Compact Packaging and Liquid Cooling Technology for Exascale

Including Achievements from ExaNeSt and Concepts and Achievements from EuroEXA

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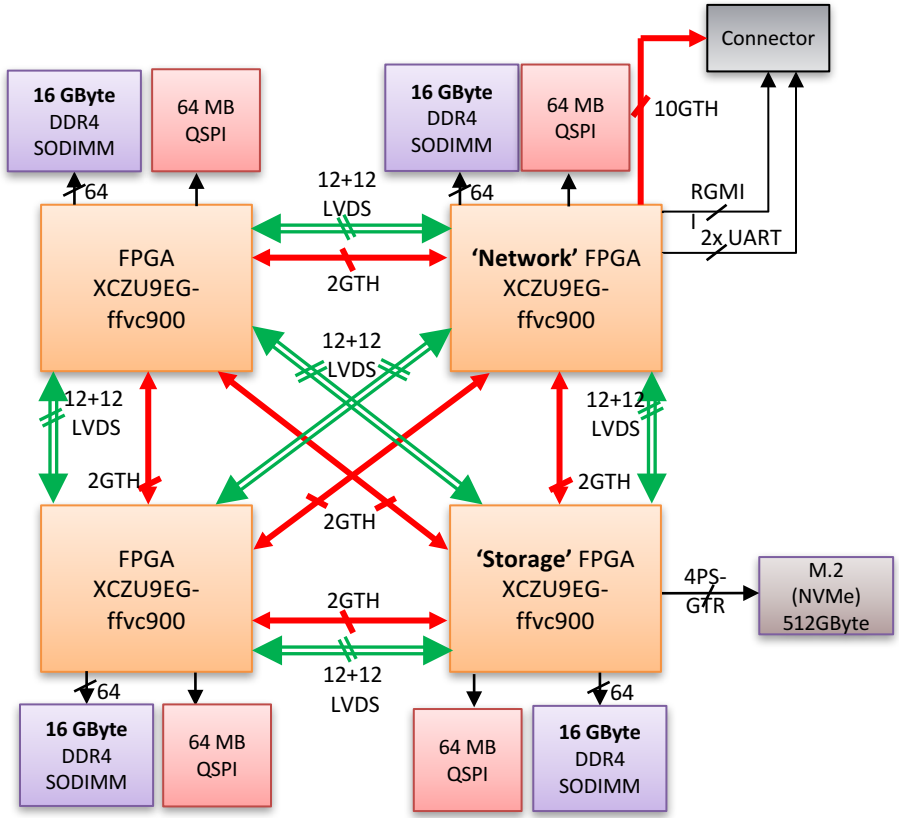
The QFDB architecture



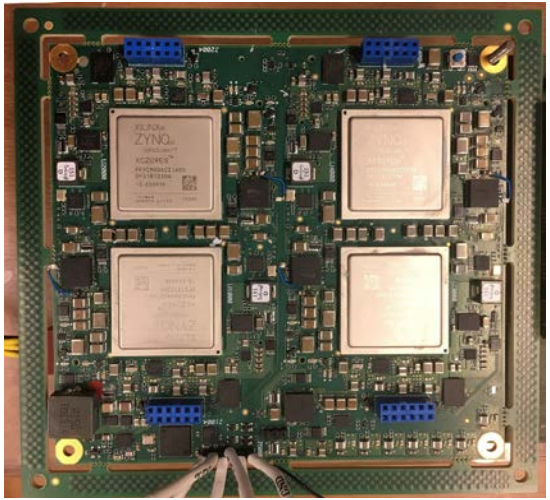
The QFDB implementation

Rev. A version

→DDR issue (erroneous swap)
→48V→12V regulator issue

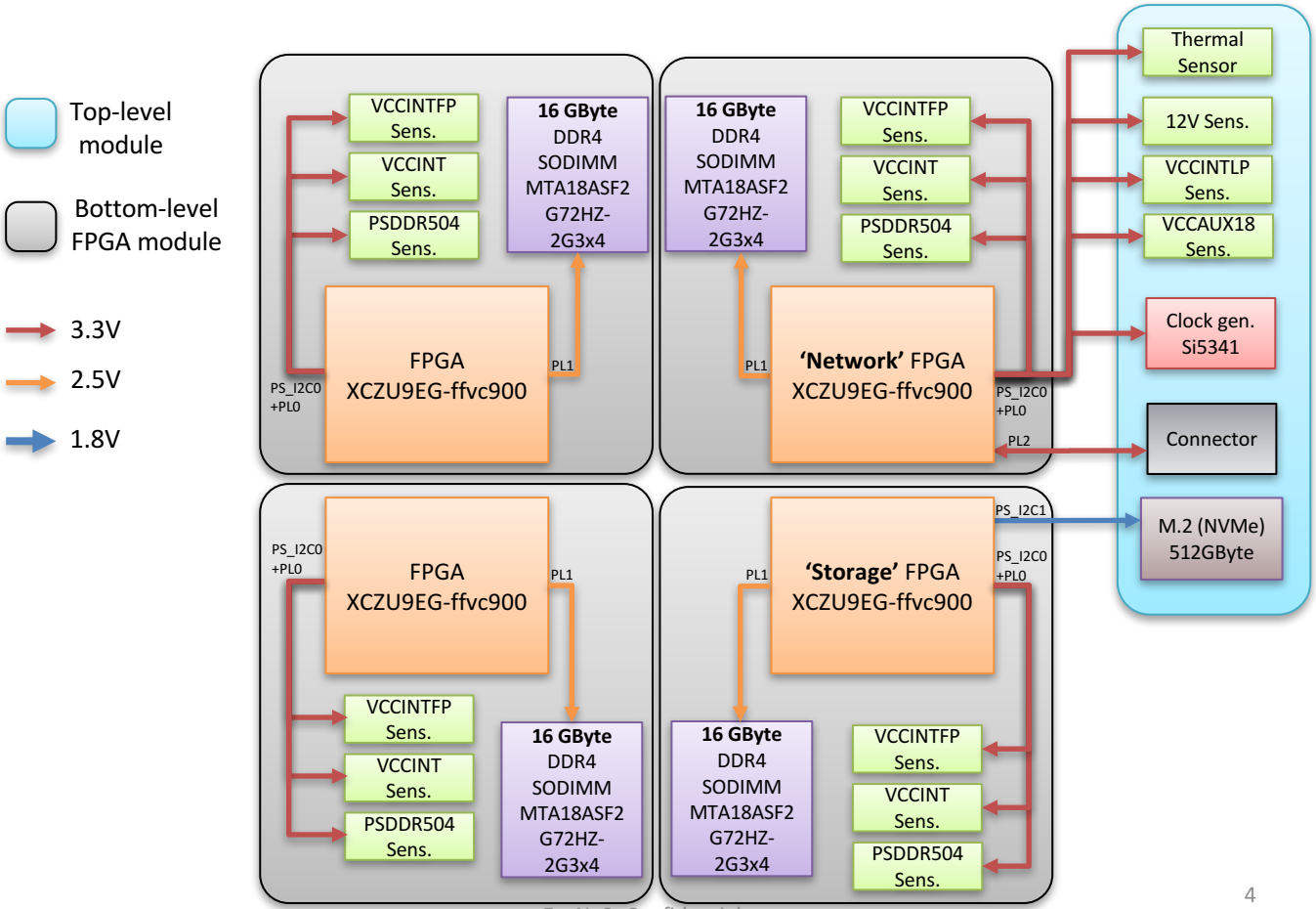
Rev. B version

→48V→12V regulator issue
→SSD (configuration) issue



Key facts	
Dimension	130 x 120 mm
Height	< 30 mm
PCB	16 layers, Megtron-6
Estimated TDP	100~120W

QFDB I2C Sensors network



Current QFDB Achievements

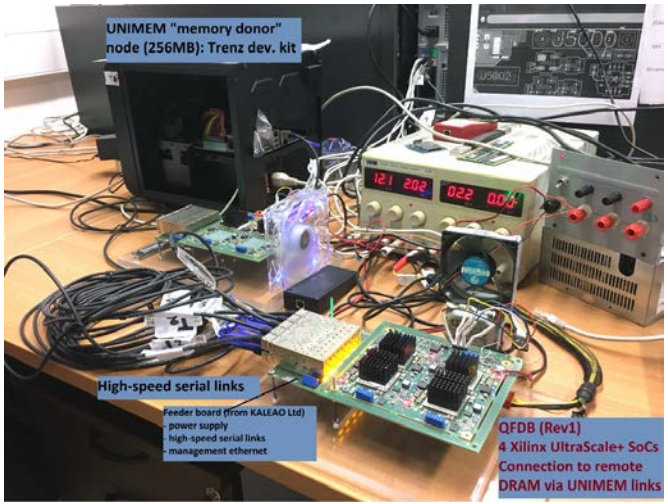
Feature	Status
Zynq functions	Validated individually,
DDR-RAM	Validated Linux runs with DDR4-2133 Bare-metal test pass with DDR4-2400
QSPI memories	Validated on Linux Minor issues with bare-metal
Gigabit Ethernet	Validated
LVDS links	Validated, ~5% of traces are problematic
I2C busses	Validated all but the M.2 device
UART links	Validated
Clock generators	Validated
M.2 Solid State Disk	Validated on Rev. A,

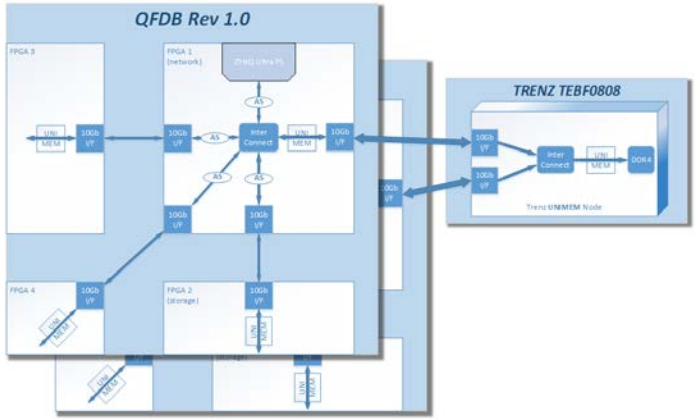
Remote RAM Linux setup

- We need Linux to validate board sub-systems:
  - PCIe, QSPI, Gigabit Ethernet
- Successful test of external RAM to boot.

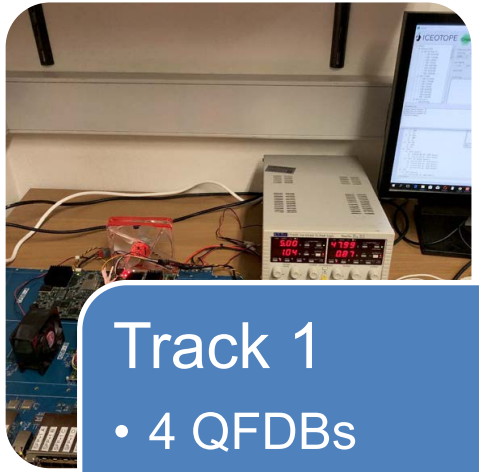
➔ Accessed memory from another board

➔ Forward memory access through Network FPGA





ExaNeSt Tracks



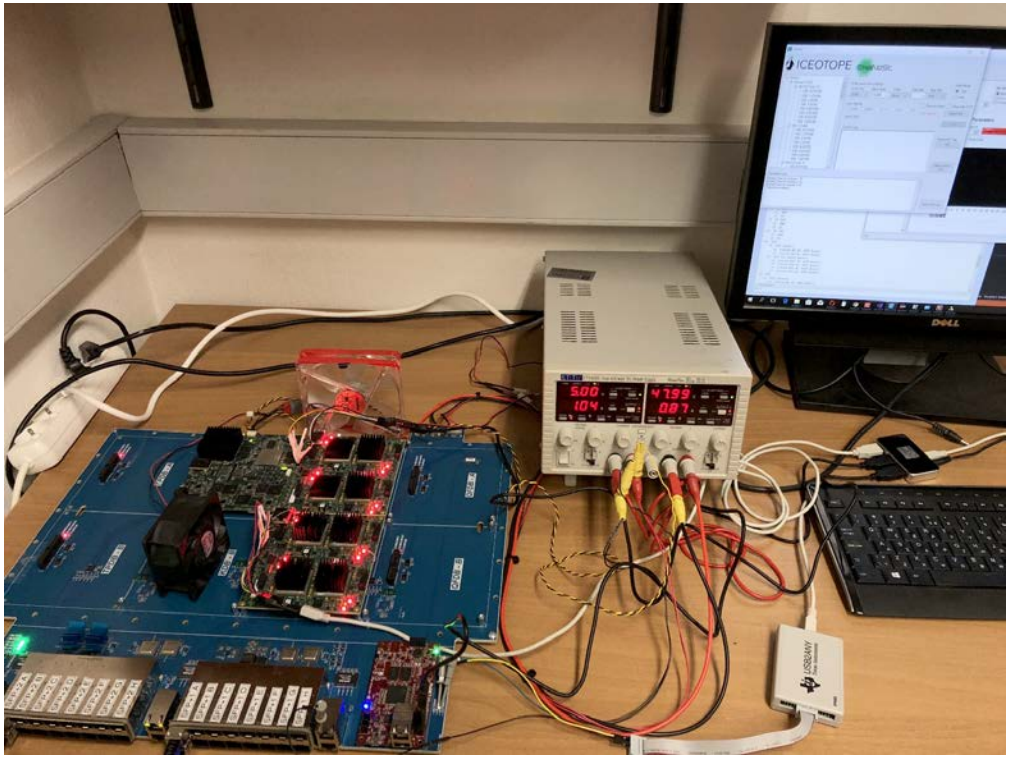
Track 1

- 4 QFDBs
- 800W Max.
- 1.5 per u (b2b)
- 45C Inlet
- Passive I/O

Track 2

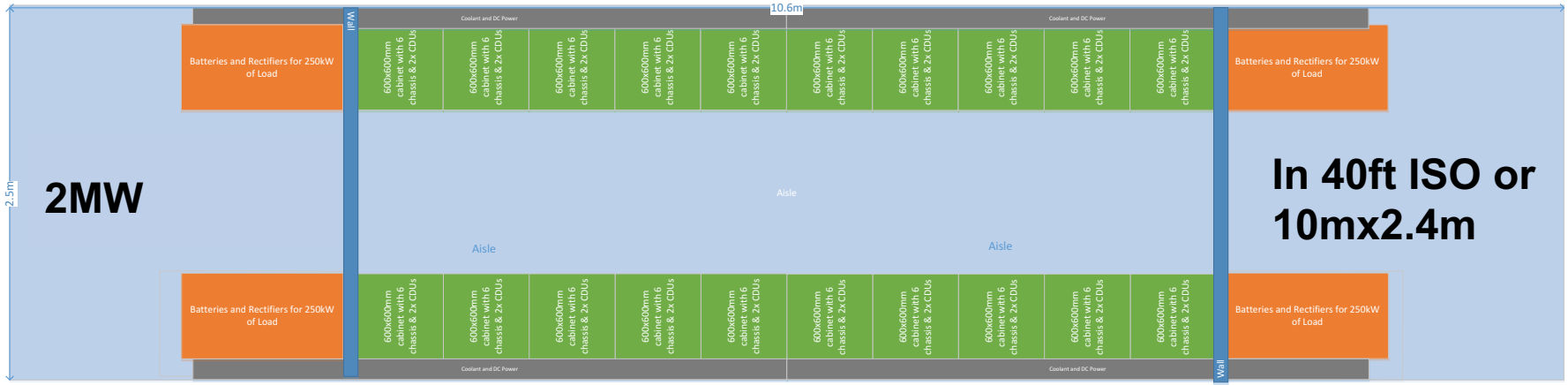
- 16 QFDBs
- 3.2kW Max
- 2 per u (b2b)
- 45C Inlet
- Onboard Switch

QFDB x Track-1 Mezzanine



EuroEXA Concepts

- Shipping Container Optimised Cabinets (2 rows)
- 2MW per shipping container
- Enables 3D stacking to minimise distances

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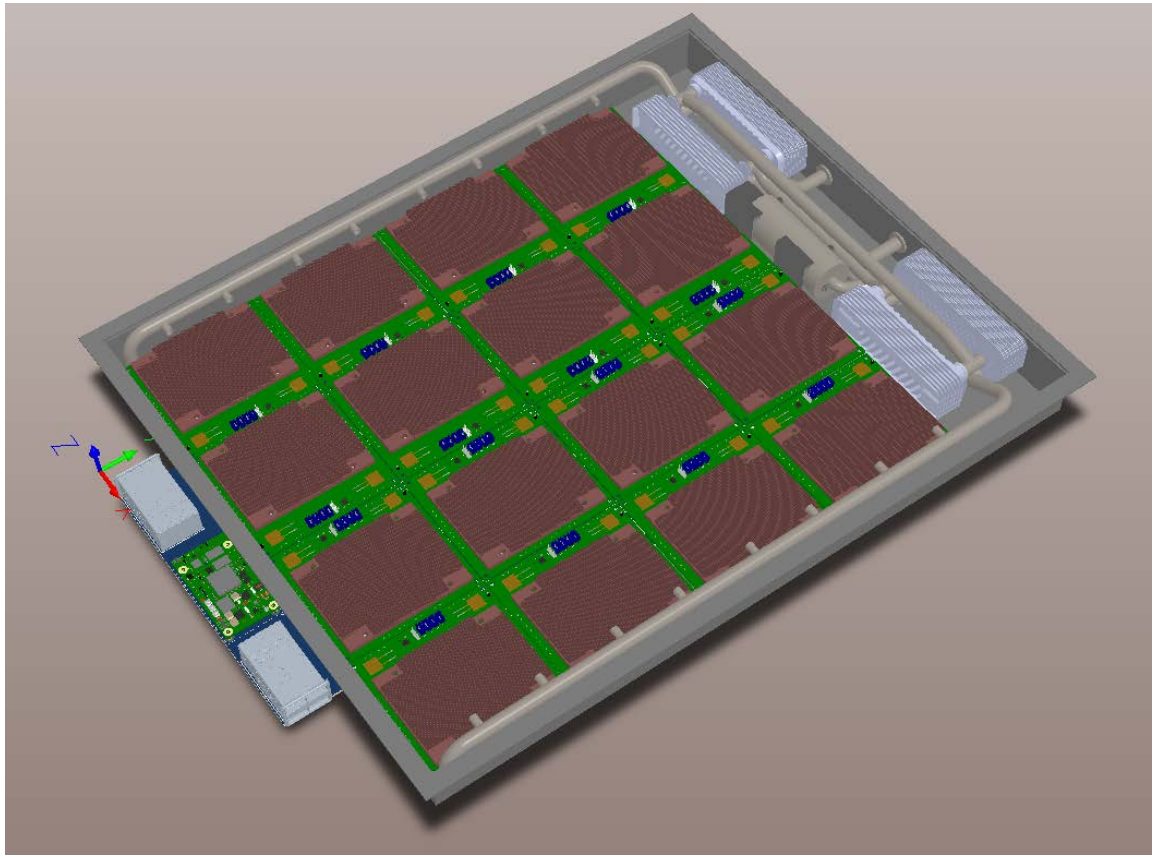
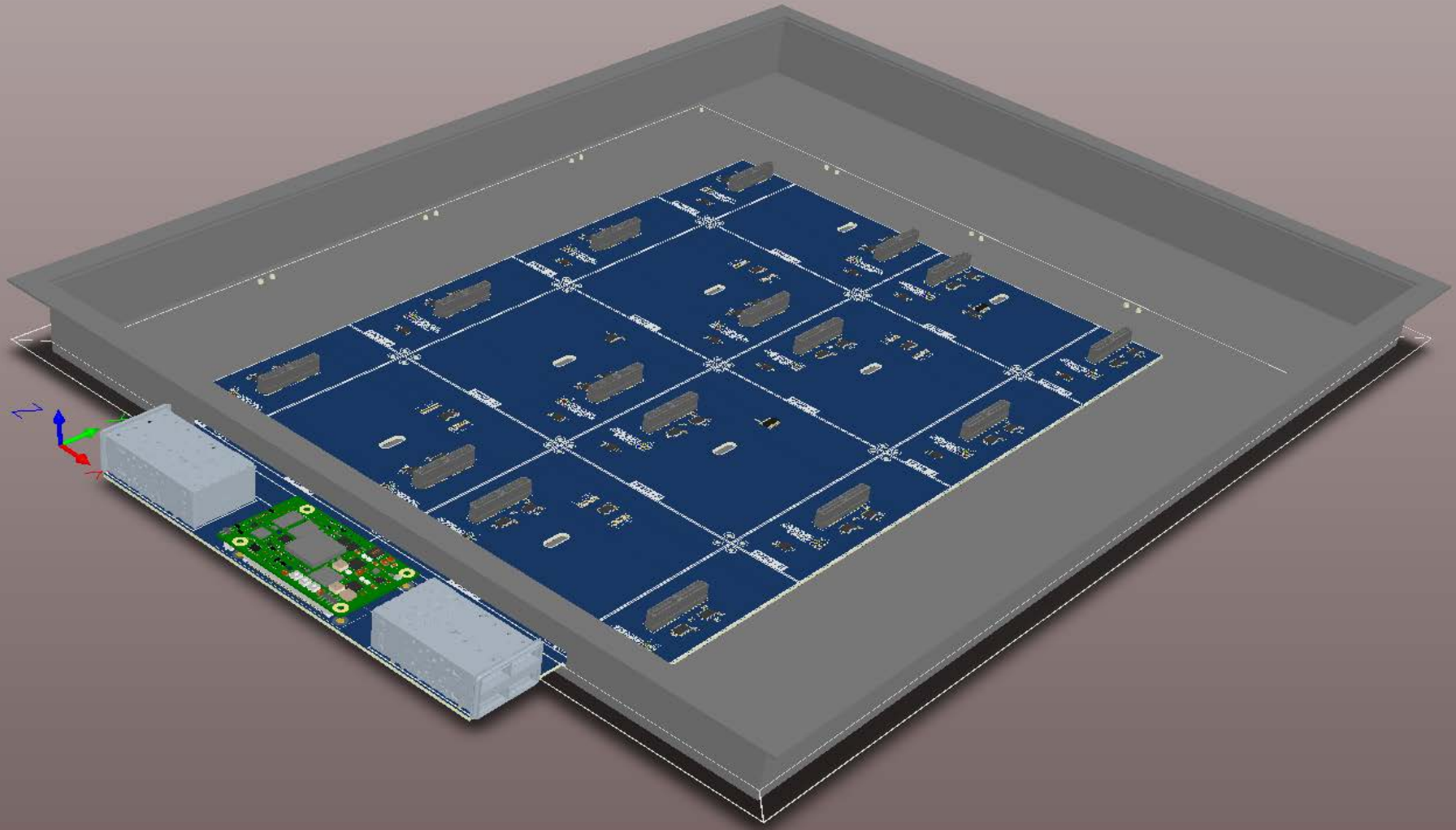
Advancing to Track 2

- >4x Thermal Improvement Required
- 7x Thermal Improvement Targetted
- Addition of an integrated high speed switch
- Large thermal and mechanical challenge

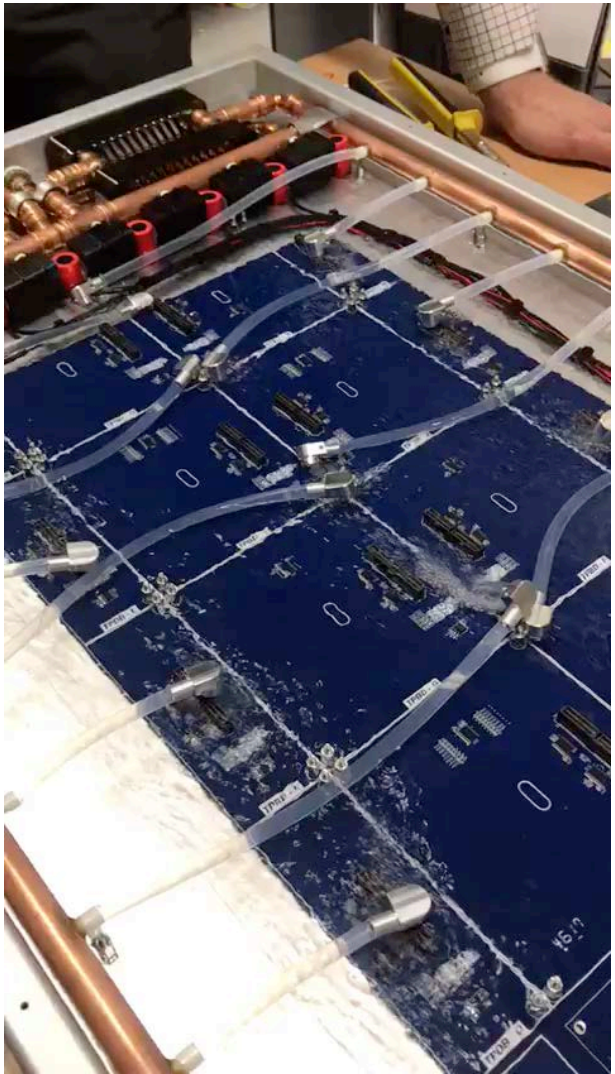
What This Means For Track 2



Key facts	
Dimension	21” Rack x 762mm Deep
Nodes	16 x QFDB (or Next Gen)
Height	1 O-u
PCB	Megtron-6
Estimated TDP	3.2kW
I/O (Uplink)	800Gb/s
I/O (Total)	2Tb/s



Tackling the 7x Cooling Challenge



Proving it will work!

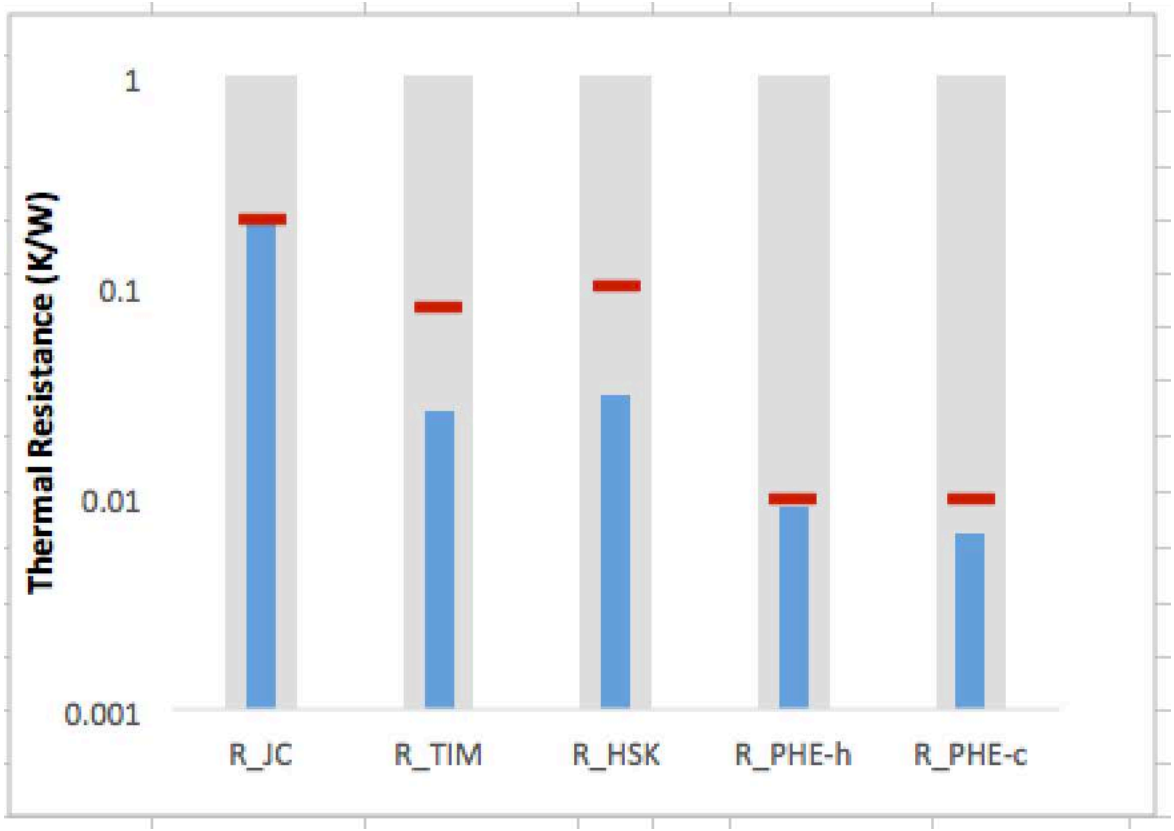
Scope

- Track 2 horizontal chassis
- Thermal proxy QFDBs x16, nominal TDP 200W (3.2kW overall)

- Critical conditions
  - Junction temperature < 100^{o}C
  - Maximum PC temperature < 70^{o}C

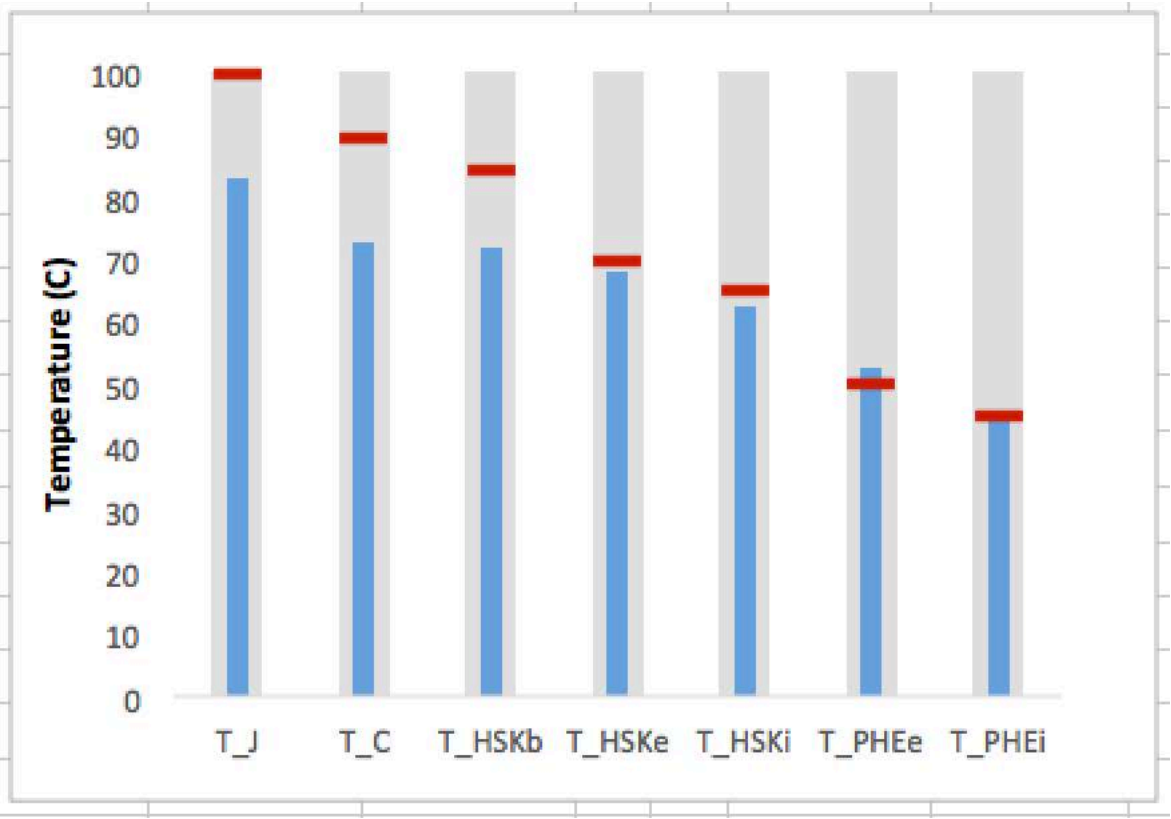
- Three tests defined
  - Critical SC inlet temperature
  - Critical TDP duty
  - Critical SC flow-rate

Proving it will work!



Results at 45C Inlet

Proving it will work!



Results at 45C Inlet

Thermal Validation Summary

Summary

- Based on stated nominal conditions The following critical conditions were determined
  - SC feed temperature is 47^{o}C
  - TDP load factor is 1.1 (1,084W)
  - SC flow-rate is 1.6

- In each case the Primary Coolant max temperature was found to be the limiting factor

- These findings still need further verification experimentally

Many Thanks
Please Connect at thecoolingguy.me

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