

INDUSTRIAL DESIGN

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VARIAN ONCOLOGY SYSTEMS | CERN Accelerator School, May 2015 | VARIAN medical systems

This slide features a blue-to-green gradient background with a dotted pattern at the bottom. It contains the title 'INDUSTRIAL DESIGN' in large white letters, followed by the presenter's name and title. The footer includes the Varian logo and event information.

Industrial Design

From Wikipedia, the free encyclopedia

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 regarded as **non-manufacture**, and 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.^[a] 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.^[a]

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 objectives, and consumer social, commercial or aesthetic attitudes. 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.^[1]

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

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The screenshot shows a browser window displaying the Wikipedia article for 'Industrial design'. The browser's address bar shows 'http://en.wikipedia...'. The article text is partially highlighted with red boxes. The footer of the slide contains the Varian logo and the text '2 | VARIAN ONCOLOGY SYSTEMS'.

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

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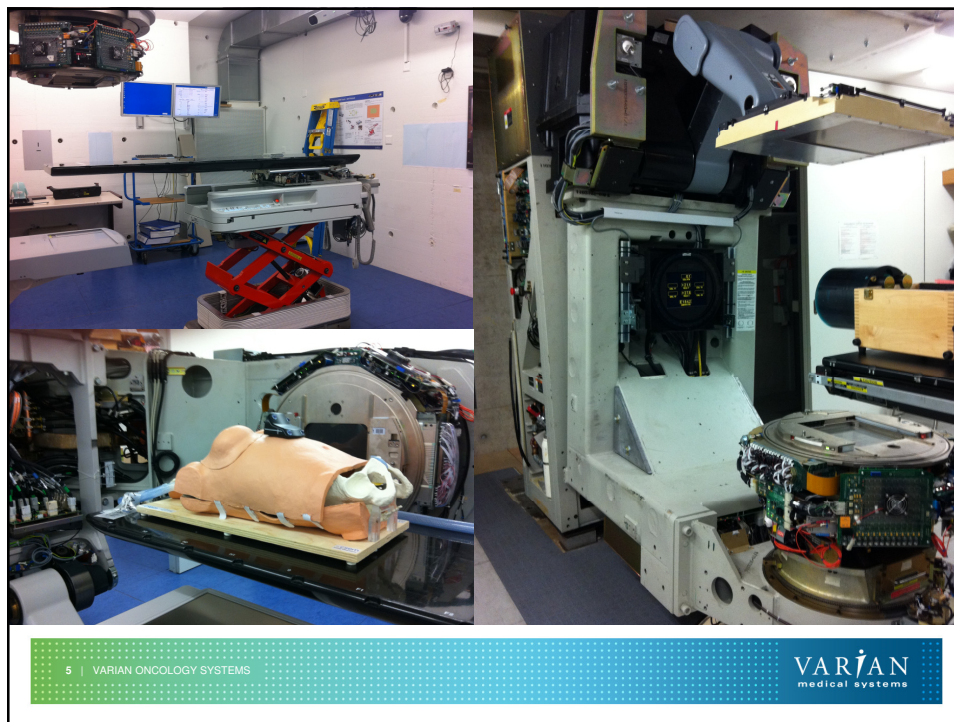
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From Research to a Clinical Product

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

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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

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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

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Clinac – The Previous State of the Art



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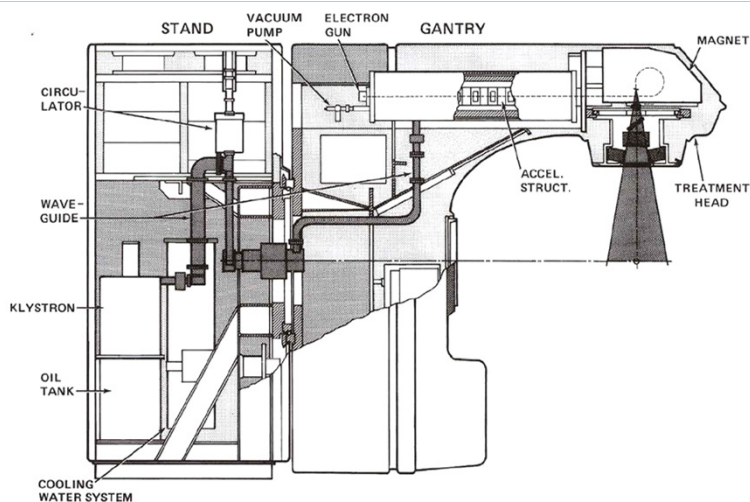
Varian High Energy Linac Fundamentals

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

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Major Accelerator Components

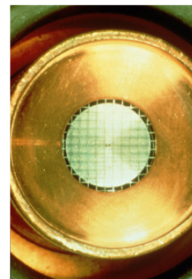


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Triode Electron Gun

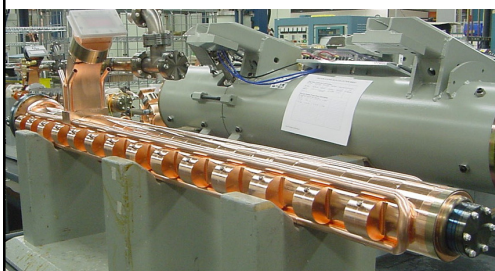
- Fastest beam-on and off.
- **Allows for fast “single” pulse control.**
- Fast control of electron emission (for IMRT, dynamic arc and gating)
- No dark current (using the grid)
- Filament & cathode remain hot for stable operation



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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**

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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

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Bending Magnet



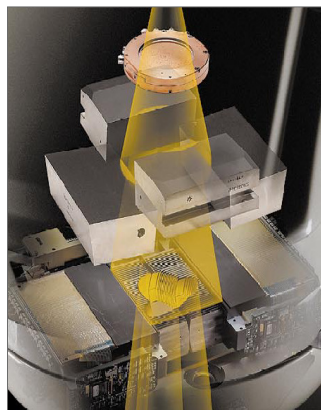
- 270-degree, 3-sector (pole), uniform pole gap, achromatic, bending magnet
- +/- 3% energy slits
- Long-term energy stability
- Direction and position independence (easy to adjust)
- Beam flatness
- Small, circular x-ray spot
 - Sharp penumbra
 - Good imaging

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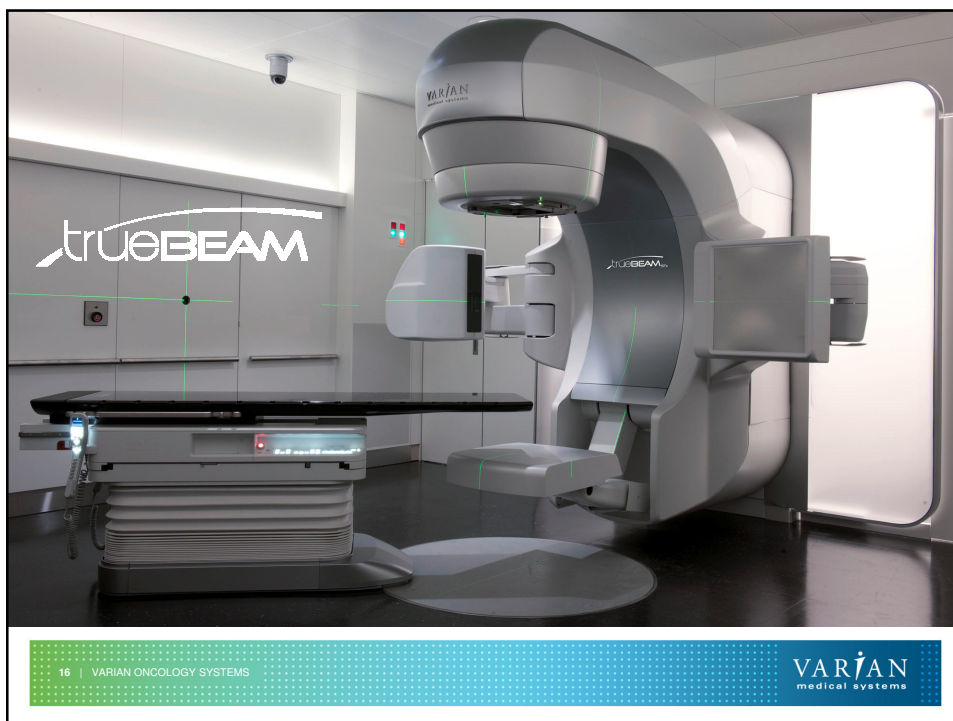
Beam Collimation

- 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



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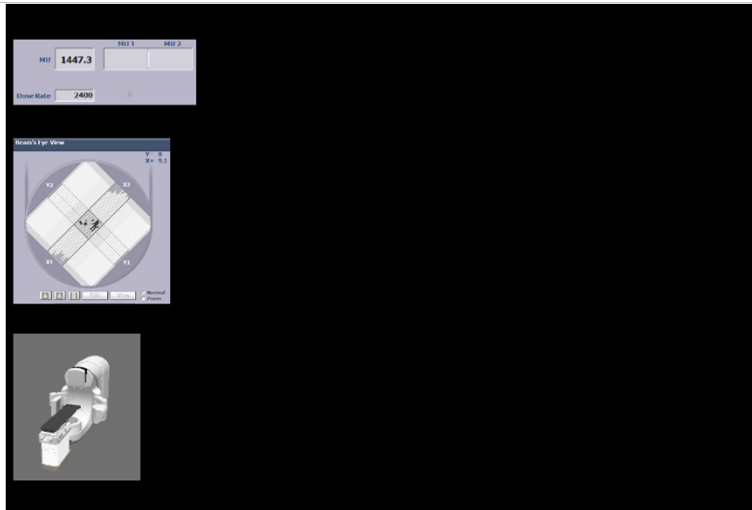
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Advanced IGRT – Automatic Beam Hold



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Images courtesy of VUmc

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A New Platform – Introducing TrueBeam

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



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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

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TrueBeam - Hardware

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New Control System

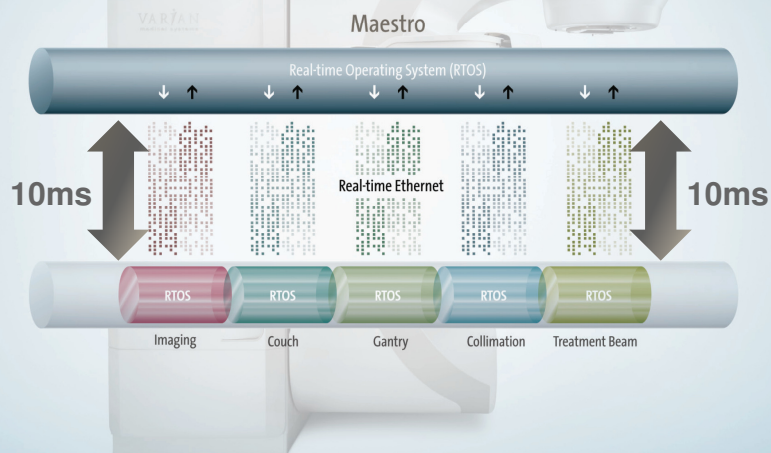
- Fully digital
- Fully integrated
- Faster “heartbeat”

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

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Maestro™ Control System



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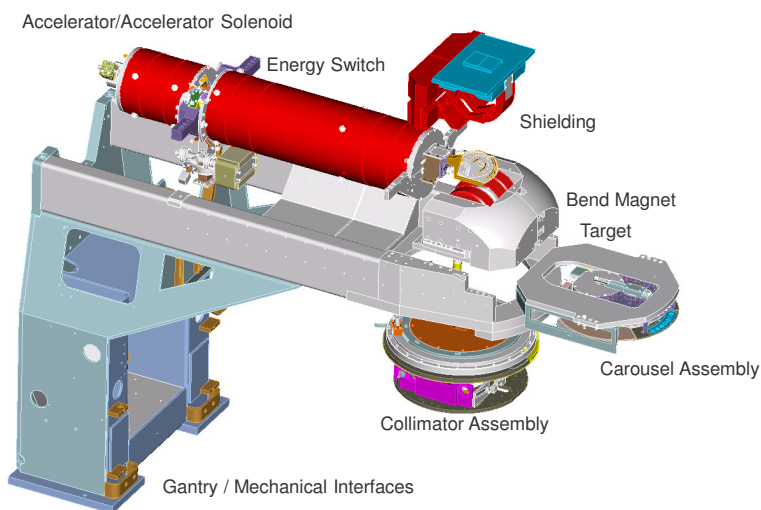
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Redesigned Beamline Components

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

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Gun

Accelerator Solenoid

Energy Switch

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

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Bending Magnet

Trim Coils

Angle steering coils

High field bends beam 180°

Beam enters low magnetic field

Strikes target below incoming beam line

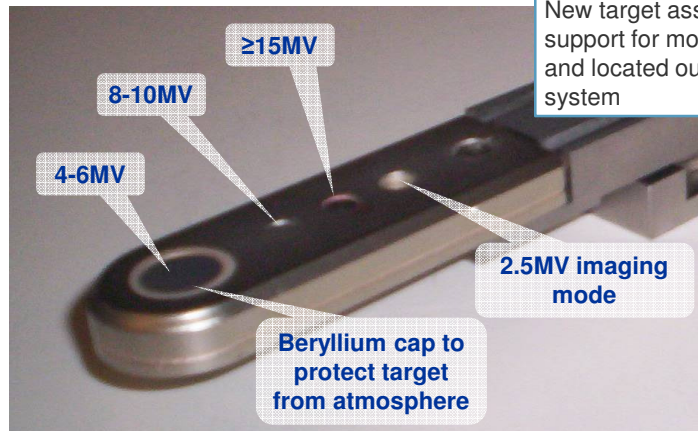
Angle steering coils location

- 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

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Beam Generation - Target



New target assembly – support for more energies and located outside vacuum system

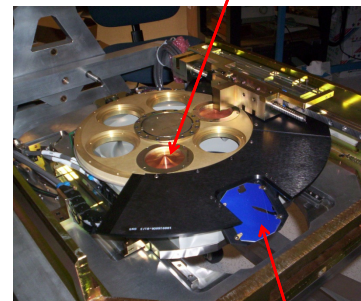
→ Retract target from beam for electron modes

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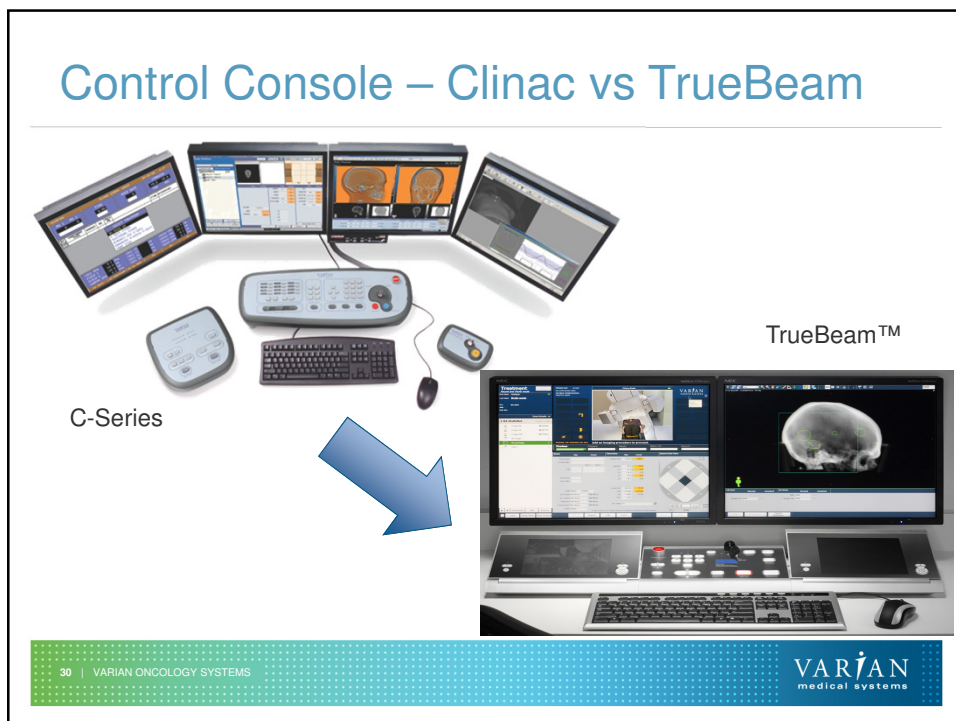
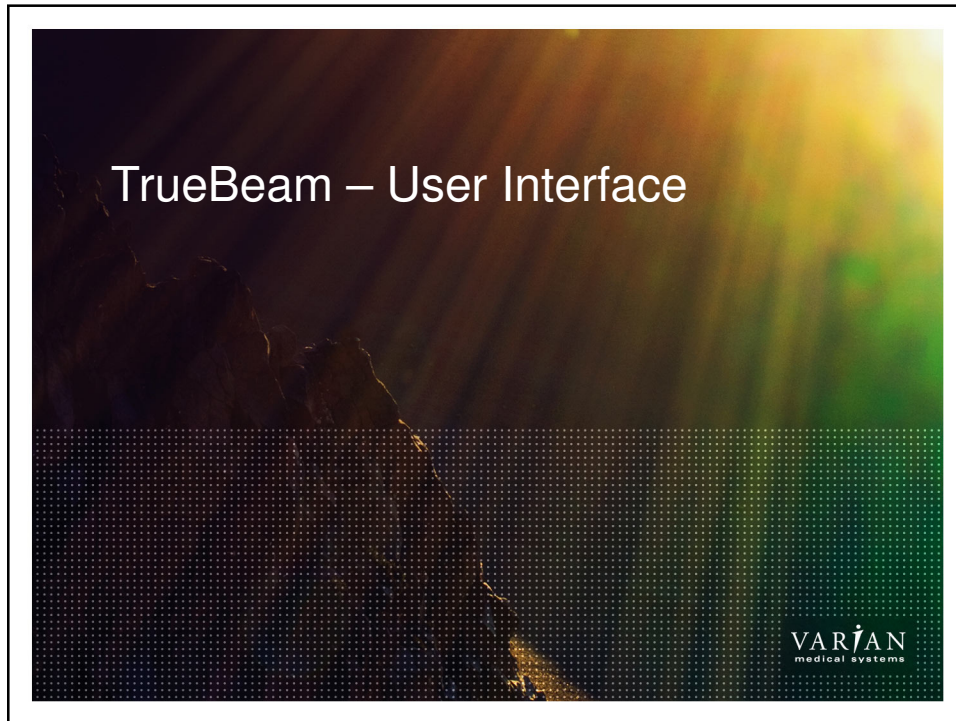
Beam Generation - Carousel

- 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



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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

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Harmonized User Interface



Console



Pendant



Couch



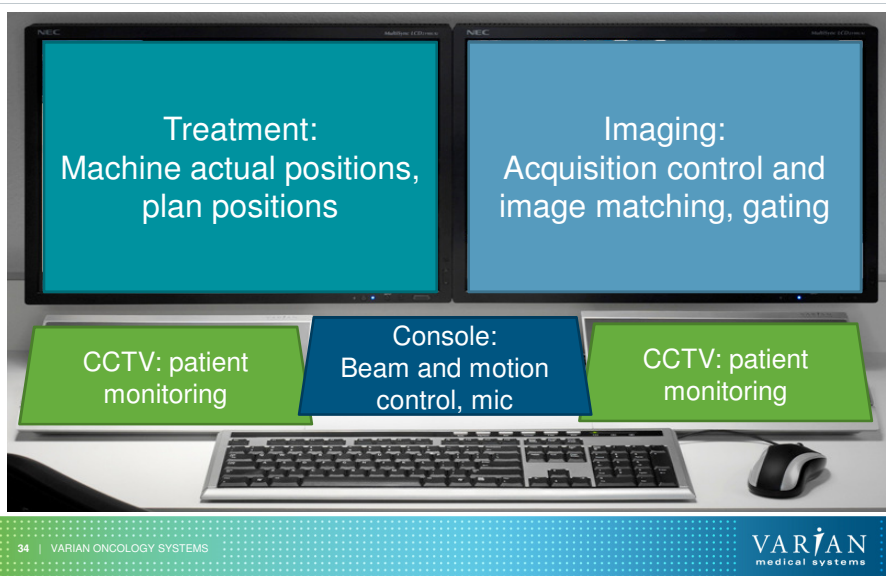
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Software – Treatment Mode



Software – Treatment Mode

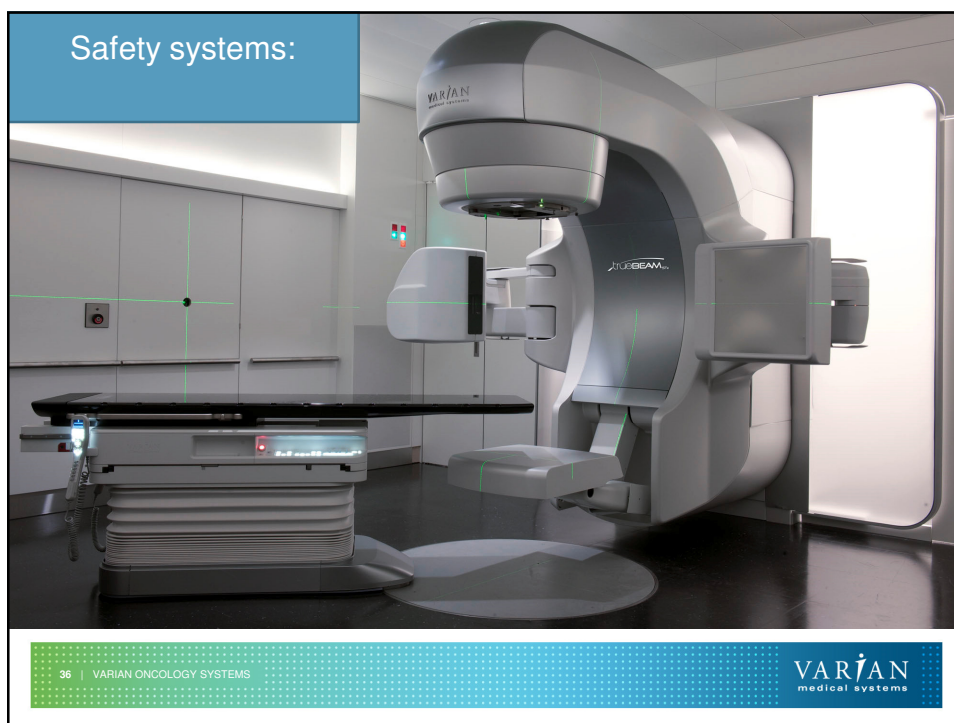


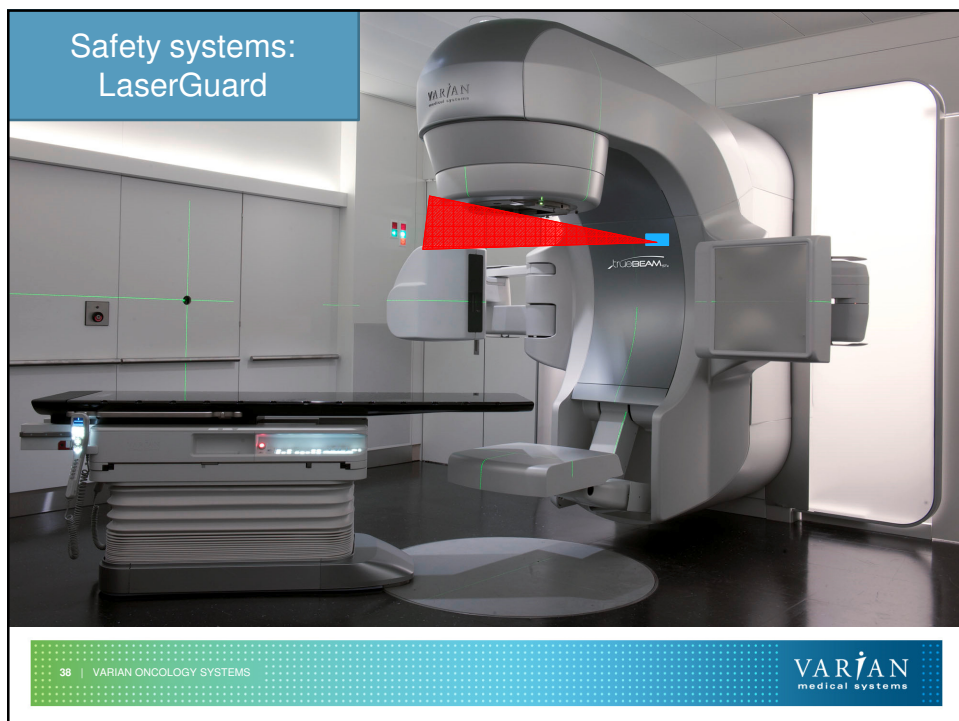
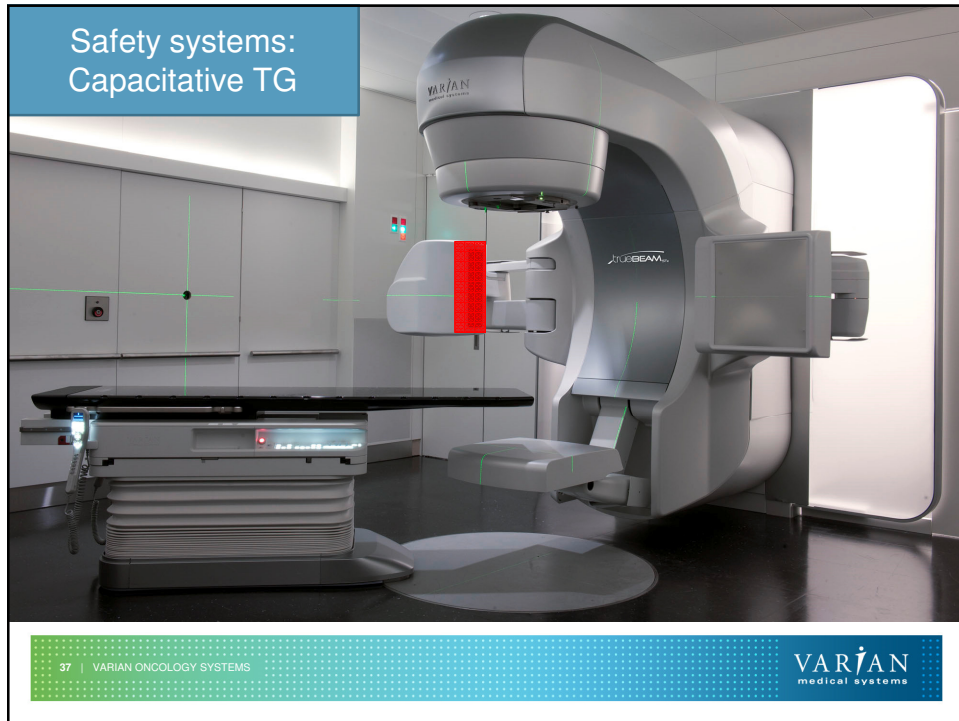
Safety

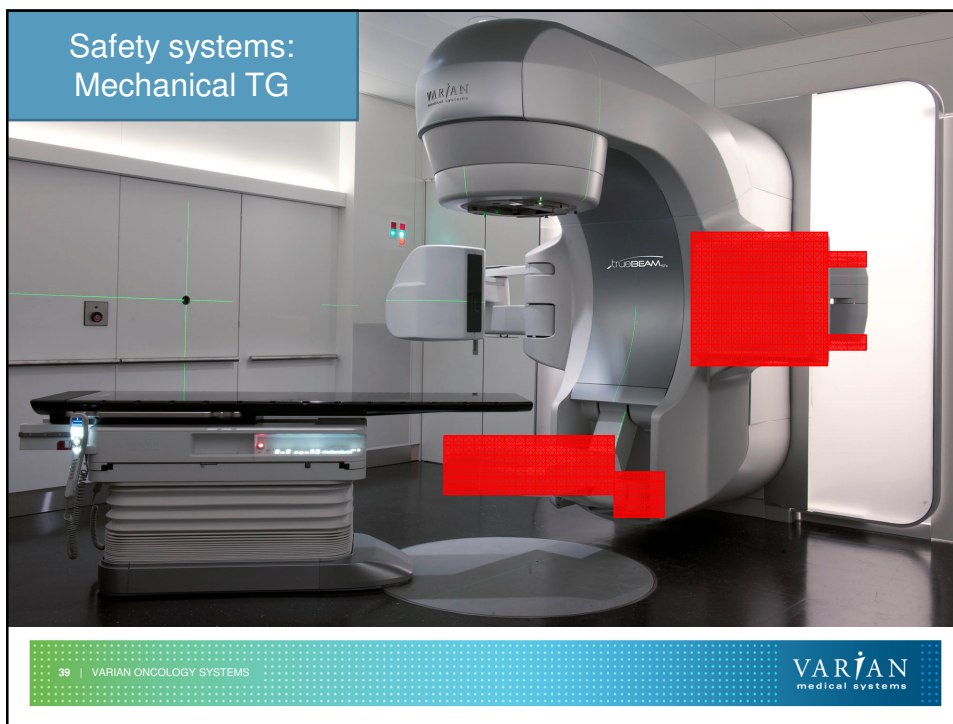
- In addition to “standard” safety features present on all medical linacs...
- Capacitative collision detection on kV source
- Laserguard to protect patient zone without contact
- Mechanical touchguards on all other moving parts
- LiveView display...
- Machine software model...

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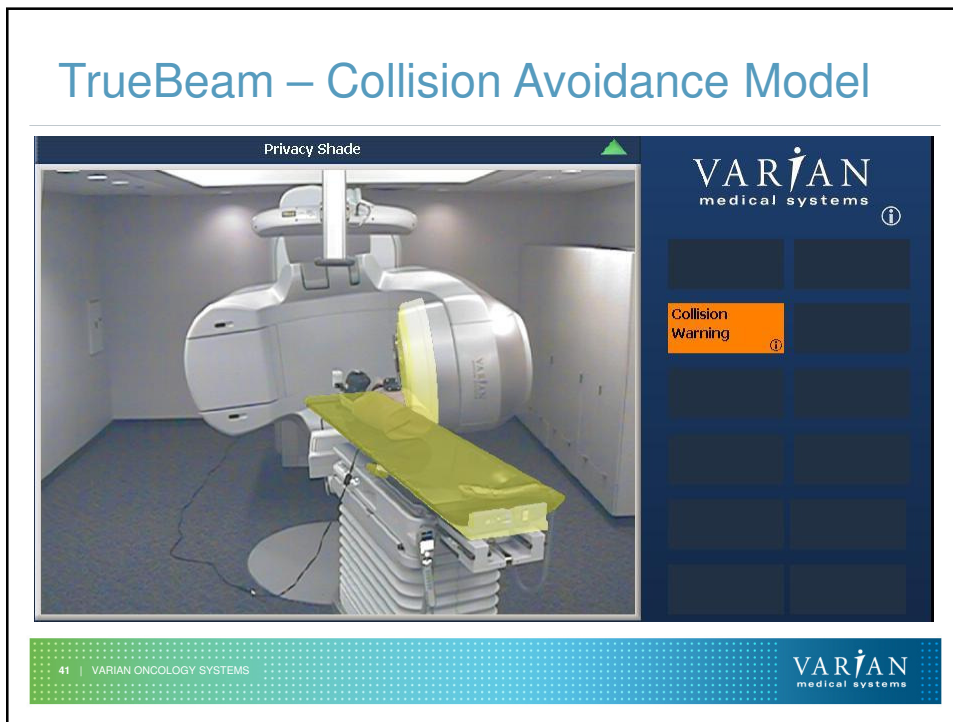
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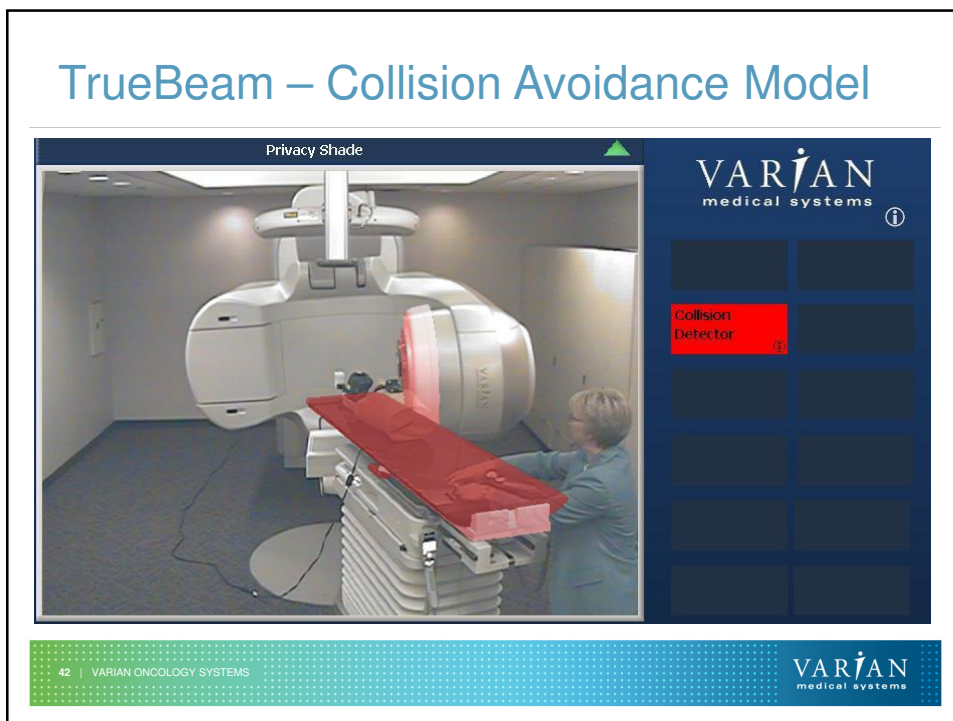




TrueBeam – Collision Avoidance Model



TrueBeam – Collision Avoidance Model

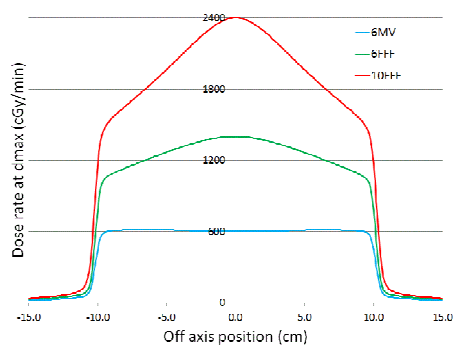




Flattening Filter Free (FFF) Mode

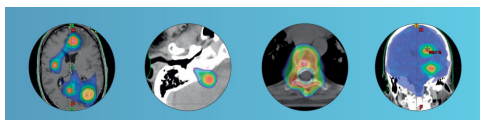
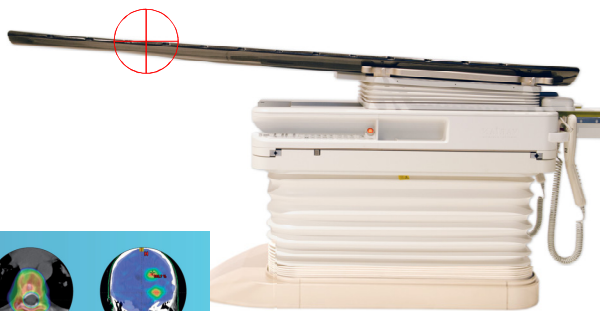
Higher dose rates, lower scatter and out of field leakage are possible by removing the flattening filter

- 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

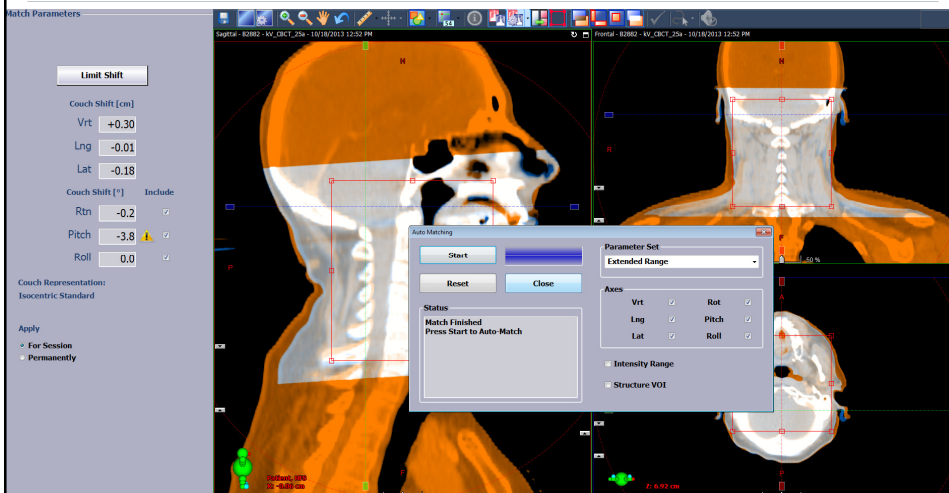
- Increased treatment precision
- Fully integrated with TrueBeam
- Precise isocentric rotation



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Matching with 6 Degrees of Freedom



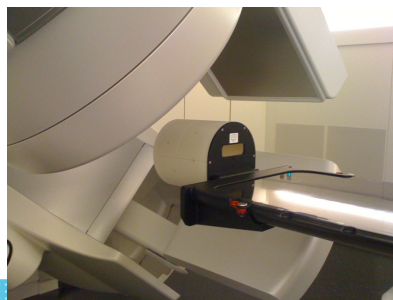
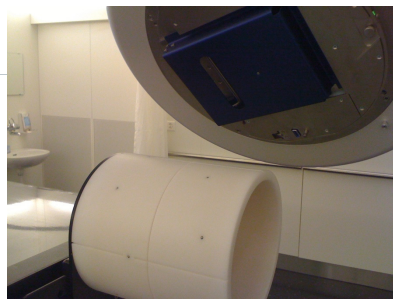
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Images courtesy of The Clatterbridge Cancer Center

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IsoCal - Phantom

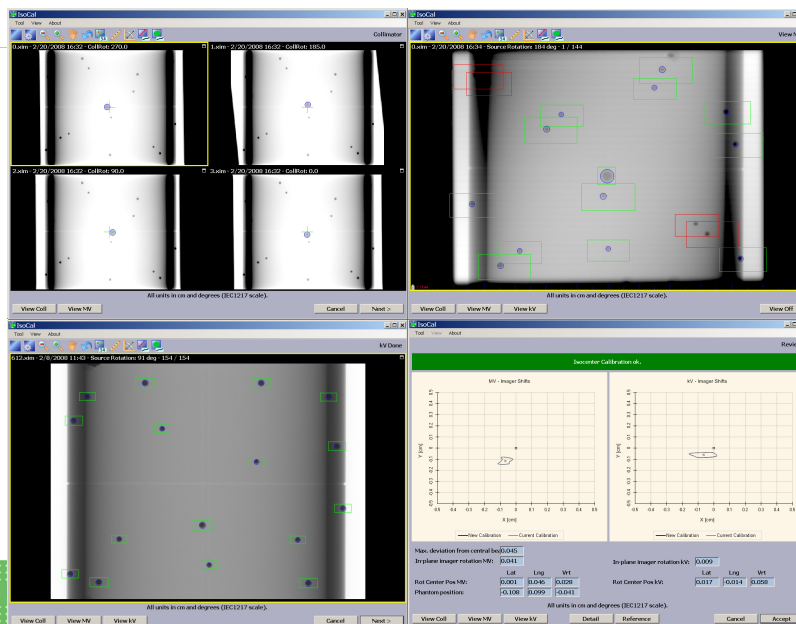
- Phantom of a known geometry with 16 BBs
- Transmission plate with a radio-opaque pin
- Based on imaging of the phantom
- 4 collimator positions to find its axis
- kV and MV projections during 360° rotation around the phantom
- Algorithm finds gantry rotational axis and the position of three isocenters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



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IsoCal – sub-millimeter precise imaging



Summary

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

