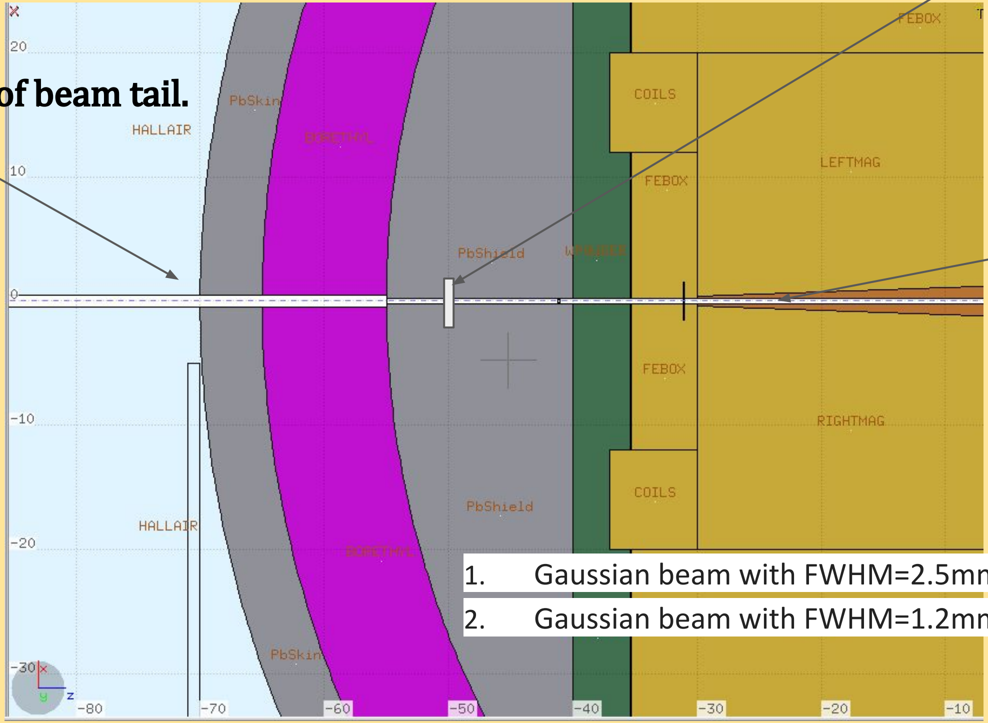
APR 22/22

DOSE-EQ and Energy Deposition in the CPS at Converter Z =-50 cm(!)

No Steering Magnet upstream.

V. Baturin (ODU)

Hot Spot!
Beam Hole 1×1 cm^2
To mitigate the effect of beam tail.

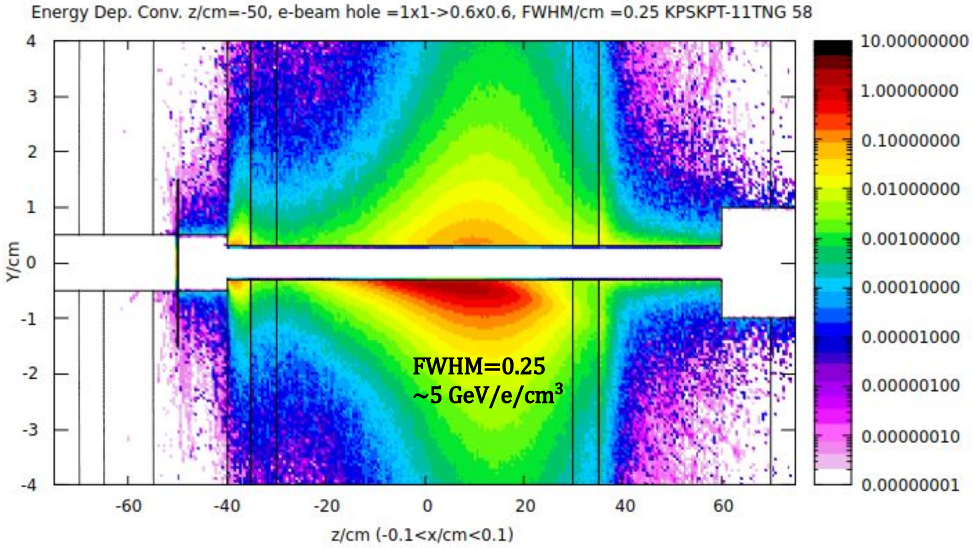


0.6 × 0.6 cm^2 ; FWHM 0.25 cm
vs
0.3 × 0.3 cm^2 ; FWHM 0.12 cm

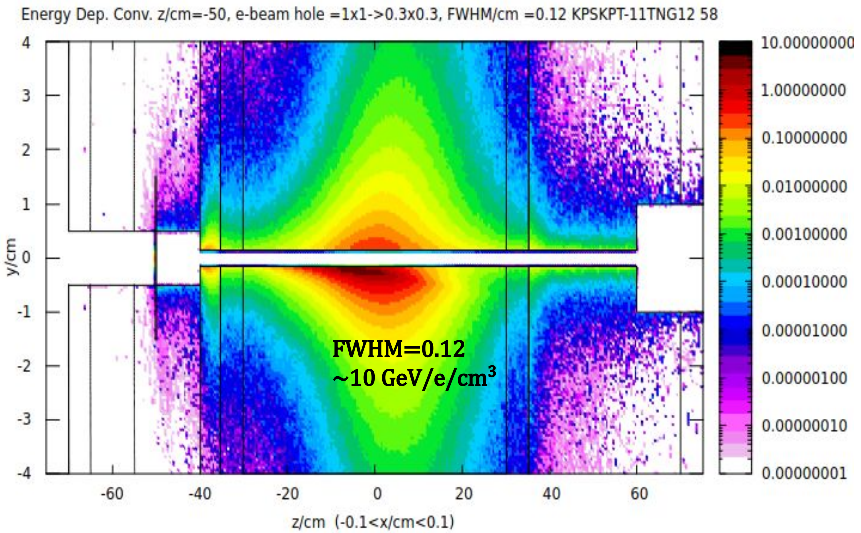
1. Gaussian beam with FWHM=2.5mm and the beam-hole in the magnet 6mm
2. Gaussian beam with FWHM=1.2mm and the beam-hole in the magnet 3mm

No Steering Magnet. Energy Deposition in the CPS at Converter Z =-50 cm.

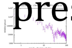
Wide beam/hole



Narrow beam/hole



- **Twice narrower** beam&hole results in ~ **twice higher** power density in the maximum.
- Numerical map/files **will be provided** for heat calculations.
- However **wider hole at same FWHM** results in lower power density. Next 2 slides from previous presentation.



Reference Power Density in Original Model.
Conversion of dE [GeV/cm^3/electron] to [Watts/cm^3]

Conversion

dW_{max}[W/cm^3/μA]=

dE_{max} [eV/cm^3/e] $\times$ Beam.Intensity [e/s/μA] $\times$ 1.6E-19 [J/eV] =

= **1.E+9 [eV/cm^3/e]** $\times$ 0.6E+13 [e/s/μA]$\times$ 1.6E-19 [J/eV] =

= ~1. [kW/cm^3/μA]

Reference model value: at current **5 μA** the max. deposited power ~**5 kW/cm^3**

Magnetic field is determined in the region

-0.5<x/cm<0.5 ; -1<y/cm<1 ; -40<z/cm<+30

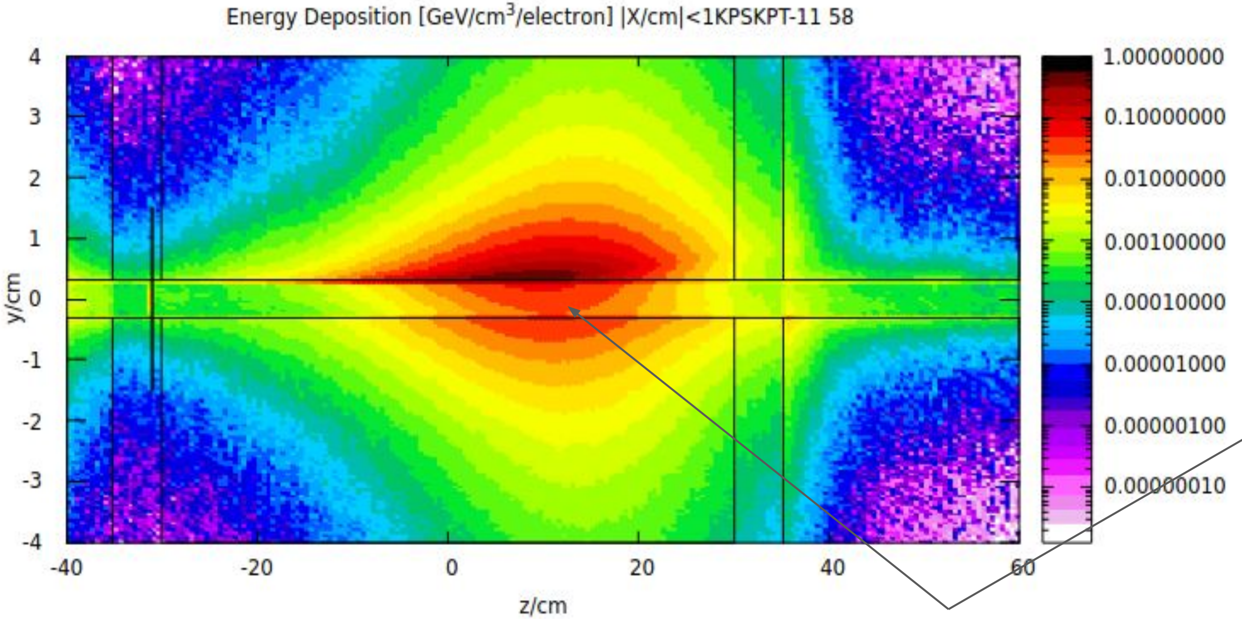
B(-0.5, -1., -40.) = ~0.13 T ; B(0.5, 1., 30.) = ~1.3 T

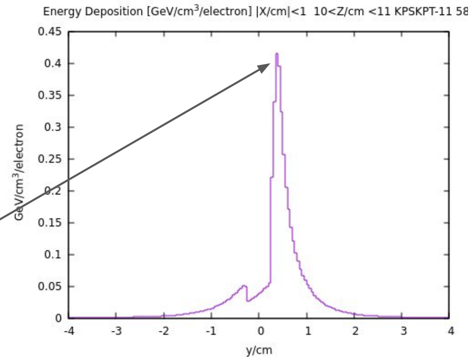
X	Y	Z	B_x/B			B
-0.5	-1.0	-40.0	-0.99	-0.004	0.09	B=0.13 T
-0.5	-1.0	-35.0	-0.99	-0.004	0.10	B=0.33 T
-0.5	-1.0	-31.0	-0.97	-0.005	0.23	B=0.94 T

What is the effect of the Fringe Field? We need Field Map from, say, Z= -200 cm !?

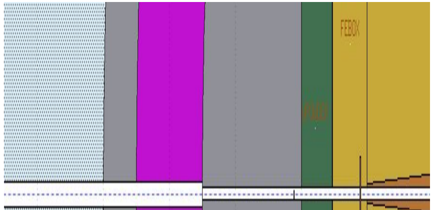
Energy Deposition for 12 GeV e-beam FWHM = 0.25 cm. Hole $0.3^2 \rightarrow 0.6^2$ cm^2

FLUKA Model from /home/baturin/KLMPHSOU

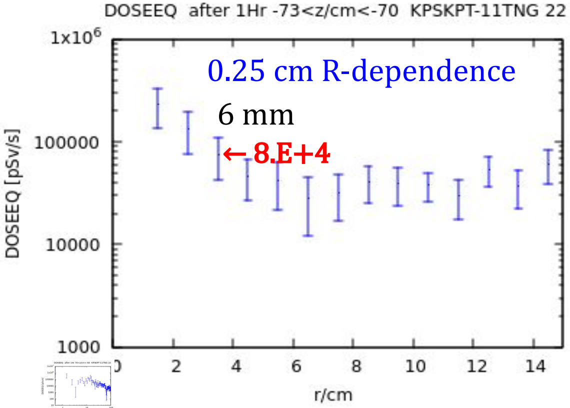


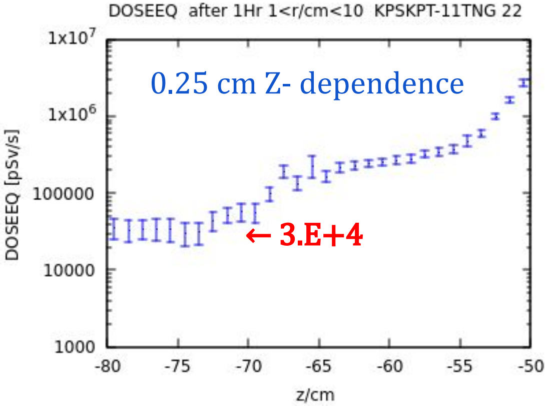


- Max Dep. Power =**0.4** [GeV/cm^3/elect] * 1.6E-10 [J/GeV] * 5.E-6 [C/s] * 0.6E+19 [elect/C] = **2 [kW /cm^3]**
- Wider hole results in ~**twice lower power density** then for the basic model (**5 kW/cm^3**)



DOSE-EQ at the entry to CPS . Converter Z =-50 cm. No Steering Magnet .





DOSE EQ=**1.E+5 [pSv/s]**=

=1.E(+5-12) [Sv/s] =

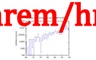
=1.E(+5-12+2) [rem/s]=

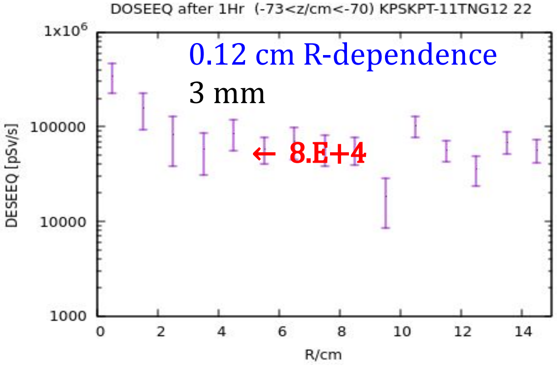
=360.E-4 [rem/hr]=

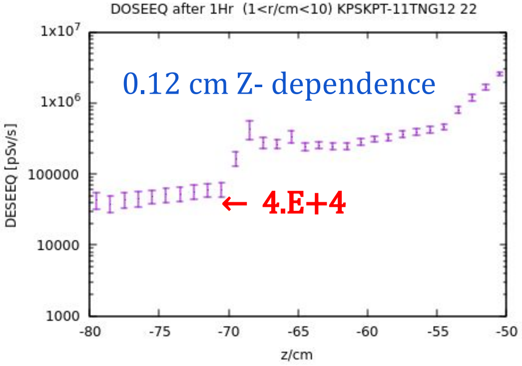
=36. [mrem/hr]

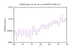
while

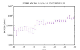
~5 [mrem/hr] is recommended.



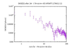




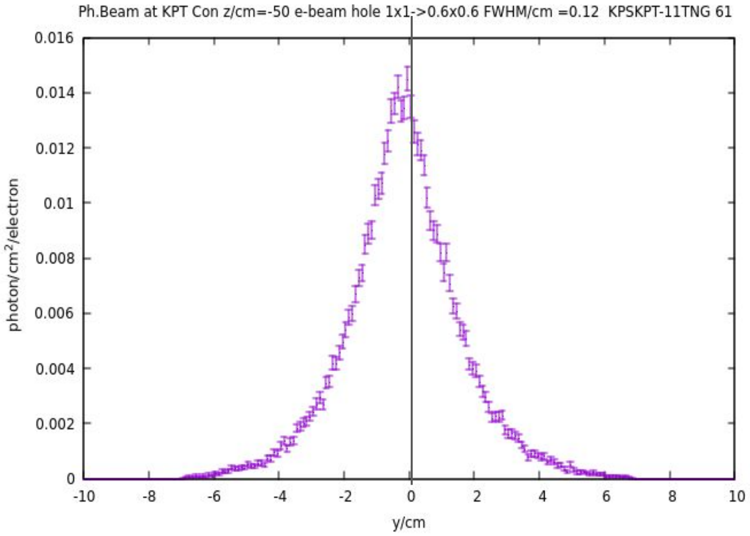


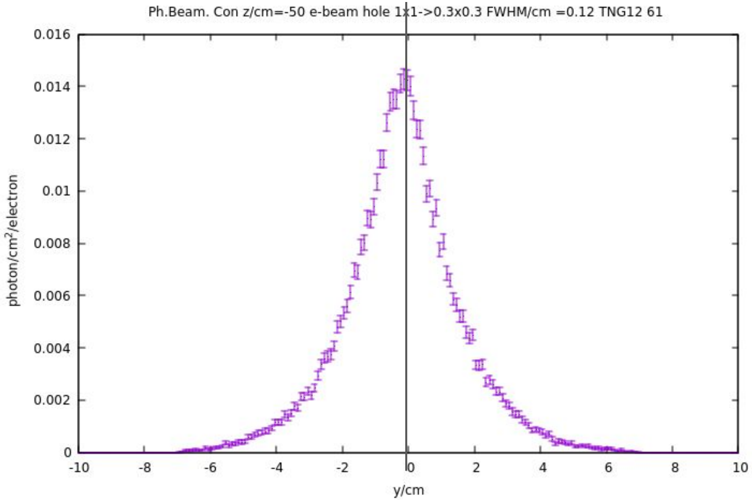


- The model with wider beam&hole looks slightly better.



Photon Beam y-profile at the entry to KPT . Converter Z =-50 cm.
No Steering Magnet .

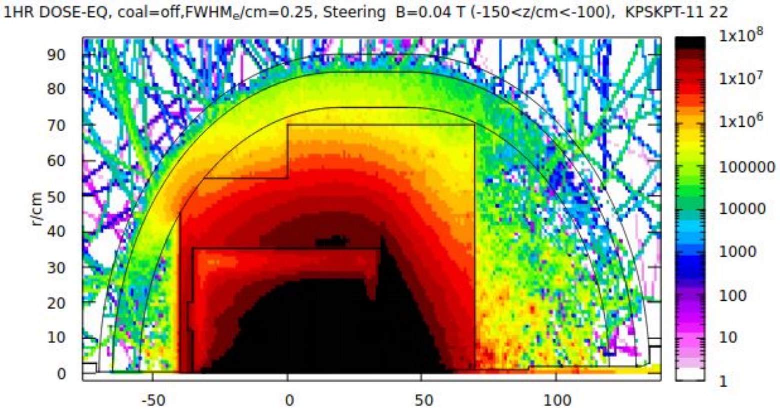


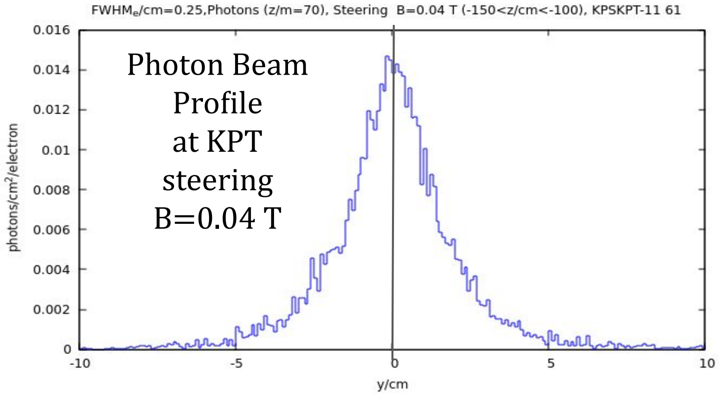


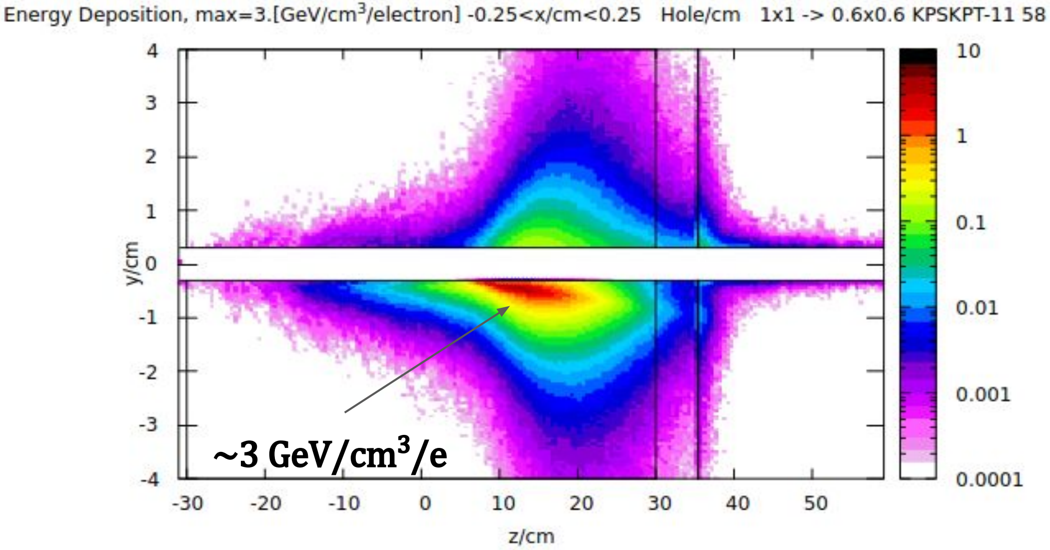
- Looks identical.
- A very small shift of the centroid to ~ –0.3 cm is due to 20 cm area of the fringe field upstream the Converter.

Steering Magnet. Energy Deposition for 12 GeV e-beam at FWHM = 0.025 cm. Longer Magnetic field area: -70<z/cm<40

FLUKA Model from /home/baturin/KLMPHSURMAG/KPSKPT-11.flair with longer b field area, beam pipes, latest FLUKA version.







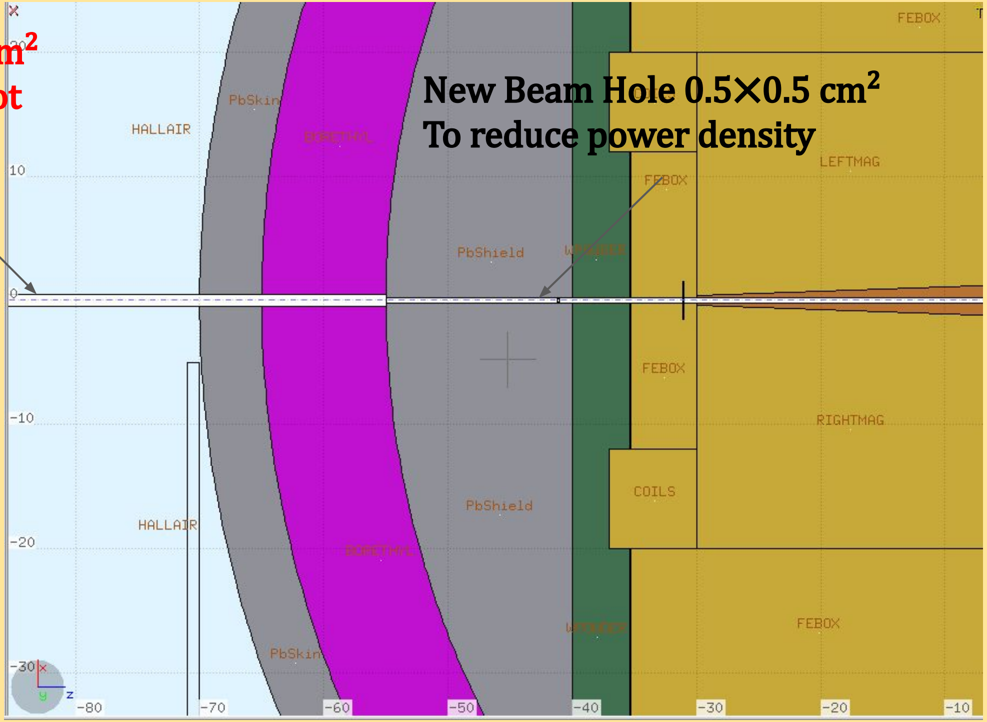
- More calculation time is required to estimate DOSE-EQ at the entry to CPS.
- However, looks like it is below 1.E+4

APR 08/22

Dode-EQ in the KPT Photon Source using FLUKA and e-bam FWHM =0.25 cm

V. Baturin (ODU)

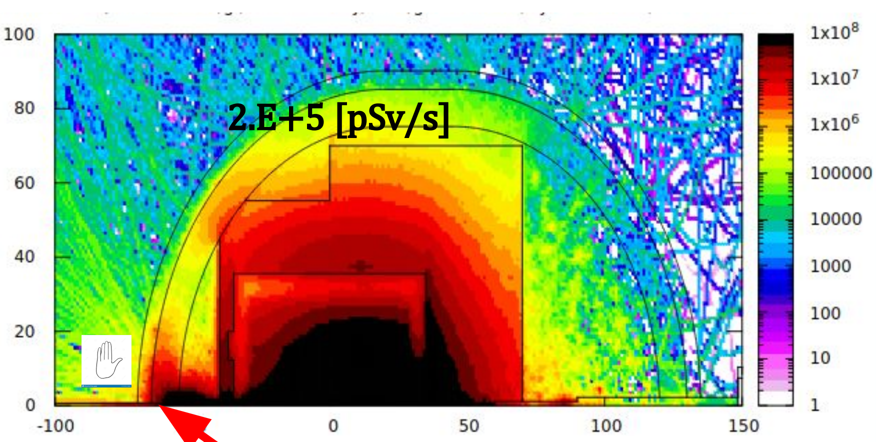
New Beam Hole 1×1 cm^2
To mitigate the Hot Spot

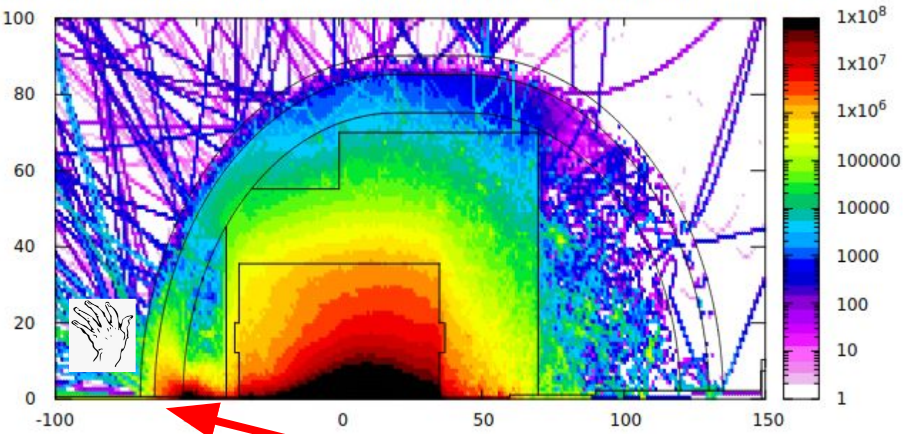


New Beam Hole 0.5×0.5 cm^2
To reduce power density

DOSE-EQ [pSv/s] rate estimates. 12 GeV e-beam ; 2.7 μA ; FWHM = 0.25 cm.

FLUKA Model from /home/baturin/KLMPHSOU

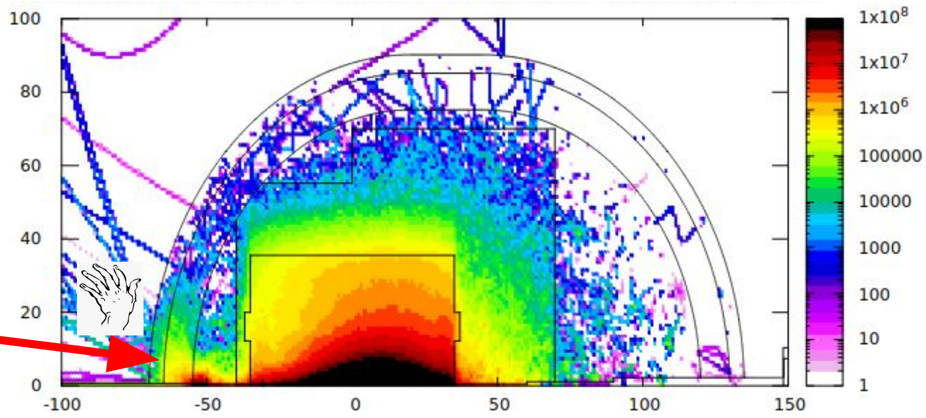




Hot spot after 1 Hr:
DE=~**1.E+6** [(pSv)/s]=~1 [μSv/s]
=~**3600** [μSv/Hr] =360 [Rem/hr]

Compare **0.5-10** [μSv/Hr]

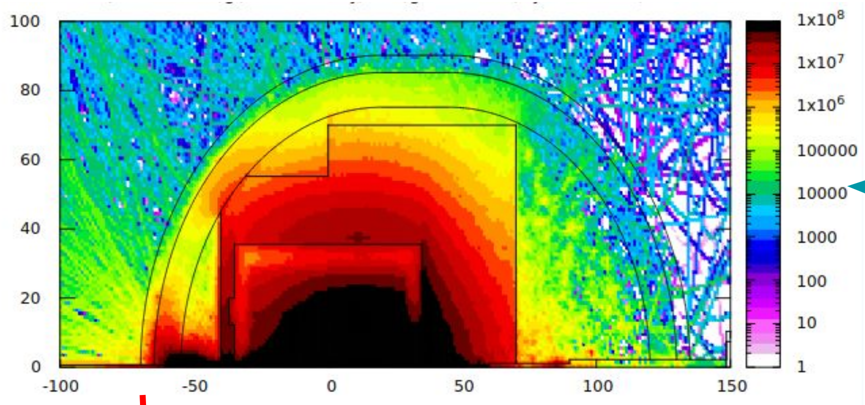
and
Max Dose 0.5 [Sv/Year] = 0.6 [μSv/Hr]
0.5 Sv during a week



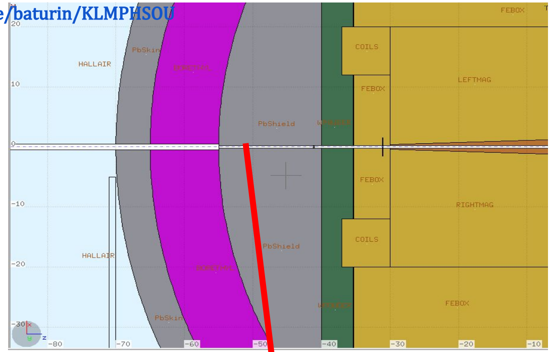
Hot spot after a week:
DE=~360 [μSv/Hr]

Hot spot after a Month:
DE=2.E+4 [pSv/s]~100[μSv/Hr]

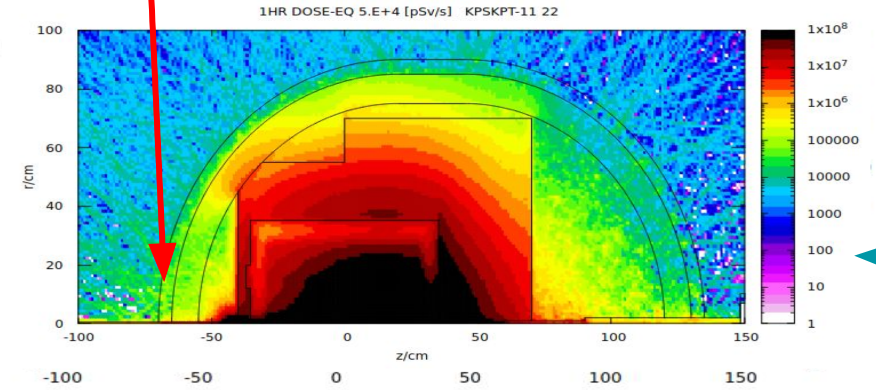
DOSE-EQ [pSv/s] rate estimates. 12 GeV e-beam ; 2.7/5 μA ; FWHM = 0.25 cm.
Effect of a deeper Beam Hole 1×1 cm^2 - ~100 times lower Dose.



FLUKA Model from /home/baturin/KLMPHSOU



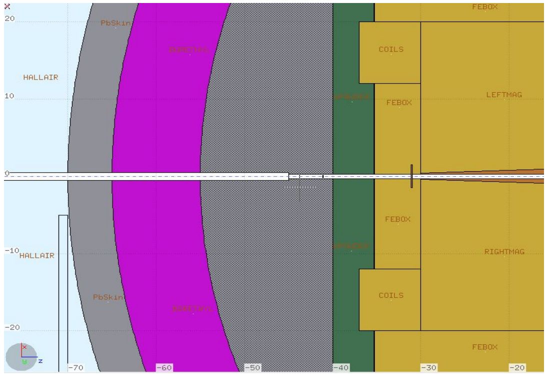
~2.E+6 [pSv/s] @ I=2.7[μA]



~2.E+4 [pSv/s] @ I=5 [μA]

So we may expect DOSE-EQ (after 1 Hr) rate as low as 3.6 [mRem/hr]

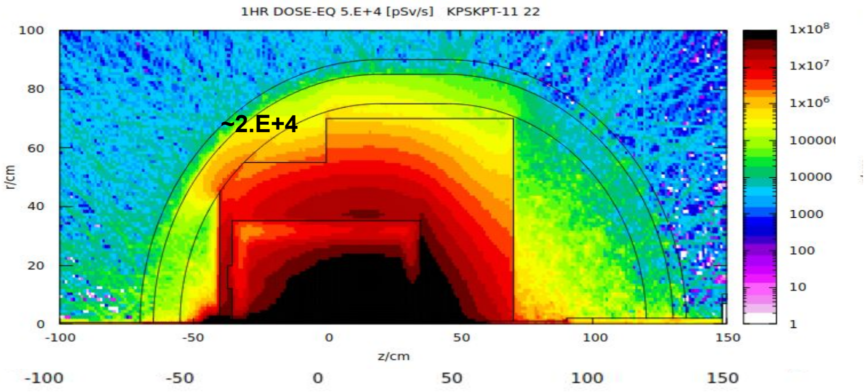
DOSE-EQ [pSv/s] rate estimates. 12 GeV e-beam ; 2.7/5 μA ; FWHM = 0.25 cm. Effect of upstream lead on place of tungsten absorber.

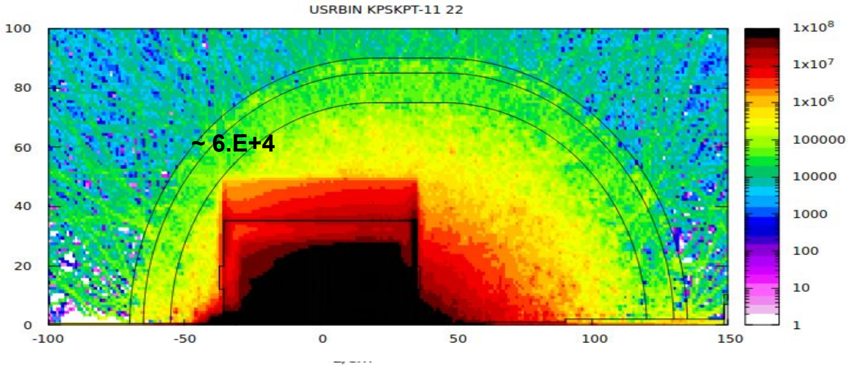


FLUKA Model from /home/baturin/KLMPHSOU

DOSE-EQ = ~4.E+4 [pSv/s] @ I=5 [μA] . What is the limit?

Seems Lead may be used on place of Tungsten.

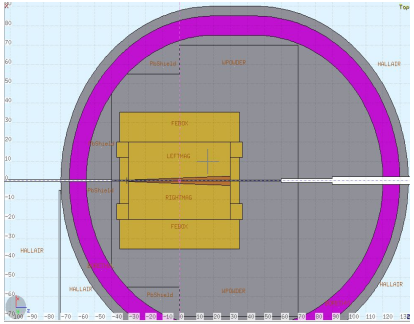




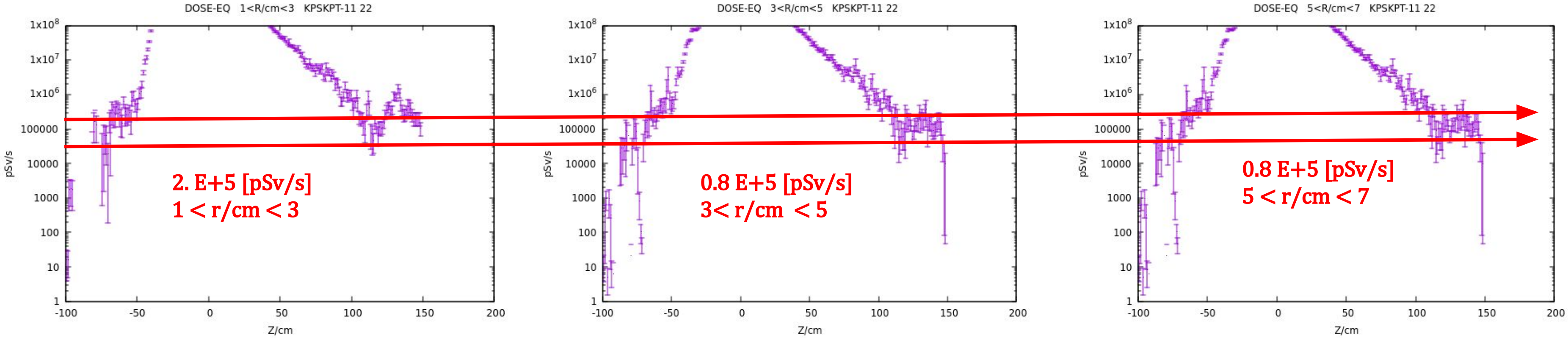
DOSE-EQ [pSv/s] rate estimates. 12 GeV e-beam ; 2.7/5 μA ; FWHM = 0.25 cm.

Led on place of tungsten.

FLUKA Model from /home/baturin/KLMPHSOU

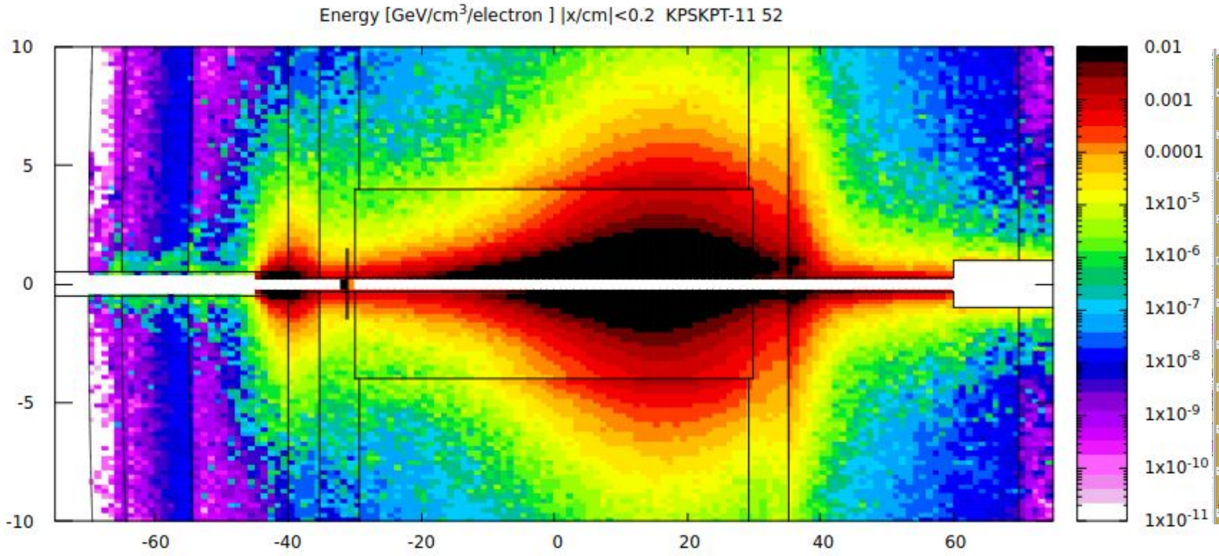


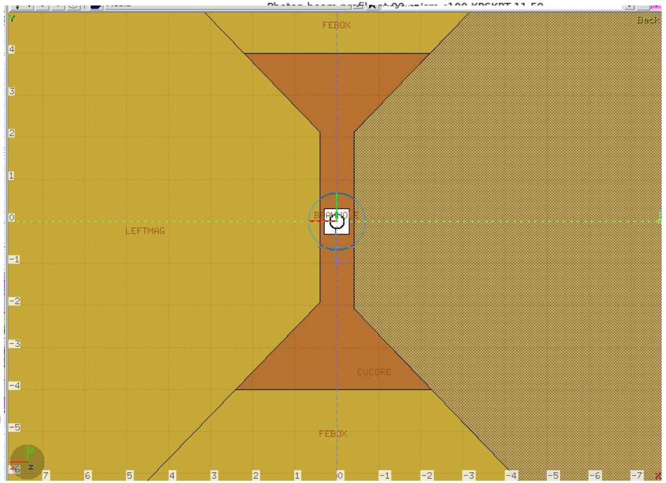
- What level of DOSE-EQ is acceptable in the hot spot ?
- “Egg” shape - is it practical?
- What are **building blocks** for **LED** and Borated PE?
- Magnet as is.
- What is realistic Hall-C design?



Energy Deposition [GeV/electron/cm^3]. 12 GeV e-beam ; 2.7/5 μA ; FWHM = 0.25 cm.
Lead on place of Tungsten absorber.

FLUKA Model from /home/baturin/KLMPHSOU





Should we make the beam channel full length 0.4 x 0.4 cm^2 . Magnet design?

- Effect of 1x1 cm^2 hole 30 cm deep - 100 times lower DOSE at the e-beam entry (hot spot).
- All Lead shielding results in 2-4 times higher DOSE in the hot spot.
- There is a chance to get rid of Tungsten. To be continued.
- Need to specify the level of DOSE-EQ acceptable in hot spots. Critical for design.
- “Egg” shape - is it practical?
- What **building blocks** for **Lead** and Borated PE we may use (incl. FLUKA)? Dimensions, cost etc.
- What is realistic Hall-C design?

Mar 11
Energy Deposition in the KPT Photon Source using FLUKA

V. Baturin (ODU)