AN EXAMINATION OF THE CIVADOT IN EGS_BRACHY

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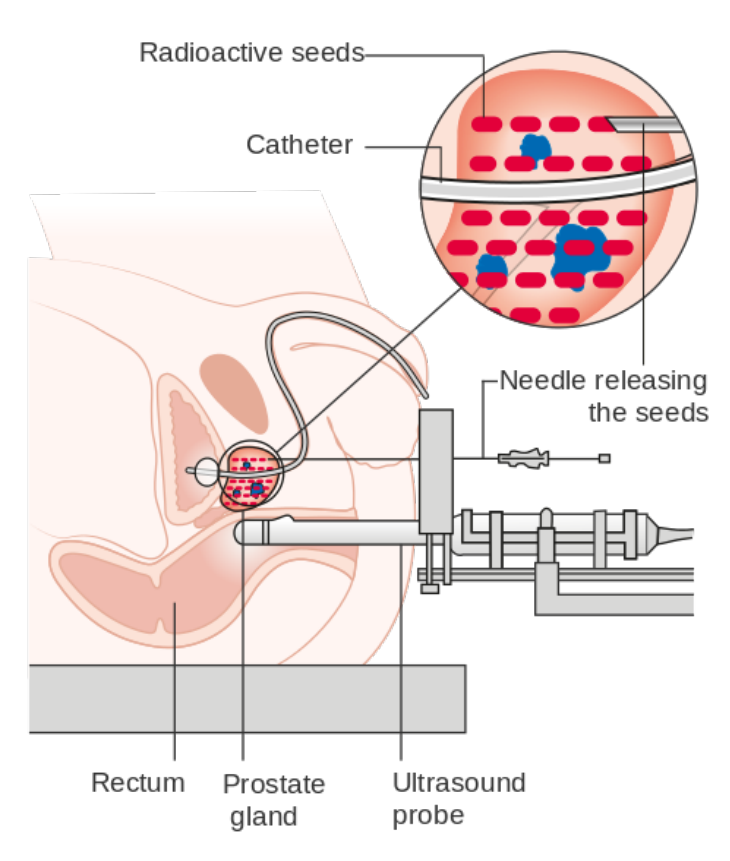
What is brachytherapy?

- A form a radiotherapy, which is the use of ionizing radiation for medical treatment
- A radioactive source is placed adjacent to or inside of the target (treated) region



- Primarily used for treating cancer, such as breast, cervix prostate and skin cancers

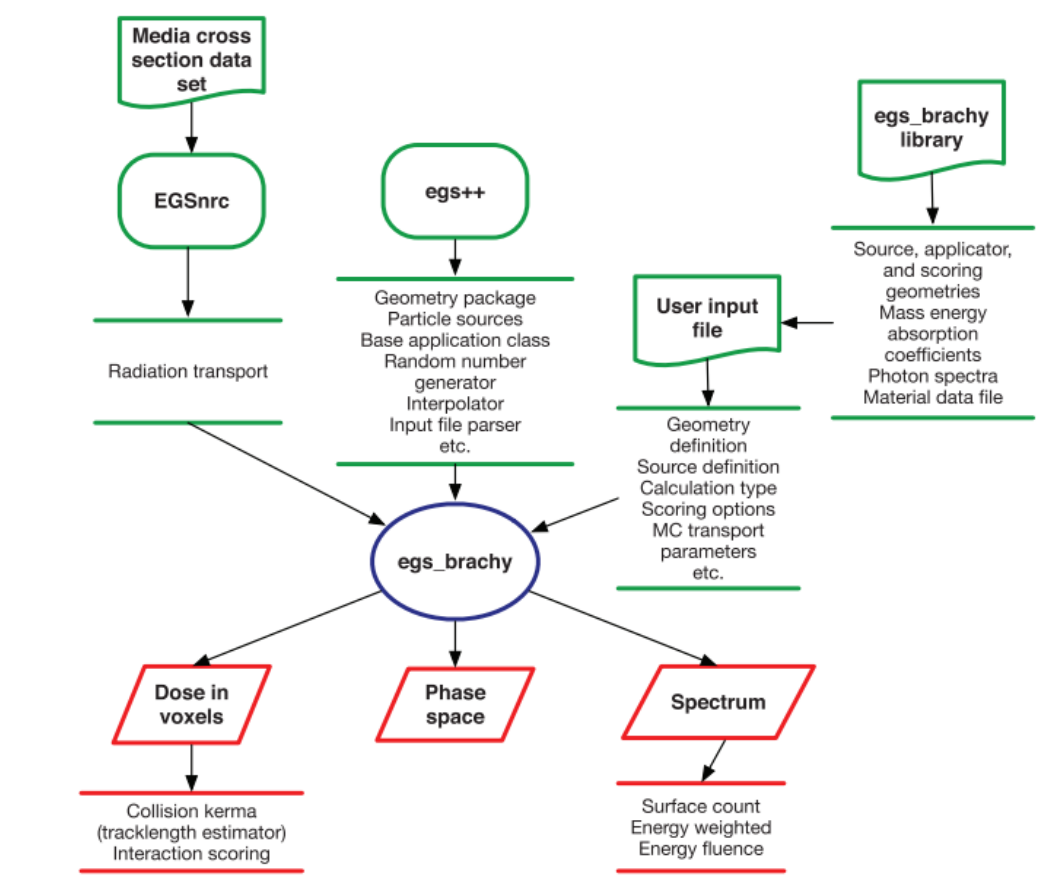
Shortcomings of TG43

- Task Group 43 formalism widely used for treatment planning system in clinical settings
  - Treat all media as water
  - Positions source at center of fixed volume phantom
  - Uses a superposition of dose distributions

- ***Compromises accuracy*** in order to increase speed of calculation
- Shortcomings led to the development of more robust dose calculation systems, such as egs_brachy

What is egs_brachy?

- An EGSnrc application that uses Monte Carlo methods for brachytherapy simulation
- Able to model custom geometries for simulated patients and radioactive sources



- Developed, maintained and improved upon by members of the CLRP
- egs_brachy will hopefully become user-friendly enough to be used in clinical settings

My Project

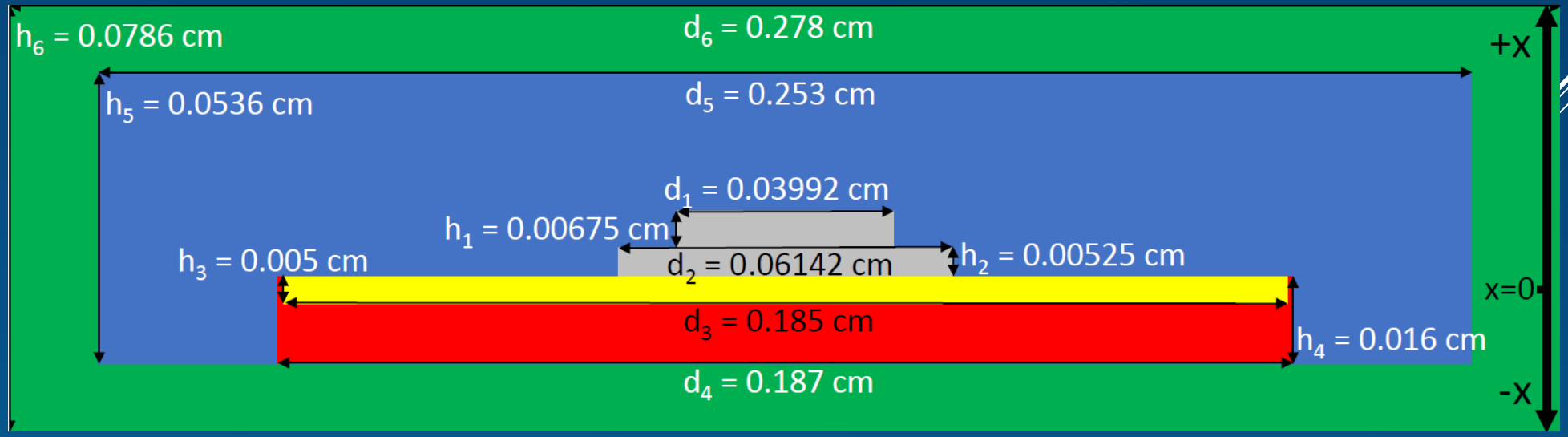
- Focused on modelling and validating the CivaDot for distribution with egs_brachy
- Validated by comparing results to previous work using MCNP software package

- Steps:
  1. Model the radioactive source using egs++ library
  2. Run simulations with source in egs_brachy, to obtain a dose distribution
  3. Analyze dose distribution and calculate TG43 dosimetry parameters

- Serve as validation for TG43Extract with non-seed sources
- Examine effects of array and superposition

The CivaDot

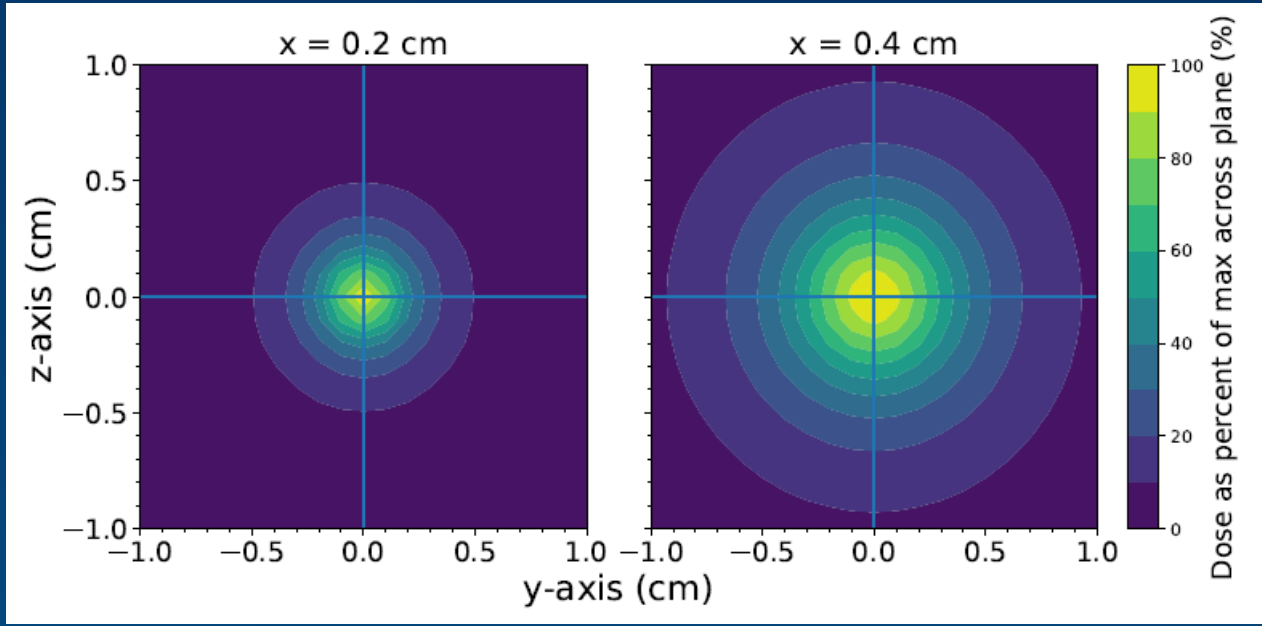
- Non-traditional brachytherapy source designed to provide unidirectional dose delivery
  - Potentially protects healthy tissue from radiation
- Has gold shielding on one side which produces a “hot” and “cold” side
- Designed for use in an array configuration (CivaSheet), which can be sized on a patient by patient basis

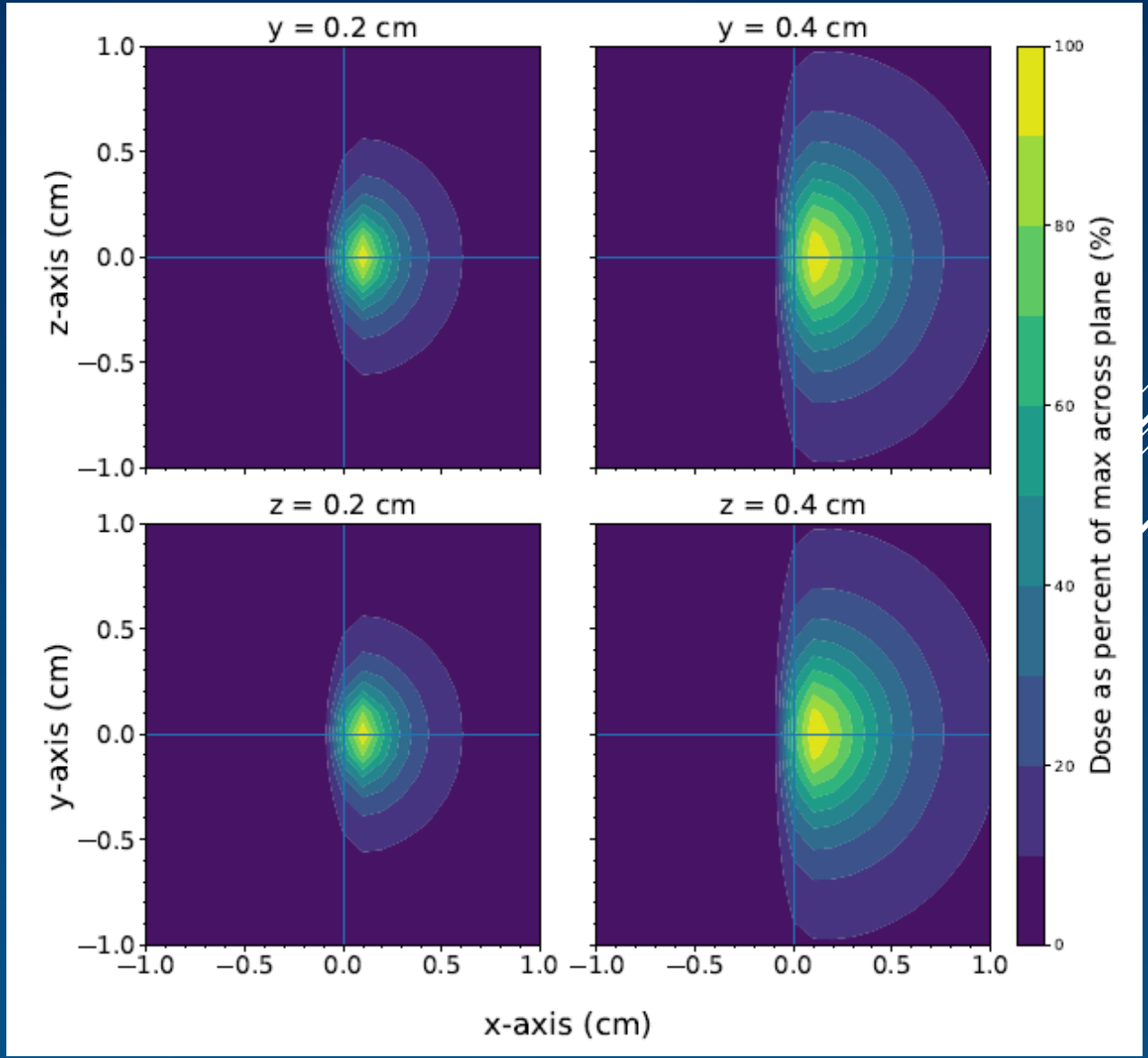


TG43 Dosimetry Parameters

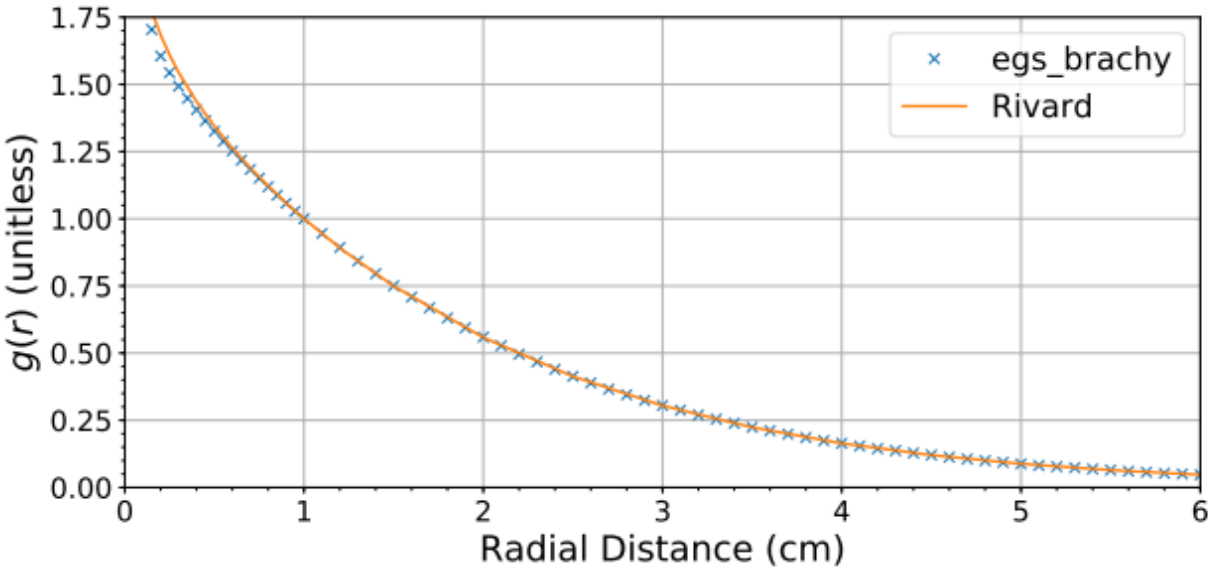
- A method of benchmarking brachytherapy sources, which can be compared across studies and methods of calculation
- Dose-rate constant: Ratio of dose at 1 cm to air kerma strength
- Radial dose function: Accounts for dose-fall off due to photon scattering and attenuation
- 2D anisotropy function: Describes the variation in the dose as a function of angle
- Dosimetry parameters calculated using TG4extract

Results: Single Source Dose Distribution





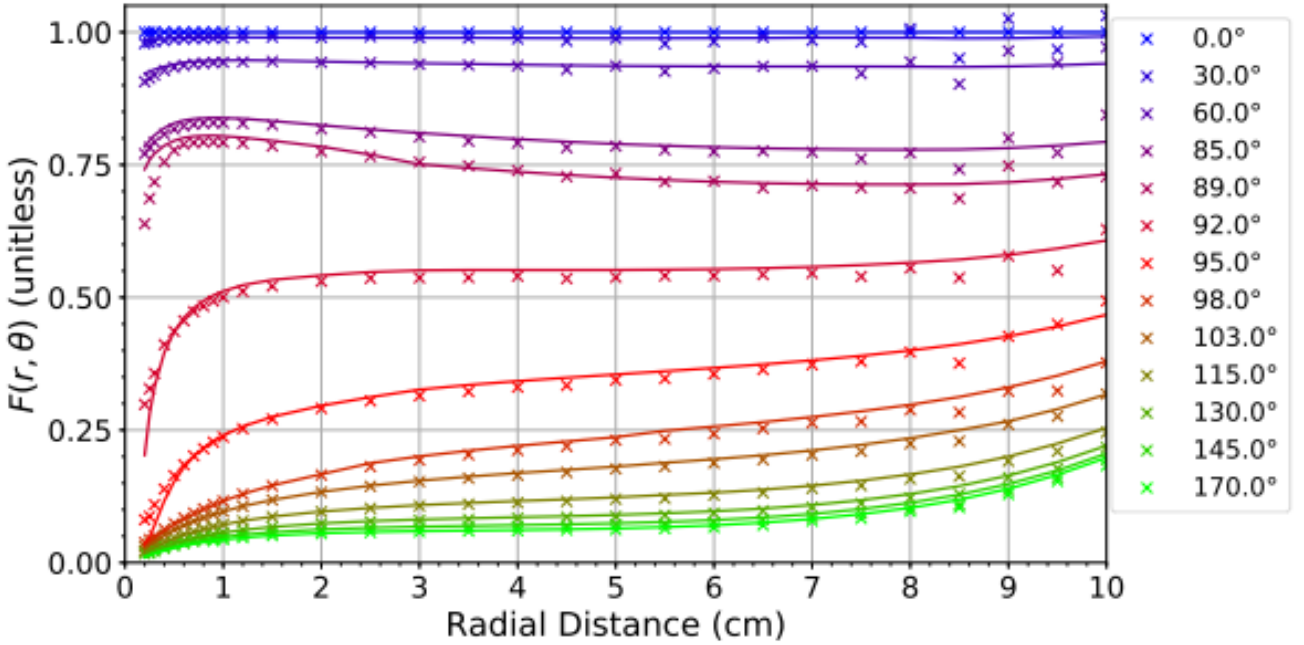
Results: Dosimetry Parameter Comparison



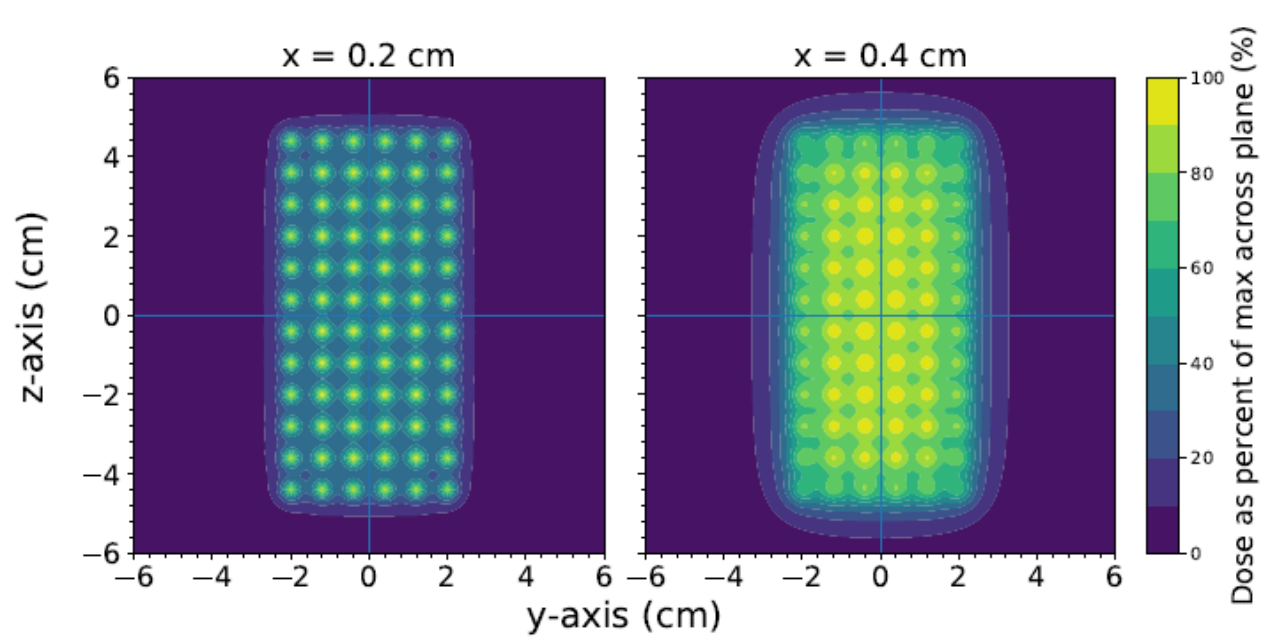
← Difference < 4.8%, r < 1 cm
← Difference < 0.20%, 1 cm ≤ r ≤ 4 cm

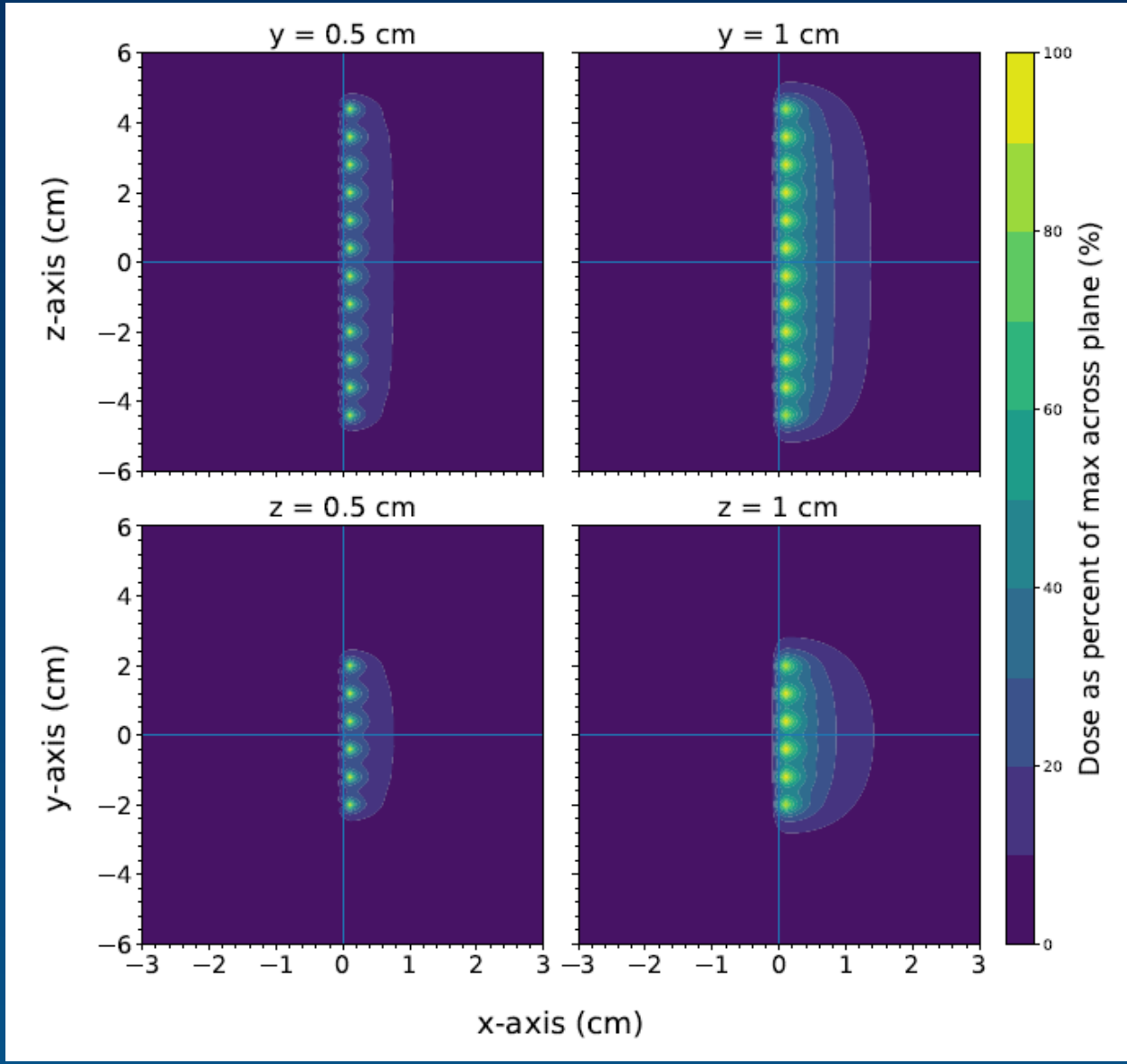
For unshielded side (angles < 90°):
Difference <1.8%, 0.2 cm ≤ r ≤ 6 cm →

For angles ≥ 90°:
Difference < 6.8%, 0.6 cm ≤ r ≤ 6 cm →
Difference > 99%, r < 0.6 cm →

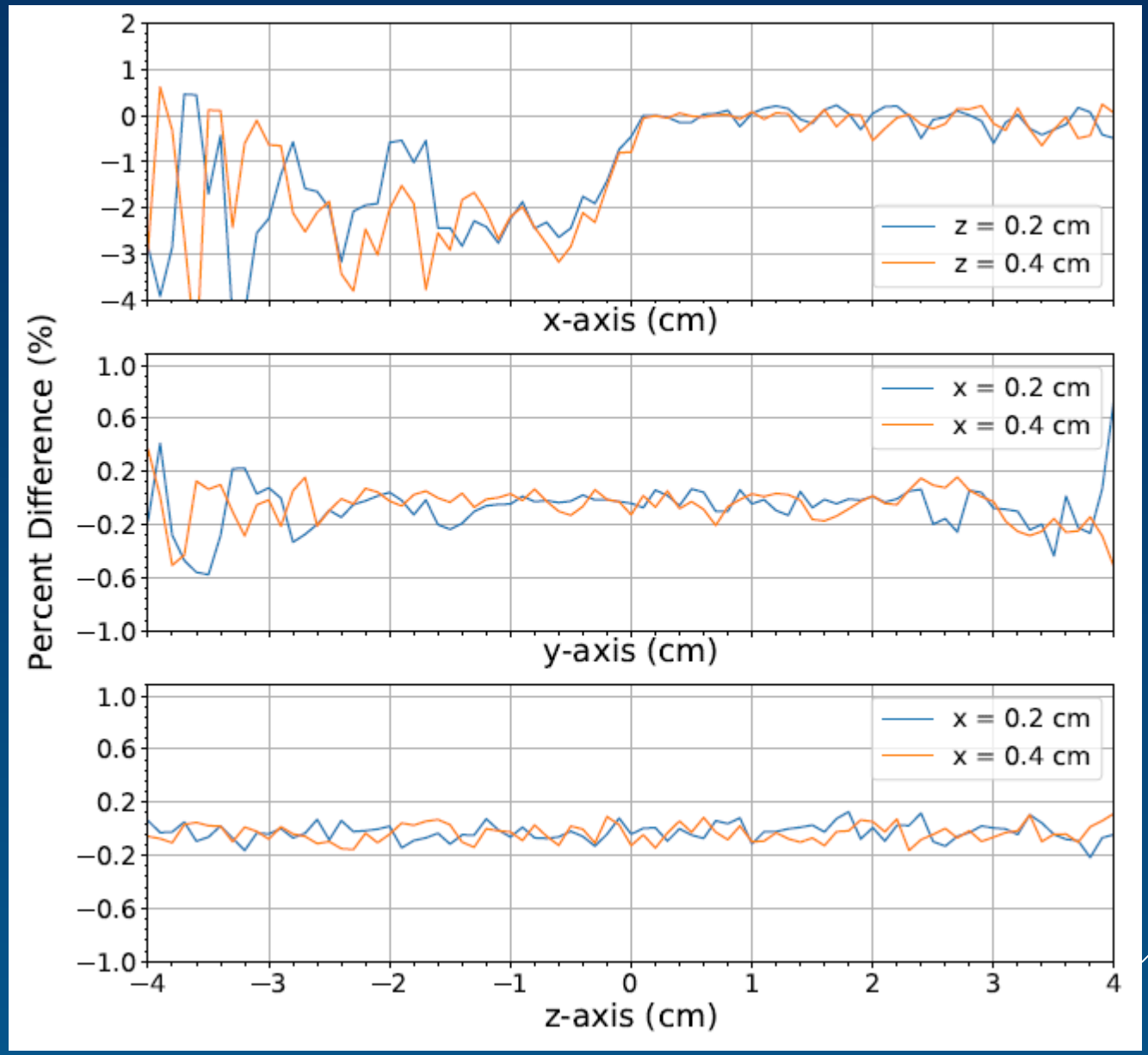


Results: Array Dose Distribution





Results: Array vs Superposition



Conclusion and Limitations

- Dose-rate constant and radial dose function showed good agreement
- 2D anisotropy function showed good agreement, except at angles close to 90° and at distances close to source

- CivaSheet delivered dose over a precise target area
- Superposition provided good estimate on unshielded side

- Not enough agreement to validate TG43extract

- Limitations:
  - Information about radioactive solution not fully disclosed by manufacturer
  - TG43extract not validated for non-seed sources

My Experiences

- Provided a gentle introduction to the world of research
- Helped me develop academic skills such as communication of ideas, literature review, report writing

- Helped me develop personal skills such as confidence in myself and my work and self-evaluation
- Taught me to look for information and solutions on my own, but also to admit when I was stuck

THANK YOU FOR YOUR TIME!
ANY QUESTIONS?