R&D of light collection system using acrylic lens

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20130621

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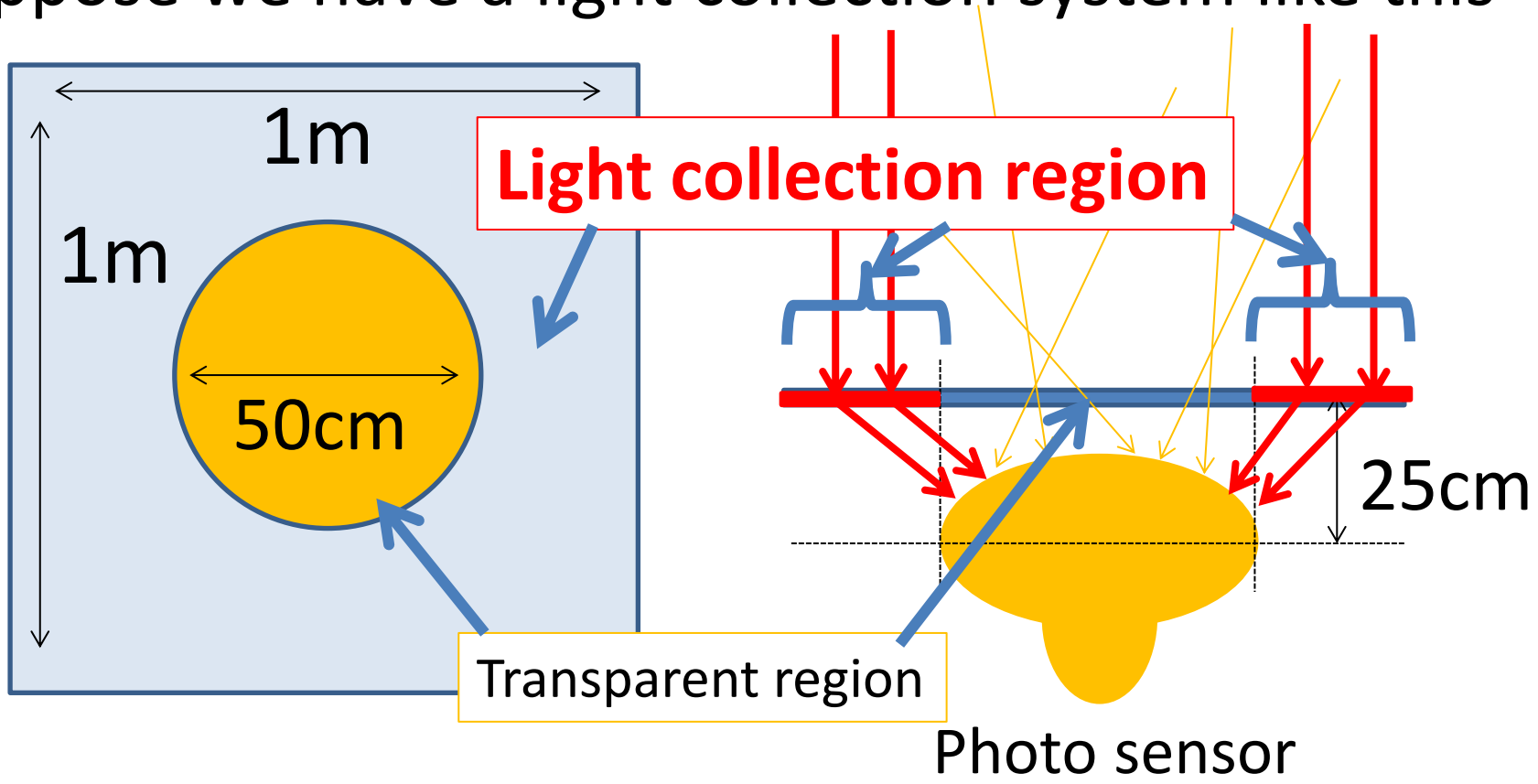
Motivation

- Base line design of HK = 20% photo-coverage(PC)
  - For high energy events : Good enough
    (based on SK-II experience)
    e.g. Beam & atm. neutrino, and proton decay
  - For low energy events : More PC is better
    - ※ Solar nu D/N flux asymmetry
    - ※ Solar nu spectrum measurement
    - ※ Supernova relic neutrino

(Very) Rough estimation of effective photo coverage

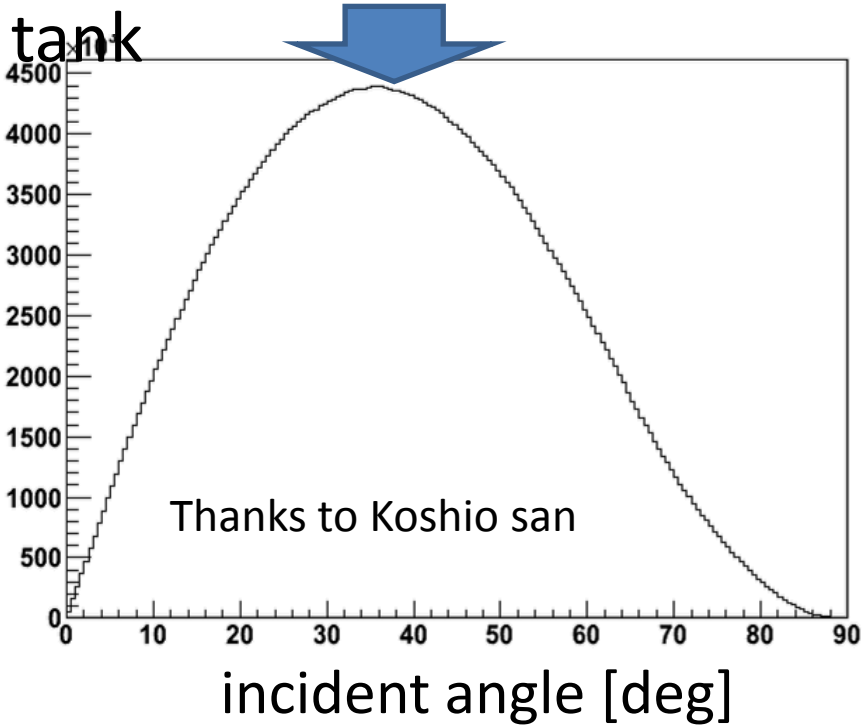
- As a first step, let's have a very rough estimation of effective photo coverage.

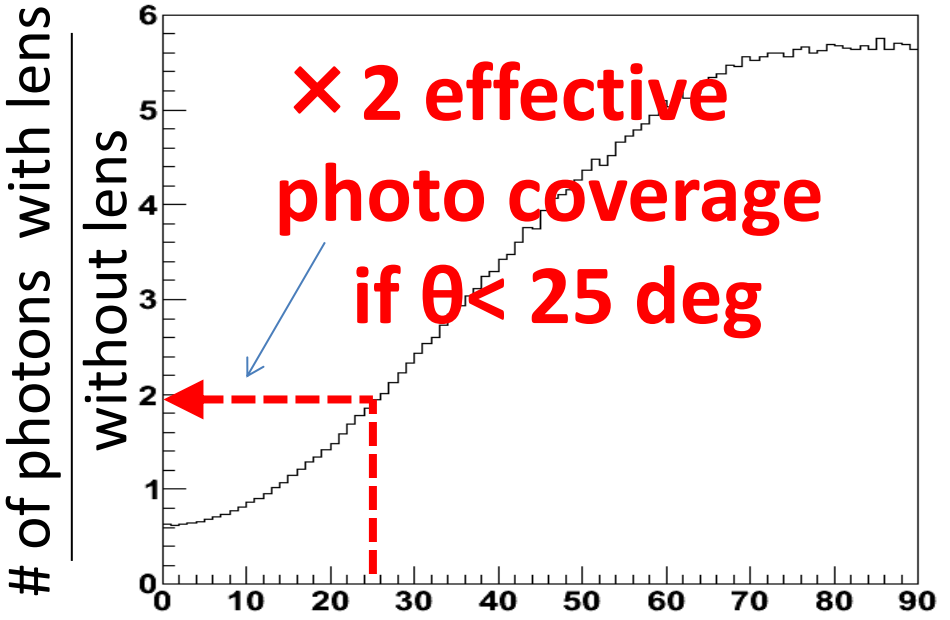
Suppose we have a light collection system like this

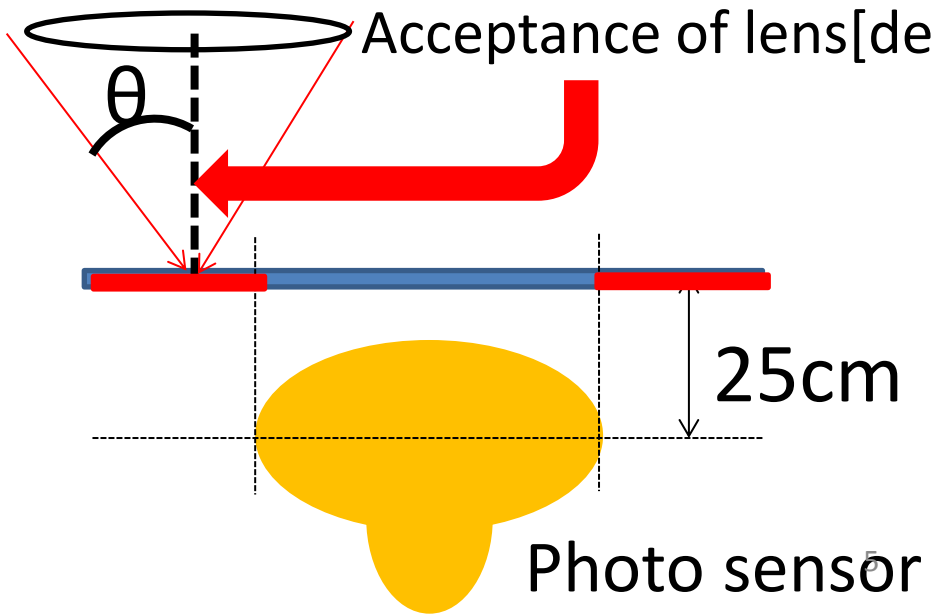


How much gain by the light collection?

Assume incident angle at lens surface of Cherenkov photons from 1GeV electron with random direction in SK tank

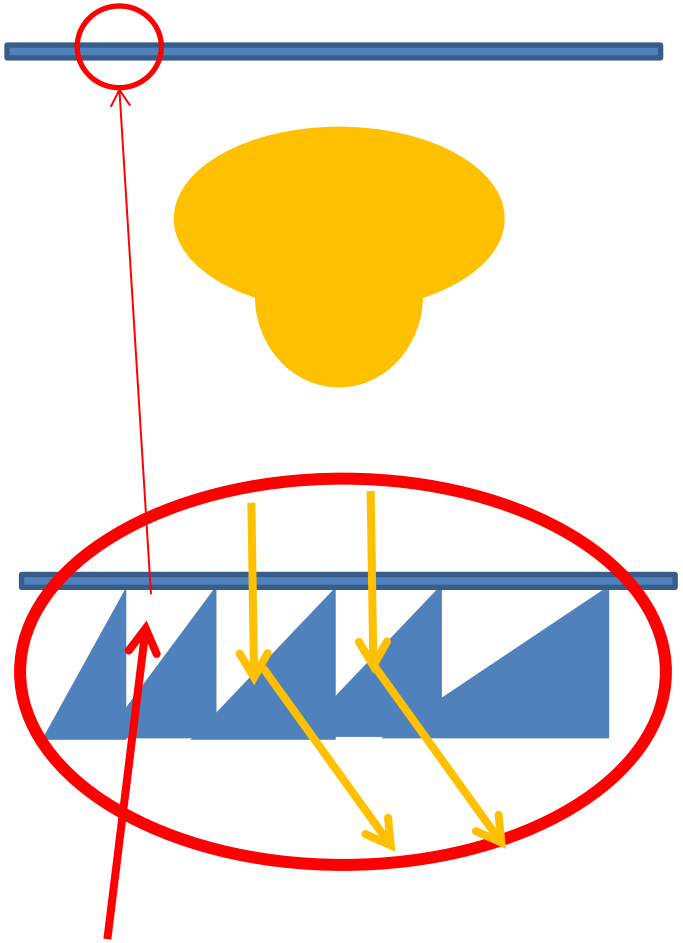




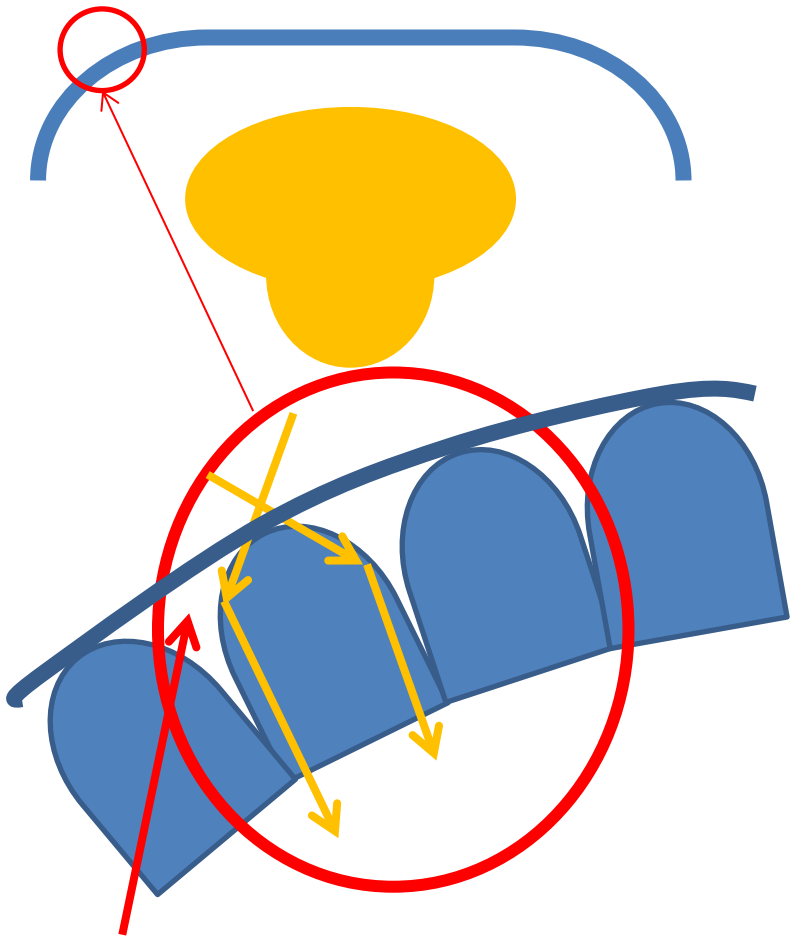


How to achieve?

1. Fresnel lens



2. Array of parabolic lens



Air layer make acrylic lens which can be used in water

How to achieve?

1. Fresnel lens

2. Array of parabolic lens

Both techniques are available!

Air layer make acrylic lens which can be used in water

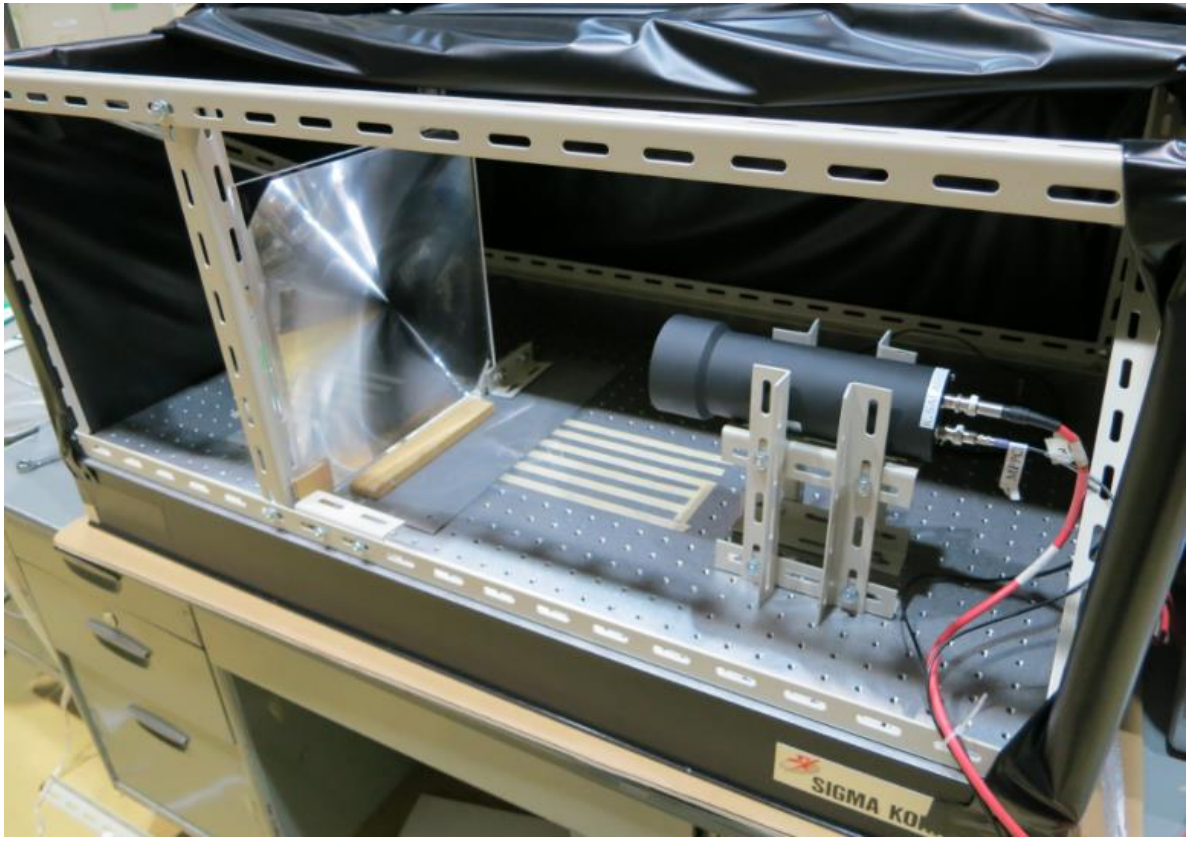
Advantage and disadvantage

- Advantage
  - Relatively small cost (few 10^4¥/each~10% of photo-sensor)
  - Technique is available (short R&D period)
  - Acrylic lens can be part of the acrylic vessel which is shown by M. Vagins
    - For Gd option
    - To protect radioactive impurities go into FV.
  - Or it can be part of photo sensor case
- Disadvantage
  - Less angular acceptance
  - Worse timing resolution (~few ns)
  - Position resolution

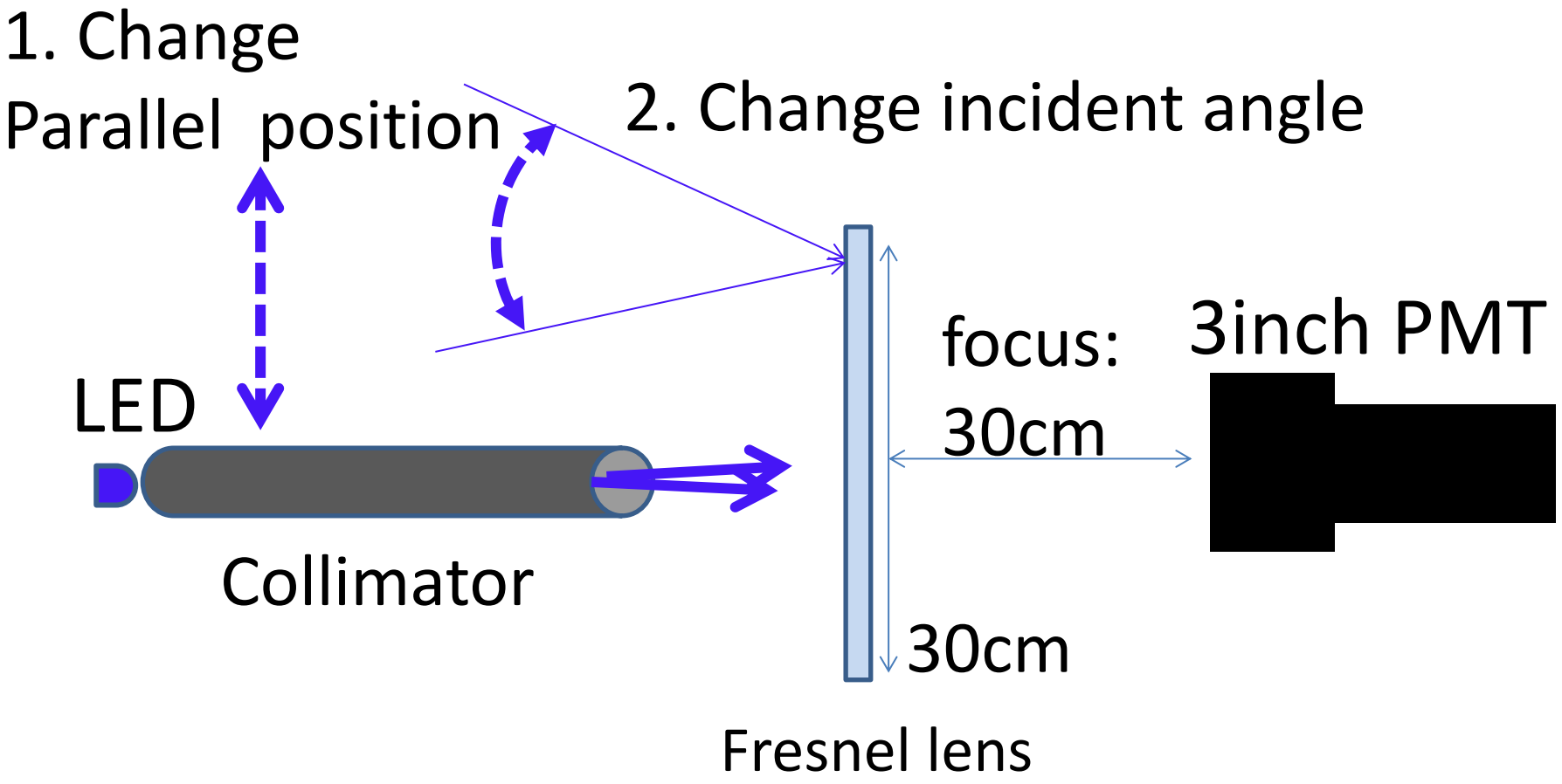
Need optical simulation

Performance check

- For option 1, I bought sample lens to test its performance.



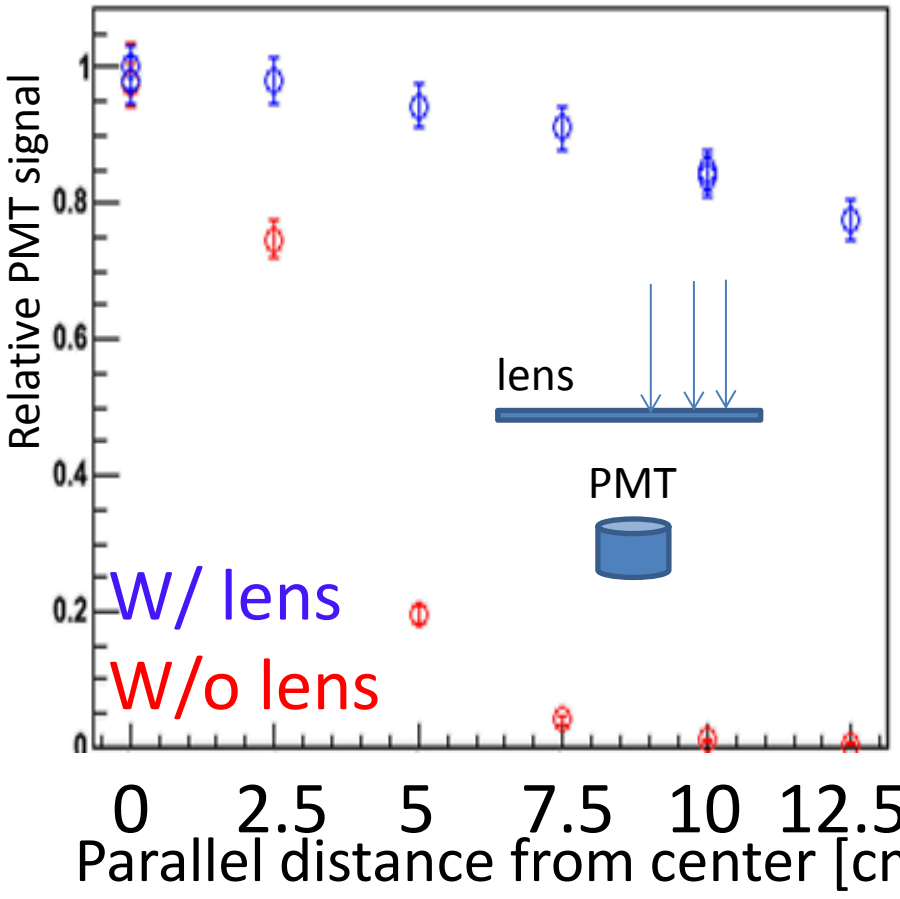
Setup for performance test



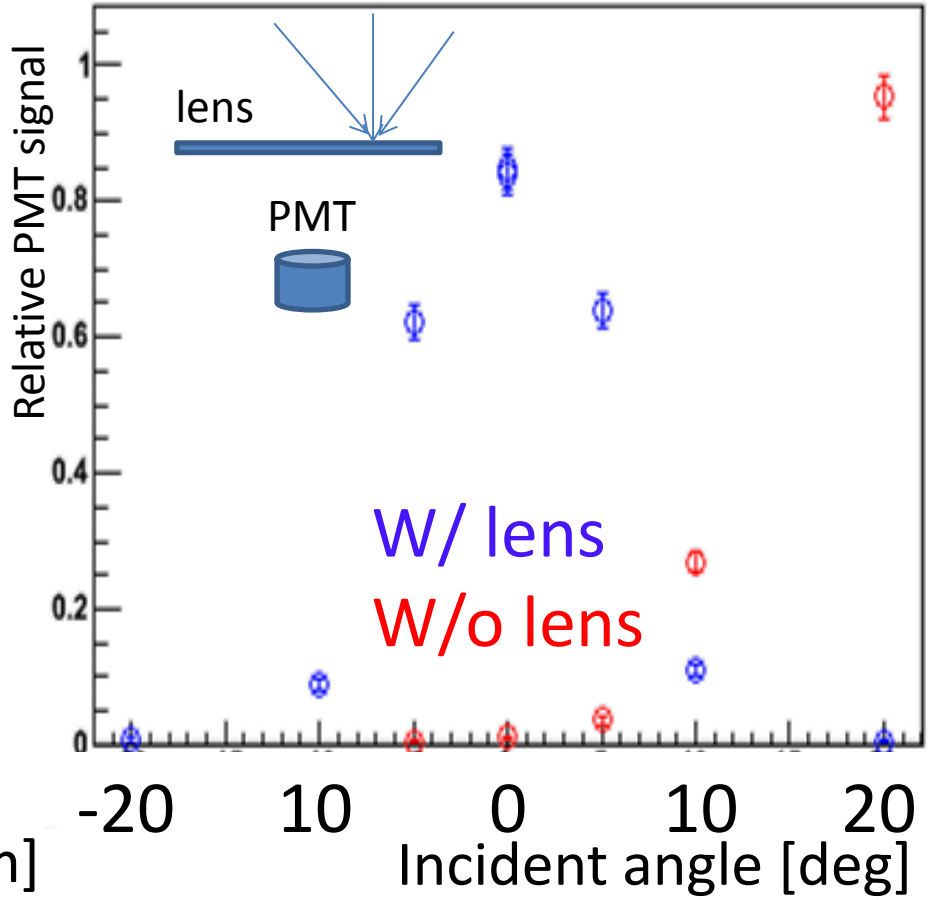
※Optical simulation is now under preparation

Results

1. Position dependence



2. Angular dependence



Fresnel lens has small angular acceptance (this is for parallel light) it seems that we cannot just use commercially available one.

Similar test will be done for lens in water

Summary and Next step

- I started the R&D for light collection system using acrylic lens
- Now I have 2 options:
  - 1. Fresnel lens
  - 2. Array of parabolic lens
- I checked the performance of a Fresnel lens
  - Confirmed good focusing
  - Angular acceptance seems too small.

Next step

- Make optical simulation
- Start R&D for option 2