

## ILC Shielding calculation results (primary results)

Wen Yin

Institute of Physics, Chinese Academy of Science

wenyin@aphy.iphy.ac.cn

In this document, I give some primary results about the ILC Ti-6%wt-4%V target shielding design. Parameters needed for detailed design are not complete and the following is based the parameters provided in your documents.

### 1 Geometrical model

Figure 1 gives the geometrical model of the Ti-6%wt-4%V target. The rim has a radial width of 5cm and a thickness of the target 1.4cm. Each strut has a width of 4cm in the plane transverse to the beam. The incident photon beam spot size is 3mm.

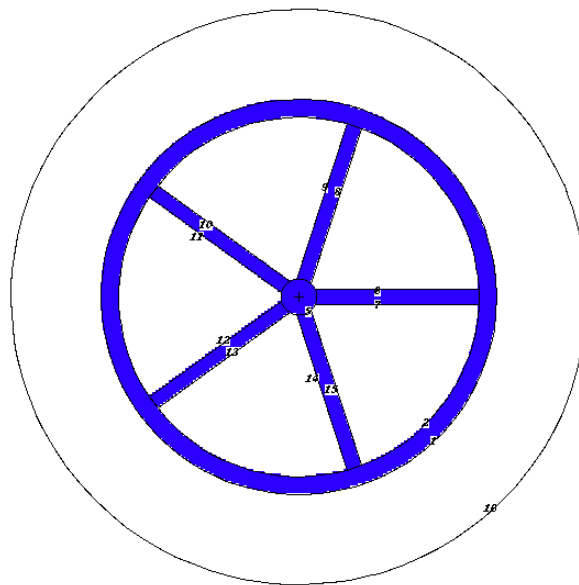


Fig1. Vertical cut of the target (the photon beam direction is perpendicular to the paper)

### 2 Heat deposition of the target with the different photon beam power

Table 1 gives the heat deposition of the target with the different photon beam power and I find some difference when compare with the document provided by the former document. The red color is the ratio between these two results and the difference maybe come from the calculation model.

Target	Average photon energy(MeV)	Photon beam power(kW)	Power deposited in target(kW)
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Ti-6%wtAl-4%wtV	10.7	214	18.3(15) 1.22
Ti-6%wtAl-4%wtV	13.7	107	8.5(7.7) 1.10
Ti-6%wtAl-4%wtV	26.6	79.3	4.2(4) 1.05
Ti-6%wtAl-4%wtV	32.3	190	8.8(8.3) 1.06

The following calculations are based on 32.3MeV incident photon and 190 kW beam power.

### 3 Activity calculations

Activity of the target is due to (p, n) reaction which generally leaves the struck nucleus in an excited state. Further radioactivity can be produced by the secondary particles released in the (p, n) reaction and by the evaporation neutrons. At last, the slowing down neutrons lead to activation by capture of low-energy neutrons. Figure 2 is the neutron intensity of the target. As an example figure 2 gives the 22-Ti-46 (p, n) 22-Ti-45 reaction cross section and figure 3 gives the cross section of 22-Ti-46(n, p)21-Sc-46.

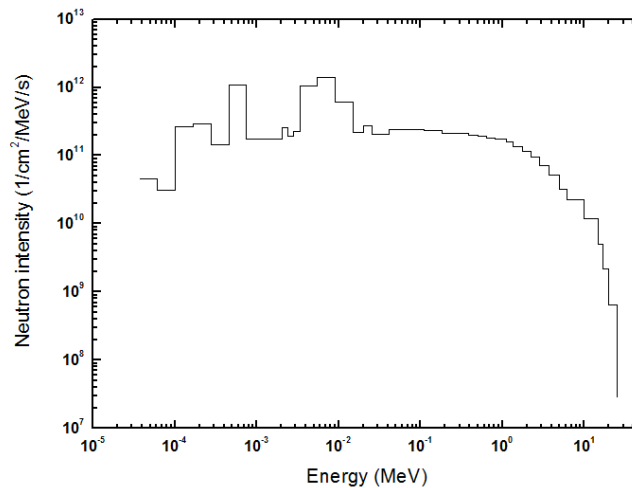


Figure 2 the neutron intensity of the target when it is bombarded by 32.3MeV photon

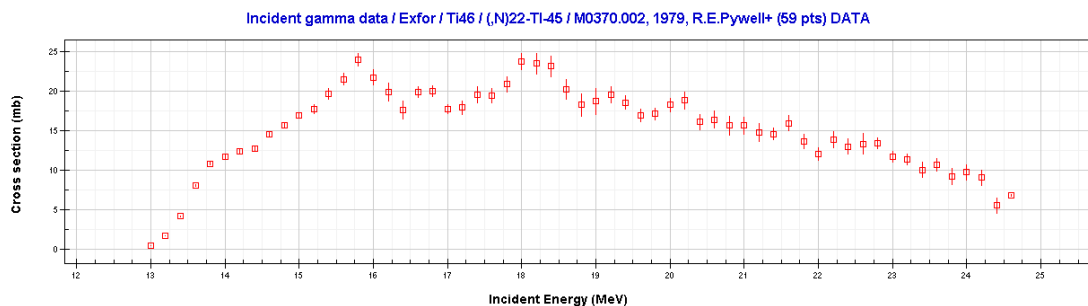


Figure3 the cross section of 22-Ti-46 (p, n) 22-Ti-45 (data from Exfor)

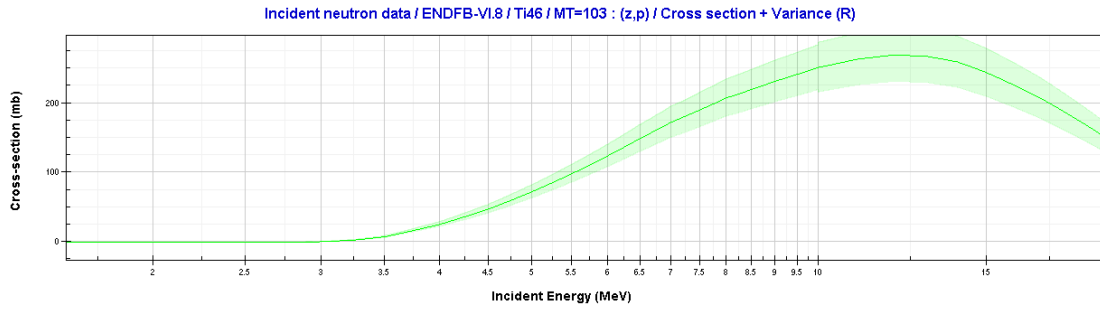


Figure 4 the cross section of 22-Ti-46 (n, p) cross section (data from ENDFB-VI.8)

Decay power for the target when it is running 5000h is below 10 watt and here I do not concern about it. Figure 4 is the activity of the target with the different cooling time.

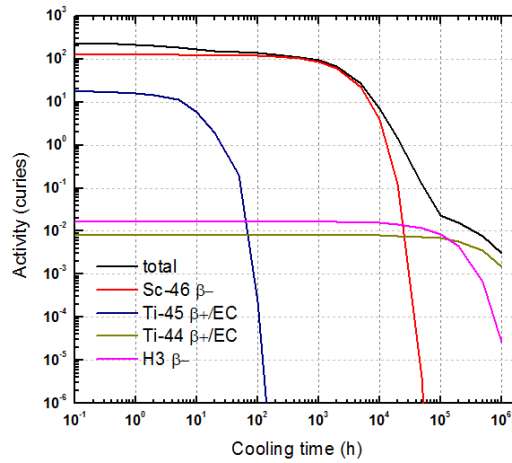


Figure 4 the activity of the target

#### 4 Shielding

First we give the dose rate of 1 meter from the activated target, which is cooled with different time after running 5000h (see figure 5). The dose rate of 1 meter from the target after cooling 7 days is approximately 164 mSv/h.

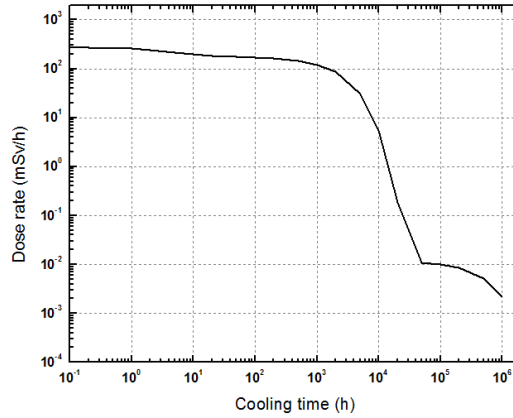


Figure 5 the dose rate 1 meter from the activated target.

Magnetite concrete is more effective for photon shielding than concrete not only because of the increased density, but also because of the Z dependence of the photoelectric and pair-production cross sections. In this document, the magnetite concrete with density 3.53 g/cc is used as the shielding material. Figure 6 is the calculation model and the red shows the heavy concrete. Figure 7 gives the gamma dose rate map (the unit is Sv/h). For clarity, we give the relationship between the dose rate and the shielding thickness (see figure 8).

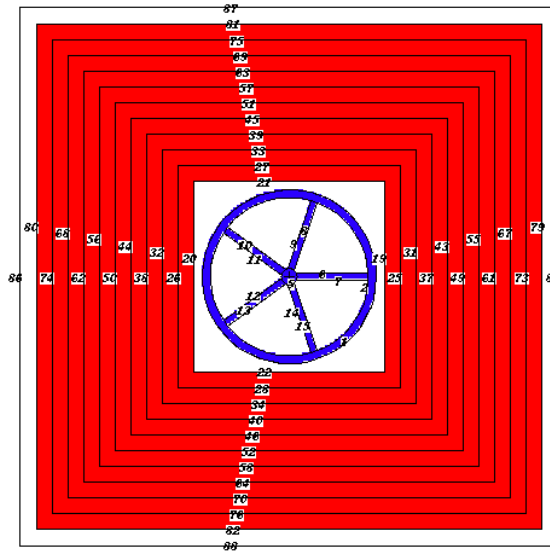


Figure 6 Shielding calculation model (the red shows heavy concrete)

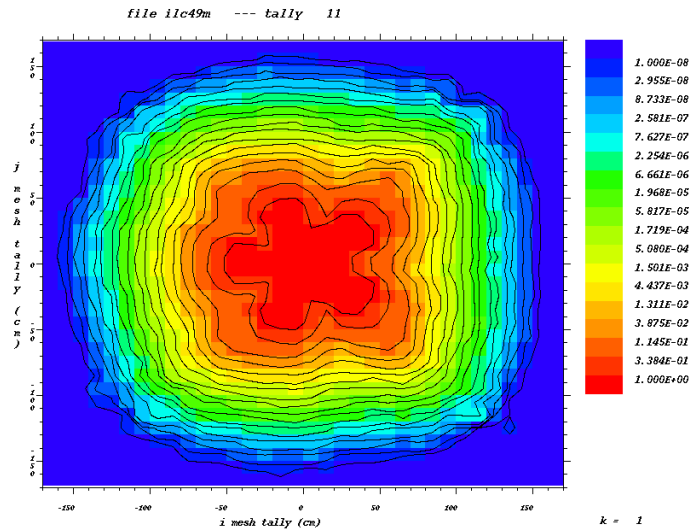


Figure 7 Dose rate map (the unit is Sv/h)

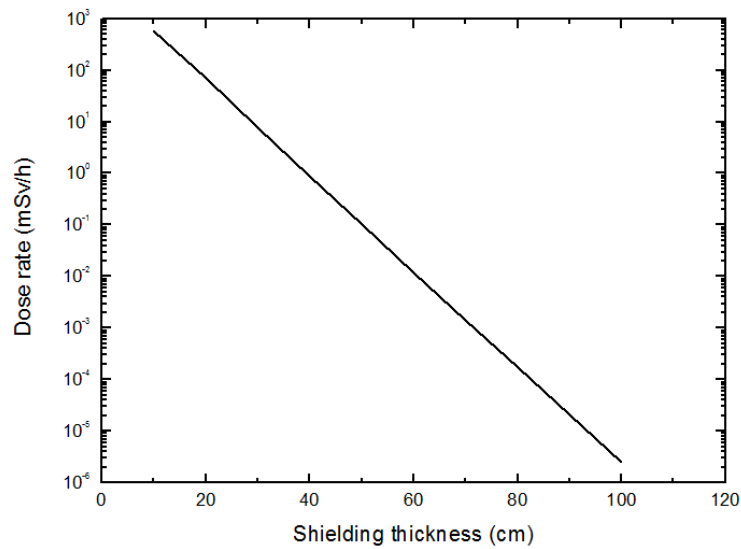


Figure 8 the relationship between the dose rate and the shielding thickness

5 Questions

Something needed to improve this design:

A the detailed parameters of the target station or the sketch of the target station?

B the lifetime of the target? It is needed for shielding design because the activity depends on the irradiated time.

C it exists some hole or not? These holes will lead to streaming effect that should be considered in the shielding design.

D the sandwich structure like steel + regular concrete +steel ... is more efficient to shield the gamma dose rate. There are some limits of the shielding such as shape or total weight?

E More documents for explaining ilc target? **Sorry ilc is a new area for me because my background is spallation neutron source.**

6 Codes and Materials used in this document

Codes and libraries

MCNPX2.5.0, CINDER90, libraries:mcplib04, e103, endf60

Target: Ti-6%wtAl-4%wtV, density 4.5g/cc

Magnetite concrete: density 3.53 g/cc