Radiation Hardness Photon Flux/Charge Studies

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Radiation Simulations

Note: All presented information are flux quantities, as there is ROOT issues preventing inclusion of up-to-date pfRICH geometry required for dose
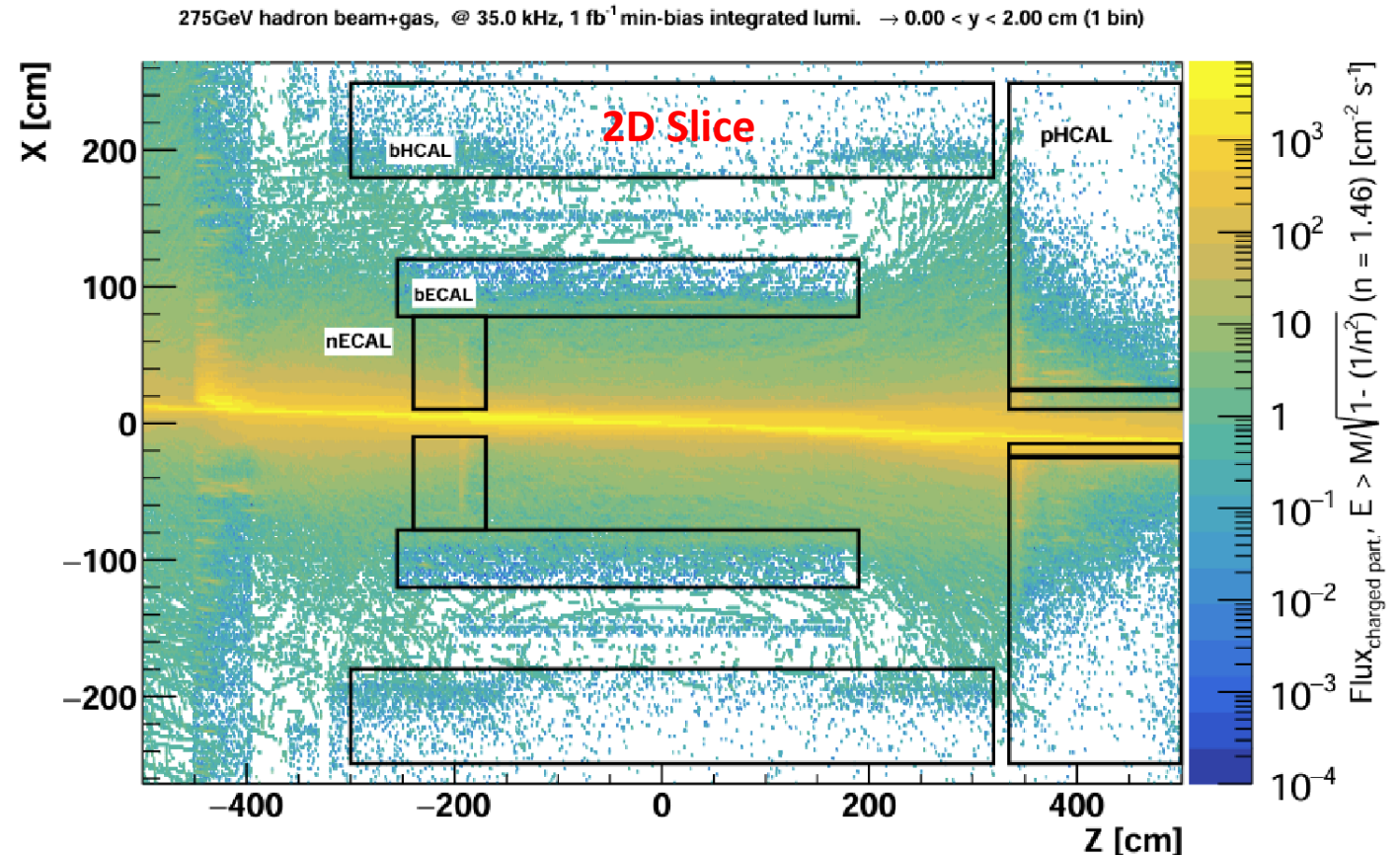
- Radiation simulations run by Alexander Jentsch, similar to those present on [Radiation Doses - Electron-Proton/Ion Collider Experiment (bnl.gov)](#) but with pfRICH specific considerations

- 3D map of Flux of <u>all</u> 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.

Goal

- To acquire a maximal estimation for the amount of photons/area and induced charge/area that will be incident on an HRPPD during a year of running

- 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 – 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
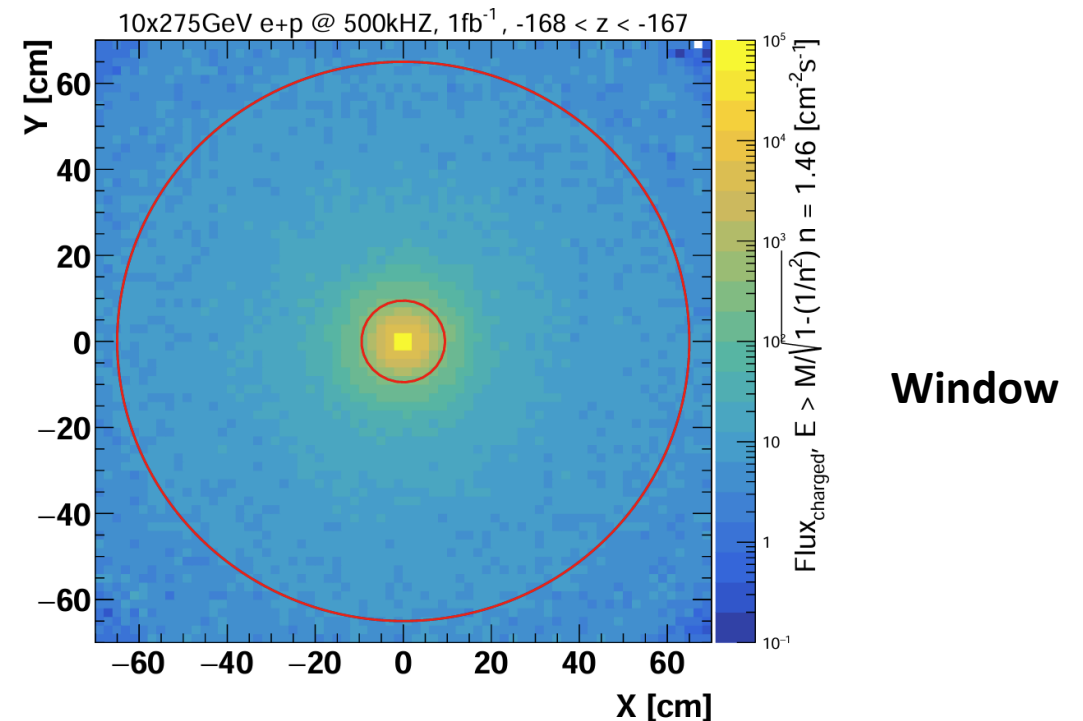
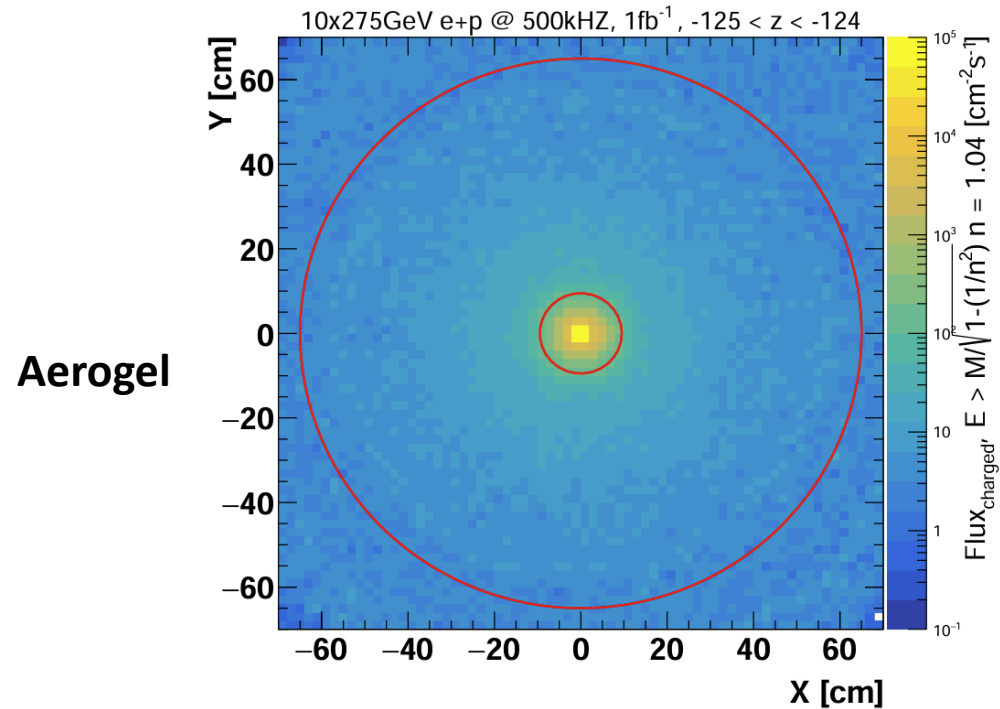Similar Flux across both window and Aerogel
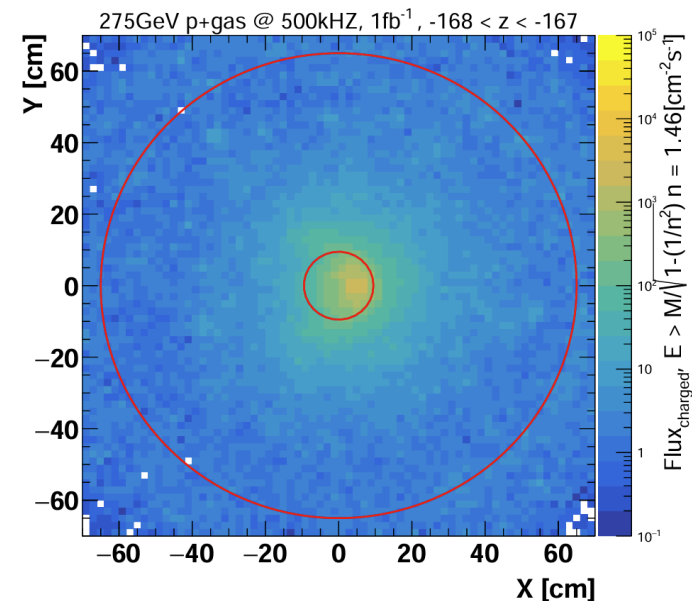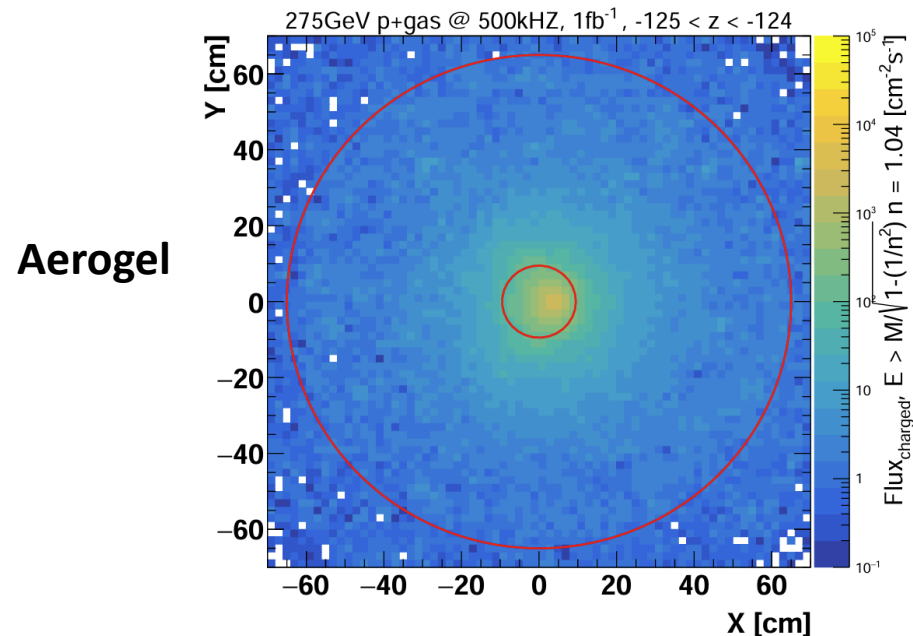
Flux Studies - Pythia

- 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

Photons Incident on HRPPD per year

HRPPD Boundary
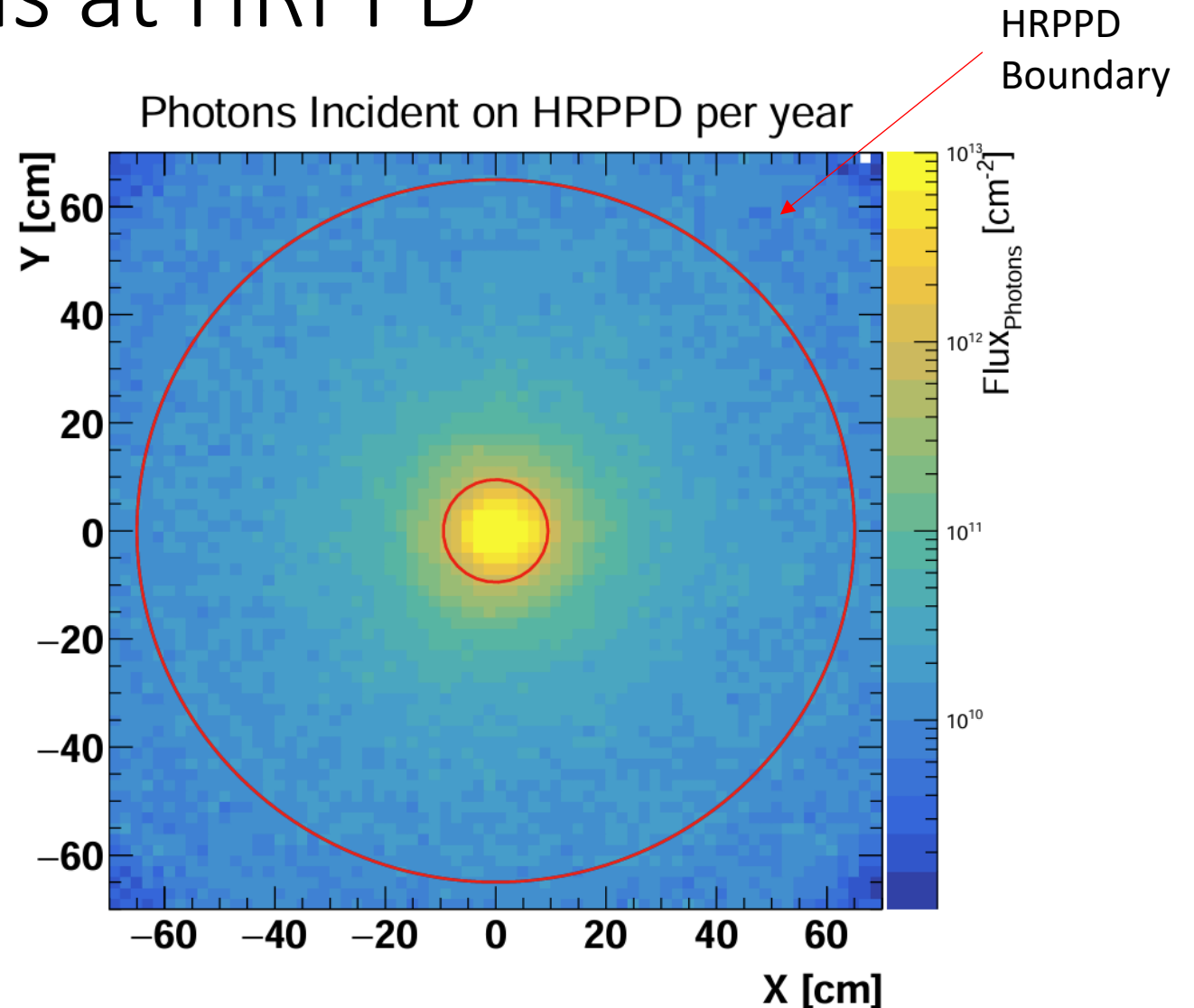
Total Charge induced on HRPPD

- 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
    Min Value: 0.00014 C/cm^2

Charge Induced on HRPPD per year
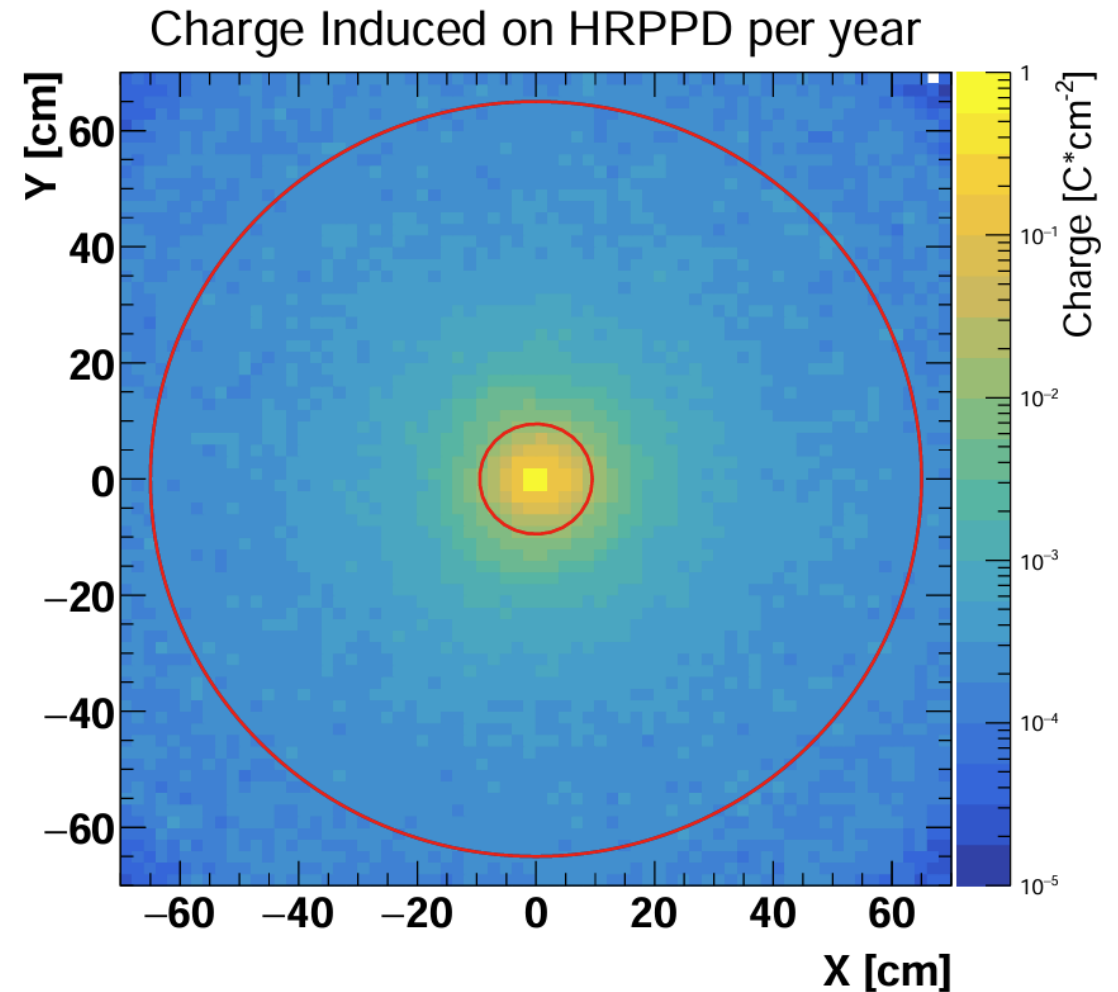
Conclusions

- After 10 years of running, would accumulate charge of approximately 0.11 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

    - Aerogel: 10

  - HRPPD Gain of 10^5

- At maximal gain of 10^7, would slightly exceed benchmark of 10 C/cm^2