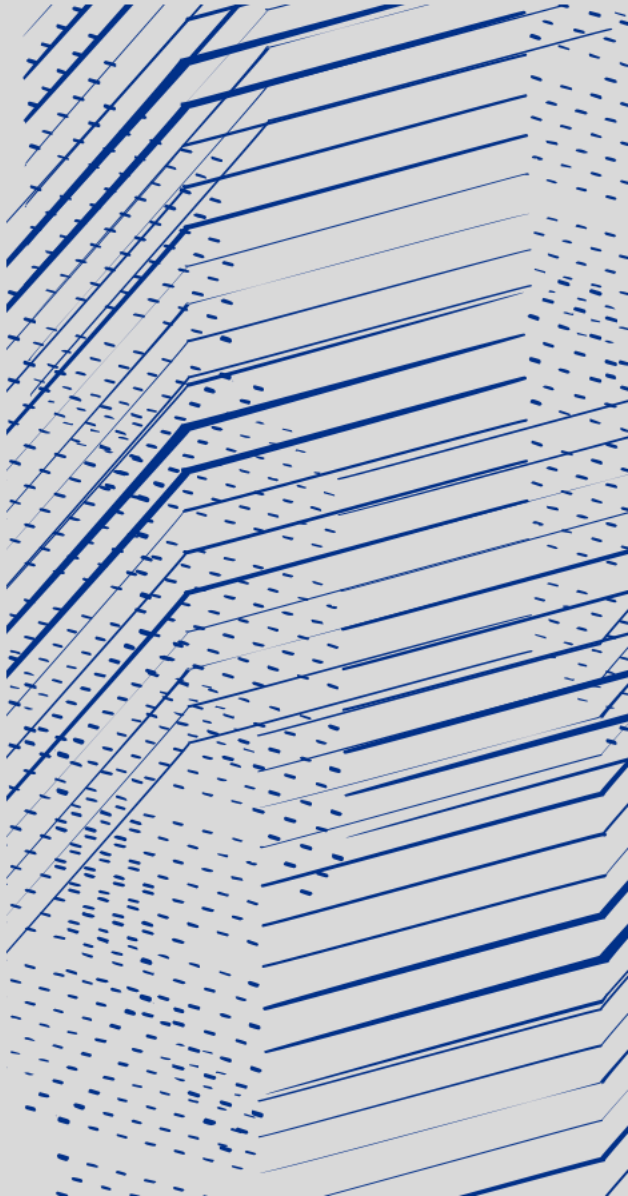
Science and Technology Facilities Council

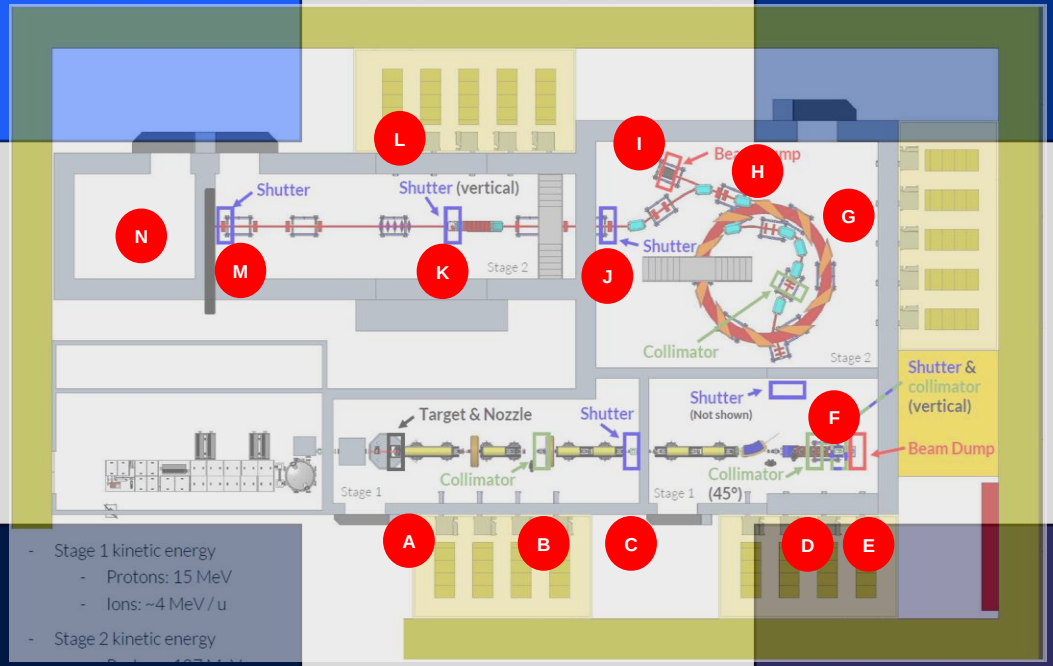
LhARA bulk shielding assessment

James Bebbington, STFC



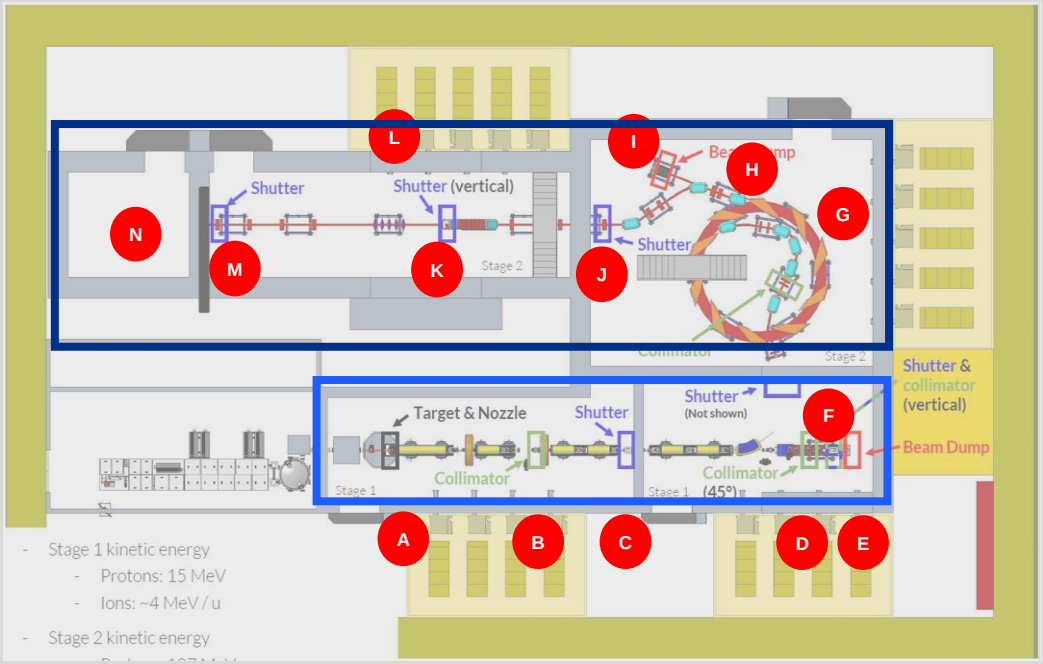
Stage 1

Stage 2



Source term

Next steps

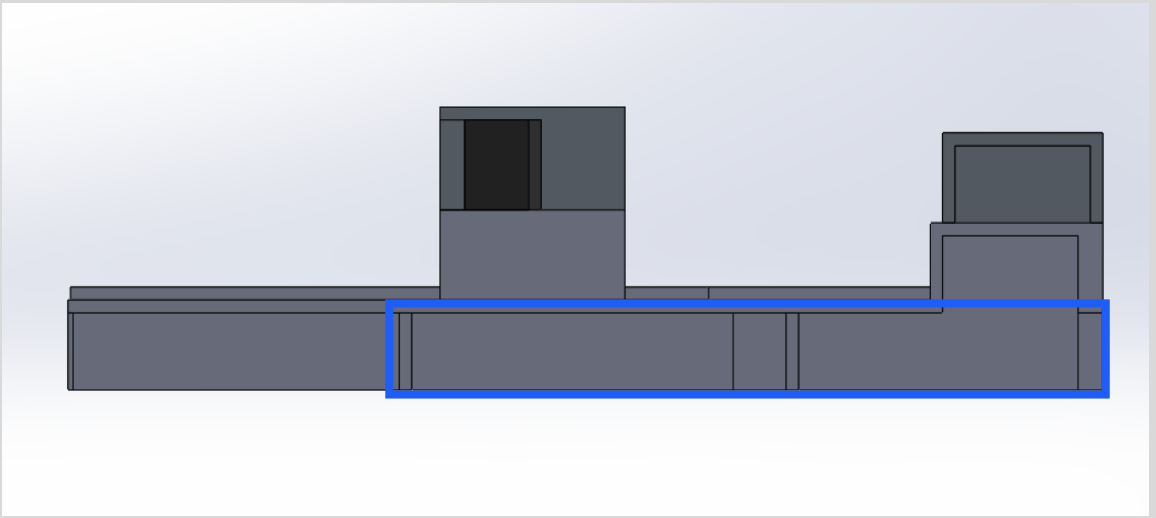


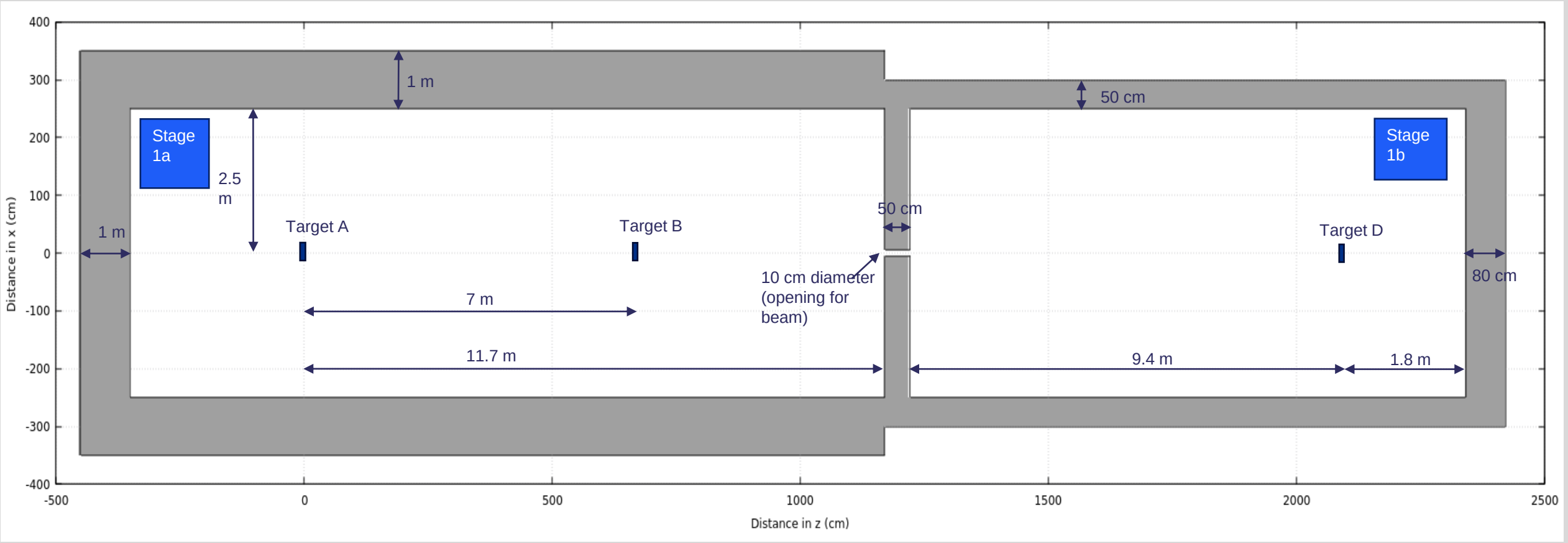
Source term

	Proton beam energy (MeV)	Frequency (Hz)	Particles incident in final station (p/s)
Stage 1 (p)	15	100	1E10
Stage 1 (C6+)	48		1E9
Stage 2 (p)	127		1E10
Stage 2(C6+)	400		1E9

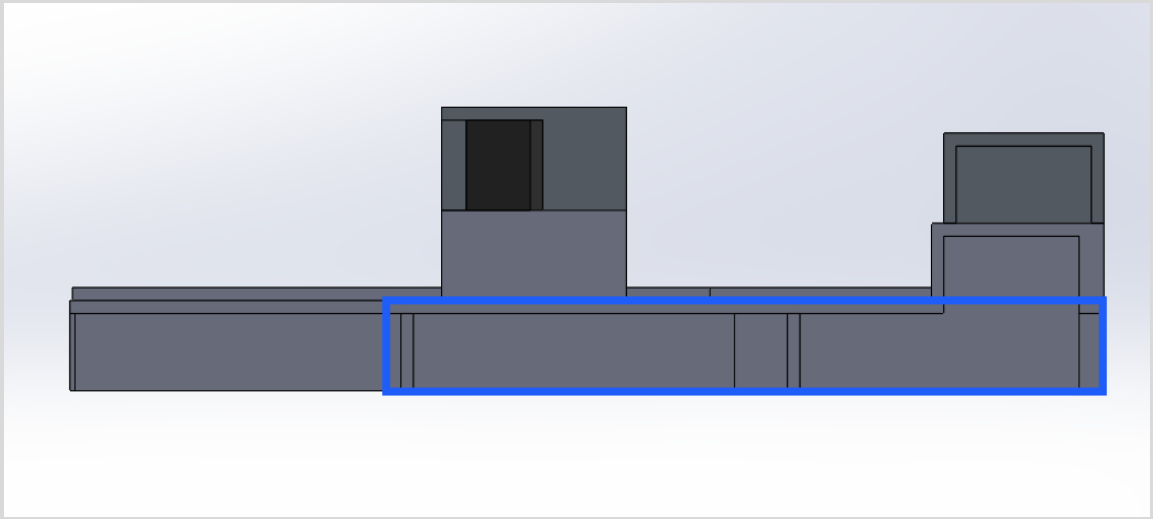
Source	Description
A	Proton/ion plasma source
B	Gabor lenses and collimator (source term exhibited by losses during this first stage of beam acceleration)
C	Source shutter (the shutter between the source stage and the stage 1 experiment)
D	In-vitro Stage 1 delivery (beam bending vertically up to delivery area)
E	Stage 1 beam dump
F	Injection line into FFA
G	FFA acceleration (source term exhibited by the acceleration mechanism of the FFA)
H	FFA extraction (the term attributed to the accelerated beam leaving the FFA)
I	FFA beam dump
J	FFA shutter
K	In-vitro Stage 2 delivery (beam diverted vertically upwards to the Stage 2 delivery area)
L	Stage 2 dump
M	Stage 2 shutter
N	In-vivo line (utilised for treatment in the final evolution of the accelerator)

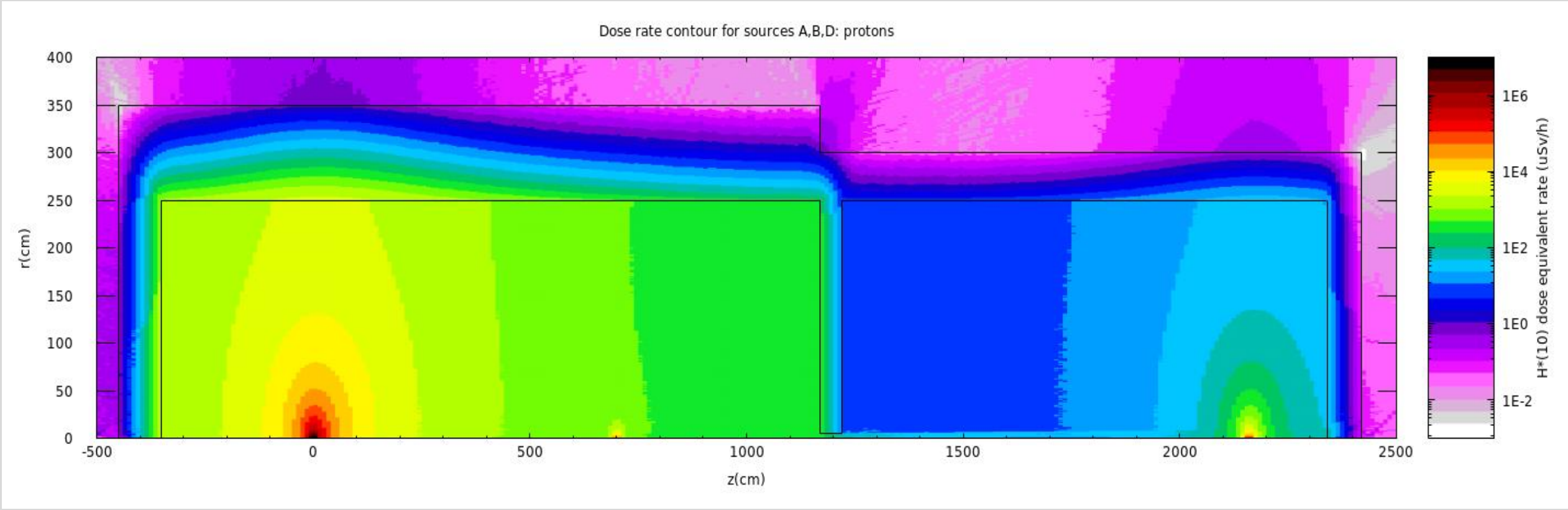
Stage 1

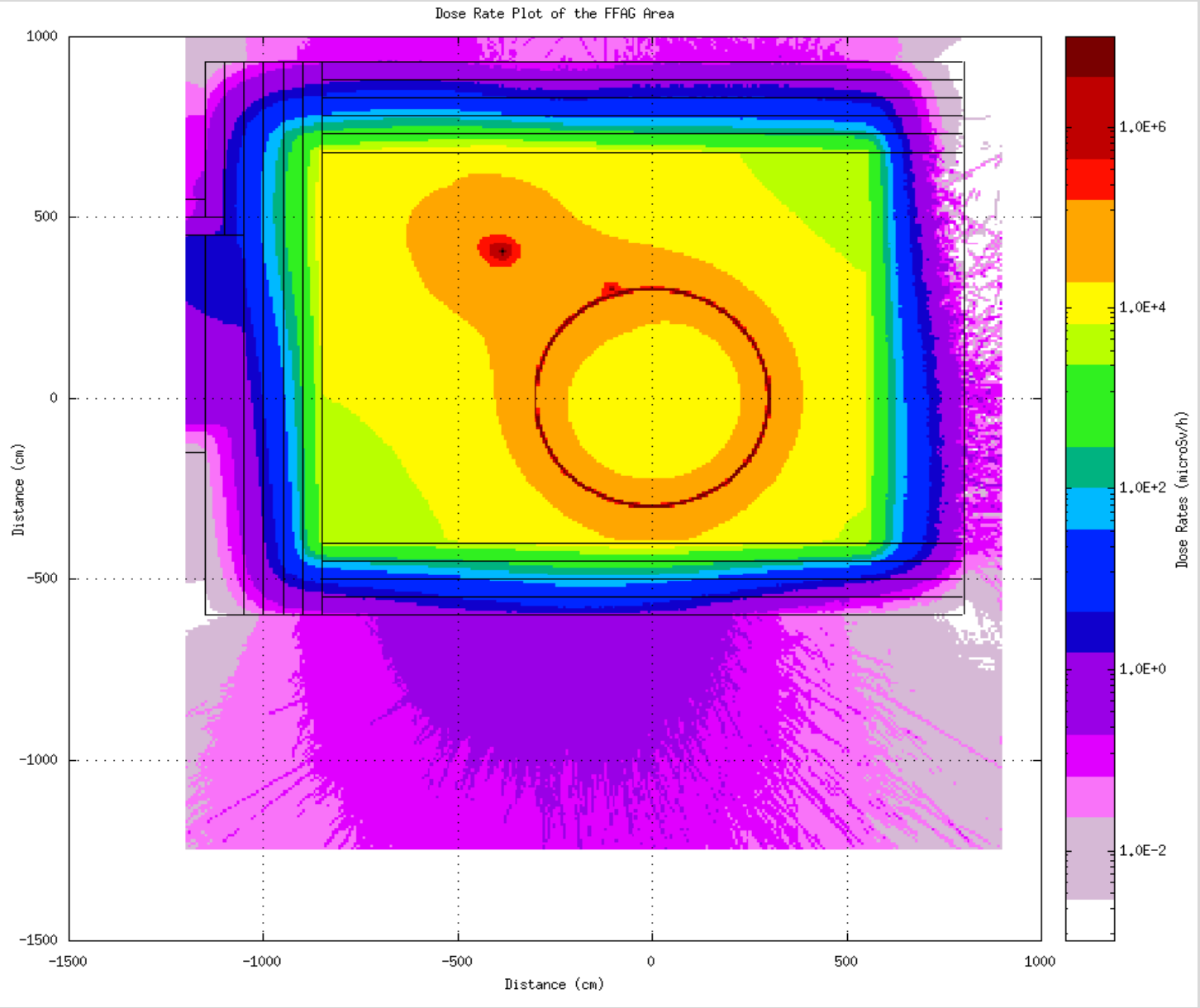



400
300
200
100
0
-100
-200
-300
-400
Distance in x (cm)
-500
0
500
1000
1500
2000
2500
Distance in z (cm)
1 m
Stage 1a
2.5 m
1 m
Target A
Target B
7 m
11.7 m
50 cm
10 cm diameter (opening for beam)
50 cm
Stage 1b
Target D
9.4 m
1.8 m
80 cm

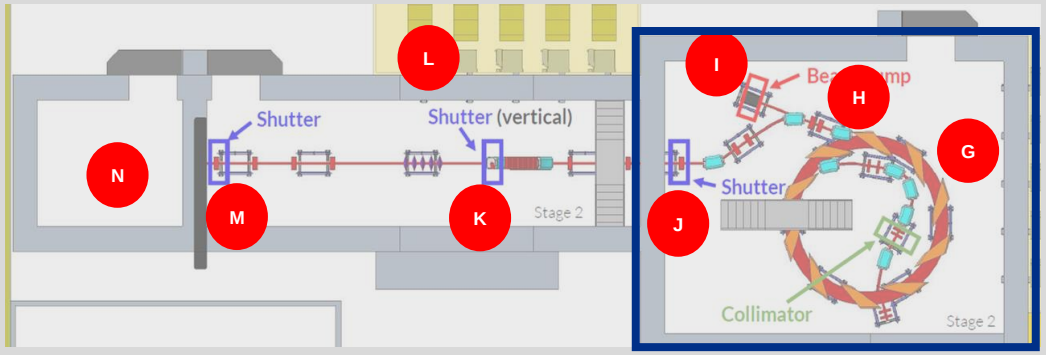
Stage 1




Dose rate contour for sources A,B,D: protons
r(cm)
z(cm)
400
350
300
250
200
150
100
50
0
-500
0
500
1000
1500
2000
2500
1E6
1E4
1E2
1E0
1E-2
H*(10) dose equivalent rate (uSv/h)



Stage 2



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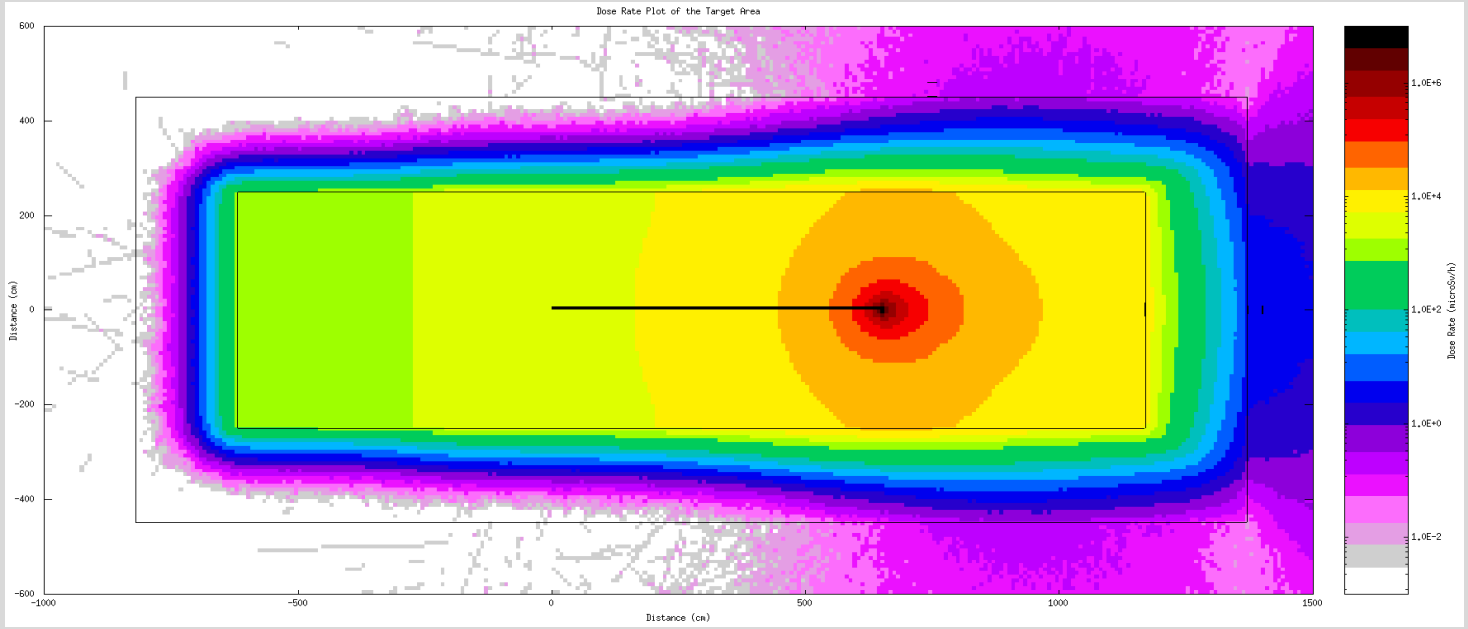
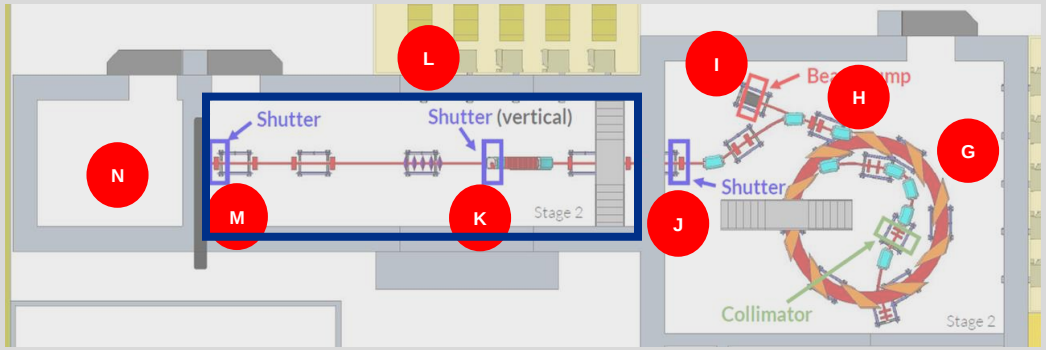
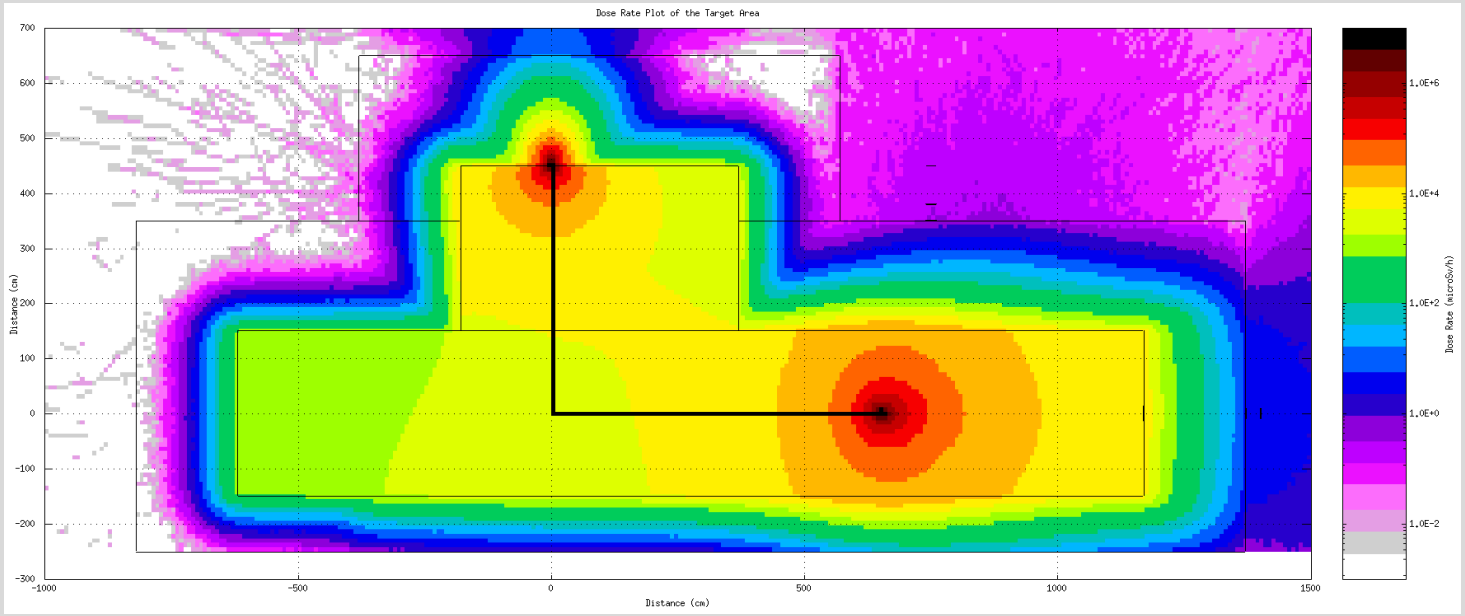
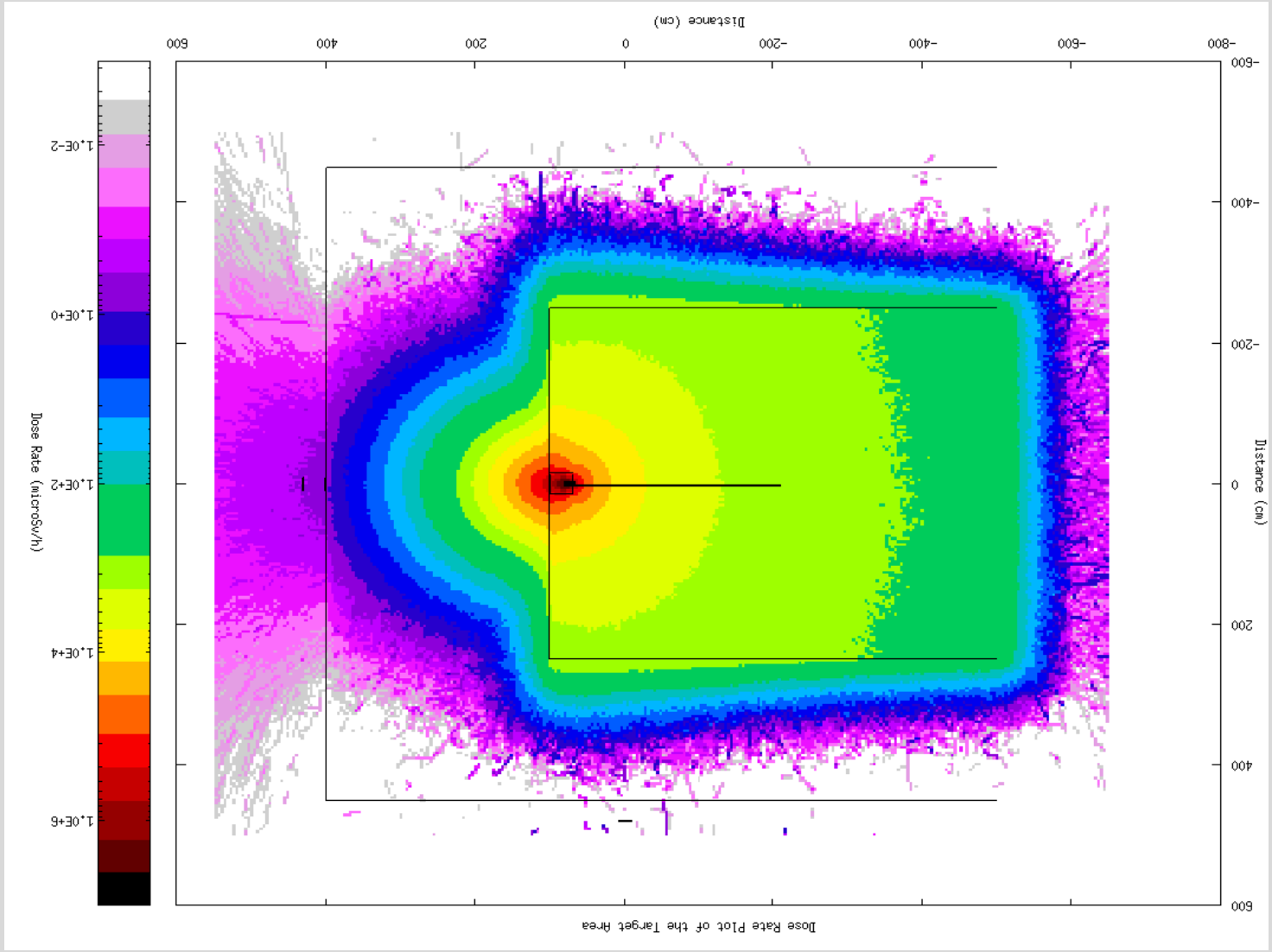

Dose Rate Plot of the Target Area
Distance (cm)
Distance (cm)
Dose Rate (microSv/h)
1.0E+6
1.0E+4
1.0E+2
1.0E+0
1.0E-2

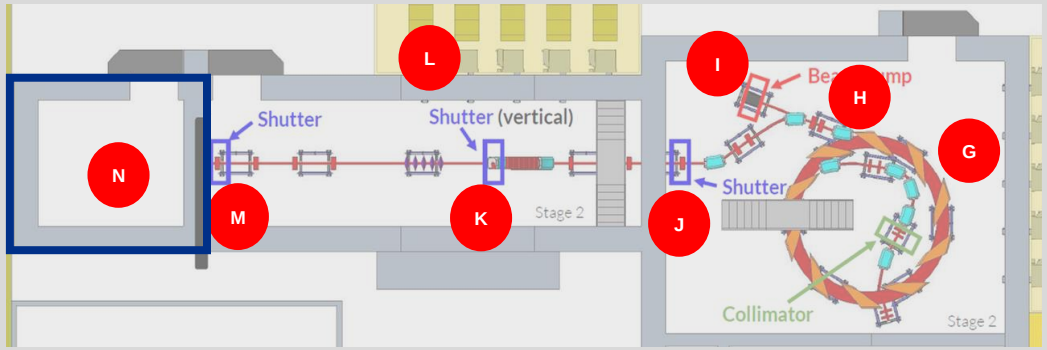
Stage 2


L
I
H
G
N
M
K
J
Shutter
Shutter (vertical)
Shutter
Stage 2
Collimator
Stage 2


Dose Rate Plot of the Target Area
Distance (cm)
Distance (cm)
Dose Rate (microSv/h)
1.0E+6
1.0E+4
1.0E+2
1.0E+0
1.0E-2



Stage 2



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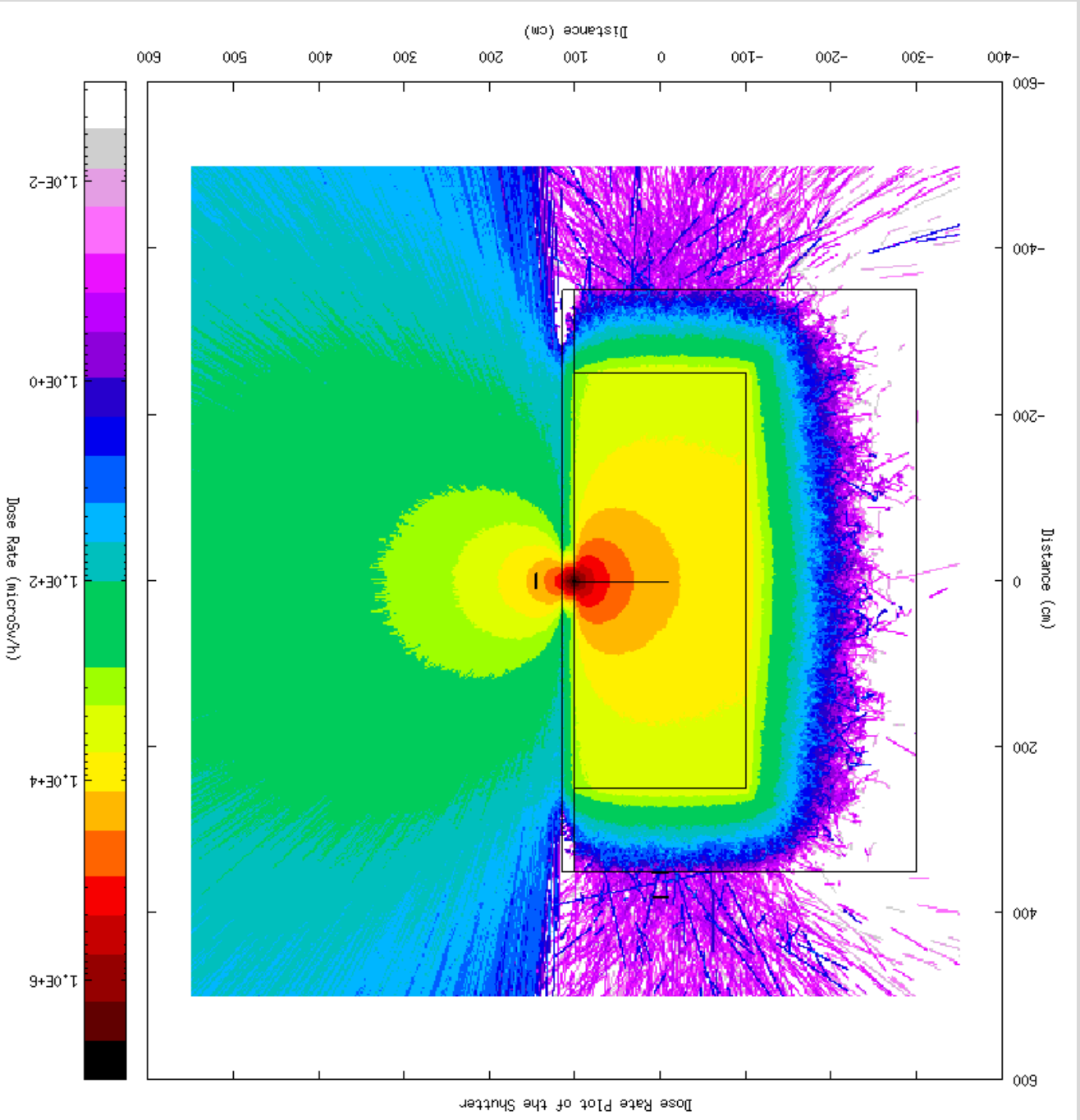
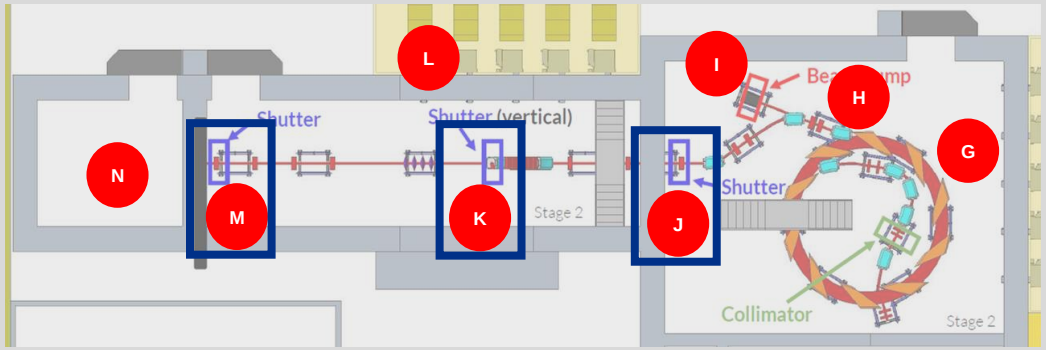
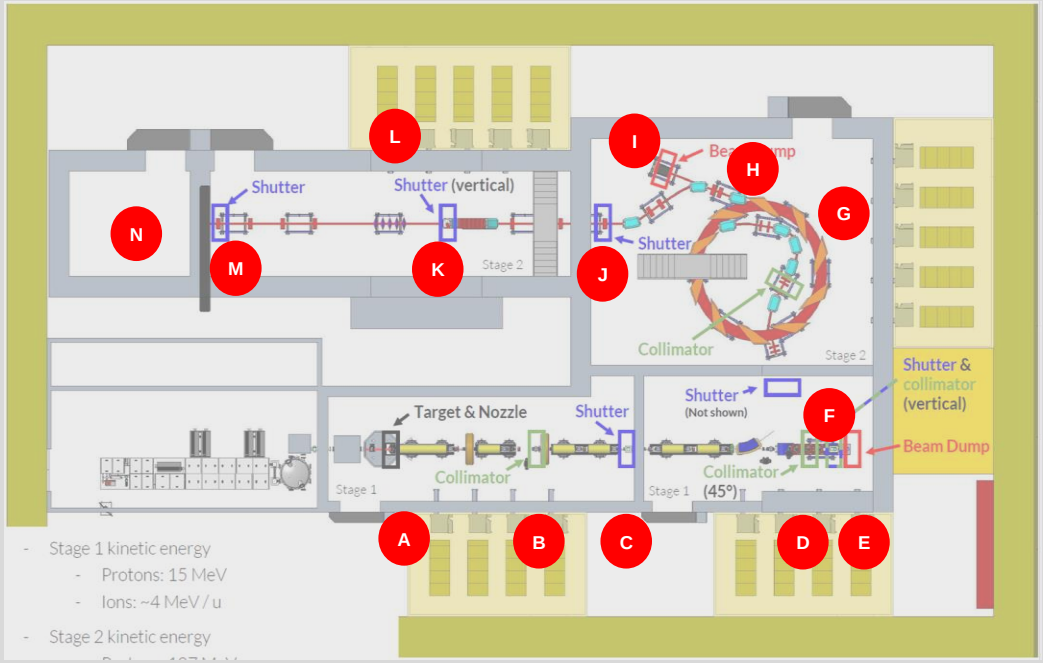

Dose Rate Plot of the Shutter
Distance (cm)
Dose Rate (microSv/h)
1.0E-2
1.0E+0
1.0E+2
1.0E+4
1.0E+6
-600
-400
-200
0
200
400
600
-400
-300
-200
-100
0
100
200
300
400
500
600

Stage 2


L
I
H
G
N
M
K
J
Shutter
Shutter (vertical)
Shutter
Collimator
Stage 2
Stage 2

1. Refine source data (electron source not currently accounted for and spectrum may be pessimistic).
2. Focus the design of dedicated beam dumps and local shielding to reduce some concrete thicknesses (300 cm in some areas).
3. Review access requirements on roof of Stage 2.
4. Design shielded shutters; the tungsten shutter alone is not enough to attenuate a 10 Hz beam to allow access into adjacent areas.
5. Still need to carry out fault scenario and activation analysis.



Next steps