

## INTRODUCTION

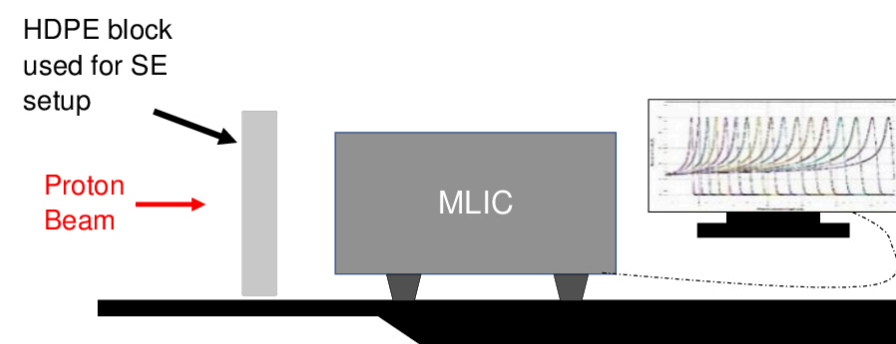
- Single-energy modulated proton arc therapy (SEM-PAT) has the potential to improve dose conformity, reduce RBE and LET concerns
- SEM-PAT uses a single-energy proton beam and modulates the energy using an energy modulator at the nozzle.
- Similar beam characteristics (such as the depth-dose profile) of a modulated energy (ME) and single energy (SE) providing the same proton range is important for optimization of Single-Energy-Modulated Proton Arc Therapy (SEM-PAT).

## AIM

- The goal of this study is to compare the beam characteristic of the ME and SE providing the same proton range.

## METHOD

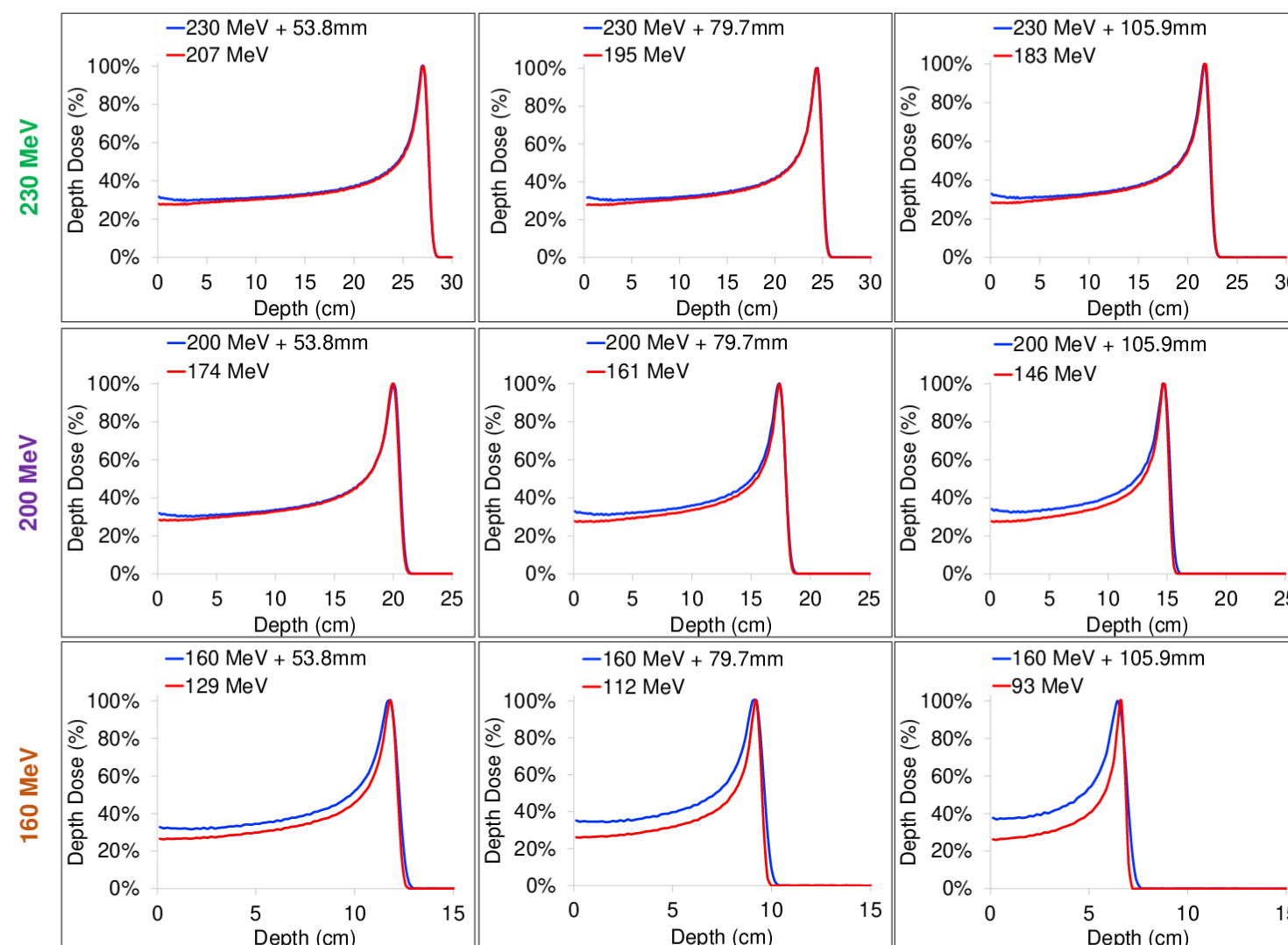
- Three proton beam energies, 230MeV, 200MeV, and 160MeV were used as the initial energies for ME.
- The range of each energy was reduced by 5.4, 6.3, 7.2, 8.0, 8.9, and 10.6cm water-equivalent-distance using high-density polyethylene (HDPE) blocks
- The depth-dose profile of each scenario was measured using a multi-layer ion chamber.
- Beam characteristics (R90, R80, dose fall-off) of ME proton beams were compared to the SE proton beam with the same proton range.
- Figures 1 shows the measurement setup for the comparison of depth dose profile and parameters for ME and SE proton beams.



**Figure 1.** Measurement setup using multi-layer ionization chamber (MLIC) to compare dose profile parameters between SE and ME proton beam

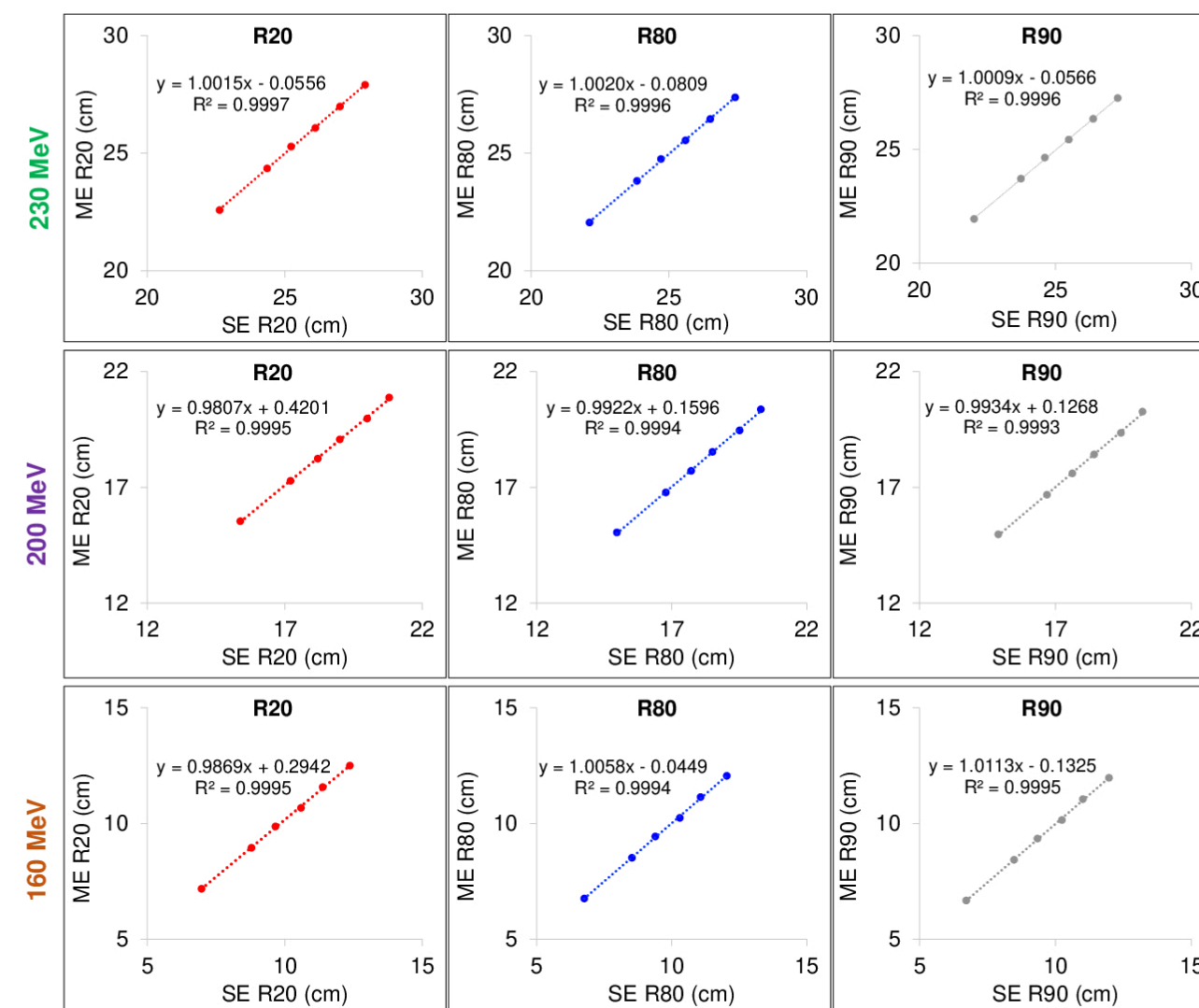
## RESULTS

- Figures 2 & 3 show the comparison of depth dose profile and parameters for ME and SE proton beam.
- The depth-dose profile of ME beams using higher energy proton beam showed better agreement with the corresponding SE beams.
- For all energies of ME, higher entrance doses were observed compared to the corresponding SE.



**Figure 2.** Depth dose profile of 230, 200 and 160 MeV proton beams with 5.38, 7.97, and 10.59cm HDPE blocks used for ME compared to corresponding SE proton beams.

- For all 3 energies, the difference between R90 and R80 of ME and SE were within 0.7mm.
- The difference between R20 and dose fall-off (R20-R80) of ME and SE were within 0.5, 1.0, and 2.0mm for 230, 200, and 160MeV, respectively.



**Figure 3.** Depth dose parameters of 230, 200 and 160 MeV proton beams of ME compared to corresponding SE proton beams.

## CONCLUSION

- Beam characteristics of the ME match within 2mm to the corresponding SE proton beam, which is insignificant considering SEM-PAT delivers dose only to the center of the target from each gantry angle.
- Beam characteristics of the SE can be used in ME for the optimization of SEM-PAT plans.

**Future Work:** The beam characteristics such as spot profile, lateral penumbra and range of more proton energies need to be analyzed.

## CONTACT INFORMATION

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