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Infrastructure and Operations

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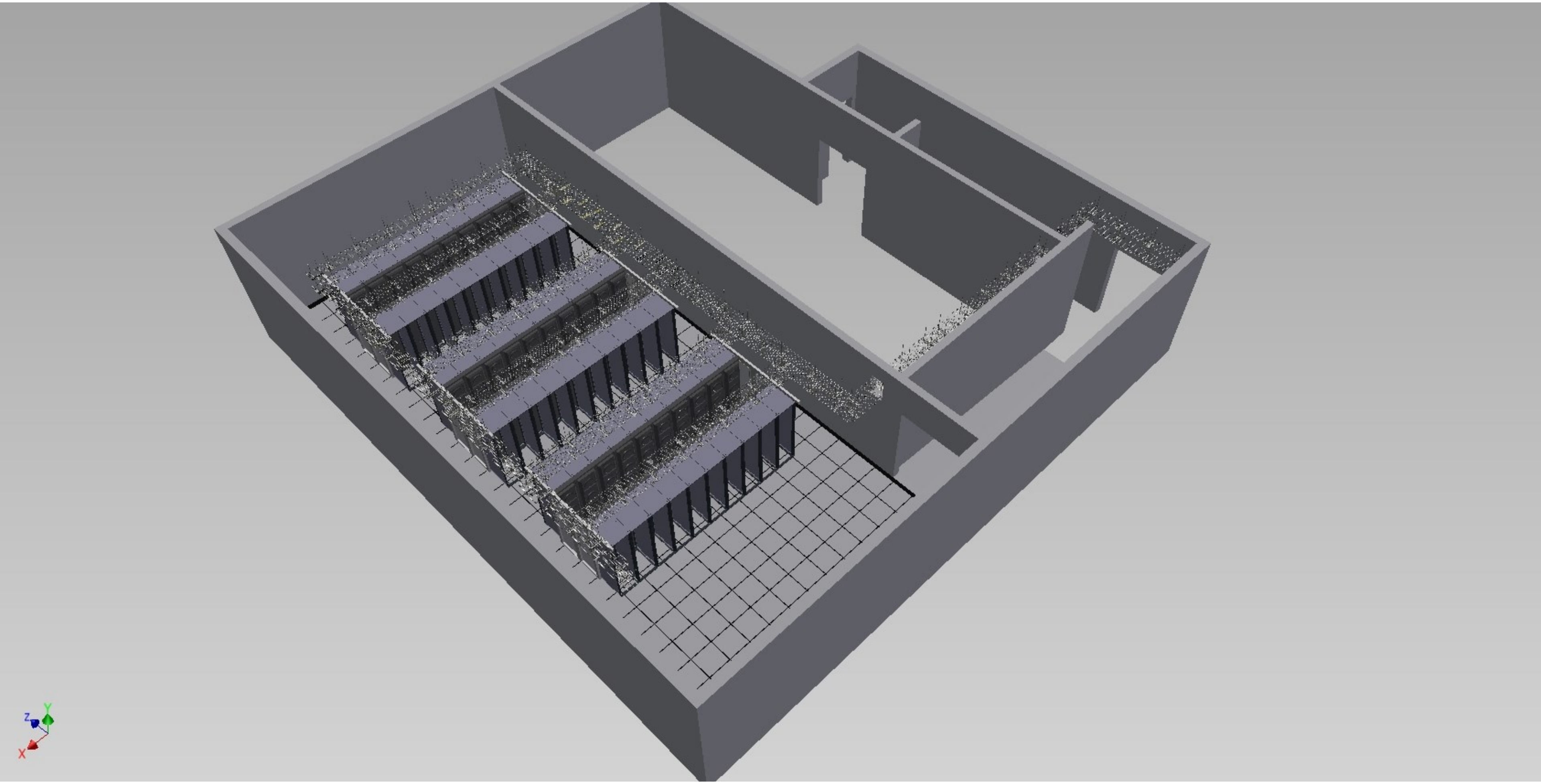
04/02/2019

Getting started

- Rack layout within CUC
- Rack types
- Cooling system
- Cable tray layout
- Coolant Pluming
- Local rack protection
- Rack PDU
- Optical Fibre Power Budgets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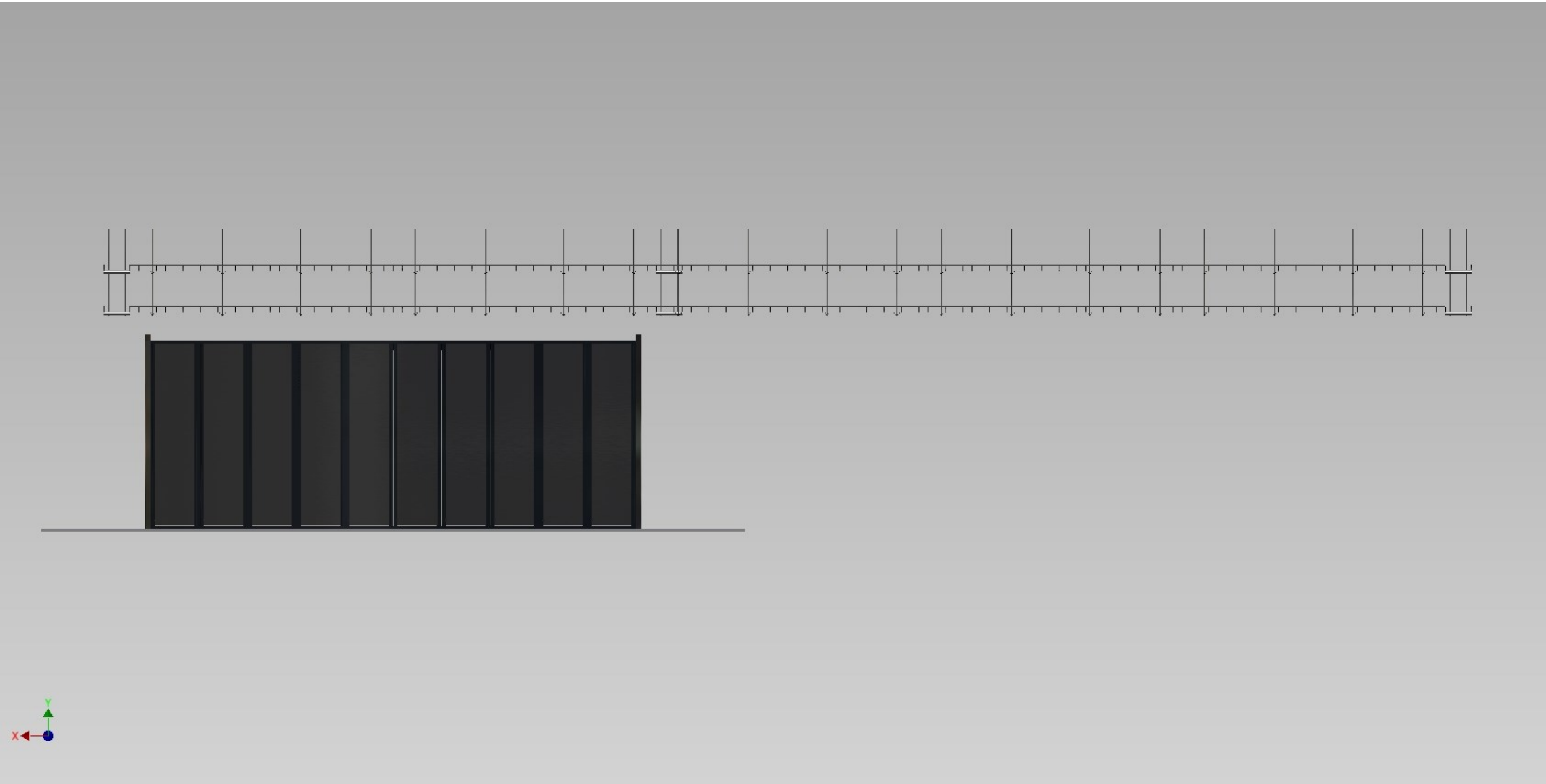
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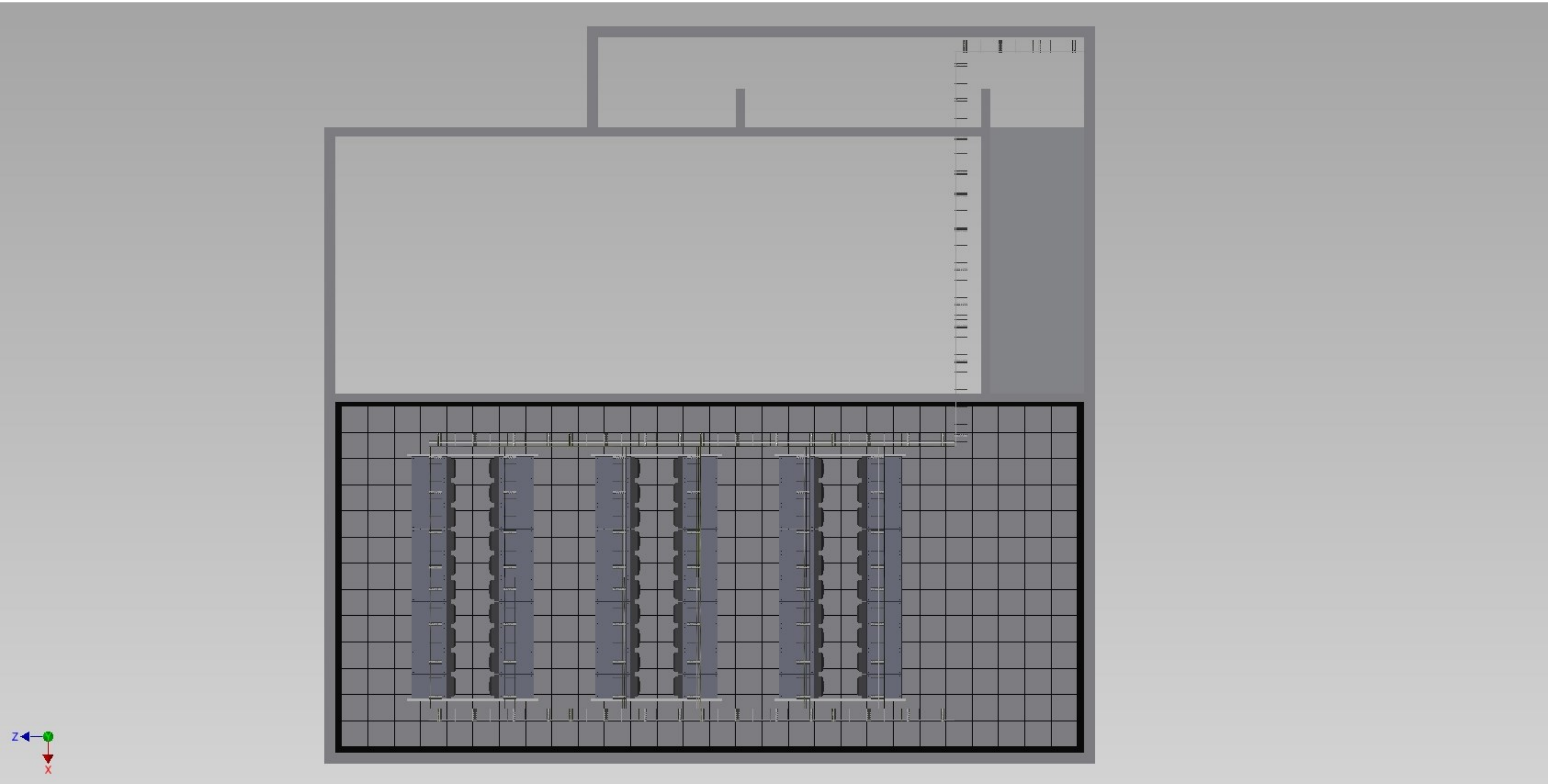

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Rack Model

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- Schroff Varistar are good quality and modular, have used them before
- Exact model will depend on rack contents, mechanical loads.

Rack Water Cooling

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- ADHX 35-6B active rear door heat exchanger from ServerCool.
- Nortek (ServerCool) are evaluating how to cool 60 racks at 10 Kw each using their system.

Water Systems

Current values from Arup

- Cooling water supply/return temperature = 66/76°F
- Cooling water flow rate = 275 gpm
- Experiment piping pressure drop = 20 psig

In Si units

- Cooling water supply/return temperature = 19 / 24.5 ºC
- Cooling water flow rate = 17.35 ls^{-1}

Water Systems

Cooling Capacity

- ΔT = 19/24.5 C = 5.5
- Flow rate = 17.35 ls^{-1}
- Heat capacity of water = 4200 J/C/Kg
- 4200*5.5*17.35 = 400785 J/s = 401 Kw

Electrical Power

- The transformer supplying the CUC is currently rated at 500 KVA
- This may go up as needs are understood.
- Probably wont go down.

Water Leak Detection

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InfraSensing water leak system

- Self contained water leak sensing
- Can alert to network via Simple Network Managed Protocol.
- Can be daisy chained but would prefer more units for greater granularity.
- Other sensors are available from the range which may prove useful. Temp, Humidity etc.
- SNMP could the basis of remote safety system, need to determine if it is rated for such.

NOT AN INTERLOCK, EARLY WARNING!!!!!!

Water Leak Interlock

Water Cooling

- Our water cooling system is a closed circuit cooled by other cooling circuits.
- A Number of methods available to determine if a bucket of water has sprung a leak.

Water Circuit

- I favour mass flow detection.
- What goes in must come back.
- Use this to determine if a sizable leak has occurred and drive a valve via PLC.

Power

- AP8970 PDU
- ~ 24 Amps per strip
- May need more than one per rack, depending on load.
- Remote access allows remote reboot of systems
- Has usual safety features.

Mains distribution in CUC

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- Mains Power network of CUC is a responsibility listed
- I have been unable to find anyone qualified to design a power network to US standard in the UK.
- I am able to specify locations and types of outlets but I am limited to that, circuit breakers and load balancing will have to be Specified by some qualified (US?).

UPS system

- A choice of two approaches.
- Use the in rack systems and limit it to only systems that are mission critical.
- Use a network one that will keep every thing afloat while shut down occurs.
- The decision will affect the operational model of the CUC for its life time.

Local Rack Protection

- Remote power down is handled by the PDU, all is required is sensing and fault tolerant infrastructure to support it.
- In most risk cases this is all that is required.
- Local Fire detection and suppression may be of benefit for certain racks within the CUC.

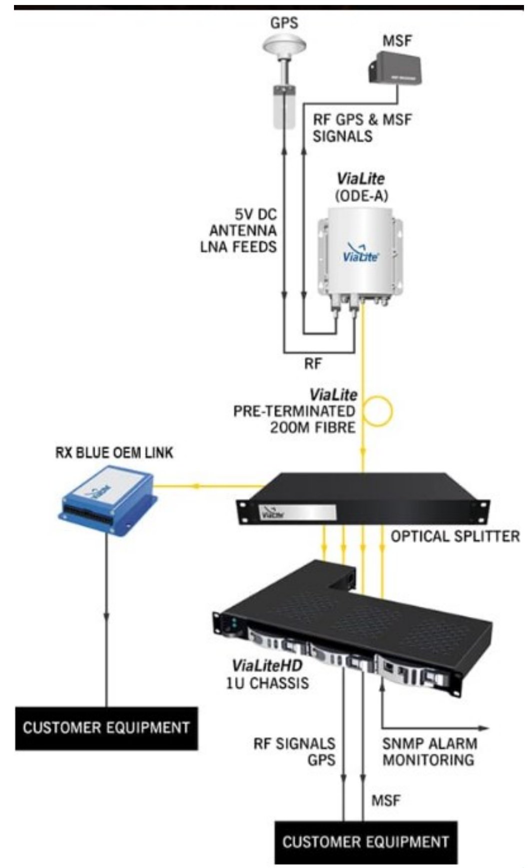
Local Rack Protection

- Redetec manufacture in-rack automatic fire suppression systems.
- As well as fire retardant, the unit has a number of switch outputs which may be utilised to send and alarm or command other equipment to shut down.

HSSD Detection

Hardware Interface

- GPS link from surface has been specified by David Cussans.
- Vialite
- The equipment is off the shelf, it requires rack space in the CUC and a path for the fibre to the surface.



Optical Fibres

Power Budget Calculation

- Optical power is expressed as a ratio of measured power to 1 mW, dBm. This allows losses attributed to attenuation, refraction, reflection and coupling mismatching to be quickly calculated through subtraction rather than more long winded processes.

- Received power is the transmission power minus the sum of the losses.
- The target of the process is to ensure the received power is greater than the minimum transition power of the receiver.
- $(Pt – Rr) > (\sum Pa+\sum Pc)$
- Pr → minimum receiver power
- Pt → minimum transmission power
- Pa → power loss through attenuation
- Pc → power loss through coupling

Selecting physical hardware

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Transmitter

- Cisco SFP-10G-SR-X
- 850 nm
- Minimum transmission power -7.3 dBm

Receiver

- Avago AFBR-821vx3Z Mini POD
- 850 nm
- Receiver Sensitivity -11.3 dBm
- Includes 2dB coupling to optical ribbon.
- AVGO-S-A0000033730-1 data sheet

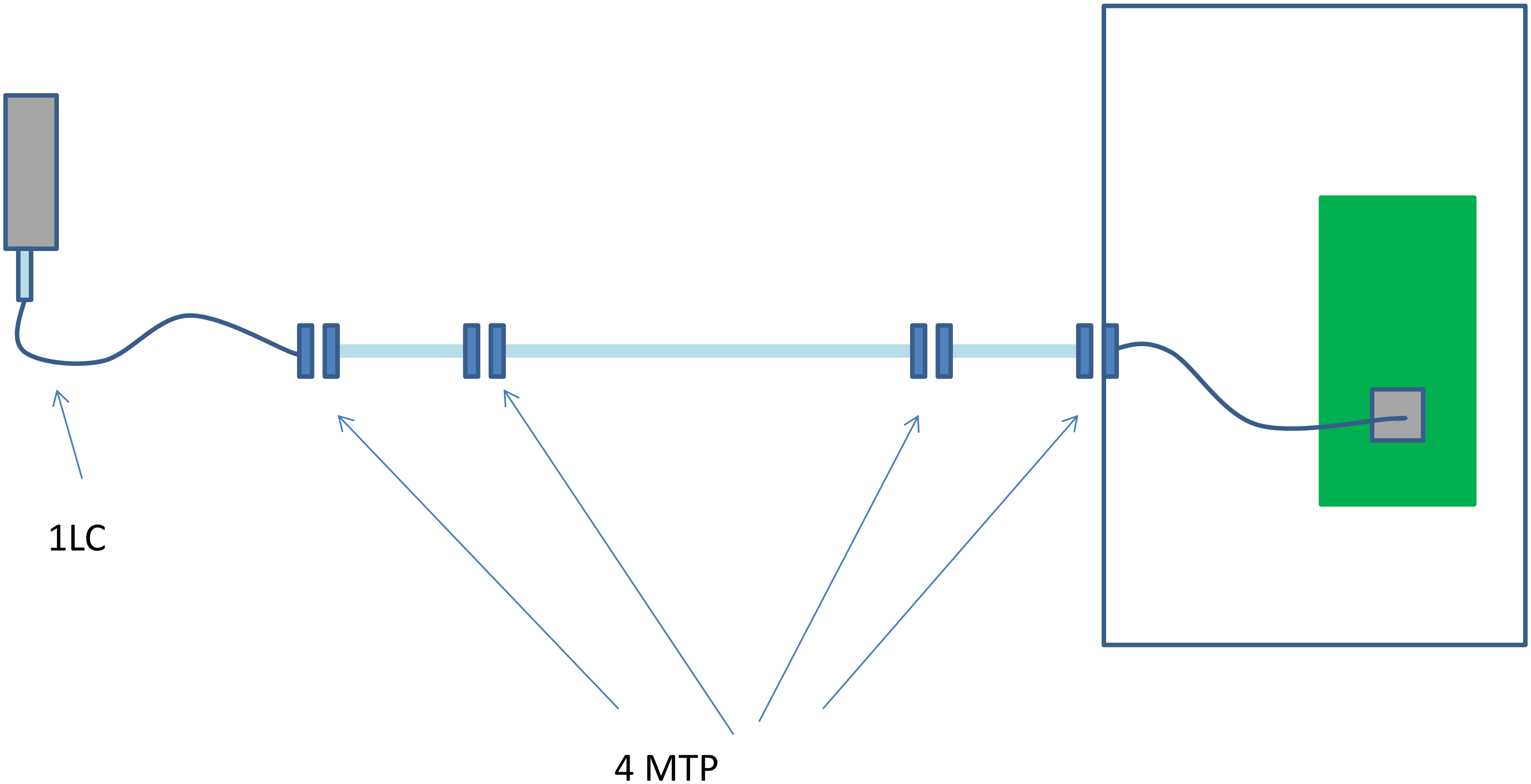
Baseline Budget

Starting Power Budget

- Pb=Pt(min) – Pr (min)
- -7.3 –(-11.3) = 4 dB

- We can now start to insert connectors and see how this affects run length.

Possible layout



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Insertion loss

- Insertion loss is power loss attributed to Fresnel reflection and coupling mismatch.
- Some more expensive connectors are engineered to reduce the latter.

- LC connector OM3
  – <0.25 dB
- US Conec MM MT Elite MTP
  – <0.35dB

Insertion Losses

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Specifications

	MM MT Elite® Multimode MT Ferrule	Standard Multimode MT Ferrule	SM MT Elite® Single-mode MT Ferrule	Standard Single-mode MT Ferrule
Insertion Loss	0.1dB Typical 0.35dB Maximum[2,3,5]	0.20dB Typical 0.60dB Maximum[2,3,5]	0.10dB Typical 0.35dB Maximum[1,4,5]	0.25dB Typical 0.75dB Maximum[1,5]
Optical Return Loss	> 20dB[5]	> 20dB[5]	> 60dB (8° Angle Polish)[5]	> 60dB (8° Angle Polish)[5]

[1] As tested per ANSI/EIA-455-171 Method D3
[2] As tested per ANSI/EIA-455-171 Method D1
[3] As tested with encircled flux launch condition on 50um fiber and 850nm per IEC 61280-4-1
[4] Compliant with IEC 61755-3-31/GRADE B
[5] For 48-fiber MM MTs, 72-fiber MM MTs, or 24-fiber SM MTs, performance assumes physical contact on all fibers. For these higher fiber counts, physical contact may be difficult to achieve. Please see our FAQs for more details.

Total insertion loss for MT Elite   4 x 0.35 dB = 1.4 dB

For standard MT 4 x 0.6 dB = 2.4 dB

Insertion Losses

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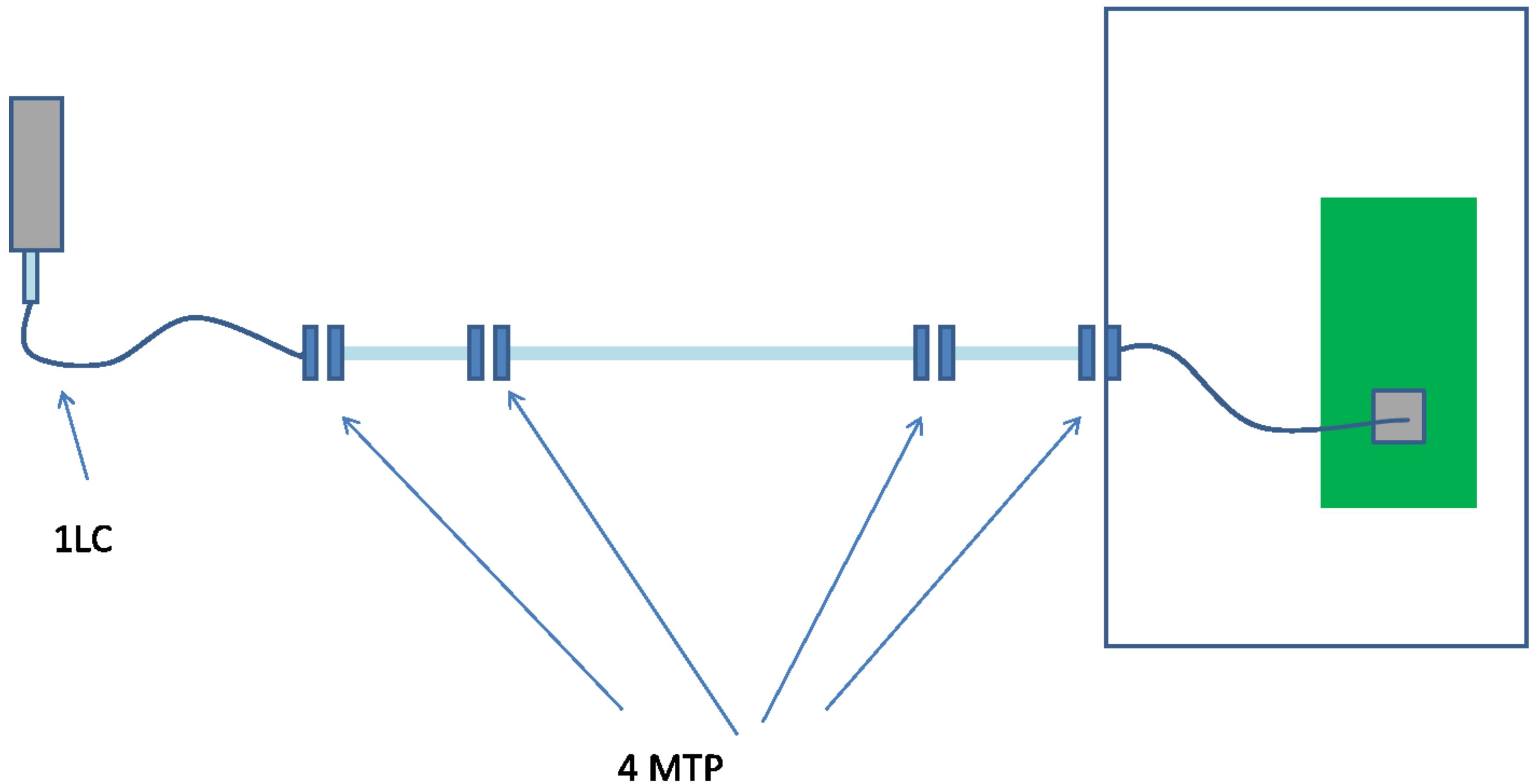
Connector parameters		
	LC SM	LC MM
Compliance	Telcordia GR-326	Telcordia GR-326
Color of housing	Blue (UPC)/Green (APC)	Aqua/Magenta
Color of boot	White (UPC) or Green (APC)	White
Polish	Flat (UPC) or Angled (APC)	Flat (PC)
Insertion Loss	<0,25dB	<0,25dB
Return Loss	>50dB (UPC)/>60dB (APC)	>30dB
Identification		
Traceability label with unique serial number on both ends of cable assembly.		
Packaging		
Each assembly in sealed PE bag, bulk pack in cardboard box. Longer lengths coiled on cardboard reel.		

Total insertion loss for LC 1 x 0.25 dB = 0.25 dB

Total connector insertion loss = (4 x 0.35 dB) + 0.25 dB = 1.65 dB

Total connector insertion loss (4 x 0.6 dB) + 0.25 dB = 2.65 dB

Lets Talk about Fibre Routes



APA Numbers

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We have 150 APA

- Each APA will be serviced by 1 x 12 OM4 ribbon terminated with an MTP connector.

144 ribbon trunk cables

- Trunk cables come in multiples of 12 (they contain 12 way ribbons!!!)
- We will use 144 way trunk cables, good compromise between convenience and serviceability.

If we reserve 2 ribbons per cable as spares, 15 cables will be needed to service the detector.

APA Service Box

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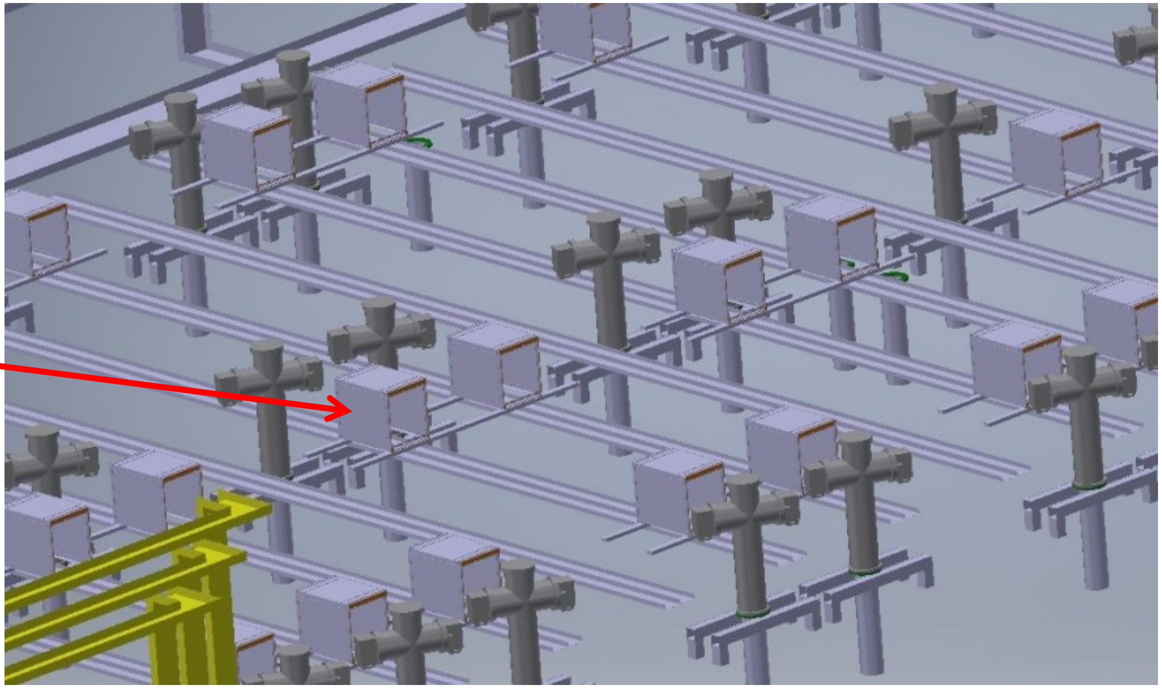
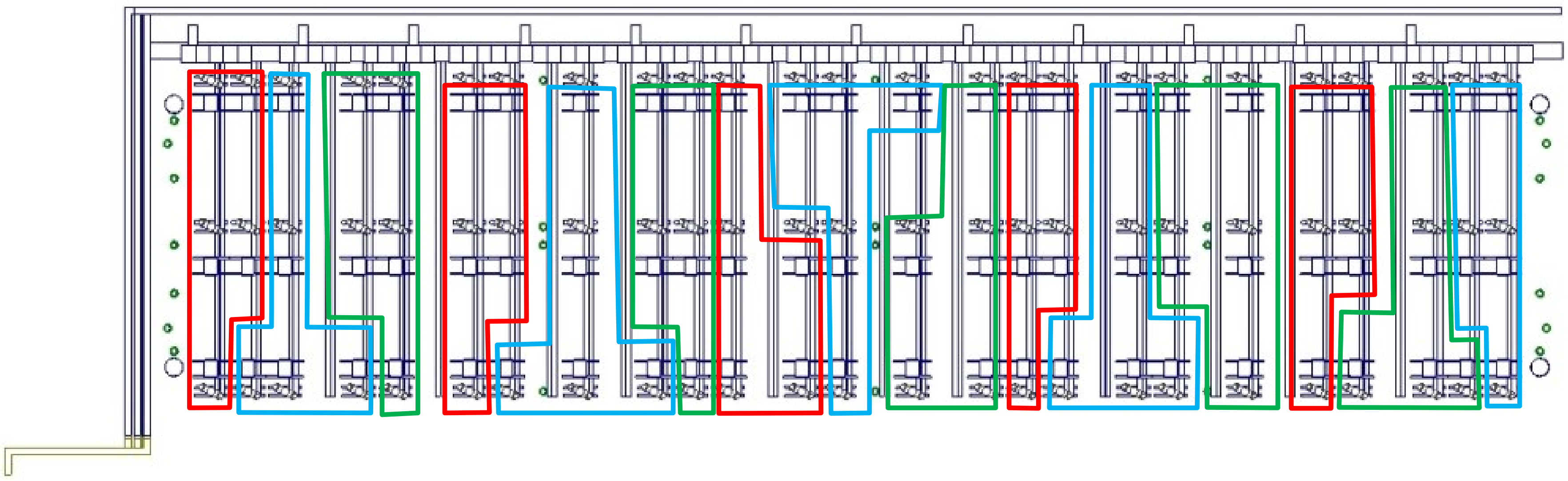
The termination point for each trunk fibre is one of the APA service boxes, housing the WIBs. Two APAs per box.

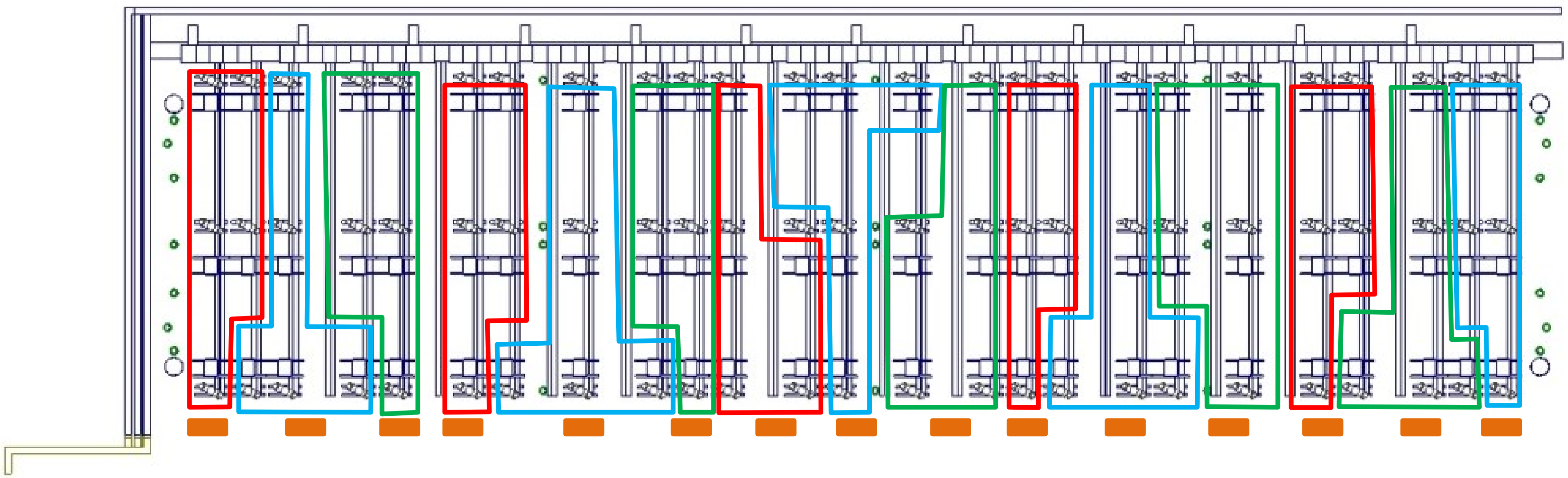


APA Domains



Each domain services by one cable of 12, 12 way ribbons. Two ribbons per Service box, one for each APA.

Trunk Cable Fan-out Patch Panel



15 patch panels for the connection of 12 x 12 MTP ribbons to 1 x 12 MTP ribbons to the WIBs.

All this has to move to the opposite side (Maybe???)

MTP Patch Panel

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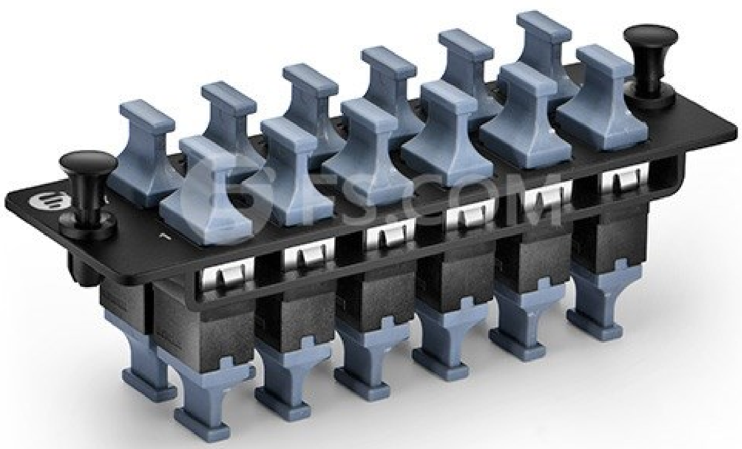
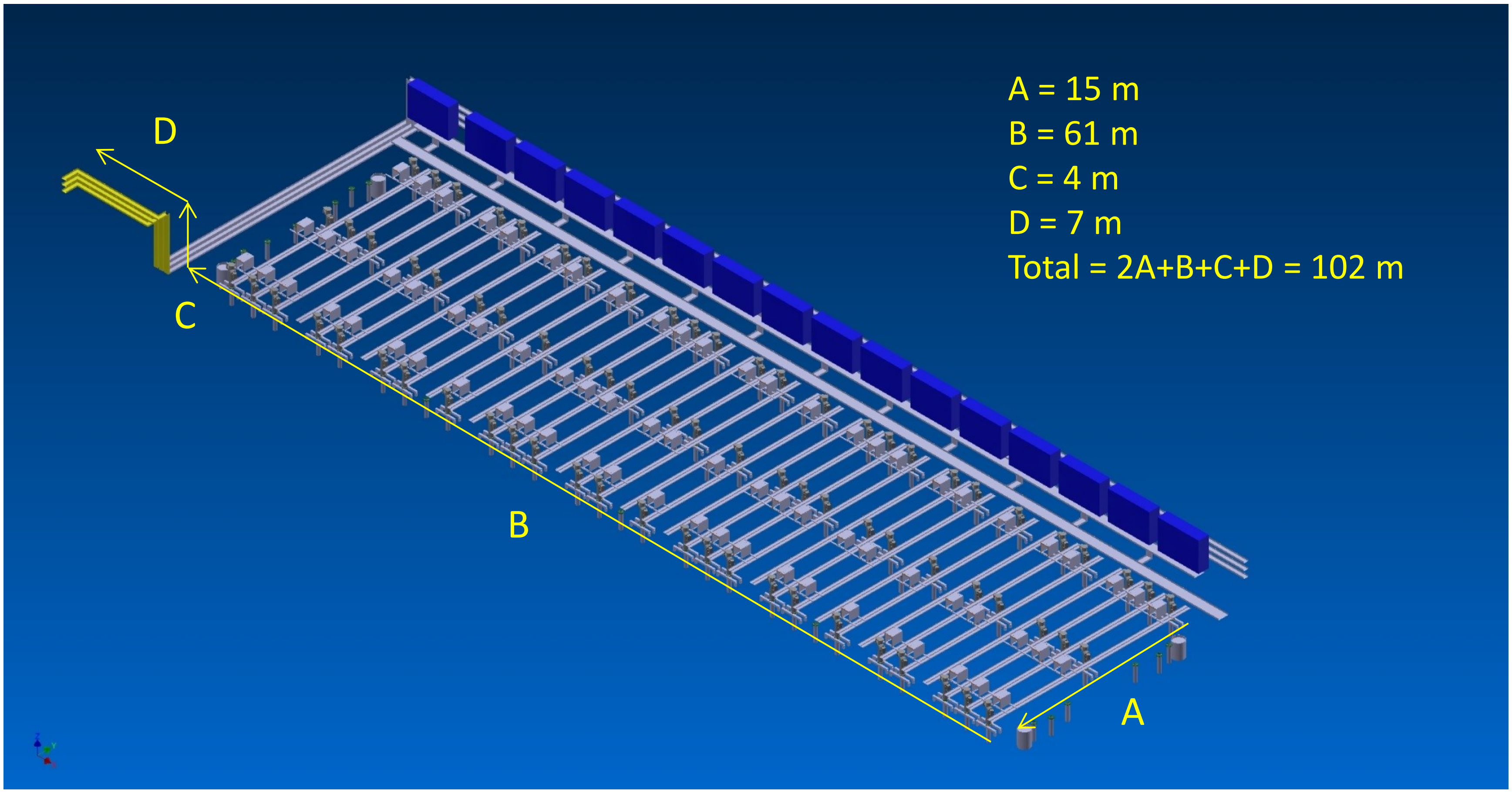
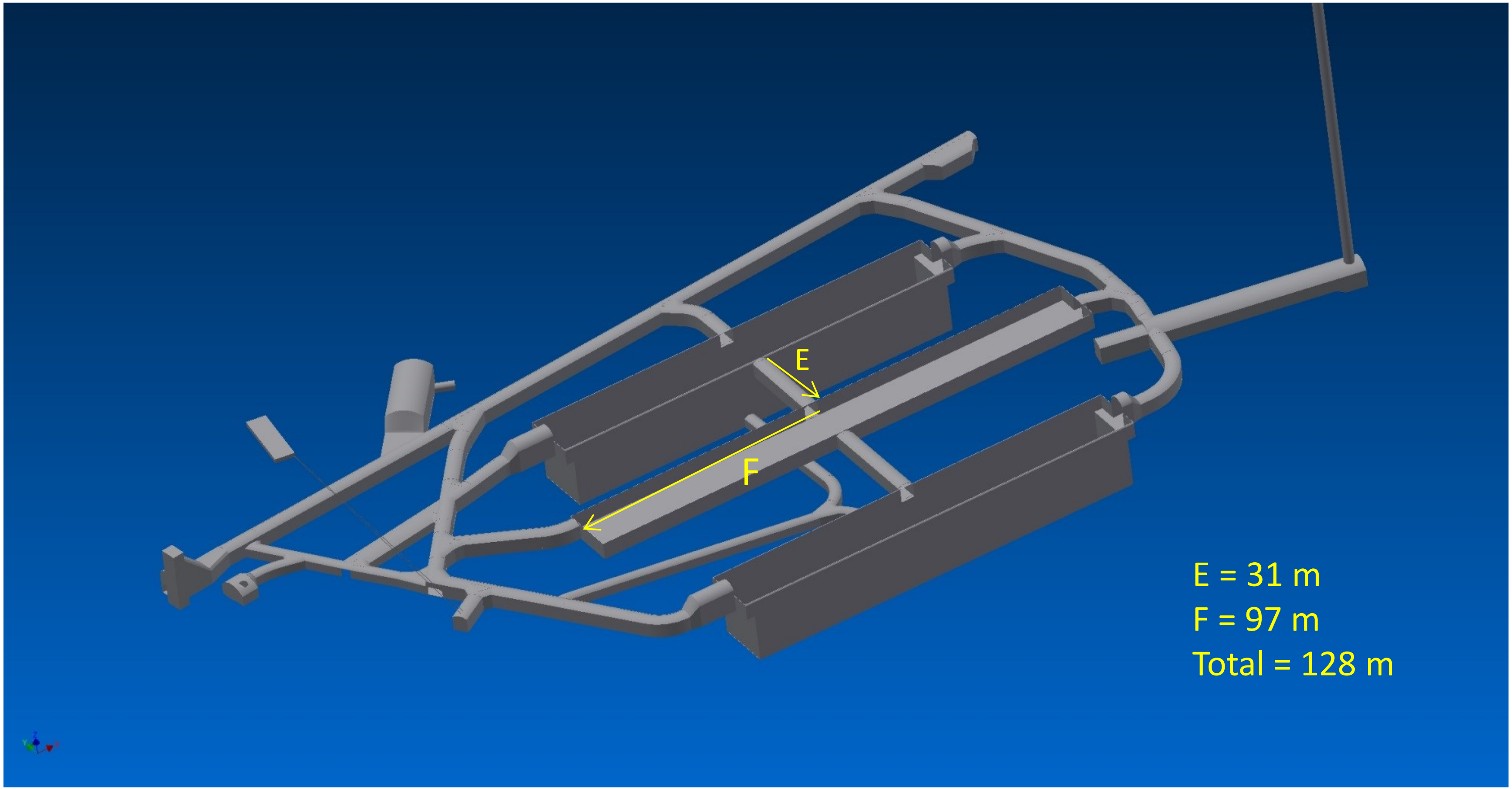


- The patch panel at the APA end will not take up much room.
- Connections can be made via a modular patch panel system that can fit into a standard 19” rackmount.

Cable Runs



Cable Runs



Cable Runs

- For the Worst case, the total optical run will be of order 230 meters (128 + 102).
- This can be extended to 230 m if we site the patch panels on the rack mezzanine.
- This is short of the 350 m dispersion limit of OM4 and 300 m of OM3.
- 250 meters of Fibre has 0.75 dB loss and our losses increases to:-

- (4 x 0.35 dB) + 0.25 dB + 0.75 dB = 2.4 dB
- Overhead 4dB – 2.4 dB = 1.6 dB

- (4 x 0.6 dB) + 0.25 dB + 0.75 dB = 3.4 dB
- Overhead 4dB – 3.4 dB = 0.6 dB

Cable Runs

- Industry standard budget hover head for Comfortable, low BER operation is 1.5 to 3dB.
- We may have to select transmitters with high output and receivers with low transaction thresholds.

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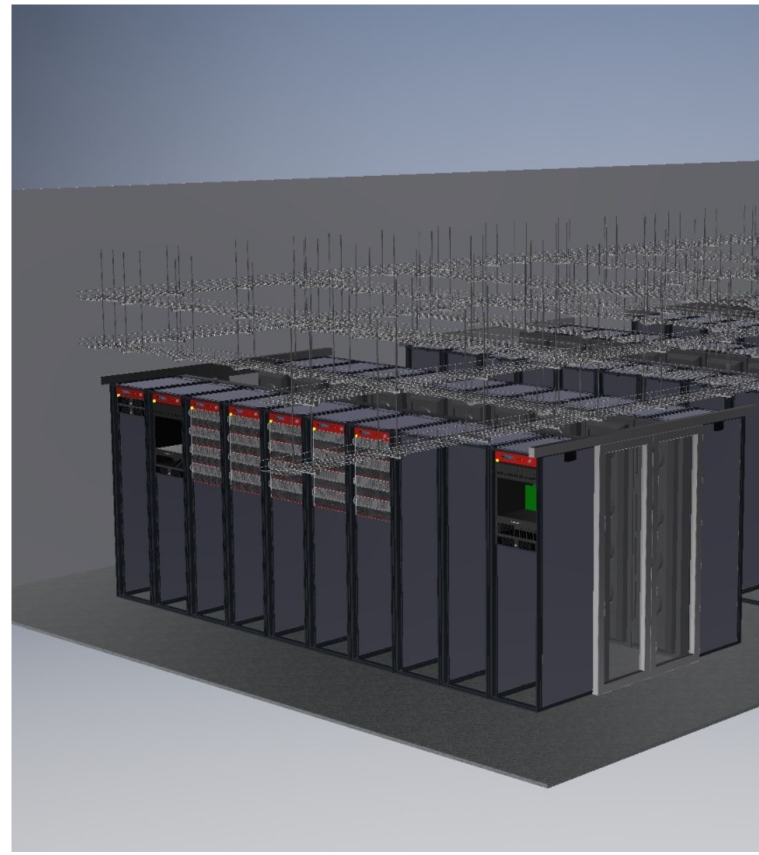
Connector Choice

- Either option of MT connector keeps the power budget in credit. Either type of optical cable will work.
- HOWEVER!!!!!
- Bending loss.
- Bending loss is the loss of optical power to macroscopic and microscopic bends in fibre.
- It is measurable but not easy to model, more of a dark art.
- Some very poor installations can have bending losses of 5dB (fibre store sales literature…..)
- Rework may be necessary post installation.

The Other End

- To Service 150 APAs 75 PCs are needed, two Felix per PC, One Felix per APA.
- Each APA domain/ trunk cable will connect to 5 PCs.
- 7.5 racks will be needed to host all PCs.



The Other End

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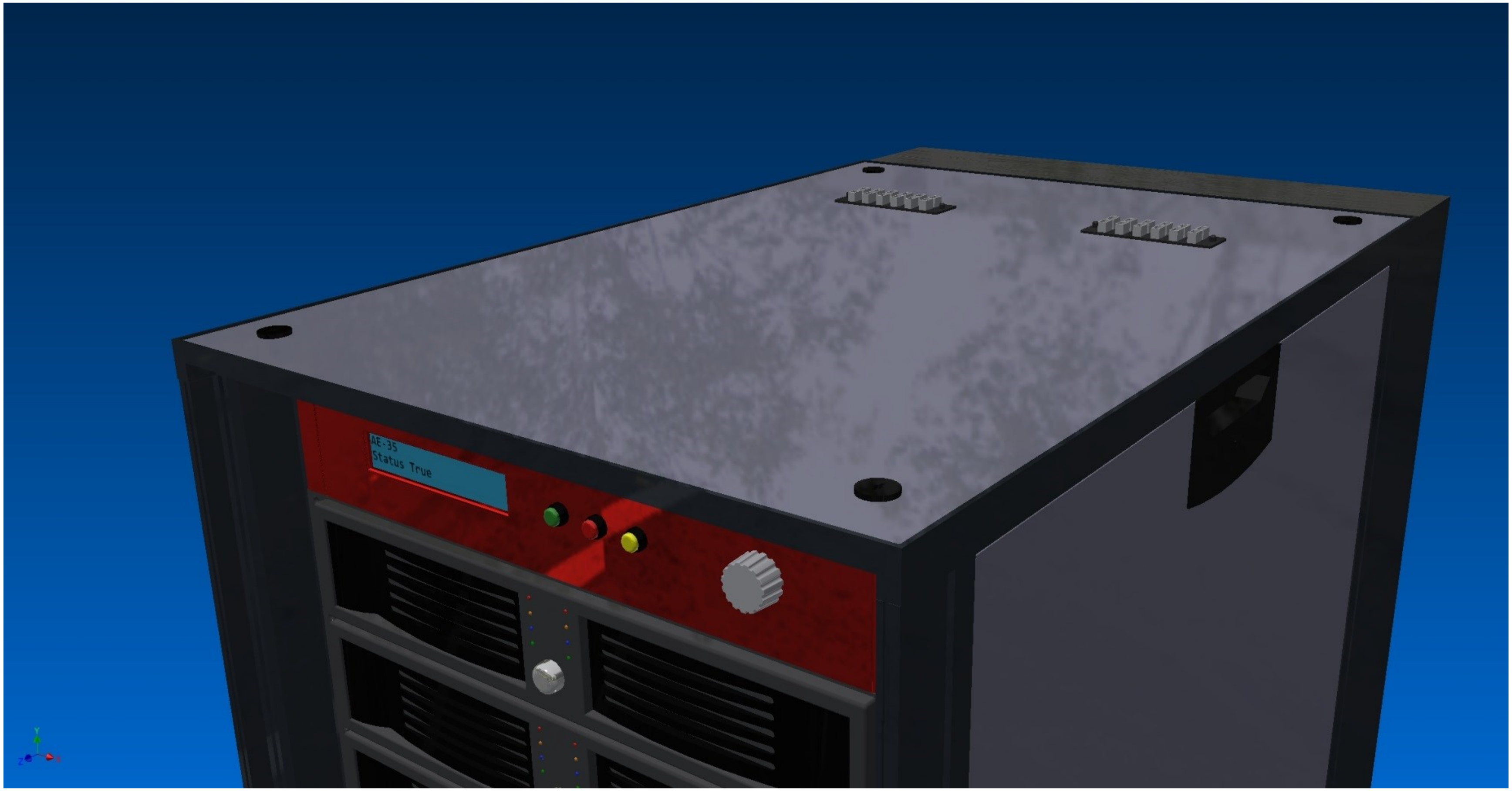
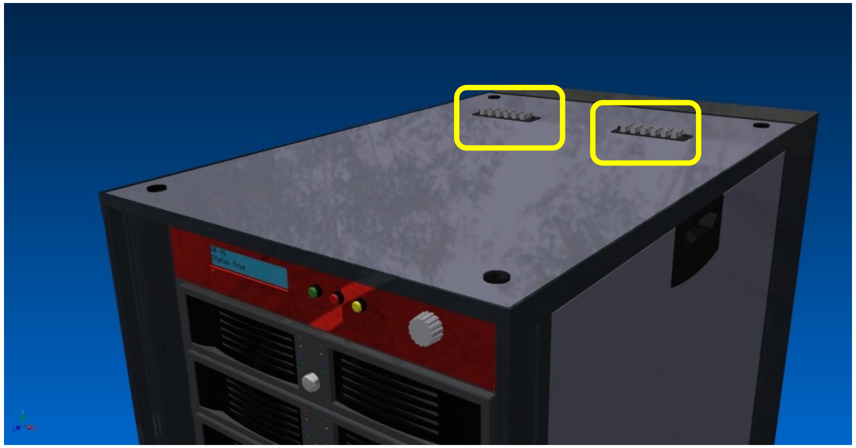


The Other End

- The Patch Panel are mounted on the top of the Rack.
- This will require a little modification but will allow best routing.
- Each Rack will service two APA Domains, each with its own patch panel.



Sensing

- We will use SNMP sensors for reporting health of Data Centre.
- This is not the SAME as Safety Interlocks.
- They report, they do not take action.
- InfraSensing Have a range of SNMP sensors that can report Data Center status.

Gateway

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BASE-WIRED

Display	OLED
Web Server:	HTTP/HTTPS
Built-In Alerting:	email, SNMP Traps, SMS, call
Protocols:	SNMP v1,v2,v3 Modbus TCP XML, JSON
Network:	IPv4 at 10/100 Mbps
External Probes:	2 optional probes
PoE:	IEEE 802.3af
Power Adapter:	12V DC
Operating Conditions	
Temperature:	0°C to 75°C / 32°F to 167°F
Humidity:	<90% RH (non-codensating)
Embedded Temperature Sensor	
Resolution:	0.1°C / 0.18°F
Accuracy:	± 0.5°C from -10°C to +85°C ± 1°F from 14°F to 185°F degrees Celsius or Farenheit

Port Expander

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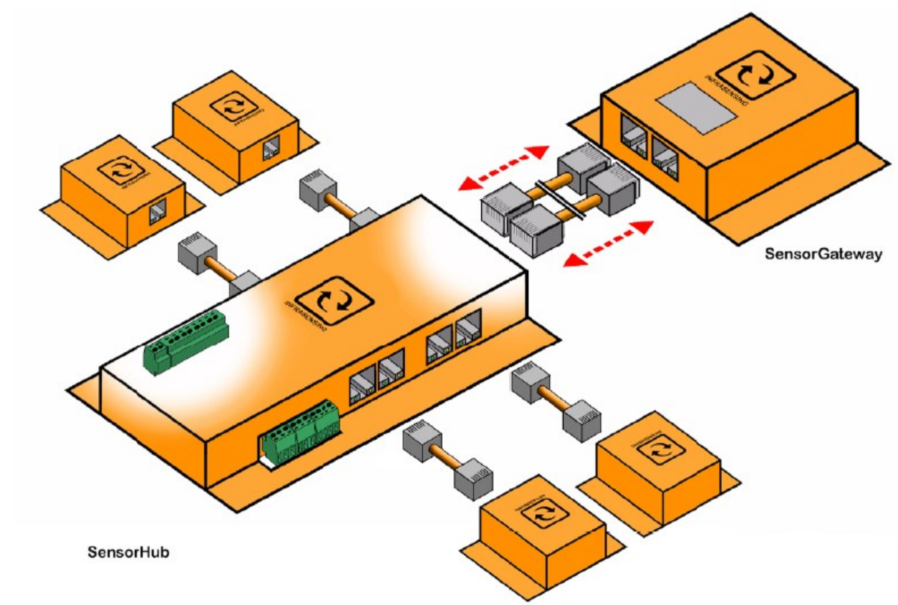
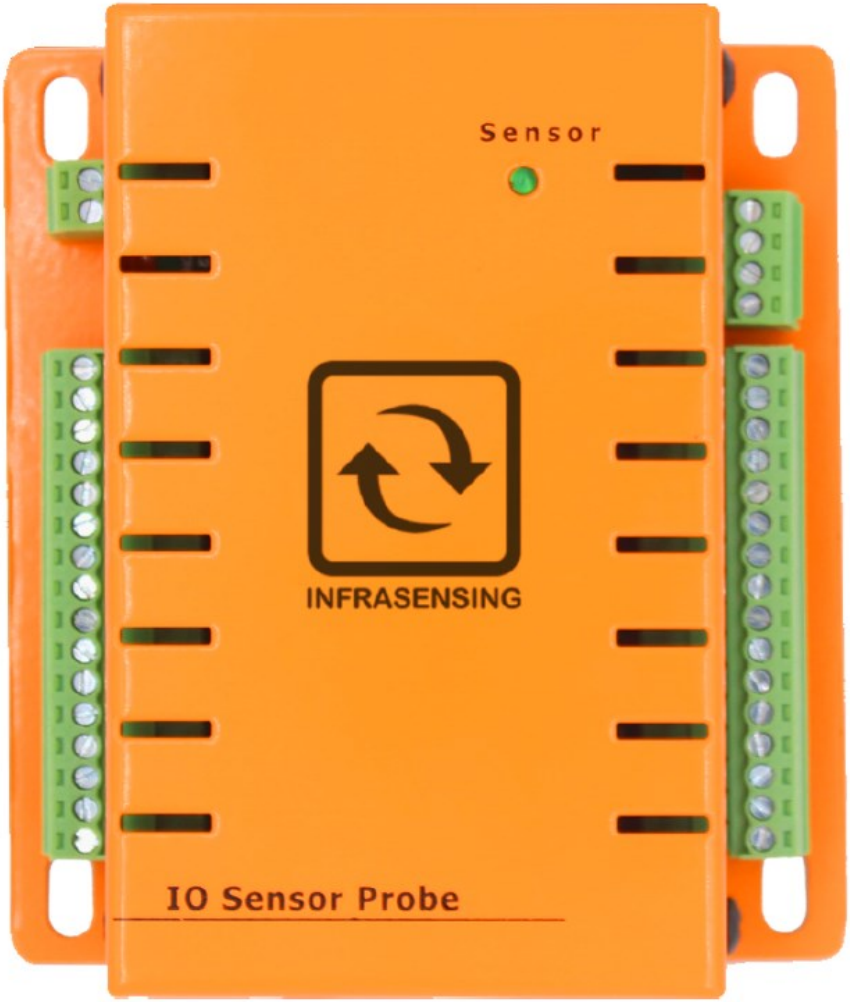
EXP-8HUB

Expansion ports for external sensor probes:	8
Dry contact input ports:	4
Dry contact output ports:	2 (digital sink 100mA)
Relay outputs:	2 (400VAC/150VDC and 200VA/192W)
Auxillary supply:	maximum current capacity of 500mA at 9 to 12 VDC
Power consumption:	650 milliWatts
Dimensions:	165 mm (6.5”) x 95 mm (3.7”) x 22 mm (0.8”)



Dry Contact Sensor



16 IO dry contact ports.

Sensors

- We will detect low level water leaks,
- Excessive humidity
- Excessive heat
- Hot Isle Doors status
- Status of each of the Fire Suppression systems.

Hazard Indicators

- Some hazards to equipment and life have common origins.

- Smoke
- Heat
- Moisture
- Oxygen Deficiency
- *Would appreciate input on any others*.

Under Consideration

Critical Systems

- Hardware interlocks responding to fire detection. Which systems to shut down and in what mode.
- Hardware interlocks Responding to excessive water leak. What level is permissible, what action should be taken under defined circumstances.

Critical Systems

- O2 sensing. Reduced oxygen environment indicating O2 displacement by cryogenics. Placement to be engineered.

Under Consideration

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Error indicators

- Environment temperature sensors. Indication of possible faults, pre determined thresholds to initiate as yet undefined responses.
- Environment humidity sensors. Possibly associated with ground water?

Error indicators

- O2 sensing. Although O2 is a critical system, its loss at a low rate could also indicate an error or fault which could be a precursor to something more serious.
- Optics. Light path integrity sensing to guard against unconstrained laser light.

Summary

Optical Budget

- Fibre optical budget looks good assuming transmitters and receivers proposed are the ones used.

Optical Fibre Routes

- Cable trays and routes look fine, at the level described in documentation available.
- No information is available, that I can find, detailing cable entry to CUC. Pressing need to clarify and document this.

Summary

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Electrical Power

- Need to identify someone able to take on the power distribution within the CUC.
- Prior to this we need to understand our requirements for redundancy or backup power to achieve uptime targets.

Cooling

- Current Specifications for water cooling provided by Arup are inadequate. Cooling capacity should exceed dissipated power.
- Work is required to understand if extra capacity or secondary circuits are needed to achieve uptime targets.