Beamline Simulations of a Dielectric Wall Accelerator for Low-Cost Proton Therapy

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Introduction

Proton therapy

✓ **Shown to provide clinical benefits, particularly for pediatric patients**

✗ **Accessibility is limited by the size and cost [1]**

Objective:

Develop and simulate a dielectric wall accelerator (DWA) beamline as a solution for low-cost, compact proton therapy

Figure 1: DWA modular waveguide and pulser boards

Methods

DWA operation:

- Uses stacks of accelerating modules consisting of high voltage pulsers and waveguides [2,3]
- Pulses are timed with the proton bunch

Simulations:

- Simulate a realistic proton source
- Model the electromagnetic fields for a single DWA module
- Stack and time the modules in the simulation [4,5]

Beamline Design

- Focusing and steering magnets
- Beam collimator and heat management
- Optimization for beam stability

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Results

Ion source: Modelled after a D-Pace off-the-shelf proton source [6]

Beam chopper: Manages the unaccelerated beam

Pre-accelerator: Manages the low-energy beam at a reduced field gradient (10 MV/m) for stability

Collimated bend: Cleans and bunches the beam for injection into main DWA

Main DWA: High field gradients up to 100 MV/m to achieve clinical energies (200+ MeV)

Focusing Magnets: Allows for precise control of spot sizes

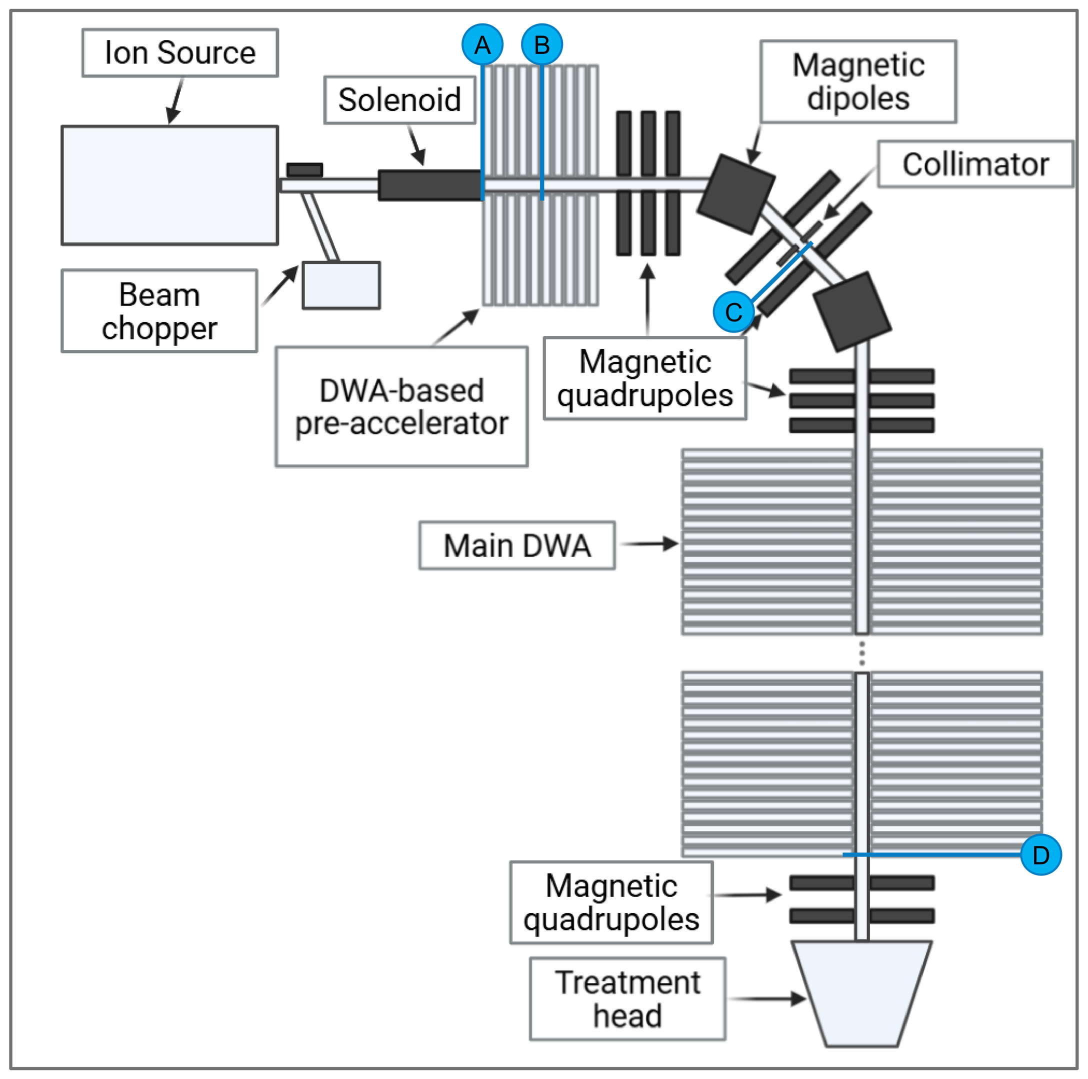

Figure 2: Simulated source-to-patient beamline design

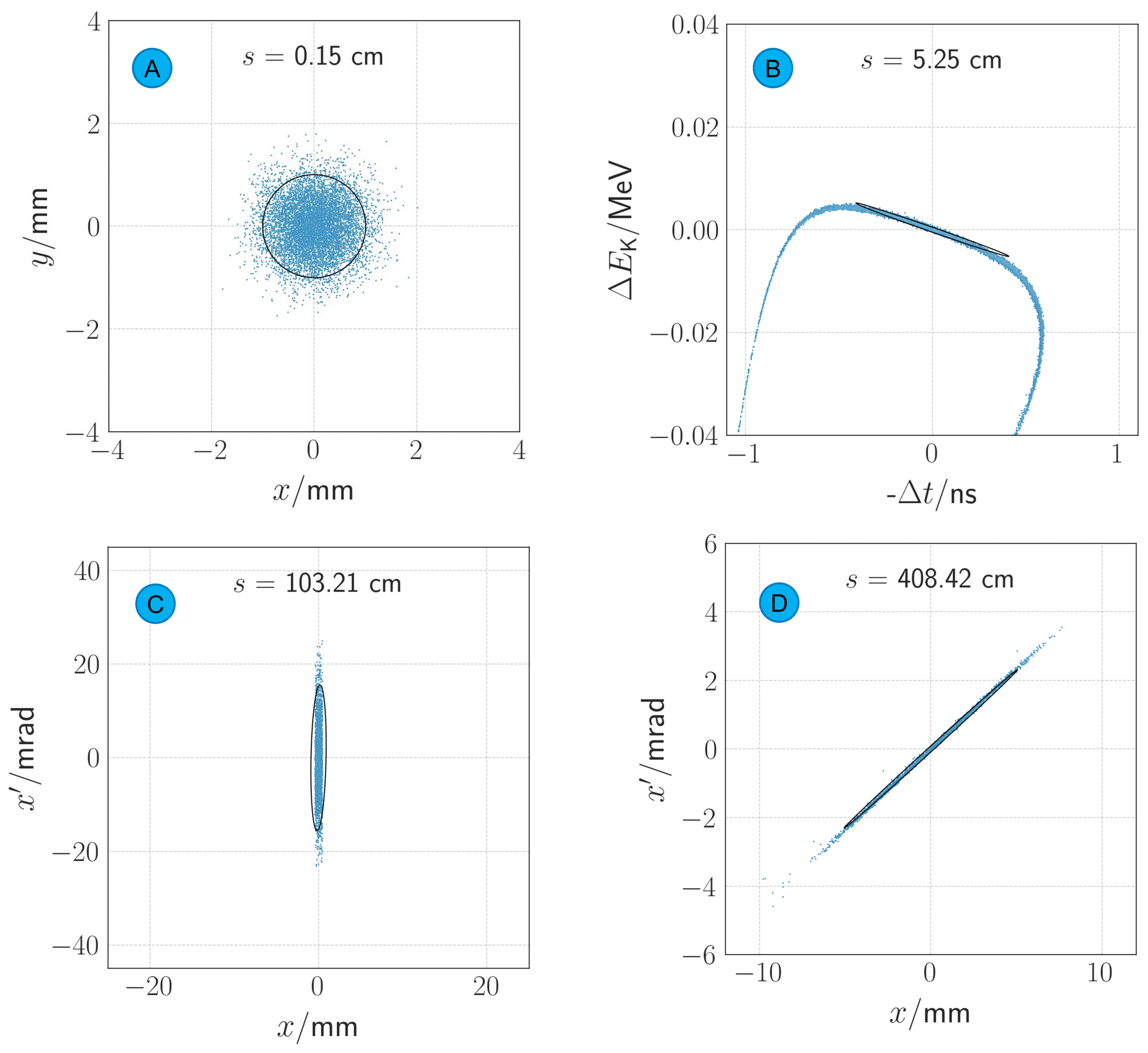

Figure 3: Example phase space plots: A) After ion source B) Inside pre-accelerator C) After collimator D) After main DWA

Highlights

Highlights:

- ✓ No bending at high energies
- ✓ Standard, continuous proton source
- ✓ No energy degraders
- ✓ Compact (4m x 2m)

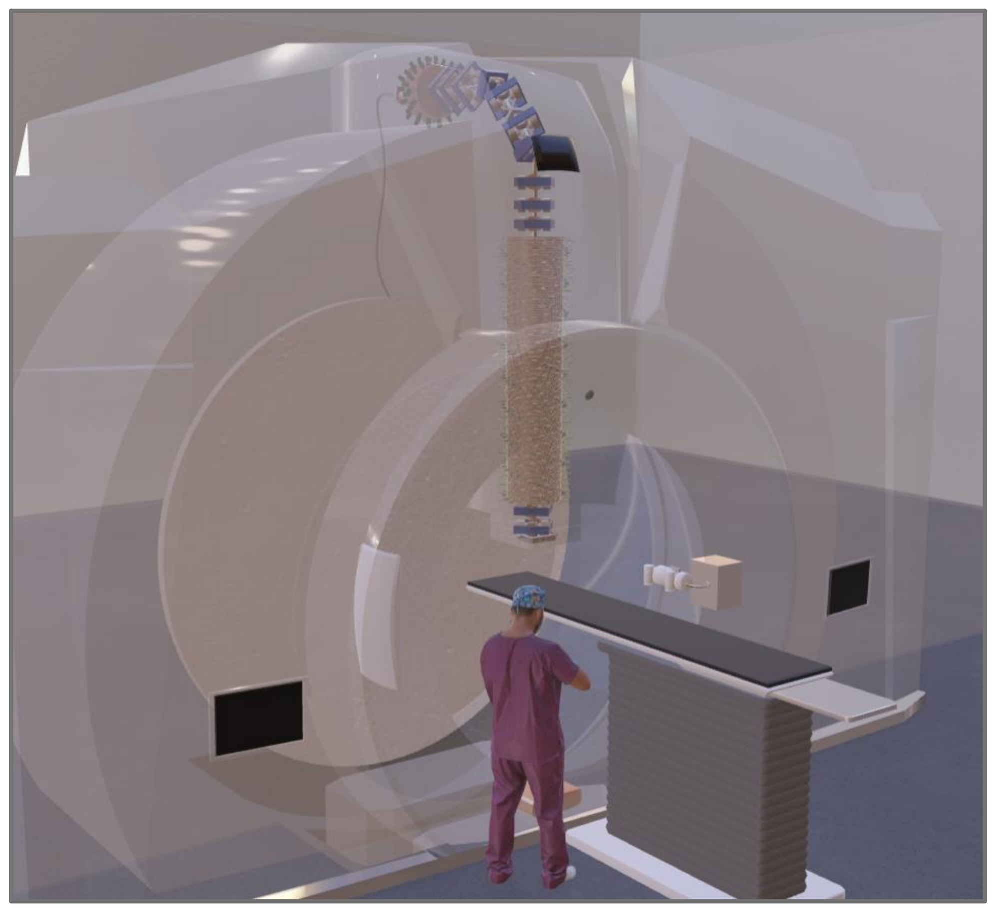

Figure 4: Artistic rendering of a clinical DWA-based accelerator

Conclusion

This work presents the feasibility, from a beam physics perspective, of a DWA-based, source-to-patient beamline

Ongoing and future work:

Experimental Setups

- Field measurements
- Module development
- See Poster #301

Clinical Research

- Treatment planning
- Clinical outcomes
- See Poster #553

Incorporate into simulations

References and Acknowledgements

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