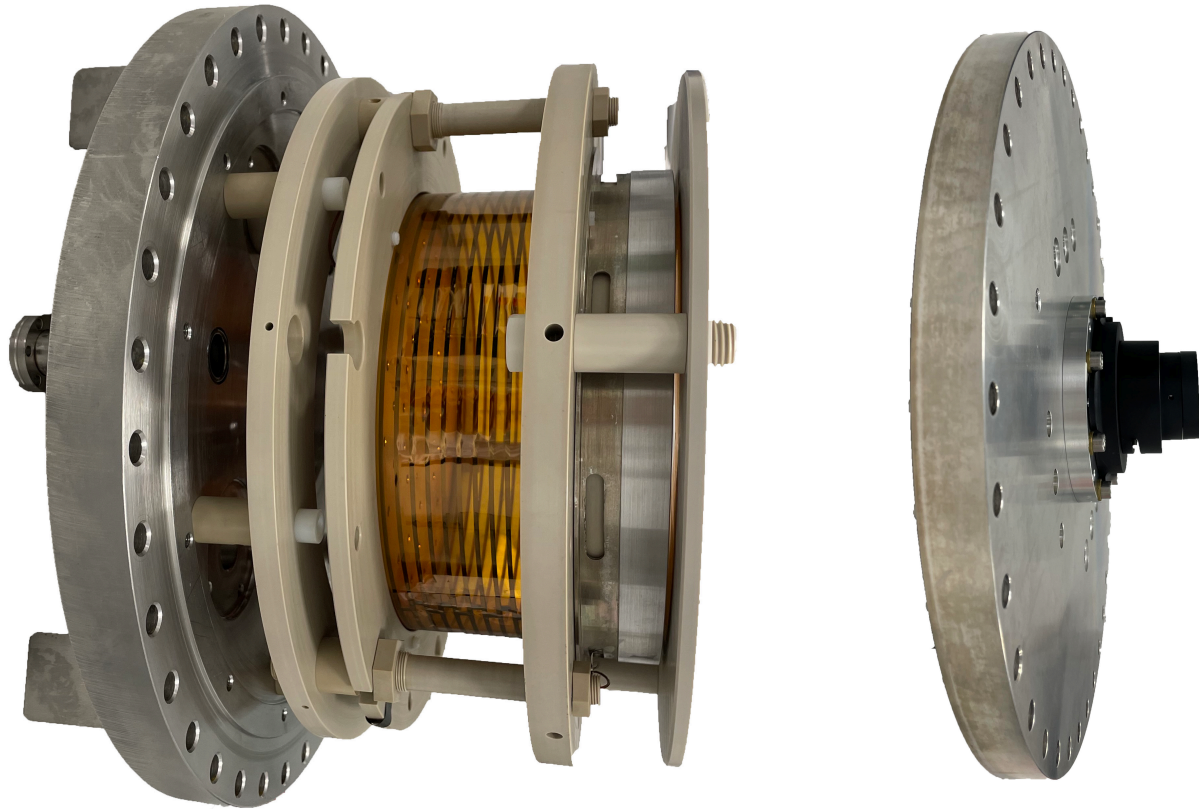


An Optical Gas Time Projection Chamber for Neutrino Experiments



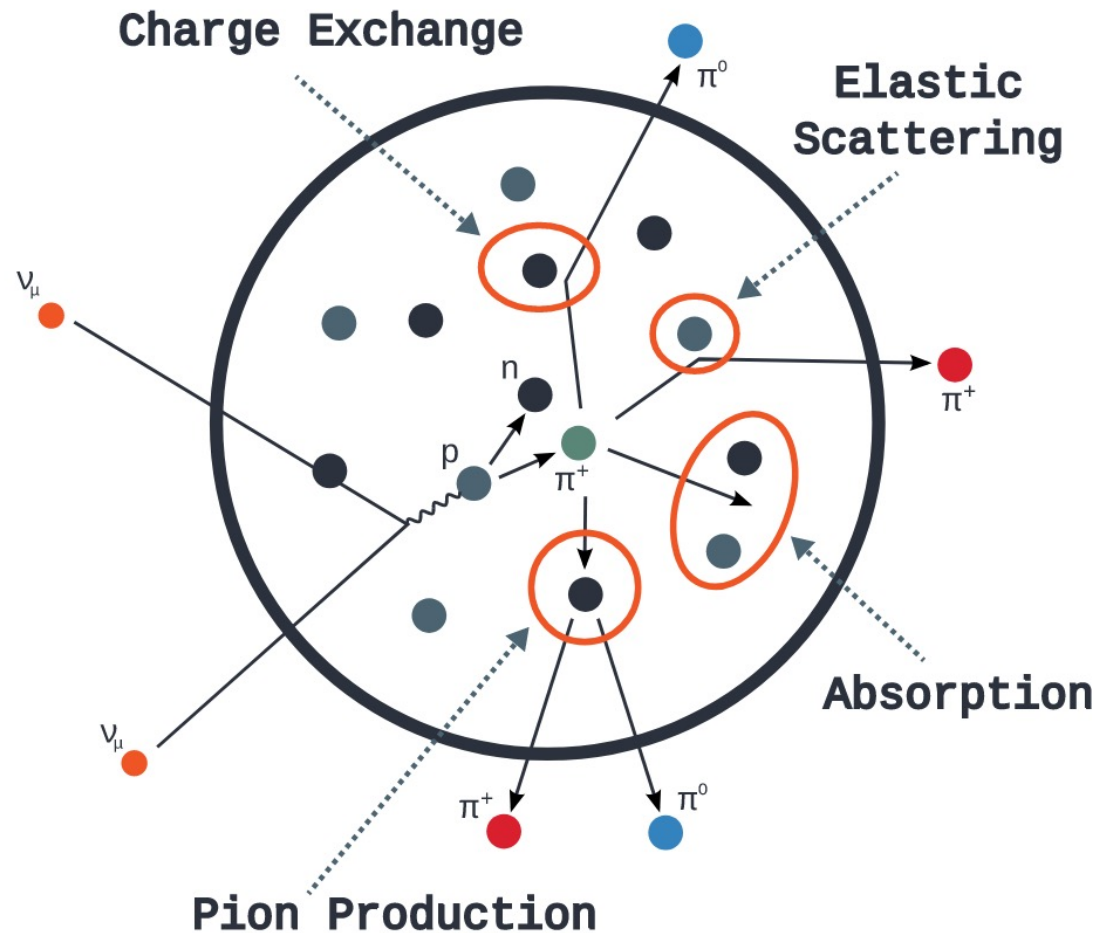
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Neutrino Nucleus Interactions

- Nucleons produced by neutrinos-nucleus interaction might undergo many interactions in the nucleus
- These are not fully understood and therefore they are a source of systematic errors in neutrino oscillation analysis/measurements.



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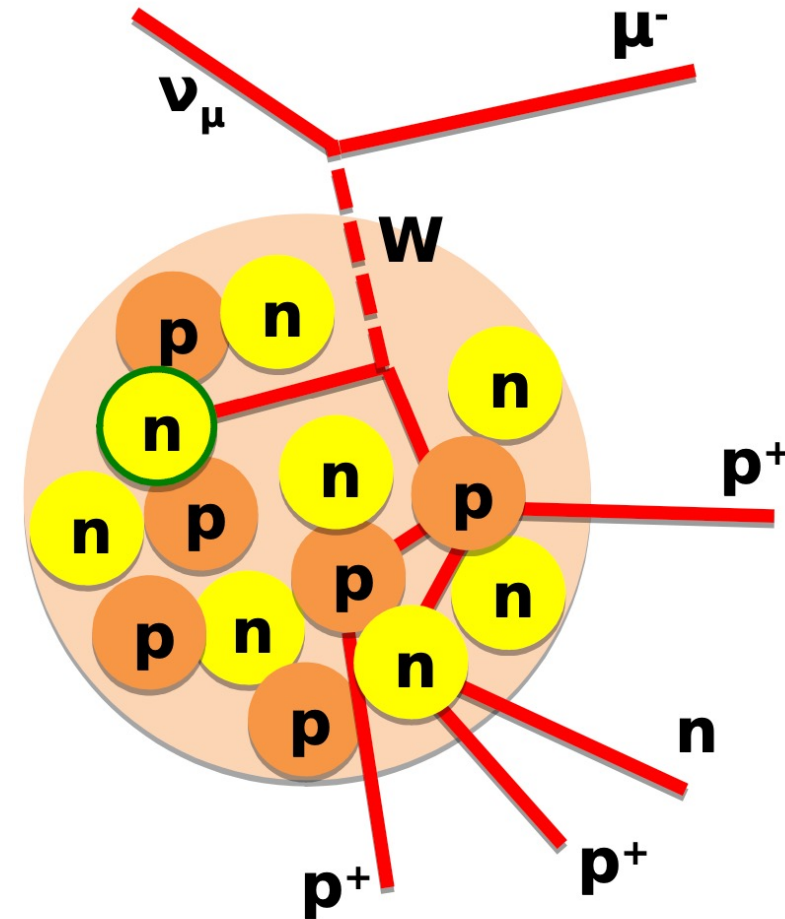
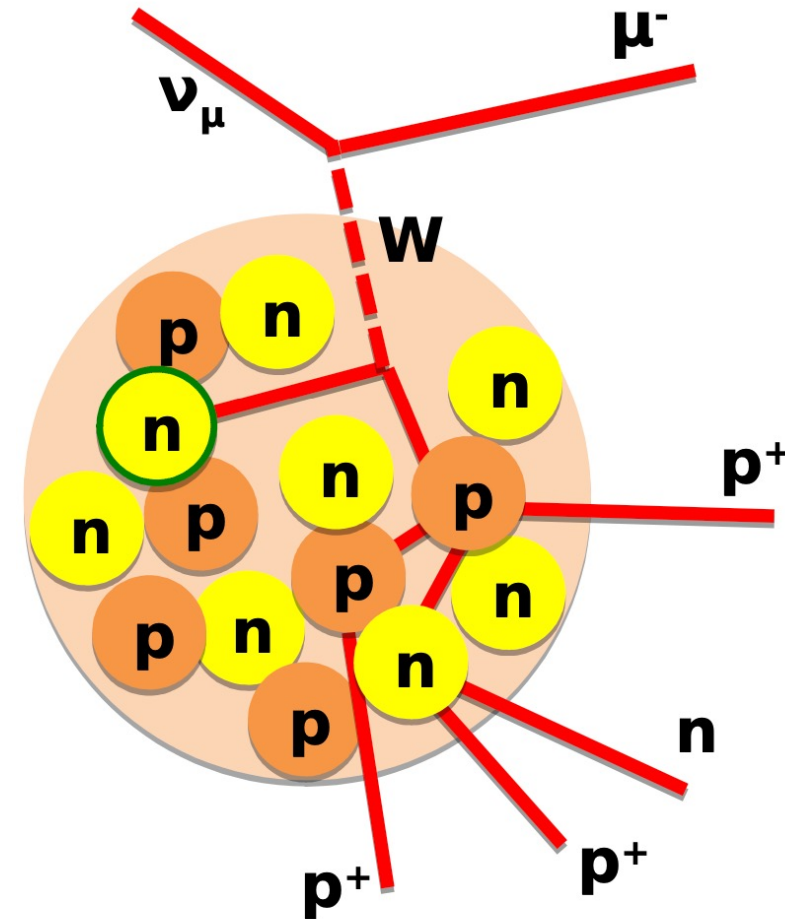


Image Credit goes to A. Schukraft

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Key Parameter: Particle Identification Momentum Treshold

Image credit goes to A. Schukraft

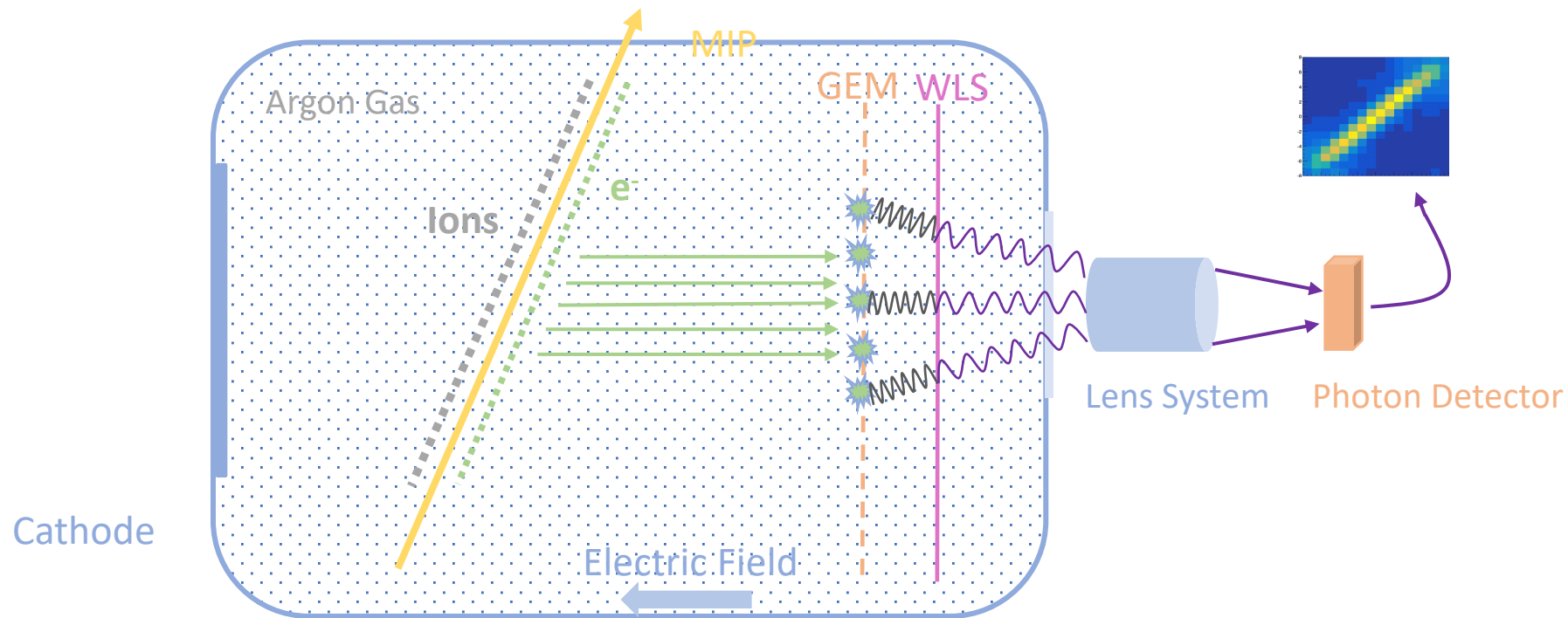
Why Gas?

- Particle detection momentum threshold reduced (at the moment, state of the art TPC: 450 MeV/c [**1**])

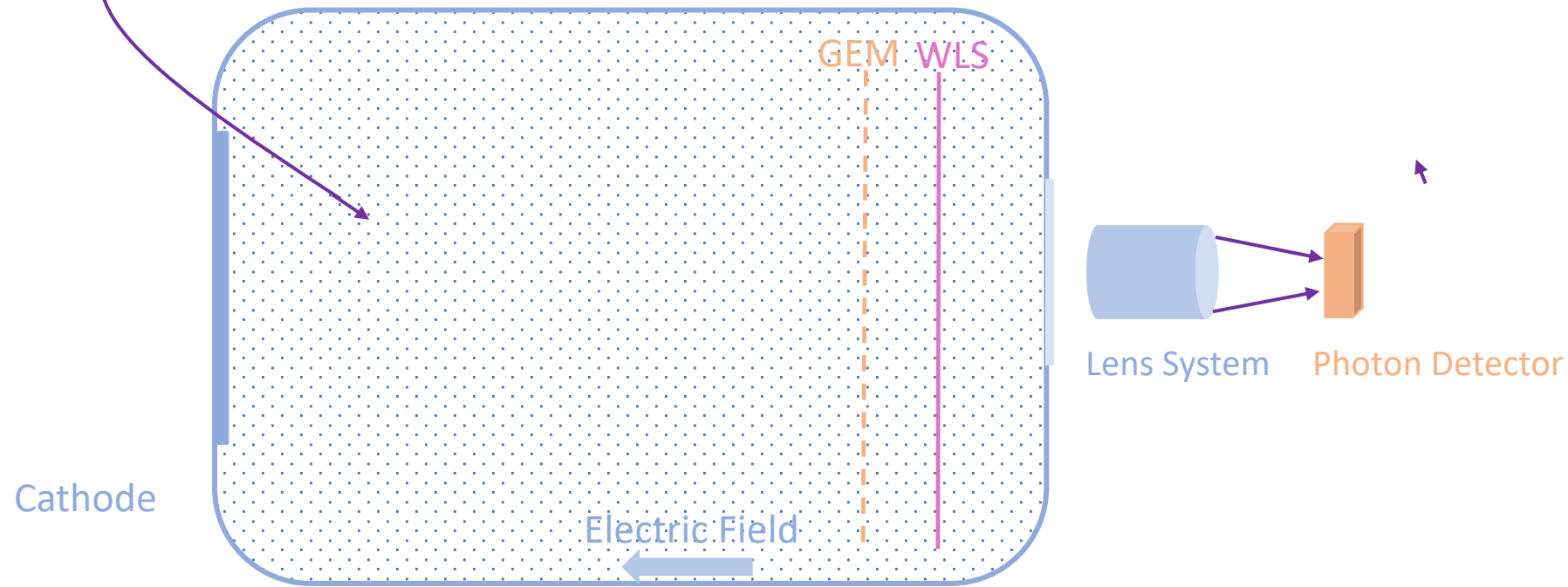
Why Optical?

- High Granularity Read-Out
- Cost effective Scale Up
- Readout decoupled from the main body

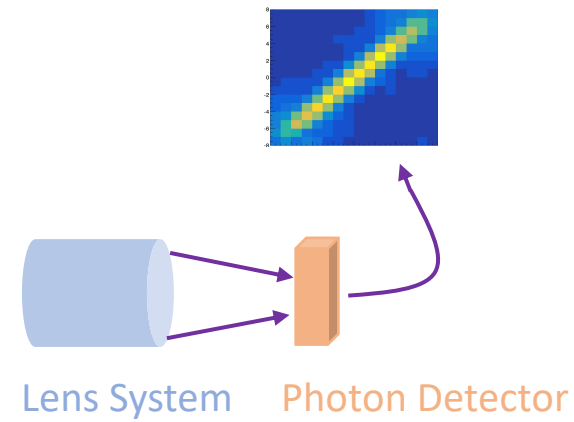
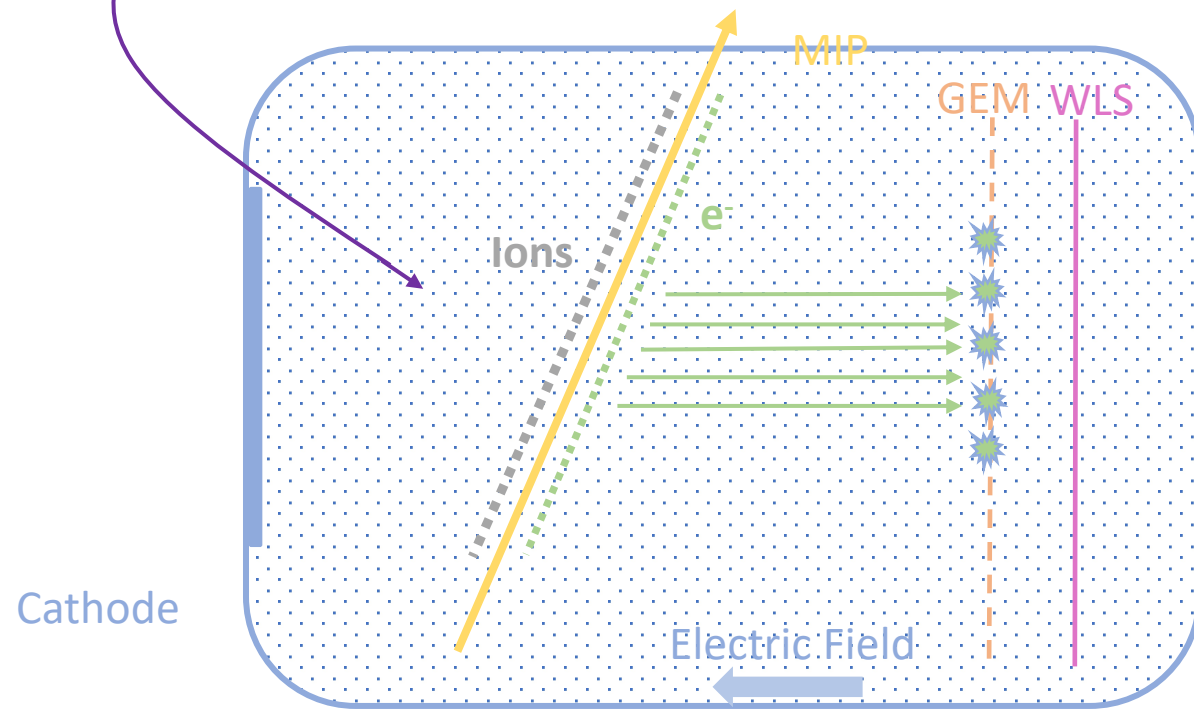
Optical Time Projection Chamber

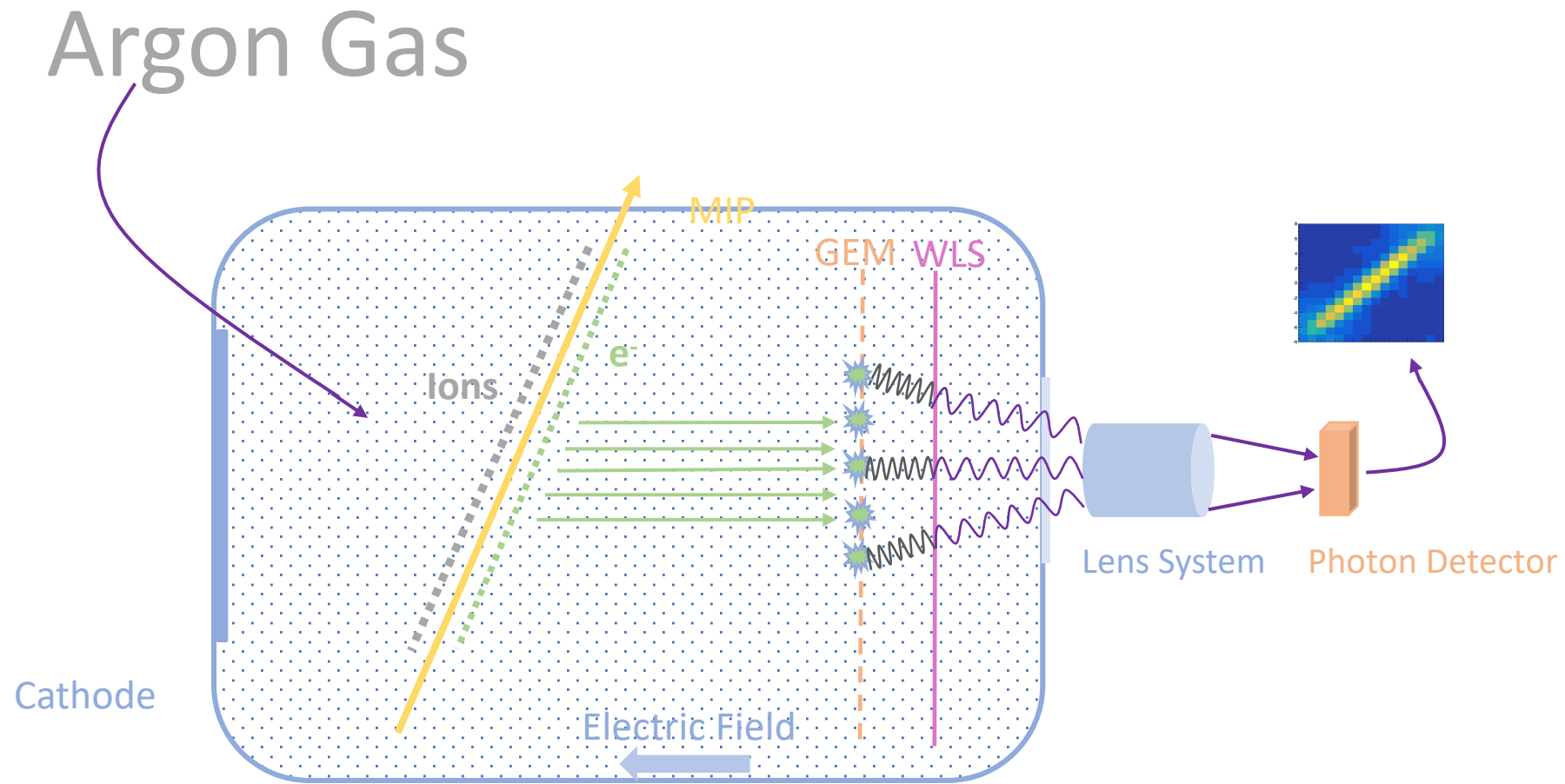


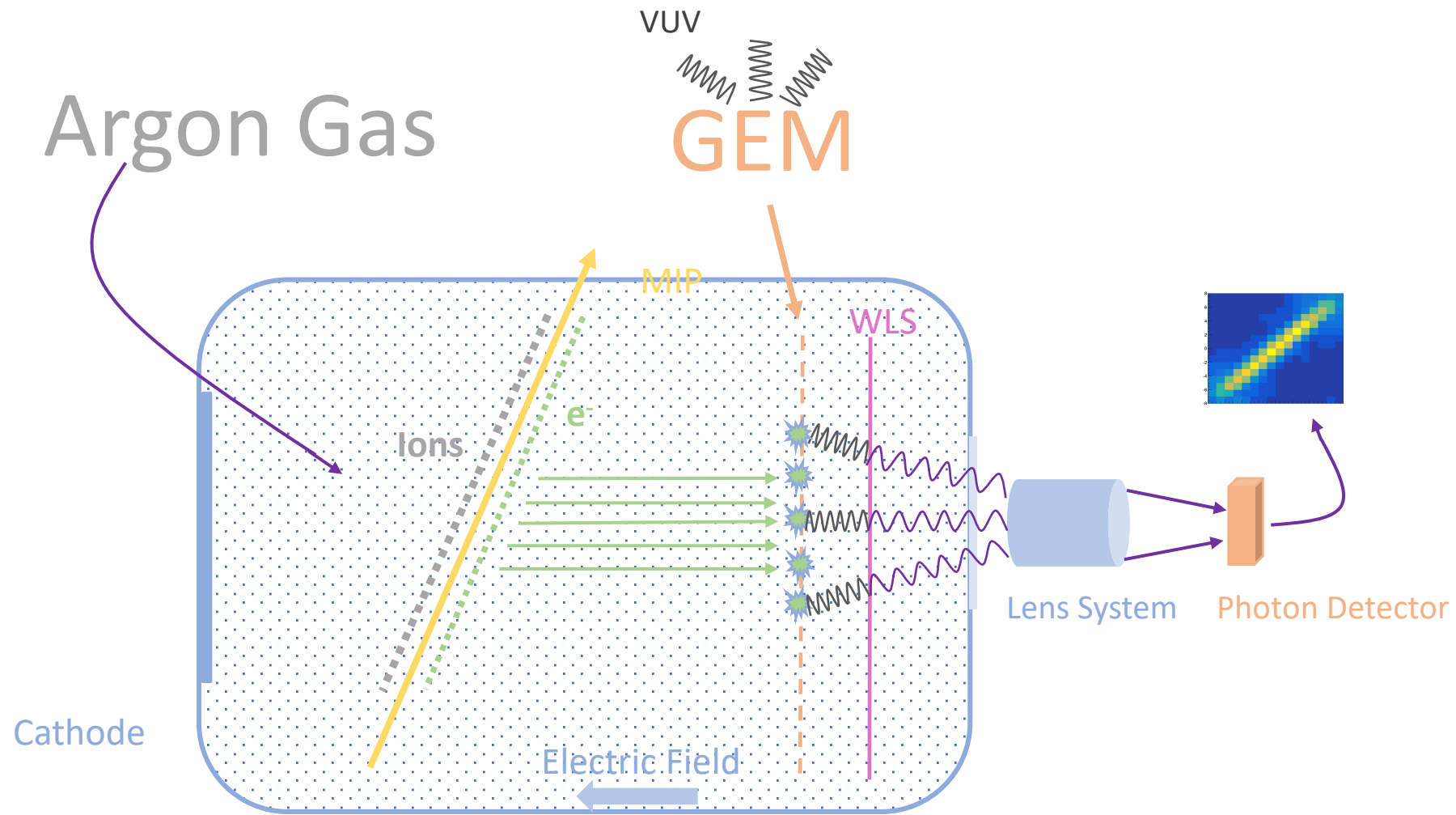
Argon Gas

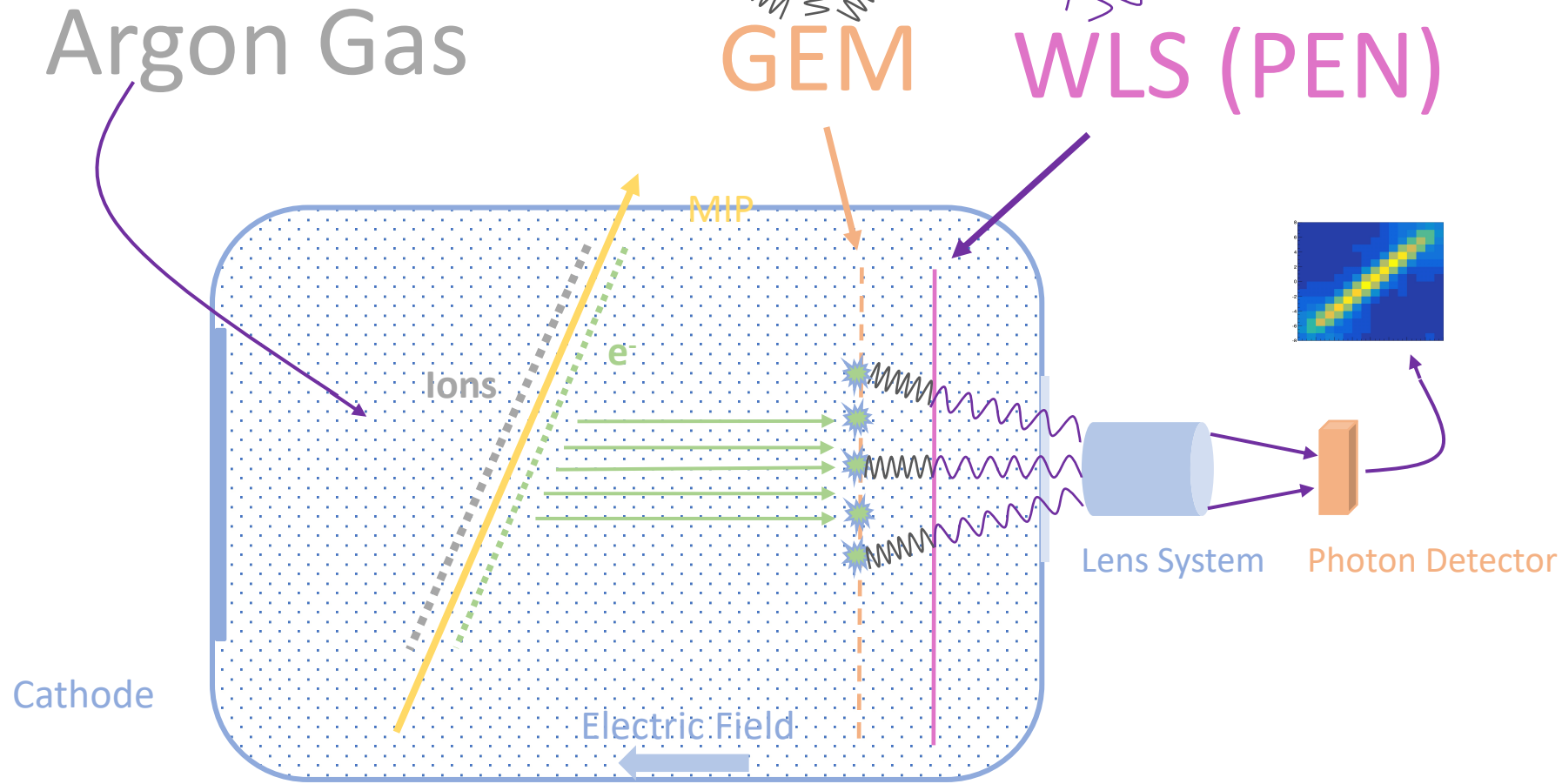


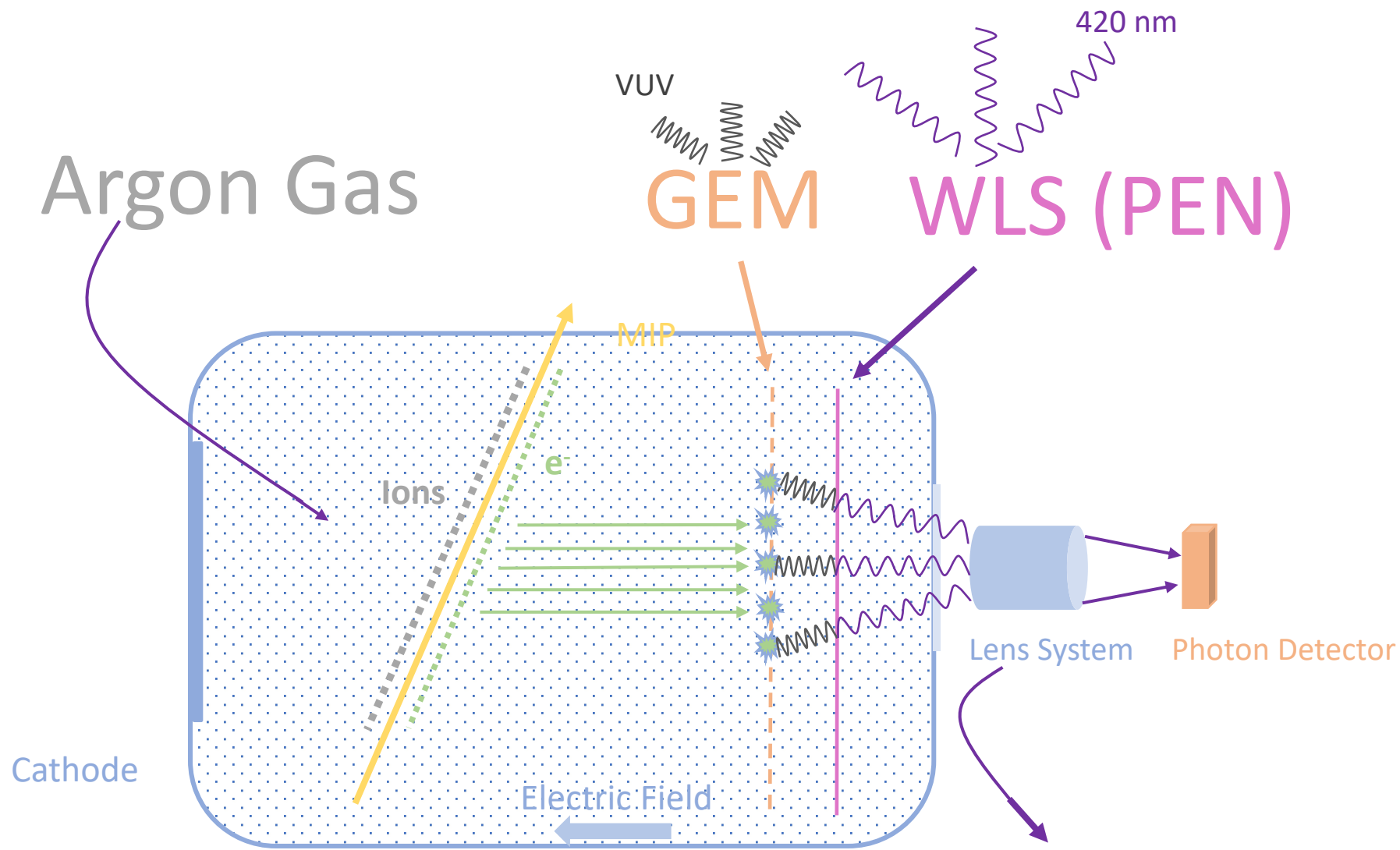
Argon Gas



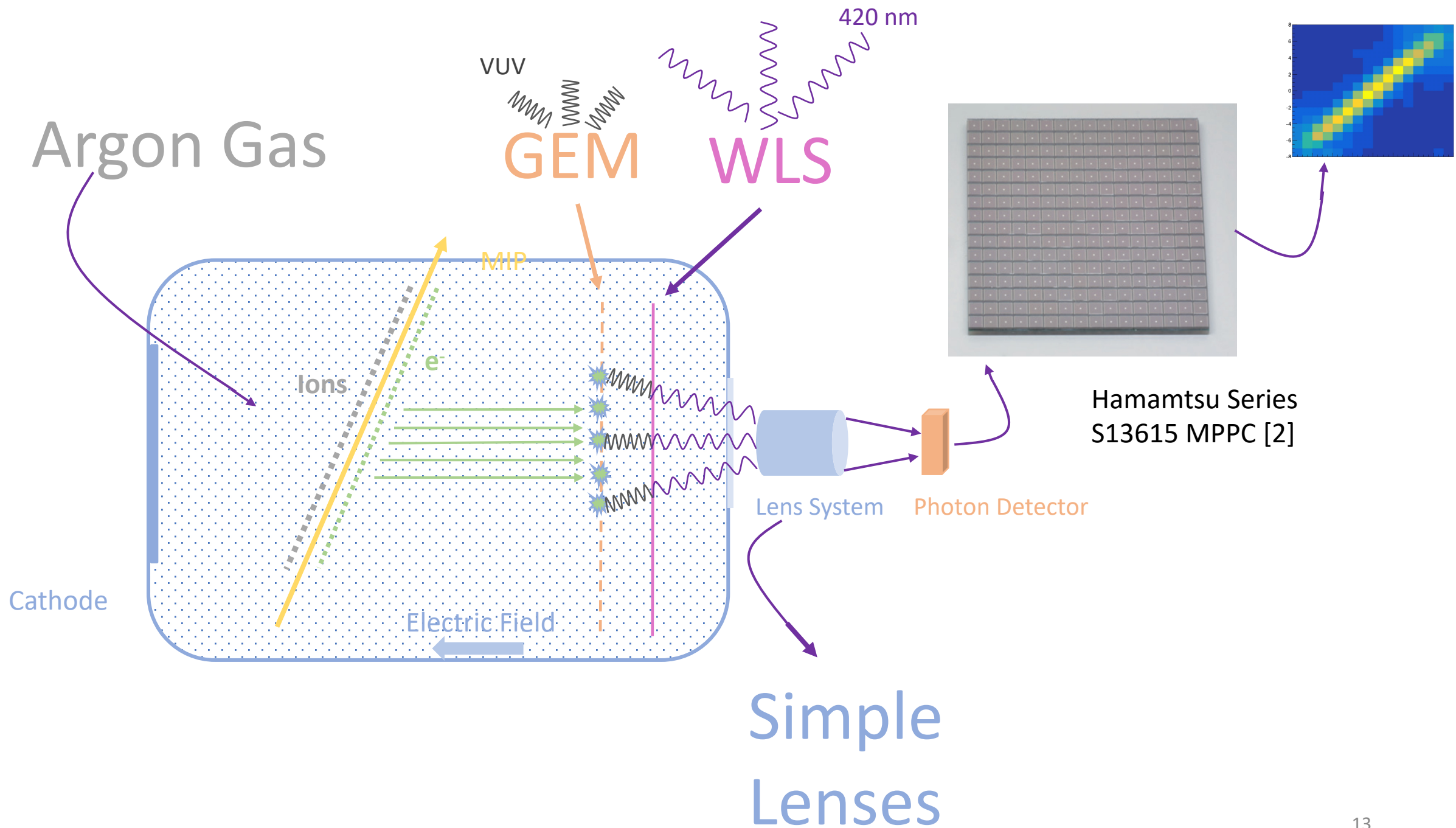


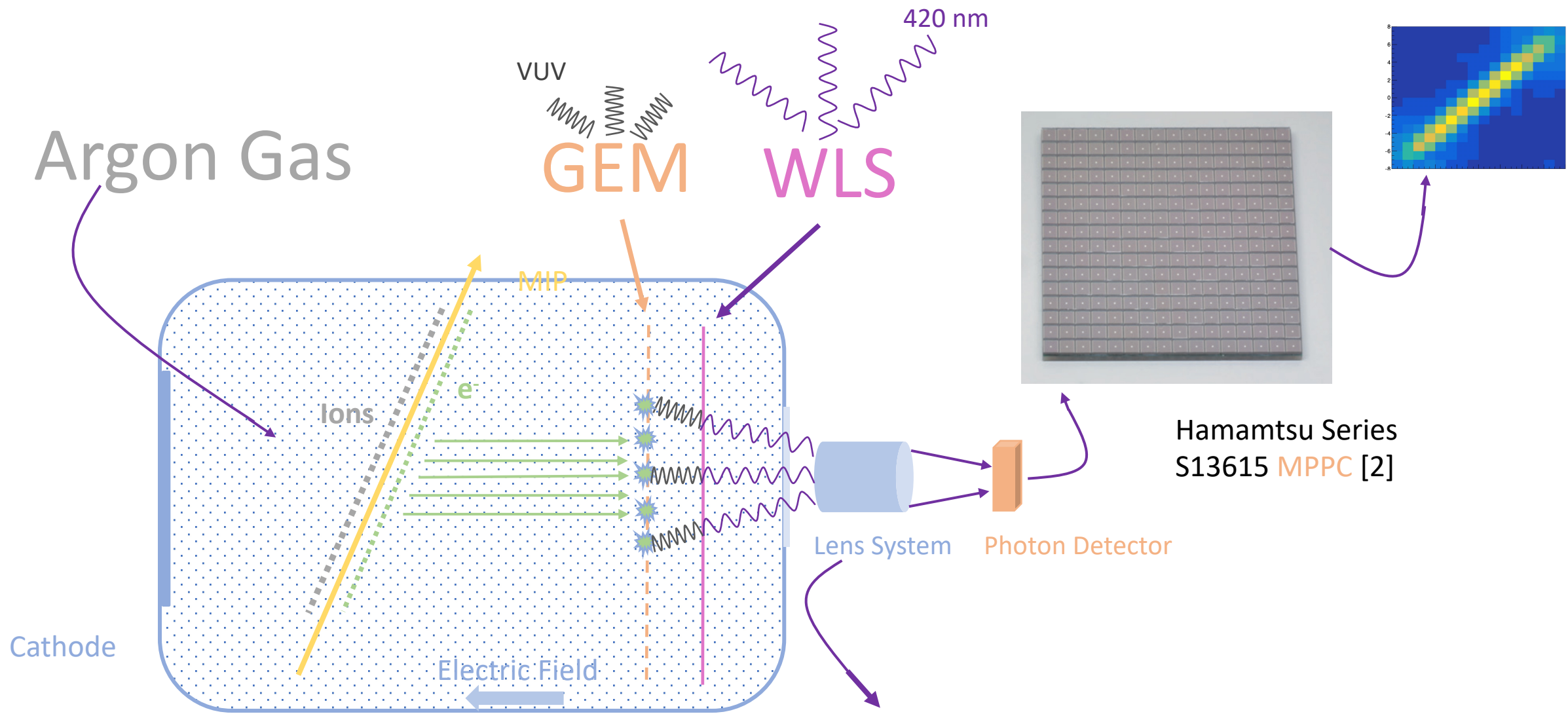






Simple Lenses





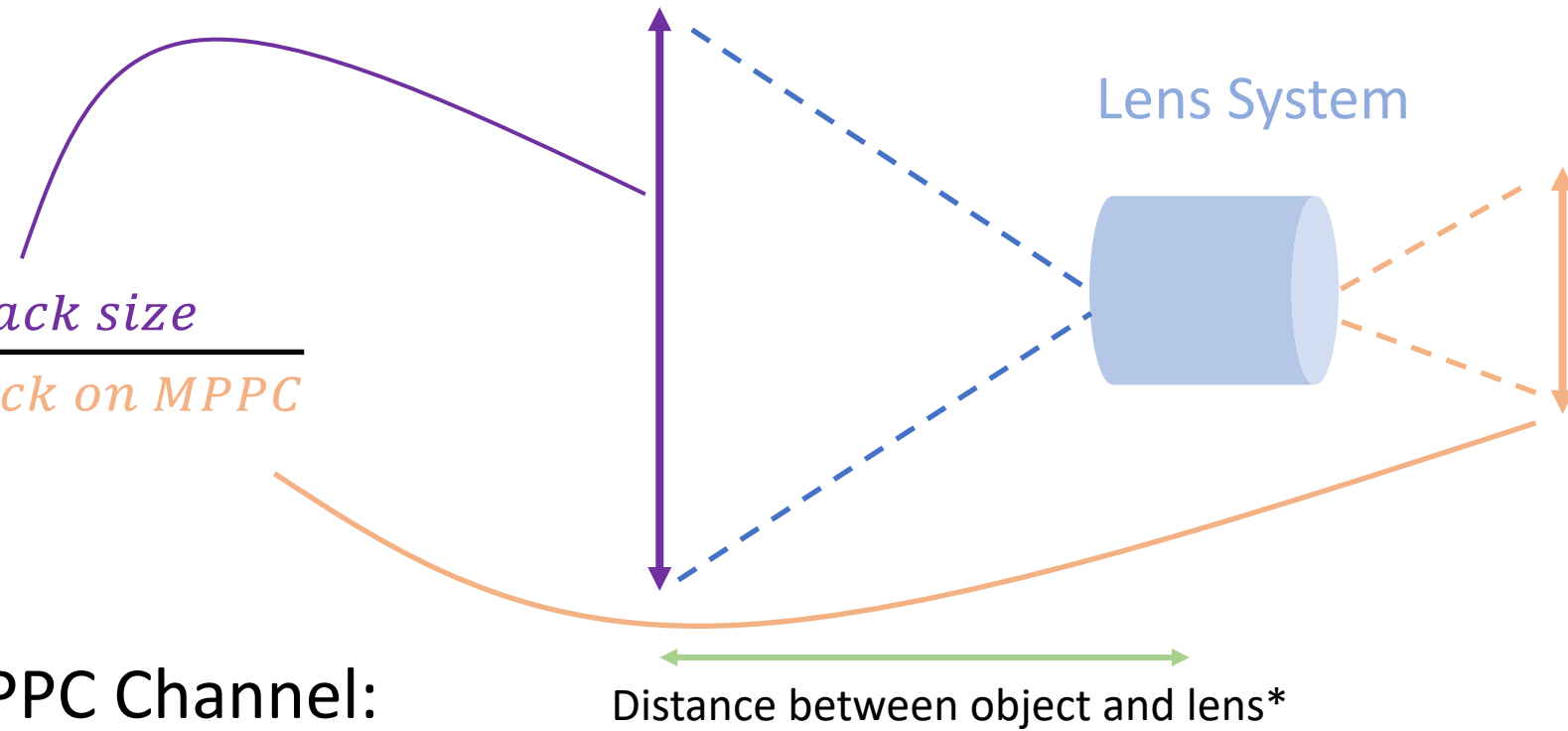
Simple Lenses????

Figures of merit:

- Magnitude:

$$\frac{\text{real track size}}{\text{size of track on MPPC}}$$

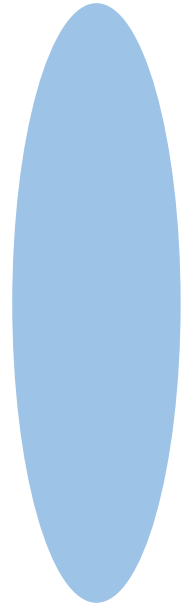
- Photon per MPPC Channel:
number of photon detected
per sensor channel.



*Magnitude changes with the distance of the lens from the object plane

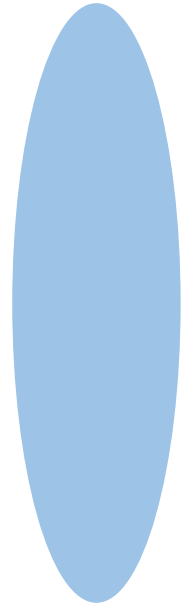
Preliminary lens “system”

- One double convex, 30mm diameter, f/1 lens
- Only ~10 photons detected per channel...



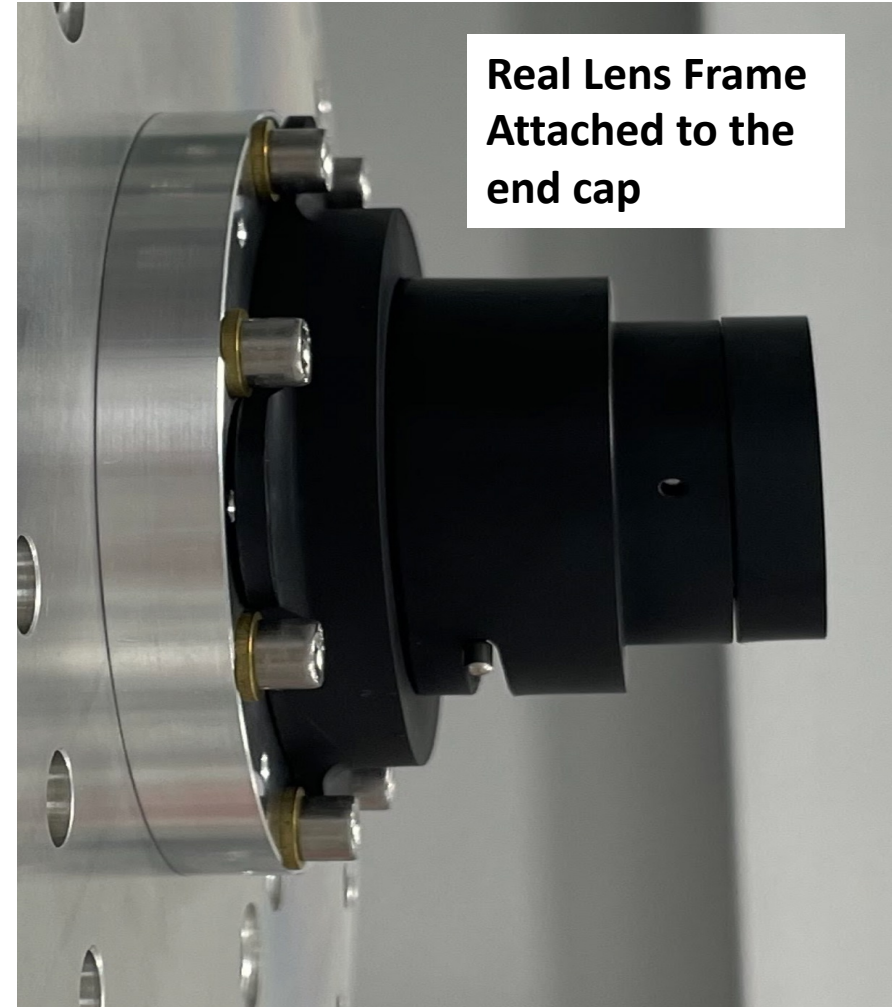
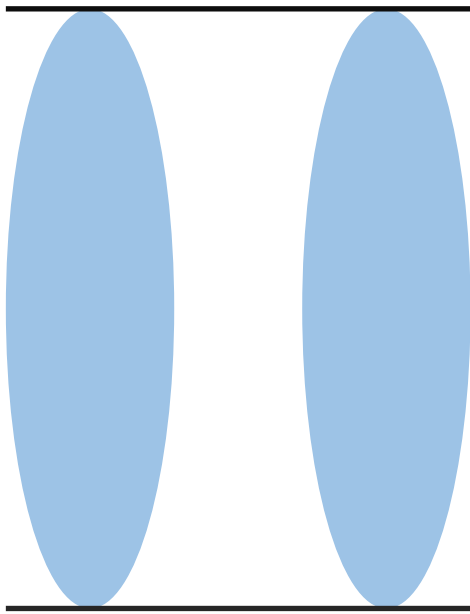
Preliminary lens “system”

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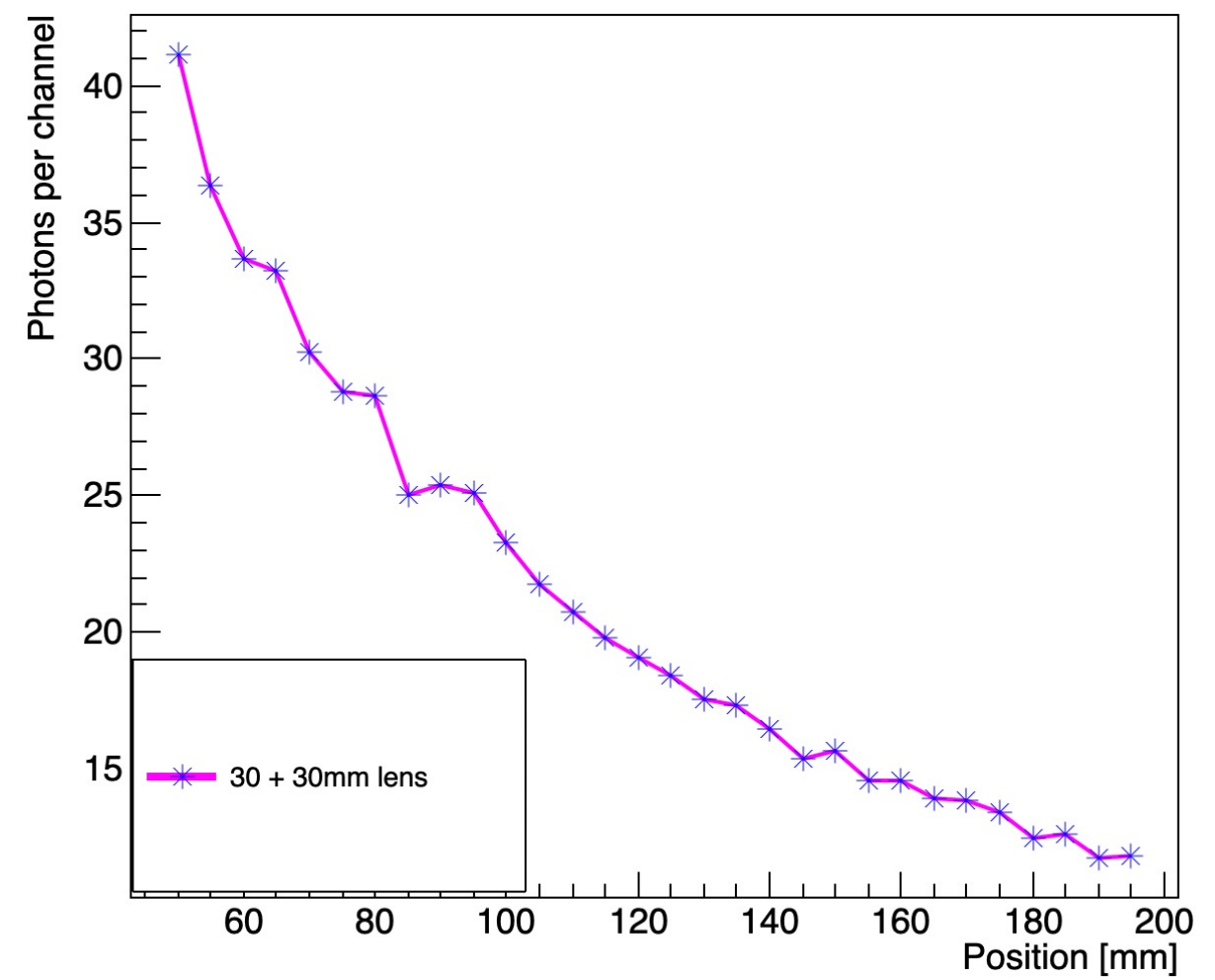
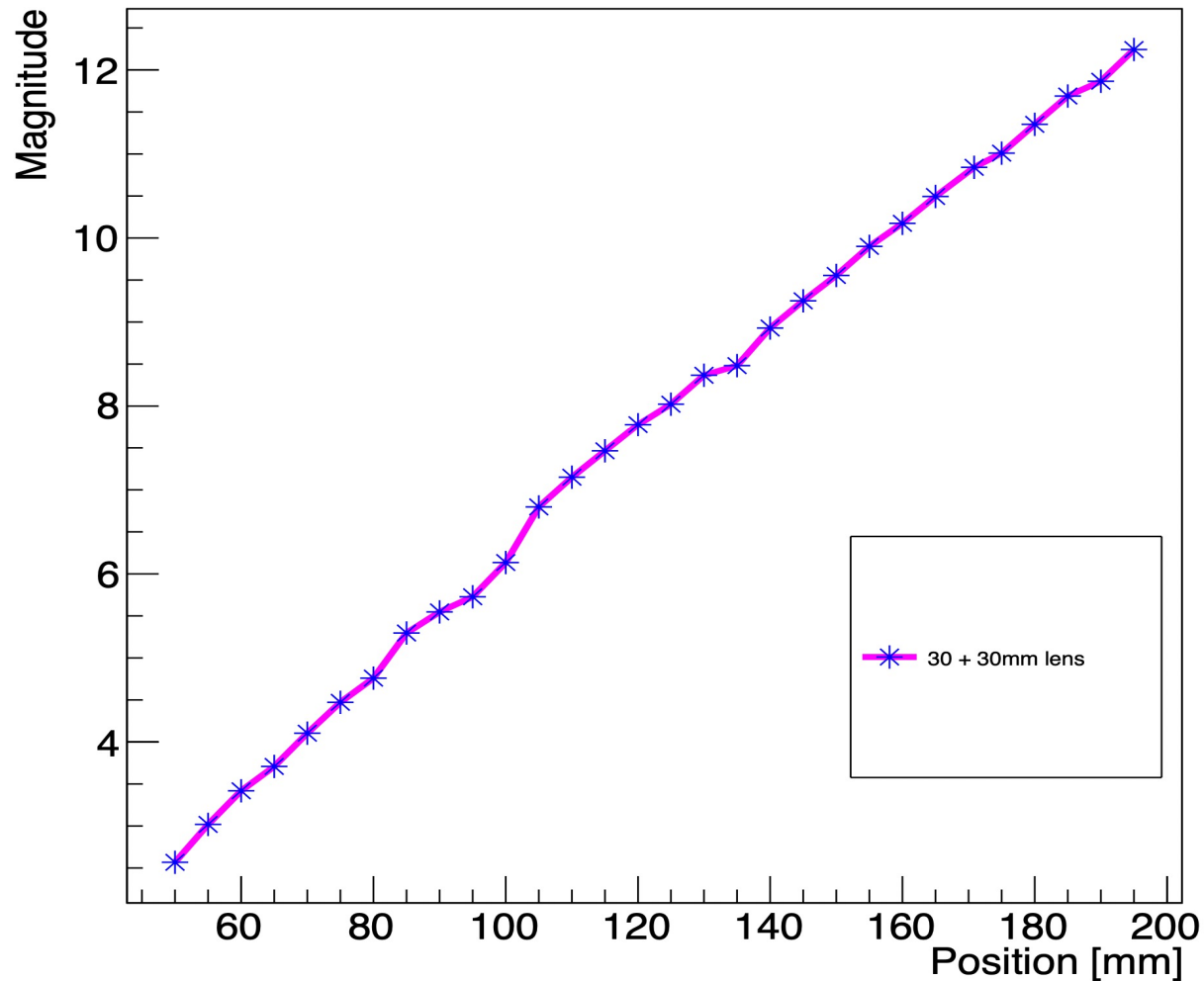


Preliminary Lens System 2

- Two double convex, 30mm diameter, $f/1$ lenses.
- ~13 mm space between them

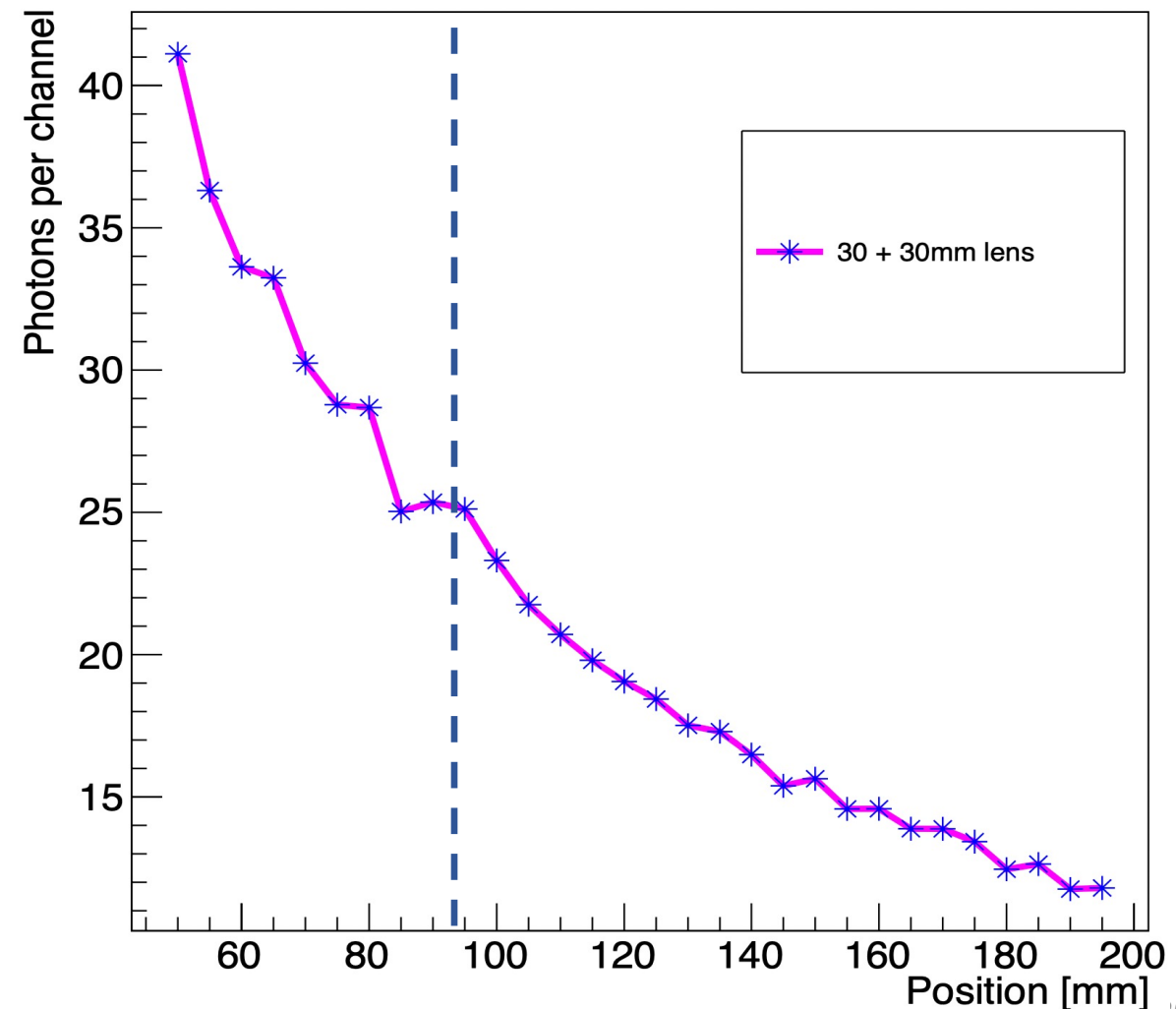
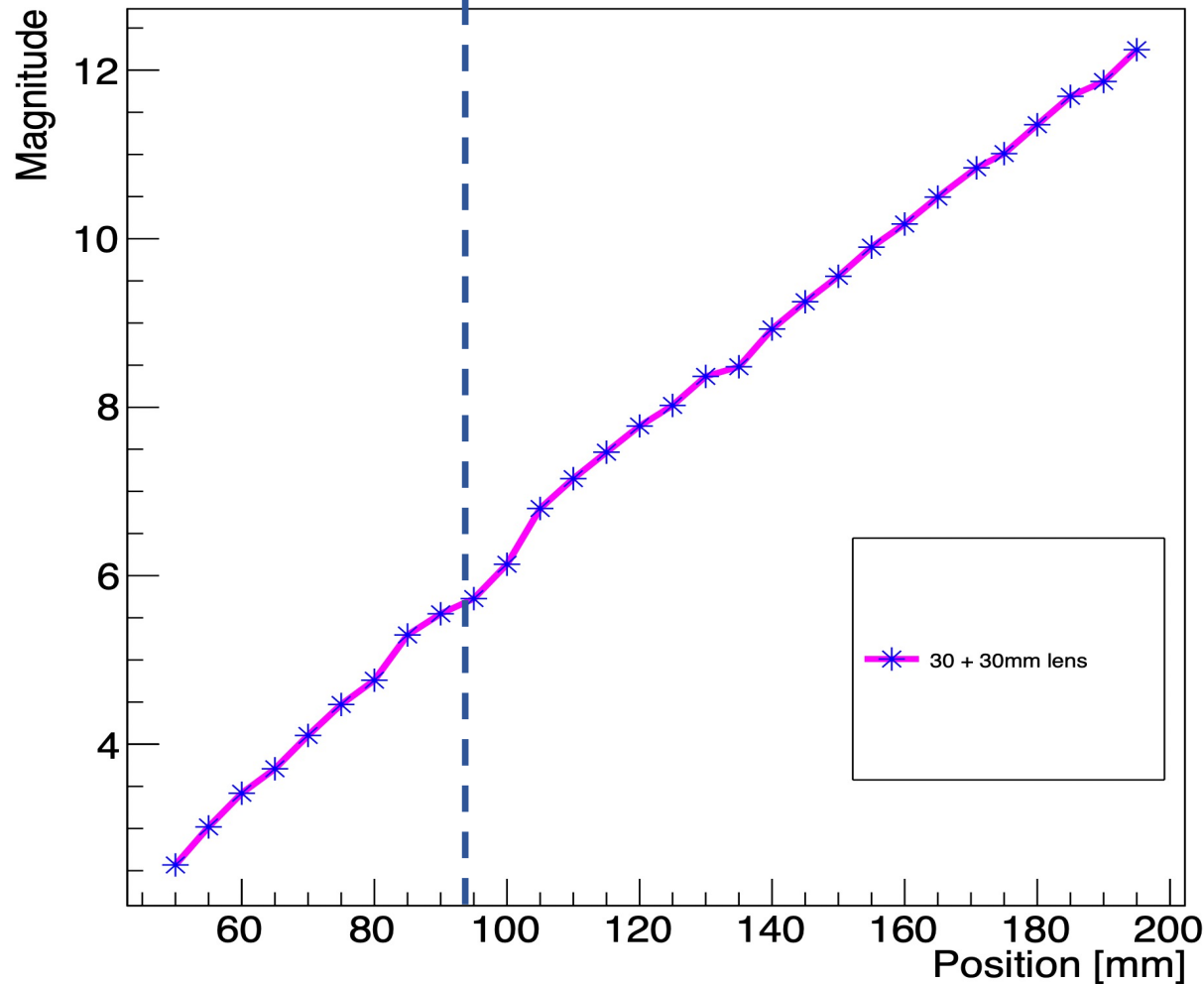


Magnitude, Photons Per Channel vs Position

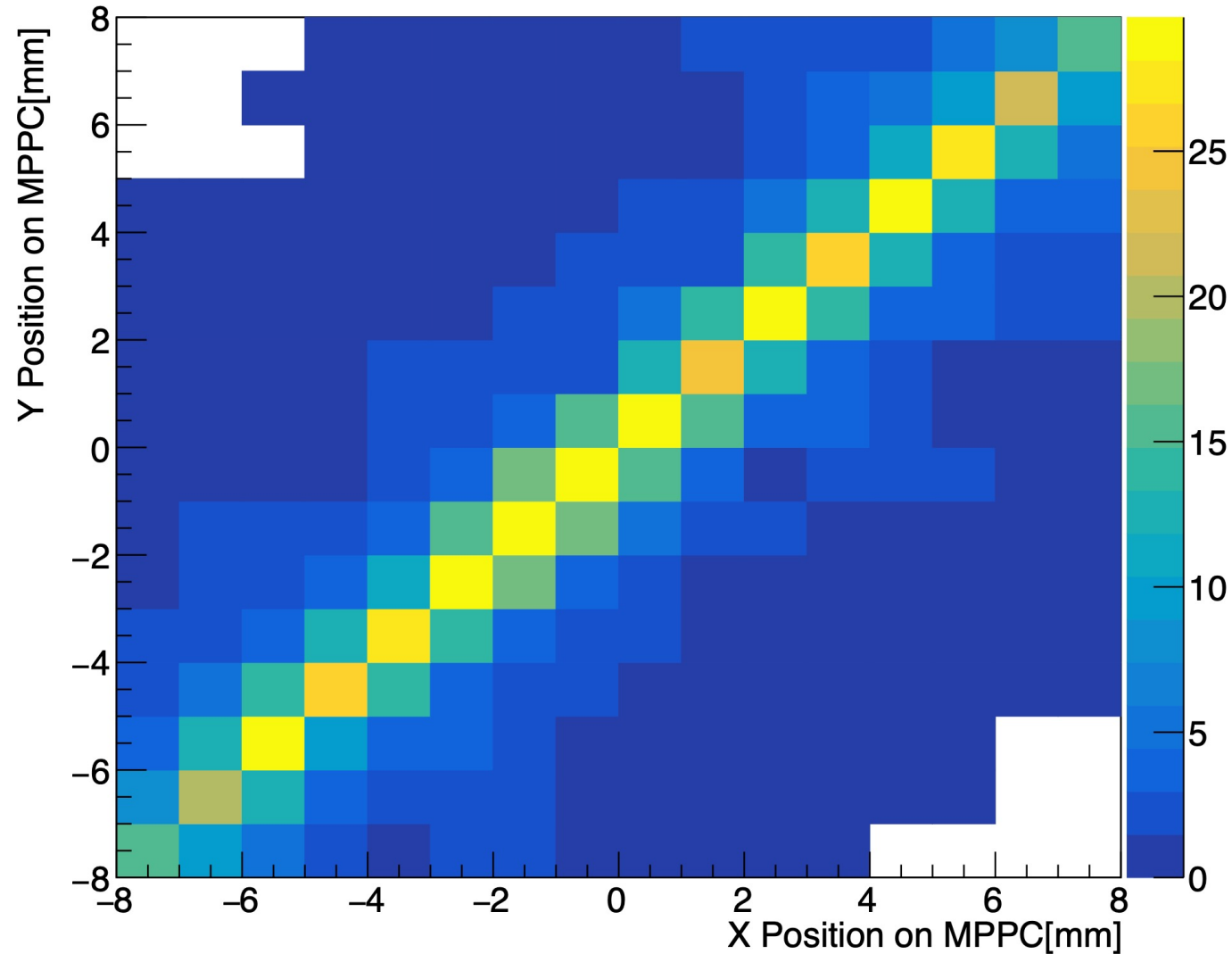


Lens Position of 95mm

Magnitude of 6 ----- 25 photons per channel

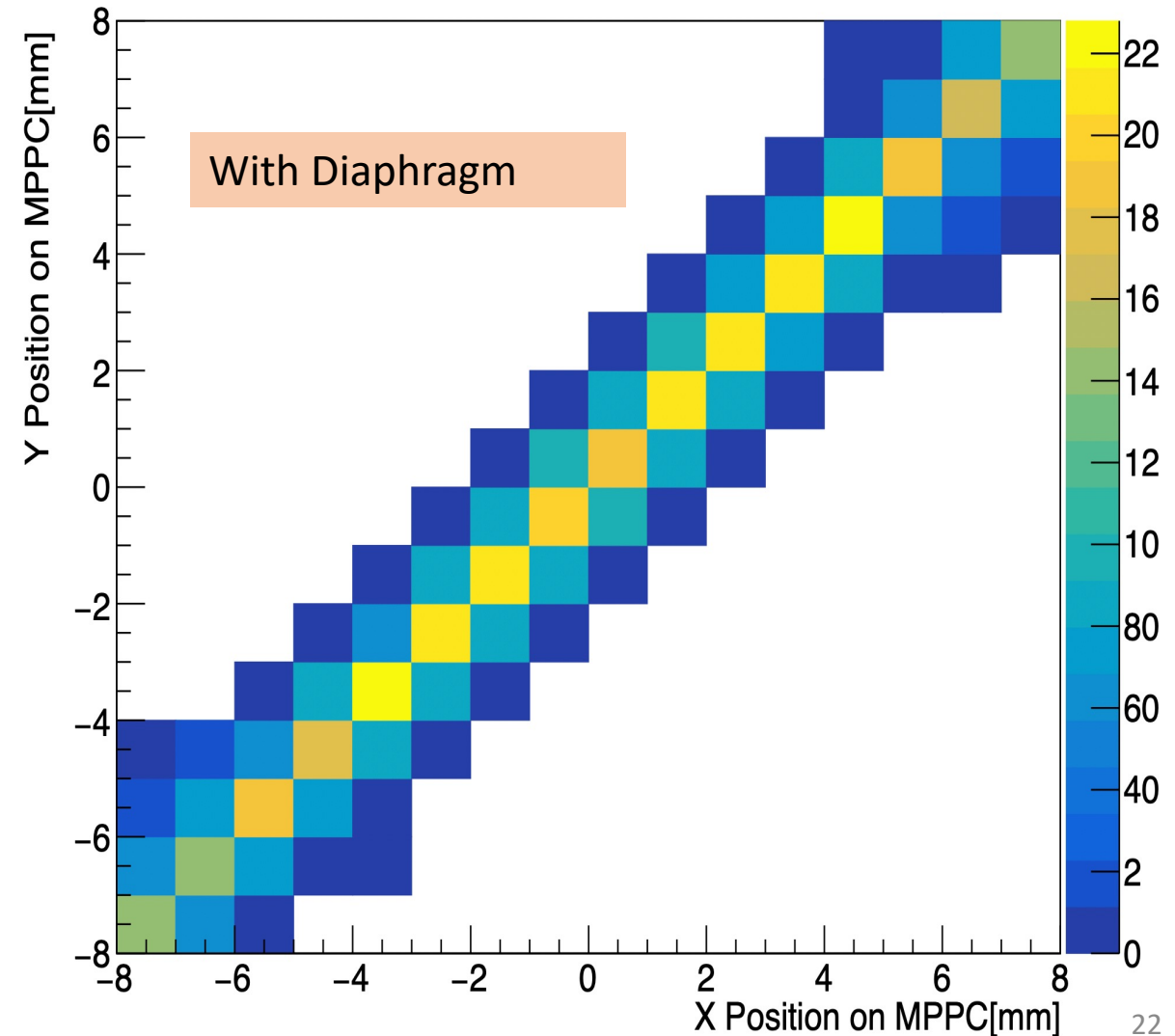
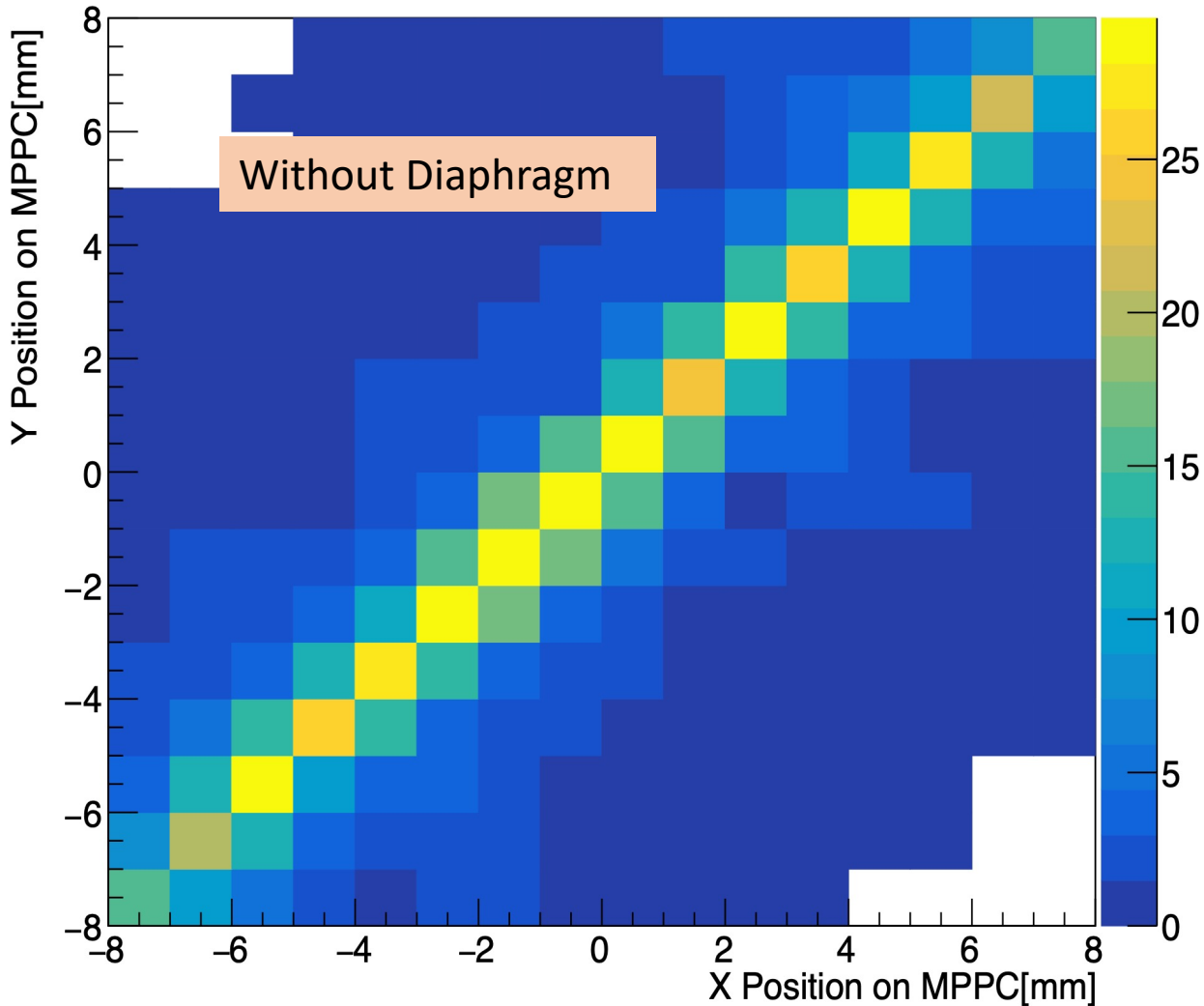


Projection on MPPC



Further improvements

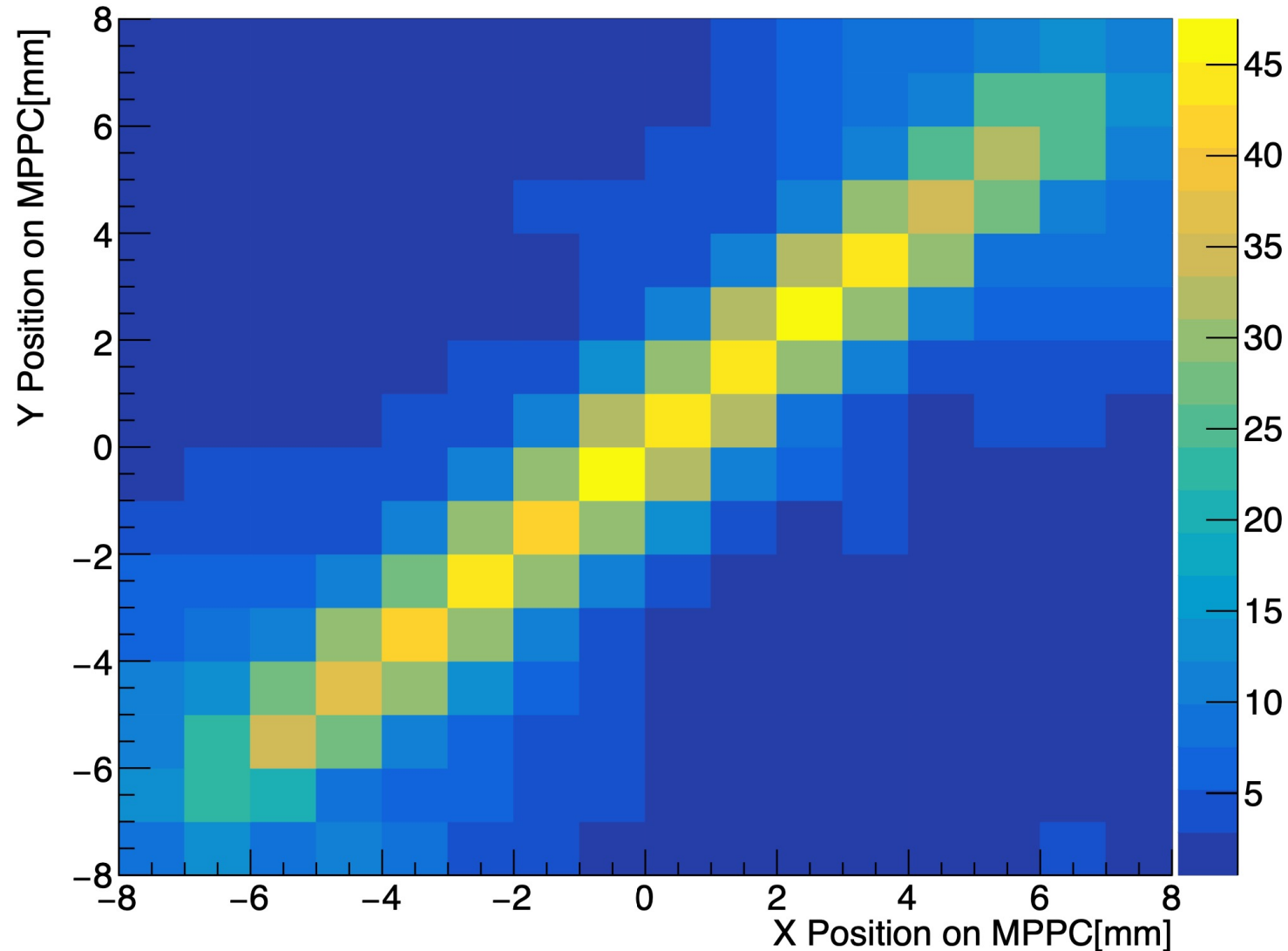
- Iris diaphragm for spherical aberrations (similar to photo cameras)



Further improvements (ii)

- Add a Convex Plane lens -> Double Number of Photons!

Lens position
140mm



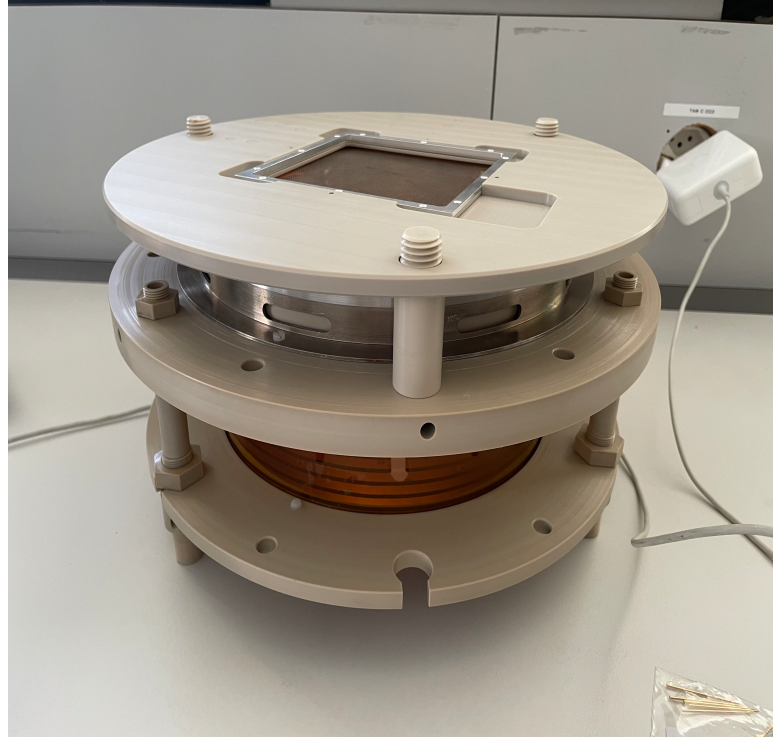
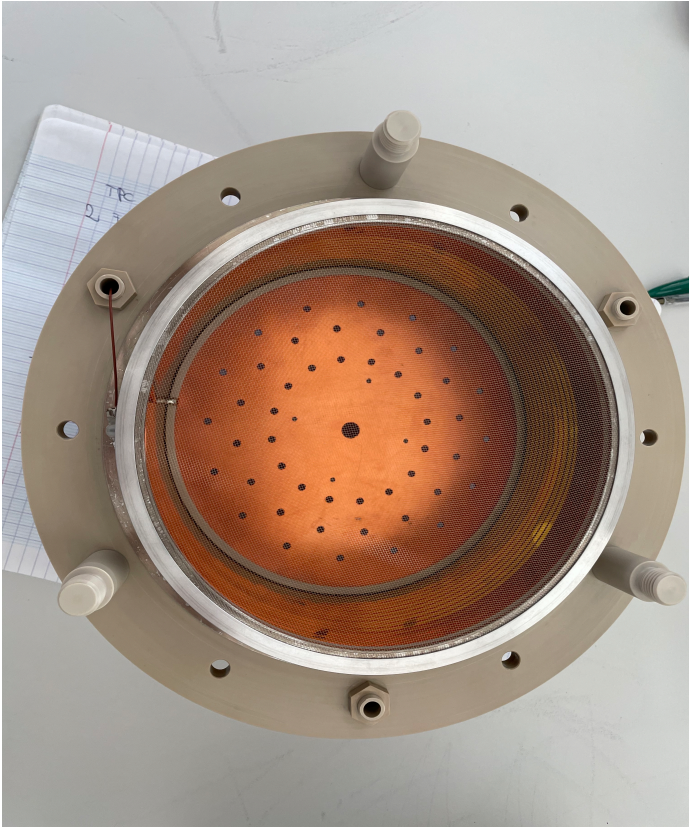
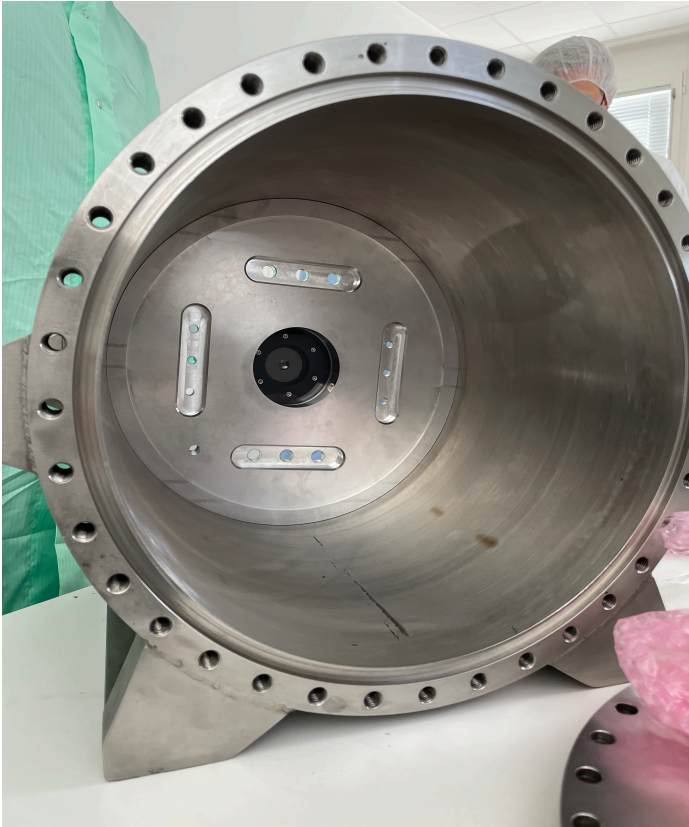
Current Status:

- Costruction done
- Data acquisition system set-up
- Comissioning ongoing:
 - Stability issues
 - Materials revisited
- Data analysis ongoing

Conclusion:

Work ongoing!

Thank you for your attention!



Bibliography

[1] <https://arxiv.org/abs/1012.0865>

[2] <https://www.hamamatsu.com/eu/en/product/type/S13615-1050N-16/index.html>

Backups

Photon per Channel – Magnitude

