

# Target Tracking at Gifu University

Yoshi030201-1

**Hiroki Yoshida**  
Gifu University, Japan

Second US/Japan Workshop on  
Target Fabrication, Injection and  
Tracking

Feb. 2-3, 2002  
General Atomics, San Diego, CA



# Outline

Yoshi030201-2

- ◆ Summery and conclusion
- ◆ Conceptual design of tracking apparatus
- ◆ Direct imaging on CCD arrays
- ◆ Matched filter

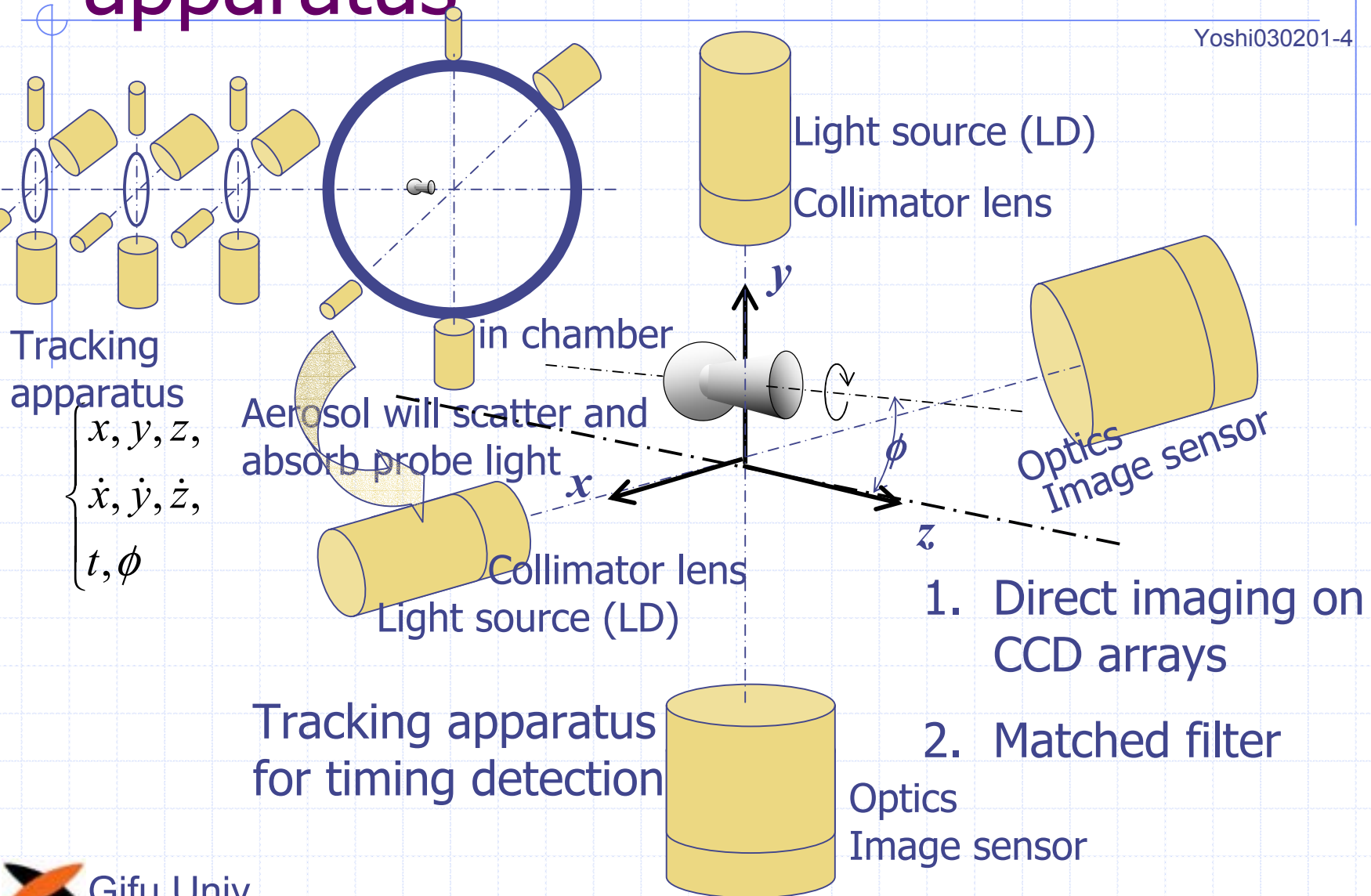
# Summery and conclusion

Yoshi030201-3

- ◆ Detectors have to provide noise reduction in tracking apparatus.
- ◆ The direct imaging on CCD arrays is constructed. In the preliminary evaluation, its accuracy is  $< 10 \mu\text{m}$  for a stationary target.
- ◆ The matched filter will be one of candidates. By the simulation, it has improved performance on S/N and detect ability of target rotation angle.

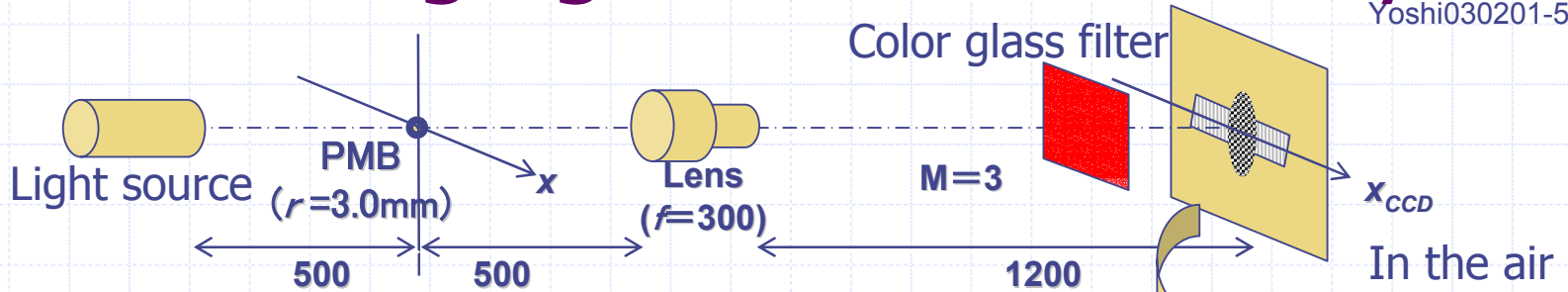
# Conceptual design of tracking apparatus

Yoshi030201-4



# Direct imaging on two CCD arrays

Yoshi030201-5

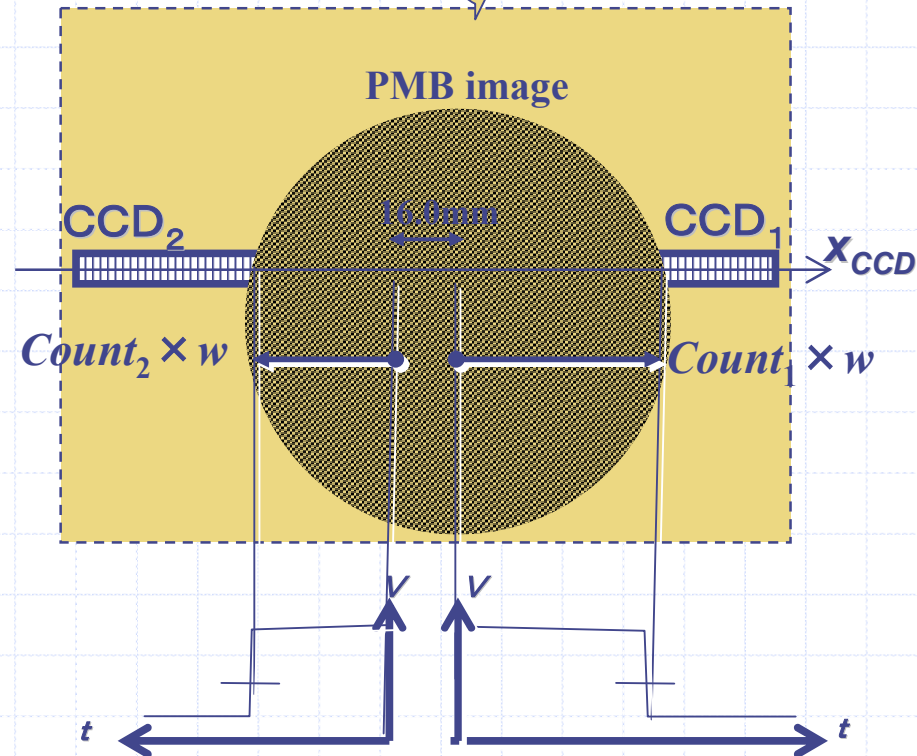


The PMB image is sampled by 500ns pulse.

Position  $x$  is determined

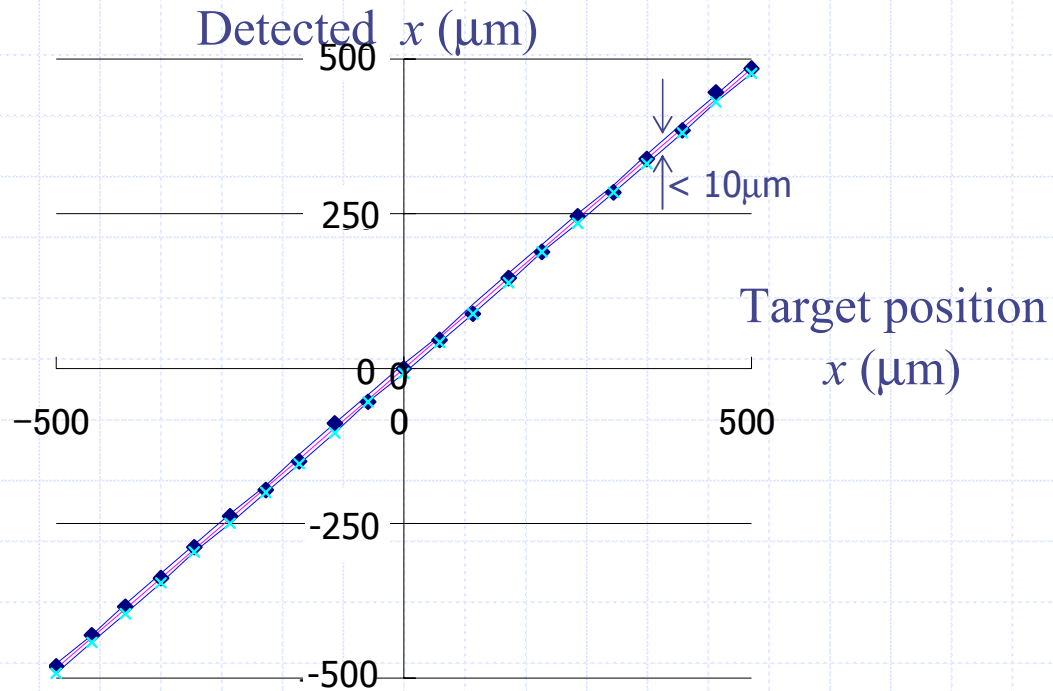
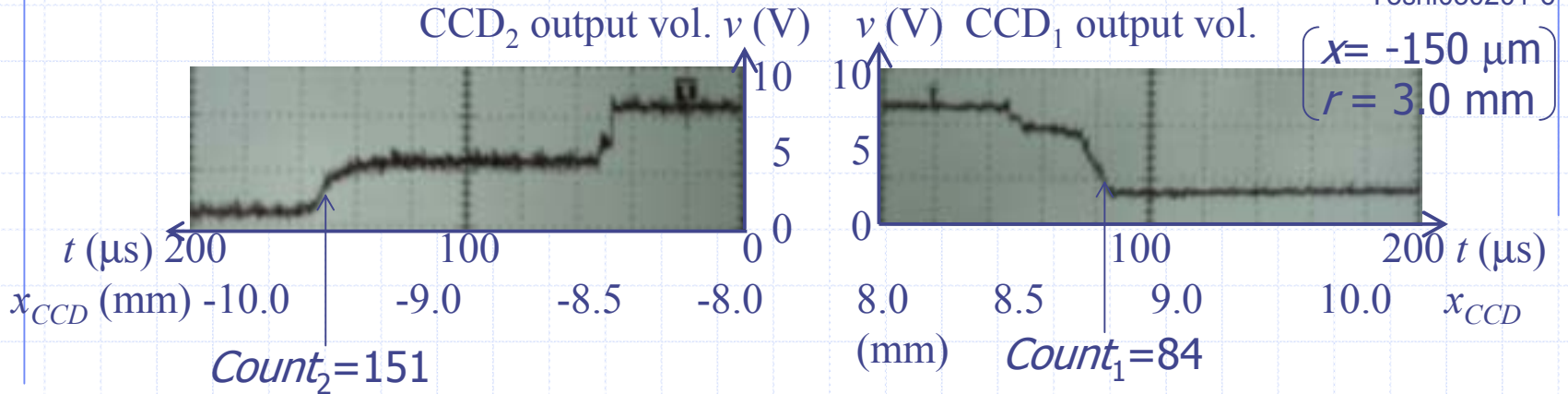
$$x = \frac{w}{M} \frac{(\text{Count}_1 - \text{Count}_2)}{2}$$

**$\text{Count}_1$** : Cell number of CCD<sub>1</sub>  
 **$\text{Count}_2$** : Cell number of CCD<sub>2</sub>  
**CCD**: TCD1023, 1024 cells  
 **$w=14\mu\text{m}$** : Cell width  
 **$M=3$** : Magnification



# Preliminary evaluation of direct imaging

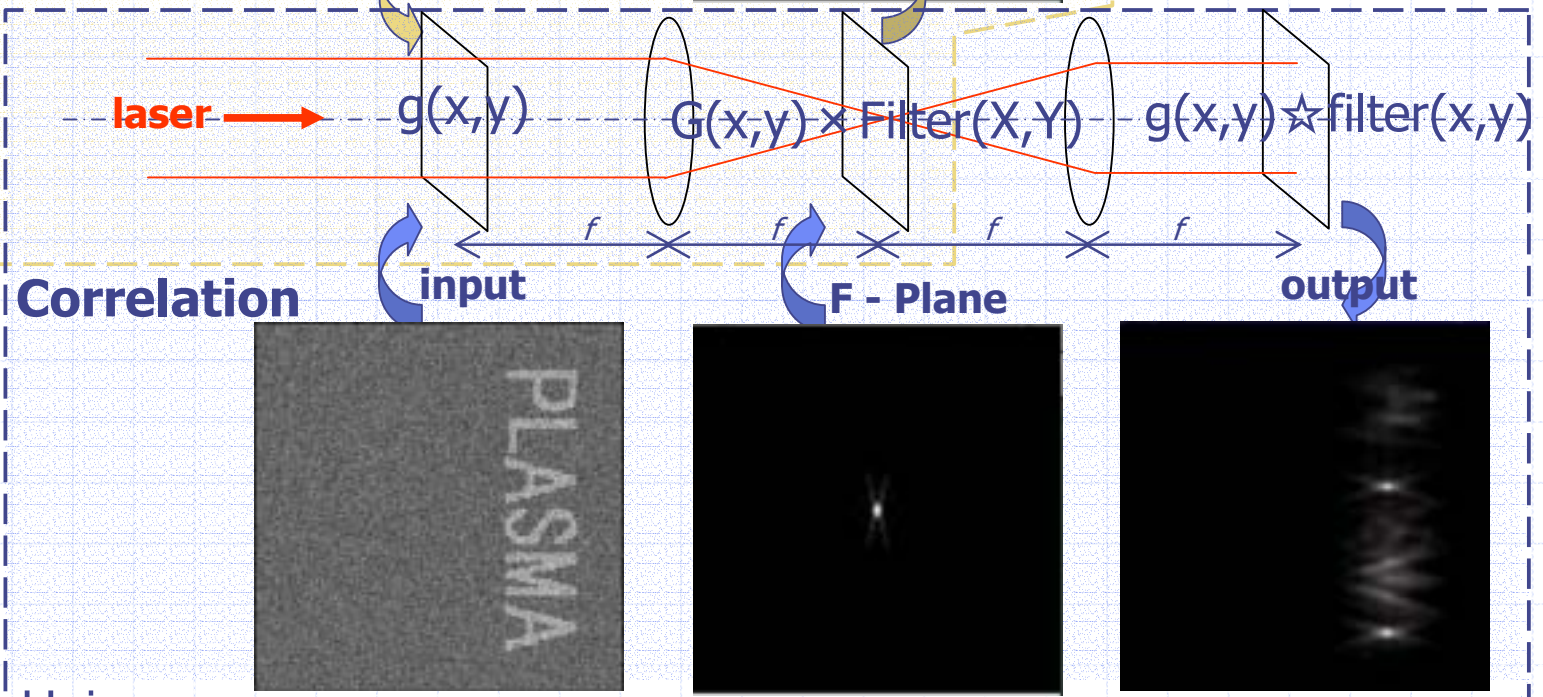
Yoshi030201-6



# Matched Filter is well developed as a pattern reorganization method

Yoshi030201-7

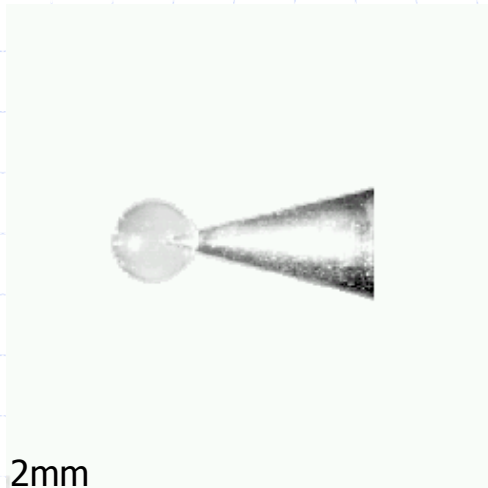
Making a matched filter



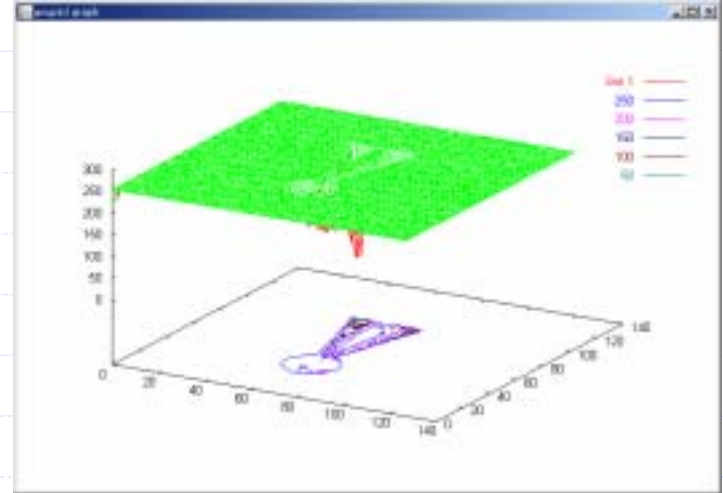
# Original image and matched filter

Yoshi030201-8

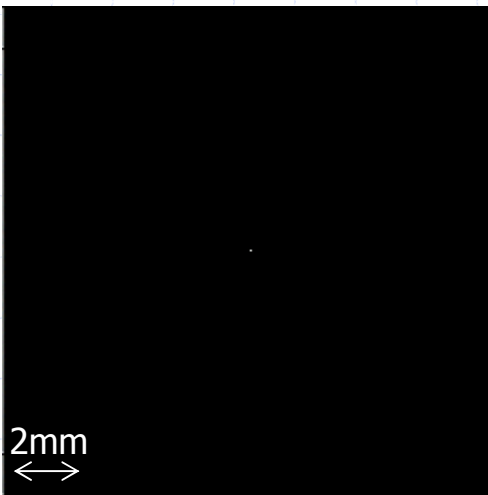
Org.  
image



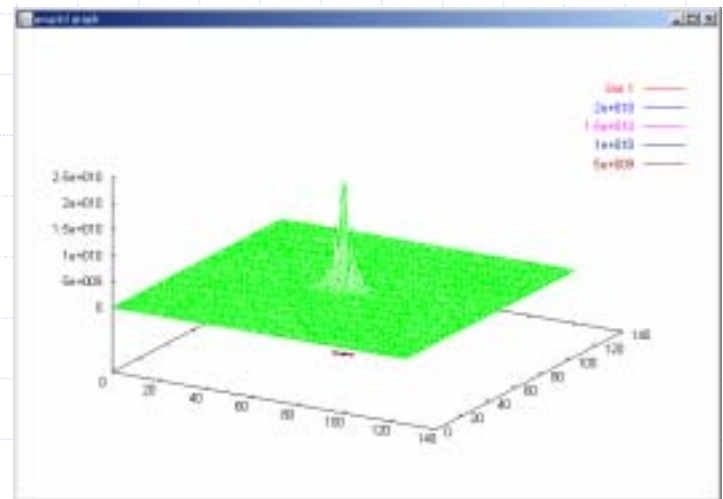
2mm  
↔



Matched  
Filter



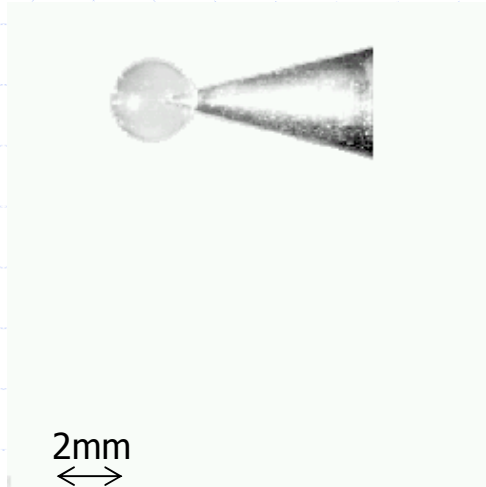
2mm  
↔



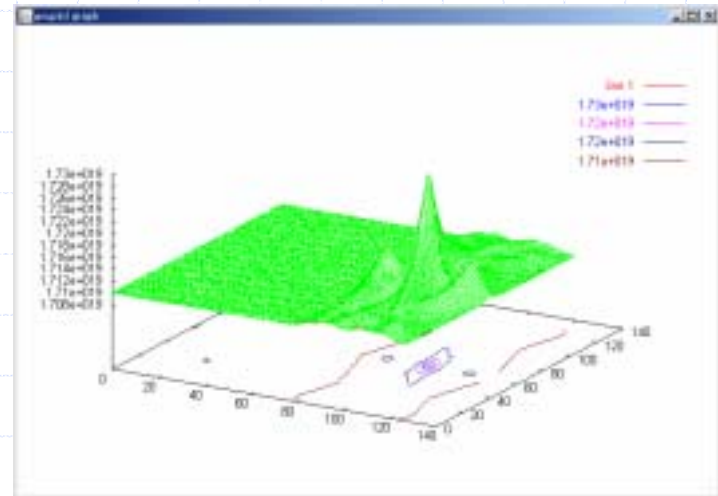
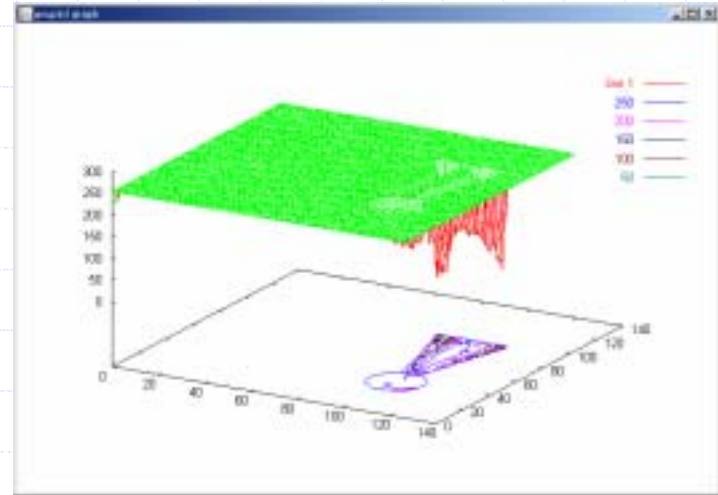
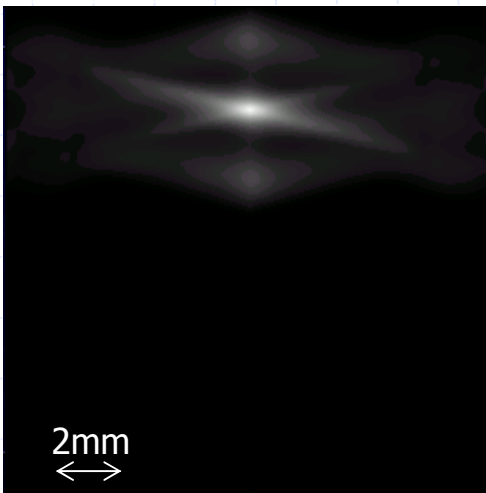
# Input image and correlation output of a cone-target

Yoshi030201-9

Input  
image



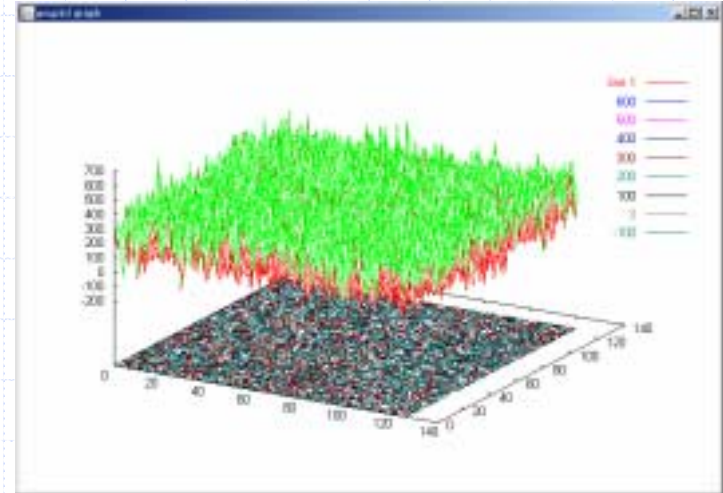
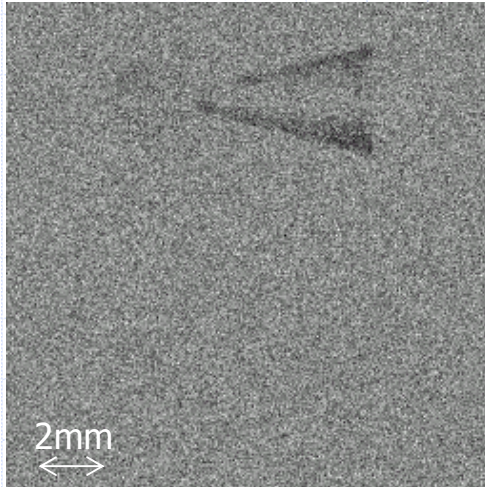
Corr.  
output



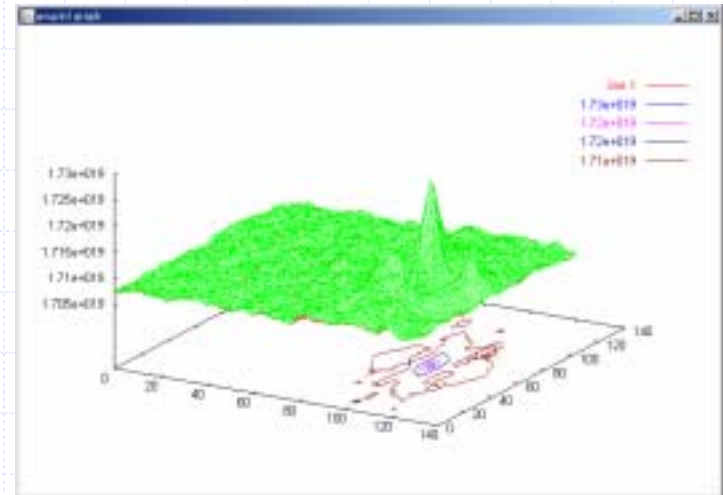
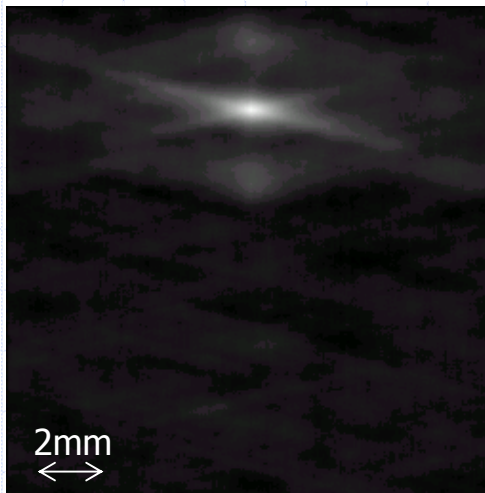
# Correlation output can be obtained from noisy signal

Yoshi030201-10

Input  
image



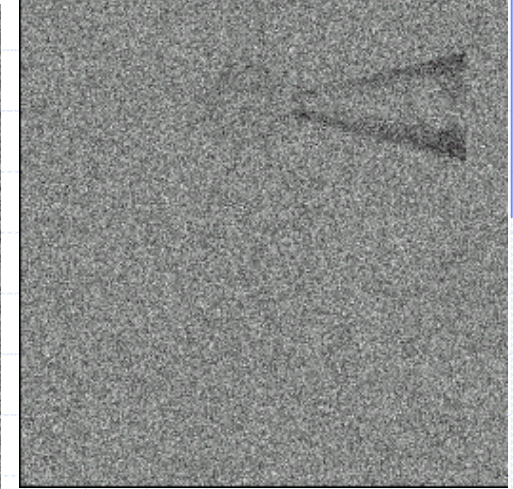
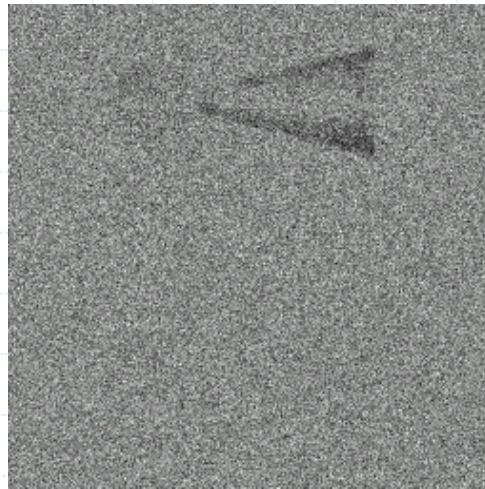
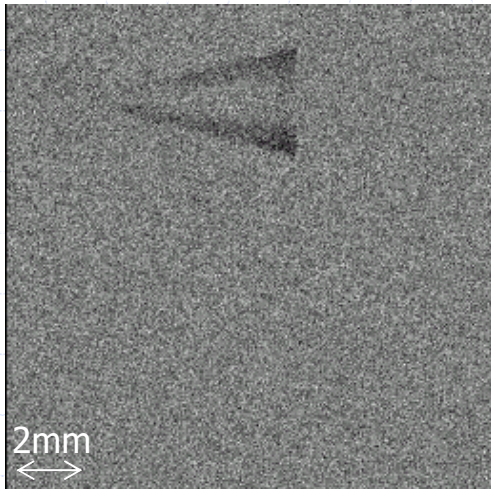
Corr.  
output



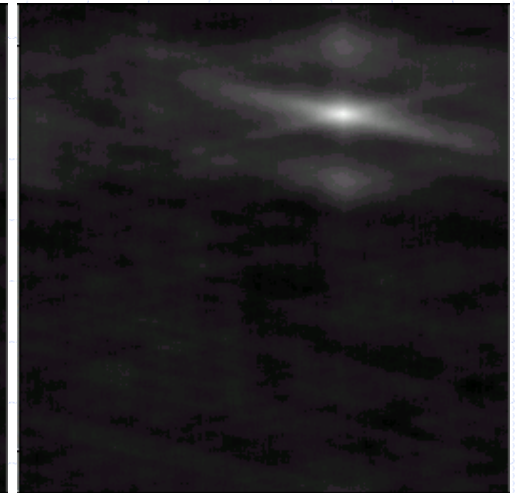
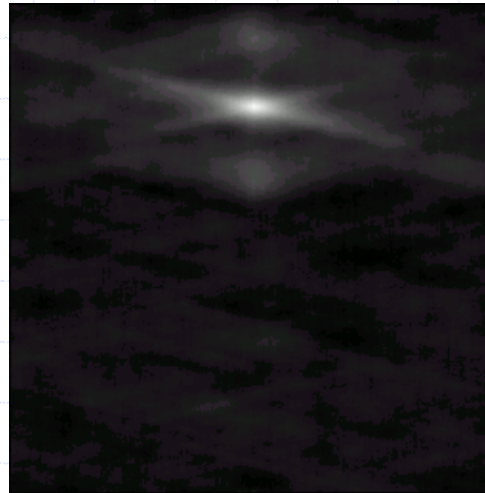
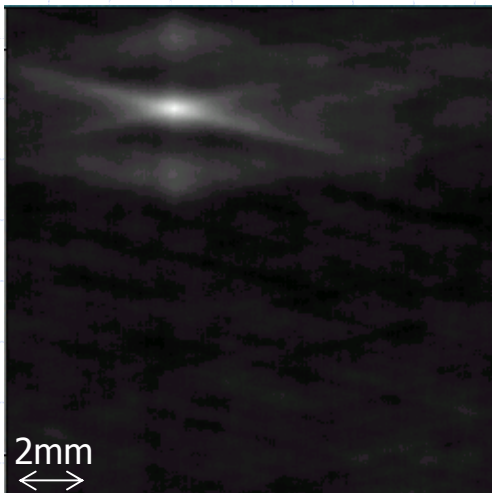
# Position is detected from correlation output

Yoshi030201-11

Input  
image



Corr.  
output



$\Delta z = -2.0$  mm

$\Delta z = 0$  mm

$\Delta z = 2.0$  mm

# Correlation output is weakly sensitive to rotation

Input image



Corr. output

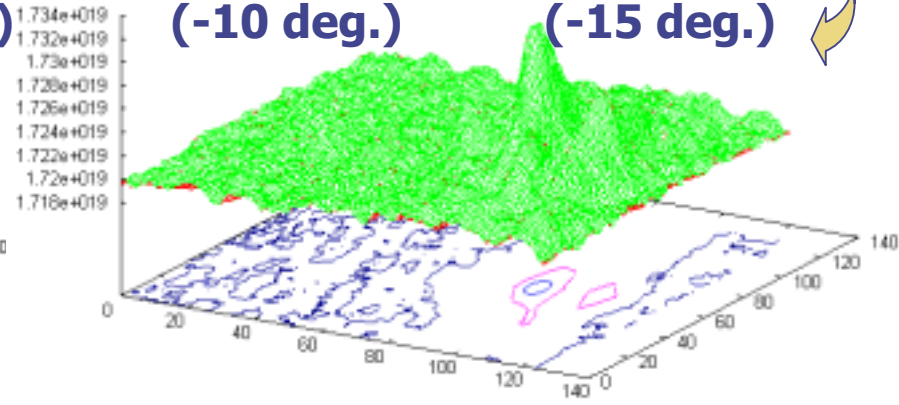
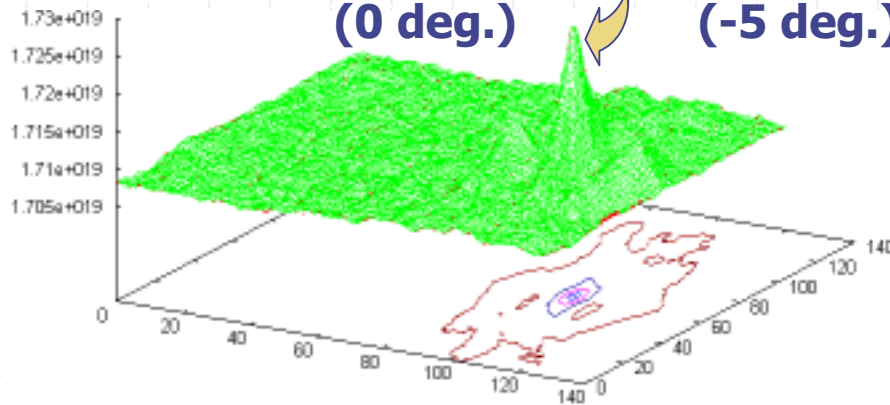


(0 deg.)

(-5 deg.)

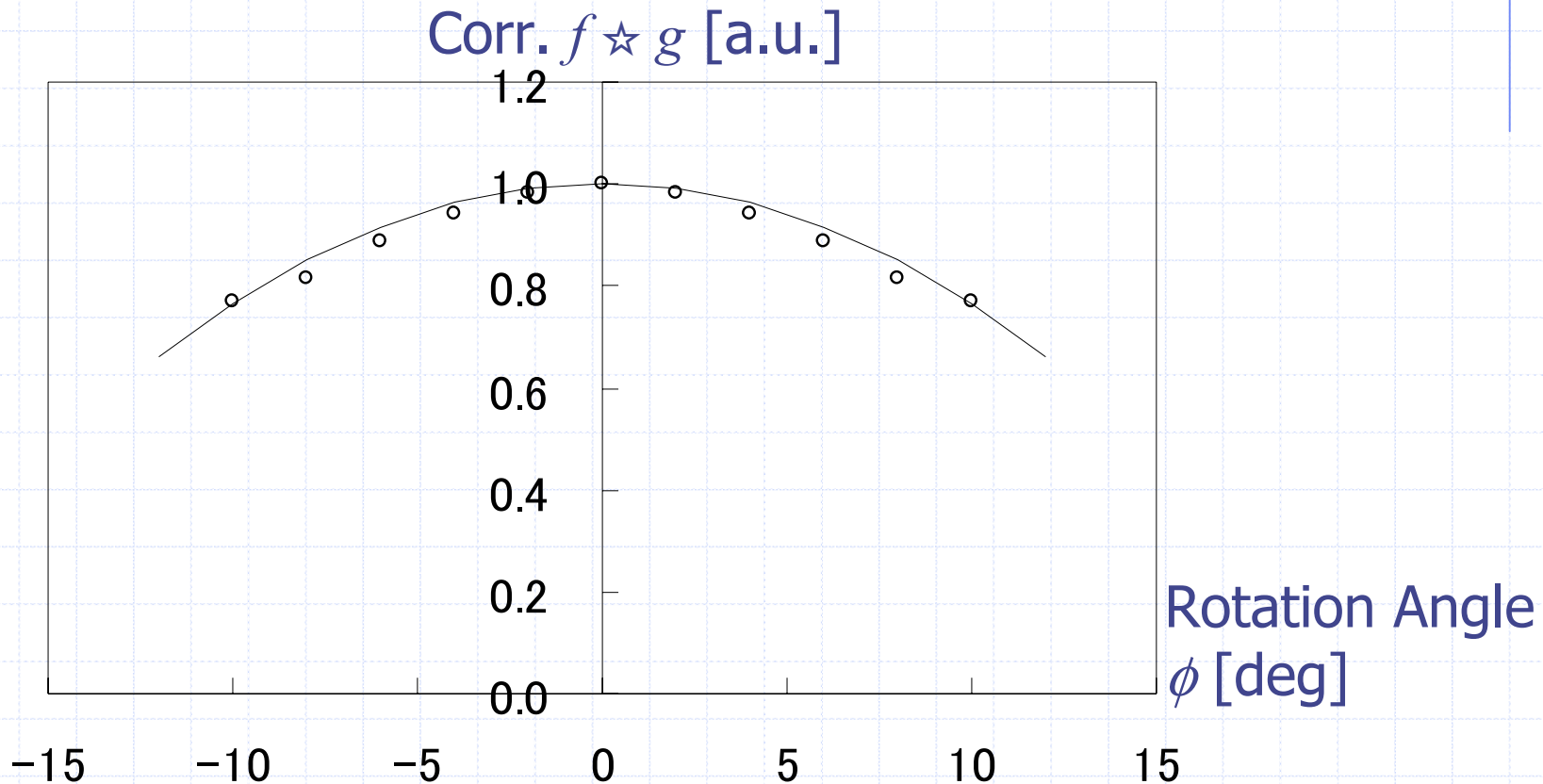
(-10 deg.)

(-15 deg.)



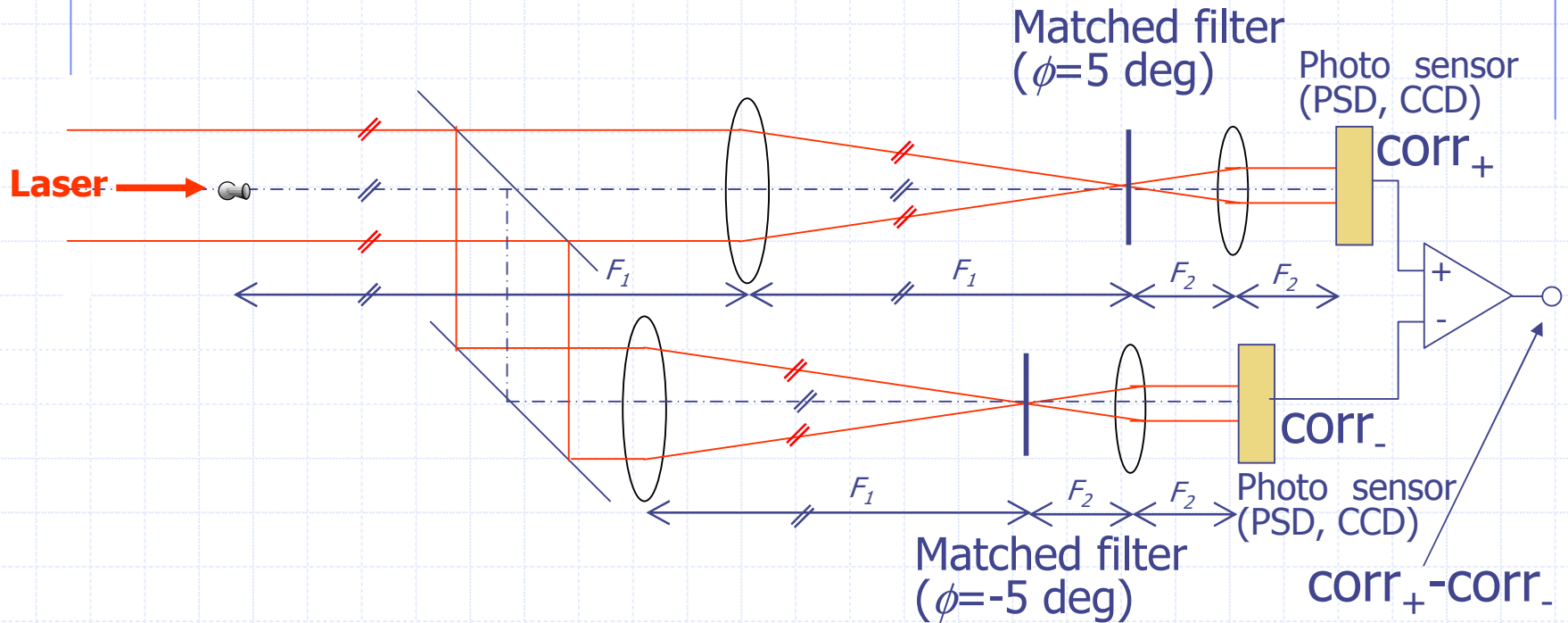
# Correlation output is a function of rotation angle $\phi$

Yoshi030201-13



# Rotation angle detection by two matched filters

Yoshi030201-14



# Rotation angle is obtained from difference of two correlation outputs

Yoshi030201-15

