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DUNE CUC and Fibre Run

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Initial Task list

List received from Terri

- Design of the AC electrical distribution from the CF supplied transformer to the 52 racks.
- Design of the rack water cooling including piping from the water spigot supplied by CF.
- Local Rack protection and power distribution.
- Hardware interface to optical fibres coming from Ross/Yates shafts.
- Optical fibre routing and cable trays within CUC UDPR.
- Understand raised floor space and verify it is sufficient.
- Water leak detection and interface to detector/safety controls.
- Understand interface to DUNE network connections.
- Understand interface with fire suppression design team (this comes from CF).
- Plan/design any local/rack UPS requirements.
- Understand lighting and cooling of room space.
- Participate in design review of provided space.

- I have attempted to group these items where they have common dependency or associated relationships.
- Attempted to identify where outcomes are limited by either known factors or items as yet to be decided.

Getting started

- From this I am able to make a start with things that have no interdependency's or constraints or where the constraints are understood.

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

Optical Fibre, Power and water routing and rack layout

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- I Visited the Grid TIER 1 Computing facility at RAL to learn about data centre standards, cooling techniques cable routing practices and personnel safety.
- From this I propose to have all cabling, electrical and optical, to be constrained to elevated cable trays and coolant routed in the under floor cavity.

Optical Fibre, Power and water routing and rack layout

- A Hot / Cold Aisle configuration reduces localised hotspots, doors on the ends of each aisle provides greater control of airflow across the racks.
- Egress routs in the data centre must be considered. More than one possible route is needed for any given location.

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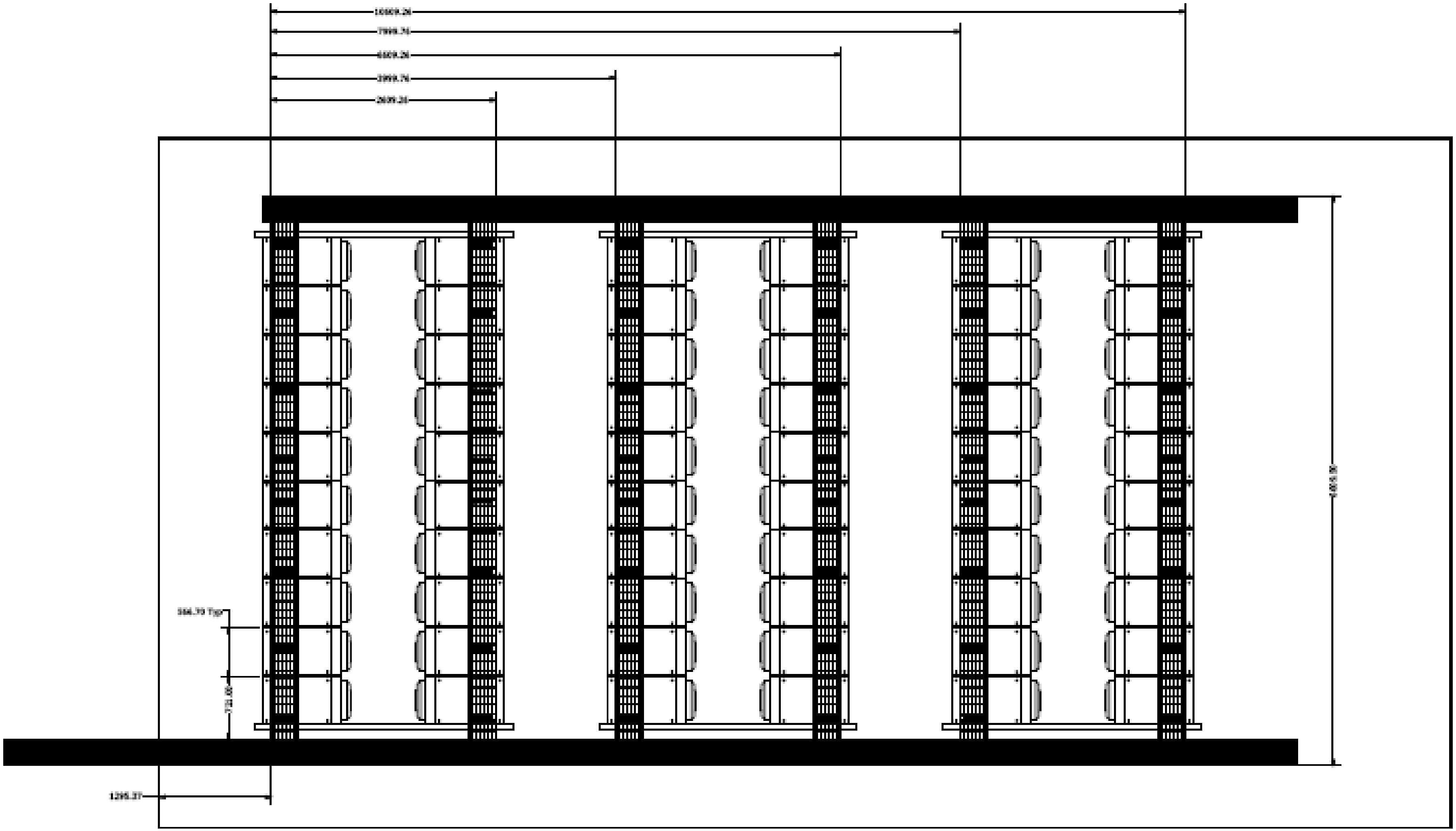

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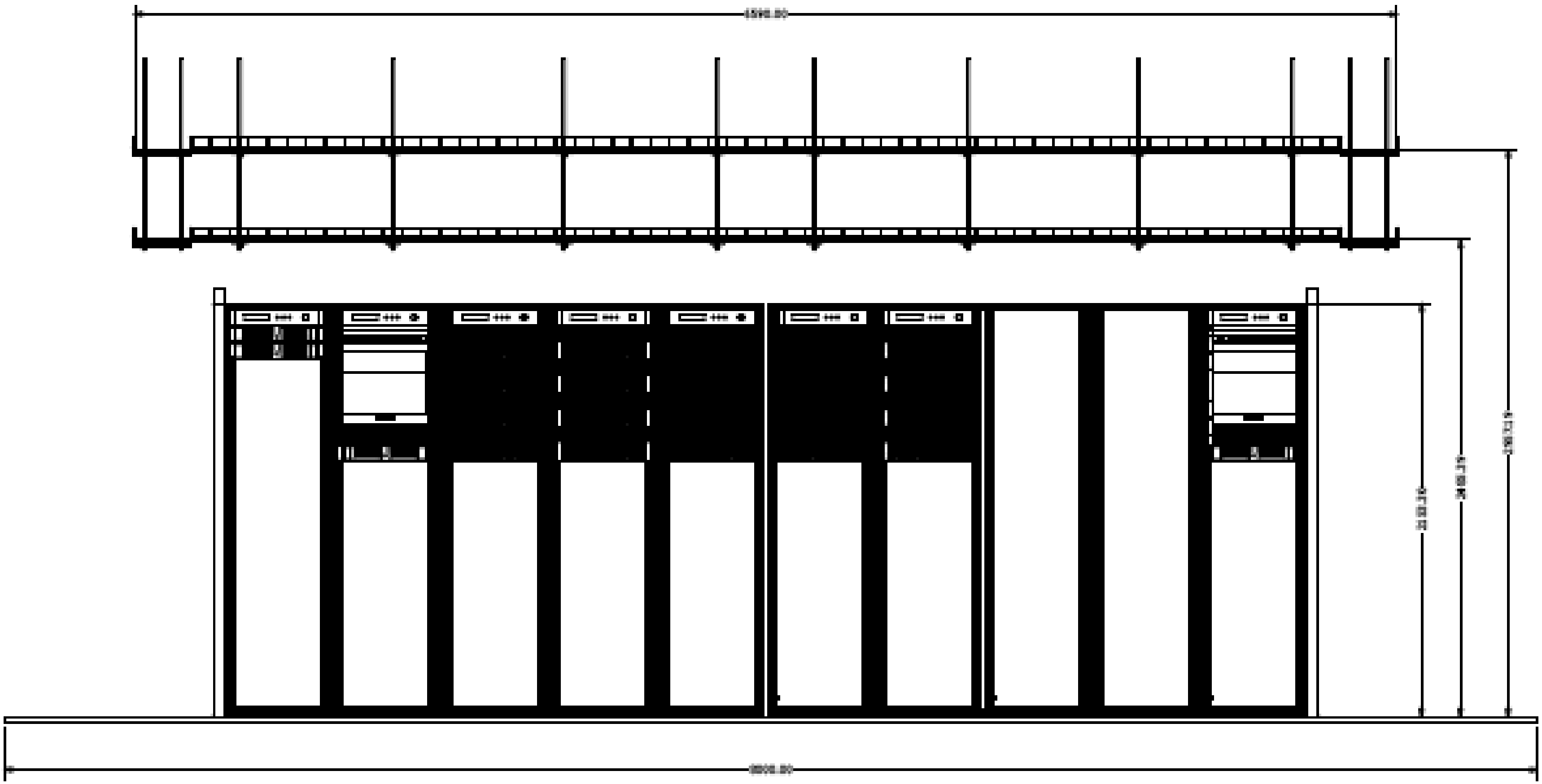

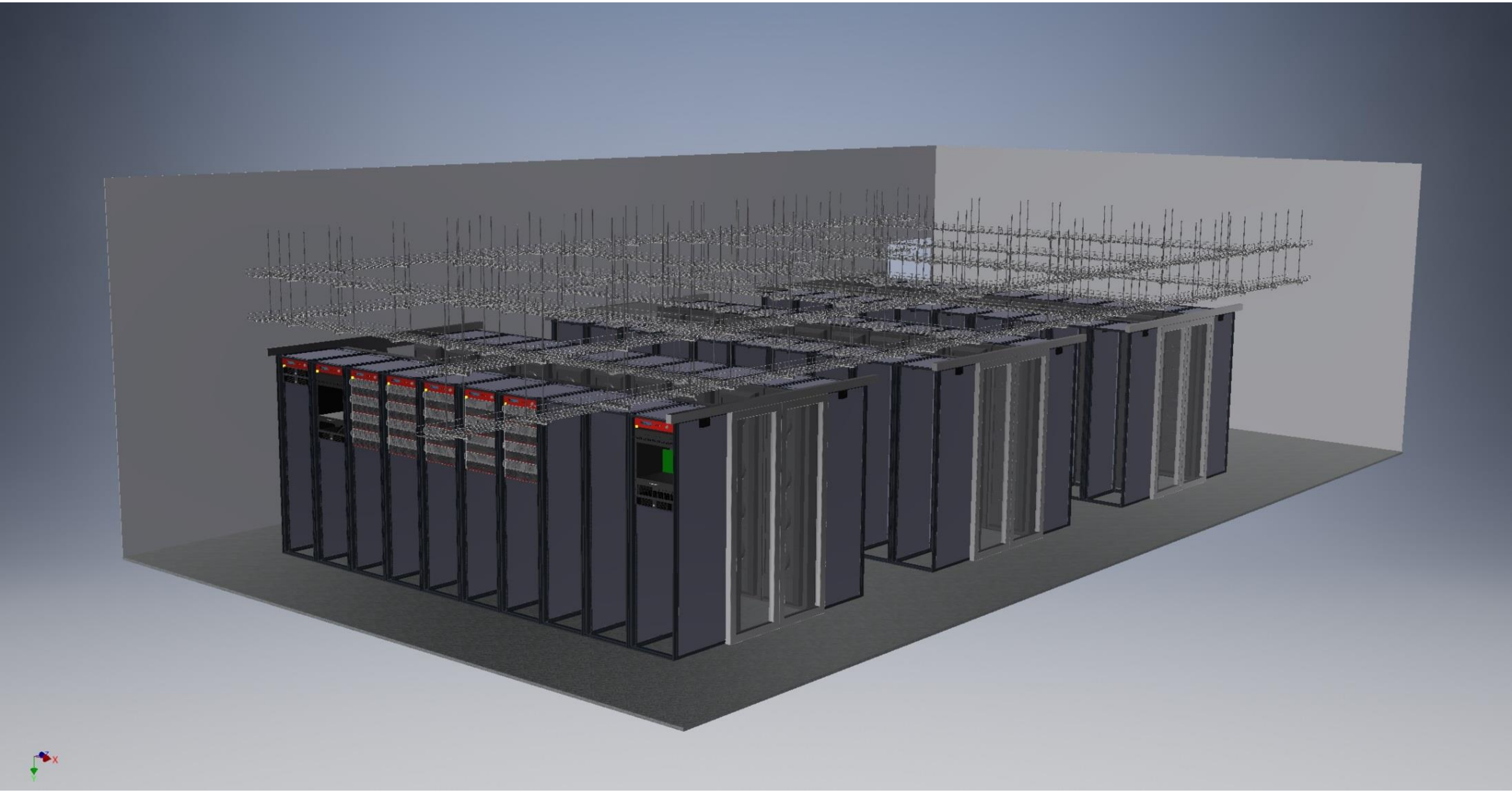

Rack Model

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

Rack Water Cooling

- Three main approaches to data centre cooling
- Underfloor, not suitable due to floor elevation and size of heat exchanger
- In rack, possible but extends the length of rows
- On rack, best for us.

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

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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

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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

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.

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.

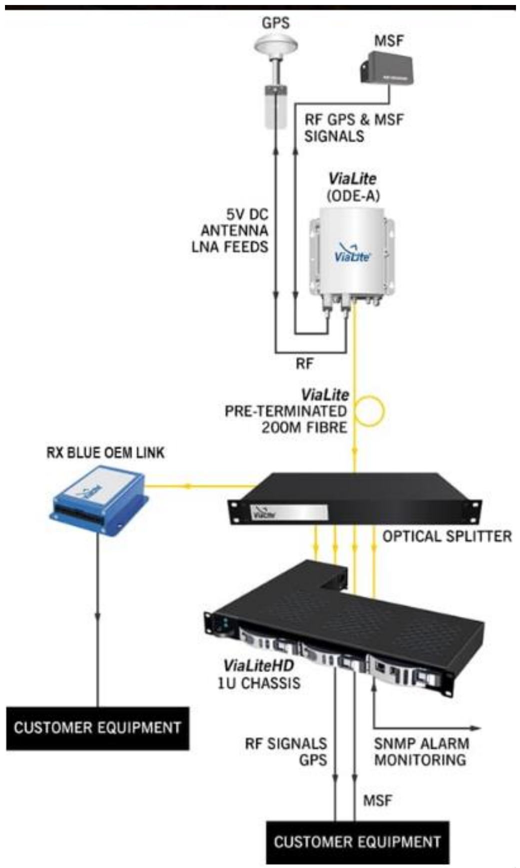
Local Rack Protection

- 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) > (∑Pa+∑Pc)
- Pr → minimum receiver power
- Pt → minimum transmission power
- Pa → power loss through attenuation
- Pc → power loss through coupling

Selecting physical hardware

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

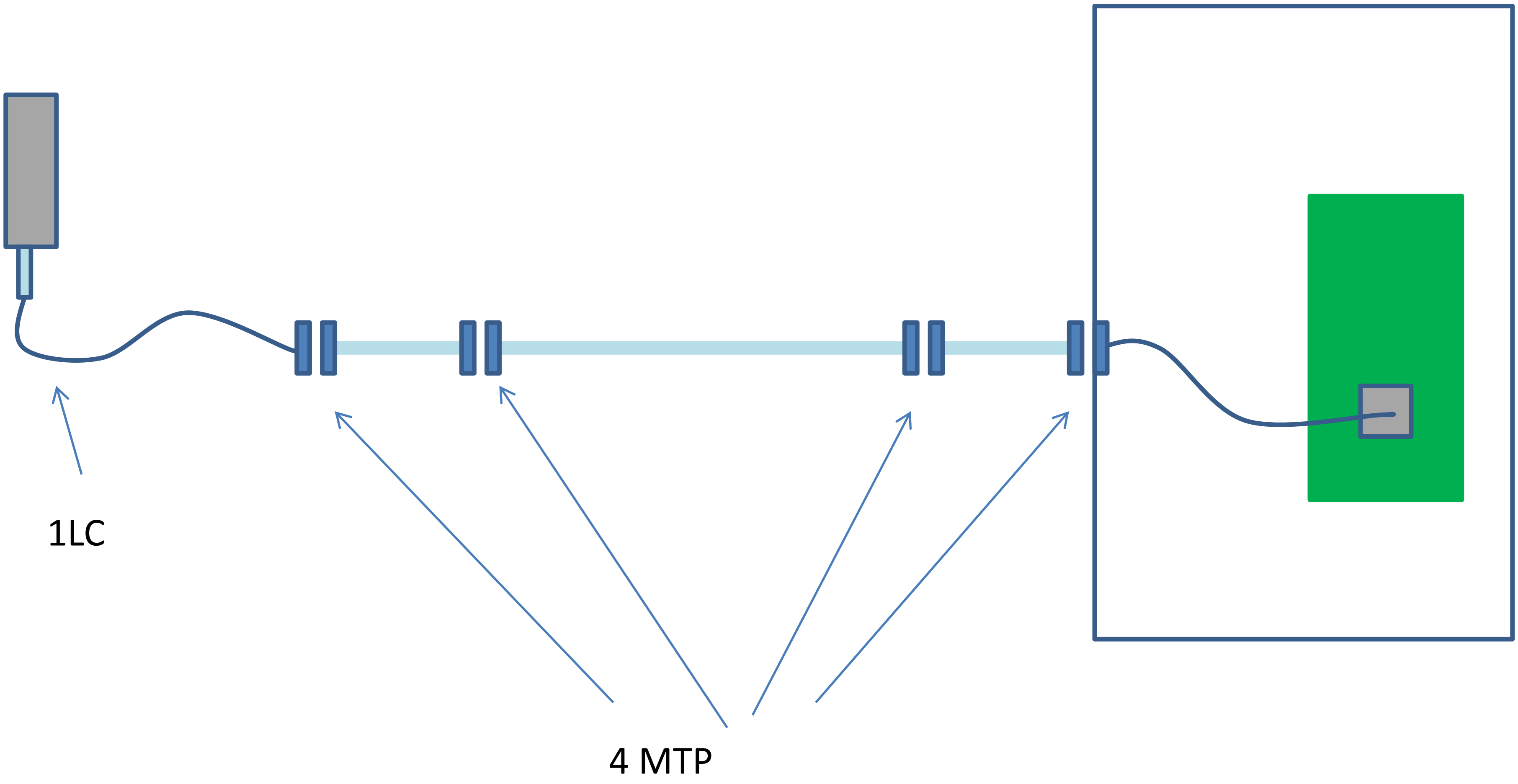
Baseline Budget

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



Insertion loss

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- 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

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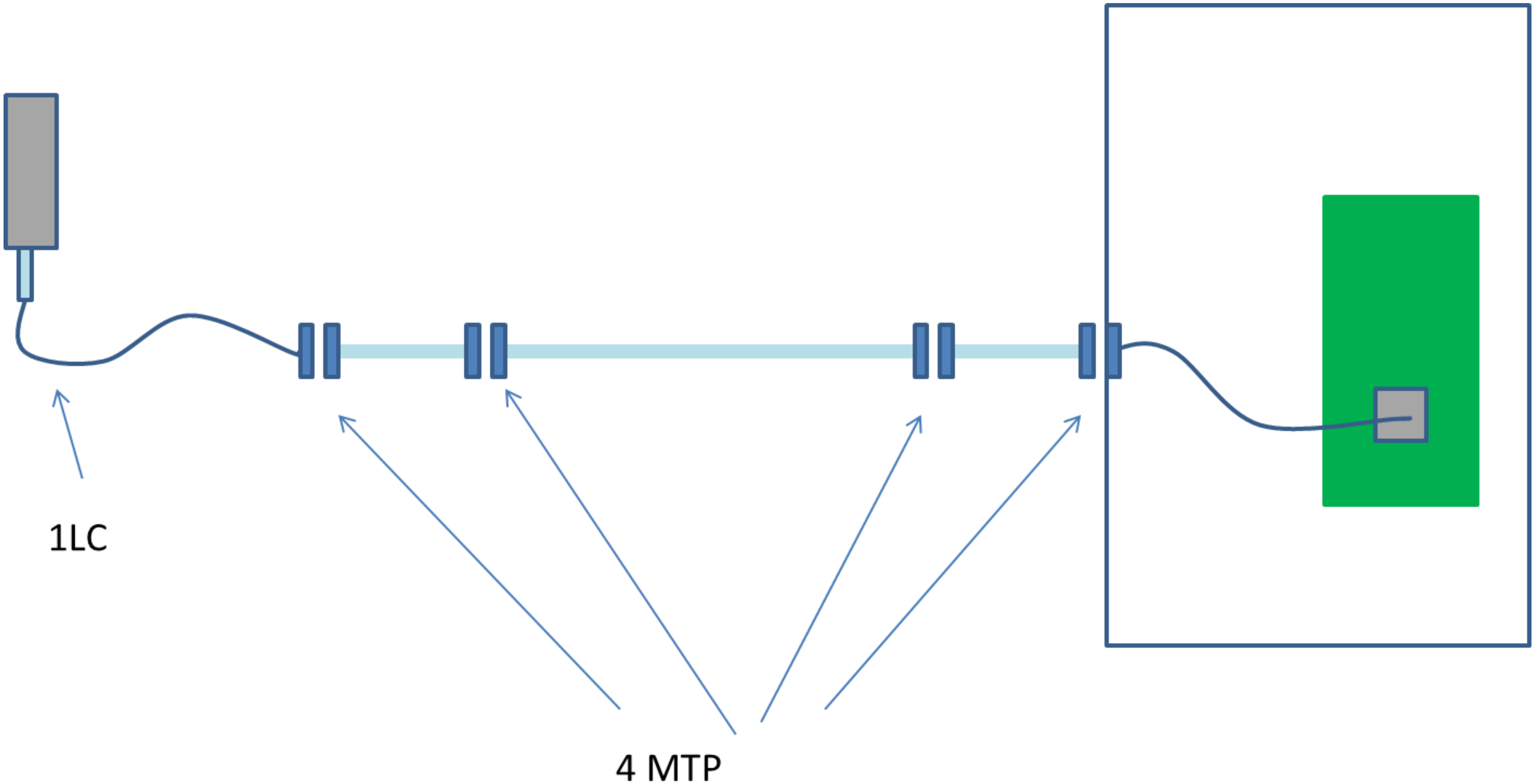

APA Numbers

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We have 150 APA

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

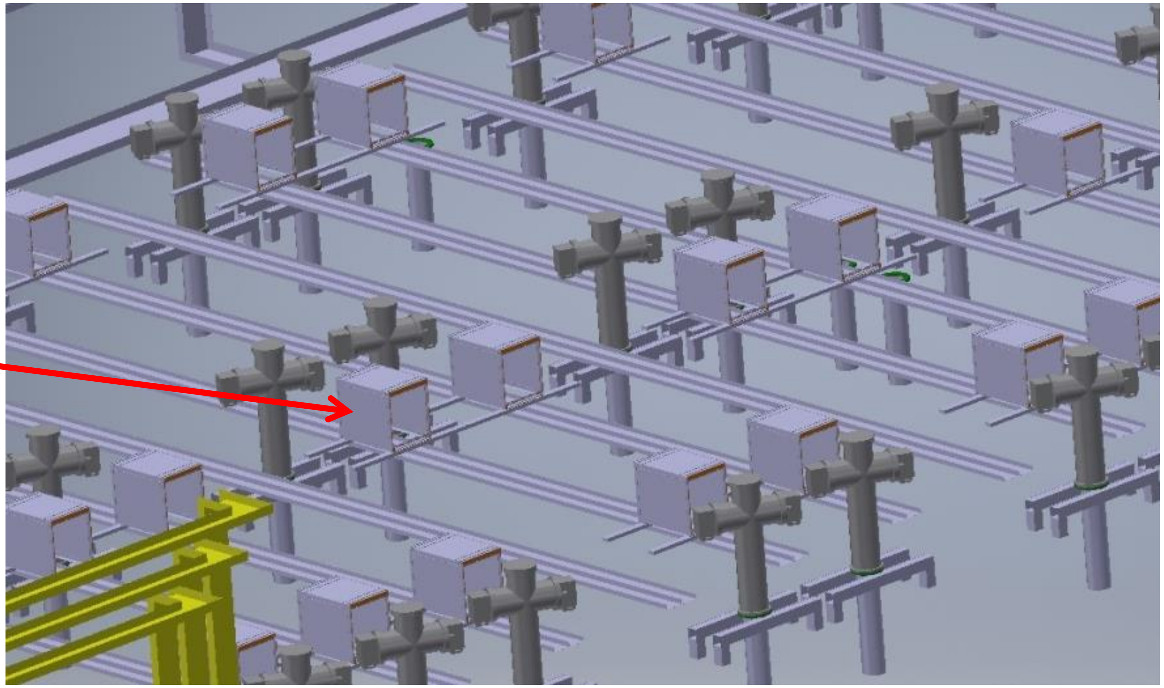
144 ribbon trunk cables

- 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.

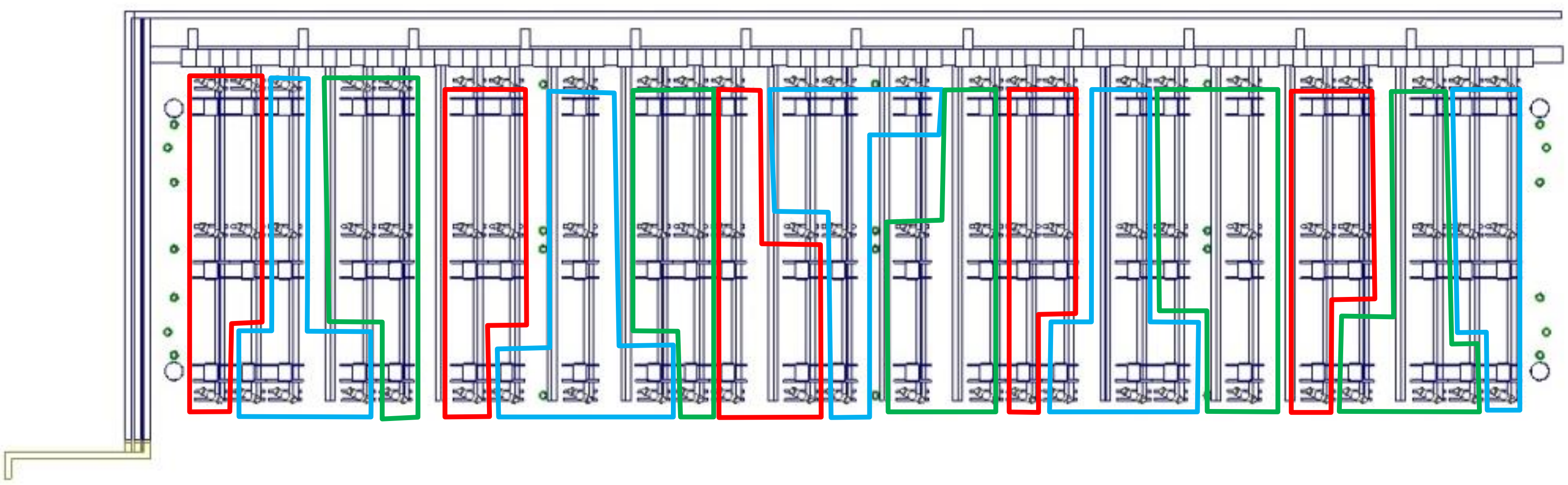
If we reserve 2 ribbons per cable as spares, 15 cables will be needed to service the detector.

APA Service Box

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

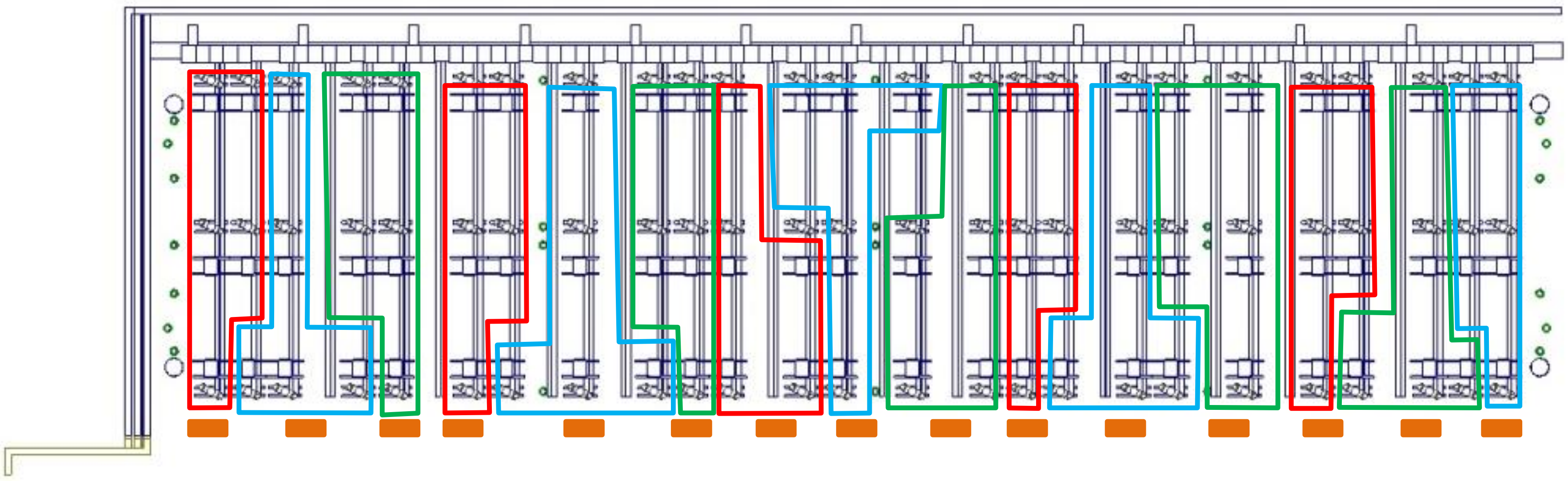


APA Domains



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.

MTP Patch Panel

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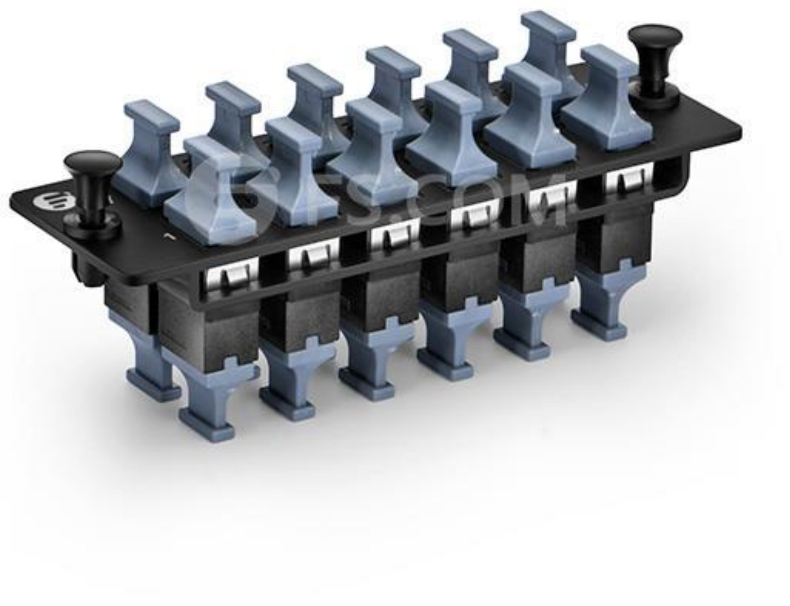
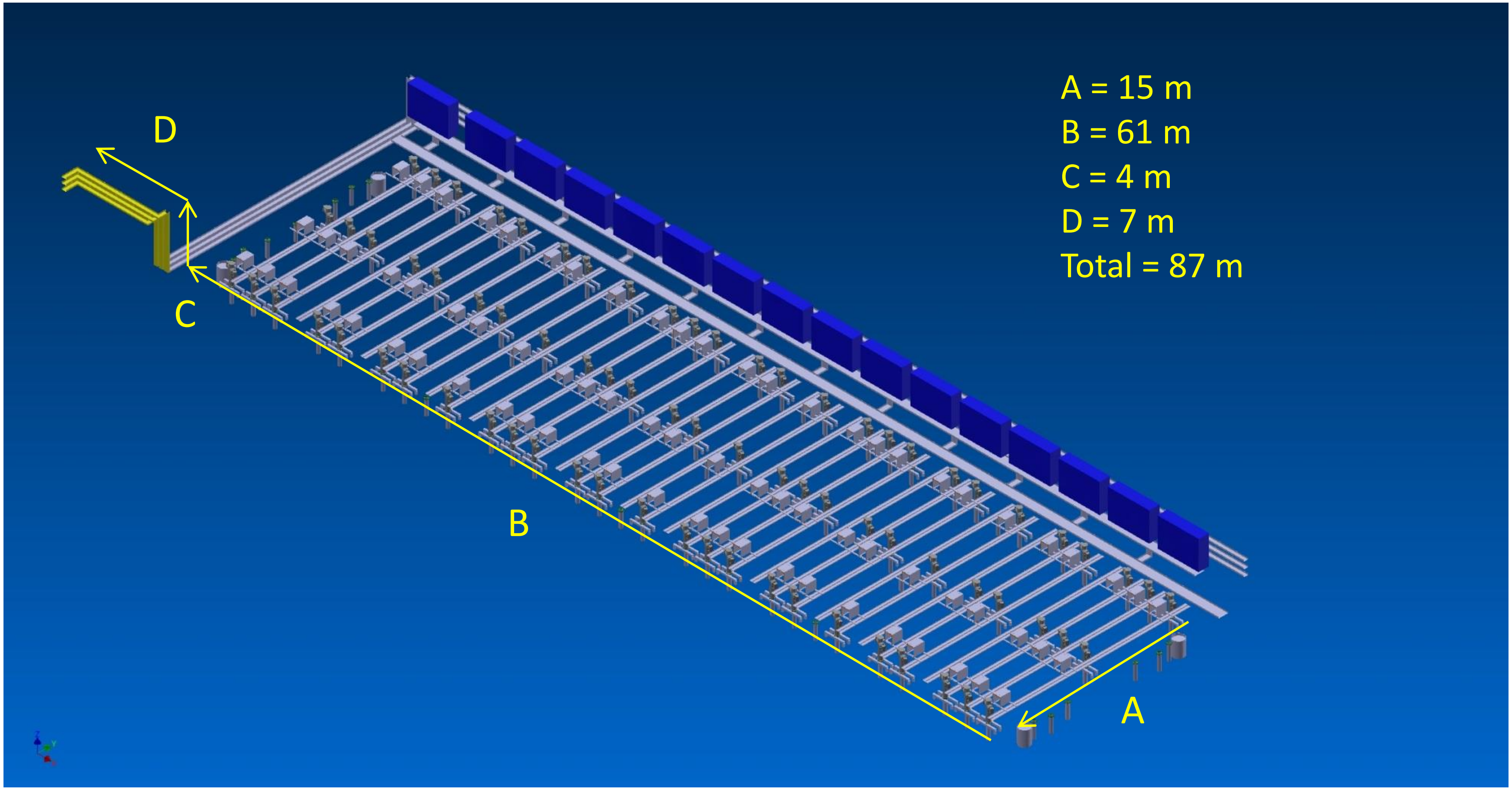
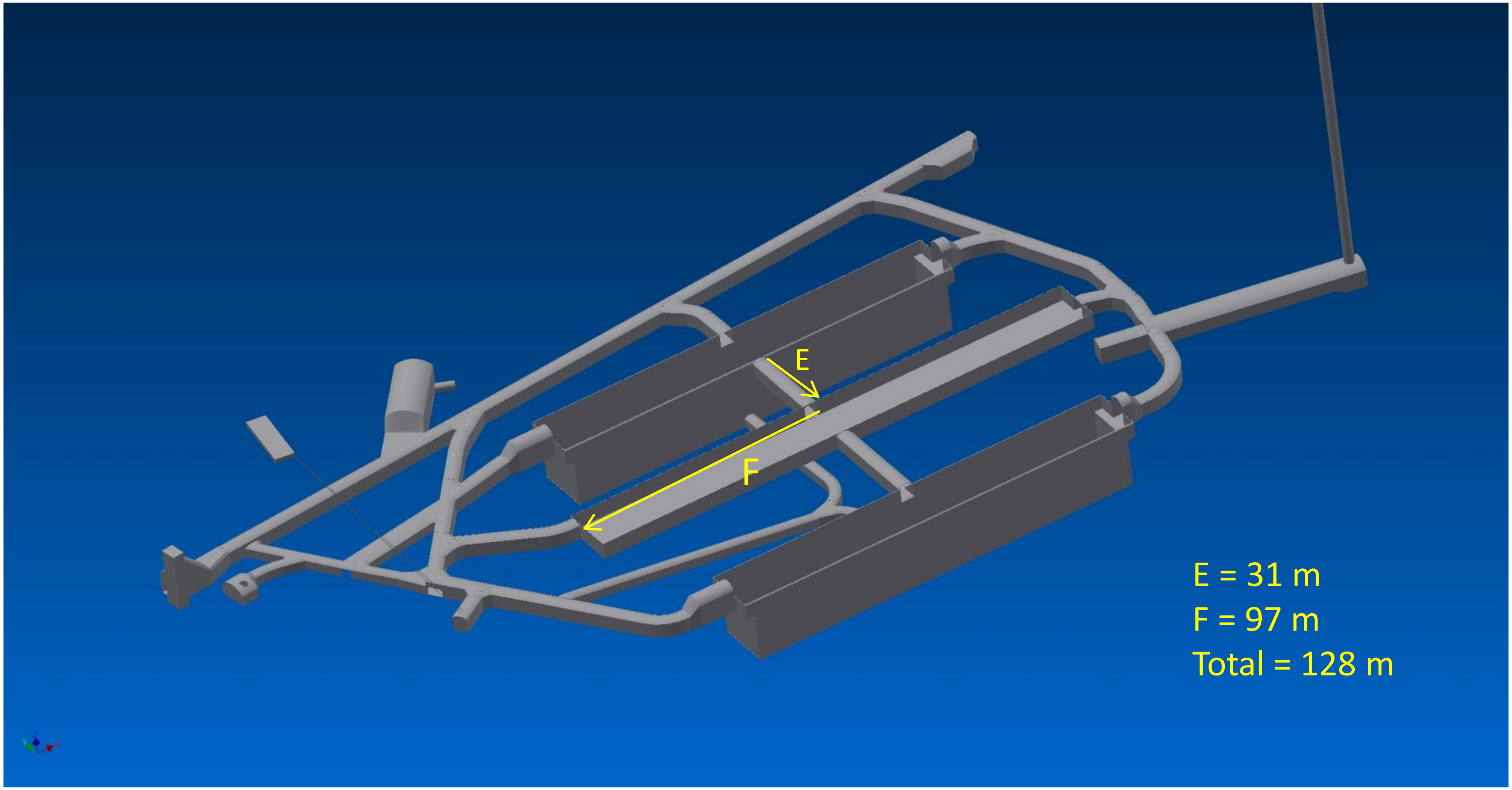


- The patch panel at the APA end will not take up much room.
- Connections can be made via a modular patch panel system that can fit into a standard 19” rackmount.

Cable Runs



Cable Runs



Cable Runs

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- For the Worst case, the total optical run will be of order 215 meters (128 + 87).
- 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

Connector Choice

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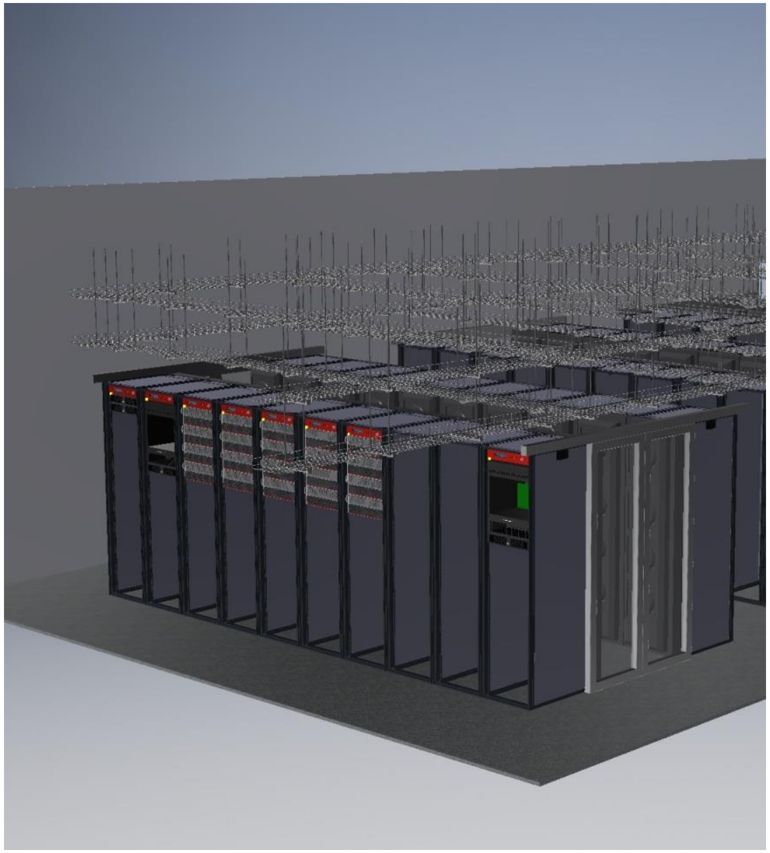
- Either option of MT connector keeps the power budget in credit. Either type of optical cable will work.
- HOWEVER!!!!!
- Bending loss.
- Bending loss is the loss of optical power to macroscopic and microscopic bends in fibre.
- It is measurable but not easy to model, more of a dark art.
- Some very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

The Other End

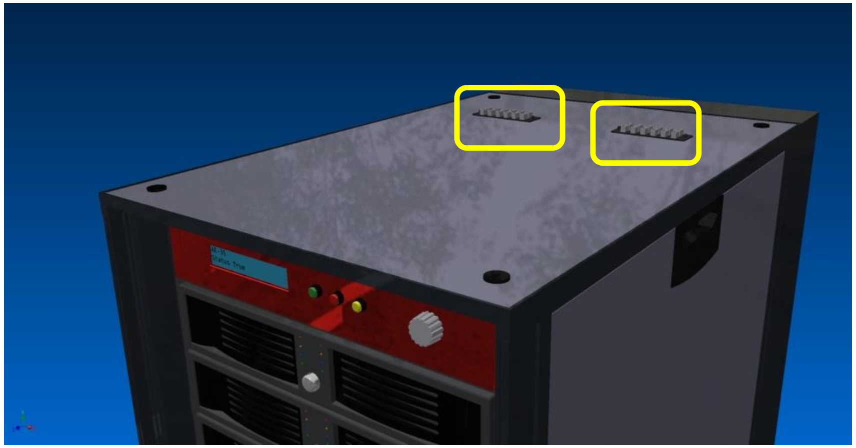
- To Service 150 APAs 75 PCs are needed, two Felix per PC, One Felix per APA.
- Each APA domain/ trunk cable will connect to 5 PCs.
- 7.5 racks will be needed to host all PCs.



The Other End

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.



Hazard Indicators

- Some hazards to equipment and life have common origins.

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

Under Consideration

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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.
- Would like conformation that on detector fibre routes are acceptable.

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.