

# Dosis- Berechnungsprogramme für die Nuklearmedizin und die Radio-Onkologie

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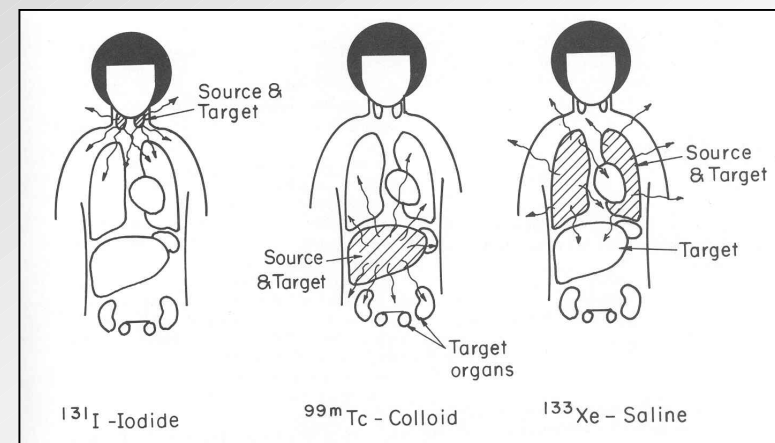
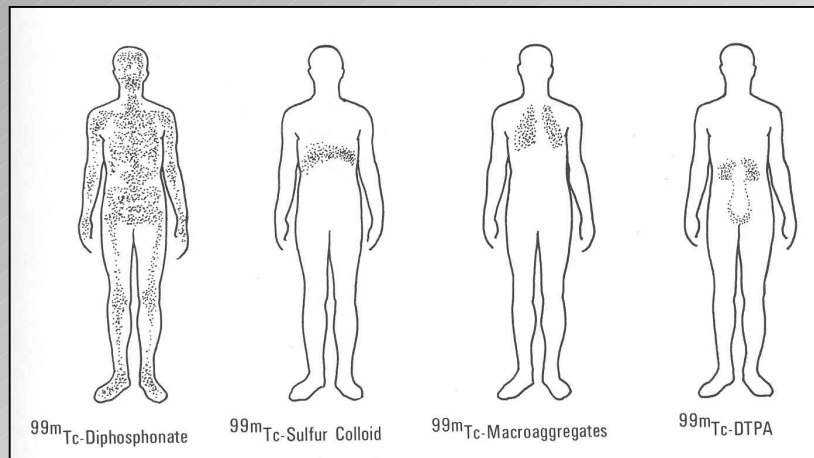
# Nuklearmedizin (Input)

## Dosisberechnung mit **Computer-Programm MIRDSE3**



### Parameter für Dosisberechnung (NM):

- verwendetes Radio-Nuklid
- Verteilung des Radio-Nuklids im Körper
- Verweilzeiten  $\tau$  (residence times) in den Organen



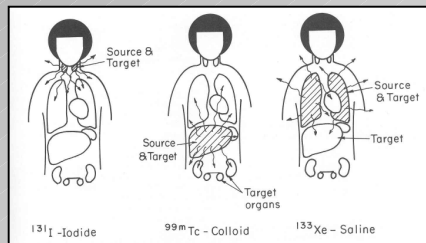
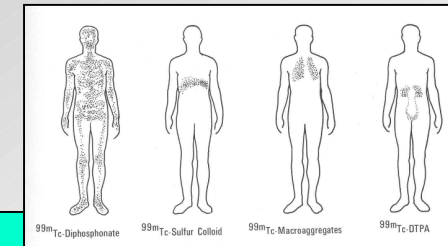
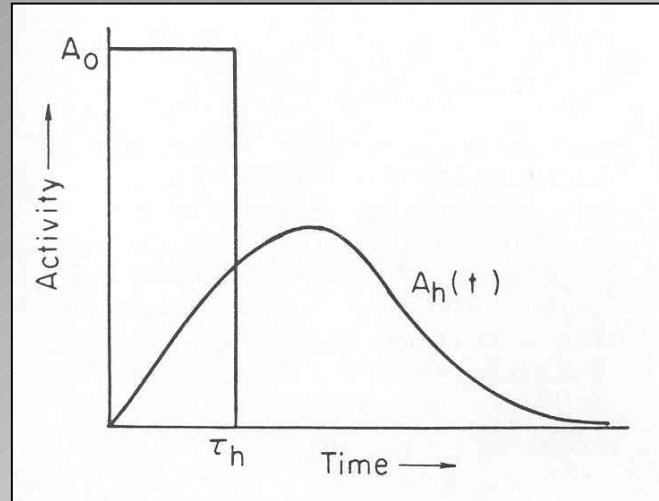
# Nuklearmedizin ( $\tau$ und S-Matrix)

$$D_t = \tilde{A} \cdot S_{t \leftarrow s}$$

$$\tilde{A} = \int_0^{\infty} A(t) \cdot dt$$

$$\tau = \frac{\tilde{A}}{A_0}$$

$$D_t = A_0 \cdot S_{t \leftarrow s} \cdot \tau$$



$A_0$  = applizierte Aktivität  
 $A(t)$  = Aktivität im Quellorgan [MBq] zur Zeit  $t$   
 $\tilde{A}$  = totale Anzahl Zerfälle im Quellorgan  
 $S_{t \leftarrow s}$  = Dosis im Zielorgan pro Zerfall im Quellorgan [mGy/(MBq · s)]  
 $\tau$  = residence time

# Nuklearmedizin ( $\tau$ , Biokinetik)

Tc  
43  
Phosphonates

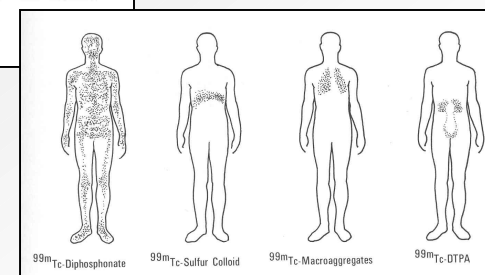
## BIOKINETIC MODELS AND DATA

### Biokinetic Data

Organ (S)	$F_s$	T	a	$\tilde{A}_s/A_0$
(1) Normal uptake and excretion				
Total body (excluding bladder contents)	1.0	0.5 hr 2 hr 3 d	0.3 0.3 0.4	4.06 hr
Bone	0.5	0.25 hr 2 hr 3 d	-1.0 0.3 0.7	3.01 hr
Kidneys	0.02	0.5 hr 2 hr 3 d	0.3 0.3 0.4	7.5 min
Bladder contents	1.0			1.15 hr
(2) High bone uptake and/or severely impaired kidney function				
Total body	1.0	$\infty$	1.0	8.69 hr
Bone	0.7	0.25 hr $\infty$	-1.0 1.0	5.84 hr



$$D_t = A_0 \cdot S_{t \leftarrow s} \cdot \tau$$



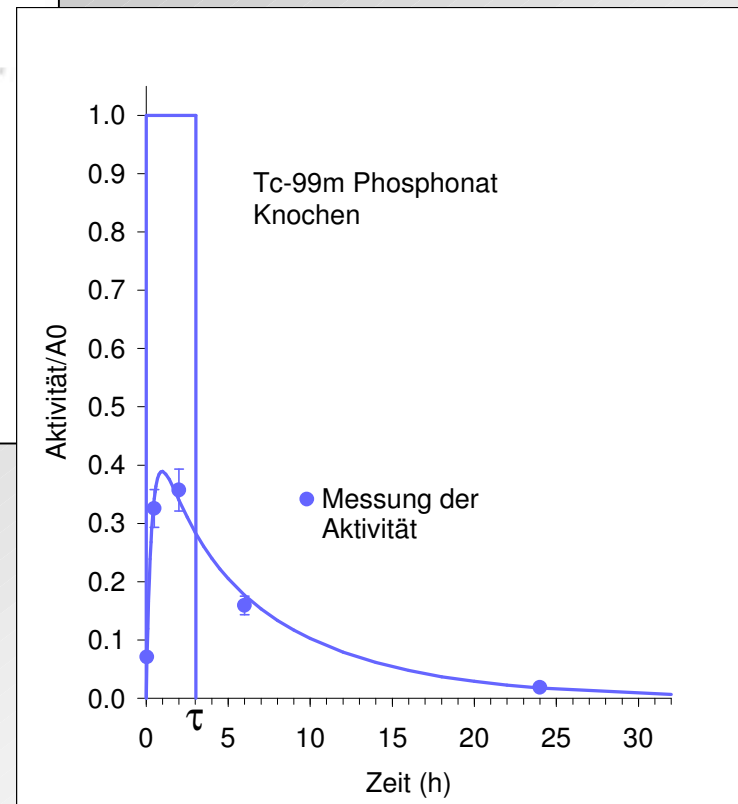
# Nuklearmedizin ( $\tau$ , Biokinetik)

## Tc-99m Phosphonat

$F_s$	T	a	$\tilde{A}_s/A_0$
1.0	0.5 hr	0.3	4.06 hr
	2 hr	0.3	
	3 d	0.4	
0.5	0.25 hr	-1.0	3.01 hr
	2 hr	0.3	
	3 d	0.7	
0.02	0.5 hr	0.3	7.5 min
	2 hr	0.3	
	3 d	0.4	
1.0			1.15 hr



$$D_t = A_0 \cdot S_{t \leftarrow s} \cdot \tau$$



# Nuklearmedizin ( $\tau$ , Biokinetik)

## Tc-99m Phosphonat

$F_s$	T	a	$\tilde{A}_s/A_0$
1.0	0.5 hr	0.3	4.06 hr
	2 hr	0.3	
	3 d	0.4	
0.5	0.25 hr	-1.0	3.01 hr
	2 hr	0.3	
	3 d	0.7	
0.02	0.5 hr	0.3	7.5 min
	2 hr	0.3	
	3 d	0.4	
1.0			1.15 hr



$$D_t = A_0 \cdot S_{t \leftarrow s} \cdot \tau$$

Input data for 99m-Tc-43

File Help

Elements	Nuclides	Phantoms
Scandium	94m-Tc-43	<input checked="" type="checkbox"/> Adult (70 kg)
Selenium	95-Tc-43	<input type="checkbox"/> 15-year-old (57 kg)
Silver	95m-Tc-43	<input type="checkbox"/> 10-year-old (32 kg)
Sodium	97m-Tc-43	<input type="checkbox"/> 5-year-old (19 kg)
Strontium	99-Tc-43	<input type="checkbox"/> 1-year-old (9.8 kg)
Sulfur	99m-Tc-43	<input type="checkbox"/> Newborn (3.4 kg)
Tantalum		<input type="checkbox"/> Adult Female - Nonpregnant
Technetium		<input type="checkbox"/> 3-month Pregnant Woman
Tellurium		<input type="checkbox"/> 6-month Pregnant Woman
		<input type="checkbox"/> 9-month Pregnant Woman

Residence Times (hr)

<input type="checkbox"/> Adrenals	.13	<input checked="" type="checkbox"/> Kidneys	<input type="checkbox"/> Testes
<input type="checkbox"/> Brain		<input type="checkbox"/> Liver	<input type="checkbox"/> Thymus
<input type="checkbox"/> Breasts		<input type="checkbox"/> Lungs	<input type="checkbox"/> Thyroid
<input type="checkbox"/> Gallbladder Contents		<input type="checkbox"/> Muscle	1.15 <input checked="" type="checkbox"/> Urin. Bl. Contents
<input type="checkbox"/> LLI Contents		<input type="checkbox"/> Ovaries	<input type="checkbox"/> Uterus
<input type="checkbox"/> SI Contents		<input type="checkbox"/> Pancreas	<input type="checkbox"/> Fetus
<input type="checkbox"/> Stomach Contents		<input type="checkbox"/> Red Marrow	<input type="checkbox"/> Placenta
<input type="checkbox"/> ULI Contents	3.01	<input checked="" type="checkbox"/> Cortical Bone	4.06 <input checked="" type="checkbox"/> Remainder of Body
<input type="checkbox"/> Heart Contents		<input type="checkbox"/> Trabecular Bone	
<input type="checkbox"/> Heart Wall		<input type="checkbox"/> Spleen	

Use ICRP 30 GI tract model? Yes

Use Dynamic Bladder Model? Yes

Select All Clear All

Nodule Module

Sphere Size:

Sphere Diameter:

Report

Self-dose S-value:

Control Panel

Calculate Doses S-Value Table

Label for Program Output:

# Nuklearmedizin (S-Matrix)

File View Help

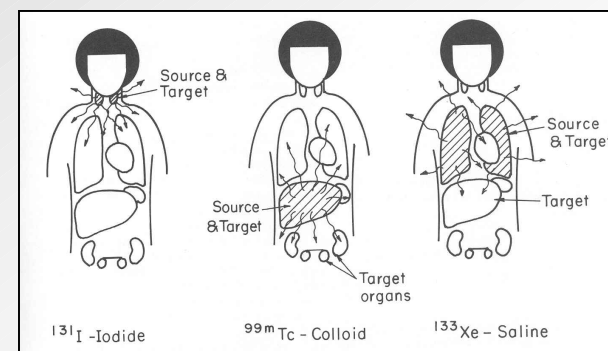
S-Values for the REFERENCE ADULT for 99m-Tc-43 (mGy/MBq-s) 04-01-2005

TARGET	Adrenals	Brain	Breasts	Gall BI Cont	LLI Cont
Adrenals	1.58E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Brain	0.00E+00	1.81E-06	0.00E+00	0.00E+00	0.00E+00
Breasts	0.00E+00	0.00E+00	7.34E-06	0.00E+00	0.00E+00
Gallbladder Wall	0.00E+00	0.00E+00	0.00E+00	2.31E-05	0.00E+00
LLI Wall	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.01E-06
Small Intestine	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Stomach	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ULI Wall	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Heart Wall	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kidneys	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Liver	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lungs	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Muscle	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ovaries	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pancreas	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Red Marrow	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bone Surfaces	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Skin	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Spleen	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Testes	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thyroid	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Back to Input Form



$$D_t = A_0 \cdot S_{t \leftarrow s} \cdot \tau$$





# Nuklearmedizin (Resultat)

## Dosisberechnung mit **Computer-Programm MIRDose3**



File View Help

Radiation Dose Estimates for the REFERENCE ADULT for 99m-Tc-43

TARGET ORGAN	Total mGy/MBq	Dose rad/mCi	Primary Contributor	Contribution	Secondary Contributor	Contribution
Spleen	5.44E-04	2.01E-03	Rem. Body	100.0%		0.0%
Testes	5.44E-04	2.01E-03	Rem. Body	100.0%		0.0%
Thymus	5.44E-04	2.01E-03	Rem. Body	100.0%		0.0%
Thyroid	5.44E-04	2.01E-03	Rem. Body	100.0%		0.0%
Urin Bladder	2.55E-02	9.45E-02	Urinary BI	98.9%	Rem. Body	1.1%
Uterus	5.44E-04	2.01E-03	Rem. Body	100.0%		0.0%
Total Body	9.34E-04	3.46E-03	Rem. Body	54.8%	Cort Bone	40.5%
EDE	3.09E-03	1.14E-02	Remainder	60.6%	Bone	27.6%
ED	2.19E-03	8.10E-03	Urin. Bladder	58.3%	Bone	13.0%
EDE/ED units:	mSv/MBq	rem/mCi				

SOURCE ORGAN	Residence Time (hr)
Kidneys	1.30E-01
Cort Bone	3.01E+00
Urinary BI Cont	1.15E+00
Remainder	4.06E+00

Dynamic Bladder Model?  Yes  No

ICRP 30 GI Model?  Yes  No

Activity in cortical and/or trabecular bone distributed on bone surfaces.

Back to Input Form

Tc-99m Phosphonat

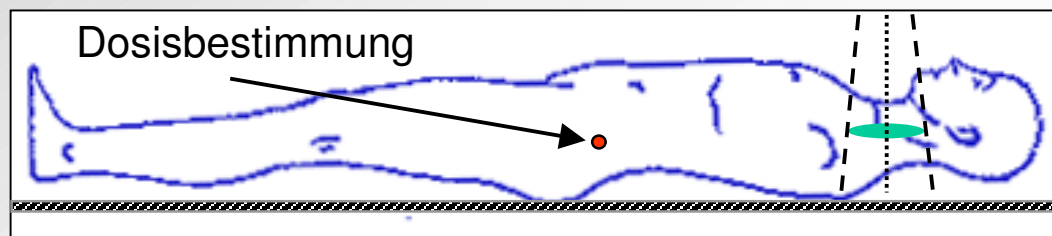
$$D_{\text{Organ}} = A \cdot f_{\text{Organ}}$$

$$E = A \cdot f_{\text{ED}}$$

# Radio-Onkologie (Input)

## Parameter für Dosisbestimmung (RT):

- Bestrahlungsgerät
- Zielvolumen
- Patientenpositionierung, -lage
- Gantrywinkel
- Fokus-Oberflächen-Distanz für jedes Feld
- Feldgrösse
- Keilfilter, Tischplatte
- Anzahl Monitoreinheiten
- individuelle Bestrahlungspläne



# Radio-Onkologie (Resultate)

## Dosisberechnung mit **Computer-Programm PeriDose**



**PeriDose**

File Help

Patient's name:  Total uncertainty:  cGy

Number of Beams:  Total Peripheral Dose:  cGy Total leakage and external scatter:  cGy

**Beam 1**

Energy:  MV  Co-60  X-Rays  (Apply to all beams)

Field Description:

IMRT  Orthogonal  Tangential

Wedge Used

Isocentric technique

Wedge properties

Wedge Type:  External  Internal

Wedge given dose at dmax:  cGy

Isocentric properties

Source Axis Distance:  cm Depth Isocenter:  cm

Field Size:  x  cm<sup>2</sup>

Distance center of field to PD-point:  cm

Patient thickness along beam axis:  cm

Depth of PD-point in beam direction:  cm

Open beam given dose at dmax:  cGy

Monitor units:  MU's

Shielding blocks used

Part of beam shielded

< 1/6  1/5  1/3

1/6  1/4  1/2

The ray-line "source-to-PD-point" is intercepted by the couch

Peripheral dose for this beam:  cGy Leakage and external scatter for this beam:  cGy

**0.9%**      **30 · 18 mGy = 540 mGy**

### Organdosis

- Streuung im Körper
- Leckstrahlung
- äussere Streuung

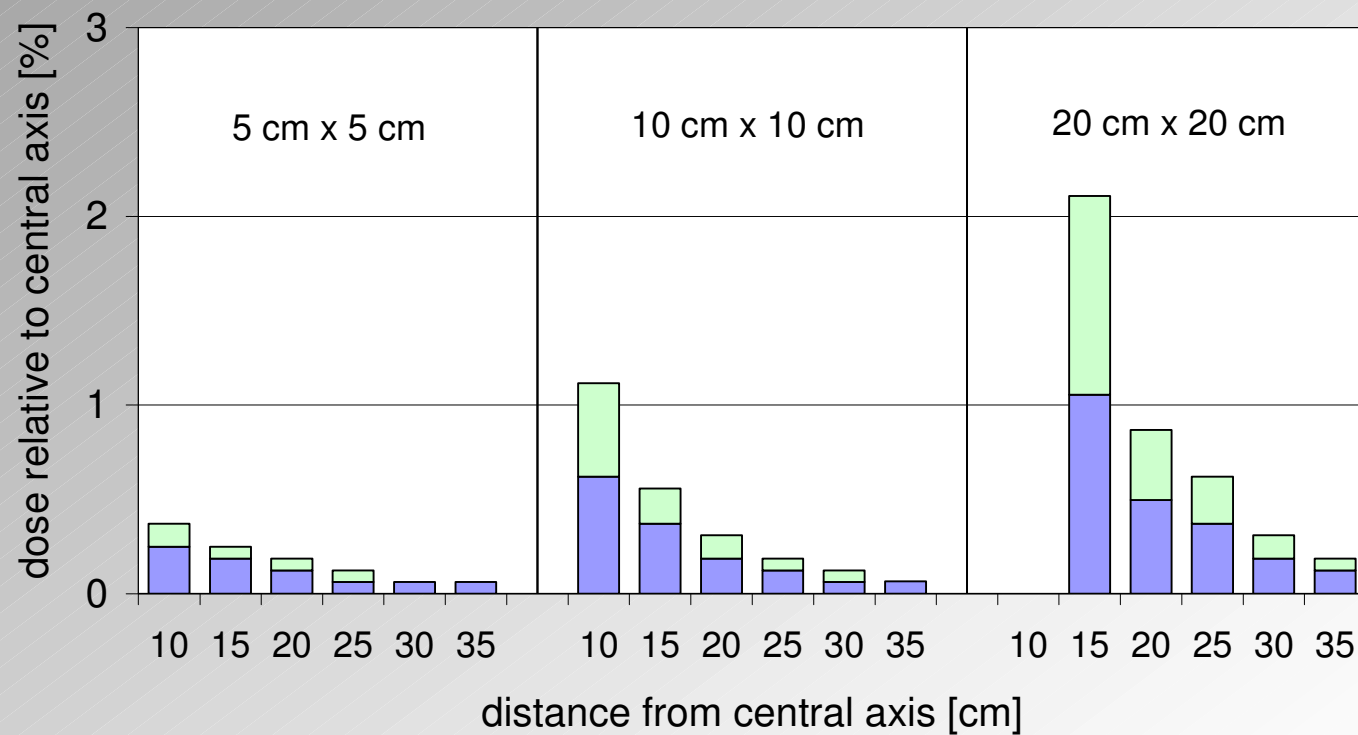
# Radio-Onkologie (Resultate)



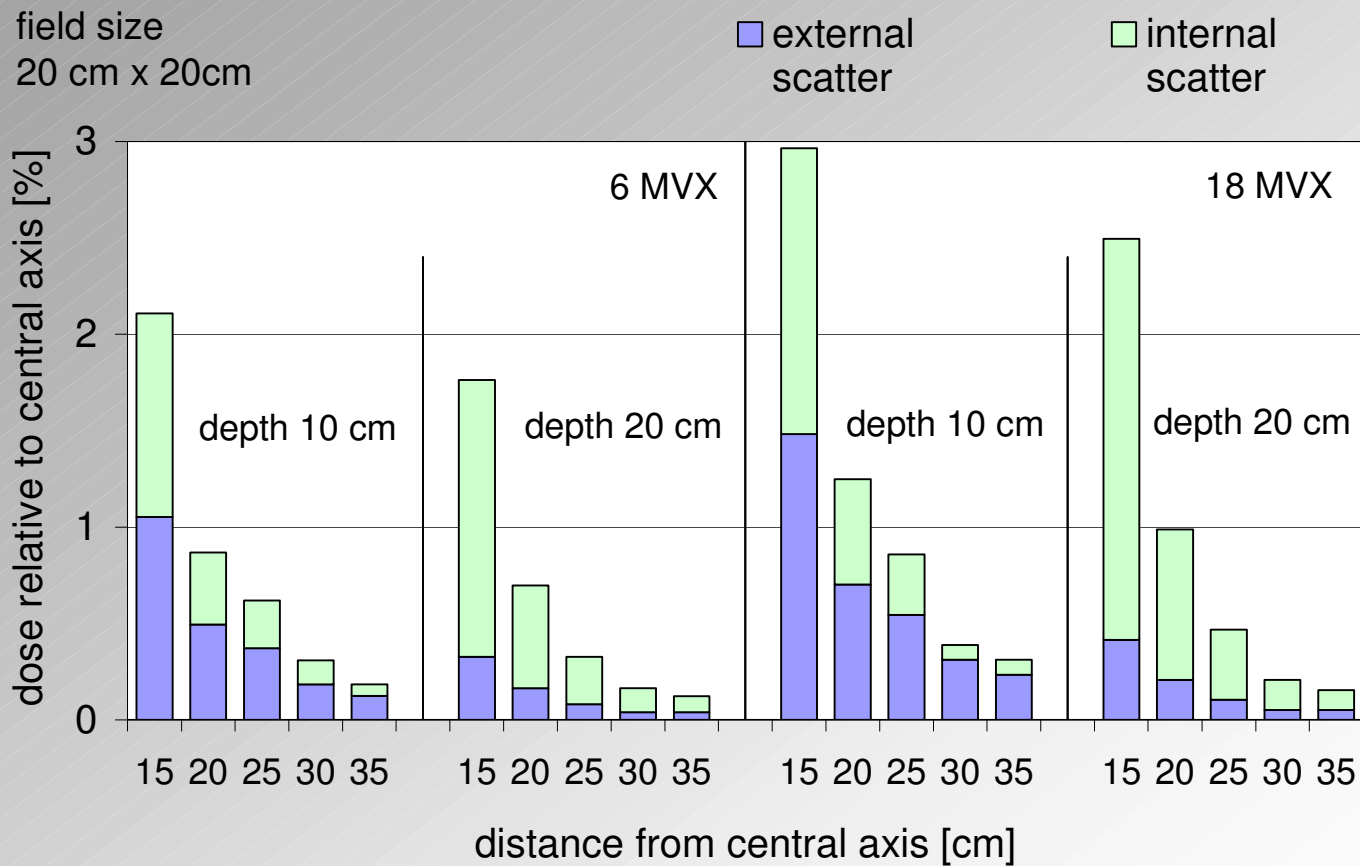
6 MVX  
depth 10 cm

external scatter

internal scatter



# Radio-Onkologie (Resultate)



# Letztes Dia

## Nuklearmedizin:

- Berechnung **aufwändig**
- **Biokinetik** muss erfasst werden

## Radio-Onkologie:

- **Messung** im Allgemeinen nötig für konkrete Situation
- **Achtung:**  
Berechnung **nicht** mit Therapie-Planungs-System,  
da optimiert für Dosen  $> 3\%$  der Herddosis