GlueX DIRC Calibration (I)

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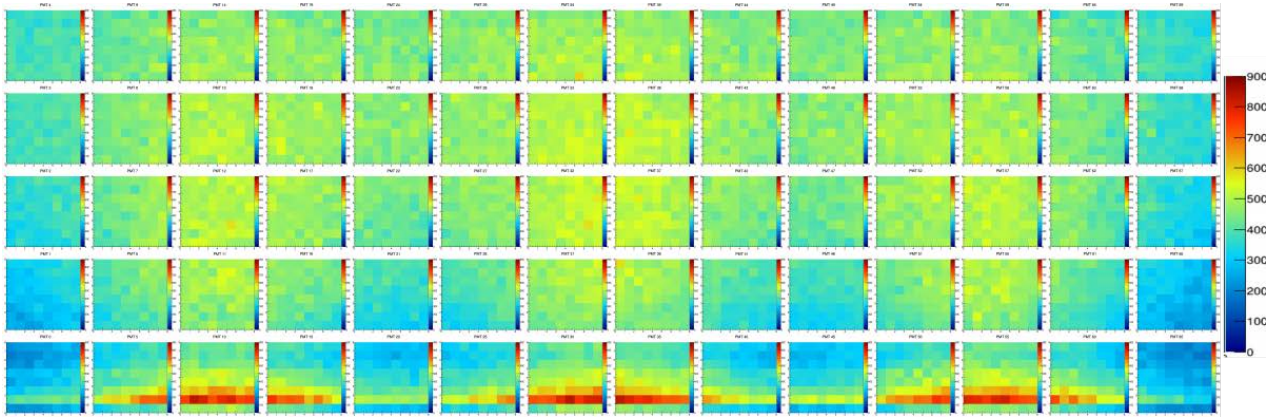
Introduction

Previous study:

- Maria had carried out a study using laser-based calibration system, which was proposed by Giessen university.



Occupancy distribution on GlueX DIRC PMT

- Laser positions are 10 mm away from the 3-segmented mirror and at distances of 212 mm from the corresponding box side.
- Photon energy is 3.0613 eV (corresponds to 405 nm).
- 1M single photon events were used for each fiber.
- Photon angular distribution is gaussian with sigma of 15 degrees.
- The polar angle of laser is 84 degrees with respect to the DIRC bars .

https://gluexdirc.mit.edu/superposition-3-fibers-sig-15-inc-6

Introduction

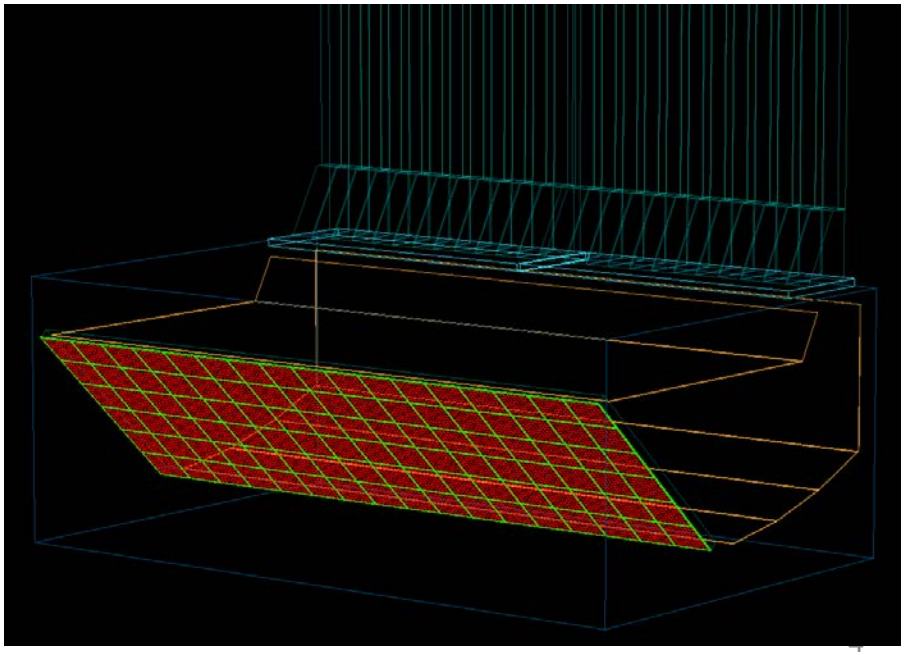
Current study:

- Considering the advantage of the low cost of LED-based calibration system, a simulation study will be performed to compare between a laser-based calibration system and a LED-based calibration system in terms of time resolution.

- The study will provide an answer to the question, can the LED-based calibration system meet the required time resolution of GlueX DIRC?

Study Approach

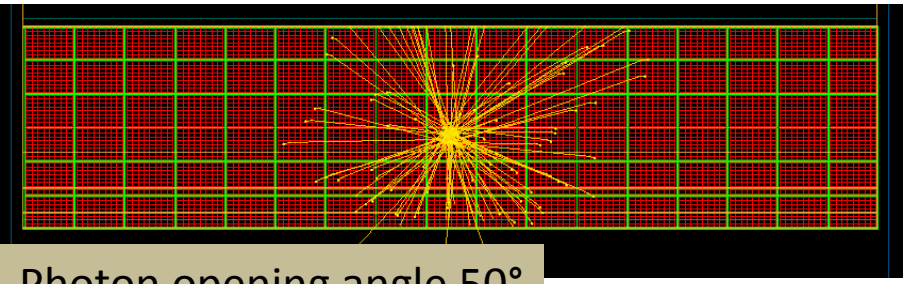
- Working environment GEANT4 standalSingle simulation using updated GlueX DIRC Geometry.
- Several critical parameter can be changed:
  - Type of the diffuser: square or circle
  - Opening angle of the diffuser
  - Time resolution of the calibration system
  - Time delays between fibers



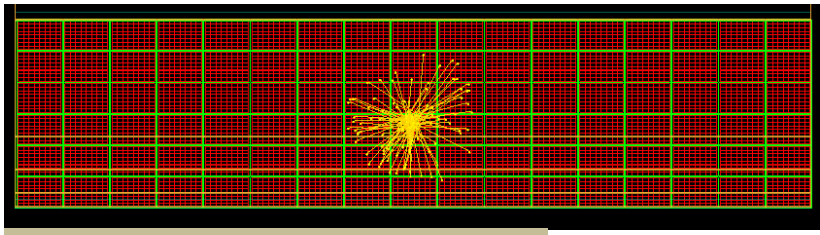
Study Approach

- Other simulation parameters:
  - Photon energy is 3.0613 eV (corresponds to 405 nm).
  - 1M single photon events were used for each diffuser.
  - The diffusers are oriented at 90° with respect to the DIRC bars.
- The output from the simulation:
  - Hit patterns, occupancy.
  - Timing distribution at each pixel
  - T0 and the associated error at each pixel
- Goals:
  - Estimating the required time resolution
  - Estimating required events statistics to perform the calibration

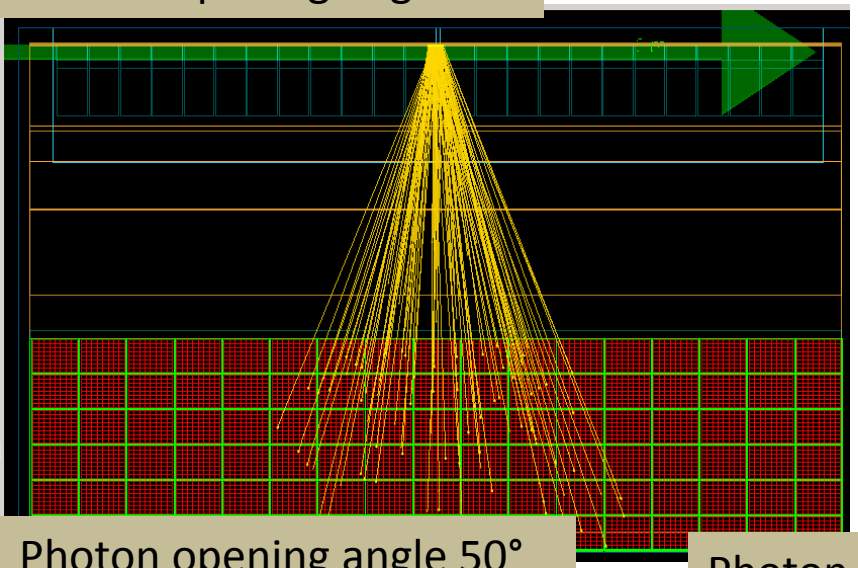
Opening Angle Visualization



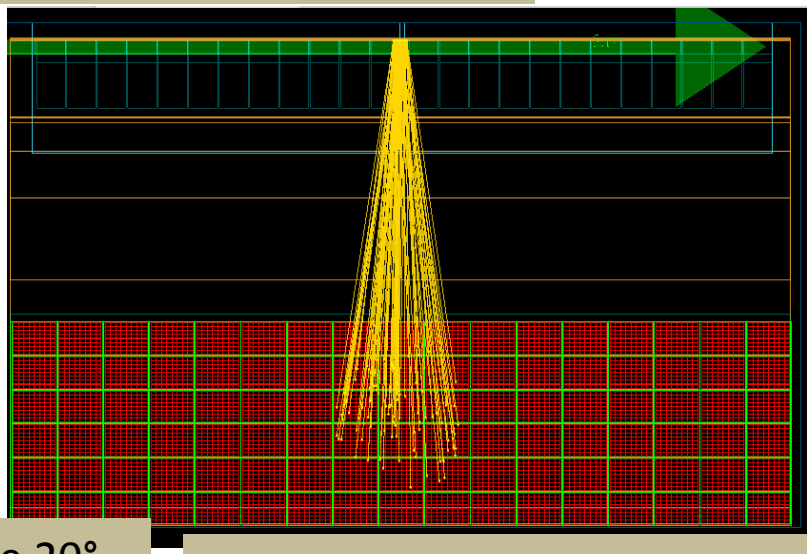
Photon opening angle 50°



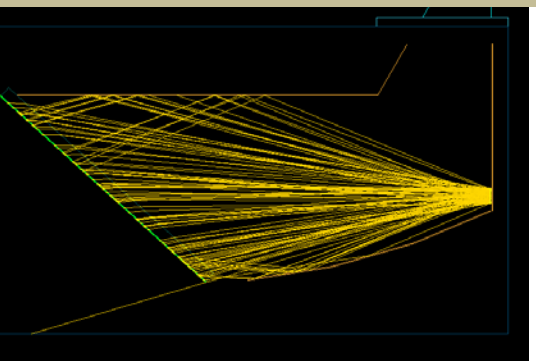
Photon opening angle 20°

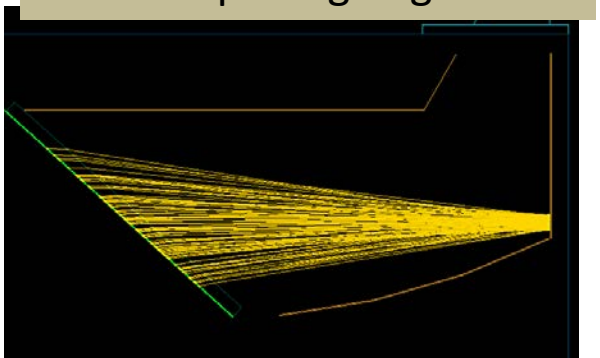


Photon opening angle 50°

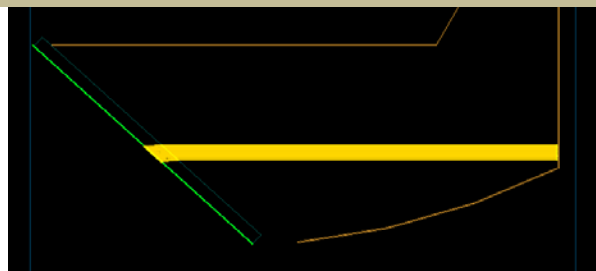


Photon opening angle 20°

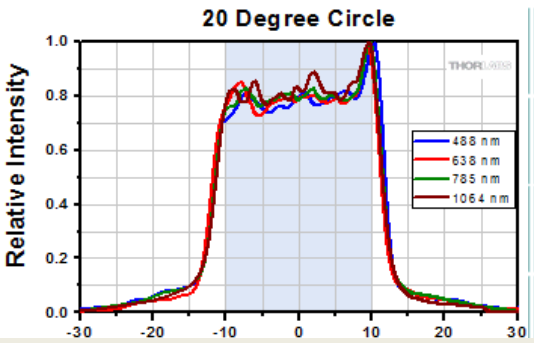




Side view:
Photon opening angle 0



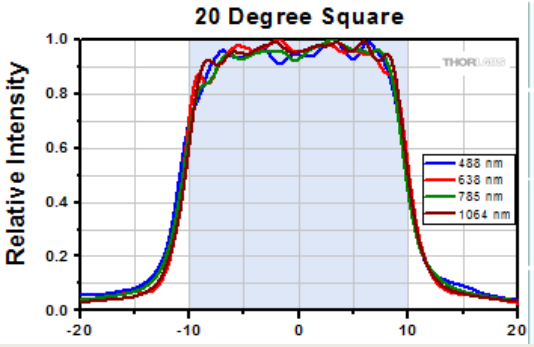
Photon Beam Cross Section



opening angle company data sheet

Circle Source shape company data sheet

Square diffuser provides a square spot light (Thanks Markus)

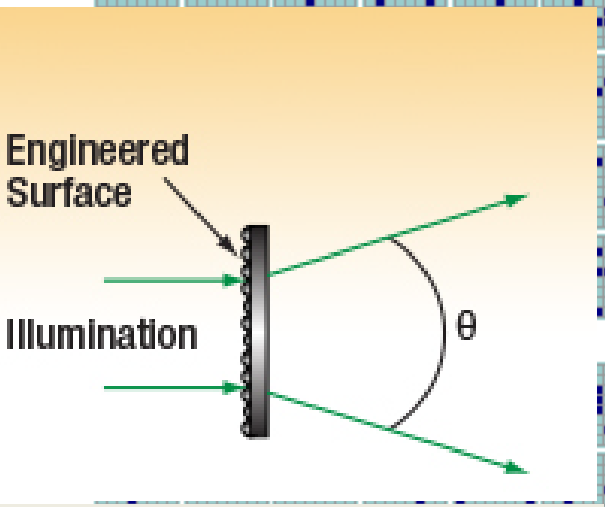


opening angle company data sheet

Square Source shape company data sheet

Occupancy distribution on a fake perpendicular PMT plane

Single Port Hit Patterns with 20° Opening Angle



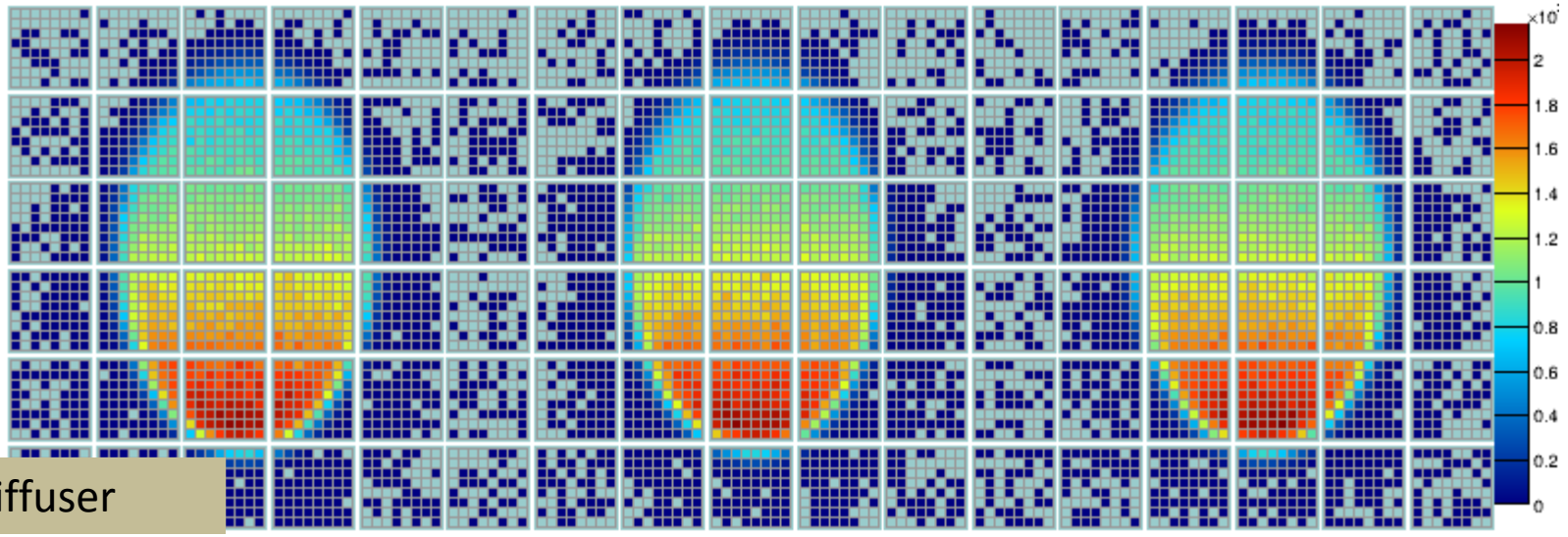
(opening angle 20°)

Circle diffuser

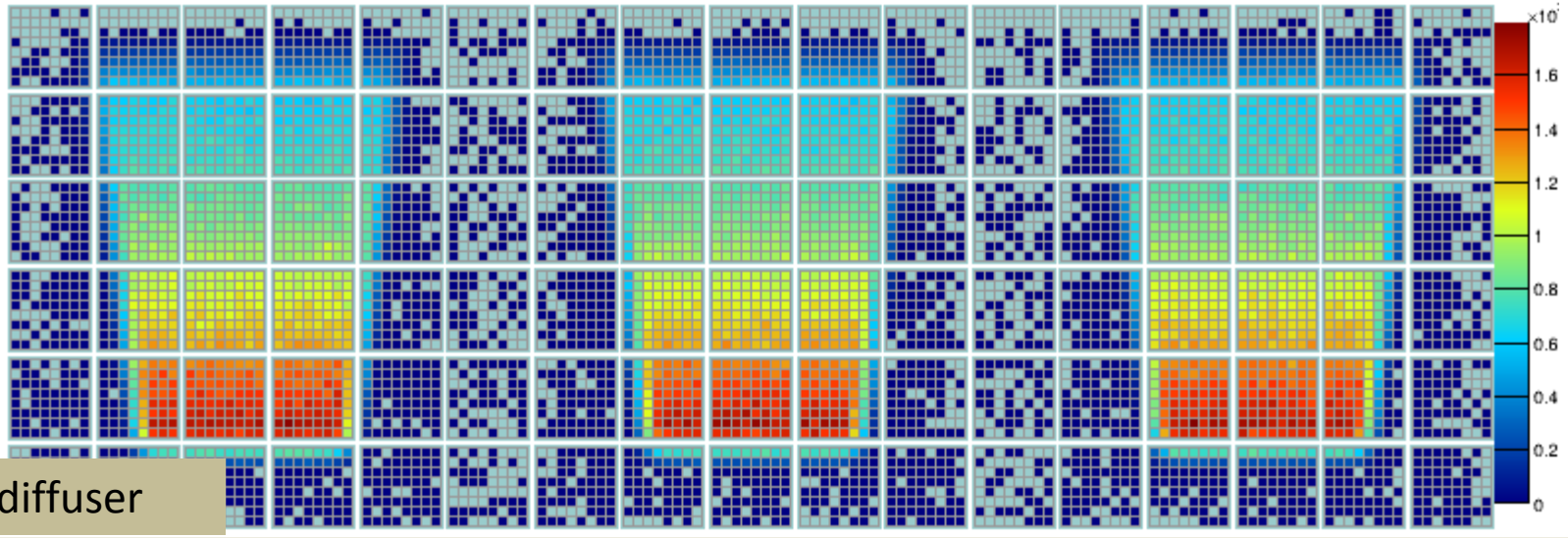
Square diffuser

Occupancy distribution on GlueX DIRC PMT plane (opening angle 20°)

Three Port Hit Patterns with 20° Opening Angle



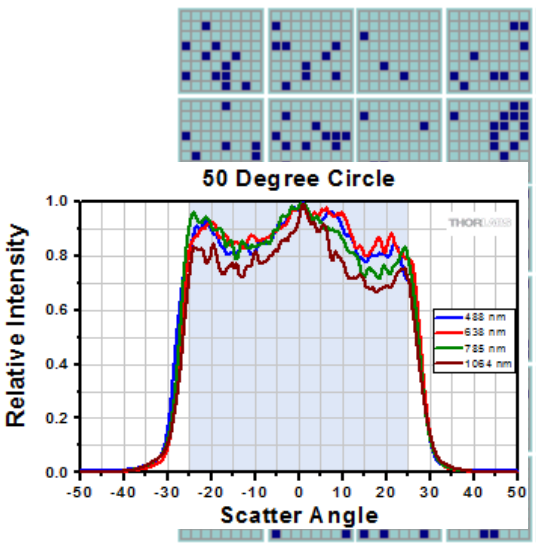
Circle diffuser



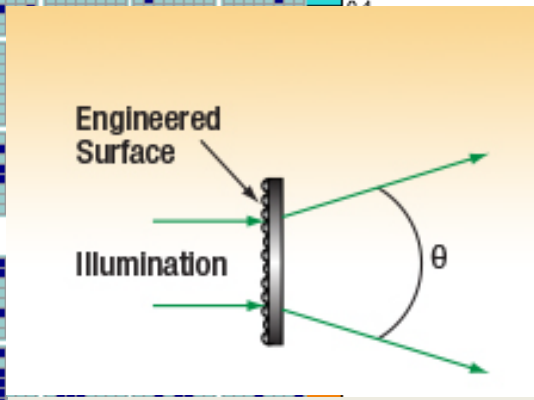
Square diffuser

Occupancy distribution on GlueX DIRC PMT plane (opening angle 20°)

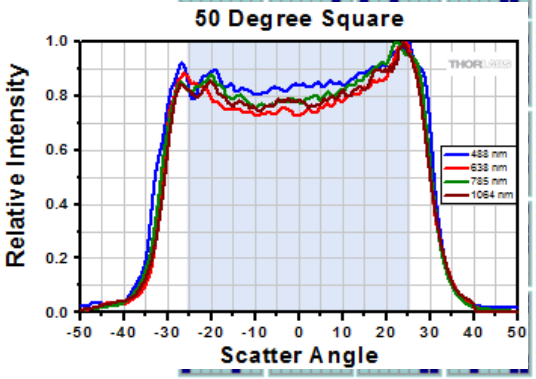
Single Port Hit Patterns with 50° Opening Angle



Circle diffuser



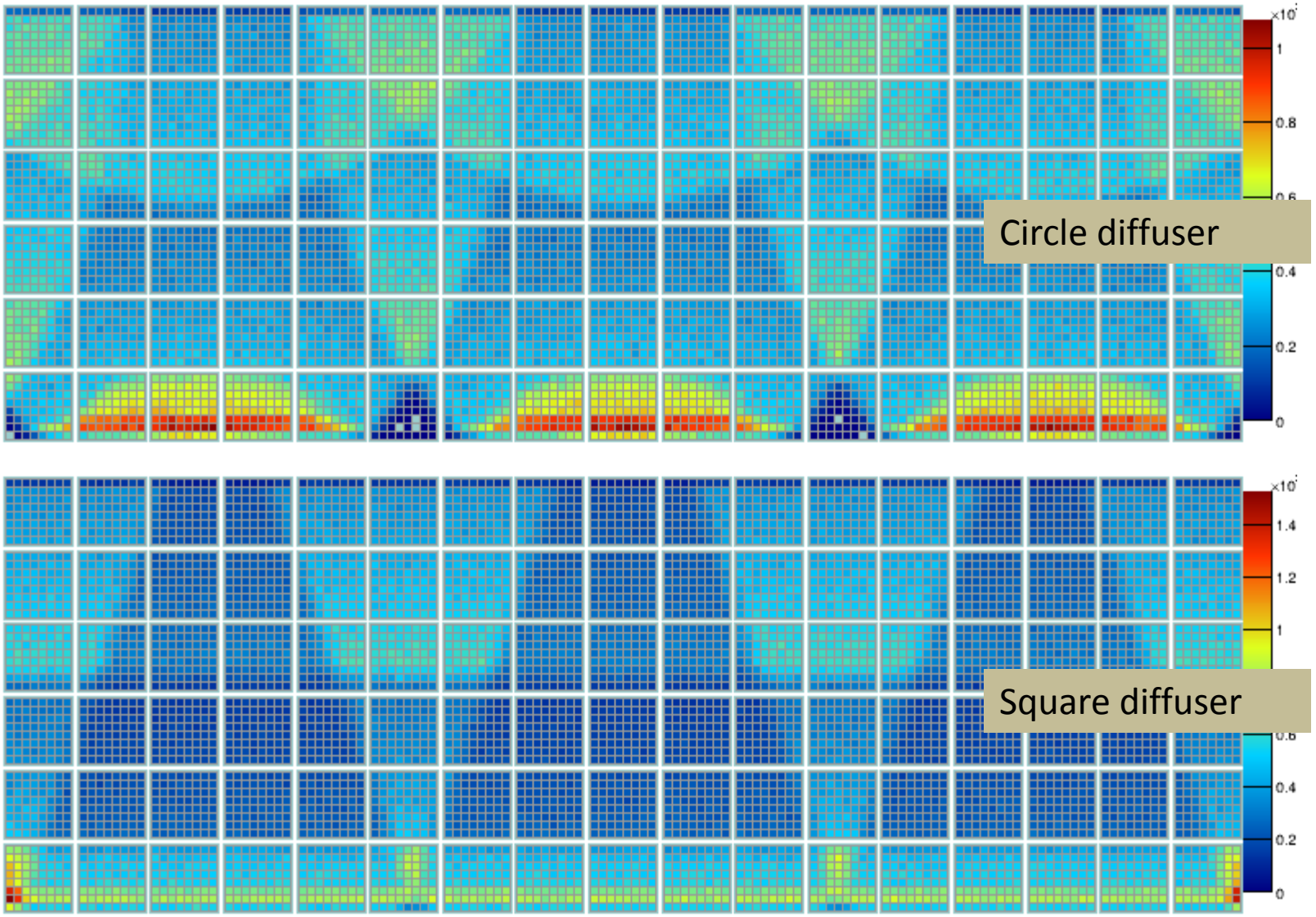
(opiningangle 50°)



Square diffuser

Occupancy distribution on GlueX DIRC PMT plane (opening angle 50°)

Three Port Hit Patterns with 50° Opening Angle

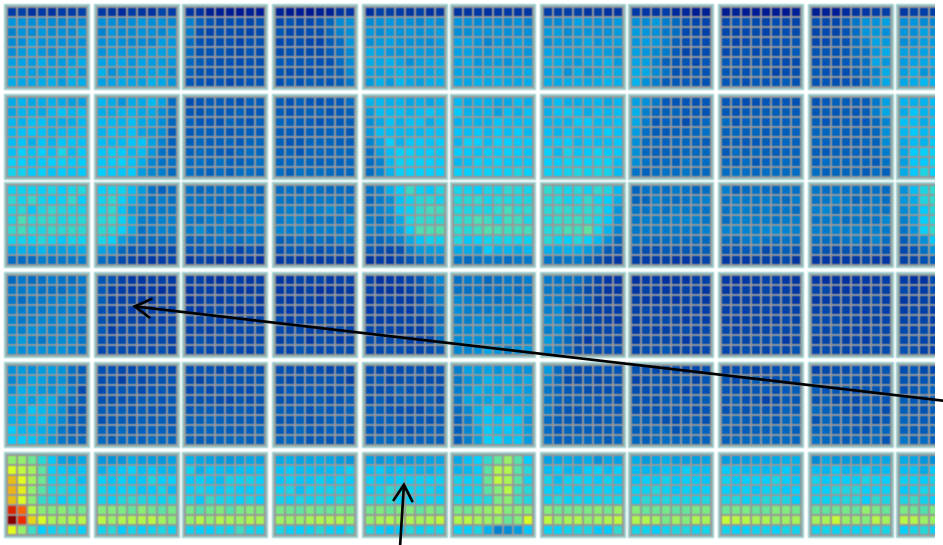


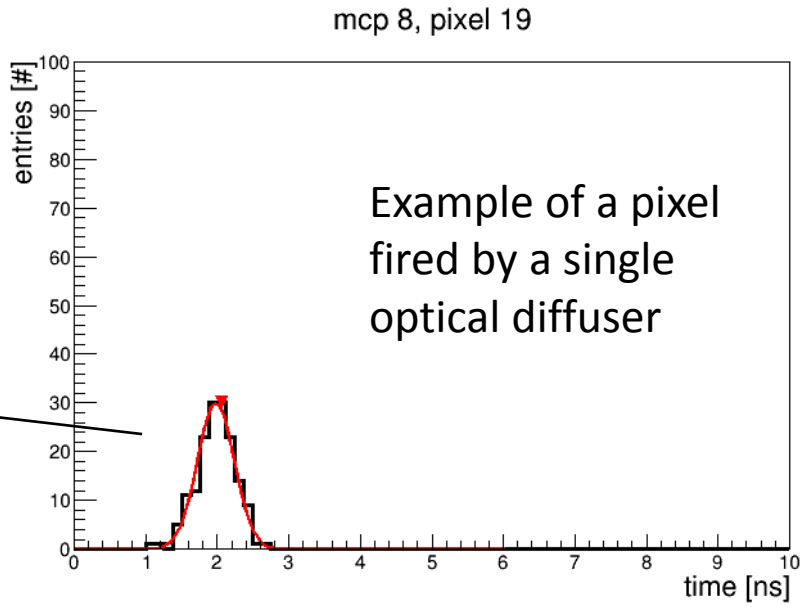
Occupancy distribution on GlueX DIRC PMT plane (opening angle 50°)

Conclusion/ Outlook

- Simulation code works
- Design a method to determine the T0 at each pixel
- Study performance for different time resolutions (Laser/LED) and diffuser properties

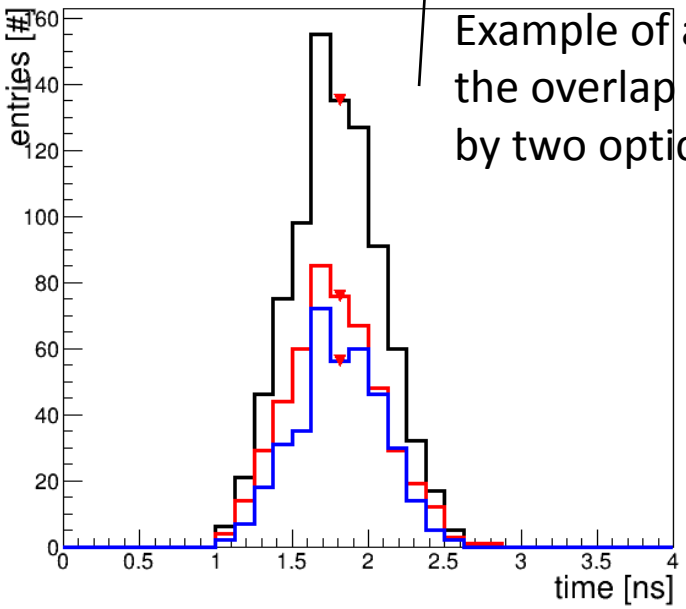
Timing Distribution at Each Pixel



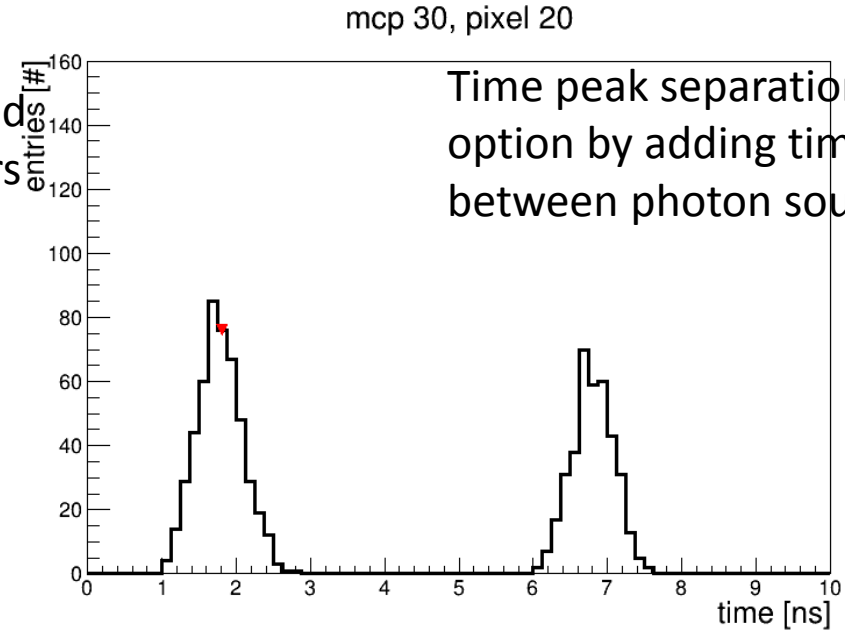


Example of a pixel fired by a single optical diffuser

mcp 30, pixel 20



Example of a pixel on the overlap region fired by two optical diffusers



Time peak separation option by adding time offset between photon sources

Thanks for your attention