Be-Target Design: Progress & Plans

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The George Washington University
(for KLF Collaboration)

- Hall D beam line for KLF.
- MCNP transport code.
- Hall D setting.
- Be-target assembly.
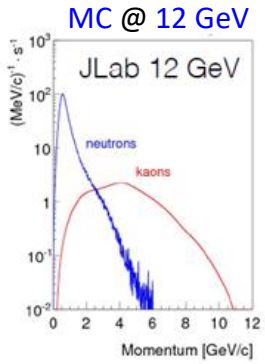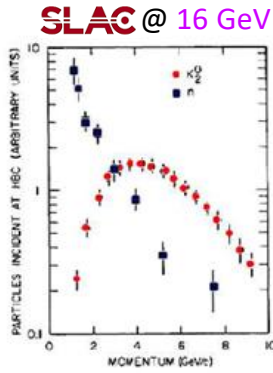- Biological dose rate.
- Where to go.

Hall D Beam Line for K-longs

K_L Beam Flux

MC @ 12 GeV

SLAC @ 16 GeV

- Electrons are hitting Cu-radiator @ CPS located in Tagger alcove.
- Photons are hitting Be-target located in collimator alcove.
- K_Ls are hitting the LH_2/LD_2 target within GLueX setting.

JLab 12 GeV

neutrons

kaons

Momentum [GeV/c]

PARTICLES INCIDENT AT H6C (ARBITRARY UNITS)

K_2^0
n

MOMENTUM (GeV/c)

$N(K_L)/sec \sim 10^4$

$\frac{N(K_L)_{JLAB}}{N(K_L)_{SLAC}} \sim 10^3$

GlueX Spectrometer

forward calorimeter

barrel calorimeter

time-of-flight

DIRC

start counter

LH2/LD2

forward drift chambers

central drift chamber

superconducting magnet

Pair Spectrometer

North LINAC

e- beam

No need in **tagging** photons

γ beam

K_L

Sweep Magnet
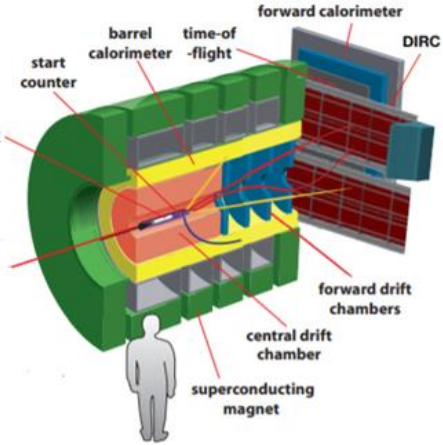
East ARC

Compact Photon Source

Kaon Production Target
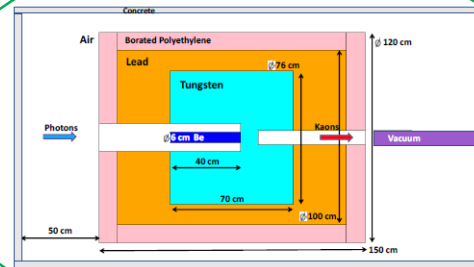
Kaon Flux Monitor
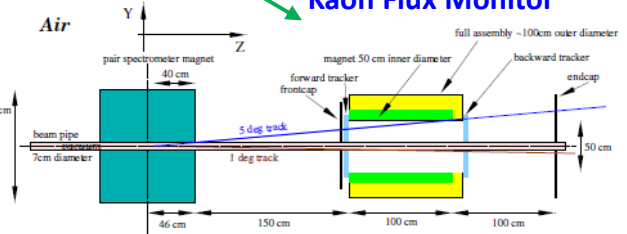
Concrete
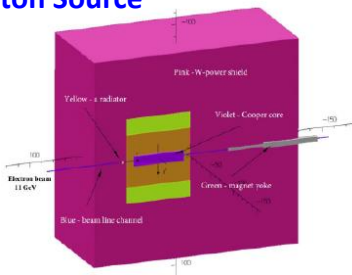
Air

Borated Polyethylene

Lead

Ø 76 cm

Ø 120 cm

Tungsten

Photons

Ø 6 cm Be

Kaons

Vacuum

40 cm

70 cm

Ø 100 cm

50 cm

150 cm

Air

Y

Z

pair spectrometer magnet

40 cm

full assembly ~100cm outer diameter

magnet 50 cm inner diameter

backward tracker

forward tracker frontcap

endcap

110 cm

beam pipe

7cm diameter

5 deg track

1 deg track

50 cm

46 cm

150 cm

100 cm

100 cm

Gaby's Talk
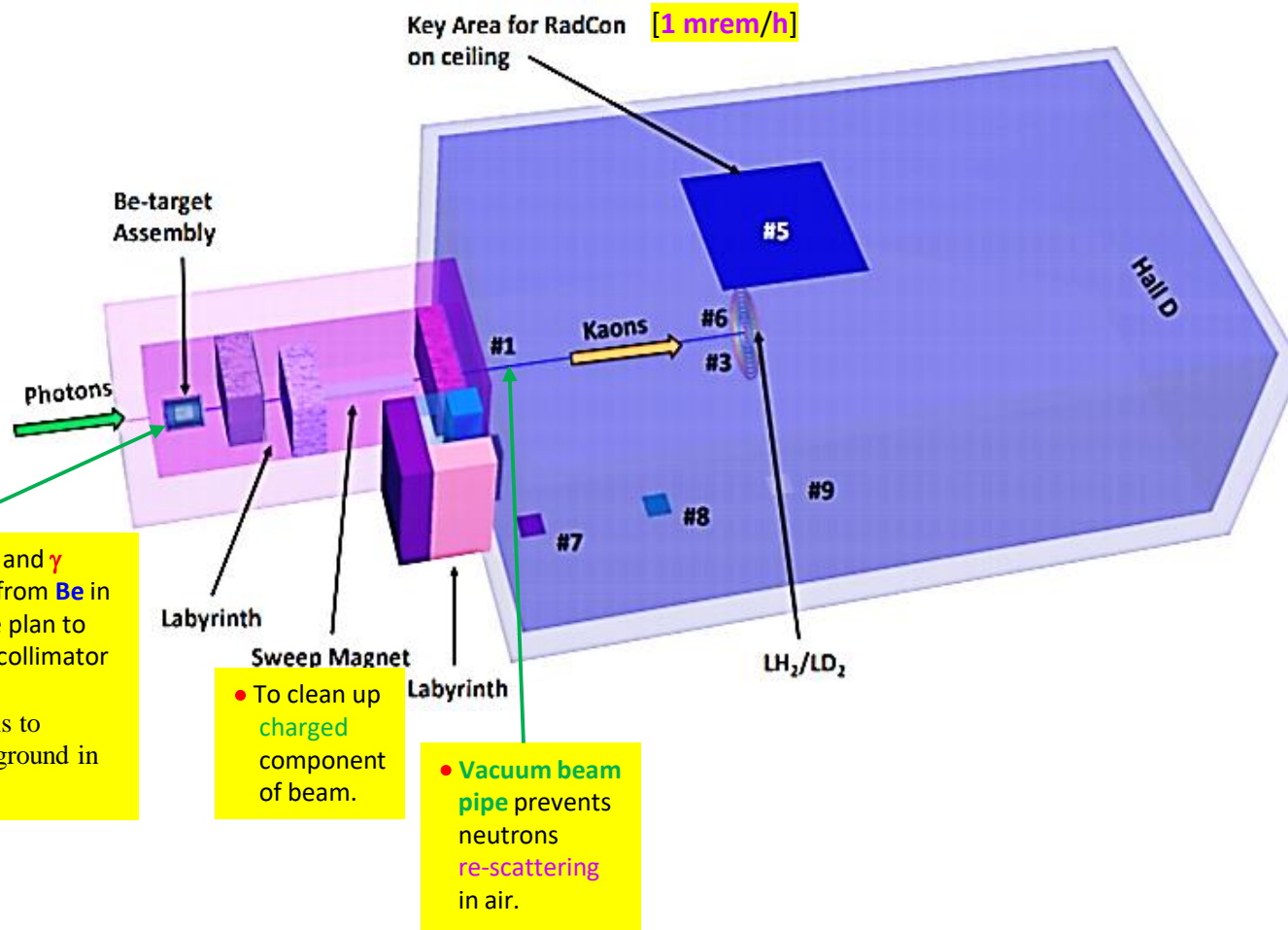
Dan's Talk

- Realism of MCNP simulations is based on advanced nuclear cross section libraries created and maintained in national laboratories of ⬡ complex.

- Physical models, implemented in MCNP6 code, take into account bremsstrahlung photon production, photonuclear reactions, neutron & photon multiple scattering processes.

- MCNP model simulates a **12 GeV 5 μA** electron beam hitting **Cu**-radiator inside **CPS**.

- Electron transport is traced in **Cu**-radiator, vacuum beam pipe for bremsstrahlung photons, & **Be**.

- Neutrons & gammas will be traced in all components of MCNP model.

- **Media** outside concrete walls of collimator alcove & bremsstrahlung photon beam pipe will be excluded from consideration to facilitate calculations.
  Additionally, we will ignore **PS** & **KFM** magnets but
  took into account **5 SEG**-blocks around beam pipe in front of **GlueX**.

- For MCNP calculations (in terms of flux [part/s/cm^2] or biological dose rate [mrem/h]).
  Several **tallies** will be placed along beam & at Tagger alcove & experimental hall for
  neutron & gamma fluence estimation.

- For neutron & gamma calculations, we will use MCNP6 transport code.

Key Area for RadCon on ceiling [1 mrem/h]

Be-target Assembly

Photons

#5

Kaons #6 #3

#1

Hall D

#7 #8 #9

LH₂/LD₂

- To reduce effect of **n** and **γ** background, coming from **Be** in experimental hall, we plan to put **KPT** upstream in collimator alcove.
- Additional shielding is to minimize **n** & **γ** background in experimental hall

- To clean up charged component of beam.

Labyrinth

Sweep Magnet

Labyrinth

- **Vacuum beam pipe** prevents neutrons re-scattering in air.

- Most important & unpleasant background for K_L comes from neutrons.

Be-Target Assembly

- **Be**-target assembly will weigh **14 tons** & has estimated cost of **$1.2M**.

xy-cross section, x-dimension
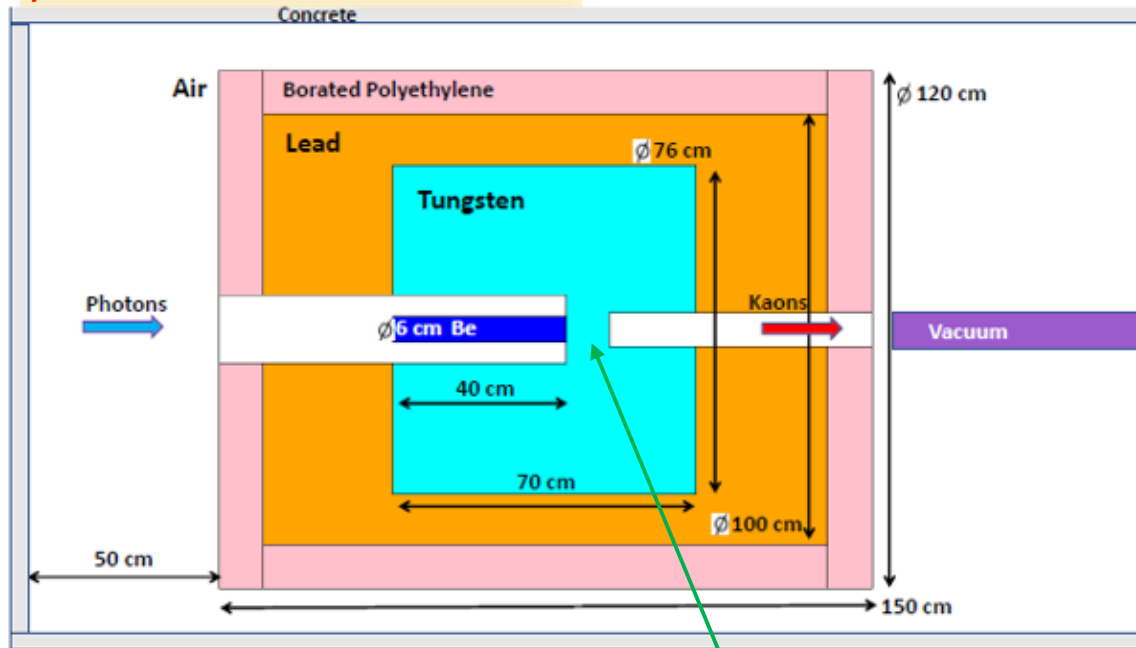
- Collimator alcove has enough space (with 4.52 m width) for **Be**-target assembly to remain far enough from beamline.

- Water cooling would be required around **Be** & **W**-plug.

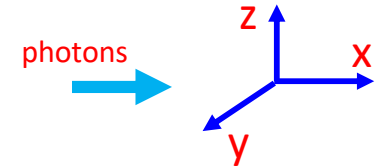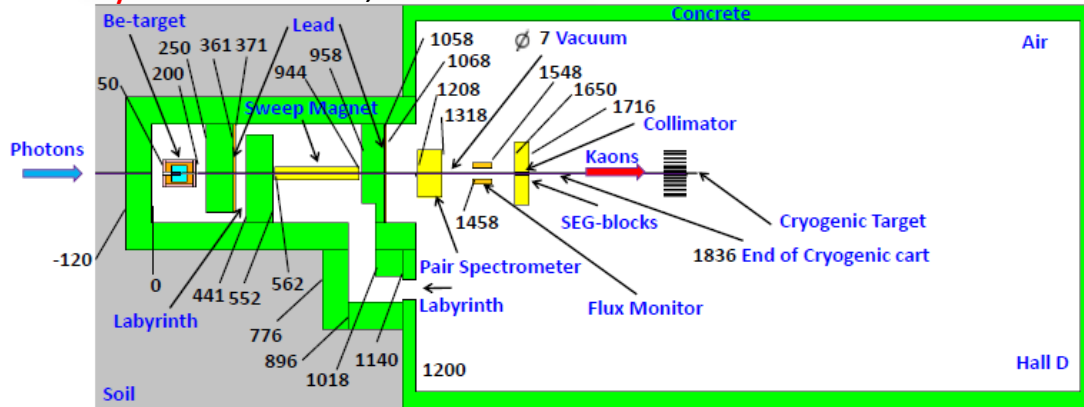 Cooling water, available in experimental hall, is sufficient to dissipate 6 kW of power delivered by photon beam to **Be**-target.
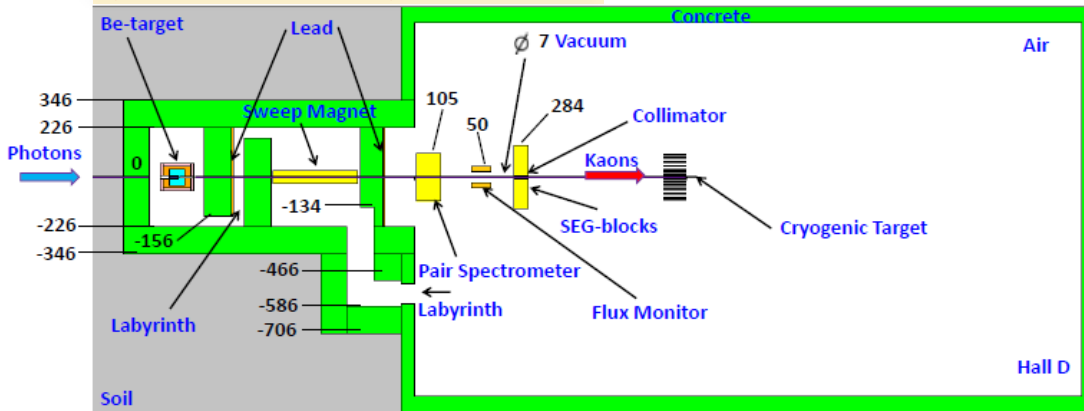
W-plug

Concrete **walls** are out of scale

Collimator Alcove & Experimental Hall

xy-cross section, x-dimension

xy-cross section, y-dimension

xz-cross section, z-dimension

- **Be**-target assembly is **cylinder**, then there is no difference between x & y dimensions.
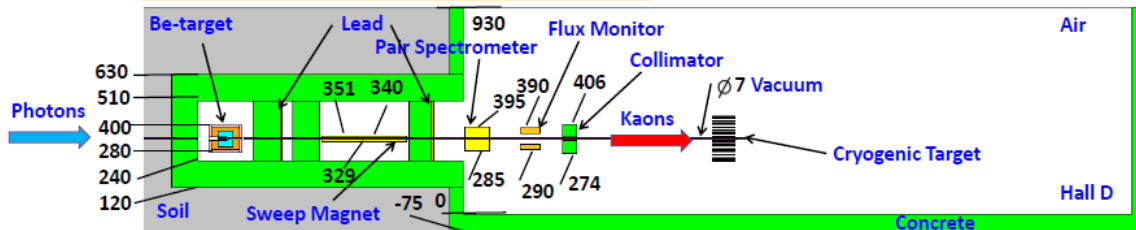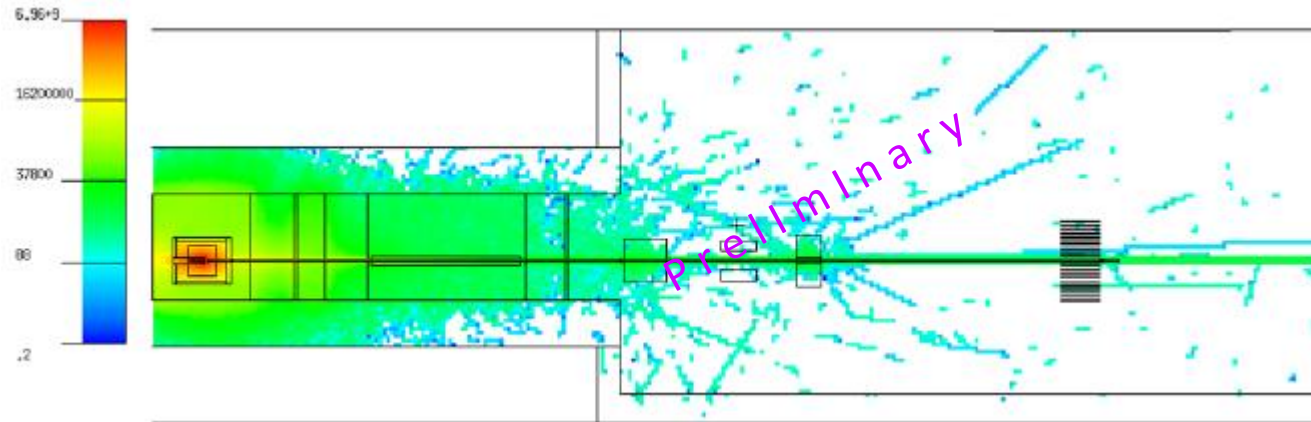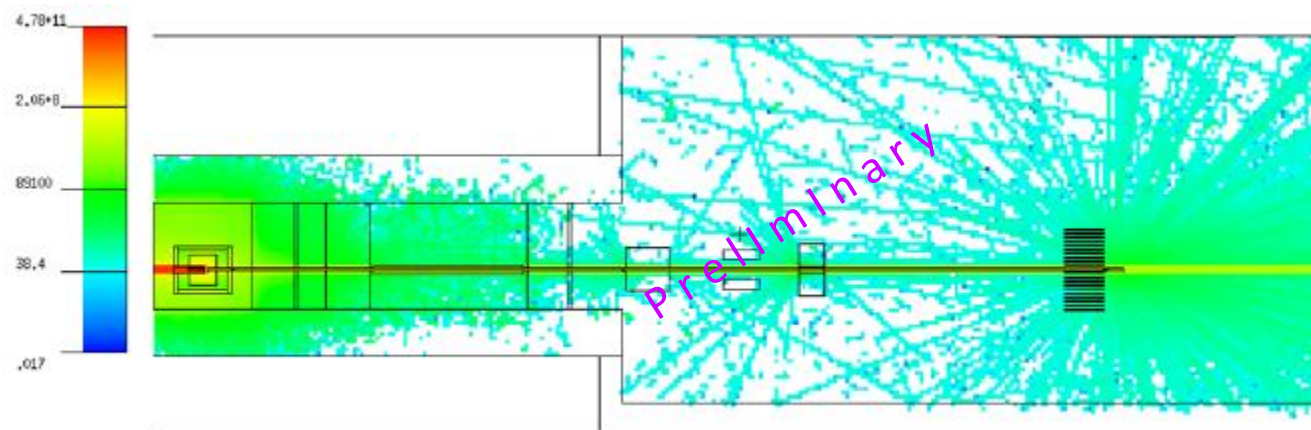
● **Vertical** cross section of **neutron** flux calculated using **MCNP**

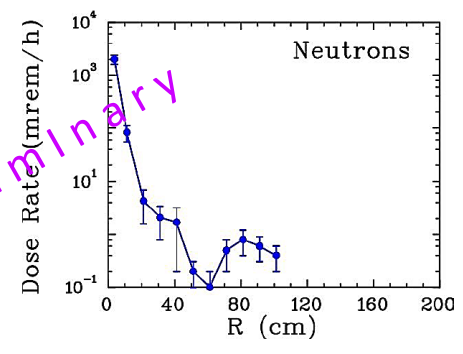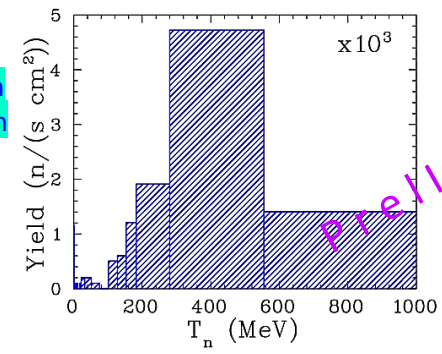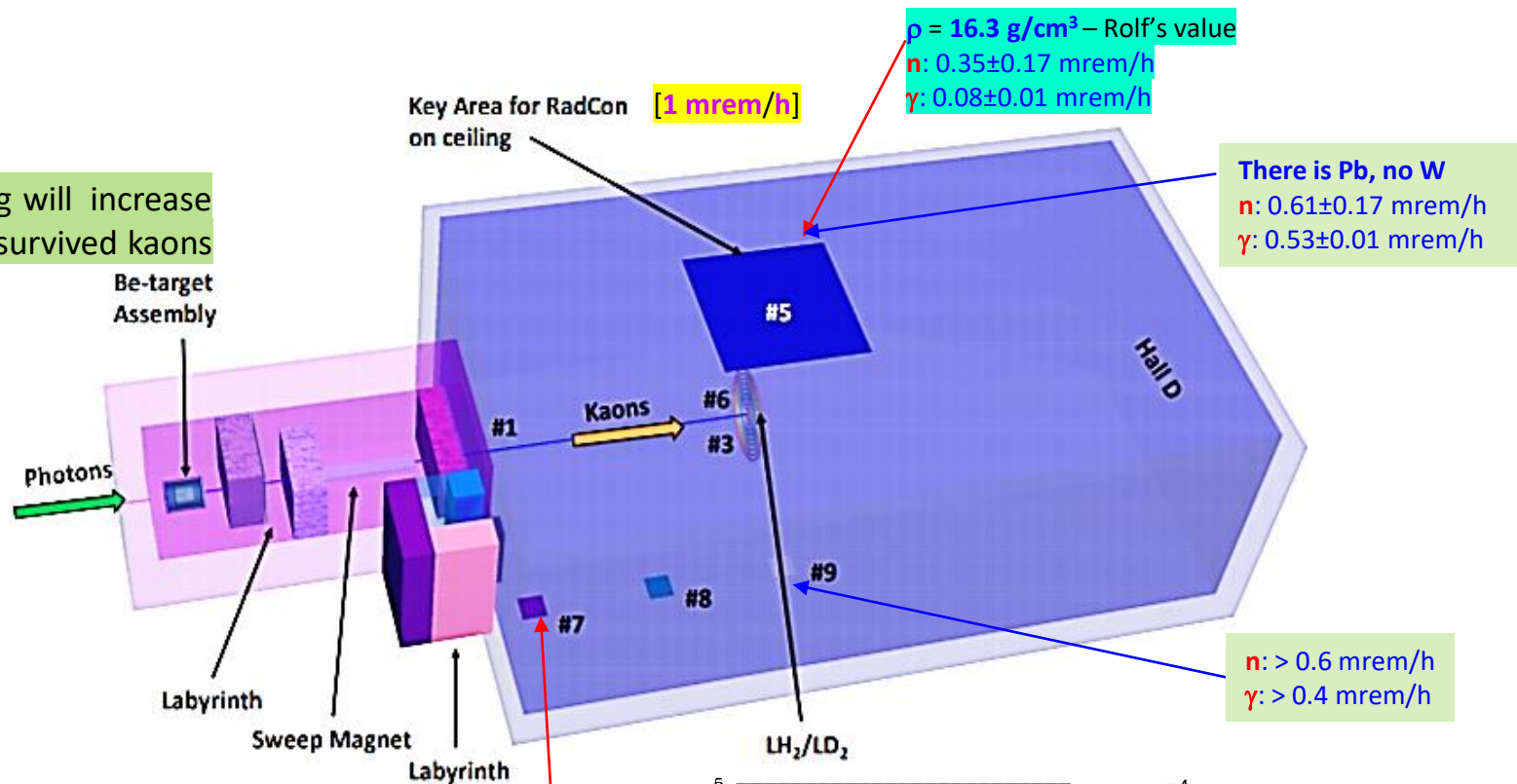● **Vertical** cross section of **gamma** flux calculated using **MCNP**

- For neutron & gamma calculations, we will use MCNP6 transport code.

ρ = **16.3 g/cm³** – Rolf's value
n: 0.35±0.17 mrem/h
γ: 0.08±0.01 mrem/h

Key Area for RadCon on ceiling [**1 mrem/h**]

There is Pb, no W
n: 0.61±0.17 mrem/h
γ: 0.53±0.01 mrem/h

- **Pb** shielding will increase fraction of survived kaons by **20%**.

Be-target Assembly

Photons

#1   Kaons   #6
#3

#5

Hall D

#7

#8   #9

Labyrinth

Sweep Magnet

Labyrinth

LH₂/LD₂

n: > 0.6 mrem/h
γ: > 0.4 mrem/h

n: > 0.1 mrem/h
γ: > 10⁻³ mrem/h

Preliminary

Neutrons

- Calculations for KPT will be performed for different shielding configurations to minimize neutron & gamma dose rate & reduce price of KPT.

- Neutron flux & energy distribution on face of LH_2/LD_2 cryogenic target is important to validate physical background in case of np or nd interactions in cryogenic target.

- Neutron dose rate for SiPM of Start counter, surrounded cryogenic LH_2/LD_2 target, & BCAL is also important to study.

- Engineering design is in order ?