Baseline proposals for FECo & FECi consensus

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Overview

- Intent of this presentation is to consolidate baseline proposals with strong consensus to expedite adoption.

802.3dj Objective/Baseline Consensus

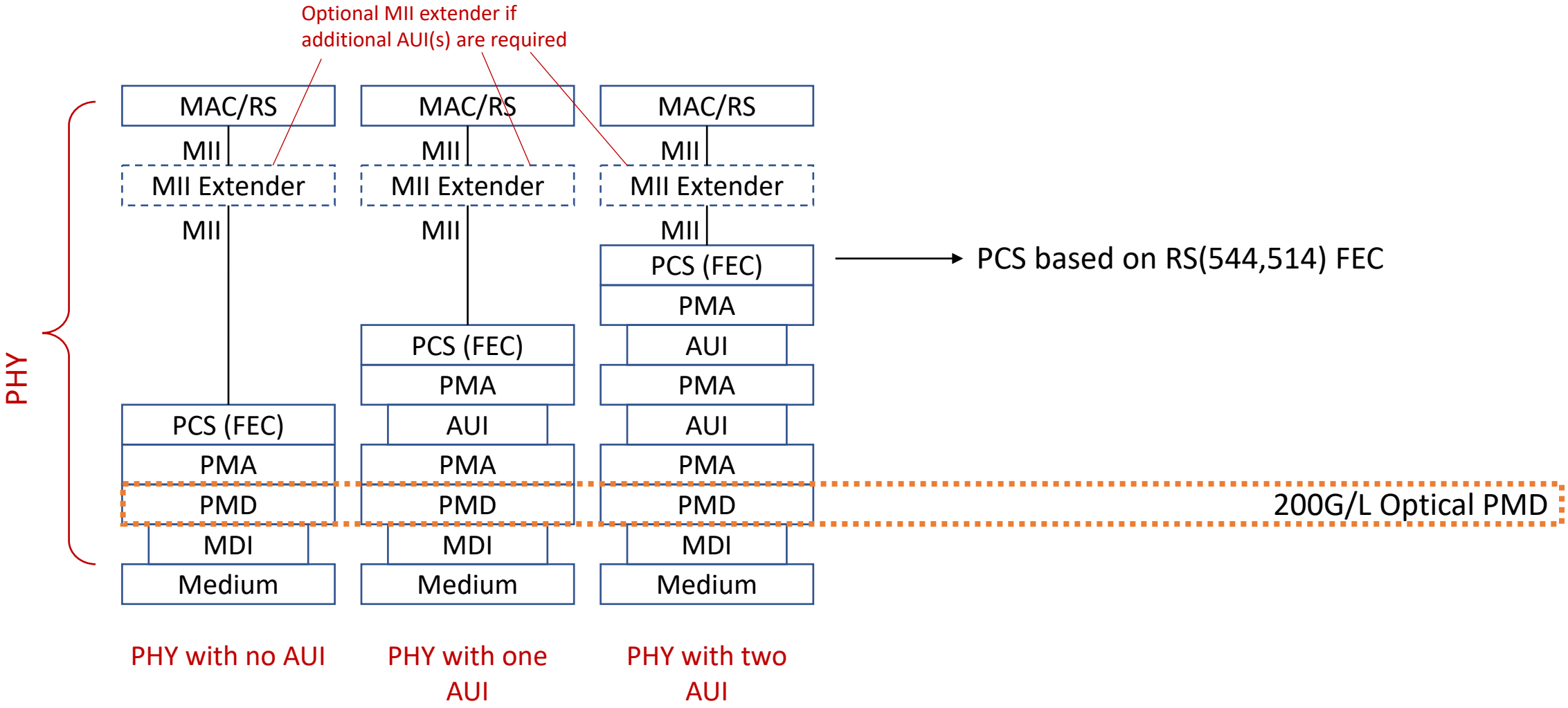
FEC	FECo	FECi
1λ	200GBASE-DR1 400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8	200GBASE-FR1 400GBASE-DR2-2 800GBASE-DR4-2 1.6TBASE-DR8-2
4λ	*800GBASE-FR4-500*	800GBASE-FR4
Reach (loss)	**500m (3dB)**	**2km (4dB)**

FEC Definitions

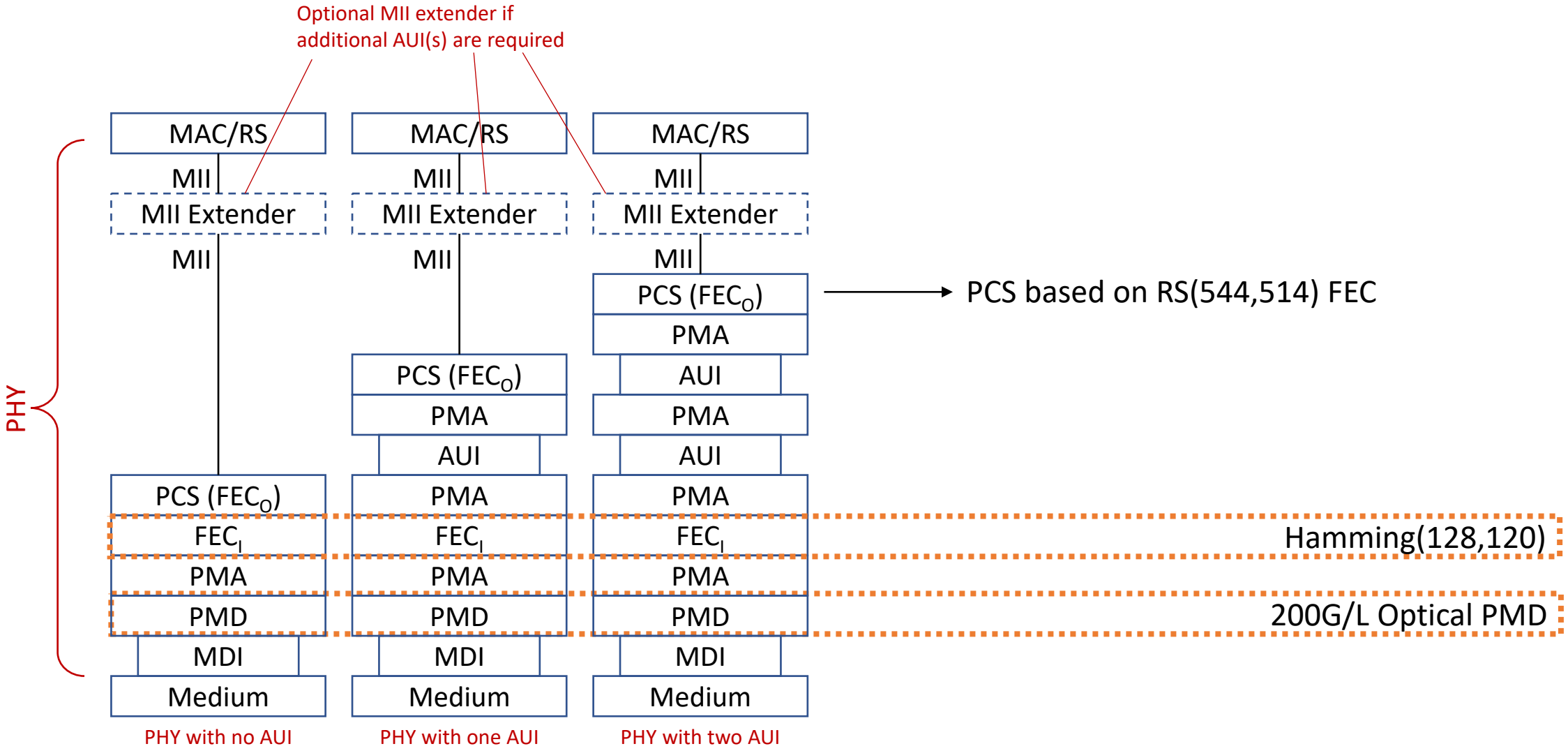
- **FECo**: Optical link runs with RS(544,514) FEC protection.
  - **Applies to**: 200GBASE-DR1, 400GBASE-DR2, 800GBASE-DR4, 1.6TBASE-DR8

- **FECi**: Optical link runs with RS(544,514) FEC protection operating as an outer code, supplemented by Hamming(128,120) FEC protection operating as an inner code.
  - **Applies to**: 200GBASE-FR1, 400GBASE-DR2-2, 800GBASE-DR4-2, 1.6TBASE-DR8-2, 800GBASE-FR4

Location in Ethernet Stack: FECo



Location in Ethernet Stack: FECi



BER Requirements

- **FECo** : The BER of the PMD link shall be less than **2.4 x 10^{-4}** provided that the error statistics are sufficiently random that this results in a frame loss ratio of less than 1.7 x 10^{-12} for 64-octet frames with minimum interpacket gap when processed with an 800GBASE-R/1.6TBASE-R PCS.

- **FECi** : The BER of the PMD link shall be less than **2 x 10^{-3}** provided that the error statistics are sufficiently random that this results in a frame loss ratio of less than 1.7 x 10^{-12} for 64-octet frames with minimum interpacket gap when processed with an 800GBASE-R/1.6TBASE-R PCS and inner code FEC sublayer.

TDECQ/TECQ/SECQ Reference Receiver

	Symbol	Value	Units
Feedforward equalizer (FFE) length	N_b	15	UI
Maximum FFE pre-cursors		3	UI
Maximum FFE post-cursors		13	UI
Normalized FFE coefficient maximum limit *n* = -3 *n* = -2 *n* = -1 *n* = 0 *n* = 1 *n* = 2 *n* ≥ 3	$bb_{max}(n)$	 TBD† TBD TBD TBD TBD TBD TBD†	-
Normalized FFE coefficient minimum limit *n* = -3 *n* = -2 *n* = -1 *n* = 0 *n* = 1 *n* = 2 *n* ≥ 3	$bb_{min}(n)$	 TBD† TBD TBD TBD TBD TBD TBD†	-
Sum of all tap weights	bb_{sum}	1	

† Coefficients at +/- 3 and beyond expected to be small

Single Wavelength Solutions

Proposed Transmitter Specifications

Description	200GBASE-DR1 400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8	200GBASE-FR1 400GBASE-DR2-2 800GBASE-DR4-2 1.6TBASE-DR8-2	Unit
Signaling rate, each lane (range)	106.25 ± 50 ppm	113.4375 ± 50 ppm	GBd
Modulation Format	PAM4	PAM4	
Lane wavelengths (range)	1304.5 to 1317.5	1304.5 to 1317.5	nm
Side-mode suppression ratio (SMSR), (min)	30	30	dB
Average launch power, each lane (max)	4	4	dBm
Average launch power, each lane (min)	-2.8	-2.1	dBm
Outer Optical Modulation Amplitude (OMA_{outer}), each lane(max)	4.2	4.2	dBm
Outer Optical Modulation Amplitude (OMA_{outer}), each lane(min) for MAX(TECQ,TDECQ) < 0.9 dB for 0.9 dB ≤ MAX(TECQ,TDECQ) ≤ 3.4 dB	 -0.3 -1.2 + MAX(TECQ,TDECQ)	 0.4 -0.5 + MAX(TECQ,TDECQ)	 dBm dBm
Transmitter and dispersion eye closure (TDECQ), each lane (max)	3.4[a]	TBD[b]	dB
TECQ (max)	3.4[a]	TBD[b]	dB
|TDECQ - TECQ| (max)	2.5[a]	TBD	dB
Average launch power of OFF transmitter, each lane (max)	-15	-15	dBm
Extinction ratio, each lane, (min)	3.5	3.5	dB
Transmitter transition time (max)	8	8	ps
Transmitter over/under-shoot (max)	22	22	%
RIN_xOMA (max)	-139	-139	dB/Hz
Optical return loss tolerance (max)	21.4 (15.5 for DR1)	21.4 (17.1 for FR1)	dB
Transmitter reflectance (max)	-26	-26	dB

[a] Measured with FFE15 reference equalizer with SER = 4.8e-4
b Measured with FFE15 reference equalizer with SER = 4e-3

Proposed Receiver Specifications

Description	200GBASE-DR1 400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8	200GBASE-FR1 400GBASE-DR2-2 800GBASE-DR4-2 1.6TBASE-DR8-2	Unit
Signaling rate, each lane (range)	106.25 ± 50 ppm	113.4375 ± 50 ppm	GBd
Modulation Format	PAM4	PAM4	
Lane wavelengths (range)	1304.5 to 1317.5	1304.5 to 1317.5	nm
Damage threshold, each lane	5	5	dBm
Average receive power, each lane (max)	4	4	dBm
Average receive power, each lane (min)	-5.8	-6.1	dBm
Receive power, each lane (OMA_{outer}) (max)	4.2	4.2	dBm
Receiver reflectance (max)	-26	-26	dB
Receiver sensitivity (OMA_{outer}), each lane (max) for TECQ < 0.9 dB for 0.9 dB ≤ TECQ ≤ SECQ	 -3.4 -4.3 + TECQ	 -4.0 -4.9 + TECQ	 dBm dBm
Stressed receiver sensitivity (OMA_{outer}), each lane (max)	-0.9[a]	TBD	dBm
Conditions of stressed receiver sensitivity test:			
SECQ	3.4[a,b]	TBD[b,c]	dB
OMA_{outer} of each aggressor lane[c]	2.9	TBD	dBm

[a] Measured with FFE15 reference equalizer with SER = 4.8e-4
[b] No aggressors needed for 200GBASE-DR1
c Measured with FFE15 reference equalizer with SER = 4e-3

Proposed Link Budget

Description	200GBASE-DR1 400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8	200GBASE-FR1 400GBASE-DR2-2 800GBASE-DR4-2 1.6TBASE-DR8-2	Unit
Power budget (for max TDECQ)	6.5	TBD	dB
Operating distance	500	2000	m
Channel insertion loss	3	4	dB
Maximum discrete reflectance	-35	-35	dB
Allocation for penalties (for max TDECQ)	3.5	TBD	dB
Additional insertion loss allowed	0	0	dB

Four Wavelength Solutions

Proposed Transmitter Specifications

Description	800GBASE-FR4	Unit
Signaling rate, each lane (range)	113.4375 ± 50 ppm	GBd
Modulation Format	PAM4	
Lane wavelengths (range)	1264.5 to 1277.5 1284.5 to 1297.5 1304.5 to 1317.5 1324.5 to 1337.5	nm
Side-mode suppression ratio (SMSR), (min)	30	dB
Average launch power, each lane (max)	4.9	dBm
Average launch power, each lane (min)	-1.8	dBm
Outer Optical Modulation Amplitude (OMA_{outer}), each lane(max)	4.8	dBm
Outer Optical Modulation Amplitude (OMA_{outer}), each lane(min) for MAX(TECQ,TDECQ) < 0.9 dB for 0.9 dB ≤ MAX(TECQ,TDECQ) ≤ 3.4 dB	 0.8 -0.1 + MAX(TECQ,TDECQ)	 dBm dBm
Transmitter and dispersion eye closure (TDECQ), each lane (max)	TBD[b]	dB
TECQ (max)	TBD[b]	dB
|TDECQ - TECQ| (max)	TBD	dB
Average launch power of OFF transmitter, each lane (max)	-15	dBm
Extinction ratio, each lane, (min)	3.5	dB
Transmitter transition time (max)	8	ps
Transmitter over/under-shoot (max)	22	%
RIN_xOMA (max)	-139	dB/Hz
Optical return loss tolerance (max)	17.1	dB
Transmitter reflectance (max)	-26	dB

b Measured with FFE15 reference equalizer with SER = 4e-3

Proposed Receiver Specifications

Description	800GBASE-FR4	Unit
Signaling rate, each lane (range)	113.4375 ± 50 ppm	GBd
Modulation Format	PAM4	
Lane wavelengths (range)	1264.5 to 1277.5 1284.5 to 1297.5 1304.5 to 1317.5 1324.5 to 1337.5	nm
Damage threshold, each lane	5.9	dBm
Average receive power, each lane (max)	4.9	dBm
Average receive power, each lane (min)	-5.6	dBm
Receive power, each lane (OMA_{outer}) (max)	4.8	dBm
Receiver reflectance (max)	-26	dB
Receiver sensitivity (OMA_{outer}), each lane (max) for TECQ < 0.9 dB for 0.9 dB ≤ TECQ ≤ SECQ	 -3.7 -4.6 + TECQ	 dBm dBm
Stressed receiver sensitivity (OMA_{outer}), each lane (max)	TBD	dBm
Conditions of stressed receiver sensitivity test:		
SECQ	TBD[c]	dB
OMA_{outer} of each aggressor lane[c]	TBD	dBm

[b] No aggressors needed for 200GBASE-DR1
c Measured with FFE15 reference equalizer with SER = 4e-3

Proposed Link Budget

Description	800GBASE-FR4	Unit
Power budget (for max TDECQ)	TBD	dB
Operating distance	2000	m
Channel insertion loss	4	dB
Maximum discrete reflectance	-35	dB
Allocation for penalties (for max TDECQ)	TBD	dB
Additional insertion loss allowed	0	dB

Summary

- Baseline proposals have been presented for:
  - 500m solutions based on FECo (single wavelength)
  - 2km solutions based on FECi (single wavelength and four wavelength)

Thank You