3. Dose Delivery and Gantries

U.S. DEPARTMENT OF ENERGY

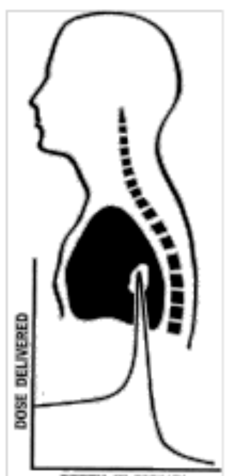
NATIONAL INSTITUTES OF HEALTH

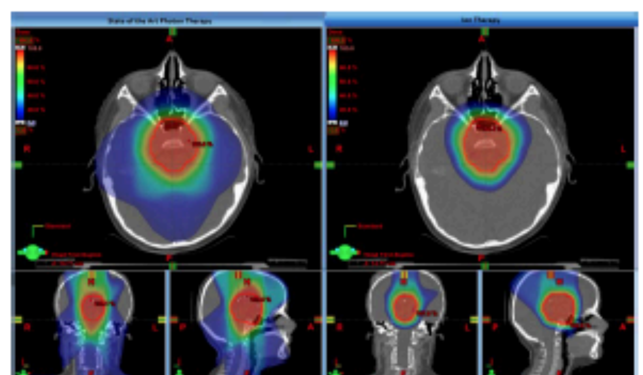
NATIONAL CANCER INSTITUTE

Workshop on Ion Beam Therapy

Summary Report

January 9–11, 2013





From NCI / DOE workshop Bethesda 2013

- Gantries and efficient beam lines will be essential to realize the complete promise of ion beam therapy. Reduction in their size is necessary to make fabrication cost-effective. Superconductivity appears to be the primary technology that can achieve significant component size reduction. Gantry and beam line components will require extensive R&D, as will their ancillary components, to increase their performance and make them more compact.

From NCI / DOE workshop Bethesda 2013

- Short dose deposition times will require fast and efficient scanning in all three spatial dimensions. This will place new demands on the accelerator, beam line and detector systems (noted below) to guide and verify dose placement.

From NCI / DOE workshop Bethesda 2013

- Improvements in beam line instrumentation and analysis software will be necessary to accurately and safely track the beam, to direct it to the correct point in the patient, and to monitor and verify that the dose is deposited where prescribed. The clinical requirements of ion beam therapy drive shorter treatment times, which in turn place severe response time demands on the detectors. Beam line detectors must track the beam through the accelerator and delivery system to the patient with high spatial precision and time resolution, and with negligible beam perturbation. Monitoring the charge over a large dynamic range with appropriate resolution is necessary to deliver the dose accurately and to terminate beam delivery when the desired dose has been achieved (or when beam transport abnormalities are detected).

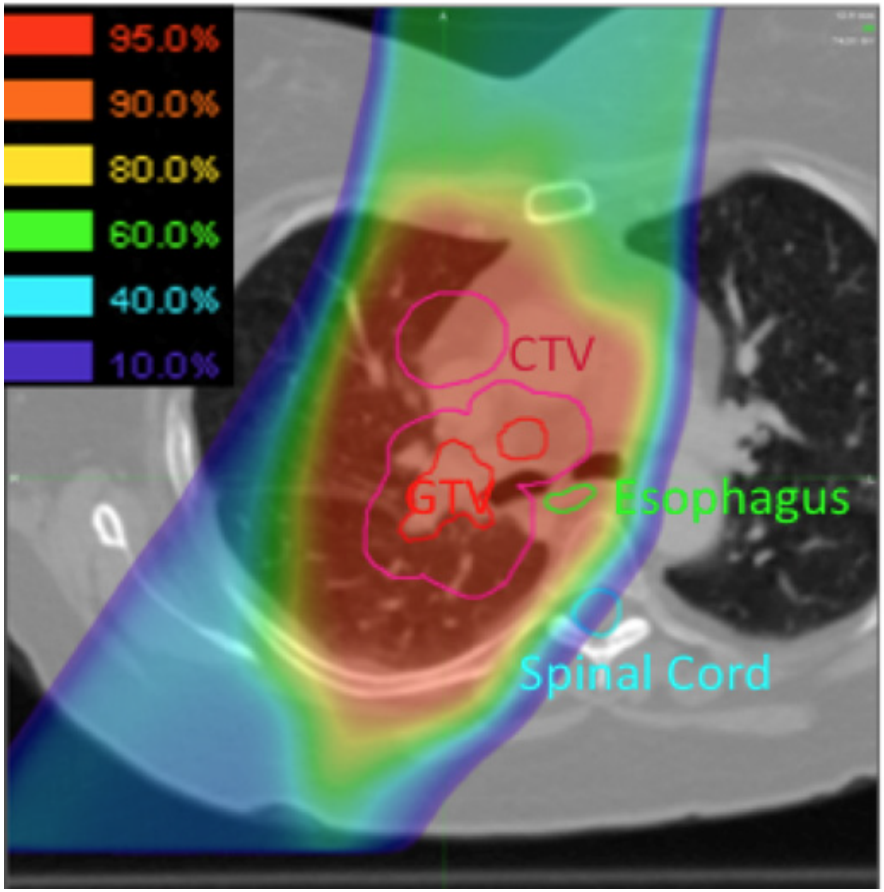
3. Dose Delivery and Gantries

- **Provocative questions**, big challenges ≈ 30 years horizon

1. Maximize precision of dose delivery: Radiation dose distributions only physics-limited, not technology limited.

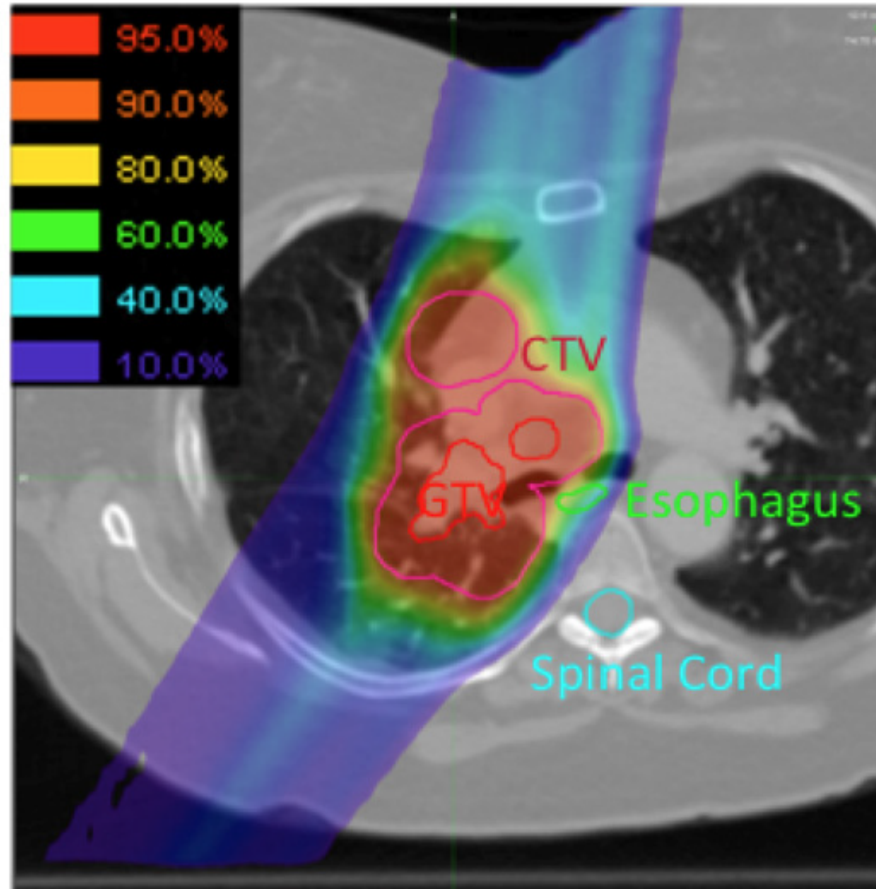
A. Gap between physical potential and clinical reality

clinical reality today



2nd generation

physical potential



3rd generation

3. Dose Delivery and Gantries

- **Provocative questions**, big challenges ≈ 30 years horizon

1. Maximize precision of dose delivery: Radiation dose distributions only physics-limited, not technology limited.
2. Affordable protons: Make proton therapy equipment as “cheap” as photon therapy.
3. Replace linacs: Make proton therapy so compact that it fits into a conventional treatment room.

3. Dose Delivery and Gantries

- **“low hanging fruit”**, success highly likely
  ≈ 5 years horizon

3. Dose Delivery and Gantries
Discussion points

- Super-conducting gantry may not be affordable for most.
- May achieve significant cost reduction without reducing cost of equipment by much
- Fractionation should be explored for cost-effectiveness, potential big savings
- Protons in linac roms – not in the next 10 years, perhaps in 30 years
- Does size really matter?   In the future new bigger treatment rooms will be built?
- Beam delivery geometry must be reflected in treatment planning (e.g. divergent beams) – dependence on planning system vendors, not market, out of our control?

3. Dose Delivery and Gantries

Discussion points

- Uncertainties in biology may be much bigger than physical/geometrical uncertainties
- Are we asking the right/ most important questions? Effectiveness more important than cost effectiveness
- Gantry not needed if moving the patient, re-imaging in different positions
- Seated treatment position promising
- Very important to optimize the workflow in the no-gantry case, image registration, etc., dose re-optimization, etc.
- Conflicting goals of cost reduction vs. “as good as it gets” (physically)

3. Dose Delivery and Gantries Conclusions / Recommendations

1. Cost is an important factor – make particle therapy affordable
   - Need specific goal, such as: reduce cost of particle therapy per treatment to cost of x-rays? That is, reduce cost factor for proton therapy from 2.4 to 1 (Goitein/Jermann).
   - Need to explore how much cost reduction that means
   - Use technology to reduce cost
   - Approach the problem from many angles, here: reducing cost of dose delivery and gantries
   - Keep in mind that effectiveness is ultimately important (and needs to be proven). But effectiveness without cost-effectiveness is not good enough.
   - CERN Biomedical Facility could provide the environment to develop and test this cost-effective technology

3. Dose Delivery and Gantries Conclusions / Recommendations

2. Reconsider the need for gantries
   - Push the envelope of no-gantry solutions (moving the patient instead of the beam).
   - Requires advanced instrumentation, imaging, robotics to make that happen
   - Emphasize tight integration of hardware and software (image registration, treatment planning and optimization) technologies
   - CERN Biomedical Facility should provide the environment to develop and test this technology

3. Dose Delivery and Gantries
Conclusions / Recommendations

3. Particle therapy in conventional treatment rooms??