IDS120h AND IDS120i GEOMETRY.

SIMULATIONS FOR 60%W+40%He SHIELDING WITH STST SHIELDING VESSELS.

Hg vs. Ga DEPOSITED POWER DISTRIBUTION
(using Ding's optimized parameters)

Nicholas Souchlas, PBL (2/7/2012)

IDS120h AND IDS120i GEOMETRIES.

Hg vs. Ga DP DISTRIBUTION USING DING'S OPTIMIZED PARAMETERS FOR BOTH TARGETS.

BeWind: DPD PLOTS FROM AZIMUTHAL SEGMENTATION SIMULATIONS .

>mars1510/MCNP

>10^{-11} MeV NEUTRON ENERGY CUTOFF

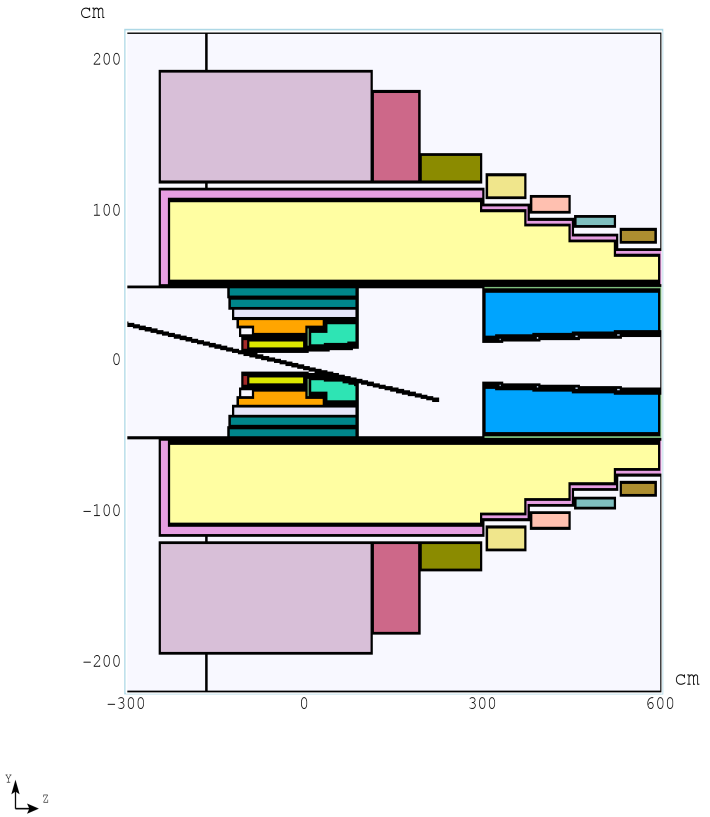
>SHIELDING:60%W+40%He (WITH STST VESSELS)

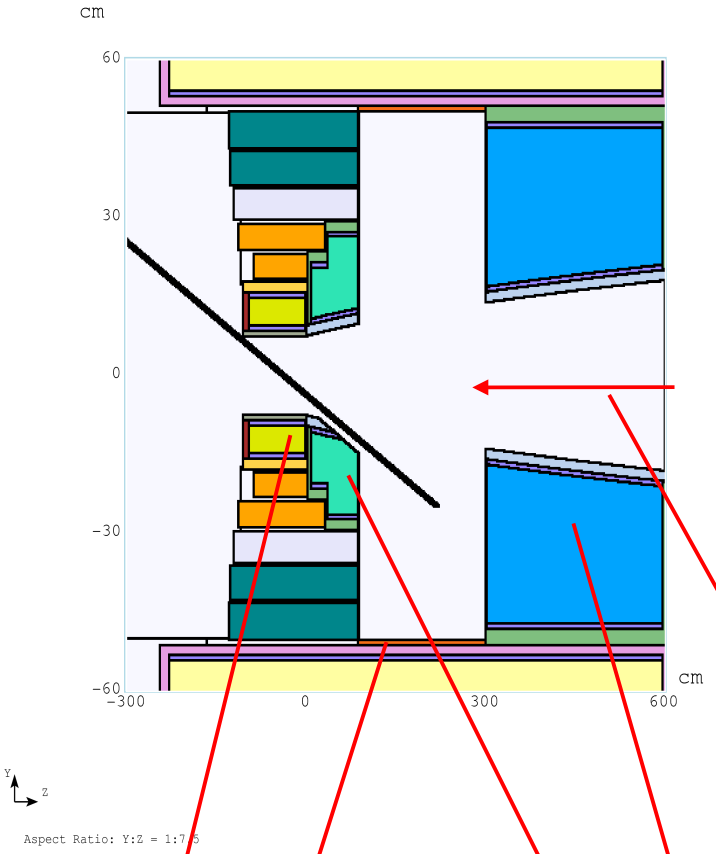
>4 MW proton beam,Np=100,000 events.

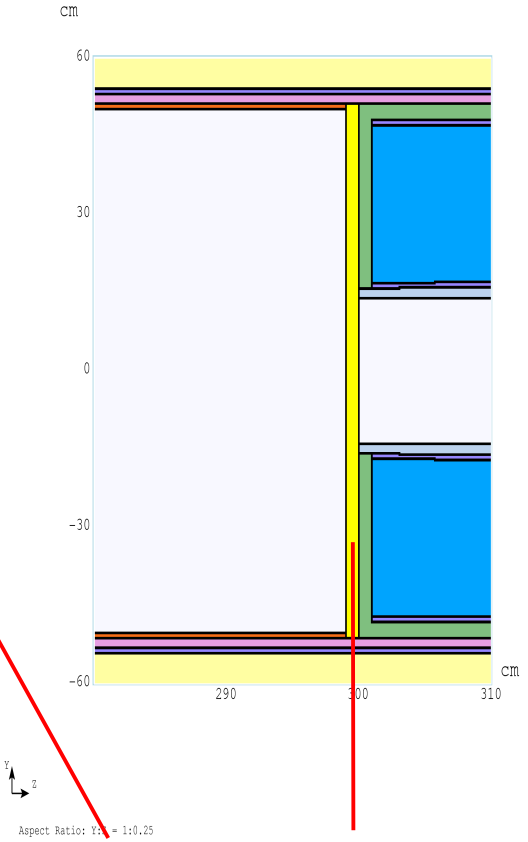
>PROTONS ENERGY E=8 GeV.

>GAUSSIAN PROFILE: $\sigma_x=\sigma_y$=0.12 cm(Hg)/0.132 cm(Ga).

IDS120hm GEOMETRY=IDS120h WITH MODIFIED Hg POLL VESSEL AND SHIFTED Be WIDOW FROM 600 cm (0.6 cm THICK) TO 300 cm (1 cm THICK).







SH1-->SH1A

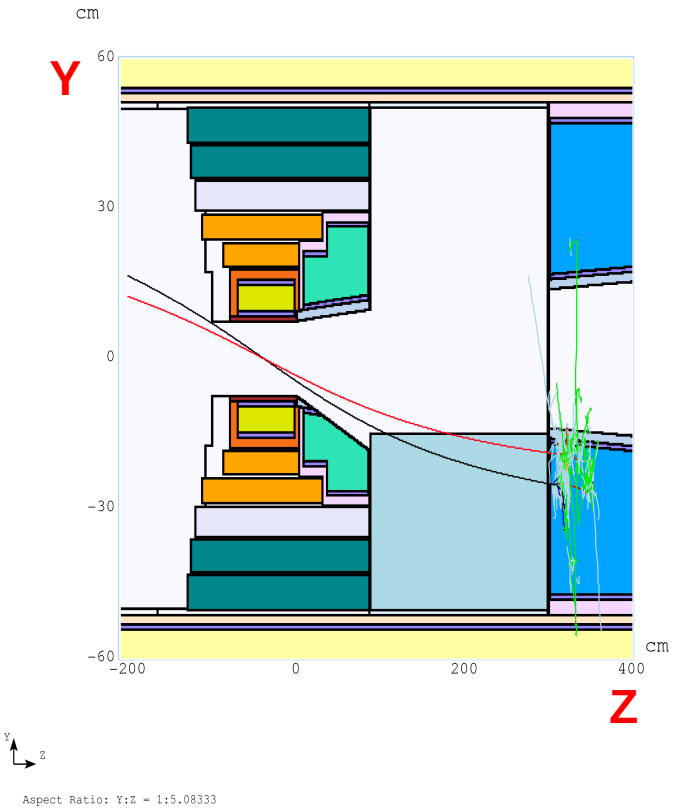
SH2-->SH1B + SH2

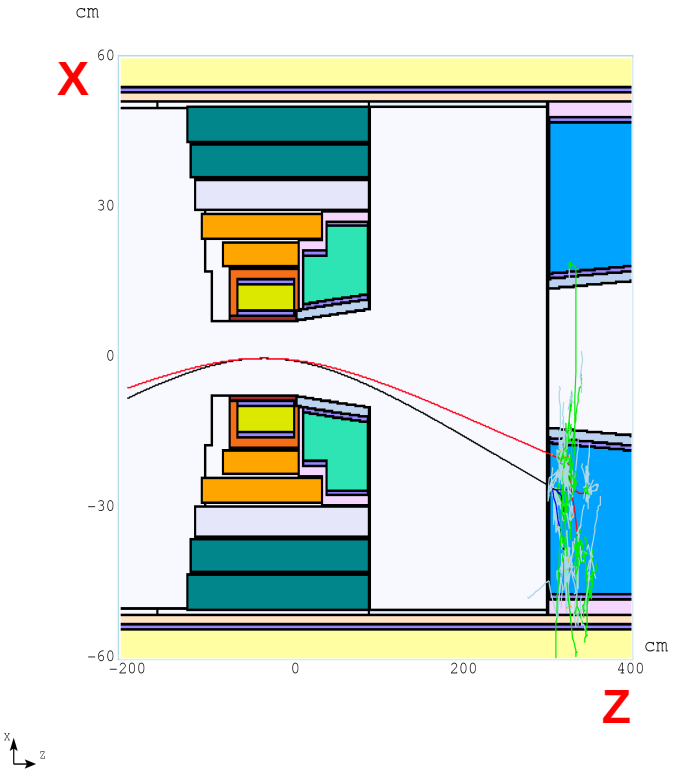
1 cm THICK Be WINDOW IS LOCATED AT 300 cm (ORIGINALLY 0.6 cm THICK PLACED AT 600 cm)

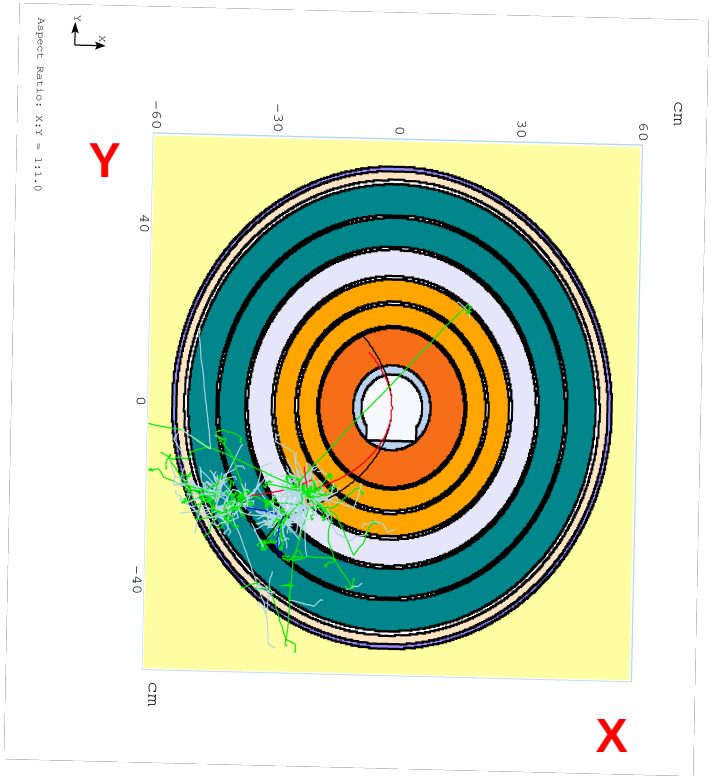
MODIFIED Hg POOL EXTENTS FROM 86 cm TO ~300 cm ALONG THE z-AXIS AND UP ~50 cm RADIALLY

1 cm THICK STST WALLS USED FOR THE Hg POOL VESSEL

CENTER OF BEAM PROTONS TRAJECTORY FOR Hg(BLACK) AND Ga(RED) TARGETS. (POOL SURFACE IN FIRST PLOT IS AT y= - 15 cm BUT FOR SIMULATIONS y= - 20 cm)







Hg TARGET: y= - 15 cm------> l(protons trajectory)>191.37 cm>14 IL(protons interaction length in Hg~ 15 cm)

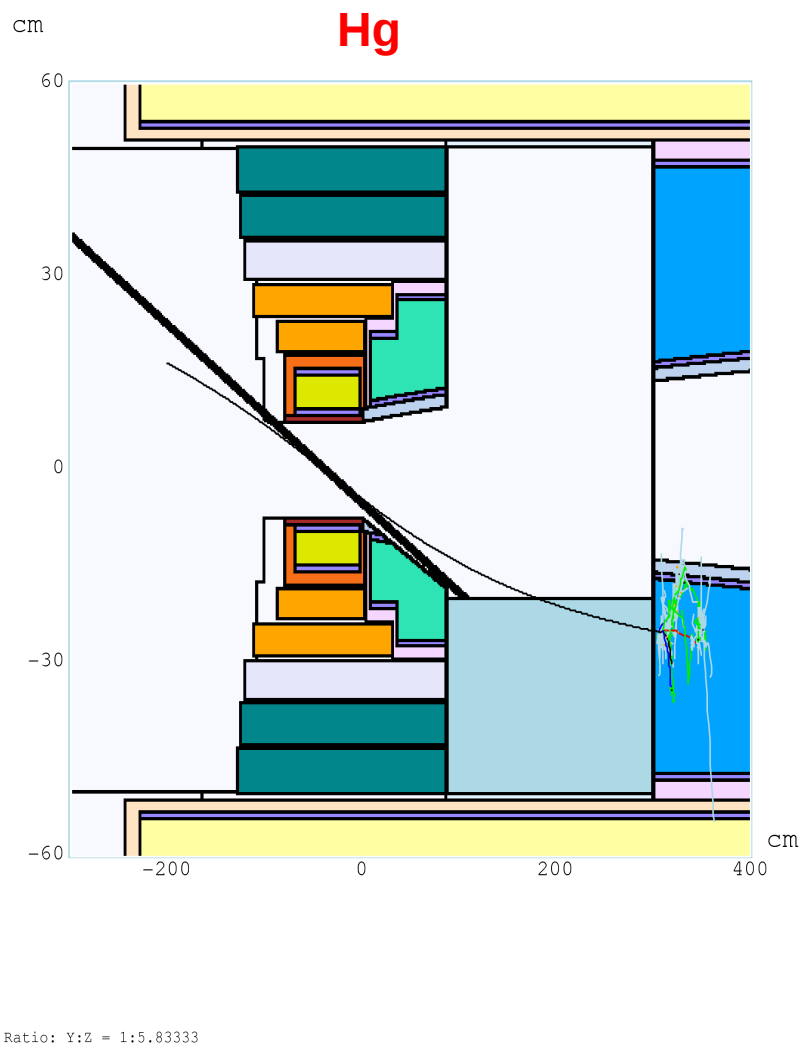
y= - 20 cm------> l(protons trajectory)>116.14 cm> 8 IL

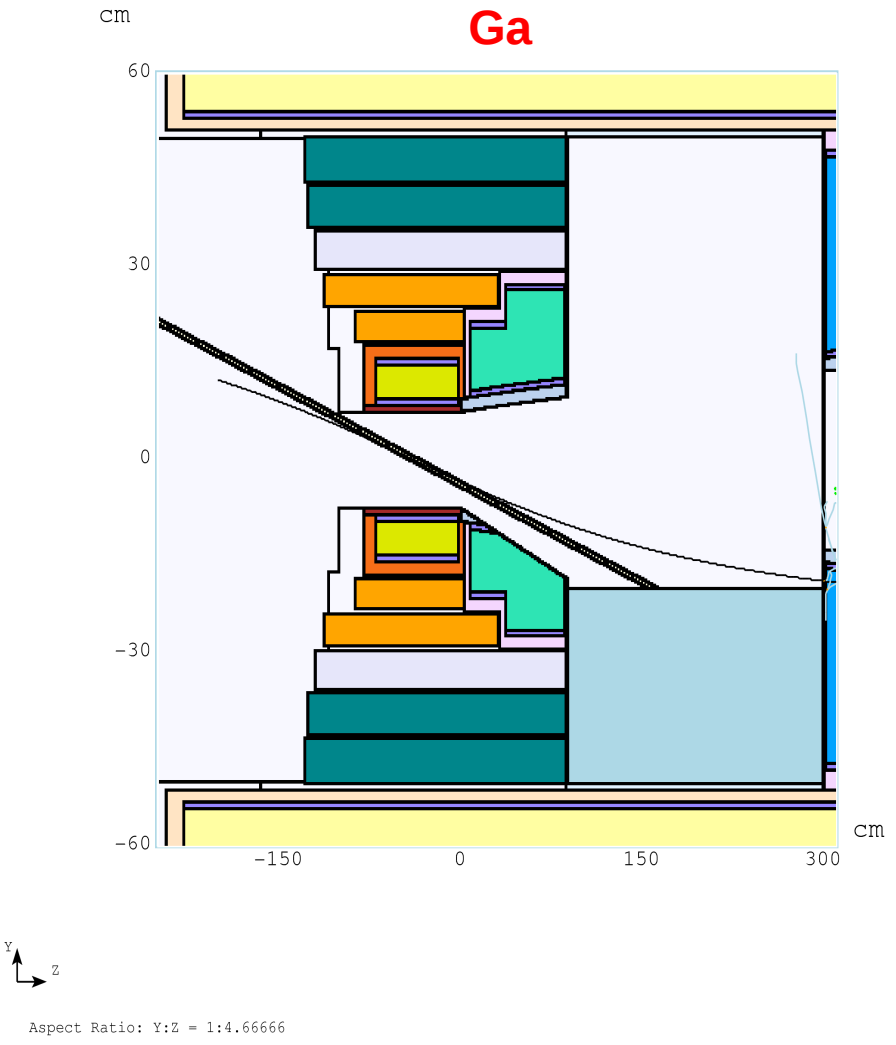
Ga TARGET: y= - 15 cm------> l(protons trajectory)>117.07 cm>5 IL(protons interaction length in Ga~ 24 cm)

y= - 20 cm------> l(protons trajectory)= 0.0 cm (protons do not enter the pool)

PROTONS ENTER Ga POOL NEAR THE CENTER AND HAVE A SHORT PATH, ONE WAY TO IMPROVE THIS IS BY SHIFTING THE POOL TO THE RIGHT(~ 100 cm)

CENTER OF BEAM PROTONS TRAJECTORY FOR Hg AND Ga TARGETS WITH JET AND POOL PRESENT(BUT NOT INTERACTING). POOL SURFACE IS AT y= - 20.0 cm





Hg vs. Ga TARGET: IT APPEARS PROTONS INTERACT WITH Ga JET IN A LONGER REGION THAN IN THE Hg TO COMPANSATE FOR THE SMALLER SIZE Ga ATOMS.

IS IT POSSIBLE TO ROTATE Ga JET TO ALLOW PROTONS ENTER SOONER THE POOL AND THEREFORE TRAVEL LONGER DISTANCE IN Ga POOL?

POWER DEPOSITED IN THE SC COILS

NiSn/NiTi	Hg(NS)	Hg(DX)	Ga(NS)	Ga(DX)
SC#1	0.271	0.264	0.167	0.199
SC#2	0.055	0.061	0.096	0.042
SC#3	0.054	0.041	0.146	0.041
SC#4	0.054	0.043	0.104	0.046
SC#5	0.026	0.006	0.021	0.019
SC#6	0.003	0.001	0.016	0.007
SC#1-6	0.455	0.461	0.550	0.354
SC#7-9	0.072	0.063	0.100	0.106
SC#10-12	0.062	0.056	0.063	0.096
SC#13-15	0.035	0.036	0.044	0.067
SC#16-19	0.066	0.059	0.067	0.092
SC#1-19	0.690	0.630	0.842	0.715

SC#1-5 RECIEVE LESS DP (~ 0.107 kW) AND THERE IS A SMALL INCREASE IN THE REST.

DEPOSITED POWER IN SHIELDING AND SHIELDING VESSELS.

60W/40He	Hg(NS)	Hg(DX)	Ga(NS)	Ga(DX)
SH#1A	715.00	790.50	499.70	692.00
SH#1B	439.65	403.30	496.75	396.60
SH#2	192.10	264.10	313.95	658.50
SH#3	23.82	21.58	25.24	32.44
SH#4	107.45	99.30	146.45	83.85
SH#1-4	1478.02	1578.78	1482.09	1863.39

SH#1A~ - 99 kW DECREASE, SH#1B~SAME, SH#2~ + 394 kW INCREASE.
DP IS SPREAD OUT MORE DOWNSTREAM, MAINLY IN THE VOLUME REGION ENCLOSED BY SC#4-10, HIGH RISK OF DPD PEAK VALUES CLOSE/ABOVE ITER LIMIT.
MORE ENERGY (~+ 285 kW) WILL BE DEPOSITED IN SHIELDING IN Ga TARGET.

STST	Hg(NS)	Hg(DX)	Ga(NS)	Ga(DX)
SHVS#1	118.85	153.50	80.35	160.70
SHVS#2	68.75	67.55	77.40	70.35
SHVS#3	0.57	0.48	0.54	0.79
SHVS#4	25.17	19.11	33.02	16.51
SHVS#1-4	213.34	240.64	191.31	248.35

ABOUT SAME TOTAL DP IN VESSELS AND ABOUT SAME DISTRIBUTION.

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

Cu	Hg(NS)	Hg(DX)	Ga(NS)	Ga(DX)
RS#1+2	134.60	149.90	84.45	115.00
RS#3	55.25	58.35	37.39	44.82
RS#4+5	69.30	72.20	46.01	54.00
RS#1-5	259.15	280.45	167.85	213.82

ABOUT 67 kW LESS DP IN RESISTIVE COILS.

STST	Hg(NS)	Hg(DX)	Ga(NS)	Ga(DX)
BP#1	206.30	222.75	152.45	206.70
BP#2	265.55	216.70	333.25	297.10
BP#3	9.30	8.79	11.10	16.09
BP#1-3	481.15	448.24	496.80	519.89

BEAM PIPE DEPOSITED POWER DISTRIBUTION CONFIRMS THAT THE ENERGY IS SPREAD MORE DOWNSTREAM (INCREASE IN DP#2 BY MORE THAN 80 kW IN Ga TARGET) CONSISTENT WITH THE EXPECTATIONS FROM A ''SOFTER'' (SMALLER ATOMS) TARGET.

SUMMARY FOR TOTAL POWER DEPOSITED IN DIFFERENT COMPONENTS IN TARGET STATION.

TOTALS	Hg(NS)	Hg(DX)	Ga(NS)	Ga(DX)
SC#1-19	0.690	0.630	0.842	0.715
SH#1-4	1478.02	1578.78	1482.09	1863.39
SHVS#1-4	213.34	240.64	191.31	248.35
RS#1-5	259.15	280.45	167.85	213.82
BP#1-3	481.15	448.24	496.80	519.89
Hg/Ga TARG.	408.10	400.60	179.75	213.50
Hg/GaPOOL	334.65	270.25	650.00	164.80
PulWALLS	13.25	9.56	14.77	8.13
Be WIND.	7.30	8.04	6.47	6.44
TOTAL	3195.65	3237.19	3189.88	3239.04

Ga TARGET RECIEVES ABOUT HALF THE POWER DEPOSITED IN Hg, WHILE Ga POOL ABOUT 105 kW LESS ENERGY THAN THAT IN Hg POOL.
THAT IS DUE TO THE SMALLER LENGTH OF THE PROTONS TRAJECTORY IN THE Ga POOL AND THE LARGER p-Ga INTERACTION LENGTH.
SINCE Ga ATOMS HAVE MUCH SMALLER ATOMIC NUMBER (31) THAN Hg ATOMS (80) A SMALLER NUMBER OF PROTONS INTERACTS WITH THE TARGET AND MORE WILL END UP IN THE Ga POOL, THAT WILL SOMEHOW MITIGATE THE EFFECT OF THE LAST TWO Ga ''DISADVANTAGES'' .

Be WINDOW ABOUT 1.6 kW LESS DP IN Ga.

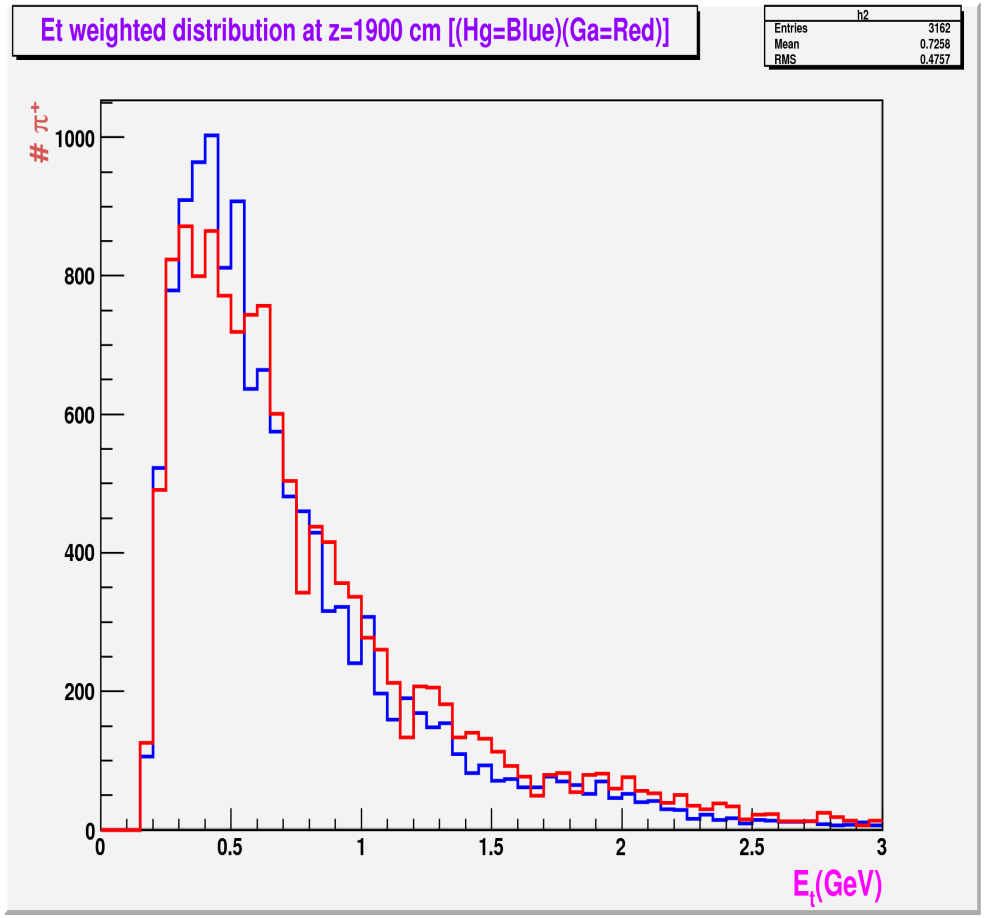
DEPOSITED POWER PEAK DENSITIES IN SC#1-11.

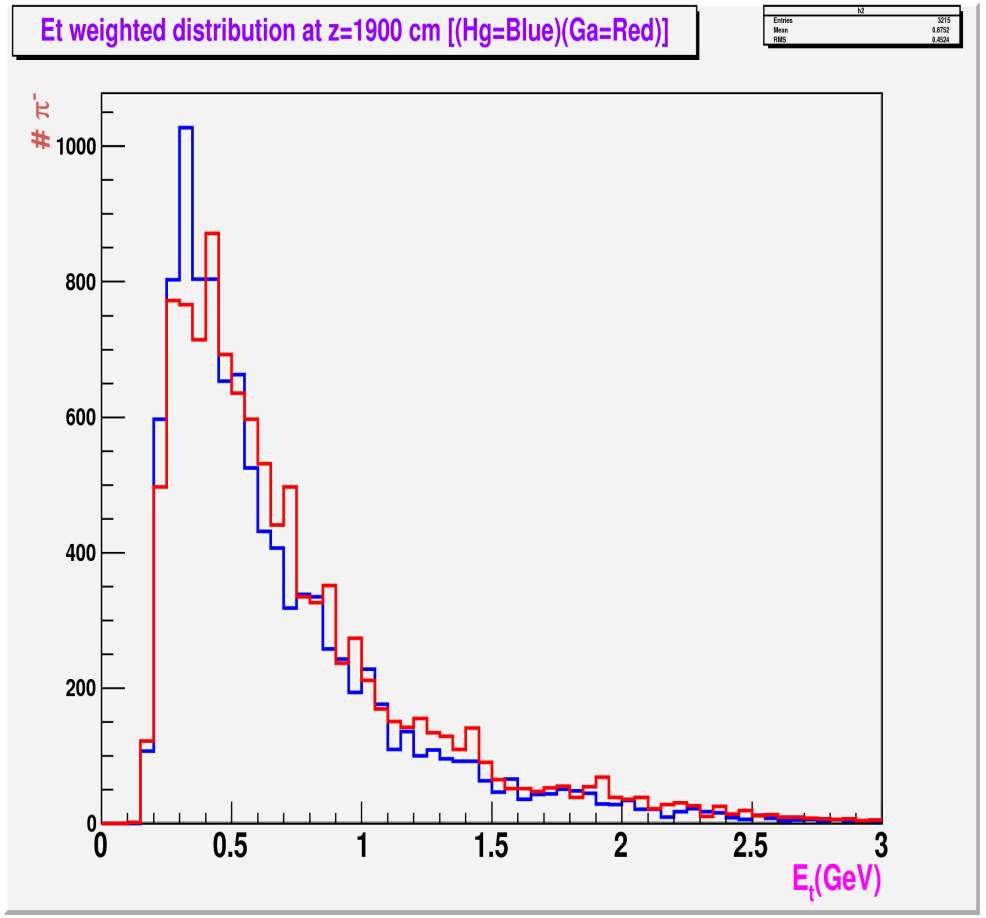
PEAK(mW/g)	Hg(NS)	Hg(DX)	Ga(NS)	Ga(DX)
SC#1	0.030	0.032	0.025	0.030
SC#2	0.014	0.012	0.022	0.022
SC#3	0.016	0.011	0.035	0.012
SC#4	0.017	0.025	0.007	0.042
SC#5	0.030	0.009	0.016	0.014
SC#6	0.001	0.001	0.006	0.014
SC#7	0.003	0.024	0.005	0.003
SC#8	0.060	0.070	0.070	0.130
SC#9	0.060	0.060	0.150	0.110
SC#10	0.064	0.070	0.050	0.090
SC#11	0.060	0.046	0.070	0.130

AS WAS EXPECTED, AZIMUTHALLY AVERAGE DPD PEAK VALUES IN SC#8-11 DOWNSTREAM, NEAR THE END OF THE ''STAIRS'', REVEAL THE VULNERABILITY OF THESE SC TO RADIATION FOR A Ga TARGET CASE.
ONE SHOULD EXPECT EVEN HIGHER DPD PEAKS FROM AZIMUTHAL DISTRIBUTION.

NS ''OPTIMIZED'' P12 POINT GAVE RESULTS IN RESONABLE AGREEMENT WITH DX MORE ''PRECISE'' OPTIMIZED/MAXIMUM YIELD POINT FOR Hg TARGET.

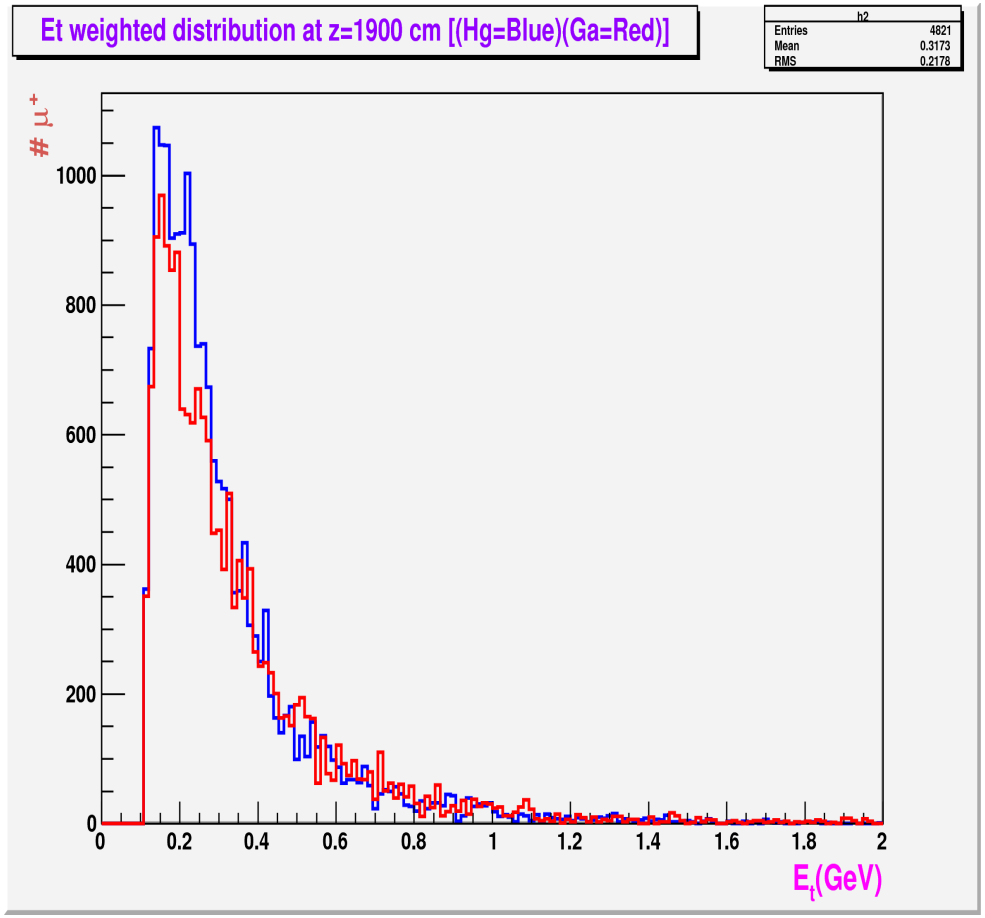
$\pi^{\pm}$ SPECTRUM HISTOGRAM PLOTS AT z=1900 cm FOR Hg AND Ga TARGETS.

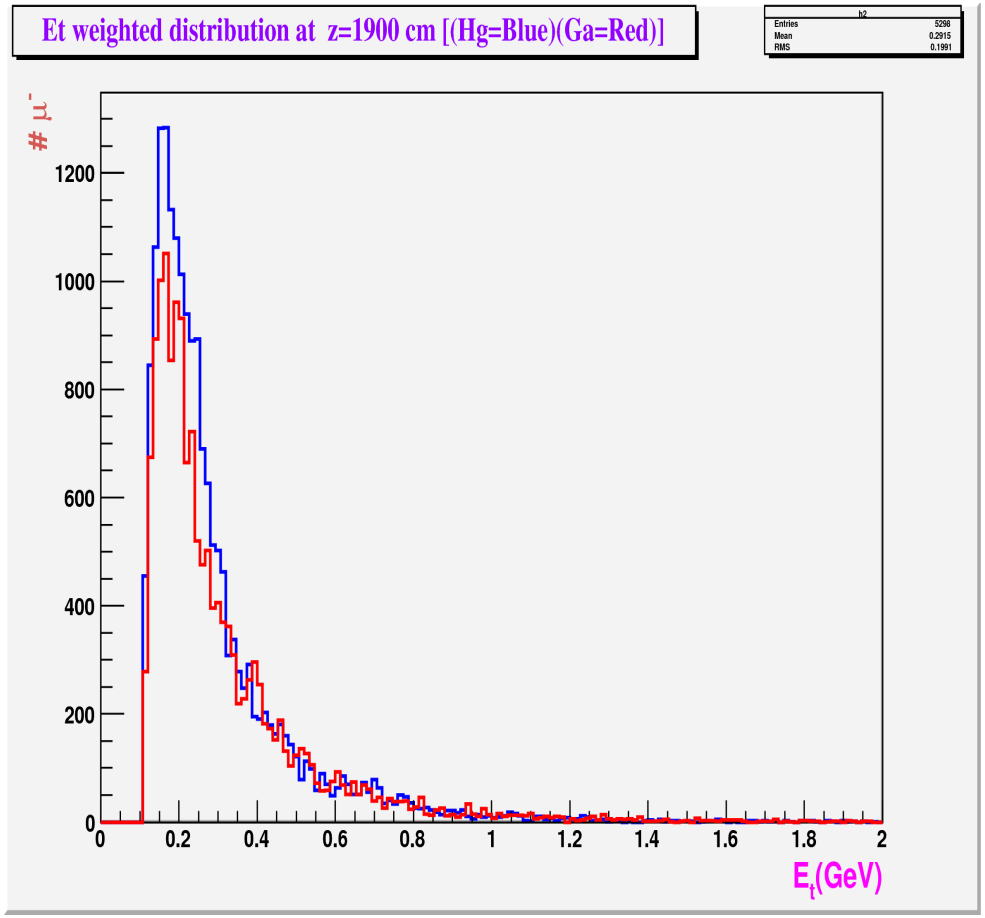




PARTICLE(TARGET)	π^+(Hg)	π^+(Ga)	π^-(Hg)	π^-(Ga)
# EVENTS PRODUCING:	3162	3148	3215	3335
# DIFFERENT EVENTS PRODUCING:	3122	3119	3195	3304
TOTAL # OF PARTICLES:	12913	13503	10444	11396
# OF PARTICLES WITH 40<KE<180 MeV:	1755	1742	1854	1622

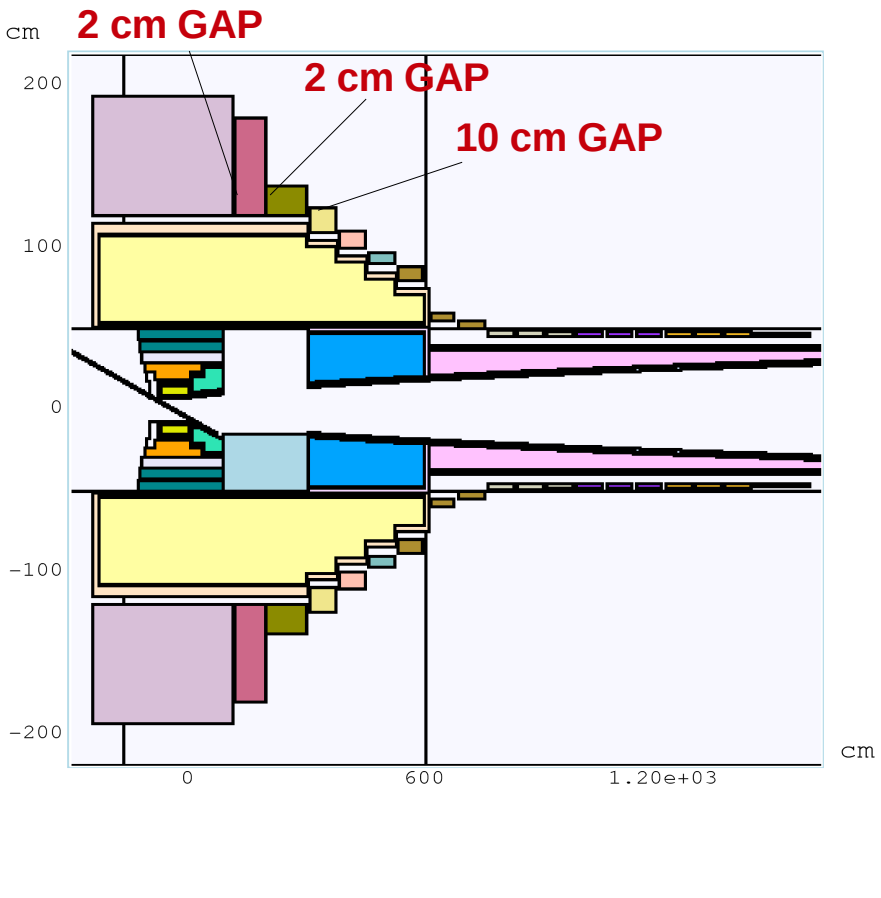
$\mu^{\pm}$ SPECTRUM HISTOGRAM PLOTS AT z=1900 cm FOR Hg AND Ga TARGETS.

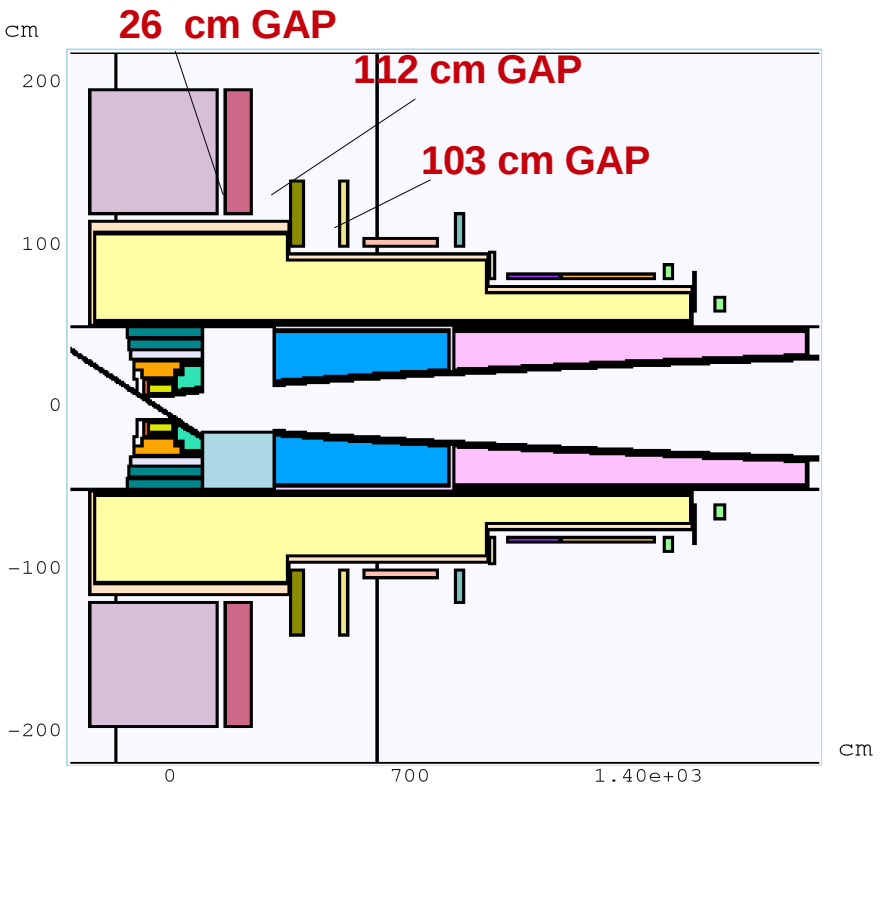




PARTICLE(TARGET)	μ^+(Hg)	μ^+(Ga)	μ^-(Hg)	μ^-(Ga)
# EVENTS PRODUCING:	4821	3821	5298	3856
# DIFFERENT EVENTS PRODUCING:	4517	3618	4962	3724
TOTAL # OF PARTICLES:	18942	17332	18610	15746
# OF PARTICLES WITH 40<KE<180 MeV:	9153	7647	10105	7972

IDS120h (LEFT) vs. IDS120i (RIGHT) [YZ CROSS SECTION] .





IDS120h

N(SC)=19

IR(SC#1-3)=120 cm

SC#4--->#10:IR=110 cm--->IR=45 cm

SC#11- 18(IR=45 cm) ---------->

SC#12- 18 ~~~~~~~~~~~~>TWO LONG SC(#8+9)/dZ~156/274 cm

IDS120i

N(SC)=12

IR(SC#1-2)=120 cm

IR(SC#3-6)=100 cm

SC#7-10(IR=80 cm)

GAPS BETWEEN THE COILS CREATED AT THE EXPANSE OF RADIAL THIKNESS.

F.E. dR(SC#2/3/4)~60/18/15 cm ~~~~~~~~~~> dR(SC#2/3/4)~ 77/40/40 cm

POWER DEPOSITED IN THE SC COILS

NiSn/NiTi	Hg	Ga
SC#1	0.338	0.256
SC#2	0.111	0.101
SC#3	0.044	0.056
SC#4	0.002	0.002
SC#5	0.001	0.001
SC#6	0.001	0.001
SC#7	0.001	0.000
SC#8	0.002	0.002
SC#9	0.001	0.002
SC#1-9	0.501	0.421
SC#10-12	0.006	0.009
SC#1-12	0.507	0.430

FIRST TWO COILS GET ALMOST ALL DEPOSITED POWER IN SCs. IN BOTH Hg AND Ga TARGET THE DP DISTRIBUTION AND TOTAL DP ABOUT THE SAME.

DEPOSITED POWER IN SHIELDING AND SHIELDING VESSELS.

—	Hg	Ga
SH#1A	871.50	766.00
SH#1B	351.60	347.45
SH#2	124.55	384.40
SH#3	12.41	18.96
SH#4	105.65	103.90
SH#1-4	1465.71	1620.71

SH#1A~ - 105 kW DECREASE, SH#1B~SAME, SH#2~ + 230 kW INCREASE.
DP IS SPREAD OUT MORE DOWNSTREAM.
MORE ENERGY (~+ 155 kW) WILL BE DEPOSITED IN SHIELDING IN Ga TARGET.

—	Hg	Ga
SHVS#1	233.55	235.05
SHVS#2	53.25	57.75
SHVS#3	0.12	0.15
SHVS#4	20.11	21.33
SHVS#1-4	307.03	314.28

SHIELDING VESSELS DP DISTRIBUTION AND TOTAL DP~ SAME IN Hg AND Ga TARGET.

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

Cu	Hg	Ga
RS#1+2	158.10	123.95
RS#3	59.30	45.57
RS#4+5	74.30	55.95
RS#1-5	291.70	225.47

ABOUT 66 kW LESS DP IN RESISTIVE COILS.

BP	Hg	Ga
BP#1	226.35	212.55
BP#2	192.45	278.70
BP#3	4.86	9.54
BP#1-3	423.66	500.79

ABOUT 77 kW MORE DP IN BEAM PIPE MOSTLY IN BP#2. THE EXTRA SPACE FOR SHIELDING DOWNSTREAM WILL PROVE VERY USEFUL IF THE TAGRET IS Ga.

POWER DEPOSITED IN SC COILS AND DPD PEAK VALUES.

TOTALS	Hg	Ga
SC#1-12	0.507	0.430
SH#1-4	1465.71	1620.71
SHVS#1-4	307.03	314.28
RS#1-5	291.70	225.47
BP#1-3	423.66	500.79
Hg/Ga TARG.	402.75	215.75
Hg/GaPOOL	384.40	368.70
POOLWALLS	10.21	9.80
Be WIND.	6.83	6.27
TOTAL	3292.80	3262.20

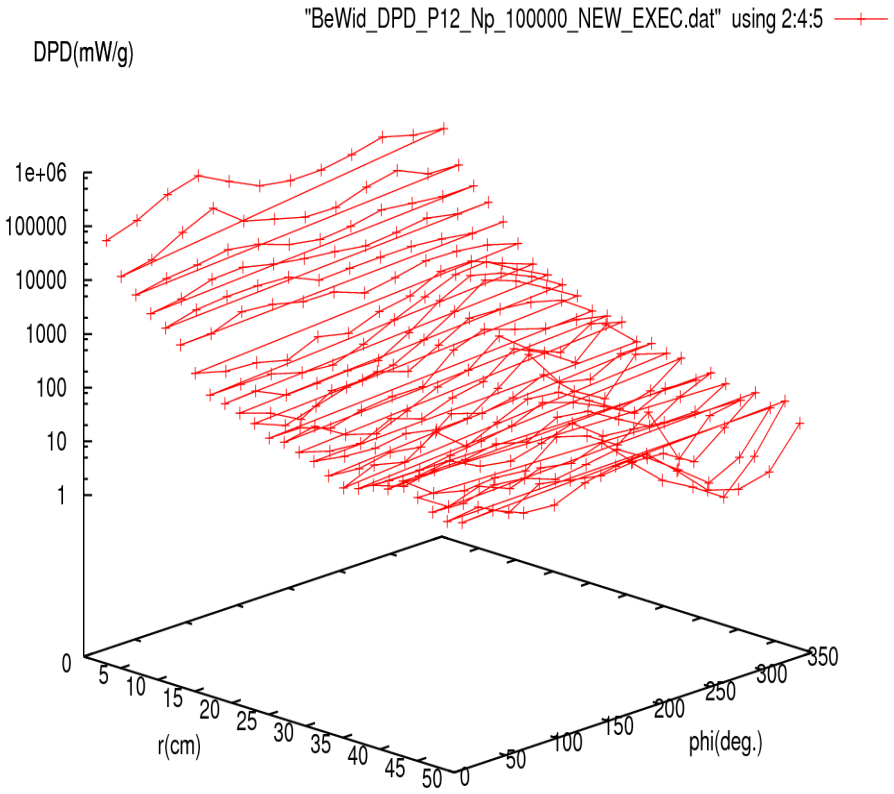
PEAK(mW/g)	Hg	Ga
SC#1	0.030	0.022
SC#2	0.020	0.030
SC#3	0.026	0.026
SC#4	0.002	0.002
SC#5	0.001	0.001
SC#6	0.001	0.001
SC#7	0.018	0.001
SC#8	0.008	0.005
SC#9	0.001	0.007
SC#10	0.001	0.003
SC#11	0.006	0.002
SC#12	0.007	0.012

Ga TARGET RECIEVES ABOUT HALF THE DEPOSITED POWER THE Hg TARGET GET BUT Ga POOL AND POOL WALLS HAVE ABOUT THE SAME DP, THE EXPLANATION WAS GIVEN EARLIER IN PAGE 9.
Be WINDOW ALSO HAS ABOUT THE SAME DP.

AZIMUTHALLY AVERAGE DPD PEAK VALUES APPEAR ABOUT THE SAME IN GENERAL FOR BOTH Hg AND Ga TARGET AND SIMILAR TO THE ONES IN IDS120h.
DETAIL ANALYSIS OF THE AZIMUTHAL DPD DISTRIBUTION IN SC IS UNDER WAY.

IDS120h Hg TARGET Be WINDOW DPD AZIMUTHAL DISTRIBUTION

3D PLOT



RADIAL FOR 12 ANGLES