

# PARTNER Final Project Meeting

14<sup>th</sup> September 2012  
CNAO, Pavia, Italy

## WP13. Adaptive Radiotherapy and treatment planning strategies for ion therapy

Comparison between different boost strategies  
for high-risk prostate and head & neck cancer

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Supervisors: Ramona Mayer, Dietmar Georg

ebg MedAustron



# Outlook

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- **Project overview:**
  - General information
  - Goals
  - Deliverables
- **Research activities:**
  - Past activities...
  - Current: Comparison between different boost strategies for high-risk prostate and head & neck cancer

# Project Overview

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- Recruitment date: 01.09.2009
- The final goal was to develop strategies for adaptive ion treatment planning  
(....details later)

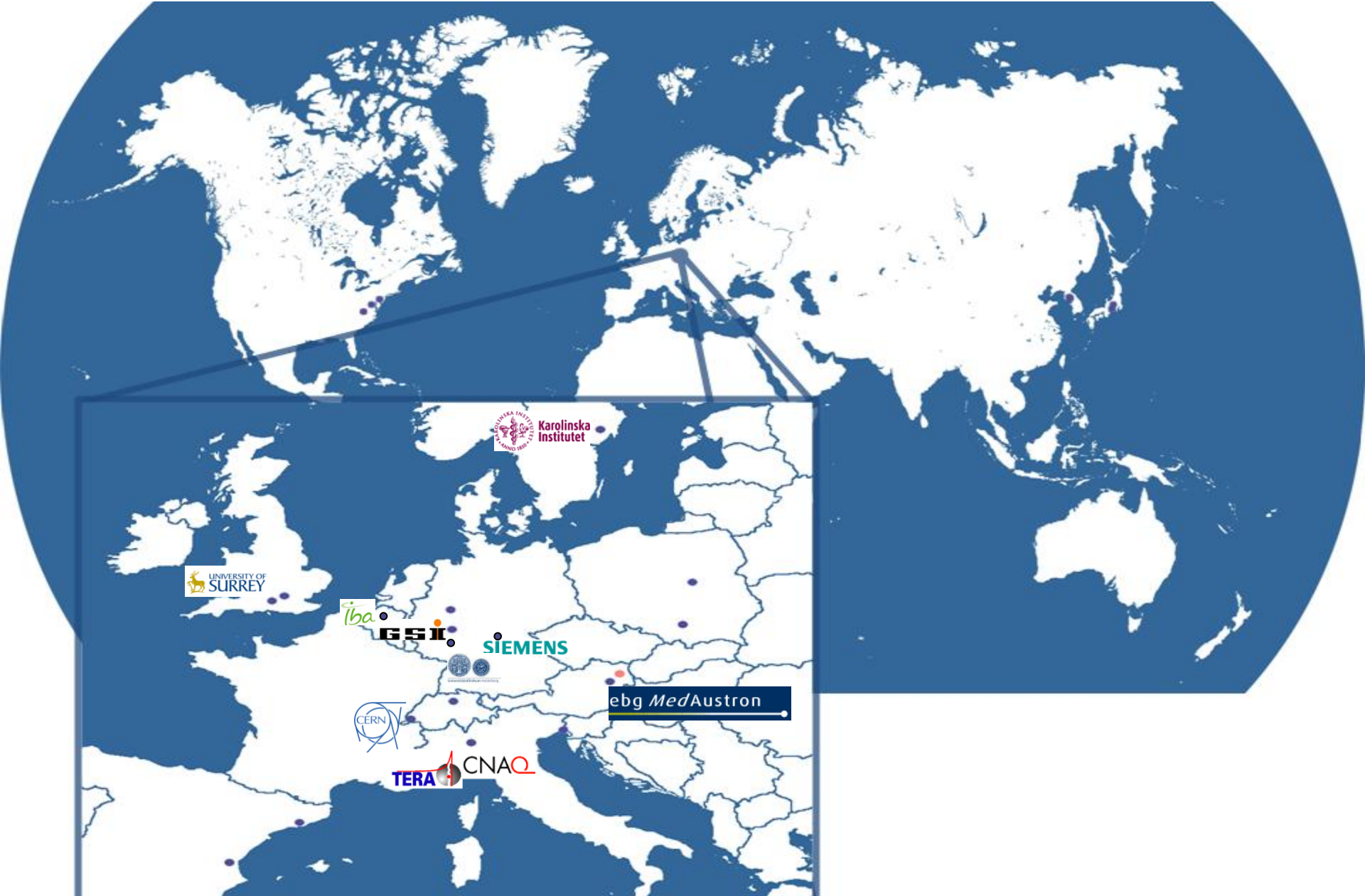
- Milestone & Deliverables:

*Expecting date*    *Milestone/Deliverable name*

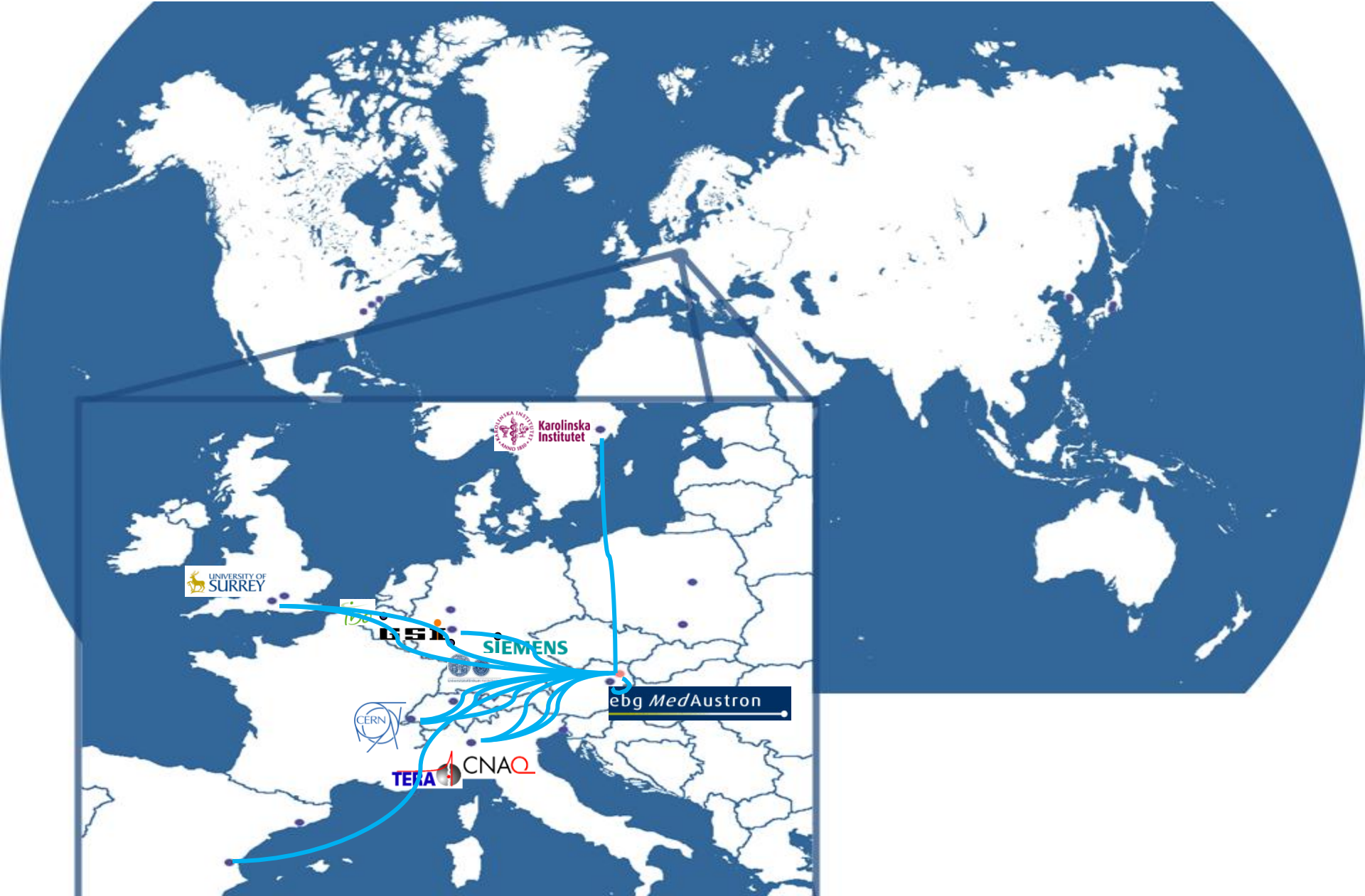
- |      |   |
|------|---|
| M 9  | • Understanding of fundamentals for light ion treatment planning                  |
| D 9  | • Report on basic principles for treatment planning software for light ions       |
| M 21 | • First 3D dose computation   |
| D 21 | • Dose computation for light ions   |
| M 24 | • First dose distribution in patient evaluated with biological models             |
| M 33 | • Light ion treatment optimized with software (forward planning)                  |
| D 33 | • Publication on evaluation and optimization of treatment planning for light ions |

Available on: <https://espace.cern.ch/partnersite/workspace/gora>

# Courses, Trainings, Conferences, Networking.....



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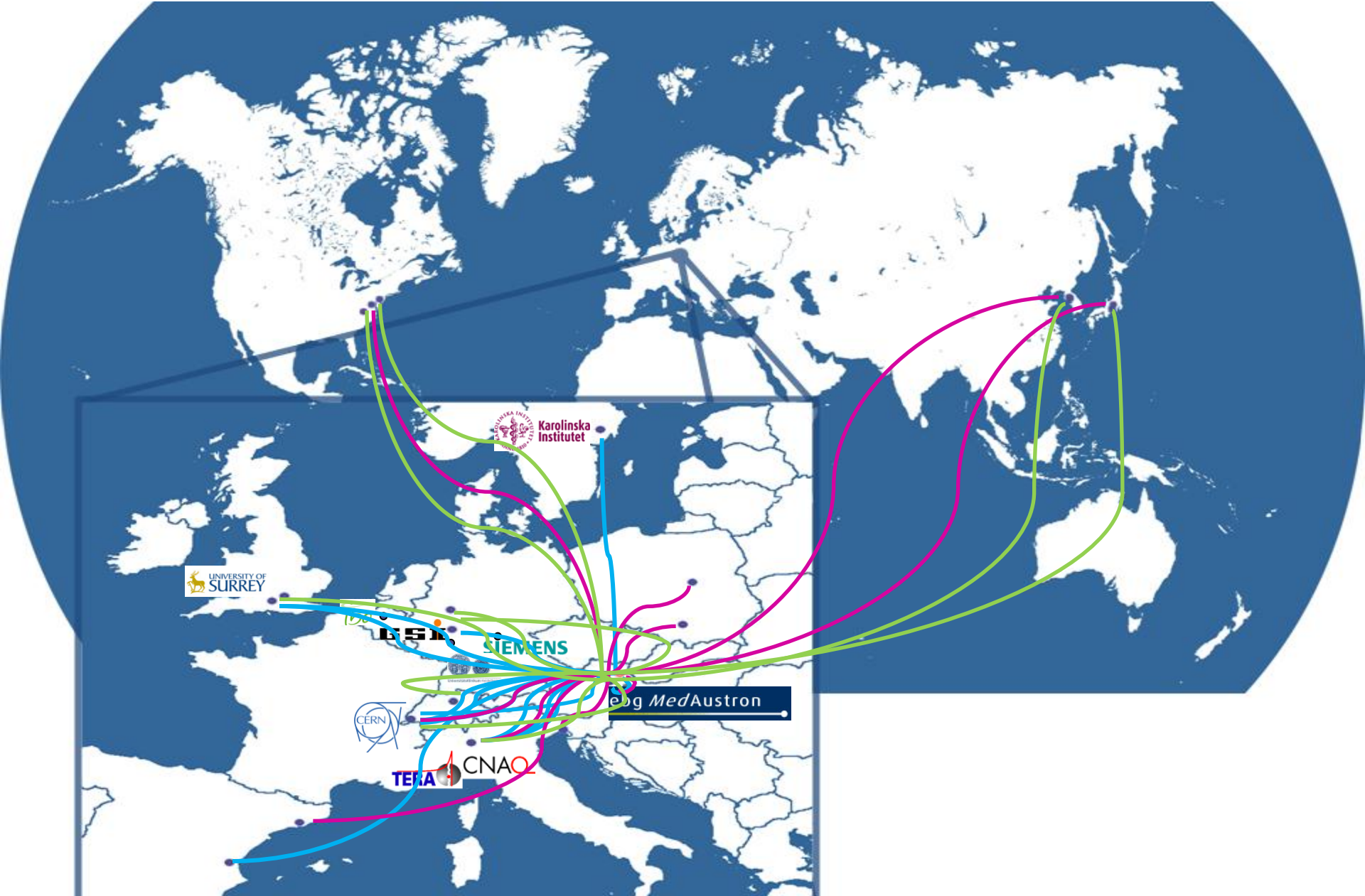




# Courses, Trainings, Conferences, Networking.....

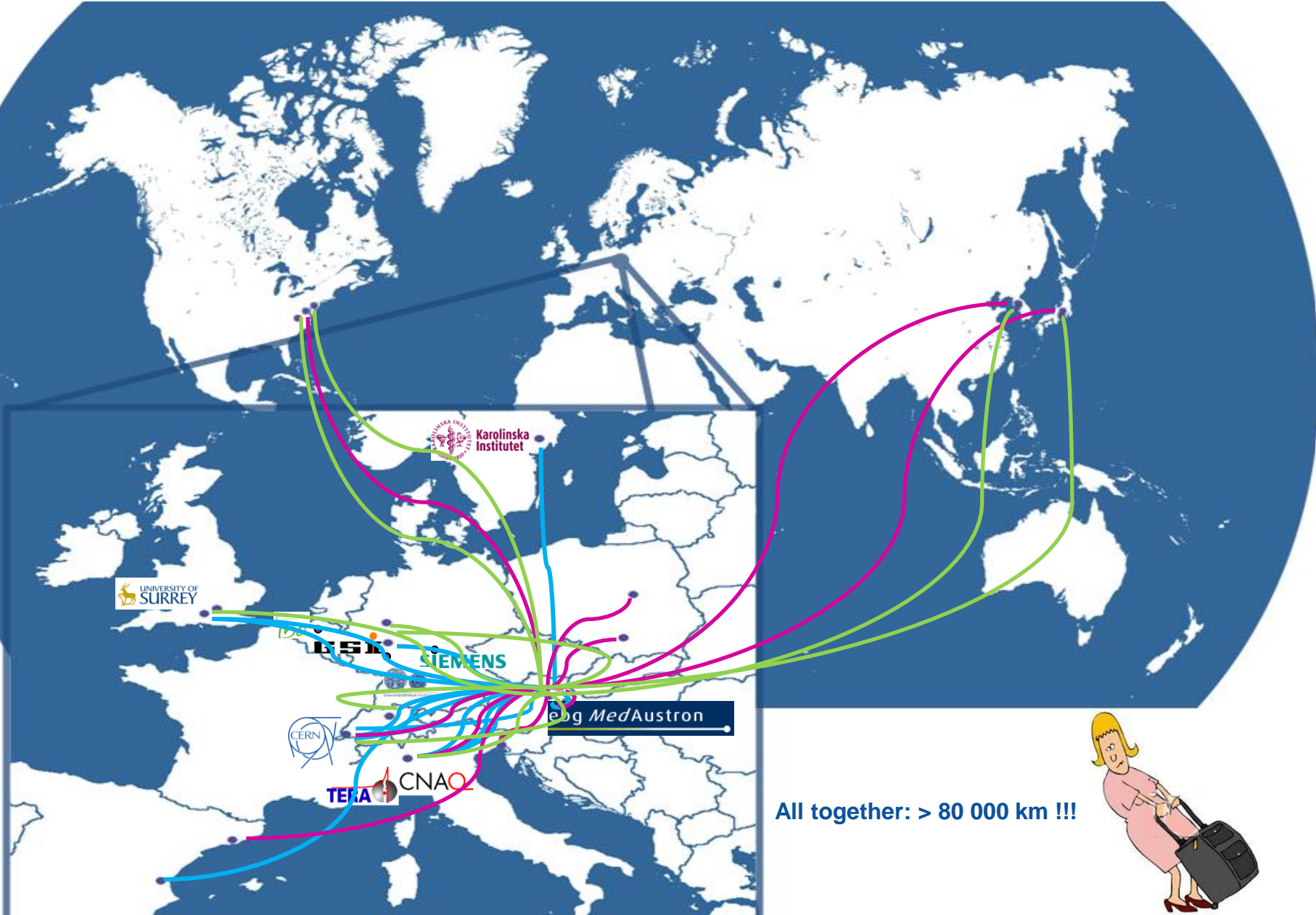


# Courses, Trainings, Conferences, Networking.....





# Courses, Trainings, Conferences, Networking.....





# Research activities

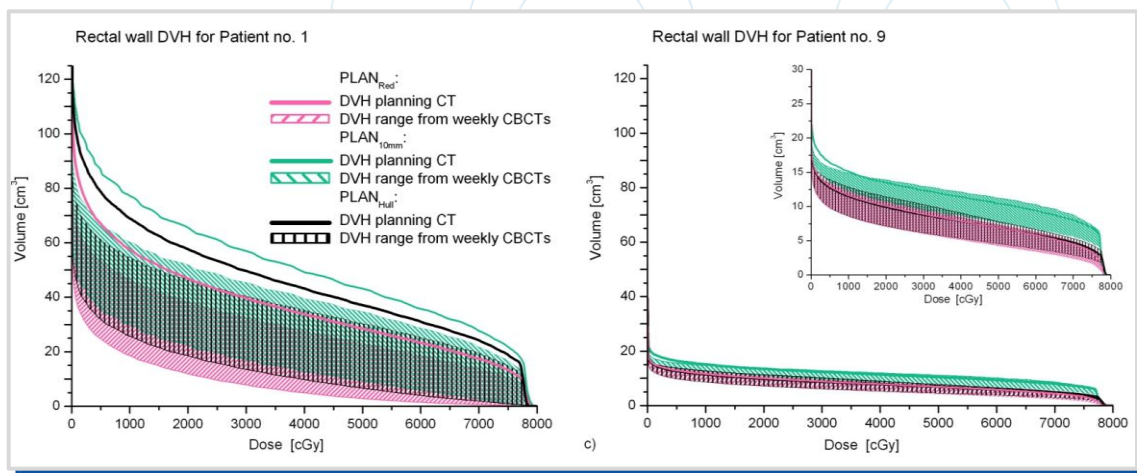
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- I. Patient-specific PTV margins in IMPT for prostate cancer
- II. Participation in ROCOCO study – multicentric *in silico* trials in radiotherapy (photons vs. protons vs. carbon ions)
- III. Participation in dosimetric comparison study of alternative treatment techniques for localized prostate cancer patients (advanced brachy vs. advanced photon vs. ion beam therapy)
- IV. Comparison of different boost techniques for advanced H&N and Prostate cancer (VMAT vs. IMPT vs. IMIT)

# I. Patient-specific PTV margins in IMPT for prostate cancer

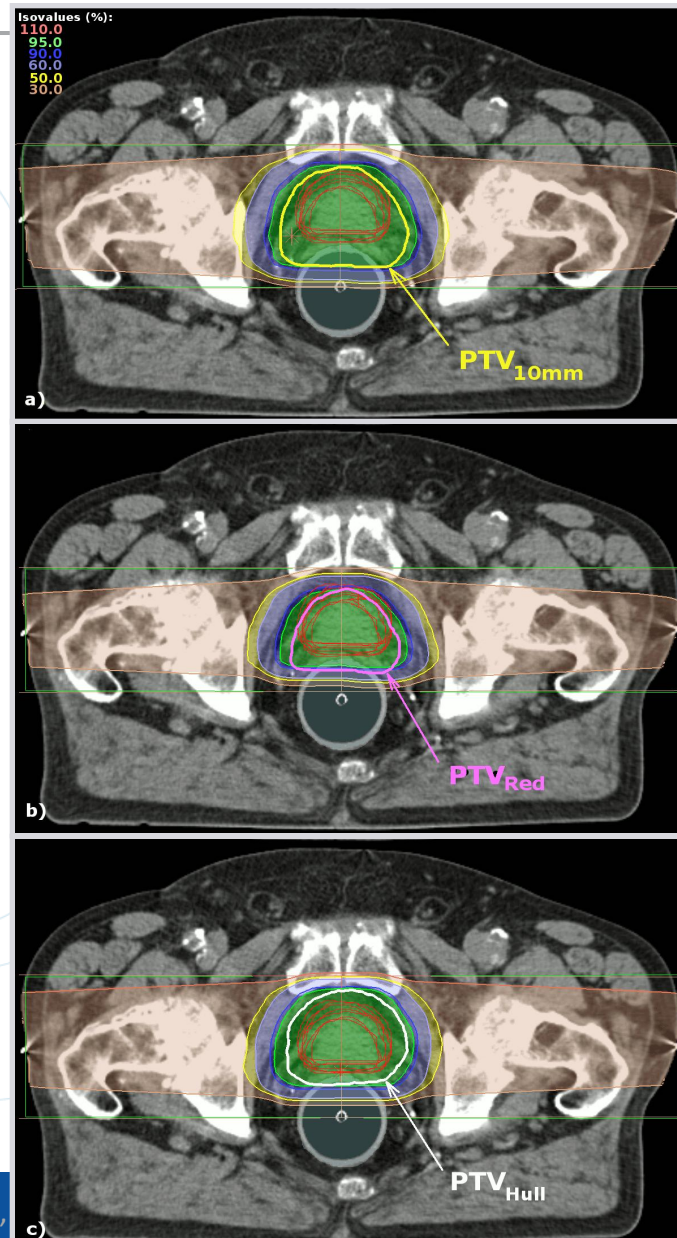
## Purpose:

Investigation of the most robust PTV margins to account for inter-fractional motion in prostate cancer



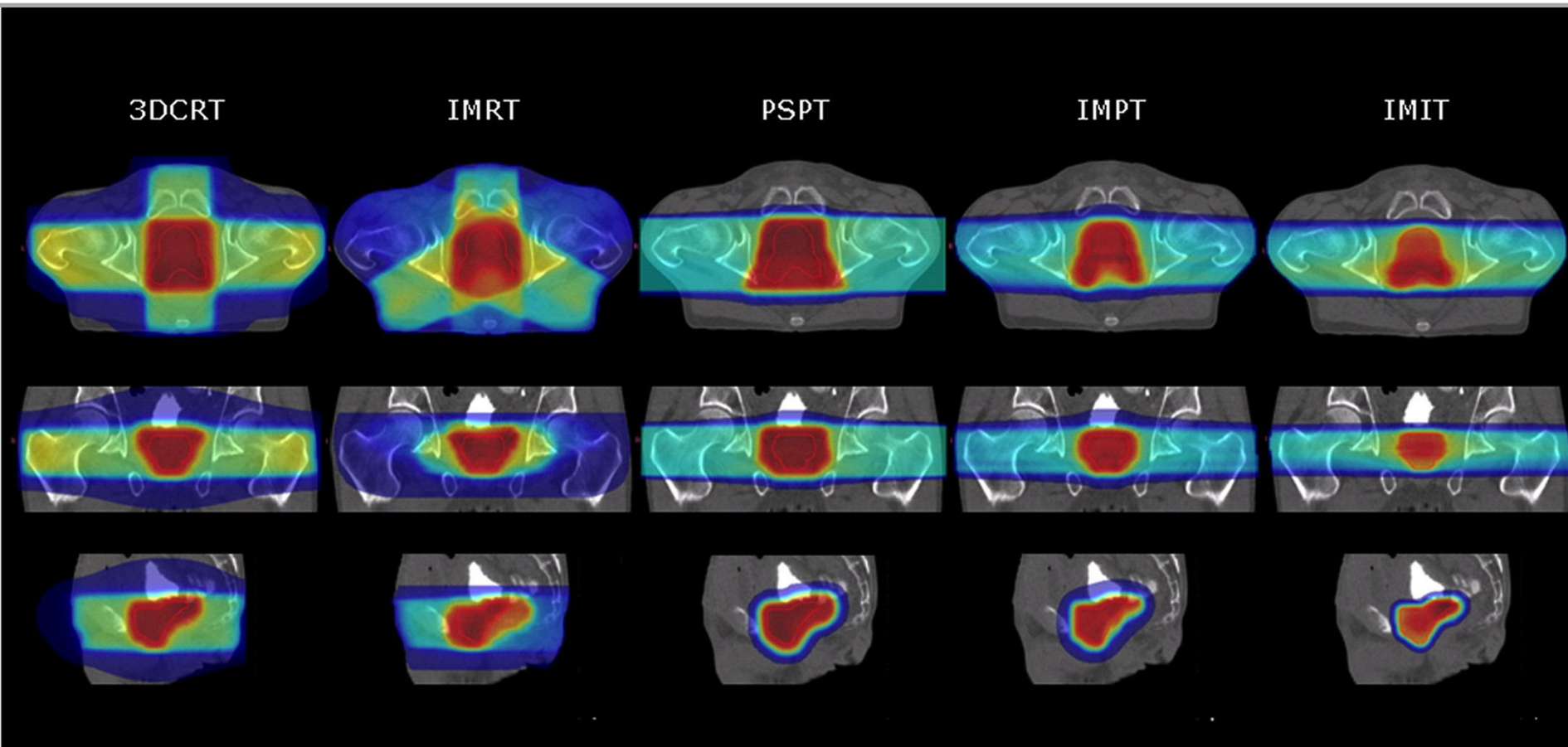
## Conclusions:

- Repeated CBCTs proved to be useful to estimate inter-fractional motion and its impact on the dose distribution
- PTV<sub>Hull</sub> was most insensitive to target motion
- In terms of organ sparing, the PTV<sub>10mm</sub> method was inferior comparing to the PTV<sub>Red</sub> and PTV<sub>Hull</sub> approaches



## II. Participation in ROCOCO study – multicentric *in silico* trials in radiotherapy

<http://rococo.mistir.info>



### General conclusions:

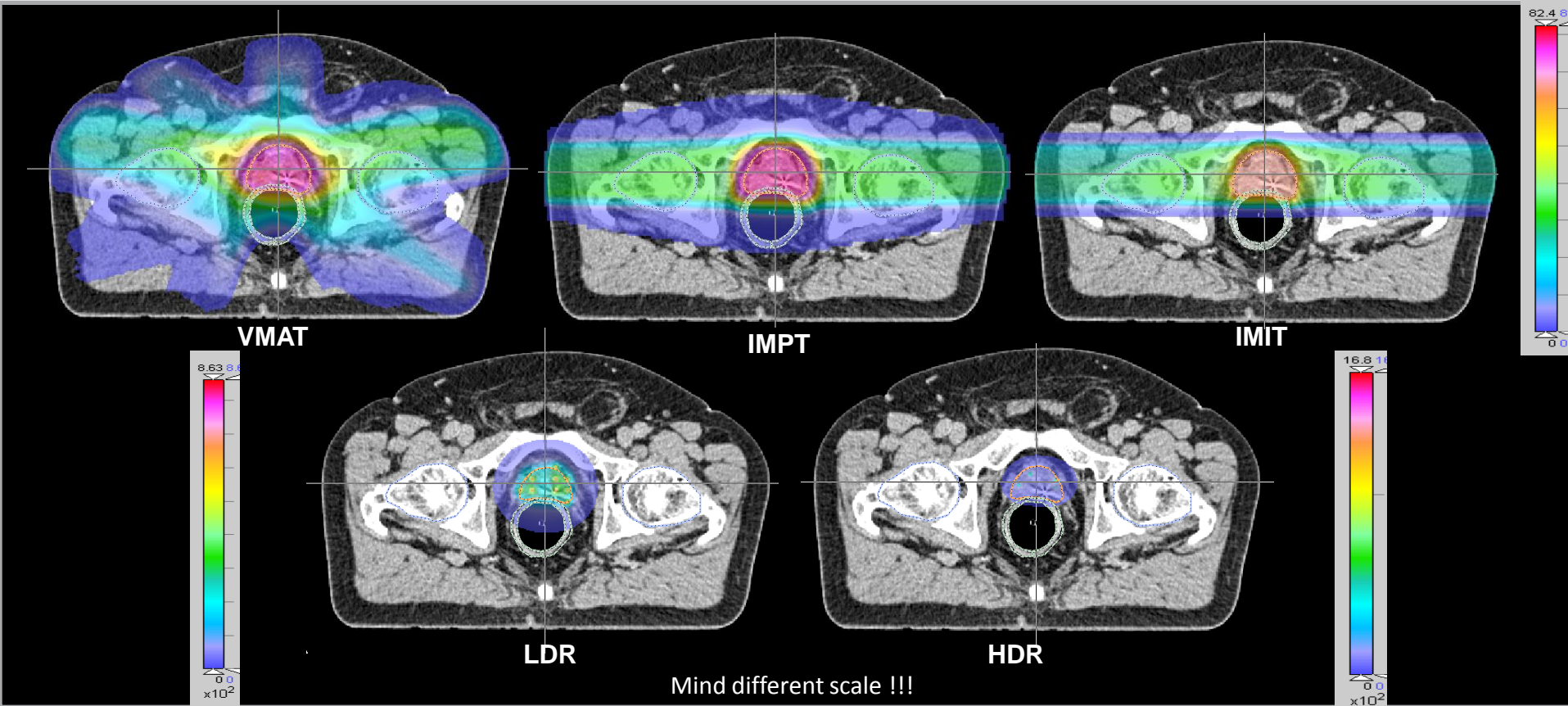
- Best overall performance with IMIT
- High rectal dose ( $D_2$ ,  $V_{70}$ )
- Femoral heads lowest with IMRT

### C-ions

- LEM 1 clinical experience
- LEM 4 has improvements in RBE at edge



### III. Participation in comparison study of alternative treatment techniques for localized prostate cancer patients

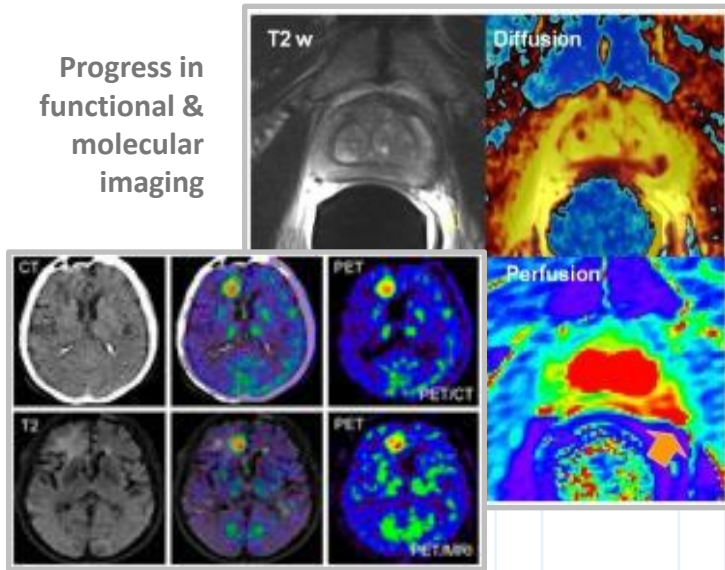


.....Ongoing study

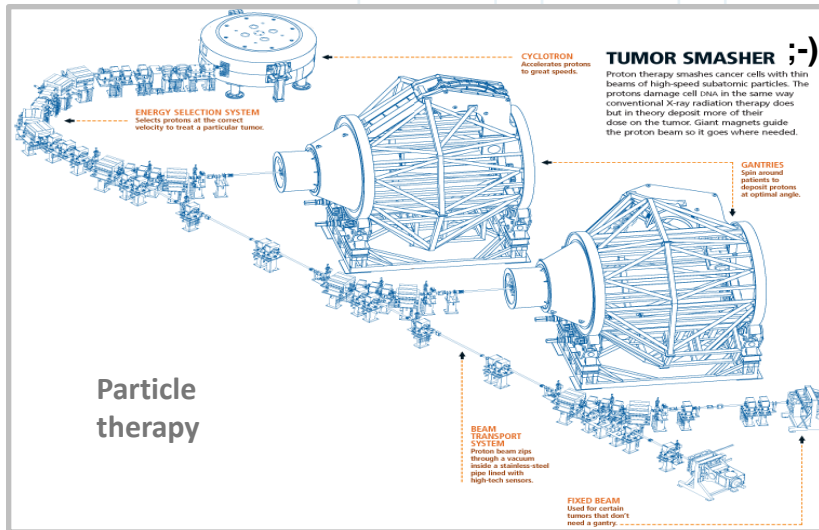
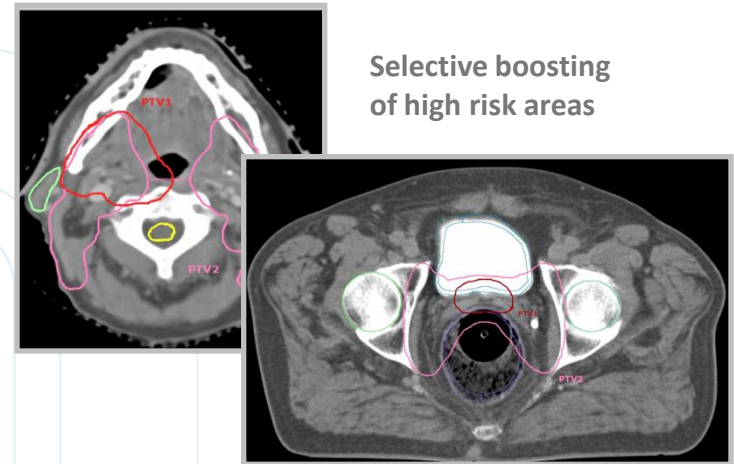


# IV. Comparison of different boost techniques for advanced H&N and Prostate cancer - motivation

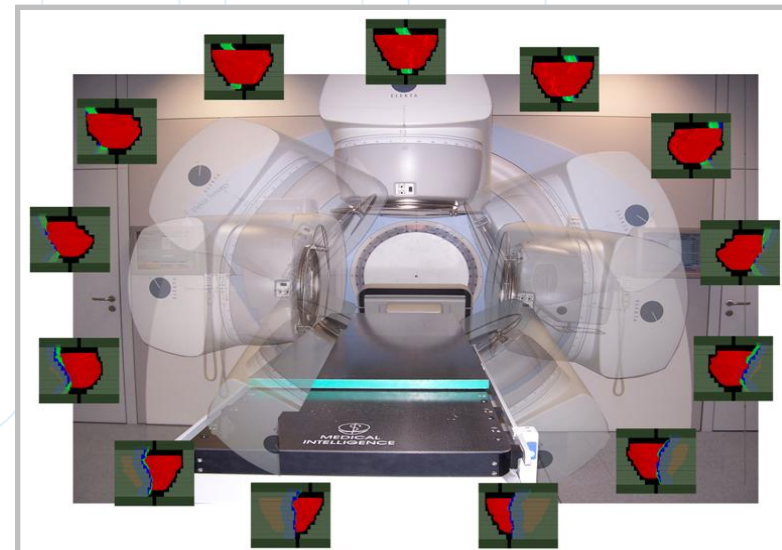
Progress in functional & molecular imaging



Selective boosting of high risk areas

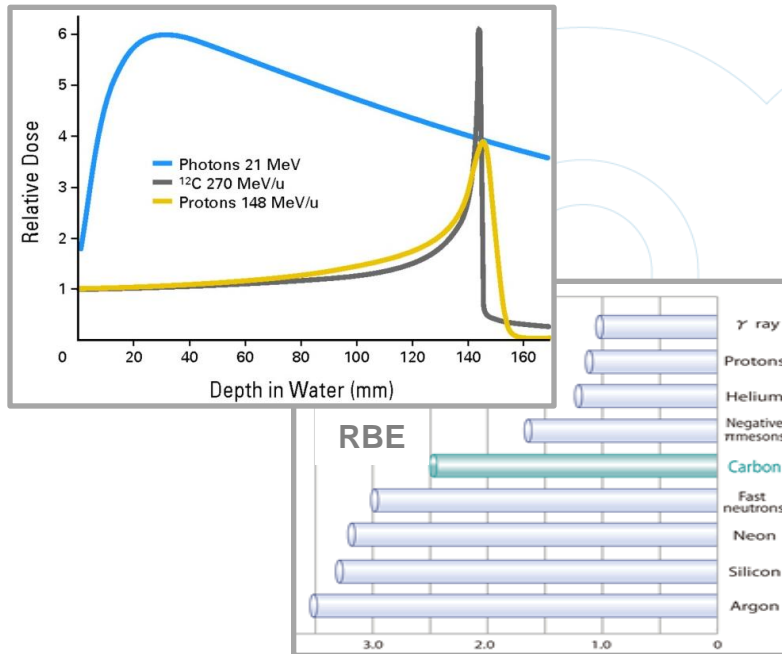


Particle therapy



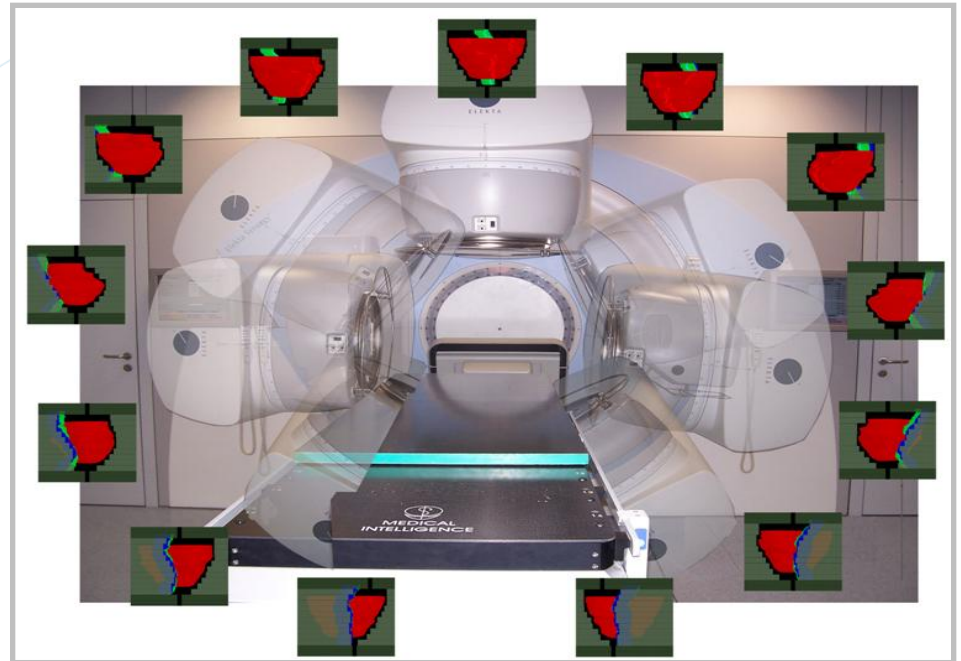
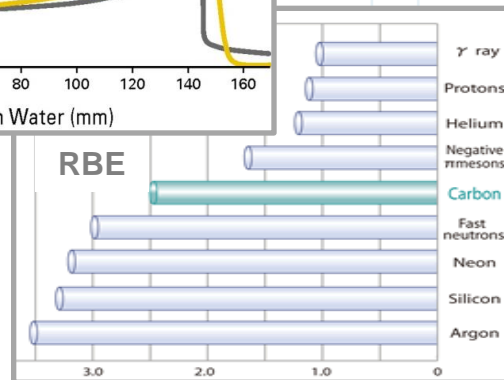
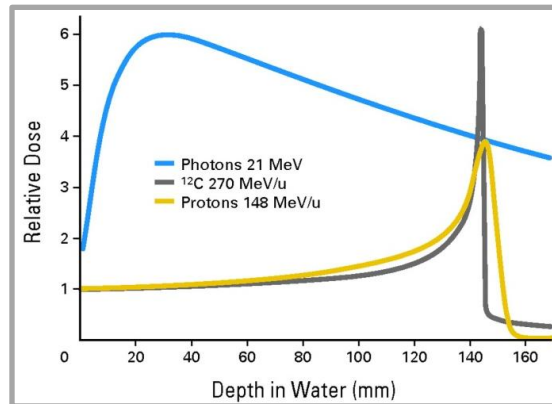
VMAT technology

# IV. Comparison of different boost techniques for advanced H&N and Prostate cancer - introduction



- VMAT- dynamic treatment technique
- radiation is delivered while the gantry rotates around the patient
- the dose is shaped using three variables:
  - MLC shape
  - gantry rotation speed
  - dose rate

# IV. Comparison of different boost techniques for advanced H&N and Prostate cancer - introduction



## Purpose:

- Evaluation of the dosimetric difference between highly advanced photon treatment vs. particle therapy
- Three alternative boost approaches: VMAT, IMPT, IMIT for advanced H&N and high-risk prostate patients

# IV. Comparison of different boost techniques for advanced H&N and Prostate cancer

- Materials & methods

- For each patient 4 treatment plans generated:
  - 1 for  $PTV_{initial}$  (VMAT)
  - 3 for  $PTV_{boost}$  (VMAT, IMPT, IMIT)

Prescribed dose	10 H&N	10 Prostate
Initial plan	$PTV_{initial} = 50 \text{ Gy}$	$PTV_{initial} = 50.4 \text{ Gy}$ , $PTV_{10mm} = 56 \text{ Gy}$
Boost plan	$PTV_{boost} = 20 \text{ GyE}$	$PTV_{boost} = 22 \text{ GyE}$

- Initial plans are summed up with the boost plans in order to evaluate the outcome of the whole treatment

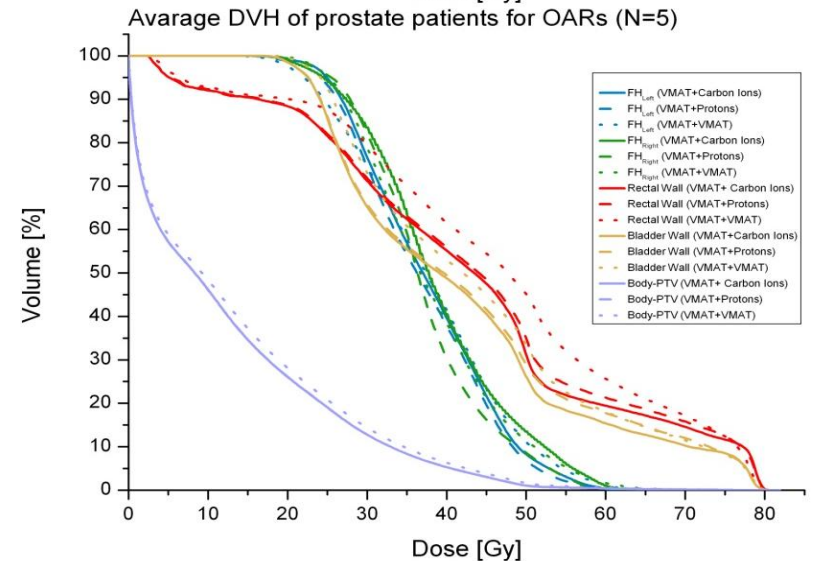
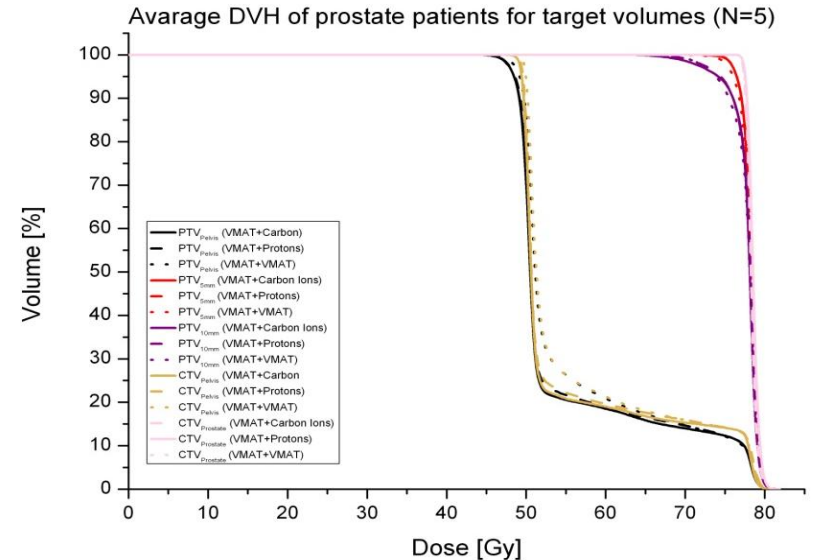
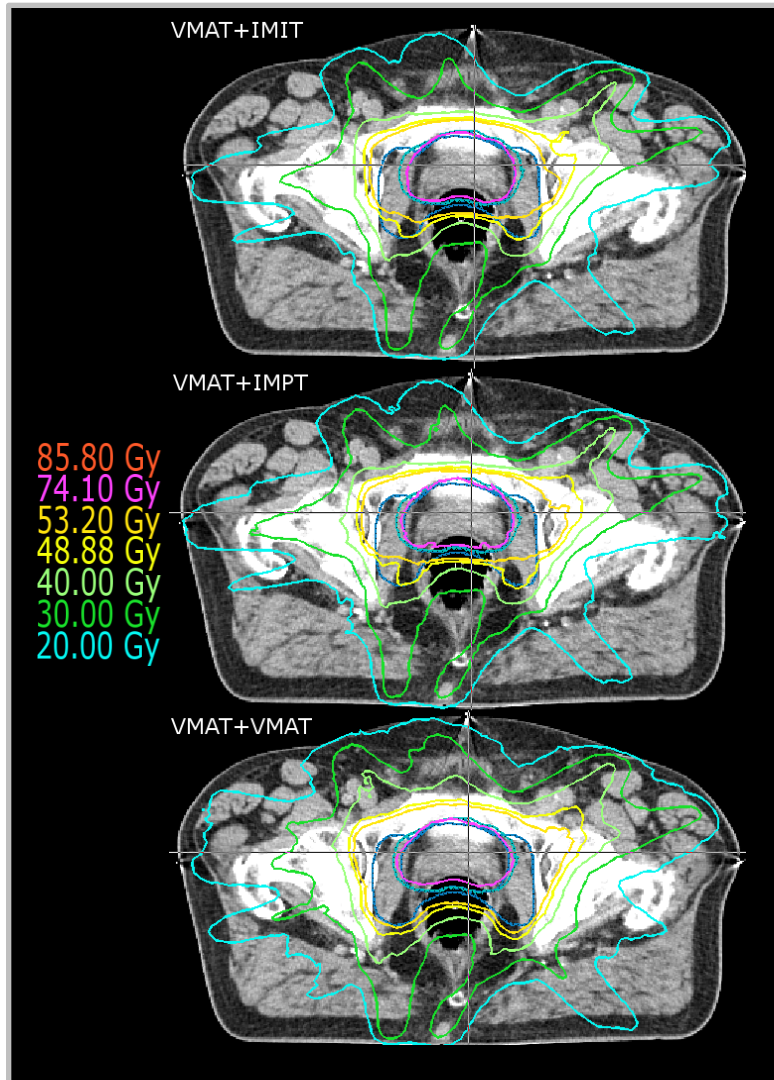


## IV. Comparison of different boost techniques for advanced H&N and Prostate cancer

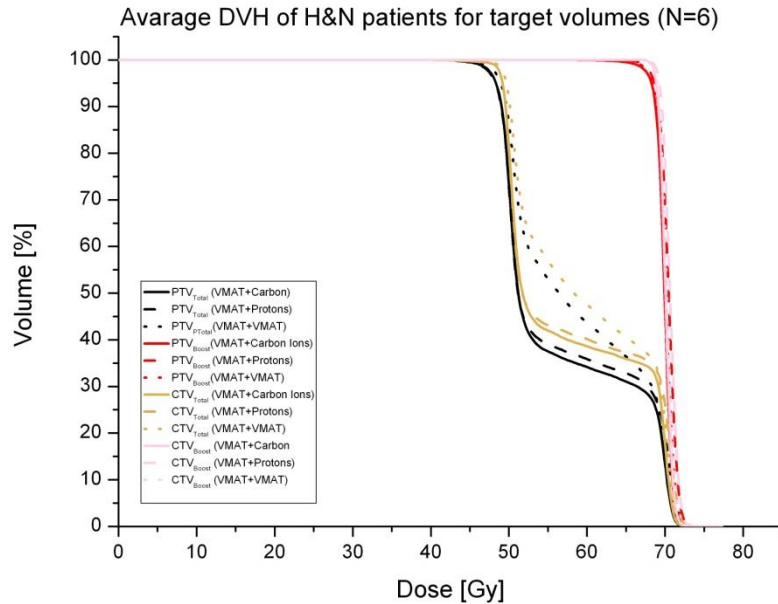
- Materials & methods cont.

		VMAT	IMPT	IMIC
TPS		MONACO (ELEKTA)	XiO (ELEKTA)	TRiP (GSI)
Calculation algorithm		MC for photons	Pencil beam	Pencil beam
RBE		1	1.1	LEM 1
Initial plan		2 arcs	-	-
Boost plans	Prostate	1 arc	2 beams (90°, 270°)	2 beams (90°, 270°)
	H&N	1 arc	2 beams (45°,90° or 270°, 315°)	2 beams (45°,90° or 270°, 315°)

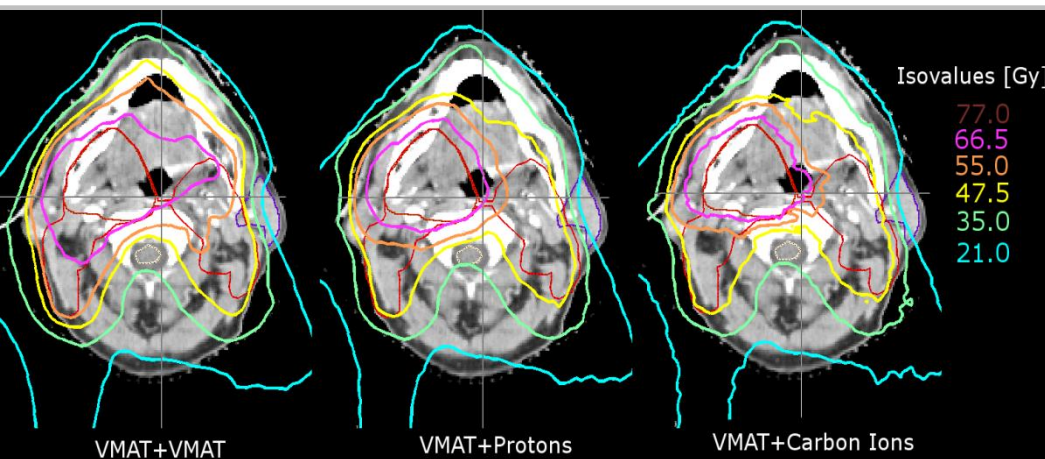
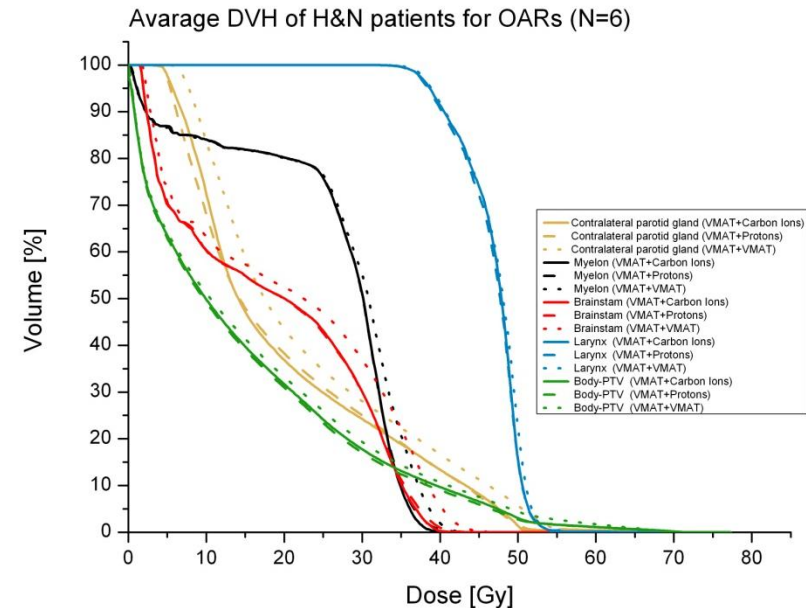
# IV. Comparison of different boost techniques for advanced H&N and Prostate cancer – preliminary results



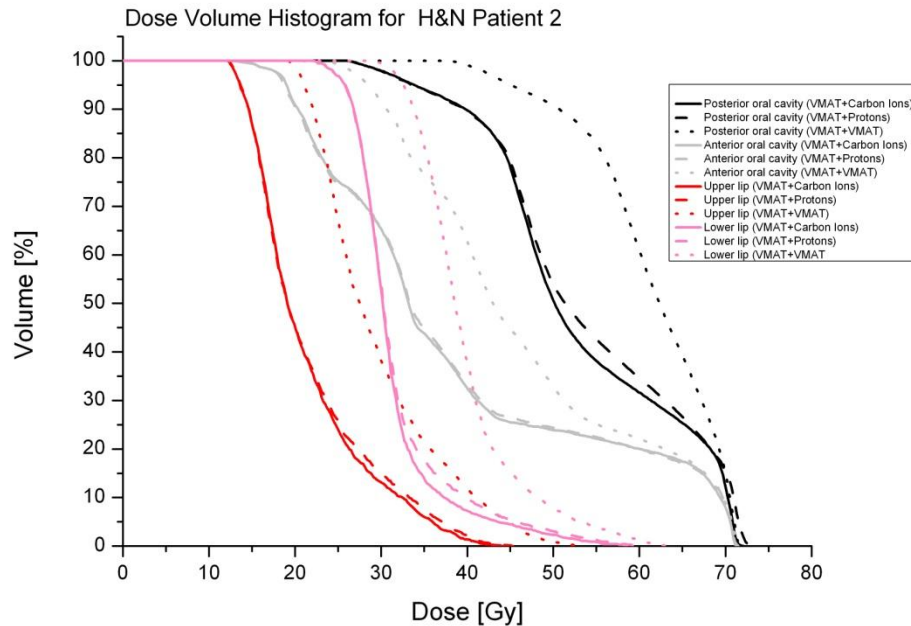
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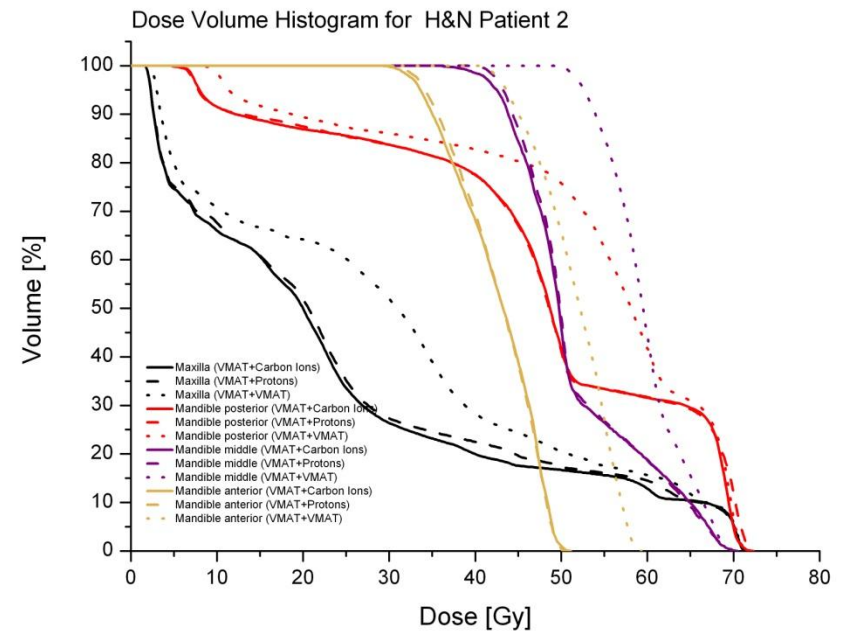
H&N Patients



# IV. Comparison of different boost techniques for advanced H&N and Prostate cancer – preliminary results

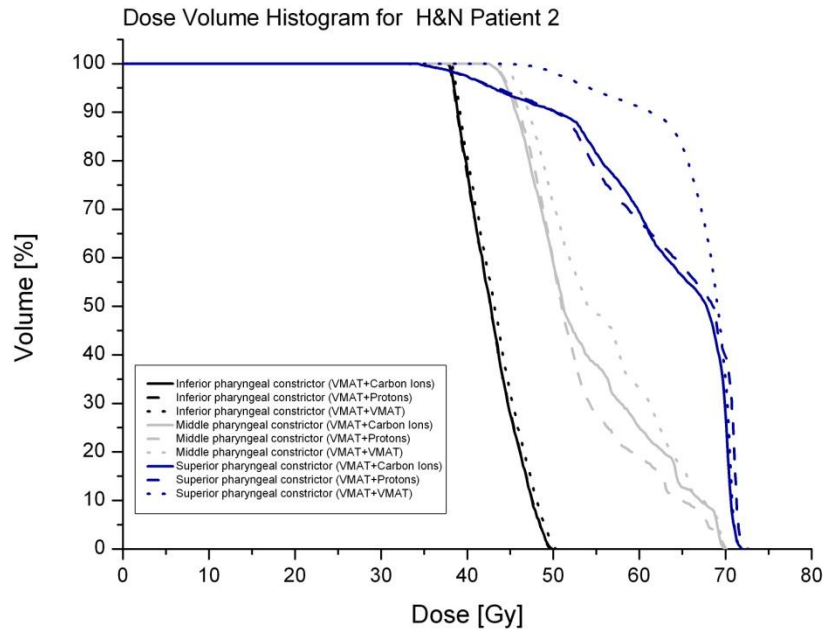


Additional organs of interest for H&N Patients

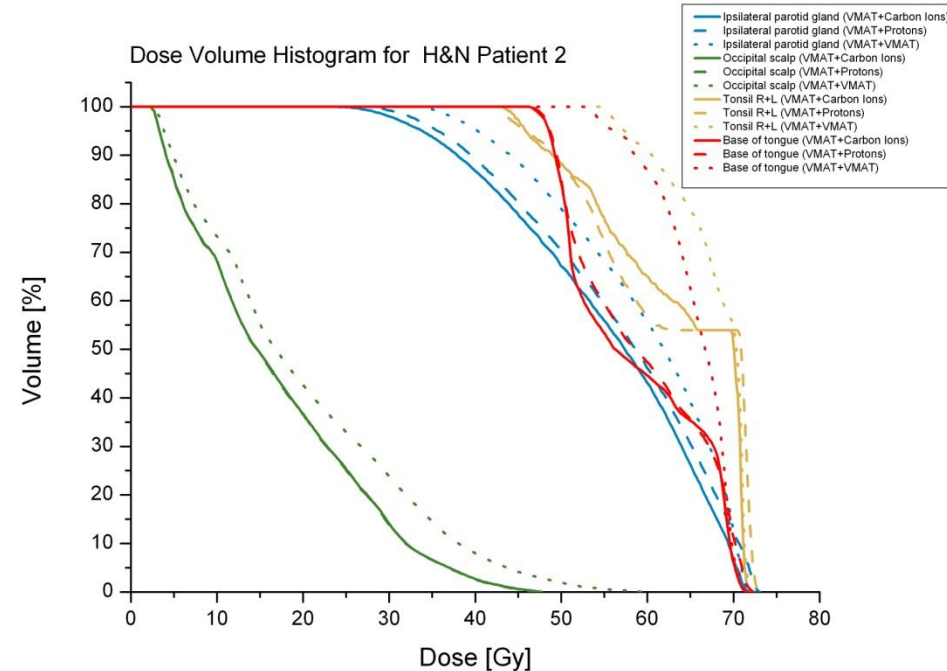




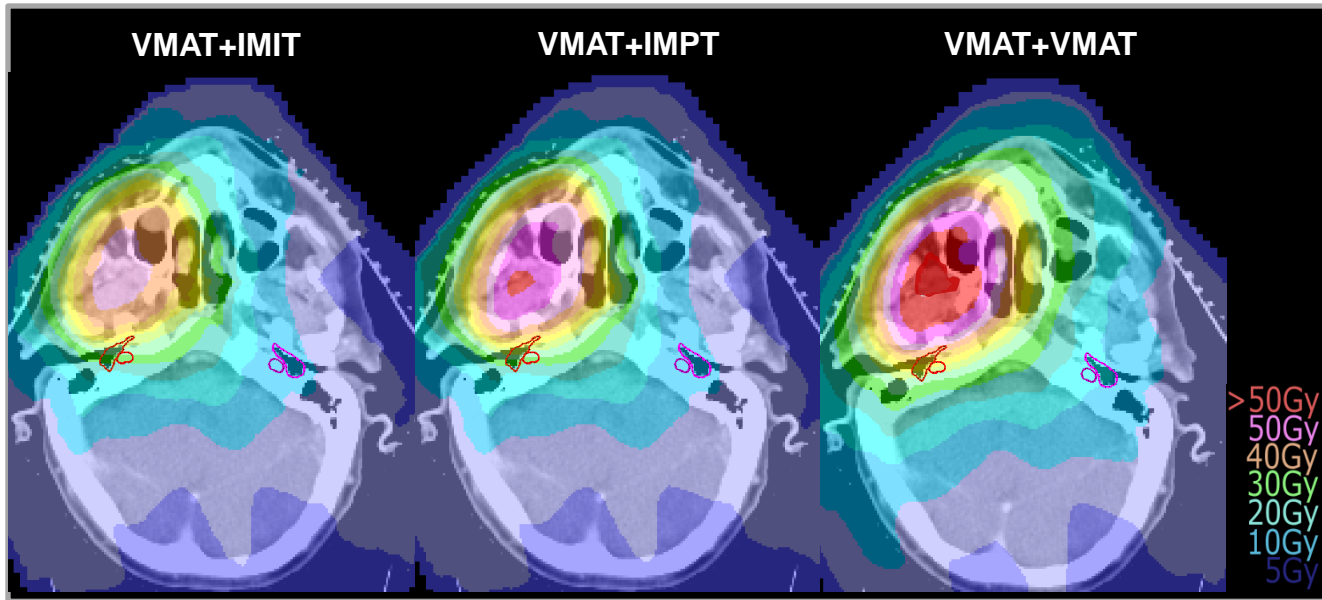
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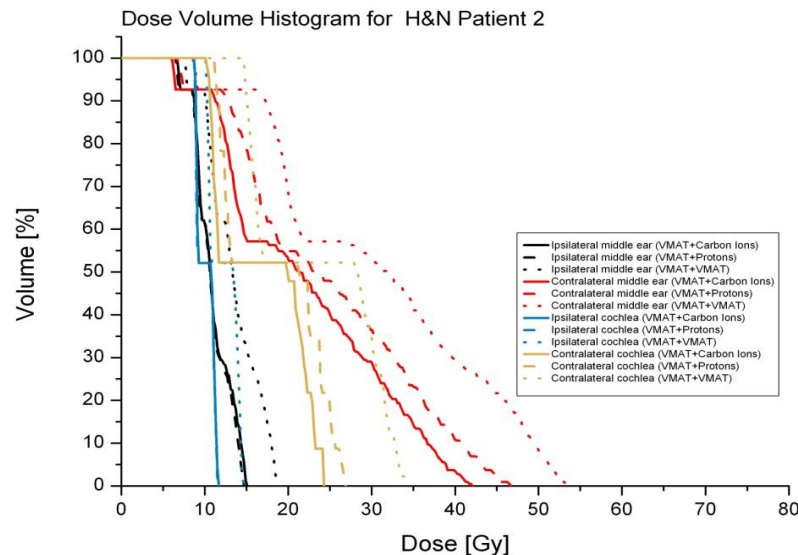
Additional organs of interest for H&N Patients



# IV. Comparison of different boost techniques for advanced H&N and Prostate cancer – preliminary results



Additional organs of interest for H&N Patients



Right after target ends

# IV. Comparison of different boost techniques for advanced H&N and Prostate cancer – (pre)conclusions

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- VMAT is able to achieve similar target coverage as IMPT or IMIT
- No big differences in integral dose within all 3 techniques
- Particle modalities spared OARs more comparing to VMAT => IMIT was a bit better than IMPT (especially for bladder and rectal wall for PC and myelon for H&N) , but if the difference is significant (!?)
- Results for the first H&N patient shows that particles can spare better other organ of interest. Limiting doses to those structures can be associated with better quality of life after radiation (breathing, swallowing, hearing)

# Acknowledgments

## MUV:

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Ramona Mayer

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**COUNTLESS OTHERS**, who I've met during our PARTNER journey .....

**Thank you all!!!!**

