

A compact zero-angle mirror alignment method based on range-resolved interferometry

Xinyu Chang



1 Motivation

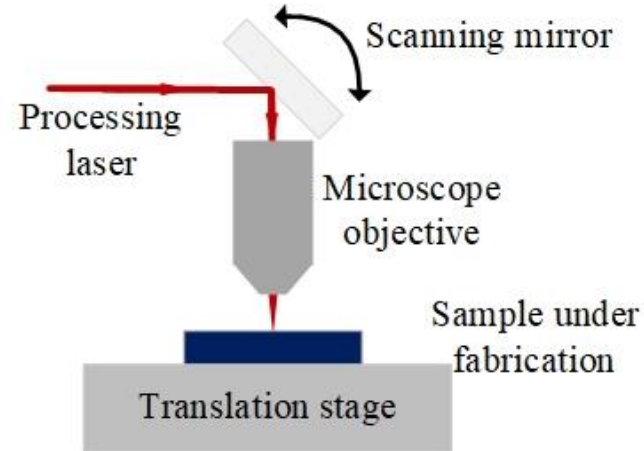
Mirror alignment



(from Elcomat)

Commercial autocollimator

Bulky

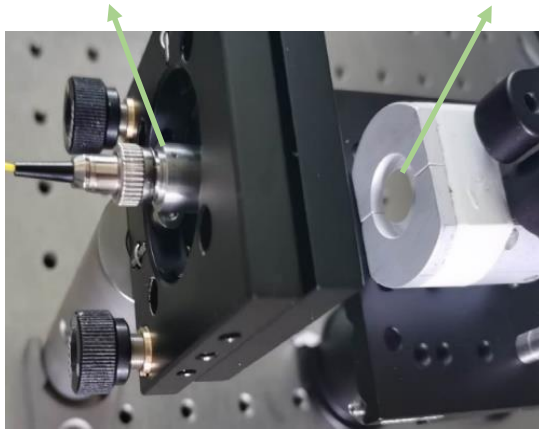


A laser direct writing system

Build a compact setup to indicate the **zero angle** for **mirror alignment** based on the **autocollimation** principle.

1 Motivation

Fiber collimation package Tip-tilt mirror



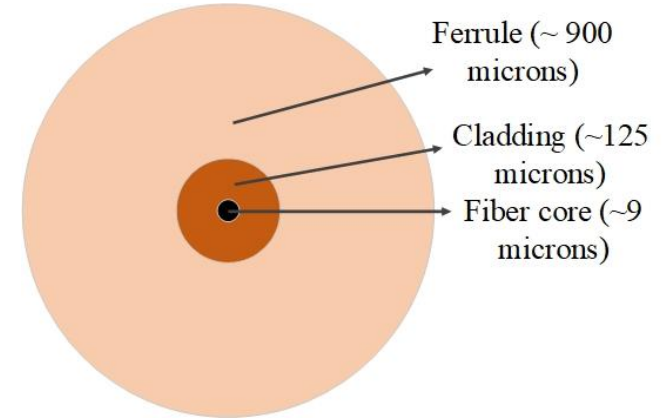
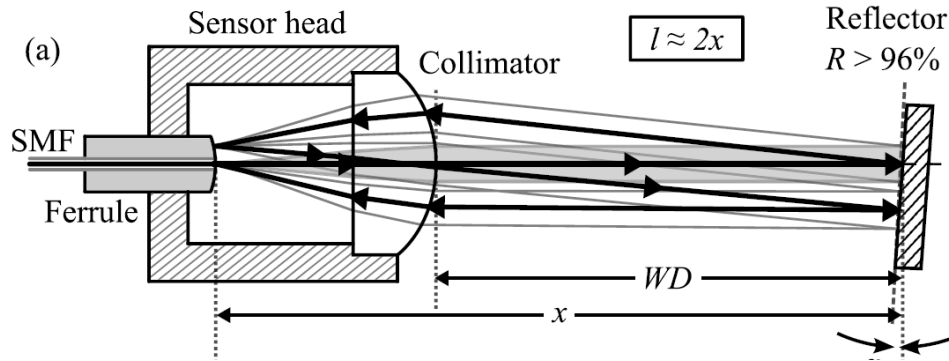
The measurement setup



The compact measurement head

1 Motivation

Study the mechanism of the multiple reflections.



Multiple reflections between the fiber end and the mirror

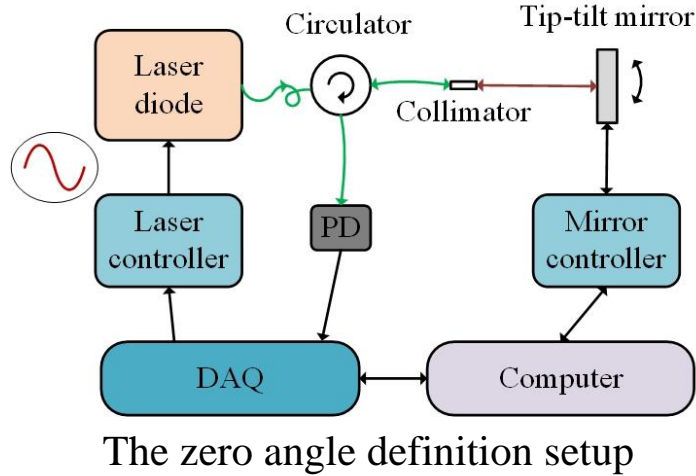
FC/PC fiber connector

Fiber-based distance sensing interferometry. Klaus Thurner, et al. in *Applied Optics*, 2015

Multiple reflections are common phenomenon but need to be studied

2 Why using range-resolved interferometry(RRI)?

RRI can demodulate different interference signals with different path lengths within one detector signal.



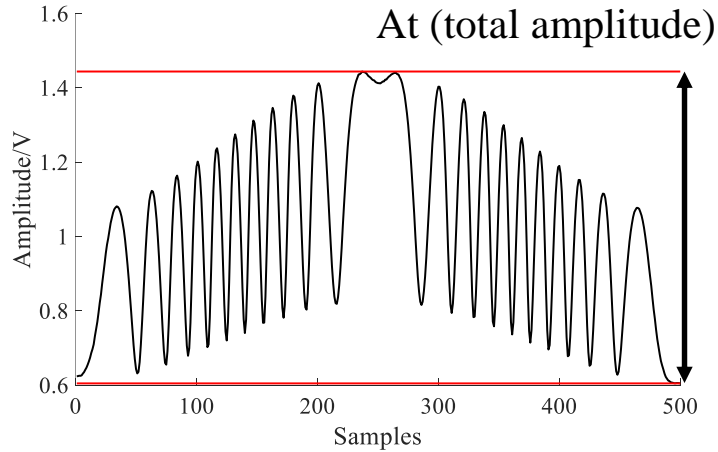
QR code for the paper describing RRI

Range-resolved interferometric signal processing using sinusoidal optical frequency modulation. Thomas Kissinger, et al. in *Optics Express*, 2015

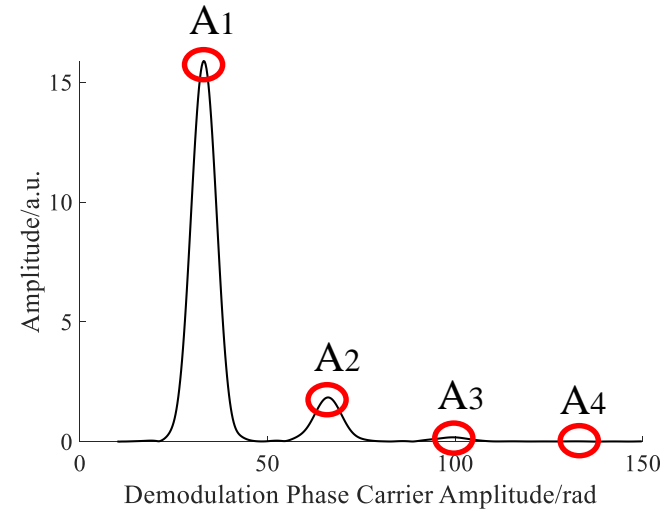
Setup and principle description

2 Why using range-resolved interferometry(RRI)?

RRI can demodulate different interference signals with different path lengths within one detector signal.



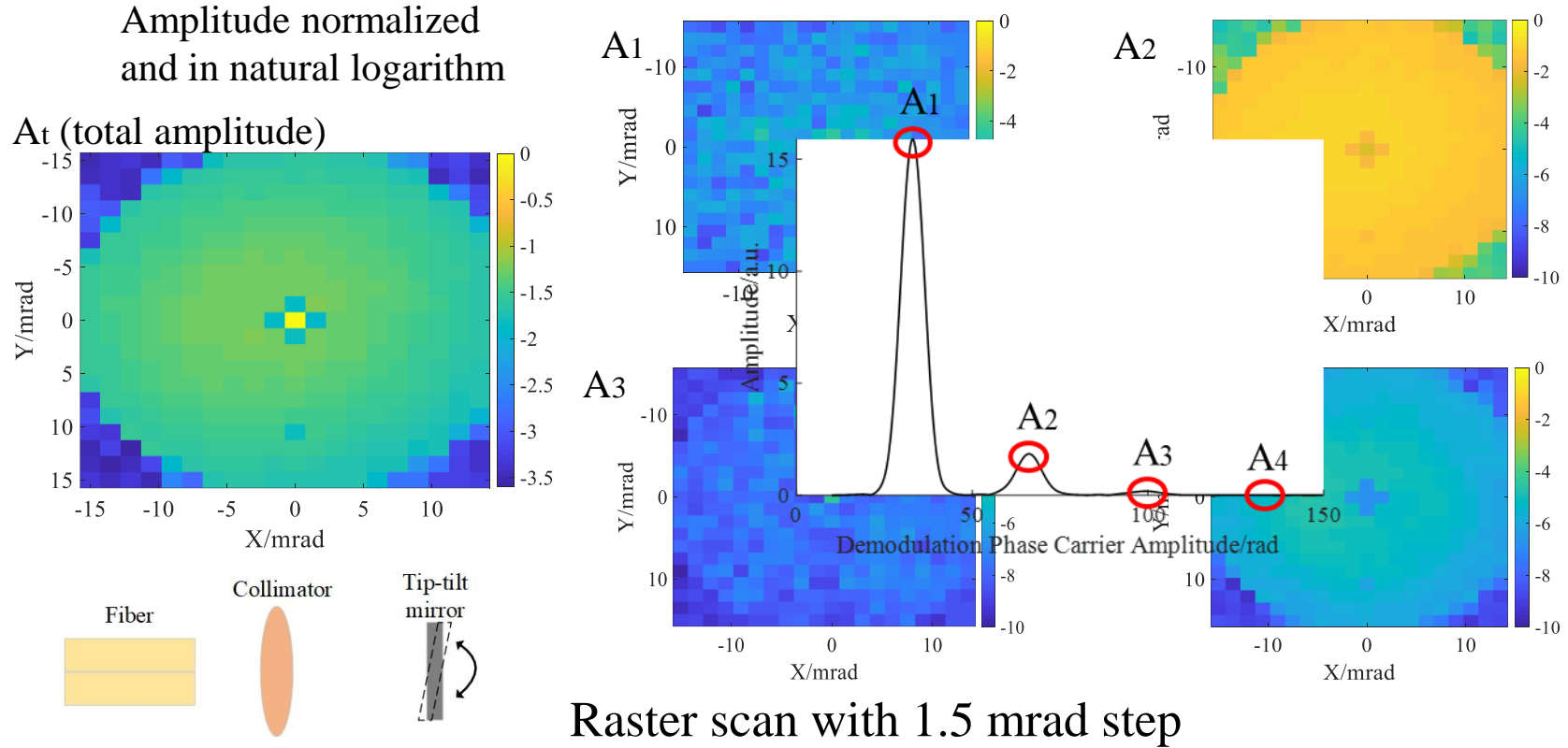
Interferogram



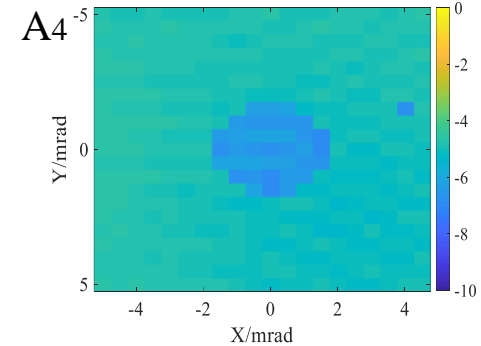
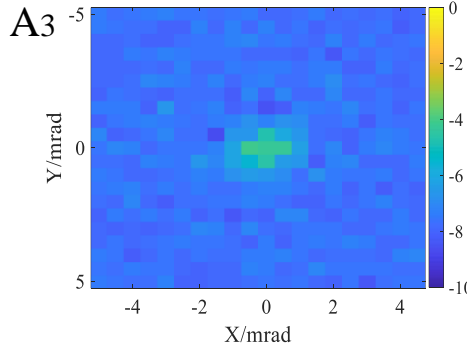
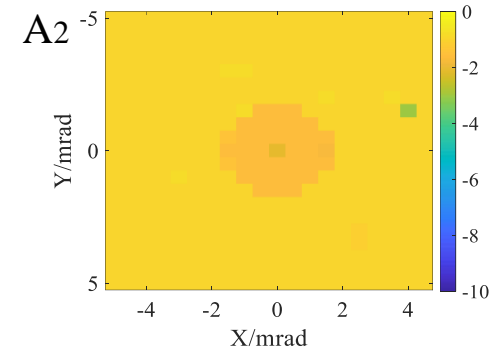
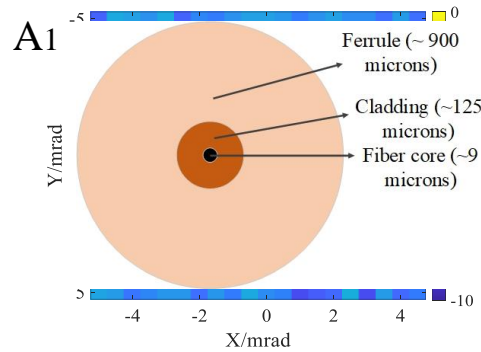
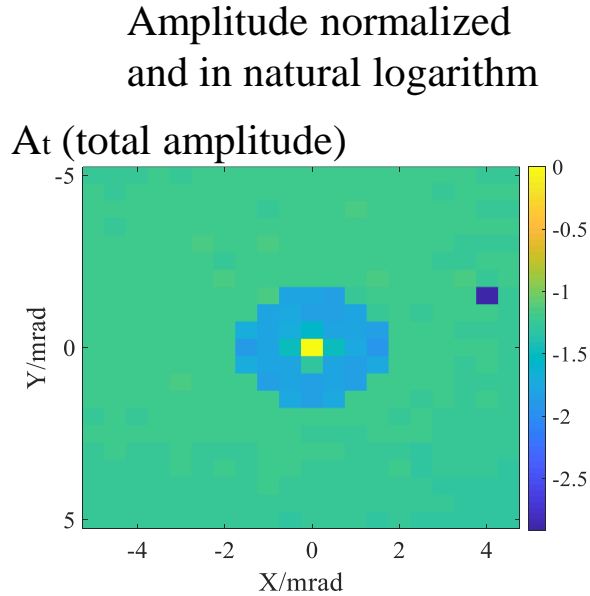
Range view

Range-resolved interferometric signal processing using sinusoidal optical frequency modulation. Thomas Kissinger, et al. in *Optics Express*, 2015

3 What are the scanning results?

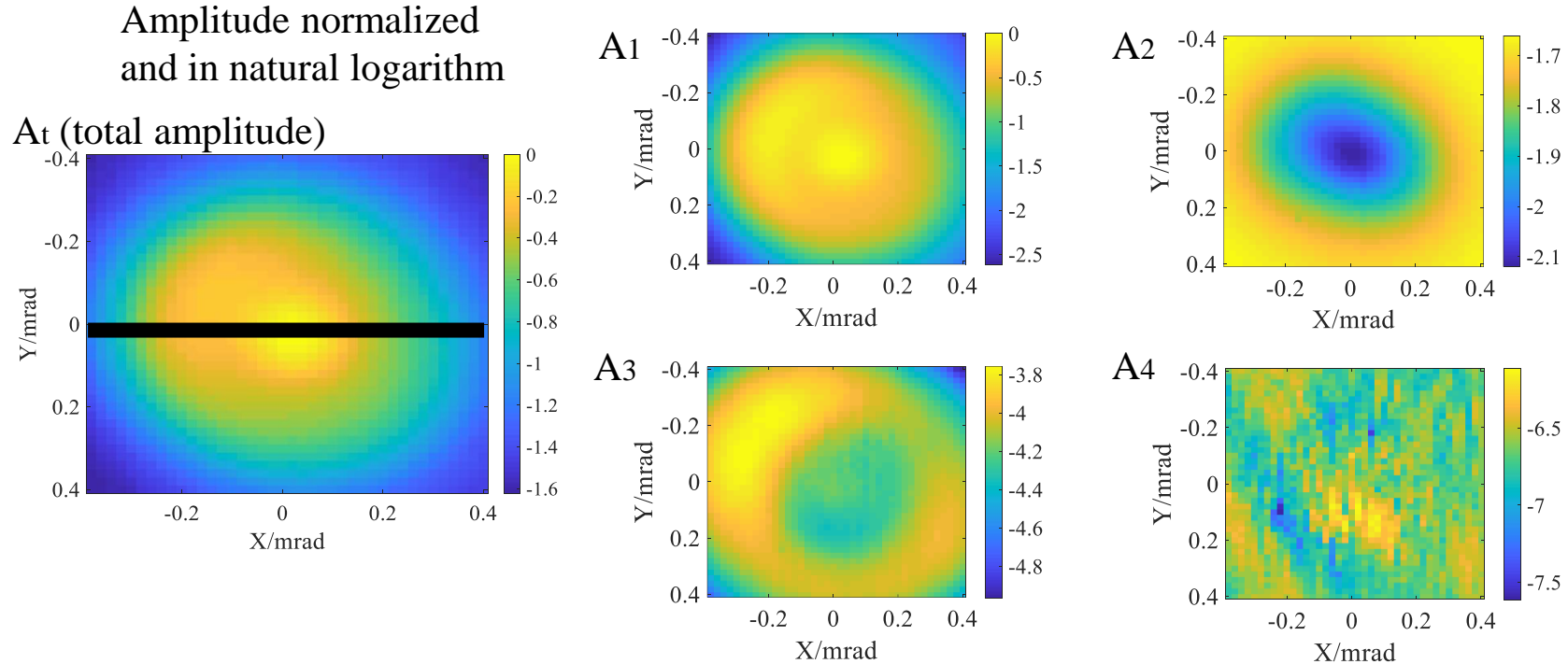


3 What are the scanning results?



Raster scan with 0.5 mrad step

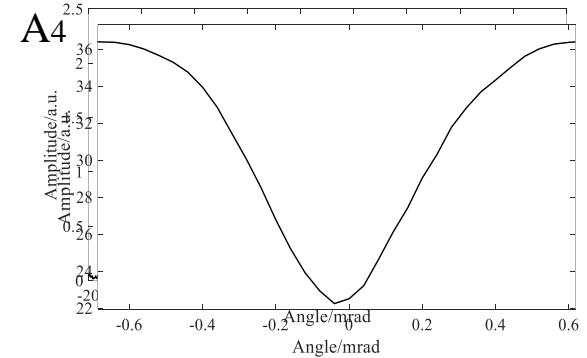
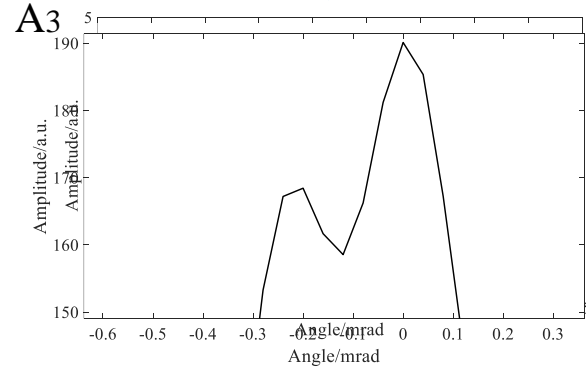
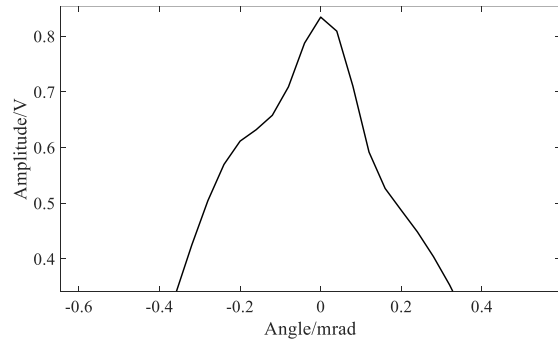
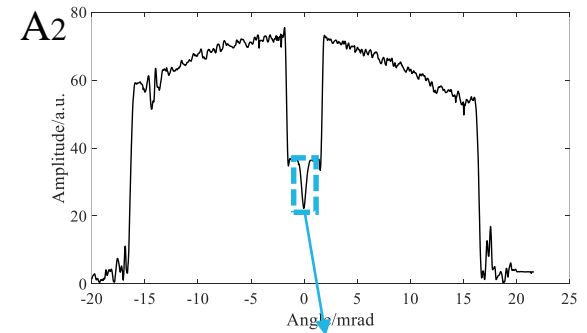
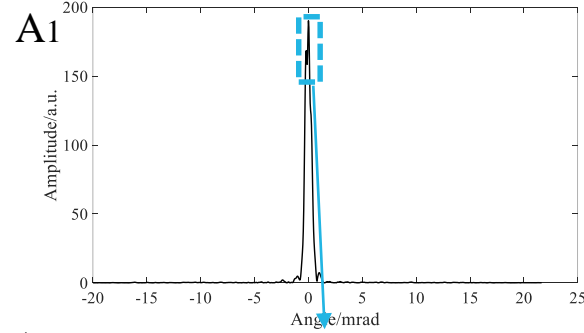
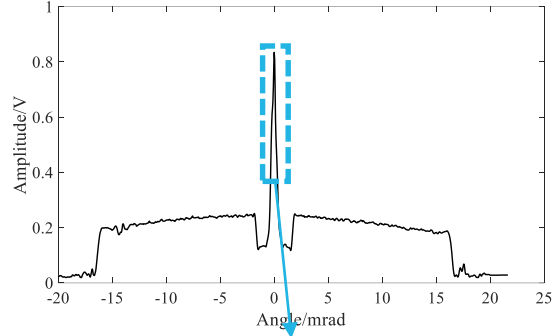
3 What are the scanning results?



Raster scan with 0.02 mrad step

3 What are the scanning results?

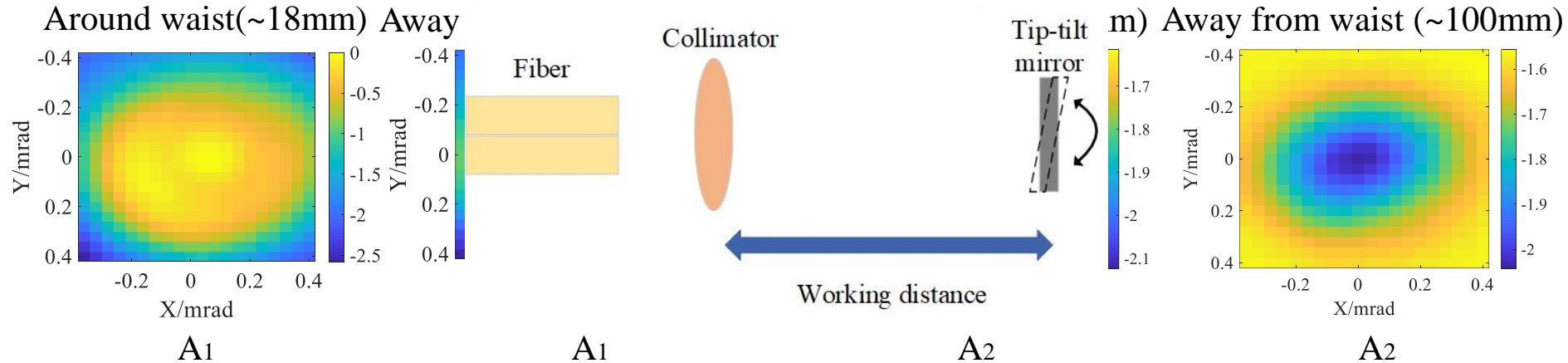
A_t (total amplitude)



Line scan crossing the maximum with 0.04 mrad step

4 Variation in working distance

Amplitude normalized and in natural logarithm



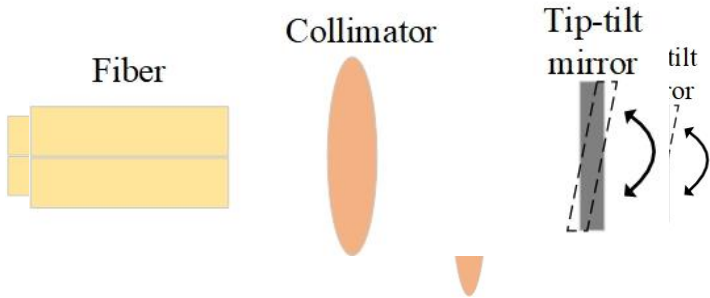
Raster scan with 0.04mrad step with different distances between the collimator and the target mirror.

Comparisons between around waist scans and away from waist scans

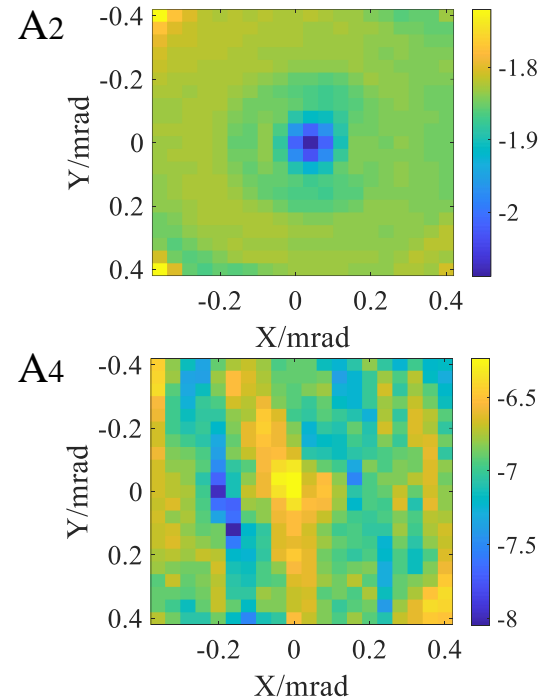
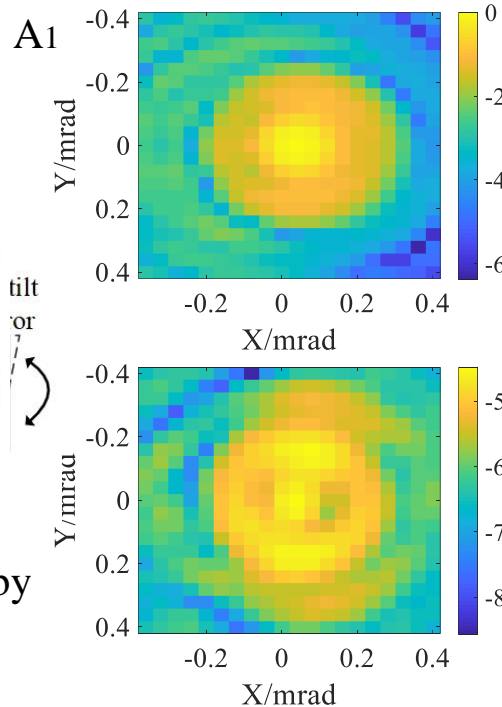
4 Change of focusing lens

Amplitude normalized
and in natural logarithm

A_t (total amplitude)



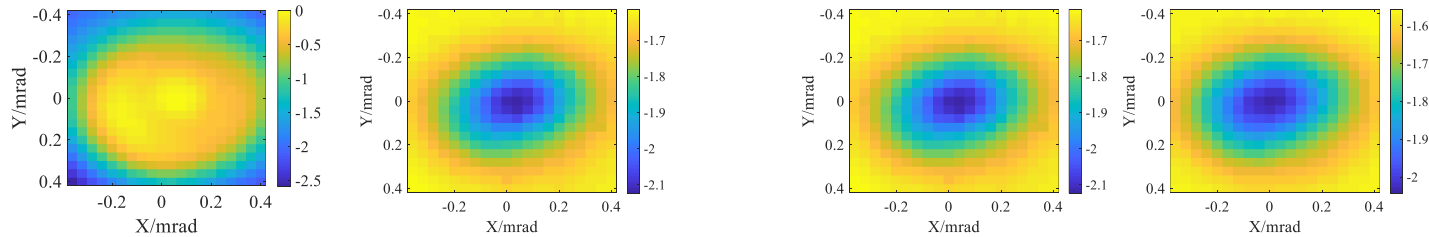
The fiber collimator was replaced by
a lens with 50 mm focal length.



Raster scan with 0.04 mrad step using a lens with 50 mm focal length

5 Conclusion and Outlook

- **Multiple Reflection** effects occur in compact autocollimation setups. **RRI** can be used to **visualize** them by **separately plotting** the intensity for each reflection order.
- The minimum of the **second reflection** intensity appears to be a **more reliable** alignment indicator **than** the peak of either the **total** intensity or the **first reflection** intensity.
- Scans made at different **working distances** and different **focal lengths** show good **consistency**.



=> New methods for optimized **mirror alignment** by **compact autocollimation sensors** are currently being investigated and alignment **uncertainties** are being **quantified**.

Thank you for your attention!

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