

INDUSTRIAL DESIGN

Tom Wilson

Product Marketing Manager – Delivery Systems

Varian Medical Systems International AG

Industrial Design

The screenshot shows the Wikipedia article for 'Industrial design'. The browser window title is 'Industrial design - ...'. The article text includes:

Industrial design is a process of **design applied to products that are to be manufactured through techniques of mass production.** Its key characteristic is that design is separated from manufacture: the creative act of determining and defining a product's form takes place in advance of the physical act of making a product, which consists purely of repeated, often automated, replication.^{[4][5]} This distinguishes industrial design from **craft-based design**, where the form of the product is determined by the product's creator at the time of its creation.^[6]

All industrial products are the result of a design process, but the nature of this process can take many forms: it can be conducted by an individual or a large team; it can emphasize intuitive **creativity** or calculated **scientific decision-making**; and it can be influenced by factors as varied as **materials, production processes, business strategy** and prevailing social, commercial or aesthetic attitudes.^[4] The role of an industrial designer is to create and execute design solutions for problems of form, usability, physical ergonomics, marketing, brand development, and sales.^[7]

Contents [hide]

- 1 History
 - 1.1 Precursors
 - 1.2 Birth of industrial design
- 2 Education
 - 2.1 University and Institutions
- 3 Definition of industrial design

Two images are shown: an iPod and a KitchenAid 5 qt. Stand Mixer. The iPod image has the caption: 'An iPod, an industrially designed product.' The KitchenAid image has the caption: 'KitchenAid 5 qt. Stand Mixer, designed in 1937 by Egmont Arens, remains very successful today'.

New York Times Article 2010

The New York Times

HEALTH | THE RADIATION BOOM

Radiation Offers New Cures, and Ways to Do Harm

By **WALT BOGDANICH** JAN. 23, 2010

As Scott Jerome-Parks lay dying, he clung to this wish: that his fatal radiation overdose — which left him deaf, struggling to see, unable to swallow, burned, with his teeth falling out, with ulcers in his mouth and throat, nauseated, in severe pain and finally unable to breathe — be studied and talked about publicly so that others might not have to live his nightmare.

Sensing death was near, Mr. Jerome-Parks summoned his family for a final Christmas. His friends sent two buckets of sand from the beach where they had played as children so he could touch it, feel it and remember better days.

Mr. Jerome-Parks died several weeks later in 2007. He was 43.

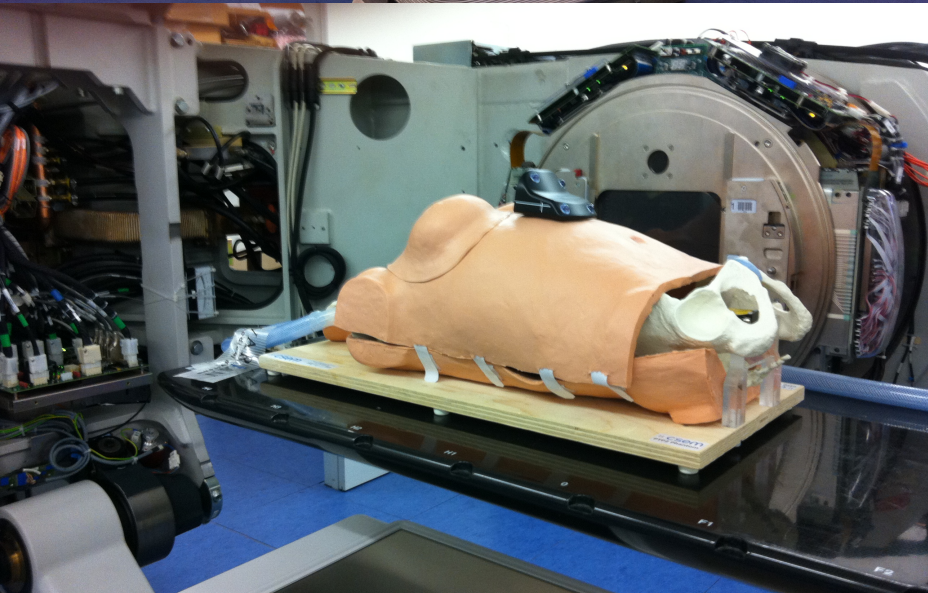
A New York City hospital treating him for tongue cancer had failed to detect a computer error that directed a linear accelerator to blast his brain stem and neck with errant beams of radiation. Not once, but on three consecutive days.

Soon after the accident, at St. Vincent's Hospital in Manhattan, state health officials cautioned hospitals to be extra careful with linear accelerators, machines that generate beams of high-energy radiation.

http://www.nytimes.com/2010/01/24/health/24radiation.html?pagewanted=1&_r=0

From Research to a Clinical Product

- There is a clear difference between a research project and a clinical product



From Research to a Clinical Product

- Before a product can be sold, must achieve market clearance
- Regulatory clearance, e.g. FDA 510(k), CE marking etc, has many complex requirements
- Safety is a fundamental component in attaining these clearances and underpins the entire design process

From Research to a Clinical Product

- New techniques and approaches to radiation therapy are constantly being researched and developed
- Before being realized in a clinical system, a safe, smooth, efficient implementation is needed
- In some cases, the market (or the users) is not ready for new techniques

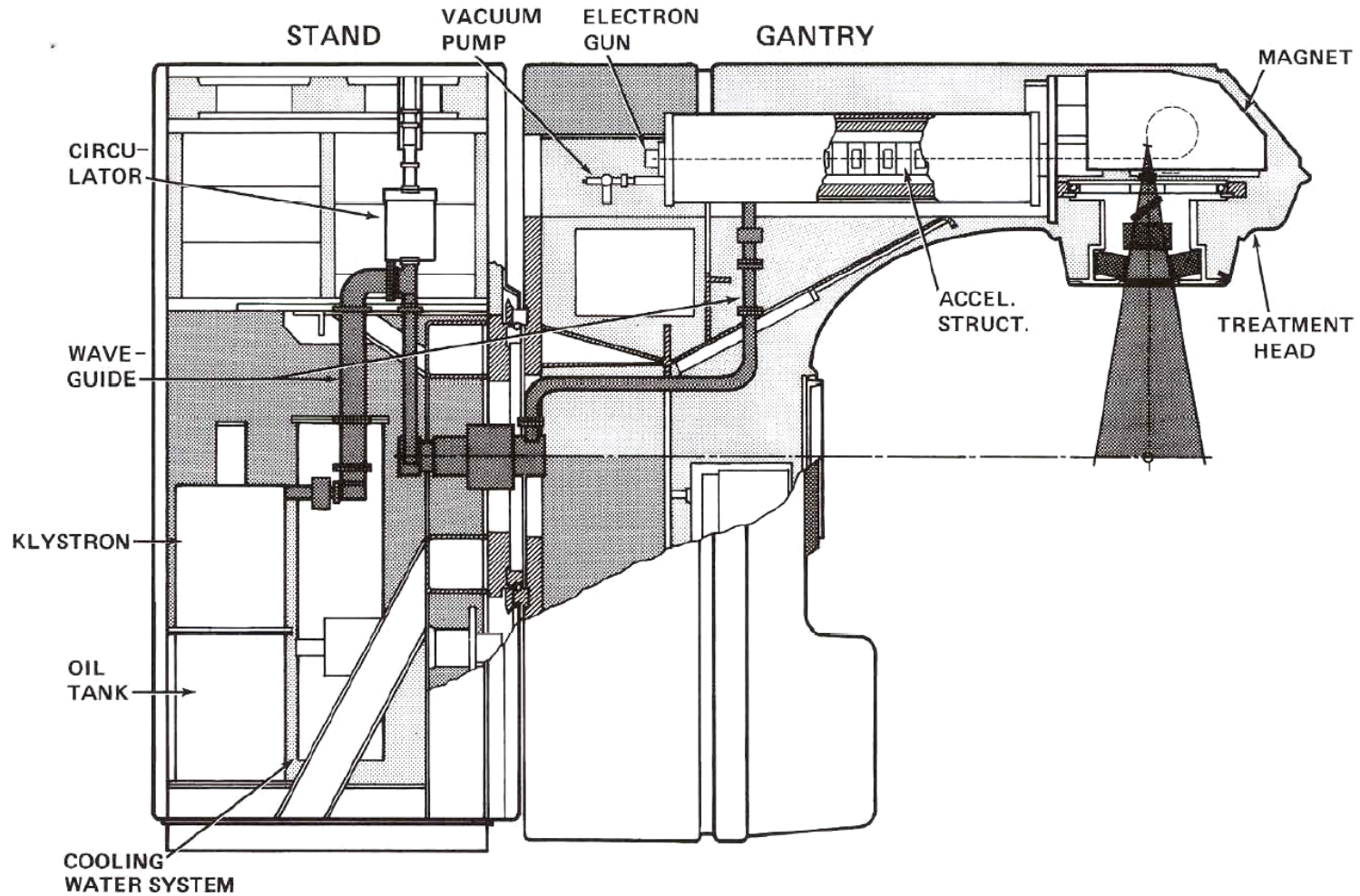
Clinac – The Previous State of the Art



Varian High Energy Linac Fundamentals

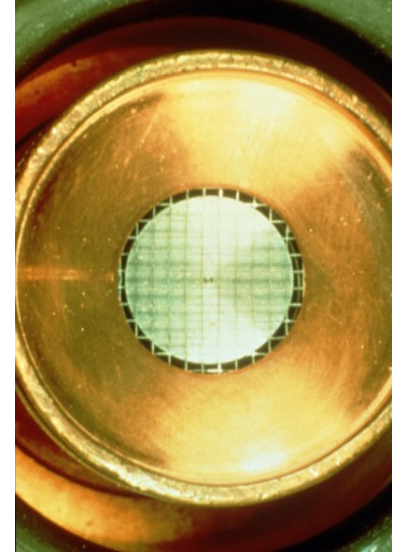
- Klystron driven
- Triode electron gun
- Standing wave guide
- 270° bending magnet
- 2 sets of independent collimators

Major Accelerator Components

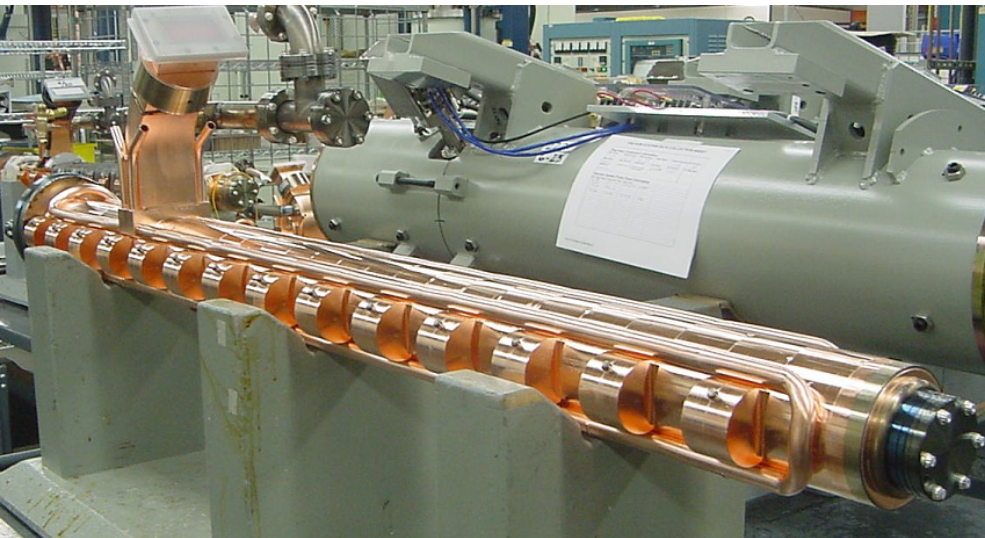


Triode Electron Gun

- Fastest beam-on and off.
- **Allows for fast “single” pulse control.**
- Fast control of electron emission (for IMRT, dynamic arc and gating)
- No dark current (using the grid)
- Filament & cathode remain hot for stable operation



Varian's Accelerator Structure



- Standing Wave, Side-Coupled
- **Energy switch for dual energy operation**
- Shorter length (smaller accelerator footprint)
- Less sensitive to temperature changes (more stable operation)
- Small spread in electron energies
- **Very stable electron and photon beam characteristics**
- **Maximum energy depends on total length of the structure**

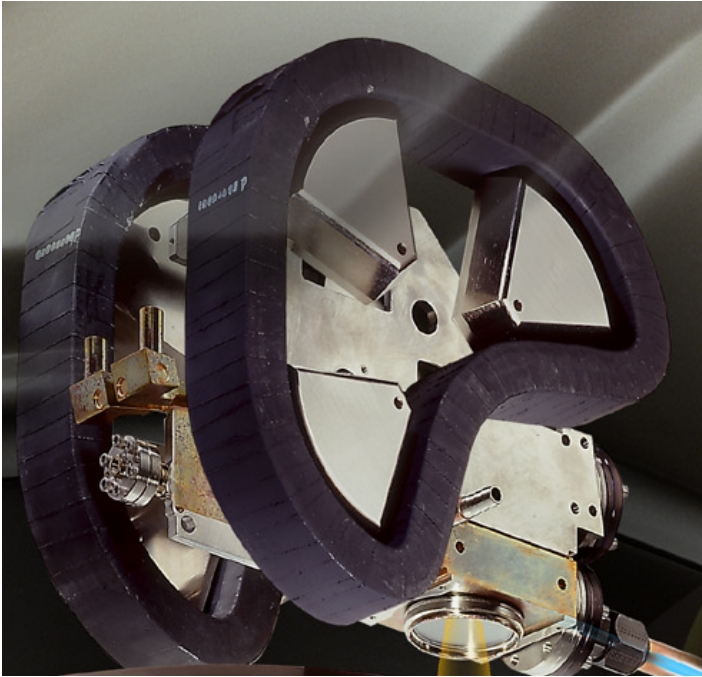
Microwave Amplifier - Varian's Klystron



- Lasts five times longer than a magnetron (less expensive over time, less “down-time” for the accelerator)
- Klystron-Amplifies Microwaves cleanly up to 5 Mega Watts
- RF power characteristics are independent of reflections from the accelerator

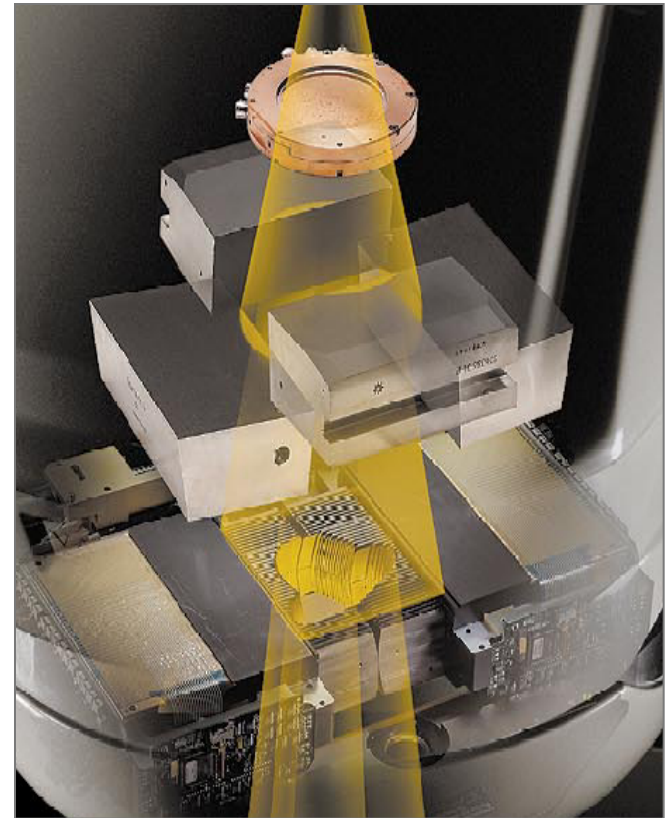
Bending Magnet

- 270-degree, 3-sector (pole), uniform pole gap, achromatic, bending magnet
- +/- 3% energy slits
- Long-term energy stability
- Direction and position independence (easy to adjust)
- Beam flatness
- Small, circular x-ray spot
 - Sharp penumbra
 - Good imaging



Beam Collimation

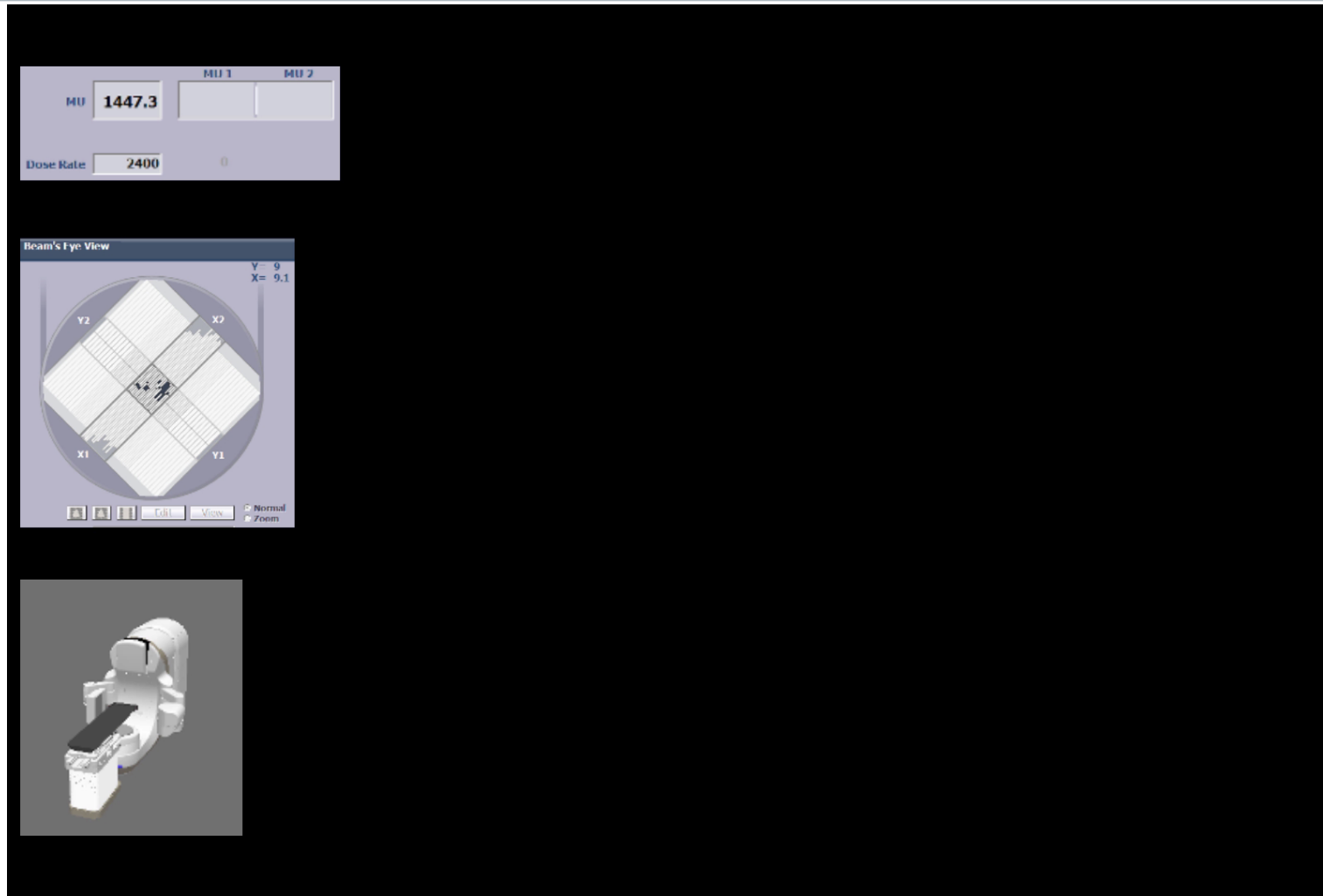
- Beam shape exiting treatment head is limited by 2 pairs of jaws and MLC
- Each jaw has independent drive and double read out system
- Multi leaf collimator is added below the jaws





trueBEAM

Advanced IGRT – Automatic Beam Hold



A New Platform – Introducing TrueBeam

- Launched 2010
- ~1000 clinical systems
- Complete redesign
- Built around core values:
 - Precision
 - Speed
 - Safety



TrueBeam Design Mission

- Ease of use, through an ergonomic and intuitive user experience, guided workflows and automation
- Superior imaging to increase confidence in challenging use cases
- Built in safety features to support advanced or complex techniques
- Improved serviceability
- Increased reliability
- Platform for future research and development

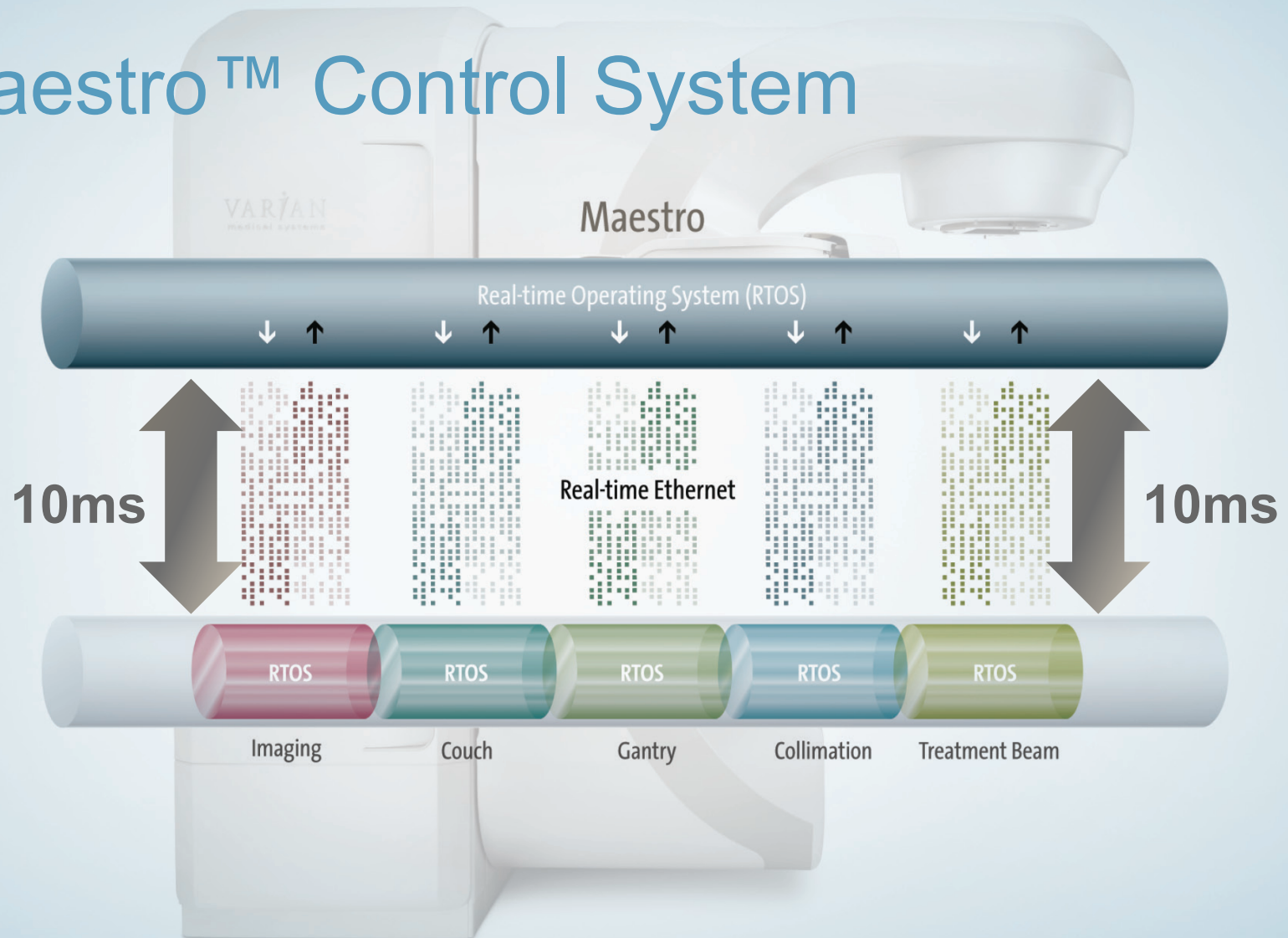
TrueBeam - Hardware

New Control System

- Fully digital
- Fully integrated
- Faster “heartbeat”

- Supervisor concept – monitors all components and compares to plan. Updates commands as required.

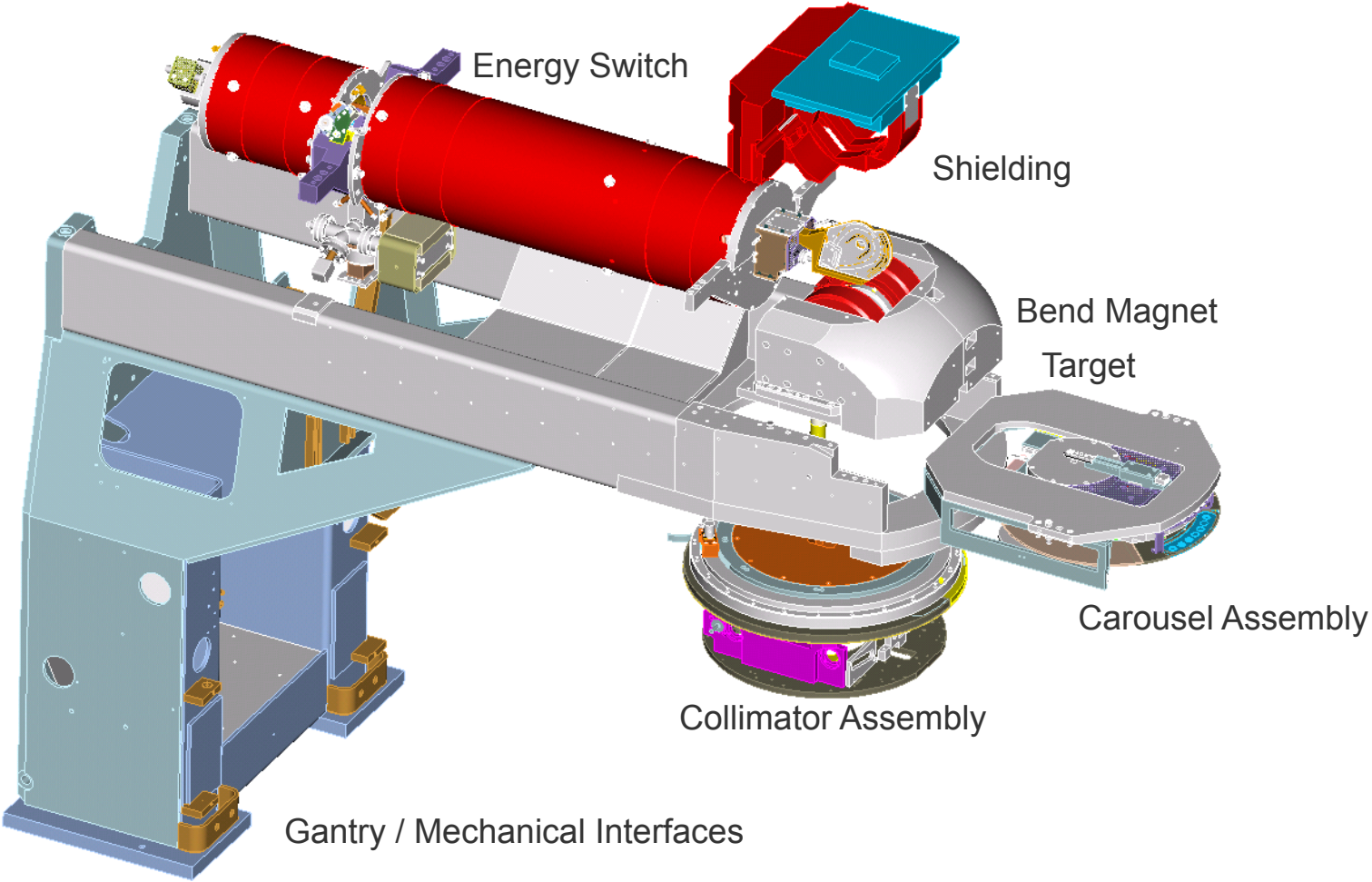
Maestro™ Control System

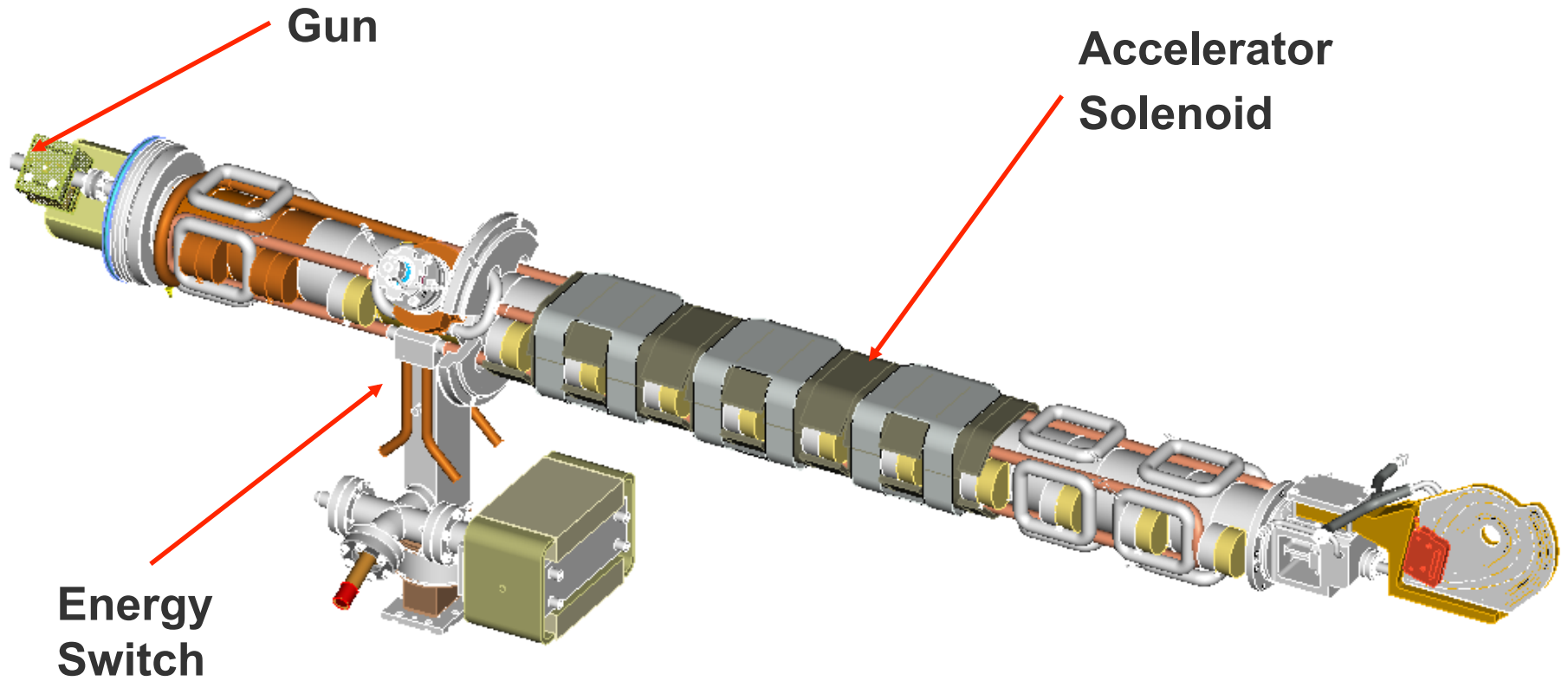


Redesigned Beamline Components

- Accelerating waveguide
- Bending magnet
- Target assembly
- New ion chamber design – additional segments to support FFF
- Revised shielding design for easier access to internal components

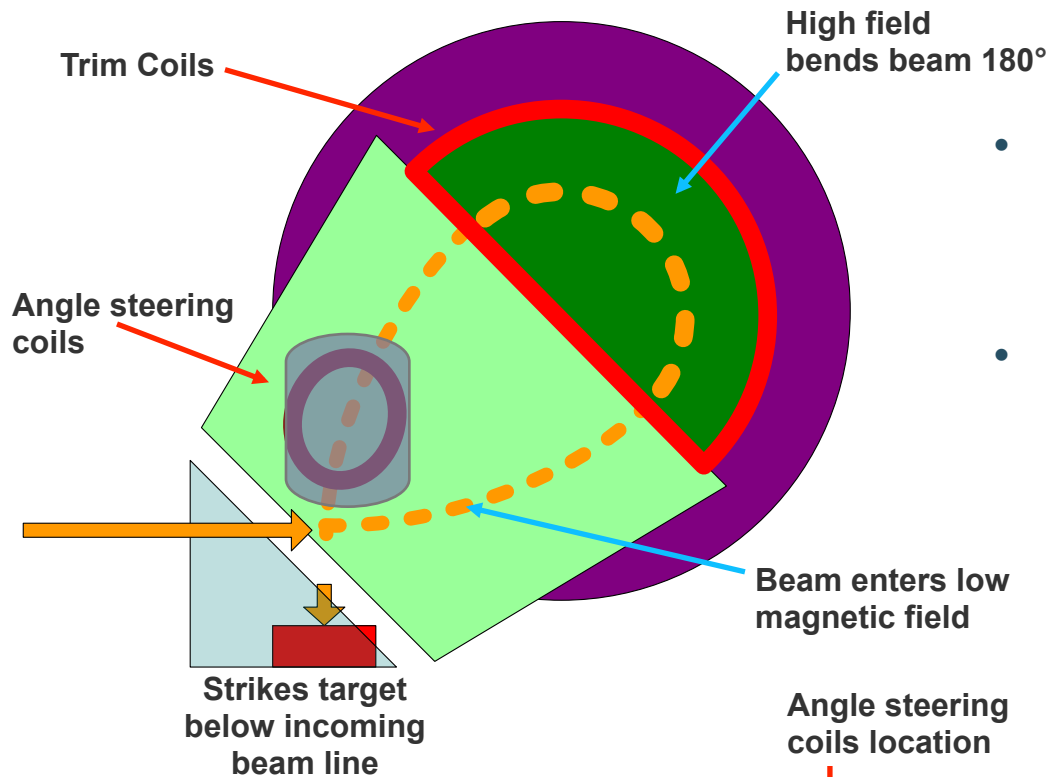
Accelerator/Accelerator Solenoid





New “universal” wave guide and energy switch, up to 5 photon energies now possible

Bending Magnet

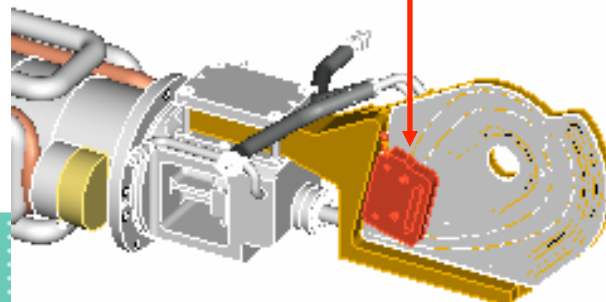


- **Function**

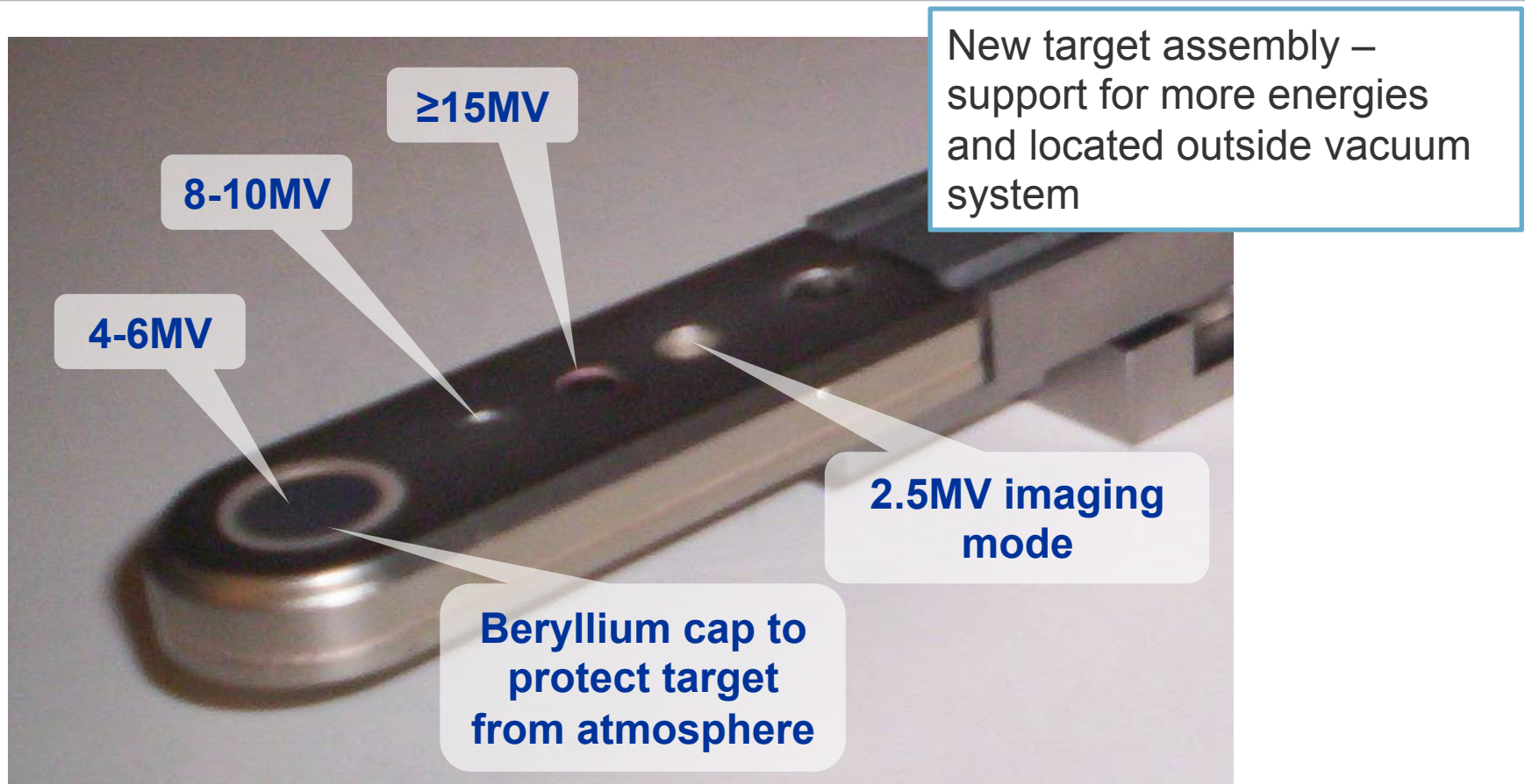
- Bends electron beam to target by 270 °

- **Features**

- Stepped pole field achromatic magnet
- Simple design
- Separate from orbit (vacuum) and target
- More space below target
- Easy to service



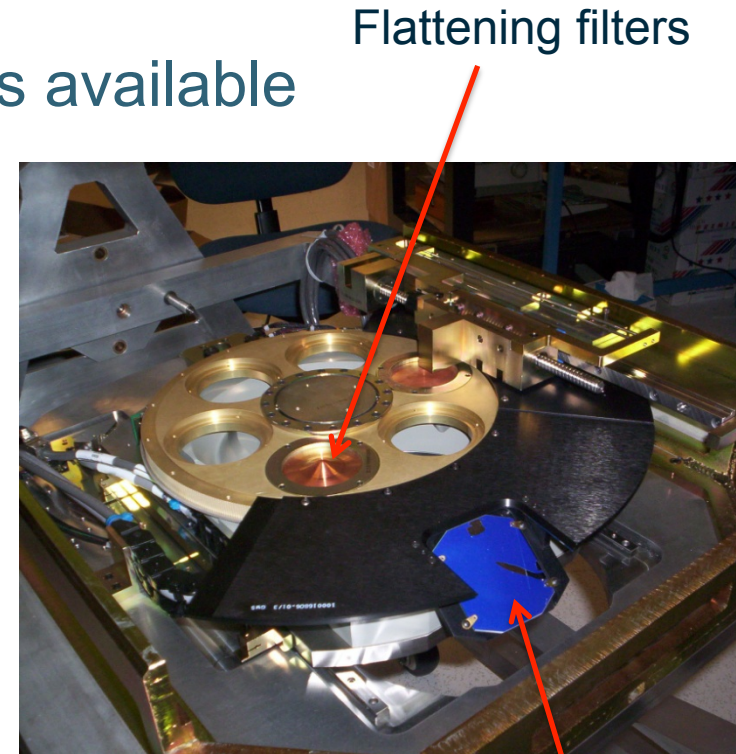
Beam Generation - Target



→ Retract target from beam for electron modes

Beam Generation - Carousel

- Multi-Energy: 13 Carousel positions available
 - Up to 4 Flattened Photon Energies:
 - Up to 600 MU/min
 - 2 High Intensity Mode Energies:
 - 6X FFF (max 1400MU/min)
 - 10X FFF (max 2400 MU/min)
 - 8 electron energies
- Carousel rotates and translates to position required elements in beam line



Flattening filters

Mirror

TrueBeam – User Interface

Control Console – Clinac vs TrueBeam



C-Series

TrueBeam™



User Interface

- Fewer points of contact – less distractions from looking at treatment and patient. Safer and more efficient.
- Simplified/harmonized interface – learn once, apply to all points of interaction
- Guided workflow – buttons light up to show what machine needs next
- Automation of imaging components

Harmonized User Interface



Console



Pendant



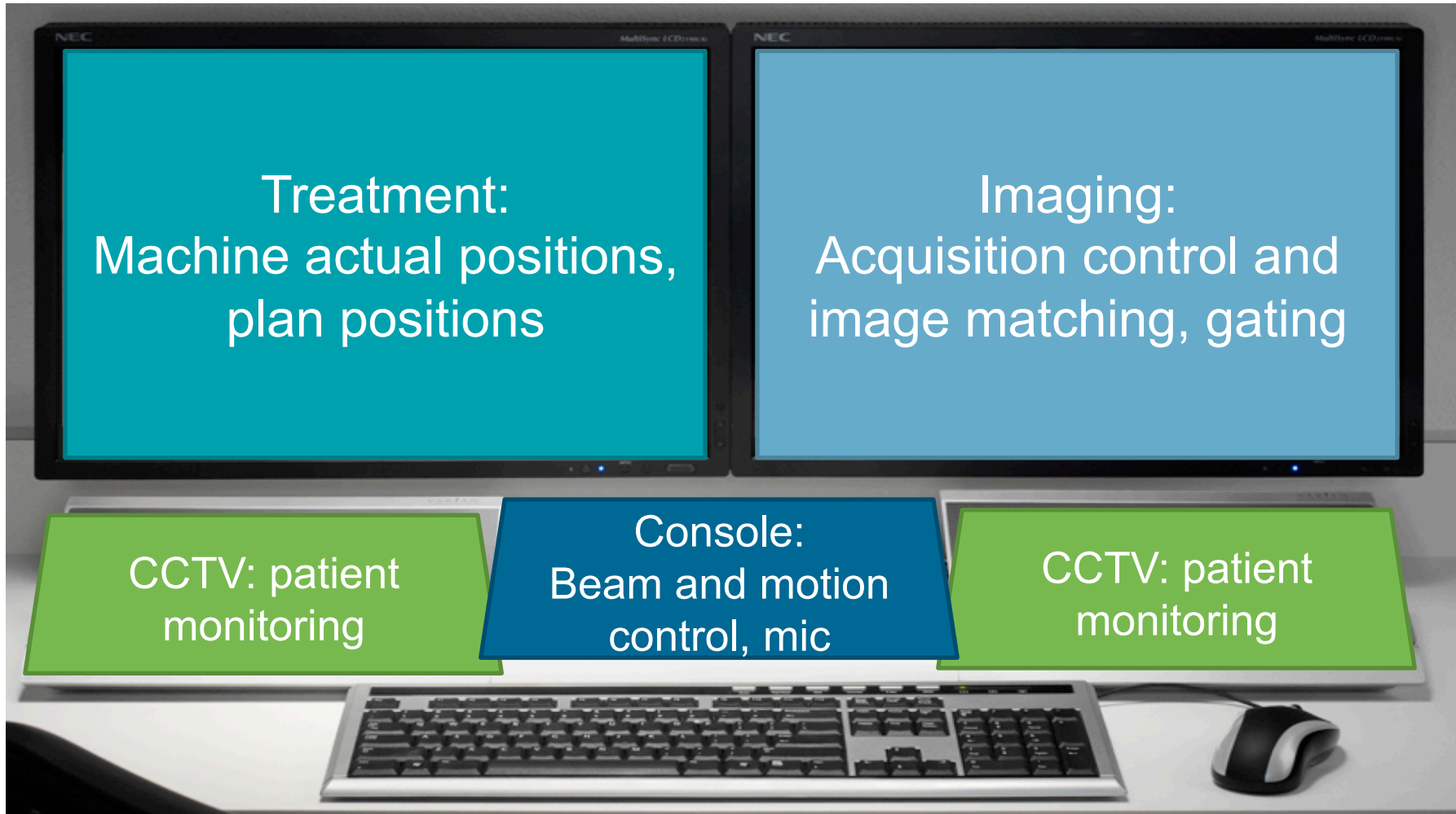
Couch



Software – Treatment Mode



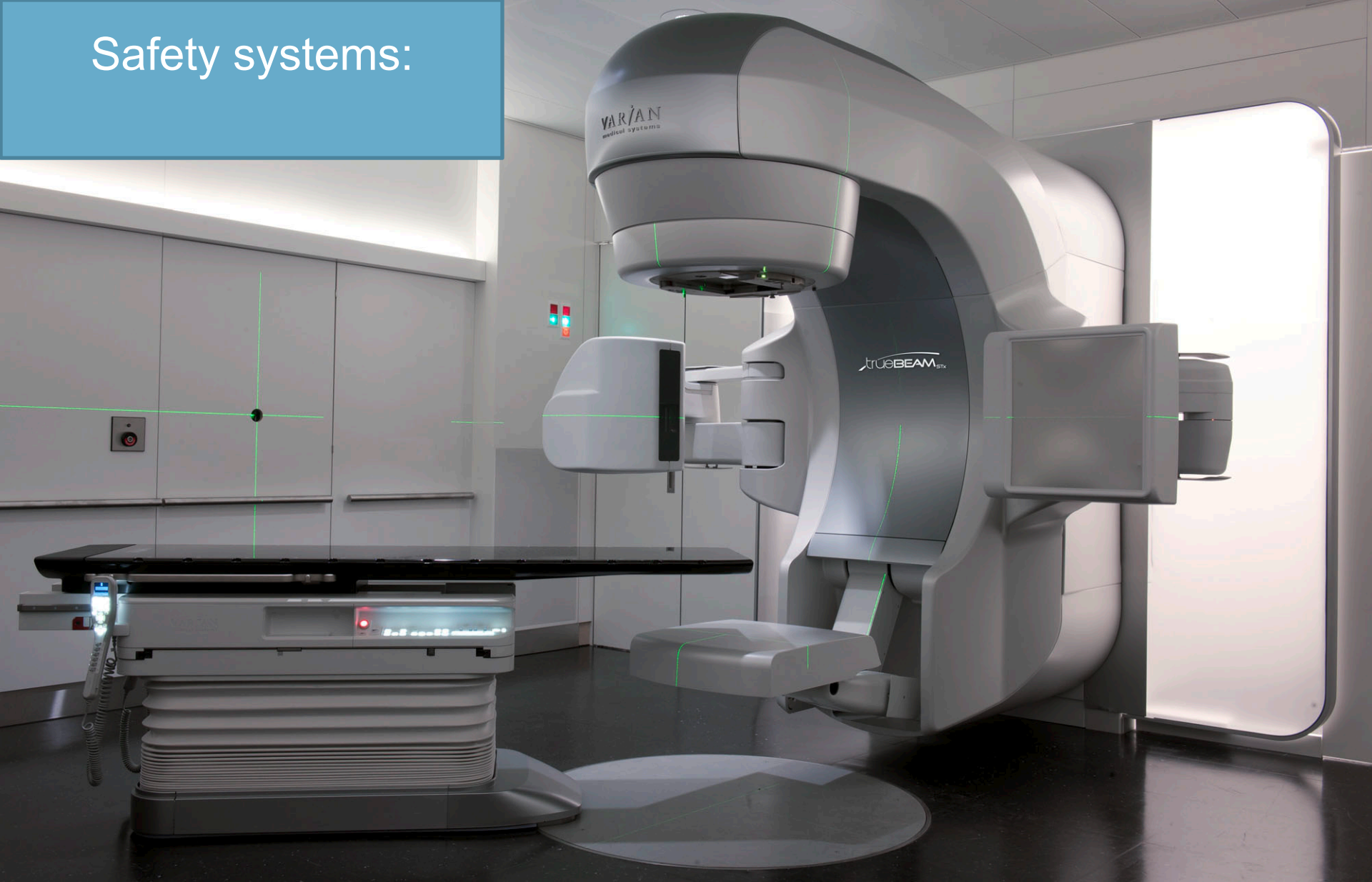
Software – Treatment Mode



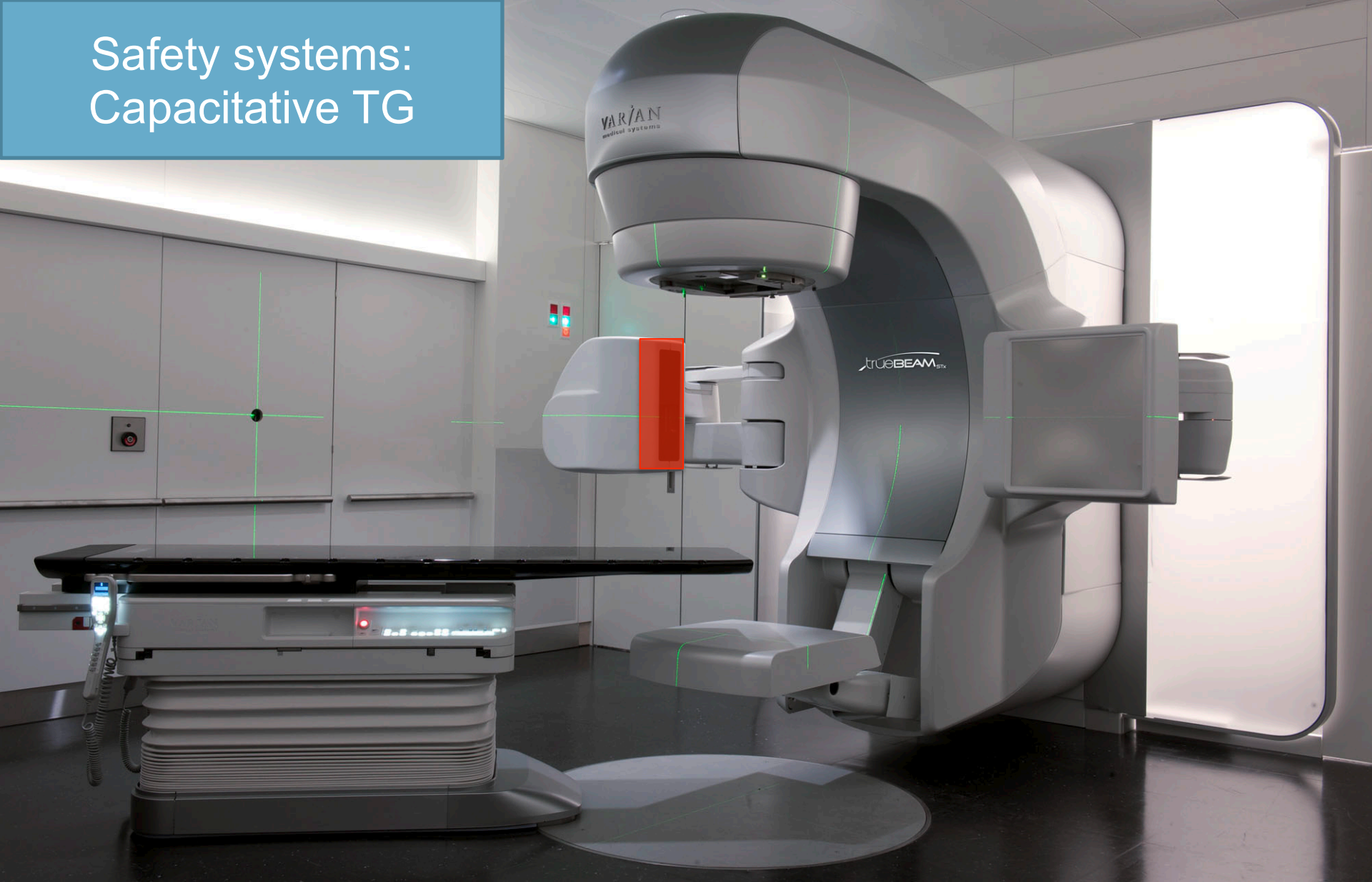
Safety

- In addition to “standard” safety features present on all medical linacs...
- Capacitative collision detection on kV source
- Laserguard to protect patient zone without contact
- Mechanical touchguards on all other moving parts
- LiveView display...
- Machine software model...

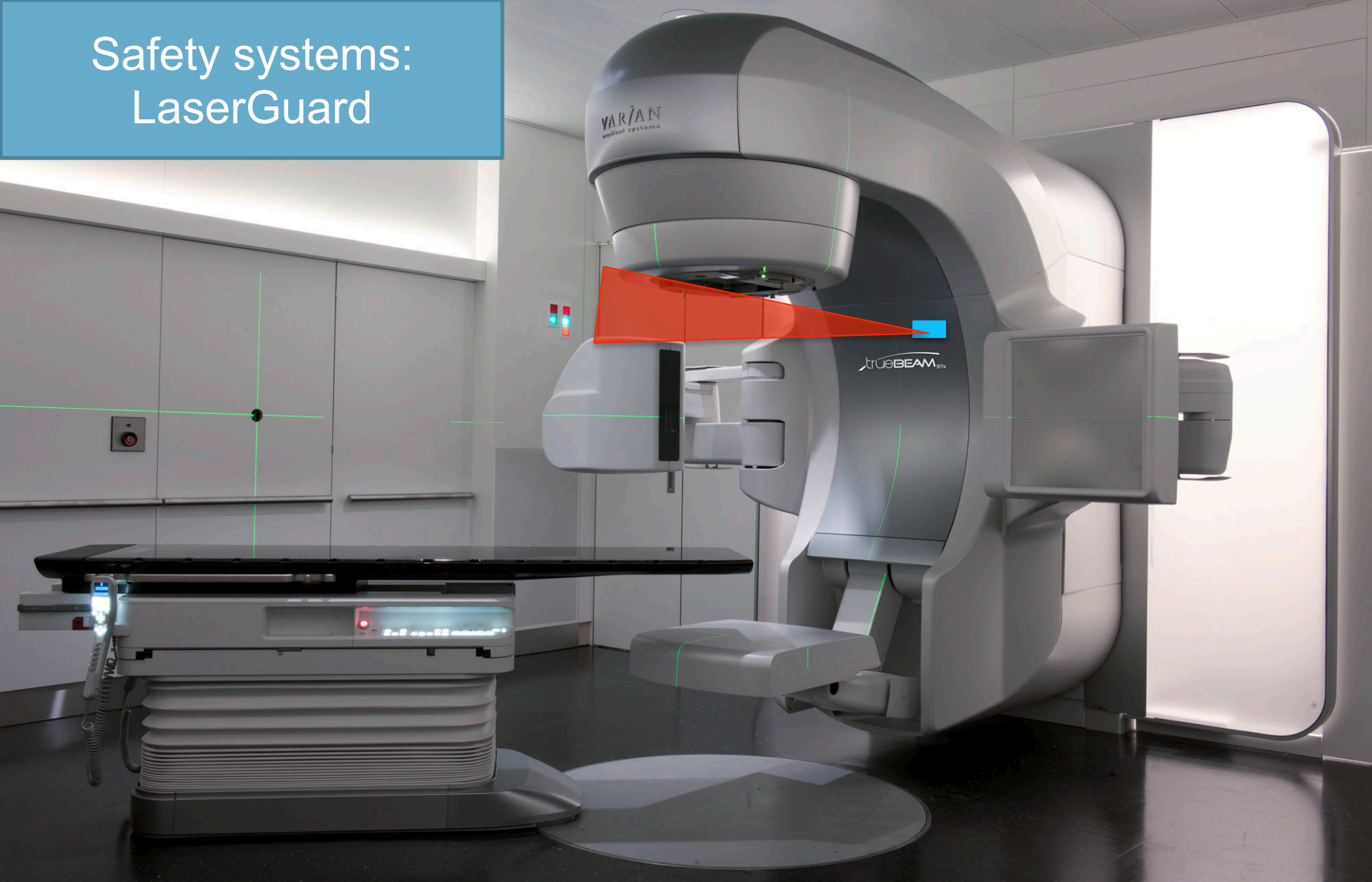
Safety systems:



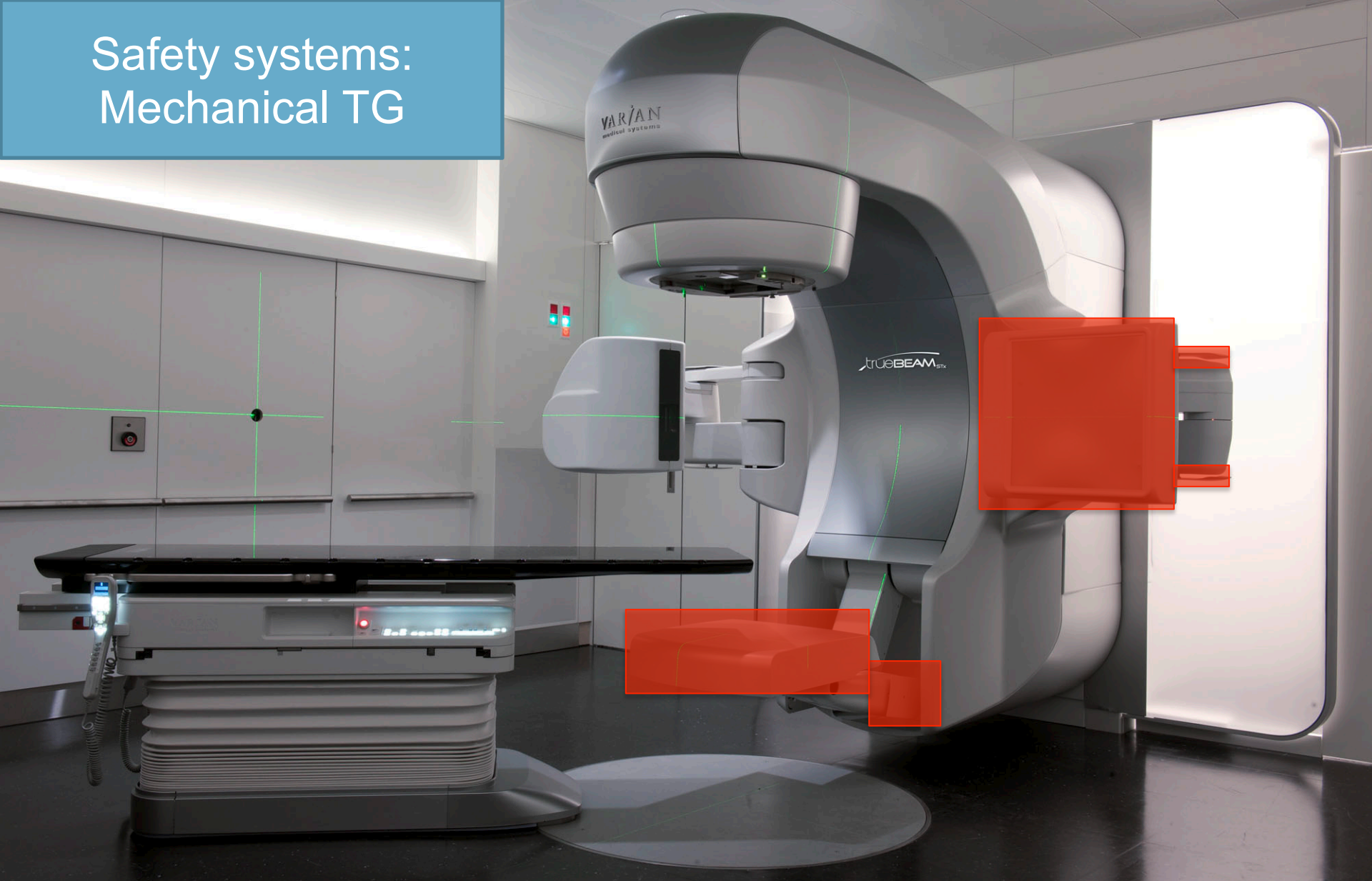
Safety systems: Capacitive TG



Safety systems: LaserGuard



Safety systems: Mechanical TG



TrueBeam – Safety Features: LiveView

Primary User acooper
06:13 PM 20-Nov-2009
PATIENT ORIENTATION
Head First, Supine

Privacy Shade

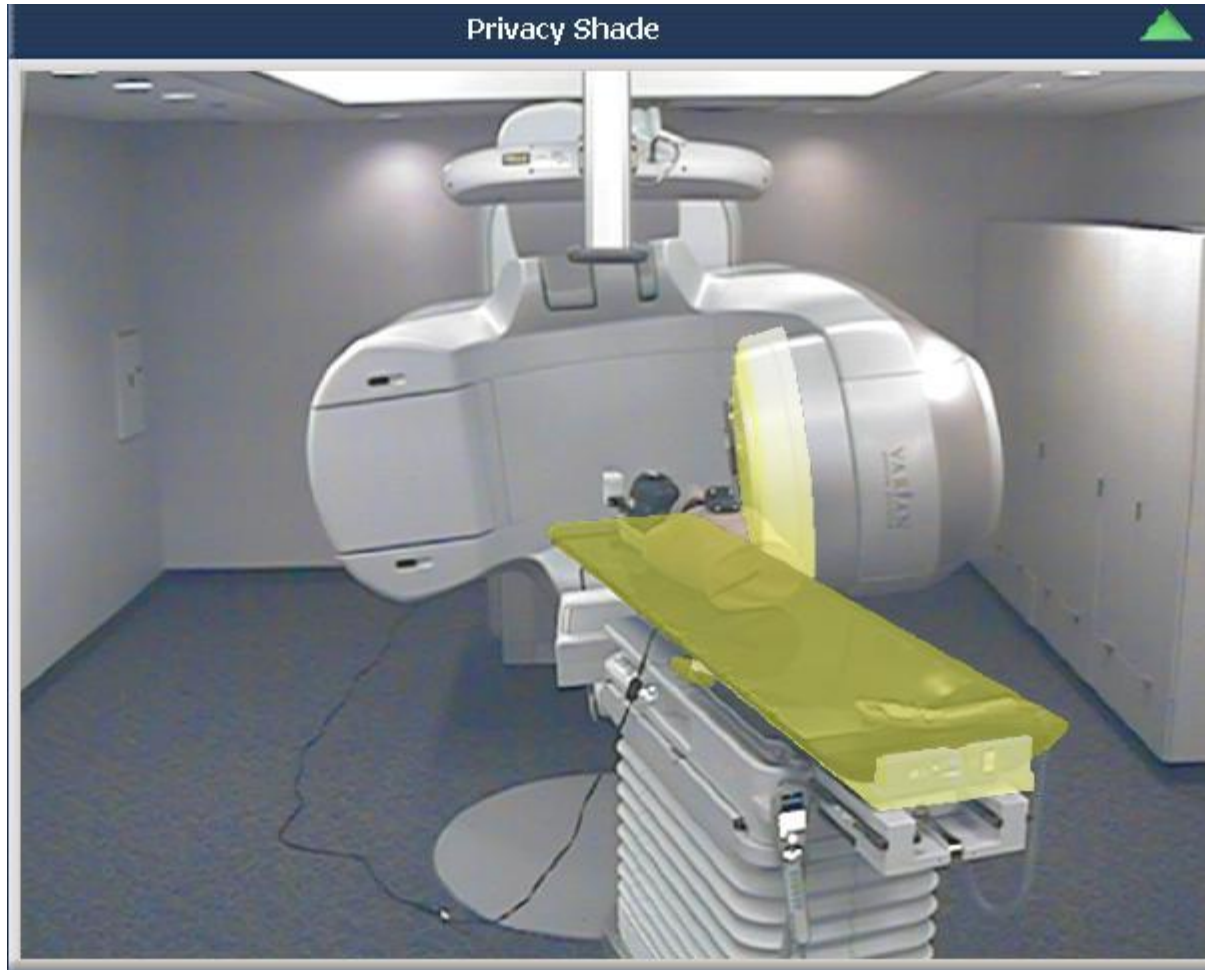


Machine ID HESN10
NDS VOS
Serial#: 0010
Scale IEC 61217
Version: 1.0.219.49

WARNING: FOR RESEARCH USE ONLY **Add an imaging procedure to proceed.**

Preview Prepare Ready Beam On Record

TrueBeam – Collision Avoidance Model



VARIAN
medical systems ⓘ

Collision
Warning ⓘ

TrueBeam – Collision Avoidance Model

Privacy Shade



VARIAN
medical systems



Collision
Detector

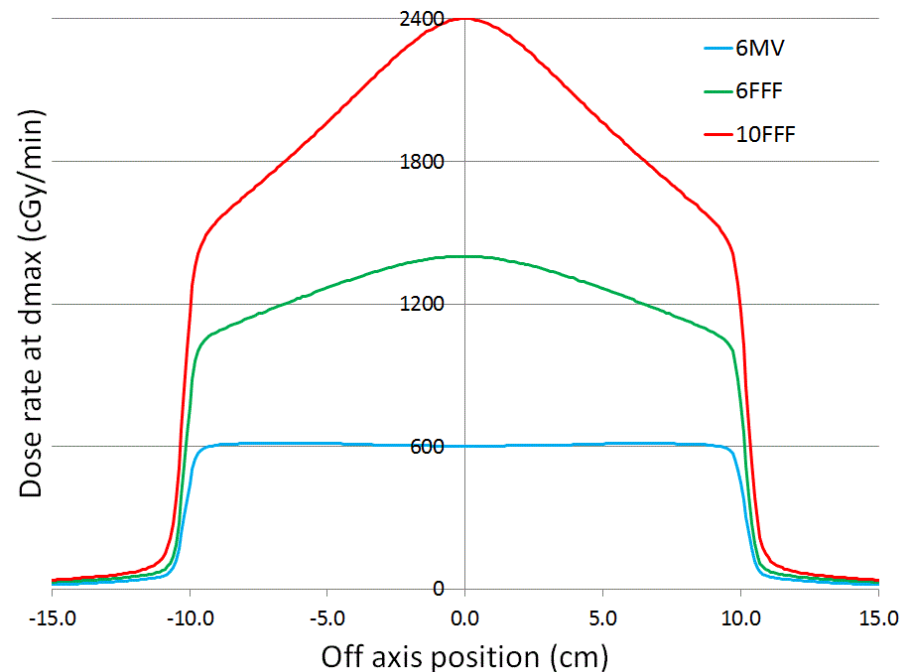


Research Applied

Flattening Filter Free (FFF) Mode

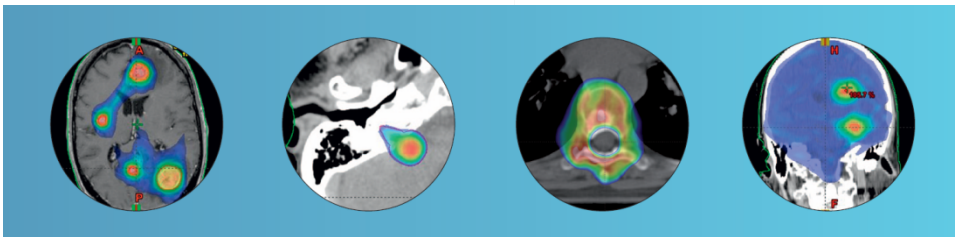
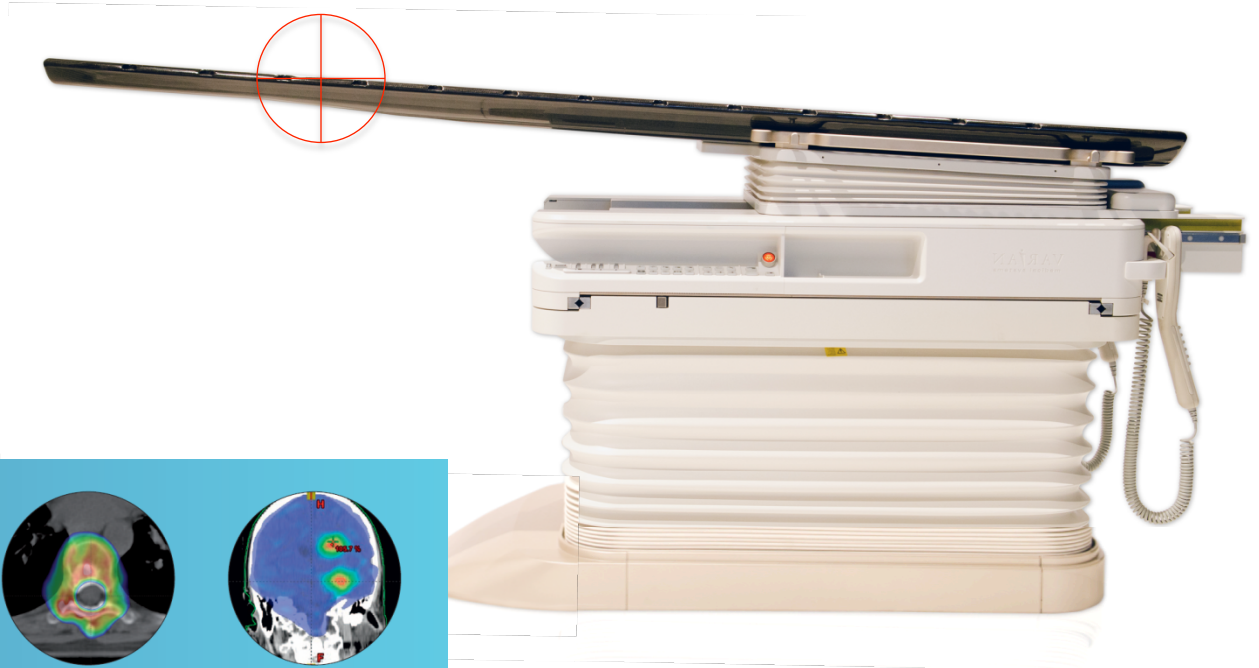
Higher dose rates, lower scatter and out of field leakage are possible by removing the flattening filter

- Gains for IMRT, RapidArc or small field SRS
- Available in clinical mode for
6 MV → 1400 MU/min
10 MV → 2400 MU/min



PerfectPitch™ Couch

- Increased treatment precision
- Fully integrated with TrueBeam
- Precise isocentric rotation



Matching with 6 Degrees of Freedom

Match Parameters

Limit Shift

Couch Shift [cm]

Vrt

Lng

Lat

Couch Shift [°] Include

Rtn

Pitch

Roll

Couch Representation:
Isocentric Standard

Apply

For Session

Permanently

Sagittal - B2882 - kv_CBCT_25a - 10/18/2013 12:52 PM

Frontal - B2882 - kv_CBCT_25a - 10/18/2013 12:52 PM

Auto Matching

Start

Reset

Close

Parameter Set

Extended Range

Axes

Vrt Rot

Lng Pitch

Lat Roll

Intensity Range

Structure VOI

Status

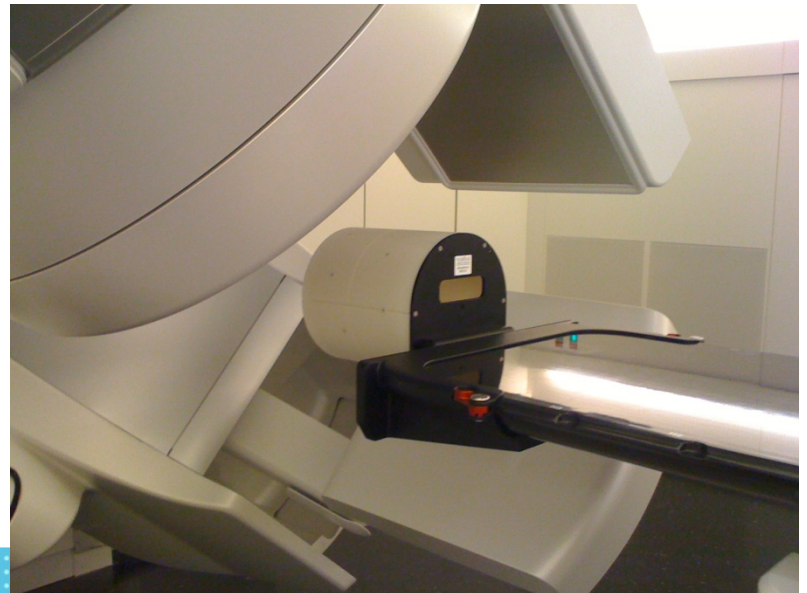
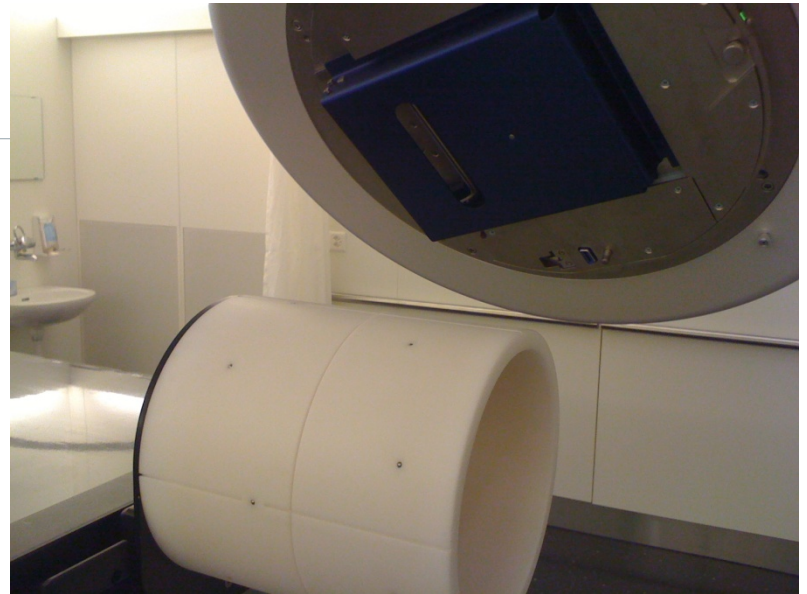
Match Finished
Press Start to Auto-Match

Patient, HFS
X: -0.06 cm

Z: 6.92 cm

IsoCal - Phantom

- **Phantom of a known geometry with 16 BBs**
- **Transmission plate with a radio-opaque pin**
- Based on imaging of the phantom
- 4 collimator positions to find its axis
- kV and MV projections during 360° rotation around the phantom
- Algorithm finds gantry rotational axis and the position of three isocenters on it
- Isocenters projected onto imagers to determine the correction shift vectors for active arm position correction



IsoCal – sub-millimeter precise imaging

The image displays four screenshots of the IsoCal software interface, showing the calibration process for a linear accelerator. The windows are arranged in a 2x2 grid.

Top Left: Collimator
 Shows four collimator images labeled 0.xim, 1.xim, 2.xim, and 3.xim. Each image shows a central spot with a crosshair. The status bar indicates: "All units in cm and degrees (IEC1217 scale)."

Top Right: View MV
 Shows a large MV image with several target spots highlighted by green and red boxes. The status bar indicates: "All units in cm and degrees (IEC1217 scale)."

Bottom Left: kV Done
 Shows a large MV image with target spots highlighted by green boxes. The status bar indicates: "All units in cm and degrees (IEC1217 scale)."

Bottom Right: Review
 Shows the final calibration results. A green banner at the top reads "Isocenter Calibration ok." Below are two graphs: "MV - Imager Shifts" and "kV - Imager Shifts". Both graphs plot Y [cm] vs X [cm] and show a small shift from the origin. Below the graphs are calibration parameters:

Max. deviation from central beam:	0.045						
In-plane imager rotation MV:	0.041			In-plane imager rotation kV: 0.009			
Rot Center Pos MV:	Lat	Lng	Vrt	Rot Center Pos kV:	Lat	Lng	Vrt
Phantom position:	0.001	0.046	0.028	0.017	-0.014	0.058	
	-0.108	0.099	-0.041				

The status bar at the bottom indicates: "All units in cm and degrees (IEC1217 scale)."

Summary

- Transition from research to design
- Consider:
 - Safety
 - Usability
 - Serviceability
 - Production cost
 - Marketability

