



2015
inac
INTERNATIONAL NUCLEAR
ATLANTIC CONFERENCE

BRAZILIAN NUCLEAR PROGRAM

STATE POLICY FOR A SUSTAINABLE DEVELOPMENT

October 04-09, 2015

Rebouças Convention Center
São Paulo, SP, Brazil

XIX ENFIR **XII ENAN** **IV ENIN**

"Perspectives on the Medical Uses of Radiation" Radiotherapy



Câncer no Mundo

2008

Casos novos de CA – 12.7 milhões - (56%)
Mortes por CA – 7.6 milhões - (64%) } países em desenvolvimento

2012

Casos novos de CA – 14.1 milhões
Mortes por CA – 8.2 milhões

Vivos com CA após 5 anos de diagnóstico – 32.6 milhões

Cancer in the world

2008

CA new cases - 12.7 million - (56%)

CA deaths - 7.6 million - (64%)

} countries
development

2012

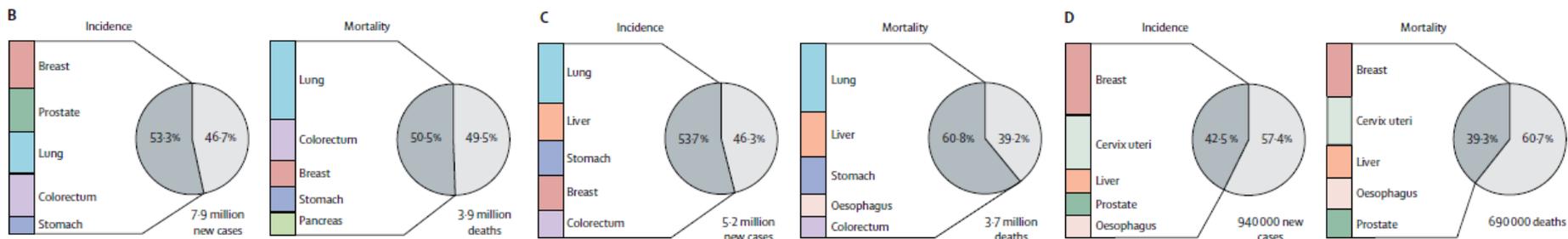
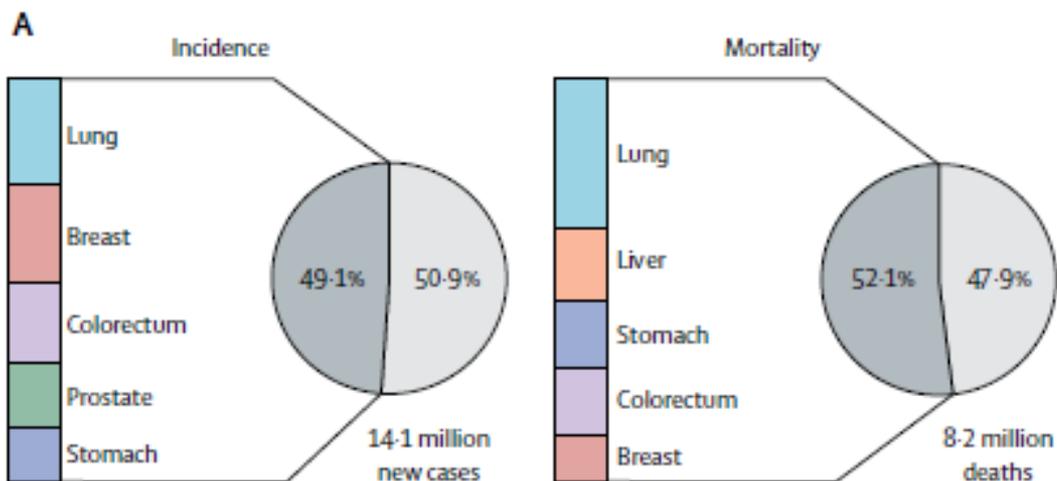
CA new cases – 14.1 million

CA deaths – 8.2 million

Living with CA after 5 years of diagnosis - 32.6 million

Expanding global access to radiotherapy

Rifat Atun, David A Jaffray, Michael B Barton, Freddie Bray, Michael Baumann, Bhadrasain Vikram, Timothy P Hanna, Felicia M Knaul, Yolande Lievens, Tracey Y M Lui, Michael Milosevic, Brian O'Sullivan, Danielle L Rodin, Eduardo Rosenblatt, Jacob Van Dyk, Mei Ling Yap, Eduardo Zubizarreta, Mary Gospodarowicz

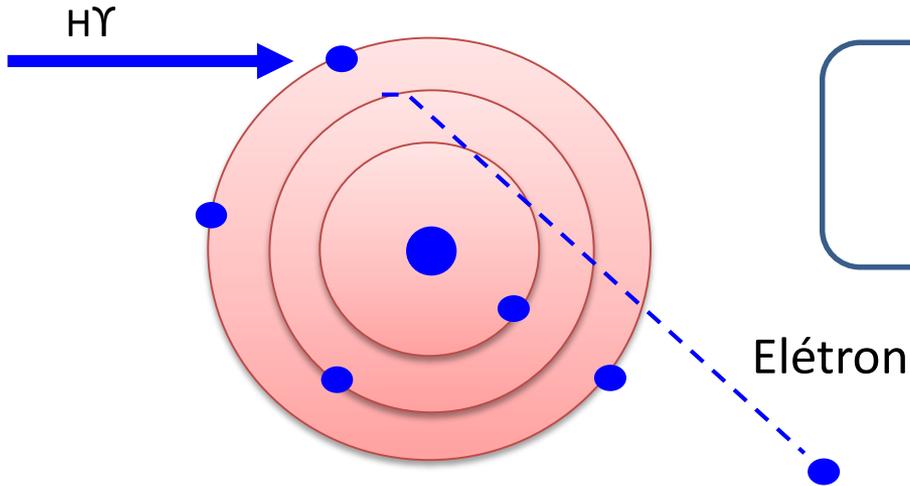


Total incidence of, and mortality from, cancer in 2012 worldwide (A), in high and very high HDI countries (B), in medium HDI countries (C), and in low HDI countries (D). The top five cancers are shown in the dark grey portion of the pie chart. HDI=Human Development Index.

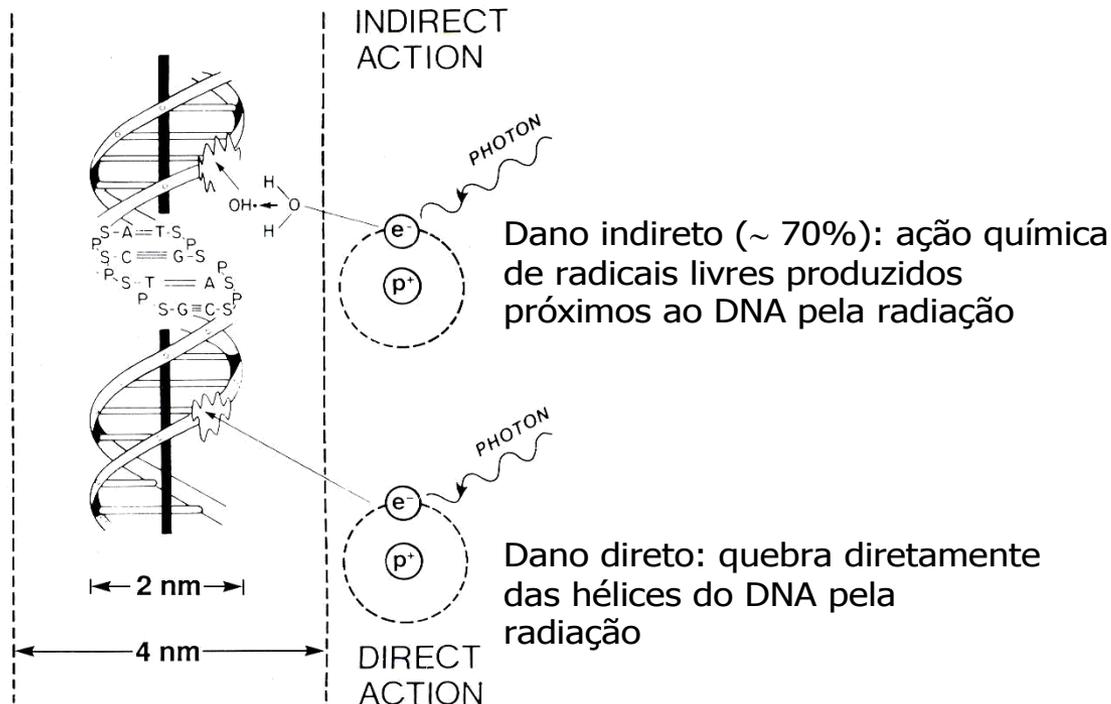
Câncer no Mundo

- Maior expectativa de vida em pacientes com CA
- Melhora do tratamento e da qualidade de vida
- **Na radioterapia - avanços tecnológicos**

Radioterapia: Uso de radiação ionizante para tratamento



Efeito Biológico da Radiação :
Dano Crítico DNA



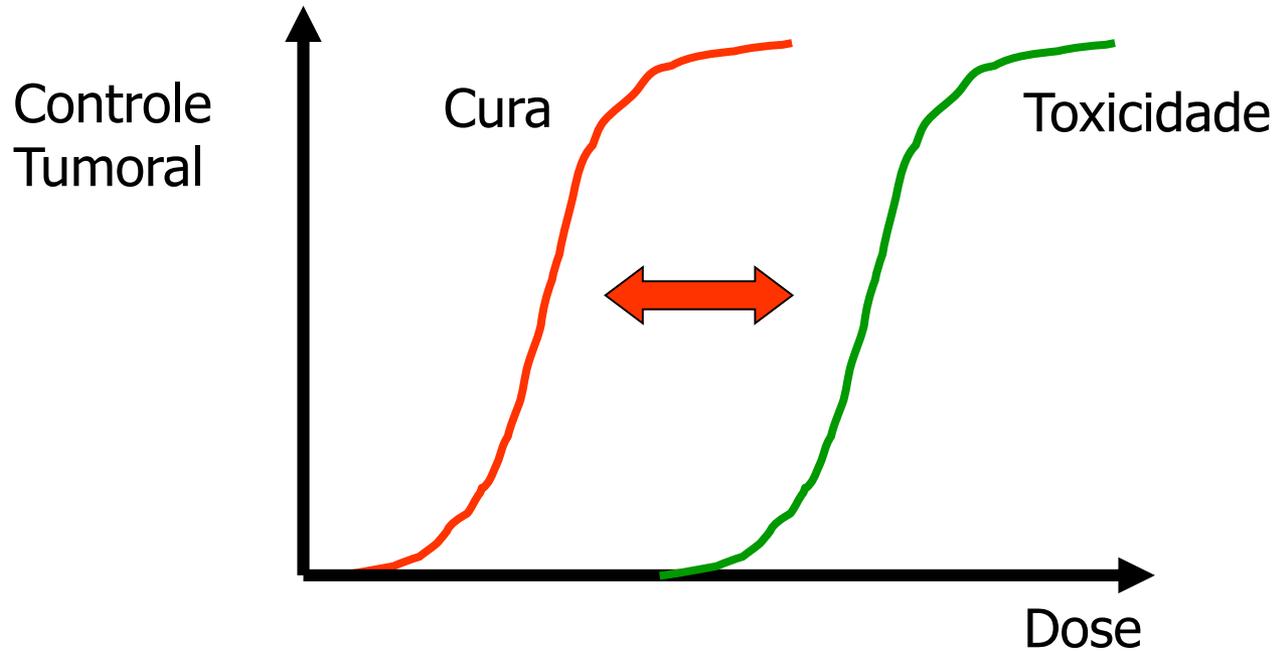
Técnicas de Radiação

- **Teleterapia:** fontes fica distante da região a ser tratada
- **Braquiterapia:** fonte próxima ou em contato implantada na região a ser tratada

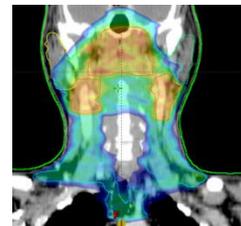
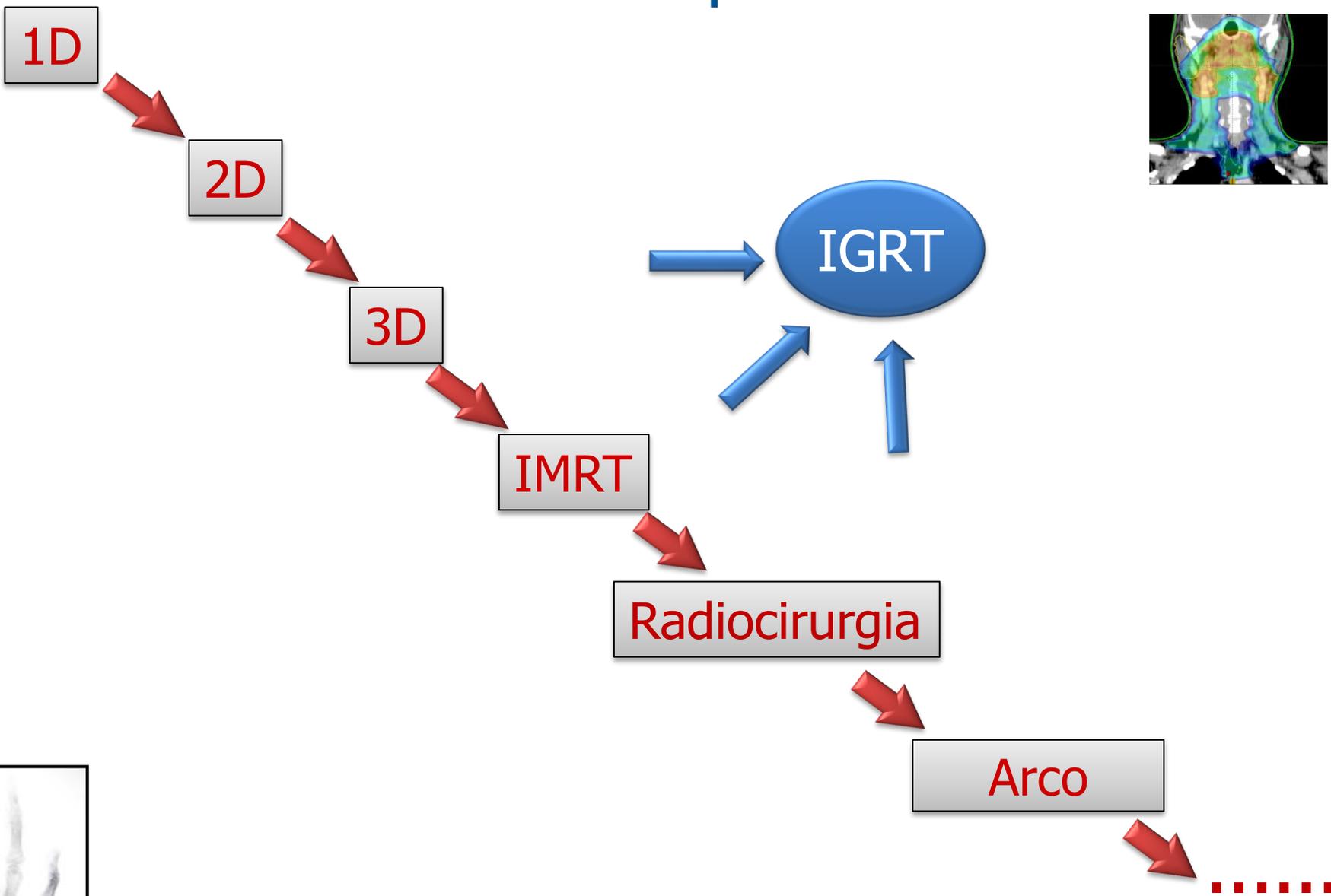
Radioterapia - Objetivo

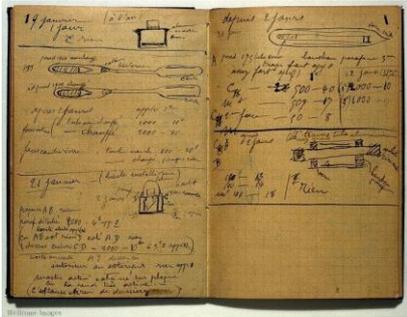
Maximizar dose ao tumor

Minimizar dose ao tecido normal



Teleterapia





1 Dimensão



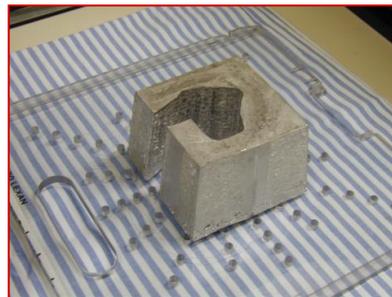
Técnica hipofracionada
Reações cutâneas importantes → necrose
"Modelo radiobiológico" observação da pele

Radioterapia Convencional

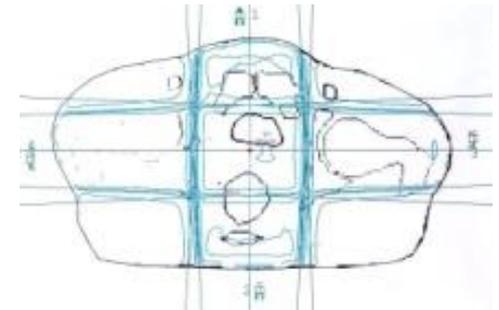
2 Dimensões



Filme de Verificação



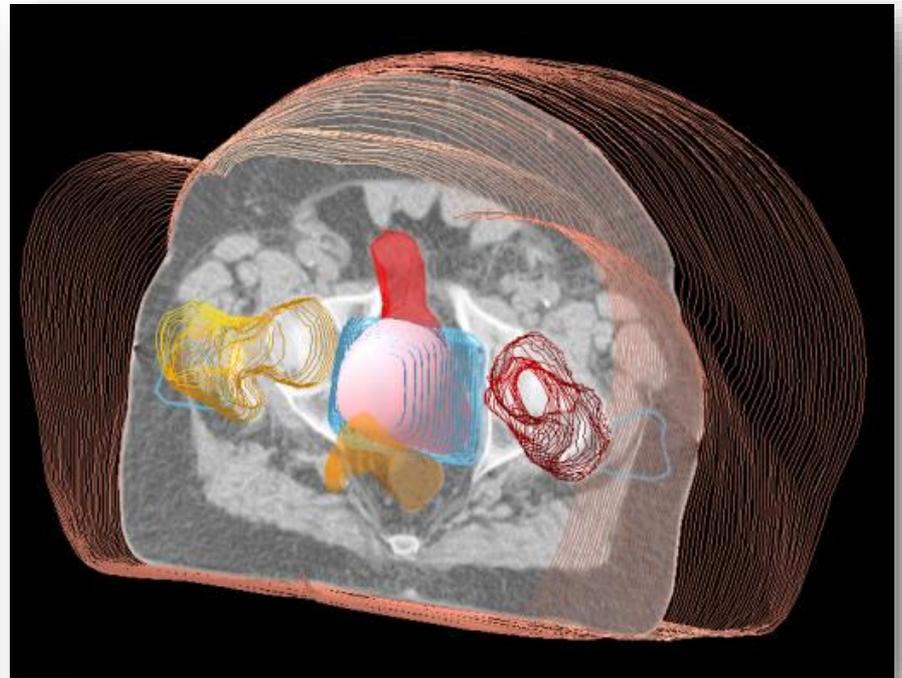
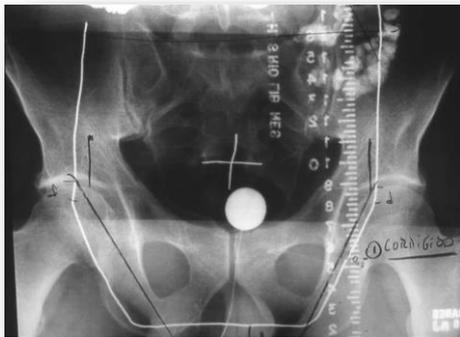
Colimação individual Blocos



Curva de Isodose Manual

3 Dimensões

3D Conformacional



Volumétrico

Relação espacial entre: Tumor e Tecidos normais

Imagens Tomografia

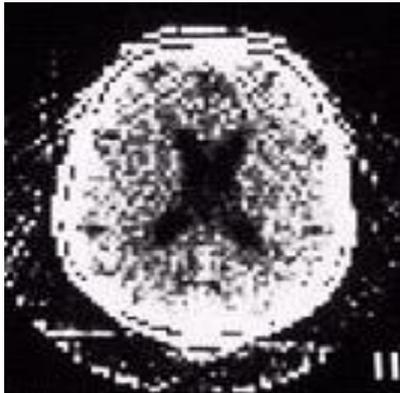


Godfrey Hounsfield



Allan Cormack

1972



Nobel Medicina 1979

Matrizes de coeficiente de atenuação convertidos em densidade eletrônica

Coeficiente de atenuação: $CT \ n^{\circ} = 1000 [\mu_i - \mu_w / \mu_w]$

μ_w = coef atenuação linear para água

Base:

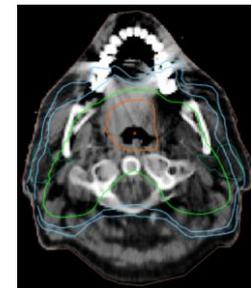
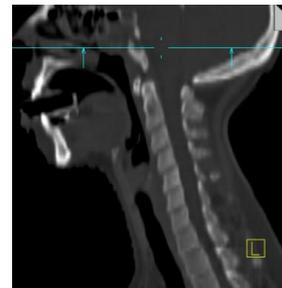
A atenuação dos fótons através de diferentes tecidos é diferente!

Permite:

Localização dos volumes (Tu e OAR)

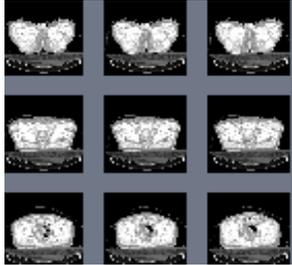
Cálculo da distribuição de dose

Determina a anatomia em 3D como um mapa de valores de densidade eletrônica



Radioterapia 3D : É necessário

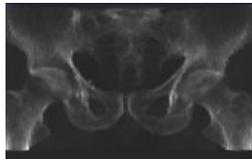
Imagens CT



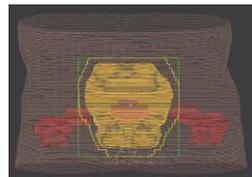
Sistema de Planejamento



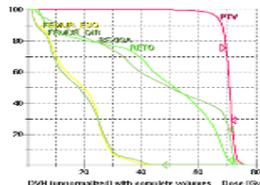
Ferramentas



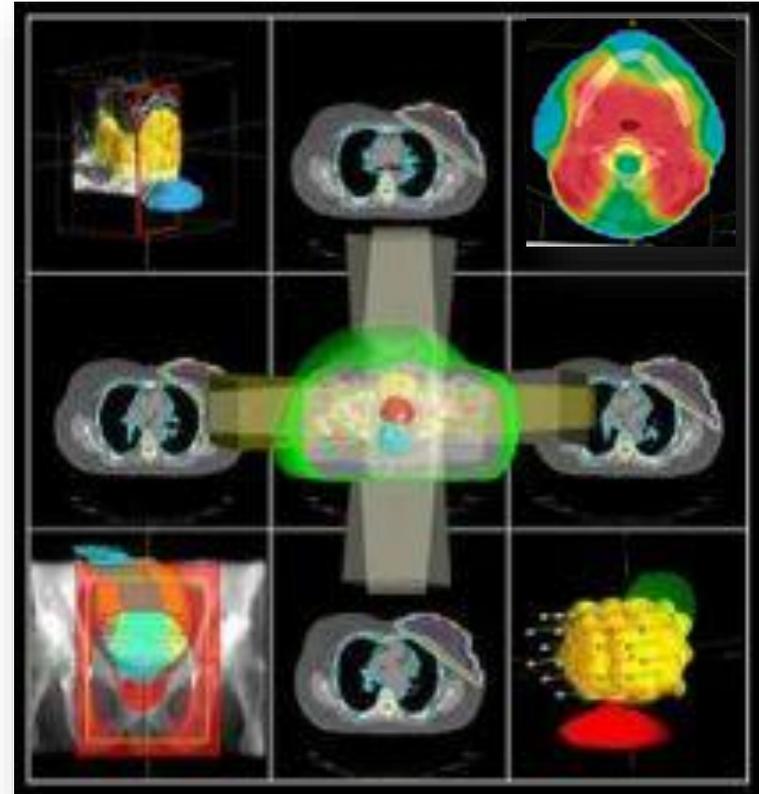
Digital Reconstruction Radiography



Beam's Eye View

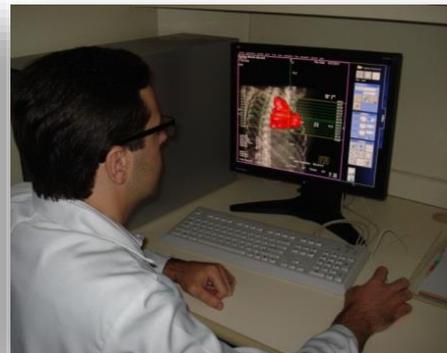


Histograma de Dose Volume



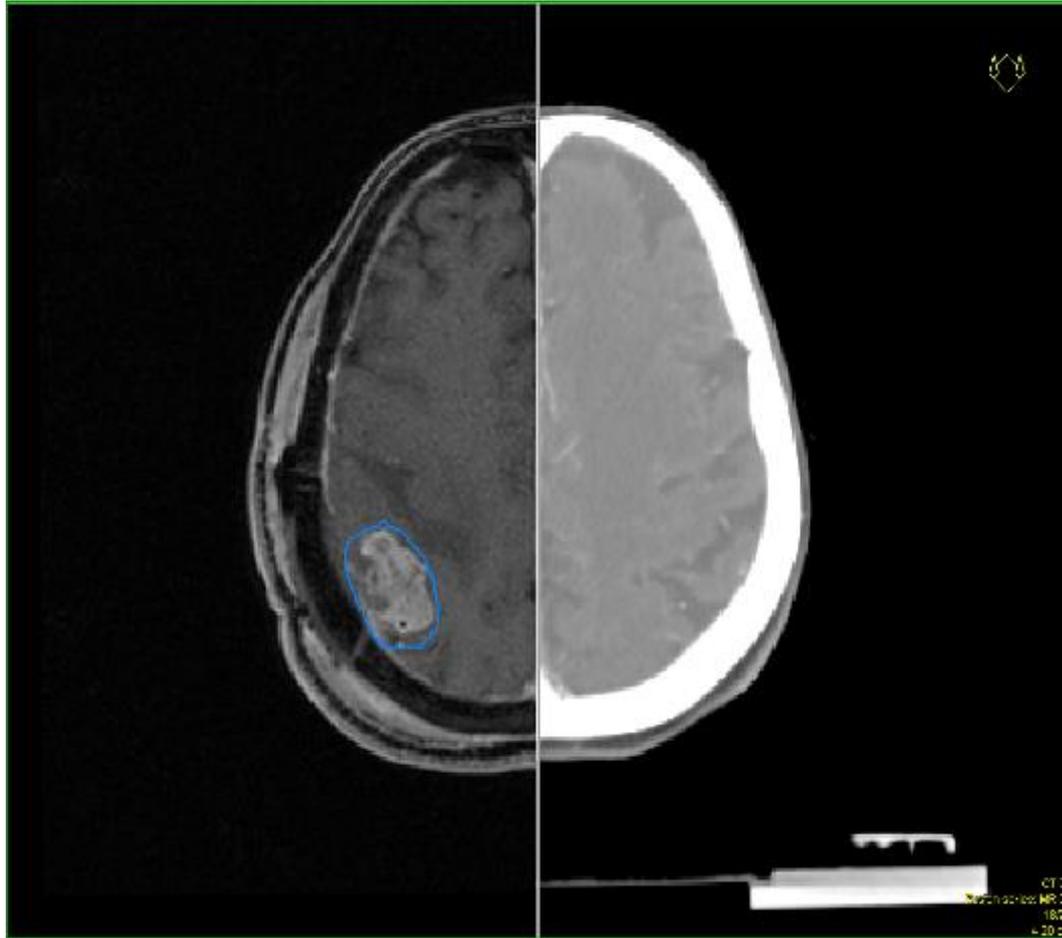
Tomógrafo Simulador

Mesa plana, sistema de laser e software específico para simulação virtual



Definição de alvo: desafio

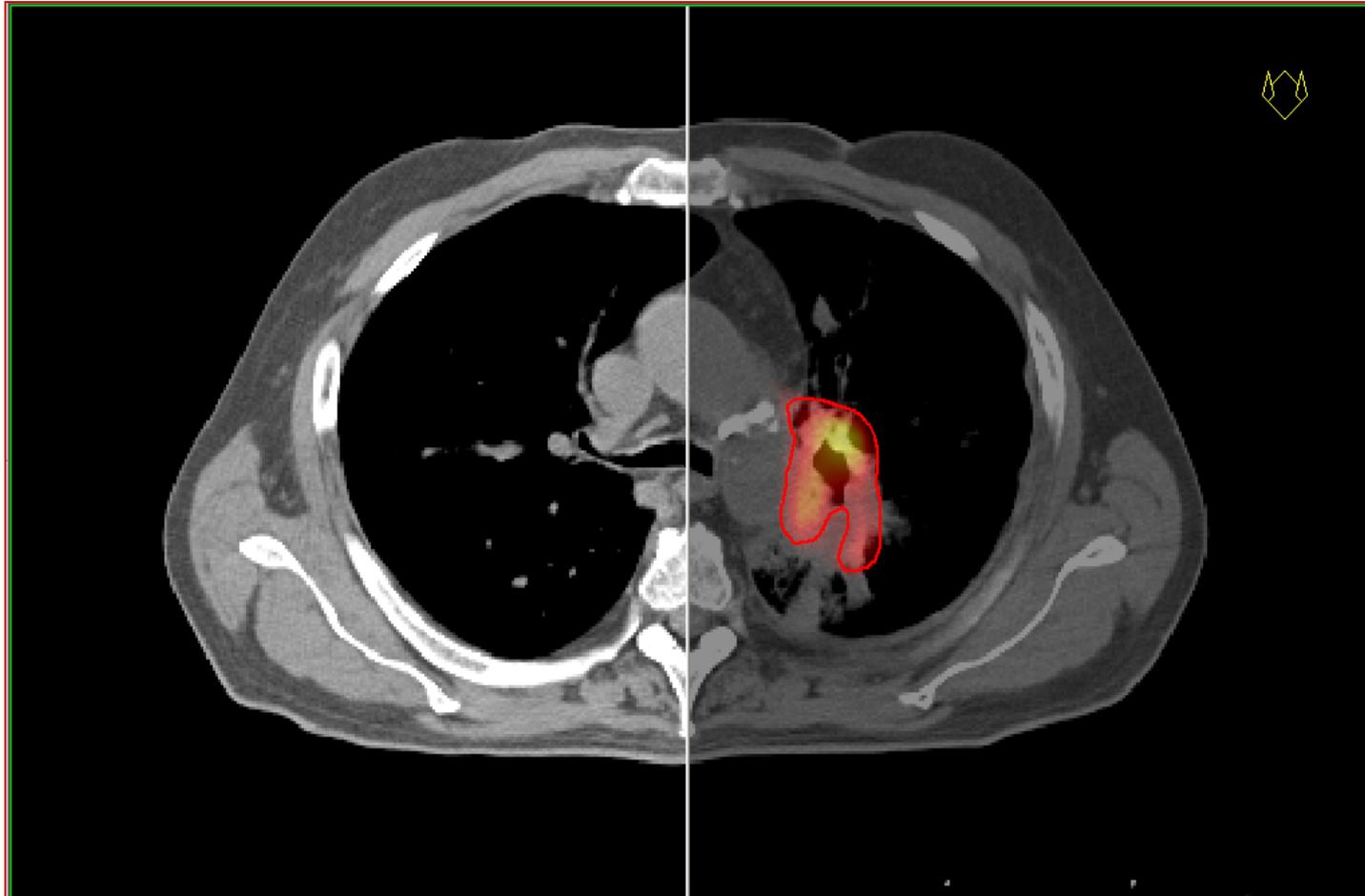
Imagens complementares



Ressonância magnética

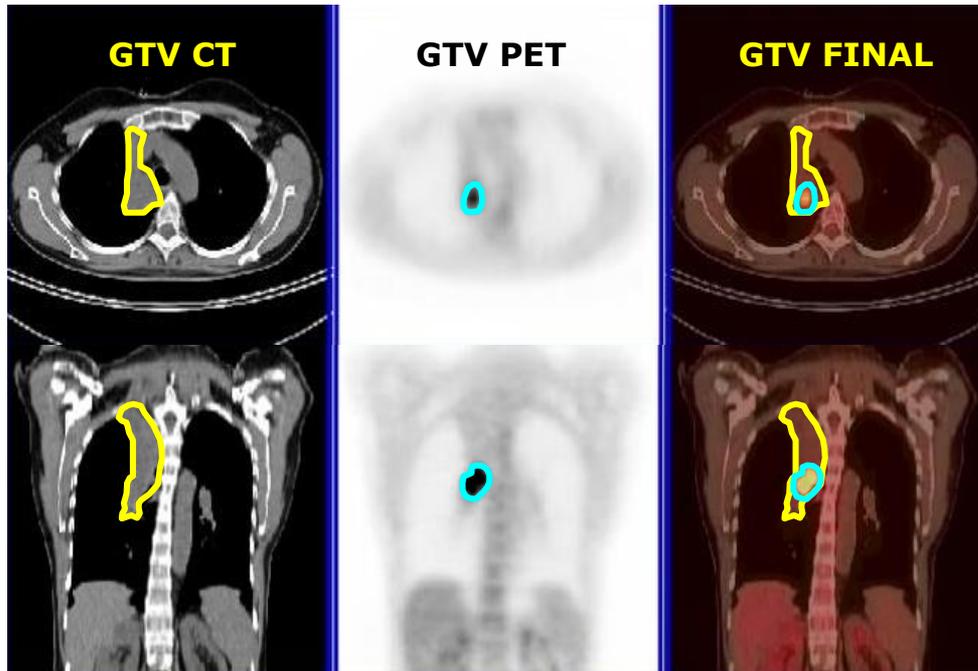
Definição de alvo: desafio

Imagens complementares

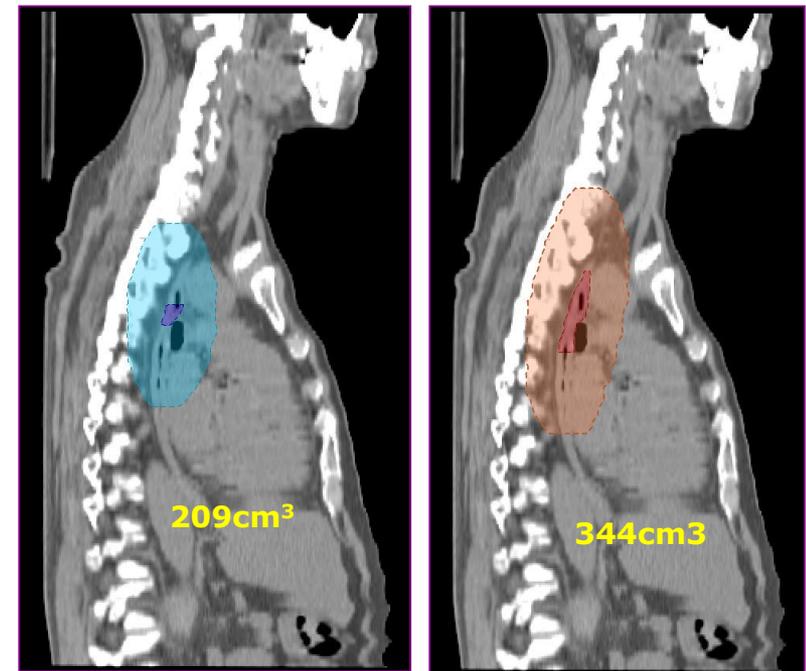


PET - CT

PET-CT em RXT



Diminui o Volume-alvo



Aumenta o Volume-alvo

 **THE VALUE OF PET/CT FOR RADIOTHERAPY TREATMENT
PLANNING: CAN TARGET VOLUMES BE CHANGED ?**
HOSPITAL SÍRIO-LIBANÊS GN Marta, SA Hanna, CMK Haddad, JLF da Silva
Hospital Sírio- Libanês - Sao Paulo - Brazil

Qual modalidade de imagem ?

Depende características do tecido a ser analisado

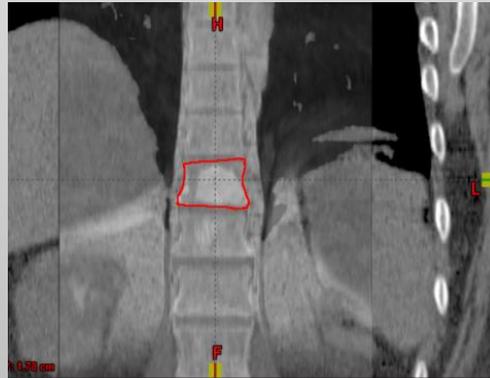
CT :

- Nódulos pulmonares
- Pulmão
- Fígado (com contraste)



MRI:

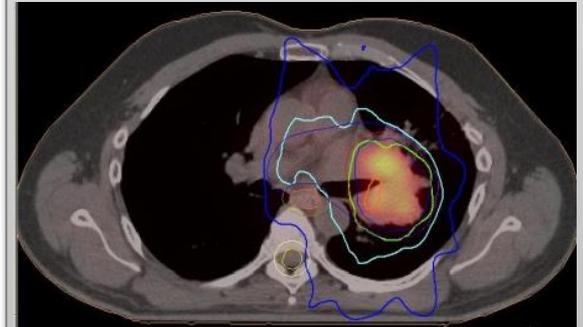
- Cérebro
- Próstata
- Espinais
- Abdome



PET-CT:

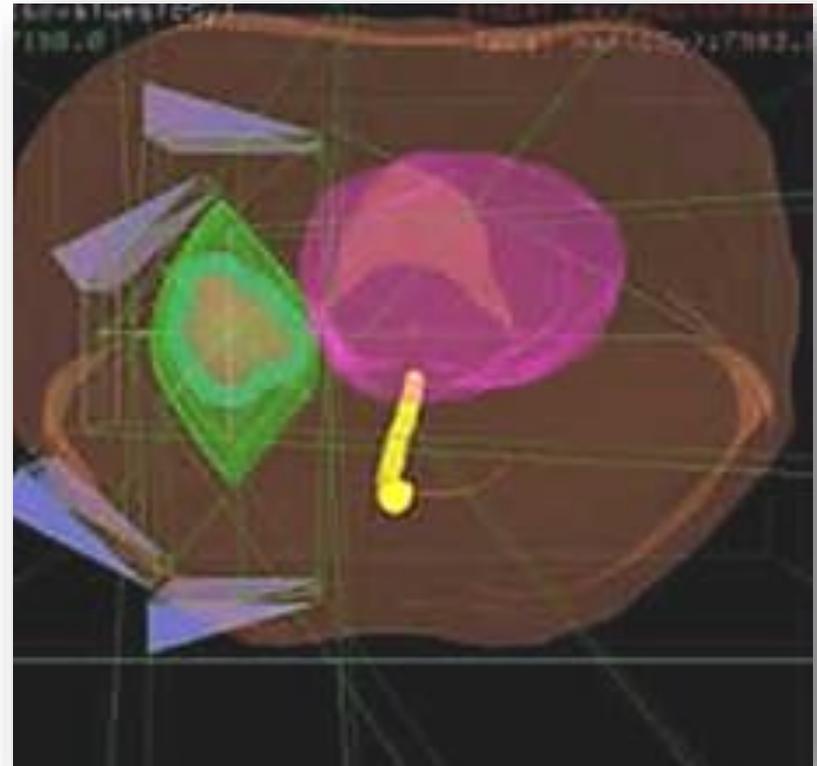
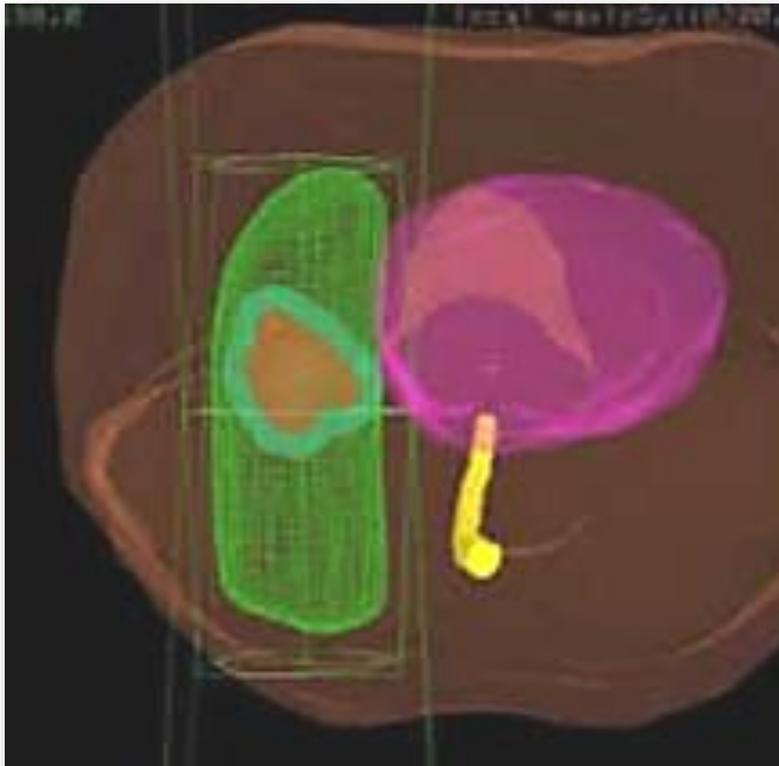
Sítio de doença ativa

- Pulmão
- HN
- Cólon
- Fígado

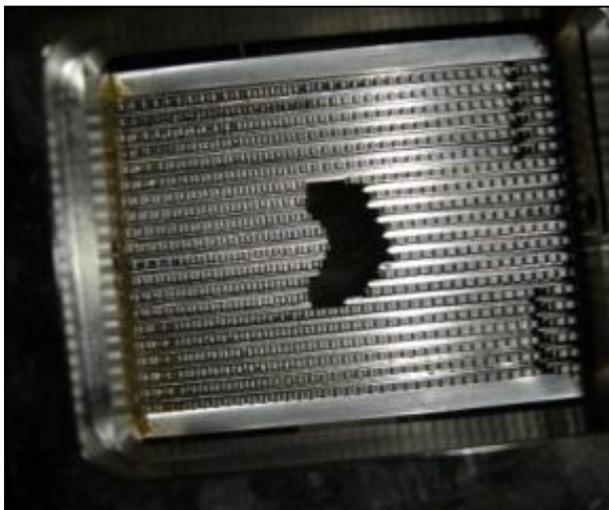


Tratamento

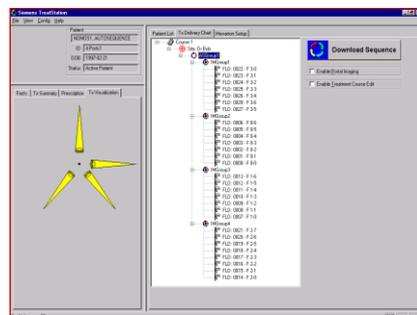
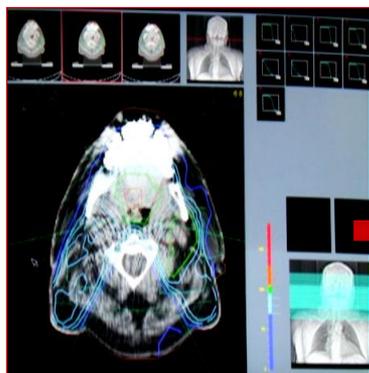
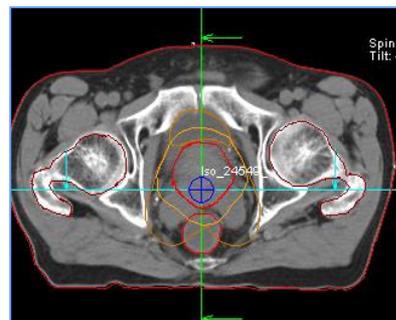
2D vs 3D



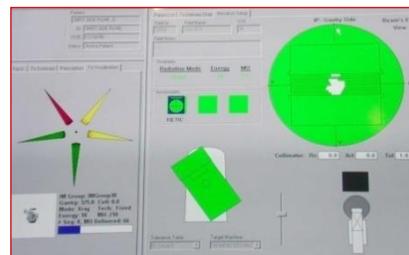
Novas Ferramentas



MLC
Colimadores de Multi Laminas



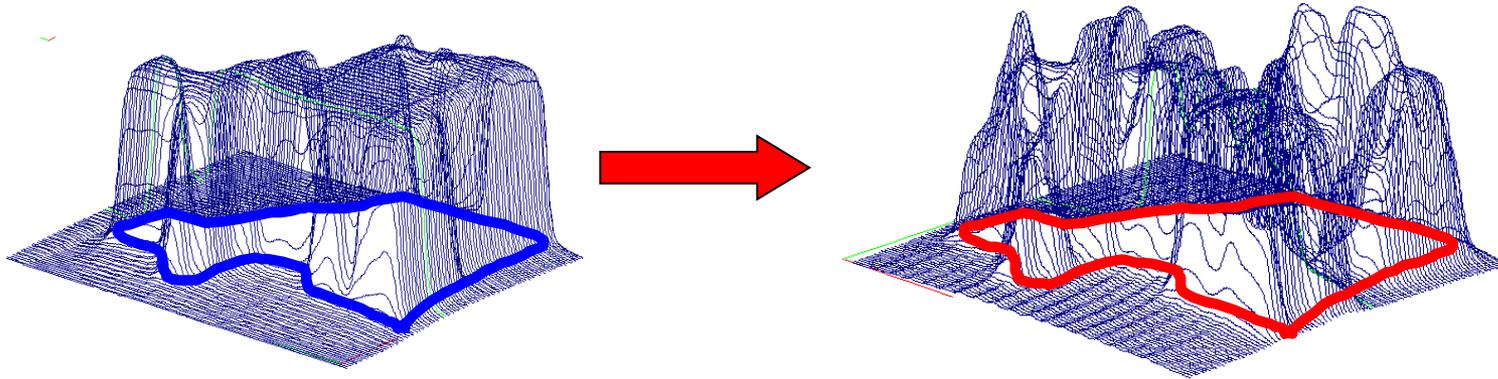
Transfere (imagens, dados)
Verifica e Registra os dados



Softwares de automatização

Novos algoritmos
TPS

Radioterapia com modulação da intensidade do feixe **IMRT**



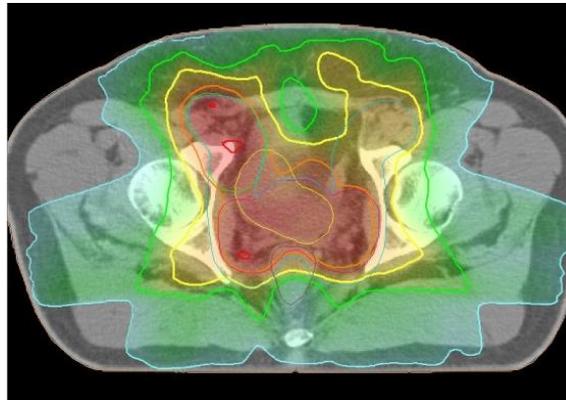
3D

+

Varição na
intensidade do
feixe

=

IMRT



IMRT : Planejamento Inverso

Ponto de partida:

Definir matematicamente os objetivos clínicos e dosimétricos

- Volumes
- Restrições de Dose

Próstata

Reto

$\leq 17\%$ a $\geq 65\text{Gy}$

$\leq 35\%$ a $\geq 40\text{Gy}$

Bexiga

$\leq 25\%$ a $\geq 65\text{Gy}$

$\leq 50\%$ a $\geq 40\text{Gy}$

Função Objetiva (Custo)



“Combustível” no processo de Otimização”

Função Objetiva: Somatória das diferenças quadráticas entre as doses desejadas e obtidas para todos os pontos de interesse dentro do paciente

Por exemplo:

$$F = \left[\left(\frac{1}{N} \right) \sum_{\vec{x}} w(\vec{x}) (D_0(\vec{x}) - D(\vec{x}))^2 \right]^{1/2}$$

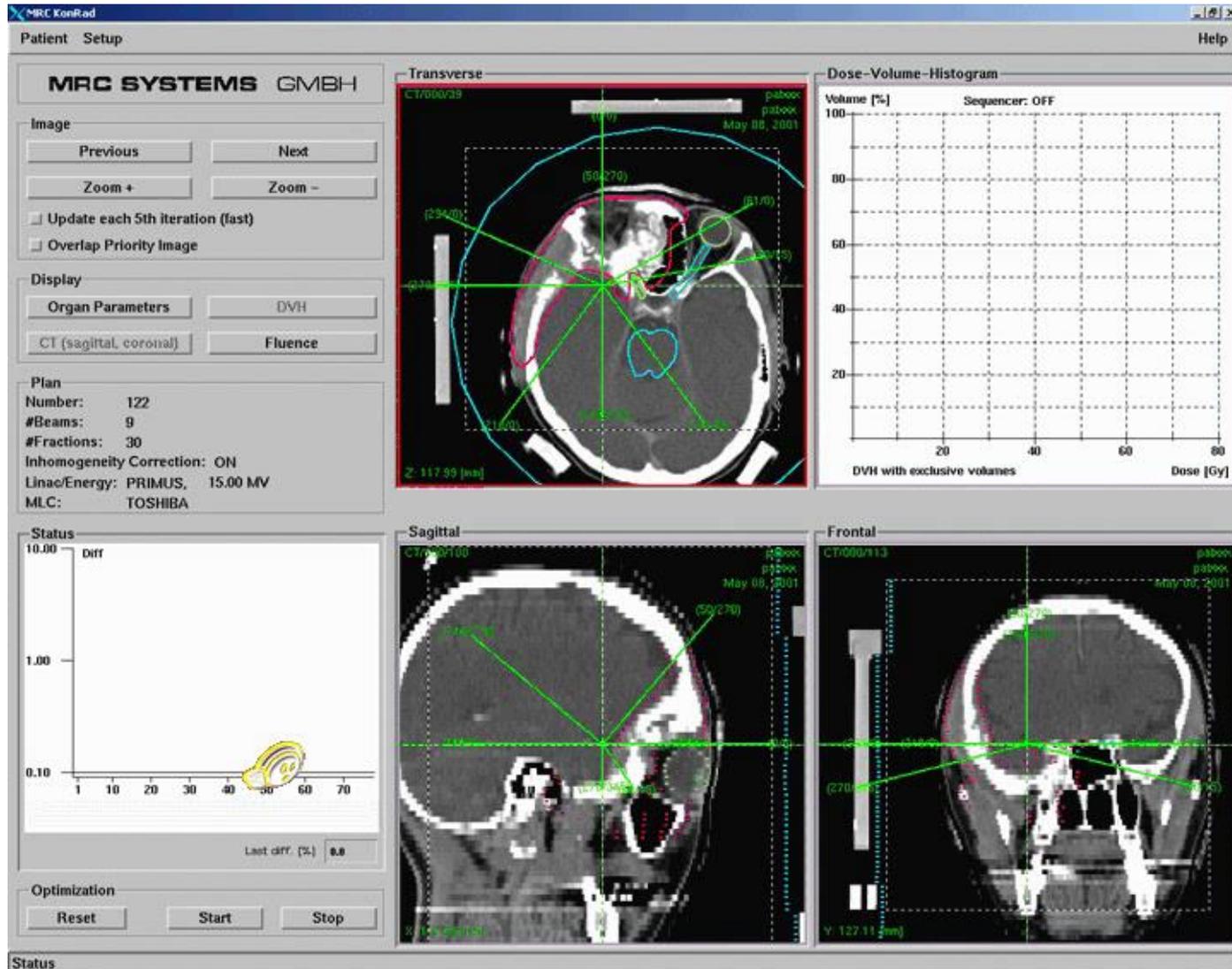
$\min F \Rightarrow$ Melhor planejamento

Importância dada ao volume de interesse

Diferença de doses

Função Objetiva (Custo)

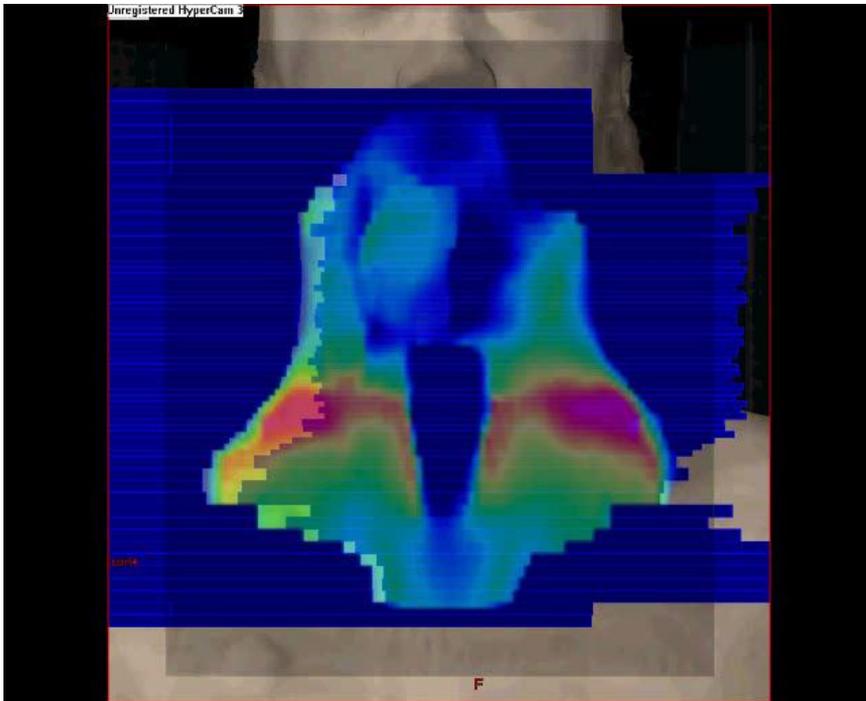
Ferramenta para cálculo que "guia" a otimização



IMRT: Tratamento

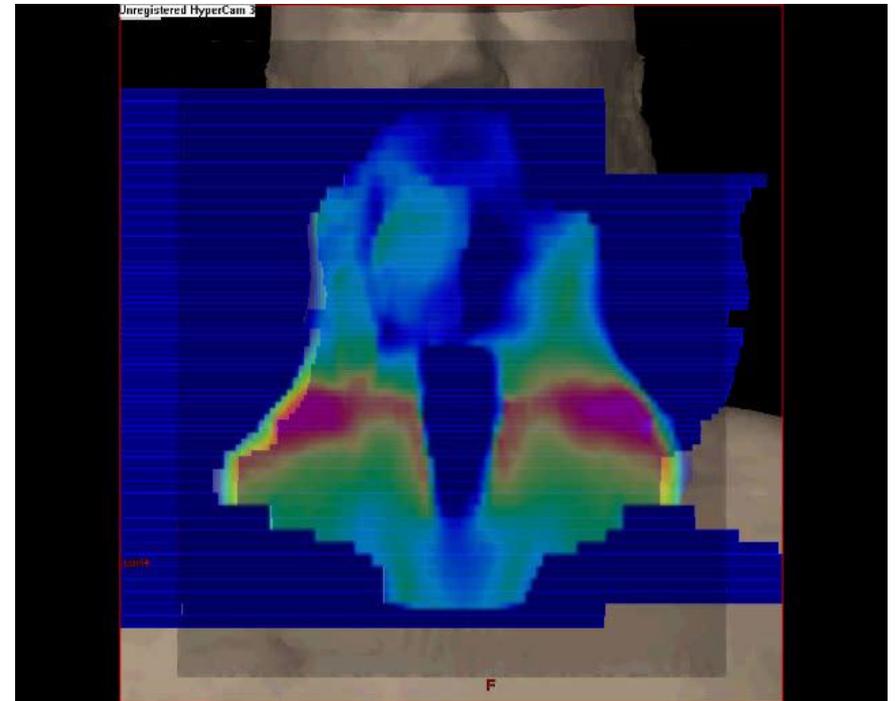
Desafios: Entrega da Dose

Mecanismos sofisticados de movimento de MLC



Step and Shoot

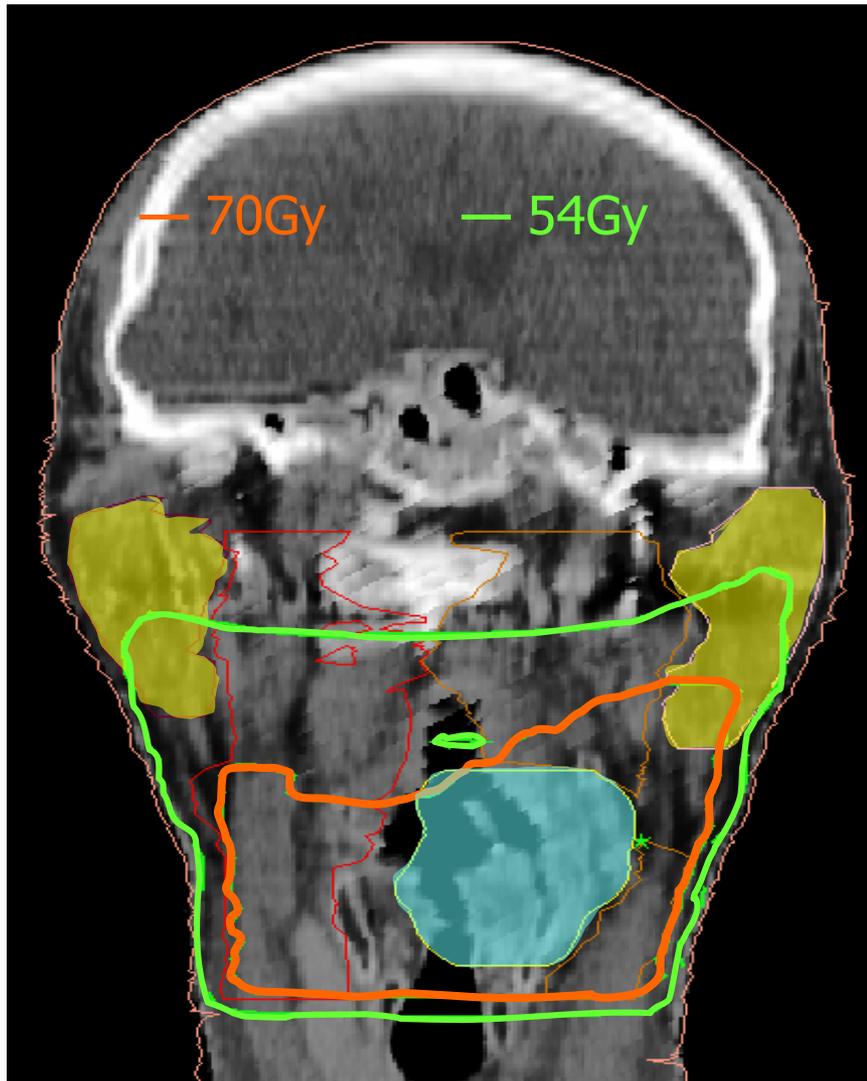
Movimento de MLC e irradiação são executados *seqüencialmente*



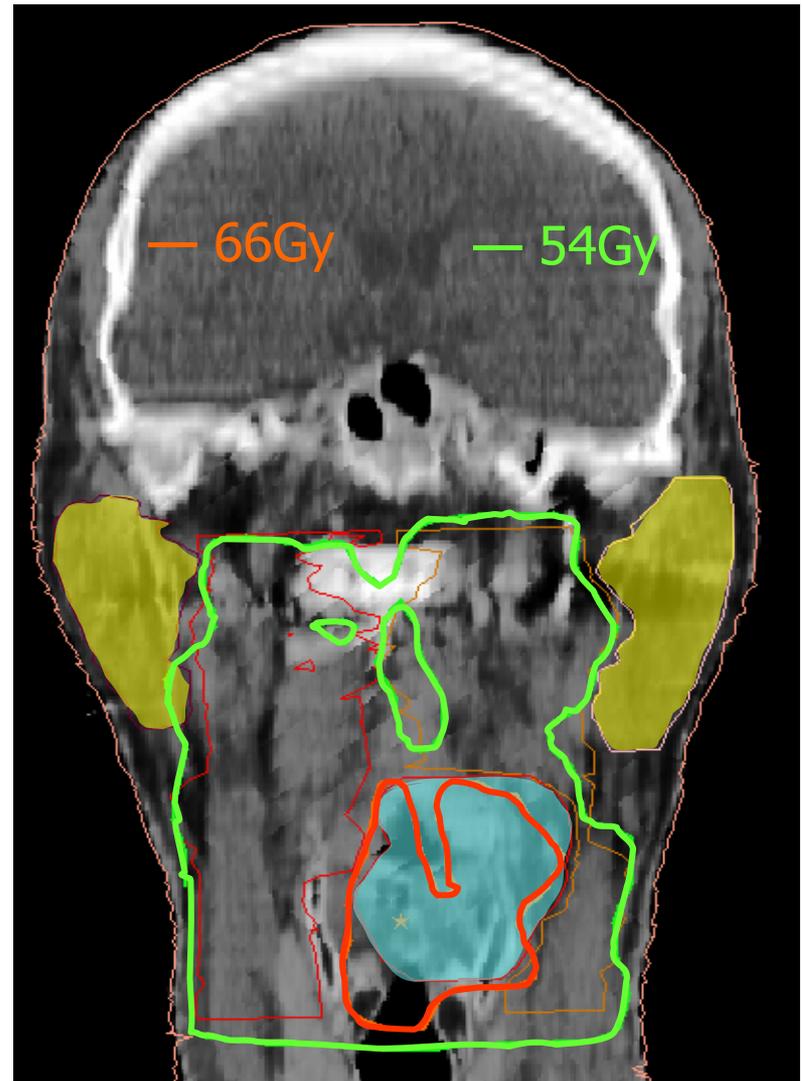
Sliding Window

Irradiação continua durante o movimento das MLC obedecendo trajetórias pré determinadas

Cabeça e Pescoço



2D

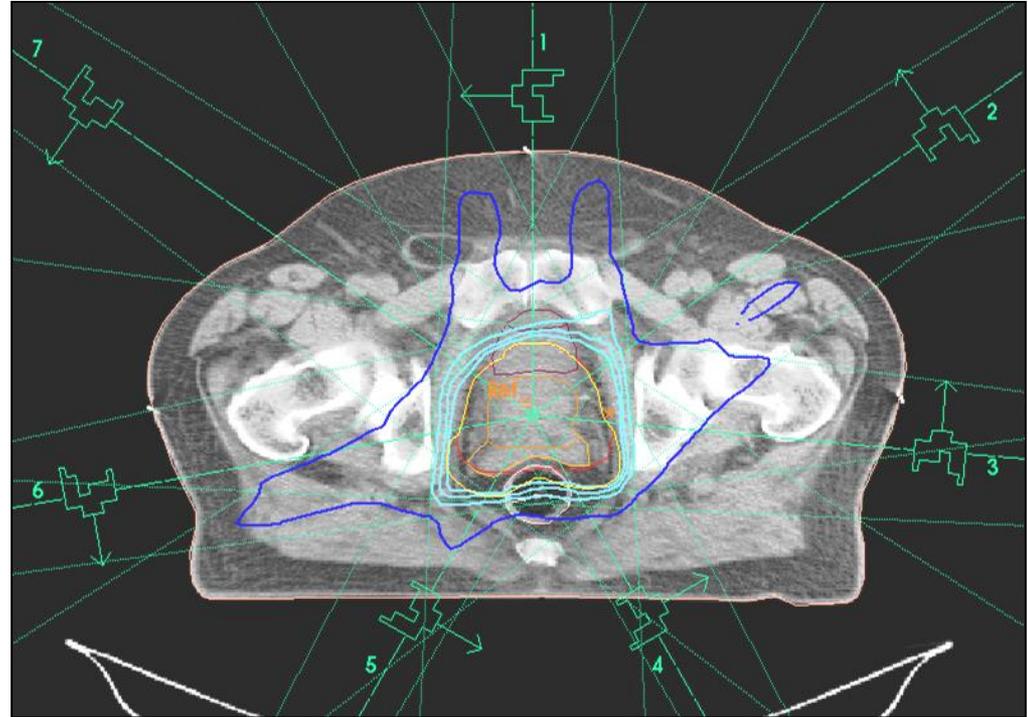


IMRT

HSL



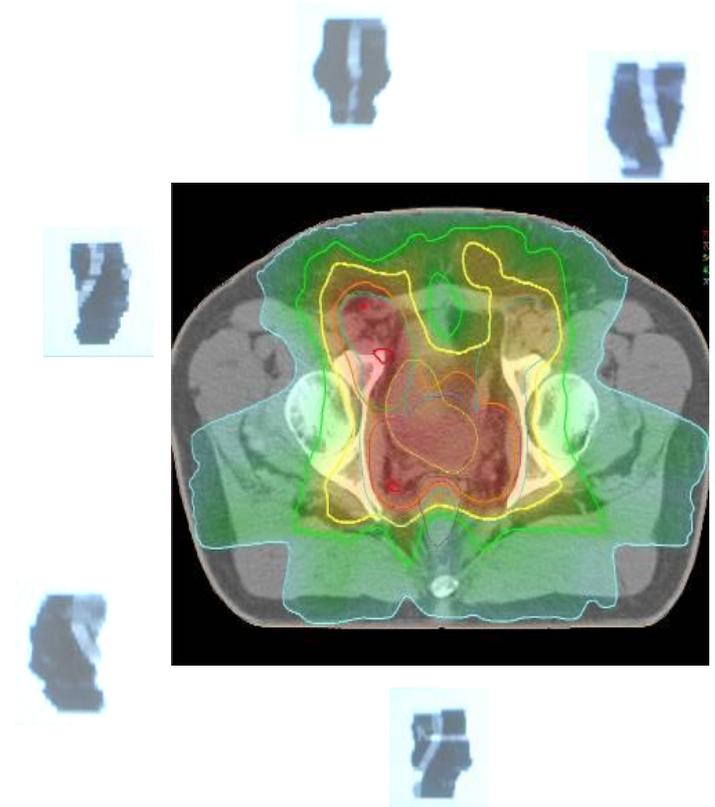
13 Outubro 2000:
Realizado: 1º **IMRT**



Próstata

Implementação Clínica do IMRT

- Equipamentos
- Experiência em 3D
- Mudança de prática
 - Multimodalidade de imagens
 - Cálculo Dose Plan Inverso
- Controle de Qualidade:
 - Tratamentos individuais
- Treinamento do staff

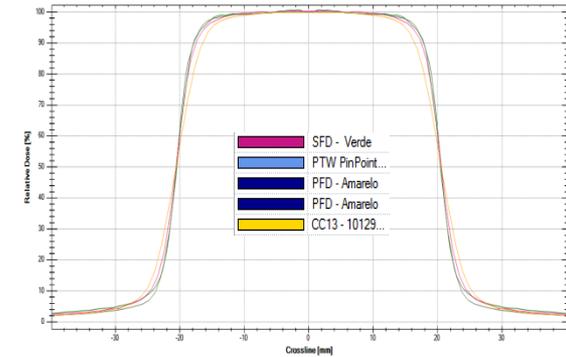
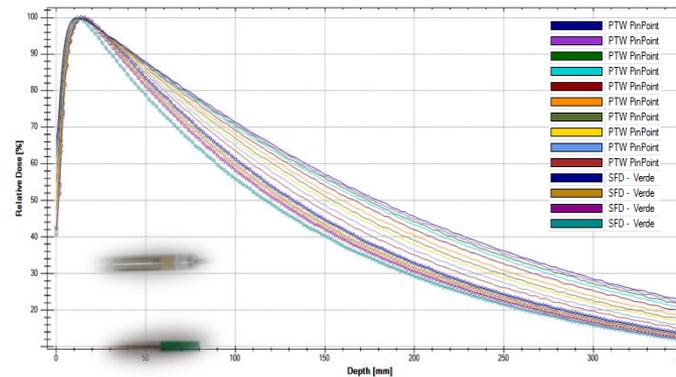
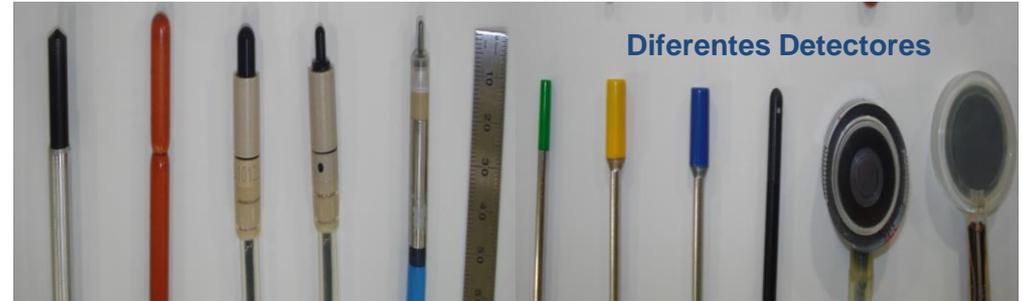


Aceitação e Comissionamento de Aceleradores Lineares

1-Verificar os requisitos e recomendações do fabricante

Tipos de dados que são adquiridos

- Perfil de Dose em Profundidade (PDD)
- Perfis de Dose nos Eixos Lateral/ Diagonais
- Perfis no Ar
- Varreduras Específicas
- Medidas pontuais absolutas e fatores relativos:
 - Medidas Absolutas
 - Fatores Output na Água/ no Ar
 - Fatores de Acessórios / Transmissão
 - Parâmetros específicos do MLC



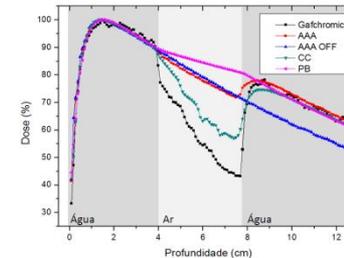
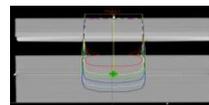
2- Requisitos Sistema de Planejamento

Validação

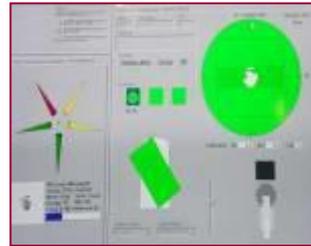
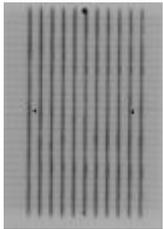
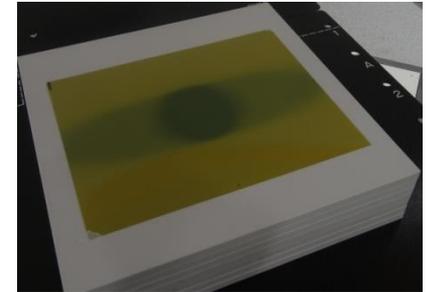
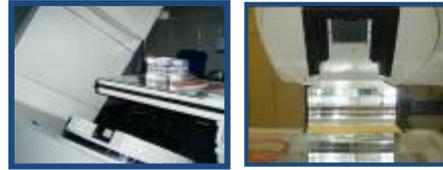
Cálculo de Dose

Heterogenidade

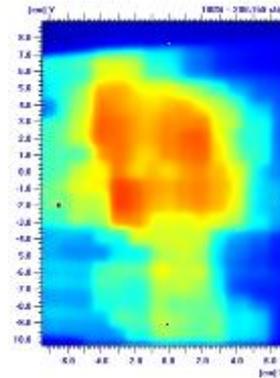
IMRT/ VMAT.....



Controle de Qualidade Equipamentos



+
Recursos Humanos

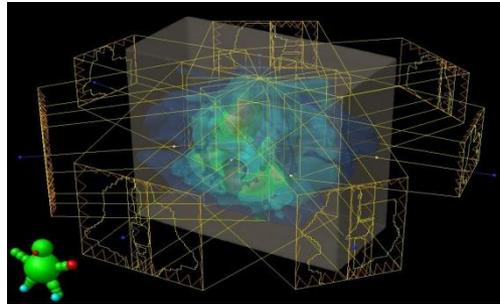


QA: Validação de cada paciente

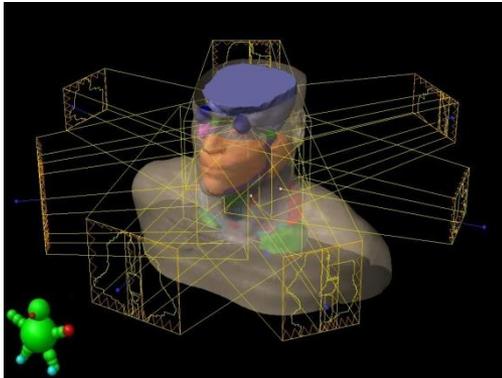
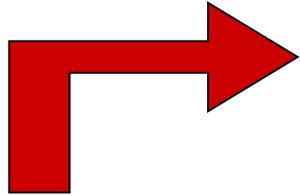
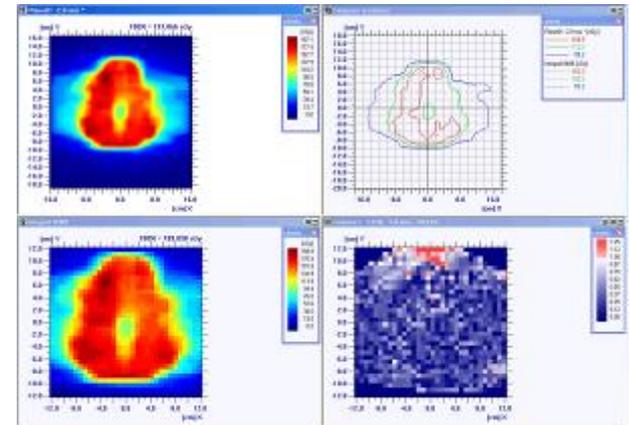


Planejamento é transferido para a CT do fantoma

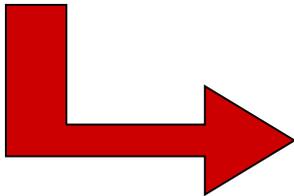
Fantoma



Função Gama



Paciente



Matrixx

Técnicas de Radiação

Radiocirurgia: SRS

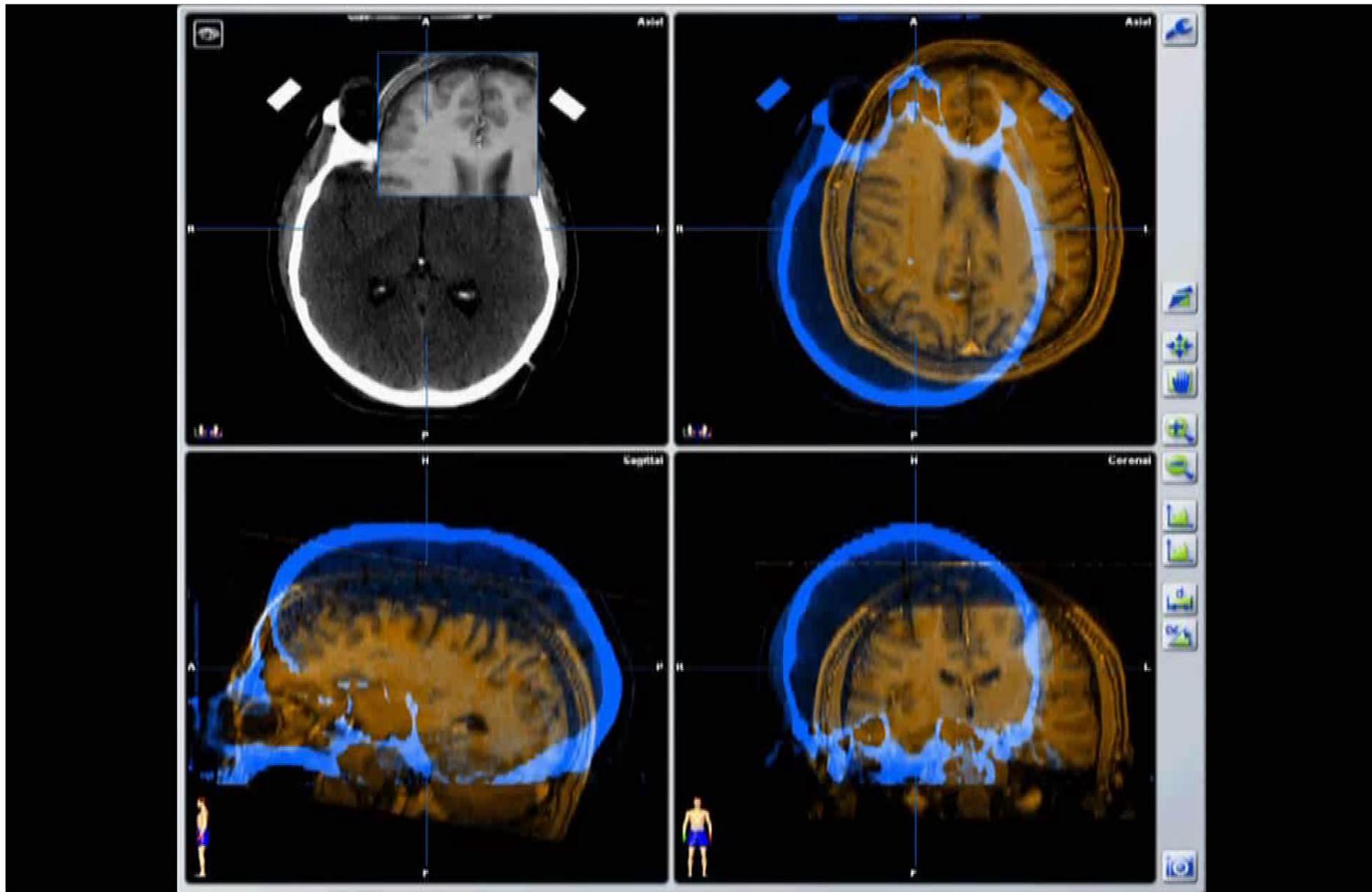
utiliza aparato esterotático e feixes de radiação com para irradiar a lesão com uma única fração ou em até 5 frações

Radioterapia Estereotática: SRT

utiliza aparato estereotático e feixes de radiação para irradiar a lesão com múltiplas frações ou tratamentos

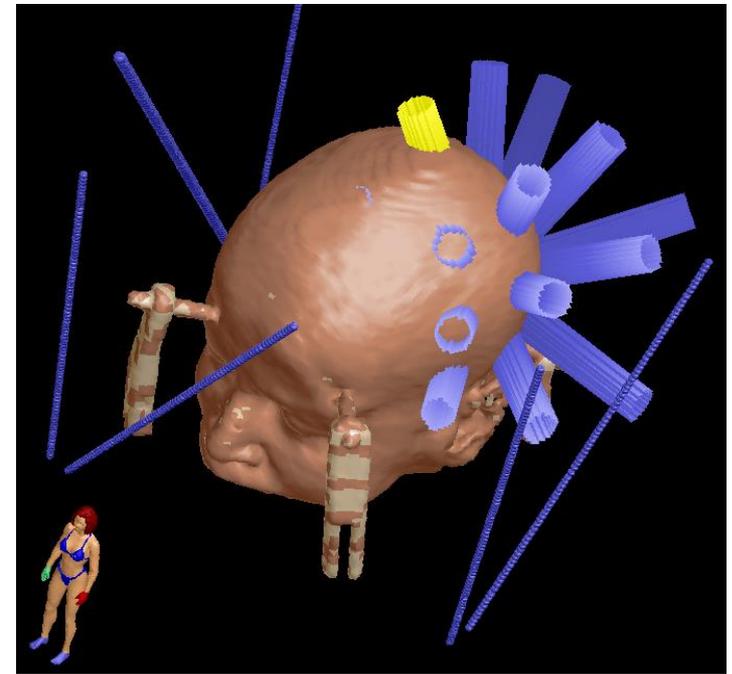
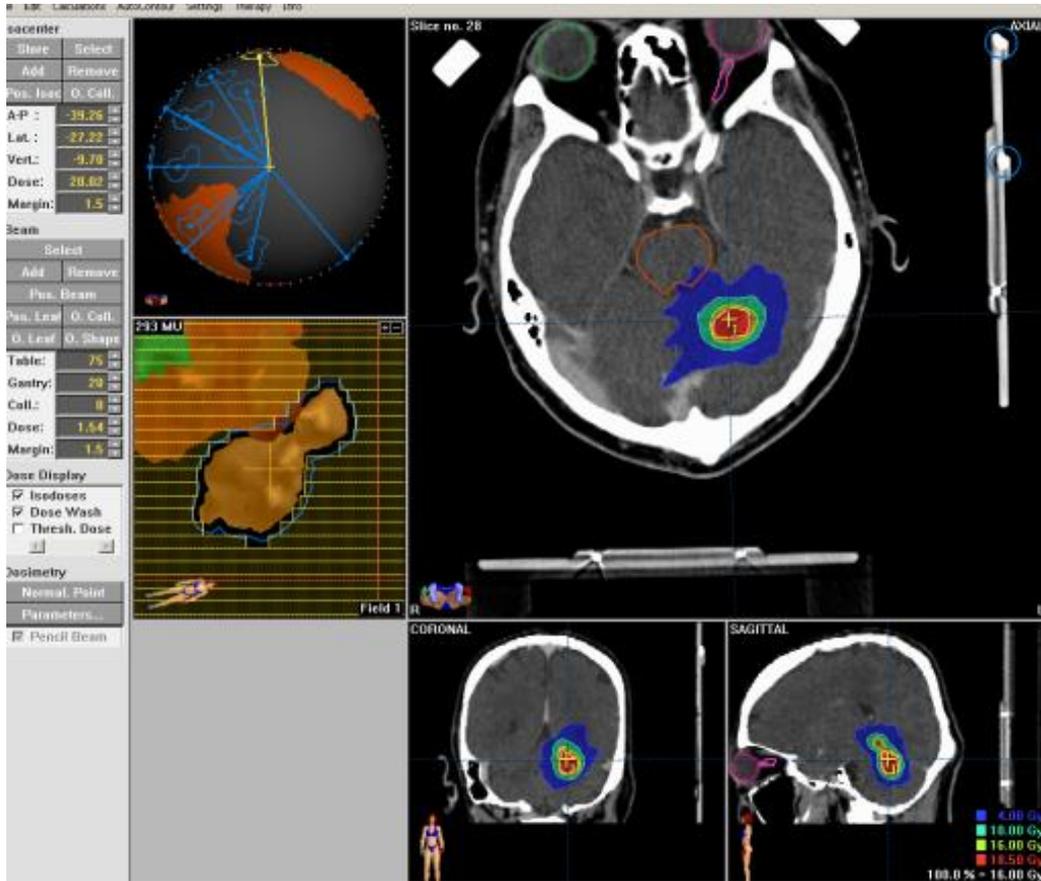


Fusão de Imagens: CT + MRI



Planejamento de Radiocirurgia

Distribuição de Dose



SRS - SRT

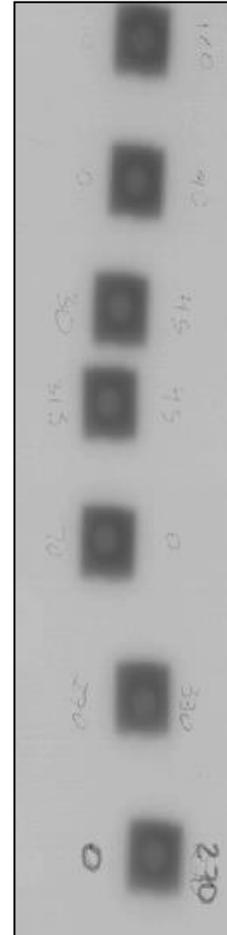
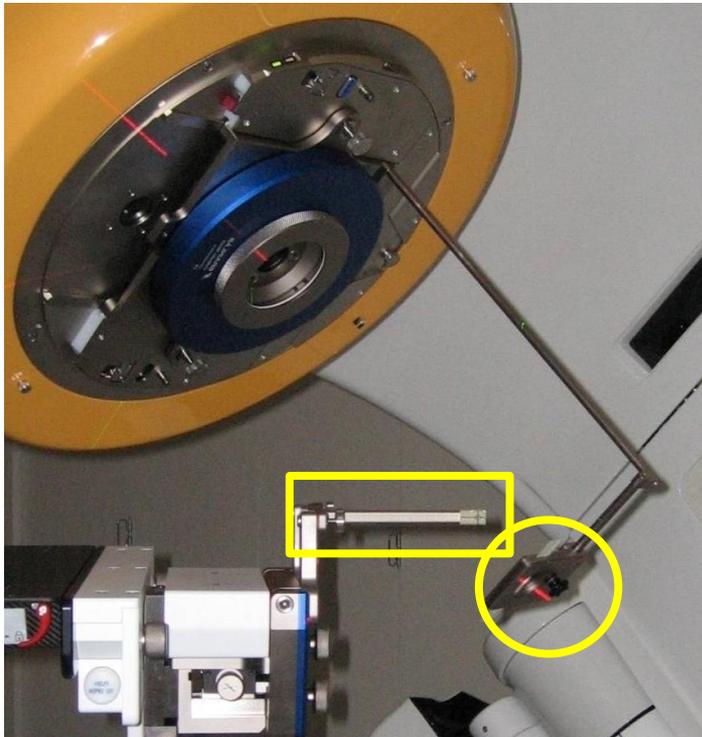
Frameless

Frame



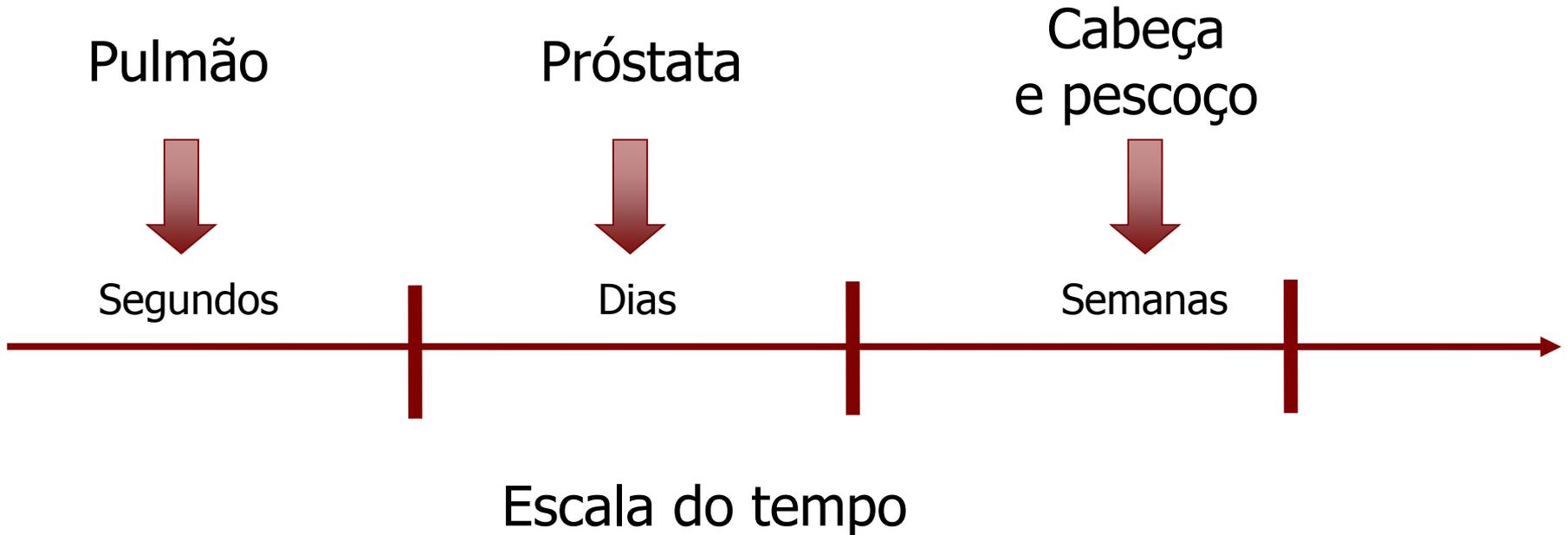
Winston-Lutz

Verifica a coincidência entre os lasers e os isocentros mecânico e radioativo do aparelho



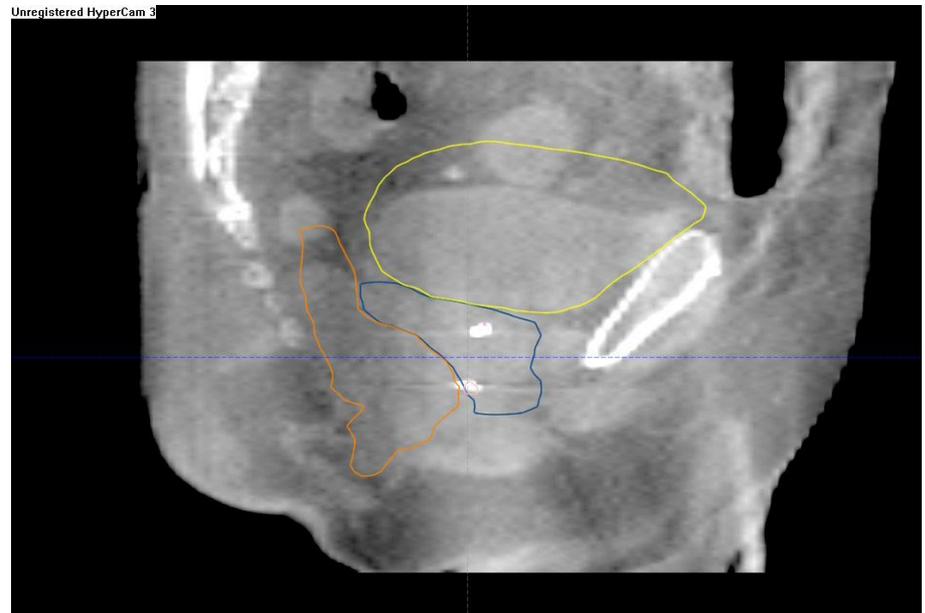
Mesa = 0° Gantry = 180°	
Mesa = 0° Gantry = 90°	
Mesa = 30° Gantry = 45°	
Mesa = 315° Gantry = 45°	
Mesa = 90° Gantry = 0°	
Mesa = 270° Gantry = 330°	
Mesa = 0° Gantry = 270°	

Movimento de Órgãos e Mudanças Anatômicas



Incertezas Geométricas

Interfração



Incertezas Geométricas

Intrafração

Devido aos sistemas
respiratório, digestivo
e cardíaco



IGRT

Image Guided Radiotherapy

Radioterapia Guiada por Imagens:

“Uso de imagem dentro da sala de tratamento para melhorar a precisão da entrega da dose”



Diferentes Estratégias!

IGRT

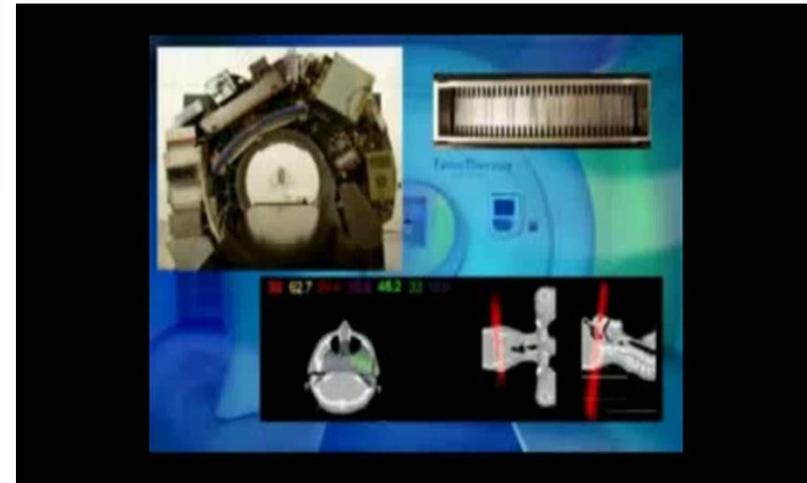
Estratégias



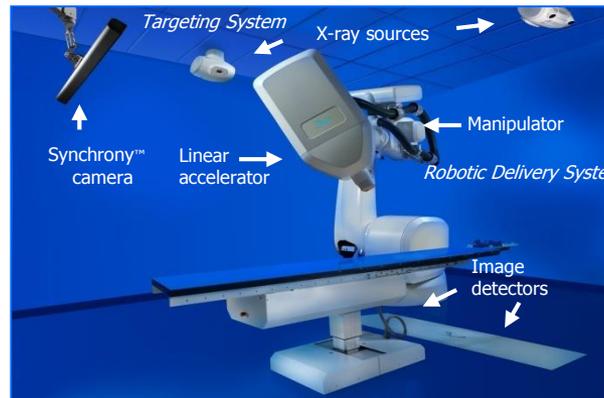
CT-on-rails



Tomoterapia

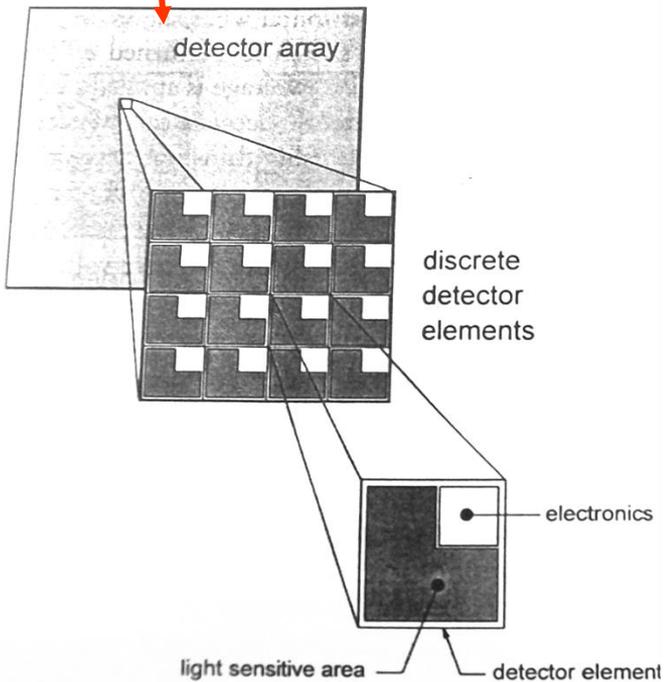


Exac Trac

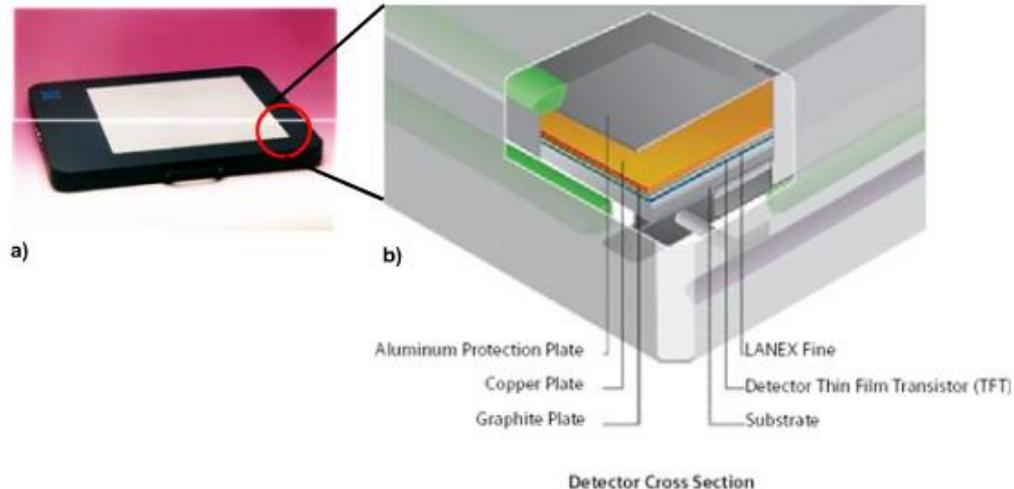


CybeKnife®

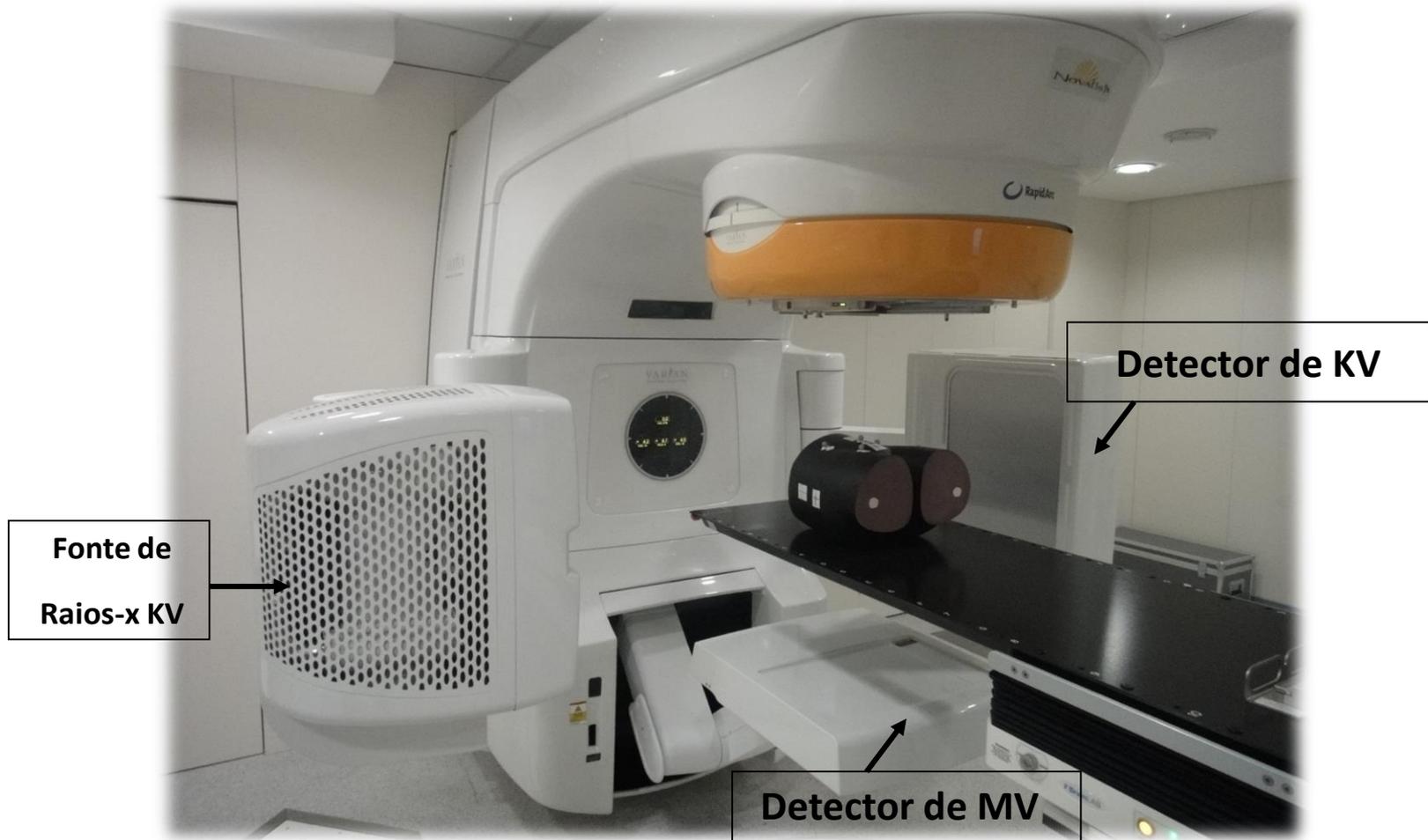
Flat Panel: a-Si



Parameter	Specification
Total Pixel Number	1024 x 1024
Pitch	400 μm
Total Area	40.96 x 40.96 cm^2
Scintillator	Lanex fast
Contrast to noise ratio (CNR)	600
Readout time	~ 145 ms
Spatial resolution at f50	0.41 Ip/mm or higher



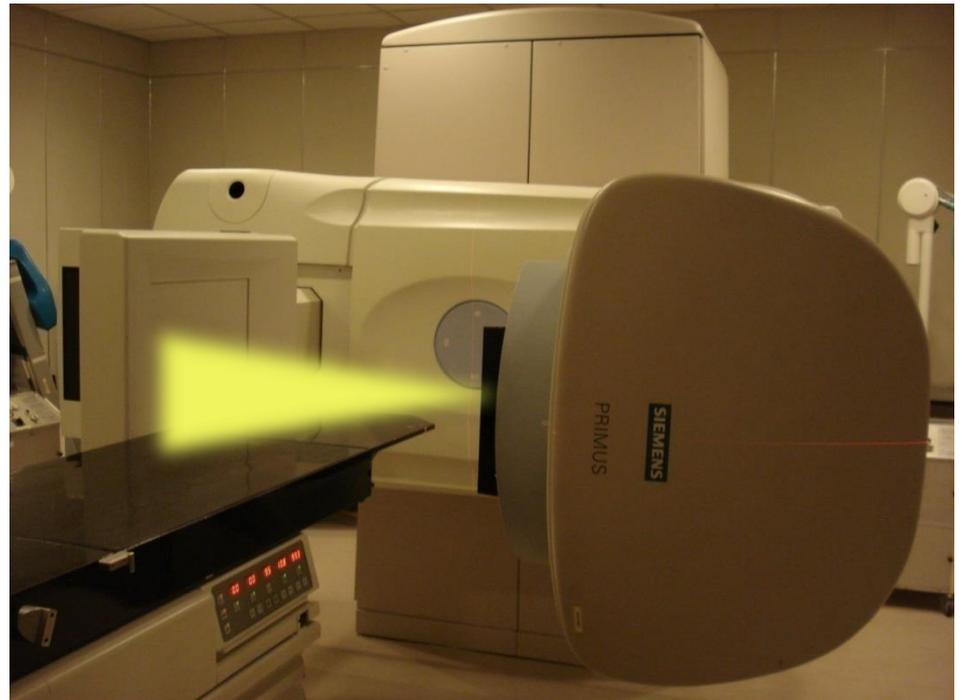
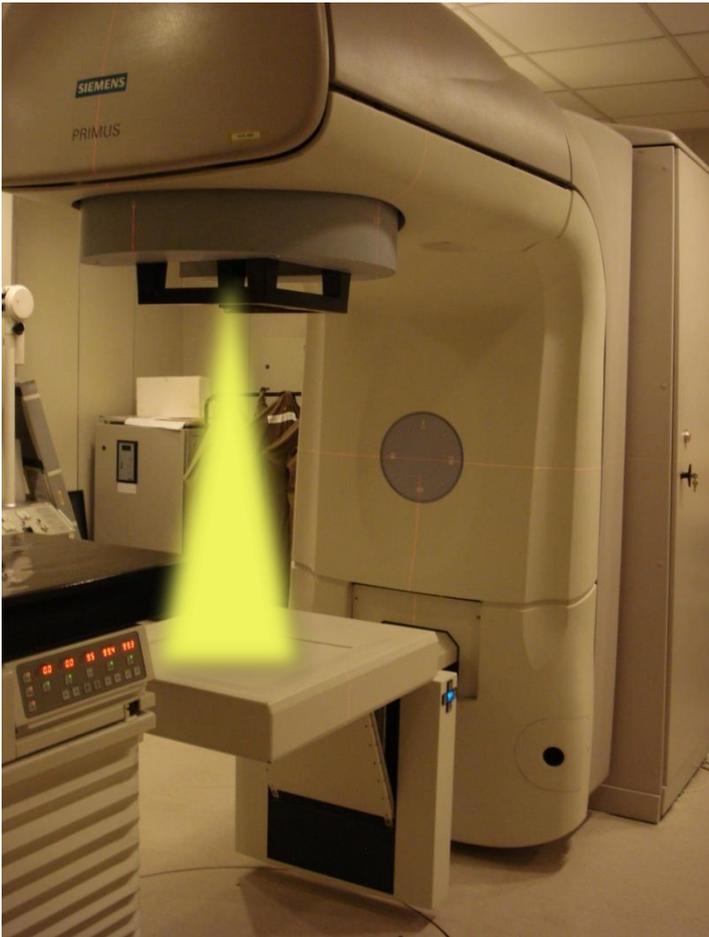
IGRT: Diferentes técnicas



Portal eletrônico diário

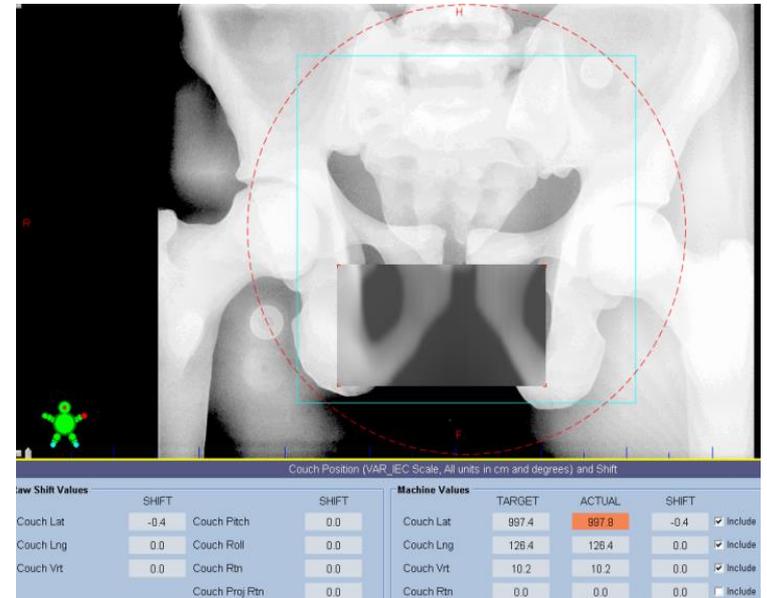
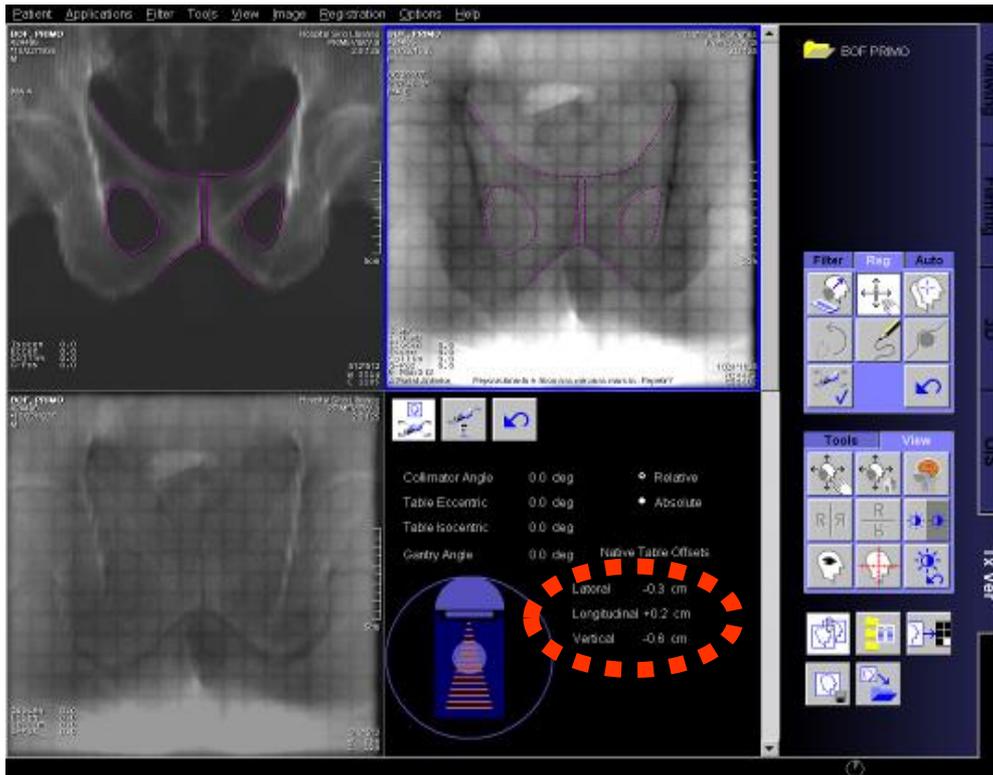
EPID- Eletronic Portal Image Device

2D



2D : EPID

Electronic Portal Image Device



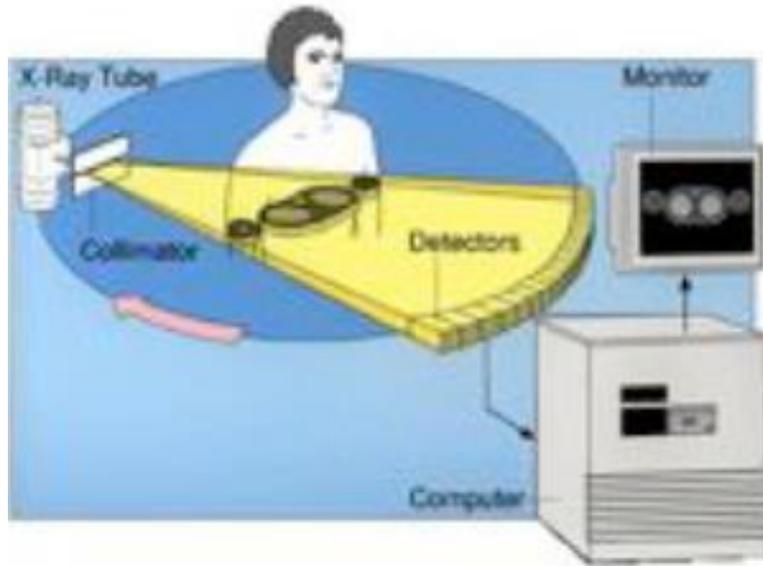
3D : IGRT

Cone Beam CT:

Integra o sistema de imagens CT diretamente no mecanismo ALX

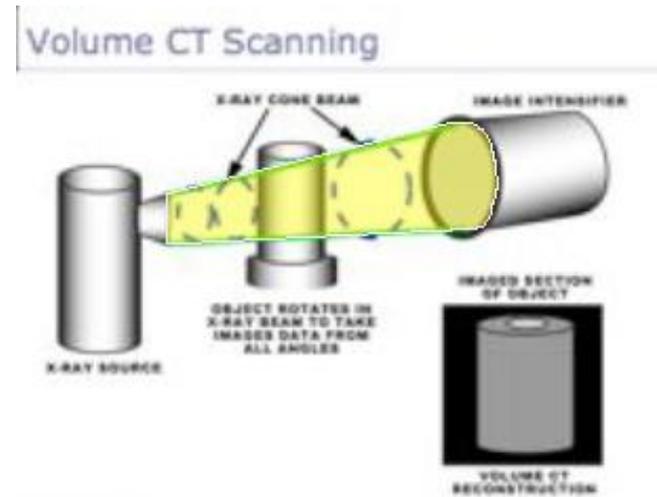


Fan beam CT



1 slice por rotação
Detectores em 1D

Cone beam CT



Volume total em 1 rotação

Detectores em 2D

Cone Beam CT

The image displays a Cone Beam CT (CBCT) software interface. The main window shows three views of a patient's head and neck: an axial view on the left, a sagittal view on the top right, and a frontal view on the bottom right. The axial view shows a cross-section of the head with a green outline of the patient's head and a red circle indicating the isocenter. The sagittal view shows the side profile of the head and neck with a green outline and a red circle indicating the isocenter. The frontal view shows the front view of the head and neck with a green outline and a red circle indicating the isocenter. A small green robot icon in the bottom left corner indicates the patient's position, with the text "Head First-Supine" and "Z: -7.82 cm". A blue star icon is in the bottom right corner.

Summary: Images (1 New) / Couch Corrections (VAR_IJC scale)

Status	CBCT
Vrt [cm]	-0.1
Lng [cm]	0.0
Lat [cm]	0.0
Rtn [deg]	0.0

Session Images | Timeline

Manual anatomy match

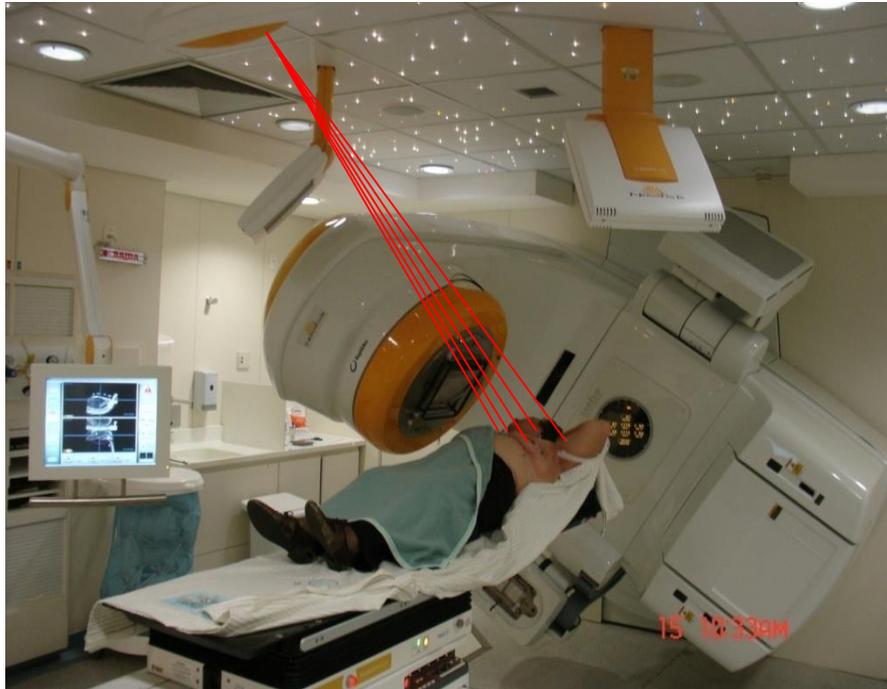
Match the two blended images manually by dragging and rotating the image with the mouse. Press the "Finish" button when the images match.

Type of match: Manual anatomy match

Online Matched P
Acquisition Posit

Cancel Finish Fini

Verificação: IGRT



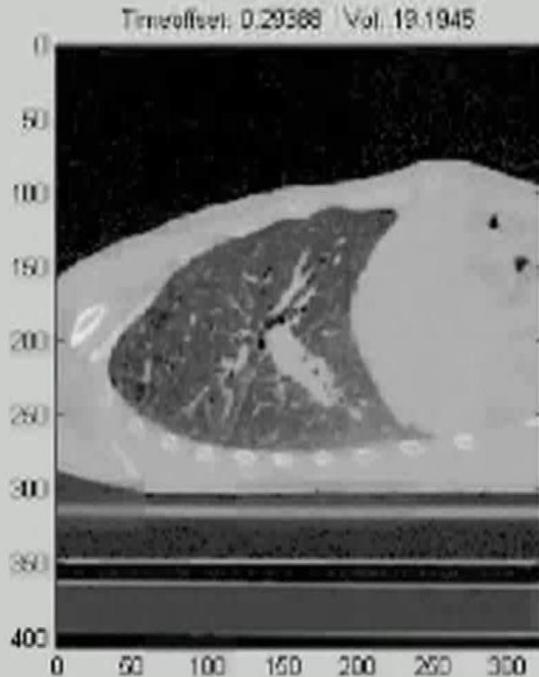
Exac Trac: Infravermelho



Exac Trac : Raios X

4 Dimensões

“Inclusão Explícita da Variação Temporal na Anatomia”



3D + tempo

from Low et. al. June 2003

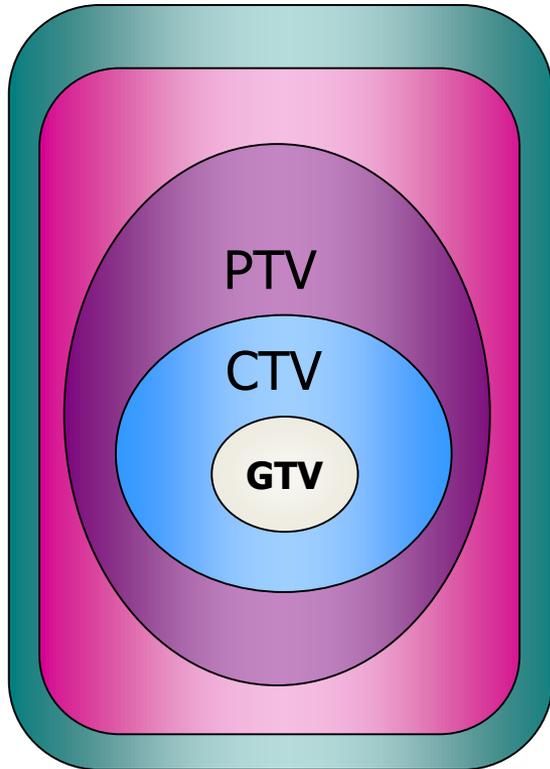
Objetivo: Permitir , redução de margens, possibilitando elevar a dose ao tumor e diminuir dose aos tecidos normais



ICRU 50

International Commission on Radiation Units & Measurements

Padronização da Nomenclatura



GTV: Gross Tumor Volume

Doença palpável ou visível por qualquer método de diagnóstico por imagem

CTV: Clinical Tumor Volume

Volume que contém o GTV e/ou doença subclínica microscópica.

PTV: Planning Tumor Volume

CTV mais margens para movimentação de órgão, efeitos de preenchimento, variação diária de posicionamento...

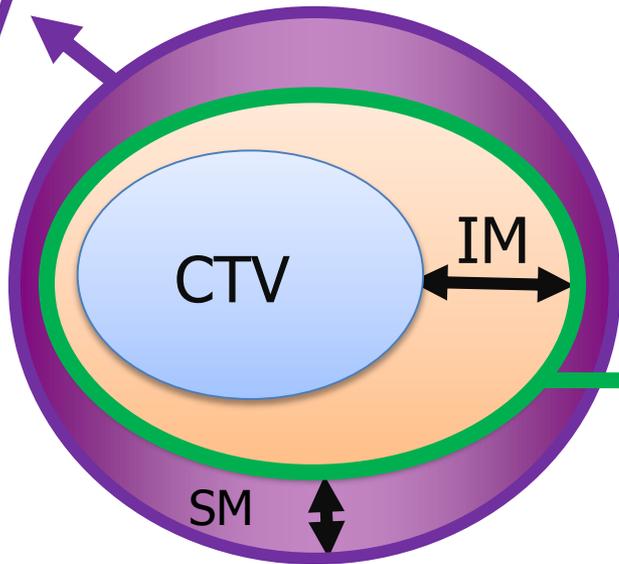


ICRU 62 : Levando em Conta Movimentação Interna

Determinar Volume Alvo Interno (ITV) para individualizar margens

$$PTV = CTV + IM + SM$$

PTV



Margem Setup

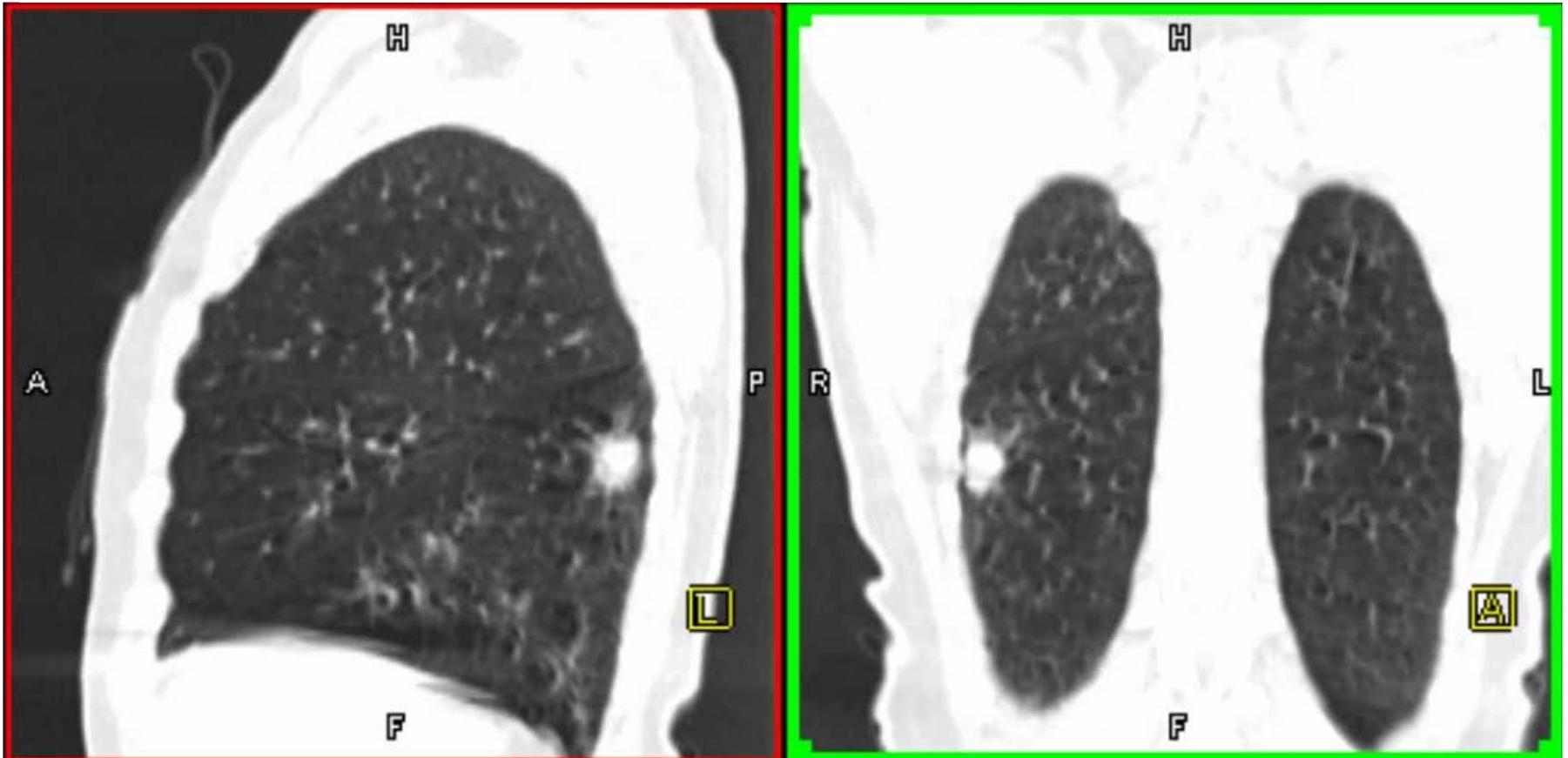
Margem Mov. Interna

ITV (Expansão do CTV por movimento interno)

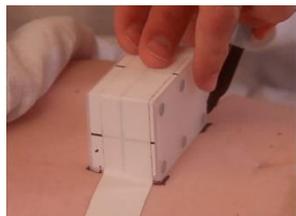
Levando em Conta Movimentação Interna

Tomografia 4D (4D CT)

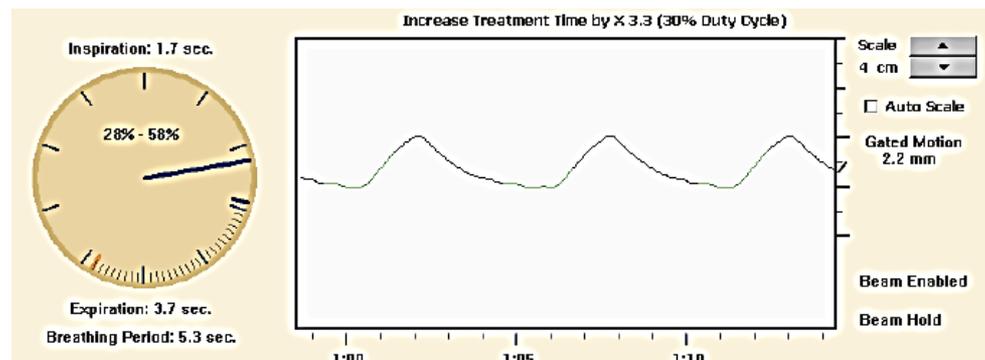
Múltiplos conjuntos de imagens com mudanças anatômicas ao longo do ciclo respiratório



Captura do Ciclo Respiratório: Simulação com tomografia 4D

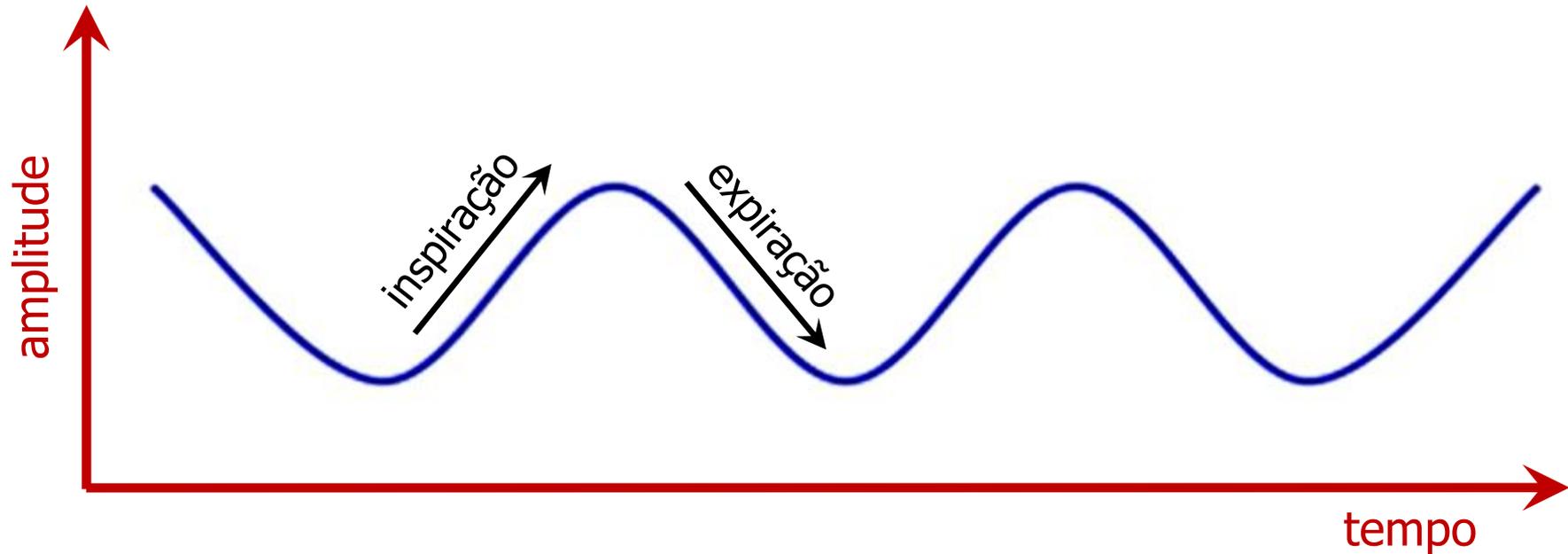


Câmera que acompanha o movimento de um marcador refletivo externo colocado no abdome



Radioterapia 4D
Efeito do Movimento

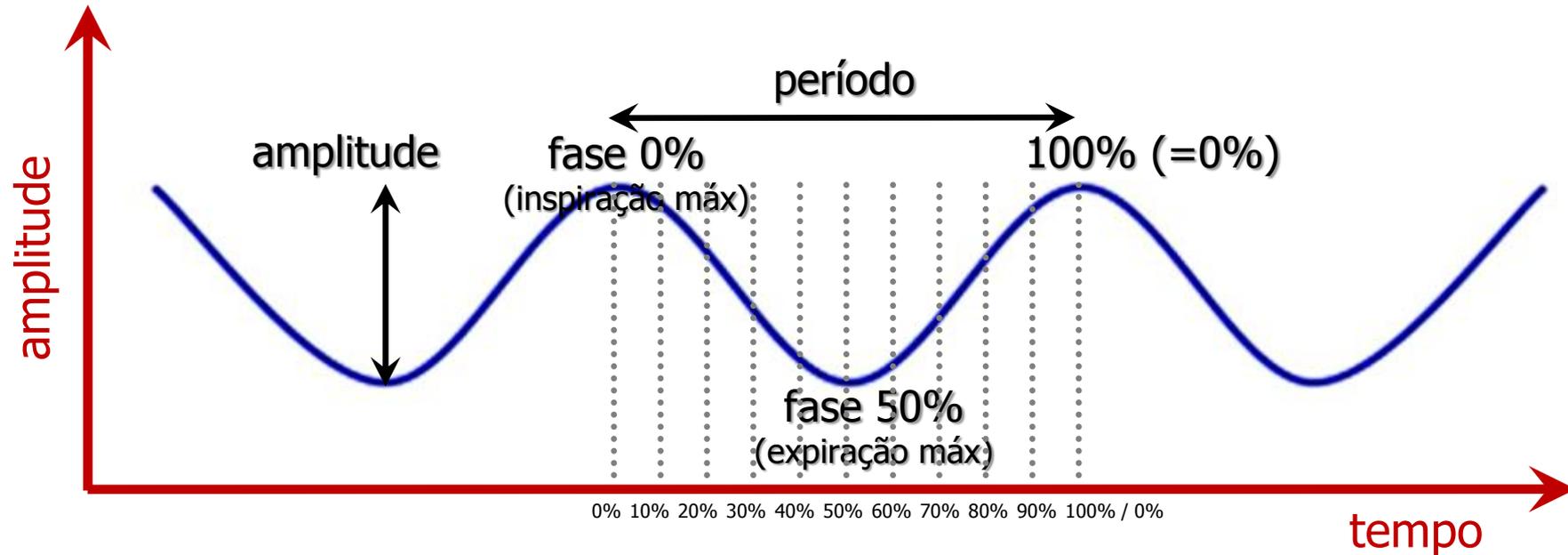
4D CT – Funcionamento



Sinal Respiratório é considerado na aquisição das imagens

4D CT – Funcionamento

→ Para uma mesma região anatômica, múltiplas imagens em diferentes fases do ciclo respiratório

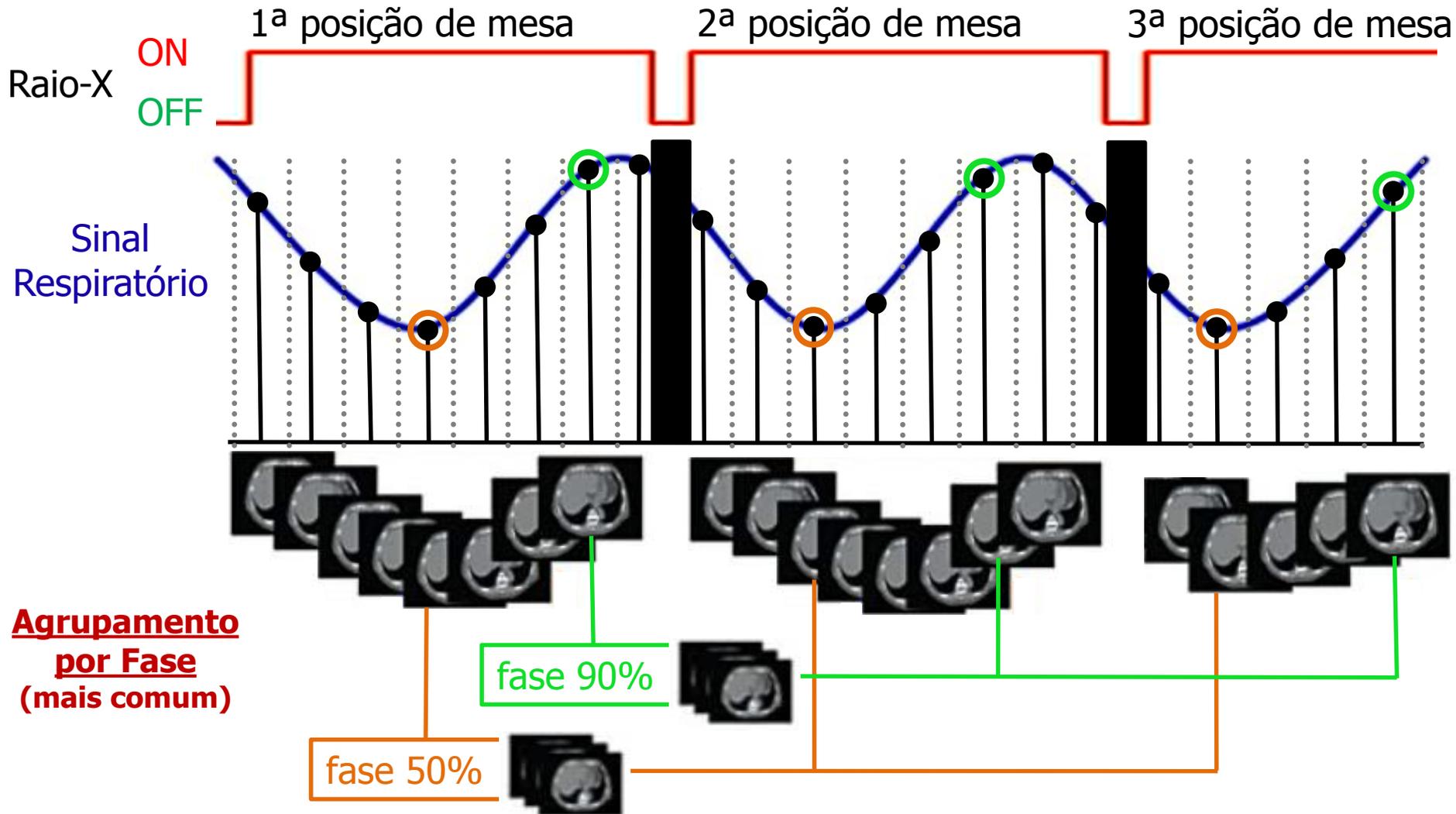


Sinal Respiratório é considerado na aquisição das imagens

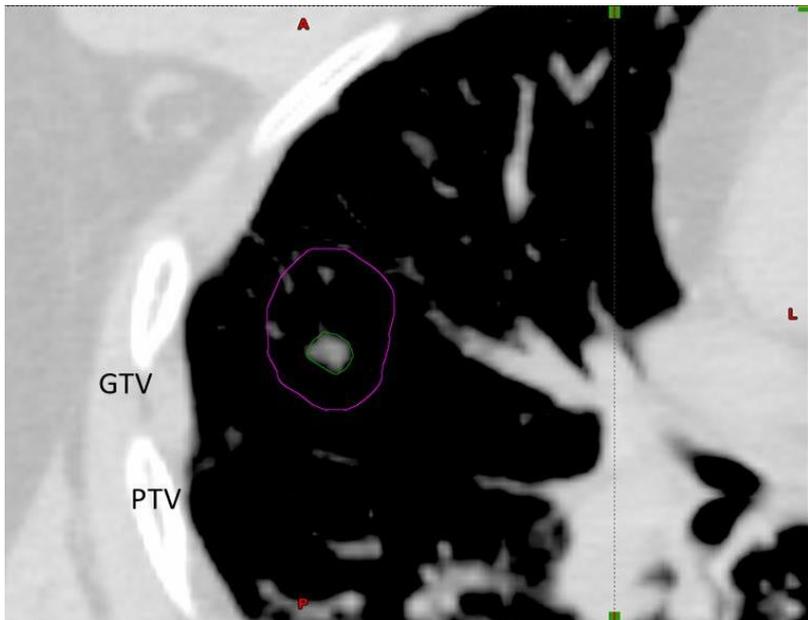
Geralmente, o período é dividido em 10 fases

4D CT – Funcionamento (Cine Axial)

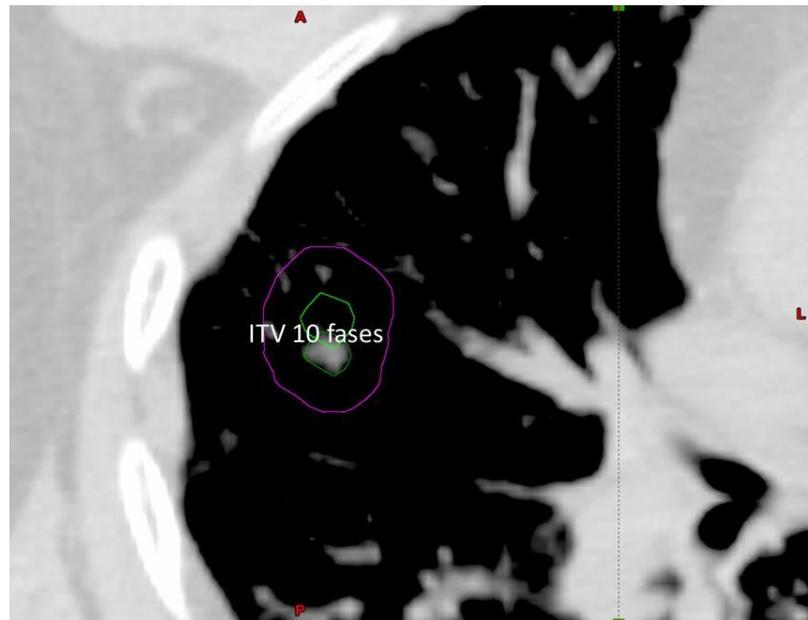
→ Para uma mesma região anatômica, múltiplas imagens em diferentes fases do ciclo respiratório



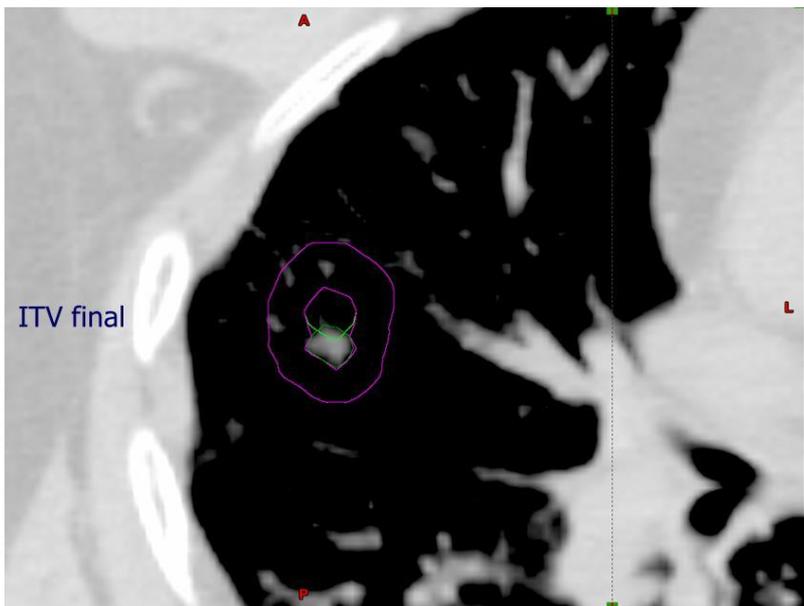
GTV normal



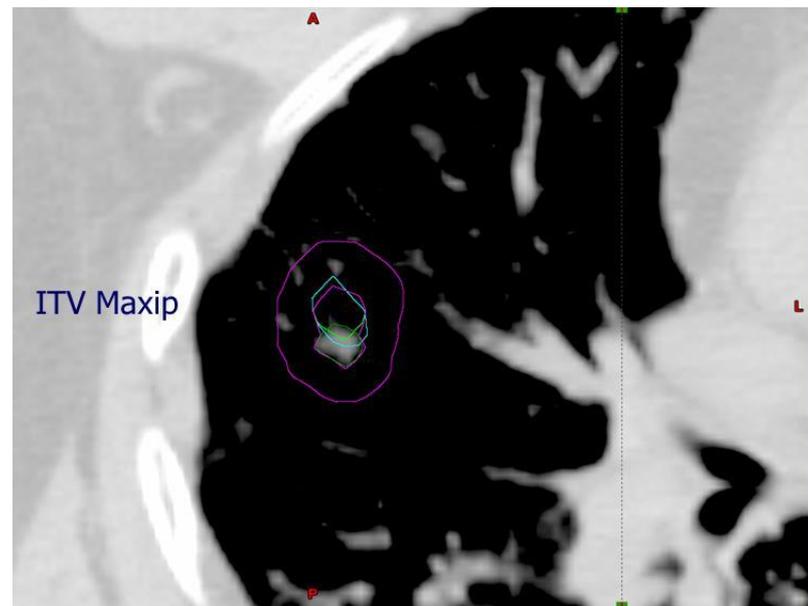
GTV + ITV 10 fases



GTV + ITV 10 fases+ ITV final

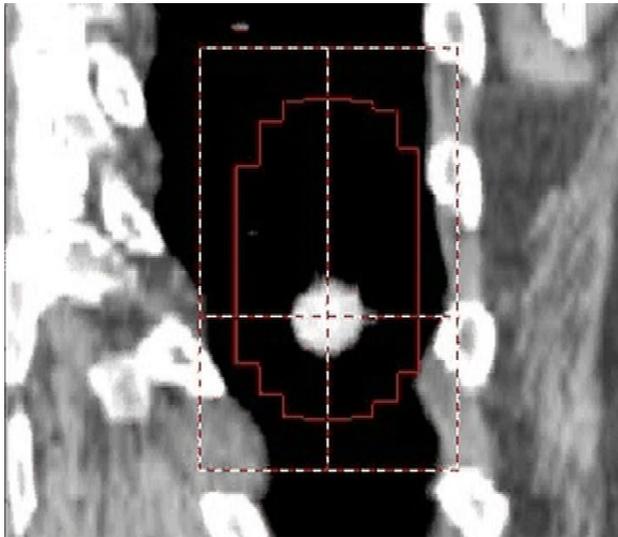
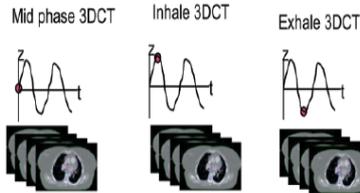
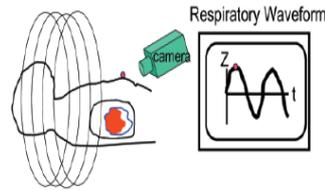
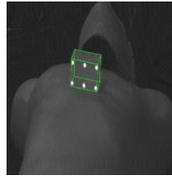
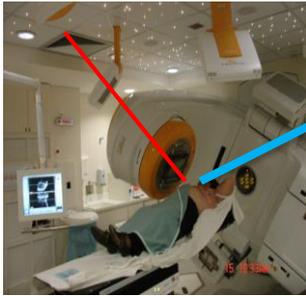


GTV + ITV 10 fases+ ITV final+ Maxip

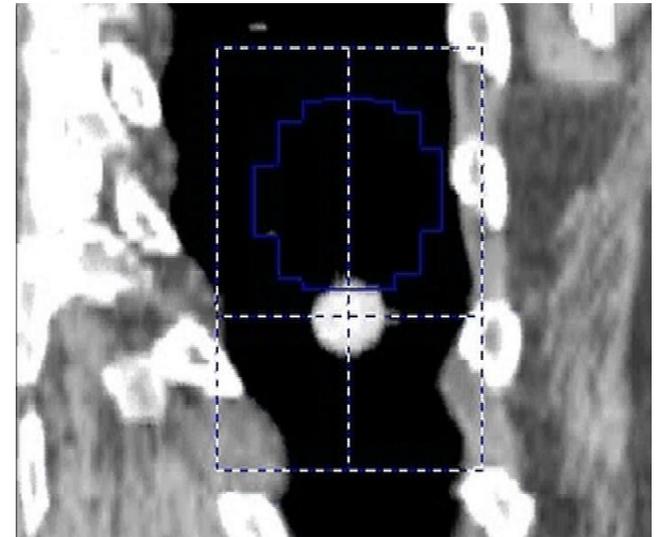


Tratamento: Gating Respiratório

Dose entregue somente em fases específicas do ciclo com o objetivo de reduzir a dose no tecido normal e sub-dosagem ao alvo



Un-Gated



Gated

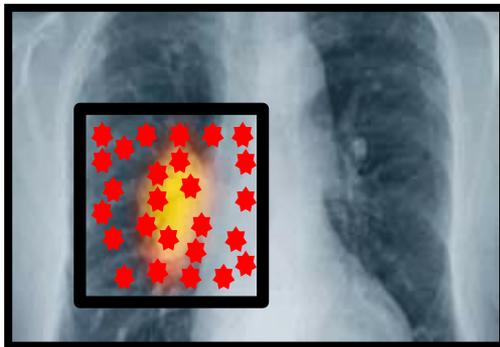
Courtesy of P. Keall

SBRT: Stereotactic Body Radiotherapy

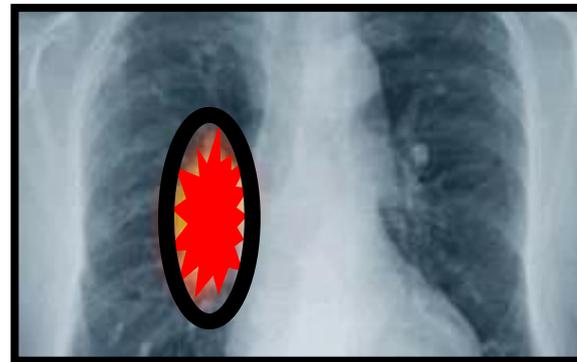
Radioterapia estereotáxica corporal

Técnica emergente de radioterapia com **alta precisão** no qual **dose muita alta de radiação** é dada ao tumor.

3DCRT: 30 x 2Gy



SBRT: 3 x 20Gy



Dose tolerância \neq Radiobiologia

SBRT: Características Principais

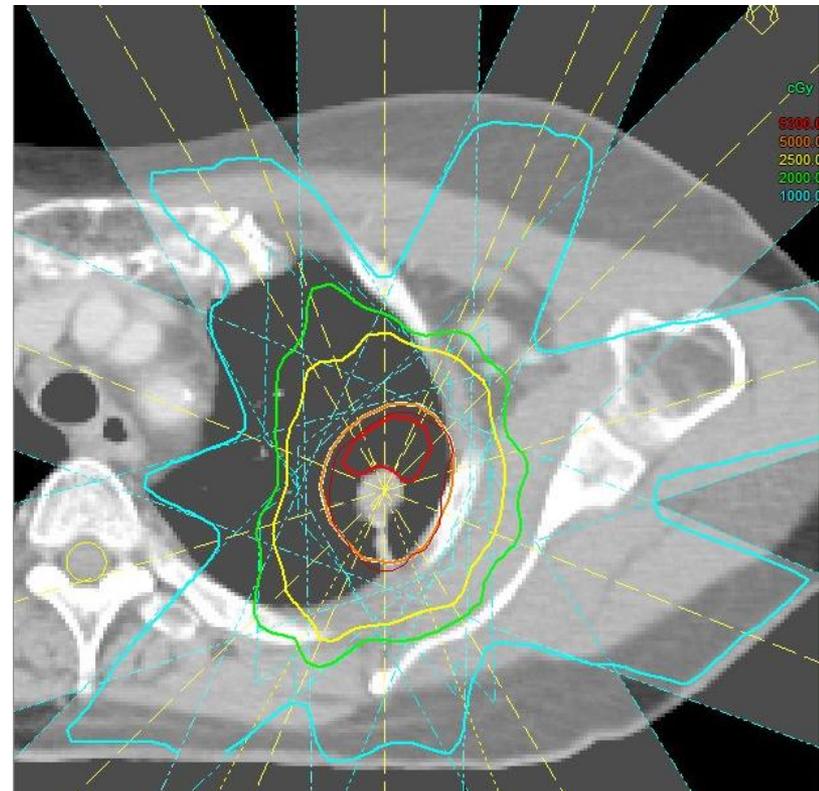
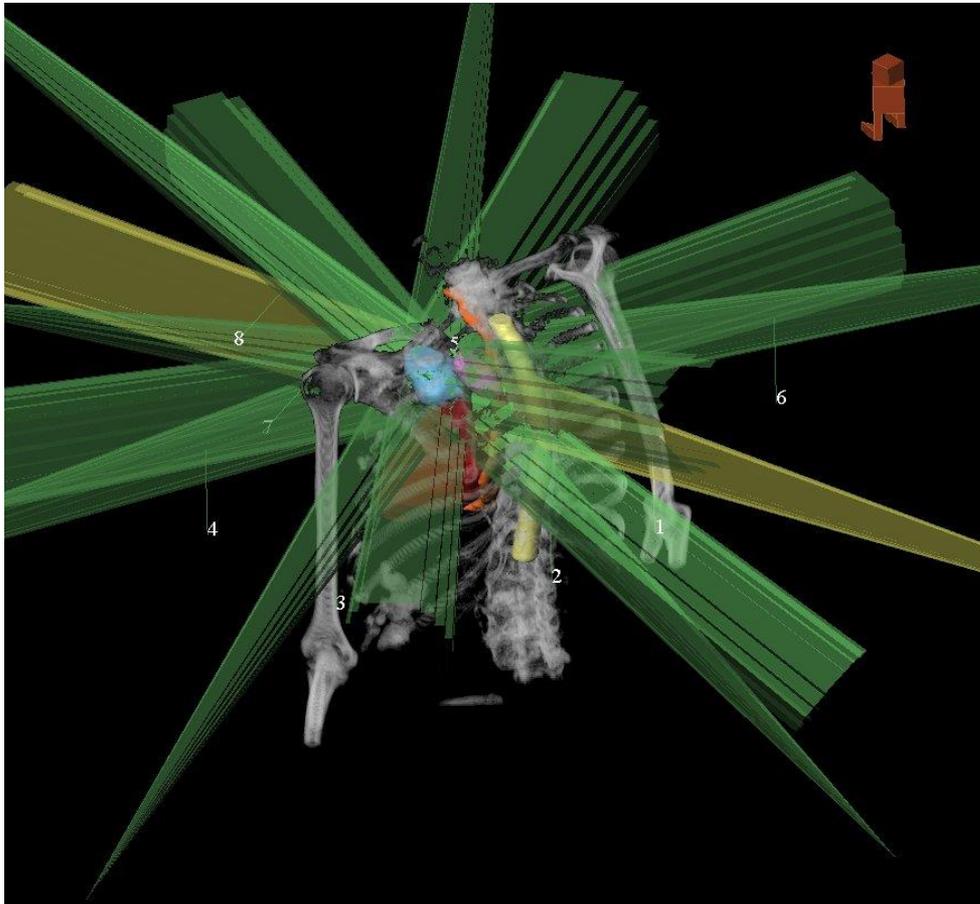
Confiança na sua precisão é conseguida pela **integração de imagem moderna**, na simulação, no planeamento do tratamento e na entrega do feixe.

Tecnologia da Imagem em todas as fases do processo

IGRT Obrigatório!!!

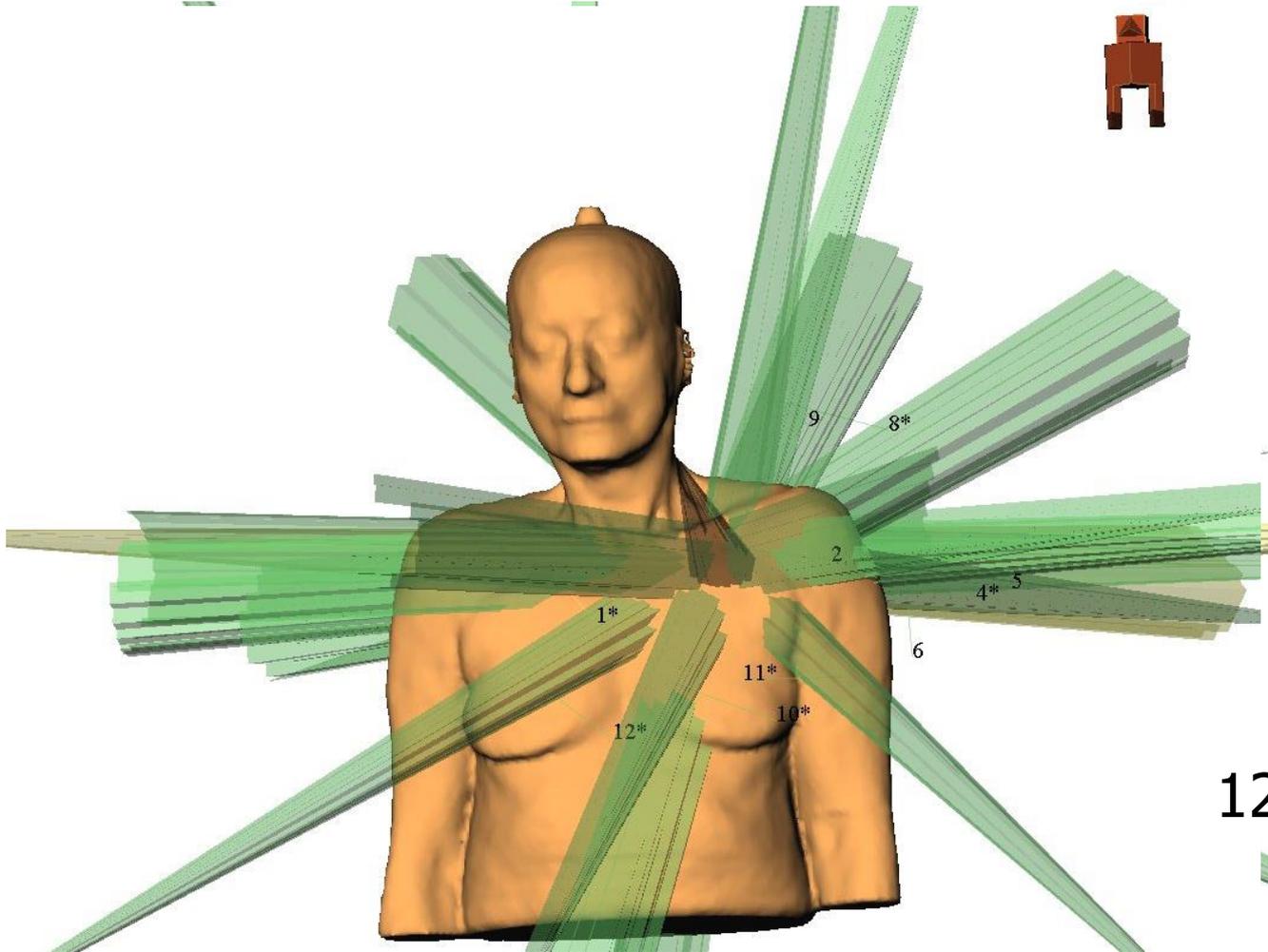
SBRT

Planejamento



SBRT

Planejamento

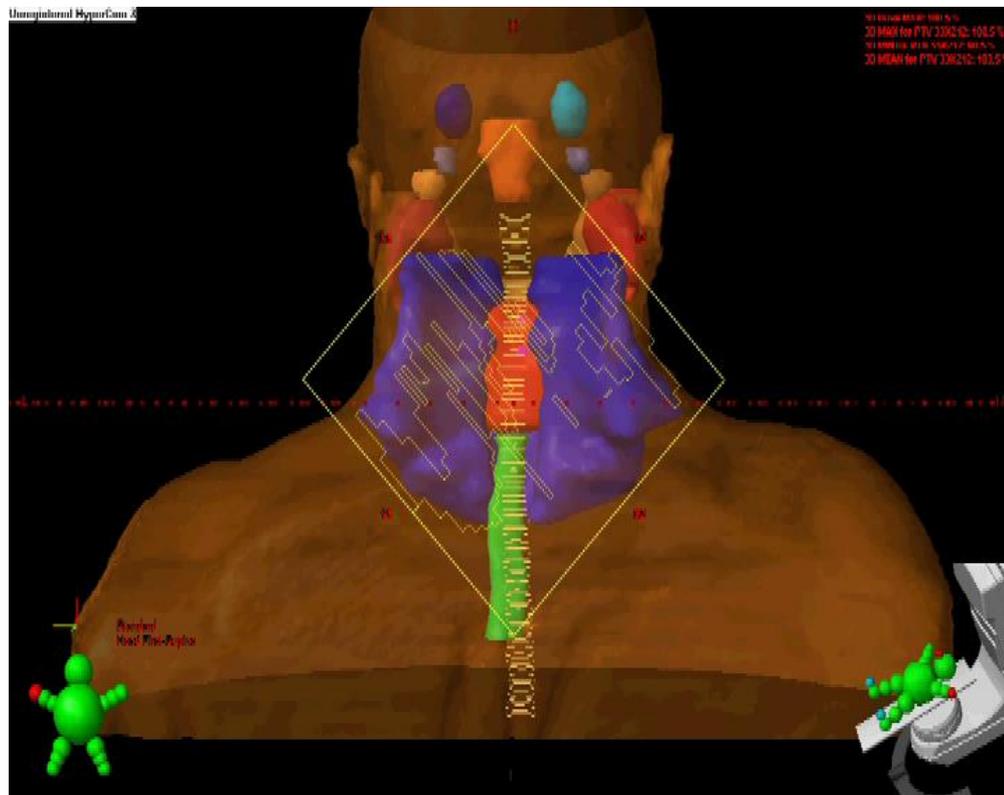


12 CAMPOS

Hoje: Volumetric Modulated Arc Therapy

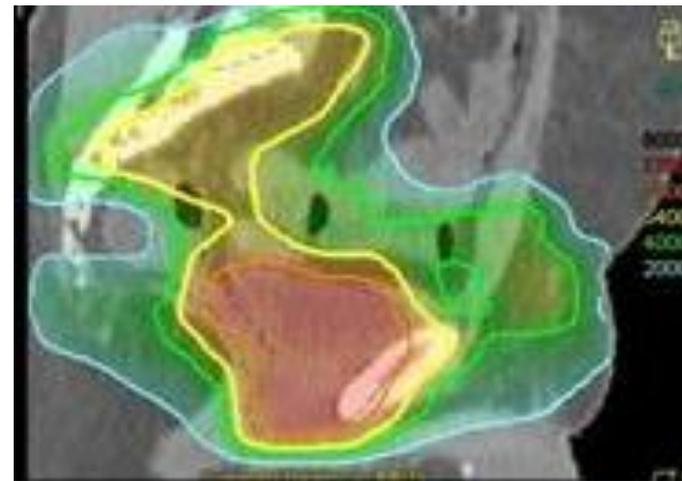
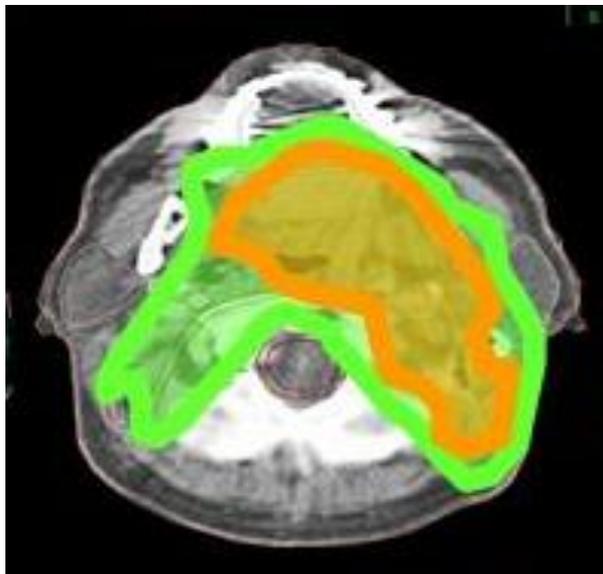
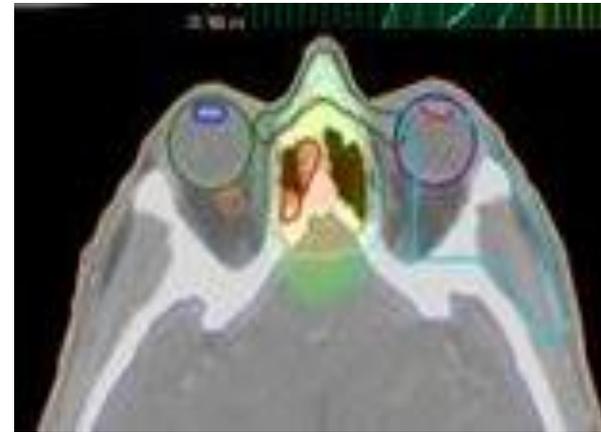
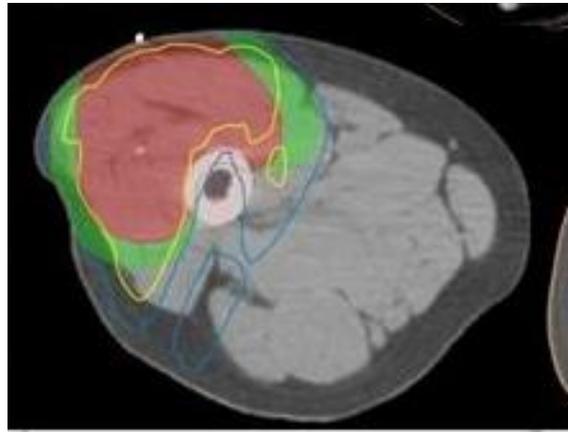
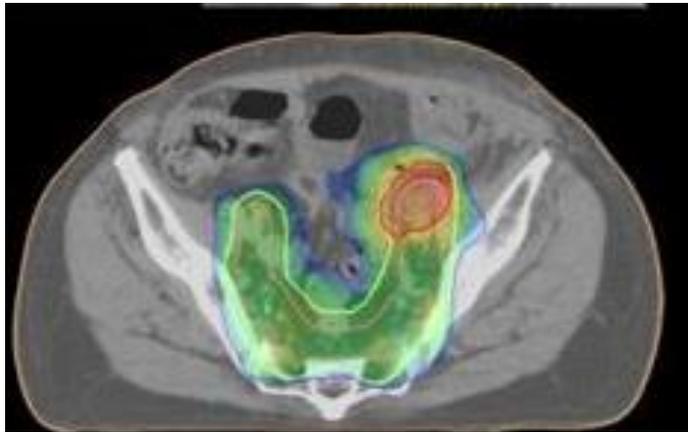
Terapia em Arco Modulada Volumetricamente

- A radiação é continuamente liberada durante a rotação do gantry.
- Pode ser variado simultaneamente:
 - Formato do MLC
 - Fluência (taxa de dose)
 - Velocidade de rotação do gantry
 - Orientação do MLC (ângulo de colimador)

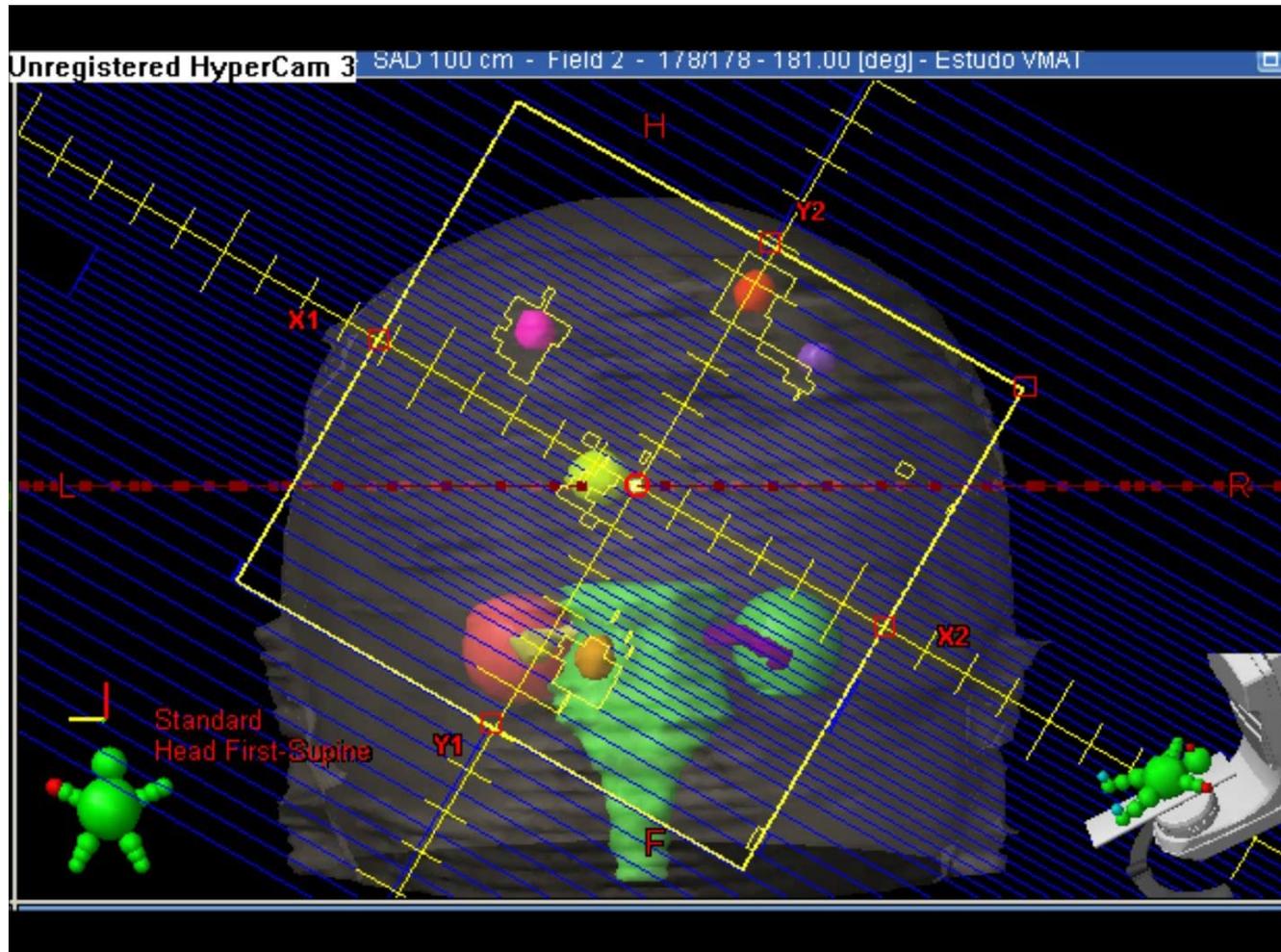


Rapid Arc

Volumetric Modulated Arc Therapy



SRS trata múltiplas lesões → 1 Isocentro+ VMAT



Pavoni, J F, W F P Neves-Junior, M A Silveira, P A M M Ramos, C M K Haddad, and O Baffa. "Feasibility on Using Composite Gel-Alanine Dosimetry on the Validation of a Multiple Brain Metastasis Radiosurgery VMAT Technique." *Journal of Physics: Conference Series* 573 (January 12, 2015)

Considerações especiais de dosimetria e cálculo: SBRT + SRS + IMRT

- **Dosimetria de campos pequenos**

Volume detector/ Falta de equilíbrio eletrônico lateral

- **MLC: ↑ incertezas:**

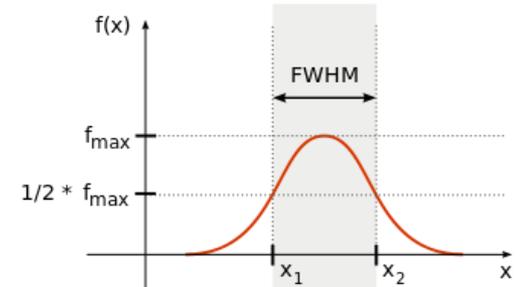
Efeito leaf-edge (tamanho campo e tipo MLC)

- **Diâmetro máximo interno do detector** deve ser inferior a metade do FWHM (Largura à meia altura) do menor feixe medido

- **Algoritmo de cálculo**

Exige algoritmo que leve em conta a falta de espalhamento (adequados tu de pulmão)

- Pencil Beam
- Monte Carlo
- Convolution/Superposition



1 - Pencil Beam clássico c/ correção

2 - Pencil Beam clássico s/ correção

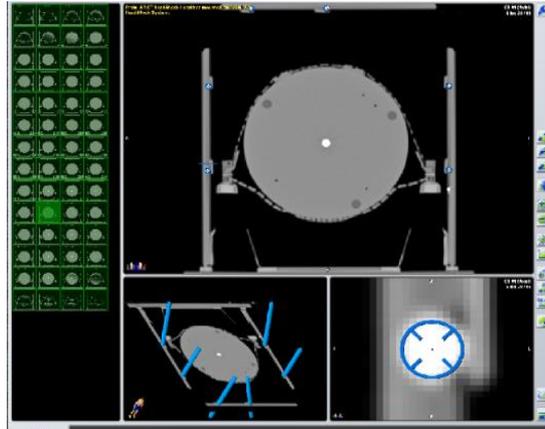
3 - Collapse Cone

Teste End-to-End

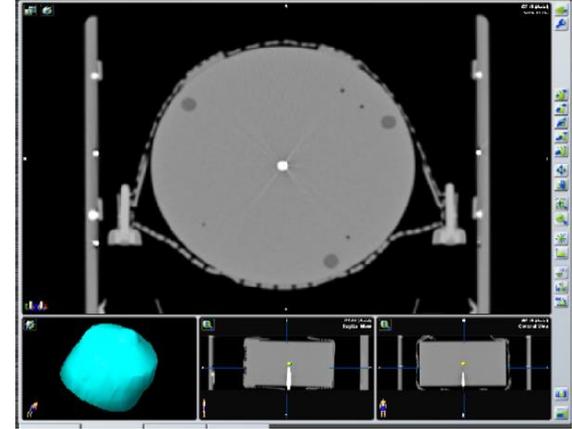
Simula um "tratamento de um detector", envolvendo todas as etapas, para avaliar o erro final de todo o processo



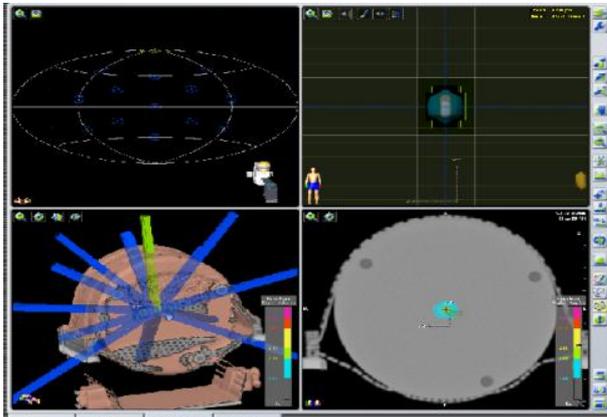
Aquisição de imagem



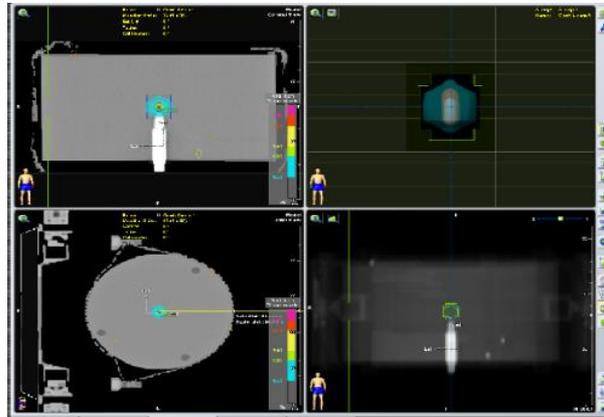
Localizer e Fusão



Delineamento



Planejamento e Cálculo



Geração de imagens de referência
e exportação

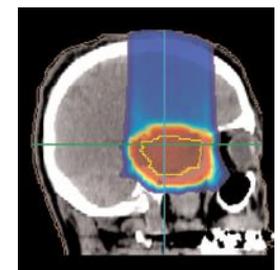
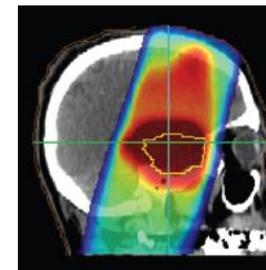
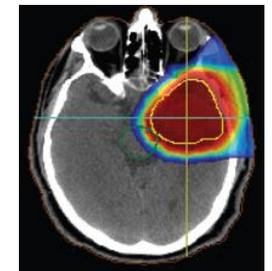
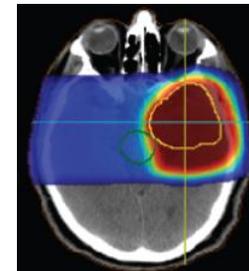
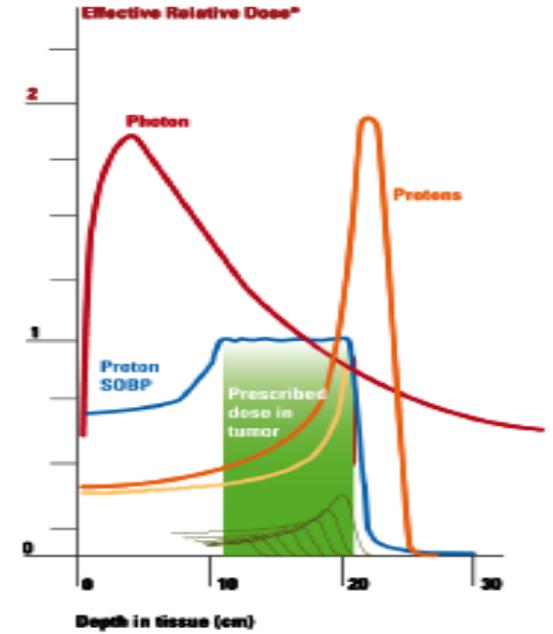


Posicionamento e tratamento

Acelerador de Prótons



Gantry and Table at manufacturer



Fótons

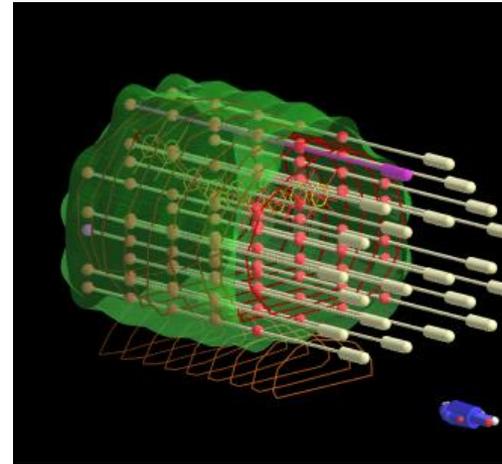
Prótons

Braquiterapia

- **Baixa Taxa de Dose:**

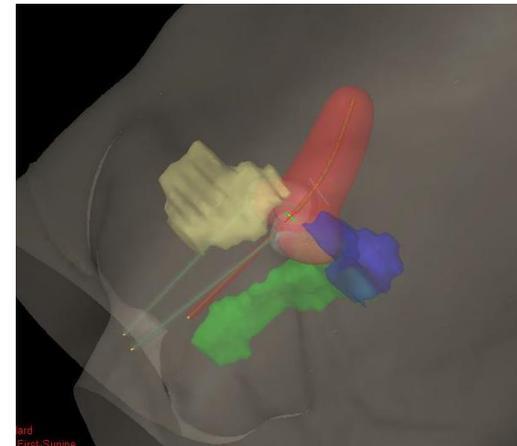
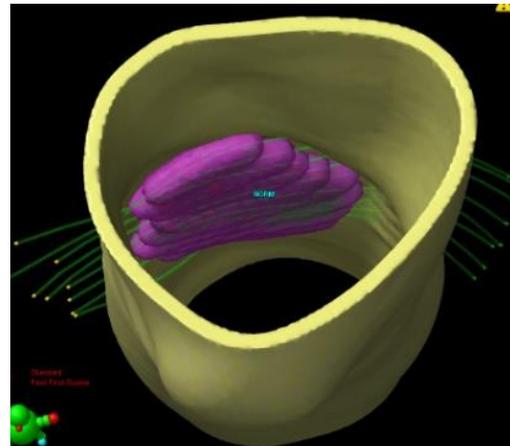
I^{125} Permanente

Ir^{192} Temporária



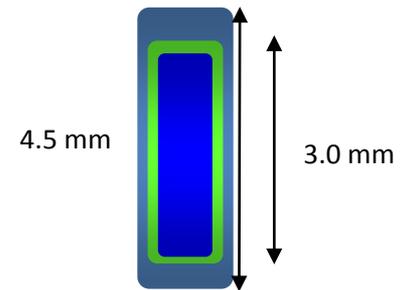
- **Alta Taxa de Dose:**

Ir^{192}



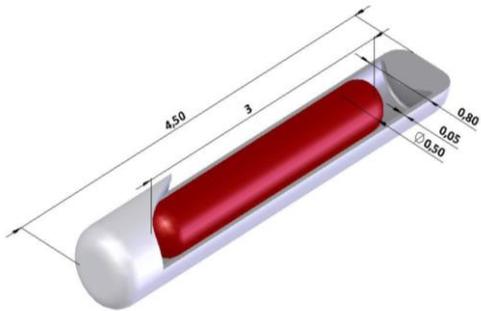
Baixa Taxa de Dose : I^{125}

Implante Permanente de Próstata



I^{125}

Meia Vida	59.4 d
Energia	27.4 Kev
HVL (mm tecido)	37
HVL (mm Pb)	0,025



Protótipo da Semente de I^{125} do IPEN



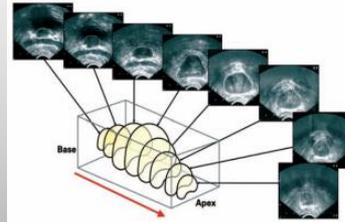
Laboratório de sementes de I^{125} - IPEN

No ano de 2014 foram vendidas 25.116 sementes de I^{125}

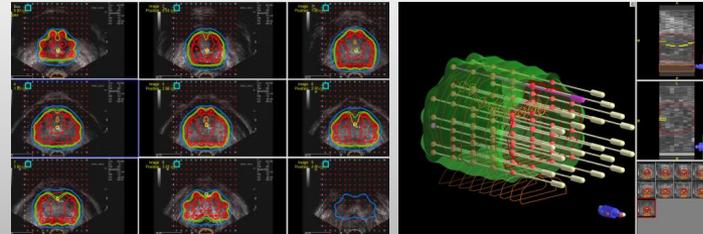
IPEN

Etapas do Procedimento

Estudo Volumétrico



Planejamento



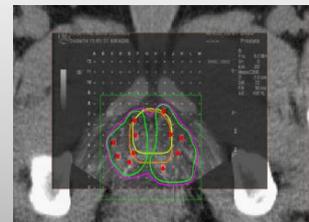
Preparo Material Radioativo



Implante



Dosimetria Pós-Implante

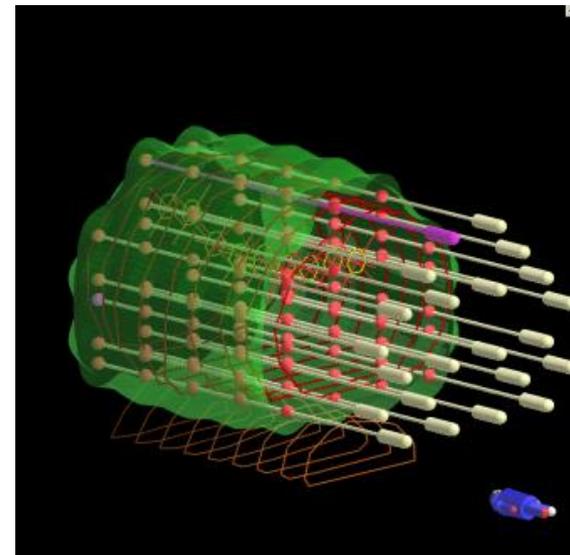
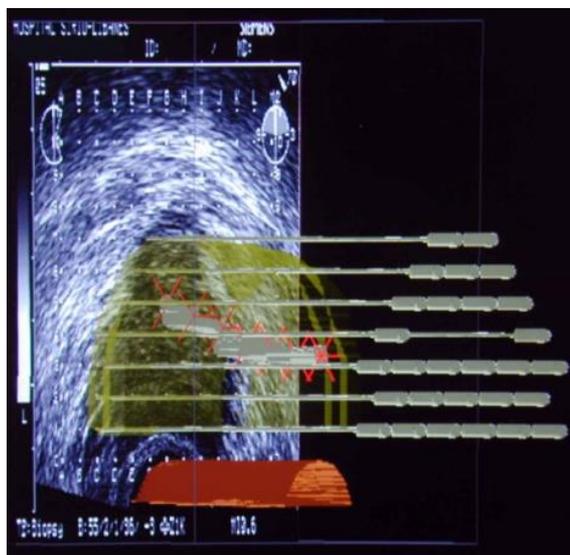
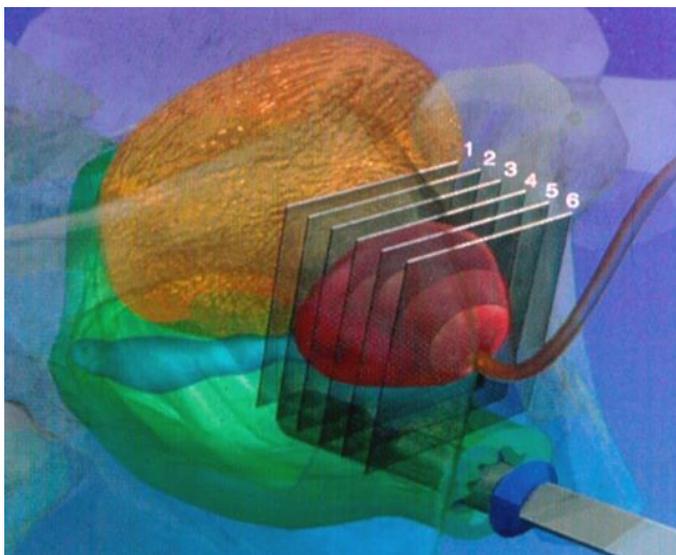


Experiência Hospital Sírio Libanês

Junho 1998 – Outubro de 2015

1027 implantes

Média: 92 sementes / implante I¹²⁵



Baixa Taxa de Dose: Ir¹⁹²

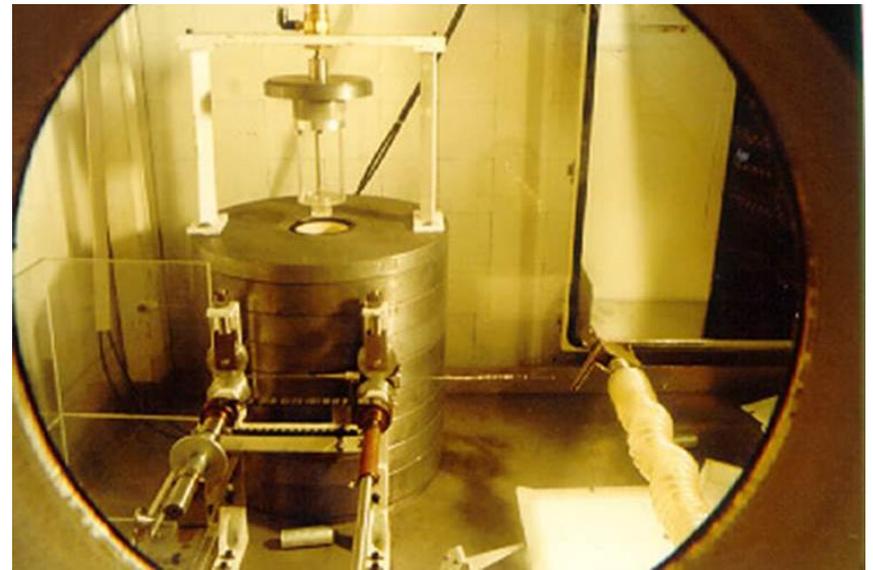
Hot cell para produção Fios de Ir¹⁹² - IPEN



Hot cell - Visão externa

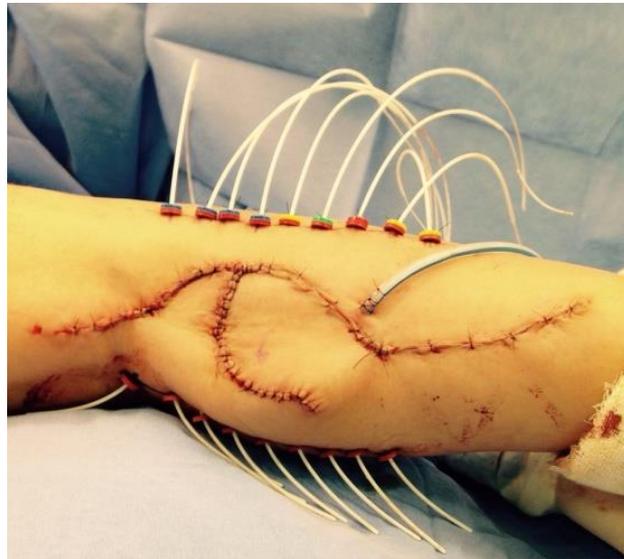
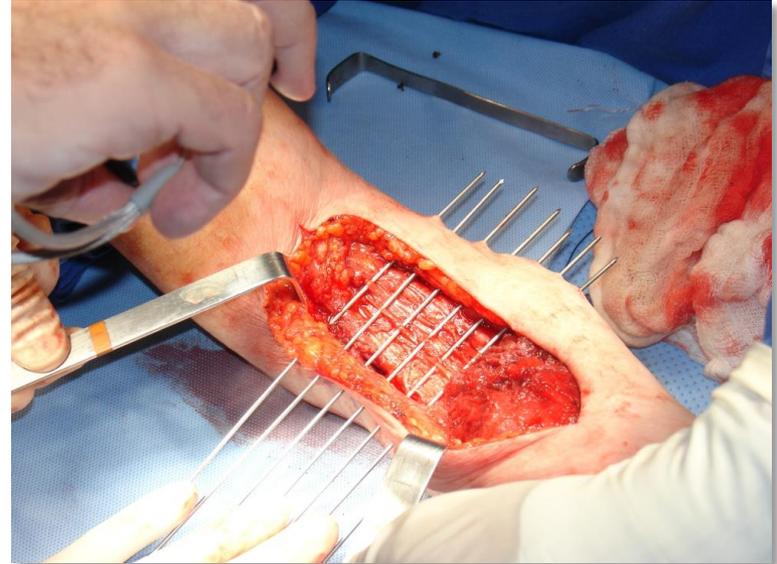


Hot cell - Visão interna



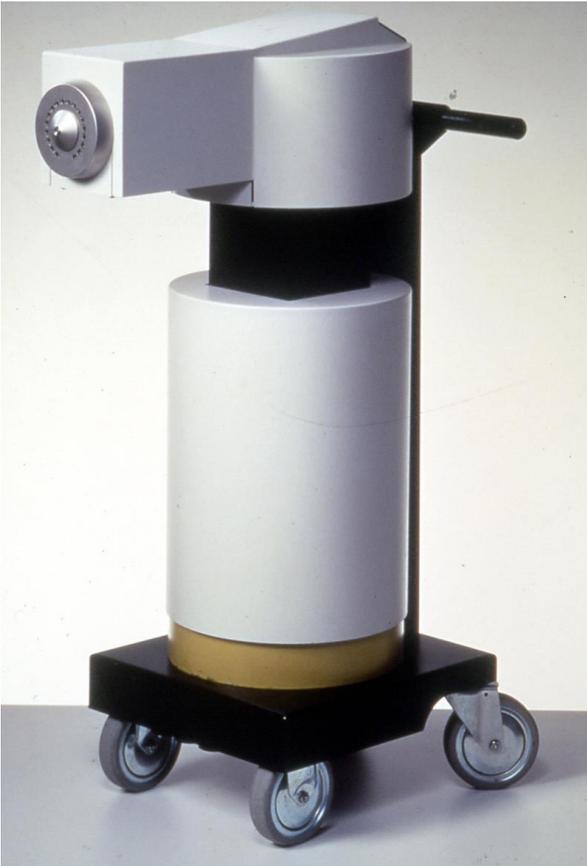


Baixa Taxa de Dose: Ir¹⁹²



Alta Taxa de Dose: Ir¹⁹²

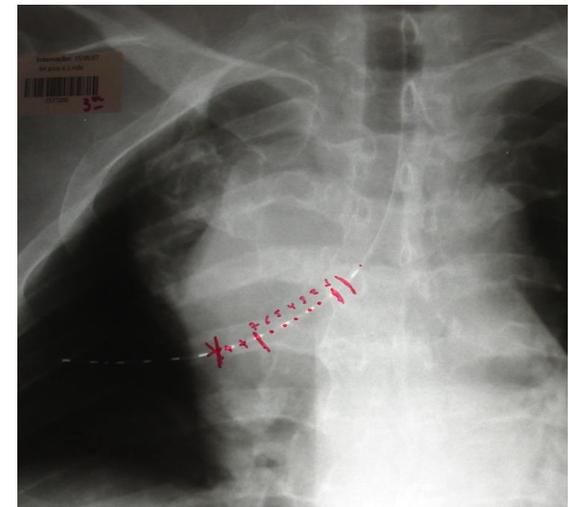
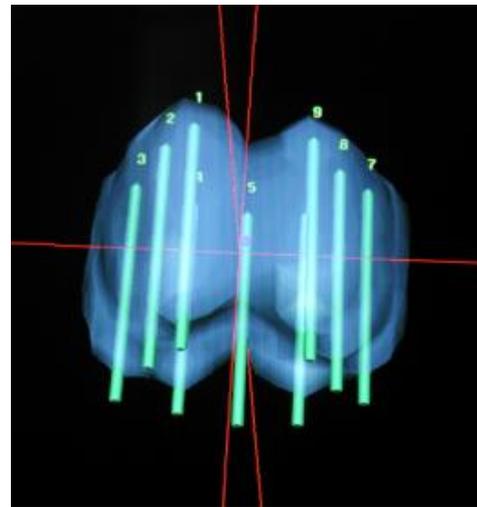
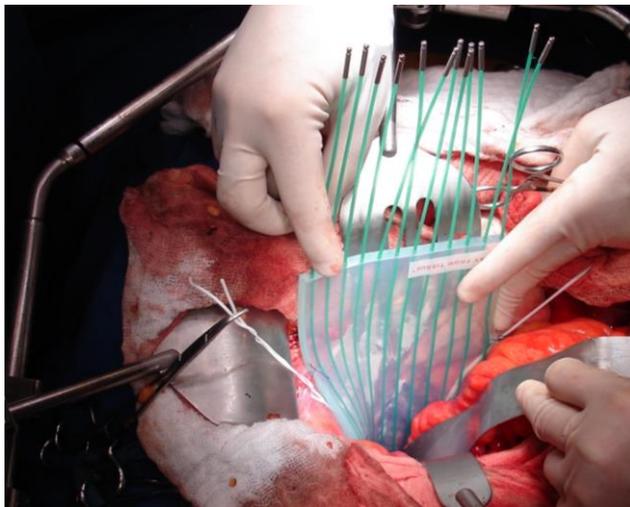
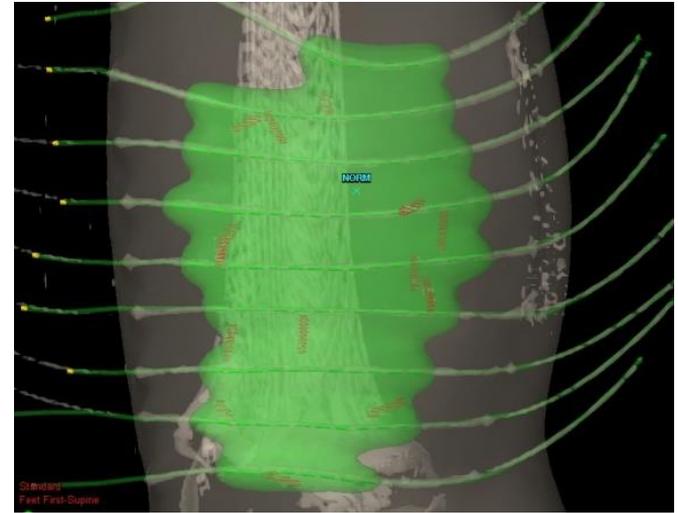
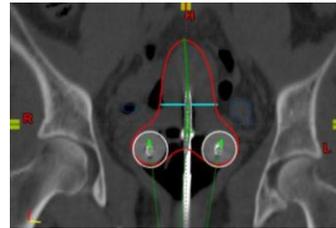
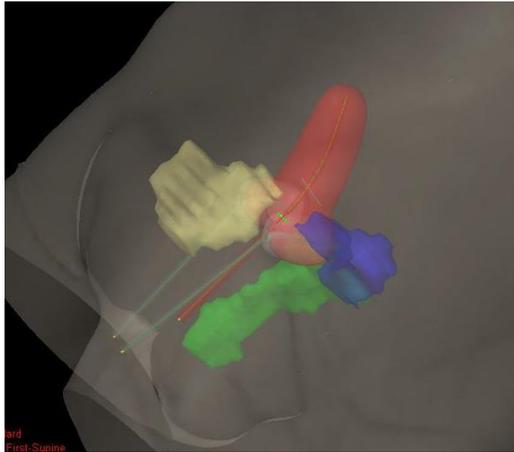
119 equipamentos
de HDR- Brasil



Prédio onde será instalado o
laboratório para confecção das
fontes de I¹⁹² HDR IPEN

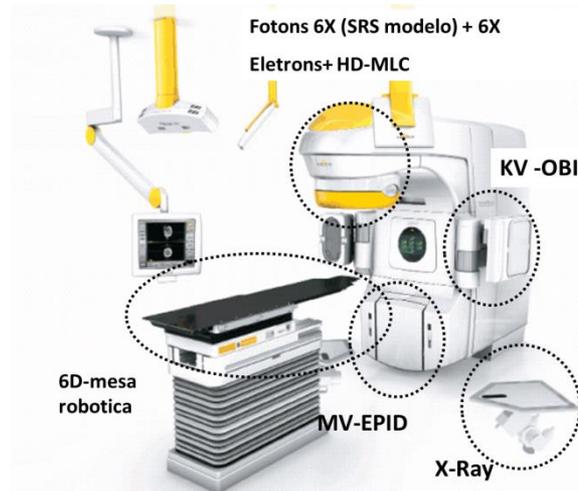
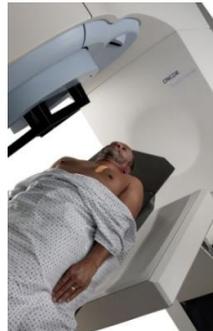
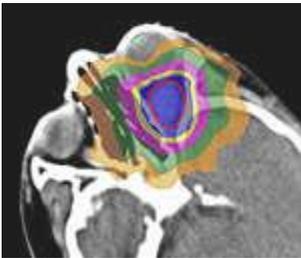
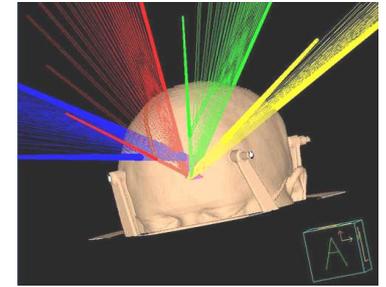
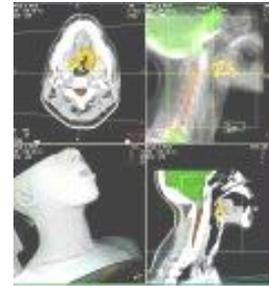
Alta Taxa de Dose: Ir¹⁹²

3D



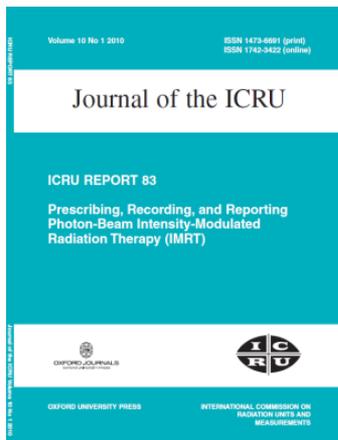
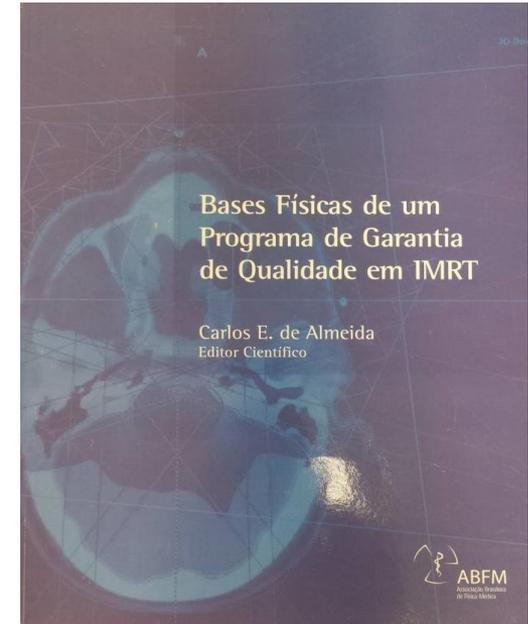
Complexidade em RXT

Objetivo da RXT é simples: Optimizar a Razão Terapêutica



- Procedimentos padronizados
- Recursos adequados
- Staff bem treinado e atualizado
- Manutenção dos recursos de hardware e software
- Clara comunicação entre toda a equipe

ABFM



ICRU Report 83
Prescribing, Recording, and Reporting
Intensity-Modulated Radiation Therapy (IMRT)
abr. 2010

TG 100 – AAPM

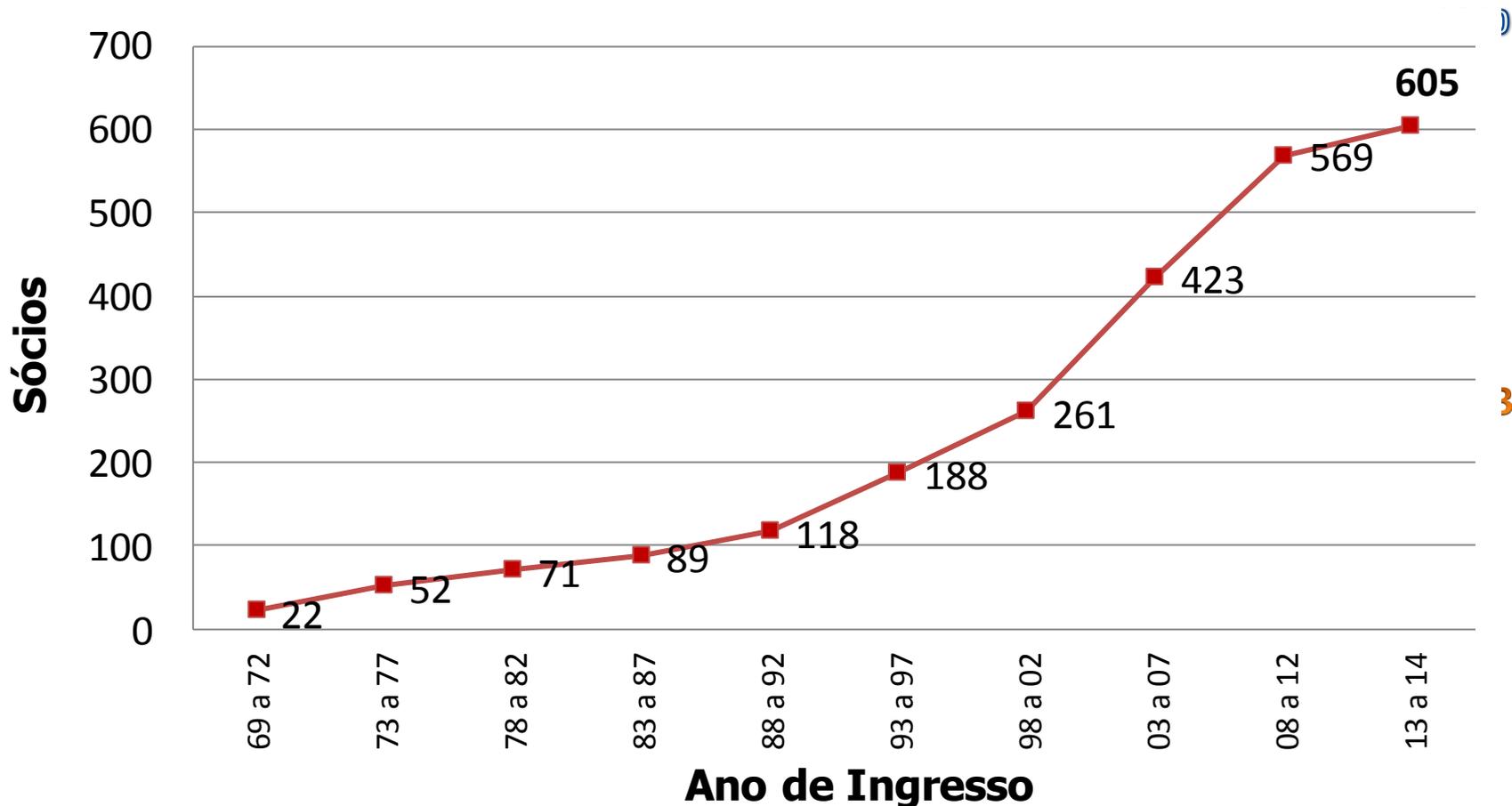
Novas abordagens : Controle da Qualidade e Gestão da Qualidade

Filosofia do TG-100:

“Todos os programas QM devem ser baseados na análise de risco dos vários processos envolvidos no tratamento do paciente”

Associação Brasileira de Física Médica

Número de Sócios por Ano



Especialistas em Física Médica



Exterior = 3

Total = 372

■ North
■ Northeast
■ Midwest
■ Southeast
■ South

Medicina Nuclear



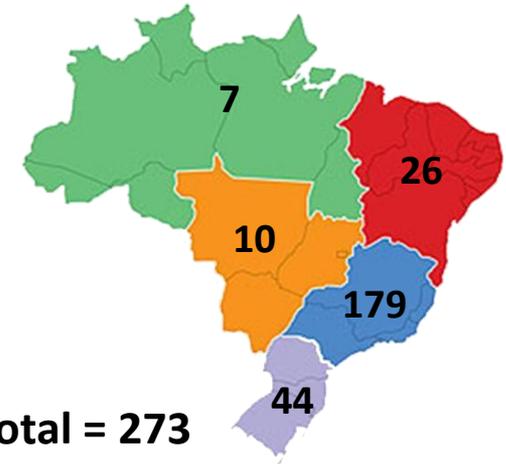
Total = 29

Radiologia



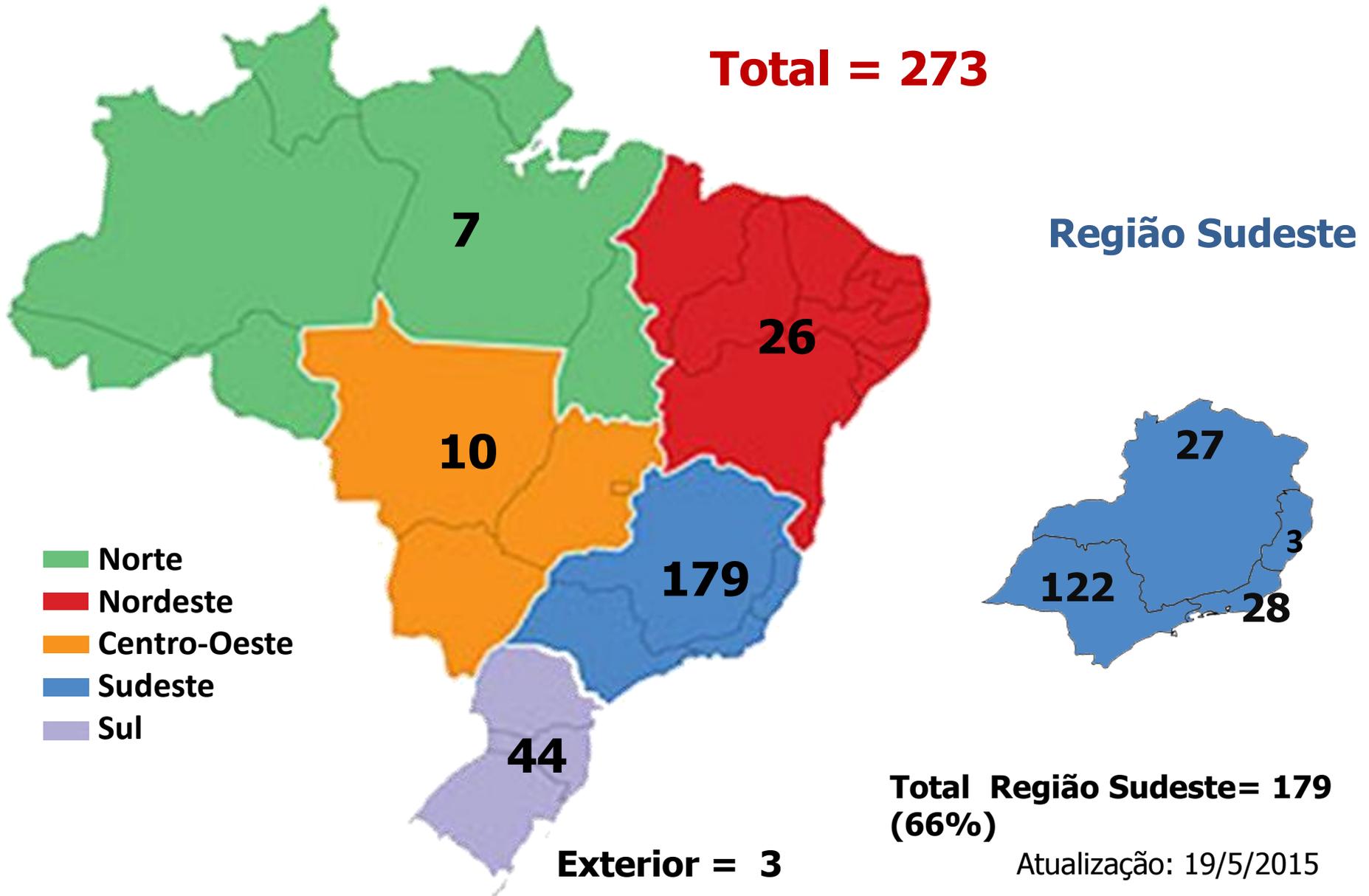
Total = 70

Radioterapia



Total = 273

Especialistas em Radioterapia



Programas Aprovados em Física Médica (MEC e MS)

Instituição	Radioterapia	Medicina Nuclear	Radiologia
Instituto Nacional de Câncer (RJ) - 2013	04	-	02
Hospital AC Camargo (SP) - 2013	03	-	-
Hospital das Clínicas USP São Paulo (SP) - 2013	04	02*	-
Hospital das Clínicas USP Ribeirão Preto (SP) - 2013	01	-	01
Hospital São Paulo UNIFESP (SP) - 2013	02*	02*	03*
Hospital de Clínicas UNICAMP (SP) - 2014	02	01	01
Hospital de Câncer de Barretos (SP) - 2014	01	-	-
Hospital Sírio-Libanês (SP) - 2013	02	-	-
Hospital Erasto Gaertner (PR)	01	-	-
Hospital São Lucas PUC (RS) - 2013	01	01	01
Total	21	06	08

* Vagas parcialmente ocupadas

Novos Programas em Física Médica

Potencial a curto prazo

Instituição	Radioterapia	Medicina Nuclear	Radiologia
Hospital de Câncer de Barretos (SP)	-	01	01
Instituto de Física da USP - InRad (SP)	-	-	02*
Hospital Universitário Clemente F. Filho (RJ)	01	01	01
Irmandade da Santa Casa de Misericórdia (SP)	01	01	01
Hospital Beneficência Portuguesa de São Paulo (SP)	02	-	-
Hospital Israelita Albert Einstein (SP)	02	01	01
Hospital de Clínicas de Uberlândia (MG)	01	01	01
Clínicas Oncológicas Integradas (RJ)	02	-	-
Centro de Oncologia D´Or (RJ)	01*	-	-
Associação de Combate ao Câncer (GO)	01*	-	-
Hospital do Câncer de Pernambuco (PE)	01	-	-
Universidade Federal de Sergipe UFS (SE)	01	01	01
Real Sociedade Portuguesa de Beneficencia (BA)	01	-	-
Hospital de Clínicas de Porto Alegre (RS)	-	01	01
Total	14 - 06	07 - 01	09 - 03

* Programas em funcionamento com financiamento próprio

Distribuição de Equipamentos e Serviços por Região do País

Região	Aceleradores	Co (60)	HDR	Serviços
Sudeste	185	37	72	128
Sul	54	9	12	48
Nordeste	47	8	18	35
Centro-Oeste	18	2	6	35
Norte	10	6	11	12
Total	314	62	119	241

Plano de Expansão da Radioterapia - Brasil

80 soluções de radioterapia:

- 39 expansões de sites existentes
- 32 novos sites
- 9 novos equipamentos de braquiterapia
- Todas as soluções incluem acessórios de dosimetria, de posicionamento e de QA

Outros itens:

- 41 fontes de strontium Sr-90
- 9 mesas ginecológicas
- 9 equipamentos de R-X

Projects:

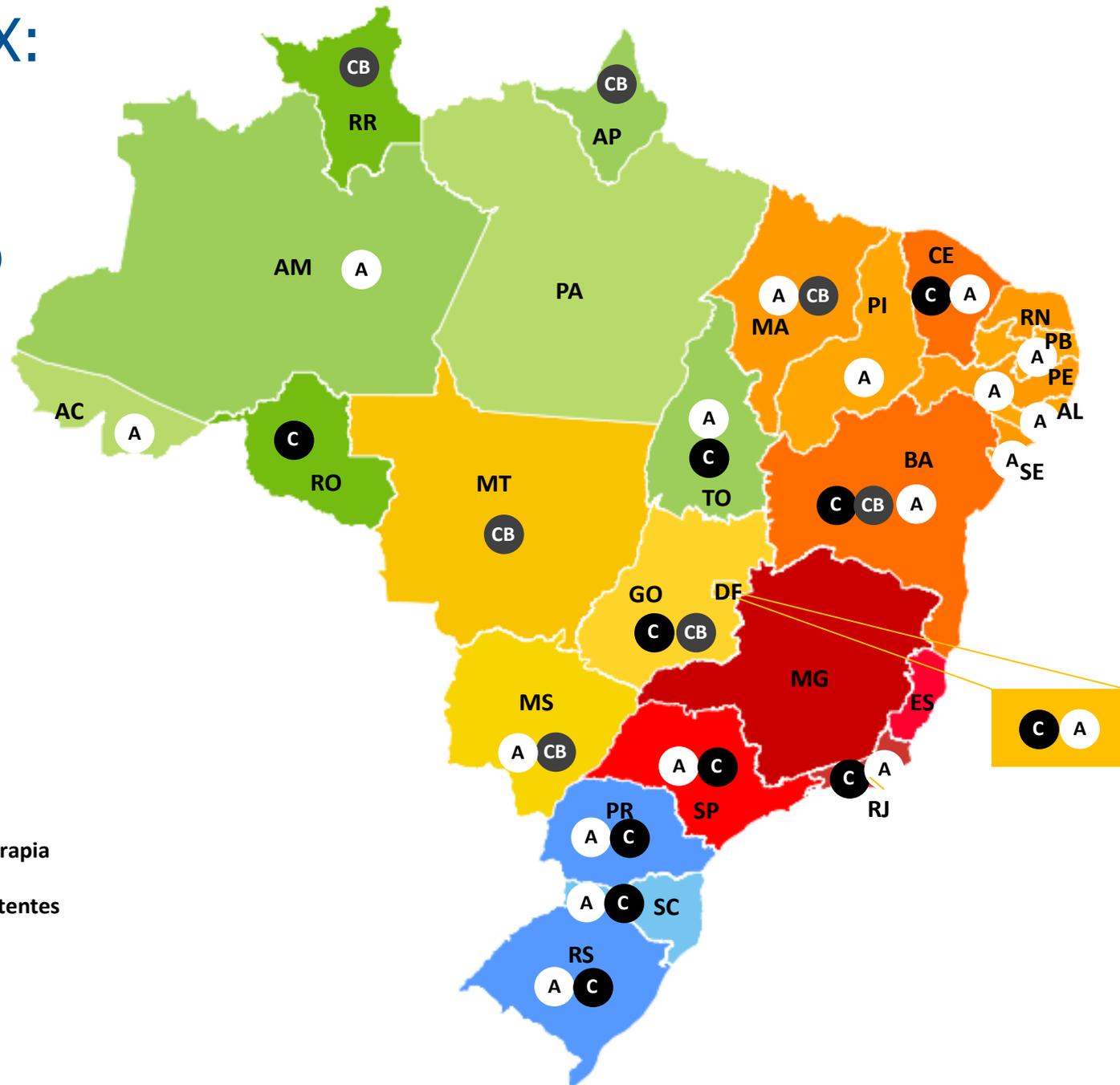
- 80 projects em execução e sujeitos a aprovação da ANVISA e CNEN

Compensação tecnológica :

- Abertura de fábrica no Brasil (Jundiaí)

80 Novos ALX:

Mapa de Distribuição



- C** 32- Novos Centros
- CB** 09- Novos Centros com braquiterapia
- A** 39 - Expansão de centros já existentes



HOSPITAL
SÍRIO-LIBANÊS
ENSINO E PESQUISA

CURSOS E CONGRESSOS

**XV CURSO DE RADIOTERAPIA
DE ÚLTIMA GERAÇÃO E
CONTROLE DE QUALIDADE**

03 e 04 / DEZ / 2015

**CURSO DE BRAQUITERAPIA
DA PRÓSTATA**

05 / DEZ / 2015

