Design of a Compact Hybrid Undulator for the THz Radiation Facility of Delhi Light Source (DLS)

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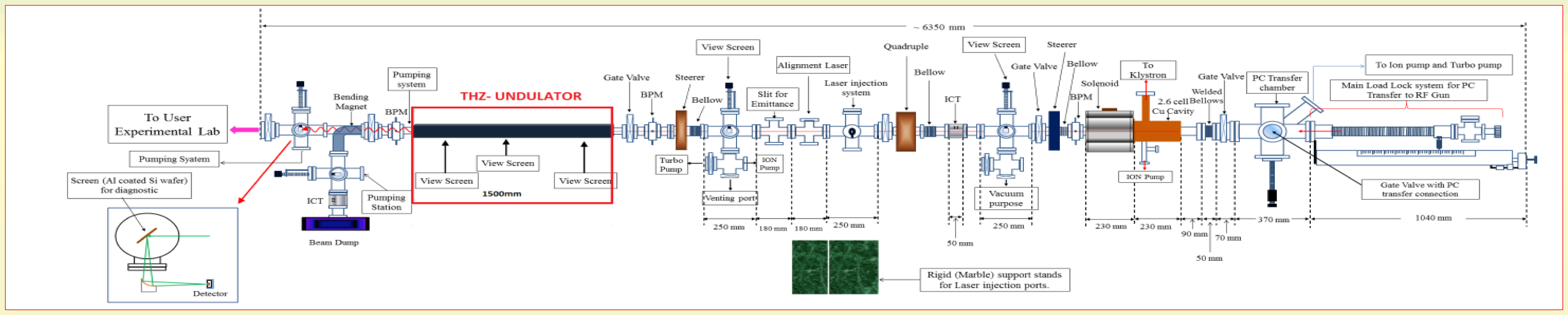
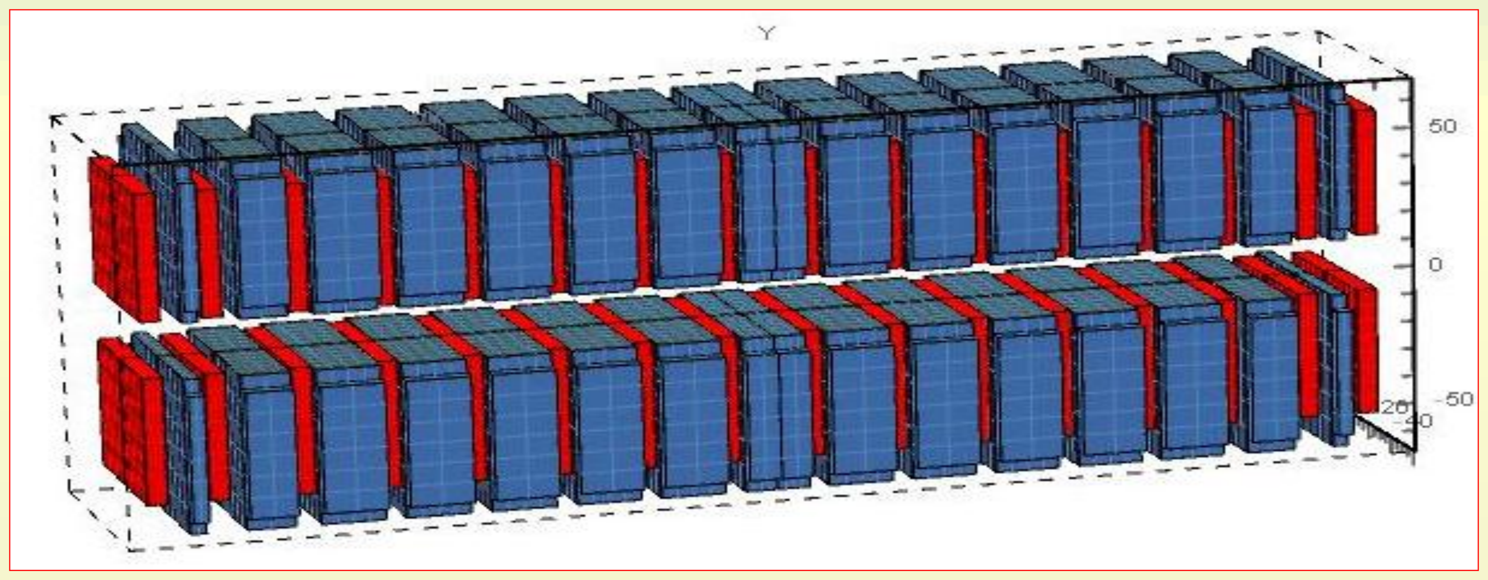
INTRODUCTION

A compact Free Electron Laser (FEL) facility to produce coherent THz radiation is in the development stage at Inter-University Accelerator Centre (IUAC), New Delhi, India [1-3]. The facility is named as" Delhi Light Source (DLS)" where it is planned to produce 8MeV electron beam from photo cathode RF gun and the electron beam will be injected into a compact undulator to generate the radiation. To produce the THz radiation in the range of 0.18 to 2.63 THz; the electron beam energy and the undulator gap have to be varied from 4 to 8 MeV and 20 to 45 mm, respectively. The variable gap undulator of 1.5 m length will consist of NdFeB magnets with vanadium permendur poles. The magnet design and dimensions are optimised by using code 3D RADIA [4]. The detailed design of the compact hybrid undulator will be presented in this paper. The **layout of the facility** is shown in below figure.



SPECIFICATION OF U50-DLS UNDULATOR

Technology	Hybrid planer Anti-symmetric
Magnet	Permanent NdFeB magnet (B_r =1.21T)
Pole	Vanadium permendur
Magnetic gap	20-45 (mm)
Period length	50 mm
No of Periods	28 (Full)
Magnetic field	0.62 -0.11 (T)
Undulator parameter (K)	2.89-0.61
Device length	~1.5 m



RADIA Model of full five period undulator U50-DLS.

RESULTS AND DISCUSSION

The design and optimization of the **Hybrid undulator** to be developed for DLS has been done by using RADIA [4]. **The magnetic field profile with full ten periods for all working gap range from 20 to 45 mm is shown in Figure 1**. The undulator has been designed with an **asymmetric structure** to ensure the vertical / horizontal first field integrals and the integrated multipoles should be made be zero. The horizontal second field integral will be also zero due to symmetry, but the **vertical second field integral** will change with the undulator gap [5] as we can see for maximum and minimum gaps in **Figure 2**. To correct this, we **will use magic finger and also correction coils on both sides**. Right now, in the RADIA calculation, there is no magic finger or corrector coils are used. The **Undulator parameter "K" variation of over the working gap range 20-45mm** is plotted and is shown in **Figure 3.** The transverse roll-off depends strongly on the transverse width of the undulator. A flat transverse roll off reduces the higher order integrated multipoles over the good field region and reduce the effect of dynamic field integrals. In this design the width of the magnet and pole has been selected to have **a good field region of ±10 mm** about the central axis of the undulator as recommended by the beam optics calculation. The percentage of the roll off with respect to the central field at **±5 mm, ±10 mm, and ±20 mm are 0.048, 0.254 , 2.922 and 0.302, 1.393, 8.746 percent at close gap 20mm and open gap 45 mm respectively. Figure 4,** shows of the decay of the transverse roll off over the full undulator width at minimum gap 20mm **(a)** and maximum gap 45 mm **(b)**.

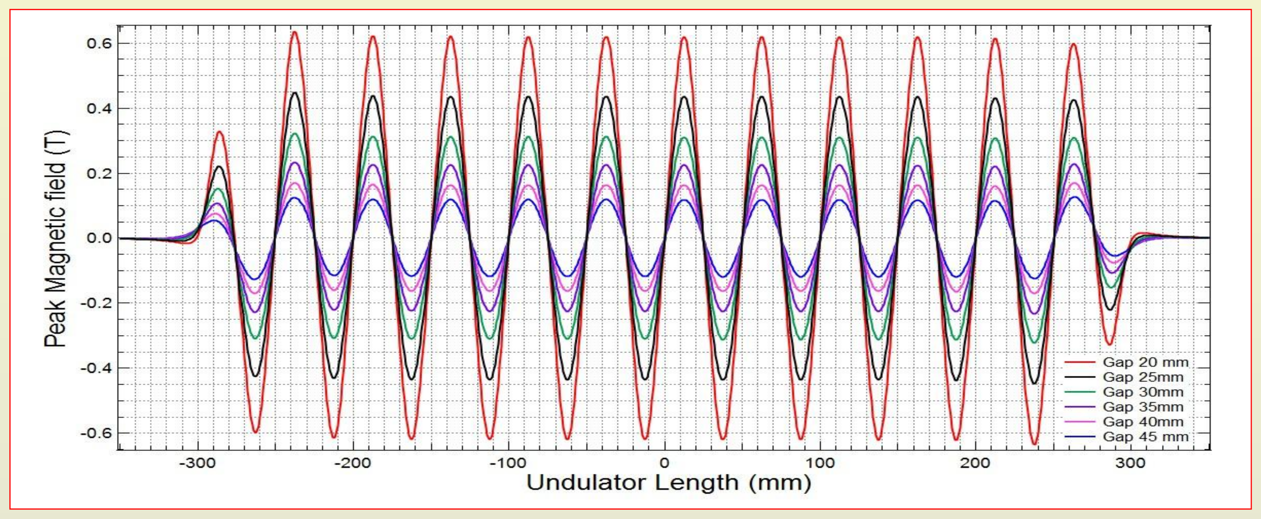


Figure 1

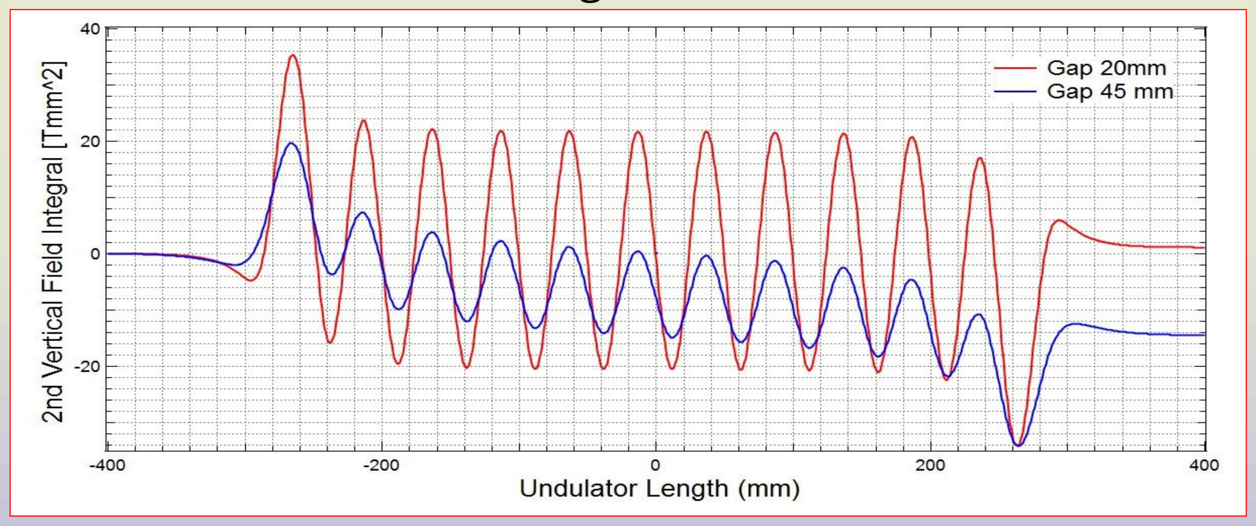


Figure 2

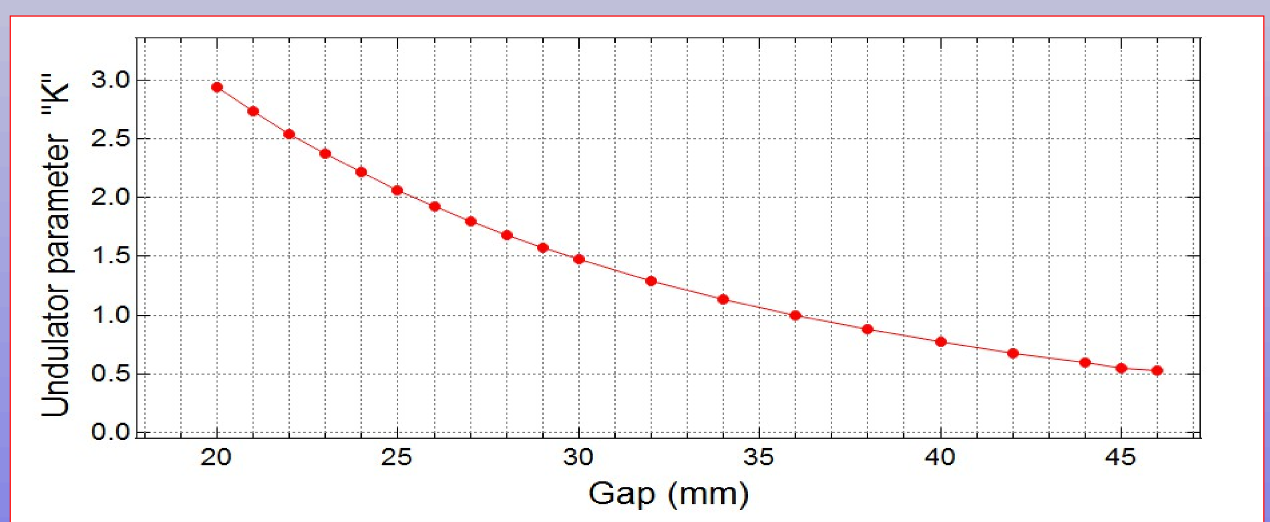


Figure 3

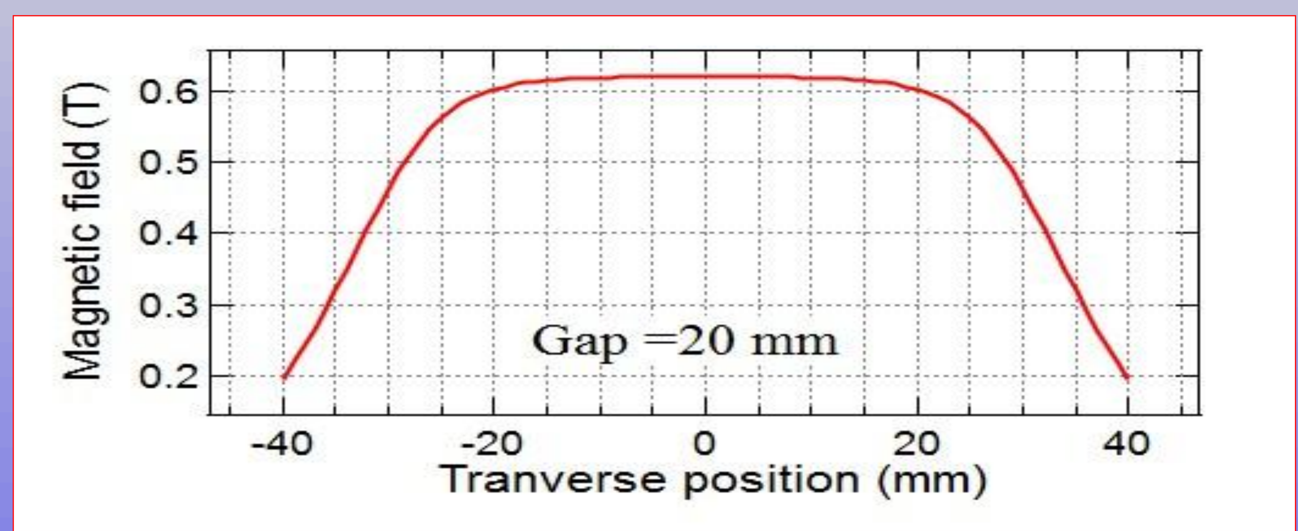


Figure 4 a)

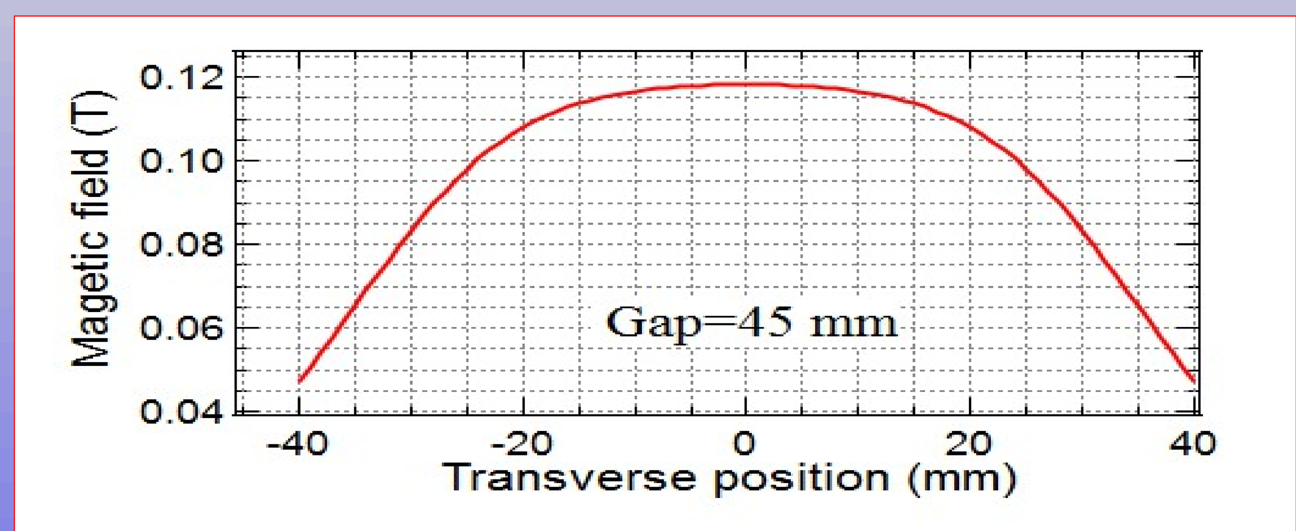


Figure 4 b)

CONCLUSIONS

- ❑ A compact hybrid planer undulator for THz radiation production at DLS facility, New Delhi, is designed and optimized successfully with code 3D RADIA.
- ❑ The mechanical design of the undulator is going to be carried out shortly and then the device will be fabricated, assembled and tested.
- ❑ As per the schedule of the DLS project at IUAC, the device should be installed in the beam line at the beginning of 2019 and the production of THz is expected to be demonstrated in the same year.

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