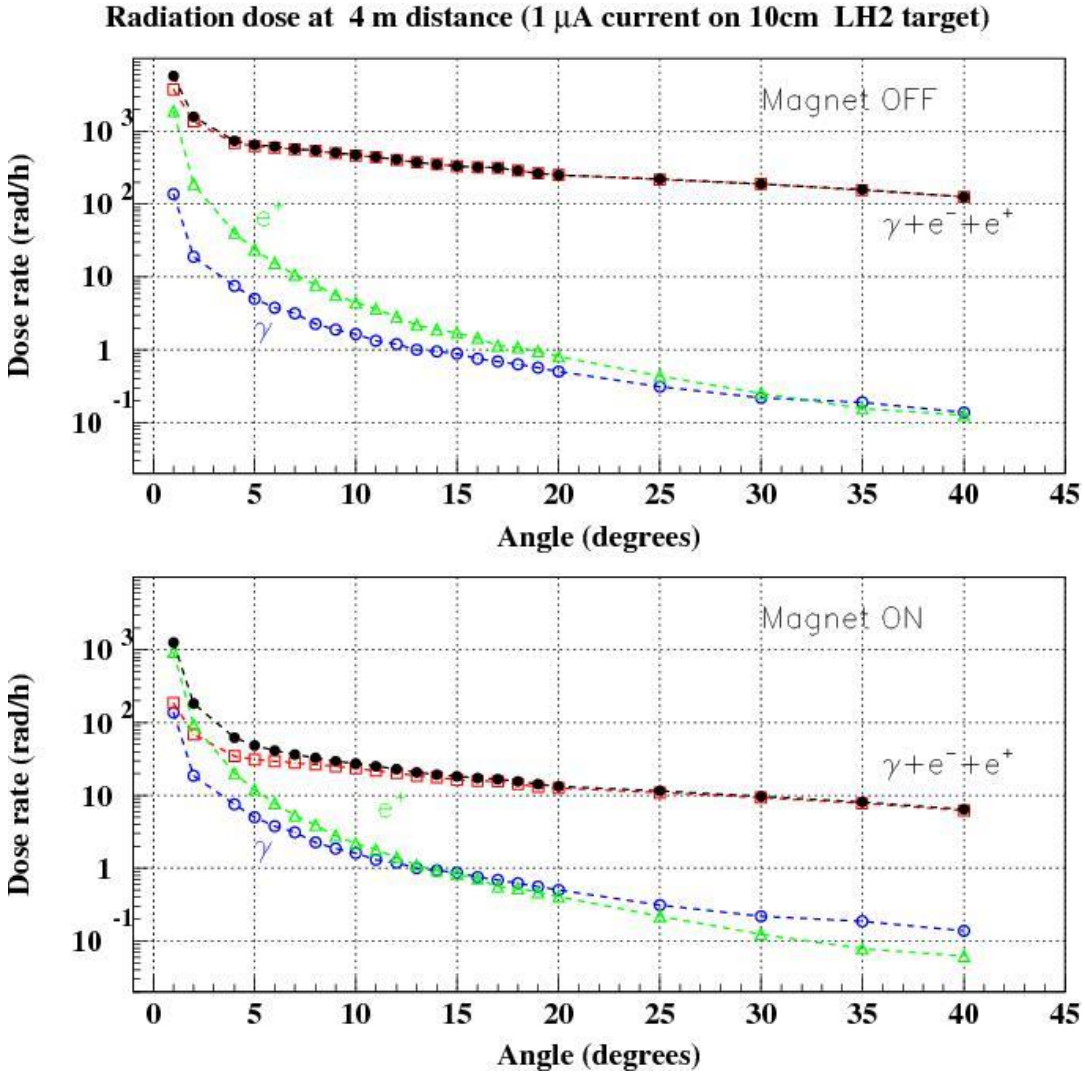
Dose rates estimation

- Radiation dose rates from Pavel Degtiarenko's realistic background simulation have been used, taking into account photons, electrons and positrons. The rhs scale in several of the simulated background rate plots of the PAC-39 C12-11-102 proposal show radiation doses for a detector at a distance of 1 meter, at 6.6 GeV, 1 μA beam current, and a 10 cm LH2 target.
- For a detector at a distance of 4 m from the target, these numbers scale down by a factor of 16.
- The dose rates in the C12-11-102 proposal are without the effect of a sweeping magnet. To estimate doses with such a magnet (magnet ON) as compared to no magnet (magnet OFF), the dose rates for electrons and positrons were scaled down proportional to their change of flux. The flux with magnet OFF and ON was taken from the simulated distributions (with E > 1 MeV).
- The realistic background simulations were cross-checked for an 11 GeV beam energy, with backgrounds found to be very similar (slightly reduced by ~10%) as compared to 6.6 GeV. This is because the background is predominantly induced by the beam-target interactions, with the envisioned beam pipe only contributing 10-20%. The detailed background simulations at 6.6 GeV beam energy were further used.
- Slide 2 shows the dose rates from photons, electrons, positron and total doses versus angle.
- Slide 3 shows data from a NIM paper about radiation effect studies of $PbWO_4$ for the LHC.
- Slide 4 shows the total dose rates as function of angle with magnet on and off as compared to a conservative 50 krad dose limit before UV curing is required.
- The 50 krad dose limit is conservative as we did not take into account any additional shielding materials, and that actual dose rates out-of-plane are much reduced. In addition, we integrated over all low-energy particles Pavel included in his calculations all low energy particles, when in reality one would not anticipate much damage from electrons with energies below 1-2 MeV.

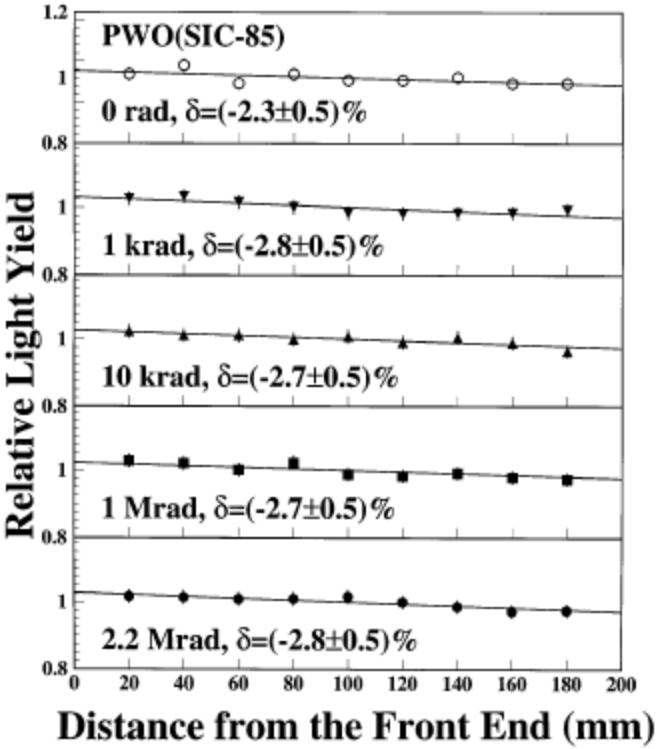
π^0 Detector Dose Rates as generated by γ,e^- and e^+

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

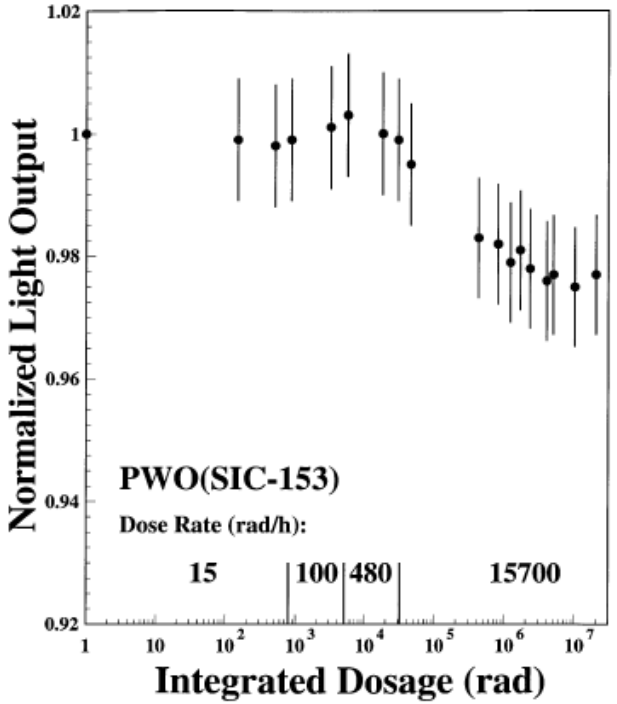


This represents the integrated radiation dose without cut in energy

Effect of accumulated radiation dose for PbWO4 per LHC studies



The light response uniformity as a function of the integrated dose for PbWO4 (From R.-Y. Zhu, NIM, A413, p297, 1998)



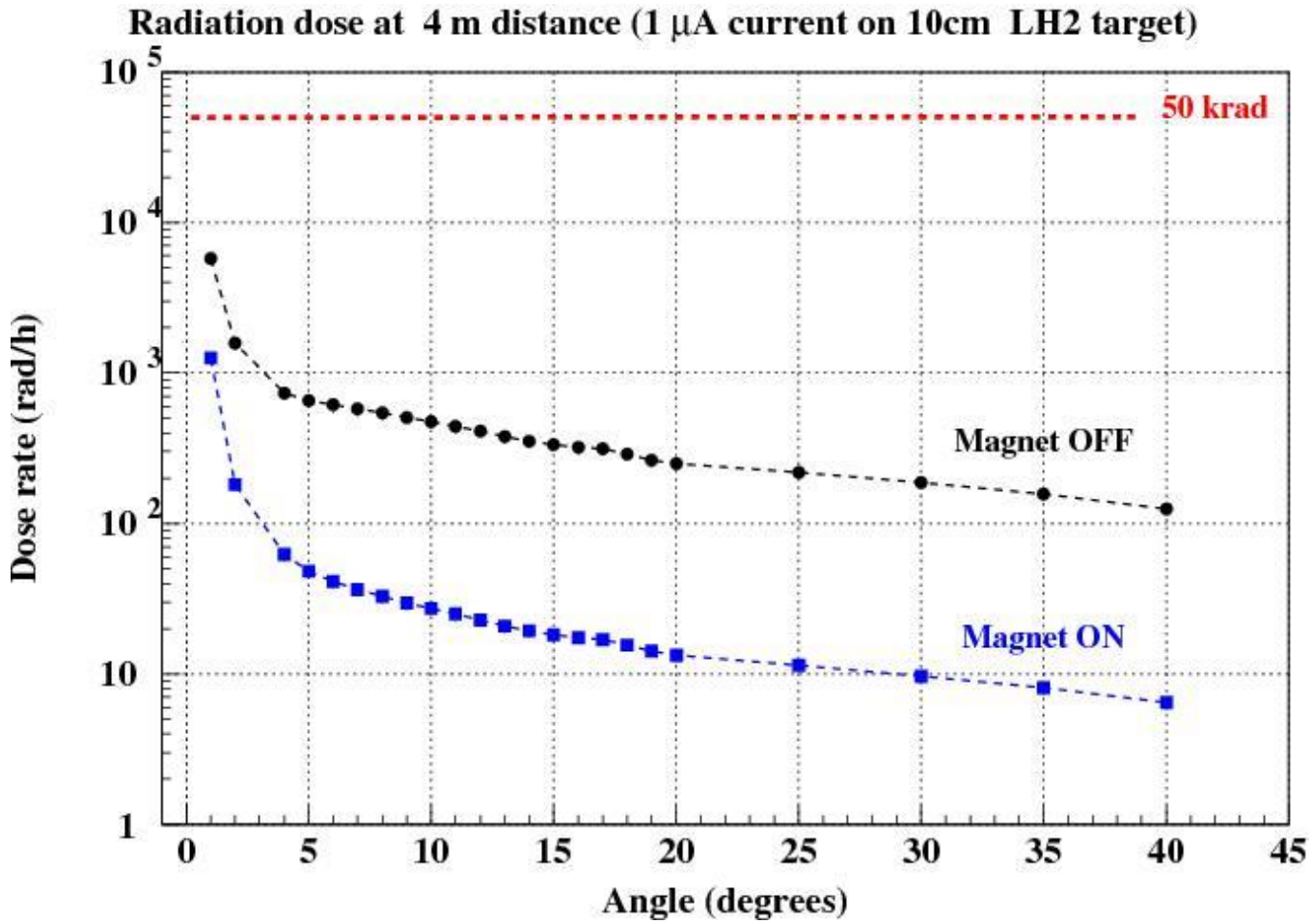
The normalized light output of PbWO4 crystals as function of the integrated dose (From R.-Y. Zhu, NIM, A413, p297, 1998)

Conclusion: light output and slope do not change up to an accumulated dose of 50 krad, with only small effects up to an accumulated does of ~2.2 Mrad.

This result confirms that the mechanism for scintillation is not damaged, with only the front few cm subjected to the radiation dose. (Note: expected dose rates at LHC are ~15-500 rad/h).

Total ($\gamma+e^-+e^+$) 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