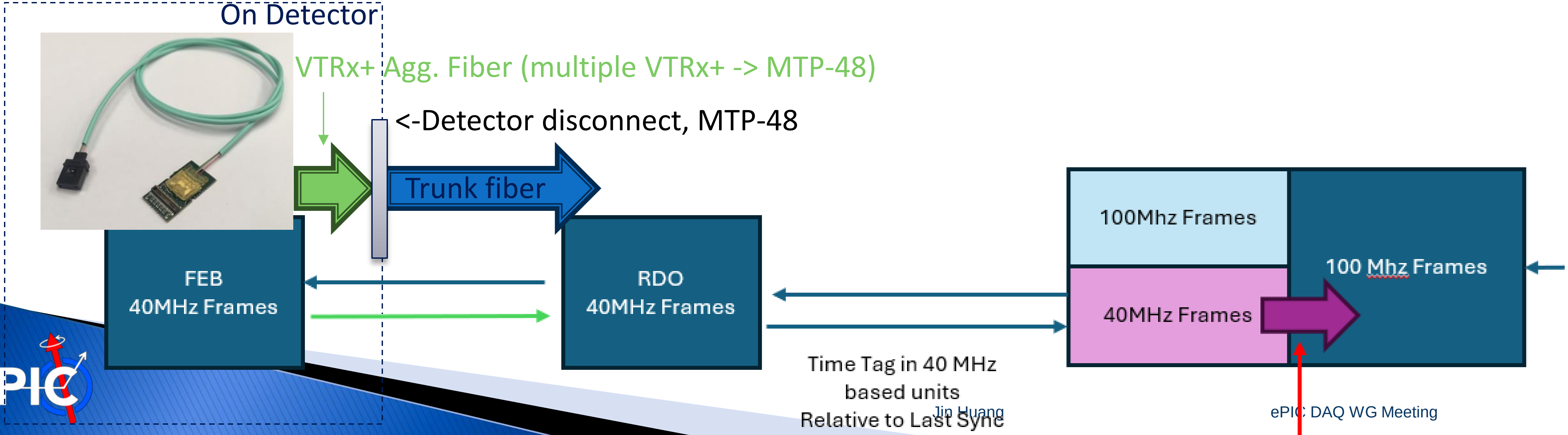
9×VTRx+ to 1×MTP aggregation fiber ?

Jin Huang (BNL)

ePIC

VTRx+ fiber routing

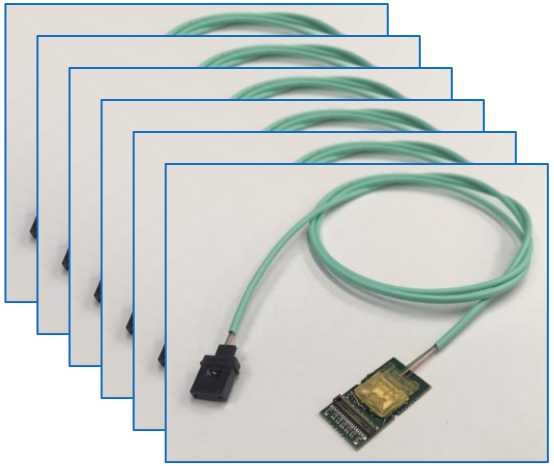
- Many of our subsystem opt for VTRx+ as FEB optical transceiver for compactness, lower power consumption and radiation hardness
- With FEB installation VTRx+ can be hard to access/replace, carry a flimsy fiber,
- Prototyping a set of VTRx+ aggregation fiber for ePIC
  - Goals: (1) protect VTRx fiber tail (2) clean detector disconnect (3) reduce number of trunk fiber and connectors
  - Prototype design with a fiber vendor (Computer Craft Inc) which also supplied custom fiber for sPHENIX and working with existing VTRx users



9-to-1 VTRx+ aggregation fiber prototype, for our discussion

On detector (within subsystem envelop)

Up to 9x VTRx+ (using all 4x TX), On FEBs



MT/MTP coupler
In detector

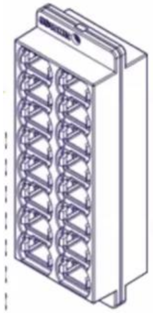
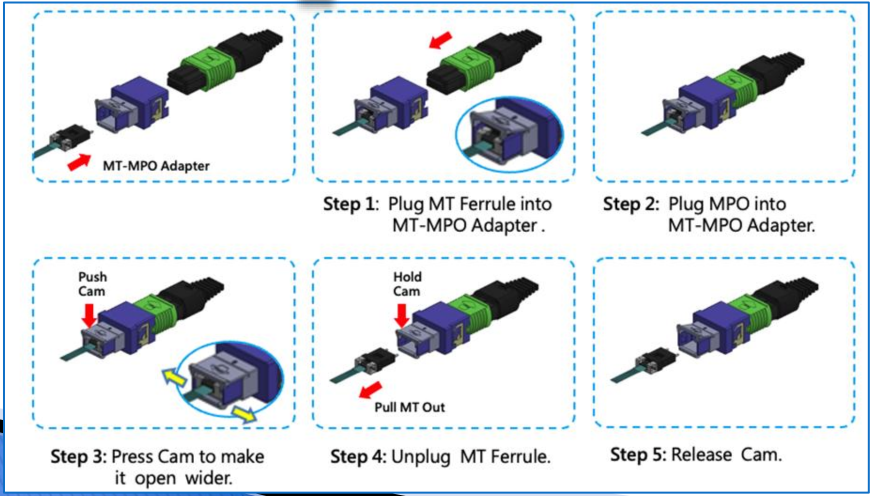
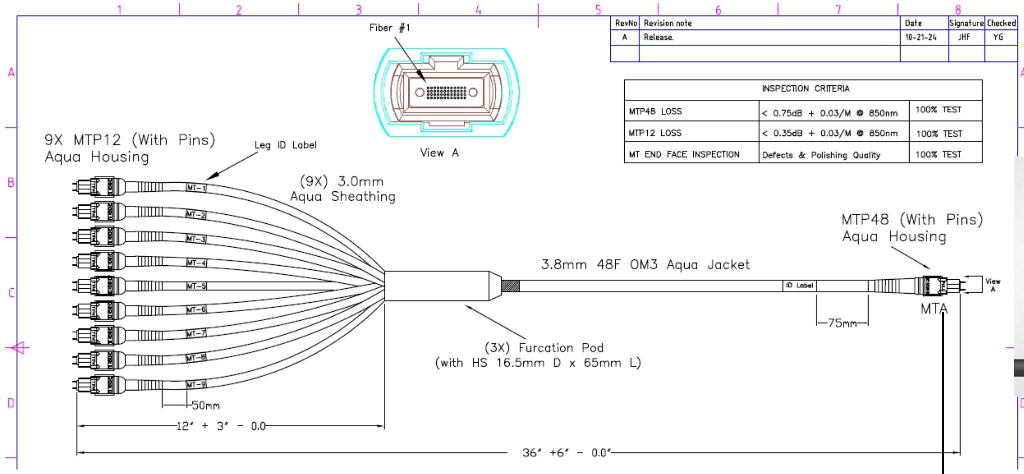


Table 8: VTRx+ module optical interface pinout.

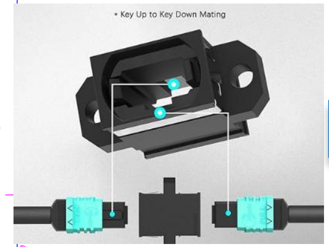
VTRx+ Function	Fibre Number
RX	7
TX1	6
TX2	5
TX3	4
TX4	3



VTRx+ aggregation fiber, in detector



MTP/MTP coupler
At detector disconnect



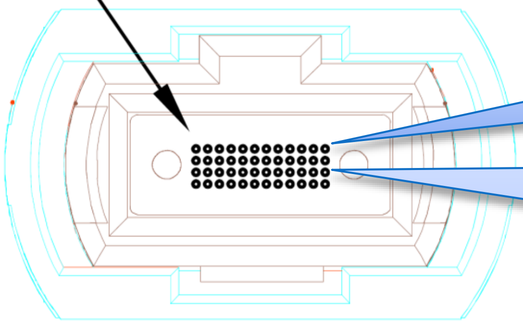
Trunk fiber → Fiber-Fiber RDO

MTPA 48 - 9X MT Polarity Mapping

MTA1	MTA2	MTA3	MTA4	MTA5	MTA6	MTA7	MTA8	MTA9	MTA10	MTA11	MTA12
MT1-7	MT2-7	MT3-7	MT4-7	MT5-7	MT6-7	MT7-7	MT8-7	MT9-7	N/A	N/A	N/A
MTA25	MTA26	MTA27	MTA28	MTA29	MTA30	MTA31	MTA32	MTA33	MTA34	MTA35	MTA36
MT4-3	MT4-4	MT4-5	MT4-6	MT5-3	MT5-4	MT5-5	MT5-6	MT6-3	MT6-4	MT6-5	MT6-6

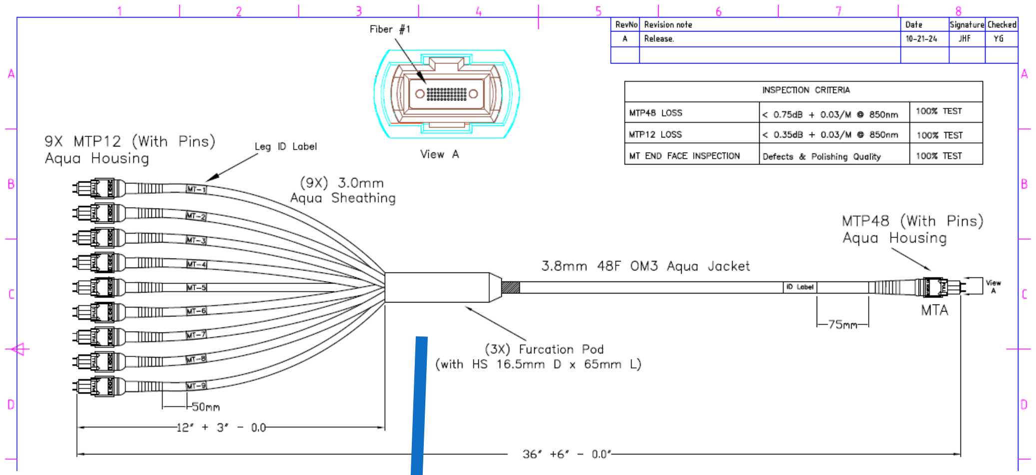
MTA13	MTA14	MTA15	MTA16	MTA17	MTA18	MTA19	MTA20	MTA21	MTA22	MTA23	MTA24
MT1-3	MT1-4	MT1-5	MT1-6	MT2-3	MT2-4	MT2-5	MT2-6	MT3-3	MT3-4	MT3-5	MT3-6
MTA37	MTA38	MTA39	MTA40	MTA41	MTA42	MTA43	MTA44	MTA45	MTA46	MTA47	MTA48
MT7-3	MT7-4	MT7-5	MT7-6	MT8-3	MT8-4	MT8-5	MT8-6	MT9-3	MT9-4	MT9-5	MT9-6

Sheet: 1 of 1

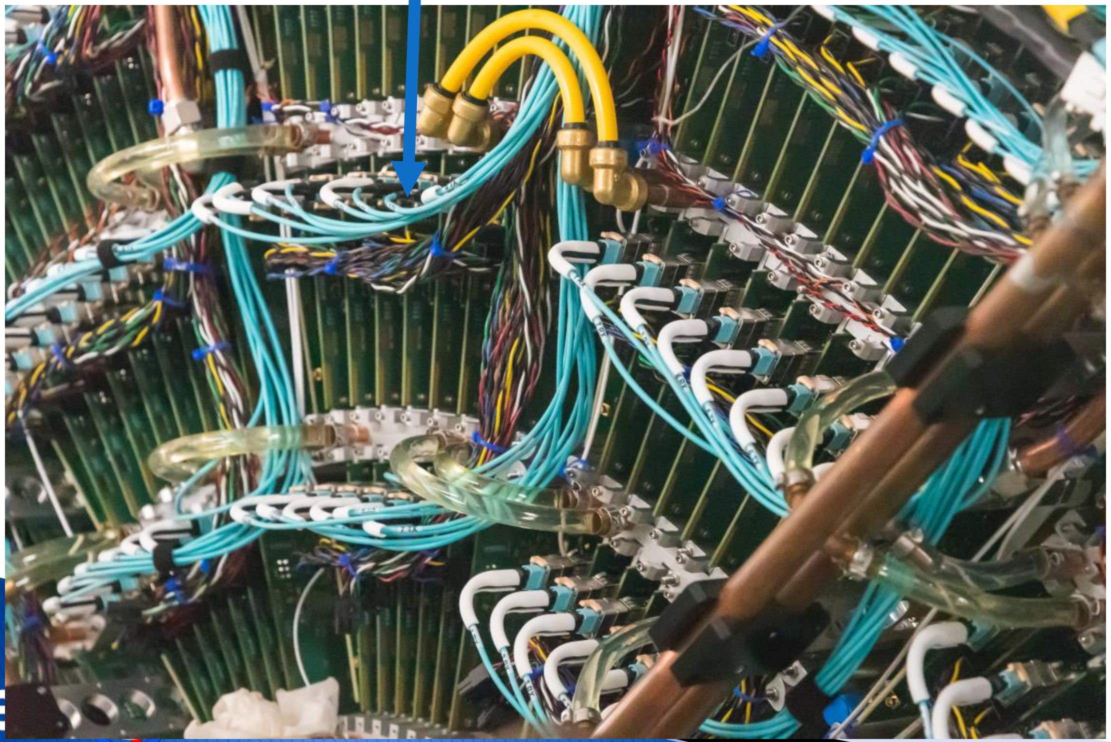


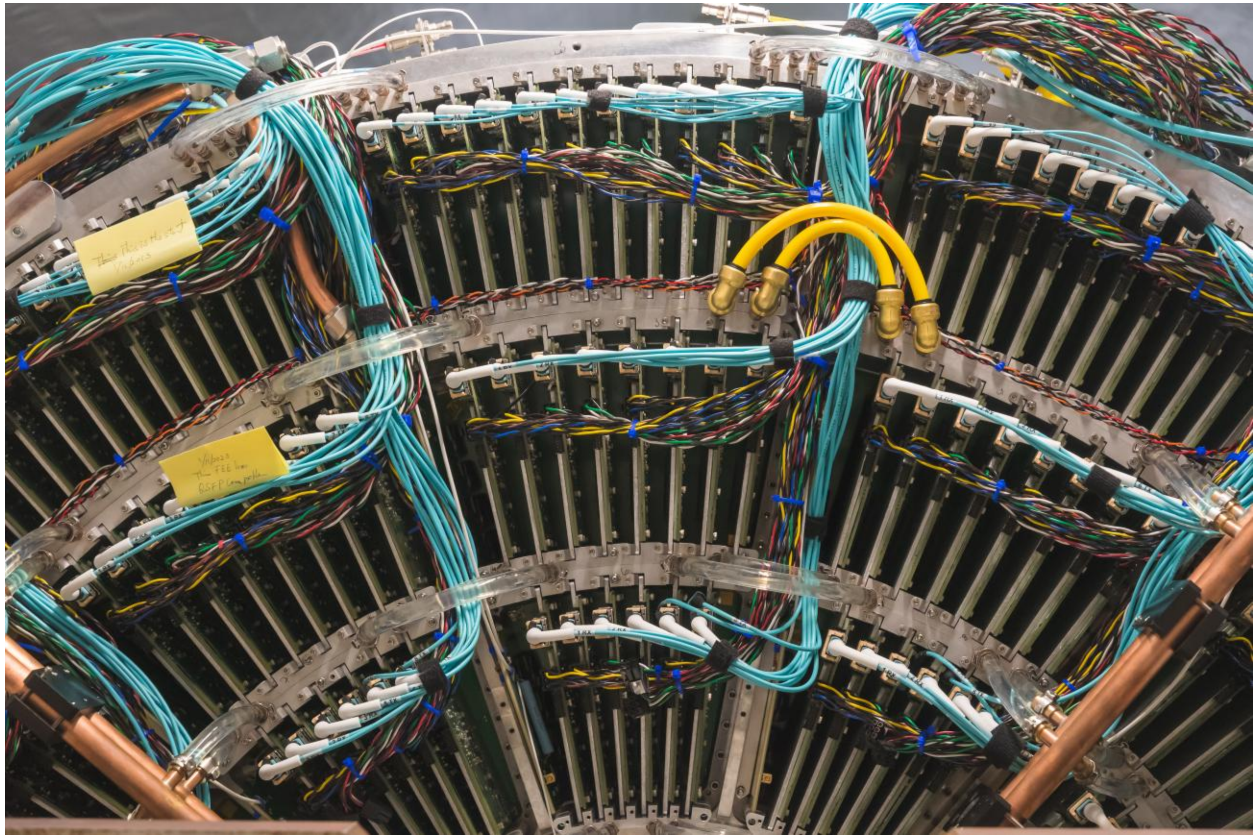
Top row: 9 active fiber for downlink firefly

Bottom three rows: 9 set of 4 uplink fiber



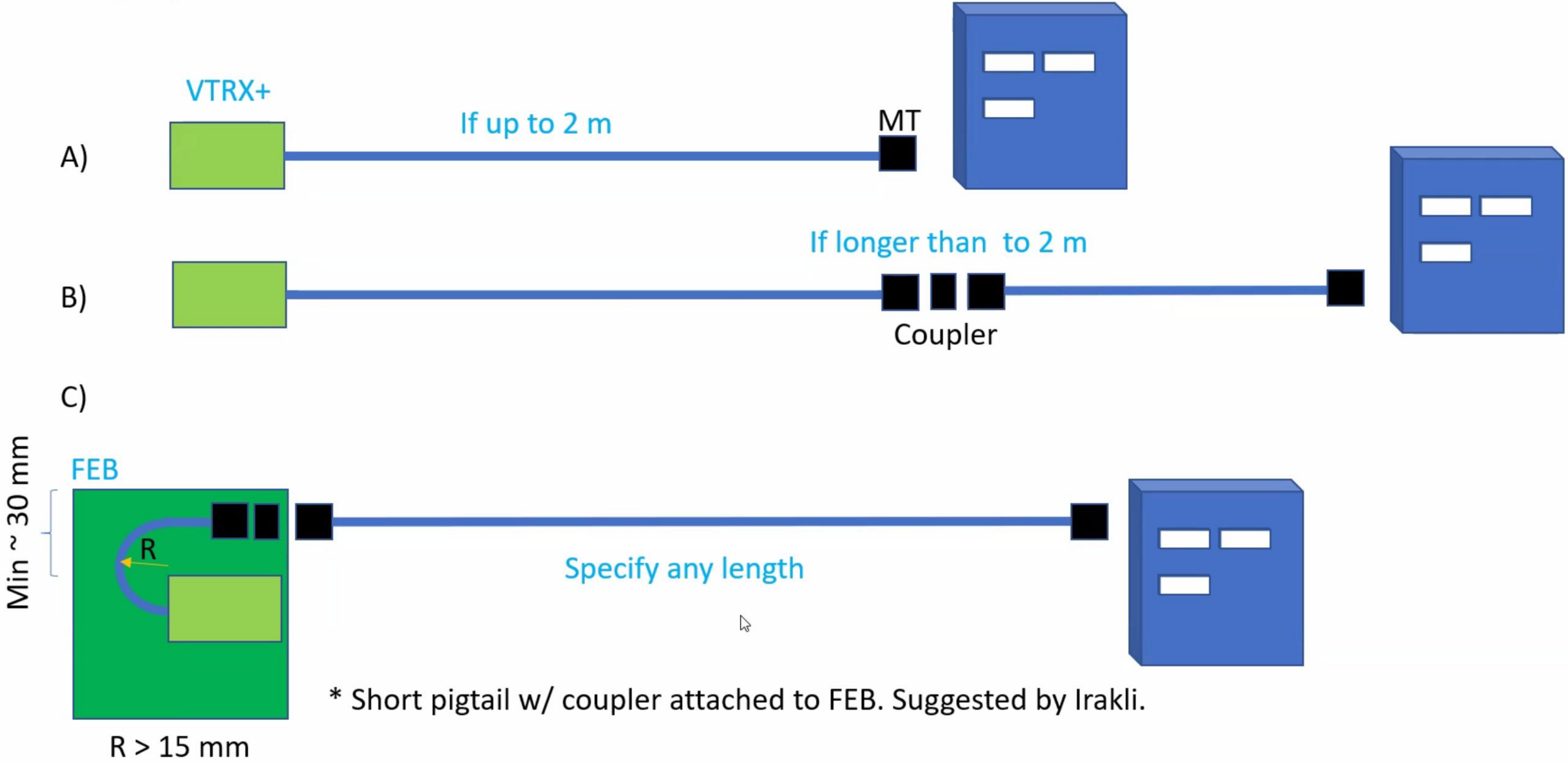
RevNo | Revision note | Date | Signature | Checked
A | Release. | 10-21-24 | JHF | YG
INSPECTION CRITERIA
MTP48 LOSS | < 0.75dB + 0.03/M @ 850nm | 100% TEST
MTP12 LOSS | < 0.35dB + 0.03/M @ 850nm | 100% TEST
MT END FACE INSPECTION | Defects & Polishing Quality | 100% TEST
Fiber #1
View A
9X MTP12 (With Pins)
Aqua Housing
Leg ID Label
(9X) 3.0mm
Aqua Sheathing
MTP48 (With Pins)
Aqua Housing
3.8mm 48F OM3 Aqua Jacket
MTA
75mm
(3X) Furcation Pod
(with HS 16.5mm D x 65mm L)
50mm
12" + 3" - 0.0
36" +6" - 0.0"



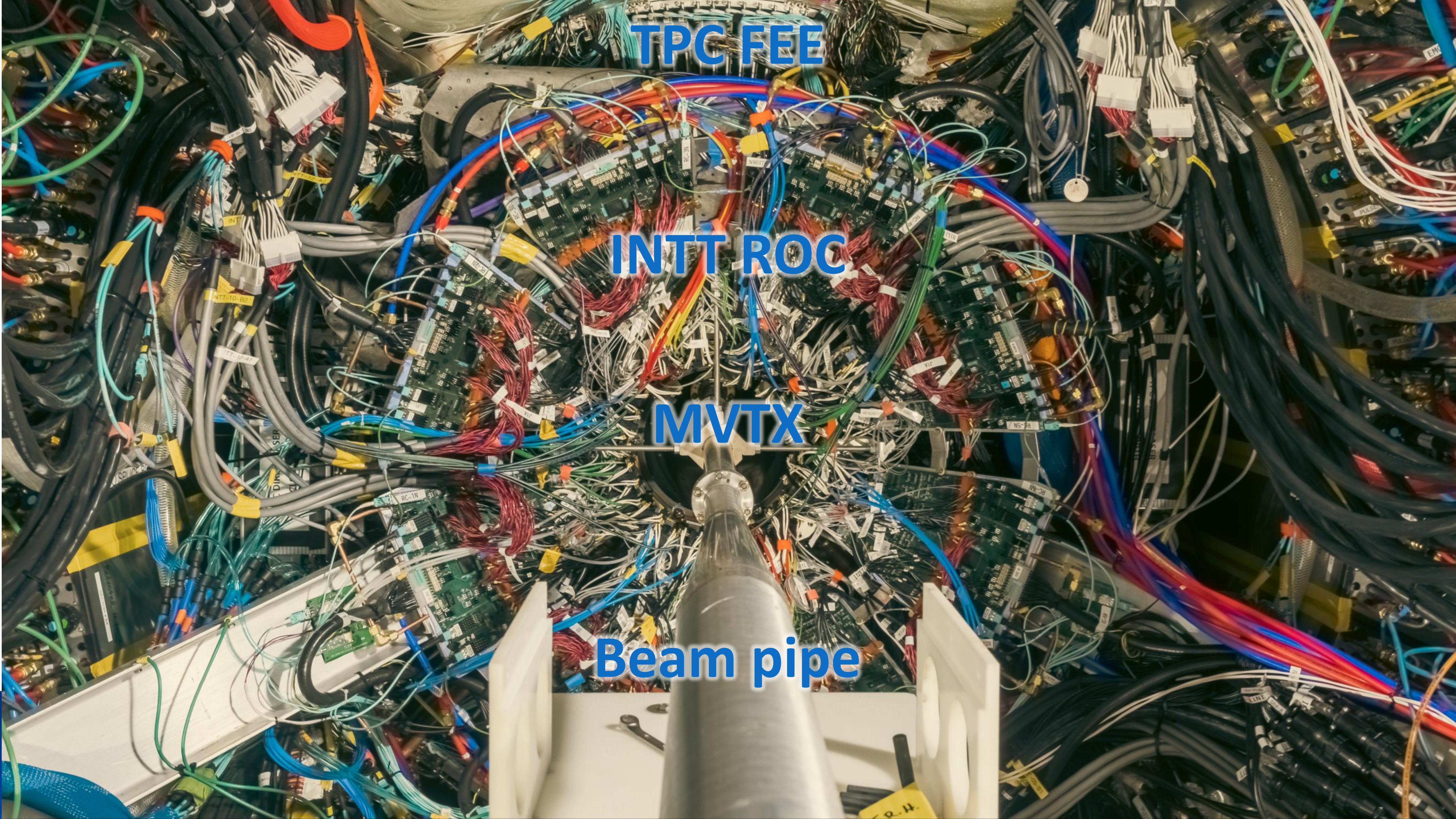


Extra Information

Routing Options:



* Short pigtail w/ coupler attached to FEB. Suggested by Irakli.

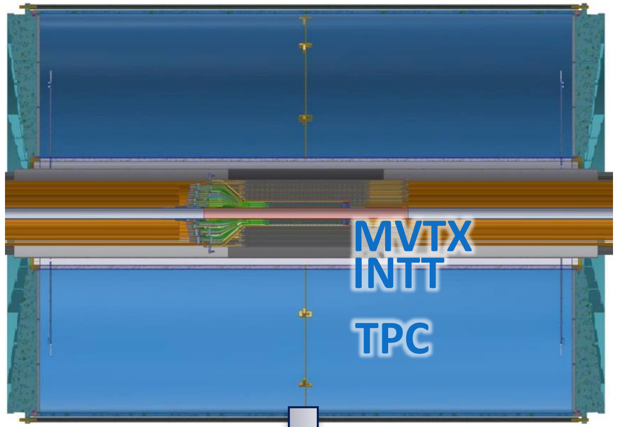


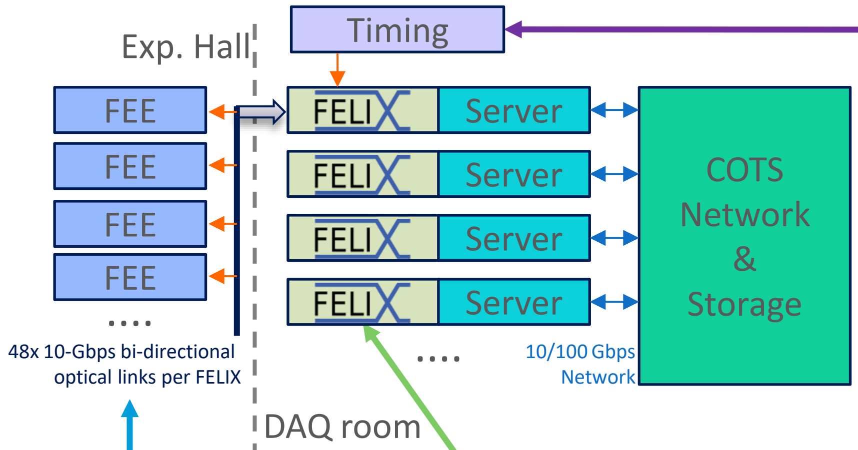
TPC FEE
INTT ROC
MVTX
Beam pipe

FELIX Readout for sPHENIX Tracker

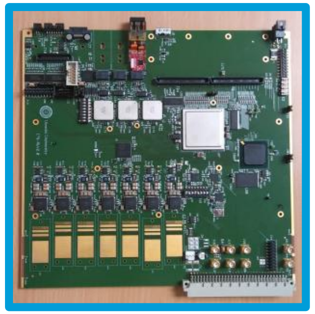
≈ GTU, x1

sPHENIX streaming DAQ for tracker





Global Timing Module (NSLS II/sPHENIX)
Receiving from RHIC RF low glitter clock source

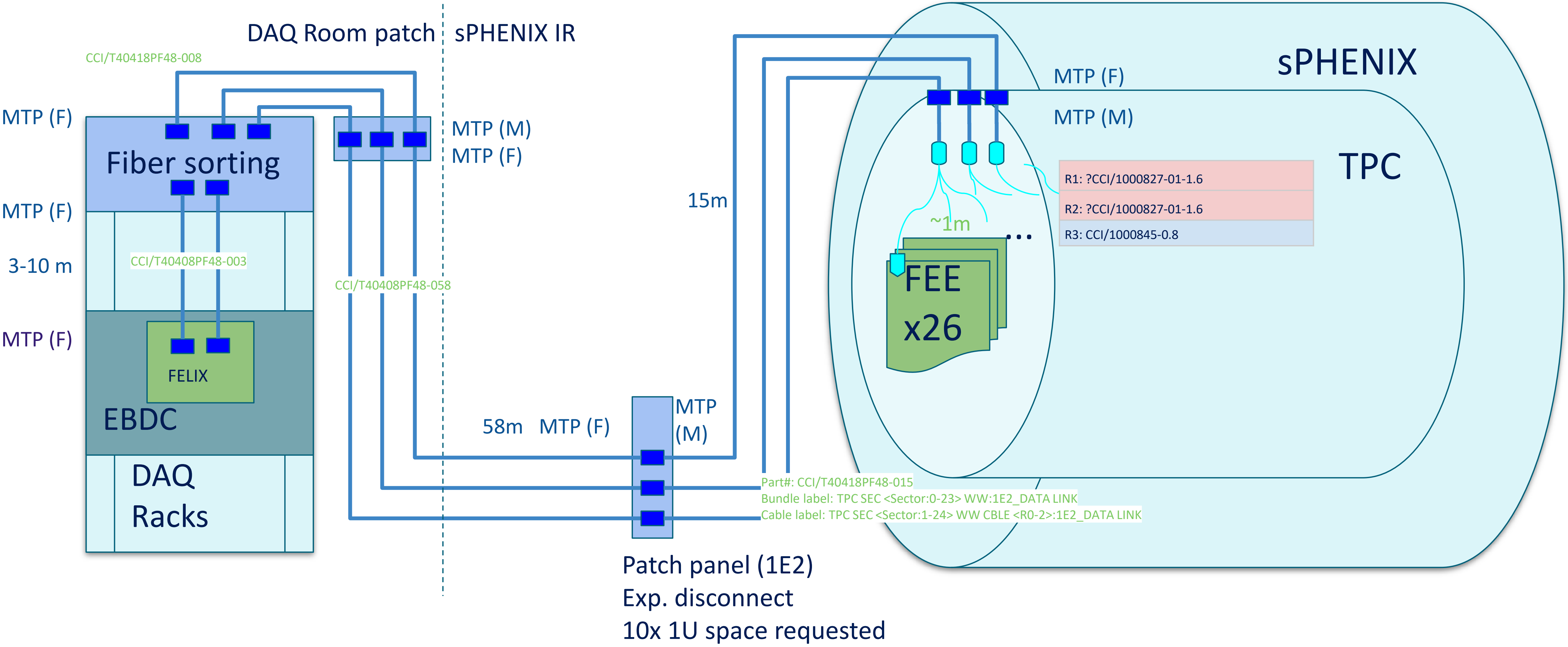


MVTX RU, 200M ch — INTT ROC, 400k ch — TPC FEE, 160k ch — BNL-712 / FELIX v2 x38 (ATLAS/sPHENIX), [Ref]

ALPIDE (ALICE/sPHENIX), FPHX (PHENIX) — SAMPAv5 (ALICE/sPHENIX) — FELIX Fiber IO: 48x bidirectional 10Gbps in 2x MTP-48

ePIC nonmature: **≈RDO x48** — **≈4xRDO, x8** — **≈FEB+RDO, x624** — **≈DAM, x38**

sPHENIX TPC Data Fiber Cabling Plan, 1 of 24 sectors shown



48F MTP Cable MTP coupler MTP-QSFP breakout QSFP MTP cable QSFP Transceiver

One-way optical loss: 1.5dB

Parts list

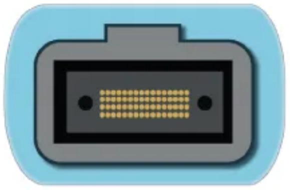
https://www.computer-crafts.com/products/

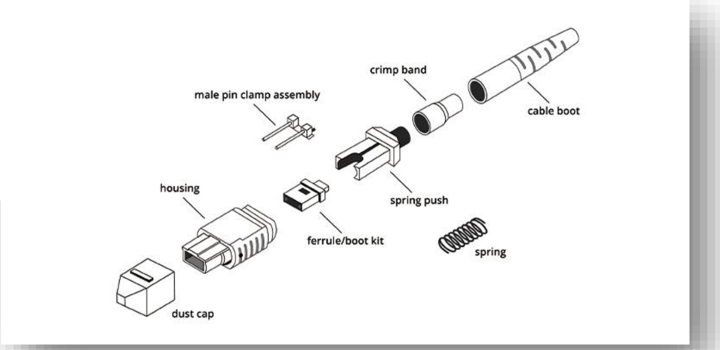
Protoyped, manufactured and QA by ComputerCrafts CC

#	Item	Part	Description
1	FELIX-> SOB	CCI/T40408PF48-003	48F MTP(F) to 48F MTP(F) on OM3 3.8mm round jacket Cable 3 meter length Pol 1-1, 48-48
2	48F MTP Cassette in SOB	CCI/56745-48MT-OM3	24 Port Duplex to 48F MTP(M) Cassette using (12X) quad LC couplers. (1X) 48F MTP - LC Hydra OM3
3	48F -> LC breakout in SOB	CCI/1000450-18I-48F	48F MTP(M) - LC Hydra assembly 48X 900um breakourts OM3 20" length
4	SOB -> DAQ room Patch	CCI/T40418PF48-008	48F MTP(F) to 48F MTP(M) on OM3 3.8mm round jacket Cable 8 meter length
5	DAQ room Patch	CCI/56349-MT	1U 19" 16 port MPO feedthru panel with 16X MPO couplers
6	DAQ room Patch -> 1E2 patch	CCI/T40408PF48-058	48F MTP(F) to 48F MTP(F) on OM3 3.8mm round jacket Cable 58 meter length, Pol 1-1 48-48
7	1E2 patch	CCI/56349-MT	1U 19" 16 port MPO feedthru panel with 16X MPO couplers
8	1E2 -> TPC endcap	CCI/T40418PF48-015	48F MTP(F) to 48F MTP(M) on OM3 3.8mm round aqua jacket Cable. Polarity straight (1-1, 48-48) 15 meter length on a collapsible reel.
9	TPC Endcap coupler	CCI/12214/USC	MTP-MTP Aqua adapter standard size with full flanges and opposing keys. Includes 2 dust caps.
9	TPC Endcap coupler (final desi	14995/USC	14995, Adapter, MTP® SC Footprint, Full Flange, Duplex, Opposed Key, Aqua, 4 Dust Plugs
10	TPC endcap breakout R1	?CCI/1000827-01-1.6	48 Fiber MTP(M) to 8X staggered 6F MTP(F) on OM3 8X 2mm OFNP Rnd. 1 Mtr breakout, 1.6 Mtr overall length
12	TPC endcap breakout R3	CCI/1000845-0.8	48F MTP(M) to 12X Staggered 4F MTP(F) on 3.8mm OM3 to staggered 2mm MT BO and a 0.8M TT

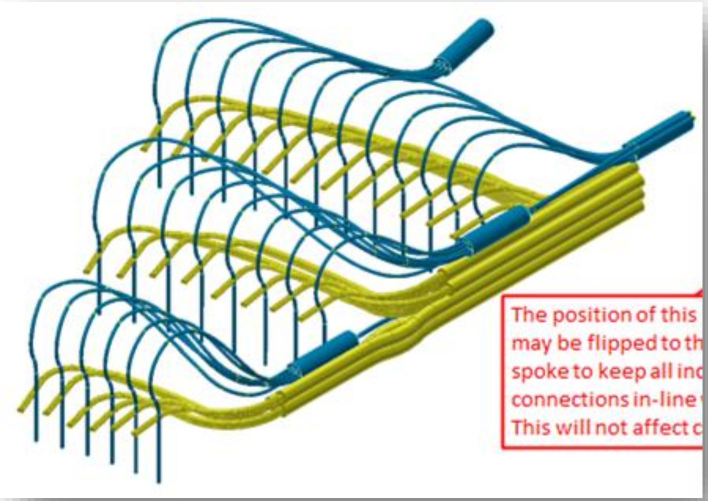
Standardized:

- MTP-48 trunk fiber: density + reliability;
- OM3 fiber: good enough, cost effective
- Custom breakout wherever needed to fit channel map and geometry
- Opposite keying coupler; female MTP connector at the mobile side of the coupler; separate TX/RX by rows in MTP-48 connector



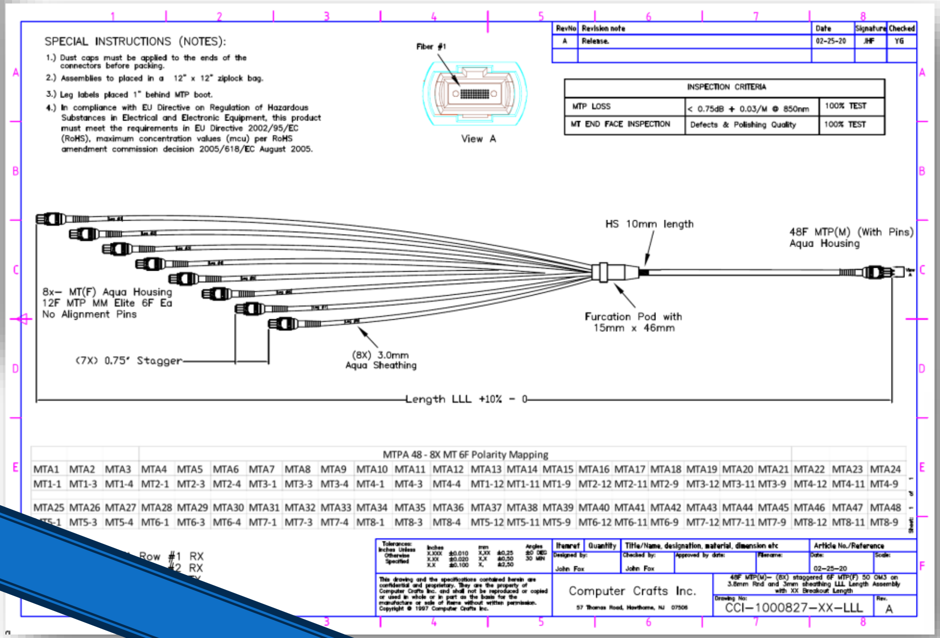


Custom MTP-48 to MTP-12 breakout

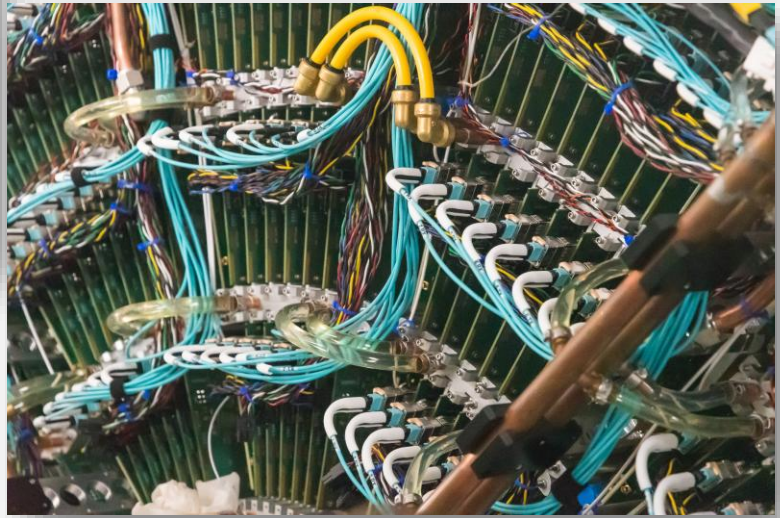


Mechanical and channel-mapping design at BNL

Drawing and manufacture/QA at CCI: ~$500 + 4wk LT



Installation at sPHENIX



SOB input MTP trunk Cable mapping, 1 of 24 sectors shown

Legend:	48F MTP trunk	QSFP/FEE	High speed link	Low speed link

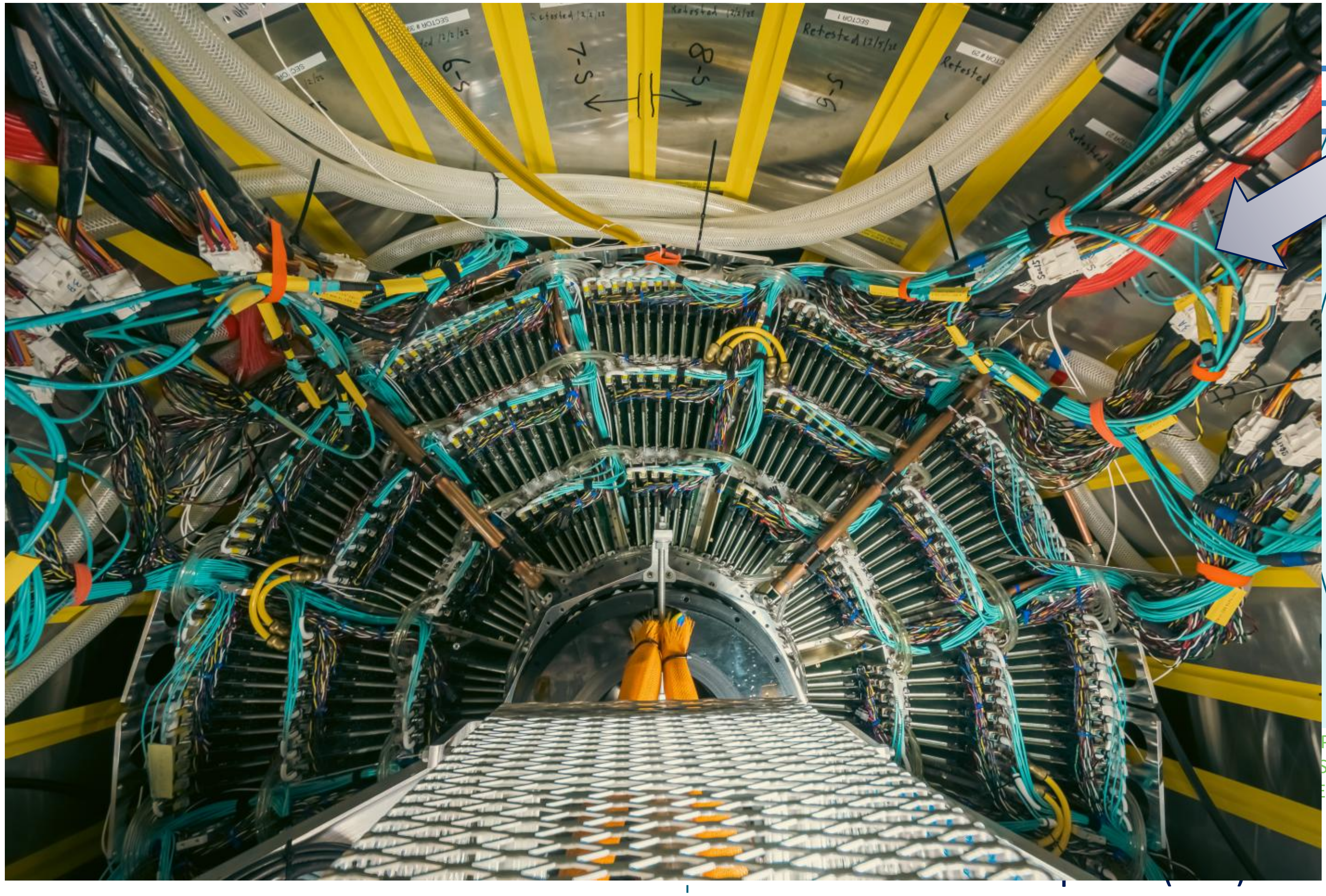
MTP 48F cable mapping

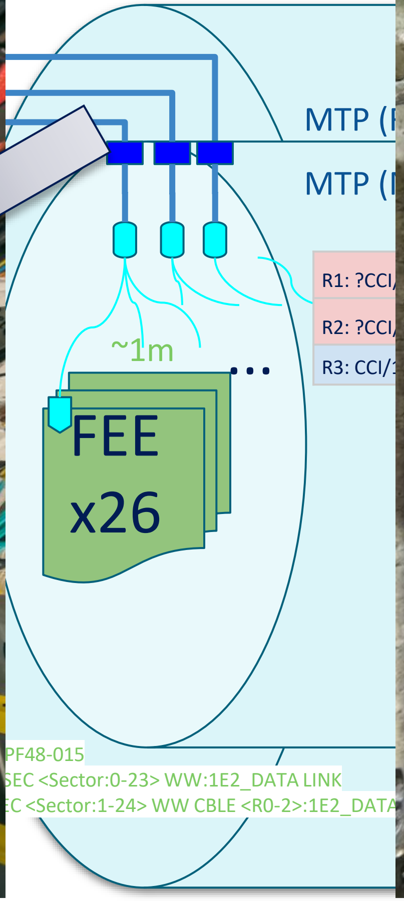
MTP Trunk cable	FEE side fiber assignment in breakout at TPC endcap											
	1	2	3	4	5	6	7	8	9	10	11	12
Trunk Fiber to R3 12xFEEs	DAM->FEE SC	DAM->FEE JTag	DAM->FEE SC	DAM->FEE JTag	DAM->FEE SC	DAM->FEE JTag	DAM->FEE SC	DAM->FEE JTag	DAM->FEE SC	DAM->FEE JTag	DAM->FEE SC	DAM->FEE JTag
	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM JTag
	DAM->FEE SC	DAM->FEE JTag	DAM->FEE SC	DAM->FEE JTag	DAM->FEE SC	DAM->FEE JTag	DAM->FEE SC	DAM->FEE JTag	DAM->FEE SC	DAM->FEE JTag	DAM->FEE SC	DAM->FEE JTag
	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM JTag
	1	2	3	4	5	6	7	8	9	10	11	12
Trunk Fiber to R2 8xFEEs	DAM->FEE SC	DAM->FEE CLK	DAM->FEE JTag	DAM->FEE SC	DAM->FEE CLK	DAM->FEE JTag	DAM->FEE SC	DAM->FEE CLK	DAM->FEE JTag	DAM->FEE SC	DAM->FEE CLK	DAM->FEE JTag
	FEE->DAM data	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM data	FEE->DAM JTag
	DAM->FEE SC	DAM->FEE CLK	DAM->FEE JTag	DAM->FEE SC	DAM->FEE CLK	DAM->FEE JTag	DAM->FEE SC	DAM->FEE CLK	DAM->FEE JTag	DAM->FEE SC	DAM->FEE CLK	DAM->FEE JTag
	FEE->DAM data	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM data	FEE->DAM JTag
	1	2	3	4	5	6	7	8	9	10	11	12
Trunk Fiber to R1 6xFEEs	DAM->FEE SC	DAM->FEE CLK	DAM->FEE JTag	DAM->FEE SC	DAM->FEE CLK	DAM->FEE JTag	DAM->FEE SC	DAM->FEE CLK	DAM->FEE JTag	DAM->FEE SC	DAM->FEE CLK	DAM->FEE JTag
	FEE->DAM data	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM data	FEE->DAM JTag
	DAM->FEE SC	DAM->FEE CLK	DAM->FEE JTag	DAM->FEE SC	DAM->FEE CLK	DAM->FEE JTag	DAM->FEE SC	DAM->FEE CLK	DAM->FEE JTag	DAM->FEE SC	DAM->FEE CLK	DAM->FEE JTag
	FEE->DAM data	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM data	FEE->DAM JTag	FEE->DAM data	FEE->DAM data	FEE->DAM JTag

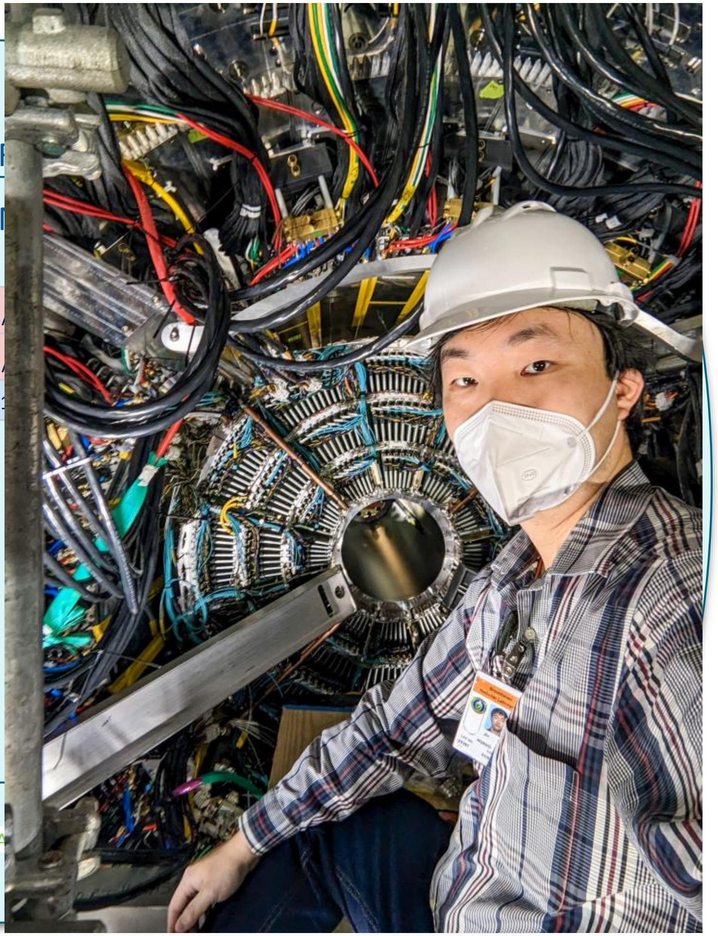
per-FEE break out mapping in 48F MTP -> 6x 12F MTP cable -> QSFP

48F MTP 6 out of 48	DAM->FEE SC	DAM->FEE CLK	DAM->FEE JTag									
	FEE->DAM data	FEE->DAM data	FEE->DAM JTag									
Fiber Number	12	11	10	9	8	7	6	5	4	3	2	1
QSFP Name	TX 1	TX 2	TX 3	TX 4	Empty	Empty	Empty	Empty	RX 4	RX 3	RX 2	RX 1
QSFP Assigned	FEE->DAM data	FEE->DAM data	Idle	FEE->DAM JTag					DAM->FEE Jtag	Clock	Idle	DAM->FEE SC

sPHENIX TPC Data Fiber Cabling Plan, 1 of 24 sectors shown





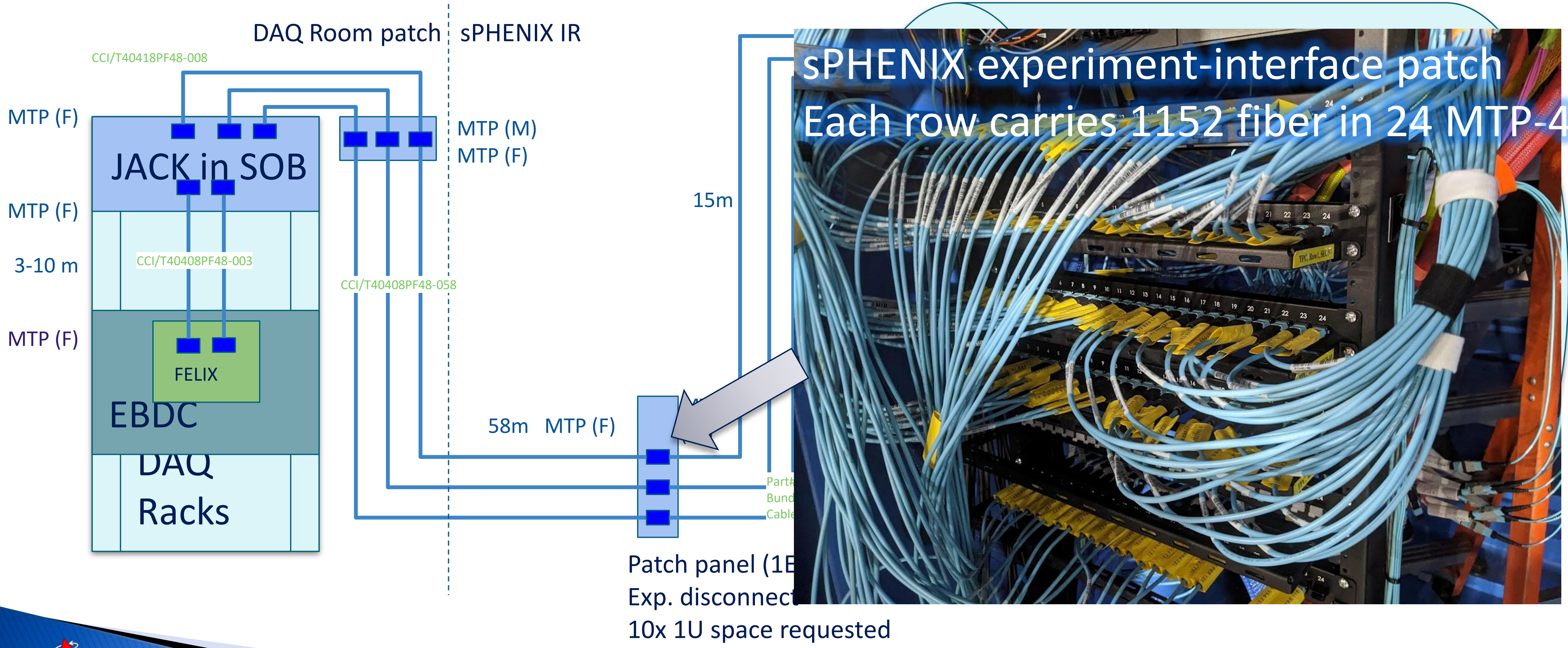


Exp. disconnect
10x 1U space requested

48F MTP Cable MTP coupler MTP-QSFP breakout QSFP MTP cable QSFP Transceiver

One-way optical loss: 1.5dB

sPHENIX TPC Data Fiber Cabling Plan, 1 of 24 sectors shown

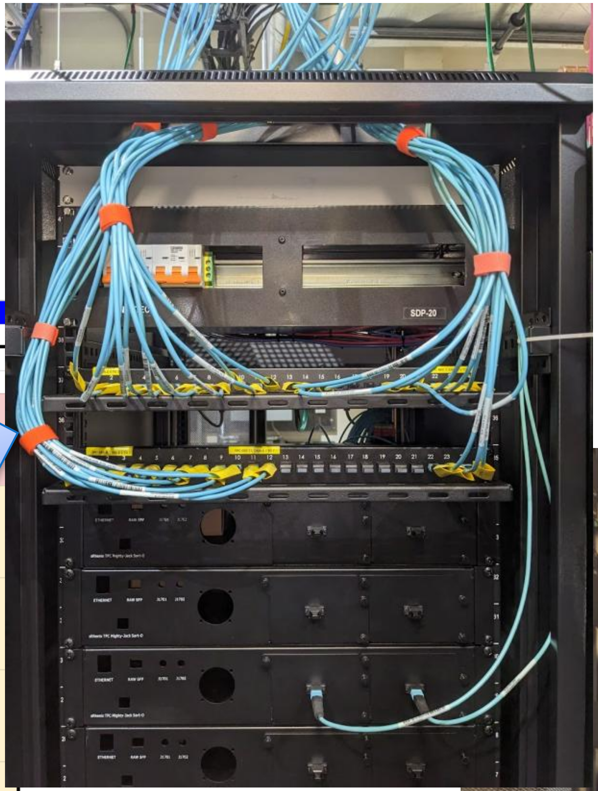


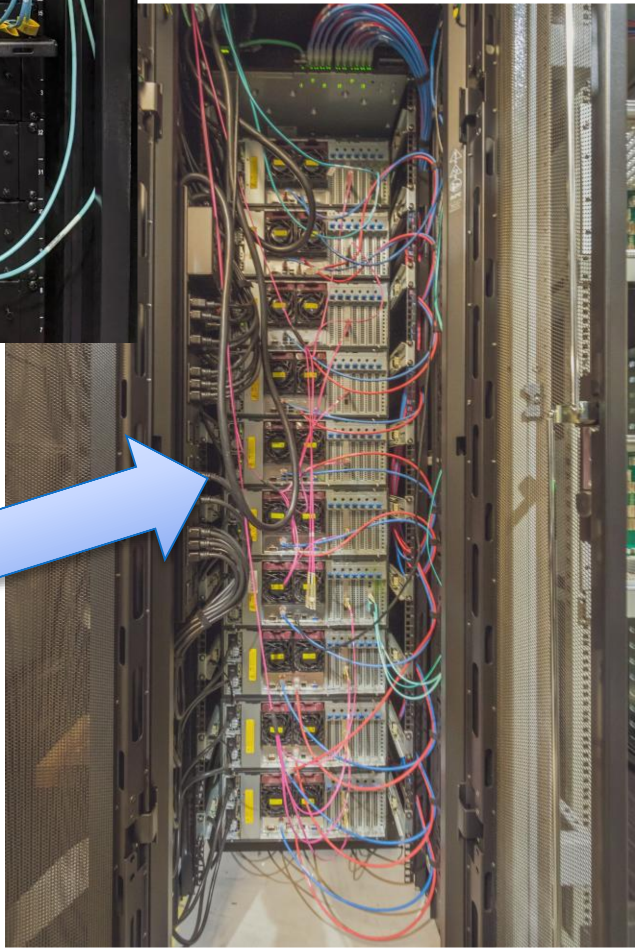
48F MTP Cable ▪ MTP coupler ▪ MTP-QSFP breakout ▪ QSFP MTP cable ▪ QSFP Transceiver

One-way optical loss: 1.5dB

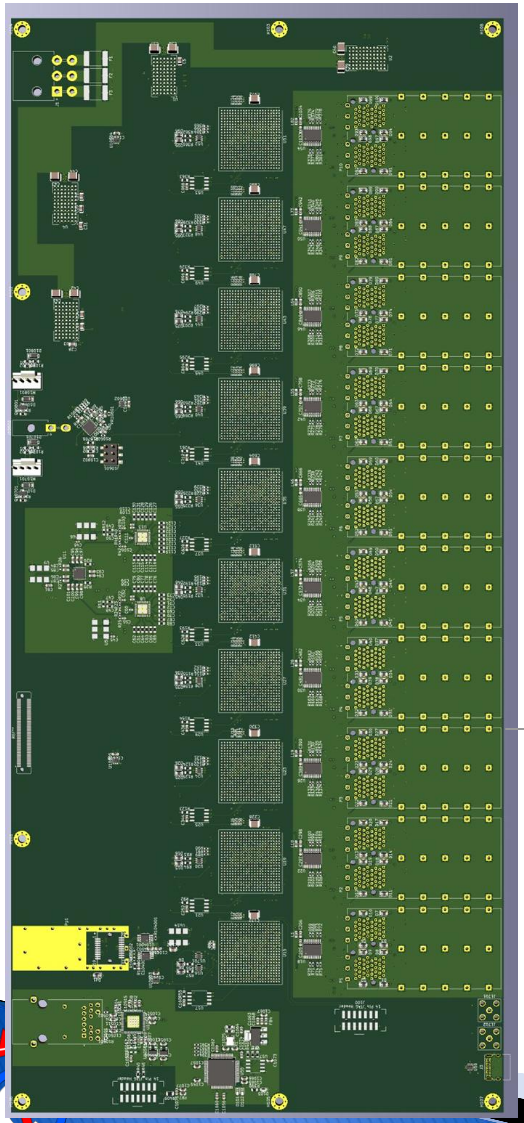
Rack room layout

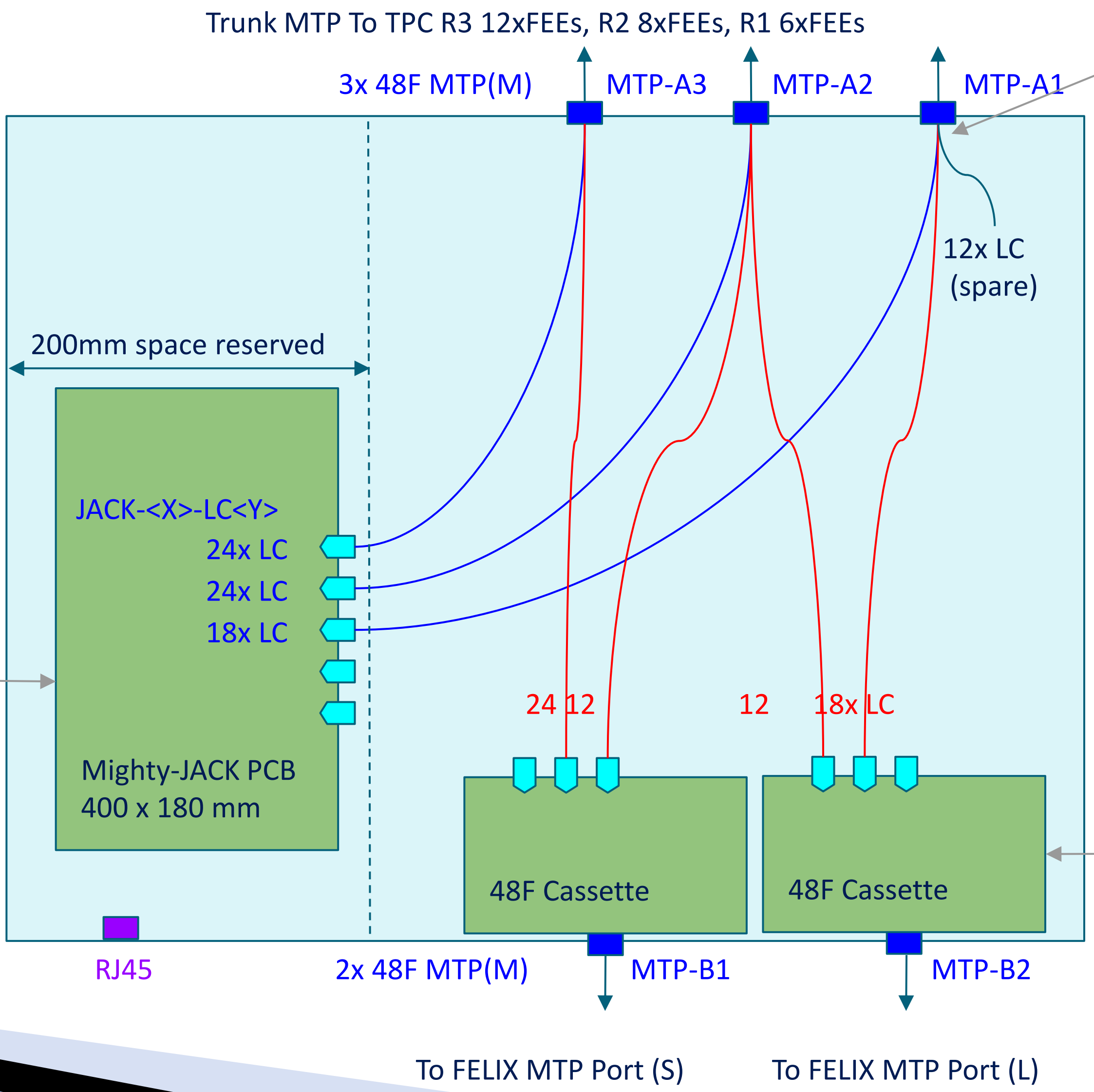
Row 3, viewed outside in								
Assignment	RHIC infrastructure	LL1	EBDC TPC South	Patch/ TPC SOB South	BDC TPC North/Sou	Patch/ TPC SOB North	EBDC TPC South	EBDC Other
Rack	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8
	1	1	1	1 Fiber Patch MVTX	1	1 Fiber Patch INTT	1	1
	2	2	2	2 Fiber Patch	2	2 Fiber Patch INTT	2	2
	3	3	3	3 Fiber Patch	3	3 Fiber Patch	3	
	4	4	4 EBDC MVTX 1	4 Fiber Patch	4 EBDC TPC S5	4 Fiber Patch	4 EBD[illegible]	
	5	5	5	5 Fiber Patch TPC S1-4	5	5 Fiber Patch TPC N1-[illegible]		
	6	6	6	6 Fiber Patch TPC S5-8	6	6 Fiber Patch TPC N5-8		6
	7	7	7	7 Fiber Patch TPC S9-12	7	7 Fiber Patch TPC N9-12		7
	8	8	8 EBDC MVTX 2	8	8 EBDC TPC S6	8	8 EBDC TPC N4	8 EBDC INTT1
	9	9	9	9	9	9	9	9
	10	10	10	10 SOB Spare	10	10 SOB TPOT	10	10
	11	11	11	11	11	11	11	11
	12	12	12 EBDC MVTX 3	12 SOB S1	12 EBDC TPC S7	12 SOB N1	12 EBDC TPC N5	12 EBDC INTT2
	13	13	13	13	13	13	13	13
	14	14	14	14 SOB S2	14	14 SOB N2	14	14
	15	15	15	15	15	15	15	15
	16	16	16 EBDC MVTX 4	16 SOB S3	16 EBDC TPC S8	16 SOB N3	16 EBDC TPC N6	16 EBDC INTT3
	17	17	17	17	17	17	17	17
	18	18	18	18 SOB S4	18	18 SOB N4	18	18
	19	19	19	19	19	19	19	19
	20	20	20 EBDC MVTX 5	20 SOB S5	20 EBDC TPC S9	20 SOB N5	20 EBDC TPC N7	20 EBDC INTT4
	21	21	21	21	21	21	21	21
	22	22	22	22 SOB S6	22	22 SOB N6	22	22
	23	23	23	23	23	23	23	23
	24	24	24 EBDC MVTX 6	24 SOB S7	24 EBDC TPC S10	24 SOB N7	24 EBDC TPC N8	24 EBDC INTT5
	25	25	25	25	25	25	25	25
	26	26	26	26 SOB S8	26	26 SOB N8	26	26
	27	27	27	27	27	27	27	27
	28	28	28 EBDC TPC S1	28 SOB S9	28 EBDC TPC S11	28 SOB N9	28 EBDC TPC N9	28 EBDC INTT6
	29	29	29	29	29	29	29	29
	30	30	30	30 SOB S10	30	30 SOB N10	30	30
	31	31	31	31	31	31	31	31
	32	32	32 EBDC TPC S2	32 SOB S11	32 EBDC TPC S12	32 SOB N11	32 EBDC TPC N10	32 EBD[illegible]
	33	33	33	33	33	33	33	
	34	34	34	34 SOB S12	34	34 SOB N12	34	
	35	35	35	35	35	35	35	
	36	36	36 EBDC TPC S3	36 SOB Spare	36 EBDC TPC N1	36 SOB Spare	36 EBDC TPC [illegible]	36 EBDC INTT8
	37	37	37	37	37	37	37	37
	38	38	38	38 SOB Spare	38	38 SOB Spare	38	38
	39	39	39	39	39	39	39	39
	40	40	40 EBDC TPC S4	40	40 EBDC TPC N2	40	40 EBDC TPC N12	40 EBDC Spare
	41	41	41	41	41	41	41	41
	42	42	42	42	42	42	42	42

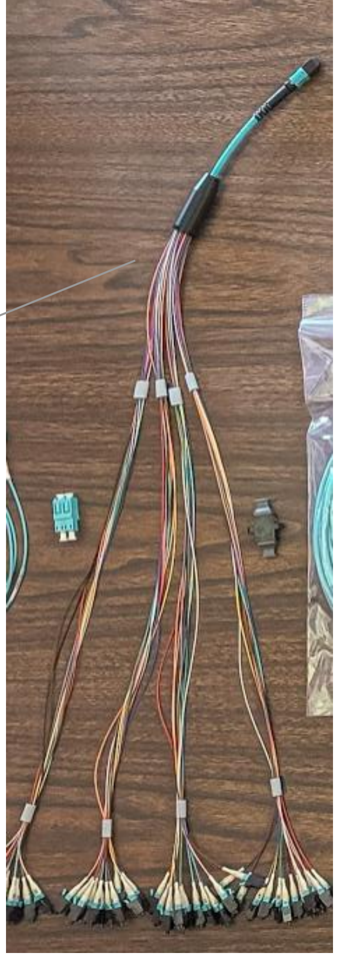




Mighty-JACK + Sort-Out Box Diagram







SOB mapping table

Row	FEE	Channel	FEE MTP-A Fib	FELIX MTP-B F	JACK LC Tranceivers
70	MTP Trunk cable: MTP-A3				
71	FEE	Channel	FEE MTP-A Fib	FELIX MTP-B F	JACK LC Tranceivers
72	FEE-R3-0	DAM->FEE SC	MTP-A3-1	MTP-B1-2	
73	FEE-R3-0	DAM->FEE JTag	MTP-A3-2		JACK-Slave0-TX0
74	FEE-R3-1	DAM->FEE SC	MTP-A3-3	MTP-B1-3	
75	FEE-R3-1	DAM->FEE JTag	MTP-A3-4		JACK-Slave0-TX1
76	FEE-R3-2	DAM->FEE SC	MTP-A3-5	MTP-B1-4	
77	FEE-R3-2	DAM->FEE JTag	MTP-A3-6		JACK-Slave0-TX2
78	FEE-R3-3	DAM->FEE SC	MTP-A3-7	MTP-B1-5	
79	FEE-R3-3	DAM->FEE JTag	MTP-A3-8		JACK-Slave0-TX3
80	FEE-R3-4	DAM->FEE SC	MTP-A3-9	MTP-B1-6	
81	FEE-R3-4	DAM->FEE JTag	MTP-A3-10		JACK-Slave1-TX0
82	FEE-R3-5	DAM->FEE SC	MTP-A3-11	MTP-B1-7	
83	FEE-R3-5	DAM->FEE JTag	MTP-A3-12		JACK-Slave1-TX1
84	FEE-R3-0	FEE->DAM data	MTP-A3-13	MTP-B1-14	
85	FEE-R3-0	FEE->DAM JTag	MTP-A3-14		JACK-Slave0-RX0
86	FEE-R3-1	FEE->DAM data	MTP-A3-15	MTP-B1-15	
87	FEE-R3-1	FEE->DAM JTag	MTP-A3-16		JACK-Slave0-RX1
88	FEE-R3-2	FEE->DAM data	MTP-A3-17	MTP-B1-16	
89	FEE-R3-2	FEE->DAM JTag	MTP-A3-18		JACK-Slave0-RX2
90	FEE-R3-3	FEE->DAM data	MTP-A3-19	MTP-B1-17	
91	FEE-R3-3	FEE->DAM JTag	MTP-A3-20		JACK-Slave0-RX3
92	FEE-R3-4	FEE->DAM data	MTP-A3-21	MTP-B1-18	
93	FEE-R3-4	FEE->DAM JTag	MTP-A3-22		JACK-Slave1-RX0
94	FEE-R3-5	FEE->DAM data	MTP-A3-23	MTP-B1-19	
95	FEE-R3-5	FEE->DAM JTag	MTP-A3-24		JACK-Slave1-RX1
96	FEE-R3-6	DAM->FEE SC	MTP-A3-25	MTP-B1-26	
97	FEE-R3-6	DAM->FEE JTag	MTP-A3-26		JACK-Slave1-TX2
98	FEE-R3-7	DAM->FEE SC	MTP-A3-27	MTP-B1-27	
99	FEE-R3-7	DAM->FEE JTag	MTP-A3-28		JACK-Slave1-TX3
100	FEE-R3-8	DAM->FEE SC	MTP-A3-29	MTP-B1-28	
101	FEE-R3-8	DAM->FEE JTag	MTP-A3-30		JACK-Slave2-TX0
102	FEE-R3-10	DAM->FEE SC	MTP-A3-31	MTP-B1-29	
103	FEE-R3-10	DAM->FEE JTag	MTP-A3-32		JACK-Slave2-TX1
104	FEE-R3-11	DAM->FEE SC	MTP-A3-33	MTP-B1-30	
105	FEE-R3-11	DAM->FEE JTag	MTP-A3-34		JACK-Slave2-TX2
106	FEE-R3-11	DAM->FEE SC	MTP-A3-35	MTP-B1-31	
107	FEE-R3-11	DAM->FEE JTag	MTP-A3-36		JACK-Slave2-TX3
108	FEE-R3-6	FEE->DAM data	MTP-A3-37	MTP-B1-38	
109	FEE-R3-6	FEE->DAM JTag	MTP-A3-38		JACK-Slave1-RX2
110	FEE-R3-7	FEE->DAM data	MTP-A3-39	MTP-B1-39	
111	FEE-R3-7	FEE->DAM JTag	MTP-A3-40		JACK-Slave1-RX3
112	FEE-R3-8	FEE->DAM data	MTP-A3-41	MTP-B1-40	
113	FEE-R3-8	FEE->DAM JTag	MTP-A3-42		JACK-Slave2-RX0
114	FEE-R3-10	FEE->DAM data	MTP-A3-43	MTP-B1-41	
115	FEE-R3-10	FEE->DAM JTag	MTP-A3-44		JACK-Slave2-RX1
116	FEE-R3-11	FEE->DAM data	MTP-A3-45	MTP-B1-42	
117	FEE-R3-11	FEE->DAM JTag	MTP-A3-46		JACK-Slave2-RX2
118	FEE-R3-11	FEE->DAM data	MTP-A3-47	MTP-B1-43	
119	FEE-R3-11	FEE->DAM JTag	MTP-A3-48		JACK-Slave2-RX3

Row	FEE	Channel	FEE MTP-A Fib	FELIX MTP-B F	JACK LC Tranceivers
70	MTP Trunk cable: MTP-A2				
71	FEE	Channel	FEE MTP-A Fib	FELIX MTP-B F	JACK LC Tranceivers
72	FEE-R2-0	DAM->FEE SC	MTP-A2-1	MTP-B1-9	
73	FEE-R2-0	DAM->FEE CLK	MTP-A2-2		JACK-Slave3-TX0
74	FEE-R2-0	DAM->FEE JTag	MTP-A2-3		JACK-Slave3-TX1
75	FEE-R2-1	DAM->FEE SC	MTP-A2-4	MTP-B1-11	
76	FEE-R2-1	DAM->FEE CLK	MTP-A2-5		JACK-Slave3-TX2
77	FEE-R2-1	DAM->FEE JTag	MTP-A2-6		JACK-Slave3-TX3
78	FEE-R2-2	DAM->FEE SC	MTP-A2-7	MTP-B1-33	
79	FEE-R2-2	DAM->FEE CLK	MTP-A2-8		JACK-Slave4-TX0
80	FEE-R2-2	DAM->FEE JTag	MTP-A2-9		JACK-Slave4-TX1
81	FEE-R2-3	DAM->FEE SC	MTP-A2-10	MTP-B1-35	
82	FEE-R2-3	DAM->FEE CLK	MTP-A2-11		JACK-Slave4-TX2
83	FEE-R2-3	DAM->FEE JTag	MTP-A2-12		JACK-Slave4-TX3
84	FEE-R2-0	FEE->DAM data	MTP-A2-13	MTP-B1-21	
85	FEE-R2-0	FEE->DAM data	MTP-A2-14	MTP-B1-22	
86	FEE-R2-0	FEE->DAM JTag	MTP-A2-15		JACK-Slave3-RX1
87	FEE-R2-1	FEE->DAM data	MTP-A2-16	MTP-B1-23	
88	FEE-R2-1	FEE->DAM data	MTP-A2-17	MTP-B1-24	
89	FEE-R2-1	FEE->DAM JTag	MTP-A2-18		JACK-Slave3-RX3
90	FEE-R2-2	FEE->DAM data	MTP-A2-19	MTP-B1-45	
91	FEE-R2-2	FEE->DAM data	MTP-A2-20	MTP-B1-46	
92	FEE-R2-2	FEE->DAM JTag	MTP-A2-21		JACK-Slave4-RX1
93	FEE-R2-3	FEE->DAM data	MTP-A2-22	MTP-B1-47	
94	FEE-R2-3	FEE->DAM data	MTP-A2-23	MTP-B1-48	
95	FEE-R2-3	FEE->DAM JTag	MTP-A2-24		JACK-Slave4-RX3
96	FEE-R2-4	DAM->FEE SC	MTP-A2-25	MTP-B2-3	
97	FEE-R2-4	DAM->FEE CLK	MTP-A2-26		JACK-Slave5-TX0
98	FEE-R2-4	DAM->FEE JTag	MTP-A2-27		JACK-Slave5-TX1
99	FEE-R2-5	DAM->FEE SC	MTP-A2-28	MTP-B2-5	
100	FEE-R2-5	DAM->FEE CLK	MTP-A2-29		JACK-Slave5-TX2
101	FEE-R2-5	DAM->FEE JTag	MTP-A2-30		JACK-Slave5-TX3
102	FEE-R2-6	DAM->FEE SC	MTP-A2-31	MTP-B2-27	
103	FEE-R2-6	DAM->FEE CLK	MTP-A2-32		JACK-Slave6-TX0
104	FEE-R2-6	DAM->FEE JTag	MTP-A2-33		JACK-Slave6-TX1
105	FEE-R2-7	DAM->FEE SC	MTP-A2-34	MTP-B2-29	
106	FEE-R2-7	DAM->FEE CLK	MTP-A2-35		JACK-Slave6-TX2
107	FEE-R2-7	DAM->FEE JTag	MTP-A2-36		JACK-Slave6-TX3
108	FEE-R2-4	FEE->DAM data	MTP-A2-37	MTP-B2-15	
109	FEE-R2-4	FEE->DAM data	MTP-A2-38	MTP-B2-16	
110	FEE-R2-4	FEE->DAM JTag	MTP-A2-39		JACK-Slave5-RX1
111	FEE-R2-5	FEE->DAM data	MTP-A2-40	MTP-B2-17	
112	FEE-R2-5	FEE->DAM data	MTP-A2-41	MTP-B2-18	
113	FEE-R2-5	FEE->DAM JTag	MTP-A2-42		JACK-Slave5-RX3
114	FEE-R2-6	FEE->DAM data	MTP-A2-43	MTP-B2-39	
115	FEE-R2-6	FEE->DAM data	MTP-A2-44	MTP-B2-40	
116	FEE-R2-6	FEE->DAM JTag	MTP-A2-45		JACK-Slave6-RX1
117	FEE-R2-7	FEE->DAM data	MTP-A2-46	MTP-B2-41	
118	FEE-R2-7	FEE->DAM data	MTP-A2-47	MTP-B2-42	
119	FEE-R2-7	FEE->DAM JTag	MTP-A2-48		JACK-Slave6-RX3

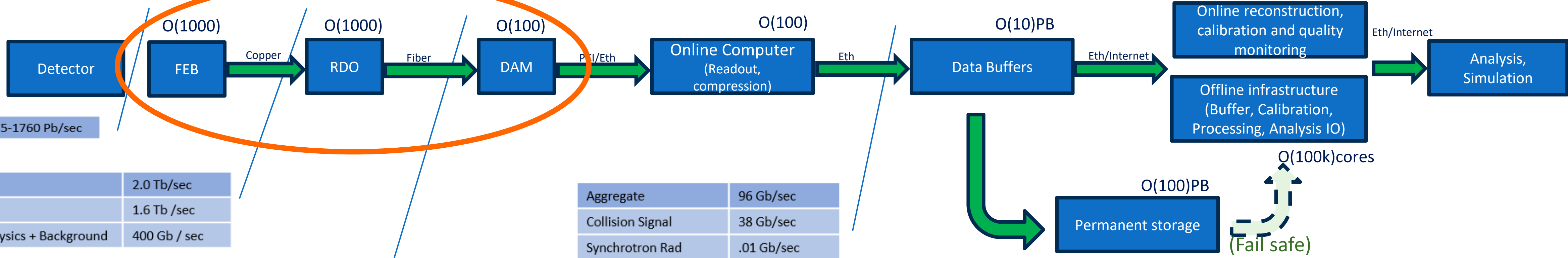
Row	FEE	Channel	FEE MTP-A Fib	FELIX MTP-B F	JACK LC Tranceivers
70	MTP Trunk cable: MTP-A1				
71	FEE	Channel	FEE MTP-A Fib	FELIX MTP-B F	JACK LC Tranceivers
72	FEE-R1-0	DAM->FEE SC	MTP-A1-1	MTP-B2-7	
73	FEE-R1-0	DAM->FEE CLK	MTP-A1-2		JACK-Slave7-TX0
74	FEE-R1-0	DAM->FEE JTag	MTP-A1-3		JACK-Slave7-TX1
75	FEE-R1-1	DAM->FEE SC	MTP-A1-4	MTP-B2-9	
76	FEE-R1-1	DAM->FEE CLK	MTP-A1-5		JACK-Slave7-TX2
77	FEE-R1-1	DAM->FEE JTag	MTP-A1-6		JACK-Slave7-TX3
78	FEE-R1-2	DAM->FEE SC	MTP-A1-7	MTP-B2-11	
79	FEE-R1-2	DAM->FEE CLK	MTP-A1-8		JACK-Slave8-TX0
80	FEE-R1-2	DAM->FEE JTag	MTP-A1-9		JACK-Slave8-TX1
81	Spare	DAM->FEE SC	MTP-A1-10		
82	Spare	DAM->FEE CLK	MTP-A1-11		
83	Spare	DAM->FEE JTag	MTP-A1-12		
84	FEE-R1-0	FEE->DAM data	MTP-A1-13	MTP-B2-19	
85	FEE-R1-0	FEE->DAM data	MTP-A1-14	MTP-B2-20	
86	FEE-R1-0	FEE->DAM JTag	MTP-A1-15		JACK-Slave7-RX1
87	FEE-R1-1	FEE->DAM data	MTP-A1-16	MTP-B2-21	
88	FEE-R1-1	FEE->DAM data	MTP-A1-17	MTP-B2-22	
89	FEE-R1-1	FEE->DAM JTag	MTP-A1-18		JACK-Slave7-RX3
90	FEE-R1-2	FEE->DAM data	MTP-A1-19	MTP-B2-23	
91	FEE-R1-2	FEE->DAM data	MTP-A1-20	MTP-B2-24	
92	FEE-R1-2	FEE->DAM JTag	MTP-A1-21		JACK-Slave8-RX1
93	Spare	FEE->DAM data	MTP-A1-22		
94	Spare	FEE->DAM data	MTP-A1-23		
95	Spare	FEE->DAM JTag	MTP-A1-24		
96	FEE-R1-3	DAM->FEE SC	MTP-A1-25	MTP-B2-31	
97	FEE-R1-3	DAM->FEE CLK	MTP-A1-26		JACK-Slave8-TX2
98	FEE-R1-3	DAM->FEE JTag	MTP-A1-27		JACK-Slave8-TX3
99	FEE-R1-4	DAM->FEE SC	MTP-A1-28	MTP-B2-33	
100	FEE-R1-4	DAM->FEE CLK	MTP-A1-29		JACK-Master-TX0
101	FEE-R1-4	DAM->FEE JTag	MTP-A1-30		JACK-Master-TX1
102	FEE-R1-5	DAM->FEE SC	MTP-A1-31	MTP-B2-35	
103	FEE-R1-5	DAM->FEE CLK	MTP-A1-32		JACK-Master-TX2
104	FEE-R1-5	DAM->FEE JTag	MTP-A1-33		JACK-Master-TX3
105	Spare	DAM->FEE SC	MTP-A1-34		
106	Spare	DAM->FEE CLK	MTP-A1-35		
107	Spare	DAM->FEE JTag	MTP-A1-36		
108	FEE-R1-3	FEE->DAM data	MTP-A1-37	MTP-B2-43	
109	FEE-R1-3	FEE->DAM data	MTP-A1-38	MTP-B2-44	
110	FEE-R1-3	FEE->DAM JTag	MTP-A1-39		JACK-Slave8-RX3
111	FEE-R1-4	FEE->DAM data	MTP-A1-40	MTP-B2-45	
112	FEE-R1-4	FEE->DAM data	MTP-A1-41	MTP-B2-46	
113	FEE-R1-4	FEE->DAM JTag	MTP-A1-42		JACK-Master-RX1
114	FEE-R1-5	FEE->DAM data	MTP-A1-43	MTP-B2-47	
115	FEE-R1-5	FEE->DAM data	MTP-A1-44	MTP-B2-48	
116	FEE-R1-5	FEE->DAM JTag	MTP-A1-45		JACK-Master-RX3
117	Spare	FEE->DAM data	MTP-A1-46		
118	Spare	FEE->DAM data	MTP-A1-47		
119	Spare	FEE->DAM JTag	MTP-A1-48		

Row	Idle ports	Idle ports
70	FELIX MTP Cables	
71	Idle ports	Idle ports
72	MTP-B1-1	MTP-B2-1
73		MTP-B2-2
74		
75		MTP-B2-4
76		
77		MTP-B2-6
78		
79	MTP-B1-8	MTP-B2-8
80		
81	MTP-B1-10	MTP-B2-10
82		
83	MTP-B1-12	MTP-B2-12
84	MTP-B1-13	MTP-B2-13
85		MTP-B2-14
86–90		
91	MTP-B1-20	
92–95		
96	MTP-B1-25	MTP-B2-25
97		MTP-B2-26
98		
99		MTP-B2-28
100		
101		MTP-B2-30
102		
103	MTP-B1-32	MTP-B2-32
104		
105	MTP-B1-34	MTP-B2-34
106		
107	MTP-B1-36	MTP-B2-36
108	MTP-B1-37	MTP-B2-37
109		MTP-B2-38
110–114		
115	MTP-B1-44	
116–119		

ePIC data flow [Sep-23 ePIC Computing @ UIC]

Throughout the data flow: monitoring, QA, feedback towards operation

See also: next session on reco.



100% Occupancy	27.5-1760 Pb/sec

Aggregate	2.0 Tb/sec
Noise	1.6 Tb /sec
Signal from Physics + Background	400 Gb / sec

Aggregate	2.0 Tb/sec
Per RDO (Avg)	.7 Gb/sec

Aggregate	96 Gb/sec
Collision Signal	38 Gb/sec
Synchrotron Rad	.01 Gb/sec
Electron Beam	22Gb/sec
Hadron Beam	4 Gb/sec
Noise	32 Gb/sec

Latency :

0ns | O(100)ns | O(1)us | O(10)us | O(1)min | O(1)min-O(1) day | O(1)day-O(1)week

Possible facilities:

On detector | On detector/rack | DAQ room | Host labs/Echelon 1 facility | Remote resources

Reference:

- ePIC DAQ wiki: https://wiki.bnl.gov/EPIC/index.php?title=DAQ
- ECCE computing plan, *Nucl.Instrum.Meth.A* 1047 (2023) 167859

ePIC

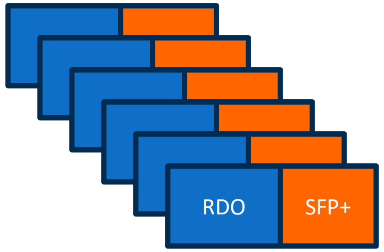
Cases for ePIC

Up to 48x RDO → 10Gbps up, 2.8-10Gbps down

2x MTP-48 to LC (or LC-duplex) breakout

→ 2x fiber trunk/patch

→ 1x DAM

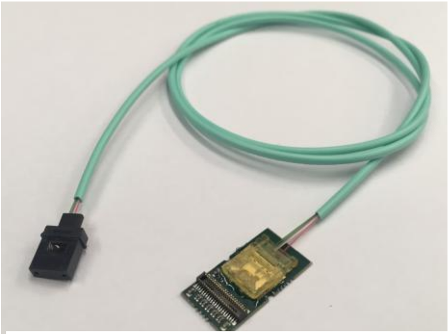


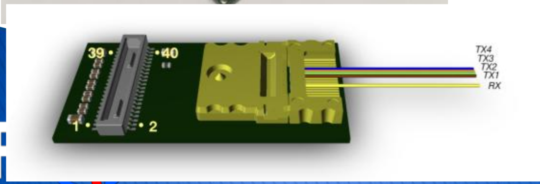
DAM

Up to 48x VTRx+ → 10Gbps up, 2.865Gbps down (3byte/BX in 8b10b)

2x MTP-48 to MTP-12 breakout

→ (Aggregator/DAM L1 if needed)→ DAM





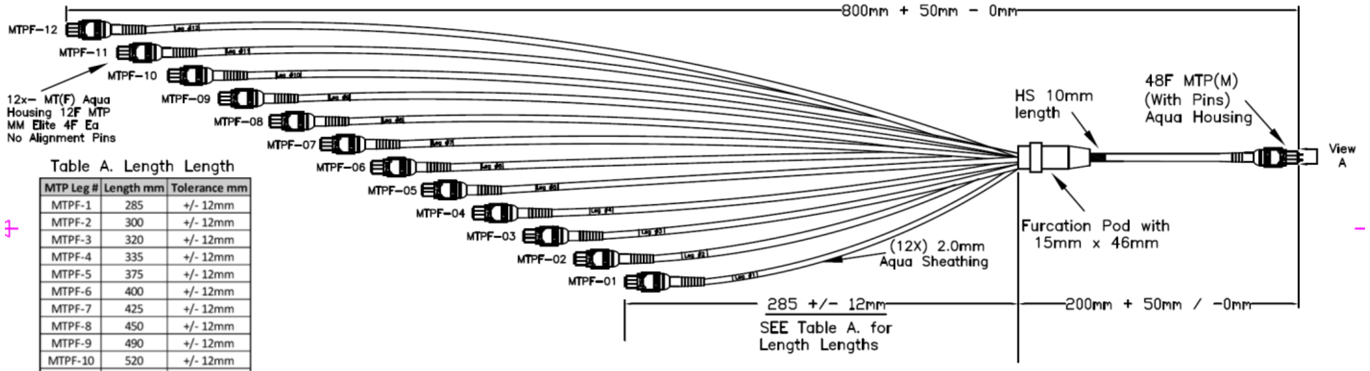
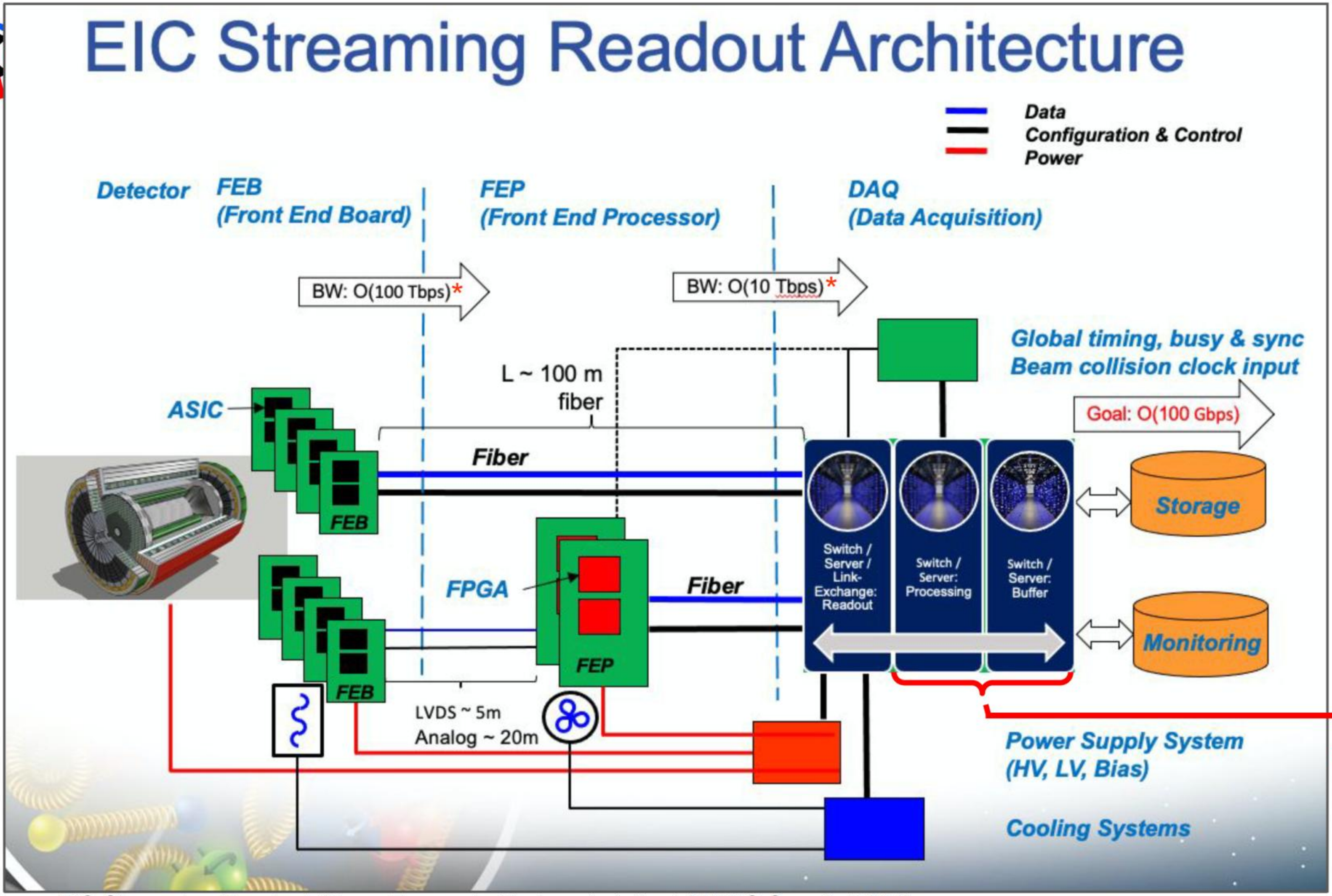


Table A. Length Length

MTP Leg #	Length mm	Tolerance mm
MTPF-1	285	+/- 12mm
MTPF-2	300	+/- 12mm
MTPF-3	320	+/- 12mm
MTPF-4	335	+/- 12mm
MTPF-5	375	+/- 12mm
MTPF-6	400	+/- 12mm
MTPF-7	425	+/- 12mm
MTPF-8	450	+/- 12mm
MTPF-9	490	+/- 12mm
MTPF-10	520	+/- 12mm
MTPF-11	550	+/- 12mm
MTPF-12	580	+/- 12mm

DAM

Streaming DAQ has been selected for EIC since YR and preCDR time



factor of 100 in data reduction

*ATHENA estimates assumed much more suppression at early stages, but still 100Gbps output. (See J. Landgraf talk at SRO X)

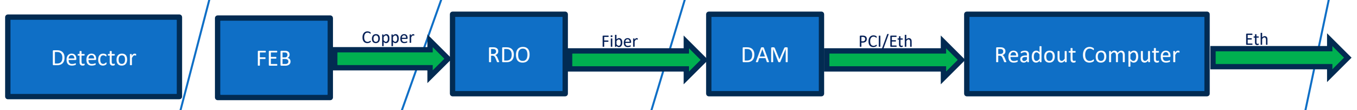
EIC Streaming Readout (From Fernando Barbosa's talk at AI4EIC Sep. 9, 2021)

By Jeff Landgraf, presented on Aug 22 WG meeting [link], Updated Sept 19

Summary of Channel Counts

Detector Group	Channels					RDO	Fiber	DAM	Data Volume (RDO) (Gb/s)	Data Volume (To Tape) (Gb/s)
	MAPS	AC-LGAD	SiPM/PMT	MPGD	HRPPD					
Tracking (MAPS)	36B					400	800	17	26	26
Tracking (MPGD)				202k		118	236	5	1	1
Calorimeters	500M		104k			451	1132	19	502	28
Far Forward	300M	2.6M	170k			178	492	8	15	8
Far Backward	82M		2k			50	100	4	150	1
PID (TOF)		7.8M				500	1500	17	31	1
PID Cherenkov			320k		140k	1283	2566	30	1275	32
TOTAL	36.9B	10.4M	596k	202k	140k	2980	6826	100	2,000	96

Summary of Data Flow



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Aggregate	2.0 Tb/sec
Noise	1.6 Tb /sec
Signal from Physics + Background	400 Gb / sec

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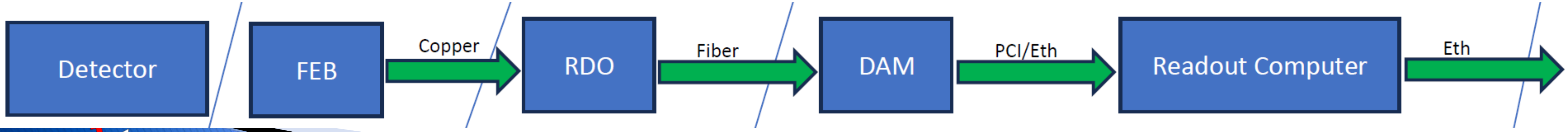
Per RDO (Avg)	.7 Gb/sec

Aggregate	96 Gb/sec
Collision Signal	38 Gb/sec
Synchrotron Rad	.01 Gb/sec
Electron Beam	22Gb/sec
Hadron Beam	4 Gb/sec
Noise	32 Gb/sec

Streaming DAQ – Computing : consideration 1

For kickstart the discussion, please interrupt to discuss at any moment

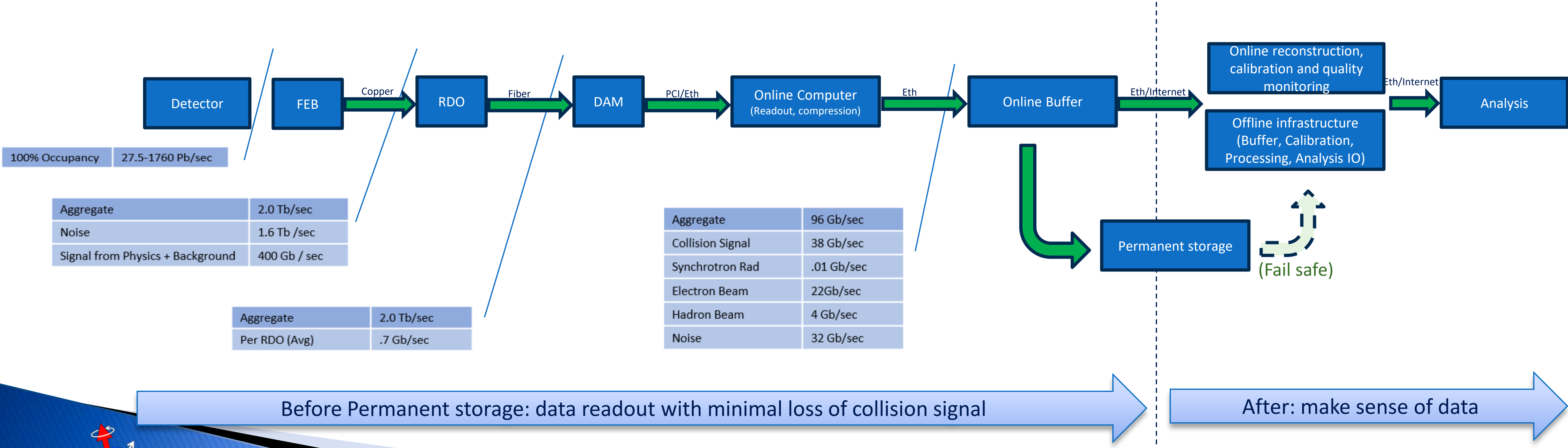
- Streaming DAQ naturally leads to no clear separation of streaming DAQ and computing
  - Streaming DAQ relies on data reduction computationally (i.e. no real-time triggering) → Any data reduction in streaming DAQ is a computing job
  - Which could be done at ASIC, FPGA, online-computers
  - Example could be zero-suppression (simple or sophisticated), feature extraction (e.g. amplitude in calo and tracklet in FB tracker)
  - Require minimal loss of collision signal; any data reduction require stringent bias control/study
- Citing ePIC software principles https://eic.github.io/activities/principles.html :
  We will have an unprecedented compute-detector integration:
  - We will have a common software stack for online and offline software, including the processing of streamed data and its time-ordered structure.
  - We aim for autonomous alignment and calibration.
  - We aim for a rapid, near-real-time turnaround of the raw data to online and offline productions.



Streaming DAQ – Computing : consideration 2

For kickstart the discussion, please interrupt to discuss at any moment

- Sooner or later, a copy of data is stored and saved for permanent storage
- This stage of first permanent storage could be viewed as a DAQ – computing boundary



100% Occupancy	27.5-1760 Pb/sec

Aggregate	2.0 Tb/sec
Noise	1.6 Tb /sec
Signal from Physics + Background	400 Gb / sec

Aggregate	2.0 Tb/sec
Per RDO (Avg)	.7 Gb/sec

Aggregate	96 Gb/sec
Collision Signal	38 Gb/sec
Synchrotron Rad	.01 Gb/sec
Electron Beam	22Gb/sec
Hadron Beam	4 Gb/sec
Noise	32 Gb/sec

Streaming DAQ – Computing : consideration 2

For kickstart the discussion, please interrupt to discuss at any moment

- Paid by project
- Has a hard archival limit (O(100Gbps)) from both throughput and tape cost
- Main goal on "online-computing" is data reduction to fit output pipeline
- Stringent quality and bias control for any lossydata reduction
- As minimal reduction as affordable to
  - (1) reduce unrecoverable systematic uncertainty
  - (2) reduce complexity, cost, failure modes.
  - Any processing beyond minimal need a physics motivation to justify project cost/schedule reviews (and possible descope reviews)
- High availability: any down time cost \$O(0.1)M/day → usually on host lab

Before permanent archival: DAQ

- Driven by collaboration, operation fund
- We would like to complete within a small latency (<O(1)week)
  - Usually driven by calibration and debugs
- Main goal on "offline-computing" is to bring out physics objects for analysis
- Quality control for reconstruction
- Can afford to redo reconstruction if new algorithm or with new physics insights (at cost of time, effort and computing)
- Can wait for short interruptions and can be distributed

After permanent archival: Computing

(last session today)
Towards the computing review Oct 19-20: the charge

1. At this stage, approximately ten years prior to data collection, is there a comprehensive and cost-effective long-term plan for the software and computing of the experiment?
2. Are the plans for integrating international partners' contributions adequate at this stage of the project?
3. Are the plans for software and computing integrated with the HEP/NP community developments, especially given data taking in ten years?
4. Are the resources for software and computing sufficient to deliver the detector conceptional and technical design reports?
5. Are the ECSJI plans to integrate into the software and computing plans of the experiment sufficient?

EPIC Detector Scale and Technology Summary:

Detector System	Channels	RDO	Gb/s (RDO)	Gb/s (Tape)	DAM Boards	Readout Technology	Notes
Si Tracking: 3 vertex layers, 2 sagitta layers, 5 backward disks, 5 forward disks	7 m^2 36B pixels 5,200 MAPS sensors	400	26	26	17	MAPS: Several flavors: curved its-3 sensors for vertex Its-2 staves / w improvements	Fiber count limited by Artix Transceivers
MPGD tracking: Electron Endcap Hadron Endcap Inner Barrel Outer Barrel	16k 16k 30k 140k	8 8 30 72	1	.2	5	uRWELL / SALSA uRWELL / SALSA MicroMegas / SALSA uRWELL / SALSA	64 Channels/Salsa, up to 8 Salsa / FEB&RDO 256 ch/FEB for MM 512 ch/FEB for uRWELL
Forward Calorimeters: LFHCAL HCAL insert* ECAL W/SciFi Barrel Calorimeters: HCAL ECAL SciFi/PB ECAL ASTROPIX Backward Calorimeters: NHCAL ECAL (PWO)	63,280 8k 16,000 7680 5,760 500M pixels 3,256 2852	74 9 64 9 32 230 18 12	502	28	19	SiPM / HG2CROC SiPM / HG2CROC SiPM / Discrete SiPM / HG2CROC SiPM / HG2CROC Astropix SiPM / HG2CROC SiPM / Discrete	Assume HGCROC 56 ch * 16 ASIC/RDO = 896 ch/RDO 32 ch/FEB, 16 FEB/RDO estimate, 8 FEB/RDO conserve. HCAL 1536x5 *HCAL insert not in baseline Assume similar structure to its-2 but with sensors with 250k pixels for RDO calculation. 24 ch/feb, 8 RDO estimate, 23 RDO conservative
Far Forward: B0: 3 MAPS layers 1 or 2 AC-LGAD layer 2 Roman Pots 2 Off Momentum ZDC: Crystal Calorimeter 32 Silicon pad layer 4 silicon pixel layers 2 boxes scintillator	300M pixel 1M 1M (4 x 135k layers x 2 dets) 640k (4 x 80k layers x 2 dets) 400 11,520 160k 72	10 30 64 42 10 10 10 2	15	8	8	MAPS AC-LGAG / EICROC AC-LGAD / EICROC AC-LGAD / EICROC APD HGCROC as per ALICE FoCal-E	3x20cmx20cm 600^cm layers (1 or 2 layers) 13 x 26cm layers 9.6 x 22.4cm layers There are alternatives for AC-LGAD using MAPS and low channel count DC-LGAD timing layers
Far Backward: Low Q Tagger 1 Low Q Tagger 2 Low Q Tagger 1+2 Cal 2 x Lumi PS Calorimeter Lumi PS tracker	1.3M pixels 480k pixels 700 1425/75 80M pixels	12 12 1 1 24	150	1	4	Timepix4 Timepix4 (SiPM/HG2CROC) / (PMT/FLASH) Timepix4	
PID-TOF: Barrel Endcap	2.2M 5.6 M	288 212	31	1	17	AC-LGAD / EICROC (strip) AC-LGAD / EICROC (pixel)	bTOF 128 ch/ASIC, 64 ASIC/RDO eTOF 1024 pixel/ASIC, 24-48 ASIC/RDO (41 ave)
PID-Cherenkov: dRICH pfRICH DIRC	317,952 69,632 69,632	1242 17 24	1240 24 11	13.5 12.5 6	28 1 1	SiPM / ALCOR HRPPD / EICROC (strip or pixel) HRPPD / EICROC (strip or pixel)	Worse case after radiation. Includes 30% timing window. Requires further data volume reduction software trigger