

UT Optical Connections

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For the UT electronics group

10/13/2015

- ❖ The UT optical connection scheme was presented the LHCb upgrade electronics meeting on April 9th, 2015. There are small adjustments on the scheme since then.
- ❖ The cost estimates are based on the unit prices that Laurent received from the Optical Fibre Group. A worst-case scenario is assumed. Better prices may be negotiated for large quantity.

(Slides are updated to include what was discussed at the meeting)

- ❖ Data concentrator boards (DCB) in the PEPI chassis.
 - Transfer event data out:
SALT → DCB (GBTx, VTTx) → TELL40

- ❖ Master control boards (MCB) in the PEPI chassis.
 - Generate master clocks for DCBs & SALT ASICs,
 - Distribute TFC to SALT,
 - Configure & read back SALT registers via ECS,
 - Read out temperature, voltage, humidity etc via ECS.MCB(GBTx, GBT-SCA, VTRx) ↔ SOL40

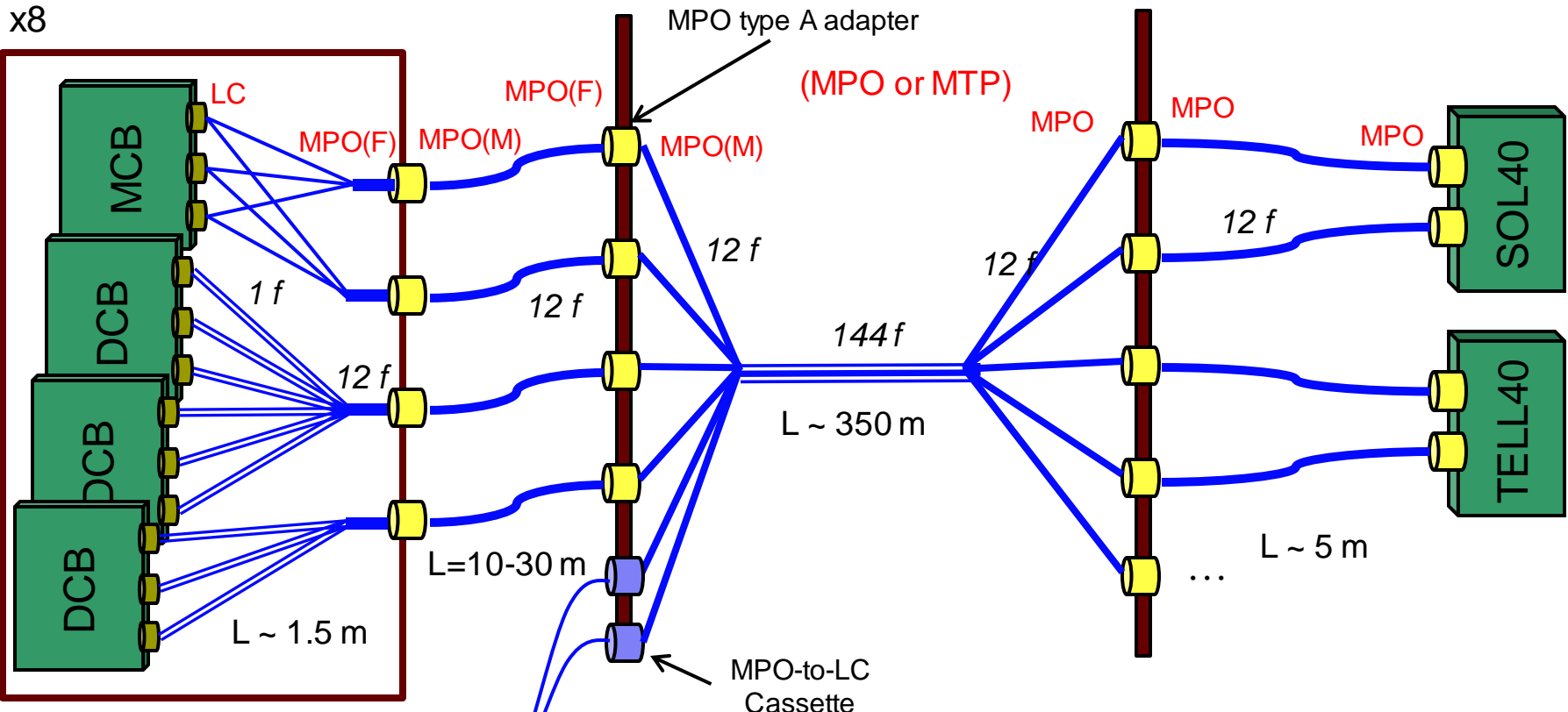
- ❖ LV monitor board in the service boxes.
 - Monitor LV parameters.LV monitor board (GBTx, GBT-SCA, VTRx) ↔ SOL40

Electronics
Chassis

UX85 Cavern
Patch Panel

Data Center
Patch Panel

DAQ PC
Rack



Scenario I: no regrouping of the 12f bundles in the counting room.

Unit	Quant.	For	GBTx (3e/4e/5e)	Single fibers	12f bundles
UTa Chassis	× 4	Event Data	138 (106/16/16)	138	16
		TFC/ECS	16	32	4
UTb Chassis	× 4	Event Data	152 (120/16/16)	152	18
		TFC/ECS	18	36	4
Service box	× 4	PS ECS	1	2	2 (total)
Total				1440	168+2

- ❖ Only ~18 of the 24 inputs of TELL40 can be due to FPGA limits. Inside UT chassis ~3 fibers of each 12f bundle are connected. There is no regrouping at later stages in this scenario.
- ❖ The number of 12x fiber cables from the VELO/RICH/UT patch panel to one chassis is 20+2 (UTa) & 22+2 (UTb), where 2/chassis are mounted spares, total 168+16.
- ❖ UT needs 170 (12x) bundles in the ~350 m long cables. No extra spares are needed as ~30% fibers are not used.

Total Cost For Scenario I

	item	Name	Unit price	Quantity	Spare	Cost (EUR)
UT Area	1	Fan-out patch cords (1.5m)	187.00	168	20	35156.00
	2	12x MPO adapter (A) plate	95.00	16	4	1900.00
	3	Multifiber patch cords (10 m)	160.00	84	8	14720.00
	4	Multifiber patch cords (30 m)	190.00	84	8	17480.00
	5	LC duplex patch cords (10,20 m)	40.00	4	2	240.00
UX85 Patch Panel	6	3U subrack+1U guide channel	155.00	2	1	-
	7	2xMPOF - 24xLC cassette	481.00	1	1	962.00
	8	12x MPO adapter (A) plate	95.00	16		-
	9	Long cable in 12x bundles (350 m)	1200.00	170		204000.00
Data Center	10	3U subrack+1U guide channel	155.00	2		-
	11	12x MPO adapter (A) plate	95.00	15		-
	12	Multifiber patch cords (5m)	147.00	170	20	27930.00
						302388.00

Subracks and MPO adapter plates are included in long cable cost.

Spare for a same item at different locations is counted only once.

Long cables have ~30% fibers unused and are spares.

Sample Of Accessories

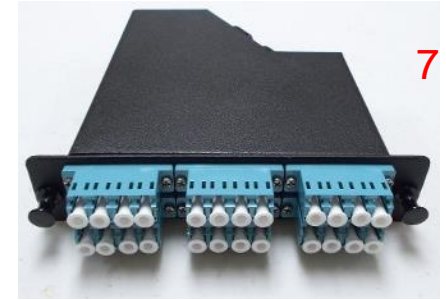
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7



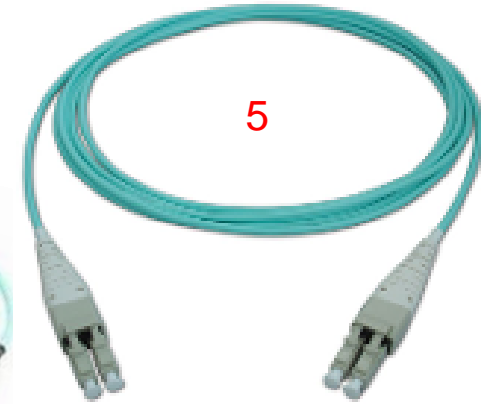
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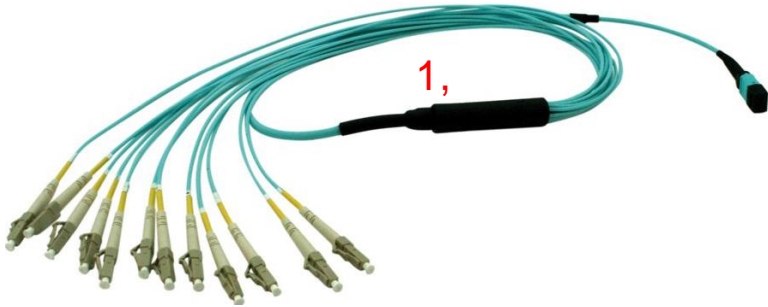
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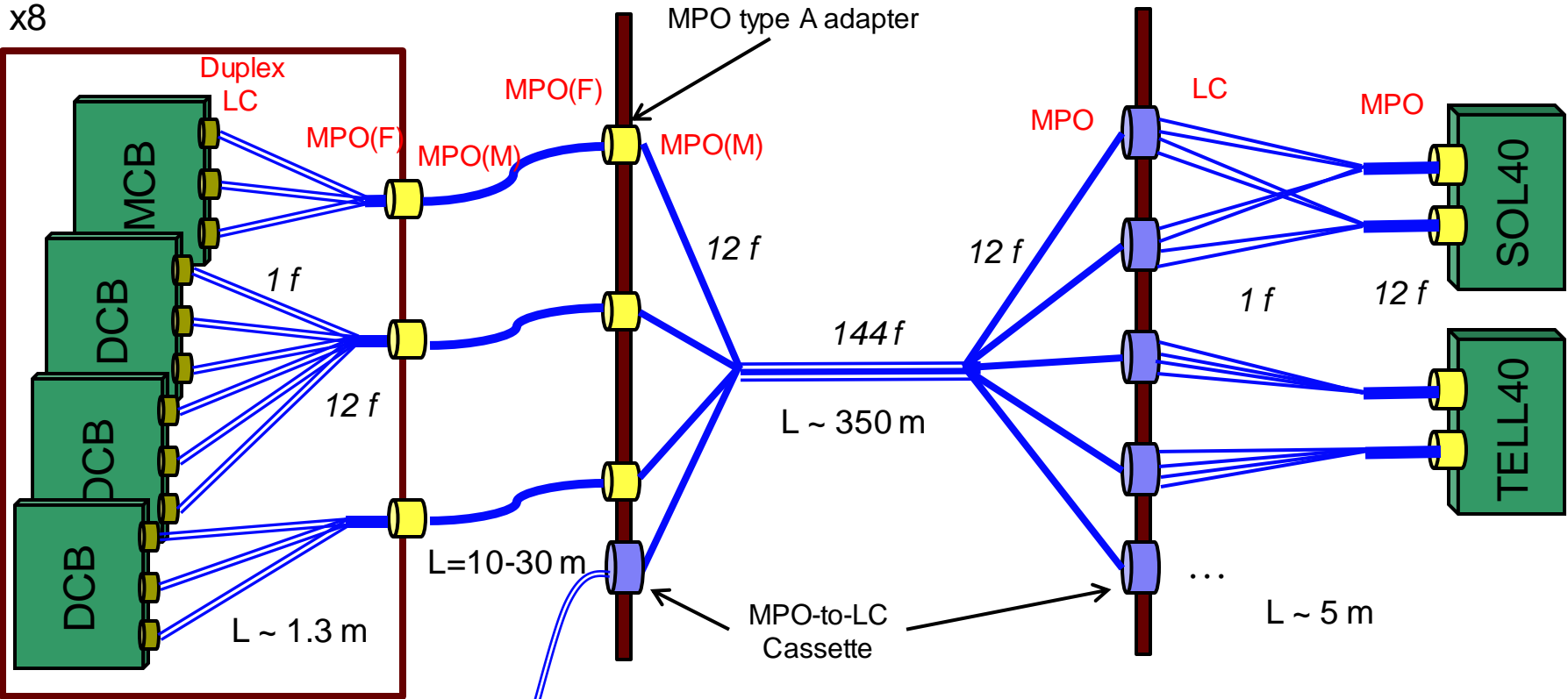


Electronics
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Scenario II: Regrouping in the counting room.
Variation: LC on the long cables at end of data center.
LC adapters on data center patch panel.

Unit	Quant.	For	GBTx (3e/4e/5e)	Single fibers	12f bundles
UTa Chassis	× 4	Event Data	138 (106/16/16)	138	15
		TFC/ECS	16	32	
UTb Chassis	× 4	Event Data	152 (120/16/16)	152	16
		TFC/ECS	18	36	
Service box	× 4	PS ECS	1	2	1 (total)
Total				1440	124+1

- ❖ In this scenario the fibers are regrouped to 12f bundle in the counting room before connecting to TELL40/SOL40.
- ❖ The number of 12x fiber cables from the VELO/RICH/UT patch panel to one chassis is 15+2 (UTa) & 16+2 (UTb), where 2/chassis are mounted spares, total 124+16.
- ❖ UT needs 125+12 (12x) bundles in the ~350 m long cables, where 12 bundles are spares (10%).

Total Cost For Scenario II

	item	Name	Unit price	Quantity	Spare	Cost (EUR)
UT Area	1	Fan-out patch cords (1.5m)	187.00	124	20	26928.00
	2	12x MPO adapter (A) plate	95.00	16	4	1900.00
	3	Multifiber patch cords (10 m)	160.00	62	8	11200.00
	4	Multifiber patch cords (30 m)	190.00	62	8	13300.00
	5	LC duplex patch cords (10,20 m)	40.00	4	2	240.00
UX85 Patch Panel	7	3U subrack+1U guide channel	155.00	1	1	-
	8	2xMPOF - 24xLC cassette	481.00	1		481.00
	9	12x MPO adapter (A) plate	95.00	11		-
	10	Long cable in 12x bundles (350 m)	1200.00	125	12	164400.00
Data Center	11	3U subrack+1U guide channel	155.00	6		-
	12	2xMPOF - 24xLC cassette	481.00	63	6	33189.00
	13	Fanout patch cords (5m)	193.00	170	20	36670.00
						288308.00

Compare to 302,388 for scenario I

We may save 3-4 PCIe40 boards in this scheme.

	item	Name	Unit price	Quantity	Spare	Cost (EUR)
UT Area	1	Fan-out patch cords (1.5m)	187.00	124	20	26928.00
	2	12x MPO adapter (A) plate	95.00	16	4	1900.00
	3	Multifiber patch cords (10 m)	160.00	62	8	11200.00
	4	Multifiber patch cords (30 m)	190.00	62	8	13300.00
	5	LC duplex patch cords (10,20 m)	40.00	4	2	240.00
UX85 Patch Panel	7	3U subrack+1U guide channel	155.00	1	1	-
	8	1xMPOF - 12xLC cassette	260.00	1	1	520.00
	9	12x MPO adapter (A) plate	95.00	11		-
	10	Long cable in 12x bundles (350 m)	1200.00	125	12	164400.00
Data Center	11	3U subrack+1U guide channel	155.00	6		-
	12	24x LC adapter plate	30.00	63	6	2070.00
	13	Fanout patch cords (5m)	193.00	170	20	36670.00
						257228.00

Compare to 302,388 for scenario I

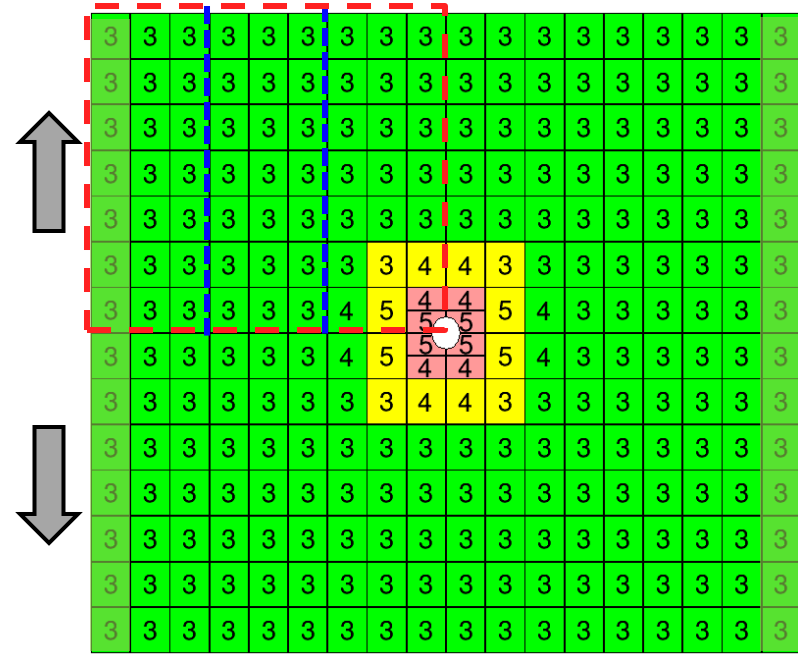
If the trunk cables are terminated with 144x LC at the end in the counting room.

Backup Slides

- E-ports operate @ 320 Mbps (8 bits / BCO).
- All e-ports of an ASIC connect to the same GBTx.
- Wide GBT frame (112 = 14 × 8 bits), partially filled.
 - 4 × 3-eport ASICs (96 bits).
 - 3 × 4-eport ASICs (96 bits).
 - 2 × 5-eport ASICs (80 bits).
- Half staves are shown in tables below.

ASICs/sensor: 4(G), 8 (Y/R)
 e-ports / ASIC: value inside

2 (a/b) × 4 (quads) chassis
 3 backplanes / chassis



A	4x3	4x3	4x3	4x3	4x3	4x3	4x3		E-ports	84
	1	1	1	1	1	1	1		GBTx	7
A*	4x3	4x3	4x3	4x3	4x3	4x3	4x4		E-ports	88
	1	1	1	1	1	1	2		GBTx	8
B	4x3	4x3	4x3	4x3	4x3	8x3	8x5		E-ports	124
	1	1	1	1	1	2	4		GBTx	11
C	4x3	4x3	4x3	4x3	4x3	8x4	8x4	8x5	E-ports	164
	1	1	1	1	1	3	3	4	GBTx	15

A A A A A A A B C C B A A A A A A

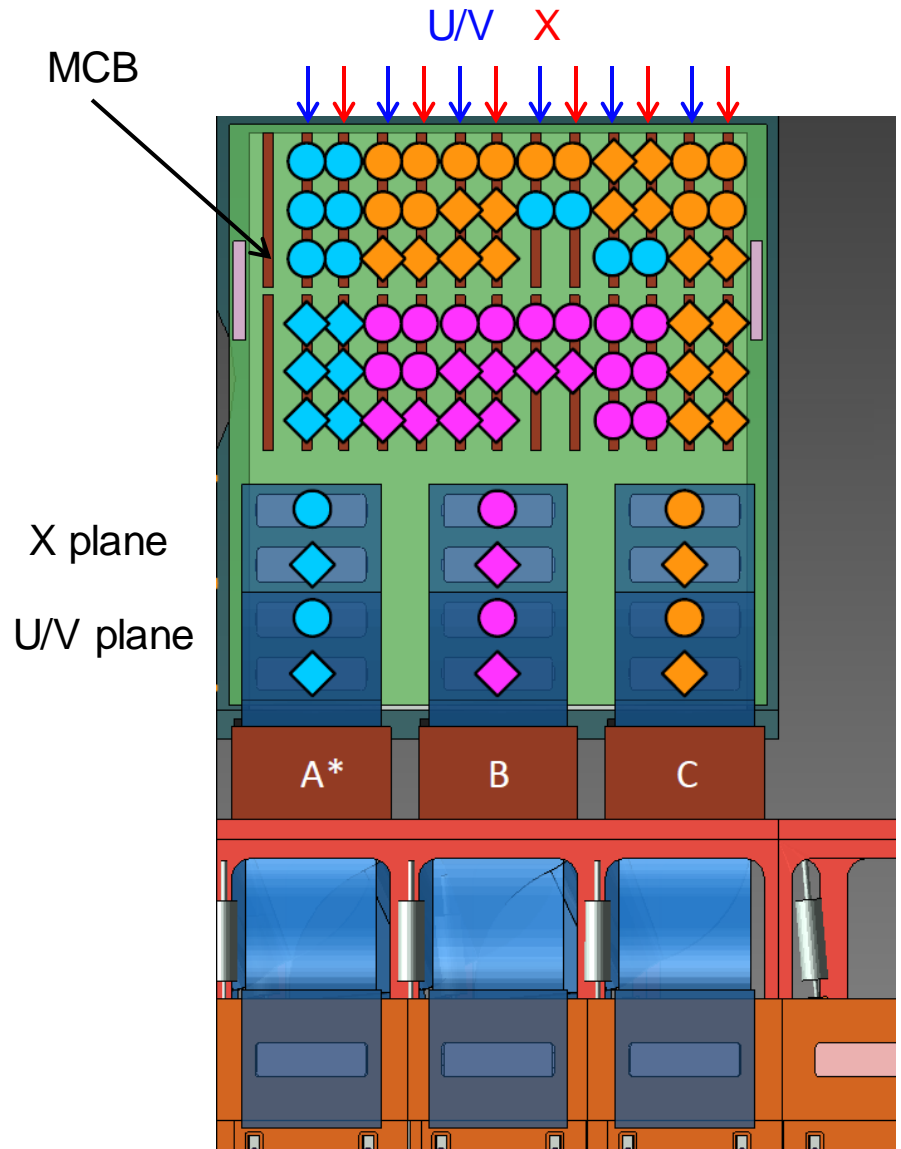
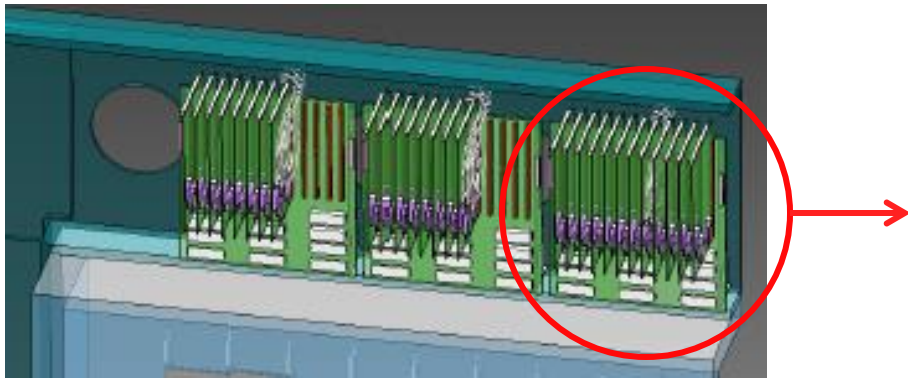
16 staves in UTaX / UTaU
 18 staves in UTbV / UTbX

For each quadrant

Stave Type		A	A	A	A	A	A	A*	B	C	Sum
GBTx	UTaX	-	7	7	7	7	7	8	11	15	69
	UTaU	-	7	7	7	7	7	8	11	15	69
	BackPlane	28			42			68			138
GBTx	UTbV	7	7	7	7	7	7	8	11	15	76
	UTbX	7	7	7	7	7	7	8	11	15	76
	BackPlane	42			42			68			152

- ❖ Multiple DCBs are plugged into one backplane. Back planes route ASIC data lines to different DCBs.
- ❖ Total 1160 GBTx chips ($4 \times 138 + 4 \times 152$) for event data.
- ❖ Electronic signals are converted to optical and sent out at VTTx links. Each VTTx serves 2 GBTx chips, & have 1 duplex LC receptacles.

PEPI backplanes route ASIC data lines to DCBs, distribute TFC, LV etc (ref: [Jason Andrews' presentation at mechanics review](#)).



ASIC Type (eports/ASIC)	GBT Links					# of TELL40	
	ASICs per Link	Links per quadrant	Links per chassis	Total Links	Max Links per TELL40	Per chassis	Total
3	4	53 / 60	106 / 120	904	18	6/7	52 (51)
4	3	8	16	128	19	1	8 (7)
5	2	8	16	128	20	1	8 (7)
Sum		69 / 76	138 / 152	1160	-	8/9	68 (65)

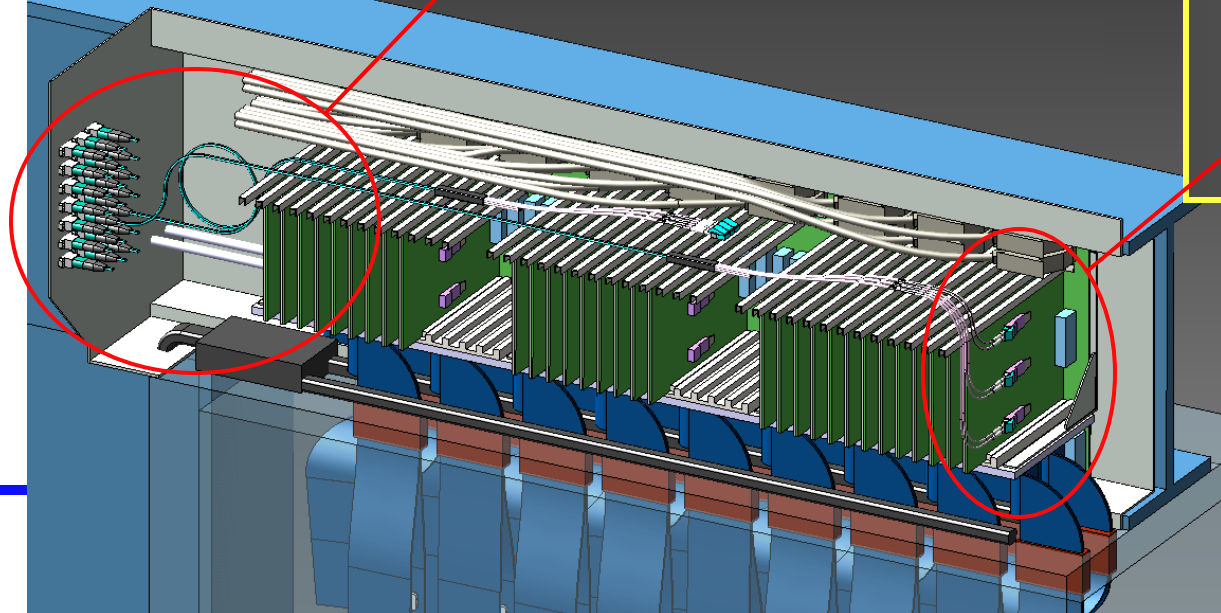
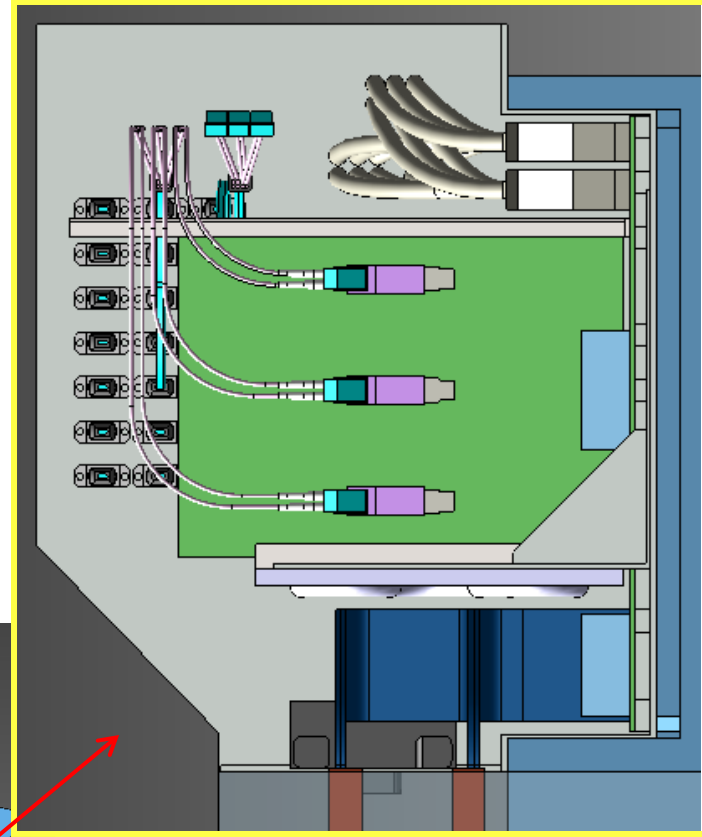
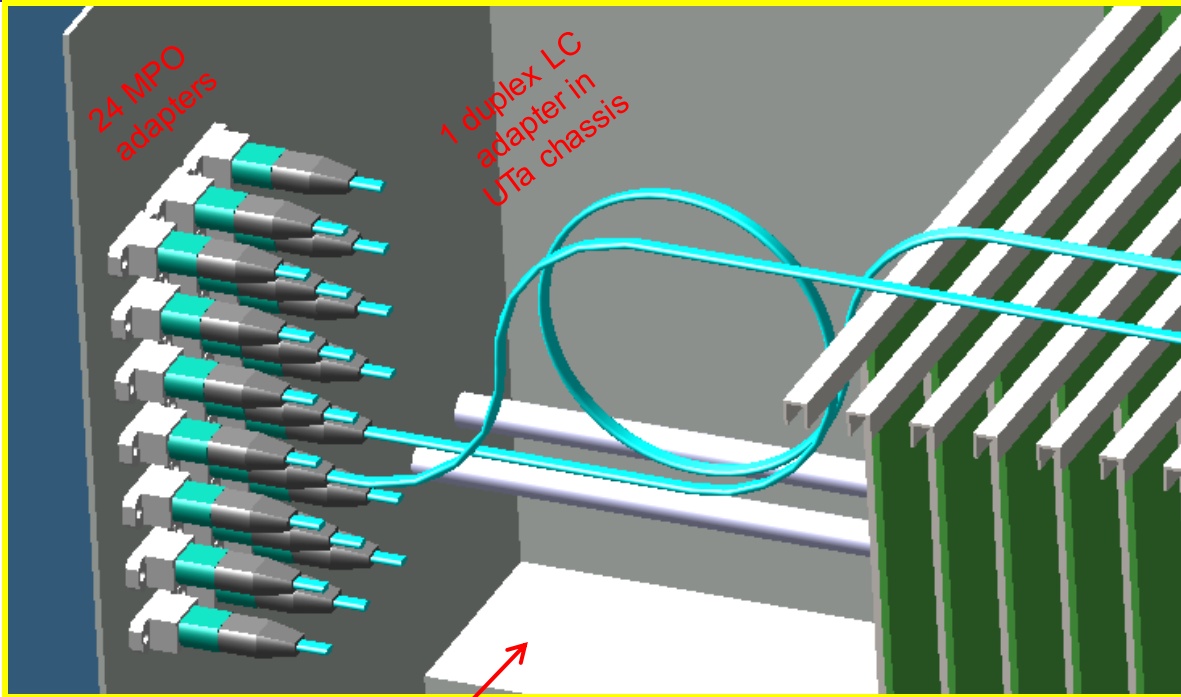
↑
Needs update
↑
regrouping

- ❑ One TELL40 board can have max 2×12 optical inputs. Not all inputs can be used for UT due to the sub-GBT-frame structure and limited resources in the FPGA.
- ❑ Designated TELL40s will be used separately for links of 3-, 4-, 5- eports/ASIC. The difference will be hard coded in the firmware so as to save resources.
- ❑ There will be NO regrouping of optical fibers in the counting room. What ever grouping of 12f in the chassis will be pertained at TELL40.

- ❖ Each UT chassis has 3 MCBs, 1 per backplane.
- ❖ One MCB can house 7 GBTx chips, total 21 per chassis. In the latest revision from Tom O'Bannon, only 16 (18) GBTx are needed per chassis.
- ❖ For optical communication 1 GBTx needs 1 VTRx and 2 fibers for input & output. Thus there are total 32 (36) active fibers per chassis, in four 12x fiber cables.
- ❖ With possible I²C changing to a different protocol, the total number of fibers may change. It should not affect the optical cable counts as there is room.

- ❖ We also need to monitor LV powers in the service boxes (Carlos Abellan Beteta).
- ❖ Each service box needs 2 fibers for input & output.
- ❖ The efficient way is to route a duplex fiber cable from a service box to the UTa chassis that the box serves.
- ❖ In the UTa chassis the pair of fibers can connect to the TFC/ECS fiber cables.

Optical Connections In PEPI Chassis



Drawing by Jason