

IMPLEMENTATION OF GANTRY-BASED TREATMENT AT THE MAYO CLINIC:

BRASS-FREE AND AUTO-GATED

Amanda Deisher, Ph.D.

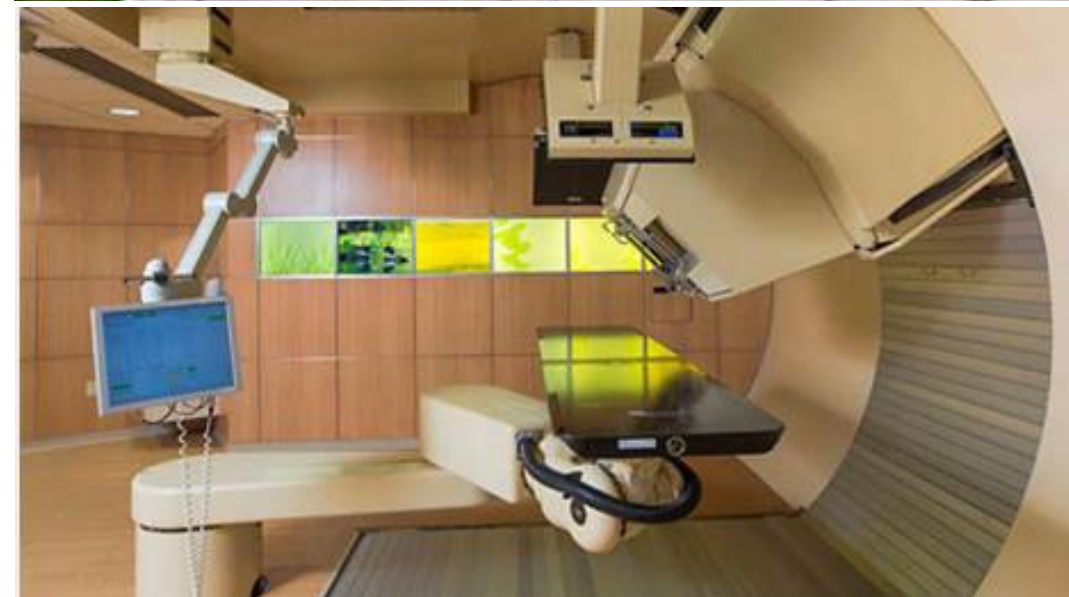
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DESIGNING A MAYO CLINIC EYE TREATMENT

FACILITY AND EQUIPMENT

Hitachi Probeat-V Spot-scanned Pencil beam

- 97 discrete energies:
 - 71.3 - 228.8 MeV (4 - 32 cm)
 - 2 mm range spacing at low energies*
 - 45 mm range shifter*
- 4 matched gantry rooms
 - 180° gantry rotation
 - Robotic couch (*head-first supine*)
 - 2D KV imaging (*BiomarC® Secure*)
- Three major *new* components
 - Mechanical aperture mount
 - Gaze-monitoring hardware/electronics
 - Gaze-gating software



MECHANICAL APERTURE

Aperture holder inserts into gantry nozzle

3D-printed patient-specific aperture

- Matches tumor shape
- Keyed for orientation
- Conical to eliminate gaps

No flex for anterior and lateral use

Compatible for treatment $\leq 6\text{cm}$ depth
and $\leq 4\text{cm}$ diameter.



GAZE MONITORING HARDWARE/ELECTRONICS

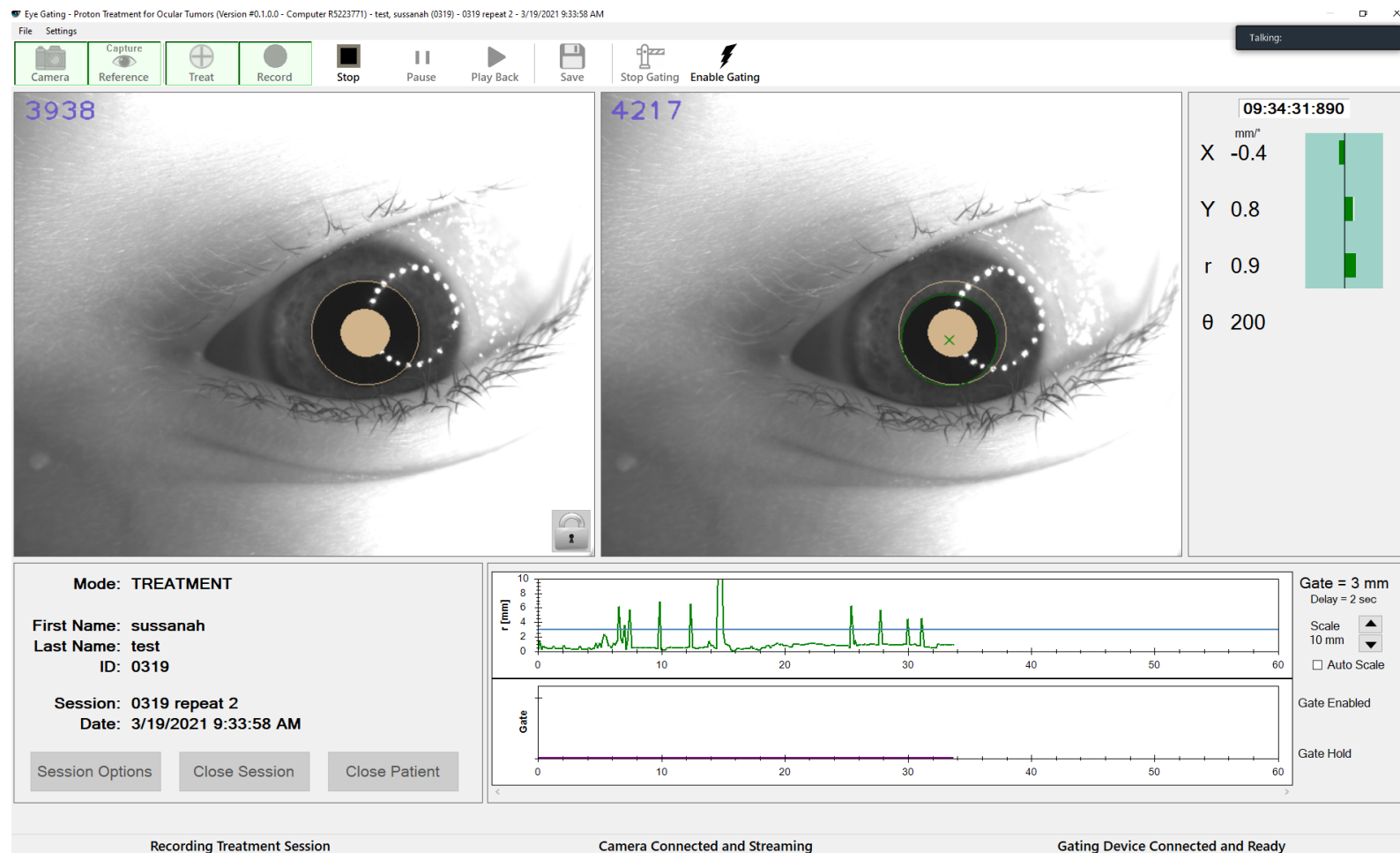


- Table-mounted, IR-illuminating ring
- Adjustable gaze target (θ, ϕ)
- Moveable camera



GAZE GATING SOFTWARE

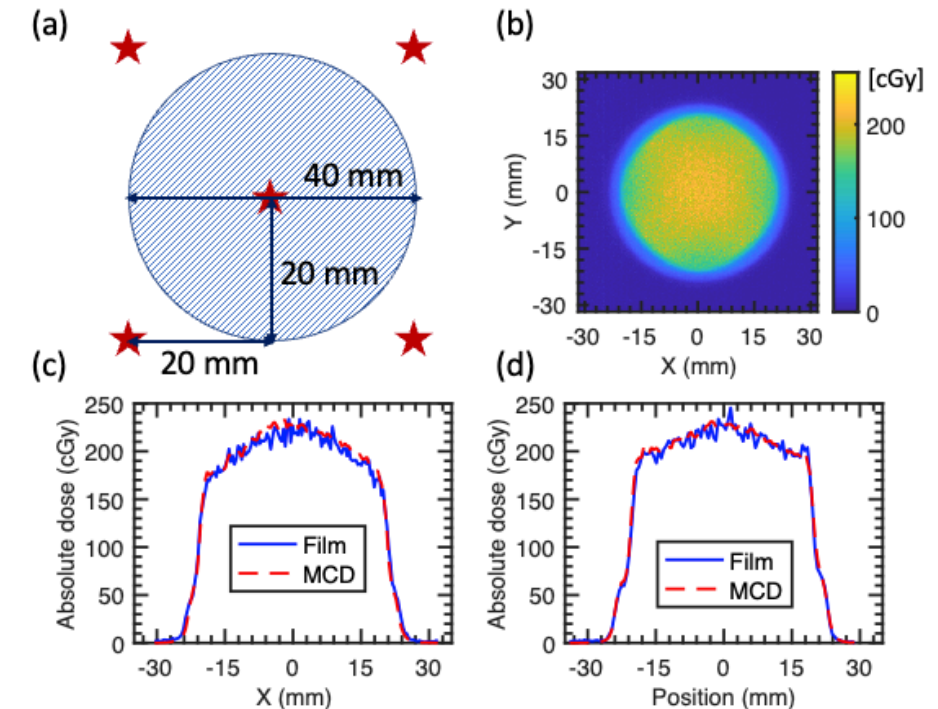
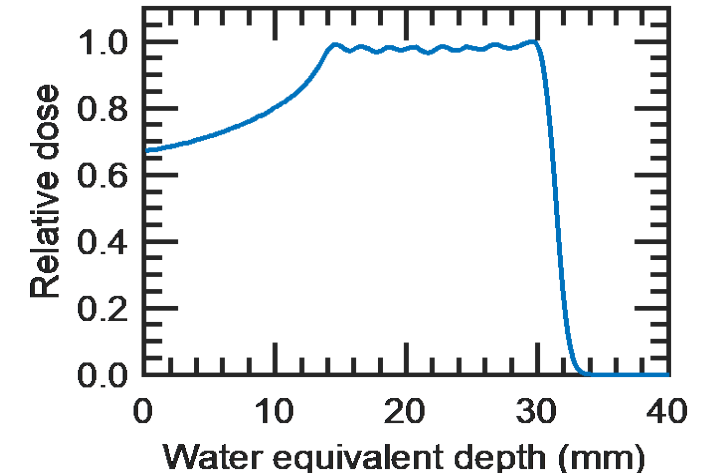
- Calculates center of pupil
- Left: Reference
- Right: Live image
- Adjustable threshold
- Software sends gate
- Manual gating possible with handheld device



BEAM DETAILS

IT DEPENDS...

- $Z_{d90\%} - Z_{d10\%} = 2.0 \text{ mm}$
- **Single** spot for <2cm diameter
 - MidSOBP 80%-20% : 1.1 mm (1 cm diameter)
 - MidSOBP 80%-20% : 1.3 mm (2 cm diameter)
- Center spot +4 corner helper spots for larger diameter
- Helper spot spacing and weight determine
 - Lateral penumbra: 2.1-3.1 mm (4 cm diameter)
 - Central axis hotspot: 110-150% (4 cm diameter)
 - Delivery time scaling: up to 2x



Credit: Dr. S. V. Hickling, in prep for publication

CT SIMULATION

Immobilization

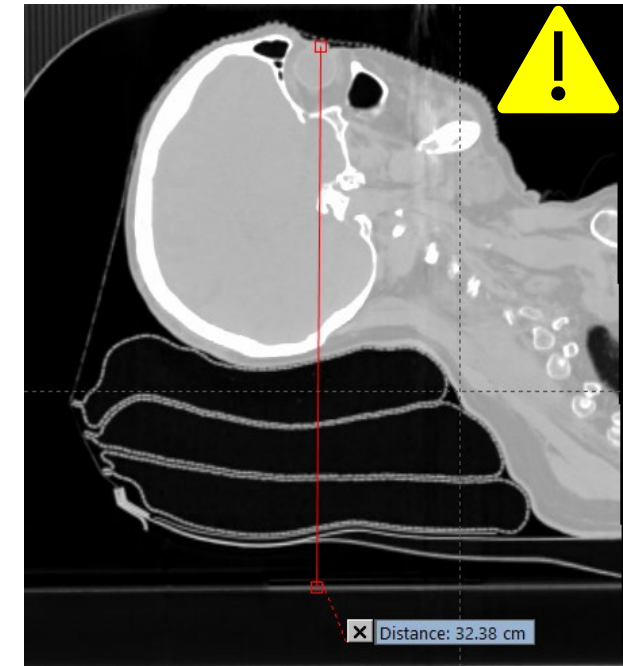
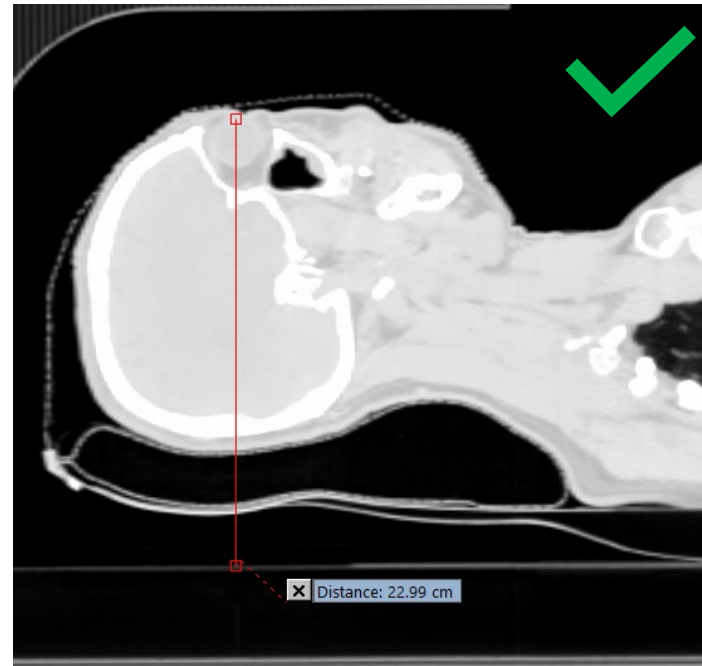
- Precise Bite™
- Klarity Cushions™
- Orfit 3-point mask

Gaze angle set at time of sim

Scan with retractors in place

Is this couch height treatable?

- Not extremely kyphotic
- Able to lay flat



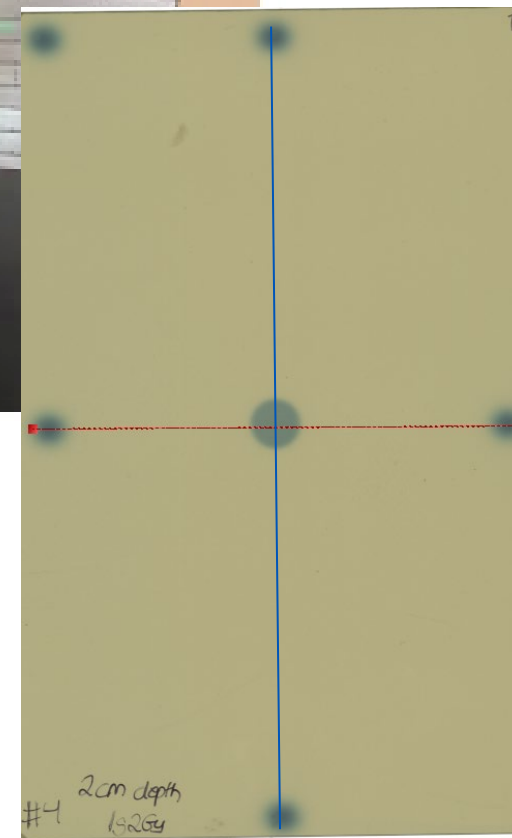
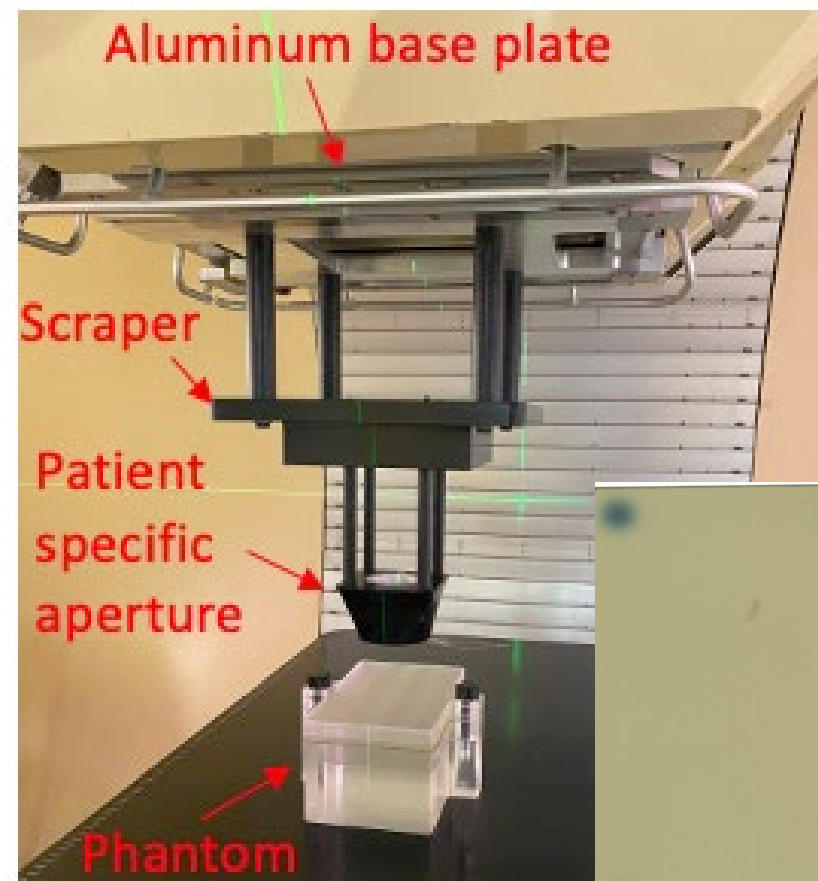
TREATMENT PLANNING

Please see Dr. Jon Kruse's talk tomorrow

PATIENT-SPECIFIC QA

RELATIVE AND ABSOLUTE MEASUREMENTS

- Absolute dose:
 - Pinpoint chamber
 - Align w/ kV 2D-2D
 - Measurement in acrylic
- Relative dose:
 - radiochromic film
 - In-house phantom
 - Align w/ kV 2D-2D
 - Shadow of BB's determine axes
- Film measurement QA's aperture shape and alignment



TREATMENT DAY

GAZE CONFIRMATION, LOCALIZATION, AND BEAM DELIVERY

- Daily QA + alignment QA of aperture mount
- Setup Room (Lat and PA kV imagers)
- Transfer to treatment room (Oblique imagers)
- Alignment procedure
 - Align to skull
 - Simultaneous capture of pupil position and KV
 - Translate to clips
 - MD inserts eyelid retractors
 - Verify clip alignment
- Request beam with high priority
- Treat single beam (12 Gy in 40-120 sec)

ITEMS TO MONITOR AS WE GO LIVE

KNOWN UNKNOWN

- Reproducibility of sim gaze angle (potential for clipless)
- Ease of alignment
- Amount of movement
- Length of simulation and treatment appointments
- Ophthalmology ↔ Radiation Oncology communication
 - Pre-sim: Patient selection, clip placement
 - Pre-tx: target contouring
- Grouping appts for efficiency?
- Patient experience (retractors, gaze tracking, timing)

We'll need a very patient 1st patient!

ACKNOWLEDGEMENTS

IT TAKES A VILLAGE

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