Power deposition maps in the forward closed horn

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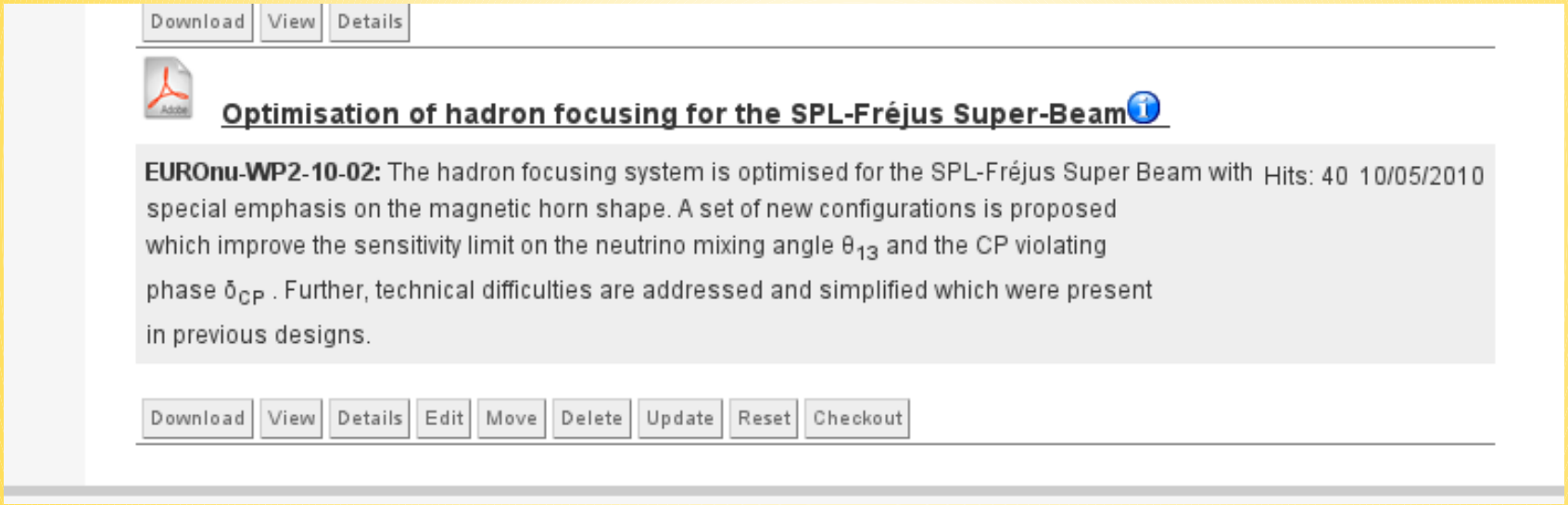
News since Kraków

1) EUROnu-note on the forward-closed horn optimisation submitted

http://heplnv135.pp.rl.ac.uk/joomla/index.php?option=com_docman&task=doc_download&gid=65&Itemid=5



2) Power deposition maps with FLUKA for this horn (note in preparation)

=> results for this item follow

Power deposition maps: ingredients

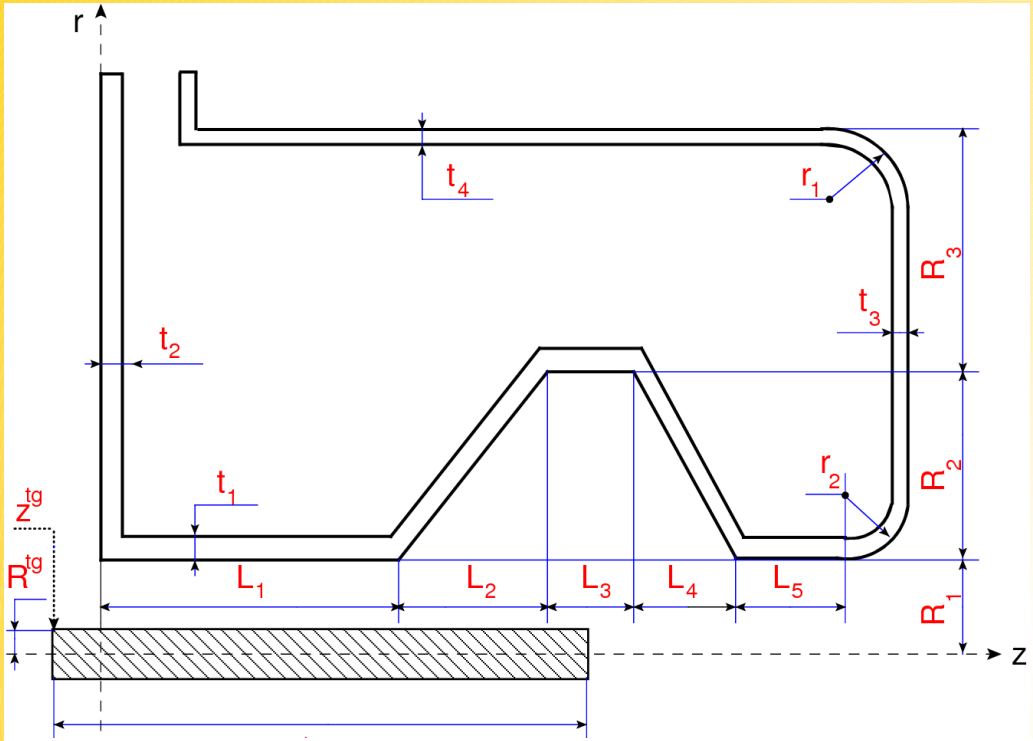
- Optimized forward-closed horn with integrated target
  - L target = 78 cm, r =1.5 cm

- Carbon target+aluminum conductors
  - simplified, easy to update results for more realistic setups - Be, AlBeMet

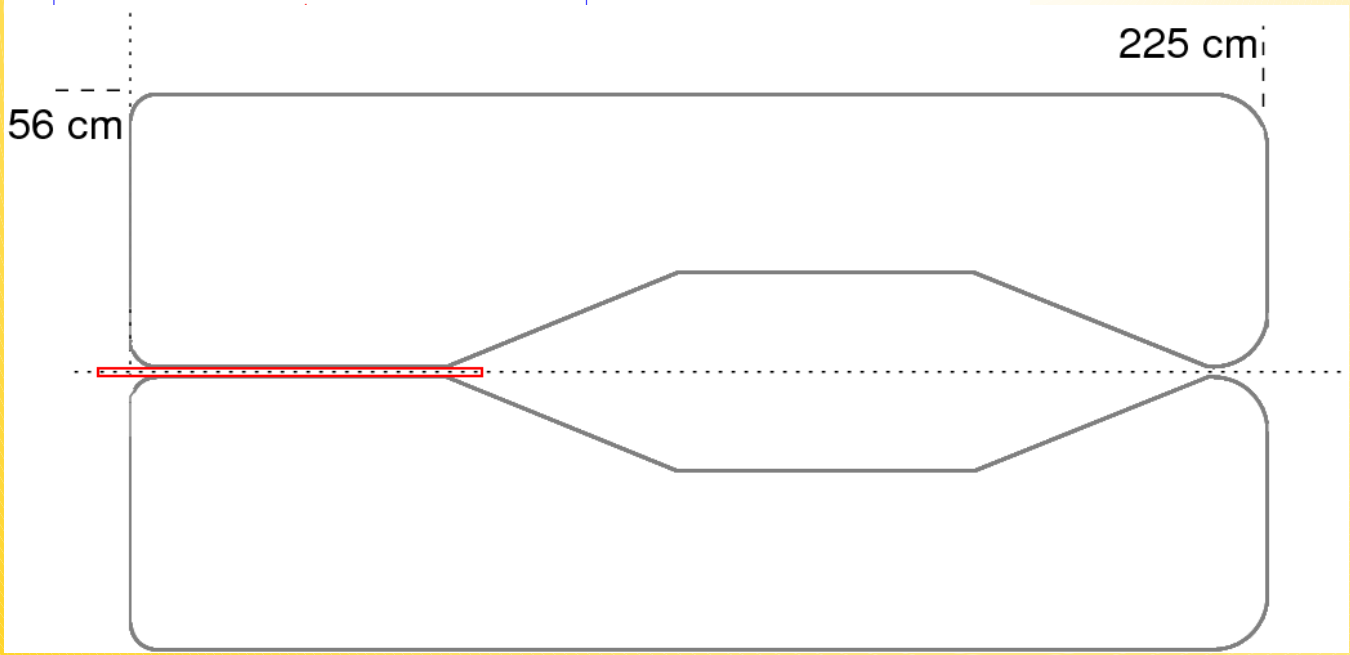
- Beam: 1.3 MW at 4.5 GeV proton energy. Gaussian with σ = 4 mm.

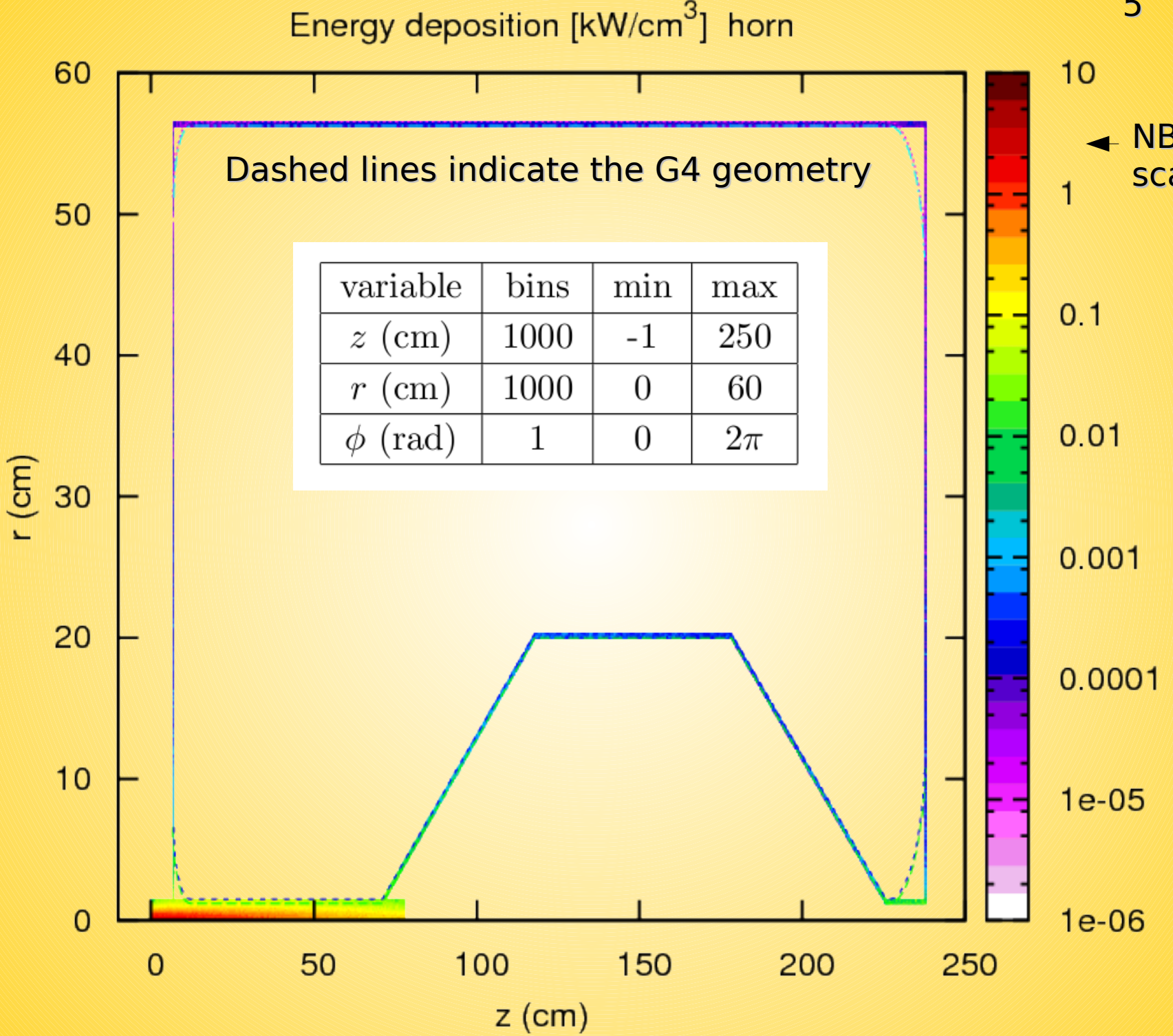
- FLUKA 2008.3d + FLAIR 0.9.0
  - At this stage some approximations in the translation of the GEANT4 geometry into FLUKA: implementation of rounded parts is not trivial. Which is the needed level of precision ?

Geometry



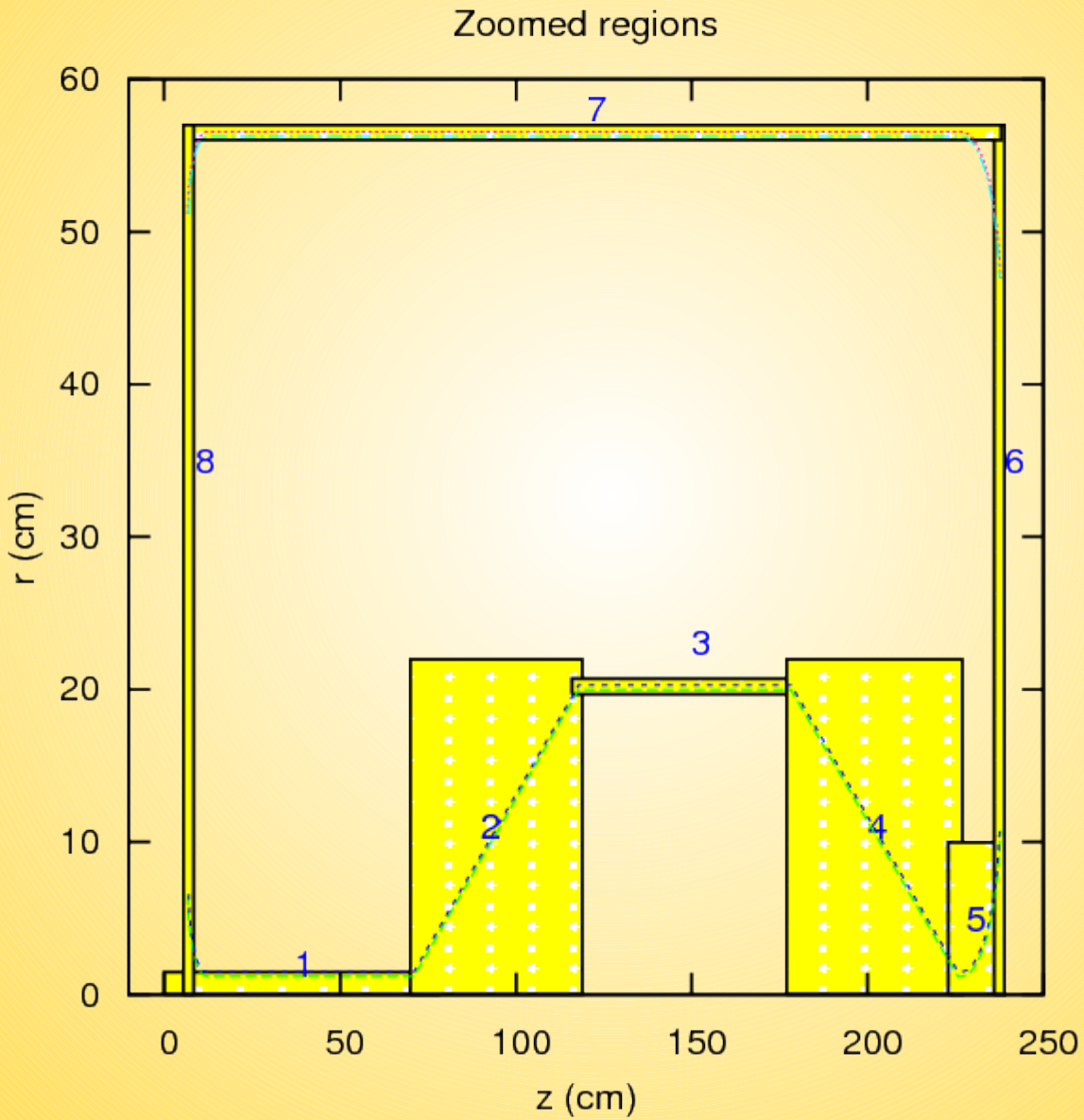
L_1	58.9	$r_1 = r_2$	10.8
L_2	46.8	R_1	1.2
L_3	60.3	$R_1 + R_2 + R_3$	56.2
L_4	47.5	$R_1 + R_2$	20.3
L_5	1.08	z_0^{tg}	-6.8





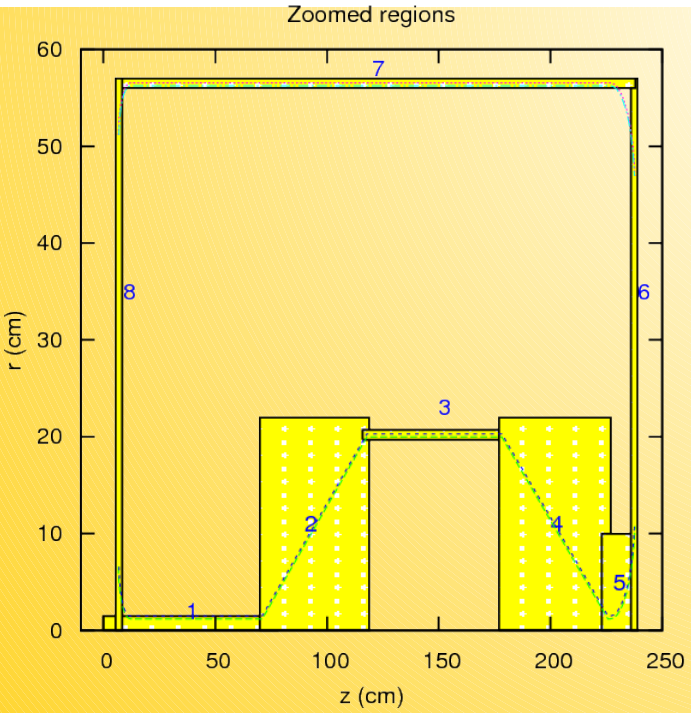
variable	bins	min	max
z (cm)	1000	-1	250
r (cm)	1000	0	60
ϕ (rad)	1	0	2π

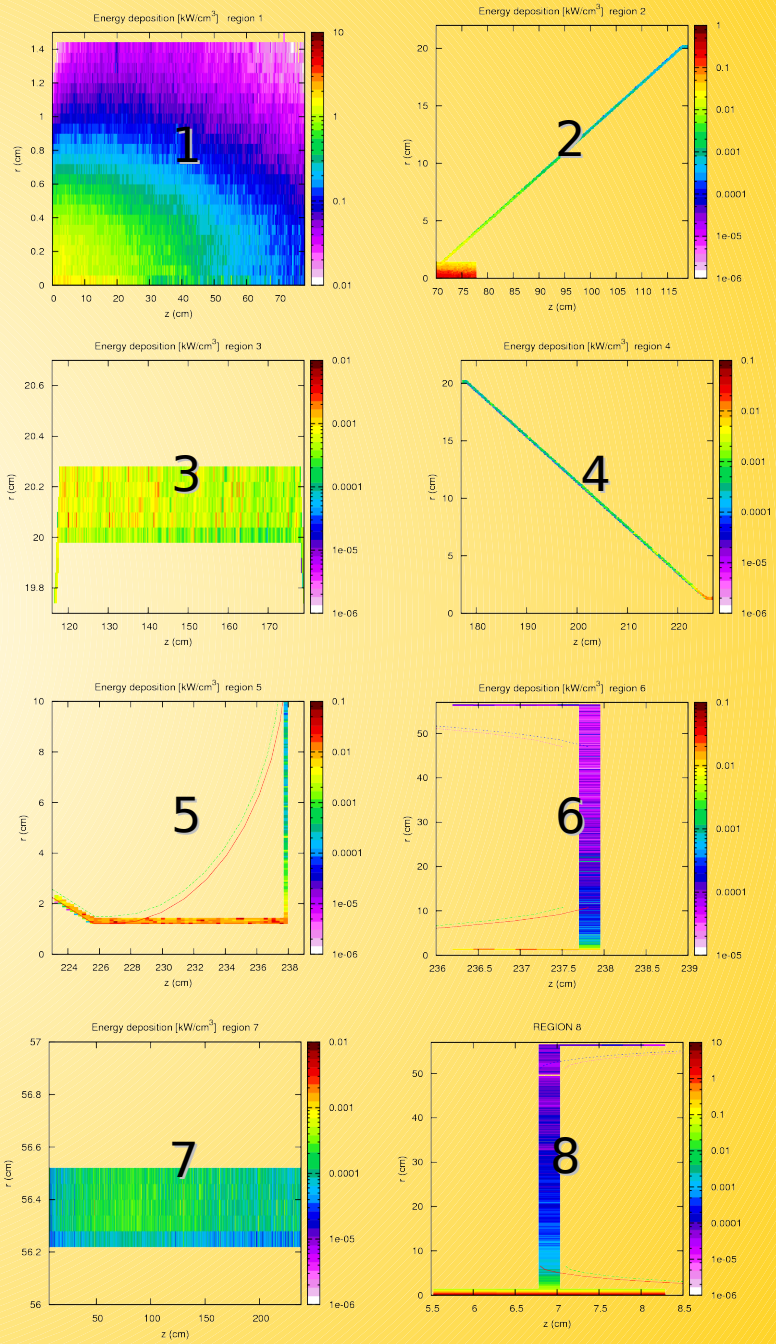
Considered regions



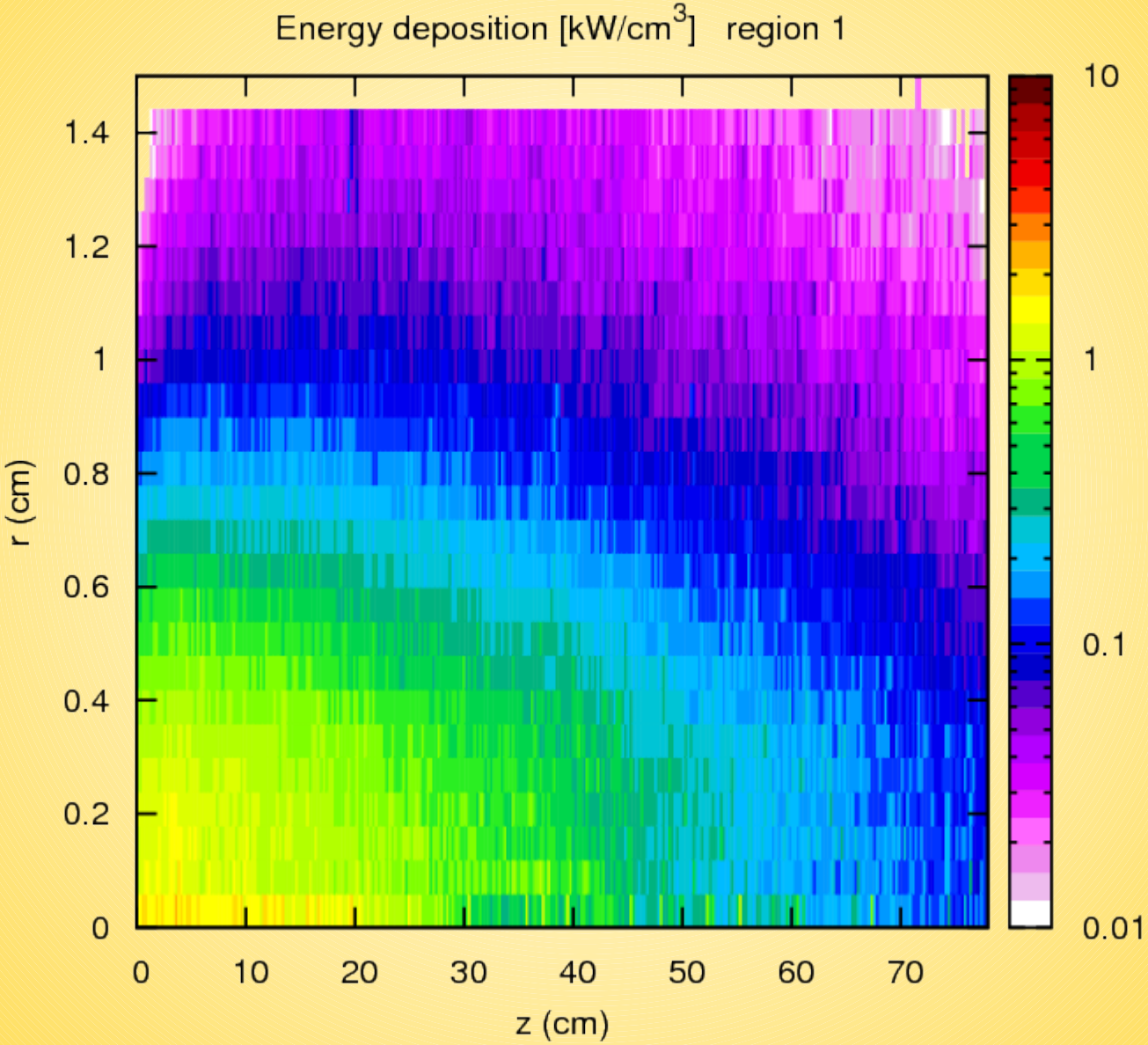
Integrated power deposition by region

Region	z range	r range	Deposited power (kW)	(%)
1	$[0, 78]$	$[0, 1.5]$	63.343	88.5
2	$[70, 119]$	$[1.5, 22]$	1.756	2.4
3	$[116, 179]$	$[19.7, 20.7]$	1.117	1.6
4	$[177, 227]$	$[0, 22]$	0.584	0.8
5	$[225, 239]$	$[0, 10]$	0.357	0.5
6	$[236, 239]$	$[10, 57]$	0.480	0.7
7	$[6.8, 238.1]$	$[56, 57]$	3.344	4.7
8	$[5.5, 8.5]$	$[1.5, 57]$	0.757	1.1
tot			71.580	100

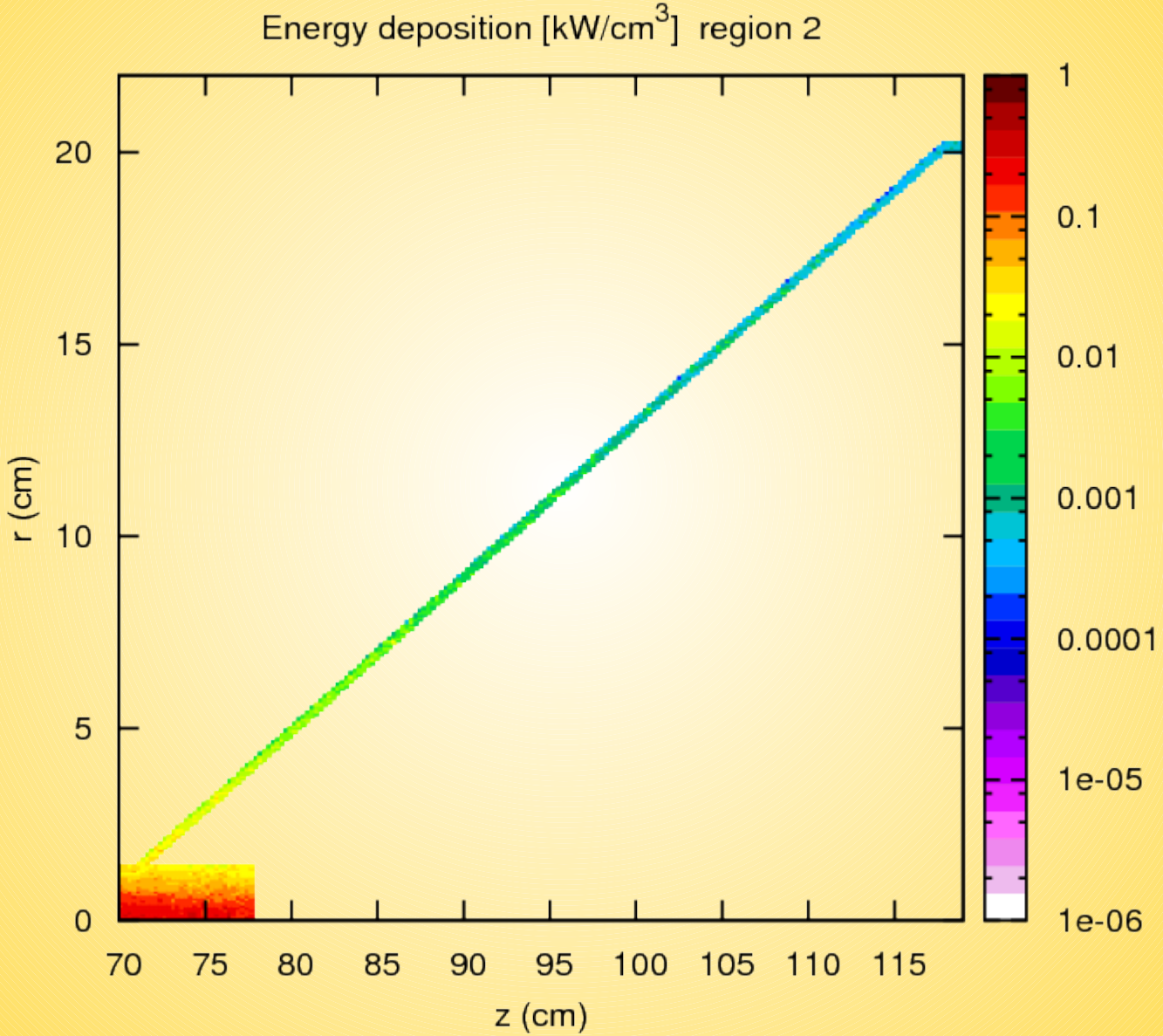




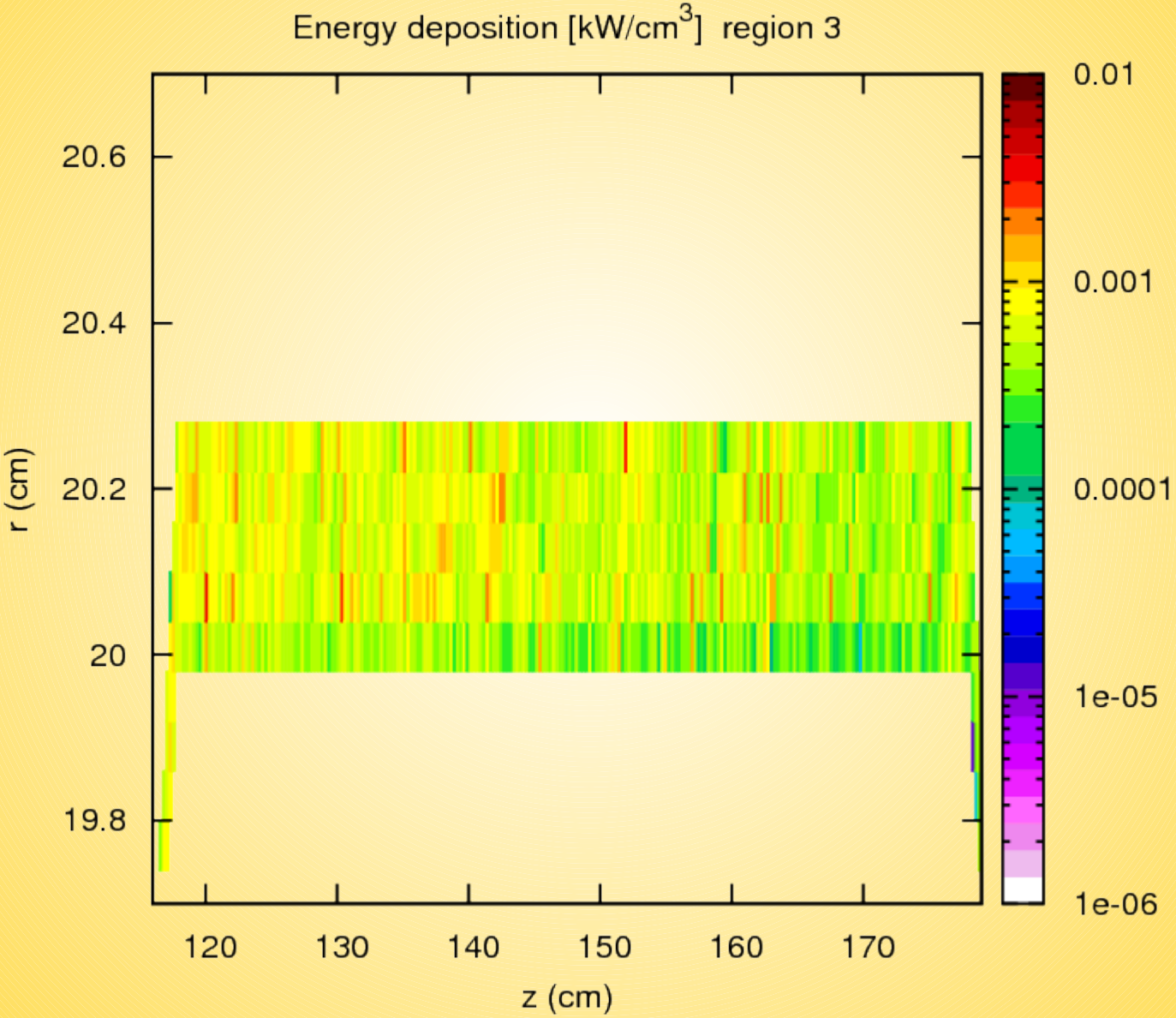
Target


Energy deposition [kW/cm3] region 1
r (cm)
z (cm)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
10
20
30
40
50
60
70
10
1
0.1
0.01

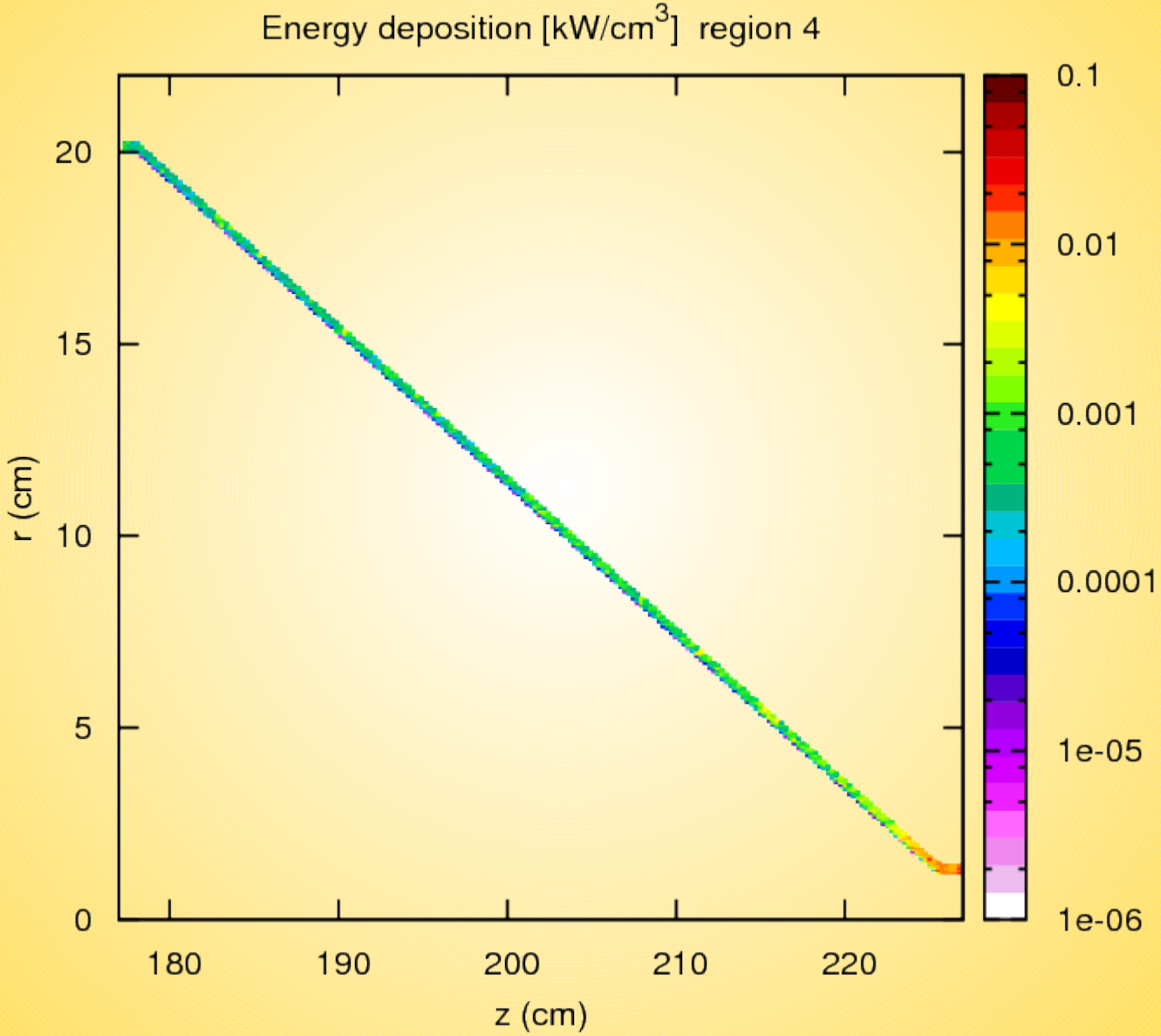
Upstream cone



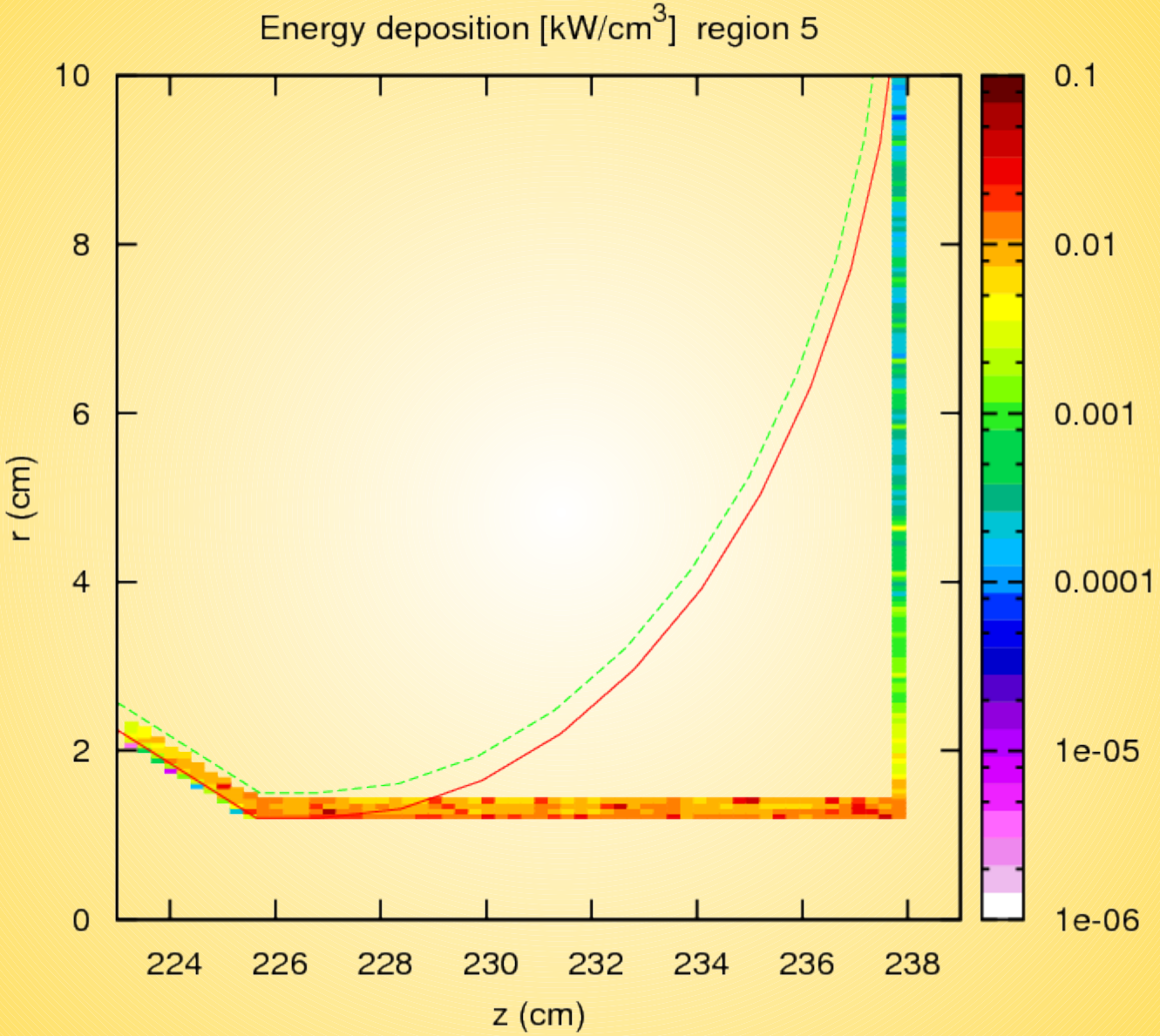
Inner cylinder



Downstream cone

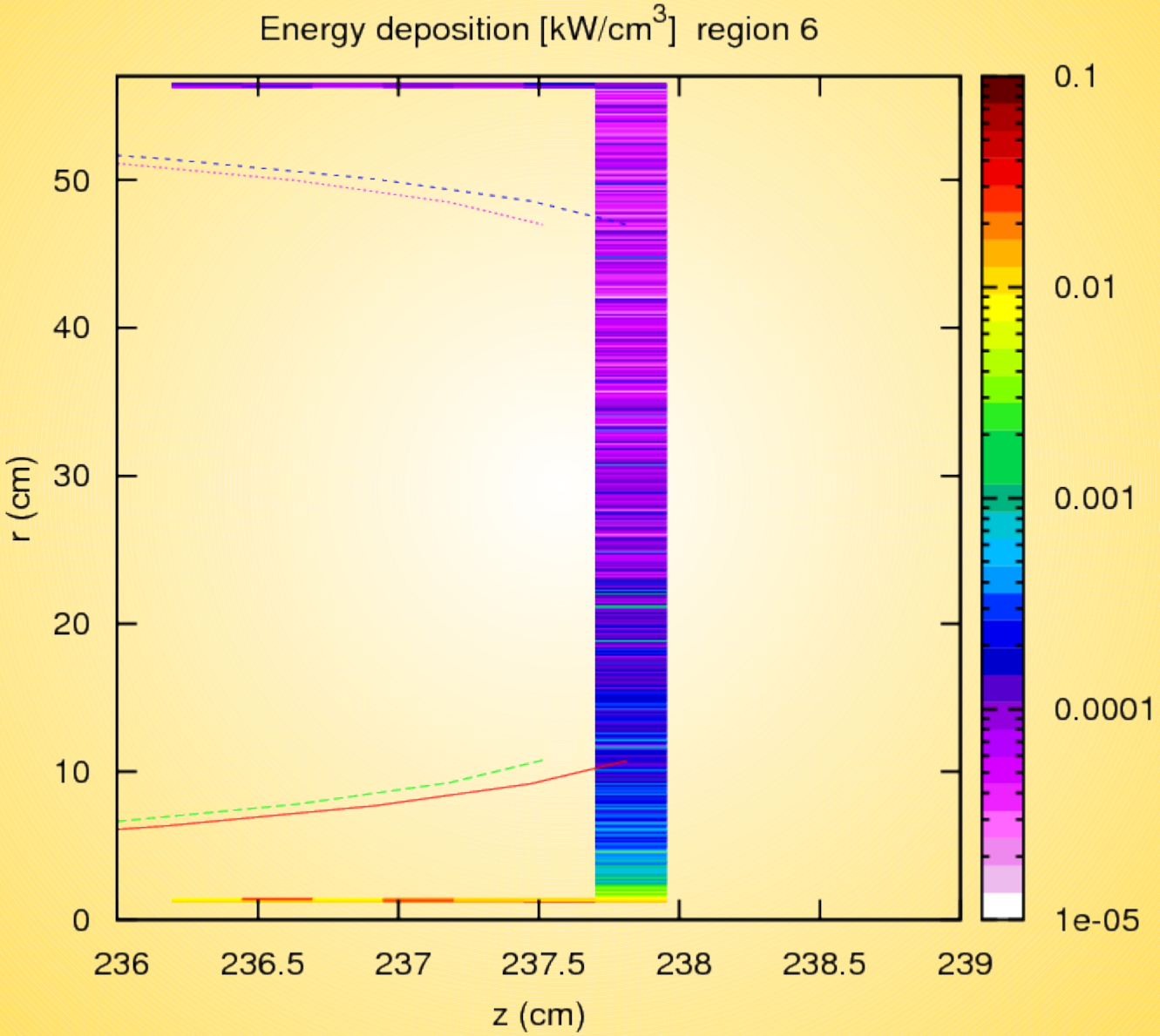


Downstream endcap

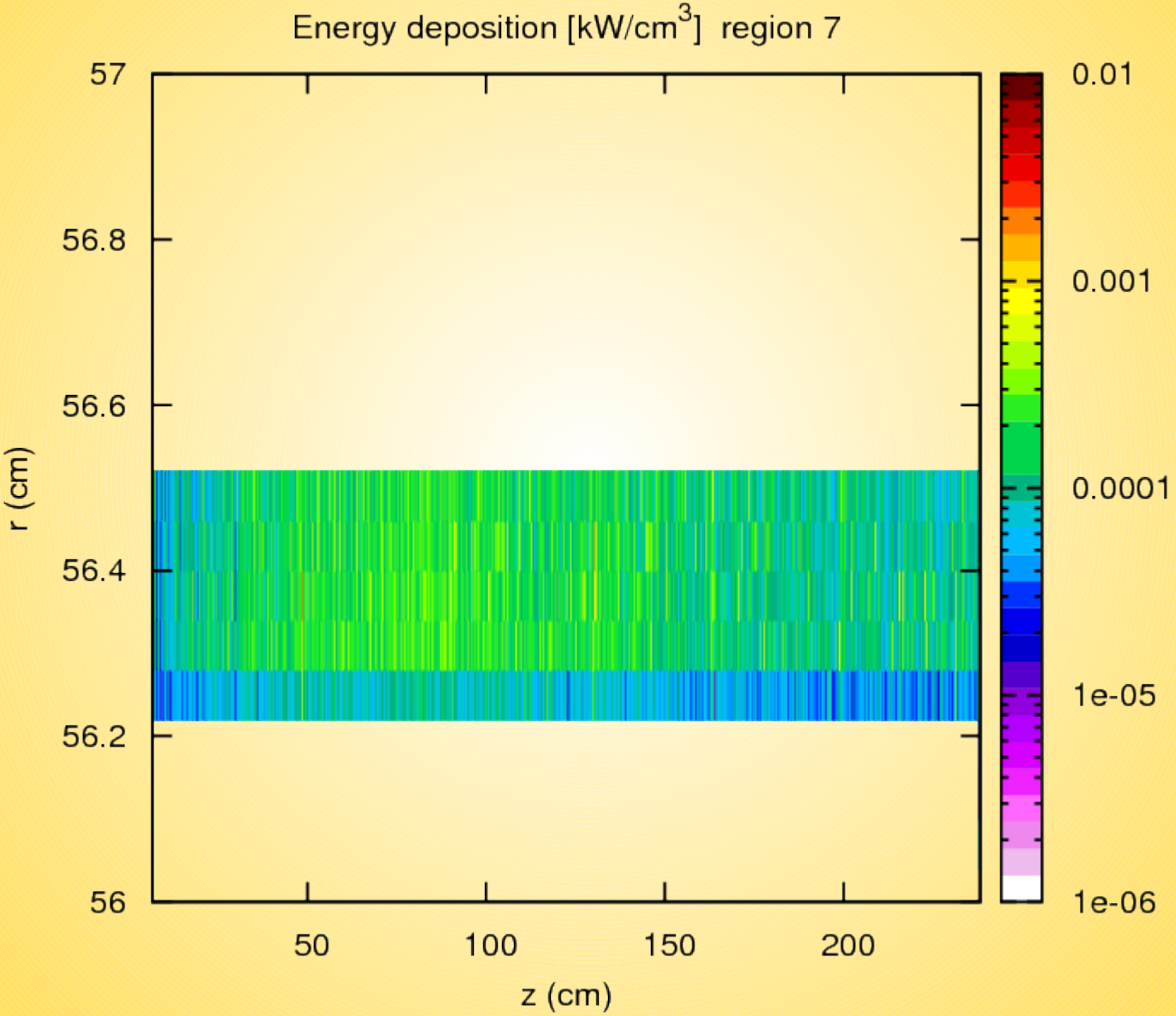


Integrated power most probably over-estimated using the approximated geometry

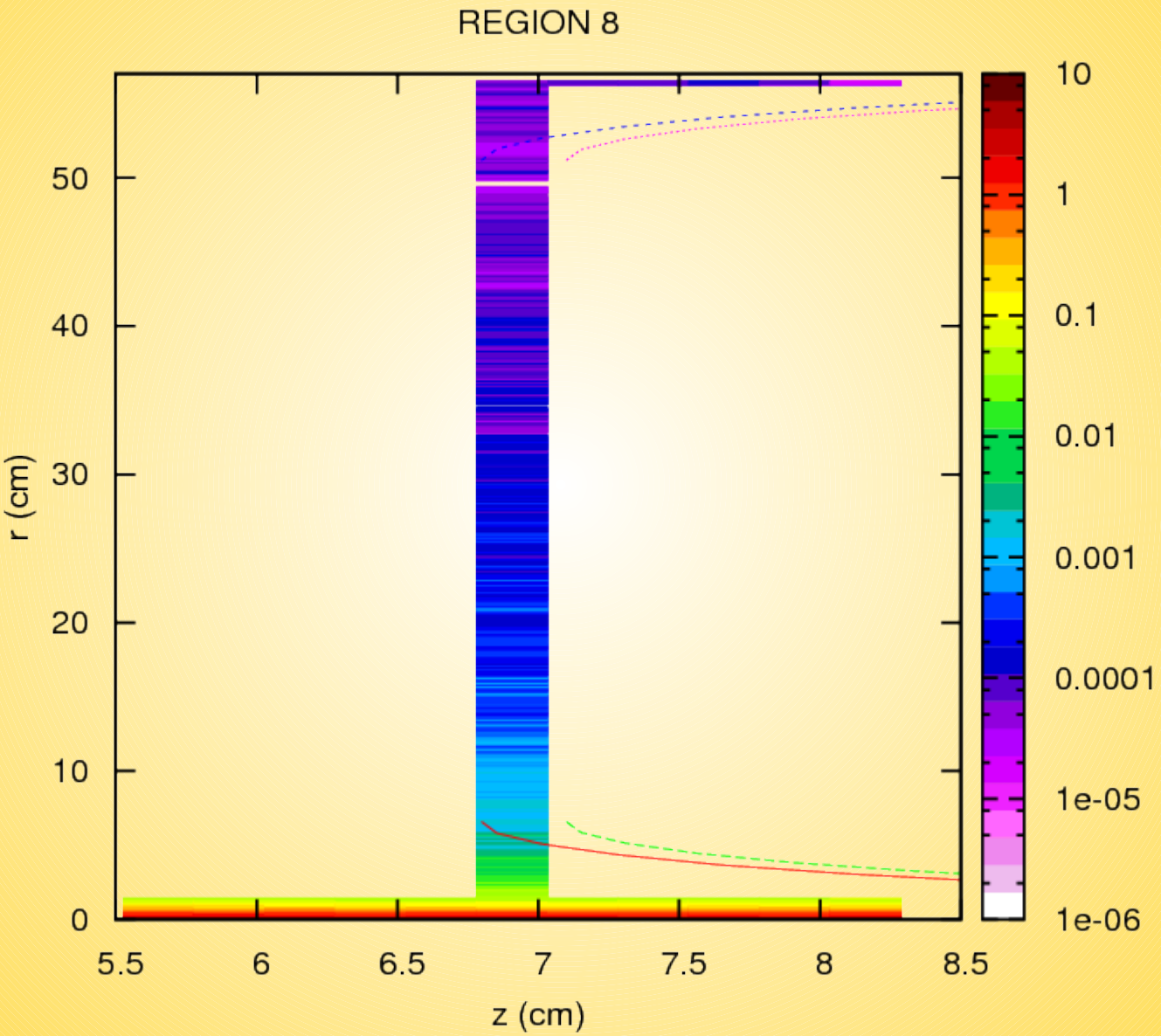
Downstream endplate



Outer cylinder



Upstream endplate



Further steps (in my mind)

1) Energy deposition:

- Improve the FLUKA geometry (if needed).

- Eventually study other materials (Be-AlBeMet, easy)

- Use these data in thermo-mechanical analysis.

2) Fluxes-sensitivities:

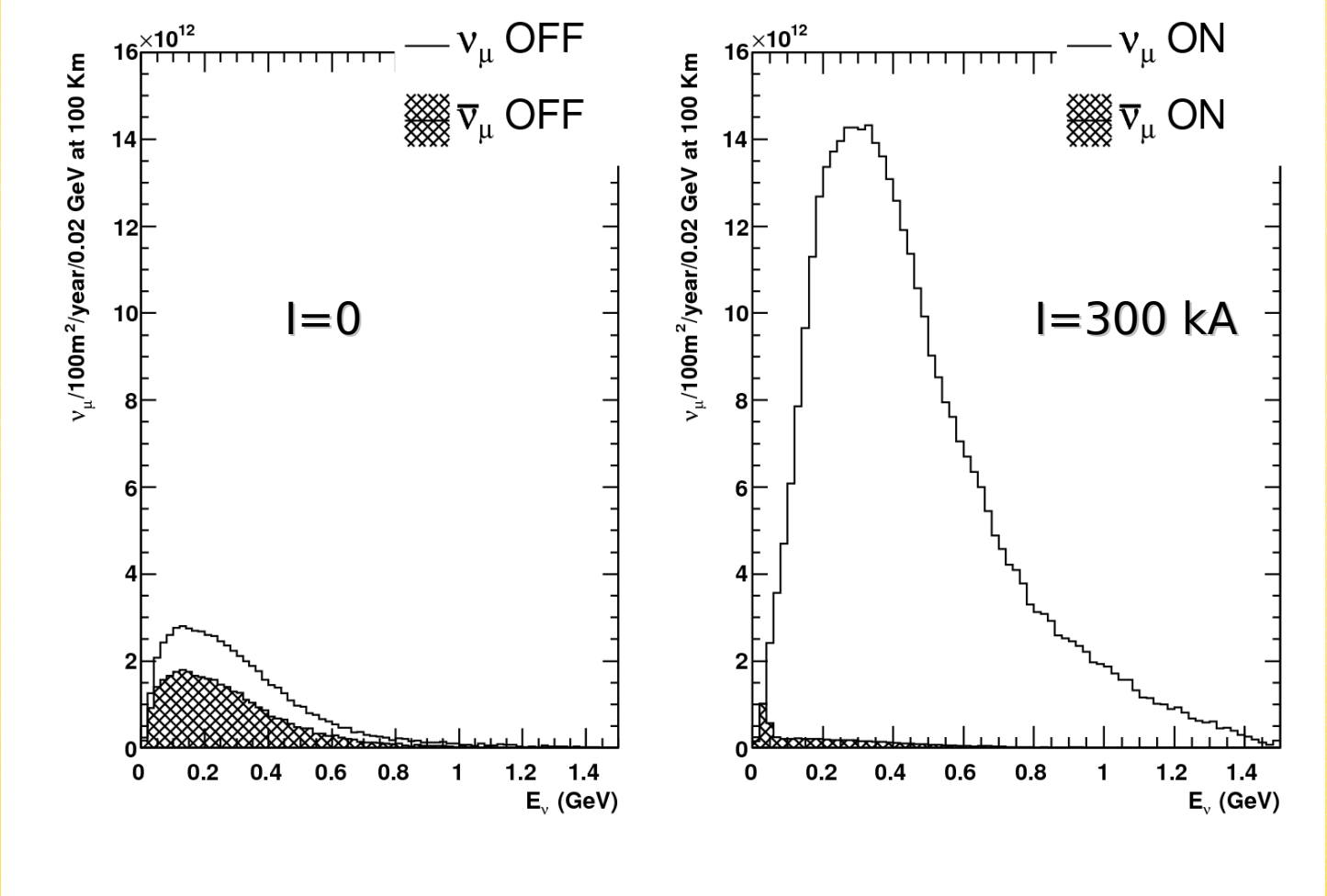
- Prepare a set of results for the non-integrated target solution with higher current (similar to those in the latest note). How much will lose ?

Back-up

Focusing power (I)

ν_μ enhancement: x 6.5

anti-ν_μ suppression: x 5.4

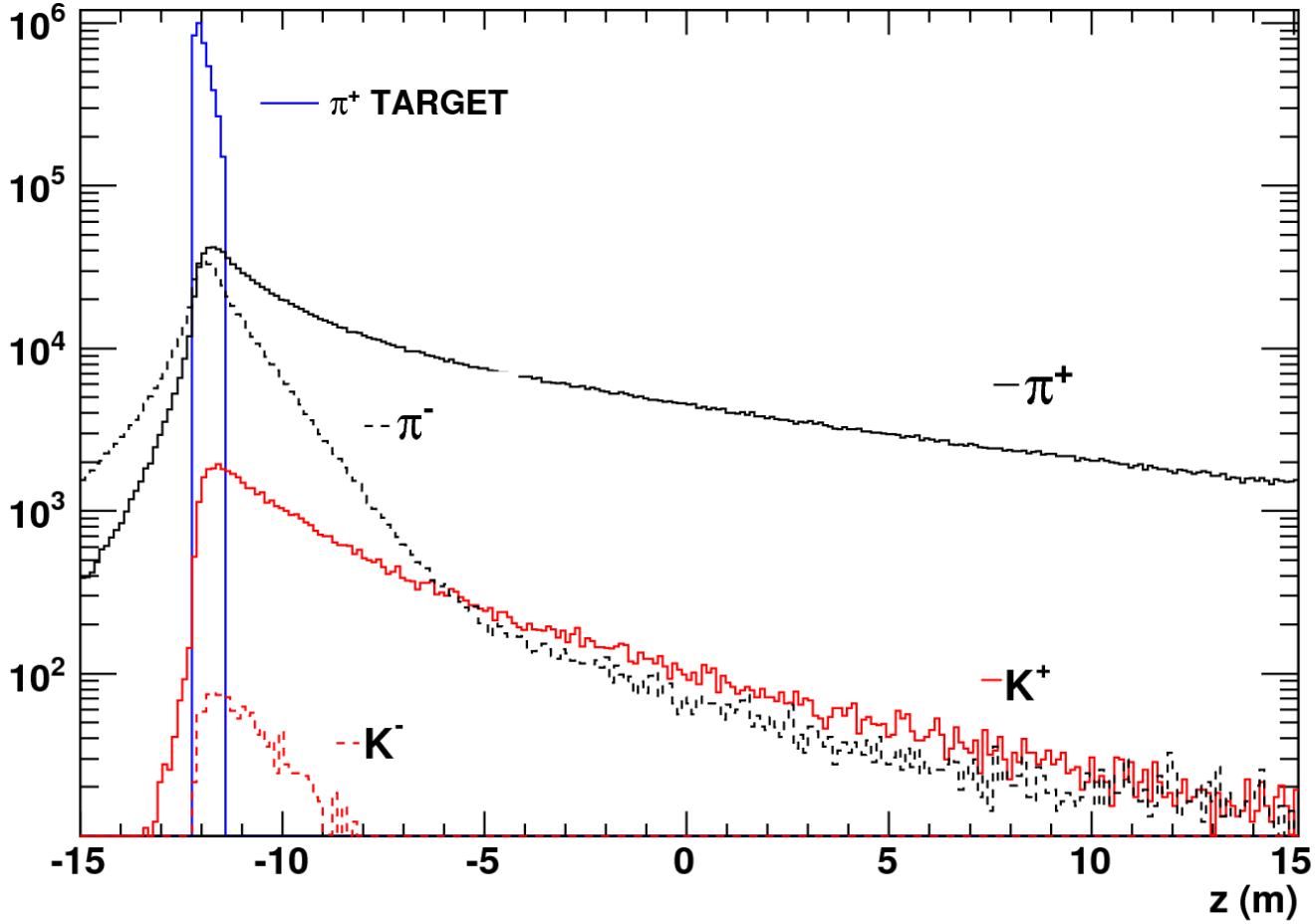


Focusing power (II)

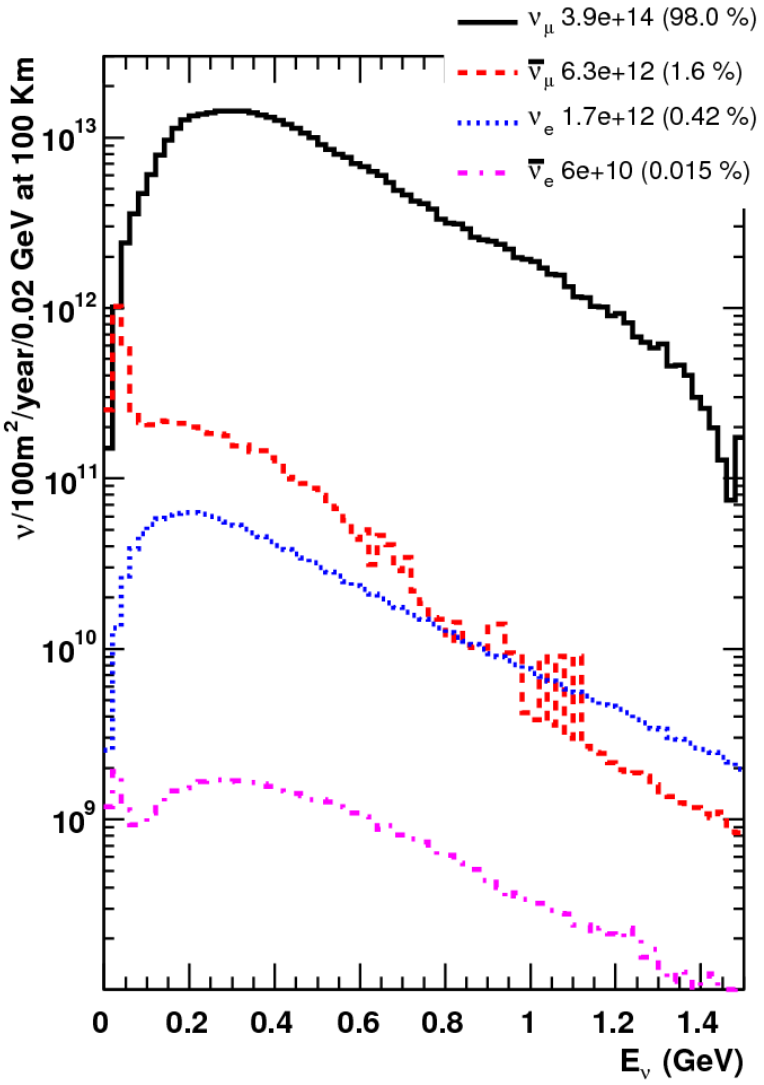
z-coordinate of $\pi^{\pm}/K^{\pm}$ decays in flight in positive focusing mode

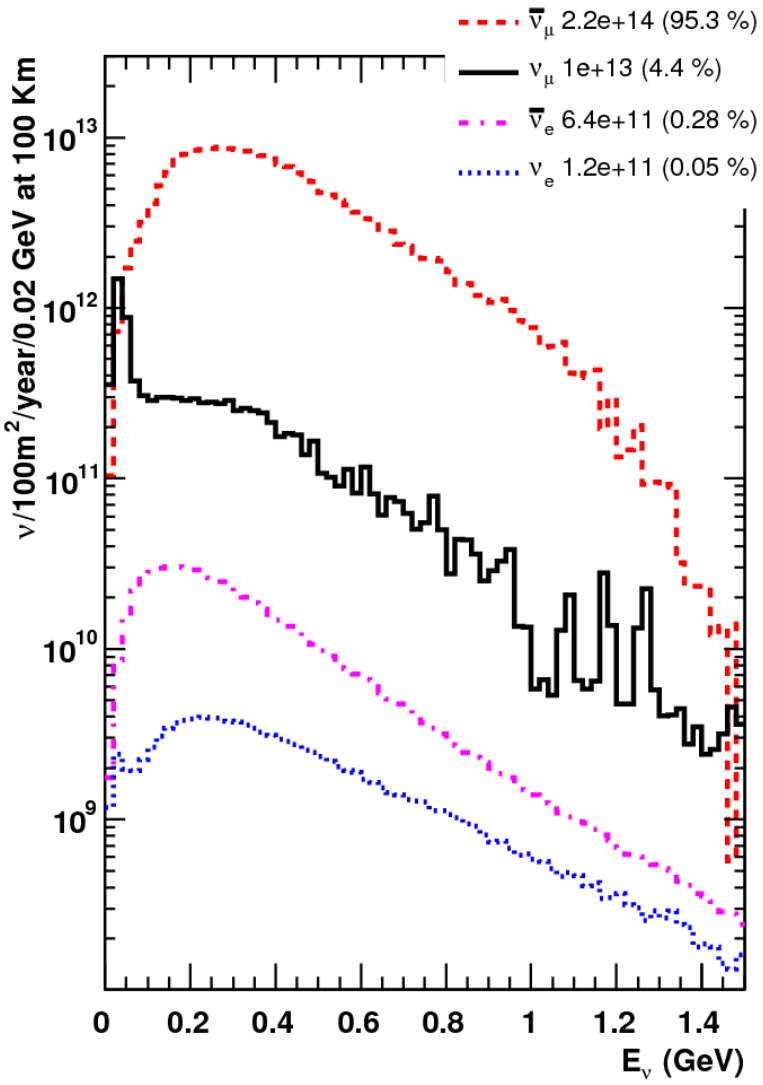
Visible differences:

* +/- (focusing)
* lifetime of π and K
* relative π/K yield



Fluxes


ν_μ 3.9e+14 (98.0 %)
$\bar{\nu}_\mu$ 6.3e+12 (1.6 %)
ν_e 1.7e+12 (0.42 %)
$\bar{\nu}_e$ 6e+10 (0.015 %)
ν/100m^2/year/0.02 GeV at 100 Km
E_ν (GeV)


$\bar{\nu}_\mu$ 2.2e+14 (95.3 %)
ν_μ 1e+13 (4.4 %)
$\bar{\nu}_e$ 6.4e+11 (0.28 %)
ν_e 1.2e+11 (0.05 %)
ν/100m^2/year/0.02 GeV at 100 Km
E_ν (GeV)

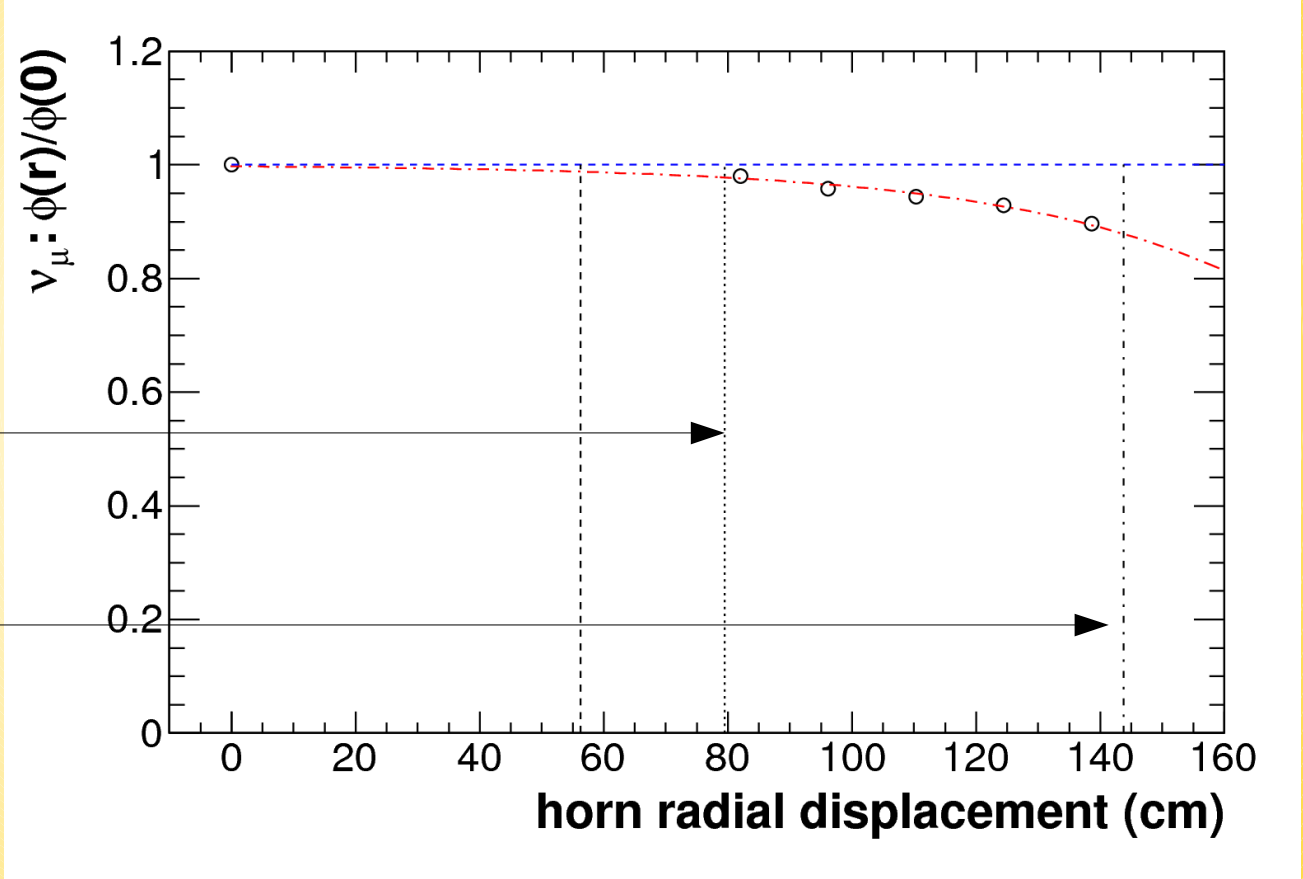
4-horn setup: effect on flux

Plot updated for the new configuration

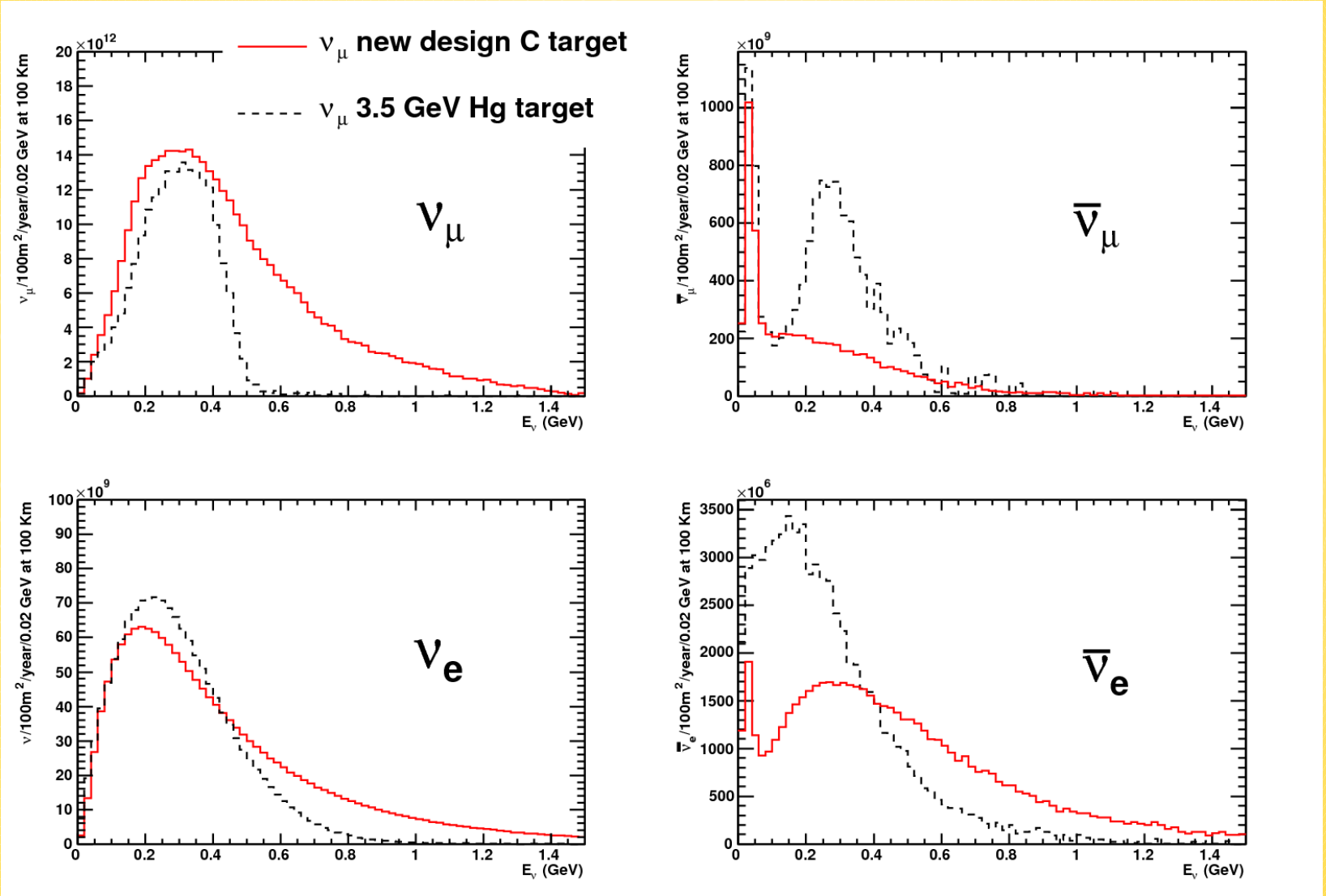
Horn radius : 56 cm
Tunnel radius: 200 cm

• horns touching the tunnel (most pessimistic assumption): 10 % loss

• 4 horns in contact (minimum possible displacement): 1-2 % loss

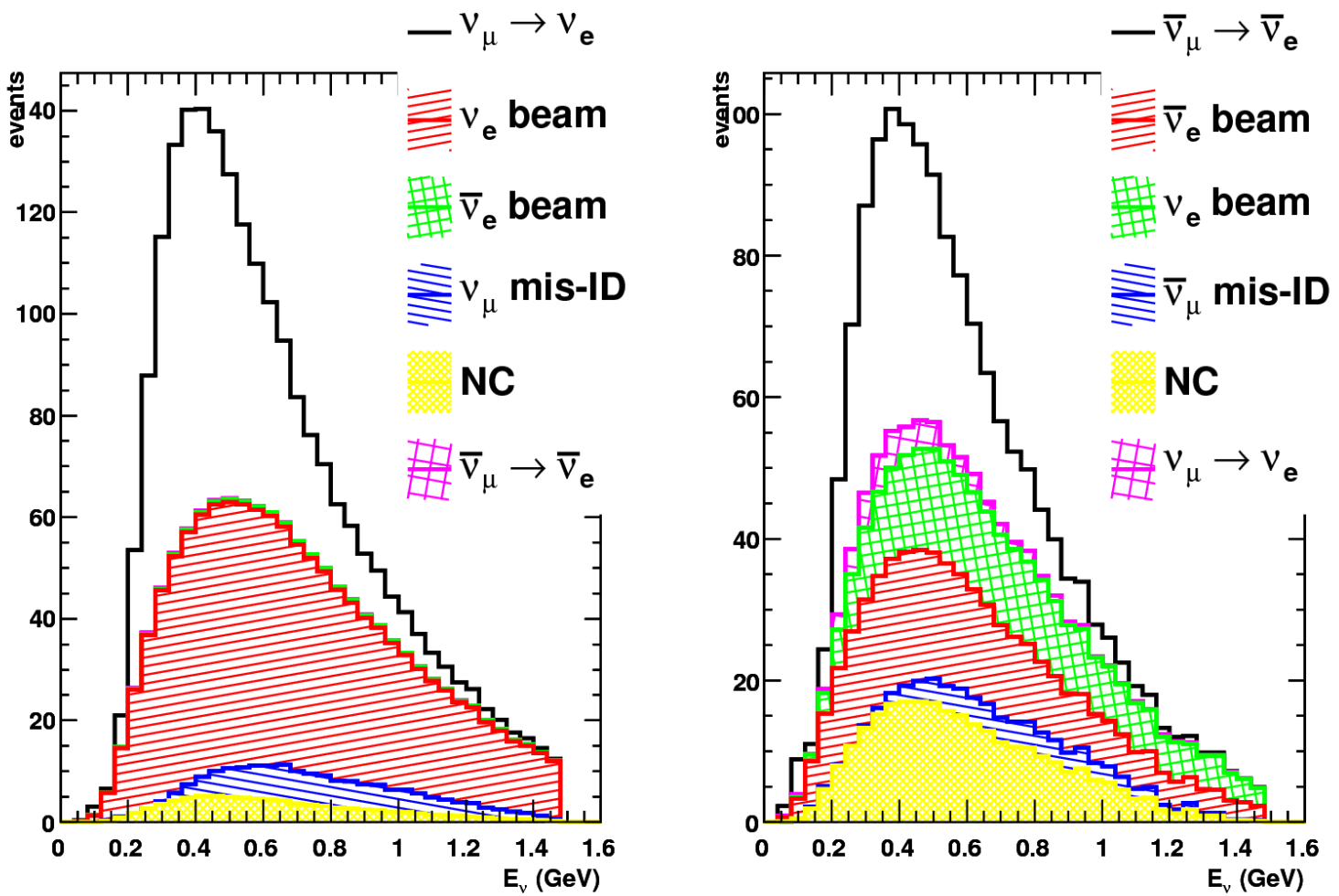


Comparison with the previous fluxes



Event rates in MEMPHYS

$\sin^2 2\theta_{13} = 0.01$, $\delta_{CP} = 0$



The bulk of the background comes from the intrinsic beam electron component
NC π^0 relevant for the anti-ν run (28%).

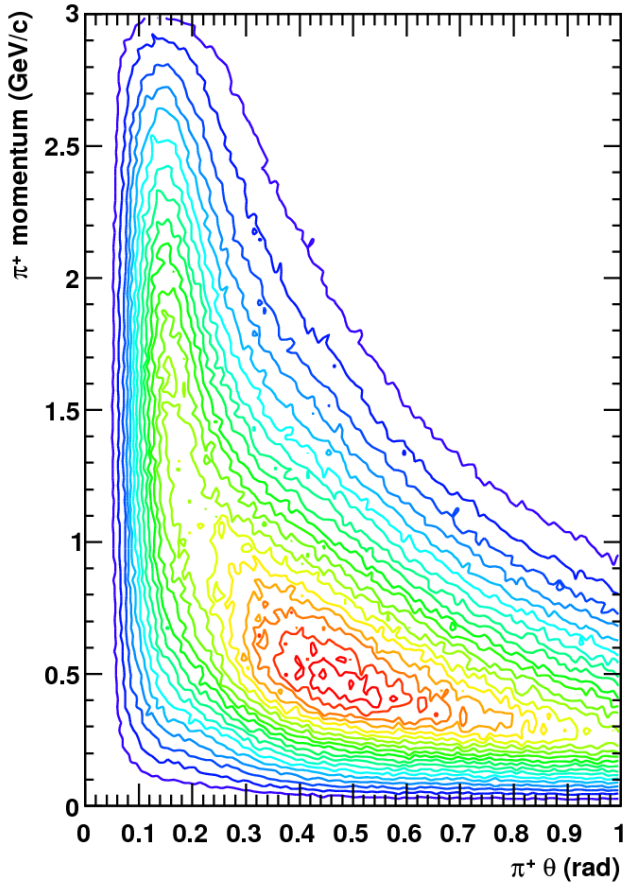
Uncertainties related to hadro-production

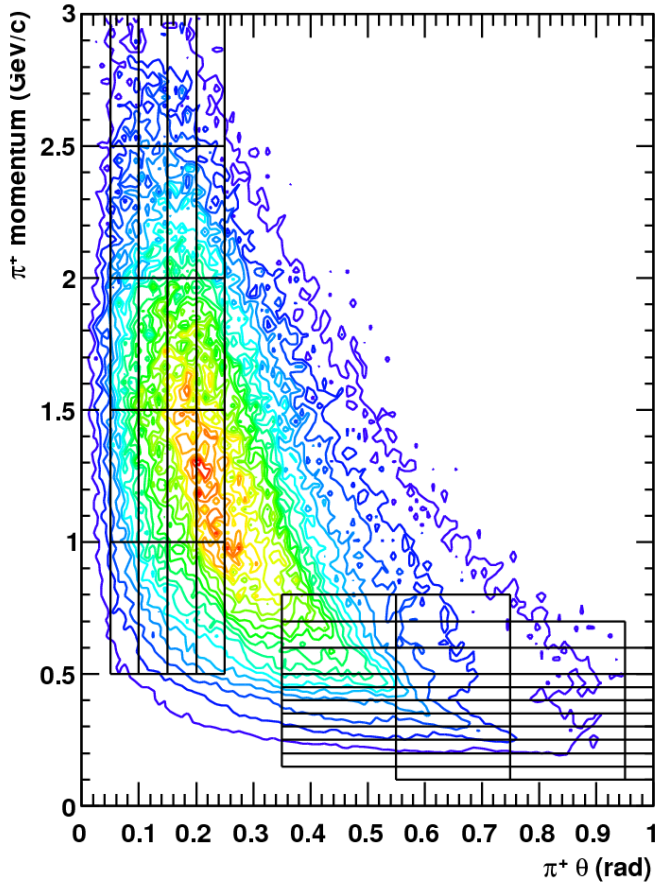
Pion phase space

At target exit

P VS θ in bins of E_ν

weighted average, $w_i = E_{\nu i}$

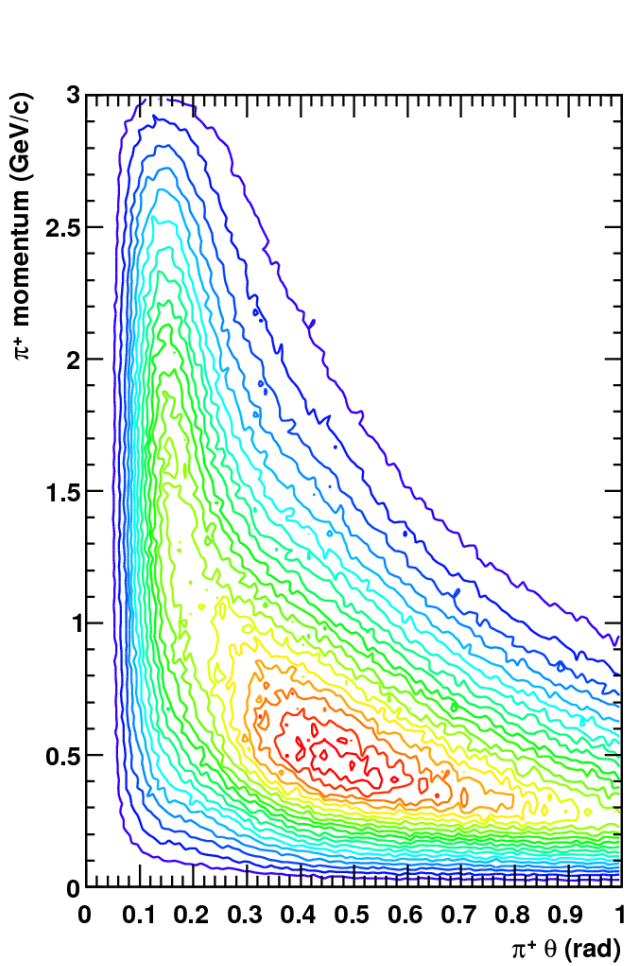


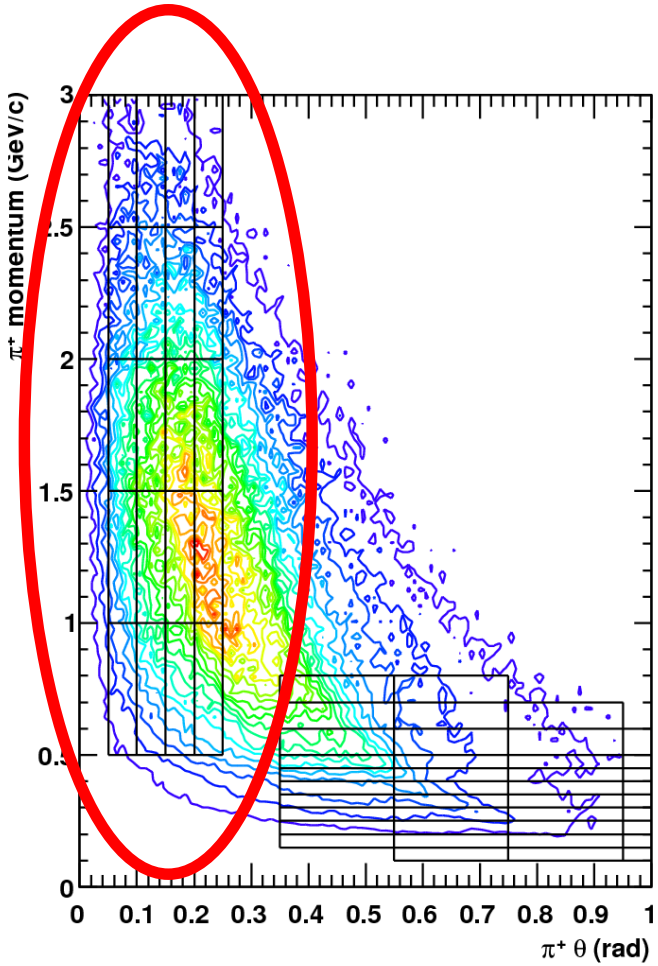


Weights according to the contribution to the neutrino flux

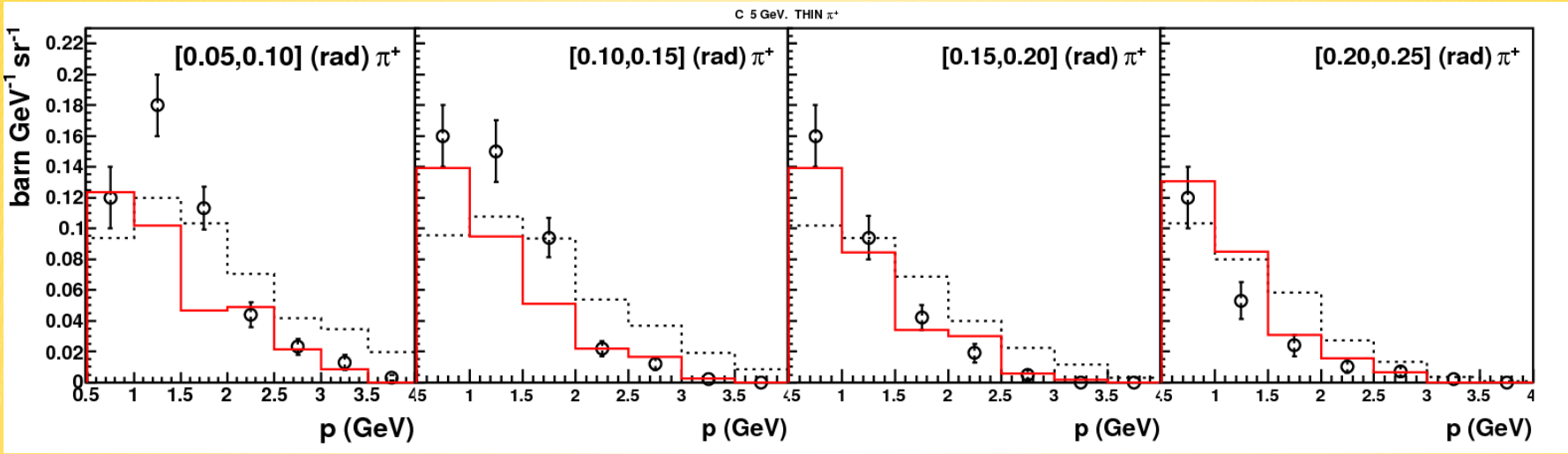
Pion phase space

HARP “Small angle” data available for a “thin target” (1.95 cm, 3 cm diameter)

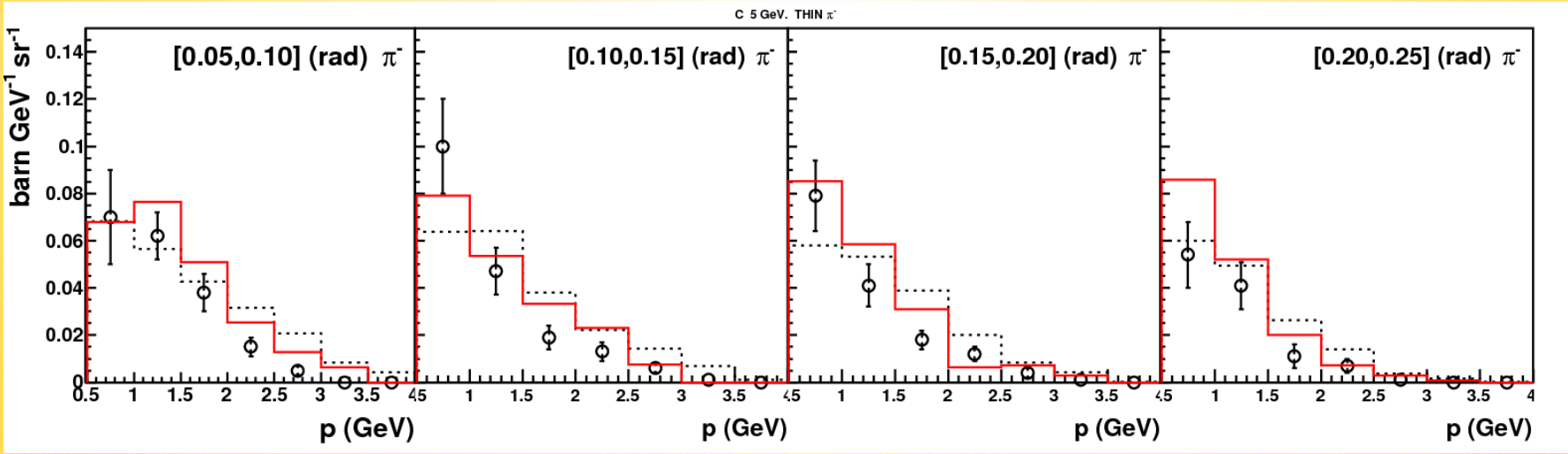




pi+


C 5 GeV. THIN π+
[0.05,0.10] (rad) π+
[0.10,0.15] (rad) π+
[0.15,0.20] (rad) π+
[0.20,0.25] (rad) π+
barn GeV-1 sr-1
p (GeV)

pi-

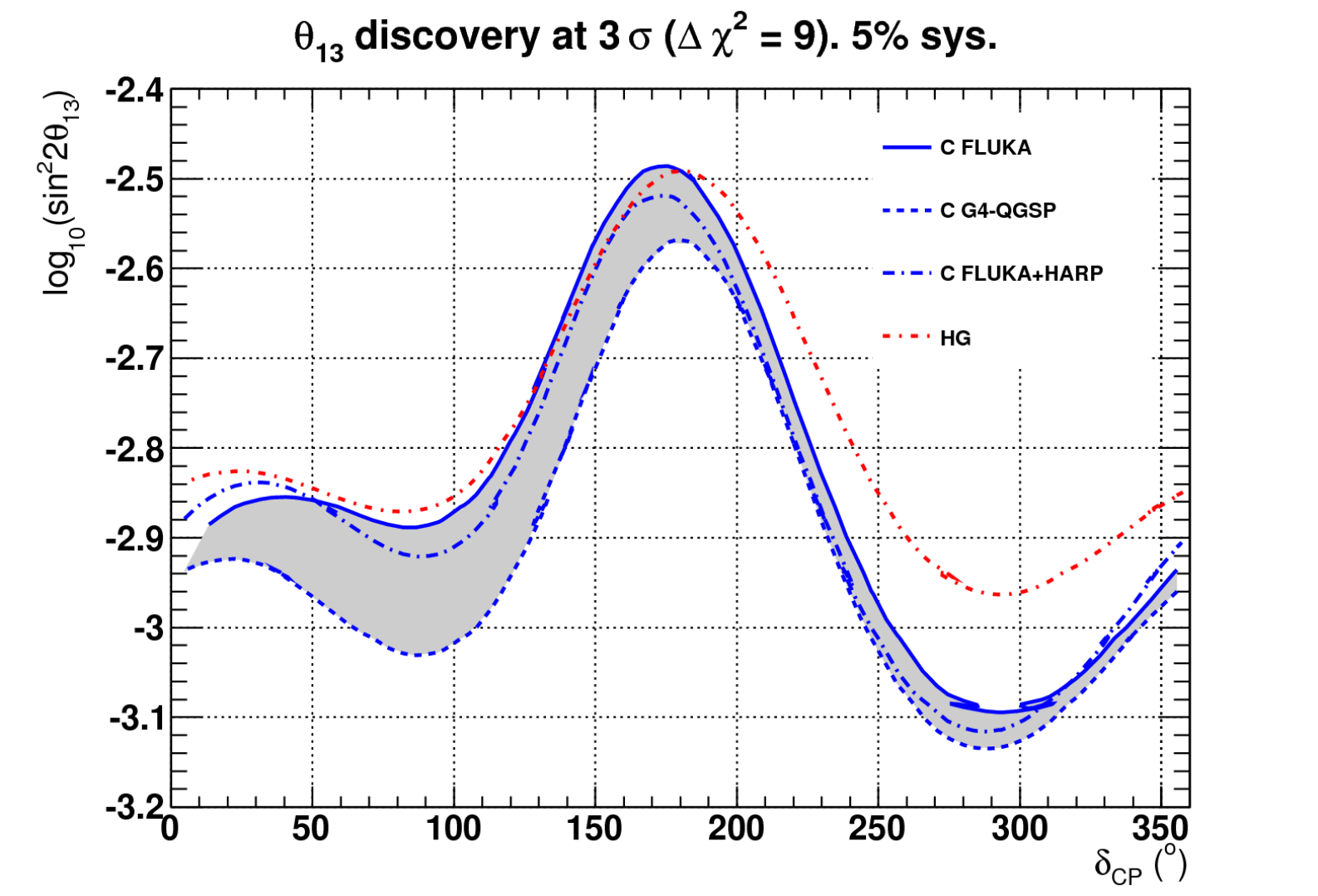

C 5 GeV. THIN π-
[0.05,0.10] (rad) π-
[0.10,0.15] (rad) π-
[0.15,0.20] (rad) π-
[0.20,0.25] (rad) π-
barn GeV-1 sr-1
p (GeV)

Discovery of $\theta_{13} \neq 0$

I assume 5% sys. Errors

low-energy neutrino interactions are a difficult terrain !

Red curves reproduce the published ones.



Discovery of CPV

I assume 5% sys. Errors

low-energy neutrino interactions are a difficult terrain !

Red curves reproduce the published ones.