CEPC LINAC HIGH EFFICIENCY KLYSTRON*

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- > The efficiency improvement of klystron will reduce the energy consumption and cost of CEPC.
- The RF power source system of CEPC LINAC includes 33 sets of pulsed klystron operating at a frequency of 2860 MHz.
- ➤ The S-band pulsed klystrons all over the world are mainly made by Canon, CPI and Thales. The efficiency of them are between 40% and 50%.
- Our design will be based on the existing S-band 65 MW klystron operating at BEPCII LINAC. With the same input power, the BAC method will be adopted to increase the klystron efficiency from 42% to 55%, so that the output power will be 80 MW.

		Parameters	Units	Original	BAC-based
RF window	Modulator Klystron 80MW	Operating frequency	MHz	2856	2856
		Output power	MW	65	80
Energy doubler		RF pulsed width	μs	4	4
Power divider	·	Beam voltage	kV	350	350
		Beam current	А	414	414
		Beam perveance	μA/V(3/2)	2.0	2.0
Accelerating structures		Efficiency	%	45	55



BEAM OPTICS DESIGN



The prototype of the electron gun for the new BAC based klystron is optimized from that of the original one. While keeping the parameters like beam voltage and beam current same, the radius of the drift tube is decreased from 15.986 mm to 12.3mm to cut off the second harmonic wave. The gun was simulated in EGUN, DGUN and CST.

Parameters	Units	Original	BAC-based
Beam voltage	kV	350	350
Beam current	А	414	414
Beam perveance	μA/V(3/2)	2	2
Drift tube radius	mm	15.896	12.3
Beam radius	mm	9.45	8.65

	Beam perveance	Beam radius
EGUN	1.993µP	8.5mm
DGUN	1.971µP	7.9mm
CST	1.997µP	8.2mm





BEAM OPTICS DESIGN



> The solenoid of BAC-based klystron is also re-designed based on the original one. Because we have extended the length of the interaction section to achieve a higher efficiency, it is necessary to have a longer magnet that also has a stronger field at the output cavity to suppress the higher spacecharge effect. The value of the magnetic field is firstly simulated by 2-D code POISSON SUPERFISH and then input to 2-D code DGUN for beam optics simulation. The result is also checked by 3-D code CST.



	Maximum beam radius	Minimum beam radius	Beam ripple
DGUN	8.54mm	7.93mm	3.7%
CST	8.7mm	8.1mm	3.6%







All the ten cavities including four new cavities are simulated in CST. The parameters like R/Q and coupling coefficient of those cavities are optimized before the dynamic simulation.



The electric filed on z axis around one of the second harmonic cavities with 12.3 mm drift tube radius was simulated in CST. The result means it will be safe if the distance between each cavity is more than 40 mm.





DYNAMIC SIMULATION RESULT



1-D dynamic simulation is completed in AJDISK. With the help of the four new cavities, the efficiency increased from the original 49% to 64.47%. 2-D dynamic simulation result showed in EMSYS is now 56%. The optimization work is still ongoing now.

