

Use of permanent seeds and HDR in prostate: Current practice and advances

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Content

- Prostate brachy LDR
- Prostate brachy HDR

⇒ Practical overview of this well established techniques, aspects well solved, cautions and required improvements.

LDR: SPOT y Oncentra Prostate Elekta, strands S06 Ibt-Bebig, SeedSelectron Elekta
HDR: SWIFT y Oncentra Prostate Elekta

Acknowledgments

- Francoise Lliso
- Vicente Carmona
- Jose Gimeno
- Mar Adria
- Nuria Carrasco

Prostate LDR

Sources

	$T_{1/2}$	E
I-125	60 d	27 keV
Pd-103	17 d	23 keV
Cs-131	9,7 d	29 keV

Initial dose rate ↓

DISCUSSION

Energy
Initial dose rate
\$\$\$
Effectivity

	Typical dose	Time 90% dose
I-125	145-160 Gy	197 d
Pd-103	125 Gy	56 d
Cs-131	100-125 Gy	32 d

Prostate LDR

Procedure

TRUS based INTRAOPERATIVE procedure

US 3D

Prostate LDR

Procedure

TRUS transversal or longitudinal ?

Prostate LDR Contouring

Interobserver

BASE

REFERENCE

Training & consensus

APEX

Prostate LDR Societal Recommendations

ESTRO-EAU-EORTC Salembier 2007 RO, AAPM TG-137 Nath 2009

145 Gy (I-125) 125 Gy (Pd-103)

GTV: Within isodose 150%

CTV (prostate+3mm excp rectum/bladder) : V100>95%, D90>100%, V150<50%

Rectum: D2cc<145 Gy, D0.1cc<200 Gy

Urethra: D10<150%, D30<130%

To be reported in postplan:

CTV-P y CTV-PM: D90, V100, V150

Recto: D2cc, D0.1cc, V100, V150

Urethra: D10, D0.1cc, D30, D5

Probe postplan?

Interactive planning or dynamic calculation RECOMMENDED

Function of the contoured urethra volume (typically 7-8 mm diameter along CTV)

Prostate LDR Societal Recommendations

ABS Davis Jan-Feb 2012 Brachyther.

Acceptable D90 130-180 Gy (I-125)

Ideal: Urethra V150<5% y V125<30% Rectum: V100<1cc

Typical activity 0.3-0.6 mCi

To be reported in postplan:

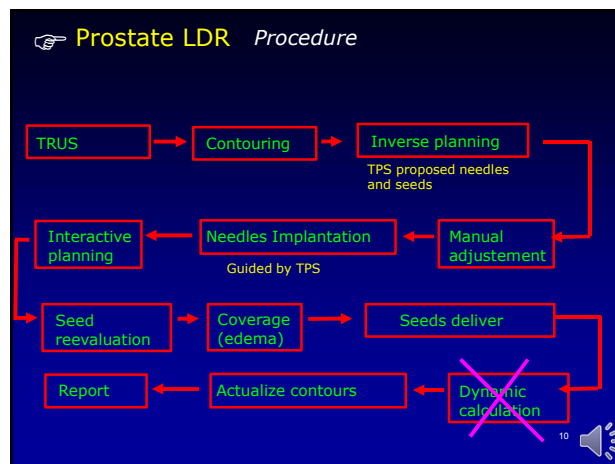
Prostate: D90, V100, V150

Rectum: V100 (cc)

Urethra: V150 (cc) V5 (%) V30 (%)

Probe postplan?

Function of the contoured urethra volume



Prostate LDR Inverse planning (pre-insertion)

Stranded

Loosed

Good prediction

Higher difficulty in strands when 160 Gy

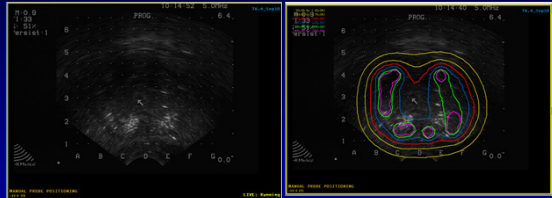
Prostate LDR Insertion guided, interactive planning

Base definition/ first seed center

Insertion guided, interactive planning

Prostate LDR

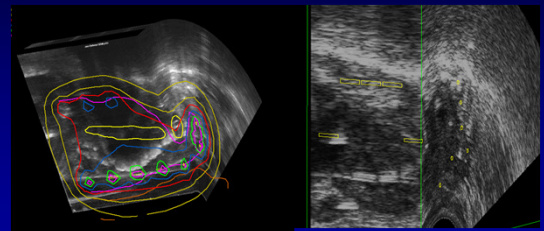
To check coverage because edema



Prostate LDR

Final evaluation

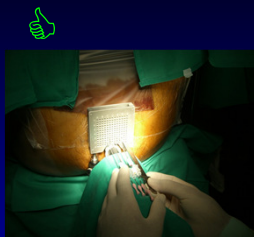
To consider deformation due insertion + edema



Problems in some TPS with the coordinate system
Deviations seeds vs needles

Prostate LDR

Delivering method



Manual

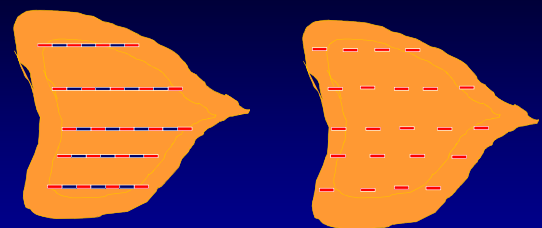


Afterloader

Skill
Procedure complexity

Prostate LDR

Seed configuration

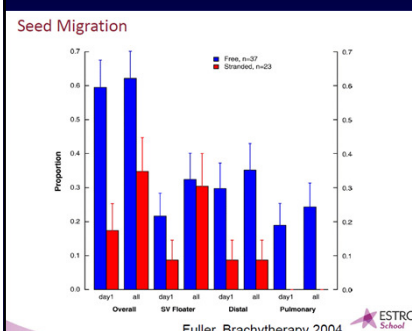


Stranded vs loosed

Prostate LDR

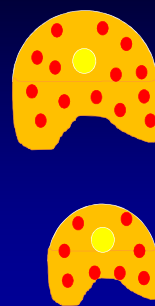
Seed configuration

Stranded vs loosed



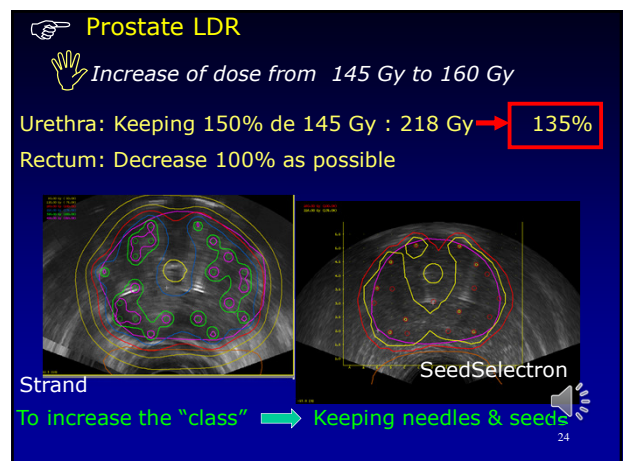
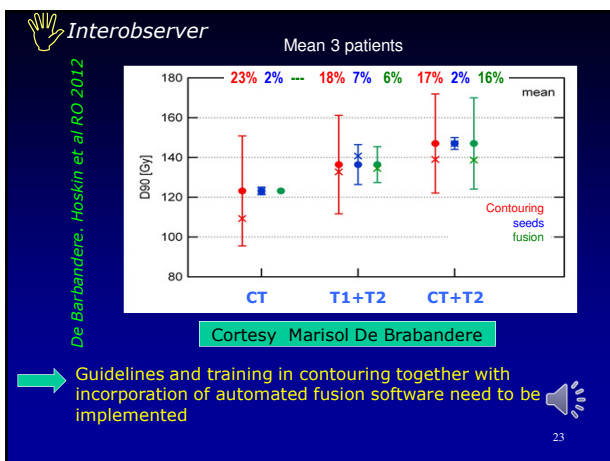
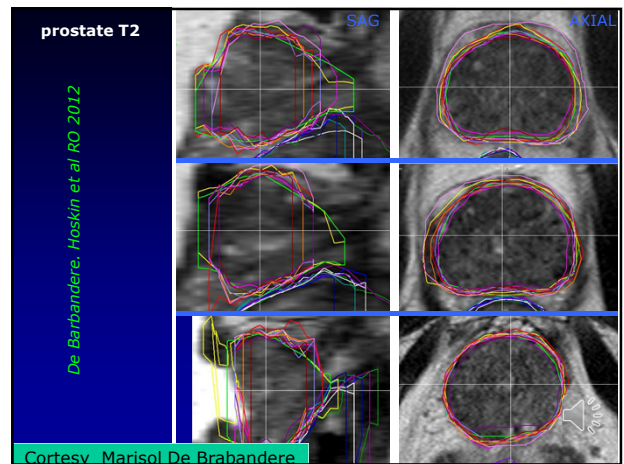
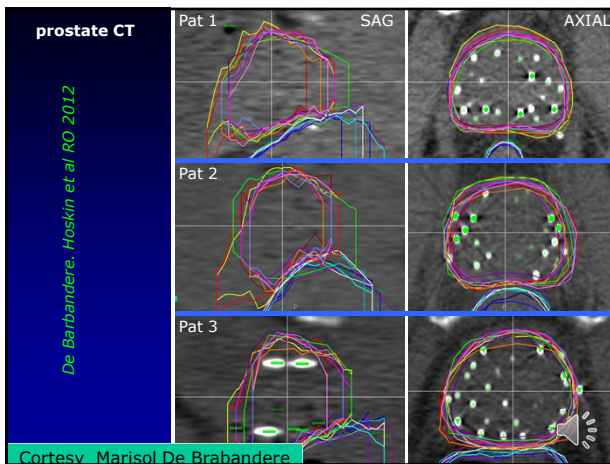
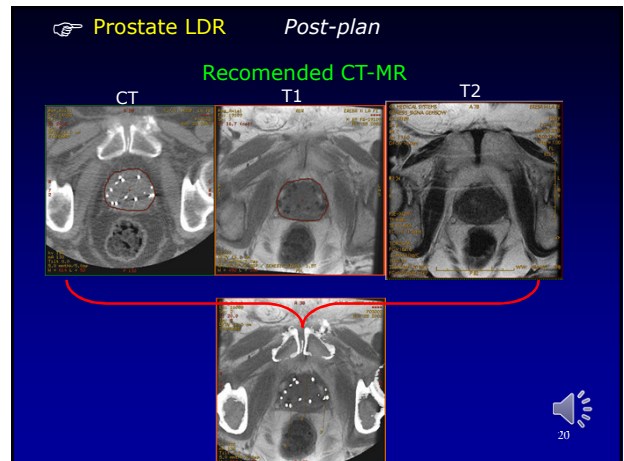
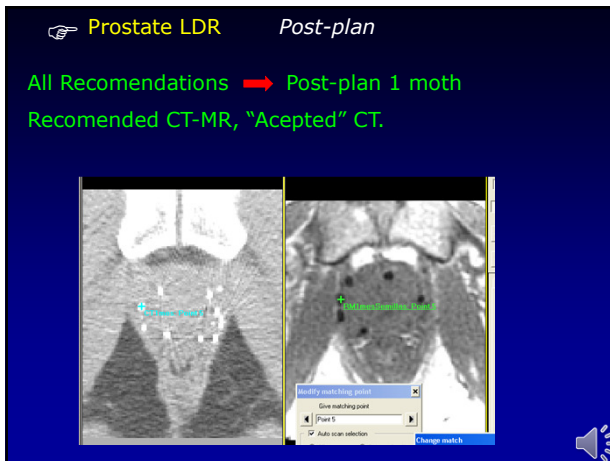
Prostate LDR

Seeds RAKR



Needles number & trauma
Accessibility in small prostates
Seeds protagonism
Hot spots volumes
.....

145 Gy	160 Gy
0,553 U	0,611 U
0,435 mCi	0,481 mCi



Prostate HDR

Radiotherapy and Oncology 107 (2013) 325–332 **2013**

Contents lists available at SciVerse ScienceDirect

Radiotherapy and Oncology

journal homepage: www.elsevier.com/locate/radonc

GEC/ESTRO recommendations

GEC/ESTRO recommendations on high dose rate afterloading brachytherapy for localised prostate cancer: An update

Peter J. Hoskin^{a,*}, Alessandro Colombo^{b,1}, Ann Henry^{c,1}, Peter Niehoff^{d,1}, Taran Paulsen Hellebust^{e,1}, Frank-Andre Siebert^{f,1}, Gyorgy Kovacs^{g,1}

2012

ELSEVIER

Brachytherapy 11 (2012) 20–32

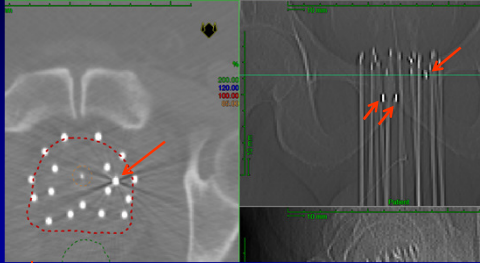
American Brachytherapy Society consensus guidelines for high-dose-rate prostate brachytherapy

Yoshiya Yamada^{1,*}, Leland Rogers², D. Jeffrey Demanes³, Gerard Morton⁴, Bradley R. Prestidge⁵, Jean Pouliot⁶, Gil'ad N. Cohen⁷, Marco Zaider⁷, Mihai Ghilezan⁸, I-Chow Hsu⁹

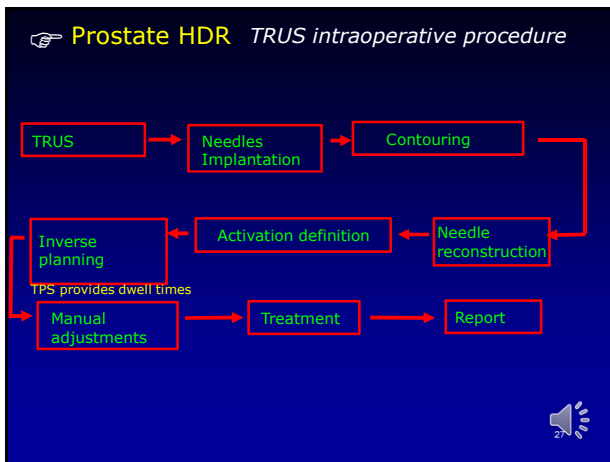
Prostate HDR Imaging

Recommended TRUS intraoperative

Some Hospitals: CT unique or in a 2nd fx



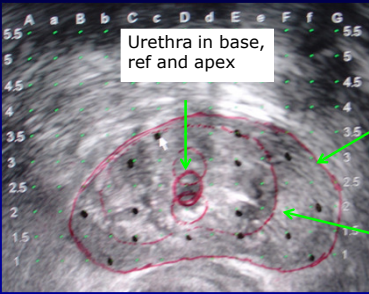
Convenient the use of gold markers to adjust needles in the 2nd fx due to edema (using SV)



Prostate HDR Needles positions

Insertion according experience

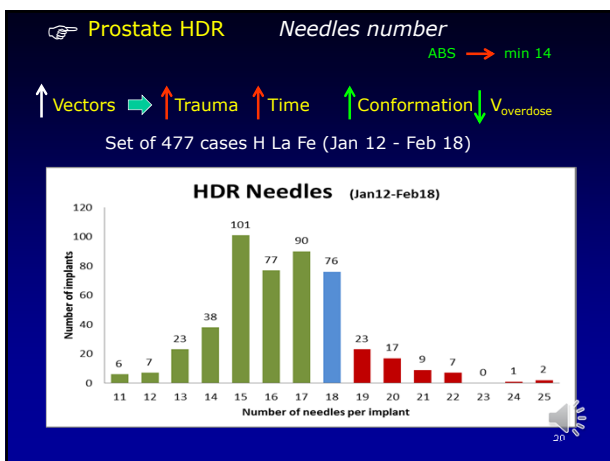
Less practical IP in virtual
Higher optimization degree than seeds
Avoid recontouring



Urethra in base, ref and apex

Reference plane

Apex plane



Prostate HDR Needles

Plastic vs Metallic

GEC/ESTRO ABS → Both

	Image quality	Bladder impact	Guide	Reconstruction	\$
Plastic	👍	👍			
Metallic			👍	👍	👍

Prostate HDR Contouring

GEC/ESTRO → CTV 3 mm margin added to prostate, with exception rectum and bladder

Urethra diameter is 8 mm ?

Prostate HDR Needles reconstruction

Use free length

$d_{\text{swit}} = 200 - d_{\text{medida}}$
 $\text{free length} = d_{\text{medida}} - 10 \text{ mm}$

Para agujas metálicas de 200 mm

B	Column	Row	Index	Depth (mm)	Free Len (mm)	Free Len (mm)	Offset (mm)	16-18 SOP (mm)	Activation	Dwell Time
L1	c	4	1408.00	9.93	55.00	Unlocked	-0.06	10.00	Unlocked	Unlocked
L2	E	4	1408.00	9.96	55.00	Unlocked	-0.12	10.00	Unlocked	Unlocked
L3	b	3.5	1408.00	9.96	55.00	Unlocked	-0.14	10.00	Unlocked	Unlocked
L4	F	3.5	1408.00	9.95	55.00	Unlocked	-0.15	10.00	Unlocked	Unlocked
L5	C	2	1408.00	9.93	55.00	Unlocked	-0.07	10.00	Unlocked	Unlocked
L6	e	3	1408.00	9.95	55.00	Unlocked	-0.10	10.00	Unlocked	Unlocked
L7	B	2.5	1408.00	9.93	55.00	Unlocked	-0.07	10.00	Unlocked	Unlocked
L8	f	2.5	1408.00	9.95	55.00	Unlocked	-0.11	10.00	Unlocked	Unlocked
L9	C	2	1408.00	9.91	55.00	Unlocked	-0.08	10.00	Unlocked	Unlocked
L10	D	2	1408.00	9.96	55.00	Unlocked	-0.13	10.00	Unlocked	Unlocked

Prostate HDR Activation

La Fe: 1 mm outside CTV

Prostate HDR Optimization

Inverse (HIPO) + manual

La Fe: A anterior "valley" is allowed, the 120% should be out from urethra. Manual adjustment for lobes, grand posterior volume and rectum (85%)

Prostate HDR Recommendations

GEC/ESTRO 2005
 Uretra < 120%

ABS 2012
 Adopt Rec CTV from GEC/ESTRO 2013. No OAR

CTV | $D_{90} \geq 100\%$
 $V_{100} \geq 95\%$

GEC/ESTRO 2013 Rectum | $D_{2cc} \leq 75 \text{ Gy EQD}_2$

Urethra | $D_{0.1cc} \leq 120 \text{ Gy EQD}_2$
 $D_{10} \leq 120 \text{ Gy EQD}_2$
 $D_{30} \leq 105 \text{ Gy EQD}_2$

EBRT + BT

Prostate HDR Recommendations

Aplicacion GEC/ESTRO 2013 H La Fe

RECOMENDACION ESTRO	ESCENARIO A 46 EXT + 2 HDR 9.5		ESCENARIO B 46 EXT + 1 HDR 15		ESCENARIO C 60 EXT + 1 HDR 9.5	
	d	%	d	%	d	%
Recto	D2ccc=75 Gy	7.15 75%	10.63 71%	7.29 77%		
Urethra	D0.1cc<=120 Gy	12.18 128%	17.79 119%	15.89 167%		
	D10<=120 Gy	12.18 128%	17.79 119%	15.89 167%		
	D30<=105 Gy	10.74 113%	15.74 105%	13.57 143%		

Results H La Fe 10 last pts 15 Gy

	Urethra		Recto	
	D10	D0.1cc	D2cc	D0.1cc
Mínimo	106%	107%	53%	74%
Máximo	112%	114%	68%	83%
Promedio	110%	111%	61%	79%

Prostate HDR Interobserver

**D2cc rectum
5 ORT after consensus**

Interobserver variability in rectum contouring in high-dose-rate brachytherapy for prostate cancer: A multi-institutional prospective analysis

Rodrigo Chiriac-Sot ^{1,2,3,4}, Francisco Celada-Alvarez ¹, Susana Rodal ¹, Silvia Rodriguez-Villalpando ¹, Miguel Santos-Olivero ¹, Pablo Soto-Castillo ¹, Blanca Bernal-Benito ¹, Leoncio Arribas ¹, Alejandro Torres ¹, Jose M. Benito ¹, Jose Perez-Catalan ¹

Patients	Range (Gy)	Dose difference (Gy)
1	67.9–70.1	2.2
2	66.0–72.0	6.1
3	67.7–76.0	8.3
4	70.6–78.7	8.1
5	72.1–80.7	8.6
6	70.4–79.2	8.5
7	63.3–66.2	2.9
8	61.7–65.8	4.1
9	70.7–77.4	6.6
10	67.1–77.8	10.7

EQD₂ = biologically equivalent dose; D_{0.05} = the minimum dose received by the most exposed 2.0 cm³ volume of the rectum. Values are based on 15-Gy high-dose-rate brachytherapy planning plus 46-Gy external beam radiotherapy.

Prostate Advances and research

AAPM and ESTRO Guidelines for Image-Guided Robotic Brachytherapy: Report of Task Group 192

AAPM-ESTRO TG-192
In progress

Table 1: Summary of the currently available robotic brachytherapy systems..... 12

- (i) **Elekta-Nucletron FIRST** (Oncentra - Integrated Prostate Solution) system 14
- (ii) **EUCLIDIAN** (TJU) – an ultrasound image-guided prostate brachytherapy system 14
- (iii) **MIRAB** (TJU) – an ultrasound image-guided prostate brachytherapy system 15
- (iv) **UMCU robot** – an **MR** guided prostate brachytherapy system 16
- (v) **JHU robot** – an ultrasound image-guided prostate brachytherapy system 16
- (vi) **JHU robot1** – an ultrasound image-guided prostate brachytherapy system 17
- (vii) **JHU MrBot** – an **MR** guided prostate brachytherapy system 17
- (viii) **JHU robot3** – an **MR** guided prostate brachytherapy system 18
- (ix) **JHU & BWH** – an **MR** guided prostate brachytherapy system 18
- (x) **UBC robot** – an ultrasound image-guided prostate brachytherapy system 19
- (xi) **RRI robot** – an ultrasound image-guided prostate brachytherapy system 19
- (xii) **CHUG robot** – an ultrasound image-guided prostate brachytherapy system 20
- (xiii) **MIRA robot** – an ultrasound image-guided lung brachytherapy system 20

Prostate Advances and research

EUCLIDEAN Robot

AAPM-ESTRO TG-192
In progress

Figure 11: JHU robot4 – MRI-guided prostate brachytherapy system.

R. Mansard (UMC Utrecht)
Comprehensive Brachytherapy Book 2013

Interstitial Rotating Shield BT: ¹⁵³Gd

Adams et al, Med Phys 41, 051703 (2014)

CORTESIA M. RIVARD

Hybrid Imaging: Example of mP-MR und 3D-U/S (Biology + Morphology)

CORTESIA D. BALTAS

Interventional Radiation Oncology Systems (CIROS)

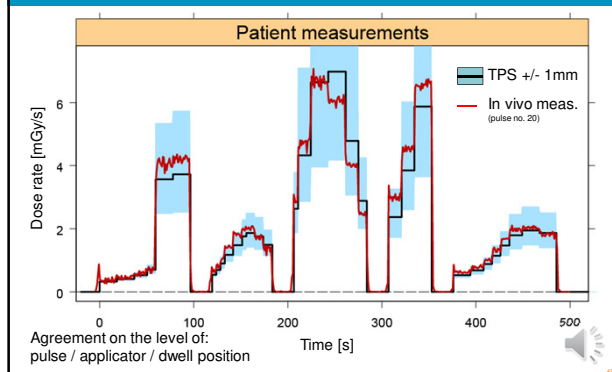
Tracking

Implant Verification by Electro-Magnetic Tracking

ELEKTA

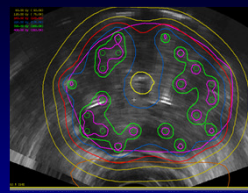
Time-resolved dose verification

Courtesy Kari Tanderup



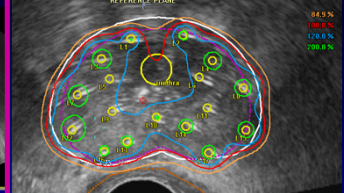
Prostate

LDR vs HDR



Permanent I-125

145 Gy
0
160 Gy



HDR Ir-192 or Co-60

13,5 Gy /app
2 app 2 week interval



Decrease of LDR against HDR



Dosimetry (optimization)
Migration, local & distance
Dose variation due edema
Uncertainties (deliver, calcifications, ...)
Radiation protection after implant
Handling seeds
Procedure duration
\$



Conclusions

- IOP TRUS based LDR/HDR **BT prostate** procedure **well established**.
- Major current issue that require efforts: **contouring interobserver**.
- Important advances: **multimodal images, tracking and in vivo dosimetry**.
- Trend** towards **HDR**.



Thank you



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