ICTR-PHE 2016


# Urethra-sparing SBRT for prostate cancer: dosimetric optimization with VMAT vs. IMRT and the learning curve effect

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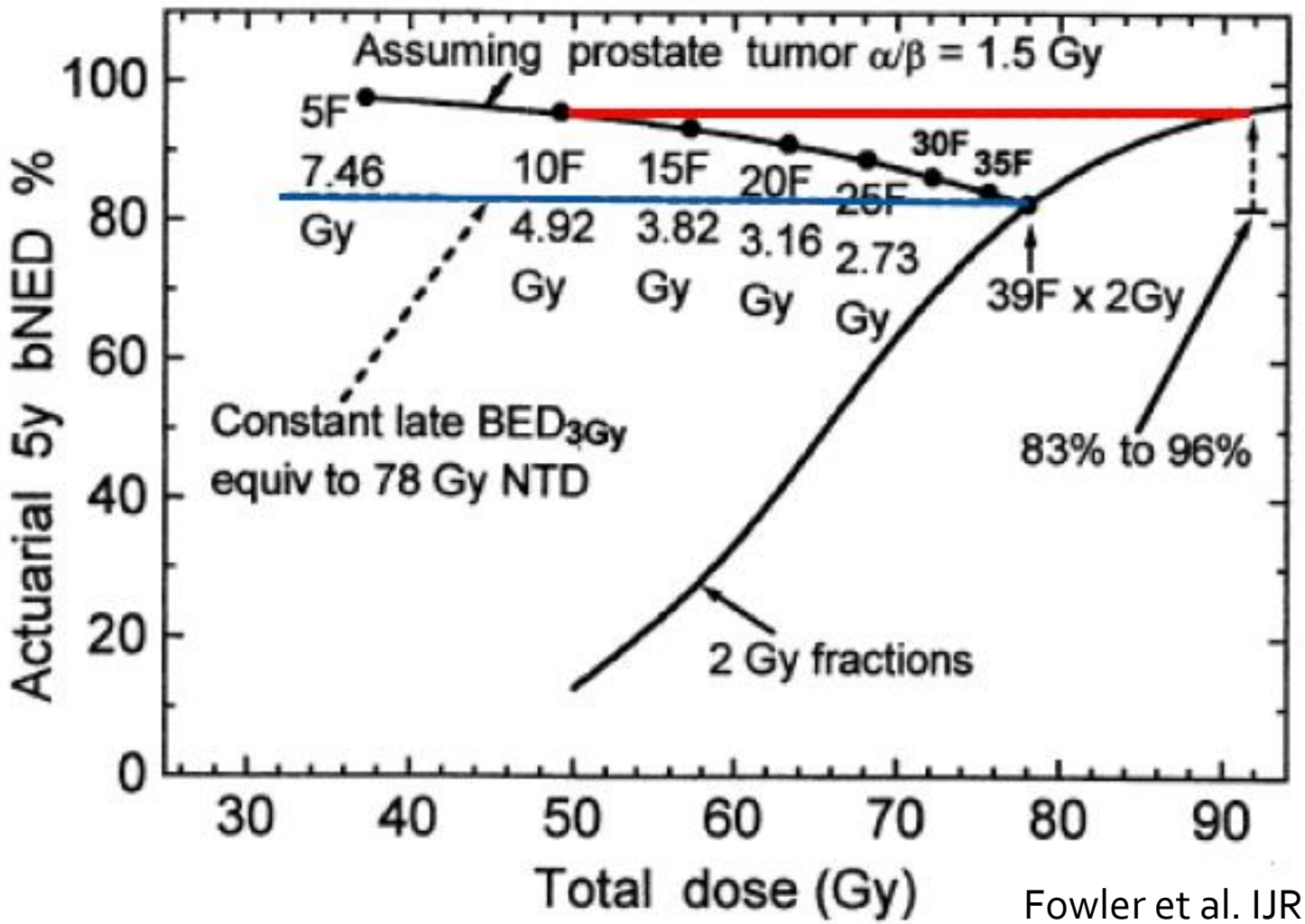
# Extreme hypofractionation: prostate SBRT




Fowler et al. IJROBP 2013

# SBRT principles

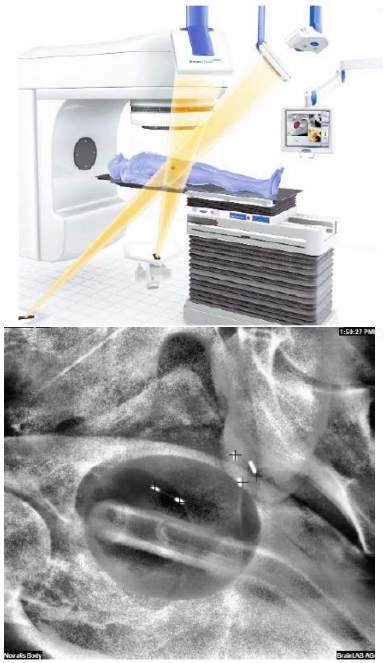
STEREOTACTIC BODY RADIOTHERAPY

**Hit precisely the target and spare OARs**

# SBRT principles

STEREOTACTIC BODY RADIOTHERAPY

Hit precisely the target and spare OARs

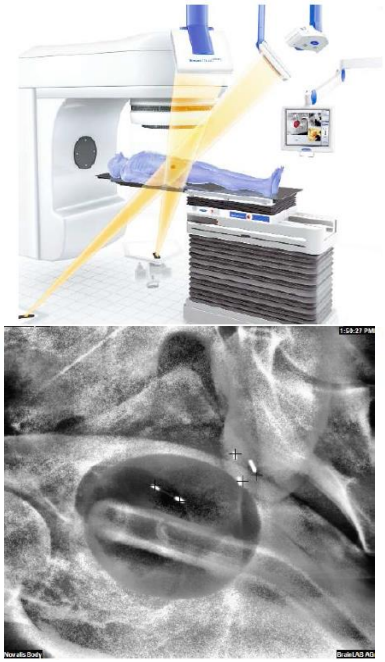


IGRT solutions

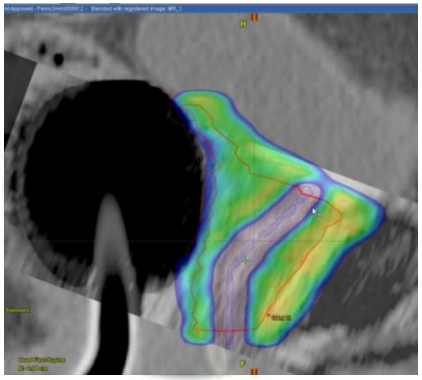
# SBRT principles

## STEREOTACTIC BODY RADIOTHERAPY

Hit precisely the target and spare OARs



IGRT solutions

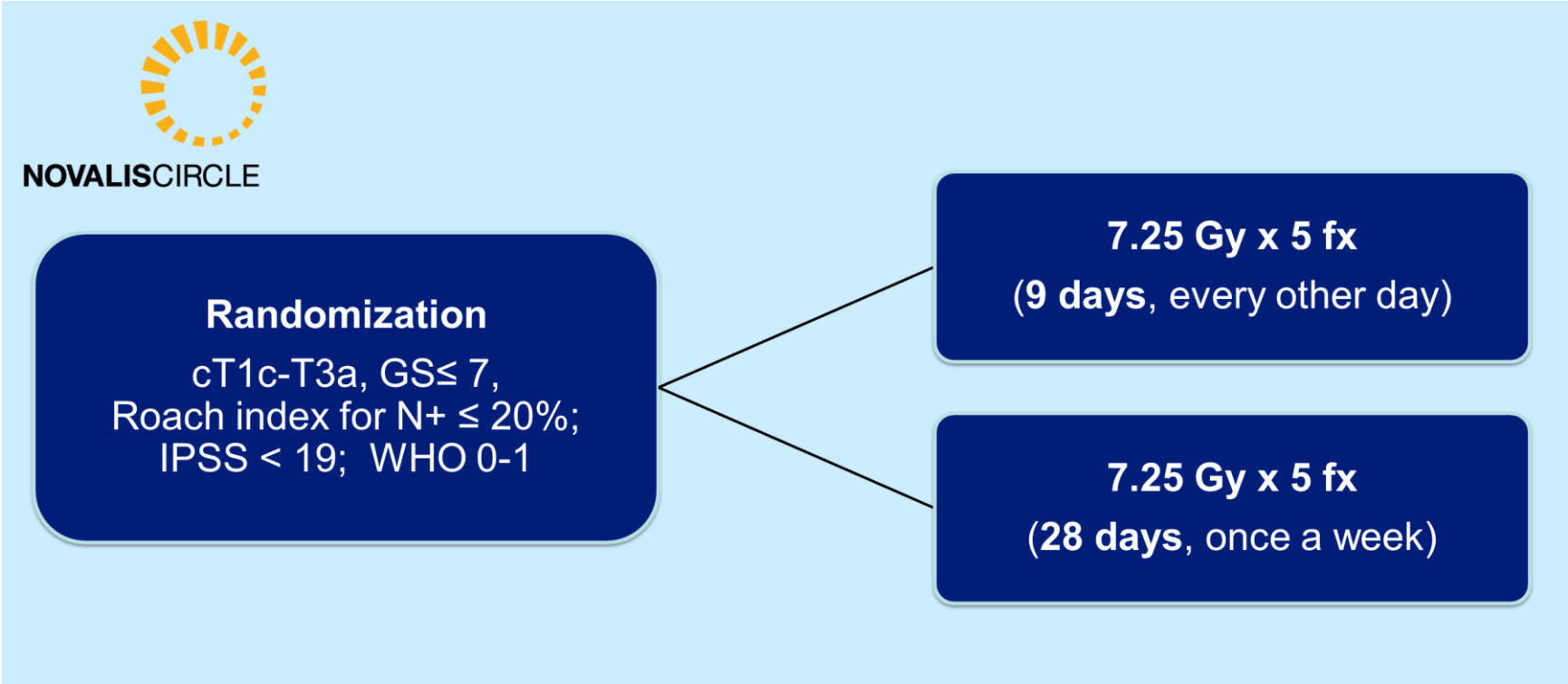


Prostate SBRT

# SBRT for localized prostate cancer: the *Novalis Circle* prospective multicenter randomized phase II trial

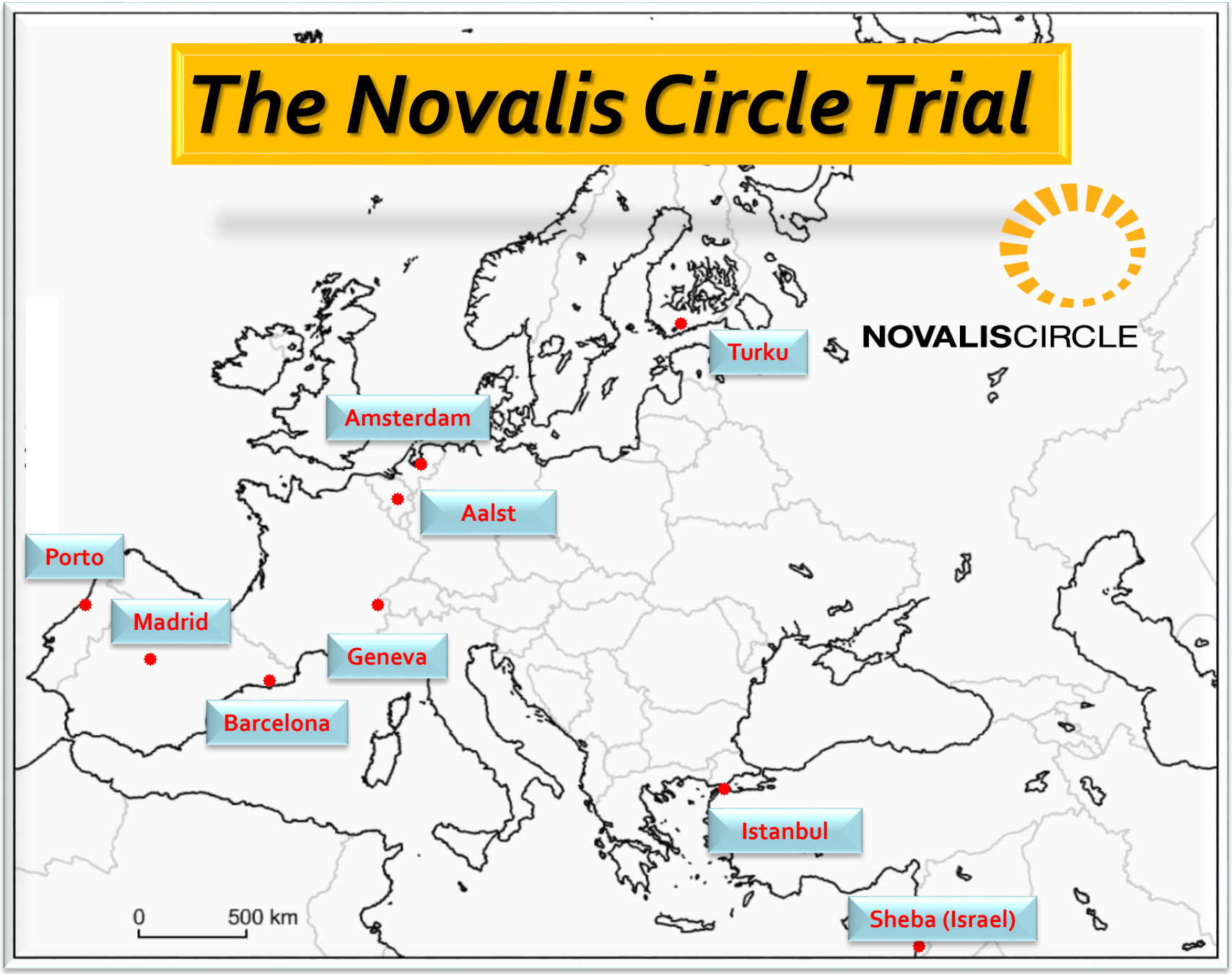
NOVALISCIRCLE

# Trial design

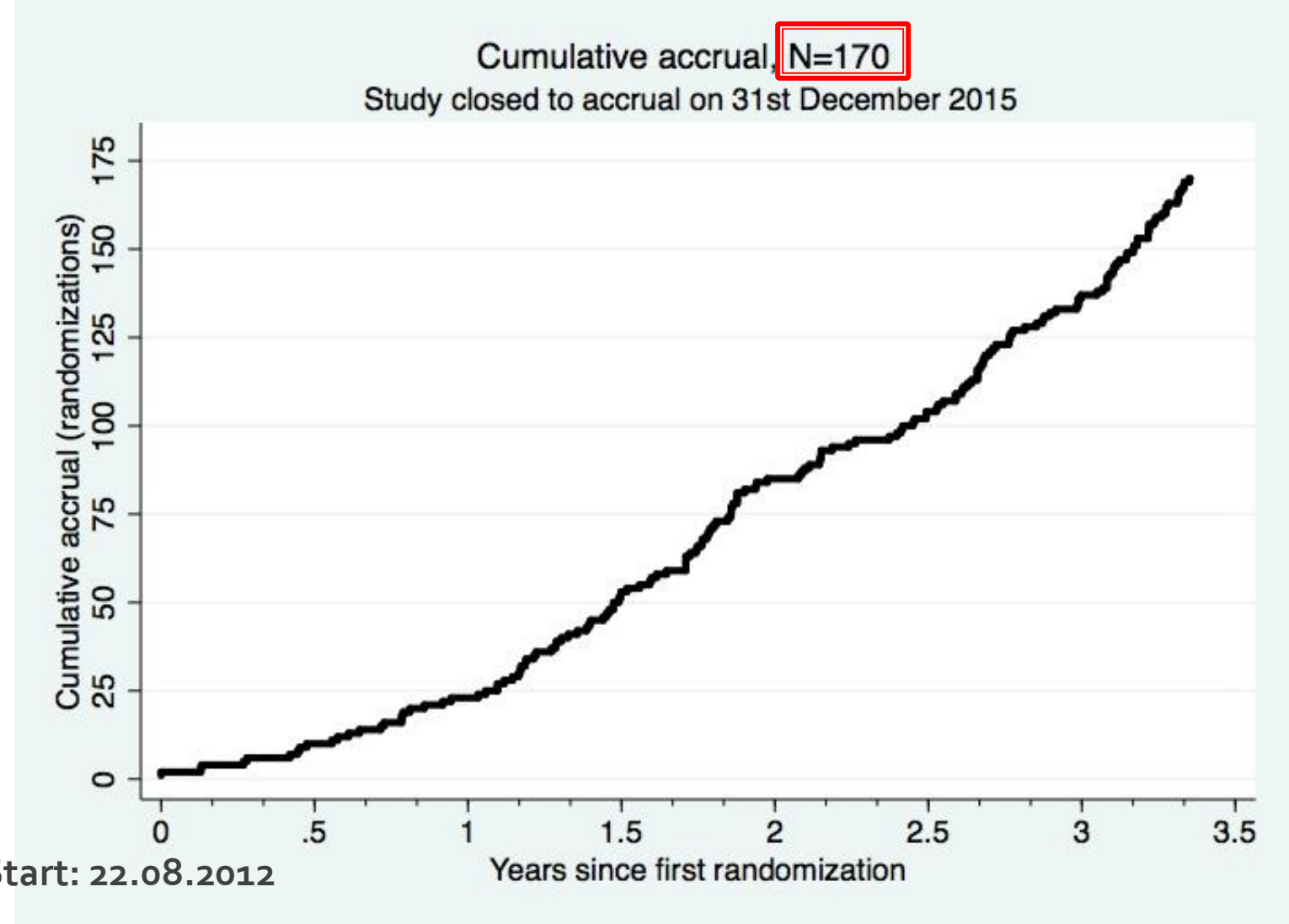



Clinicaltrial.gov NCT01764646

# The Novalis Circle Trial



# Cumulative Accrual




Start: 22.08.2012

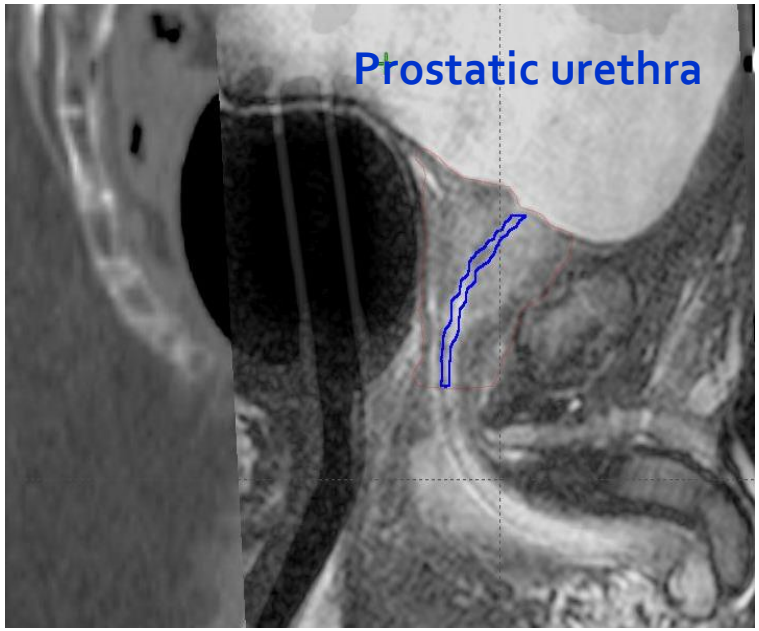
# Treatment schedule: urethra sparing

| PTV = Prostate ± SV (excluding urethral PRV) | | | | | |
|---|---|---|---|---|---|
| # fractions | dose/fraction (Gy) | Total dose (Gy) | α/β (Gy) | $NTD_{2Gy}$ | |
| 5 | 7.25 | 36.25 | 1.5 | 90 | TUMOR |
| 5 | 7.25 | 36.25 | 3.0 | 74 | LATE TOX |
| 5 | 7.25 | 36.25 | 10.0 | 50 (9d OTT)<br>39 (28d OTT) | ACUTE TOX |

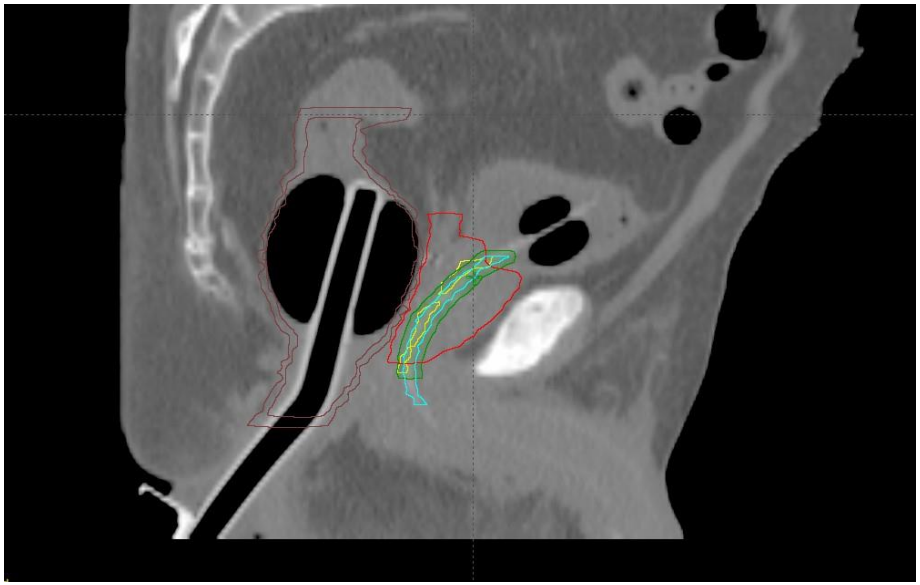
| Urethral_PRV | | | | | |
|---|---|---|---|---|---|
| # fractions | dose/fraction (Gy) | Total dose (Gy) | α/β (Gy) | $NTD_{2G}$ | |
| 5 | 6.5 | 32.5 | 1.5 | 74 | TUMOR |
| 5 | 6.5 | 32.5 | 3.0 | 62 | LATE TOX |

# 1. Treatment volumes: urethra sparing

- **Prostate PTV** (5 mm except posteriorly, 3 mm)
- **Urethral PRV** (planning risk volume)

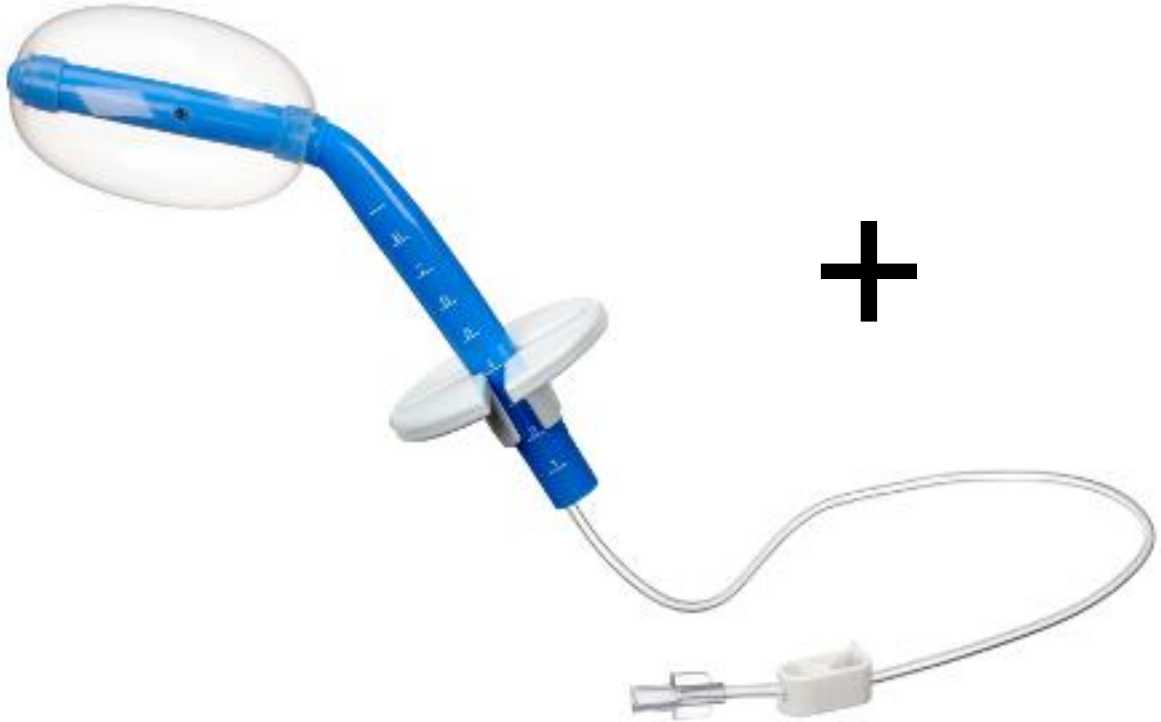



**PLANNING MRI**



- **3 mm isotropic margins** around the catheter / MRI urethra
- Includes both "urethras"

# 2. IGRT: fiducials + ERB



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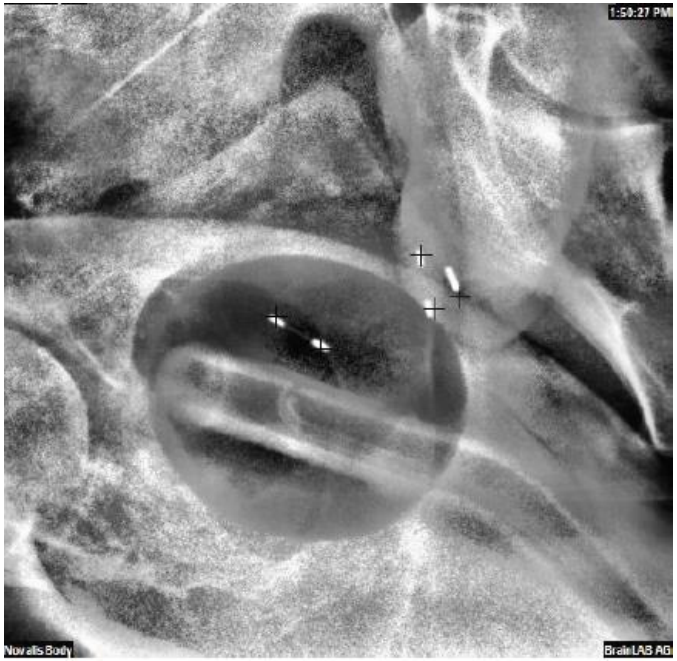
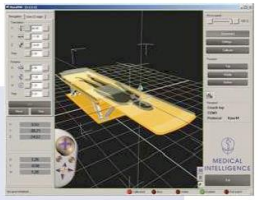
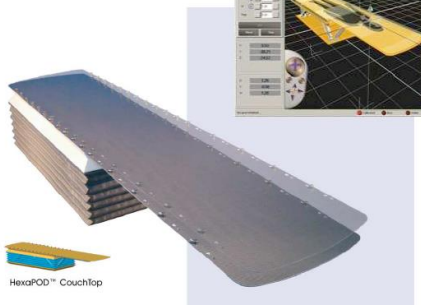


# 3. Technology: Novalis

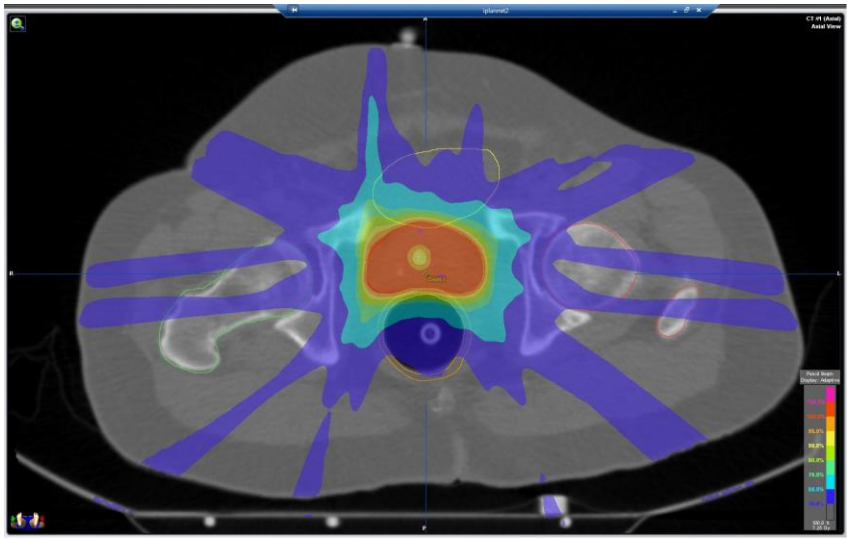
- 6-axis-couch
  - Real 3D-repositioning
  - Submillimeter accuracy
  - Dynamic approach: respiration compensation

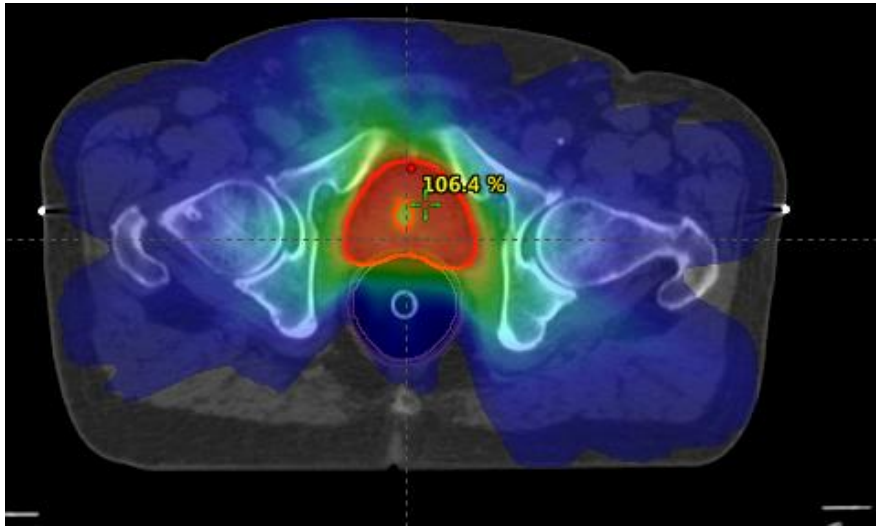


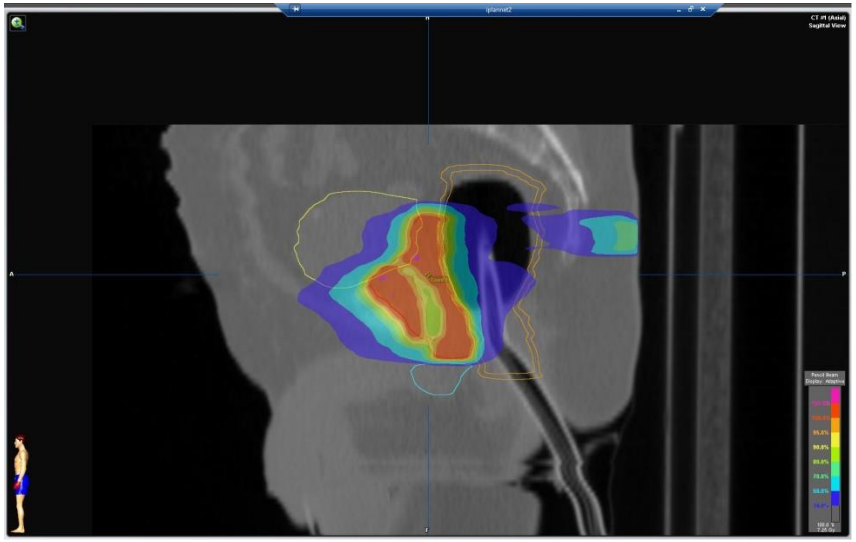
**ExacTrac® system**

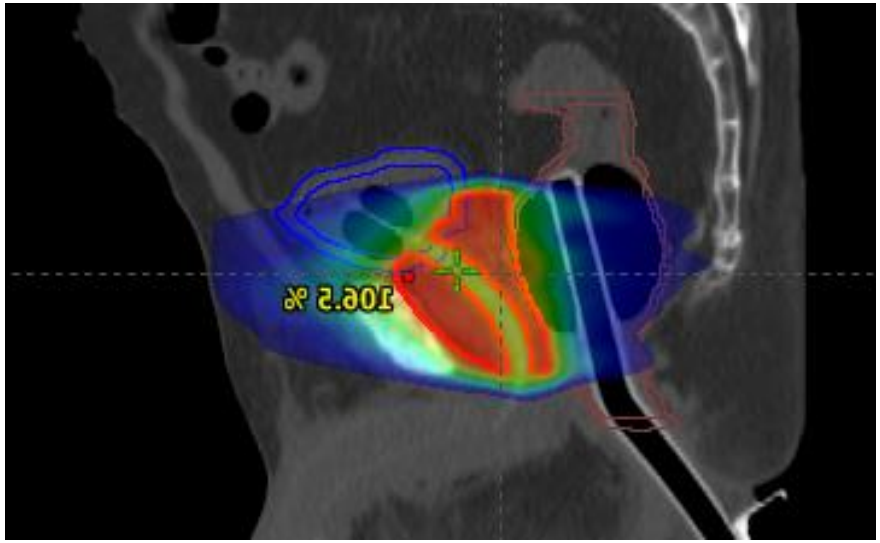


# 4. Urethra-sparing: IMRT - VMAT







# Aims of the study

**Aims:**

1. **To compare the dosimetric results of intensity-modulated radiotherapy (IMRT) and volumetric modulated arc therapy (VMAT)**

2. **To assess the learning curve effect on dosimetric optimization with VMAT**

# 1. Materials and Methods

## Dosimetric optimization IMRT vs VMAT

- ***Dosimetric data*** of the first **40 patients** randomized between 07/2012 and 03/2014 in 9 different centers

- 20 patients treated on **prostate only**
- 20 patients treated on **prostate + seminal vesicles**

- Plans generated using either a **VMAT** (n=20) or **IMRT** (n=20) technique, with each modality including (n=10) or not (n=10) seminal vesicles in the PTV

- ***Parameters***: mean doses (± SD) to the PTV, uPRV, OARs, PTV homogeneity index (HI) and dice similarity coefficient (DSC)

# 2. Materials and Methods

## Learning curve effect in VMAT optimization

- *Multicenter analysis*: VMAT plans of the *first 20 patients* were compared with VMAT plans generated in the *last 20* randomized patients (05/2014-08/2015)

- *Institutional analysis* : 25 VMAT plans (Geneva, 2012-2015)

# 1. Dosimetric results: IMRT *vs* VMAT

| | | *Constraints ICRU 83* | *IMRT* | *VMAT* | *p-value* |
|---|---|---|---|---|---|
| **Monitor Units** | | | **3685** | **2245** | ***p*=.0001** |
| **Homogeneity index** | | | **0.11** | **0.09** | ***p*=.002** |
| **Urethral PRV** | $D_{98\%}$ | ≥ 30.9 Gy | **30.1 Gy** | **31.2 Gy** | ***p*=.001** |
| **Rectal wall** | $V_{100\%}$ | < 5% | 1.6±1.4% | 2.5±1.9% | *p*=NS |
| | $V_{90\%}$ | < 10-15% | 10.3±3.0% | 11.0±3.3% | *p*=NS |
| | $V_{80\%}$ | < 20-25% | 16.2±3.7% | 14.8±4.2 | *p*=NS |
| **Bladder wall** | $V_{100\%}$ | < 10-15% | 7.8±3.7% | 7.0±3.8% | *p*=NS |
| | $V_{90\%}$ | < 20% | 15.3±4.0% | 13.1±4.8% | *p*=NS |
| | $V_{50\%}$ | < 40-50% | **37.2±9.2%** | **28.4±11.6%** | ***p*=.011** |

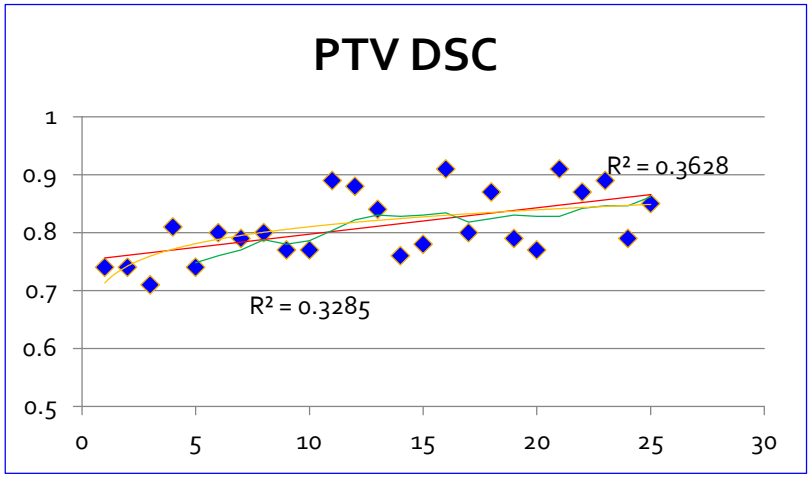
# 2. Learning curve effect in VMAT

**Last 20 VMAT plans *vs.* first 20 VMAT plans (*multicenter analysis*)**

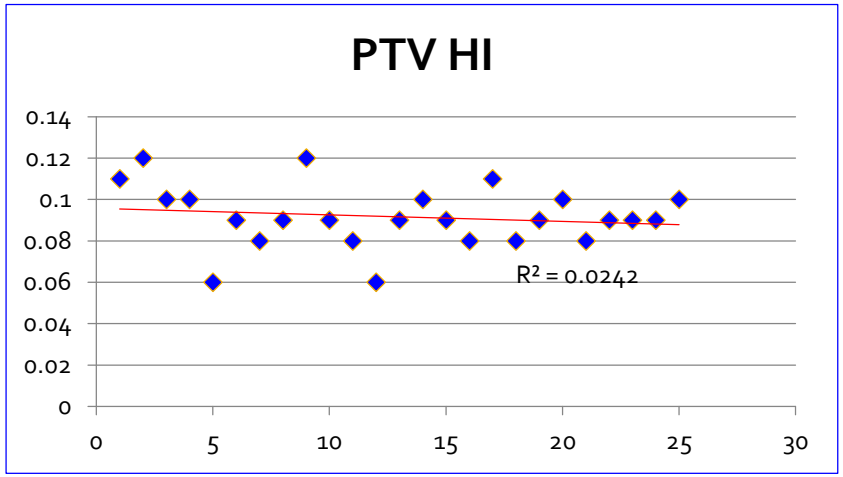
- PTV DSC value = 0.88 *vs.* 0.78, $p$=.009
- Rectal wall $V_{100}$ = 1.3% *vs.* 2.5%, $p$=.023
- Bladder wall $V_{100}$, $V_{90}$ and $V_{80}$ = overall significant better sparing in last VMAT plans, $p$<.05

# 2. Learning curve effect in VMAT

***Institutional analysis*** : 25 VMAT plans (Geneva University Hospital, 2012-2015)

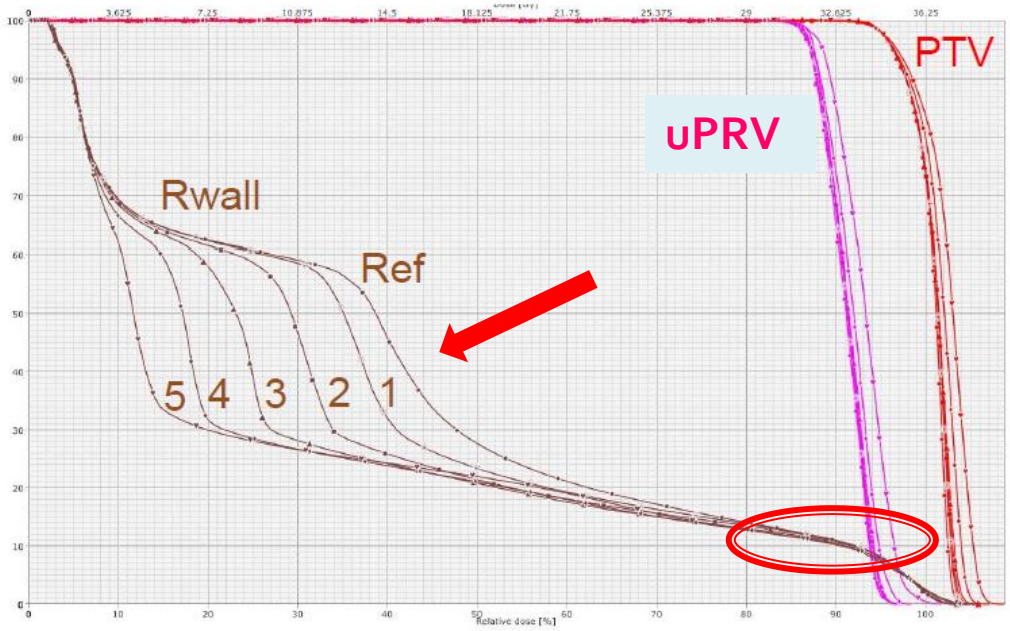



#patients

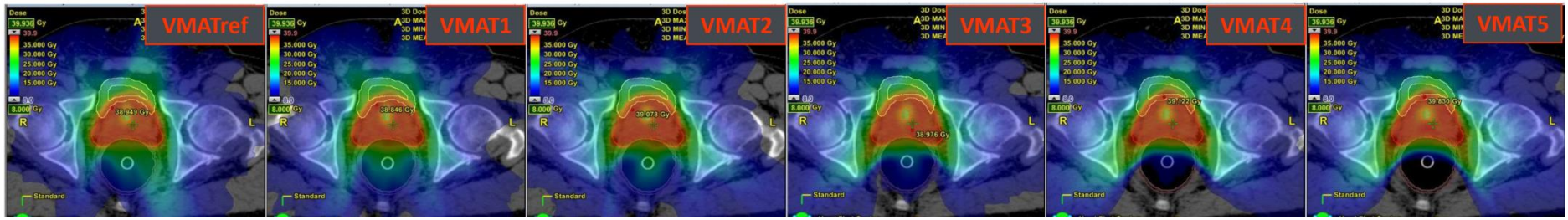



#patients

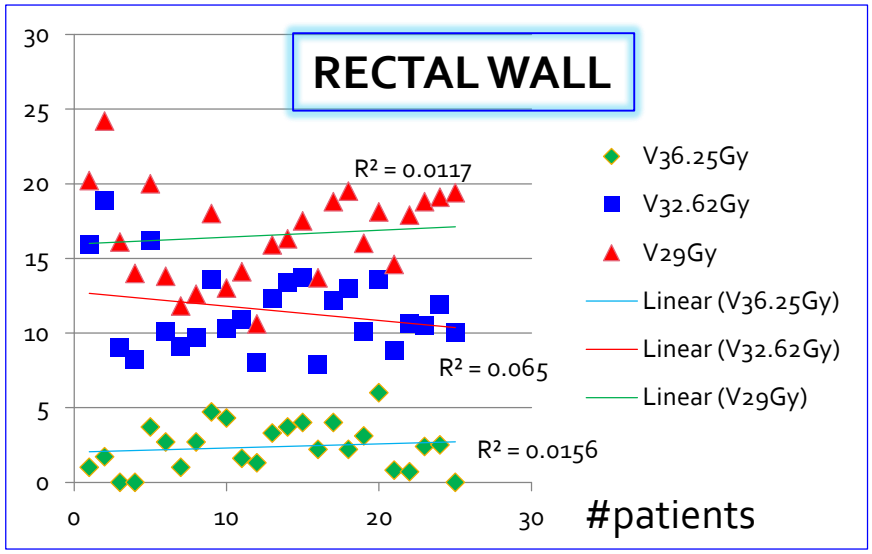
# 2. Learning curve effect in VMAT

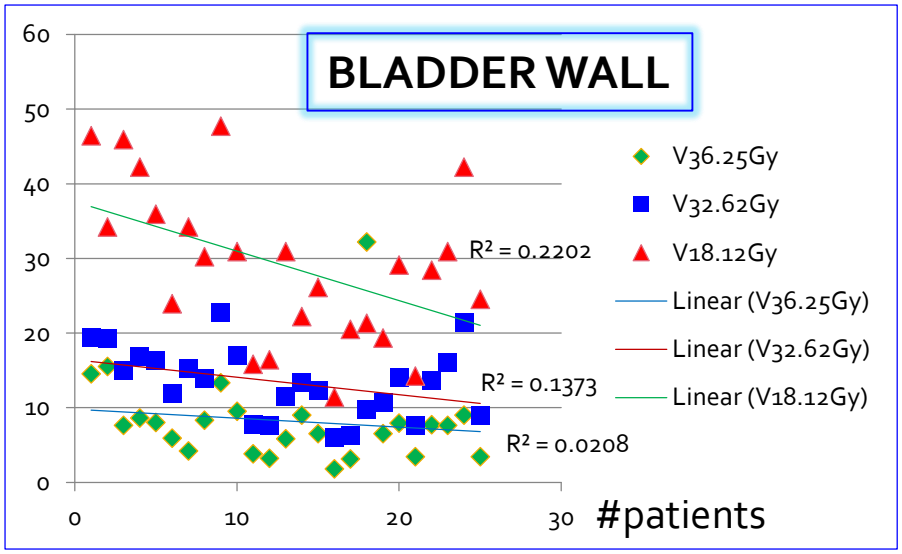


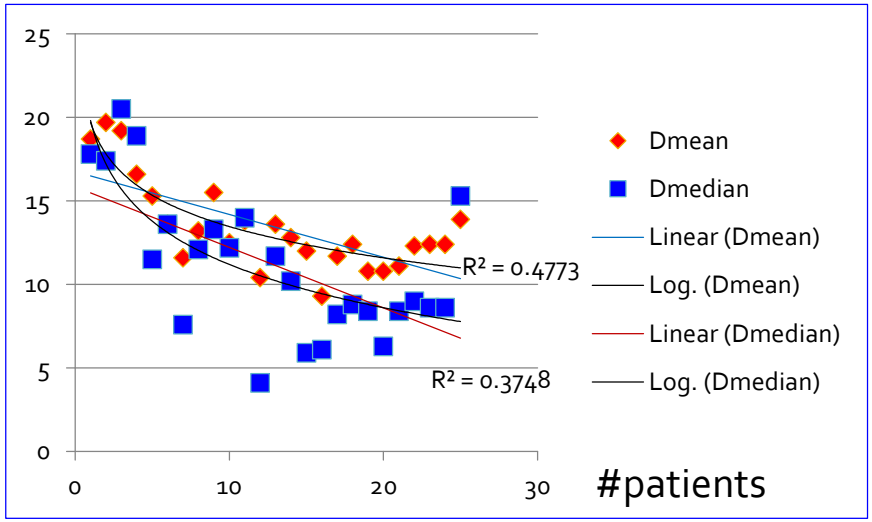

**Optimization on rectal wall**

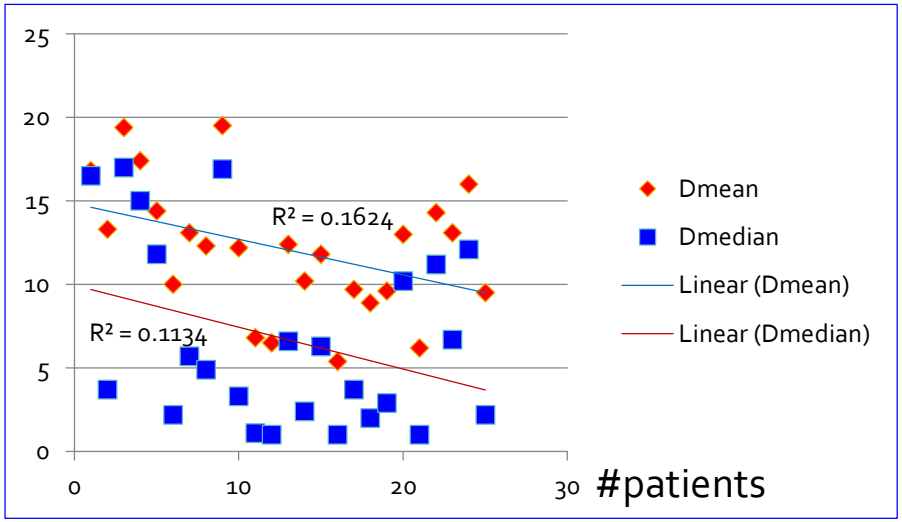


# 2. Learning curve effect in VMAT



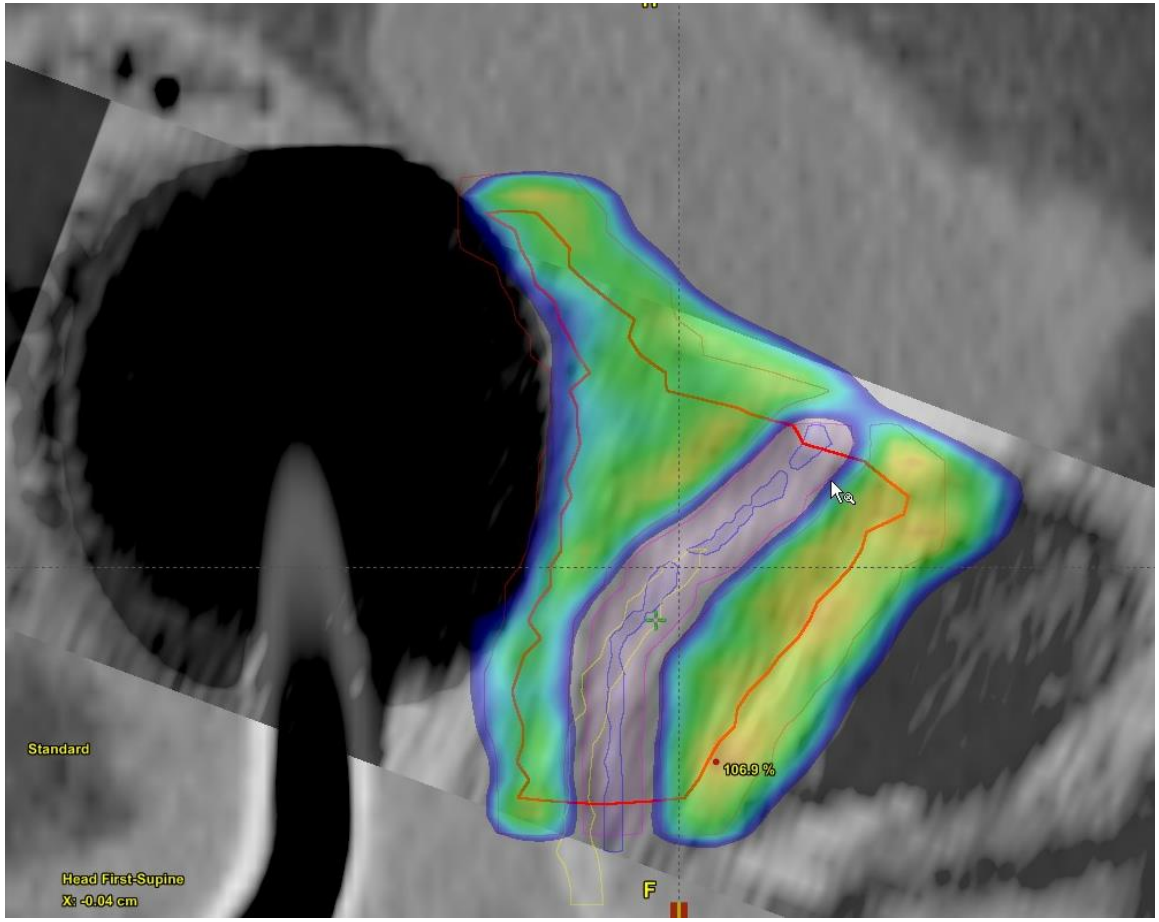



# Conclusions

- For all participating centers, urethra-sparing SBRT plans met all the dosimetric endpoints in terms of PTV coverage as well as OAR sparing, irrespectively of the technique used.
- Compared with IMRT, VMAT plans resulted in more homogeneous dose distribution, reduced number of MU, and better uPRV coverage.
- Conformality and OAR sparing with VMAT may be improved after gaining experience in SBRT plan optimization.

# Thank you for your attention!




Ceci n'est pas une prostate