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# Verification of Commissioning Data of Indigenous LINAC Siddharth II ICONIC as per Task Group-142 Guidelines at Amor Super Speciality Hospitals

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## Introduction

- Linear accelerators (LINACs) are essential in modern radiotherapy for delivering high-precision treatments.Recently,PMT has introduced a new class of Linear Accelerator refered as Siddharth - II ICONIC(Panacea Medical Technology Pvt Ltd), an indigenous LINAC, has been recently commissioned and installed in Amor Super Speciality Hospitals,Hyderabad.Siddharth II ICONIC is a new clinical Linear Accelerator designed with a ring - mounted gantry enclosed in bore (150cm) with 6MV FFF beam at 800 MU/min dose rate and FF beam at 600 MU/min dose rate.Siddharth II ICONIC's treatments are true image guided radiation therapy(IGRT) using kV imaging system to generate the Planar(2D-2D match) and CBCT images(3D-3D match) to ensure the patient positioning accuracy.only single isocentre per plan, limiting treatment to its maximum field size of 30 × 30 cm2.
- Ensuring the accuracy and safety of treatment delivery is paramount, making verification against American Association of Physicists in Medicine (AAPM) Task Group-142 (TG-142) guidelines crucial.

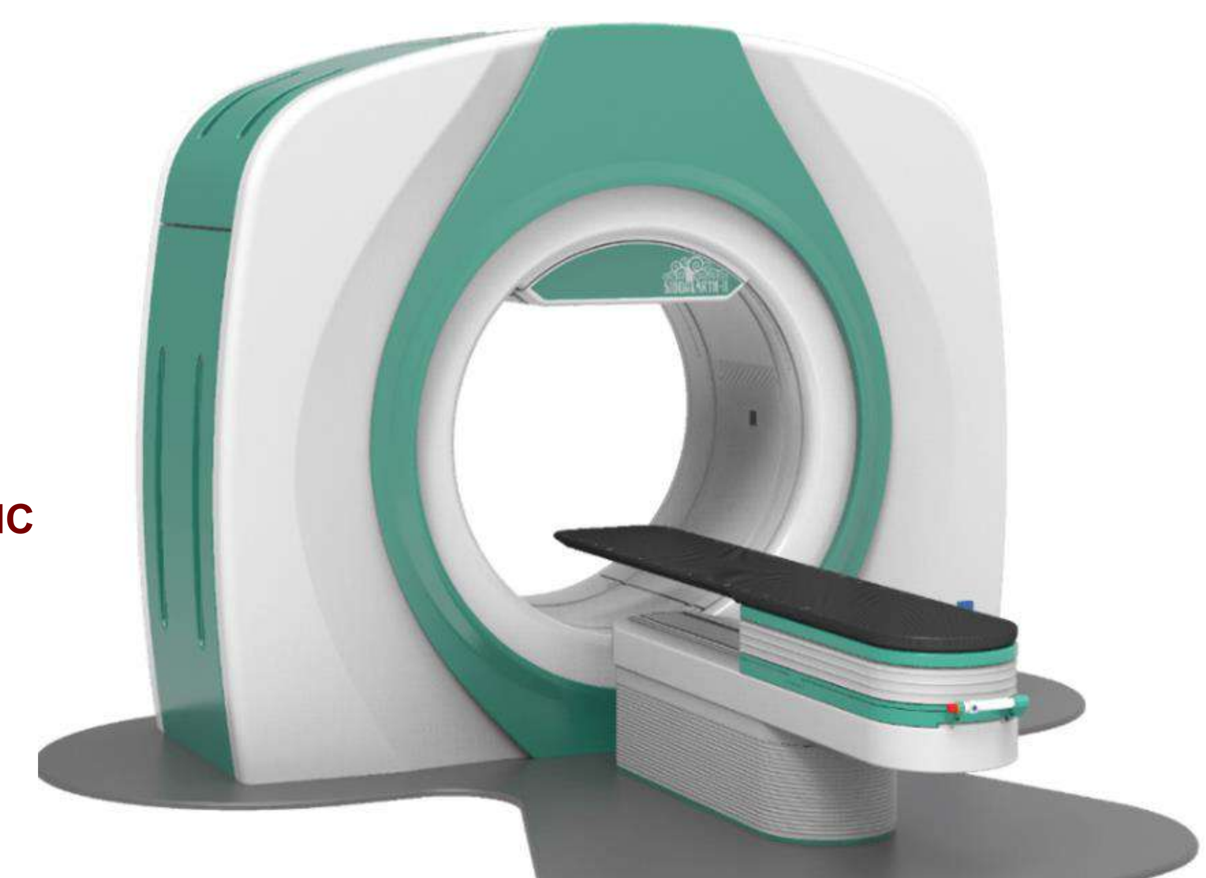
## Objectives/Goals

- This study aims to verify the commissioning data of the Siddharth - II ICONIC LINAC against TG-142 standards. We focus on the performance evaluation of dosimetric, geometric, and mechanical parameters, ensuring conformity to international quality standards.

## Methods:

### Equipment

- Siddharth - II ICONIC is a dual mode of 6 MV-FFF and 6 MV FF(Small field and Large Field modes) beam linear accelerator, mounted opposite to a beam stopper in a ring geometry enclosed with carbon fibre bore. Bending magnet is used. Siddharth-II is equipped with a rapid, high-precision MLC system that enables the shaping of the radiation beam to conform to the shape of the tumor. The MLC has 46 pairs* of leaves, each independently controlled, which can be adjusted to create complex radiation fields with high accuracy. This makes Siddharth-II highly versatile and capable of delivering complex treatments like IMRT, VMAT and SBRT.
- Siddharth-II's patented Scanomatika(PMT) is an advanced and intuitive robotic RFA that simplifies the process of acquiring beam data. With its in-built robotic arm, Scanomatika(PMT) descends and aligns to the water level in the 3D water phantom,moving in three axes to capture beam data at different levels. The feature-rich software autonomously captures the data with minimal user intervention and populates the chart for the user to analyze and begin treatment. With Scanomatika(PMT),the user can focus more on patients and less on machine QA. Set up the system and leave for the day, and Scanomatika's robotic arm will perform the measurements and desired QA in one go. The next day, the acquired data is ready and documented, simplifying beam data acquisition like never before.
- Commissioning data of Siddharth - II ICONIC beam was performed in a water tank Scanomatika(PMT). For absolute measurements, a 0.6-cc waterproof Farmer chamber (SNC600) and electrometer (Sun Nuclear, USA) calibrated at MD Anderson Dosimetry Laboratory, USA were used. All relative measurements (CAPDDs, In-line cross-line and angular profiles) were performed with 0.04cc (DS04-100 IBA)ion chamber from IBA. The corrections for effective point of measurement were applied.



Siddharth-II ICONIC

## Results

- Mechanical tests of the couch, gantry and collimator's spoke test,Congruence test(No light field with reference of Laser).SSD indicator rod is provided by PMT(Field light is not available)All the parameters were well below their tolerance values
- MLC tests,Leakage measurements,DMLC output with gantry angle obtained values are below tolerance values.DMLC Test:Average and maximum MLC transmission were measured using a farmer-type ionization chamber (0.6 cm3) at NTD. According to TG-50 the average leaf transmission should be < 2%. Accuracy of positioning and leaf speed modulation of MLC was verified in both the static and dynamic mode of delivery, using Picket fence tests with gafronic films.
- Planar kV and CBCT images were evaluated(CIRS 062QA-35),Geometric distortion,Spatial resolution,Contrast,Uniformity and Noise,HU constancy which was under tolerance.

### Radiation dosimetry tests

**Energy Stability check(TPR 20/10) for all beams:** The consistency of TPR20/10 values measured at different time in a day with a CoV of 0.2576.

PDD,Dmax,PSD were determined in accordance with TRS-398 and TG-51 protocol, respectively.Penumbra was quantified and compared to other Siddharth - II ICONIC machines for the transverse and radial beam profiles. For FFF beams,AERB QA protocol for un-flat beam -rev.1 took the reference for evaluation of Beam Penumbra,Symmetry inflection Points and all parameters.

| Performance Test | Siddharth-II Iconic | |
|---|---|---|
| | Manufacturer defined baseline/tolerance | Acquired Results |
| Accuracy of radiation isocentre | 2 mm dia sphere | Combined Spoke Test: 0.74 mm dia<br><br>Gantry Spoke Test: 0.26 mm dia |
| Output (cGy/MU) for all available photon beam energies for field size 10x10 cm2 under reference condition | | 6 MV LF (30FF): 0.998 cGy/MU<br>6 MV SF (16 FF): 0.998 cGy/MU |
| Beam quality or Quality Index (TPR20/10) | 6MV LF: 0.677±3% | 6 MV LF (30FF): 0.663 |
| | 6MV SF: 0.64 ±3% | 6 MV SF (16 FF): 0.643 |
| | 6MV FFF: 0.635±2% | 6MV FFF: 0.626 |
| PDD | 6MV LF: 67.5%±2% | 6 MV LF (30FF): 66.68 % for 6 MV FF |
| | 6MV SF: 64.84%±2% | 6 MV SF (16 FF): 64.84% for 6 MV FF |
| | 6MV FFF: 10x10 cm2: 64±2% | 6MV FFF: 10x10 cm2: 63.8% |
| Dmax (Depth of dose maximum) | 6MV LF: 1.5±0.2 cm | 6 MV LF (30FF): 15.5 mm for 6 MV FF |
| | 6MV SF: 1.5±0.2 cm | 6 MV SF (16 FF): 14 mm for 6 MV FF |
| | 6MV FFF: 10x10 cm2: 15mm | 6MV FFF: 10x10 cm2: 13.5mm |
| Difference in % Surface Dose (PSD) between flat and unflat beams of similar nominal photon beam energy | 6MV FFF: 10x10 cm2:90%≤10%* | 6MV FFF: 10x10 cm2: 93.47% |
| | 6MV FFF: 20x20 cm2:91% ≤10%* | 6MV FFF: 20x20 cm2: 87.98% |
| Percent surface dose for 30x30 cm2 | 6 MV LF (30FF): ≤ 60% for 6 MV | 6 MV LF (30FF): 57.8 % for 6 MV FF |
| Off Axis Ratio (OAR) : (at ±3 cm from central axis at 10 cm depth) | 6MV FFF: 10x10 cm2:95%±2% | 6MV FFF: 10x10 cm2 Cross Plane: 95.21% Inplane: 94.78% |
| Separation between IPL & IPR | 6MV FFF: 20x20 cm2: 20±2mm | 6MV FFF: 20x20 cm2: 19.952 mm |
| Lateral width at 90% dose level (X90%) | 6MV FFF: 20x20 cm2: 105.5±2mm | 6MV FFF: 20x20 cm2: 106.2mm |
| Lateral width at 75% dose level (X75%) | 6MV FFF: 20x20 cm2: 179±2mm | 6MV FFF: 20x20 cm2: 178.13mm |
| Lateral width at 60% dose level (X60%) | 6MV FFF: 20x20 cm2: 194.5±2mm | 6MV FFF: 20x20 cm2: 194.74mm |
| Radiation beam Penumbra (Pb-Pa) | 6MV FFF: 20x20 cm2: 5.5mm±2mm | 6MV FFF: 20x20 cm2: 5.61mm |
| | 6MV LF: 10x10 cm2: ≤6mm | 6 MV LF (30FF): 10x10(Inline):- Pen Left: 4.35 mm & Pen Right: 4.52 mm 10x10(Crossline):- Pen Left: 4.99 mm & Pen Right: 4.73 mm |
| | 6MV SF: 10x10 cm2: ≤6mm | 6 MV SF (16 FF): 10x10(Inline):- Pen Left: 4.44 mm & Pen Right: 4.34 mm 10x10(Crossline):- Pen Left: 4.75 mm & Pen Right: 4.7 mm |
| Symmetry | 6MV FFF: 20x20 cm2:100%±2% | 6MV FFF: 20x20 cm2:100.82% |
| | 6MV LF: 10x10 cm2: ≤ 103 % | 6 MV LF (30FF):<br><br>10x10(Inline): 100.63 %<br>10x10(Crossline): 100.30 %<br><br>30x30(Inline): 100.86 %<br>30x30(Crossline): 100.80 % |
| | 6MV SF: 10x10 cm2: ≤ 103 % | 6 MV SF (16 FF):<br><br>10x10(Inline): 101.22 %<br>10x10(Crossline): 100.70 %<br><br>16x16(Inline): 101.16 %<br>16x16(Crossline): 100.83 % |
| Flatness | 6MV LF: 10x10 cm2: ≤ 106 % | 6 MV LF (30FF):<br><br>10x10(Inline): 103.58 %<br>10x10(Crossline): 103.77 %<br><br>30x30(Inline): 103.47 %<br>30x30(Crossline): 103.54 % |
| | 6MV SF: 10x10 cm2: ≤ 106 % | 6 MV SF (16 FF):<br><br>10x10(Inline): 104.49%<br>10x10(Crossline): 103.64%<br><br>16x16(Inline): 105.46%<br>16x16(Crossline): 105.08% |

## Conclusion:

- The indigenous LINAC Siddharth II ICONIC meets international standards for quality and safety as per TG-142 guidelines. Continued verification and periodic quality assurance (QA) are recommended to maintain the system's reliability in clinical practice.

## Discussions

Parameters related to mechanical, radiation safety, dosimetrical and multi-leaf collimators of Siddharth - II ICONIC beams were systematically measured. The central axis depth dose curve, beam profiles, relative output factors, DMLC parameters and other dosimetric data were systematically analysed. The measured commissioning data show consistency and are in a good agreement with the other units with the same energy.

**References:**

- AAPM TG-142,TG-50,TRS-398,AERB QA protocol for un-flat beam -rev.1.docx,Panacea Siddharth-II manuals.