



# **INTRACAVITARY BRACHYTHERAPY**

## **MODERN DAY APPLICATORS AND TECHNIQUES**

### **FOR**

### **CERVICAL CANCERS**



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***(A Unit of Tata Memorial Centre, Mumbai, India)***

# Radiotherapeutic Management of Cervical cancer

## TREATMENT PRESCRIPTION- PLANNING AIM

- **RADICAL CHEMO-RADIATION with EBRT & BRACHYTHERAPY (BT)**
- **EXTERNAL BEAM RT**
  - **EBRT TECHNIQUE:** CONVENTIONAL / CONFORMAL / IMRT/VMAT.....
  - **SIMULATION :** CONVENTIONAL / CT BASED
  - **DOSE :** 45 - 50 Gy / 25# @ 5# PER WEEK in 5 - 6 weeks
- **CONCOMITANT CT:** CISPLATIN 40 mg/m<sup>2</sup> x atleast 5 Cycles
- **BRACHYTHERAPY BOOST:** High Dose Rate BT with 7 Gy TO POINT 'A' ONCE WKLY x 4 #  
  
STARTING FROM 4-5 WEEK ONWARDS
- **OTT :** < 7 - 8 weeks

# **Treatment Prescription for Cervical Cancer**

## **Concomitant chemoradiation**

### **Planning Aim (External + BT)**

- Concurrent Cisplatin CT 40 mg/m<sup>2</sup> once weekly x at least 5 cycles
- **Tumoricidal Doses (All doses in EQD2)**
  - For primary: 85 – 90 Gy (External + Brachytherapy doses)
  - Pelvic / Parametrium external boost (optional): 50-55 Gy
  - Nodes: 45 -50 Gy (External) +/- Boost (N+ disease)
- **External Beam** : 45 – 50 Gy @ 1.8 – 2 Gy per fraction
- **Brachytherapy (Fractionated HDR Schedule)**
  - 3 - 4 # of HDR boost @ 7 Gy to Point A / HR-CTV
- **OAR' s** : Rectum / Sigmoid: 70 -75 Gy EQD2  
Bladder : 90 - 95 Gy EQD2

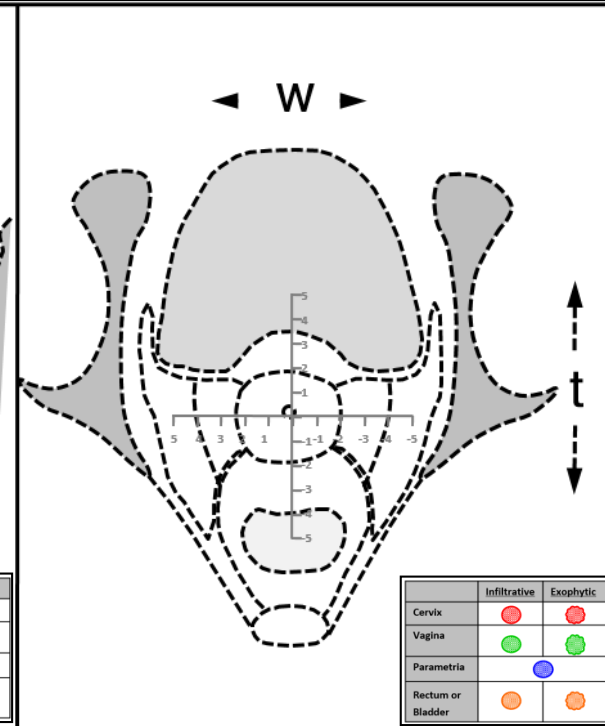
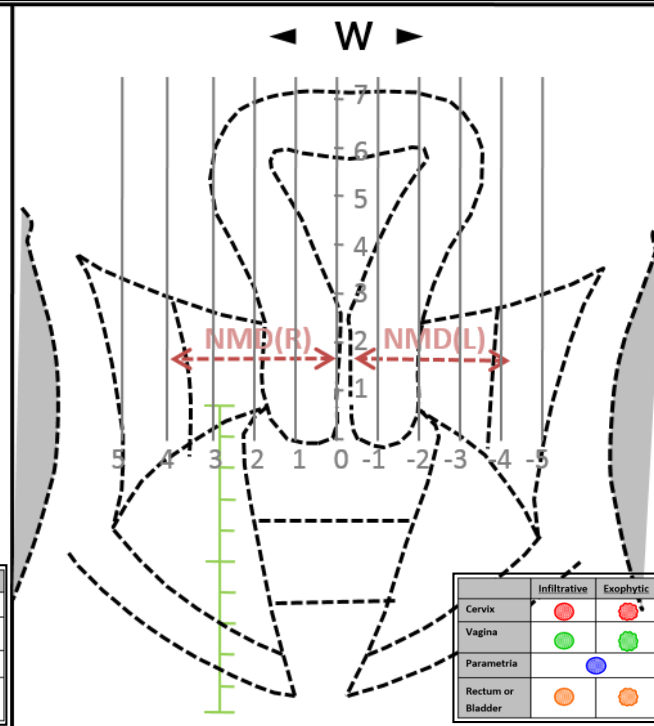
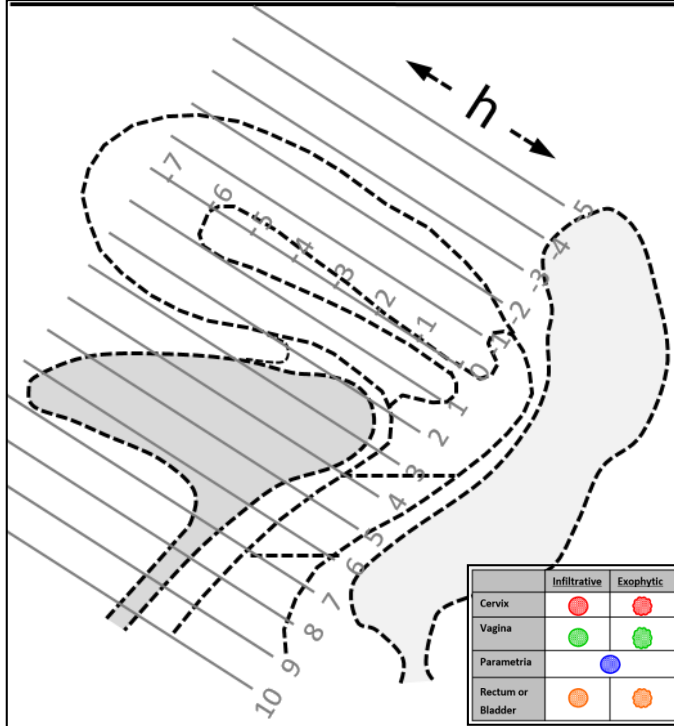
# Revised Clinical Drawings : Version 2.0

## Local Disease Documentation & Mapping

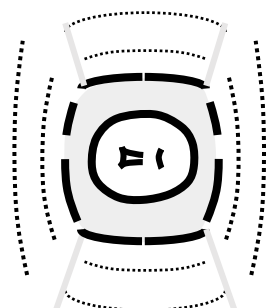
Patient Initials :

ID :

- ☐ Initial evaluation  
☐ At brachy (fraction no. \_\_)

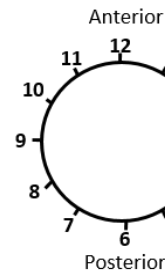


h = \_\_\_\_ cm    t = \_\_\_\_ cm    NMD (R) = \_\_\_\_ cm    NMD (L) \_\_\_\_ cm    w = \_\_\_\_ cm    (NMD = Near Maximum Distance)



### Vaginal Disease

Ant : \_\_\_\_ cm  
 Post : \_\_\_\_ cm  
 Rt Lat: \_\_\_\_ cm  
 Lt Lat: \_\_\_\_ cm



### FIGO (2018)

T  N  M

BT<sub>category</sub> : I<sub>BT</sub> / II<sub>BT</sub> / III<sub>BT</sub> / IV<sub>BT</sub>

Remarks:

Signature & Date :

# Message 1 : Clinical Examination & documentation using Revised Clinical Drawings

<b>Patient Initials :</b>	<b>ID : 33422-CN(SD)-TATA 04</b>	<input checked="" type="checkbox"/> Initial evaluation <input type="checkbox"/> At brachy (fraction no. __)
---------------------------	----------------------------------	--

	Infiltrative	Exophytic
Cervix	●	●
Vagina	●	●
Parametria	●	●
Rectum or Bladder	●	●

	Infiltrative	Exophytic
Cervix	●	●
Vagina	●	●
Parametria	●	●
Rectum or Bladder	●	●

	Infiltrative	Exophytic
Cervix	●	●
Vagina	●	●
Parametria	●	●
Rectum or Bladder	●	●

### Measurements

h = 5 cm    t = 5 cm    NMD (R) = 4 cm    NMD (L) = 3 cm    w = 7 cm    (NMD = Near Maximum Distance)

**Vaginal Disease**

Ant : 0 cm

Post : 1 cm

Rt Lat: 1 cm

Lt Lat: 0 cm

**FIGO (2018)**

**III C1**

T 3b N 1 M 0

BT<sub>category</sub>: I<sub>BT</sub> / II<sub>BT</sub> / III<sub>BT</sub> / IV<sub>BT</sub>

**Remarks: Cystoscopy : Negative**

On MR : RT Obturator node : 10mm, no other nodes

Signature & Date : UMM  
07.11.2016

# Patient Selection- Brachytherapy

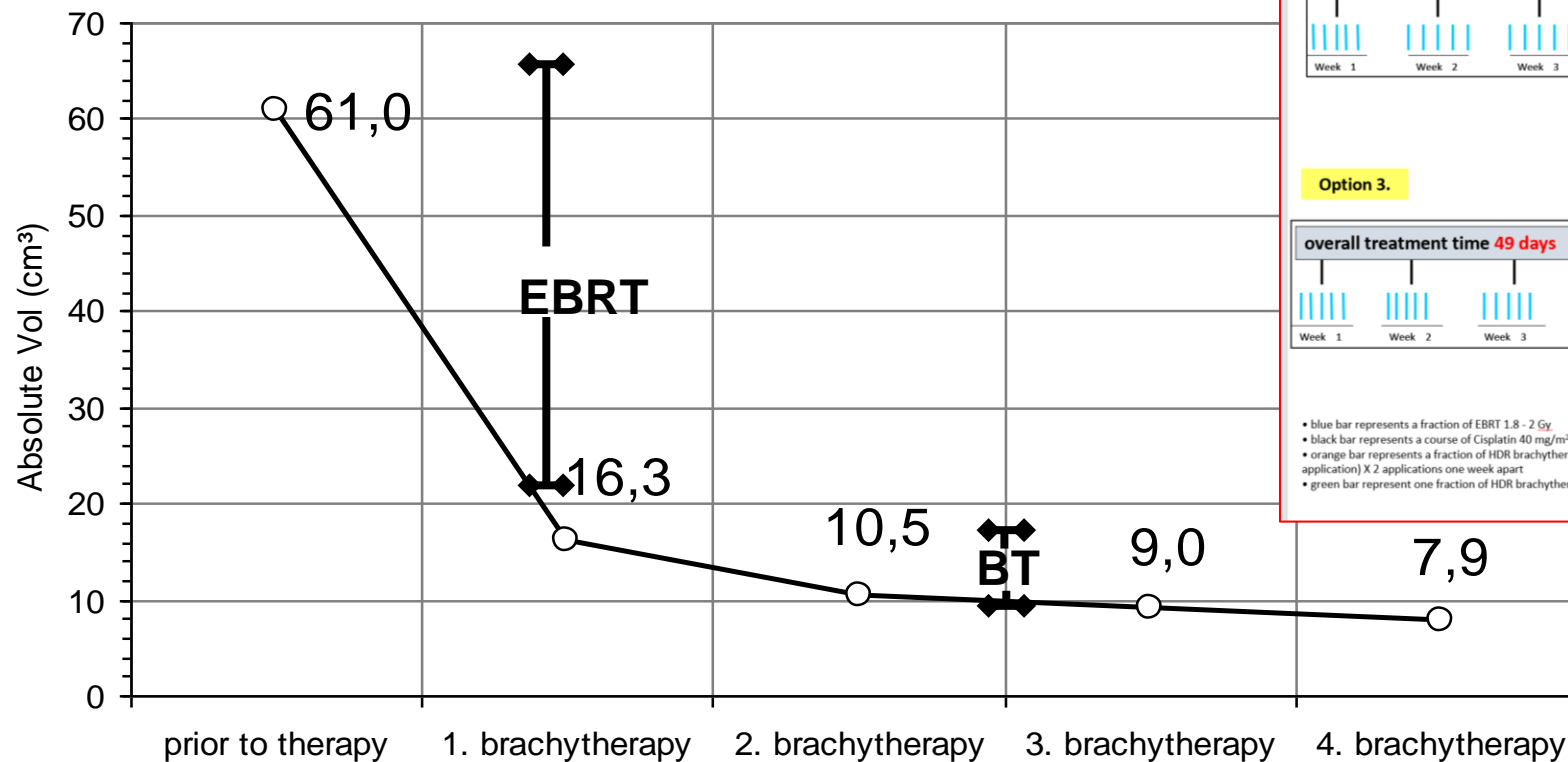
- Brachytherapy boost is planned towards the end or after completion of external beam radiation therapy (*Respect the Overall treatment time!*)
- Pelvic examination to assess suitability for brachytherapy application
- **Brachytherapy Procedure Pre-requisites:**
  - Review for fitness to undergo anesthesia
  - Medical Comorbidities (For Ex: Cardiac Issues, Long standing hypertension, H/O DVT:: *Trail of Investigations & delay in BT!*)
  - Pelvic anatomy and tumor topography suitable for appropriate applicator placement
- **Pre-planning:** Tumor topography, Imaging & availability of applicators
  - Lie of the Uterus, Size of Uterus (Thick/Thin), Presence of Fluid in the cavity, large fibroids, Cysts (*No surprises during procedure!*)

## Message 2: Scheduling and Timing for- Brachytherapy after EBRT

### Quantitative tumor regression

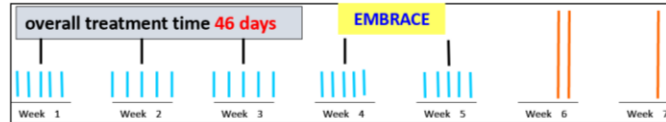
EBRT: tumor regression 75%  
Brachytherapy: tumor regression 10%

easy to predict

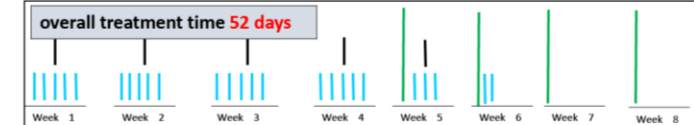


### Treatment Schedule for Fractionated High Dose Rate Brachytherapy & Overall Treatment Time

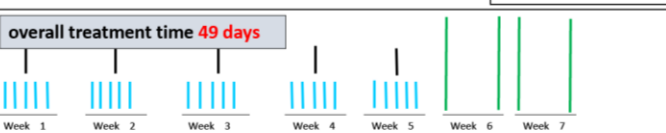
#### Option 1.



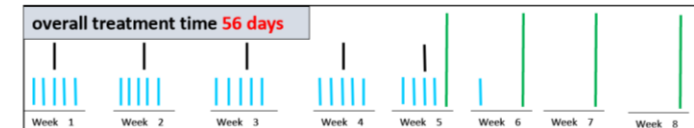
#### Option 2.



#### Option 3.



#### Option 4.



- blue bar represents a fraction of EBRT 1.8 - 2 Gy
- black bar represents a course of Cisplatin 40 mg/m<sup>2</sup>,
- orange bar represents a fraction of HDR brachytherapy 7 Gy (2 fractions within one application) X 2 applications one week apart
- green bar represent one fraction of HDR brachytherapy 7 Gy per application

# Anesthesia for Brachytherapy Procedure

- **Principle:** Adequate relaxation for cervical dilatation, vaginal packing & application reproducible esp. in fractionated HDR
- **Short General Anesthesia:** preferred for proper application especially if many procedure lined up
- **Spinal Anesthesia with Epidural Analgesia:** is also an effective alternative
- If patient high risk for general / spinal anesthesia:
  - Sedation and analgesics
  - Regional Blocks: Obturator blocks
  - Local blocks: Para-cervical blocks

**Message 3 : Short General or Spinal Anesthesia mandatory irrespective of type of BT application**



## Principles of BT application

**Cervical Cancer**  
**Post EBRT + Cis Chemo**

**Intact uterus**

No residual disease

Residual disease limited to cervix & immediate para-cervical tissues

Residual disease at cervix limited to medial parametrium and/or upper vagina

Residual disease extending to distal parametrium and/or lower vagina

**BT Category I**

**BT Category II**

**BT Category III**

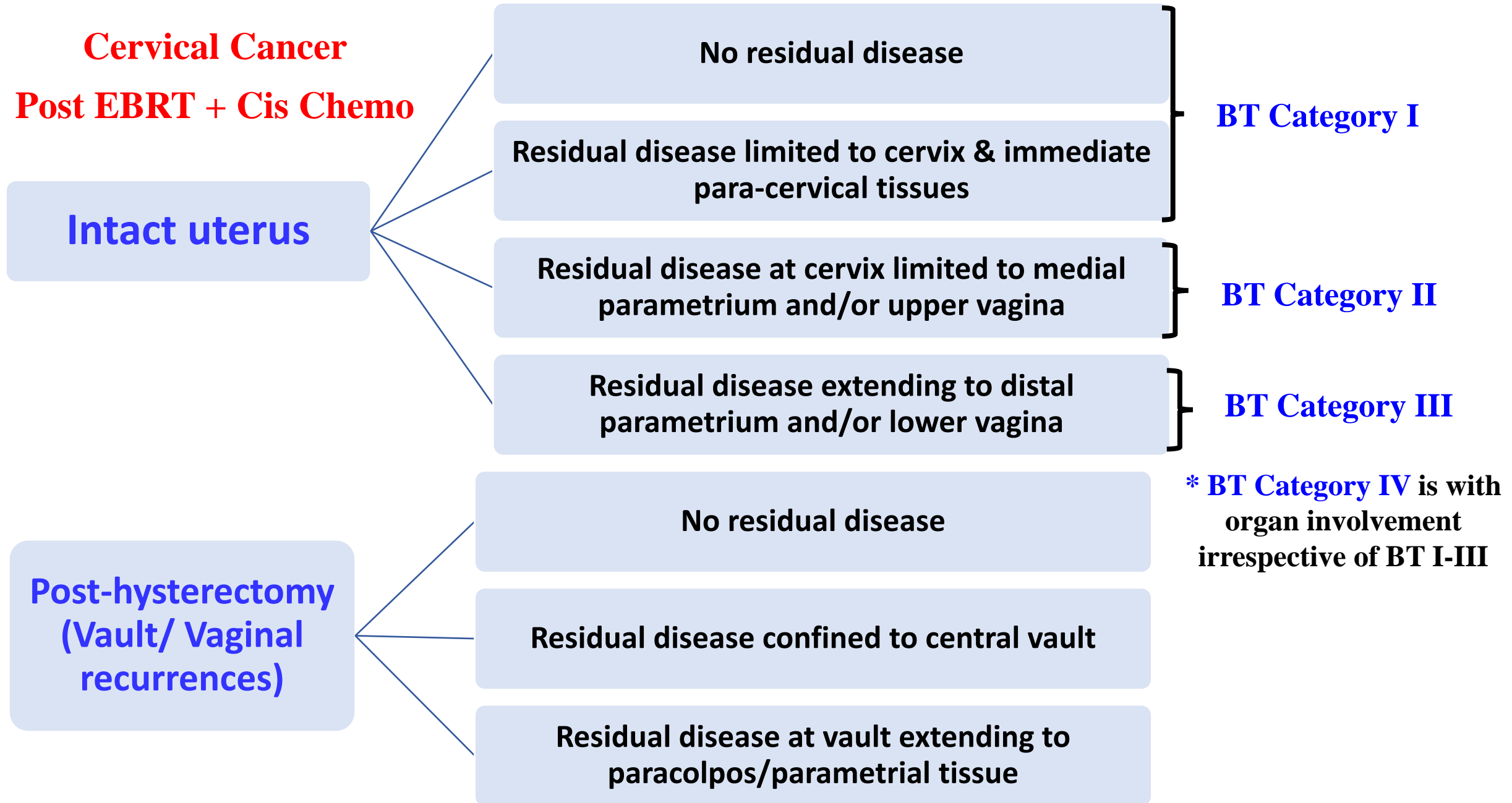
**\* BT Category IV is with organ involvement irrespective of BT I-III**

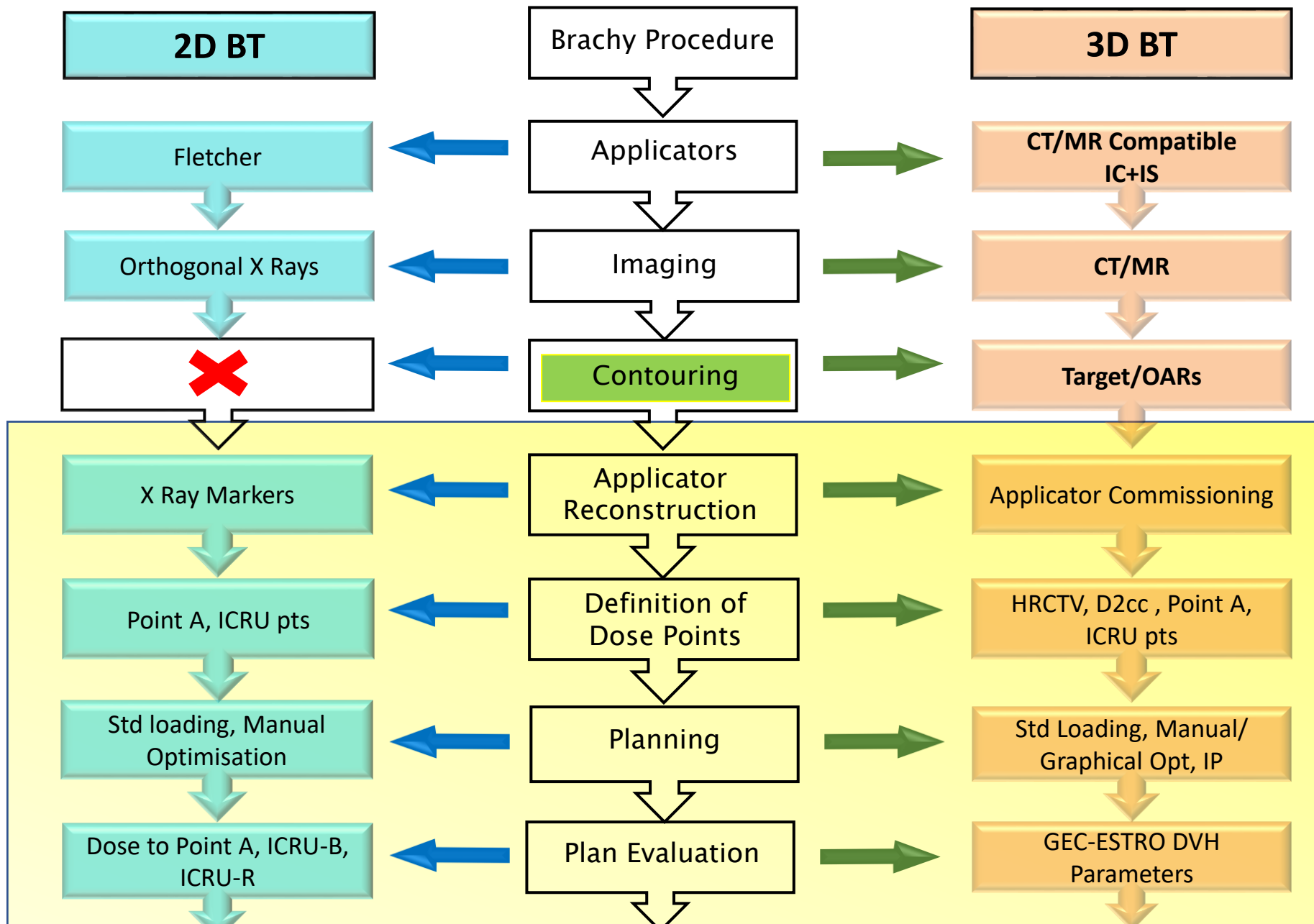
No residual disease

Residual disease confined to central vault

Residual disease at vault extending to paracolpos/parametrial tissue

**Post-hysterectomy**  
**(Vault/ Vaginal recurrences)**





**Message 4 : BT Planning Process – Basic understanding & Implementation**

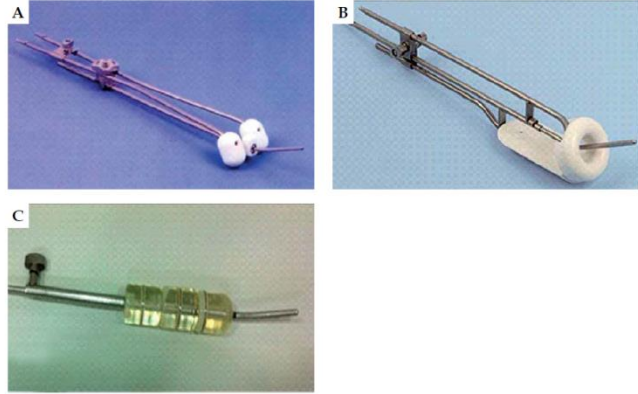
## Brachytherapy Planning

- **Brachytherapy** : EUA, Appropriate Applicator placement
- **MR Imaging** : Bladder protocol, T2 axial, sagittal, coronal (3-5mm with 1mm)  
(GEC-ESTRO RECOMMENDATION-IV)
- **Contouring** : Targets (GTV-B, HR-CTV, IR-CTV & OAR's (Rectum, Bladder, Sigmoid, Small Bowel)  
(GEC-ESTRO RECOMMENDATION-I)
- **Planning** : TPS (Brachyvision / Oncentra / Plato )
  - Catheter reconstruction (GEC-ESTRO RECOMMENDATION-III)
  - Loading pattern (Std with Needles ratio)
  - Optimization (Manual / Inverse)
- **Plan evaluation:** EQD2 values (GEC-ESTRO RECOMMENDATION-II)
  - Doses to HR-CTV, GTV (D90, D100, V100 etc...)
  - Doses to OAR's ( rectum, bladder, sigmoid 0.1 cc, 1 cc, 2cc)

# BT Technique & Applicators

## Type of BT Technique

### Intracavitary BT (ICBT)

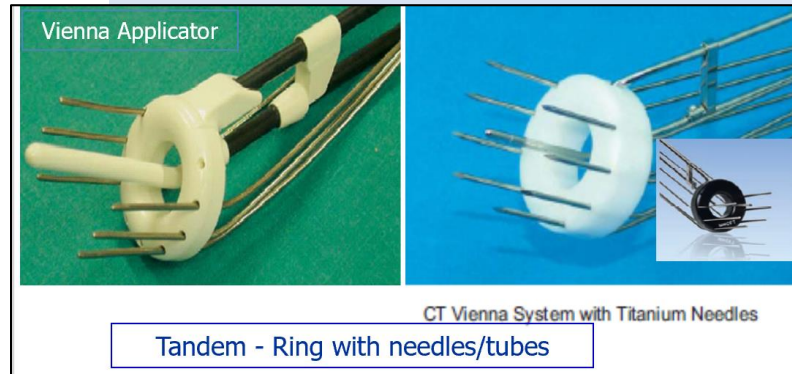


Tandem-Ovoid

Tandem-Ring



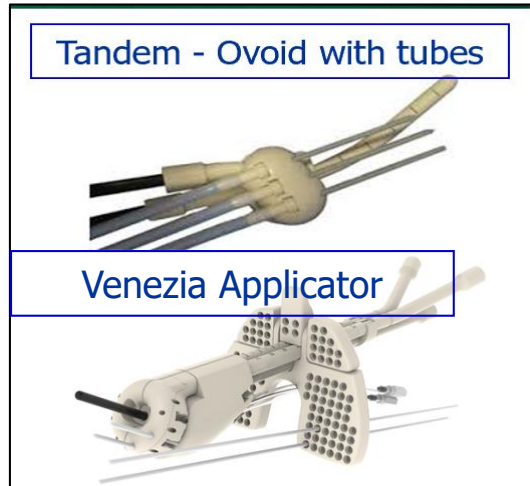
### Combined intracavitary & interstitial BT (ICIS)



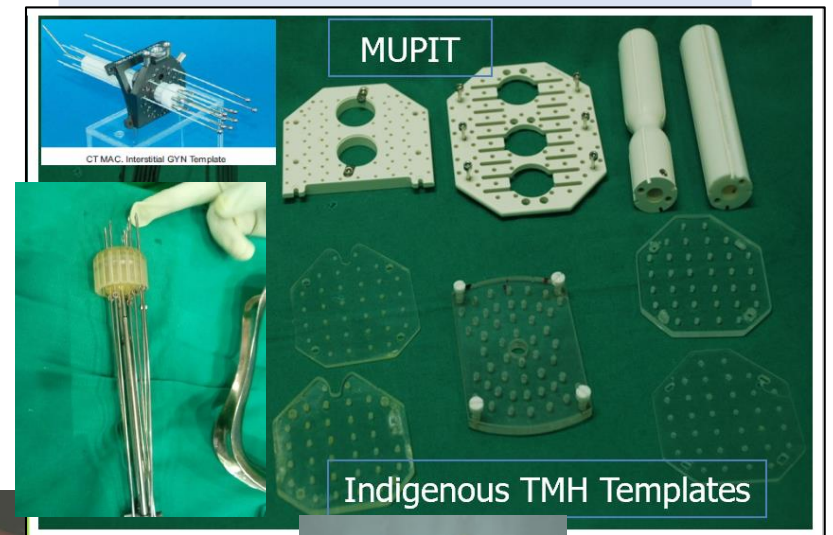
Tandem - Ring with needles/tubes

Tandem - Ovoid with tubes

Venezia Applicator



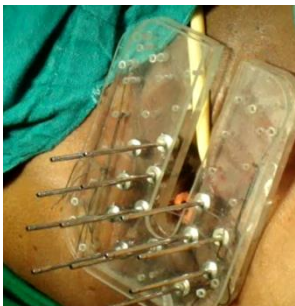
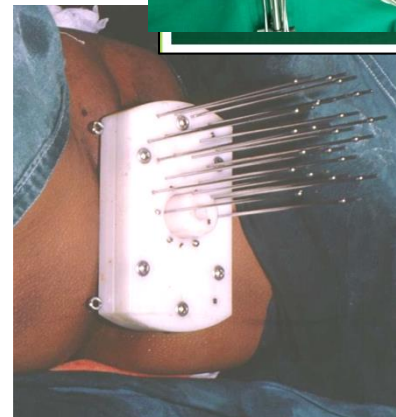
### Interstitial BT (ISBT)



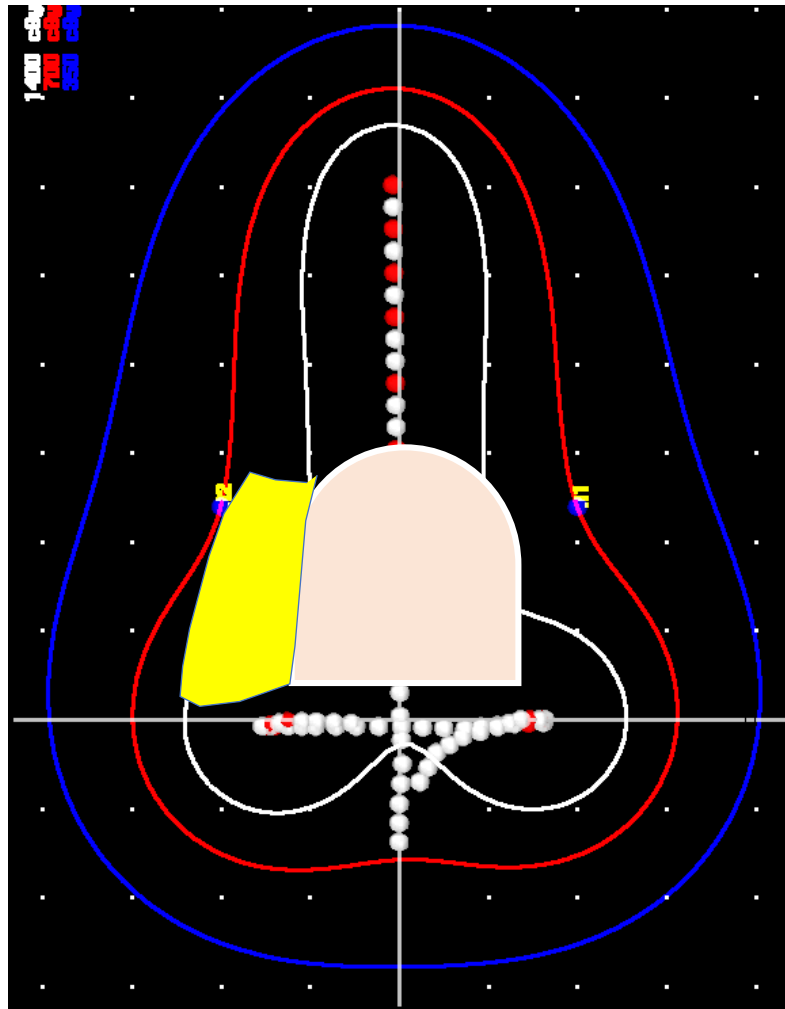
MUPIT

CTMAC Interstitial GYN Template

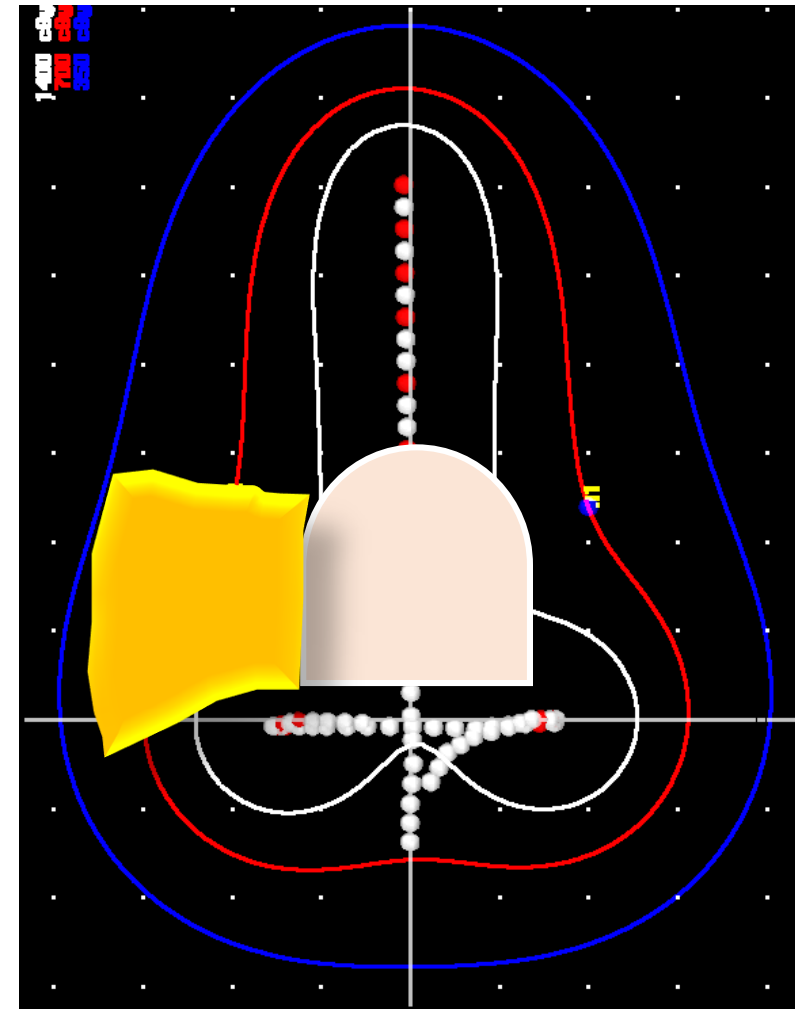
Indigenous TMH Templates



## Message 5 : STANDARD PEAR – Basic understanding & Implementation



**LIMITED RESIDUAL DISEASE**



**EXTENSIVE RESIDUAL DISEASE**

## Dimensions of prescribed dose: different levels

### Standard loading

Prescribed dose

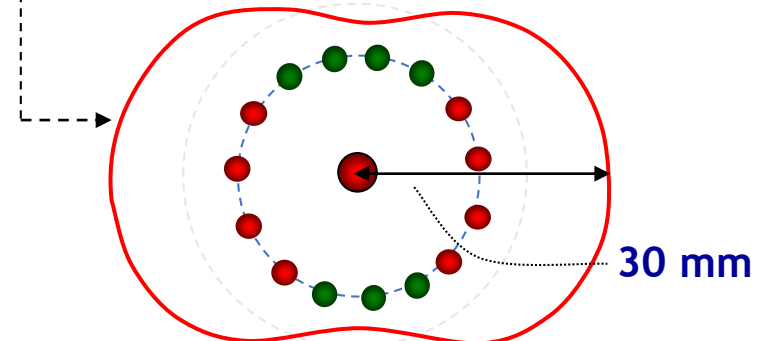
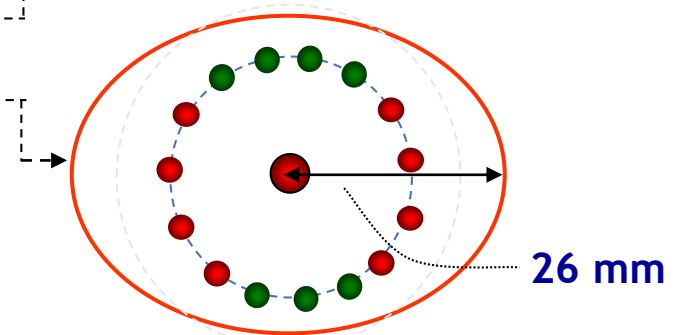
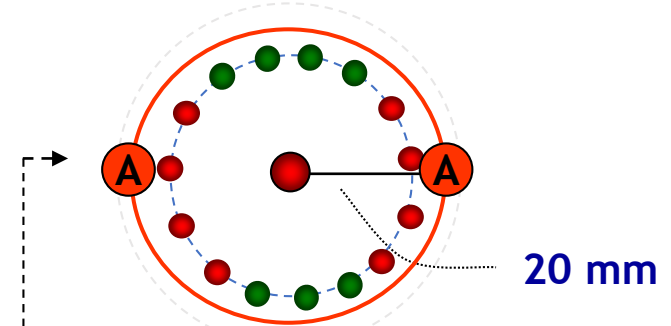
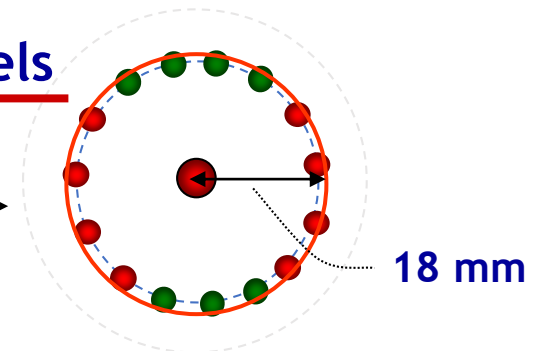
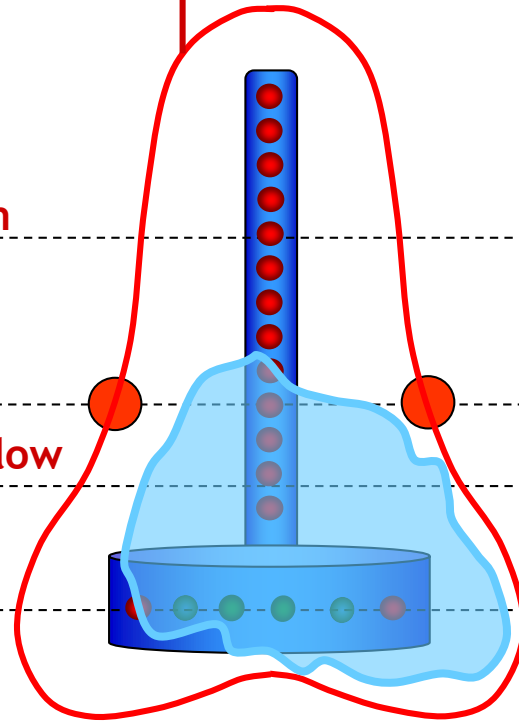
Level

A + 2 cm

Point A

1 cm below  
Point A

Ring  
sources

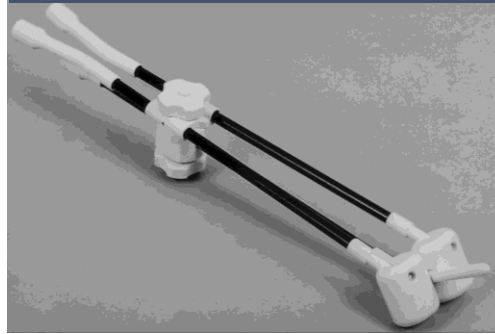


### Example:

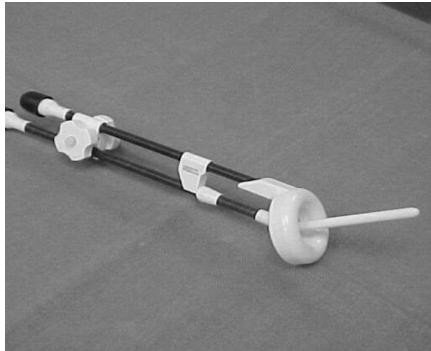
Tandem & Ring applicator:

30 mm ring & 60 mm tandem



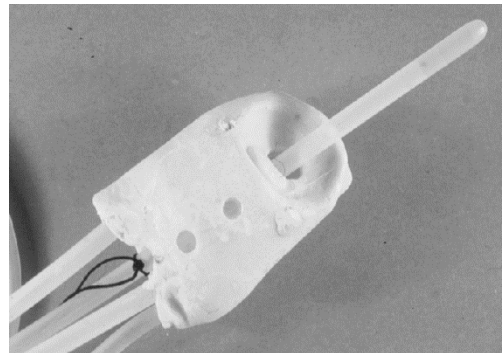


**Modern  
Manchester  
Applicator**

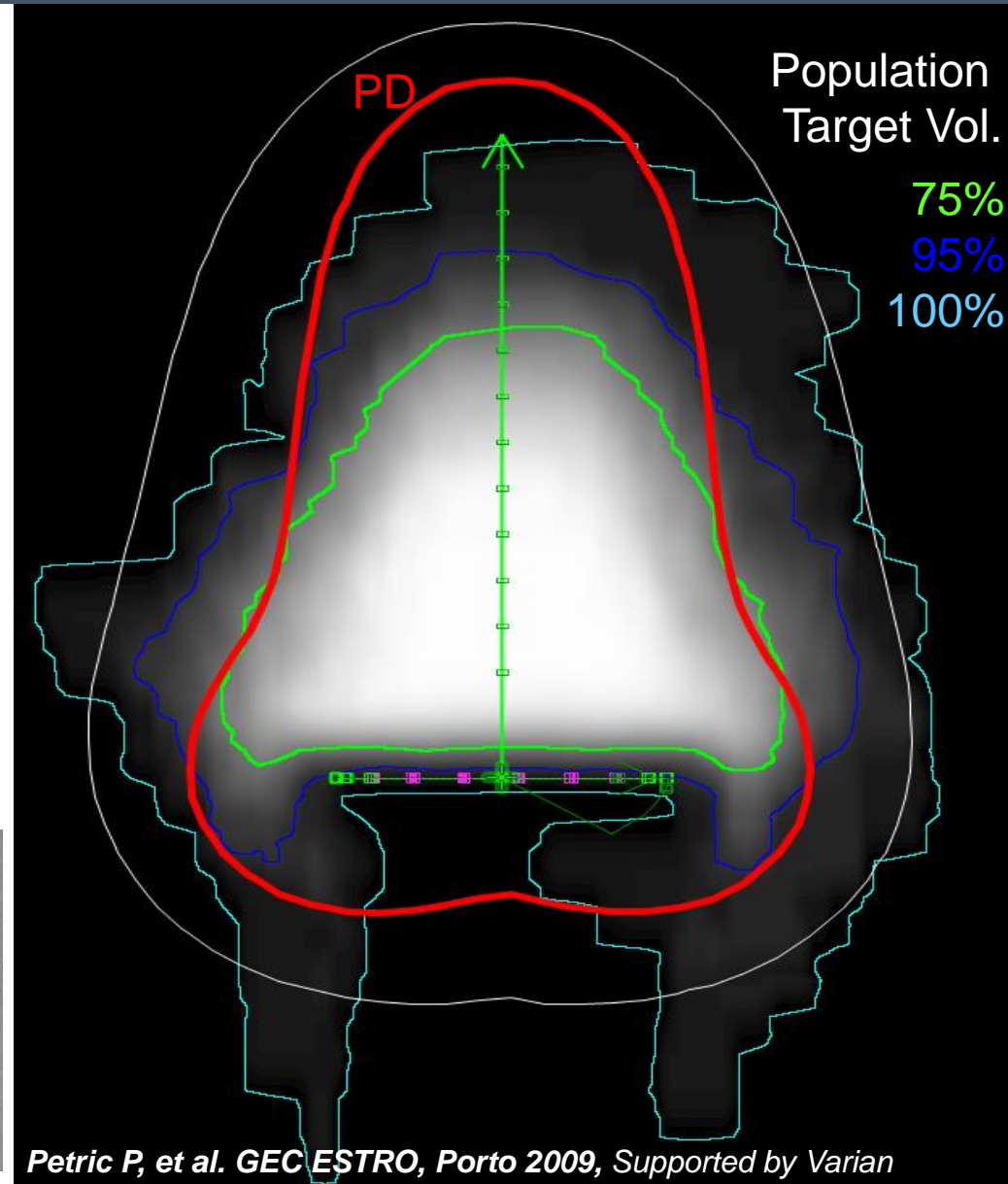


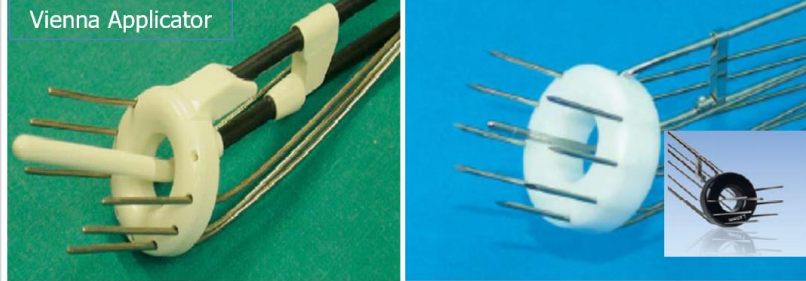
**Modern Stockholm  
Applicator**

**Ring applicator**



**Mould Applicator**

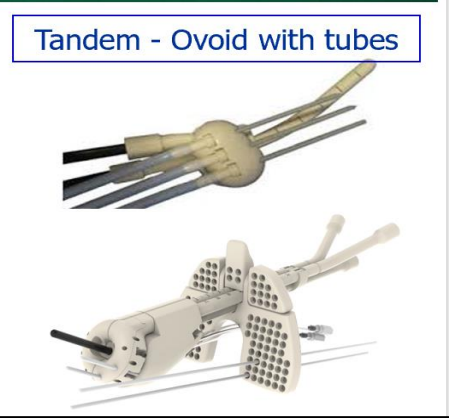




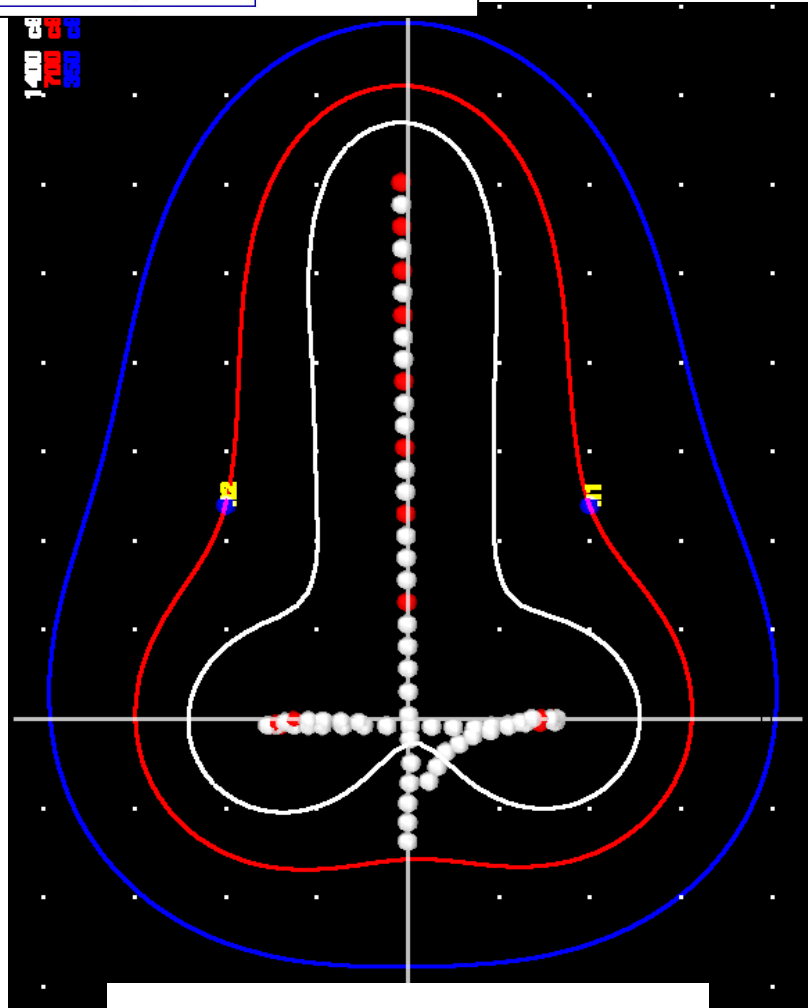
CT Vienna System with Titanium Needles

# Modern Intracavitary BT Applicators STD IC Versus IC + IS Principles

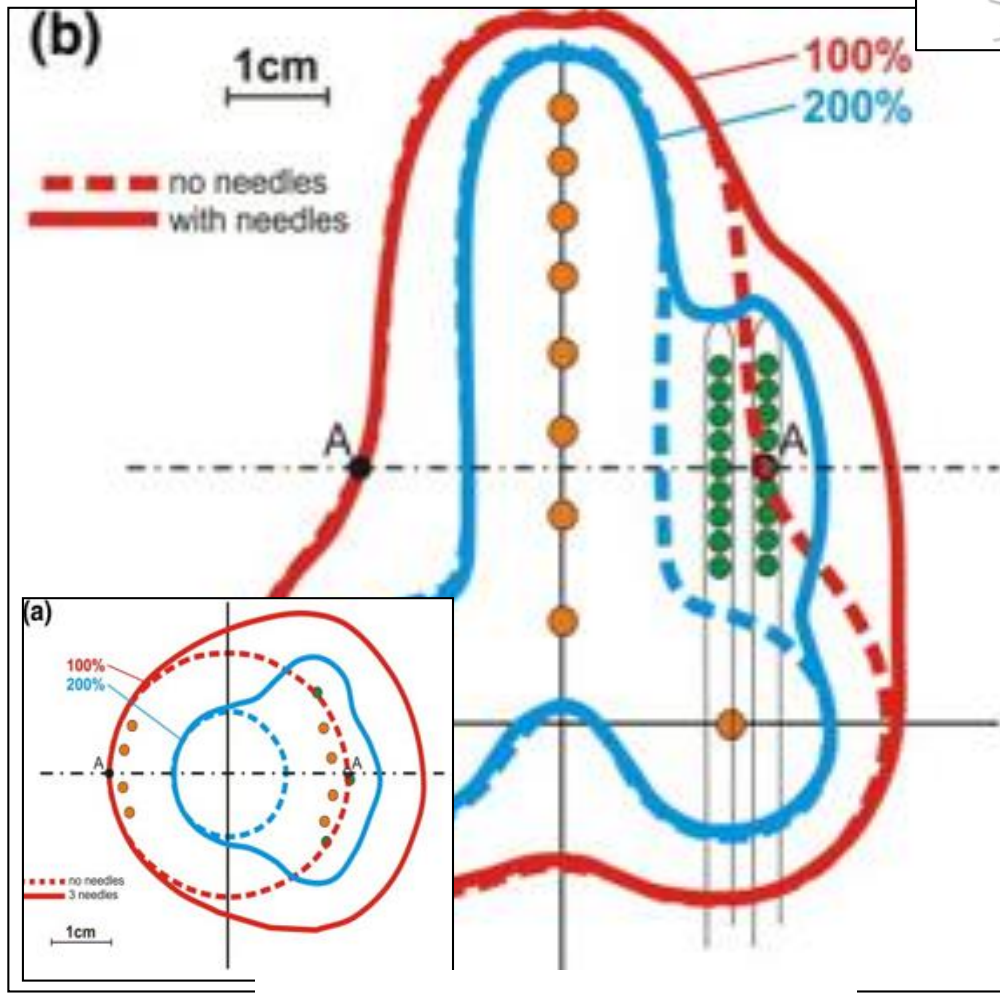
Tandem - Ring with needles/tubes



Tandem - Ovoid with tubes



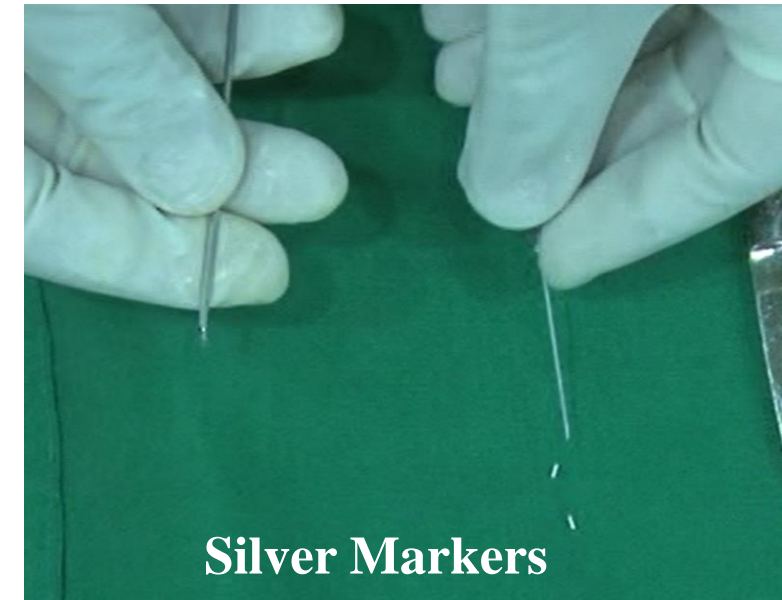
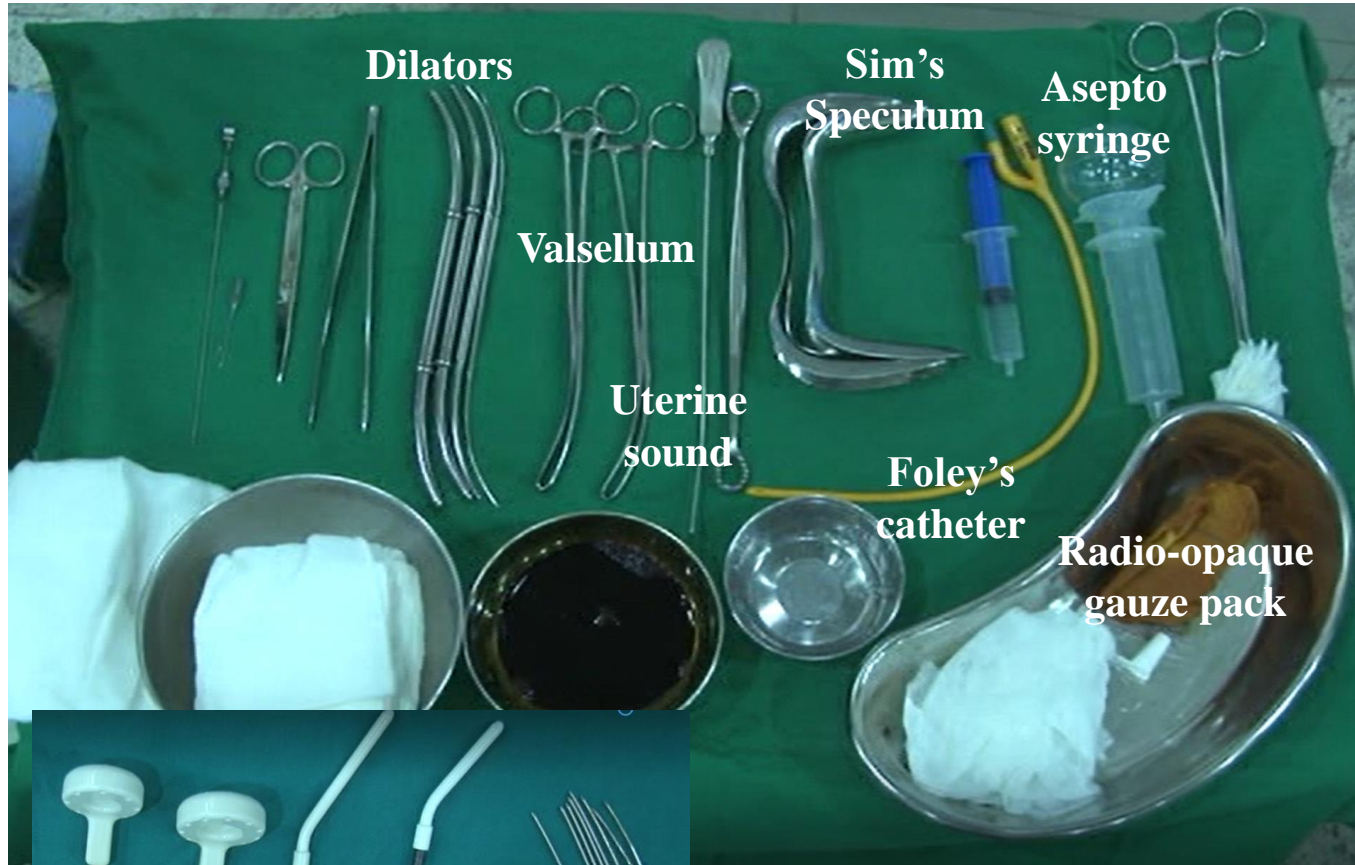
STD Pear Distribution



IC + IS Distribution



# Advanced BT Procedure – Basic Instrumentation Set-up



- Radio-opaque 2-3 mm in length & < 1 mm diameter
- Implanted into tissue with the help of spinal needle
- Tissue interactions: Nil, hence need not be removed





# **ADVACNED BT TECHNIQUE (for eg. using Vienna Applicator) - PROCEDURE PRINCIPLES**

**Bladder Catheterization  
& use of Aspeto syringe**



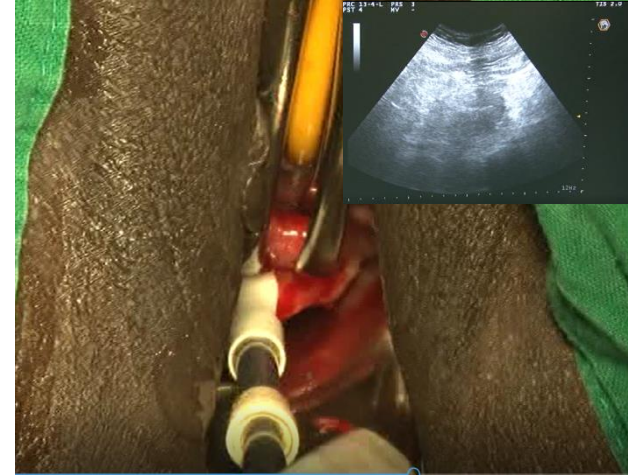
**Pelvic examination**



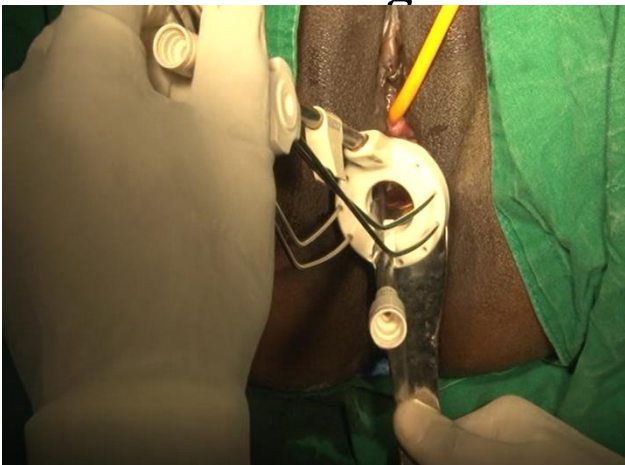
**Uterine canal  
sounding & dilatation**



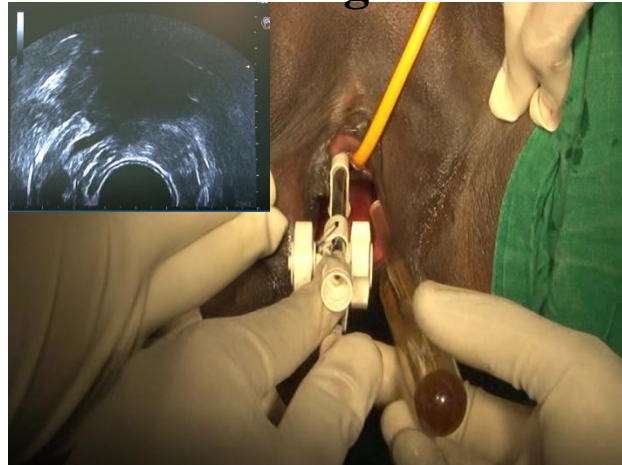
**Uterine tandem insertion  
confirmed by Trans-  
abdominal US**



**Ring insertion &  
locking**



**Needles insertion & Trans-  
rectal US guidance**



**Vaginal Packing**



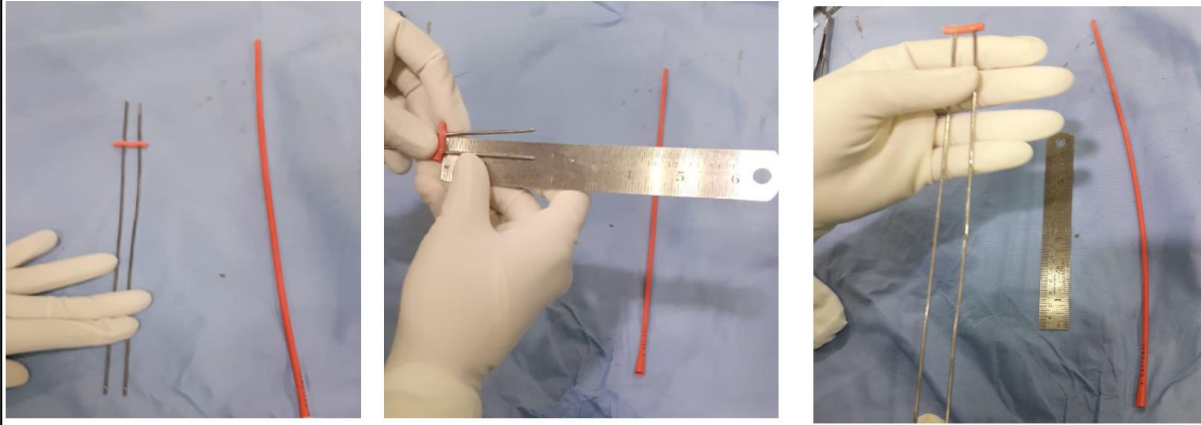
**Packing & fixation to  
perineum**



# Customization – IC + IS Application using Free hand needles & rubber tube

## Customized IC + IS Application

### Free hand Needles with semi-template



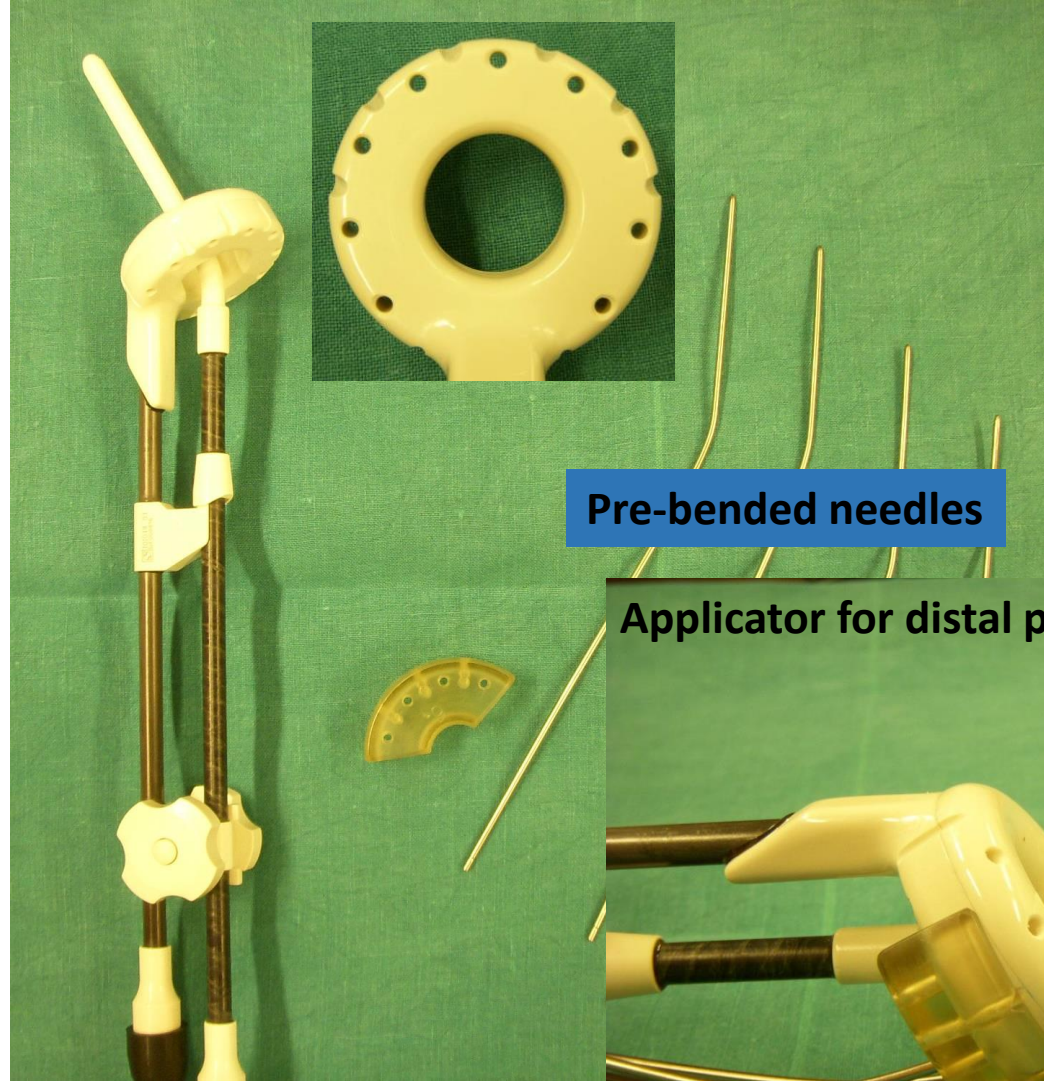
- After STD Intracavitary application
- Insert rubber tube with needles lateral to ovoids
- Push each needle into the tissues for 4-5 cm only
- Ensure no migration of needles during vaginal packing



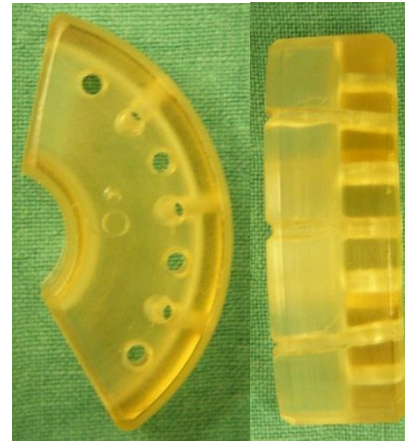


# Advanced IC + IS Principles

## Advanced needle Guiding Template

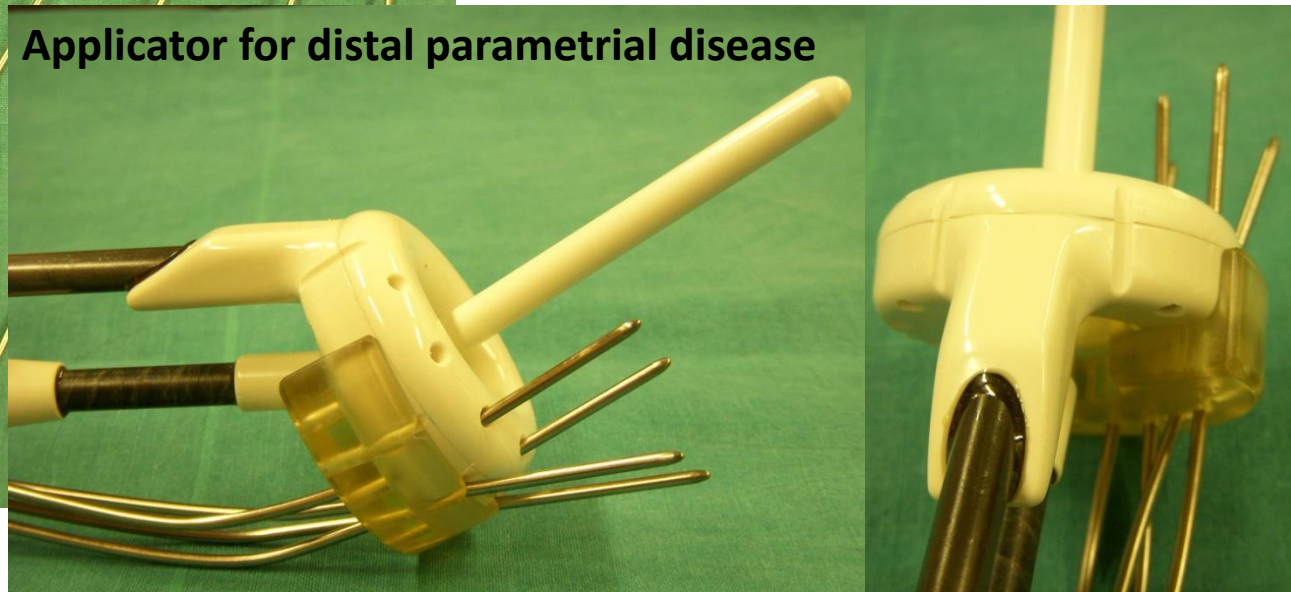


Pre-bended needles



Modified Vienna Ring

Applicator for distal parametrial disease



Approximately 60 patients experience : Vienna & Mumbai



### Original Article

## Vienna-II ring applicator for distal parametrial/pelvic wall disease in cervical cancer brachytherapy: An experience from two institutions: Clinical feasibility and outcome

Umesh Mahantshetty<sup>a,\*</sup>, Alina Sturdza<sup>b,\*</sup>, Pushpa Naga CH<sup>a</sup>, Daniel Berger<sup>b</sup>, Israel Fortin<sup>c</sup>, Laura Motisi<sup>d</sup>, Maximilian P. Schmid<sup>b</sup>, Dheera Aravindakshan<sup>a</sup>, Yogesh Ghadi<sup>d</sup>, Jamema V. Swamidas<sup>e</sup>, Supriya Chopra<sup>e</sup>, Lavanya Gurram<sup>a</sup>, Nicole Nesvaci<sup>b,f</sup>, Christian Kirisits<sup>b,f</sup>, Richard Pötter<sup>b,f</sup>

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### ARTICLE INFO

#### Article history:

Received 22 March 2019

Received in revised form 28 July 2019

Accepted 7 August 2019

Available online xxxxx

#### Keywords:

Cervical cancer

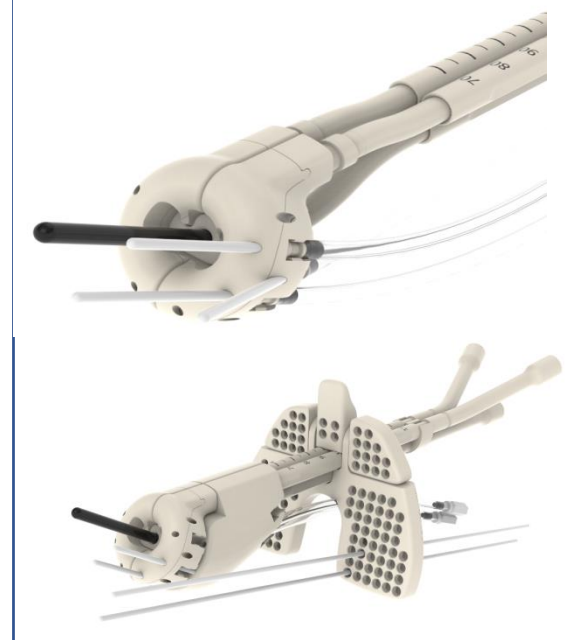
Image-guided adaptive brachytherapy

Vienna II applicator

### ABSTRACT

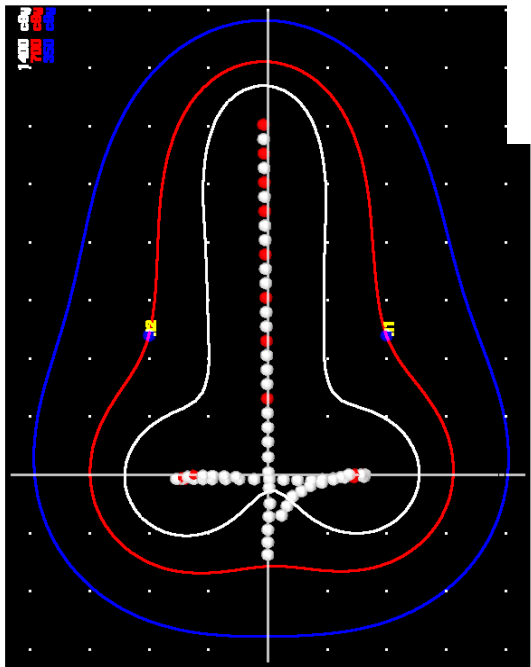
**Purpose:** Recent evidence from EMBRACE shows that around 16% patients with locally advanced cervical cancer (LACC) have residual **tumor** in distal parametrium (DP) and pelvic wall disease (LPW) after concurrent radio-chemotherapy (CCRT). Adequate target coverage with standard brachytherapy approaches represents a challenge. Therefore, we modified the Vienna I applicator with an add-on cap allowing for additional oblique needles into the DP/LPW (Vienna II). We report here the feasibility and clinical outcomes using Vienna II applicator in LACC patients treated in 2 institutions.

**Methods and materials:** 69 patients with residual disease in DP/LPW after CCRT were accrued. FIGO (2009) stage was 26% IIB, 52% III, 15% IVA, 7% IVB (para-aortic nodes). At diagnosis 91% had disease involving DP/LPW. After CCRT, patients underwent image guided adaptive brachytherapy (IGABT) using Vienna II applicator. IGABT details, acute complications, dose volume parameters and clinical outcome variables



Venezia Applicator

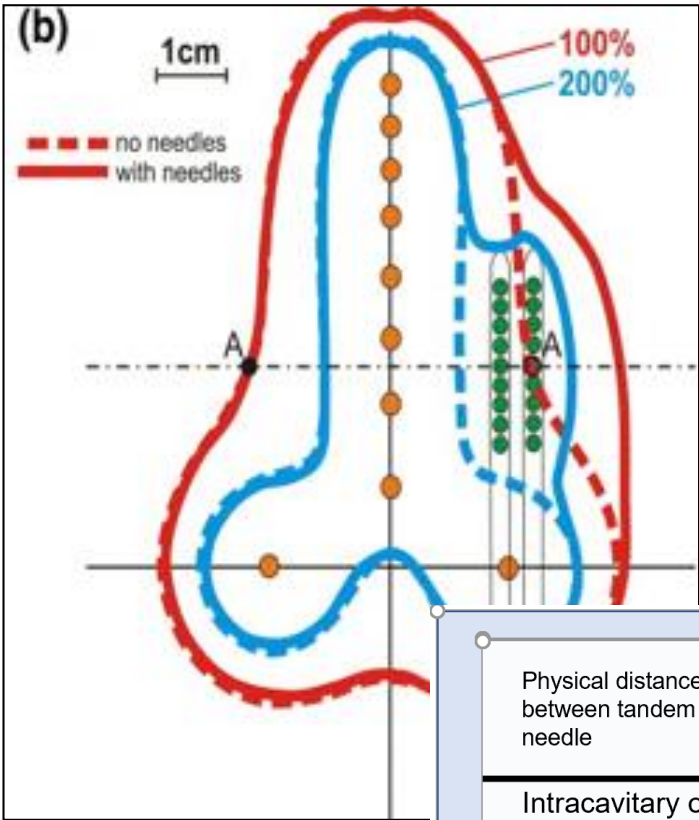
# STD Pear Distribution



# STD IC Versus IC + IS Principles

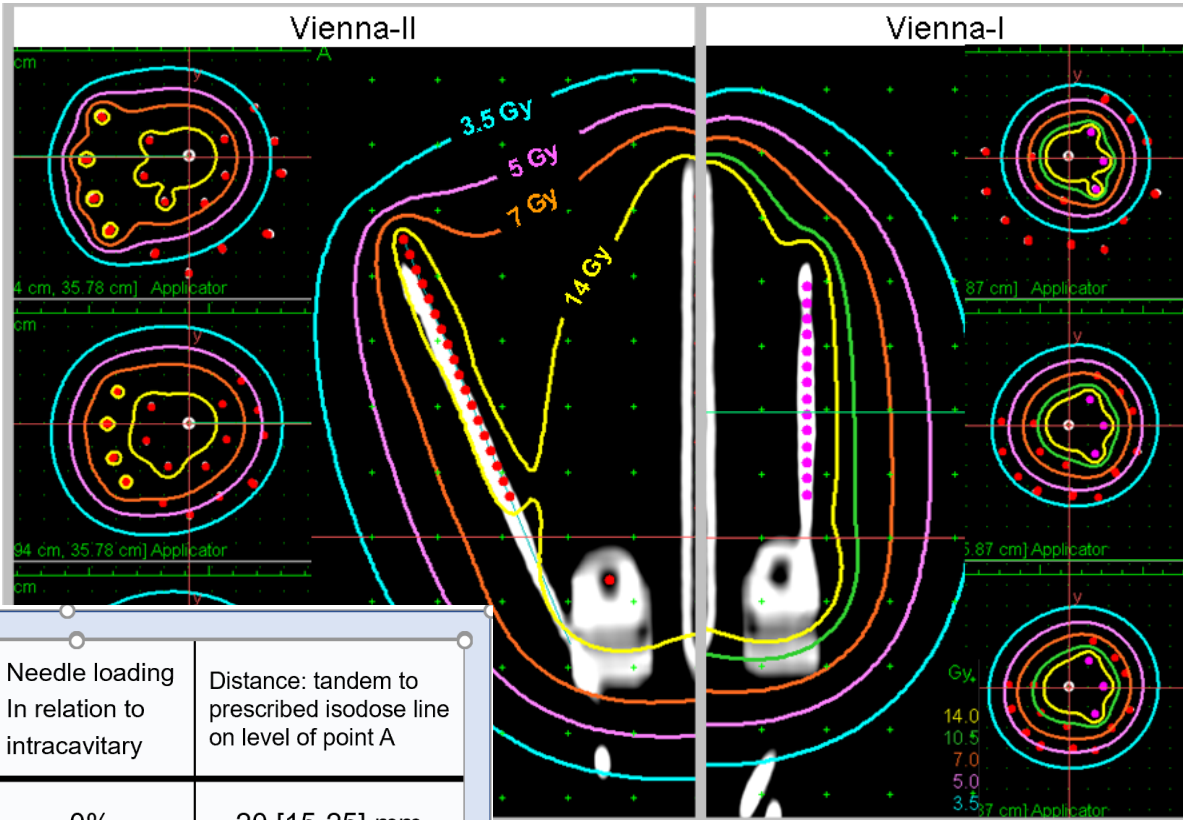
IC + IS

Distribution with straight needles



IC + IS

Distribution with straight and oblique needles

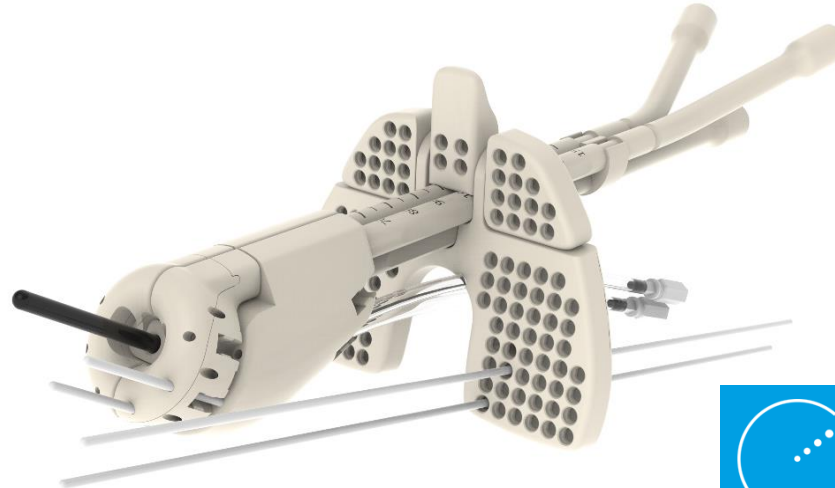
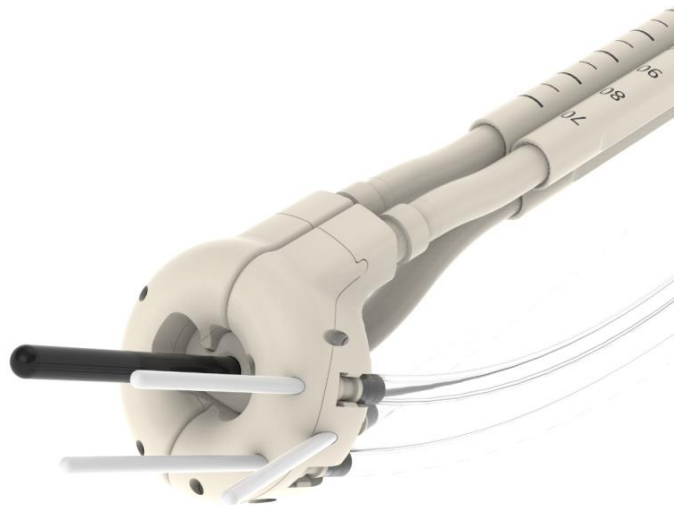
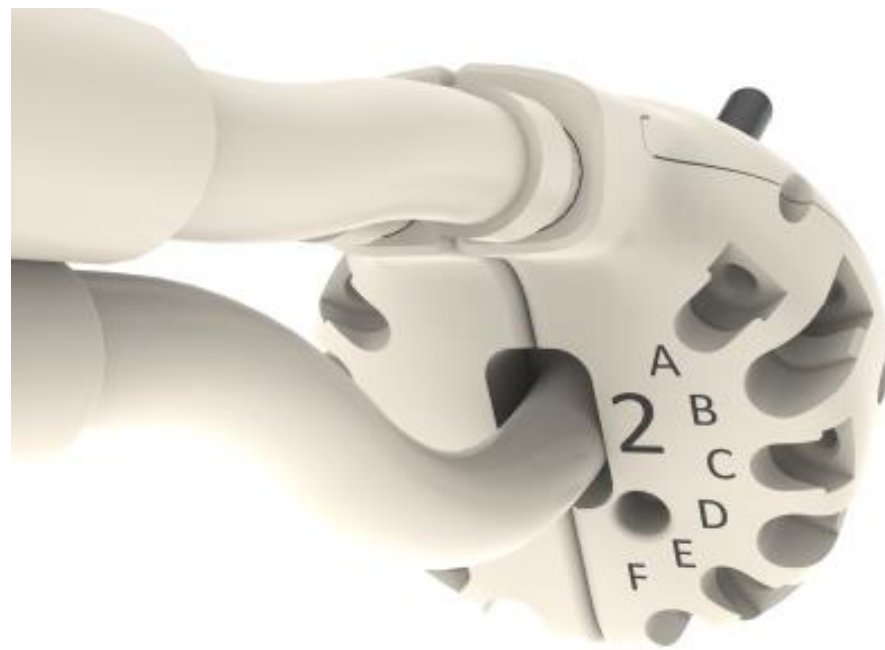


Physical distance between tandem and needle	Needle loading In relation to intracavitary	Distance: tandem to prescribed isodose line on level of point A
Intracavitary only		
No needles	0%	20 [15-25] mm
+ Parallel needles 20mm	10-20%	25-35 mm
+ Oblique needles 20° (23-27mm)	5-10%	35-40mm



## Latest Development in Applicators

### VENEZIA GYN APPLICATOR



Mission

264 patients

Utrecht

Venezia

Modern  
Manchester  
Applicator

Modern Stockholm  
Applicator

Ring applicator

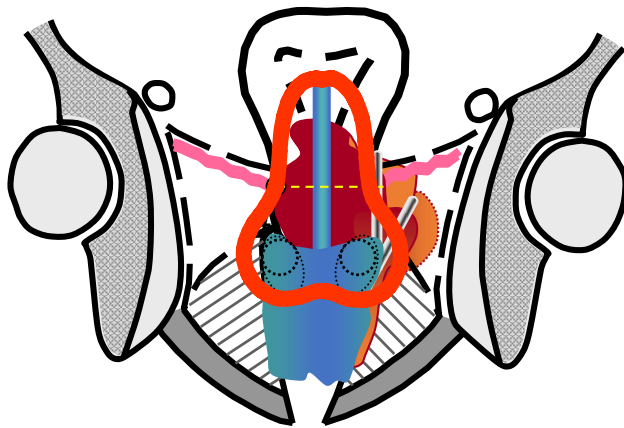
Vienna

Population  
Target Vol.

75%

95%

100%



Petric P, et al. GEC ESTRO, Porto 2009, Supported by Varian

Courtesy: P. Petric, D. Berger

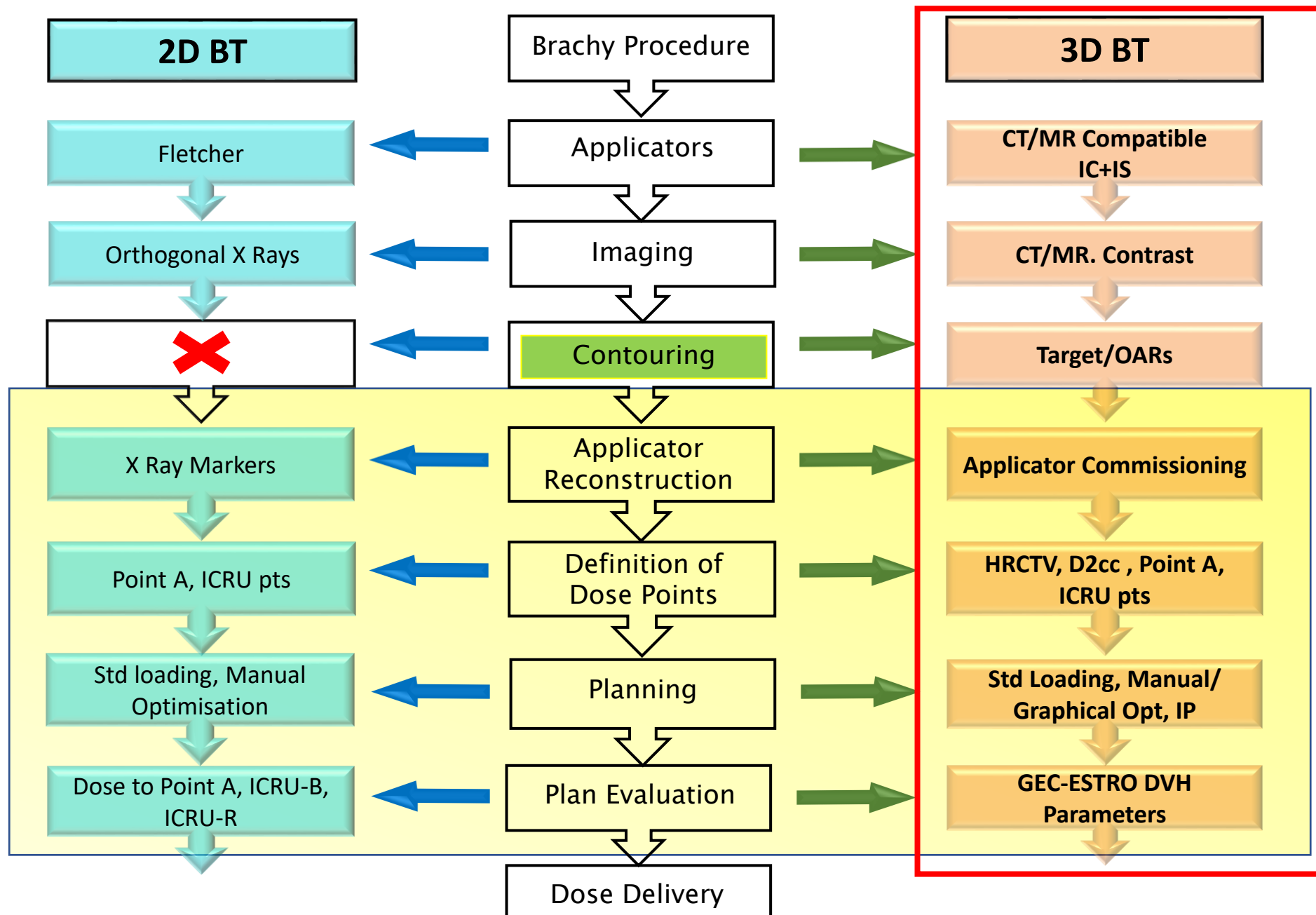
# Brachytherapy Techniques

- Choice of appropriate technique depends on:
  - residual tumor topography at brachytherapy
  - availability of brachytherapy applicators
  - availability of expertise
- In General: depending on residual disease at brachytherapy
  - Disease confined to cervix and immediate para-cervical tissues: IC alone (Category I)
  - Extensions into/ beyond medial third parametrium: IC + IS combination (Category II)
  - Extensive disease not amenable to IC + IS: IS (Category III)
- Applications can be modified in subsequent fractions (esp. HDR)

**Message 5 : Appropriate type of BT application important for optimum local control rates**



# Workflow for 3 D Image Based Brachytherapy Planning



# TREATMENT PLANNING PROCESS

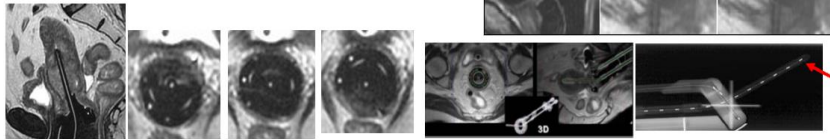
## 1. Catheter Reconstruction

(GEC-ESTRO RECOMMENDATION - III)

### Applicator Reconstruction: Physicist

Inaccuracy in applicator reconstruction can lead to **geometrical uncertainties** and thus uncertainties in the definition of **source positions** which influence the accuracy of the **delivered dose** to both target volumes and organs at risk.

- Direct reconstruction: MPR
- New method: Applicator library



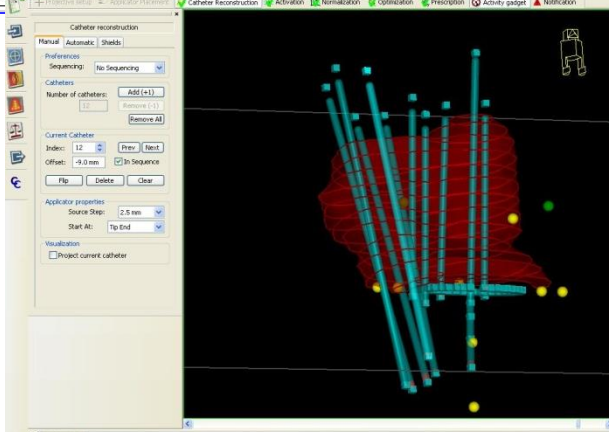
GEC-ESTRO Recommendations

Recommendations from Gynaecological (GYN) GEC-ESTRO Working Group: Considerations and pitfalls in commissioning and applicator reconstruction in 3D image-based treatment planning of cervix cancer brachytherapy

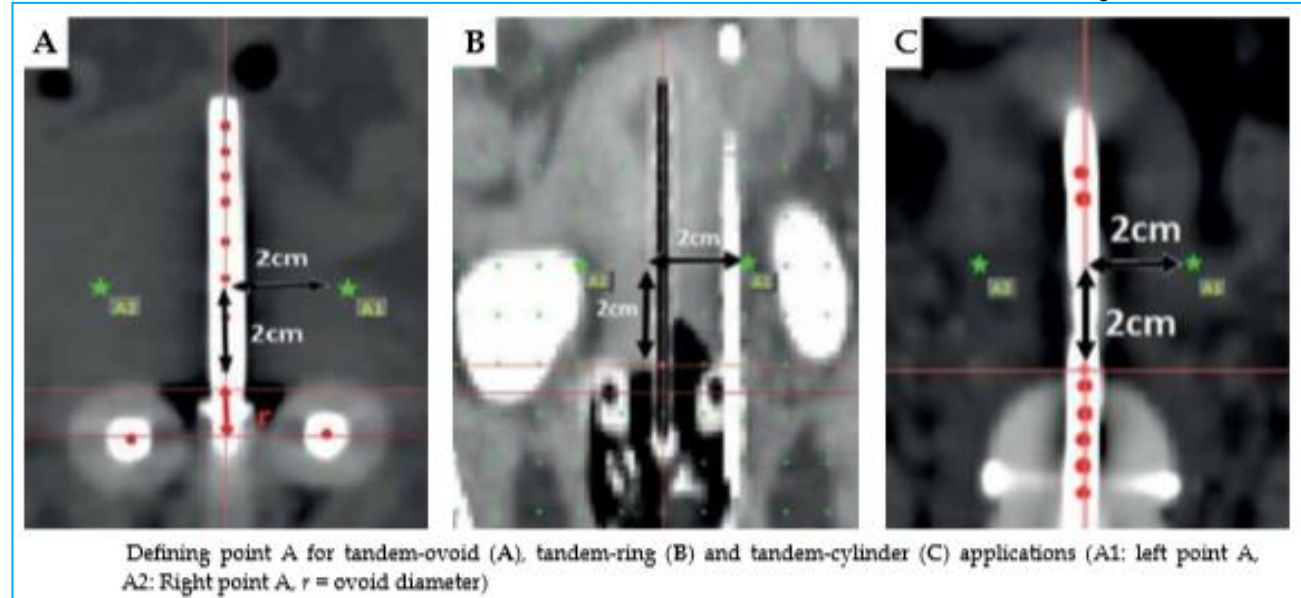
Taran Paulan<sup>a</sup>, Mallabanka<sup>a</sup>, Christian Krieger<sup>b</sup>, Daniel Boman<sup>b</sup>, Jack Böhm, Cabaud<sup>c</sup>, Marisol De Kari Tande



st; Radioth Oncol, 2010



## 2. Pt 'A' Definition for different IC Systems



## 3. ICRU- B & RV (ICRUR) Points

Vaginal points:

- High dose points
- PIBS, PIBS + 2 & PIBS - 2 points

# **Treatment Prescription for Cervical Cancer**

## **Concomitant chemoradiation**

### **Planning Aim (External + BT)**

- Concurrent Cisplatin CT 40 mg/m<sup>2</sup> once weekly x at least 5 cycles
- **Tumoricidal Doses (All doses in EQD2)**
  - For primary: 85 – 90 Gy (External + Brachytherapy doses)
  - Pelvic / Parametrium external boost (optional): 50-55 Gy
  - Nodes: 45 -50 Gy (External) +/- Boost (N+ disease)
- **External Beam** : 45 – 50 Gy @ 1.8 – 2 Gy per fraction
- **Brachytherapy (Fractionated HDR Schedule)**
  - 3 - 4 # of HDR boost @ 7 Gy to Point A / HR-CTV
- **OAR' s** : Rectum / Sigmoid: 70 -75 Gy EQD2  
Bladder : 90 - 95 Gy EQD2

