IDS120h GEOMETRY WITH SHIELDING VESSELS

SHIELDING MATERIAL: 60% W + 40% He vs. 60% WC + 40% H_2O

USING Be FOR PART OF BP1 AND BP2

SIMULATIONS FOR 60% W + 40% He SHIELDING

WITH SUPPORTING RIBS FOR VESSELS

Nicholas Souchlas, PBL (11/15/2011)

IDS120h with shielding vessels.

 # Different cases of shielding material.

 # N = 500,000 events simulation for 60% W + 40% He and 60% W + 40% H_2O shielding.

 # BP1 and BP2 with Be sections (N=100,000).

 # N = 100,000 simulation with supporting ribs for vessels.

>mars1510/MCNP

>10^{-11} MeV NEUTRON ENERGY CUTOFF

>SHIELDING: 60% W + 40% He , 60% WC + 40% H_2O (WITH W VESSELS)

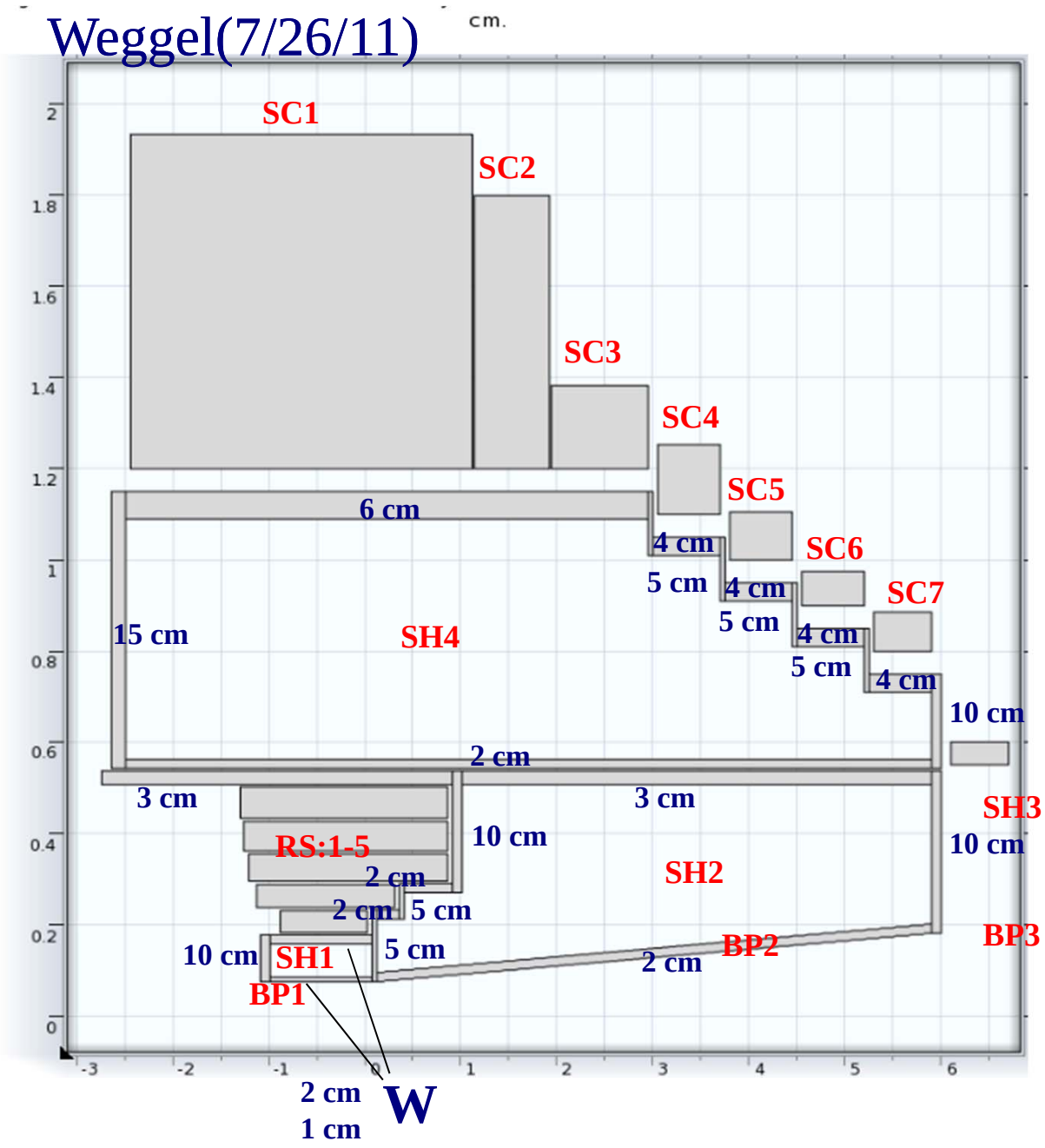
>4 MW proton beam, Np = 100,000/500,000

>PROTONS ENERGY E = 8 GeV.

>GAUSSIAN PROFILE: $\sigma_x = \sigma_y = 0.12$ cm.

IDS120h:SHIELDING VESSELS (USING W).

Bob Weggel(7/26/11)



BEAM PIPE

BP1: 1 cm STST → 1 cm W

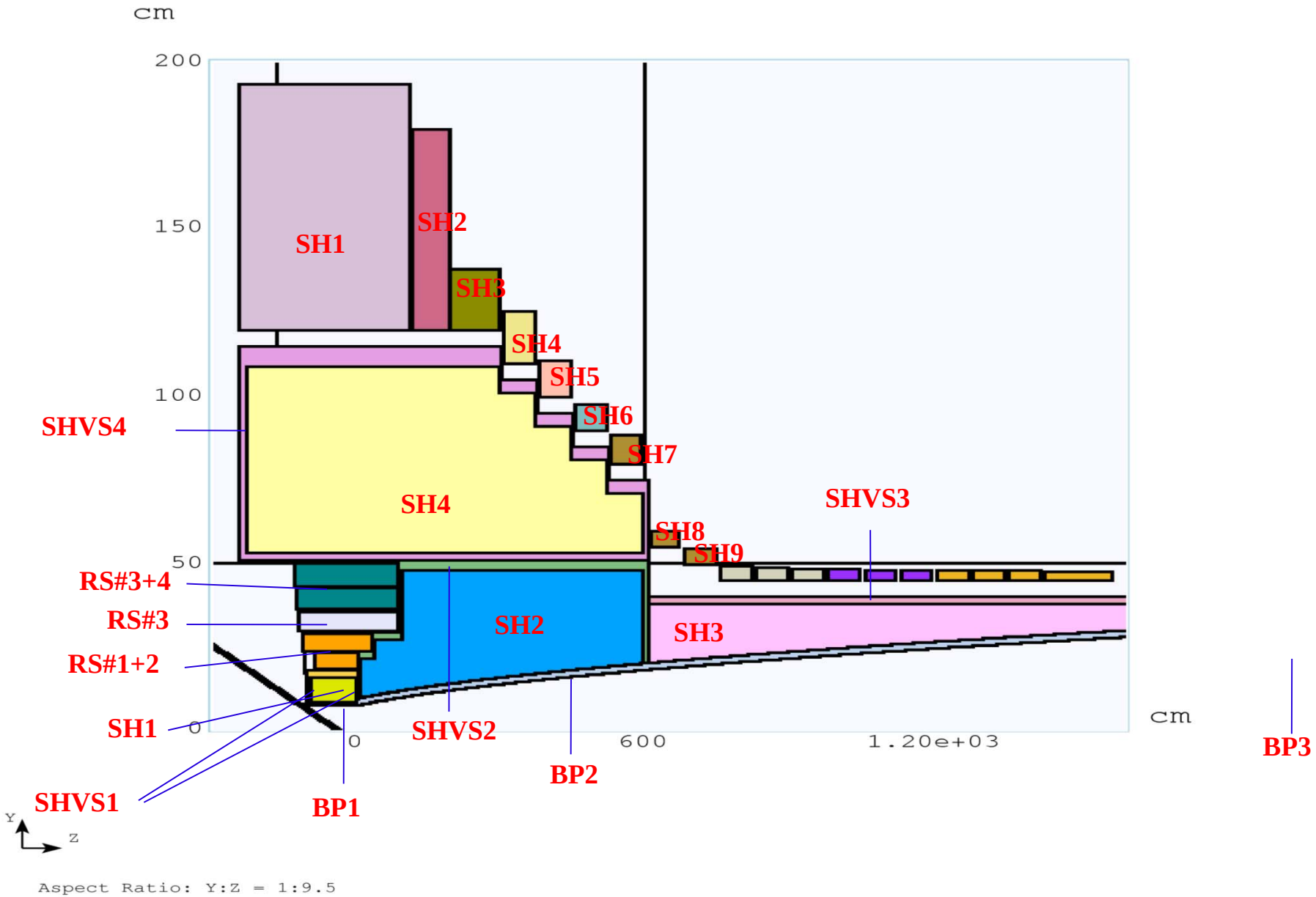
BP2/BP3: 1 cm STST → 2 cm STST

TUBE 1 (= BP1) AND TUBE 2 WITH 1 cm AND 2 cm THIKNESS IN THE SH1 VESSEL ARE MADE OF W TO FURTHER REDUCE THE POWER DEPOSITED IN THE RESISTIVE COILS.

5 cm DISTANCE BETWEEN VESSELS AND SC COILS FOR CRYOGENIC COOLING COMPONENTS

0.5 cm SPACE BETWEEN TUBE 2 OF SH1 AND RS1,
AND 1.0 cm BETWEEN TUBE 1 OF SH4 AND RS5

IDS120h: SHIELDING VESSELS DETAIL PLOTS.



IDS120h WITH SHIELDING VESSELS: N = 500,000 EVENT SIMULATIONS

60% W + 40% He vs. 60% WC + 40% H_2O

POWER DEPOSITED IN THE SC COILS

NiSn/NiTi	60W/40He	60WC/40H2O
SC#1	0.141	0.258
SC#2	0.008	0.027
SC#3	0.007	0.022
SC#4	0.010	0.020
SC#5	0.007	0.011
SC#6	0.002	0.001
SC#1-6	0.175	0.339
SC#7-9	0.033	0.047
SC#10-12	0.037	0.044
SC#13-15	0.028	0.037
SC#16-19	0.034	0.048
SC#1-19	0.307	0.515

SC1: 0.141 kW --> 0.258 kW SC1-6: 0.175 kW --> 0.339 kW SC#1-19: 0.307 kW --> 0.515 kW.

POWER DEPOSITED IN THE SHIELDING (SH#), SHIELDING VESSELS (SHVS#), AND SH1 W TUBE 2 (SH1T2)

—	60W/40He	60W/40H2O
SH#1	867.50	893.50
SH#2	746.00	802.00
SH#3	21.71	23.01
SH#4	31.64	48.36
SH#1-4	1666.85	1766.87

MORE POWER IN SH#1-4

SH#1: 867.50 kW --> 893.50 kW (+26.00 kW)
SH#2: 746.00 kW --> 802.00 kW (+56.00 kW)
SH#1-4: 1666.85 kW --> 1766.87 kW (+100.20 kW)

—	60W/40He	60WC/40H2O
SHVS#1	60.45	82.10
SHVS#2	66.25	84.75
SHVS#3	0.490	0.73
SHVS#4	7.10	14.55
SHVS#1-4	134.29	182.13
SH1T2(W)	45.63	68.95

TWO SH1 STST FLANGES: 60.45 kW --> 82.10 kW (+21.65 kW)
SH1 2 cm W TUBE#2: 45.63 kW --> 68.95 kW (+23.32 kW)

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

Cu	60W/40He	60WC/40H2O
RS#1+2	79.00	91.15
RS#3	36.52	40.43
RS#4+5	49.16	54.50
RS#1-5	164.68	186.08

MORE POWER IN RS#1-5

RS#1+2: 79.00 kW --> 91.15 kW (+12.15 kW)

RS#1-5: 164.68 kW --> 186.08 kW (+21.40 kW)

BP	60W/40He	60WC/40H2O
BP#1(W)	427.70	452.45
BP#2(ST)	278.60	285.65
BP#3(ST)	8.89	8.75
BP#1-3	715.19	746.85

MORE POWER IN BP#1,BP#2

BP#1: 4 27.70 kW --> 452.45 kW (+24.75 kW)

BP#2: 278.60 kW --> 285.65 kW (+7.05 kW)

BP#1-3: 715.19 kW --> 746.85 kW (+31.66 kW)

TOTAL POWER DEPOSITED IN DIFFERENT AREAS AND SC#1-11 PEAK VALUES.

TOTALS	60W/40He	60WC/40H2O
SC#1-19	0.307	0.515
SH#1-4	1666.85	1766.87
SHVS#1-4	134.29	182.13
RS#1-5	164.68	186.08
BP#1-3	715.19	746.85
Hg TARG.	409.85	409.05
Hg POOL	218.40	228.85
HgP.WALLS	0.299	0.43
Be WIND.	0.866	0.87
TOTAL	3356.06	3590.17

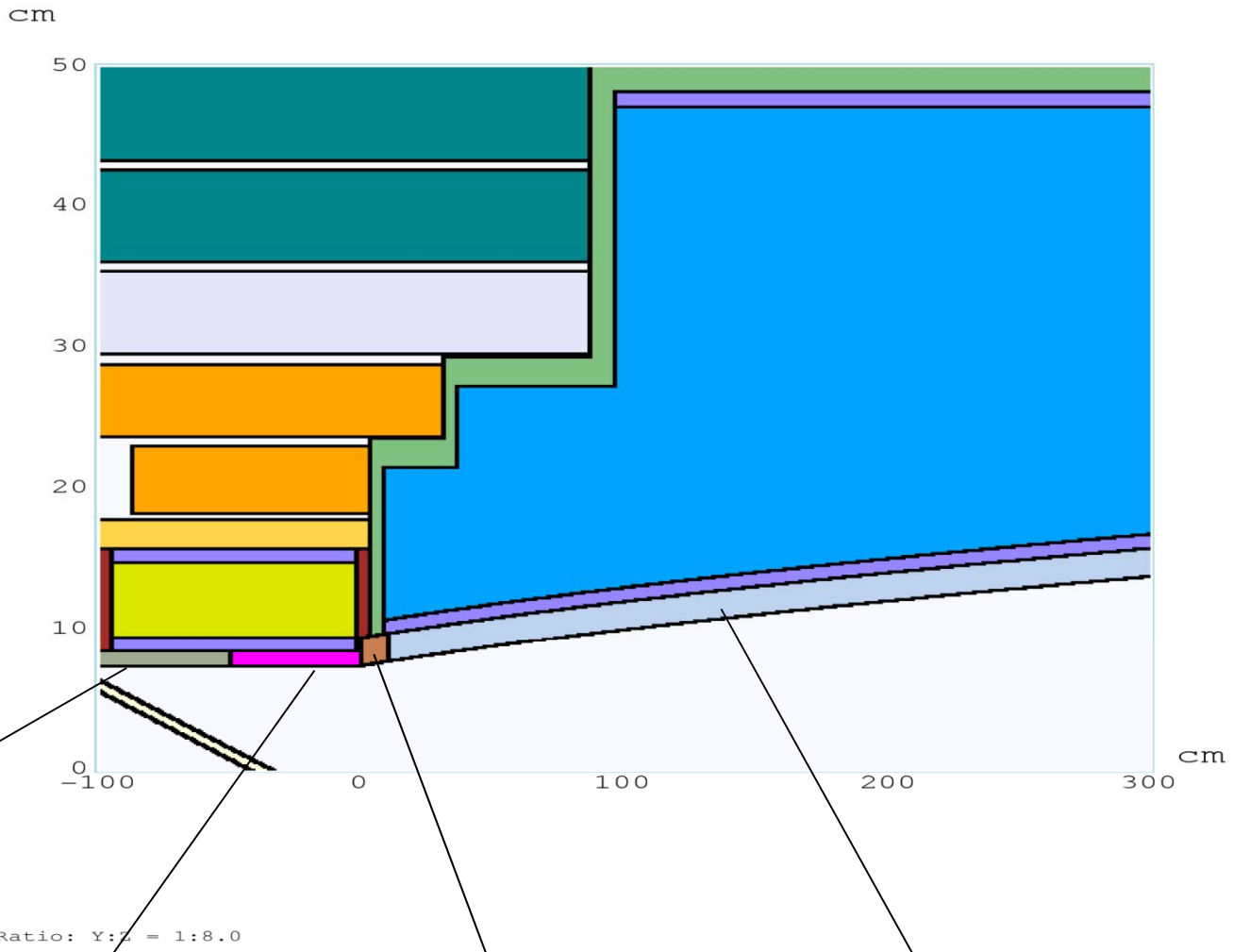
MORE POWER IN SC#1-19: 0.307 kW --> 0.515 kW (+0.208 kW)
MORE POWER IN SH#1-4: 1666.85 kW --> 1766.87 kW (+100.02 kW)
MORE POWER IN RS#1-5:164.68 kW --> 186.08 kW (+21.40 kW)
MORE POWER IN BP#1-3: 715.19 kW- -> 746.85 kW (+31.66 kW)
TOTAL POWER IS TRG STATION: 3356.06 kW --> 3590.17 kW (+234.11 kW)

PEAK TDP(mW/g)	60W/40He	60WC/40H2O
SC#1	0.022	0.025
SC#2	0.008	0.007
SC#3	0.007	0.007
SC#4	0.007	0.007
SC#5	0.012	0.008
SC#6	0.002	0.001
SC#7	0.001	0.002
SC#8	0.025	0.045
SC#9	0.043	0.045
SC#10	0.033	0.035
SC#11	0.046	0.030

SC#1 PEAK: 0.022 --> 0.025 mW/g ~ NO CHANGE
SC#1-19 PEAK: ~ SMALL DIFFERENCE

IDS120h WITH SHIELDING VESSELS: N = 100,000 EVENT SIMULATIONS

SH = 88% W + 18% He, BP1: LAST 50 cm Be, BP2: FIRST 10 cm Be



BP1: 60 cm W

BP1: 50 cm Be

BP2: 10 cm Be

BP2: STST

POWER DEPOSITED IN THE SC COILS.

NiSn/NiTi	W	W/Be
SC#1	0.061	0.062
SC#2	0.006	0.005
SC#3	0.001	0.001
SC#4	0.008	0.013
SC#5	0.003	0.004
SC#6	0.001	0.001
SC#1-6	0.076	0.085
SC#7-9	0.029	0.034
SC#10-12	0.040	0.063
SC#13-15	0.027	0.035
SC#16-19	0.056	0.044
SC#1-19	0.228	0.261

SC1: 0.061 kW --> 0.062 kW SC1-6: 0.076 kW → 0.085 kW SC#1-19:0.228 kW --> 0.261 kW.
SLIGHT INCREASE IN THE TDP.

POWER DEPOSITED IN THE SHIELDING (SH#), SHIELDING VESSELS (SHVS#), AND SH1 W TUBE 2 (SH1T2)

—	W	W/Be
SH#1	721.00	926.00
SH#2	706.00	775.00
SH#3	20.31	21.83
SH#4	26.96	27.42
SH#1-4	1474.27	1750.25

MORE POWER IN SH#1,SH#2

SH#1: 721.00 kW --> 926.00 kW (+205.00 kW)

SH#2: 706.00 kW --> 775.00 kW (+69.00 kW)

SH#1-4: 1474.27 kW --> 1750.25 kW (+275.98 kW)

—	W	W/Be
SHVS#1	82.00	112.60
SHVS#2	68.00	107.10
SHVS#3	0.51	0.48
SHVS#4	8.32	8.48
SHVS#1-4	158.83	228.66
SH1T2(W)	53.40	68.95

MORE POWER IN SHVS#1 SHVS#2

SHVS#1: 82.00 kW- -> 112.60 kW (+3.6 kW)

SHVS#1-4: 158.83 kW --> 228.66 kW (+69.83 kW)

SH1 2 cm W TUBE#2: 53.40 kW --> 68.95 kW (+15.55 kW)

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

Cu	W	W/Be
RS#1+2	104.90	137.95
RS#3	43.92	48.18
RS#4+5	59.20	62.40
RS#1-5	208.02	248.53

MORE POWER IN RS#1-5

RS#1+2: 104.90 kW --> 137.95 kW (+33.05 kW)

RS#1-5: 208.02 kW --> 248.53 kW (+40.51 kW)

BP	W	W/Be
BP#1(W)	437.05	79.00 [16.85(W),62.15(Be)]
BP#2(ST)	285.10	291.74[279.7(ST),12.04(Be)]
BP#3(ST)	8.59	8.67
BP#1-3	730.74	379.41

MUCH LESS POWER IN BP#1

BP#1: 437.05 kW --> 79.00 kW (-358.00 kW)

BP#2: 285.10 kW --> 291.74 kW (+6.640 kW)

BP#1-3: 730.74 kW--> 379.41 kW (-351.33 kW)

TOTAL POWER DEPOSITED IN DIFFERENT AREAS AND SC#1-11 PEAK VALUES.

TOTALS	W	W/Be
SC#1-19	0.228	0.261
SH#1-4	1474.27	1750.25
SHVS#1-4	158.83	228.66
RS#1-5	208.02	248.53
BP#1-3	730.74	379.41
Hg TARG.	408.70	409.20
Hg POOL	213.95	217.95
HgP.WALLS	0.31	0.30
Be WIND.	0.86	0.86
TOTAL	3249.29	3293.43

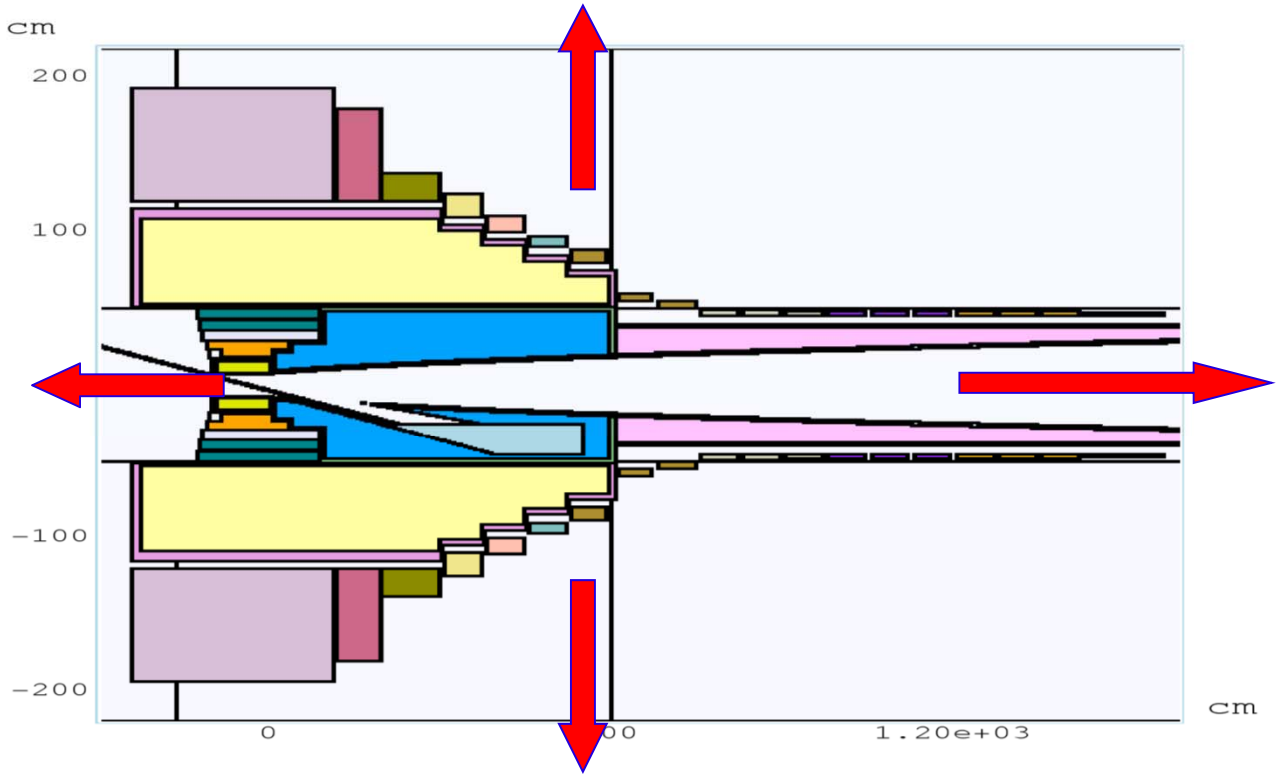
~SAME POWER IN SC#1-19: 0.228 kW --> 0.261 kW
MORE POWER IN SH#1-4: 1474.27 kW --> 1750.25 kW (+275.98 kW)
MORE POWER IN RS#1-5: 208.02 kW --> 248.53 kW (+40.51 kW)
MUCH LESS POWER IN BP#1-3: 730.74 kW --> 379.41 kW (-351.33 kW)
TOTAL POWER IS TRG STATION :3249.29 kW --> 3293.43 kW (+44.14 kW)

PEAK TDP(mW/g)	W	W/Be
SC#1	0.022	0.025
SC#2	0.003	0.004
SC#3	0.001	0.001
SC#4	0.002	0.012
SC#5	0.004	0.008
SC#6	0.001	0.001
SC#7	0.002	0.005
SC#8	0.020	0.025
SC#9	0.040	0.055
SC#10	0.030	0.062
SC#11	0.040	0.120

SC#1 PEAK :0.022 --> 0.025 mW/g ~ NO CHANGE
SC#1-19 PEAK: ~ SMALL DIFFERENCE
SC#11------WTH !!??

ENERGY FLOW FOR IDS120h FOR 88% W + 12%He, WITH BP1, BP2 PARTIAL Be, FROM 100,000 EVENTS

146.90 / 146.79 kW At R= 2 m



182.16 / 164.75 kW
at z = -2.5 m

436.99 / 432.08 kW
at z = 19 m

146.90 / 146.79 kW At R = 2 m

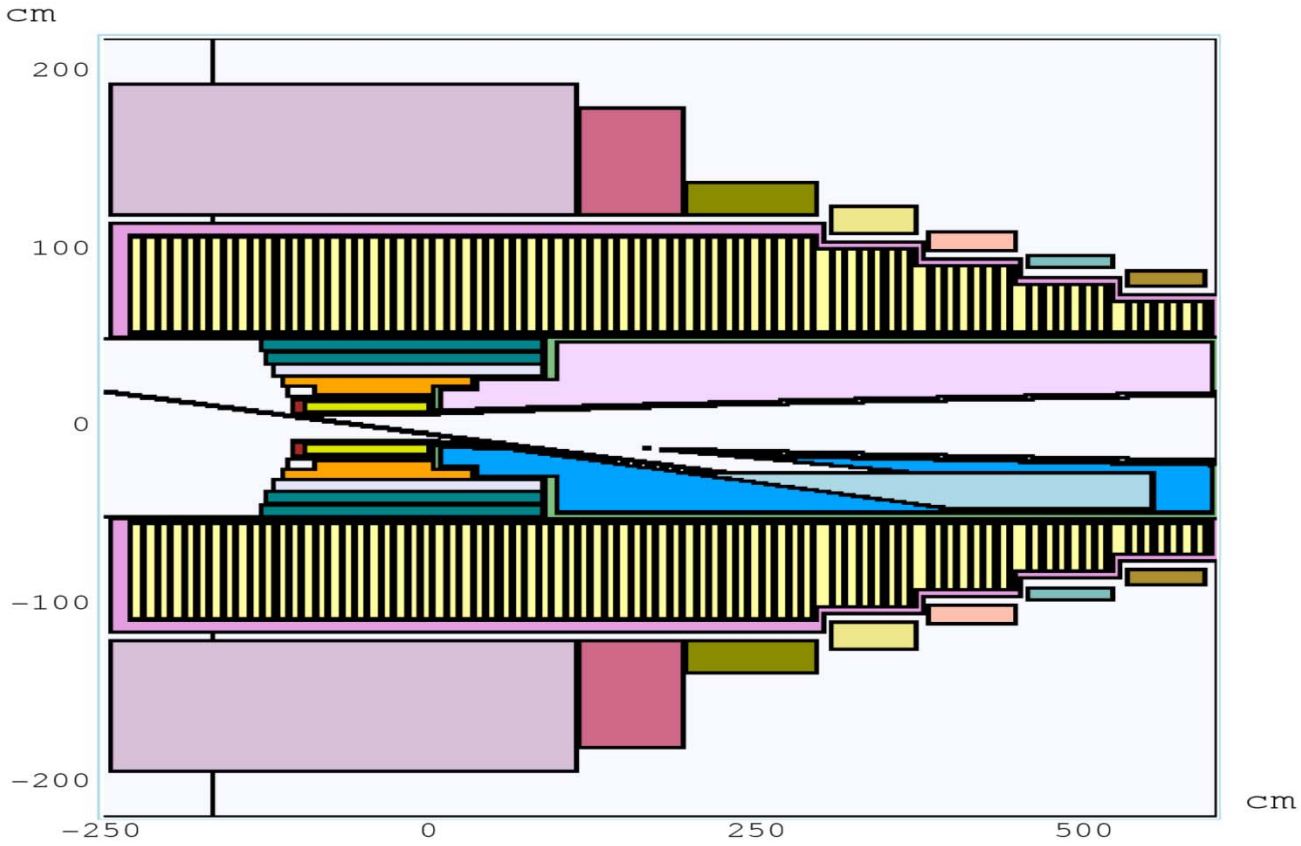
TDP FLOW (kW)	W	W/Be
R=200 cm	146.90	146.79
z=-250 cm	182.16	164.75
z=1900 cm	436.99	432.08
TOTAL FLOW	766.05	743.62
TOTAL	4015.34	4037.05
(TOTAL-4 MW)	+15.34	+37.05

TOTAL POWER GOING THROUGH THE SURFACES: 766.05 / 743.62 kW
TOTAL POWER IN TARGET STATION: 4015.34 / 4037.05 kW
POWER DIFFERENCE FROM 4 MW ~ +15.34 / 37.05 kW

SH1,SH2 TDP PEAK SLIGTLY HIGHER ~ 11 W/g
BP1, BP2 TDP PEAKS ABOUT THE SAME, BINS SIZE PROBLEMS
FURTHER INVESTIGATION REQUIRED.

IDS120h WITH SHIELDING VESSELS: N = 100,000 EVENT SIMULATION
SH = 60% W + 40% He, INTRODUCING SH VESSELS STST SUPPORT RIBS

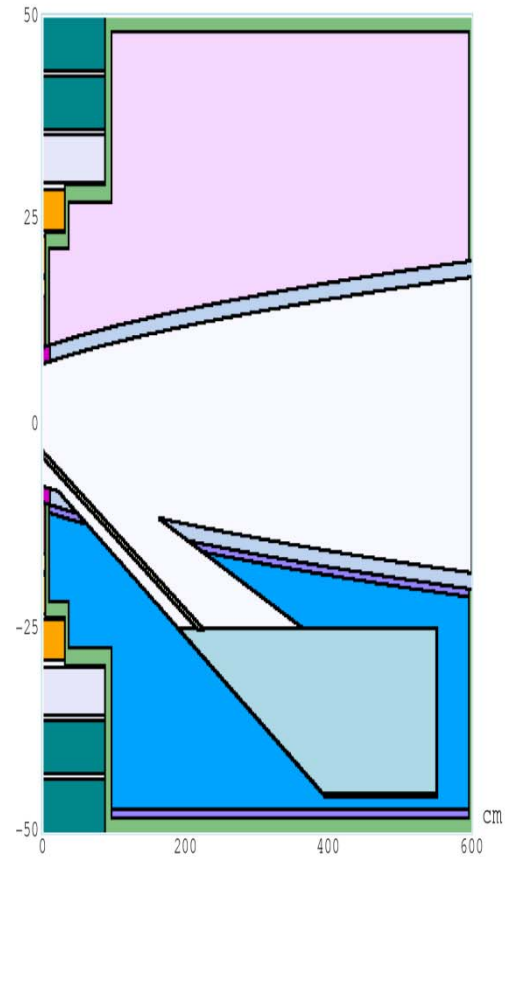
SH2--> 2 cm THICK STSTS SLAB ALONG y-z PLANE.
SH3--> 2 cm THICK STST DISCS EVERY 100 cm.
SH4--> 2 cm THICK STST DISCS EVERY 10 cm.



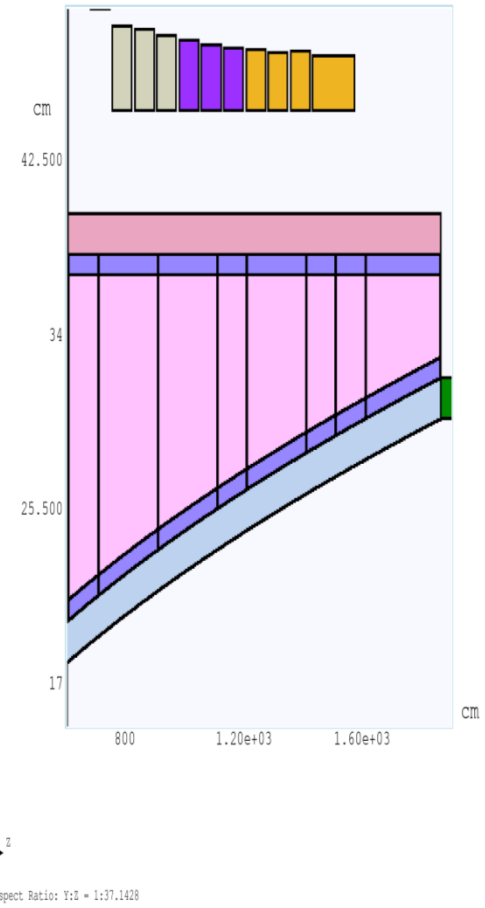
SH2--> 2 cm THICK STST SLAB ALONG y-z PLANE.
SH3--> 2 cm THICK STST DISCS EVERY 100 cm.
SH4--> 2 cm THICK STST DISCS EVERY 10 cm.

SH2, SH3, SH4 RIBS DETAILS

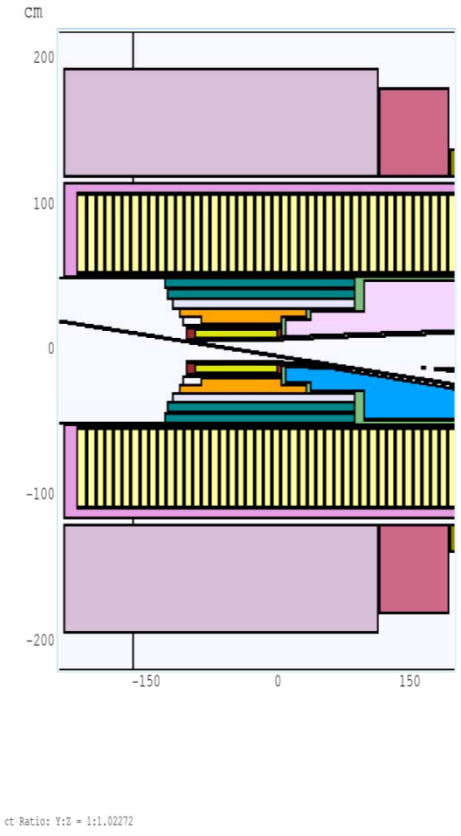
SH2 RIB DETAILS (Longitudinal)



SH3 RIB DETAILS (Transverse)



SH4 RIB DETAILS (Transverse)



POWER DEPOSITED IN THE SC COILS.

NiSn/NiTi	WOR	WR
SC#1	0.190	0.236
SC#2	0.010	0.012
SC#3	0.012	0.013
SC#4	0.012	0.016
SC#5	0.008	0.008
SC#6	0.049	0.009
SC#1-6	0.286	0.294
SC#7-9	0.029	0.039
SC#10-12	0.041	0.057
SC#13-15	0.042	0.031
SC#16-19	0.059	0.050
SC#1-19	0.459	0.471

SC1: 0.190 kW --> 0.236 kW SC1-6: 0.286 kW--> 0.294 kW SC#1-19: 0.459 kW --> 0.471 kW.
SLIGHT INCREASE IN THE TDP.

POWER DEPOSITED IN THE SHIELDING (SH#), SHIELDING VESSELS (SHVS#), AND SH1 W TUBE 2 (SH1T2)

—	WOR	WR
SH#1	727.00	697.50
SH#2	752.00	745.50
SH#3	21.13	19.95
SH#4	37.21	31.67
SH#1-4	1537.34	1494.62

LESS POWER IN SH#1, SH#2, SH#4

SH#1: 727.00 kW --> 697.00 kW (-29.50 kW) !!??

SH#2: 752.00 kW --> 745.50 kW (-6.50 kW)

SH#1-4: 1537.34 kW --> 1494.62 kW (-42.72 kW)

—	WOR	WR
SHVS#1	58.40	80.55
SHVS#2	79.90	80.65
SHVS#3	0.77	0.69
SHVS#4	8.75	9.15
SHVS#1-4	147.82	171.04
SH1T2(W)	69.60	69.40

MUCH MORE POWER IN SHVS#1

SHVS#1: 58.40 kW --> 80.55 kW (+22.15 kW) !!??

SHVS#1-4: 147.82 kW --> 171.04 kW (+23.22 kW)

SH1 2 cm W TUBE#2 ~THE SAME

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

Cu	WOR	WR
RS#1+2	110.75	111.70
RS#3	47.61	47.85
RS#4+5	63.35	63.20
RS#1-5	221.71	222.75

~ SAME POWER IN RS#1-5

BP	WOR	WR
BP#1(W)	438.00	438.95
BP#2(ST)	290.80	289.10
BP#3(ST)	8.52	8.38
BP#1-3	737.32	736.43

~ SAME POWER IN BP#1-3

TOTAL POWER DEPOSITED IN DIFFERENT AREAS AND SC#1-11 PEAK VALUES.

TOTALS	WOR	WR
SC#1-19	0.459	0.471
SH#1-4	1537.34	1494.62
SHVS#1-4	147.82	171.04
RS#1-5	221.71	222.75
BP#1-3	737.32	736.43
Hg TARG.	408.85	408.95
Hg POOL	217.15	219.90
HgP.WALLS	0.31	0.31
PLSH2	—	4.09
DSSH3	—	0.31
DSSH4	—	3.99
Be WIND.	0.88	0.86
TOTAL	3341.12	3332.80

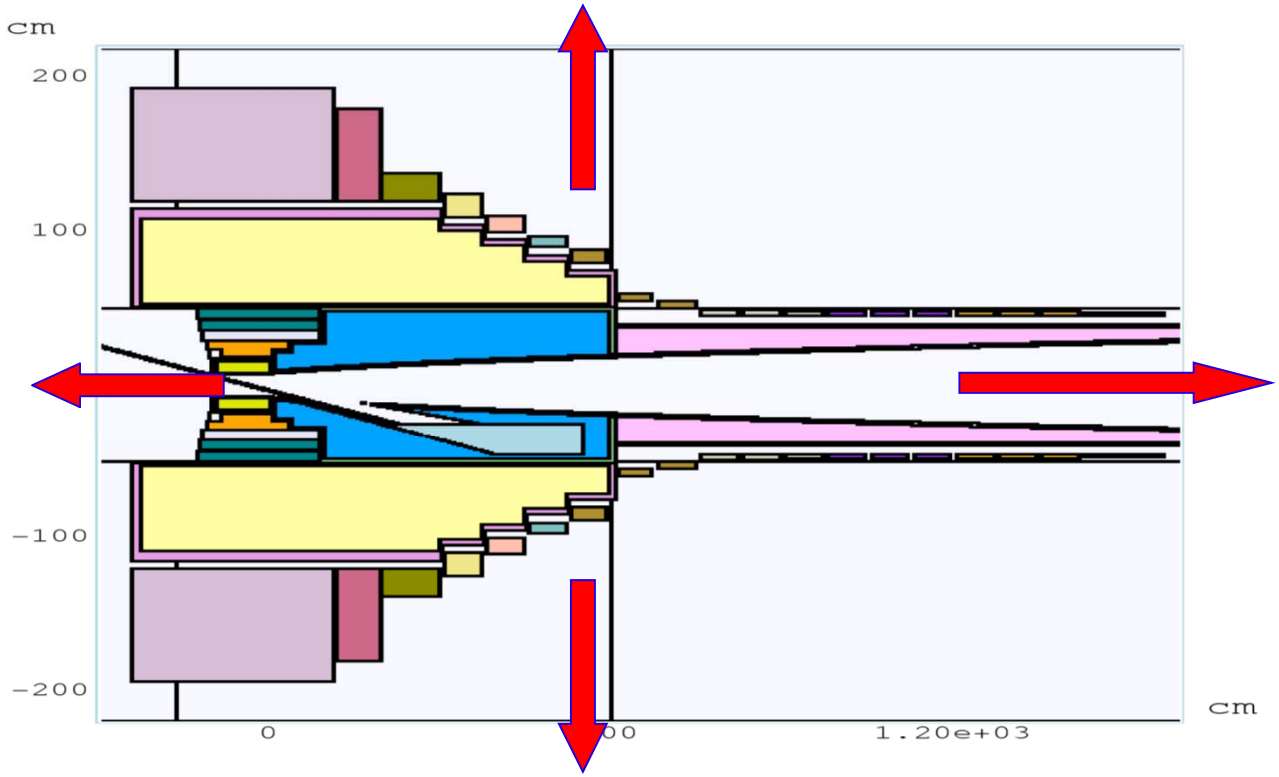
~SAME POWER IN SC#1-19: 0.459 kW --> 0.471 kW
SLIGHTLY LESS POWER IN SH#1-4: 1537.34 kW --> 1494.62 kW (-42.73 kW)
~SAME POWER IN RS#1-5: 221.71 kW --> 222.75 kW
~SAME POWER IN BP#1-3: 737.32 kW --> 736.43 kW
SLIGHTLY MORE POWER IN SHVS#1-4: 147.82 kW --> 171.04 kW (+23.22 kW)
~SAME TOTAL POWER IS TRG STATION: 3341.12 kW --> 3332.80 kW

PEAK TDP(mW/g)	WOR	WR
SC#1	0.045	0.044
SC#2	0.006	0.005
SC#3	0.005	0.009
SC#4	0.006	0.011
SC#5	0.007	0.008
SC#6	0.008	0.025
SC#7	0.007	0.001
SC#8	0.080	0.050
SC#9	0.005	0.060
SC#10	0.045	0.050
SC#11	0.033	0.100

SC#1 PEAK :0.045 --> 0.044 mW/g ~ NO CHANGE
SC#1-19 PEAK: ~ SMALL DIFFERENCES
SC#11------WTH !!??

ENERGY FLOW FOR IDS120h FOR 60% W + 40% He SHIELDING FROM 100,000 EVENTS: WOR / WR

144.85 / 141.63 kW At R = 2 m



175.45 / 173.56 kW
at z = -2.5 m

432.53 / 431.33 kW
at z = 19 m

144.85 / 141.63 kW At R = 2 m

TDP FLOW (kW)	WOR	WR
R=200 cm	144.85	141.63
z=-250 cm	175.45	173.56
z=1900 cm	432.53	431.33
TOTAL FLOW	752.83	746.52
TOTAL	4093.95	4079.32
(TOTAL-4 MW)	+93.95	+79.32

TOTAL POWER GOING THROUGH THE SURFACES: 732.83 / 746.52 kW
TOTAL POWER IN TARGET STATION: 4093.95 / 4079.32 kW
POWER GAP: +93.95 / +79.32 kW