

Enzhuo Quan^{*,1}, Yuchao Hu¹, Jianan Wu¹, Chenbin Liu¹, Zhen Ding¹, Meiling Xu¹, Yajun Jia¹, Yang Li¹

^{*,1} Radiation Oncology, Chinese Academy of Medical Sciences Cancer Hospital (Shenzhen), China

Objectives

The Shenzhen Proton Center, part of the Chinese Academy of Medical Sciences Cancer Hospital (Shenzhen), is in the final stages of commissioning a multi-room proton therapy facility featuring the IBA Proteus®Plus system. The facility includes a 230 MeV isochronous cyclotron and five treatment rooms (four gantry, one fixed-beam), all equipped with pencil beam scanning (PBS) (Figure 1). This report summarizes the comprehensive commissioning process, guided by international standards and institutional collaborations.

Methods

Absolute dose calibration was performed using a plane-parallel chamber in single-layer fields at energy-specific depths, in accordance with TRS-398 rev.1, with an RBE factor of 1.1 applied. A CT number-to-mass density calibration curve was established in the treatment planning system (TPS), with stopping power ratio (SPR) conversion validated through animal tissue measurements. Beam modeling data included integral depth dose (IDD) curves measured with a Bragg peak chamber in a water phantom and in-air spot profiles collected at six source-to-surface distances using a 2D scintillation detector (Figure 2). TPS model accuracy was validated by measuring point and planar doses at multiple depths, along with longitudinal dose distributions, for a series of SOBP fields per TG-185, as well as heterogeneous plans including standard and clinical cases. Water-equivalent thickness of all immobilization, support, and QA devices was measured using a multi-layer ionization chamber. A structural model of each treatment couch was implemented in the TPS, and detailed strategies for their clinical application—including collision assessment and material assignment—were also established. Imaging systems—including orthogonal kV, CBCT, and optical imaging—were commissioned and integrated into the clinical workflow. The Mosaic information system was configured and tested for data transfer, accessory interlocks, and treatment gating.

Results

Range measurements in animal tissues showed SPR conversion accuracy within 2%. TPS model validation yielded point dose agreement within 2% (mean difference 0.11%, SD = 0.56%) and average planar dose gamma passing rates of 98.0% (SD = 2.74%) at 2%/2 mm for uniform fields and 98.7% (SD = 2.4%) at 3%/3 mm for heterogeneous fields (Table 1). End-to-end testing using an anthropomorphic phantom confirmed system readiness across multiple treatment sites. Full clinical workflows and QA programs have been designed and are currently being finalized in preparation for clinical launch.

Conclusions

Through a rigorous commissioning effort, the Shenzhen Proton Center is approaching full clinical readiness for proton therapy. This experience highlights the importance of standardized protocols, multidisciplinary collaboration, and structured training in bringing large-scale proton therapy services into clinical operation in China.

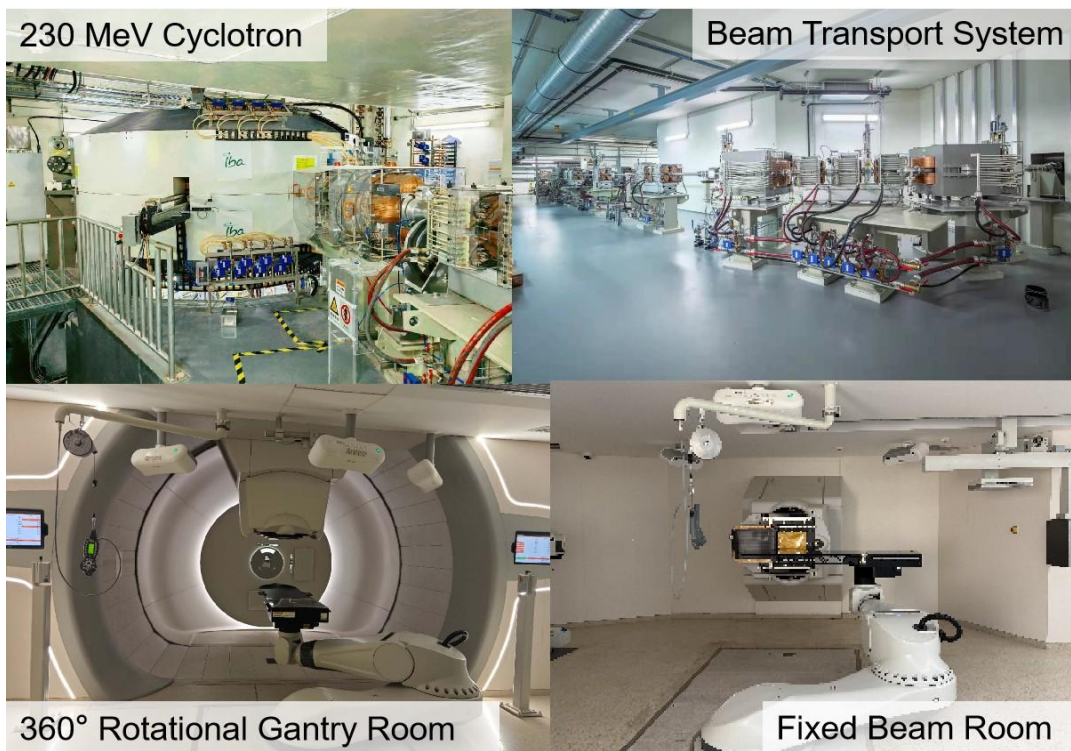


Figure 1. Key areas of the Shenzhen Proton Center

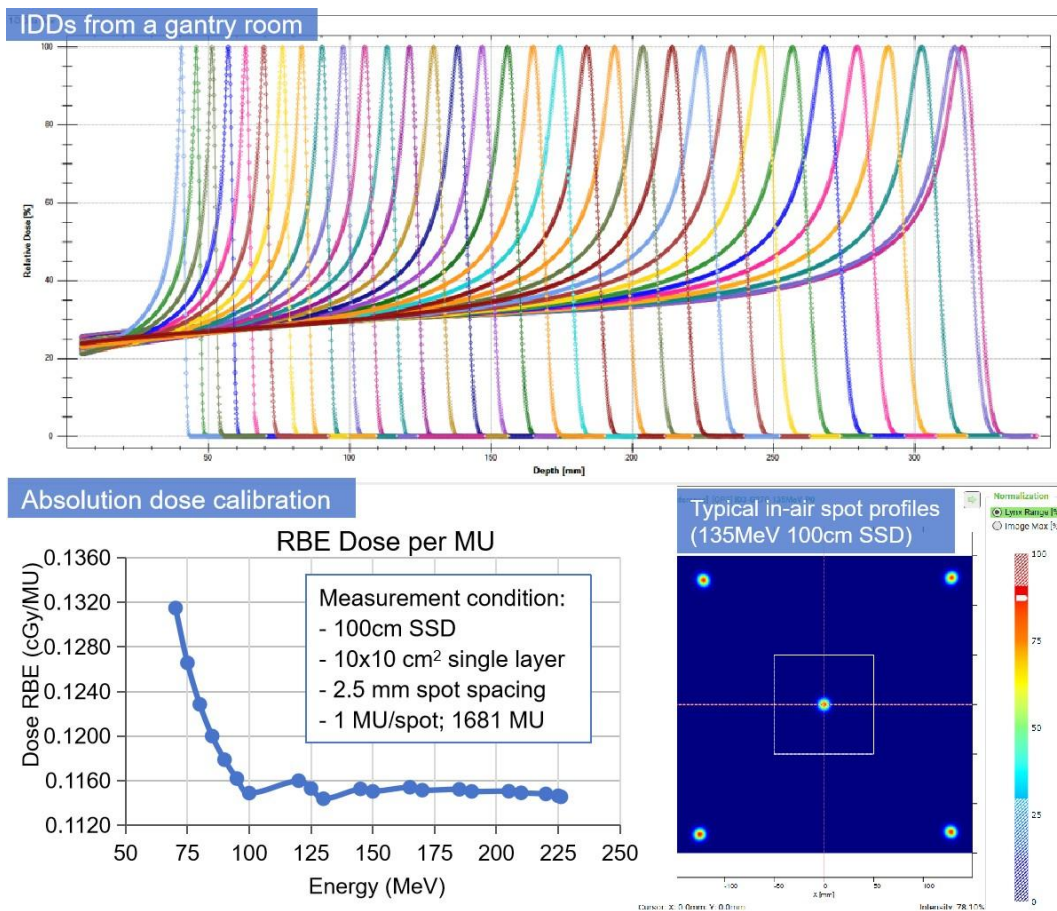


Figure 2. Representative beam modeling data acquired in one gantry room

Table 1. Summary of TPS model validation results in one gantry room

Uniform SOBP fields					
Range Shifter	Measurement depth	Key Metrics	Criteria	Mean (SD) (%)	Range
None	Entrance region	γ Passing Rate	2%/2mm	97.75 (3.58)	93.40 - 100.00
		Point Dose Difference		0.37 (0.25)	0.01 - 0.88
	Proximal D90	γ Passing Rate	2%/2mm	99.44 (0.63)	97.30 - 100.00
	Center of SOBP	γ Passing Rate	2%/2mm	98.54 (2.32)	91.20 - 100.00
		Point Dose Difference		-0.11 (0.45)	-0.70 - 0.56
	Longitudinal	1D γ Passing Rate	2%/2mm	0.99 (0.01)	0.95 - 100.00
4 cm	Entrance region	γ Passing Rate	2%/2mm	94.49 (4.33)	88.60 - 100.00
		Point Dose Difference		-0.5 (0.64)	-1.52 - 0.51
	Center of SOBP	γ Passing Rate	2%/2mm	97.71 (2.51)	91.00 - 100.00
		Point Dose Difference		-0.83 (0.61)	-1.63 - 0.17
	Longitudinal	1D γ Passing Rate	2%/2mm	0.99 (0.01)	0.96 - 100.00
Heterogeneous Fields					
Type/Anatomical Site	γ Passing Rate (3%/3mm)		γ Passing Rate (2%/2mm)		
	Mean (SD) (%)	Range	Mean (SD) (%)	Range	
TG-119-type Test Cases	99.96 (0.13)	99.50 - 100.00	98.85 (1.59)	93.70 - 100.00	
Head/Head and Neck	98.80 (1.32)	94.90 - 100.00	94.77 (3.30)	84.00 - 99.40	
Thorax	99.43 (1.99)	93.10 - 100.00	97.53 (4.80)	82.80 - 100.00	
Breast	94.19 (2.64)	90.00 - 98.40	83.42 (5.56)	70.60 - 90.3	
Pelvis	99.95 (0.15)	99.40 - 100.00	99.06 (0.71)	97.60 - 100.00	