Compact Photon Source

updates&ideas for 11/21/2017

B. Wojtsekhowski for the collaboration

New developments

the list from our previous meeting

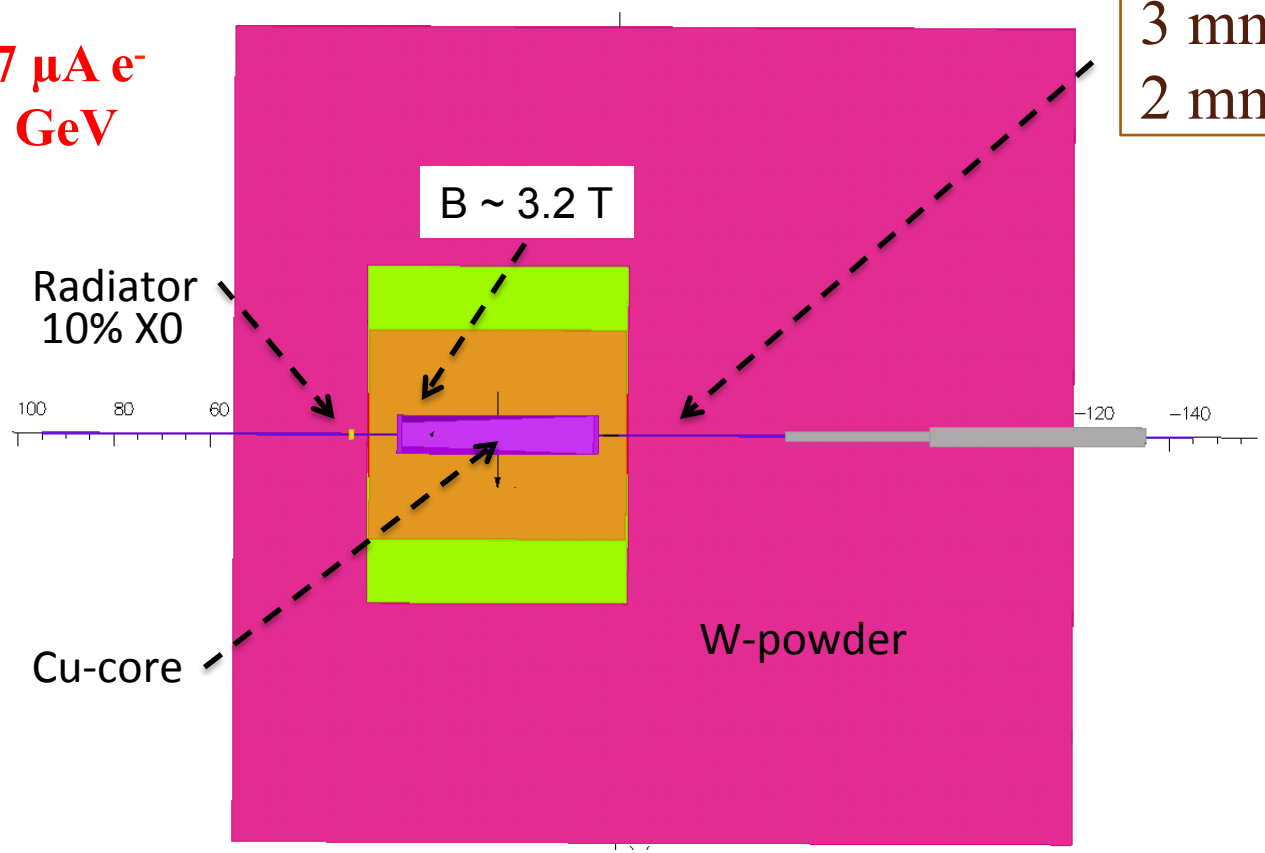
1. The raster is 2 mm x 2 mm (requires pol. target rotation)
2. The magnet pole is shaped to boost the B field to 3.2 T -> length reduction which allows a longer front shield and a wedged absorber.
3. The central absorber of Cu has 1.9 x better heat conductivity, 4.2 x longer radiation length than the W-Cu (20%) alloy.
4. W-powder external shield (16 g/cm^3 density) for better shielding.
5. Gradual "stepped" opening of the beam line for rad. leak reduction
6. Shielding requirement logic: The radiation from the source should be a few times lower than that from the photon beam interaction with the material of a polarized target.

Current model of the γ-Source

Distance to target ~200 cm
photon beam diameter on target ~0.9 mm

2.7 μA e^-
11 GeV

3 mm x 3 mm hole
2 mm x 2 mm raster



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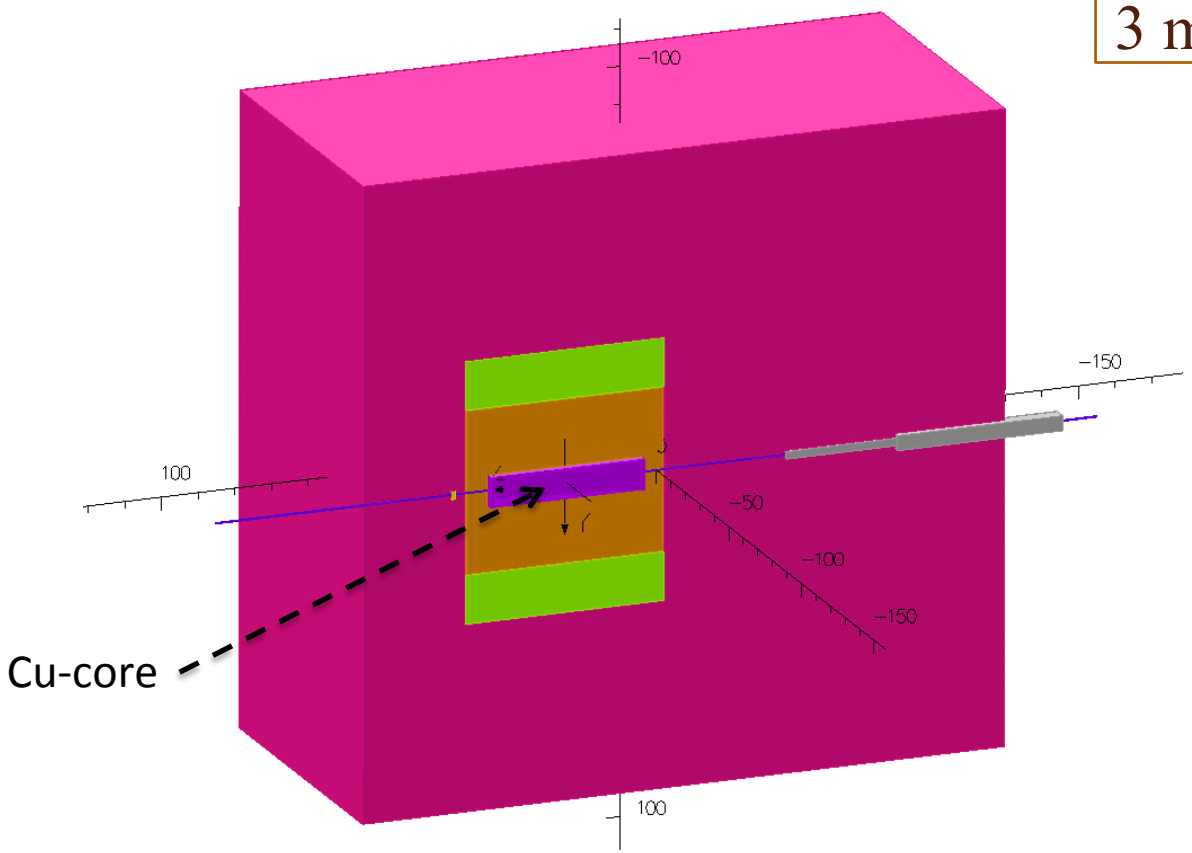

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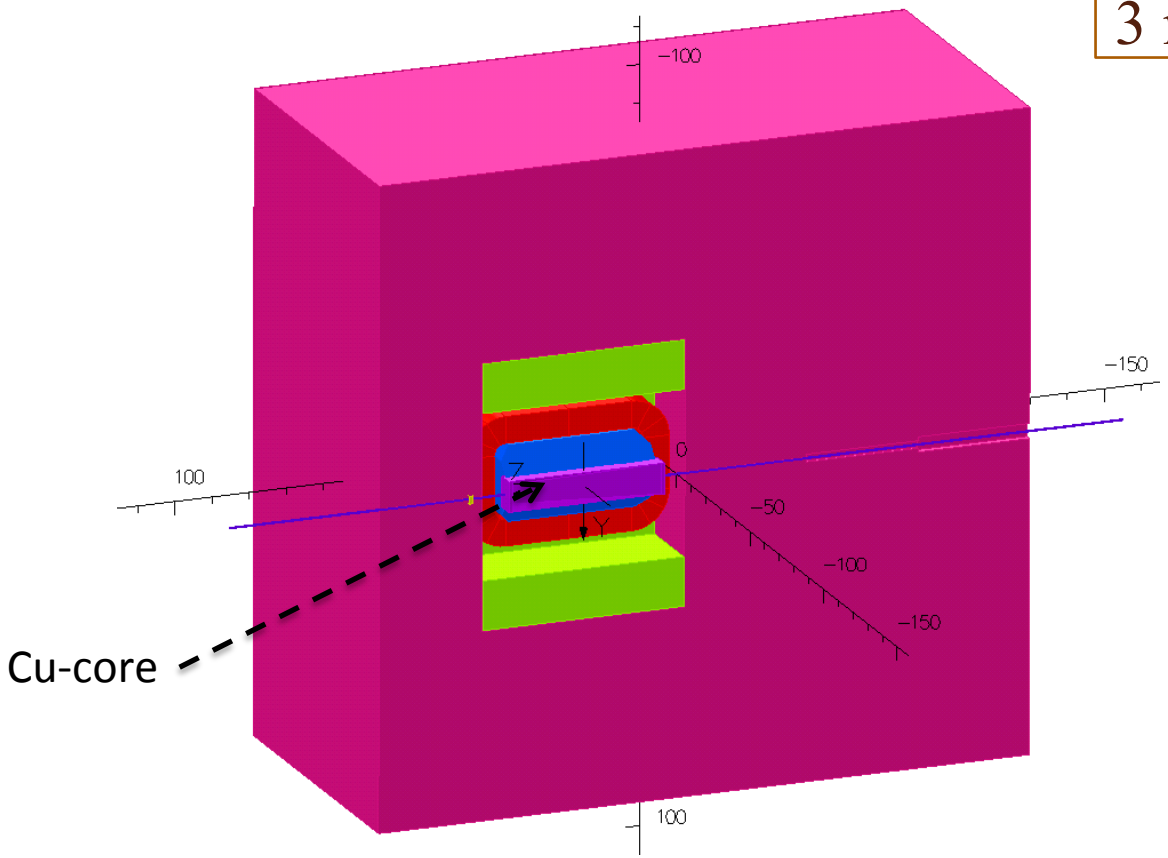
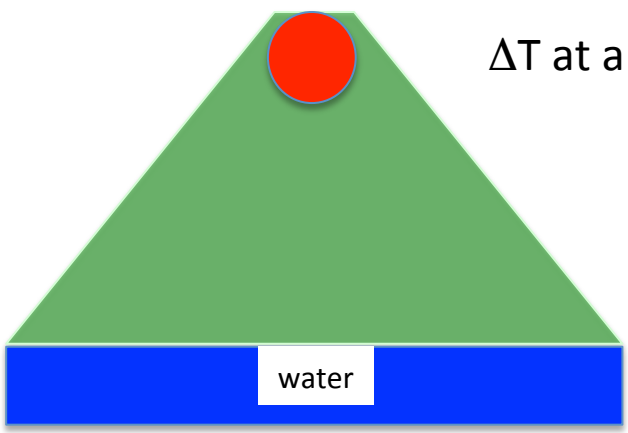


Considerations for a 6-point list

3. The central absorber of Cu has 1.9 x better heat conductivity, 4.2 x longer radiation length than the W-Cu (20%) alloy.

An estimate: The power distributed over 30 cm with diameter of 2 cm. Using a wedge shape of the Cu (in x-y plane) with angle of 90 degrees and cooling at 12 cm distance from the power source we can estimate the temperature profile: 600+ 140 x $(1-r^2)$ for r<1 cm and a log. profile for r>1 cm 240 ln(12/r). A 3D calculation would be useful.



ΔT at a hot center = 600 + 140 C

Considerations for a 6-point list

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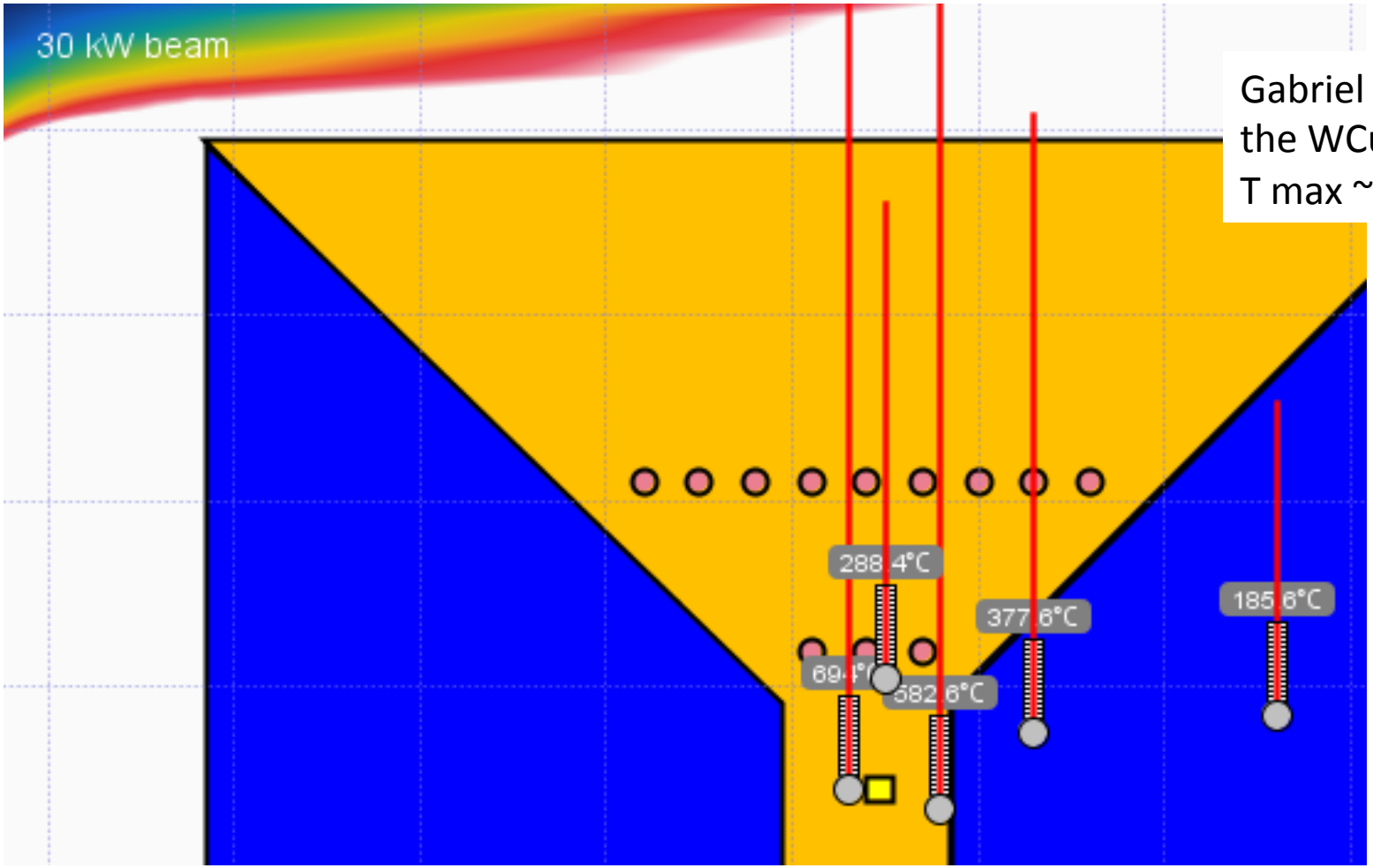


Gabriel found for the WCu absorber: T max ~ 700 C

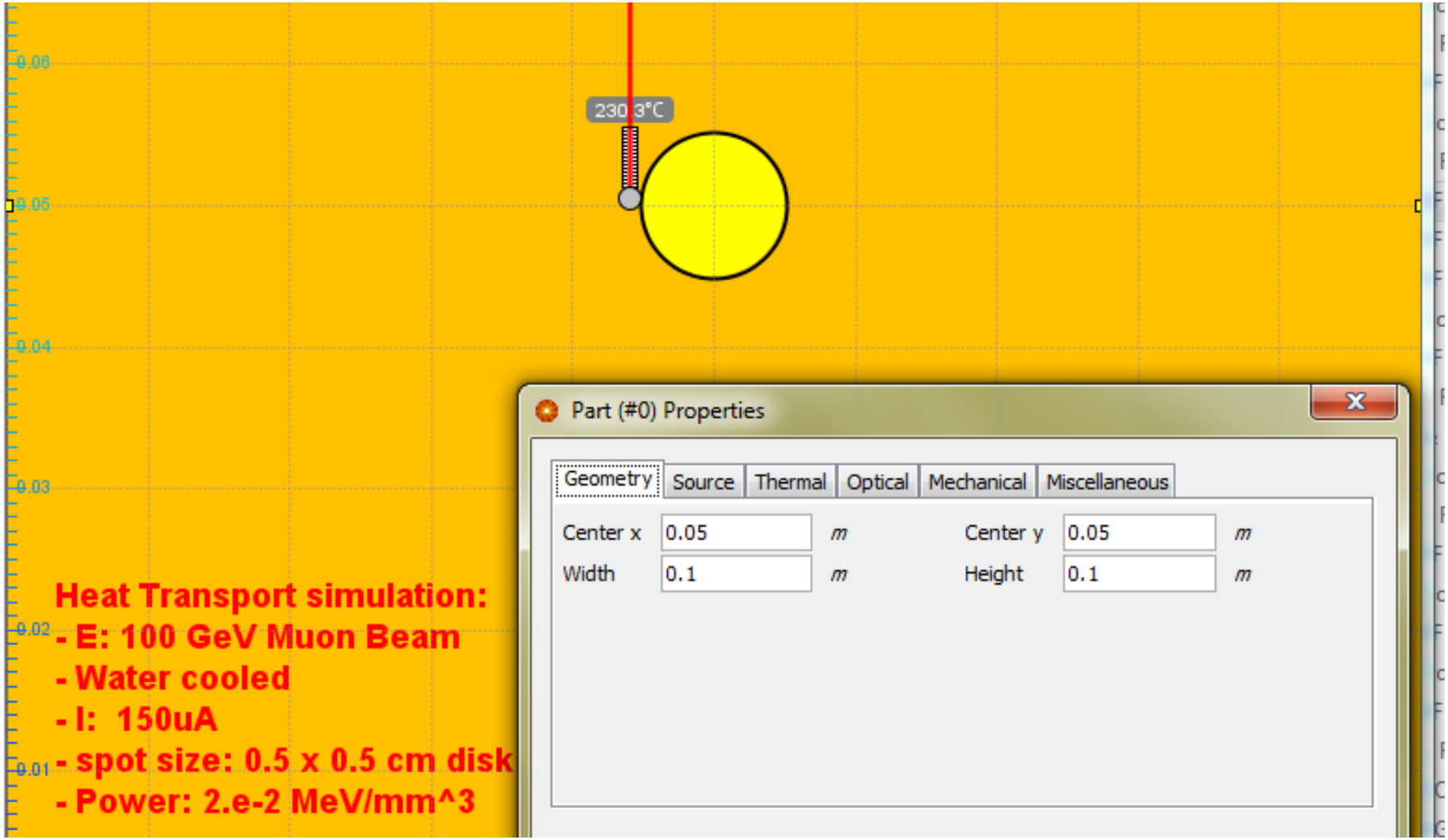
Test of 2D Temp-code

Marco made a GEMC with a set of 44 Cu blocks 10x10x1 cm; 100 GeV muons in 1 cm diameter spot for heat generation – mainly ionization losses.

Gabriel used the G4/root output file to find the max power in Z and used it for 2D analysis of the temperature profile => $T_{r=0.5\ cm}$ = 240 C

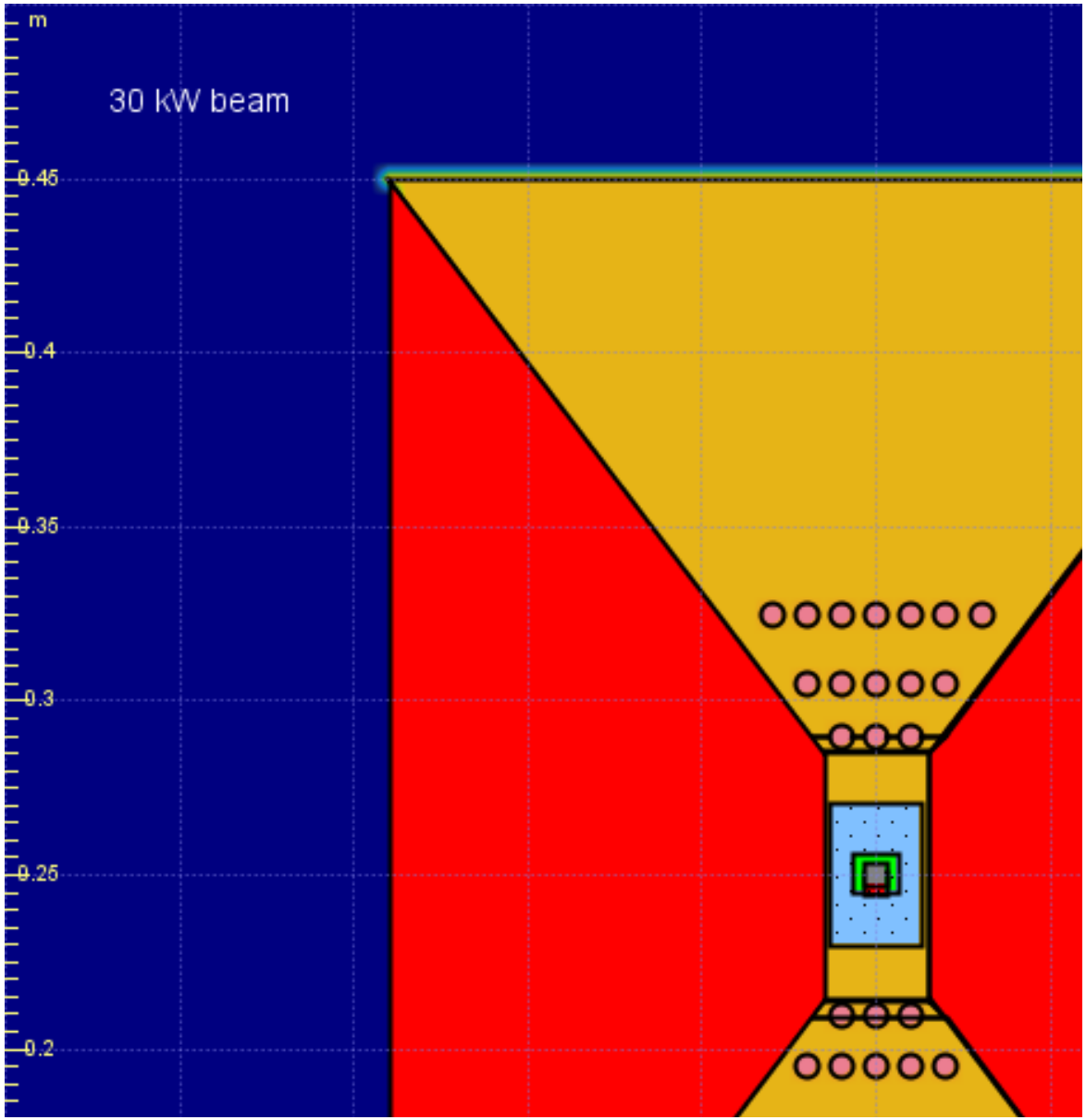
My analytical result for that point is about 246-255 C

Test of 2D Temp-code



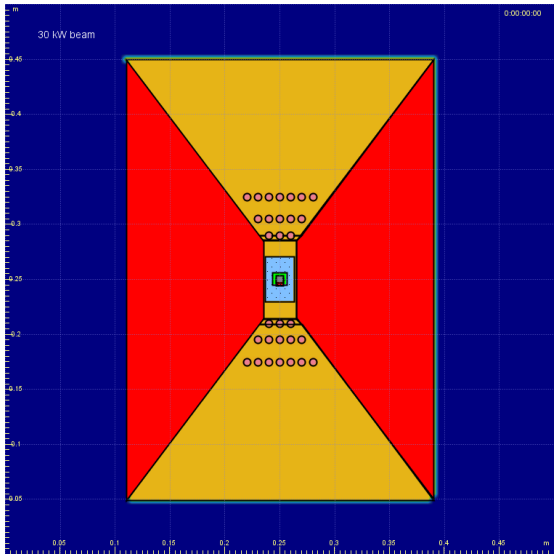
Considerations for a 6-point list

Gabriel used Marco's CPS power profile, took the max power at Z = -55 cm



Updated calculations (Nov. 20)

HCPS, Cu center, 30 kW z=-55 cm



y [cm] \ x [cm]	0	2	4	6	8	10	12	14
0	379.5	289.2	244.4	178	139.3	115.1	99.1	88.2
−2	293.6	254	223.1	167.9	133.9	111.9	97.2	86.9
−4	124.4	121.5	121.4	114	103.3	93.5	85.4	79.1
−6	47.1	50.7	66.2	78.1	79.9	78	75	71.8
−8	40.8	42.3	42.9	51.1	60	63.3	64.5	64.1
−10	30	30	30	36.6	45.2	51.8	55.3	56.9
	30.6	30.8	31.5	33.4	35.8	43.1	47.9	50.7
	30	30	30	30	34.1	36.8	42.3	45.7
	31.4	31.5	31.8	32.6	34.1	35.5	38.5	41.9
	32.4	32.5	32.9	33.5	34.5	35.5	36.5	39
	33.2	33.3	33.7	34.2	34.8	35.6	36.3	37.1

y [cm] \ x [cm]	16	18	20	22	24	26	28	30
0	80.6	75.2	71.8	68.7	67	66.1	64.2	62.4
−2	79.7	74.5	70.8	68.8	66.8	65.8	63.9	62.1
−4	74.2	70.5	67.8	65.8	64.5	63.8	62.1	60.4
−6	68.9	66.6	64.7	63.3	62.4	61.9	60.2	58.7
−8	63.2	62.1	61.2	60.4	59.8	59.5	58	57.2
−10	57.5	57.6	57.4	57.2	57	56.8	55.6	54.5
	52.4	53.3	53.8	54	54.1	54.1	53	52.1
	48	49.5	50.4	50.9	51.2	51.4	50.5	49.8
	44.4	46.1	47.3	48.1	48.6	48.8	48.2	47.5
	41.5	43.3	44.7	45.6	46.2	46.5	46	45.4
	39.3	41.1	42.4	43.4	44	44.3	44	43.4

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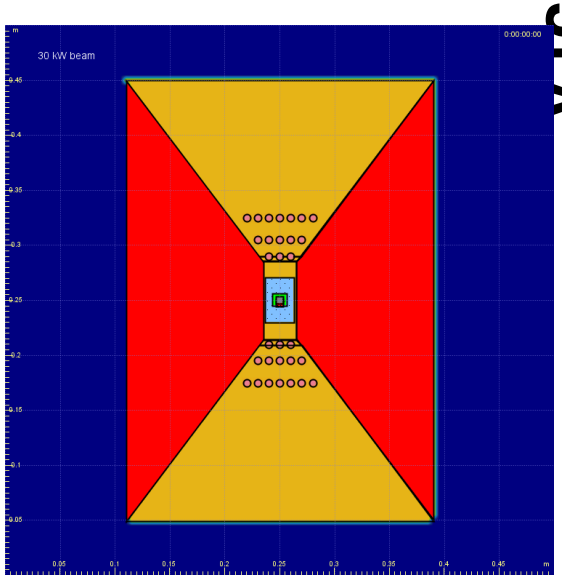
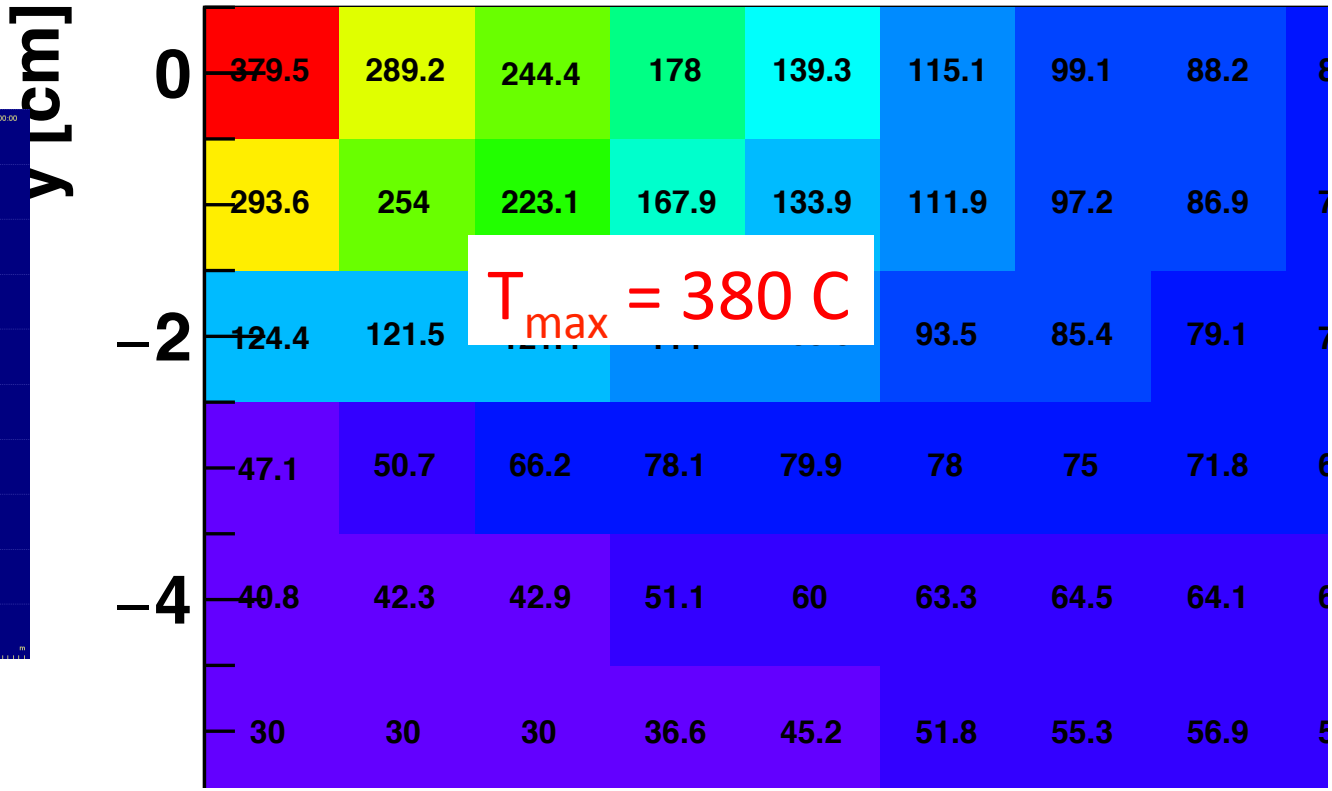
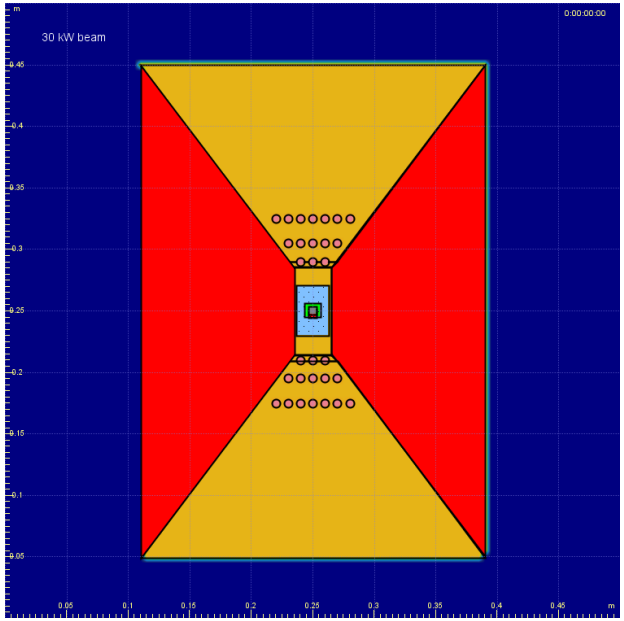




Updated calculations (Nov. 22)

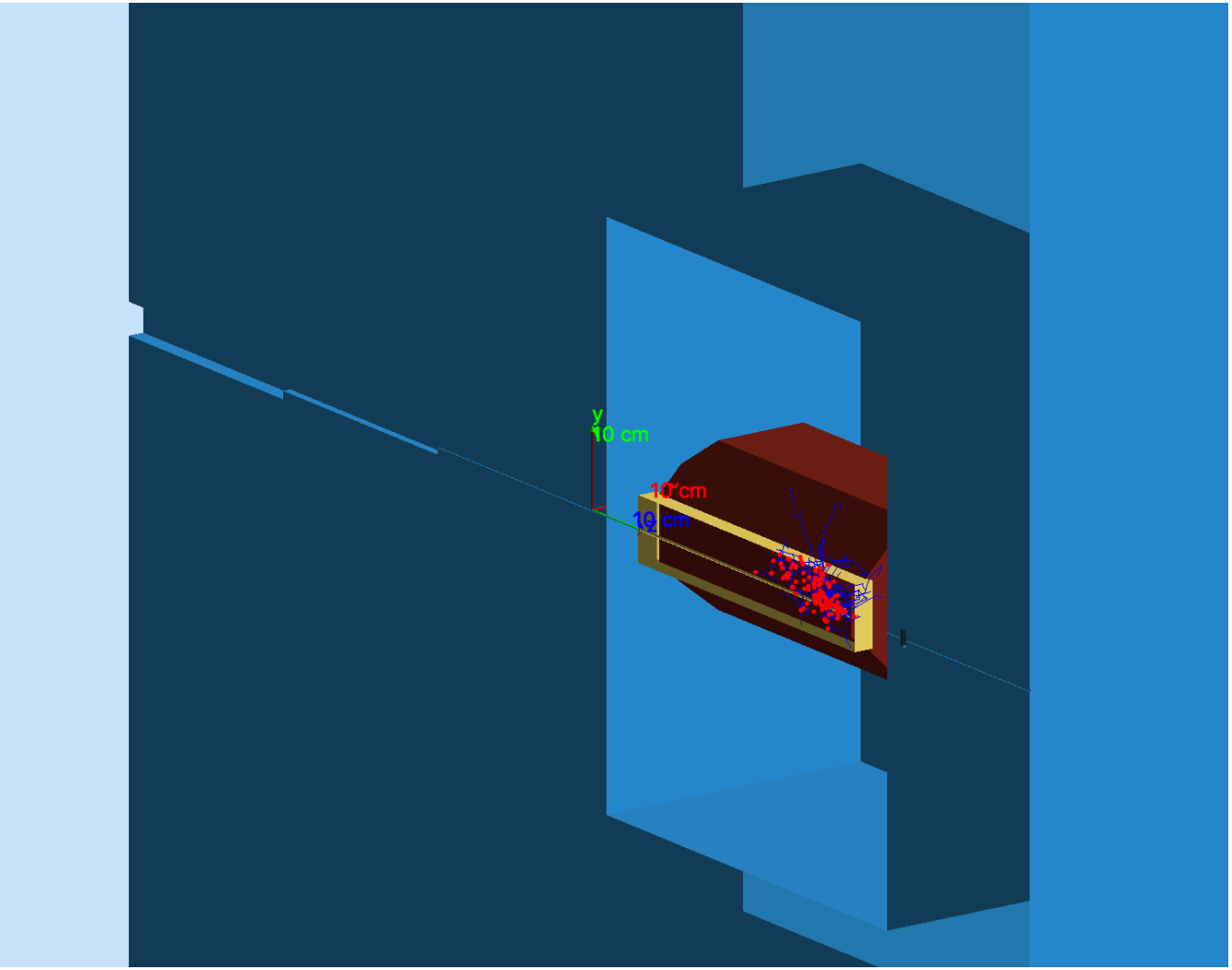


Reply to Rolf's question about cooling:

Water cooling system has two parts
Each 15 x 0.5 ~ 8 meters long 5 mm ID
For water pressure drop of 105 psi
The temperature rise is dT = 30 C

1									
2			Units		Units		Units		
3	d			5	mm	0.016404	ft		
4	L	8	m	8000	mm				
5	epsilon					0.000005	ft		
6	nu	0.00001216	ft^2/sec						
7	Coil Power	15	kW						
8	DeltaP				f	v	Re	q	DT
9	(psi)	(ft/sec)	(no units)	(no units)		(ft/sec)		(gpm)	(deg.C)
10	105	3.12416271	0.000678	6.337632	0.024897	19.79979	26710.51	1.877934536	30.3525
11									

Geant4 model (GEMC framework)



Marco,
Maurizio
BW

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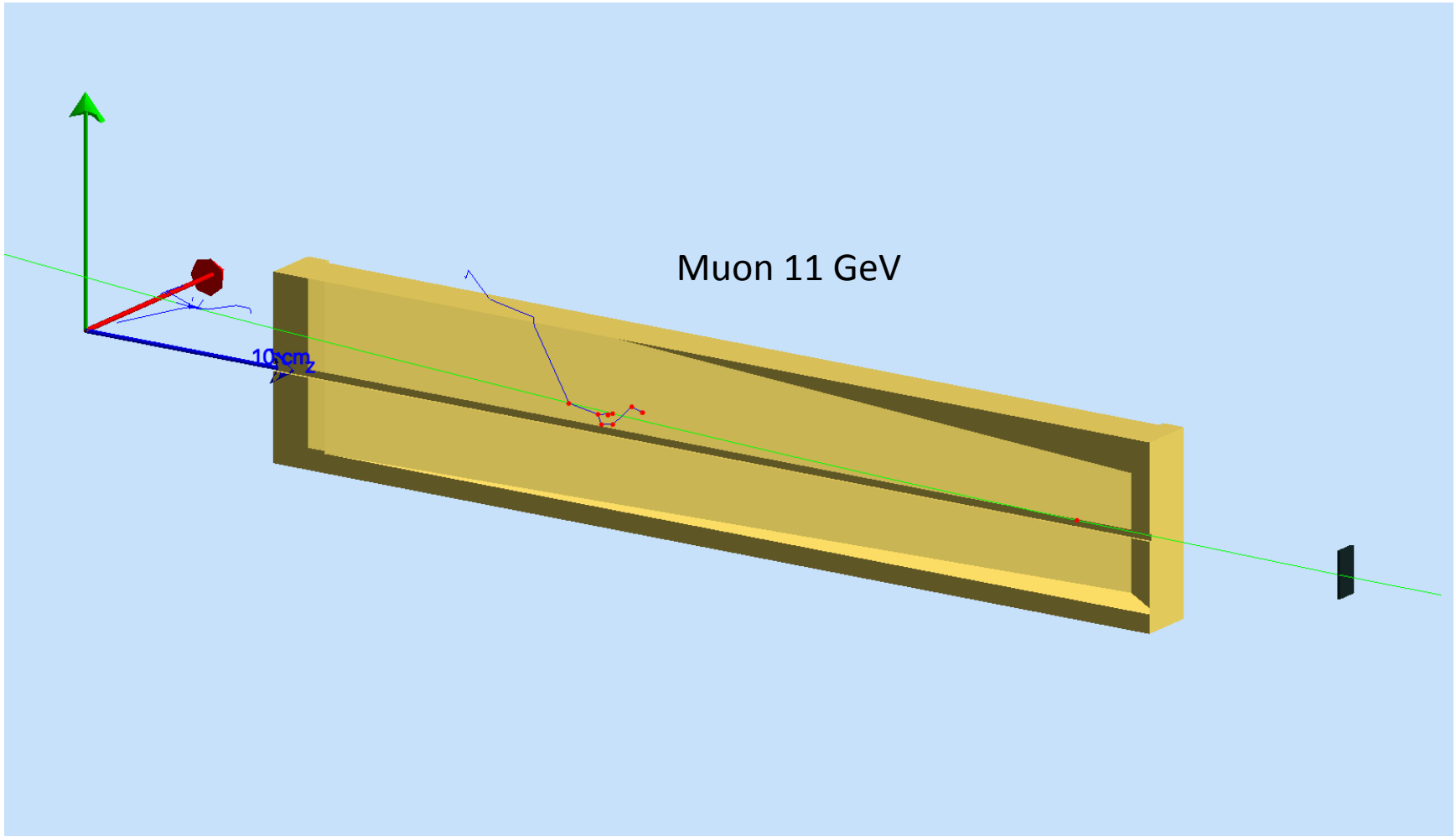

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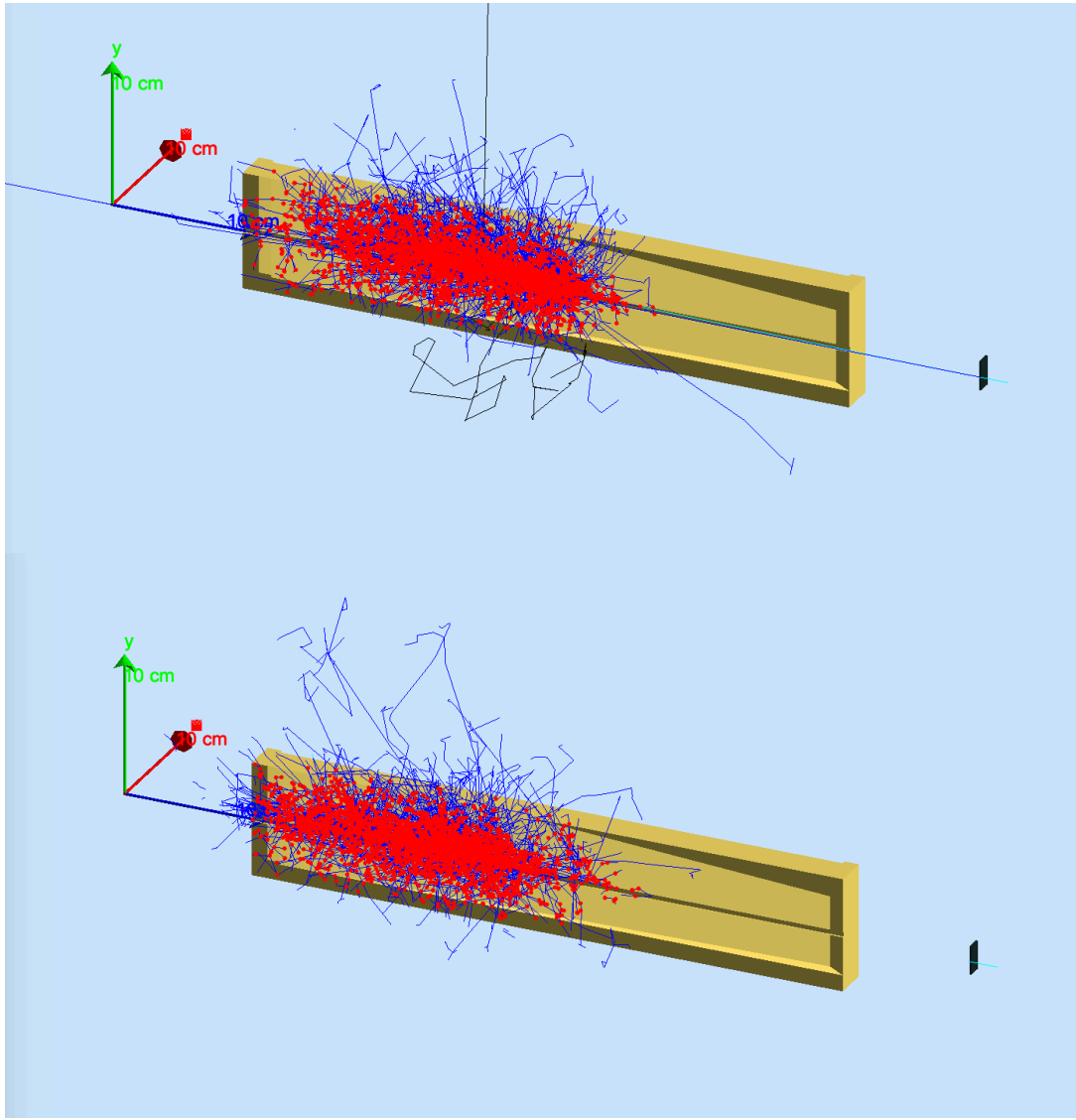


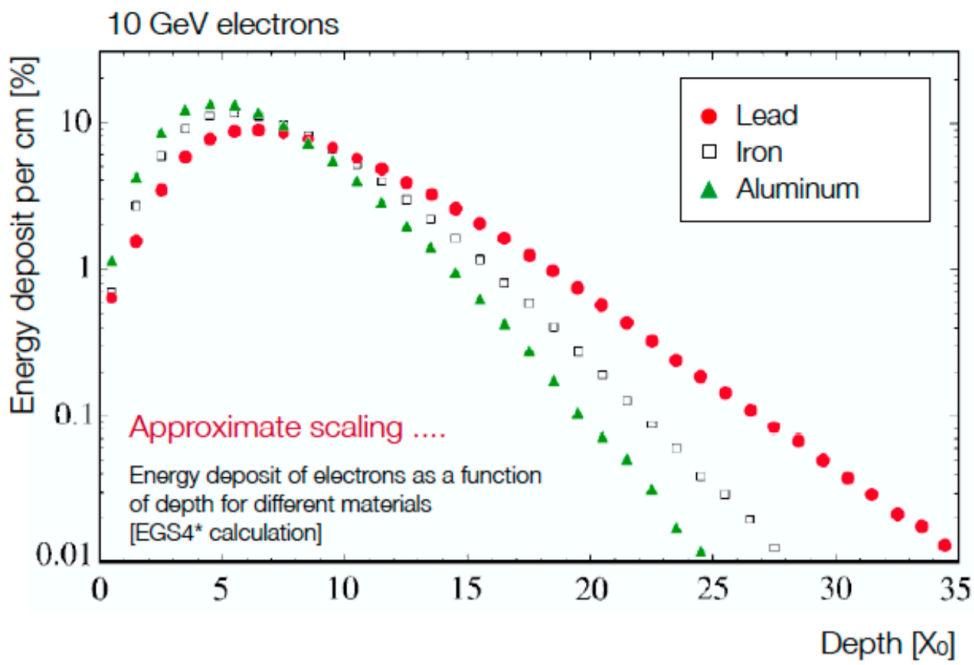
11 GeV e-
and a photon

11 GeV e-
Yv = -1 mm

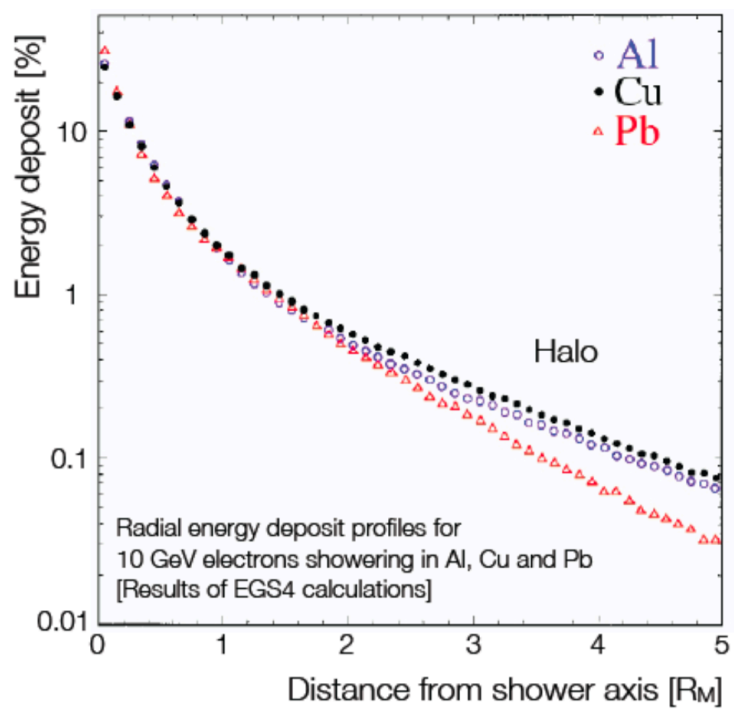
Geant4 model (GEMC framework)

We checked of the shower profiles, magnetic field implementation etc

Longitudinal profile



Transverse profile



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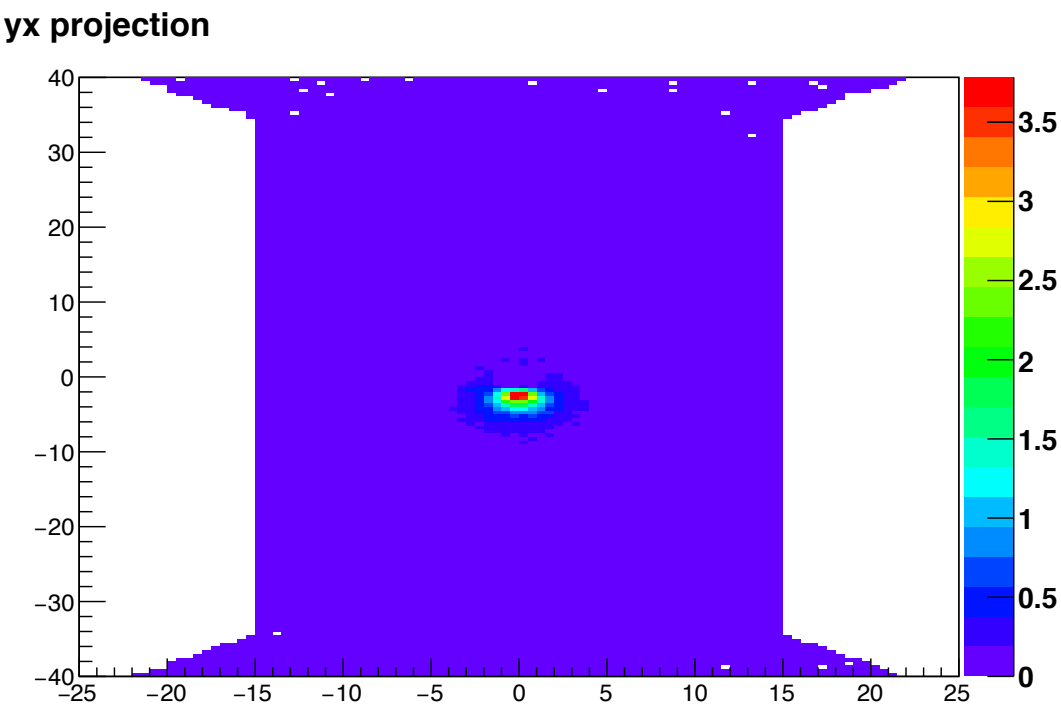
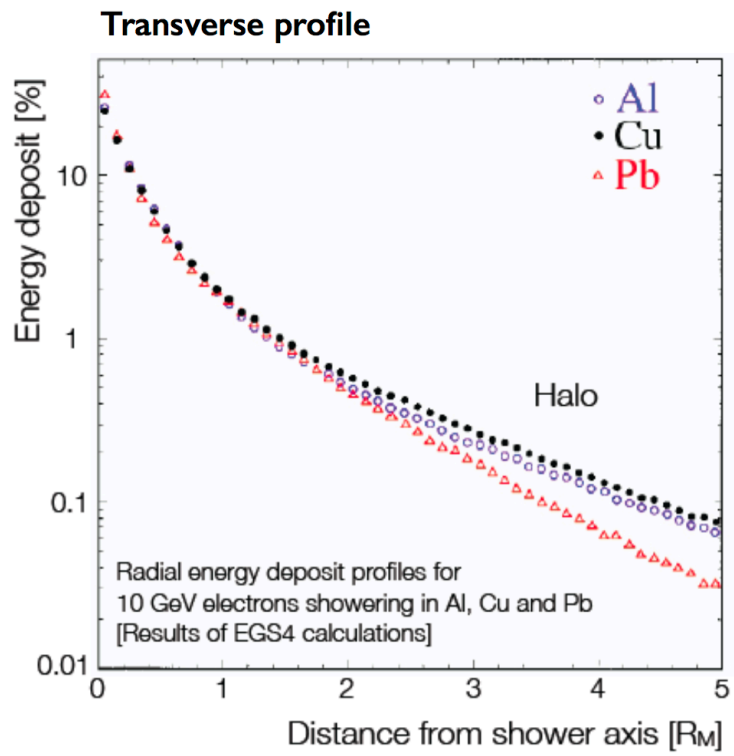
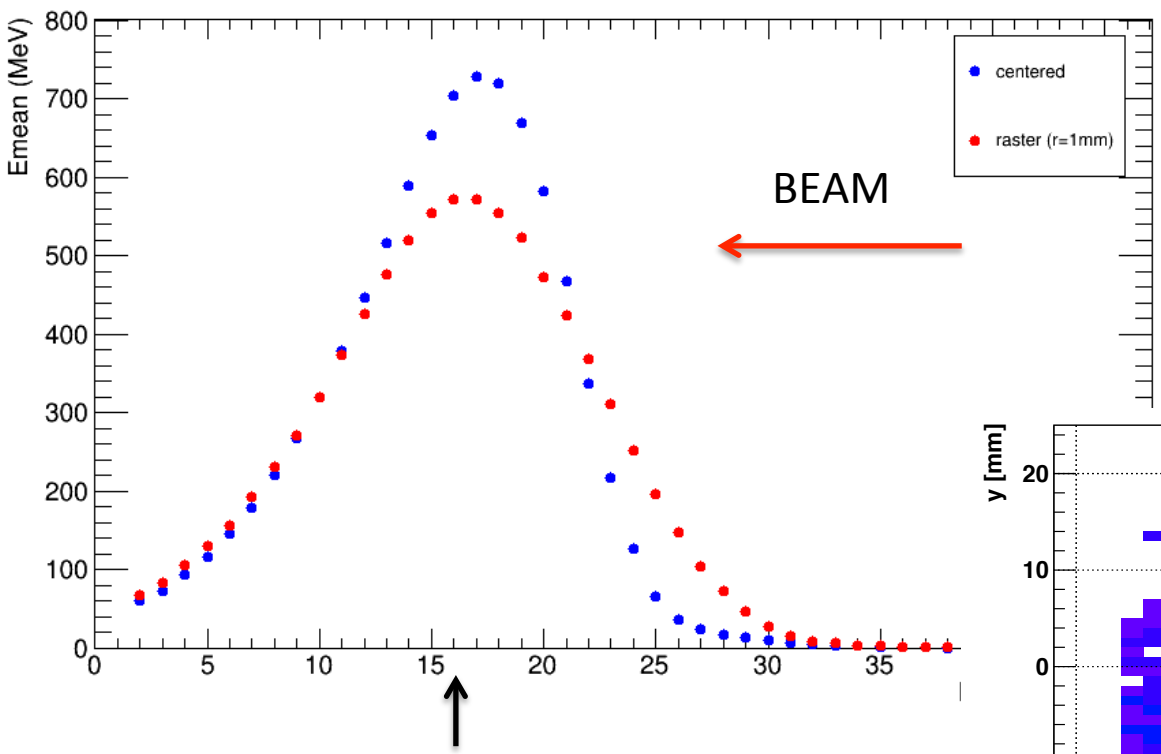


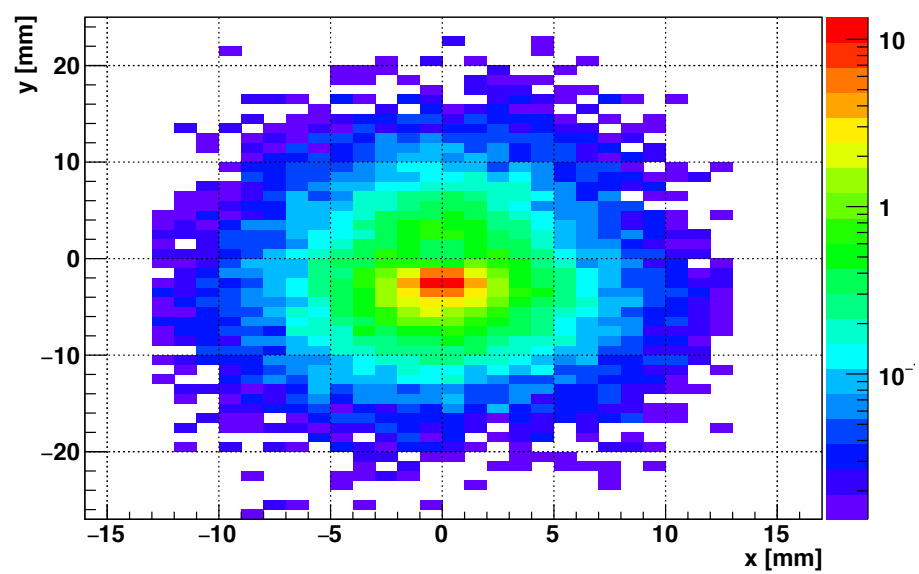


Geant4 model (GEMC framework)

Marco got the power profiles

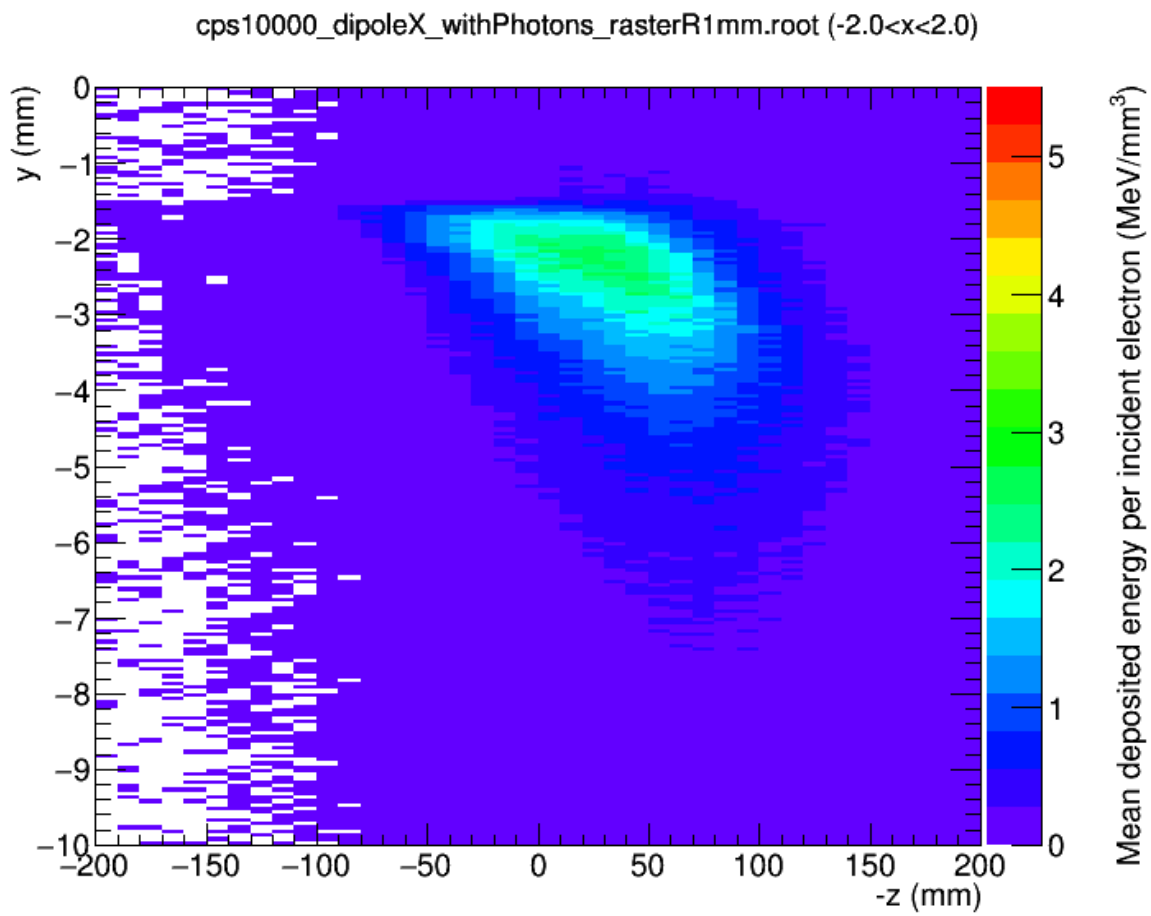


point of 2D T analysis



Geant4 model (GEMC framework)

Marco got the snapshot for power profile



Geant4 model (GEMC framework)

Logical approach to optimization of the outer shielding:

What are the particle spectra?