XV FOOT Collaboration Meeting

Activities at the Trento Proton Therapy Center

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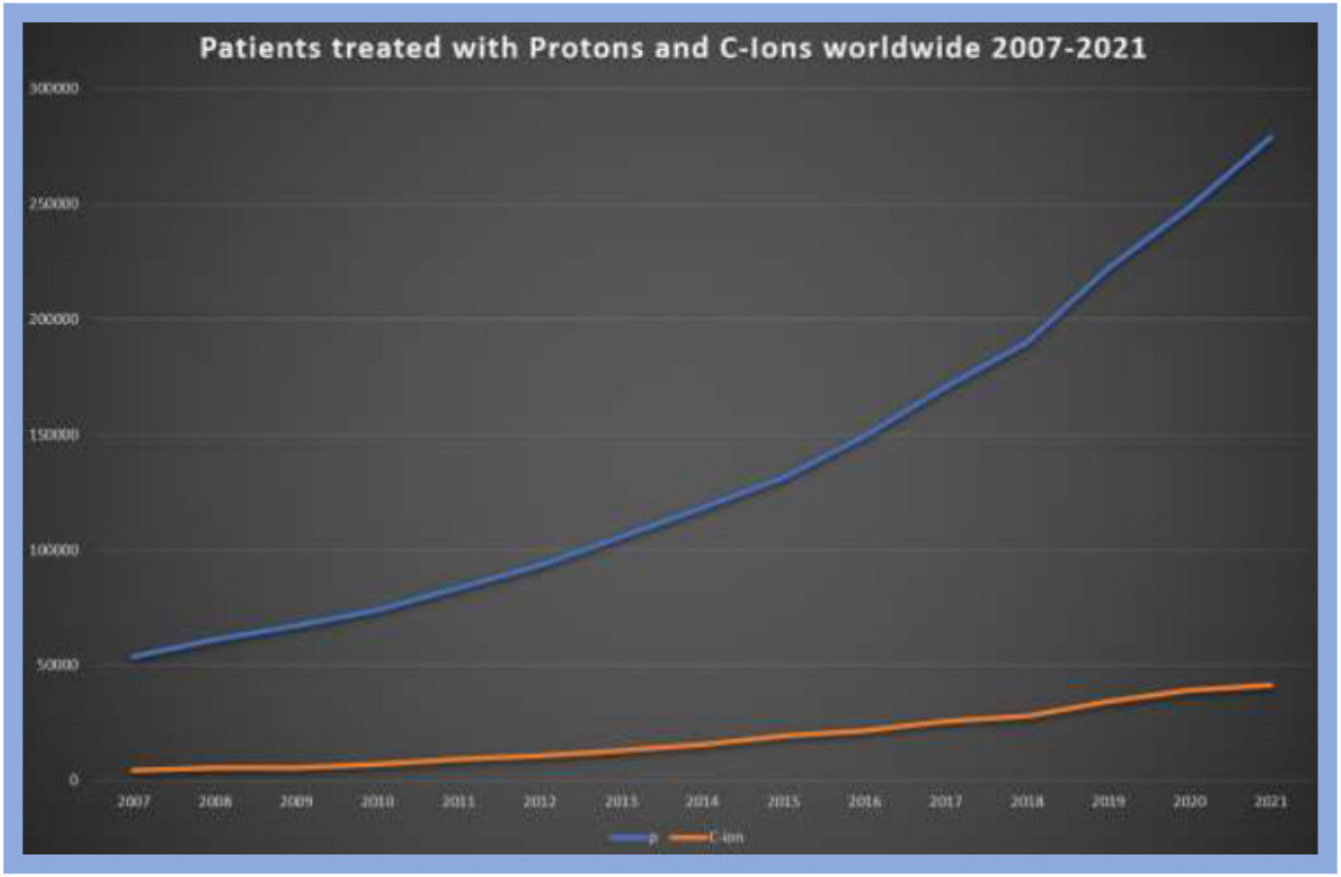
Trento, 13 December 2023

Particle therapy centers over the world

Number of treated patients with particle therapy



Alla fine del 2007 erano circa 62.000

Cinque anni dopo, nel 2012, il numero era salito a quasi 95.000

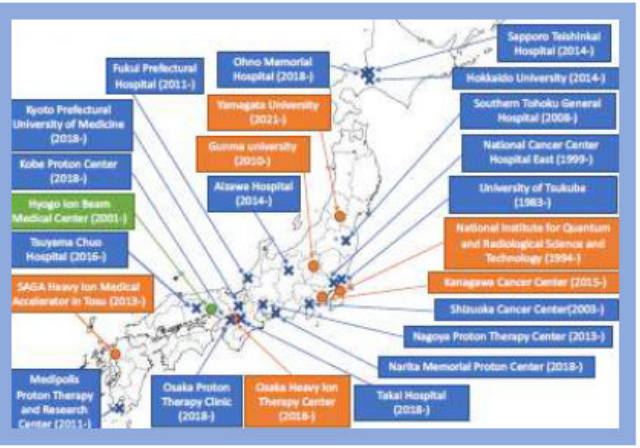
Dopo altri 5 anni, nel 2017, sono diventati circa 170.000

Nel 2021, il totale è arrivato ad oltre 270.00

Crescita di circa 25.000 nuovi pazienti per anno

Ratio treatment rooms/inhabitants

	Numero di abitanti (M)	Sale trattamento/No. abitanti
Giappone	127	2.3
Stati Uniti	328	3.2
Europa	514	7.1
Danimarca	5.8	1.9
Repubblica Ceca	10.5	2.1
Svizzera	8.5	2.8
Austria	8.8	2.9
Olanda	17.1	3.4
Svezia	10.3	5.1
Belgio	11.4	5.7
Germania	82.8	6.3
Regno Unito	66	6.6
Francia	67	11
Italia	60.1	12
Polonia	37.8	18.9



Spagna/Fondacion Ortega 263.5 M€

- Un equipo en la Comunidad Autónoma del País Vasco
- Dos equipos en la Comunidad Autónoma de Cataluña
- Un equipo en la Comunidad Autónoma de Galicia,
- Dos equipos en la Comunidad Autónoma de Andalucía
- Un equipo en la Comunidad Autónoma de Valencia
- Un equipo en la Comunidad Autónoma de Canarias
- Dos equipos en la Comunidad Autónoma de Madrid

Particle therapy centers in Italy

- Operating centers
- Centers under construction

Indications and Reimbursments – the current status

DECRETO DEL PRESIDENTE DEL CONSIGLIO DEI MINISTRI 12 gennaio 2017

Definizione e aggiornamento dei livelli essenziali di assistenza, di cui all'articolo 1, comma 7, del decreto legislativo 30 dicembre 1992, n. 502. (17A02015)

elenco note e corrispondenti condizioni di erogabilità/indicazioni appropriatezza prescrittiva		
n. nota	tipo nota	contenuto nota
97	CONDIZIONE EROGABILITA'	Pazienti con una delle forme tumorali sottoelencate, in assenza di malattia metastatica, in cui siano presenti tutte le seguenti condizioni: a) il trattamento abbia finalità radicali curative; b) PS: 0-2 ECOG; c) non siano presenti concomitanti malattie o comorbidità invalidanti che riducano in maniera significativa l'attesa di vita: 1) cordomi e condrosarcomi della base del cranio e del rachide; 2) tumori del tronco encefalico (esclusi i tumori intrinseci diffusi del ponte) e del midollo spinale; 3) sarcomi del distretto cervico-cefalico, paraspinali, retroperitoneali e pelvici; 4) sarcomi delle estremità ad istologia radioresistente (osteosarcoma, condrosarcoma); 5) meningiomi intracranici in sedi critiche (stretta adiacenza alle vie ottiche e al tronco encefalico); 6) tumori orbitari e periorbitari (es. seni paranasali) incluso il melanoma oculare; 7) carcinoma adenoideo-cistico delle ghiandole salivari; 8) tumori solidi pediatrici; 9) tumori in pazienti affetti da sindromi genetiche e malattie del collageno associate ad un'aumentata radiosensibilità; 10) recidive che richiedono il ritrattamento in un'area già precedentemente sottoposta a radioterapia.

DM aprile 23. Entrata in vigore delle nuove tariffe **dal 1 gennaio 2024**

92.29.U	ADROTERAPIA - Ciclo intero.	€ 21.000,00	
92.29.V	ADROTERAPIA - Boost (sino a 6 frazioni).	€ 8.000,00	Per un numero di sedute superiore a 6 la remunerazione è 0
92.29.W	ADROTERAPIA - Stereotassi (1-3 frazioni).	€ 10.000,00	Per un numero di sedute superiore a 3 la remunerazione è 0

APSS Trento Proton Therapy Center

Azienda Provinciale per i Servizi Sanitari
Provincia Autonoma di Trento

Turn-key (‘‘commercial’’) proton therapy solution

European tender lauched at beginning of 2007

Contract signed in December 2009

Clinical activities started in October 2014 (1° Gantry room in Italy)

PTC was designed as the first block of the New Hospital…(2030??)

More than 2000 pts treated (from *classical* particle therapy indications to moving target lesions, e.g.: lungs)

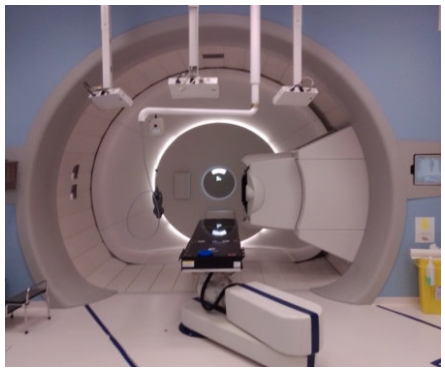
Trento Proton Therapy Center: the history in short

• **May 2000**	initial proposal
• **February 2001**	meeting in Trento about the idea
• **Early 2002**	preliminary feasibility analysis
• **Late 2002**	PAT project financial endorsement
• **July 2003**	ATreP creation
• **Autumn 2004**	ATreP director nomination
• **Early 2005**	working group formation
• **2007**	European tender call
• **2008**	winner designation and negotiation beginning
• **December 2009**	contract with IBA-Mantovani
• **2010-2013**	building of the centre and of the working group
• **August 2013**	delivery of the centre
• **September 2013**	acceptance test beginning
• **1st January 2014**	ATreP discontinuation and taking over by APSS (Azienda Provinciale per I Servizi Sanitari)
• **22nd October 2014**	1st patient treated

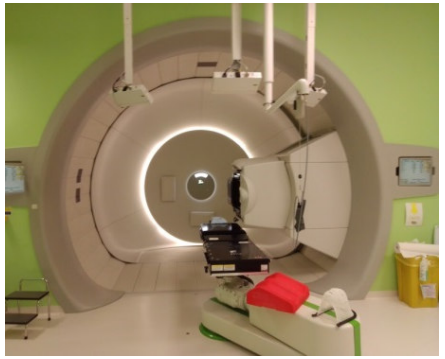
Trento Proton Therapy Center - Layout

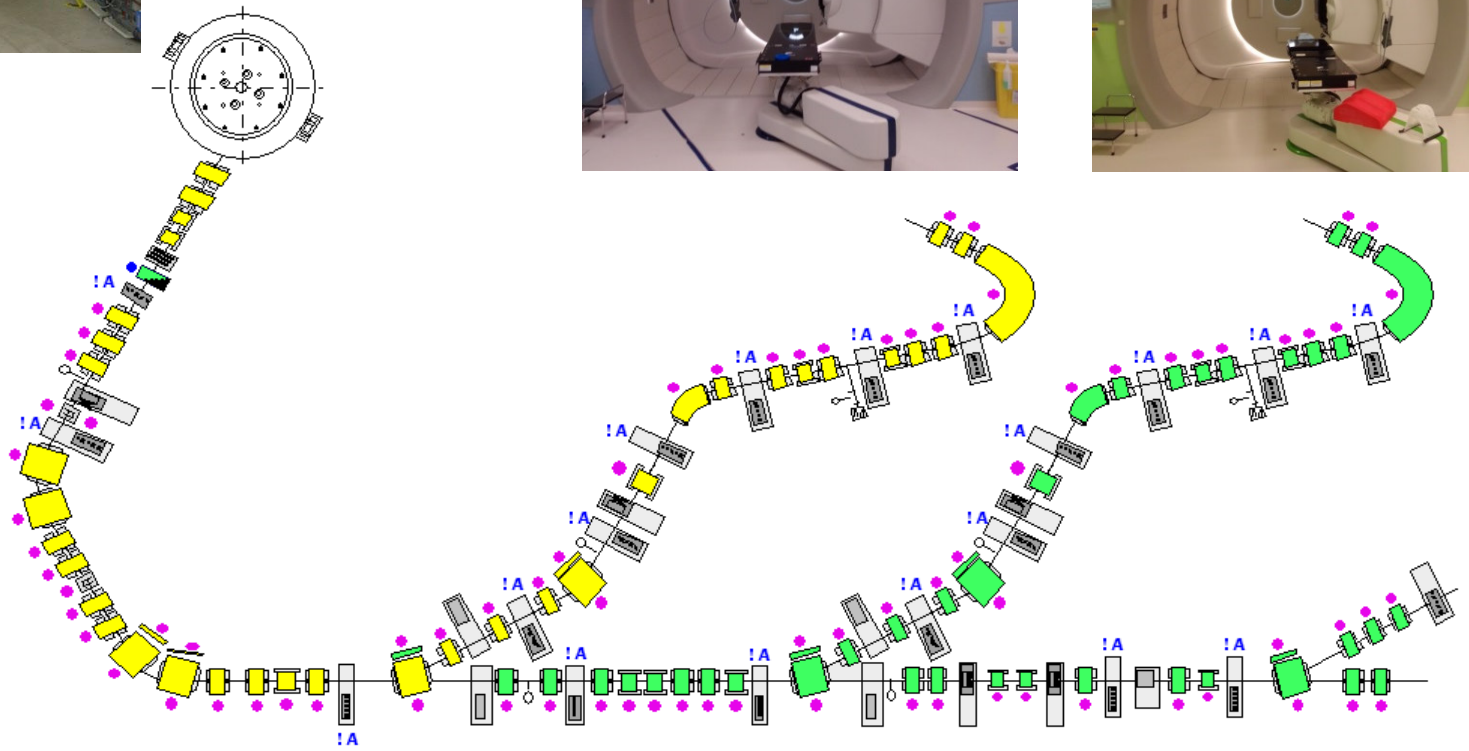
Cyclotron
(230 MeV)

Gantry1



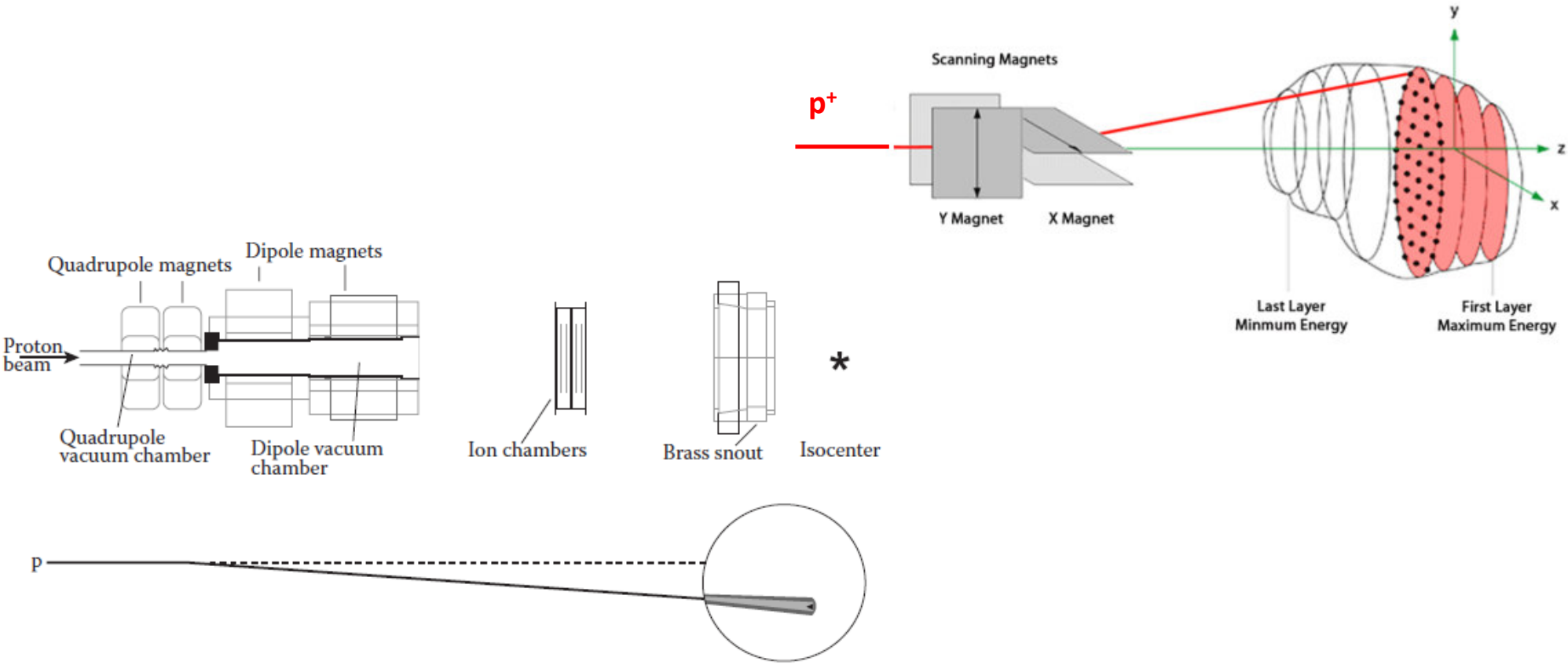
Gantry 2





Experimental Area

Pencil Beam Scanning delivery technique

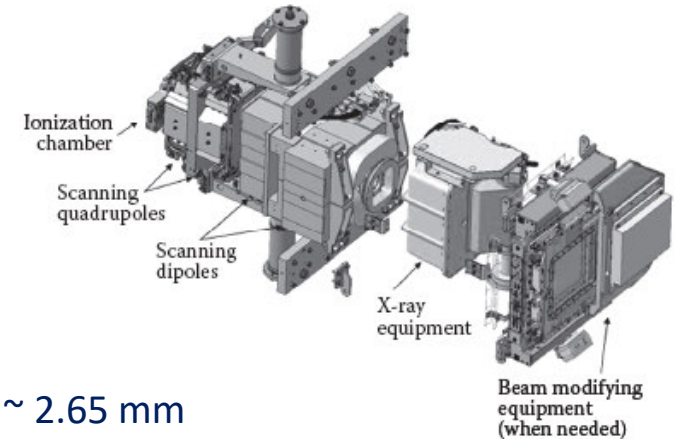


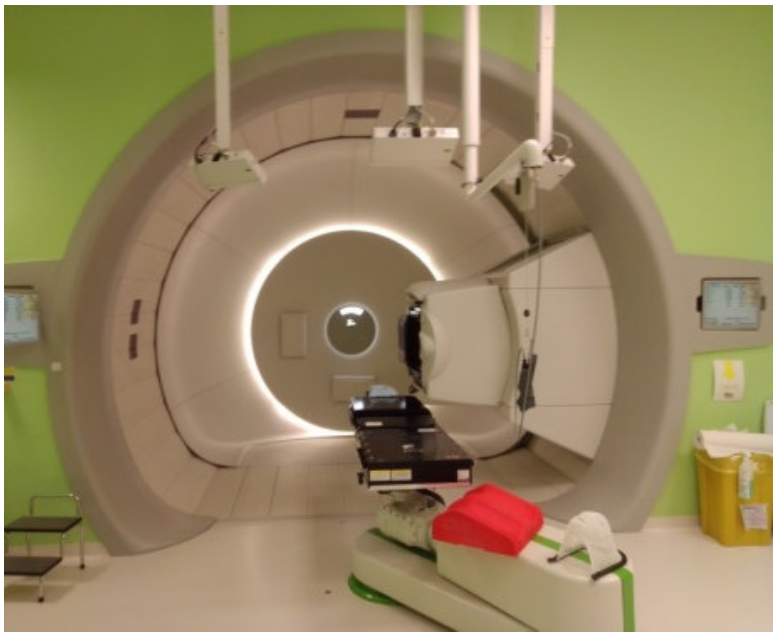
Flanz, ch. 6 Proton Therapy Physics

Full 3D modulation of dose distribution allowed
State of the art in proton therapy

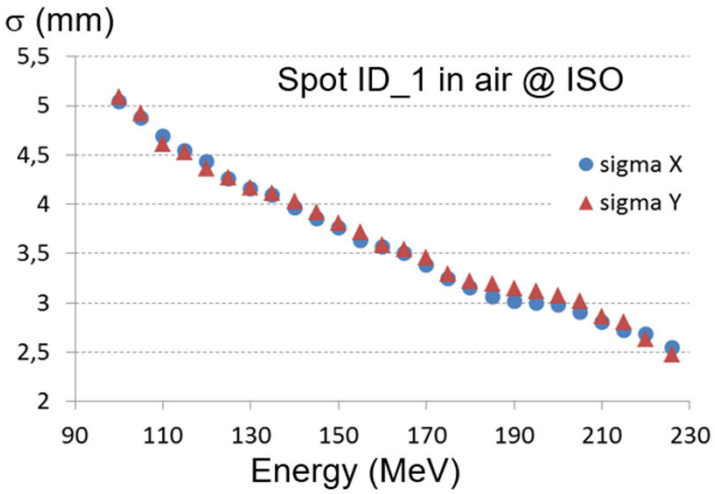
Trento Proton Therapy Center - Beam Delivery System

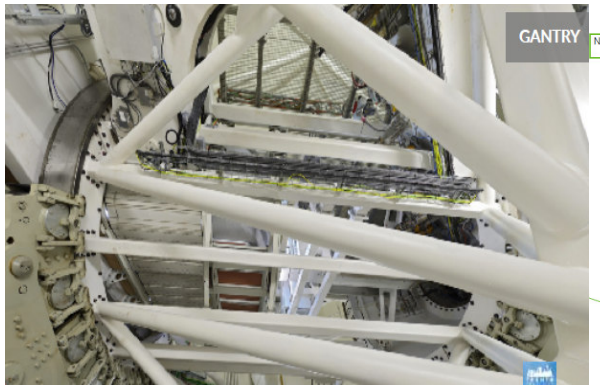
Active Scanning Dedicated Nozzle

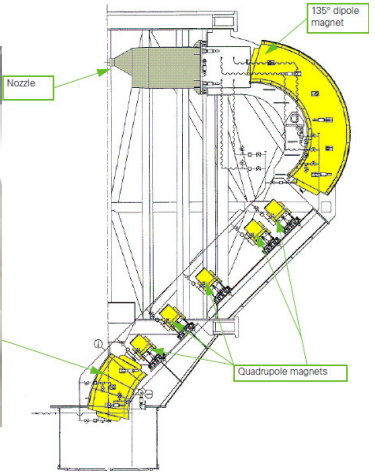




Spot sigma @ 32 g/cm2 ~ 2.65 mm
@ 4 g/cm2 ~ 6.78 mm



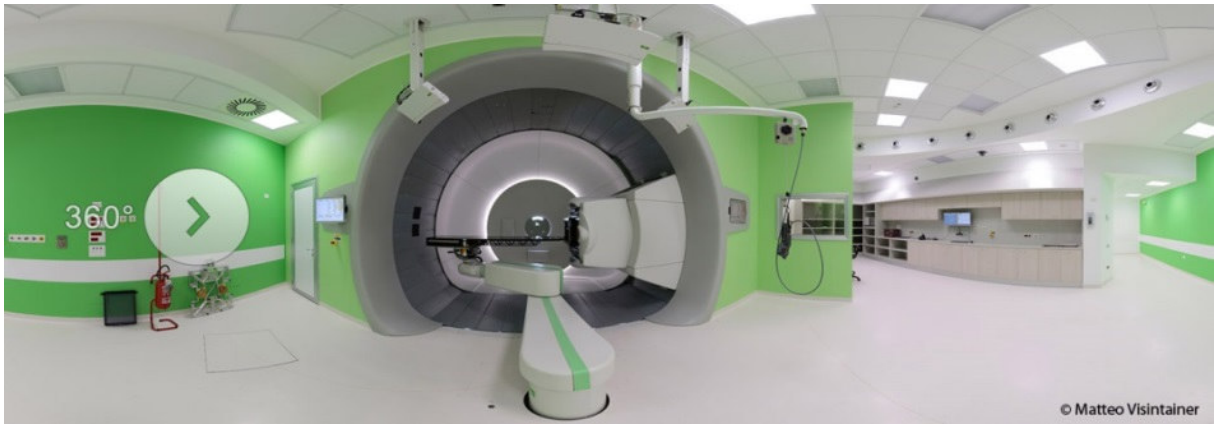




2 rooms with 360° Gantry

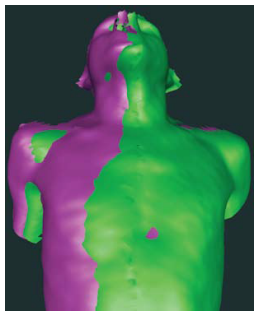
Trento Proton Therapy Center – Imaging systems

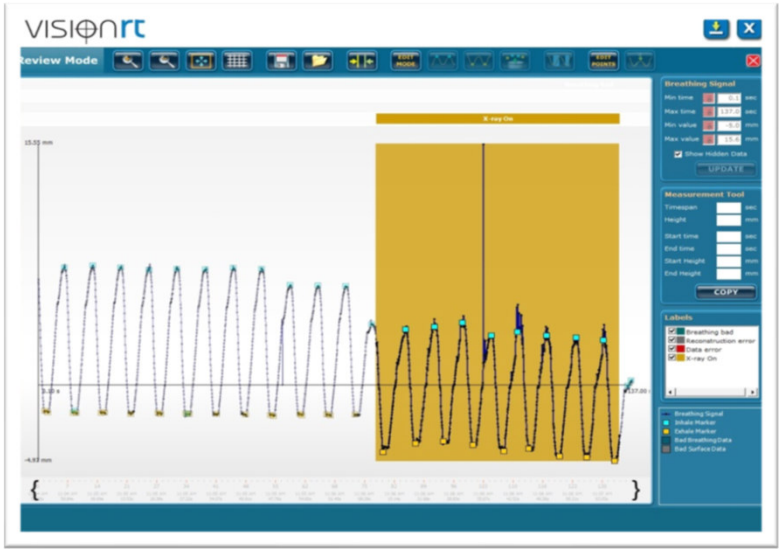
Dedicated simulation CT & MRI
2D KV images in both gantry rooms



CT on rail in one Gantry room

Surface Guided Radiation Therapy





APSS Trento Proton Therapy Center

Operation and Maintenance are provided by Iba company (full service solution)

- Proton therapy Equipment (Cyclotron, Transportation line and Ancillary Devices, gantry rooms, …)

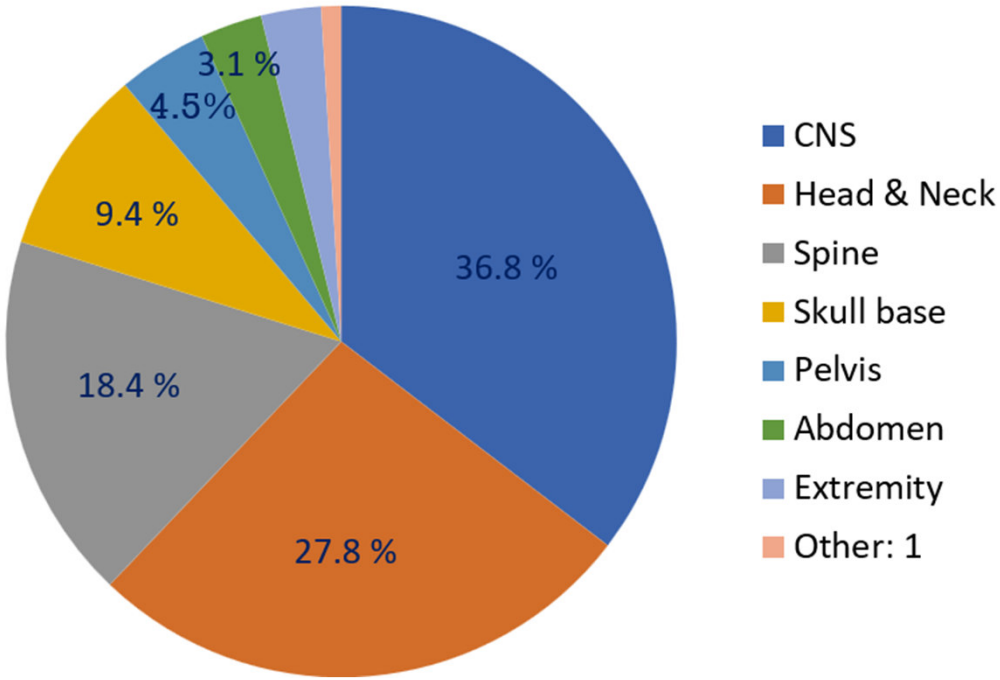
- Clinical Infrastructure (TPS, OIS, VisionRT, MR, TC, soon TC-PET…)

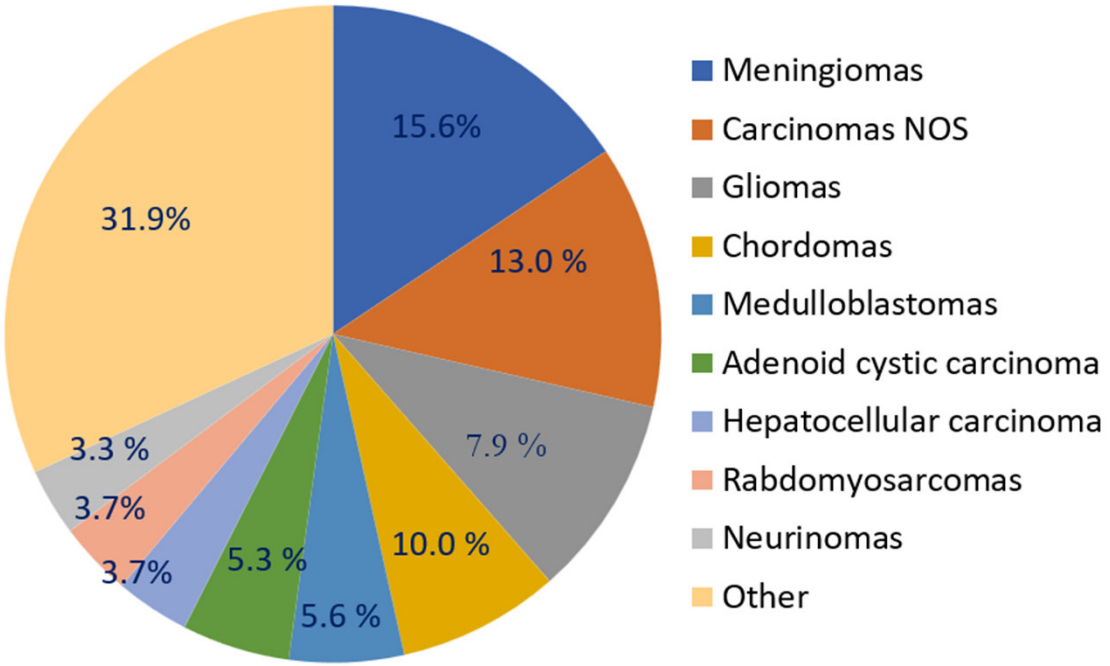
- Building

SOH (Standard Operating Hours): Mon-Wed 6:30-22:30, Thu-Fri 7:00-23:00 and Sat 7:00-14:30
Clinical activities from 7am to 8pm, QA activities and Research ativities afterwards

Weekly meeting are carried-out between Iba and APSS representatives

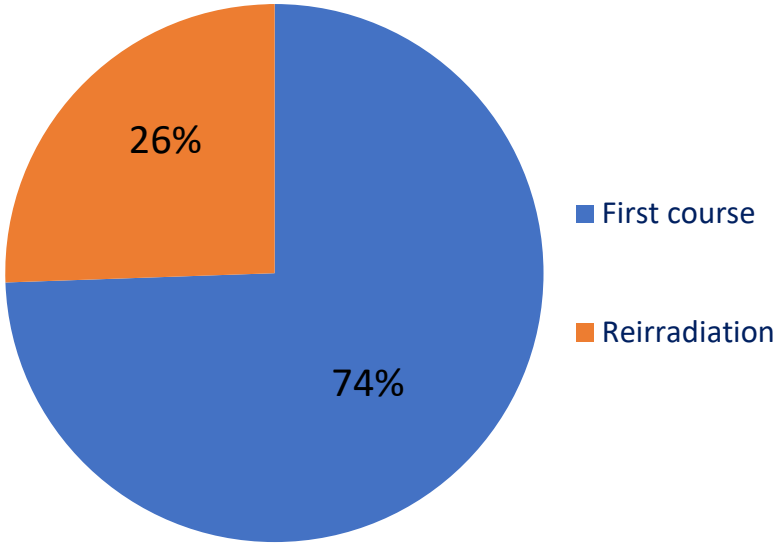
Lesions sites and pathologies treated

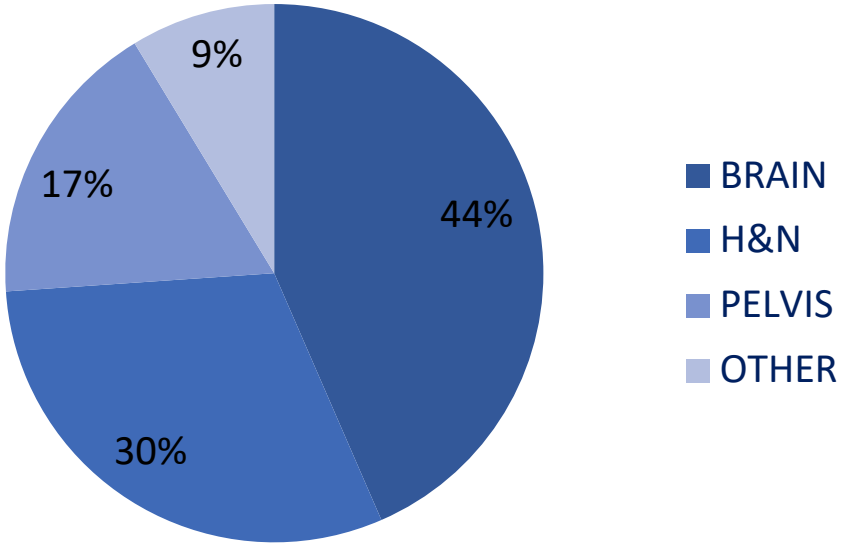




More recently
Lymphoma and Lung

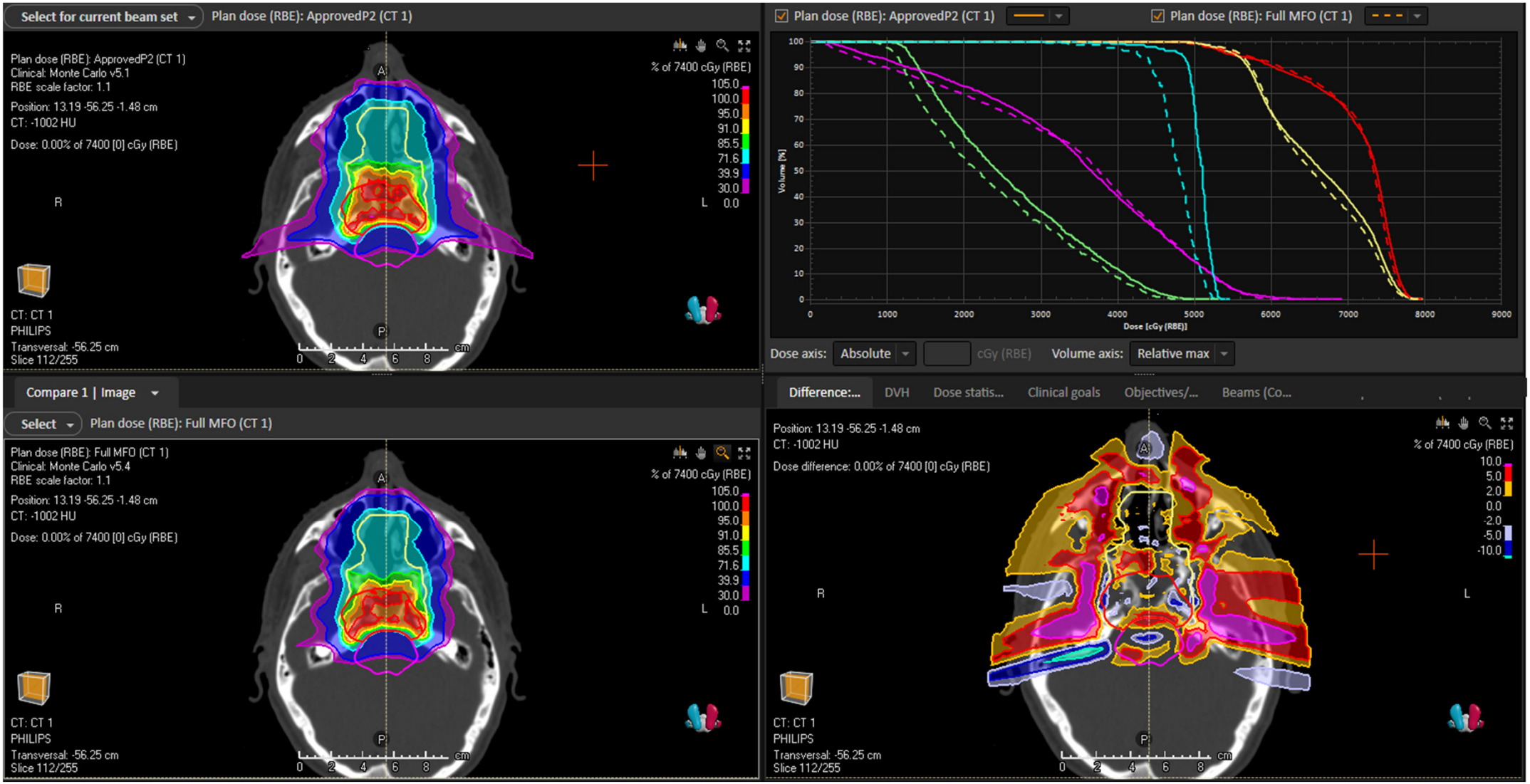
Protons as Re-irradiation





Planning

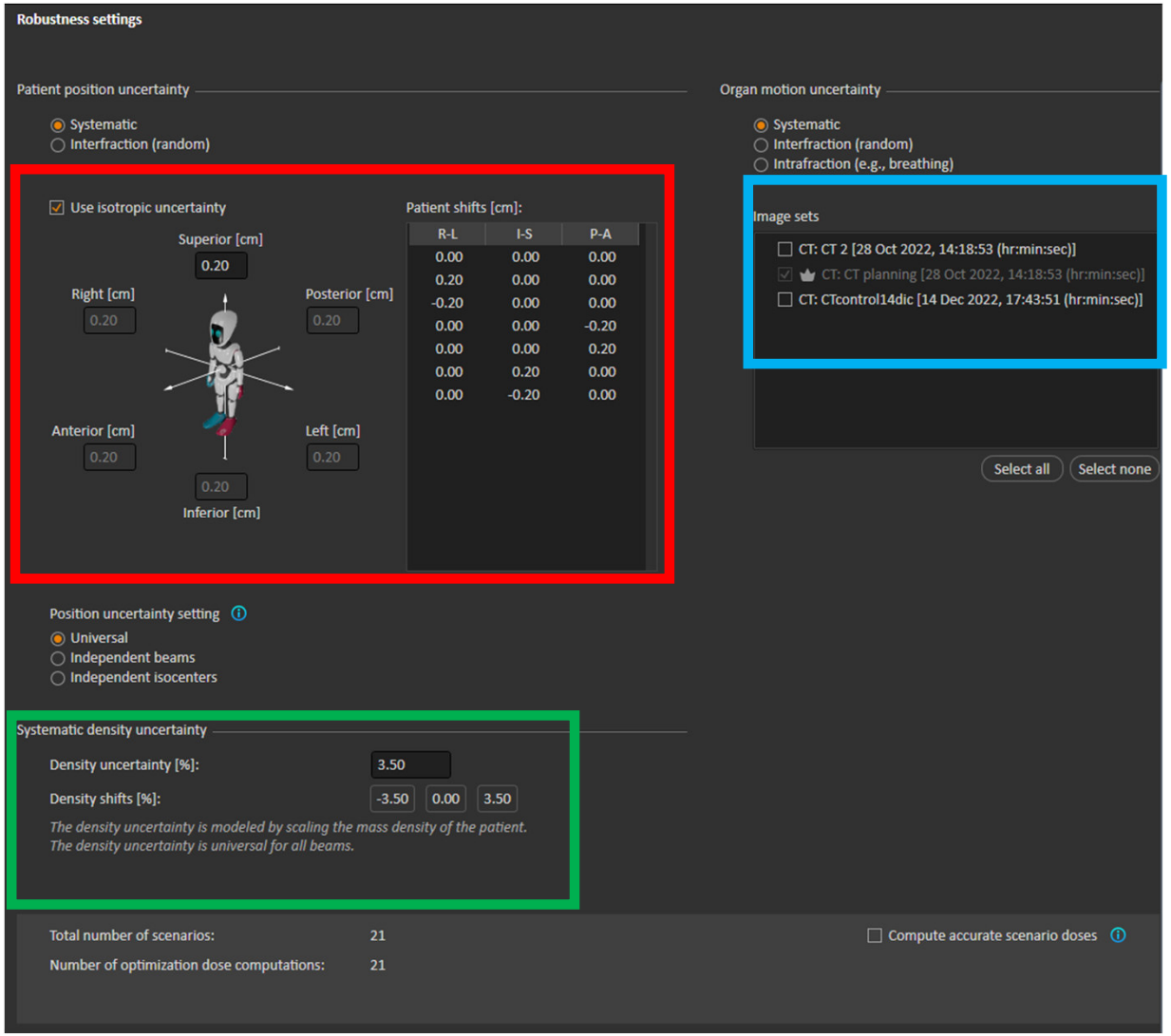
From PTV to full MFO…



Planning – Robust Optimization

Setup Uncertainties

Range Uncertainties



Different Pt Anatomies

Planning – Robust Evaluation

Standard Robust Evaluation (3min calc time):

Parameters used:

Setup: 2,0 mm | 1,5 mm | 1,0 mm | 0,5 mm

Range: ± 3,5%

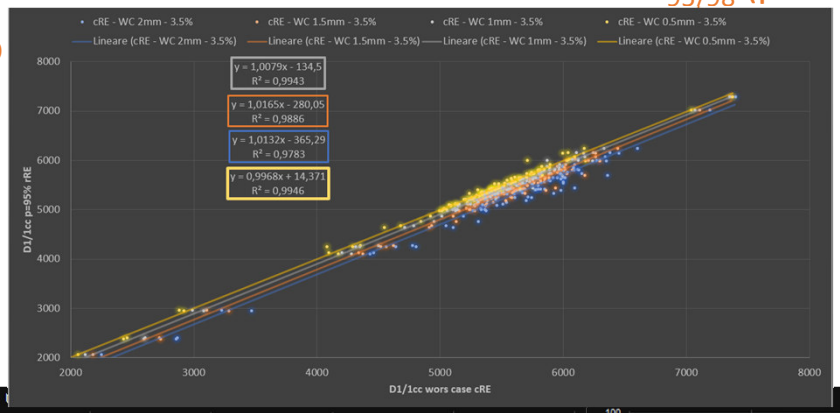
OAR

$D_{1/1cc}$ worst case scenario

Target

D_{95} worst case scenario

D_{98} worst case scenario



Realistic Robust Evaluation (15h ÷ 54h calc time):

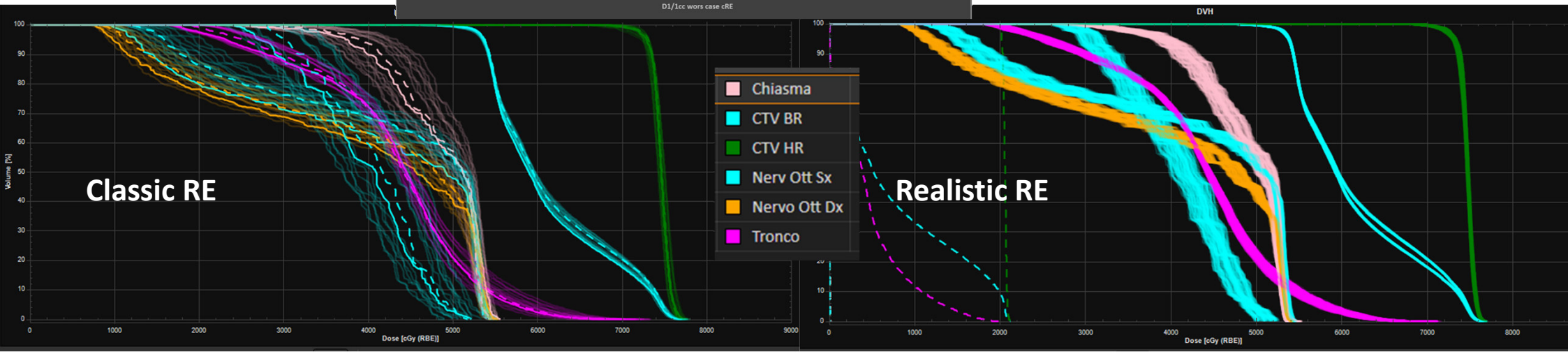
OAR

$D_{1/1cc}$ (p95%) -> 95% of $D_{1/1cc}$ results are **lower** than this value

Target

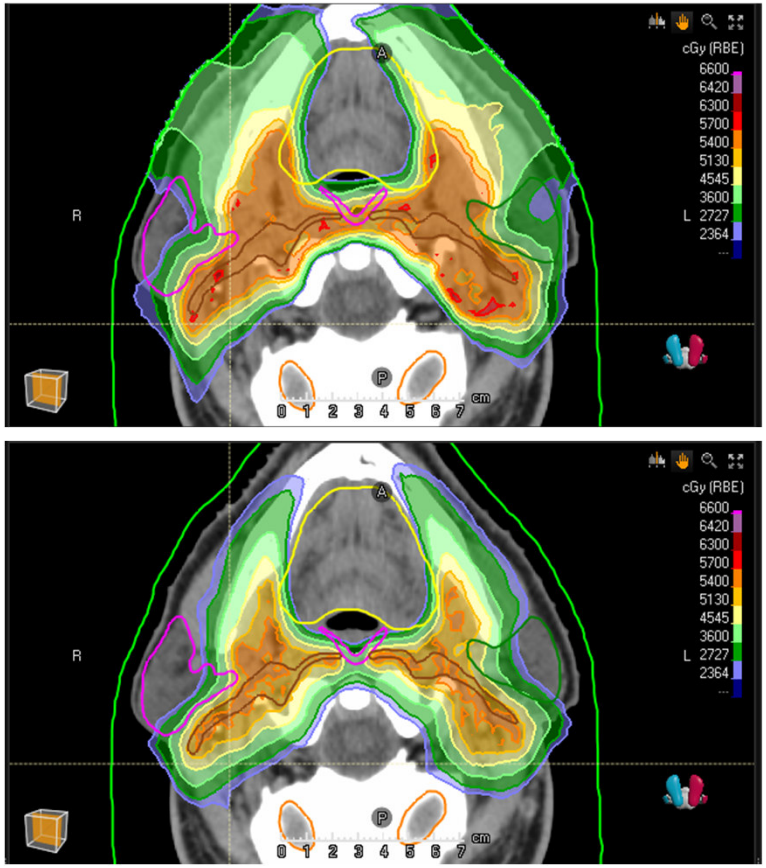
$D_{95/98}$ (p95%) -> 95% of $D_{1/1cc}$ results are **higher** than this

Fracchiolla F. et al. (internal data, not yet published)

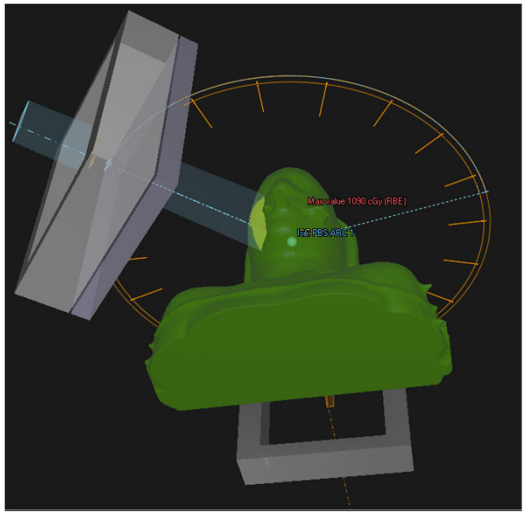


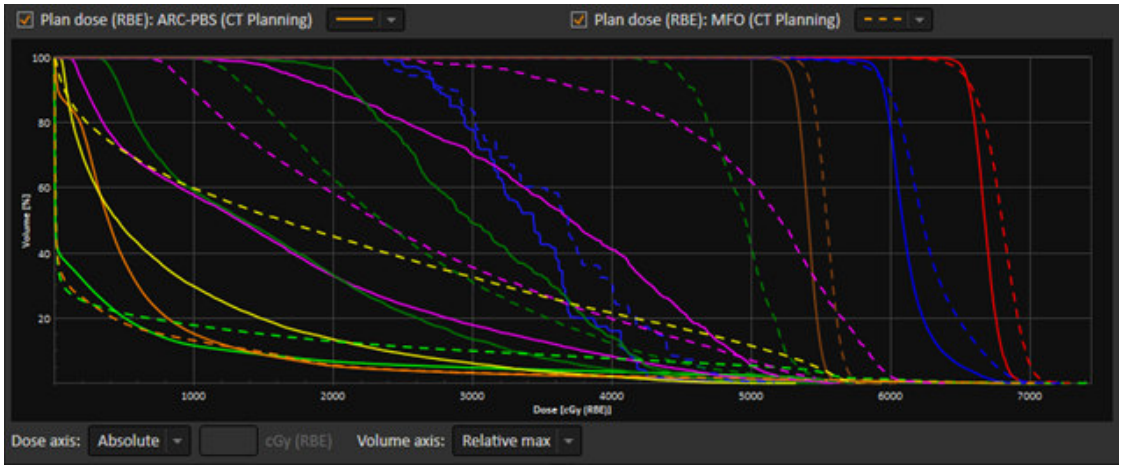
Proton Arc Therapy (1)

MFO delivered Plan



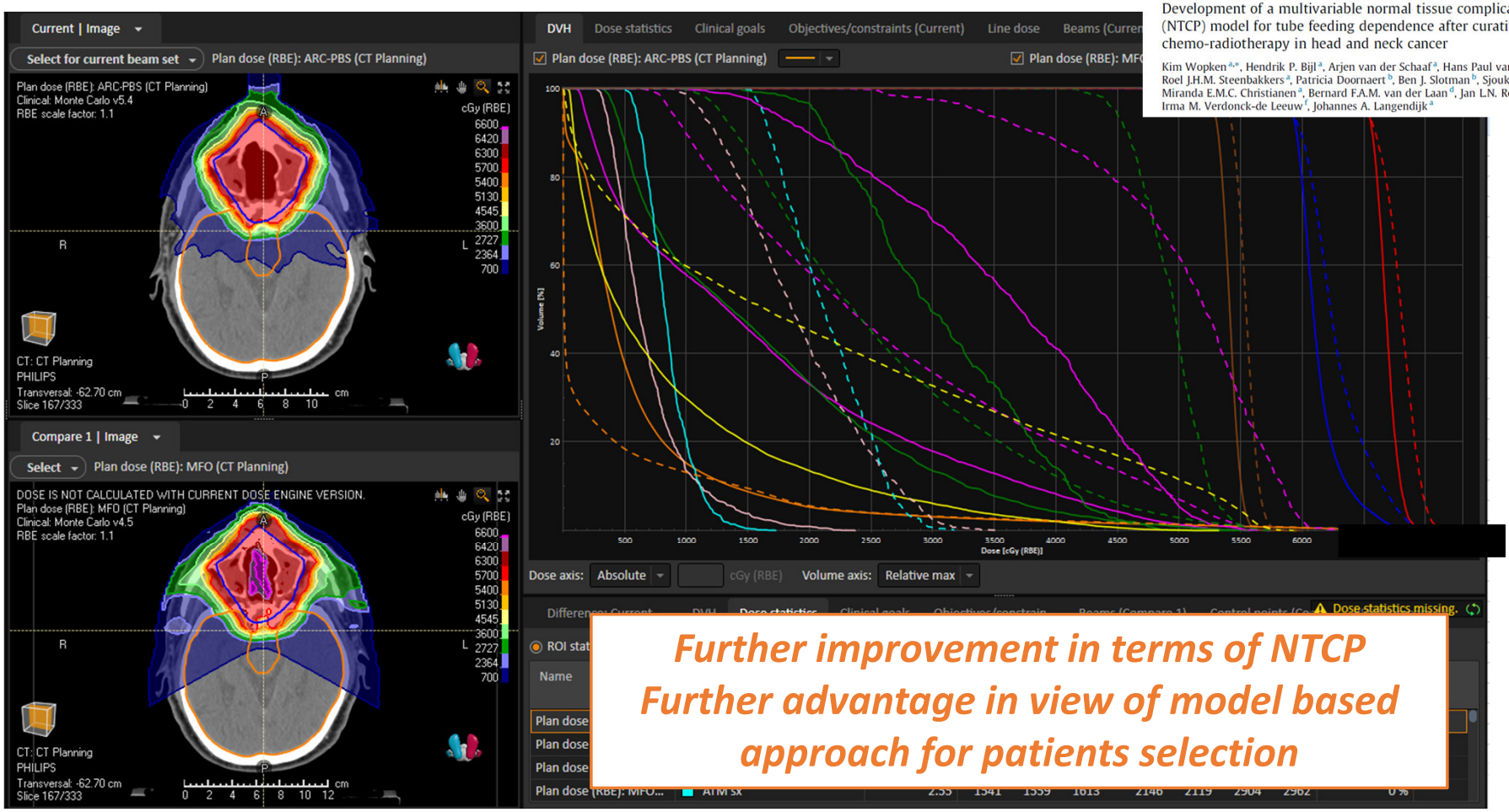
Proton ARC





Fracchiolla F. internal data, not yet published

Proton Arc Therapy (2)



Radiotherapy and Oncology 113 (2014) 95–101

Contents lists available at ScienceDirect

Radiotherapy and Oncology

journal homepage: www.thegreenjournal.com

Late effects in head and neck radiotherapy

Development of a multivariable normal tissue complication probability (NTCP) model for tube feeding dependence after curative radiotherapy/chemo-radiotherapy in head and neck cancer

Kim Wopken [a,*], Hendrik P. Bijl [a], Arjen van der Schaaf [a], Hans Paul van der Laan [a], Olga Chouvalova [a], Roel J.H.M. Steenbakkers [a], Patricia Doornaert [b], Ben J. Slotman [b], Sjoukje F. Oosting [c], Miranda E.M.C. Christianen [a], Bernard F.A.M. van der Laan [d], Jan L.N. Roodenburg [e], C. René Leemans [f], Irma M. Verdonck-de Leeuw [f], Johannes A. Langendijk [a]

Further improvement in terms of NTCP
Further advantage in view of model based approach for patients selection

LET painting

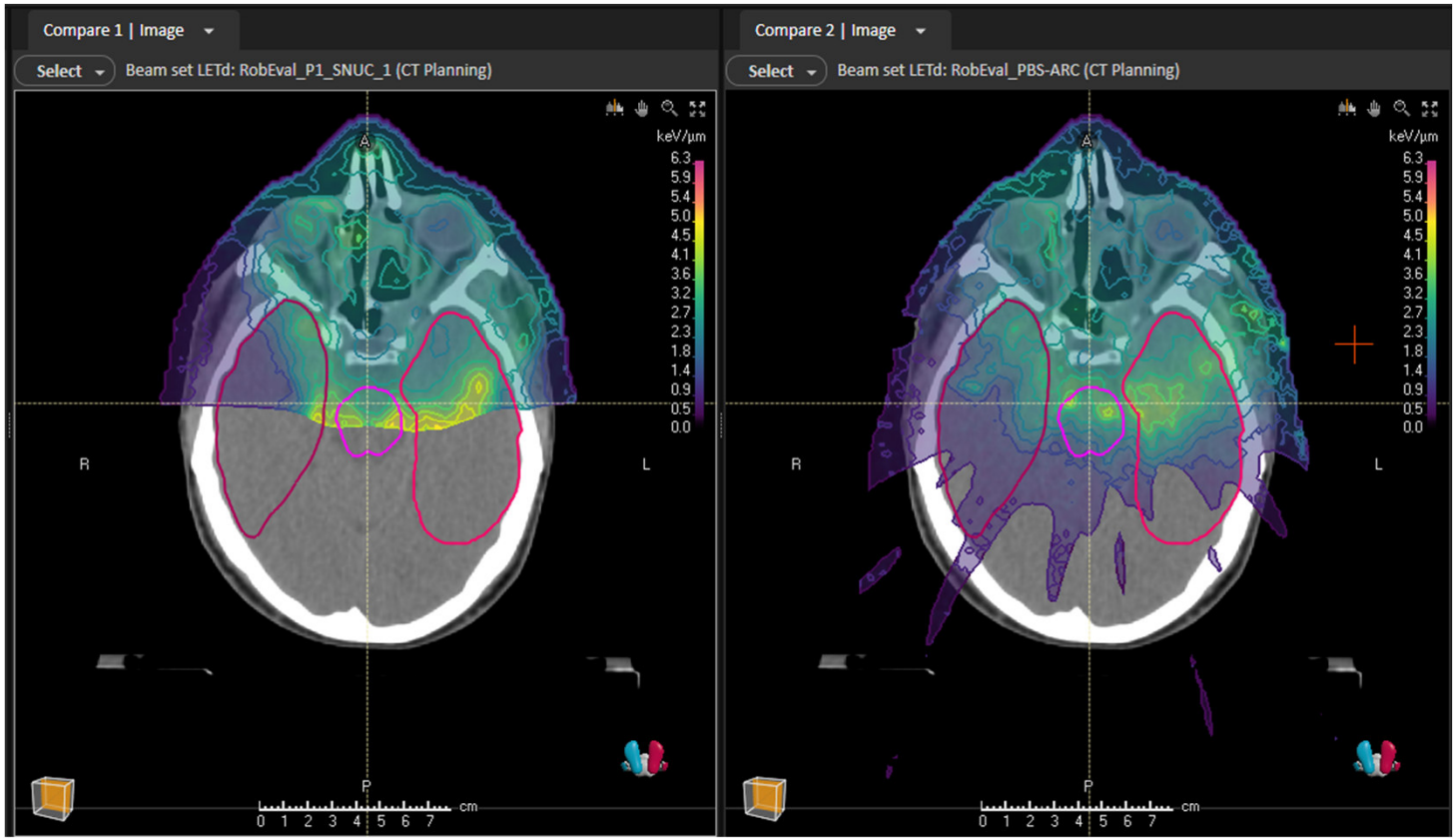
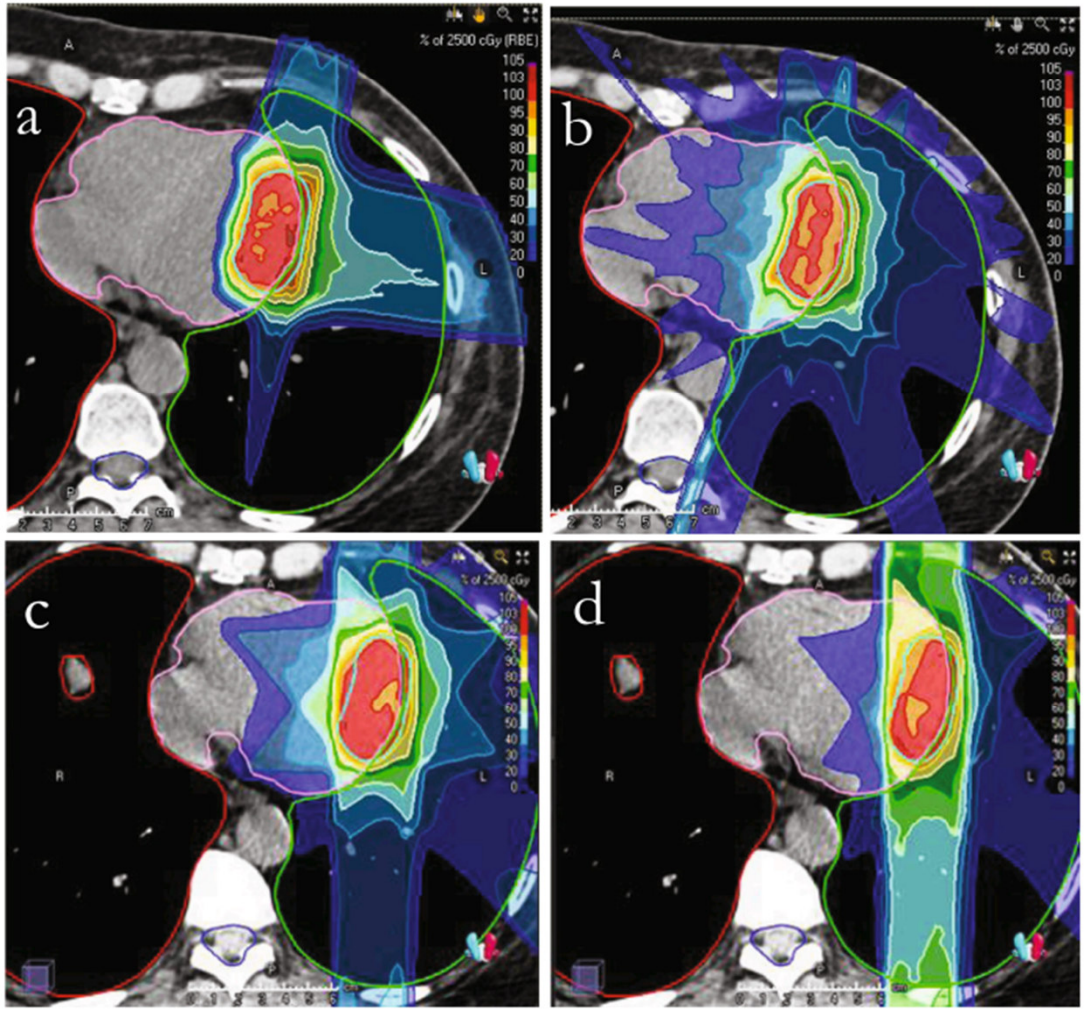


Image provided within a research agreement with Raysearch

Proton Heart



Contents lists available at ScienceDirect

Physica Medica

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

Original paper

Proton or photon radiosurgery for cardiac ablation of ventricular tachycardia? Breath and ECG gated robust optimization

Lamberto Widesott[a,*], Francesco Dionisi[a], Francesco Fracchiolla[a], Francesco Tommasino[b,c], Maurizio Centonze[d], Maurizio Amichetti[a], Maurizio Del Greco[e]

The aim of this preliminary study is to assess the feasibility of stereotactic body radiation therapy (SBRT) proton therapy (PT) plans for the treatment of Ventricular Tachycardia, adopting a robust optimization technique.

Dosimetry and QA

Titolo: *Dispositivi per applicazioni di Protonterapia ottenuti da tecniche avanzate di stampa 3D (**Proton3D**)*

[Pro]M MECHATRONICS PROTOTYPING FACILITY

UNITRENTO

FONDAZIONE VRT VALORIZZAZIONE RICERCA TRENTINA

3° Bando Impact Innovation 2021 FONDAZIONE VRT

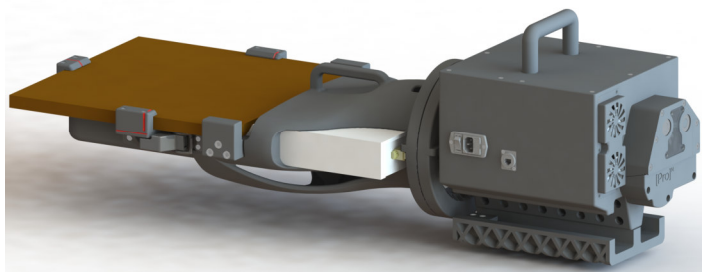
Accelerare le eccellenze scientifiche tecnologiche sviluppate in Trentino che hanno l'intento di generare un impatto misurabile per salute, ambiente, cultura e turismo.

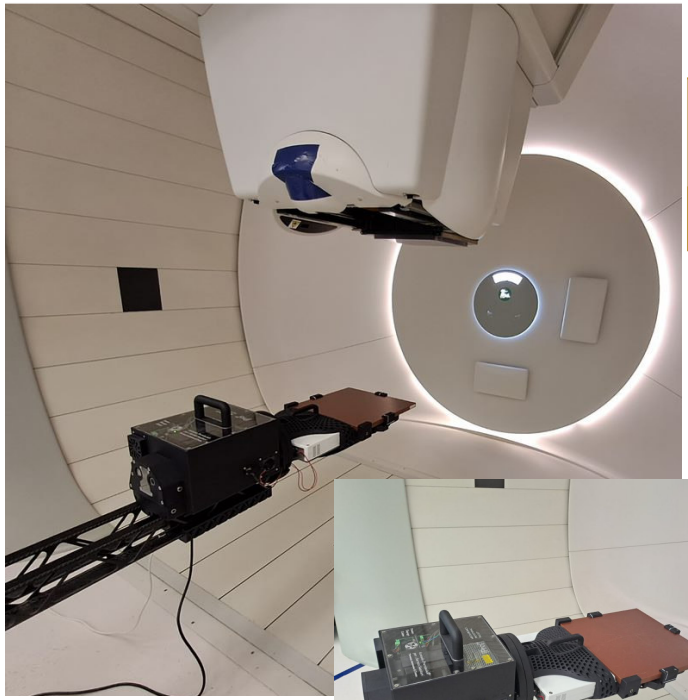
Gli aggiornamenti verranno trasmessi esclusivamente sulle pagine LinkedIN, YOUTUBE, Facebook della @FondazioneVRT.

Nella seduta del Consiglio di Amministrazione di Fondazione VRT del 07 maggio 2021 è stato deliberato il 3° Bando 2021 di Fondazione VRT.

DATA EMISSIONE DEL BANDO: 18 maggio 2021

TERMINE PRESENTAZIONE PROGETTI: 7 giugno 2021 ore 12.00

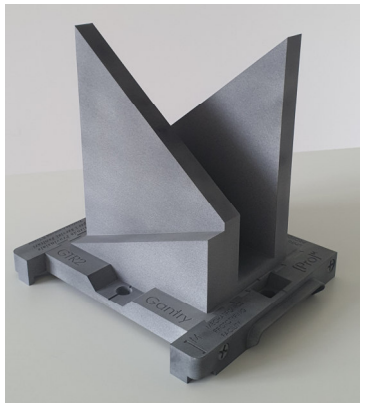




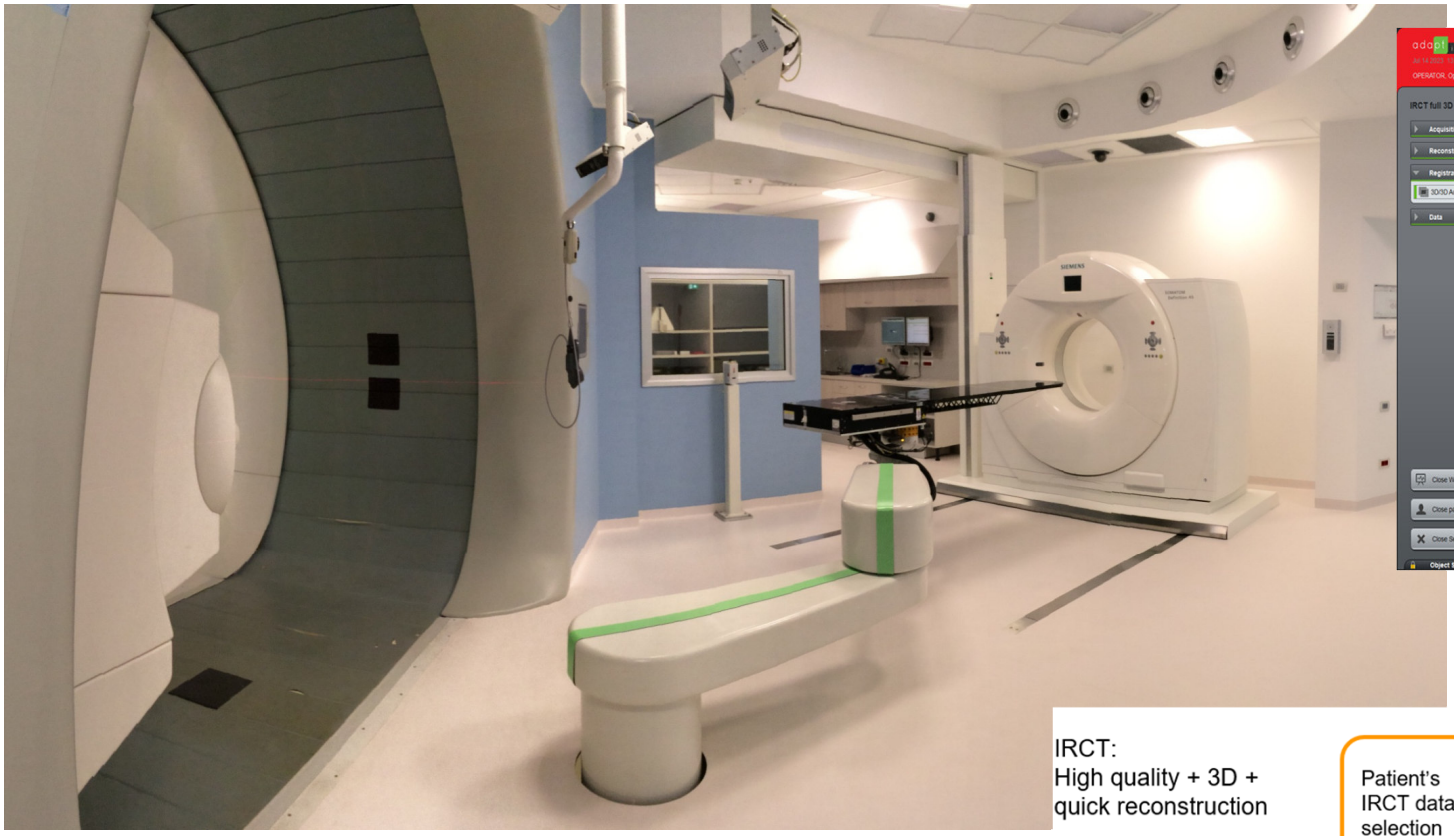
2022 PREMIO INNOVAZIONE smau

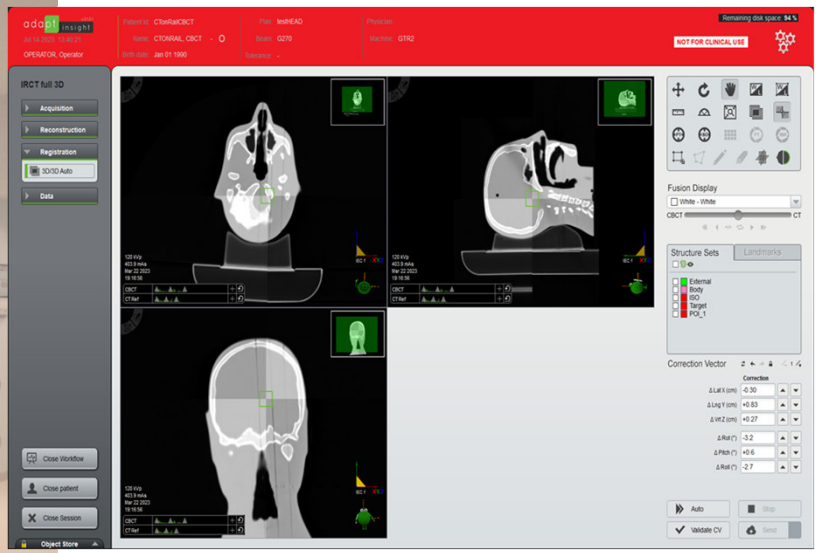
Progettazione e realizzazione di un supporto rotante comandato da remoto per l'esecuzione dei Controlli di Qualità pre-trattamento

Prototipazione Meccatronica e Stampa 3D di supporti e fantocci



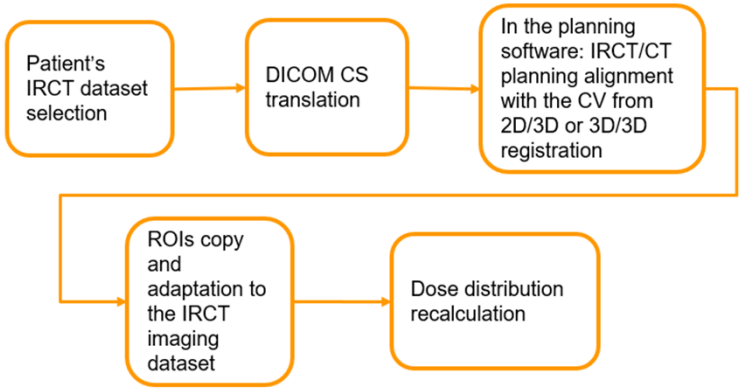
Imaging workflow for patient positioning and plan adaptation





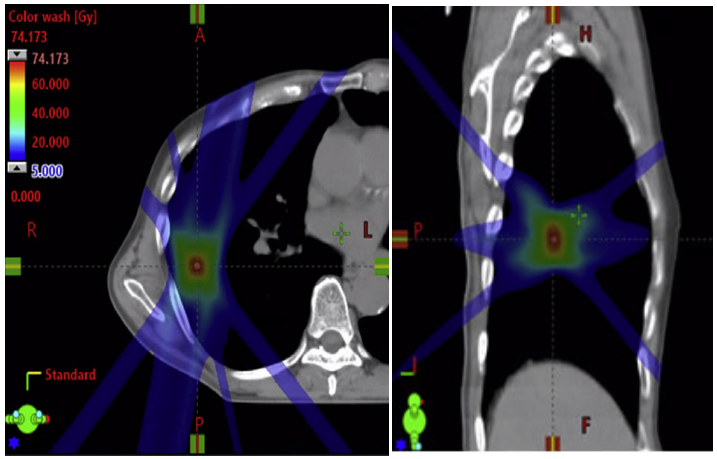
IRCT:
High quality + 3D +
quick reconstruction

Script to import in
Treatment Planning
System

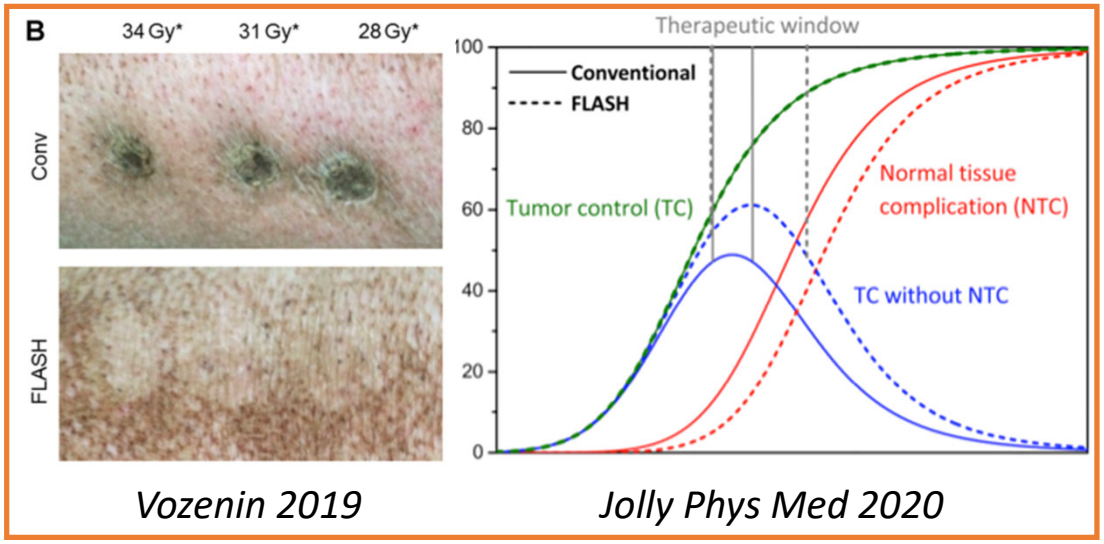


Ultra High Dose Rate (UHDR) and FLASH Proton Therapy

Dedicated planning techniques



Van Marlen IJROBP 2020



Vozenin 2019 *Jolly Phys Med 2020*

Dose Rate >40 Gy/s

Dedicated delivery techniques (beam monitoring, beam shaping, reference dosimetry, etc…)

Research

JAMA Oncology | Original Investigation

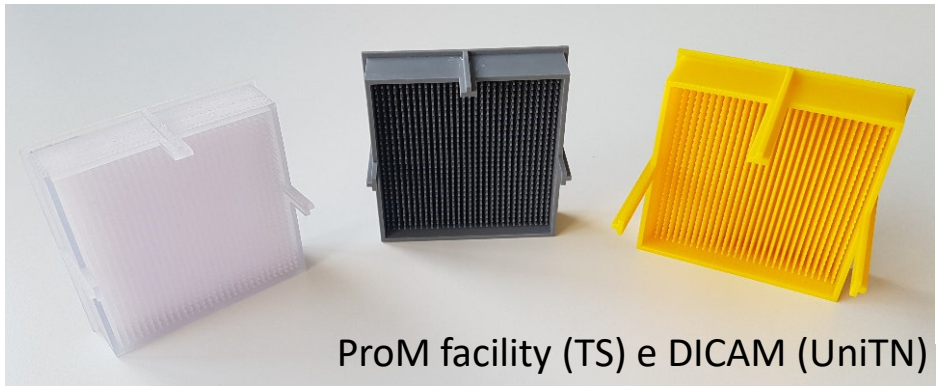
Proton FLASH Radiotherapy for the Treatment of Symptomatic Bone Metastases
The FAST-01 Nonrandomized Trial

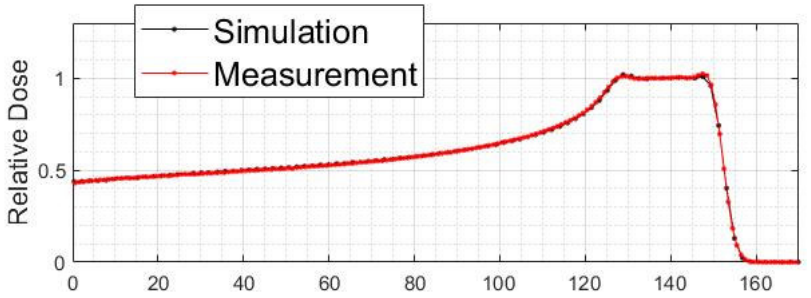
Anthony E. Mascia, PhD; Emily C. Daugherty, MD; Yongbin Zhang, MS; Eunsin Lee, PhD; Zhiyan Xiao, PhD; Mathieu Sertorio, PhD; Jennifer Woo, BSc; Lori R. Backus, BA; Julie M. McDonald, CCRP; Claire McCann, PhD; Kenneth Russell, MD; Lisa Levine, PhD; Ricky A. Sharma, MD, PhD; Dee Khuntia, MD; Jeffrey D. Bradley, MD; Charles B. Simone II, MD; John P. Perentesis, MD; John C. Breneman, MD

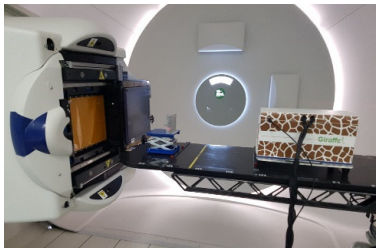
From January 2023 FLASH beam availbale @ Trento PTC
First FLASH irradiations of cells done in Trento on May 2023

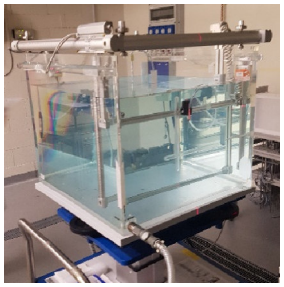
Characterization and Setting of the beam-line for using at FLASH regimen (UHDR)

Modulatori 2D





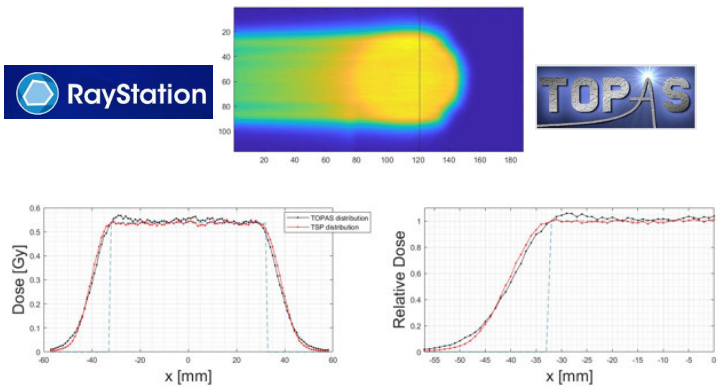


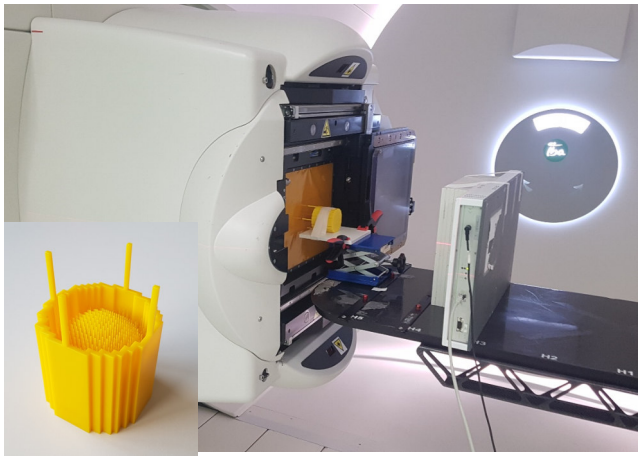


Modulatori 3D

RayStation

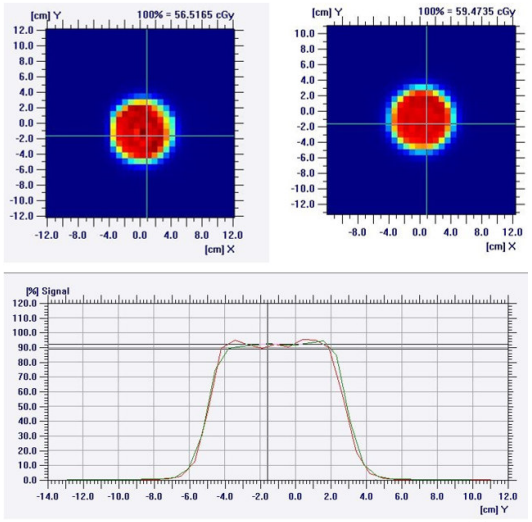
TOPAS





Measurement

Simulation



Attività propedeutica al possibile impiego dei regimi FLASH per scopi di ricerca e clinica

Network

TIFPA

Trento Institute for Fundamental Physics and Applications

[Pro]M MECHATRONICS PROTOTYPING FACILITY

POLO MECCATRONICA

IPACS

ITALY POLAND AUSTRIA CZECH SWEDEN CO-OPERATIVE GROUP

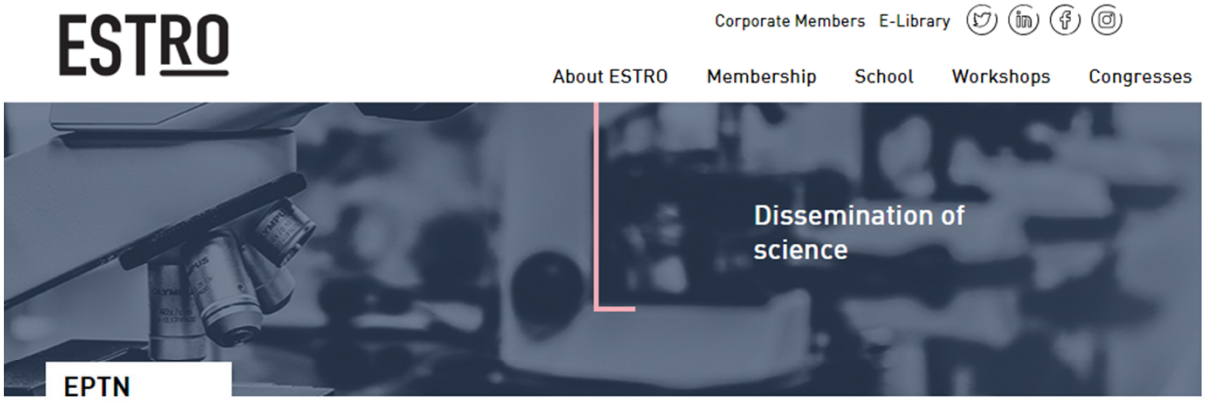
UNIVERSITAS ATHESINA STUDIORUM

UNITRENTO

INFN Istituto Nazionale di Fisica Nucleare

FONDAZIONE BRUNO KESSLER

CIBIO Centre for Integrative Biology



European Particle Therapy Network (EPTN)

The European Particle Therapy Network (EPTN) became a task force of ESTRO in 2017. It was established in 2015 in response to the anticipated increase in the number of particle therapy centres in Europe. In addition, the need to cooperate among centres and integrate particles (i.e. protons and carbons) in the framework of clinical research networks was identified as being of paramount importance. ESTRO, at the time of initiation of the network, was asked to collaborate with EPTN and agreed to facilitate the group.

Particle therapy (PT) is only one part of radiation oncology, and needs to be well aligned with other radiation techniques as well as with general developments in cancer research and patient care. PT offers both new opportunities for providing excellence in cancer care, and for high-quality research within the framework of European networks.

Partnership with INFN/TIPFA-UNITN-FBK

CONVENZIONE QUADRO
relativa alla prosecuzione e al funzionamento del
Trento Institute for Fundamental Physics and Applications (TIFPA)
Centro scientifico e tecnologico dell'Istituto di Fisica Nucleare in partenariato con l'Università
degli Studi di Trento, la Fondazione Bruno Kessler e l'Azienda Provinciale per i Servizi Sanitari della Provincia Autonoma di Trento

TERZO ACCORDO ATTUATIVO

per la disciplina dei rapporti di collaborazione fra l'Azienda Provinciale per i Servizi Sanitari della Provincia autonoma di Trento e l'Istituto Nazionale di Fisica Nucleare

TRA

L'Azienda Provinciale per i Servizi Sanitari della Provincia Autonoma di Trento (di seguito APSS), in persona del Direttore Generale facente funzioni, dr. Antonio Ferro, elettivamente domiciliato per la carica presso la sede di APSS

E

l'Istituto Nazionale di Fisica Nucleare (di seguito INFN), in persona del suo Presidente, prof. Antonio Zoccoli,

Nuova Convenzione Quadro

relativa alla prosecuzione e al funzionamento del

TIFPA - Trento Institute for Fundamental Physics and Applications

TRA

l'**Istituto Nazionale di Fisica Nucleare**, con sede in Frascati, Via Enrico Fermi, n. 54, (di seguito anche: INFN) in persona del suo Presidente e legale rappresentante, Prof. Antonio Zoccoli, a ciò autorizzato con deliberazione n 12933 adottata dalla Giunta Esecutiva in data 15/10/2021,

l'**Università degli Studi di Trento**, con sede in Trento, Via Calepina 14, (di seguito anche: UniTn) in persona del Rettore e legale rappresentante, Prof. Flavio Deflorian, a ciò autorizzato con deliberazione n. 6 adottata dal Senato Accademico in data 29/06/2021,

la **Fondazione Bruno Kessler** (di seguito anche: FBK) con sede legale in Trento, via Santa Croce, n. 77 – C.F. e P.IVA 02003000227, nella persona del prof. Gianluigi Casse nato a Susa (TO) il giorno 12 settembre 1961, Direttore del Centro Sensors & Devices (SD) della Fondazione, autorizzato giusta procura a rogito dott. Paolo Piccoli, Notaio in Trento, di data 11 dicembre 2020, rep. n. 42.854/17.440, reg.ta a Trento il giorno 18 dicembre 2020 al n. 28134, S. 1T,

l'**Azienda Provinciale per i Servizi Sanitari** con sede in Trento, Via Alcide De Gasperi 79 (di seguito anche: APSS), in persona del suo Direttore Generale ff, dott. Antonio Ferro a ciò autorizzato con deliberazione n. 1176 adottata dalla Giunta Provinciale in data 12/07/2021,

Thank you for your attention

Proton United – stagione 2023

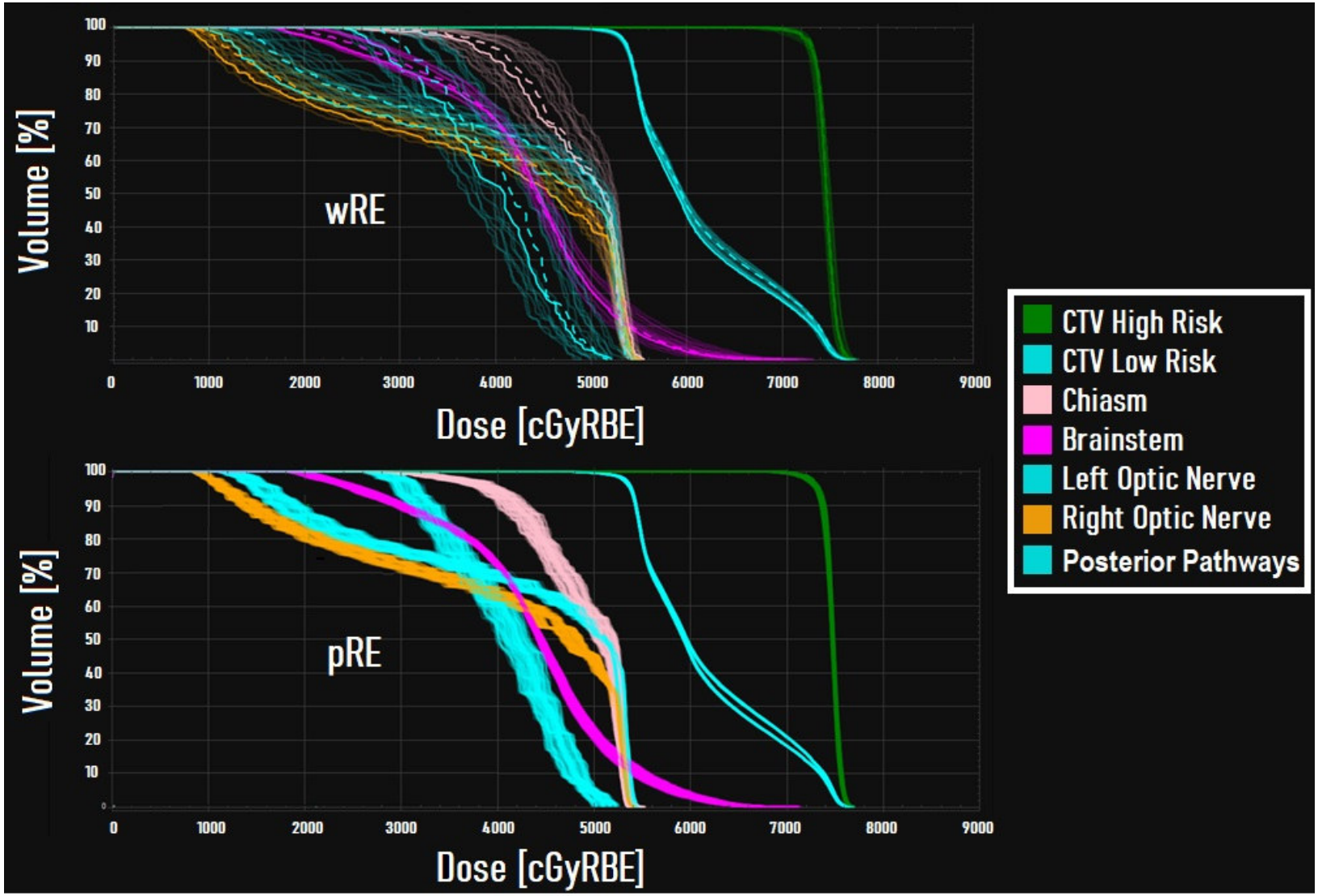


Figure 1: pRE vs wcRE DVH-bands results comparison. High and low risk CTV, optic nerves, chiasm and brainstem highlighted.