

New Phase Stable Optical Fiber

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Motivation

- Most synchronization systems use optical fibers to distribute reference signals
- Problem: the signal delay in these fibers changes due to temperature changes
⇒ synchronization errors
- Countermeasure: using optical fiber cables where the delay change is low
→ phase stable optical fibers

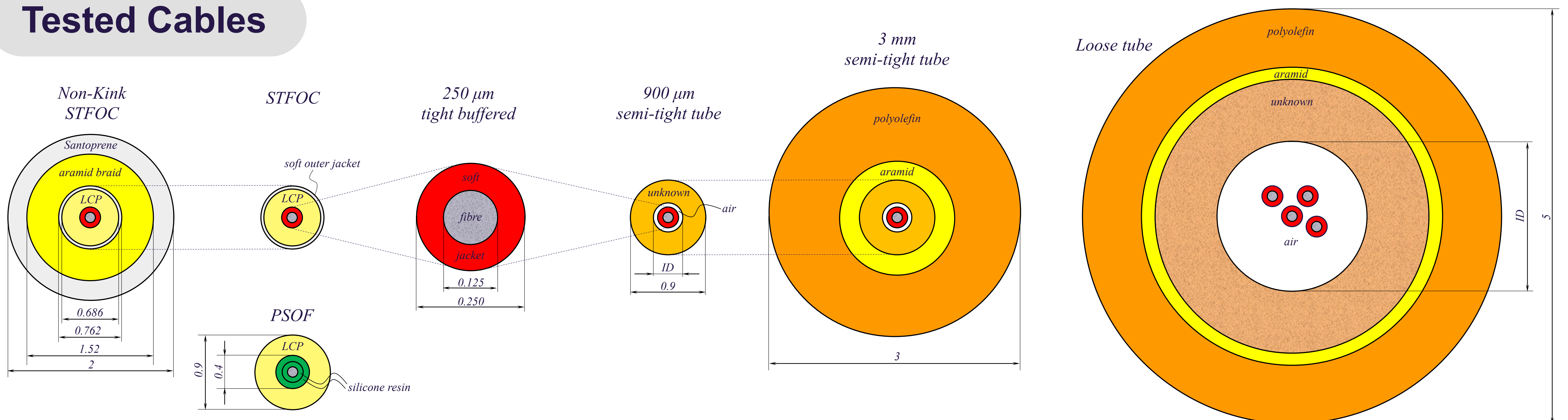
Introduction

- The Thermal Coefficient of Delay (*TCD*) can be calculated

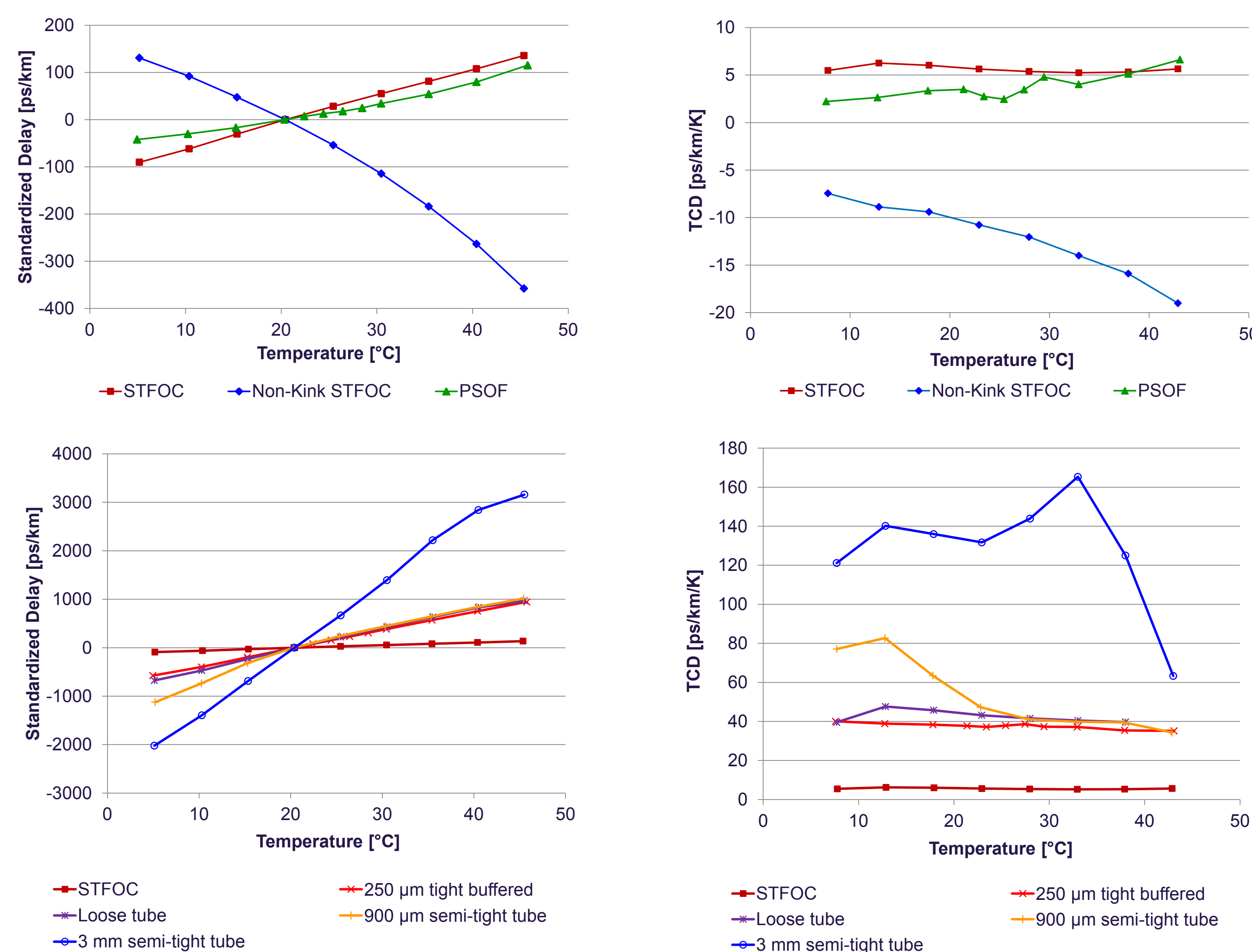
$$TCD = \frac{1}{c} \left[\underbrace{N_g K}_{\text{expansion}} + \underbrace{\frac{dN_g}{dT}}_{\text{temperature}} + \underbrace{\frac{dN_g}{d\sigma} E_f (K - k_f)}_{\text{stress}} \right] \quad \text{with} \quad K = \frac{A_f E_f k_f + A_j E_j k_j}{A_f E_f + A_j E_j}$$

- If the thermal coefficient of expansion of the fiber jacket k_j goes down, *TCD* will be lowered.
- Linden Photonics offers a cable called *STFOC* with a negative $k_j = -6 \cdot 10^{-6} \text{ K}^{-1}$ which significantly reduces the *TCD* compared to normal cables.
- The jacket is made from LCP, similar to the *PSOF* cable made by Furukawa.

Tested Cables



Measurement Results



Optical Cable	TCD [ps/km/K]		Comment
	Measurement	Calculation	
250 µm tight buffered	37.5	33.4 to 42.7	As expected
STFOC	5.6	11.1	Better than expected
Non-Kink STFOC	-12.2	11.1	Negative
PSOF	3.7	< 5.0	As expected
Loose tube	42.6	33.4 to 42.7	As expected
900 µm semi-tight tube	53.9	> 33.4	Increased
3 mm semi-tight tube	128.3	> 33.4	Much increased

- *TCD* of *STFOC* is better than expected
- *Non-Kink STFOC*: negative *TCD*
- The *loose tube* cable coating does not affect the *TCD* of the *250 µm tight buffered* cables inside
- The coating of the *semi-tight tube* cable has an effect and increases the *TCD*

Conclusion

- An alternative for the *PSOF* from Furukawa has been found.
- The *STFOC* shows a similarly excellent behavior:
 $TCD = 5.6 \text{ ps/km/K}$.
- The *Non-Kink STFOC* is the first known fiber cable which shows a negative *TCD*:
 $TCD = -12.2 \text{ ps/km/K}$

Project Partners



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