IDS120i GEOMETRY.

SIMULATIONS FOR 60%W+40%He SHIELDING WITH

STST SHIELDING VESSELS.

Hg vs. Ga DEPOSITED POWER DISTRIBUTION.
(using Ding's optimized parameters)

SC#1 AND SC#2 AZIMUTHAL DEPOSITED POWER DISTRIBUTION STUDIES.

Nicholas Souchlas, PBL (2/16/2012)

IDS120i GEOMETRY.

Hg vs. Ga DP DISTRIBUTION USING DING'S OPTIMIZED PARAMETERS FOR BOTH TARGETS(Np=100,000).

SC#1 AND SC#2 DPD AZIMUTHAL DISTRIBUTION SIMULATIONS (Np=300,000/400,000).

>mars1510/MCNP

>10^{-11} MeV NEUTRON ENERGY CUTOFF

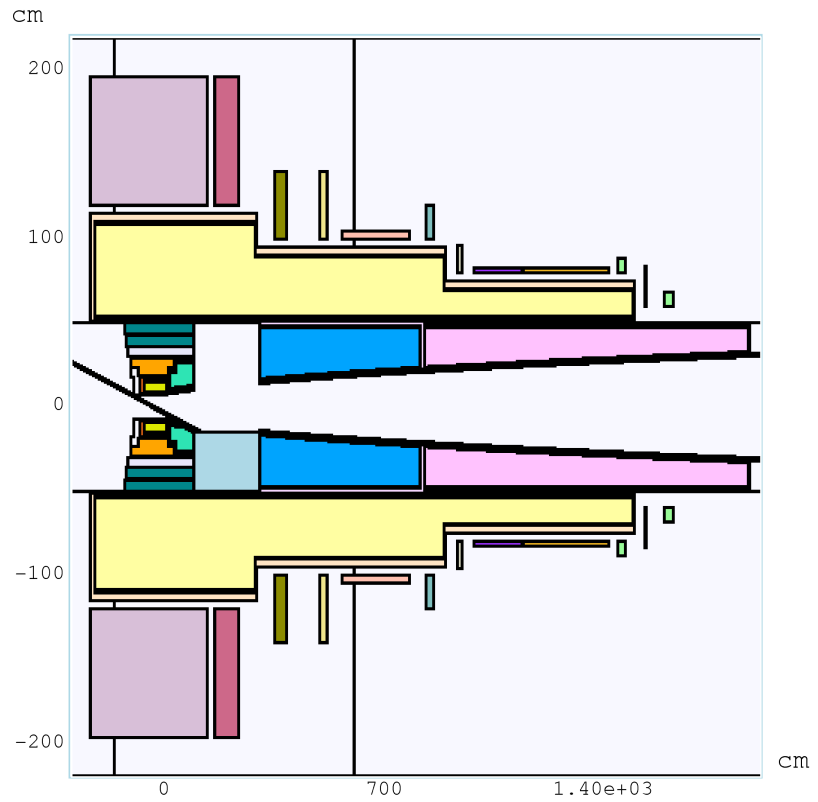
>SHIELDING:60%W+40%He (WITH STST VESSELS)

>4 MW proton beam,Np=1E5/3E5/4E5 events.

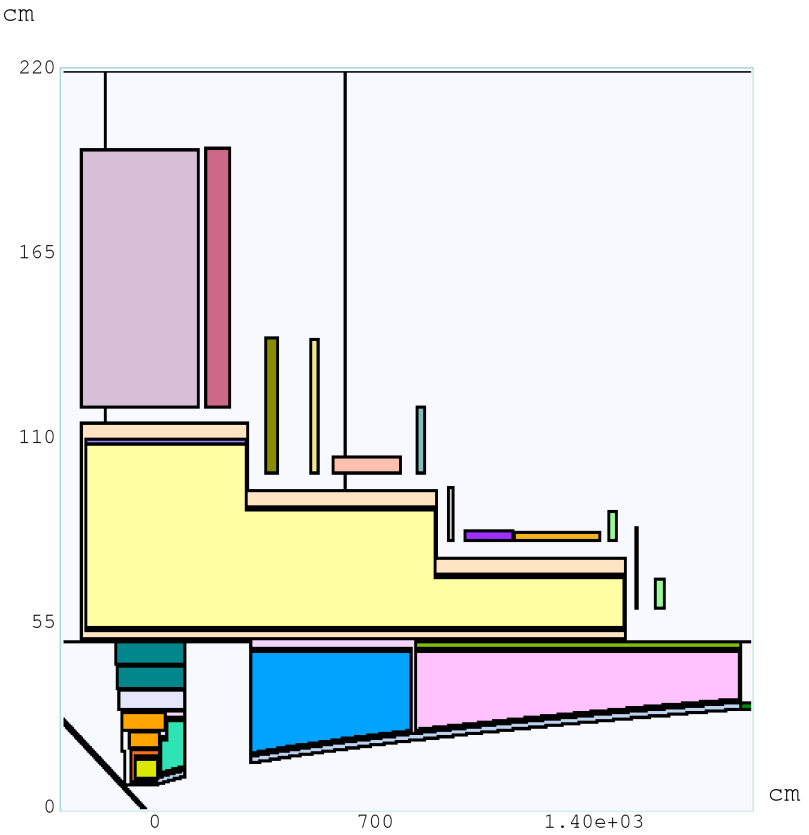
>PROTONS ENERGY E=8 GeV.

>GAUSSIAN PROFILE: $\sigma_x=\sigma_y$=0.12 cm(Hg)/0.132 cm(Ga).

IDS120i:YZ CROSS SECTION AT y=0.0 (LEFT) AND UPPER HALF ONLY(RIGHT).

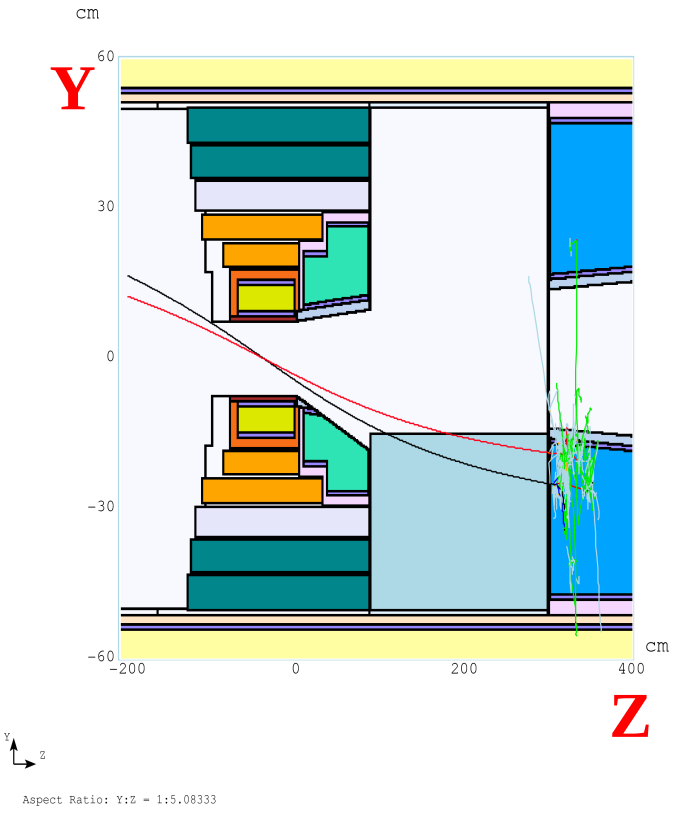


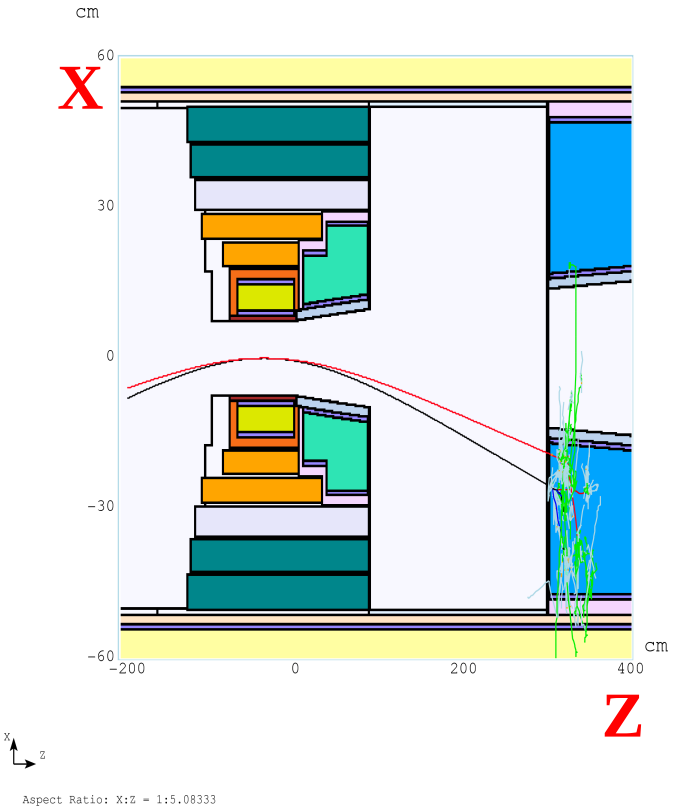
Aspect Ratio: Y:Z = 1:5.0

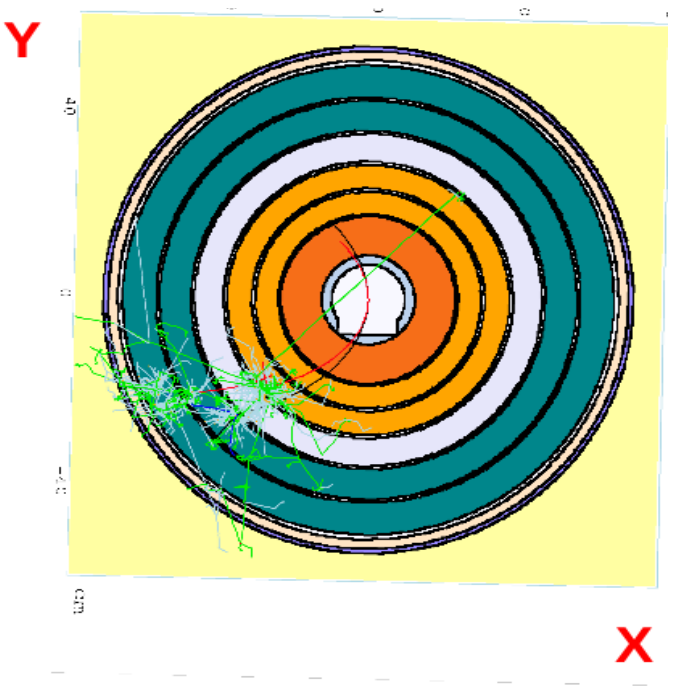


Aspect Ratio: Y:Z = 1:10.0

CENTER OF BEAM PROTONS TRAJECTORY FOR Hg(BLACK) AND Ga(RED) TARGETS. (POOL SURFACE IN FIRST PLOT IS AT y= - 15 cm)





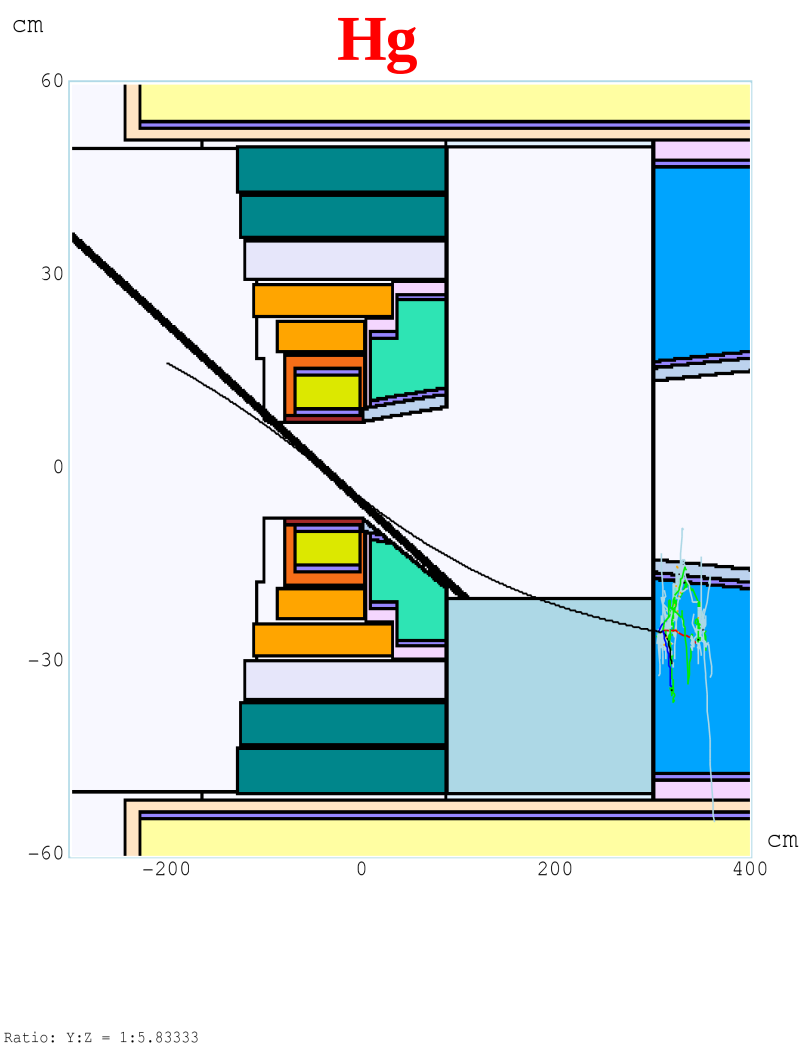


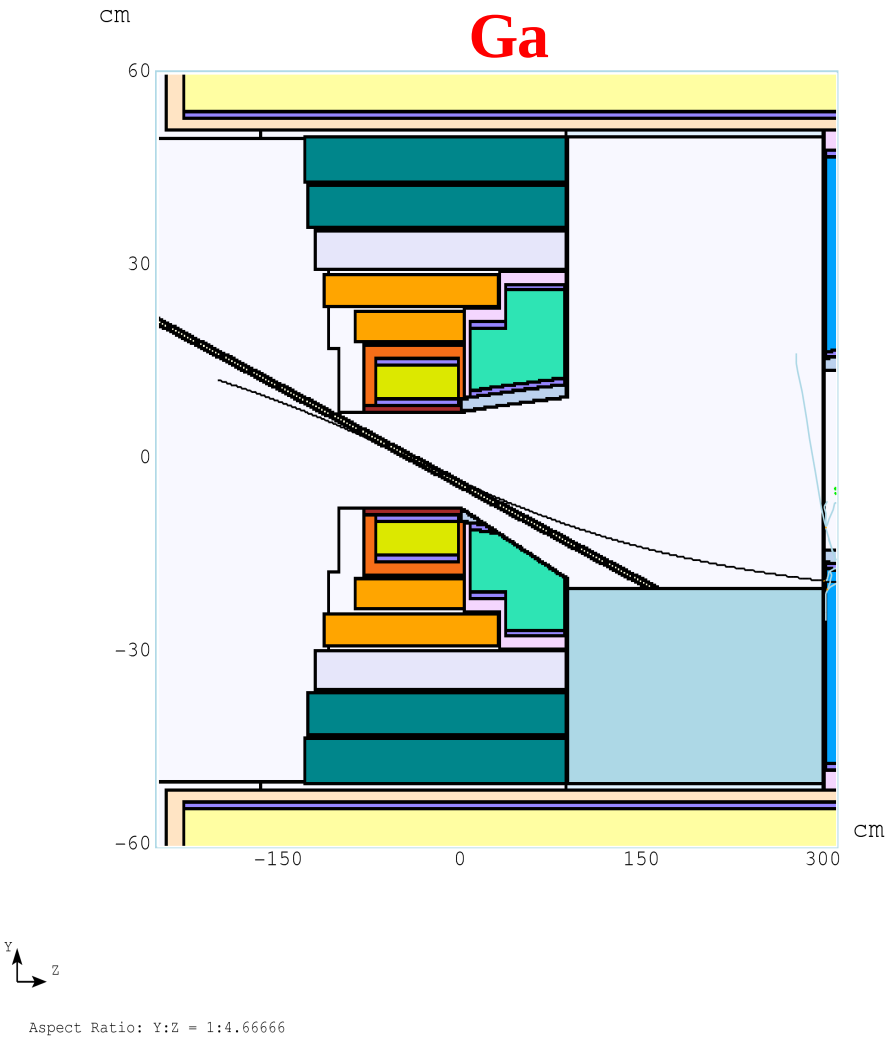
Hg TARGET: y= - 15 cm------> l(protons trajectory)>191.37 cm>14 IL(protons interaction length in Hg~ 15 cm)
y= - 20 cm------> l(protons trajectory)>116.14 cm> 8 IL

Ga TARGET: y= - 15 cm------> l(protons trajectory)>117.07 cm>5 IL(protons interaction length in Ga~ 24 cm)
y= - 20 cm------> l(protons trajectory)= 0.0 cm (protons do not enter the pool)

PROTONS ENTER Ga POOL NEAR THE CENTER AND HAVE A SHORT PATH, ONE WAY TO IMPROVE THIS IS BY SHIFTING THE POOL TO THE RIGHT(~ 100 cm)

CENTER OF BEAM PROTONS TRAJECTORY FOR Hg AND Ga TARGETS WITH JET AND POOL PRESENT(BUT NOT INTERACTING). POOL SURFACE IS AT y= - 20.0 cm





Hg vs. Ga TARGET: IT APPEARS PROTONS INTERACT WITH Ga JET IN A LONGER REGION THAN IN THE Hg TO COMPANSATE FOR THE SMALLER SIZE Ga ATOMS.

IS IT POSSIBLE TO ROTATE Ga JET TO ALLOW PROTONS ENTER SOONER THE POOL AND THEREFORE TRAVEL LONGER DISTANCE IN Ga POOL?

POWER DEPOSITED IN THE SC COILS

NiSn/NiTi	Hg	Ga
SC#1	0.322	0.274
SC#2	0.079	0.093
SC#3	0.044	0.128
SC#4	0.002	0.006
SC#5	0.003	0.002
SC#6	0.000	0.000
SC#7	0.000	0.000
SC#8	0.001	0.003
SC#9	0.002	0.003
SC#1-9	0.453	0.509
SC#10-12	0.007	0.009
SC#1-12	0.460	0.518

ABOUT SAME TOTAL AMOUNT OF DP FOR BOTH Hg AND Ga. NOTICEABLE DIFFERENCE IS THE SC#3 DP: ABOUT 3 TIMES MORE DP IN SC#3 FOR Ga TARGET.

DEPOSITED POWER IN SHIELDING AND SHIELDING VESSELS.

—	Hg	Ga
SH#1A	873.00	776.00
SH#1B	350.20	345.50
SH#2	124.50	385.65
SH#3	12.37	19.13
SH#4	106.45	105.20
SH#1-4	1466.52	1631.48

SH#1A~ - 97 kW DECREASE, SH#1B~SAME, SH#2~ + 261 kW INCREASE.
DP IS SPREAD OUT MORE DOWNSTREAM, MAINLY IN THE VOLUME REGION ENCLOSED BY SC#4-10, HIGH RISK OF DPD PEAK VALUES CLOSE/ABOVE ITER LIMIT.
MORE ENERGY (~+ 165 kW) WILL BE DEPOSITED IN SHIELDING IN Ga TARGET.

—	Hg	Ga
SHVS#1	236.45	220.70
SHVS#2	53.70	58.20
SHVS#3	0.10	0.18
SHVS#4	20.53	21.17
SHVS#1-4	310.78	300.25

ABOUT SAME TOTAL DP IN VESSELS AND ABOUT SAME DISTRIBUTION.

POWER DEPOSITED IN RESISTIVE MAGNETS (RS#) AND BEAM PIPE (BP#).

Cu	Hg	Ga
RS#1+2	158.60	123.00
RS#3	59.95	45.73
RS#4+5	74.75	55.50
RS#1-5	293.30	224.23

ABOUT 69 kW LESS DP IN RESISTIVE COILS IN Ga TARGET.

BP	Hg	Ga
BP#1	224.80	212.00
BP#2	190.75	281.45
BP#3	4.66	9.29
BP#1-3	420.21	502.74

BEAM PIPE DEPOSITED POWER DISTRIBUTION CONFIRMS THAT THE ENERGY IS SPREAD MORE DOWNSTREAM (INCREASE IN DP#2 BY MORE THAN 90 kW IN Ga TARGET) CONSISTENT WITH THE EXPECTATIONS FROM A ''SOFTER'' (SMALLER ATOMS) TARGET.

SUMMARY FOR TOTAL POWER DEPOSITED IN DIFFERENT COMPONENTS IN TARGET STATION.

TOTALS	Hg	Ga
SC#1-12	0.460	0.518
SH#1-4	1466.52	1631.48
SHVS#1-4	310.78	300.25
RS#1-5	293.30	224.23
BP#1-3	420.21	502.74
Hg/Ga TARG.	400.90	215.15
Hg/GaPOOL	388.05	375.00
POOLWALLS	10.53	10.04
Be WIND.	6.88	6.32
TOTAL	3297.63	3265.73

Ga TARGET RECIEVES ABOUT HALF THE POWER DEPOSITED IN Hg, WHILE Ga POOL ABOUT 13 kW LESS ENERGY THAN THAT IN Hg POOL.
SINCE Ga ATOMS HAVE MUCH SMALLER ATOMIC NUMBER (31) THAN Hg ATOMS (80) A SMALLER NUMBER OF INTERACTIONS WILL OCCUR BETWEEN p AND Ga TARGET. A SMALLER NUMBER OF INTERACTIONS WILL ALSO TAKE PLACE BETWEEN PROTONS AND Ga ATOMS IN THE POOL. IN ADDITION SINCE Ga IS A ”SOFTER” TARGET THE SCATTERING ANGLES ARE SMALLER. MORE PROTONS IS EXPECTED TO END UP IN THE Ga POOL.

THAT WILL SOMEHOW MITIGATE THE EFFECT OF THE INTERACTION LENGTH p-Ga ''DISSADVANTAGE'' AND AT THE END WE GET ABOUT THE SAME DP IN Hg AND Ga POOLS(ASSUMMING MOST OF THE DP IN THE POOL IS DUE TO PROTONS AND/OR THE DP FROM OTHER RADIATION SOURCES IS ABOUT THE SAME FOR BOTH CASES.

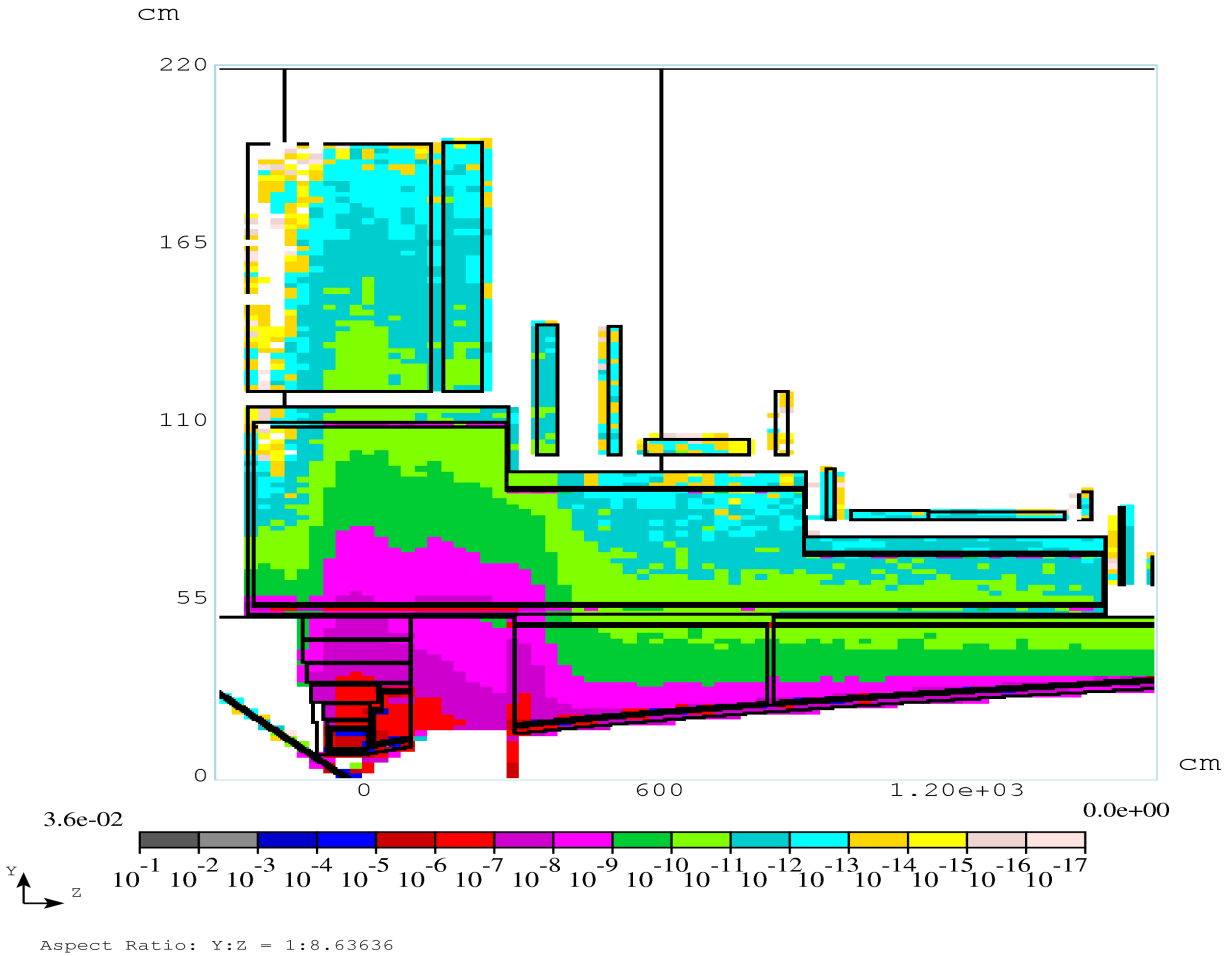
Be WINDOW ABOUT SAME DP FOR BOTH TARGETS.

AZIMUTHALLY AVERAGE DEPOSITED POWER DENSITY PEAKS IN SC#1-12.

PEAK(mW/g)	Hg	Ga
SC#1	0.040	0.040
SC#2	0.026	0.017
SC#3	0.018	0.090
SC#4	0.003	0.003
SC#5	0.012	0.007
SC#6	0.001	0.001
SC#7	0.001	0.001
SC#8	0.002	0.007
SC#9	0.005	0.001
SC#10	0.001	0.004
SC#11	0.008	0.004
SC#12	0.007	0.004

THE PEAK VALUES IN BOTH Hg AND Ga TARGETS ARE VERY SIMILAR AND THE ONLY SIGNIFICANT DIFFERENCE IS OBSERVED IN SC#3.

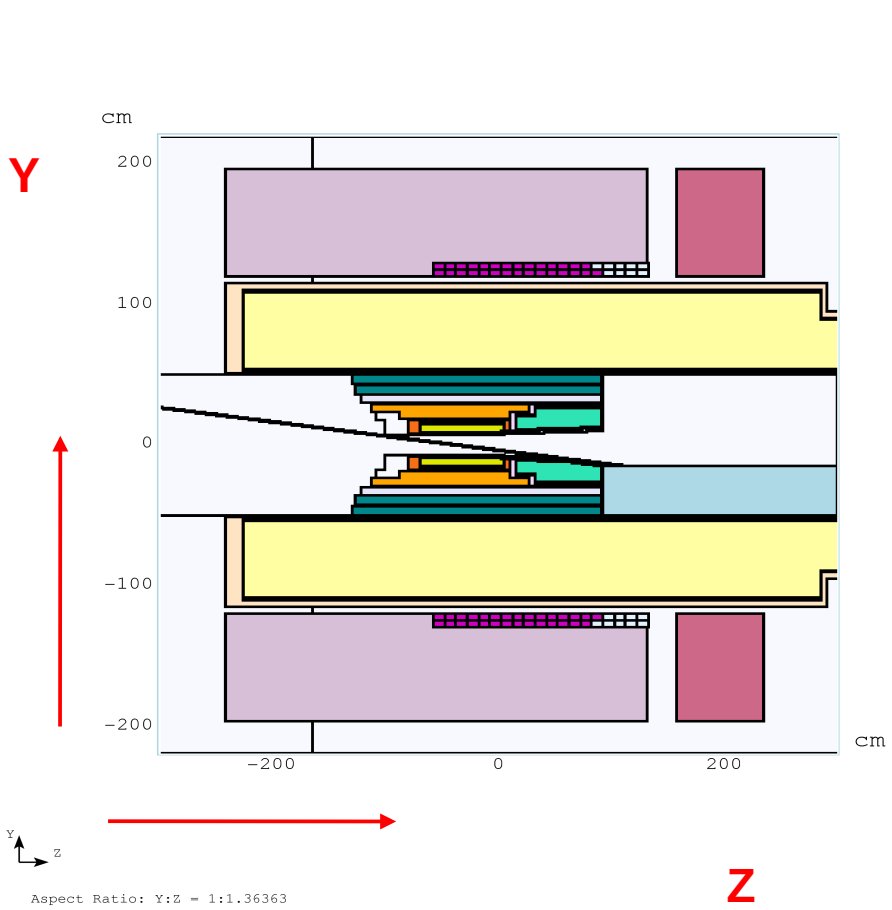
IDS120i: AZIMUTHALLY AVERAGE DEPOSITED ENERGY DISTRIBUTION FROM Np=400,000 EVENT SIMULATION

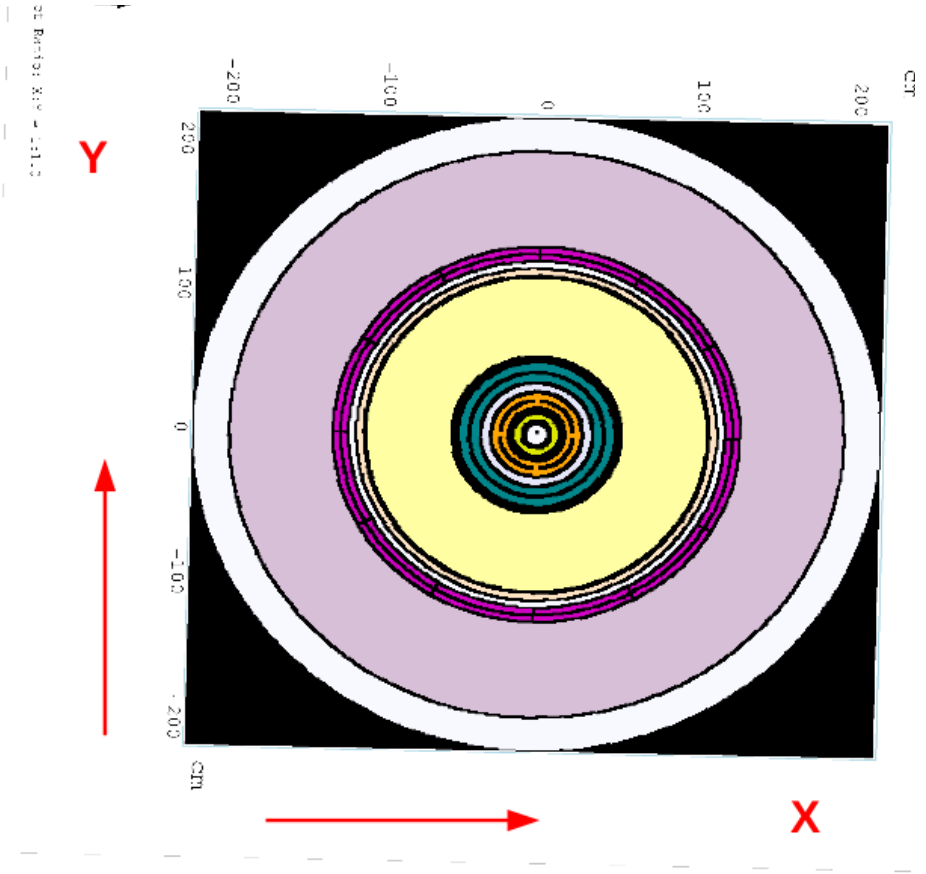


THE MARS PLOT FOR THE AZIMUTHALLY AVERAGE DEPOSITED ENERGY DISTRIBUTION WILL BE USED TO ISOLATE THE SCs AREAS OF INTEREST AND PERFORM A SEGMENTATION STUDY. OTHER AREAS MAY HAVE ISOLATED SPIKES IN THE DPD, IN SOME DIRECTION, AND OVERALL SMALL AVERAGE AZIMUTHAL DPD BUT WE START WITH THE MOST OBVIOUS AND HIGHT RISK AREAS DETERMINED FROM THE ABOVE PLOT.

SH#1 AZIMUTHAL SEGMENTATION STUDIES

IDS120i:SC#1 PARTIAL SEGMENTATION YZ CROSS SECTION y=0.0 (LEFT) AND YX CROSS SECTION z=- 57.0 cm (RIGHT)





120.0 < r < 130.0 cm dr= 5.0 cm N_r=2 bins

-58.0 < z < 133.0 cm dz=10.0 cm N_z=19 bins

0.0 < φ < 360.0 deg. dφ=30.0 deg. N_φ=12 bins

N_{tot}=456 "pieces"

TOP TEN DEPOSITED POWER DENSITIES FOR SC#1 FOR 3 SIMULATIONS.

Np=3E05 EVENTS

RID	r(cm)	z(cm)	ϕ	DPD(mW/g)
464	127.5	107	315	0.22505
223	127.5	7	285	0.1023
288	127.5	37	75	0.091
232	122.5	17	195	0.0754
196	127.5	-3	195	0.07395
217	127.5	7	105	0.0709
227	122.5	17	45	0.0647
156	122.5	-13	75	0.0559
445	122.5	107	105	0.0509
502	127.5	127	15	0.046665

Np=4E05 EVENTS

RID	r(cm)	z(cm)	ϕ	DPD(mW/g)
464	127.5	107	315	0.16745
156	122.5	-13	75	0.13275
339	127.5	57	165	0.05905
109	122.5	-33	105	0.0586
223	127.5	7	285	0.05255
172	127.5	-13	195	0.05025
210	122.5	7	255	0.04845
150	127.5	-23	255	0.046835
126	127.5	-33	255	0.045645
200	127.5	-3	315	0.041945

Np=3E05 EVENTS(NE)

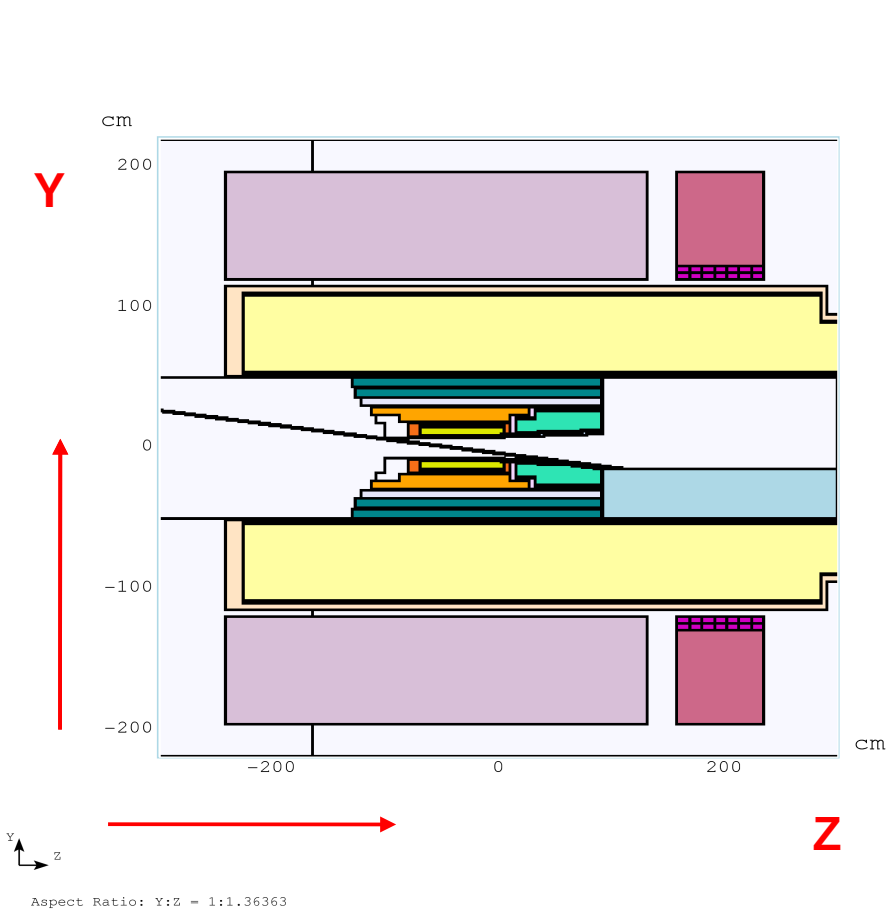
RID	r(cm)	z(cm)	ϕ	DPD(mW/g)
209	122.5	7	225	0.071
60	122.5	-53	75	0.06535
88	122.5	-43	195	0.06365
155	122.5	-13	45	0.0618
179	122.5	-3	45	0.0607
242	127.5	17	135	0.05705
433	127.5	97	105	0.045895
207	122.5	7	165	0.045425
141	122.5	-23	345	0.044225
113	122.5	-33	225	0.042865

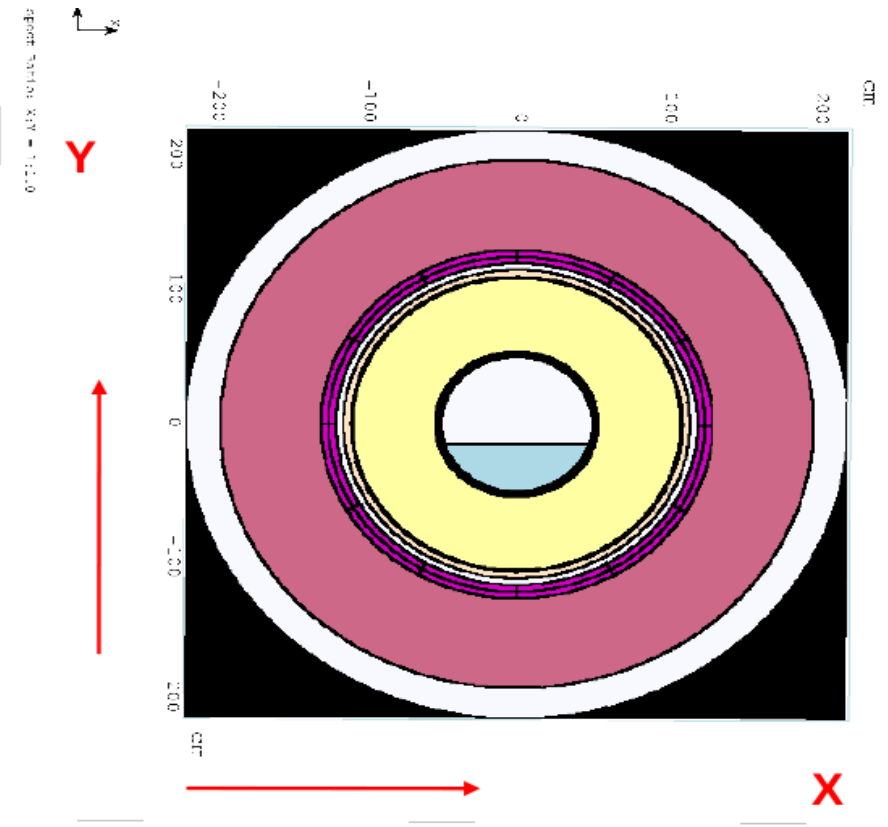
SH#1 APPEARS TO HAVE A SPOT WITH DPD>0.15 mW/g. STATISTICAL FLUCTUATIONS CAN BE SIGNIFICANT FOR A VOLUME AT IR=120 cm WHERE VERY LITTLE ENERGY IS DEPOSITED AND THERE IS MORE UNIFORMITY IN THE AZIMUTHAL DPD DISTRIBUTION.
SIMULATIONS WITH LARGER NUMBER OF EVENTS/LARGER VOLUMES MAYBE NECESSARY. WORK IN PROGRESS.

SC#1 SUM(PARTIAL) OF DEPOSITED POWER USING PARTIAL SUM FROM 456 "PIECES"
0.225(0.0051)kW 0.222(0.0047) kW 0.187(0.0041) kW
vs. 0.316 kW WITHOUT SEGMENTATION FROM 4E05 EVENTS

SH#2 AZIMUTHAL SEGMENTATION STUDIES

IDS120i:SC#2 PARTIAL SEGMENTATION YZ CROSS SECTION y=0.0 (LEFT) AND YX CROSS SECTION z=158.0 cm (RIGHT)





$120.0 < r < 130.0$ cm $dr = 5.0$ cm $N_r = 2$ bins

$157.8 < z < 234.3$ cm $dz = 10.93$ cm $N_z = 7$ bins

$0.0 < \varphi < 360.0$ deg. $d\varphi = 30.0$ deg. $N_\varphi = 12$ bins

$N_{tot} = 168$ "pieces"

TOP TEN DEPOSITED POWER DENSITIES FOR SC#2 FOR 3 SIMULATIONS.

Np=3E05 EVENTS

RID	r(cm)	z(cm)	ϕ	DPD(mW/g)
168	127.5	206.979	75	0.1988
156	122.5	206.979	75	0.0803
127	127.5	185.121	285	0.02642
157	122.5	206.979	105	0.02106
112	122.5	185.121	195	0.02062
110	122.5	185.121	135	0.02023
134	122.5	196.05	135	0.019315
130	122.5	196.05	15	0.01754
99	127.5	174.193	165	0.017165
184	122.5	217.907	195	0.016025

Np=4E05 EVENTS

RID	r(cm)	z(cm)	ϕ	DPD(mW/g)
168	127.5	206.979	75	0.17435
156	122.5	206.979	75	0.0668
127	127.5	185.121	285	0.019815
157	122.5	206.979	105	0.016325
112	122.5	185.121	195	0.015735
110	122.5	185.121	135	0.015355
134	122.5	196.05	135	0.01474
61	122.5	163.264	105	0.013395
130	122.5	196.05	15	0.013155
99	127.5	174.193	165	0.01307

Np=3E05 EVENTS(NE)

RID	r(cm)	z(cm)	ϕ	DPD(mW/g)
155	122.5	206.979	45	0.05835
108	122.5	185.121	75	0.0554
111	122.5	185.121	165	0.031665
101	127.5	174.193	225	0.027665
133	122.5	196.05	105	0.026365
73	127.5	163.264	105	0.02405
137	122.5	196.05	225	0.02249
64	122.5	163.264	195	0.02143
96	127.5	174.193	75	0.01783
136	122.5	196.05	195	0.017795

SH#2 ALSO APPEARS TO HAVE AN ISOLATED SPOT WITH DPD>0.15 mW/g. STATISTICAL FLUCTUATIONS CAN BE REALTIVELY LARGE FOR THE SC#2 DPD DISTRIBUTION. THAT IS ANOTHER UNCERTAINTY IN THE DETERMINATION OF HOT SPOTS. IT IS NECESSARY TO RUN MANY JOBS TO GET AN ESTIMATION OF THE STATISTICAL FLUCTUATION.

SC#2 SUM(PARTIAL) OF DEPOSITED POWER USING PARTIAL SUM FROM 168 "PIECES"

0.038(0.00088) kW 0.036(0.00078) kW 0.044 (0.0006) kW

vs. 0.062 kW WITHOUT SEGMENTATION FROM 3E05 EVENTS