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Depth-dose distribution dependence on the energy profile of linear and laser wakefield accelerator electron beams

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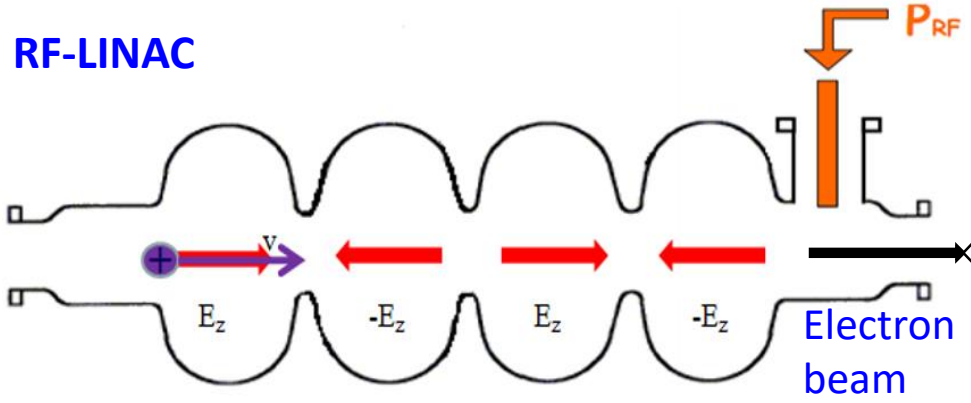
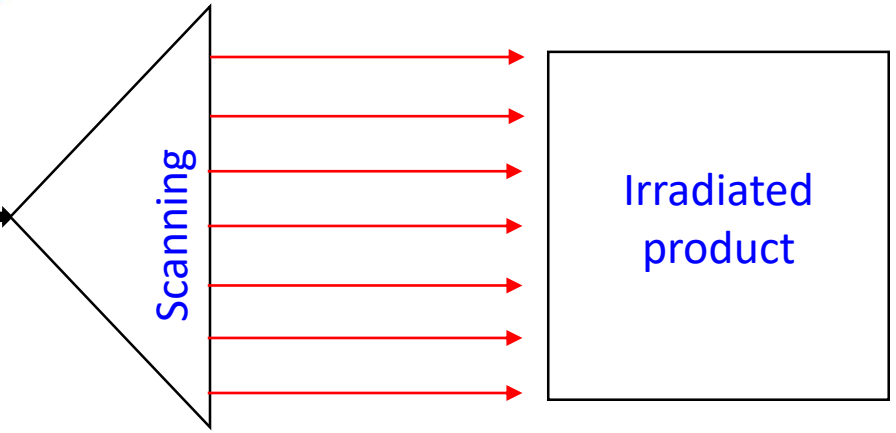
Introduction

RF-LINAC



10 MeV
Gausian spectrum



- Depth-dose profile
- Maximum area density
- DUR (Dose Uniformity Ratio)

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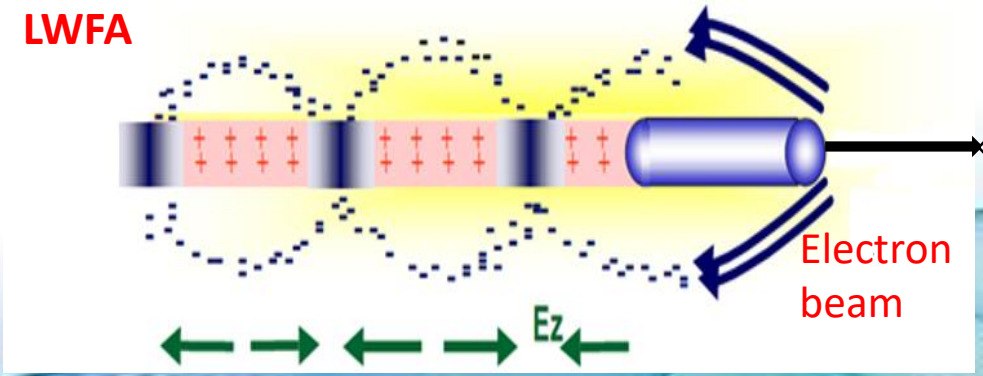
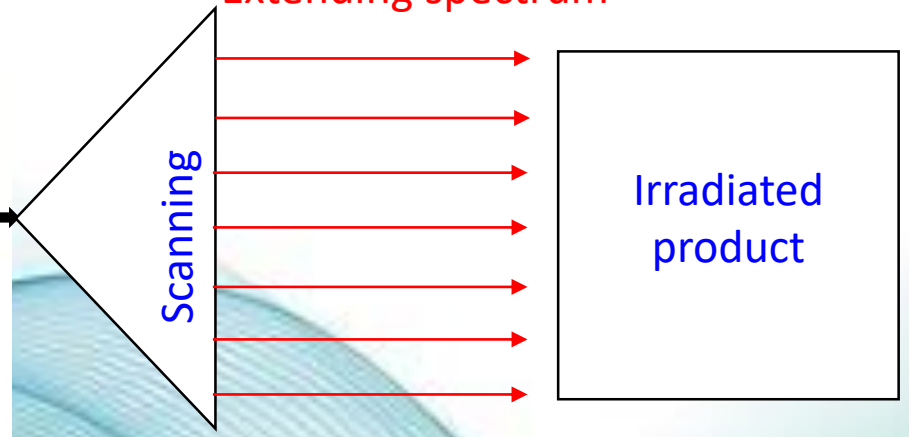
LWFA



10 MeV
Extending spectrum

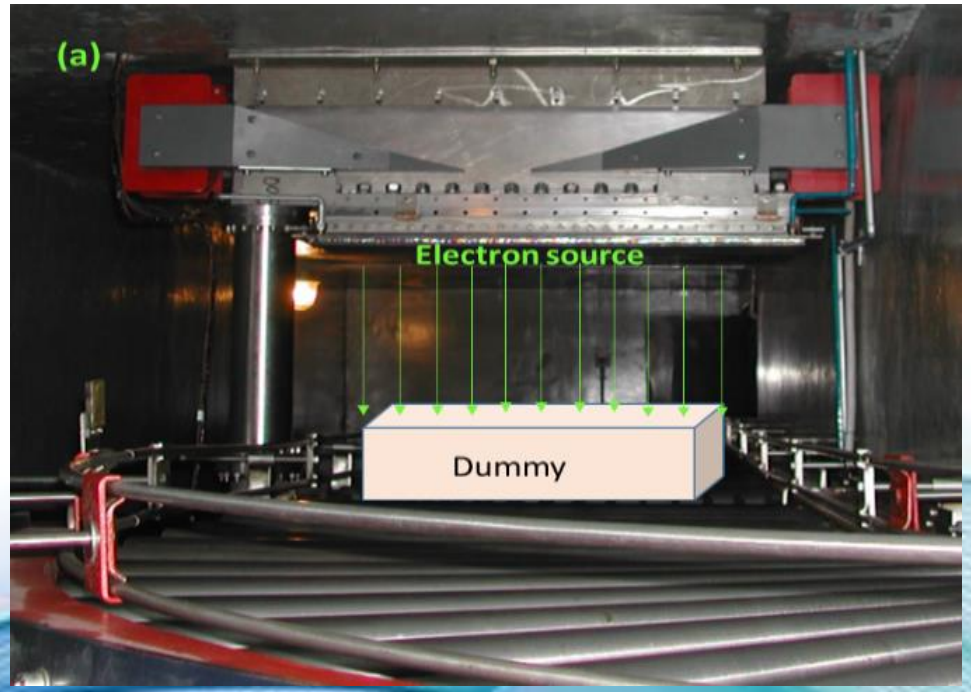


- Depth-dose profile
- Maximum area density
- DUR (Dose Uniformity Ratio)

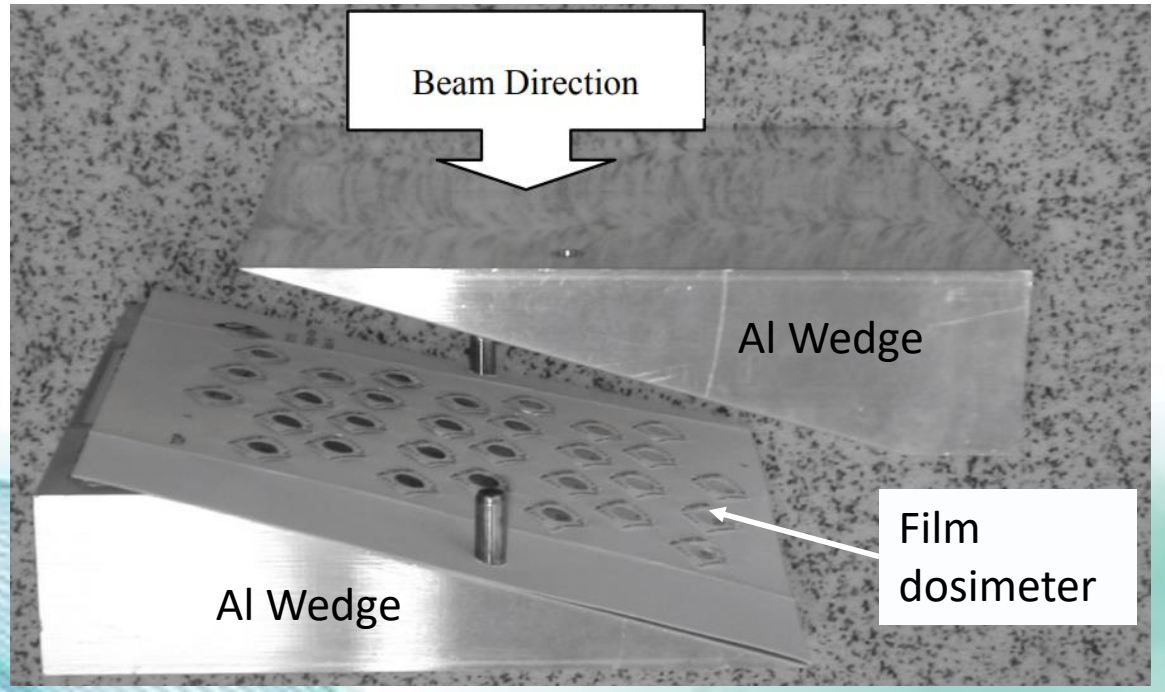
Experiment and simulation

- Experiment at the UELR-10-15S2 (LINAC) of Research and Development Center for Radiation Technology, Vietnam Atomic Energy Institute, includes:

1. The depth-dose distribution in the polypropylene (PP) stack dummy.



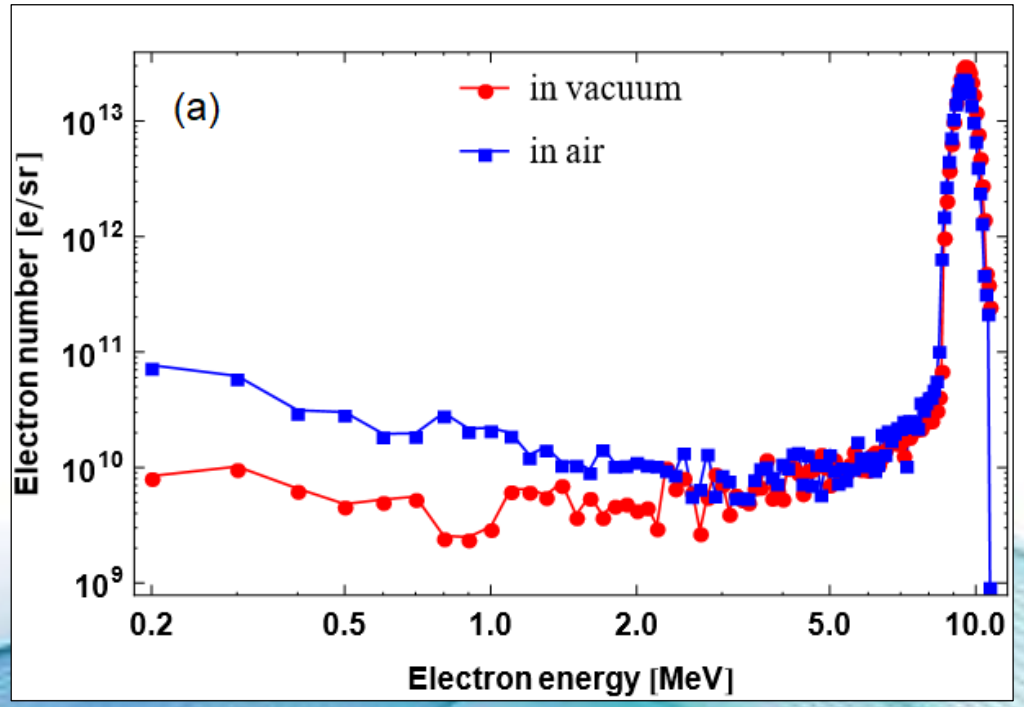
2. Measurement of electron energy by alumilum Wedge



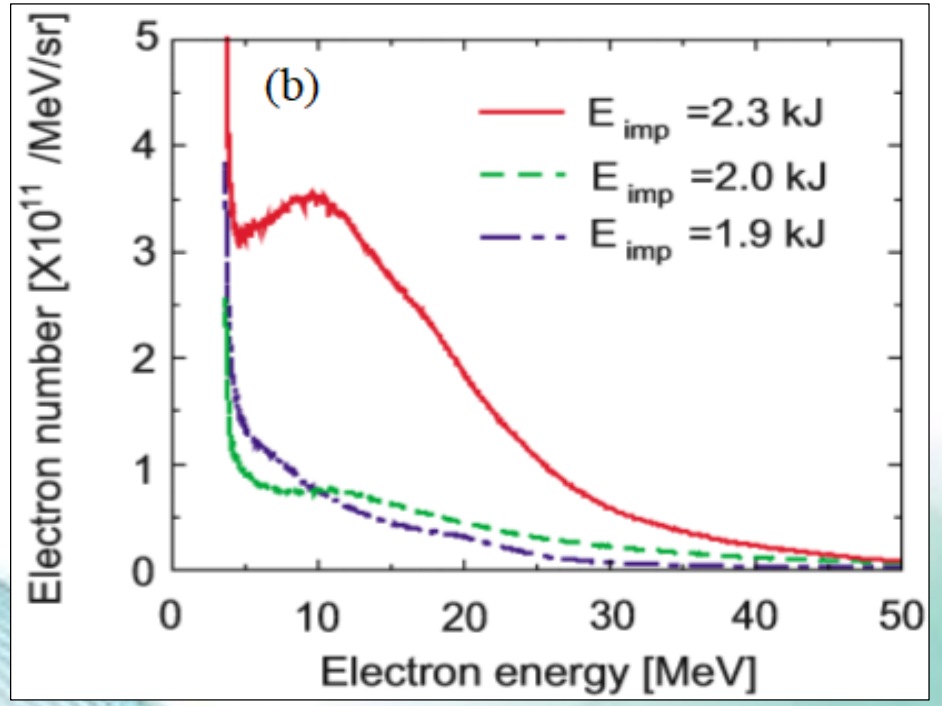
Electron Energy Spectrum of RF-LINAC and LWFA

- RF-LINAC: Measurement + MCNP → Electron energy spectrum
- LWFA: Data of of the GEKKO Petawatt laser system at the Institute of Laser Engineering (ILE) at Osaka University

Spectrum of RF-LINAC

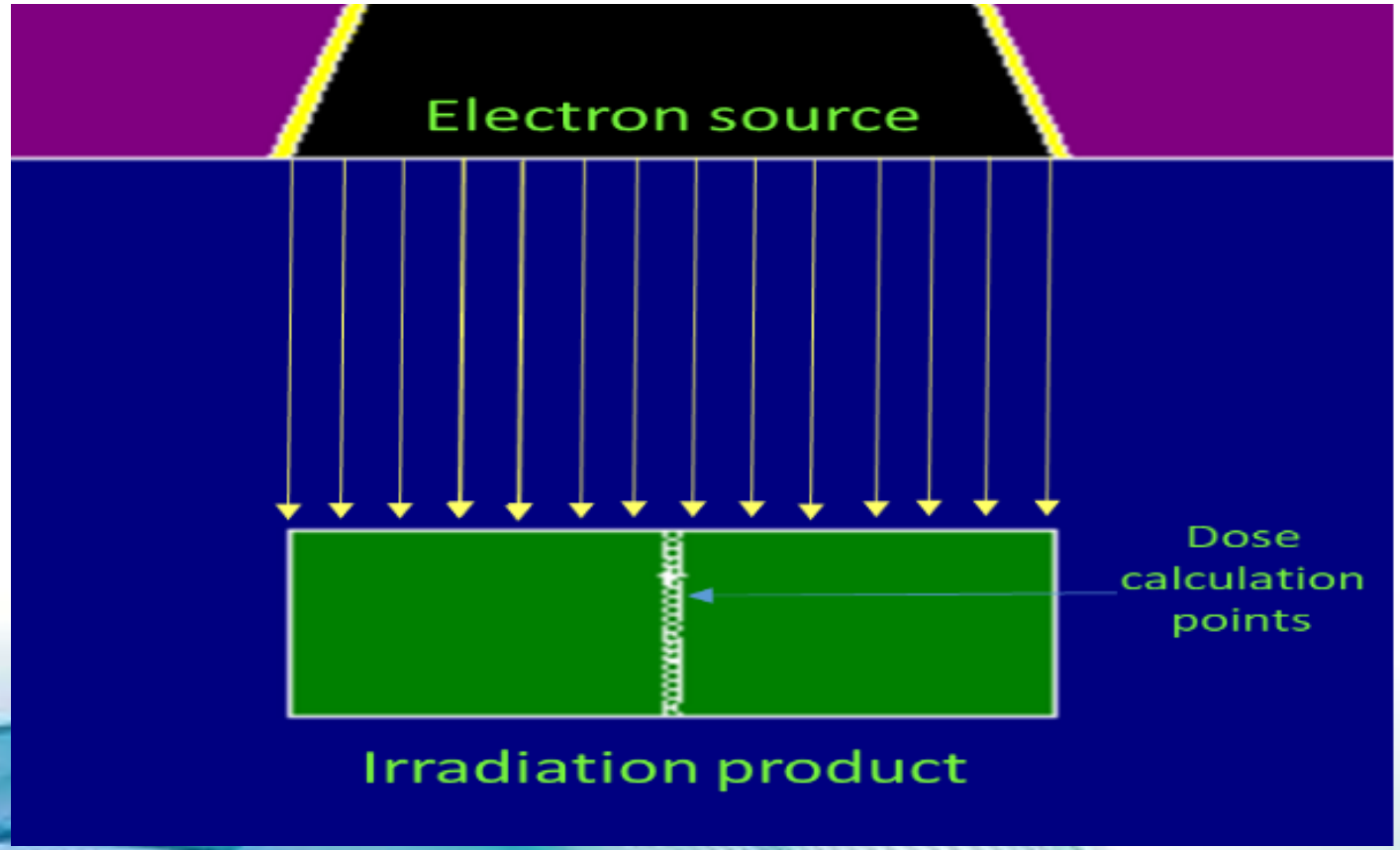


Spectrum of LWFA



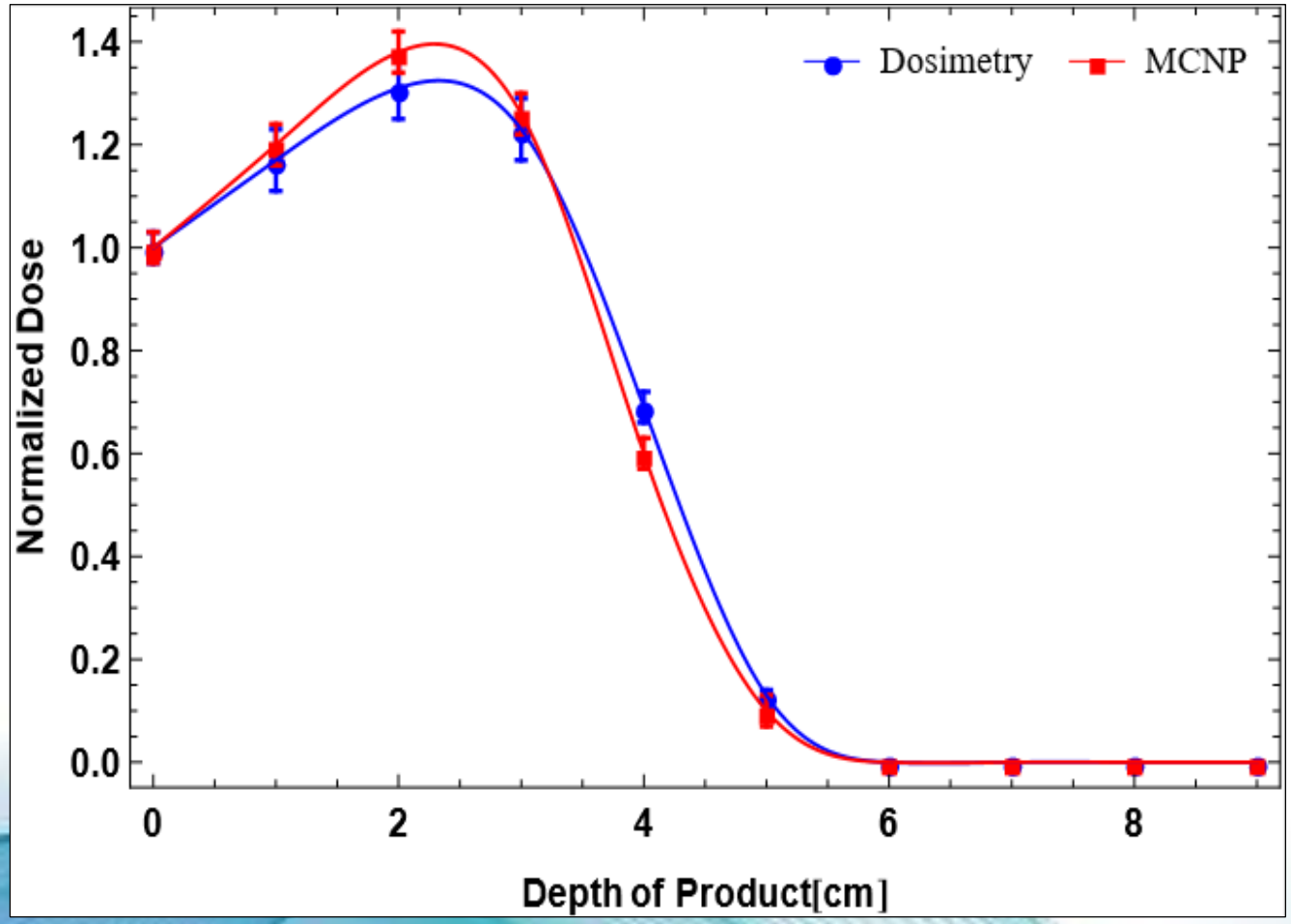
MCNP simulation of Depth-Dose Profile (DDP)

- MCNP simulation of DDP for RF-LINAC → Comparision of MCNP and Measurement
- MCNP simulation of DDP for LWFA → Comparision of LWFA and RF-LINAC

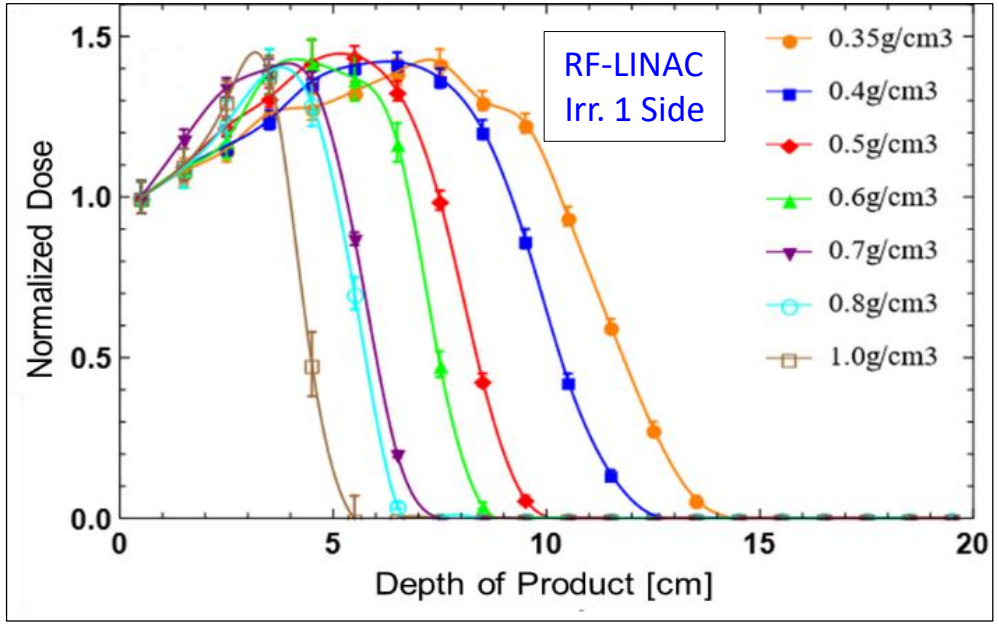


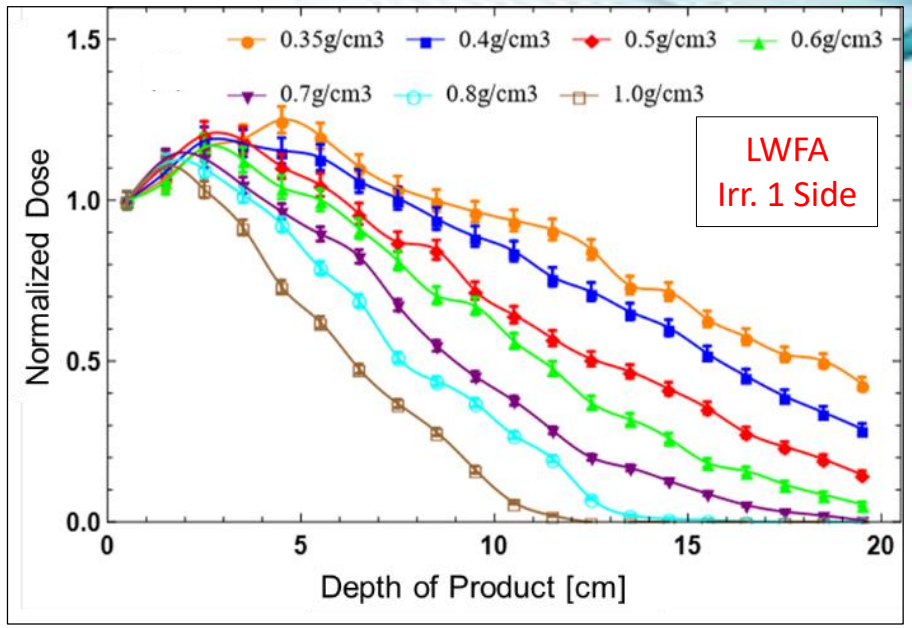
Result and Discussion

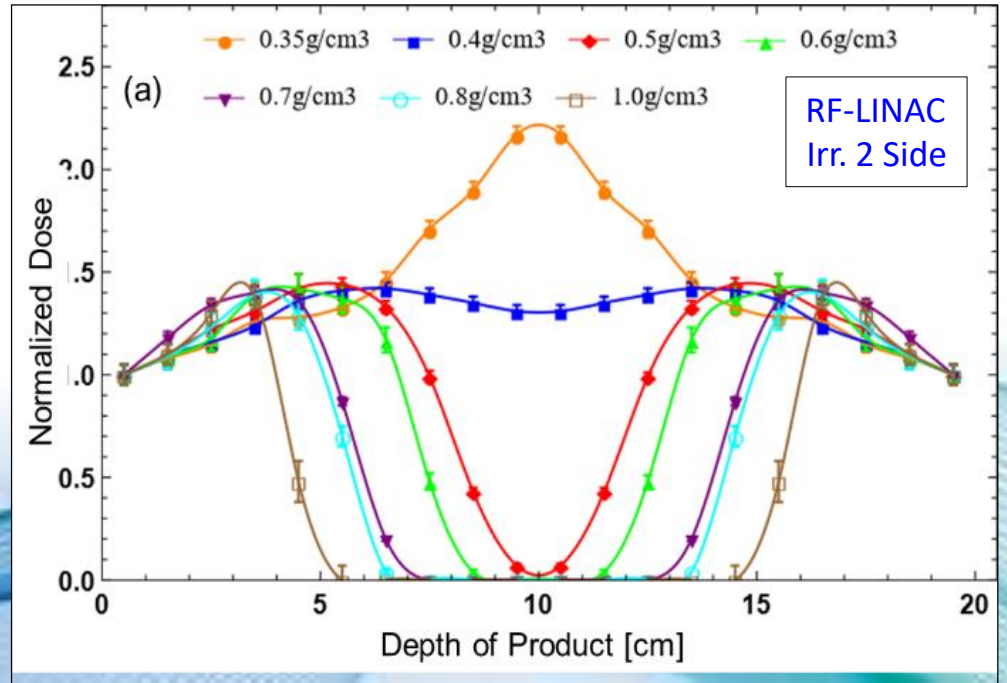
Comparison between MCNP and dosimetry

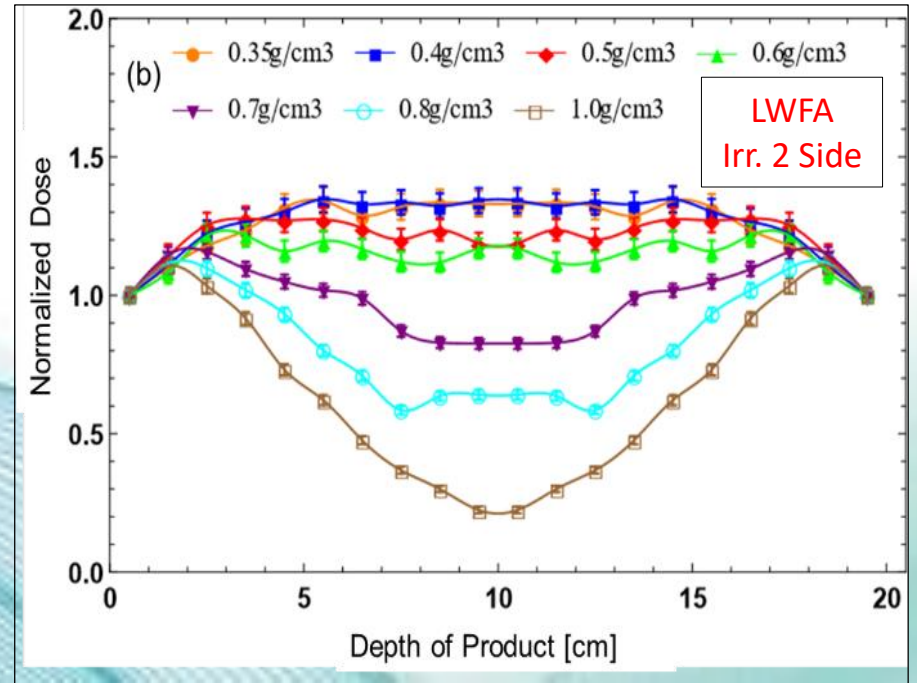


Comparision of Depth dose profile from LINAC and LWFA









Result and Discussion

Table 1: Penetrations and ADL values for homogeneous products irradiated by electron beam 10 MeV from LINAC and LWFA.

Parameters	Mono energy electron 10 MeV	LINAC with average electron 9.9 MeV and Gauss distribution spectrum	LWFA with LWFA has a bump around 10 MeV
r_{opt1}, cm	3.5	3.7	3.0
ADL_1, g/cm^2	3.5	3.7	3.0
DUR_1	1.4	1.4	1.2
r_{opt2}, cm	4.3	4.25	6.5
ADL_2, g/cm^2	8.6	8.5	13.0
Optimal area density	$\rho_A \leq 3.5$; $7.5 \leq \rho_A \leq 8.6$	$\rho_A \leq 3.7$; $7.5 \leq \rho_A \leq 8.5$	$\rho_A \leq 13.0$

Conclusion

In this work, we presented the results of our measurements and MCNP simulations of depth-dose distribution of homogeneous materials of food irradiation interest with a 10 MeV electron beams from our linear accelerator. We also presented our simulation results for model LWFA electron beams with a broad peak at 10 MeV. The broad energy spectrum of LWFA renders the depth-dose distribution less steep and offers a more uniform dose in the interior of materials. This might prove to be an advantage for irradiating bulk quantities of food, when the technology becomes available. However, the long tails of electron energy spectrum of LWFA may be of some concern as health hazard. This issue merits further studies.