

IDS120j WITHOUT RESISTIVE MAGNETS

SEMMENTATION STUDIES FOR BP#2 WITHIN FIRST CRYOSTAT AND RIGHT FLANGE OF Hg POOL INNER VESSEL (20 cm GAPS AND 15.8 g/cc W BEADS)

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IDS120j GEOMETRY, NO RESISTIVE COILS: WITH 20 cm GAPS

SIMULATIONS USING LOWEST GRADE W BEADS IN SHIELDING (OF 15.8 g/cc)
BP#2 SEGMENTATION STUDIES WITHIN THE FIRST CRYOSTAT AND RIGHT
FLANGE OF Hg POOL INNER VESSEL.

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

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

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

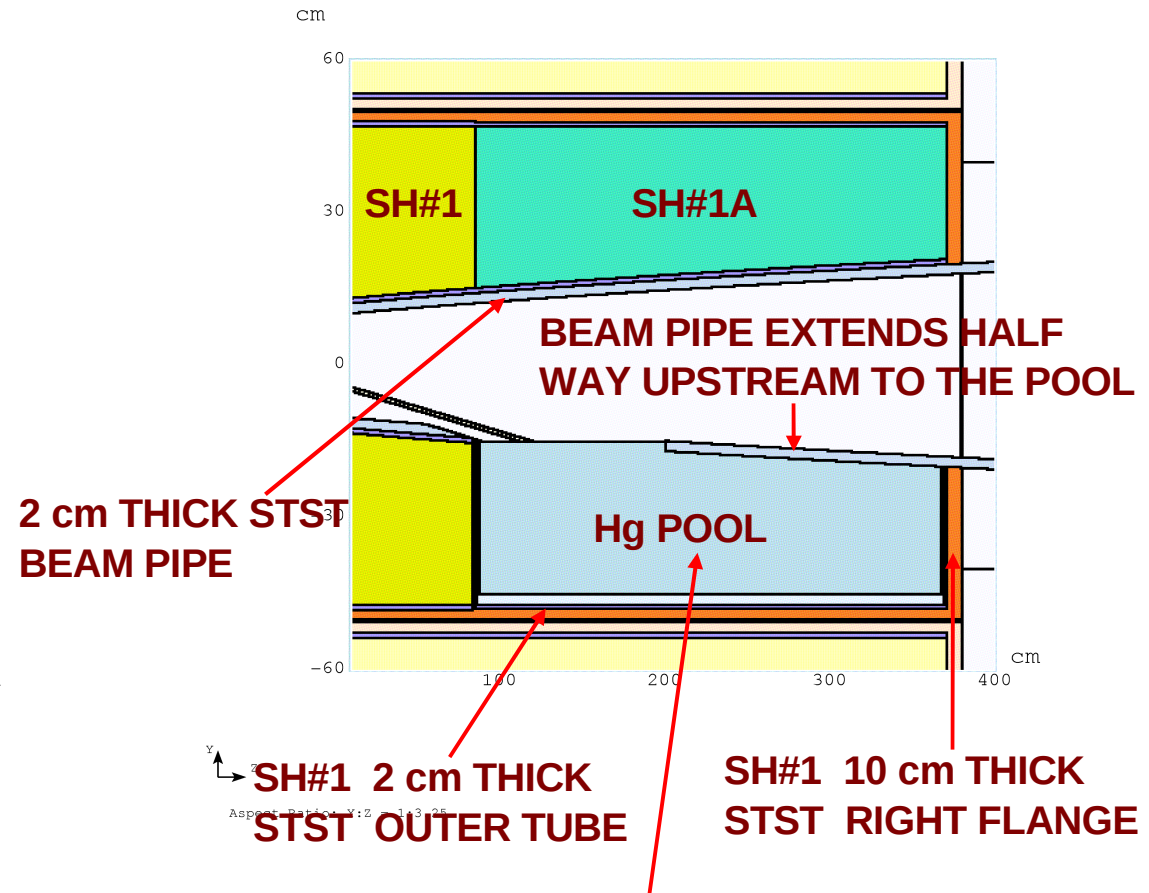
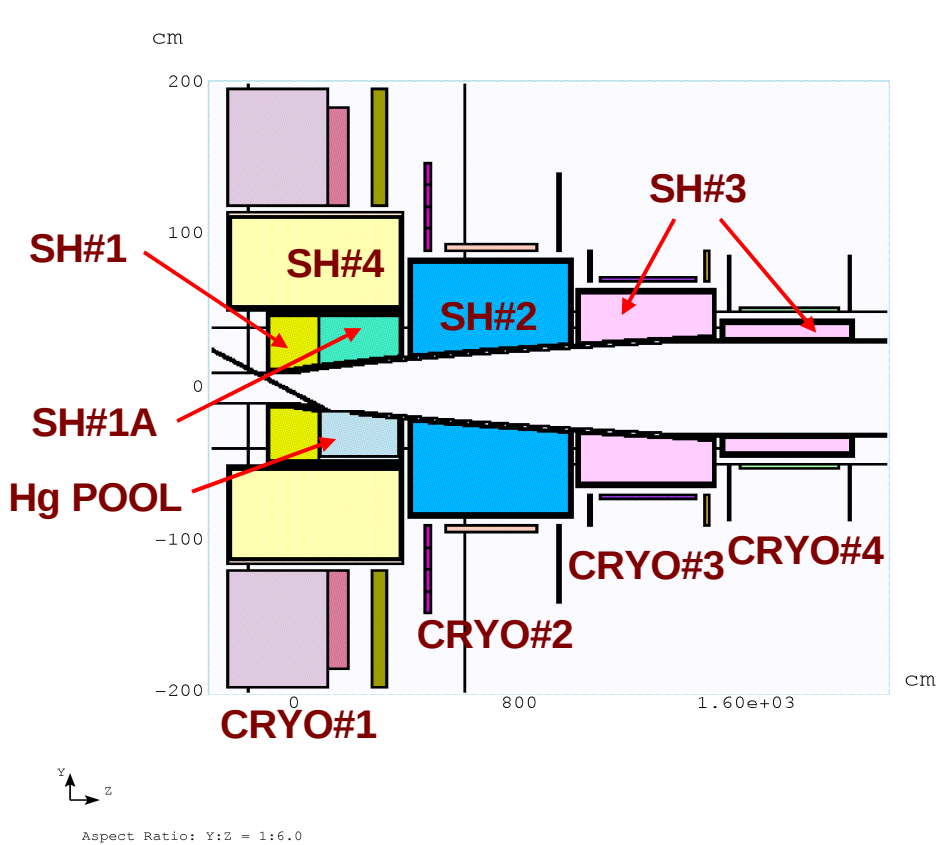
>PROTON BEAM POWER: 4 MW

>PROTON ENERGY: $E = 8$ GeV

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

>EVENTS IN SIMULATIONS : $N_p = 500,000$

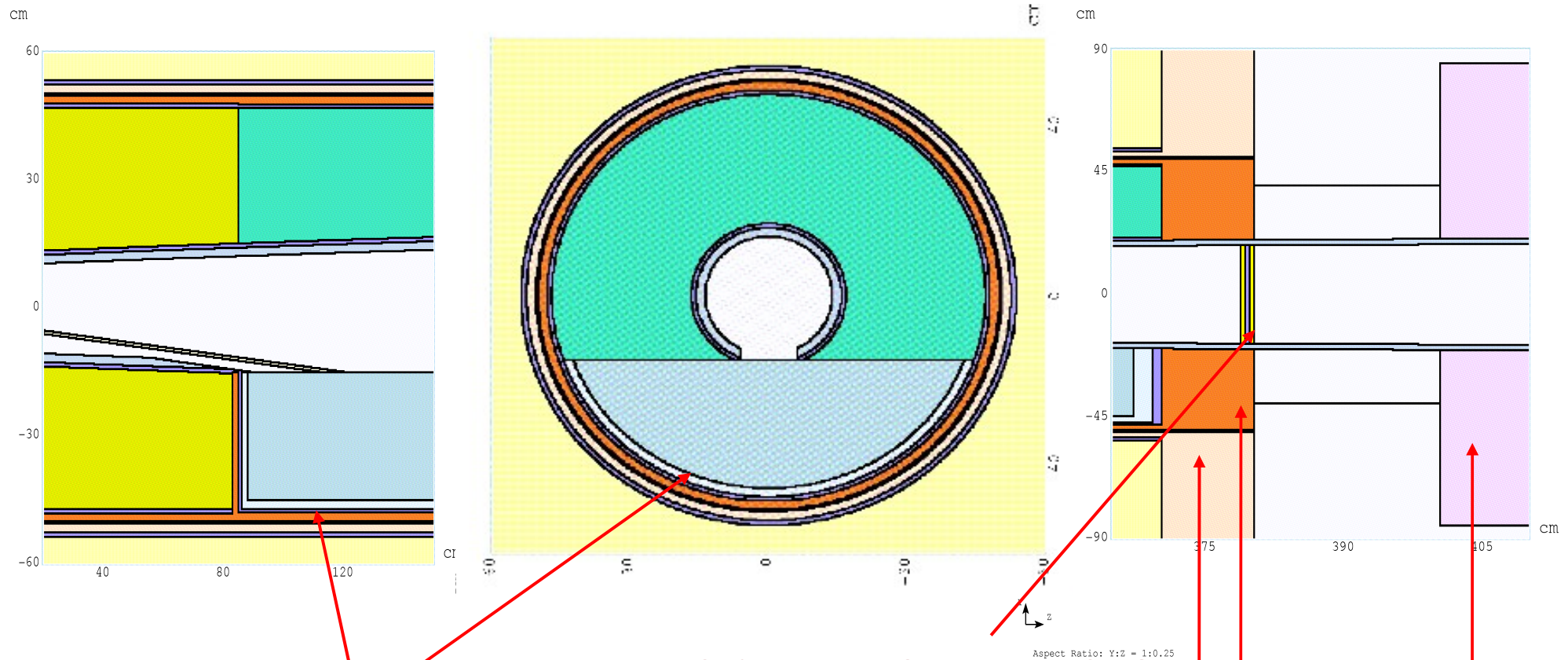
IDS120j: REPLACING RESISTIVE MAGNETS AND FILLING UPPER HALF OF Hg POOL WITH SHIELDING. GENERAL OVERVIEW (LEFT), POOL REGION DETAILS (RIGHT). [20 cm GAPS]



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

SHVS WALLS, Hg POOL VESSEL DOUBLE WALLS, Be WINDOW, He GAP IN Be WINDOW AND IN HG POOL HAVE NOMINAL VALUES FOR THEIR THICKNESS. STRESS FORCES ANALYSIS AND LOCAL DPD DISTRIBUTION WILL BE USED TO DETERMINE THEIR VALUES.

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

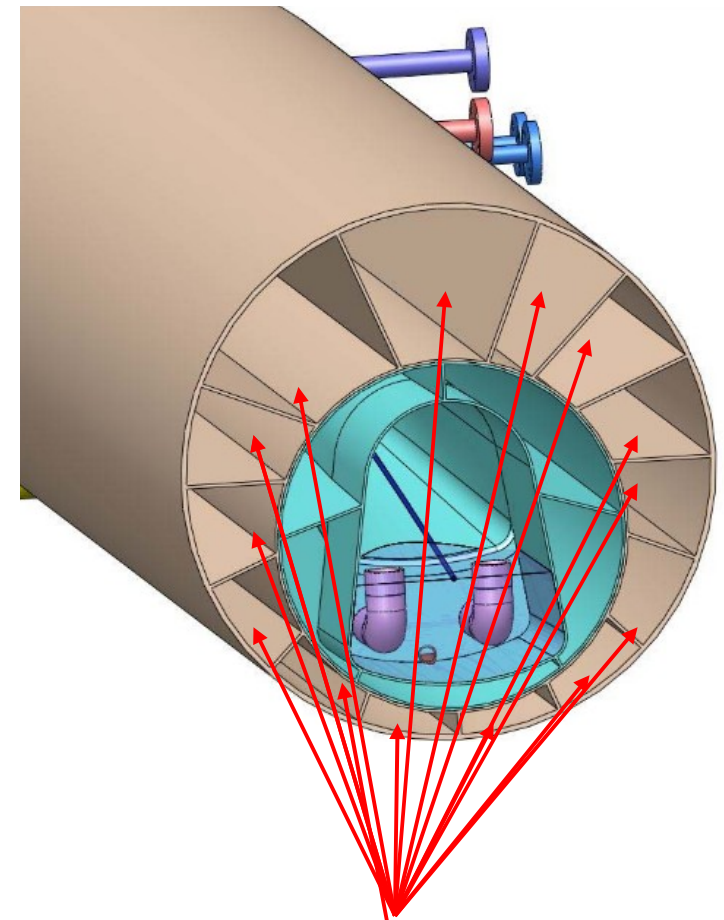
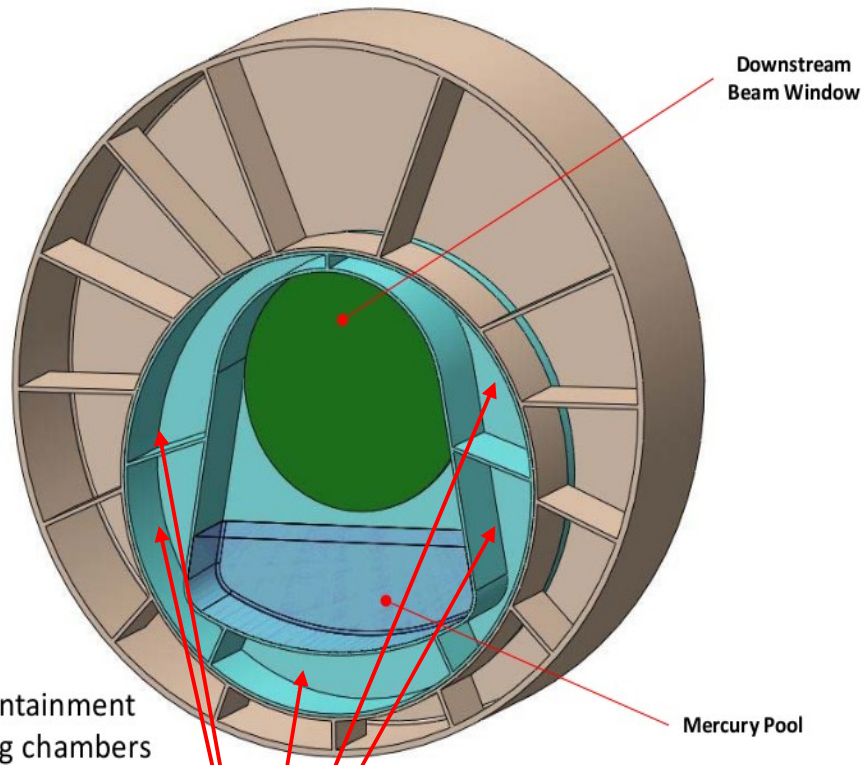


2 cm THICK STST INNER Hg POOL VESSEL WITH 1 cm He GAP FOR COOLING.

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.

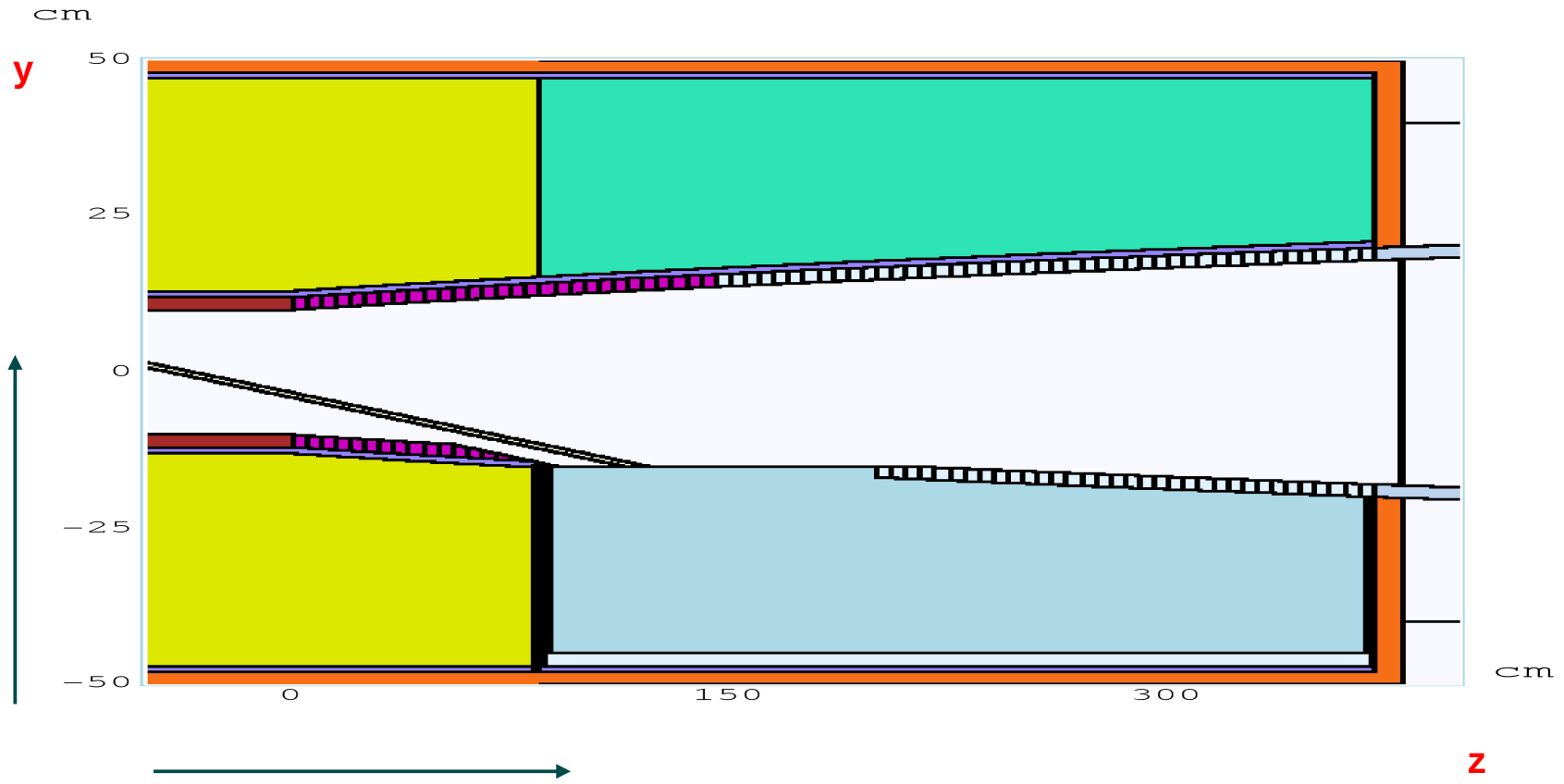
**IDS120j: DETAILS OF THE DOUBLE WALL Hg POOL VESSEL ENVISIONED BY VAN GRAVE.
(PLOTS ARE FROM VAN GRAVE'S 6/12/2012 PRESENTATION)**



He GAS WILL BE FLOWING BETWEEN THE TWO WALLS FOR COOLING. THE BEAM PIPE IN THAT AREA WILL BE PART OF THE POOL VESSEL AND REMOVING THE HEAT LOAD WILL BE A CHALLENGING TASK. SEGMENTATION ANALYSIS WILL BE PERFORMED TO DETERMINE THE AZIMUTHAL DPD DISTRIBUTION.

VESSEL FILLED WITH He COOLED W BEADS FOR SCs SHIELDING.

IDS120j: yz CROSS SECTION WITH DETAILS OF THE BP#2 SEGMENTATION



Aspect Ratio: Y:Z = 1:4.5

$$R_{ap}(z) < r < R_{ap}(z) + dr \text{ cm}$$

$$0.00 < z < 370.00 \text{ cm}$$

$$0.0 < \phi < 360.0 \text{ deg.}$$

$$dr = 2.00 \text{ cm}$$

$$dz = 5.00 \text{ cm}$$

$$d\phi = 30 \text{ deg.}$$

$$N_r = 1 \text{ bins}$$

$$N_z = 74 \text{ bins}$$

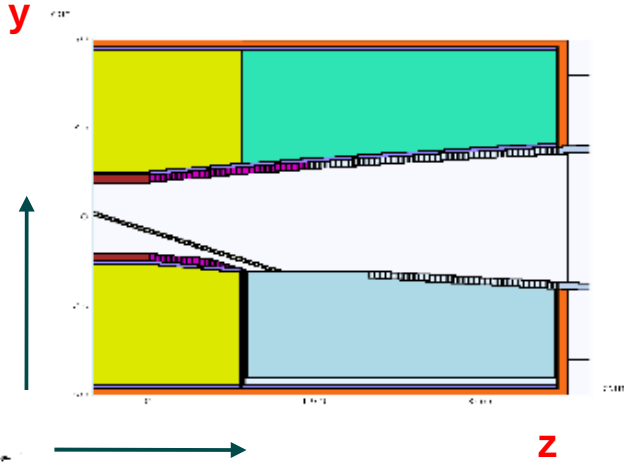
$$N_\phi = 12 \text{ bins}$$

$$N_{\text{tot}} = 888 \text{ "pieces"}$$

Volumes calculated using a closed form expression. The pieces in the lower half of the pipe, near the beginning of the pool, and after the end of the pool gap CAN NOT be calculated precisely and whole volumes were used instead in mars. The DP densities therefore are not correct.

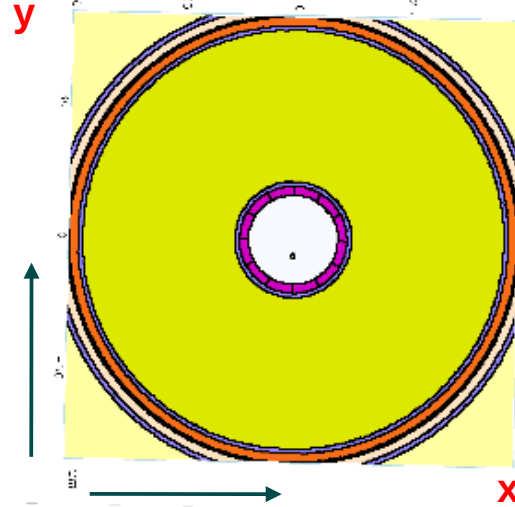
IDS120j: yz AND xy CROSS SECTIONS WITH DETAILS OF THE BP#2 SEGMENTATION (1)

$x = 0.0$



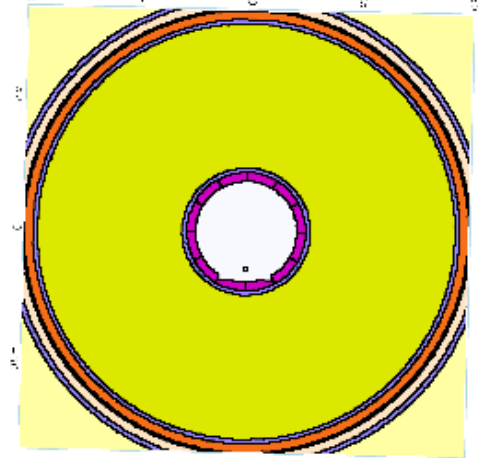
$z = 0.0$

$\phi = 90^\circ$

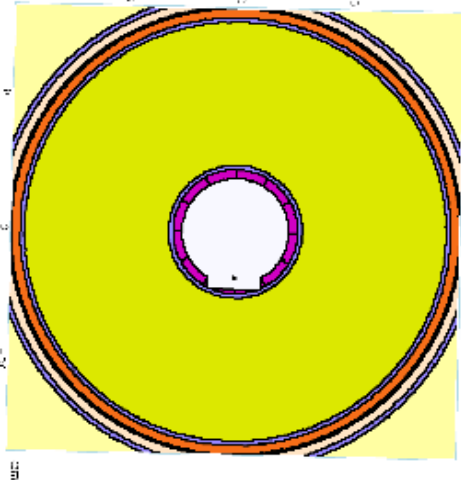


$z = 50.0$

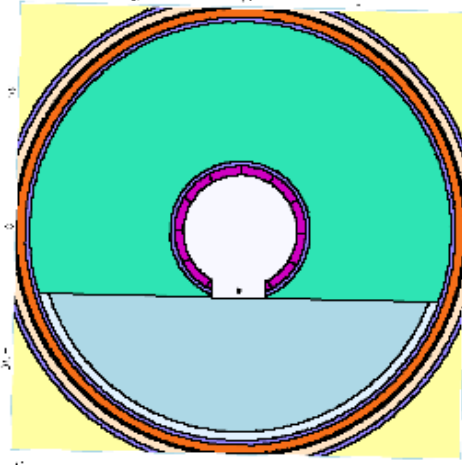
$\phi = 0^\circ$



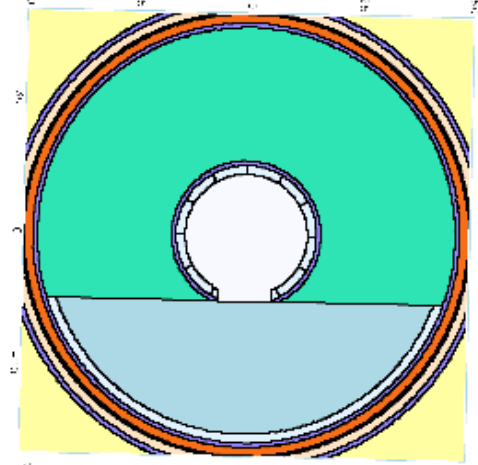
$z = 70.0$



$z = 100.0$

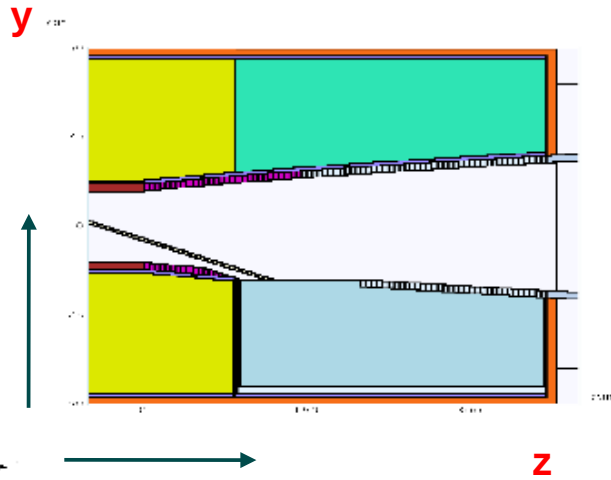


$z = 150.0$



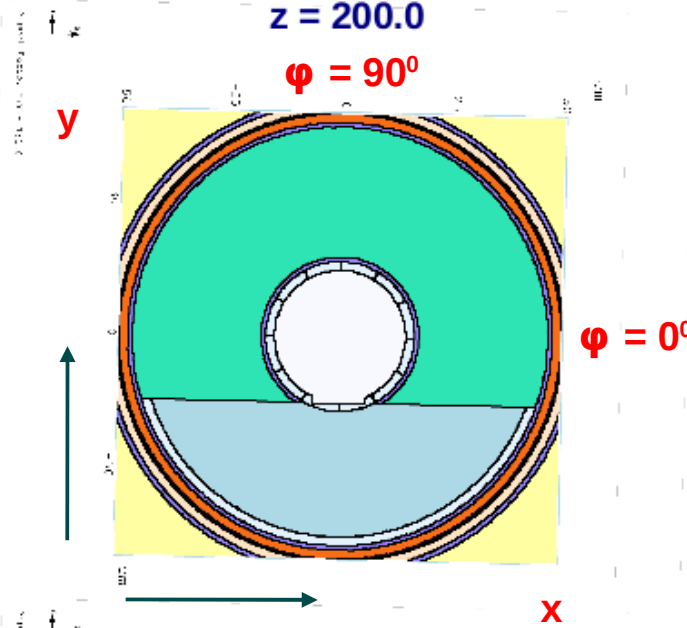
IDS120j: yz AND xy CROSS SECTIONS WITH DETAILS OF THE BP#2 SEGMENTATION (2)

$x = 0.0$



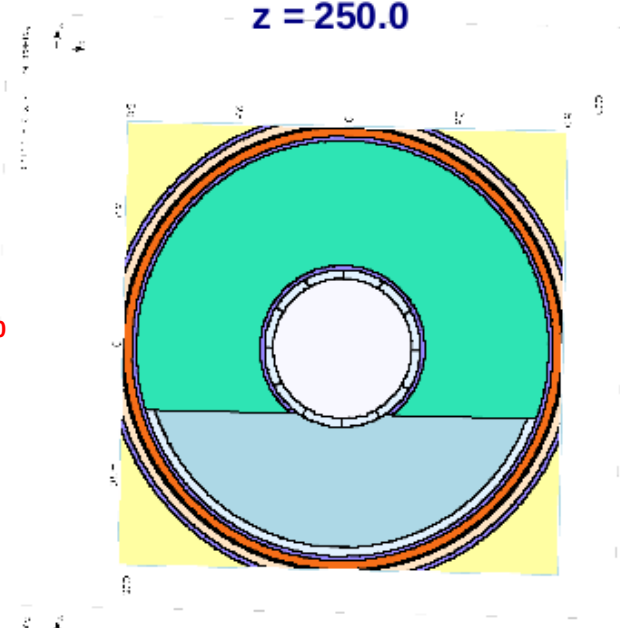
$z = 200.0$

$\varphi = 90^\circ$

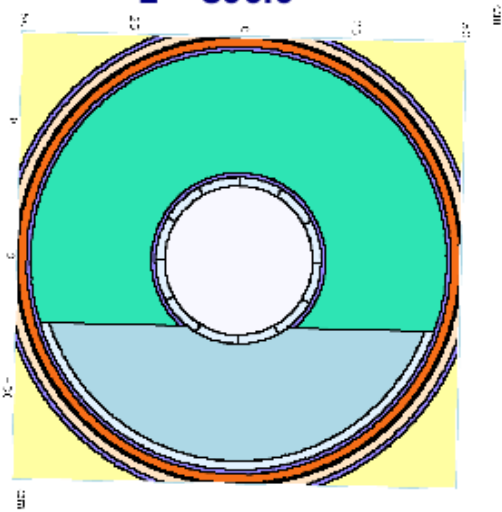


$z = 250.0$

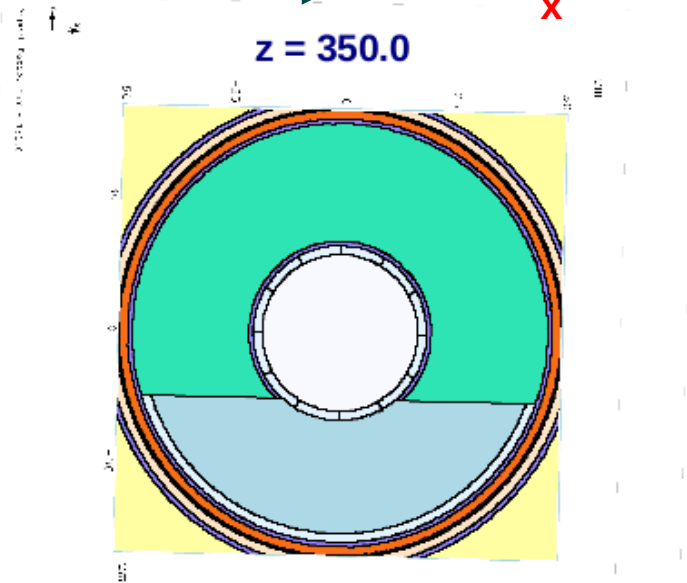
$\varphi = 0^\circ$



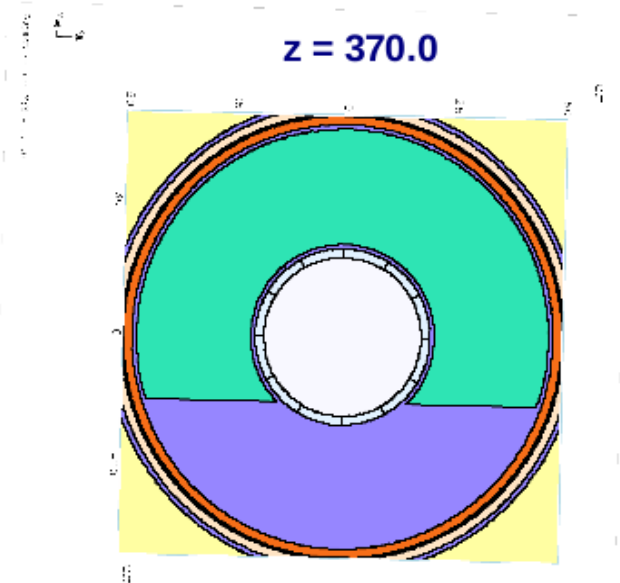
$z = 300.0$



$z = 350.0$

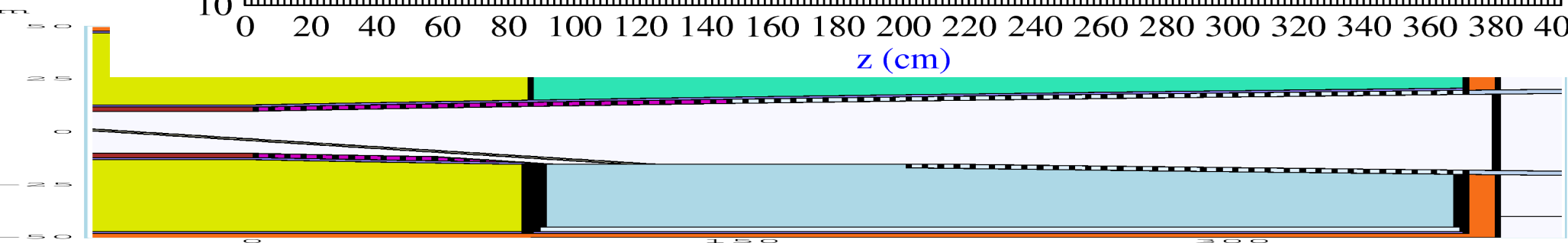
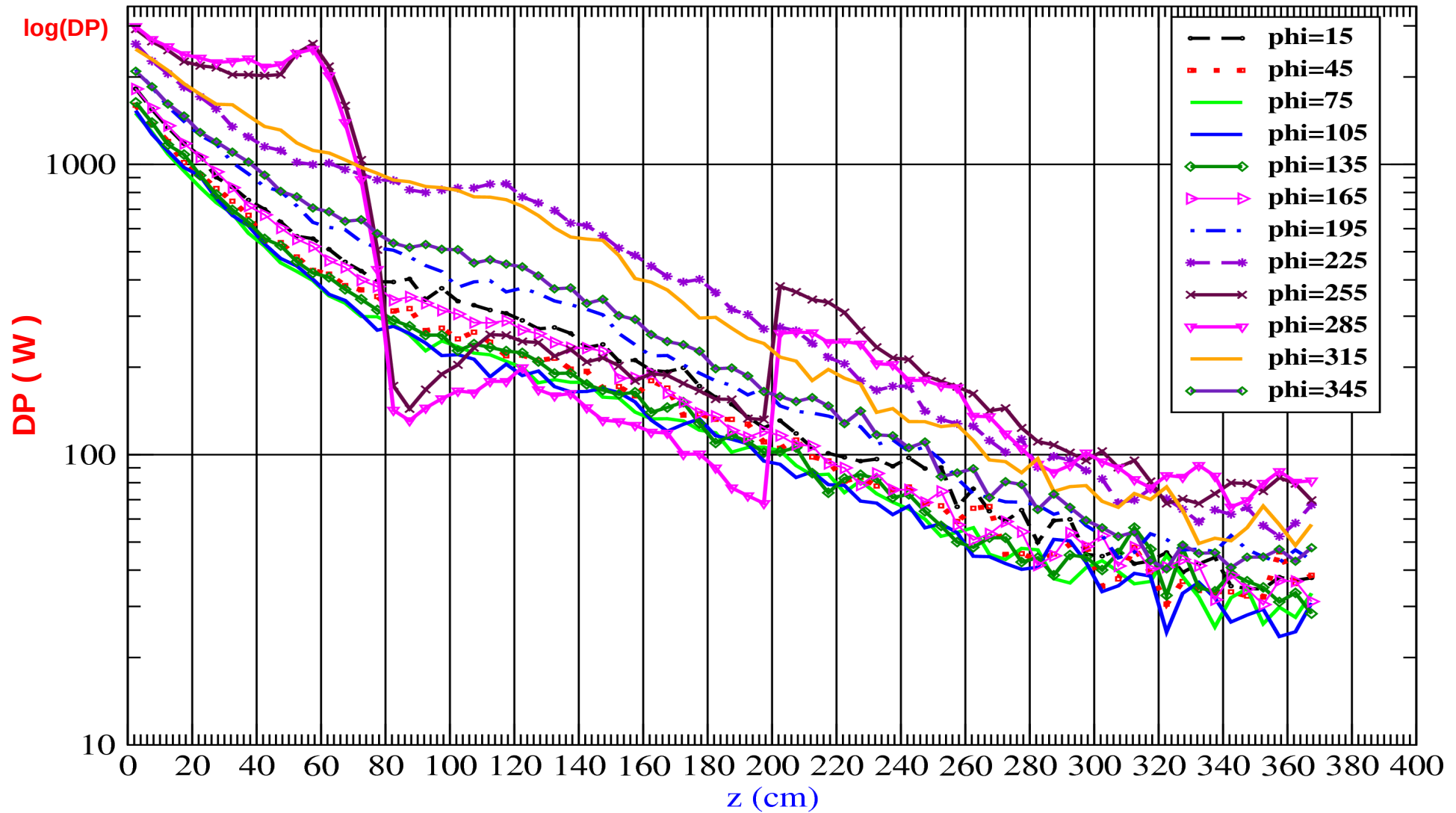


$z = 370.0$



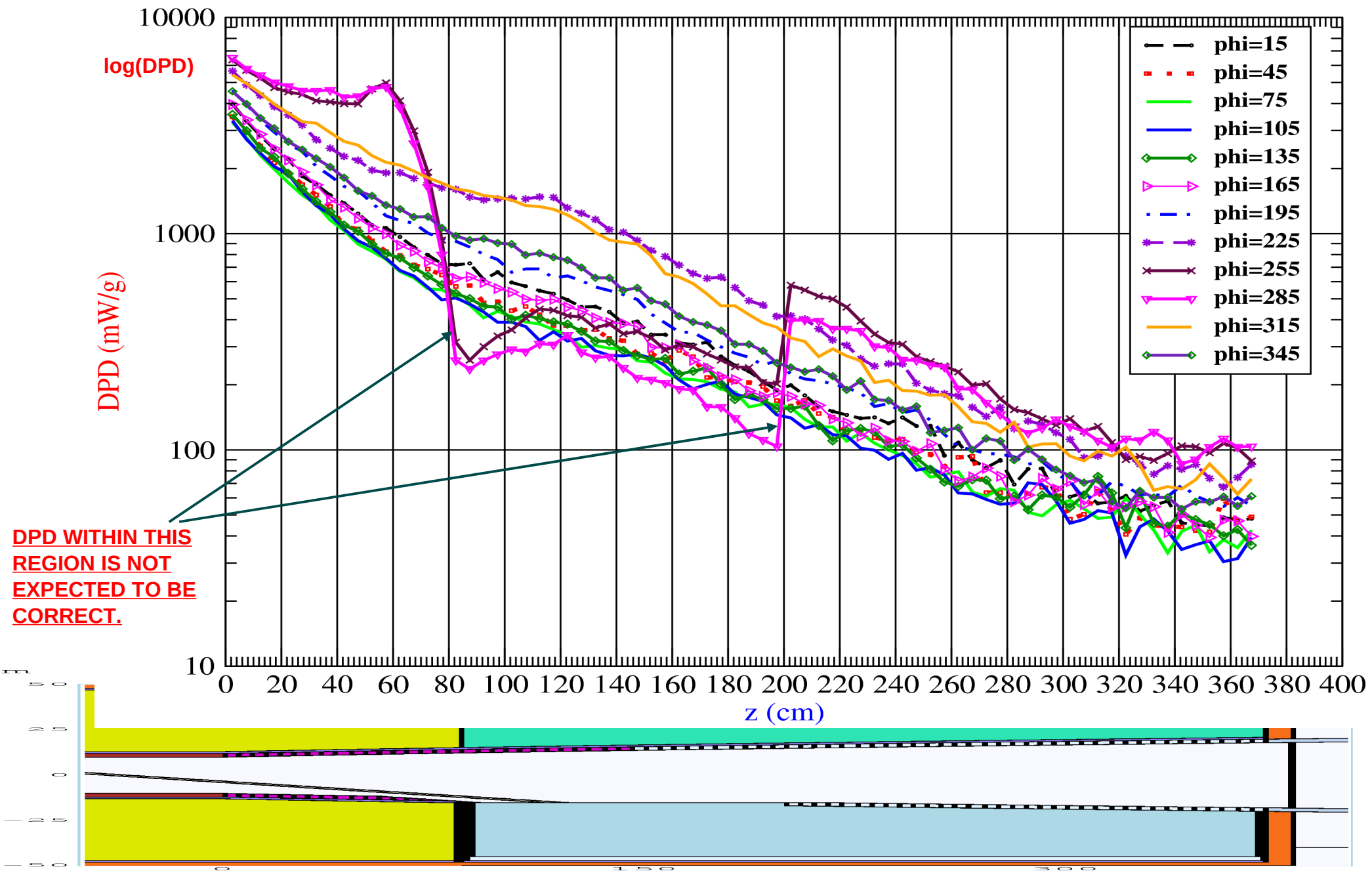
DP vs. z in BP#2 from $0 < z < 370$ cm with $dz=5.0$ cm, $dr=2.0$ cm and $d\phi=30$ deg for 12 angles

Coordinates are for the center of each piece, BP is 2.0 cm thick STST



DPD vs. z in BP#2 from $0 < z < 370$ cm with $dz=5.0$ cm, $dr=2.0$ cm and $d\phi = 30$ deg for 12 angles

Coordinates are for the center of each piece, BP is 2.0 cm thick STST



SUM OF DP FROM 888 PIECES :	335.72 kW
DP FROM REST OF BP#2 :	48.00 kW
TOTAL DP IN BP#2 :	383.72 kW
BP#2 DP WITHOUT SEGMENTATION:	384.06 kW

335.72 kW IS DEPOSITED IN BP#2 PART WITHIN THE FIRST CRYOSTAT AND ANOTHER 322.49 kW IN THE 100 cm LONG BP#1 IN THE TARGET REGION. IN TOTAL ~ 707 kW GO TO THE BEAM PIPE WITHIN THE FIRST CRYOSTAT (INNER SHIELDING VESSEL LENGTH ~ 5 m). IT IS MORE THAN ~ 300 kW THE DP WE HAVE IN THAT AREA WITH RESISTIVE COILS PRESENT. THIS IS A RESULT OF THE DIFFERENT MAGNETIC FIELD PROFILE IN THE TARGET REGION.

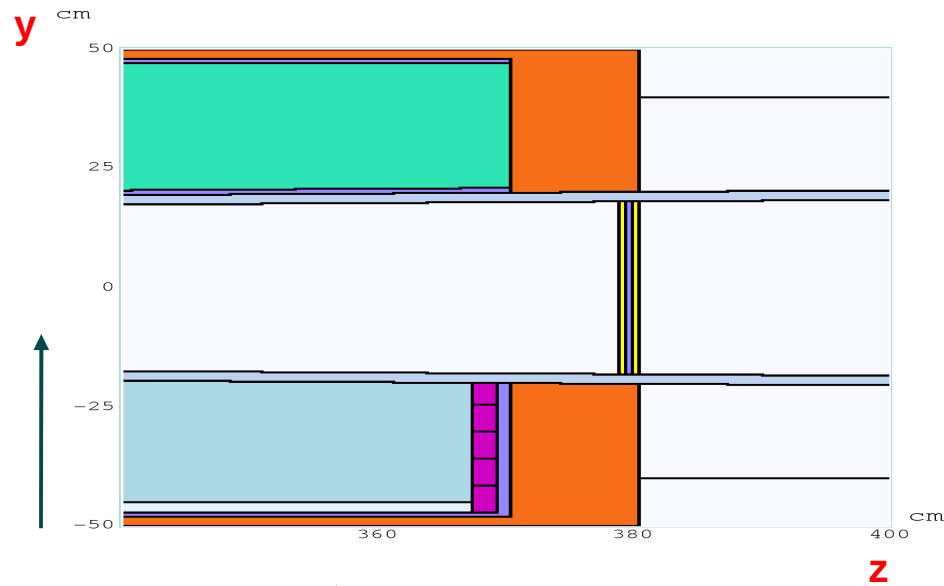
LOWEST DP IS EXPECTED ALONG THE - x DIRECTION WHILE MOST OF THE DP IS BETWEEN 255 AND 315 DEGREES (- y DIRECTION).

HOT SPOTS ARE EXPECTED IN THE PIECES NEAR THE GAP OF THE POOL. DP HAS BEEN ESTIMATED THERE BUT DP DENSITY CAN NOT BE DETERMINED UNLESS WE HAVE THE PRECISE VOLUME OF THE "INCOMPLETE" PIECES.

IN REALITY THERE WILL BE A SHARP CUTOFF FOR THE BEAM PIPE AT THE BEGINNING OF THE POOL. IN THE SIMULATIONS THIS CAN BE IMPLEMENTED BY JUST HAVING THE Hg POOL BEGINNING AT 75 - 80 cm INSTEAD AT 85 cm. STILL THERE WILL BE "INCPOMLETE" PIECES BECAUSE OF THE AZIMUTHAL SEGMENTATION. A SMALLER ANGULAR BIN SIZE MAY IMPROVE THE SITUATION.

A BELL-LIKE SHAPE FOR THE Hg POOL VESSEL CAN BE IMPLEMENTED IN MARS IF THERE IS AN EQUATION THAT CAN BE USED FOR THAT PURPOSE.

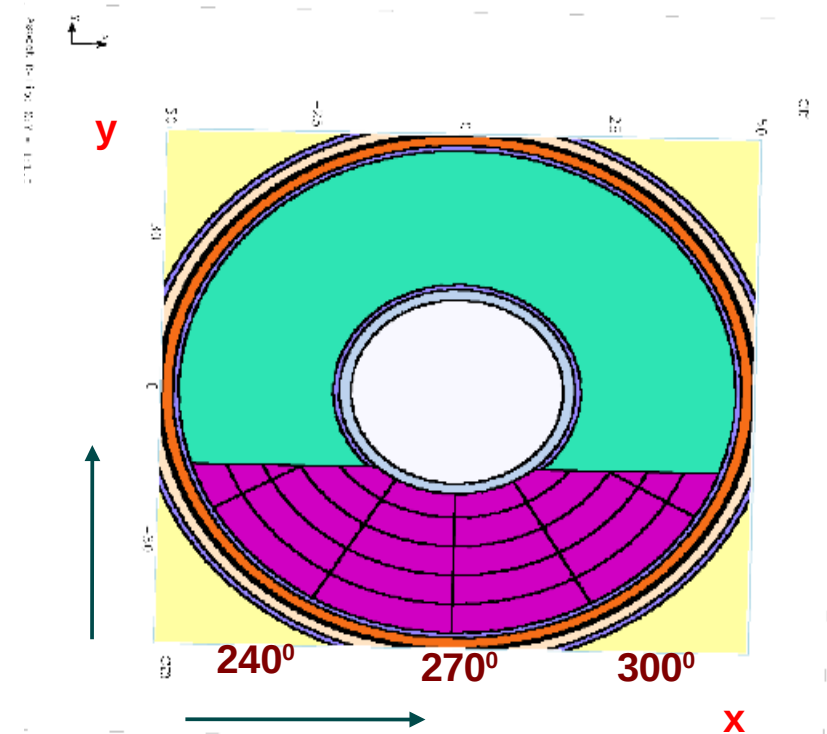
IDS120j: yz AND yx CROSS SECTIONS WITH DETAILS OF Hg POOL INNER VESSEL RIGHT FLANGE



Aspect Ratio: Y:Z = 1:0.6

$R_{ap}(367) < r < 47.0 \text{ cm}$
 $367.34 < z < 369.34 \text{ cm}$
 $0.0 < \phi < 360.0 \text{ deg.}$

$N_{tot} = 60$ "pieces"

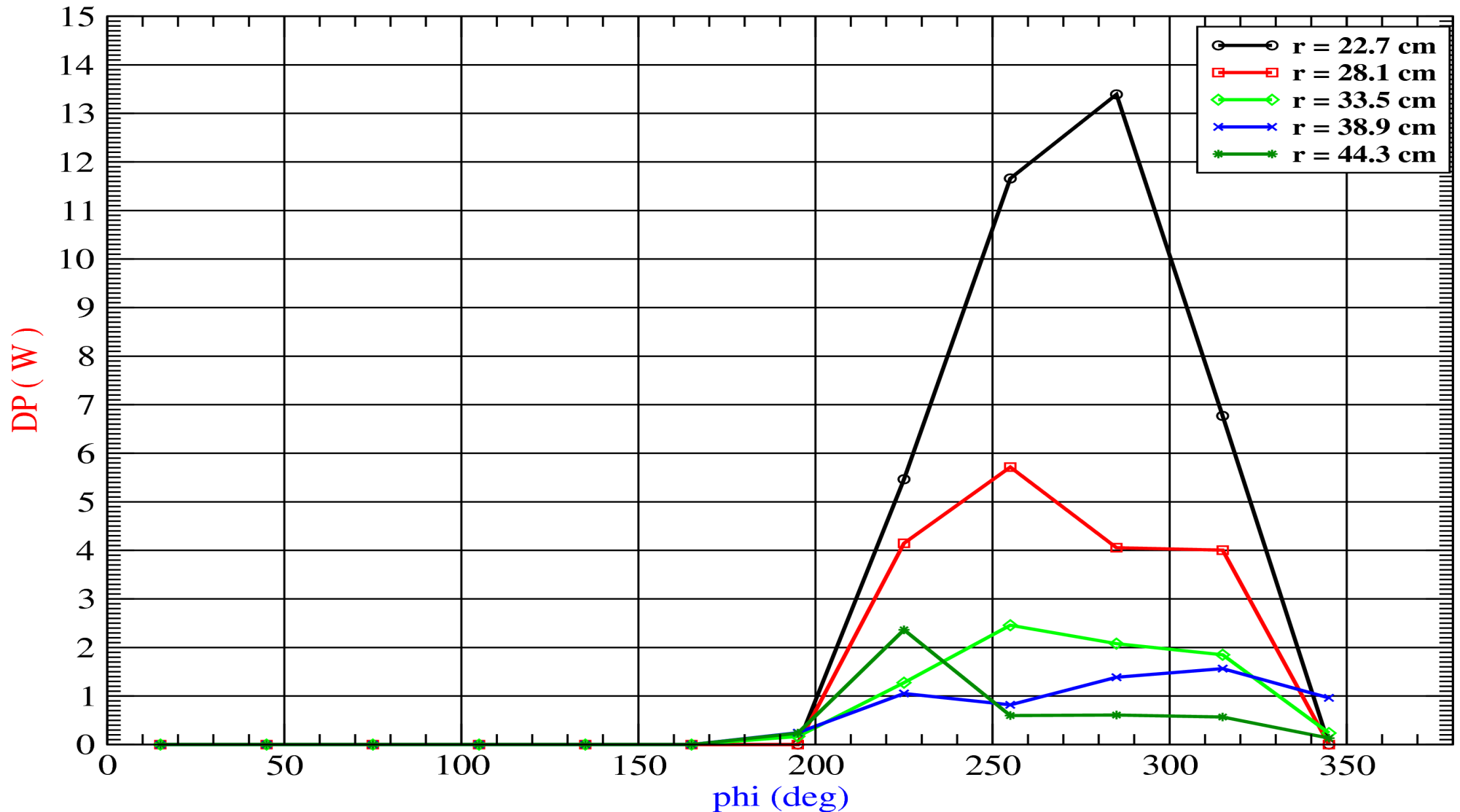


$dr = 5.4 \text{ cm}$ $N_r = 5 \text{ bins}$
 $dz = 2.0 \text{ cm}$ $N_z = 1 \text{ bins}$
 $d\phi = 30 \text{ deg.}$ $N_\phi = 12 \text{ bins}$

As in the case of BP#2 segmentation, it is not possible to calculate the volume of pieces that are incomplete (near the shielding region). Full volume values for these pieces were inserted in mars subroutine and the estimated DP densities are not correct. The DP is correct. One would expect most of the DP from whatever beam protons reach the end of the pool to be in the 240 - 300 degree region. Therefore we are interested mostly for the DPD in these pieces.

Hg pool inner vessel right flange DP vs. phi from $20 < r < 47$ cm with $dr=5.4$ cm, $dz=2.0$ cm and $dphi = 30$ deg

Coordinates are for the center of each piece, flange is 2.0 cm thick STST

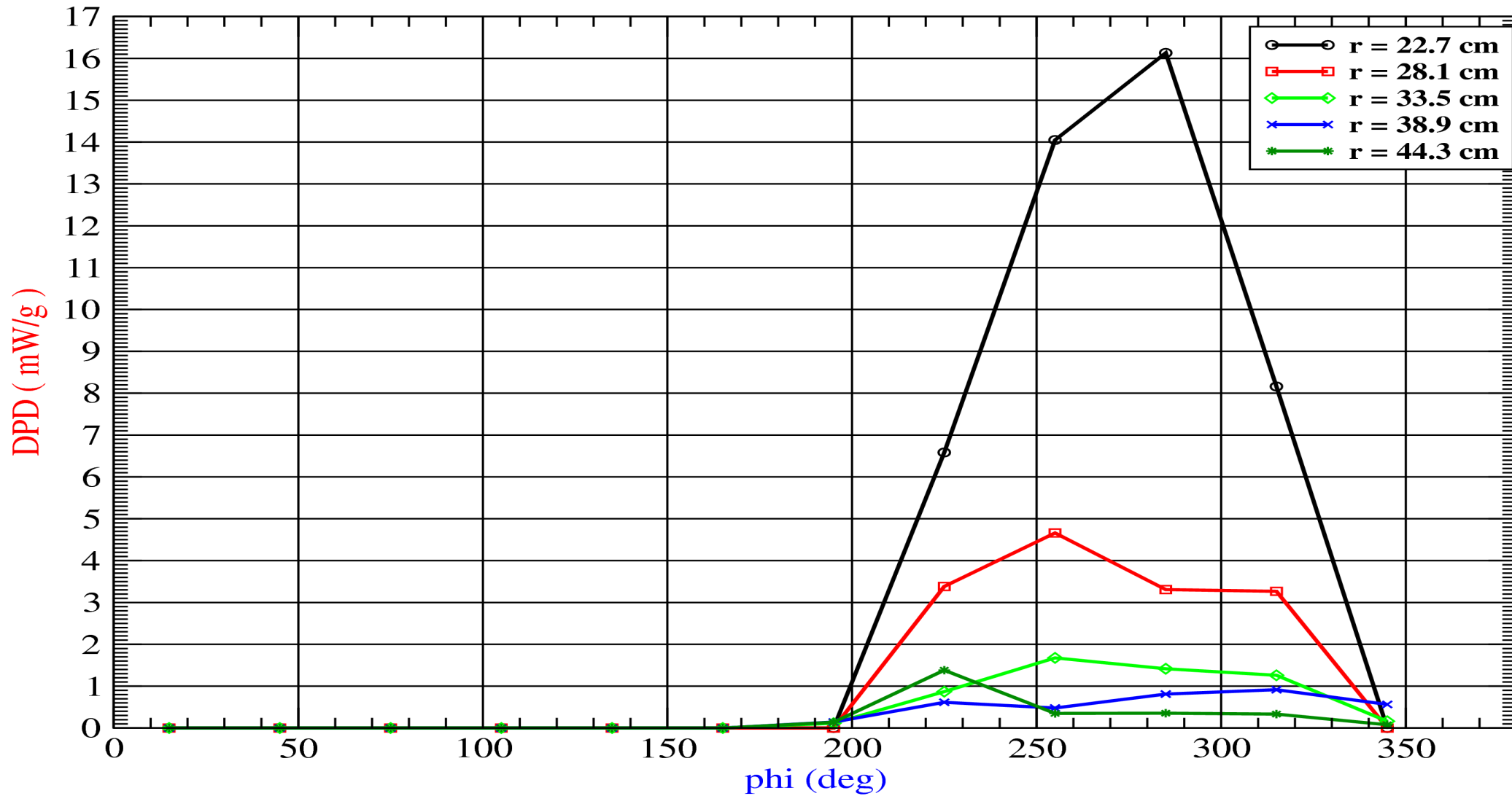


TOTAL DEPOSITED POWER IN RIGHT FLANGE IS 0.0737 kW WHILE THE TOTAL IN THE INNER VESSEL (NOT INCLUDING THE BEAM PIPE THERE) IS ~ 6.5 kW.

THE POOL LENGTH IS ABOUT 300 cm AND MOST OF THE PROTONS ENERGY IS LOST IN THE Hg. IT IS ALSO POSSIBLE MOST OF THEM ARE SPREAD OUT IN DIFFERENT DIRECTIONS AND VERY FEW REACH THE FLANGE.

Hg pool inner vessel right flange DPD vs. phi from $20 < r < 47$ cm with $dr=5.4$ cm, $dz=2.0$ cm and $dphi =30$ deg

Coordinates are for the center of each piece, flange is 2.0 cm thick STST



PEAK POWER DENSITY IS ABOUT 16 mW/g AT ~ 270 deg AND $r = 22.7$ cm. THAT IS THE AREA CLOSE TO THE BEAM PIPE AS ONE WOULD EXPECT. AN EXCESSIVE AMOUNT OF POWER IS DESPOSITED IN THE BEAM PIPE IN THE IDS120j WITHOUT RS SINCE MORE PROTONS ARE "SCRAPING" NOW THE PIPE. DPD VALUES NEAR 200 deg AND 350 deg ARE NOT CORRECT. THE PIECES ARE INCOMPLETE THERE AND THE WHOLE VOLUME WAS USED UNDERESTIMATING IN THAT WAY THE DPD VALUES.