Fizeau or Twyman-Green?

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05/27/2010

Outline

- Background
- Purpose of this presentation
- Important points for an interferometer
  - Trade study
  - Ghost
  - Spatial frequency
- Summary

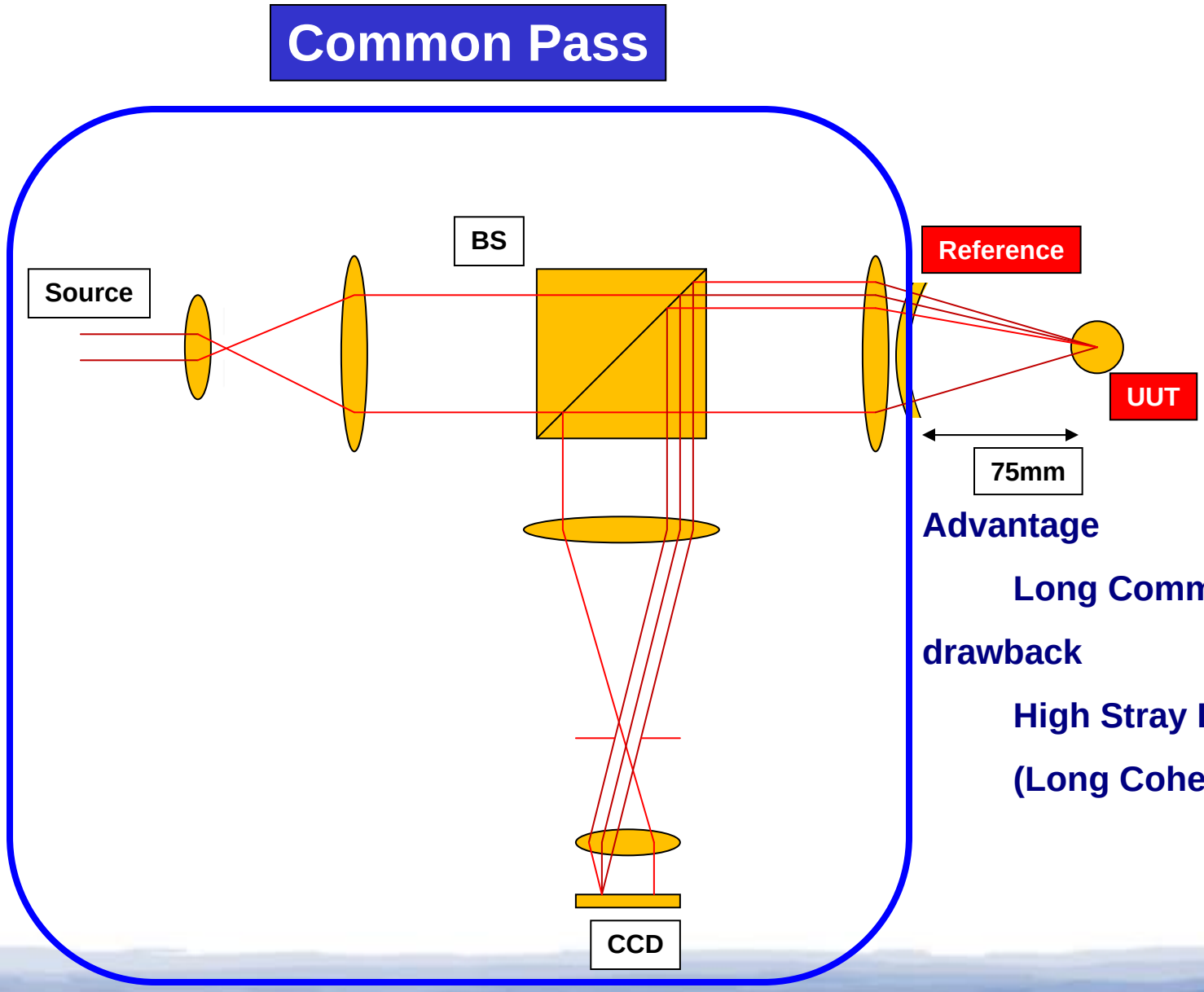
Background

- In the 3rd case study of OPTI524A, my team's tasks were
  - Design an interferometer
  - Build an interferometer
  - Measure a roundness of Silicon Nitride ball.
- I learned a lot I should care.
- Then,,,

Purpose of this presentation

- Summarize important points when we design an interferometer.
  - Trade study (Fizeau or Twyman-Green?)
  - Ghost
  - Spatial frequency

1. Trade study (Fizeau)



Advantage

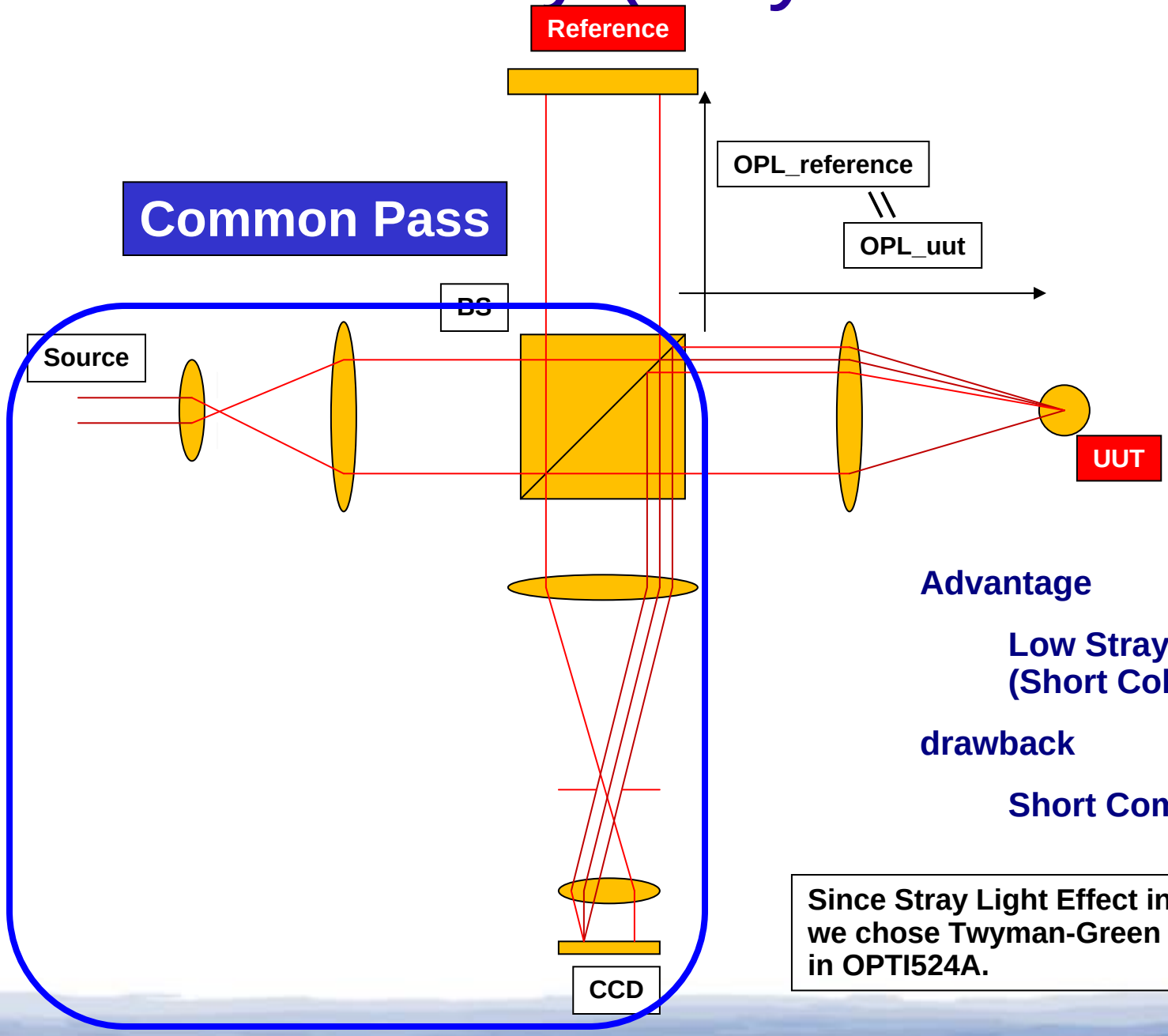
Long Common Pass

drawback

High Stray Light Effect

(Long Coherence ~150mm)

1. Trade study (Twyman-Green)



Advantage

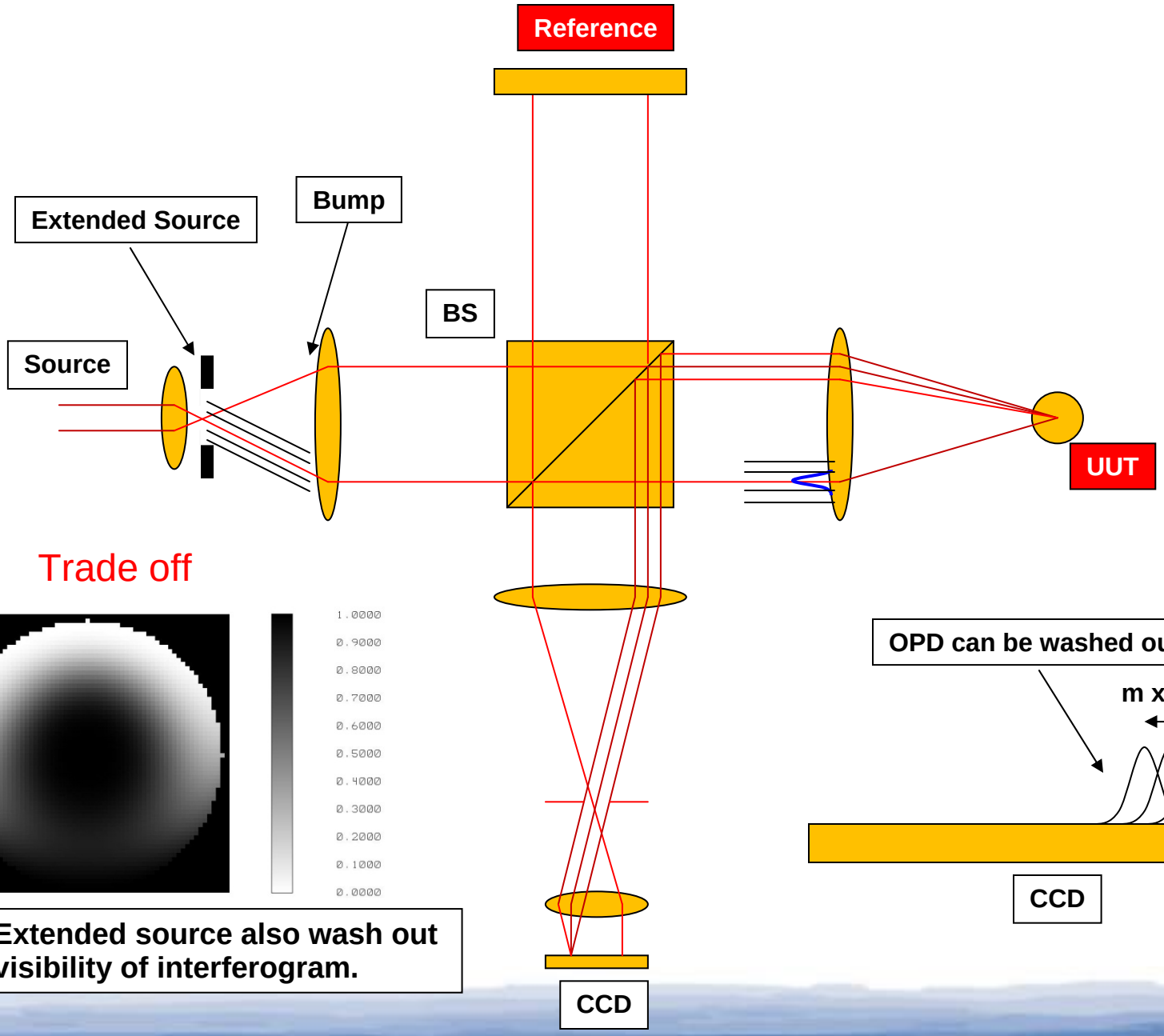
Low Stray Light Effect (Short Coherence ~50um)

drawback

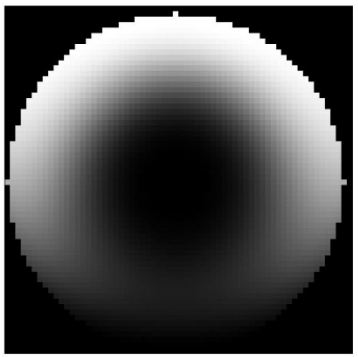
Short Common Pass

Since Stray Light Effect in Fizeau was large, we chose Twyman-Green Interferomenter in OPTI524A.

2. Ghost

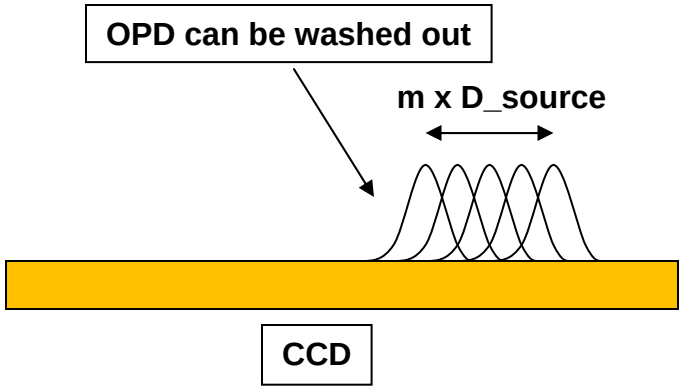


Trade off



THU MAY 13 2010
0.5250 μm AT 0.
PEAK TO VALLEY
SURFACE: IMAGE
EXIT PUPIL DIAM
XTILT = 0.00, Y

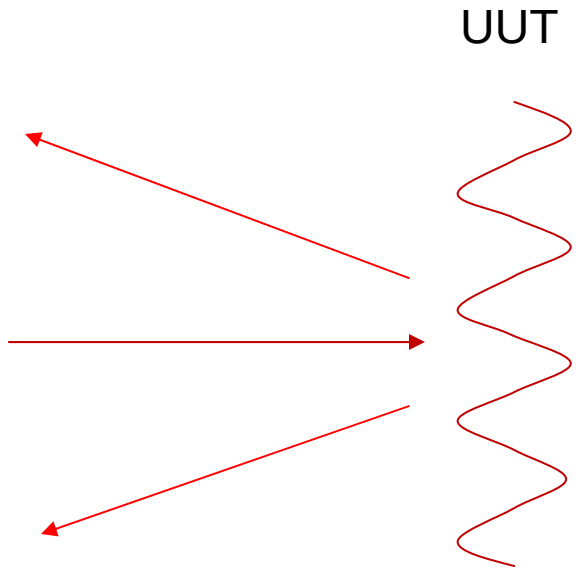
Extended source also wash out visibility of interferogram.



3. Spatial frequency

Assumptions

•UUT has sinusoidal surface irregularity.
•Our target of spatial frequency is more than 50 cycles/mm.

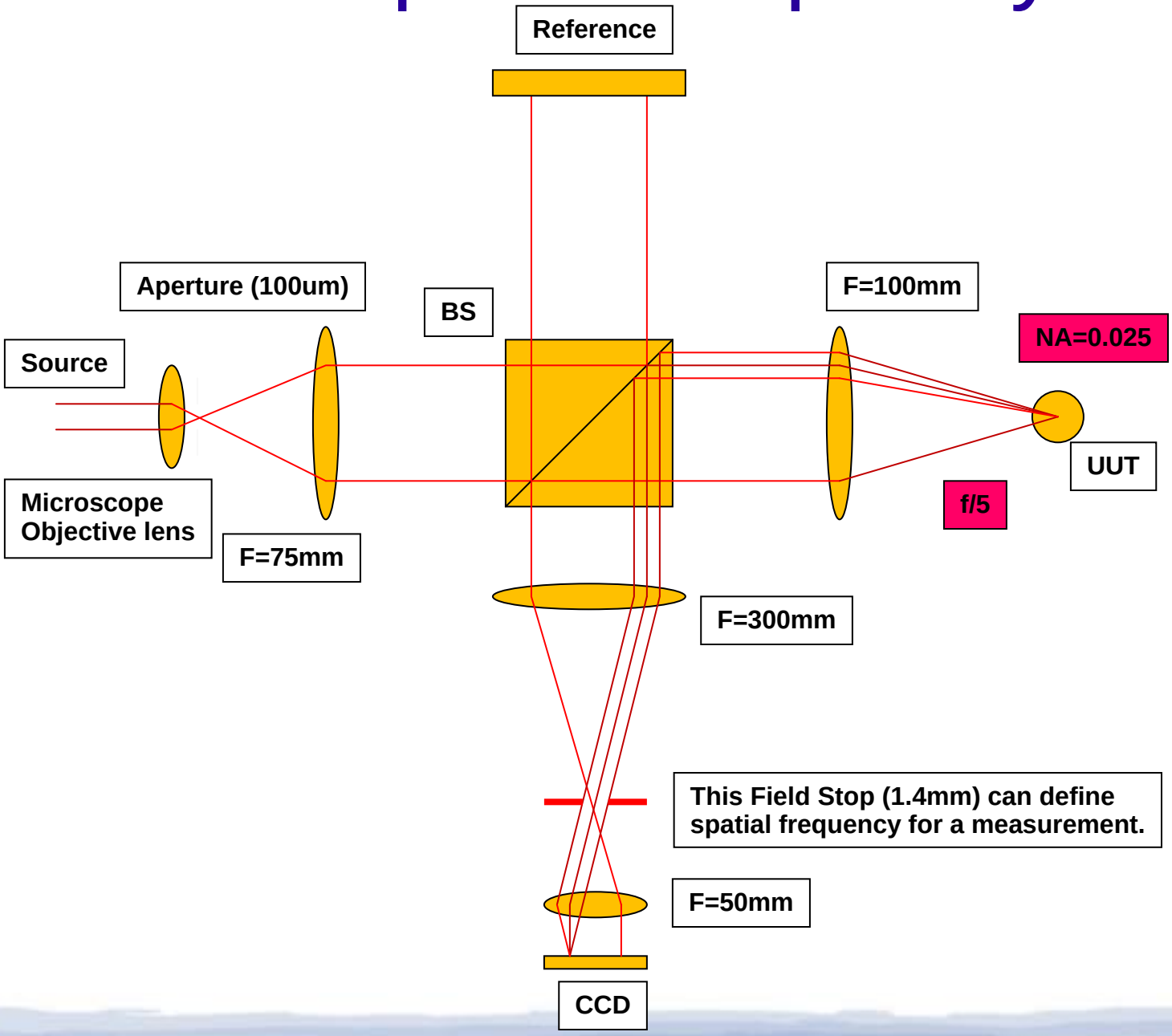


$$m\lambda = d\sin\theta_m$$

$$d \le \frac{2[mm]}{100[cycles]} = 20[um]$$

$$NA \simeq \sin\theta_1 \ge \frac{m\lambda}{d} = \frac{1\cdot 0.5[um]}{20[um]} = 0.025[rad]$$

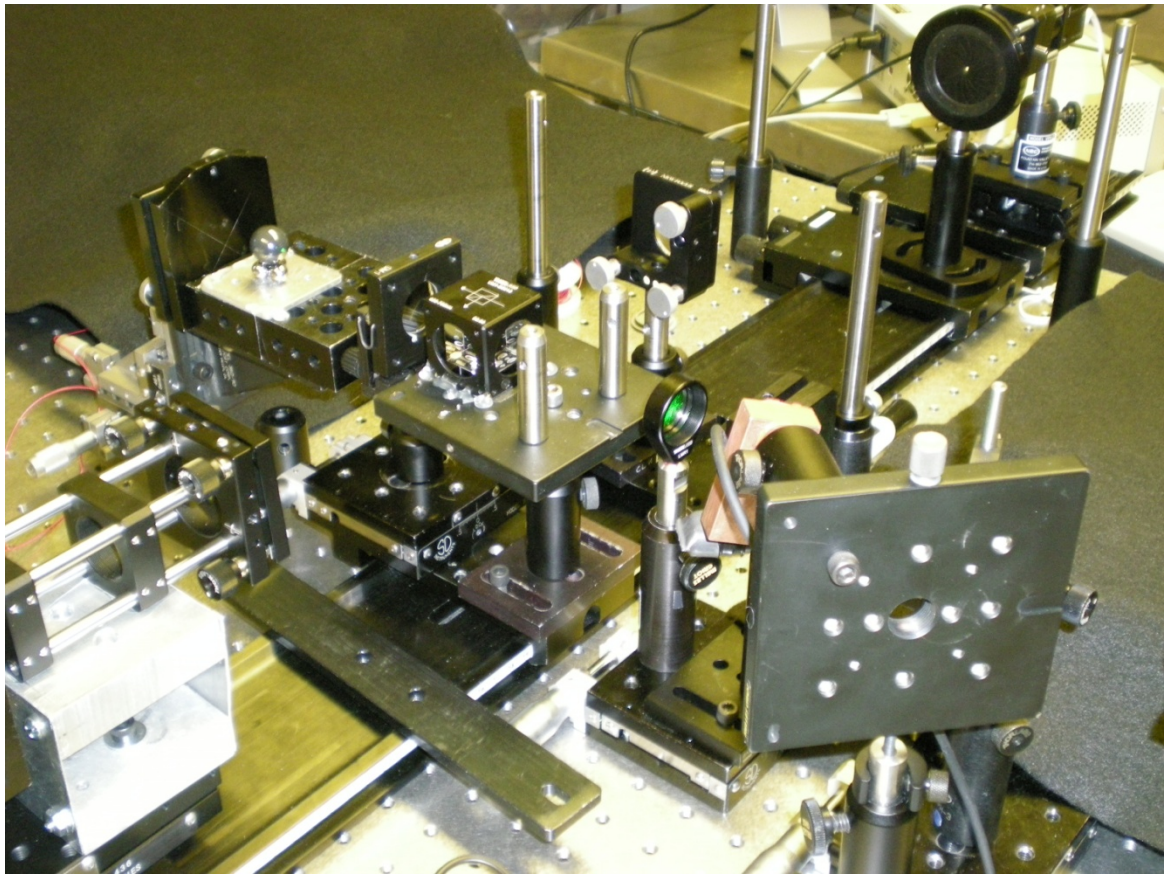
3. Spatial frequency



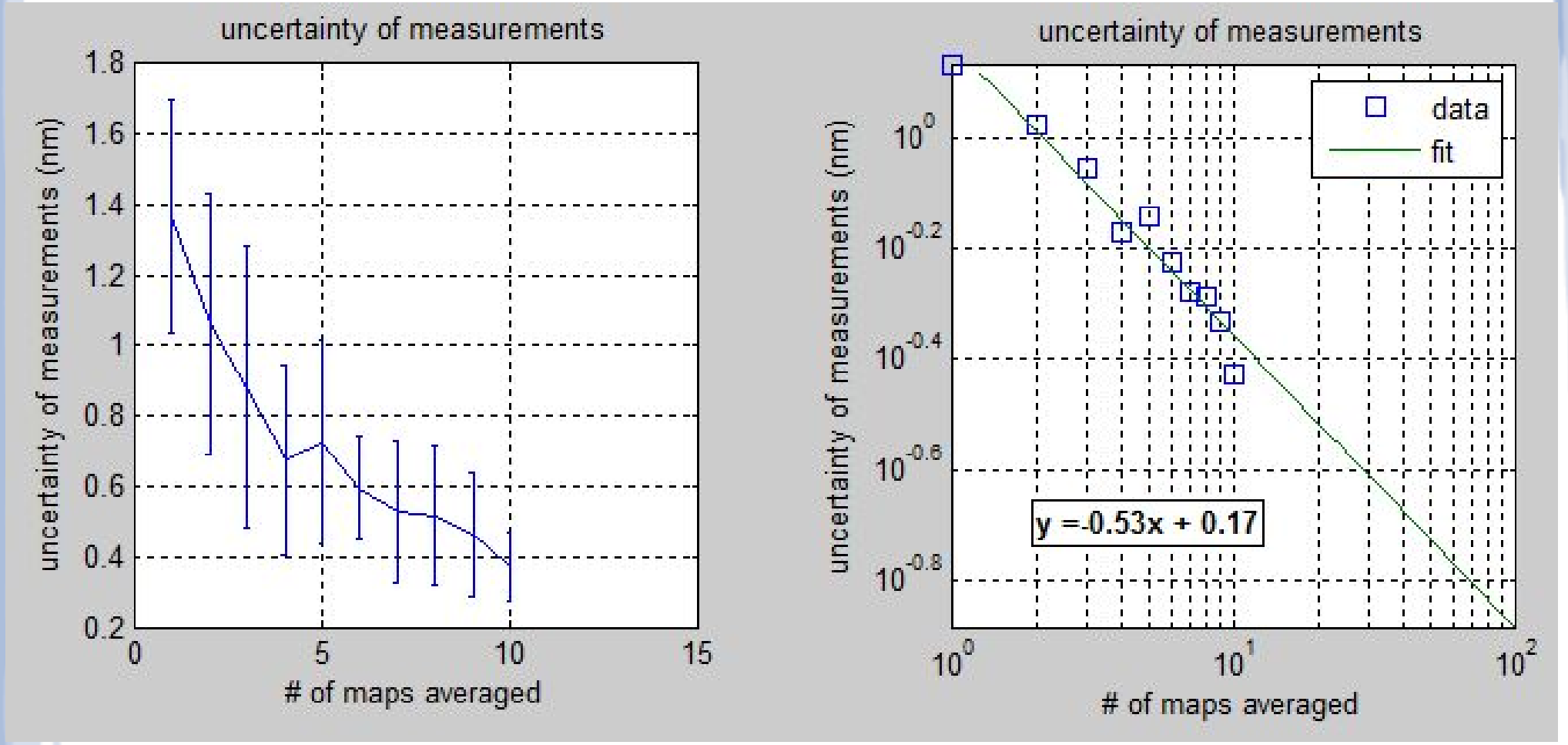
Conclusion

- Summarized important points when we design an interferometer.
  - Trade study
    - Fizeau has long common pass but need long coherence.
    - Twymann-Green does not need long coherence but has short common pass.
  - Ghost
    - Extended source can reduce ghost effect but has trade off.
  - Spatial frequency
    - We should consider spatial frequency for measurements

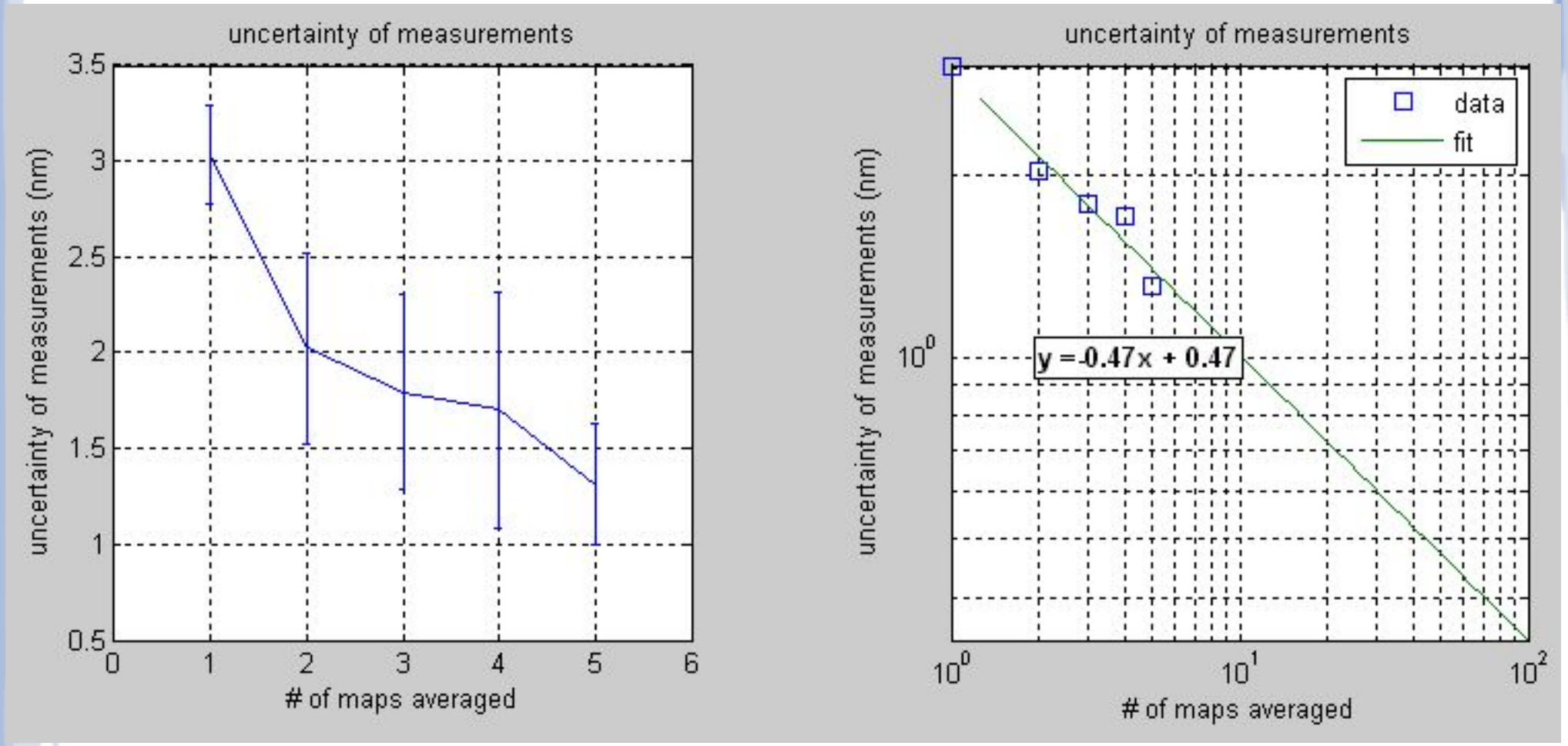
Our System



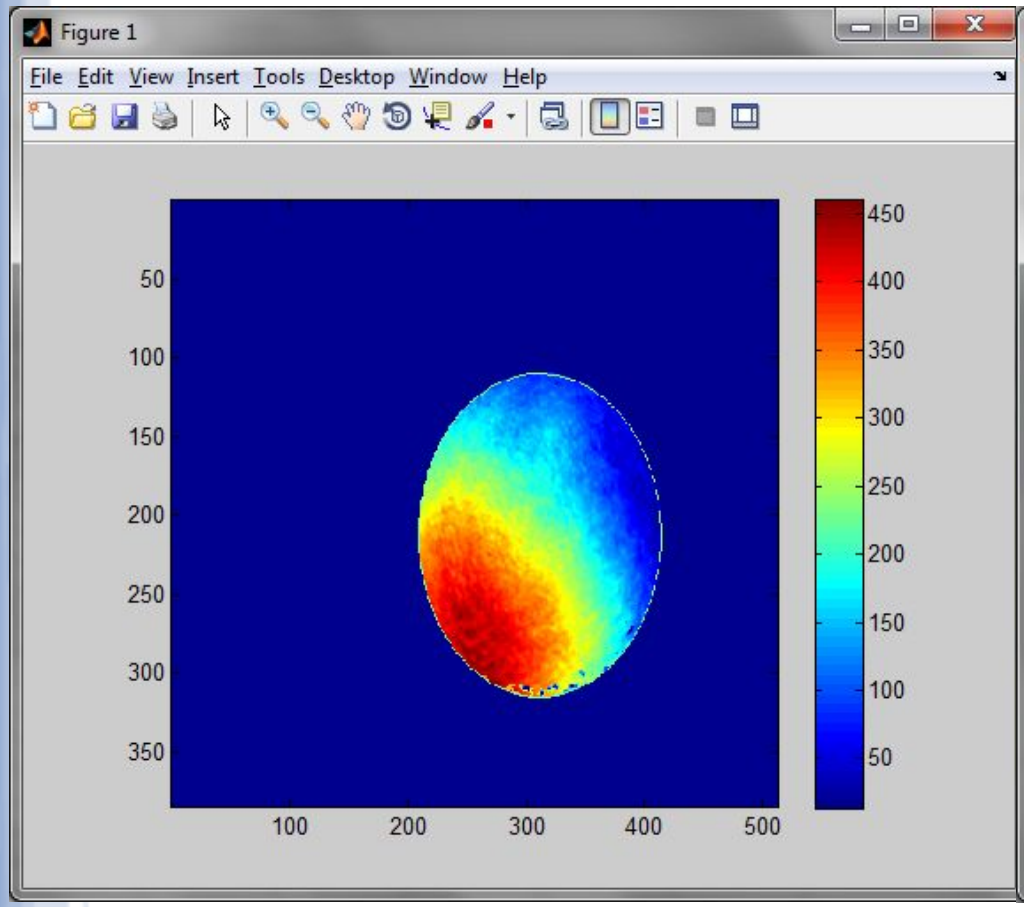
Uncertainty (temporal)



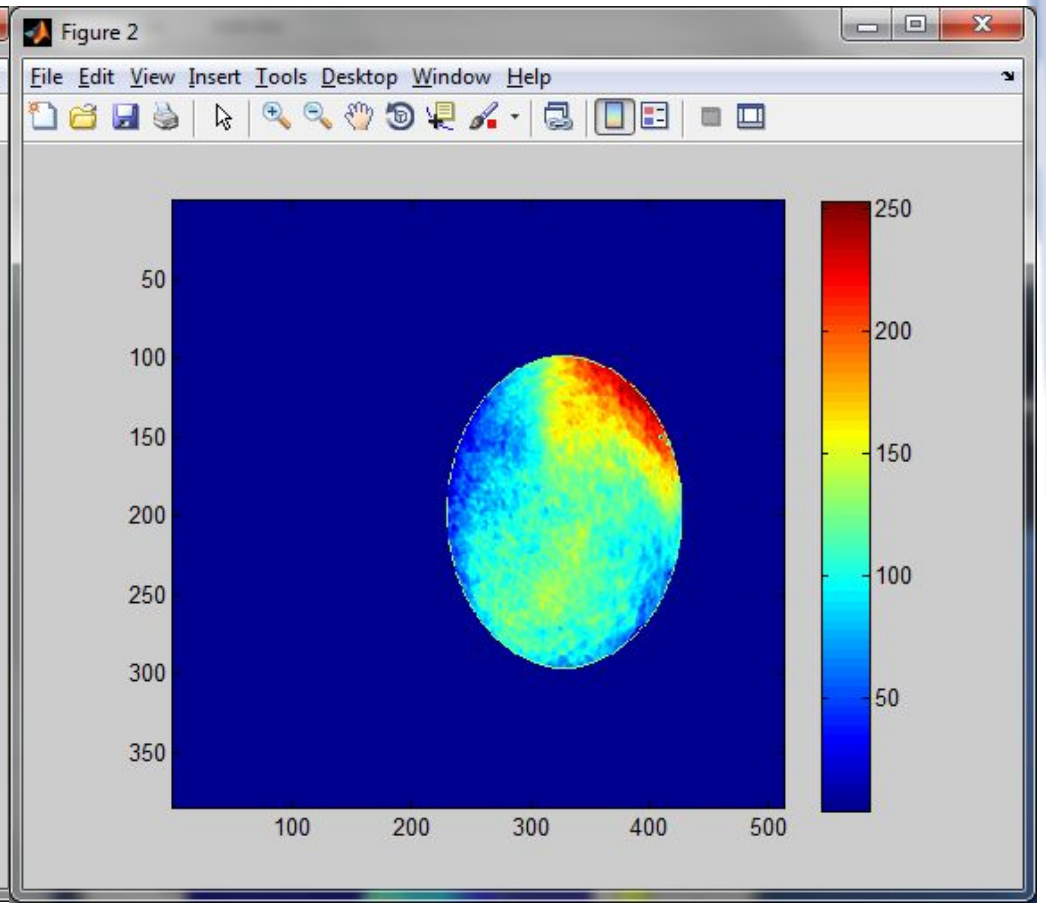
Uncertainty (pattern)



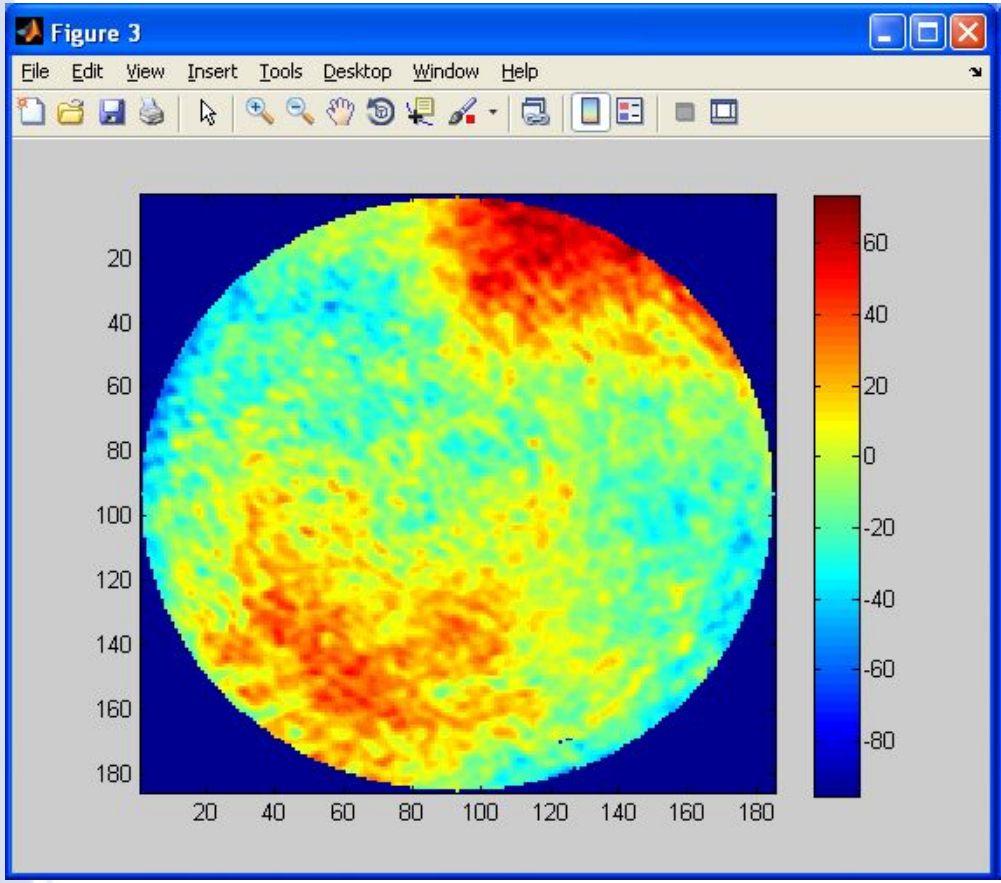
Surface Irregularity 1



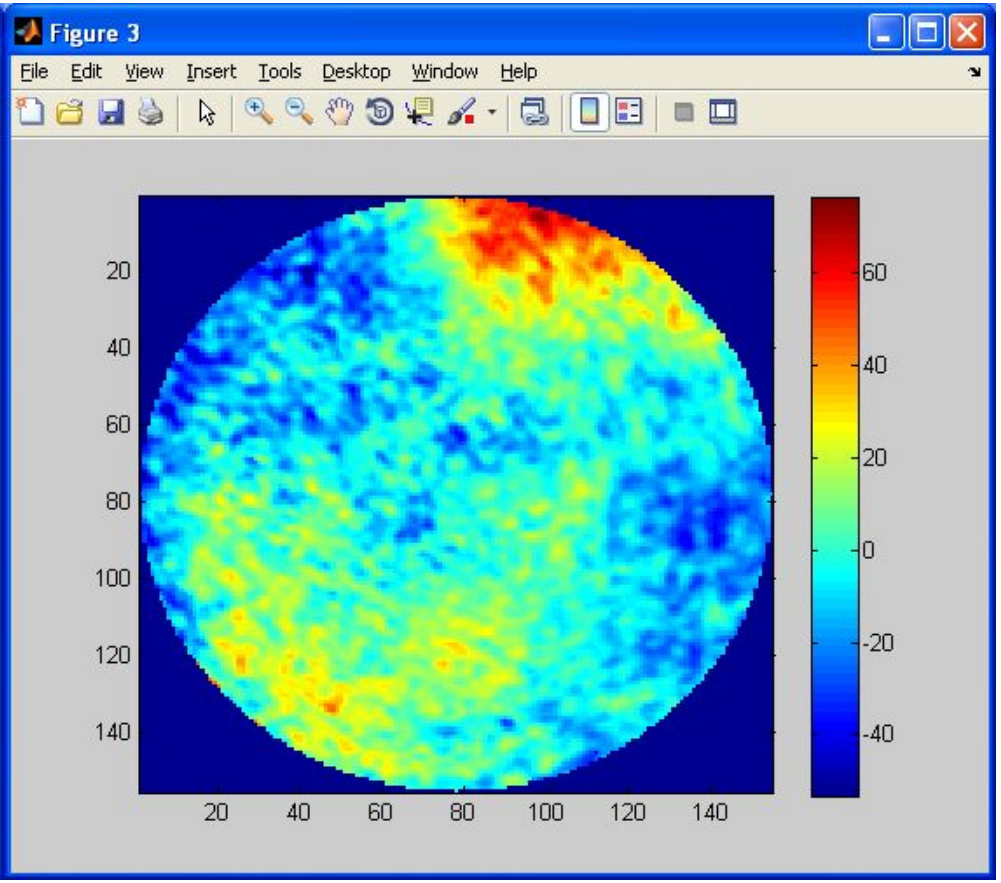
Calibration Data



Data (8 x 10 times)

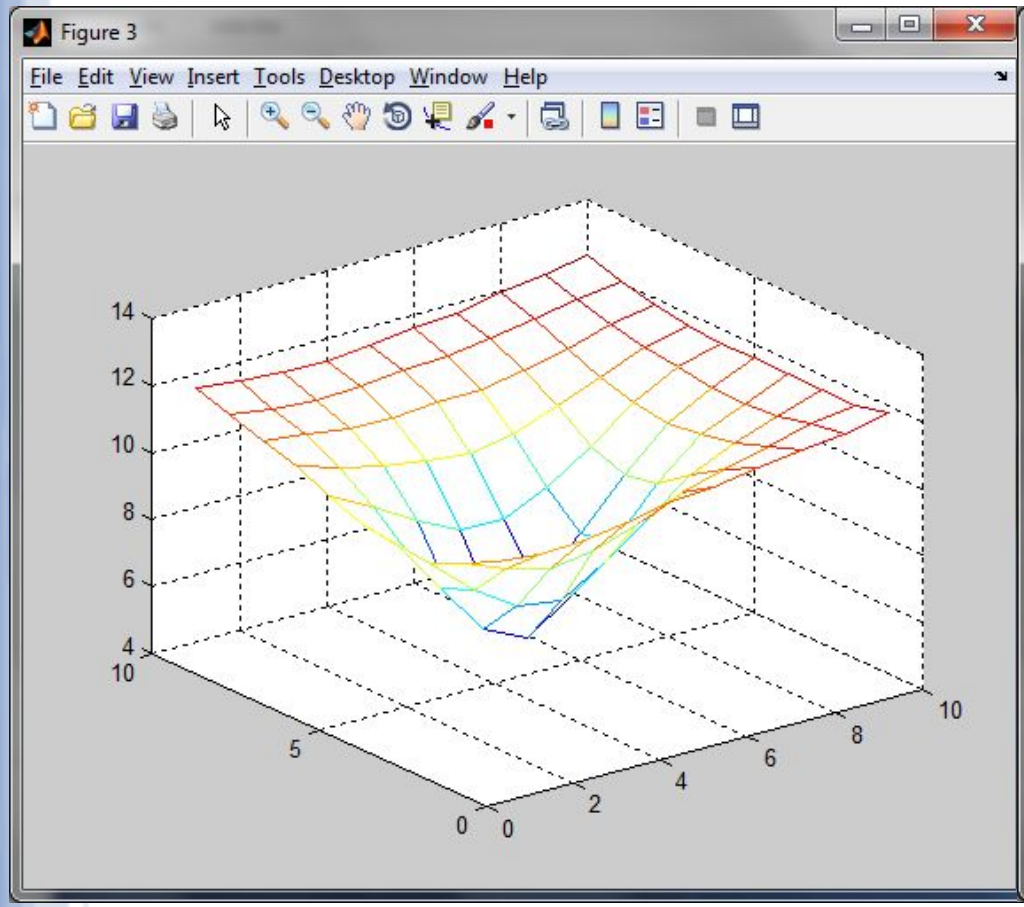


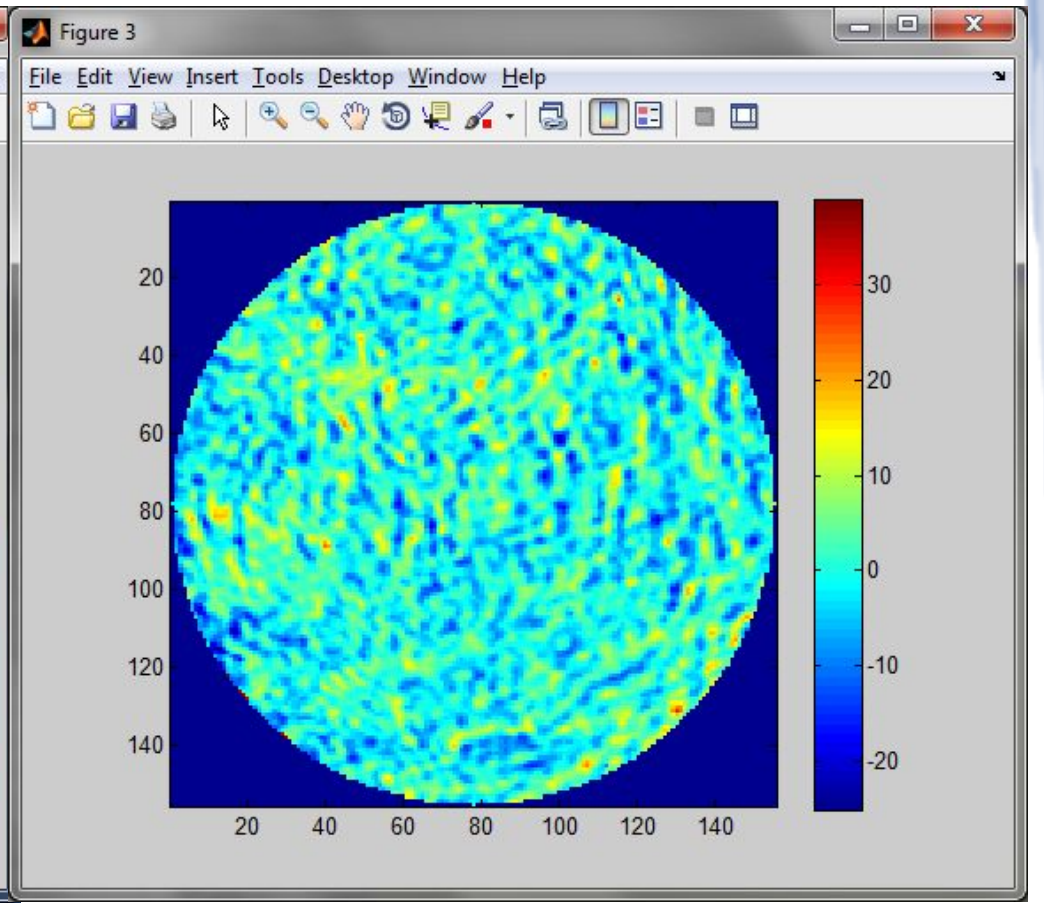
Calibration Data



Data (8 x 10 times)

Surface Irregularity 2





5.81 nm RMS

Comparison Table

	Long Coherence	Short Coherence
Small Source	FZ / TG (Ghost)	TG (Power)
Big Source	TG (Path Matching) (Stray Light)	TG (Path Matching)