

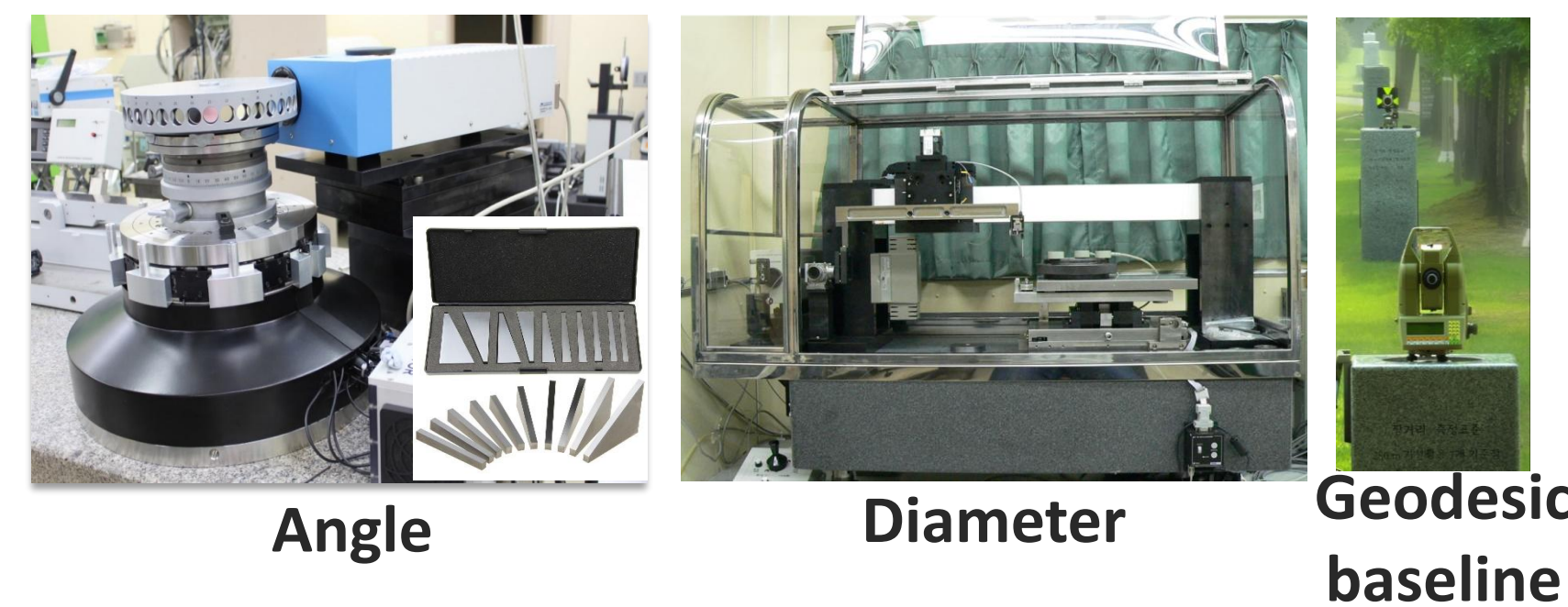
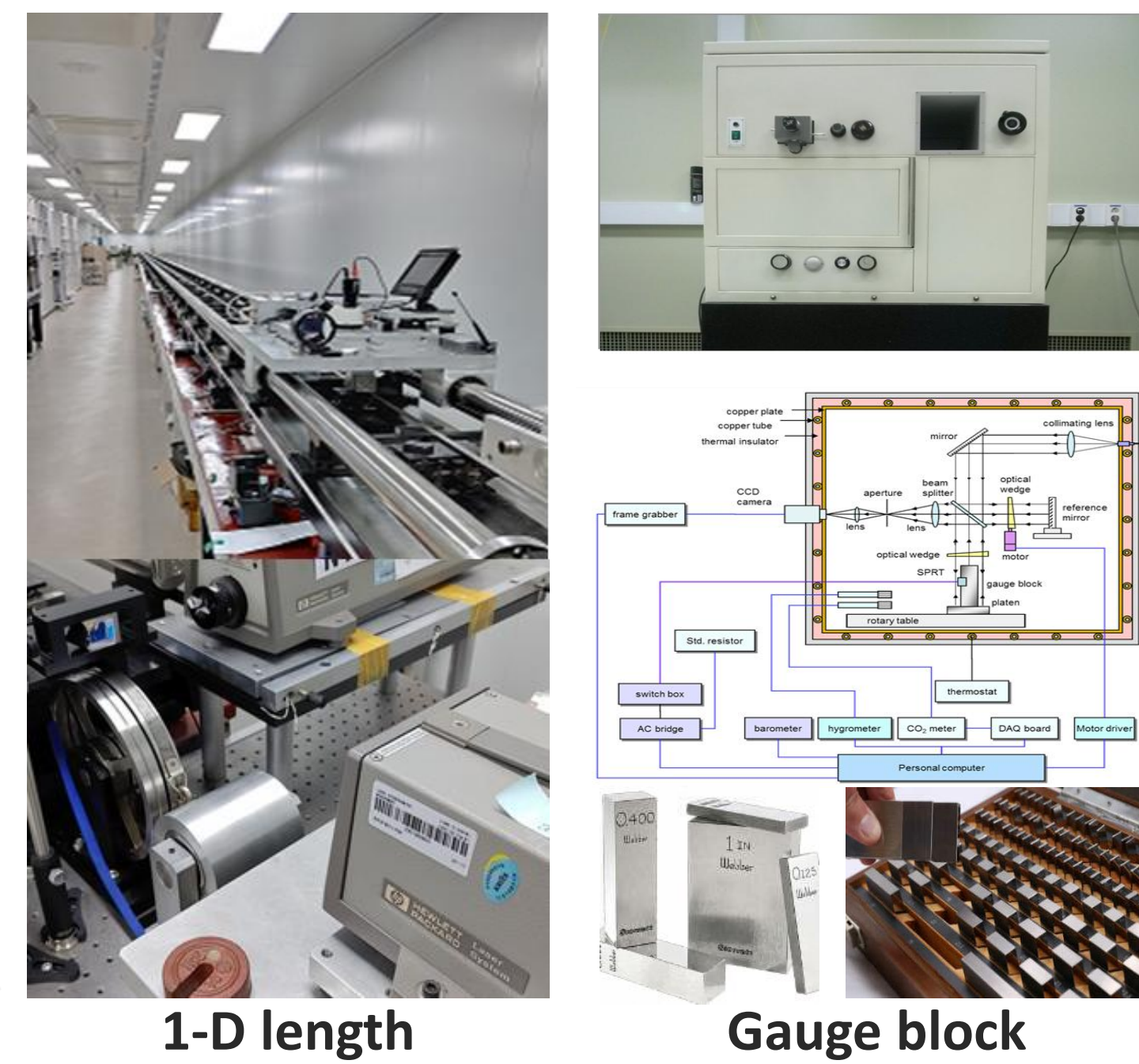
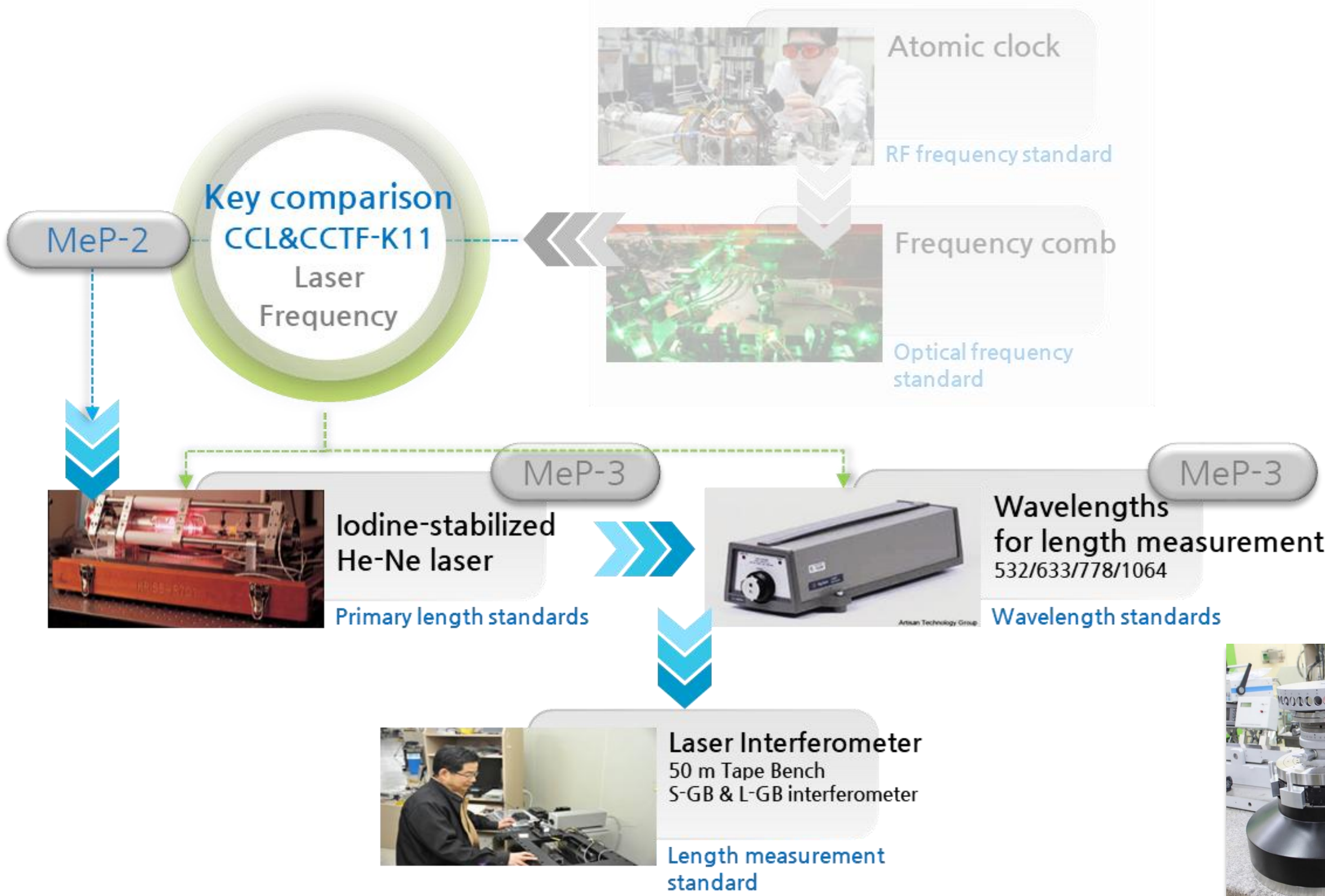
Recent achievements and future research of KRISS length measurement standards

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Introduction

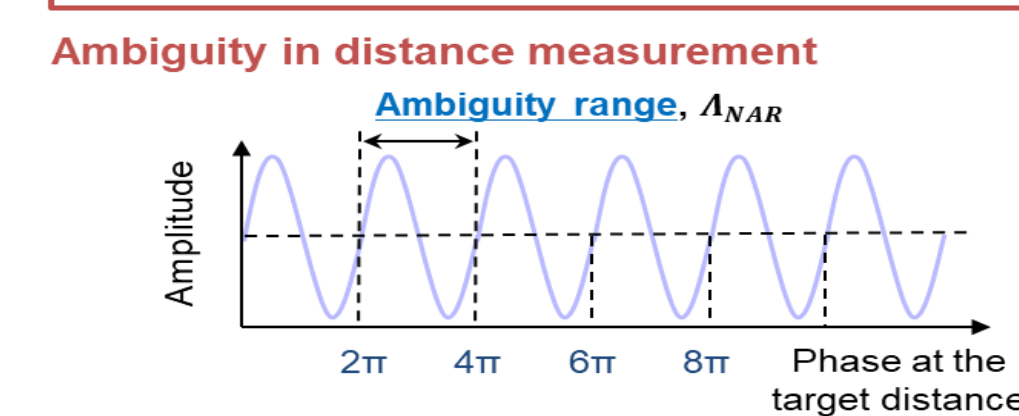
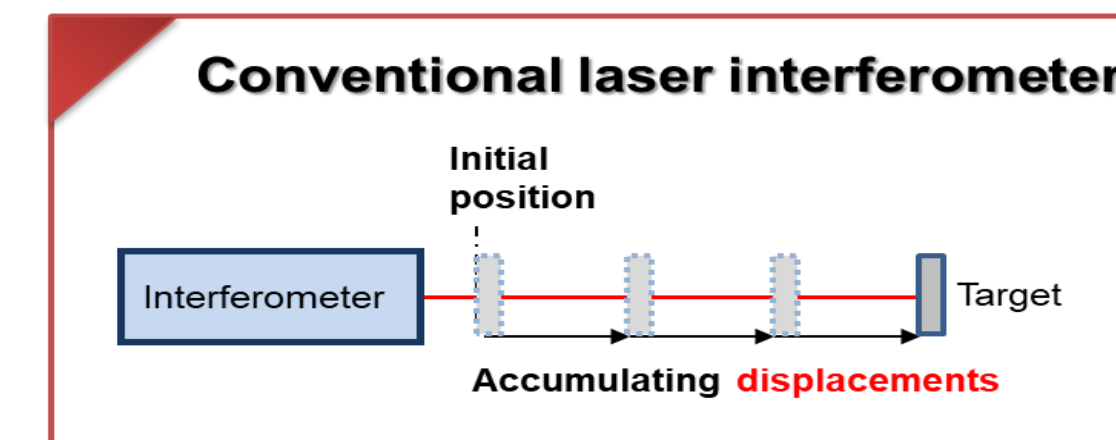
KRISS Length Standards Over the Last 50 Years



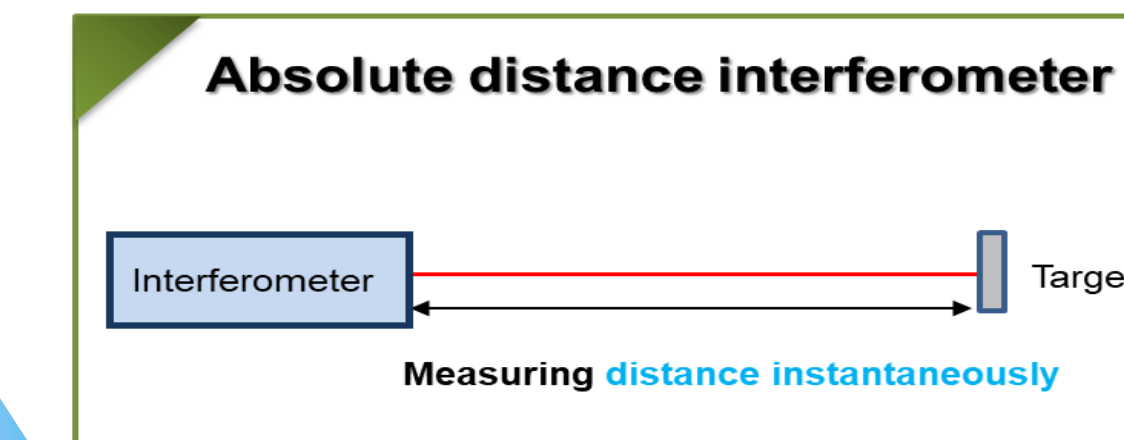
Methods

KRISS Next-Generation Length Standards

Length measurement standard



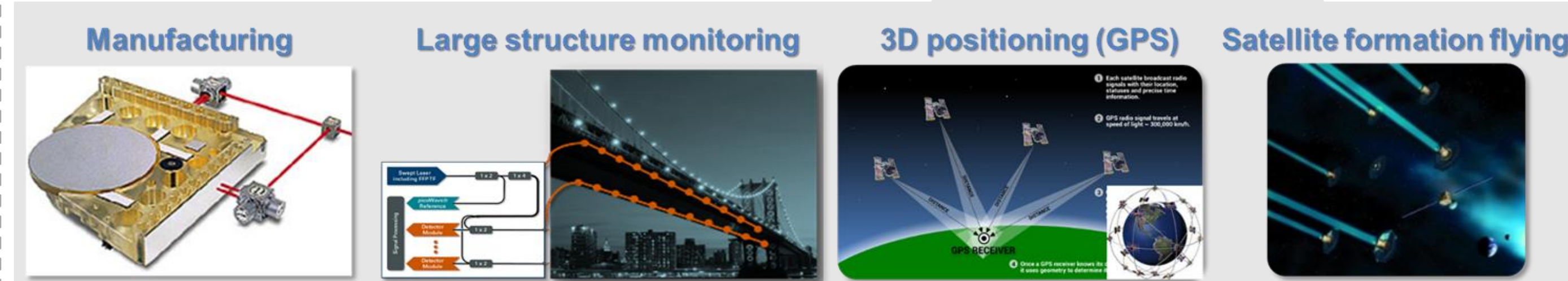
- Target should be moved from initial position continuously.
- Measurement datum is lost when return beam is blocked.



As is

To be

- #### Advantages of ADM
- Instantaneous single operation
 - Without target movement
 - Distance is continuously measured even return beam is blocked.



Primary length standard



Iodine stabilized He-Ne laser

- (PROS) Uncertainty: 10^{-11}

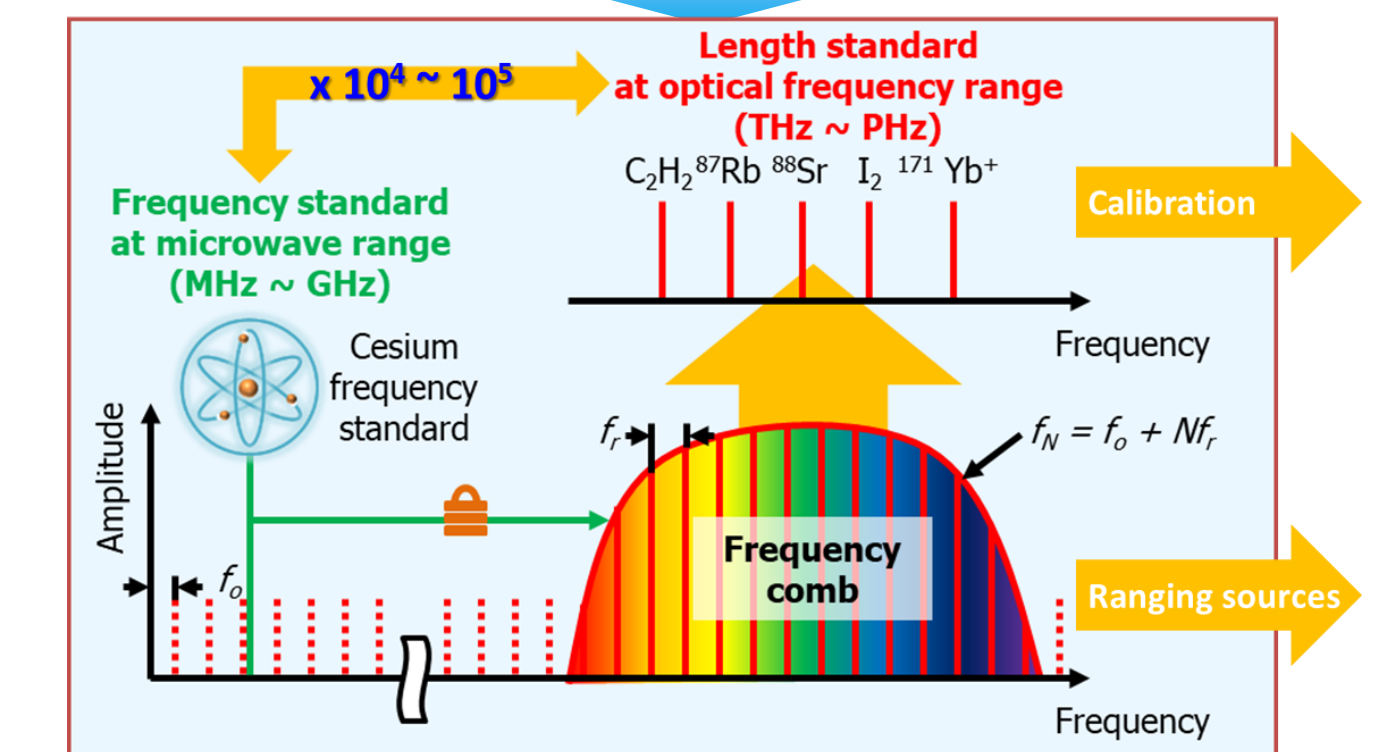
- (CONS) Single wavelength

→ Only displacement measurement

- (CONS) Periodic calibration required

As is

To be



Frequency comb

- (PROS) Uncertainty: 10^{-12} or better

- (PROS) Multiple wavelength

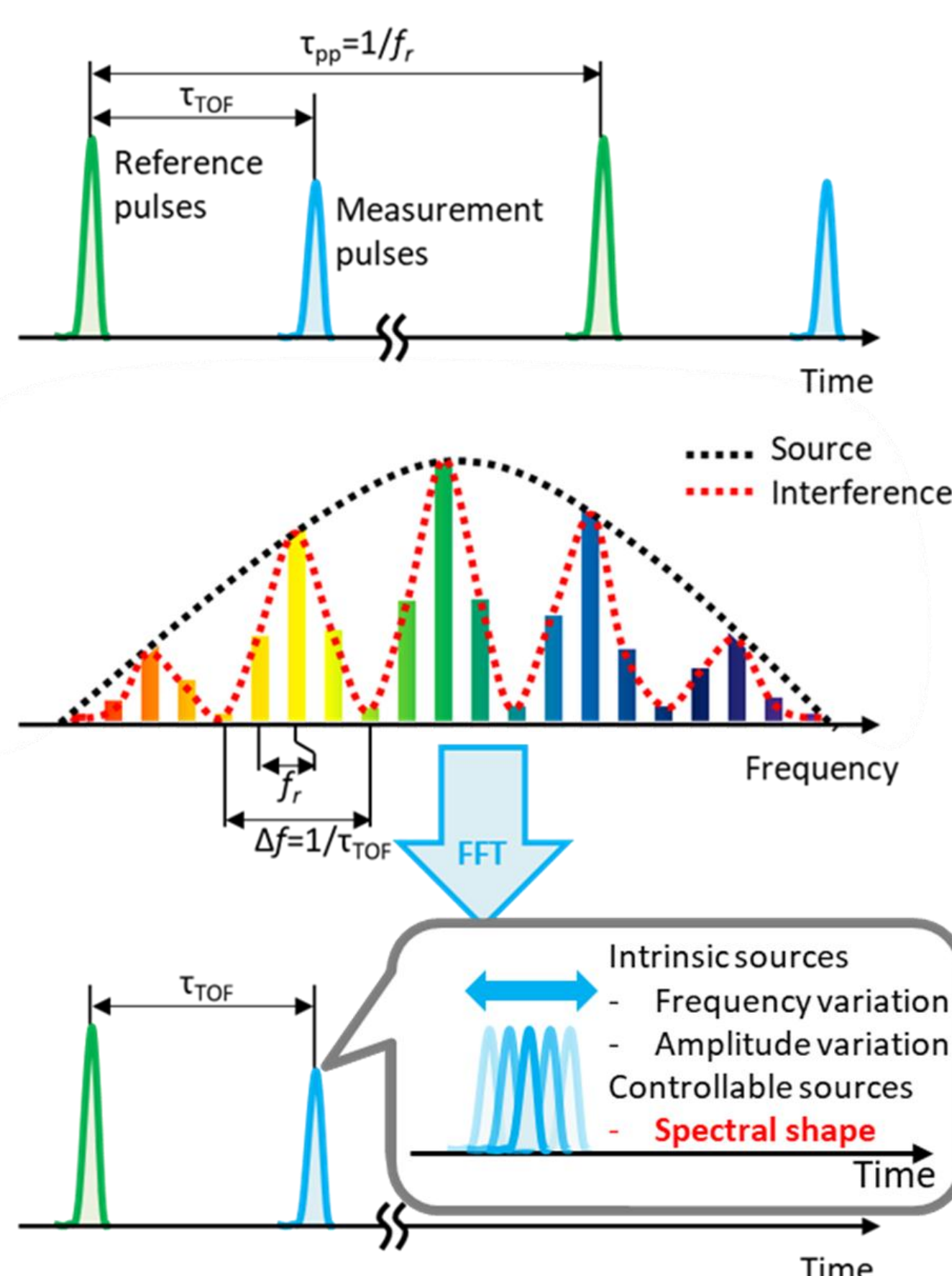
→ Can measure absolute distance

- (PROS) Direct traceability to atomic clock

Results

Frequency comb based spectral interferometric ranging

Basic principle of frequency comb based spectral interferometry



$$\varphi(v) = \frac{2\pi(nL)}{\lambda} = 2\pi \frac{v(nL)}{c} = 2\pi v T_{TOF}$$

Requirement for SDI

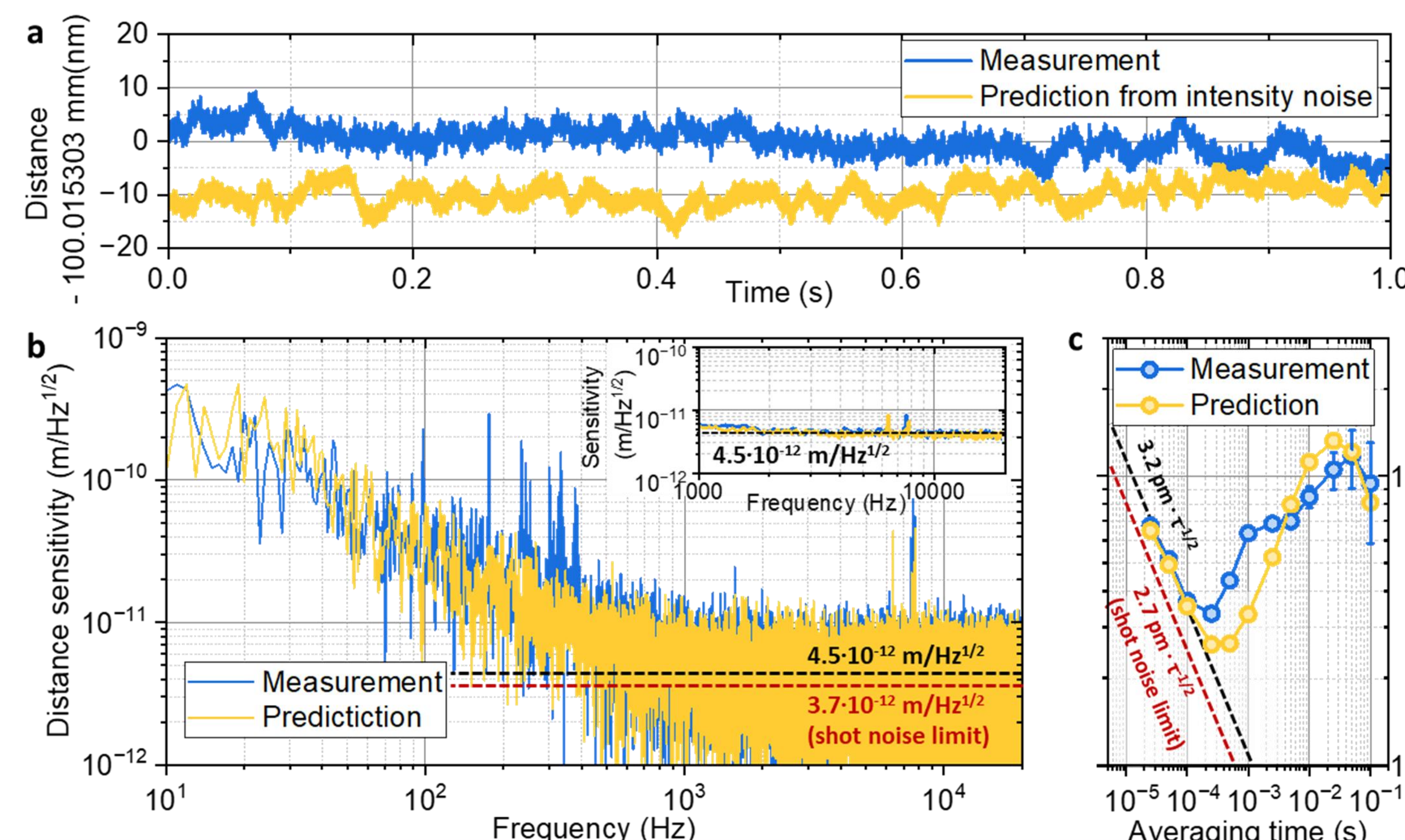
- Spectral bandwidth: > 1 THz
- Repetition rate: > 15 GHz
- Smooth spectral shape

Harmonic mode-locking?

High repetition rate?

Repetition multiplication?

Quantum limited precision



Conclusions

- Last 50 years, KRISS has been at the forefront of developing national length standards.
- As industry goes advanced, we have been preparing next-generation length measurement standards that overcome limitations of conventional methods.
- Recently, we demonstrated a world-class precision optical comb absolute distance measurement study.

Reference

- [1] Physical review letters 126 (2), 023903
- [4] Int. J. of Precis. Eng. Manuf. 25 (3), 659-674

- [2] Photonics Research 11 (1), 72-80
- [5] arXiv preprint arXiv:2501.10044

- [3] Optics & Laser Technology 170, 110324



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