Comments about projected luminosity for Hall C DVCS kinematics:
Charles Hyde 18 April 2013.

The radiation hardness of PbF2 and PbWO4 are similar. The Hall A DVCS experiment has run twice. Each time with several hundred hours at a luminosity of 1.0e37 (equivalent to 3.75 μA on 10cm liquid H_2) with the smallest angle crystal edge at 7deg. The light yield dropped by as much as 20%, but no catastrophic radiation damage occurred. The only 'curing' we have actually performed in production is to let the crystals sit for years in between the two experiments. In these Hall A experiments, the front face of the calorimeter is at 110 cm from the center of the target.

The proposed kinematics for the Hall A 12 GeV experiment and the Hall C proposal are in file DVCS-kin-E12-06-114-v3.xls. In our projections for the Hall A experiment, the distance *D*, from target to calorimeter was increased as necessitated to ensure separate identification of the two cluster events from exclusive π^0 decay. In our Hall A luminosity projections, we scaled the luminosity as $L = L_0\,(D/110cm)^2$, with L_0 = 1.0e37/cm²/s. In this manner, the dose rate per crystal is kept constant.

In the proposed kinematics for Hall C, the smallest angle of an active crystal edge is 3°. From Hamlet Mkrtchyan's simulations (see below), the sweep magnet reduces the dose rate by a factor of 10 for any fixed angle ≥ 5°. Furthermore, while the unshielded dose rate in a crystal at 7° is ~600 Rad/hour (at reference luminosity 1μA×10cm ~ 0.4e37), with the sweep magnet, the rate in a crystal at **3°** is only 20 Rad/hour.

In my initial luminosity estimates for Hall C, I used the luminosity scaling $L = L_0\,(D/110cm)^2$, but for central calorimeter angles < 5.5°, I reduced the projected luminosity by a factor of 10, to $L = (1.e36)(D/110cm)^2$. This factor of 10 reduction was an arbitrary guess to account for the rapid rise in the background at small angles. Hamlet's background study suggests that the sweep magnet will allow us run at high luminosity even at small angles. On the other hand, we have not yet fully quantified the effect on the (e,e'γ)X missing mass and the pi0 mass reconstruction from fluctuations in the background. Event-by-event fluctuation of individual ~100 MeV photons can significantly degrade the resolution.

In my revised spreadsheet (v3), I propose a luminosity compromise, for the three run groups I have identified:

- Hall C complement to Hall A: $L = (1.e37)(D/110cm)^2$.
  - These are all relatively large (calo) angle settings. Background will be modest.
- Low-x Extension: Run at reduced luminosity $L = (1.e36)(D/110cm)^2$ for the three out of four settings with θ_q <5.5°.
  - The count rate is still high because the BH is large, so systematic precision is important.
  - Even at reduced luminosity, this whole run group is only a few days.
- High-Q^2 Extension: Run at full Luminosity: $L = (1.e37)(D/110cm)^2$.
  - These points are more speculative, as the cross section is very low.

- We can run this late in the experiment, when we understand backgrounds better, and we can afford to be a little risky with the Calo.
- If we don't run at full luminosity, we may not have any chance of getting a signal.

The spreadsheet has both a detailed worksheet and a summary worksheet. The 'current' row is calculated for a 10 cm target.

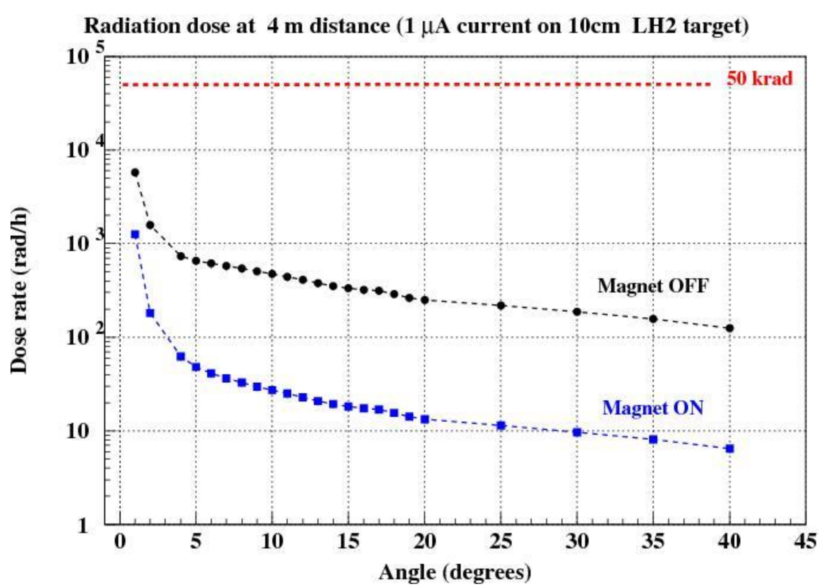
There is a further issue in the target to distance parameter *D.* For the settings 'Hall C Complement', this is optimized to 3 m. Increasing this to 4 m (as required for the sweep magnet design) will significantly reduce the *t*-acceptance. I see four possible options:

1. Move the calorimeter back to 4 m and accept the loss in acceptance
2. Run without the magnet at these settings, since they are at larger angles than the Hall A experiment, which is running without a sweep magnet
3. Move the magnet 25% (about 30cm) closer to the target for these settings. This should be (barely) possible, again, these are large angle settings.
4. Modify the magnet in the middle of the run by increasing the gap (lower field). Or build a second magnet, and swap magnets in the middle of the run.

For the proposal, I suggest we stick with the full acceptance at 3m, and worry later how to resolve the problem (or compromise the acceptance).

Total (γ+e^-+e^+) Dose Rate as seen by the π^0 detector

Radiation dose for a detector at a distance of 4 meter, assuming 1 μA and 10 cm LH2



- Dose rates are typically between 10 and 100 rad/hour with sweeping magnet on
- 50 krad is a conservative limit for accumulated radiation dose before UV curing