20to2T5m WITH RESISTIVE MAGNETS: C TARGET
SC#3, BeWind#1, SHVS#4 INNER TUBE TDPD AZIMUTHAL DISTRIBUTION
[UPDATED]

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20to2T5m WITH RESISTIVE MAGNETS: 10 cm GAPS BETWEEN CRYOSTATS

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 # SC#3 AND BeWind#1, SHVS#4 INNER TUBE AZIMUTHAL TDPD SIMULATIONS, WITH ADDITIONAL SHIELDING AFTER THE RS (SH#4 REGION) [ICEM = 1 MODE SIMULATIONS].

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➡ **SIMULATION CODE: mars15(2014)[USING MCNPDATA x-SECTION LIBRARIES FOR NEUTRON INTERACTIONS WITH KE < 14 MeV]**

➡ **NEUTRON ENERGY CUTOFF: 10^{-12} GeV**

➡ **SHEILDING: 60% W + 40% He [WITH STST VESSELS]**

➡ **B_z (r = 0, z) : 20 T [z = 0.0 cm] ---→ 2.0 T [z ~ 500.0 cm]**

➡ **C ROD RADIUS / ANGLE: 0.80 cm / 65 mrads (~ 3.72 degrees) [-40.0 < z < 40.0 cm]**
C density ~ 1.8 g/cc { C DUMP: NO DUMP }

➡ **PROTON BEAM POWER: 4.0 MW**

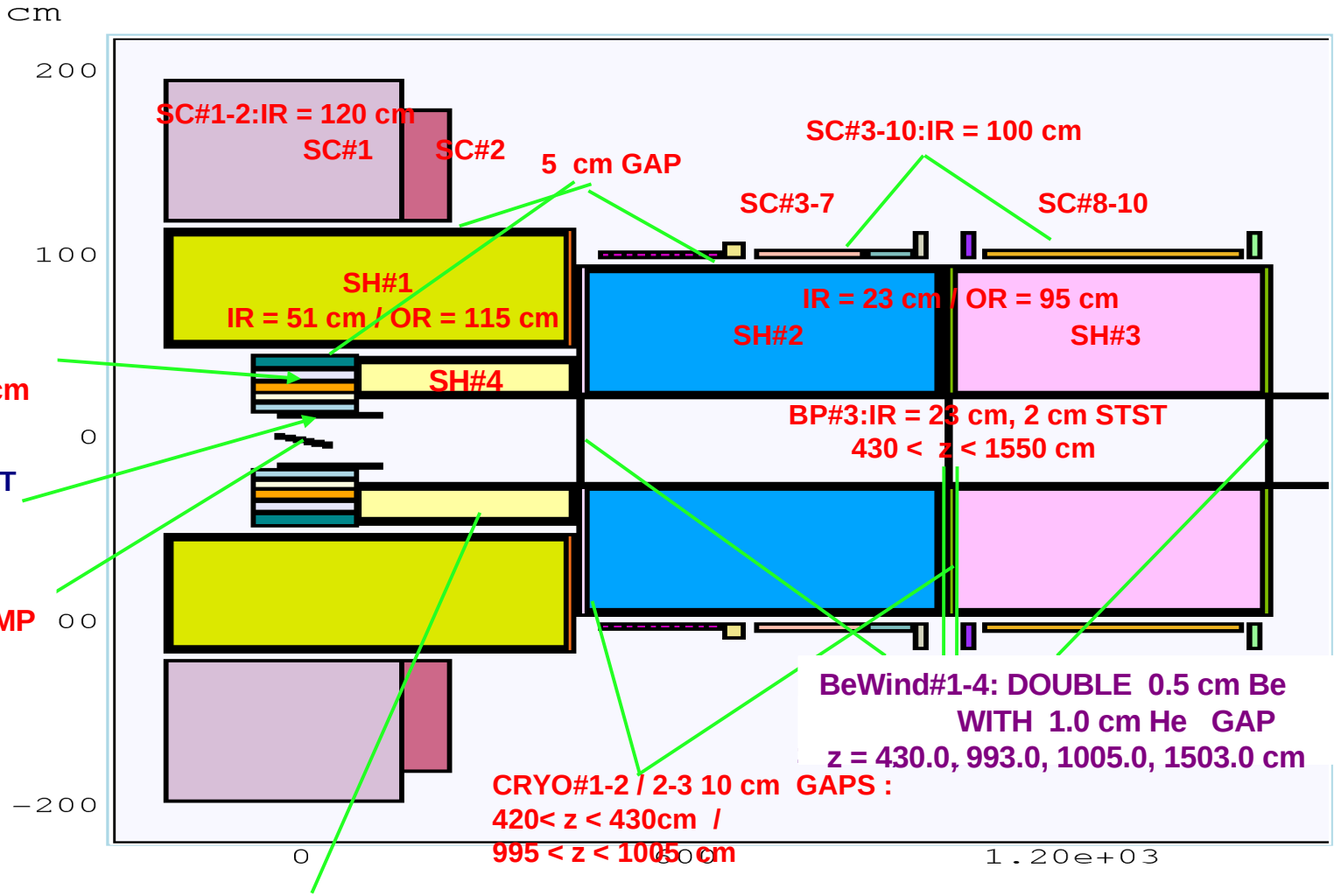
➡ **PROTON ENERGY: E = 6.75 GeV**

➡ **PROTON BEAM PROFILE : GAUSSIAN, σ_x = 0.3268 σ_y = 0.3272 cm**
[5 micron emmitance, sigma star =0.18 at z = 0.0 cm]

➡ **PROTON BEAM LAUNCH : (xo, yo, zo) = (-2.274236, 5.93971, -100.0) cm**
(dcxo, dcyo, dczo) = (0.03922601, -0.0503227, -0.9979624)

➡ **EVENTS IN SIMULATIONS : N_p = 5E6 ==> 100 (SUBDIRECT) x 5E4 (STEP: 10^-3)**

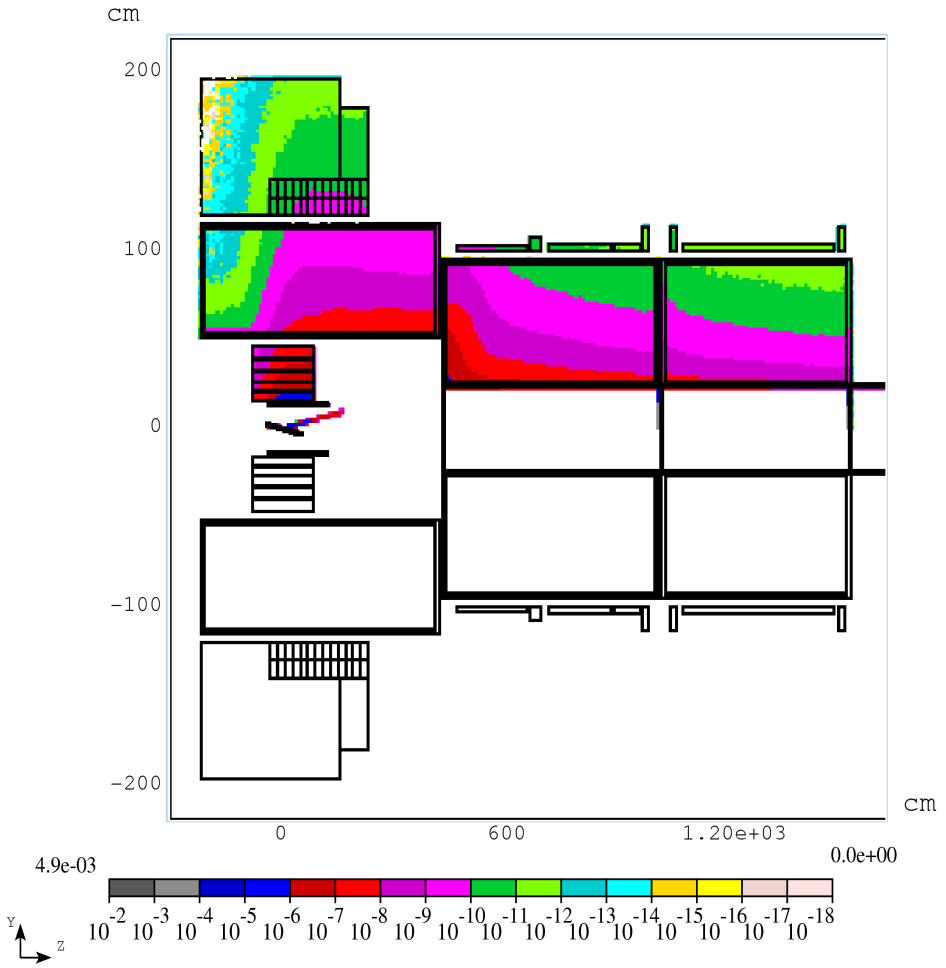
20to2T5m: yz CROSS SECTION (x = 0.0 cm) WITH GEOMETRY DIMENSIONS / PARAMETERS.
ADDITONAL SHIELDING HAS BEEN INSERTED AFTER THE RS TO PROTECT SC#3.

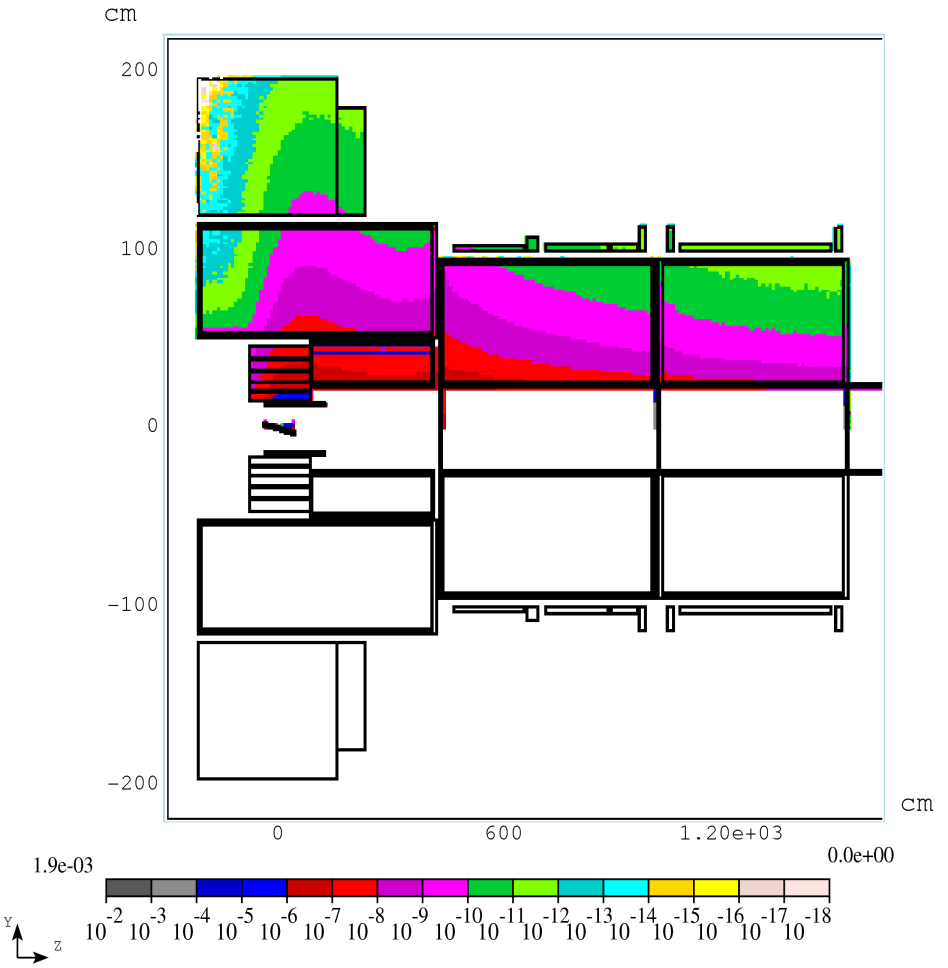


20to2T5m: yz CROSS SECTION (x = 0.0 cm) WITH AZIMUTHALLY AVERAGE TDPD DISTRIBUTION BEFORE (LEFT) AND AFTER INTRODUCING SHIELDING AFTER THE RS REGION (RIGHT)

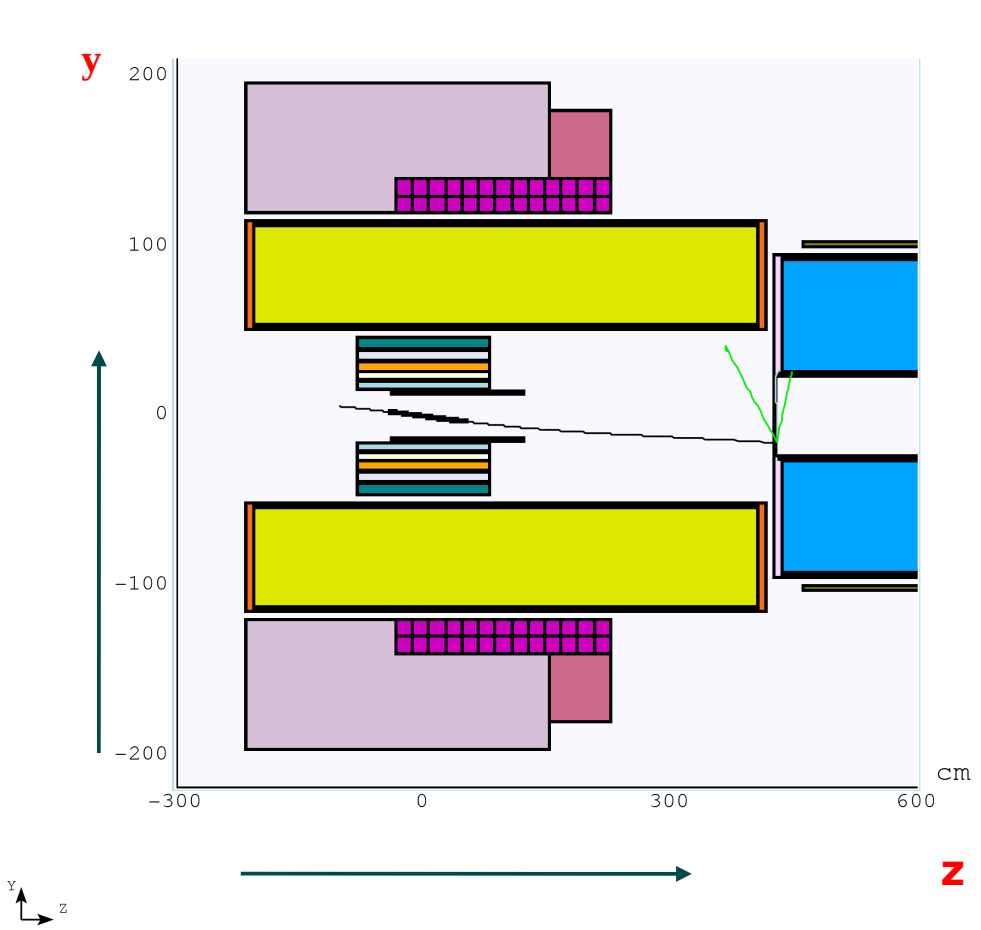
{ LEFT PLOT HAS R= 0.72 cm C TRGT AND DUMP WITH 40 < z < 160 cm FOR DUMP }

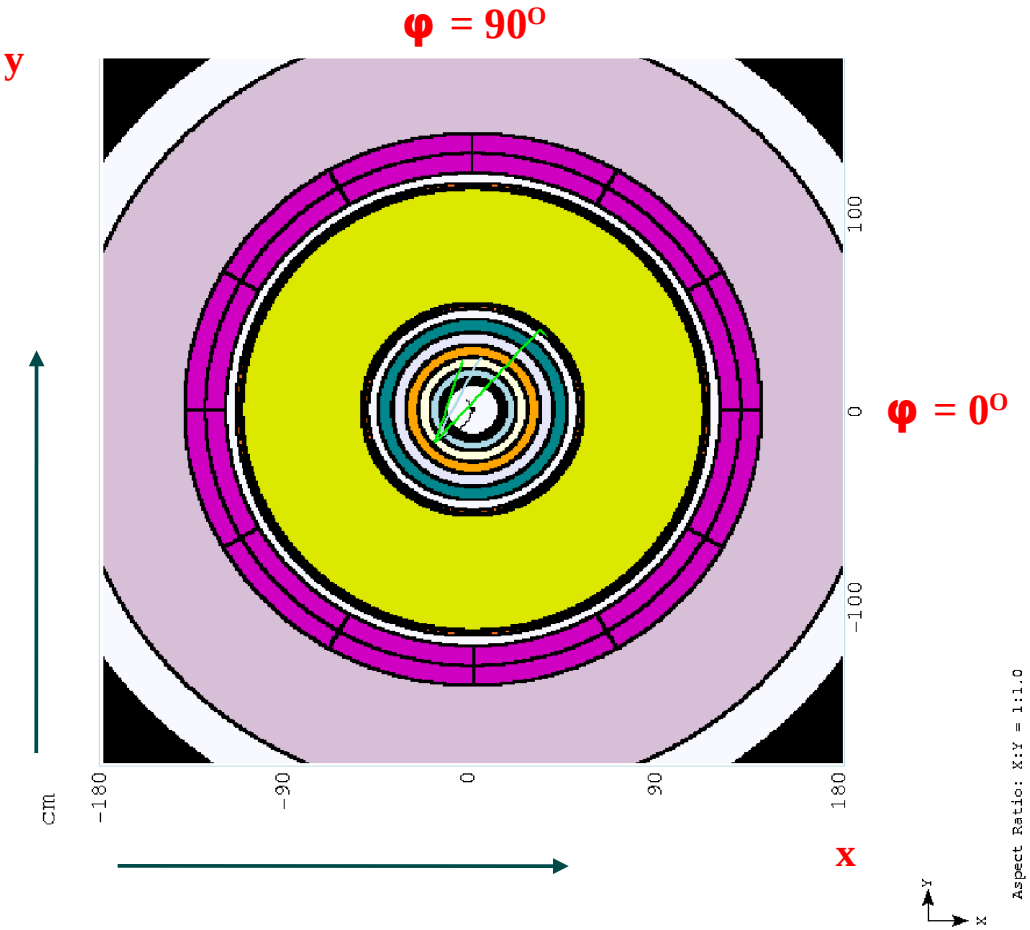
COLOR SCALES ARE THE SAME FOR BOTH PLOTS





SC#1+2 SEGMENTATION DETAILS : yz AT x = 0.0 cm [LEFT] AND xy AT z = 0.0 cm [RIGHT] CROSS SECTION.





$120.0 < r < 140.0$ cm $dr = 10.0$ cm $N_r = 2$ bins

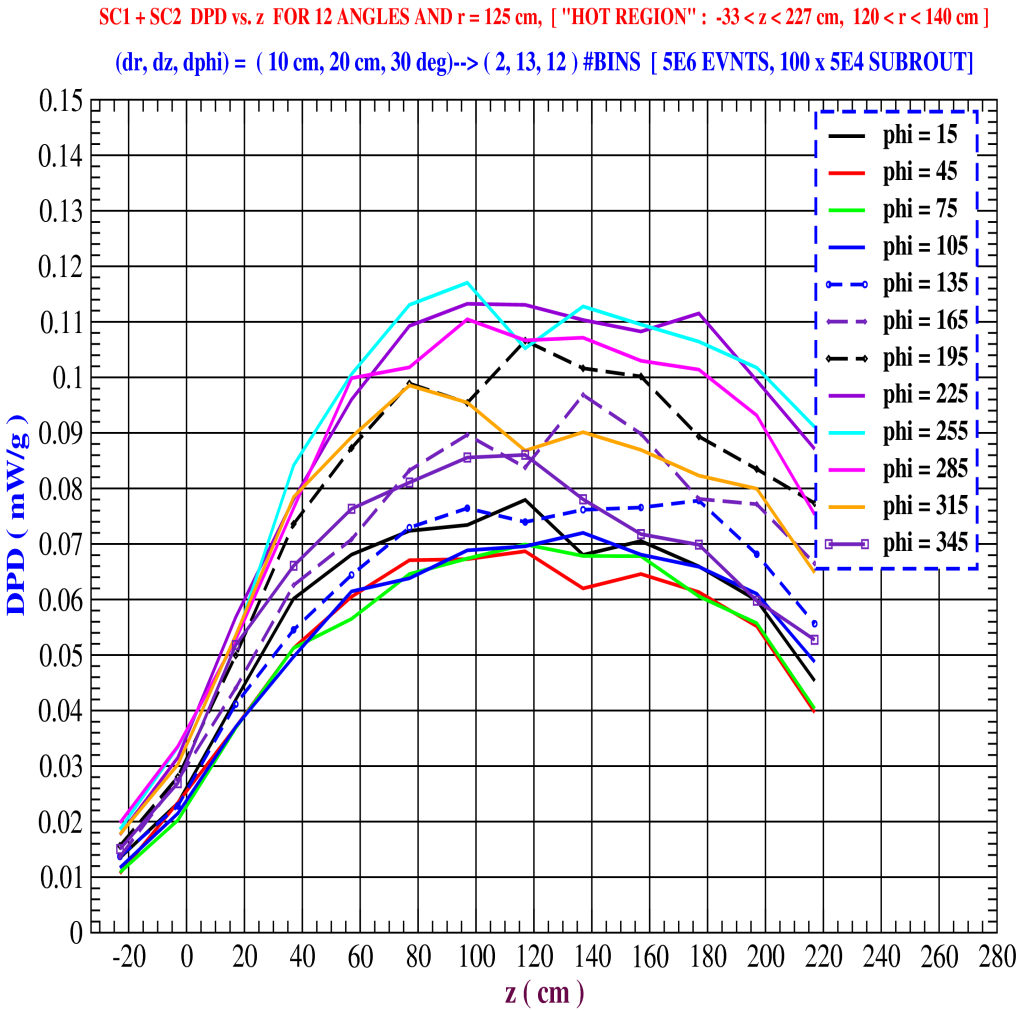
$-33.0 < z < 227.0$ cm $dz = 20.0$ cm $N_z = 13$ bins

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

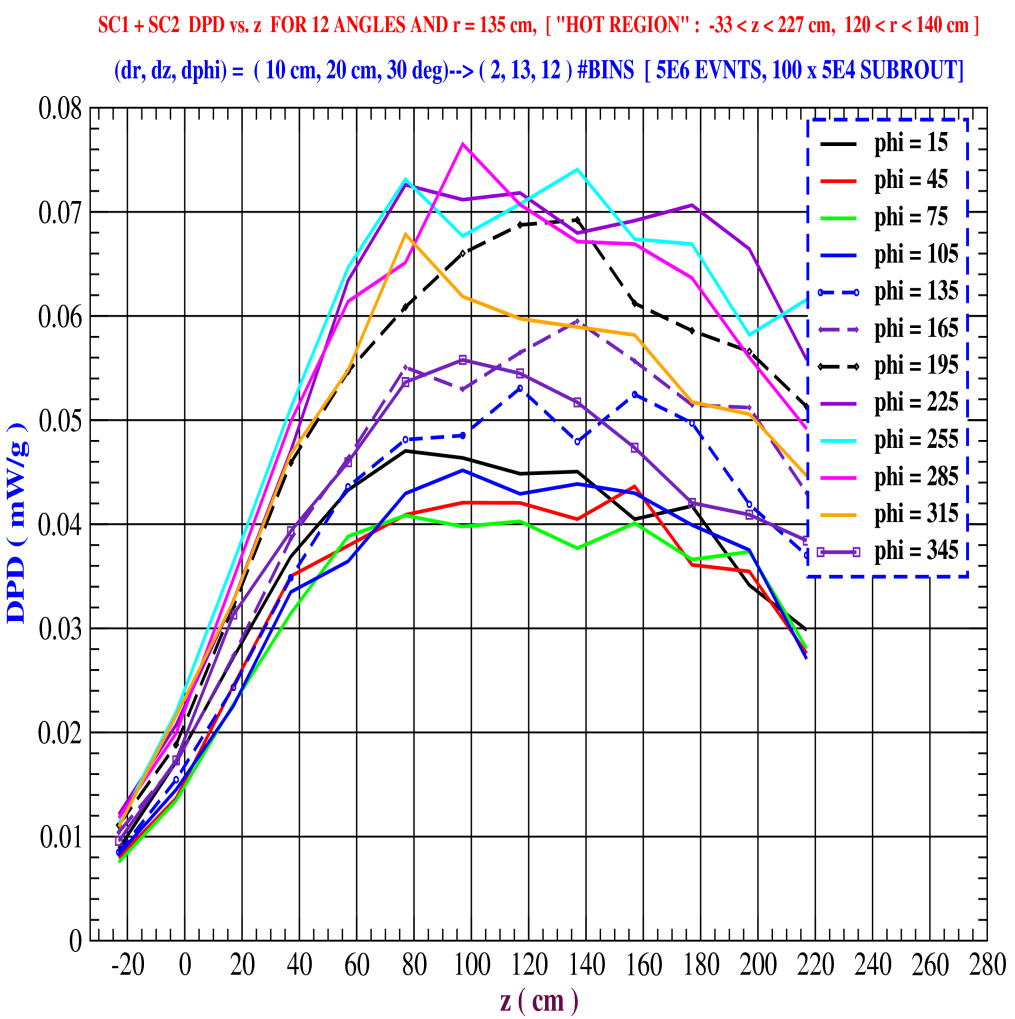
$N_{tot} = 312$ "pieces"

SC#1+2 : TDPD AZIMUTHAL DISTRIBUTION FOR 12 ANGLES.

R = 125.0 cm "PIECES"



R = 135.0 cm "PIECES"



PEAK: 0.12 mW/g AT (r, z, phi) = (125.0 97.0 255)

PEAK: 0.07mW/g AT (r, z, phi) = (135.0 77.0 255)

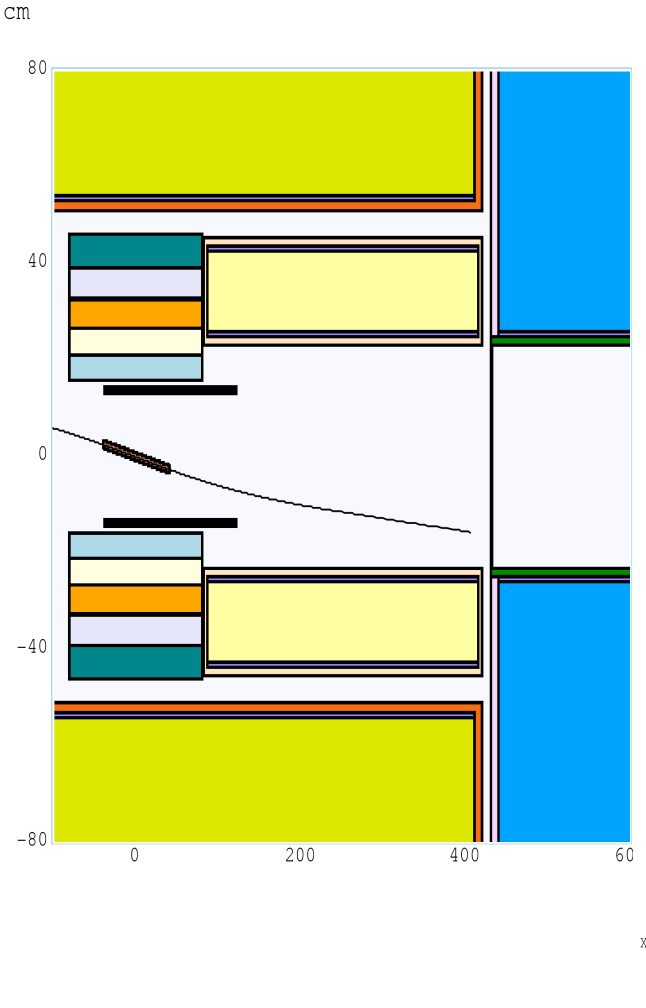
TDP: 1.59 kW ("PIECES") + 1.058 kW (REST) = 2.65 kW vs. 2.63 kW (NO SEGMENTATION)

FOR 1 MW PROTON BEAM CURRENT SHIELDING PROVIDES ADEQUATE PROTECTION FOR SC#1+2, BUT NOT FOR A 4 MW BEAM. WITH Hg MODULE ADDITIONAL SHIELDING WILL BE NEEDED IN POSSIBLE R < 51 cm AREAS (ESPECIALLY THE LOWER PART OF THE MODULE).

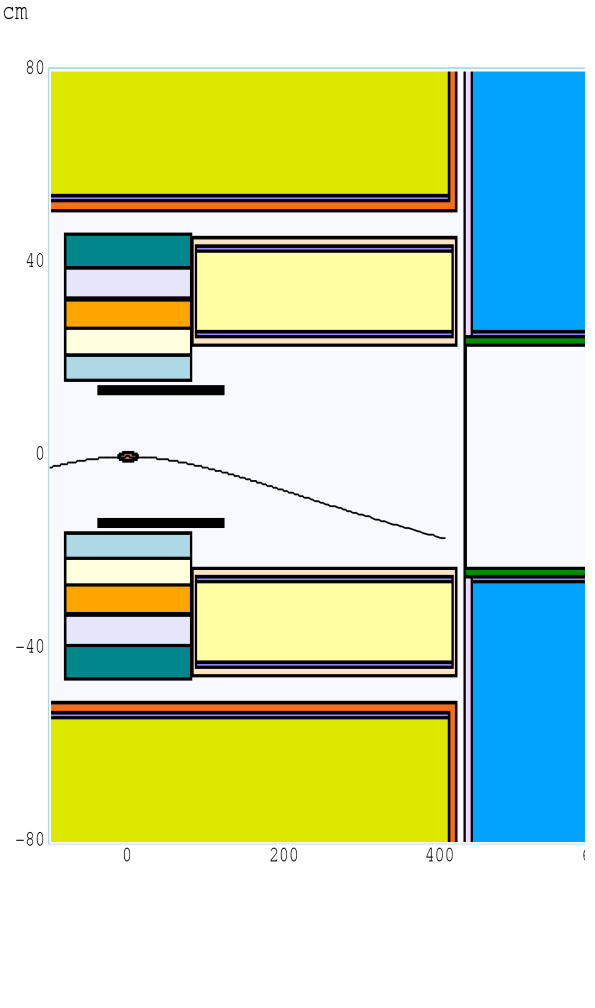
20to2T5m: **yz AT x = 0.0 cm (RIGHT) , xz AT y = 0.0 cm (MIDDLE), xy AT z = 405.0 cm (LEFT) CROSS SECTION WITH THE PROTON BEAM CENTROID TRAJECTORY PROJECTION WITHOUT C TARGET AND BeWind#1. TRAJECTORY DATA SHOW THAT THE PROTONS WILL CRASH ON THE SHVS#4 INNER TUBE WALL AT z ~ 405.0 cm (NEAR THE END OF THE VESSEL)**

(THE PEAK TDPD OF SC#3 IS AT ~ 225 degrees AS ONE MAY EXPECT FROM THE xy PLOT)

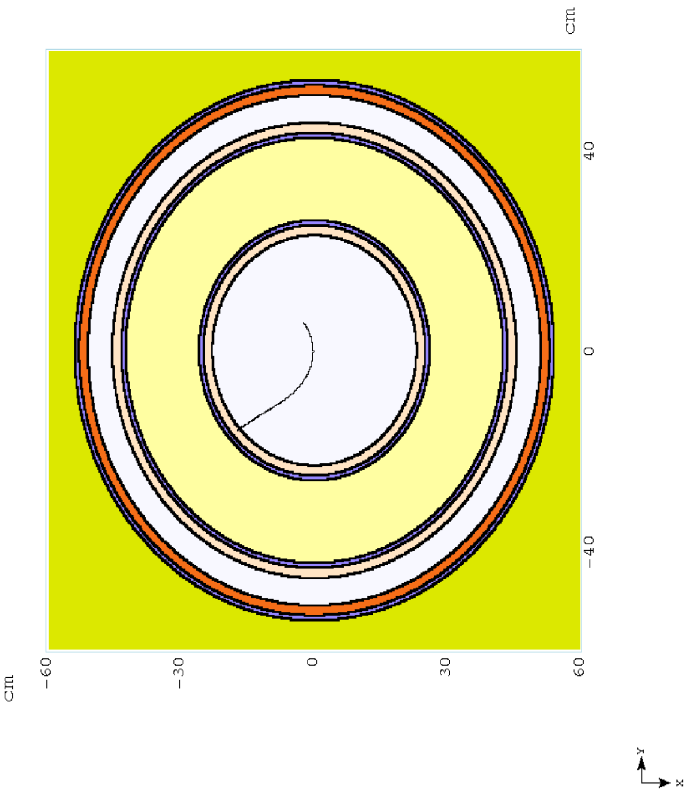
yz AT x = 0.0 cm



xz AT y = 0.0 cm

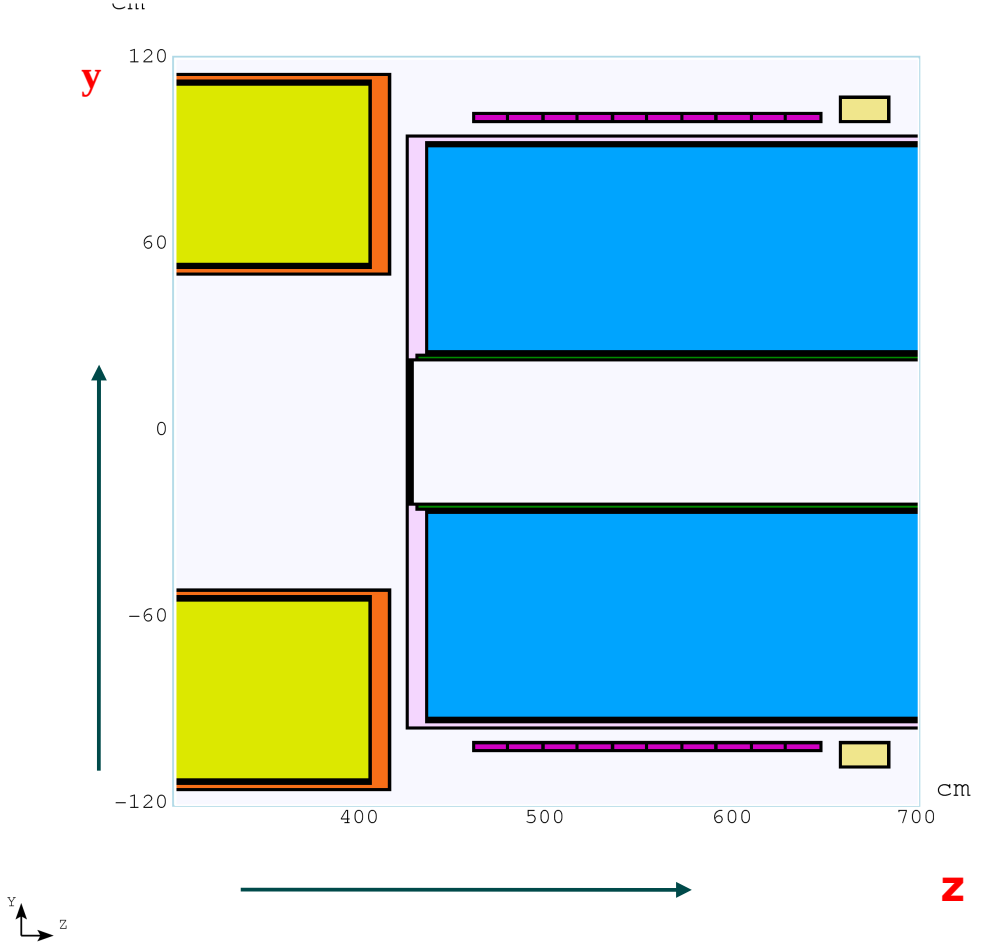


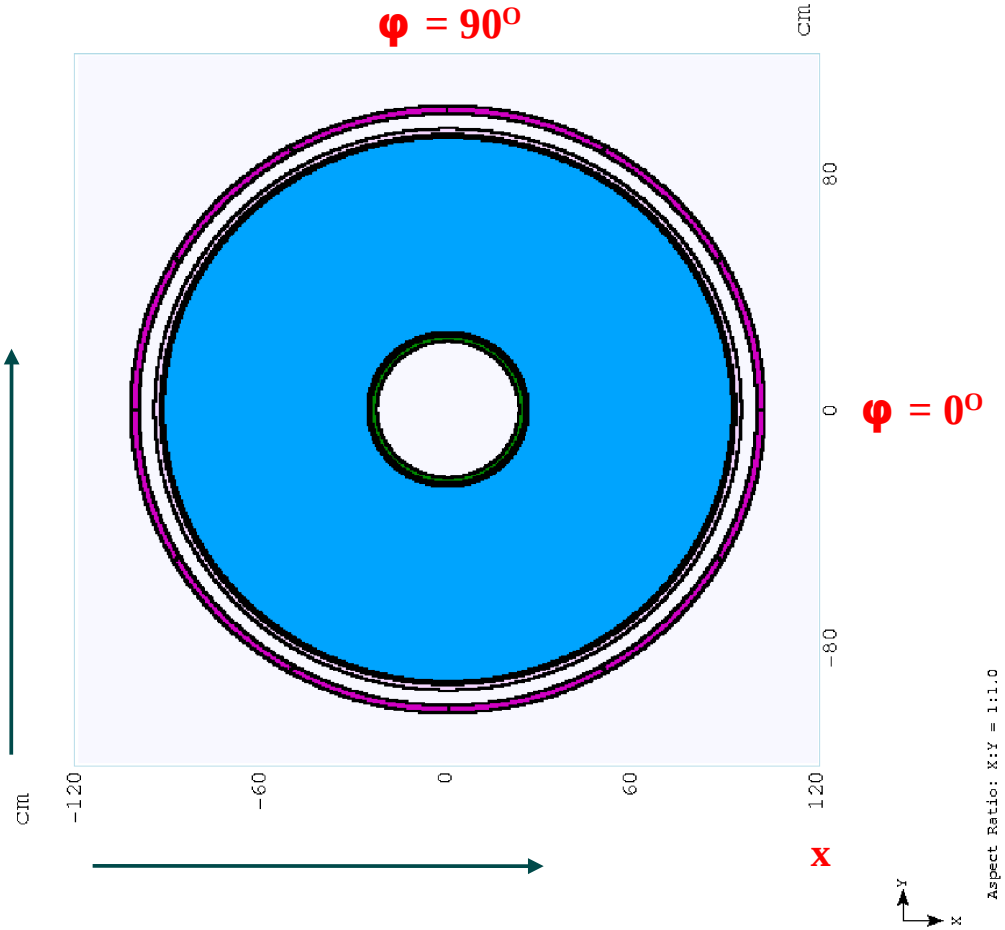
xy AT z = 405.0 cm



SC#3 AZIMUTHAL TDPD DISTRIBUTION (UPDATED)

SC#3 SEGMENTATION DETAILS : yz AT x = 0.0 cm [LEFT] AND xy AT z = 540.0 cm [RIGHT] CROSS SECTION.





100.0 < r < 102.67 cm dr = 2.67 cm N_r = 1 bins

460.0 < z < 647.19 cm dz = 18.706 cm N_z = 10 bins

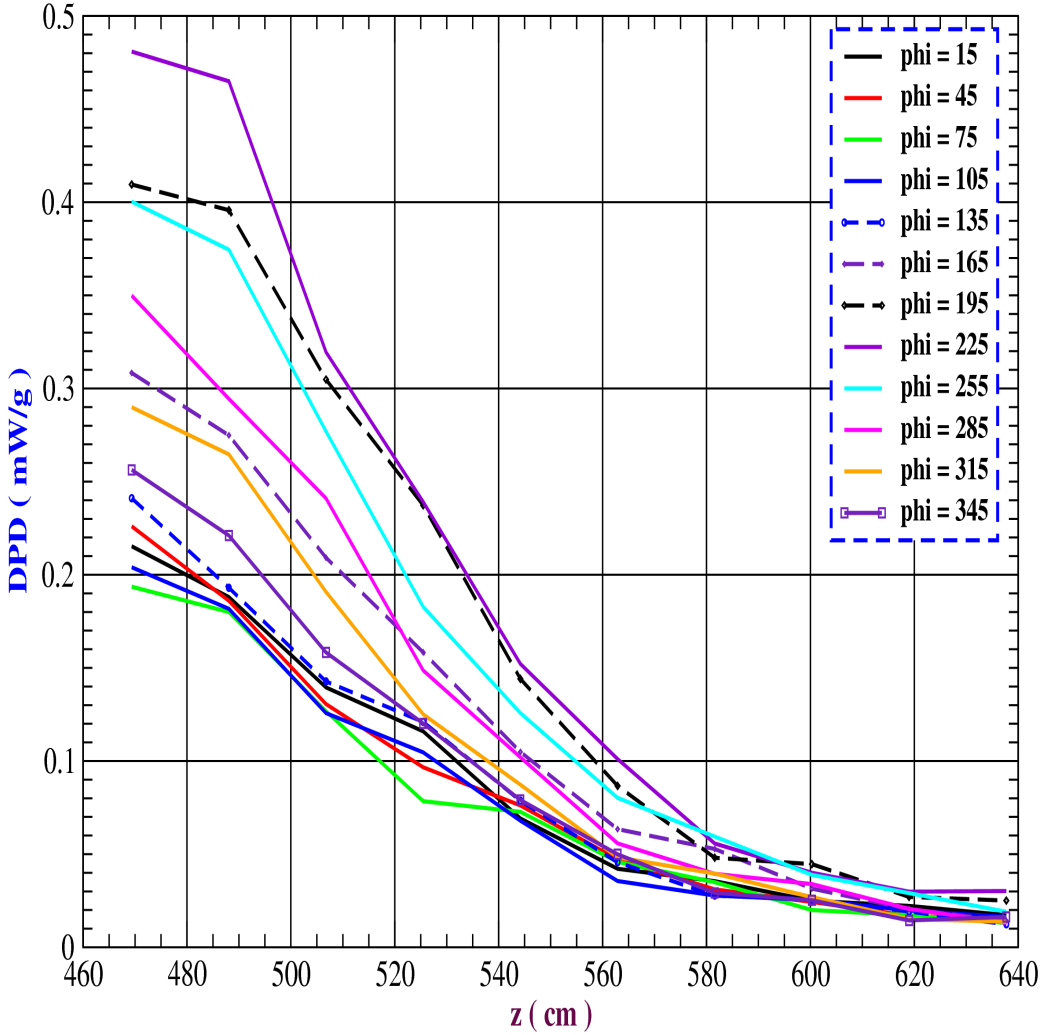
0.0 < φ < 360.0 deg. dφ = 30 deg. N_φ = 12 bins

N_{tot} = 120 "pieces"

SC#3 : TDPD AZIMUTHAL DISTRIBUTION FOR 12 ANGLES.
BEFORE (LEFT) AND AFTER ADDITIONAL SHIELDING AFTER RS (RIGHT)

SC3 DPD vs. z FOR 12 ANGLES AND r = 101.335 cm, [460.0 < z < 647.19 cm, 100 < r < 102.67 cm]

(dr, dz, dphi) = (2.67 cm, 18.706 cm, 30 deg)--> (1, 10, 12) #BINS [5E6 EVNTS, 100 x 5E4 SUBROUT]

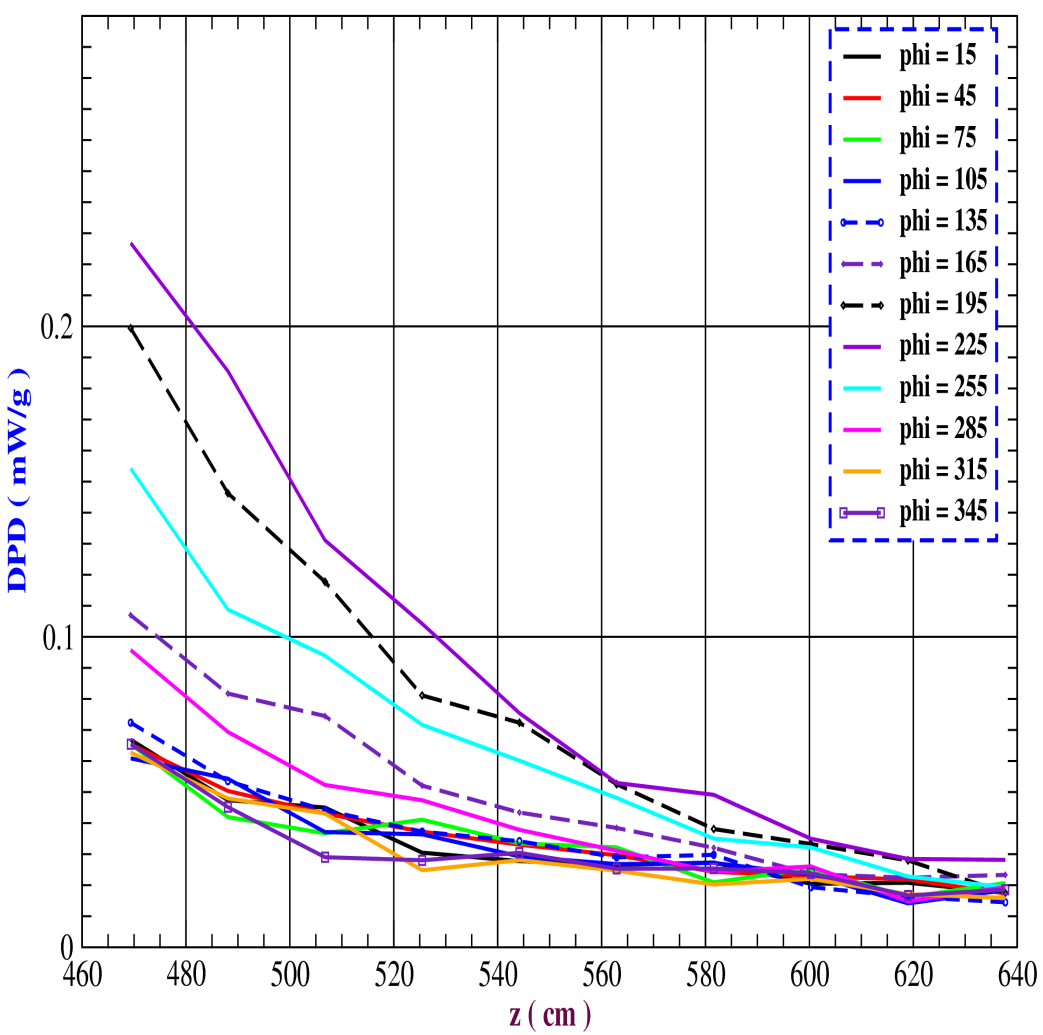


PEAK: 0.48 mW/g AT (r, z, phi) = (101.335 469.353 225)

TDP: 0.253 kW (''PIECES'') vs. 0.252 kW (NO SEGMNT)

SC3 DPD vs. z FOR 12 ANGLES AND r = 101.335 cm, [460.0 < z < 647.19 cm, 100 < r < 102.67 cm] < WITH SH#4 >

(dr, dz, dphi) = (2.67 cm, 18.706 cm, 30 deg)--> (1, 10, 12) #BINS [5E6 EVNTS, 100 x 5E4 SUBROUT]



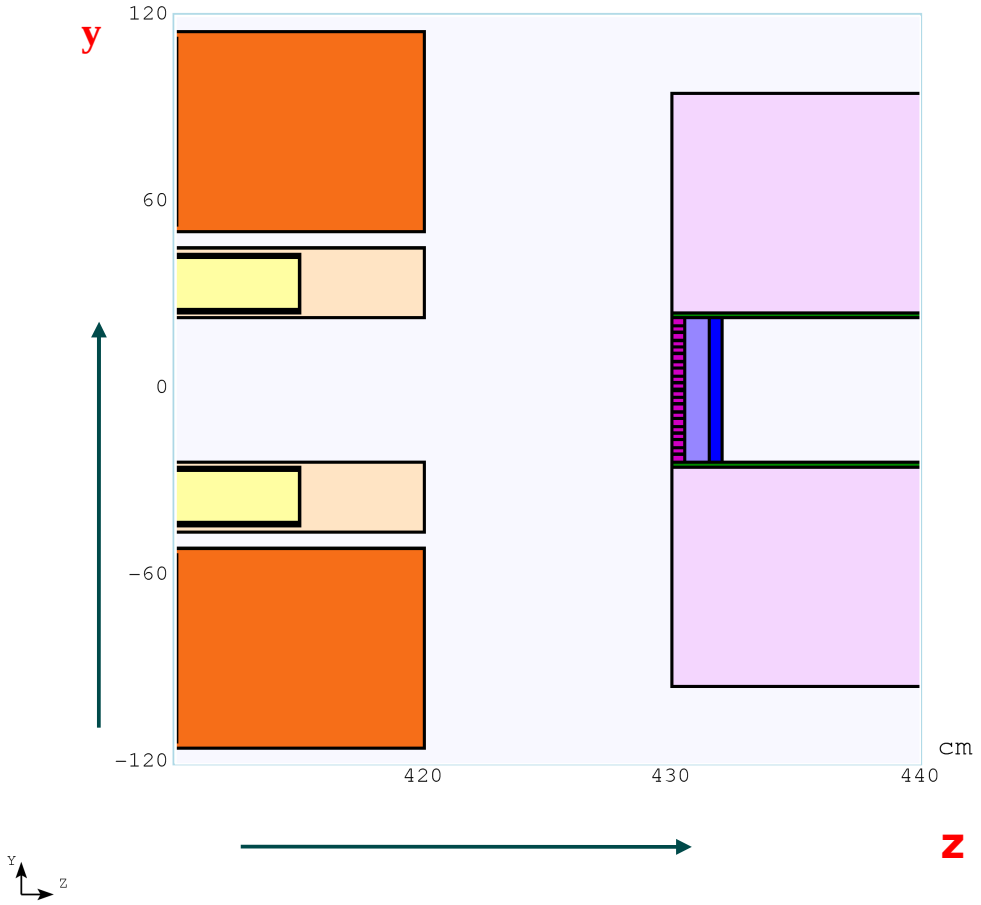
PEAK: 0.23 mW/g AT (r, z, phi) = (101.335 469.353 225)

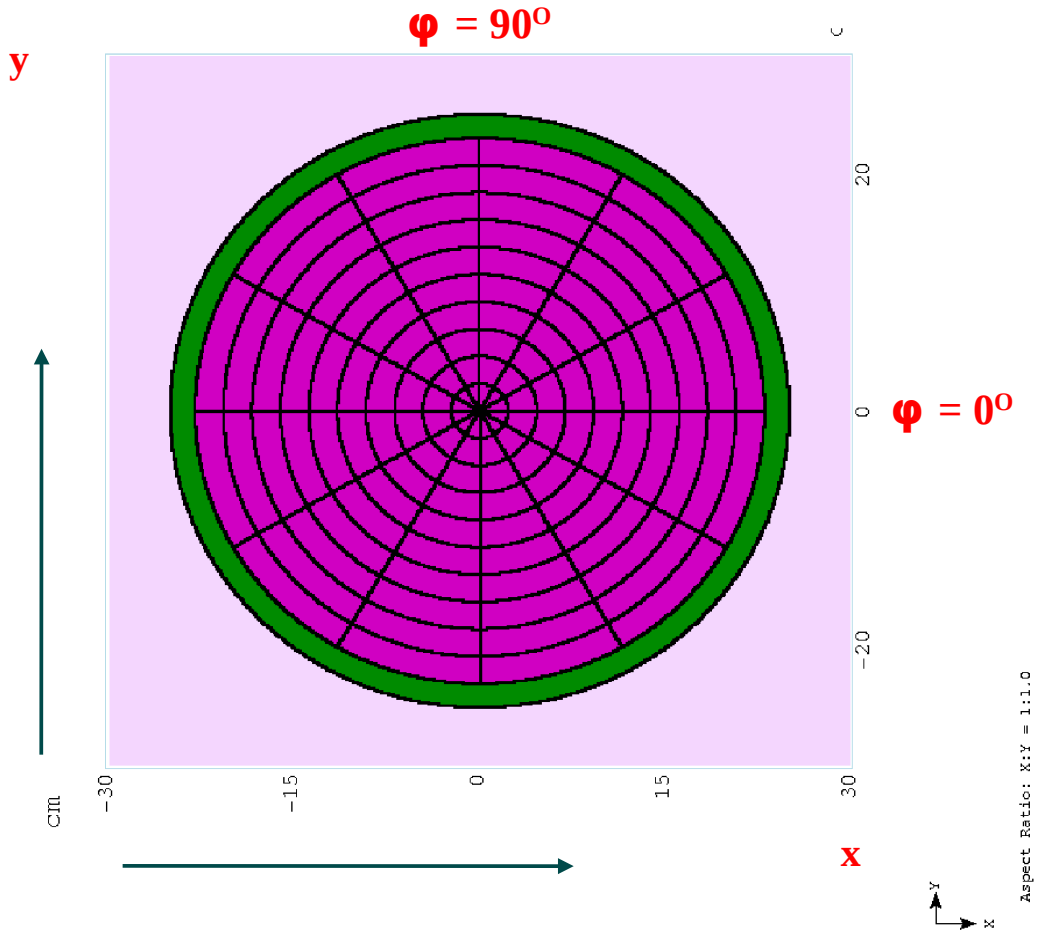
TDP: 0.100 kW (''PIECES'') vs. 0.099 kW (NO SEGMNT)

WITH THE ADDITIONAL SHIELDING THE PEAK TDPD DECREASES BY MORE THAN 50%
AND FOR 1 MW IS MUCH SMALLER THAN 0.1 mW / g

BeWind#1 AZIMUTHAL TDPD DISTRIBUTION (UPDATED)

BeWind#1 SEGMENTATION DETAILS : yz AT x = 0.0 cm [LEFT] AND xy AT z = 430.2 cm [RIGHT]
CROSS SECTIONS FOCUSED IN THE GAP#1 BeWind#1 REGION.





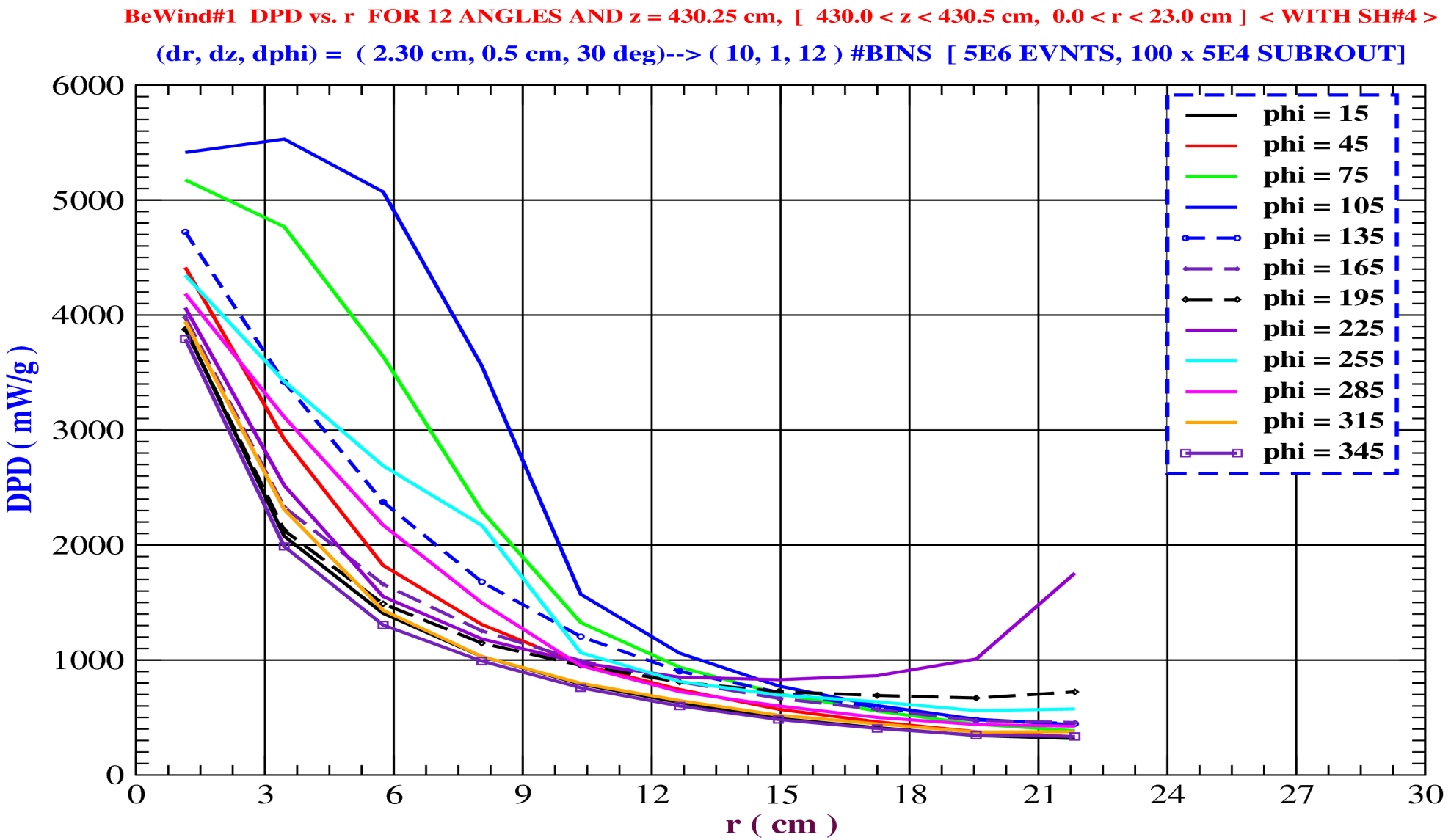
$0.0 < r < 23.0$ cm $dr = 2.3$ cm $N_r = 10$ bins

$430.0 < z < 430.5$ cm $dz = 0.5$ cm $N_z = 1$ bins

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

$N_{tot} = 120$ "pieces"

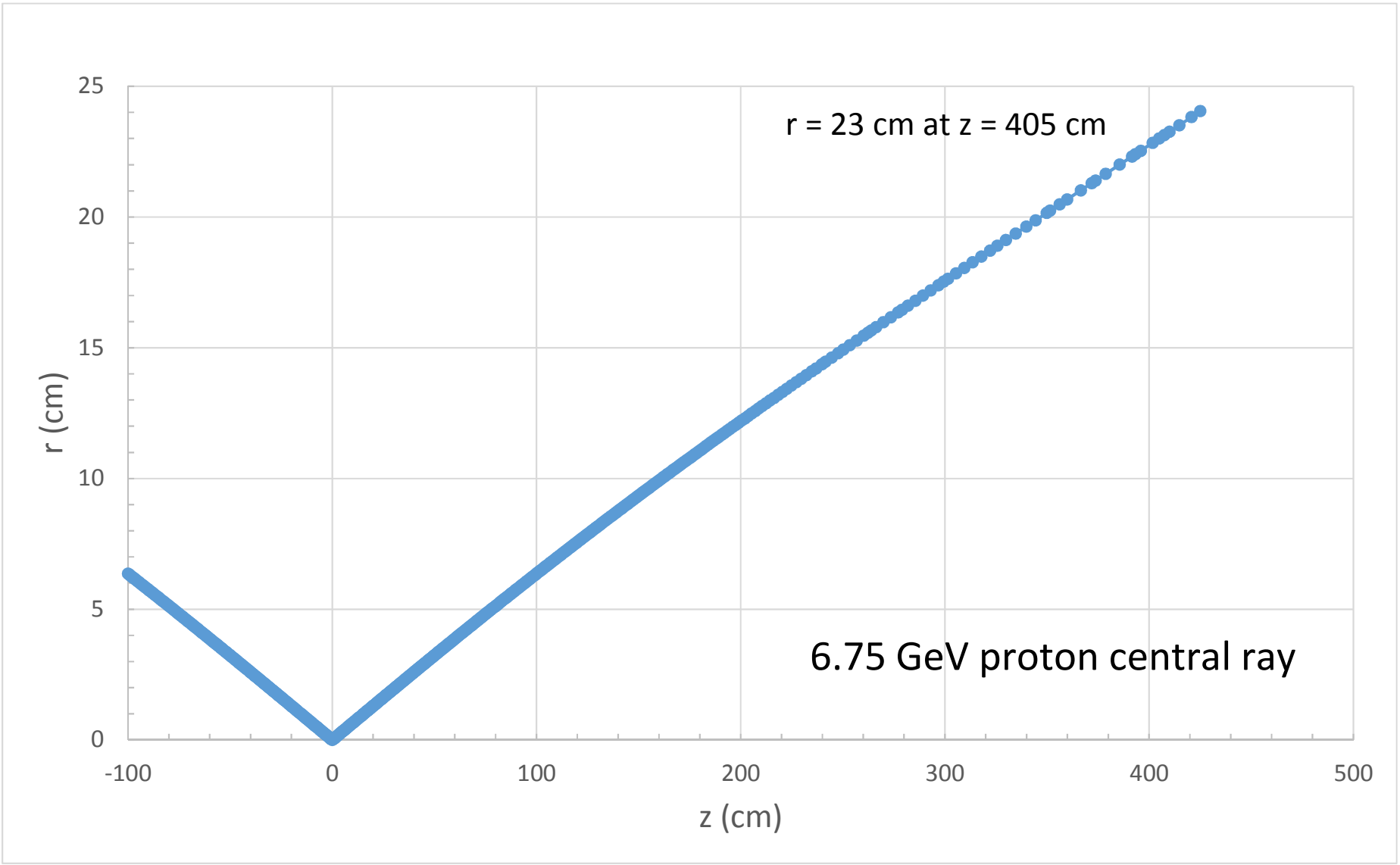
BeWind#1 : TDPD AZIMUTHAL DISTRIBUTION (vs. r) FOR 12 ANGLES.



PEAK: 5530.64 mW/g AT (r, z, phi) = (3.45 430.5 105)

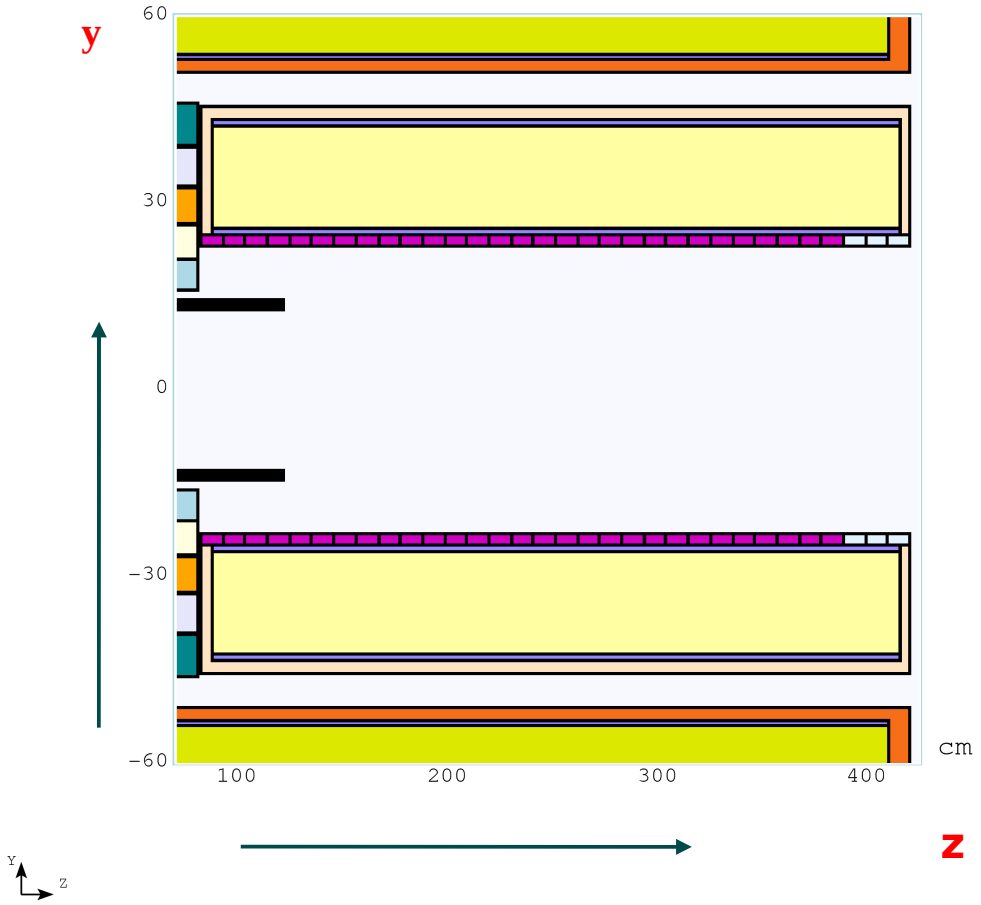
TDP: 1.373 kW (''PIECES'') + 1.652 (REST) ~ 3.03 vs. 3.375 kW (NO SEGMNT)

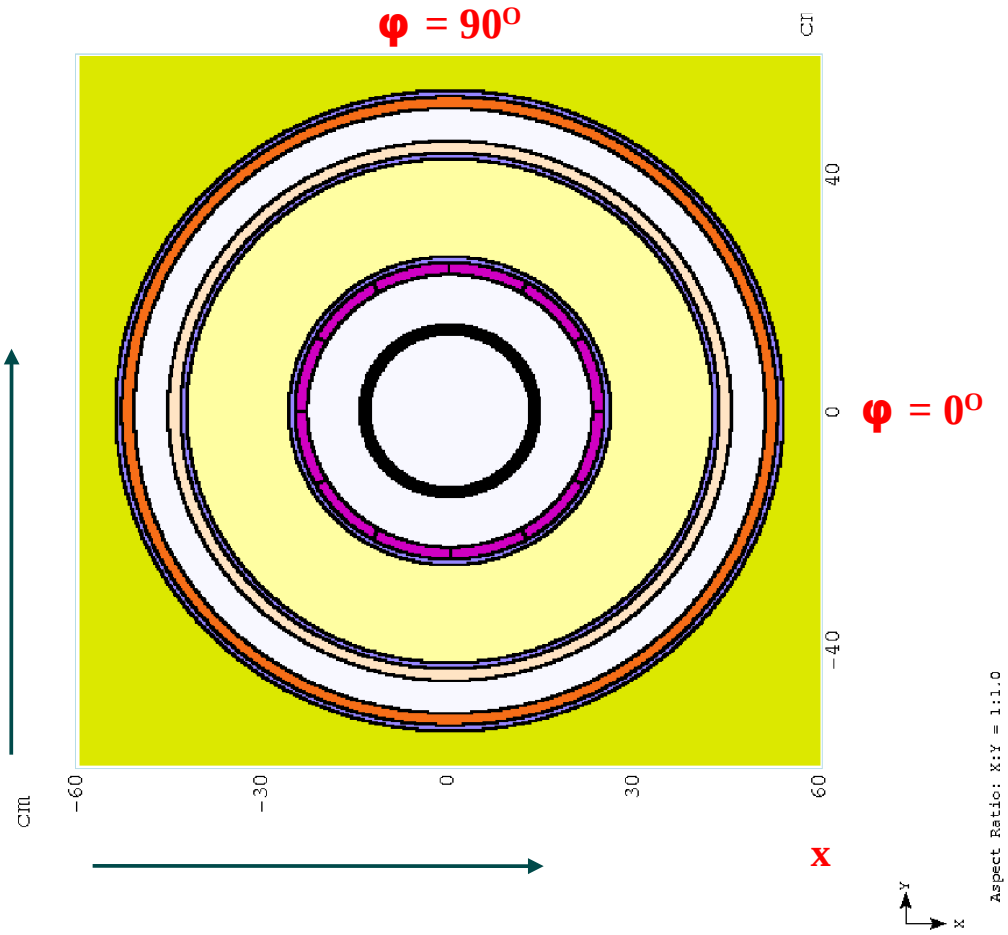
SHVS#4 INNER TUBE AZIMUTHAL TDPD DISTRIBUTION



The trajectory of a particle produced at r = 0 eventually returns to r = 0, but r vs. z is almost straight for the first few meters of a 6.75 GeV proton because the period of its helical trajectory is large.

SHSV#4 INNER TUBE SEGMENTATION DETAILS : yz AT x = 0.0 cm [LEFT] AND xy AT z = 85.0 cm [RIGHT] CROSS SECTION.





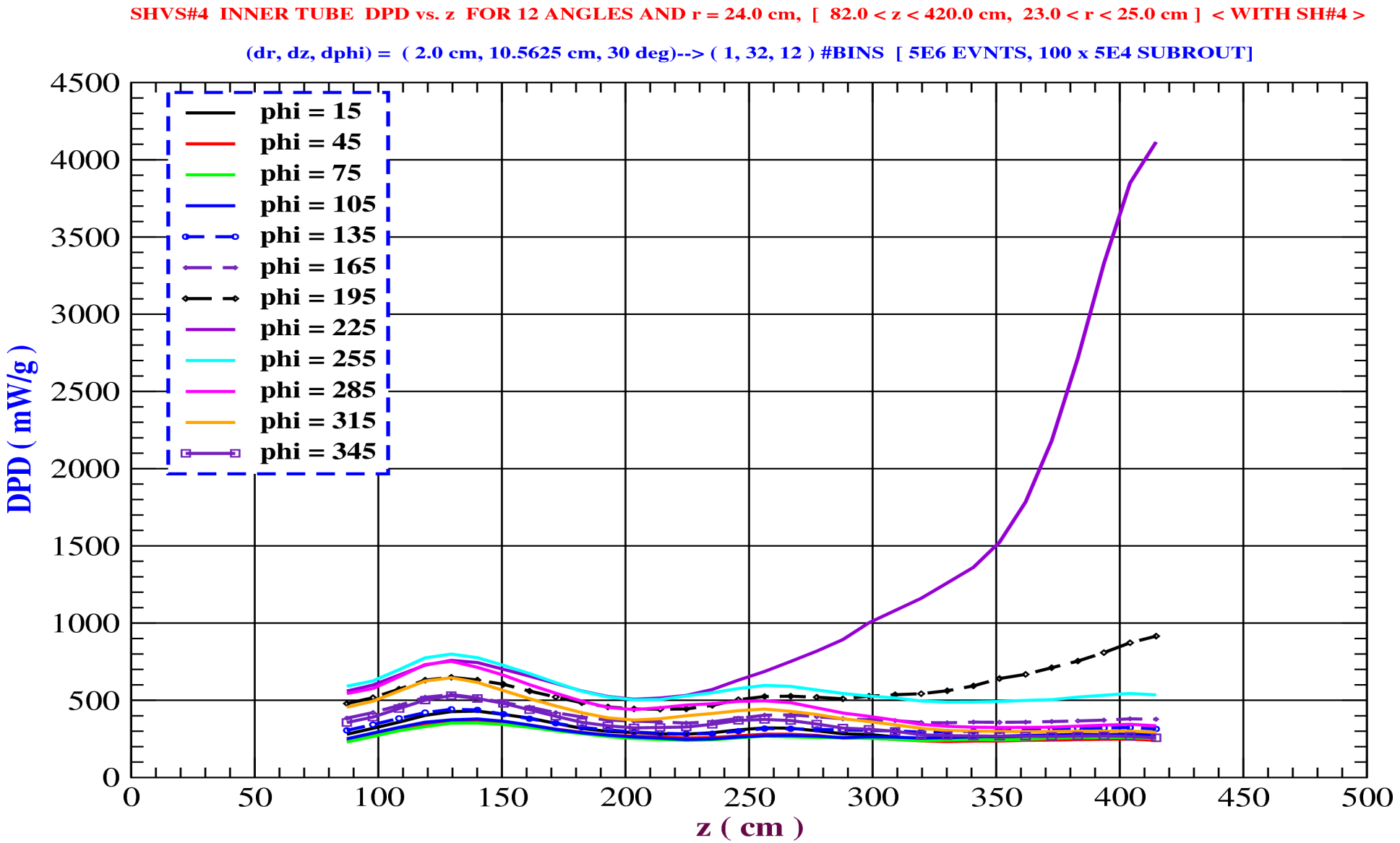
$23.0 < r < 25.0$ cm $dr = 2.0$ cm $N_r = 1$ bins

$82.0 < z < 420.0$ cm $dz = 10.5625$ cm $N_z = 32$ bins

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

$N_{tot} = 384$ "pieces"

SHVS#4 INNER TUBE : TDPD AZIMUTHAL DISTRIBUTION (vs. z) FOR 12 ANGLES.



PEAK: 4114.94 mW/g AT (r, z, phi) = (24.0 414.719 225)

TDP: 366.24 kW ("PIECES") + 43.322 (REST) ~ 409.646 vs. 409.625 kW (NO SEGMNT)

mars15 (2014) : ***~ 3.5 - 4 hrs FOR 5E4 EVENTS, ~ 4 - 8 hrs FOR 5E6 = 100 SUBDIRECTORY x 5E4 SIMULATIONS***
(SINCE SOMETIMES SOME SUBDIRECTORY JOBS WILL START AFTER SOME WAITING TIME) **[BOTH:MCNP, ICEM =1]**

{DING XIAOPING SET UP 3 NEW GNUMake FILES FOR mars1514 MULTIDIRECTORY JOB}

mars1514 + new Princeton cluster much faster than mars1512 + Old Princeton cluster

******* DEPOSITED POWER IN DIFFERENT PARTS OF THE TARGET STATION IN kW (Np / STEP): 5E6 / 10^{-3} *******

A) SC# 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10 : 1.757 / 0.498 / 0.100 / 0.016 / 0.022 / 0.005 / 0.004 / 0.006 / 0.010 / 0.002

TOTAL DP SC#1-10: 2.42 { WITH ~ 2.36 kW JUST IN SC#1+2+3 }

B) DP IN RS COILS RS# 1 / 2 / 3 / 4 / 5 : 401.698 / 193.210 / 100.419 / 58.869 / 34.585

TOTAL: 788.78 (USING A 65% Cu + 7% H_2O +288% MgO MIXTURE WITH ~ 7.0 g/cc DENSITY)

C) DP IN SHIELDING SH# 1 / 2 / 3 / 4 : 138.047 / 490.086 / 39.557 / 682.99

TOTAL : 1,350.680 (~ 34 % OF 4 MW)

D) DP IN VESSELS SHVS# 1 / 2 / 3 / 4 : 18.950 / 39.59 / 2.882 / 409.625

TOTAL: 471.027

E) DP IN C TRGT : 112.81 (USING 1.8 g/cc DENSITY FOR BOTH TARGET AND DUMP)

F) DP IN Be WINDOW 1 / 2 / 3 / 4 : 3.375 / 1.557 / 1.418 / 1.183

TOTAL: 7.532

G) DP IN BP# 1 / 3 : 217.063 / 284.491

TOTAL DP IN TARGET STATION :3,234.82

20to2T5m : yz CROSS SECTION (x = 0.0 cm) WITH B FIELD MAP AND CENTROID TRAJECTORY WITHOUT C TARGET / DUMP PRESENT . THE BEAM WILL REACH THE CRYO#1 UPSTREAM Be WINDOW (AT z ~ 430 cm) NEAR THE BOTTOM AREA. POWER LEAK FLOW { ENERGY FLOW = KE (p, n)+E($e^{\pm}$, $\pi^{\pm}$, π^{0}, $\mu^{\pm}$, $K^{\pm}$, γ) } .

[z = - 200.0 , 1500.0 cm, R = 210.0 cm SURFACE DETECTORS].