# Radiation Hardness Photon Flux/Charge Studies

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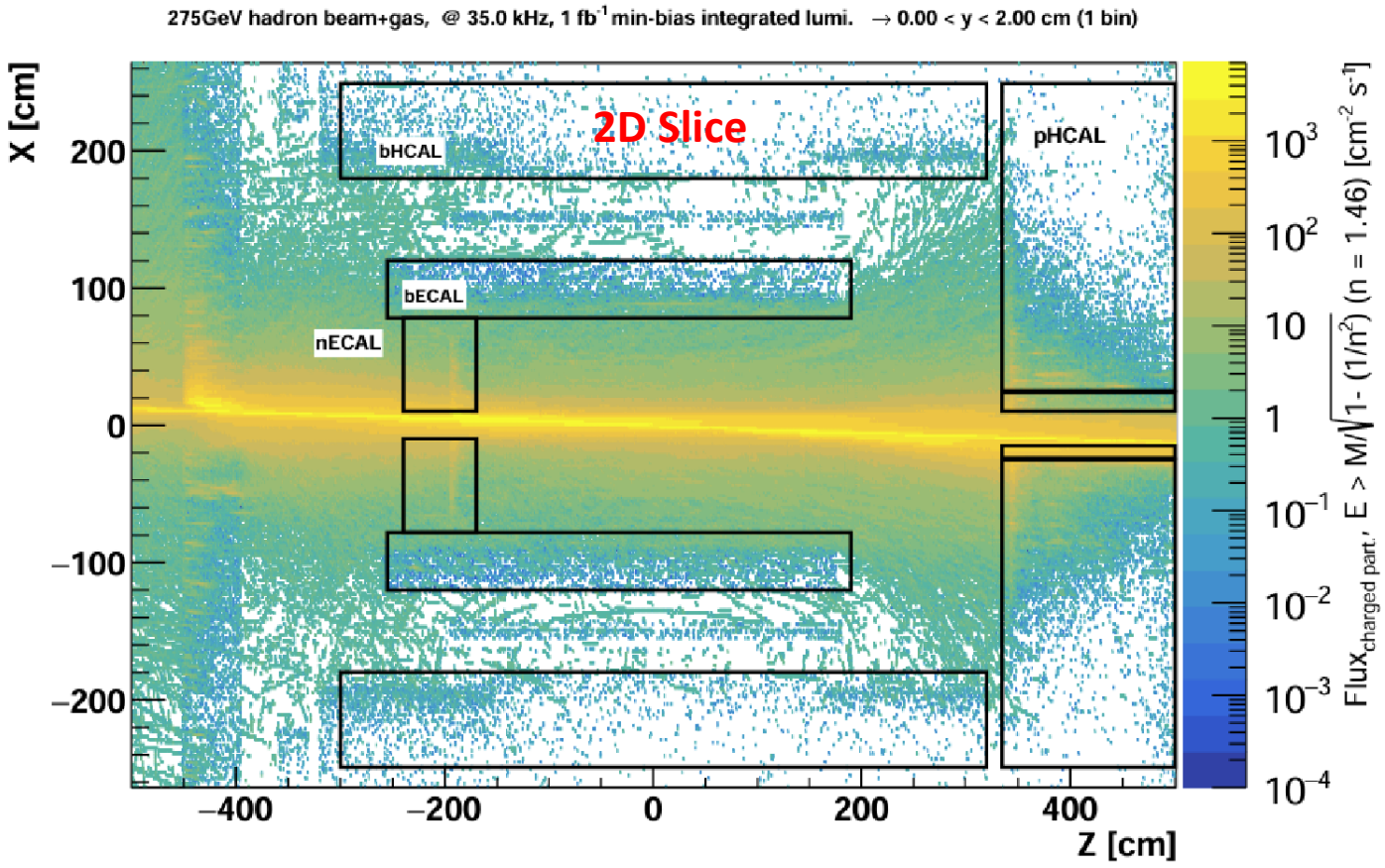
# Radiation Simulations

- Radiation simulations run by Alexander Jentsch, similar to those present on Radiation Doses - Electron-Proton/Ion Collider Experiment (bnl.gov) but with pfRICH specific considerations
- 3D map of Flux of all charged particles that pass Cherenkov cut

$$E > \frac{M}{\sqrt{1-\left(\frac{1}{n}\right)^2}}$$

- Separate histograms for n of aerogel and HRPPD window as well as particles produced via beam-gas interactions and DIS.



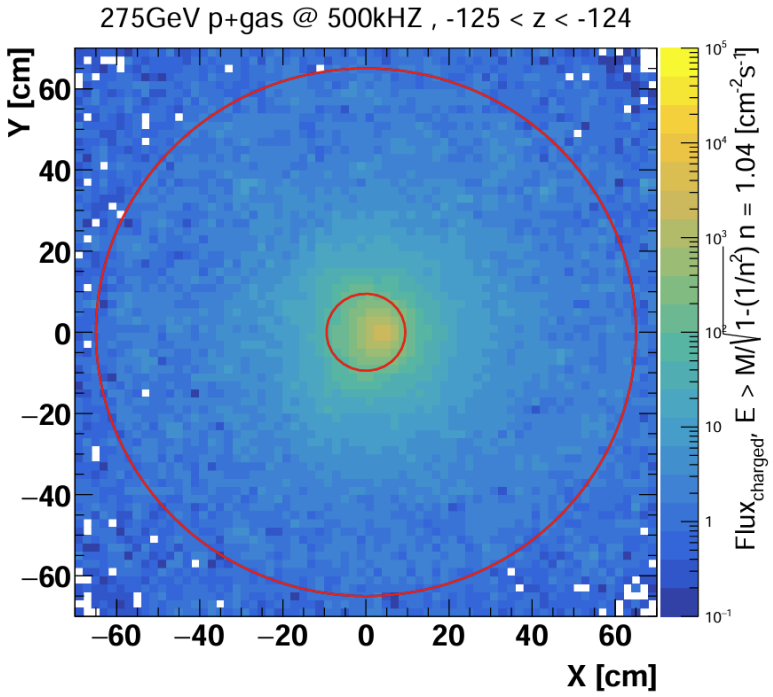
# Updates

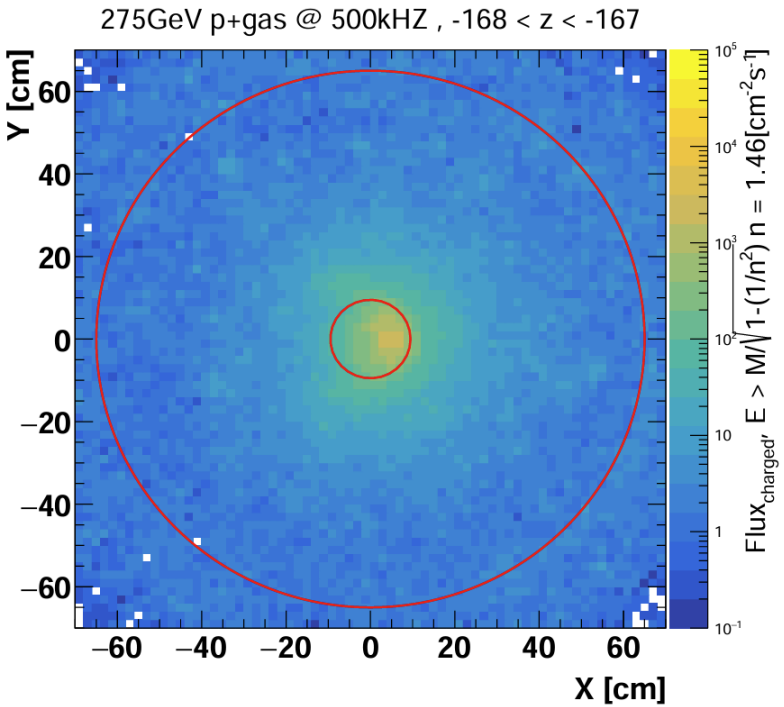
- Have now included electron-beam+gas contribution
- Photons originating from aerogel now spread 6-8cm equally in all directions
  - Expansion volume of 400mm and angle of 180mrad
- Assumptions:
  - 26 weeks of 24hr running
  - Luminosity of 1 x $10^{34} cm^{-2} s^{-1}$
  - Photons Produced per Cherenkov inducing particle (factors in quantum eff.)
    - Window: 100
    - Aerogel: 10
  - HRPPD Gain of $10^5$

# Flux Studies – Proton Beam Gas

- Contributions due to beam-gas interactions and DIS were simulated separately
- Take slice for particles passing window Cherenkov cut at z = -168, and for those passing aerogel cut at z = -125 to get total flux of particles producing Cherenkov

**Aerogel**



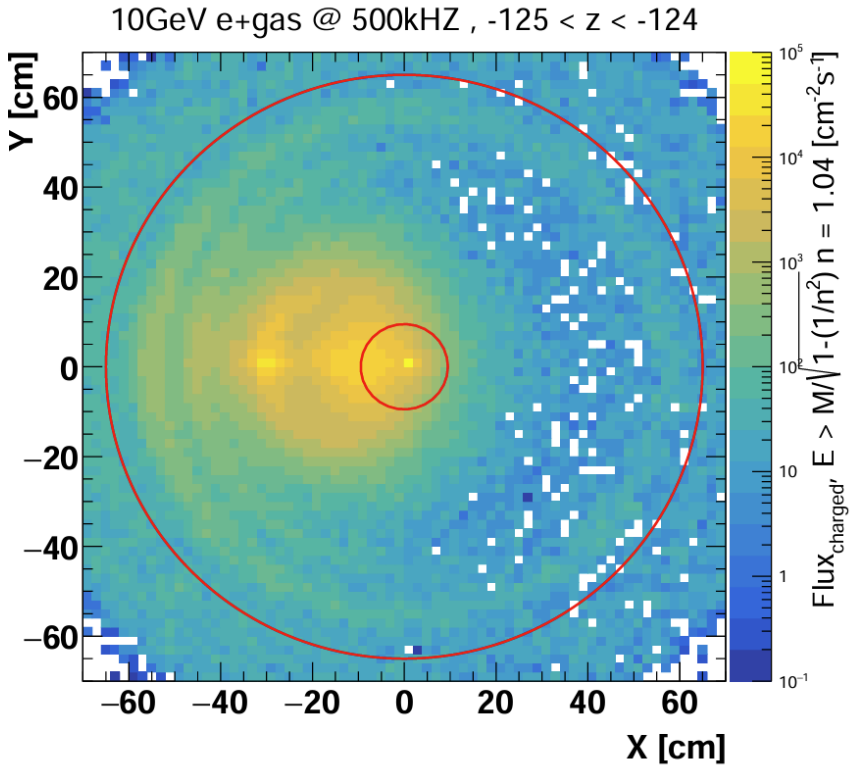



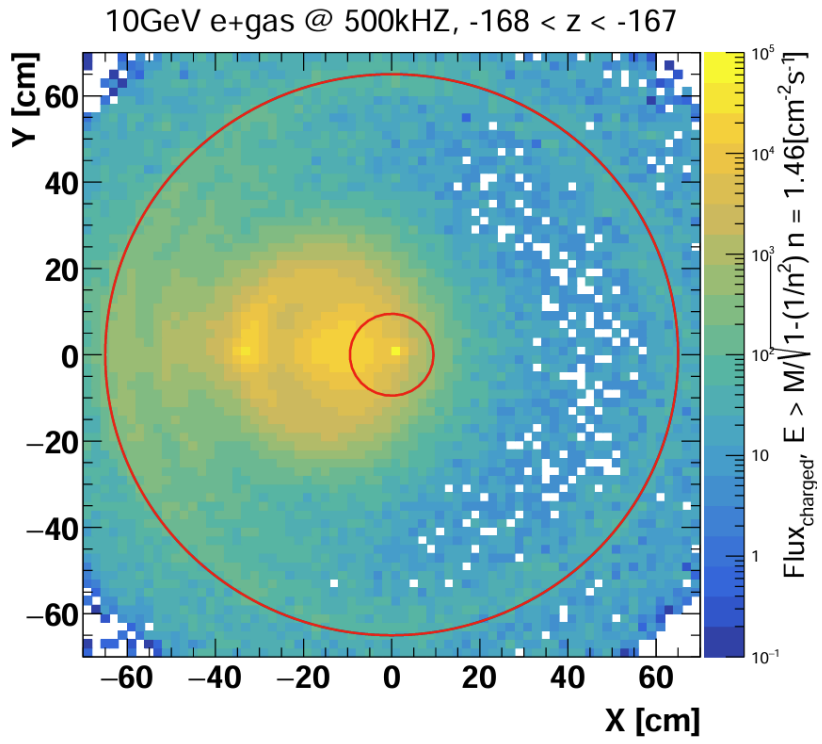

**Window**

# Flux Studies – Electron Beam Gas

- Now, largest contribution
- Causes largest dose to be offset from the beam-pipe

**Aerogel**



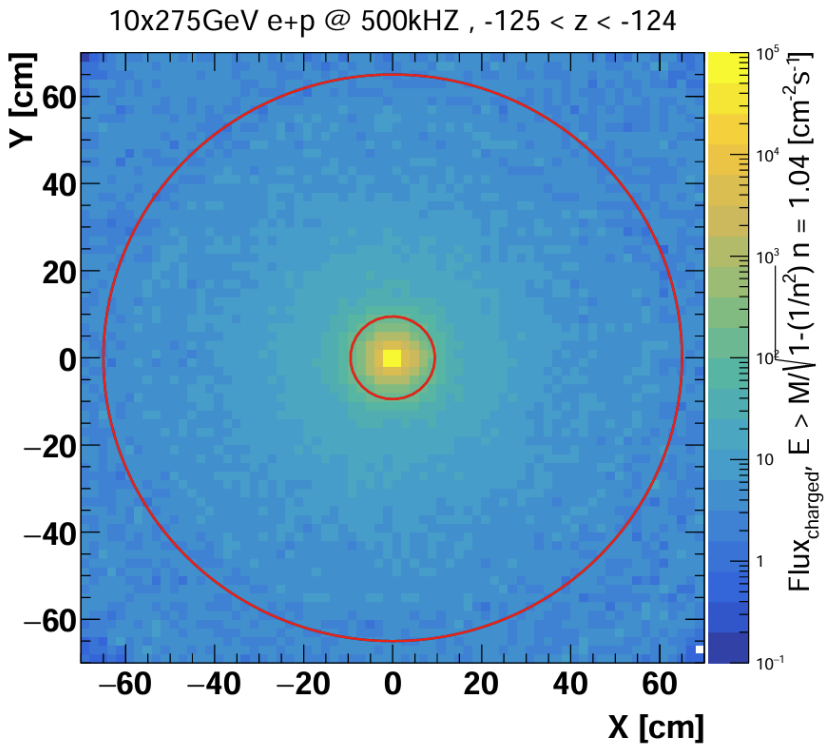



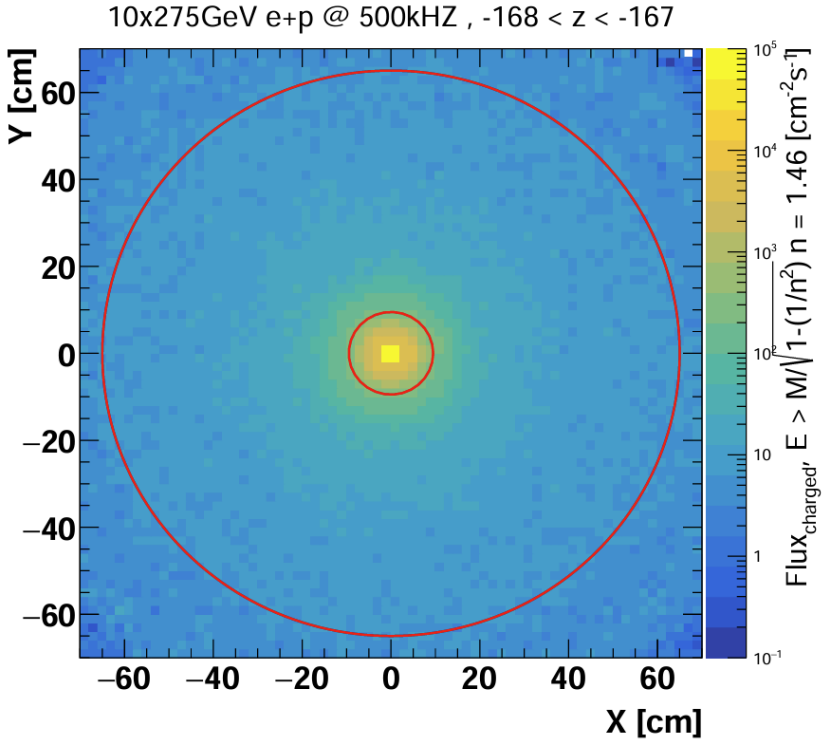

**Window**

# Flux Studies - DIS

- Repeat study for particles resulting from DIS
- Add together all contributions: aerogel/window DIS/Beam-Gas (next slide)

**Aerogel**

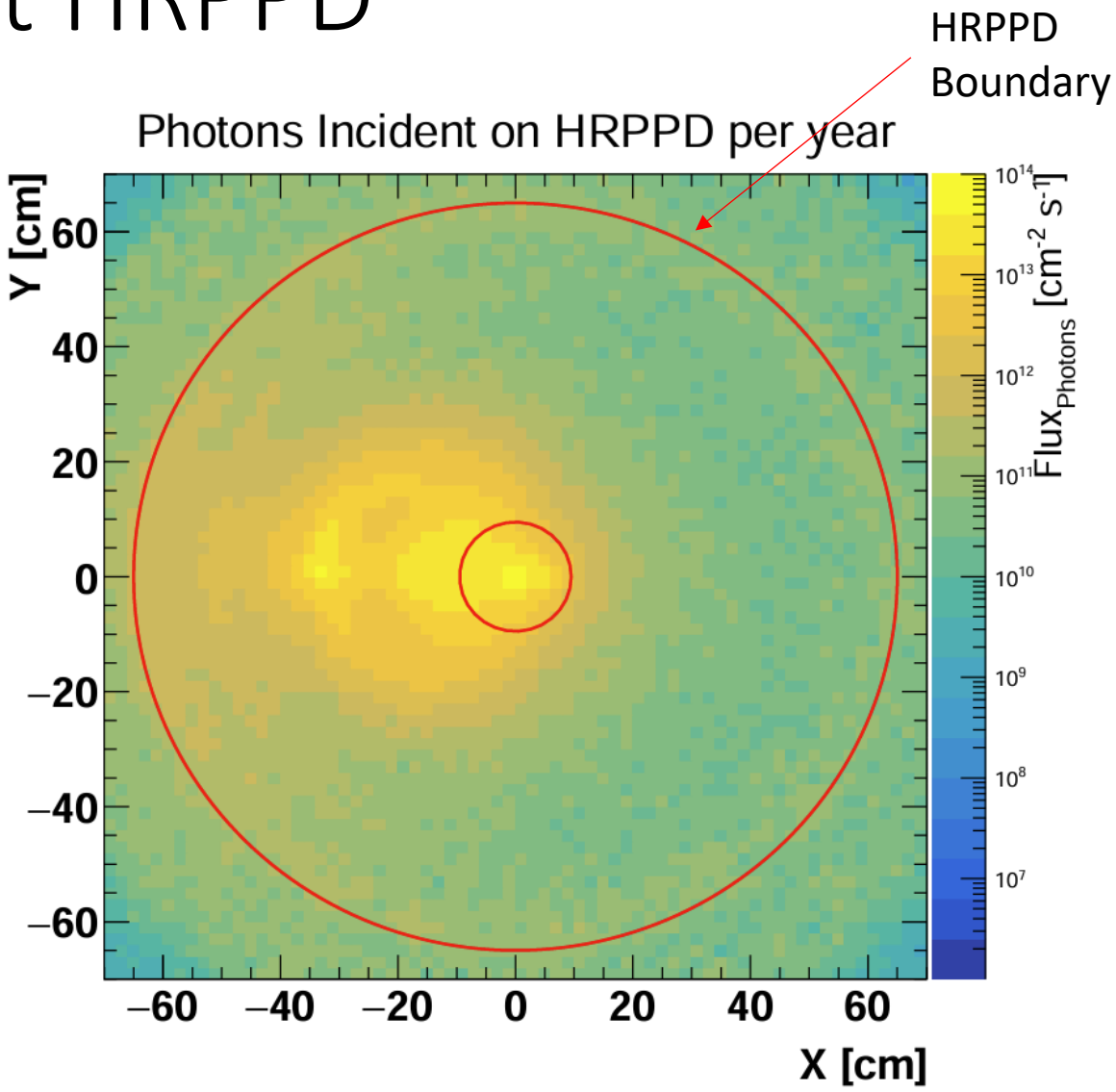



**Window**

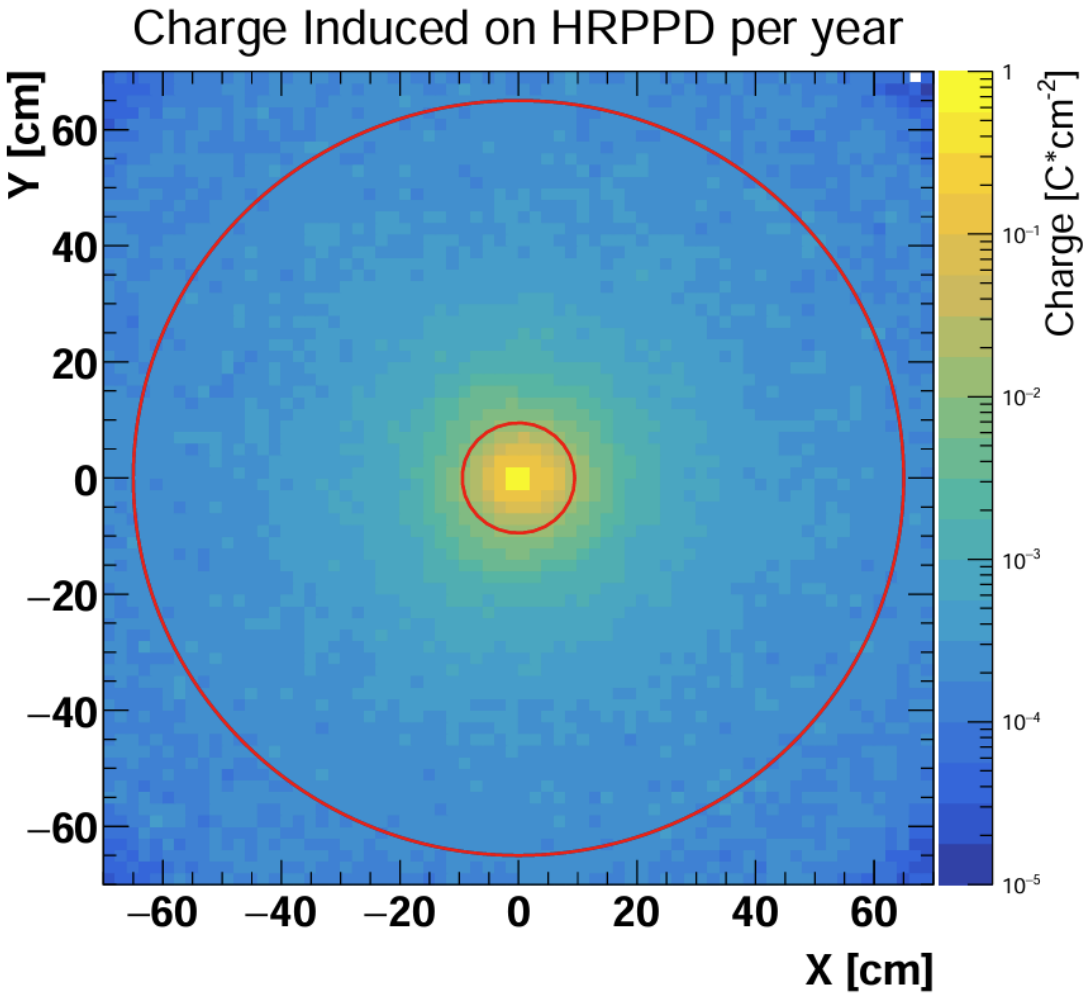
# Total Flux of photons at HRPPD

- Scale total per second flux by 26 weeks in seconds
- Add together both contributions, and scale to 100 photons/particle at window at 10 photons/particle at aerogel
- Assuming all photons travel straight ahead (naïve assumption for now)
- Total photons incident on HRPPD in one year of running



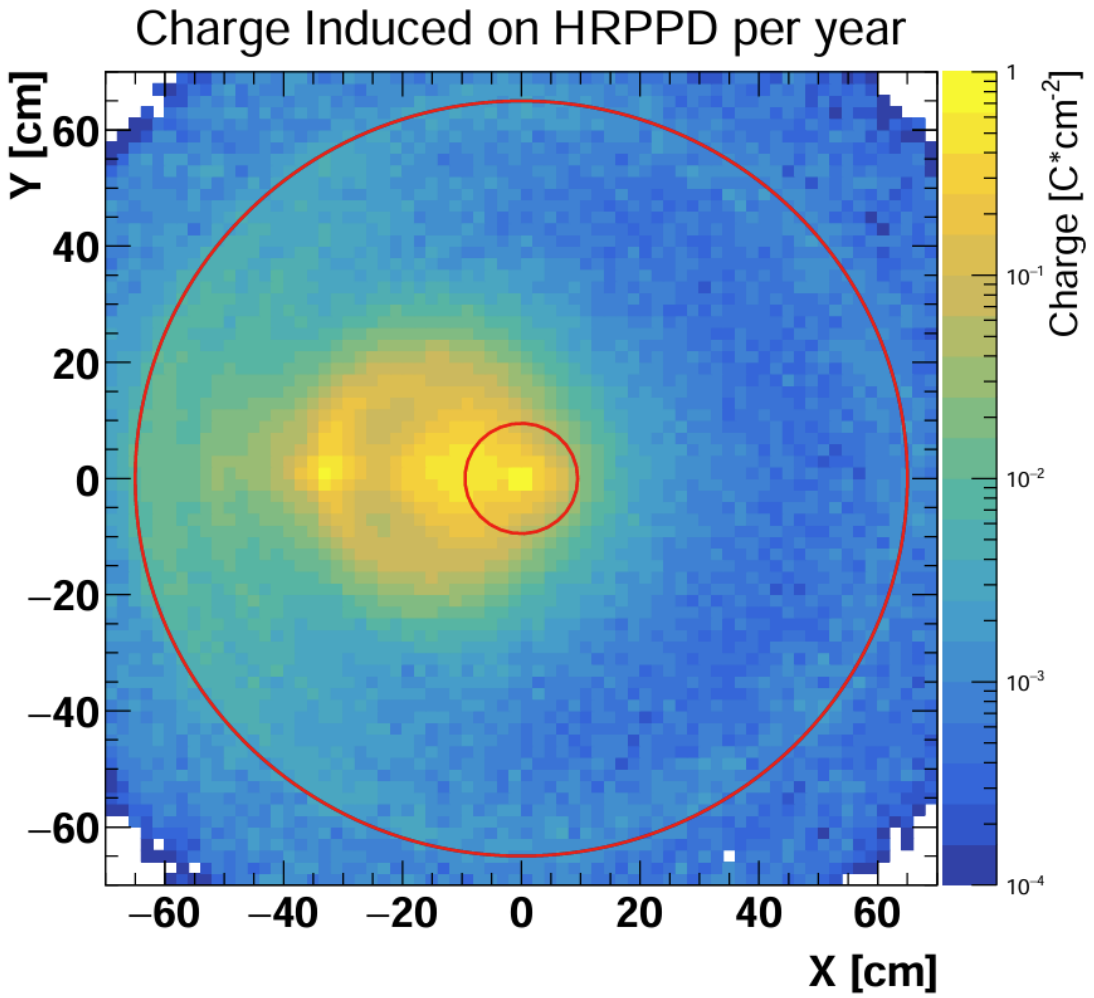
# Total Charge induced on HRPPD (Previous Estimate)

- Scale total flux by HRPPD Gain
  - assuming $10^5$
- Then scale by charge of electron for total charge induced in a year
- Within pfRICH radius:
  - Max Value: 0.011 C/$cm^2$



# Total Charge induced on HRPPD (Including electron-beam + gas contribution)

- Scale total flux by HRPPD Gain
  - assuming $10^5$
- Then scale by charge of electron for total charge induced in a year
- Within pfRICH radius:
  - Max Value: 0.805 C/$cm^2$
- Large Contribution in negative X is coming from electrons bent by B0
  - Max Value in Positive X: 0.021 C/$cm^2$



# Conclusions

- Electron-Beam + gas is by far the largest contribution to Cherenkov background.
- Requires better understanding of electrons deflected by BO
- After 10 years of running, would accumulate charge of approximately 8 C/$cm^2$ at gain of $10^5$
  - 26 weeks of 24hr running
  - Luminosity of 1 x $10^{34} cm^{-2} s^{-1}$
  - Photons Produced per Cherenkov inducing particle (factors in quantum eff.)
    - Window: 100
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  - HRPPD Gain of $10^5$