IDS120j WITHOUT RESISTIVE MAGNETS

MODIFYING Hg MODULE (UPDATED)

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IDS120j GEOMETRY, NO RESISTIVE MAGNETS: WITH 20 cm GAPS BETWEEN CRYOSTATS

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 # MODIFYING Hg MODULE TO SIMULATE VAN GRAVE'S DESIGN.

VAN GRAVE DURING THE LAST MEETING INDICATED AND/OR CLARIFIED DETAILS OF VARIOUS DIMENSIONS.

NEW DESIGN RESULTS IN SIGNIFICANT LOSS OF SHIELDING MATERIAL, ESPECIALLY AROUND THE TARGET REGION (FIRST ~ 2 m OF CRYO#1)

 # FIRST RESULTS FROM SIMULATIONS WITH MODIFIED Hg POOL.

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>SIMULATIONS CODE: mars1512 (USING MCNP CROSS SECTION LIBRARIES)

>NEUTRON ENERGY CUTOFF: 10^{-11} MeV

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

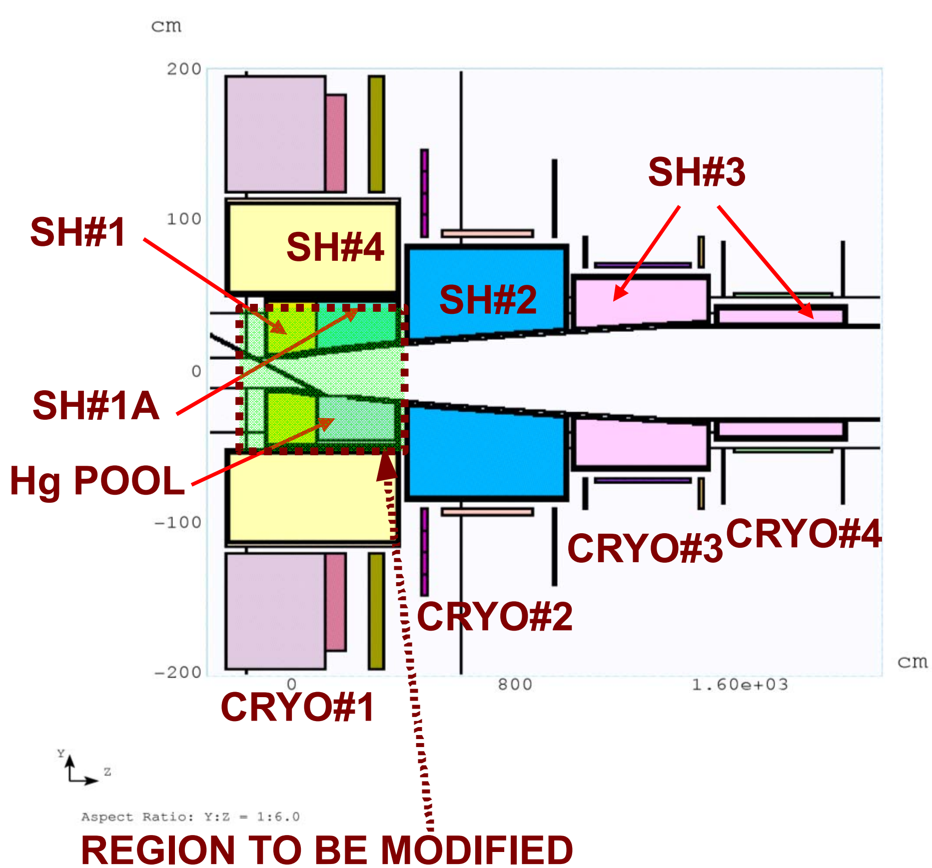
>PROTON BEAM POWER: 4 MW

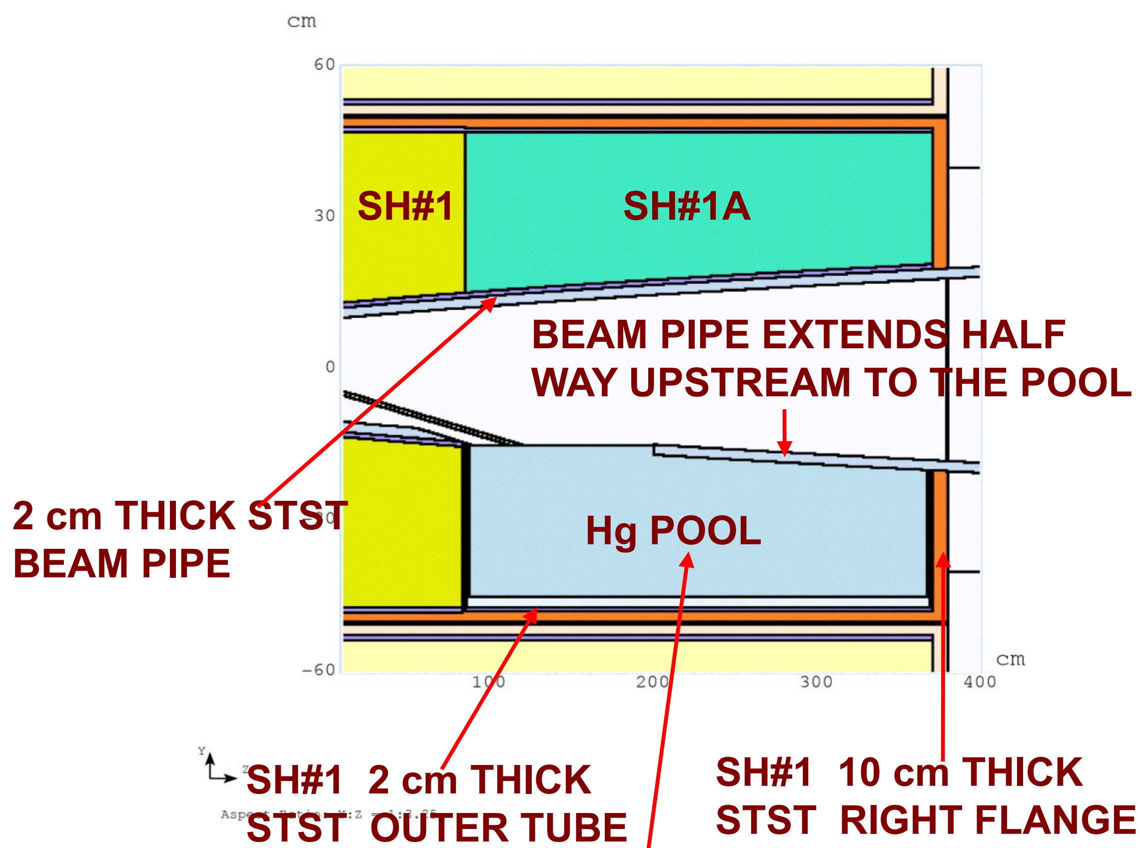
>PROTON ENERGY: E = 8 GeV

>PROTON BEAM PROFILE: GAUSSIAN, $\sigma_x = \sigma_y = 0.12$ cm

>EVENTS IN SIMULATIONS : $N_p = 500{,}000$ (OR 4 x 500,000 FOR SC#1+2)

IDS120j: GENERAL OVERVIEW (LEFT), POOL REGION DETAILS (RIGHT). [20 cm GAPS]

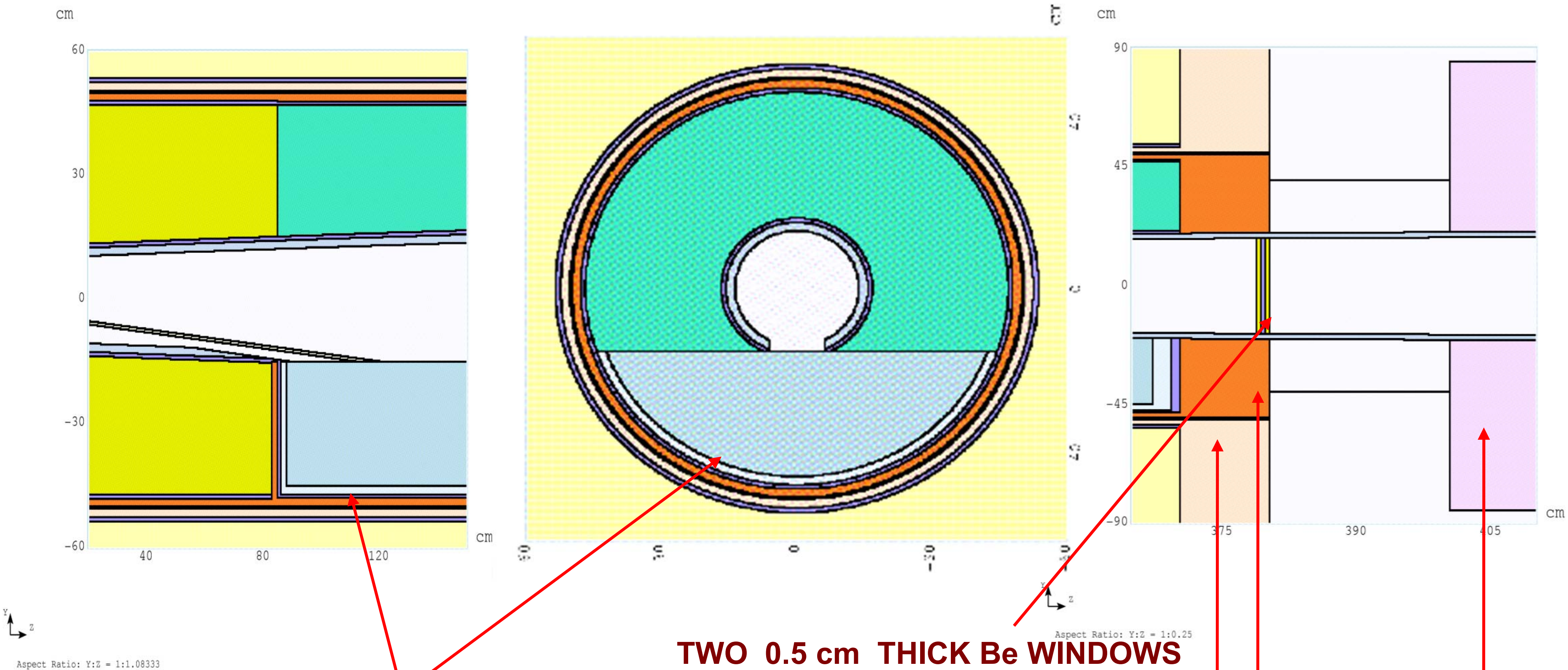




Hg POOL STARTS ~ 85 cm AND EXTENDS ALL THE WAY TO THE END OF THE FIRST CRYOSTAT ~ 370 cm.

THE NEW Hg POOL MODULE WILL DISPLACE A LARGE VOLUME OF SHIELDING MATERIAL IN SH#1 AND THE FIRST HALF OF SH#1A (TOP VOLUME REGION), WHERE IT IS MOSTLY NEEDED FOR THE PROTECTION OF SC#1 – SC#4. AFTER CONSULTING VAN GRAVES THE LOWER PART OF VESSEL BEFORE THE Hg POOL WILL BE EMPTY !

IDS120j: WITHOUT RESISTIVE MAGNETS. DETAILS OF THE DOUBLE STST Hg POOL VESSEL (LEFT, MIDDLE) AND THE DOUBLE Be WINDOW (RIGHT). [20 cm GAPS]

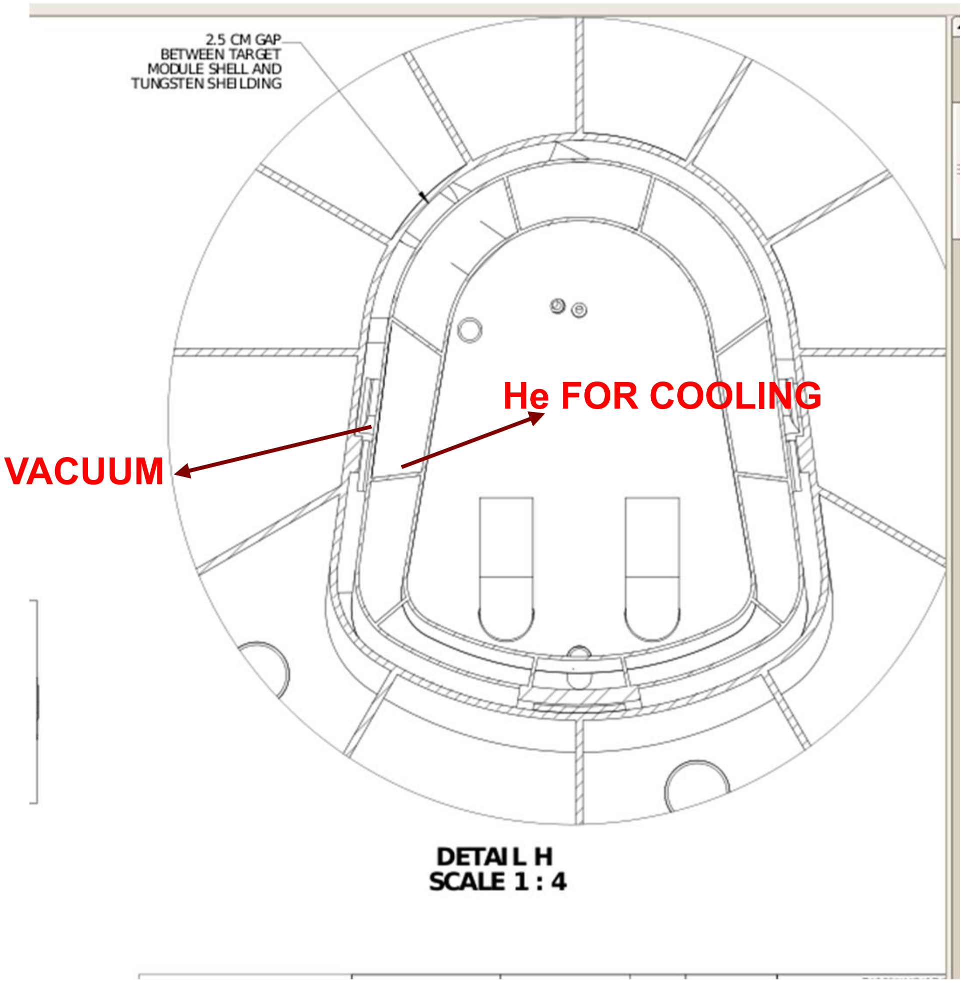


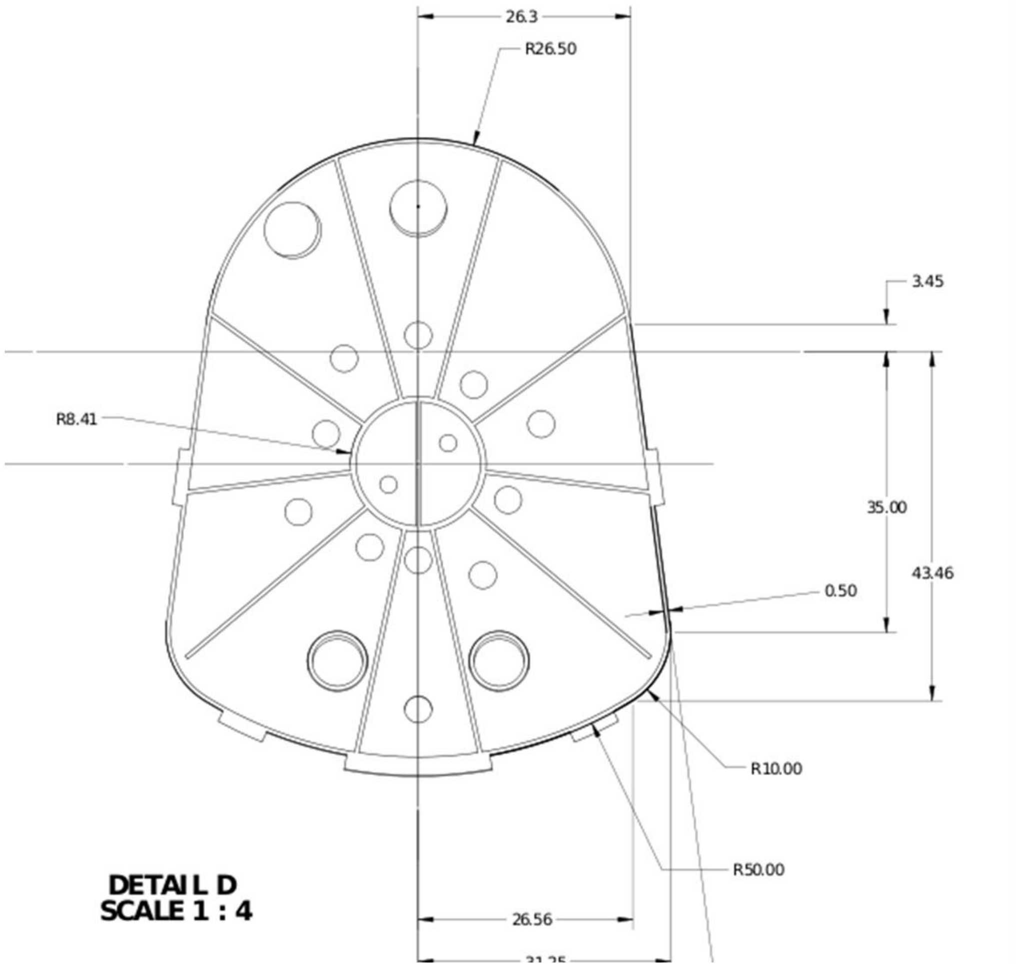
2 cm THICK STST INNER Hg POOL VESSEL WITH 1 cm He GAP FOR COOLING.

TWO 0.5 cm THICK Be WINDOWS AT THE END OF CRYO#1 WITH 0.5 cm He GAP BETWEEN THEM FOR COOLING.

10 cm THICK STST RIGHT / LEFT FLANGE OF SHVS#4, SHVS#1 / SHVS#2 WITH 20 cm GAP BETWEEN THEM.

IDS120j: yz CROSS SECTIONS WITH DETAILS OF Hg POOL MODULE FROM VAN GRAVE'S PRESENTATION (8 / 9 / 2012).

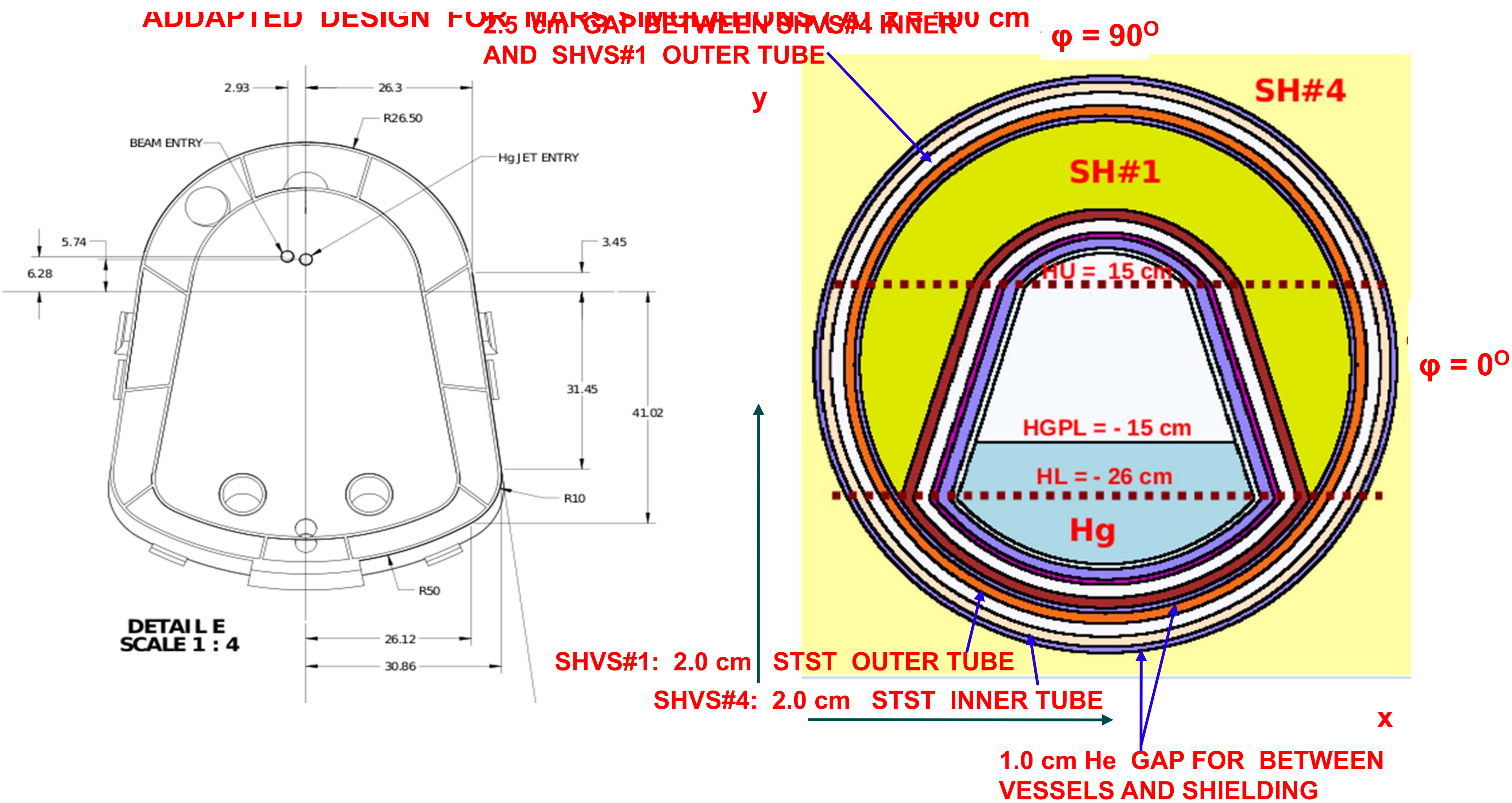




THE DESIGN REQUIRES A 2.5 cm ! GAP BETWEEN SH#1 INNER VESSEL AND Hg POOL MODULE OUTER VESSEL. AN EVEN LARGER SPACE APPEARS TO BE BETWEEN INNER AND OUTER VESSEL OF THE Hg POOL MODULE FOR THE FLOW OF He GAS FOR COOLING THE POOL.

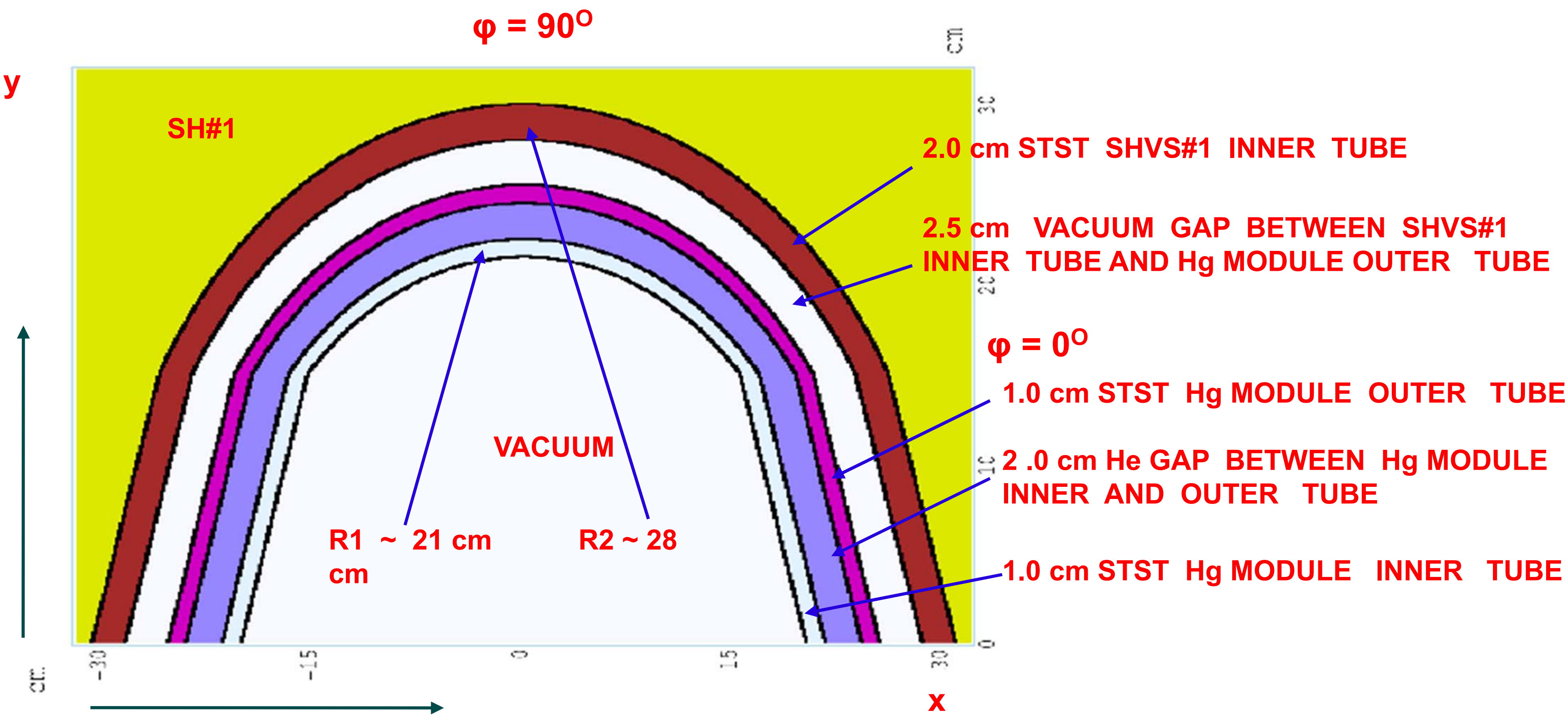
THE RADIUS OF THE UPPER HALF SEMICIRCULAR SECTION OF INNER Hg POOL VESSEL WILL BE 26.5 cm, MUCH LARGER THAN THE BEAM PIPE APERTURE AT THE END OF CRYO#1 (~ 17.7 cm).

IDS120j: yx CROSS SECTION WITH DETAILS OF Hg POOL MODULE FROM VAN's PLOTS (LEFT) AND ADAPTED DESIGN FOR MARS SIMULATIONS (RIGHT) [AT z = 100 m].



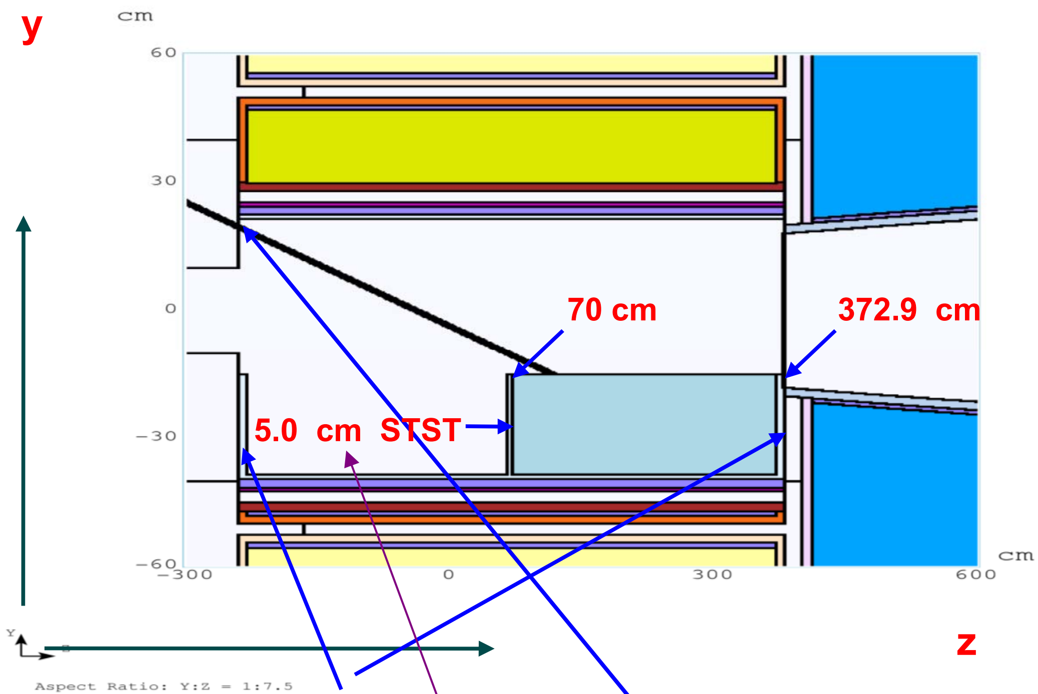
EVERYTHING HAS BEEN PARAMETRIZED FOR FUTURE CONVINIENCE. THE HEIGHTS OF THE END POINTS OF THE STRAIGHT SECTIONS ARE HL = - 26 cm AND HU = 15 cm. THE FREE Hg POOL SURFACE IS AT y = - 15 cm. THE RADIUS OF THE LOWER HALF OF THE INNER VESSEL OF THE Hg MODULE IS NOW SMALLER THAN BEFORE : FROM ~ 45 cm ----> ~ 39 cm. THE REST OF THE SPACE BETWEEN SHVS#1 INNER AND OUTER TUBE IS FILLED WITH SHIELDING.

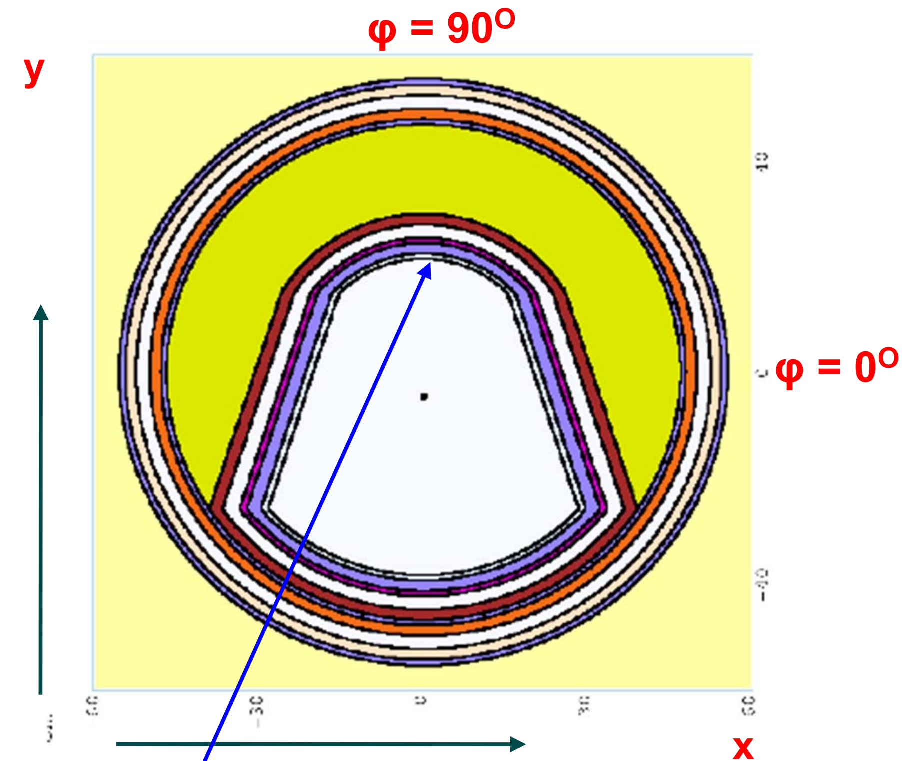
IDS120j: yx CROSS SECTION AT z = 200 cm WITH DETAILS OF THE Hg MODULE TOP SECTION



TUBES THICKNESS AND GAPS SIZE ARE PARAMETRIZED. SHVS#1 INNER TUBE THIKNESS IS SET TO 2.0 cm TO SUPORT THE SHIELDING WEIGHT, THE LOWER Hg MODULE INNER TUBE CAN ALSO BE THICKER TO SUPPORT THE WEIGHT OF Hg IN THE POOL. [ARE THICKNESS NUMBERS I USE RESONABLE ?]
R1 RADIUS OF SEMICIRCULAR TOP SECTION OF Hg MODULE INNER TUBE IS SUCH THAT BEAM PROTONS WILL NOT BE INTERCEPTED BY THE TUBE AT THE BEGINNING OF CRYO#1 (z ~ - 240 cm).
IS IT NECESSARY FOR THE Hg MODULE TO START AT THE BEGINNING OF CRYO#1 ?

IDS120j: yz (LEFT) AND yx AT z = 10 cm (RIGHT) CROSS SECTION WITH DETAILS OF THE NEW Hg MODULE AND THE LOWER HALF OF THE UPSTREAM REGION.



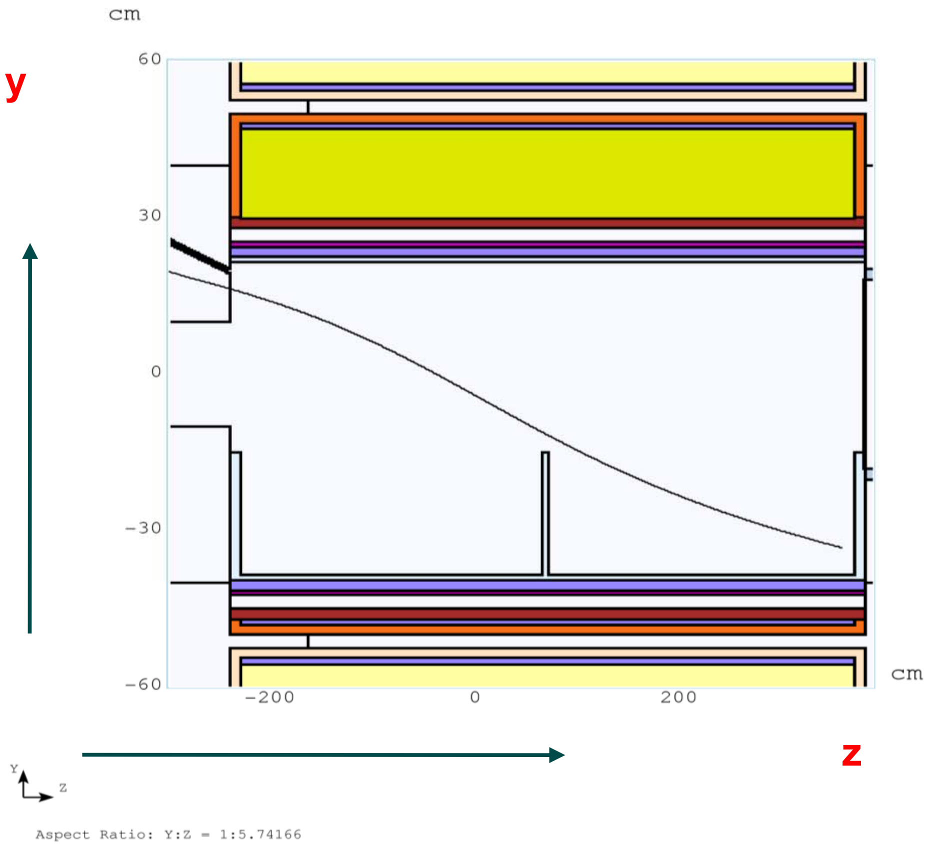


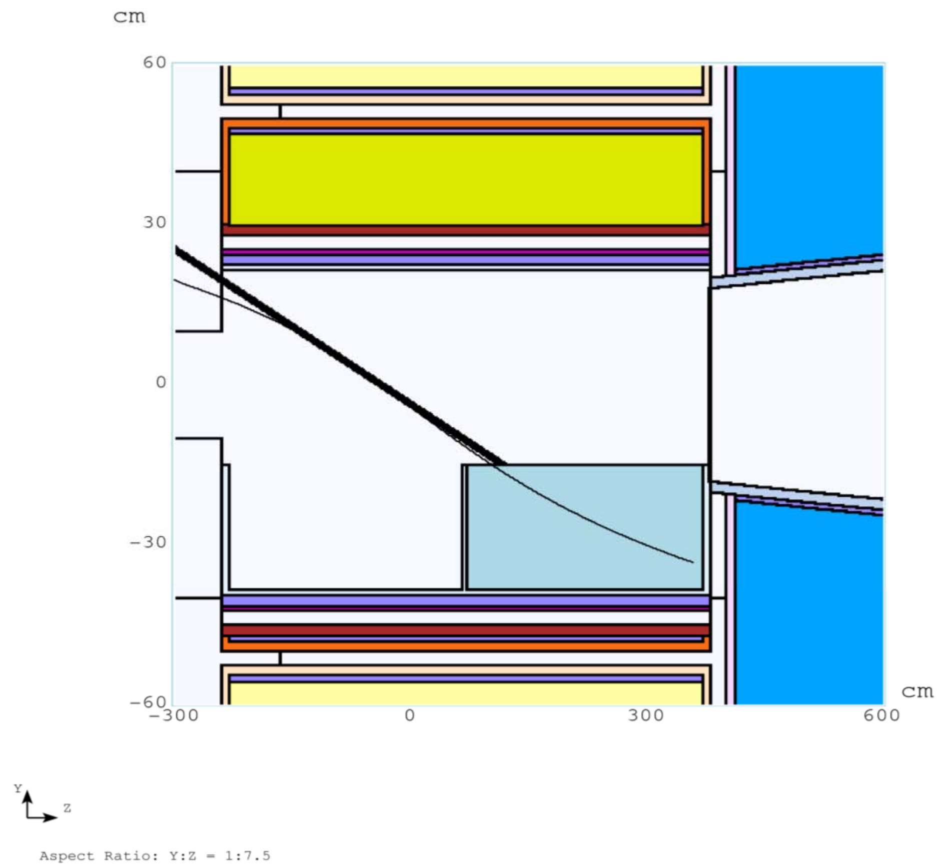
THE RADIUS OF THE TOP SEMICIRCULAR SECTION OF THE Hg INNER TUBE IS SUCH THAT WILL NOT INTERFERE WITH THE Hg JET AND THE BEAM PROTONS AT THE BEGINNING OF CRYO#1 (z ~ - 240 cm)

ACCORDING TO VAN'S DESIGN THE VOLUME FROM THE BEGINNING OF CRYO#1 (z ~ - 240 cm) TO THE BEGINNING OF THE Hg POOL (z ~ 65 cm) AND FROM y ~ -15 cm TO THE BOTTOM OF THE Hg MODULE INNER VESSEL (R ~ 39 cm) WILL BE EMPTY TO ACCOMODATE THE PIPES AND OTHER COMPONENTS OF THE Hg POOL MODULE.

SOME IMPROVEMENT IN SHIELDING CAN BE ACHIEVED BY UNIFYING SH#1 AND SH#4. THERE WILL BE SIGNIFICANT INCREASE IN THE SHIELDING WEIGHT TO BE CONTAINED IN THE NEW VESSEL AND GREATER ASSYMETRY IN THE WEIGHT DISTRIBUTION.

IDS120j: yz CROSS SECTION WITH THE PROTON BEAM CENTROID P12 TRAJECTORY SHOWING (RIGHT) AND WITHOUT SHOWING (LEFT) THE Hg POOL AND Hg JET.





 # PROTONS ENTER THE Hg POOL AT (x, y, z) ~ (- 1.61, -15.00, 104.66) cm AND WILL BE STOPPED BY THE SIDE (SEMICIRCULAR) WALL AT (x, y, z) ~ (-19.39, -33.26, 358.80) cm (~ 10 cm BEFORE THEY REACH THE RIGHT SIDE FLANGE OF Hg MODULE) COVERING A DISTANCE ~ 255.41 cm ~ 17 IL (1 IL ~ 15 cm).

 # IS IT POSSIBLE FOR POOL TO BE SHORTER AND FILL THE REST OF THE UPSTREAM VOLUME WITH SHIELDING ?

 # NOTICE : R1, HU (HL ?) DIMENSIONS OF Hg MODUL ARE DETERMINED FROM THE SPACE NEEDED FOR THE PROTON BEAM TRAJECTORY. DIFFERENT INJECTION POINTS WILL PROBABLY REQUIRE DIFFERENT VALUES FOR THESE PARAMETERS.

IDS120j: yx (AT z = 200 cm) (LEFT) AND xz (RIGHT) CROSS SECTION WITH THE PROTON BEAM CENTROID P12 TRAJECTORY.

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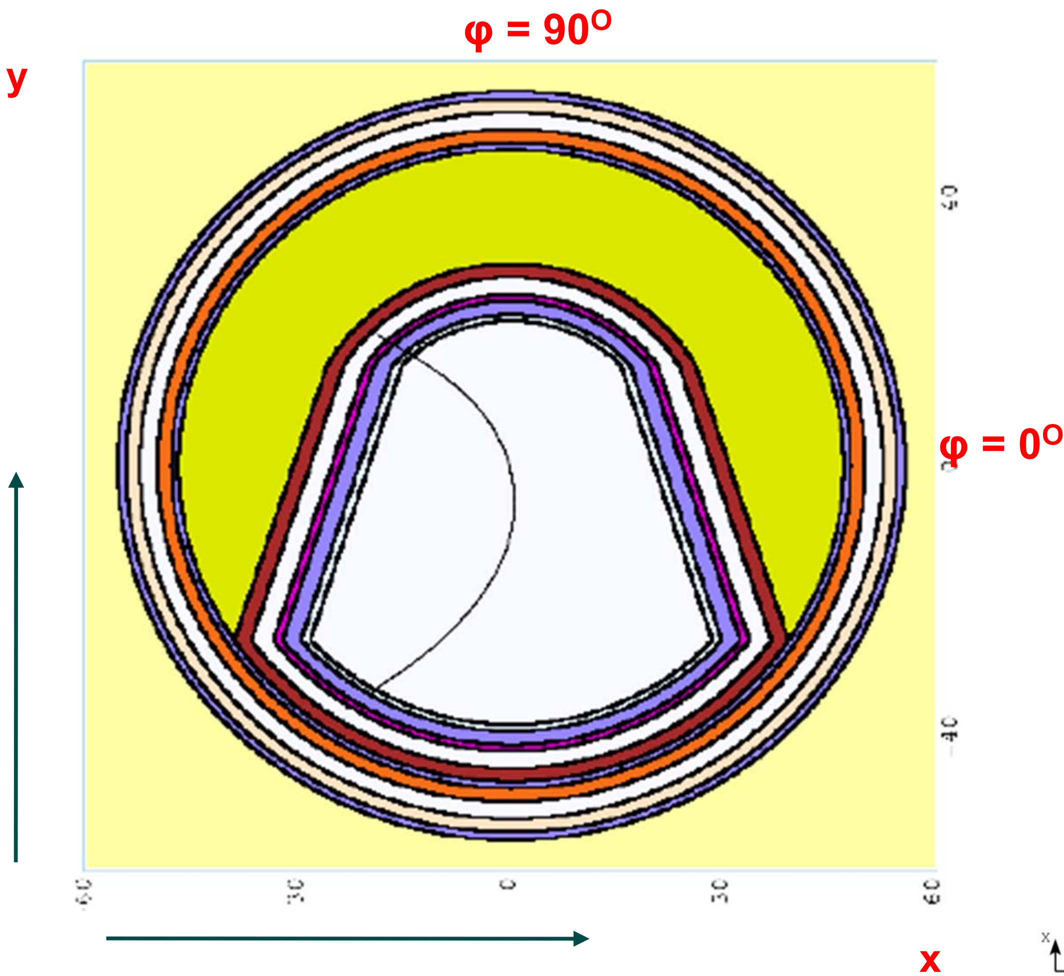
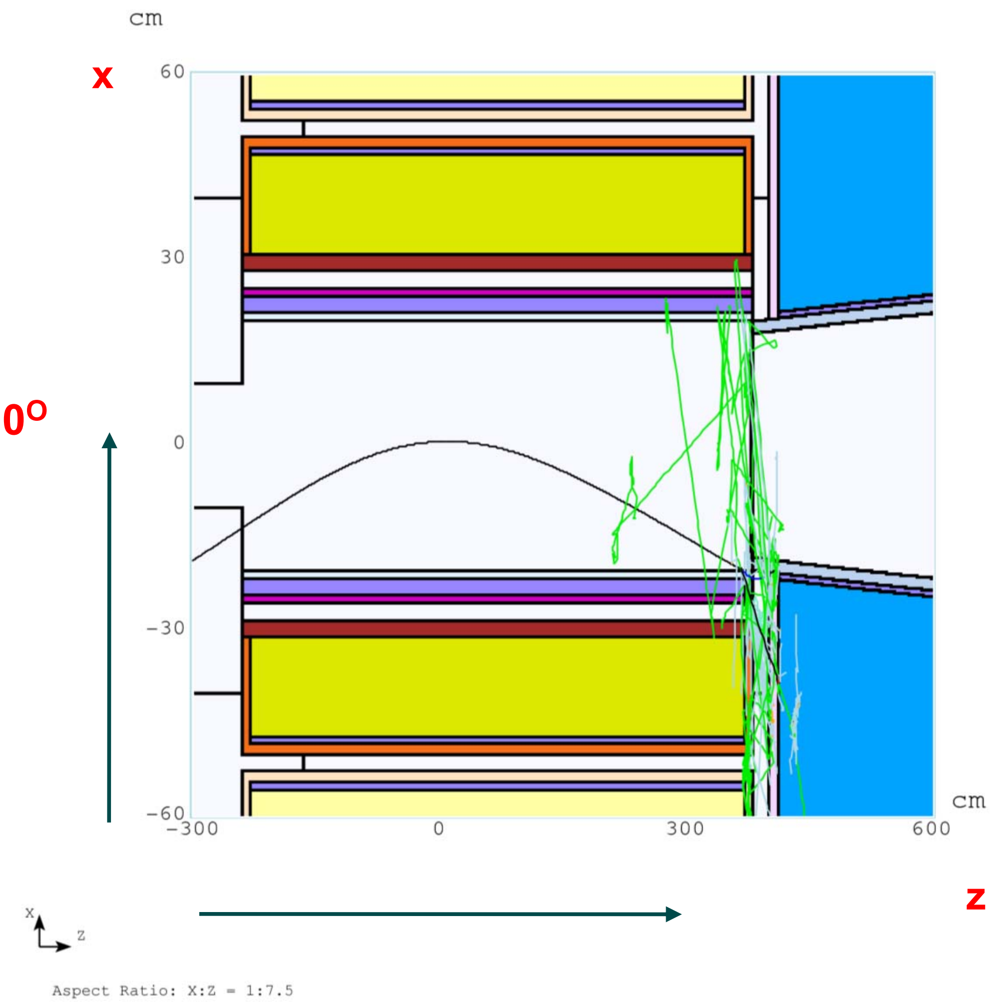
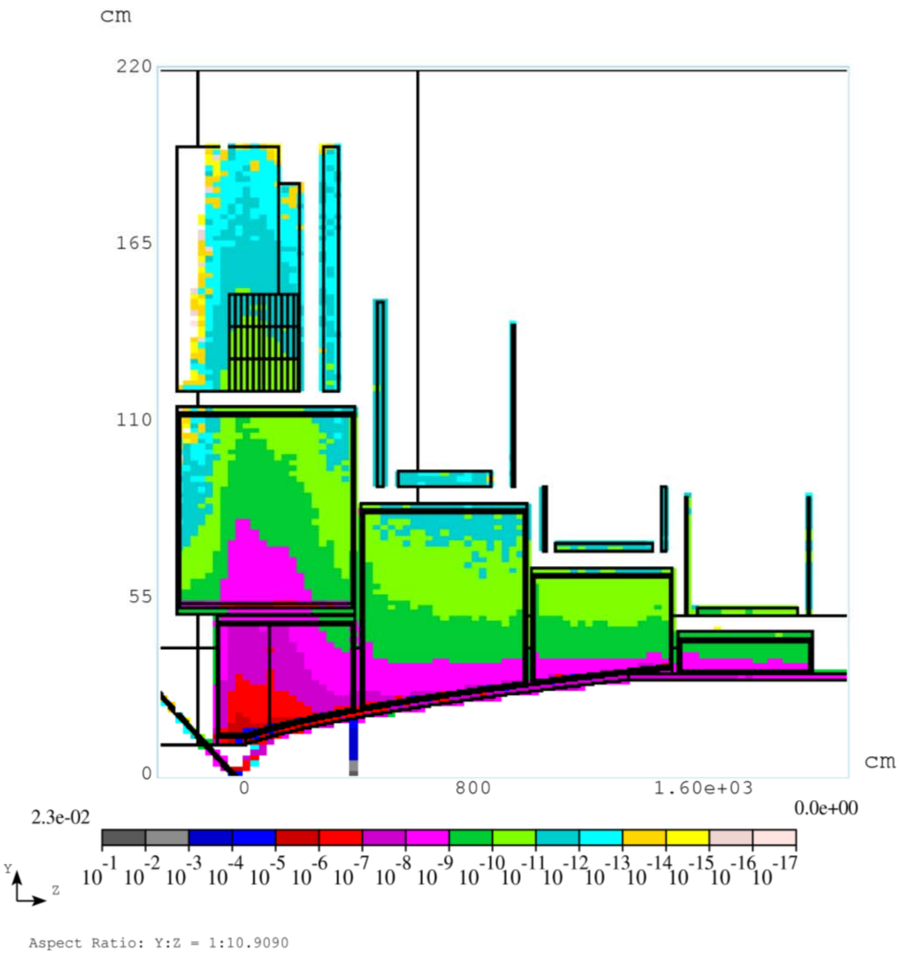
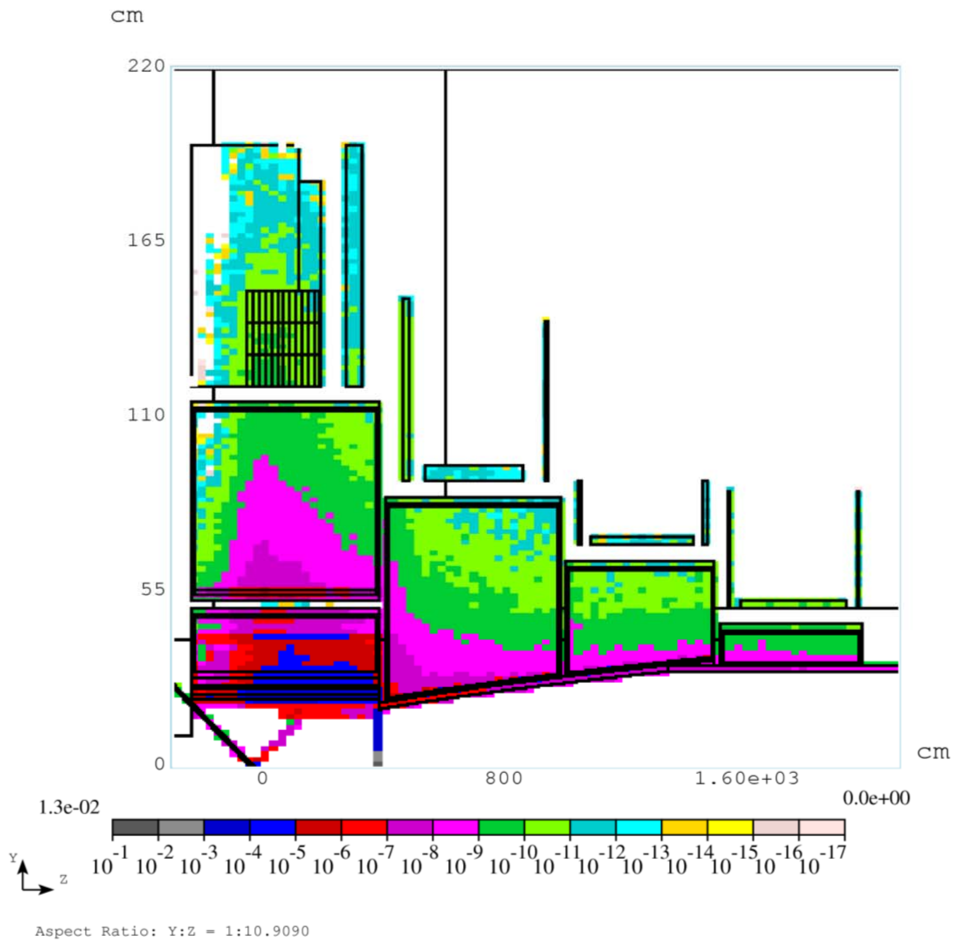




IDS120j: yz CROSS SECTION FOR THE AZIMUTHALLY AVERAGED TDPD WITH THE OLD Hg POOL VESSEL (LEFT) AND THE NEW ONE (RIGHT) [P12 POINT].

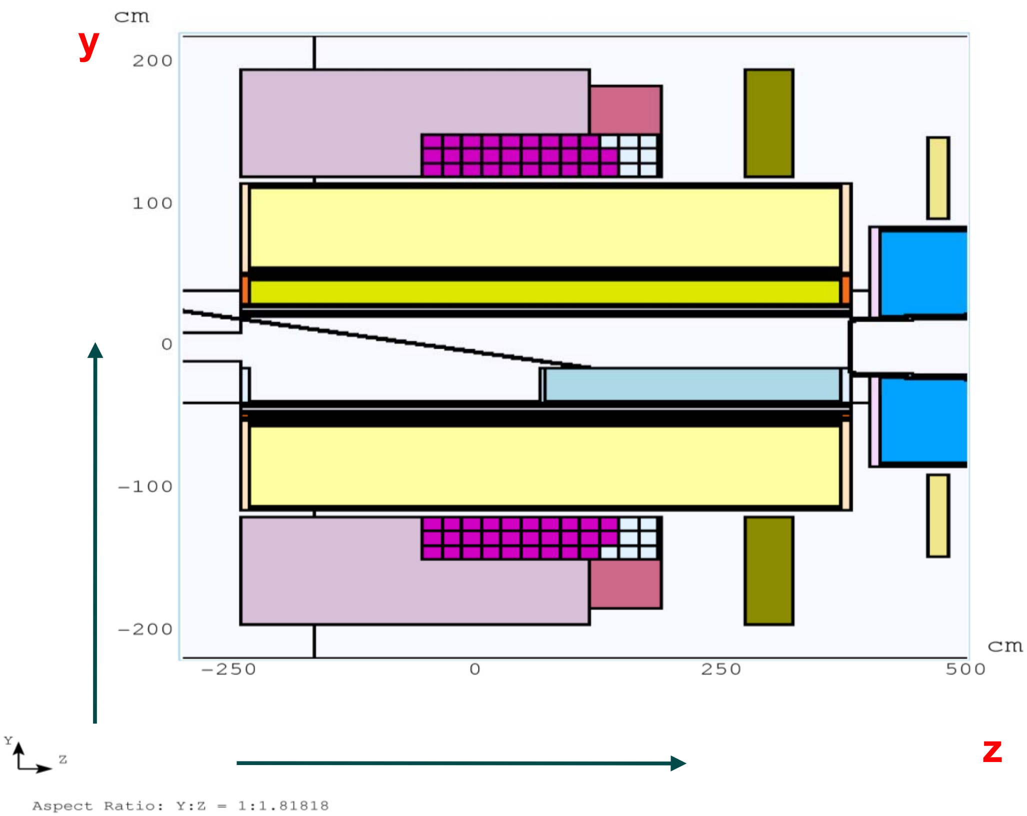


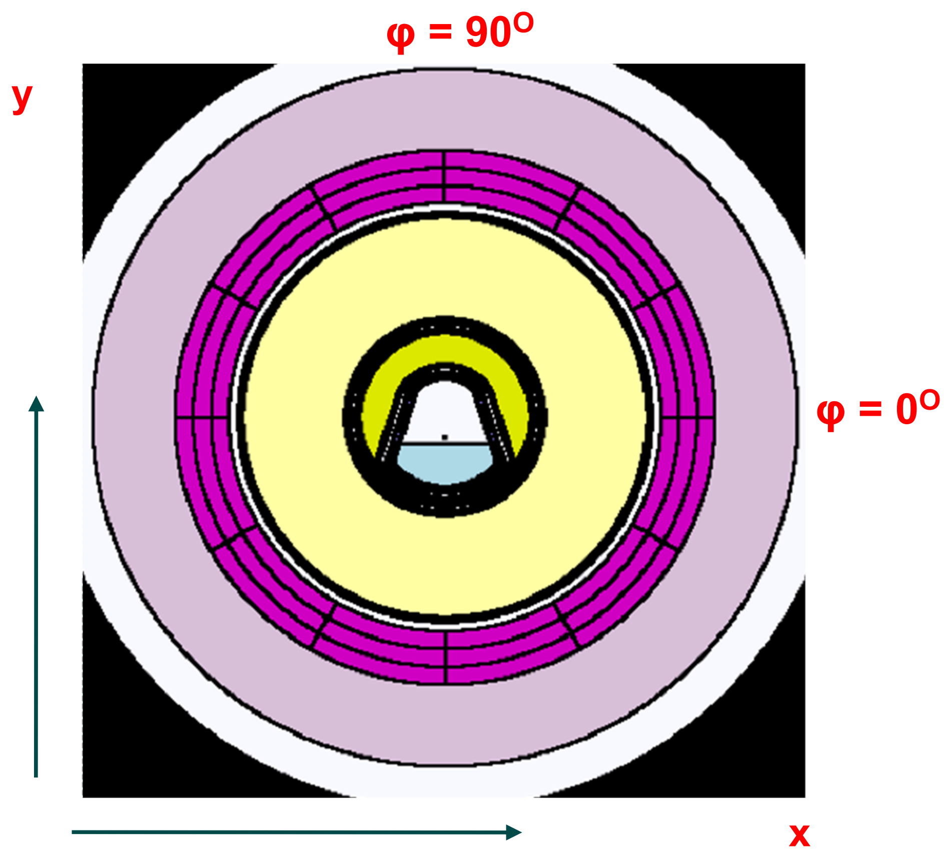


 # COMPARISON OF THE AZIMUTHALLY AVERAGED TDPD BETWEEN OLD AND NEW Hg MODULE REVEALS THE SIGNIFICANT INCREASE IN THE DP AROUND THE TARGET REGION AS WELL AS FURTHER DOWNSTREAM (CRYO#2 SHIELDING REGION). COLOR SCALE IS SAME FOR BOTH PLOTS.

TDPD = Total Deposited Power Density

IDS120j: yz (LEFT) AND yx CROSS SECTION WITH DETAILS OF THE SC#1+2 SEGMENTATION.





$120.0 < r < 150.0$ cm dr = 10.0 cm N_r = 3 bins

$-55.0 < z < 185.0$ cm dz = 20.0 cm N_z = 12 bins

$0.0 < \varphi < 360.0$ deg. $d\varphi$ = 30 deg. N_φ = 12 bins

N_{tot} = 432 "pieces"

ONLY THE AREA WITH HIGHEST AVERAGE AZIMUTHAL TDPD (DETERMINED FROM MARS PLOTS) WAS STUDIED.

RID	r(cm)	z(cm)	ϕ	DPD(mW/g)
140	125	-5	315	0.26995
138	125	-5	255	0.20205
167	125	15	45	0.19815
66	125	-45	255	0.19045
102	125	-25	255	0.17545
76	135	-45	195	0.17315
139	125	-5	285	0.1592
293	135	75	225	0.15715
188	135	15	315	0.1567
116	135	-25	315	0.1497
104	125	-25	315	0.14815
283	125	75	285	0.14495
223	135	35	285	0.13775
175	125	15	285	0.1298
174	125	15	255	0.12915
207	125	35	165	0.1263
114	135	-25	255	0.1185
173	125	15	225	0.1182
250	135	55	15	0.1167
213	125	35	345	0.11665
67	125	-45	285	0.1156
113	135	-25	225	0.11515
103	125	-25	285	0.11055
176	125	15	315	0.10815
187	135	15	285	0.1056
107	135	-25	45	0.10555
317	125	95	225	0.10325
147	135	-5	165	0.09855

AND NOW THE BAD NEWS ....

A) THE PEAK DPD IN SC#1+2 IS ~ 0.27 mW / g AT (r, z, phi) = (125 cm, -5 cm, 315 deg) IN SC#1 LOWER HALF OF THE COIL (y < 0, x > 0) CLOSE TO THE -y AXIS. MANY OTHER PIECES IN THE LOWER HALF AND A FEW ONES IN THE UPPER HALF HAVE PDPD > 0.1 mW / g.

B) 1.76 kW ! OF DEPOSITED POWER IN THE SC#1+2 SEGMENTED VOLUME ONLY. ABOUT 2.3 kW ! IN COILS SC#1+2. 2.7 kW DEPOSITED POWER IN ALL 12 SCs. DEPOSITED POWER IN SC#4 ~ 0.205 kW IS QUITE HIGH ---> POSIBLE PIECES WITH DPD ABOVE ITER LIMIT.

C) INNER TUBE OF Hg MODULE RECEIVES ~ 357 kW WHILE OUTER TUBE ~ 199 kW (BOTH 1 cm THICK STST BELL LIKE SHAPE. INNER TUBE OF SHVS#1 (2 cm THICK STST BELL -LIKE SHAPE) WILL GET ~ 206 kW.

D) ~ 425 kW DEPOSITED IN SH#1, ~ 124 kW IN SH#2, ~ 15 kW IN SH#3 AND ~ 216 kW IN SH#4.

THEN WHAT ?? ......