT_X0129/RX         MGT_X0129/RX         15.991 Geps	7.922E14 7.922E14 7.922E14	0E0 0E0 0E0 0E0 0E0 0E0 0E0	1.262E-15 [ 1.262E-15 [ 1.262E-15 [ 1.262E-15 ] 1.262E-15 [ 1.262E-15 ]	Reset Roset Roset Roset Roset Roset Roset	PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit		PR85 7-bit		0 00 dB (00000) 0 00 dB (00000)		0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000)		950 mV (1100 950 mV (1100 950 mV (1100 950 mV (1100 950 mV (1100 950 mV (1100 950 mV (1100	
Imp. 1000           Context 121 Vision, Latorylevs21020 14.039271, L.G., OMERTODAK, 12041.           Context 121 Vision, Latorylevs21020 14.039271, L.G., OMERTODAK, 12041.           Context 121 Vision, Latorylevs210 14.039271, L.G., OMERTODAK, 13041.	MGT_X0Y9/RX         MGT_X0Y9/RX         16.009 Geps           MGT_X0Y18/RX         MGT_X0Y19/RX         16.000 Geps           MGT_X0Y18/RX         MGT_X0Y19/RX         16.000 Geps           MGT_X0Y18/RX         MGT_X0Y19/RX         16.000 Geps           MGT_X0Y28/RX         MGT_X0Y28/RX         16.014 Geps           MGT_X0Y28/RX         MGT_X0Y28/RX         15.901 Geps           MGT_X0Y28/RX         MGT_X0Y20/RX         15.901 Geps	7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14	0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0	1.262E-15 [ 1.262E-15 [ 1.262E-15 [ 1.262E-15 [ 1.262E-15 [ 1.262E-15 [ 1.262E-15 [ 1.262E-16 [	Reset Reset Reset Reset Reset Reset Reset	PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit		PR85 7-bit		0.00 dB (00000) 0.00 dB (00000)		0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000)		950 mV (1100 950 mV (1100 950 mV (1100 950 mV (1100 950 mV (1100 950 mV (1100 950 mV (1100	
Big (2016)         State (2017)         State (2017) <th>MGT_J0Y9RX_MGT_J0Y9RX_15.009 Gbps MGT_J0Y9RX.MGT_J0Y9RX15.009 Gbps MGT_J0Y9RX.MGT_J0Y9RX15.009 Gbps MGT_J0Y2BRX.MGT_J0Y2RX15.15.919 Gbps MGT_J0Y2BRX.MGT_J0Y2RX15.15.991 Gbps MGT_J0Y3RX15X.J0Y2GX75.15.909 Gbps MGT_J0Y3RX15X.MGT_J0Y2GX75.15.009 Gbps</th> <th>7 922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14</th> <th>0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0</th> <th>1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15</th> <th>Reset Reset Reset Reset Reset Reset Reset Reset Reset</th> <th>PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit</th> <th></th> <th>PR857-bit           PR857-bit           PR857-bit           PR857-bit           PR857-bit           PR857-bit           PR857-bit           PR857-bit           PR857-bit           PR857-bit           PR857-bit</th> <th></th> <th>0.00 dB (00000) 0.00 dB (00000)</th> <th></th> <th>0.00 dB (00000) 0.00 dB (00000)</th> <th></th> <th>950 mV (1100 950 mV (1100</th> <th></th>	MGT_J0Y9RX_MGT_J0Y9RX_15.009 Gbps MGT_J0Y9RX.MGT_J0Y9RX15.009 Gbps MGT_J0Y9RX.MGT_J0Y9RX15.009 Gbps MGT_J0Y2BRX.MGT_J0Y2RX15.15.919 Gbps MGT_J0Y2BRX.MGT_J0Y2RX15.15.991 Gbps MGT_J0Y3RX15X.J0Y2GX75.15.909 Gbps MGT_J0Y3RX15X.MGT_J0Y2GX75.15.009 Gbps	7 922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14	0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0	1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15	Reset Reset Reset Reset Reset Reset Reset Reset Reset	PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit		PR857-bit		0.00 dB (00000) 0.00 dB (00000)		0.00 dB (00000) 0.00 dB (00000)		950 mV (1100 950 mV (1100	
Imp. 1000           Context 121 Vision, Latorylevs21020 14.039271, L.G., OMERTODAK, 12041.           Context 121 Vision, Latorylevs21020 14.039271, L.G., OMERTODAK, 12041.           Context 121 Vision, Latorylevs210 14.039271, L.G., OMERTODAK, 13041.	MGT_X0Y9/RX         MGT_X0Y9/RX         16.009 Geps           MGT_X0Y18/RX         MGT_X0Y19/RX         16.000 Geps           MGT_X0Y18/RX         MGT_X0Y19/RX         16.000 Geps           MGT_X0Y18/RX         MGT_X0Y19/RX         16.000 Geps           MGT_X0Y28/RX         MGT_X0Y28/RX         16.014 Geps           MGT_X0Y28/RX         MGT_X0Y28/RX         15.901 Geps           MGT_X0Y28/RX         MGT_X0Y20/RX         15.901 Geps	7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14	0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0	1.262E-15 [ 1.262E-15 [ 1.262E-15 [ 1.262E-15 [ 1.262E-15 [ 1.262E-15 [ 1.262E-15 [ 1.262E-16 [	Reset Reset Reset Reset Reset Reset Reset	PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit PRBS 7-bit		PR85 7-bit		0.00 dB (00000) 0.00 dB (00000)		0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000) 0.00 dB (00000)		950 mV (1100 950 mV (1100 950 mV (1100 950 mV (1100 950 mV (1100 950 mV (1100 950 mV (1100	
(# 169     (# 169     (% 169     )     (% 169	MGT_20Y9RX_MGT_20Y9RY_15_009 Gbps MGT_20Y98RX_MGT_20Y9RY_16_009 Gbps MGT_20Y98RX_MGT_20Y9RY_15_009 Gbps MGT_20Y28RX_MGT_20Y28RY_15_014 Gbps MGT_20Y28RX_MGT_20Y28RY_15_014 Gbps MGT_20Y38RX_MGT_20Y37RY_16_009 Gbps MGT_20Y32RX_MGT_20Y37RY_16_009 Gbps	7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14	0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0	1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15	Reset Roset Reset Reset Reset Reset Reset Reset Reset	PRBS 7-68 PRBS 7-68 PRBS 7-68 PRBS 7-68 PRBS 7-68 PRBS 7-68 PRBS 7-68 PRBS 7-68 PRBS 7-68 PRBS 7-68	• • • • • • • • • •	PR85 7-58		0.00 dB (00000) 0.00 dB (00000)	c < c < c < c < c < c < c < c < c < c <	0.00 dB (00000) 0.00 dB (00000)		800 mV (1100 950 mV (1100	
(1)         (2)           (2)         (3)         (2)	Not_JONNEX         Mot_JONNEX         80.000 Cpcs           Not_JONNEX         Not_JONNEX         80.000 Cpcs	7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.928E14 7.928E14 7.928E14 7.928E14	0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0	1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.261E-15 1.261E-15 1.261E-15 1.261E-15	Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset	PRBS 7-68 PRBS 7-68	• • • • • • • • • • • •	PR05 7-bit		0.00 dB (00100) 0.00 dB (00100)		0.00 dB (00000) 0.00 dB (00000)		BS0 mW (1100           950 mW (1100	
(a) (18)     (b) (18)     (c) (18)		7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.928E14 7.928E14 7.928E14 7.928E14 7.928E14	0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0	1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.201E-15 1.201E-15 1.201E-15 1.201E-15 1.201E-15 1.201E-15	Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset	PRBS 7-68 PRBS 7-68	• • • • • • • • • • • • • • • • • • •	PR05 7-bit		0.00 dB (00100) 0.00 dB (00100)		0.00 dB (00000) 0.00 dB (00000)		850 mW/(1100 950 mW/(1100	
(1)         (2)           (2)	Not_JONNEX         Mot_JONNEX         80.000 Cpcs           Not_JONNEX         Not_JONNEX         80.000 Cpcs	7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.928E14 7.928E14 7.928E14 7.928E14	0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0	1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.261E-15 1.261E-15 1.261E-15 1.261E-15	Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset	PRBS 7-68 PRBS 7-68		PR05 7-bit		0.00 dB (00100) 0.00 dB (00100)		0.00 dB (00000) 0.00 dB (00000)		BS0 mW (1100           950 mW (1100	
(a) (18)     (b) (18)     (c) (18)		7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.928E14 7.928E14 7.928E14 7.928E14 7.928E14	0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0	1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.261E-15 1.261E-15 1.261E-15 1.261E-15 1.261E-15 1.261E-15 1.261E-15	Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset	PR03 7-bit		PRBS 7-bit		0.00 dB (00100) 0.00 dB (00100)		0.00 dB (00000) 0.00 dB (00000)		800 mW/(1100 950 mW/(1100	
(a) Calibra		7 922E14 7 922E14	0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0	1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.20E-15 1.20EE-15 1	Reset Roset Res Reset Res Reset Rese	PR03 7-bit PR03 7-bit		PR05 7-bit		0 00 48 (00400) 0 00 48 (00400)		0.00 dB (00000) 0.00 dB (00000)		BSG mik/t1100           SSG mik/t100	
(m)         (m)           (m)		7 922E14 7 922E14	0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0	1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.201E-15	Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset Reset	PRBS 7-bit PRBS 7-bit		PR05 7-34 PR05 7-34		0 00 48 (00100) 0 00 48 (00100)		0.00 dB (00000) 0.00 dB (00000)		BS0 mk/(1100           950 mk/(1100	
(a) Calibra		7 922E14 7 922E14	0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0	1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.20E-15 1.20EE-15 1	Reset Roset Res Reset Res Reset Rese	PR03 7-bit PR03 7-bit		PR05 7-bit		0 00 48 (00400) 0 00 48 (00400)		0.00 dB (00000) 0.00 dB (00000)		BSG mik/t1100           SSG mik/t100	
(m)         (m)           (m)		7 922E14 7 922E14	0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0	1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.202E-15 1.201E-15	Resst Resst	PRBS 7-ait PRBS 7-ait		PR057-bit PR057-		Concerning (Section)     Concerning (Sect		0 00 48 (0000) 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		850 m/c/1100 950 m/c/1100	
(m)         (m)           (m)		7 922E14 7 922E14	0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0	1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.261E-15	Reast Rost Rost Rest Rest Rest Rest Rest Rest Rest Re	PR03 7-94 PR05 7-94 PR05 7-96 PR05 P		PH057-54 PH057-		0.00 481 (00000)         0.00 481 (00000)<		0 00 481 (9000) 0 0 491 (9000)		Bits mir/(1100           Side mir/(1100	
(1)         (2)           (2)		7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14 7.922E14	0E0	1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.261E-15	Resst	PR03 7-04 PR05 7-04	>         >	PH03-7-44 PH03-7-44		Control (Control (Contro) (Contro) (Control (Contro) (Contro) (Contro) (Contro) (Contro)		0.00 481 (99000) 0.00 481 (99		Biol mir/1106           Sidi mir/1106	
(1)         (2)           (2)		7 922E14 7 922E14	0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0 0E0	1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.262E-15 1.261E-15	Resst	PR037-34 PR037-34	>         >	PR057-34 PR0		0.00 481 (00000)         0.00 481 (00000)<		0 00 481 (9000) 0 0 491 (9000)		Bits mir/(1100           Side mir/(1100	
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### OFF-CHIP LINK IBERTS

- 120 simultaneous IBERTs
  - 16Gbps
  - 60 through fireflys, 60 over copper
  - Default settings
- With highlighted caveats, each link passed 8e14 bits
  - No errors
- 1board, 85Pb between FPGAs

### CARRIER TESTING

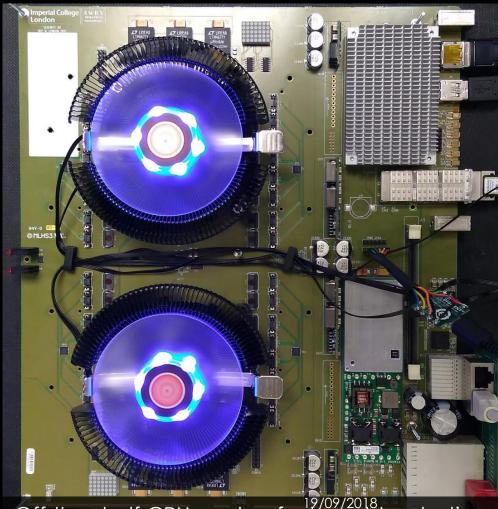
- Com-express & GBE
  - HD display-port, USB, SSD, Centos-7, GBE<sup>†</sup> all working
- Artix-7 Service FPGA
  - JTAG, Flash, Heartbeat LED, Clocks, PCIe to Com-express all working
- IPbus-over-PCle
- The existing MP7 I2C-over-Ipbus and JSM JTAG-over-IPbus infrastructure also work unchanged



### COMMUNICATION VIA PCIE

- JTAG to both KU115s via the Artix
  - Digilent USB-debugger via Artix GPIO
  - XVC-over-lpbus-over-PCle
  - Directly over lpbus
- Heartbeat LEDs
- Debug LED arrays
- Programming Flash
- PCIe & system clock

00:1f.3 SMBus: Intel Corporation Atom Processor E3800 Series SMBus Controller (rev 11) 01:00.0 Serial controller: Xilinx Corporation Device 7021 02:00.0 Serial controller: Xilinx Corporation Device 8031 03:00.0 Serial controller: Xilinx Corporation Device 8031 04:00.0 Ethernet controller: Intel Corporation I210 Gigabit Network Connection (rev 03) Andrew Rose, Imperior College London



Off-the-shelf CPU coolers for benchtop testing

### EMP FIRMWARE: EXAMPLE

- Many large Xilinx parts are now multi-die
  - Super Logic Region
  - How do algorithms developed in MP7 port to UltraScale?
- HT Track Trigger
  - Geometric Processor Component
  - Concern over inter SLR routes
  - Quickly port to KU115
  - VU9P or KU15P also available.
  - Only 20% of inter-die routes used.

