Strahlentherapie mit geschlossenen radioaktive Strahlenquellen

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Strahlentherapie

A: Perkutane Therapie
Teletherapie

B: Brachytherapie
Curie-Therapie

Radionuklide

Zur Zeit sind 2685 Nuklide von 112 Elementen bekannt. 297 (ca. 10%) sind natürlicher Herkunft. Viele künstliche Radionuklide werden durch Kernreaktionen erzeugt und sind instabil.

Erzeugung radioaktiver Strahlenquellen für die Medizin

-chemische Isolation von spezifischen Radionukliden aus Spaltprodukten nach Kernspaltung schwerer Elemente

-künstliche Aktivierung natürlicher stabiler Elemente durch Neutronenbeschuss (Neutroneneinfang)

-künstliche Induzierung von Kernumwandlungen durch Beschuss mit beschleunigten elektrisch geladenen Teilchen (Protonen,α..)

Radioaktive Quellen

Radioelement	Halbwertszeit	Energie der ausgesendeten Strahlung β*	γ
H-3	12,26 Jahre	β-: 18.6 keV	
C-14	5730 Jahre	β-: 156 keV	
P-32	14.3 Tage	β-:1.71 MeV	
K-40	1.27 . 10^9 Jahre	β-:1.3 Mev	1.46 MeV
Cr-51	27.7 Tage		0.32 MeV
Co-60	5.26 Jahre	β-:0.31 MeV	1.17 MeV
		1.49 MeV	1.33 MeV
Se-75	121 Tage		136 keV
			265 keV
			280 keV
Sr-90	28.1 Jahre	β-: 0.55 MeV	
Y-90	64 Tage	β-: 2.27 MeV	
Mo-99	66.7 Std.	β-: 0.46 MeV	40 keV
		1.23 MeV	140 keV
Tc-99m	6.03 Std.		180 keV
I-123	13.0 Std.		140 keV
I-125	60 Tage		159 keV
I-131	8.06 Tage		35.4 keV
Xe-133	5.31 Tage	β-:0.61 MeV	365 keV
Cs-137	30.0 Jahre	β-: 0.35 MeV	81 keV
Ir-192	74.2 Tage	β-: 0.51 MeV	0.662 MeV
		β-: 0.67 MeV	0.296 Mev
		β-:	0.308 Mev
			0.317 Mev
			0.468 Mev
Au-198	2.69 Tage	β-: 0.96 MeV	0.412 MeV
Ra-226	1600 Jahre	α : 4.78 MeV + Tochterprodukte	
Am-241	458 Jahre	α : 5.64 MeV	60 keV
Cf-252	2.65 Jahre	α : 6.17 MeV + Spaltneutronen	

Offene radioaktive Strahlenquellen

Strahlenquellen, die radioaktive Stoffe enthalten und die sich ausbreiten und Kontamination verursachen können

nehmen am Stoffwechsel teil

Geschlossene radioaktive Strahlenquellen

Strahlenquellen, die radioaktive Stoffe enthalten, und deren Bauart unter üblicher Beanspruchung ein Austreten radioaktiver Stoffe vollständig verhindert und so die Möglichkeit einer Kontamination ausschliesst. Die Quellenkapselung soll für die vorgesehene Anwendung den Anforderungen der ISO-Normen genügen und entsprechend klassifiziert sein.

nehmen am Stoffwechsel nicht teil; oft nur Gamma-Strahler

In der Medizin verwendete Radionuklide

Radio-Onkologie

Geschlossene radioaktive Strahlenquellen

Nuklearmedizin

Offene radioaktive Strahlenquellen

In der Medizin verwendete Radionuklide

Radionuklide werden in der Medizin zu diagnostischen und therapeutischen Zwecke eingesetzt

Radio-Onkologie

-perkutane Strahlentherapie
-Brachytherapie

Nuklearmedizin

-Nuklearmedizinische Diagnostik
-Nuklearmedizinische Therapie

In der Medizin verwendete Radionuklide

Therapeutische perkutane Strahlenexpositionen

geschlossene Quellen mit langer HWZ

-Tiefentherapie, Gamma-Strahler

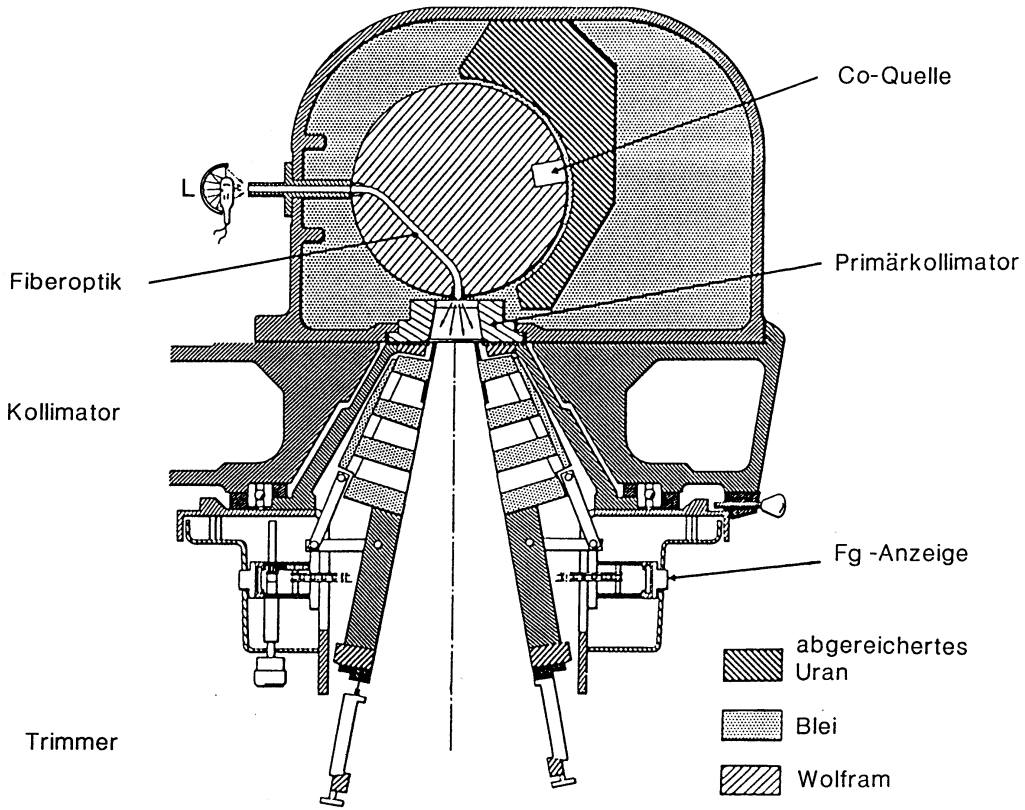
Co-60; $E\gamma$=1.17 MeV und 1.33 MeV
Cs-137 $E\gamma$=0.662 MeV

-Oberflächentherapie, Beta-Strahler

Sr-90 $E\beta$= 0.54 MeV
P-32 $E\beta$=1.71 MeV

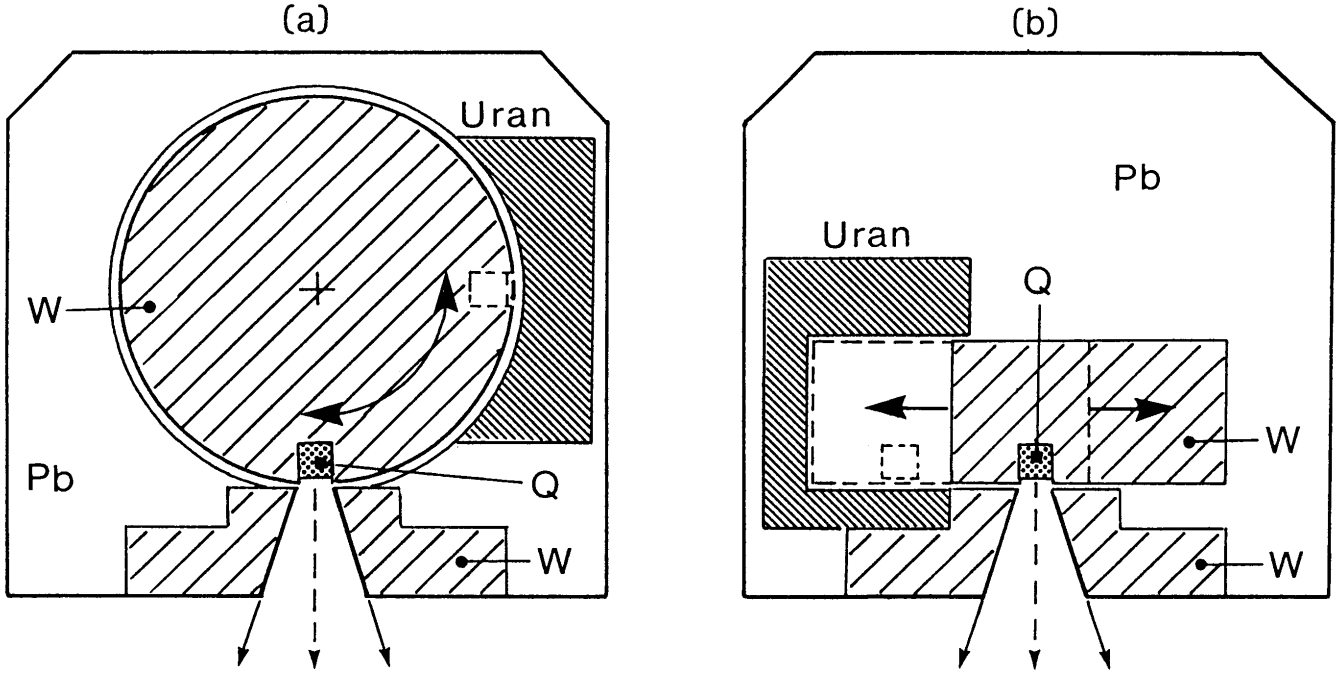
Dermatologie, Ophtalmologie

Kobalt-Anlagen



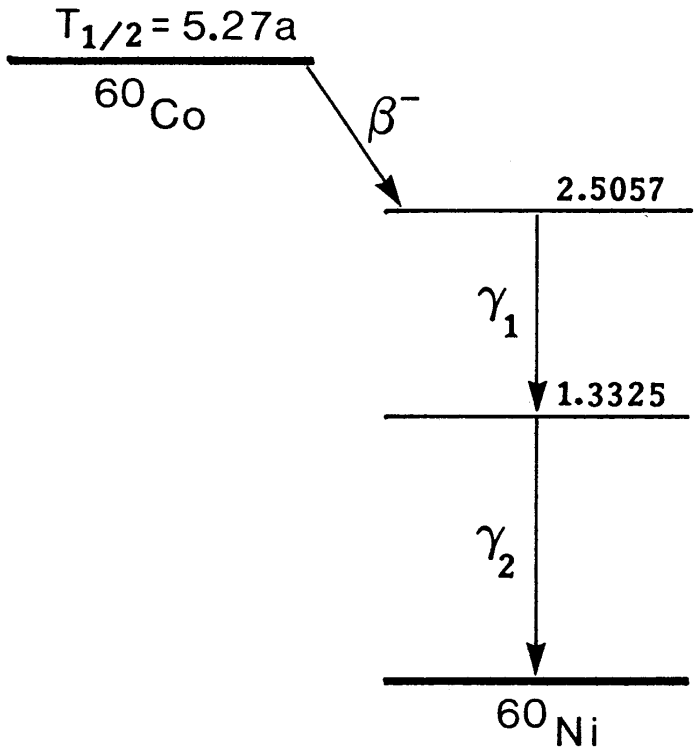
Moderner Strahlerkopf einer Kobaltanlage für die Telegamma-Strahlentherapie mit Drehverschluß und hervorragender Strahlgeometrie (Fg-Anzeige: Anzeige der Feldgröße, L: Lichtvisierlampe).

Kobalt-Anlagen



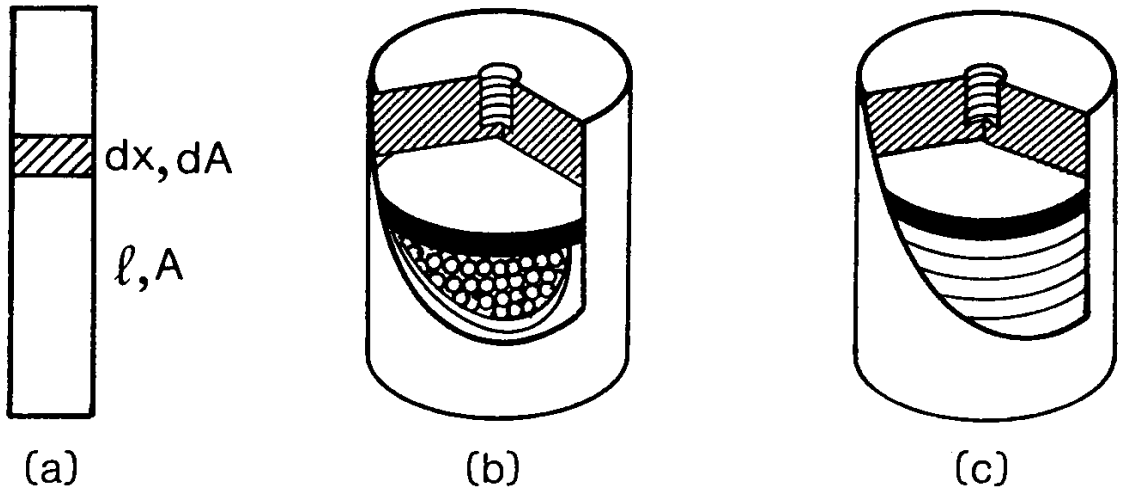
Verschlußkonstruktionsprinzipien von Kobalt-Therapiegeräten, (a): Drehverschluß, (b): Schiebeverschluß (Q: Quelle, Pb: Blei, W: Wolfram).

Kobalt-Anlagen



Vereinfachtes Zerfallsschema von ^{60}Co, nach [Lederer], Energien in MeV.

Kobalt-Anlagen



Bauformen kommerzieller Kobalt-Therapiequellen, (a): Quellenmodell zu Gleichung (1.5.1), (b): Quelle mit vernickelten "l-mm-Pellets", (c): Quelle mit massiven kreisförmigen Scheiben (Durchmesser 17 mm, Höhe 2.5 mm), Hüllen aus Edelstahl.

$$A_{eff} = \int_0^{\ell} dA \cdot e^{-\mu \cdot x} = A / \ell \cdot \int_0^{\ell} e^{-\mu \cdot x} dx = \frac{A}{\mu \cdot \ell} \cdot (1 - e^{-\mu \cdot \ell})$$

Strahlentherapie mit geschlossenen radioaktiven Quellen

Brachytherapien

- 3000-5000 Therapien/Jahr
- A/Therapie = 1 GBq – 500 GBq
- D_{Target}, fraktioniert = bis 100 Gy

In der Medizin verwendete Radionuklide

Brachytherapie

Applikationstechnik: **temporär oder permanent**

temporäre Implantate; **lange HWZ**

Cs-137 $E\gamma$=0.662 MeV

Ir-192 $E\gamma$=0.375 MeV

permanente Implantate; **kurze Reichweite**

I-125 $E\gamma$=0.035 MeV

Strahlentherapie

temporäre Implantate; **kurze Reichweite, lange HWZ**

P-32 $E\beta$=1.71 MeV

Kardiologie

Brachytherapie

HNO	Mundhöhle Nasopharynx Hypopharynx Zungengrund Lippe
Gyn	Brust Scheide Gebärmutter
Uro	Penis Prostata Blase
Darm	Anus Rectum
Andere	Bronchien Oesophagus

Brachytherapie

Methoden der Quellenapplikation

A: Direkte Quellenapplikation

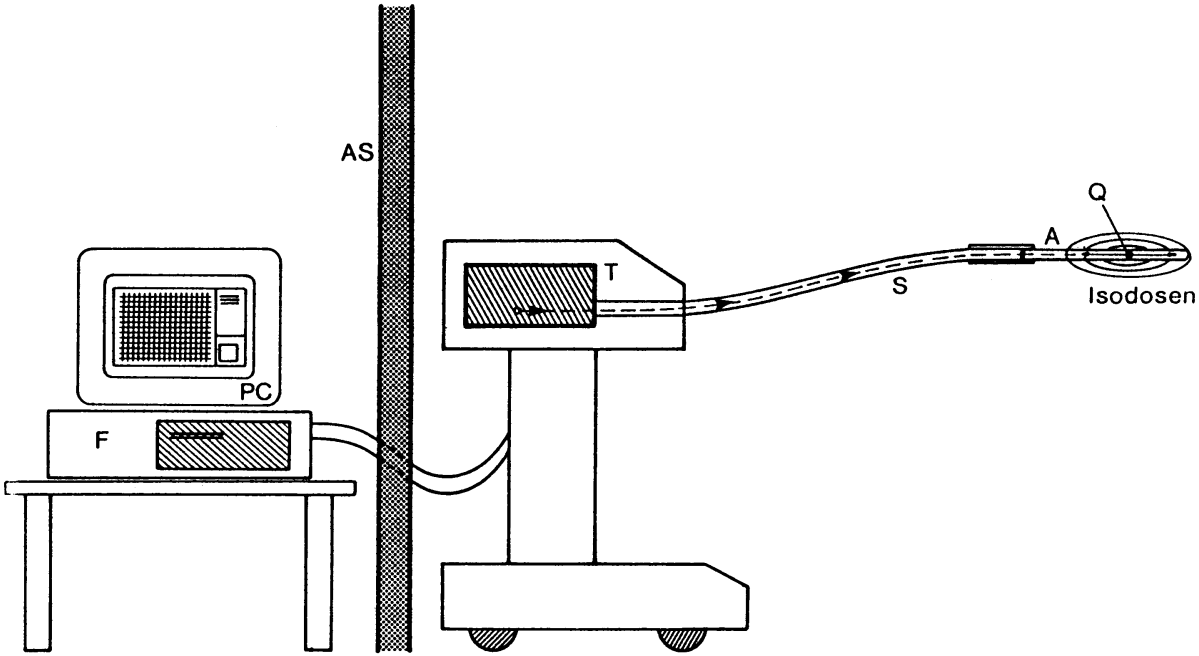
B: Afterloading-(Nachlade-)Verfahren
- manuell
- ferngesteuert

Brachytherapie

Therapietechniken

		DR in 10 cm Gewebetiefe
A: LDR („low dose rate“)	:	≤ 2 Gy/h
B: MDR („medium dose rate“)	:	2 bis 12 Gy/h
C: HDR („high dose rate“)	:	> 12 Gy/h
D: PDR („pulsed dose rate“)	:	> 1 Frak/d

Einführung in die HDR-Afterloading-Brachytherapie



Prinzip der Nachladetechnik (T: Quellentresor, S: Führungsschlauch, Q: bewegliche Quelle, A: Applikator, F: Fernsteuerung, PC: Personalcomputer, AS: Abschirmung).

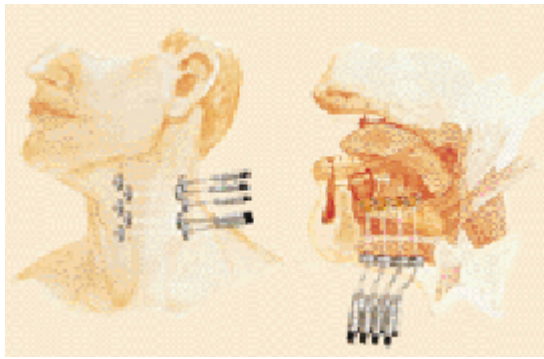
Brachytherapie als Teil eines multimodalen Therapiekonzeptes

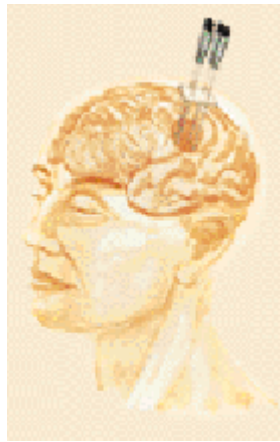
Brachytherapie

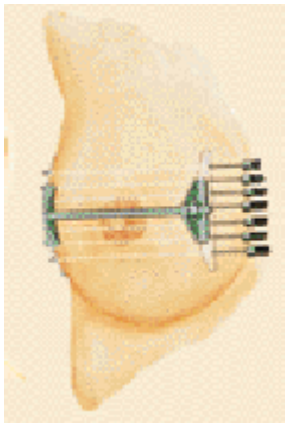
Therapieformen

A:	Interstitielle Brachytherapie
B:	Endoluminale Brachytherapie
C:	Intrakavitäre Brachtherapie
D:	Oberflächen-Kontaktbestrahlungen

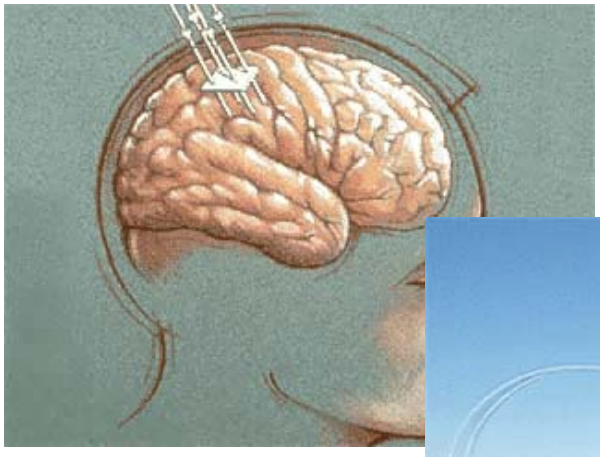
A: Interstitielle Brachytherapie

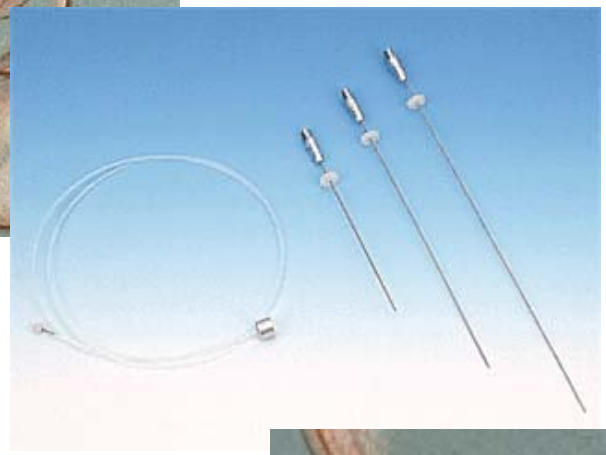


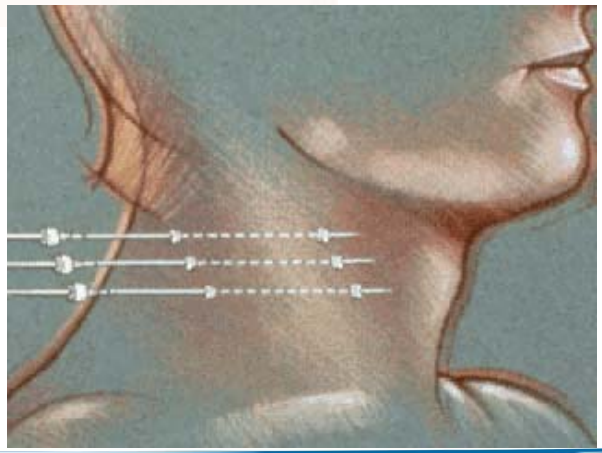




Bestrahlung von Tumoren im Kopfbereich

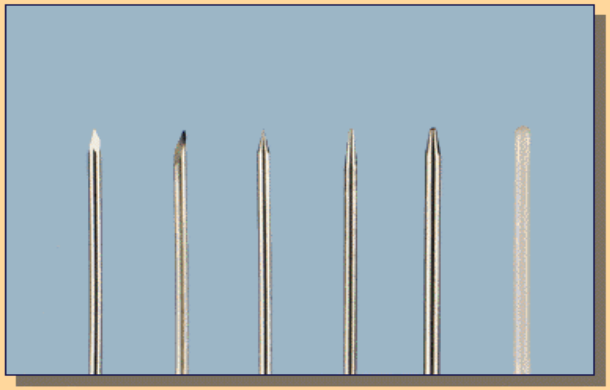






Interstitielle Brachytherapie

Implants and Moulds

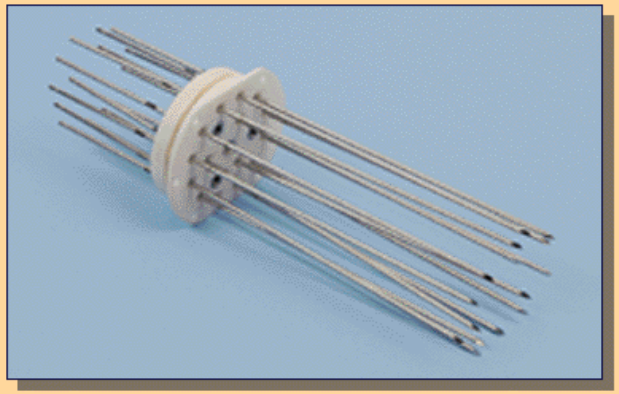


Interstitial Needles

Introduction
The interstitial needles are developed for use with Nucletron template sets, but can also be used with other templates.

- Template Set for Breast Implants
- MUPIT Template Set
- Manchester Rectal Template Set
- Porter Perineal Template Set
- Anal Template Set
- Fritz Anorectal Template Set.

Prostatic, Perineal & Rectal Templates



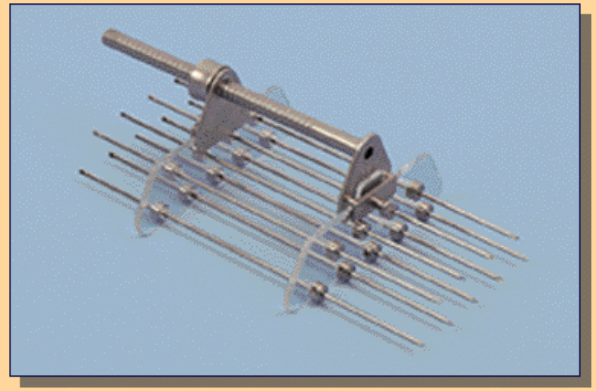
Porter Perineal Applicator Set

- **Porter Perineal Applicator Set for 1.9 mm**
  Part # 083.073

The microSelectron Porter Perineal applicator set for 1.9 mm implant needles is designed to irradiate cancers in the perineal region, such as prostatic neoplasms.

By means of special ball joints, needles can be implanted at the optimal angle for the required treatment and then

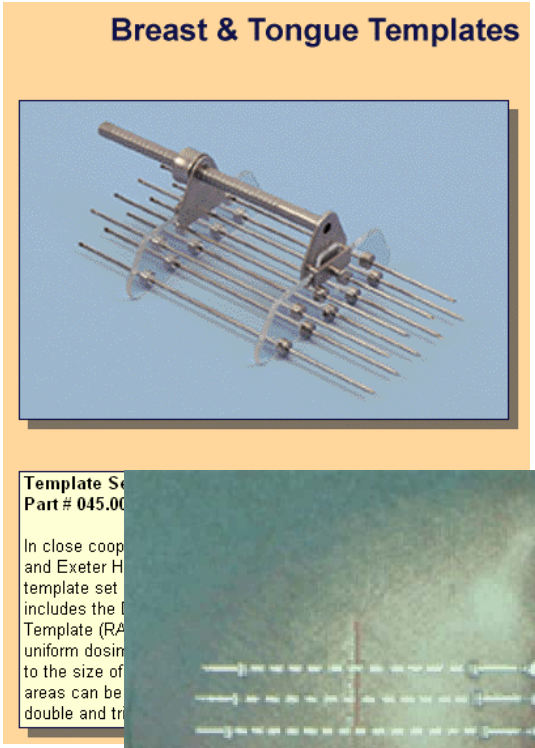
Breast & Tongue Templates

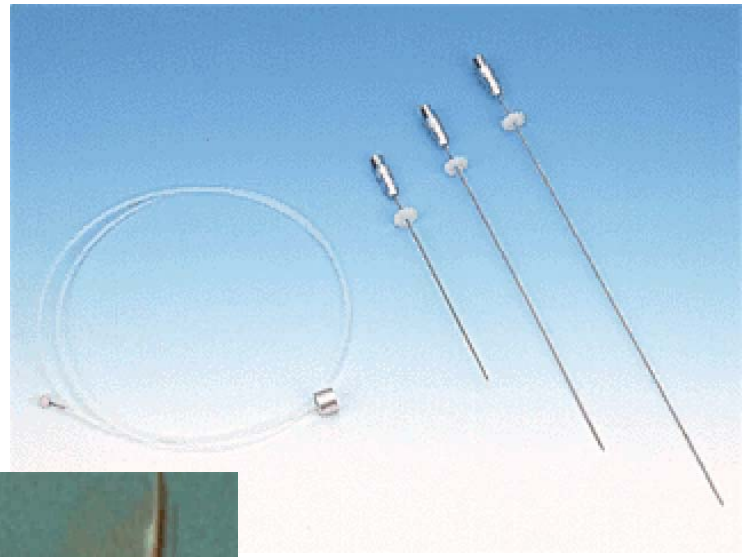


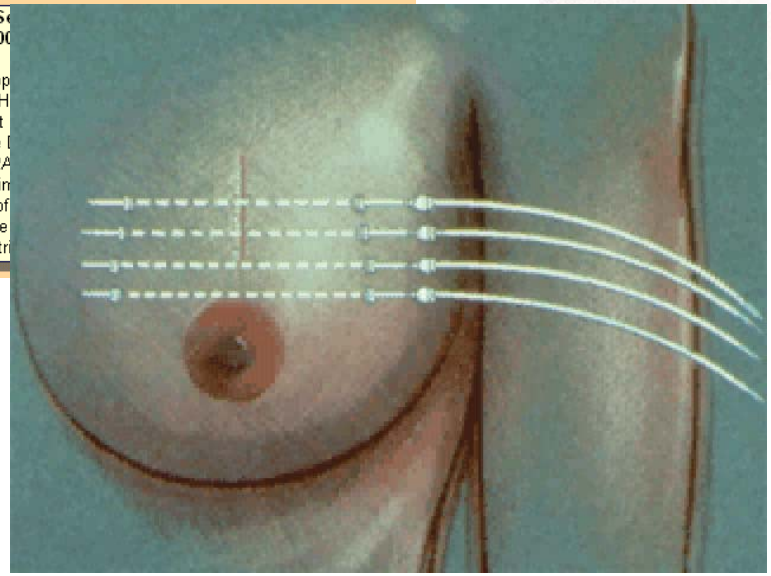
Template Set, Breast Implants (Complete)
Part # 045.006

In close cooperation with Dr. Rowland, of the Royal Devon and Exeter Hospital, Exeter, England we developed a new template set according the Paris Dosimetry System which includes the Dr. Rowland Adjustable Breast Implant Template (RABIT) holder. The holder is designed to ensure uniform dosimetry of the breast implant and can be adjusted to the size of the breast. With this template set all target areas can be covered. The set includes subsets of single, double and triple plane template pairs with different basal

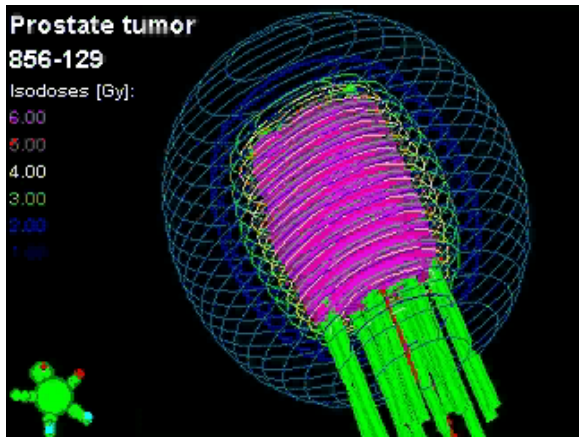
Brustbestrahlungen

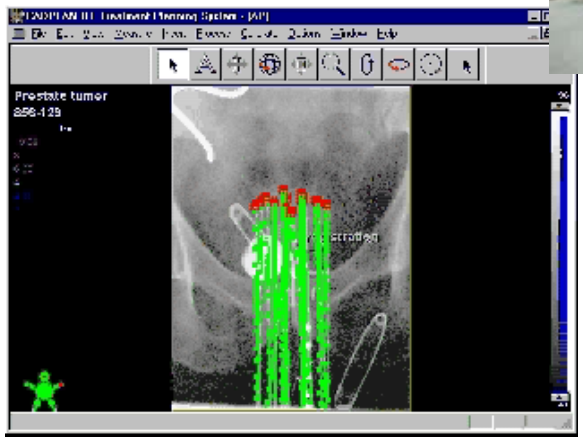


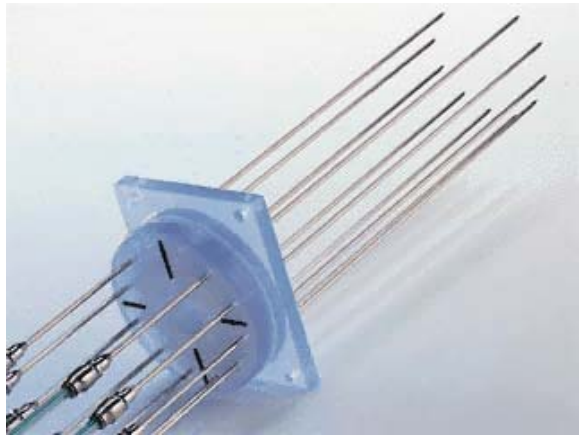




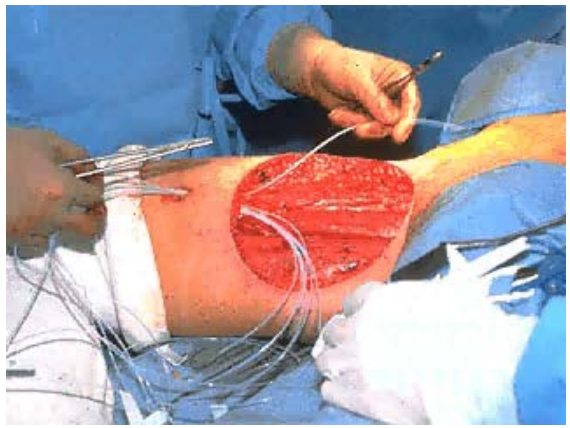
Prostatabestrahlungen

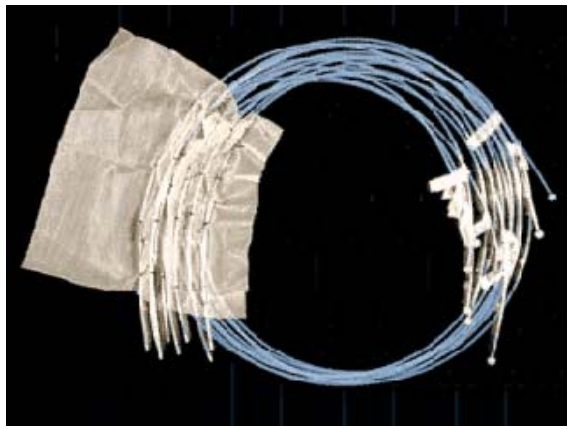


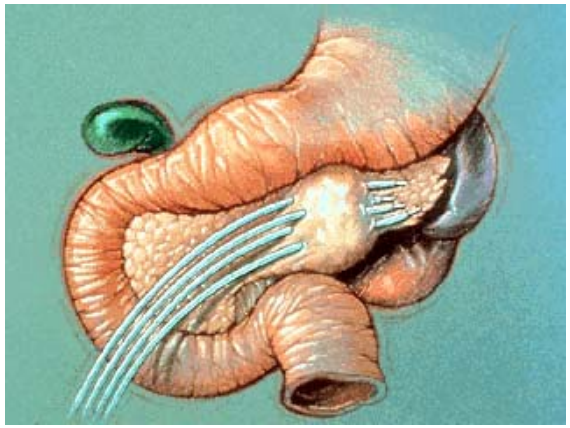


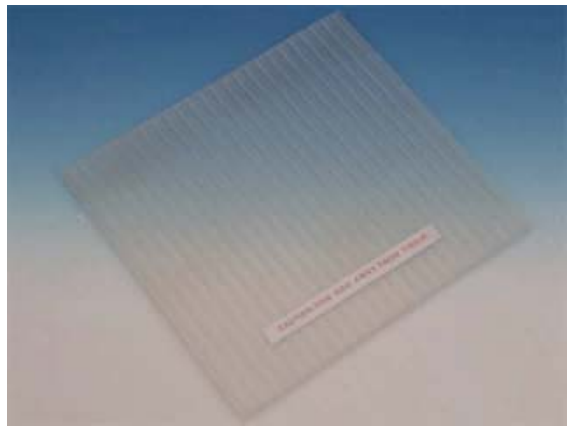


Intraoperative Brachytherapie

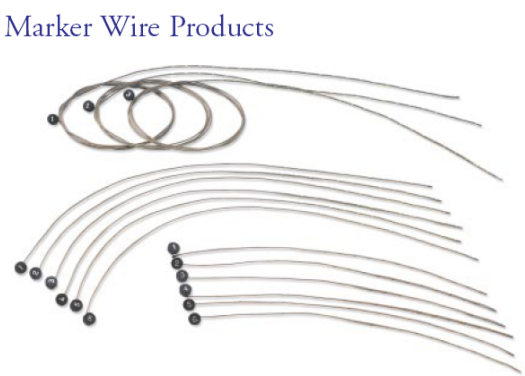


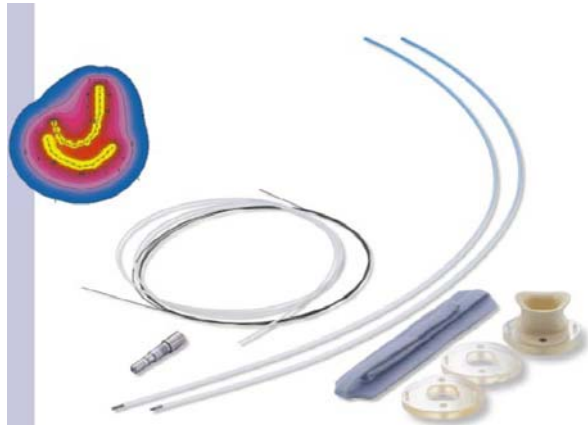






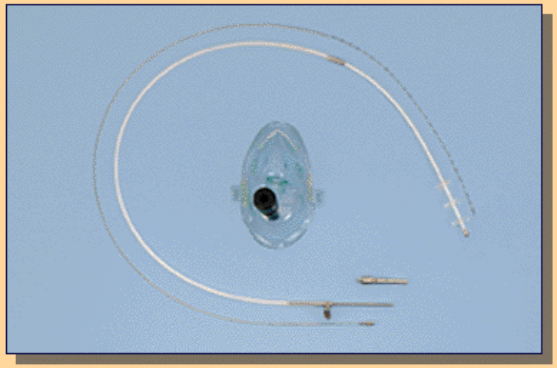
B: Endoluminale Brachytherapie





Speiseröhre

Oesophageal Applicators

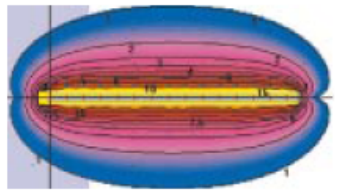


Adjustable Intralumenal Applicator Set

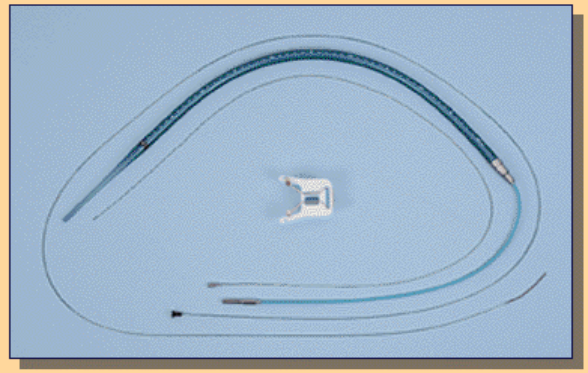
- **Adjustable Intralumenal Applicator Set, 100 cm, Part # 085.009**
- **Adjustable Intralumenal Applicator Set 6 mm, 150 cm, Part # 085.070**

The Adjustable Intralumenal Applicator Set is available in different lengths. It automatically positions in the centre of the bronchial lumen. This central position in the lumen leads to a clear improvement of the dose distribution. The applicator is built on the principle of a co-axial tube. Parts of

NOTE: FOR REGULATORY REASONS, THIS PRODUCT IS ONLY FOR SALE IN THE EUROPEAN UNION



Oesophageal Applicators

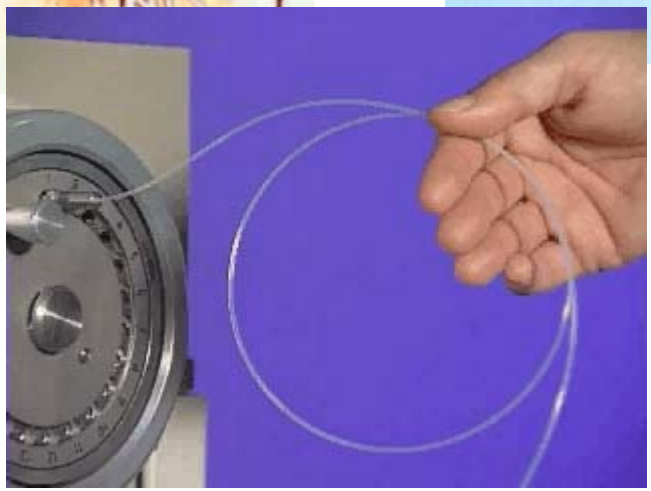


Bonvoisin-Gérard Oesophageal Applicator Set

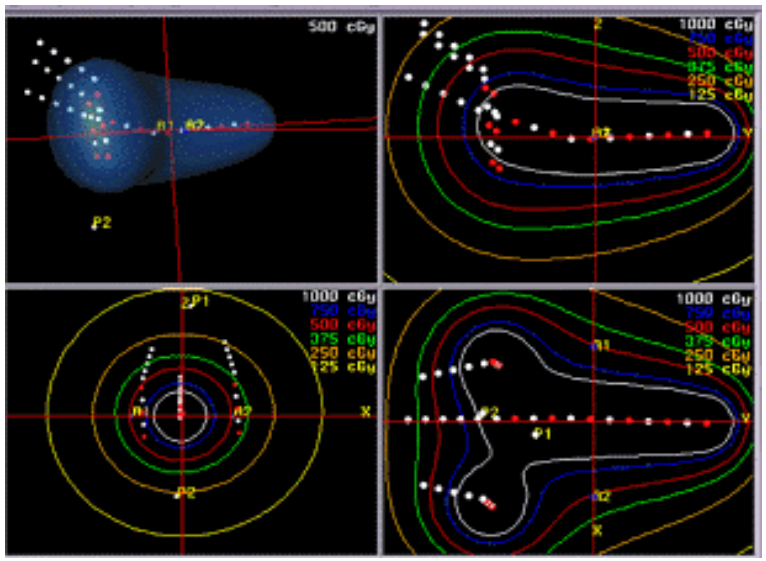
- **Bonvoisin-Gérard Oesophageal Applicator Set, Part # 085.035 (microSelectron-HDR)**
- **Bonvoisin-Gérard Oesophageal Applicator Set, Part # 087.015 (microSelectron-PDR)**

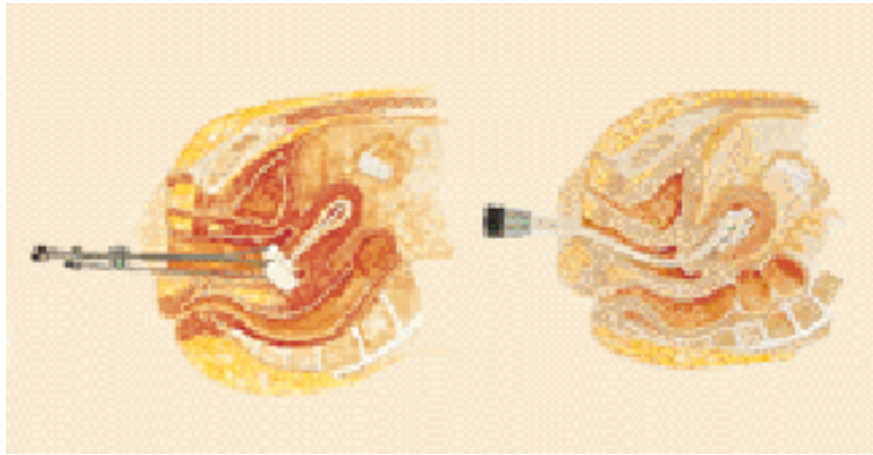
Introduction
The Bonvoisin-Gérard Oesophageal Applicator Set has been developed for the treatment of malignant oesophageal stenosis with the Hôpital Lyon Sud, France. If the malignant stenosis is endoscopically obstructed, the caudal tumour

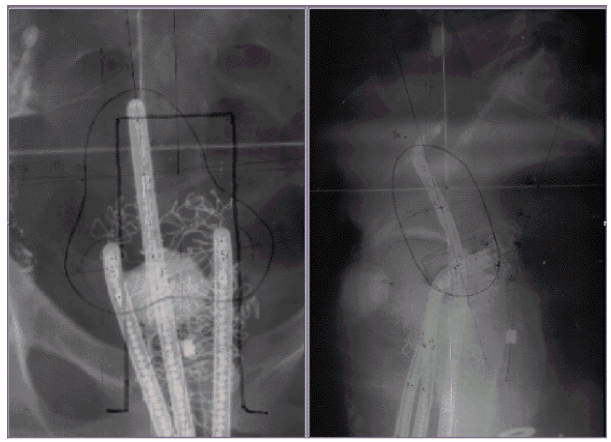
Bronchus-Lungenbestrahlungen



C: Intrakavitäre Brachytherapie

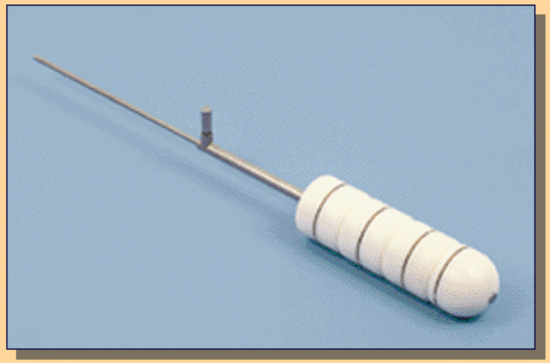






Gynäkologische Bestrahlungen

Vaginal Applicators

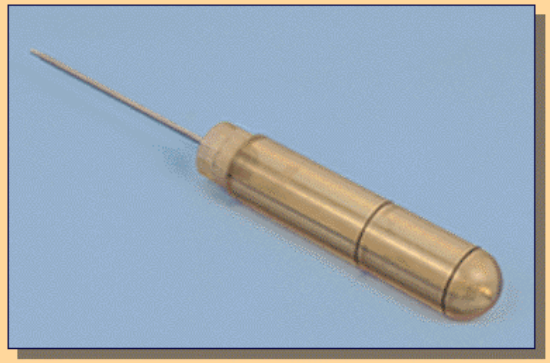


Vaginal Applicator Set
Part # 084.350

Applications
- Treatment of the vagina.
- Treatment of the vaginal cuff.
- Treatment of the cervix.
- Treatment for endometrium.
- Treatment of rectal cancer.

Features
- A versatile applicator which can be used not only for

Vaginal Applicators

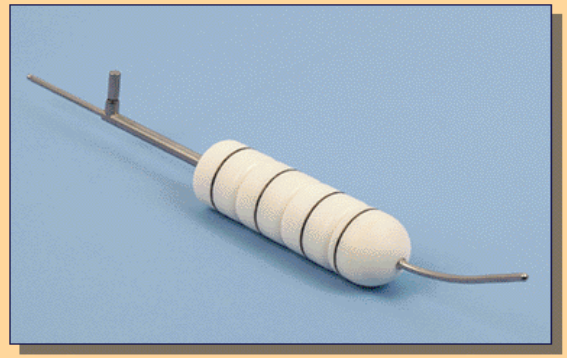


Shielded Cylindrical Applicator Set
Part # 084.320

Introduction
The microSelectron-HDR shielded cylindrical applicator is designed for vaginal and rectal treatments where shielding is required. Shielding of 90°, 180° or 270° can be achieved using a combination tungsten alloy shields.

Stainless steel shields are also available to provide less attenuation.

Cervical Applicators



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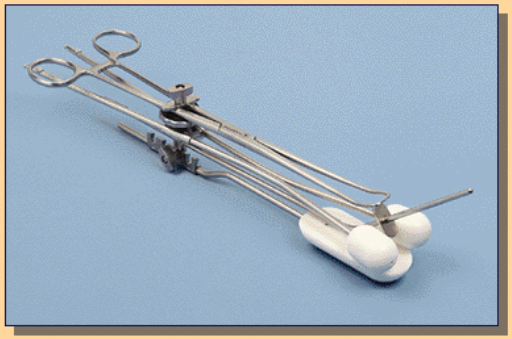
Gynäkologische Bestrahlungen

Cervical Applicators

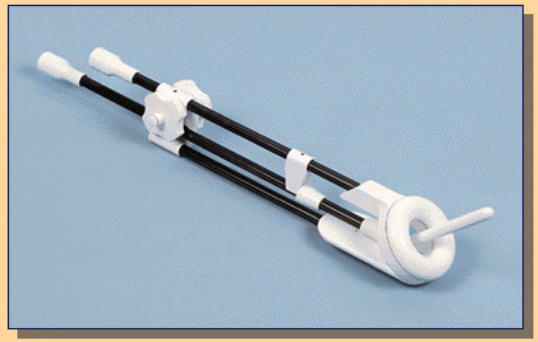


Joslin-Flynn Cervix Applicator Set
Part # 084.241

Introduction
The Joslin-Flynn Cervix Applicator Set has been developed with the Radiotherapy Centre, Cookridge Hospital, Leeds, United Kingdom. The applicator was designed specifically for high dose rate treatments using a rectal retractor to reduce the rectal dose. The dosimetry can duplicate the Manchester System.

Applications

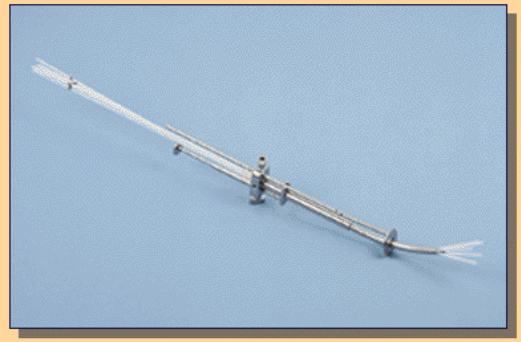
Cervical Applicators



Ring Applicator Set, CT/MR
Part # 101.035
(Not for sale in the USA. Pending 510k Food and Drug Administration(FDA) clearance)

Introduction
This non-metallic applicator is designed, using special composite tubing, to eliminate distortion on CT or MR images. This enables treatment planning to be based on the actual tumour position after insertion of the applicator. The geometry of the applicator simulates the Stockholm box technique using the ring and an intrauterine tube.

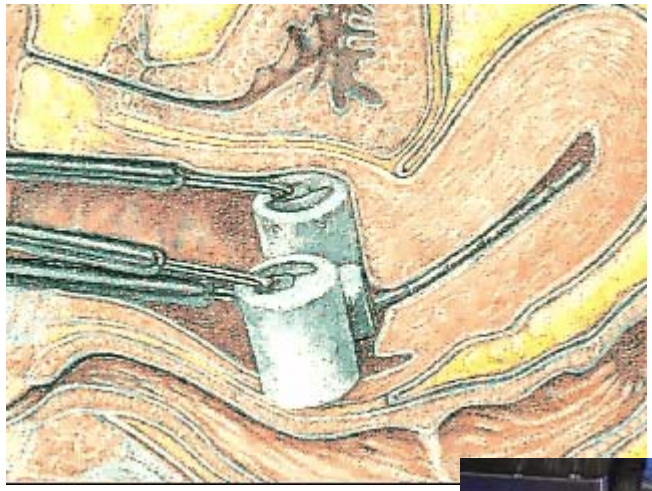
Endometrial Applicators

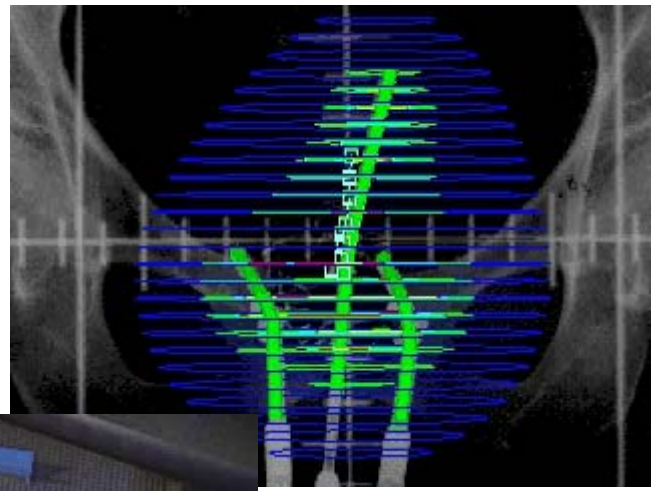


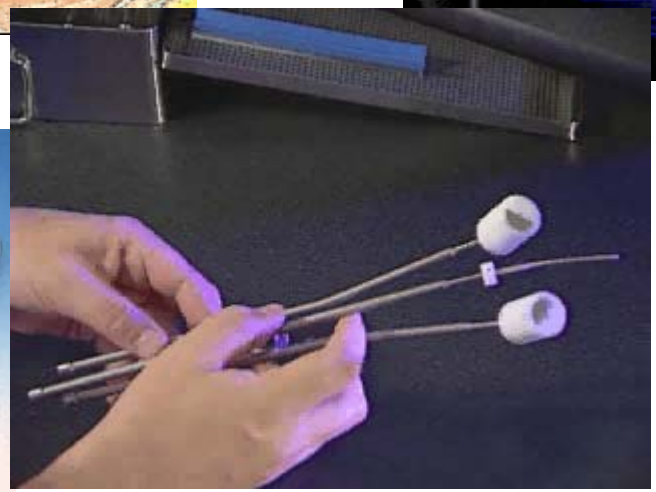
Bauer Endometrial Applicator Set
Part # 083.465
Basic

Introduction
The Bauer Endometrial applicator was designed in co-operation with Dr. Bauer of University of Heidelberg, Germany. The applicator is designed to simulate the dosimetry of Heyman packing and utilizes source dosimetry. 6 catheters are enclosed within a single 8 mm sheath. When the sheath is pulled back the catheters are released in a fan arrangement to adequately cover the

Gynaekologische Bestrahlungen

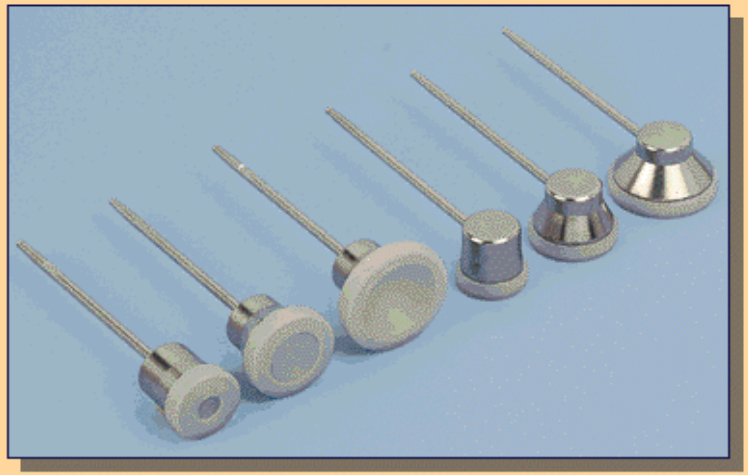






D: Oberflächen-Kontaktbestrahlungen

Implants and Moulds



Leipzig Applicator Set
Part # 085.040

Introduction
The Leipzig Applicator Set was developed with the Radiation Therapy Department of the University of Leipzig, Germany. This applicator, used with high dose rate brachytherapy can replace the superficial X-ray techniques and high energy linear accelerator electron beam techniques for the treatment of superficial tumours.

Applications

Strahlentherapie mit geschlossenen radioaktive Strahlenquellen