

# **Baseline proposal for 50G single-wavelength (Rev. 1a)**

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- ❑ In Berlin meeting, a joint contribution (wangbo\_3ca\_2\_0717) proposed to start 50G single-wavelength in IEEE p802.3ca.
- ❑ In Berlin meeting, motion #6 was passed.
  - The Task Force should analyze and compare the following solutions for 50G PON and choose the best one for 50G EPON:
    1. Single wavelength TDM-PON with 50Gb/s line rate,
    2. Two-wavelength TDM/WDM-PON with 25Gb/s line rate per lane.
- ❑ 50G single-wavelength TDM-PON is the requirement of a big potential EPON market (Zhang\_3ca\_1\_0318), also a good convergence with ITU-T 50G PON.
- ❑ This contribution presents a baseline proposal for 50G single-wavelength in IEEE p802.3ca.

# Candidates for 50G single-wavelength

## □ Two candidates for 50G single-wavelength

### 1. 50G PAM4 at 25G Baud

- working with 25G optics in 4-level detection
- DSP at both Tx and Rx for pre/post equalization and clock recovery

### 2. 50G NRZ at 50G Baud with MLSE

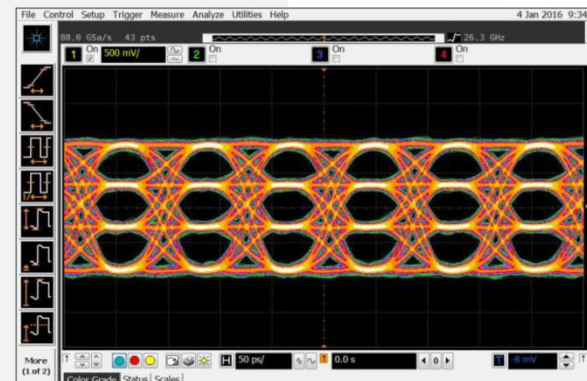
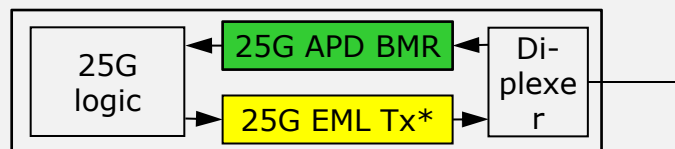
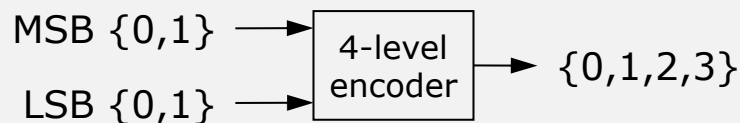
- working with 25G optics in 2-level detection
- DSP at both Tx and Rx for pre/post equalization, MLSE and clock recovery

## □ Many contributions in past meetings showed technical feasibility of 50G single-wavelength.

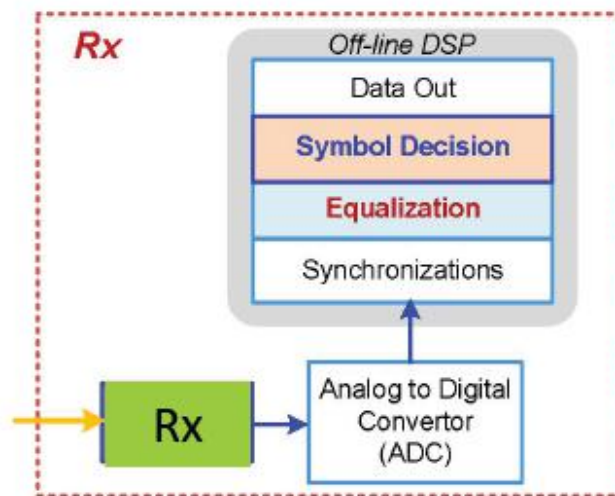
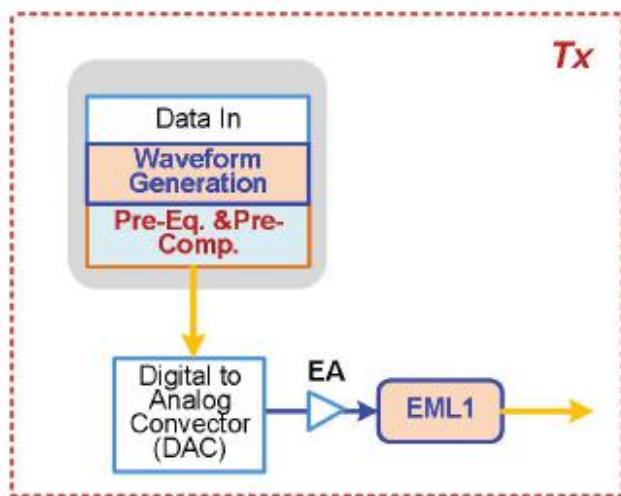
1. 50G PAM4
2. 50G NRZ

# Trasceiver setup for 50G PAM4 (25G Baud)

## 50G PAM-4



liu\_3ca\_2a\_0917

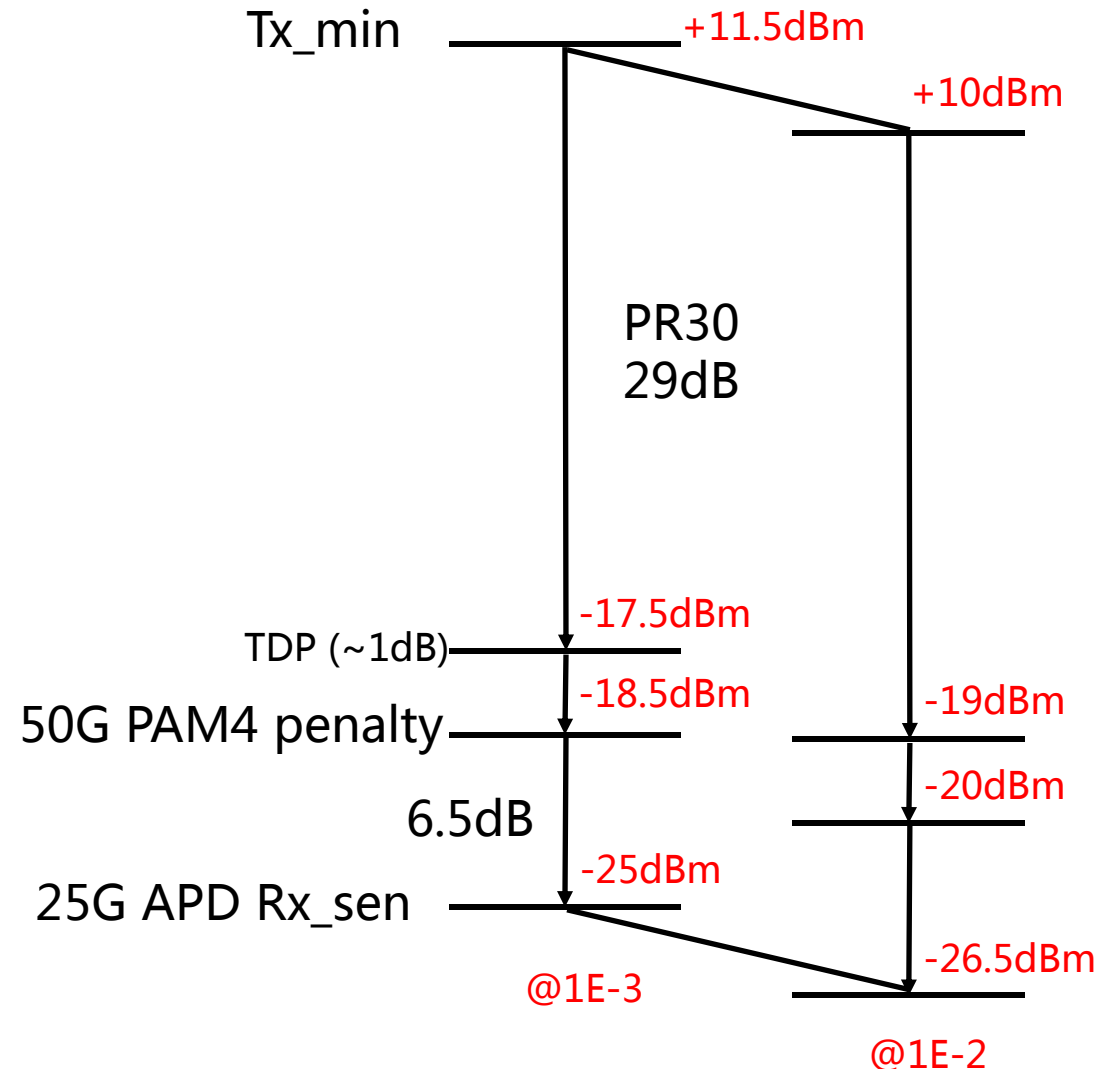


zhang\_junwen\_3ca\_1\_1117

# Test parameters & results for 50G PAM4

	Contributor	Parameters	Tested Rx Sensitivity
50G PAM4 (25G Baud)	liu_3ca_2a_1117	25G EML: 1310nm 3dB BW~18.75GHz Tx power ~+5dBm 25G APD: 3dB BW~18.75GHz	-20.7dBm@1E-3 -23dBm@1E-2
	zhang_junwen_3ca_1_1117	25G EML: O-band 3dB BW~20GHz Tx power ~2.5dBm 25G APD: 3dB BW~18GHz	-20dBm@1E-3 -23dBm@1E-2

# Proposed power budget for 50G PAM4 (25G Baud)



- ❑ -25dBm@ $10^{-3}$  for **25G NRZ** by 25G APD after 2020
  - harstead\_3ca\_5\_0117
  - liu\_3ca\_2a\_1117
- ❑ 1.5dB optical gain for enhance FEC, e.g., LDPC
  - laubach\_3ca\_3a\_0118
- ❑ 5.5dB~7dB penalty between 50G PAM4 and 25G NRZ
  - liu\_3ca\_2a\_1117
  - zhang\_junwen\_3ca\_1\_1117
- ❑ 0.5dB~1dB TDP after dispersion compensation by DSP
  - zhou\_3ca\_1\_0318



# 25G Tx launch power and ER vendor survey results

liu\_3ca\_4\_0517

	25G EML		25G cooled DML		25G uncooled DML		25G EML+SOA	
	Power (dBm)	ER (dB)	Power (dBm)	ER (dB)	Power (dBm)	ER (dB)	Power (dBm)	ER (dB)
vendor 1	3~4	8	7	4.5	5~6	4.5	7 (note 1)	8
vendor 2	3	8	5	5	4	4	7	8
vendor 3	4	6	4	4	xx	xx	6~7	6
vendor 4	2.5	8	5.8	4	xx	xx	xx	xx
vendor 5	4.3	8	5.5	4.5	4	4	7	7
vendor 6	4.5	8	6	5	4	4	x	x

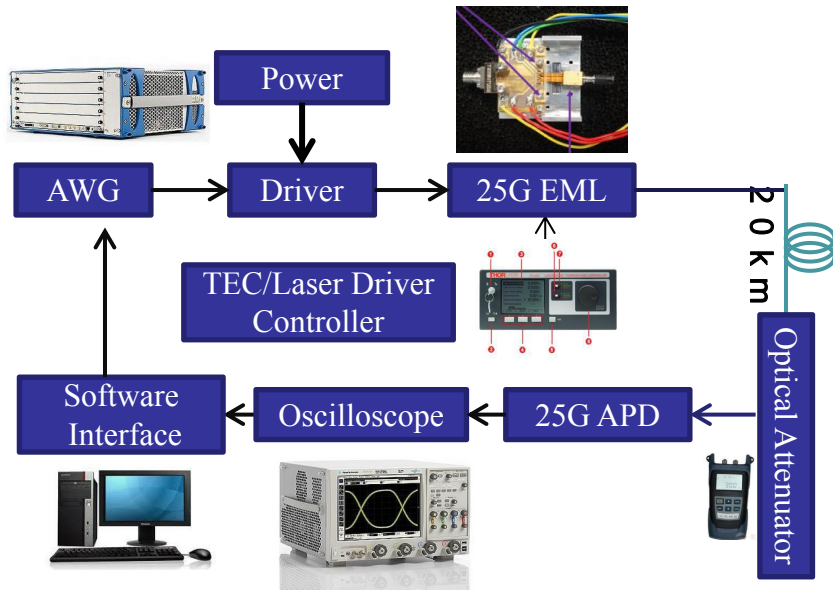
Note 1: Proposed to add one more option 10~11dBm with the relative cost ~20 (Assuming develop a new device specially optimized in future)

harstead\_3ca\_3\_0917

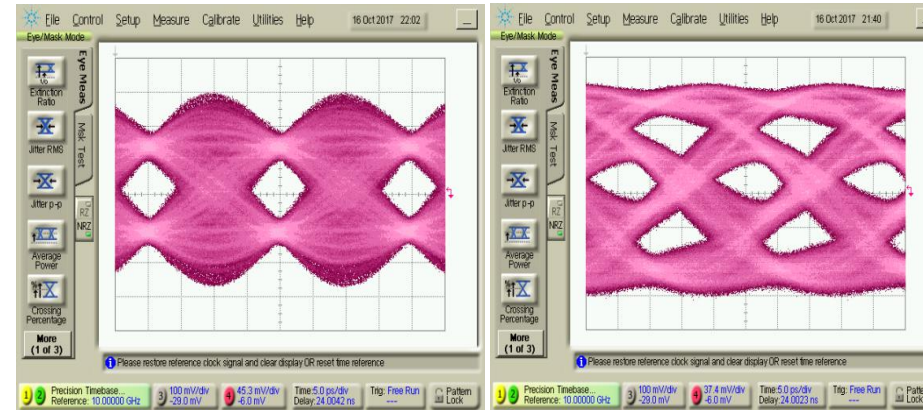
AVPmin (dBm)	number	mean	$\sigma$
EML	6	4.6	0.7
EML+SOA	3	8.7	2.0
cooled DML	6	6.5	0.5
uncooled DML	5	4.7	1.0
ER (dB)			
EML	6	7.5	0.8
EML+SOA	3	7.3	1.2
cooled DML	6	5.2	1.0
uncooled DML	5	4.6	0.7

1. 50G PAM4
- 2. 50G NRZ**

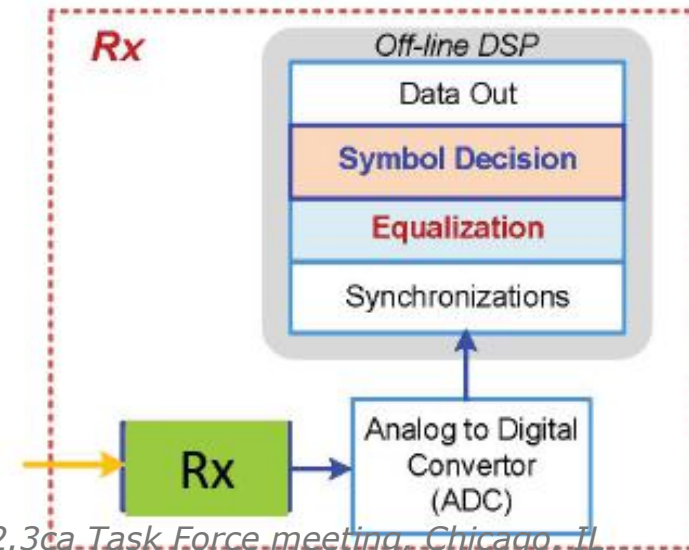
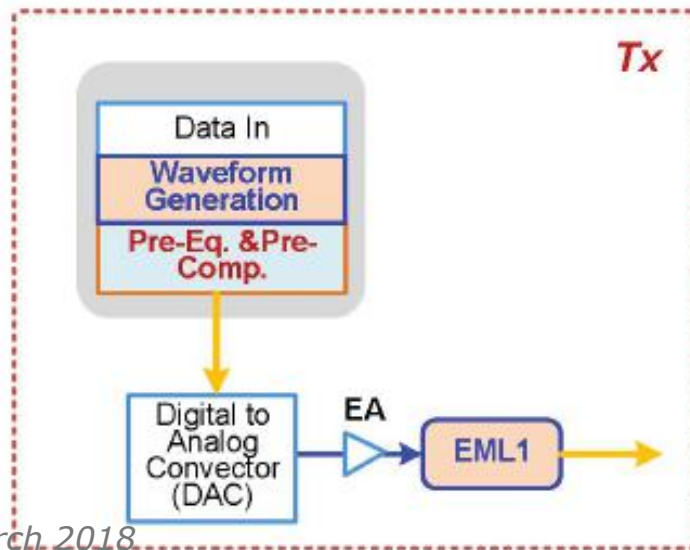
# Transceiver setup for 50G NRZ (50G Baud)



Electronic eye diagram Optical eye diagram



liu\_3ca\_2a\_1117

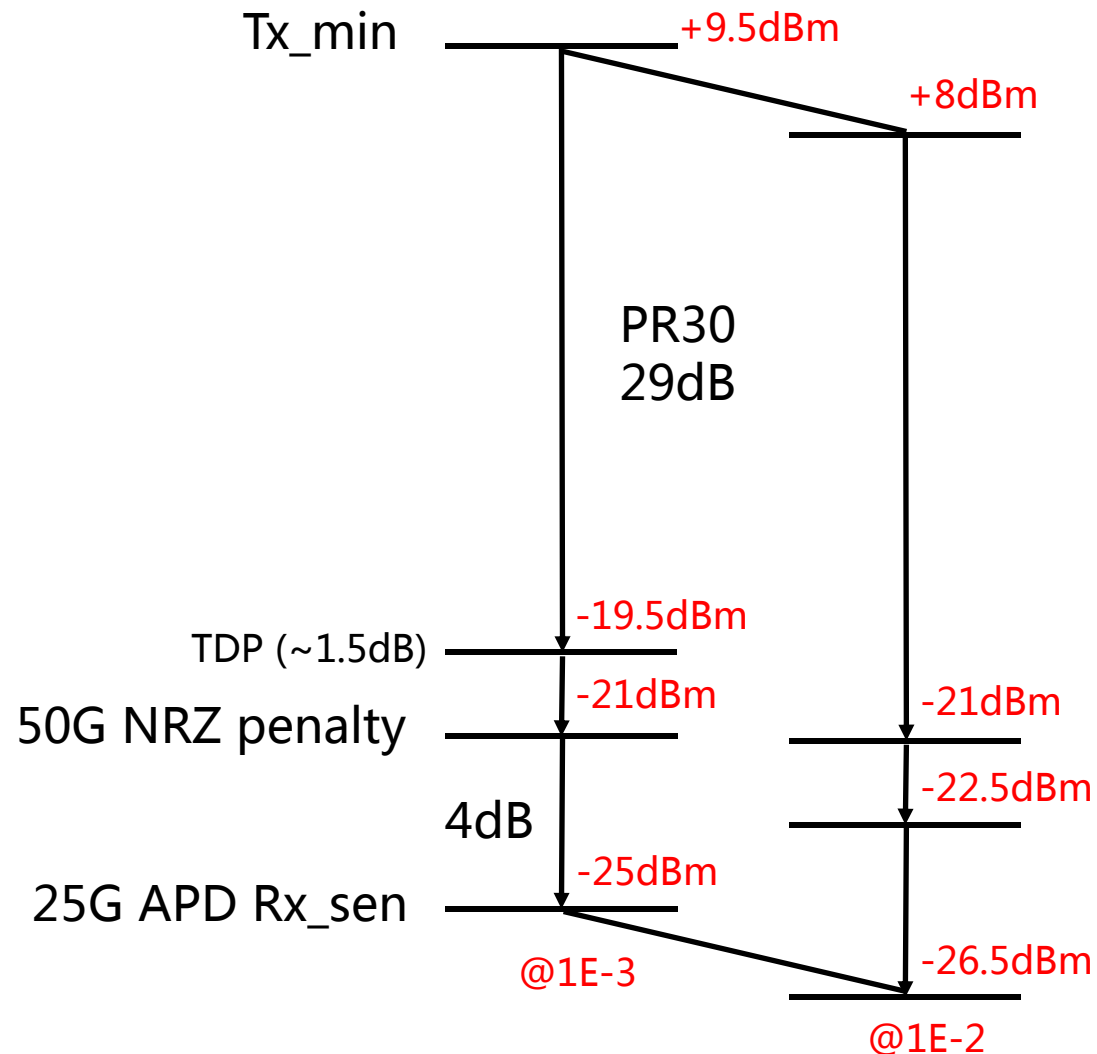


zhang\_junwen\_3ca\_1\_1117

# Test parameters & results for 50G NRZ

	Contributor	Parameters	Tested Sensitivity
50G NRZ/DSP	liu_3ca_2a_1117	25G EML: 1310nm 3dB BW~18.75GHz Tx power ~4dBm 25G APD: 3dB BW~18.75GHz DSP: DFE/FFE/MLSE	-25dBm@1E-3 -27.5dBm@1.4E-2
	zhang_junwen_3ca_1_1117	25G EML: O-band 3dB BW~20GHz Tx power ~2.5dBm 25G APD: 3dB BW~18GHz DSP: DFE/FFE/MLSE	-23dBm@1E-3 -24.5dBm@1E-2

# Proposed power budget for 50G NRZ (50G Baud)

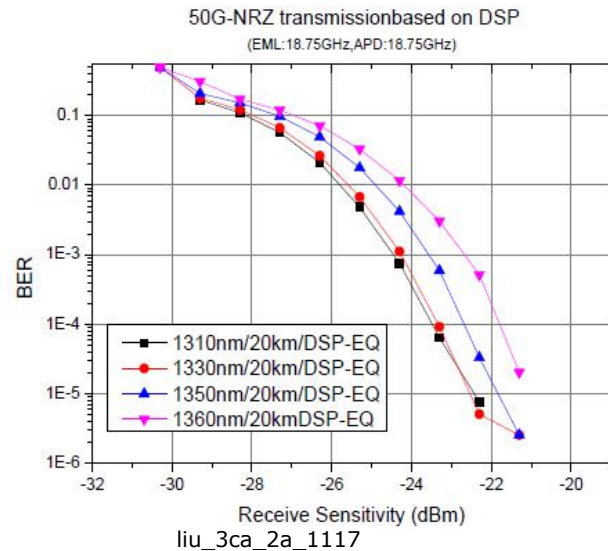


- ❑ -25dBm@ $10^{-3}$  for 25G NRZ by 25G APD after 2020
  - harstead\_3ca\_5\_0117
  - liu\_3ca\_2a\_1117
- ❑ 1.5dB optical gain for enhance FEC, e.g., LDPC
  - laubach\_3ca\_3a\_0118
- ❑ 3dB~5dB penalty between 50G NRZ and 25G NRZ
  - liu\_3ca\_2a\_1117
  - zhang\_junwen\_3ca\_1\_1117
- ❑ 1dB~1.5dB TDP after dispersion compensation by DSP
  - zhou\_3ca\_1\_0318

# Wavelength plan for 50G single-wavelength

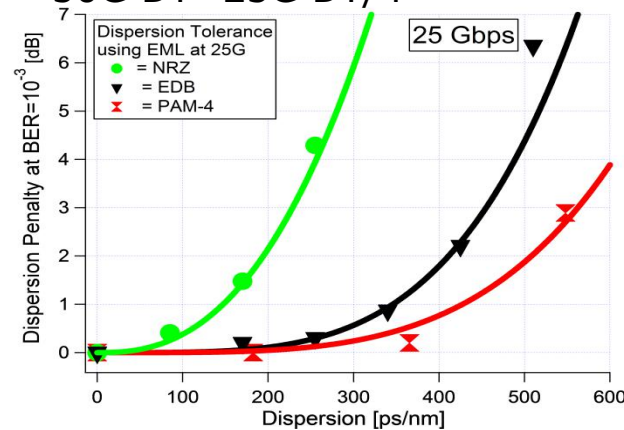
# Wavelength Plan for 50G single-wavelength

## 50G NRZ dispersion penalty with EQ



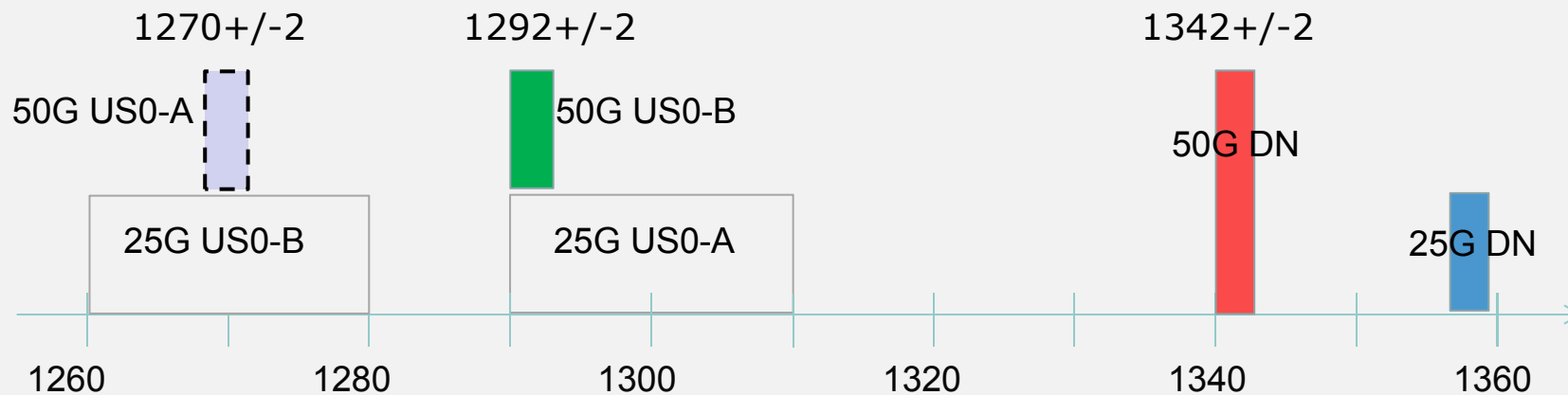
## 25G dispersion tolerance w/o DC

As a first approximation,  
50G DT=25G DT/4



V. Houtsma, D. van Veen, "A Study of Options for High-Speed TDM-PON Beyond 10G", J. Lightwave Tech., Feb. 2015.

- 50G per wavelength dispersion penalty in O- band is very small
- DP in 1340nm for PAM4 (<0.5dB) and EDB is tolerable (~1dB)
- DP in 1340nm for NRZ is manageable after EQ





- ❑ Two solutions for 50G single-wavelength
  - 50G PAM4 at 25G Baud
  - 50G NRZ at 50G Baud with MLSE
- ❑ Downstream PMD proposal for 50G single-wavelength

	Proposed Tx Power	Proposed Sensitivity	Wavelength
50G PAM4 (25G Baud)	+10dBm	-20dBm@1E-2	DS:1342+/- 2 nm US: Option 1: 1270+/-2nm Option 2: 1292+/-2nm
50G NRZ/DSP (50G Baud)	+8dBm	-22.5dBm@1E-2	



P802.3ca shall adopt 1 X 50Gb/s as the solution for 50G-EPON.

Moved: Yong Guo

Second: Dekun Liu

For:

Against:

Abstain:

Adopt 1342+/-2nm as the downstream wavelength plan for 1x50G-EPON.

Moved: Yong Guo

Second: Dekun Liu

For:

Against:

Abstain:

Adopt 50GBaud NRZ or 25GBaud PAM4 modulation format at the transmitter for 1x50G-EPON downstream.

Moved: Yong Guo

Second: Dekun Liu

For:

Against:

Abstain:

Adopt the following wavelength plan for 1x50G-EPON upstream:

Option 1: 1270+/-2nm

Option 2: 1292+/-2nm

Moved: Yong Guo

Second: Dekun Liu

For:

Against:

Abstain:

**Thank you**

		Components	Tested Sensitivity
50G NRZ (50G Baud)	liu_3ca_2a_1117	50G EML and APD (37.5G Hz)	-25.3 @1E-3
50G EDB (50G Baud)	liu_3ca_2a_1117		
	zhang_junwen_3ca_1_1117		-22dBm@1E-3 -24dBm@1E-2
50G PAM4 (25G Baud)	liu_3ca_2a_1117	25G EML 25G APD	-20.7dBm@1E-3 -23dBm@1E-2
	zhang_junwen_3ca_1_1117	25G EML, 3dB BW~20GHz 25G APD: 3dB BW~18GHz	-20dBm@1E-3 -23dBm@1E-2
50G NRZ/DSP	liu_3ca_2a_1117	25G EML & 25G APD DFE/FFE/MLSE	-25dBm@1E-3 -27.5dBm@1.4E-2
	zhang_junwen_3ca_1_1117	25G EML, 3dB BW~20GHz 25G APD: 3dB BW~18GHz	-23dBm@1E-3 -24.5dBm@1E-2