

# Realistic cable lengths and chromatic dispersion values for channel modeling

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# Supporters

# Currently working towards a Monte Carlo simulation of dispersion in 2 km and 10 km links

- Parameters to consider:
  - Zero dispersion wavelength and slope
  - Number of segments and segment lengths
- We may also consider
  - Total length distributions
  - Center wavelength distributions
- Best to use real world data when available
- This contribution will share examples of cable lengths and dispersion parameters

# Data center links use multiple cables with different lengths and dispersion values

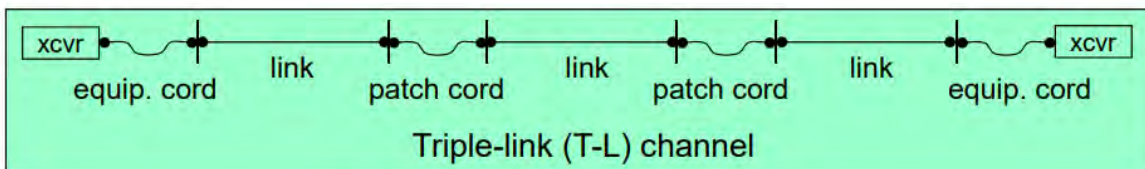
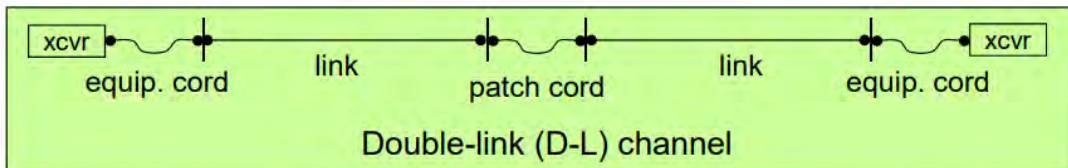
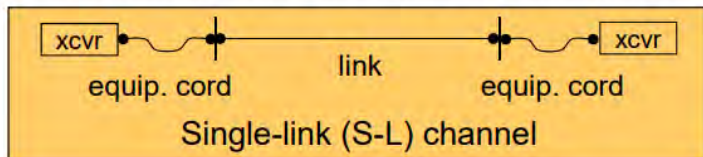
## Cabling Terminology

Cords – used to administer connectivity from:

1. equipment (transceivers) to patch panel, called equipment cords
2. patch panel to patch panel, called patch cords

Links – permanent cabling between two patch panels

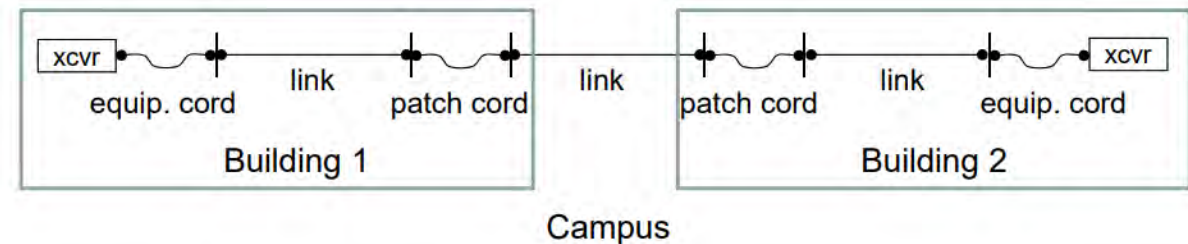
Channels – complete end-to-end connectivity between equipment consisting of concatenations of cords and permanent link(s)



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## Triple-link Channels – Really?!

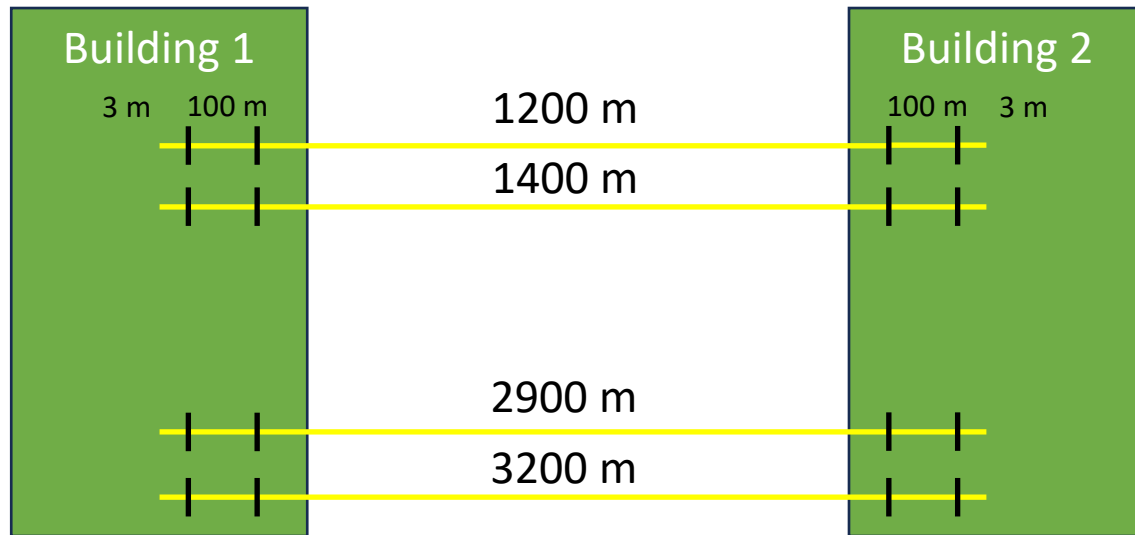
- Previous contributions modeled single-link and double-link
  - Suitable for topologies within a building ( $\leq 500$  m)
- $\geq 2$  km reach aims to span between buildings
  - Introduces additional campus link
- Supporting triple-link channels permits
  - One link in each building plus campus link



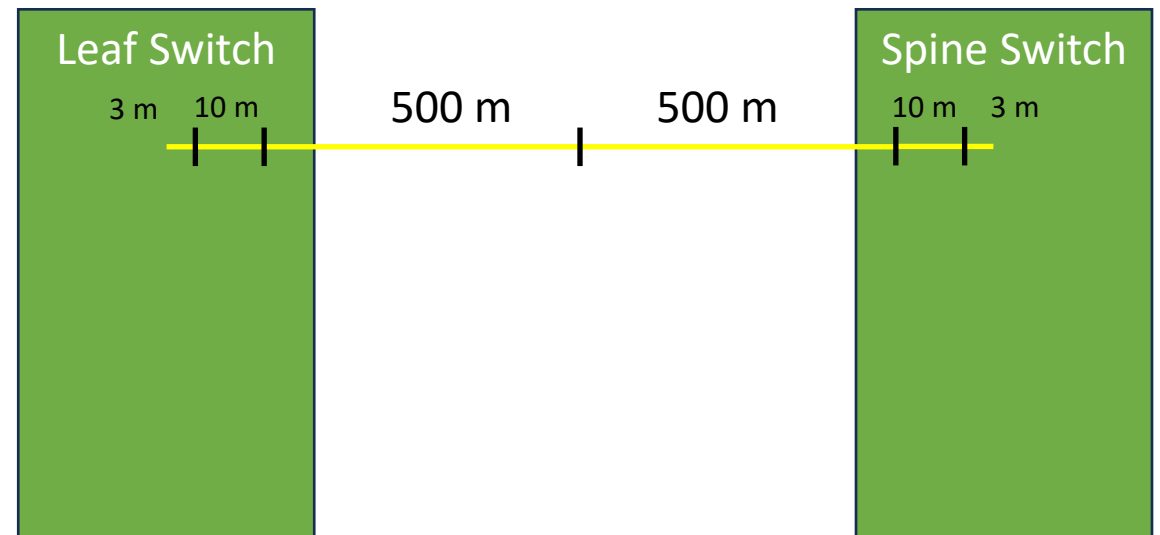
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# Two cases to consider for FR links (2 km)

- Campus link – length dominated by single cable between buildings



- In-building link – two or more long cables with comparable lengths



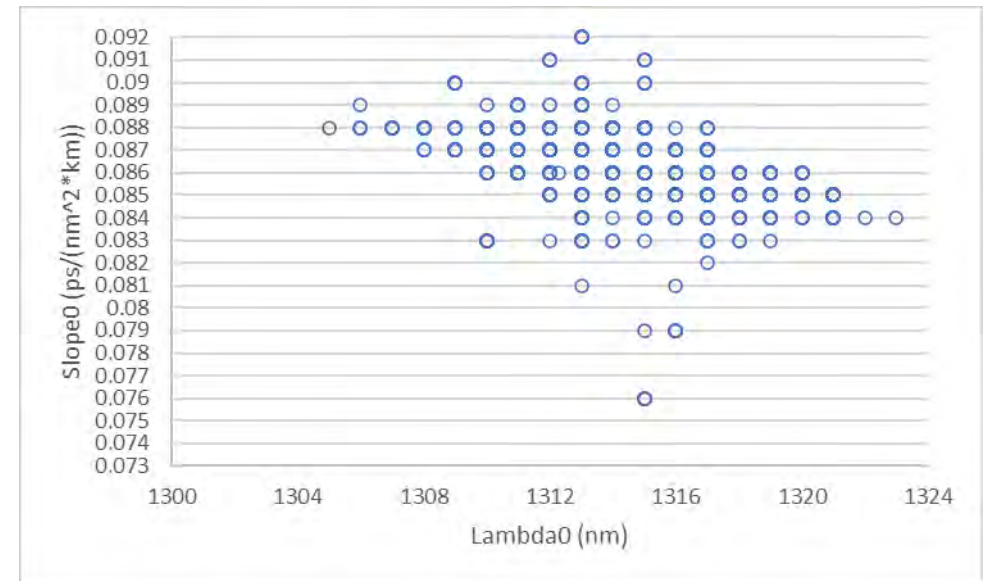
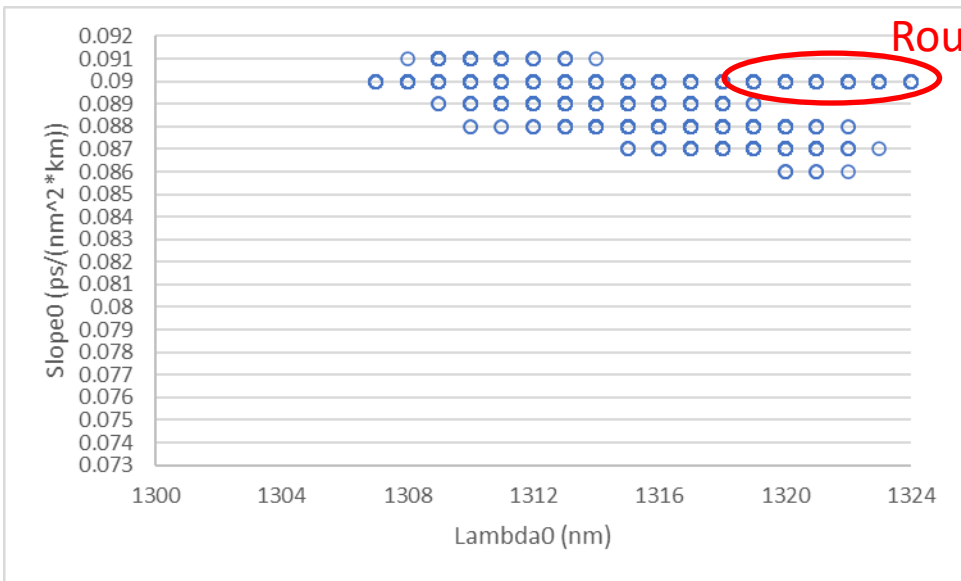
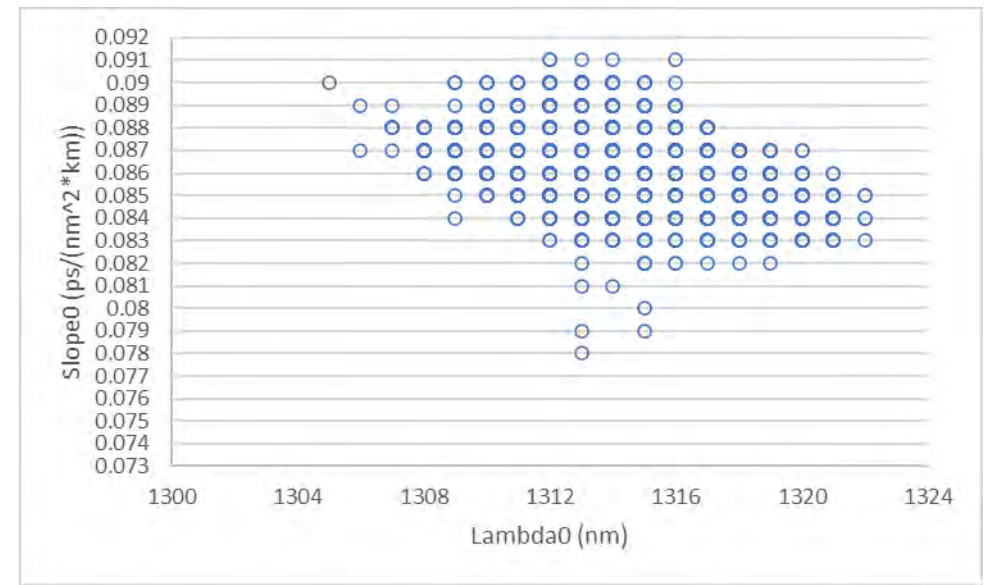
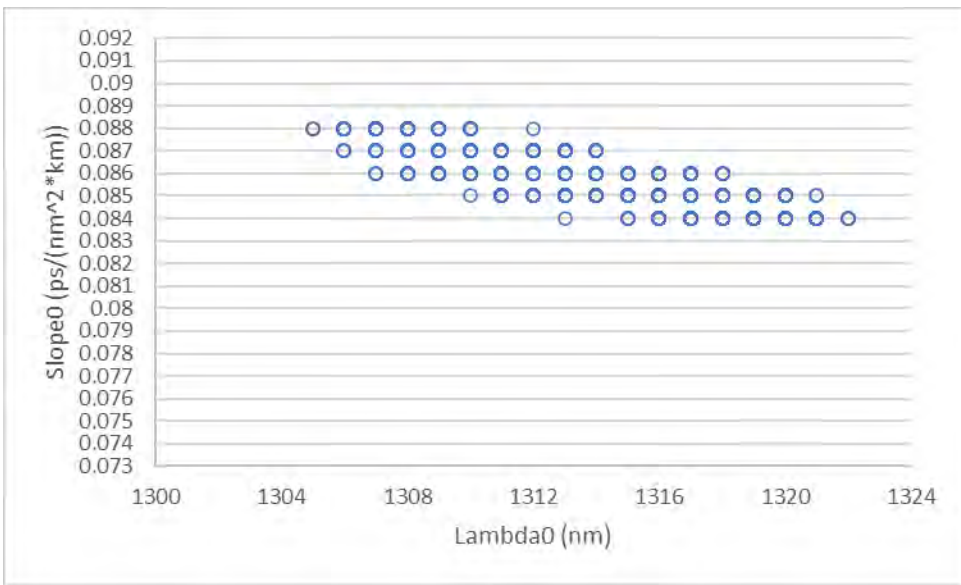
Need more data on segment lengths and total lengths

# For LR links (10 km) need to consider max cable length available

- High fiber count cables require large spool (> 2m diameter)
  - Limited by what can fit on a truck
- Examples:
  - 288 fiber cable, stranded loose tube, limited to 3 km per spool
  - 3456 fiber cable, rollable ribbon, limited to 2 km per spool
- Expect at least 4 different fibers in an LR (10 km) link
- Note: fusion splice within a single cable not allowed by standards

# Real world dispersion data (presented Feb 27, 2024 Ad Hoc)

- Analyzed zero dispersion wavelength and zero dispersion slope
- Values reported by fiber manufacturers
- 4 different manufacturers included
- Single fiber spools, not ribbon
- G.652.D/G.657.A1 – compliant with both
- Fibers shipped 2023
- >10k fiber spools per manufacturer



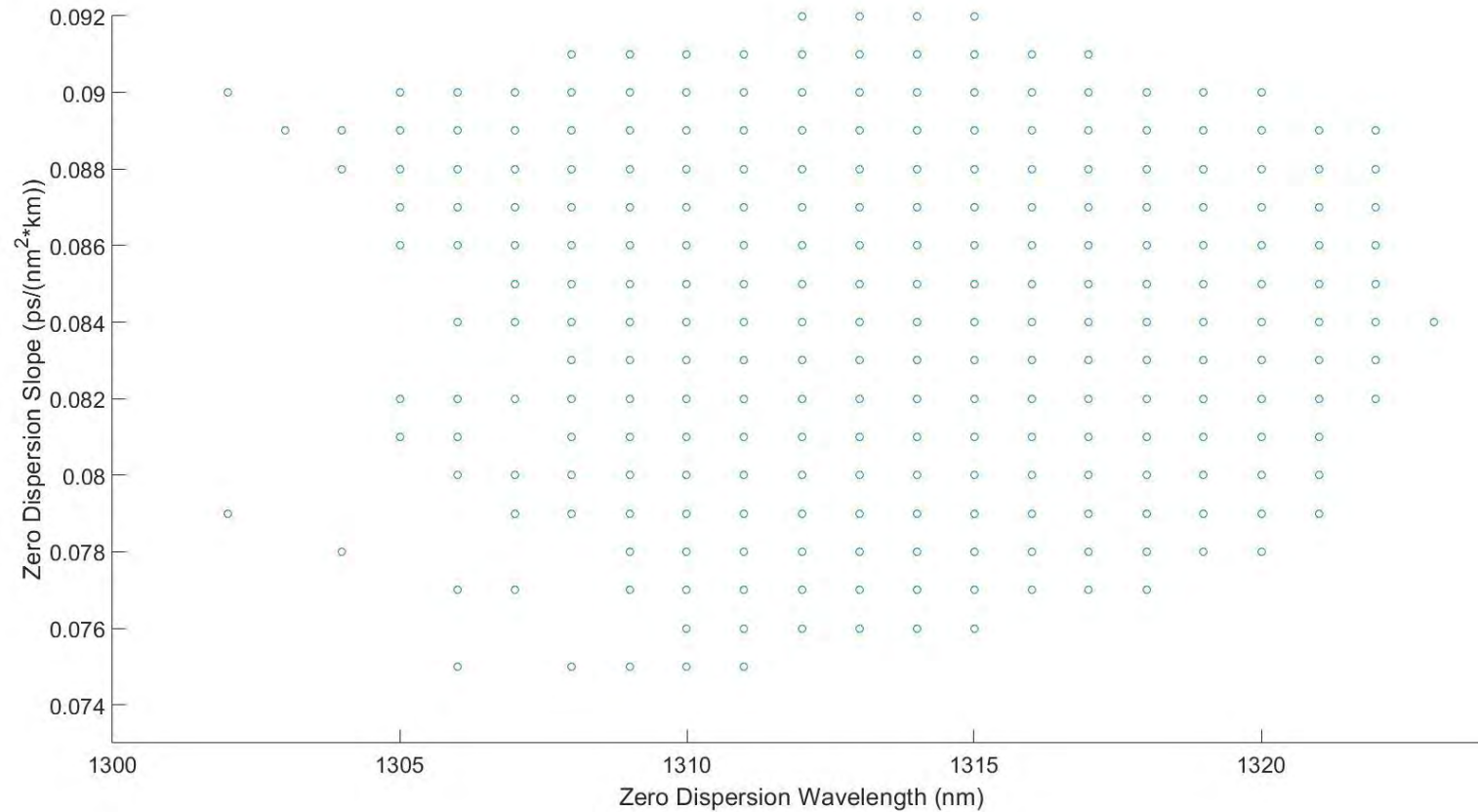
- Some variation between manufacturers
- Subset of values allowed by standard used
- One manufacturer rounded reported slope values – will send update



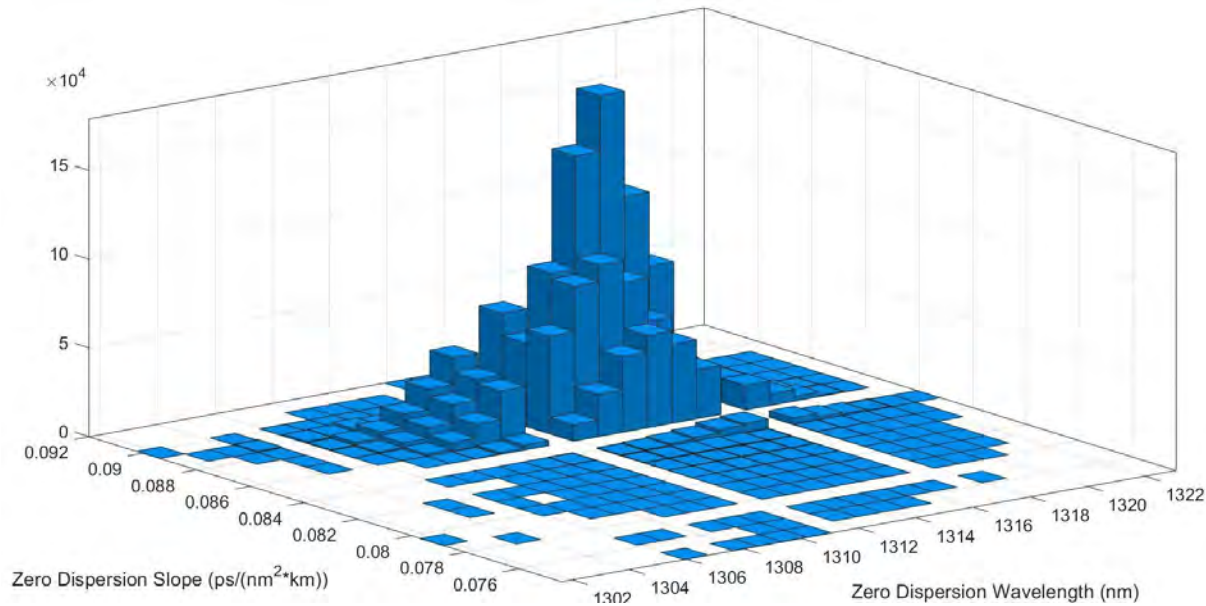
# Real world dispersion data - update

- Removed manufacturer with rounding issue
- Added 2 more manufacturers, 5 manufacturers total
- Collected data 2014-2023, 10 years total
- > 1.6 million fibers
- Look at zero dispersion wavelength, slope, and dispersion over 2 km for different wavelengths

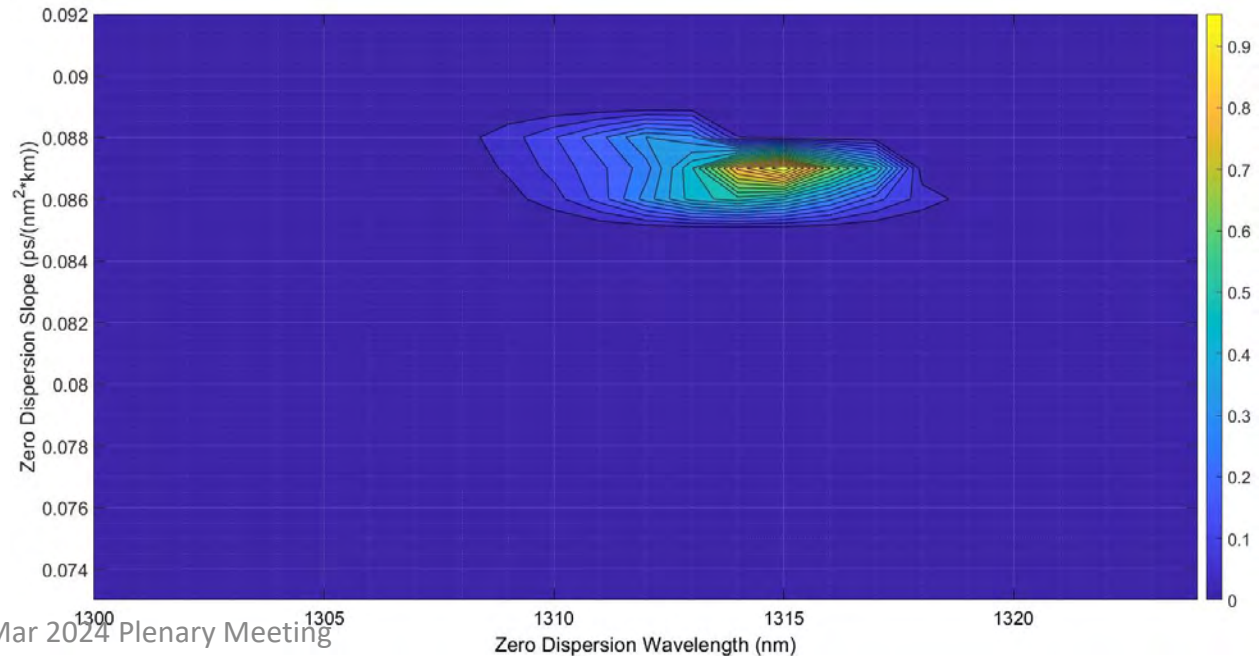
# Fibers found with wide range of wavelength and slope values



# Vast majority of fibers are found in a narrow wavelength and slope range

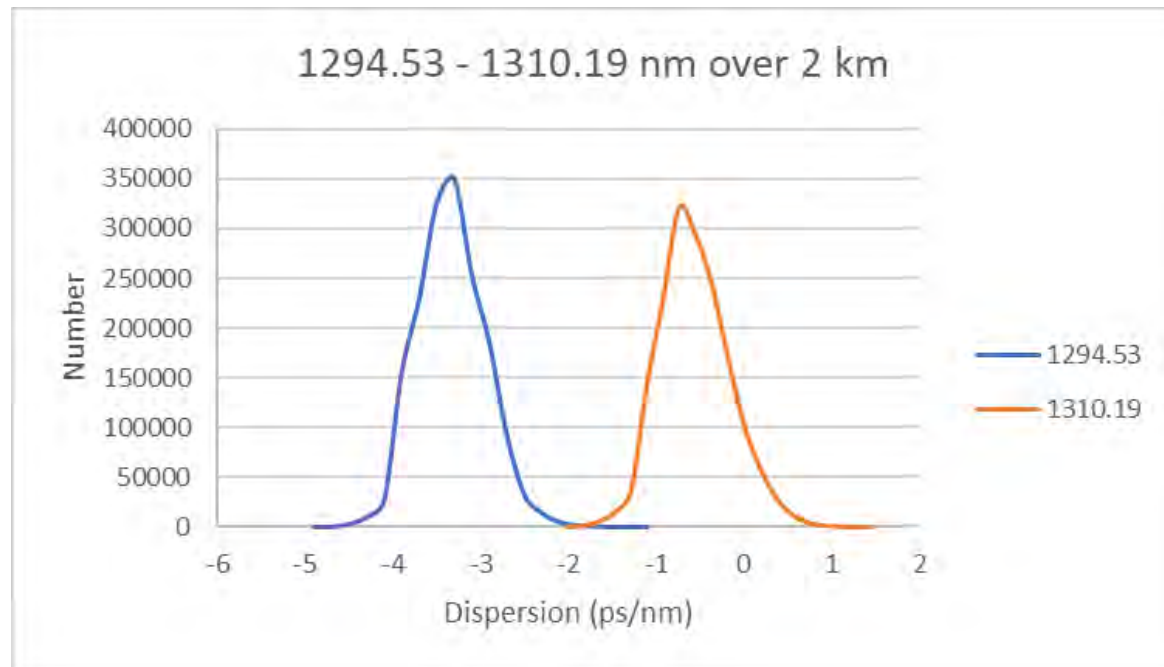


Use these fibers to calculate accumulated dispersion over 2 km at relevant Q values



# Case 1:

## 1294.53 – 1310.19 nm over 2 km single fiber

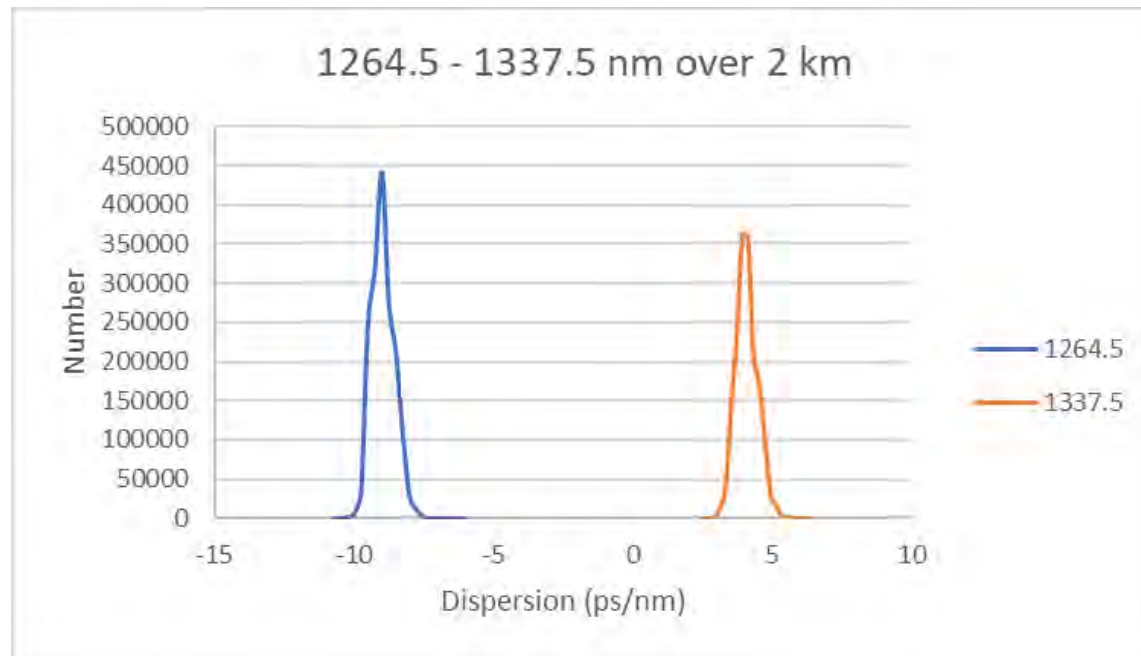


1294.53 nm	D (ps/nm)
99.99%	-4.76
99.9%	-4.53
99%	-4.28

1310.19 nm	D (ps/nm)
99.99%	0.95
99.9%	0.74
99%	0.38

# Case 2:

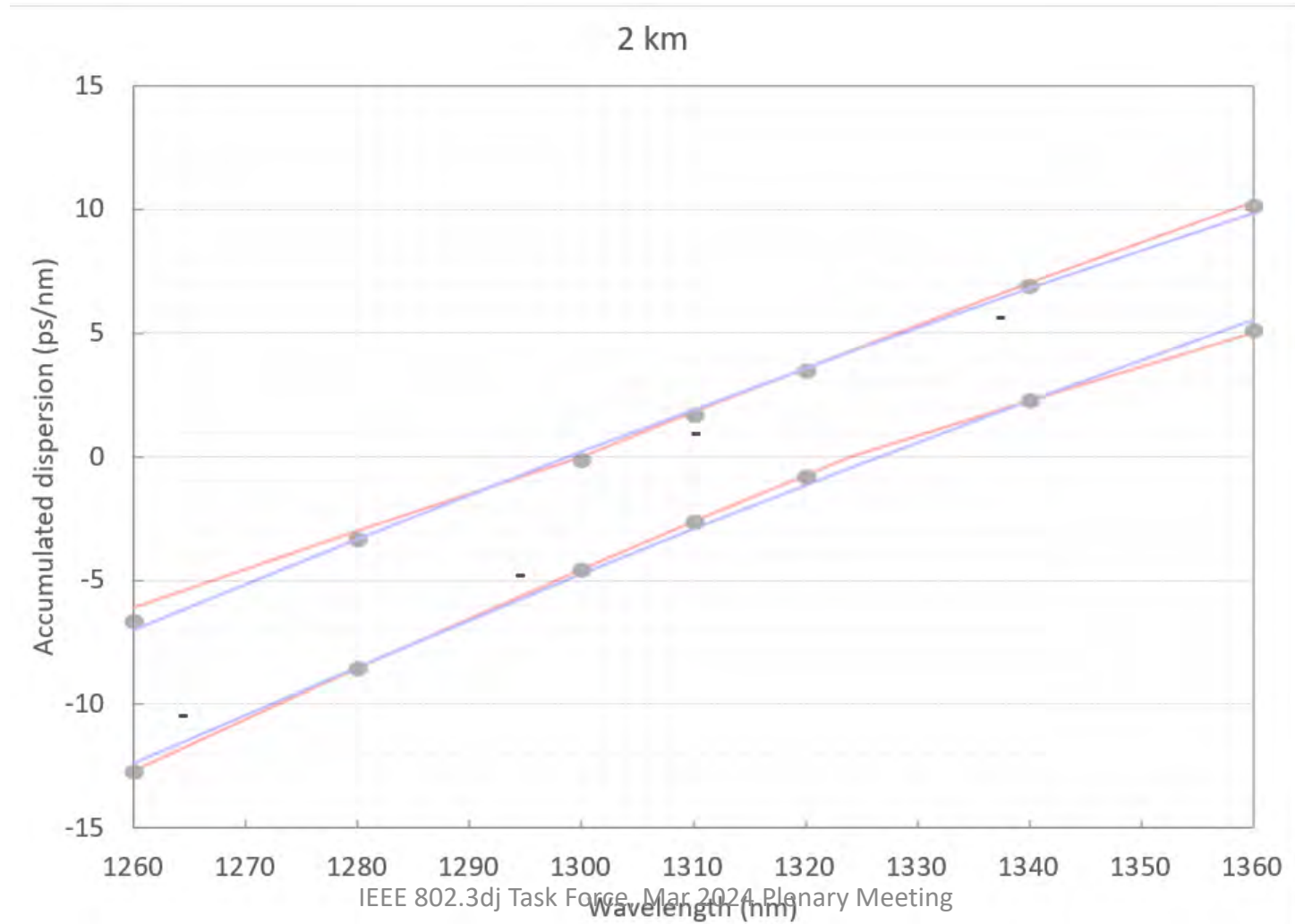
## 1264.5 – 1337.5 nm over 2 km single fiber



1264.5 nm	D (ps/nm)
99.99%	-10.46
99.9%	-10.19
99%	-9.92

1337.5 nm	D (ps/nm)
99.99%	5.63
99.9%	5.41
99%	4.97

This data set shows less dispersion over 2 km at 99.99% than ITU-T results



# Conclusions

- Working towards Monte Carlo model of accumulated dispersion
- Example lengths for FR and LR links shown
  - Need more data
- Dispersion values shown from 1.6 million fibers from 5 manufacturers over 10 years
  - Most zero dispersion wavelength and slope values in narrow range
  - 99.99% accumulated dispersion less than ITU-T results
- Will continue to develop this model through offline consensus building and ad hoc meetings