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# High Dose Rate (HDR) Prostate Brachytherapy

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# No Disclosures

# Brachytherapy



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- Brachytherapy (from the Greek word βραχύς *brachys*, meaning "short-distance") – wikipedia
- Radioactive materials are placed inside or near a tumor or region at risk



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# Prostate Brachytherapy at Loyola

# Background



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- Active Prostate LDR seed program since early 2000's
  - ~25-30 patients per year
- Planned to develop Prostate HDR program in mid-2015
- Brachytherapy team members visited high-volume centers including **American Brachytherapy Society fellowship**
- Adopted a CT-based planning approach

# HDR Brachytherapy at LUMC



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- First patient treated in 9/2015
- CT-based planning initially
- Added MRI to planning for better prostate identification in 2017
- HDR Alone: 2 implants 1-2 weeks apart
  - Low Risk
  - Intermediate Risk
  - Prior Radiation to the prostate with recurrence in the prostate
- HDR Boost: 1 implant, 1-4 weeks before OR after external beam radiation
  - Intermediate risk with disease extending outside of the prostate
  - High Risk

# HDR Brachytherapy at LUMC

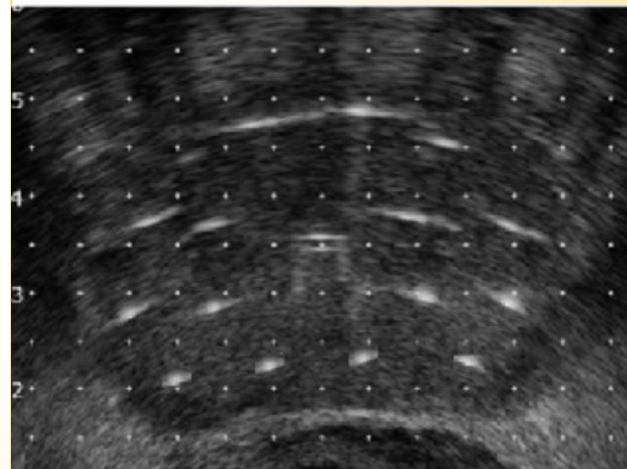
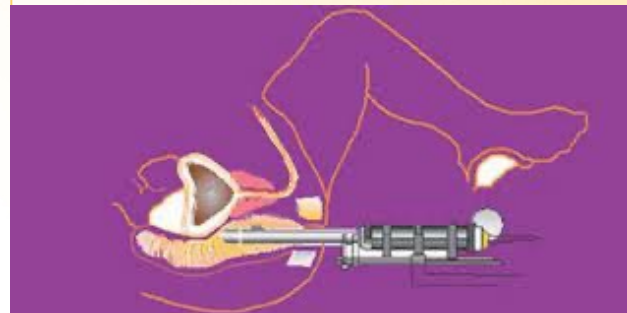


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## ■ Procedure (1-1.5 hours)

- General anesthesia (put to sleep)
- Catheter in penis to drain urine
- Legs up, penis/scrotum elevated, ultrasound in rectum
- Size of prostate measured
- Template chosen based on prostate size
- Needles placed through perineum (skin between scrotum and rectum) to cover entire prostate using ultrasound to guide positioning
- Needles can be repositioned as needed to ensure good positioning
- Needles advanced
- Template sewn to the perineum
- Cystoscopy (urologist inserts camera through penis in to the bladder)
- Advance needles to abut the bladder but not into bladder
- Wake from anesthesia

## ■ OR Recovery (1 hour)



# HDR Brachytherapy at LUMC



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## ■ Treatment Planning (3-4 hours)

- Radiation Planning CT and MRI Scans
- Hang out while we plan and approve treatment
- Connect needles to HDR machine

## ■ Treatment (30 minutes)

- Radiation seed treats inside each needle, top to bottom as planned
- No pain, heat, burning
- No radiation left inside after treatment
- Radiation seed goes back to machine

## ■ Finishing up (30-60 minutes)

- Disconnect needles from HDR machine
- Removal of needles
- Removal of catheter
- Go pee
- Go home







# After Care

## ■ Medications

- Tamsulosin 0.4mg daily (can increase to twice daily if needed) – for urination
- Naproxen 250mg twice daily – for inflammation
- Can resume blood thinners (where applicable) the next day

## ■ Restrictions

- 10lb lifting for 3 days

## ■ NOT restrictions

- No radiation safety concerns
  - OK to share bed with a partner
  - OK to be around individuals age <18 or pregnant
- Sexual activity OIK

## ■ Follow up at 1 month for symptom check

## ■ PSA at 3 months for surveillance (continue every 3-6 months)

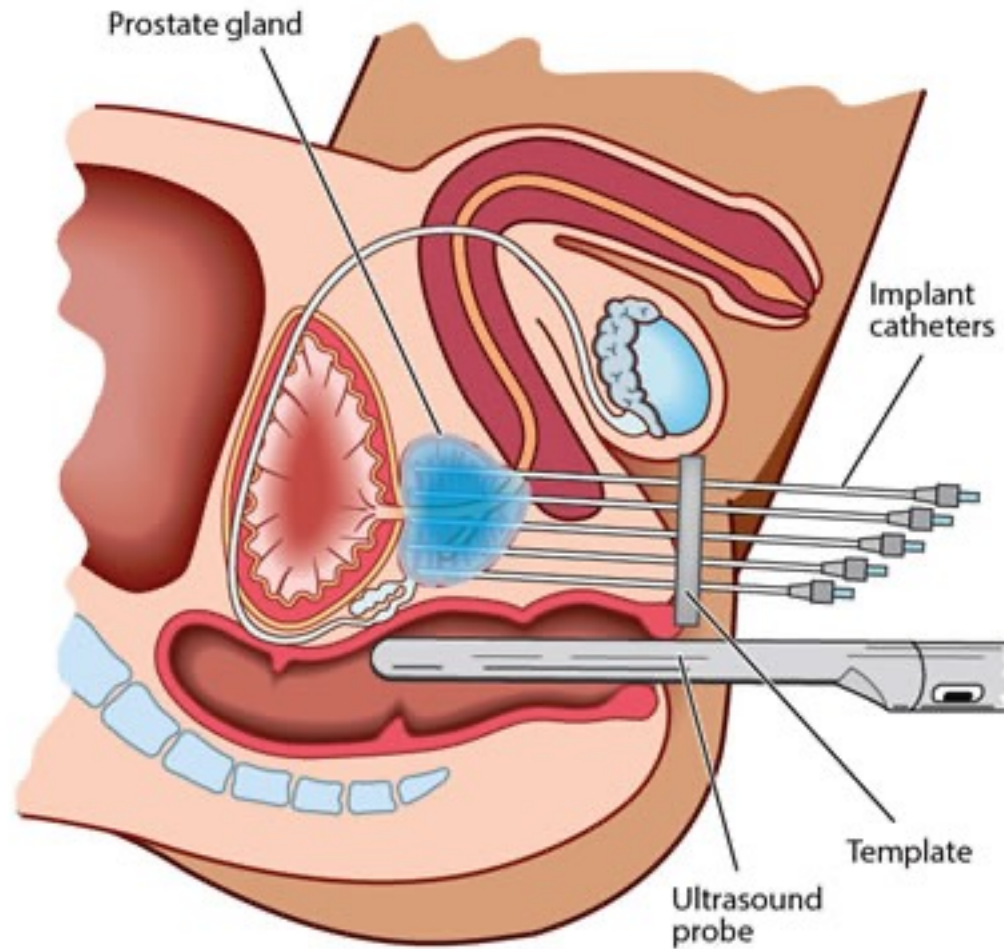


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# HIGH-DOSE RATE BRACHYTHERAPY

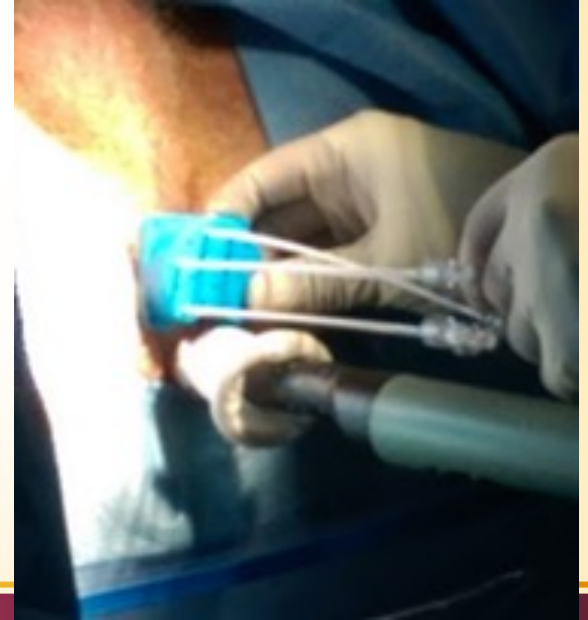
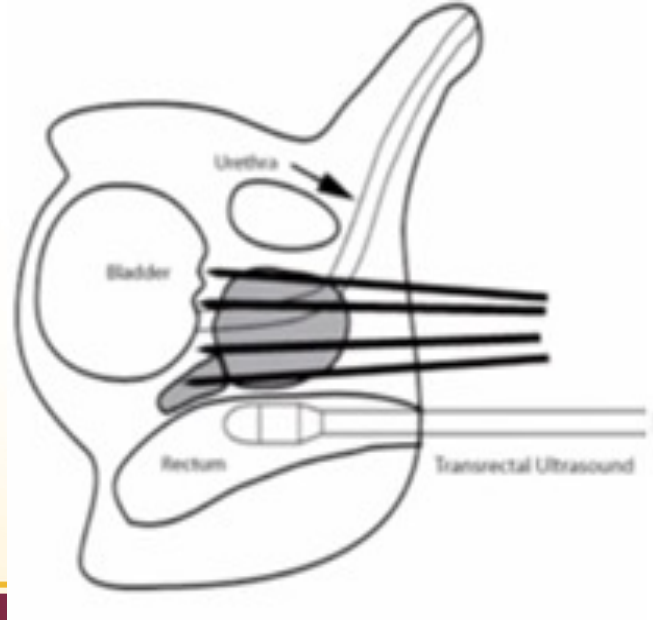


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## FREE-HAND TEMPLATE



## U/S-GUIDED CATHETER



# HIGH-DOSE RATE BRACHYTHETAPY



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## TREATMENT PLANNING





# Treatment Planning

Structure	Index		Target Value	Actual ...
PTV	V100.00 [% of volume]	is more than	95.00	98.27
PTV	V150.00 [% of volume]	is less than	35.00	29.77
PTV	V200.00 [% of volume]	is less than	20.00	7.81
BLADDER	D1.00cc [cGy]	is less than	1125.00	1122.66
BLADDER	D0.10cc [cGy]	is less than	1425.00	1235.64
BLDR*NECK...	D0.10cc [cGy]	is less than	1200.00	1039.26
RECTUM	D1.00cc [cGy]	is less than	1125.00	1124.62
URETHRA	D0.00cc [cGy]	is less than	1800.00	1798.95
URETHRA	D1.00cc [cGy]	is less than	1650.00	1649.11
BLADDER	V11.25Gy [cm <sup>3</sup> ]	is less than	1.00	0.97
RECTUM	V11.25Gy [cm <sup>3</sup> ]	is less than	1.00	1.00

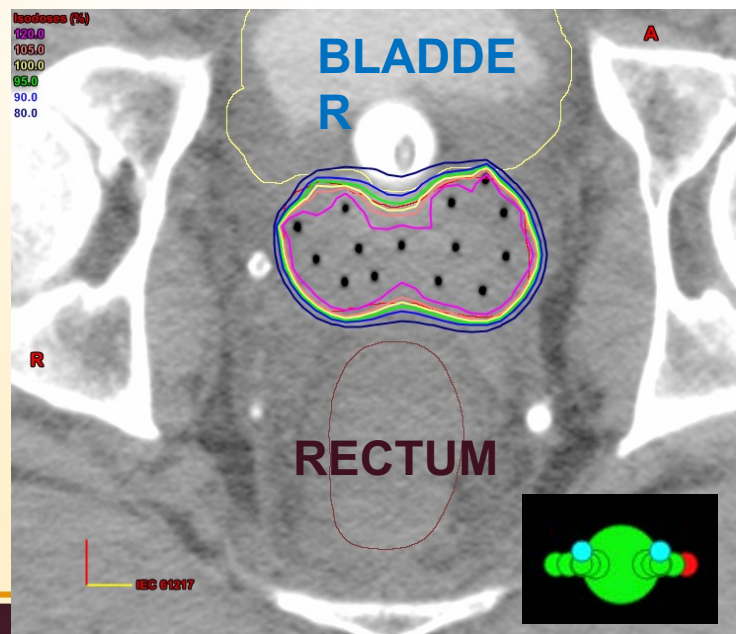
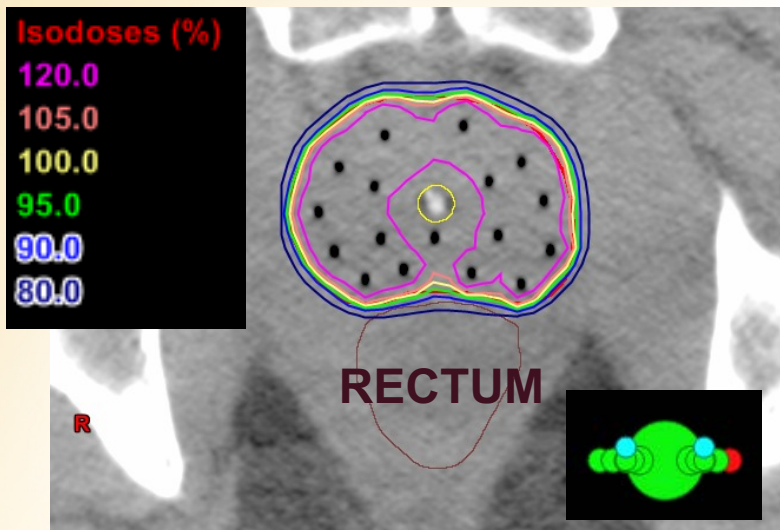
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# HIGH-DOSE RATE BRACHYTHETAPY



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## TREATMENT PLAN



# HDR Alone

## Disease Control



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	Fractionation	N	Median Follow-up	Study	PSA Control
CET/UCLA Hauswald, IJROBP 2015	7-7.25 Gy x 6	448	6.5 yrs	Low/Int	99%
UK Hoskin, Radiother Oncol 2017	13 Gy x 2 19-20 x 1	293	4 yrs	Int/High	91-94%
Beaumont Jawad, IJROBP 2016	9.5 Gy x 4 13-13.5 Gy x 2	494	4 yrs	Low/Int	87-97%
GammaWest Rogers, J Urol 2012	6.5 Gy x 6	284	3 yrs	Int only	94%
Germany Zamboglou, IJROBP 2013	9.5 Gy x 4 11.5 x 3	718	4.4 yrs	All	93%

# HDR Monotherapy Toxicity



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Study	Fractionation	Urinary Grade 2	Urinary Grade 3	Bowel Grade 2	Bowel Grade 3
CET/UCLA Hauswald, IJROBP 2015	7-7.25 Gy x 6	NR	4.7%	NR	0%
UK Hoskin, Radiother Oncol 2017	10.5 Gy x 3 13 Gy x 2 19-20 x 1	15-33%	2-11%	2-6%	0-1%
Beaumont Jawad, IJROBP 2016	9.5 Gy x 4 13-13.5 Gy x 2	20%	<1%	<10%	0%
GammaWest Rogers, J Urol 2012	6.5 Gy x 6	1.5%	0.6%	0%	0%
Germany Zamboglou, IJROBP 2013	9.5 Gy x 4 11.5 x 3	~2-9%	3.5%	~0.5%-1.5%	1.6%



# LDR vs. HDR Acute Toxicity

## LUMC Experience



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- N=167
- 2012-2017

	Total (n=167)	LDR (n = 78)	HDR (n = 89)	P-value
Age (Mean, SD)	66.5 (8.4)	66.7 (9.6)	66.4 (5.8)	0.77
Gland Size (Mean, SD)	35.8 (12.3)	34.4 (11.0)	37.0 (13.3)	0.18
Setting (n, %)				0.99
Monotherapy	122 (73%)	57 (73%)	65 (73%)	
Boost	45 (27%)	21 (27%)	24 (27%)	
Risk Category (n, %)				<0.01
Low	59 (35%)	40 (51%)	19 (21%)	
Intermediate	89 (53%)	34 (44%)	55 (62%)	
High	19 (11%)	4 (5%)	15 (17%)	

# LDR vs. HDR

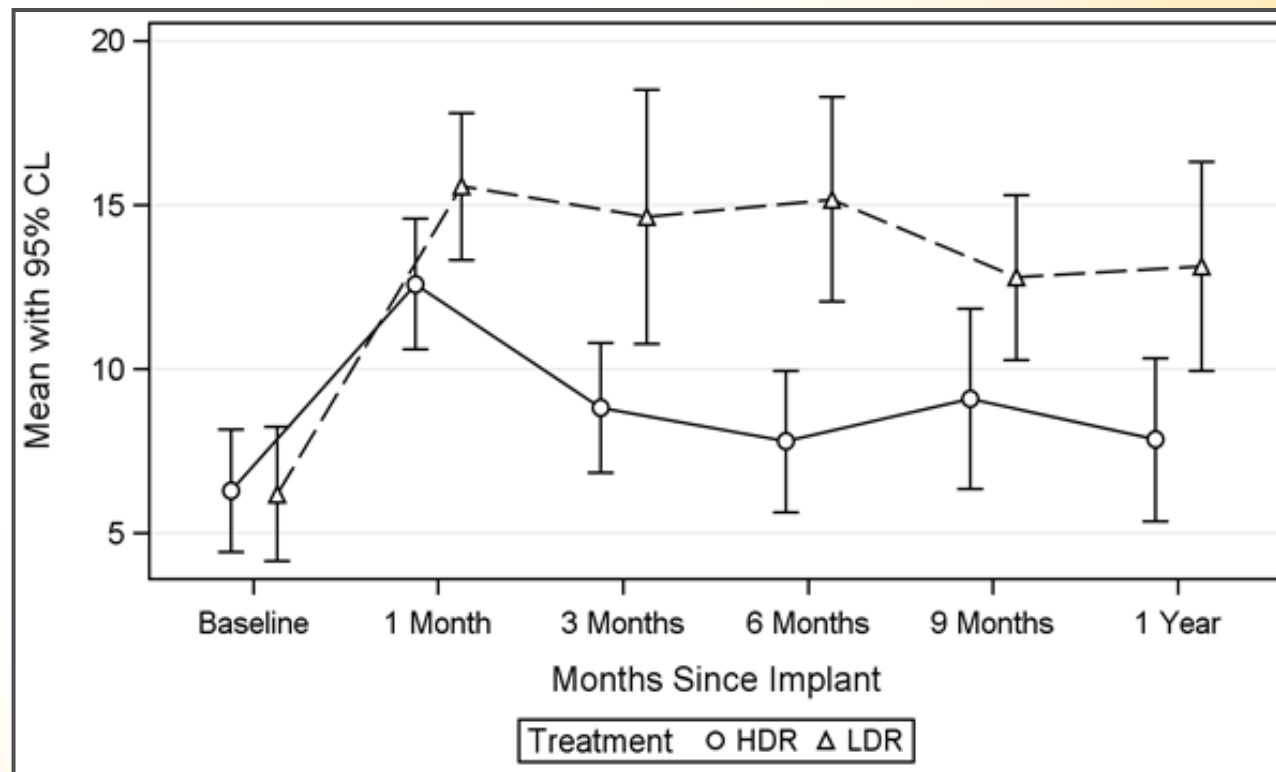
## IPSS Score Kinetics



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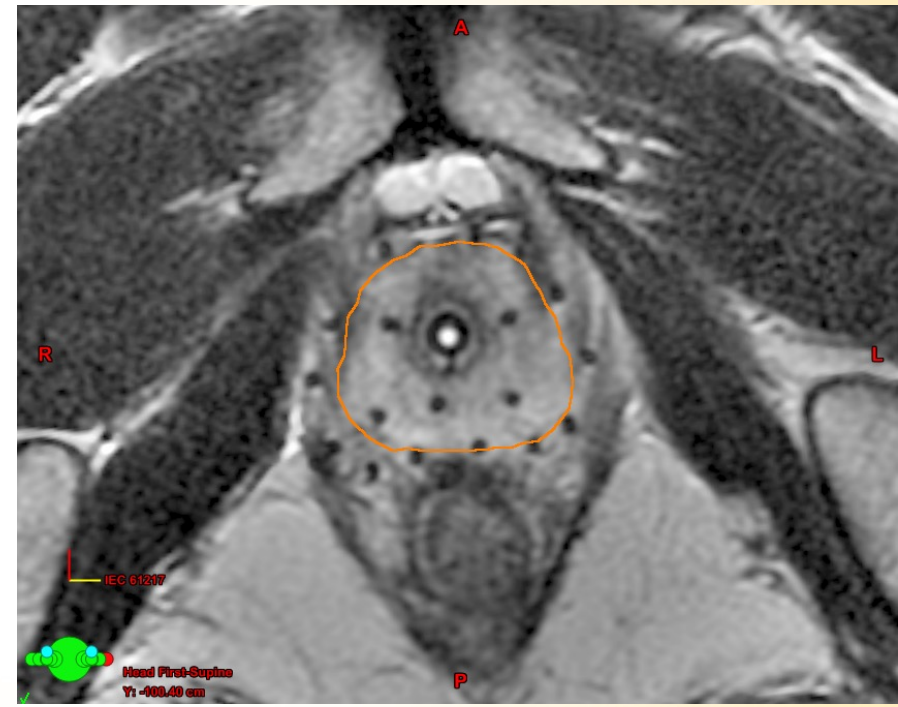
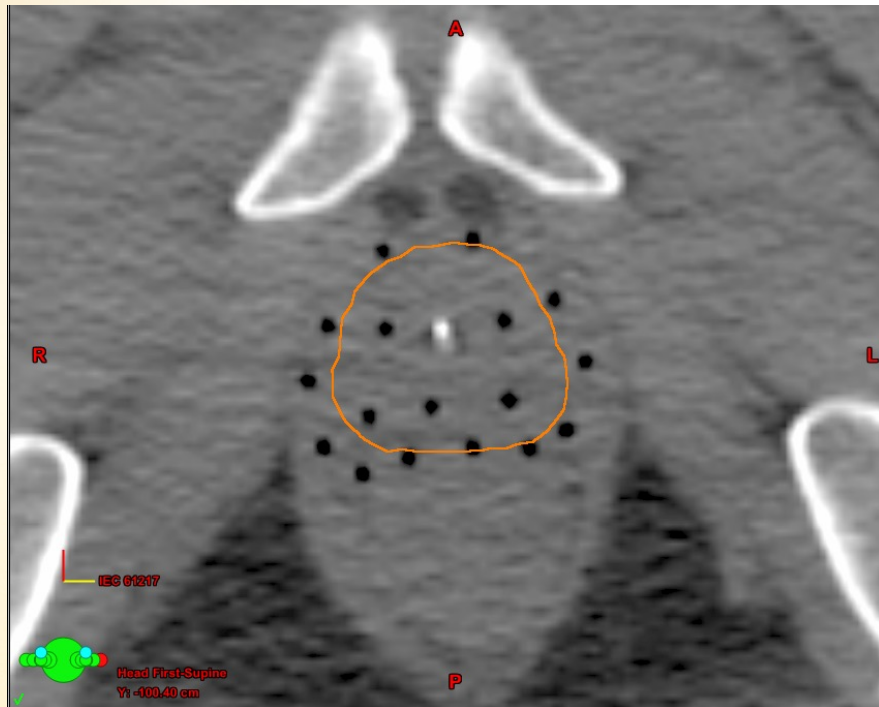
### HDR:

- **More Rapid Improvement in Urinary Fxn**
- **Resolves closer to baseline**



Hentz et al, ASTRO, 2017

# MRI-guided Brachytherapy Planning





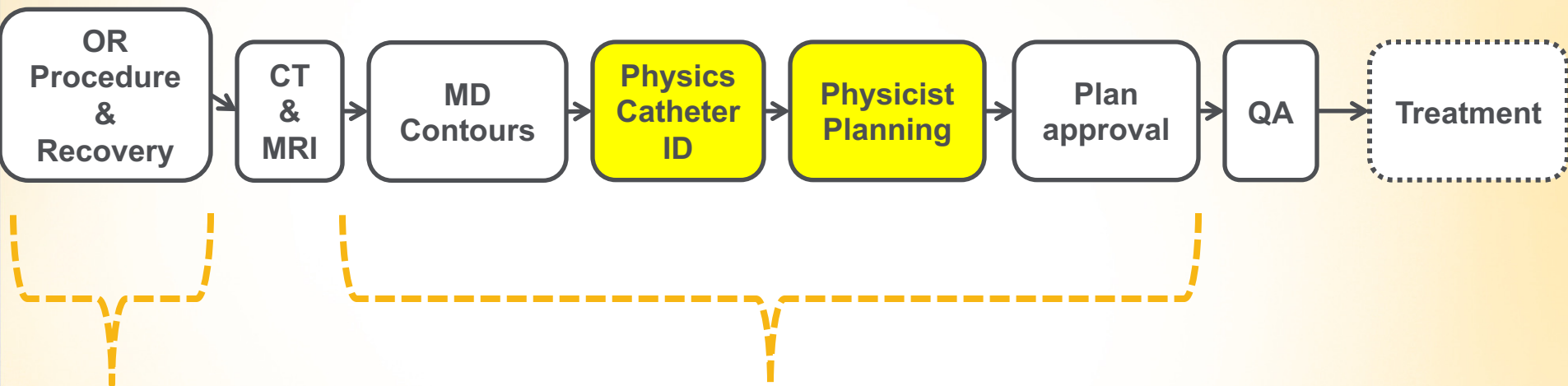
# MRI-guided Brachytherapy Planning



# Workflow



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Implant Procedure  
Duration

Treatment Planning  
Duration

# Patient selection



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## ■ Any risk group

- Low/Intermediate – HDR alone
- High – HDR + external + hormone therapy
- Prior radiation and recurrent in prostate only (PET and MRI)
- Not a good option for lymph nodes or distant sites involved

## ■ Urinary function

- Good/Fair
- Poor urinary function increases risk of side effects

## ■ Prostate size

- Rare limitation by large size (>100cc)
- No medications needed to downsize prostate

# Conclusion



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- HDR brachytherapy is one of several good curative options for patients with prostate cancer
- Results in excellent cure rates with good urinary and bowel function



# Questions



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- Procedure numbers – 8-10 per month
- Prep work or tests – Primary Doc or Cardiologist within 6 mos (any tests per MD). Hold blood thinner.
- Volume study needed – only for very large gland (~100cc)
- Dislikes about procedure – long day, slight adjustments at CT scan
- Expected PSA control
  - Low/Favorable intermediate ~95%
  - Unfavorable intermediate ~90%
  - High risk ~85%



# Acknowledgements



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## Loyola Rad Onc Team:

- Abhishek Solanki, MD
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- Hyejoo Kang, PhD
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- Jacob Jackson, MS
- Tiffany Tsui, MS



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# Questions?



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# What is Radiation Therapy



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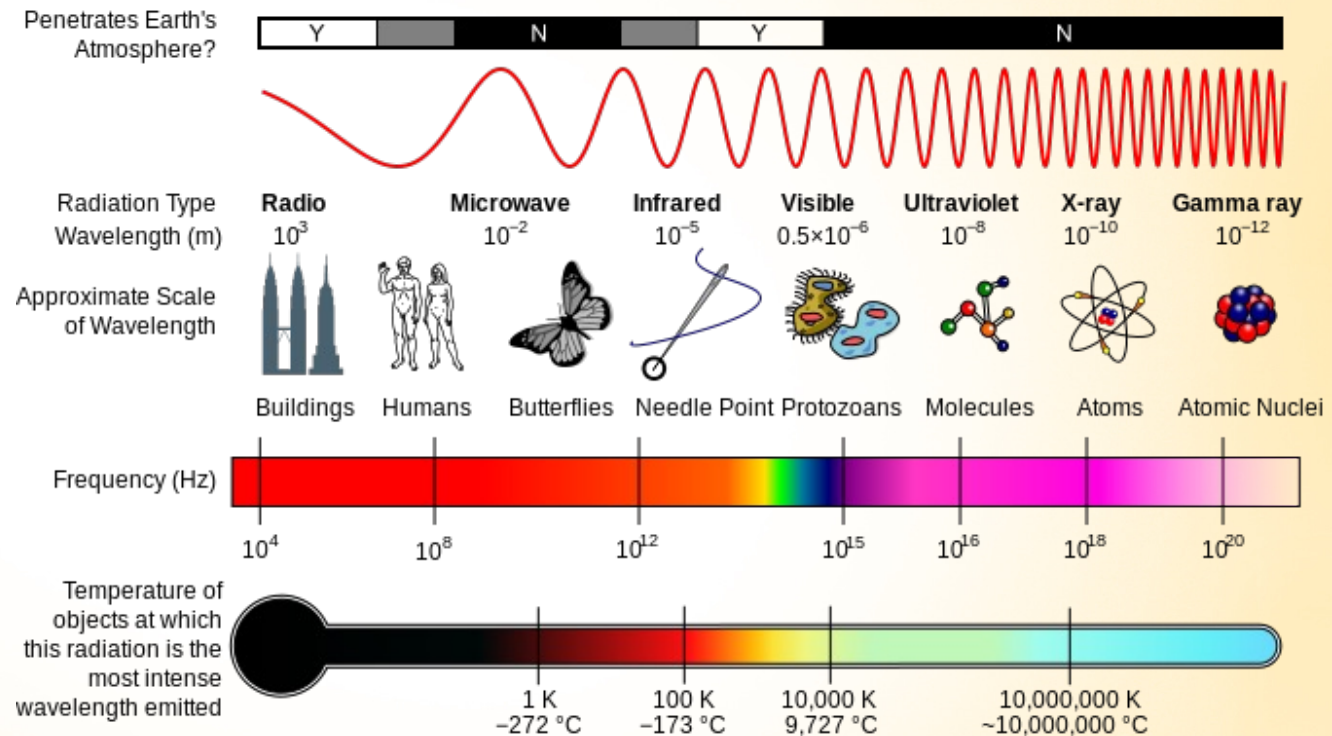
- Photons
  - X-rays
  - Gamma Rays
- Electrons
- Protons
- Neutrons
- Alpha Particles
- Carbon Ions

# What is Radiation Therapy



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## ■ Photons



# What is Radiation Therapy



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## ■ Photons

- A photon is a massless elementary particle, the quantum of light

### ■ X-rays

- Emitted by electrons
- Generated by linear accelerator
- Particle used in **external beam radiotherapy (EBRT)**

### ■ Gamma Rays

- Emitted by the atomic nucleus
- Generated by nuclear decay of unstable (radioactive) isotopes
- Particle used in **brachytherapy**

# External Beam Radiation Therapy



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- Broader Term is Teletherapy (*tele* from Ancient Greek τῆλε (*tēle*, “at a distance, far off, far away, far from”)). – wikipedia
- Patient lies on a table and the radiation source or linear accelerator is aimed at an intended part of the body (the tumor or regions at risk for harboring tumor cells)

# External Beam Radiation Therapy



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## ■ EBRT

- Includes older technologies – Cobalt-60, Orthovoltage
- More modern techniques – 3D-Conformal RT
- Even more modern techniques – Intensity Modulated Radiation Therapy
- Even more targeted techniques – Stereotactic Radiosurgery



# Linear Accelerator



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# Linear Accelerator

# Radiation Dose



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- **Gray (always singular)**
  - Unit of dose of radiation therapy
  - Quantifies the deposition of radiation in tissue
  - Transfer of light energy (photons) into physical and chemical energy (moving electrons) in the patient
  - Electrons will damage DNA directly and also create free radicals (hydroxyls) to damage DNA indirectly