Antoine Lacassagne
CENTRE DE LUTTE CONTRE LE CANCER DE NICE

Centre Antoine Lacassagne

Organ preservation for rectal cancer. Should we use HDR or Contact x-ray *CXB* boost ?

J.P. GERARD

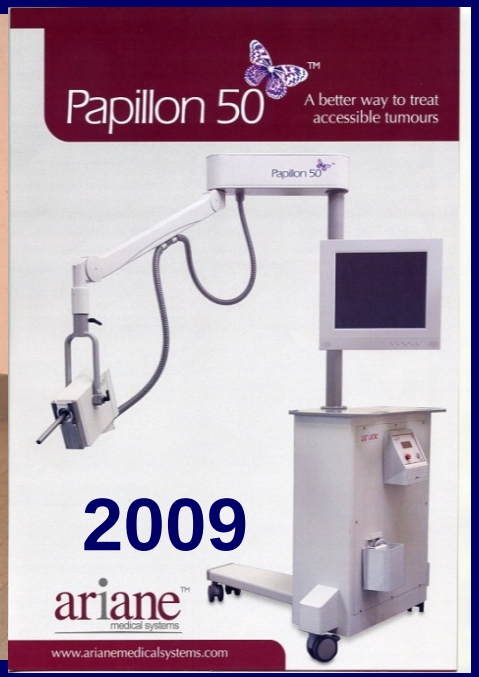
Leiden, 20th November 2017 15 mn

DECLARATION D'INTERET - DISCLOSURE

Ariane Medical Systems™ (UK)

Contact X Ray Brachytherapy 50 kV

"Papillon 50"

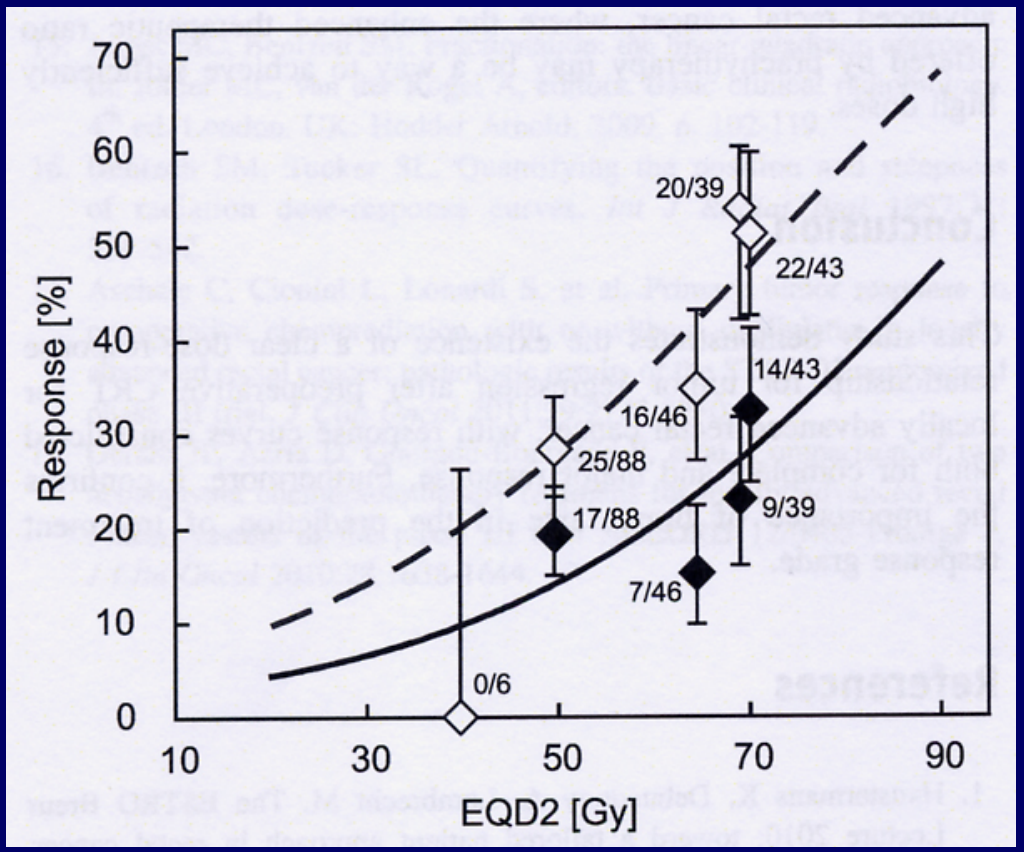


J.P. GERARD

Medical Advisor

Rectal adenocarcinoma : radioresistant

Radiation Dose-Response Model (EQD 2)



T3 rectal ADK

for 50% pCR :

Dose = 92 Gy

Rectum Tolerance Dose

< 75 Gy

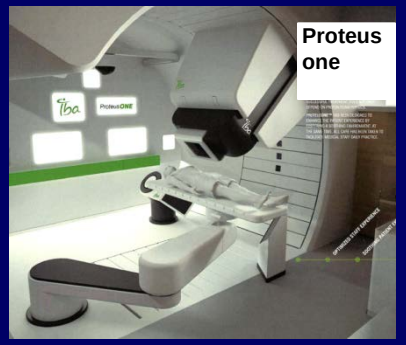
A Appelt - Jakobsen Int J R OBP 2013 ; 85: 74

Rectum External Beam RT (EBRT) BOOST ??

EBRT : - stereotactic Body RT (SIB)

- cyberknife

- proton



***ACCORD 12 phase III* : 45 Gy vs 50 Gy ypCR : 13% - 19%**

***GRECCAR 12* « « : 50 Gy vs 60 Gy R0 : 83% - 88%**

But …. Toxicity is the ultimate Limit

With EBRT impossible to increase Dose > 80 Gy

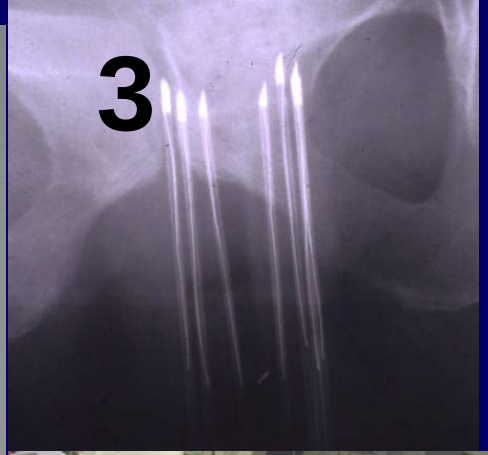
Gerard J Clin Onc 2012 - Rouanet D C R 2017

Higher Tumor Dose (no toxicity +++)

Endoluminal approach

Brachy RT $(1/r^2)$

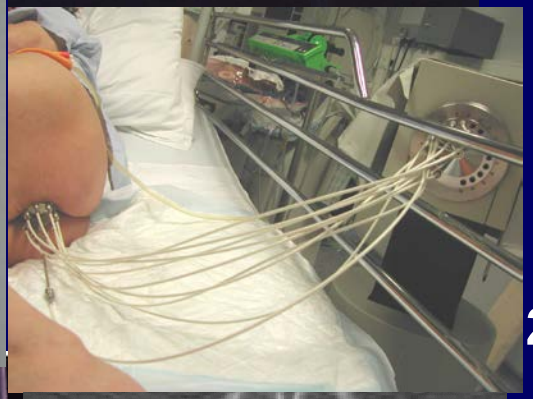
FSD : Focus Surface Distance



Brachytherapy

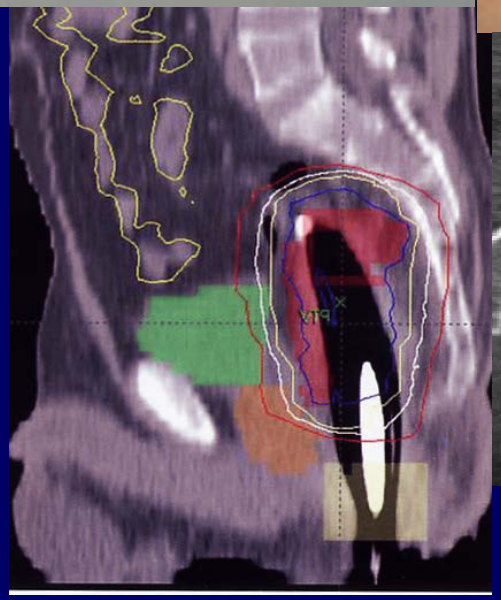
1) **CXB**

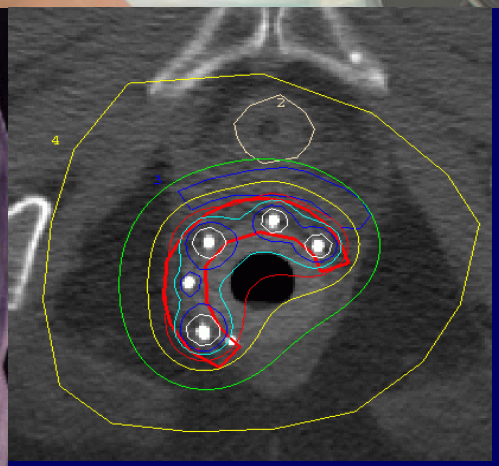
X50 kV



2) **Endoluminal**

HDR Ir192





3) **Interstitial**

HDR Ir192

CXB > Iridium

1) Higher *(inhomogeneous)* dose in Tumor:

2) **Better accurate Targetting *(eye vs image guided)***

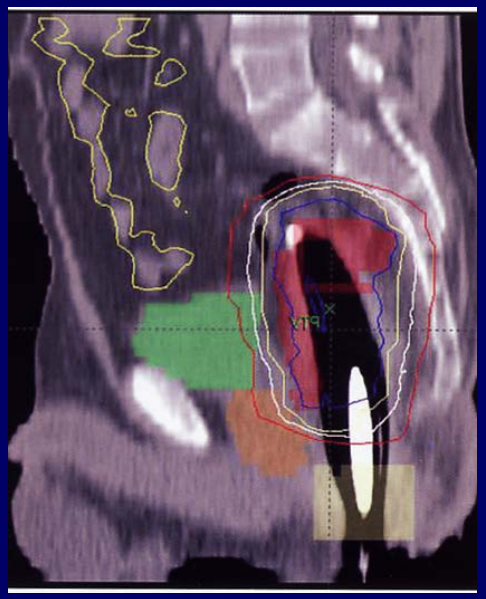
3) Better protection of normal rectum

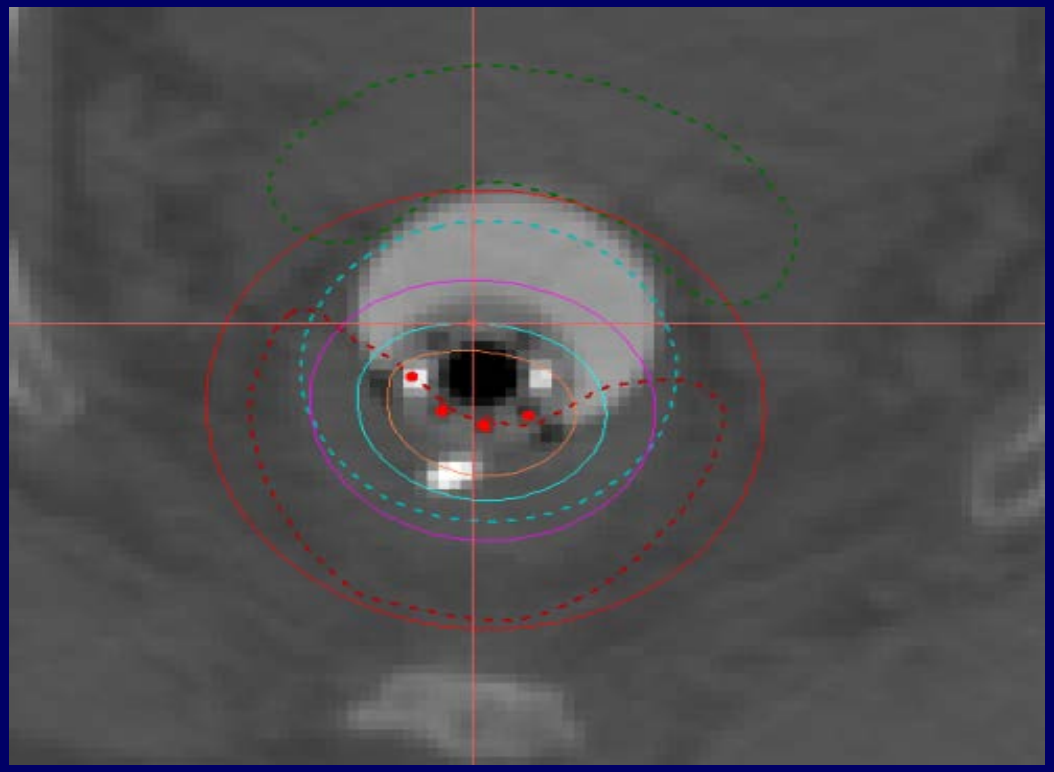
4) Simple - radioprotection - Cheap

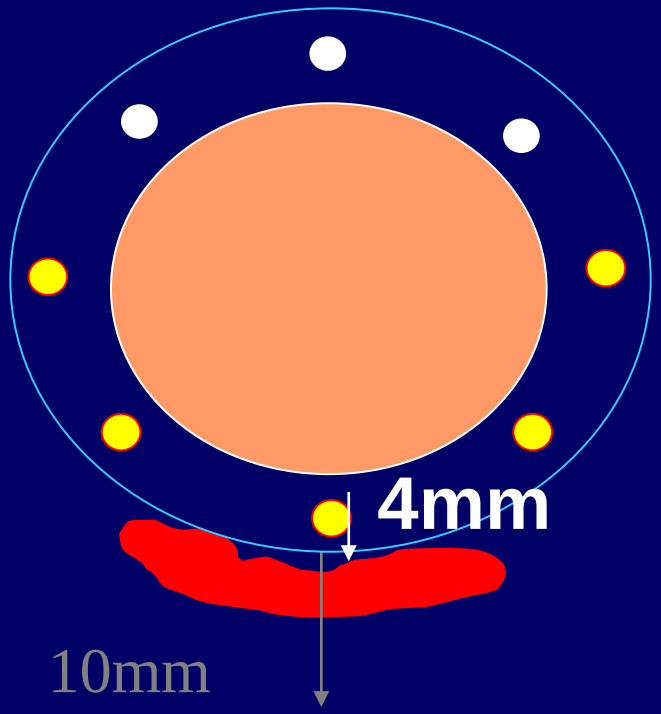
5) Sustainable development *(no radioactive waste)*

LIMITATIONS

Endoluminal Iridium 192 HDR

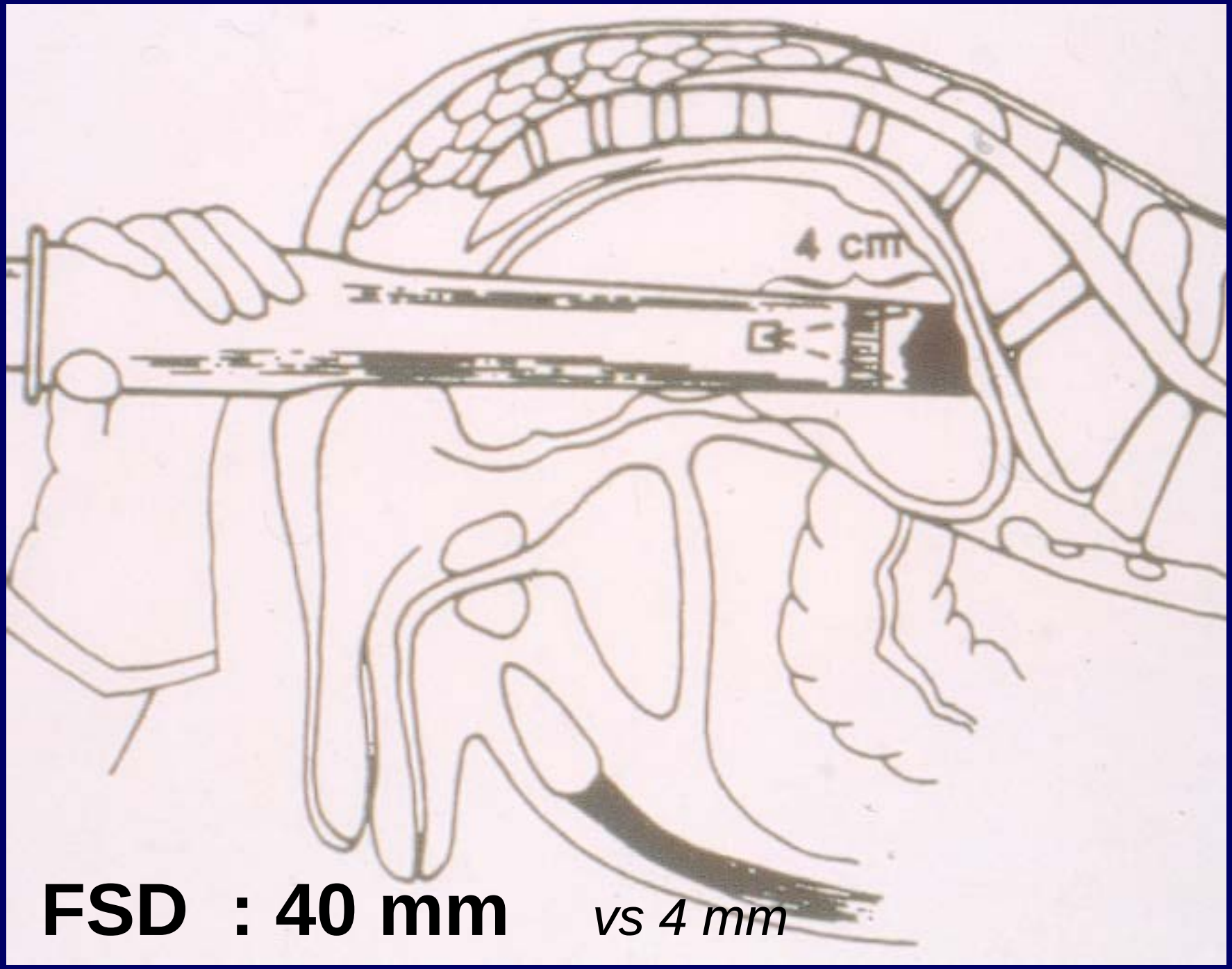






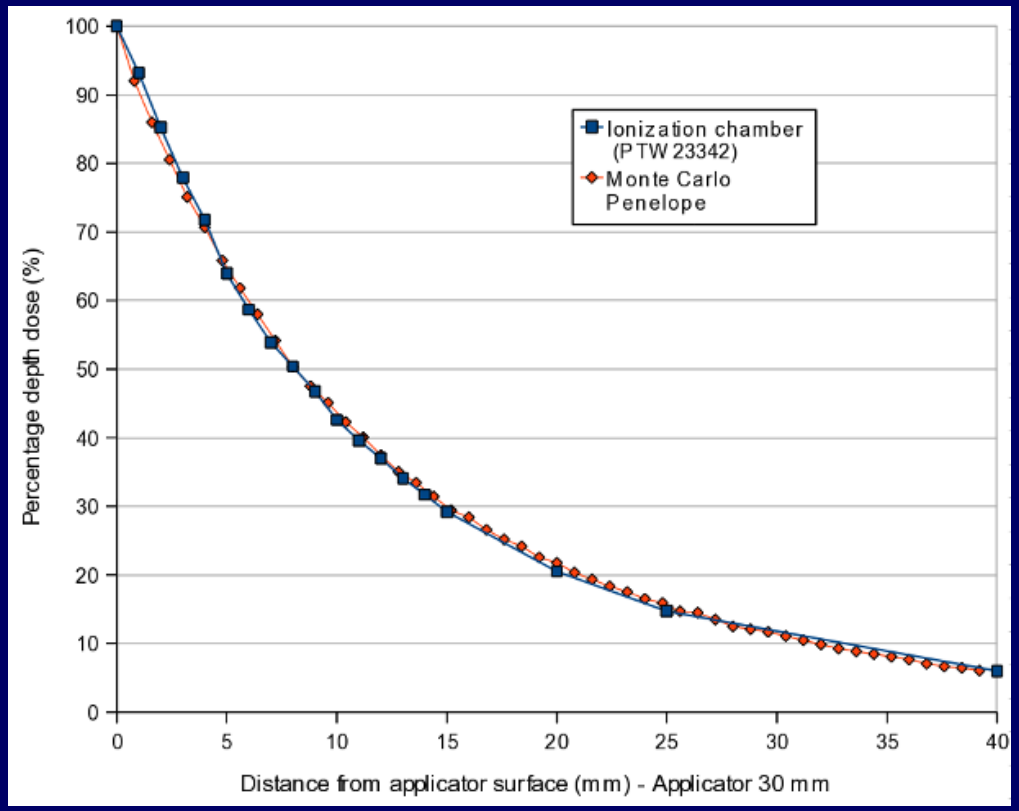
FSD : 4 mm

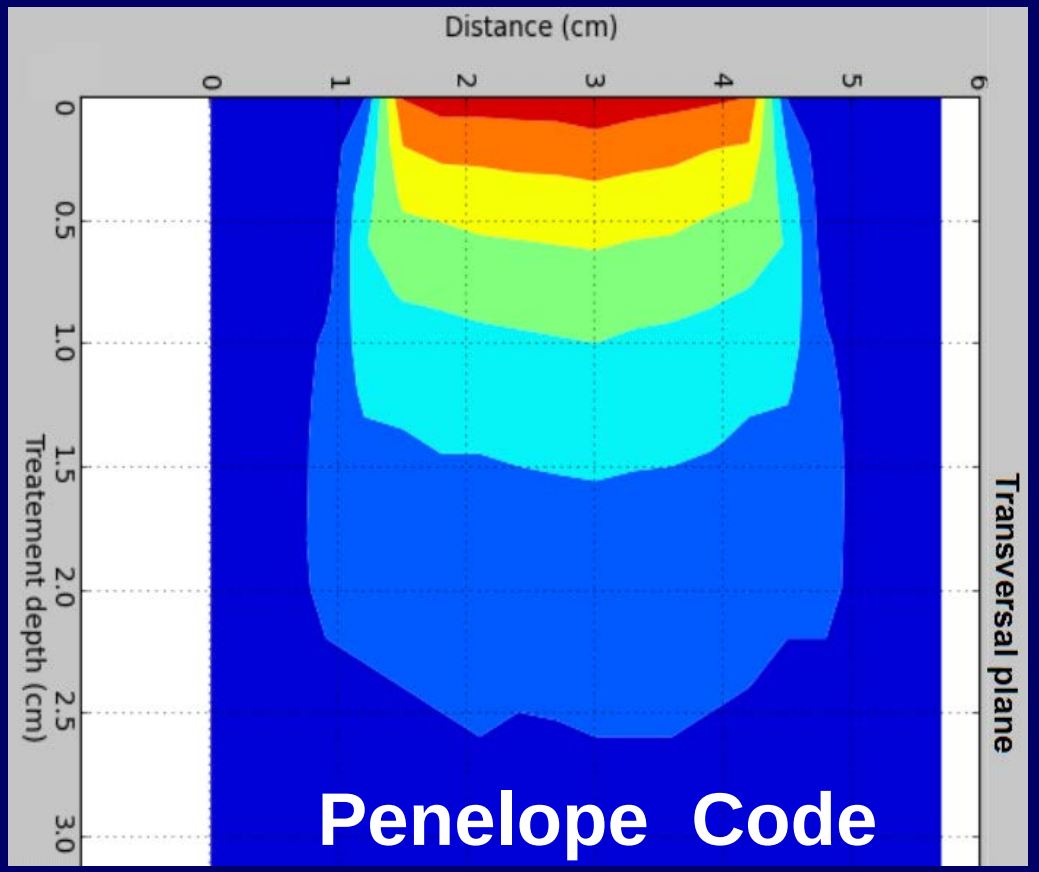
Courtesy Te Vuong



FSD : 40 mm *vs 4 mm*

Dosimetry : Monte Carlo M C 2 PLAN™

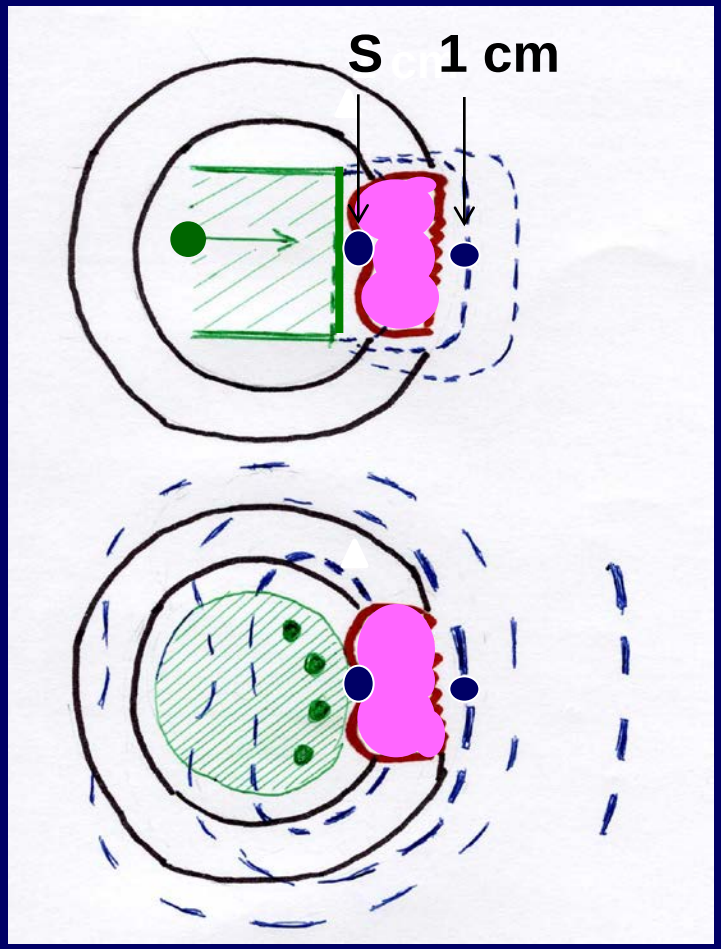




Applic 3 cm ⌀ - FSD : 4 cm

Dose 50% at 7 mm

Brachy Endoluminal Rxtherapy Rectum



Cont X Brachy

50 kV **FSD : 40 mm**

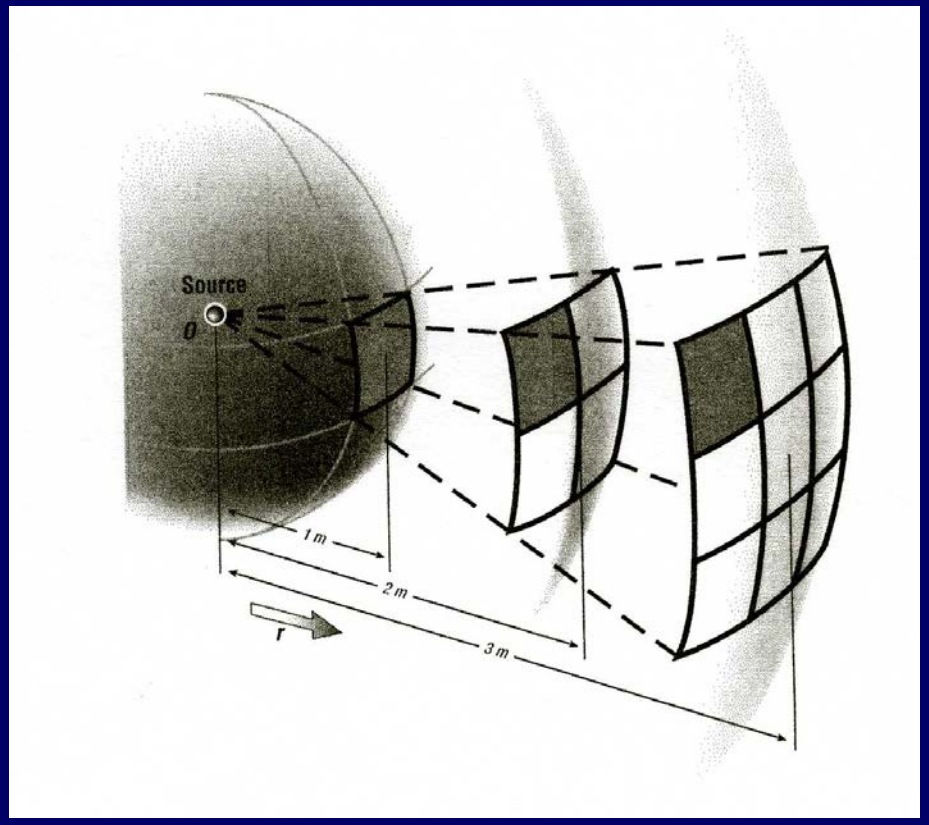
Iridium 192

HDR 300 kV **FSD : 4 mm**

Dose at surface applicator (S) vs Dose at 1 cm

Inverse Square Law S : $4 \pi r^2$

ISOTROPIC RADIATION distribution : sphere



1 cm S : 1 Dose 10 Gy

2 cm S : 4 D 25% 2.5

3 cm S : 9 D 11% 1.1

Point Source

Rectum Brachytherapy - Dose Distribution

	Iridium 192 HDR 300 kV	Contact X Brachy 50 kVp (25 kV)
FSD	0,4 cm	4 cm
Surface	10 Gy	10 Gy
T Depth 1cm	2.2 Gy	4.0 Gy

Protocol AAPM TG-43 U1 : $D = Sk.\Lambda. \mathbf{(1/r2)}.gp(r). \varphi an(r)$

Catherine DEJEAN

When FSD is short :
0.5 to 6 cm (5 – 60 mm)

- Dose is **inhomogeneous**

- For penetration (% depth-Dose)
  FSD (Focus- surface –Distance)
  is much more important
  than **Energy of beam**

CXB > Iridium

1) **Higher** *(inhomogeneous)* **dose in Tumor: Brachy RT** ***(1/ r^2)***

2) **Better accurate Targetting** ***(eye vs image guided)***

3) **Better protection of normal rectum**

4) **Simple - radioprotection - Cheap**

5) **Sustainable development** ***(no radioactive waste)***

LIMITATIONS

But …

EXPERT REVIEWS

Renaissance of contact x-ray therapy for treating rectal cancer

Expert Rev. Med. Devices 8(4), 483–492 (2011)

Jean-Pierre Gérard[†1], Arthur Sun Myint[2], Olivier Croce[3], Jacob Lindegaard[4], Anie Jensen[4], Robert Myerson[5], Jean-Michel Hannoun-Lévi[1] and Serge Marcie[1]

Contact x-ray therapy (CXRT) with 50 kV has proven to be an efficient radiation therapy technique to achieve local control and rectal preservation for early rectal adenocarcinoma. Despite these results, CXRT has not been used due to the shortage of the no longer manufactured Philips RT 50™ unit. Recently, a new CXRT machine (Papillon 50™) became available on the market. This machine delivers a beam of 50 kV with a dose rate close to 15 Gy/min and has a percentage depth dose of 50% at 6–7 mm. The applicator size varies from 2–3 cm in diameter. Due to the original design of the main tube, treatment delivery is quick and more comfortable for the patients. An online viewing system incorporated in the tube allows a good visualization of the tumor with improved accuracy of radiation delivery. An international collaborative trial (Contact Endoscopic Microsurgery [CONTEM]) was set up to accrue approximately 300 cases

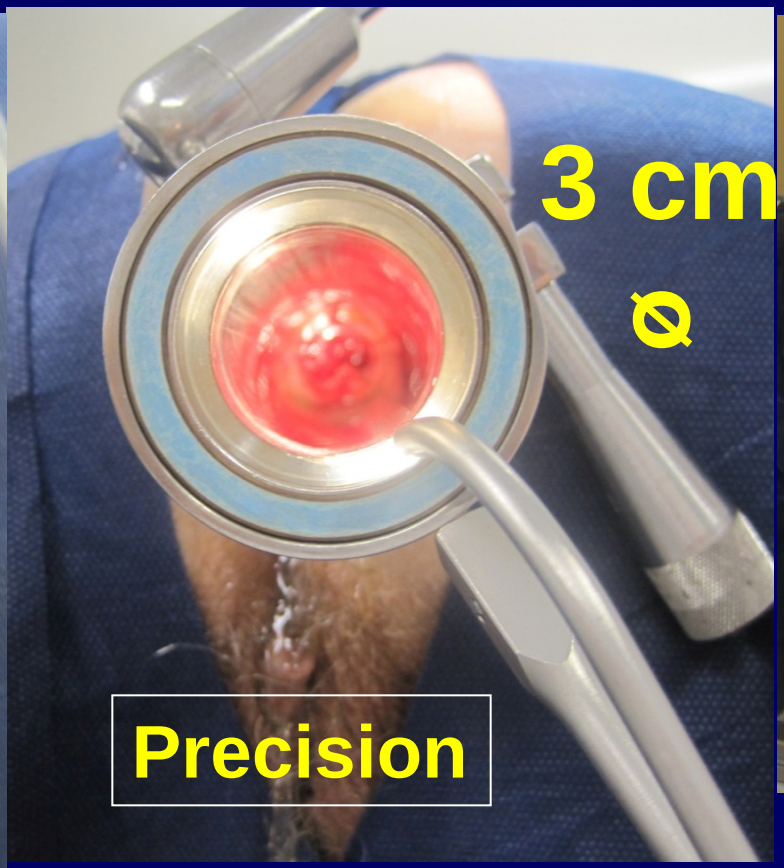
➢ **2001 Philips machine Stop**

2009 : Papillon 50 ™

UK- French design

Exp Rev Med Dev
2010; 34: 231
JP Gerard & al

1) Rigid scope 2) Target- Fixation 3) Irradiation



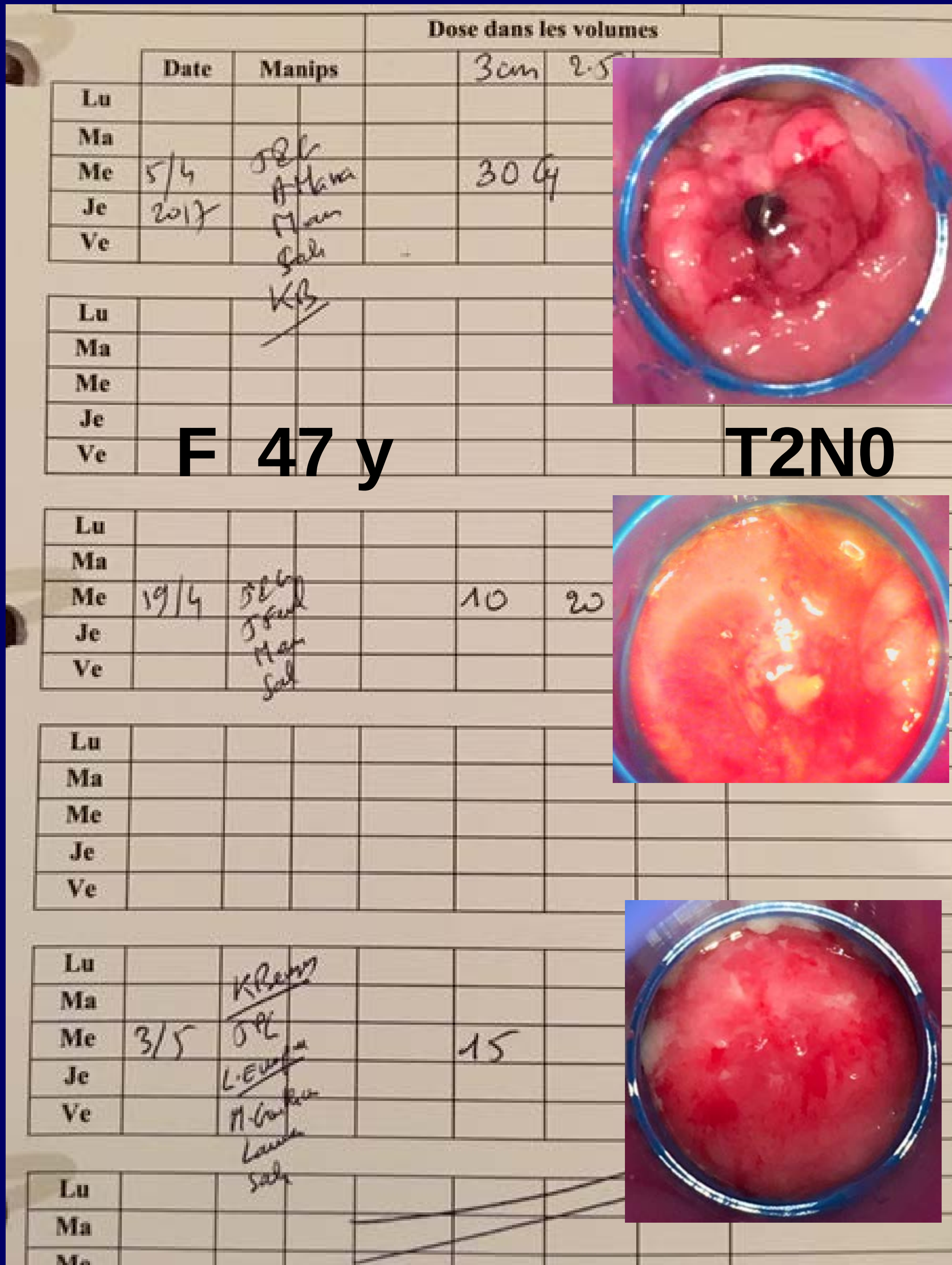
Papillon 50 **Transanal Endoscopic Brachytherapy**

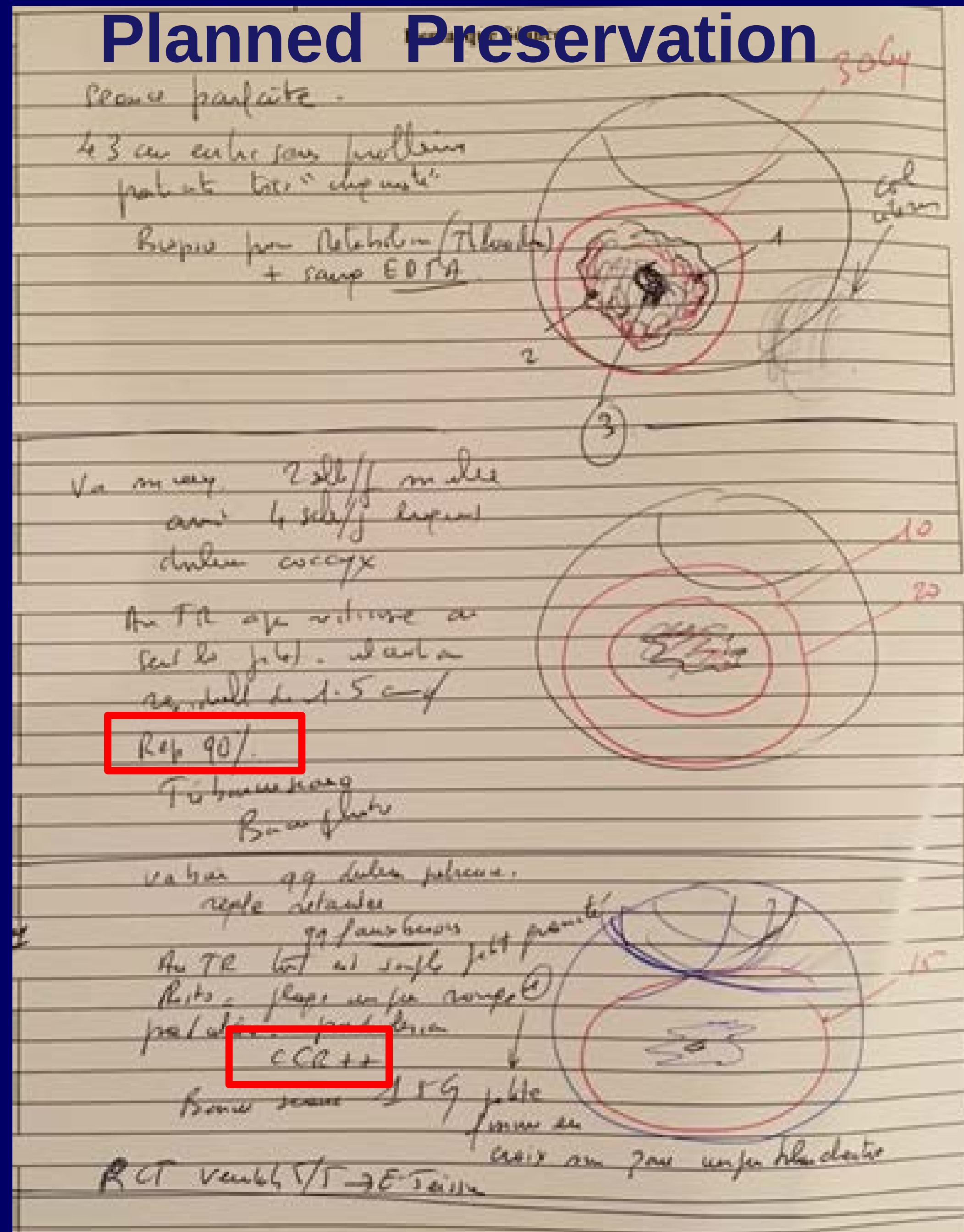
Non Toxic . Efficient . Simple (any age - ambulatory)

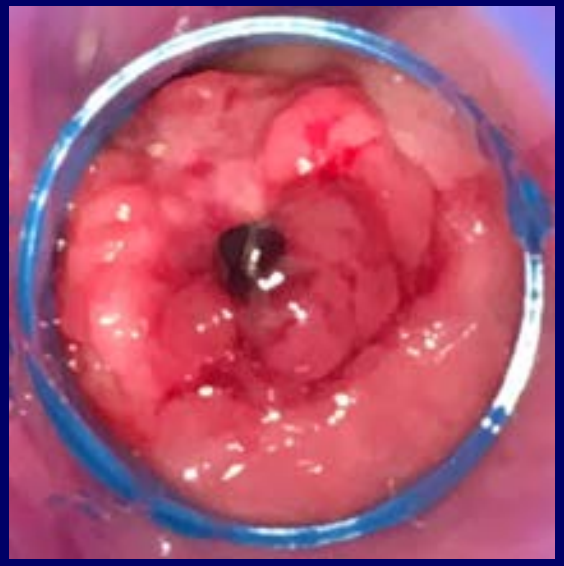
Clinical Expertise

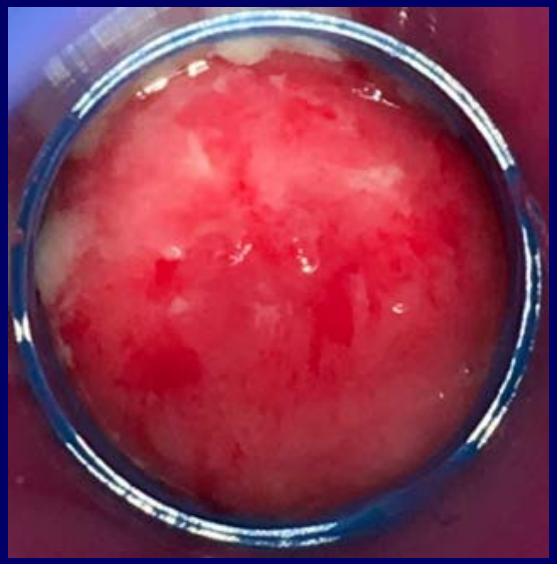
Planned Preservation

F 47 y **T2N0**





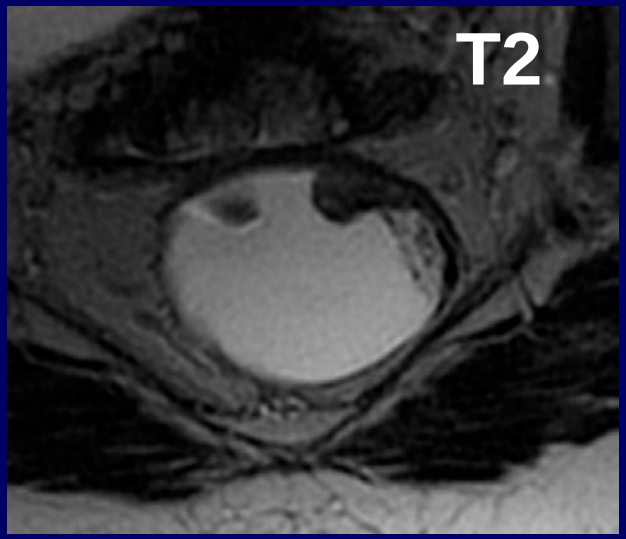




D1 - April 2017

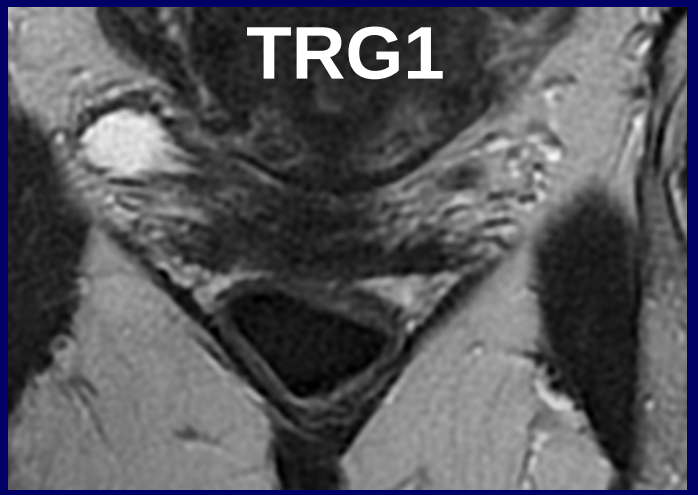
D 28: cCR

3 months



+

CAP 50



« Planned » Organ Preservation

CXB France

Mâcon 2010
N Barbet

Lyon-Villeurbanne 2010

R Coquard
N Barbet

Nice 2002

JP Gérard
K Benezery
J Doyen

Epargne rectale - Papillon 50 - France

2003 – 2016 : 84 pts Contact: 90 Gy/ 3 fr + CAP 50

median age : 74 years Med Fol-up : 53 months

Inst	N° pt	T2	T3	cCR	Loc Rec	Org Pres	Sp S 4 y
Lyon V	16	13	3	16	2	14	83
Macon	11	7	4	10	1	10	86
Nice	57	32	25	53	3	57	81
Total	84	52	32	79 (94%)	6/79 (11%)	81 (94%)	82%

Frin AC & al Eur J Canc 2017;72:124-36

Rectal Preservation Papillon^{50} Europe

2017 Europe

11 P 50 units (Amst.)

Liverpool – Clatterbridge

Papillon Suite: Pr Sun Myint

CXB + CRT organ preservation Europe

Inst	N° pt	T2	T3	cCR	Loc Rec	Org Pres
Clatterbridge 2002-2014	200	89 21	90	72%	11%	62%
Hull 2010-2014	43	26	17	90%	15%	89%
Nice – M.V. 2002-2016	84	52	32	94%	11%	94%
Total	327	188	139	85%	12%	81%

Sun Myin t *BJR 2017 -* ***Dhadda*** *Clin Onc 2017 -* ***Frin AC*** *& al Eur J Canc 2017*

CXB > Iridium

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2) **Better accurate Targetting** ***(eye vs image guided)***

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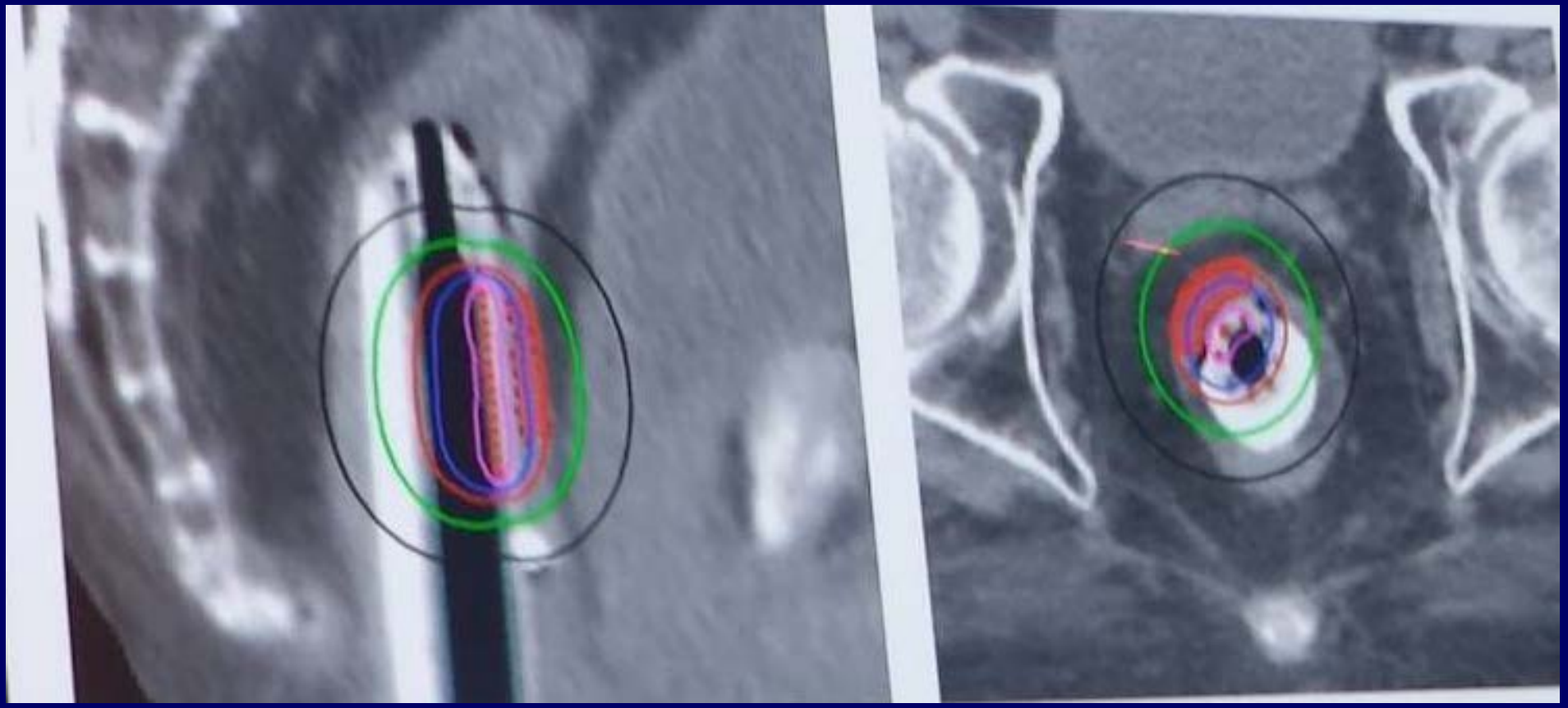
LIMITATIONS

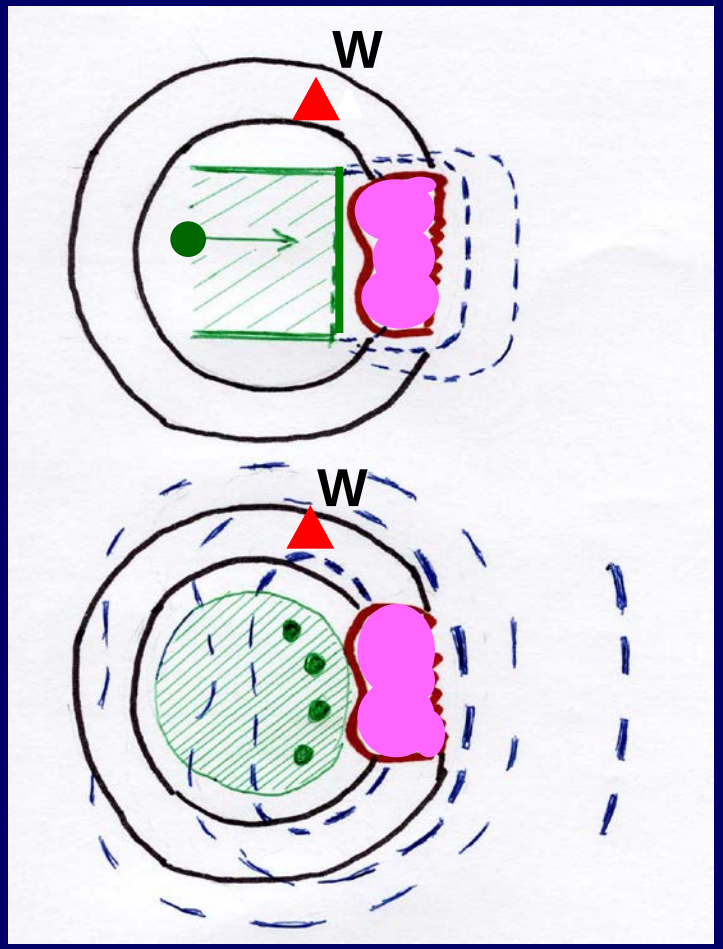


« Leyden » Hebert Study *C Marijnen*

Max Tolerated Dose : 7 Gy surface (X3) (even with balloon) 30 Gy

Rijkmans E Hehert study Int J Rad O B P 2017; 98: 908-17

Brachy Endoluminal Rxtherapy Rectum



Cont X Brachy

50 kV **FSD : 4 cm**

Iridium 192

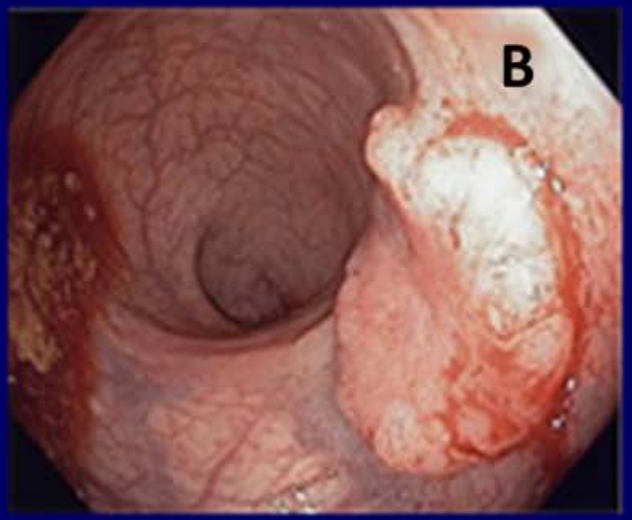
HDR 300 kV **FSD : 0.4 cm**

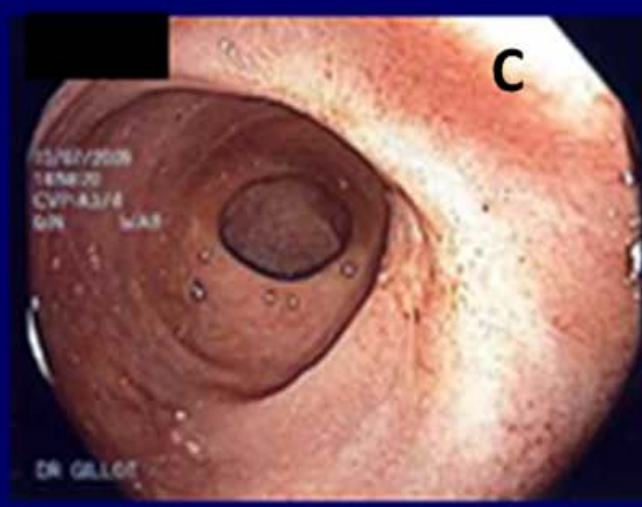
Dose at normal Rectal Wall : W

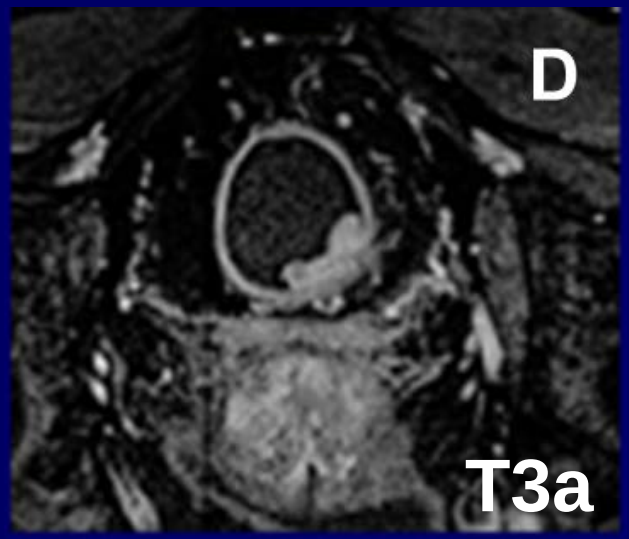
Rectum Brachytherapy - Dose Distribution

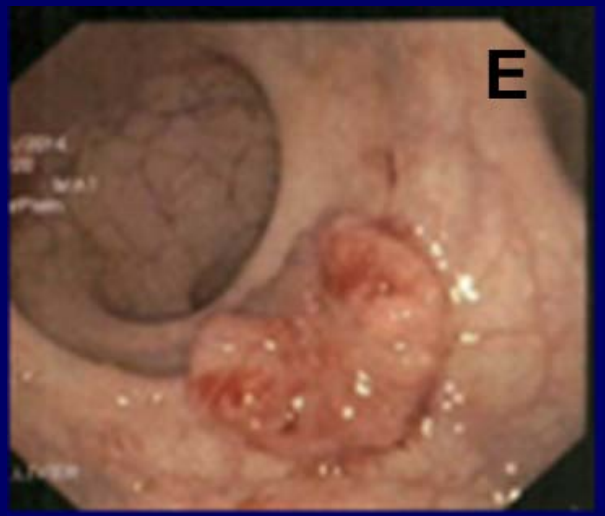
	Iridium 192 HDR 300 kV	Contact X Brachy 50 kVp
FSD	**0,4 cm**	**4 cm**
Surface	10 Gy	10 Gy
1 cm lat.	4 Gy	< 0.1 Gy

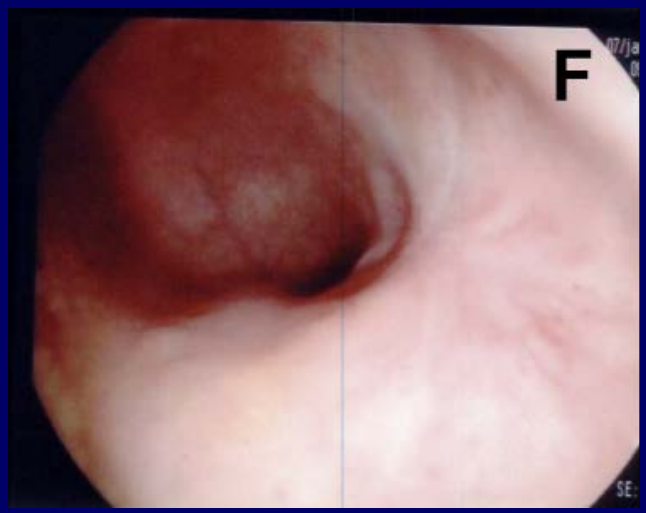
protocolAAPM TG-43 U1 : $D = Sk.^{\wedge}. \mathbf{(1/r2).} gp(r). \circledcirc an(r)$



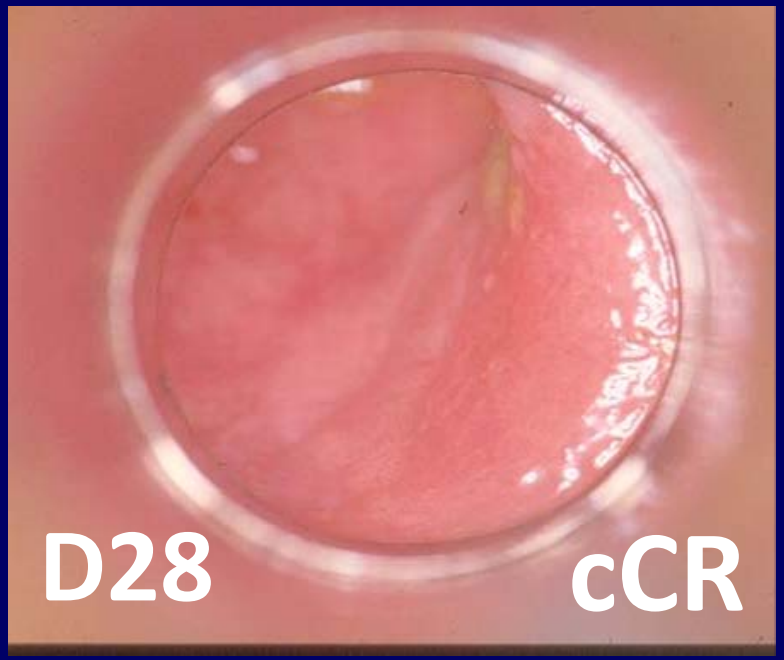


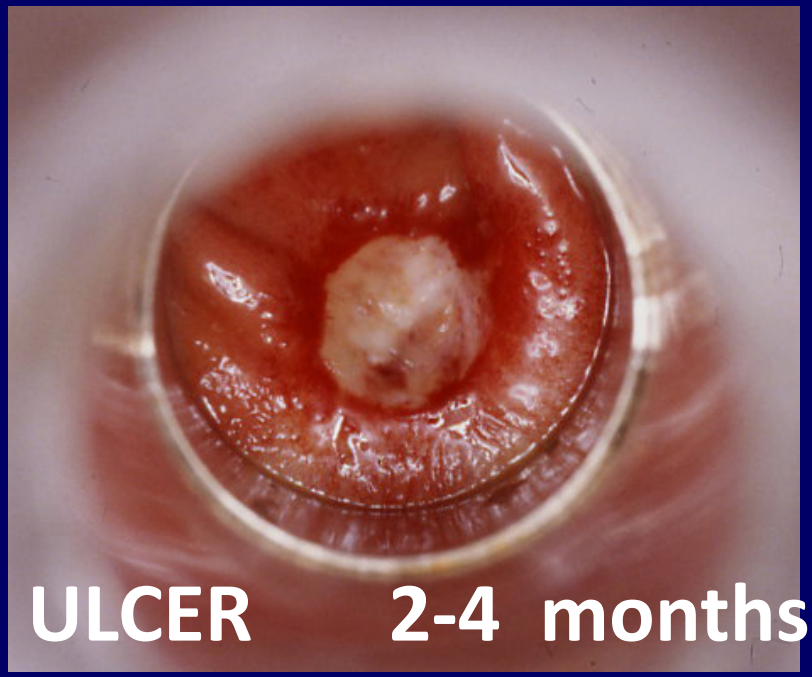


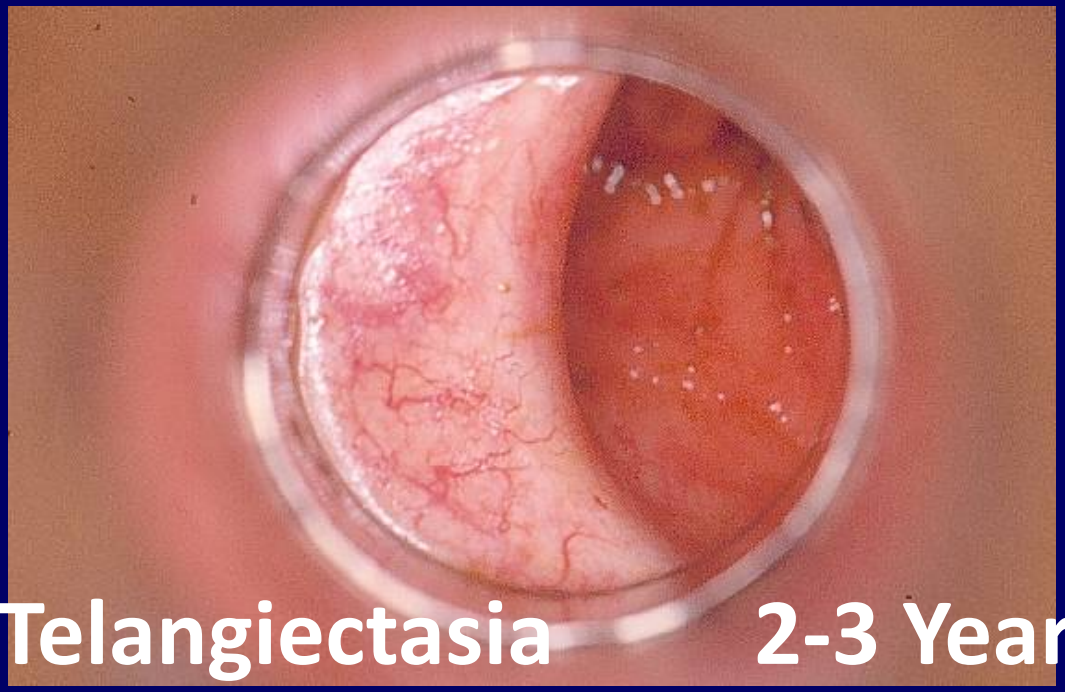




« Petit » T3a-b N0 ≤ 4 cm : CXB+ CRT







LARS SCORE

During the past month, do you ever have occasion when you cannot control your flatus (wind)?	
No (never)	0
Yes, less than once per week	4
Yes, at least once per week	7
During the past month do you have any accidental leakage of liquid stool?	
No, Never	0
Yes, less than once per week	3
Yes, at least once per week	3
During the past month how often do you open your bowel?	
More than 7 times per day (24 hours)	4
4-7 times per day	2
1-3 times per day	0
Less than once per day	5
During the past month, do you ever have to open your bowel again within one hour of the last bowel opening?	
No, never	0
Yes, less than once per week	9
Yes, at least once a week	11
During the last month, do you ever have such a strong urge to open your bowel that you have to rush to the toilet?	
No, never	0
Yes, less than once a week	11
Yes, at least once a week	16

TOXICITY - BOWEL FUNCTION (Nice - 57 pts)

- **Rectal Bleeding** (1-3 years after RT)

  G1-2 : 25% G3 : 9% (plasma-argon)

- **Bowel Function** (score)

  - **MSKCC** : Good-excellent : 82.5% - Fair : 12.5%

    Poor : 5%

  - **LARS** (26 pts) : Good (0-20) : 15 Fair (21-29): 9 Poor > 30: 0

Minsky B IJROBP 1992;23:387 - Emmersten k Ann Surg 2012; 255:922

CXB > Iridium

1) **Higher** *(inhomogeneous)* **dose in Tumor: Brachy RT** ***(1/ r^2)***

2) **Better accurate Targetting** ***(eye vs image guided)***

3) **Better protection of normal rectum : less toxicity**

4) **Simple - radioprotection** *(room shield)* **- Cheap**

5) **Sustainable development** ***(no radioactive waste - Terrorism)***

Intraluminal Brachytherapy For Rectal Cancer

CXB > HDR

CXB > Iridium

1) Higher dose in Tumor: Brachy RT *(1/ r^2)*

2) Better accurate Targetting *(eye vs image guided)*

3) Better protection of normal rectum and OAR ++

4) Simple - radioprotection - Cheap

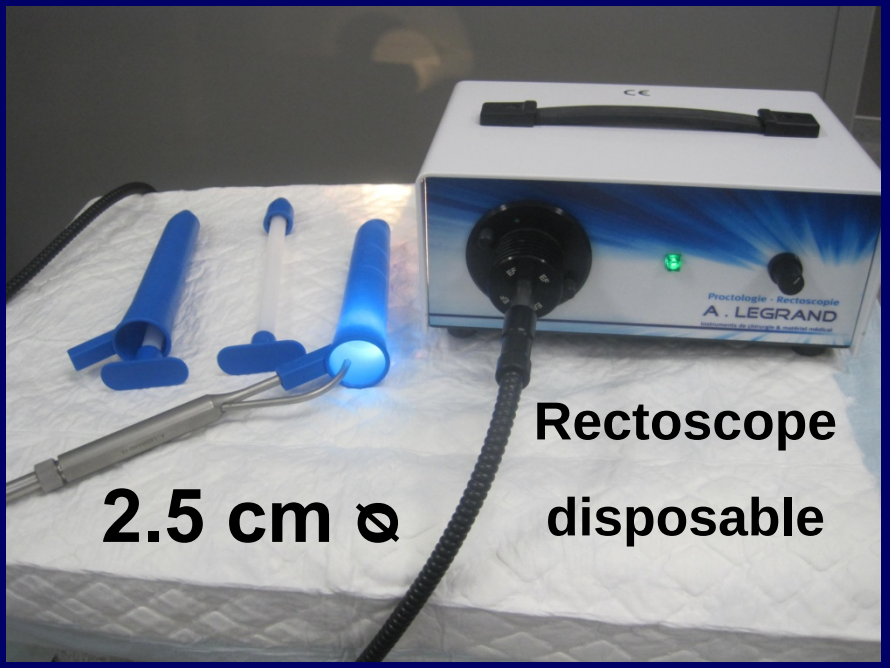
5) Sustainable development

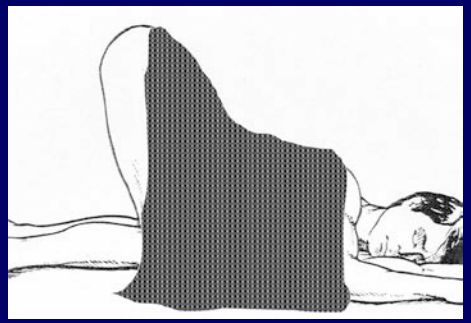
LIMITATIONS +++

Limitations

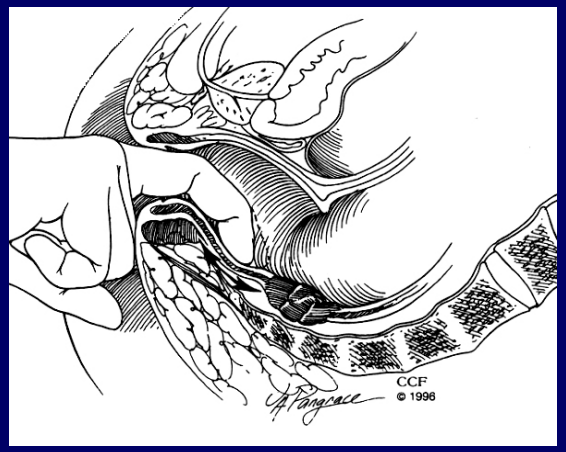
- **Size Tumor : < 5 cm ∅** *(4 cm ?)*
- **Site : Anal canal , Supra anal post , > 10 cm AV**
- **Operator dependent : Rigid rectoscopy : Training**
- **Still few strong evidence : OPERA**
- **Few machines but … Papillon +**

Rigid RECTOSCOPY clinical practice

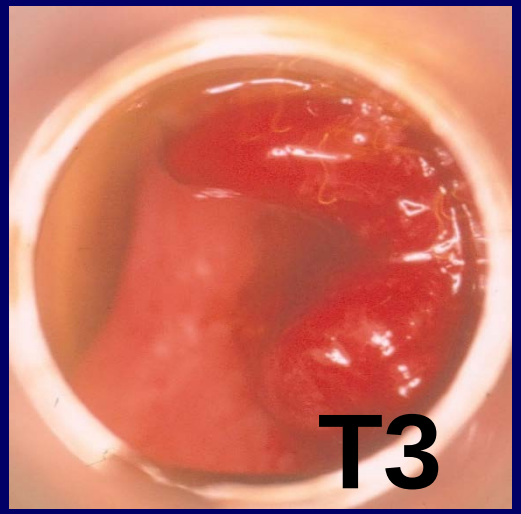




Knee-chest



« BIOPROBE »



CRT first line – Organ Preservation

Habr Gama (W Heald) : Watch & Wait **if cCR**

Sao Paulo : *T2 vs T3* **- Canada - US :**

MSKCC : T2 CRT + loc. Exc ; Prospect

Europe : UK – NL- DK – France (*GRECCAR***) – Italy**

IWWD : 1 009 pts

cCR : 15 - 50% **Loc Rec : 25 %** [10-35]

Organ preservation : 20-40%

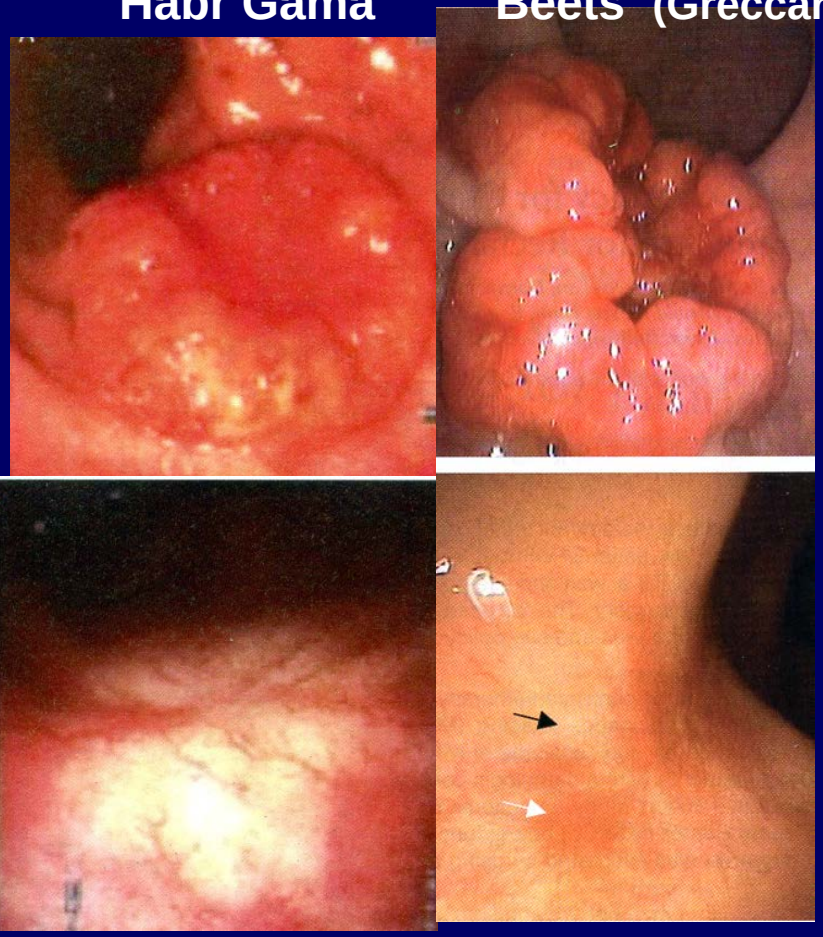
Habr Gama ; Garcia Aguilar ; Jakobsen; Beets ; Rullier ; Renehan;

T2-3ab

CRT Alone

Habr Gama

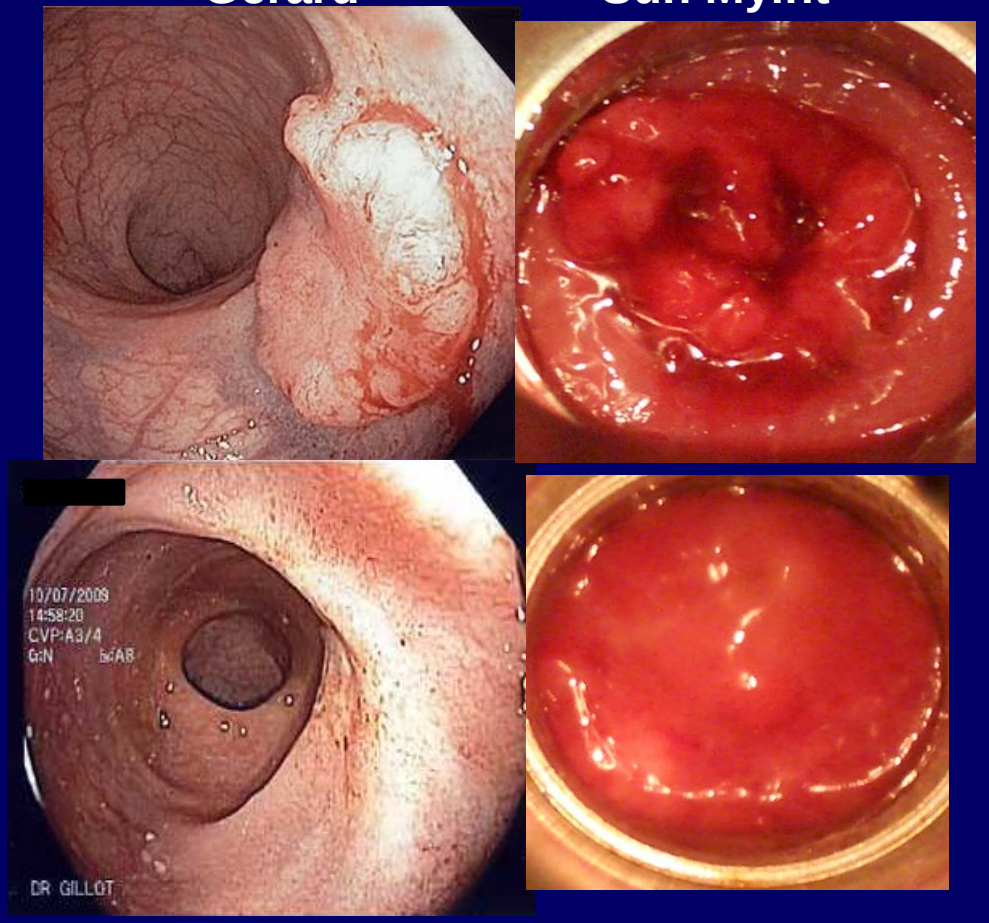
Beets (Greccar)



CRT + boost CXB

Gérard

Sun Myint



	CRT alone	CRT + Boost CXB
cCR	45 %	90 %
Loc Rec	30 %	≤15 %

7/6/2017

ORGAN PRESERVATION

NAME	N°	PHASE	INCLUSION CRITERIA	DESIGN	END POINTS	N PATIENTS	STATUS	COMMENTS
STAR-TREC UNIVERSITY OF BIRGIMGHAM	NCT02945566	II	mriT1-3bN0 (<5 mm mesorectal invasion) or uT1-T3b Tumour < 4 cm	A -TME B - 50 Gy + Cap C - 5x5Gy	1st - Organ saving rate at 12 months 2ndary – TME Rate, 3 year pelvic failure, mrTRP assessment by MRI rate, OS, SFS,	120 (4 III 400)	ONGOING	
OPERA CAL Pr Gérard	NCT02505750	III	A – EBRT + Boost 9Gy	A – Cap 45 Gy + Boost 9Gy B – Cap 45 Gy + CXB 90 Gy	1st -Organ preservation rate without salvage surgery and absence of stoma at 3 year 2ndary – cCR, OS, DSF, TRG score	236	ONGOING	
GRECCAR 12 CHU Bordeaux E.Rullier	NCT02514278	III	cT2-T3, cN0-1 T < 4 cm, < 10 cm to AV	A – FOLFIRINOX (x4) + CAP 50 B- Cap 50	1st -Organ preservation rate and absence of stoma at 1 year 2ndary – Compliance, tolerance, rpCR, histologic CR rate, curative surgery rate,	218	ONGOING	
MORPHEUS Jewish General Hospital Sir Mortimer B. Davis	NCT03051464	Pilot Study	mT2-T3, N0-N1 (<5 mm mesorectal invasion) T < 5 cm, < 10 cm to AV	A – Cap 45 + boost 9Gy B- Cap 45 + HDBRT 30 Gy x3	1st -rectum preservation at 2 year 2ndary – Local reccurence, SFS, OS, QoL	40	ONGOING	

EVIDENCE OPERA : Phase III (Start 6-2015)

Organ Preservation Early Rectal Adenocarcinoma

T 2-3a-b < 5 cm ⌀ N0 M0 ; Distal- Middle Rectum

R

- CRT 45 + EBRT : 9 Gy
- CRT 45 + CXB : 90 Gy

W 14 → **Clinical response**

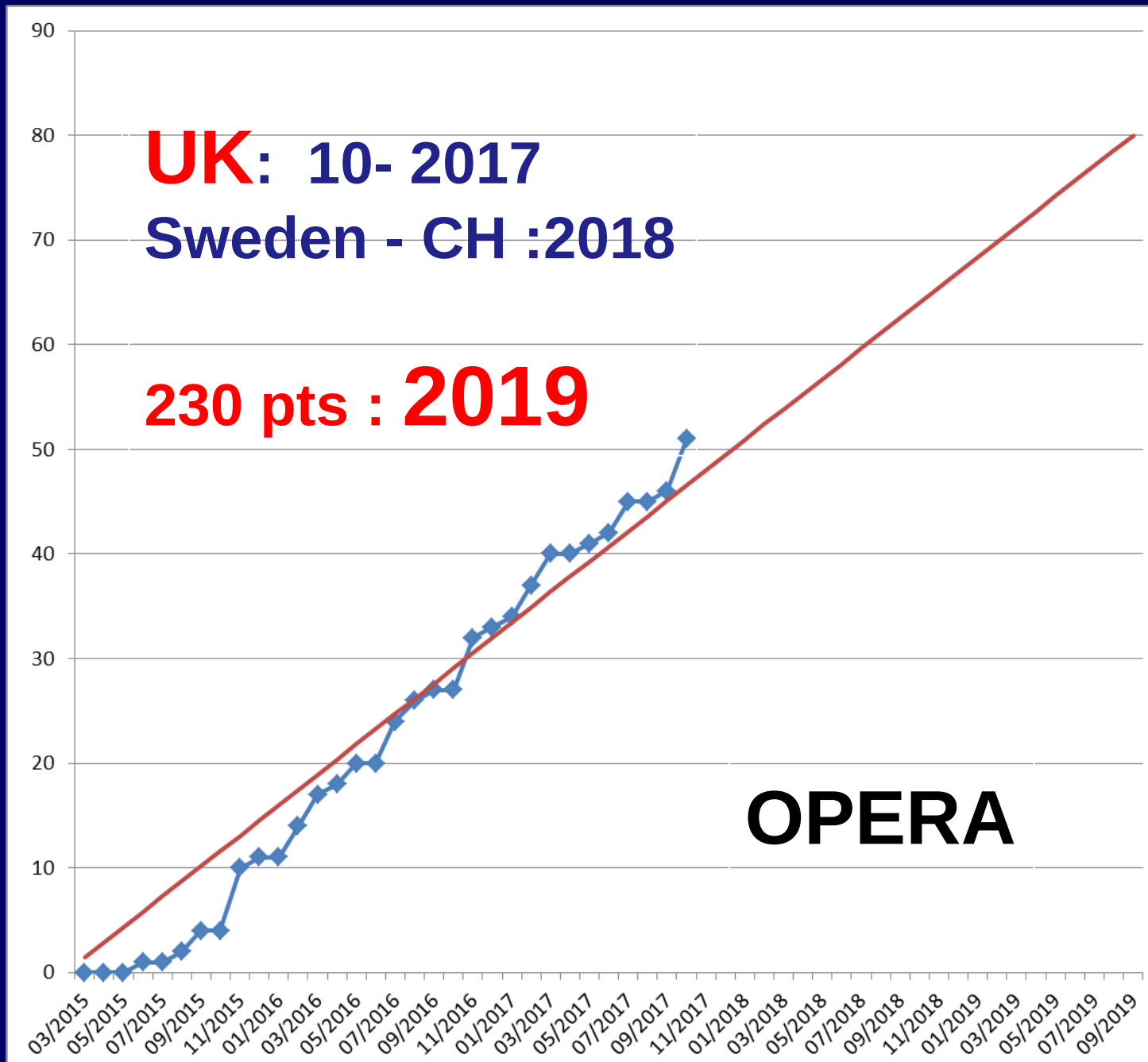
W 20 - 24

Resp

- Partial : TME
- cCR : Watch/ Wait or Local Excision

End point : organ (rectal) preservation 3 years (stoma- Loc R)

Hypothesis : 20 % to 40 % 236 pts (HR:0.56)



France

90 pts

start

June 2015

November 2017

55 patients

OPERA : Some blinded data Oct. 2017 *16-11*

50 pts randomized

- Med age : 68 y
- T2 : 32 / T3 : 18 ≤ 3 cm ⌀ : 21 / > 3cm : 29
- Distal : 36 / Middle : 14
- CRF : 27 pts cCR (12) + near cCR (9) : 21/27 (78%)
-

No SAE **Gr 3 Toxicity : 3** **Death : 0**

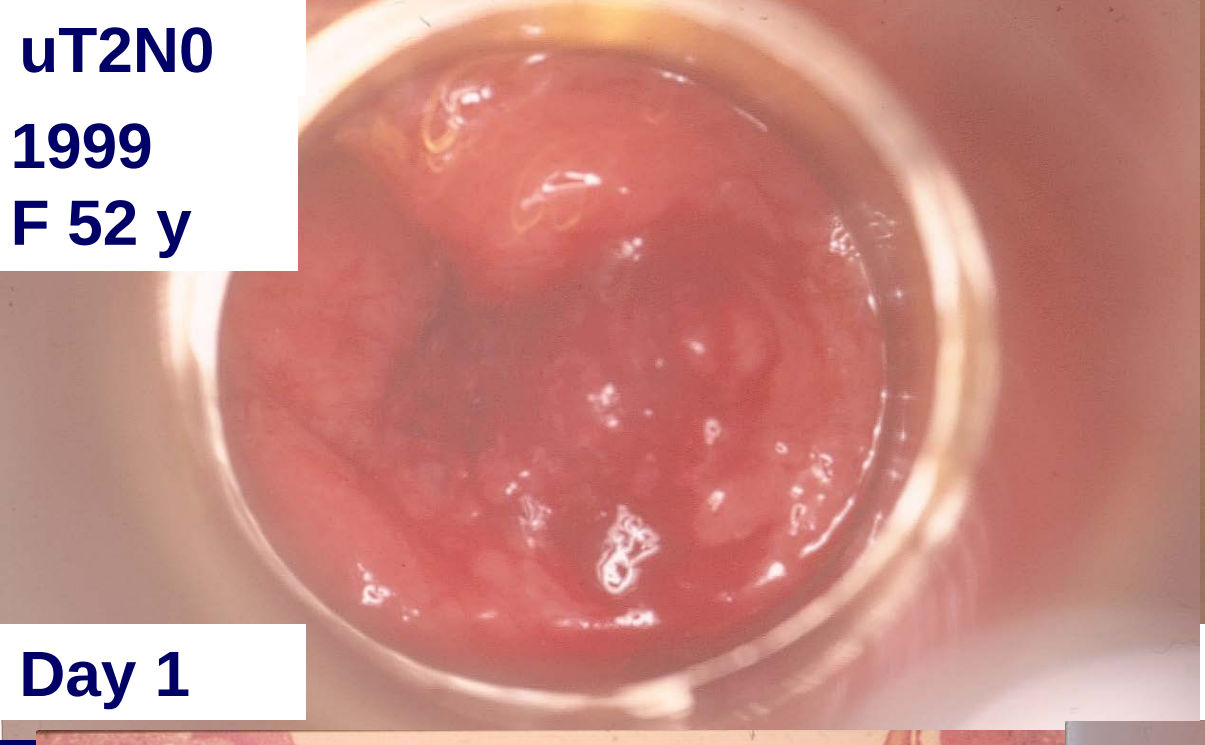
Randomisez trial : Lyon R 96-02

- **T2-3 Distal rectum Opérable : 90 pts 1996-2001**

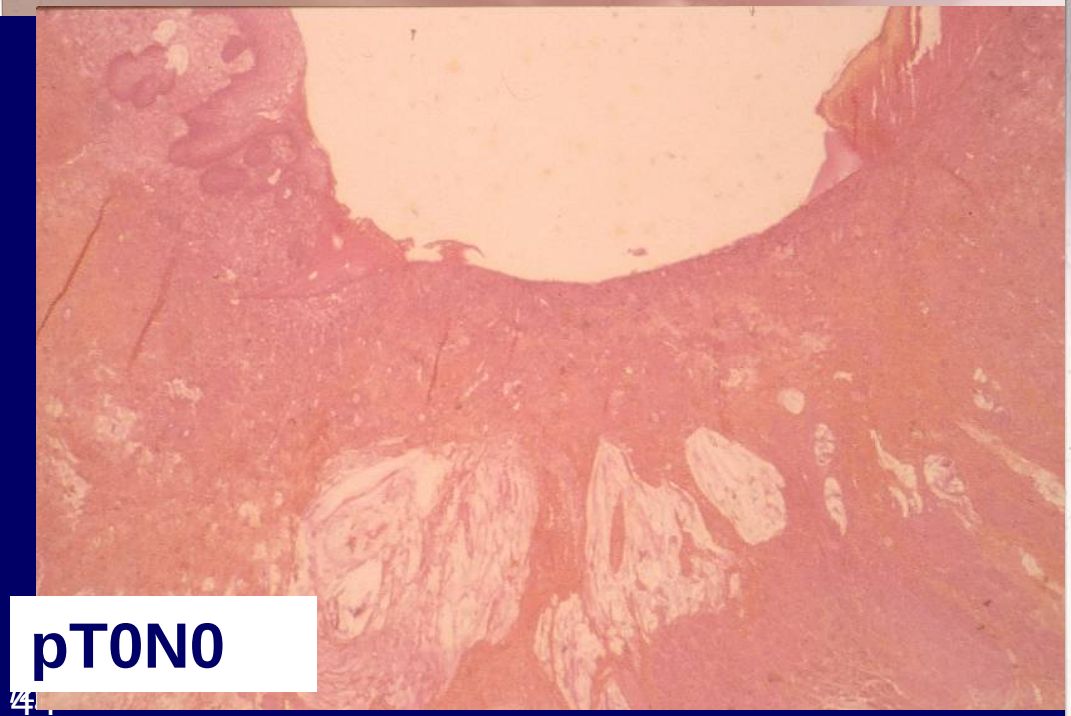
  Preop alone EBRT *vs* EBRT + Boost CXB : TME to all pts

- **Main End Point : sphincter preservation**
- **Clinical CR: 2% vs 30% Sph pr : 44% vs 76% (p< 0.05)**
- **At 10 years , 10 patients cCR : rectum Conservation**
- **TME after boost contact : Feasible – No extra toxicity**
- **No isolated perirectal recurrence**

Gérard : J Clin Oncol 2004; 22 : 2012 Ortholan IJROBP 2012


uT2N0
1999
F 52 y
Day 1

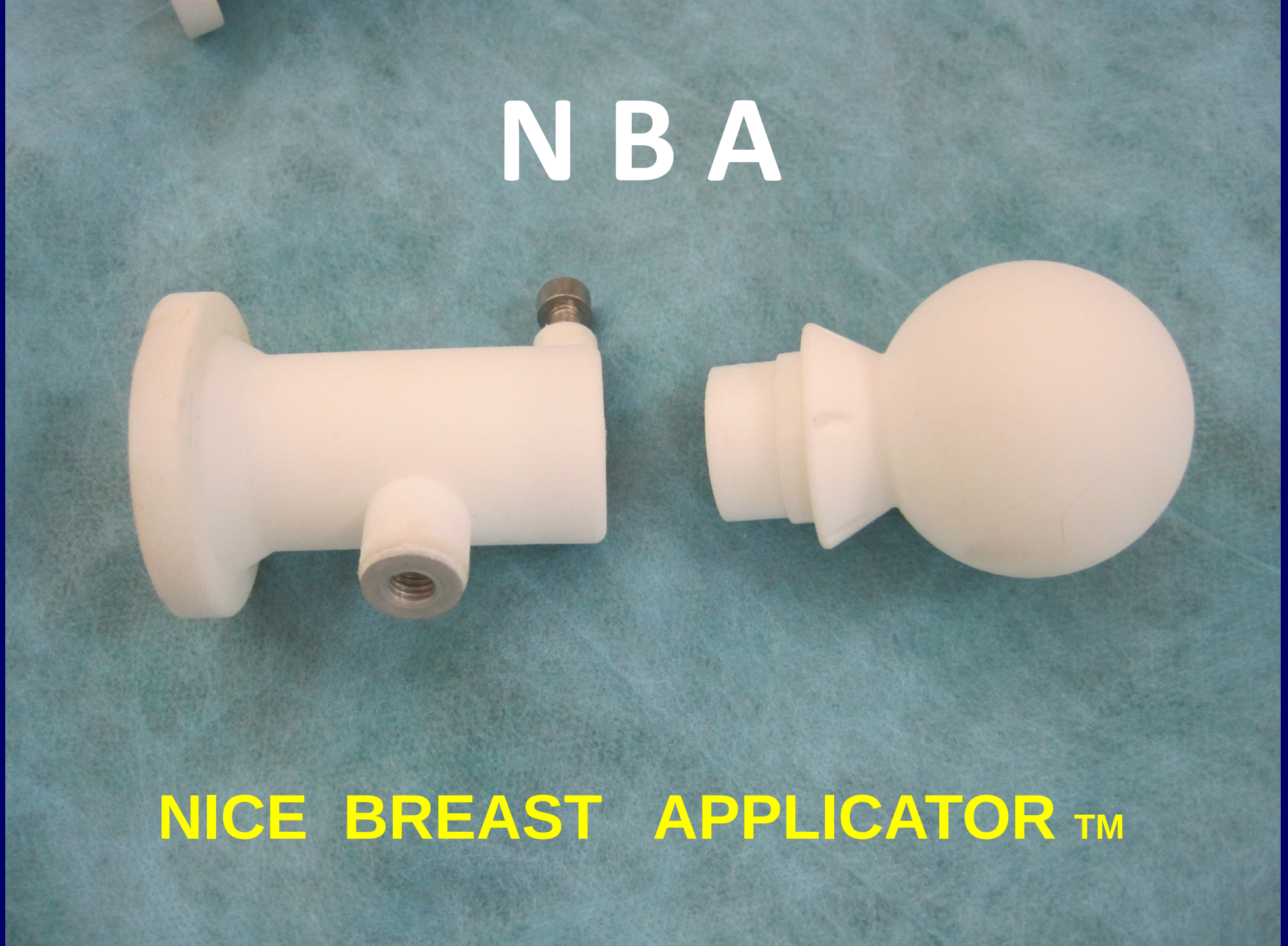

Day 70


pT0N0

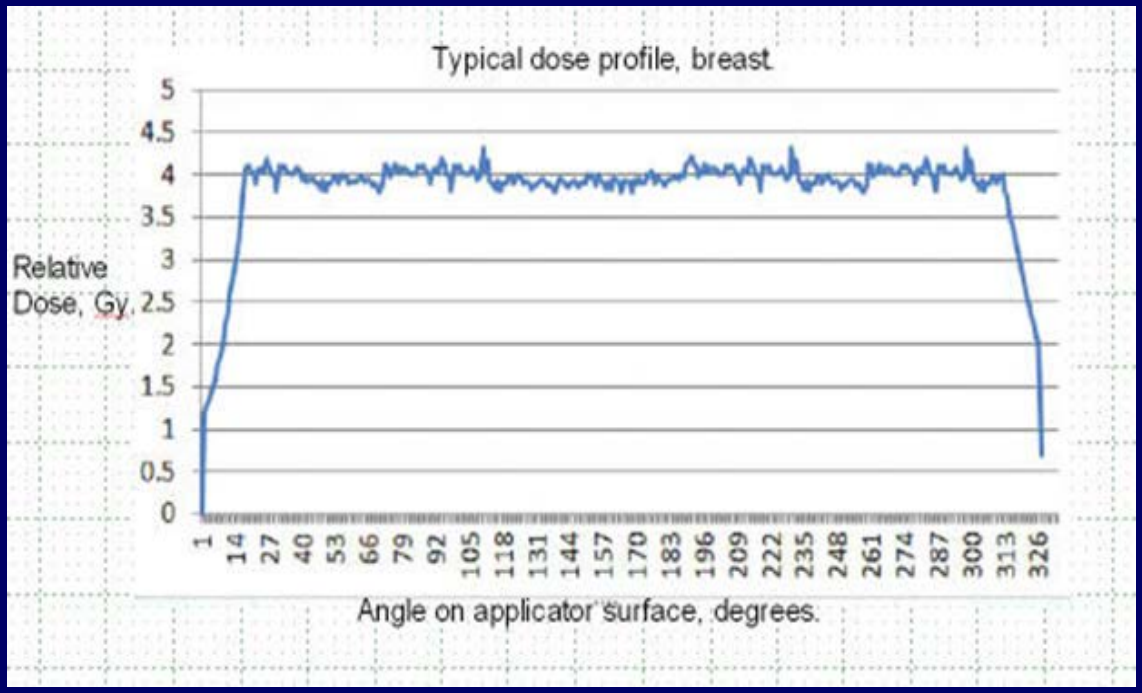

14 years
(2013) NED

« Magic stick 2017 »

Papillon + X Ray Tube : Micronode 310 °


N B A
NICE BREAST APPLICATOR TM

Gaf Chromic Films 3/2013 Derby



NBA Dose profile Flatness

JP GERARD 2013 Rad Oncol ; 106 supp 2 OC- 0479

CABINET HAUTIER
CONSEILS EN PROPRIÉTÉ INDUSTRIELLE
FONDÉ EN 1892

DEPOT D'UNE DEMANDE DE BREVET

PAYS : FRANCE

DONNEES DE DEPOT :
Numéro : FR.11/53529
Date de dépôt : 22.04.2011

DEPOSANT(S) : Centre Antoine Lacassagne
Gérard Jean-Pierre

INVENTEUR(S) :

TITRE DE L'INVENTION :
Dispositif muni d'un jeu d'applicateurs pour la radiothérapie de contact et système comprenant ledit dispositif

REFERENCE : NICE BREAST APPLICATOR - DOSSIER : B2262

N/Réf : B2262/PCT - RRI (JPD/VS)

OBJET : DEMANDE DE BREVET INTERNATIONALE PCT/EP2012/057317 DEPOSEE LE 20.04.2012
Réf : NICE BREAST APPLICATOR – Dossier B2262
RAPPORT DE RECHERCHE INTERNATIONALE et OPINION ECRITE

Cher Monsieur,

Nous venons de recevoir le rapport de recherche internationale sur la demande PCT ci-dessus référencée ainsi que la première opinion de l'examinateur international, dont nous vous remettons ci-joint une copie.

RAPPORT DE RECHERCHE INTERNATIONALE

Comme vous le remarquerez, ce rapport reprend les documents déjà cités dans le rapport de recherche de la demande de brevet français. Vous possédez déjà un exemplaire de chacun d'eux. Par conséquent, nous en conservons la copie dans nos dossiers.

OPINION ECRITE

Comme vous le remarquerez, l'opinion indique que les revendications répondent aux critères suivants :

REVENDICATIONS CONCERNEES	NOUVEAUTE	ACTIVITE INVENTIVE	POSSIBILITE D'APPLICATION INDUSTRIELLE
OUI	-	7, 9, 15-17	1 – 17
NON	1 - 17	-	-

OMBI – OFFICE MEDITERRANEEN DE BREVETS D'INVENTION ET DE MARQUES
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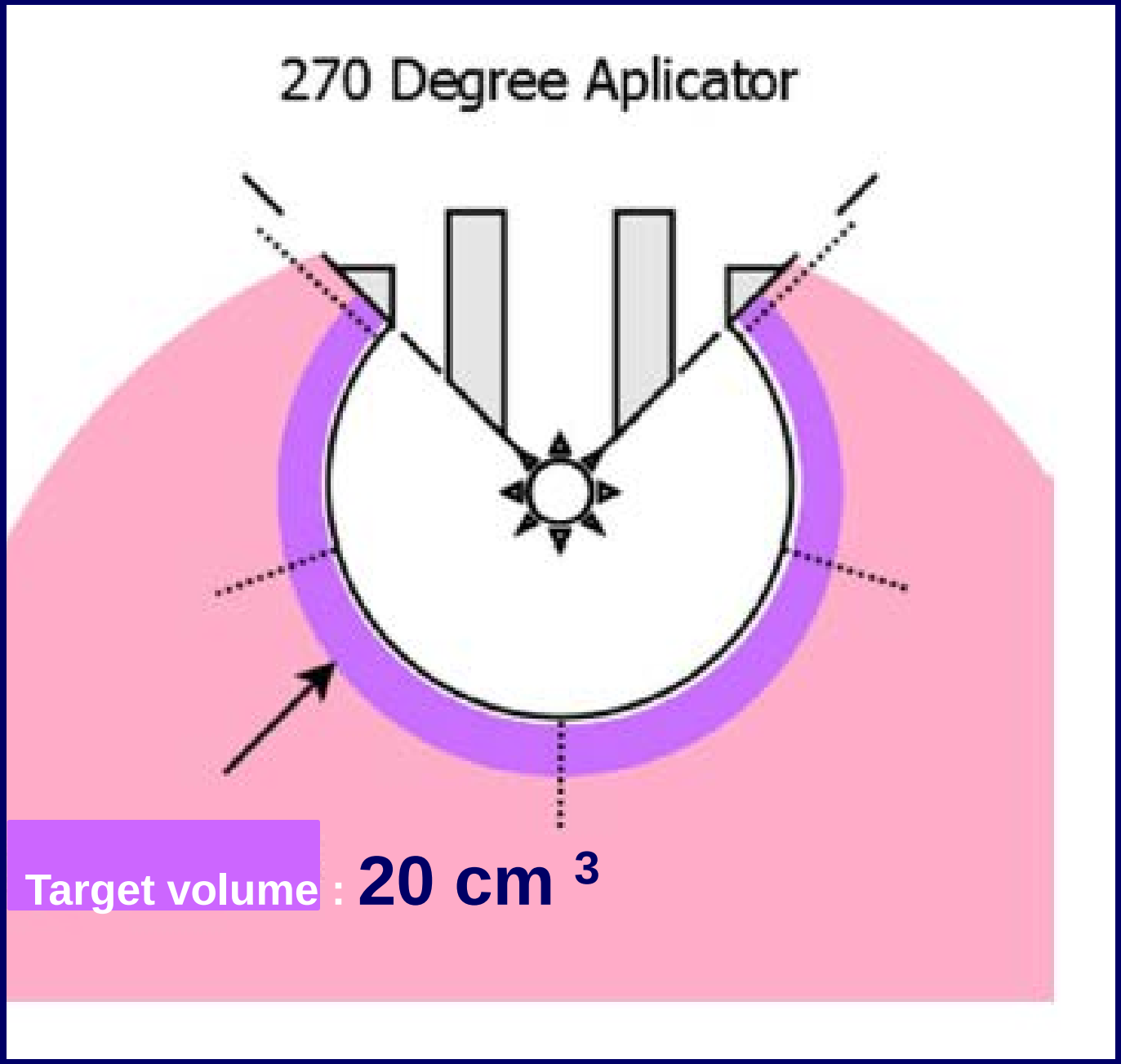
LES ALGORITHMES - BAT ARISTOTE A
2000, ROUTE DES LUCIOLES
06901 SOPHIA ANTIPOLIS CEDEX – FRANCE
TÉL. : +33 (0) 4 92 94 47 87

French patent
04.2011

European PCT patent
03.2013

NBA Patent



Isotropic beam

Appareil Papillon+™ : 12 - 2017

Breast IORT 2 mn → Cancer Rectum

2017 – 2018

New Papillon +

Amsterdam NKI
RMH
…

Amendment
OPERA

Papillon future developments

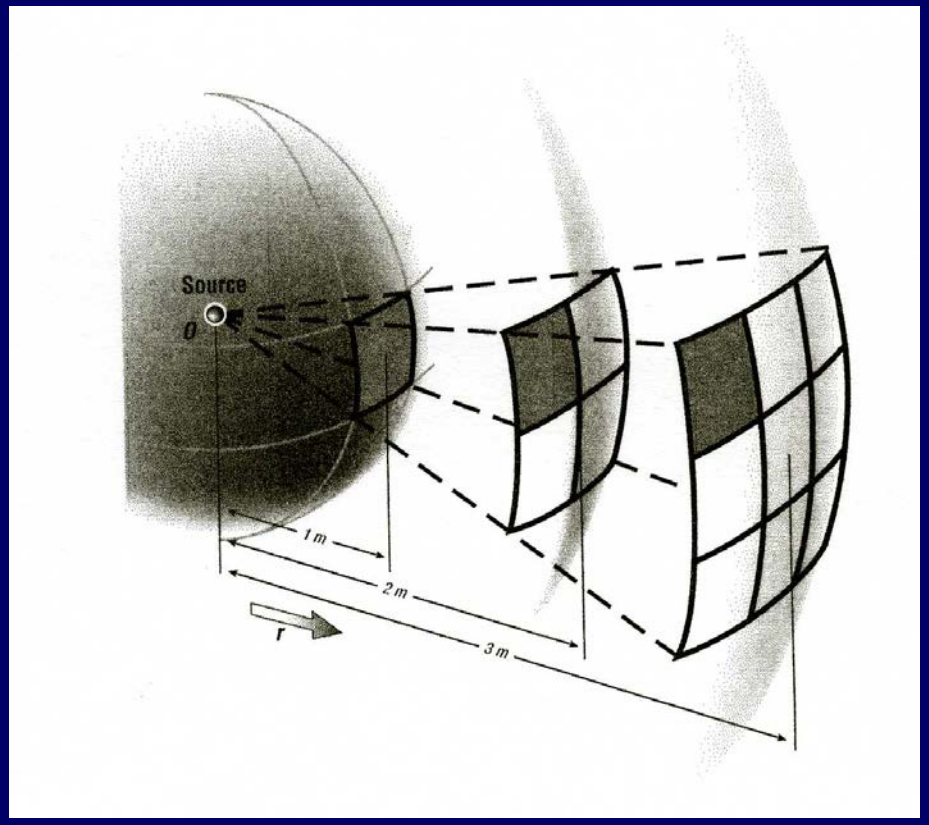
- Papillon + ^{tm} , rode (tube) ⌀ : 22 mm - 16 mm
- Beam distribution: isotropic (lateral beam)
- Intraluminal « stepping source »
- Larger T3 Tumor :

  > 5 cm long > ½ circumference
- Shielding (efficient) normal rectum : 50 kV: lead

2018 - 2019 ??

Inverse Square Law S : $4 \pi r^2$

ISOTROPIC RADIATION distribution : sphere



1 cm S : 1 Dose 10 Gy

2 cm S : 4 D 25% 2.5

3 cm S : 9 D 11% 1.1

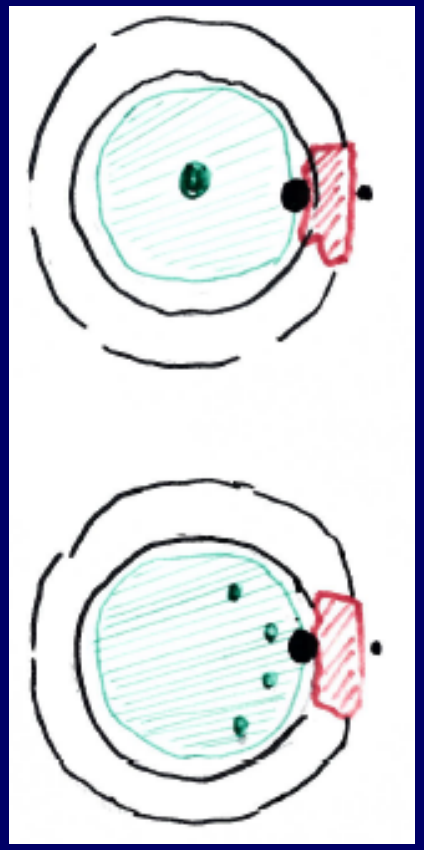
Point Source

When FSD is short :
0.5 to 6 cm (5 – 60 mm)

- Dose is inhomogeneous

- For penetration (% depth-Dose)
  Increased FSD (Focus- surface –Distance)
  is the most important

Veijle vs Novisad / Oncosmart Applicator : Iridium HDR



Veijle

HDR 300kV FSD : 10 mm

Novisad

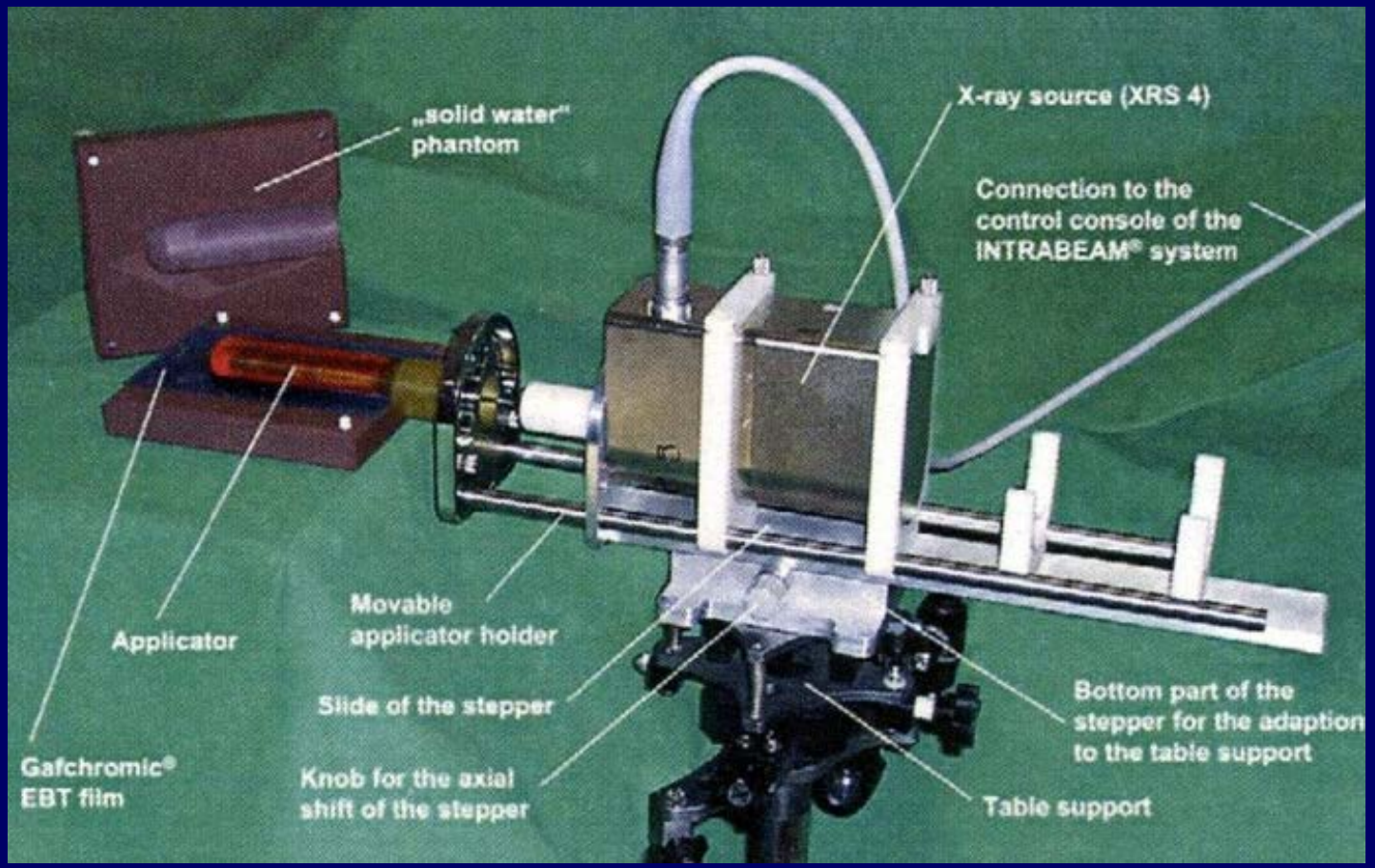
HDR 300 kV FSD : 4 mm

Novisad / Oncosmart (4mm) vs Veijle (10 mm)

FSD 4mm	r	r^2	dose	↗surface	dose↘	dose
	4	16	100			100
5mm	9	81		81/16 : 5	5	20
10mm	14	196		196/16 : 12	12	8

FSD 10mm						
	10	100	100			100
5 (15)	15	225		225/100 : 2.25	2.25	40
10 (20)	20	400		400/100 : 4	4	25

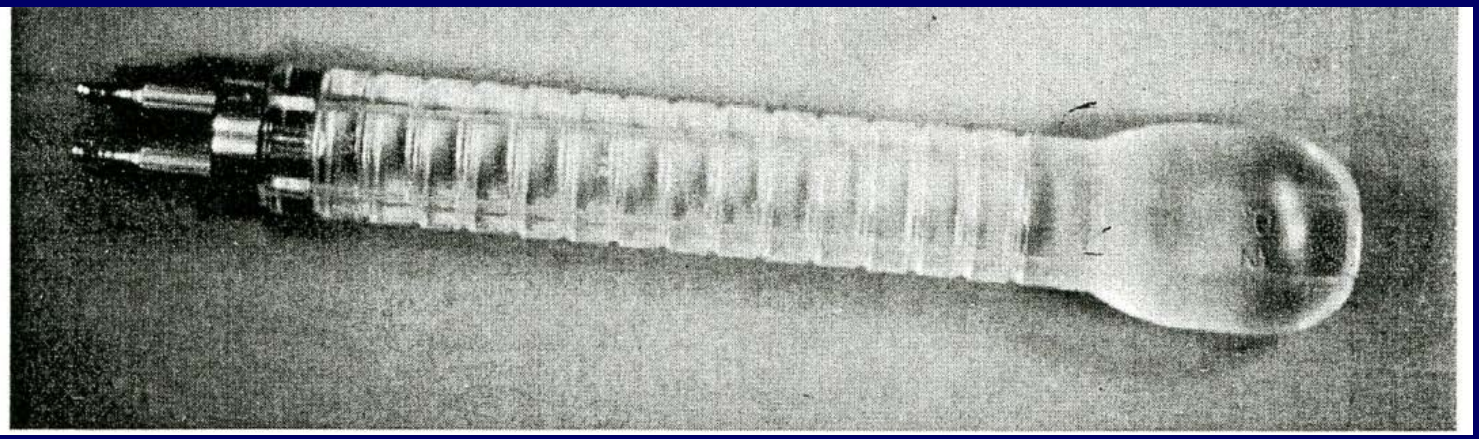
Brachytherapy : FSD Key parameter for Depth Dose



HDR
vaginal vault
Stepping source
X 50 kV

Schneider IJROBP 2009

Papillon +

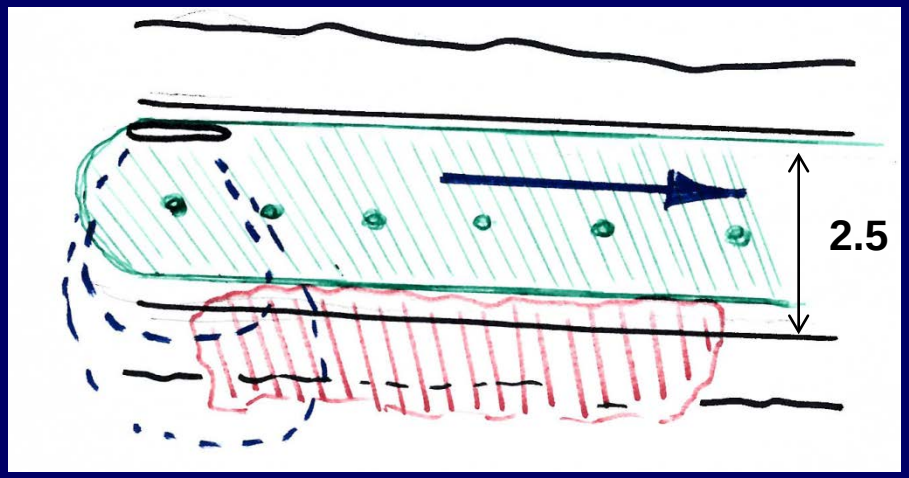


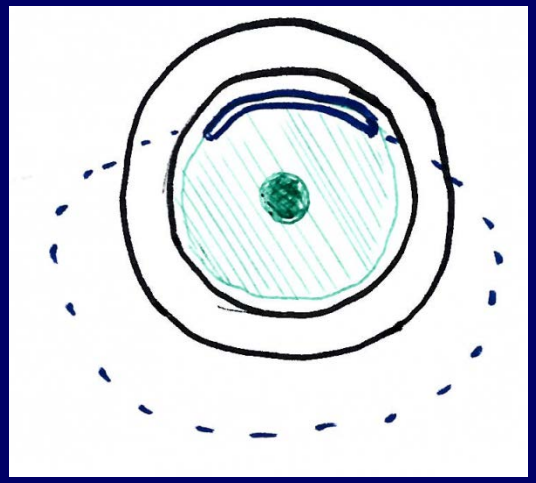
Rectal Applicator

2.5 cm ⌀

FSD : ≥ 1 cm

T3 b-c > 4 cm



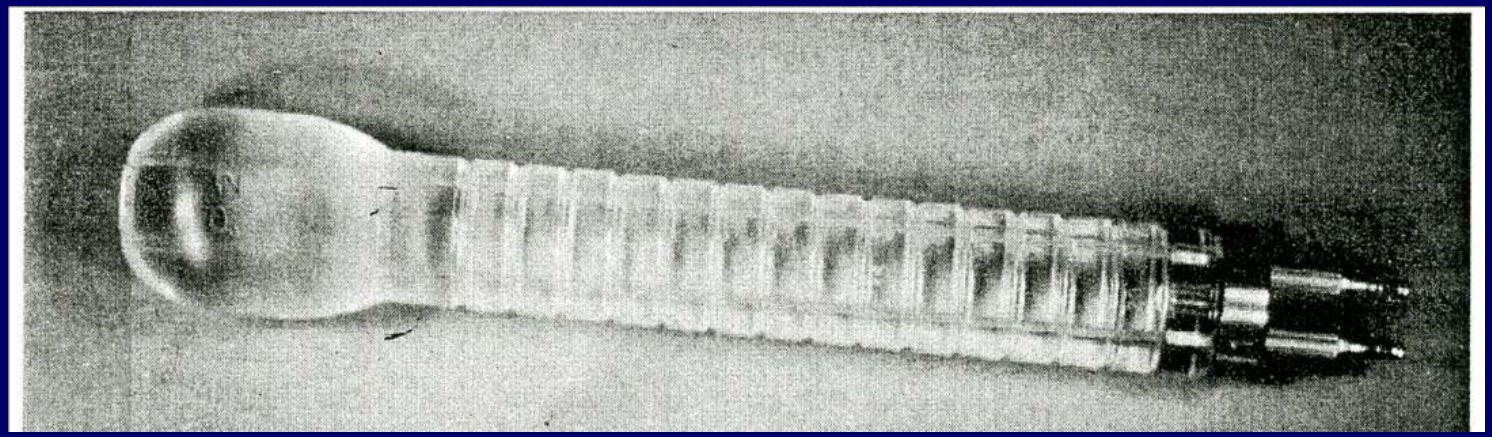


Papillon + 50 kV
Rectal Applicator

2.5 cm ⌀

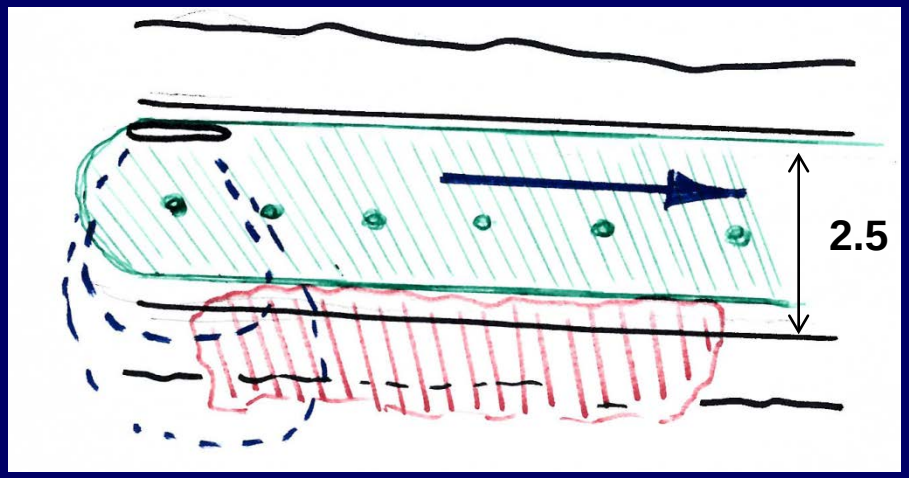
FSD : ≥ 1 cm

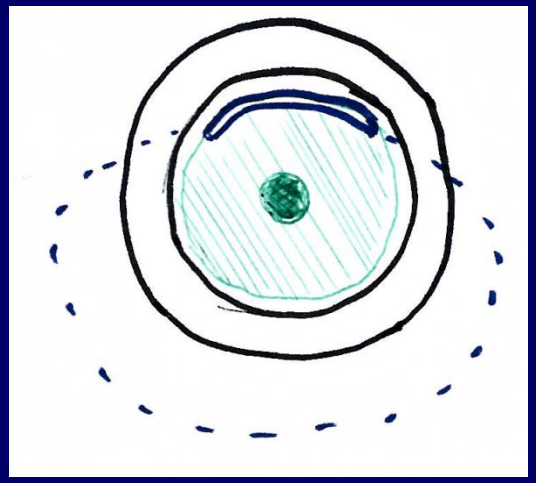
T3 b-c > 4 cm



Lateral beam
Lead shield
Stepping source

Montreal – Veijle - Leyden





Papillon + 50 kV
Rectal Applicator

2.5 cm ⌀

FSD : ≥ 1 cm

T3 b-c > 4 cm

Lateral beam
Lead shield
Stepping source

Take home message

- OPERA - Morpheus
- Radioprotection 50 kV > Iridium
- Efficacy : T targeting - High Dose

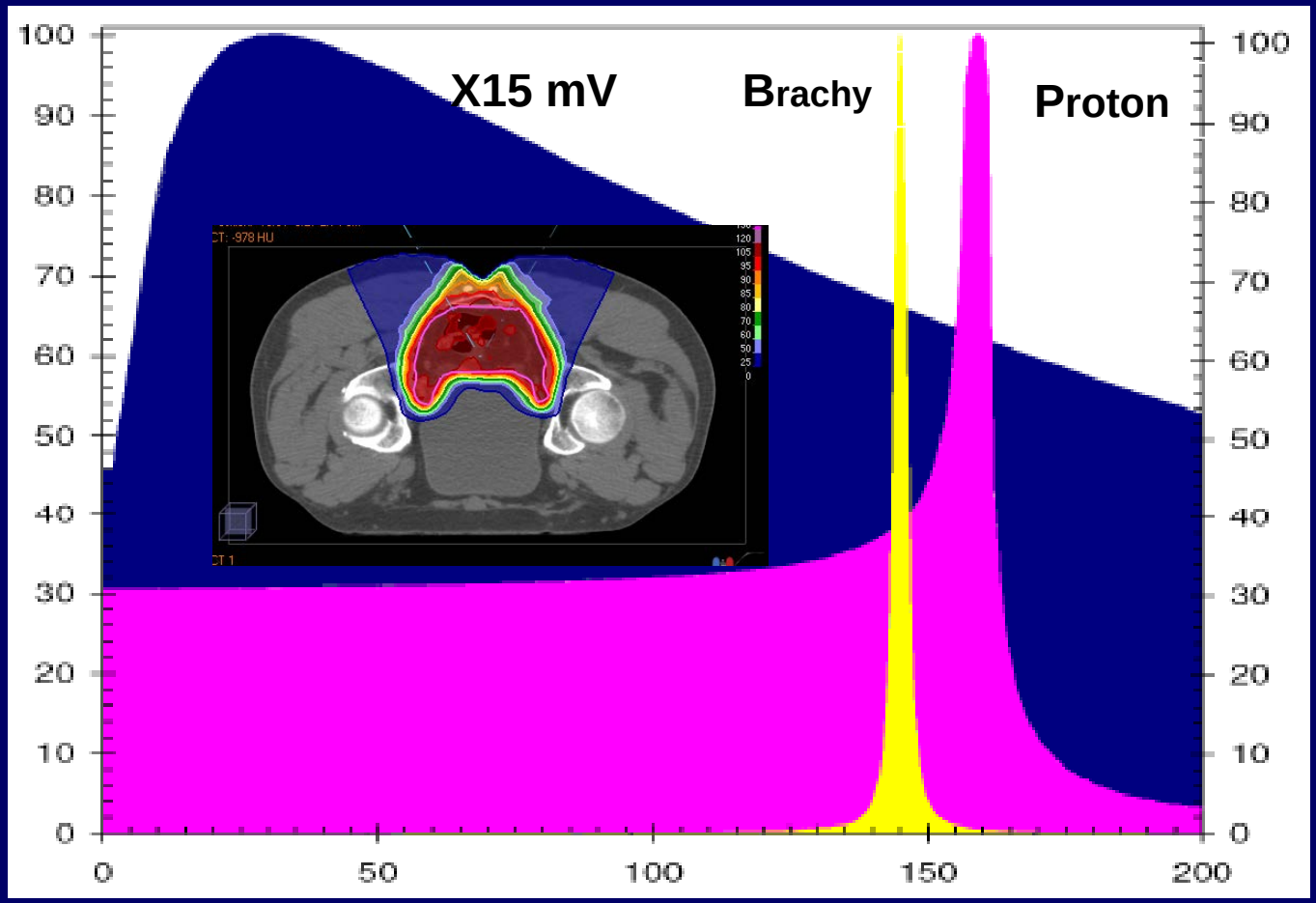
OAR protection

Therapeutic ratio

- Cooperation (cost/benefit ratio)

Rectal Cancer Radiotherapy 2024 !

Proton + Brachy




Paris - BATACLAN - Bruxelles -
NICE -Londres- Barcelone – New York
Not afraid !
MERCI

Step and shoot linear rectal treatment with Papillon X ray brachytherapy system.

Example

Step and shoot: 25 mm diameter applicator, 60mm beam length, 7 steps
HVL: 0.65 mm Al,
SSD: 11mm
Dose at 5mm tissue depth: 36%
Total radiation beam on time: 4 minutes.
Annular shielding: 0.25 mm Pb. over 120 degree segment reduces radiation to <1%

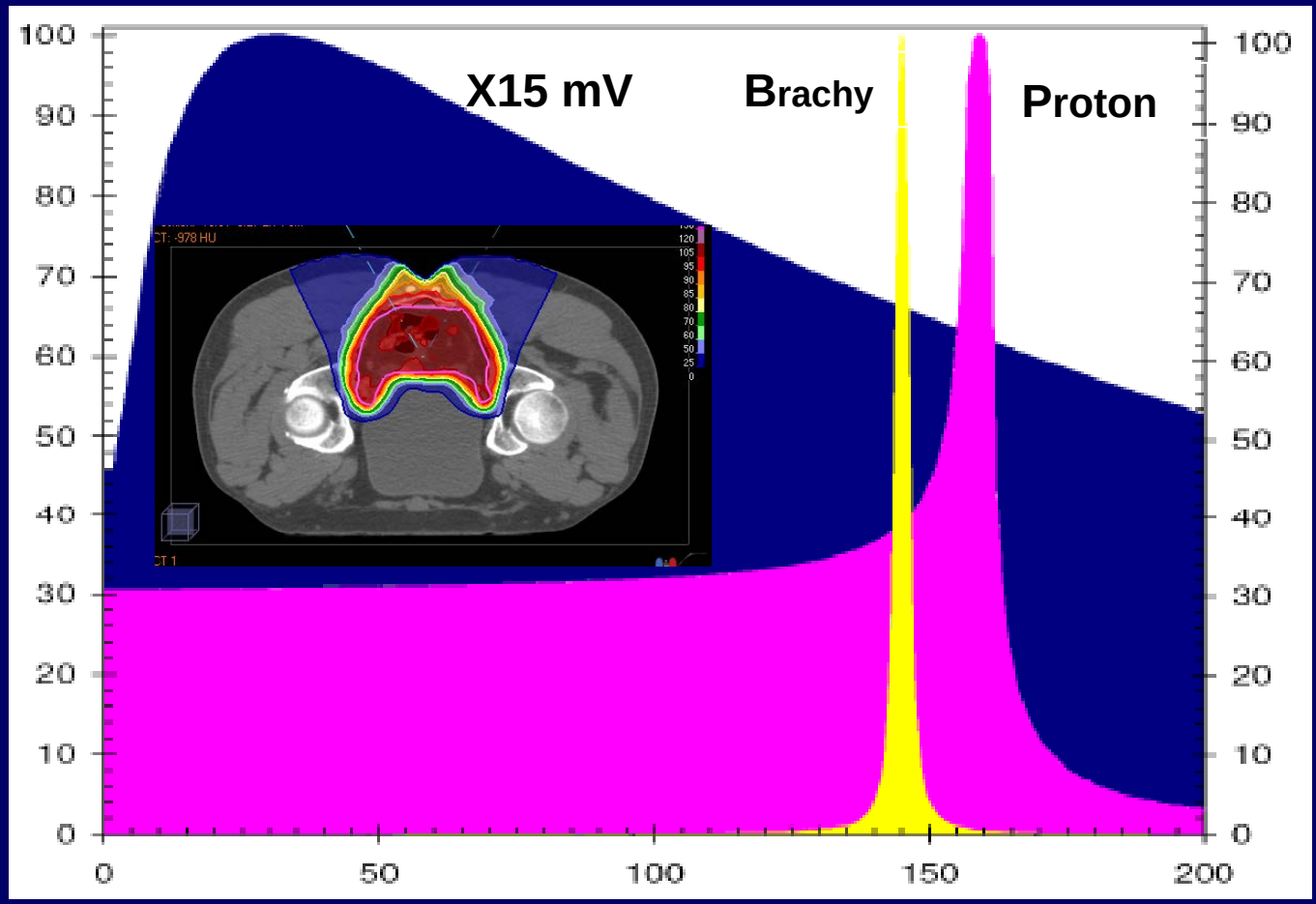
KAS 16-11-17

Past-Present- Future : dose 100% PTV – 0% OAR

2024 !

Rectum:

Proton + Brachy



Brachytherapy – particle therapy-Hadron

But …

EXPERT REVIEWS

Renaissance of contact x-ray therapy for treating rectal cancer

Expert Rev. Med. Devices 8(4), 483–492 (2011)

Jean-Pierre Gérard[†1],
Arthur Sun Myint[2],
Olivier Croce[3],
Jacob Lindegaard[4],
Anie Jensen[4],
Robert Myerson[5],
Jean-Michel Hannoun-Lévi[1]
and Serge Marcie[1]

Contact x-ray therapy (CXRT) with 50 kV has proven to be an efficient radiation therapy technique to achieve local control and rectal preservation for early rectal adenocarcinoma. Despite these results, CXRT has not been used due to the shortage of the no longer manufactured Philips RT 50™ unit. Recently, a new CXRT machine (Papillon 50™) became available on the market. This machine delivers a beam of 50 kV with a dose rate close to 15 Gy/min and has a percentage depth dose of 50% at 6–7 mm. The applicator size varies from 2–3 cm in diameter. Due to the original design of the main tube, treatment delivery is quick and more comfortable for the patients. An online viewing system incorporated in the tube allows a good visualization of the tumor with improved accuracy of radiation delivery. An international collaborative trial (Contact Endoscopic Microsurgery [CONTEM]) was set up to accrue approximately 300 cases

2001 Philips machine Stop

2009 : Papillon 50 ™

UK- French design

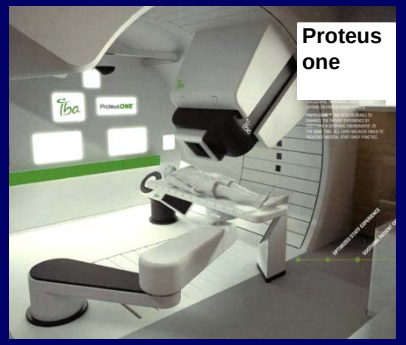
Exp Rev Med Dev
2010; 34: 231
JP Gerard & al

Rectum External Beam RT (EBRT) BOOST ??

EBRT : - stereotactic Body RT (SIB)

- cyberknife

- proton



***ACCORD 12 phase III* : 45 Gy vs 50 Gy ypCR : 13% - 19%**

***GRECCAR 12* « « : 50 Gy vs 60 Gy R0 : 83% - 88%**

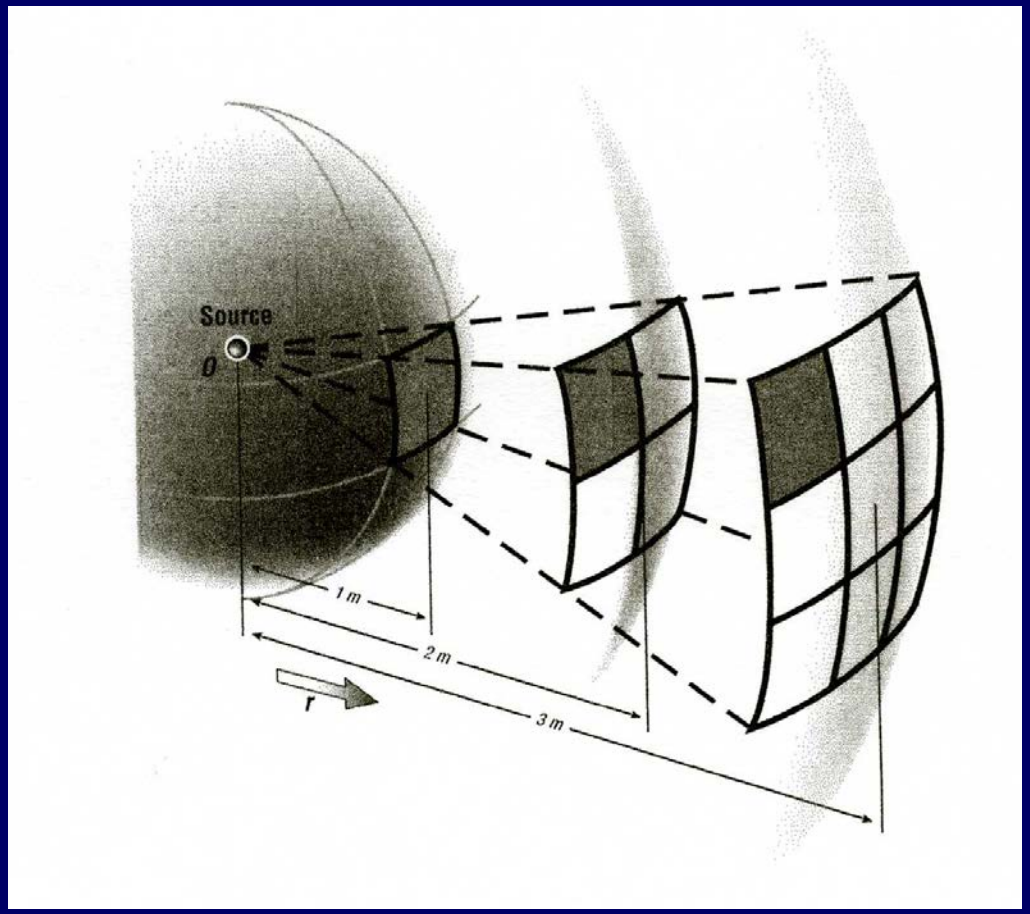
But …. Toxicity is the ultimate Limit

With EBRT impossible to increase Dose > 80 Gy

Gerard J Clin Onc 2012 - Rouanet D C R 2017

Inverse Square Law S : $4\pi r^2$

ISOTROPIC RADIATION source : sphere



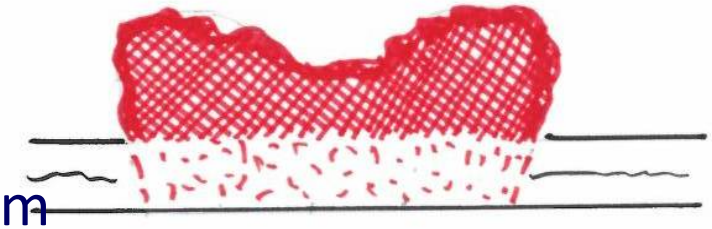
1 cm *S :1* **Dose 10 Gy**
2 cm *S :4* **25%: 2.5**
3 cm *S :9* **11%: 1.1**

10 cm *S :100*
1cm/10cm : *1% :*
1000 Gy : 10 GY

1mm : 15%

- *« Tumor destroyed layer by layer »*
  J Papillon

10 mm



5 mm

2,8 x 2,8 x 1,5 = 9,2 cm3

D 1

30 Gy

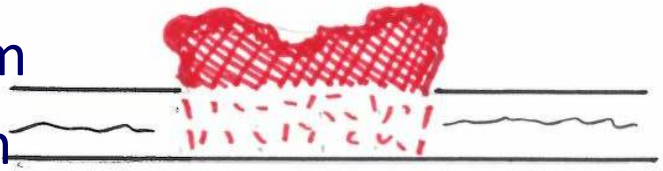
- **Contact X ray Brachy**

D1 – D 28 : 90 Gy / 3 Fr

Mean Dose:48Gy / 3 F

α/β : 10 (S Marcié)

7 mm



5 mm

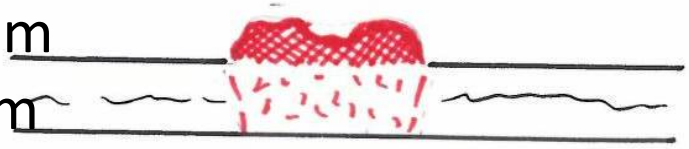
2.2X2.2X1.2 = 4.5 cm3

D 14

30 Gy

EQD2 = 98 Gy

4 mm



5mm

1.8X1.8X0.9 = 2.3 cm3

D 28

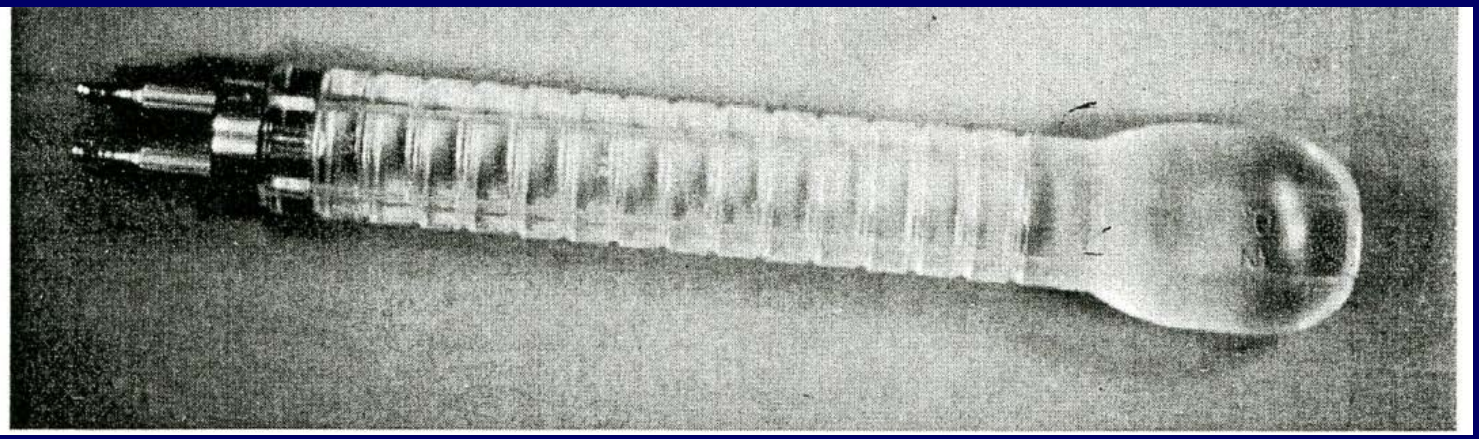
30 Gy

- *Appelt T 3cm ⌀ x2 thick 30 Gy*

α/β : 10 : EQD2 : ***33.9 Gy***

Papillon + 50 kV
Rectal Applicator
Lateral Beam
Stepping source

vs Iridium



Organ preservation

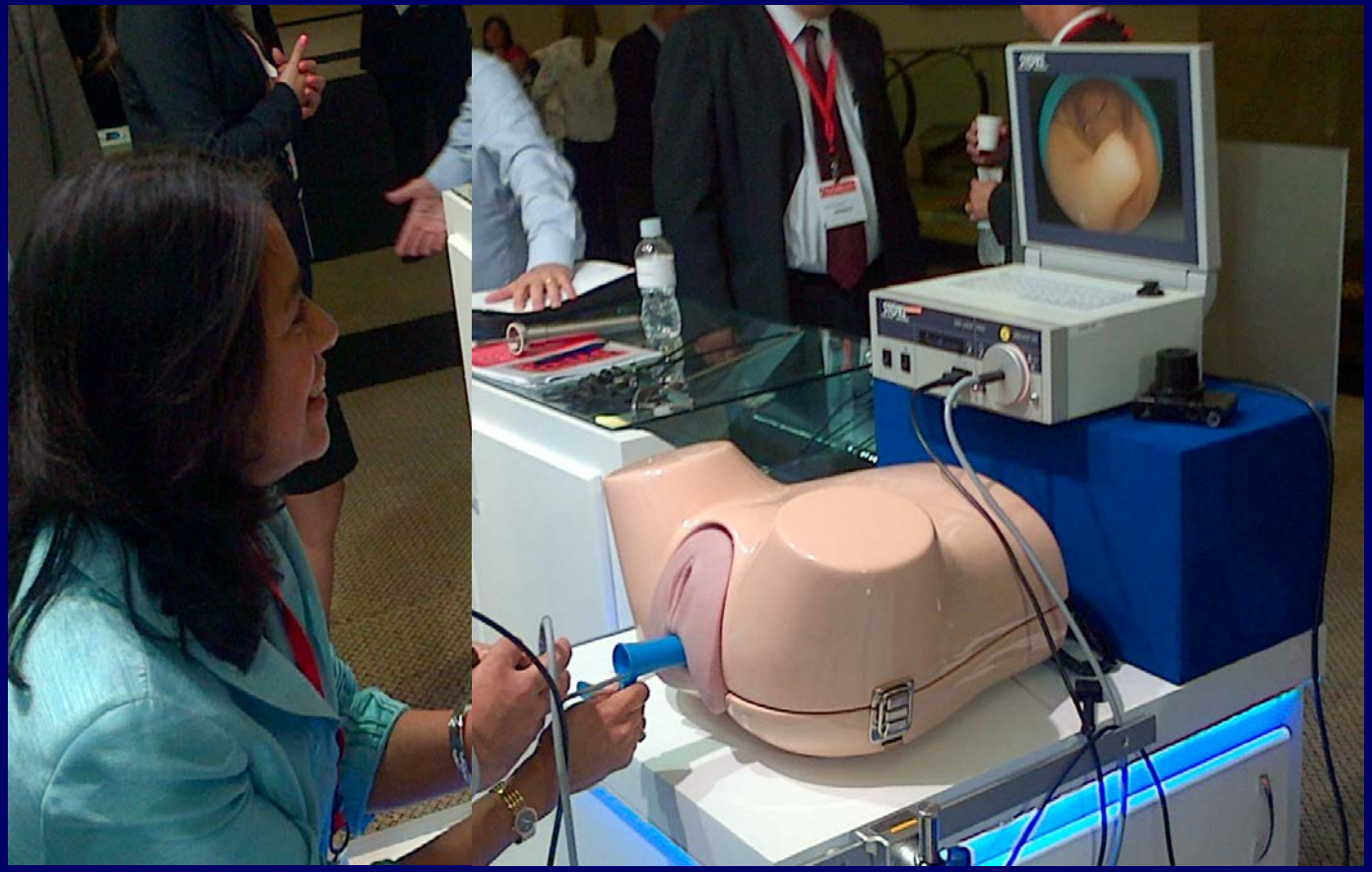
- Topic of interest ++ (LARS Syndrome)
- To « hope »for organ preservation: first Clinical CR
- CRT alone : Sao Paulo; NY; UK; NL; France

  IWWD : 1008 pts

  cCR : 20-50% Loc Rec : 25% [15-40%]
- ADK rectum : quite radioresistant tumor
- RT dose escalation (toxicity) : BOOST

Isotropic Dose Distribution- Sphere Surface : $4\pi r^2$

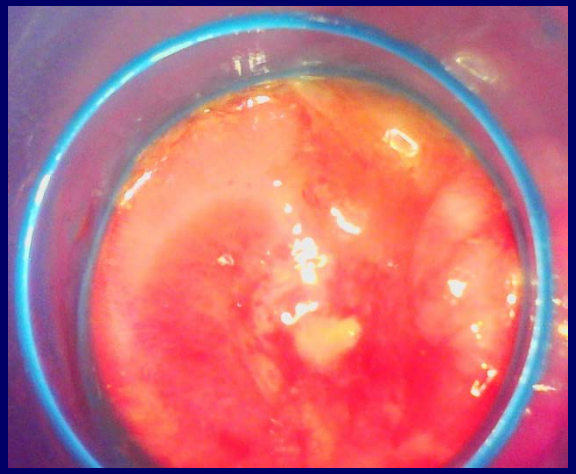
FSD 4mm	r	r^2	dose	↗surface	dose↘	dose
	4	16	100			100
5mm	9	81		81/16 : 5	5	20
10mm	14	196		196/16 : 12	12	8
FSD 40mm						
	40	1600	100			100
5 (45)	45	2025		2025/1600 : 1.2	1.2	83
10 (50)	50	2500		2500/1600 : 1.56	1.56	64



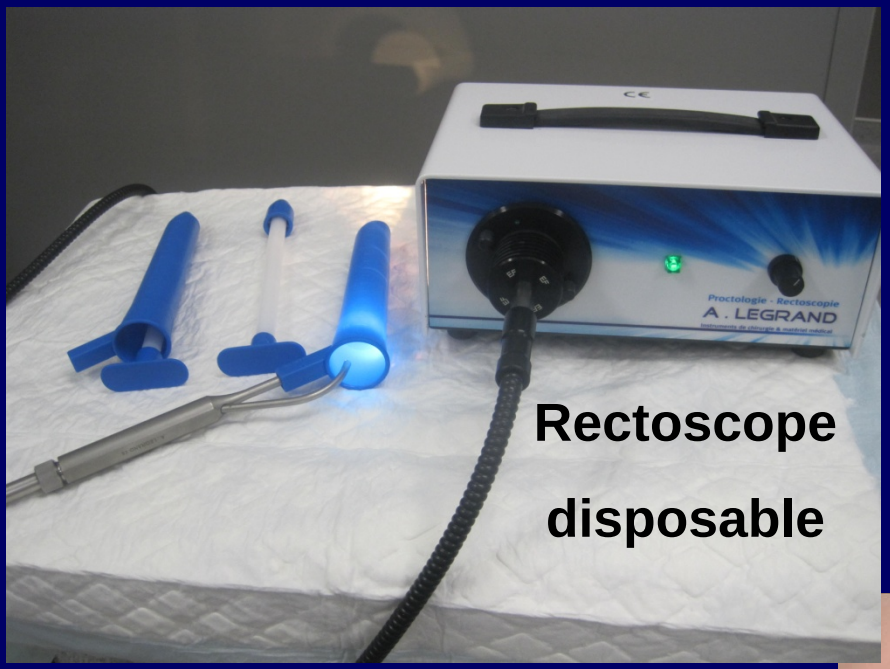
DRE + ED+NDOSCOPY :

Key examens

Rectoscope Legrand Paris

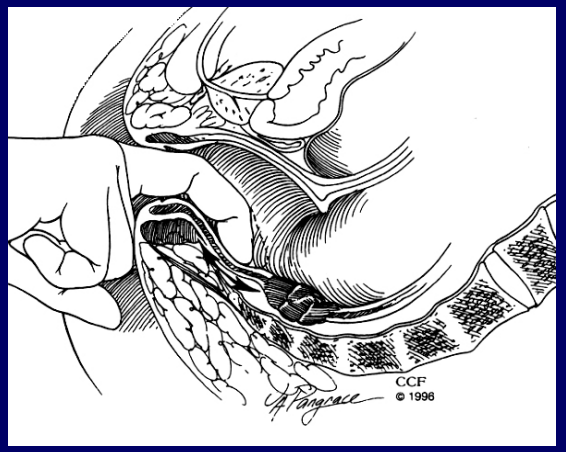


RECTOSCOPY + DRE in KNEE CHEST POSITION

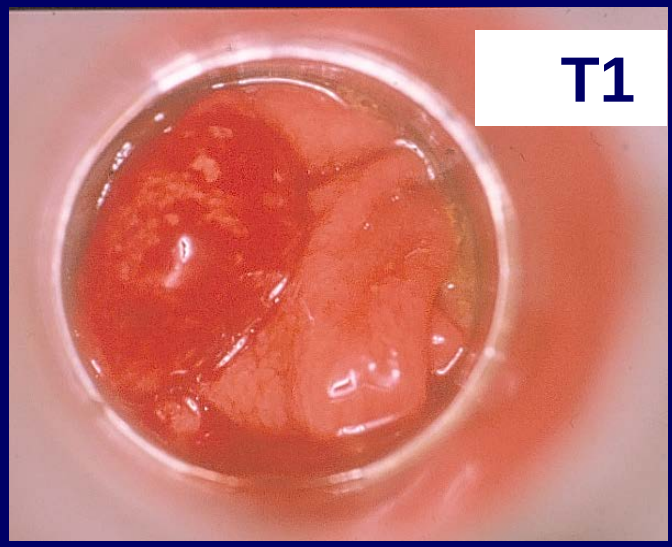


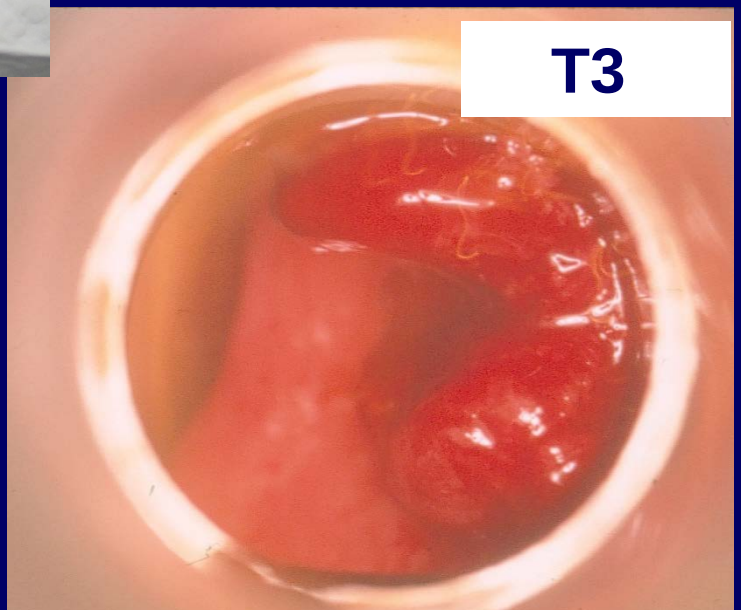
Rectoscope disposable

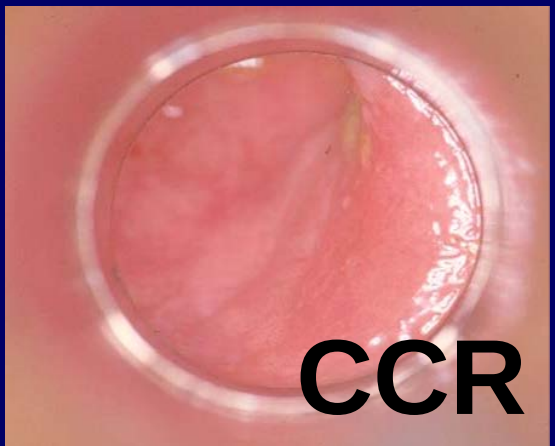
LEGRAND tm

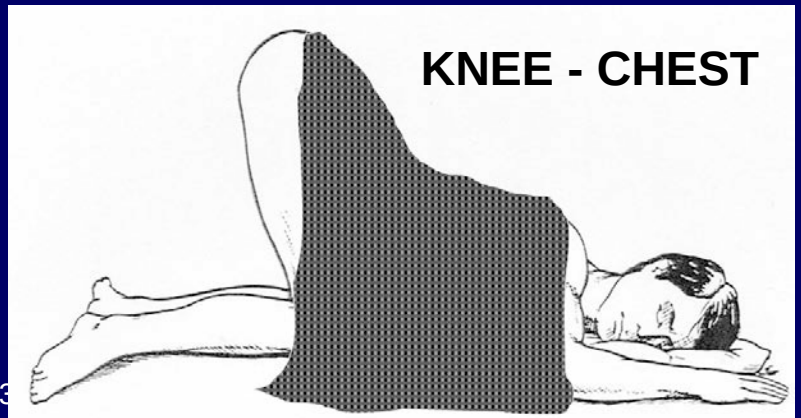


« BIOPROBE »

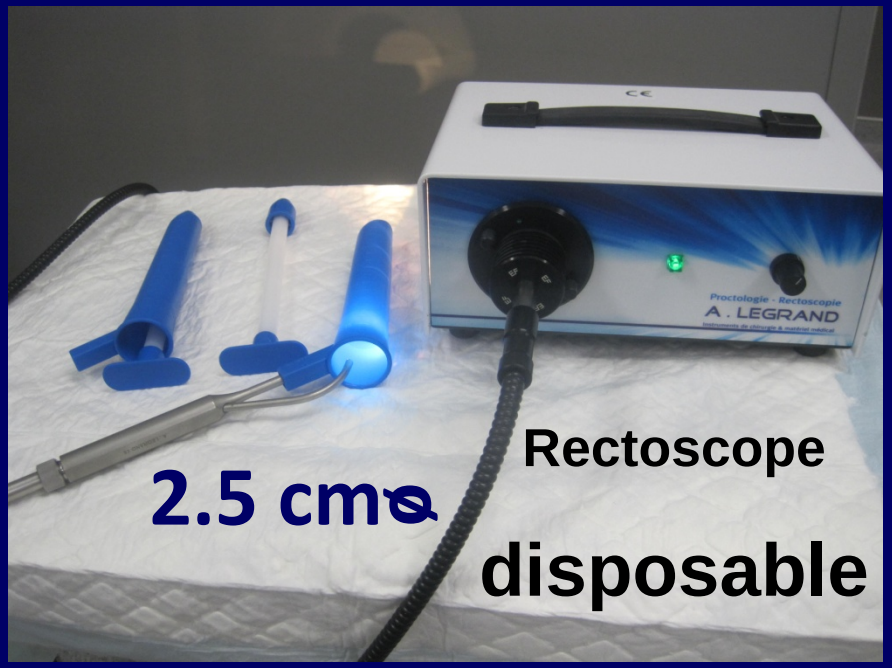


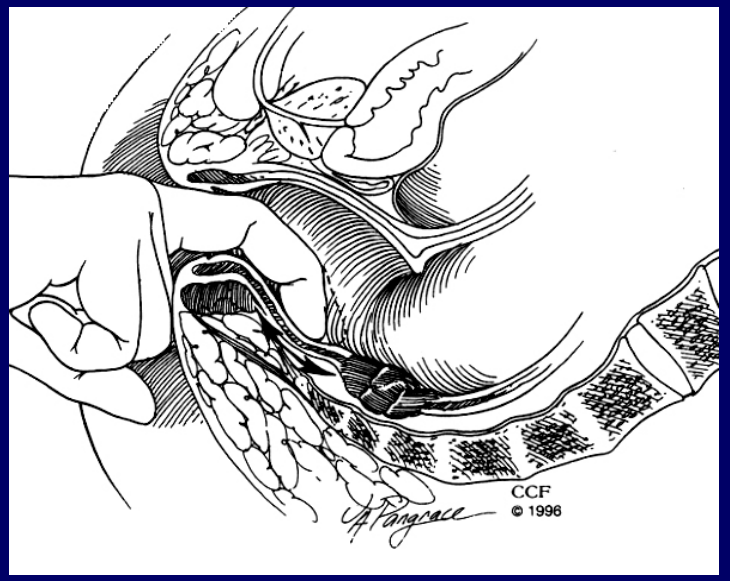






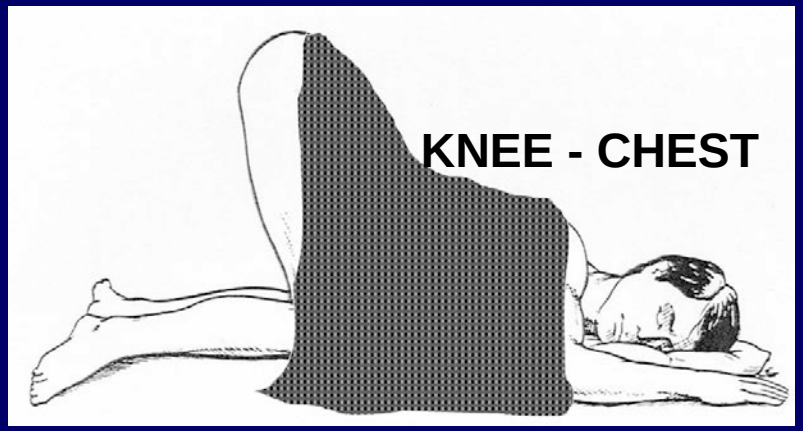
Wek 14 : RECTOSCOPY + DRE + MRI

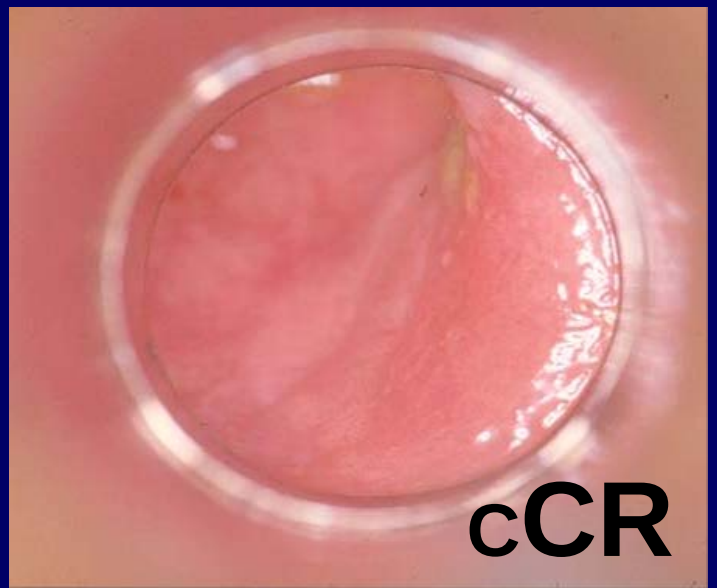




« BIOPROBE »

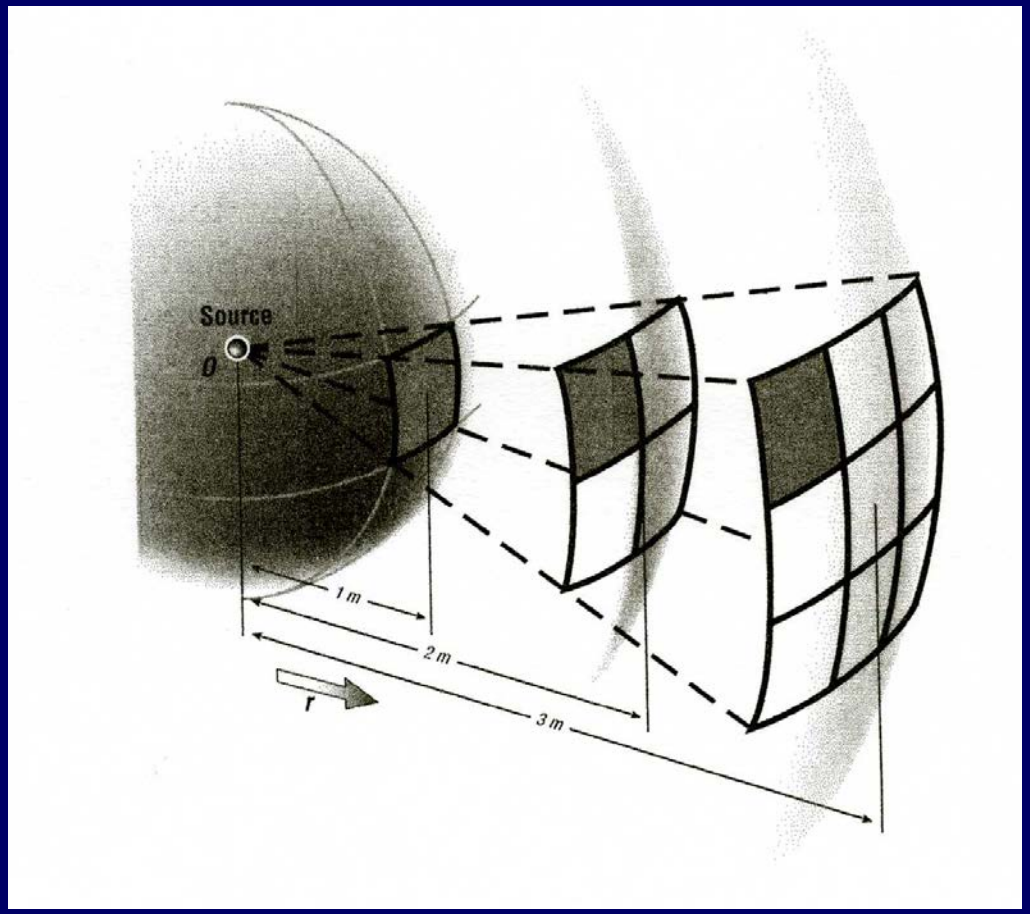
LEGRAND tm





Inverse Square Law S : $4\pi r^2$

ISOTROPIC RADIATION source : sphere



1 cm *S :1* **Dose 10 Gy**
2 cm *S :4* **25%: 2.5**
3 cm *S :9* **11%: 1.1**

10 cm *S :100*
1cm/10cm : *1% :*
1000 Gy : 10 GY

1mm : 15%