

revised 20 Dec 2006

Carnot efficiency is 0.20 for these smaller plants

	40 K to 80 K	4.4 K
	Temperature level	Temperature level

Temp in	(K)	40.00	4.4	Note: cells highli
Press in	(bar)	16.0	1.2	
Enthalpy in	(J/g)	223.8	11.1	
Entropy in	(J/gK)	15.34	3.78	
Temp out	(K)	80.00	4.4	
Press out	(bar)	14.0	1.2	
Enthalpy out	(J/g)	432.5	30.6	
Entropy out	(J/gK)	19.24	8.21	
300 K, 1.2 bar enthalpy	(J/g)		1580.2	
300 K, 1.2 bar entropy	(J/gK)		30.6	
Predicted RF + magnet static heat per cryoplant	(W)	4900.00	940.00	
Predicted RF + magnet dynamic heat per cryoplant	(W)	180.00	720.00	
Predicted liquid consumption per cryoplant	(g/s)		0.80	
Liquid production equivalence	(W per g/s)		125.00	
Other (static) heat load per cryogenic plant	(W)	200.0	40.0	Add 40 W and 20
Total predicted static heat per cryogenic plant	(W)	5100.00	980.00	
Total predicted dynamic heat per cryogenic plant	(W)	180.00	720.00	
Total predicted heat per cryogenic plant	(W)	5480.0	1740.0	
Predicted mass flow cryogenic plant	(g/s)	26.3	89.0	
Total predicted liquid production per plant	(g/s)		0.80	
Ideal power based on predicted heat and liquid	(W)	25235.3	121688.8	
Heat uncertainty factor on static heat		1.10	1.10	Heat uncertainty
Heat uncertainty factor on dynamic heat		1.10	1.10	
Loaded heat load per cryogenic plant	(W)	6028.00	1914.00	
Loaded mass flow per cryogenic plant	(g/s)	28.89	97.95	
Loaded liquid production per cryogenic plant	(g/s)		0.88	
Liquid production heat equivalent	(W/(g/s))		125.00	
Loaded ideal power based on loaded heat and liquid	(W)	27758.9	133857.6	
4.5 K equiv ideal loaded power	(W)	422.8	2038.6	
Efficiency (fraction Carnot)		0.20	0.20	Helium inventory Guess 30 liters p Guess 5 liters pe Total 500 l not inc
Efficiency in Watts/Watt	(W/W)	23.0	330.7	
Operating power based on predicted heat	(kW)	126.2	608.4	
Operating power with heat uncertainty	(kW)	138.8	669.3	
Overcapacity factor		1.40	1.40	Overcapacity fact is average overal
Overall net cryogenic capacity multiplier		1.54	1.54	
Installed power	(kW)	194.3	937.0	
Installed 4.5 K equiv	(kW)	0.6	2.9	Using 0.2 as refe
Percent of total power at each level		17.2%	82.8%	
Operating power per plant based on predicted heat (MW)			0.88	Includes Fo = 1
Total installed power for one plant (MW)			1.13	
Total installed 4.5 K equivalent power for one plant (kW)			3.45	
Fraction of largest practical cryoplant			0.14	

highlighted in yellow are independent variables, parameters that are entered

10 W per plant total for other heat  
at 5 K and 40 K, respectively,  
due to transfer lines and end boxes

factor is margin for underestimating heat loads,

per frig  
per module  $\times 8 = 240$  l  
per meter of wiggler  $\times 50$  m = 250 l  
including piping

factor ( $F_o$ ) is margin for off-optimal operation and control  
net multiplier

reference efficiency

1.2