

# TMS Electronics Interfaces

## - Summary -

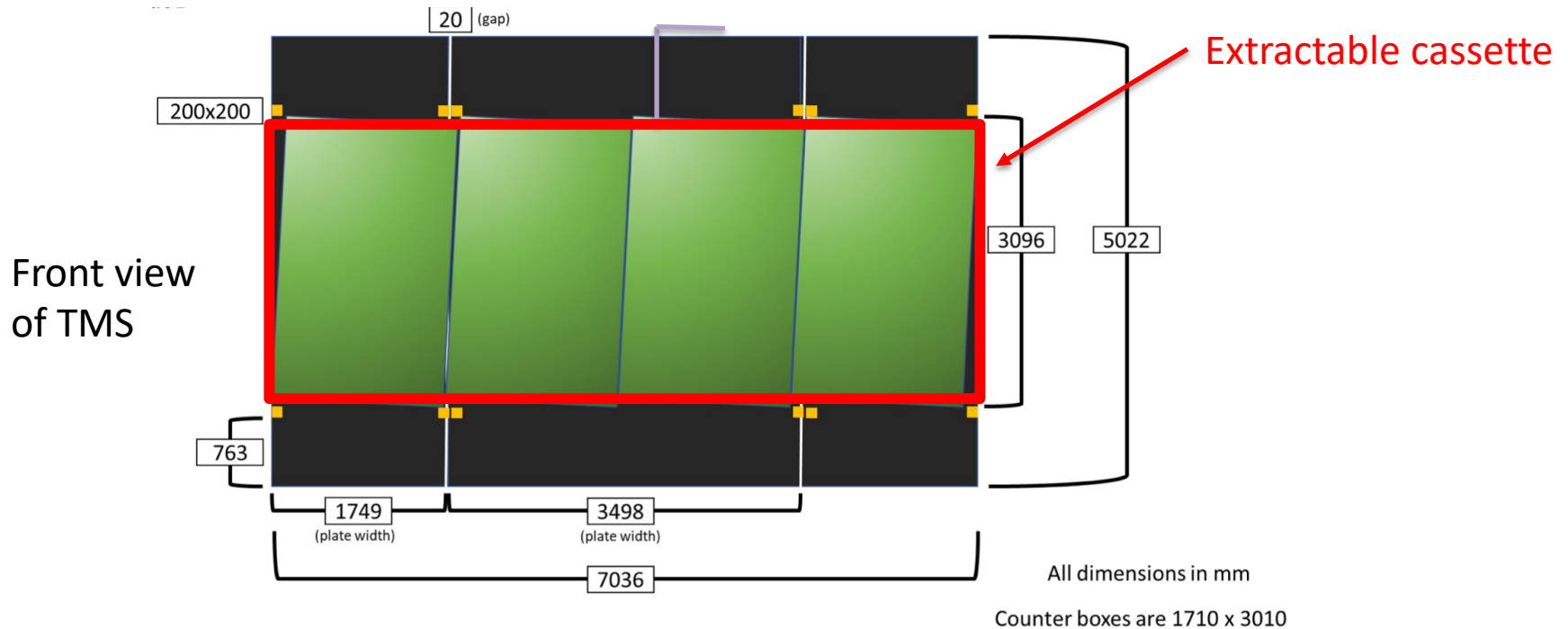
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# Outline

- Conceptual scintillator module/layer assumption
- Interfaces
  - 1) Electronics hardware location on magnet
  - 2) SiPM to WLS fiber/scintillator
  - 3) Cable routing and bundling
- Summary

# TMS Geometry Assumptions



## Extractable scintillator cassette (= 1 TMS layer) contains:

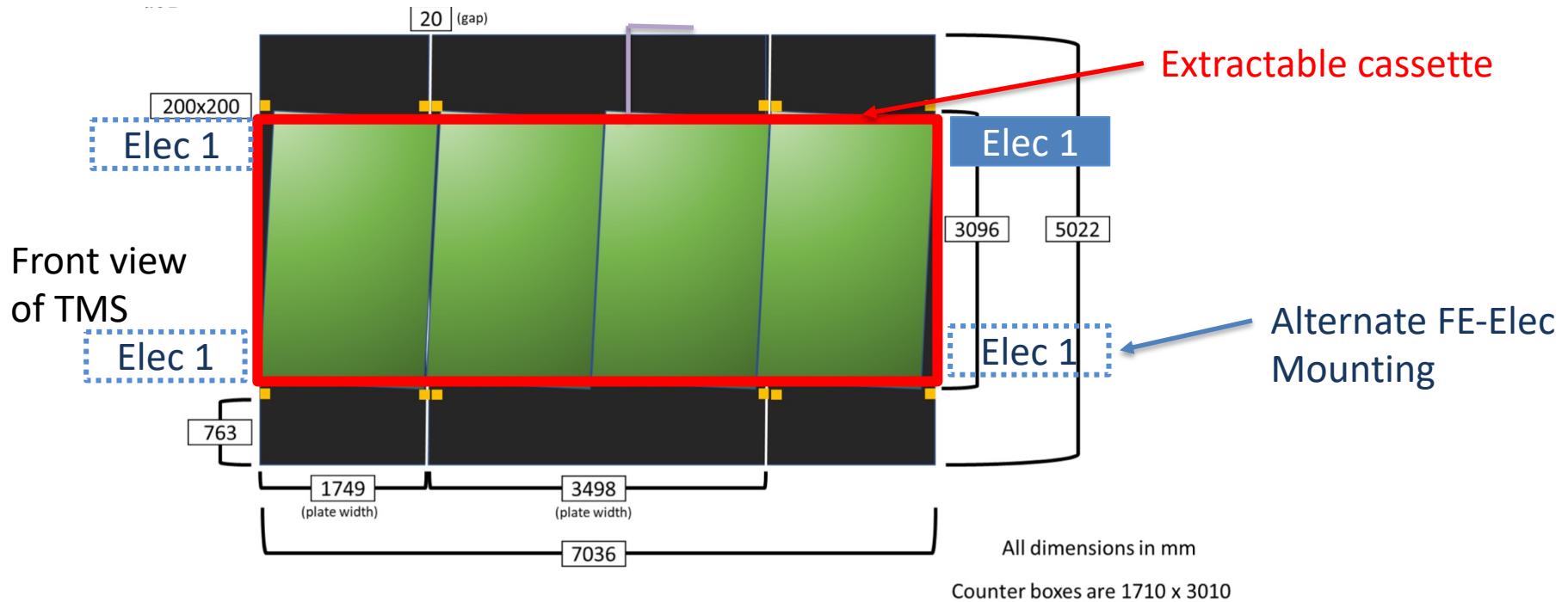
4 modules with 48 scintillator bars each

→ 192 SiPMs and readout channels per layer

→ Couples to 3 CAEN FE boards (64 channels each) per TMS layer

→ Scintillator bars are (near) vertical with SiPM either at top or bottom

# 1) FE-Electronics Location



## FE-Electronics:

1) **Side Mounting** (left or right; near top or bottom of cassette, depending whether SiPMs will be mounted on top or bottom of scintillator strips)

→ Mounted on side of magnet near cable channel of cassette

2) **Top Mounting** is in principle viable option (with additional cable routing complications)

→ Requires interface board between chosen cable/connector type and FE-board interface (conceivable to integrate “correct” connector onto CAEN FE board)

# 1) FE-Electronics Location

## Questions for magnet and facility (and safety) groups:

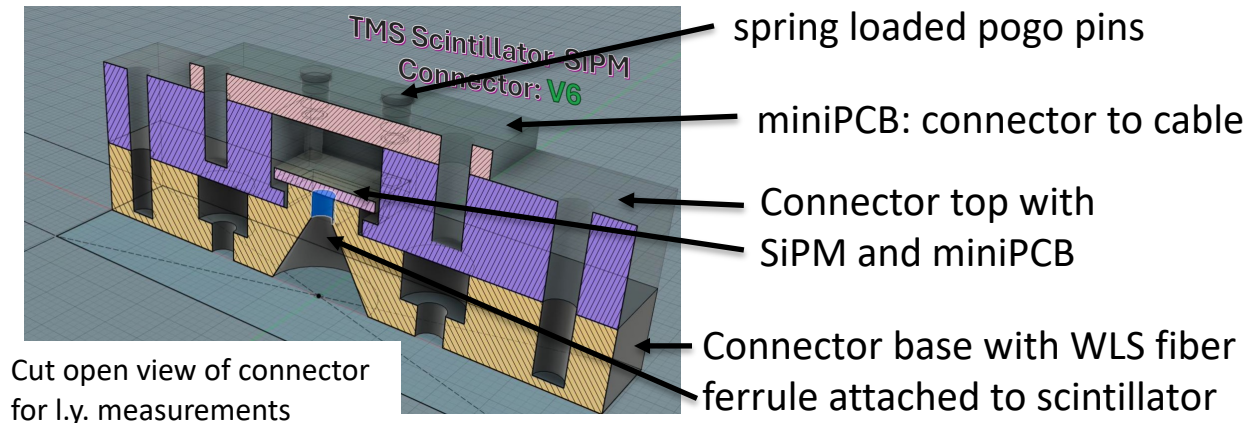
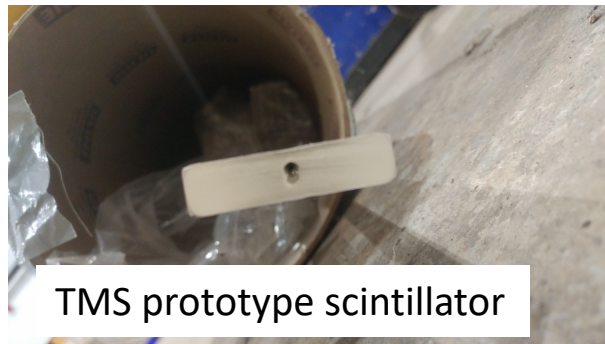
- What locations are available for electronics mounting ?
  - Fewer centralized locations ?
  - More widely distributed locations ?
- What will accessibility be ?
- Preferences for type of FE-Electronics Mounting:
  - Crate or boxed stack mounting ?
  - Individually boxed FE card mounting ?

## Preference:

Electronics mounting on one side

Module/cassette extraction on opposite side

## 2) SiPM to WLS Fiber/Scintillator Interface



### Assumptions:

- 1 WLS fiber per scintillator bar with nominal diameter of 1.4 mm or smaller
  - 1 connector with SiPM and mini-PCB per scintillator
  - nominal 2 shielded mini co-ax cables per mini-PCB (one for signal, one for bias voltage) but very likely can reduce to one mini co-ax cable and use AC coupling on FE side
- R&D task for electronics group: demonstrate single coax cable per channel with AC coupling

### Questions for scintillator group:

- Does packaging for 48 bars provide light tightness or is other scheme foreseen ?
- What are resulting requirements for connector ?

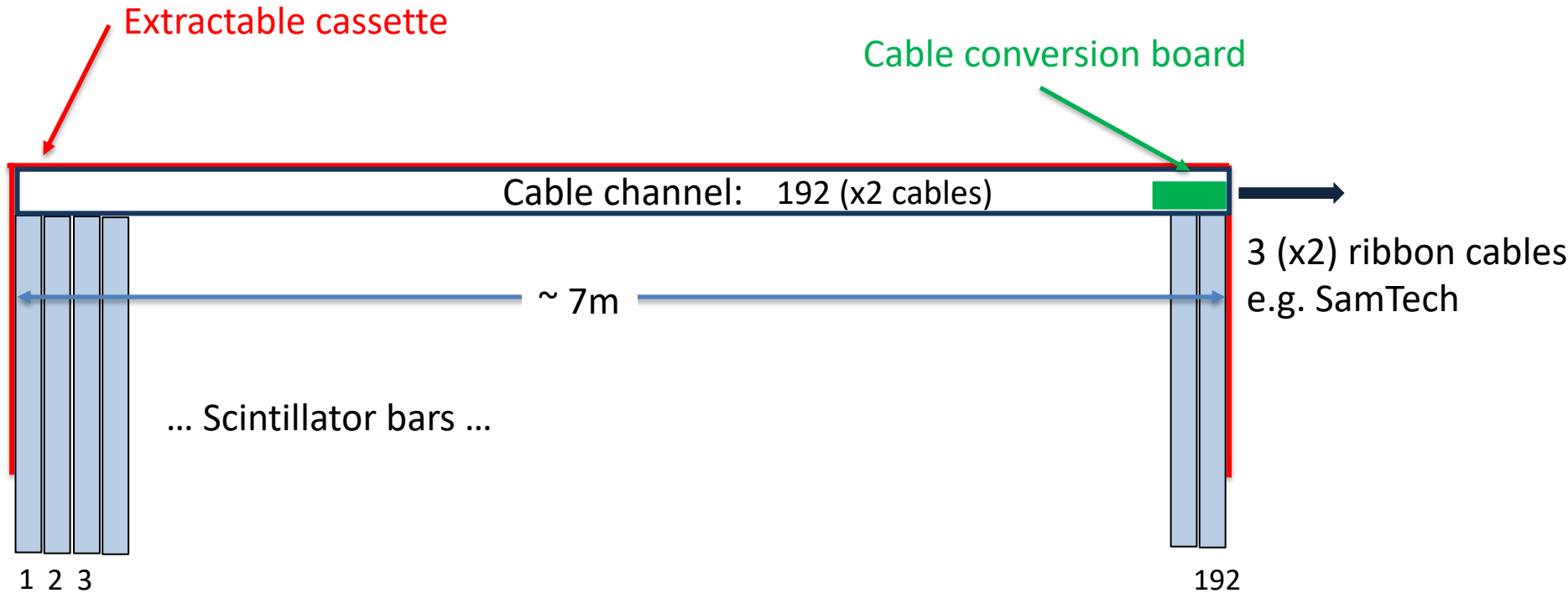
Discussion: grouping of no. of WLS fibers per connector, boundary of light tight box, ...

# 3) Cable Connections Approach

## Cabling options summary for all cases:

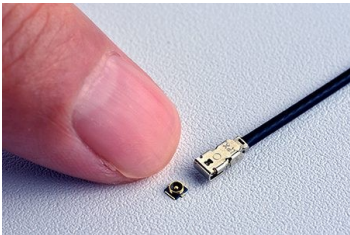
- 1) Establish cable connections and perform tests of many individual cables at factories
- 2) Only make few ribbon cable connections in detector hall during installation

# 3.1) Cable Routing and Bundling

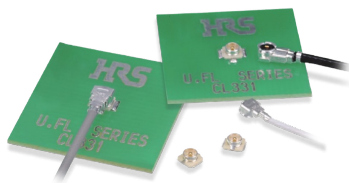


## Cabling option 1a :

Individual mini-coax cables form each scintillator to conversion board at edge of cassette  
e.g. : Hirose mini-coax, typical OD: 1.13 mm, groups of different lengths, cost TBD



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# 3.1) Cable Routing and Bundling

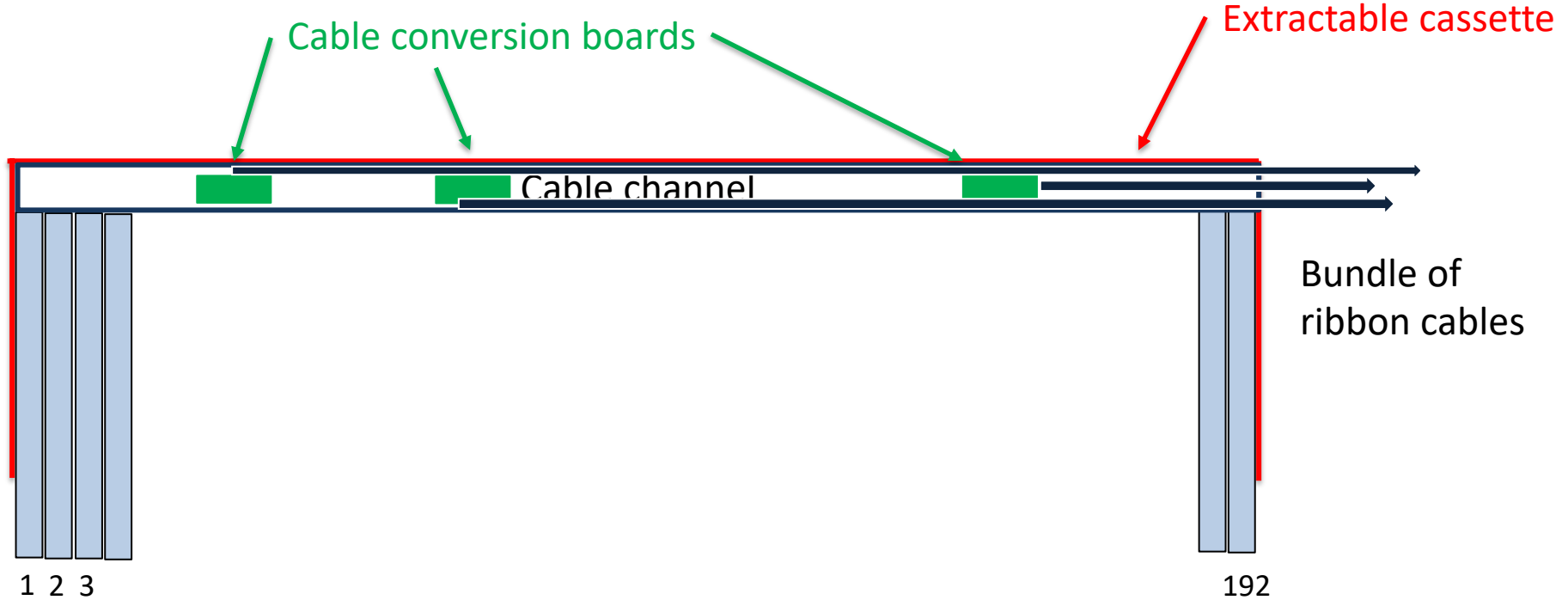
Cabling option 1: e.g. : Hirose mini-coax, typical OD: 1.13 mm

## Product Specifications

Nominal Impedance	50 Ω	Operating Temperature	-40 to +105°C (90% RH Max.)
Rated Frequency	0 to 8GHz	Storage Temperature	-30 to +70°C (90% RH Max.)

Item	Standards	Condition			
Contact Resistance	Center: 20m Ω Max. (50m Ω Max.) External: 10m Ω Max. (20 Ω Max.) (U.FL(A))	Measured at 10 mA Max.			
Insulation Resistance	500M Ω Min.	Measured at 100V DC			
Withstanding Voltage	No insulation break down	200V AC for 1 minute			
V.S.W.R.†	Cable Type	0 to 3GHz	3GHz to 6GHz	6GHz or faster	
	U.FL-LP-040HF	φ 0.81	1.3 Max.	1.35 Max.	6 to 8 GHz: 1.4 Max.
	U.FL-LP(V)-040HF	φ 0.81	1.3 Max.	1.3 Max.	8 to 12 GHz: 1.4 Max.
	U.FL-LP-068HF	φ 1.13	1.3 Max.	1.4 Max.	6 to 8 GHz: 1.6 Max.
	U.FL-LP-066HF	φ 1.32	1.3 Max.	1.5 Max.	6 to 8 GHz: 1.7 Max.
	U.FL-LP-062HF	φ 0.95	1.3 Max.	1.3 Max.	6 to 8 GHz: 1.4 Max.
	U.FL-LP-088HF	φ 1.37	1.3 Max.	1.4 Max.	6 to 8 GHz: 1.6 Max.
	U.FL(A)-LP(P)-068	φ 1.13	1.3 Max.	1.4 Max.	6 to 9GHz : 1.5 Max. 9 to 12GHz : 1.6 Max. 12 to 15 GHz: 1.7 Max. 15 to 18GHz : 2.0 Max.
U.FL(A)-LP(P)-088	φ 1.37				
Female Contact Retention Force	0.15N Min. /0.1N Min. (062, U.FL (A))	Measured with a pin gauge of φ 0.475			
Mating Durability	Contact Resistance : Initial + 5 m Ω	30 times			
Vibration Resistance	No electrical discontinuity of 1 μ s or more No damage, cracks or part dislocation.	Frequency 10 to 100Hz, Half amplitude 1.5mm, Acceleration 59 m/s <sup>2</sup> for 5 cycles in each of the 3 axes direction.			
Shock Resistance	No damage, cracks or part dislocation.	Acceleration 735 m/s <sup>2</sup> , for a duration of 11 ms, sine half-wave waveform, 3 cycles in each of the 6 axes direction.			
Humidity Resistance (Steady State)	Insulation Resistance 10M Min. (in a high humidity environment) 500M Min. (in a dry environment)	96 hours at temperature of 40°C and humidity of 95%.			
Temperature Cycle	No damage, cracks or part dislocation.	Temperature: -40°C→ +5 to +35°C→ +105°C→ +5 to +35°C Time: 30 minutes → within 5 minutes → 30 minutes → within 5 minutes. 5 cycles			

# 3.2) Cable Routing and Bundling



## Cabling options:

Individual cables to nearby conversion boards then ribbon cable(s) out to edge of cassette and to FE boards, e.g.: short Hirose cables + longer SamTech cables

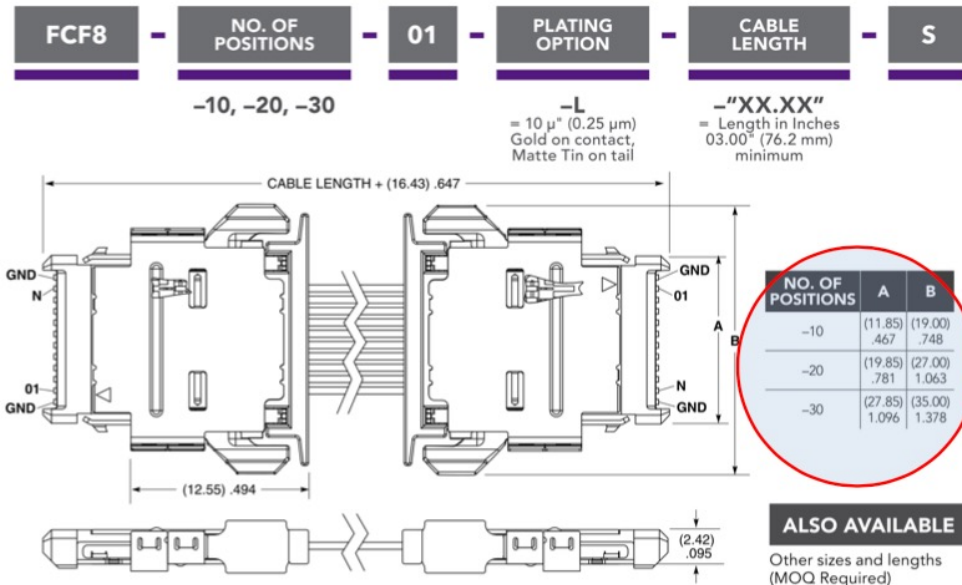
- a) Use 10, 20, 30, 40, 50 coax Samtech cable/connector:
- b) Use 80 pin coax Samtech cable/connector → total of 3 (one per FEB)



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## Q PAIRS® TWINAX CABLE ASSEMBLIES

14 Gbps



(0.50 mm) .0197" & (0.80 mm) .0315" PITCH • HQDP/EQDP SERIES

EQDP	HQDP	EQDP	SERIES	NO. OF PAIRS	WIRE LENGTH	END NO. 1	END NO. 2	WIRING OPTION	SCREW OPTION
Mates: QTE-DP, QSE-DP	Mates: -040, -060 (20 pairs per bank) HQDP Series	Mates: QTH-DP, QSH-DP	-020, -040, -060 (20 pairs per bank) HQDP Series	-014, -028, -042 (14 pairs per bank) EQDP Series	XX.XX" Wire Length (Inches, 3.7mm) .0197" pitch (0.50mm) minimum	Specify END ASSEMBLIES from chart		-5 = Pin 1 to Pin 1 -6 = Pin 1 to Pin 2 -7 = Pin 1 to Second Last Pin -8 = Pin 1 to Last Pin	Leave blank for no Screw Option -F = Pin 1 to Pin 2 -S = End No. 2 -B = Both Ends

**SPECIFICATIONS**

**Cable:** 30 AWG twinax ribbon

**Signal Routing:** T/O Differential

**Cable Bending Radius:** (3.18 mm) 1/8" min

**Plating:** Au over 50 μ" (1.27 μm) Ni

**Current Rating:** EQDP = 500 mA per pin  
HQDP = 400 mA per pin (6 adjacent pins powered)

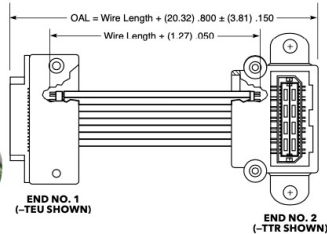
**Propagation Delay:** 4.62 nsec/meter

**Operating Temp Range:** -25 °C to +105 °C

**Skew (pair-to-pair):** <10 ps/in

**Skew (within a pair):** <5 ps/ft

**EMI Performance:** FCC Class A



END	SURFACE MOUNT
TTR	Terminal, Top, Notch Right
TTL	Terminal, Top, Notch Left
TBR	Terminal, Bottom, Notch Right
IBL	Terminal, Bottom, Notch Left
STR	Socket, Top, Notch Right
STL	Socket, Top, Notch Left
SBR	Socket, Bottom, Notch Right
SBL	Socket, Bottom, Notch Left

END	EDGE MOUNT
TEU	Terminal, Edge, Notch Up
TED	Terminal, Edge, Notch Down
SEU	Socket, Edge, Notch Up
SED	Socket, Edge, Notch Down

WIRING REQUIREMENTS	
WIRING OPTION	END OPTIONS
5 or 6	TTR, TBL, STL, SBR, TEU, SED to TTR, TBL, STL, SBR, TED, SEU or TTL, TBR, STR, SBL, TEU, SED to TEU, TED, SED
7 or 8	TTR, TBL, STL, SBR, TEU, SED to TTL, TBR, STR, SBL, TEU, SED or TTL, TBR, STR, SBL, TED, SEU to TTR, TBL, STL, SBR, TED, SEU

**Notes:** Cable lengths longer than 40.00' (1 meter) are not supported with S.I. test data.

Design your full cable assembly with Samtec's High-Speed Cable Solutionator® at [www.samtec.com/cablebuilder](http://www.samtec.com/cablebuilder)

This Series is non-standard, non-returnable.



(1.27 mm) .050" PITCH • DISCRETE WIRE ASSEMBLY/COMPONENTS



SERIES	PAIRS PER ROW	WIRE GAUGE	PLATING OPTION	ASSEMBLED LENGTH	END OPTION	END 2 OPTION
SFSD = Double Row PVC Cable	-03, -04, -05, -07, -10, -15, -20, -25, -40, -50 (Standard sizes)	-28 = 28 AWG -28C = Color Coded Cable (SFSD only) -30 = 30 AWG	-G = 10 μ" (0.25 μm) Gold on contact, Gold Flash on balance	"-XX.XX" = Assembled Length in Inches (76.20 mm) 03.00" min. for -S end option (82.60 mm) 03.25" min. for -D and option	-S = Single Ended -D = Double Ended For -X specify for single ended and "D" for double ended.	Requires -D, -DS, -DR (End 1 Notch Up) -NUS = Notch up, straight (Pin 1 to Pin N-1) -NDS = Notch down, straight (Pin 1 to Pin 2) -NUX = Notch up, crossed (Pin 1 to Pin N) -NDX = Notch down, crossed (Pin 1 to Pin 1)

**-28C CABLE COLOR CODING**

PIN	COLOR
1	BROWN
2	RED
3	ORANGE
4	YELLOW
5	GREEN
6	VIOLET
7	GRAY
8	WHITE
9	BLACK
10	BLUE
ETC	REPEAT

**SFSD(T) Board Mates:** TFM, TFM-L, TFC (-SR & -DR requires -WT option)

**SPECIFICATIONS**

**Insulator Material:** Black LCP

**Contact Material:** BeCu

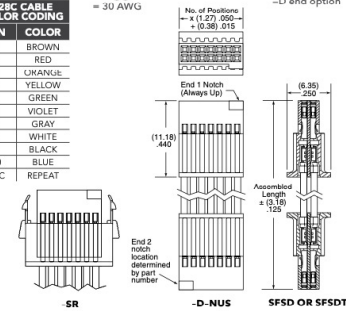
**Plating:** Au over 50 μ" (1.27 μm) Ni (2 pins powered)

**Current Rating:** 2.9 A per pin

**Operating Temp Range:** -10 °C to +80 °C (PVC)  
-40 °C to +125 °C (Teflon™ Fluoropolymer)

**Voltage Rating:** 280 VAC (PVC)  
313 VAC (Teflon™ Fluoropolymer)

**Wires:** 28 or 30 AWG



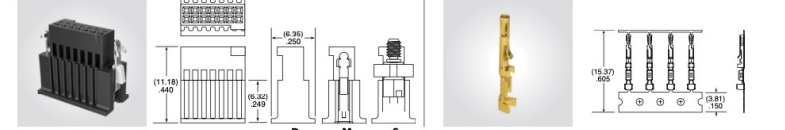
\*Teflon™ is a trademark of The Chemours Company FC, LLC used under license by Samtec.

**Notes:** Teflon™ Fluoropolymer cable is intended for crimp only. Contact Samtec for solderable cable applications.

For wiring option information refer to drawings on web.

View complete specifications at: [samtec.com?SFSD](http://samtec.com?SFSD) & [samtec.com?SFSDT](http://samtec.com?SFSDT)

ISDF	POSITIONS PER ROW	ROW OPTION	OPTION	SERIES	WIRE GAUGE	01	PLATING
	-03, -04, -05, -07, -10, -15, -20, -25, -40, -50 (Standard sizes)	-D = Double Row	-M = Metal Retention Latch -S = Screw Down	CC03R = Contact, Full Reel (35,000 Parts per Reel) CC03M = Contact, Mini Reel (1,000 - 5,000 Parts per Reel)	-2830 = 28 to 30 AWG		-GF = Gold flash contact -G = 10 μ" (0.25 μm) Gold on contact



# 3.2) Cable Routing and Bundling

## Cabling options:

Individual cables to nearby conversion boards then ribbon cable(s) out to edge of cassette and to FE boards, e.g.: short Hirose cables + longer ribbon cables

Other potential vendors:

20/30/40/50 PIN  
0.5 mm Pitch CONN

PCB	Cable
Receptacle	Cable assembly
20455	20453
20455-A20E-99	20453-320T-13
20455-030L-99	20453-3301-13
20455-040E-99	20453-340T-13
20455-050E-99	20453-350T-13S

[www.micro-coaxial.com](http://www.micro-coaxial.com)

HRS DF36 Series

HRS DF56 Series

Enhanced shielding (standard type)

Multi-point contacts

Distinct tactile click

4-point lock : 2 points at each end

[www.micro-coaxial.com](http://www.micro-coaxial.com)

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# Preliminary task list for Electronics Group

- Select suitable SiPM
  - Design SiPM board (**connector interface**)
  - demonstrate single coax cable per channel with AC coupling
  - Identify cable options and perform tests (**routing interface**)
  - LED light injection (**connector interface**)
  - Identify FE electronics housing/crates (**magnet interface**)
  - Check CAEN electronics features
    - SiPM spectra in timing mode,
    - trigger rates and deadtime
    - Trigger configurations
    - Integration of LED pulsing
    - ...
- need good communication and mutual understanding of interfaces between numerous working groups

# Summary/Outlook

- Many questions and unspecified parameters exist
- Used conceptual approach to readout 19,200 TMS WLS fibers/scintillators to start discussion of layout and interfaces
- Interfaces and preliminary list of options
  - Options for FE-electronics locations → need input
  - SiPM to scintillator → need input
  - Cable routing and types in TMS module cassette → only brought forward some ideas to solicit feedback and narrow options before being able to identify candidate cables
- Meant as start of discussion and to collect external constraints

