IR hall dose estimates for a “self-shielding” detector

T. Sanami (KEK, SLAC)

3rd ILD Workshop, Ewha Womans University, Seoul,

Korea, 16-18 February,2009

presented by T. Tauchi (KEK)

ILD note for LoI supplement

IR hall dose rate estimates for a "Self-shielding" Detector

T.Sanami[1) 2)]

[1)] High energy accelerator research organization (KEK),

[2)] SLAC national accelerator laboratory (SLAC)

1. Introduction

This paper summarizes efforts to estimate dose rate in IR hall with several types of detector design. This work has been performed until 2006 by SLAC and KEK radiation physics group with corporation of ILC-BDS group. Most of the results are presented at BDS meeting in SLAC from Sep. 2006 to Jul. 2007, ALCPG Physics and Detector meeting at Oct.19, 2006, IRENG 2007. The purpose of this paper is to support ILD-LoI which is under preparation by March 31, 2009.

The interaction region hall (IR hall) with push pull scheme detector exchange is assumed the following evaluations. In section 2, the design goal of dose rate for shielding is discussed based on existing rules in SLAC and KEK. Section 3 describes case studies of dose rate evaluation in IR hall for several situations. Section 3-1 to 3-3 is for shielding capability of detectors with GLD and SiD concept. Section 3-4 and 3-7 are for evaluation of pacman that is the connection part between a detector and tunnel. Section 3-5 describes about effect from the upstream. Section 3-6 studies beam loss condition due to mis-setting steering magnet. Based on section 3 studies, section 4 describes consideration of current ILD00 design. Conclusion and future plan are in section 5.

It should be noted that this document do not cover entire radiation safety design since active devices for PPS and BCS, residual activity estimation, access policy, effect from the upstream of IR hall are not included.

Tolerances of ambient dose rate

Normal operation	LHC	SLAC	KEK	ICRP Publication 26	ILC Garage area
non-designated area	0.1uSv/h	-	0.2uSv/h & 0.1mSv/evt	1mSv/y	-
supervised area(GERT)	1uSv/h	0.5uSv/h	1.5uSv/h	100mSv/5ys & 50mSv/y	0.5uSv/h
simple controlled area	3uSv/h	5uSv/h & 10mSv/y	20uSv/h	-	-
Mis-steering	-	4mSv/h & 10mSv/y	1.5uSv/h	-	-
System failure	-	250mSv/h & 30mSv/evt	-	-	250mSv/h & 1mSv/evt

Beam loss (the system failure) estimation

- 500 GeV, 18 MW beam loss as maximum credible beam power

  < 250 mSv/h with shielding, i.e. 0.014mSv/h/kW

- Beam loss position and material to be hit

  If it is available :

  use realistic ones, e.g. BCAL, IP beam pipe in ILD

  If it is not available :

  take the worst scenario with a target of $2X_0$ (2.86cm) diameter, $20\ X_0$ thick Cu at the weakest point;

  SHIELD11 can calculate with this target.

- 3D Monte-Carlo simulation, e.g. MARS, Fluka
- Analytic expressions for fast calculation, e.g. SHIELD11

Radiation Shield of Detector : IR Documents

(1) Self-shielding the detector

(2) Nominal operation : < 0.5 μSv/hour in the garage area

(3) Accident :

< 250 mSv/hour for maximum credible beam

(simultaneous loss of both beams anywhere near IP)

The integrated dose < 1mSv / accident in the garage area

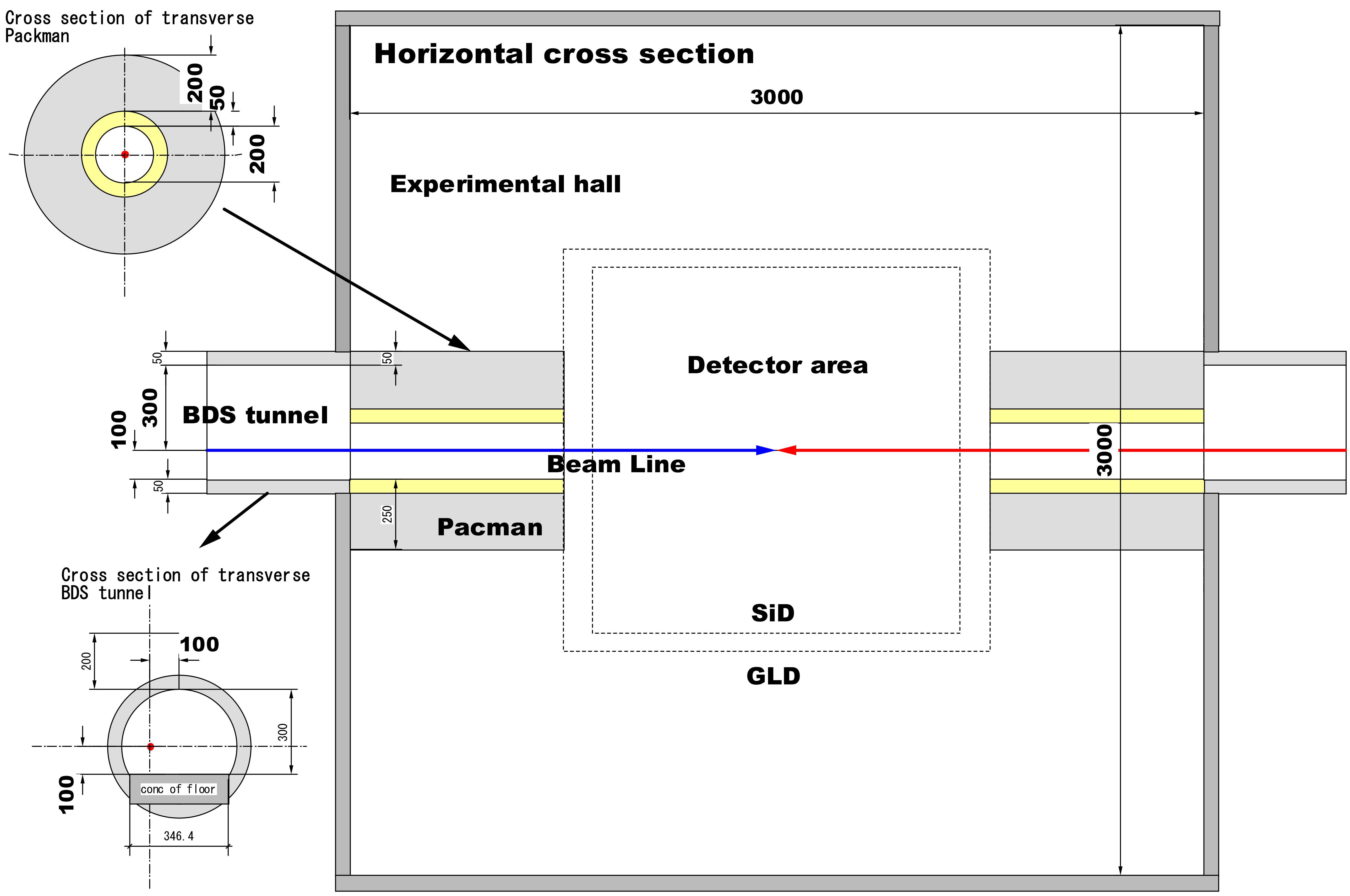


Fig 3-2-1 Layout of IR hall used in this calculation

GLD : Dose rate from beam loss on FCAL

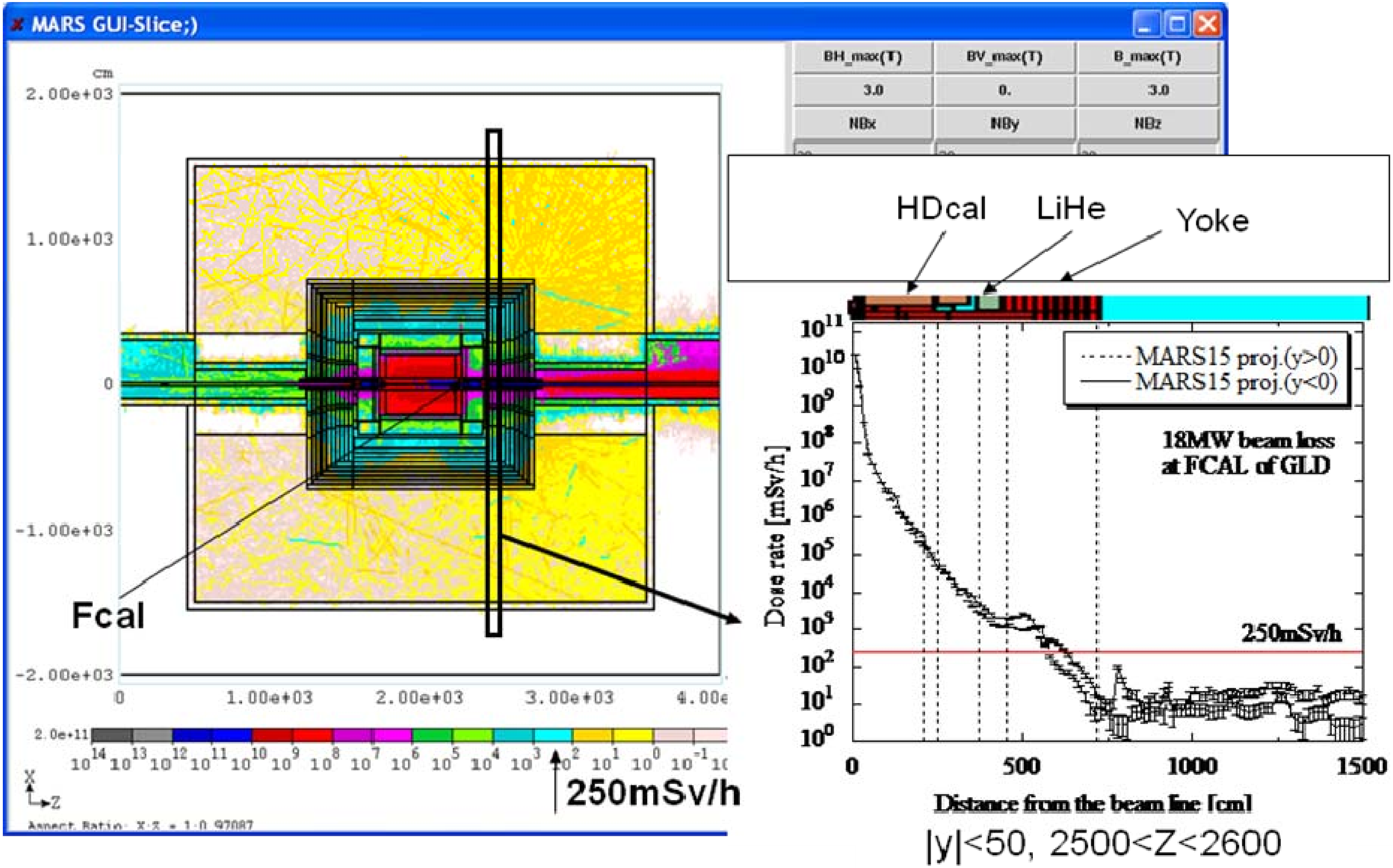


Fig 3-2-3 Results of simulation for beam loss at FCAL

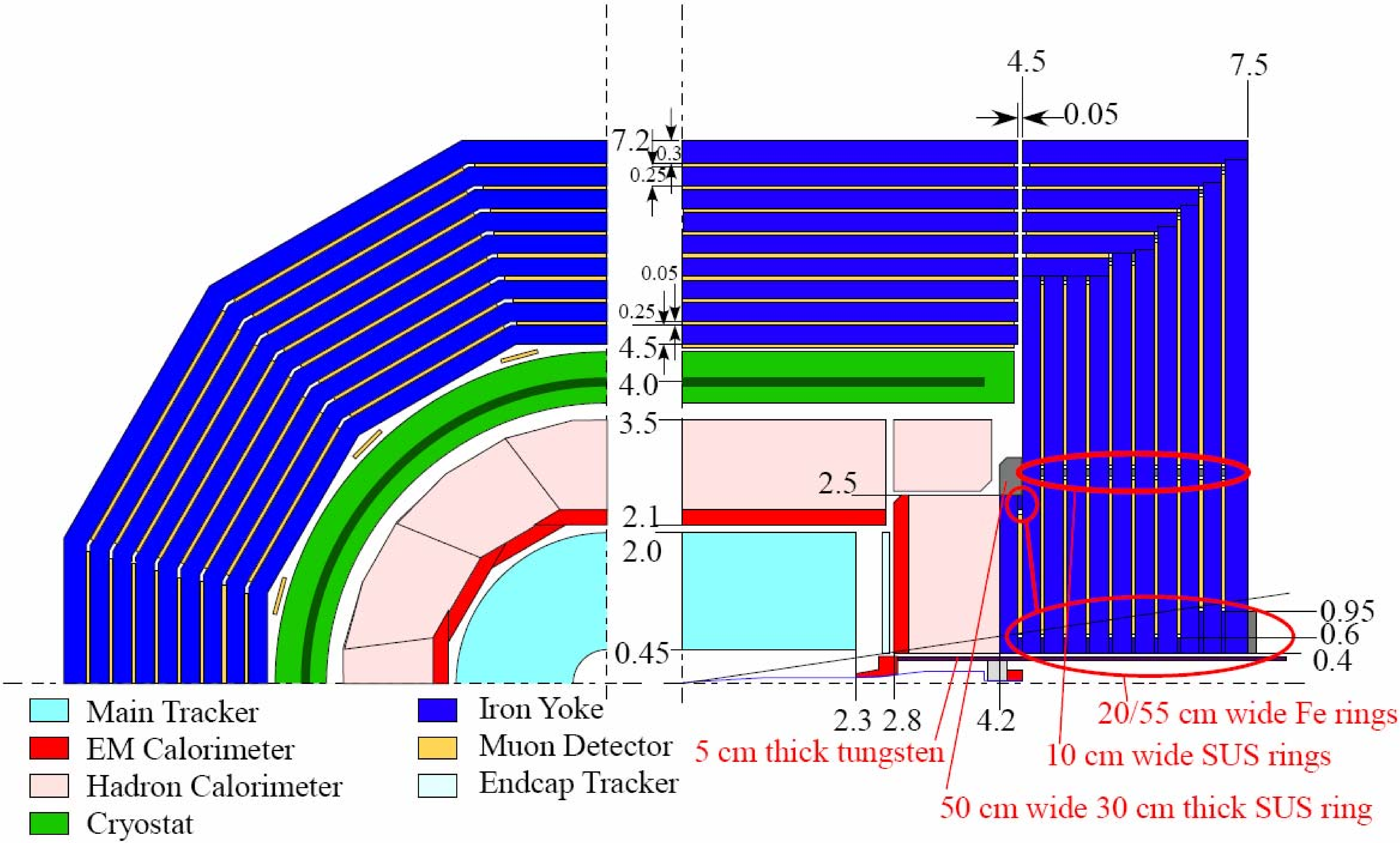
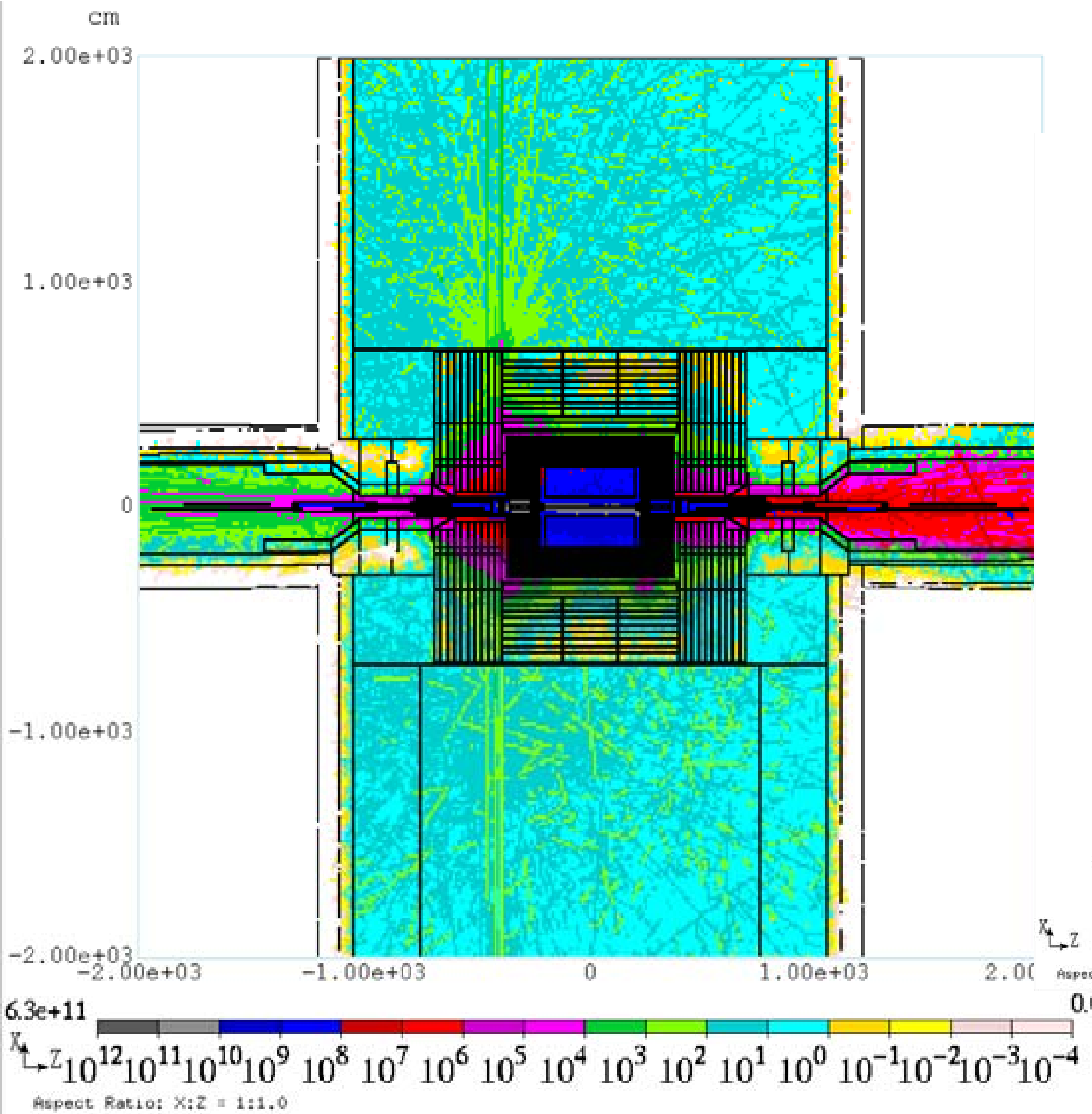


Fig.3-1-1 Layout of components of GLD detector concept [Y.Sugimoto]

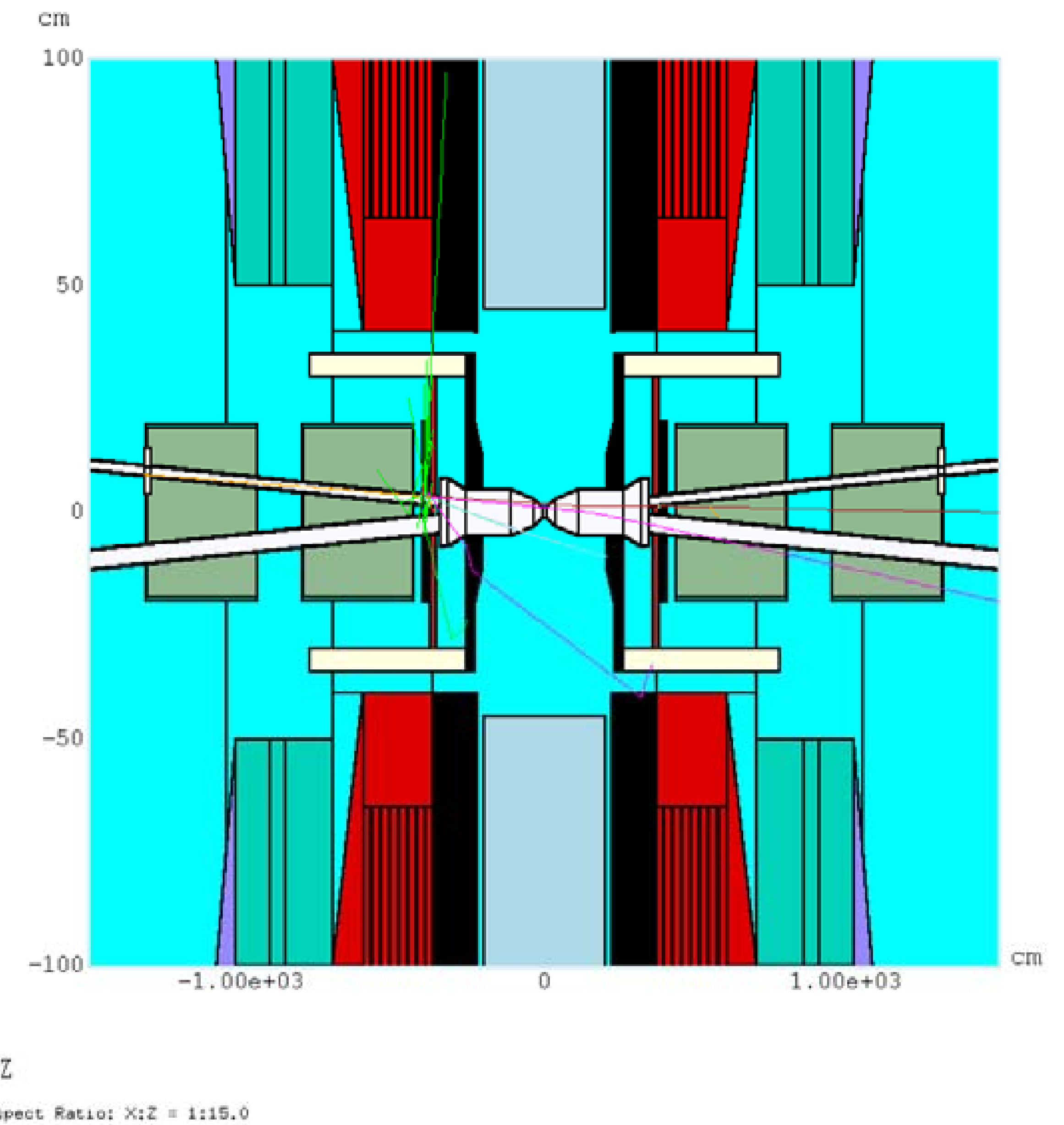
GLDc (CMS style assembling) : Dose rate from beam loss on FCAL

Remarks : gaps in CMS style assembly and PACMAN at beam line

Plan view



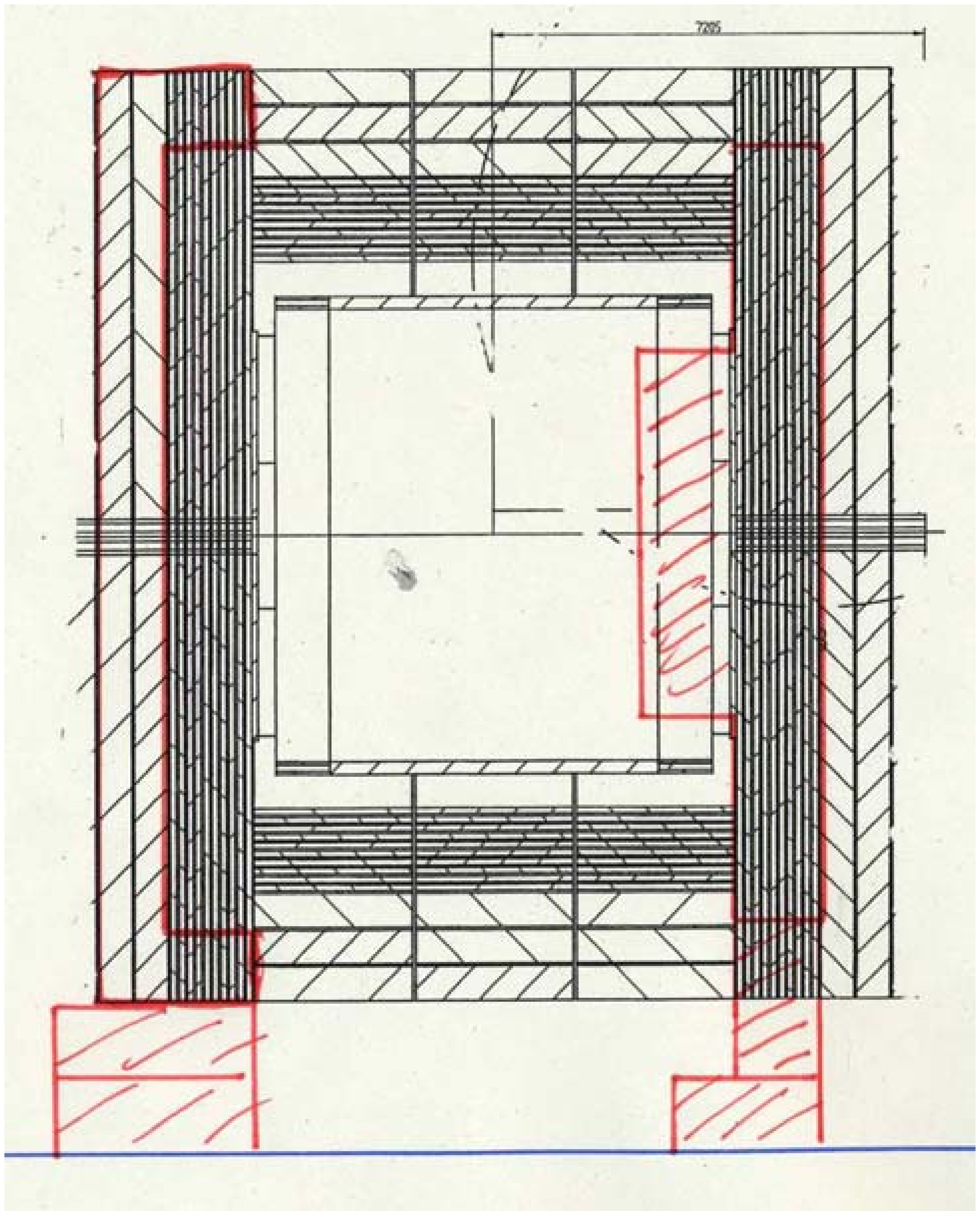
IR in plan view



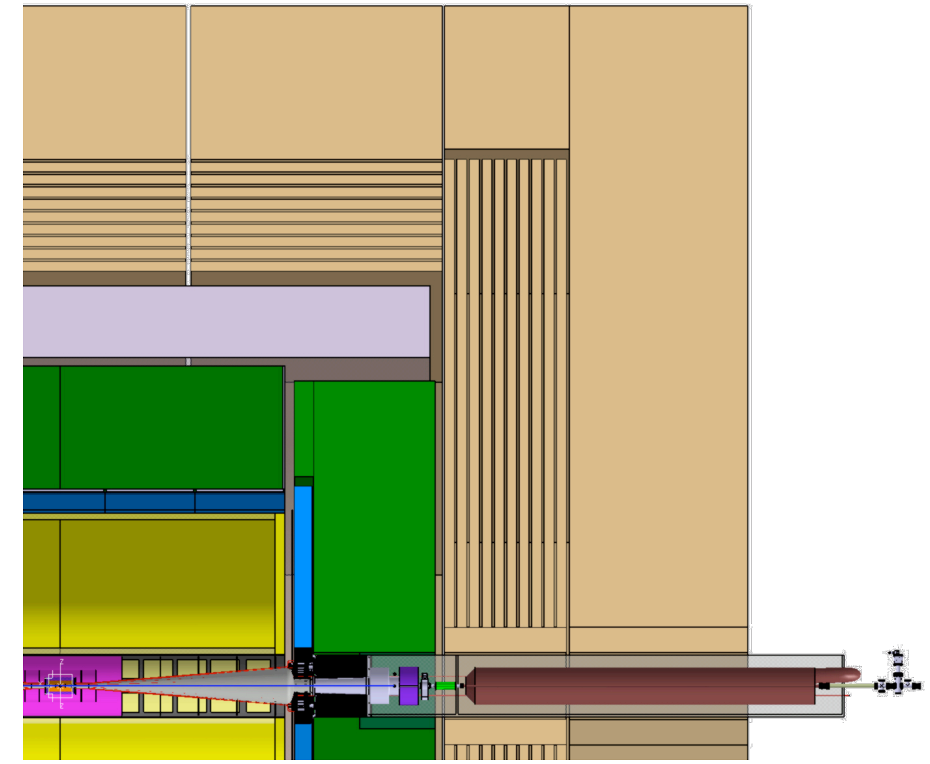
ILD End-cap Design

Split end-cap

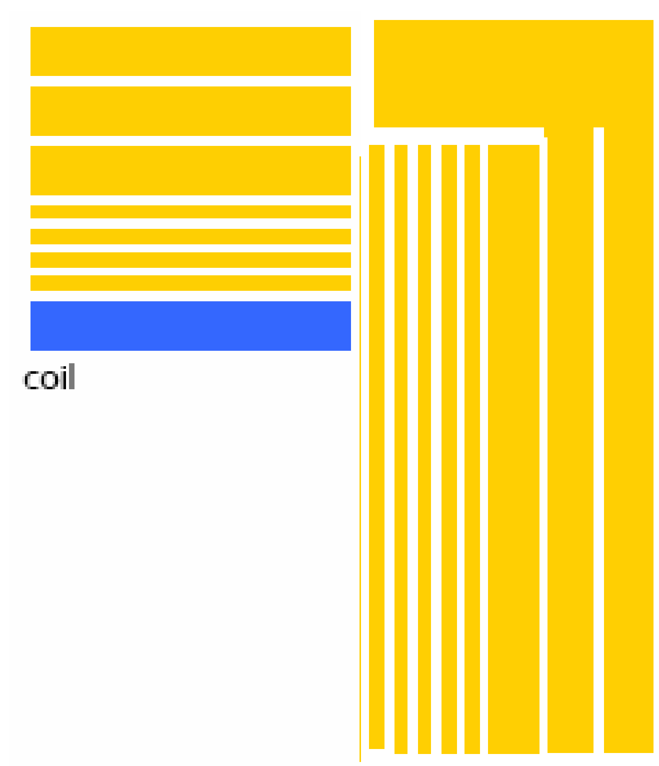
side view



3D-CAD model



Iron yoke option



Pipe (L-He line) passing through the barrel yoke has to be considered for adopting some radiation protection.

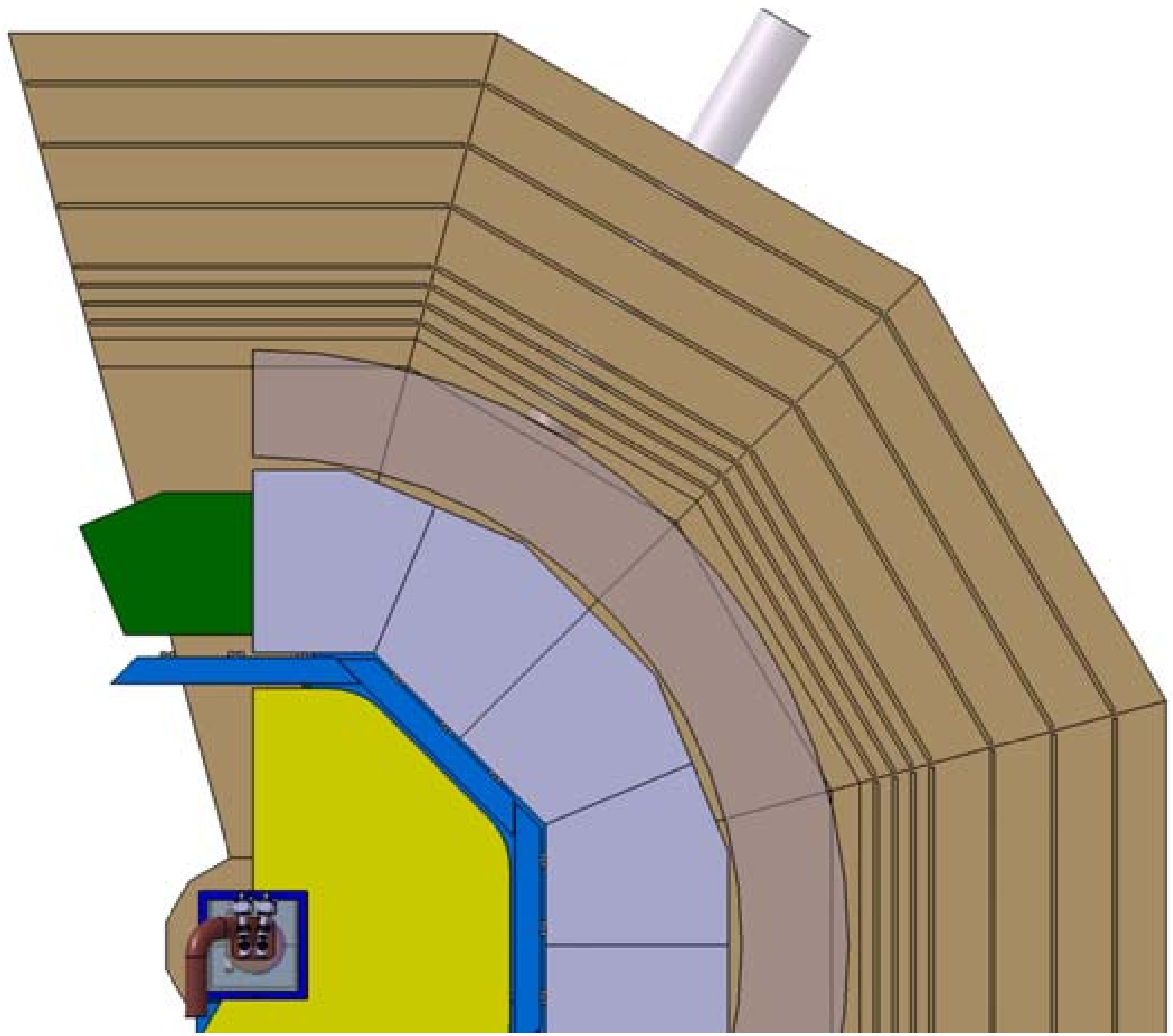


Fig 4-2 Cross sectional view of ILD00 design perpendicular to the beam line

Conclusion

We need to figure out the followings for further engineering evaluation of radiation safety design of IR hall,

1. Approved beam loss scenario for normal mis-steering and system failure cases and how to or which devices ensure it
2. List of geometry, material, position of devices possibly to terminate beams accidentally.
3. Detail of detector structure. Which part would be fixed and replaced?
4. Information all gaps and penetrations of detector and pacman
5. Design of BCS and PPS devices

   PPS = Personnel Protection System   BCS = Beam Containment System
6. Map of area where individuals wants to access during operation
7. Take into account radiation protection rules in another laboratory or institute
8. Beam loss and shielding condition of upstream to know contribution to dose rate in IR hall for normal operation, mis-steering situation and system failure case. The estimation will need entire model of BDS tunnel and beam line.