

# Tomorrow Begins with Tomo

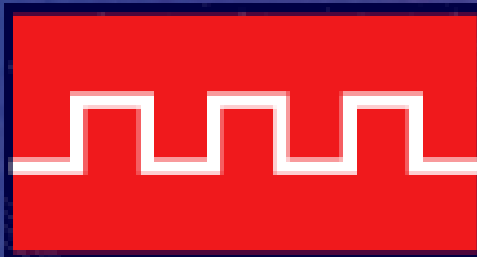


**Thomas Rockwell Mackie**  
**University of Wisconsin**  
**Emeritus Professor**

# Disclosure of Potential Conflicts of Interest



I am the Co-founder, Chief Innovation Officer and Chairman of the Board and have financial interest in Leo Cancer Care which is developing an upright radiotherapy system. Leo has partnerships with Hitachi, Mevion, Asto CT, RaySearch, Nelco, CQ, Neutron Therapeutics, Theryq, Tibaray, and Cosylab.



**COSYLAB**

I am a Board Member and have financial remuneration by Cosylab which provides control software to science laboratories and particle therapy equipment manufacturers worldwide.

# Accuray Disclaimers and Disclosure

## **Disclosure**

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## **Medical Advice Disclaimer**

Accuray Incorporated as a medical device manufacturer cannot and does not recommend specific treatment approaches. Individual results may vary.

## **Safety Statement**

Most side effects of radiotherapy, including radiotherapy delivered with Accuray systems, are mild and temporary, often involving fatigue, nausea, and skin irritation. Side effects can be severe, however, leading to pain, alterations in normal body functions (for example, urinary or salivary function), deterioration of quality of life, permanent injury and even death. Side effects can occur during or shortly after radiation treatment or in the months and years following radiation. The nature and severity of side effects depend on many factors, including the size and location of the treated tumor, the treatment technique (for example, the radiation dose), the patient's general medical condition, to name a few. For more details about the side effects of your radiation therapy, and if treatment with an Accuray product is right for you, ask your doctor.

# Outline

- TomoTherapy paradigm.
- Early publications.
- UW clinical prototype.
- First customers.
- Early days at TomoTherapy Inc.
- Clinical quality.
- Form follows function.
- TomoTherapy System helping to pioneer modern radiotherapy.

# What is the TomoTherapy System Paradigm?

A treatment device designed to improve the therapeutic ratio:

$$\text{Therapeutic Ratio} = \frac{\text{Tumor Control}}{\text{Harm to Normal Tissues}}$$

- More homogeneous dose to the tumor
- Minimizing dose to normal tissue
- More precise delivery
- Quantification of actual delivery
- Adapting delivery to the changing patient

# Optimization -> IMRT -> More Conformal Dose Distributions



From Brahme A. (1988) *Radiotherapy and Oncology* 12, 129



From Brahme A. (1988) *Radiotherapy and Oncology* 12, 129

**Anders Brahme first showed that intensity-modulated fields of radiation would lead to more conformal dose distributions that would minimize dose to normal tissue.**

# Invention of the Binary MLC 1988-1989

U.S. Patent

May 31, 1994

Sheet 1 of 7

5,317,616

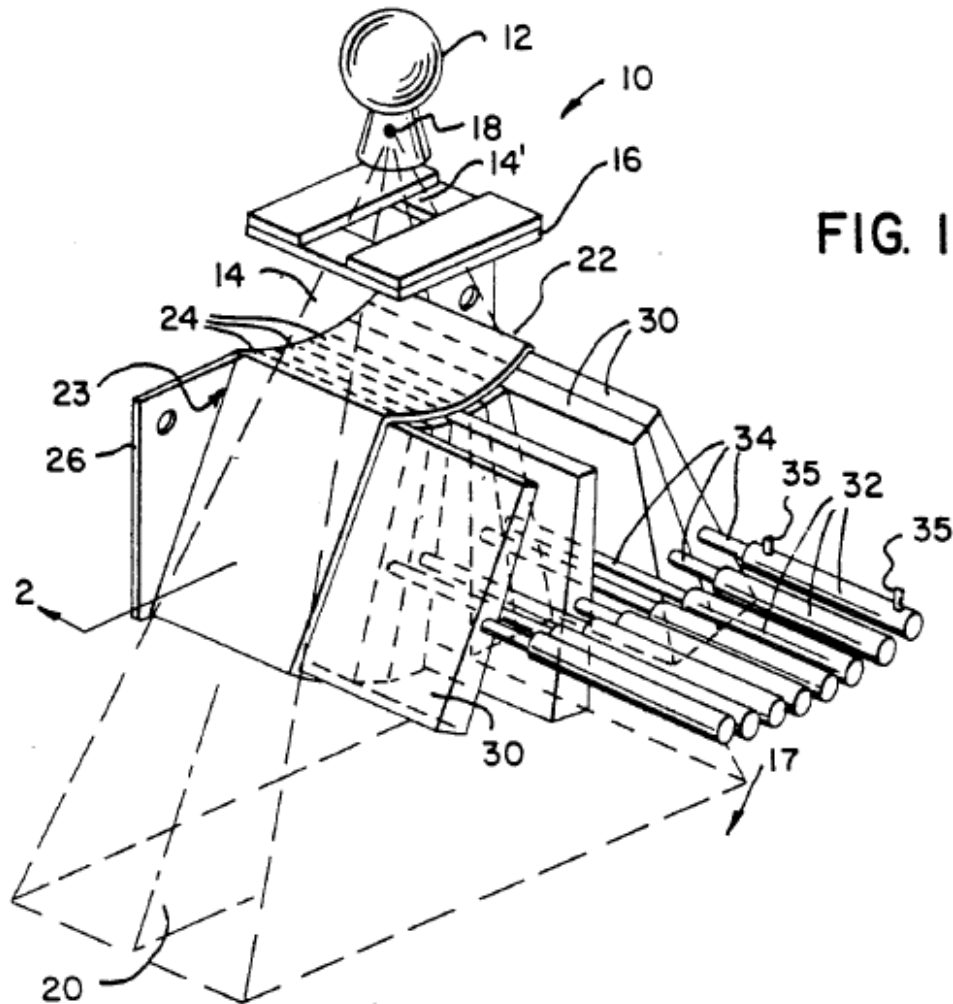
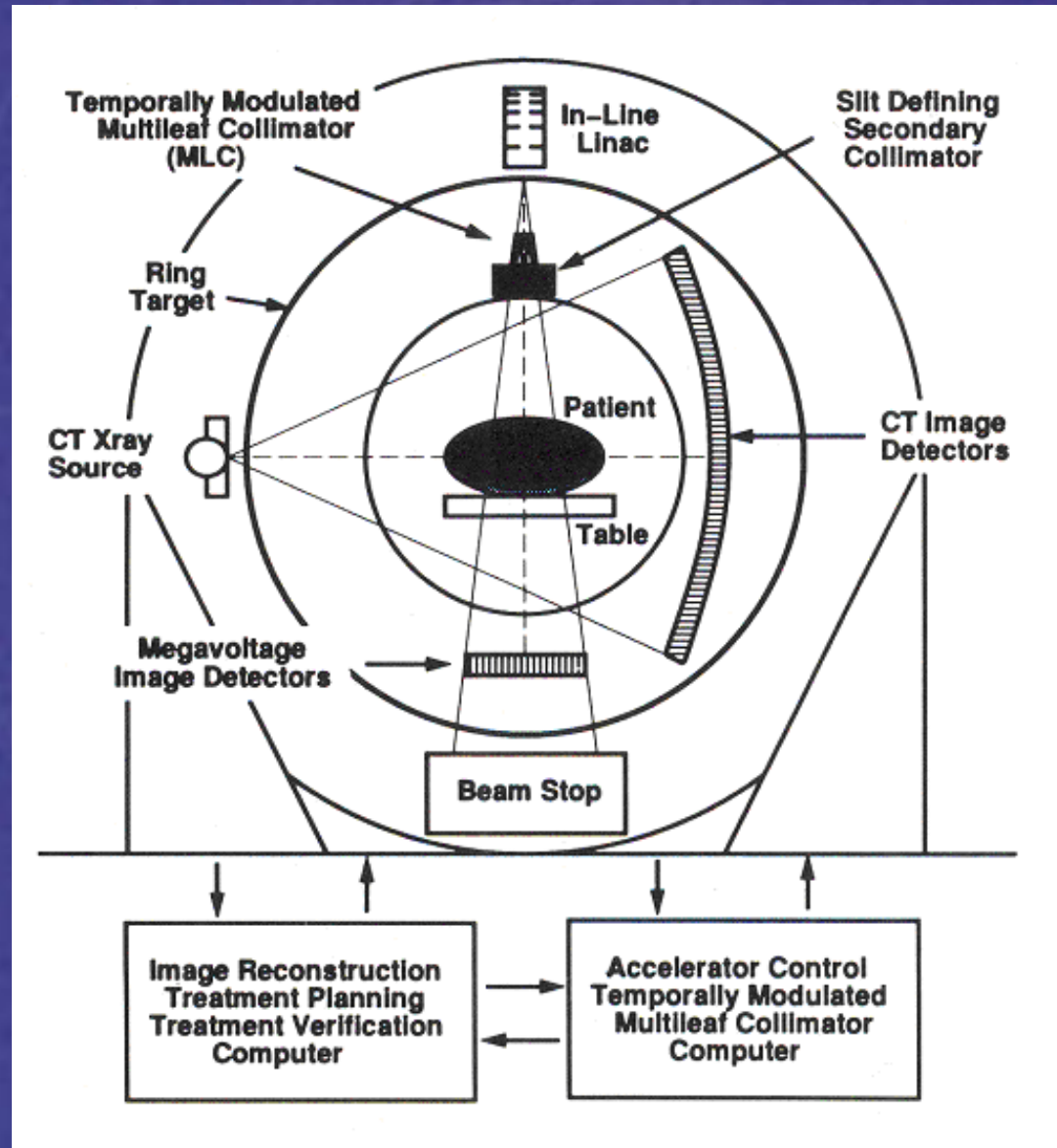


FIG. 1

Sverdloff  
Mackie  
Holmes

# First Publication 1993

“Marriage of  
a Linac  
And a  
CT Scanner”





# Predictions of 1993 Paper

## Adaptive Radiotherapy

**“In principle, the CT image set and the dose reconstructed could be used to modify the treatment in the subsequent fractions.”**

## Simultaneous Concomitant Boosting

**“It may be better to deliver both the primary field and the larger regional field for the full treatment duration to increase repair of normal tissues encompassed by the regional field or to provide more tumor cell killing at the same probability of normal tissue damage.”**

# TomoTherapy 1995

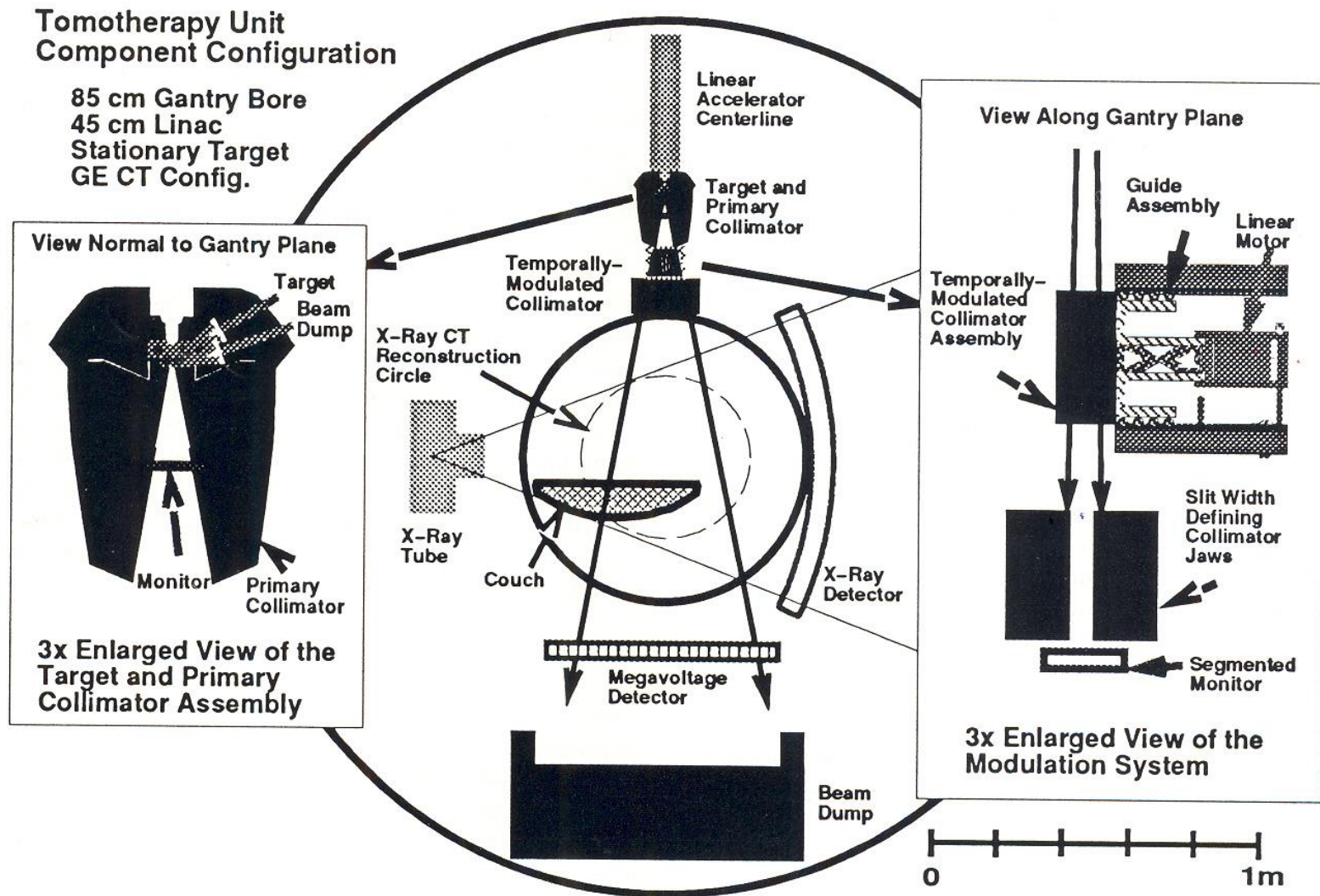
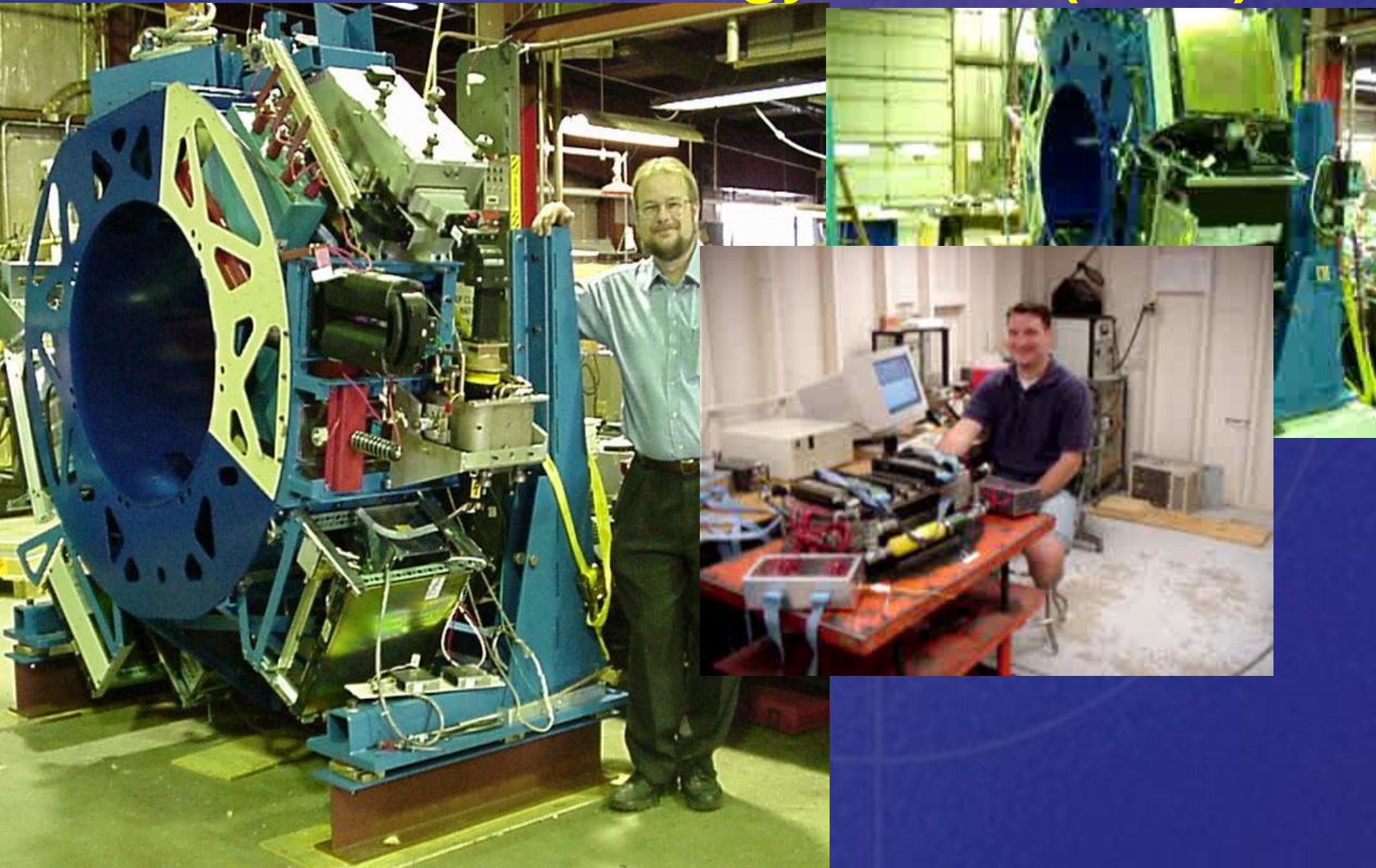
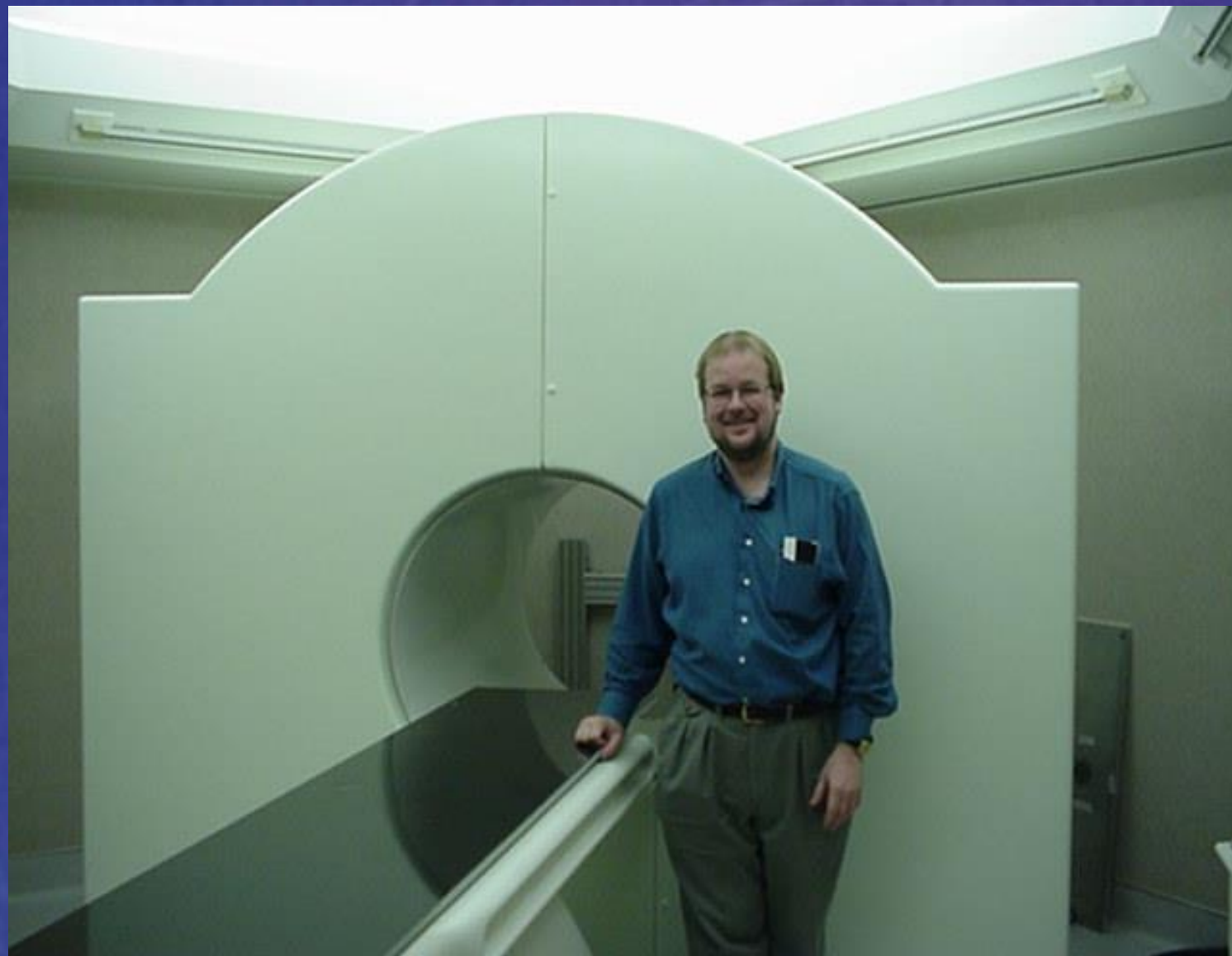


Figure 1. A hypothetical tomotherapy unit.

# First Helical TomoTherapy Unit GE and Siemens Technology Inside (2000)



# First Clinical TomoTherapy Unit



January 2001 at UW Radiotherapy Clinic

# **TomoTherapy Old Facility (1999-2003)**



**This was a former onion powder factory.**

# TomoTherapy First Customers are Canadians



**Colin Field**

**Gino Fallone**

**Jake Van Dyk**

**Jerry Battista**

**Cross Cancer  
Institute,  
Edmonton**

**London Regional  
Cancer Centre,  
London Ontario**

**Dave Murray,  
First Director  
Of  
Engineering**

# First Patients Treated - 2002



August 2002 at UW Radiotherapy Clinic

# Jim Welsh, First TomoTherapy Radiation Oncologist





A man with glasses and a beard, wearing a dark blue and black striped button-down shirt and black trousers, stands smiling next to a large, white, circular radiation therapy machine. He is leaning his right hand on the dark, reflective surface of the machine's gantry. The machine is labeled "TomoTherapy HI-ART" in black text on its inner wall. To the right of the man, there is a control panel with a small screen and several buttons. Two red circular lights are visible on the machine's exterior wall. The background is a plain, light-colored wall.

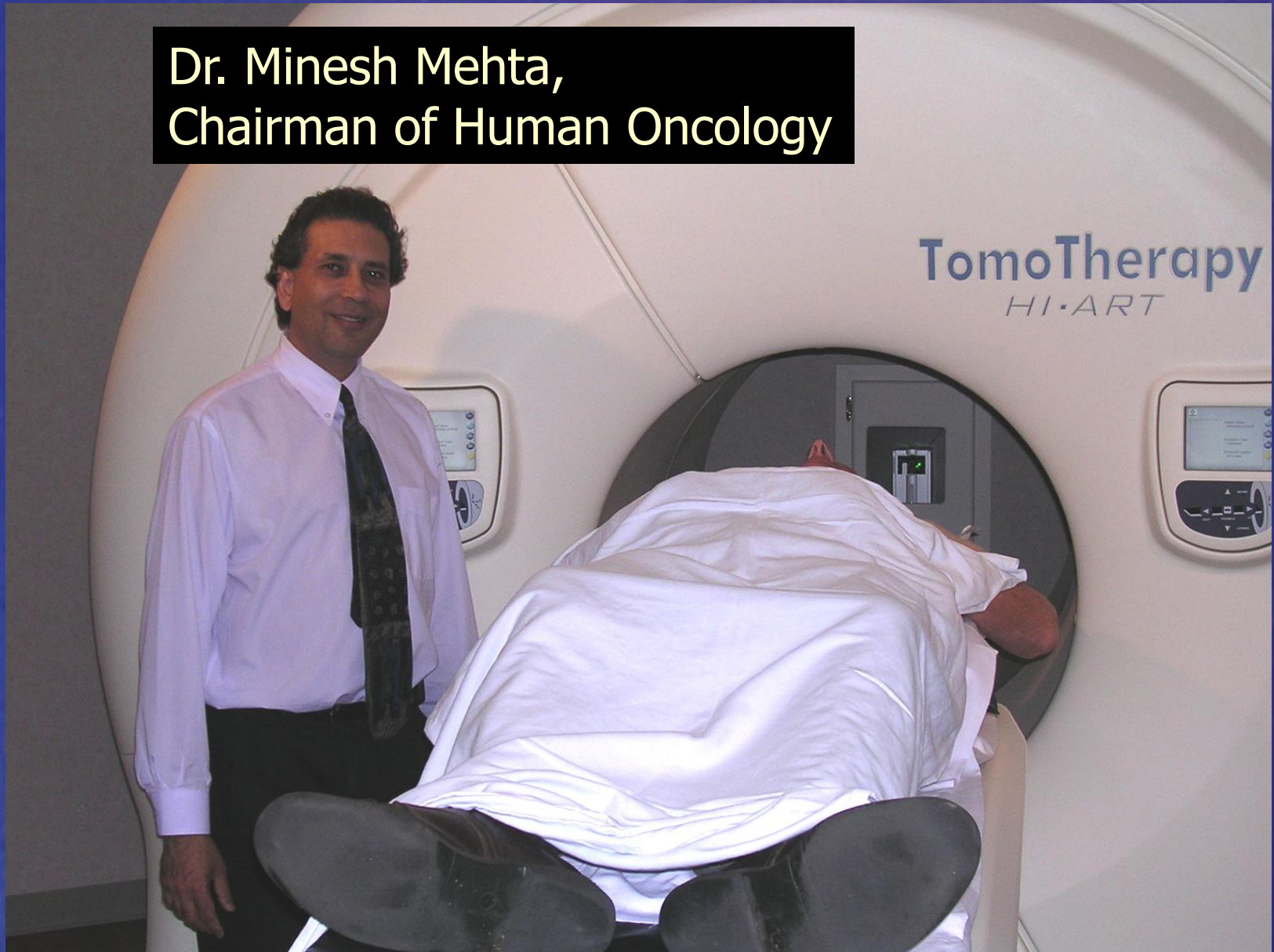
**TomoTherapy**  
*HI-ART*

# Assembly Floor in July 2003



# Commercial Unit (Gantry #6) at the UW

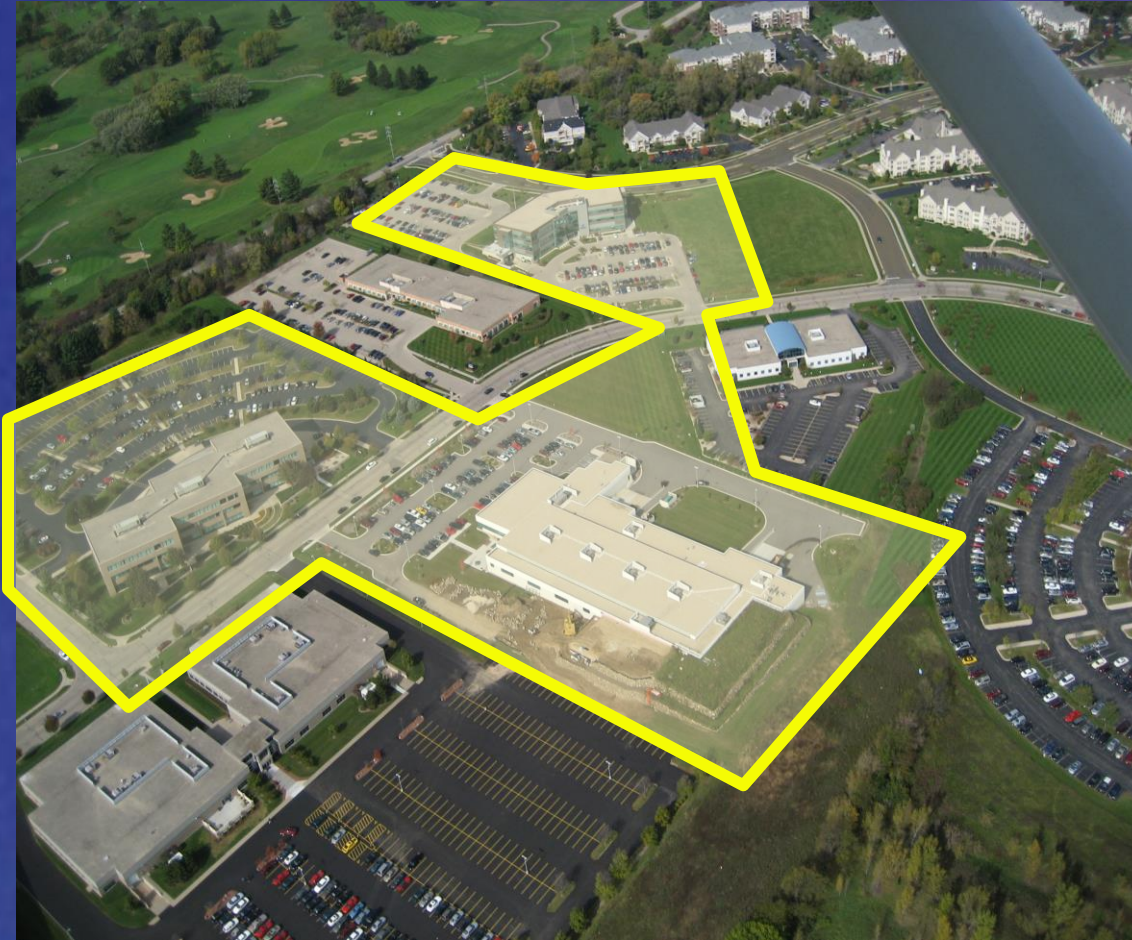
Dr. Minesh Mehta,  
Chairman of Human Oncology



# Assembly Floor in July 2005



# **TomoTherapy Campus 2007**



**650 Employees  
~400 Clinical Systems  
Operating in 25 Countries  
IPO, May 2007**

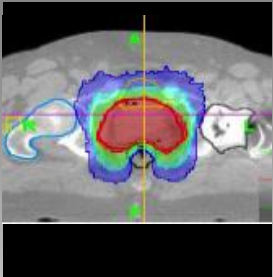
**TomoTherapy Campus of Three Buildings in Madison WI**

# Proved its Versatility

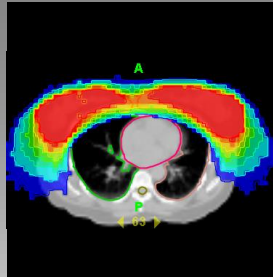
TomoTherapy System is Used for the Full Range of Cancer Types

## Standard Treatments

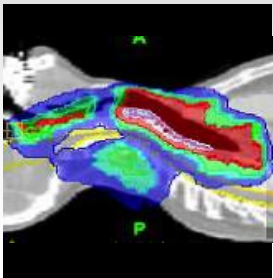
### Prostate



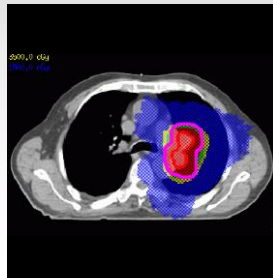
### Breast



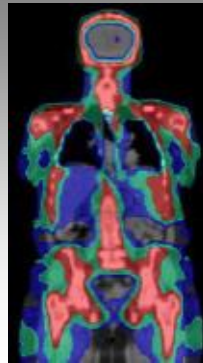
### Head and Neck



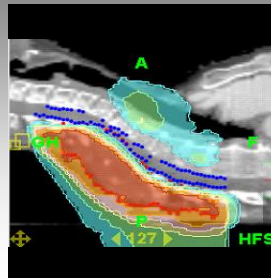
### Lung



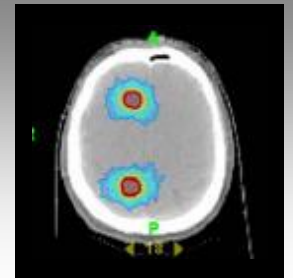
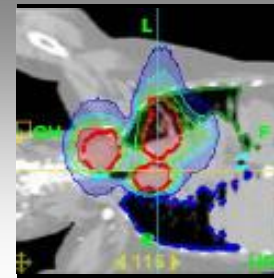
## Total Bone Marrow Irradiation



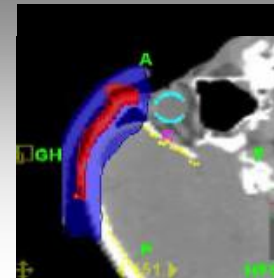
## Tumor Retreatments



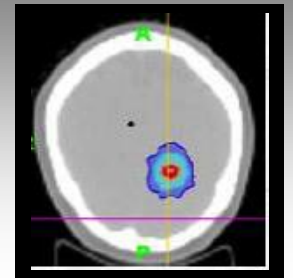
## Multiple Targets at the Same Time



## Superficial Treatments



## Stereotactic Radiosurgery

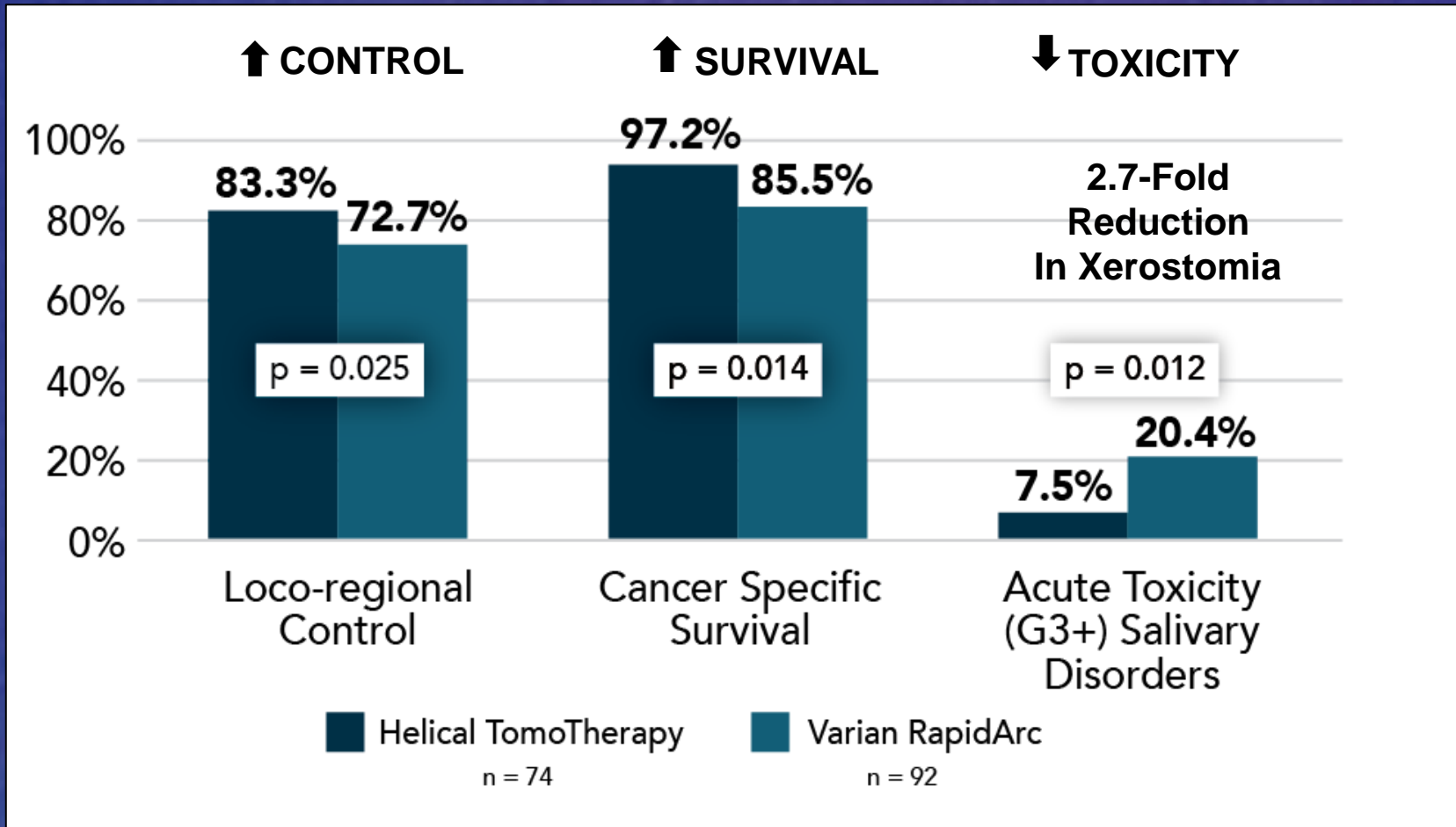


# **TomoTherapy System Proven Clinical Quality**

- **A large body of peer-reviewed literature confirms the clinical advantages of helical tomotherapy for complex cases.**
- **Reasons for improved clinical quality:**
  - **Feasibility of daily image guidance**
  - **Adaptive therapy**
  - **Rotational therapy**
  - **Very high modulation capability**

# Head and Neck TomoTherapy System Vs VMAT

- 14 centers in France – government funded
- 166 patients enrolled, 74 Tomo, 92 Rapid Arc
- 18 month follow up





# Form Follows Function



- IMRT and 3D Delivery
- CT Guidance
- Image Database
- Record and Verify
- Planning System
- Delivery QA
- Adaptive Therapy
- Fully Integrated

**Designed to Make  
the Complex  
Seem Simple**

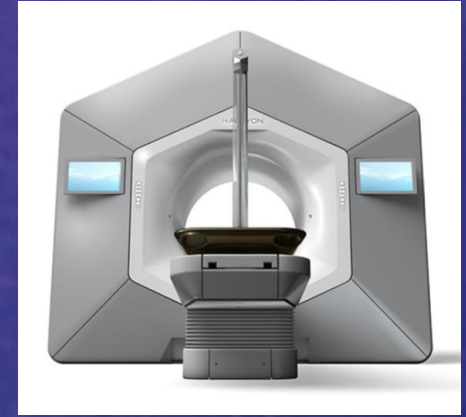
# TomoTherapy Pioneered Modern Coplanar Workhorse IGRT Linacs



**Accuray Radixact (CT)**



**View Ray (MRI)**



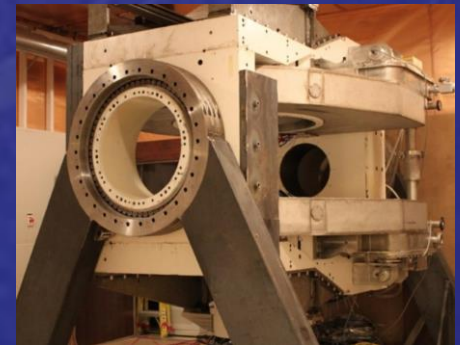
**Siemens Halcyon (CBCT)**



**Elekta Unity (MRI)**



**Reflexion Scintix (PET)**



**MagnetX Aurora-RT (MRI)**

# Take Aways

- **Began as a University of Wisconsin research project with funding from GE and with Siemens linac technology inside.**
- **The TomoTherapy System is the marriage of a CT scanner and a radiotherapy unit, and it pioneered IMRT and IGRT.**
- **In hundreds of peer-reviewed publications TomoTherapy System has documented clinical quality.**
- **Designed to make the complex seem simple.**