

CEPC 360GeV and 365GeV Power and SCRF Voltage difference

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Introduction

- CEPC 360GeV and 365GeV Power
 - Beam energy 180GeV and 182.5GeV
 - Synchrotron radiation power /beam is 30MW, which means there is no addition power for beams.
- SCRF Voltage difference

Powers in CDR

		Z 45.5GeV(MW)	W 80GeV (MW)	Higgs 120GeV (MW)	备注
1	RF Power Source	63.05*	109.75	109.75	不变*
2	Cryogenic System	4.94	8.07	14.02	增加
3	Vacuum System	14.222	14.222	14.222	不变
4	Magnet Power Supplies	13.65	31.24	61.9	增加
5	Instrumentation	1.7	1.7	1.7	不变
6	Radiation Protection	0.35	0.35	0.35	不变
7	Control System	1.81	1.81	1.81	不变
8	Experimental devices	4	4	4	不变
9	Utilities	25.3	32.32	38.53	增加
10	General services	19.75	19.75	19.75	不变
	Total	148.772	223.212	266.032	

*Synchrotron radiation power /beam (MW) for Z is 16.5MW, not 30MW.

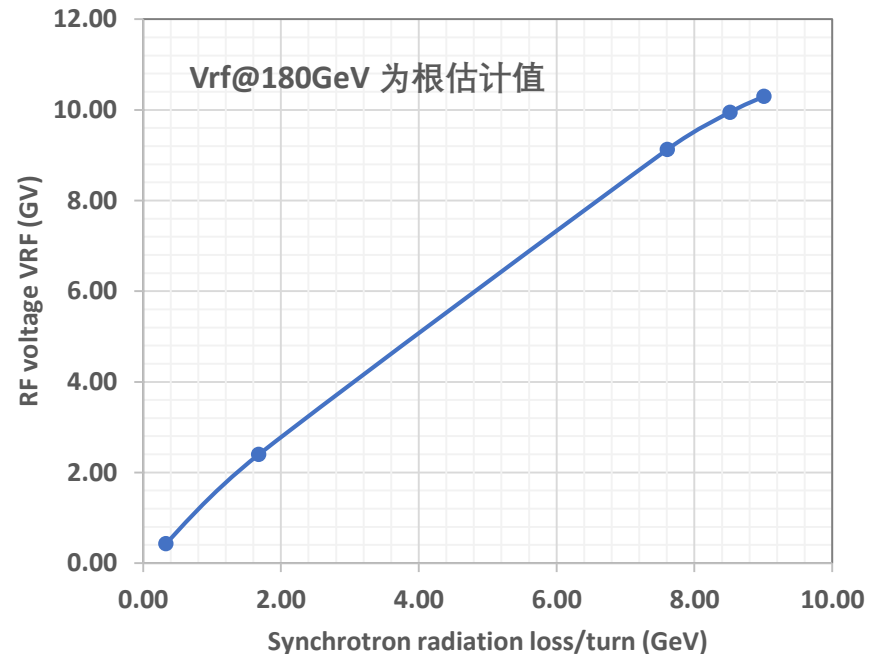
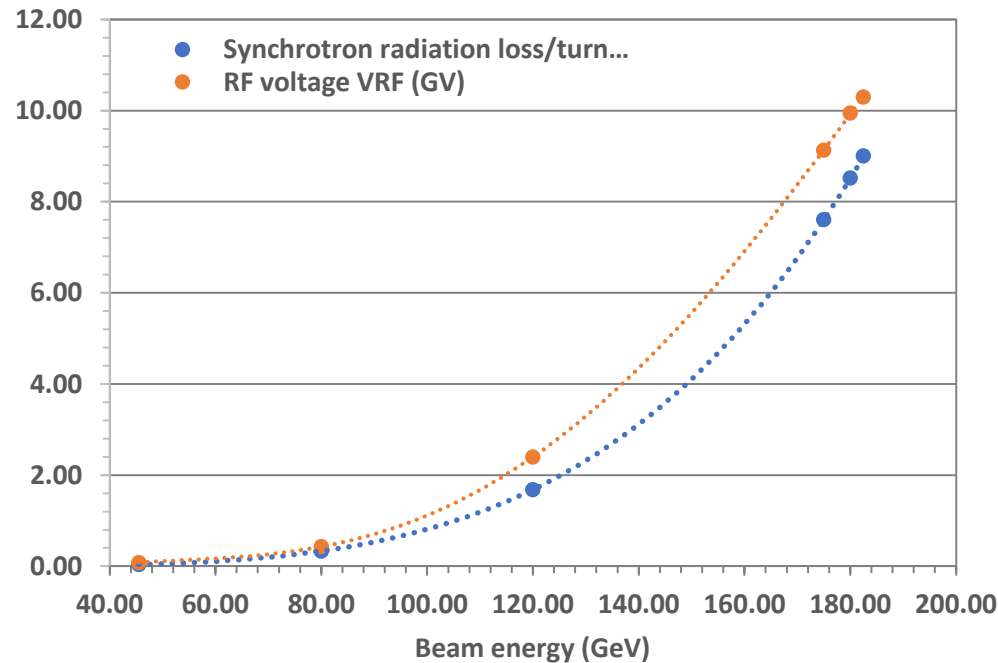
Heat load at Cryogenic System

Higgs Mode	Unit	Collider		
		40-80K	5-8K	2K
Predicted static heat load per cryomodule	W	300	60	12
Cavity dynamic heat load per cryomodule	W	0	0	153.59
HOM dynamic heat load per cryomodule	W	20	12	2
Input coupler dynamic heat load per cryomodule	W	60	40	6
Module dynamic heat load	W	80	52	161.59
Connection boxes	W	50	10	10
Cryomodule number		40		
Total heat load	kW	17.20	4.88	7.34
Total predicted mass flow	g/s	82.42	152.26	346.58
Overall net cryogenic capacity multiplier		1.54	1.54	1.54
4.5K equiv. heat load with multiplier	kW	1.99	6.80	36.18
Total 4.5K equiv. heat load with multiplier	kW	44.96		
Total 4.5K equiv. heat load of booster and collider	kW	47.4		
Installed Power	MW	9.84		
		10.		

SCRF Voltage difference

courtesy of Dou Wang

	<i>tt</i>			<i>Higgs</i>	<i>W</i>
Beam energy (GeV)	175.00	180.00	182.50	120.00	80.00
Circumference (km)	100.00				
Synchrotron radiation loss/turn (GeV)	7.61	8.52	9.01	1.68	0.33
Beam current (mA)	3.95		3.30	17.80	90.40
Synchrotron radiation power /beam (MW)	30.00				
Bending radius (km)	10.70				
RF voltage V_{RF} (GV)	9.13	9.95*	10.30	2.40	0.43



Cryogenic Pow change

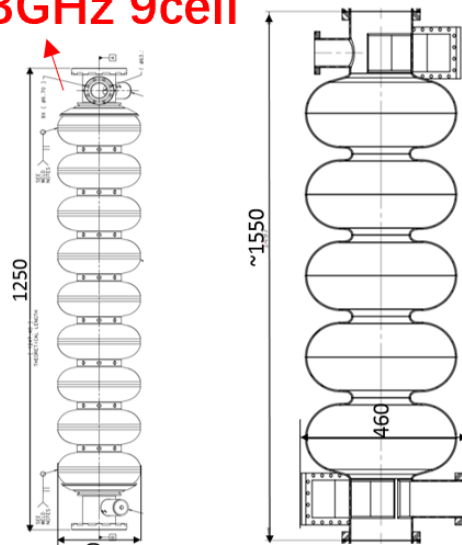
Thanks to Jiyuan for tt RF tables and discussion

- tt upgrade scheme of SRF system

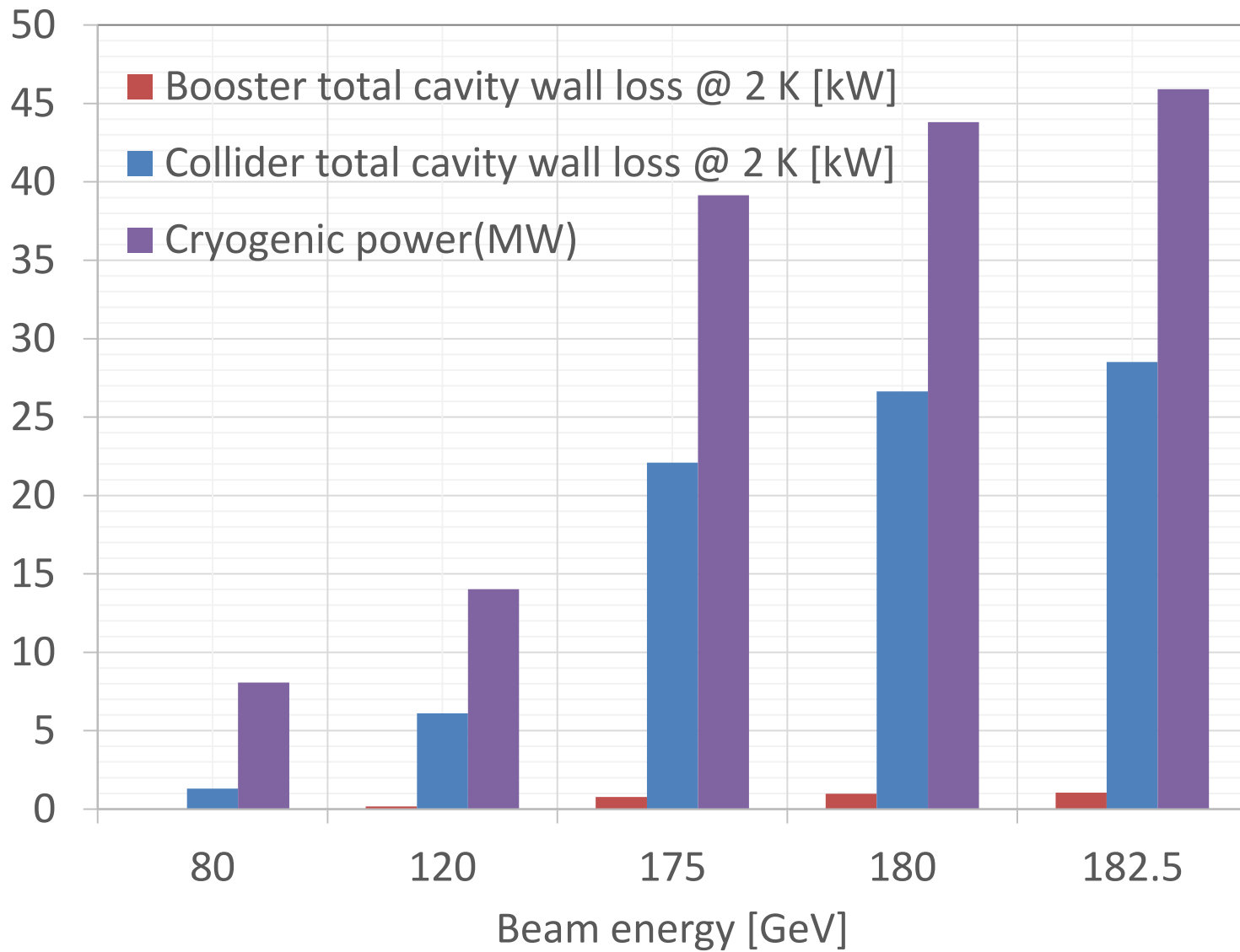
New machine parameters 20190226 SRF parameters 20190301	CD	
	H	
Luminosity / IP [$10^{34} \text{ cm}^{-2}\text{s}^{-1}$]	2.93	
SR power / beam [MW]	30	
RF voltage [GV]	2.17	
Beam current / beam [mA]	17.4	
Bunch charge [nC]	24	
Bunch number / beam	242	
Bunch length [mm]	3.26	
Cavity number (650 MHz)	240	
Cell number / cavity	2	
Idle cavities on line / ring	0	
Cavity gradient [MV/m]	20	
Q_0 for long term operation	1.5E+10	
Input power / cavity [kW]	250	
Klystron max power [kW]	800	
Number of cavities / klystron	2	
HOM power / cavity [kW]	0.57	
Optimal QL	1.5E+6	
Optimal detuning [kHz]	0.2	
Wall loss / cavity @ 2 K [W]	25.6	
Total cavity wall loss [kW]	6.1	



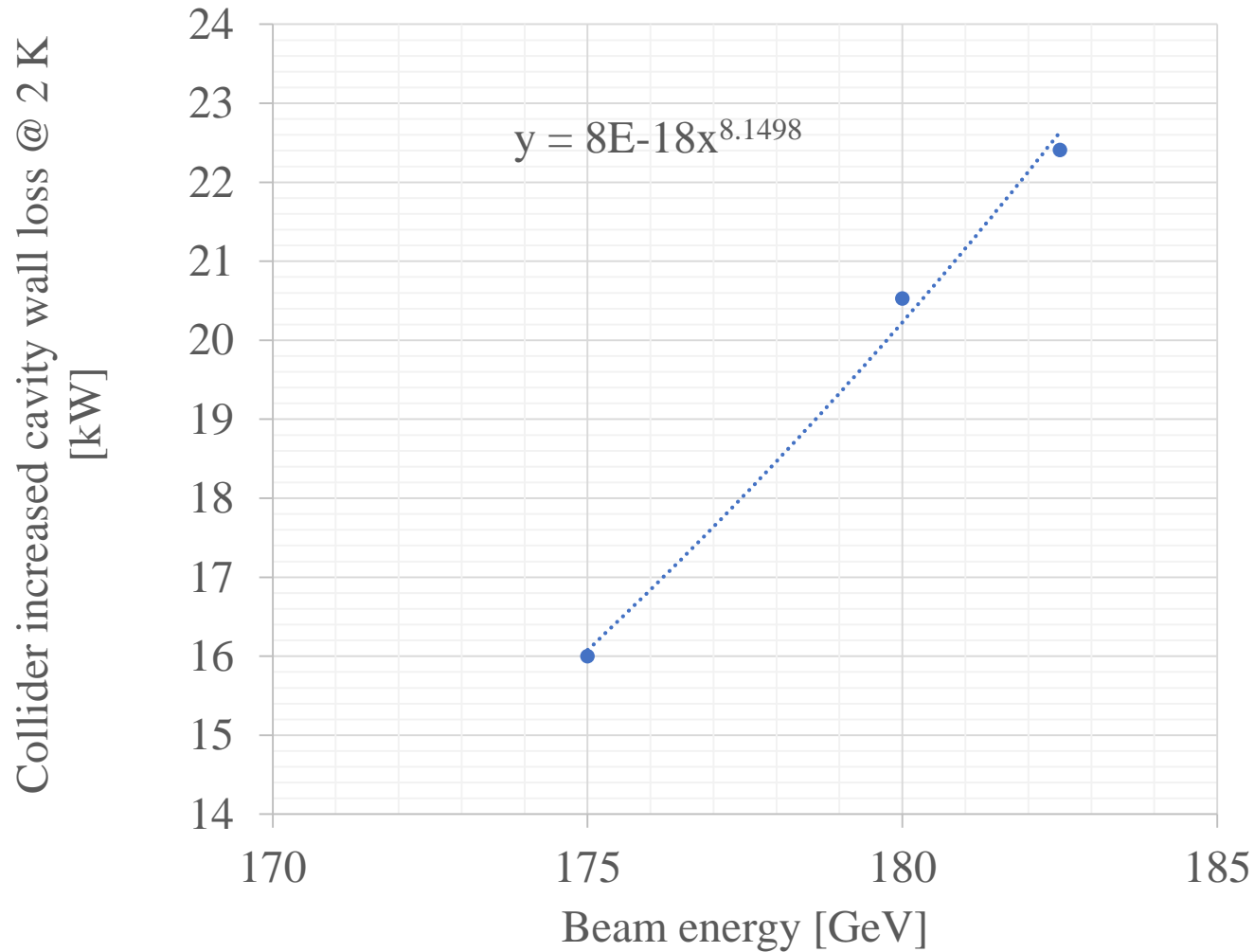
20180112 Collider parameters: 20180109. ttbar and Higgs with common cavities		ttb:
		Additional tt cavities
Luminosity / IP [$10^{34} \text{ cm}^{-2}\text{s}^{-1}$]		0.3
SR	1.3GHz 9cell	30
RF		9.1
Beam		3.4
Bunch		40
Bunch		2.8
650		
Cell		
Gradient		
Q_0		0
HOM		7
Input		
Opti		3
Opti		3
Cav		
Klys		
Klys		
Cav.		
Cryo	For Booster	For Collider
Total cavity wall loss @ 2 K [kW]		
RF length [m]		1152



- Add additional tt cavities for the rest voltage
- Keep the **cavity numbers** for different voltage.



- Increased cavity wall loss at collider @ 2 K [kW]



Cryogenic Power

Beam energy [GeV]	Collider total cavity wall loss @ 2 K [kW]	Booster total cavity wall loss @ 2 K [kW]	Total cavity wall loss @ 2 K [kW]	Cryogenic power(MW)
80	1.3	0.01	1.31	8.07
120	6.1	0.17	6.27	14.02
175	22.1	0.77	22.87	39.14
180	26.63	0.97	27.6	43.81
182.5	28.51	1.04	29.55	45.91

Power of magnetic power supply

Power consumption for H (30 MW /beam)				
Location	Magnet	Power supply	Magnet cable	Total
Collider	33.7631	4.7214	8.7297	47.21
Booster	7.6037	1.1621	2.8547	11.62
BTL	0.8382	0.1056	0.1124	1.06
Linac	1.1747	0.1454	0.1337	1.45
Damping Ring	0.1925	0.0255	0.2299	0.448
IR	0.0000	0.0255	0.2299	0.26
Total	43.5723	6.1900	12.1376	61.90

They are in proportion to the squared energy.

Power will keep the same.

Power of magnetic power supply

Energy (GeV)	Collider (MW)	Booster (MW)	BTL (MW)	Linac (MW)	Damping Ring (MW)	IR (MW)	Total power (MW)
45.50	9.52	2.14	0.19	1.45	0.30	0.05	13.65
80.00	23.35	5.52	0.50	1.45	0.30	0.12	31.24
120.00	47.21	11.62	1.06	1.45	0.30	0.26	61.90
175.00	112.04	24.72	1.06	1.45	0.30	0.26	139.83
180.00	118.53	26.15	1.12	1.53	0.32	0.28	147.93
182.50	121.85	26.88	1.15	1.58	0.33	0.28	152.07

Power of Utilities

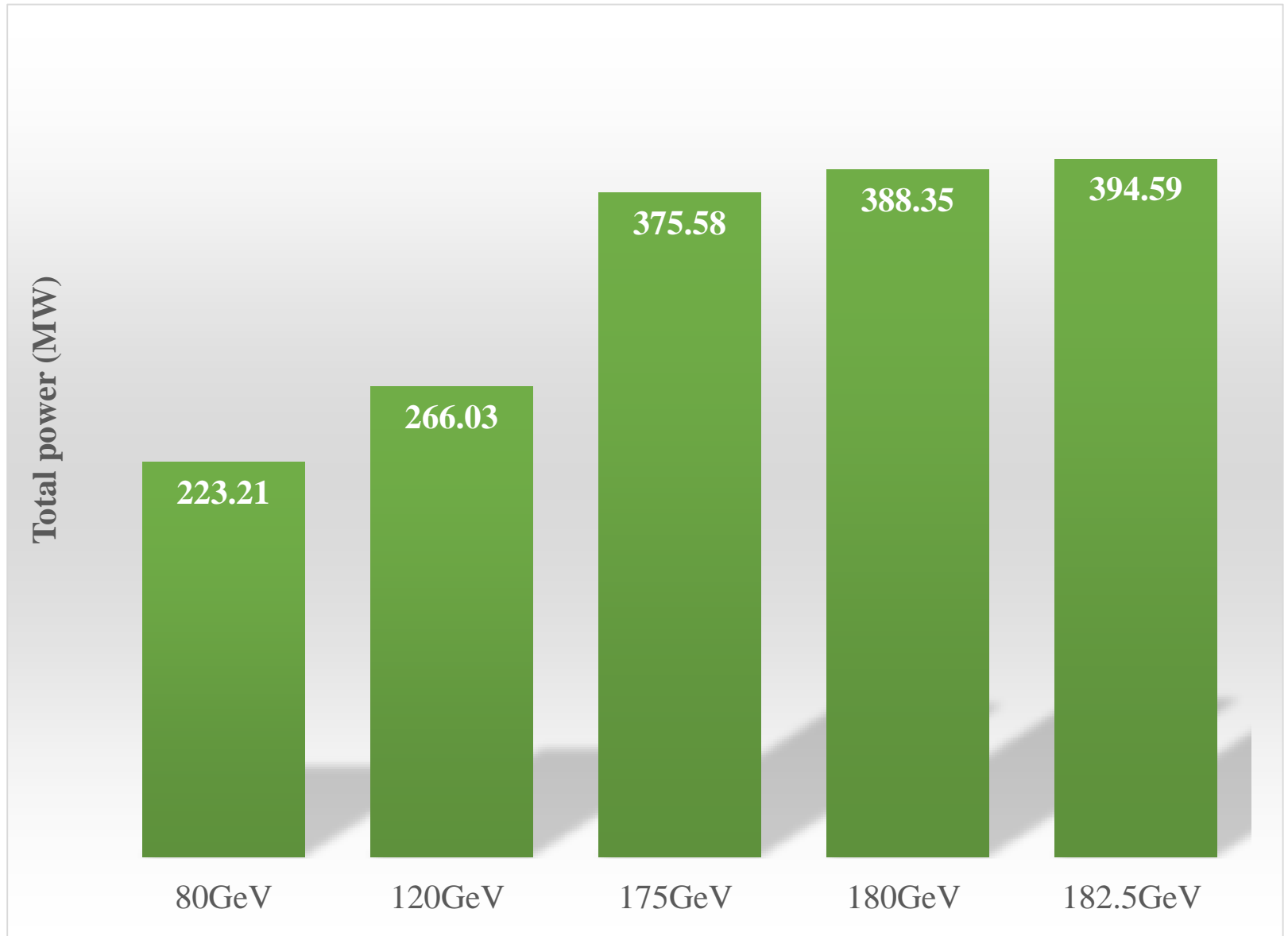
- Water cooling
 - Cooling for RF power supplier
 - Magnet cooling
- Air compression
- Air conditioner

		Z 45.5GeV(MW)	W 80GeV (MW)	Higgs 120GeV (MW)	备注
9	Utilities	25.3	32.32	38.53	增加

So, for 175~182.5GeV, the additional power show be around 6.5MW

Summary

	30MW/ beam	W 80GeV	Higgs-120GeV	tt bar 175GeV	tt bar 180GeV	tt bar 182.5GeV
1	RF Power Source	109.75	109.75	109.75	109.75	109.75
2	Cryogenic System	8.07	14.02	39.14	43.81	45.91
3	Vacuum System	14.22	14.22	14.22	14.22	14.22
4	Magnet Power Supplies	31.24	61.90	139.83	147.93	152.07
5	Instrumentation	1.70	1.70	1.70	1.70	1.70
6	Radiation Protection	0.35	0.35	0.35	0.35	0.35
7	Control System	1.81	1.81	1.81	1.81	1.81
8	Experimental devices	4.00	4.00	4.00	4.00	4.00
9	Utilities	32.32	38.53	45.03	45.03	45.03
10	General services	19.75	19.75	19.75	19.75	19.75
11	Total	223.21	266.03	375.58	388.35	394.59



Thanks !