

Oscillateur Optoélectronique Couplé faible bruit de phase à 10GHz

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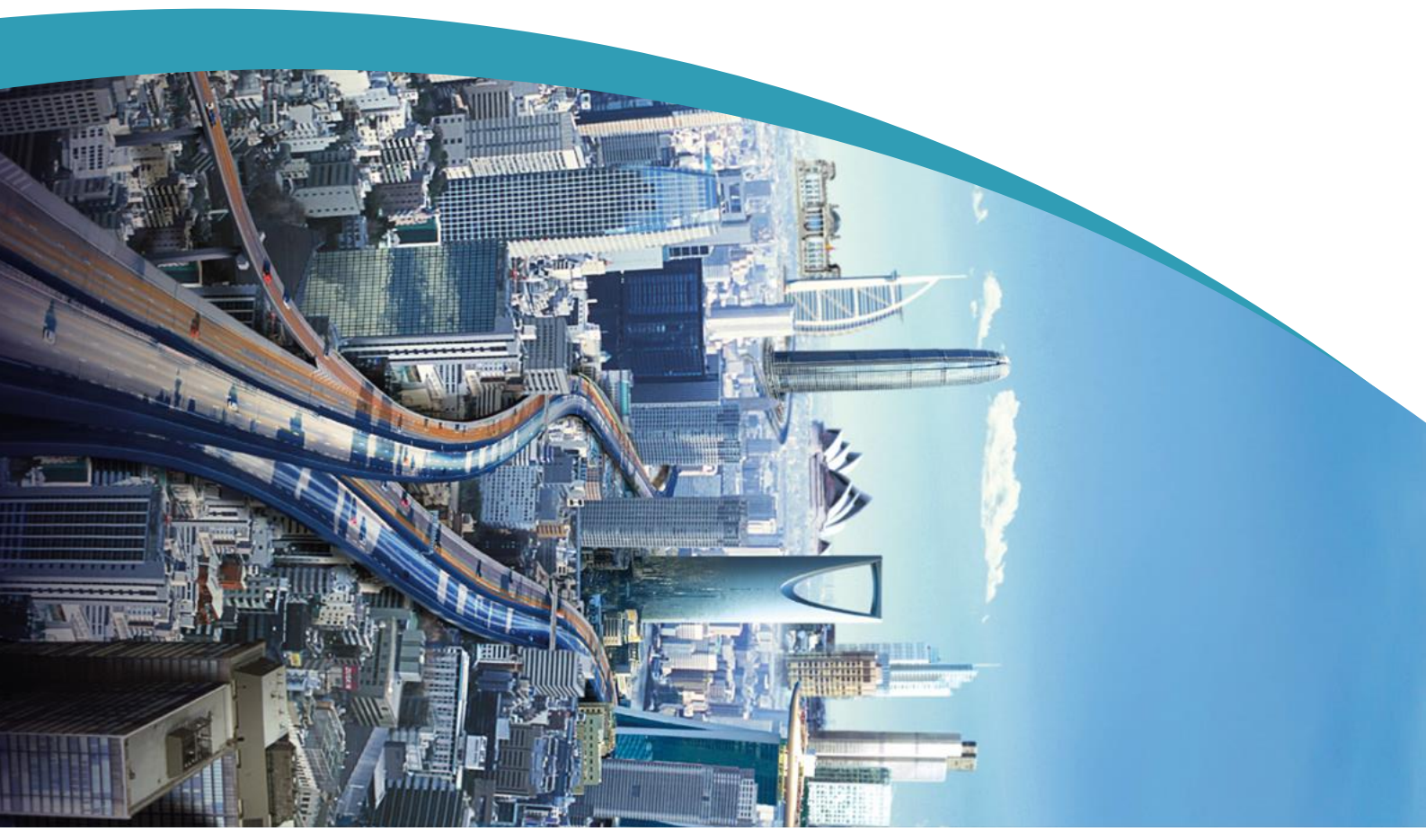
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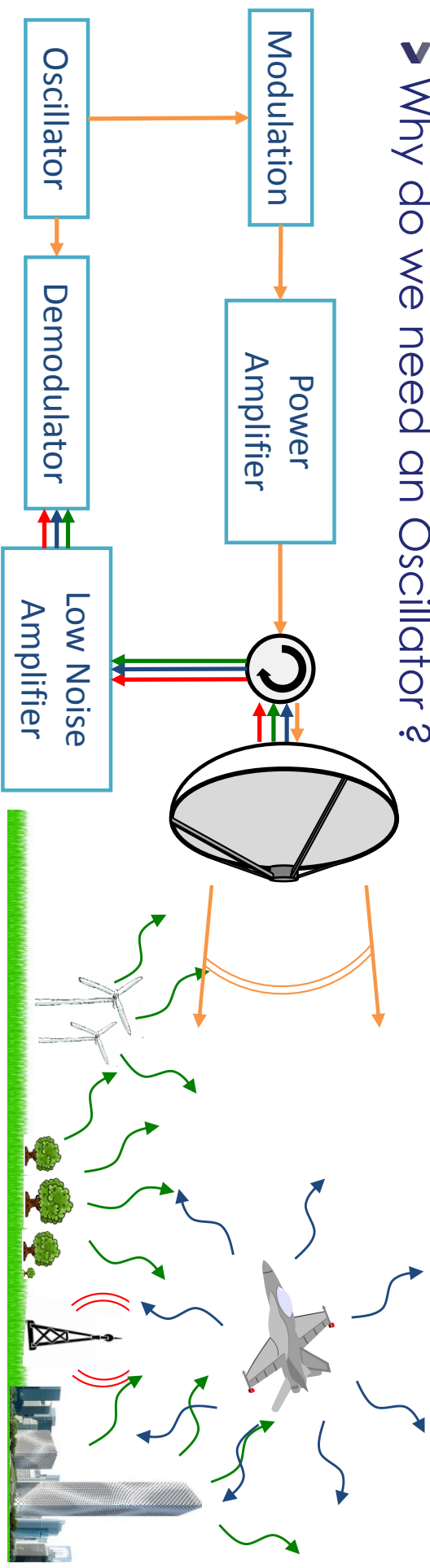
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Introduction

Oscillator?

➤ Why do we need an Oscillator?



➤ Low Noise oscillator

➤ What Frequency ?

- $\sim 1 - 3 \text{ GHz} \rightarrow$ Ground Radar
- $\sim 10 \text{ GHz} \rightarrow$ Airborne Radar
- ...

Introduction

How to get a 1-10 GHz frequency reference?

➤ Quartz oscillator

- Initial oscillation range : 10-100 MHz
- Excellent phase noise and stability
- Frequency multiplication: xN
 - Phase noise degradation (especially the phase noise floor)

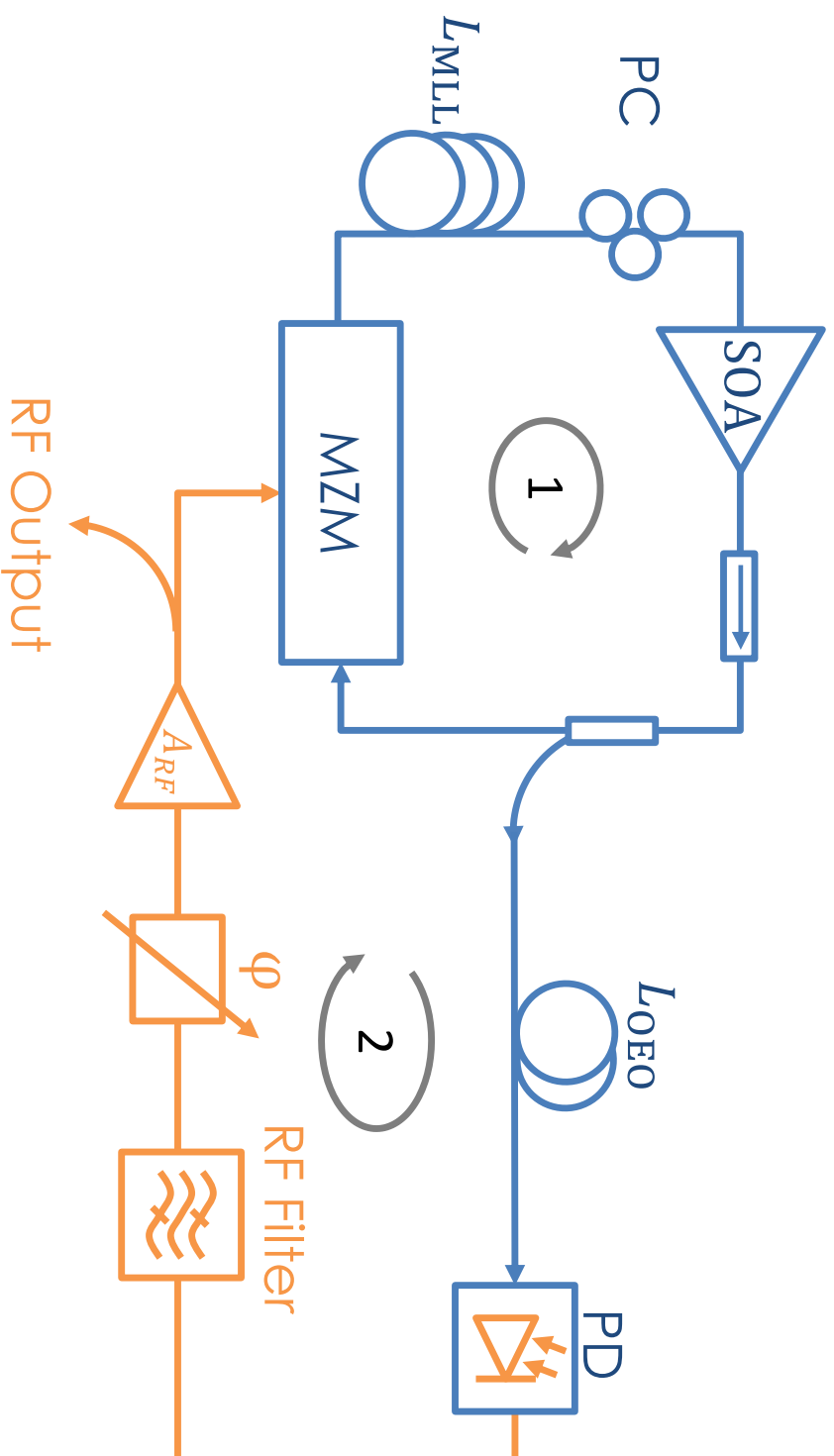
➤ An alternative solution: optics?

- High speed components (modulators, photodiodes)
- Low noise optical sources
- Low propagation losses (fibers)

Coupled Optoelectronic Oscillator

Coupled OptoElectronic Oscillator (COEO)

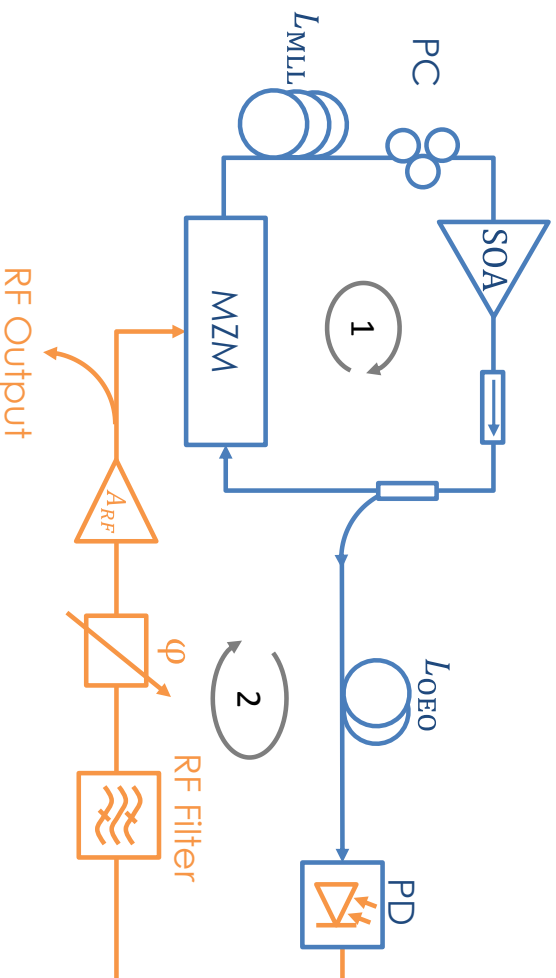
- Inherent low phase noise with shorter fibers (compared to OEO)
- COEO = mode locked laser + OEO



Coupled Optoelectronic Oscillator

Our goal

- Understanding the key parameters to design low noise COEO



First step: Fiber length optimization

Second step: Dispersion optimization

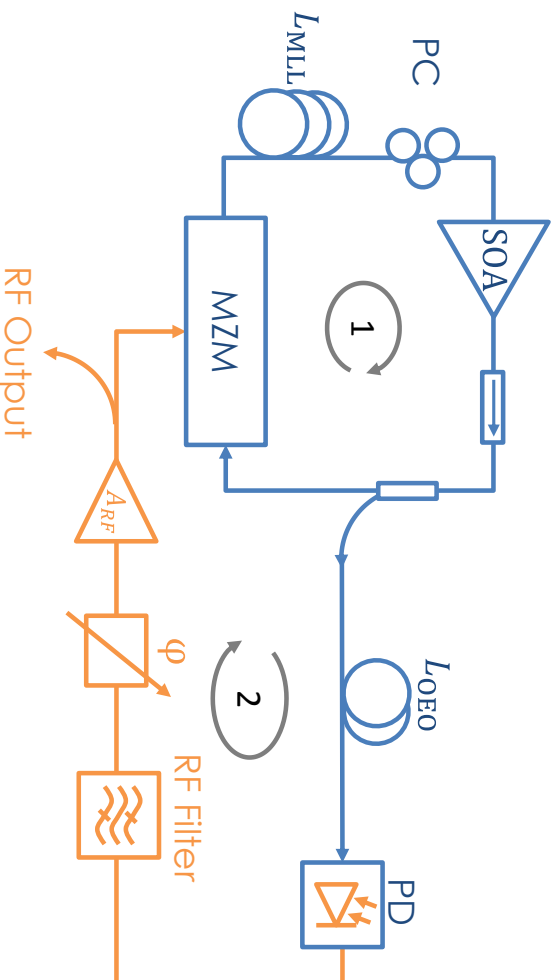
Key Parameters

- Fiber length
 - Optimization of the filtering function in each loop
- Dispersion
 - AM/PM conversion ?

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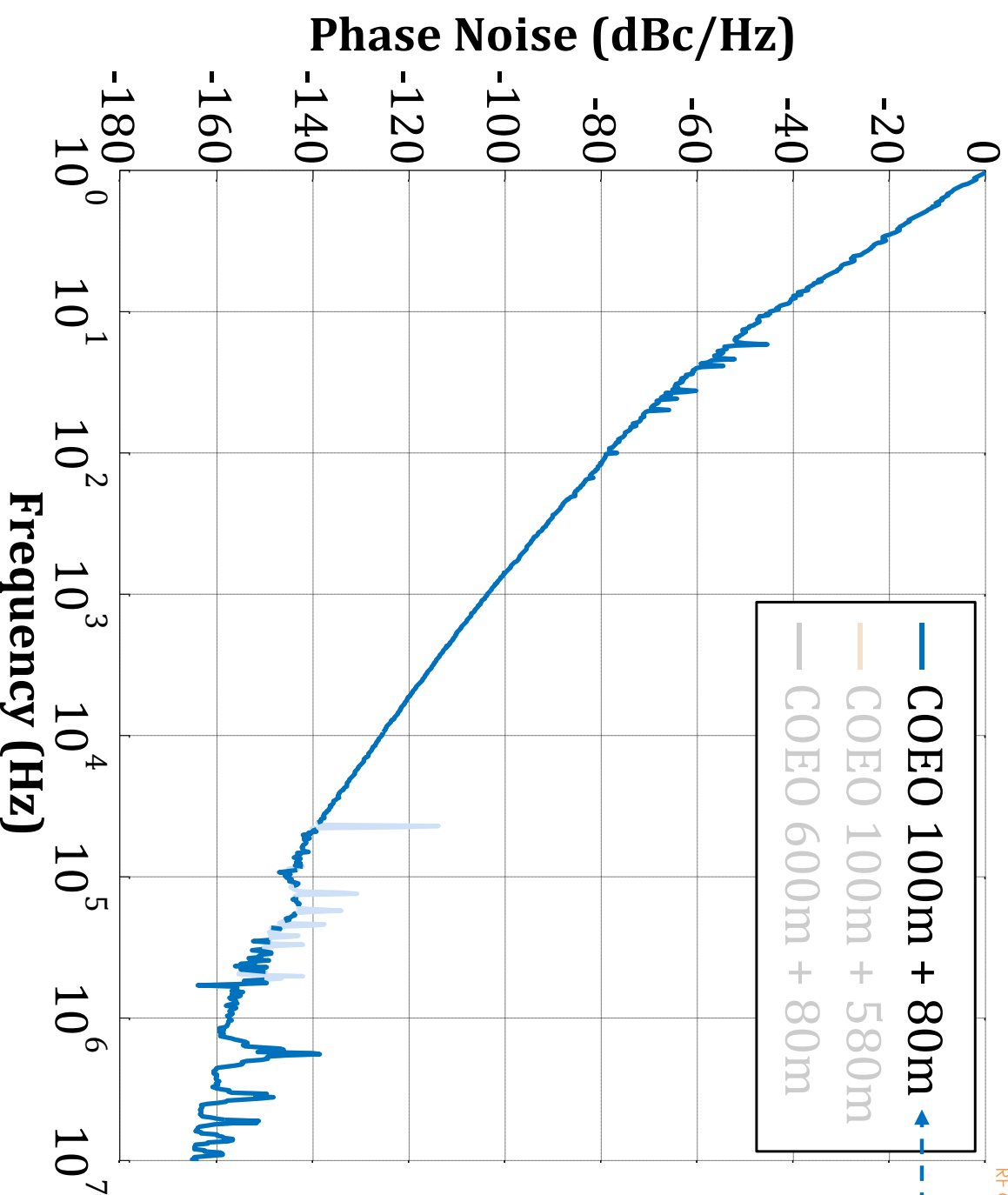
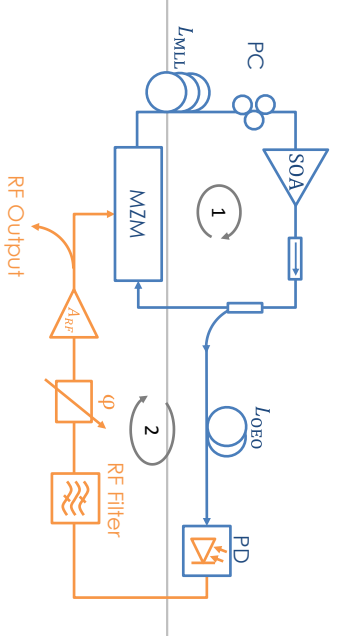
Which loop should have the longer fiber ?

Step 1 → Initial COEO = high noise COEO

Step 2 → 500m of zero dispersion fiber is added to loop 1 and 2

Coupled Optoelectronic Oscillator

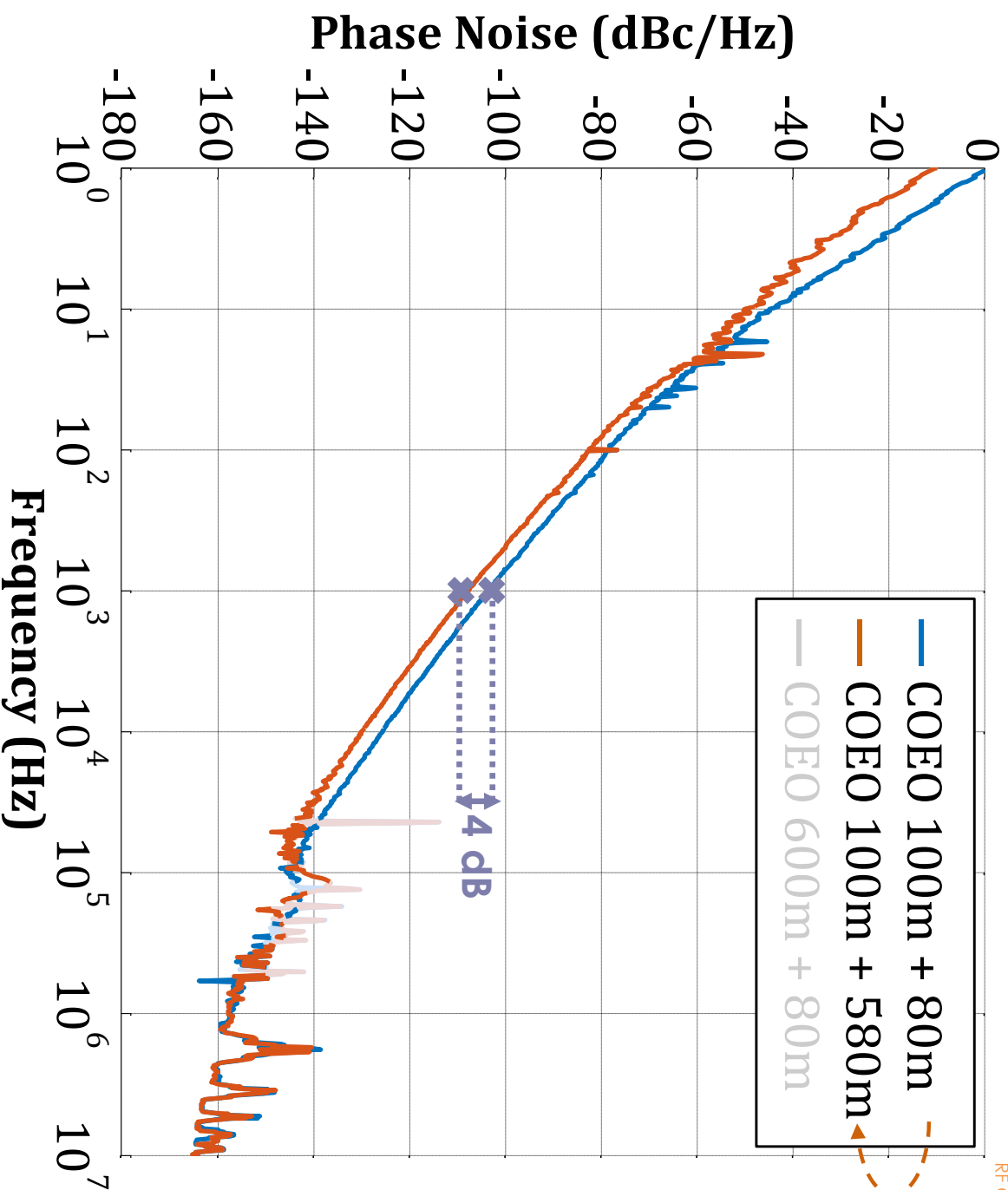
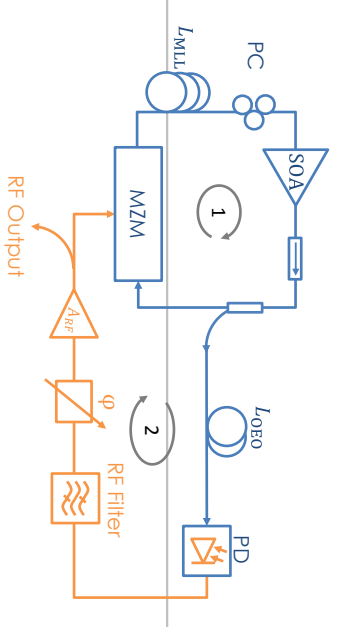
First step → Optimizing the fiber length



Initial COEO
= high noise COEO

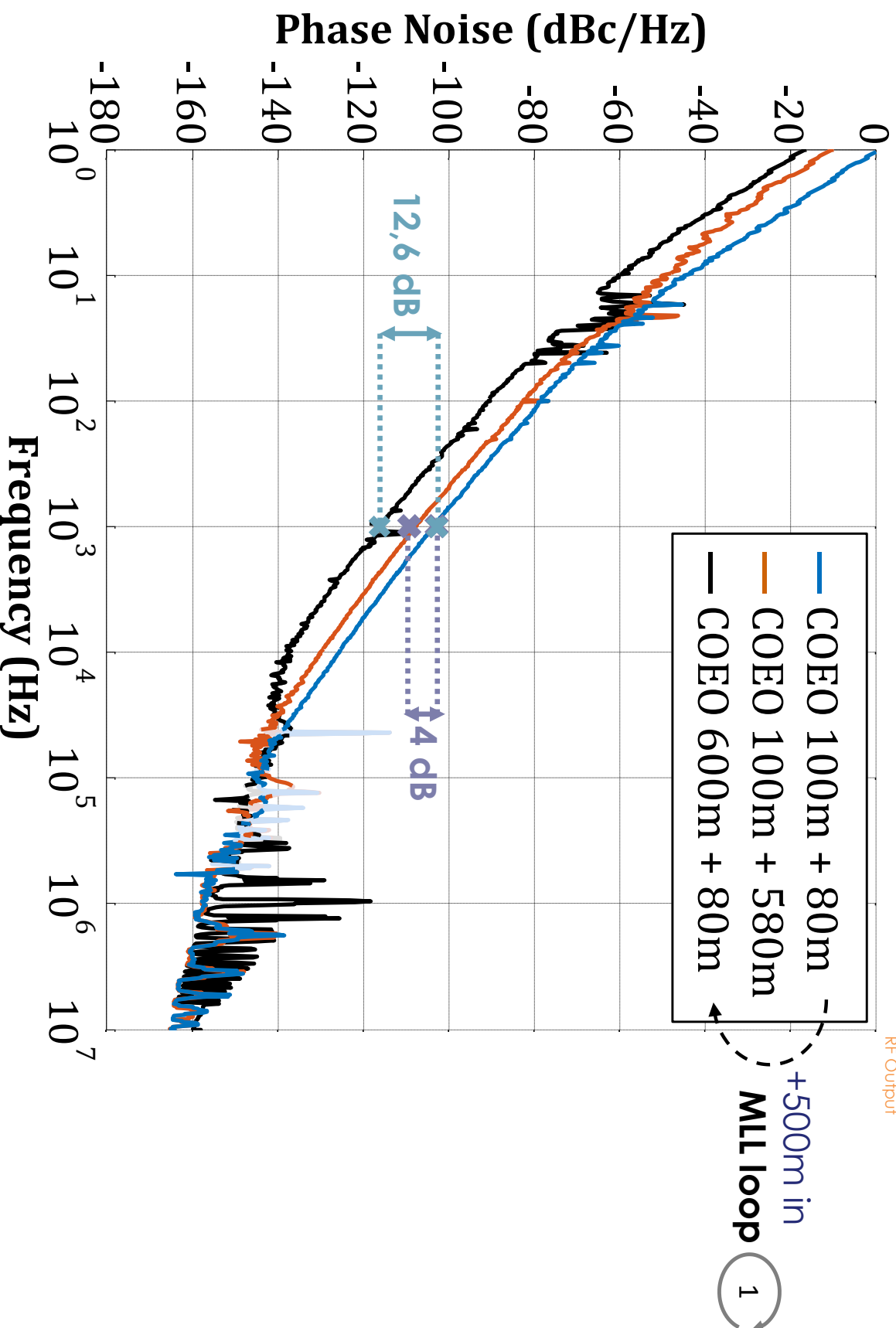
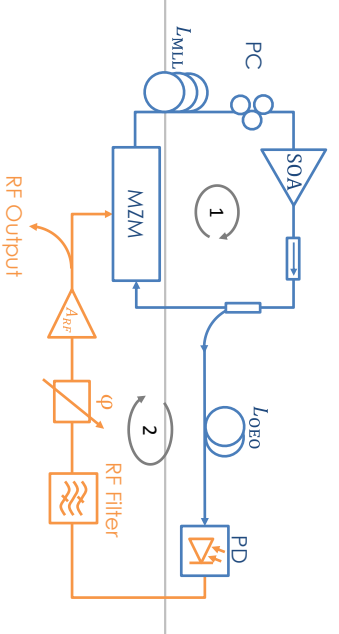
Coupled Optoelectronic Oscillator

First step → Optimizing the fiber length



Coupled Optoelectronic Oscillator

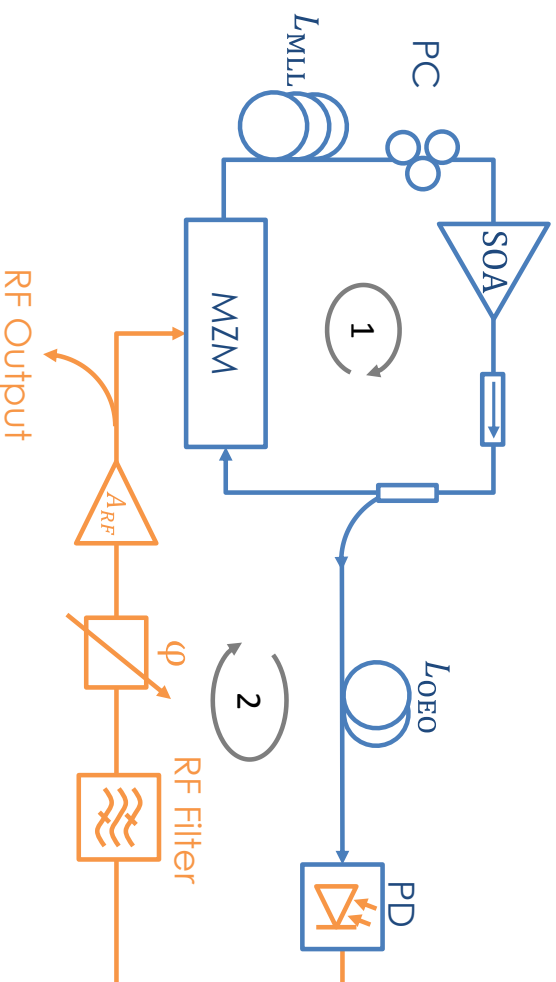
First step → Optimizing the fiber length



Coupled Optoelectronic Oscillator

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➤ Understanding the key parameters to design low noise COEO



First step: Fiber length optimization ✓

Second step: Dispersion optimization

Which loop should have the longer fiber ? Loop 1

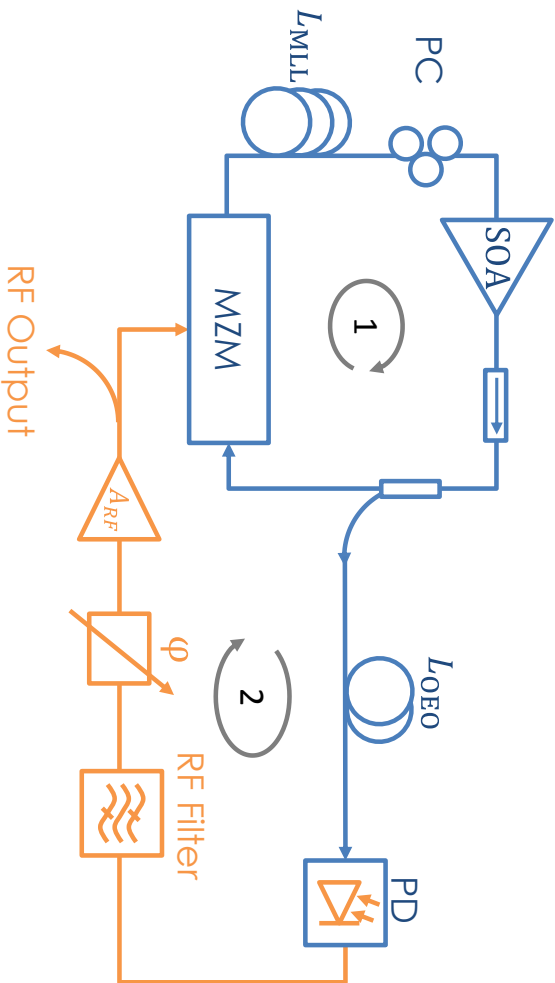
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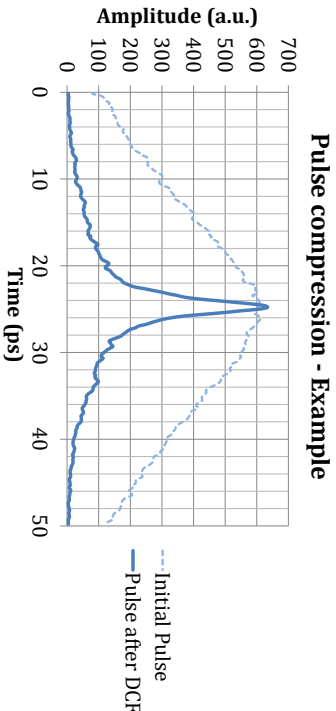
Pulse Compression ?

Step 1 → Initial COEO

Step 2 → Dispersion in loop

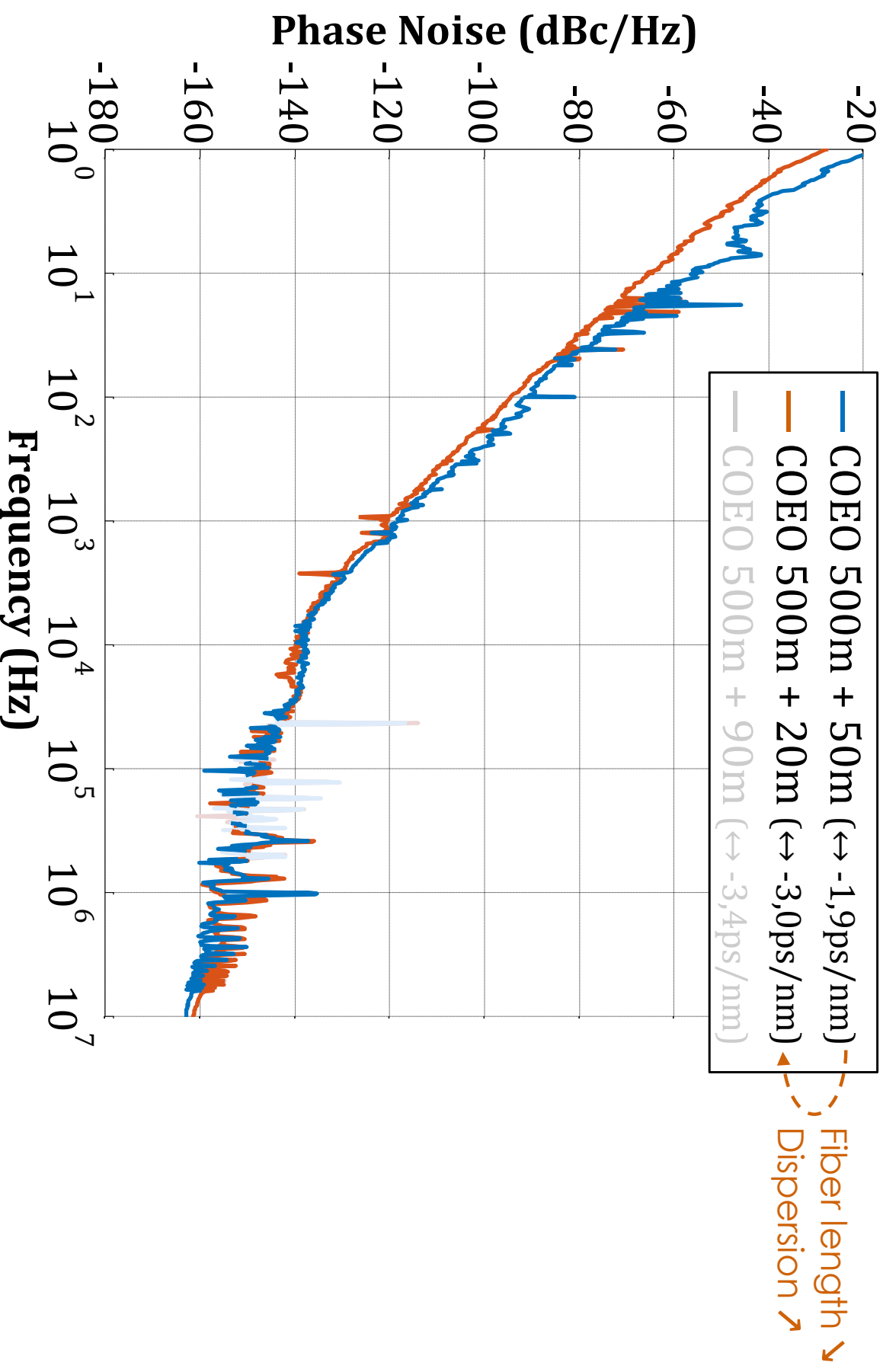
2 vary

First step: Fiber length optimization ✓
Second step: Dispersion optimization



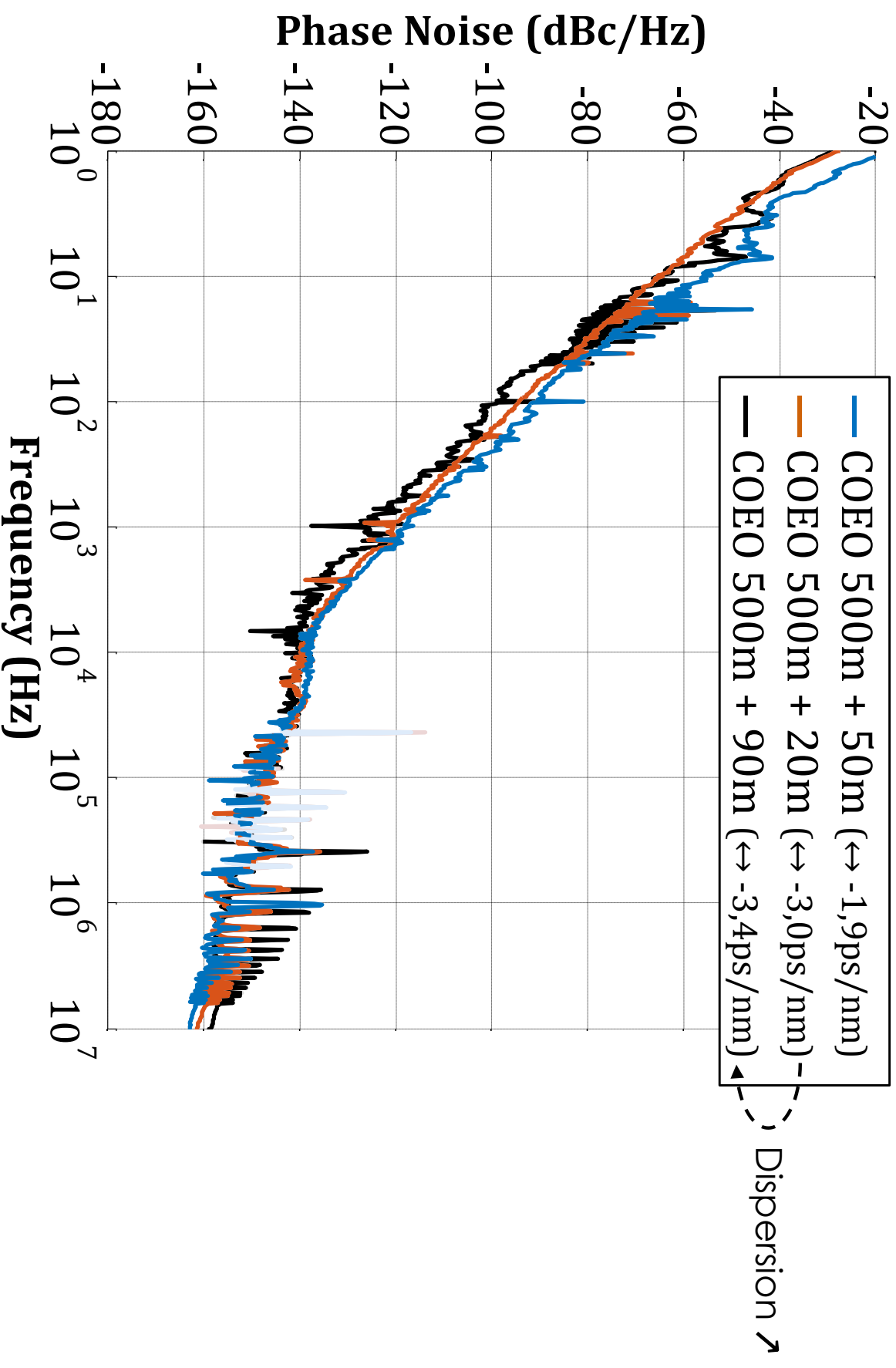
Coupled Optoelectronic Oscillator

Second step → Optimizing the dispersion



Coupled Optoelectronic Oscillator

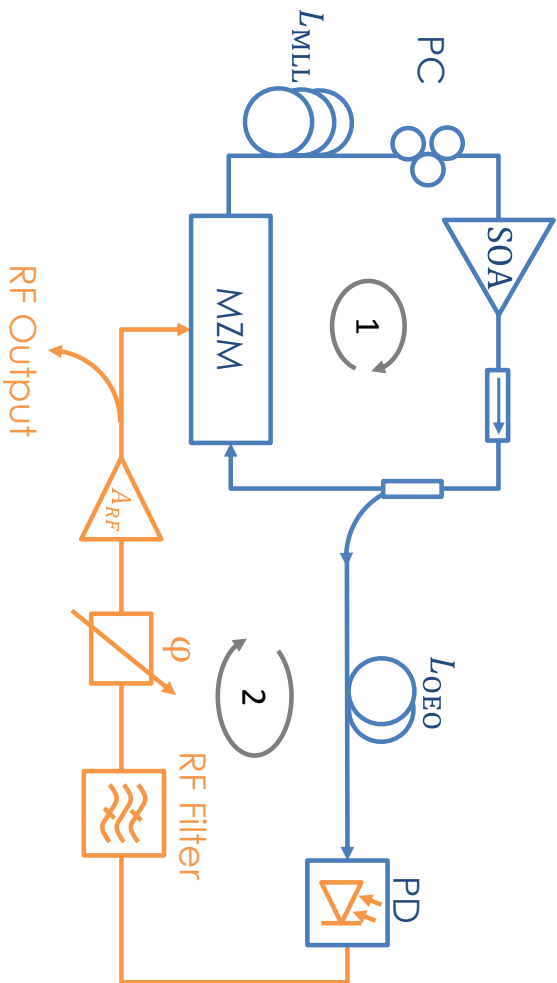
Second step → Optimizing the dispersion



Coupled Optoelectronic Oscillator

Our goal

➤ Understanding the key parameters to design low noise COEO

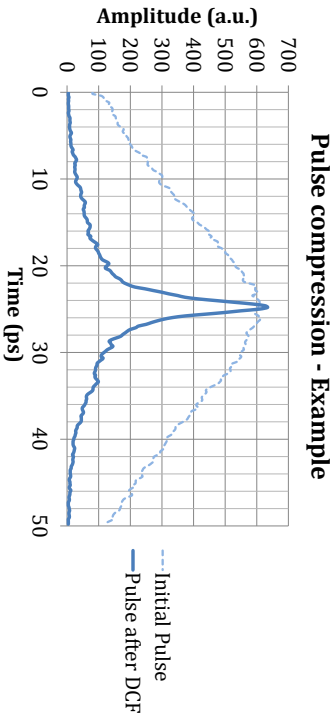


Pulse Compression ? Low noise COEO

Step 1 → Initial COEO
Step 2 → Dispersion in loop

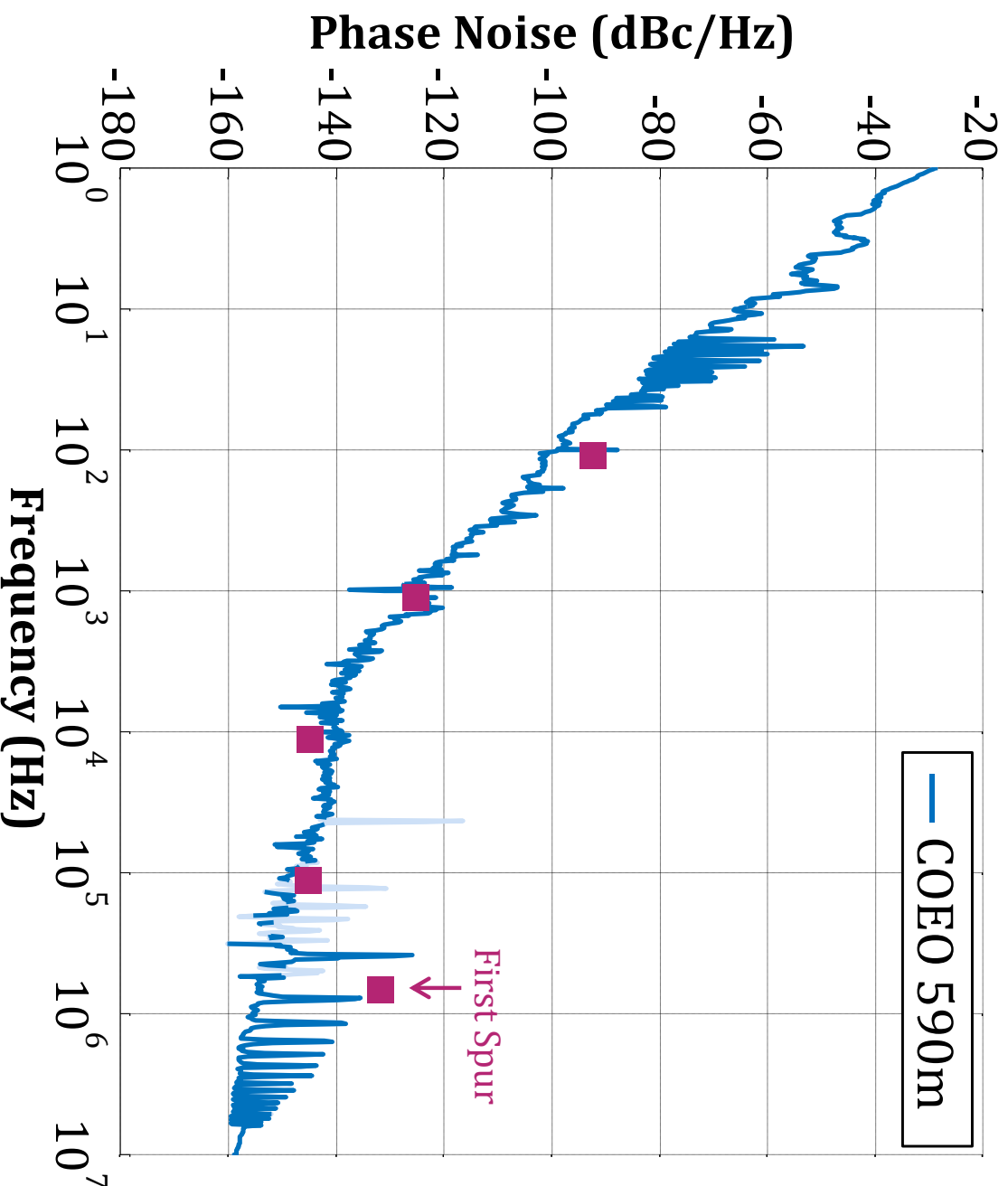
2 vary

First step: Fiber length optimization ✓
Second step: Dispersion optimization ✓



Coupled Optoelectronic Oscillator

590m COEO VS State of the art COEO at 10 GHz (literature)



E. Saïik, et al., An Ultralow Phase Noise Coupled Optoelectronic Oscillator, Photon. Technol. Lett., 19 444-446, 2007.

Laser

MLL with SOA

Fiber Length (estimation)

300 m
(600 kHz)

First Spur Level

-135 dBc/Hz

Conclusion & Perspectives

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Conclusion

- Our 10 GHz COEO
 - Low close-to-carrier phase noise ✓
 - Low Spurs Level (-127 dBc/Hz) ✓
- Key parameters to design low noise COEO ✓

Perspectives

- Phase noise further improvement
 - Spurs Level improvement
 - Shorter fiber length
- COEO Phase Noise Model