# Overview of clinical implementation of IMRT

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MD ANDERSON
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# disclosure

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# references

"Guidance document on delivery, treatment planning, and clinical implementation of IMRT: Report of the IMRT subcommittee of the AAPM radiation therapy committee"

Ezzell, Galvin, Low, Palta, Rosen, Sharpe, Xia, Xiao, Xing, Yu

Medical Physics 30:2089-2115, 2003

"Implementing IMRT in clinical practice: A joint document of the American Society of Therapeutic Radiology and Oncology and the American Association of Physicists in Medicine"

Galvin, Ezzell, Eisbrauch, Yu, Butler, Xiao, Rosen, Rosenman, Sharpe, et al

Int J Rad Onc Biol Phys 58:1616-1634, 2004

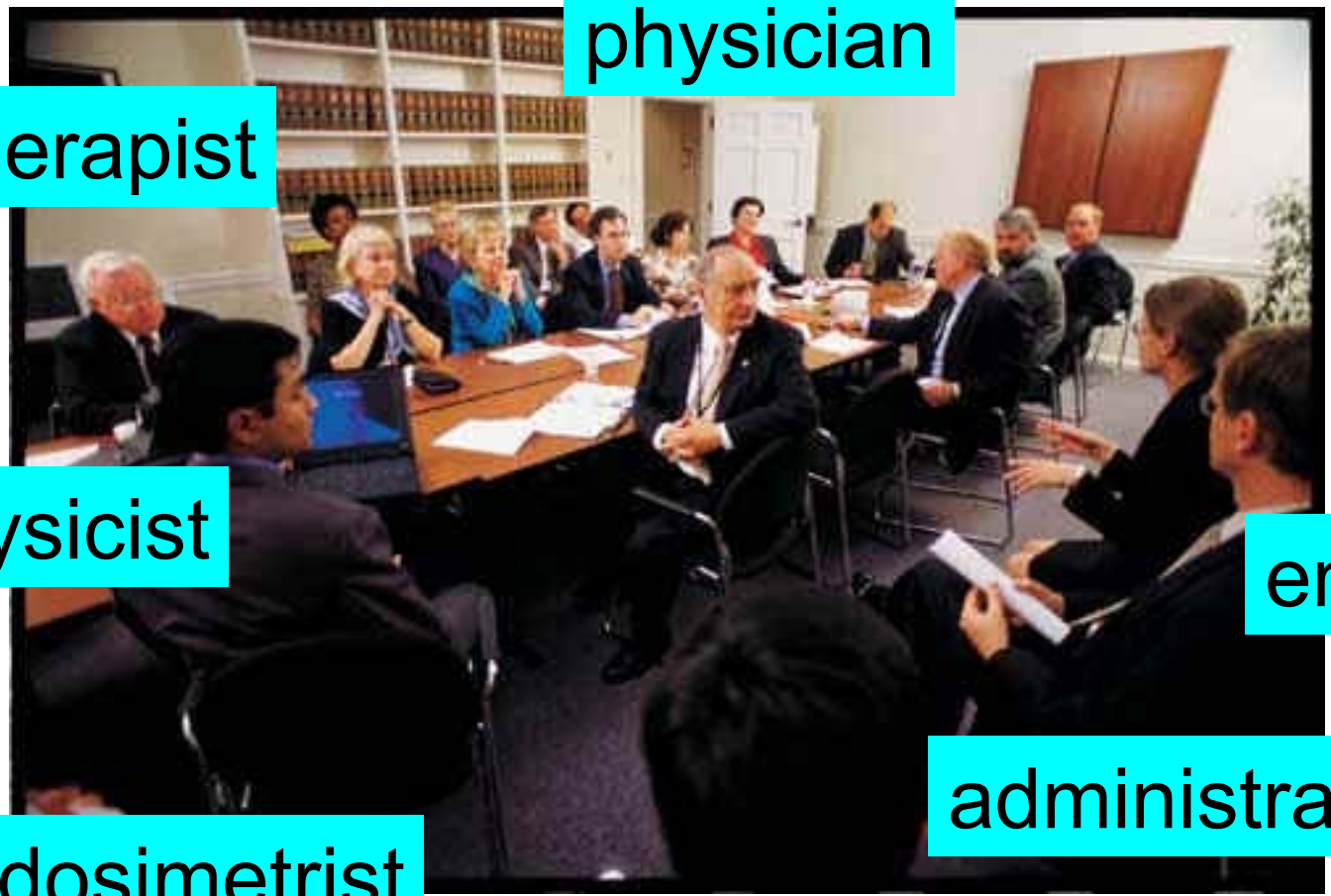
# what to think about

- treatment equipment
- treatment planning
- acceptance testing
- commissioning
- routine quality assurance
- dosimetry equipment
- monitor unit checks
- policies and procedures
- record-and-verify
- system integration
- patient immobilization
- charting
- space
- manpower
- training
- billing

# a business can plan help

- start-up costs (equipment, etc.)
- on-going costs (service/maintenance contracts, additional personnel, etc.)
- overall increase in patient census
- expected number of IMRT treatments
- expected billing and revenue
- timelines

# lots of people are involved



# what delivery method will you use?

- MLC
  - dynamic
  - step-and-shoot
- tomotherapy
  - serial
  - helical
- physical attenuators
- field-in-field

# already have an MLC?

- dynamic mode
  - efficient delivery
  - relatively sensitive to MLC operation
  - no static segments to check
- step-and-shoot mode
  - less efficient delivery (may be very inefficient)
  - less sensitive to MLC operation
  - first segment can be used to visually verify treatment field

# tomotherapy complete solutions

- serial
  - linac add-on
  - NOMOS
  - complete commercial solution
- helical
  - facility add-on
  - TomoTherapy, Inc.
  - complete commercial solution

# field-in-field

- relatively simple technique
- forward planned
- need an MLC
- no patient-specific QA needed
- billable???

# what about physical attenuators?

- known simple technology
- construction can be outsourced
- no MLC needed
- patient-specific QA is straightforward
- billable???

# IMRT implementation at MDACC

| | |
|---|---|
| business plan | Mar 1998 |
| ■ NOMOS MIMiC, Corvus, 6X | Dec 1998 |
| ■ Varian MLC(80), Corvus, 6X, prostate | May 2000 |
| ■ Varian MLC(80), Corvus, 6X, all patients | Sep 2000 |
| ■ Siemens MLC, Pinnacle3 | Jan 2001 |
| ■ Varian MLC(80), Corvus, 18X | Jul 2001 |
| ■ Varian MLC(120), Corvus | Oct 2001 |
| ■ Varian MLC(120), Pinnacle3, 6X | Jan 2002 |
| ■ Varian MLC(120), Pinnacle3, 18X | Jan 2003 |

# MDACC IMRT physicists (1998-2003)

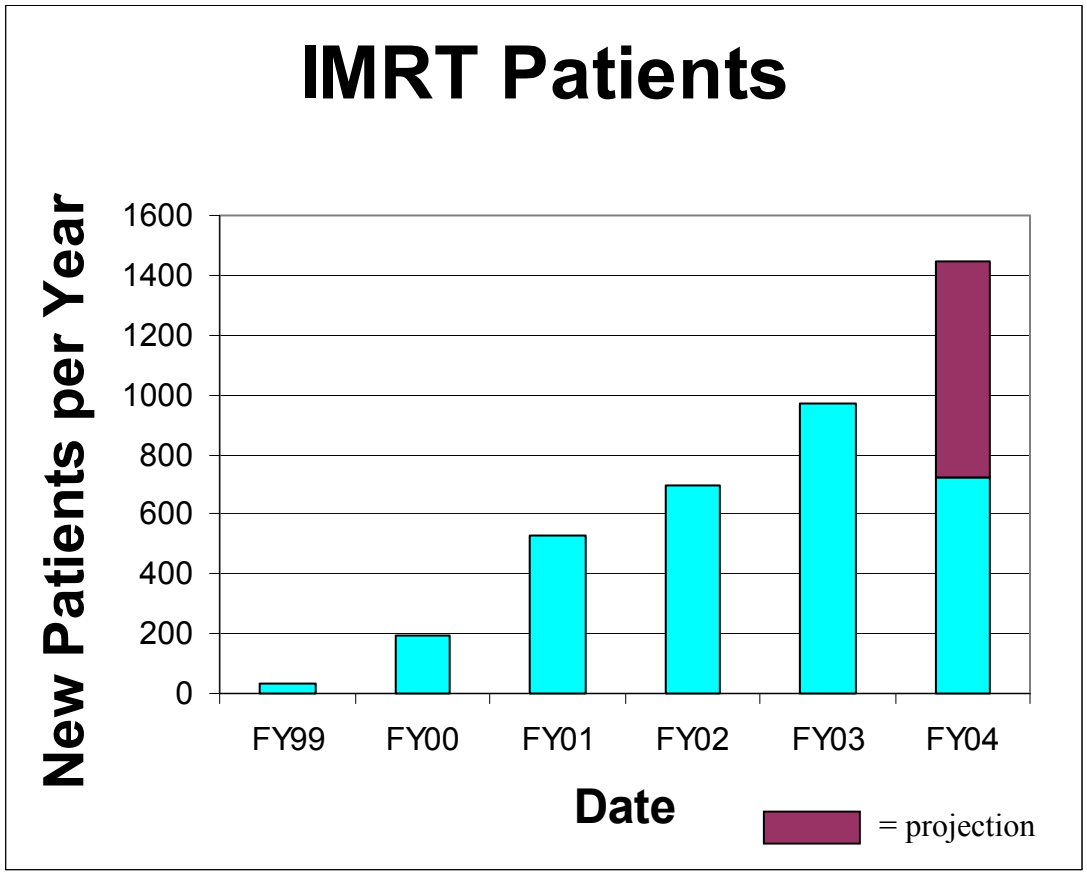
(in alphabetical order)

- John Antolak, Ph.D.
- Nathan Childress, M.S.
- Lei Dong, Ph.D.
- Ken Forster, Ph.D.
- Robin Kendall, M.S.
- Steve Kirsner, M.S.
- Rajat Kudchadker, Ph.D.
- Laura O'Neill, M.S.
- Karl Prado, Ph.D.
- Mohammad Salehpour, Ph.D.

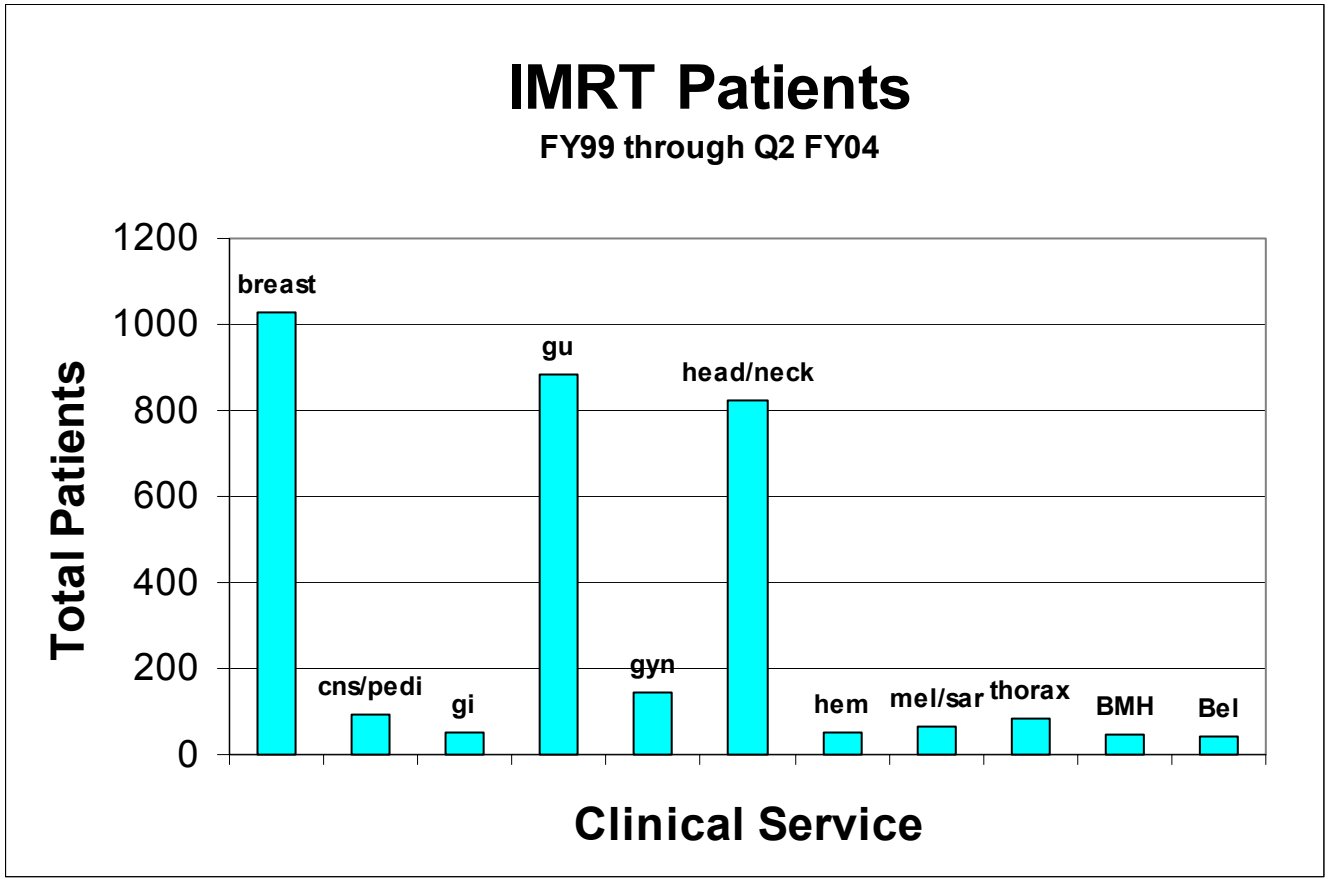
# MDACC IMRT utilization

<u>Planning</u>
Corvus
Pinnacle$^3$

<u>Delivery</u>
Varian sMLC
NOMOS MIMiC
Siemens sMLC



# MDACC IMRT utilization



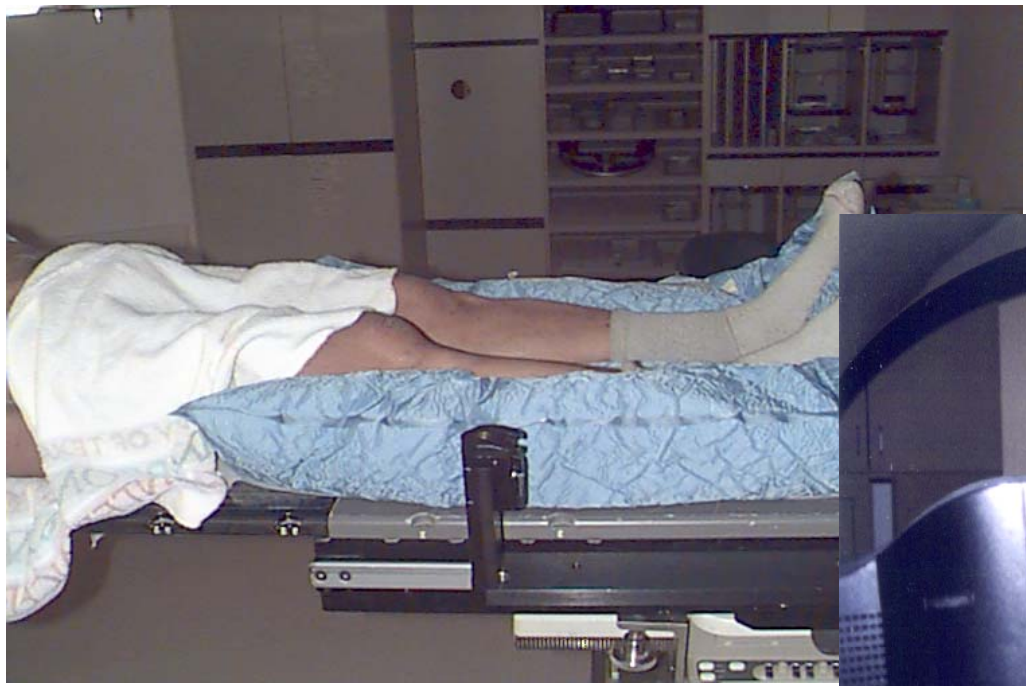
# treatment planning system

- System testing
- Beam modeling
  - Plan checks
  - Monitor unit verification
- Training
  - how to run the software
  - how to get a good clinical plan?

# patient treatment planning

- more demanding than 3DCRT
- finer spacing on CT images
- multi-modality images and/or contrast
- more anatomy segmentation required
- more time to learn
- compare IMRT to 3DCRT and conventional

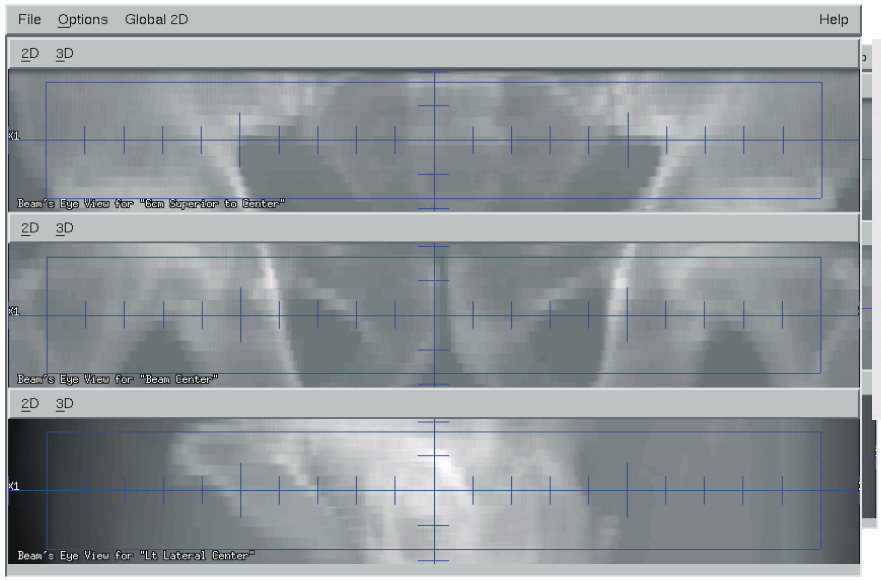
# more conformal plans need better immobilization and localization

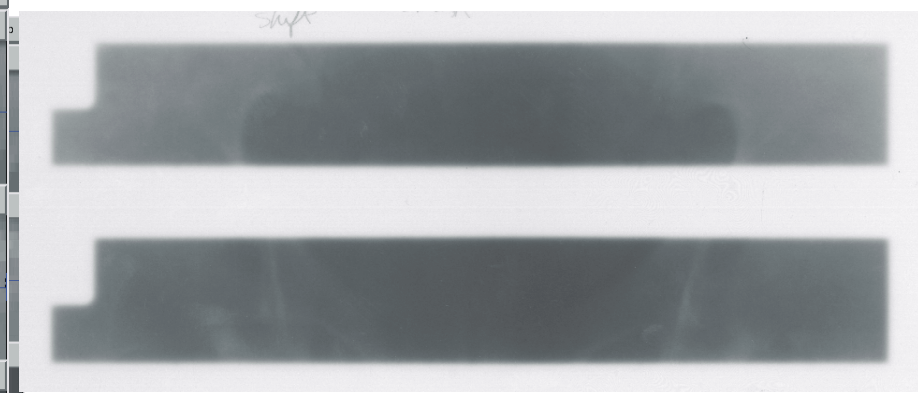


# treatment delivery issues

- longer treatment times
- recovery from machine failures
- verification of correct beam
- verification of patient setup
- training

# MIMiC setup verification



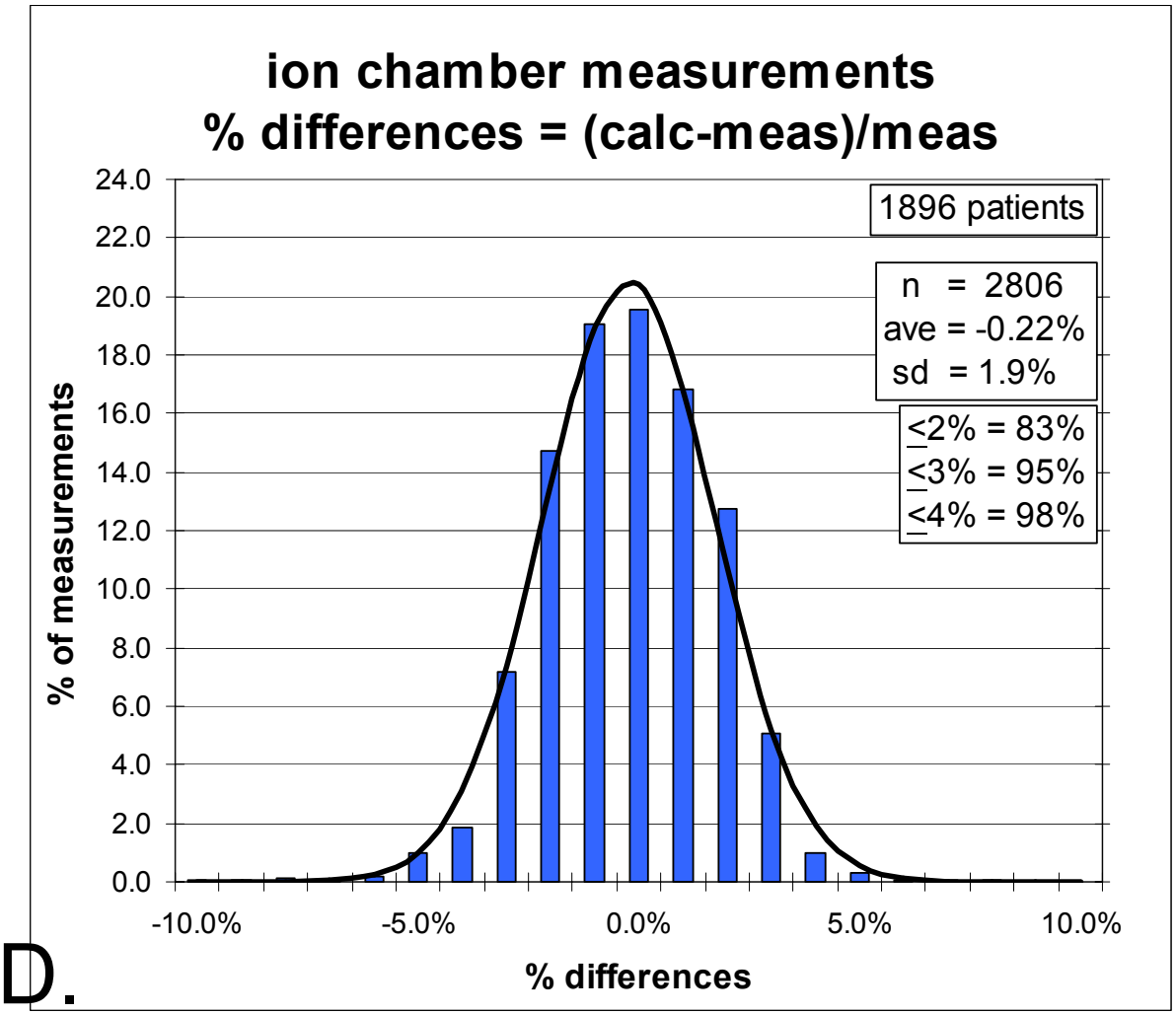



# QA of patient treatments

- ion chamber for absolute output
- film for relative output

# patient ion chamber QA results

Dec 1998
thru
Jan 2004



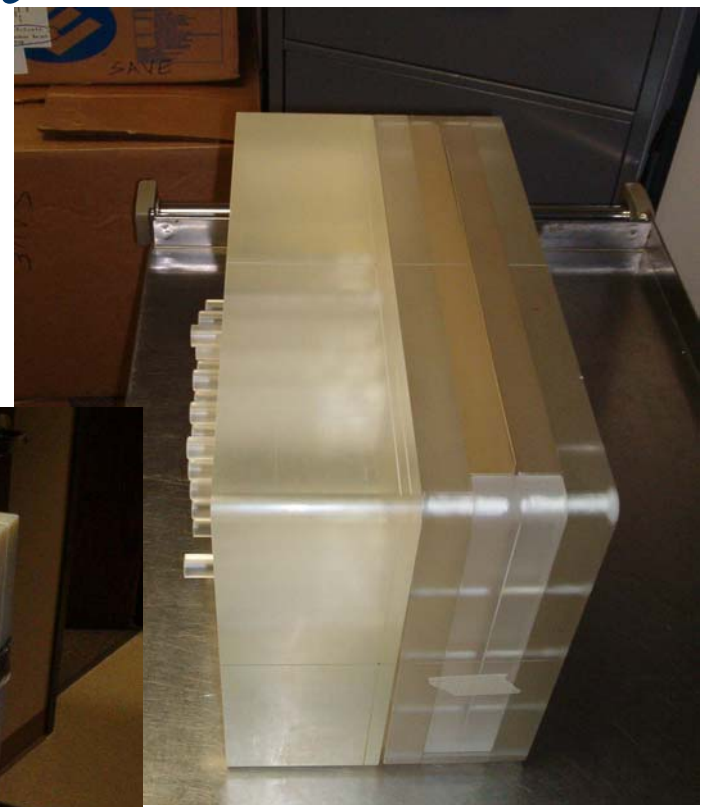

Lei Dong, Ph.D.

# patient ion chamber QA results

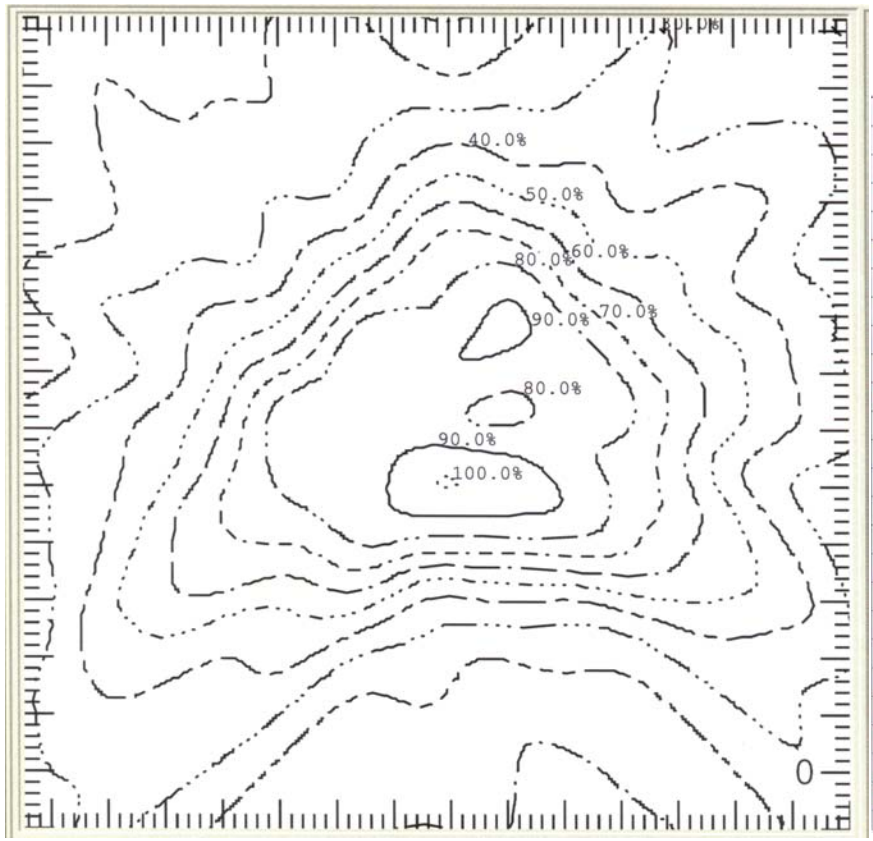
| Energy | n | average | sd |
|---|---|---|---|
| 6MV | 2488 | -0.22% | 1.9% |
| 18MV | 298 | -0.22% | 2.1% |

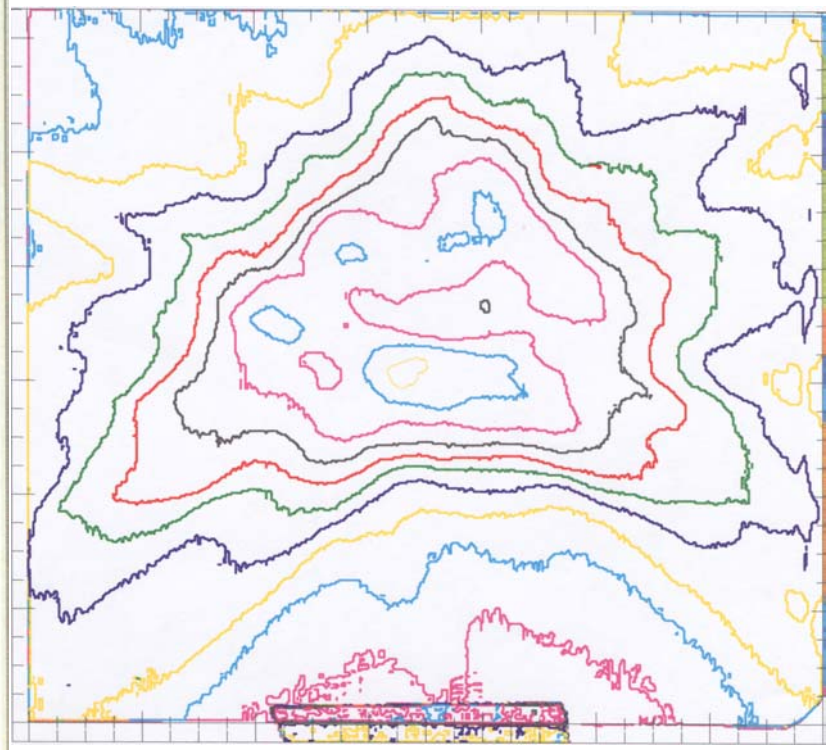
| Service | n | average | sd |
|---|---|---|---|
| CNS | 81 | -0.23% | 2.9% |
| GI | 98 | -0.08% | 2.1% |
| GU | 1434 | -0.22% | 1.7% |
| Gyn | 105 | -0.04% | 2.0% |
| Hem | 33 | -0.23% | 2.0% |
| H&N | 832 | -0.23% | 2.0% |
| Pedi | 26 | -1.00% | 2.9% |
| Sar | 27 | -0.94% | 2.4% |
| Thor | 142 | -0.21% | 2.7% |

# MDACC film dosimetry

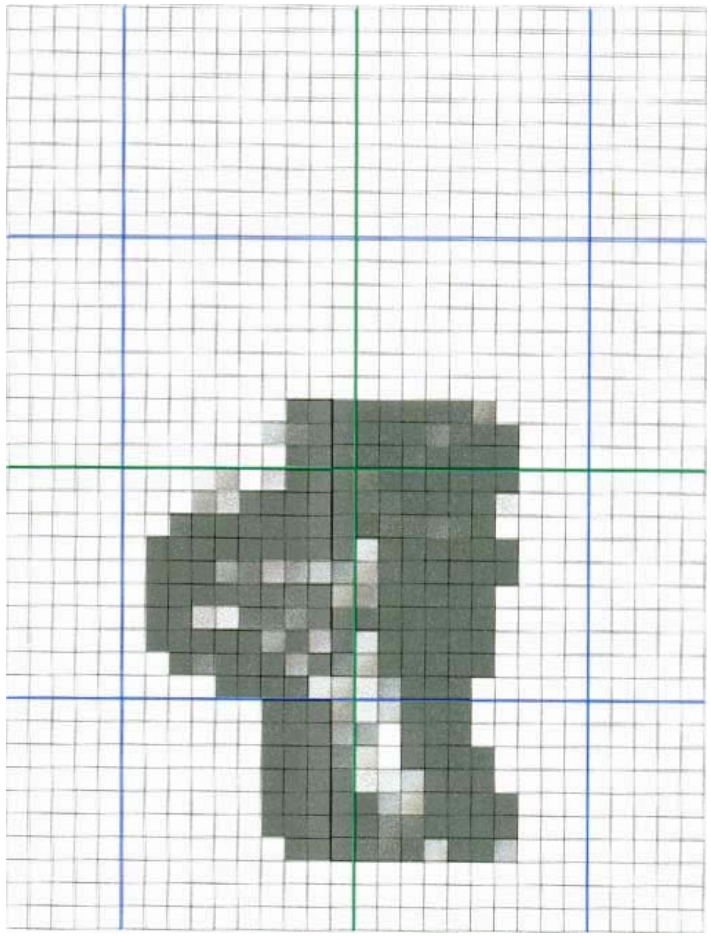


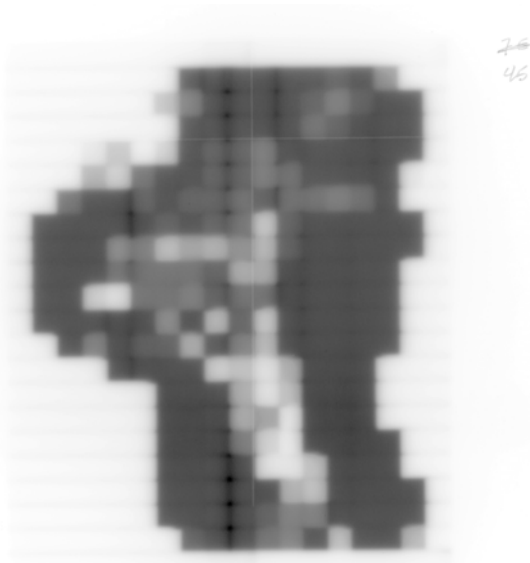
# plan verification



# fluence map verification

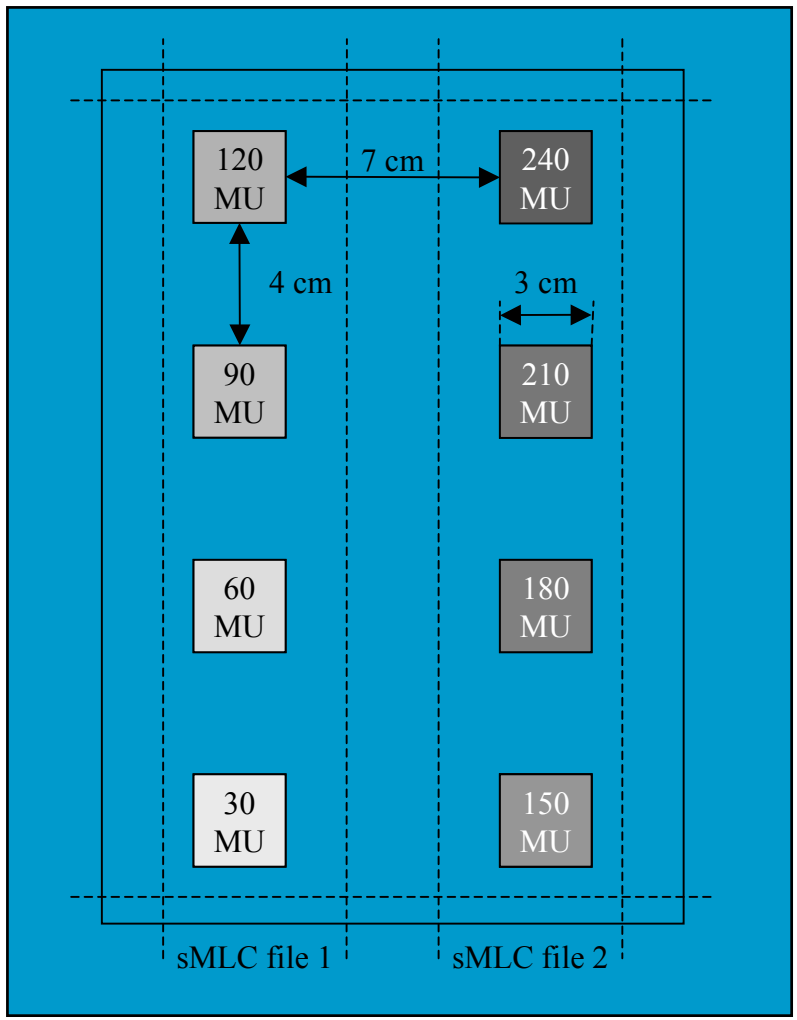


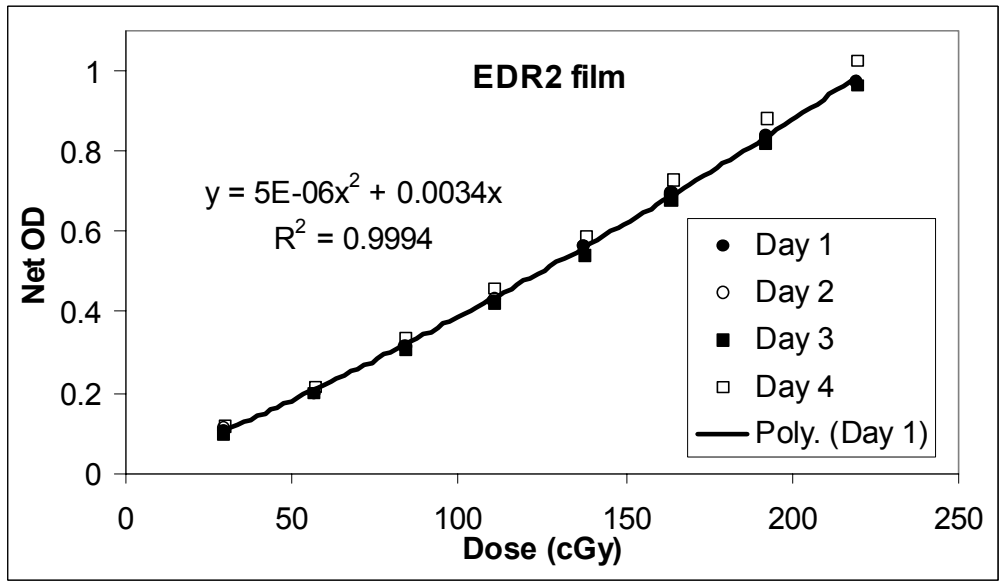


# film QA at MDACC

- EDR2 film
- Vidar 16-bit scanner
- DoseLab in-house software

# single-film calibration



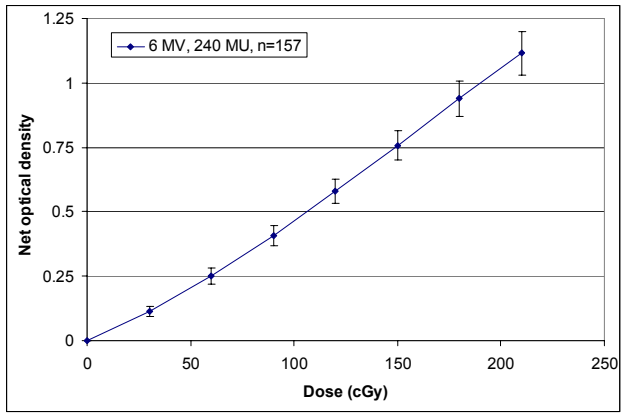




Lei Dong, Ph.D.
Nathan Childress, M.S.

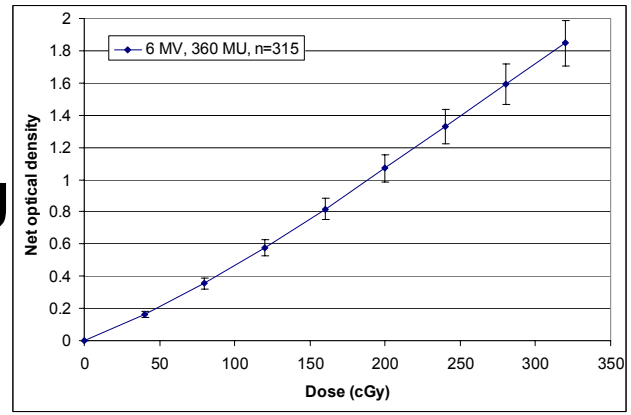
# variation in film sensitivity

## 547 calibrations - 18 months

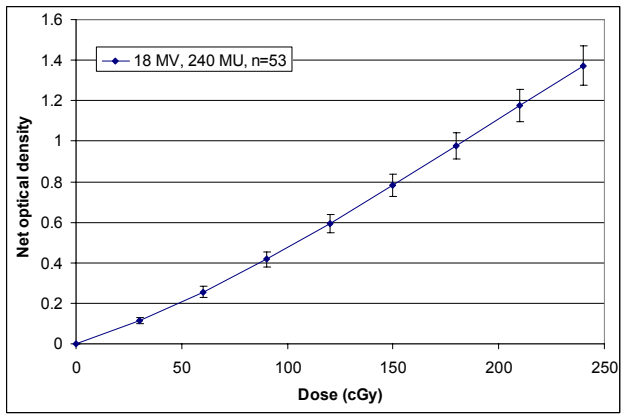
6MV
240 MU



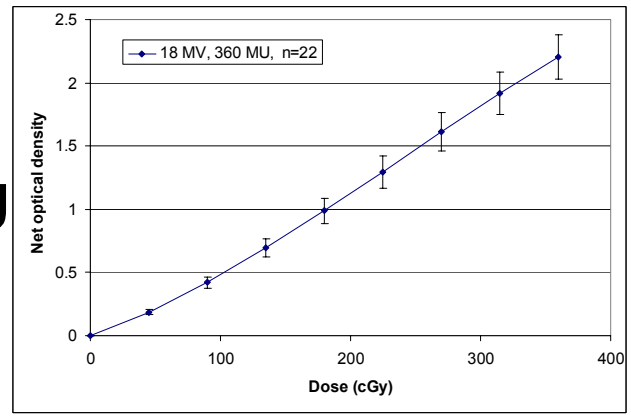

6MV
360 MU




18MV
240 MU



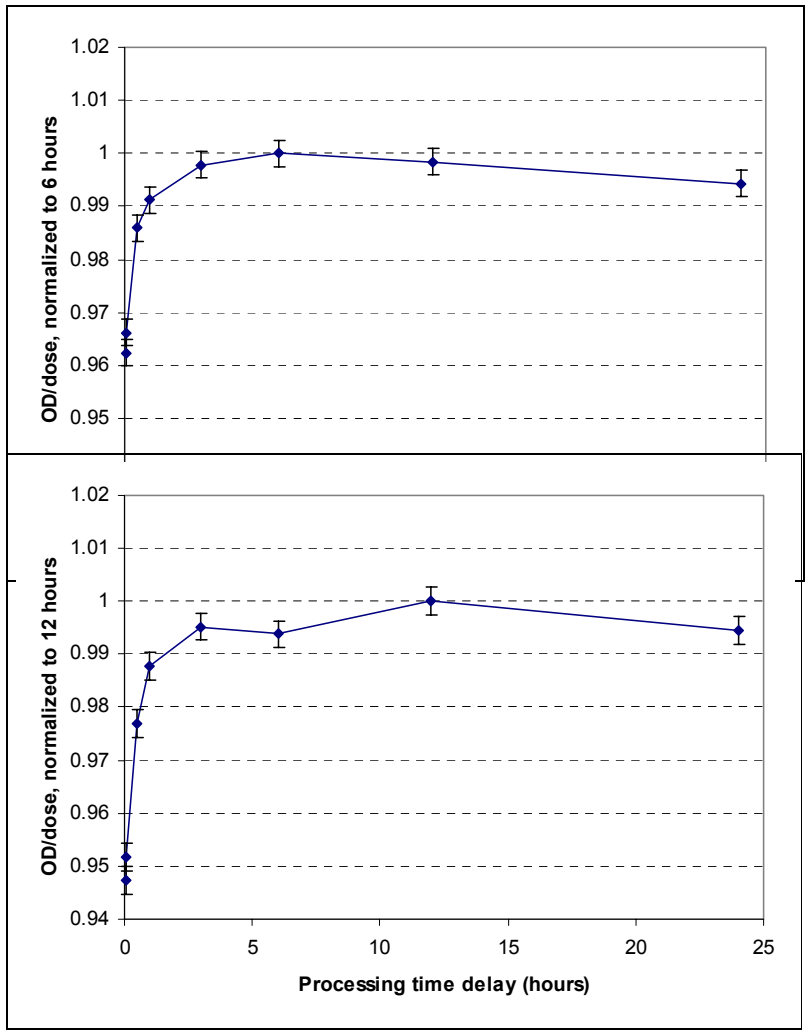

18MV
360 MU

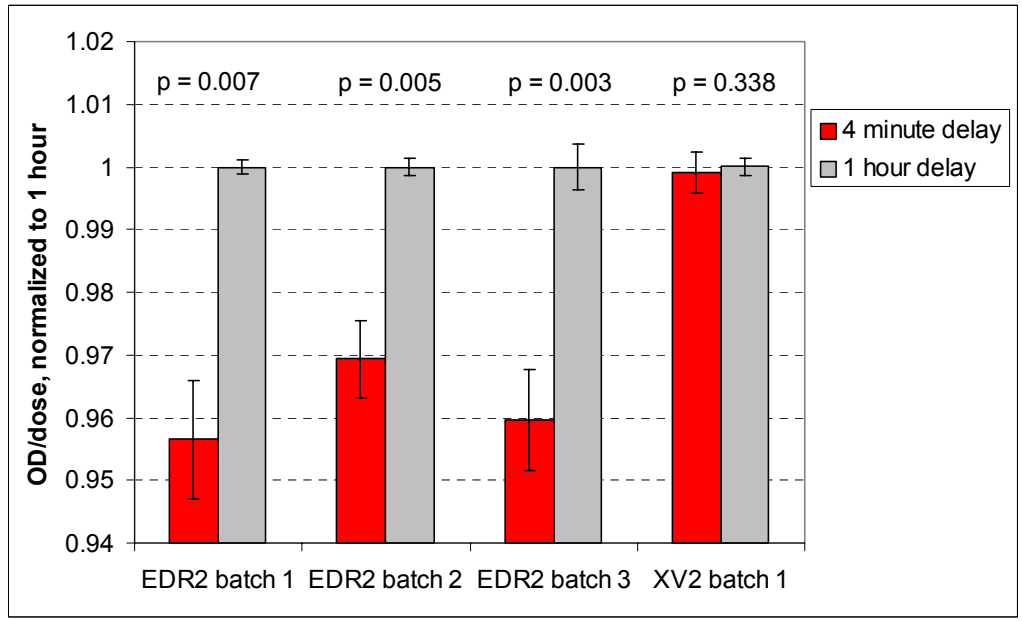



standard dev = 8-15%

standard dev = 7-8%

# EDR2 time delay effect




Nathan Childress, M.S.

# system integration

- transfer of images to planning system
- transfer of delivery parameters to linac
- transfer of information to RV system

# shielding

- 2-4 times more MU for MLC based delivery
- up to 10 times more MU for serial tomotherapy

=> greater leakage

=> secondary barriers should be checked

=> for high energy beams, neutron shielding should be checked

# space


John Antolak, Ph.D.

# training

- dosimetrists
- physicists
- engineers
- physicians
- therapists

# work effort and personnel

- Everything takes longer!

  (maybe it will get faster later)

- Who does what?

| | |
|---|---|
| outlining anatomy | planning |
| checking the plan and MU | chart QA |
| transferring delivery data | plan dosimetry |

- How many people will you need?

# IMRT staffing - physics/dosimetry

- physics and dosimetry effort per patient (3/2000)
  - prostate ~16 h/patient
  - others ~22 h/patient

Assuming an average of ~20 h/patient,

$\Rightarrow$ $\approx$100 patients/yr/FTE

# IMRT staffing - physics/dosimetry

March 2000 estimates

| | New patients per year | |
|---|---|---|
| | standard | IMRT |
| 1 FTE dosimetrist | 200 | 150 |
| 1 FTE physicist | 600 | 300 |

$\approx$100 new patients/yr/FTE

# making money - part 1

- 77301

  “Intensity modulated radiotherapy plan, including dose-volume histograms for target and critical structure partial tolerance specifications”

  --- CPT 2004

# making money - part 1, continued

- 77301

  “(Dose plan is optimized using inverse or forward planning technique for modulating beam delivery (eg, binary, dynamic MLC) to create highly conformal dose distribution. Computer plan must be verified for positional accuracy based on dosimetric verification of the intensity map with verification of treatment set-up and interpretation of verification methodology)”

  --- CPT 2004

# making money - part 2

- 77418

  “Intensity modulated treatment delivery, single or multiple fields/arcs, via narrow spatially and temporally modulated beams (eg, binary, dynamic MLC), per treatment session)”

--- CPT 2004