Comments for the RSC Meeting of August 10, 2006 on ERL
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The meeting is called to get feedback from the committee on two items for ERL.

The first is to get committee input on the critical devices (see reference 1) that are planned for terminating the radiation sources when needed.

The second item is to consider the potential fault doses and what limits and devices the committee will recommend as acceptable for use to reduce such faults. The physical configuration is being reconsidered and it is an opportune time to get feedback from the committee on what is an acceptable radiation protection scheme.

Two documents with different approaches have been prepared to address the radiation issues outside the shielding. The first uses MCNPX calculations (see reference 2) to determine dose rates under specific conditions. These calculations should be considered accurate for the geometry to which they are applied. The second method uses thick target formulas coupled with broad-beam attenuation numbers. This method is conservative in that it uses a target that is optimal for generating radiation and attenuation (broad beam) that assumes uniform irradiation of the interior wall. The committee is not requested to review these specific calculations but to use them as a guide to the potential radiation levels outside the shielding under fault conditions.

The present shielding consists of four feet of light concrete. Locations and methods to place additional shielding are under consideration to reduce the potential dose rates in faults. Methods to limit the amount of lost beam using devices that are part of the ERL equipment are being considered, which will/could supplement the chipmunks that will be used to detect radiation outside the shielding. The project would like guidance as to how much credit can be given to using these devices in evaluating the shielding configurations. The following methods are being considered:

- Reduce Gun current by reducing laser power.
    - Maximum gun power 1 MW.
    - Routine gun power 100 kW.

- Reduce Beam losses by using two beam current transformers in differential mode. Factors of 10^{-4} to 10^{-5} are considered to be practical.

- Reduce power to the 5-cell accelerating cavity. A factor of 10 may be possible.

- Limits on local (global) beam loss
    - 1 MW assumed at gun energy (3.5 MeV)
    - 50 kW assumed at 25 MeV
    - Machine protection at few microamps (about 10^{-5})

The area outside the shielding will be posted as a radiation area. An unplanned exposure of 100 mrad is a reportable occurrence. This may establish the scale for the largest potential fault doses. This corresponds to 360 rad/hr for a fault of 1-second duration.

3.5 MeV Beam Loss

Maximum power 1 MW – localized loss outside shielding 15 rads/hr

- Loss not sustainable due to equipment damage, but do not have a better estimate of the limit
- 15 rads is conservative.

Reduce Laser Power 100 kW – 1.5 rads/hr

- Methods acceptable by committee

Current transformers in differential mode (10^{-3}) – 1.5 mrem/hr.

Chipmunks

25 MeV beam Loss

Max. sustainable loss 50kW (beam is about 10 MW)

- The max. the power supply can provide to 5-cell cavity
- 90-degree dose rate 1.- 13 rads/hr -- assume 4 rads/hr for now.
- 0 degree dose rate 2,700-13,000 rads/hr—assume 5, 000 rads/hr
- approx. 2mA of beam loss
- expect machine protection at few microAmps

Chipmunks will be distributed to detect losses. Several may be on the roof.

Two beam current transformers in differential mode to limit losses

- 10^{-3} to 10^{-5} possible
- keep alive currents
- place in ACG configuration control.
- Null detection for differential mode
- Possible fast turn off if hardwired to laser.

Limit gun power via laser to 100kW

- Decreases probability of maximum fault, not max.

Limit power to 5-Cell Cavity

- Decreases max. fault – factor of 10

Duty factor and/or administrative processes to limit current

Establish max. loss per meter that machine can tolerate without failure

References

1. E-mail from J. Reicht to D. Beavis, August 7, 2006.
2. K. Yip, " radiation Estimates Related to the Energy Recovery Linac Facility (ERL) ", March 22, 2006
3. D. Beavis, "Simple Estimates of ERL Radiation", August 1, 2006.