



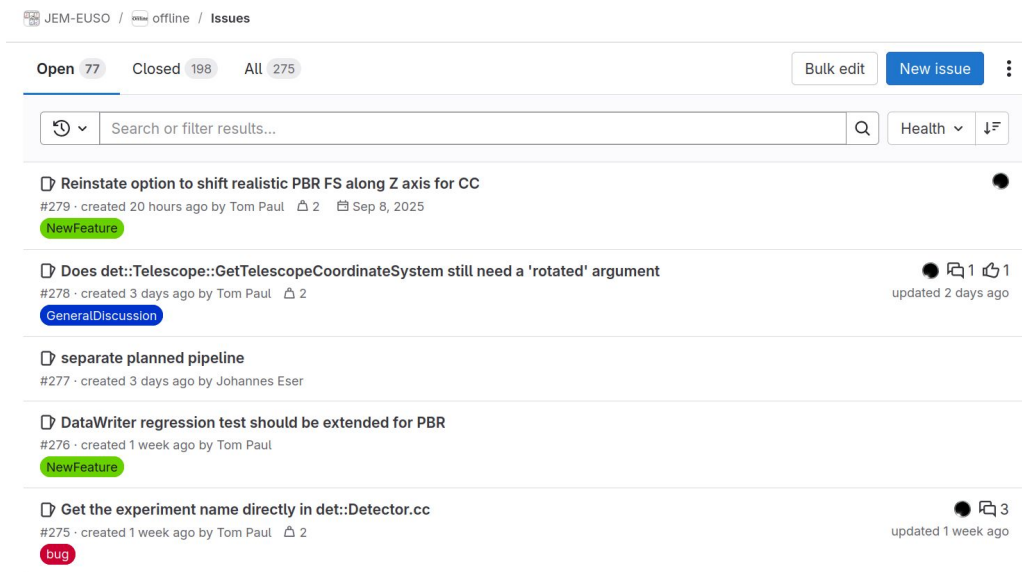
# PBR simulation update

Tom Paul

On behalf of Offline simulation contributors  
37'th JEM-EUSO Collaboration Meeting  
31 May - 6 June 2025, Paris

# Take home

- I'll summarize progress since last meeting (Chicago)
  - Several ongoing projects, not all completed yet
- Pending simulation items
- Solicit your ideas/requests for projects to add to our list  
[add your ideas here at any time](#)

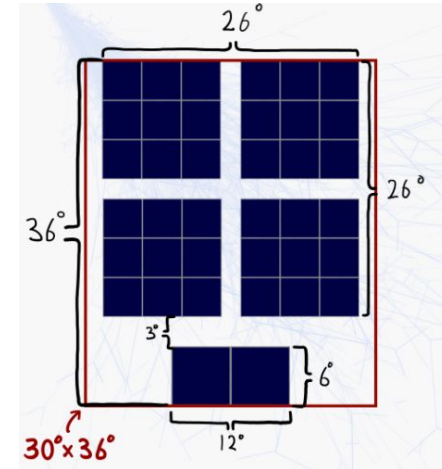
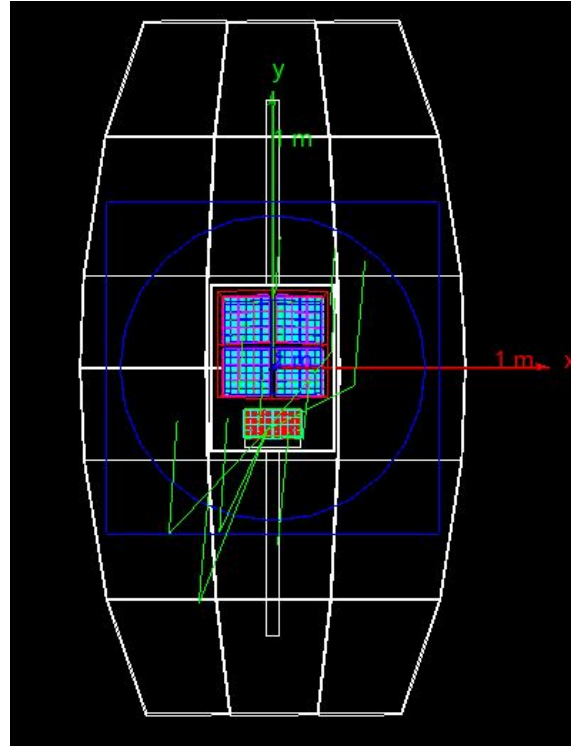
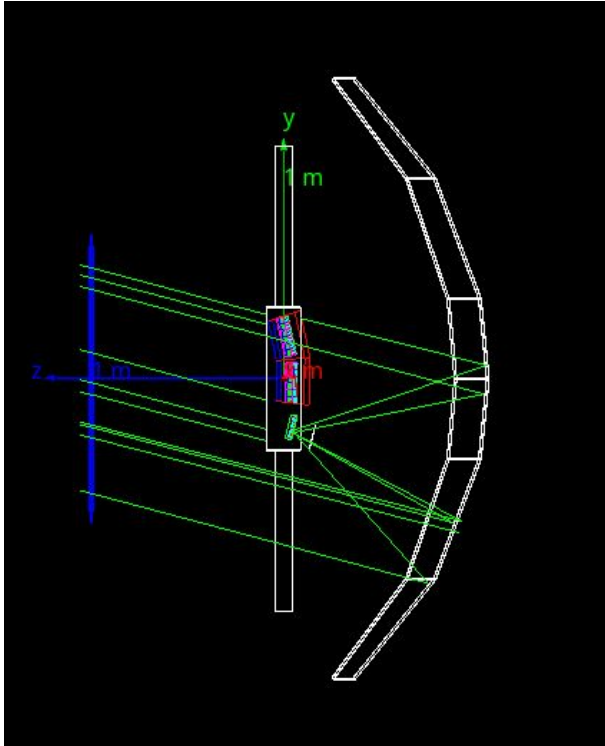


The screenshot displays the GitHub Issues interface for the JEM-EUSO repository. The header shows the repository name 'JEM-EUSO', its status 'offline', and the section 'Issues'. Below this, filters for 'Open' (77), 'Closed' (198), and 'All' (275) are visible, along with 'Bulk edit' and 'New issue' buttons. A search bar with the placeholder 'Search or filter results...' and a 'Health' dropdown are present. The issue list contains four items:

- Reinstate option to shift realistic PBR FS along Z axis for CC** (Issue #279, created 20 hours ago by Tom Paul, 2 upvotes, Sep 8, 2025). Label: **NewFeature**.
- Does det::Telescope::GetTelescopeCoordinateSystem still need a 'rotated' argument** (Issue #278, created 3 days ago by Tom Paul, 2 upvotes, updated 2 days ago). Label: **GeneralDiscussion**.
- separate planned pipeline** (Issue #277, created 3 days ago by Johannes Eser).
- DataWriter regression test should be extended for PBR** (Issue #276, created 1 week ago by Tom Paul). Label: **NewFeature**.
- Get the experiment name directly in det::Detector.cc** (Issue #275, created 1 week ago by Tom Paul, 2 upvotes, updated 1 week ago). Label: **bug**.

## Brief reminder

1.1m aperture, ACP, flatteners, BG3, FC, CC (almost), mirror, bifocalizer pending

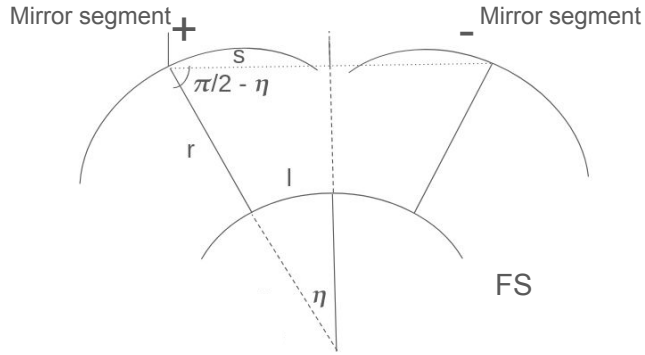


# Some items developed since Chicago meeting

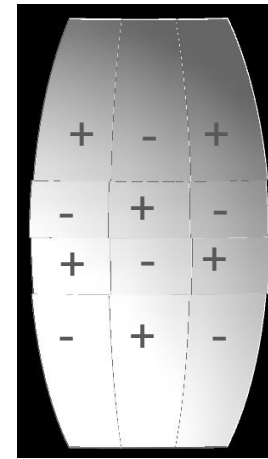
## Bifocalization

- OA status
- Possible backup? Bifocalize with mirrors
  - Mirror bifocalizer is **NOT** our 1'st choice  
(ie at conferences, don't say this is how we will do it, please)

# Mirror bifocalizer



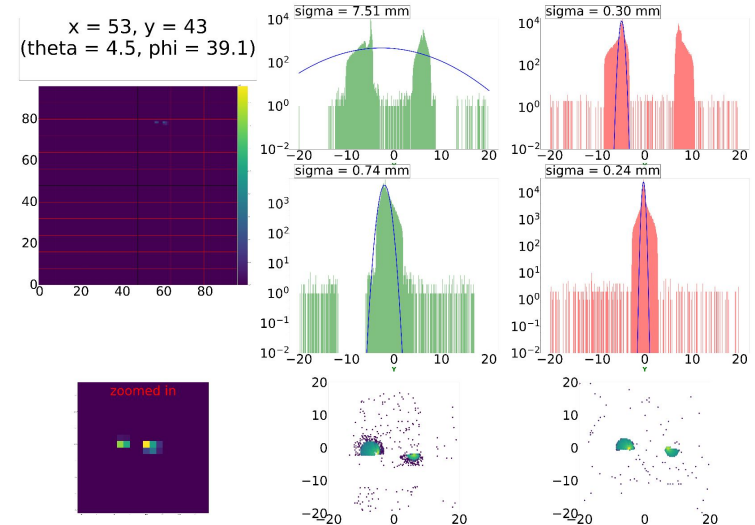
Problem: triggered event rate reduced to ~60-70% of original rate (less light / pixel)



“Checkerboard” configuration

Every other segment goes on a different sphere.

Realistic FC FS    Ideal FC FS



# “Generic” mirror bifocalizer

- Each mirror can be independently placed on its own sphere.
- Idea: maybe if we **don't checkerboard the whole mirror**, the effect on FC trigger can be reduced while still bifocalizing CC acceptably

Ideal FC FS

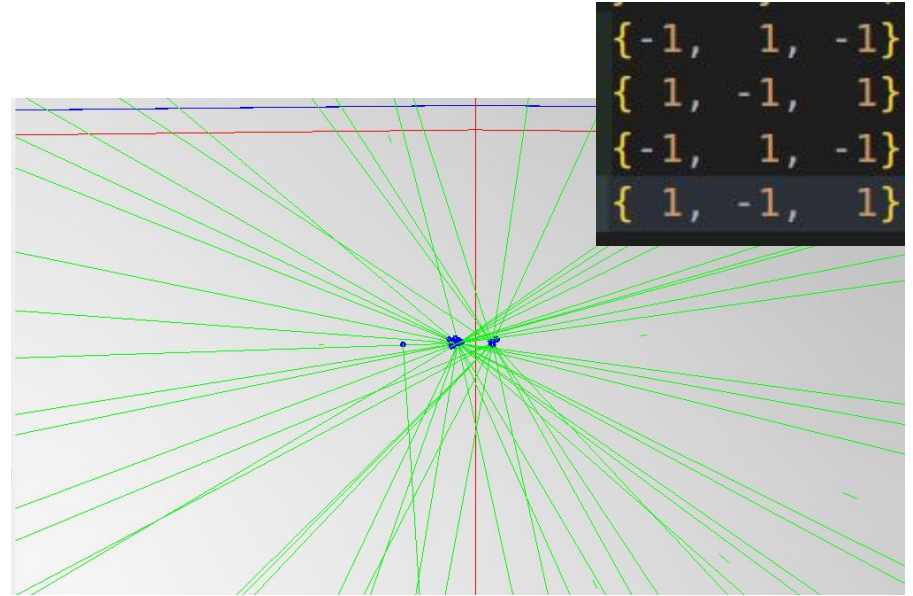
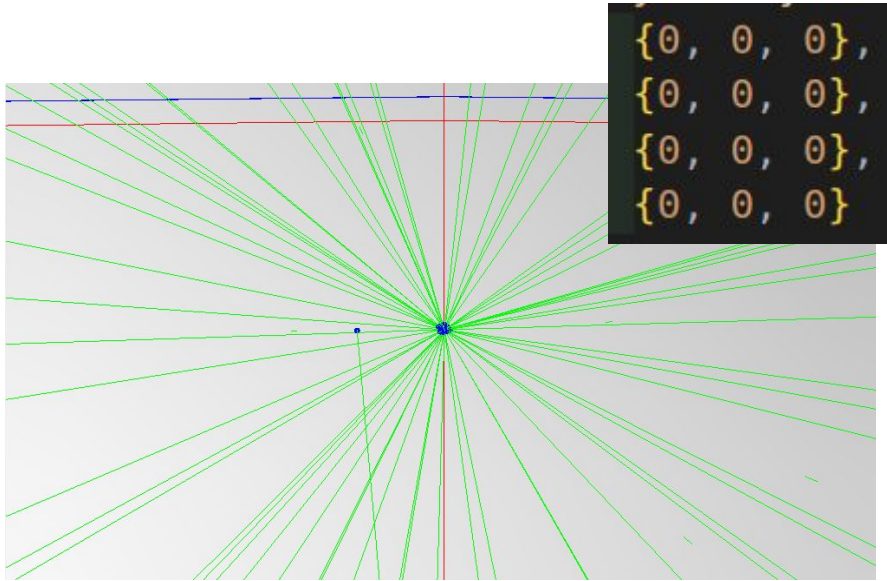
Geant4  
photon hits  
(not pixels)

```
{1, 1, 1},  
{1, 1, 1},  
{1, 1, 1},  
{1, 1, 1}
```

```
{-1, -1, -1},  
{-1, -1, -1},  
{-1, -1, -1},  
{-1, -1, -1}
```

# Mirror bifocalizing examples

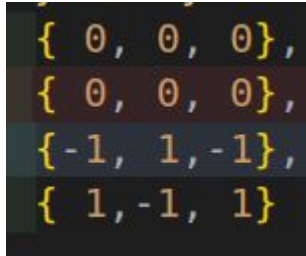
0  $\rightarrow$  aiming a center, hits center,  $\pm 1 \rightarrow$  shift by desired offset



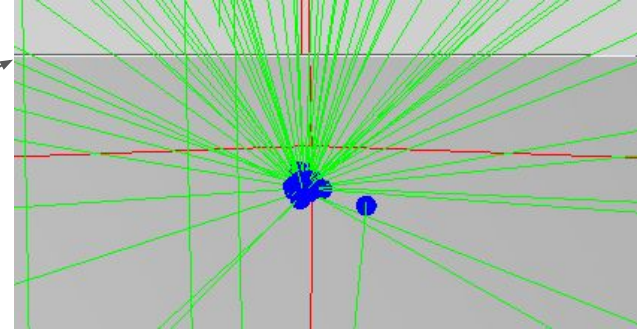


# Does it work?

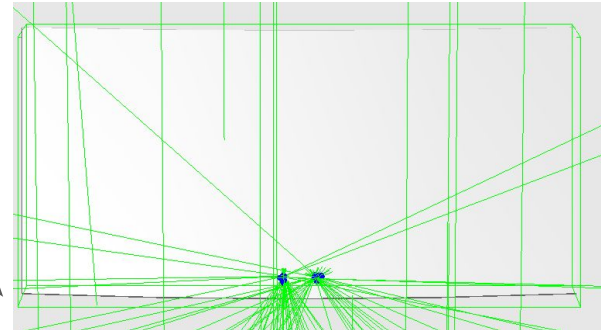
Only checkerboard lower  
two rows of mirrors  
(more light to CC comes from  
lower parts of mirror)



Top of FC



Bottom of CC

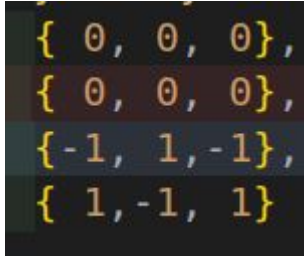




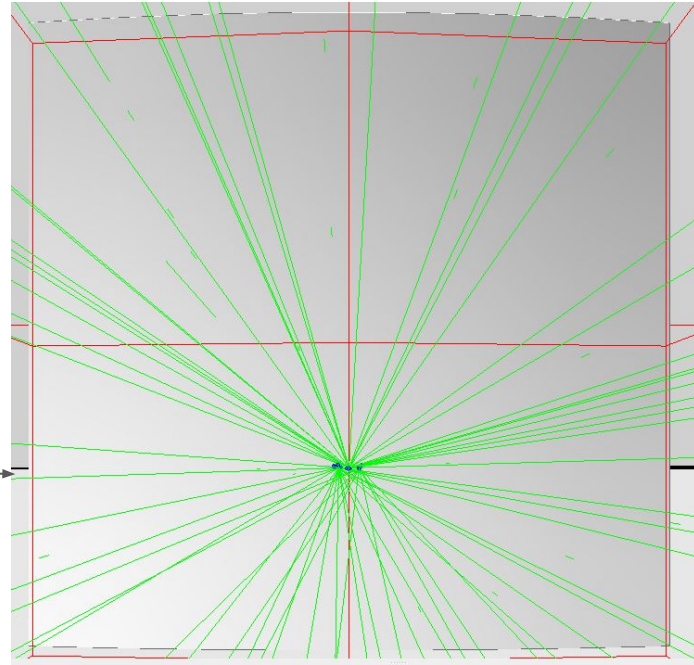
# Does it work?

Sort of. 😞

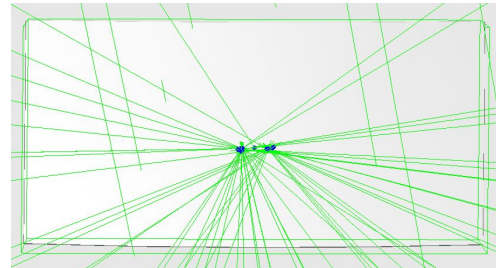
Not a clean on/off for FC or CC by isolating checkerboard



Middle of FoV



CC



# How do different checkerboard patterns work for FC, CC

Definitive answer pending.

George is checking if it is go/no-go from FC trigger point of view

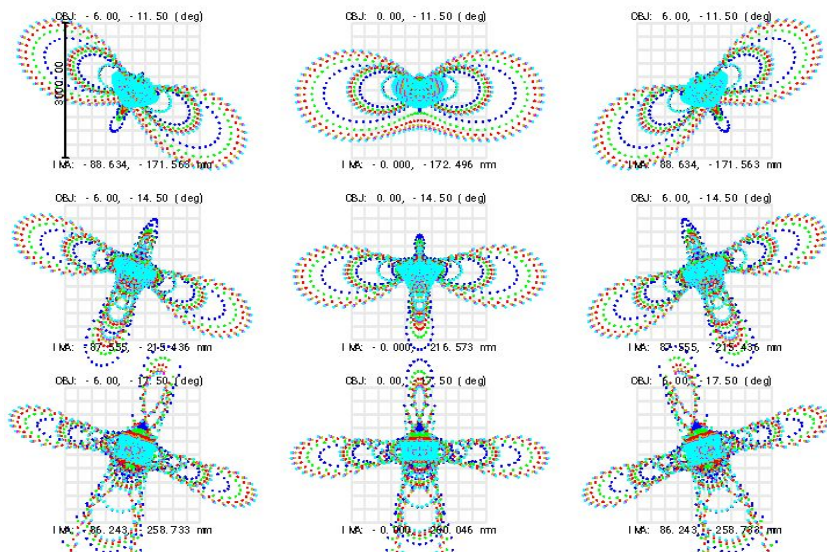
Alex and I are checking if it is go/no-go from CC point of view

Will post results on simulation slack channel when we have them

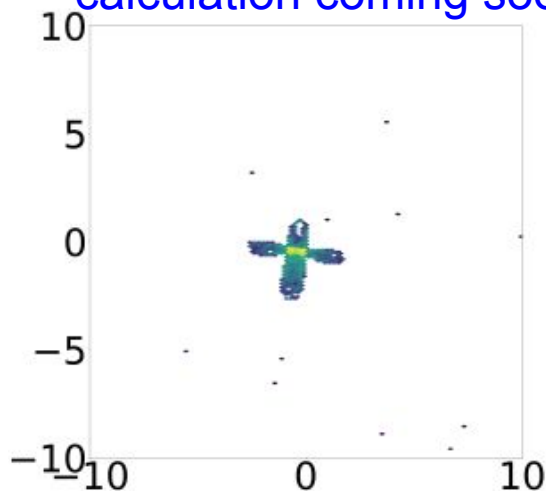
# But good news:

Eric Mentzell (optics Engineer at Goddard) is working on OA (zemax sims)  
(Thanks John and Toni!)

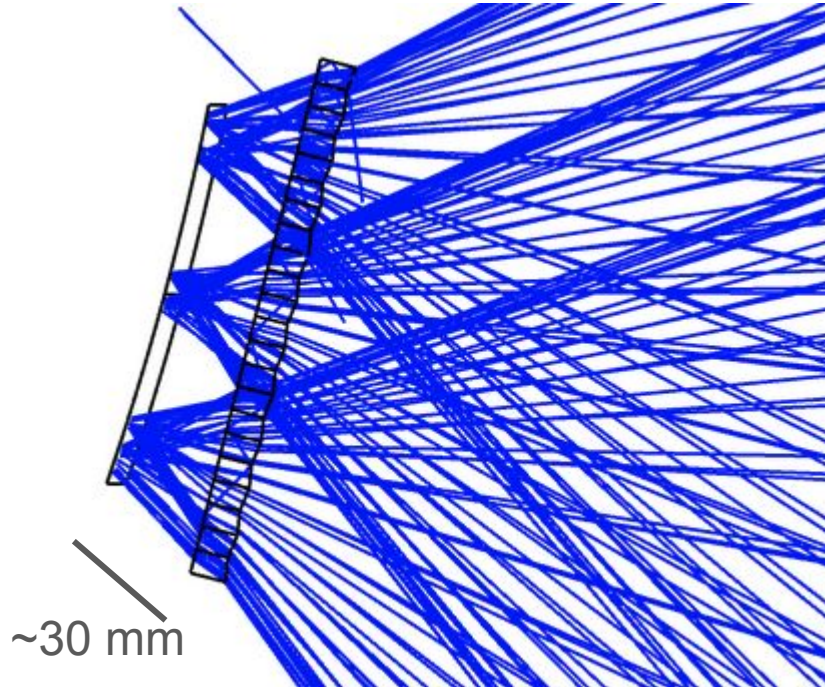
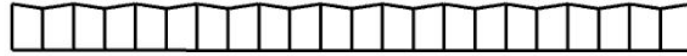
CC PSF's (no OA)



G4 CC sim PSF  
(energy containment  
calculation coming soon)

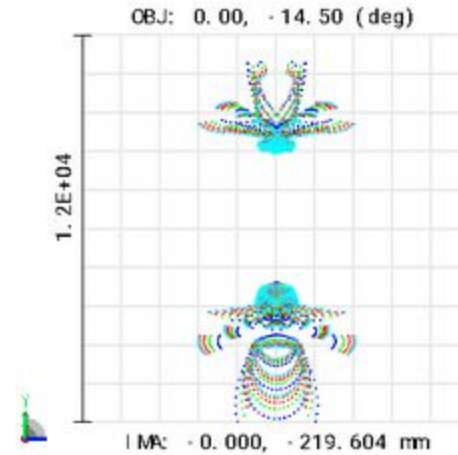


# OA in Eric's model



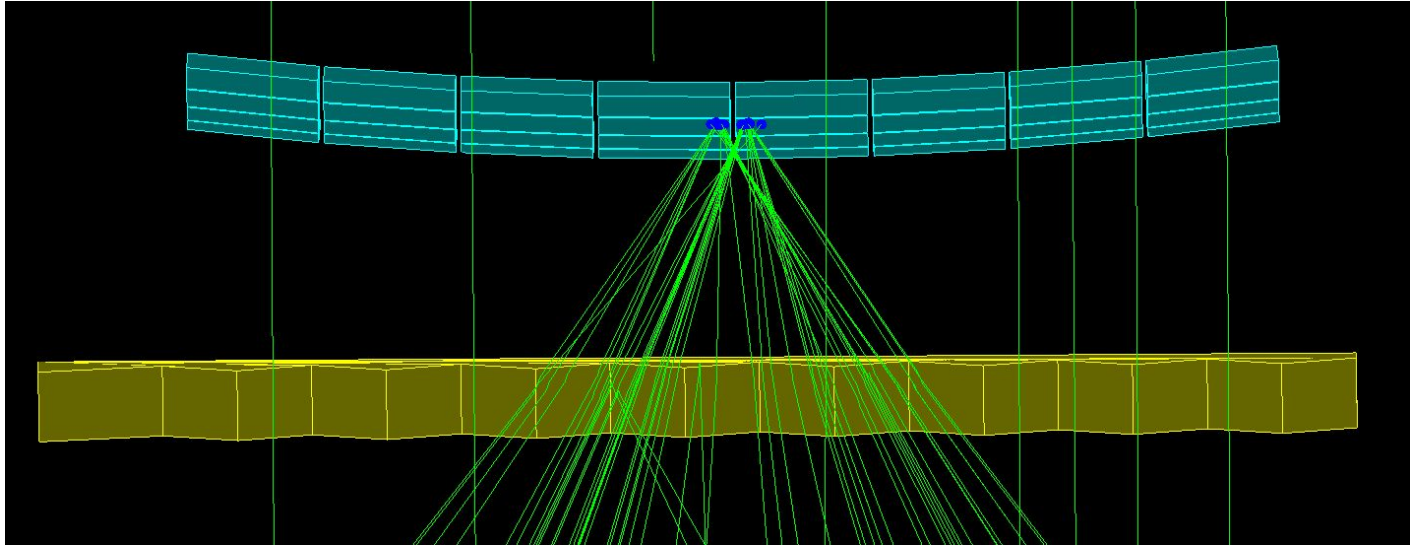
Note: split here is vertical  
Horizontal split pending

## PSF with OA



~6 mm separation

# Preliminary OA model in Geant4

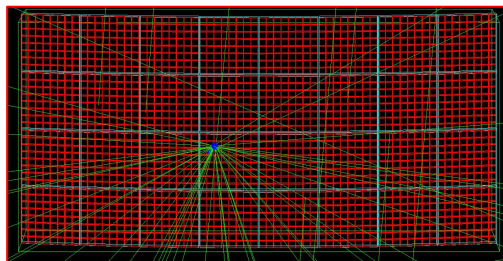


Qualitatively does the correct thing  
Will tune to Eric's model once complete (with horizontal split)

# CC Electronics

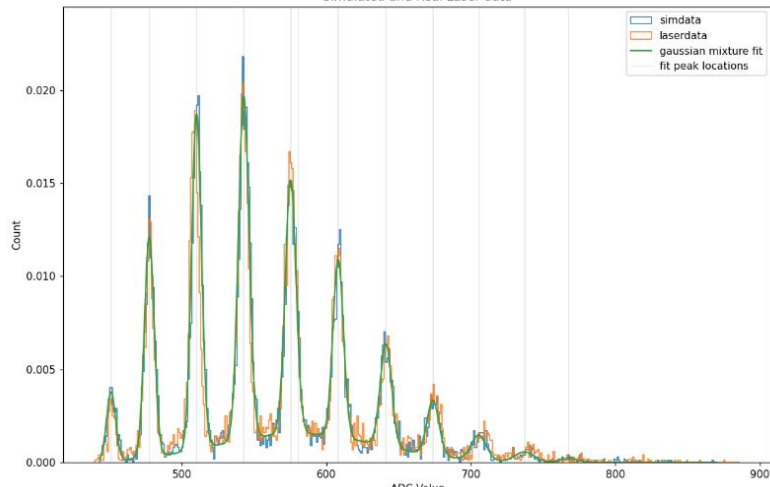
Isaac, Beatrice

G4 up to hits



Electronics sim

Simulated and Real Laser data



- Light releases PE in SiPM
- PE → avalanche breakdown in a microcell
  - 3584 microcells / pixel
  - Gain (ADC/PE)  $\approx$  digitized integral current from 1 breakdown
  - Details: crosstalk, afterpulses, multiple avalanches

## Sim implementation options in offline

- Record variance of ADC per PE
  - Fast
  - Noise treated to 1'st order
- Individually treat each contribution to ADC
  - Closer to real life
  - Fewer parameters from calibration
  - Correct contributions to ADC variance arise naturally

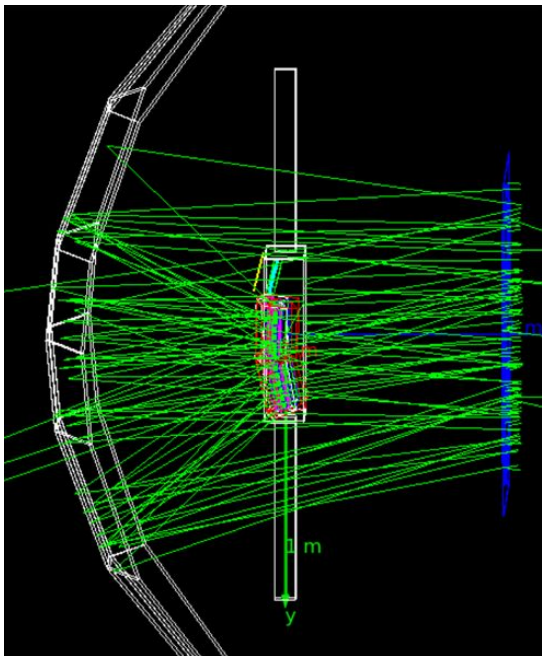


# Background simulation

Enzio, Alex

Start from 400 photons/m<sup>2</sup>/st/ns

Isotropically injected photons



- removing the shelf  
→  $N_h = 5100 (+1000)$
- increasing the injection solid angle to  $\Omega = 0.99$  sr  
( $N = 378 \text{ ph} \cdot \text{ns}^{-1}$ )  
→  $N_h = 4500 (+400)$
- both (plots)  
→  $N_h = 5700 (+1600)$

5000 hits/us / 8192 pixels  $\approx 0.5$  G4 hits/pixel/us  
(lower than George's estimate of 1 hit/pixel/us)



# Items not yet addressed (as far as I'm aware)

- CC trigger simulation
- CC event format that will be stored to disk  
(currently using an old SPB2 format)
- Dark box
- Direct hits simulation (eg. GCR)
  
- Your ideas here

# To participate

Please see the [Simulations Wiki](#)

- You'll find mailing list (for meeting announcements)
- Materials from talks, CAD files, documentation, instrument measurements

To post specific simulation issues, see the [Offline gitlab page](#)

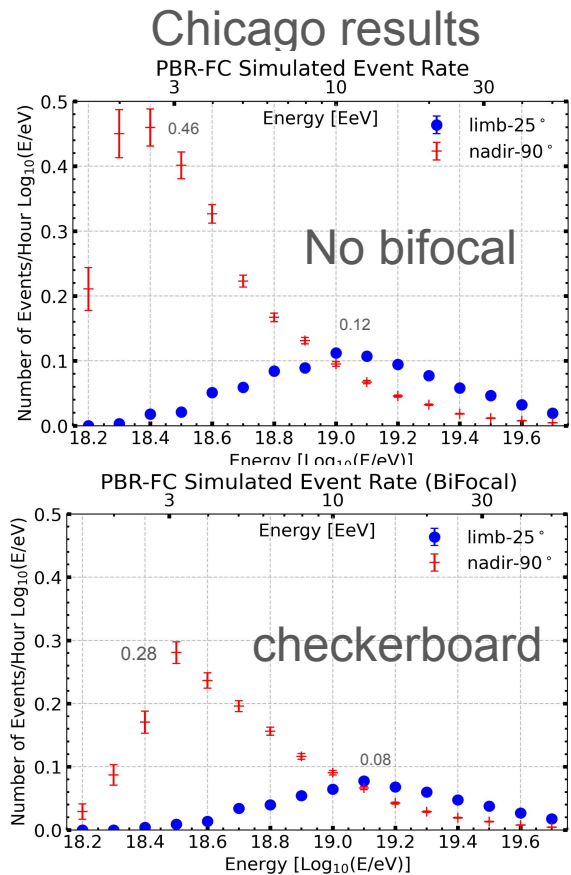
- Both the code and project management tools live there
- You can post simulation ideas for discussion and coding
- And report bugs too...

# The End

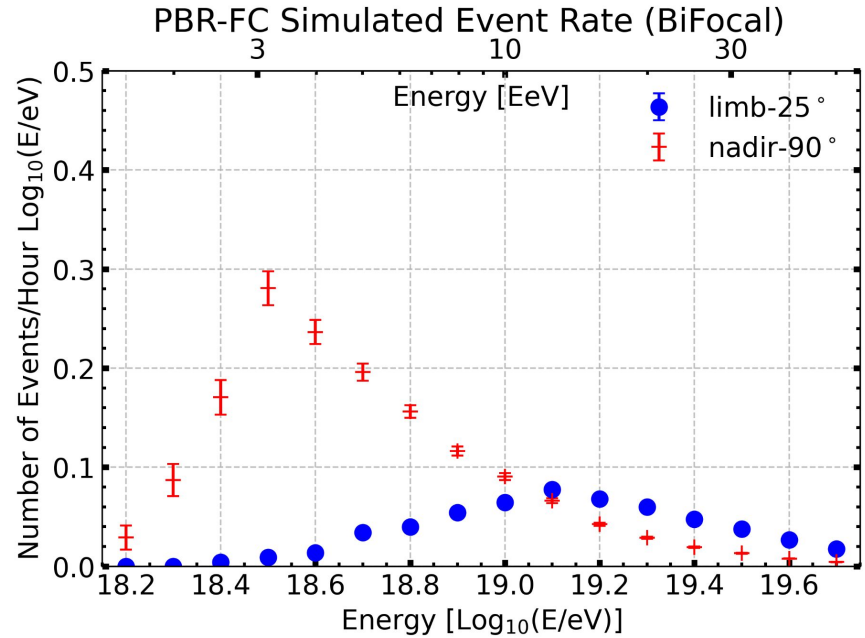
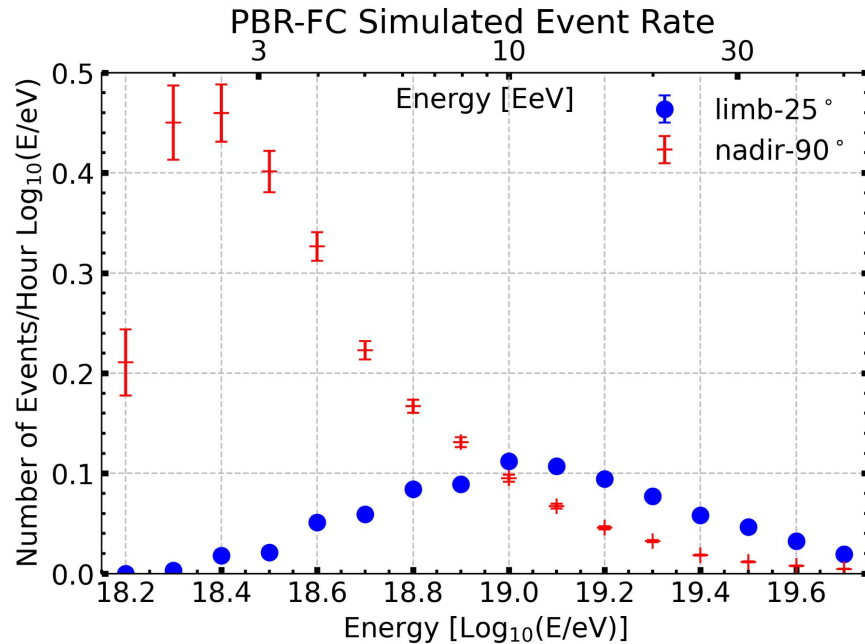
thanks

Extras

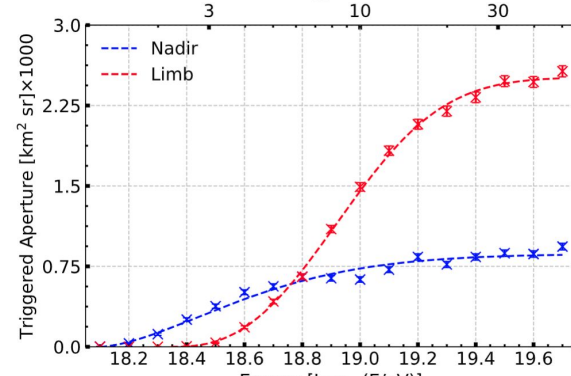
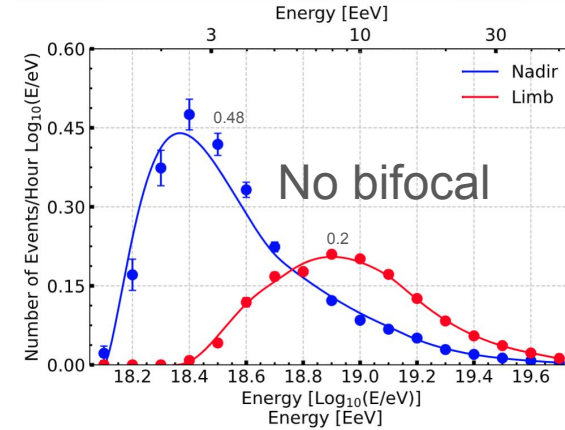
# Previous bifocal



# Effect of mirror biocalization on trigger rate



# Bifocalizing using “reduced” checkerboard



## Perlmutter

Status

Details

Perlmutter

⊗ Down

Unavailable - 2025-06-01 23:02 – 9999-01-01 01:01 PST, Unavailable  
An issue with the Lustre file system has been identified. Engineers are investigating.