Intra-operative radiation therapy (IORT)

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IORT refers to a single-fraction treatment delivered to a surgically exposed area

- Electron beam (not discussed here)
- High dose-rate (HDR) Ir-192 afterloader

Advantages:

- The treatment is performed at the time of surgery, when the target area (the tumor bed) is exposed and the applicator can be placed directly over the target
- Organs at risk may be retracted and shielded as necessary
- The applicator can be used in virtually any anatomic location (e.g. treatment of colorectal malignancies where the tumor bed is often inaccessible to the cones of a linac based system)
- Avoids cold spots and hot spots often encountered when using the electron beam approach due to angle of beam incidence and field matching
- Convenience and cost effectiveness

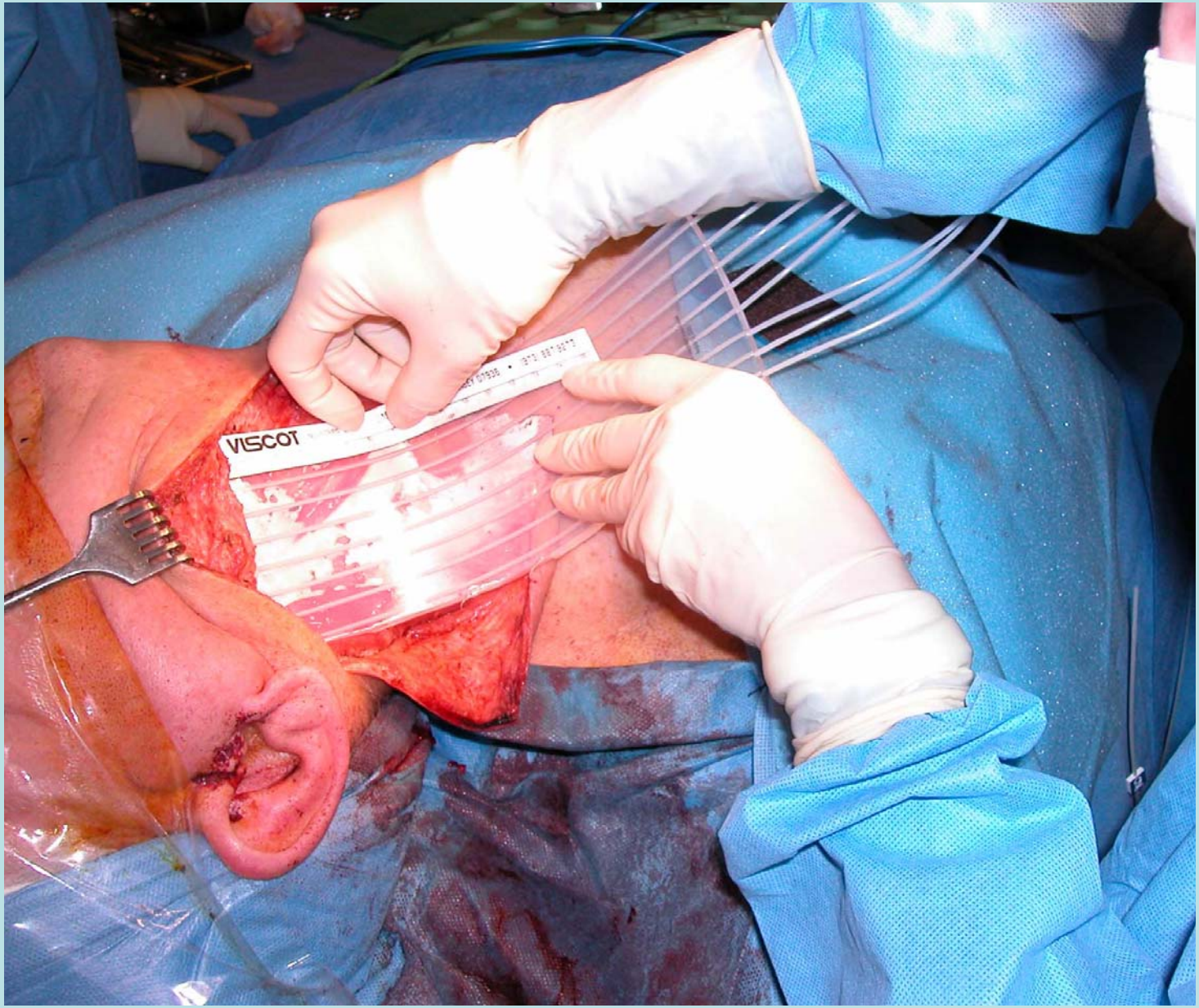
Afterloading devices:

- Gammamed (Varian Medical Systems, Inc)
- VariSource (Varian Medical Systems, Inc)
- Nucletron, BV

The Harrison-Anderson-Mick applicator (has FDA 510K approval)

- 130-cm source guides embedded at 1-cm spacing in 8-mm thick silastic rubber
- 5 mm from the center of catheter to front, and 3 mm to back (to gain flexibility)
- 2 to 24 catheters
- 22-cm long (can treat up to 20x23 cm^2)
- Prescription point 1 cm away from source plane (0.5 cm from the surface)

Mick Radionuclear Instruments, Mt. Vernon, NY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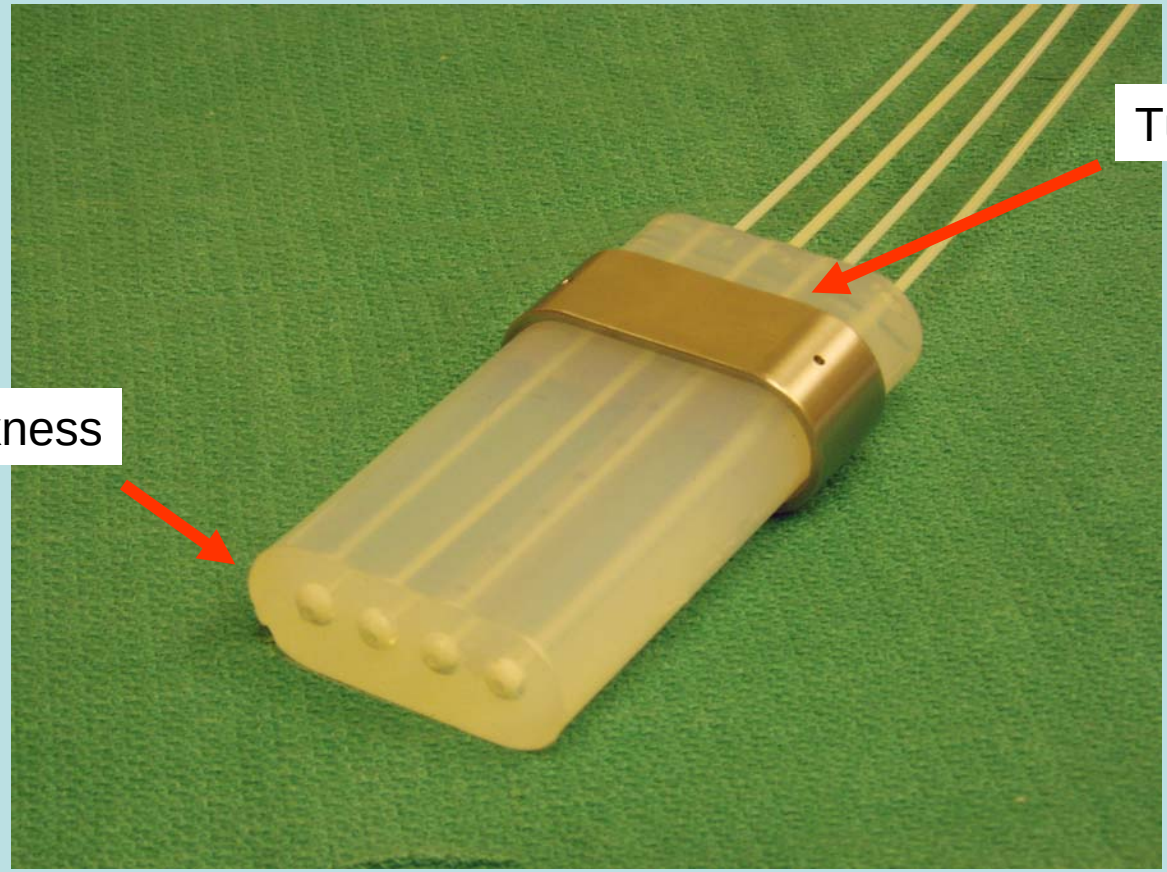
Modified breast HAM
(Mick Radionuclear Instruments)

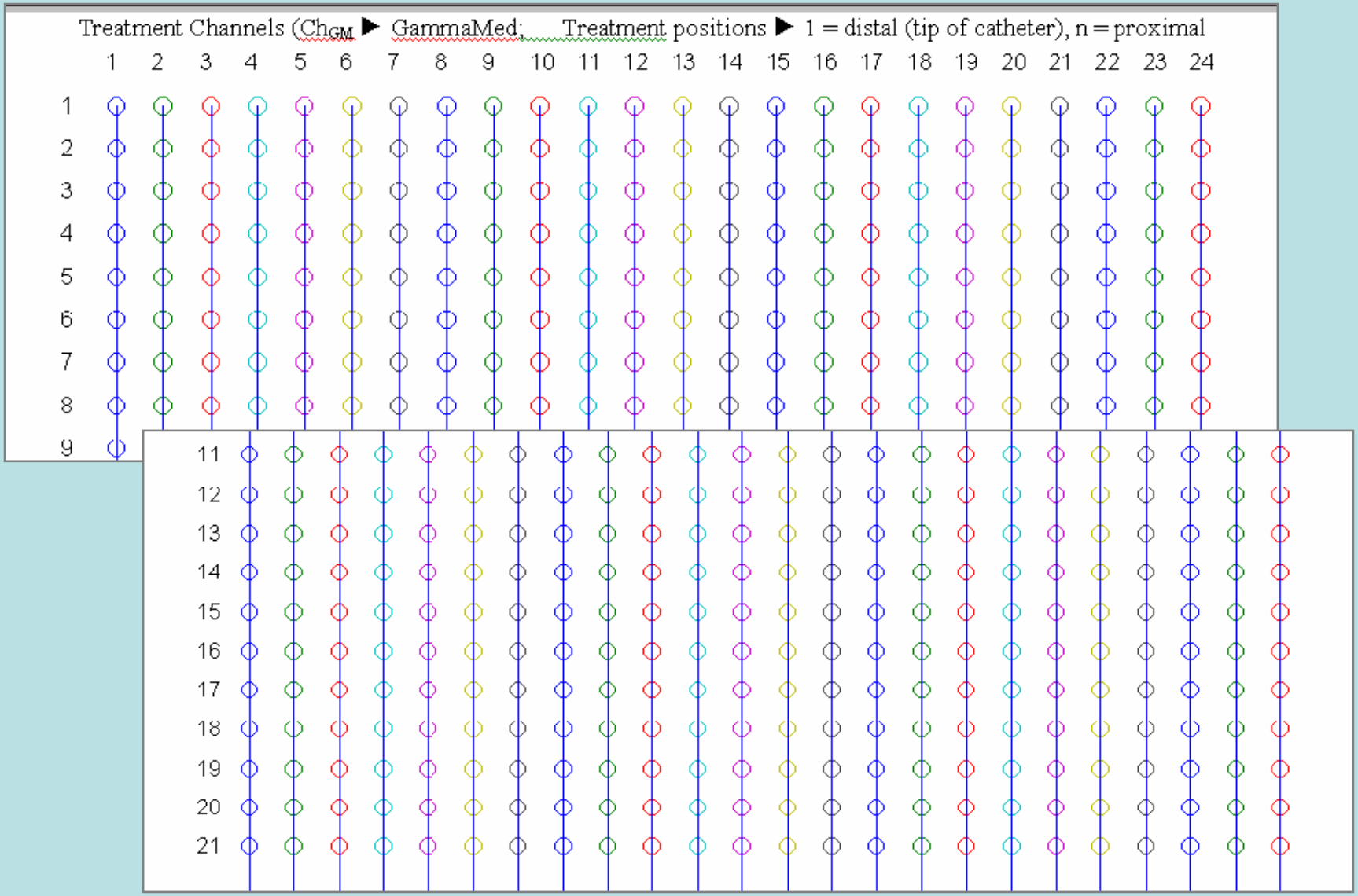


Prescription at 2 cm from the source plane

IORT prescription:

- Physicist takes oral (rather than written prescription)
- Prescription details should be repeated by physicist and confirmed by physician
- Prescription includes: number of channels (width), length (number of stopping positions), dose and prescription point(s).

Treatment planning: Prescription / worksheet



IORT Dose specification

y, homogeneous dose is desired throughout the treatment

ranges between 15 - 20 Gy at 5 mm in tissue

r dose for pediatric cases: 7.5 -12.5 Gy

r dose also used if IORT is combined w/ EBRT: 10 -12.5 Gy

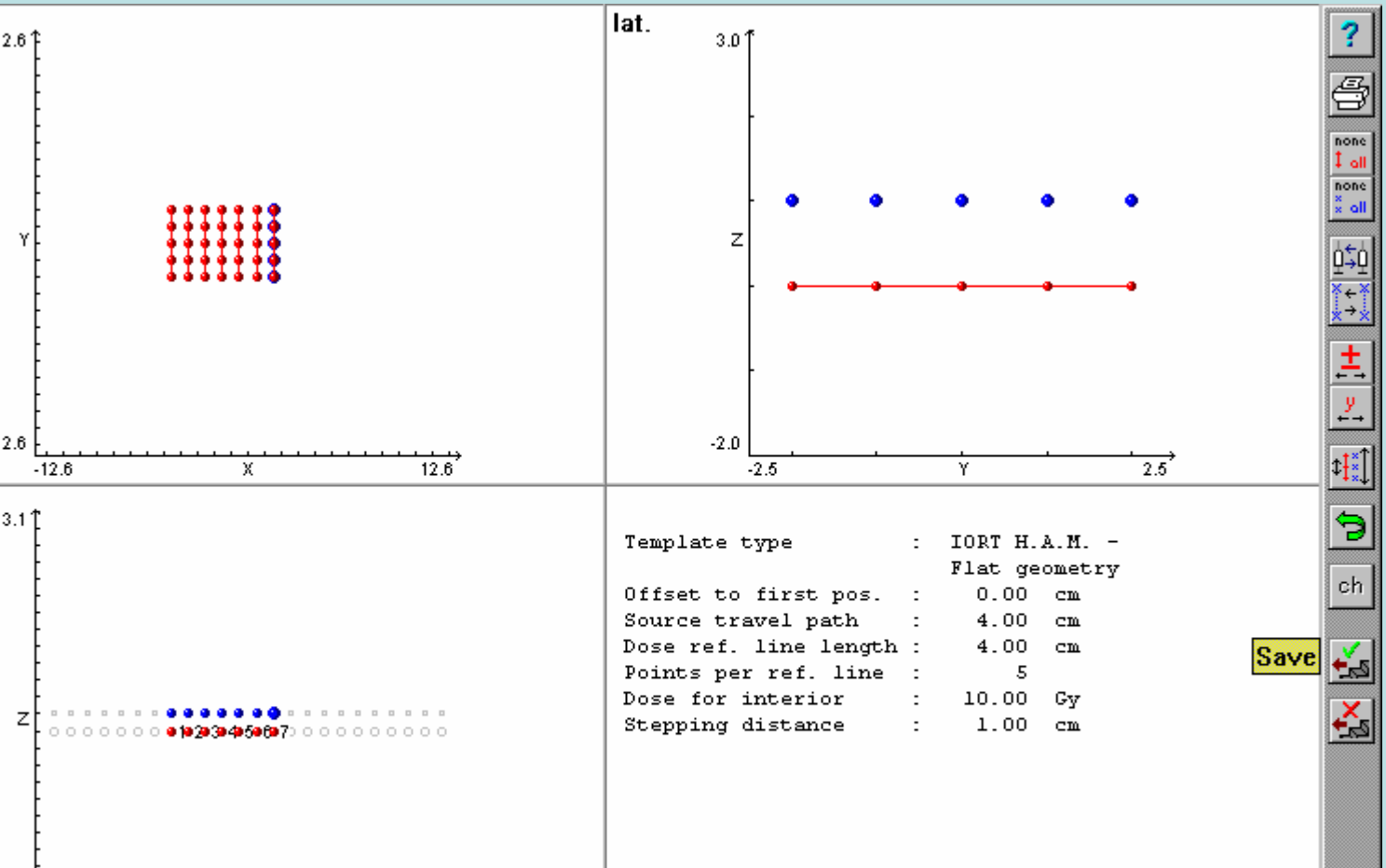
t IORT: 20 Gy at 1 cm in tissue

r dose prescription has been reported in the literature (30 Gy

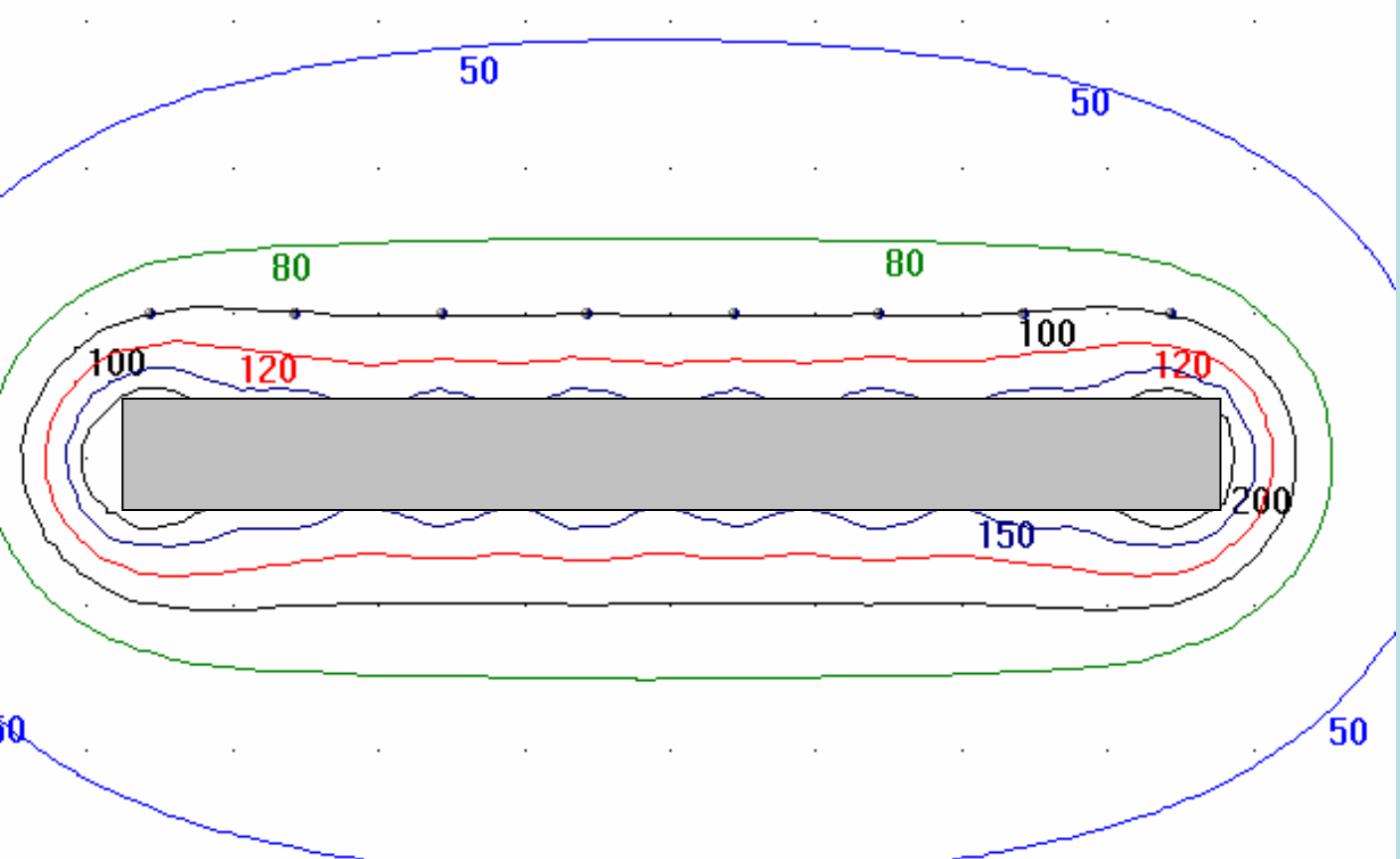
iary / hepatic treatments)

ionally, non-uniform dose and irregular treatment geometry

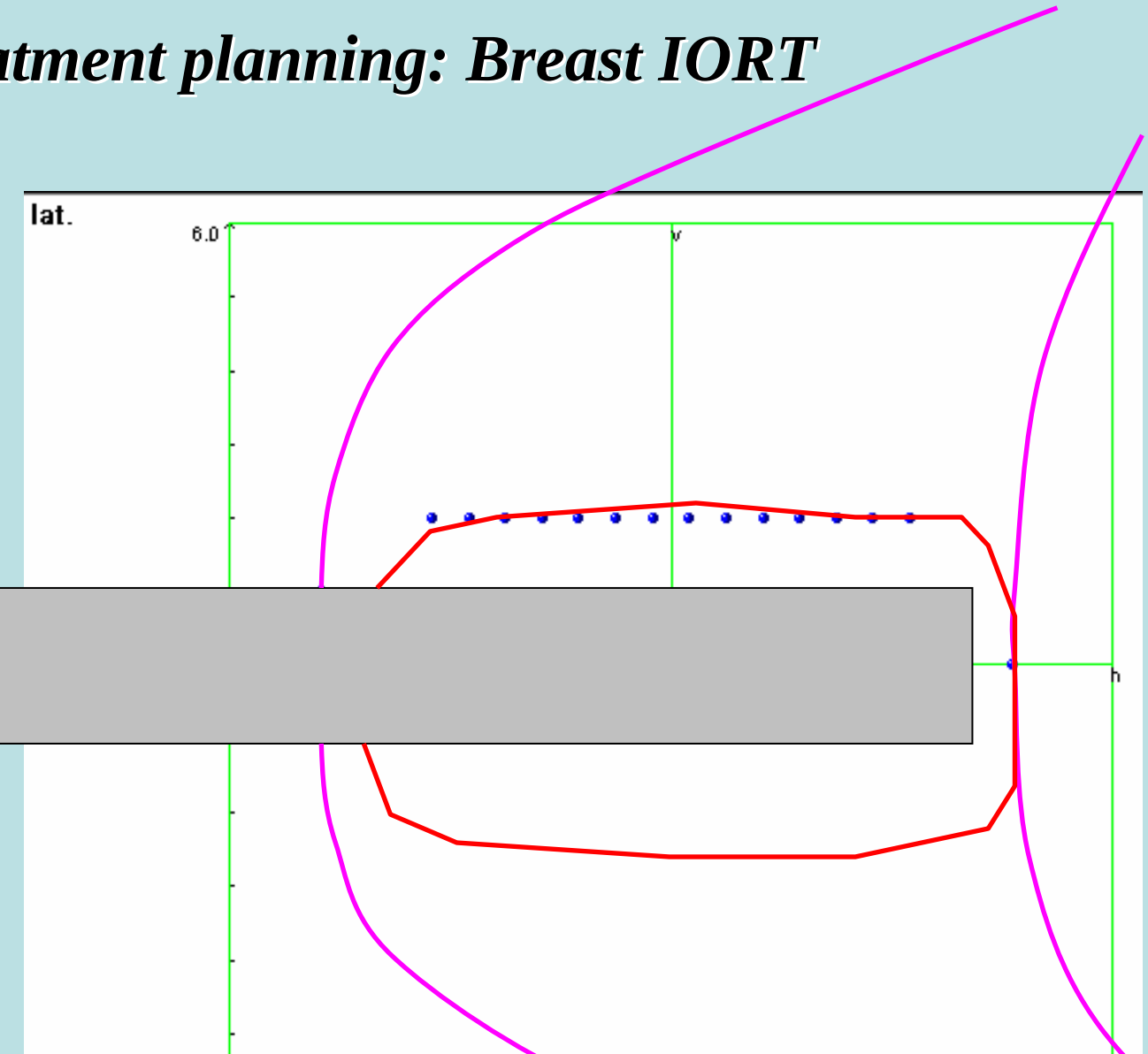
Treatment planning: Standard Geometry



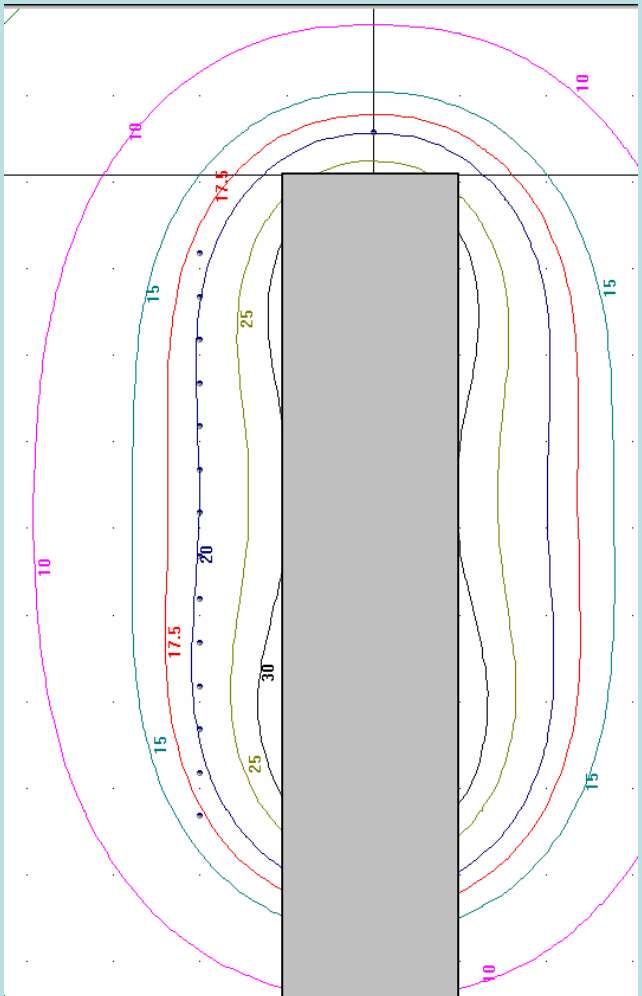
Treatment planning: Standard Plane

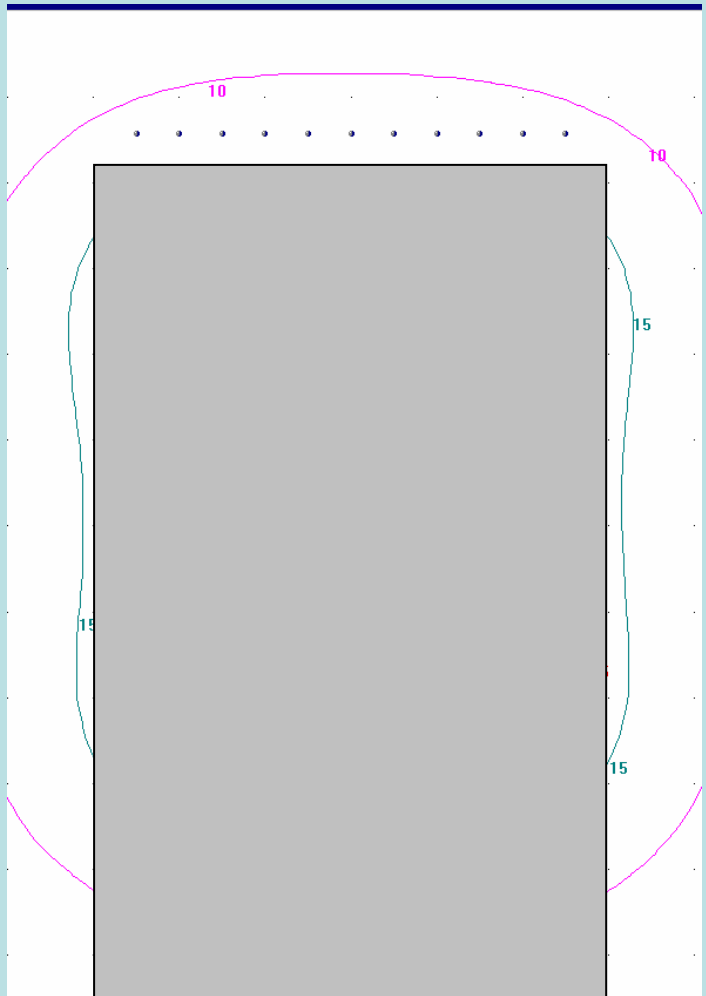


tment planning: Breast IORT



Treatment planning: Breast IORT





QA Considerations

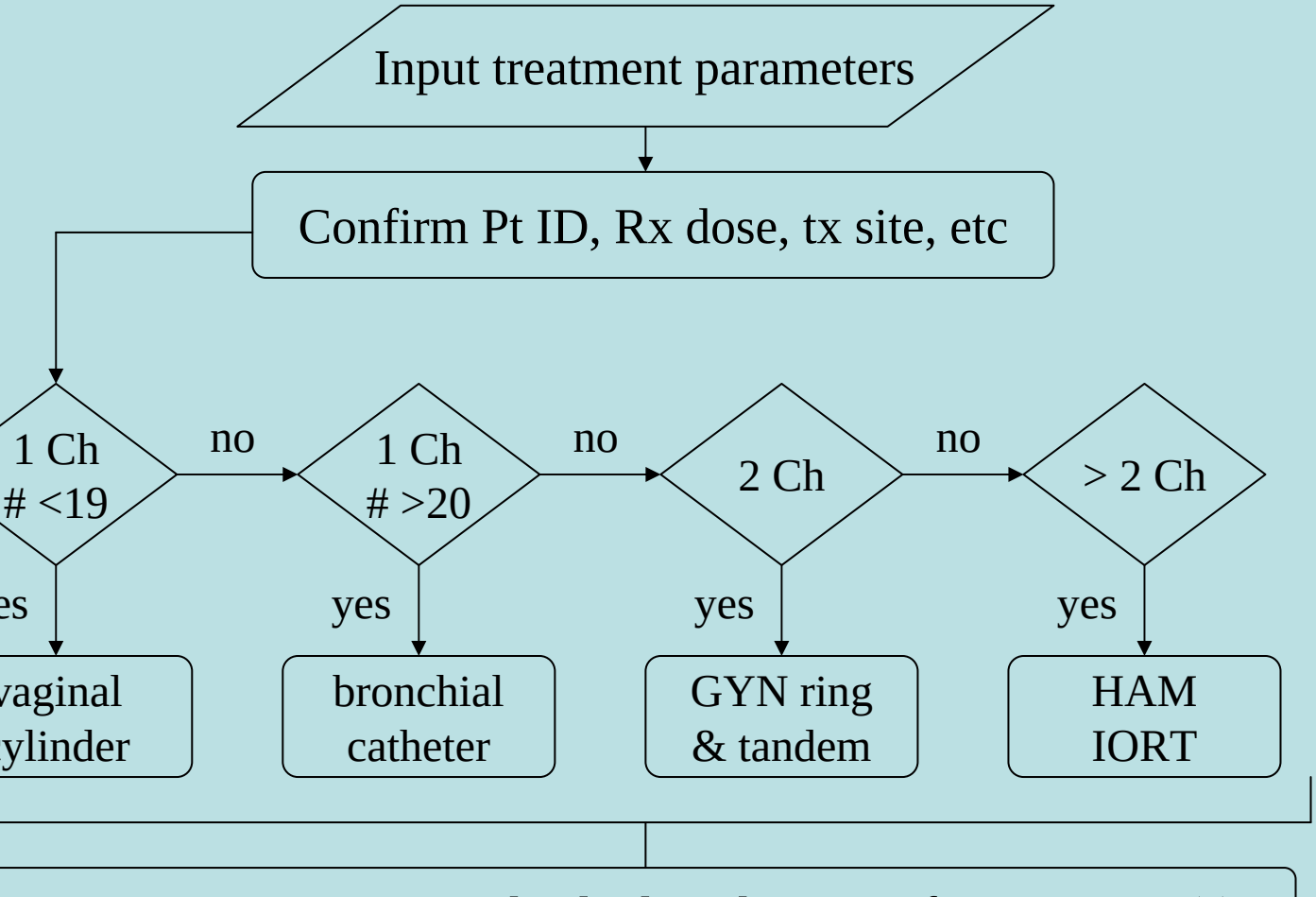
Applicator QA

rior to sterilization: catheter length and
tegrity, labels

fter treatment: applicator integrity

sure that sterilization does not damage
e applicator

QA: Computer Assisted Independent Dose Calculation and Verification



QA: Classical systems (Manchester)

total air kerma strength, S_K, needed to deliver dose D at distance h
time t is given by:

$$S_K = \frac{D(Gy)}{10.} \frac{1}{t_{eff}(h)} M\left[A\left(\frac{0.5}{h}\right)^2, 0.5\right]\left(\frac{h}{0.5}\right)^2 ElongationFact$$

ere:

$$t_{eff} = \frac{T_{1/2}}{\ln(2)}\left[1 - e^{-\frac{\ln(2)}{T_{1/2}}t}\right]$$

d in the case of HDR, the nominal treatment time (s):

$$T = 0.0659 \; M\left[A\left(\frac{0.5}{h}\right)^2, 0.5\right]\left(\frac{h}{0.5}\right)^2 \exp(0.05[E-1]^{3/4})$$

Table 1. Manchester System planar implant tables for source strength given either as (equivalent) mass of radium or as air kerma strength.*

Area (cm^2)	Cumulated source strength to produce 1000 cGy in water		Area (cm^2)	Cumulated source strength to produce 1000 cGy in water	
	Milligram hours	IRAK ($cGy\ cm^2$)		Milligram hours	IRAK ($cGy\ cm^2$)
0	31	227	64	875	6324
2	101	733	68	913	6596
4	147	1065	72	949	6860
6	185	1337	76	988	7139
8	215	1556	80	1026	7411
10	246	1775			
12	273	1972	84	1062	7676
14	301	2176	88	1100	7948
16	329	2380	92	1136	8212
18	358	2584	96	1173	8477
20	385	2780	100	1207	8726
22	411	2969	120	1366	9874
24	436	3150	140	1529	11053
26	462	3339	160	1681	12148
28	487	3521	180	1825	13191
30	512	3702	200	1965	14203
32	536	3876	220	2099	15170
34	561	4057	240	2229	16107
36	583	4216	260	2358	17044
38	607	4389	280	2480	17920
40	630	4556	300	2608	18850
42	652	4714	320	2741	19809
44	673	4865	340	2861	20678
46	695	5024	360	2983	21554
48	716	5175	380	3103	22423
50	737	5326	400	3220	23269

Other precautions:

emote monitoring of patient and
esthesia equipment

R stuff remain scrubbed during treatment
case of emergency

case of emergency the patient can not
ave the OR; instead, a shielded
closure should be provided for the
terloader and source

Personnel requirements

Physician, Therapist, and two Physicists

Be aware of the unpredictable timing of IORT

How much it costs:

Initial investment:

shielding (with assoc. structure)	250K
after-loader	200K
planning software	30-50K
applicators (capital investment)	up to 25K ea

Running costs:

source change + PMI $12K quarterly

HAM applicator ~$100. / ch

n an average of five channels / treatment and one IORT
edure / week, cost /procedure excluding initial investment
ughly $1500.