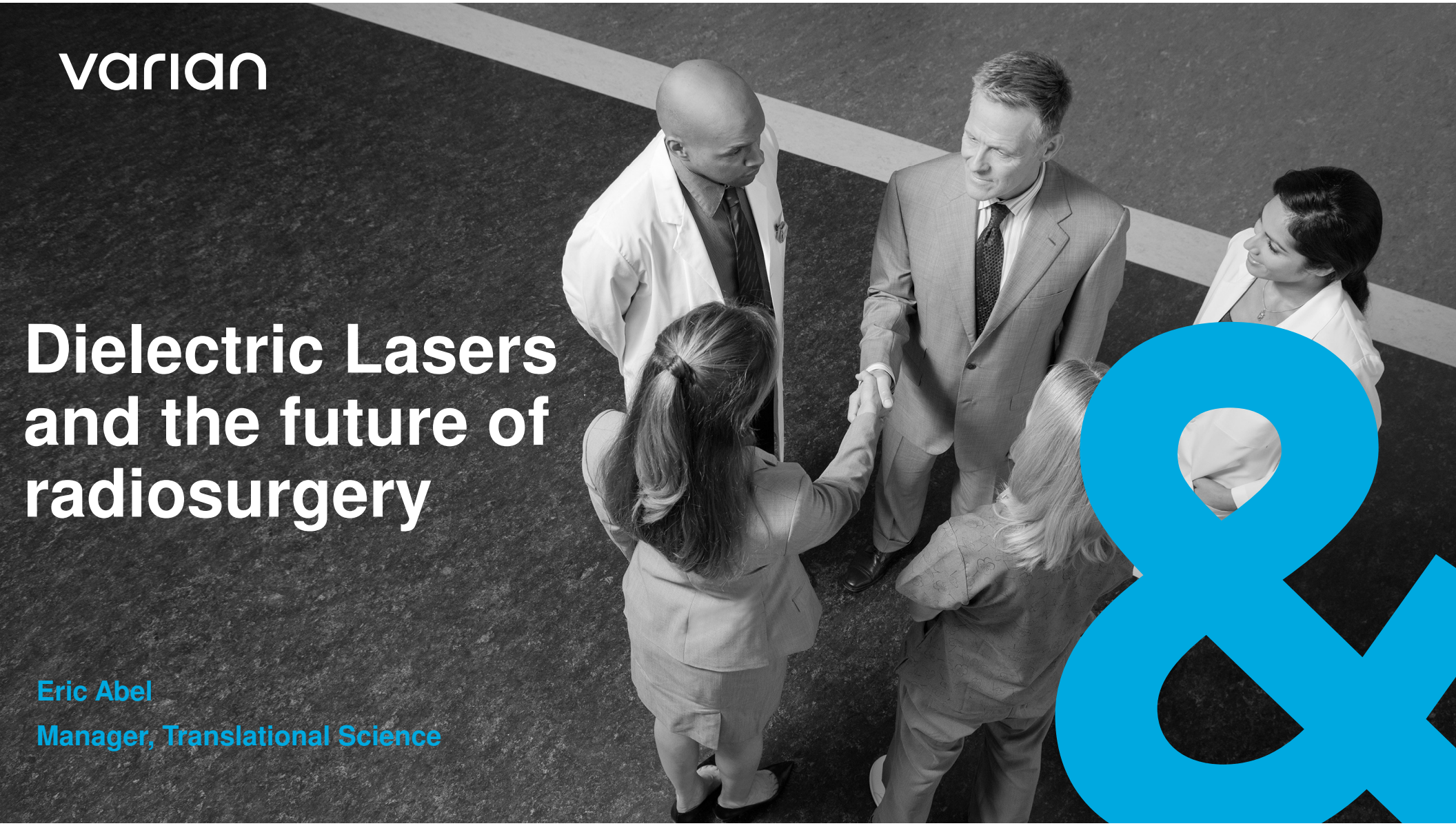
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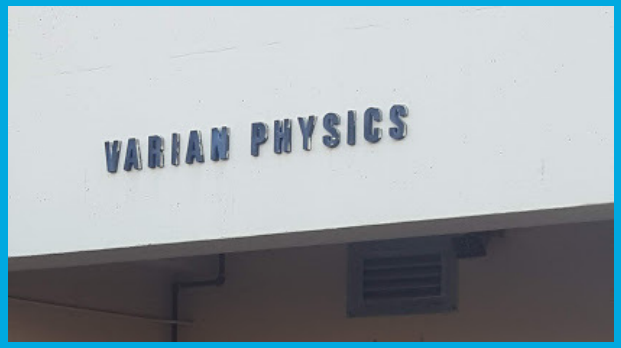
Dielectric Lasers and the future of radiosurgery
&
Eric Abel
Manager, Translational Science

Varian Legacy



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Vision:

A World Without Fear of Cancer

Varian today – a snapshot

Global Leader in radiation therapy	**>7,000** employees	**>3M** Cancer patients touched/year	**$2.9B** FY18 revenues
A focused cancer company			
>8,000 medical linear accelerators	**5,000** software installs	**70** proton therapy rooms	**>40** worldwide training centers

Cancer affects everyone

24.6 Million
New Cancer Cases by 2030

$2 Trillion
Global Economic Burden in 2010

50 - 60%
Cancer Patients Requiring RT

56%
Cancers Diagnosed In
High Income Countries

10%
Cancer Patients That Have Access
To RT in Low Income Countries

> 20,000*
Linacs needed by 2035; greatest
need in low + mid-income countries

*8,700 new machines plus 13,100 replacements = 21,800 additional machines needed
Source: Expanding global access to radiotherapy. Lancet Oncol. Vol 16, Sept. 2015

WORLDWIDE CANCER BURDEN – A CALL TO ACTION

24.6M

new cancer cases diagnosed per year by 2030*

A ~75% increase in cancer incidence from 2012**

*Expanding global access to radiotherapy. Lancet Oncol. Vol 16, Sept.2015
**Global cancer facts and figures, 3rd edition, ACS

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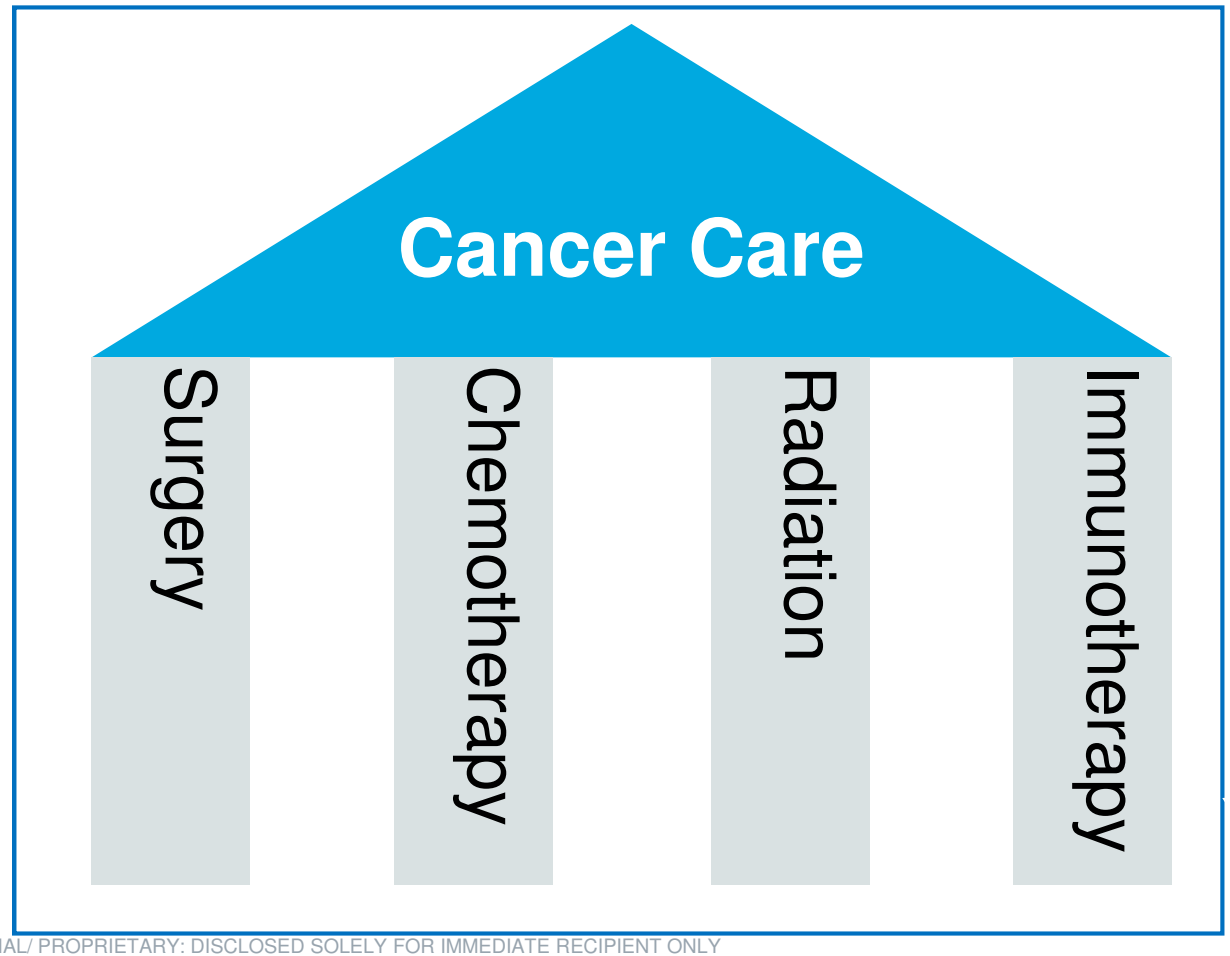
Cancer Treatment Pillars



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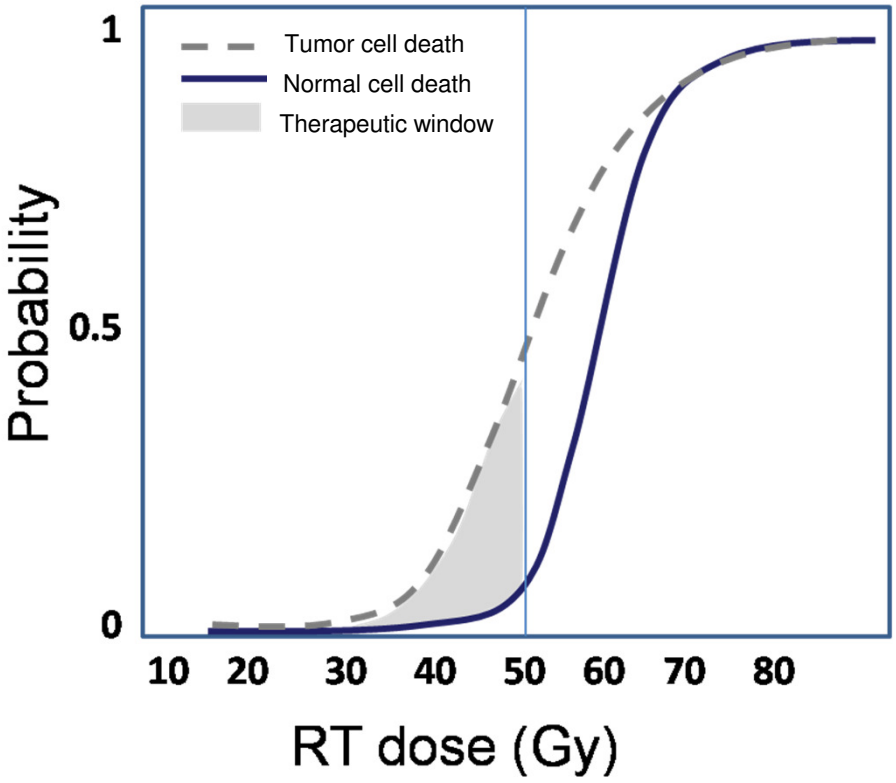
Cell Response to Radiation



- Differential response of normal and cancer cells to radiation defines therapeutic window
- Therapeutic window can be enhanced through the use of **conformal radiation**

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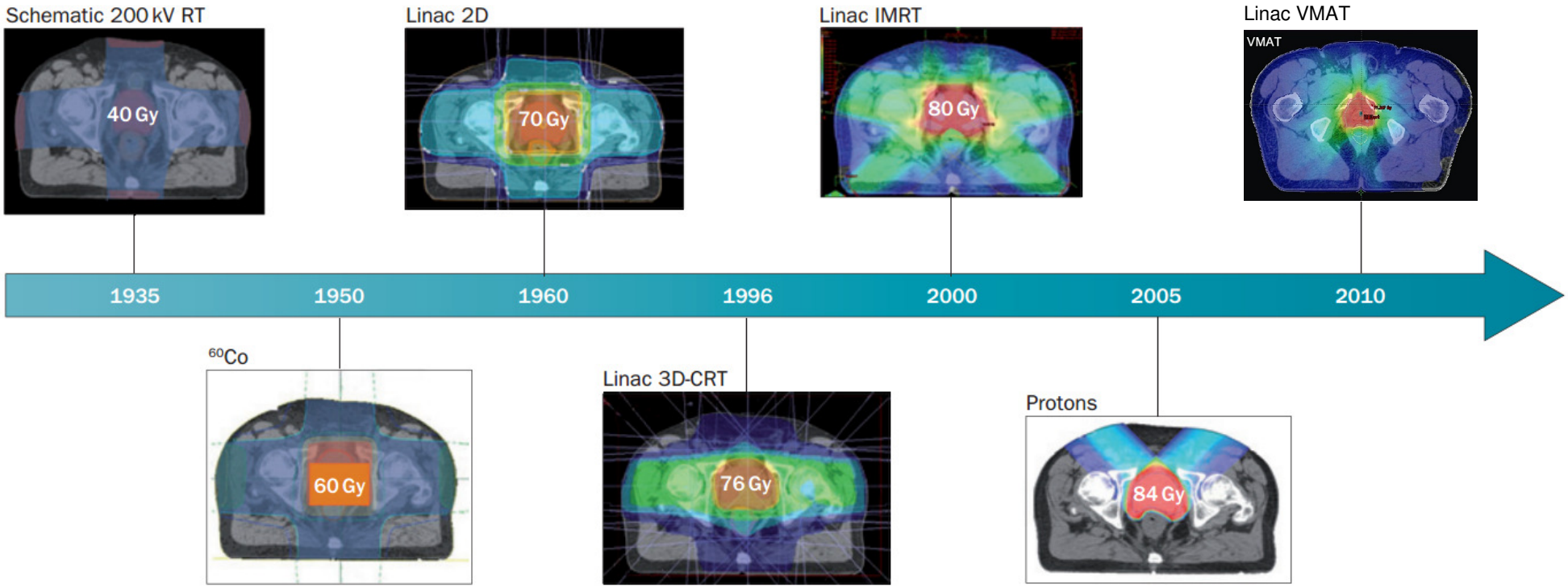
Expanding the therapeutic window: Radiation



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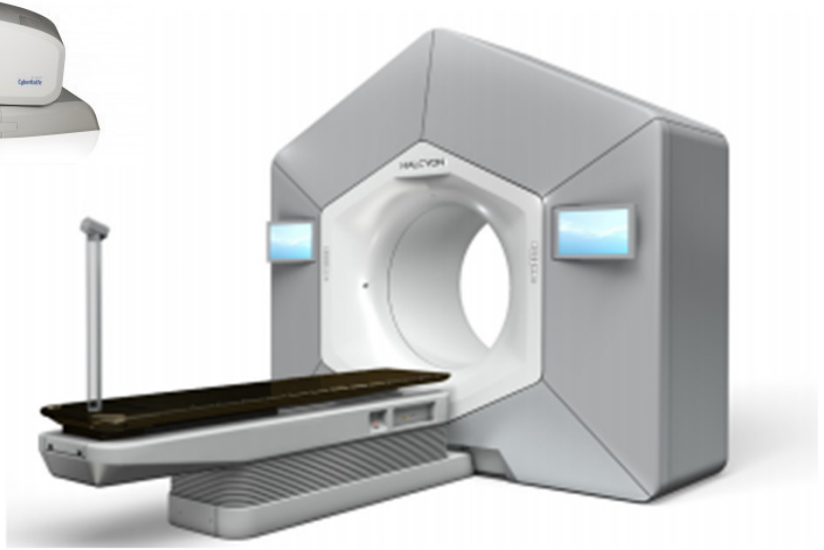
State of the art “Photon” Therapy Systems

Photon delivery platforms

C-arm

Robotic

Closed Bore



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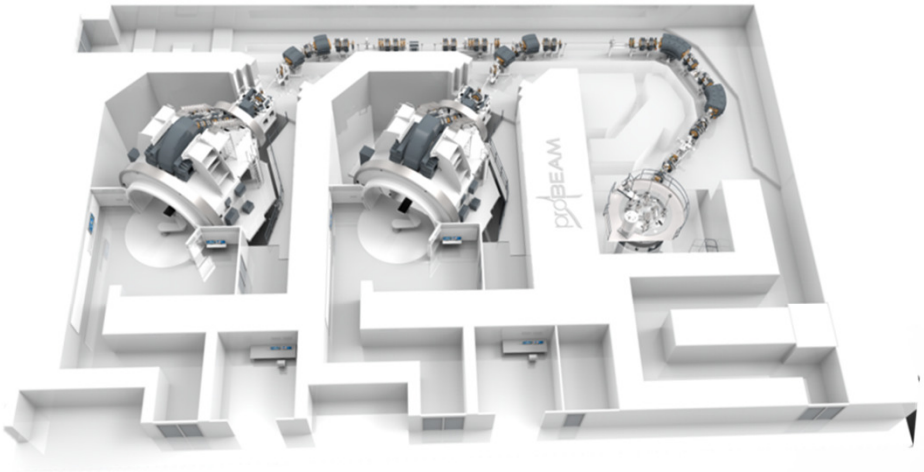
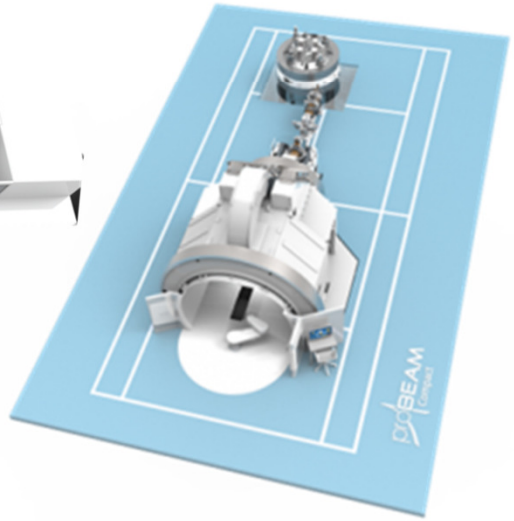
State of the art proton therapy systems

Proton center configurations

Multi-room



Single Room



Gantry Mounted Cyclotron

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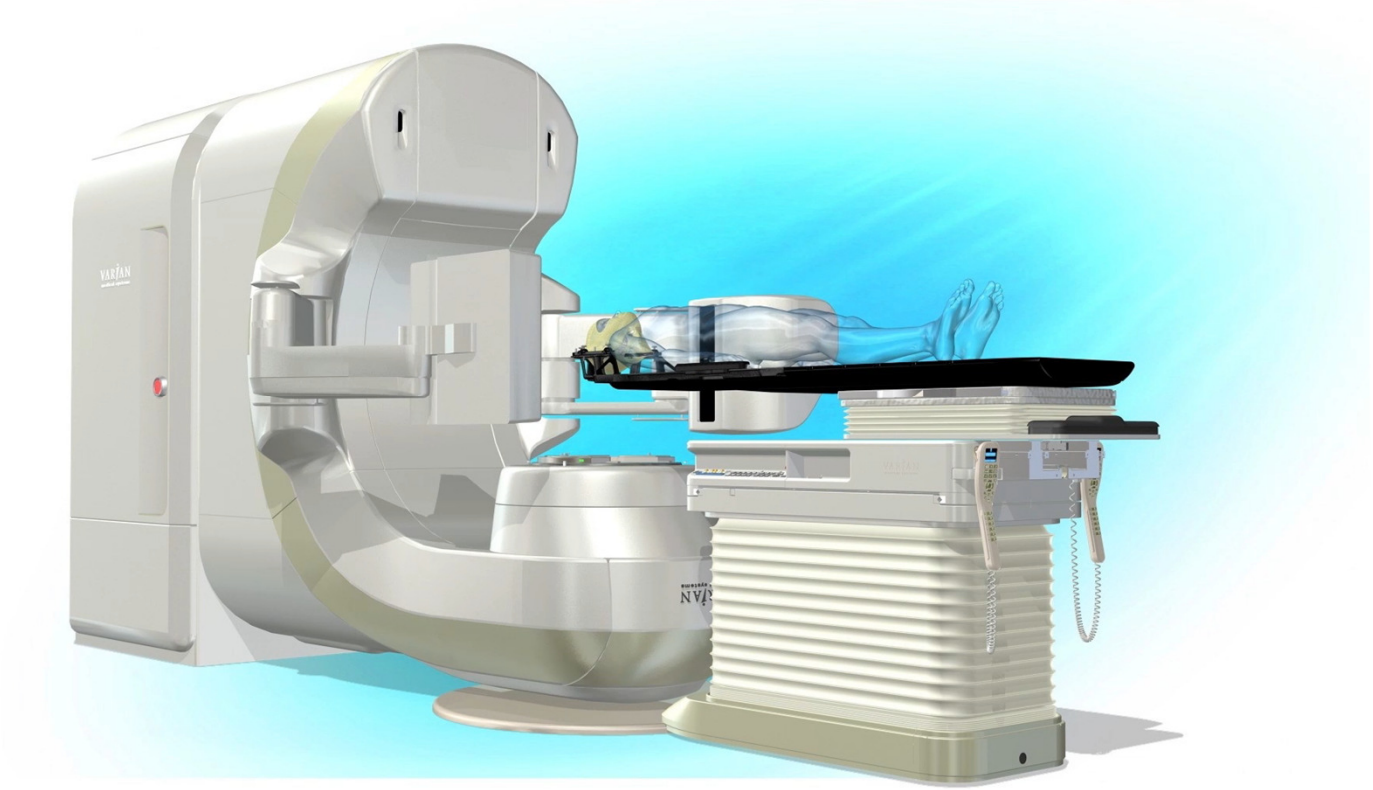
Radiosurgery - VMAT

Multiple Brain Metastases



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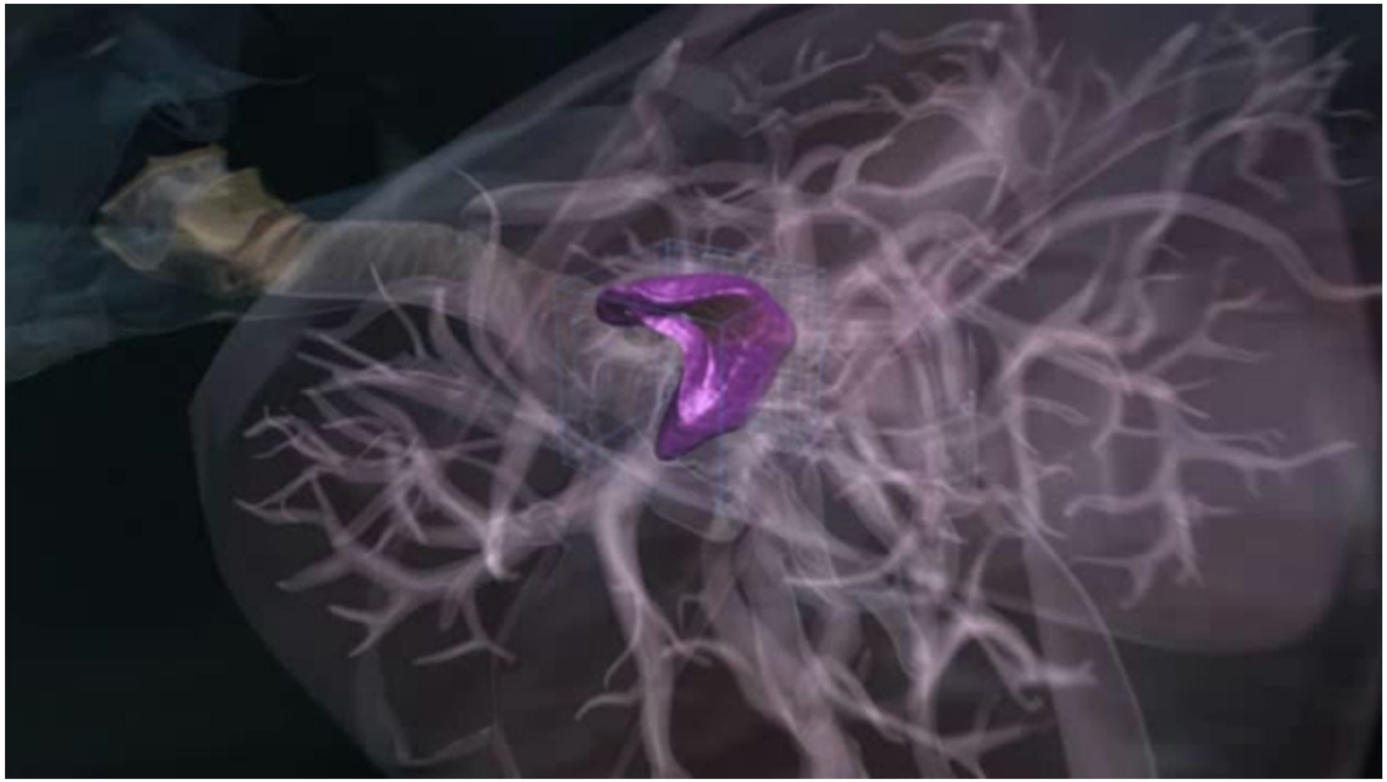
State-of-the-art Proton Therapy

Intensity Modulated Proton Therapy (IMPT)



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What about 2019 and beyond?

A look to the future of radio therapy

- Therapeutic window optimization through conformal dose shaping is reaching an asymptote
- Further enhancements can come from
  - Novel delivery paradigms (FLASH, SFRT)
  - Combination therapies (RT modulated immunotherapy, RT sensitizers)

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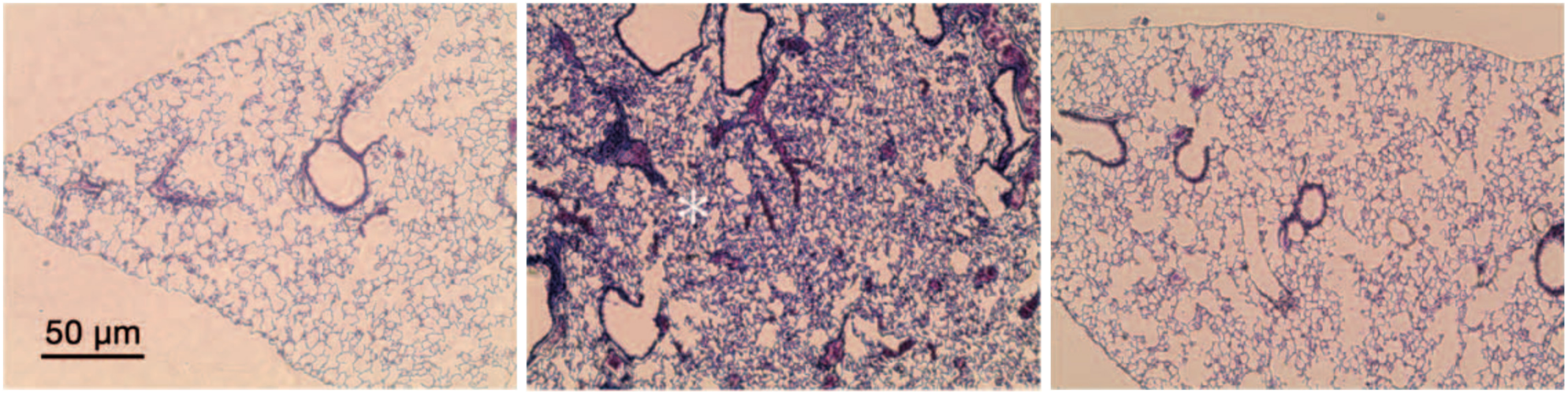
Flash (ultra high dose rate) spares normal tissue



NORMAL TISSUE	SIGNIFICANT FIBROSIS	NO APPARENT DAMAGE
Control 0 Gy/s	**Standard RT 17 Gy** 0.03 Gy/s	**FLASH 17 Gy** 60 Gy/s

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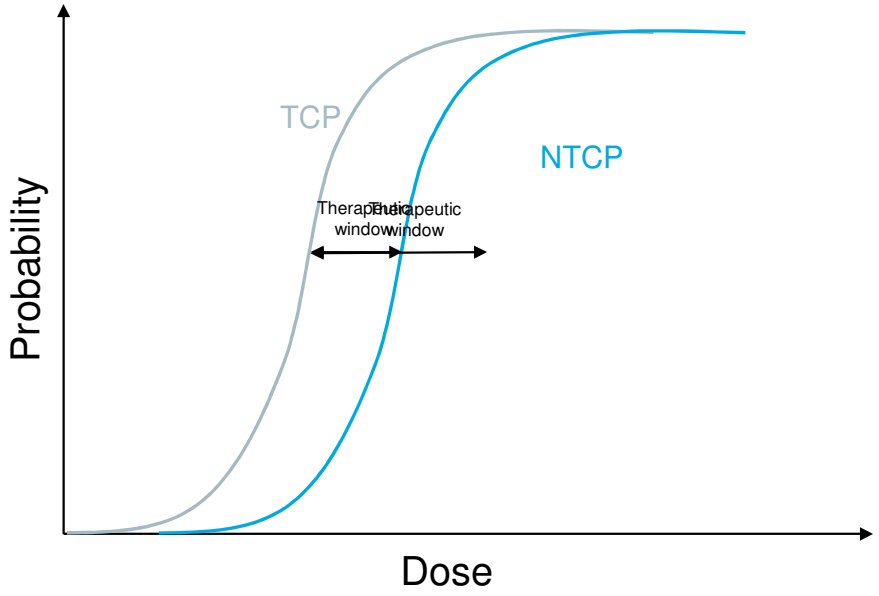
From Favaudon et al., Sci. Transl. Med., 16 Jul 2014: Vol. 6, Issue 245, 245ra93 (DOI: 10.1126/scitranslmed.3008973). Reprinted with permission from AAAS.

Increasing the effective ionizing radiation dose by **10%** could increase tumour control rates by **5-30%**



Therapeutic window

FLASH therapy promise:

- Improving Normal Tissue Complication Probability (NTCP)
- While maintaining Tumor Control Probability (TCP)
- Thereby widening the therapeutic window

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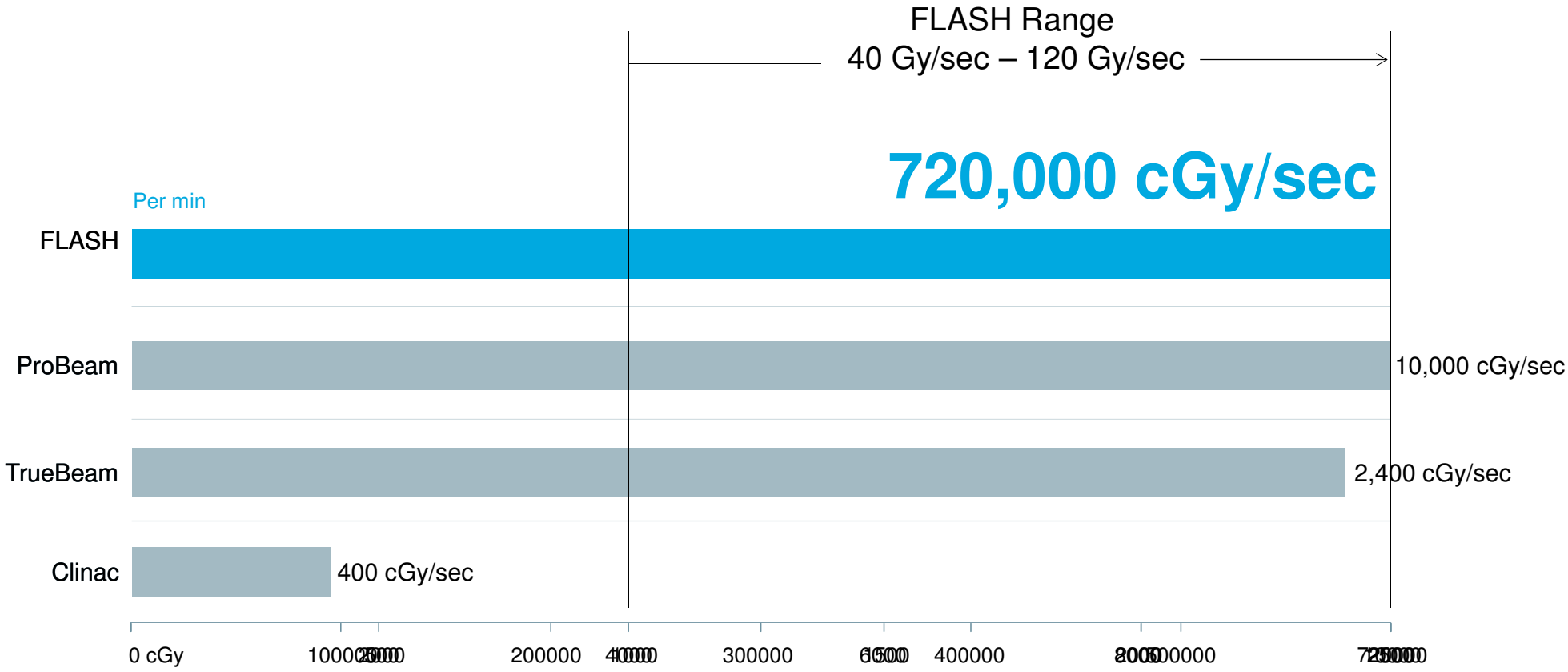
Ultra high dose rates



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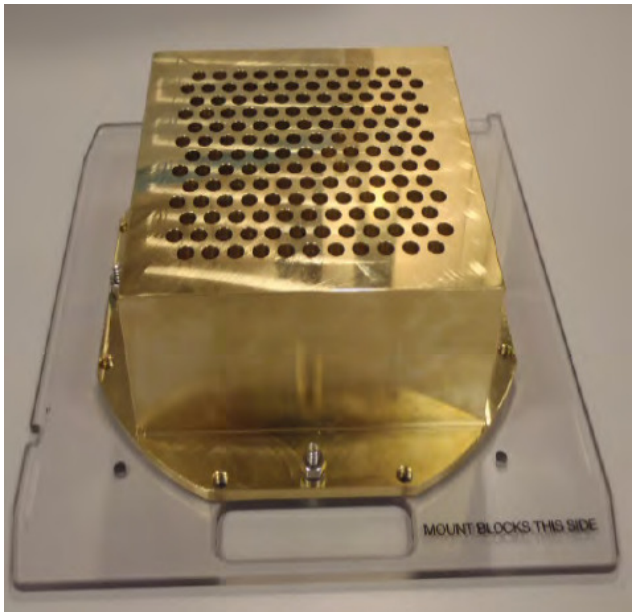
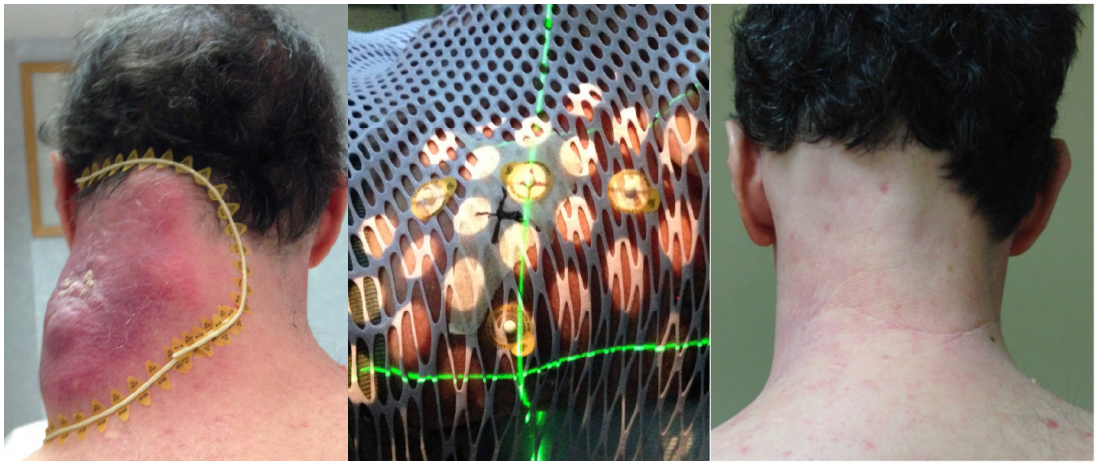
Spatially Fractionated Radiation Therapy (SFRT)

Grid Therapy

Gantry Mounted Grid Block

Lower integral dose to normal tissue allows for escalation of dose to tumor





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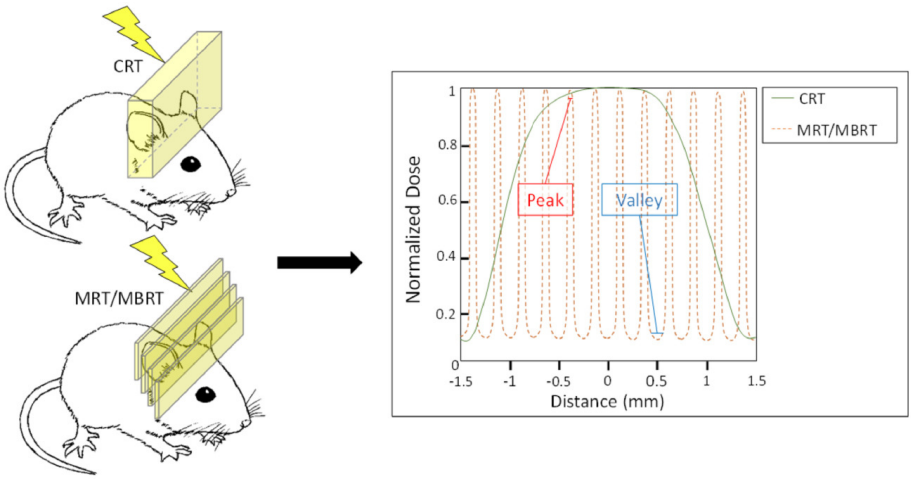
SFRT

Minibeam/microbeam therapy



- Preclinical experiments showing that delivering dose in thin “sheets” spares normal tissue
- Tumor control is preserved resulting in enhancement of therapeutic window

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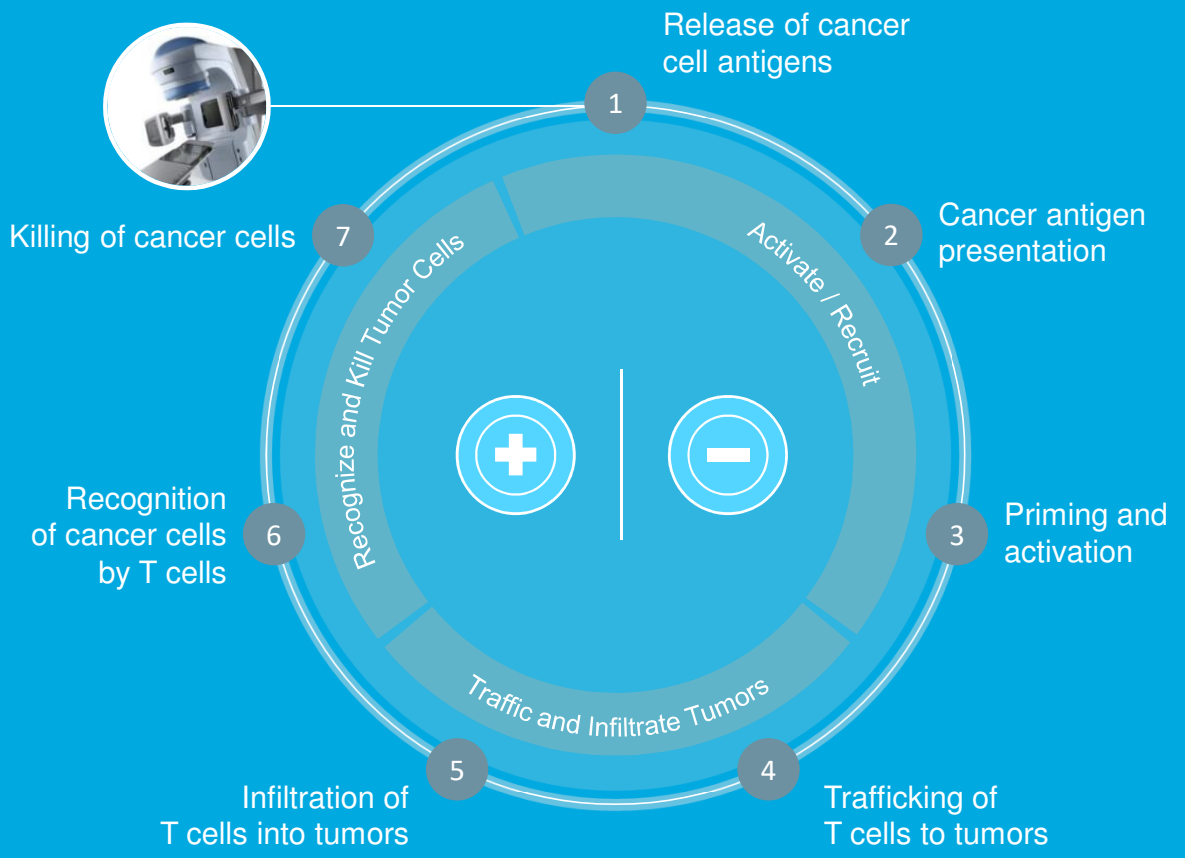
IMMUNITY CYCLE

Opportunities and challenges to eradicate cancer and the role of radiation

SEVEN
steps to complete the cycle from recognition to killing

THREE
compartments where the action takes place

TWO
opposing mechanism control advancement from one step to the next



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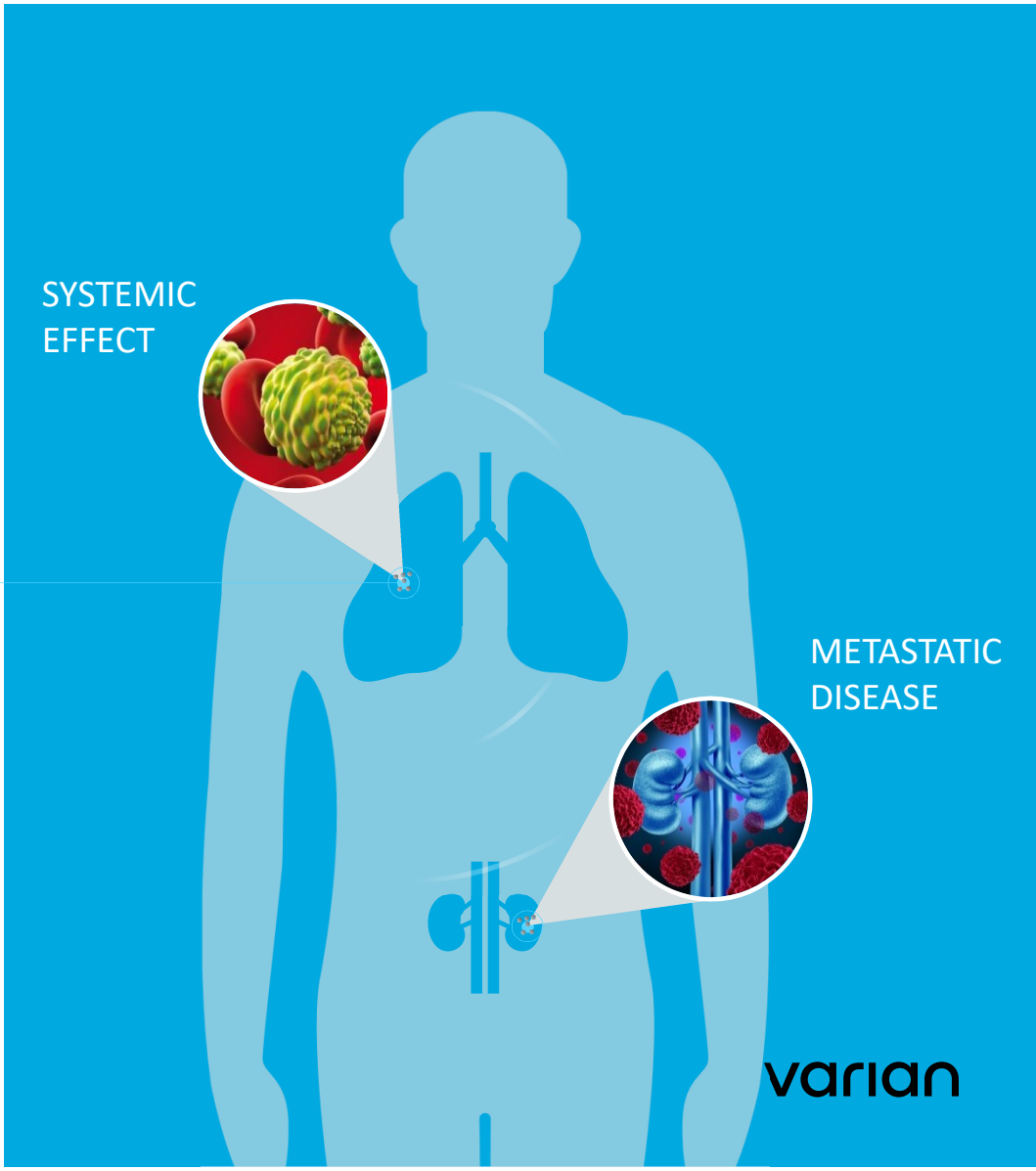
ABSCOPAL EFFECT

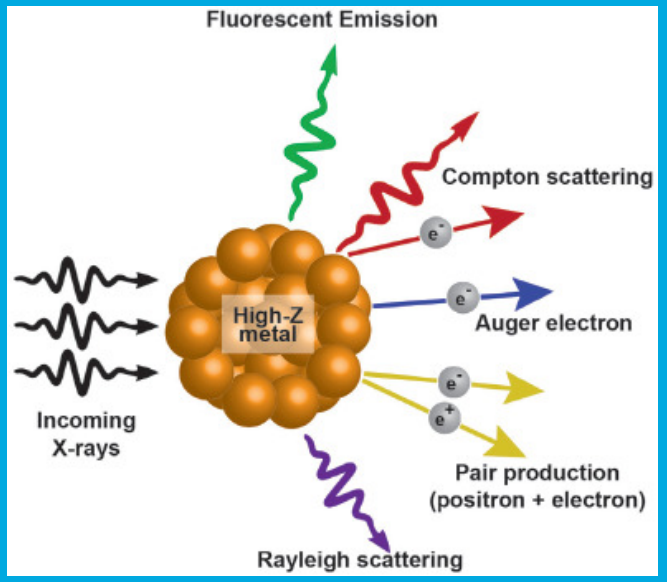
- Radiotherapy in one site can potentially eradicate tumors elsewhere



Radiosensitizers

- Any compound which helps to enhance the therapeutic window of RT alone
- Can be a drug, or inert compound such as polymer or metal

Gold nanoparticles can “amplify” dose locally



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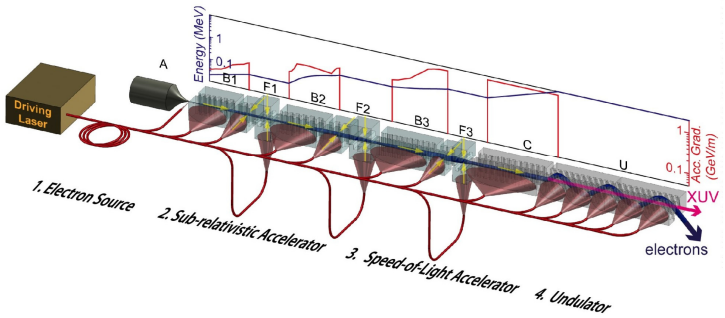
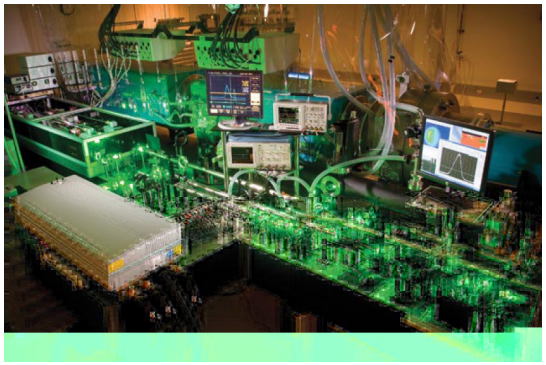
Lasers in the clinic

Dielectric Laster Acceleration

Wakefield Acceleration	Dielectric Laser Acceleration	Radiation Pressure Acceleration
• Terawatt Lasers • Ultrahigh electron gradients • Short pulse, low duty cycle	• Benchtop laser • Stageable • Compact • Low dose rate	• Petawatt lasers • Sub-clinical proton energies • Short pulse, low duty cycle





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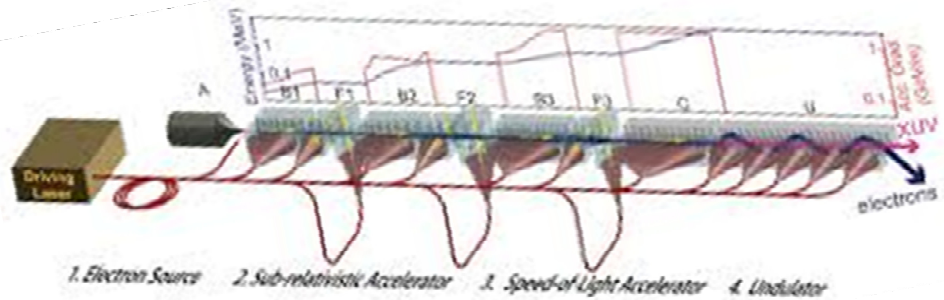
DLA – “Radioscalpel” of the future

Dream a little…



Advantages of DLA for Medical Applications :

- Compact, customizable
- Conducive to image guidance
- Potentially inexpensive
- Small beams
- Electron or x-ray possible
- Ideal for transition away from conformal therapy

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DLA – Radioscalpel of the future

Dream a little…

Possible to treat smaller legions with less toxicity (small early stage tumors)

Plus…

Possible novel (non-oncology) applications :

- Movement disorders, treat base of skull (2-3mm region)
- Keloids, the target is the skin (so appropriate for keloids).
- Alzheimers
- Cardiac
- Myasthenia gravis (back of the eye)

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(Thank You)