Capital Market Day

Olivier Legrain (CEO)

22 October 2018

Agenda

Introduction

Olivier Legrain, Chief Executive Officer, IBA

Proton therapy US Market evolution

Beth Klein, President IBA North America

Model-Based Approach development in Europe and in USA

Prof. Dr. J.A. Hans Langendijk, Chair, Department of Radiation Oncology at University Medical Center Groningen

The Beaumont experience with Proteus®One after one year of operation

Craig W. Stevens, MD, PhD, Chair of Radiation Oncology, Beaumont Health System

Questions and answers

Optional tour of IBA's booth, # 2135

Disclaimer

This presentation may contain forward-looking statements concerning industry outlook, including growth drivers; the company's future orders, revenues, backlog, or earnings growth; future financial results; market acceptance of or transition to new products or technology and any statements using the terms "could," "believe," "outlook," or similar statements are forward-looking statements that involve risks and uncertainties that could cause the company's actual results to differ materially from those anticipated. The company assumes no obligation to update or revise the forward-looking statements in this release because of new information, future events, or otherwise.

Strategy for growth

Grow the PT market

- Facilitate evidence generation
- Increase awareness of PT benefits
- Increase affordability of PT solutions

Examples of IBA initiatives to support PT adoption

- Support of Proton Collaborative Group (PCG)
- Support of patient advocacy groups (e.g. Alliance)
- Promote the model based approach for proper patient selection
- Leverage IBA PT Users meeting
- Expand symposiums on PT
- Facilitate multidisciplinary focus groups
- Launch Victoria Advisory Committee at ASTRO 2018 to define the future of Proton Therapy
- Publicize white papers
- Continuously strive to reduce treatment cost

Strategy for growth

Increase IBA's market share

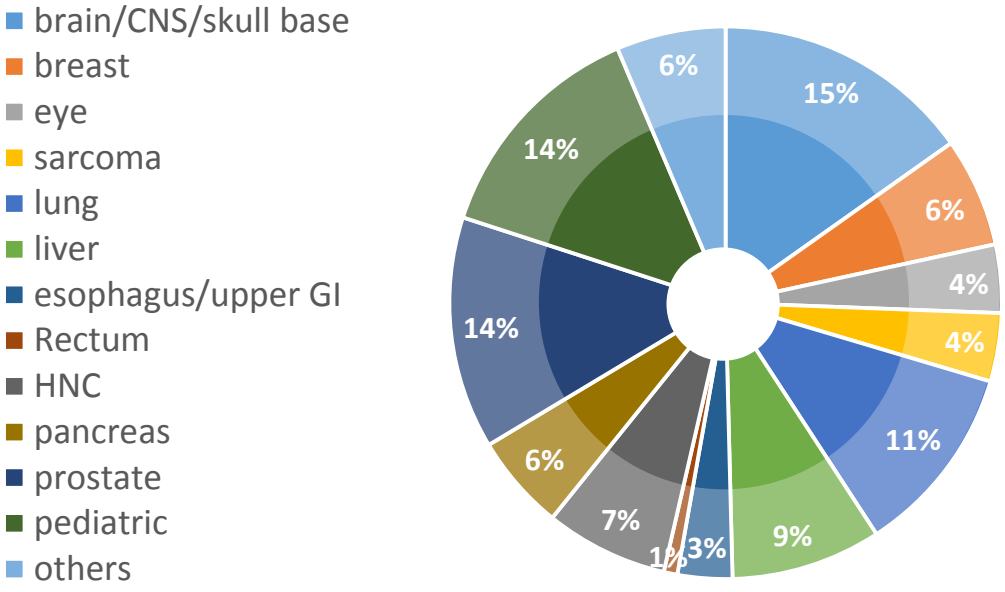
- Superior clinical technology
- Fastest installation in the market
- Reliability of IBA equipment
- Continuous upgradability of systems
- Strategic Partnerships

Example of initiatives to increase market share

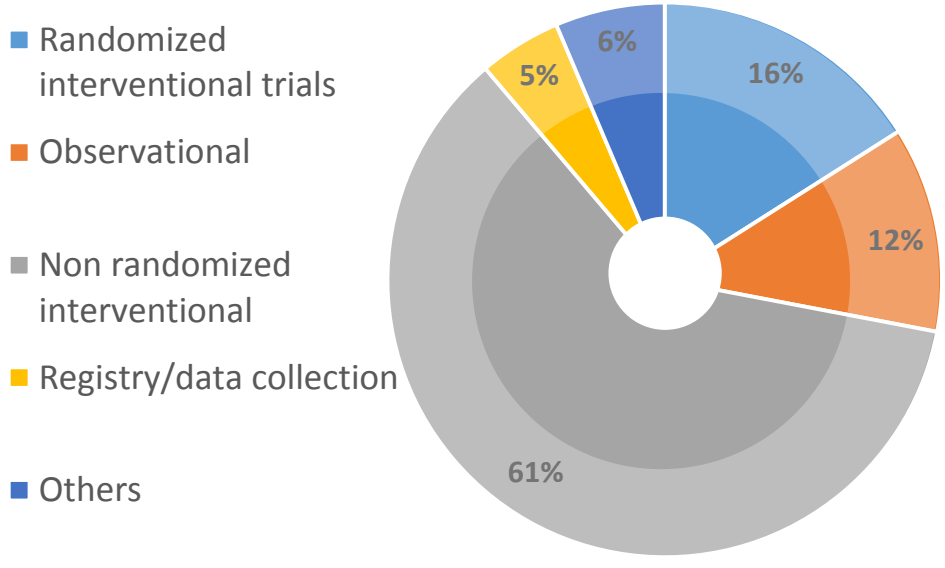
- Continued research and development on beam, imaging, workflow and software integration
- Continued reduction of installation time
- Proven availability of IBA systems (uptime of 98%)
- Most comprehensive training program
- All systems upgradable to the latest technology
- Largest and most experienced PT users community
- Continued clinical innovation with our partners
- Extension of sales network with our partners
- Open vendor policy coupled with strong partnerships with RT leaders

On going trials on a large number of indications

Trials by Tumor Site



Trials by Type of Design



19 Oct 2018, on clinicaltrial.gov

Long-term potential of PT is encouraging

North America

- Change of business model (integrated approach)
- Beaumont: highly compelling clinical and business case
- PT prospects on the rise

Europe

- Special issue of the Green Journal on PT
- Model based approach is gaining momentum

APAC

- IBA is the only PT company with an operating licence in China
- Market environment still fuzzy

Growing evidence globally

174 on going trials at end H1 2018

287 publications in H1 2018

8 high level seminars promoting PT in all regions

Emergence of new treatment modalities

Hypofractionation

Arc Therapy

Flash Therapy

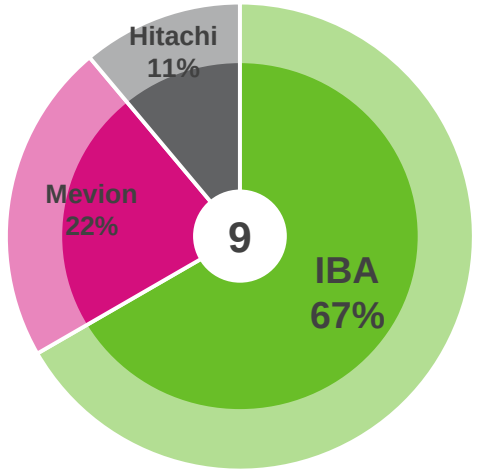
Combination with immunotherapy

IBA leads the PT market

Market Evolution

IBA leading market share – order intake 2018

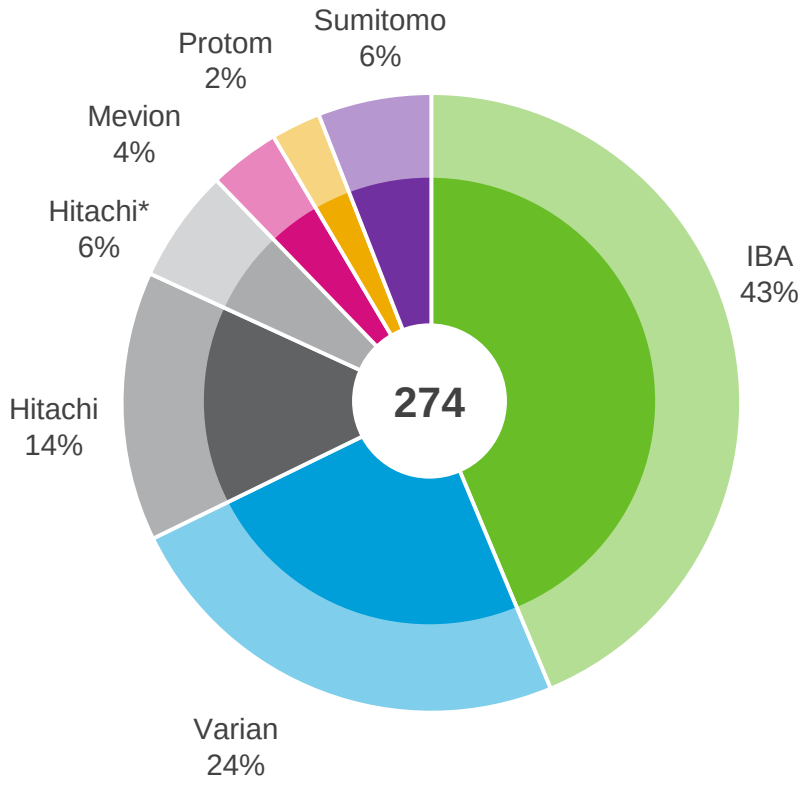
Center	No of rooms	Region	Vendor
Proton Partners International 7*	1	Europe	IBA
Proton Partners International 8*	1	Europe	IBA
Proton Partners International 9*	1	Europe	IBA
European Institute of Oncology (IEO)**	1	Europe	IBA
China CNNR**	1	Asia	IBA
Parkway Pantai	1	Asia	IBA
Jiangxi Cancer Hospital	1	Asia	Mevion
Tokushukai Medical Group	1	Asia	Hitachi
University of Utah	1	North America	Mevion



* Under financing
** Down payment received

IBA – a global leader in proton therapy

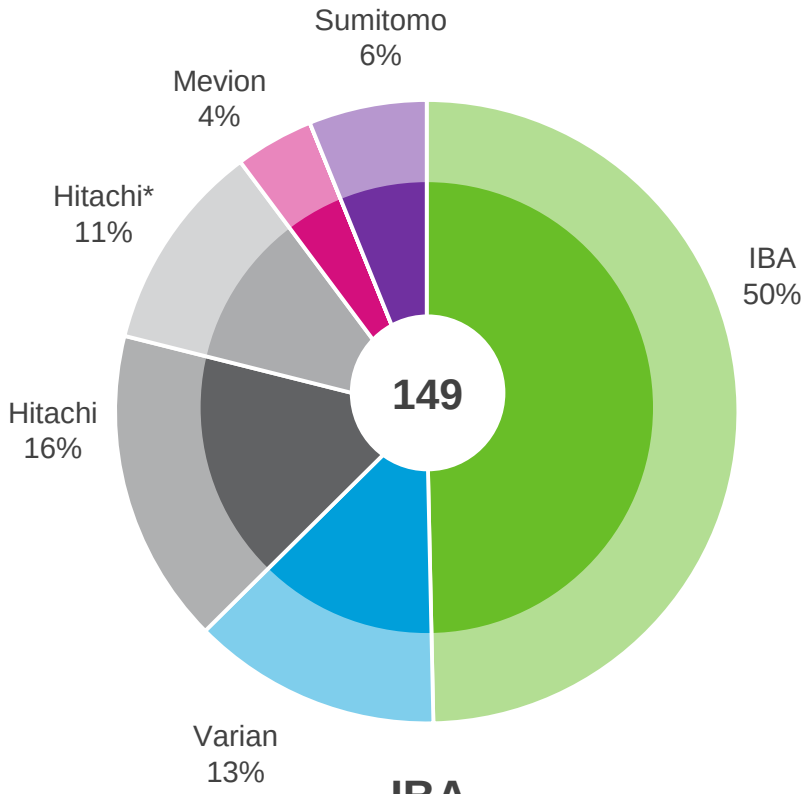
Sales



IBA
118 rooms

Market share in rooms

In operation



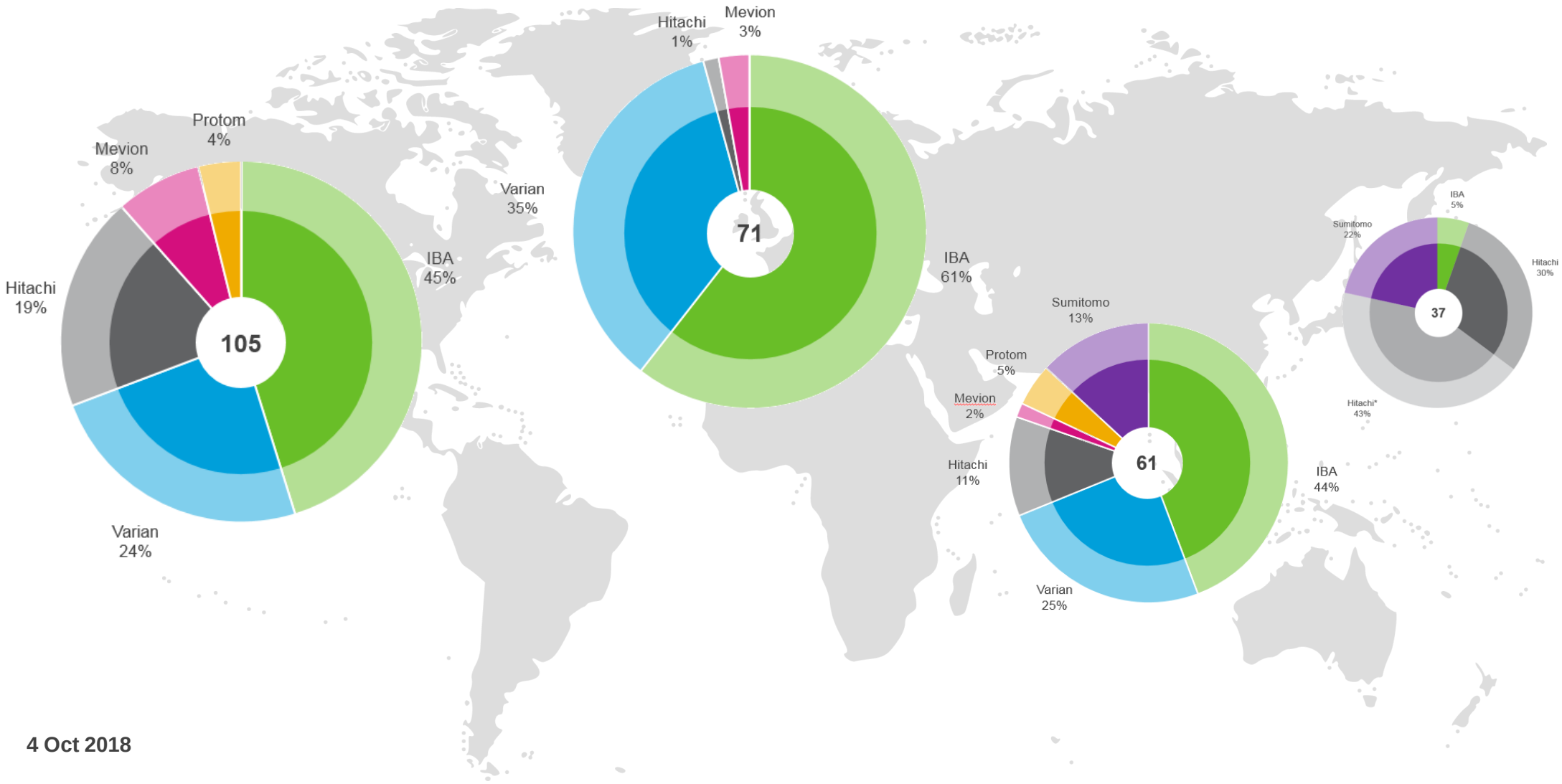
IBA
75 rooms

About **70,000 patients** have been treated on IBA systems

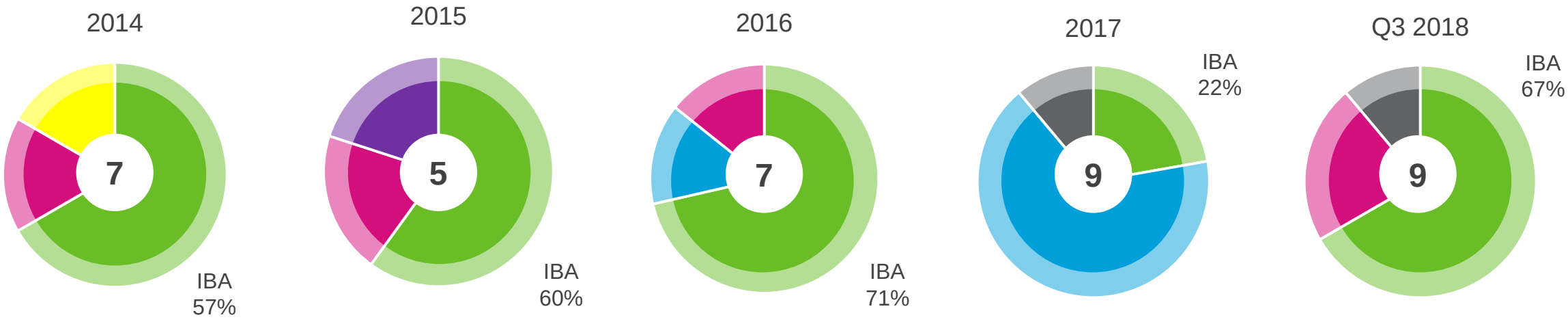
4 Oct 2018

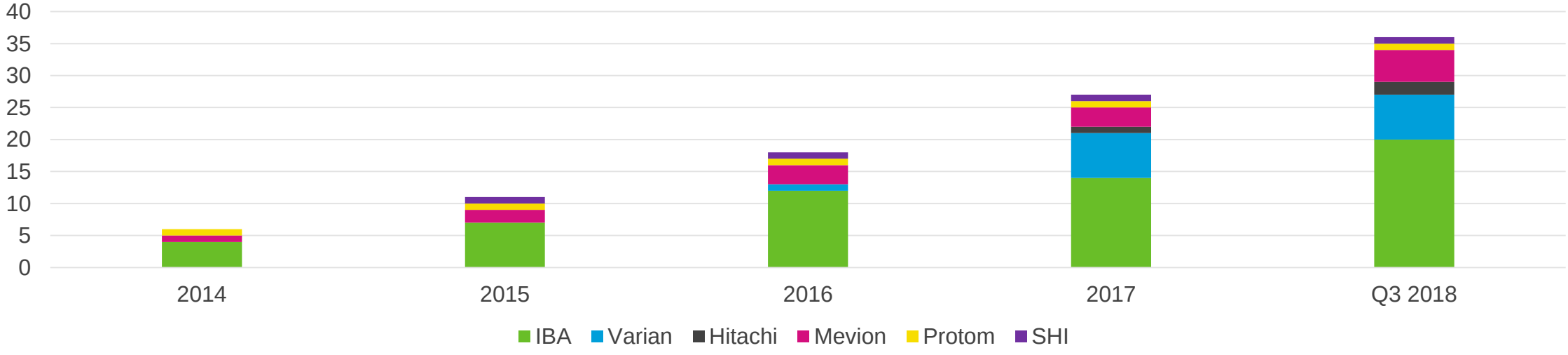
* Mitsubishi (MELCO) bought by Hitachi

IBA – a global leader in proton therapy

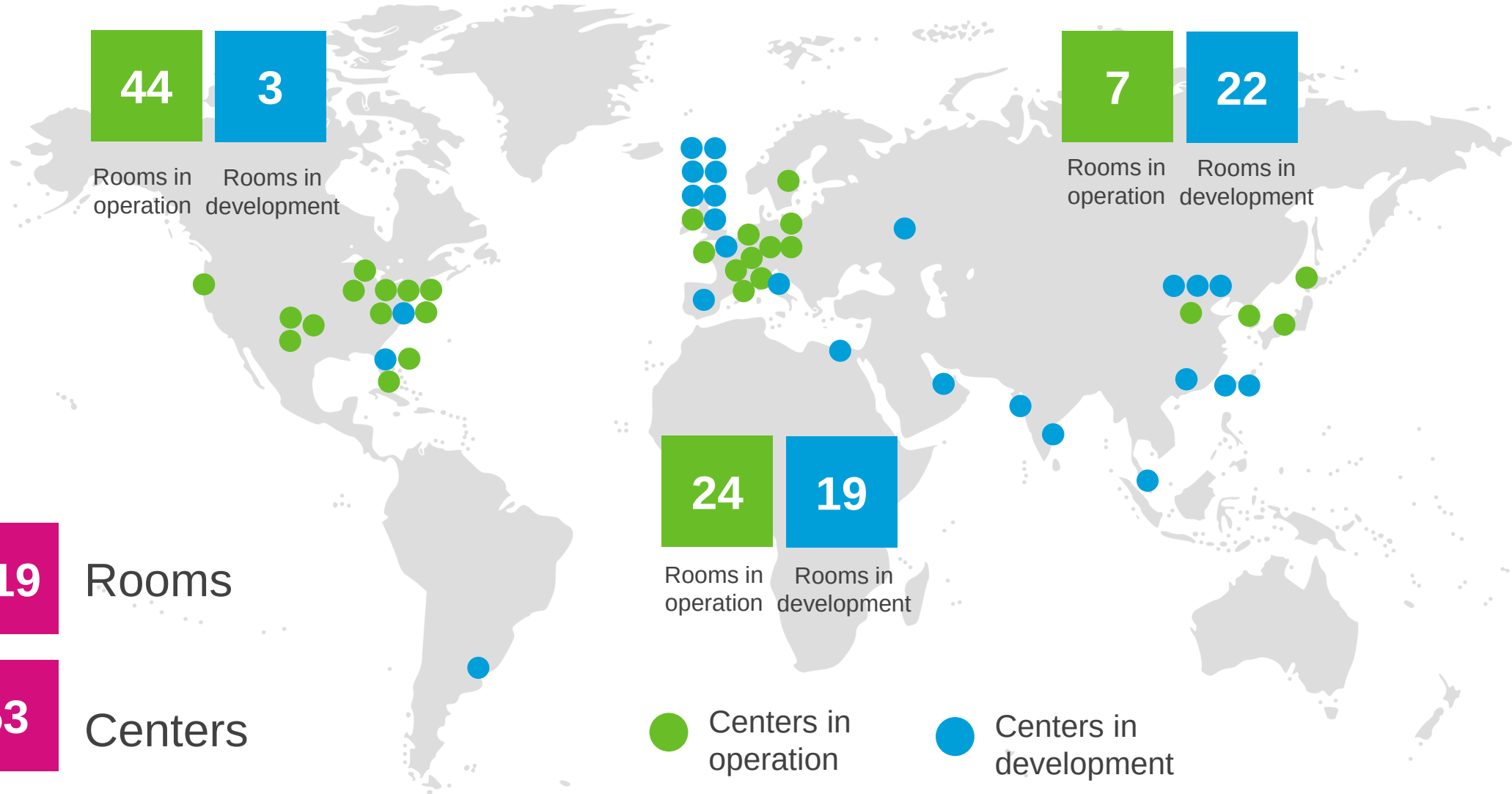


Evolution of single room solution market share





IBA – a global leader in proton therapy

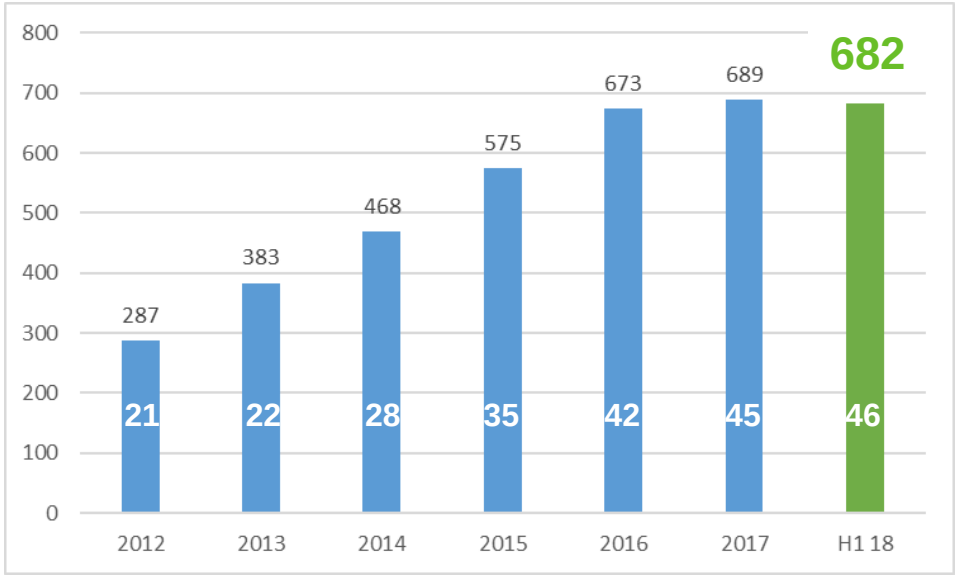


119 Rooms

53 Centers

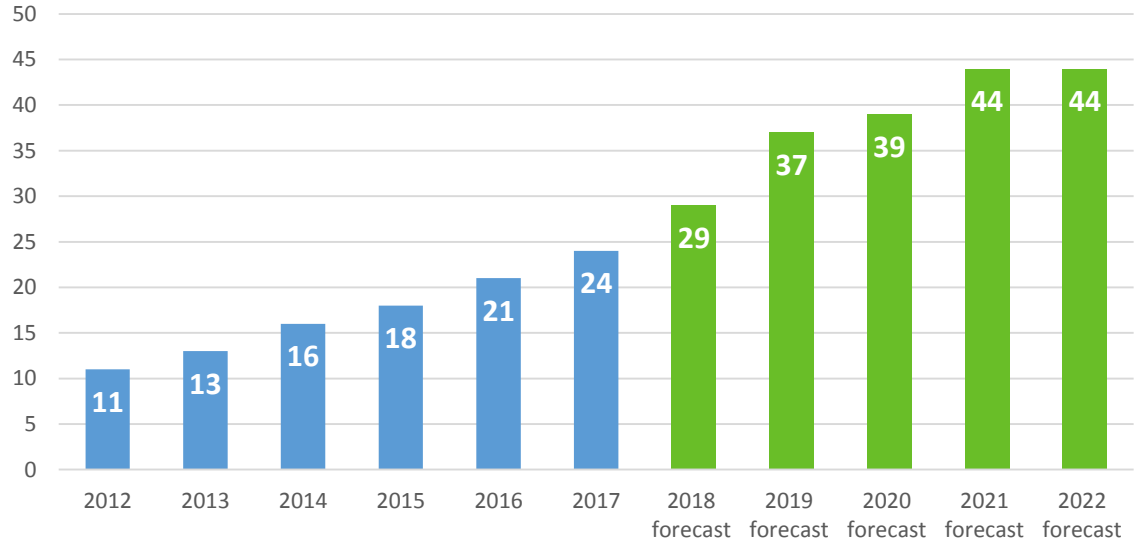
IBA Service revenues

- Service backlog



Figures in million euros

- Service contracts



Including only financially activated contracts

IBA leads the PT market

IBA Solutions

Undisputable advantages of IBA solutions

- Fastest installation
- True compactness
- Smart workflow
- Clinical excellence
- Software integration
- Strategic partnerships
- Innovation built on expertise
- Continuum upgradability

Proteus®ONE

In the most important segment - single room solutions,
IBA is by far stronger than the competition

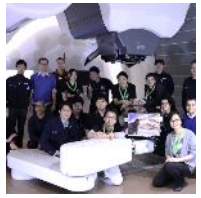
Proteus®ONE and Proteus®PLUS are brand names of Proteus 235

Fastest installation in the market

Consistently delivered* on schedule < 12 months in H1

Proteus®**ONE**
Rutherford CC, Newport, UK
9 months**

Proteus®**ONE**
Toyohashi , Japan
10 months**



Proteus®**ONE**
Hokkaido Ohno, Sapporo, Japan
11 months

Proteus®**ONE**
Cyclhad/Archade, Caen, France
12 months

Proteus®**PLUS**
UMCG, Groningen, The Netherlands
12 months

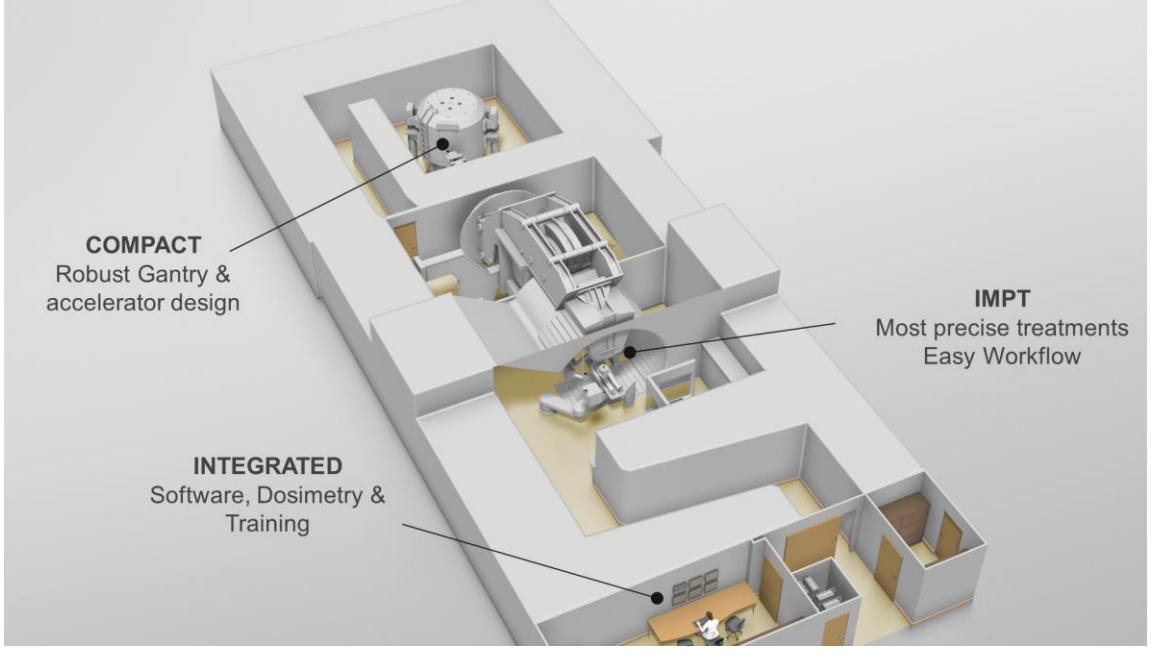
Vs 28 months for IBA's main competitor in HPTC***

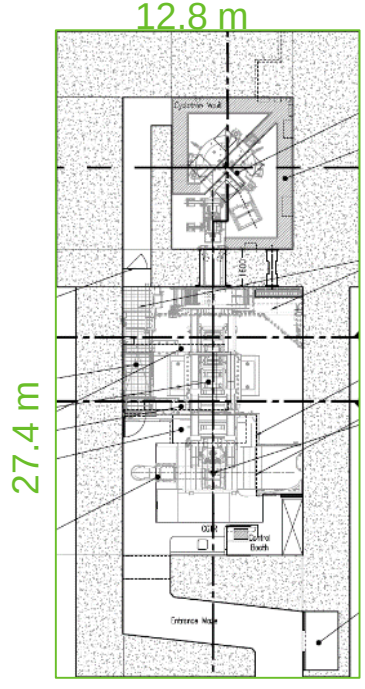
* From rigging to acceptance ** Non standard installation ***Latest installation with system #7

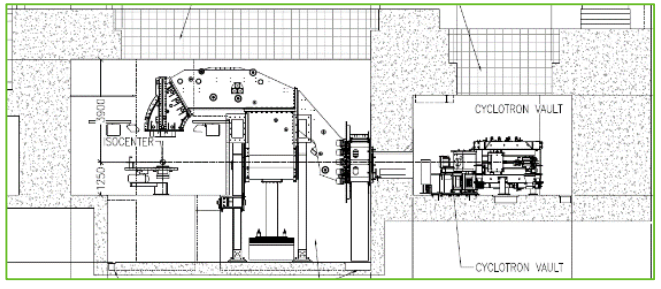
True compactness

Proteus®ONE

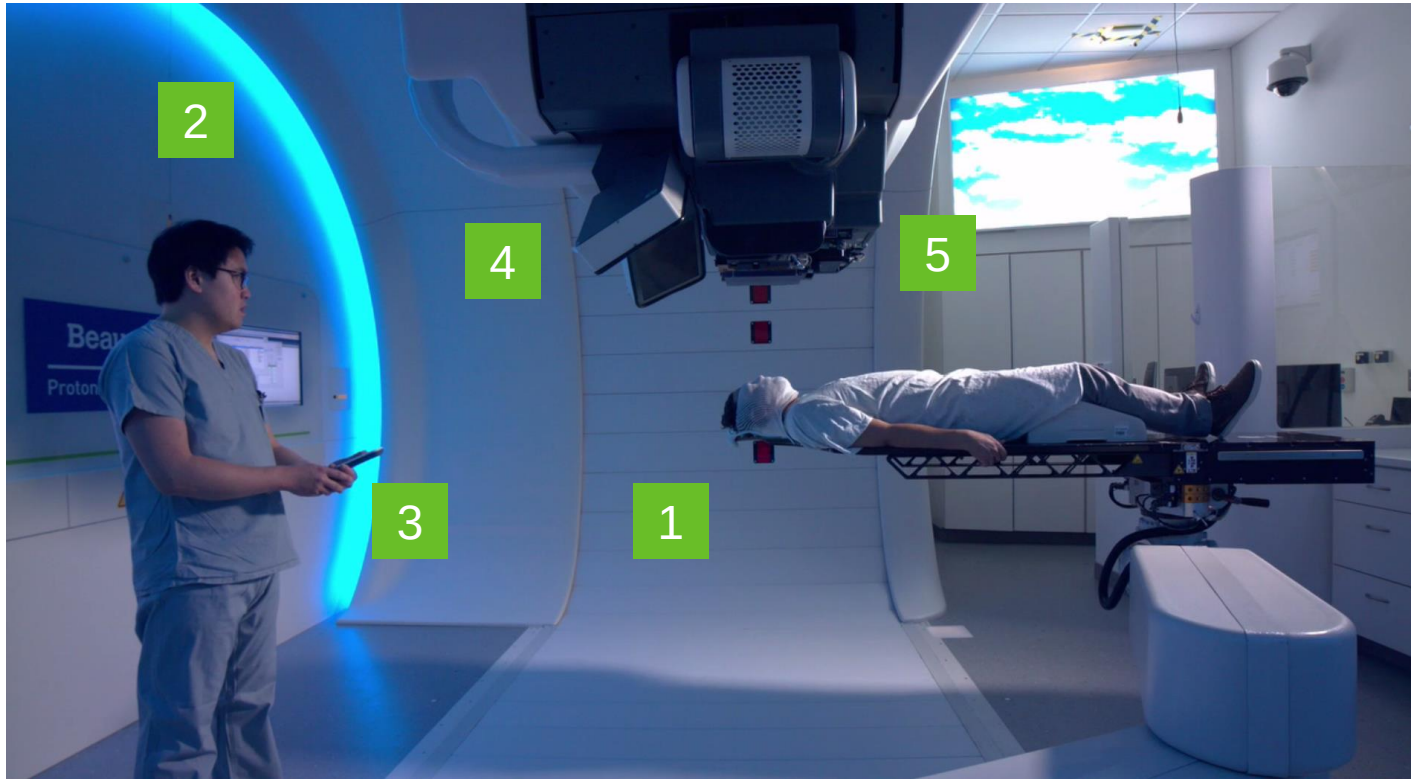
The true compact IMPT single room solution.
IBA's main competitor 70% bigger in volume







Smart workflow – 16min/patient in treatment room



1. Open environment to ease patient setup
2. Ambient experience to decrease patient anxiety
3. Wireless hand pendant to increase staff comfort
4. Unique instantaneous imaging available all the time
5. Remote operation of accessories

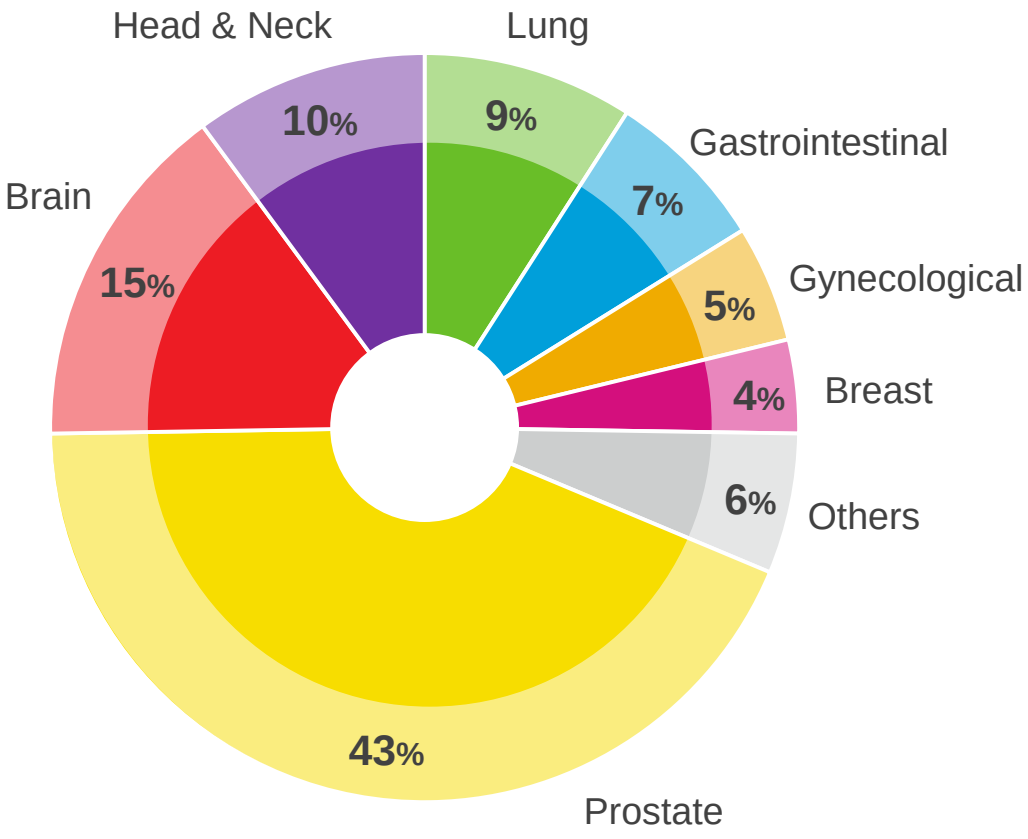
~ 20%
more efficient than competition

→

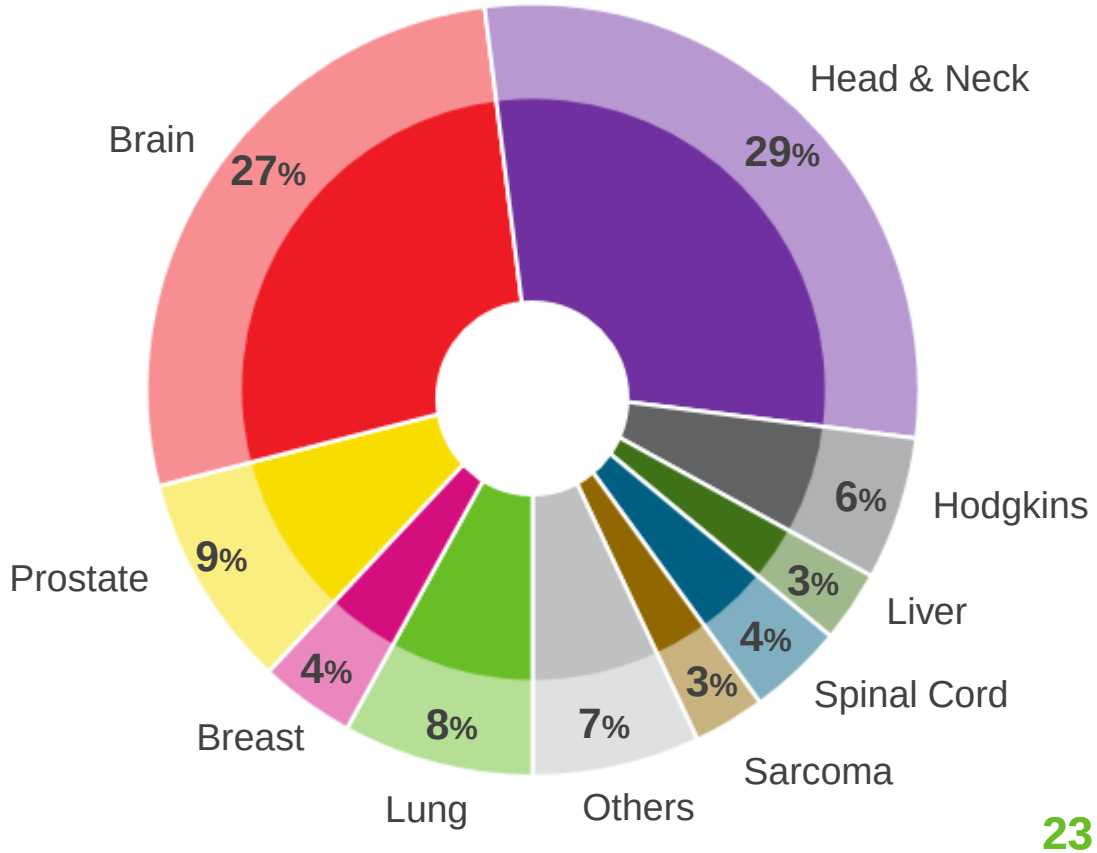
~ 60
more patients that could be treated per room per year with IBA solution

Proven Clinical Excellence

First 500 patients treated at Willis-Knighton, LA, US



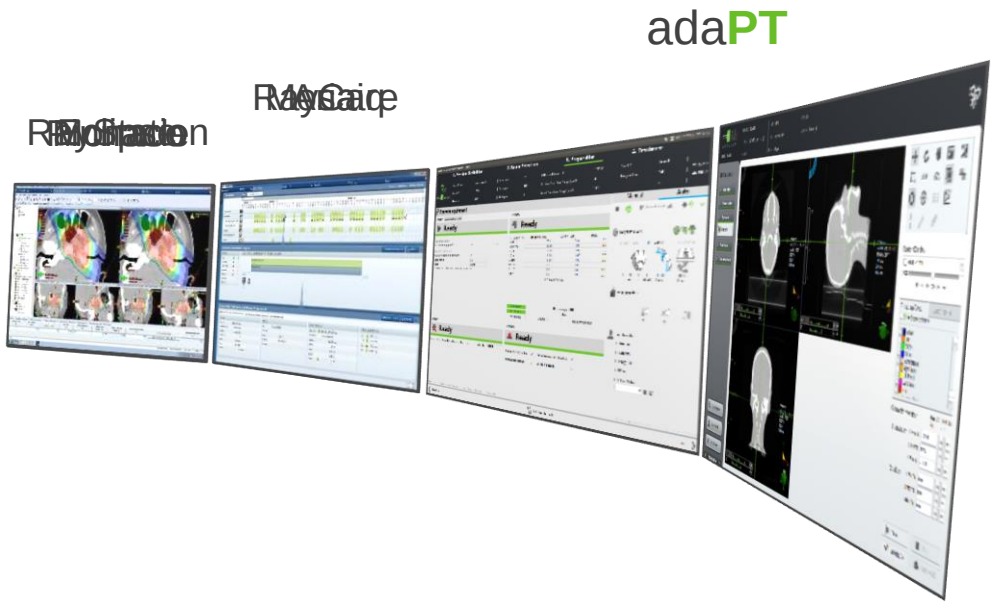
First 100 patients treated at Beaumont, MI, US



20% are pediatrics

Software integration

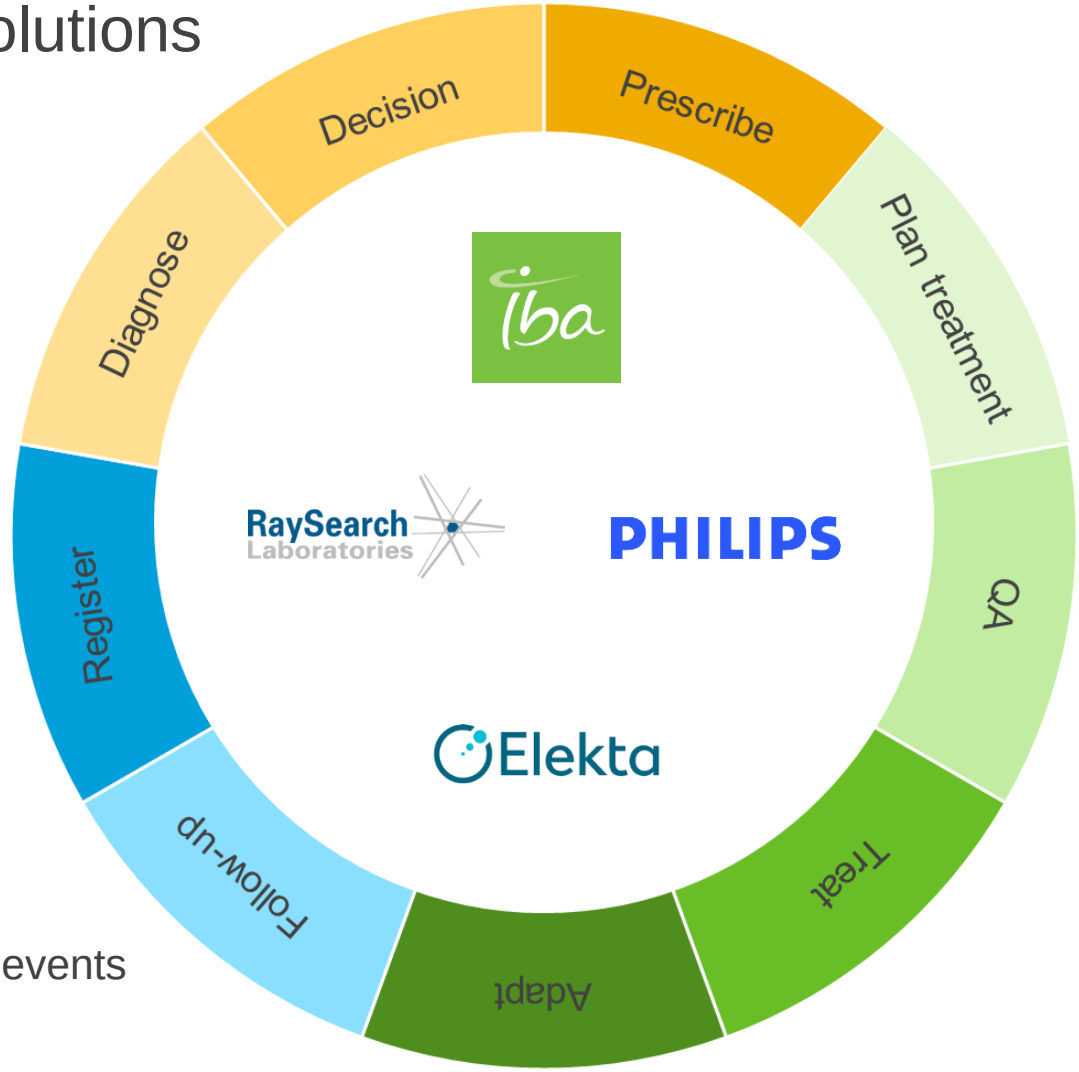
- Supporting all configurations



TPS/OIS: open vendor strategy

Strategic partnerships

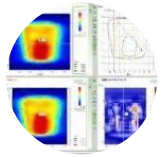
- Integration of software and imaging solutions
- Patient-focused solutions
- Commercial collaboration
- Co-marketing



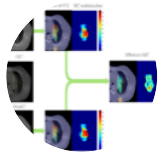
Flow-chart of patient treatment events

Continued research and development

Log-based patient QA

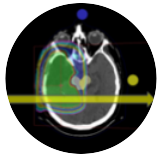


Virtual CT

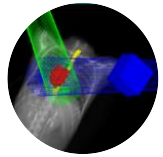


Prompt Gamma

Proton Radiography

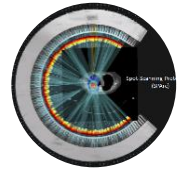


MR Guided Proton Therapy



Automated re-planning

Fast motion estimation and 4D CBCT



Arc therapy

Online adaptive workflow

Others

Competition confirms IBA strategy

Good news for PT Market development

- Major RT player invest in PT
- Compact one room is the way to go
- High clinical interest in new clinical modalities
  - ARC Therapy
  - Hypofractionation
  - Combination with immuno
  - FLASH

IBA remains 3 steps ahead with proven superiority of open gantry

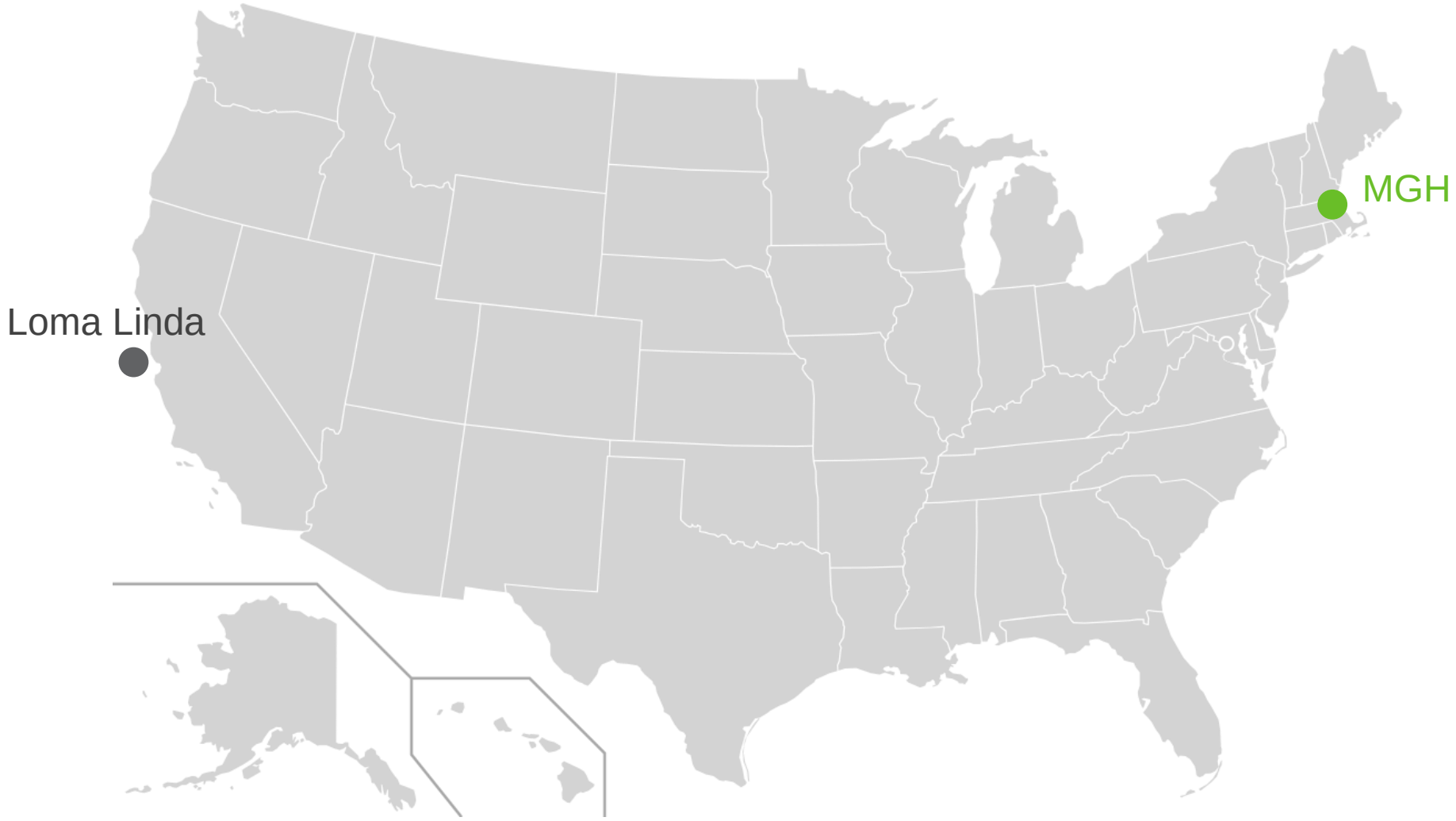
- Main competitor still 70% bigger
- Proven clinical performance
- Most efficient workflow
- Fastest installation
- Demonstated performance through largest installed base: 26 systems sold, 7 in operation
- Newer, more cost efficient cyclotron

Proton Therapy US Market Evolution

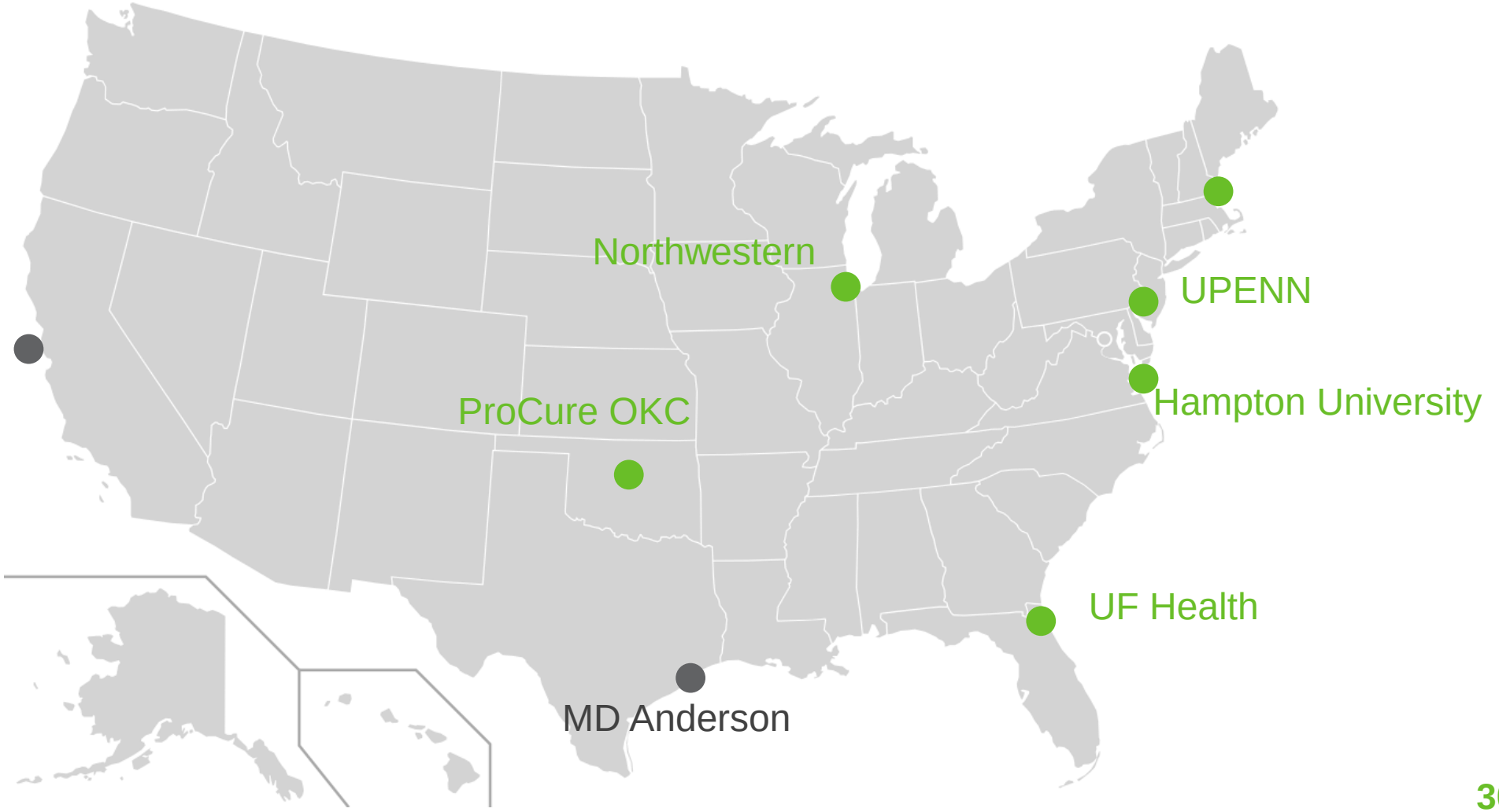
Beth Klein, President IBA PT North America

22 October 2018

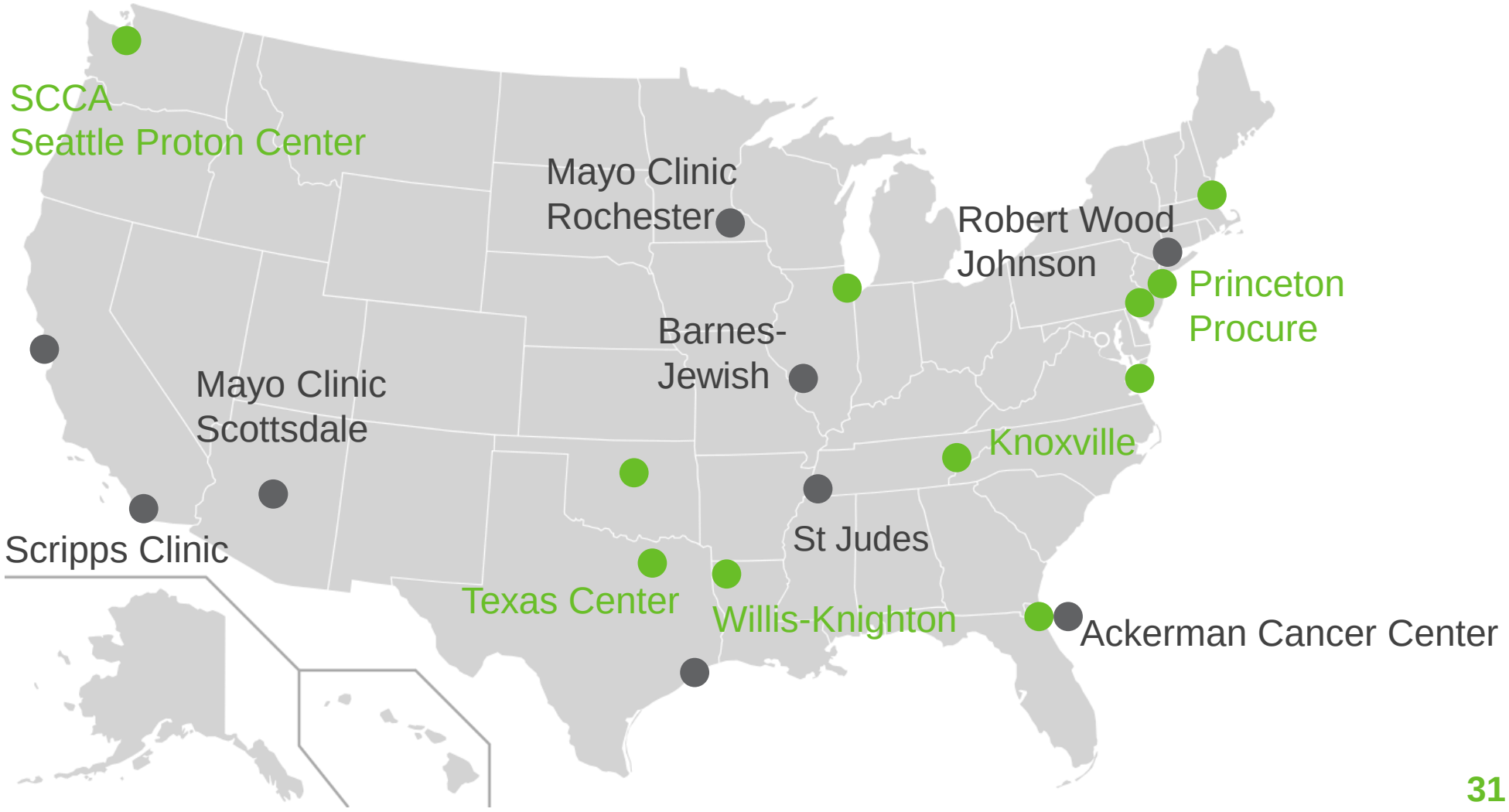
Operational Proton Therapy Centers in North America in 2005



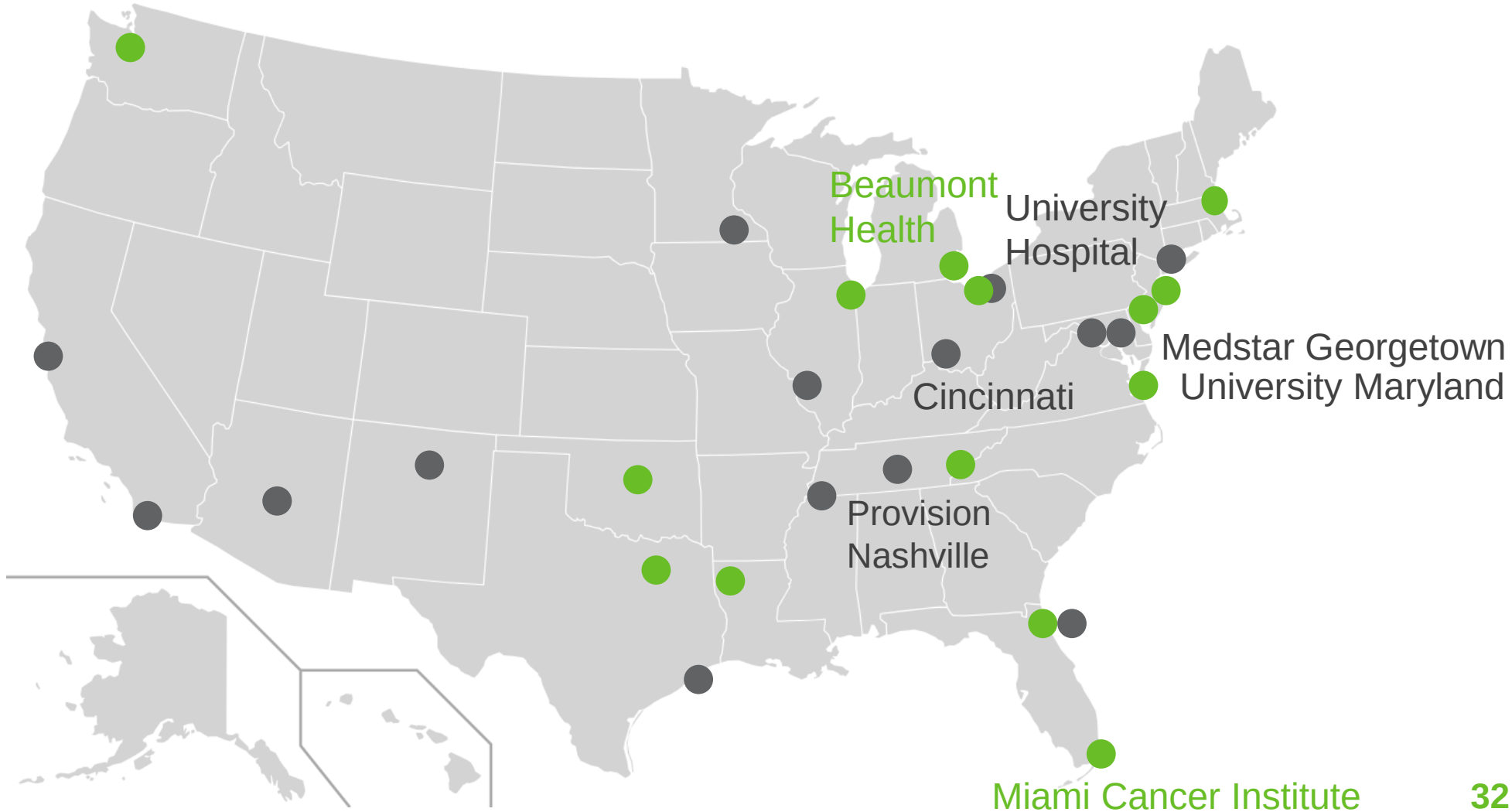
Operational Proton Therapy Centers in North America in 2010



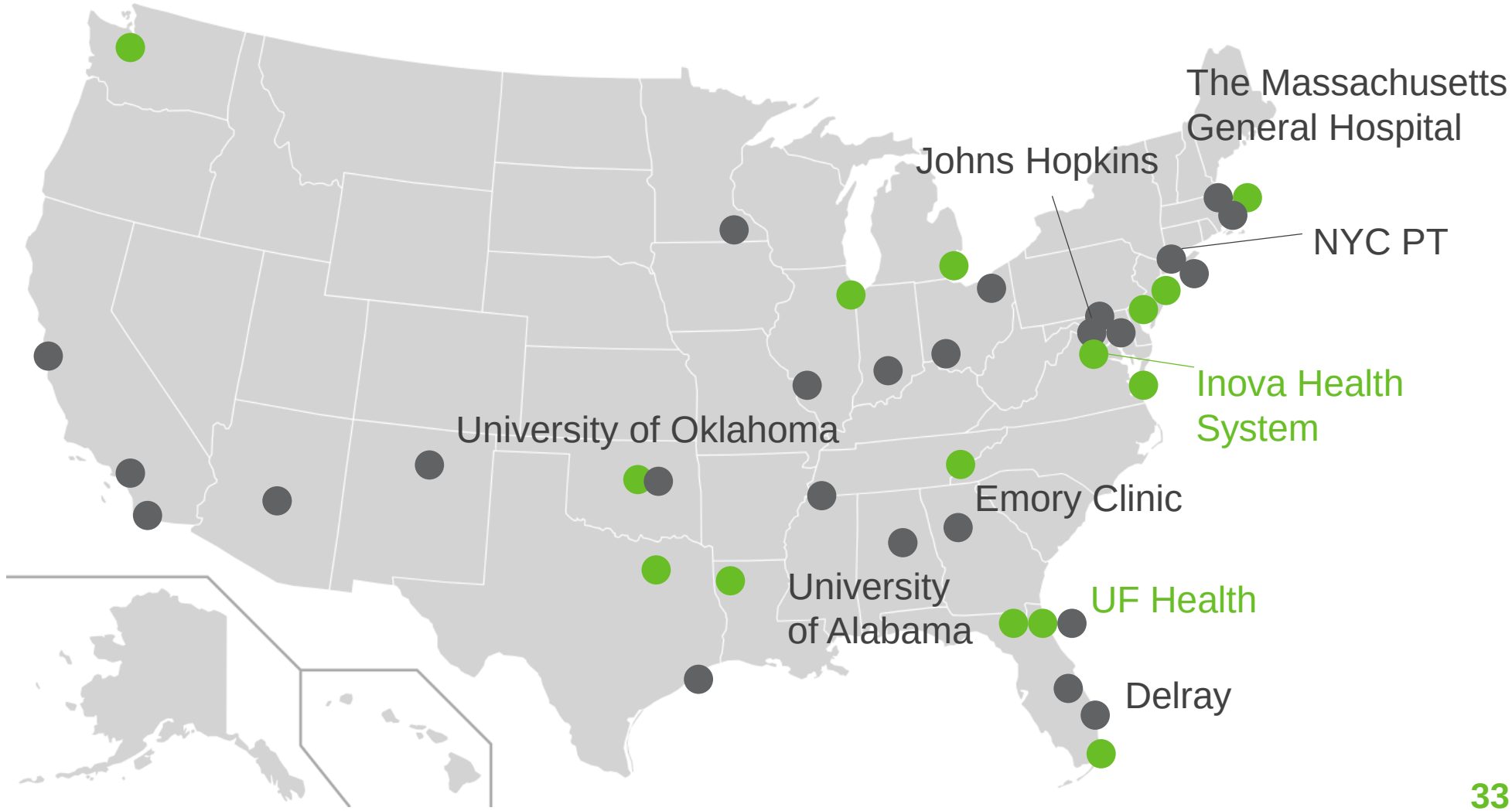
Operational Proton Therapy Centers in North America in 2015



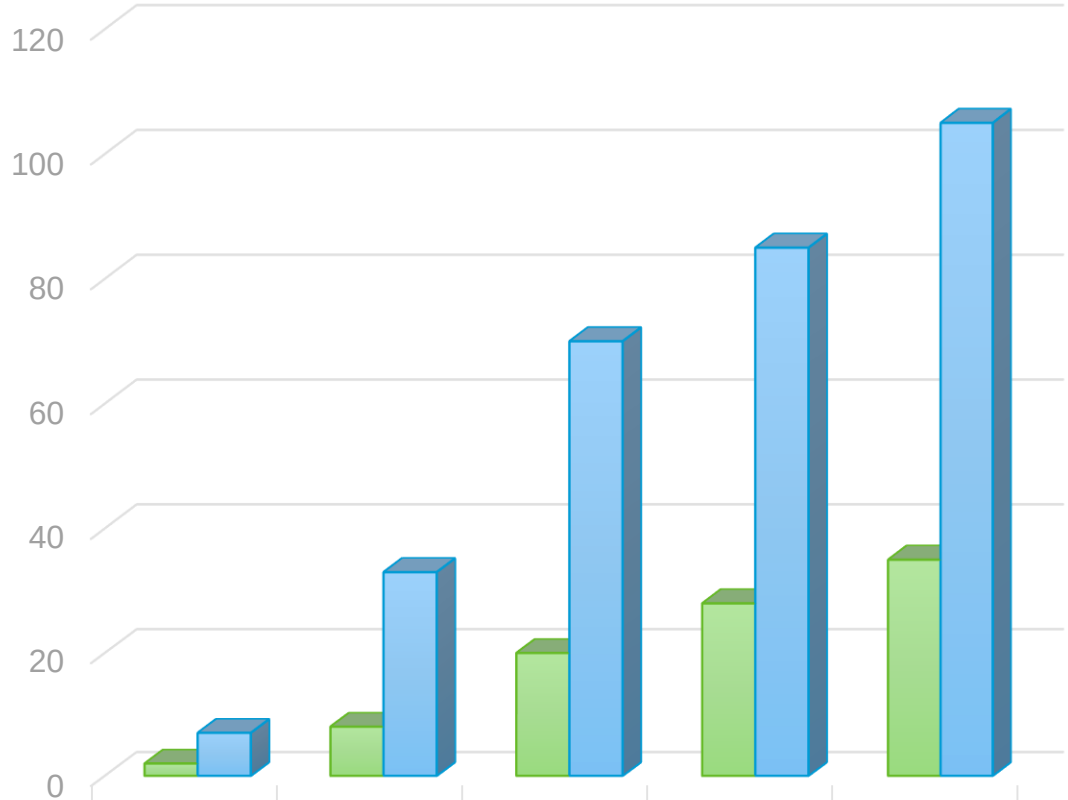
Operational Proton Therapy Centers in North America in 2018



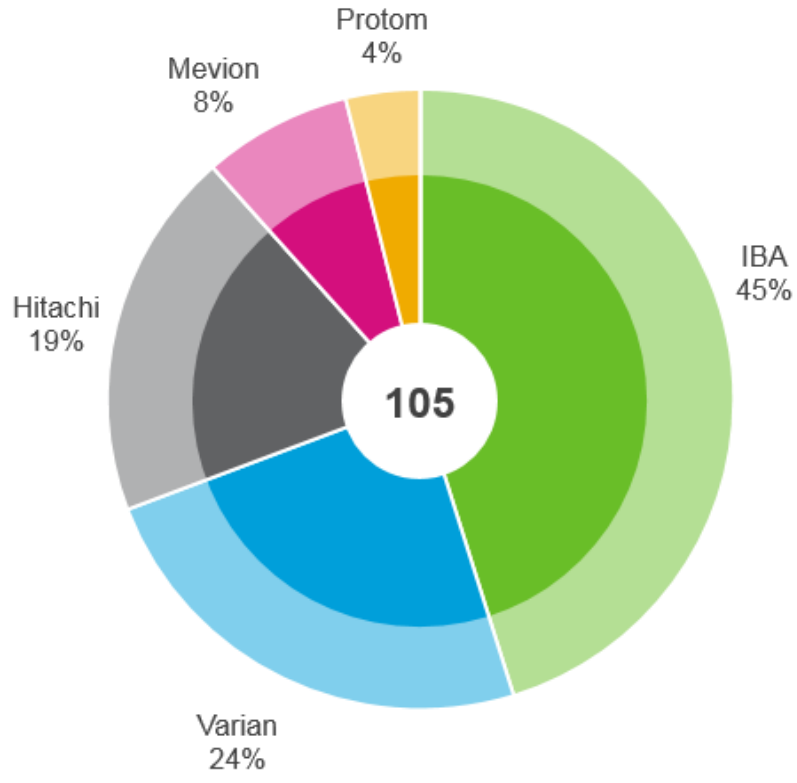
Projected Operational PT centers in North America in 2020



Evolution of the proton therapy market in North America



	2005	2010	2015	2018	2020
Accumulated Centers	2	8	20	28	35
Accumulated Rooms	7	33	70	85	105



IBA leads US Market Share

High level market drivers

ACCELERATORS

- Center Competition fueling demand (fear of losing share)
  - Turf war is on - defensive & offensive strategies
  - Fear of losing patients/revenue > fear of PT investment
- Prestige driving academic institutions
  - Need PT to attract & maintain top academic staff
  - PT becoming a ”Must-Have” for a complete residency
- Reduction in barriers to entry
  - Affordable - compact systems
  - Linac-like workflow
  - Increased indications/throughput due to PBS and CBCT
  - Access to capital easing-up

BRAKES

- Payor Denials
  - Private Payers not paying; no prostate
  - Denial process drives patient to RT
- TCO (Total cost of Ownership) High
  - Competing projects
- Negative press
  - Quantification of PT value needed
  - Early Center failures

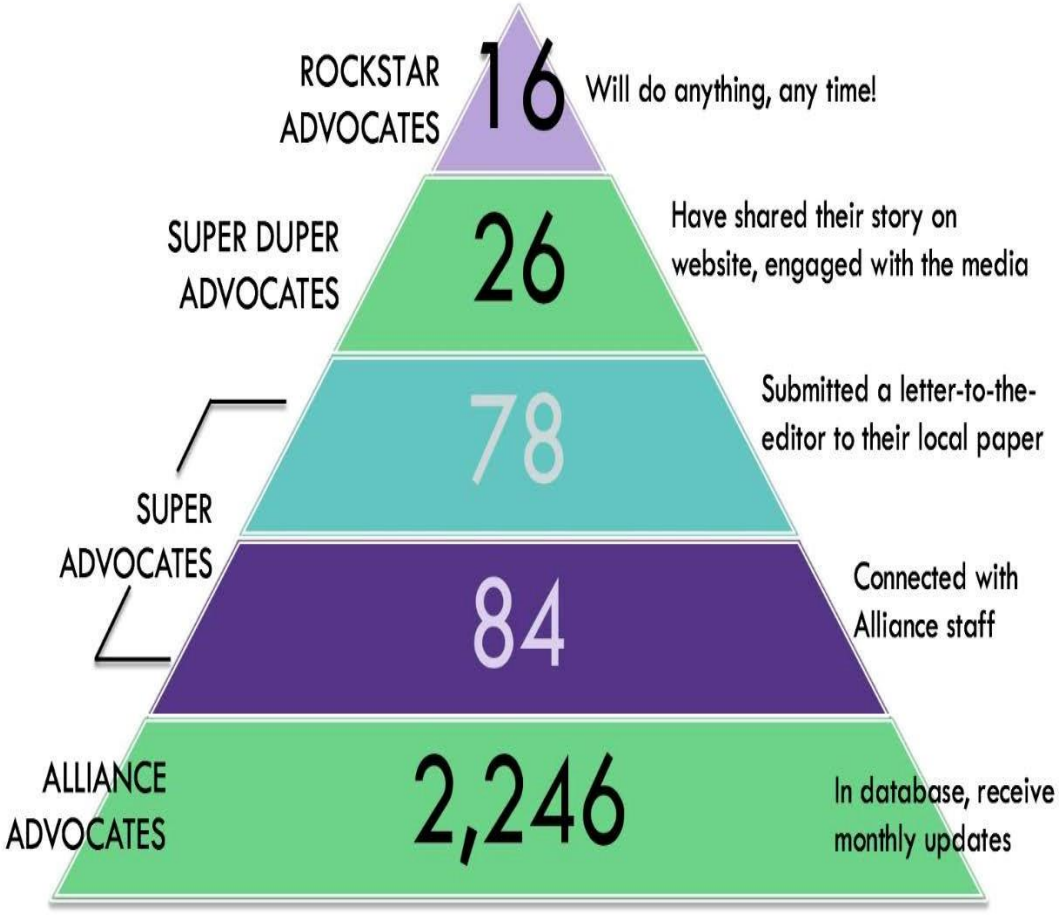
North America Initiatives to drive more access

Alliance for Proton Therapy Access

Focused on PT Insurance Reform through Patient Advocacy

Patient Focused Campaigns	Build Patient Advocacy Base	Increase Media Placement

Patient Campaigns



Building Patient Advocacy Base

CANCER PATIENTS' TIMELY TREATMENT BILL OF RIGHTS:

Principles to Ensure Fair, Timely, and Transparent Access to Cancer Treatment

Cancer patients and their doctors should be fighting *cancer*, not insurance companies. Unfortunately, too many cancer patients are battling restrictive, opaque, and unfair insurance review and appeal processes that drastically delay or make it impossible to receive treatments their doctors appropriately prescribe.

The Cancer Patients' Timely Treatment Bill of Rights: What All Cancer Patients Deserve

- **Fair, appropriate access to doctor-recommended treatment,** with approval/denial decisions made:
  - in a transparent process
  - based on accurate and up-to-date clinical criteria, and
  - appeals handled by a medically qualified expert in the type of cancer the patient is facing, and the specific type of treatment recommended
- **Timely access to treatment** with initial approval/denial decisions made within **1 day** – and appeals settled no later than **5 days** – from the initial request. State insurance commissioners review final denials and hand down a decision within **15 days**
- **Enforcement mechanisms executed by insurance commissioners,** including:
  - automatic approval if insurer fails to meet 5-day timeline for expedited appeal
  - meaningful and substantial fines for repeated failure to provide fair, appropriate approvals
- **The same rights for cancer patients covered by employer self-funded plans,** which are not regulated by state insurance commissioners

Elevating patient voice through Media placement

Secured 70+ media placements that elevated the patient voice to educate the public, decision makers, and key opinion leaders about proton therapy benefits and cancer care access issues.

- ***CNN put the value of proton therapy and access issues in the national spotlight*** *when reporter Wayne Drash published a long story featuring a cancer patient's struggle to get payment for proton therapy.*
- *The story, which referenced the Alliance and our Cancer Care Denied Report, was amplified by 100 additional news outlets through syndication; it also inspired additional coverage by CNN's Headline News.*

Alliance Website & Social Media

Proton Collaborative Group

Research. Innovation. Results.

The Proton Collaborative Group

- Started in 2009
- Independent 501c3
- 100+ volunteer physicians and physicists
- **The ONLY multi-institutional research platform with 13+ treatment centers**
- **10,000+ patient registry**
- **9 Trials**
- 10 Disease Site Committees
- Data Safety Monitoring Board
- Publications Committee
- Physics Committee
- International Data Steering Committee

Current PCG Member Institutions

Miami Cancer Institute — Baptist Health South Florida

Beaumont

Scripps

Maryland Proton Treatment Center

Mayo Clinic — Arizona and Minnesota

Seattle Cancer Care Alliance Proton Therapy Center

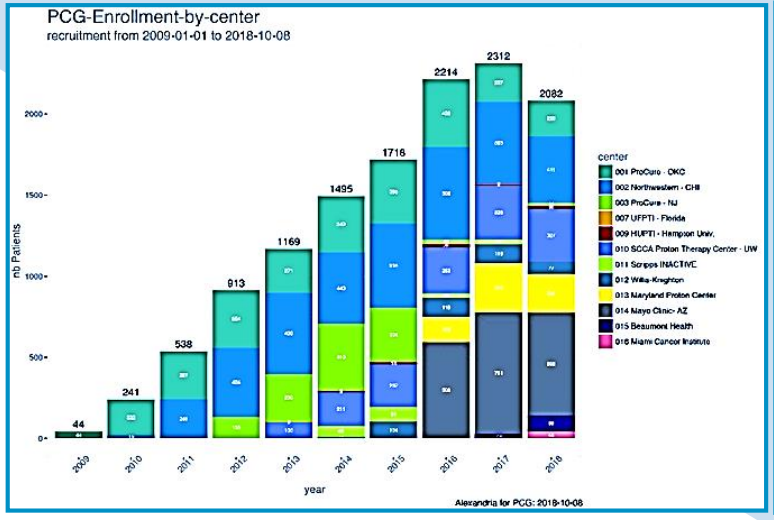
UF Proton Therapy

Northwestern Medicine Chicago Proton Center

Willis-Knighton Health System

ProCure Proton Therapy Center — Oklahoma City and New Jersey

Hampton University Proton Therapy Institute



- Largest PT Registry; fosters multi-center collaboration and publications.
- High quality data drives quicker and more robust collection.
- Standardized high quality data helps develop and validate predictive models.

Changing the Business Model

The New York Times

Although most of the proton centers in the United States are profitable, the industry is littered with financial failure: Nearly a third of the existing centers lose money, have defaulted on debt or have had to overhaul their finances.

Factors driving failure;

- Early market stage- no data to build realistic business models
- Large; 4-5 rooms- high patient volume expectations
- Stand-alone; not aligned with a hospital partner
- Early technology; no IMPT, CBCT
- Highly leveraged financing

Current Center Profiles;

- Compact single-room solutions are less risky
  - Most centers opt for 1-2 rooms
- Most centers are hospital base providing in-house RT patients and staff/equipment synergies
- Business models are more conservative in terms of debt ratio and revenue projections
- Remaining stand-alone centers considering partnership with hospital for patient referral

*Seattle had to close one room. The average on 3 rooms is 19.33 patients per day per room

PROTECT +
ENHANCE +
SAVE LIVES

Driving to make Proton therapy accessible to every patient who can benefit from it!

Model-Based Approach development in Europe and in USA

Prof. Dr. J.A. Hans Langendijk, Chair, Department of Radiation Oncology at University Medical Center Groningen

The model-based approach

IBA meeting, San Antonio (US)

Prof. dr. Hans Langendijk

Department of Radiation Oncology, UMCG

umcg

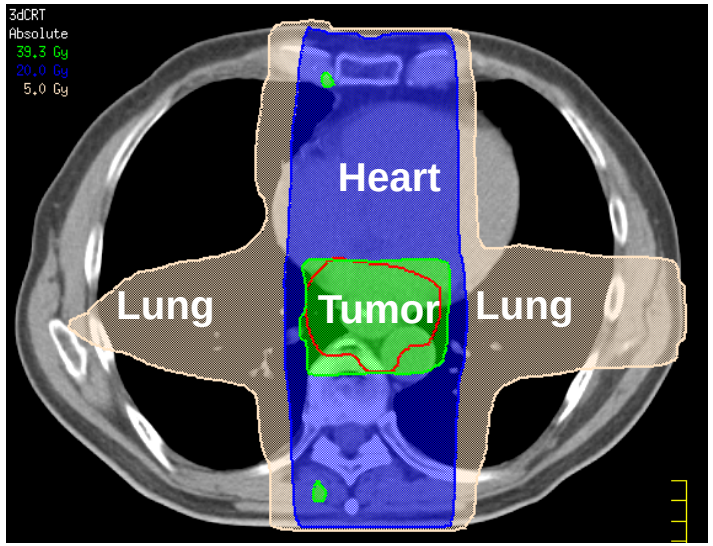
Disclosures

	COI status	Names of companies / organizations
① Post of executive / consultant	No	Honorarium from IBA for consultancy and presentation at IBA symposia paid to UMCG Research BV
② Stocks	No	
③ Patent royalties	No	
④ Stage moneys	No	
⑤ Manuscript fees	No	
⑥ Grant / Research funding	YES	Department of Radiation Oncology has research collaborations with IBA, RaySearch, Siemens and Mirada
⑦ Other rewards	No	

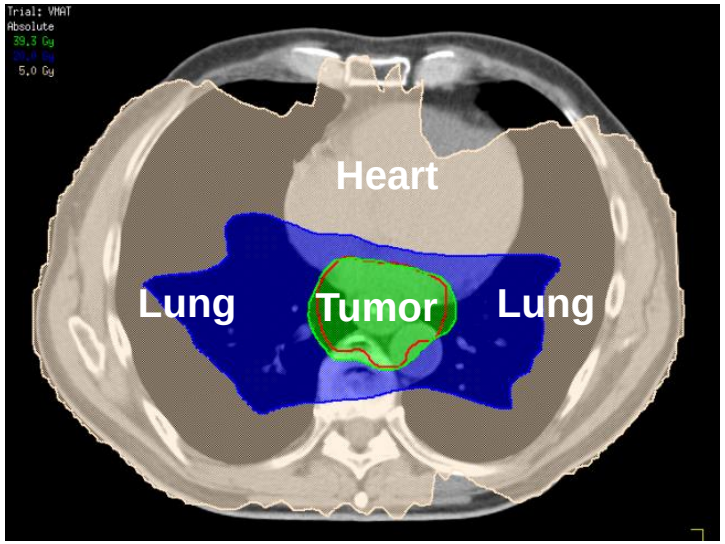
Current standard: photons

Problem: Dose-redistribution

Photons



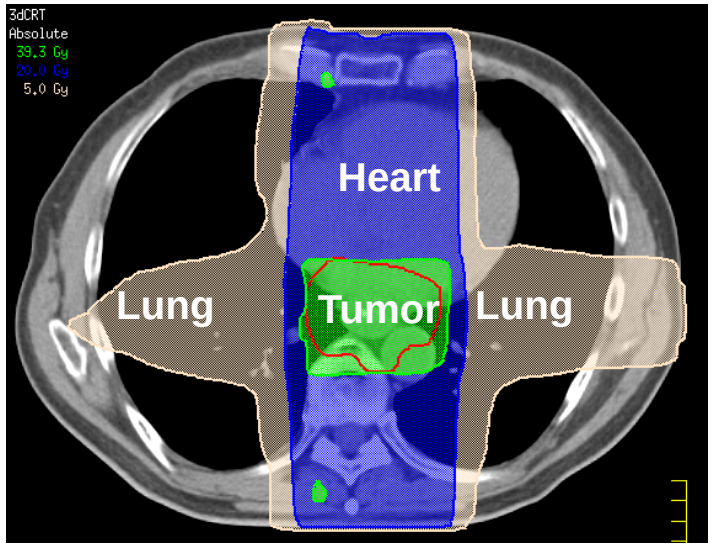
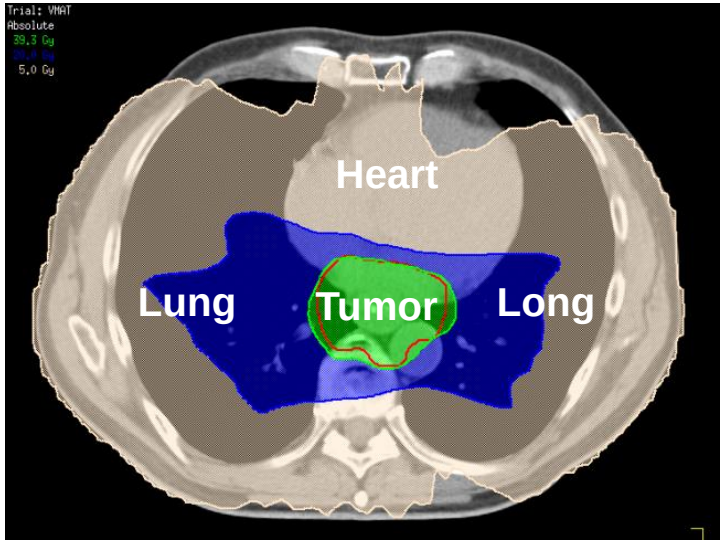
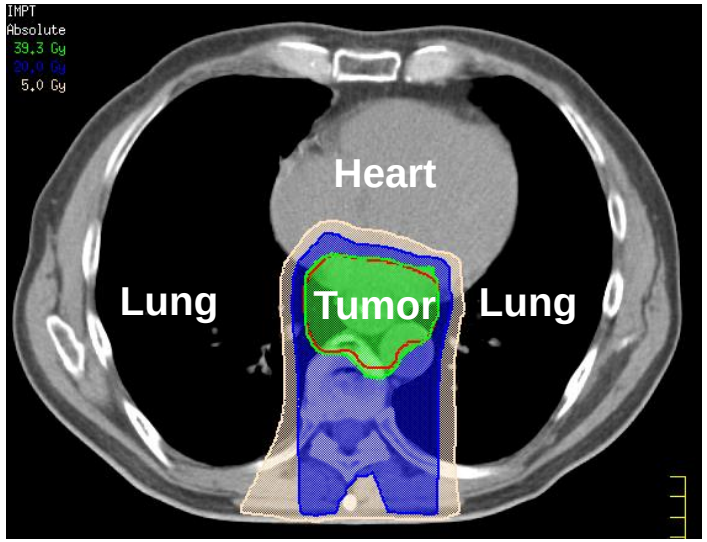
Maximal sparing lungs



Maximal sparing heart

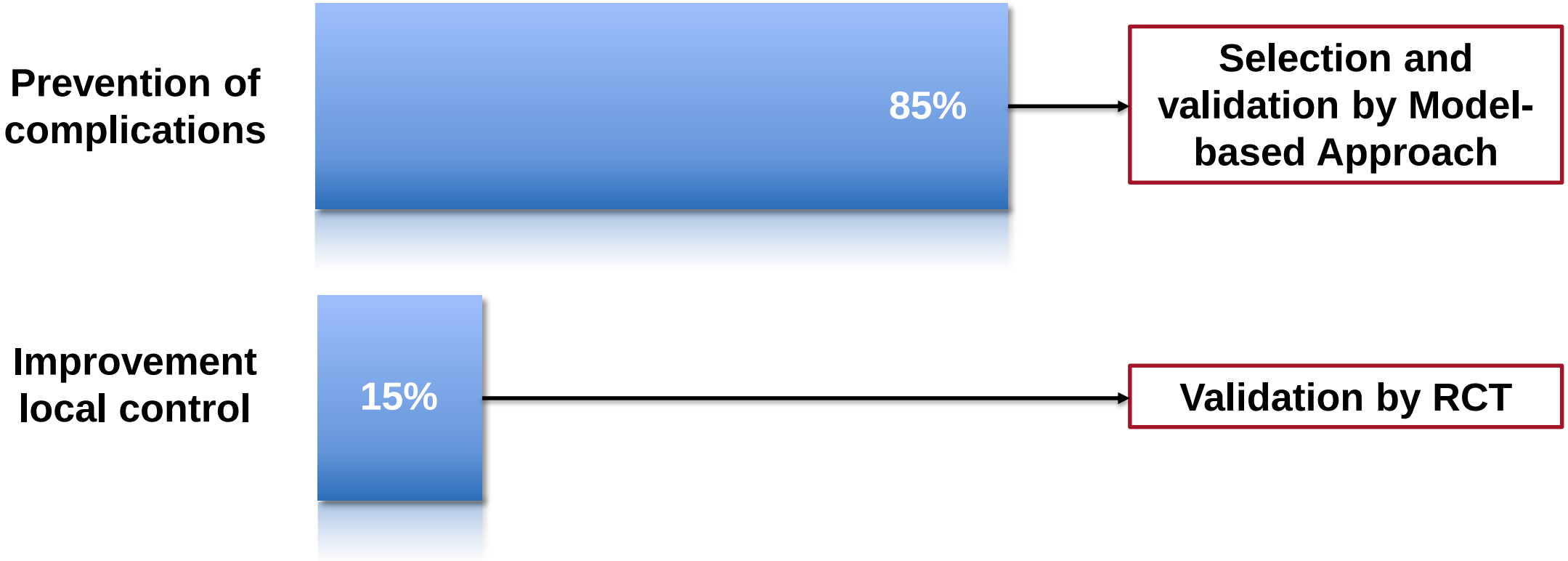
Advantage protons

Superior beam properties: ↓↓ Dose-redistribution

Photons		Protons
		
Maximal sparing lungs	Maximal sparing heart	Sparing of heart and lungs

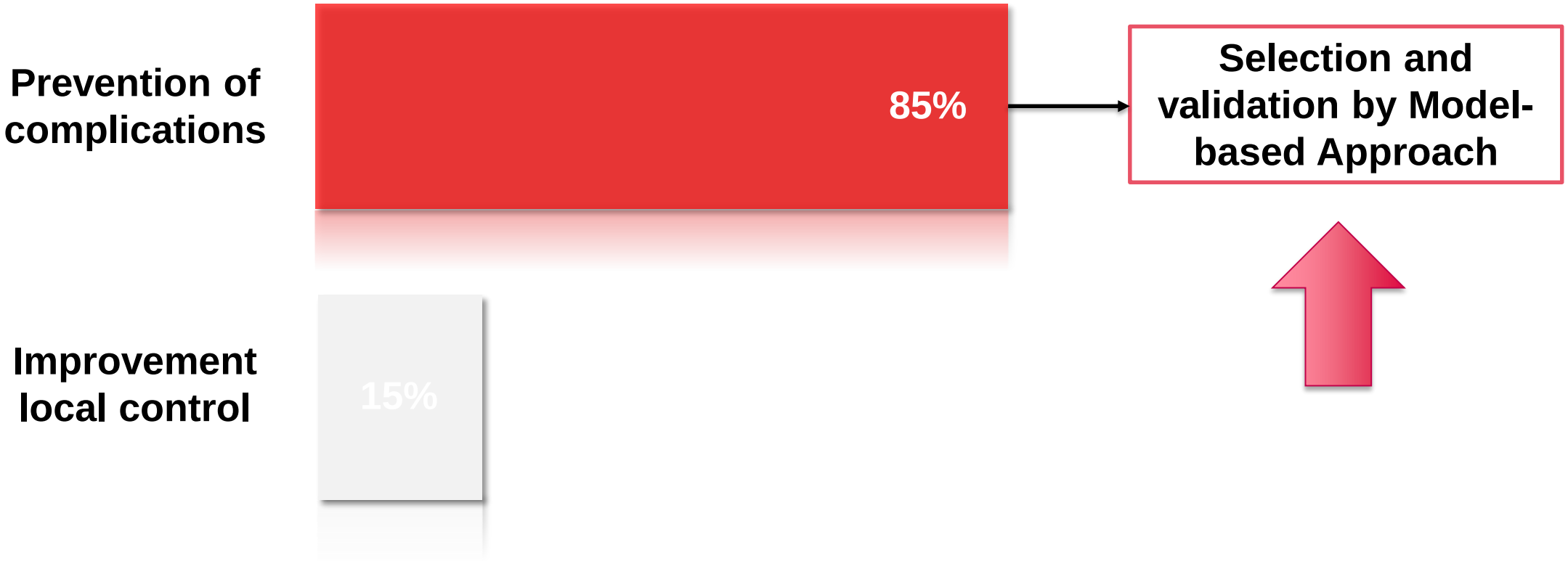
Indications proton therapy

Health Council Report (2009)



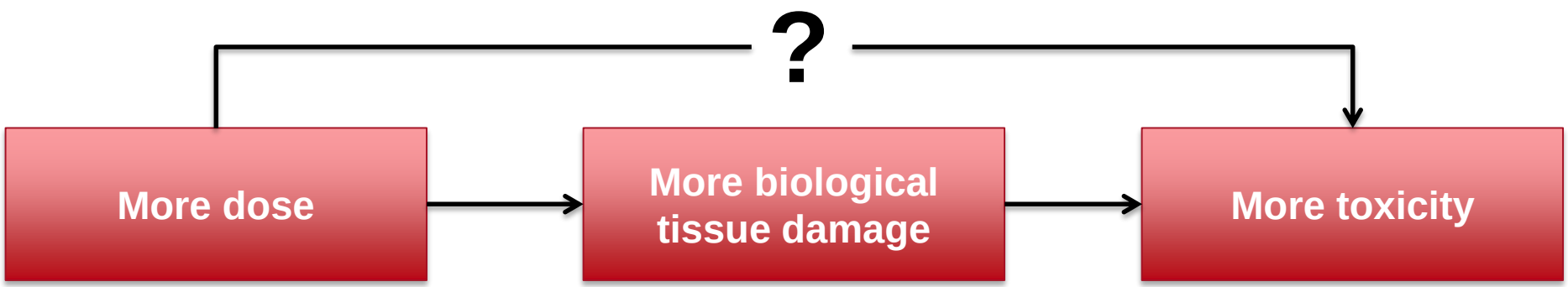
Indications proton therapy

Health Council Report (2009)



Innovation radiotherapy

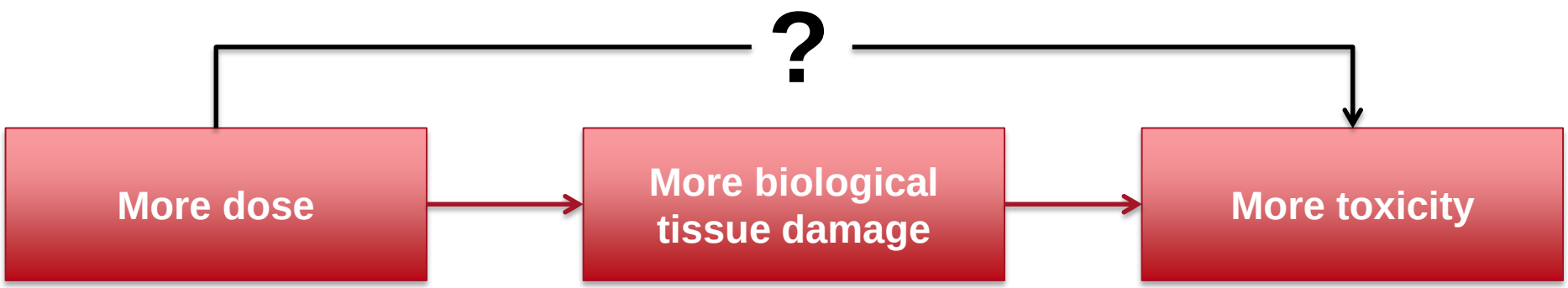
- Incentive of most technological development in RT
  - Maximum tumor control ⟺ minimal toxicity
  - ALARA-principe: A Low As Reasonably Achievable



Model-based Approach

Main conditions:

1. Bio-equivalent target dose → *local control similar*
2. ΔDose in or more organs at risk
3. ΔDose results in clinically relevant reuction of toxicity (ΔNTCP)



National Indication Protocol Proton Therapy

HEAD and NECK CANCER

Landelijk Indicatie Protocol Protonen Therapie

HOOFD-HALSTUMOREN

Landelijk Platform Protonentherapie (LPPT)

2 november 2017

Concept	
Verstuurd naar leden LPPT en LPRHHT	1 september 2017
Deadline schriftelijk commentaar	4 september 2017
Invitational Conference	28 september 2017
Definitieve versie	4 oktober 2017
Vastgesteld in LPRHHT	18 oktober 2017
Toegestuurd aan ZiN	26 oktober 2017
Goedgekeurd door ZiN	3 november 2017
	22 januari 2018

Model-based approach

Selection

STEP 1: Select NTCP model

- Multivariable NTCP-models

STEP 2: Individual dose comparison

- Dose reduction (**ΔDose**): relevant DVH parameters

STEP 3: Estimate NTCP reduction (ΔNTCP)

- Translate **ΔDose** to **ΔNTCP**

Validation

STEP 4: Validation

- External validation NTCP-model with new technology

Model-based selection

Only applicable when the intended use of protons is to prevent radiation-induced side effects

Three main conditions:

1. Bio-equivalent dose to the target
2. ΔDose in one or more organs at risk
3. ΔDose translates into clinically relevant ΔNTCP

Model-based approach

STEP 1: Select NTCP models

- Multivariable NTCP-models

STEP 2: Individual dose comparison

- Dose reduction (**ΔDose**): relevant DVH parameters

STEP 3: Estimate NTCP reduction (ΔNTCP)

- Translate **ΔDose** to **ΔNTCP**

STEP 4: Validation

- External validation NTCP-model with new technology

Langendijk *et al*, R&O 2014

NTCP-model selection procedure

1. Committee of experts in the field
2. Selection of published NTCP-models
   - Predefined quality criteria
   - Limited number of endpoints:
     - Xerostomia
     - Dysphagia
3. External validation in independent data sets
   - Independent epidemiology centre (Julius Centre, Utrecht)

National indication protocol

Head and neck cancer (primary setting)

Predictors	NTCP-models (6 months after end of RT)		
	Patient-rated moderate-to-severe xerostomia [1]	Dysphagia grade ≥ 2 [2]	Tube feeding dependence [3]
D_{mean} contralateral parotid gland	B=0.052		B=0.022
D_{mean} oral cavity		B=0.024	
D_{mean} superior PCM		B=0.024	B=0.030
D_{mean} inferior PCM			B=0.013
D_{mean} cricopharyngeal muscle			B=0.008
Baseline xerostomia	Predictor		
Baseline dysphagia		Predictor	
Treatment modality			Predictor
Weigh losss prior to RT			Predictor
T-stage			Predictor

[1] Beetz *et al*, R&O 2011; [2] Christianen *et al.* R&O 2012; [3] Wopken, *et al.* R&O 2016

Model-based approach

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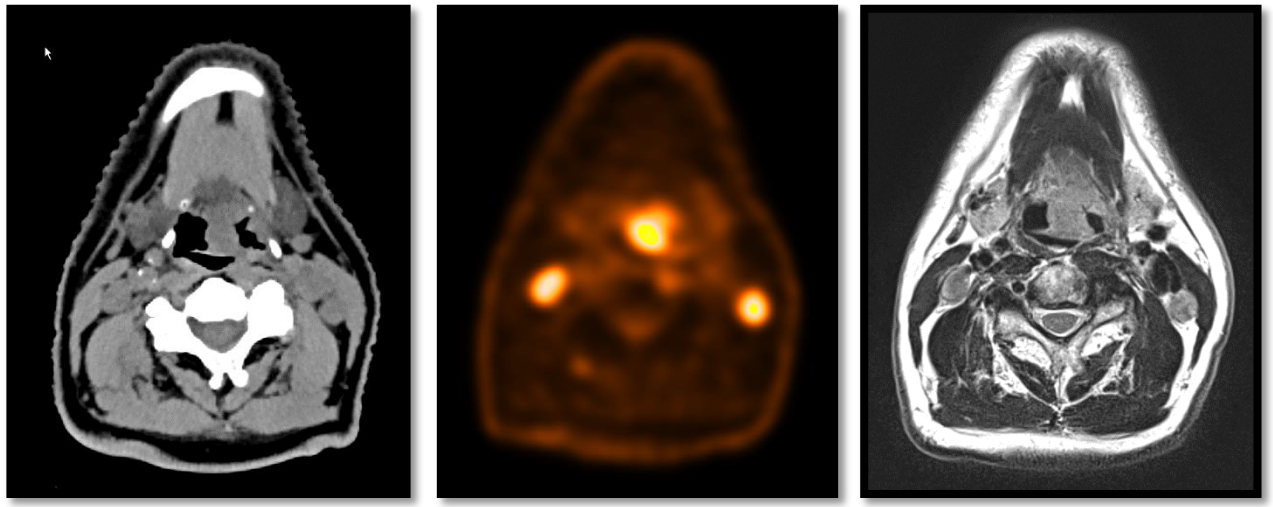
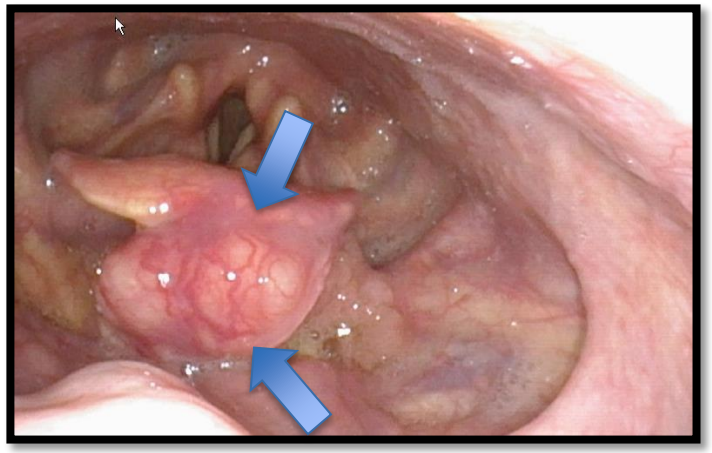
- External validation NTCP-model with new technology

Langendijk *et al*, R&O 2014

Case

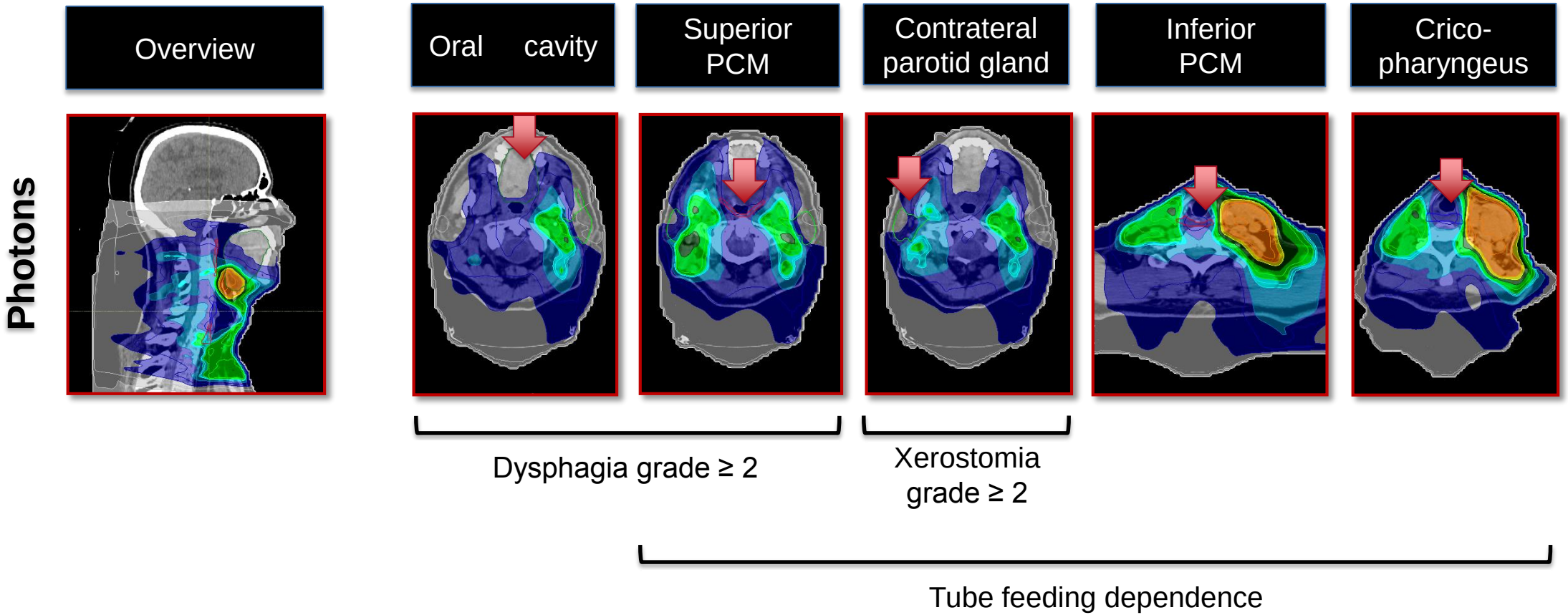
- cT3N2cM0
- Base of tongue carcinoma
- Planned for concurrent chemoradiation
- Baseline toxicity:
  - Grade I xerostomia
  - Grade II dysphagia
  - No weight loss





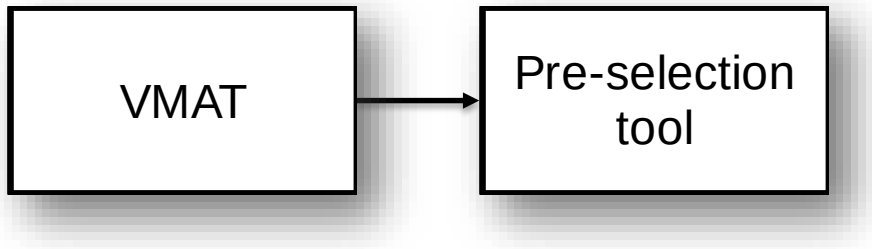
Produce best VMAT-plan

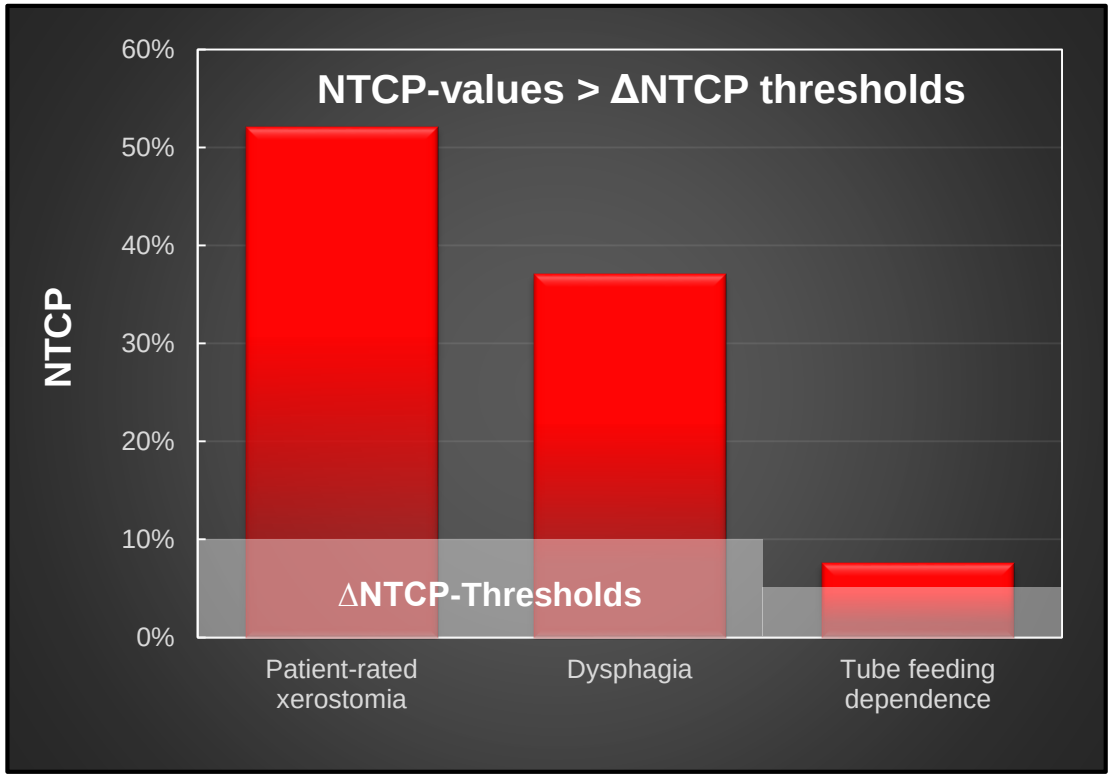
Model-based optimization



Pre-selection tool

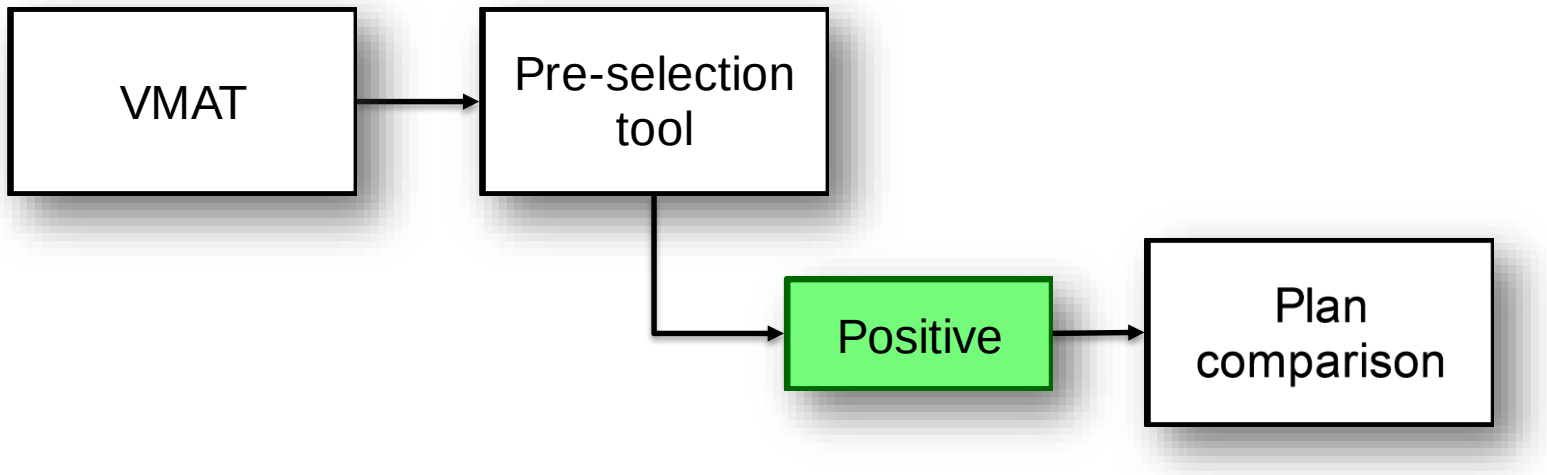
Does the patient qualify for a plan comparison (VMAT versus IMPT)?





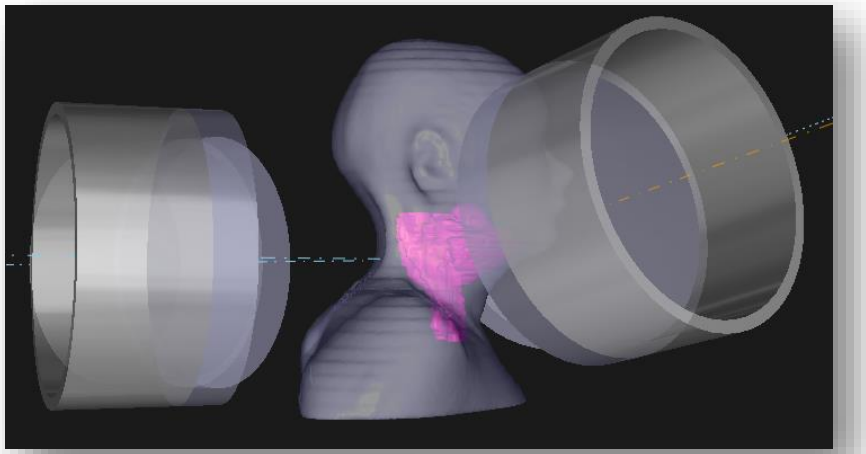
Pre-selection tool

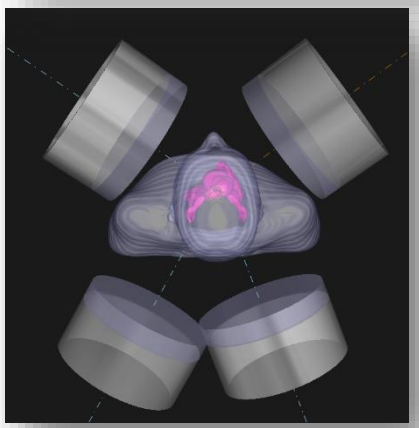
Does THIS patient qualify for a plan comparison (VMAT versus IMPT)?



Plan comparison

Proton therapy treatment planning



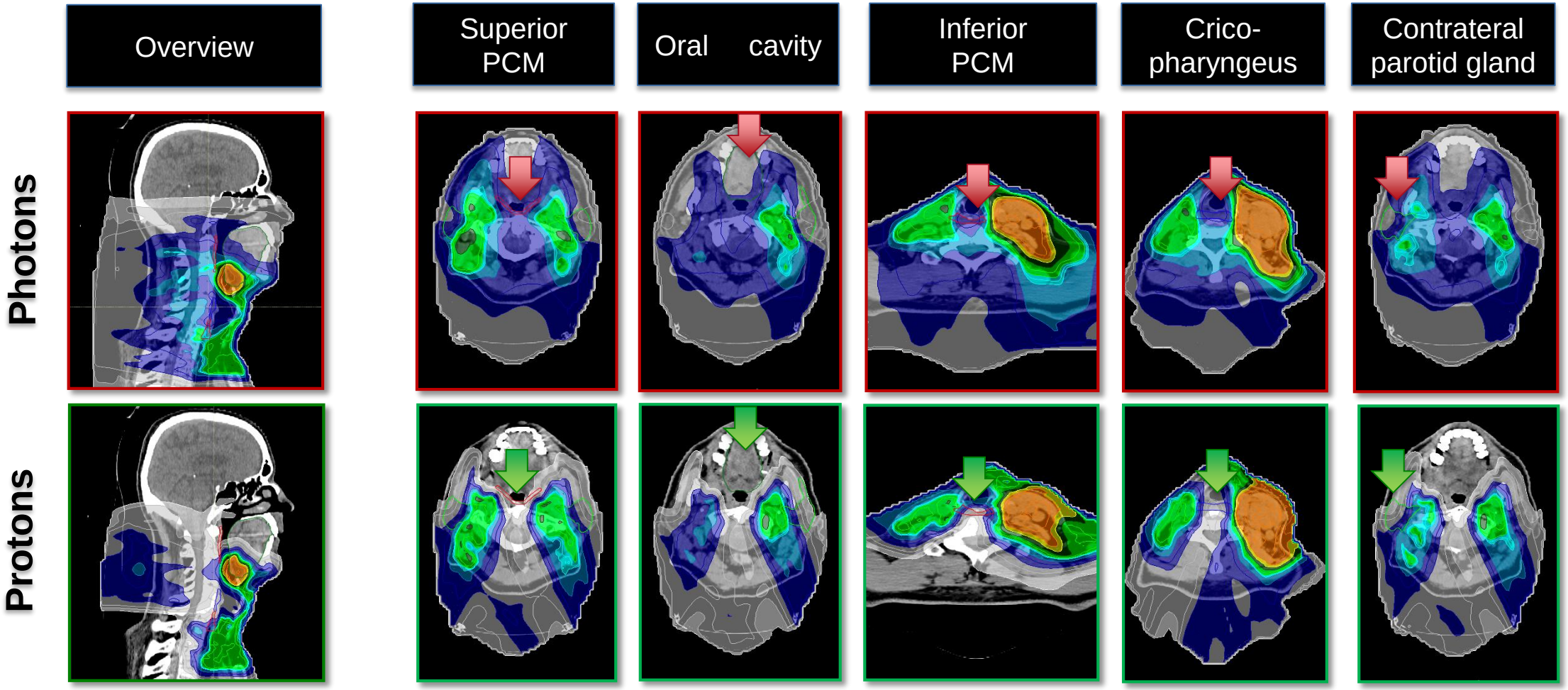


- Similar dose prescription and fractionation as for VMAT
  - 35 x 2.00 Gy / 5 times per week = 70.00 Gy
  - 35 x 1.55 Gy / 5 times per week = 54.25 Gy
- IMPT Pencil beam scanning
  - Standard 4-field beam configuration with post hoc adjustment of beam set up
  - Robust treatment planning:
    - 5 mm set up inaccuracy
    - 3% range uncertainty

Courtesy: Dan Scandurra (UMCG)

Produce best IMPT-plan

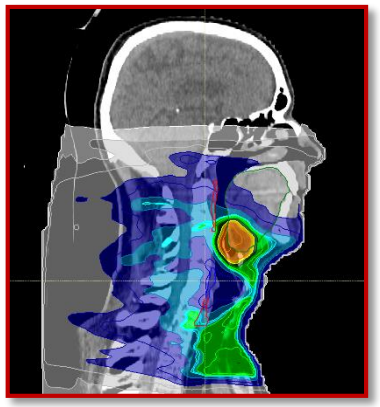
Model-based optimization: similar dose constraints

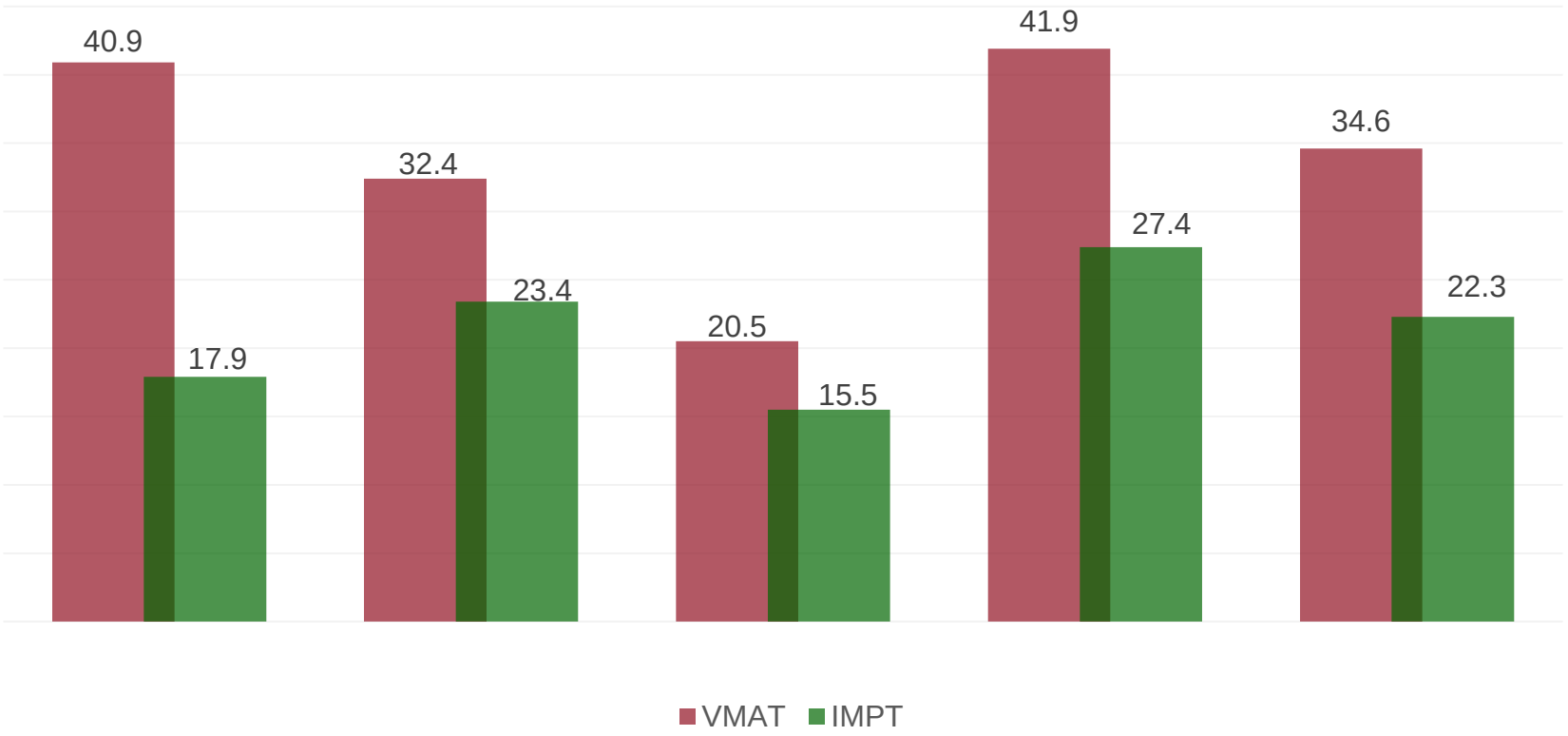


Model-based selection

Step 2: Plan comparison to determine ΔDose

Overview	Superior PCM	Oral cavity	Contrateral parotid gland	Inferior PCM	Crico-pharyngeus
Photons	40.9	32.4	20.5	41.9	34.6
Protons	17.9	23.4	15.5	27.4	22.3





Model-based approach

STEP 1: Select NTCP models

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STEP 2: Individual dose comparison

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STEP 3: Estimate NTCP reduction (ΔNTCP)

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- External validation NTCP-model with new technology

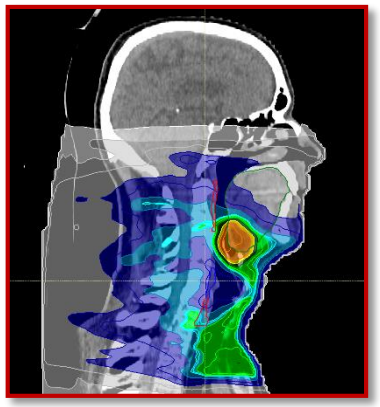
Langendijk *et al*, R&O 2014

Model-based selection

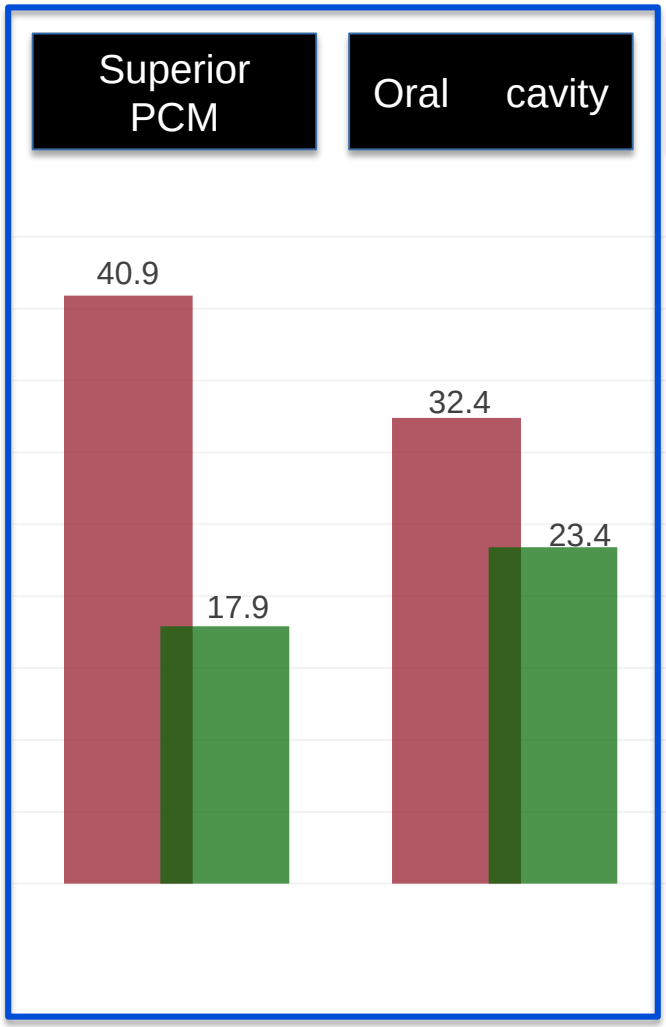
Step 2: Plan comparison to determine ΔDose

Overview

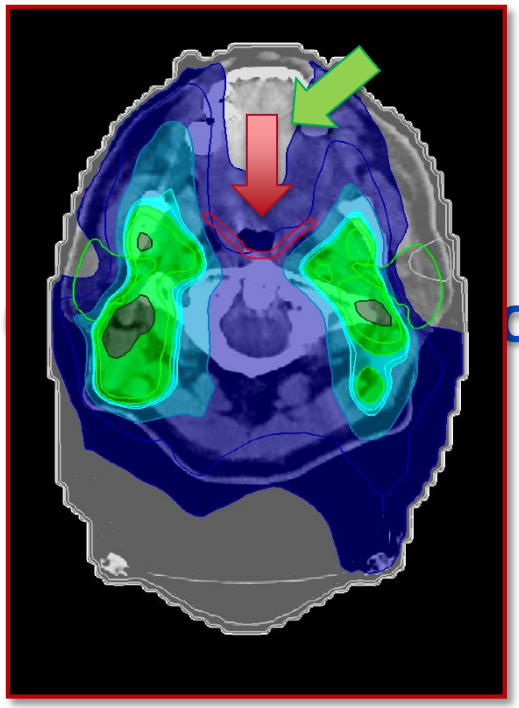
Photons



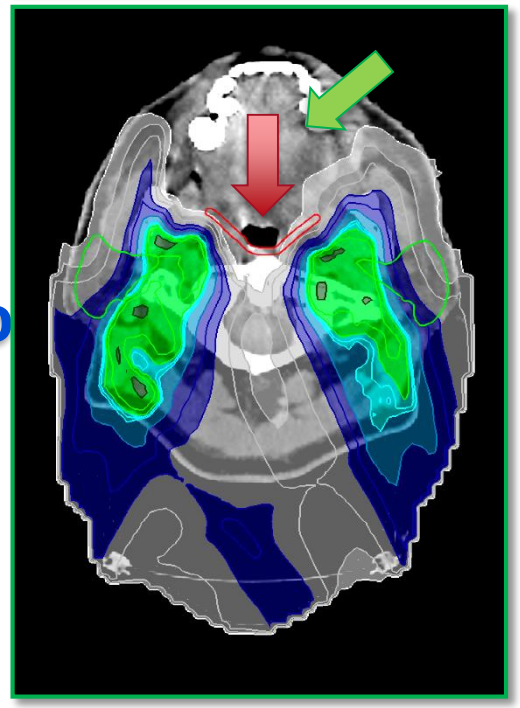
Protons



VMAT (photons)



IMPT (protons)



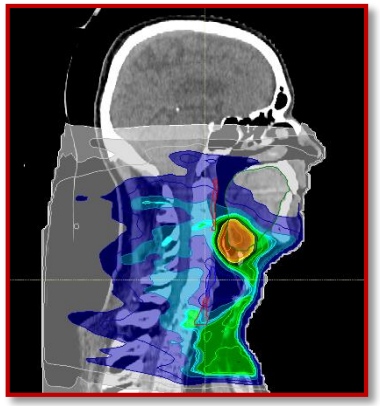
Model-based selection

Step 3: Translate ΔDose into ΔNTCP

Planning comparison

NTCP-model

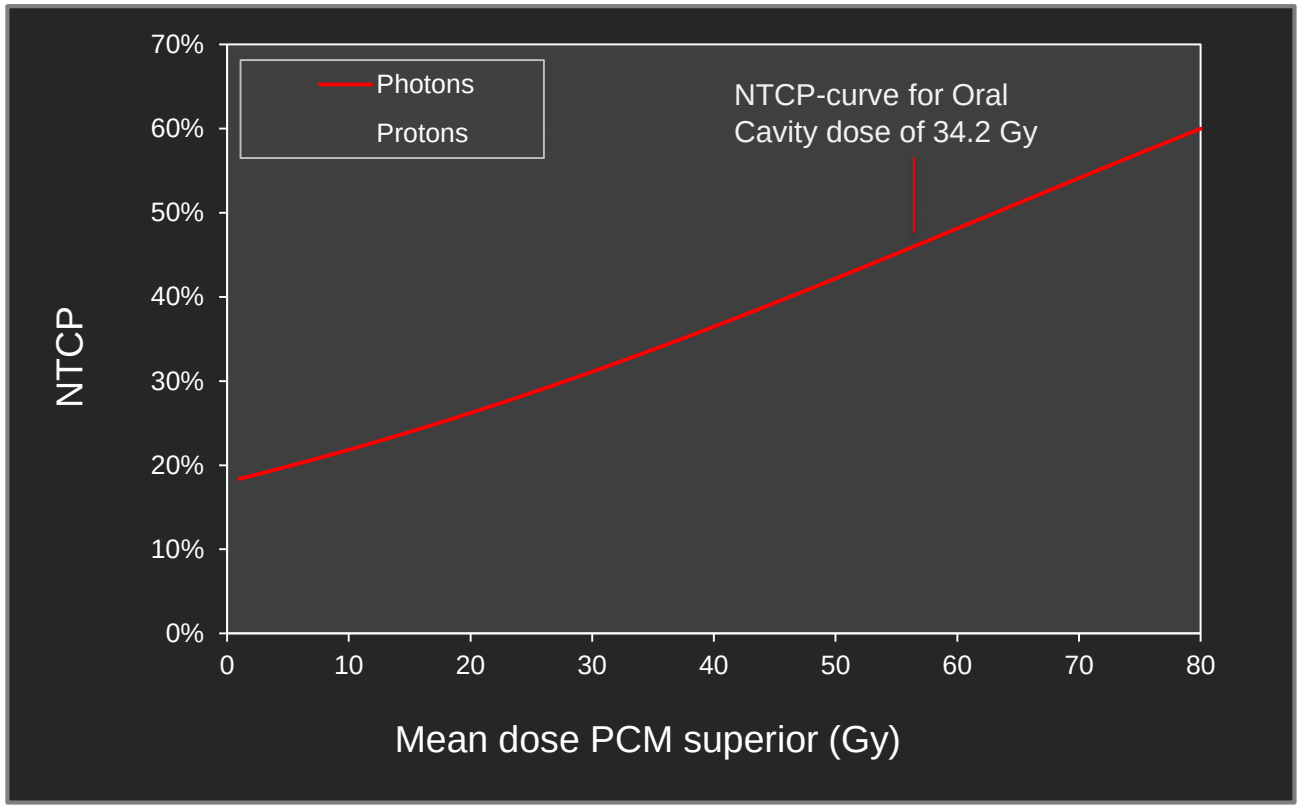
Photons



Organ at risk	Mean dose (Gy)
Superior PCM	
Oral cavity	34.2

Protons

Organ at risk	Mean dose (Gy)



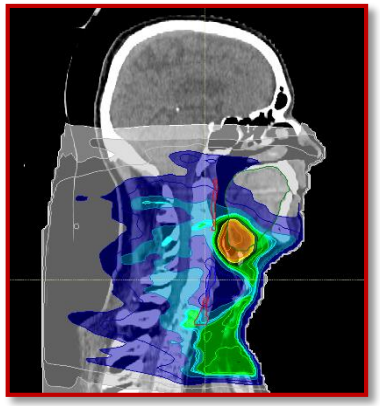
Model-based selection

Step 3: Translate ΔDose into ΔNTCP

Planning comparison

NTCP-model

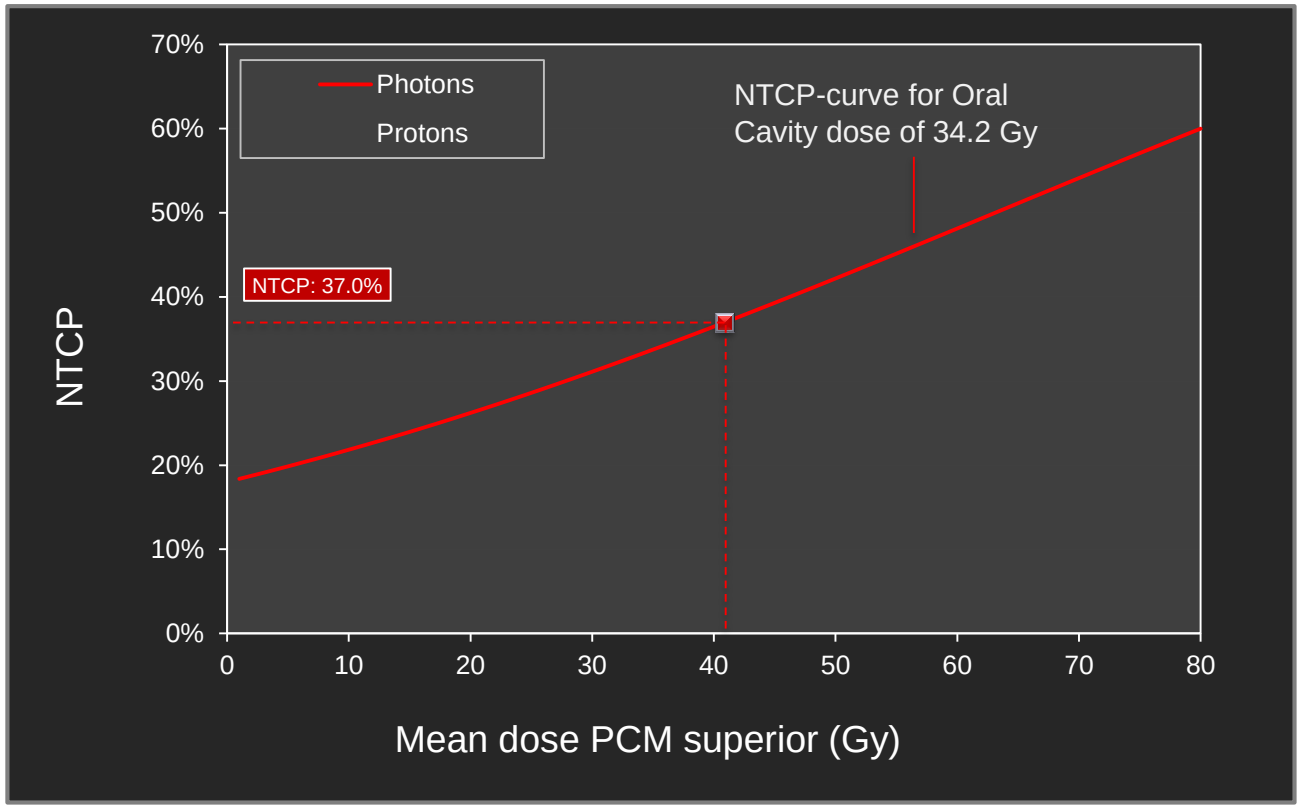
Photons



Organ at risk	Mean dose (Gy)
Superior PCM	40.9
Oral cavity	34.2

Protons

Organ at risk	Mean dose (Gy)



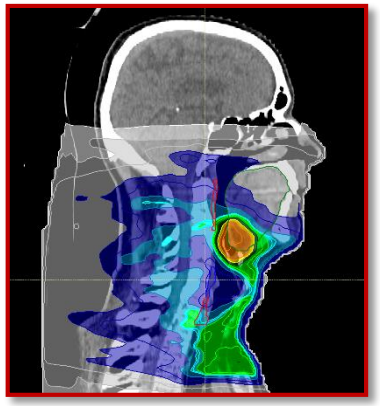
Model-based selection

Step 3: Translate ΔDose into ΔNTCP

Planning comparison

NTCP-model

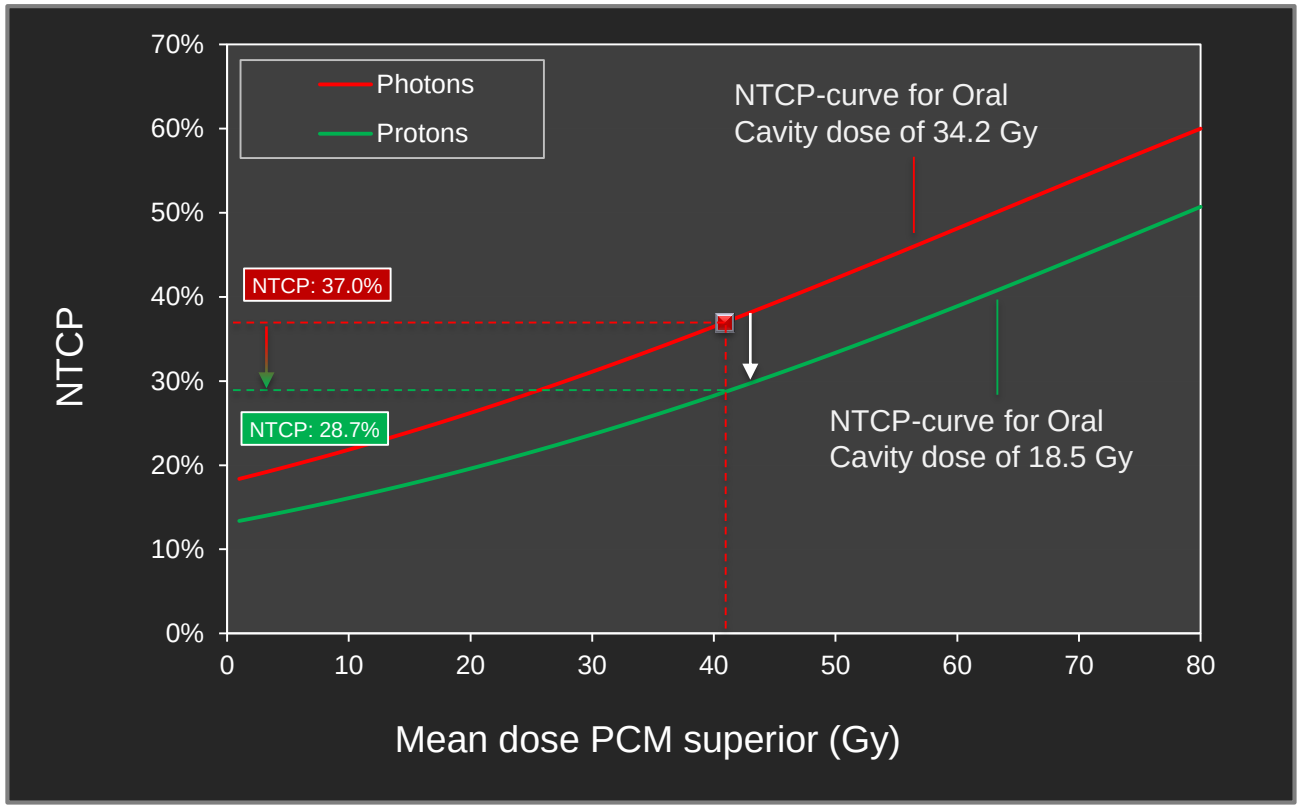
Photons



Organ at risk	Mean dose (Gy)
Superior PCM	40.9
Oral cavity	34.2

Protons

Organ at risk	Mean dose (Gy)
Oral cavity	18.5



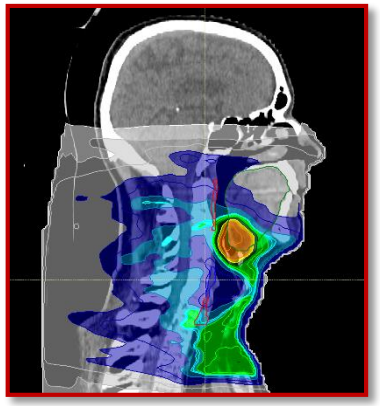
Model-based selection

Step 3: Translate ΔDose into ΔNTCP

Planning comparison

NTCP-model

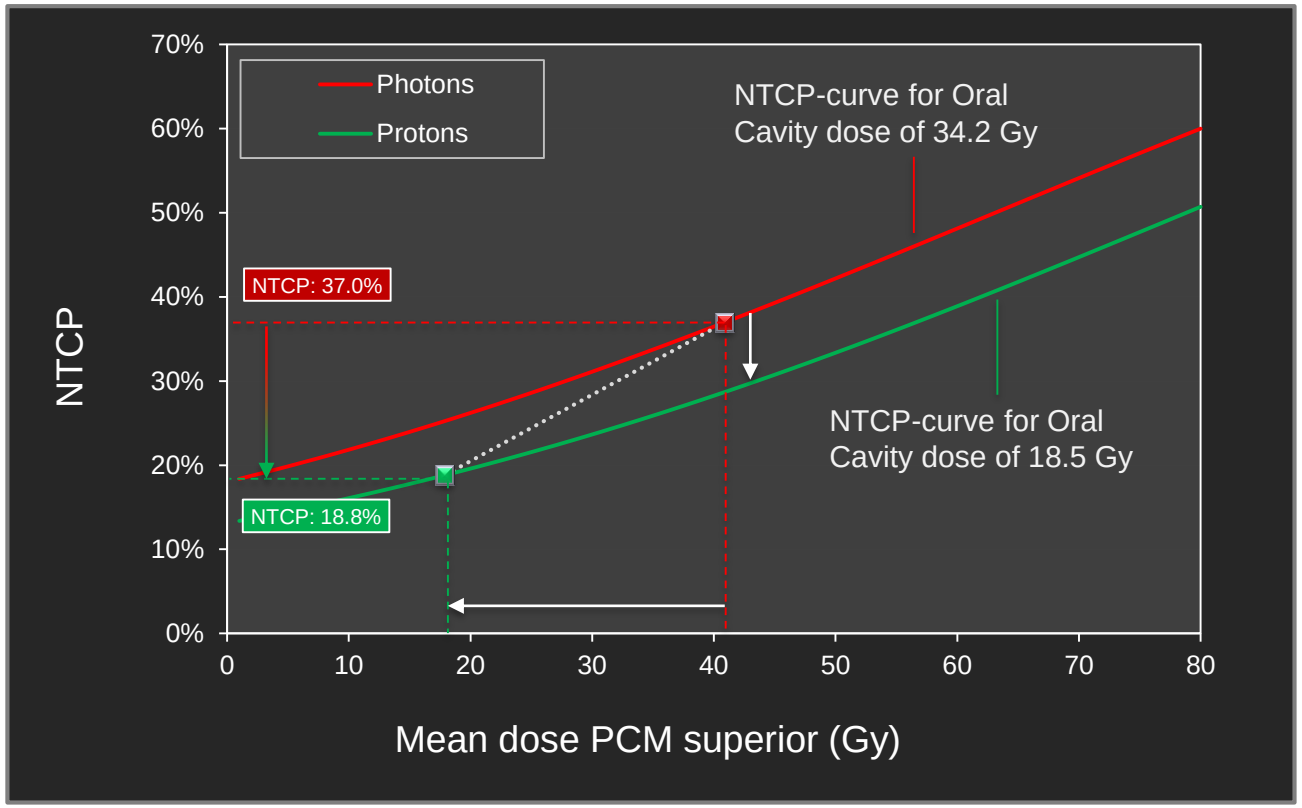
Photons



Organ at risk	Mean dose (Gy)
Superior PCM	40.9
Oral cavity	34.2

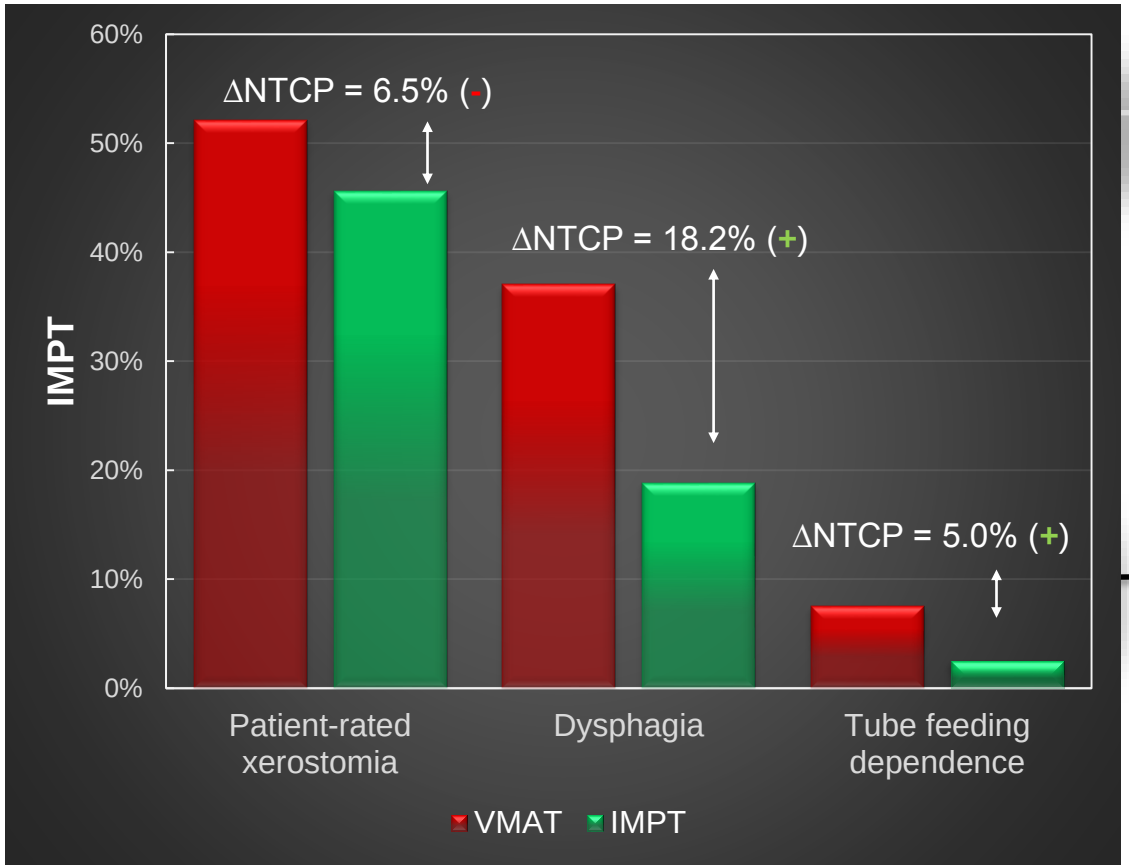
Protons

Organ at risk	Mean dose (Gy)
Superior PCM	17.9
Oral cavity	18.5



ΔNTCP-profile

Does THIS patient qualify for protons?



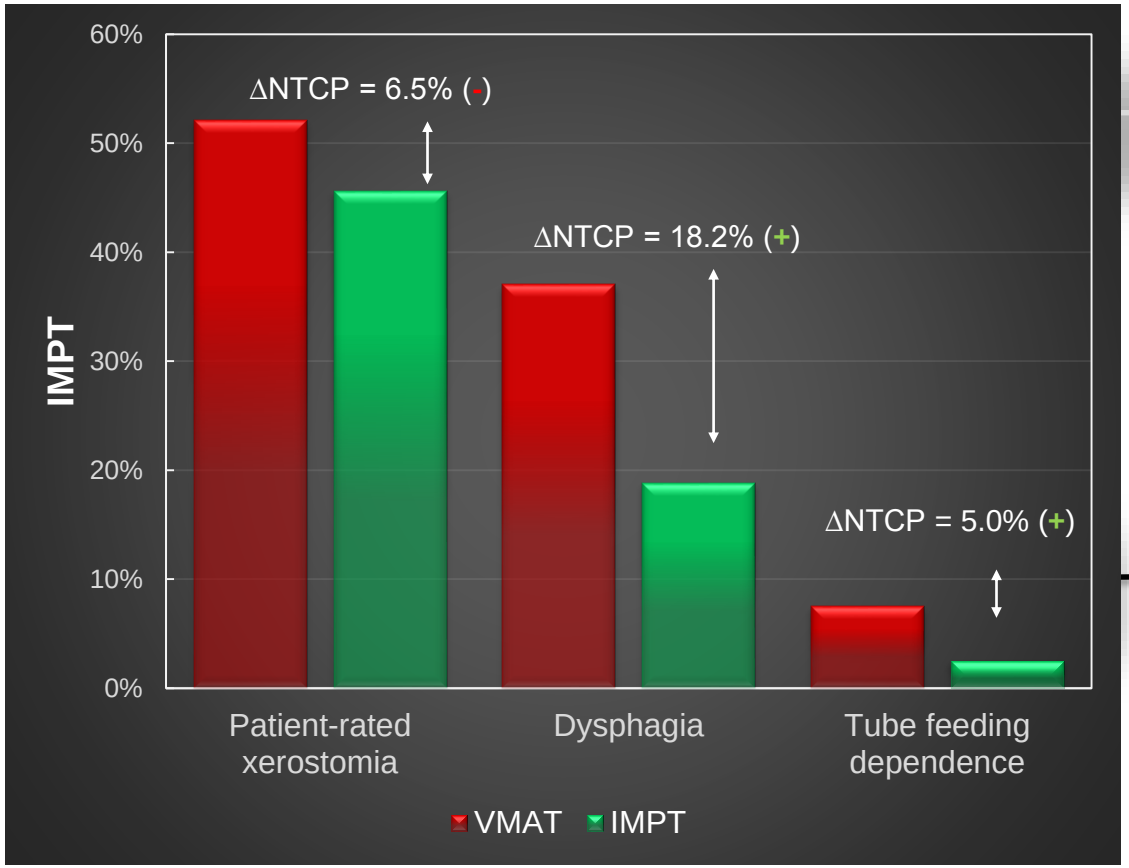
Plan comparison

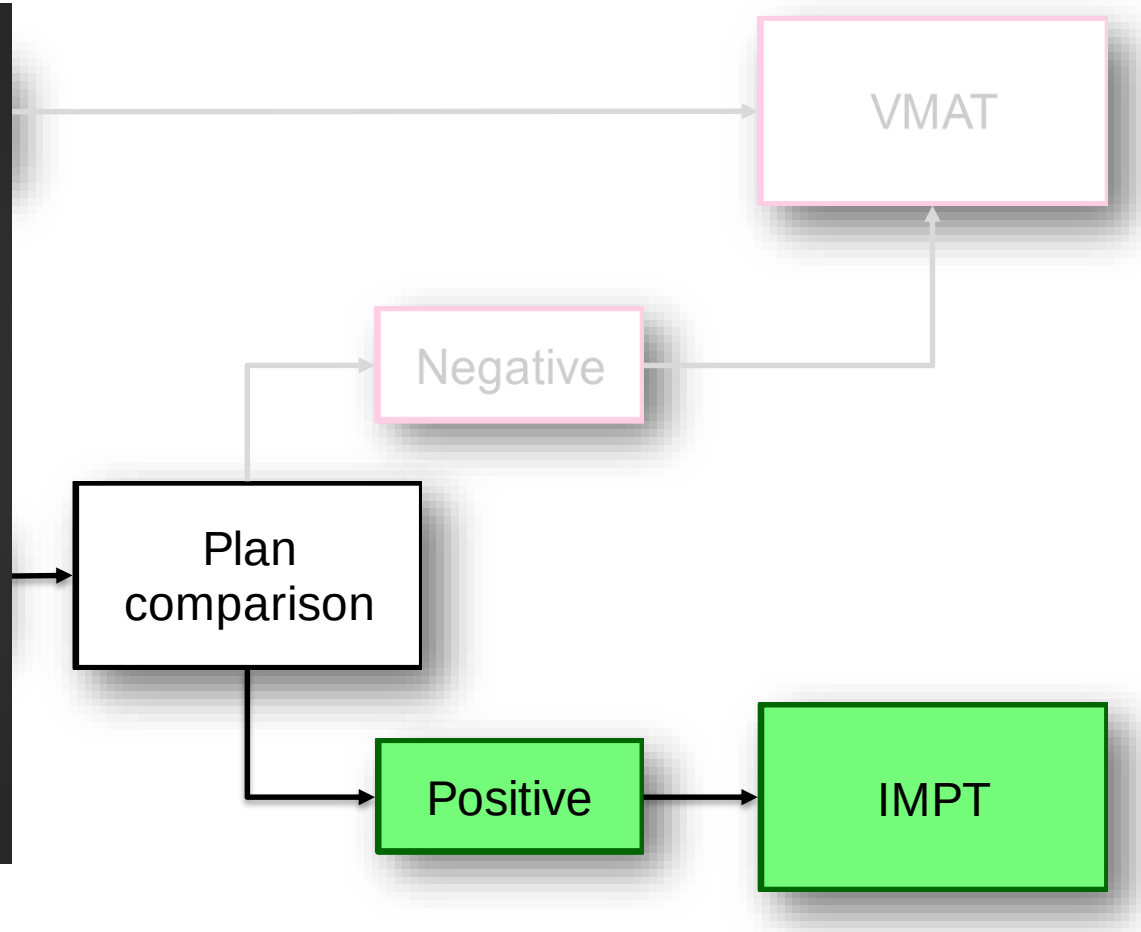
Negative → VMAT

Positive → IMPT

ΔNTCP-profile

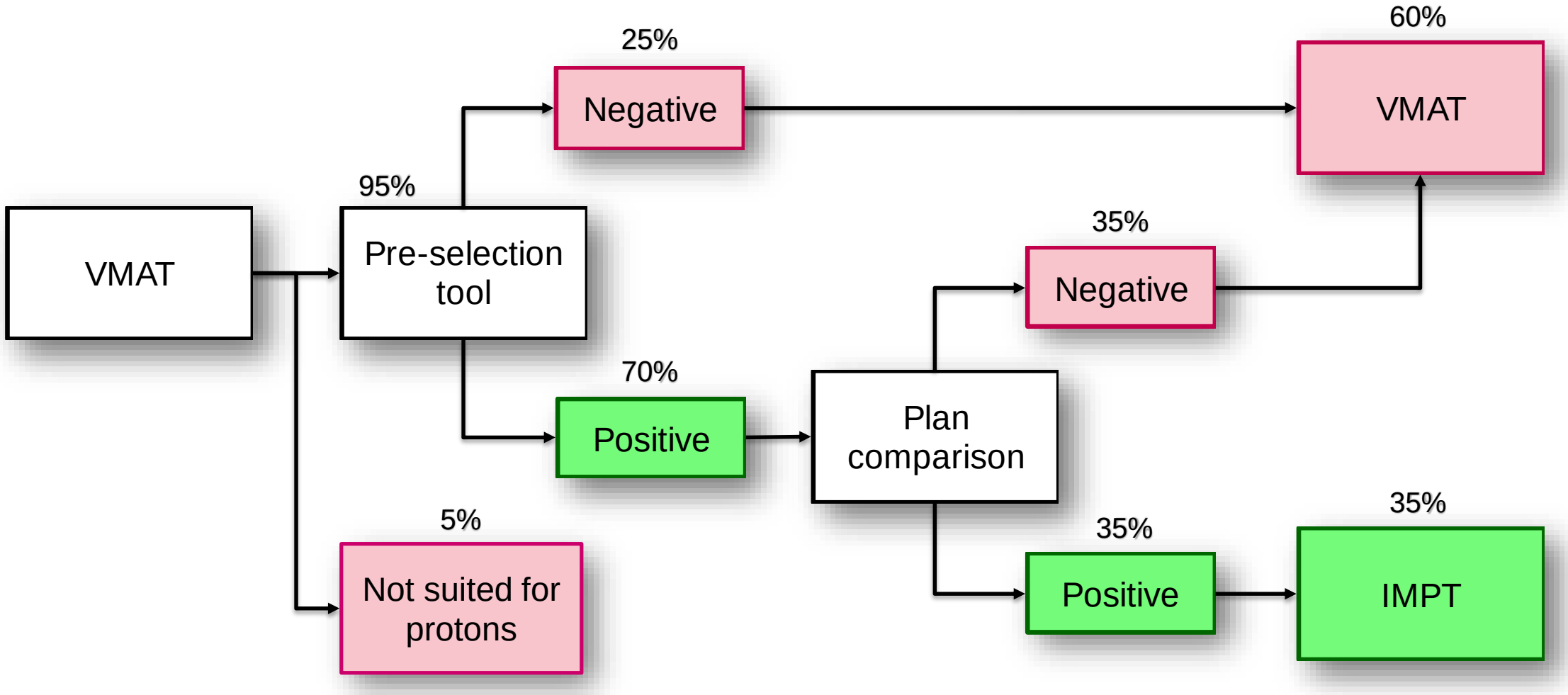
Does THIS patient qualify for protons?





First experience UMCG

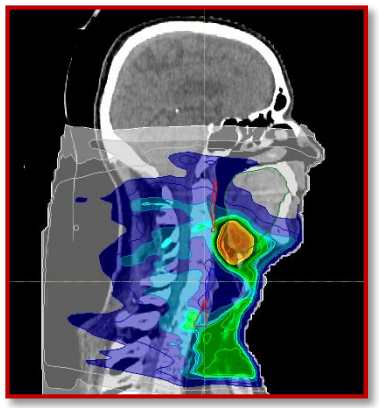
Primary setting



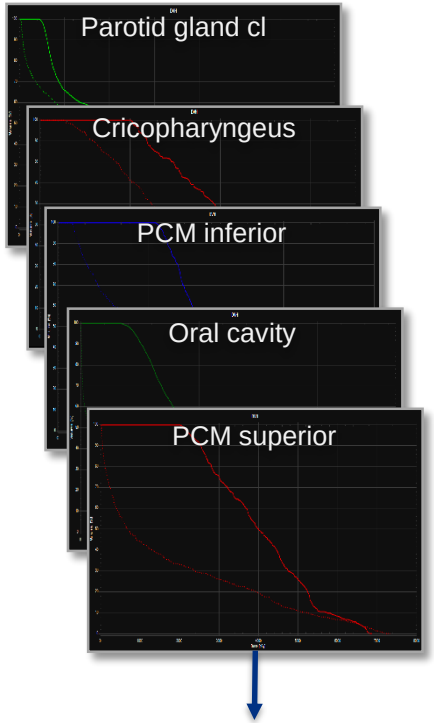
Model-based selection

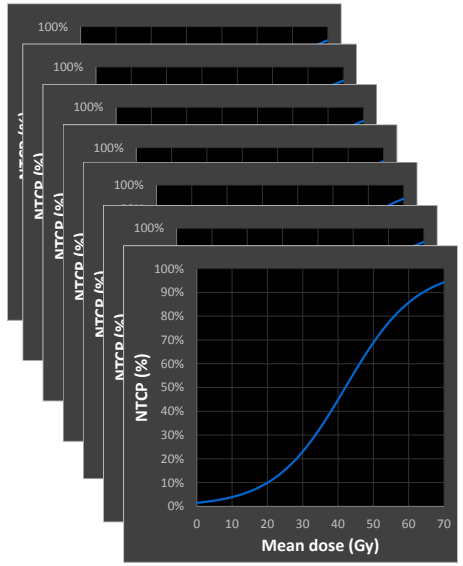
Plan comparison	Dose Volume Histogram	NTCP-models	NTCP-profile

Photons



Protons





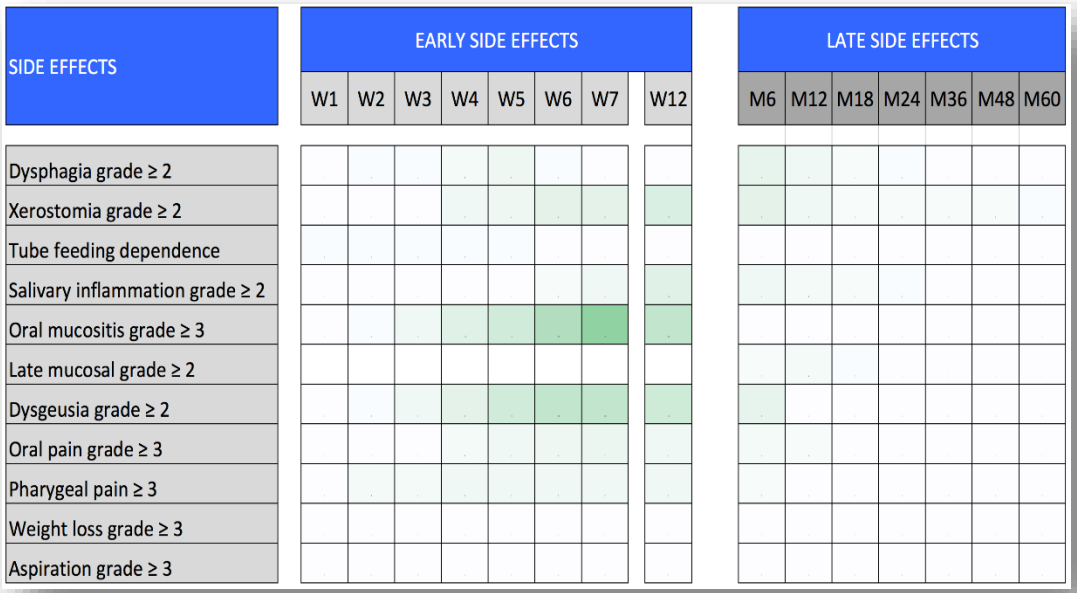
ΔDose profile → ΔNTCP profile

Model-based selection

ΔNTCP-profile (biomarker for benefit of protons)

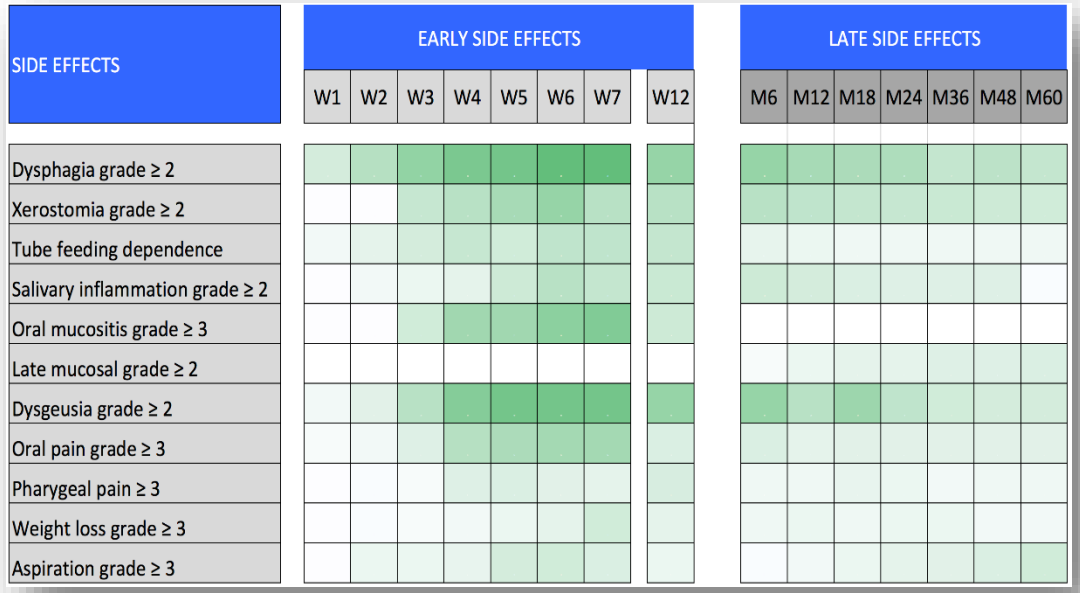
umcg

ΔNTCP-profile with SMALL benefit



NO indication proton therapy

ΔNTCP-profiele with LARGE benefit



Proton therapy indicated

Model-based approach

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- Translate **ΔDose** to **ΔNTCP**

STEP 4: Validation

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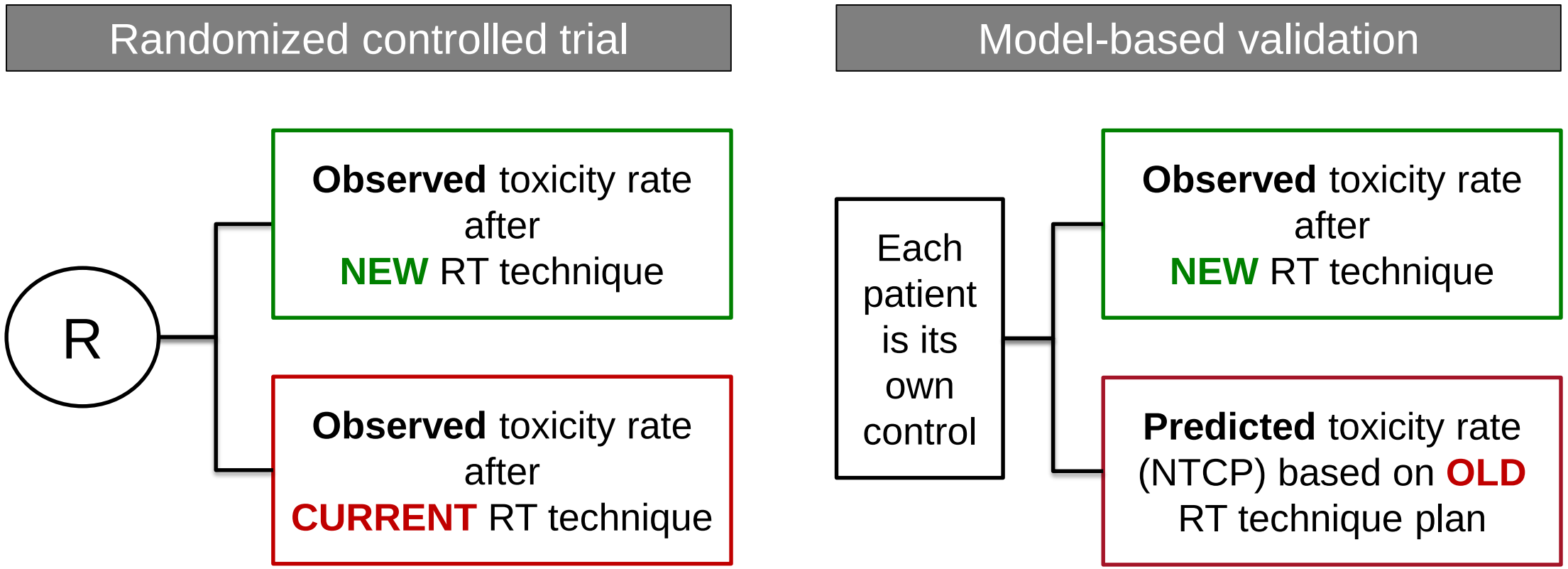
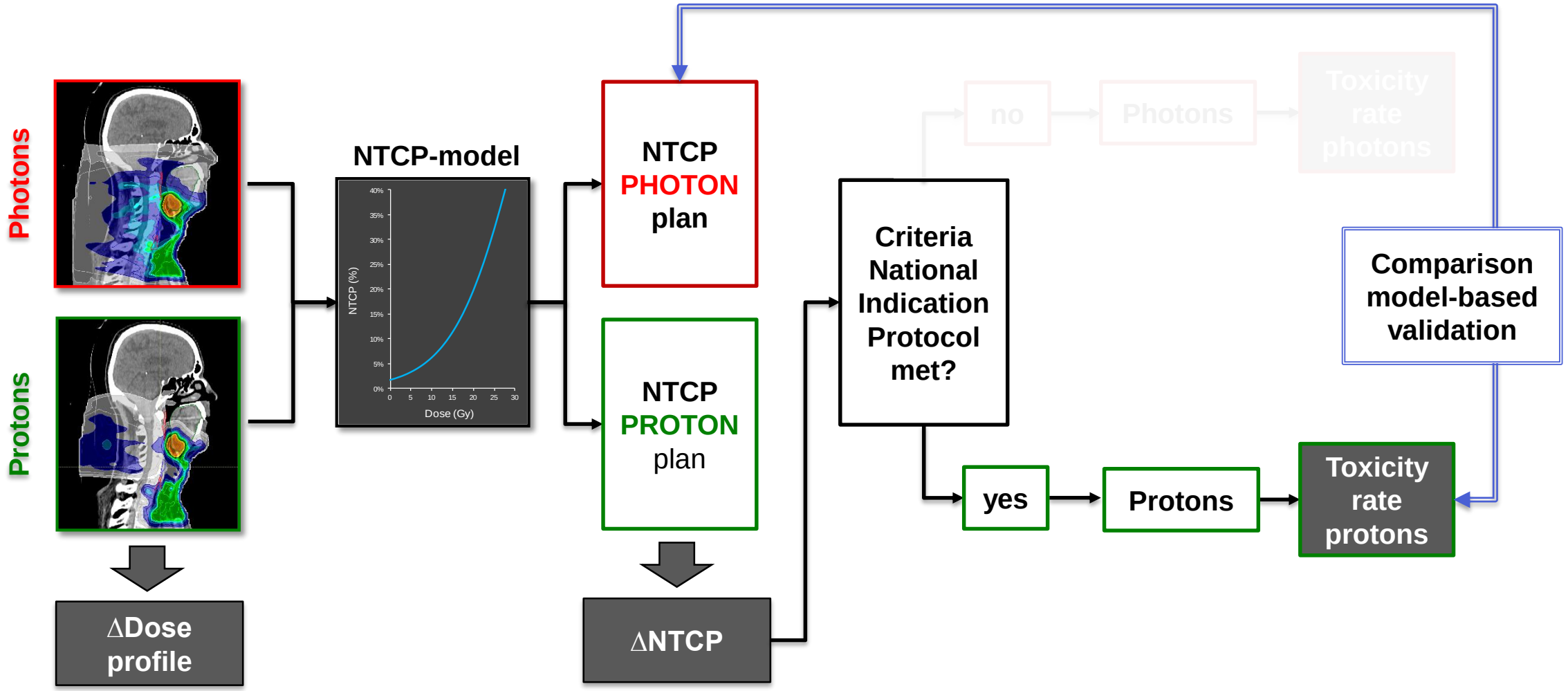
Langendijk *et al*, R&O 2014

Model-based versus RCT validation



Model-based comparison study

Study design



Head and neck cancer radiotherapy

Toxicity profiles of concurrent chemoradiation

Side effects	Acute toxicity								Late toxicity			
	W1	W2	W3	W4	W5	W6	W7	W12	M6	M12	M18	M24
Dysphagia (grade≥2)	16%	25%	44%	64%	82%	85%	86%	56%	45%	31%	23%	20%
Tube feeding dependent	4%	8%	12%	42%	51%	60%	62%	45%	30%	20%	15%	14%
Xerostomia (grade≥2)	5%	11%	34%	45%	56%	60%	57%	54%	42%	35%	31%	30%
Sicky saliva (grade≥2)	6%	15%	36%	48%	53%	54%	52%	40%	35%	30%	19%	18%
Loss of taste (grade≥2)	3%	15%	34%	60%	70%	80%	83%	60%	45%	31%	21%	20%
Oral mucositis (grade≥3)	0%	5%	16%	46%	64%	70%	74%	29%				
Aspiration (grade≥3)	5%	3%	6%	8%	10%	16%	14%	18%	12%	15%	10%	14%
Osteoradionecrosis (grade≥3)								1%	6%	5%	4%	3%
Hypothyroidism (grade≥3)									10%	17%	25%	31%

0%	20%	40%	60%	80%	100%	Percentage with toxicity

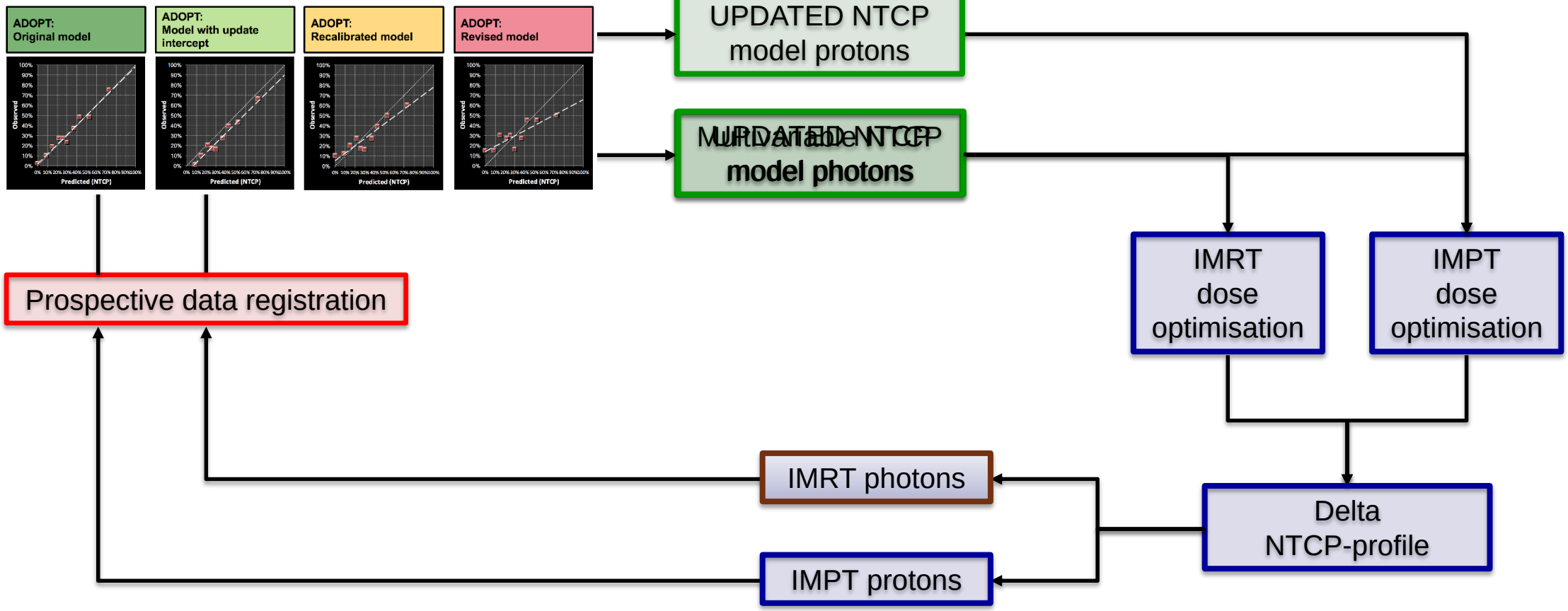
Prospective HEAD & NECK Data Registration Program UMCG

Standard follow up program

Assessment	T0	Weekly during RT	After completion of radiotherapy					
			6 weeks	6 months	12 months	18 months	24 months	➔ 60 months
Acute toxicity	+	+	+					
Late toxicity	+			+	+	+		yearly
PROMs	+	+	+	+	+	+		yearly
Objective endpoints	+			+	+			

UMCG Head & Neck Prospective Data Collection Program

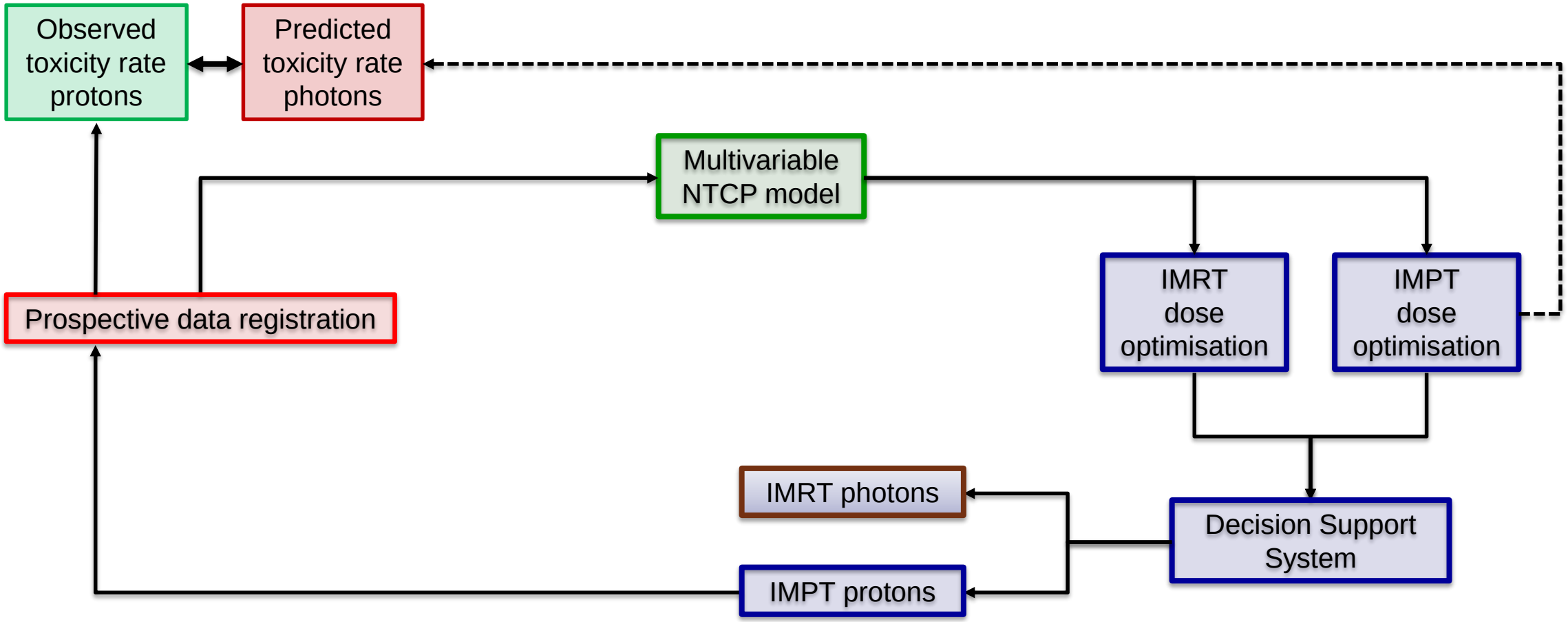
Rapid learning health care system



Rapid learning health care system

umcg

Model-based validation



Conclusions

- Model-based approach
  - Model-based selection
  - Model-based optimization
  - Model-based validation
- Model-based selection is feasible in clinical setting
- First results in head and neck cancer suggest benefit with regard to less acute toxicity
- Alternative for RCT when protons are used to prevent side effects

Acknowlegements

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Hans Reitsma
Ewoud Schuit

The Beaumont experience with Proteus®One after one year of operation

Craig W. Stevens, MD, PhD, Chair of Radiation Oncology, Beaumont Health System

Beaumont

Beaumont Proton Therapy Center

Craig W. Stevens, M.D., Ph.D.
Professor and Chair
Department of Radiation Oncology

Thanks!

- IBA
- Team at Beaumont
  - Too many people to count but
  - Xuanfeng Ding, PhD
  - Peyman Kabolizadeh, MD PhD
  - Tom Lanni
  - Patti Cardoze

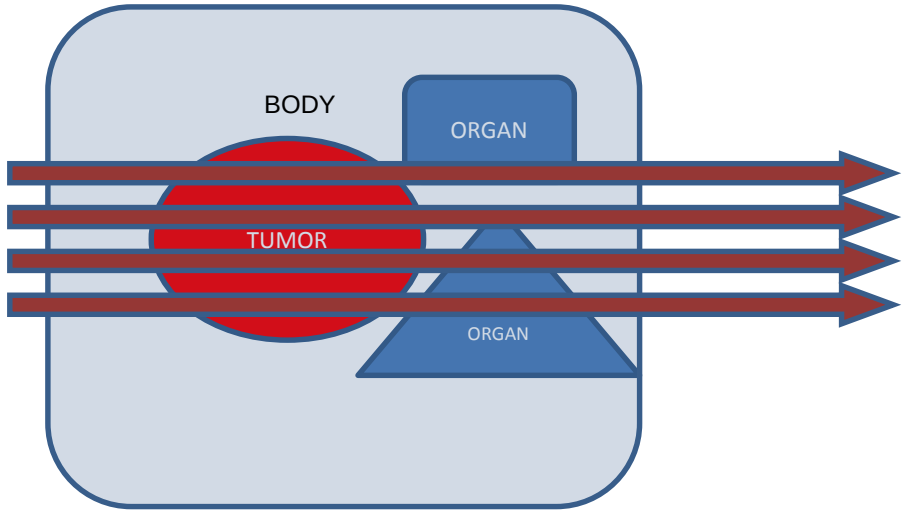
Summary

- We successfully installed and commissioned the first proton center in MI
- We met critical C.O.N. timeline requirements
- This allowed us to
  - Treat the first proton patient in MI
  - Increase our overall consults by almost 10%
  - Treat the first pediatric patient with protons in MI
  - Develop the next generation of proton therapy with IBA
- Impossible without STRONG commitment from IBA

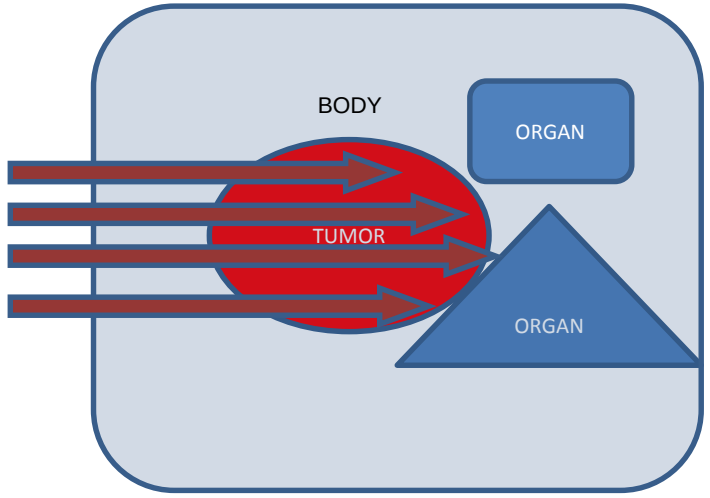
Beaumont Proton Therapy Center

Physics of Proton Therapy

- Photons



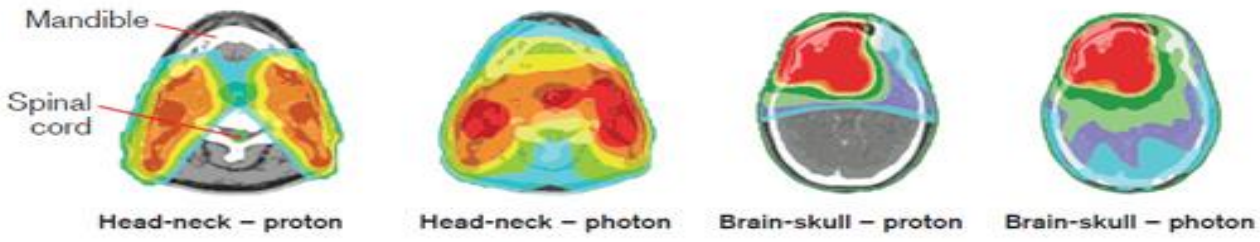
- Protons



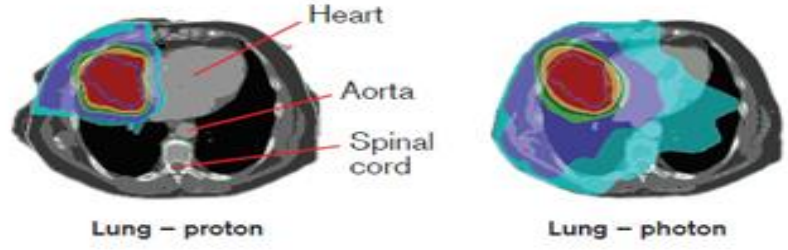
Disease sites

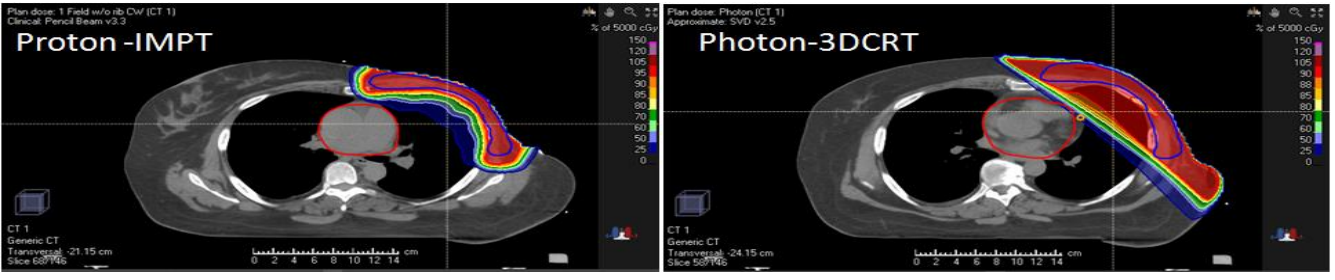
Less integral dose

Head, Neck and Brain

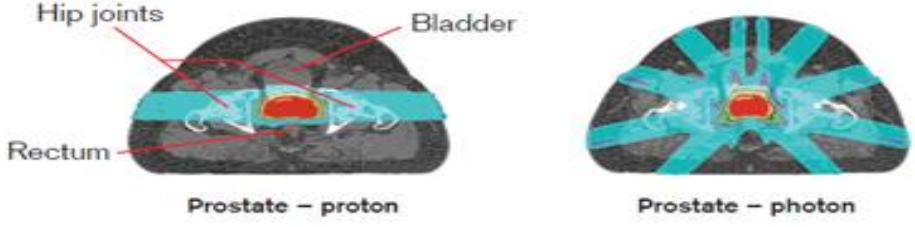


Lung

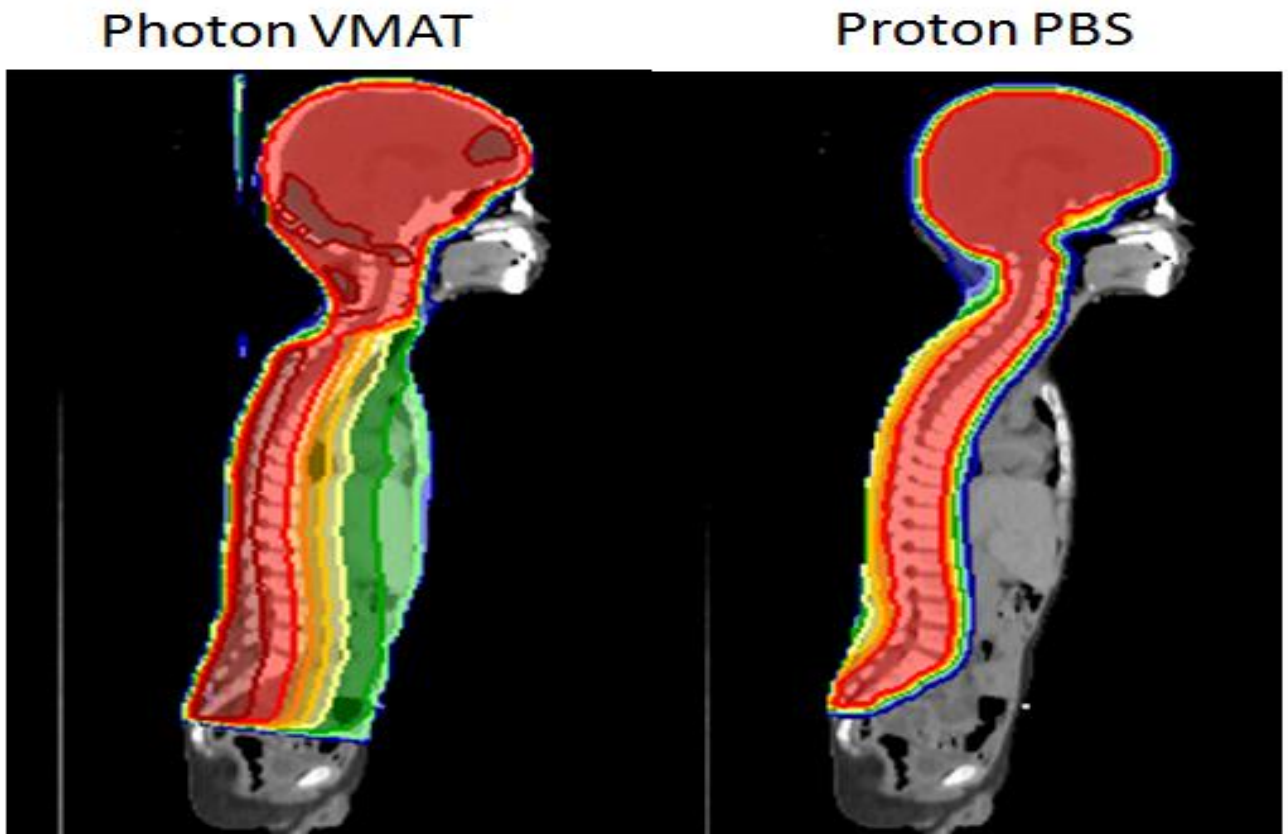




Prostate



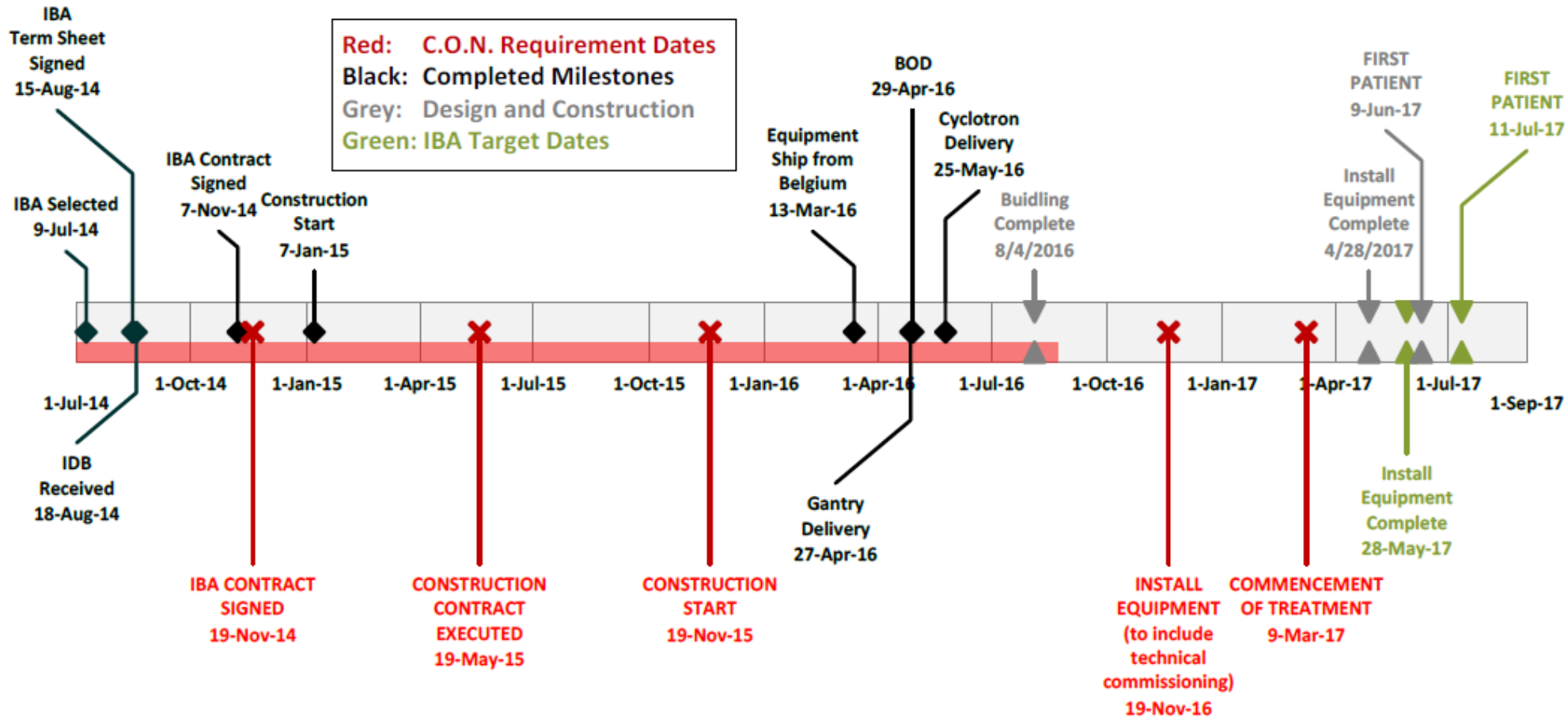
For Pediatric patient



Beaumont Journey

- Initial plan for Proton Center dates from ~2007
  - The 5 room plan was tabled due to the financial crisis
- When I was being recruited to Beaumont in 2013, PTC was reintroduced.
- Board approval in January of 2014
- CON requirements were daunting
  - CON commission had NEVER overseen the construction of a successful center
  - Penalties could be severe if we failed

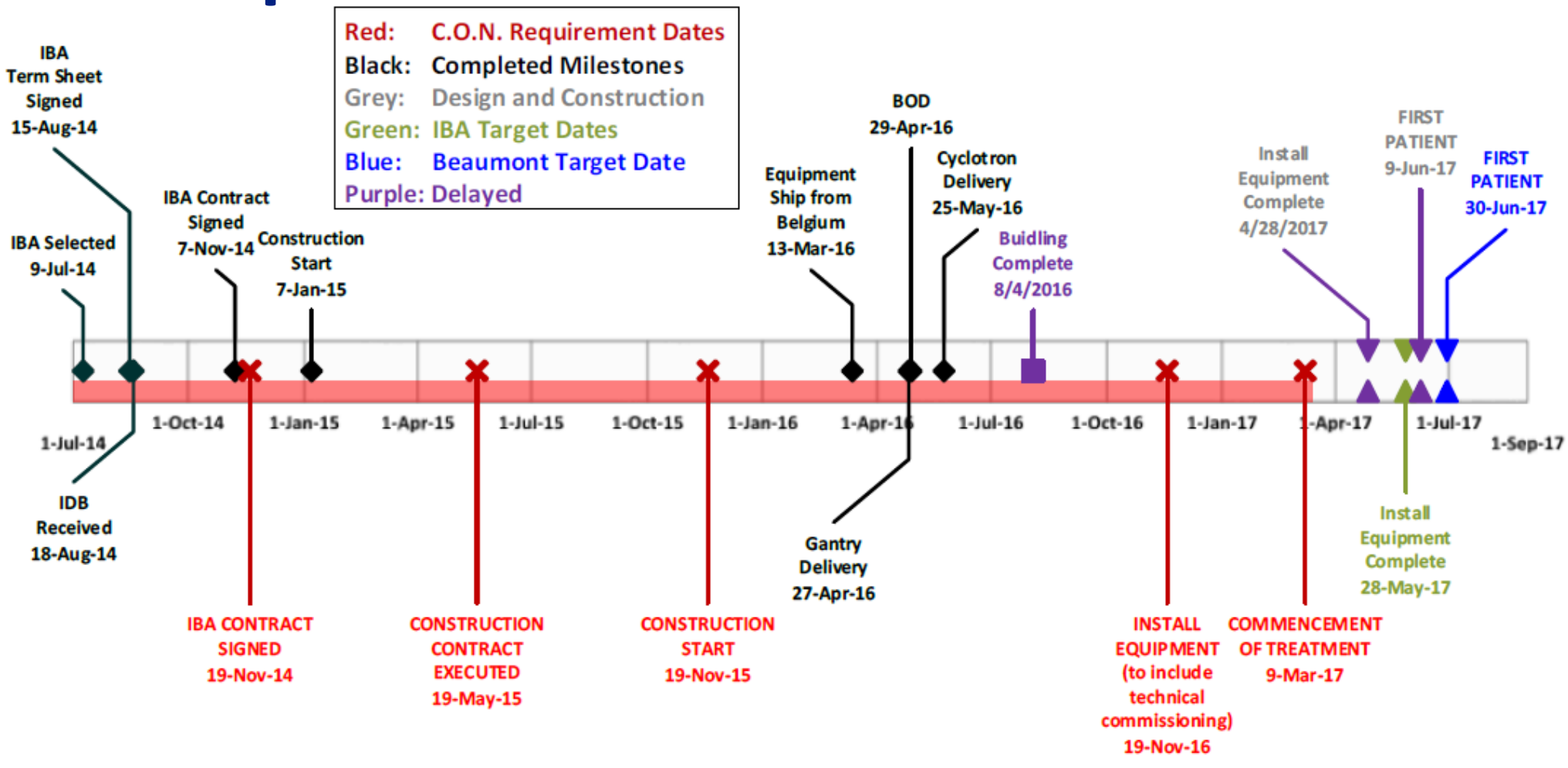
CON Requirements



Beaumont Journey

- Request for Proposals Drafted
  - With help from Proton International
  - IMPT, CBCT, FDA approved, install by March 2017
- Sent to 7 vendors
  - 6 responded
- Three vendors were chosen for site visit
  - One couldn’t deliver IMPT
  - One had a compact cyclotron that would reduce the cost of construction and operations so…….
- IBA was selected July 2014

CON Requirements



Beaumont Journey

- In November 2016, clear we would miss the last two milestones
  - One because it was never reasonable
  - One because of weather and other construction delays
- We restated the time line with a plan to treat the first patient by June 30, 2017

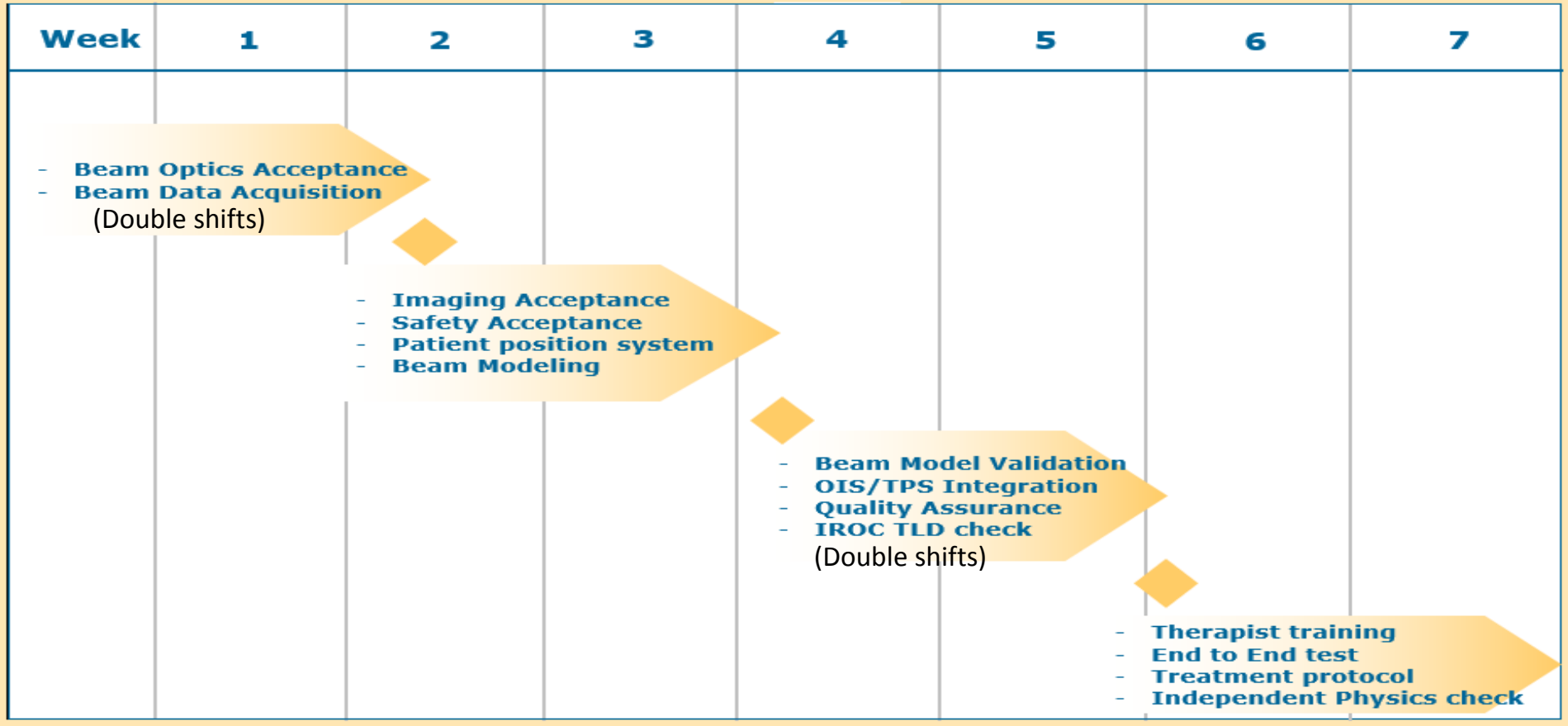
Beaumont Journey

- In February 2017, the schedule slipped again
- We reached out to IBA and other partners to develop an aggressive new schedule
- Plan for first patient to be a patient with a brain tumor

Collaborate and synchronize the team schedule

- Combine the beam data acquisition procedure with acceptance test (IBA & Beaumont)
    - Lock beam optics settings
- Beam modeling and validations (Beaumont & RaySearch America & Sweden)
    - Dry run with current data format
    - Communicate with the RaySearch team
- Mosaiq integration and on-site therapist training
    - Address the bugs and workflow issues
- Independent Physics Check/IROC TLD check
    - Dr. Gao from Chicago Proton Center
    - IROC team (Beaumont commission and treatment schedule)
- **Took 16 week process and condensed it to 7**

Beaumont Commissioning Timeline



Ding et al. NA-PTCOG 2017

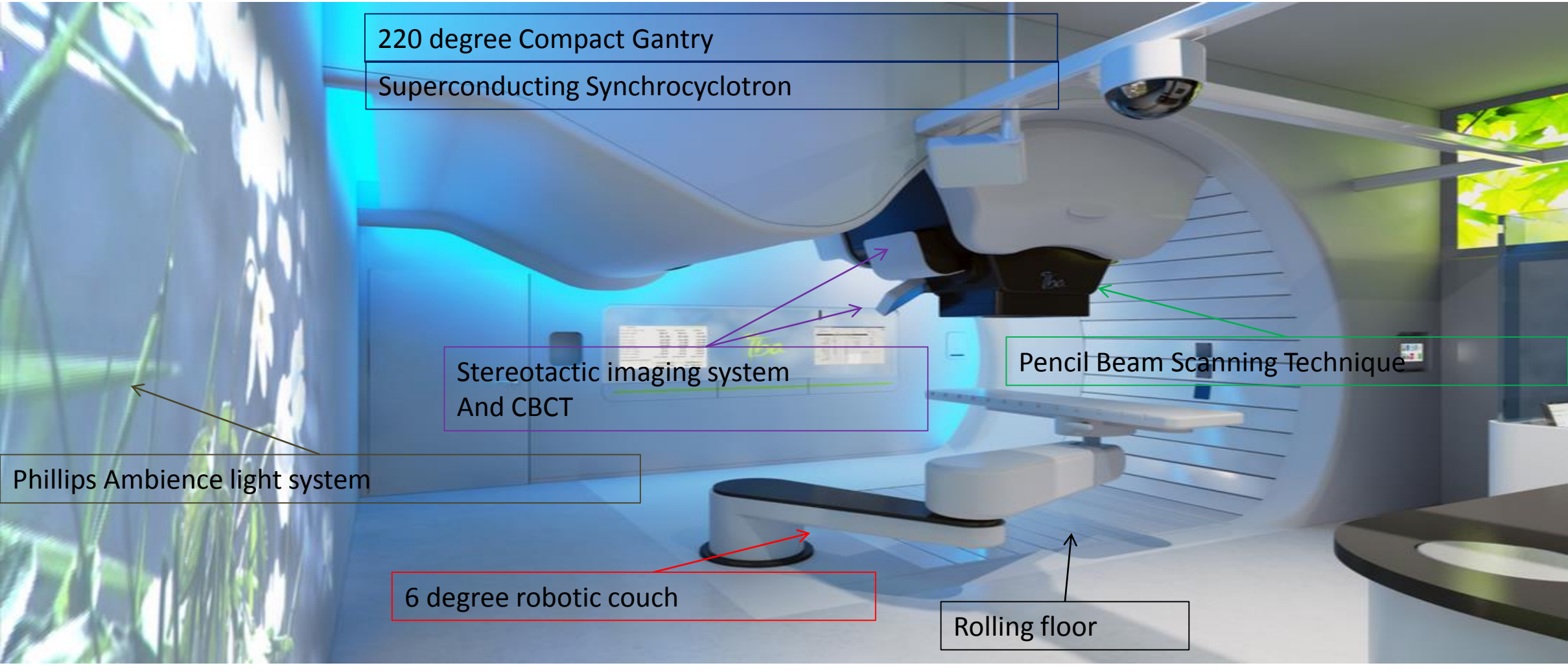
Ahead of Schedule


ERICKSONS
Proton Therapy
Center
Beaumont

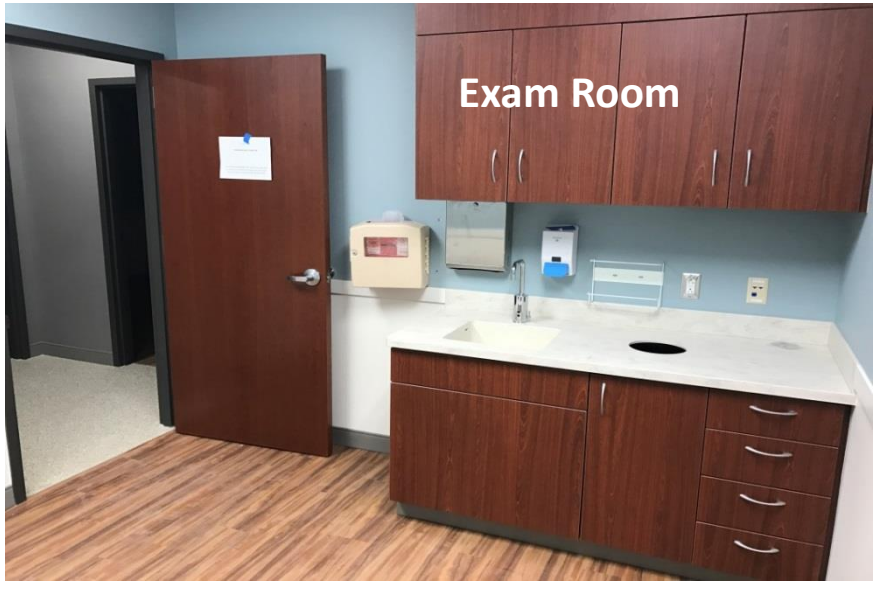
Protons

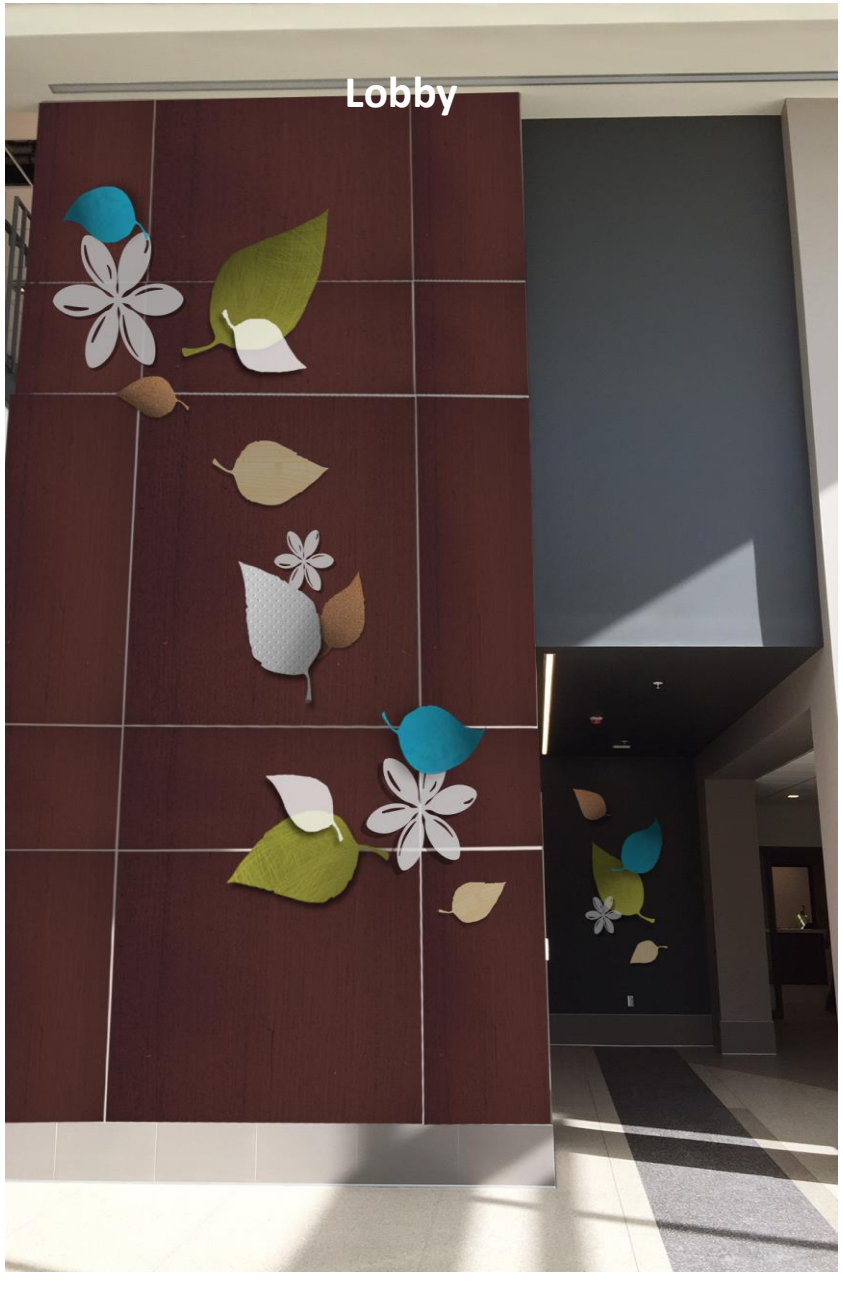
Beaumont Proton Therapy Center

ProteusONE treatment room




Treatment Room


Exam Room


Lobby

Protons

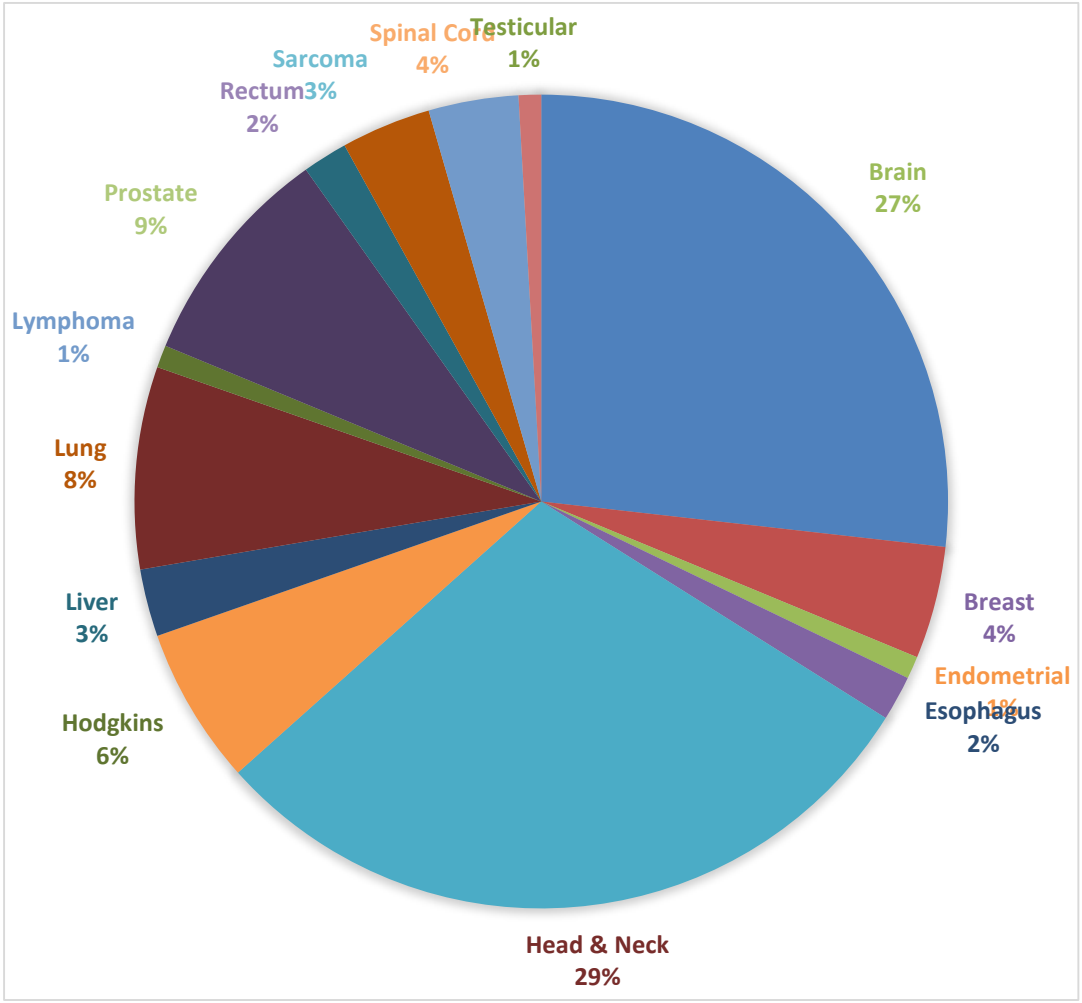
- Our center has IMPT and 3 options for daily imaging
  - Very precise delivery of dose to tumor
  - Reduce uncertainties, and so reduce the target volume
  - This further reduces normal tissue doses

  - Better dose to tumor with less side effects!!!
- Pediatric Oncology relocated to second floor of PTC
  - More than doubles space for pediatrics

Beaumont

Proton Center 1st Patient Treatment
June 28, 2017

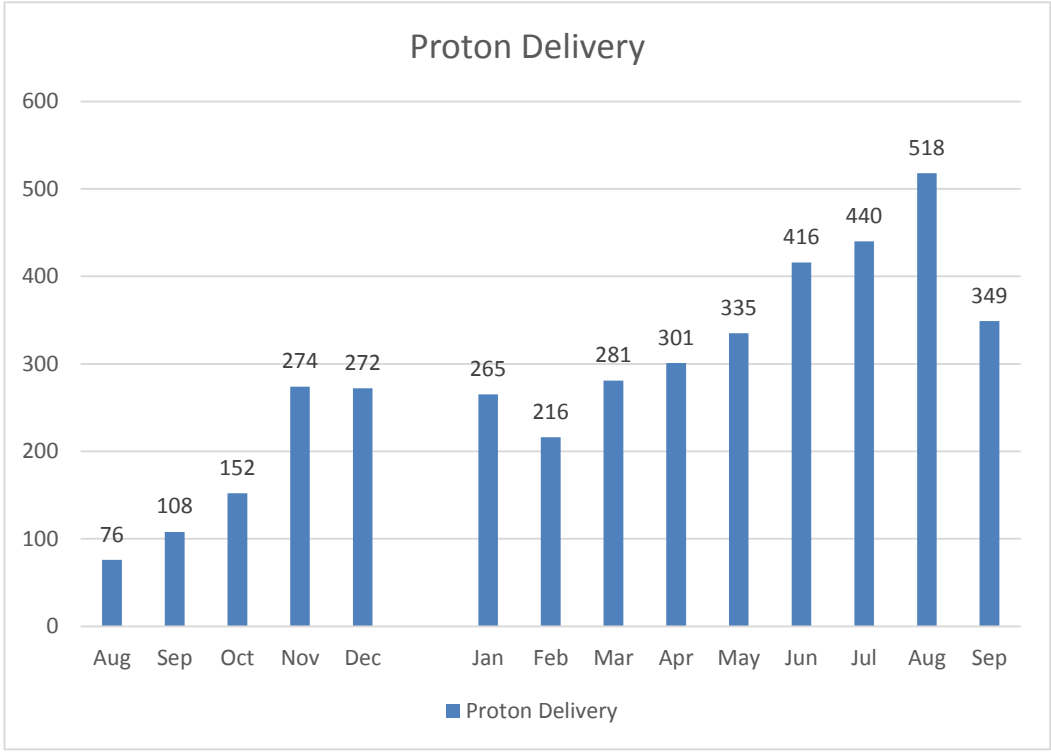
Treatment mix



- Mostly CNS and H&N
- Small volume of prostate
- About 20% peds
  - Depends on your definition……
- 1-3 anesthesia cases

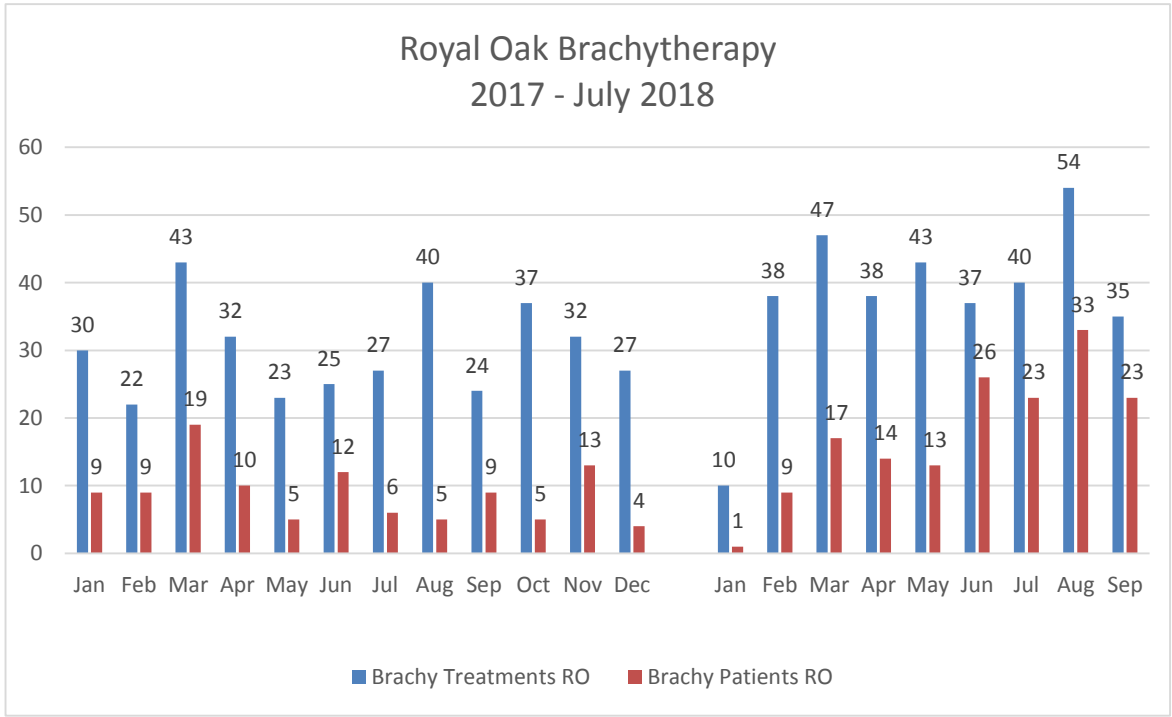
Ramp up

- Intentionally slow
- Treating 15hrs/day
- Averaging 25-27 pts/day



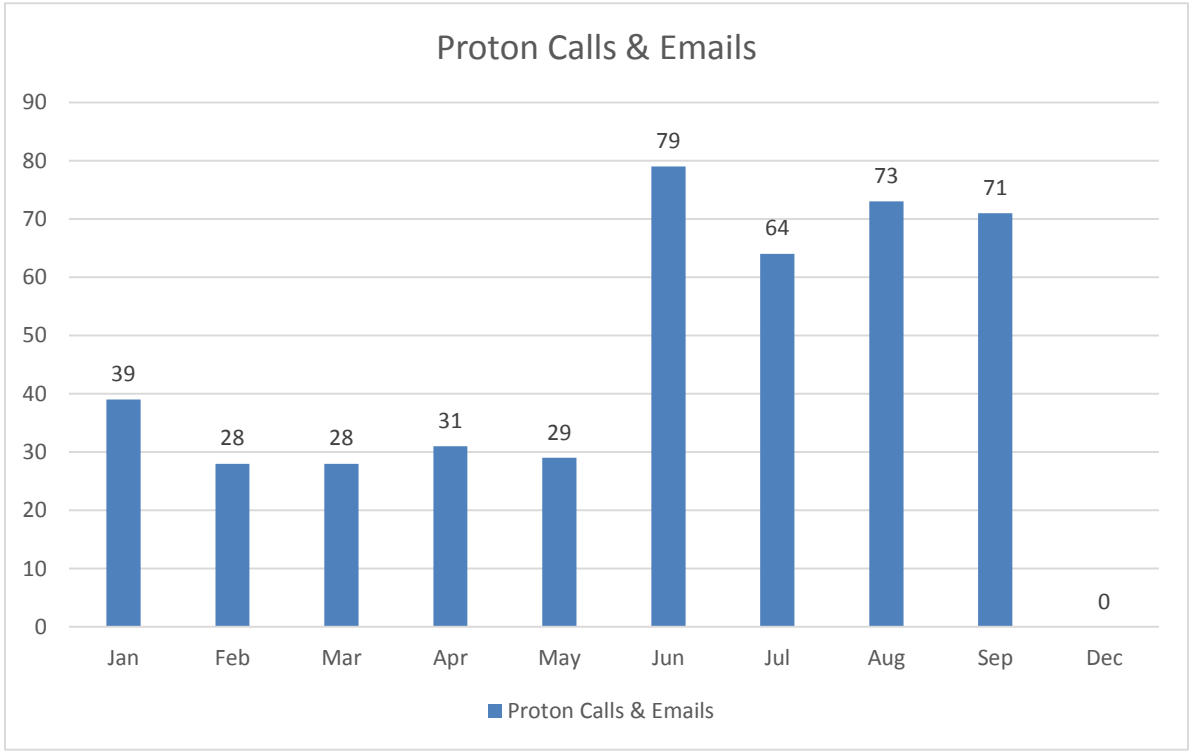
Interesting observations

- Proton installation resulted in growth in Brachytherapy
  - Especially prostate
- No effect on GK
- Linac volumes
  - Across 10 linac system
  - 10% growth at RO
  - Stable elsewhere



Advertising works

- Proactive media outreach started in June
- 3X call volume
- Increased proton #s
- Increased X-ray #s



Beaumont Proton Therapy Center

Commissioning

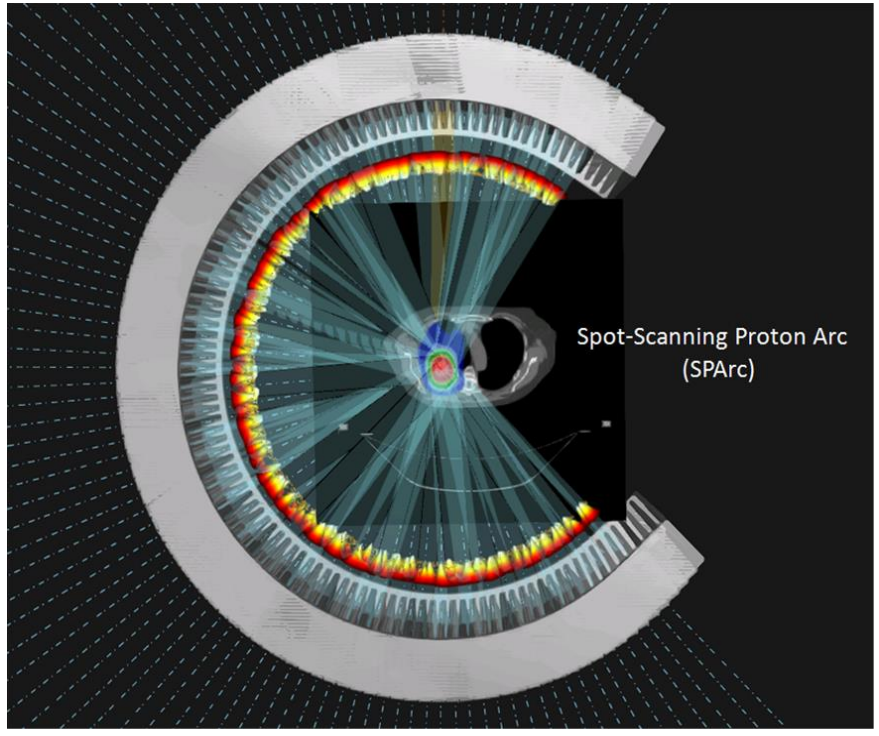
- All tumor sites commissioned in 6 months
- Waited June -> November for anesthesia
- Highly mobile tumors still a problem
  - Though SPArc may help significantly…..
- Eyes – 2020ish

During this time we also

- Dr. Ding has developed a process for rotational IMPT with PBS
  - SParc
- Developed a sponsored research program with IBA
- Submitted R03 for technology development
- Published extensively
- Developed and opened a Patient Access Center to facilitate referrals and coordinate care
- Enhanced authorization and billing process
  - <10% patients ultimately failed authorization

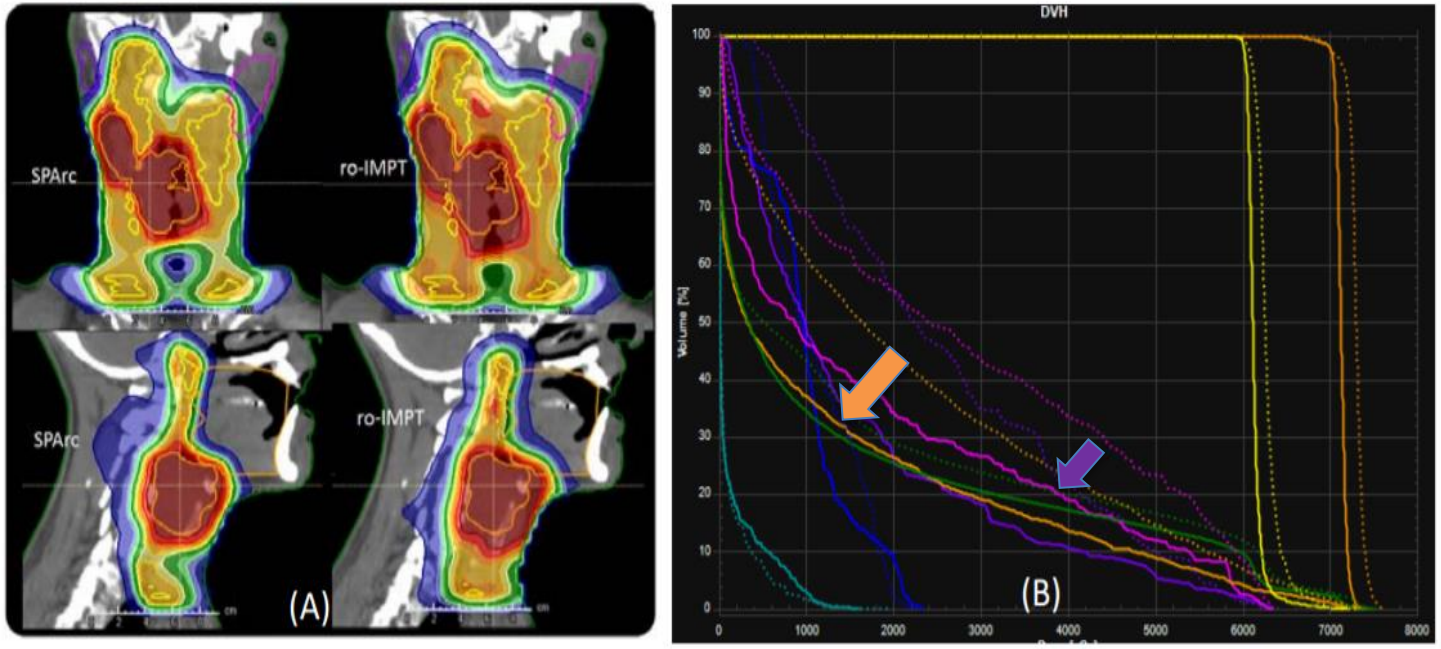
Spot-Scanning Proton Arc (SPArc)

- A robust, delivery efficient and potential for continuous arc delivery advanced IMPT optimization algorithm
  - Prostate (PTCOG 2017)
  - Brain Hippocampus sparing (AAPM 2017)
  - Cranial SRS (ASTRO 2017)
  - Spine SRS (ASTRO 2017)
  - Bilateral Head & Neck (AAPM 2017)
  - Advanced staged lung cancer (NA-PTCOG 2016)
  - Mobile tumor – interplay (AAPM 2017)



Ding X & Li X IJROBP 2016

HNC: Dosimetric comparison

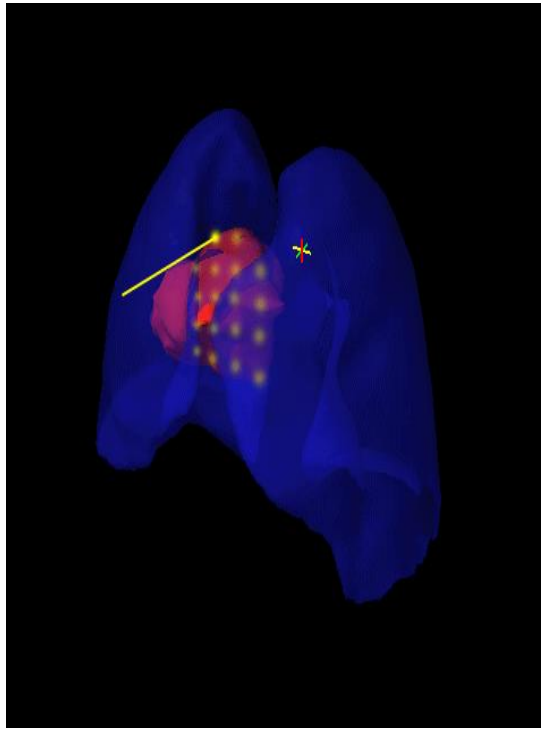


More than 30% reduction in the parotid mean dose

Figure 1 (A) Dose distribution comparison between SPArc and ro-IMPT for patient #3. B) DVH evaluation, SPArc (solid line) and ro-IMPT (dotted line); Ding et al. AAPM 2017

Interplay effects for proton therapy

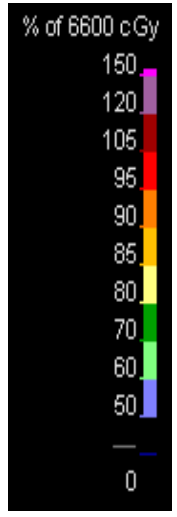
- The motion of the beam could interfere with the motion of target
- May result in distortion of the planned dose distribution, local over- and under- dosage
- One of the major concerns for treating lung cancer with scanning beam proton



Single-fraction 4D dynamic dose

SPArc

IMPT



Li et al. Radiation Oncology 2018

Patient 6, ITV volume of 402cc, S-I motion of 1.2 cm

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Questions?

Conclusion

Olivier Legrain, Chief Executive Officer, IBA

Conclusion

- Strong perspectives for the proton therapy market
  - Growing acceptance of proton therapy
  - Change of business model (integrated compact system)
  - Strong pipeline
- IBA technological lead over competition
  - IBA world-class innovative proton therapy solutions
  - Strong partnerships
  - IBA experience in installing equipment clearly established

Question and Answer