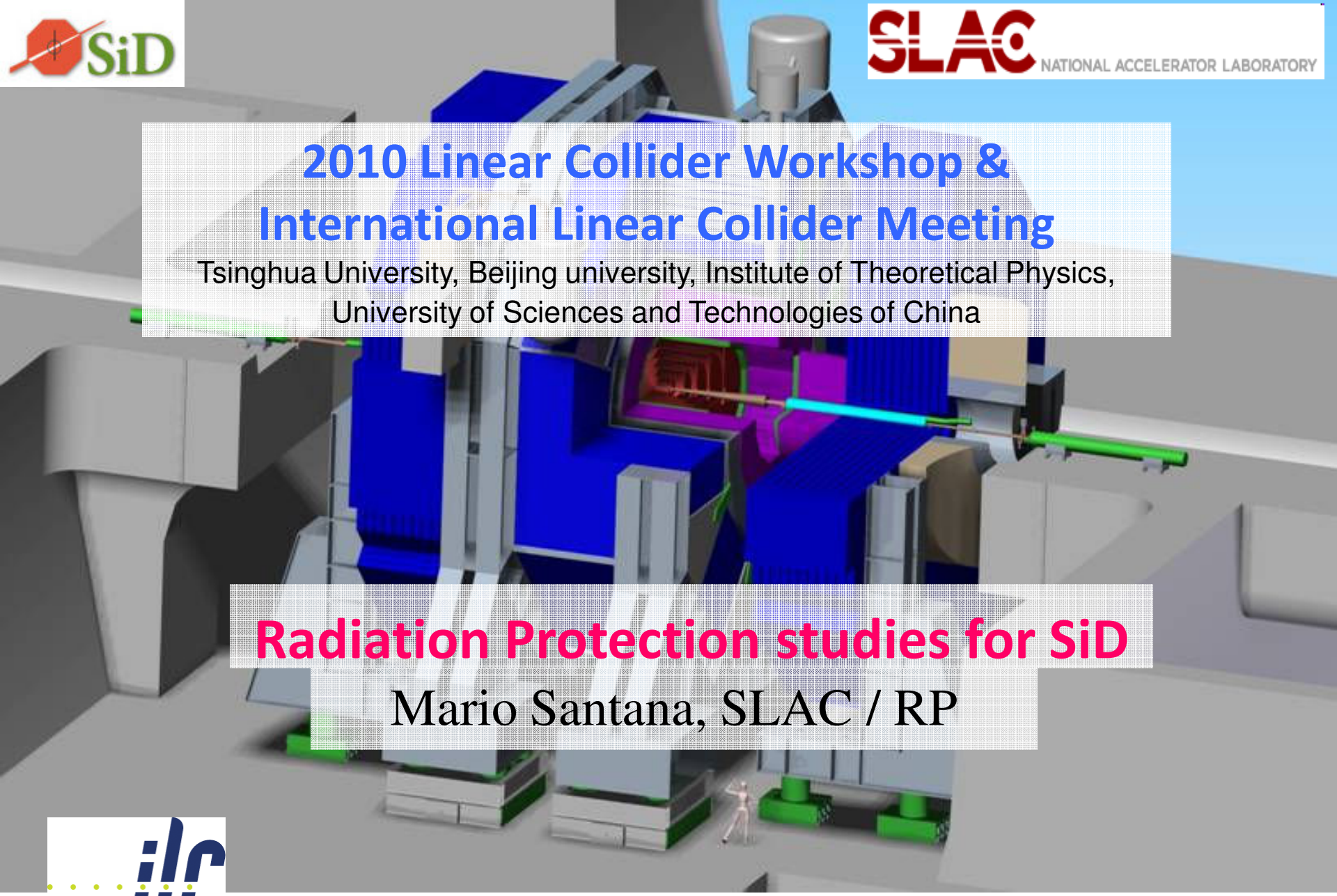


2010 Linear Collider Workshop & International Linear Collider Meeting

Tsinghua University, Beijing university, Institute of Theoretical Physics, University of Sciences and Technologies of China

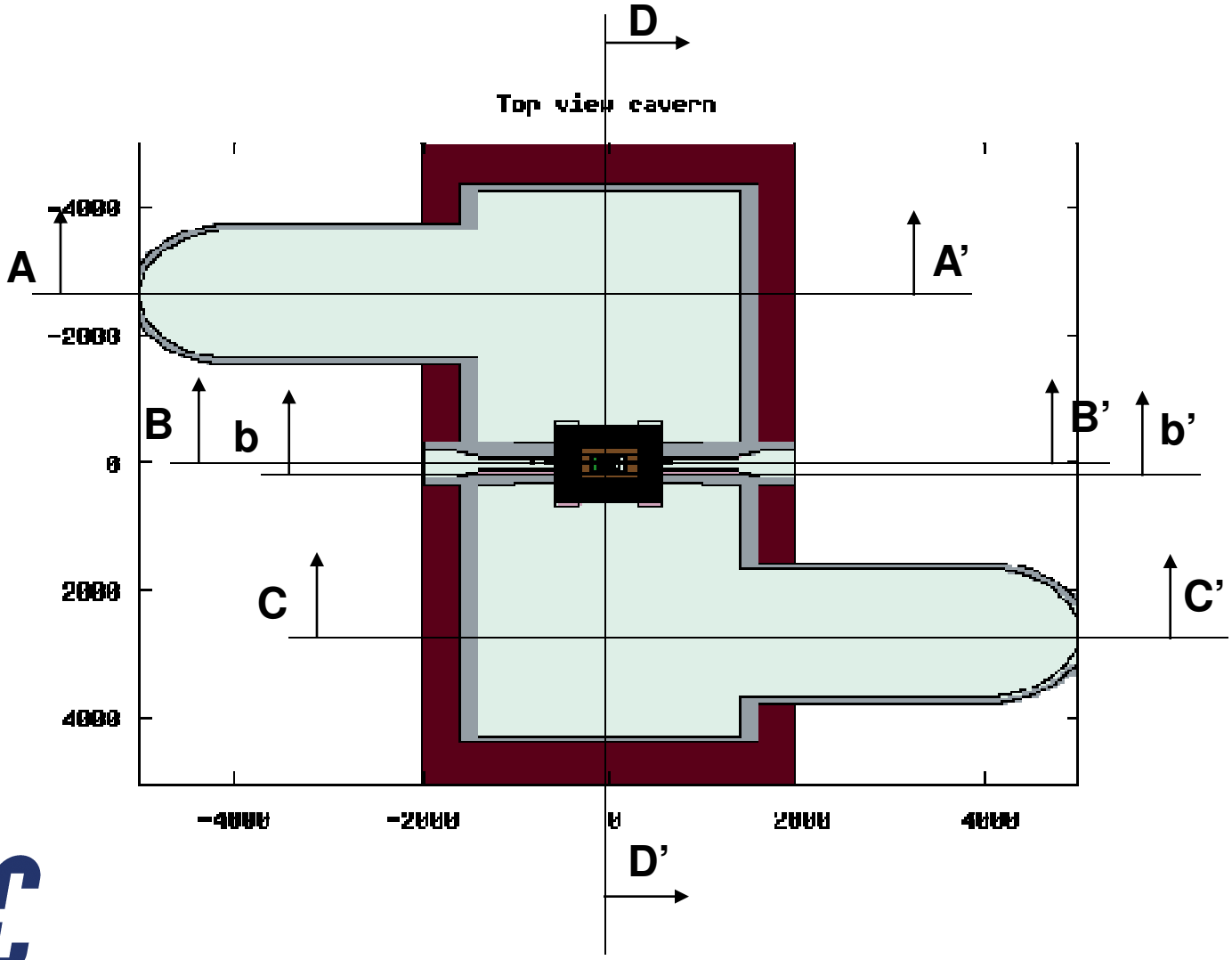
Radiation Protection studies for SiD

Mario Santana, SLAC / RP

Overview

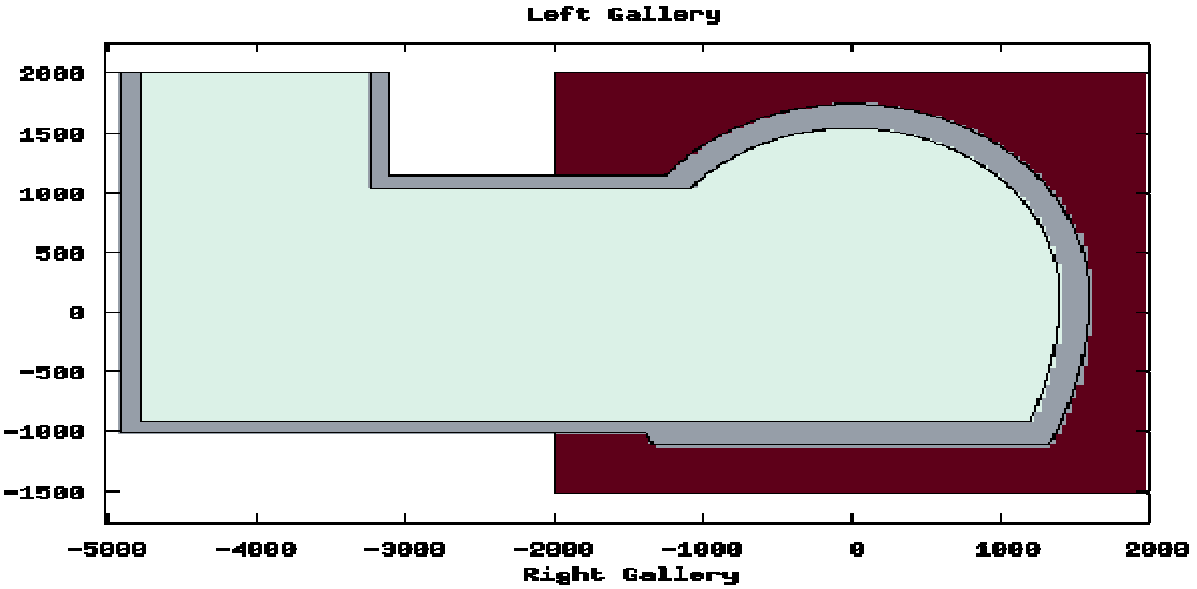
1. Geometry and Monte Carlo Settings
2. Dose limits and Beam Conditions
3. Interface pacman-cavern
4. Pacman and penetration
5. SiD detector
6. Ongoing studies
7. Provisional conclusions

SiD Geometry implementation

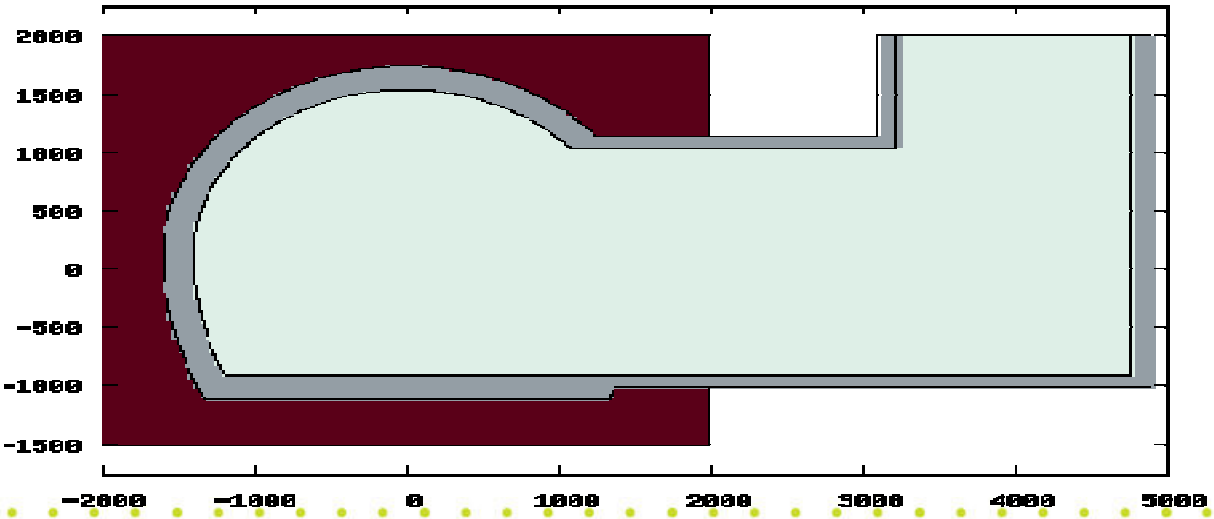


Geometry: end shafts

A-A’



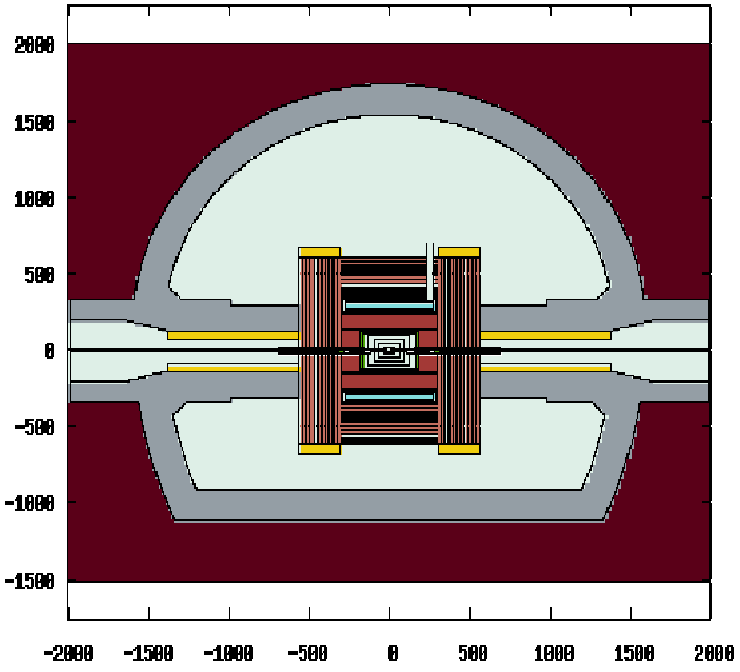
C-C’



Geometry: pacman and SiD

B-B'

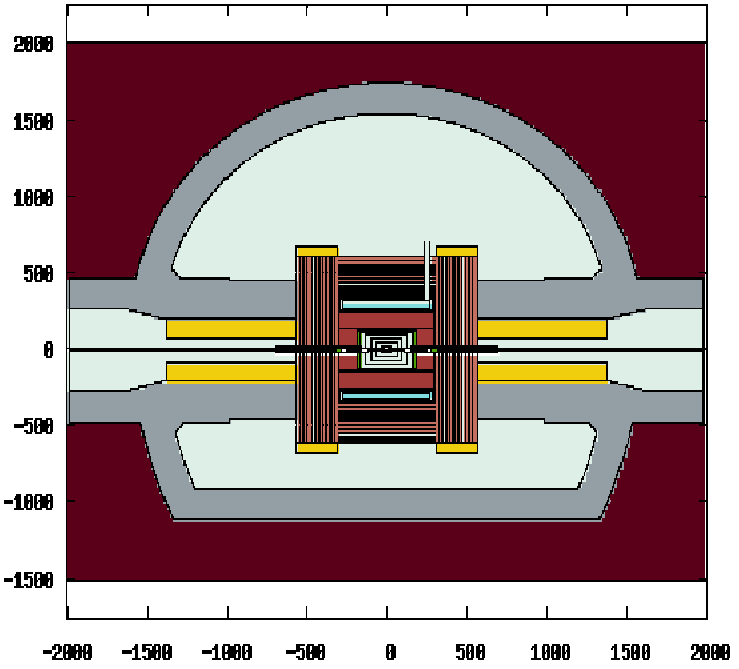
SiD elevation at beam plane
Small PACMAN



50 cm steel +

170 cm concrete

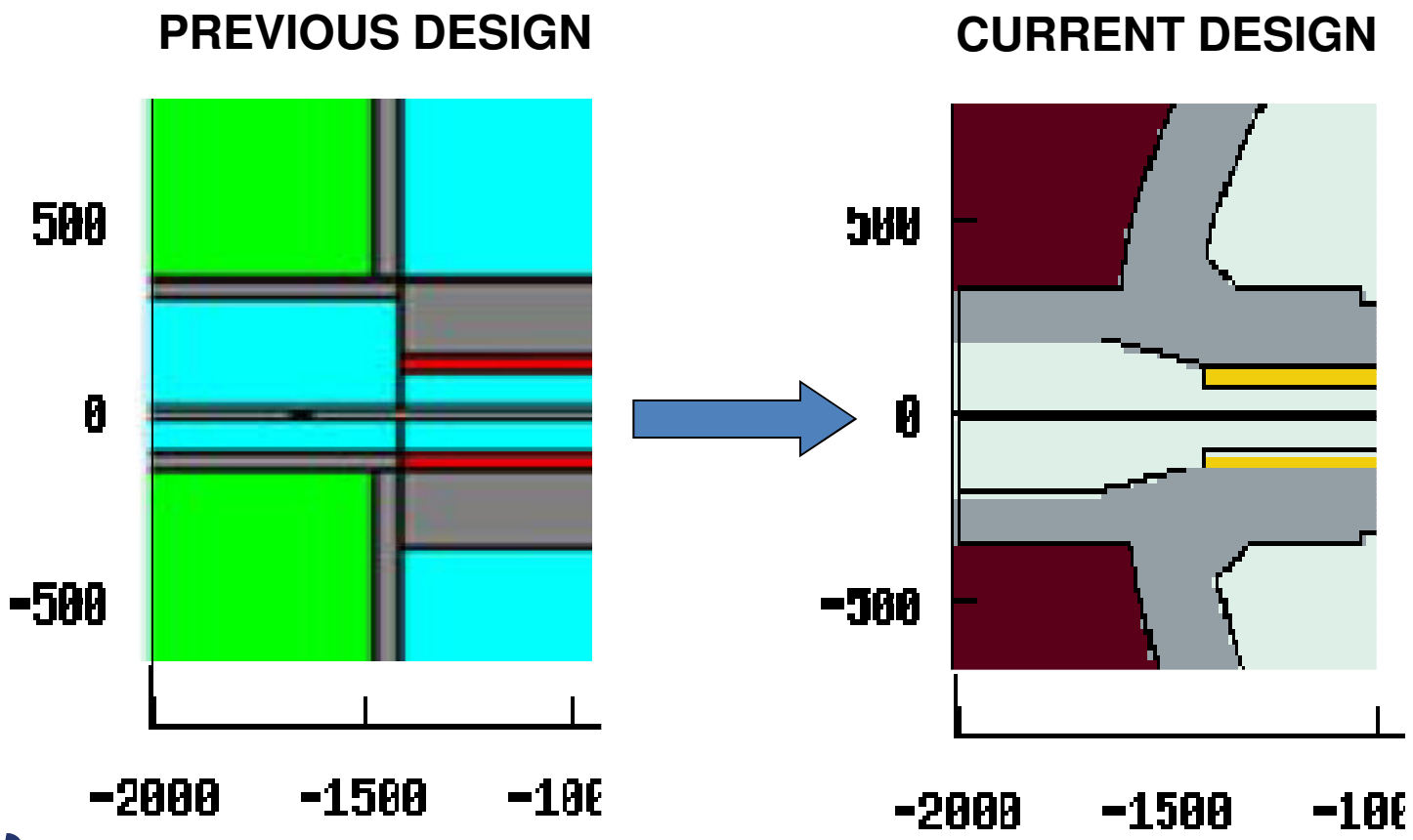
SiD elevation at beam plane
Large PACMAN



120 cm steel +

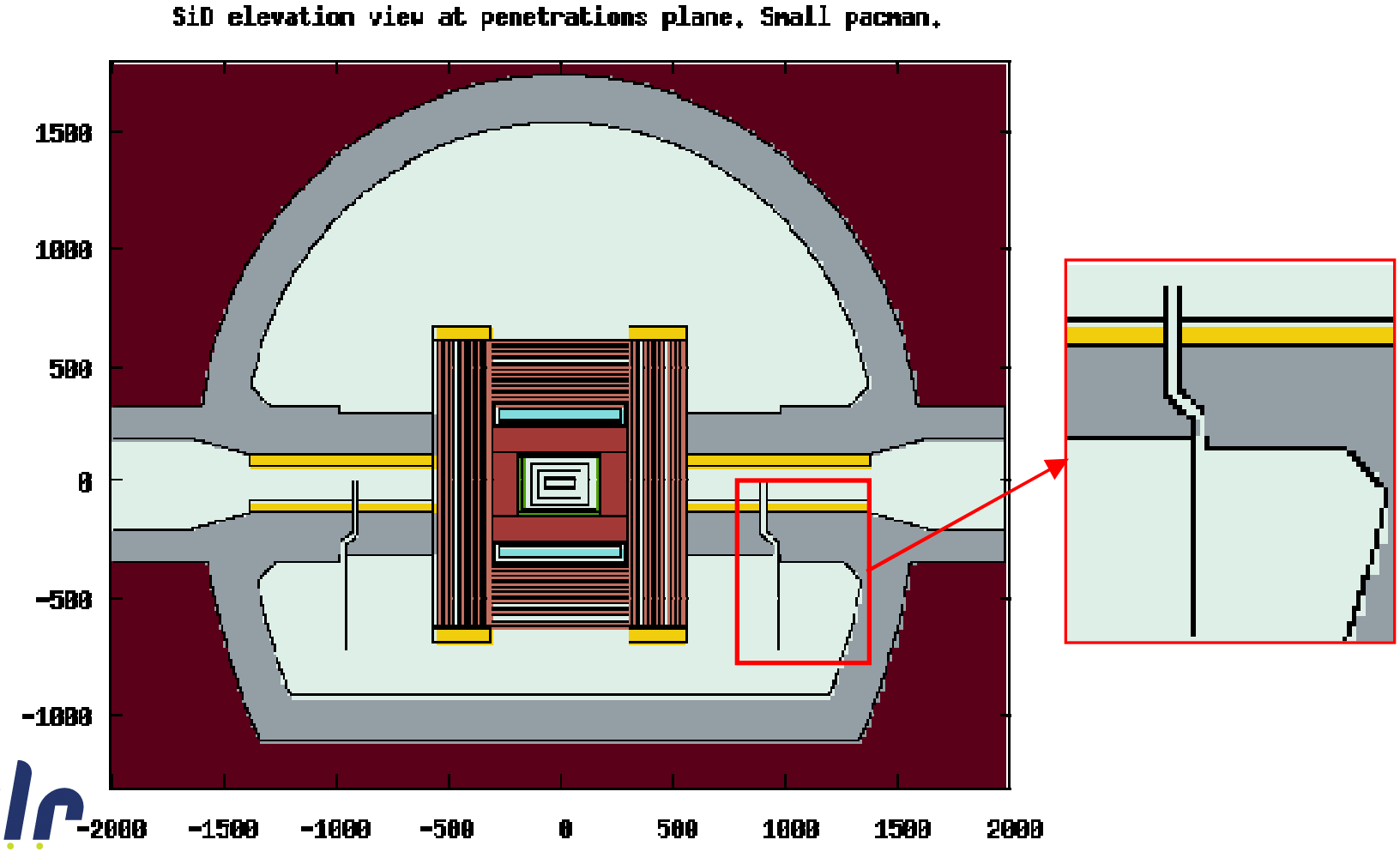
250 cm concrete

Geometry: pacman-cavern interface



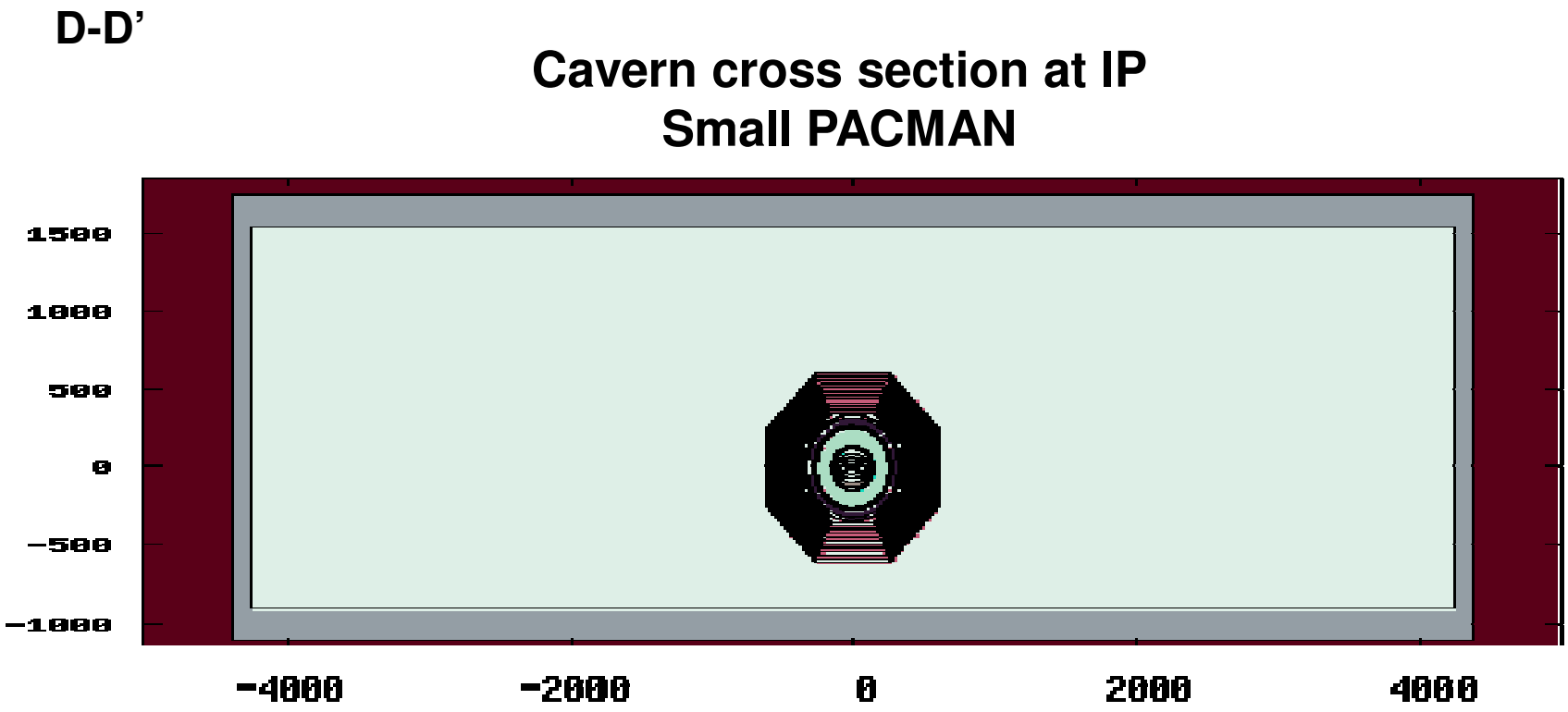
Geometry: pacman penetrations

b-b’



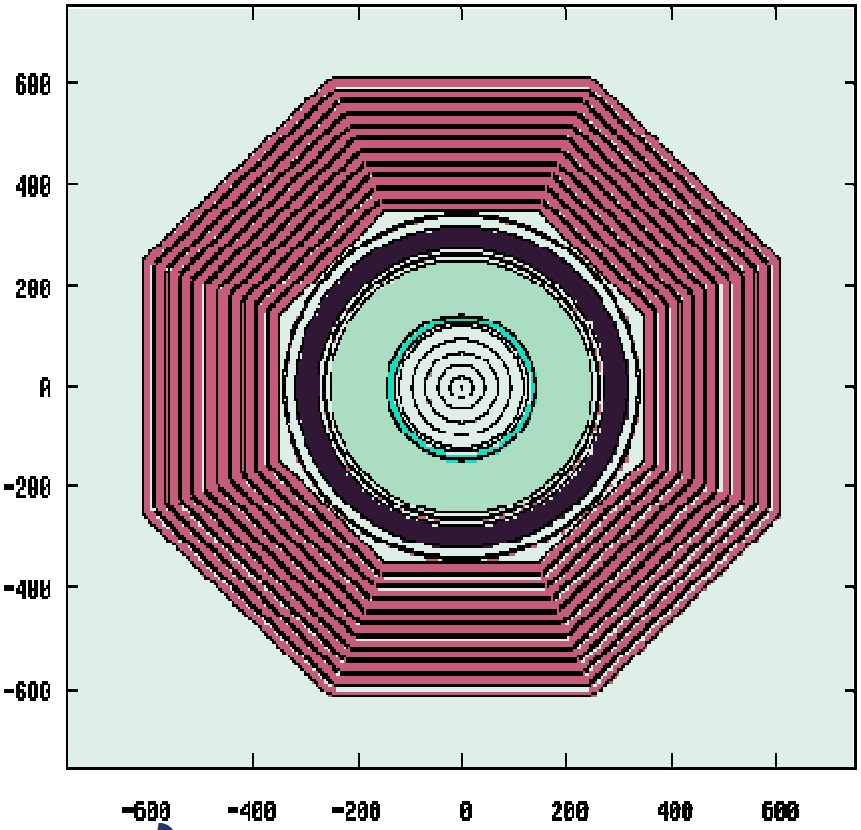
Geometry: cross section at IP

D-D'

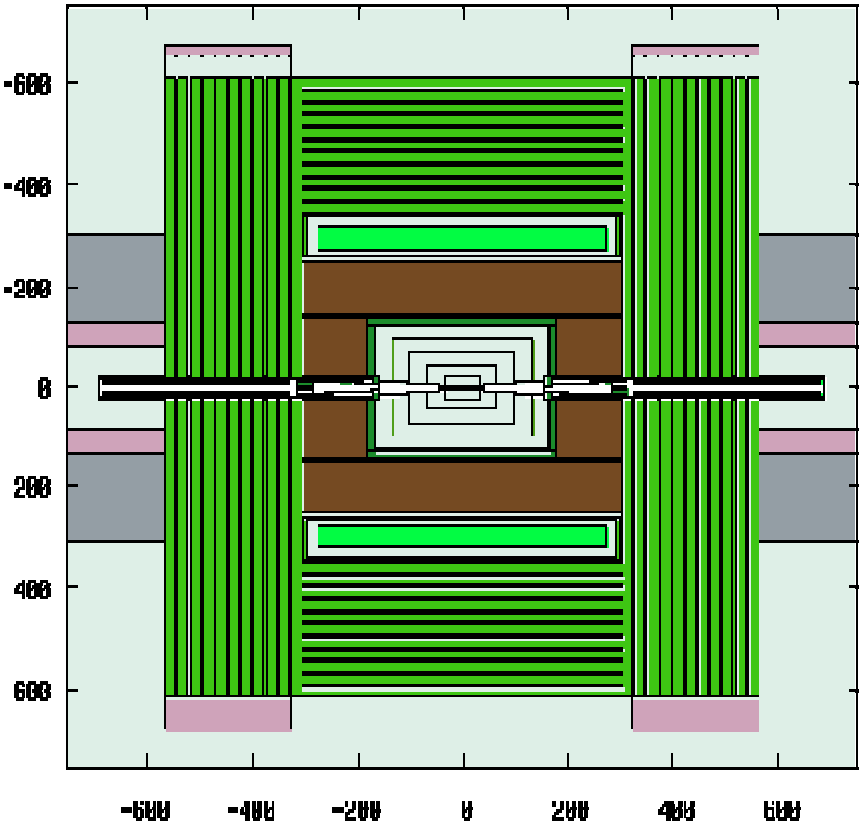


Geometry: SiD

SiD cross section at IP



SiD top view



Monte Carlo tools and methods

- FLUKA Intra Nuclear cascade code
  - Latest version
  - LAM-BIASING, Photonuclear/Photomuon reactions
- Deq99 fluence to dose conversion routine
- FLAIR GUI
- PARALLEL simulations at SLAC farm: about 76000 CPU-hour (some more biasing required…)

] A. Fassò, A. Ferrari and P.R. Sala, *Electron-Photon Transport in FLUKA: Status*, Proc. MonteCarlo 2000 Conference, Lisbon, October 23–26 2000, A. Kling, F. Barao, M. Nakagawa, L. Tavora and P. Vaz eds., Springer-Verlag Berlin, p. 159–164 (2001)
A. Fassò, A. Ferrari, J. Ranft and P.R. Sala, *FLUKA: Status and Prospective for Hadronic Applications*, same proceedings, p. 955–960 (2001)

] S. Roesler, G.R. Stevenson, *deq99.f - A FLUKA user-routine converting fluence into effective dose and ambient dose equivalent*, Technical Note CERN-SC-2006-070-RP-TN, EDMS No. 809389 (2006)

] M. Pelliccioni, *Overview of fluence-to-effective dose and fluence-to-ambient dose equivalent conversion coefficients for high energy radiation calculated using the FLUKA code*, Radiation Protection Dosimetry 88 (2000) 279-297

V.Vlachoudis "FLAIR: A Powerful But User Friendly Graphical Interface For FLUKA" Proc. Int. Conf. on Mathematics, Computational Methods & Reactor Physics M&C 2009), Saratoga Springs, New York, 2009

Dose limits

Annual Occupational Dose Limits (Radiation Worker):

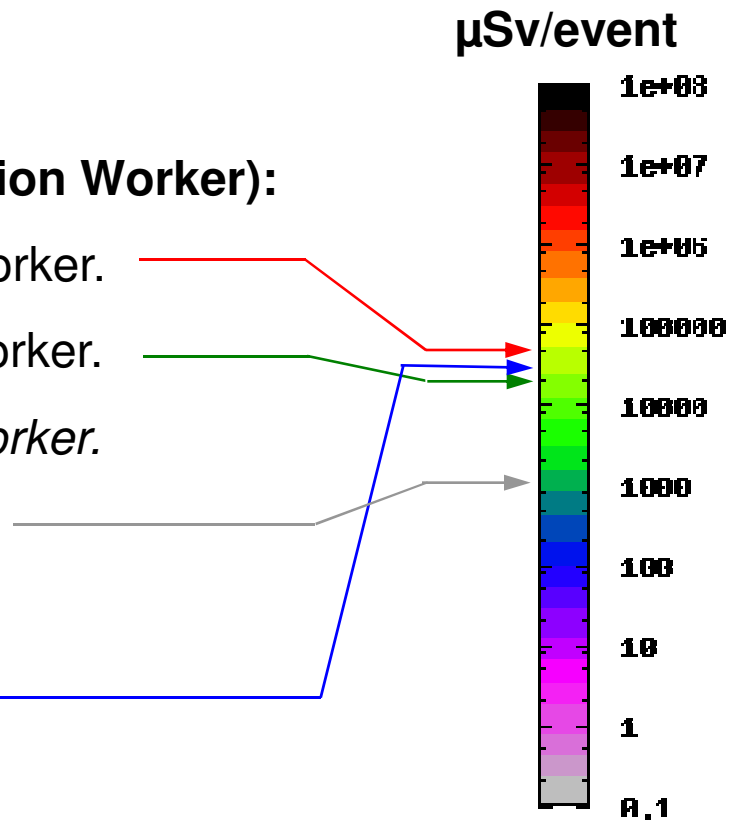
- DOE/DOD: 50 mSv (5000 mrem). Rad worker.
- ICRP: 20 mSv (2000 mrem). Rad worker.
- SLAC: *5 mSv (500 mrem). Rad worker.*
  1 mSv (100 mrem). GERT.

Dose limit per accident:

- SLAC: 30 mSv (3000 mrem)

Dose *rate* limit for an accident:

- SLAC: 250 mSv/h (25 rem/h)

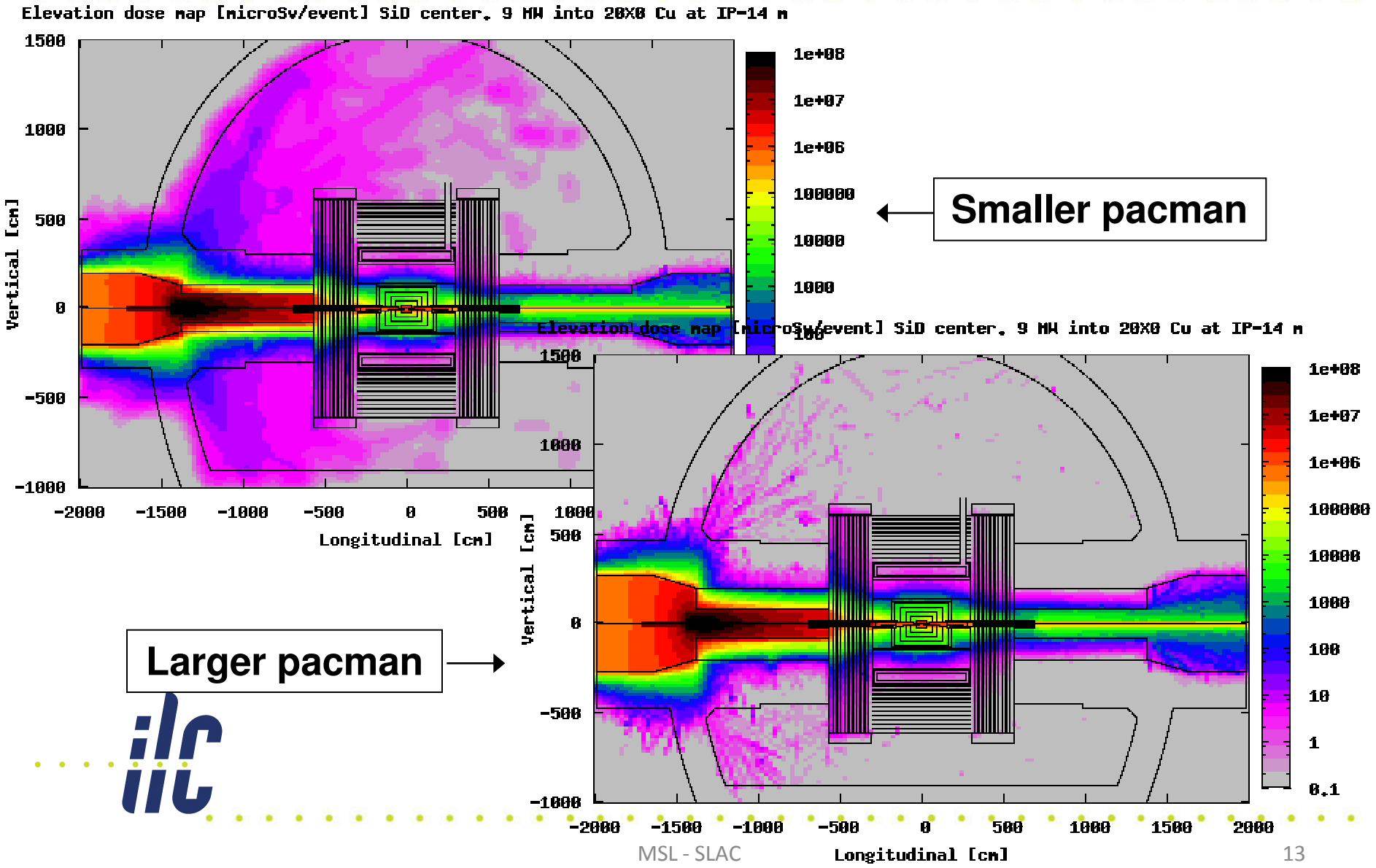


For our beam conditions: 1 µSv/event → 18 mSv/h

Beam conditions / accident conditions

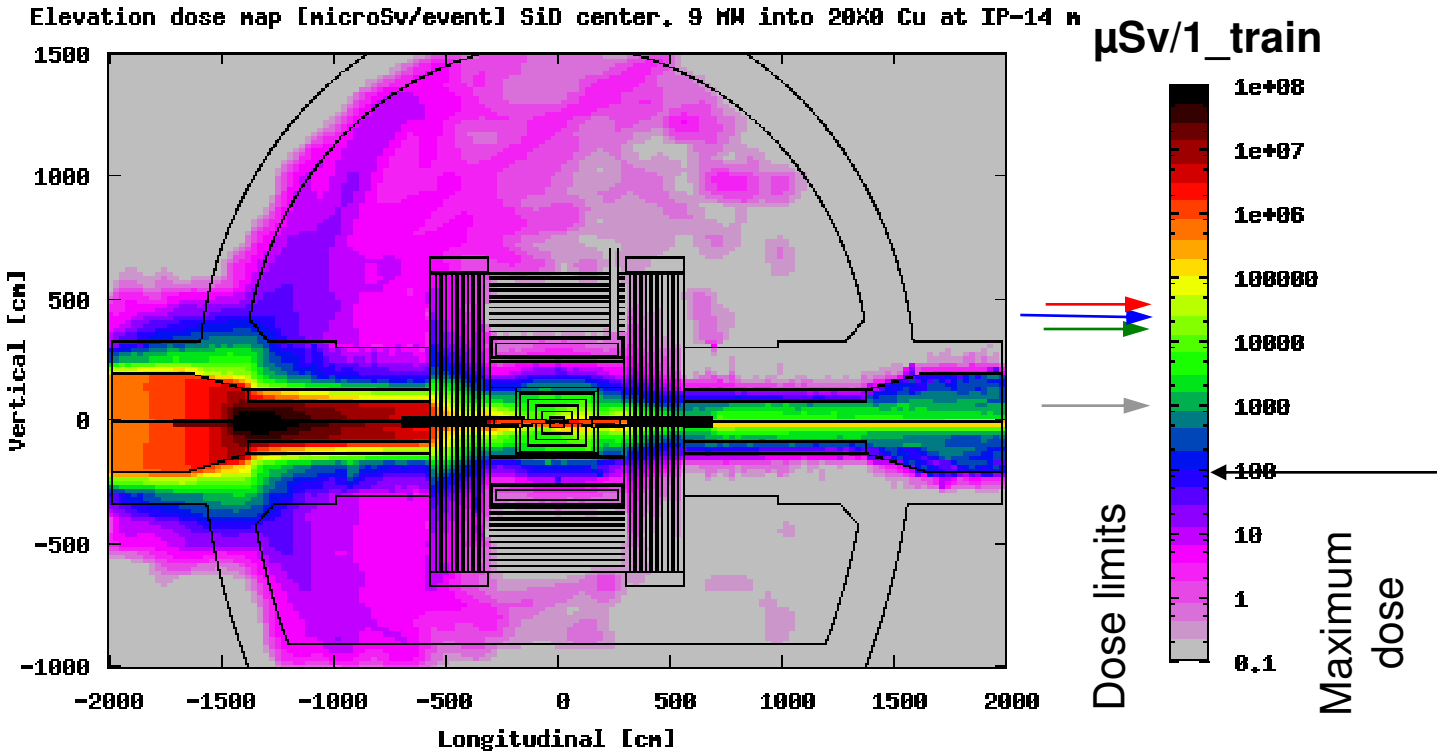
- 500 GeV / beam
- 9 MW / beam
- Typical accidents:
  - Beam1 **AND** beam2 hit thick target at IP-14 m
    - Weakness cavern-pacman interface?
  - Beam1 **AND** beam2 hit thick target at IP-9 m
    - Pacman is sufficiently thick? Weakness in penetration.
  - Beam1 hits tungsten mask at IP-3 m (unsteered)
    - SiD is sufficiently shielded?
- Beam aborted after one train = up to 3.6 MJ

20 R.L. Cu target in IP-14 m. Pacman size.



20 R.L. Cu target in IP-14 m. Small pacman.

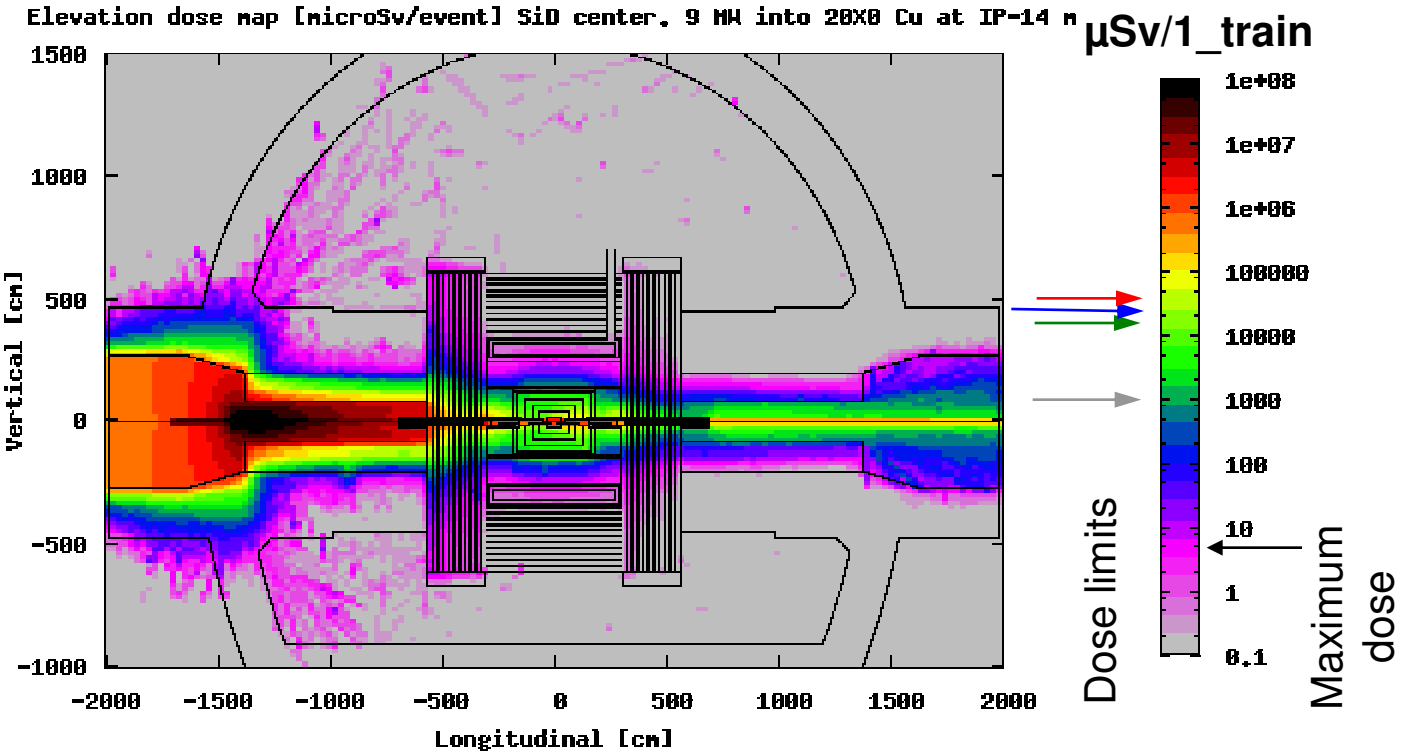
9 MW



- The maximum **integrated dose** per event is ~100 μSv << 30 mSv
- The corresponding peak **dose rate** is 1800 mSv/h >> 250 mSv/h

20 R.L. Cu target in IP-14 m. Large pacman.

9 MW



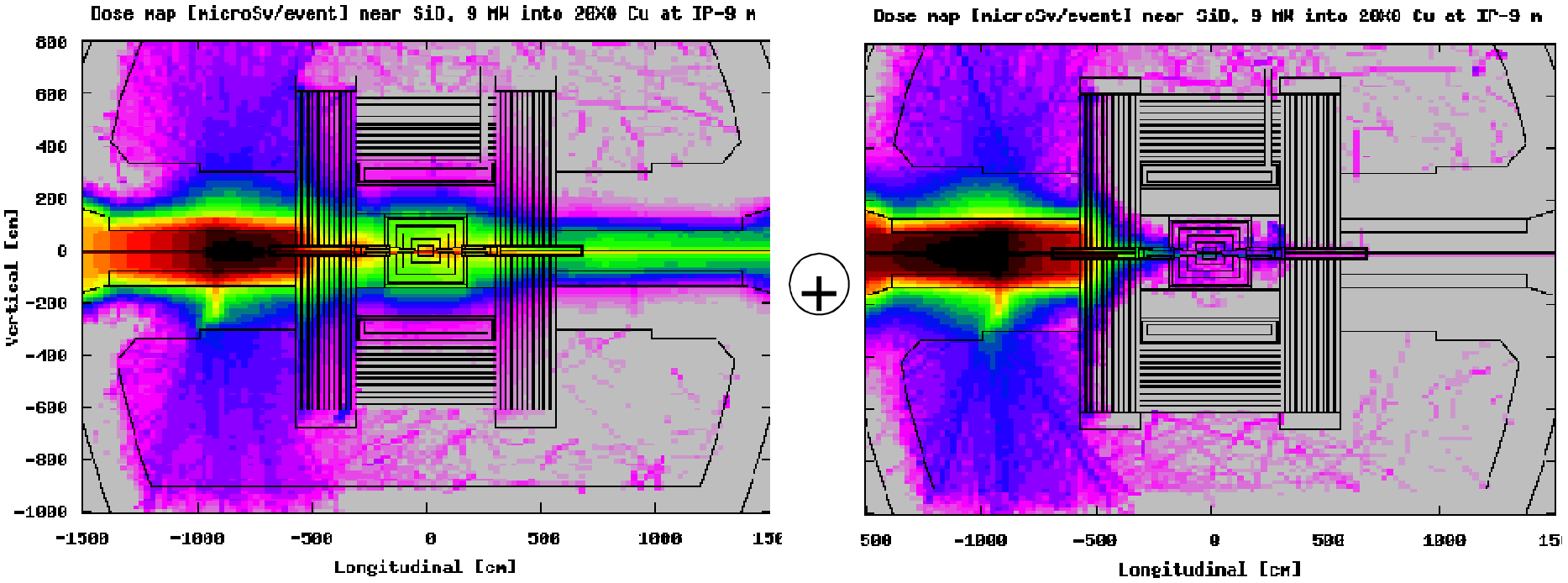
- The maximum **integrated dose** per event is ~8 µSv << 30 mSv
- The corresponding peak **dose rate** is ~140 mSv/h < 250 mSv/h

20 R.L. Cu target in IP-9 m. Small pacman.

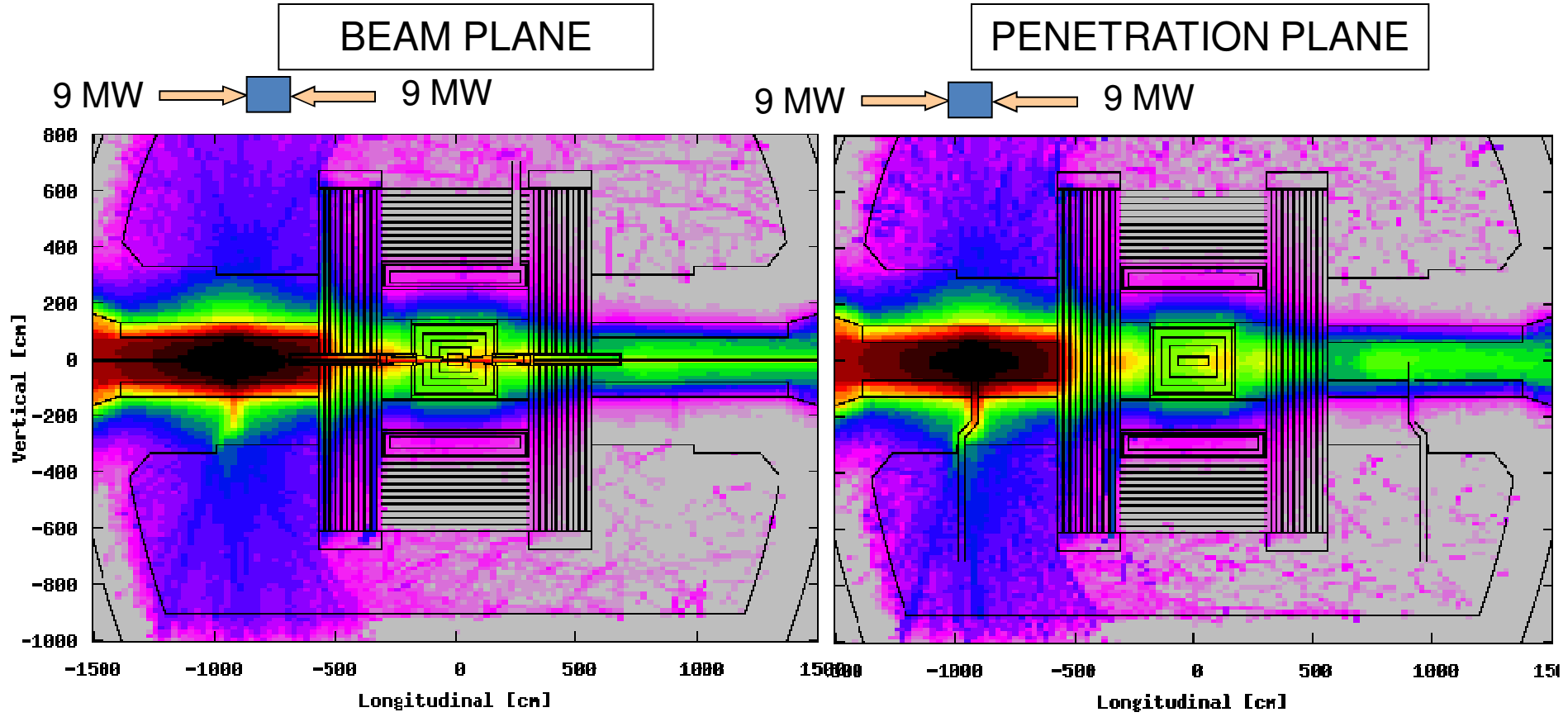
BEAM PLANE

Beam 1

Beam 2



20 R.L. Cu target in IP-9 m. Small pacman.



- 1000 μSv/event
- 18000 mSv/h

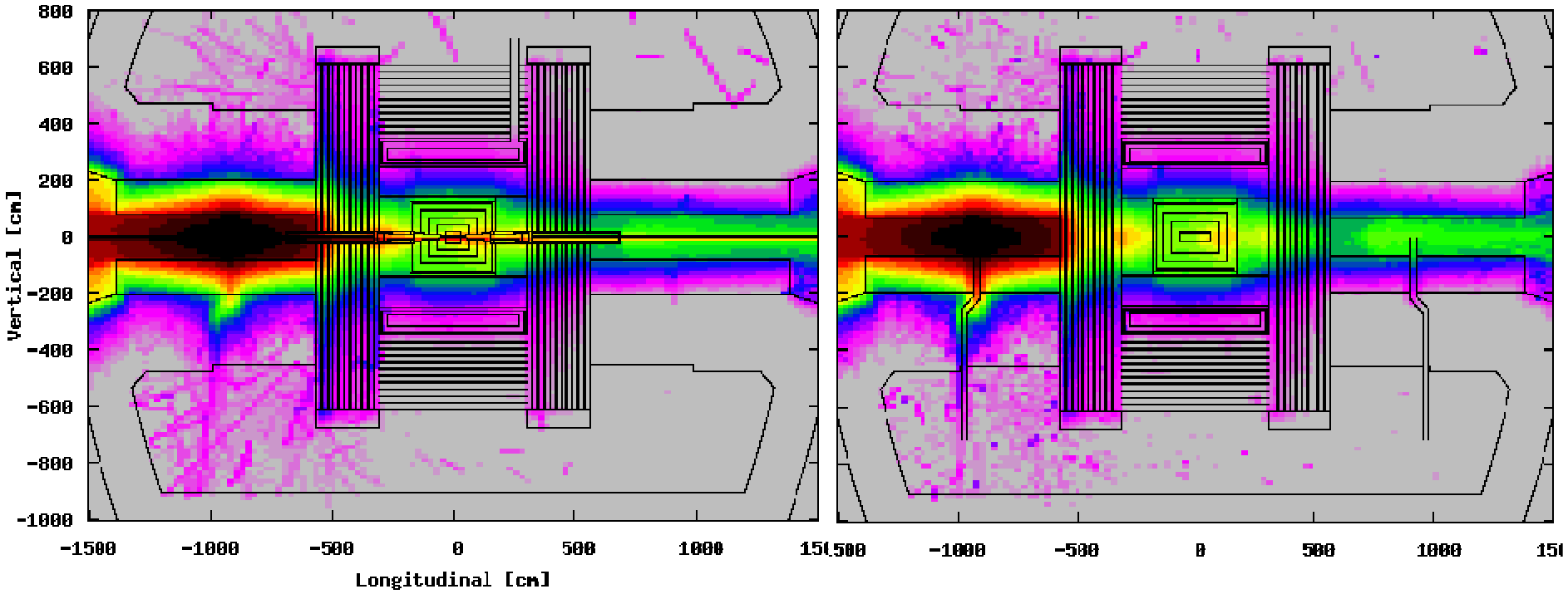
20 R.L. Cu target in IP-9 m. Large pacman.

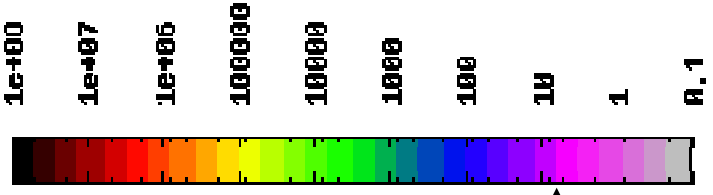
BEAM PLANE

9 MW → ← 9 MW

PENETRATION PLANE

9 MW → ← 9 MW





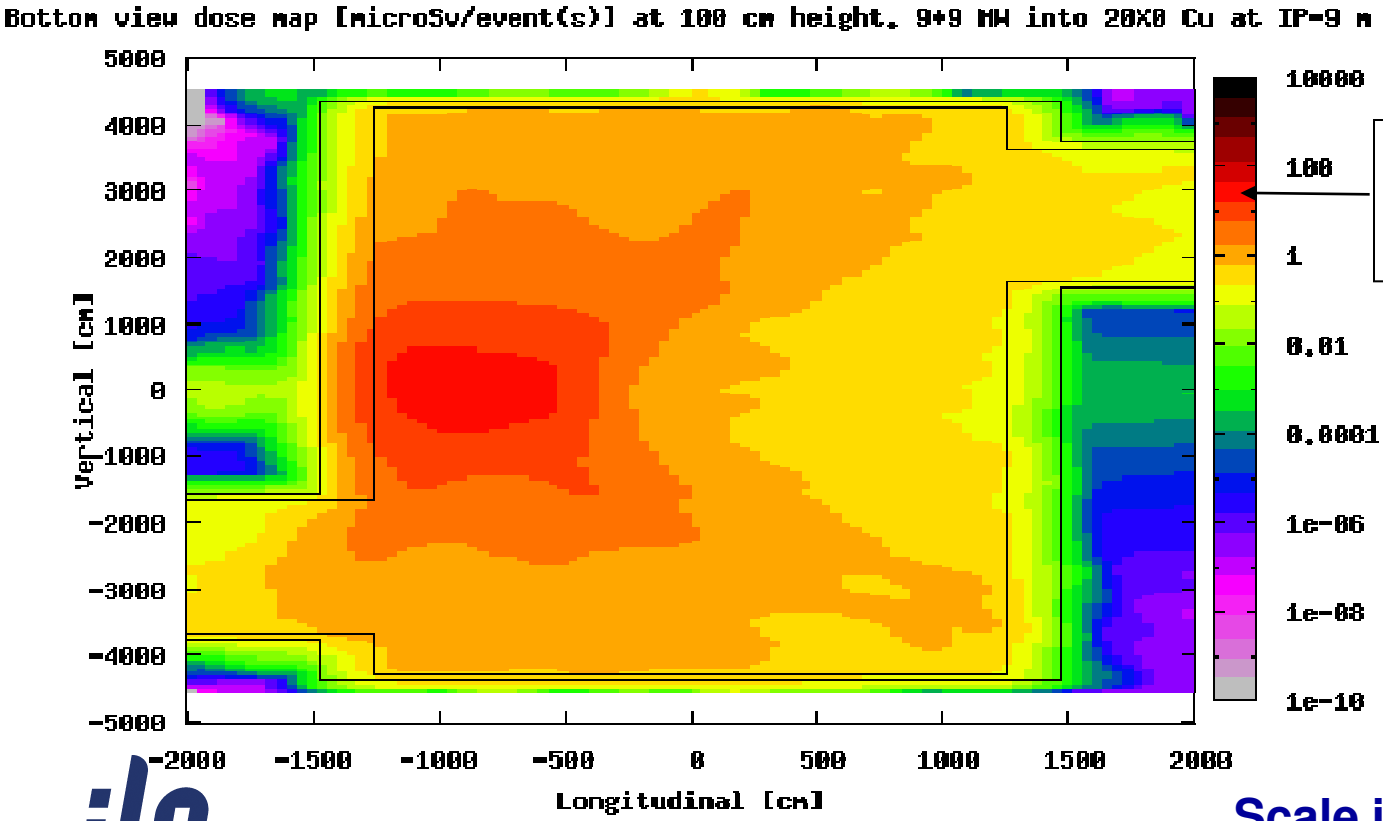
- 10 µSv/event
- 180 mSv/h

20 R.L. Cu target in IP-9 m. Small pacman.

BOTTOM VIEW AT 100 CM HEIGTH (FROM FLOOR)

9 MW  9 MW

μSv/2_train



~ 30 μSv/event
~ 540 mSv/h

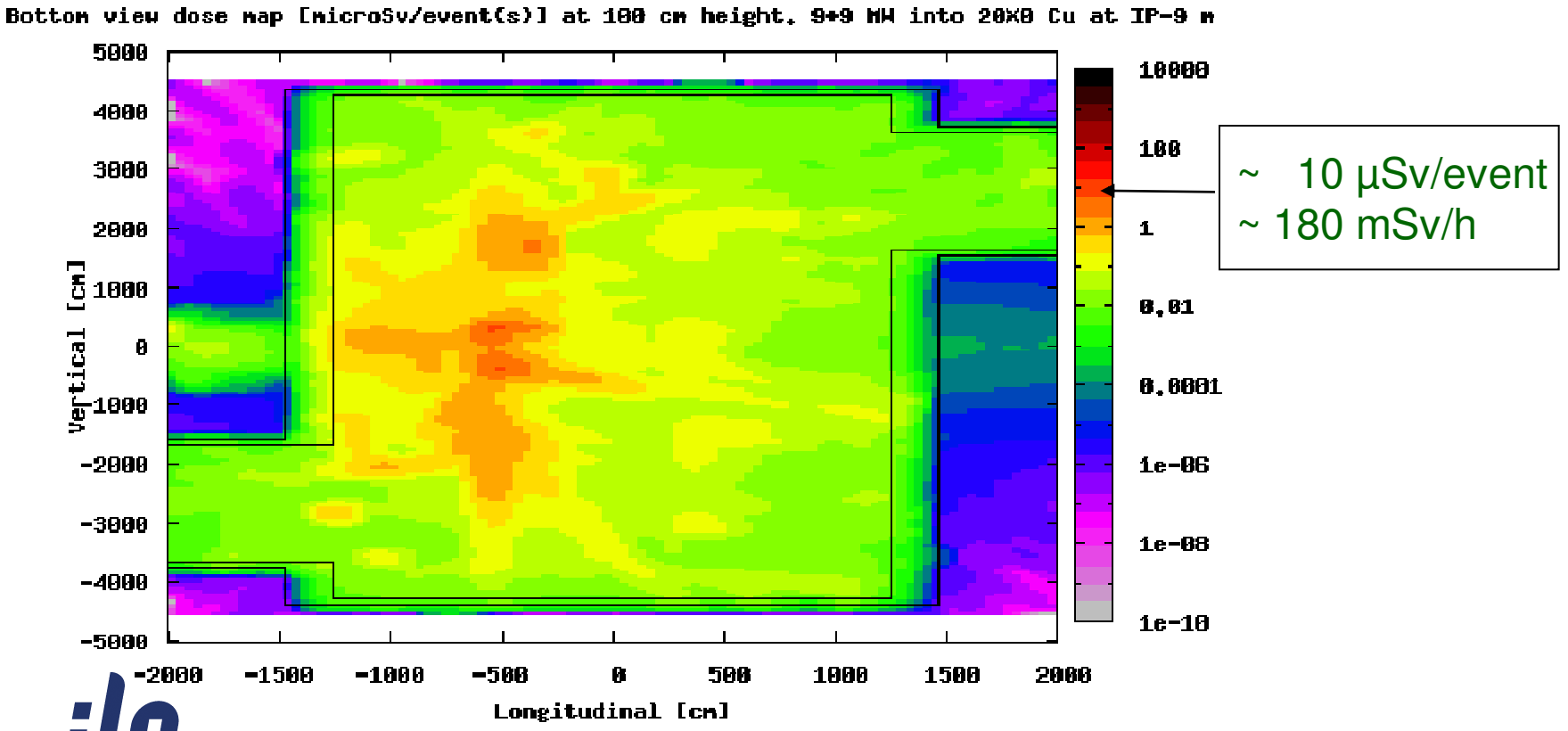
Scale is different from that of elevation plots !!

20 R.L. Cu target in IP-9 m. Large pacman.

BOTTOM VIEW AT 100 CM HEIGTH (FROM FLOOR)

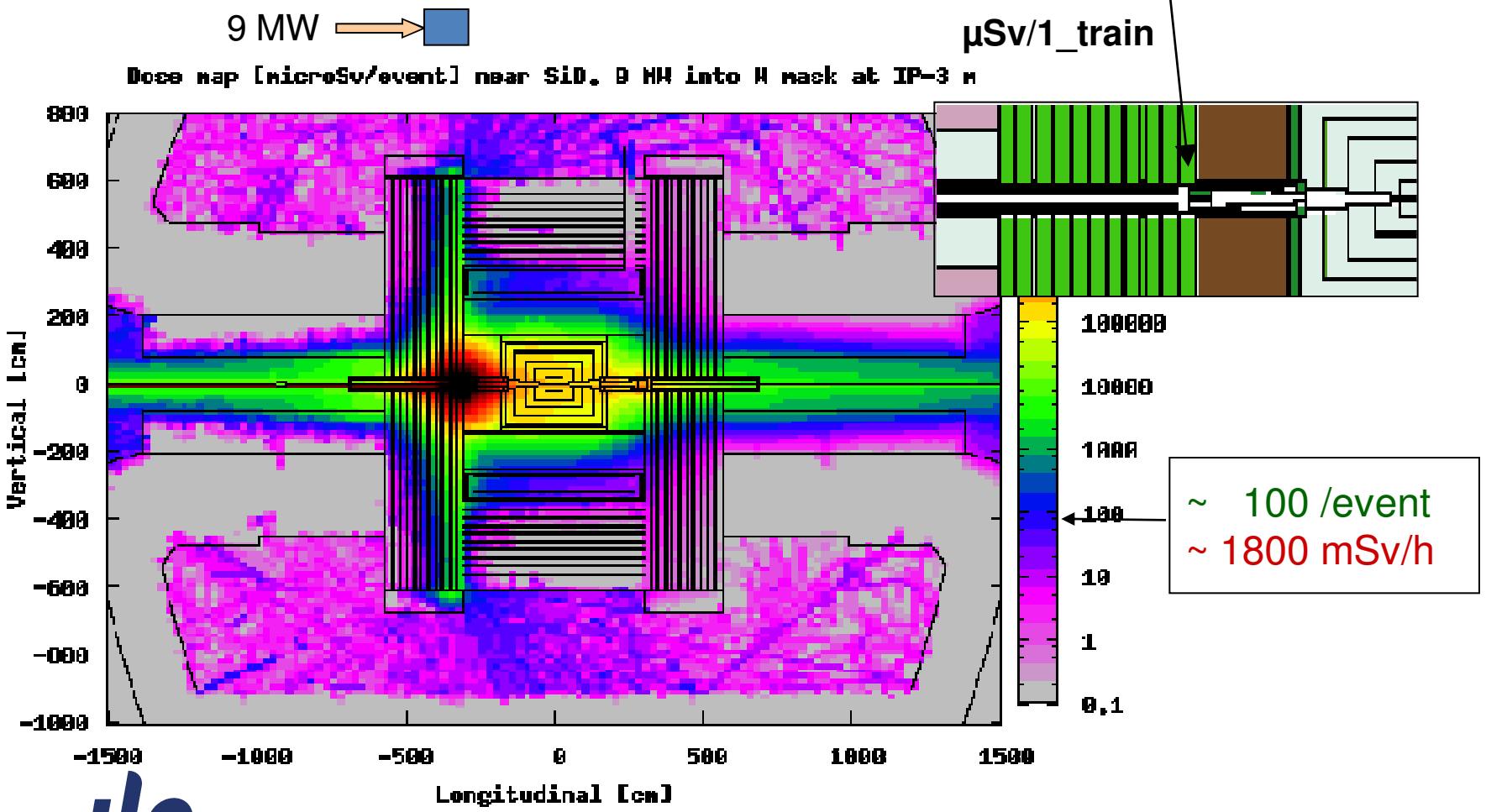
9 MW → ← 9 MW

µSv/2_trains



~ 10 µSv/event
~ 180 mSv/h

Beam 1 hits tungsten mask at IP-3 m



The spaces between the door plates are empty in the model, but in the real detector they will be partially filled

Ongoing studies

1. Better resolution: Customized biasing + weight windows
2. Mis-steering studies
3. Analysis of other possible weakness
4. …

Provisional conclusions

- Small pacman and pacman-cavern interface are sufficient in terms of *dose per event*.
- However, the *dose rates* for the small pacman are very high:
  - Proven mechanisms should be installed to:
    - avoid these accidents to occur
    - shut off beam after 1 train (200 mS)
  - Possible Debates
- The large pacman complies with all criteria.
- The penetrations in the pacman don't require local shielding.
- The shielding of the detector may be insufficient to comply with dose rate limit. Exclusion area?
- More studies ongoing (mis-steering…)