Scripps Proton Therapy Center:
Configuration and Implementation

Anthony Mascia

Proton Symposium

2013 Annual AAPM Meeting

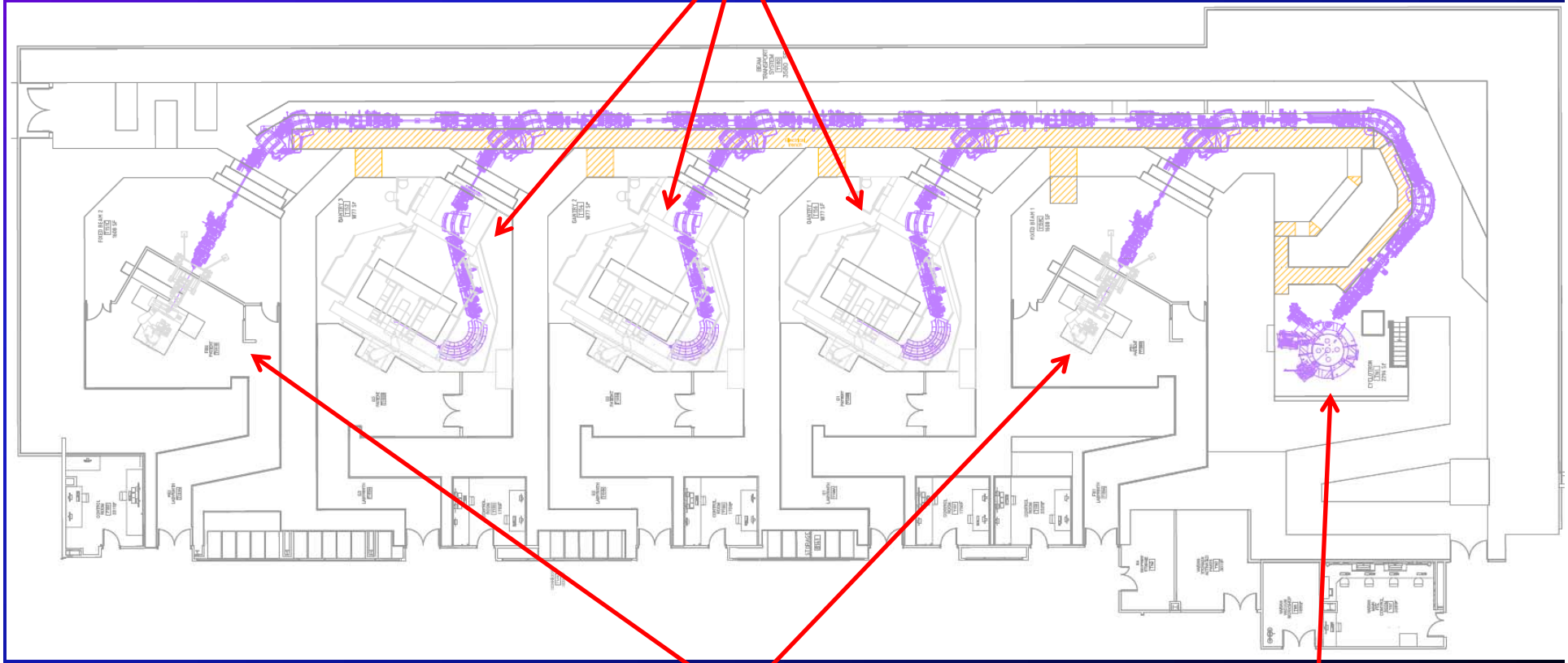
Indianapolis, Indiana USA

Facility Configuration

Scripps Proton Therapy Center

***All Rooms : PBS Only

360º Gantry

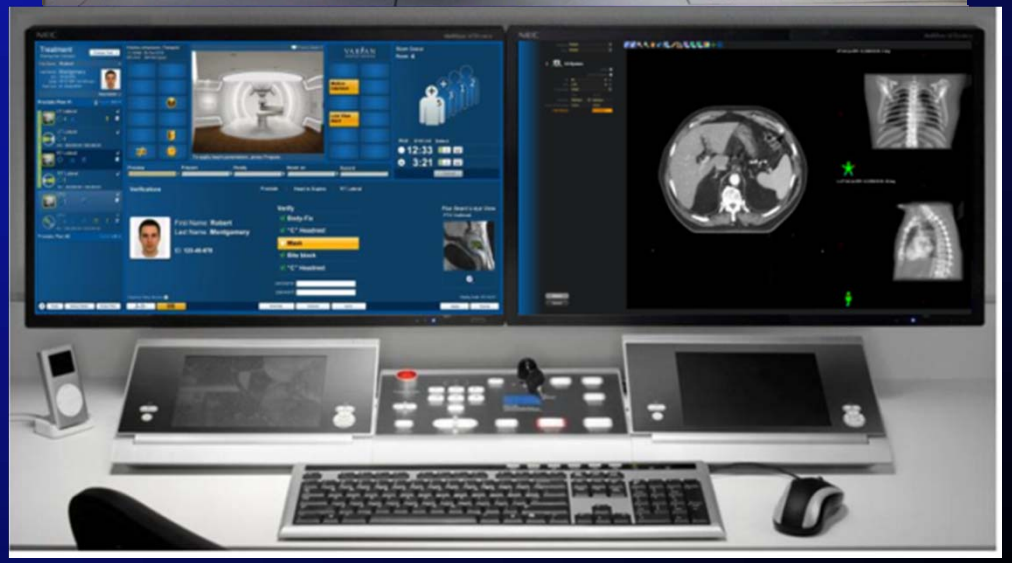


Fixed Horizontal Beamline

Cyclotron
Max E : 250 MeV

Scripps Proton Therapy Center

- Gantry-mounted dual x-ray imaging system
- Full CBCT function
- Internal and external imaging console
- TrueBeam-like treatment console
- Robotic, 6-degree of freedom patient positioner



Scripps Proton Therapy Center

- Designed treatment capacity: 2400 pts per year
- Planned patient mix:
  - Prostate Cancer: 800 patients/year
  - Lung Cancer: 200 patients/year.
  - Head & Neck Cancers: 200 patients/year
  - Pediatric Cancer: 100 patients/year
  - Breast Cancer: 200 patients/year
  - CNS Tumors: 400 patients/year
  - Other tumor sites

Scripps Proton Therapy Center

- Physicians (4)
  - Carl Rossi
  - Huan Giap, Ryan Grover, Andrew Chang
- Physicists (7)
  - Lei Dong
  - Annelise Giebler, Anthony Mascia, Yongbin Zhang, Franko Piskulich, Richard LePage, Luis Perles
- Physicist Assistants
  - To be hired: January 2014
- Dosimetrists (2)
  - First cohort started: July 2013
- Radiation Therapists (5)
  - First cohort started: August 2013

Quality Assurance

Daily Machine QA

Daily Quality Assurance	
QA Item	**Tolerances (% or mm)**
1. Dosimetry	
proton output constancy	3%
proton range in water	1mm
2. Mechanical / Imaging	
laser localization	2mm
imaging-treatment coordinate coincidence (one gantry angle)	1mm
collision interlocks	functional
3. Safety	
door interlock	functional
door closing safety	functional
audiovisual monitors	functional
radiation area monitor	functional
beam on indicator	functional

Courtesy PTW

- Duration 15 minutes; performed by RTTs
- In short, an end-to-end test using daily QA detector
- Rotate proton energy daily, Monday Through Friday
- PBS volumetric irradiations (i.e. not single spots)

Ding X, Zheng Y, Zeidan O, Mascia A, Hsi W, Kang Y, Ramirez E, Schreuder N, Harris B. “A novel daily QA system for proton therapy.” J Appl Clin Med Phys. 2013 Mar 4;14(2):4058

Weekly Machine QA

Summary

- Comprehensive spot pattern tests
  - Initially performed: weekly
- Deliver a fixed spot pattern at two gantry angles, two energies
- This spot pattern is benchmarked at commissioning
- The physical measurement results and their comparison to benchmark are recorded
- 30 minutes per room

Courtesy IBA Dosimetry

Test Parameters

- Position – location of spot on Lynx versus planned location
- Shape – ratio of x-axis and y-axis
- Size – sigma of x-axis and y-axis
- Output – output constancy

Monthly Machine QA

Monthly Quality Assurance	
QA Item	Tolerances (% or mm)
1. Dosimetry	
proton output constancy	2%
backup monitor constancy	2%
proton profile constancy	2%
proton range constancy	1mm
2. Mechanical	
lasers coincident at isocenter	1mm
laser coincident at 50cm from isocenter	2mm
gantry indicators at cardinal angles	1 degree
treatment couch position accuracy	1mm / 1 degree
latch/interlock for range shifter	functional
3. Safety	
door interlock	functional
door closing safety	functional
audiovisual monitors	functional
radiation area monitor	functional
beam on indicator	functional
4. Imaging	
imaging, couch and radiatio coincidence (@ four cardinal angles)	1mm
scaling	1mm
spatial resolution	baseline
constrast	baseline
uniformity and noise	baseline
dead pixels, artifacts, etc	baseline

- The Daily + Weekly QA programs are comprehensive and reviewed daily/weekly; detailed trend analysis performed as part of monthly QA
- Monthly QA tests a wider spectrum of the beam delivery system in one session (e.g. more ranges, more doses, etc)
- Precise quantification of the treatment couch using Winston-Lutz style tests performed at cardinal gantry angles
- Image quality assessment of the imaging system

Annual QA

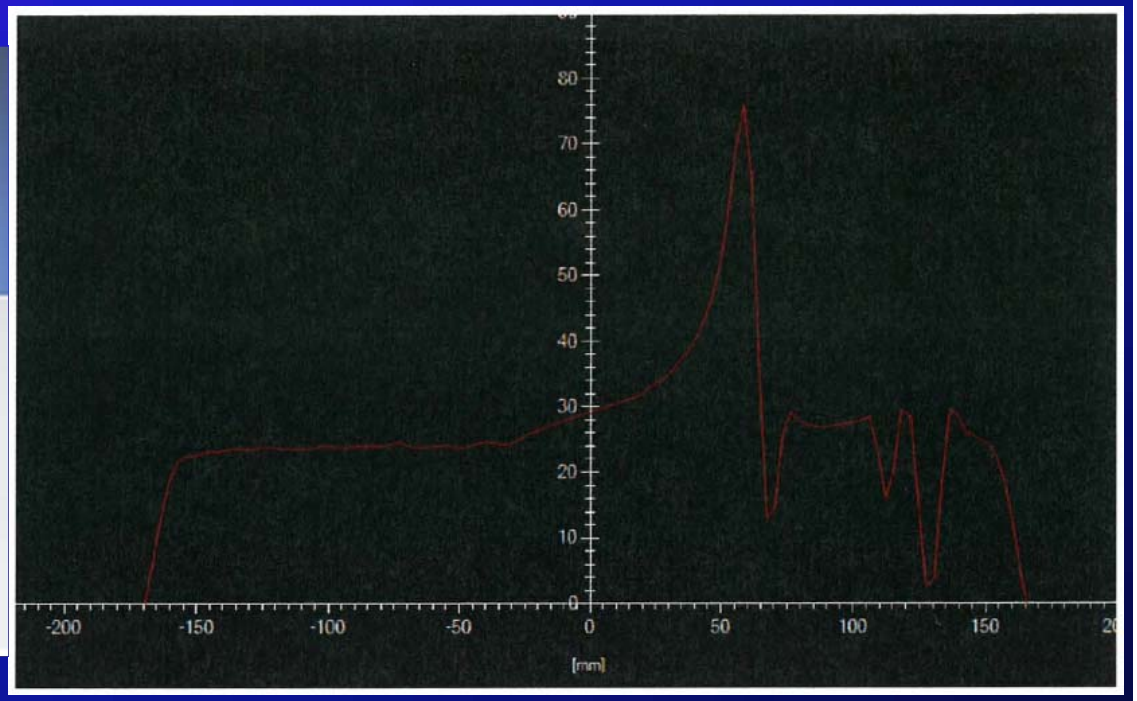
- As opposed to constancy measurements, the annual QA re-measures / re-validates baseline/commissioning data using commissioning caliber equipment
- Detectors:
  - Water tank + Bragg peak chamber
  - Water tank + Farmer chamber
  - Lynx or Logos scintillator detectors
  - OctaviusXDR ion chamber array
- Absolute Calibration: IAEA TRS 398

Patient Specific QA

- Every field for every patient undergoes quality assurance procedure prior to treatment
- Procedure highlights:
  - For each field, three transverse profiles, each at different depth, measured with 2D ion chamber array; compared to calculation in Eclipse
  - For each field, at least one point dose measurement is made using cross-calibrated ion chamber (i.e. IBA Dosimetry CC04)
  - Measurement setup:
    1. Gantry 0 degrees: all field recalculated to 0 degrees; all fields measured at 0 degrees
    2. Planned Gantry Angle : all fields measured at planned gantry angles and compared to calculation
- Passing criteria is being developed
  - Starting point: 3% / 3mm with 90% passing
  - Evalute and determine during commissioning and validation

Novel Monthly Machine QA Technique

Courtesy PTW

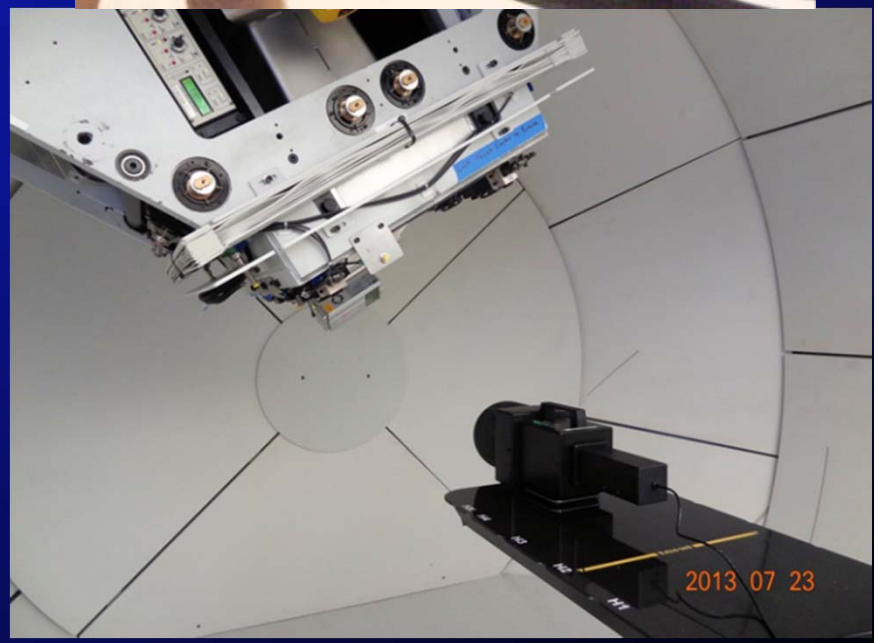


- Use OctaviusXDR or StarCheckMaxi + BQ Check phantom
- Using single detector, measure: spot position, dose constancy, proton range/energy, field uniformity (symmetry/flatness)
- Additional setup (e.g. imaging bb + Lynx mounted to gantry) required for Winston Lutz tests

Testing/development with Varian, Rinecker Proton Therapy Center and Scripps Proton Therapy Center

Novel QA Implementation

- Logos Systems Inc XRV device:
  - Conical scintillator-based detector
  - Alignment: laser, imaging device, and beam isocenter.



Isofocus Beam Summary				
Beam Center		X	Y	Z
Average:		**0.22**	**0.09**	**75.71**
Max:		0.49	0.41	76.33
Min:		-0.03	-0.23	74.84
StDev:		0.18	0.23	0.43
			FD=	69.44
			FE=	79.45
Laser @ 0.64 of DE:			Laser @	75.8464
		X (mm)	Y (mm)	Z (mm)
Laser Error		0.22	0.09	-0.14

Novel Patient QA Technique

- Aluminum mount interfaces to Varian nozzle
- OctaviusXDR array rigidly held in place
- 4 x Slide Nuts securely hold up to 25.0cm of solid water in front of the ion chamber array
- Allows transverse plane at any water equivalent depth (up to 25.0cm)
- Because Varian nozzle holder translates, also allows measurements upstream and down stream of isocenter

Thanks to Glen Mounce, machinist

Acknowledgements

- SPTC Colleagues, especially the physics group:
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  - Yongbin Zhang
  - Luis Perles
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- Our partners at Varian Medical Systems, Particle Therapy Group

Thank you!