DESIGN CALCULATION ON BEAM DYNAMICS AND THz RADIATION OF DELHI LIGHT SOURCE

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Introduction

❖ Delhi Light Source (DLS): Project to develop super-radiant THz facility based on Coherent Undulator Radiation emission from pre-bunched e- beam at IUAC, Delhi

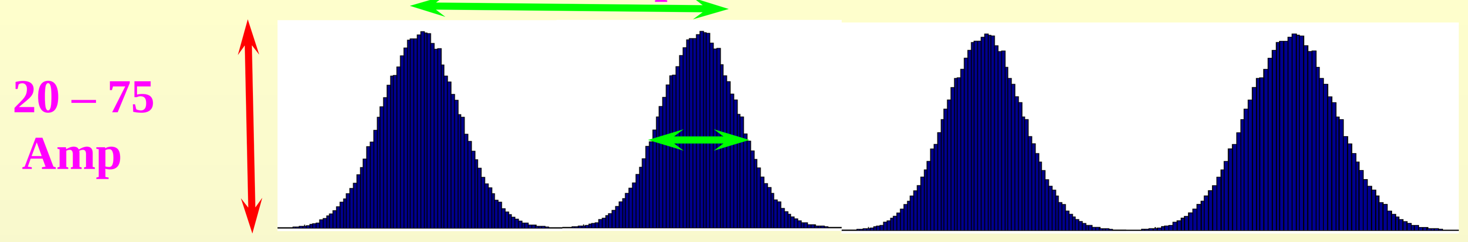
❖ Deliverables:

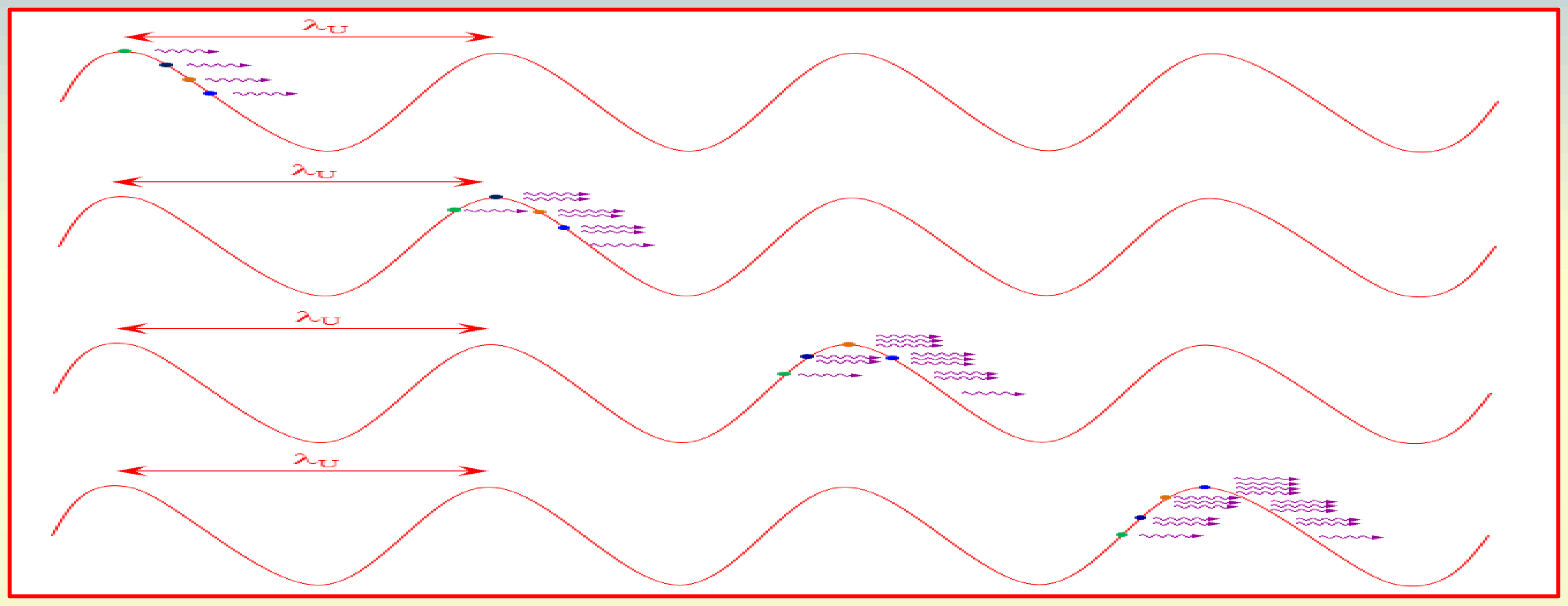
- Laser System to deliver "comb" laser pulses with variable time separation between 'spikes'
- Cu/Cs_2Te photocathode based 2.6 cell RF cavity coupled with solenoid to generate ~ 4 – 8 MeV micro-bunched e-beam having ~15pC/microbunch charge.
- Variable number of microbunches: 2 - 16
- Micro-bunch separation variable from 0.1mm to 2 mm.
- Tunable THz radiation from 1.5m compact PPM undulator ~0.4 < Krms < ~2 in Frequency range: 0.15THz – 3THz

THz emission scheme from super-radiant pre-bunched e-beam

e- Beam Requirement
- E = ~ 4 – 8 MeV
- FWHM = ~200 fs
- Micro-bunch separation: ~333fs – 6.67 ps
- Charge/Microbunch: ~15pC
- No. of microbunches: 2 - 16

Radiation Requirement
- Frequency = 3 – 0.15 THz
- Wavelength = 100 µm to 2 mm





$$E_{macrobunch} = N_e E_0 \sum_{n=0}^{Ne} exp^{iwt_n}$$

$$I_{single\ bunch} \approx |N_e E_0 B_w|^2$$

$$B_w^2 = \frac{1}{N_e^2}\left|\sum_{n=0}^{Ne} exp^{iwt_n}\right|^2$$

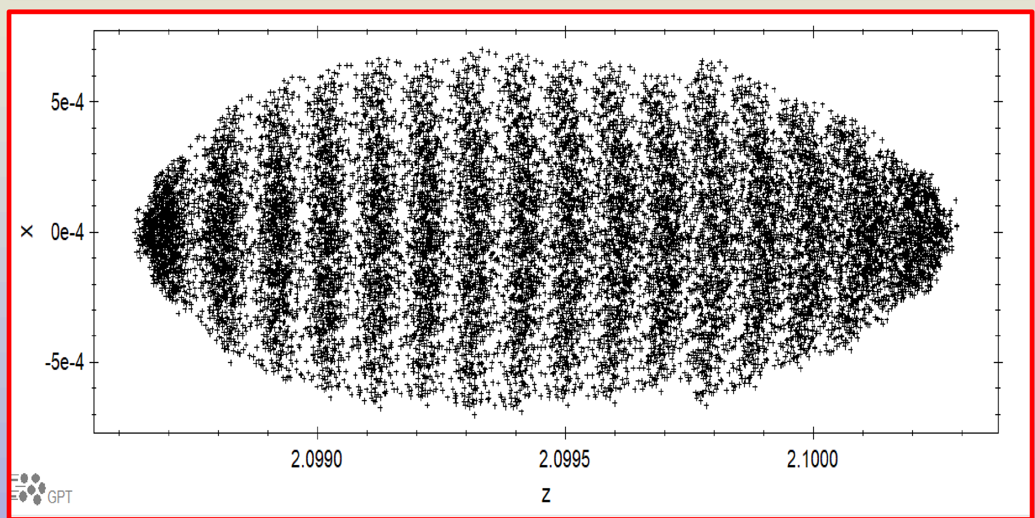
$$E_{microbunch} = N_m N_e E_0 \sum_{n=0}^{Ne} exp^{iwt_n}$$

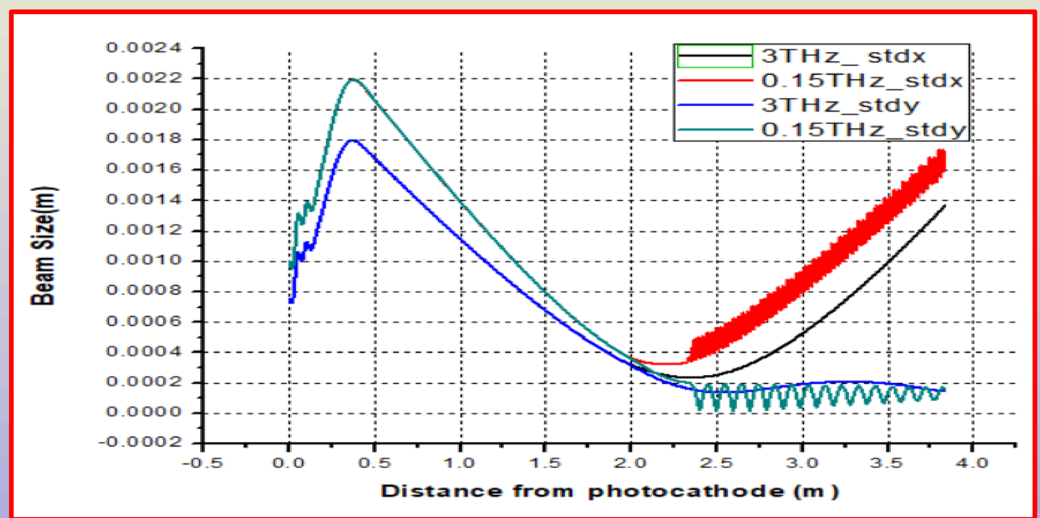
$$I_{microbunch} \approx |N_m N_e E_0 B_w|^2$$

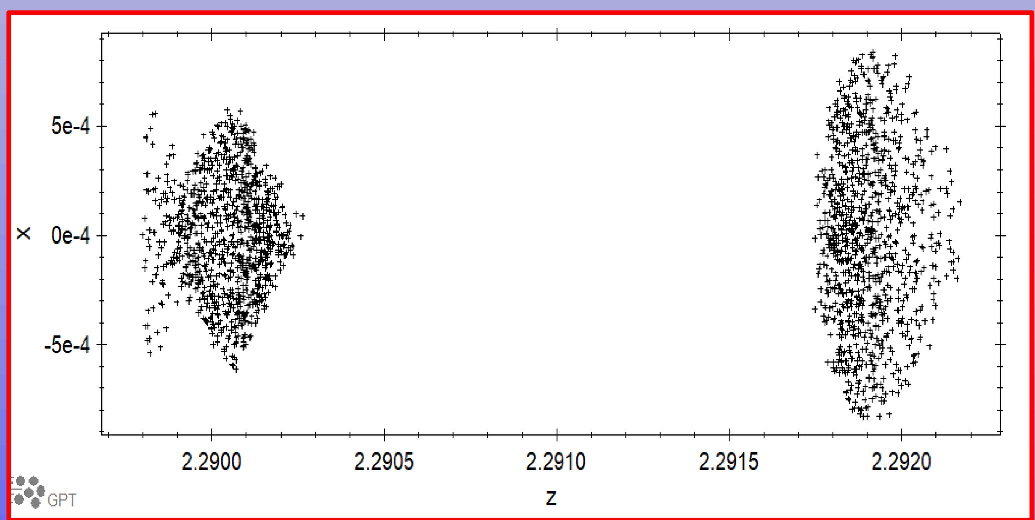
BEAM OPTICS SIMULATIONS

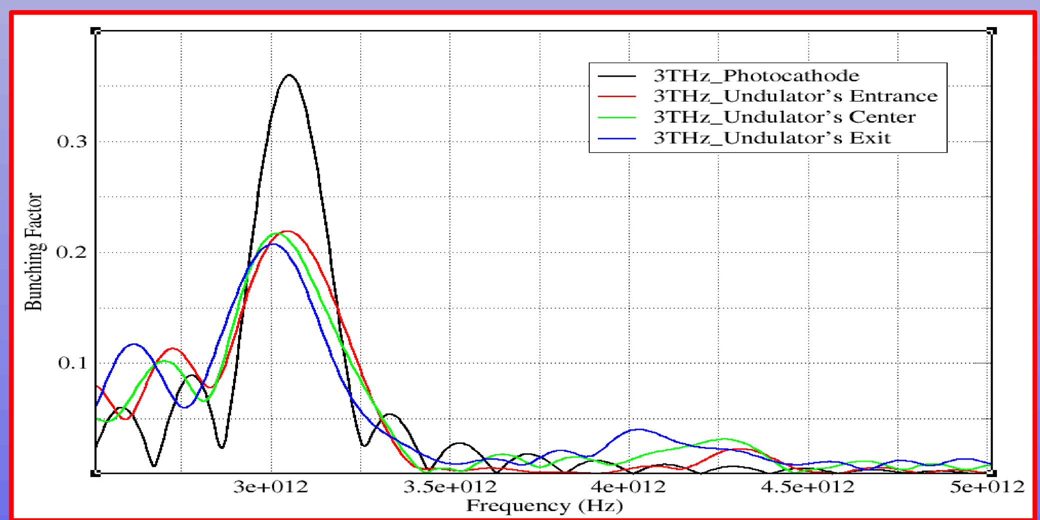
Radiation Frequency (THz)	0.15	3
No. of microbunches	2	16
Charge per micro bunch (pC)	15	15
Accelerating Field (MV/m)	58.5	110
Energy (MeV)	4	8
Energy Spread (%)	1.1	0.43
FWHM (fs)	~750	~ 200
$\sigma_{y,x}$ (mm)	0.19, 0.275	0.175,0.25
Emittance, $\varepsilon_{x,y}$ (π mm-mrad)	3.7, 0.04	0.2, 0.01
Avg. Separation	6.6 ps	345 fs
Peak Current (Amperes)	20	75

- Minimize the size, energy spread and emittance of the e- beam
- Maximize the bunching factor of the micro bunched beam
- Minimize overlapping of the microbunch structure of the beam bunches starting from undulator entrance to exit
- Maximize the charge in an individual microbunch



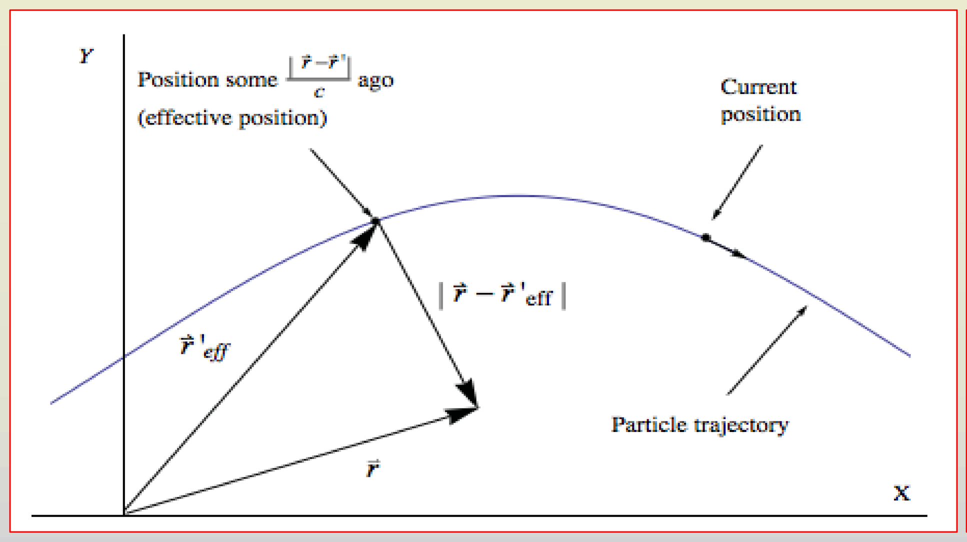


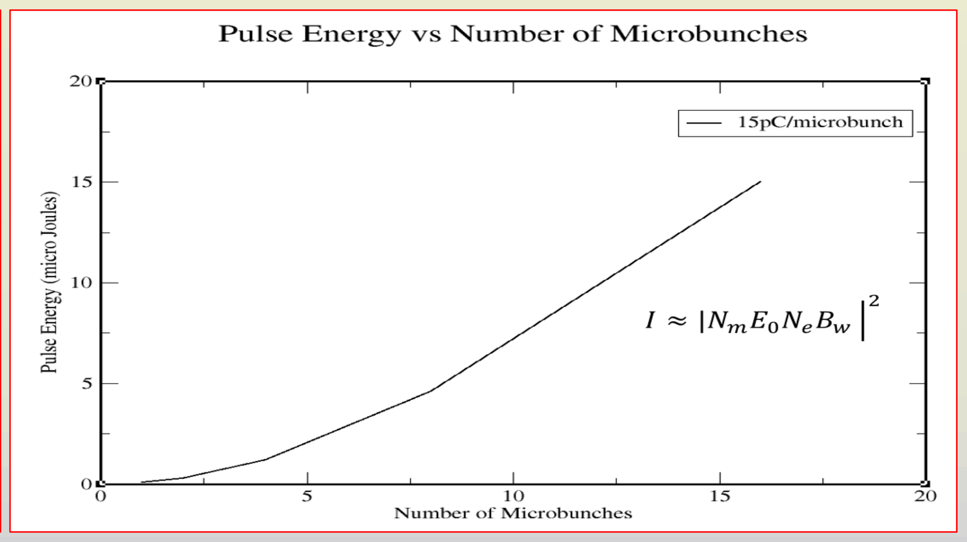


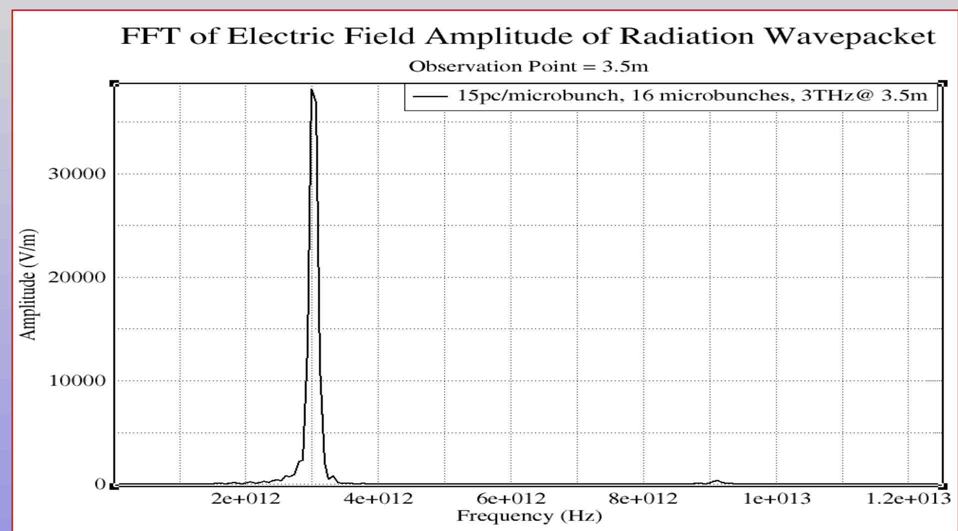


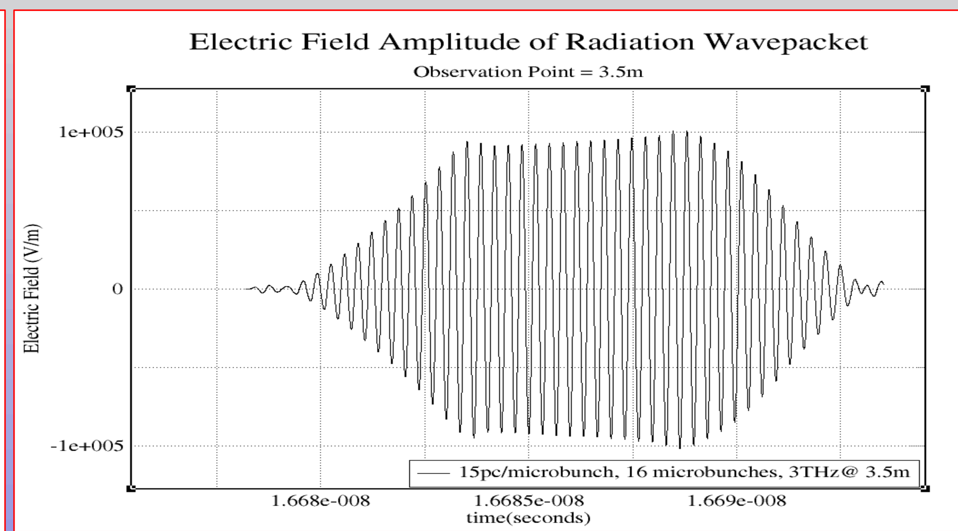
SIMULATION CALCULATIONS OF THz

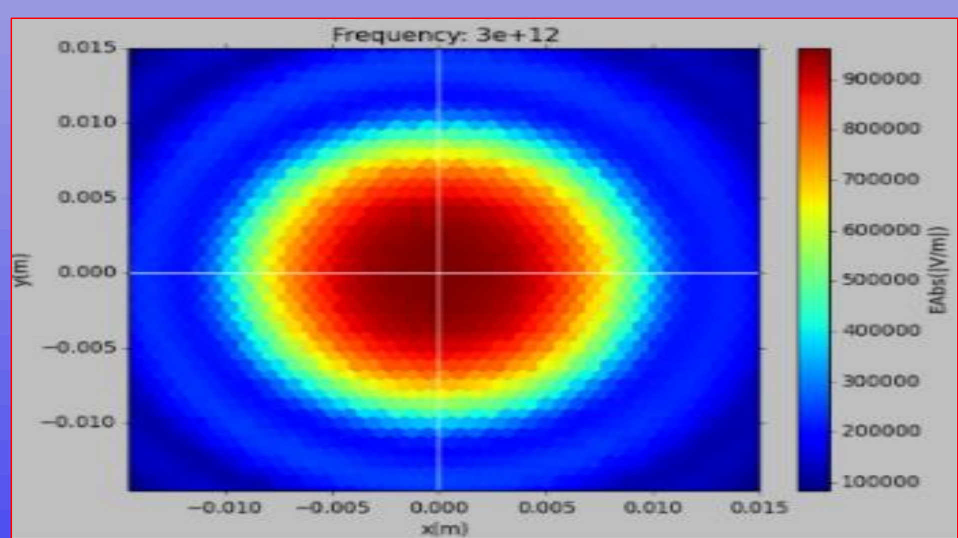
- C++ based Lienard Wiechert field solver developed.
- Track particles through the undulator and evaluate the position, momentum and acceleration at retarded times to find the electromagnetic fields at some observer point or a grid.

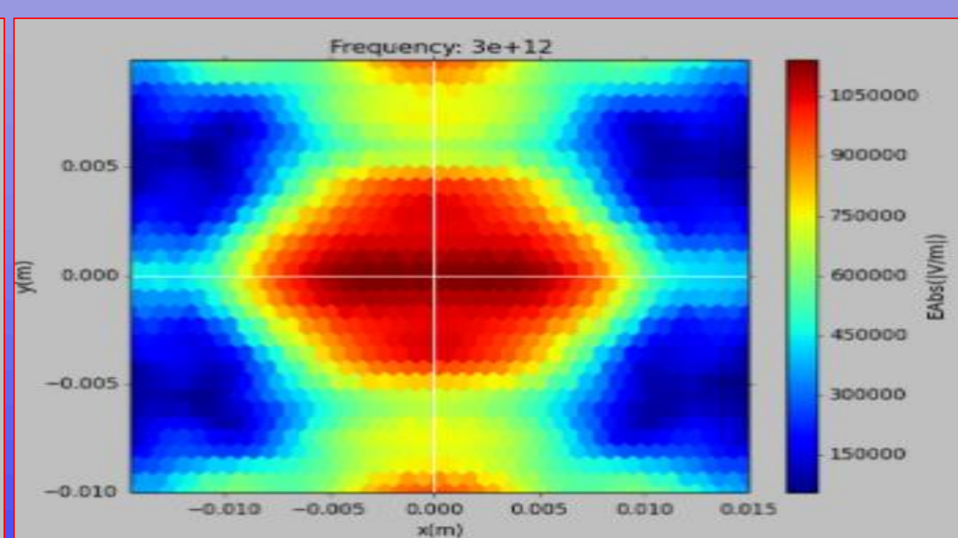












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Acknowledgement: This work is supported by Board of Research in Nuclear Sciences (BRNS) and IUAC

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