Best Particle Therapy, Inc. is Developing a Highly Revolutionary New Treatment for Cancer Therapy

The most precise and conformal Cancer Therapy, using hypo-fractionation, supported by a range of the most advanced cyclotrons for research and radioisotope production for medical diagnosis and therapy in the world

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Cincinnati, Ohio & Washington, DC, USA

Best Theratronics Ltd. (BTL), Best Cyclotron Systems (BCS), Best Particle Therapy (BPT), and Best Medical International (BMI) – all part of TeamBest Medical Companies – are the only companies offering a range of new medical cyclotrons and synchrotrons. These use the most advanced new technologies to offer revolutionary diagnosis and treatment capabilities.

In the next couple of years, Best Particle Therapy will introduce their unique 400 MeV ion Rapid Cycling Medical Synchrotron (iRCMS) with Variable Energy, Heavy Ion Treatment Technologies, offering Proton-to-Carbon Heavy Ion, for Highly Precise, Conformal and Hypo-Fractionated Radiation Therapy. This will be the most advanced new technology for Cancer Therapy, enhancing the cure for many millions of Cancer patients, who do not have this option currently.

The advantages of the Best 400 MeV iRCMS are:

- Intrinsically small beams – facilitating beam delivery with precision for the most conformal radiation therapy
- Hypo-fractionated radiation therapy
- Small beam sizes – small magnets, light gantries – smaller footprint
- Highly efficient single turn extraction – less shielding
- Flexibility – heavy ion beam therapy (protons and/or carbon), beam delivery modalities

In addition to the iRCMS, BCS currently offers a range of New Advanced Technology Cyclotrons, ranging from 15 MeV to 70 MeV – with as high as 1000 micro Amp current for each cyclotron. With the development of a Multi-Particle (Alpha, Deuteron and Proton) 35 MeV Cyclotron, BCS can support the needs of all new therapy capabilities as well.

In partnership with Best Cure Foundation (BCF), TeamBest Companies will set up a Hub-and-Spoke Model of Healthcare Delivery System, using Express and Mobile Clinics, linked to General and Super-Specialty Medical Centers, using all of TeamBest's new and advanced technologies globally.

For more info, please visit: **www.teambest.com** and **www.teambest.com/about_bio.html**.

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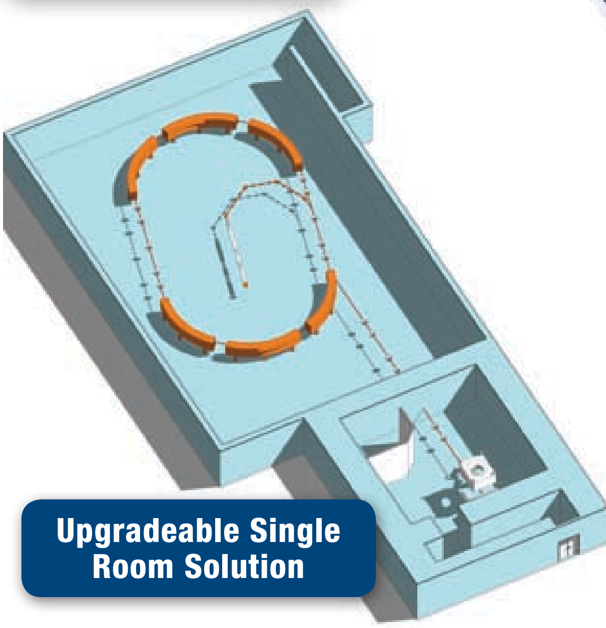
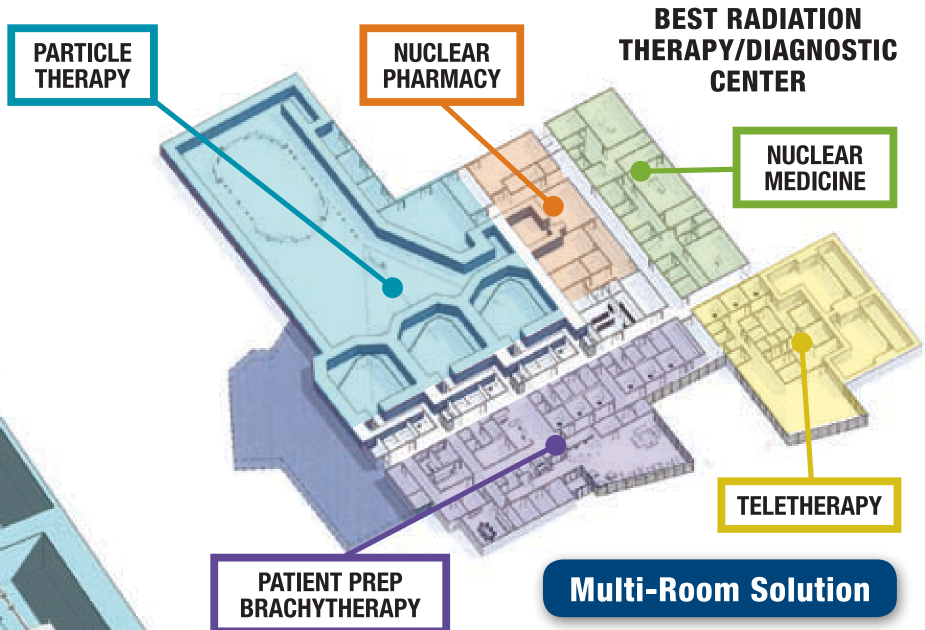
together we are the cure
Best Cure FOUNDATION

One World • One Source • The Best!
healthcare for everyone
TeamBest®
Your True Partner

Best™ Particle Therapy



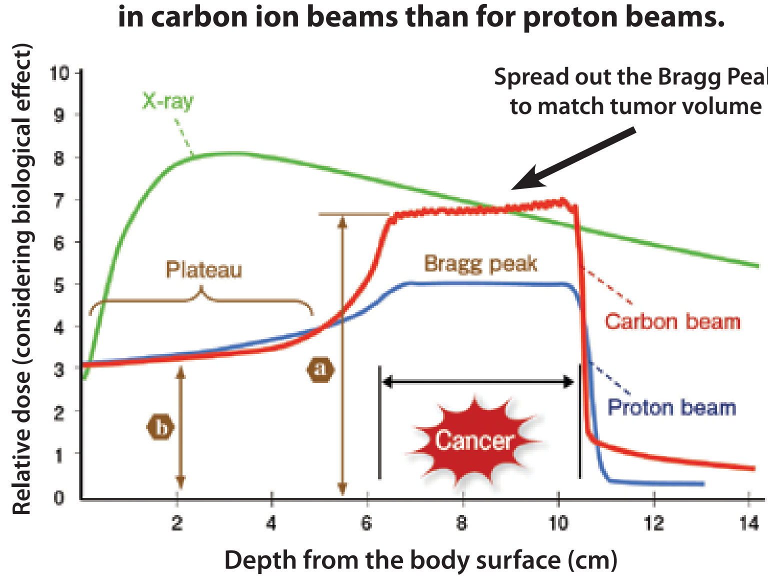


Best Particle Therapy is developing a Proton-to-Carbon therapy system to deliver energetic particle beams of protons and carbon ions, achieving a high level of precision to treat deep-seated as well as radiation-resistant tumors.

400 MeV Rapid Cycling Medical Synchrotron for Proton-to-Carbon Heavy Ion Therapy:

- A unique combination of advanced spot scanning with rapid energy modulation
- Elimination of neutron contamination associated with patient specific hardware
- Intrinsically small beams facilitating beam delivery with precision
- Small beam sizes – small magnets, light gantries – smaller footprint
- Highly efficient single turn extraction
- Efficient extraction – less shielding
- Flexibility – heavy ion beam therapy (proton and/or carbon), beam delivery modalities

Peak-to-Plateau ratio of the RBE (a/b) is larger in carbon ion beams than for proton beams.

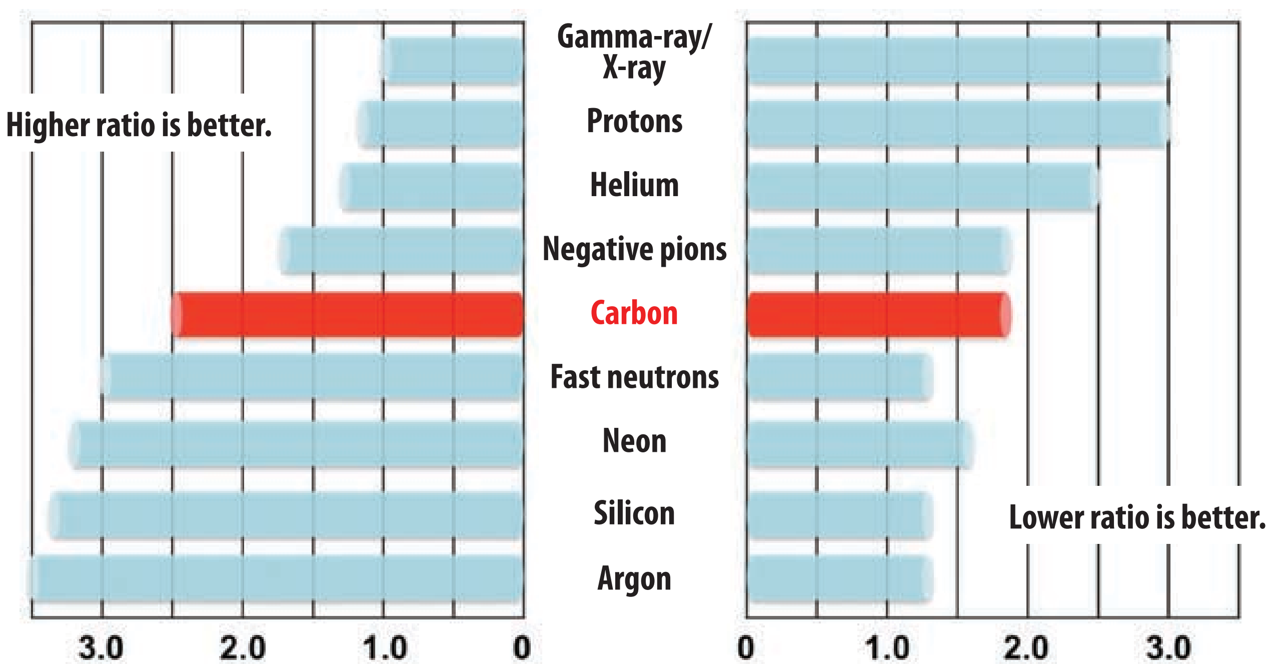


Graph courtesy of Hirohiko Tsujii et al., Radiological Sciences, 50(7), 4, 2007

Accelerator Comparison Table

				Maximum Credible Incidence (MCI)	
	Energy *Maximum* (MeV)	**Avg. Current** *Delivered* (nA)	**Charge** *Accelerated* (nC/s)	**Risk Ratio** *MCI/ Delivered*	**Shielding (50 mSv/yr)** *Concrete @10.00 m* (m)
Protons (206 MeV)					
Isochronous Cyclotron (NC)	230	2	1250	625	2.89
Isochronous Cyclotron (SC)	250	2	313	156	2.44
Synchro Cyclotron (SC)	250	2	1	0.50	0.54
Slow Cycling Synchrotron	250	2	20	10	1.53
Best ion Rapid Cycling Medical Synchrotron (iRCMS)	**1200**	**2**	**0.133**	**0.067**	**0.13**

RBE: Relative Biological Effectiveness
OER: Oxygen Enhancement Ratio



RBE represents the biological effectiveness of radiation in the living body. The larger the RBE, the greater the therapeutic effect on the cancer lesion.

OER represents the degree of sensitivity of hypoxic cancer cells to radiation. The smaller the OER, the more effective the therapy for intractable cancer cells with low oxygen concentration.

** Specifications are subject to change. Product shown not available for sale currently.*

Best Particle Therapy

ION RAPID CYCLING MEDICAL SYNCHROTRON (IRCMS) STATUS AND FUTURE PLANS

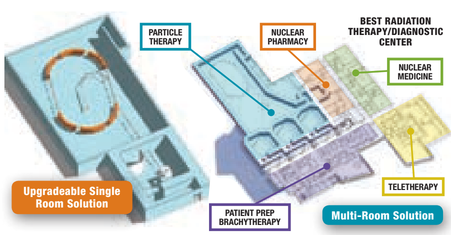
Manny Subramanian[1], Stephen G Peggs[2], Joseph P. Lidestri[3], JK Kandaswamy[1], Krishnan Suthanthiran[1]

[1]Best Medical International, Springfield, VA, 22153 USA • [2]Brookhaven National Laboratory, Upton, NY, 11973 USA • [3]Columbia University, New York, NY, 10032 USA

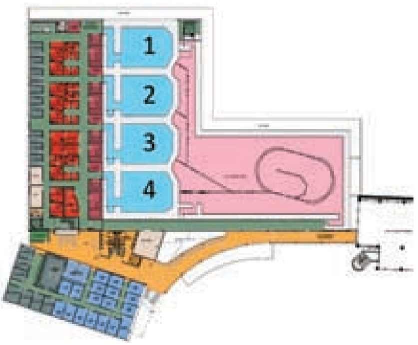
PTCOG 55 • PROTON THERAPY CENTER • PRAGUE, CZECH REPUBLIC • MAY 22–28, 2016

Best Medical International (BMI) entered a Cooperative Research and Development Agreement (CRADA) with Brookhaven National Laboratory to advance the design of the ion Rapid Cycling Medical Synchrotron (iRCMS). The iRCMS is a state-of-the-art synchrotron designed for future cancer therapy facilities that foresee the need to deliver clinical or pre-clinical beams heavier then typical protons. The Collider Accelerator Department (CAD) at Brookhaven National Laboratory (BNL) has optimized an accelerator design under the CRADA funded by BMI specifically for the generation of carbon ions with a maximum energy of 400MeV/u in addition to protons of typical clinical energies. The accelerator is optimized to cycle with a frequency of 15 Hz to the top energy required to deliver treatment at a maximum depth of 27 cm. The iRCMS uniquely combines advanced spot scanning with rapid energy modulation thereby eliminating the contamination associated with patient specific hardware. Extremely small beam emittances are also associated with rapid cycling, which facilitates the generation of particle beams with unprecedented precision. The iRCMS lattice design is a racetrack with two zero dispersion parallel straight sections ideal for injection, extraction and RF systems. The racetrack is 12 meters wide and 23 meters long with the two arcs having a bending radius of ~5 meters. These arcs are made up of 24 combined function magnets with a maximum magnetic field of Bmax~1.3 Tesla. The iRCMS was conceived to include highly efficient single turn injection and extraction and shall utilize a linac to inject carbon ions and protons at a kinetic energy of 8 MeV/u.

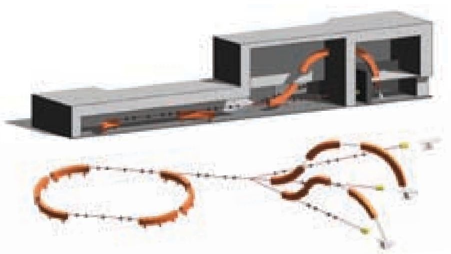
Best Particle Therapy Rapid Cycling Synchrotron



Best Medical Synchrotrons with Variable Energy from Proton to Carbon, in Single or Multi-Room Solutions, with or without Gantry



Advanced Beam Delivery – Less Shielding



Shielding Estimate Comparisons

Accelerator Comparison Table					
				Maximum Credible Incidence (MCI)	
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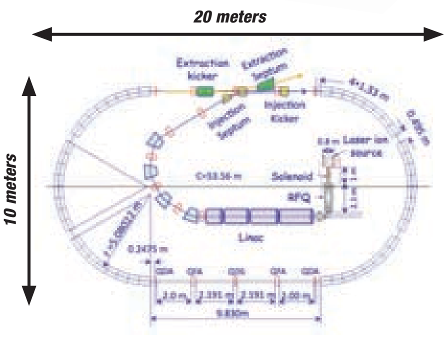
Synchro Cyclotron (SC)	250	2	1	0.50	0.54
Slow Cycle Synchrotron	250	2	20	10	1.53
Rapid Cycle Synchrotron	1200	2	0.133	0.067	0.13

Estimates above *were calculated using the Moyer Model*
Neutron source terms for 177 MeV protons
Neutron transmission factors
Neutron attenuation length in concrete (SLAC PUB 130339)

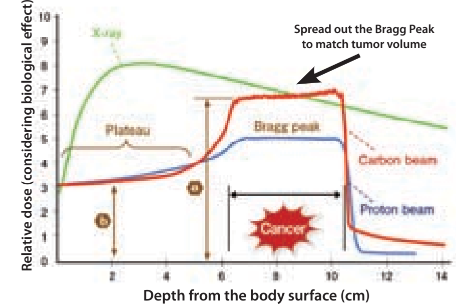
Final shielding calculations *use a full scale Monte Carlo method (MCNPX, GEANT, FLUKA)*

Racetrack Synchrotron – Smaller Area Footprint



Clinical Comparison: X-rays, Protons & Carbon Ions

Peak-to-Plateau ratio of the RBE (a/b) is larger in carbon ion beams than for proton beams.



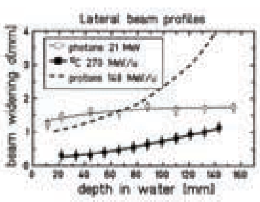
Protons – Base/Peak = 60% Carbon Ions – Base/Peak = 45%

Graph courtesy of Hirohiko Tsujii et al., Radiological Sciences, 50(7), 4, 2007

Carbon Ions are more precise than Protons

The intrinsic spot width for ~206 MeV/u Protons is $2\sigma = 11.4$ mm

The intrinsic spot width for ~400 MeV/u Carbon Ions is $2\sigma = 2.93$ mm



"Lines to guide the eye"
U. Weber GSI (1996)

Prototype iRCMS Combined Function Magnet

Summary

BMI & BNL have jointly developed a rapid cycling proton/ carbon synchrotron that enables advanced features including:

- A unique combination of advanced spot scanning with rapid energy modulation
- Elimination of neutron contamination associated with patient specific hardware

Rapid cycling technology has several natural advantages:

- Intrinsically small beam emittances facilitating beam delivery with unprecedented precision
- Small beam sizes – small magnets, light gantries – smaller footprint
- Highly efficient single turn extraction
- Efficient extraction, less charge per bunch – less shielding
- Flexibility – protons and or carbon, future beam delivery modalities

Best™ Cyclotron Systems

Best™ Cyclotron Systems 15/20/25/30/35/70 MeV Proton & 35/70 MeV Multi-Particle (Alpha, Deuteron & Proton)

Best Cyclotron Systems and TeamBest provide turnkey systems that not only include a cyclotron specific to your isotope requirements but also targets, automated radiochemistry, infrastructure, operations, and maintenance support.

As consistent supplies of radioisotopes become more uncertain, particularly for reactor-supplied isotopes, the Best family of cyclotrons provides a Total Solution™ for the medical community that is less dependent on unreliable sources.

- Currents from 100uA to 1000uA (or higher) depending on the particle beam are available on all BCS cyclotrons
- Best 20u to 25 and 30u to 35 are fully upgradeable on site

Cyclotron	Energy (MeV)	Isotopes Produced
Best 15	15	^{18}F, ^{99m}Tc, ^{11}C, ^{13}N, ^{15}O, ^{64}Cu, ^{67}Ga, ^{124}I, ^{103}Pd
Best 20u/25	20, 25–15	Best 15 + ^{123}I, ^{111}In, $^{68}Ge/^{68}Ga$
Best 30u (Upgradeable)	30	Best 15 + ^{123}I, ^{111}In, $^{68}Ge/^{68}Ga$
Best 35	35–15	Greater production of Best 15, 20u/25 isotopes plus ^{201}Tl, $^{81}Rb/^{81}Kr$
Best 70	70–35	$^{82}Sr/^{82}Rb$, ^{123}I, ^{67}Cu, ^{81}Kr + research

Assembly of a Best 35 MeV Cyclotron at Best Theratronics facility, Ottawa, Ontario, CA

Installation of Best 70 MeV Cyclotron at Italian National Laboratories (INFN), Legnaro, Padua, IT

Best 15

15 MeV
100–1000 µA

Best 20u/25

20, 25–15 MeV
200–1000 µA

Best 30u/35

30, 35–15 MeV
400–1000 µA

Best 70

70–35 MeV
700–1000 µA

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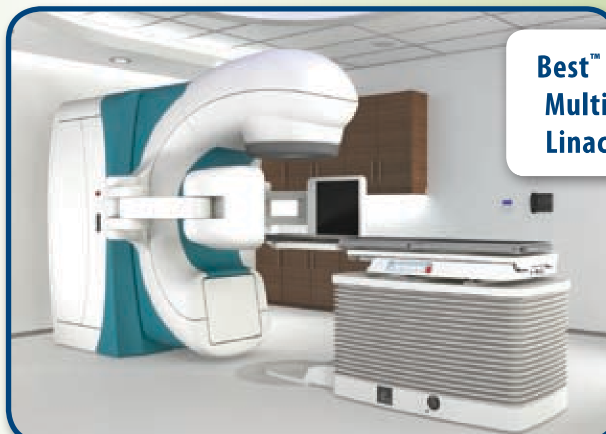
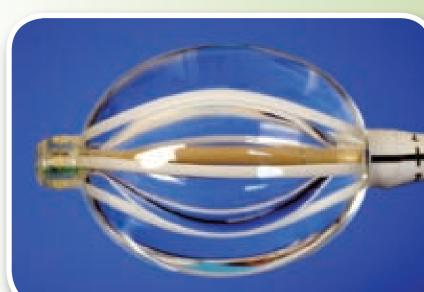
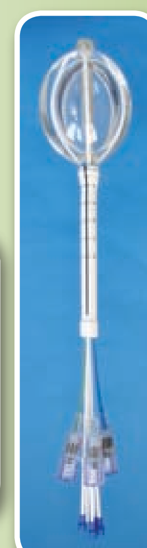


Best™ Intra Luminal Balloon Applicator (Esophageal)

Best™ HDR Afterloader

Best™ Double-Balloon Breast Brachytherapy Applicator





* Certain products shown are not available for sale currently.

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