IDS120j WITHOUT RESISTIVE MAGNETS

MARS vs. FLUKA SIMULATIONS
(20 cm GAPS AND 15.8 g/cc W BEADS)

Nicholas Souchlas, PBL (6/11/2012)

IDS120j GEOMETRY, NO RESISTIVE COILS: WITH 20 cm GAPS

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SIMULATIONS USING LOWEST GRADE W BEADS IN SHIELDING (OF 15.8 g/cc)
MARS vs. FLUKA DEPOSITED POWER COMPARISON.

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>SIMULATIONS CODE: mars1510 / MCNP

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

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

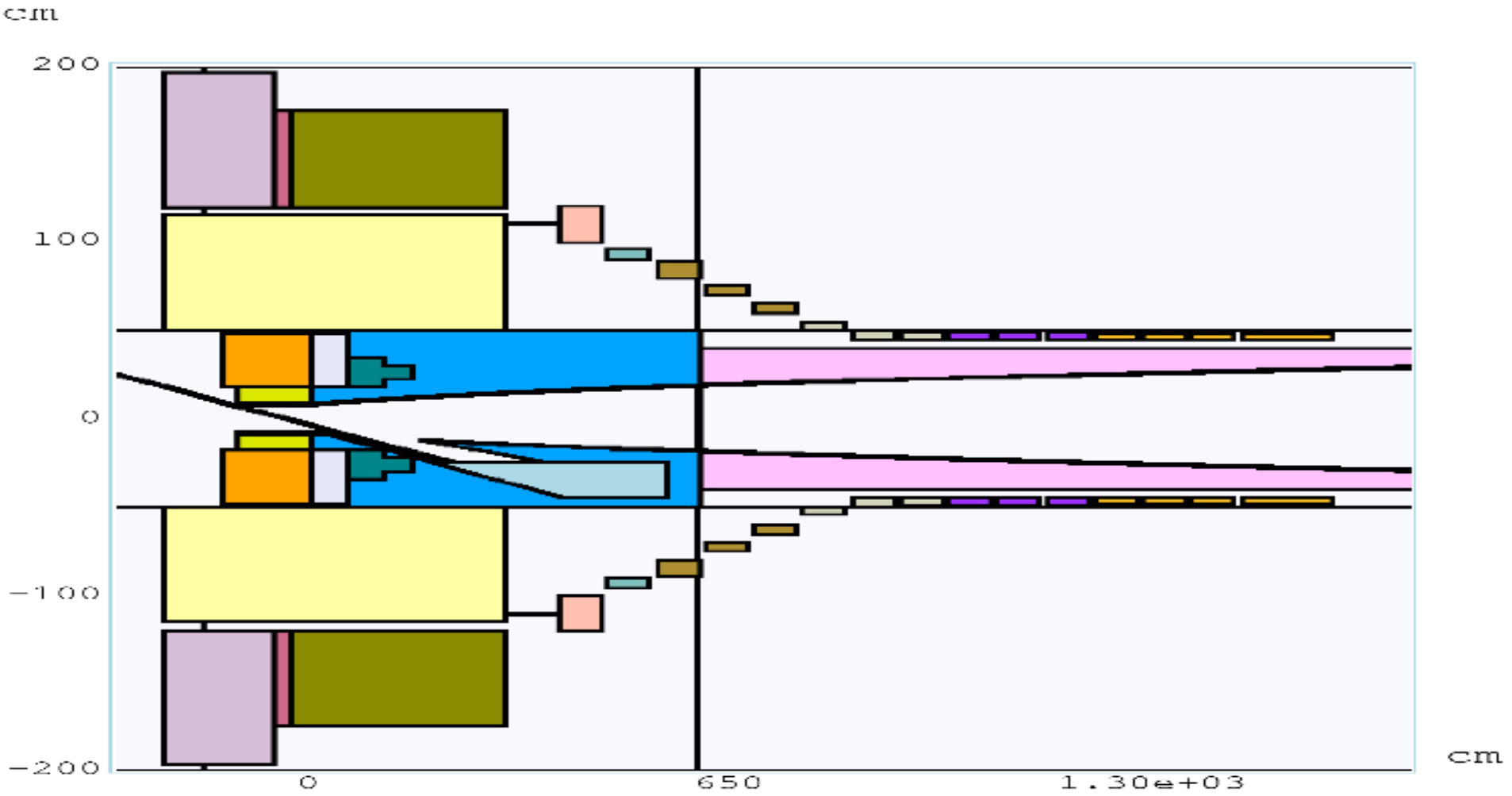
>PROTON BEAM POWER: 4 MW

>PROTON ENERGY: E = 8 GeV

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

MARS vs. FLUKA FOR IDS120h GEOMETRY (4/20/2011)

IDS120f GEOMETRY



Ratio: Y:Z = 1:5.0

ENERGY DEPOSITED IN SC SOLENOIDS (SC#), SHIELDING (SH#).

NiSn/NiTi	m1507	m1510	FLUKA
SC#1	0.034	0.044	0.052
SC#2	0.025	0.039	0.032
SC#3	0.26	0.28	0.26
SC#4	0.004	0.004	0.004
SC#5	0.19	0.17	0.066
SC#6	0.049	0.041	0.014
SC#1-6	0.60	0.58	0.43
SC#7-9	0.12	0.13	0.047
SC#10-12	0.09	0.09	0.036
SC#13-15	0.08	0.1	0.021
SC#16-19	0.08	0.027	0.027
SC#1-19	0.97	0.99	0.56

NiSn/NiTi	m1507	m1510	FLUKA	60/40	m1507	m1510	FLUKA
SC#1-6	0.60	0.58	0.43	SH#1	924.0	962.5	1050.0
SC#7-9	0.12	0.13	0.047	SH#2	1015.0	1030.5	1018.0
SC#10-12	0.09	0.099	0.036	SH#3	36.78	38.21	20.0
SC#13-15	0.08	0.1	0.021	SH#4	44.28	47.22	60.9
SC#16-19	0.08	0.08	0.027	–	–	–	–
SC#1-19	0.97	0.99	0.56	SH#1-5	2020.06	2078.43	2148.9

ENERGY DEPOSITED IN RESISTIVE COILS (RS#), BEAM PIPE (BP#).

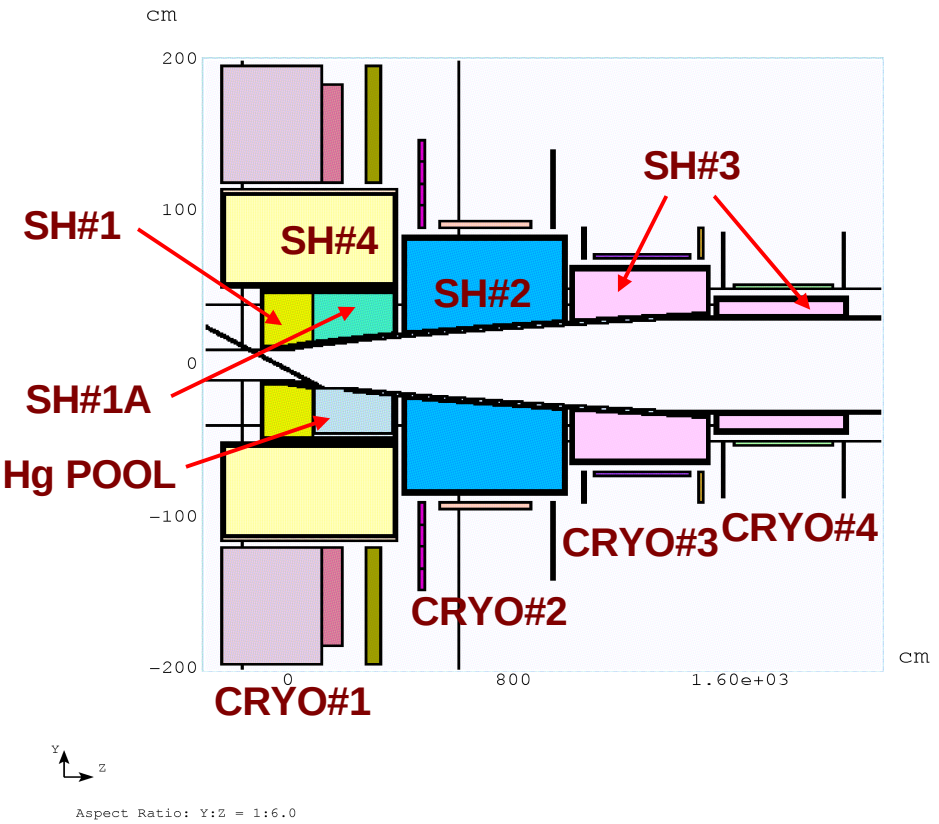
Cu	m1507	m1510	FLUKA	(STST)	m1507	m1510	FLUKA
RS#1+2	167.0	180.05	190.1	BP#1	203.7	212.8	237.6
RS#3	88.5	93.1	140.0	BP#2	249.2	245.9	(2+3)
RS#4+5	74.05	76.3	75.0	BP#3	5.49	5.54	245.2
RS#1-5	329.55	349.45	405.1	BP#1-3	458.39	464.29	482.8

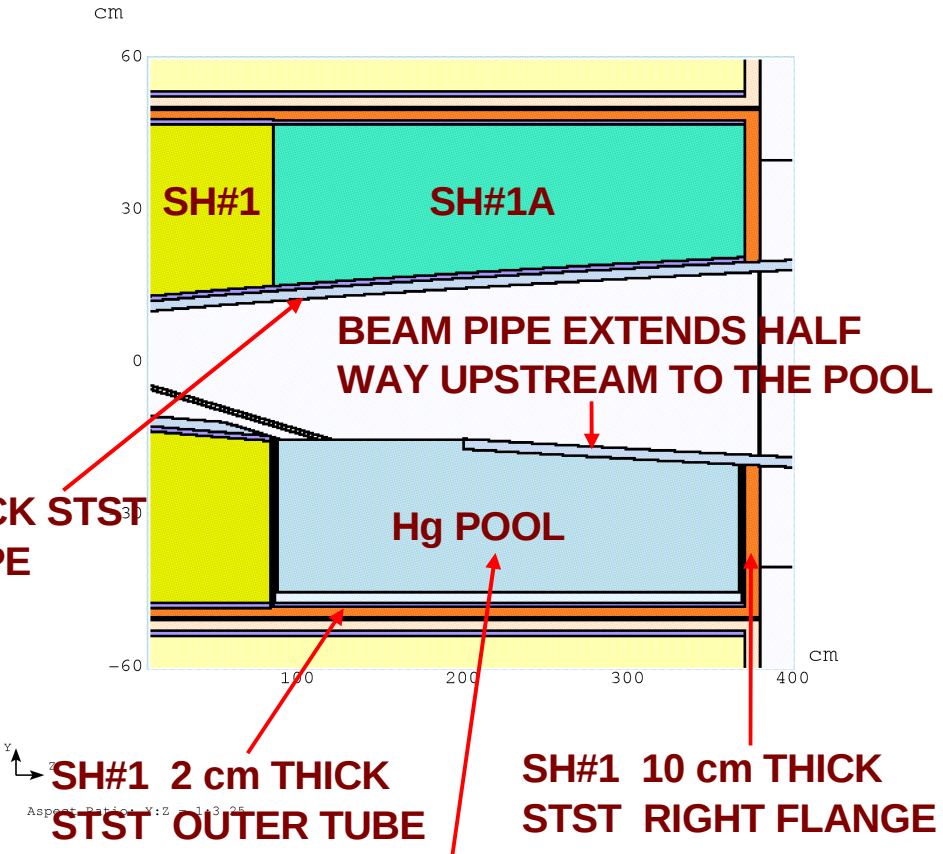
IDS120f:ENERGY DEPOSITED IN OTHER PARTS AND TOTALS.

TOTALS	m1507	m1510	FLUKA	
SC#1-19	0.97	0.99	0.56	-0.43
SH#1-4	2020.06	2078.43	2148.9	+70
RS#1-5	329.55	349.45	405.1	+56
BP#1-3	458.39	464.29	482.8	+19
Hg TARG.	376.5	389.85	319.0	-71
Hg POOL	10.16	10.53	4.4	-6
Be WIND.	0.53	0.73	2.1	
TOTAL	3196.16	3294.27	3362.86	+68

MOST SIGNIFICANT DIFFERENCE IS IN SH#1 DP AND IN Hg JET. FLUKA CALCULATES MORE DP IN SHIELDING, RESISTIVE COILS AND BEAM PIPE WHILE IT GIVES MUCH LOWER ENERGY DEPOSITED IN Hg. IS THIS BECAUSE OF DIFFERENCES IN THE WAY THE CODES HANDLE INTERACTIONS OF PROTONS AND NEUTRONS WITH MATTER OR THERE IS SOMETHING DIFFERENT IN THE SET UP OF THE CODES THAT AFFETCS THE INTERACTION OF THE PROTON BEAM AND THE Hg JET ? ANOTHER POSSIBLE EXPLANATION IS DIFFERENCES IN THE TRACKING OF THE PARTICLES.

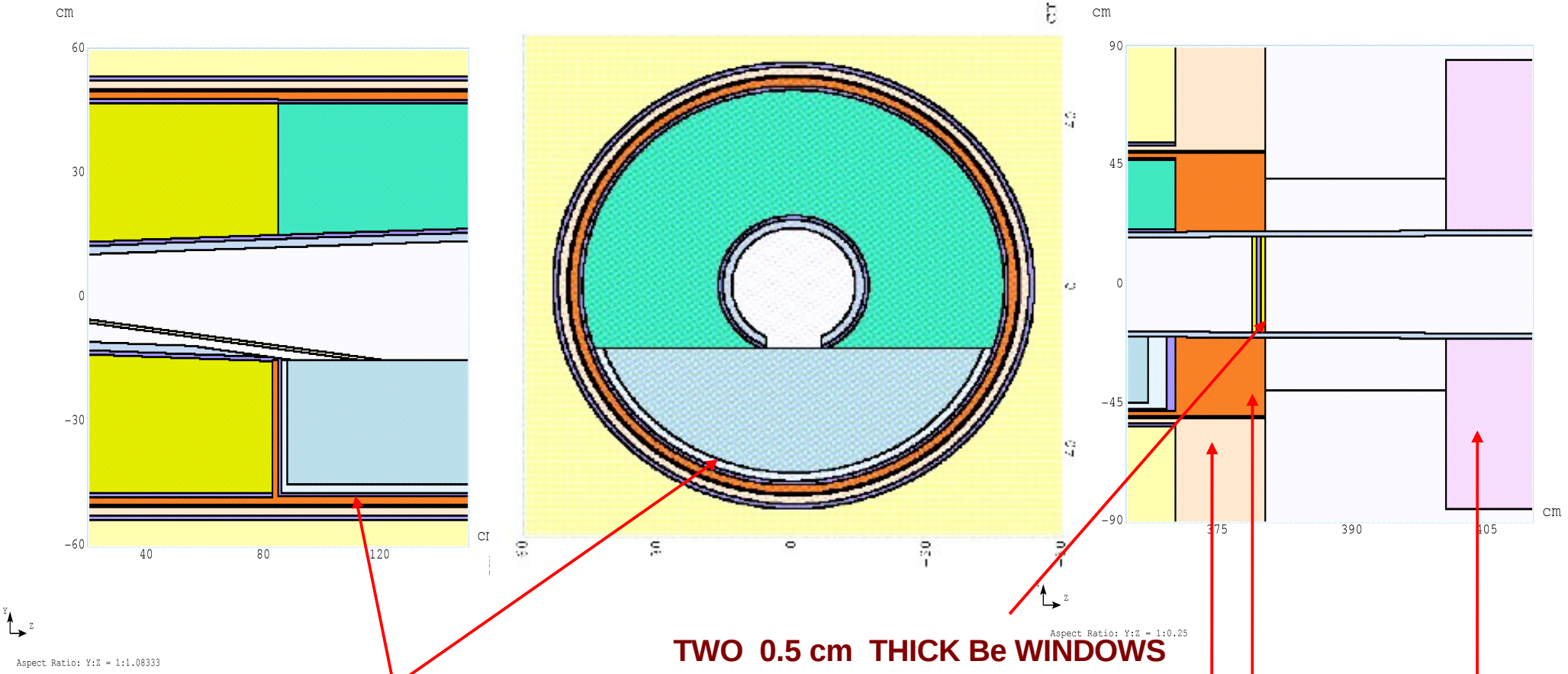
IDS120j: REPLACING RESISTIVE MAGNETS AND FILLING UPPER HALF OF Hg POOL WITH SHIELDING. GENERAL OVERVIEW (LEFT), POOL REGION DETAILS (RIGHT). [20 cm GAPS]





SHVS WALLS, Hg POOL VESSEL DOUBLE WALLS, Be WINDOW, He GAP IN Be WINDOW AND IN HG POOL HAVE NOMINAL VALUES FOR THEIR THIKNESS. 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]

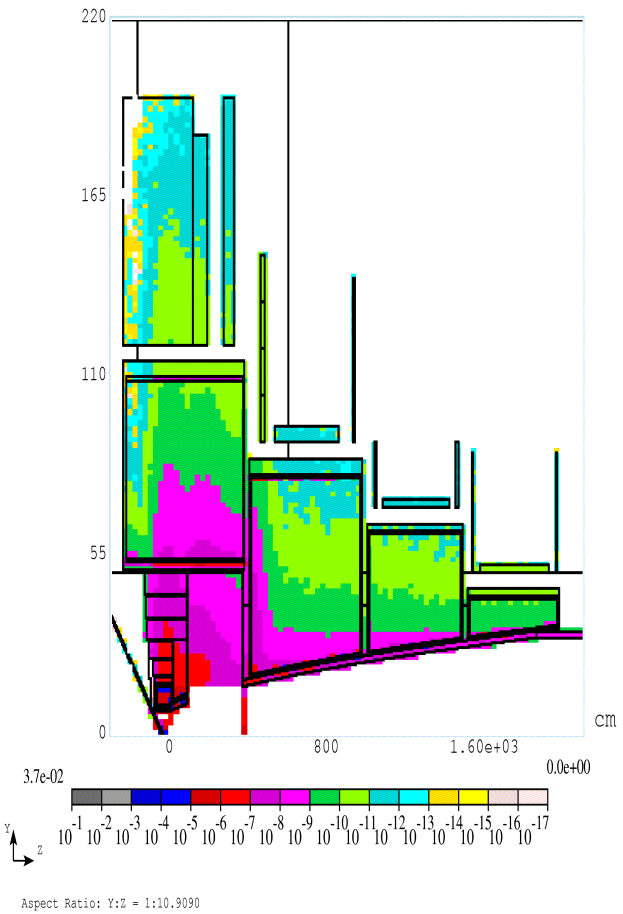


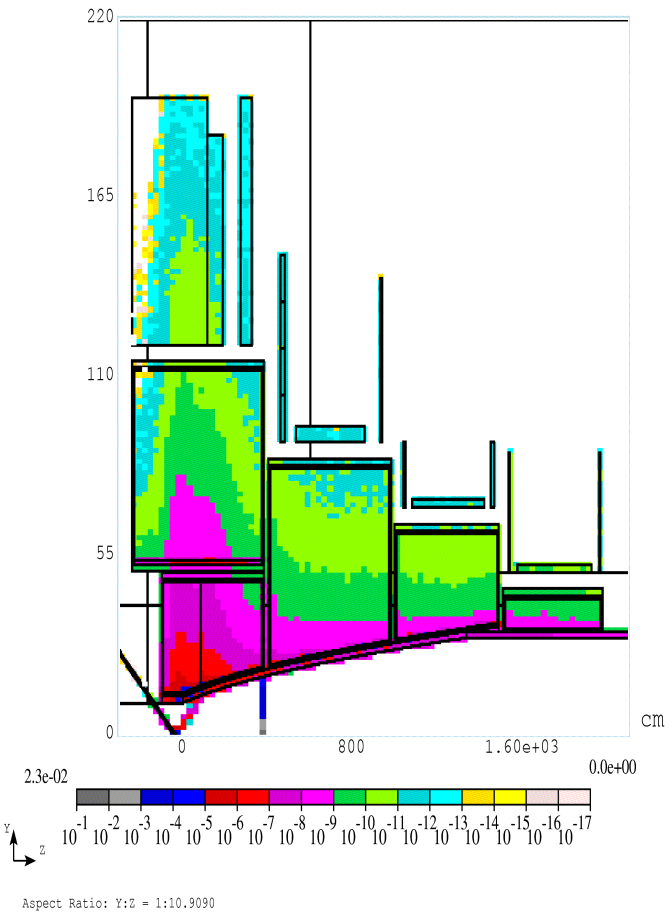
2 cm THICK STST INNER Hg POOL VESSEL WITH 1 cm He GAP FOR COOLING.

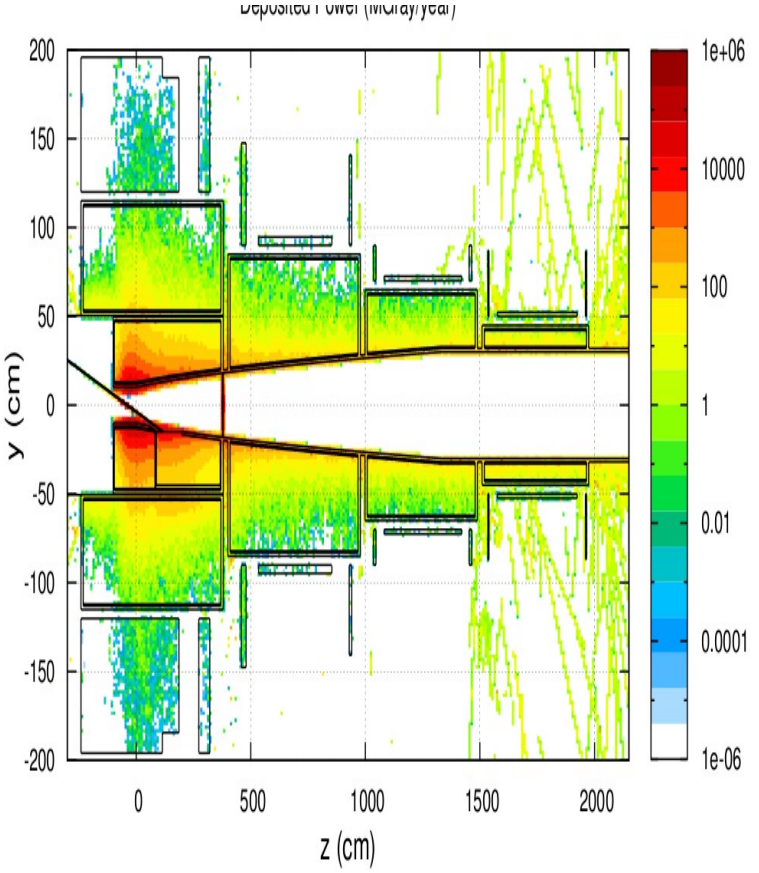
TWO 0.5 cm THICK Be WINDOWS AT THE END OF CRYO#1 WITH 0.5 cm He GAP BETWEEN THEM FOR COOLING.

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

IDS120j: AZIMUTHALLY AVERAGE DPD MARS PLOTS, FOR 15.8 g/cc W BEADS, WITH (LEFT) AND WITHOUT RESISTIVE MAGNETS FOR 20 cm GAPS (MARS MIDDLE/ FLUKA RIGHT. P12 INITIAL PROTON BEAM POINT WAS USED FOR THE LAST CASE SIMULATIONS.

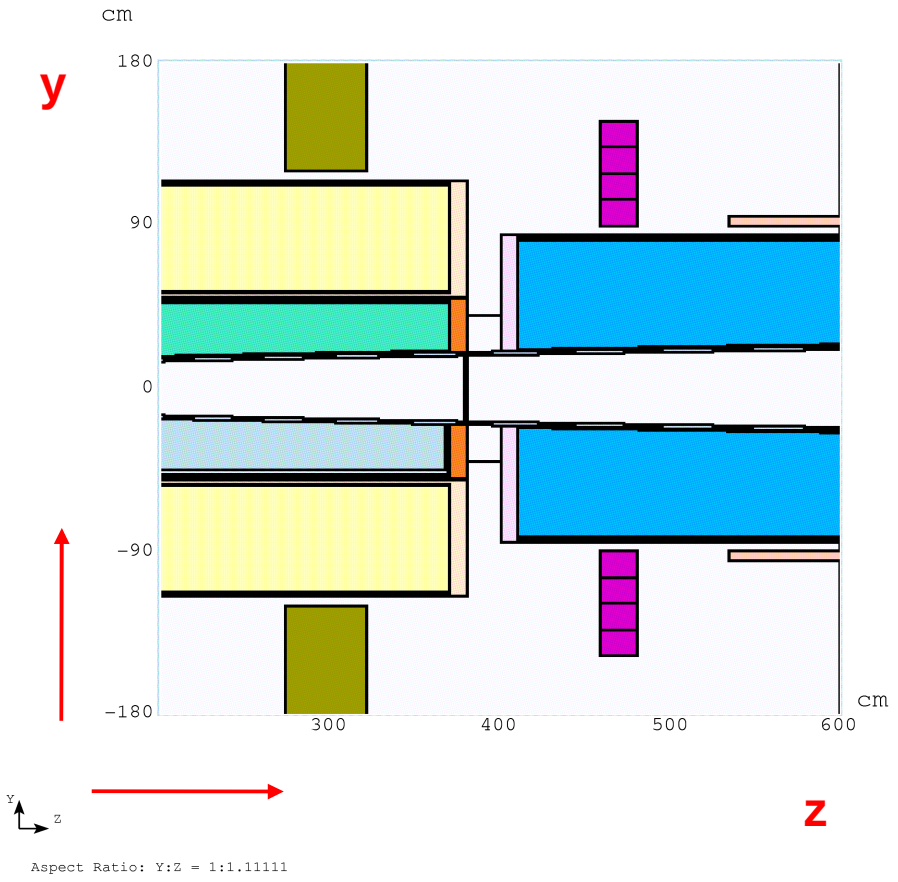


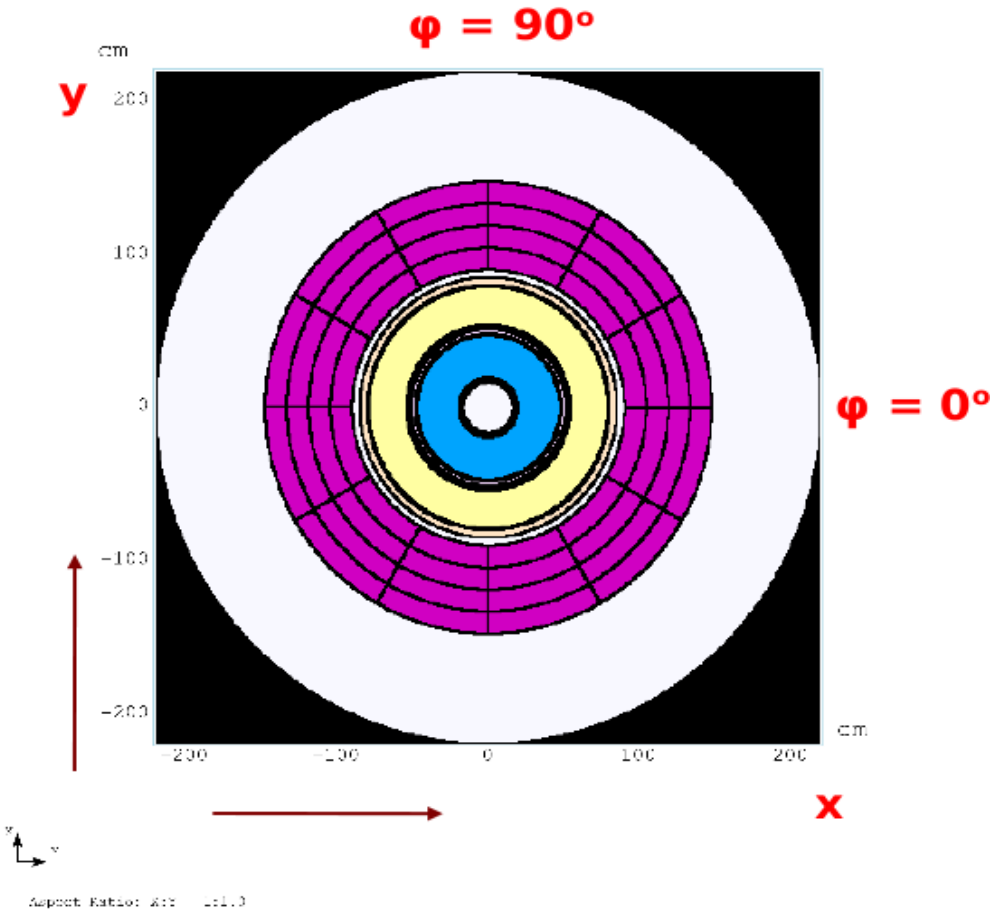




FIRST LOOK: AS A RESULT OF THE THE SHIELDING IN THE UPPER HALF OF THE Hg POOL IT APPEARS RADIATION ENERGY MOSTLY DUE TO NEUTRONS IS NOT SPREAD OUT SO MUCH DOWNSTREAM THERE. ON THE OTHER HAND, DUE TO THE DIFFERENT MAGNETIC FIELD PROFILE MORE PROTONS ENERGY WILL END UP IN THE LAST TWO CRYOSTATS REGION. ALSO, SURPRISINGLY, REPLACING THE RESISTIVE COILS WITH SHIELDNING IT APPEARS DOES NOT CHANGE SO MUCH THE RADIAL SPREADING AROUND THE TARGET REGION. THIS, IN PART, MAYBE IS RELATED TO THE DIFFERENT INITIAL BEAM POINTS USED FOR THE TWO CASES AND/OR THE LARGER APPERTURE (7.5 --> 10.0 cm) IN THE TARGET REGION.

IDS120j: NO RESISTIVE COILS. GAP BETWEEN CRYO 1-2 AND SC#4 SEGMENTATION DETAILS.





90 < r < 147.61 cm dr = 14.40 cm N_r = 4 bins

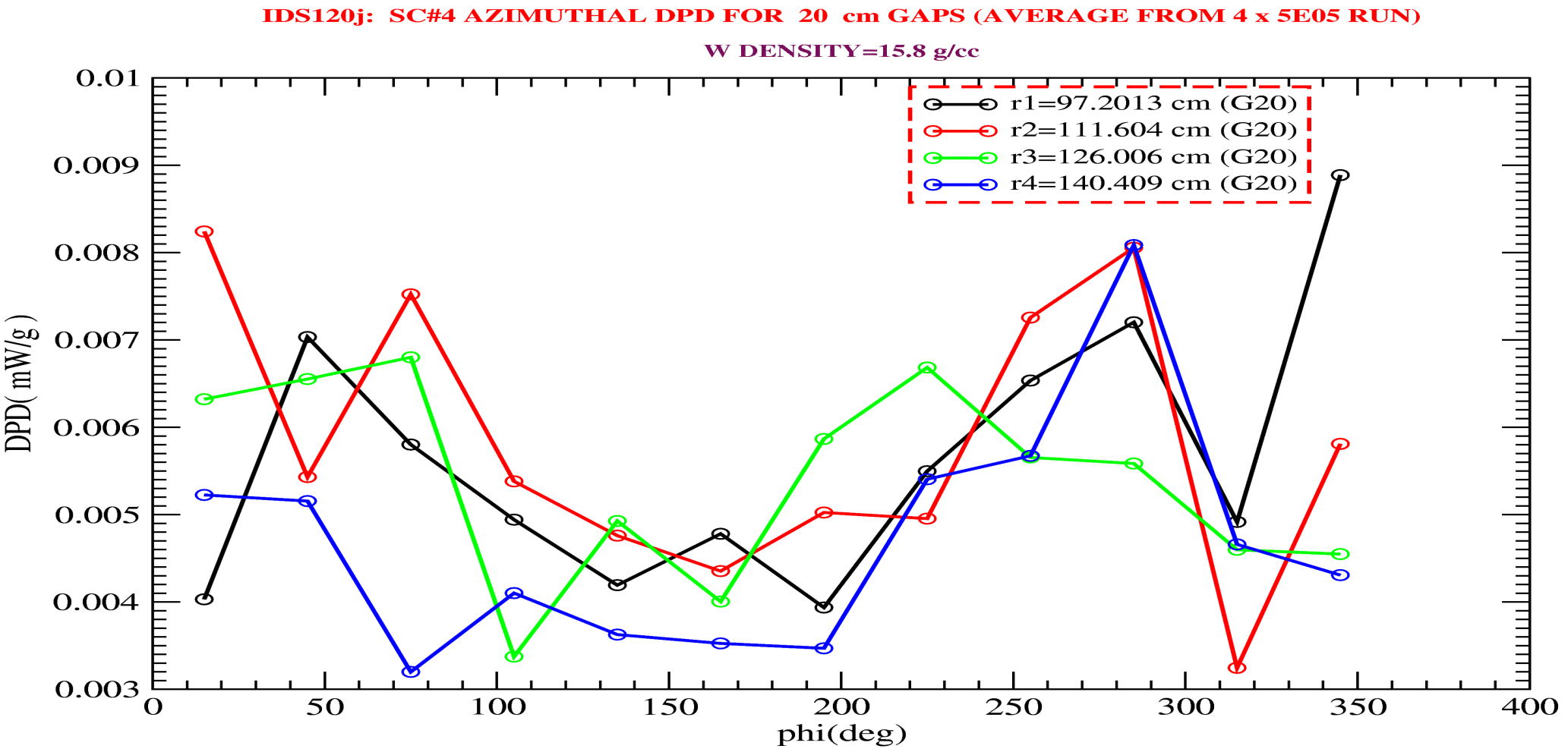
459.0 < z < 480.31 cm dz = 21.31 cm N_z = 1 bin

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

N_{tot} = 48 "pieces"

JOHN INFORMED US THAT AN AZIMUTHAL SEGMANTATION OF 8 deg ! WAS USED FOR THE FLUKA SIMULATIONS. THIS IS MACH SMALLER THAN THE ONE I HAVE BEEN USING. NO INFO WAS PROVIDED ABOUT THE SEGMENTATION ALONG THE OTHER TWO DIRECTIONS.

IDS120j: SC#4 DPD AZIMUTHAL DISTRIBUTIONS FOR 20 cm GAPS
(FORM 4 x 5E05 EVENTS, 15.8 g/cc W BEADS DENSITY)



AS WAS EXPECTED 20 cm OR LARGER GAPS IN THE SHIELDING FOR THE CRYOSTATS #1 AND #2 APPEAR TO PRESENT NO PROBLEM FOR THE PEAK DPD IN SC#4, IT IS MUCH LOWER THAN THE ITER LIMIT. PEAK VALUES FOR P12 APPEAR IN THE LOWER HALF OF THE COIL (DUE TO Hg POOL).

AVERAGING ALONG THE RADIAL DIRECTION FLUKA PREDICTED PEAKS < 0.26 mW/g BUT AVERAGING ALONG THE AZIMUTHAL DIMENSION PREDICTED PEAKS ~ 0.62 mW/g FOR THE COILS IN THE LAST CRYOSTAT (WHAT ARE THE STATISTICAL UNCERTAINTIES FOR THESE? LOCATION OF PEAKS?). THE BIN SIZE WE USE IN MARS IS MUCH LARGER THAN THOSE IN FLUKA. NEVERTHELES THE PEAK DPD WE GET FROM ABOVE PLOT FOR SC#4 IS VERY CLOSE TO THE ONE PREDICTED BY FLUKA ALONG THE RADIAL DIRECTION ~ 0.01 mW/g . SAME GOOD AGREEMENT WE HAVE FOR THE SC#1, SC#2, SC#3 DPD PEAKS (~ 0.01- 0.03 mW/g). SIMULATIONS FOR DOWNSTREAM COILS WILL BE PERFORMED AS SOON AS WE HAVE A BEAM PIPE FUNCTION.

IDS120j : DEPOSITED POWER (kW) IN DIFFERENT COMPONENTS (FLUKA)

	WITH RS, 20 cm GAPS	WITHOUT RS, 20 cm GAPS, P12			
BeWind:	5.95	7.57		(8.4±0.1)	(+ 0.8)
Hg POOL:	435.56	443.89		(342.8±7.3)	(- 101.1)
Hg JET:	400.40	396.40		(431.8±2.9)	(+ 35.4)
RS:	310.69	------			
BP1:	223.35	322.49			
BP2:	185.28	384.06			
BP3:	4.99	17.79	--- MORE THAN 3x DP IN DOWNSTREAM BP SECTION		
BP TOT:	413.62	724.34	--- MORE DP IN BPs	(835.2)	(+ 111) (!?)
SC#1:	0.658	0.470	--- ONLY A SMALL DECREASE	(0.386±0.050)	
SC#2:	0.194	0.092		(0.082±0.020)	
SC#3:	0.114	0.022		(0.016±0.008)	
SC#4:	0.272	0.033		(0.025±0.009)	
SC#5-9	0.021 (0.008/0.002/0.007/0.009/0.004)	0.031 (0.006/0.002/0.008/0.014/0.005)		(0.035)	
SC#10-12	0.054	0.144	--- MORE DP IN DOWNSTREAM SCs	(0.216)	
SC TOT:	1.313	0.792	--- TOTAL DP IN SC < 1 kW	(0.76±0.07)	
SH#1:	896.88	1256.00	--- MORE THAN ~ 30 % OF 4 MW		
SH#1A:	330.29	179.60	SH#1+1A (1435.60)	(1565.5±8.2)	(+130) (!?)
SH#2:	92.99	29.52		(35.4±1.3)	(+ 6)
SH#3:	8.36	12.65		(17.6)	(+ 5)
SH#4 :	115.15	41.43		(53.6±0.6)	(+ 12)
SH TOT:	1443.67	1519.20		(1672.0)	(+ 153)
SHVS#1:	182.38	10.66	--- DIFFERENT CONFIGURATION		
SHVS#2:	71.28	2.84	--- DIFFERENT CONFIGURATION		
SHVS#3:	0.72	1.47			
SHVS#4:	26.13	4.28			
SHVS TOT:	280.50	19.25			
Hg POOL WALL:	15.36	6.45 (INNER WALL)		(12.4±0.5)	(+ 6)
TOTAL:	3307.06	3118.95		(3303.5±13.5)	(+ 184.6)
(!!??)					