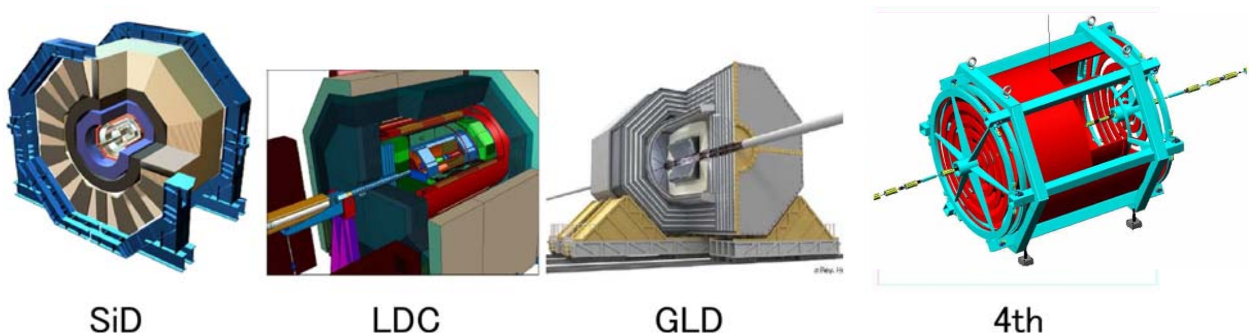
Summary of Dose Rate Estimations for IR Hall

T.Sanami
SLAC/KEK

A.Fasso, L.Keller, A.Seryi , S,Rokni
SLAC

Motivation

- Shield thickness along the beam line
  - **Beam loss distribution**
    - Physical and Political
  - **Area classification**
    - Access policy and control
  - **Detector and Beam line component**
    - Detector type, Engineering design



→ **Shielding thickness**

Problems should be addressed

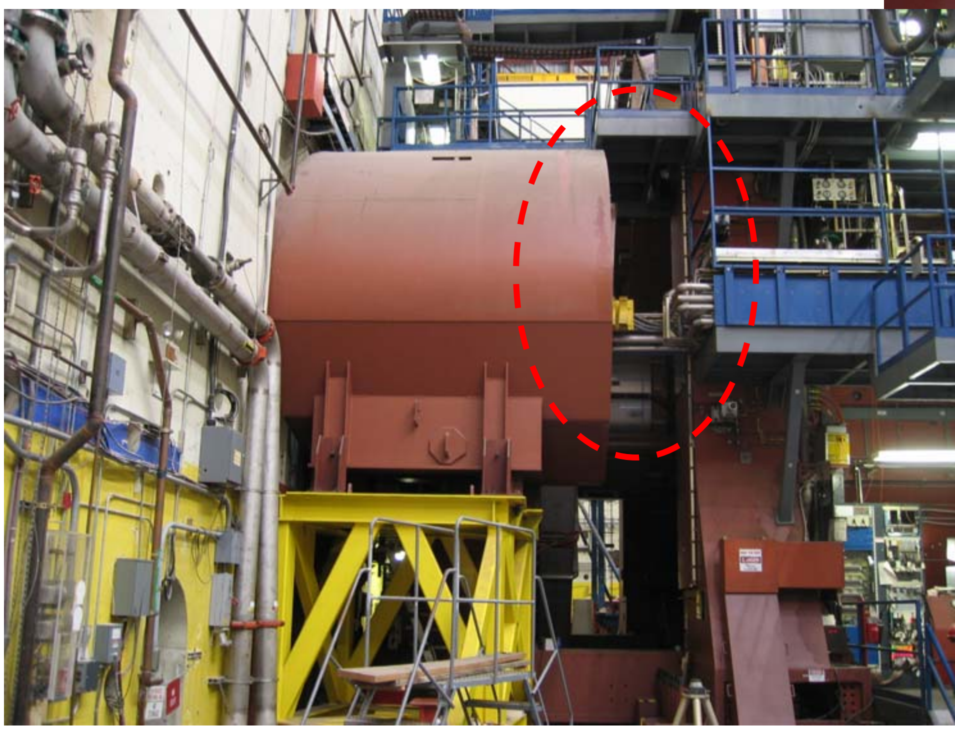
- IR hall
  - **Shaft and wall between detectors**
    - Commissioning run
  - **Shielding capability of a detector**
    - Self shielding or not
    - Effects of gaps for cables and tubes
  - **Pacman thickness**
    - Inner diameter
    - Requirement of penetration
  - **Effects from upstream part (muon etc)**

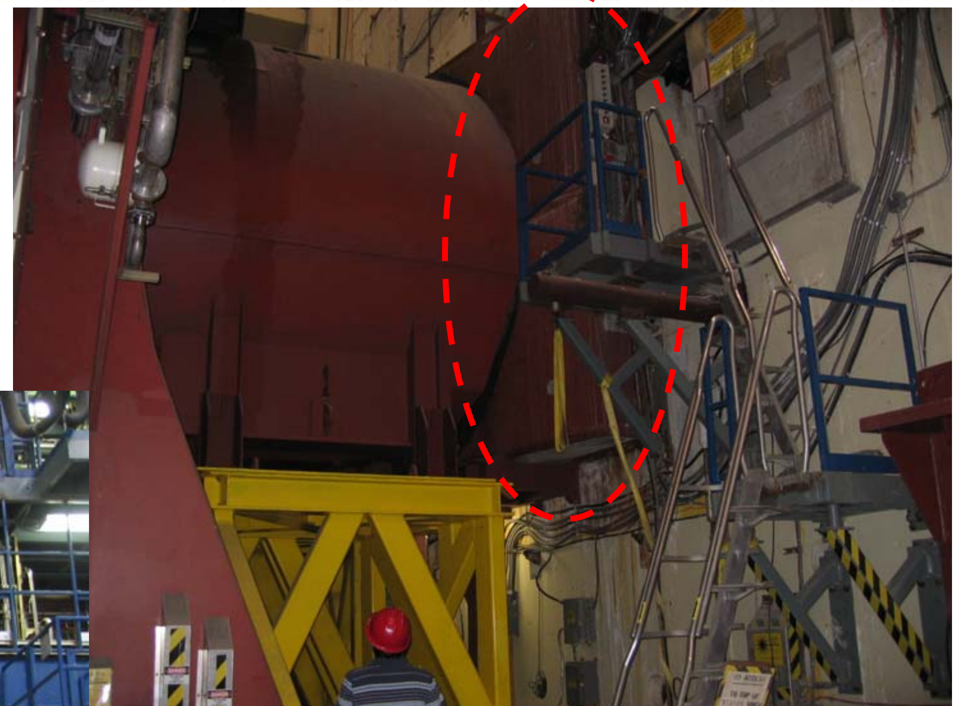
3D Monte-Carlo simulation

→ MARS15-MCNP code is used

Pacman

Open





Close

Parameters

Beam Energy and Power : 500 GeV, 18 MW
Beam loss : 1 W at any point
Design goal : 0.05 mrem/h for normal,
400 mrem/h for mis-steering,
25 rem/h (3rem/event) for system failure
Target material: 20 X0 Copper cylinder or actual component

→ Shielding capability : 25 rem/h /18MW = 1.39 mrem/h/kW
288 kW for 400 mrem/h, 36 W for 0.05 mrem/h

Cover of shaft and wall between dtectors

Case #	Detector	Target	To know
1	None (3m conc. around)	Cu $20X_0$	Requirement of shaft cover
2	None	Cu $20X_0$	Requirement of shaft cover and acceptable clearance for crane

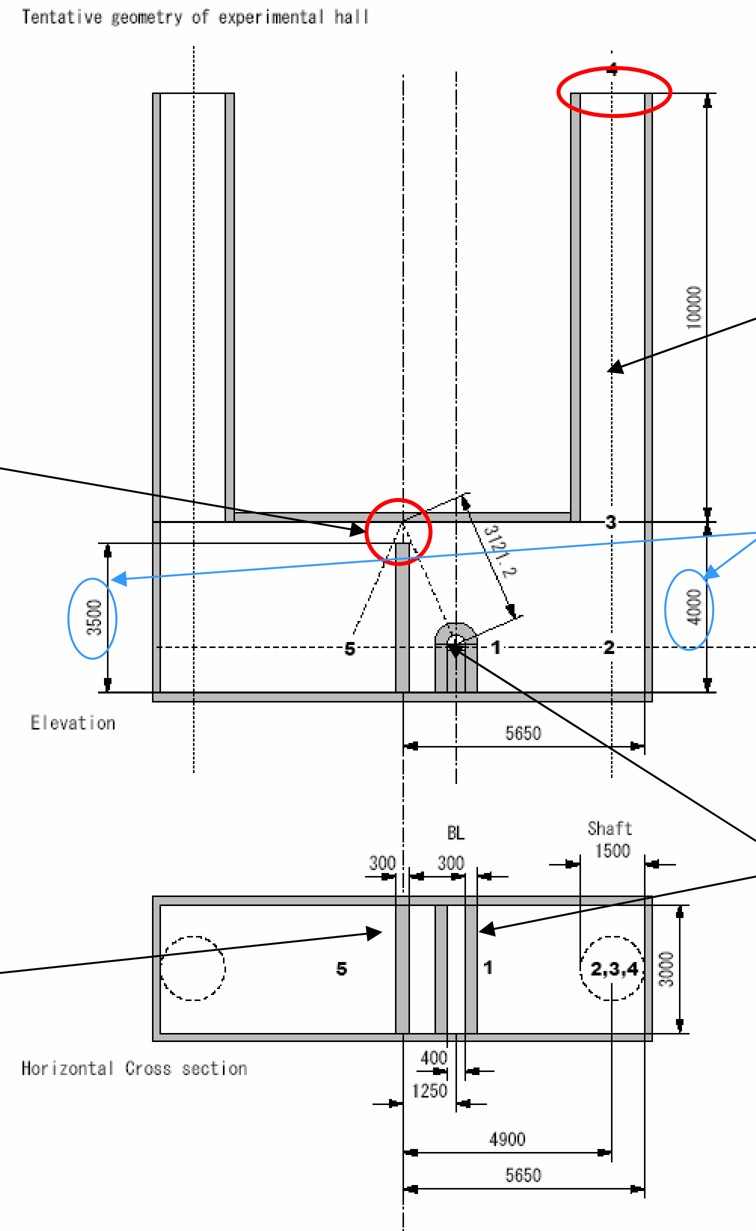
Geometries for calculation

1. Shielding cover on access shaft over the IR hall

The shaft

Effect of gap on the top of the Wall

2. Dose rate distribution in experimental hall



These values are not decided, yet

5m = 50-100t crane

Someone wants 400t class!

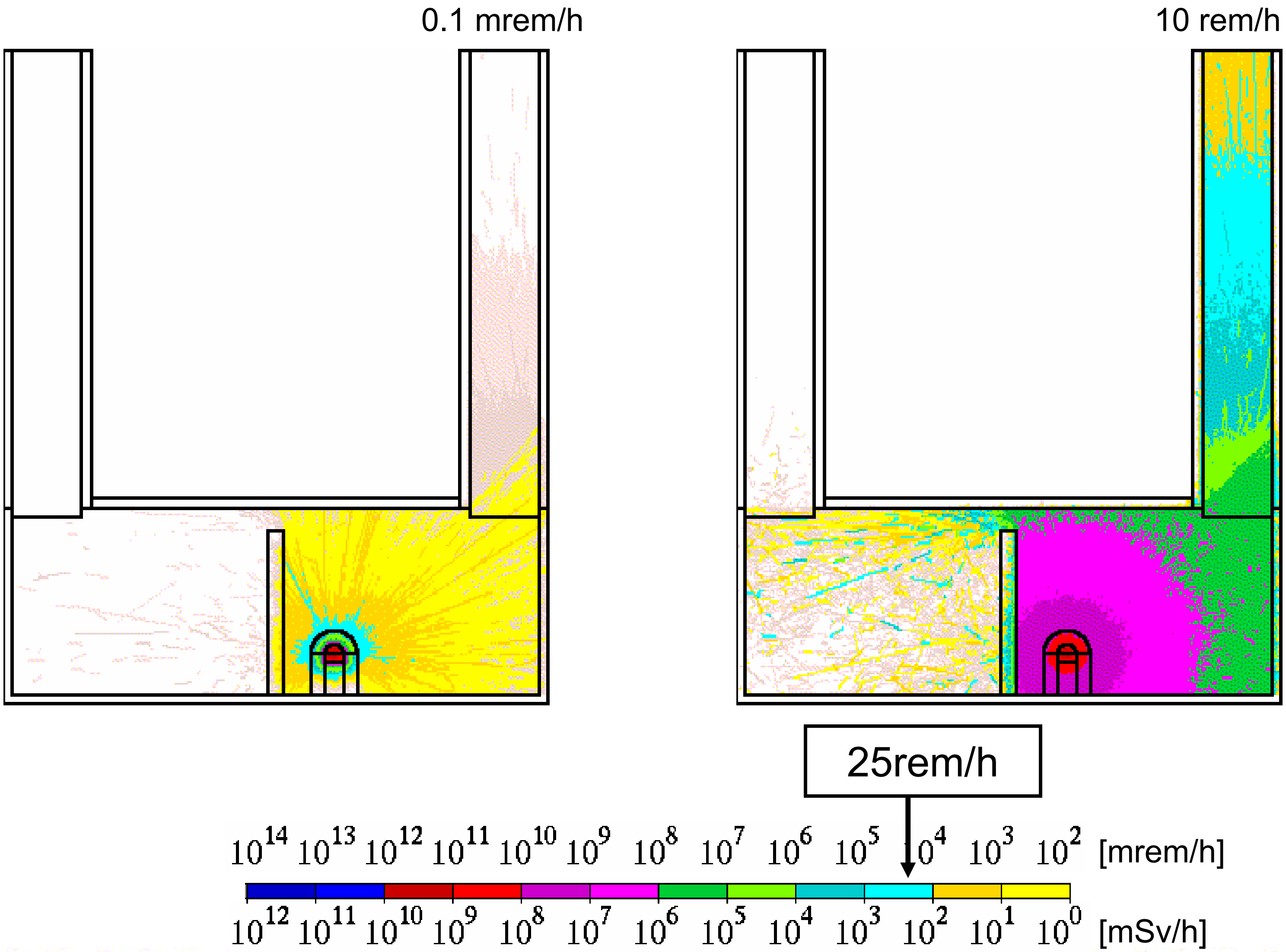
Beam line and

3m thick concrete shield

(for beam commissioning)

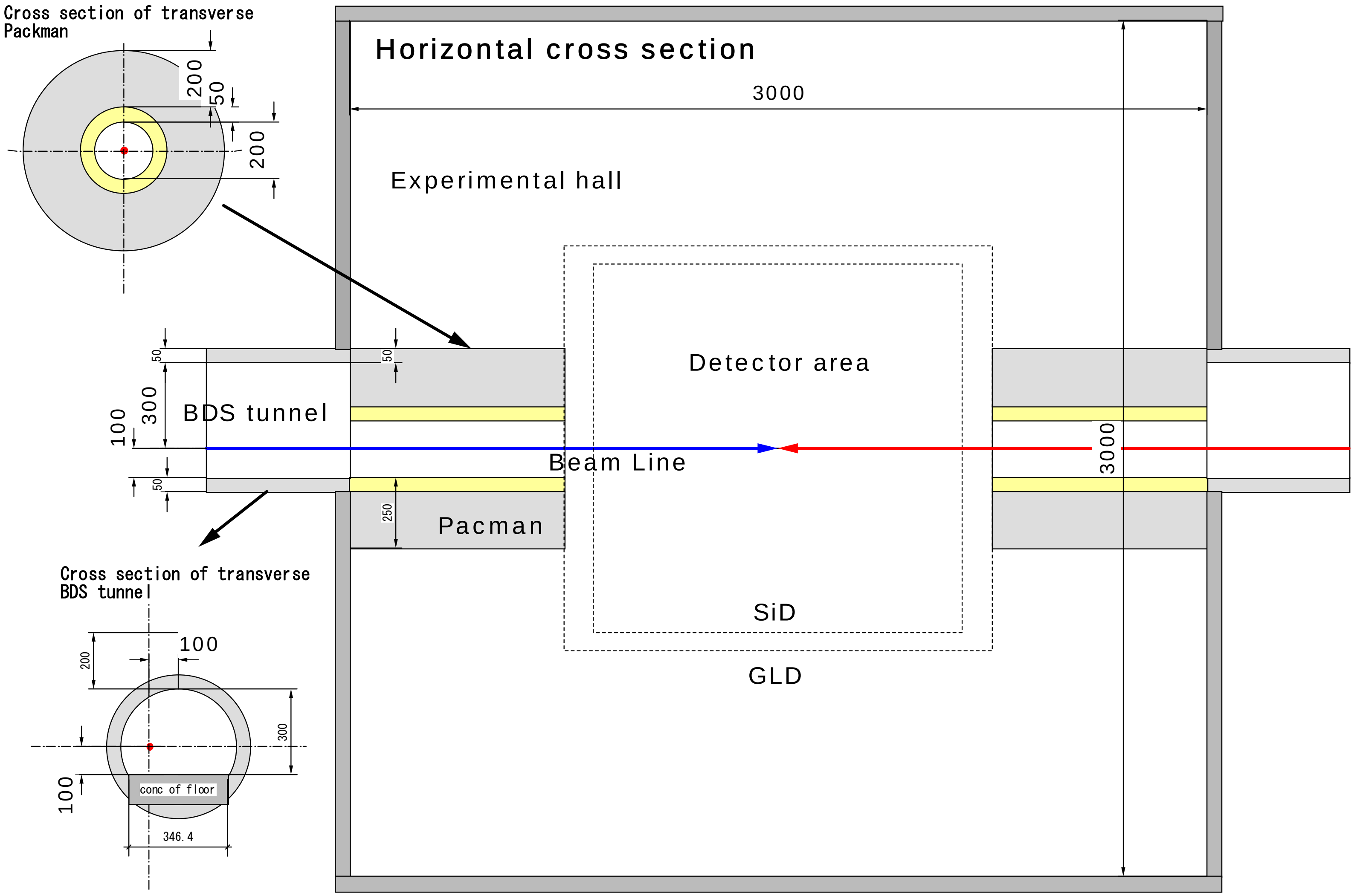
The wall between detectors

Results of calculation

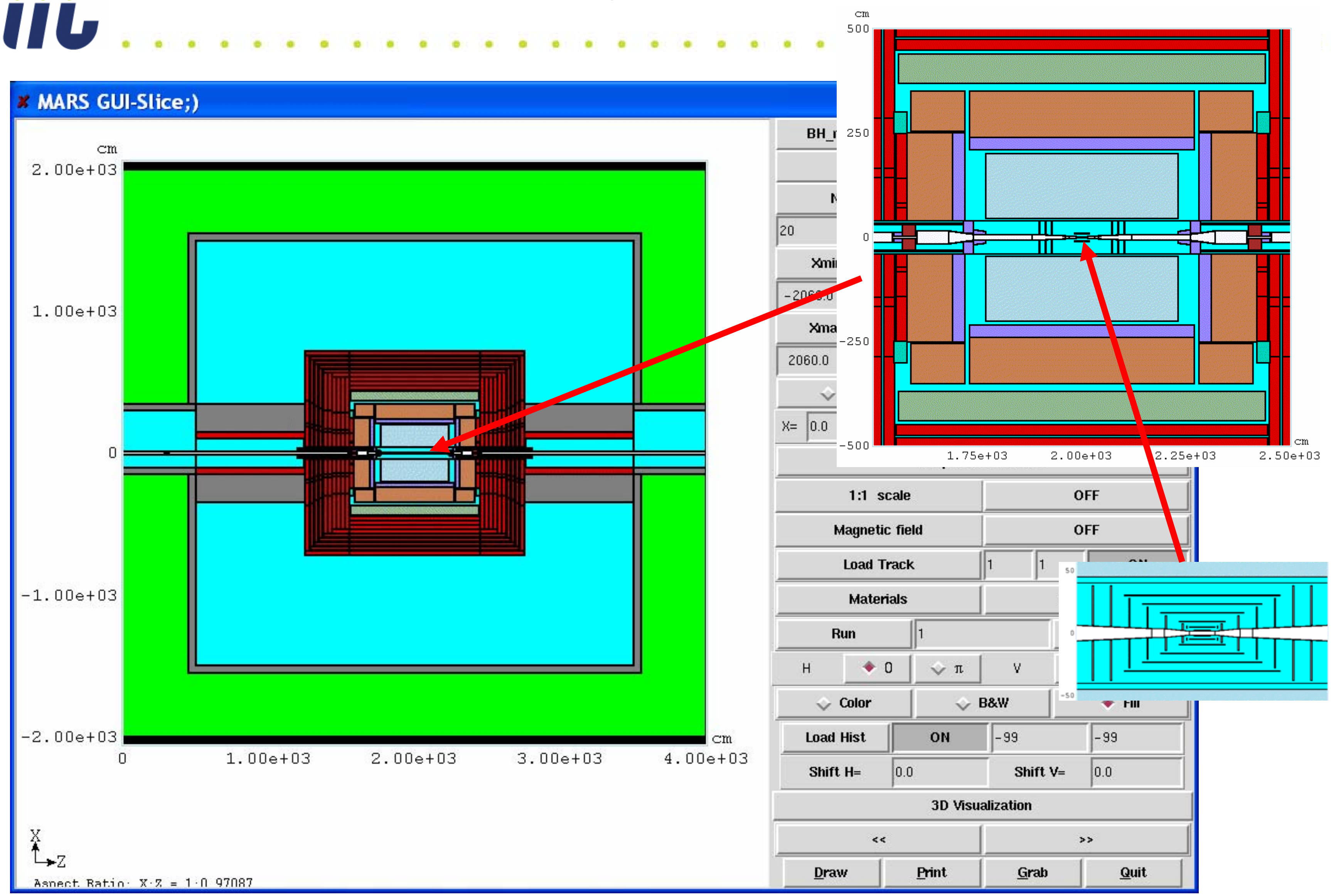


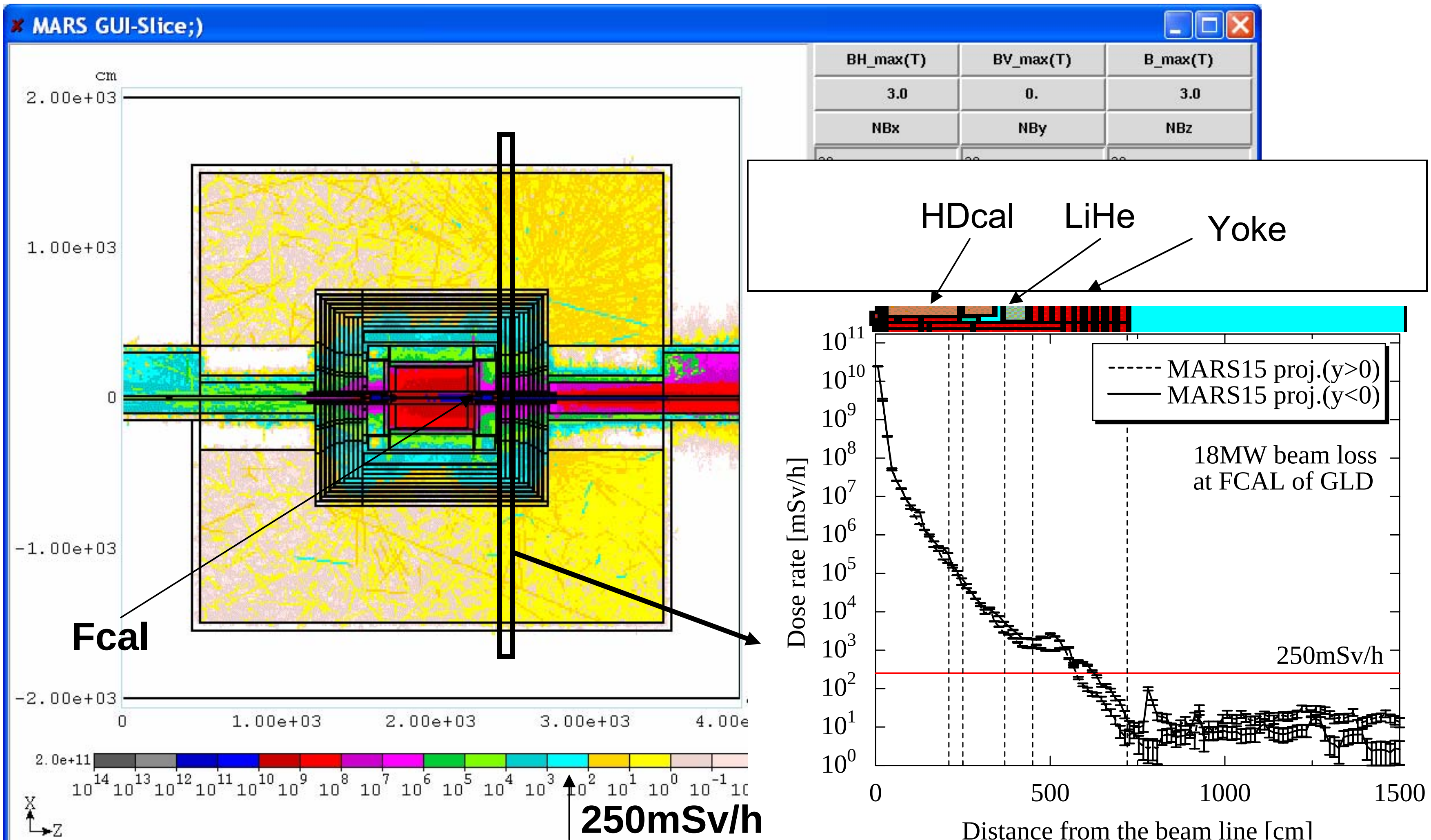
Self shielding detector : GLD

Case #	Detector	Target	To know
3	GLD	FCAL	Overall self-shielding capability of detector
4	GLD	Cu $20X_0$@BDS	Connection point between BDS tunnel and Pacman


Cross section of transverse
Packman
200
50
200
Horizontal cross section
3000
Experimental hall
Detector area
BDS tunnel
Beam Line
Pacman
SiD
GLD
3000
50
300
100
50
250
Cross section of transverse
BDS tunnel
100
200
300
100
conc of floor
346.4

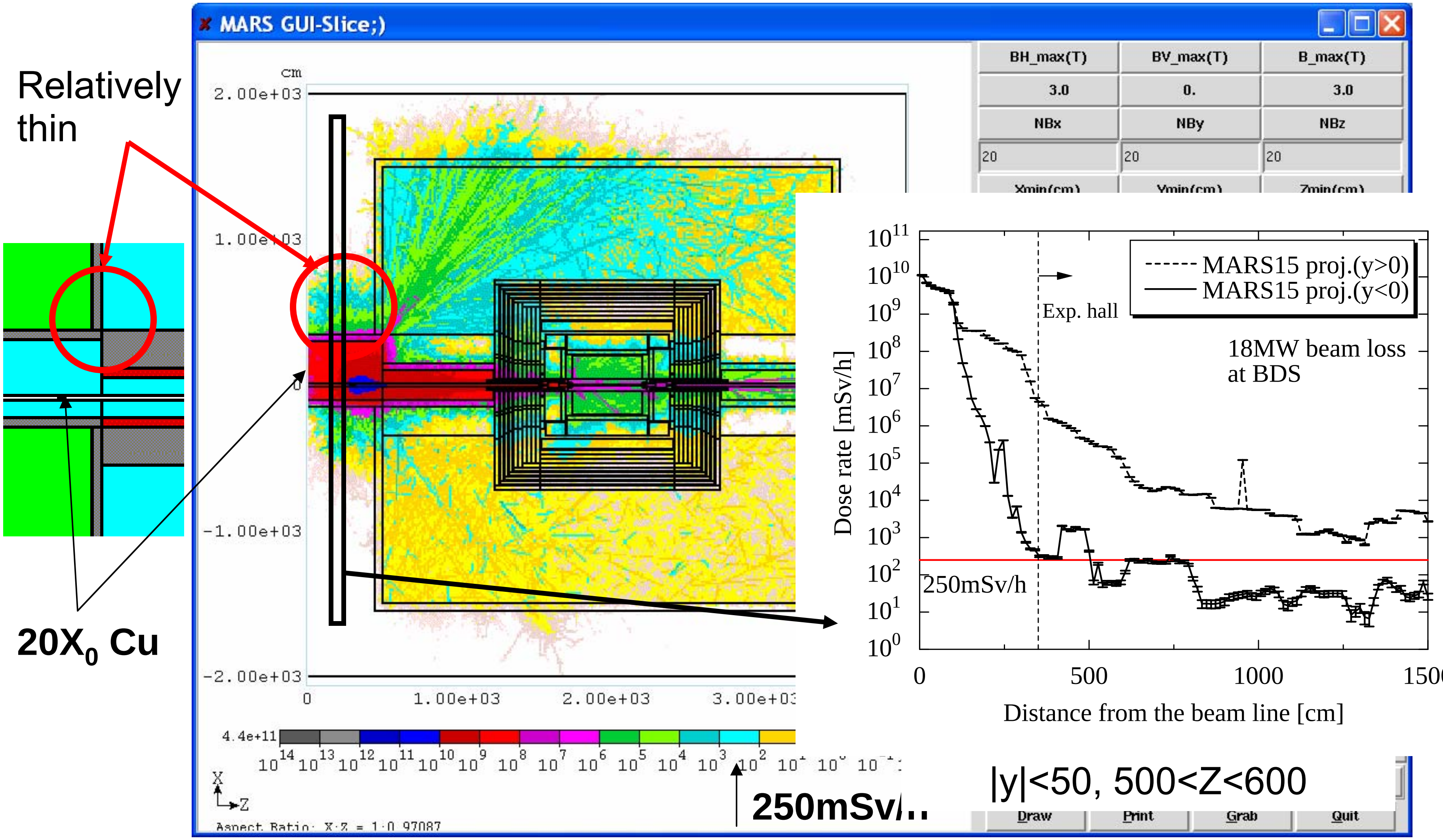
GLD


MARS GUI-Slice;)
cm
2.00e+03
1.00e+03
0
-1.00e+03
-2.00e+03
0
1.00e+03
2.00e+03
3.00e+03
4.00e+03
cm
X
Z
Aspect Ratio: X:Z = 1:0.97087
20
2060.0
X= 0.0
1:1 scale
OFF
Magnetic field
OFF
Load Track
1
1
Materials
Run
1
H
0
π
V
Color
B&W
Load Hist
ON
-99
-99
Shift H=
0.0
Shift V=
0.0
3D Visualization
<<
>>
Draw
Print
Grab
Quit
cm
500
250
0
-250
-500
1.75e+03
2.00e+03
2.25e+03
2.50e+03
cm



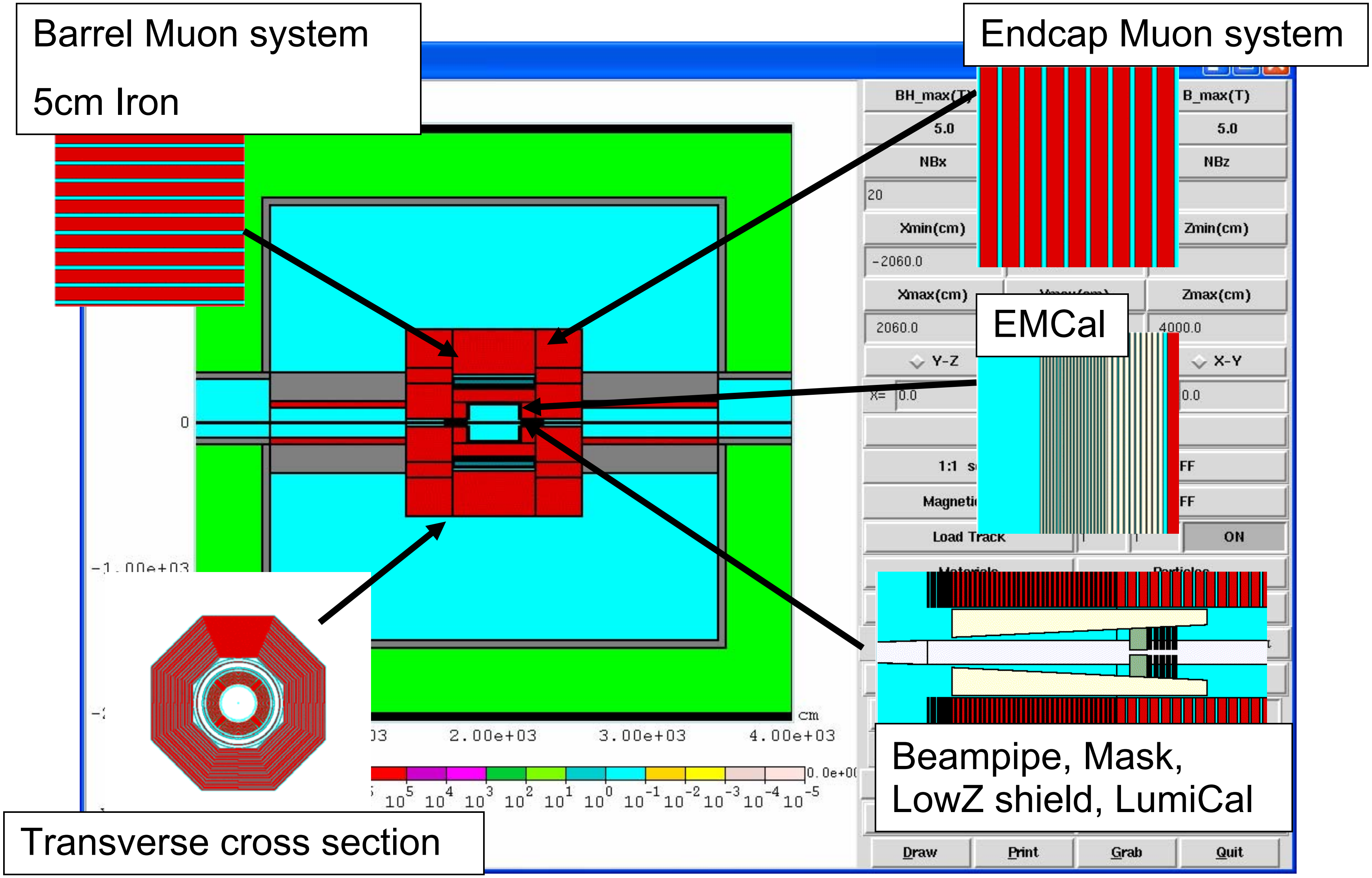
|y|<50, 2500<Z<2600

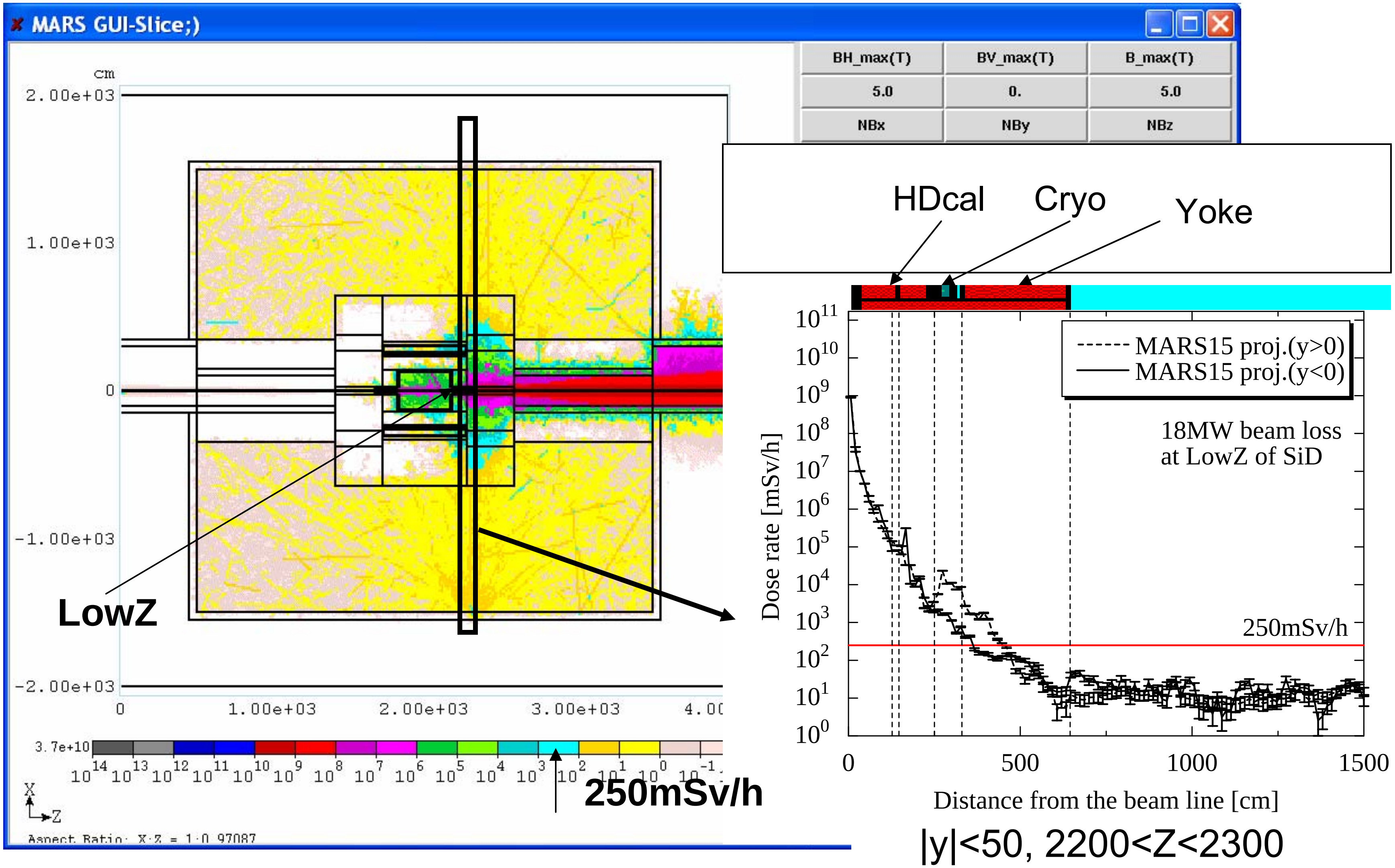
Result #3 Beam loss in BDS tunnel



Self shielding detector : SiD

Case #	Detector	Target	To know
5	SiD	LowZ	Overall self-shielding capability of detector

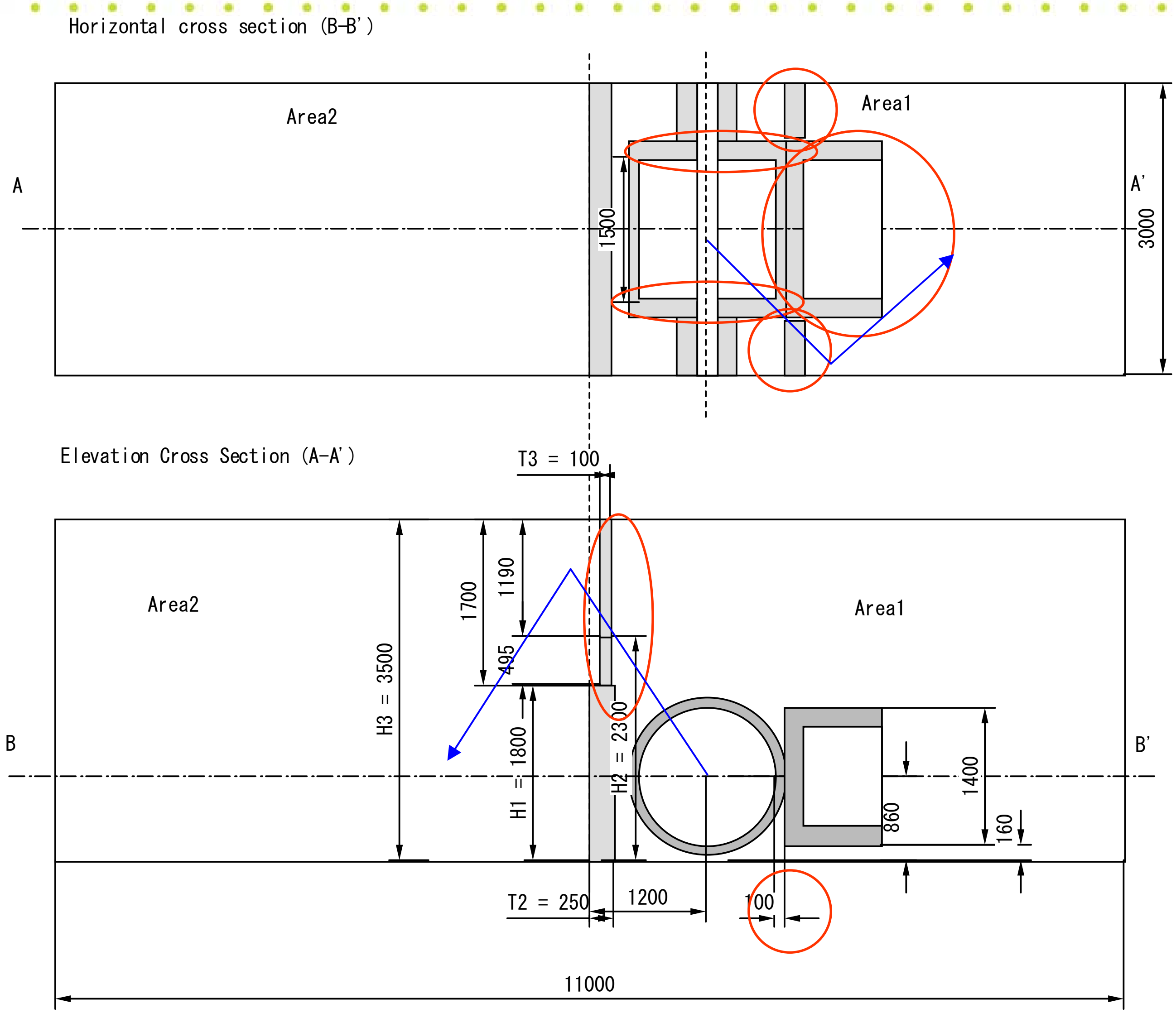

Barrel Muon system
5cm Iron
Endcap Muon system
EMCal
Beampipe, Mask,
LowZ shield, LumiCal
Transverse cross section
BH_max(T)
B_max(T)
5.0
5.0
NBx
NBz
20
Xmin(cm)
Zmin(cm)
-2060.0
Xmax(cm)
Zmax(cm)
2060.0
4000.0
Y-Z
X-Y
X=
0.0
0.0
Load Track
ON
0
-1.00e+03
2.00e+03
3.00e+03
4.00e+03
cm
Draw
Print
Grab
Quit


MARS GUI-Slice;)
BH_max(T)
BV_max(T)
B_max(T)
5.0
0.
5.0
NBx
NBy
NBz
HDcal
Cryo
Yoke
LowZ
250mSv/h
MARS15 proj.(y>0)
MARS15 proj.(y<0)
18MW beam loss
at LowZ of SiD
250mSv/h
Dose rate [mSv/h]
Distance from the beam line [cm]
|y|<50, 2200<Z<2300

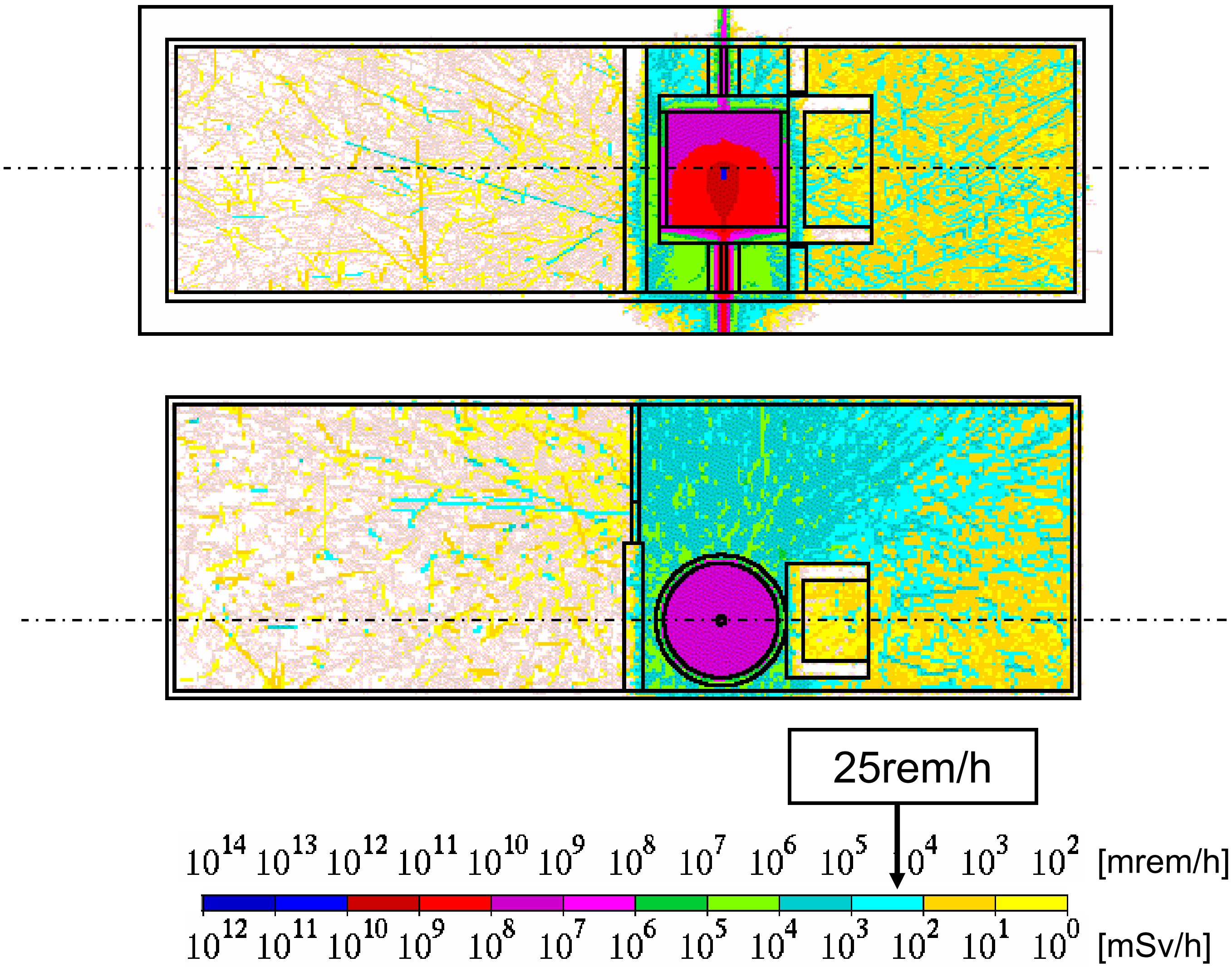
Non self shielding detector : 4th concept

Case #	Detector	Target	To know
6	4th	Cu 20 X_0	Example of shielding

Geometries for calculation



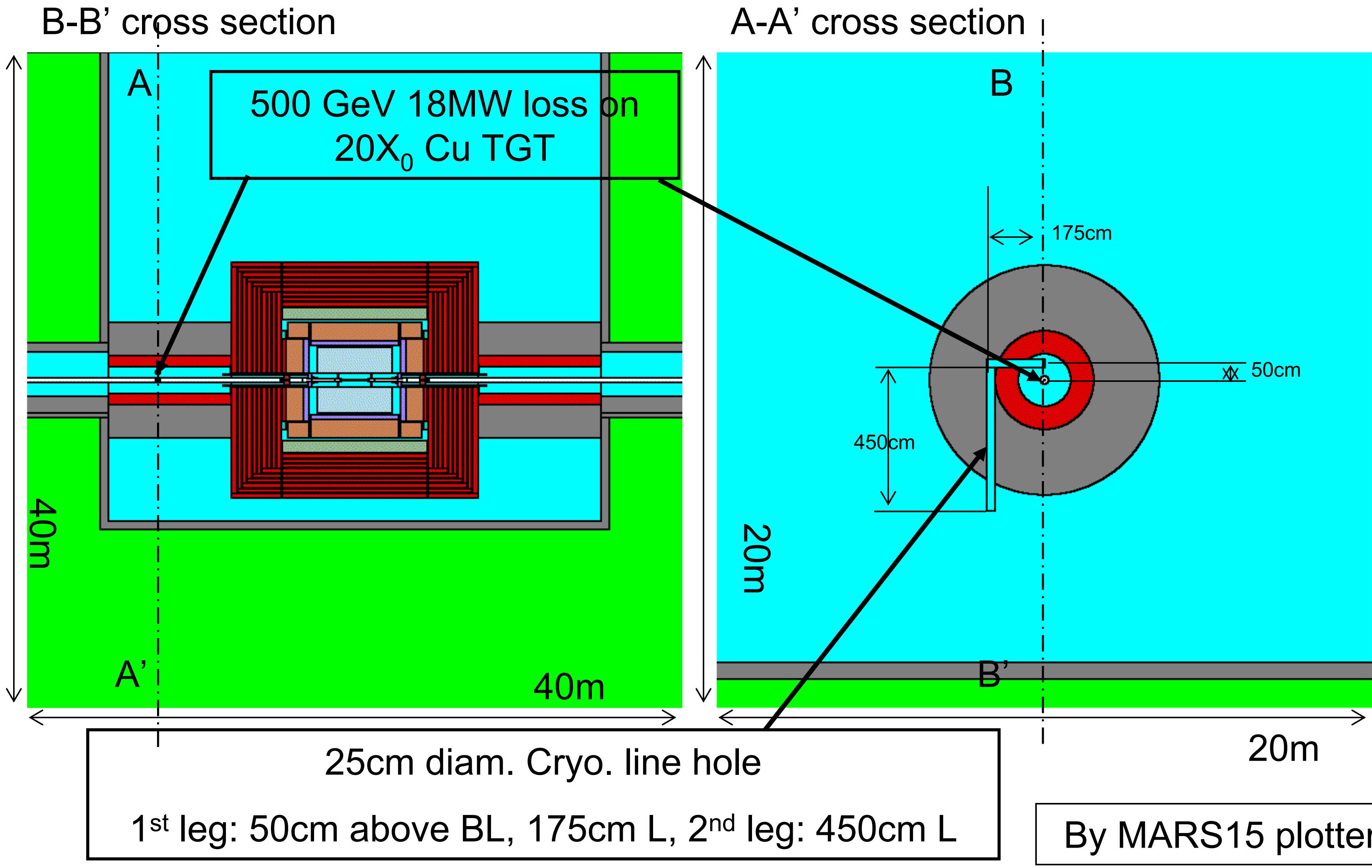
Results of calculation



Cryo penetration

Case #	Detector	Target	To know
7	GLD	Cu 20 X_0	Penetration of pacman

25cm 1 knee geometry

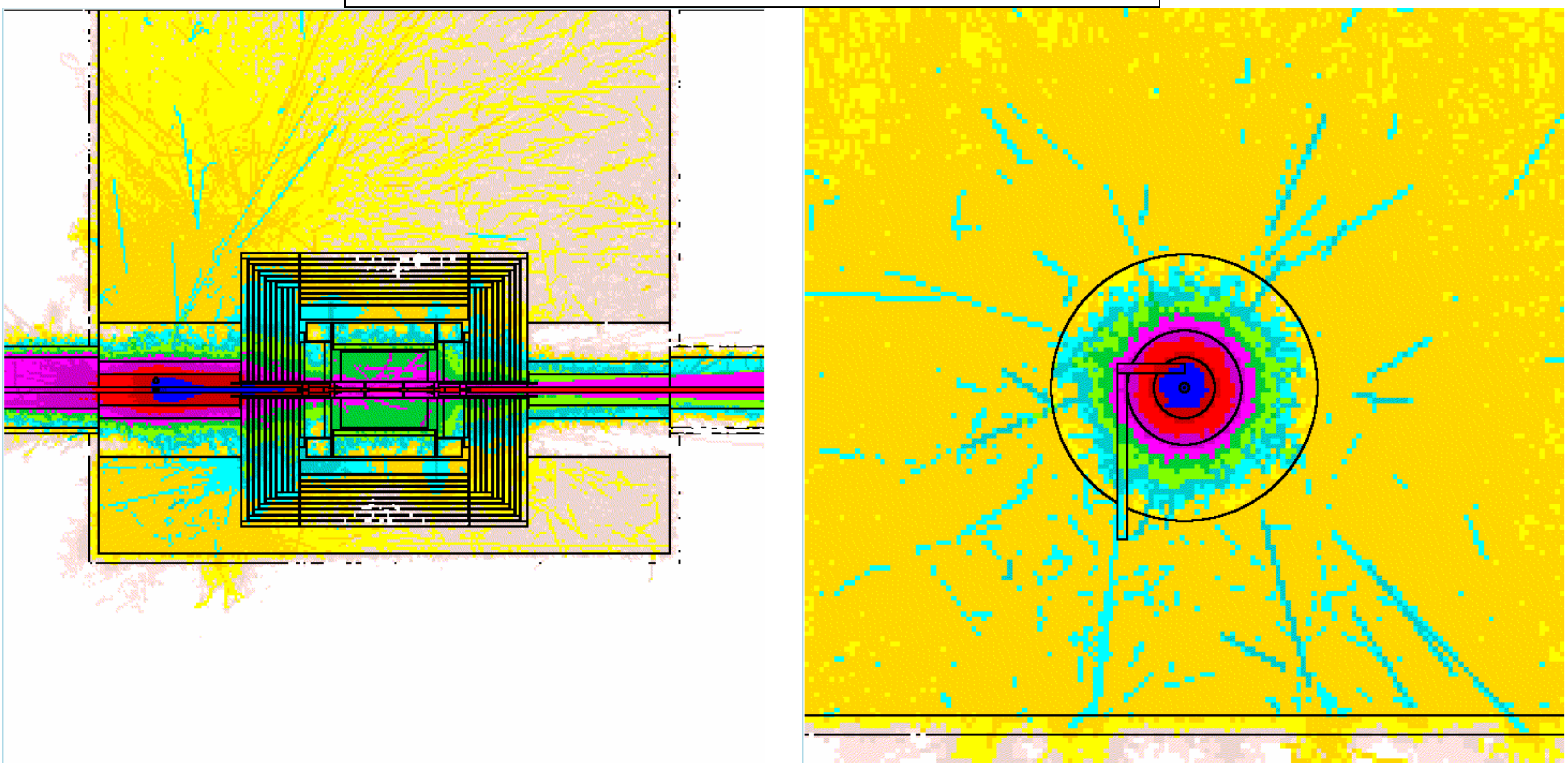


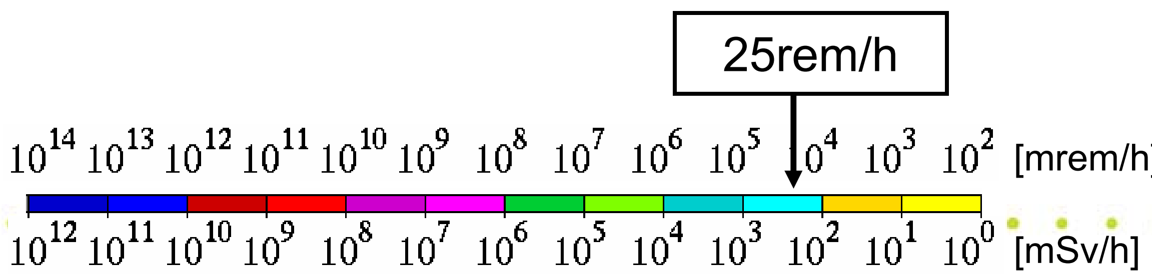
By MARS15 plotter

Detector: GLD, IR hall: 20m(L)x110m(W)x35m(H)

Pacman: ID:160cm, Iron 70cm, Conc 200cm → 16.2rem/h for 18MW (Shield11)

500 GeV, 18MW on $20X_0$ Cu cylinder





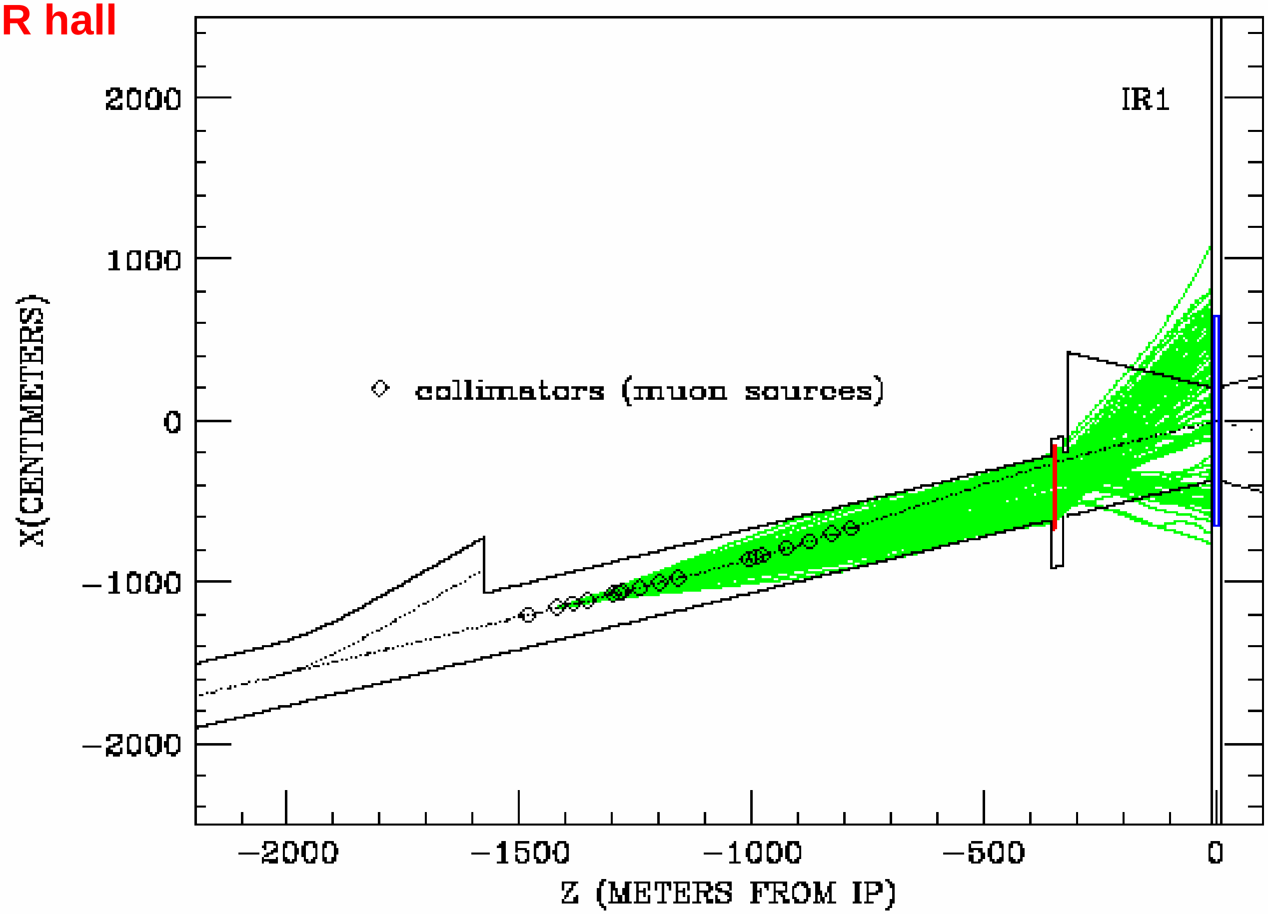
- Still unknown parameters
  - **Beam loss distribution and scenario**
  - **Area classification**
  - **Detector and Beam line component**

- IR hall
  - **Shaft and wall between detectors**
    - Commissioning run
  - **Shielding capability of a detector**
    - Self shielding or not
    - Effects of gaps for cables and tubes
  - **Pacman thickness**
    - Inner diameter
    - Requirement of penetration

Supplement slides

Question: Do muons from sources in the collimation section cause a dose rate problem outside a self-shielded detector?

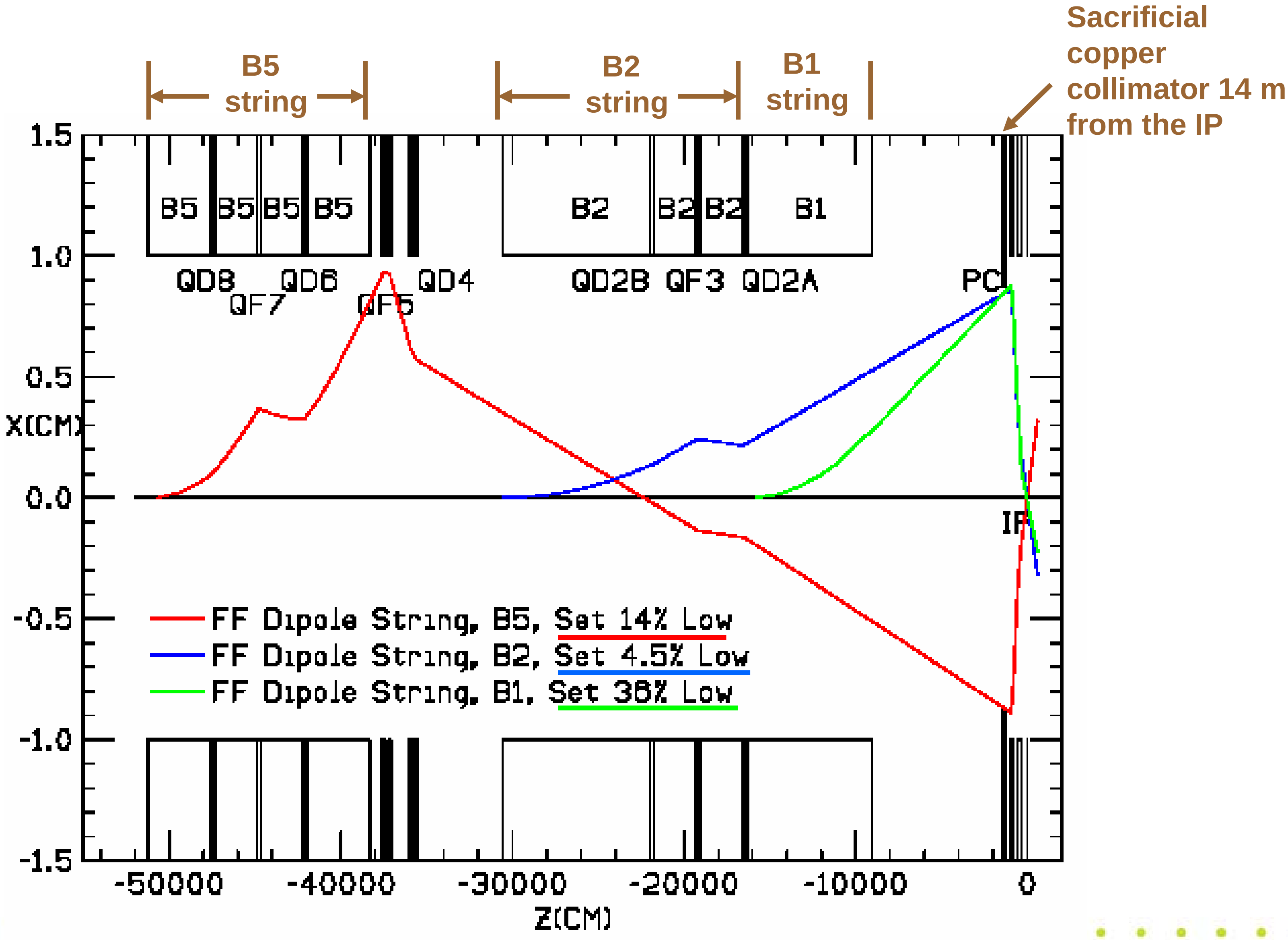
Plot showing how the 5 m magnetized wall disperses muons from a single source which reach the IR hall



Answer: The estimated dose rate outside a 6.5 m radius detector from all sources, 0.1% collimated halo, both beams, is 0.045 mrem/h

– SLAC limit is 0.05 mrem/h

Examples of FF Soft Bend Mis-settings which Steer Bunches into the Final Doublet



[SLAC rule]

- Normal operation :

  → **0.05mrem/h (= 0.5μSv/h) for GERT, 0.5mrem/h (= 5μSv/h) for RW**

- Miss steering :

  → **400mrem/h (= 4mSv/h)**

- System Failure :

  → **25rem/h (250mSv/h) for maximum credible beam loss in any accessible area**

  assuming that the BCS devices that limit beam power have failed

[LHC design] **(from http://indico.cern.ch/conferenceDisplay.py?confId=1561 talk of D. Forkel-Wirth)**

- Normal operation :
  - → 0.3 mrem/h (= 3μSv/h) for Simple controlled area
  - → 0.1 mrem/h (= 1μSv/h) for Supervised area
  - → 0.01 mrem/h (= 0.1μSv/h) for Non-designated area
- Total Beam loss :
  - → 5 rem (50mSv) for Simple controlled area
  - → 250 mrem (2.5mSv) for Supervised area
  - → 30 mrem (0.3mSv) for Non-designated area

[J-PARC design] **(from Dr. Nakashima, JAEA)**

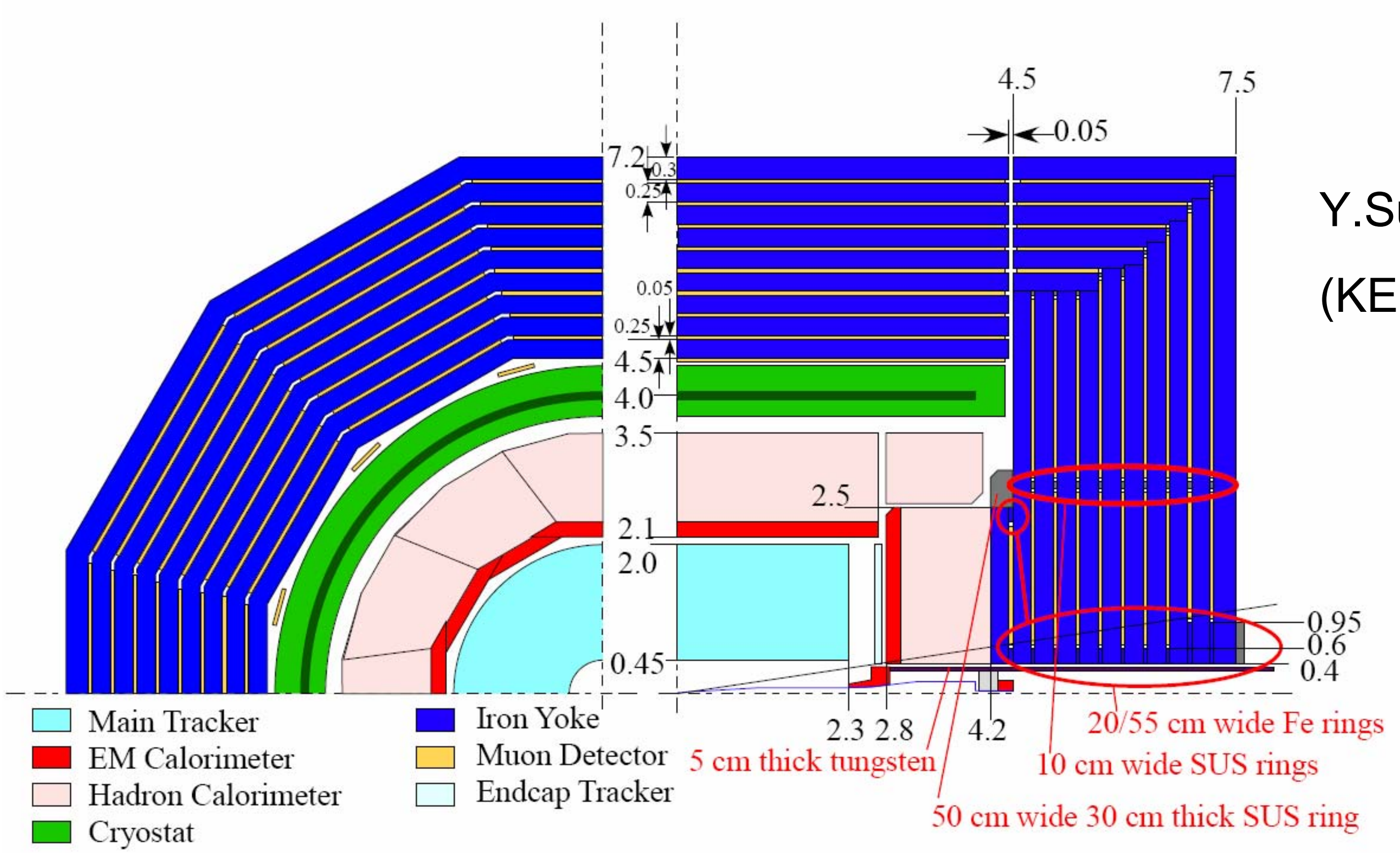
- Normal operation : (**1W/m beam loss assumed for 1MW**)
  - → 1.25 mrem/h (= 12.5μSv/h) for Controlled area
  - → 0.025 mrem/h (= 0.25μSv/h) for In-site

Total Beam loss :

Accelerator stops within 1 sec
by monitoring beam current, beam loss and 1 hour integrated dose rate

	Perfectly modeled	Modeled with simplification	Ignore
GLD (Large detector)	Iron Yoke, Endcap	Beam tube, VTX, BIT, FIT, ET, TPC, ECAL, HCAL, FCAL,BCAL, Cryostat, Mag. Field	Muon chamber
SiD (Small detector)	Iron Yoke, End cap	EMcal, Hadron cal, Solenoid , Mag. field	Vertex Det, Tracker, Muon chmabers

Shield effective part (underlined parts) must be taken into account.



Y.Sugimoto

(KEK)

Endcap Tracker, FCAL, BCAL, EM Calorimeter

→ W (ρ=9.9) for >20MeV, W+CH2 (ρ=9.9) for <20MeV

Hadron Calorimeter →Pb(8.88) for >20MeV, Pb+CH2 (ρ=8.88) for <20MeV

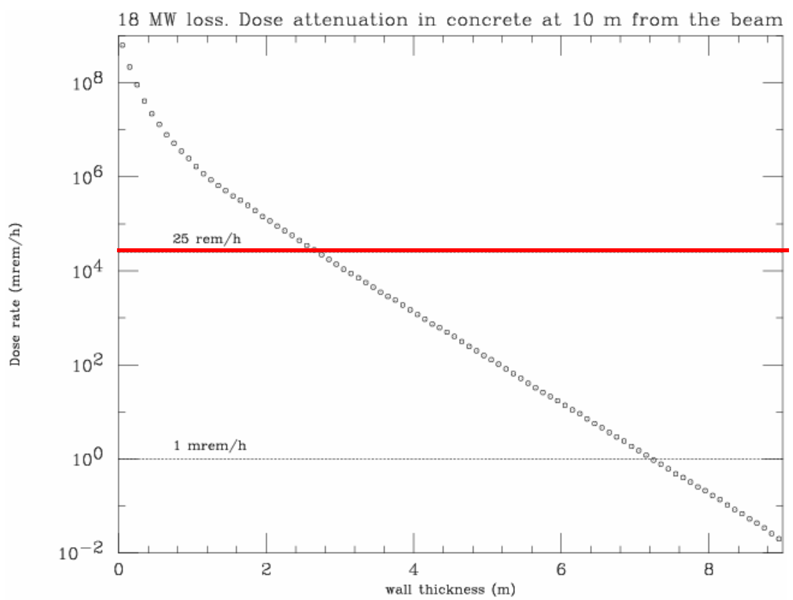
Use structure and values described in
http://confluence.slac.stanford.edu/display/ilc/sid00

Iron Yoke → Octagonal shape

EM Calorimeter → W plates 0.275cm x 20layers + 0.50cm x 10layers

Hadron Calorimeter →Fe plates 2.0cm x 34layers

- Experimental hall : 30m long – 30m width – 30m height
  - **Tentative, depend on crane size, how to assemble detectors,, etc.**
- BDS tunnel and Pacman
  - **Tentative, depend on shield design, scheme of detector exchange, etc.**
- Minimum shield for 18MW electron beam
  - **Concrete 3m**
    (Determined by our previous work)



18MW loss Dose attenuation in concrete at 10m from the beam