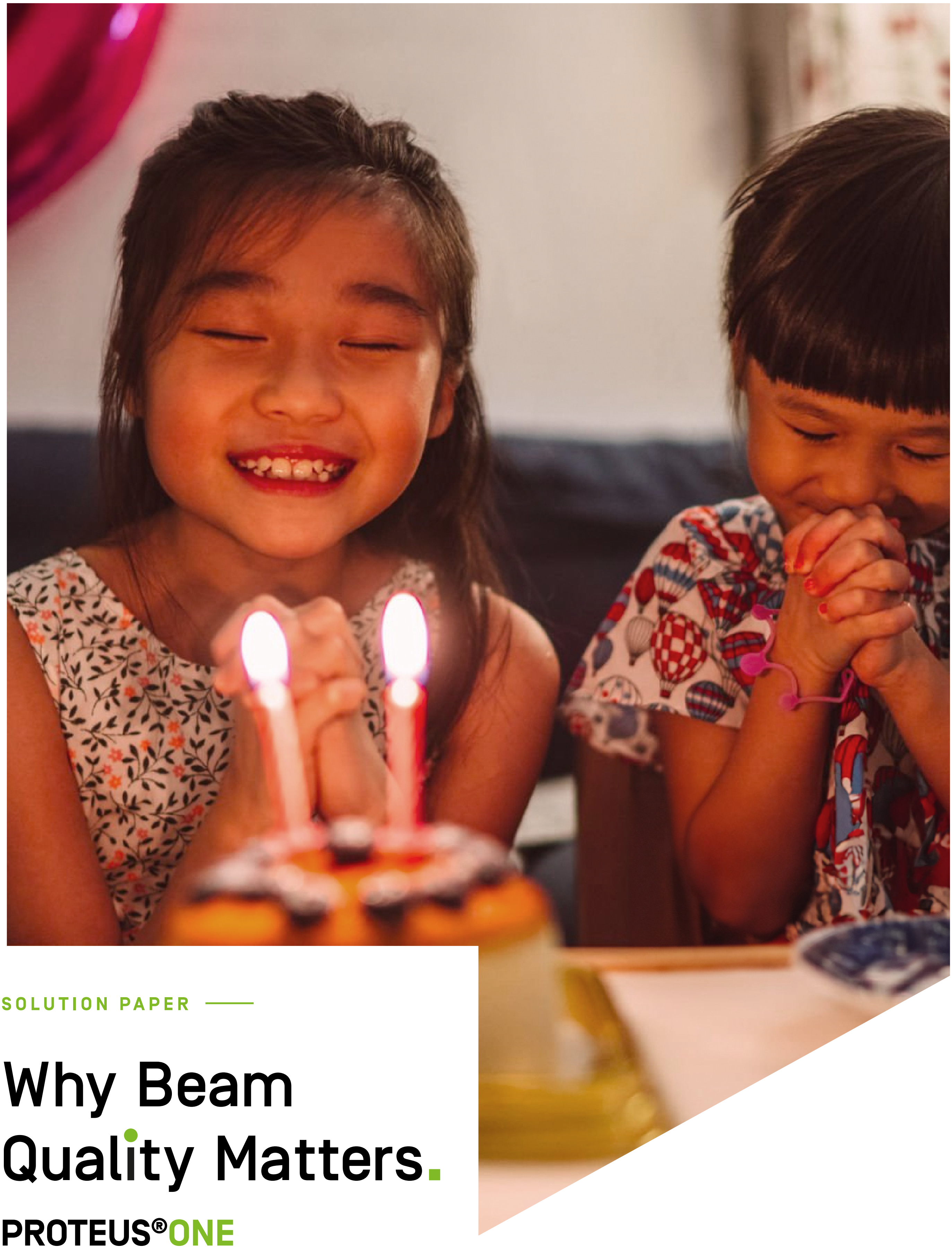
Life.
Science.



SOLUTION PAPER

Why Beam Quality Matters.

PROTEUS®ONE

Key insights in this Solution Paper

IBA and its 40+ treating centers understand that the design of a proton therapy system significantly influences key beam parameters, directly impacting patient care.

In this Solution Paper, we will address:

- The main physical parameters contributing to a high-quality beam
- How proton beam quality affects:
  - Treatment plans and quality
  - Diversity of treatment indications
  - Treatment speed
  - Generation of stray radiation
  - Hospital's efficiency and return on investment
- How IBA's ProteusONE is designed to deliver a high-quality, cleaned and pure beam

Understand why beam quality matters and join us in our mission to protect, enhance, and save lives.

Beam quality & conformality is very or extremely important for 93% of users [1]

Physical and technological parameters influence the quality of a proton beam

ENSURING A PRECISE ENERGY DEPOSITION ON THE TUMOR [2-5]

Proton beam therapy differs from conventional radiotherapy as it delivers high radiation doses to tumor cells with minimal exposure of the surrounding normal tissue. Proton therapy ensures higher conformality of the dose to the tumor, offering the possibility to escalate the dose for the same toxicity or to reduce the toxicity while maintaining local control. This helps preserve life beyond treatment, **keeping everything but cancer.**

Photon beams exhibit an initial rise in dose deposition followed by an exponential decrease, deposing most of their energy outside the target volume, before and after the tumor (Fig. 1, yellow dashed line). In contrast, proton beams have a well-defined penetration range. Their dose deposition gradually increases as they penetrate tissue, culminating in the **Bragg peak** within the target area, followed by a swift radiation dose decline (Fig. 1, green dashed line). By modulating the proton beam energy, the Bragg peak can be aligned with the tumor to precisely deliver the maximum radiation while sparing surrounding healthy tissue.

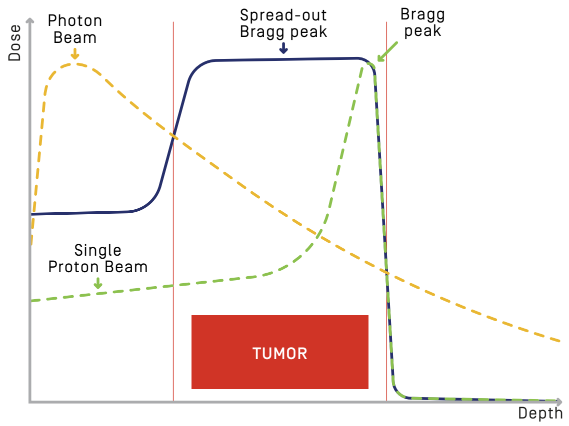


Fig. 1: Schematic representation of the dose distributions as a function of penetration depth in tumor (normalized to the maximum dose) for photon, single proton beam, and spread-out proton beam. Adapted from Hu M et al. 2018

Longitudinal uniformity of the dose within the tumor can be achieved by combining multiple Bragg peaks with appropriate energies and weights, producing a spread-out Bragg peak (SOBP) (Fig. 1, blue line).

MAXIMIZING PROTON THERAPY SYSTEM PERFORMANCE FROM THE CORE [2,6-9]

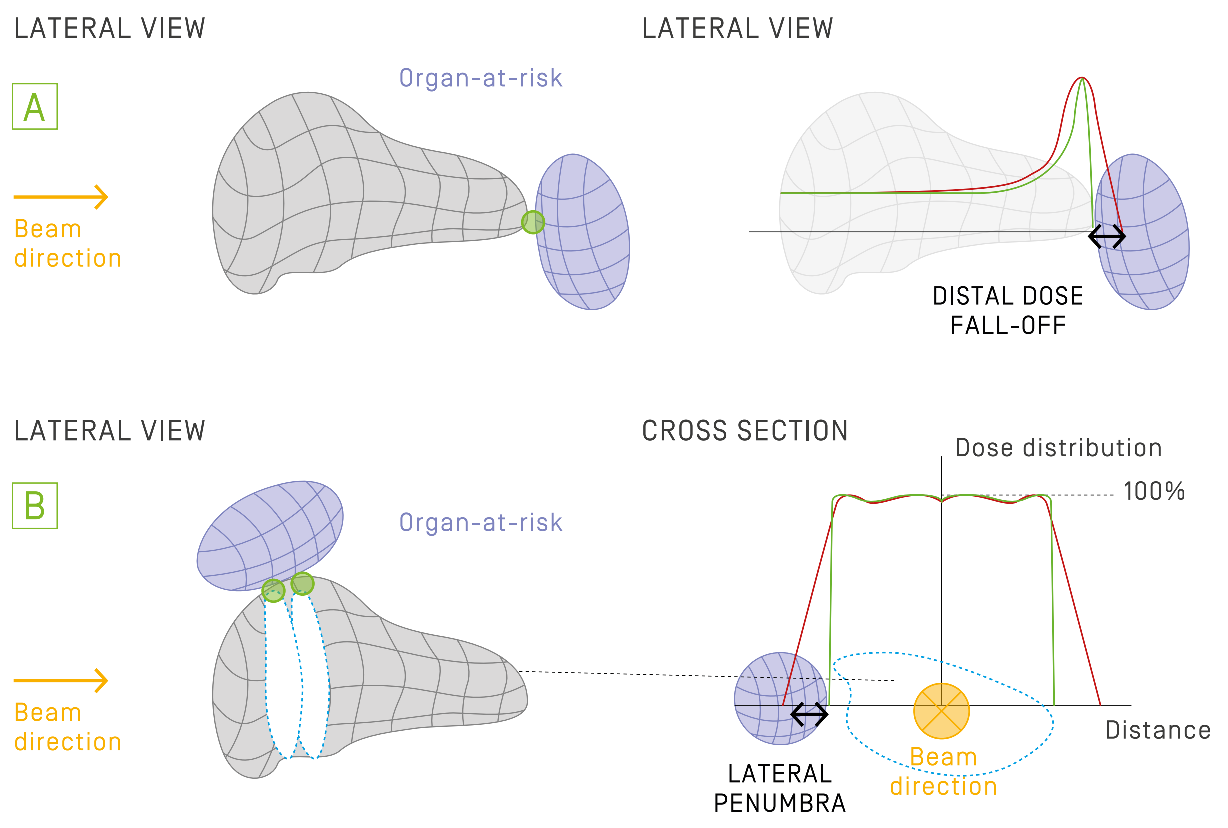
Proton therapy relies on particle accelerators that produce the proton beam, adapting technology from nuclear physics to treat cancer patients. The particle accelerators use magnets and radio waves to bend and accelerate protons to two-thirds the speed of light. Energy can be adjusted allowing protons to penetrate at **depths ranging from 5 to 32 cm (2-13 inches) into the body**, ideal for deep-seated tumors. The proton beam transport, extraction, modulation and scanning as well as its stability, uniformity and accuracy vary among different particle accelerators.

Among others:

- **Cyclotrons**, like the IBA ProteusPLUS, weighing up to 200 tons and 6-14 feet (1.8-4.3 m) in diameter, provide a fixed high-energy beam, highly stable and suitable for pencil beam scanning, and which require an energy degrader or energy selector to adapt to treatment requirements.
  - **Superconducting synchrocyclotrons**, like the one of IBA's ProteusONE, offer benefits like reduced size (46 tons and 7.2 feet/2.2 m diameter), lower power consumption, and improved extraction efficiency, and also require a degrader or energy selector to adapt to treatment requirements.
- **Synchrotrons**, lighter but with a larger diameter of 16-25 feet (5-7.6 m), provide batches (pulses) of protons of the desired energy, that are extracted and transmitted to the treatment room in cycles of variable periods of time (0.5 to 4.5 seconds). Several pulses might be needed to deliver a clinically-relevant dose at a specific energy.

The precision and effectiveness of clinical proton beams used in tumor treatment can be optimized based on several key parameters:[2, 4, 10]

- **The beam energy** determines its range/depth of penetration within the tissue, where the Bragg peak occurs: a higher energy leads to a deeper Bragg peak within the body. The beam energy can be adjusted through magnets, or energy degraders, placed in the path of protons.
- **The beam intensity** refers to the number of protons per time and area and influences the dose rate and treatment time.
- **The beam spot size** indicates its diameter at a specific position, impacting spatial resolution and dose distribution conformity. Magnets bend and focus the beam, collimators remove the scattered beam, and steering magnets precisely guide pencil beams to a predetermined position within the target.
- **Distal dose fall-off (DDF)** defines the distance between the distal 80 % and 20 % dose points. It affects the distal tissue sparing. (Fig. 2A)
- **Lateral penumbra (LP)** at the edge of the target is the distance between the lateral 80 % and 20 % dose points, which influences the lateral tissue sparing (Fig. 2B).



IBA proton beam energy deposition profile

Other commercial proton therapy system proton beam energy disposition profile

Fig. 2: Schematic representation of the distal dose fall-off (DDF) and lateral penumbra (LP). Different dose distribution curves, represented in red and green, create different DDFs and LPs.

TARGETING THE TUMOR IN ALL ITS DIMENSIONS [2,5,6]

Pencil Beam Scanning (PBS) uses magnets to steer the position of narrow proton beams within the tumor, creating a customized three-dimensional delivery shape. The position in the X and Y directions are adjusted through magnetic deflection and depth modulation is controlled by varying proton energy. During treatment, radiation is deposited pixel by pixel and layer by layer (Fig. 3), conforming the dose to the specific shape of the tumor. IBA introduced PBS in 2008, paving the way for intensity-modulated proton therapy (IMPT), potentially the most effective form of proton therapy, in which scanning beams of protons are used to "paint" radiation dose on the target.

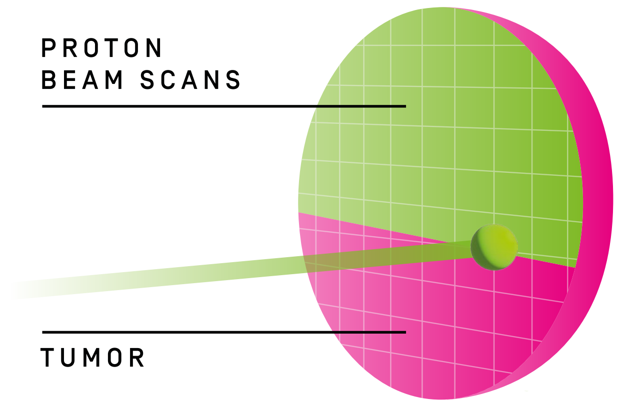


Fig. 3: Schematic representation of PBS: the green proton beam scans the red tumor in the X and Y directions.

Beam quality matters, as it impacts treatment throughput and hospital efficiency

IBA's efforts and continuous innovation have been focused on building a proton therapy system that delivers a high-quality beam, enhancing both patient throughput and hospital efficiency, and contributing to sustainably meeting the return on investment (ROI) targets.

IBA'S SMALL SPOT SIZE HELPS OPTIMIZE TREATMENT PLANS AND QUALITY [10,12]

Optimized treatment plans ensure local tumor control while minimizing the risk of complications for the surrounding healthy tissue. **IBA's ProteusONE is designed to deliver the sharpest beam among all compact accelerator solutions, without the need for accessories or multileaf collimators (MLC), liberating users from the MLC impact on treatment workflow, treatment planning, commissioning, uptime and maintenance. ProteusONE's high-quality beam has a native small spot size,** with constant symmetry regardless of gantry angle, ensuring several advantages for patient care:

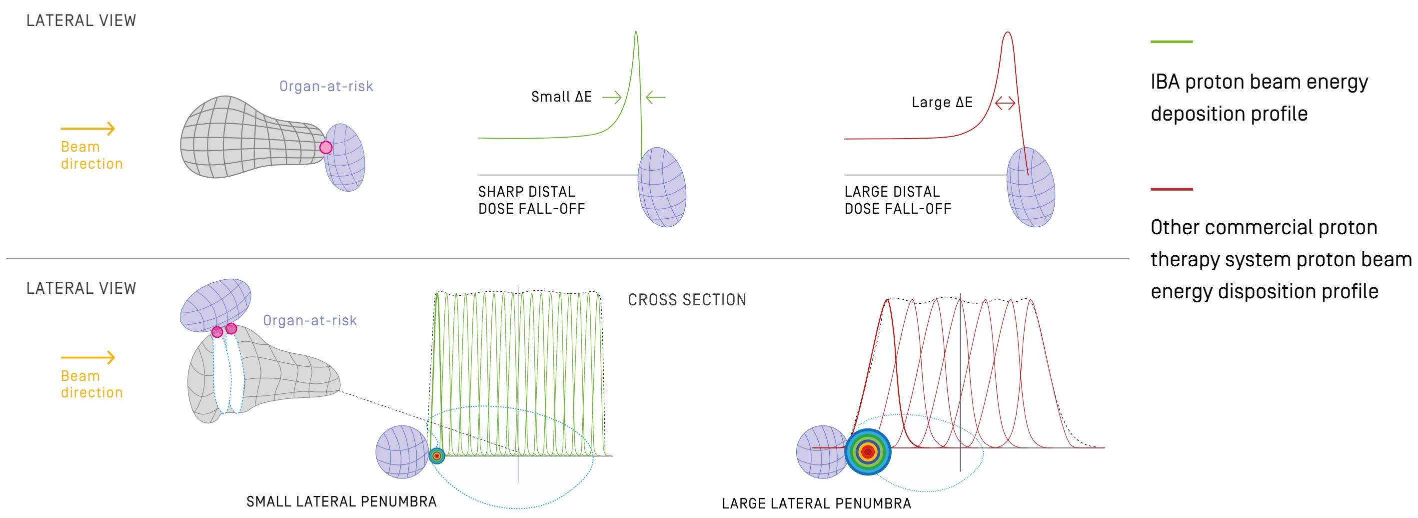


***Fig. 4:** Schematic representation of the impact of different beam energies and spot sizes on distal dose fall-off and lateral penumbra*

- **Reduced penumbra and sharper dose delivery:** smaller spot sizes enable more precise dose delivery to the target volume, resulting in a sharper distal dose fall-off and lateral penumbra, while larger spot sizes may cause excess dose spillage to surrounding healthy tissues and a broader penumbra, leading to more spread-out dose distribution around the target (Fig. 5). The difference between small (2.5 mm) and large (10 mm) spots can result in an extra 2-13 Gy (RBE) - relative biological effectiveness - affecting the healthy tissue around the target region. Systems with spot sizes exceeding ~8 mm median sigma at isocenter need beam-specific apertures and range compensators while IBA's native small spot size eliminates the need for additional accessories.
- **Improved conformity**: the spot size significantly influences the conformity of IMPT systems and, ideally, the dose distribution should be highly conformal. Accurate beam shaping in 3D contributes to its conformity while any material in the beam path, including the patient, will spread the beam energies and increase distal penumbra.
- **Consistent spot symmetry**: by precisely controlling beam emittance, size and ellipticity, IBA delivers a spot with constant symmetry irrespective of gantry angle, enhancing treatment planning, and speeding up the critical commissioning period and overall quality assurance. This differs from synchrotron-based systems, which yield asymmetrical beam shapes varying with energy levels, making it difficult to commission all energies.

IBA'S BEAM PRECISION ALLOWS THE TREATMENT OF DIVERSE INDICATIONS, EVEN COMPLEX ONES [3,13]

By delivering a **high-quality proton beam**, IBA's ProteusONE system efficiently targets the desired location while significantly reducing unnecessary radiation exposure to surrounding organs. With more than 120,000 patients treated on the Proteus platform [13], IBA users excel in treating a large mix of cancer types, including very complex cancers, such as:

- **Head and Neck tumors**: often large or irregularly shaped, and situated near critical organs like the brainstem and spinal cord.
- **Pediatric tumors**: typically fast-growing and located in, or near, developing organs like the brain and bone marrow. Proton therapy can be beneficial to minimize long-term side effects such as secondary cancers and growth impairment.
- **Ocular tumors***: usually superficial, small, and spherical, located near sensitive structures like the optic nerve and retina.

Medical centers around the world use IBA's high-precision pioneering system to treat a diverse mix of eligible patients (Fig. 5).

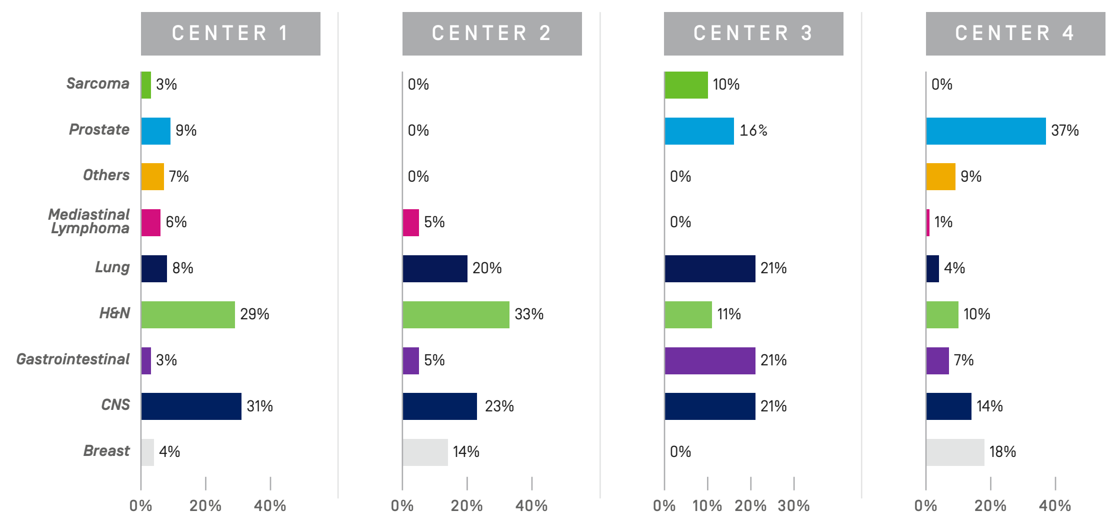


Fig. 5: *Diversity of patient mix in 4 medical centers using IBA's Proteus system in 2020. Data are courtesy of the respective centers.*

CLICK OR SCAN THE QR CODE TO DISCOVER THE DIVERSITY OF PATIENTS TREATED AT COREWELL HEALTH HOSPITAL, AS EXPLAINED BY DR CRAIG STEVENS

> *Our machine has been completely full for the past 9 months. Now we're treating 28-32 patients a day.*

DR CRAIG STEVENS
Chief of Radiation Oncology
Corewell Health,
Royal Oak, Michigan, United States

IBA's versatility in treating various cancer types highlights its commitment to ensuring every eligible patient can potentially access and benefit from the unparalleled precision of proton therapy.

**Ocular tumors can be treated using IBA technologies, but not ProteusONE.*

IBA'S INNOVATIONS AND HIGH-QUALITY BEAM HELP ENHANCE TREATMENT SPEEDS [5,9,14-19]

In IMPT, the proton beam range is highly sensitive to tissue moving in and out of the targeted region and the high precision of PBS - distal dose fall-off and lateral penumbra - requires an exact knowledge of the target's location, which can be challenging during patient movements, like breathing or organ motion. Different motion management strategies can be applied, such as breath-hold, free breathing, gating or layer repainting, to increase the confidence of treatment planning and delivery. Accelerating the delivery of proton therapy reduces the risk of patient movement, on top of increasing patient comfort, as well as patient throughput.

ProteusONE's superconducting synchrocyclotron delivers a **structured and stable beam** that reduces treatment time compared to synchrotron-based systems, making it ideal for moving targets:

- **Beam structure**: IBA's beam pulsed at high frequency enables FLASH irradiation*, while synchrotron-pulsed beams, emitted at low frequency, deliver a lower dose rate and complicate the treatment of moving targets.
- **Beam current stability**: synchrocyclotrons deliver a stable, continuous current while synchrotrons experience large variations in current during extraction.
- **Layer switching time**: IBA's ProteusONE has a fast layer switching time, which is a critically important parameter to shorten the irradiation time, even more in motion management techniques such as repainting.

Beyond high beam quality and speed, IBA is currently developing solutions for the efficient treatment of moving targets**, including **ultrafast scanning, multiple repainting techniques, open interface for gating systems** to perform free-breathing, breath-hold and gated irradiation safely, and **imaging solutions** to track targets during treatment.

A MOVING TUMOR TREATMENT SUCCESS STORY IN THE NETHERLANDS [14, 15]

The Department of Radiation Oncology at the University Medical Center of Groningen, Netherlands, has successfully treated moving tumors for the past years using an IBA proton therapy system:

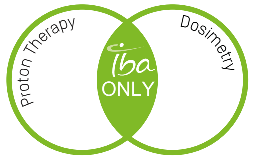
- In **stage III Non-small Cell Lung Cancer (NSCLC),** robust optimization allowed to limit the impact of the setup, range uncertainties, breathing motion and interplay effects on the coverage, dose homogeneity and organ-at-risk dose parameters. The optimized IMPT plans achieved **40 % reduction in the surrounding mean lung dose** and **60 % reduction in mean heart dose** parameters, compared to standard of care in conventional radiotherapy.
- In **thoracic tumors with large motion - thymoma, lung and esophageal cancer** - the Groningen team reports adequate IMPT treatment in free breathing for **target motion amplitudes up to 17 mm.**

ConformalFLASH® is the registered brand of IBA's Proton Therapy solution which is currently under research and development. ConformalFLASH® will be available for sale when regulatory clearance is received. Due to a continuous research and development program, IBA reserves the right to make changes in design, technical descriptions, and specifications of its products without prior notice. Some features are under development and may be subject to review by competent authorities.

***Motion management solutions are currently under research and development and will be available for sale when regulatory clearance is received. Due to a continuous research and development program, IBA reserves the right to make changes in design, technical descriptions, and specifications of its products without prior notice. Some features are under development and may be subject to review by competent authorities. For more information, contact your IBA representative.*

TREATMENT TIMES CAN BE FURTHER OPTIMIZED [16-19]

IBA offers a wide range of solutions and cutting-edge features that help further reduce treatment time while ensuring precise delivery of therapy to the target:



IBA Dosimetry provides a full range of solutions and services to streamline the machine quality assurance (QA) workflows, automating processes without deviating from the standard Patient QA workflow. This is achieved through the DOPA (Dosimetry Proton Therapy Alliance) Server, allowing seamless communication between the myQA platform and the IBA ProteusONE system. The synergy between IBA Proton Therapy and IBA Dosimetry ensures seamless integration, improved efficiency, and substantial time and quality gains during clinical commissioning and daily operations.

Future innovations currently under development or research, such as DynamicARC®* and ConformalFLASH®*, have the potential to further reduce treatment times and a high system performance is necessary for their implementation. IBA's ProteusONE is ready to integrate these future innovations, given its high-energy delivery capabilities:

DynamicARC* enables dynamic irradiation while the gantry is rotating, targeting the tumor from multiple directions, enhancing delivery efficiency and improving clinical treatment throughput. ProteusONE's current high beam stability and precise beam control are essential for this novel delivery technique of faster, simpler and sharper more conformal treatments. **Reductions of over 60 % of the treatment delivery time per patient**, compared to IMPT, were achieved during the research phase [16, 17].

The development of **ConformalFLASH***, delivering treatment at ultra-high dose rates, might revolutionize radiotherapy by widening the therapeutic window, potentially reducing toxicity, shortening treatment times, and expanding its application to various indications. IBA has launched the first **ConformalFLASH*** research project conducted on a synchrocyclotron in a clinical setting, using the Bragg peak for deeper, faster and sharper treatments. ProteusONE's beam structure, pulsed at high frequency, with a high beam current stability, is crucial for the development of **ConformalFLASH***[18,19].

IBA's fully integrated range of solutions, combined with its interoperability with major vendors, make ProteusONE the ideal tool for exploring and advancing the most innovative proton therapy protocols, ensuring users remain at the forefront of cancer treatment for decades to come.

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IBA'S HIGH-QUALITY BEAM DELIVERY DESIGN REDUCES STRAY RADIATION [4,20,21]

Similar to other types of external-beam radiation therapies, proton therapy generates stray radiation affecting the patient, including stray neutrons from the treatment apparatus, and neutrons produced by therapeutic proton radiation inside the body (Fig. 6). Exposure to this stray radiation increases the risk of radiogenic side effects such as radiation-induced secondary cancers later in life.

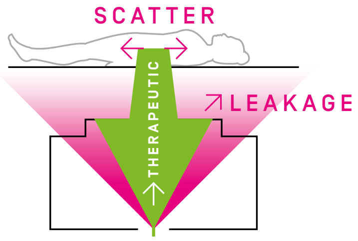

Fig. 6: Schematic diagram of proton beam irradiation of the spine, showing the therapeutic protons radiation (green) and stray neutrons (pink). Adapted from Newhauser WD et al. 2015

The design of proton therapy systems should be optimized to reduce non-intended radiation exposure, including from stray neutrons, and ensure patient and staff safety, by:

- **Increasing the distance from the treatment unit** and decreasing the snout distance from the isocenter.
- **Adding shields near the patient** and upstream collimators near the range shifter (RS).
- **Bulk shielding** and finding an acceptable balance between safety, utility and cost.

IBA's design of ProteusONE prioritizes patient safety by minimizing neutron exposure, through:

- **Scattering at a distance**: the majority of scattering takes place in the degrader, situated at a substantial distance from the patient (approximately 32 feet or 10 meters). This degrader is shielded adequately, in stark contrast to other equipment available in the market today where scattering occurs in the nozzle and collimator, near the patient, often without proper shielding.
- **Minimal interaction**: following the degrader, the proton beam encounters no further interactions with the equipment, ensuring focused and precise delivery.
- **Patient-centric scanning**: PBS actively scans the beam within the patient, minimizing neutron exposure. Most neutrons traversing the patient result from nuclear reactions within the patient's body.

This design approach prioritizes patient safety by significantly reducing neutron dose during treatment with ProteusONE.

LOWER NEUTRONS DOSE AND RISK OF SECONDARY CANCER WITH PROTEUSONE VS A RANGE-SHIFTING (RS) SYSTEM [20]

ProteusONE's neutron dose generation has been compared to an ideal pure PBS treatment and a system employing a range shifter (RS) of variable thickness, placed close to the patient to prevent beam spot size increase and mimic a PBS-like irradiation. Results indicate that:

- The RS approach delivers a higher neutron dose (H_T/D) to the tissues than ProteusONE PBS (Fig. 7).

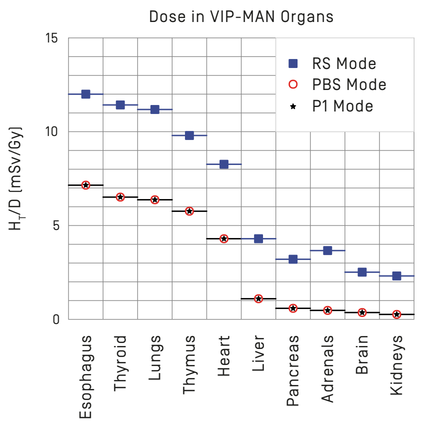

Fig. 7: Comparison of the 10 largest doses obtained in the organs of VIP-MAN model for the three studied irradiation modes: PBS mode, RS mode and ProteusONE mode (P1). Adapted from Stichelbaut F et al. 2014

- The ProteusONE solution does not introduce any significant increase in the second cancer risk, while the system relying on the RS approach leads to an over 3-fold increase of that risk (Table 1).

Table 1: Effective dose and lifetime risk of second cancer for the three considered treatment modalities.

Treatment mode	Effective Dose [mSv Gy⁻¹]	Risk of secondary cancer [%]
PBS	1.900	1.037
Proteus®ONE	1.910	1.052
RS	4.901	3.262

Adapted from Stichelbaut F et al. 2014

IBA'S PROTEUSONE BEAM DELIVERY IS DESIGNED TO OPTIMIZE HOSPITAL EFFICIENCY [9,17,18]

Beyond the clinical advantages of proton therapy, several characteristics of a high-quality beam delivery system have a direct impact on the efficiency and financial success of a hospital:

- **Energy efficiency**: cyclotrons typically have lower energy consumption due to their streamlined design and efficient RF systems, improving the total cost of ownership.
- **Treatment speed**: faster treatments equate to more patients treated per day without compromising treatment efficacy. Two out of 10 hours of clinical operations could be saved every day with IBA's DynamicARC* treatment delivery [17,18].
- **Treatment versatility**: the high-quality proton beam delivered by IBA's ProteusONE system ensures treatment delivery with minimal unnecessary radiation exposure, broadening the possibilities of treated cancer types, including very complex cases, such as brain cancer requiring vertex beams.
- **Commissioning and QA**: fast commissioning contributes to a rapid ramp-up while streamlined QA minimizes downtime, enabling more patient treatments. ProteusONE's round and symmetric beam shape facilitates clinical commissioning while synchrotron-based systems' asymmetric beam complicates it, degrades plan conformity, and increases machine QA time. The streamlined QA workflow in partnership with IBA Dosimetry greatly contributes to ProteusONE's efficiency.
- **Future-proofing**: unlike synchrotron-based systems, the high-quality, high-precision beam delivery of ProteusONE ensures the system's readiness for future innovations, like DynamicARC* and ConformalFLASH* therapy.

HOSPITAL EFFICIENCY CAN BE FURTHER OPTIMIZED

IBA's ProteusONE system is purposefully designed to maximize clinical throughput and hospital efficiency beyond high-quality beam delivery, ensuring cost-effectiveness and maximizing long-term value:

- **Footprint and building size**: a smaller accelerator size, like IBA's compact ProteusONE synchrocyclotron, leads to a reduced need for a large accelerator vault, resulting in cost savings on building size and land requirements.
- **Maintenance**: cyclotrons have lower complexity, making them easier and more affordable to maintain, ensuring minimal disruptions to operations.
- **Uptime**: the high availability of the system for patient treatments directly impacts the financial health of the facility.
- **Scalable design and upgradability**: ProteusONE can easily be scaled up and upgraded, with no or minimal interruptions to clinical daily practice, ensuring unmatched long-term value.

CLICK OR SCAN THE QR CODE FOR A DETAILED WEBINAR ON PHYSICS AND COMMISSIONING IN PROTON THERAPY BY DR. TERRY WU, CHIEF PHYSICIST AT WILLIS-KNIGHTON HEALTH SYSTEM

> *We were treating our first patient just 10 weeks after the acceptance test and commissioning.*

DR TERRY WU
Chief Physicist
Willis-Knighton Health System, Shreveport, Louisiana, United States

IBA's ProteusONE is purposefully designed to deliver a cleaned and pure beam[7,20]

IBA's unequaled experience in particle accelerator technology, and especially in proton therapy, has powered the development of the ProteusONE system with the goal of delivering unparalleled precise radiation to every patient who could benefit from it. Building upon the long experience with ProteusPLUS, ProteusONE has been designed with our users for the users and the components of its Beam Management System (BMS) have been carefully developed and optimized to deliver a clean and pure beam, aiming to help maximize proton therapy treatment possibilities and improve patient care.

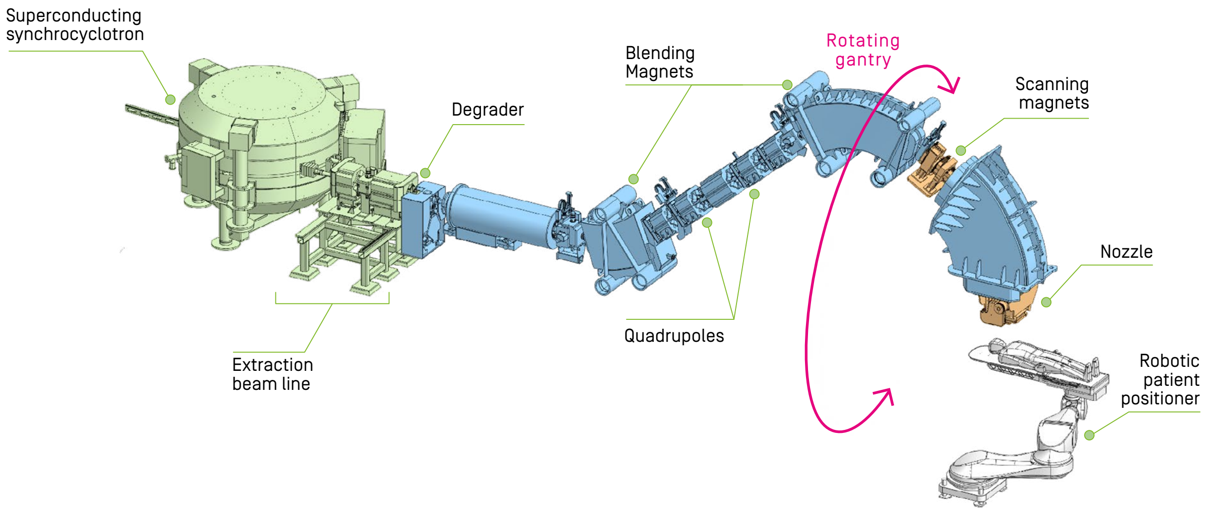

***Fig. 8:** Schematic representation of IBA's ProteusONE Beam Management System highlighting the beam production components (green), the beam selection and transport components (blue), the beam delivery components (yellow), and the rotating gantry (pink).*

A BEAM PRODUCTION SYSTEM THAT DELIVERS A MONO-ENERGETIC PULSED BEAM OF 230MEV

IBA's ProteusONE system accelerator is a **superconducting synchrocyclotron** that produces protons and accelerates them at a kinetic energy of 230MeV. This high energy capability opens the possibilities of implementing future innovations, such as ConformalFLASH*, and expands the usage versatility of ProteusONE, from routine clinical treatment to research. The **extraction beam line** is made of quadrupoles and slits to deliver a compact beam at the output. The last element is an ionization chamber that measures the beam current.

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A BEAM SELECTION AND TRANSPORT SYSTEM THAT ADAPTS AND FOCUSES THE BEAM

IBA's ProteusONE Energy Selection System (ESS) ensures the beam is adapted to the treatment plan and the specific needs of each patient's tumor, by modulating its energy, trajectory and shape. Unlike other systems that adapt the beam's energy by interposing absorbing materials along the beam path, IBA's ESS has the following key elements:

The **degrader** reduces the beam energy to control the depth at which the protons deposit the maximum dose. After passing through the degrader, the beam is scattered and must be filtered through the **slits** to keep only the protons of interest for a specific treatment beam. These slits reduce the energy spread of the beam, impacting the distal dose fall-off and optimizing the peak-to-skin ratio close to a pure mono-energetic pencil beam.

Beamline magnets play a crucial role in bending and focusing the proton beam through the transport system, to the treatment room, and ultimately to the patient. ProteusONE is designed to minimize aberrations (deviations from ideal optics) and dispersion (dependence of position on momentum) that may impact the beam quality, through dipoles and quadrupoles:

- **Dipoles** act as magnetic prisms to spread out the different beam energies and curve the beam trajectory to reach the required orientation.
- **Quadrupoles**, paired as doublets, are electromagnets that act as magnetic lenses, focusing the beam on the beam's central axis.

At the output of the ESS, the beam is focused around a virtual point called the isocenter, which is the reference point for the positioning and alignment of the tumor.

A BEAM DELIVERY SYSTEM THAT ENSURES THE RIGHT DOSE GETS TO THE RIGHT LOCATION

The scanning system is essential for steering and scanning the proton beam across the tumor area to achieve a conformal dose distribution. ProteusONE's active scanning system performs PBS by combining the use of **scanning magnets** to deflect the beam laterally, spot by spot, on the X and Y axis with the precise energy modulation by the ESS to control the longitudinal depth deposition.

The nozzle, the final part of the beamline, impacts beam quality by influencing beam divergence, lateral penumbra, and distal dose fall-off. The IBA nozzle is equipped with ionization chambers to check the beam properties (size, position, dose) and with a **patented accessory management system** (with range shifter, ridge filter, snouts, etc.) to further tune the beam properties according to the needs, just before it enters the patient's body.

The direction of the beam relative to the patient is changed through the **rotating gantry**. It ensures that the beam is delivered to the target tumor at the right angle prescribed by the treatment plan. IBA's ProteusONE compact gantry allows 360° of treatment access, by combining its 220° rotating structure with the horizontal robotic patient positioner. This combination makes ProteusONE the most versatile compact proton therapy system available today, allowing for 4-Pi beam delivery for a large flexibility of types of treatment, facilitating the delivery of non-coplanar and vertex beams and increasing the number of eligible patients.

Essential takeaways

IBA'S PROTEUSONE UNEQUALED BEAM QUALITY ENSURES CLINICAL AND OPERATIONAL EXCELLENCE AND THE MOST ADVANCED PATIENT CARE

It is important to understand that **not all proton therapy beams are the same.** The design of a proton therapy system will greatly influence the beam parameters, including the depth-dose curve, uniformity, and distal dose fall-off and lateral penumbra, directly impacting the efficient treatment of a large variety of tumors while sparing surrounding normal tissue.

IBA carefully designed and developed the ProteusONE system to ensure every eligible patient could access and benefit from the unparalleled precision of proton therapy.

	IBA PROTEUS®ONE	COMPETITOR A Collimator-using system	COMPETITOR B Synchrotron-based system
Essential quality of a proton therapy system			
Cyclotron-based proton therapy system	✓	✓	✗
Small uncollimated spot size (<4mm) at high energy	✓	✗	✗
No need for accessories or MLC to improve the beam profile	✓	✗	✓
Small lateral penumbra	✓	✗	✓
Limited secondary neutron dose by design	✓	✗	✓
Ready to shape the future of proton therapy with ARC therapy or FLASH	✓	✗	✓

IBA analysis. For more information, contact your IBA representative.

IBA's ProteusONE unequaled beam quality helps patients keep everything but cancer.

CONTACT US!

CLICK OR SCAN THE QR CODE TO COMPLETE THE FORM

IBA'S EXPERTISE AND LEGACY RELATED TO BEAM QUALITY

Since its foundation in 1986 by Yves Jongen, **IBA has been leading the development of accelerator solutions.**

Our journey began with pioneering the use of H^- ions to accelerate protons for medical applications, and Cyclone C30, C10/5 and C18/9 cyclotrons quickly became the standard in the medical field. In the 1990's, we designed and installed **the first commercially-available cyclotron-based proton therapy center**, in the Massachusetts General Hospital, although synchrotrons were the solution used everywhere. Since then, we developed **the largest network of proton therapy centers and experience**, with over 75 projects installed or underway worldwide, and a proton therapy installed base that will double in the next 5 years, fully dedicating ourselves to transforming cancer care.

We have a long history of providing new cyclotron technologies to the market, establishing ourselves as the world leader in Proton Therapy, Radio Pharma Accelerators, Industrial Accelerators and Dosimetry. Around the world, **thousands of hospitals use equipment designed, produced, maintained, and upgraded by IBA.**

Our technological and clinical expertise and long-term partnerships with our users have shown that **the design of a proton therapy system significantly influences key beam parameters and directly impacts patient treatment as well as hospital efficiency and return on investment.**

Before choosing IBA ProteusONE, we carefully looked at the technology, to be sure that the current technology for the unit gives us the best precision of treatment. And indeed, many physics aspects of the unit, including the Bragg peak and spot size, were really appealing to us compared to the other options on the market. We also looked at the future development of the technology, and we know that IBA is working on multiple different areas of research and technical development, including ARC therapy and FLASH therapy.

DR RONALD CHEN
Chair of Radiation Oncology
University of Kansas Medical Center, Kansas City, United States

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