



A novel 3D coordinate measurement system based on FSI & galvanometer

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Laser and Optoelectronics Measurement Technology Research Group

Vision Measurement Systems

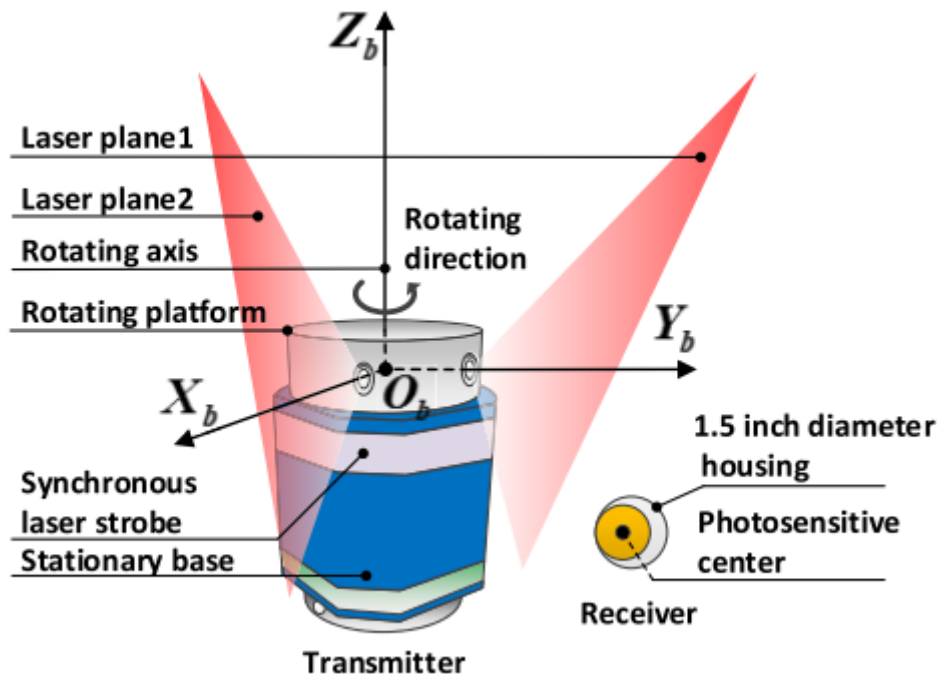


workshop Measurement Positioning System





workshop Measurement Positioning System



Working range	3-40m
Accuracy of angle measurement	$\pm 2''$
Measurement frequency	30Hz





Outline



- **Backgrounds**
- **Frequency scanning interferometry**
- **Ranging system based on galvanometer**
- **Target recognizing**
- **Experiment**
- **Summary**





Backgrounds



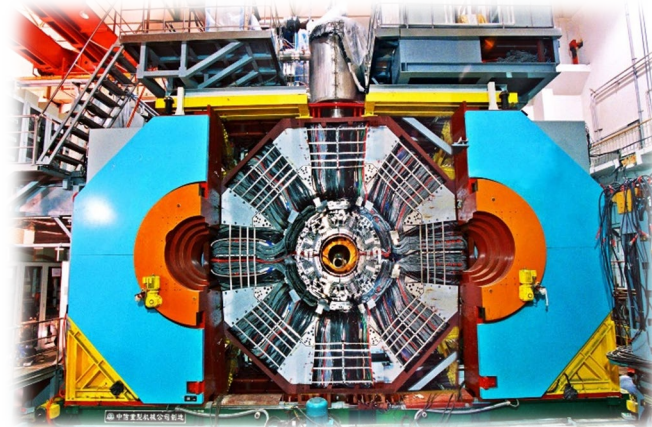
Automobile manufacturing



Airplane assembling



Ship building

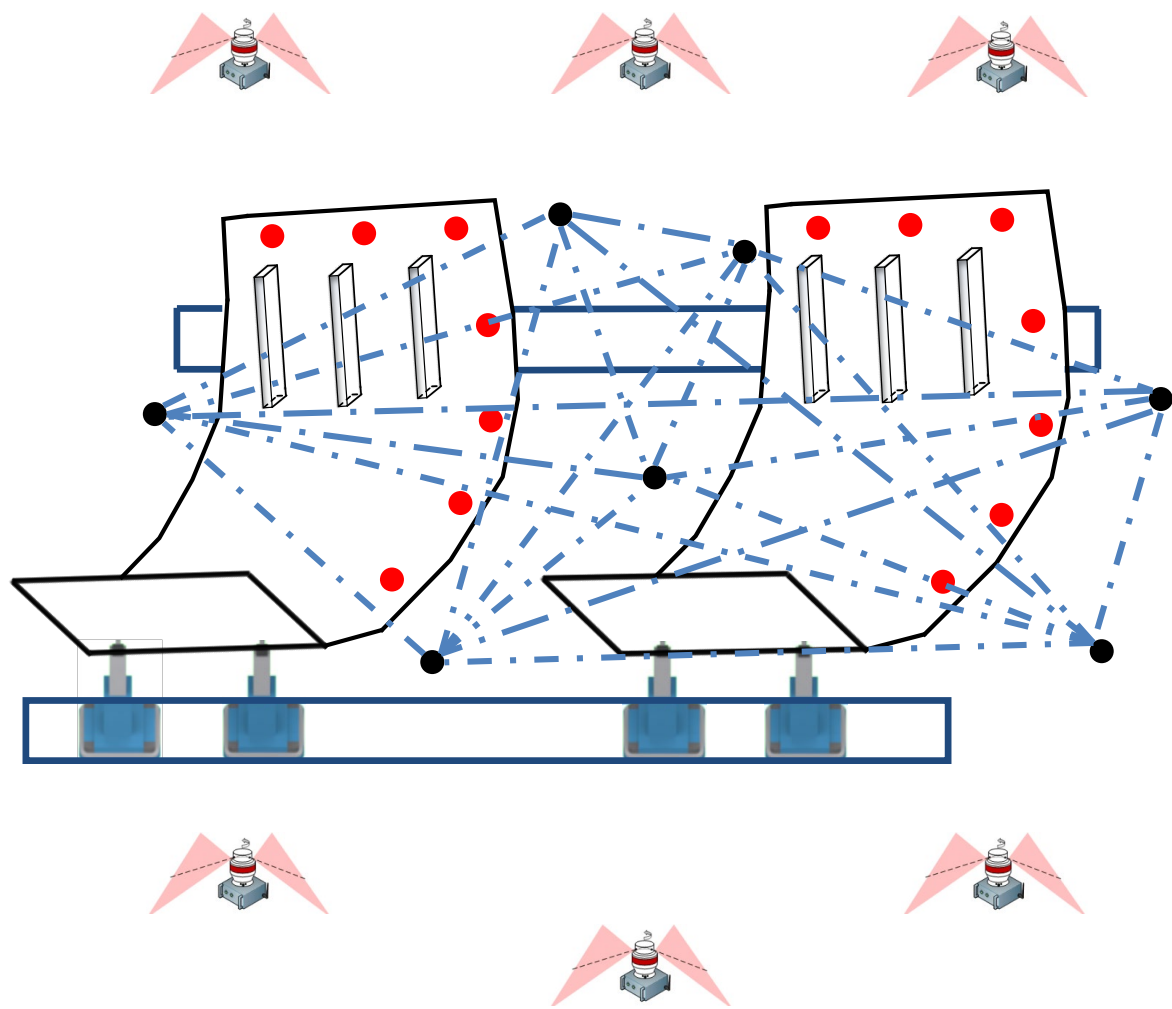


Large scientific instruments construction





Backgrounds

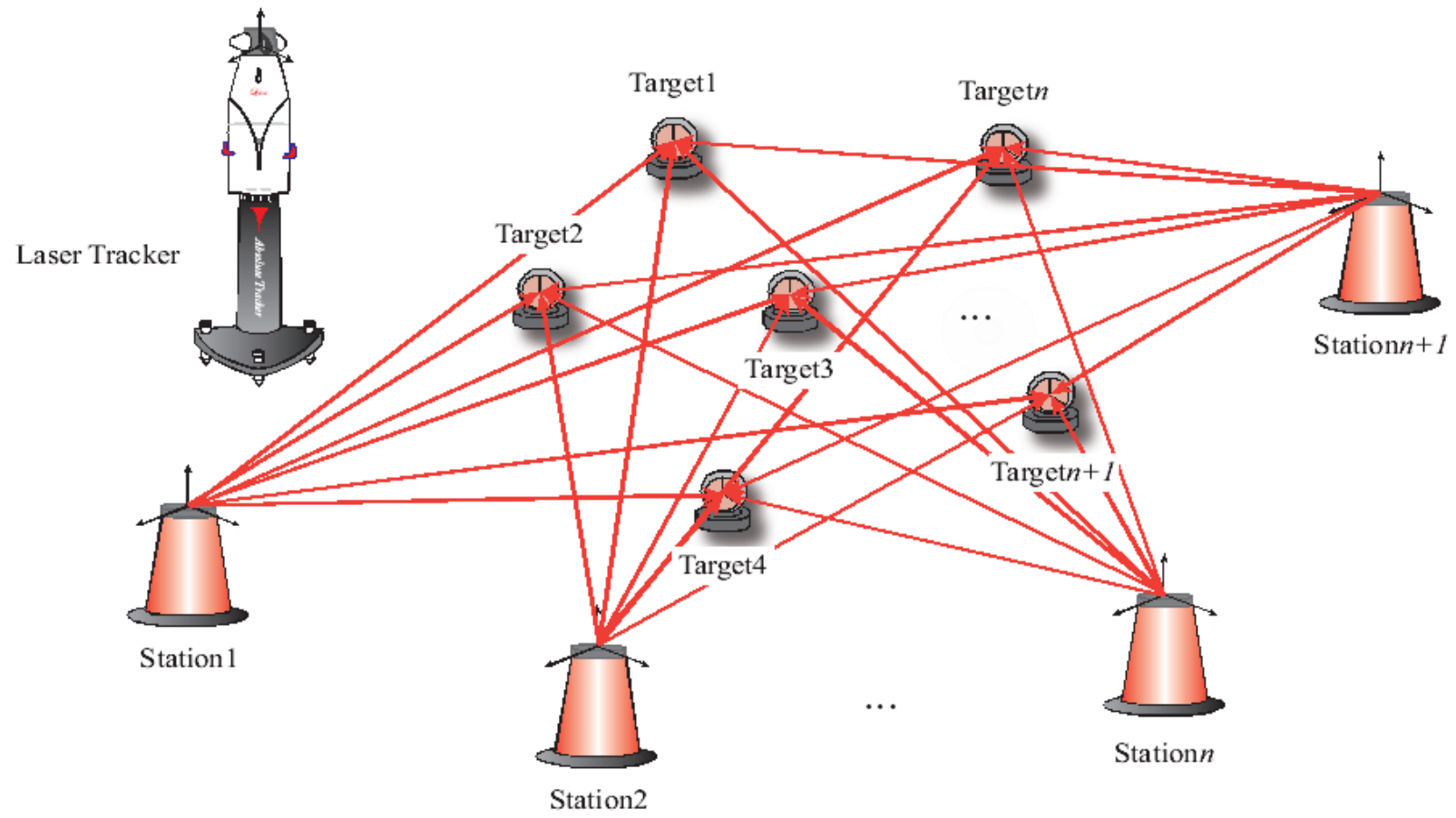


State key Laboratory of Precision Measuring Technology and Instruments





Backgrounds





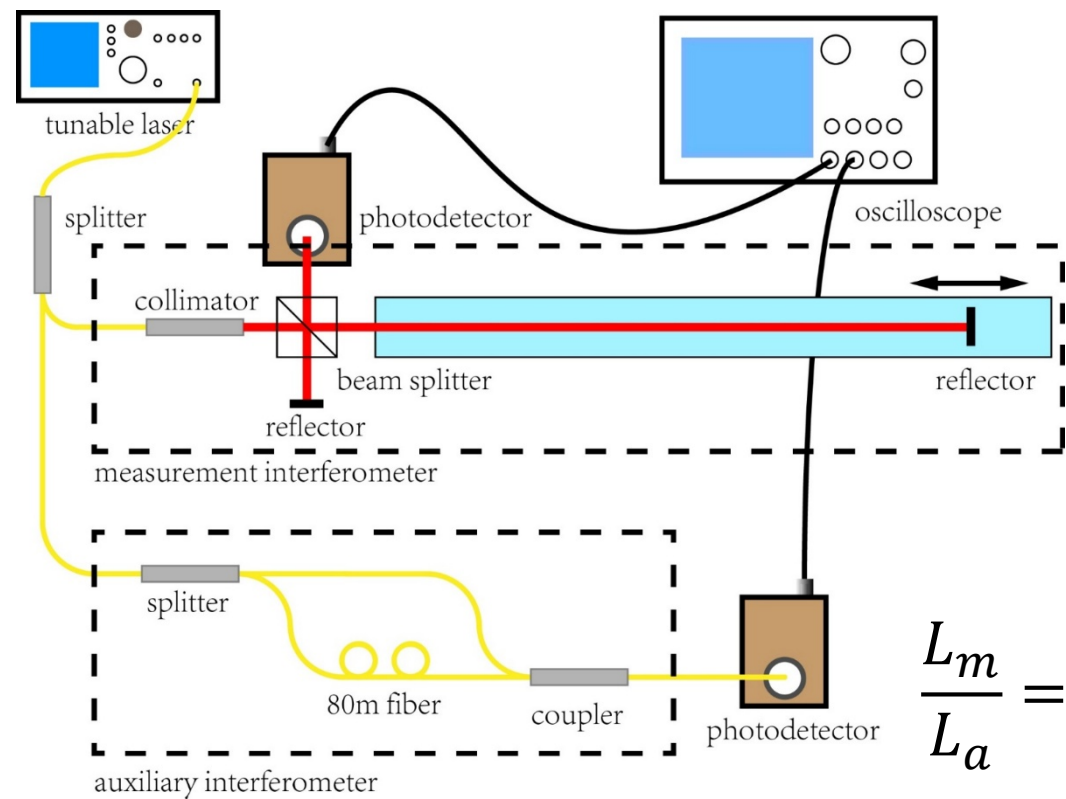
Frequency scanning interferometry

Traditional interferometer

$$\Delta\phi = \frac{L(t_2)}{\lambda} - \frac{L(t_1)}{\lambda}$$

Frequency scanning interferometer

$$\Delta\phi = \frac{L}{\lambda(t_2)} - \frac{L}{\lambda(t_1)}$$



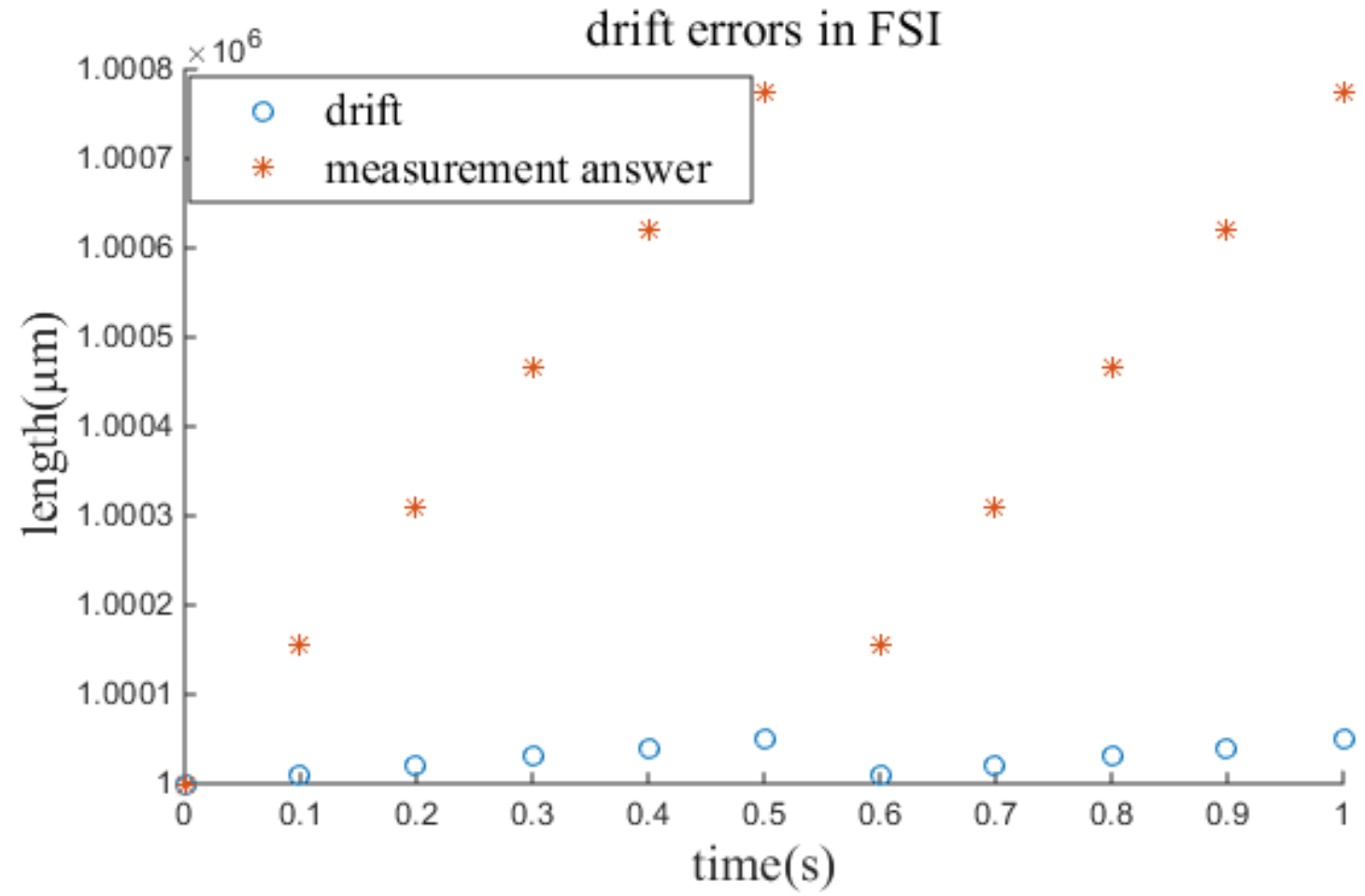
$$\frac{L_m}{L_a} = \frac{\Delta\phi_m}{\Delta\phi_a}$$





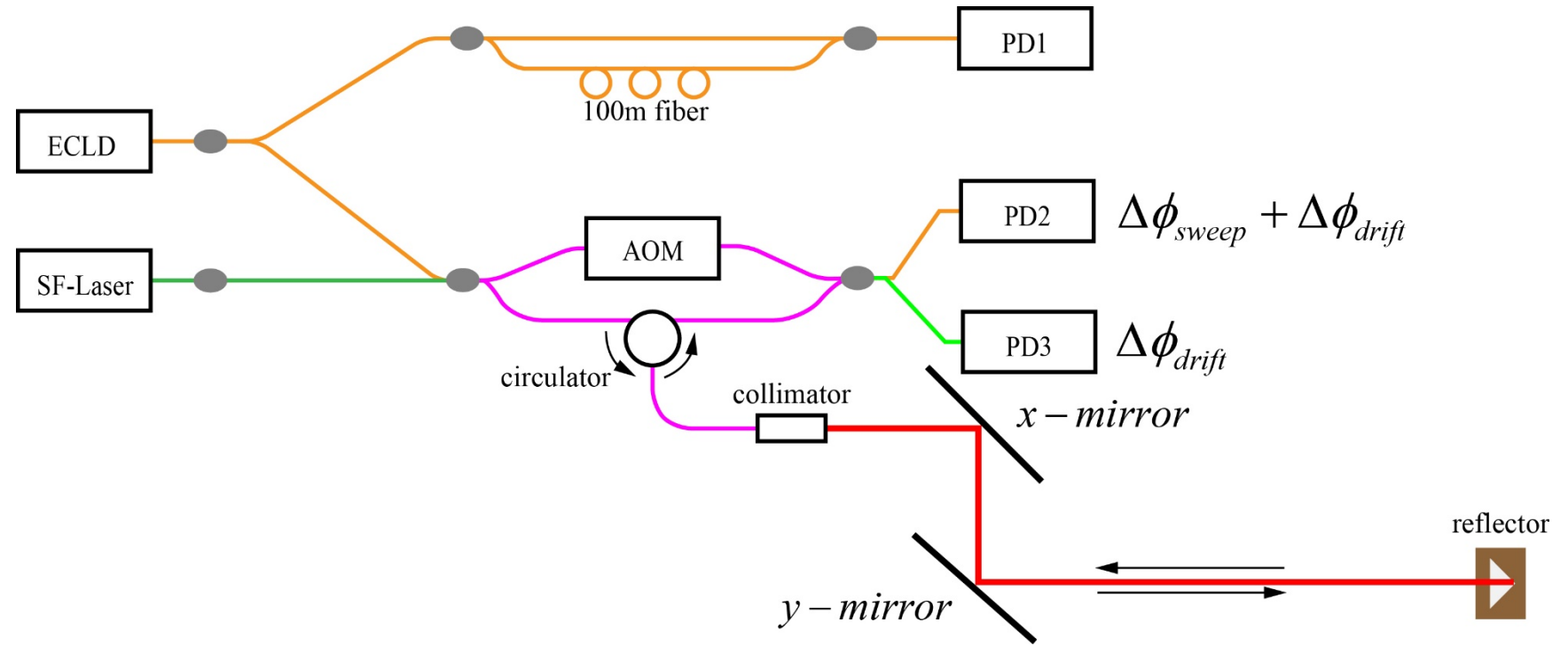
Frequency scanning interferometry

When OPD in measurement interferometer drifts:





Frequency scanning interferometry



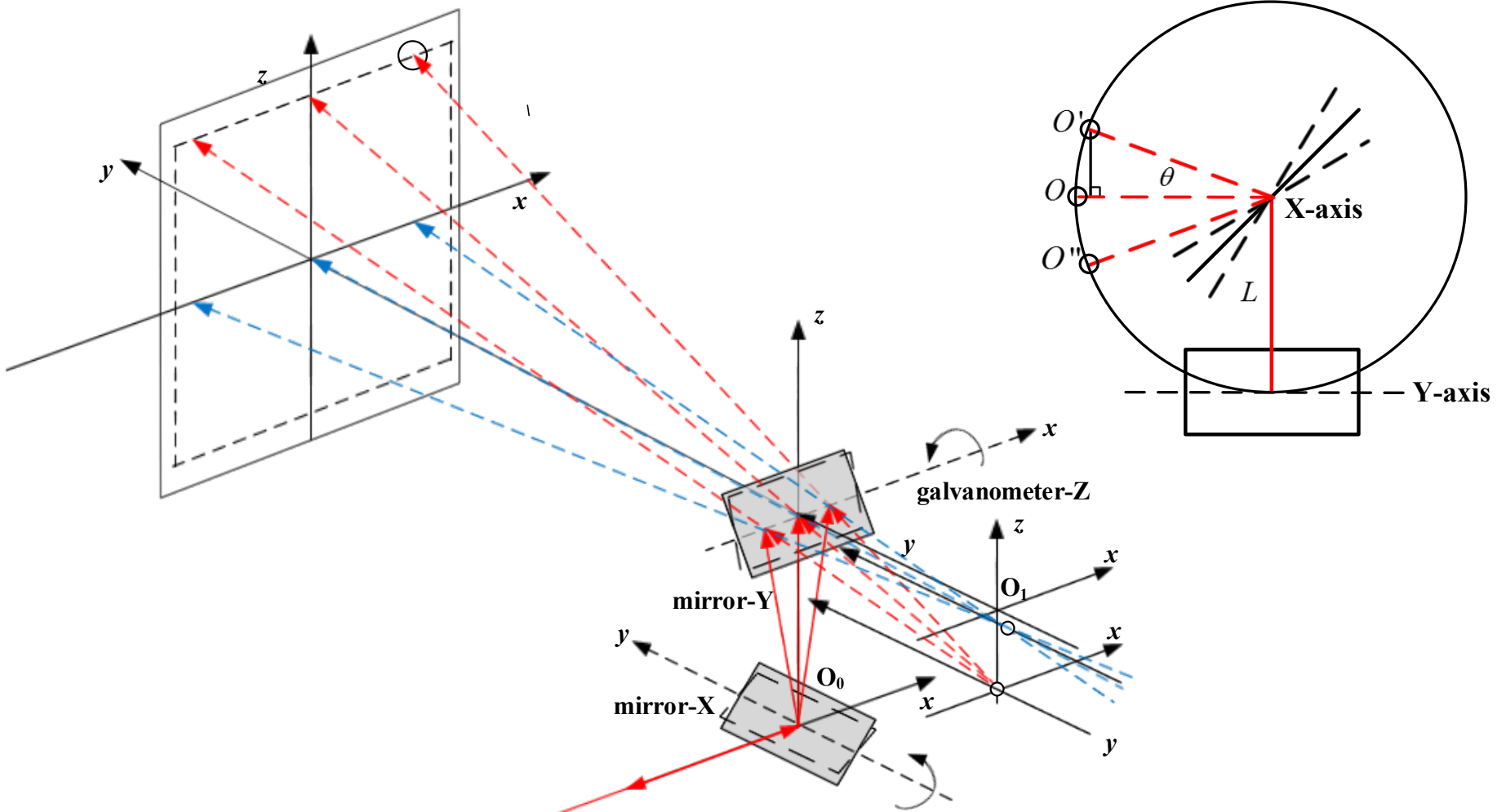
$$\Delta\phi' = \frac{\Delta L}{\lambda(t_2)} + L(t_1) \frac{\Delta\lambda}{\lambda(t_2)\lambda(t_1)} - \frac{\Delta L}{\lambda_s}$$

Compensation of drift error in FSI





Ranging system based on galvanometer

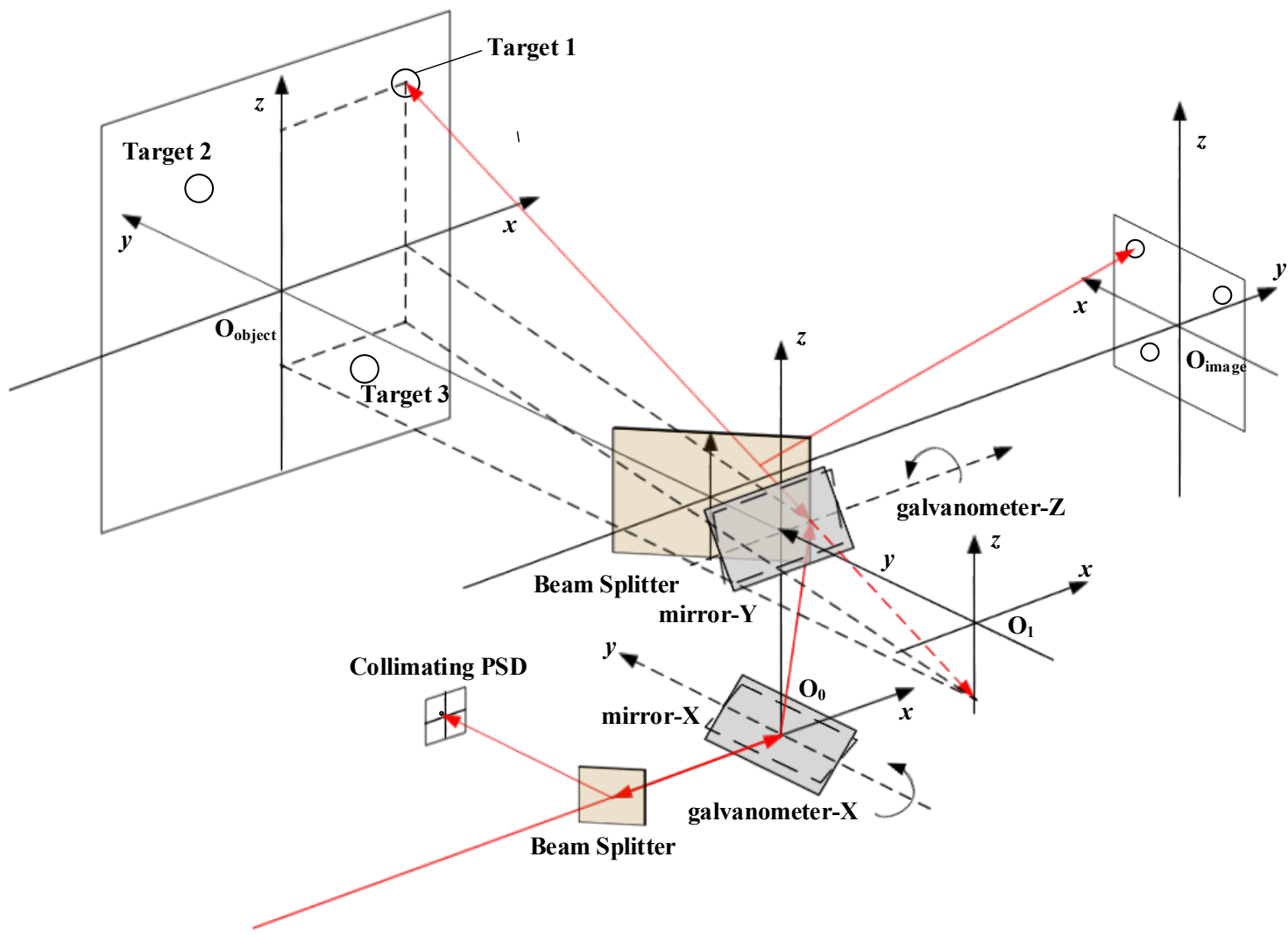


$$L^2 = (x_{target} - x_0)^2 + (y_{target} - y_0 + L\cos\theta_x - L)^2 + (z_{target} - z_0 - L\sin\theta_x)^2$$



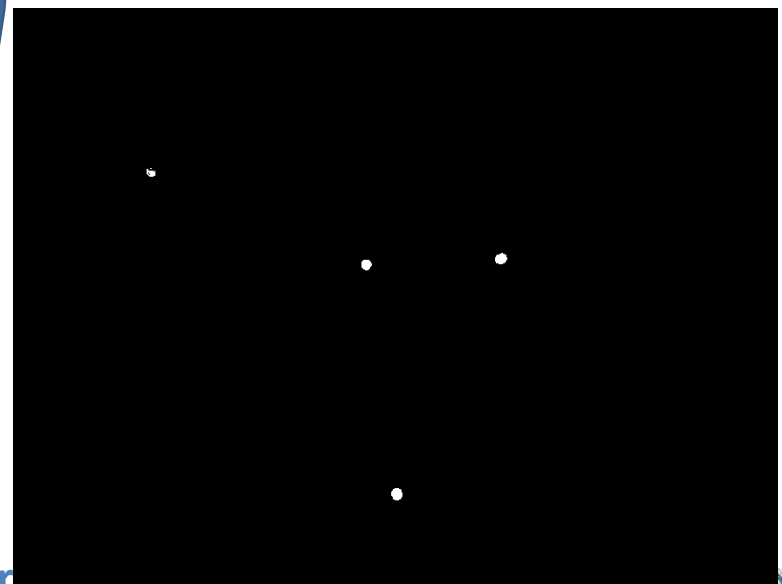
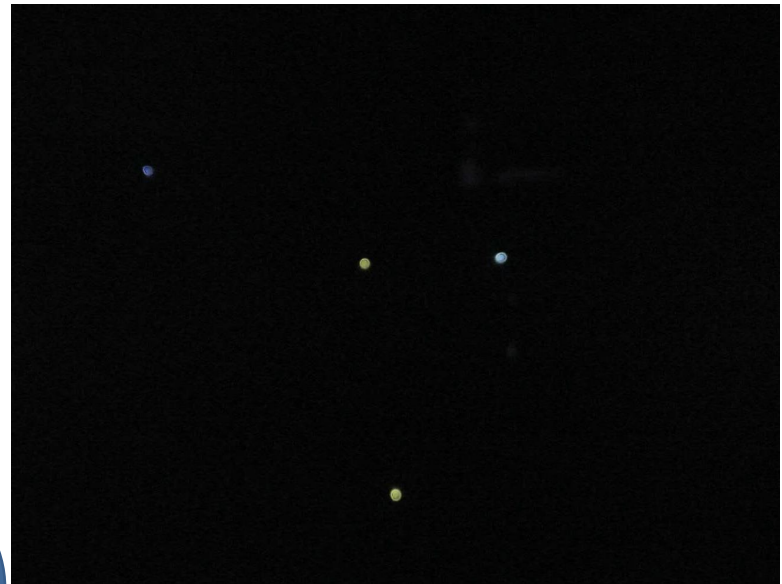


Ranging system based on galvanometer





Target recognizing



1*
(364, 284)

2*
(735, 442)

3*
(965, 432)

*4
(786, 836)

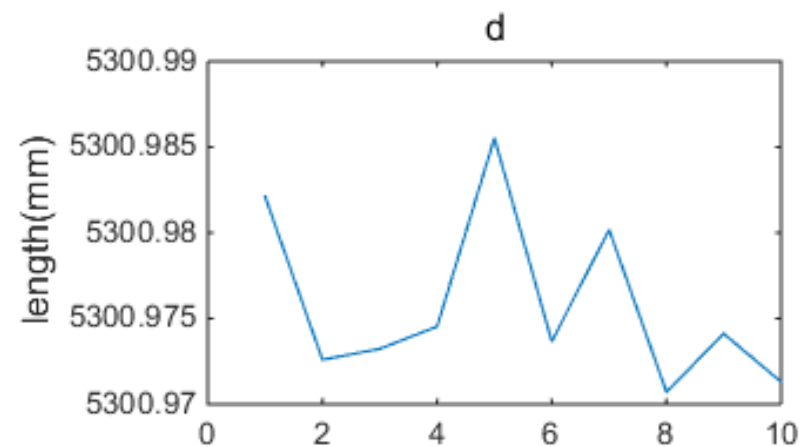
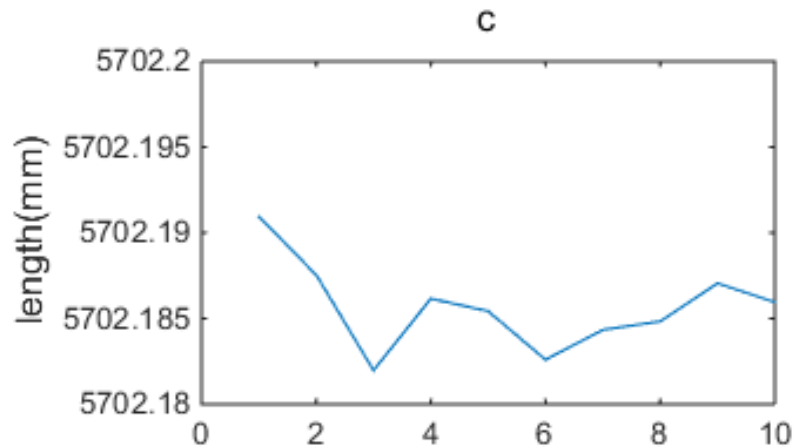
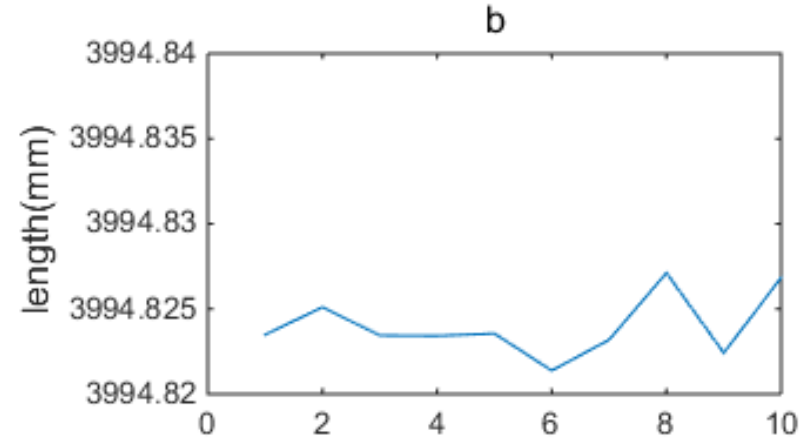
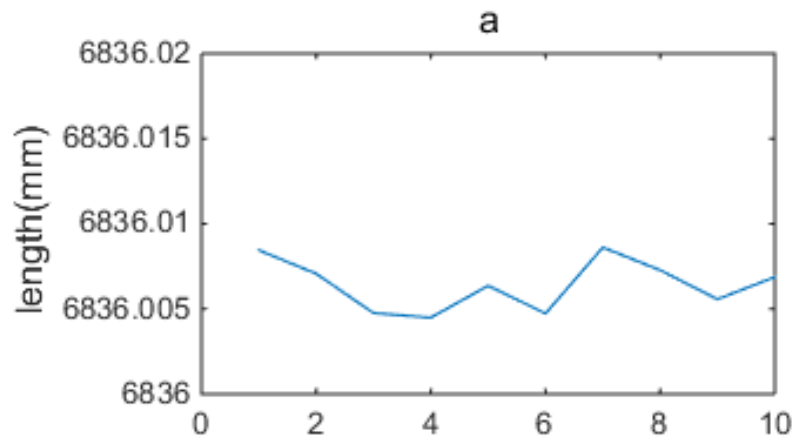




Experiment

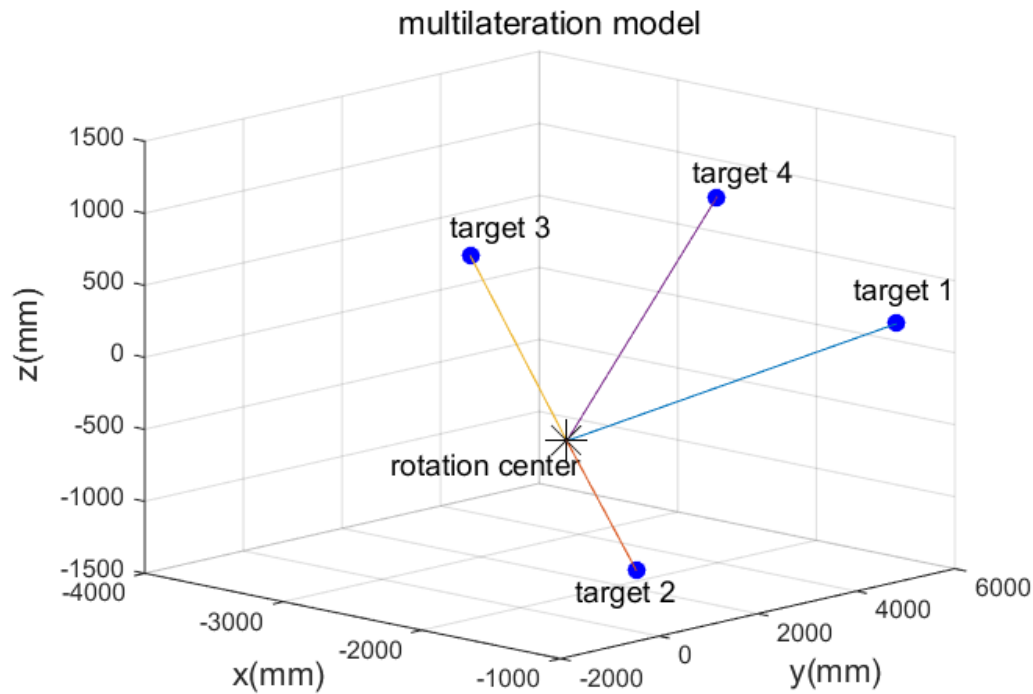


Length measurement answer





Experiment



	X(mm)	Y(mm)	Z(mm)
1	-1088.724	-1620.935	-35.903
2	-1088.704	-1621.041	-35.877
3	-1088.764	-1620.819	-35.892
4	-1088.817	-1620.569	-35.909
5	-1088.684	-1621.110	-35.898
6	-1088.721	-1620.988	-35.887
7	-1088.692	-1621.122	-35.888
8	-1088.698	-1621.088	-35.867
9	-1088.689	-1621.089	-35.882
10	-1088.673	-1621.175	-35.864
Std.	0.0439	0.1212	0.0148





Error source analyze



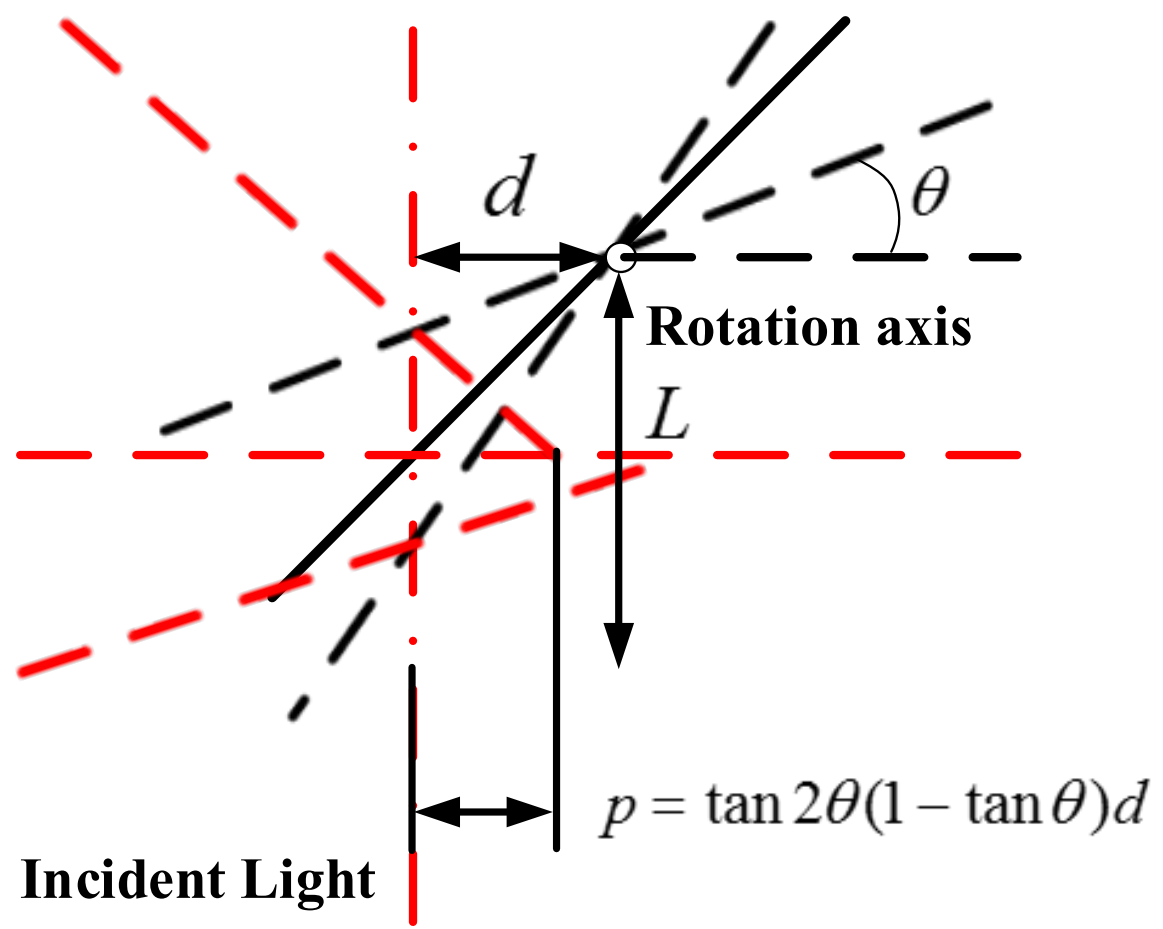
- Absolute distance measurement:
better than $\pm 0.5\text{ppm}(<10\text{m})$
- Coordinate error of the target(laser tracker):
 $15\mu\text{m}+5\mu\text{m}/\text{m}$
- Galvanometer system mechanism error





Error source analyze

Incident laser offset errors





Summary



1. A 3d coordinate measurement system which used for monitoring the global 3d coordinate control network has been proposed.
2. Drift error in FSI has been analyzed and we introduce a heterodyne interferometer into the FSI system to correct the result.
3. A ranging system based on FSI and galvanometer has been established and experiment shows that an length measurement accuracy about $\pm 0.5\text{ppm}$ could achieved which leads a coordinate measurement standard deviation about(0.04,0.12,0.01)mm.





Thank you for listening!

Welcome to visit Tianjin University

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