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Proton Radiation Therapy for Breast Cancer

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Proton Radiation Therapy for Breast Cancer

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- Radiation Therapy plays an important role in various stages of breast cancer
  - After lumpectomy (Breast-Conserving Therapy)
  - After mastectomy (for node-positive or larger tumors, to reduce the risk of recurrence or spread).
  - For metastatic disease/spread—to control symptoms, improve quality of life, potentially prolong survival.

- Improving the “therapeutic ratio”—enhancing the benefit or reducing the risk—of treatment remains critically important as we strive to improve patient outcomes.

Radiation Therapy for Breast Cancer

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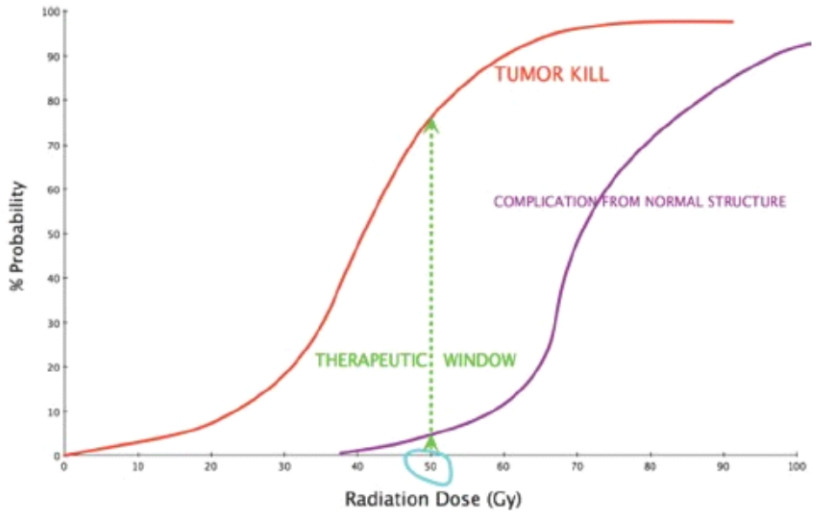
- Radiation Oncology: Finding the ***"Therapeutic Window"***



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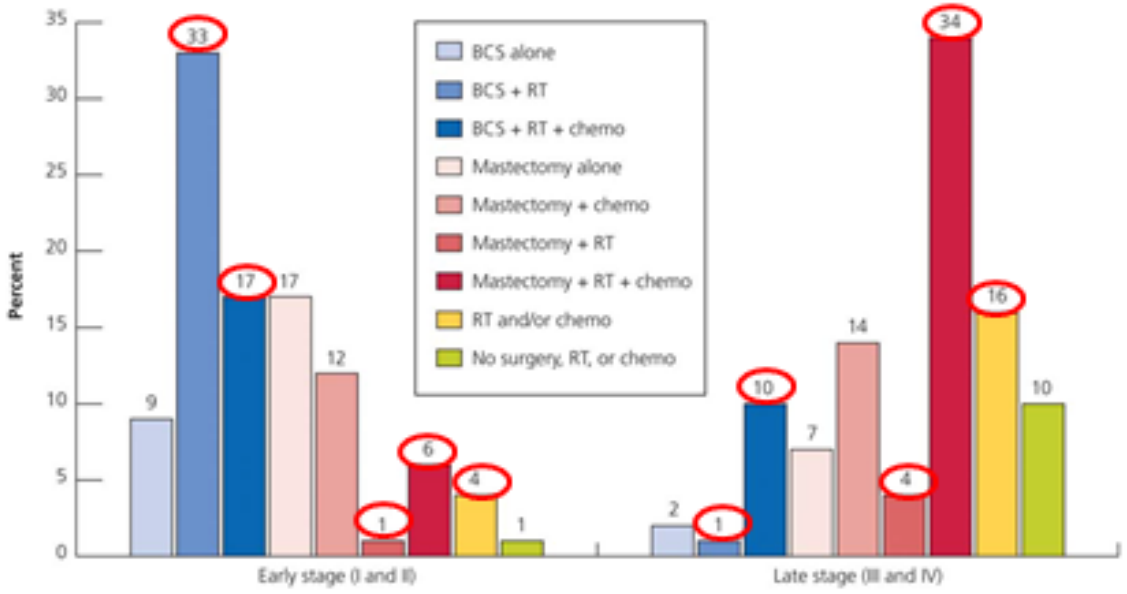
Multi-modality Therapy in Breast Cancer



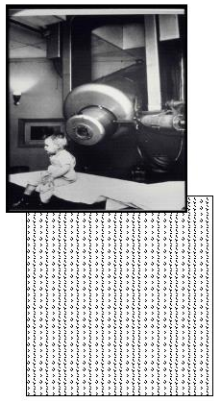
- RT implemented in 61% of early stage and 65% of late stage breast cancers

DeSantis CE. CA Cancer J Clin. 2014.

The Evolution of Radiation Therapy

1960's

The First Clinac



Standard Collimator

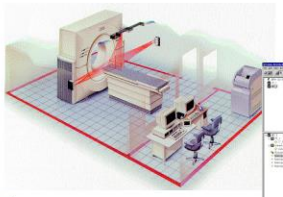
The linac reduced complications compared to Co60

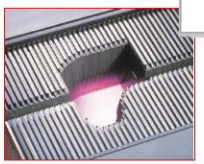
1970's

Custom blocks

Blocks were used to shape the beam

1980's

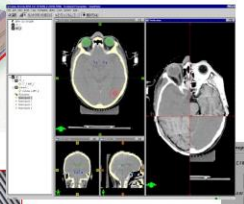


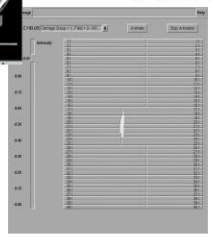


Multileaf Collimator

MLC leads to 3D conformal therapy which allows the first dose escalation trials.

Computerized 3D CT Treatment Planning





Dynamic MLC and IMRT

Computerized IMRT introduced which allowed escalation of dose and reduced compilations

1990's

Functional Imaging

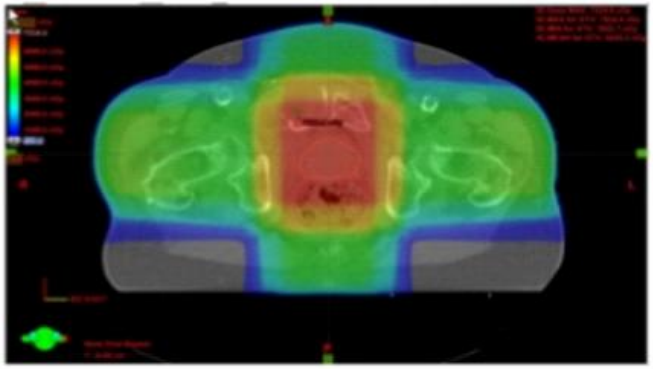
High resolution IMRT

Introduction of new imaging technologies

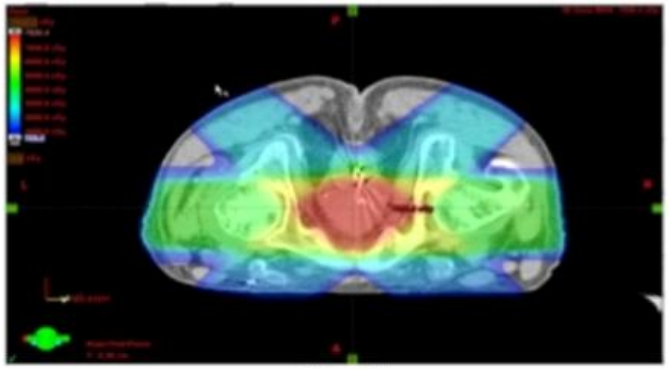
2000's

Photon Radiation Evolution

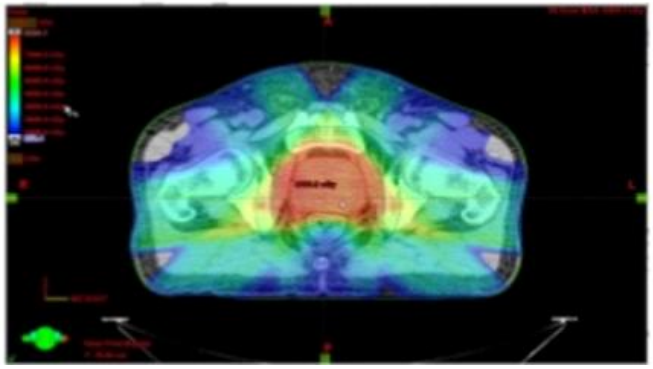
2D RT



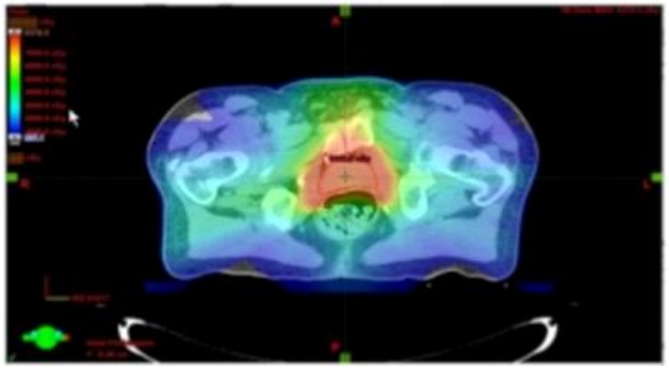
3DCRT



IMRT



Rapid Arc



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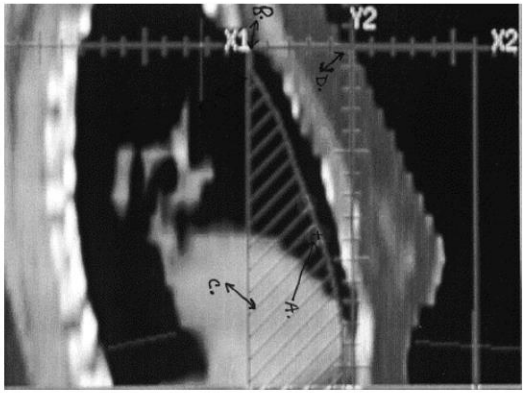
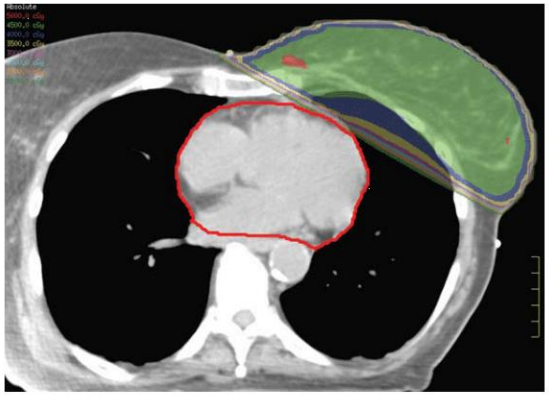
"3-D" Techniques





"Customized" shielding for each patient to spare the heart

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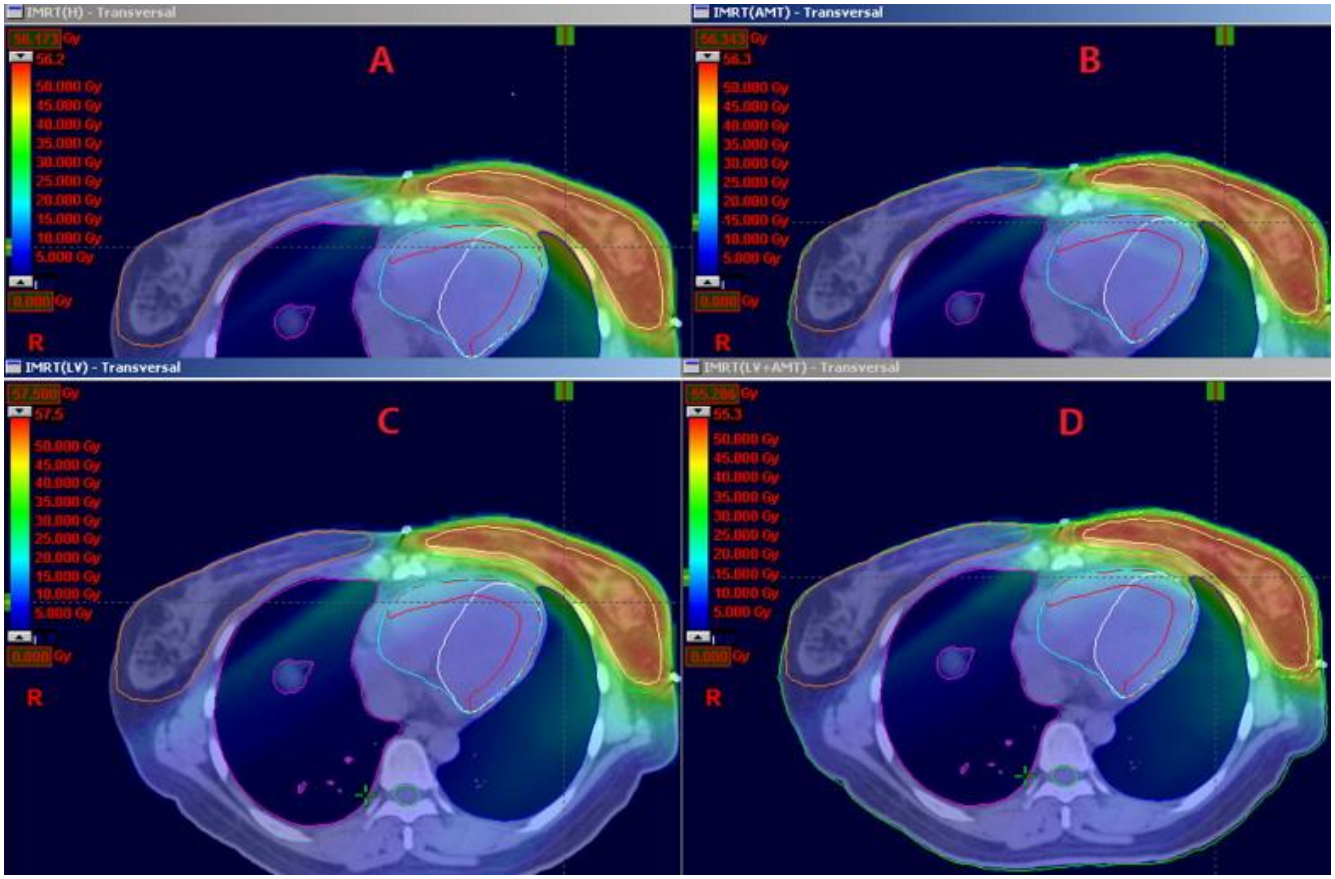
Intensity Modulated Radiation Therapy (IMRT)



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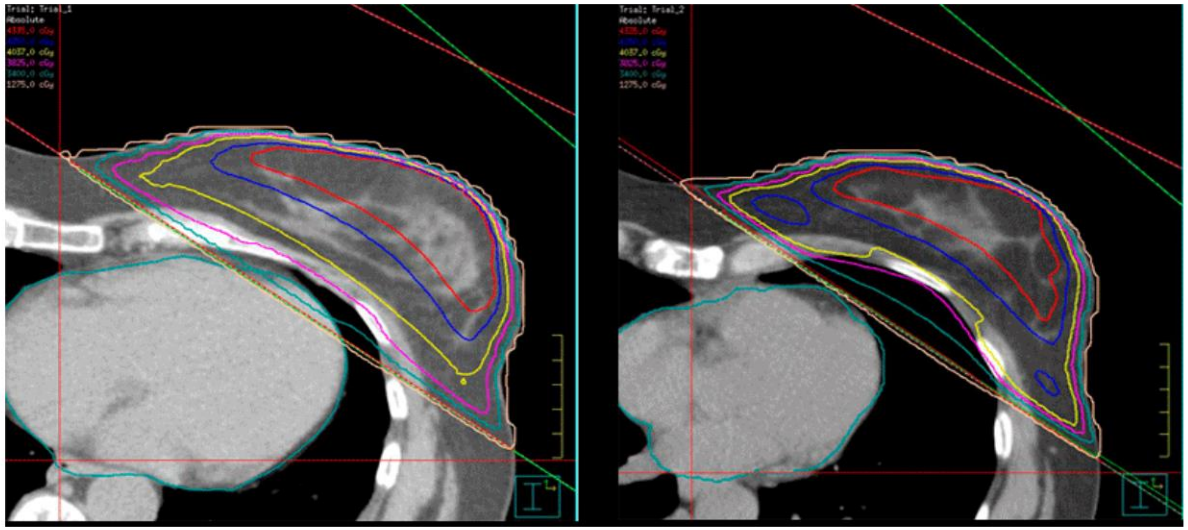
– “Deep Inspiration Breath Hold” (DIBH)



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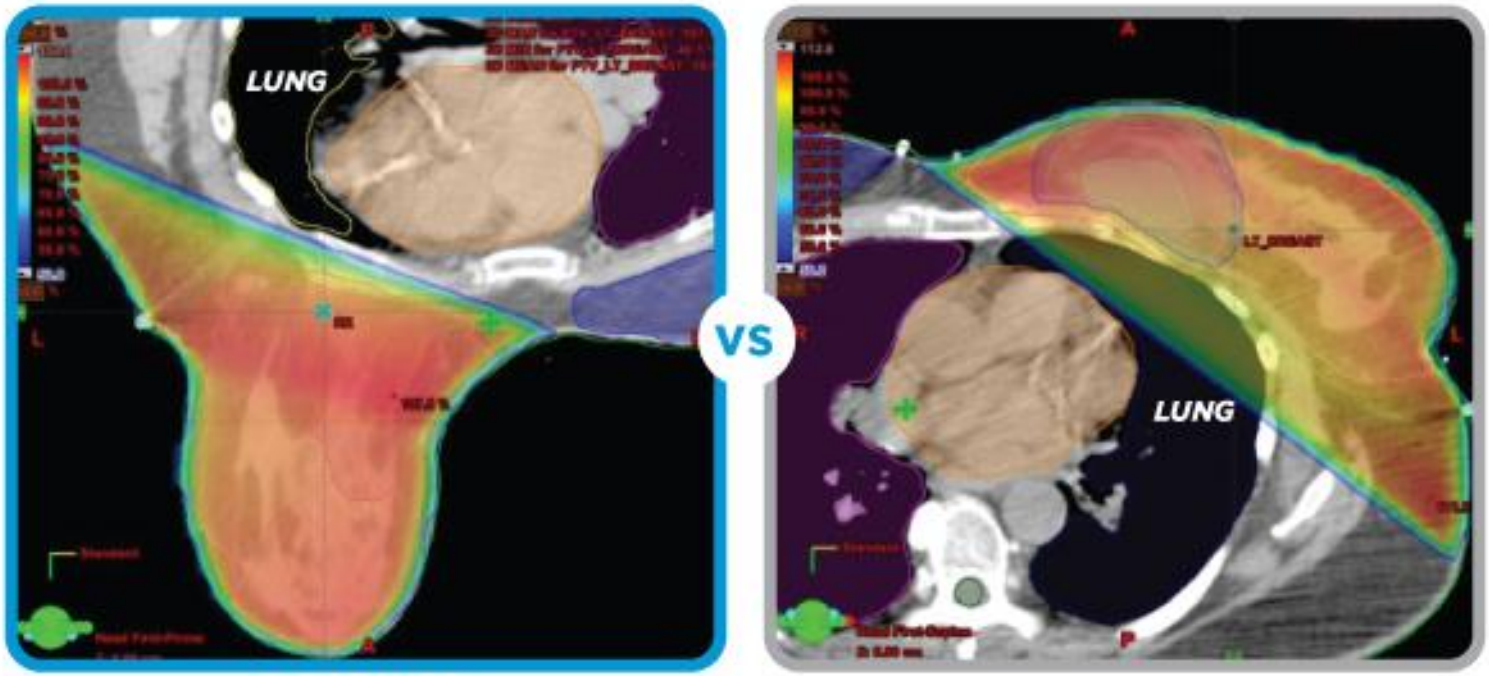

PRONE SUPINE

*Notice the patient with a radiation plan in the **prone position** compared to supine position. The colorwash demonstrates the parts of the body exposed to radiation. In the prone position, there is none going into the lung area.*

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Radiation Therapy for Breast Cancer

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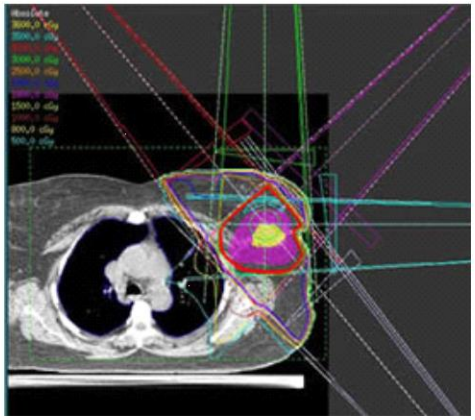
- Newer “cutting edge” options

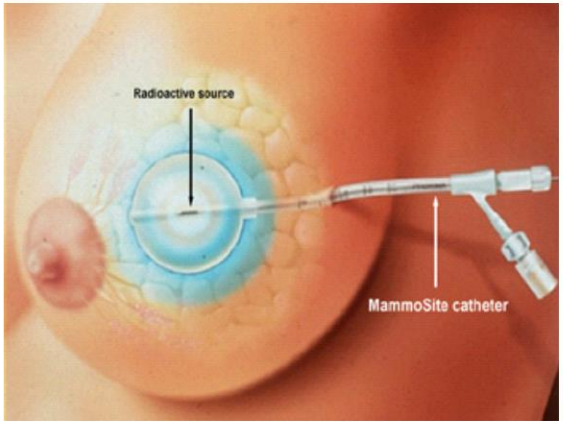
Accelerated Partial Breast Irradiation (APBI)

Treatment in as little as 5 days!

3D (external)



Intracavitary



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Radiation Therapy for Breast Cancer

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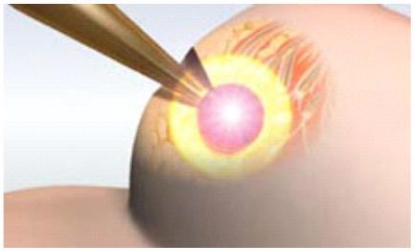
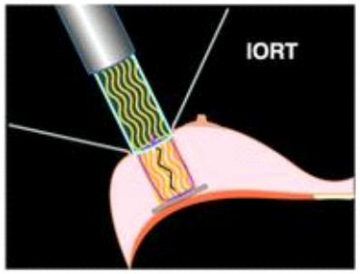
- Newer “cutting edge” options
  - Intraoperative Radiation Therapy (IORT)





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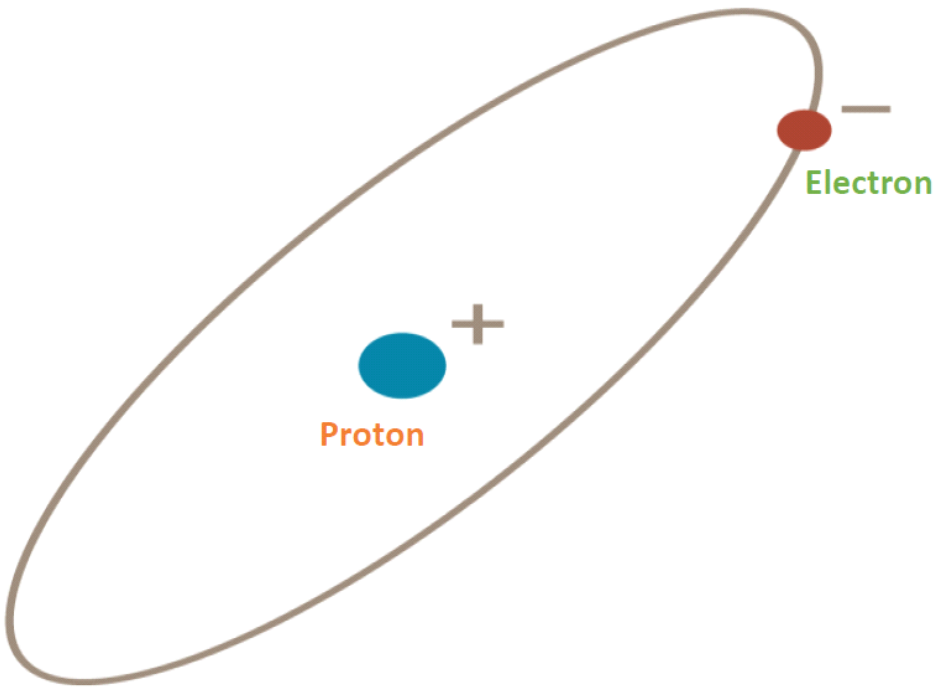
Proton is hydrogen atom without electron
(Heavy particle)



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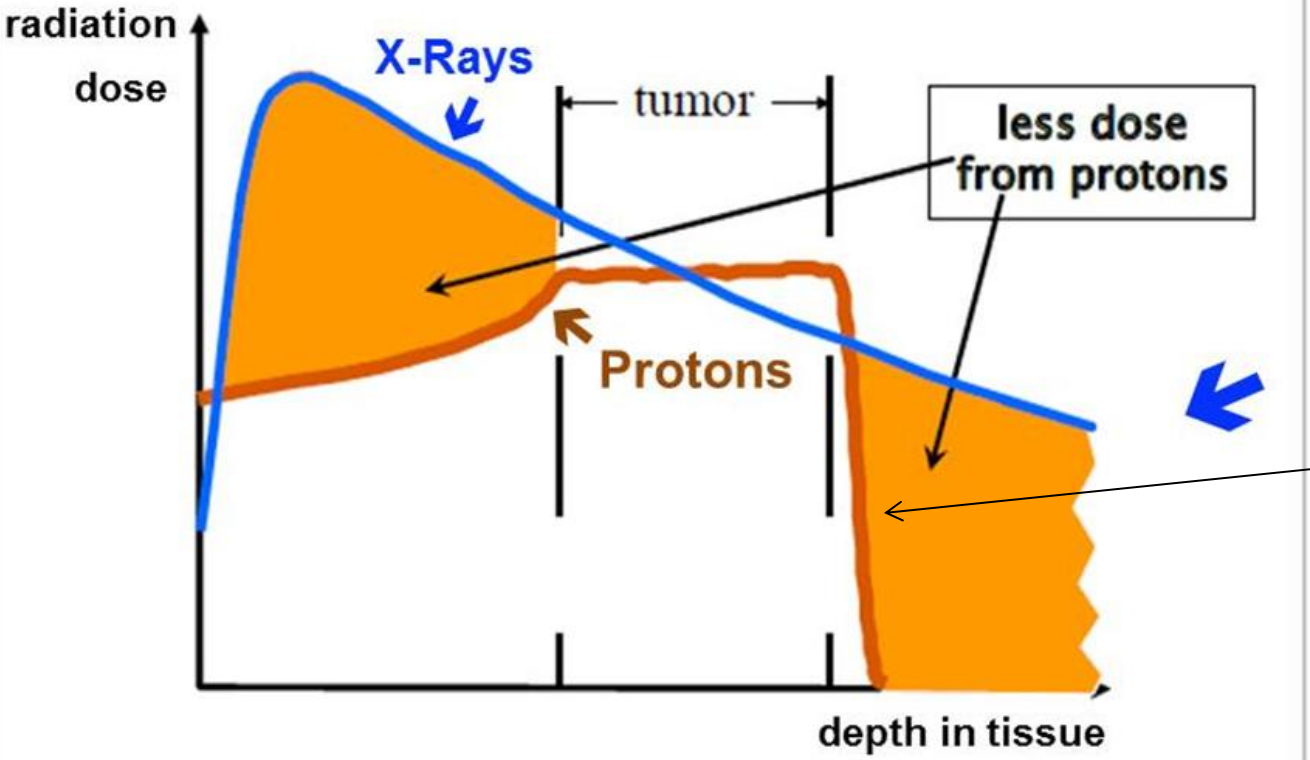

Figure 1: Comparison between spread out Bragg peak (SOBP) protons and 10 MeV photons.

PROTONS

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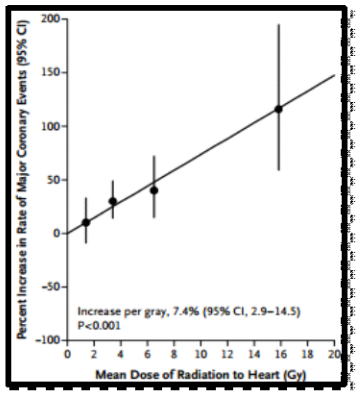
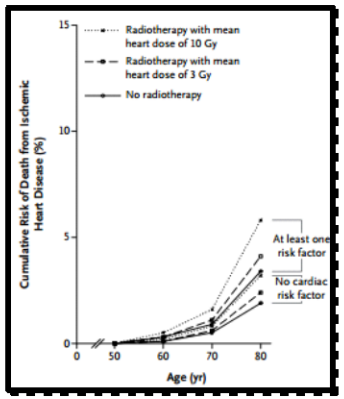
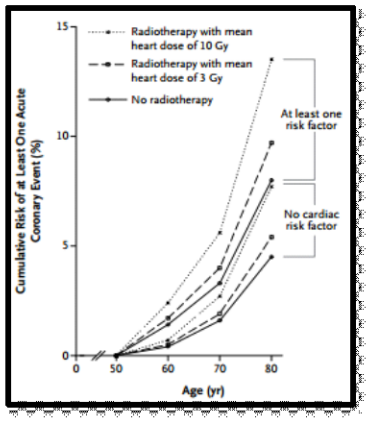
The Potentials of Proton Therapy

Why are Protons important to consider for our Breast Cancer Patients?







- There is a linear relationship between radiation dose and major coronary events with no safe lower threshold
- Radiation is an independent risk factor for cardiac death and it is additive of existing risk factors
- Increased risk begins 5 years after radiation and continues into third decade

Darby, NEJM 2013

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Cardiac Toxicity

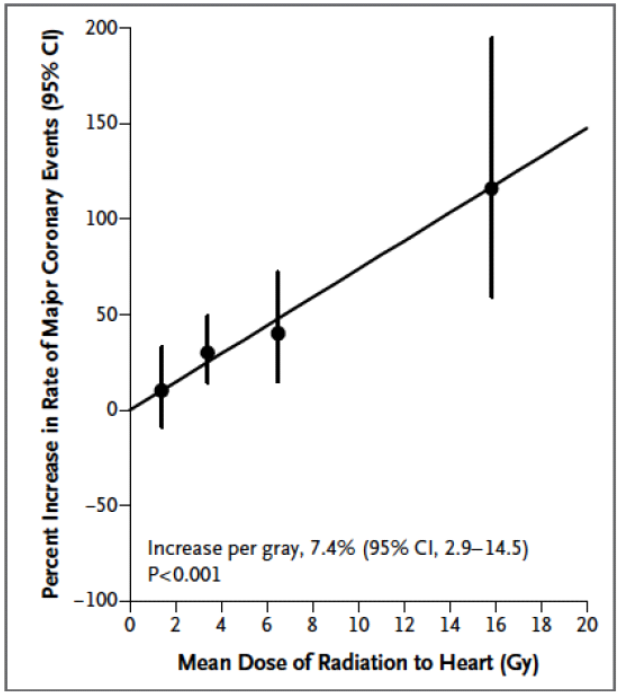

Table 3. Percentage Increase in the Rate of Major Coronary Events per Gray, According to Time since Radiotherapy.

Time since Radiotherapy*	No. of Case Patients	No. of Controls	Increase in Rate of Major Coronary Events (95% CI)†
			% increase/Gy
0 to 4 yr	206	328	16.3 (3.0 to 64.3)
5 to 9 yr	216	296	15.5 (2.5 to 63.3)
10 to 19 yr	323	388	1.2 (−2.2 to 8.5)
≥20 yr	218	193	8.2 (0.4 to 26.6)
0 to ≥20 yr	963	1205	7.4 (2.9 to 14.5)

- Myocardial infarction
- Coronary revascularization tx
- Death from ischemic heart disease

7.4% increase major cardiac event for each 1 Gy increase in mean radiation dose to heart (without threshold)

Darby SC, et al. *N Eng J Med. 2013;368(11):987-98.*

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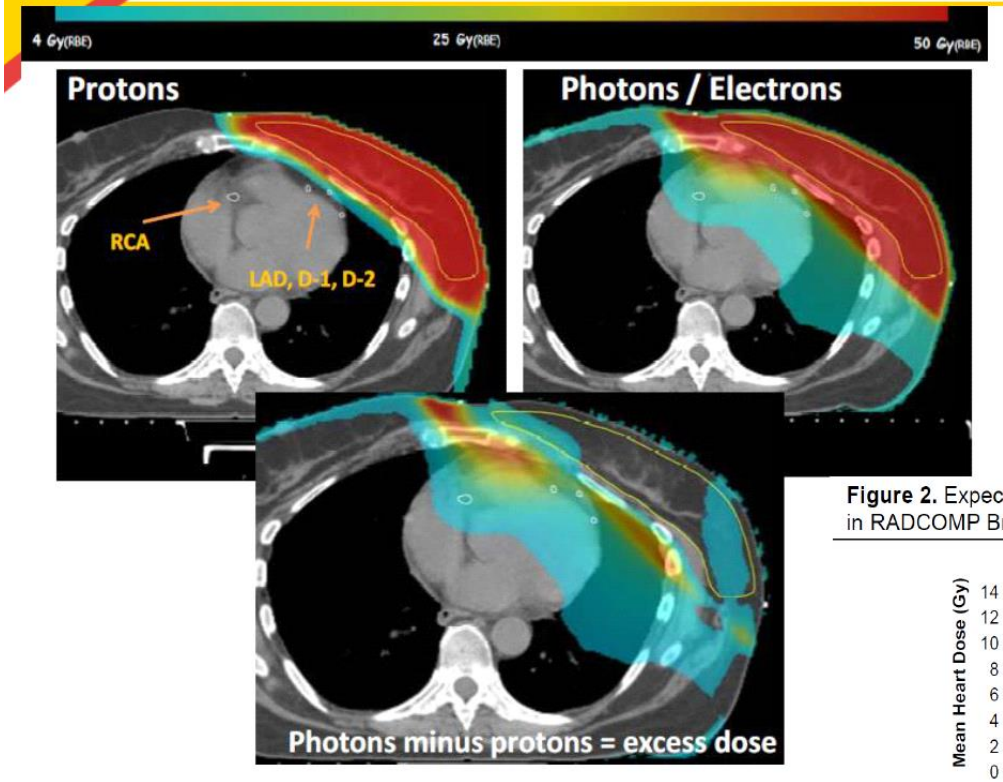
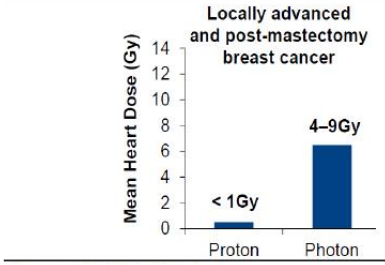
Breast Cancer
Incidental Heart Dose: Proton vs. Photon



Hug et al. 2013; MacDonald et al, RO 2013

Figure 2. Expected Range of Mean Heart Doses in RADCOMP Breast Cancer Study



Source: RADCOMP analysis

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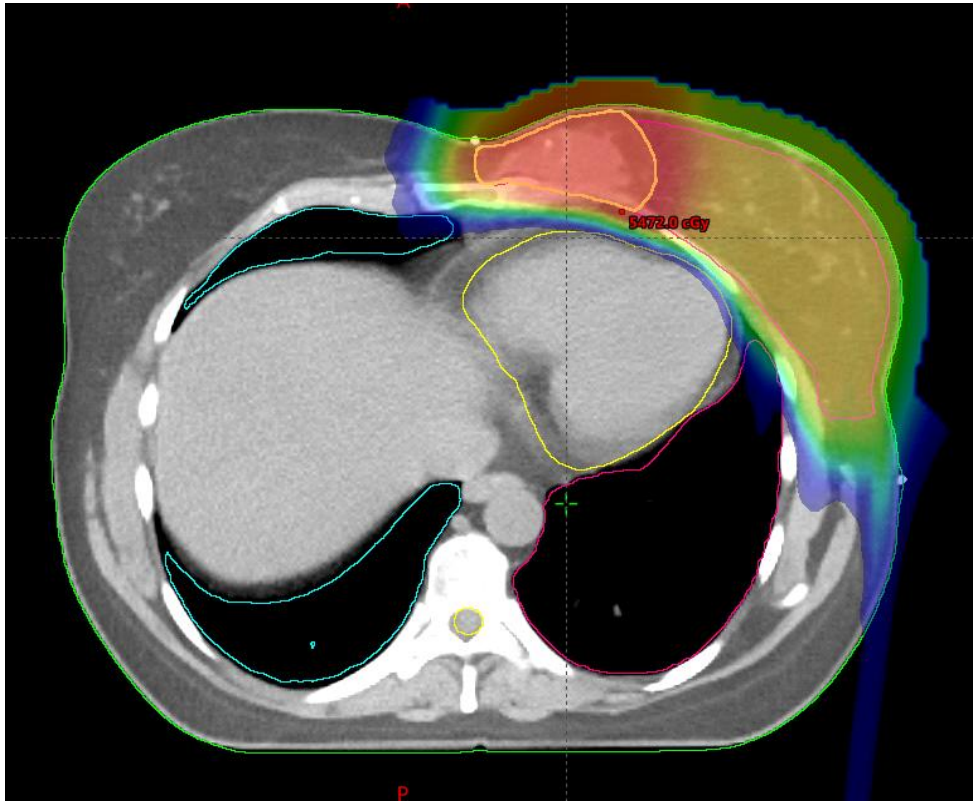
Patient 1: pT1cN0 lower medial tumor location with unfavorable anatomy



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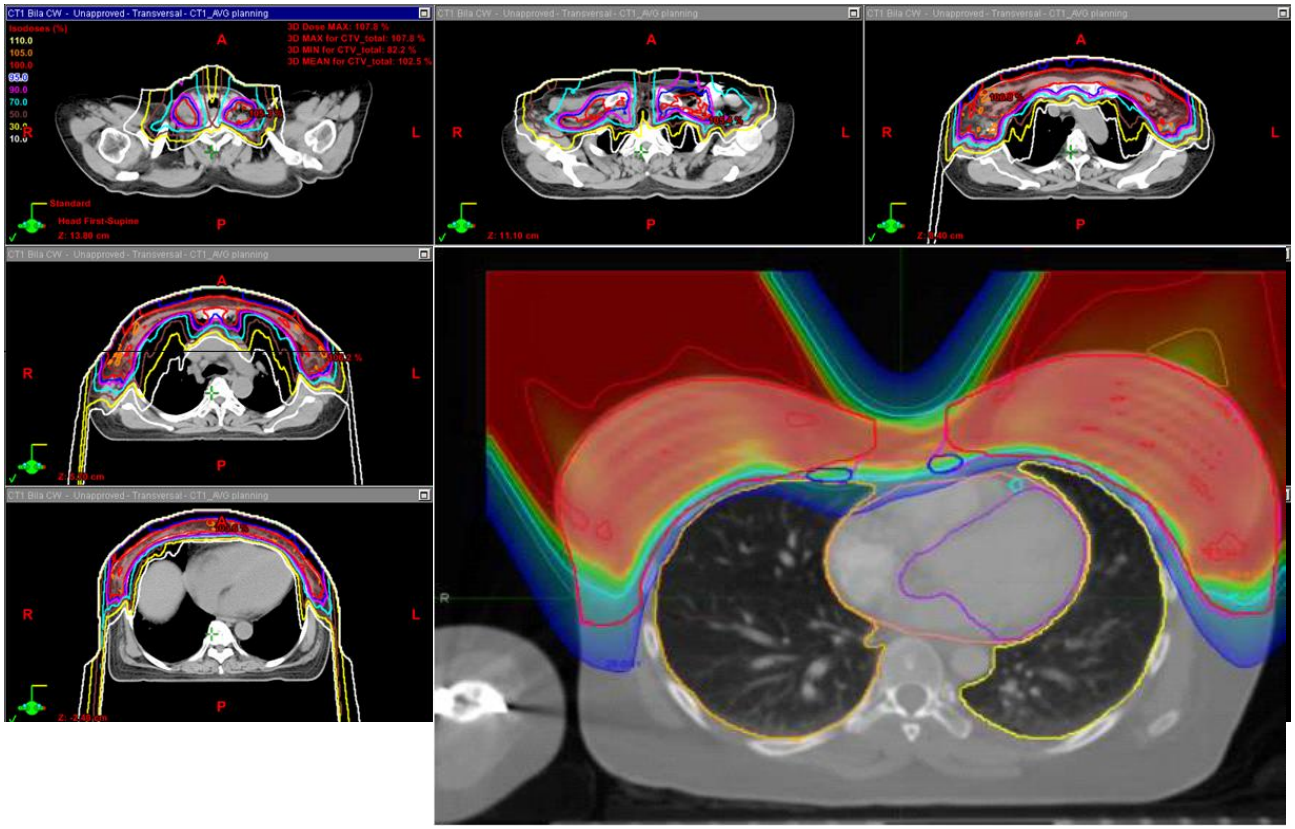
Patient 4: Bilateral Treatment



Potential Benefits of Proton Therapy for Breast Cancer

- For ***some*** patients, proton therapy ***might***:
  - Decrease heart radiation dose (potentially avoiding cardiac morbidity)
  - Decrease lung radiation dose (possibly lowering risk of radiation pneumonitis)
  - Decrease rates of lymphedema/shoulder stiffness (better able to avoid joint without compromising nodal target coverage)
  - Decrease rates of secondary malignancy (due to lower whole body integral radiation dose)

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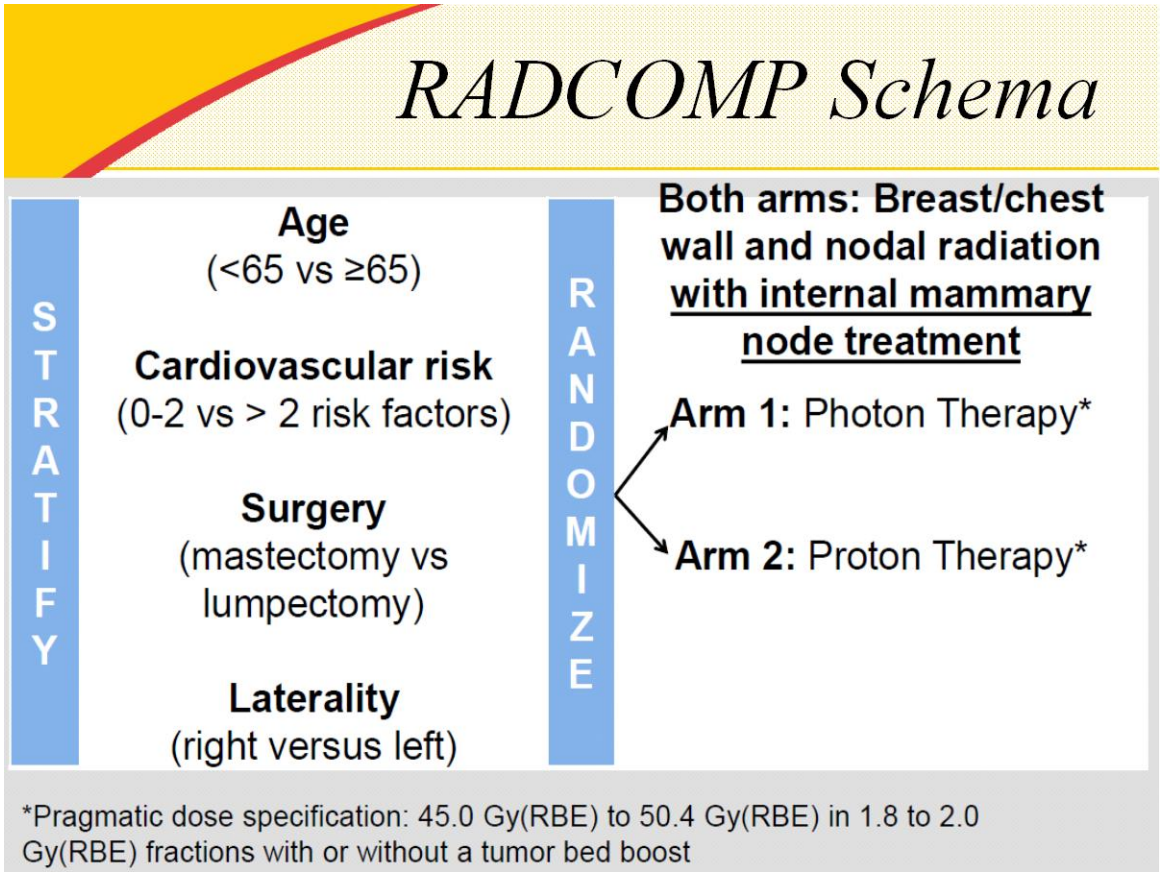

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- Possible downsides of Proton Therapy for Breast Cancer:
  - Increased skin dose (protons “stop”, but enter body at a higher dose—loss of “skin-sparing” effect)
  - Uncertainty at “end of range”
  - Biologic Uncertainty
  - Image guidance limitations
  - Cost

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- Breast Cancer Patients for whom Protons Should be Considered off-protocol (my 2 cents):
  - Re-irradiation (reduce long-term risks)
  - Lack of heart displacement from other techniques (beam stops!)
  - Bilateral (both sides) treatment when internal mammary lymph nodes are a target.
  - Unusual anatomy (pectus excavatum)-to reduce lung dose.
  - Genetic predisposition to secondary cancer (less “integral dose”)

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- Conclusions
  - Proton Radiotherapy is a very exciting technology with a significant chance to improve outcome for a wide variety of cancer patients.
  - For Breast Cancer patients, **reduction in long-term cardiac risks** is a meaningful goal for which proton therapy can be a useful strategy.
  - Long-term studies and outcomes analysis will be needed to fully define the role for proton radiotherapy in breast cancer care.
  - It will be a useful “tool” in our arsenal (3D-CRT, IMRT, IORT, APBI, DIBH, prone positioning, and….Protons)!

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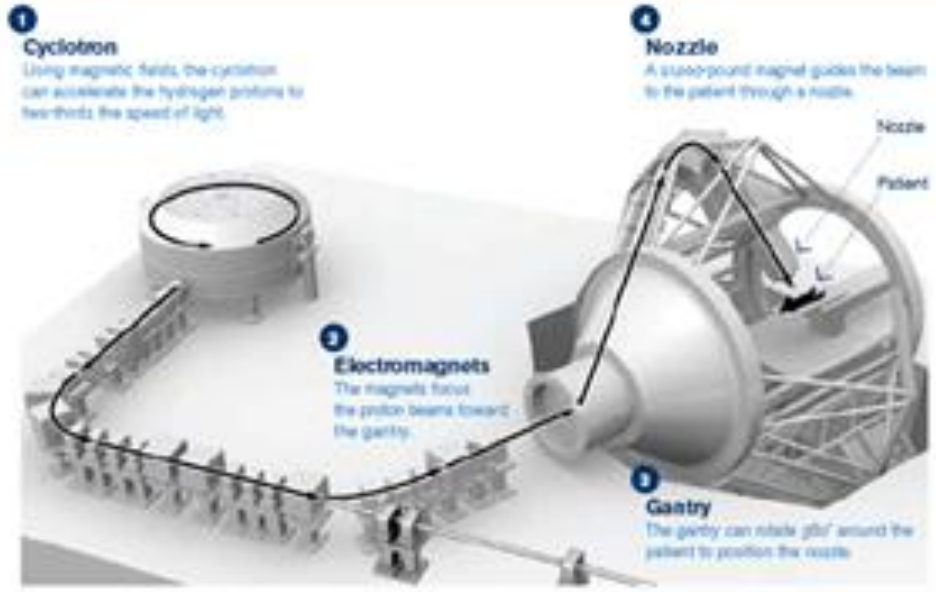

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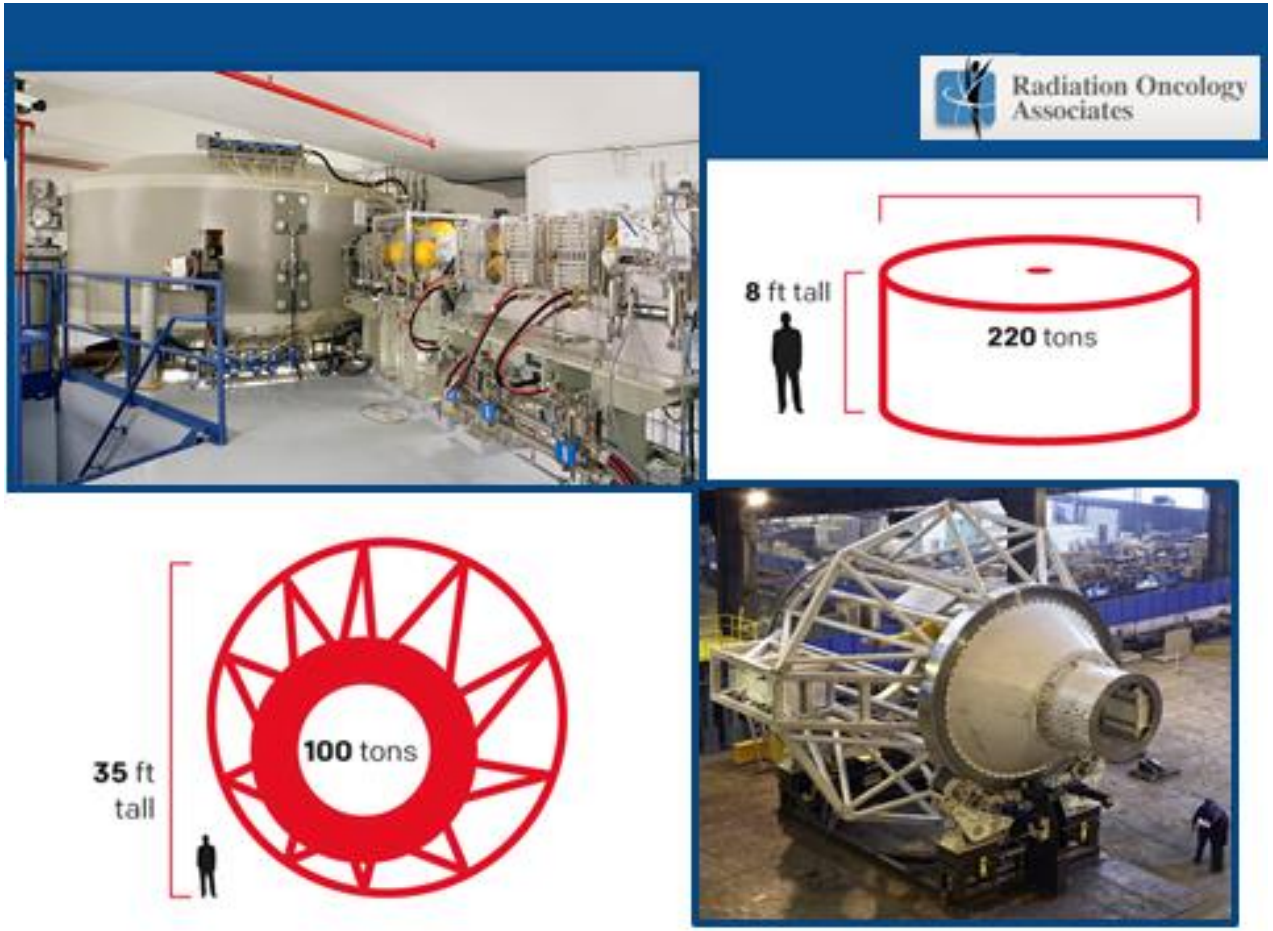

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THANK YOU!